US Army Corps
of Engineers
Los Angeles District

Little Colorado River at Winslow, Navajo County, Arizona

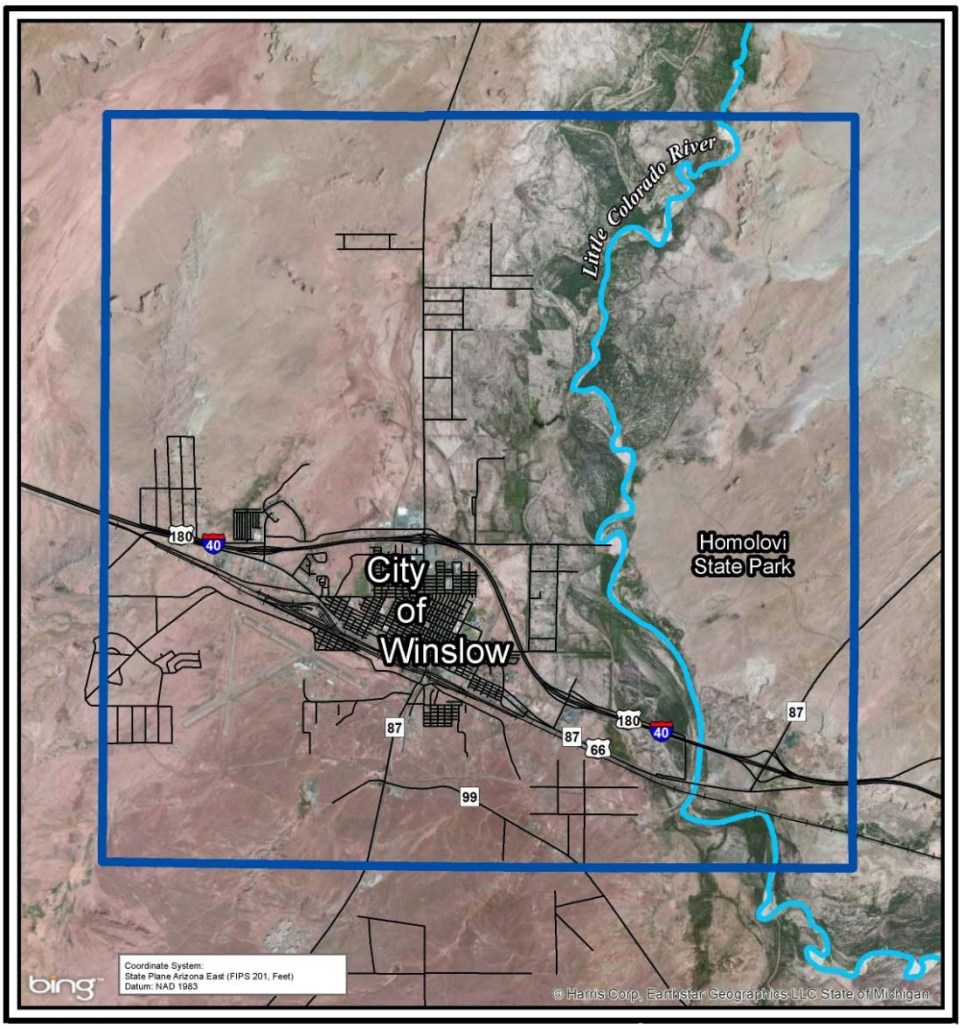
Flood Risk Management Feasibility Study

APPENDIX E

Cost Engineering

October 2018

Cost Engineering Appendix
Little Colorado River at Winslow, Navajo County, Arizona
Flood Risk Management Feasibility Study



Prepared June 12th, 2018

This Appendix was prepared by:
The Cost Engineering and Specifications Section
U.S. Army Corps of Engineers, Los Angeles District

7/12/2018

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1.0 Overview

The study area is located in the City of Winslow, west-central Navajo County, Arizona (AZ), within the middle of the Little Colorado River (LCR) Watershed. The LCR originates 160 miles upstream of Winslow, AZ, in the White Mountains, south of Springerville, AZ, and continues for another 155 miles downstream of Winslow. The study area encompasses the floodplain of the LCR from the vicinity of the Clear Creek confluence to the north terminus of the Winslow Levee. The study area includes the majority of the City of Winslow, including the Ruby Wash Diversion Levee (RWDL) and the Ruby Wash Levee. Figure 1 and 2 present a map showing a listing of known utilities within the project area from various sources and site visits. These figures also shows disposal and borrow locations identified during the aforementioned site visit by the non-federal sponsor. The study is being conducted to address the following key problems:

- The existing levee system is at risk of overtopping and does not provide the flood risk reduction for which it was designed, exposing the City of Winslow, the surrounding community, and critical facilities (e.g., hospitals, schools, nursing homes, utility infrastructure, etc.), and cultural/historic resources are subject to significant flood risk, flood related damages, and life, safety, and health impacts.
- The existing levee system includes components of older, non-engineered levees that do not meet current design, construction, or reliability analyses, leading to a risk of underseepage and piping failure, leading to the risks and damages listed above.
- Lateral channel migration, reduced channel capacity due to sedimentation, and obstruction of flow by vegetation such as saltcedar contribute to the risk of levee overtopping and failure.

