2021

Lake Pontchartrain & Vicinity GRR
Appendix I - Cost Engineering

(Including Cost & Schedule Risk Analysis Report)

US Army Corps of Engineers®
New Orleans District

U.S. Army Corps of Engineers, New Orleans District

Non-Federal Sponsor: Coastal Protection and Restoration Authority Board of Louisiana

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LAKE PONTCHARTRAIN AND VICINITY GENERAL RE-EVALUATION REPORT
COST ENGINEERING APPENDIX

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TOTAL PROJECT COST AND SCHEDULE

SCHEDULE

1. LAKE PONTCHARTRAIN AND VICINITY COST

1.1. GENERAL

COST ESTIMATE DEVELOPMENT

Alternative cost estimates were developed at a Class 4 Level of effort utilizing Parametric/Historical costs or the latest TRACES MII cost estimating software. The cost estimates used the standard approaches for a feasibility estimate structure regarding labor, equipment, materials, crews, unit prices, quotes, sub- and prime contractor markups. This philosophy was taken wherever practical within the time constraints. It was supplemented with estimating information from other sources where necessary such as quotes, bid data, and historical data. The intent was to provide or convey a "fair and reasonable" estimate that which depicts the local market conditions. The estimates assume a typical application of tiering subcontractors. All of the construction work (e.g., Embankment, Borrow Development, Excavation, Floodwalls, Pilings, Rock, Armoring etc.) is common to the gulf coast region. The construction sites are accessible from land. Access is easily provided from various local highways.

ESTIMATE STRUCTURE

The estimates are structured to reflect the projects performed. The estimates have been subdivided by alternative and USACE feature codes.

BID COMPETITION

It is assumed that there will not be an economically saturated market and that bidding competition will be present.

CONTRACT ACQUISITION STRATEGY

There is no declared contract acquisition plan/types at this time. Although it has not been declared, it is anticipated to be Hubzone or 8a small business.

LABOR SHORTAGES

It is assumed there will be a normal labor market.

LABOR RATES

Local labor market wages are above the local Davis-Bacon Wage Determination and actual rates have been used.

MATERIALS

Cost quotes are used on major construction items when available. Material prices quotes were taken from previous job or historical data. The estimate does anticipate government furnished materials.

QUANTITIES

Quantities for Levees were provided by MVN Civil Branch and quantities for Floodwalls was provided from MVN Structures Branch.

EQUIPMENT

Rates used are based from the latest USACE EP-1110-1-8, Region VI. Adjustments are made for fuel and facility capital cost of money (FCCM Full FCCM/Cost of Money rate is latest available; Mii program takes EP recommended discount, no other adjustments have been made to the FCCM. Equipment was chosen based on historical knowledge of similar projects.

SEVERE RATES

No Severe Rates were used.

FUELS

Fuels (gasoline, on and off-road diesel) were based on local market averages for on-road and off-road for the Gulf Coast area. Used latest fuel price attained.

CREWS

Major crew and productivity rates were developed and studied by senior USACE estimators familiar with the type of work. All of the work is typical to the gulf coast area and New Orleans District cost engineers. The crews and productivities were checked by local MVN estimators, discussions with contractors and comparisons with historical cost data and adjusted as necessary. Major crews include haul, earthwork, piling, armoring, floodwalls and concrete slope pavement.

Most crew work hours are assumed to be 10 hours 6 days/week which is typical to the area.

UNIT PRICES/BID PRICES

The unit prices/bid prices found within the various project estimates will fluctuate within a range between similar construction units such as floodwall concrete, armoring, concrete slope pavement, transitions and piling. Variances are a result of differing haul distances (trucked), small or large business markups, subcontracted items, designs and estimates by others.

RELOCATION COSTS

No Relocations.

MOBILIZATION

Contractor mobilization and demobilization are based on the assumption that most of the contractors will be coming from within the gulf coast/southern region. Mob/demob costs are based on historical studies of detailed Government estimate mob/demob which are in the range of approximately 3-5% of the construction costs. With

undefined acquisition strategies and assumed individual project limits, the estimate utilizes a 5% value for Levees and 3% for Floodwalls at each contract.

FIELD OFFICE OVERHEAD

The estimate used a field office overhead rate based on the average of relevant armoring jobs and MRL. The reason this was done is because similar work is being done in the same areas. The job office overhead should also be similar.

OVERHEAD ASSUMPTIONS

Overhead assumptions may include superintendent, office manager, pickups, periodic travel, costs, communications, temporary offices (contractor and government), office furniture, office supplies, computers and software, as-built drawings and minor designs, tool trailers, staging setup, camp/facility/kitchen maintenance and utilities, utility service, toilets, safety equipment, security and fencing, small hand and power tools, project signs, traffic control, surveys, temp fuel tank station, generators, compressors, lighting, and minor miscellaneous.

HOME OFFICE OVERHEAD

Estimate percentages range based upon consideration of 8(a), small business and unrestricted prime contractors. The rates are based upon estimating and negotiating experience, and consultation with local construction representatives. Different percent are used when considering the contract acquisition strategy regarding small business 8(a), competitive small business and large business, high to low respectively. This project will assume an acquisition strategy of small business and assume a Home Office Overhead of 8%.

TAXES

Local taxes will be applied based on the parishes that contain the work. Reference the tax rate website for Louisiana: http://www.salestaxstates.com. The contracts are in many different parishes. Usually the tax rate ranges from 8 to 10%. For this project it was decided to use 9%.

BOND

Bond is assumed 1.5% applied against the prime contractor, assuming large contracts. No differentiation was made between large and small businesses.

PLANNING, ENGINEERING & DESIGN (PED)

The PED cost includes such costs as project management, engineering, planning, designs, investigations, studies, reviews, value engineering and engineering during construction (EDC). Historically a rate of approximately 12% for E&D plus small percentages for other support features is applied against the estimated construction costs. Other USACE civil works districts such as St. Paul, Memphis, and St. Louis have reported values ranging from 10-15% for E&D. Additional support features might include project management, engineering, planning, designs, investigations, studies, reviews, and value engineering. This project used 14% which was provided by the PM.

SUPERVISION & ADMINISTRATION (S&A)

Historically a range from 5% to 15% depending on project size and type applied against the estimated construction costs. Other USACE civil works districts such as St. Paul, Memphis, and St. Louis report values ranging from 7.5-10%. Consideration includes that a portion of the S&A effort could be performed by contractors. S&A costs are percentage based. This project has an S&A of 9% provided by the PM.

CONTINGENCIES

Contingencies were developed using the USACE Abbreviated Cost Risk Analysis (ARA) program based on cost risks determined by the PDT. The contingency for is 33%. For more information see risk report.

ESCALATION

Escalation used is based upon the latest version of the US Army Corps of Engineers Engineering Manual (EM) 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS).

HTRW

The estimate does not include costs for any potential Hazardous, Toxic, and Radioactive Waste (HTRW) due to lack of any concerns.

SCHEDULE

The project schedule has been developed. The CSRA and TPCS has taken schedule into account. Schedule can be found in appendix.

1.2. SELECTED PLAN COST ESTIMATE

Table 1 show the baseline project cost for the Selected Plan This information is taken from the Total Project Cost Sheet (TPCS).

Table 1: LPV GRR 1% Alternative

Feature	Cost	Contingency	Total
01 Lands & Damages	$6,858	25%	$8,573
06 Fish & Wildlife Facilities	$2,230	33%	$2,966
11 Floodwall and Levee	$454,016	33%	$603,841
11 Floodwall and Levee	$214,345	33%	$285,079
30 PED	$93,883	33%	$124,864
31 Construction Management	$60,353	33%	$80,270
TOTAL	$831,685		$1,105,593

1.3. LEVEL III COST ESTIMATE

A level III cost estimate was completed on the further refined feasibility level of design after all review comments were received and the agency has endorsed the tentatively selected plan. After the higher level estimate was completed, cost was entered into the Cost Schedule Risk Analysis (CSRA). A CSRA is a report that 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.

LPV GRR INTERM

Estimated by	Steven Lowrie
Designed by	Lauren Hatten
Prepared by	Steven Lowrie
Preparation Date	7/6/2021
Effective Date of Pricing	7/6/2021
Estimated Construction Time	Days

Date	Author	Note
10/21/2019	Notes	Assumption and Notes:Properties:1. Latest Labor template was used.2. Latest Equipment template was used. MII Equipment 2016 Region 033. Latest Cost Book was used. 2016 MII English Cost Book4. Fuel Price quote from 2020. 5. CMR: 1.1256. Sales Tax: 9%Markups:1. Ignore Index Dates. Since this project has lots of different year escalation, it was assume escalation will be done by fiscal year. FY xx to FY19.2. Field Office Overhead was calculated by taking the average of armoring jobs and relevant LPV jobs.3. Home Office Overhead was assumed to be 8%.4. Profit was assume to be 10%.5. Bond was assume to be 1.5%.6. Subcontractor was assumed to be 15%.6. Overtime: Assume a 6 day work week with a 10 hour day.Mobilization:1. The mobilization and demobilization cost is assume to be 5% of the cost of prime excluding armoring for levees and 3% for Floodwalls. 2. The mobilization and demobilization will be calculated per lift and per contract. Borrow Pit Development:1. The borrow pit was assume to have a 15' depth2. The pit was assume to have a waste depth of 2'.3. The pit is assume to have Light and Heavy Clearing and Grubbing. Light Clearing and Grubbing quantity is assumed to be 75% of the total pit acres. Heavy Clearing and Grubbing quantity is assumed to be 25% of the total pit acres.4. An access road is assumed to be needed. The length of the road is assumed to be .5 mile long and 20' wide.5. It was assumed that some light clearing will be need in order to construct the access road.6. The quantity unit of measure is bank cubic yards. The quantities were given in In-Place cubic yards. A 1.25 multiplier was added to the in-place quantity.Embankment, Compacted Fill1. The haul distance was assumed to be an average of 15 miles. The unit of measure for the haul item is Loose Cubic Yards. A 1.5 multiplier was added to the in-place quantity.2. A standard protection rate of 125 Cy/hr was used. 3. 2 Truck wash down rack were assumed to be need per lift.4. Standard testing will be done to embankment material.Silt Fence1. Price quote was given by J.C. Cheek Construction Co. within the last year. The price is an install price. Clearing and Grubbing1. The clearing and grubbing was assumed to be light. The production rate that was used is a standard rate.Fertilizing, Seeding, and Mulching1. Fertilizing, Seeding and Mulching: Price quote was given by J.C. Cheek Construction Co. within the last year. The price is an install price.2. Assumed that Lime and Sulfur Soil Amendment are needed. Lime Soil Amendment quantity was calculated multiplying the AC quantity by 1. Sulfur Soil Amendment quantity was calculated multiplying the AC quantity by .5.Armoring1. Armoring which includes concrete slope pavement, HPTRM and Articulate Concrete Blocks (ACB) will need to be removed and replaced each time a lift is placed.2. Cost Engineering has the abstract or bid schedule for all armoring jobs that will be used in this project. 3. Removal and Disposal of HPTRM price was taken from LPV ARM 02 and escalated to FY 19. Markup and contractor designation already included; therefore, it was not included in the estimate.4. Removal of concrete slope pavement quantity was not quantified. A quantity was calculated through looking at the old drawings of the designated project. The replacement of concrete slope pavement will be taken from another project with markup and contract designation.5. Removal of ACBs or concrete pavements could not be found in the armoring abstract; therefore, a cost to remove was calculated.6. Install Armoring: The cost was taken from the abstracts for the designated armoring project and escalated as needed. Some items needed to be deleted in order to not cost out items twice. Fertilizing, Seeding and Mulching and Surface prep were deleted. The reason these items were deleted is because the quantity given by civil already included these quantities. In MII estimate, 1 Armoring contract would cover 2 or more jobs. The 2 or more jobs were combined into 1 contract, therefore, 1 armoring folder was used for that contract. See quantities and MII estimate. Foreshore Protection1. Cost was taken from LPV 20.2 and escalated. The markup and contracting designation is included.Transitions 1. The transition quantity was give per EA. A transition cost was taken from abstract LPV ARM 06, escalated and used for all transitions. The markup and contracting designation is included.Floodwall 1. Quantities were given by structures per LF.

Labor ID: NOLA2021 EQ ID: EP18R03 Currency in US dollars TRACES MII Version 4.4

Description	Quantity	UOM	ContractCost	Contingency	Escalation	ProjectCost
bid schedule summary			**649,205,395.85**	**0.00**	**19,156,037.30**	**668,361,433.16**
			649,205,395.85			*668,361,433.16*
11 Levees and Floodwalls	**1.0000**	**JOB**	**649,205,395.85**	**0.00**	**19,156,037.30**	**668,361,433.16**
			434,860,053.26			*454,016,090.56*
1101 Levees	**1.0000**	**JOB**	**434,860,053.26**	**0.00**	**19,156,037.30**	**454,016,090.56**
			29,984,842.63			*31,969,960.95*
LPV-00.2	**1.0000**	**JOB**	**29,984,842.63**	**0.00**	**1,985,118.31**	**31,969,960.95**
			53,835,434.36			*57,802,334.65*
LPV-01.1 & 02.2	**1.0000**	**JOB**	**53,835,434.36**	**0.00**	**3,966,900.29**	**57,802,334.65**
			6,802,233.14			*7,397,686.11*
LPV-03d.2	**1.0000**	**JOB**	**6,802,233.14**	**0.00**	**595,452.97**	**7,397,686.11**
			37,027,895.84			*38,734,648.04*
LPV-04.2	**1.0000**	**JOB**	**37,027,895.84**	**0.00**	**1,706,752.21**	**38,734,648.04**
			56,033,907.15			*59,647,394.20*
LPV-05.2	**1.0000**	**JOB**	**56,033,907.15**	**0.00**	**3,613,487.05**	**59,647,394.20**
			51,213,911.85			*54,771,977.13*
LPV-19.2 & 20.1	**1.0000**	**JOB**	**51,213,911.85**	**0.00**	**3,558,065.28**	**54,771,977.13**
			36,255,118.56			*38,765,643.46*
LPV-108	**1.0000**	**JOB**	**36,255,118.56**	**0.00**	**2,510,524.89**	**38,765,643.46**
			15,995,098.85			*16,607,800.01*
LPV-109.02a	**1.0000**	**JOB**	**15,995,098.85**	**0.00**	**612,701.16**	**16,607,800.01**
			20,062,187.37			*20,669,222.52*
LPV-111.01	**1.0000**	**JOB**	**20,062,187.37**	**0.00**	**607,035.14**	**20,669,222.52**
			127,649,423.51			*127,649,423.51*
LPV-MRL-1	**1.0000**	**JOB**	**127,649,423.51**	**0.00**	**0.00**	**127,649,423.51**
			214,345,342.59			*214,345,342.59*
1102 Floodwalls	**1.0000**	**JOB**	**214,345,342.59**	**0.00**	**0.00**	**214,345,342.59**
			12,548.66			*12,548.66*
SC01-A1	**702.0000**	**LF**	**8,809,159.25**	**0.00**	**0.00**	**8,809,159.25**
			12,553.34			*12,553.34*
SC04	**378.0000**	**LF**	**4,745,161.21**	**0.00**	**0.00**	**4,745,161.21**
			12,553.69			*12,553.69*
SC04	**394.0000**	**LF**	**4,946,154.28**	**0.00**	**0.00**	**4,946,154.28**
			12,665.28			*12,665.28*
SC04-G	**101.0000**	**LF**	**1,279,193.59**	**0.00**	**0.00**	**1,279,193.59**

Currency in US dollars

Description	Quantity	UOM	ContractCost	Contingency	Escalation	ProjectCost
			12,572.60			*12,572.60*
SC05-FW	**153.0000**	**LF**	**1,923,608.06**	**0.00**	**0.00**	**1,923,608.06**
			12,565.75			*12,565.75*
SC05-FW	**180.0000**	**LF**	**2,261,835.31**	**0.00**	**0.00**	**2,261,835.31**
			12,623.65			*12,623.65*
SC05-G	**42.0000**	**LF**	**530,193.33**	**0.00**	**0.00**	**530,193.33**
			12,552.16			*12,552.16*
SC06	**404.0000**	**LF**	**5,071,071.20**	**0.00**	**0.00**	**5,071,071.20**
			12,567.22			*12,567.22*
SC12-FW1	**122.0000**	**LF**	**1,533,201.19**	**0.00**	**0.00**	**1,533,201.19**
			12,545.55			*12,545.55*
90E-LF	**2,465.0000**	**LF**	**30,924,776.03**	**0.00**	**0.00**	**30,924,776.03**
			13,131.12			*13,131.12*
LPV-MRL-1	**11,600.0000**	**LF**	**152,320,989.13**	**0.00**	**0.00**	**152,320,989.13**

Currency in US dollars

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: **LPV GRR INTERM**
PROJECT NO: 452002
LOCATION: Lake Pontchartrain Vicinity

DISTRICT: **MVN District**
POC: **CHIEF, COST ENGINEERING, xxx**

PREPARED: **7/6/2021**

This Estimate reflects the scope and schedule in report; 2021 General Re-Evaluation Report

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2021									
						Effective Price Level Date: 1 OCT 20									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: **1-Oct-20** ($K)	**TOTAL FIRST COST** ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*K*	*L*	*M*	*N*	*O*
06	FISH & WILDLIFE FACILITIES	$2,230	$736	33.0%	$2,966	0.0%	$2,230	$736	$2,966	$0	$2,966	6.0%	$2,362	$780	$3,142
11	LEVEES & FLOODWALLS	$203,271	$67,080	33.0%	$270,351	0.0%	$203,271	$67,080	$270,351	$0	$270,351	133.4%	$474,367	$156,541	$630,908
11	LEVEES & FLOODWALLS	$128,157	$42,292	33.0%	$170,449	0.0%	$128,157	$42,292	$170,449	$0	$170,449	109.1%	$267,994	$88,438	$356,432
11	LEVEES & FLOODWALLS	$122,587	$40,454	33.0%	$163,041	0.0%	$122,587	$40,454	$163,041	$0	$163,041	208.6%	$378,350	$124,856	$503,206
11	LEVEES & FLOODWALLS	$214,345	$70,734	33.0%	$285,079	0.0%	$214,345	$70,734	$285,079	$0	$285,079	68.2%	$360,579	$118,991	$479,570
08	ROADS, RAILROADS & BRIDGES	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
09	CHANNELS & CANALS	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
10	BREAKWATER & SEAWALLS	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$670,591	$221,295		$891,886	0.0%	$670,591	$221,295	$891,886	$0	$891,886	121.2%	$1,483,652	$489,605	$1,973,258
01	LANDS AND DAMAGES	$6,858	$1,715	25.0%	$8,573	0.0%	$6,858	$1,715	$8,573	$0	$8,573	100.2%	$13,729	$3,432	$17,162
30	PLANNING, ENGINEERING & DESIGN	$93,883	$30,981	33.0%	$124,864	0.0%	$93,883	$30,981	$124,864	$0	$124,864	183.0%	$265,725	$87,689	$353,414
31	CONSTRUCTION MANAGEMENT	$60,353	$19,917	33.0%	$80,270	0.0%	$60,353	$19,917	$80,270	$0	$80,270	193.6%	$177,216	$58,481	$235,698
	PROJECT COST TOTALS:	$831,685	$273,908	32.9%	$1,105,593		$831,685	$273,908	**$1,105,593**	$0	**$1,105,593**	133.3%	$1,940,323	$639,208	$2,579,531