The Recommended Plan is illustrated in Figure 3 and includes the following improvements:

- Rebuild the Winslow Levee from the RWDL downstream to a point 0.8 of a mile north of North Road
- Set back a short segment of the Winslow Levee across the LCR from the Homolovi I Pueblo
- Rebuild the eastern end of the RWDL
- Construct a new levee parallel to I-40
- Improve conveyance under the BNSF Railroad Bridge

This cost engineering assessment is compliant with ER 1110-2-1302 - Civil Works Cost Engineering and ETL 1110-2-573 – Construction Cost Estimating Guide for Civil Works both dated September 2008.

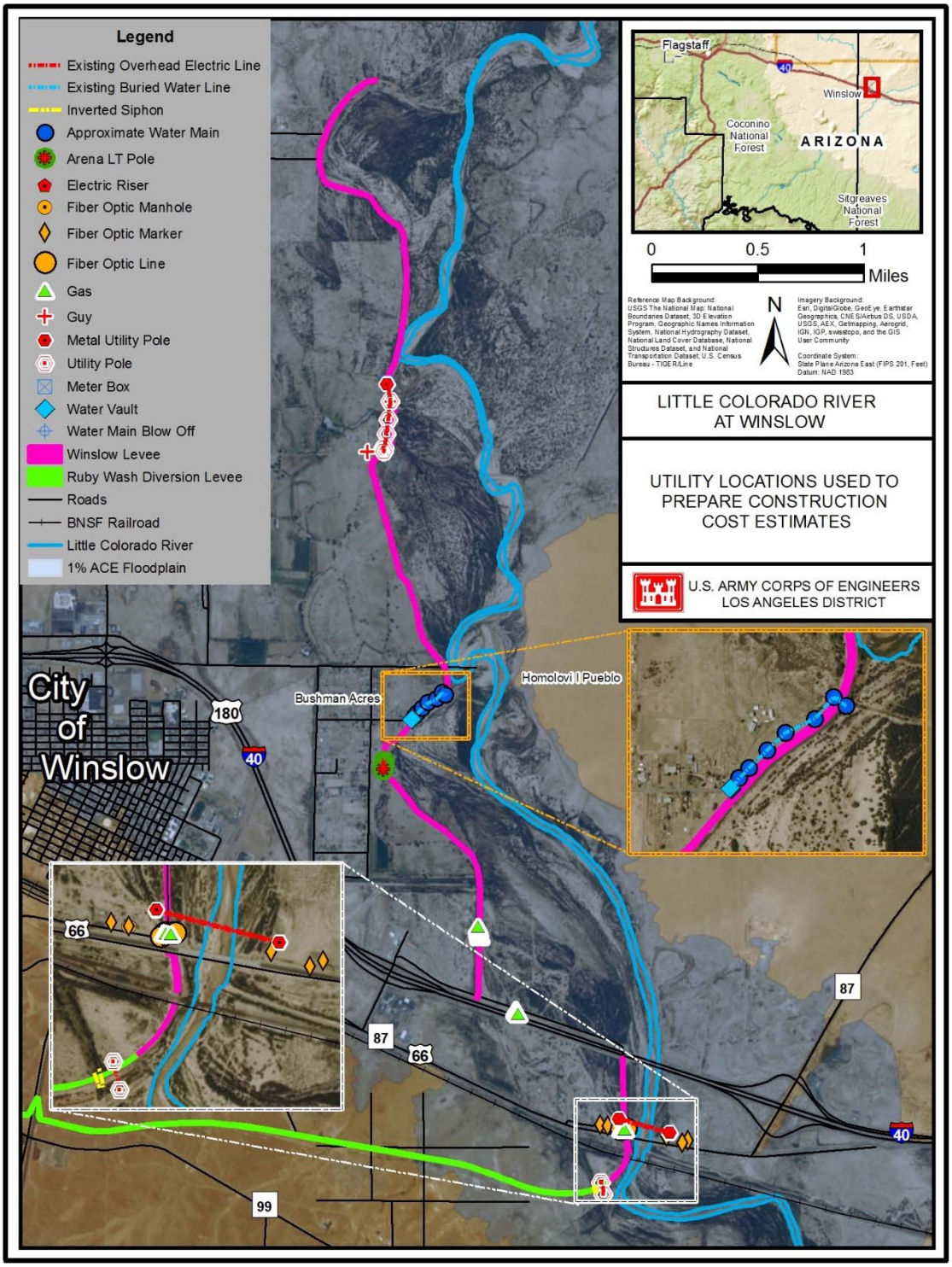

Figure 1 – Utility Locations

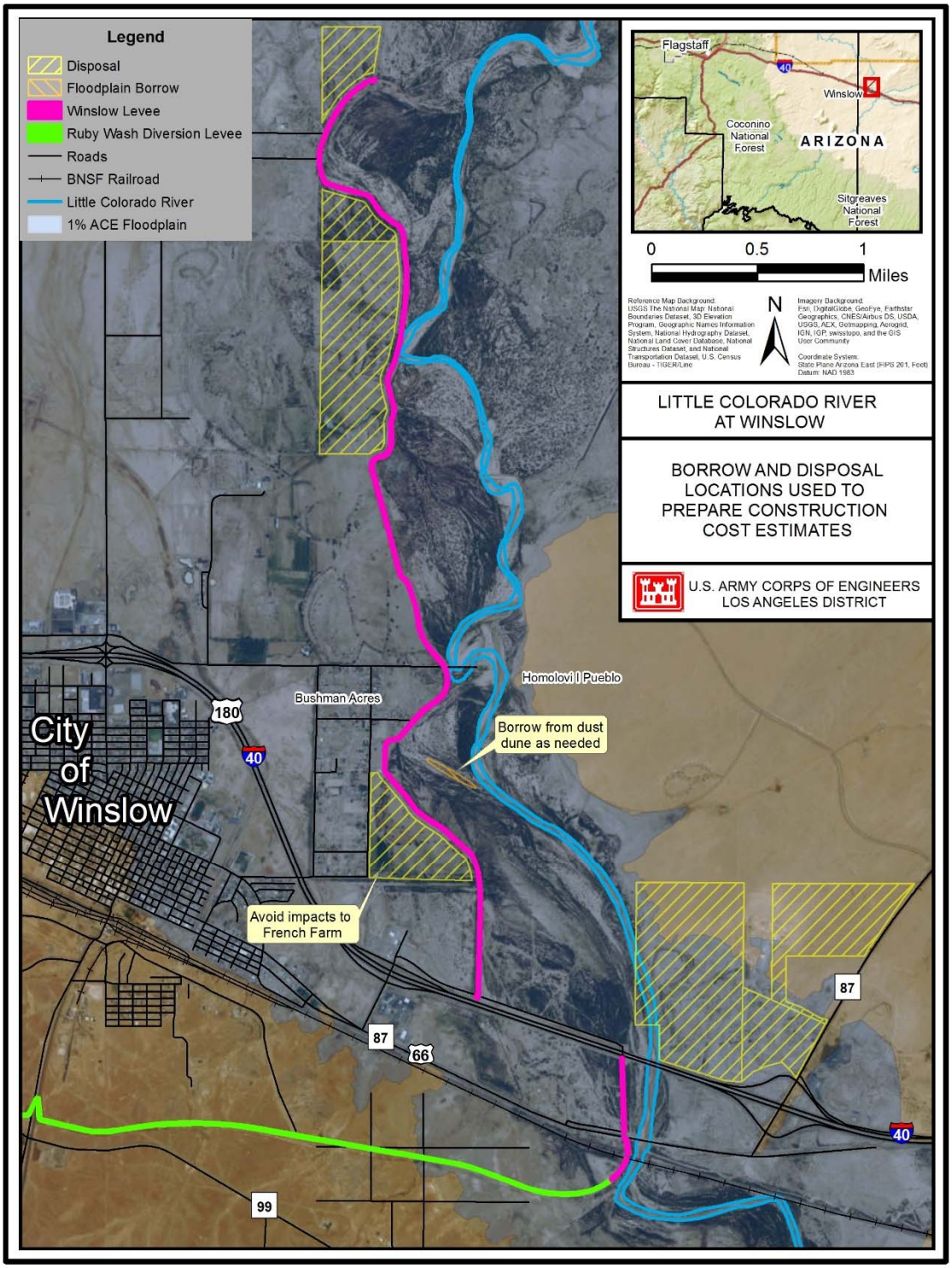

Figure 2 – Disposal and Borrow Locations

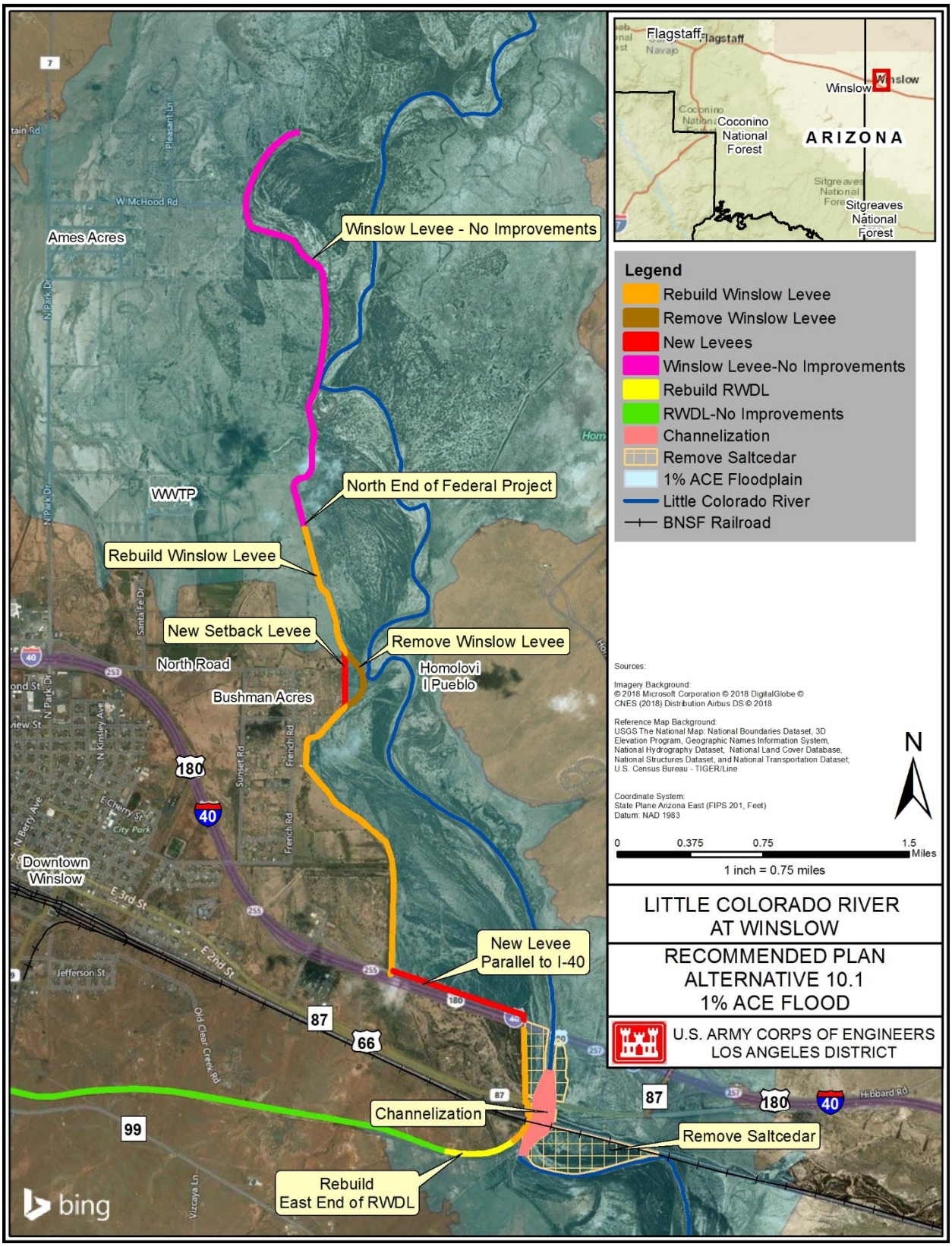

Figure 3 - The Recommended Plan, Alternative 10.1

2.0 Recommended Plan Analysis