ESTIMATED TOTAL PROJECT COST: **$2,579,531**

_____ **CHIEF, COST ENGINEERING, xxx**

_____ **PROJECT MANAGER, xxx**

_____ **CHIEF, REAL ESTATE, xxx**

_____ **CHIEF, PLANNING, xxx**

_____ **CHIEF, ENGINEERING, xxx**

_____ **CHIEF, OPERATIONS, xxx**

_____ **CHIEF, CONSTRUCTION, xxx**

_____ **CHIEF, CONTRACTING,xxx**

_____ **CHIEF, PM-PB, xxxx**

_____

_____ **CHIEF, DPM, xxx**

100 YEAR LEVEL OF RISK REDUCTION

LPV GRR SCHEDULE	Line Item Cost from Cost Input Sheet	Total with Cont. & Esc.	Total (Check)	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070
LEEVES AND ARMORING																																																				
LPV-03d.2																																																				
LPV-04.2																																																				
LPV-05.2																																																				
LPV-00.2																																																				
LPV-01.2 & 02.2																																																				
LPV-19.2 & 20.1																																																				
LPV-MRL-1																																																				
LPV-108																																																				
LPV-109.02a																																																				
LPV111.01																																																				
Floodwall																																																				
SC01-A1																																																				
90E-LF																																																				
SC04-G																																																				
SC05-FW																																																				
SC05-FW																																																				
SC04																																																				
SC04																																																				
SC05-G																																																				
SC12-FW1																																																				
SC06																																																				
LPV103																																																				
LPV MRL - 1																																																				

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Feasibility Level
Cost and Schedule Risk Analysis Report

Prepared for:

U.S. Army Corps of Engineers
Mississippi Valley Division
New Orleans District

Prepared by:

New Orleans District

Date: 17-February-2021

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APPENDIX A Detailed Risk Register A-1

EXECUTIVE SUMMARY

This General Re-Evaluation Report (GRR) with integrated Environmental Impact Statement presents the results of a U.S. Army Corps of Engineers (USACE) coastal storm risk management study for the Lake Pontchartrain and Vicinity (LPV) project located in New Orleans, Louisiana. This study is authorized by Section 3017 of the Water Resources Reform and Development Act of 2014. USACE is undertaking the study in partnership with the Coastal Protection and Restoration Authority Board of Louisiana, the study's non-federal sponsor. This report provides documentation of the plan formulation process to identify a recommended coastal storm risk management plan, along with environmental, engineering, and cost details of the Recommended Plan.

The existing LPV project includes features in four parishes (St. Charles, Jefferson, Orleans, and St. Bernard) located in the greater New Orleans area on the east bank of the Mississippi River. This is a high-density residential and commercial area. Currently, the LPV project includes a total of approximately 126.5 miles of levees and 56 miles of floodwalls, floodgates, water control structures, and other risk reduction features. This includes primary perimeter storm surge risk reduction features, and detention basin features along the IHNC and GIWW, and the three outfall canals. The existing project reduces the risk of flooding associated with a coastal storm surge and wave event with a 1% chance of being exceeded in any given year.

Southeast Louisiana, including the greater New Orleans area, is generally characterized by weak soils, general subsidence, and the global incidence of sea level rise that will cause levees to require future lifts (raises) to sustain the current performance of the project. This GRR reevaluates the performance of the LPV system given the combined effects of consolidation, settlement, subsidence, and sea level rise over time and the availability of new elevation data (vertical datums), and determines if additional actions are recommended to address the economic and life safety risks associated with overtopping of the levee system due to hurricanes and tropical storms.

The study utilized a 50-year period of analysis and estimated future conditions at the end of that period if no action is taken to address the identified problems. These projections include over $246 million in expected annual economic damages. The future estimated average annual incremental life loss related to overtopping of the system is 3E-02 (0.032) lives per year. Additionally, for the climate change analysis, the study considered potential relative sea level change impacts on system performance and adaptability during a 100-year performance horizon.

USACE identified several structural and non-structural measures to reduce coastal storm risk in the study area. An initial array of five action alternatives was formulated, evaluated, and compared primarily (but not exclusively) based on cost, economic damage reduction, life safety risk reduction related to overtopping of the system, and environmental and cultural resources impacts.

The National Economic Development (NED) Plan is the alternative that reasonably maximizes net economic benefits while remaining consistent with the federal objective of protecting the environment. Alternative 2 was identified as the NED Plan and the Recommended Plan.

The Recommended Plan includes system-wide levee lifts and raising floodwalls to address the projected 1% annual exceedance probability (AEP) flooding event through the year 2078. The

general features included in the Recommended Plan can be seen in Figure ES-1. The plan consists of 50 miles of levee lifts to be constructed before the combined effects of consolidation, settlement, subsidence, and sea level rise reduce the levee elevations in each levee reach below the required design elevation. Additionally, the Recommended Plan includes 1 mile of floodwall replacements and 2.2 miles of new floodwall to be constructed prior to the combined effects causing the design requirements to be exceeded for each structure. Existing foreshore protection along Lake Pontchartrain will be restored following levee or floodwall modifications. Mitigation is anticipated to be required to address potential impacts to habitat along the Mississippi River. The Recommended Plan has a total project first cost of approximately $1.1 billion and a Benefit-to-Cost Ratio (BCR) of 7.3. It reduces the estimated annual economic damages to approximately $53 million and reduces life loss related to overtopping risk.

The Recommended Plan has many other benefits (both positive and negative) in addition to NED benefits. Regional Economic Development (RED) benefits support a total of 292 average annual, full-time equivalent jobs, $1.1 billion in labor income, $1.3 billion in gross regional product, and $2.1 billion in economic output in the local impact area. Other Social Effects (OSE) benefits include a reduction of life safety risk associated with overtopping of the levee system to tolerable levels, a reduction in the risk of overtopping that could result in contamination of farmland and drinking water and could negatively impact community cohesion, and reduced overtopping flood risk to three National Register Historic Districts and an archaeological site. The plan has negative Environmental Quality (EQ) effects including impacts to bottomland hardwoods along the Mississippi River and lake bottom habitat in Lake Pontchartrain, as well as soil and wildlife impacts in borrow sites.

Implementation of the Recommended Plan would result in potential impacts to Bottomland Hardwood-Wet (BLH-Wet) habitat. These impacts would be avoided to the maximum extent practicable but would be unavoidable in some locations due to existing infrastructure on the protected side of the levees. The proposed mitigation plan assumes these 12.1 Average Annual Habitat Units (AAHUs) of BLH-Wet impacted (approximately 20 acres) by the Recommended Plan would be offset through the purchases of equivalent mitigation bank credits.

The public had the opportunity to review and comment on the draft report during the 55-day public review period which began in December 2019. Public meetings were held in January 2020 to present the tentatively selected plan and allow the public to respond and ask questions prior to finalizing the recommendation. Comments received and responses can be found in Appendix L. Numerous environmental commitments are listed within the EIS to ensure environmental compliance, including development of a Programmatic Agreement with State Historic Preservation Officers, Tribes, and the Advisory Council on Historic Preservation. Additional NEPA documentation and associated public review would be conducted, as necessary, to address any changes not evaluated within the scope of the impact assessment.

The CSRA process for this project includes an analysis on the Structures, Levees and all other tasks. The results of the analyses are determined by qualifying and quantifying all potential cost risks and running a Monte Carlo simulation to produce the frequency spectrum and probability range for the applied risk costs. The cost contingency is obtained from the 80-percent contingency as determined by this analysis.

Initial Risk Register considered over 51 risk items. A total of 16 potential risk items for the Structures and Levees / All Other tasks were developed by the CSRA team and applied to a risk registry for analysis. Assumptions were made for each risk

item before running the Monte Carlo simulation. The result of the simulation gave a 33% percent (rounded) contingency respectively at the 80-percent confidence level.

The contingency cost for this project was utilized for a Micro Computer Aided Cost Estimating System (MCACES) estimation of the costs associated with the 100 Year Protection Plan (1% Annual Chance Surge Risk Reduction Plan). The potential cost risks developed during this analysis also serve as an indicator of how to avoid unforeseen escalation of project costs throughout project implementation and therefore, may be used as a valuable tool in all future aspect of the project study, design, and construction planning and estimation.

The major contributors to the resulting total project cost contingency for the Structural and Levee/All other remaining Features were:

- (CA-1) Acquisition Strategy – defined as small business 8a
- (TR-2) Confidence in the scope and design and critical quantities– 50-year market condition could change – other walls may need to be demolished and constructed.
- (EX-2) Market Condition – 50-year market condition could change
- (EX-4) Fuel prices– Used historical fuel prices and used average of several months of highest prices.

The major contributor to the resulting total project contingency for the Schedule feature was:

- (EX-1) High River MRL Levees – risk of additional impacts which will cause delays.

The corresponding Total Cost including contingency (cost & schedule) for the Structural and Levee/All other Features is presented on table 1.