2.1 Unit Cost Basis

2.1.1 Direct Cost

Labor rates used to develop the estimate were provided from the latest Davis-Bacon Wage Rates (November 2017).

Equipment rates are based on the Department of the Army EP 1110-1-8 "Construction Equipment Ownership and Expense Schedule", 2016 Region 7.

2.1.2 Quantity and Material Analysis

All existing basaltic rip-rap will be salvaged and reused. Any additional quantities of basaltic rip-rap would be purchased from a local quarry and delivered to the project site.

All existing sandstone will be removed from the existing levee and relocated to the closet disposal site. No tipping fees will be incurred because these sites are not the local landfill.

Excavated material will be reused to the extent possible. The estimate assumes the following:

- Material excavated from the levee will be re-used
- Material excavated from the channelized section within the vicinity of the BNSF Bridge will be reused.
- All material excavated from the trench drain will be re-used

Excess material will be taken to the nearest stockpile site within the work area being performed. Material placed at the stockpile sites will be graded to ensure proper drainage.

Surplus material that is appropriate for re-use will be stockpiled at a nearby stockpile site.

All green waste will be disposed of at the Painted Desert Landfill, 9001 N Porter Rd, Joseph City AZ.

2.1.3 Excise Tax

An excise tax of 4.615% has been applied to the total construction cost of the project. This percentage includes all applicable state, county, and local taxes.

2.1.4 Contractor Markups

All contractor and sub-contractor markups for Job Office Overhead (JOOH), Home Office Overhead (HOOH), Profit and Bond were based on the assumed contracting mechanism..