Table 1. Structures and Levee/All other Features Contingency Analysis Table

INITIAL CONSTRUCTION

Contingency Analysis

Base Case Estimate (Excluding 01)	$670,591,133	
Confidence Level	**Contingency Value**	**Contingency**
0%	**53,647,291**	**8%**
10%	**134,118,227**	**20%**
20%	**147,530,049**	**22%**
30%	**160,941,872**	**24%**
40%	**174,353,695**	**26%**
50%	**181,059,606**	**27%**
60%	**194,471,429**	**29%**
70%	**207,883,251**	**31%**
80%	**221,295,074**	**33%**
90%	**241,412,808**	**36%**
100%	**335,295,567**	**50%**

The rounded contingency percentage for **Structural Features** and for the **Levees/All Other Features (33.0%)** were transferred to the TPCS for final calculation of total contingency and cost. Lands and Damages cost and contingency are not included in the above. (NOTE: The rounding of the contingencies causes the totals on the TPCS to be slightly higher than and not add up to exactly the costs above.)

1. PURPOSE

The general purpose of this study with integrated Environmental Impact Statement (EIS) is to analyze alternatives to reduce hurricane and storm risk within the LPV study area. The study will evaluate and compare the benefits, costs, and impacts (positive or negative) of alternatives including the No Action Alternative. The study will identify whether an economically justified plan exists to reduce economic damages and life risk due to the combined effects of subsidence, consolidation, settlement, sea level rise, and datum changes on the LPV system. This report also satisfies the requirement of the National Environmental Policy Act (NEPA) to evaluate the proposed federal action.

Risks to human life are a fundamental component of all facets of flood and coastal storm risk management and must receive explicit consideration throughout the study process. As described in Section 3.4 of the main report, a risk assessment was performed to identify the magnitude of the risk associated with levee system overtopping. This assessment, including an evaluation of tolerable risk guidelines informed the formulation and evaluation of alternatives for the study.

2. BACKGROUND

The LPV project includes features in four parishes (St. Charles, Jefferson, Orleans, and St. Bernard) located in the greater New Orleans area on the east bank of the Mississippi River. Currently, LPV contains approximately 126.5 miles of levees and 56 miles of floodwalls, floodgates, water control structures, and other risk reduction features. This includes primary perimeter storm surge risk reduction features along the IHNC and GIWW, and the three outfall canals. The project is in a high-density residential and commercial area.

The Mississippi River and Tributaries' levee (MR&T levees or MRL) along with the Lower Bonnet Carré Guide Levee provides risk reduction from riverine flow flood risks. The LPV project connects to the MRL at both the west and east of the system.

The levees and floodwalls along the Inner Harbor Navigation Canal (IHNC) and Orleans Parish outfall canals were removed from frontline or perimeter risk reduction features and became interior risk reduction features by construction of the Seabrook Gate Closure and the IHNC - Lake Borgne Surge Barrier and Permanent Canal Closures and Pumps. Although these interior levees and floodwalls are not part of the hurricane perimeter defenses, they are an integral part of the LPV hurricane and storm damage reduction system required for reducing the risk of flooding caused by precipitation during a hurricane or tropical storm and over topping of the Lake Borgne Closure Surge Barrier.

Typical operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) activities include mowing levees and ensuring sufficient turf growth, maintaining High Performance Turf Reinforcement Mats (armoring), maintaining and repairing spalls in floodwalls and concrete levee transition armoring, maintaining and operating floodgates, and operating and maintaining the complex structures such as IHNC surge barrier, Seabrook Complex, and Permanent Canal Closures and Pumps.

3. REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all project features.

3.1. Project Scope

Engineering Circular Bulletin (ECB) 2007-17, Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs (Sept. 10, 2007) requires that a formal risk analysis be prepared for all decision documents requiring Congressional authorization whose total costs are in excess of forty million dollars. In addition, to broadly defined risk analysis standards and recommended practices, a risk analysis is to be performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering Directory of Expertise for Civil Works (Cost Engineering Dx), dated May 17, 2009.
- Engineer Regulation (ER) 1110-2-1302 Civil Works Cost Engineering, dated Sept. 15, 2008.
- Engineer Technical Letter (ETL) 1110-2-573 Construction Cost Estimating Guide for Civil Works, dated Sept. 30, 2008.

Specific study objectives were developed to identify measures and alternatives which can address the study area's problems while taking advantage of the identified opportunities and avoiding the constraints. The following study objectives were developed based on the study area problems, opportunities, and goals, as well as the federal objective and regulations. Per the study's authorizing language, the following objectives will include, at a minimum, consideration of an alternative to restore the authorized level of risk reduction (the 1% AEP flood event).

Objectives:

1. Reduce the risk of life loss due to hurricane and storm damage in LPV over the 50-year period of analysis associated with consolidation, settlement, subsidence, sea level rise, and new datum. This includes identifying at least one alternative which reduces life safety risk associated with system overtopping below tolerable levels (see Section 3.4.1). This will be primarily measured by life safety risk reduction estimates.

2. Reduce economic damages due to hurricane and storm damage in LPV over the 50-year period of analysis associated with consolidation, settlement, subsidence, sea level rise, and new datum. This will be primarily measured by economic benefits estimates.

The report includes the project technical scope, estimates, and schedules as developed and presented by USACE New Orleans District. Consequently, these documents serve as the basis for the risk analysis. In general terms, the construction scope consists of the following:

Lands and Damages
Fish and Wildlife Facilities
Levees and Floodwalls
Planning, Engineering and Design
Construction Management

3.2. 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 reflected within the risk analysis report 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 iteratively 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 requirements and 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.
Memorandum from Major General Don T. Riley (U.S. Army Director of Civil Works), dated July 3, 2007.
Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10,

2007.

4. METHODOLOGY/PROCESS

The Project Delivery Team is composed of various USACE New Orleans District branches including Project Management, Real Estate, Planning, Contracting, Structures and Levee Design, Hydrologic and Geotechnical and Cost Engineering Offices.

This CSRA outcome is pending approval by Agency Technical Review (ATR).

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence. A parallel process is also used to determine the probability of various project schedule duration outcomes and quantify the required schedule contingency (float) needed in the schedule to achieve any desired level of schedule confidence.

In simple terms, contingency is an amount added to an estimate (cost or schedule) to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering DX guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk adverse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. Because Crystal Ball is an Excel add-in, the schedules for each option are recreated in an Excel format from their native format. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results would be provided in section 6.

4.1. Identify and Assess Risk Factors

Identifying the risk factors via the PDT are considered a qualitative process that results in establishing a risk register that serves as the document for the further study using the Crystal Ball risk software. 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.

A formal PDT meeting was held in USACE New Orleans HQ for the purposes of identifying and assessing risk factors. The meeting held on 10/28/2020 - 11/4/2020 included representatives from multiple project team disciplines and functions including:

Project/program managers.
Economist.
Contracting/acquisition.
Real Estate.
Environmental.
Civil, structural, geotechnical, and hydraulic design.
Cost and schedule engineers.
Construction.

This meeting focused primarily on risk factor identification using brainstorming techniques, but also facilitated discussions based on risk factors common to projects of similar scope and geographic location. Individual meetings were realized with each disciplines branch primarily for risk factor assessment and quantification.

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 involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering, designers, and risk analysis team members with lesser inputs from other functions and disciplines.

The probabilistic distribution functions are used to describe the characteristic population (tendencies) of the risk factor inputs. The following elements of each risk factor were addressed in the risk factor quantification process:

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.
Mathematical correlations between risk factors.
Affected cost estimate and schedule elements.

In this example, the risk discussions focused on the various project features as presented within the USACE Civil Works Work Breakdown Structure for cost accounting purposes. It was recognized that the various features carry differing degrees of risk as related to cost, schedule, design complexity, and design progress. The example features under study are presented in table 2:

Table 2. Work Breakdown Structure by Feature

01	LANDS AND DAMAGES
11	LEVEES & FLOODWALLS
30	PLANNING, ENGINEERING & DESIGN
31	CONSTRUCTION MANAGEMENT

The resulting product from the PDT discussions is captured within a risk register as presented in section 6 for both cost and schedule risk concerns. Note that 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.

4.3. 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 only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the base cost estimate. 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.

For schedule contingency analysis, the option schedule contingency is calculated as the difference between the P80 option duration forecast and the base schedule duration. These contingencies are then used to calculate the time value of money impact of project delays that are included in the presentation of total cost contingency in section 6. The resulting time value of money, or added risk escalation, is then added into the contingency amount to reflect the USACE standard for presenting the "total project cost" for the fully funded project amount.

Schedule contingency is analyzed only on the basis of each option and not allocated to specific tasks. Based on Cost Engineering DX guidance, only critical path and near

critical path tasks are considered to be uncertain for the purposes of contingency analysis.

5. KEY ASSUMPTIONS

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

The following are examples of key assumptions for the risk analysis that could be identified by the PDT and risk analyst.

Level of Design: The cost comparisons and risk analyses performed and reflected within this report are based upon design scope and estimates that are considered to be well developed and designed.
Design Scope: The prescribed scope satisfies the requirements of this acquisition given that it is an economic update.
Operation and Maintenance: Operation and maintenance activities were not included in the cost estimate or schedules
Contract Acquisition Strategy: Consistent with cost estimate and schedule assumptions, it is assumed that the contract acquisition strategy is predominately firm fixed price.
Confidence Levels: The Walla Walla Cost Engineering Dx guidance generally focuses on the eighty-percent level of confidence (80%) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (80%) was used. It should be noted that the use of 80% as a decision criteria is a moderate risk aversion approach, generally resulting in higher cost contingencies. However, the 80% level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to completely capture actual project costs.
Only moderate and high risk levels were applied for the purposes of the CSRA analysis.

The following list identifies the key risk analysis assumptions and limitations within the context of the WBV GRR PAC CSRA. For each item, the context is first provided and then followed by the key assumption or limitation.

- *Unknown Decisions or Decision Makers:* The CSRA was prepared using a framework to generate contingency information that is appropriate for use by State of Louisiana and USACE decision makers for scheduling, budgeting, and project control purposes. The framework may generate results that are appropriate for use by a wide variety of decision makers or stakeholders; however, the assumed use of CSRA results is limited to scheduling, budgeting, and project control. Other uses by unknown decision makers may not be appropriate.

- *Dynamic Risks:* Risk events are dynamic, not static, and should be evaluated regularly through all phases of design, construction and O&M (if required). The CSRA is based on the identification and assessment of risks as of the date of this document. Reduced utility of current CSRA results should be assumed if the likelihood and impact of risks change over time.
- *Causal Relationships:* With the exception of risk events identified as correlated in the risk register, it is assumed that the impacts of risks are independent and that the realization of one risk does not cause the realization of another. Significant variance of the risk model results from actual project costs and schedules may be experienced if significant causal relationships exist between risks assumed to be independent.
- *Conservation of Market Pricing Risk:* The CSRA assumes that market pricing risks are not created or destroyed but can only be transferred or shared *at a price* as a result of various contract acquisition strategies. As an example, it is assumed that a contractor will add a level of contingency to a fixed price bid, relative to a cost reimbursable bid, that is reflective of the risk transferred contractually from the Government to the contractor. Other aspects of contract acquisition strategies not related to market pricing, such as the management cost of modifications or claims, are not included in this assumption. Any contract acquisition strategy that actually transfers market pricing risk to a contractor *at no cost* to the Government is not reflected in the CSRA.
- *Unknown Unknown* and *Unknowable Risks*: The Cynefin Framework describes decision-making contexts, in part, by characteristic types of uncertainty. Simple, complicated, complex and chaotic contexts within the framework are respectively associated with *known known*, *known unknown*, *unknown unknown* and *unknowable* uncertainties. The CSRA process focuses on *known known* and *known unknown* risks and is not intended to quantify the impacts of *unknown unknown* or *unknowable* risks. Significant variance of the risk model results from actual project costs and schedules may be experienced if *unknown unknowable* risks, as defined in the Cynefin Framework, are realized.

6. RISK ANALYSIS RESULTS

The following sections discuss the risk register, cost risk analysis results, schedule risk analysis results, and the combined cost and schedule risk analysis results.

6.1. Risk Register

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. A summary risk register that includes typical risk events studied (high and moderate levels) is presented in a table in this section. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis. The complete detailed risk register is attached as Appendix A. The detailed risk registers in Appendix A include low level and unrated risks, as well as additional information regarding the specific nature and impacts of each risk. A condensed version of the Risk Register of modeled risk items can be seen on Table 3.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
Communicating risk management issues.
Providing a mechanism for eliciting risk analysis feedback and project control input.
Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

Table 3. Risk Register – Modeled Items

CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Risk Level (C)	Risk Level (S)
Organizational and Project Management Risks (PM)					
PM1	Project competing with other projects, funding and resources	Demands on resources	Normal demand on resources within the district.	Low	Low
PM2	Unplanned work that must be accommodated	Hurricane Effects	There always a risk that hurricanes could cause damage causing scope increases. This item will be taken into account under the category construction risk item mods and claims.	Low	Low
PM3	Local agency/regulator issues	Sponsor Request for changed work	Sponsors may request modification post contract award. Taken into account in construction category item modification.	Low	Low
PM4	Staff Turnover	Staff turnover over the next 50years plus is guaranteed.	Turnover is likely to cause inefficiencies and result in lost institutional knowledge. Marginal cost growth over the next 50 years is likely due to that inefficiency, re-learning of lessons and lost knowledge. Effect PED. Drive up cost 1 to 2 percent.	Medium	Low
PM5	Established Project	All of the LPV GRR projects that are add ons from existing projects done within the last 20 years.	Project is well developed and pitfalls are known and work arounds developed. Overall project cycle is well understood as long as wholesale staff turnover is not experienced.	Low	Low
Contract Acquisition Risks (CA)					
CA1	Small Business and 8(a) Contracting	The project is assumed to be done using an acquisition strategy of small business and 8(a) contracting.	Estimate has taken small business into account by assuming certain items will be subcontracted. Is it possible for these contract go out as a different acquistion strategy? Probably not. Only if contract goes over bond capacity, Project is to high cost or to large scope wise. Low risk because better price with big business contractors will have better competition. SO low risk. Cost could be higher due to not enough subcontracting and other issues (Procurement Strategy) or bids could come in lower due to competition other issues (Procurement Strategy).	Medium	Low
CA2	Acquistion planning	Strategy and funding stream	A strategy is in place. The strategy is that projects and funding will be spread work out over 50 years. Assume funding stream will not be a problem.	Low	Low
CA3	Design Build	Levee and Floodwall work is not typically Design Build.	Design Build is not likely to provide benefits for this type of project. Design Build is unlikely.	Low	Low
General Technical Risks (TR)					
TR1	Design Criteria	All designs incorporate current design requirements.	Currently no pending design criteria changes are known. Most work being done will occur on existing levees or existing floodwalls. Work is typical at the MVN district.	Low	Low

TR2	Floodwall confidence in design	confidence in the scope and design and critical quantites	Pre-Katrina perimeter T-wall was checked against the post-Katrina HSDRRS Design Guidelines for the 2057 design life. GRR considers a longer design life (e.g. 2073) with higher associated SWLs (sea water levels). The higher SWLs (sea water level) associated with the longer design life will cause the factors of safety for most, if not all, of the post-Katrina T-walls to fall below the required HSDRRS Design Guidelines. In order to have a accurate risk for this item, new fragility curves would be needed to be done. Since new fragility curves can not be done due to the amount of work vs time available to comple, an assumption base on historical data and engineering experience will be used to access this risk. Therefore, this risk to the scope of the project is high.	**High**	**Low**
TR3	Floodwall confidence in design	confidence in the scope and design and critical quantites	The typical section used for the floodwall quantities were assume to be an average of total LF of the floodwall to be replaced. It ls assumed that the quantities could be -5% to +5 of the current quantities used.	**Medium**	**Low**
TR4	Level of Design - Floodwalls	Floodwall design is highly conceptual.	New Orleans will replace deficient floodwall with new higher floodwall. HESCO basket/stockpile flood figting material temporary protection will be deployed as needed during construction.	**Medium**	**Low**
TR5	Floodwall confidence in design	confidence in the scope and design and critical quantites	Ran a profile surveys before study started. The profile was used to predict straddle lifts and the slopes from the previous lift were used. Low Risk	**Low**	**Low**
TR6	Confidence in scope, investigations, design, critical quantities	Used previous lift schedule to predict settlement on all the reaches.	Used representative previous lift schedules to predict settlement on all the reaches. The settlement could increase or decrease causing quantities to increase or decrease. A conservative lift schedule was used; therefore, the quantity should be on the conservative side.	**Low**	**Low**
TR7	Floodside Shifts	Possible floodside shift may occur but technical assume all straddle levees	MRL- Some of the MRL Reaches would probably need floodside shift but due to time contraints straddle lifts were assumed for quantities. A small analysis was done that showed that quantities take offs for a straddle levee in place of a possible floodside shift is convservative.	**Low**	**Low**

TR8	Sufficiency / availability of as-built data / base map data	As builts have been provided.	Used typical section to arrive at quantity. Heights of floodwall can vary in elevation but do not forsee major changes. TR3 already takes possible quantity change into account.	Low	Low
TR9	Right-of-way analysis in question	Change from straddle to flood side shift	The MRL levees in some areas could have floodside stability issues that would need to be analyzed during PED phase. Affect to quantities is negligible. Increase to right of way is possible. Assume there could be up to 25' of ROW for 7000LF of Levee needed to be acquired.	Medium	Low
Civil/Site Design (CV)					
CV1	Borrow Material	Haul locations have been assumed (15 mile haul distances).	Suitability of borrow material may be in question requiring either additional acreage and mitigation.	Low	Low
Lands and Damages (LD)					
LD1	New Orleans	Some 76 sites have been identified for Lands, Easements, Rights-of-way, Relocations and Disposal (LERRD) needed to acquire. right of way and borrow site locations with approximately 75 ownerships	MVN opinion is current footprint is worst case. Increase in acreage is unlikely.	Low	Low
LD2	Environmental Mitigation	Availbility of mitigation bank credits (area)	Mitigation cost may be low due to demand of mitigation bank credits. The cost could potential go up by 100%. Assumption made by Kip.	Medium	Low
LD3	Property Acquisitions	Several landowners with land fronting canal (waterfront) voiced their opposition to losing their water access - floodwall acres acquisition could be problematic.	Opinion is to give them options for water access. Costs in REP includes damages for their loss of waterfront.	Low	Low
Regulatory Environmental Risks (RG)					
RG1	Programmatic Agreement	An overall literature search is being conducted for the entire areas. A programmatic agreement will lay out how surveys will be conducted and what to do if resources are encountered.	Programmatic agreement should allow for more efficient coordination between USACE, SHPO and Tribes.	Low	Low