The project is estimated as acquired through an Invitation For Bid (IFB) contractual mechanism with full and open competition.

2.2 Improvements

On the landward side of the levee assumed that a 50-foot wide corridor for working space purposes and 2-lane access road are required.

On the riverside of the levee assumed that a 20-foot wide corridor for working space and 2-lane access road for transportation of soil cement and stone are required.

A nominal dollar amount was assumed for any potential impact on cultural resources associated with the Homolovi I Pueblo site near the levee set-back area..

Replanting costs are based on direct costs from similar replanting efforts from past projects.

2.7 Federal and Non-Federal percent breakdown

Federal and non-federal cost sharing percentages are 65% and 35%, respectively.

2.8 Cost Schedule Risk Analysis

A Cost Schedule Risk Analysis (CSRA) brainstorming session was completed during the week of March 5th, 2018. A separate CSRA report documenting the risk drivers was prepared.

2.9 Schedule of Work

A project schedule was developed for the recommended plan based on a single construction phase. The schedule assumes crews work 10 hour days, 6 days a week. No construction is assumed during the monsoon season (Jul-Aug-Sep). Diversion and control of water at two locations mitigates the potential impact high flows within the river may have on construction and ensure there are no gaps in the levee system. The estimated construction duration is 2.5 years. A construction schedule for the recommended plan can be found in Attachment 5.

Attachment 1
Total Project Cost Summary

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For Project No. 138648

SPL – Little Colorado River Winslow, Arizona
Flood Risk Management Project

The Little Colorado River Winslow, AZ Flood Risk Management Project, as presented by Los Angeles District, has undergone a successful Cost Agency Technical Review (Cost ATR), performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of April 18, 2018, the Cost MCX certifies the estimated total project cost:

FY18 Project First Cost: $ 77,202,000
Fully Funded Amount: $ 91,032,000

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

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

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

PROJECT: Little Colorado Winslow FRM
PROJECT No: P2 - 138648
LOCATION: Winslow, Arizona

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: May 5, 2018

This Estimate reflects the scope and schedule in: Chiefs Report

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2018									
						Effective Price Level Date: 1 Oct 2017									
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 2017 ($K)	TOTAL FIRST COST ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*				*M*	*N*	*O*
11	LEVEES & FLOODWALLS	42,194	14,346	34%	56,540		42,194	14,346	56,540		56,540	14.9%	48,492	16,487	64,979
02	RELOCATIONS	761	304	40%	1,065		761	304	1,065		1,065	10.5%	841	336	1,177
18	CULTURAL RESOURCE PRESERVATION	150	51	34%	201		150	51	201		201	14.9%	172	59	231
	CONSTRUCTION ESTIMATE TOTALS:	43,105	14,701	34%	57,806		43,105	14,701	57,806		57,806	14.8%	49,505	16,882	66,387
01	LANDS AND DAMAGES	138	55	40%	194		138	55	193		193	8.3%	149	60	209
30	PLANNING, ENGINEERING & DESIGN	11,312	3,848	34%	15,160		11,312	3,848	15,160		15,160	25.8%	14,232	4,842	19,074
31	CONSTRUCTION MANAGEMENT	3,017	1,026	34%	4,043		3,017	1,026	4,043		4,043	32.6%	4,001	1,361	5,362
	PROJECT COST TOTALS:	57,572	19,630	34%	**77,202**		57,572	19,630	**77,202**		**77,202**	17.9%	67,887	23,145	**91,032**

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CHIEF, COST ENGINEERING AND SPECIFICATIONS, Michael D. Newnam, P.E.

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PROJECT MANAGEMENT, Priyanka Wadhawan

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CHIEF, REAL ESTATE, Cheryl Connett

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CHIEF, ENGINEERING, Gary J. Lee, P.E.

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

**** CONTRACT COST SUMMARY ****

PROJECT: Little Colorado Winslow FRM
LOCATION: Winslow, Arizona
This Estimate reflects the scope and schedule in feasibility report; Chiefs Report