RG2	Cultural Resources	Most of the construction will be in the existing footprint, borrow areas will be more likely to encounter resources.	Cultural surveys will be conducted once borrow areas are identified. Programmatic agreement will lay out the process if resources are discovered. Primarily risk would be to schedule to allow time for surveys and proper documentation (if required). Efforts will be made to avoid cultural impacts.	Low	Low
RG3	Archeological Sites and Standing Structures	Most Standing Structures are known within the LPV/WBV. Archeological sites are likely known with the exception of the portion MRL levee lifts.	LPV/WBV levee and flood are low risk. MRL has higher potential of risk but will be address in PA (Programmatic agreement) Historic sites previously "capped" by existing levee are likely to be encountered with this MRL. If eligible sites are encountered additional cost and schedule for site documentation and mitigation. Flexibility in MRL schedule would individual sites to be shuffled to allow time for individual site surveys to be completed. Indirect (visual) impacts to urban would need to be consider. Surveys could be minimal from $100k. Site Mitigation would range from $250k to $500k for site mitigations (full archeological survey and documentation). Cultural survey costs have been included in the baseline estimate. Site mitigation has not been included. If encountered construction would work around the site until addition consultation is completed and resolved.	Low	Low
RG4	Burial Locations	Unknown burial sites are unlikely to be encountered	It is not likely burial sites will be located during construction. If encountered, burial location will be avoid until location is resolved. With the exception of the MRL levee shifts, all other projects have been previously disturbed; therefore, low risk.	Low	Low
RG5	Threatened and Endangered Species	Several endangered species in the project area.	Through coordination with Fish and Wildlife services and NMFS and through use of best management practices impacts are unlikely. If this would occur, it would effect the schedule which would gives a moderate impact.	Low	Low
RG6	Clean Water Act Compliance and Mitigation Impacts	Mitigation has been developed based on projected Impacts.	There will be times when assumptions have not been meet and actual mitigation requirements will be increased.	Low	Low
RG7	HTRW in Borrow Areas	Borrow areas have not been identified HTRW survery's will be conducted.	If HTRW is found, another borrow will be need be found. According to Kip Runyon and Joe Musso, the likelihood o finding HTRW at borrrow pits is low. The cost impact could be because of haul distance. (See CO5) Schedule could be delayed due to finding a borrow area but since the project is 50 year program if the project is delayed it would not affect the overall program.	Low	Low
RG8	Environmental Justice	High or high adverse disproportionate impacts must be encountered before mitigation will be required per EO 12898.	Cost and Schedule impacts are not likely.	Low	Low
RG9	Environmental and Water quality issues	Potential Submerged Aquatic Vegetation (SAV) in Foreshore protection areas. Construction Dredging Access may not be able to avoid SAV. (only LPV)	If SAV is can't be avoided then will have to mitigate. This would cause construction of a new mitigation area cause cost and schedule growth.	Low	Low
Construction Risks (CO)					
CO1	Site Access and Site Constraints - Floodwalls		Site have been access in past. Jobs are mostly add ons.	Low	Low

CO2	Weather	Contracts will include weather days.	New Orleans historically experiences significant time growth due to weather delays, especially for large clay construction contracts and moisture control. Will impact costs (see CO4), but little overall impact to larger project timeline	Low	Low
CO3	Weather	Contracts will include weather days.	New Orleans historically experiences significant time growth due to weather delays, Floodwall, from historical data, has a certain percentage of servere weather increase. Will impact costs (see CO4), but little overall impact to larger project timeline	Low	Low
CO4	Poor Performing Contractor	Poor performing contractors can significantly delay individual contracts.	Individual contracts will be impacted by poor performing contractors. Overall program schedule is not likely to be impacted. Contracts are independent. Program Risk is low and not modeled.	Low	Low
CO5	Mods and Claims	Every project experiences cost growth after award.	LPV projects have typically tracked best case 5%, most likely 8% and 12% worst case after award cost growth. Schedule growth on individual contracts is likely, but overall program is unlikely to be affected.	Medium	Low
CO6	Material availability and delivery	Haul Distance and material availability	Availability in location in future may be an issue but will happen before award. Material located in relation to the project. It was assumed that 15 mile haul will used. Medium risk because assuming borrow pit will be an average of 15 mile for work site. Haul can be over 15 miles or under. Assume a low of 10 mile haul and high of 20 mile haul.	Medium	Low
Estimate and Schedule Risks (ES)					
ES1	New Orleans Estimates	T-Wall replacement based on recent Floodwall cross section with crews and adjusted localized production rates. Floodwall estimate includes designer provided quantities. Site specific crews and production rates. Earthwork based on government furnished material and assumed 15mile haul.	Levee estimates are likley cost neutral. Floodwalls are typical work, Typical production rates and production were used. Cost risk is Low.	Low	Low
ES2	LABOR AVAILABILITY/PRICING	Labor shortages and increase rates	Assume economy will have low unemployment. Assuming labor cost could increase.	Medium	Low
ES3	MATERIAL AVAILABILITY/PRICING	material shortages and increased cost	Projects are using standard materials, quotes for all major materials. Material Prices could increase will improving economy and tariffs.	Medium	Low
ES4	Government vs Contractor	Possibility of the some borrow area switching to contractor furnished.	Possible that some borrow areas could change to contractor furnished borrow area. Assume 20% of the material could change to contractor furnished material.	Medium	Low
ES5	Material Pricing Uncertainty	Floodwall and Material Pricing could fluctuation over the project life (50 to 100years)	Assume moderate cost risk with ENR commodity computations. Assume taken into account in ES3.	Low	Low
ES6	Differing Site conditions	Differing Site conditions	Production Rates are from historical data but unforeseen site condition could lower production rate causing cost impacts.	Medium	Low

External Risks (EX)					
EX1	High Water- MRL Colocated sections	Mississippi in recent years has remained at above average stages for significant portions of the year impacting project access, design and construction.	Continued high water events would result in schedule delays and associated cost impacts. Since the high river only effect MRL, a high risk is implemente only the schedule for MRL jobs. Assume that those project will be high risk. Usually, high water comes in the winter or (historically) spring and ends by June. 6-8 months could be affect in any given year. -(Construction) Government labor S&A cost. Personnel (inspector other construction personnel) will be on the job for longer period of time. S&A for MRL projects was separated from other LPV contracts in the Cost and Schedule Summary. The S&A used is from historical data including High water.	Low	High
EX2	Market Conditions	Construction Market and bidding competition	To project market conditions 50 years into the future is difficult. Competition of levee and floodwall work has been robust in recent years. Do not foresee an issue in the future but since changes could happen a medium risk was assumed. Low 0% High 5%.	Medium	Low
EX3	Federal Funding	MRL and LPV/WBV Separate Funding	MRL is separate funding. From history, it doesn't seem like funding was be a issue. It is assumed that it will continue to be so. LPV/WBV - If intial funding is appropriated by Congress, it is expect that ongoing appropriation will occur for the life of the project.	Low	Low
EX4	Unexpected escalation on key materials	Fuel prices and key materials	The inflation of fuel and key materials is always a possibility and fuel is a cost driver for the mob/demob and other construction items. Fuel cost has flucuated and is low at the moment. It will increase in near future.	Medium	Low
EX5	Political and Sponsor Support	Political and Sponsor Support remains committed to the project and public safety.	Natural disasters could draw additional attention to the project potentially increasing funding (opportunity).	Low	Low
EX6	Hurricane Risk	Hurricane Effects	Hurricane often occur and a process is already in place. Cost and Schedule changes will be taken into account under the construction risk category item mods.	Low	Low
EX7	Sponsor Funding	Sponsor is responsible for LERRDS and cost share.	Sponsor funding should not be an issue. Project is a typical cost sharing, sponsor is responsible for LERRDS.	Low	Low
EX8	Stakeholders	late changes, new changes	Assume any changes that occur will be Included in construction risk category under item called modifications.	Low	Low
EX9	Environmental Community	Lawsuits have been filed previously over project impacts.	USACE has successfully defended lawsuits in the past through full disclosure of impacts in the EIS. Future litigation will likely also not result in changes to the project. Project work continued during previous litigation and would likely be able to continue during any future litigations. Overall Lawsuit Risk is considered Low.	Low	Low

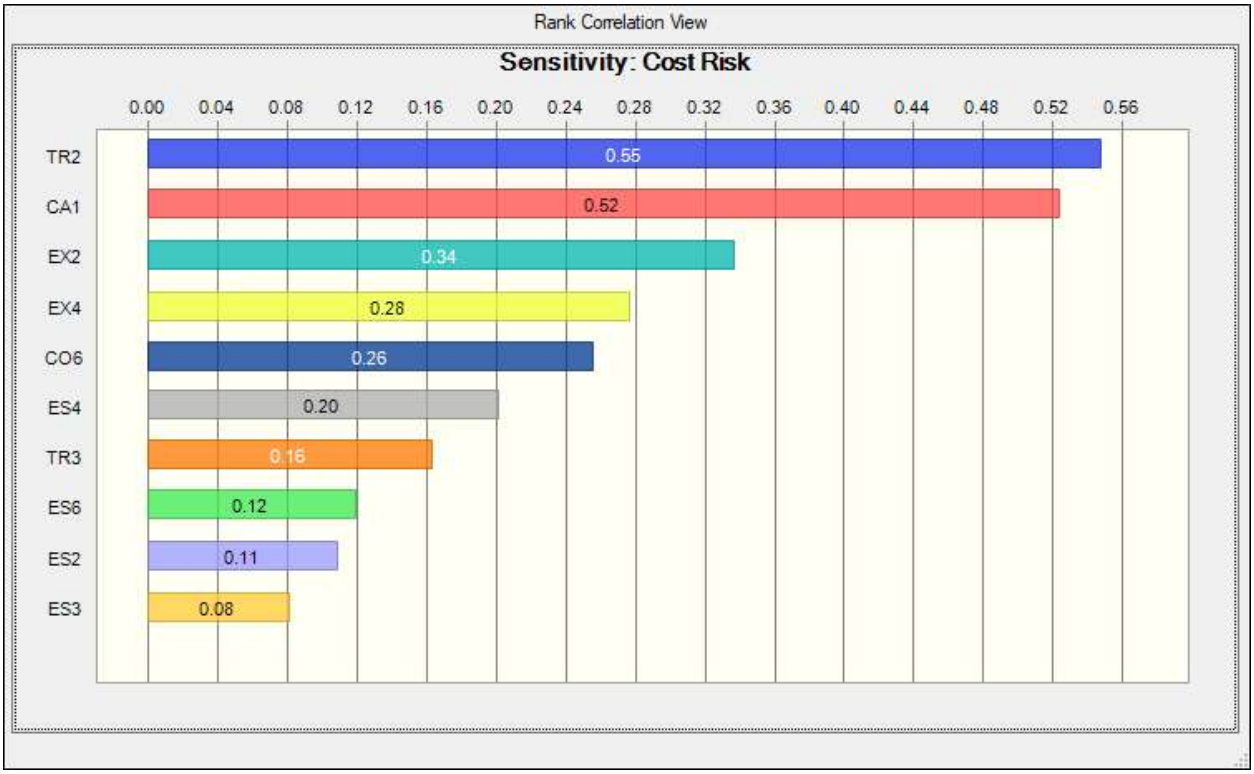
6.2. Cost Risk Analysis - Cost Contingency Results

A cost risk models was run for the Structural Features and for the Levees/All Other Features of construction work. As shown in Table 3, there were a total of 16 risks used in the modeling for the risk analyses which had a cost impact of moderate or high.

Some risks applied only to one feature set and some applied to both. The risk was analyzed using the low, most likely, and high estimates for each risk item and the items associated variance distribution. The analysis produced a sensitivity chart of the risk items and confidence levels from 0 to 100% and the associated contingency amount.

The cost sensitivity chart for the Structural Features and Levees/All Other is shown in Figure 1. The sensitivity chart shows the influence of each risk items on the resulting cost contingency. The risk items are ranked according to their importance to the cost contingency. As shown in the Cost Sensitivity Charts, Acquisition Strategy, market conditions, Confidence in the scope and design and critical quantities and Fuel prices had the most influence on the cost contingency for the Structural, Levee/others Features.

Figure 1. Structures and **Levees/All Other Cost Sensitivity Chart**



The cost risk analysis also produced a confidence table in ten percent increments of project confidence associated with contingency dollars. The confidence levels are shown in Table 4. As seen in the table, all but one of the associated contingency dollar amounts are positive. The contingency dollar amounts range from over $53 million to $336 million. The recommended cost contingency amount for the Structural Features and Levees/All Other is $221,295,074.

Table 4. Structures and Levees/All Other Cost Confidence Table

INITIAL CONSTRUCTION

Contingency Analysis

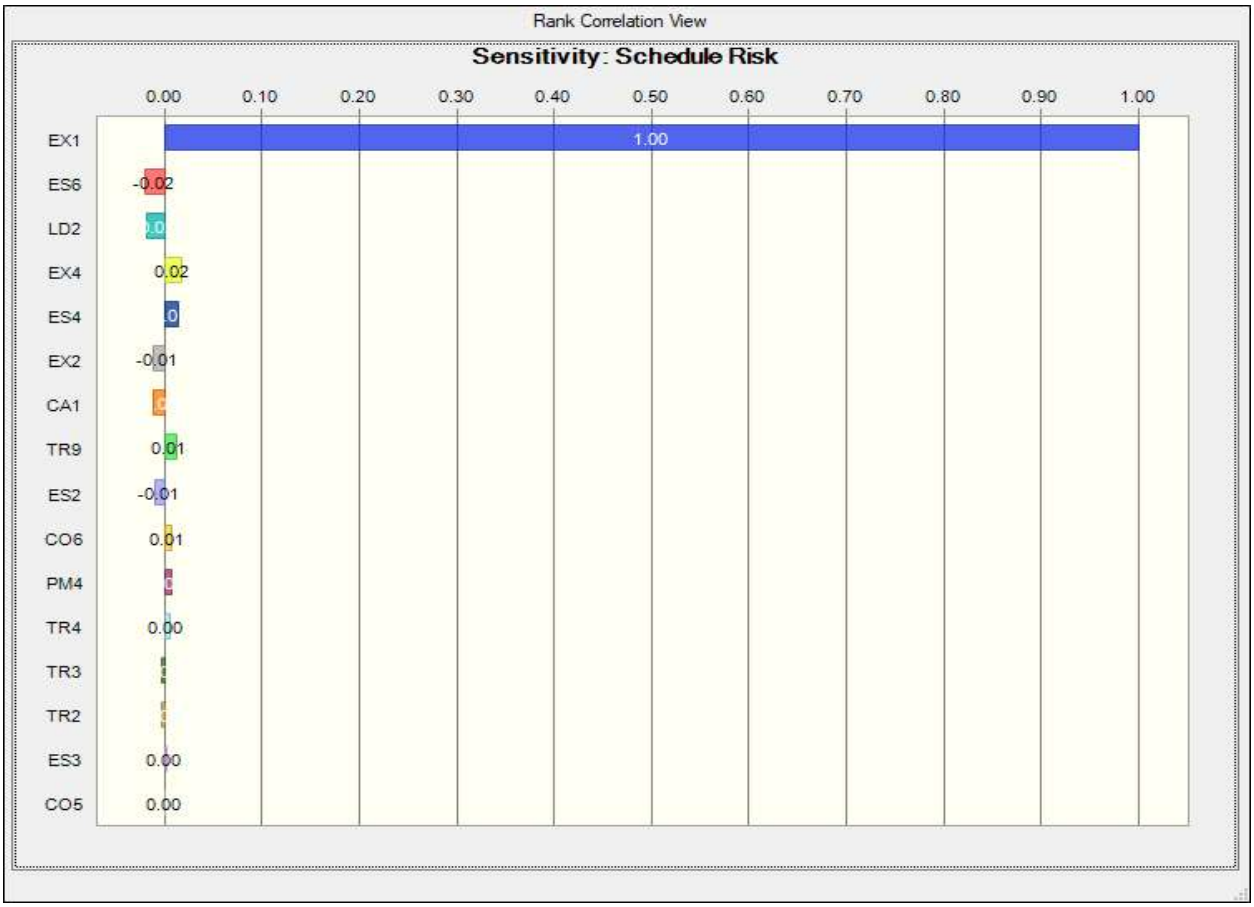
Base Case Estimate (Excluding 01)	$670,591,133	
Confidence Level	**Contingency Value**	**Contingency**
0%	**53,647,291**	**8%**
10%	**134,118,227**	**20%**
20%	**147,530,049**	**22%**
30%	**160,941,872**	**24%**
40%	**174,353,695**	**26%**
50%	**181,059,606**	**27%**
60%	**194,471,429**	**29%**
70%	**207,883,251**	**31%**
80%	**221,295,074**	**33%**
90%	**241,412,808**	**36%**
100%	**335,295,567**	**50%**

6.3. Schedule Risk Analysis - Schedule Contingency Results

A schedule risk analysis was conducted on 1 risk of the risk register, shown in Appendix A, which had a schedule impact of moderate or high. The project Risk Register originally considered over 51 risk items but only 1 risk was determined to have an impact on the overall program schedule. The risk was analyzed using the low, most likely, and high estimates for each risk item and the items associated variance distribution. The analysis produced a sensitivity chart of the risk items and confidence levels from 0 to 100% and the associated contingency amount.

The schedule sensitivity chart is shown in Figure 2 below. The sensitivity chart shows the influence of each risk items on the resulting schedule contingency. The risk items are ranked according to their importance to the schedule contingency. As shown in the Schedule Sensitivity Chart, High Water item had the most influence on the schedule contingency. It is important to note again that the schedule is for a Program rather than a Single Project and therefore very few items were considered to be a High risk to the program and did not significantly affect the overall schedule.

Figure 2



Schedule Sensitivity Chart

The schedule risk analysis also produced a confidence table in ten percent increments of project confidence associated with contingency months. The confidence table is shown in Table 5 below. As seen in the table, all the associated contingency month amounts are positive. The contingency month amounts range from 6 months to 17 months. The recommended schedule contingency amount is 11 months. Note that these results reflect only those contingencies established from the schedule risk analysis.