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: May 5, 2018

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 5 May 2018 Effective Price Level: 1 Oct 2017				Program Year (Budget EC): 2018 Effective Price Level Date: 1 Oct 2017								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Rebuild Winslow Levee													
02	RELOCATIONS	761	304	**40%**	1,065		761	304	1,065	2023Q1	10.5%	841	336	1,177
11	LEVEES & FLOODWALLS	42,194	14,346	**34%**	56,540		42,194	14,346	56,540	2025Q1	14.9%	48,492	16,487	64,979
18	CULTURAL RESOURCE PRESERVATION	150	51	34%	201		150	51	201	2025Q1	14.9%	172	59	231
	CONSTRUCTION ESTIMATE TOTALS:	43,105	14,701	34%	57,806		43,105	14,701	57,806			49,505	16,882	66,387
01	LANDS AND DAMAGES	138	55	40%	194		138	55	193	2023Q3	8.2%	149	60	209
30	PRECONSTRUCTION ENGINEERING & DESIGN (PED)													
1.0%	Project Management	431	147	34%	578		431	147	578	2023Q3	24.6%	537	183	720
1.0%	Planning & Environmental Compliance	431	147	34%	578		431	147	578	2023Q3	24.6%	537	183	720
5.3%	Initial Geotech Investigations, studies, ….	2,290	779	34%	3,069		2,290	779	3,069	2023Q3	24.6%	2,853	971	3,824
0.9%	Initial Scour Analysis (H&H), studies ….	400	136	34%	536		400	136	536	2023Q3	24.6%	498	169	667
12.0%	Engineering & Design	5,173	1,759	34%	6,932		5,173	1,759	6,932	2023Q3	24.6%	6,445	2,192	8,637
1.0%	Reviews, ATRs, IEPRs, VE	431	147	34%	578		431	147	578	2023Q3	24.6%	537	183	720
0.5%	Life Cycle Updates (cost, schedule, risks)	216	73	34%	289		216	73	289	2023Q3	24.6%	269	91	360
0.5%	Contracting & ReprographicsContracting	216	73	34%	289		216	73	289	2023Q3	24.6%	269	91	360
3.0%	Engineering During Construction	1,293	440	34%	1,733		1,293	440	1,733	2025Q1	32.6%	1,715	584	2,299
1.0%	Real Estate and Planning During Construction	431	147	34%	578		431	147	578	2025Q1	32.6%	572	195	767
	Project Operation													
26.2%			PED Subtotal:		15,160			PED Subtotal:	15,160				PED Subtotal:	19,074
31	CONSTRUCTION MANAGEMENT													
7.0%	Construction Management	3,017	1,026	34%	4,043		3,017	1,026	4,043	2025Q1	32.6%	4,001	1,361	5,362
	Project Operation:													
	Project Management													
	CONTRACT COST TOTALS:	57,572	19,630		77,202		57,572	19,630	77,202			67,887	23,145	**91,032**
COST SPLIT														
65.0%	**FEDERAL COST TOTALS:**				50,056				50,056					59,035
35.0%	**NON-FEDERAL COSTS TOTALS:**				27,147				27,146					31,997

Attachment 2
Cost and Schedule Risk Analysis (CSRA)

US Army Corps
of Engineers®

Little Colorado River at Winslow, Navajo County, Arizona
Flood Risk Management Feasibility Study

Project Cost and Schedule Risk Analysis Report

Prepared by:

U.S. Army Corps of Engineers
Los Angeles District

June 2018

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Risk Register ..... APPENDIX A

Acronyms:

A/E – Architect/Engineer
ADWR – Arizona Department of Water Resources
ATR – Agency Technical Review
BCOES – Biddability, Constructability, Operability, Environmental and Sustainability Reviews
BIM – Building Information Modeling
BMP's – Best Management Practices
BNSF - Burlington Northern and Santa Fe Railway
CAD – Computer Aided Design
CSRA – Cost and Schedule Risk Analysis
CY – Cubic Yard
EPA – Environmental Protection Agency
ESA – Endangered Species Act
Phase 1 ESA – Environmental Site Assessment
FY – Fiscal Year. USACE fiscal year begins on October 1 and ends on September 31.
GAO – U.S. Government Accountability Office
H&H – Hydraulics and Hydrology
HOOH – Home office overhead
HTRW – Hazardous, Toxic and Radioactive Waste
IEPR – Independent External Peer Review
LA – Los Angeles
LCR – Little Colorado River
LERRD's – Lands, Easements, Rights of Way, Relocations, and Dredged Material Disposal Areas
MOD's – Construction Modifications (AKA change orders)
NED – National Economic Development
NPDES - National Pollutant Discharge Elimination System
OC – USACE Office of Counsel
O&M – Operation and Maintenance
PARC – Principal Assistant Responsible for Contracting.
PDT – Project Delivery Team
PED – Planning, Engineering and Design
PL 91-646 – (Public Law 91-646) Uniform Relocation Assistance and Real Property Acquisition Act of 1970
PM – Project Manager
PMP – Project Management Plan
PPA – Project Partnership Agreement
RE – USACE Office of Real Estate
RMF – Risk Management Framework
RWDL - Ruby Wash Diversion Levee
SBA – Small Business Administration
SDB – Small Disadvantaged Business
USACE – U.S. Army Corps of Engineers

EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), Los Angeles District, presents this Cost and Schedule Risk Analysis (CSRA) report regarding the risk findings and recommended contingencies for the Little Colorado River at Winslow, Navajo County, Arizona Flood Risk Management Feasibility Study In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis, *Monte-Carlo* based-study was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommend 80% confidence level of successful execution to project completion.

The City of Winslow has a long history of flooding along the LCR and its tributaries. There is an immediate need to reduce the risk of property damage caused by flooding in the City of Winslow and the surrounding communities. More importantly, there is a need to reduce the risk of loss of life, and safety caused by flooding.

One (1) contract is planned to reconstruct Winslow Levee. The contract consists of the following phases:

Phase 1: Saltcedar Removal Within the Vicinity of BNSF Bridge

Phase 2: Reconstruct Ruby Wash Levee and 600' of Winslow Levee

Phase 3 - Channelization Within the Vicinity of BNSF Bridge

Phase 4 - Reconstruct Winslow Levee and Build New levee along I-40

Phase 5 - Reconstruct Winslow Levee and Build Setback Levee

Phase 6 - Reconstruct Winslow Levee

Los Angeles District, Cost Engineering performed a risk analysis using the *Monte Carlo* technique for the estimated construction costs, supported by the District PDT input. The following ES-1 tables portray the development of the construction contingencies. The contingency is based on an 80% confidence level, as per USACE Civil Works guidance. Knowing that estimates can fluctuate to a certain degree over time with little to no change in risk, it is common to rely on the percent of contingency applied against the costs under study. The current construction estimate may have changed to a minor degree with no change in risks.

Table ES-1. Construction Contingency Results

Baseline Estimate Cost	$57,572,000	
Confidence Level	**Project Cost ($) with Contingency**	**Contingency**
50%	$73,692,160	28%
80%	**$77,202,000**	**34%**
90%	$78,297,920	36%

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based in cost and percent values. Should cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, and cost values rounded.

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The PDT worked through the risk register on 7-8 March, 2018. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $17.3M and schedule risks adding another potential of $2.3M, both at an 80% confidence level.

Cost Risks: From the CSRA, the key or greater Cost Risk items for Construction Contracts include:

- TL2 – Scour Analysis – Concern that the scour depth assumptions may be inadequate. Current design uses scour depths from the report completed by ADWR during a 1980 study. Additional analysis may result in design variations within all phases and a detailed scour analysis at Interstate Highway 40 (I-40), State Route (SR) 87 and the BNSF Bridge may result in additional project features.

- ET-9 – Production Rates Variance – Concern that hauling productivity rates may be slower than anticipated due to congestion from multiple crews. Construction is limited to a 270 foot corridor with several heavy construction equipment travelling along the corridor. Excavation and Backfill hauling equipment may interfere. A site construction model may mitigate this risk. Although this may affect cost, the project site is large enough to run multiple crews without affecting construction schedule.

- CO9 – Dewatering – Concern that the contractor may have a problem developing a dewatering plan. It may take time for the contractor to optimize his dewatering

system. Risk concerns on phases 2, 3, 4, 5 and 6. Schedule is not impacted since the contractor will be able to accomplish other work while optimizing the dewatering system and diversion of water.

- TL6 – River Suitable Material – Concern on excavated material from the LCR 1,000 ft upstream and 1,500 ft downstream of the BNSF Railroad Bridge suitability for levee construction. Concern is the material is not usable as planned. Excavated volume is sufficient to build most of the levee. If material excavated from the LCR cannot be used for levee construction, additional cost will be incurred as import and export from another source.

- ET2 – Variation in Quantities – Concern that the estimate is based on quantities that are assumed. Quantities are the cornerstone for cost development. If quantities are inaccurate, there will be a lack of confidence in the estimate and the construction schedule. Quantities in the Current Working Estimate (CWE) have been verified; however, as more information is made available, the quantities may change. Current estimate assumes that the majority of the material excavated from the channel and the levee can be used for construction of the new levee. Additional information may change this assumption and lead to a variation in quantities.

- CA4 – Bidding Climate – Concern on market conditions at time of bid. Multiple bidders typically compete for USACE contracts. The assumption is that there will be a competitive bidding climate on this project. The last decade has had large economic swings, changing the bidding climate. The PDT is concerned that there may be inadequate competition for the projects, causing construction costs to go up.

- TL10 – Ground Subsidence in Levee Foundation – Concern that subsidence or other soil instability will be encountered. Seismic refractive profiling completed in 2013 did not indicate any areas of concern, however there is still a risk problematic areas could be identified once additional geotechnical exploration is completed. If encountered, the design of the levee would need to be revised to accommodate the new conditions.

- PM10 – Railroad Coordination –Extensive coordination with the Railroad is required to implement channelization and other measures. BNSF's approval of removing sediment under their bridge is needed for the project to work. Excavation below the original (design) river depth is not required; however, BNSF may have concerns that the project will adversely impact their bridge structure. Additional structural analysis may be required to mitigate this risk.

- TL13 – Internal/Sponsor Review Process – Concern that scope could change as a result of multiple reviews by the USACE, BNSF, and local sponsor. Risk focus on internal and sponsor reviews.