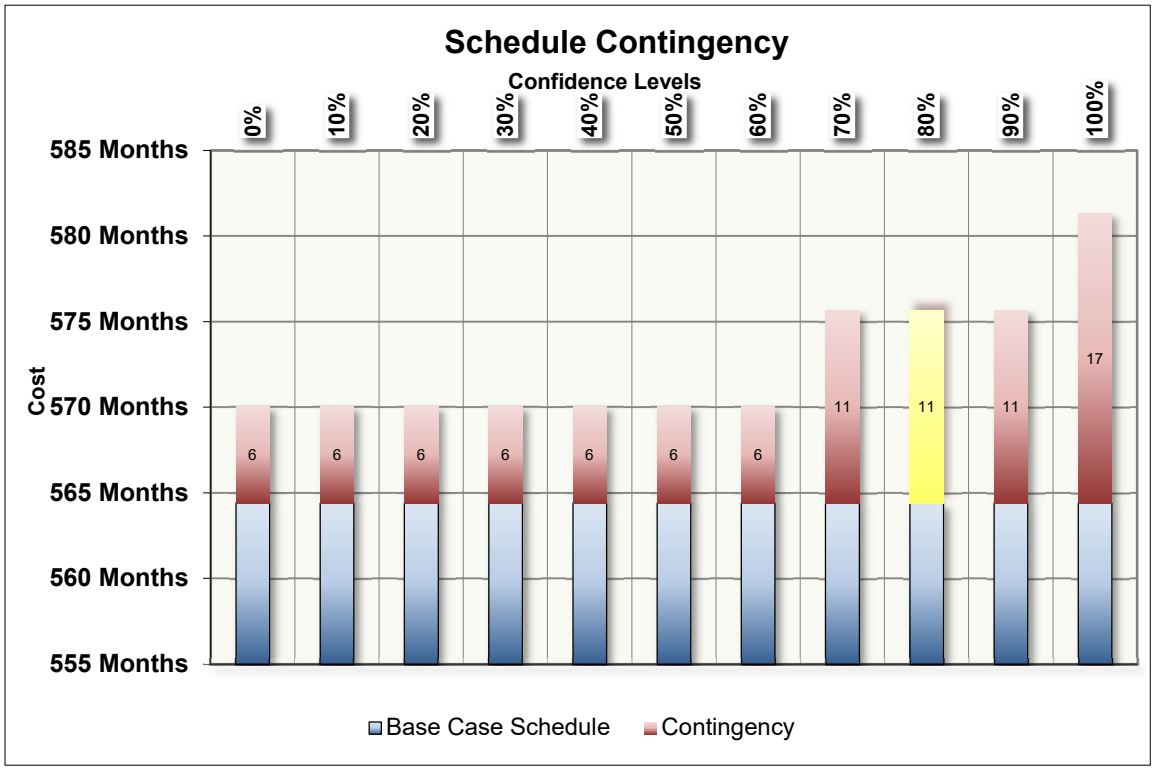
Table 5. Schedule Confidence Table

Contingency Analysis

Base Case Schedule	564.4 Months	
Confidence Level	**Contingency Value**	**Contingency**
0%	**6 Months**	**1%**
10%	**6 Months**	**1%**
20%	**6 Months**	**1%**
30%	**6 Months**	**1%**
40%	**6 Months**	**1%**
50%	**6 Months**	**1%**
60%	**6 Months**	**1%**
70%	**11 Months**	**2%**
80%	**11 Months**	**2%**
90%	**11 Months**	**2%**
100%	**17 Months**	**3%**

From the table, a confidence bar chart was also established that shows the relationship of percent confidence with contingencies in months. That bar chart is shown in Figure 3. Due to not many risk modeled, all confidence levels show a steady increase in the contingency amount.

Figure 3. Schedule Confidence Curve



7. MAJOR FINDINGS/OBSERVATIONS

The cost and schedule risk analysis resulted in a recommended combined cost contingency of $221,295,074 and a schedule recommended contingency of 11 months. The project construction costs for confidence levels 0 to 100% are shown below. Table 6 presents construction costs, which include base cost plus cost and schedule contingencies. Lands and Damages cost and contingency are not included. Figure 4 illustrates the construction cost risk analysis confidence bar chart. The recommended contingency is 33% Structural Features and the Levees/All Other Features, based on the 80% confidence level. These contingencies were applied to the detailed estimate for the tentatively selected plan for the LPV GRR project. The rounded contingency percentages for Structural Features and the Levees/All Other Features (33.0%) where transferred to the TPCS for final calculation of Total Contingency and Total Cost. Lands and Damages cost and contingency are not included in the above numbers.

Contingency Summary Table - Cost

PROJECT CONTINGENCY (BASELINE ESTIMATE)	Percentile	Baseline w/ Contingency	Contingency %
	0%	**$724,238,424**	**8%**
	10%	**$804,709,360**	**20%**
	20%	**$818,121,182**	**22%**
	30%	**$831,533,005**	**24%**
	40%	**$844,944,828**	**26%**
	50%	**$851,650,739**	**27%**
	60%	**$865,062,562**	**29%**
	70%	**$878,474,384**	**31%**
	80%	**$891,886,207**	**33%**
	90%	**$912,003,941**	**36%**
	100%	**$1,005,886,700**	**50%**

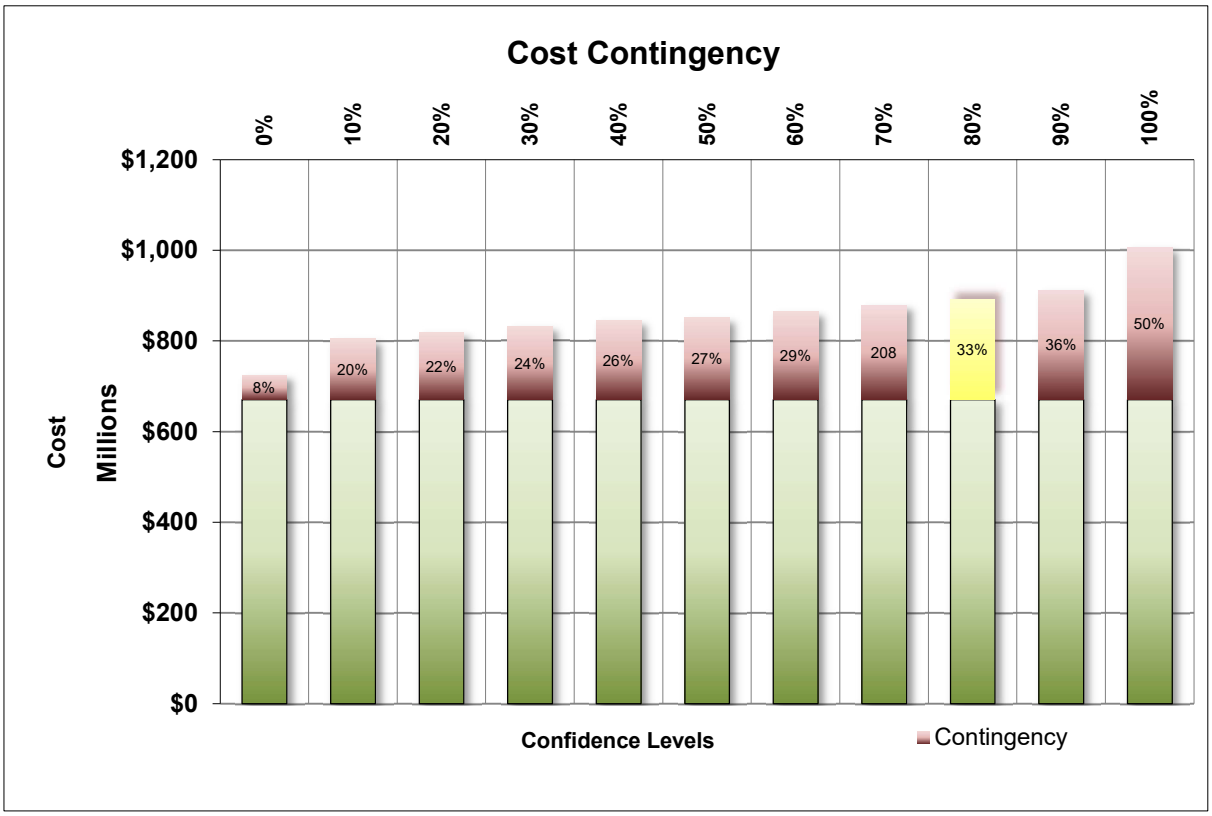
Contingency Summary Table - Schedule

PROJECT CONTINGENCY (BASELINE SCHEDULE)	Percentile	Baseline w/ Contingency	Contingency %
	0%	**570.0 Months**	**1%**
	10%	**570.0 Months**	**1%**
	20%	**570.0 Months**	**1%**
	30%	**570.0 Months**	**1%**
	40%	**570.0 Months**	**1%**
	50%	**570.0 Months**	**1%**
	60%	**570.0 Months**	**1%**
	70%	**575.7 Months**	**2%**
	80%	**575.7 Months**	**2%**
	90%	**575.7 Months**	**2%**
	100%	**581.3 Months**	**3%**

Table 6. Project Contingencies (Base Cost plus Contingency)

The above costs do not include 01 Lands and Damages and rounding of the contingency used when transferred to the TPCS and therefore will not match the TPCS exactly.

Figure 4. Project Confidence Curve



The major contributors to the resulting total project cost contingency for the Structural and Levee/All other remaining Features were:

- (CA-1) Acquisition Strategy – defined as small business 8a
- (TR-2) Confidence in the scope and design and critical quantities– 50-year market condition could change – other walls may need to be demolished and constructed.
- (EX-2) Market Condition – 50-year market condition could change
- (EX-4) Fuel prices– Used historical fuel prices and used average of several months of highest prices.

The major contributor to the resulting total project contingency for the Schedule feature was:

- (EX-1) High River MRL Levees – risk of additional impacts which will cause delays.

These items are discussed in more detail in the Mitigation Recommendations section.

Lands and Damages are not included in the CSRA because it was not considered to be an overall program risk by the PDT. Lands and Damages is a very small project cost and any schedule delay in a specific location would not significantly affect the midpoint of the overall program. The Local Sponsor is responsible for LERRDs and in order to

serve as the Non-Federal sponsor must have the authority to appropriate (take) property.

The above risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. These conclusions were reached by identifying and assessing risk items for use in the risk analysis. These quantitative impacts of these risk items are then analyzed using a combination of professional judgment, empirical data, and analytical techniques. The total project cost contingency is then analyzed using the Crystal Ball software. *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.

8. MITIGATION RECOMMENDATIONS

An important outcome of the cost and schedule risk analysis is the communication of high risk areas which have a high potential to affect the project cost and/or schedule. For the LPV GRR, the high cost risk items are the Acquisition Strategy, market conditions, Confidence in the scope and design and critical quantities and Fuel prices had the most influence on the cost contingency for the Structural, Levee/others Features.

Mitigation measures for Acquisition Strategy, if competition is high and it usually is for the type of projects being constructed than the cost can decrease.

Market Condition may not fluctuate as much as risk model predicts

Fuel prices have reached high values but there is a possibility that the Fuel prices will not fluctuate the value estimated in risk register.