- TL17 – Controlled Overtopping Section – Controlled overtopping may be needed along the levee near the BNSF bridge. This feature is currently unaccounted for in the preliminary design. Currently, the estimate includes an allowance to account for this feature. This cost may be over or understated. Current cost is a Rough Order of Magnitude (ROM) based on limited information from preliminary hydraulic analysis.

Schedule Risks: The schedule risk indicates some uncertainty of key risk items; time duration growth that can translate into added costs. Over time, risks increase on out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The key or greater Cost Risk items include:

- CO1 – Construction Schedule – Concern that the contractor may take longer to perform the work. Monsoon storms and other natural storm events regularly occur. The project is in the desert, with minimal rainfall and river flow is normally low between April and June with the possibility of monsoonal storms between July and September. The concerns are from a swollen river and possibly biological species (nesting seasons). Rain averages are minimal. Down time due to precipitation should be relatively small between April and June. The PDT has planned the work so that demolition of the existing levee system will not impact the function of the entire levee system. It is possible that contracts could be structured to allow contractors to take advantage of good weather (through contract options), to mitigate this risk.

- PM10 – Railroad Coordination – Extensive coordination with the BNSF Railroad is required to implement channelization and other measures. BNSF's approval of removing sediment under their bridge is needed for the project to work. Excavation below the original (design) river depth is not required; however, BNSF may have concerns that the project will adversely impact their bridge structure. Additional structural analysis may be required to mitigate this risk. The Railroad may not allow the work to proceed as planned.

- TL13 – Internal/Sponsor Review Process – Concern that scope could change as a result of multiple reviews by the USACE, BNSF, and local sponsor. Railroad review is under way. Risk focus on internal and sponsor reviews

- PM3 - Timely Response to Critical Decisions/Reviews/PDT Priories – Concern that the project manager has no control over staff priorities. The PDT assumed that the remainder of the design will be done in house where competing priorities may slow work on the project. There is also a possibility that the project may come to a stop until critical input is received.

- LD3 - Unwilling Seller – An unwilling seller could lead to condemnation which impacts implementation schedule and requires PL91-646 compliance.

- PR6 – Local Utility Relocation – There are several utilities which traverse the levee. Utility relocations may delay the schedule. The local sponsor will be relocating high pressure gas and water lines. Utility relocation work needs to be done before construction begins on Phases 4 and 5.

- CO11 – Consideration for Post-Award Construction Claims and Modifications – This item captures the risk that post-award construction modifications or claims may cause a variance to project cost and schedule, in particular related to geotechnical concerns.

Recommendations: The CSRA study serves as a “road map” towards project improvements and reduced risks over time. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

MAIN REPORT

1.0 PURPOSE

Under the auspices of the US Army Corps of Engineers (USACE), Los Angeles District, this report presents a recommendation for the total project cost and schedule contingencies for the Little Colorado River at Winslow, Arizona, Flood Risk Management Project.

2.0 BACKGROUND

The project is located near the city of Winslow, County of Navajo, Arizona, approximately 55 miles east of the intersection of Highway 17 and Interstate Highway 40 (I-40) in the northeastern portion of Arizona, at the confluence of the LCR and Ruby Wash. The LCR generally runs from south to north near Winslow. Ruby Wash joins the LCR just south of State Route (SR) 87. The existing Ruby Wash Diversion Levee (RWDL) generally runs in an east-west direction.

The Recommended Plan, based on previous studies, is known as Alternative 10.1. Alternative 10.1 involves using salvaged excavation materials from the Winslow levee and the RWDL to the maximum extent possible. It includes rebuilding the Winslow Levee from the RWDL downstream to a point 0.8 miles north of North Road, approximately 3.55 miles, set back of a 2,000-ft segment of the Winslow Levee across the LCR from the Homolovi I Pueblo, removal of the original Winslow Levee in the setback area, rebuilding the eastern end of the RWDL, constructing a new levee parallel to I-40, and improving conveyance under the BNSF Railroad Bridge with channelization and salt cedar removal.

New levee construction would be designed at a scale that provides 90% assurance of containing the 1% ACE flood event. The levee would include both soil cement and riprap slope protection with a launchable stone toe that will reduce excavation requirements. Local drainage would be collected by a proposed concrete V-ditch located along the landside of the levee.

One contract is planned to reconstruct Winslow Levee. The contract consists of the following phases:

Phase 1- Saltcedar Removal Within the Vicinity of BNSF Bridge
This contract includes removal of all Saltcedar in the vicinity of BNSF Bridge. There is 60 Acres upstream, and 36 acres downstream of the bridge.

Phase 2 - Reconstruct Ruby Wash Levee and 600' of Winslow Levee
Includes 2,000 LF of Ruby Wash Diversion Levee upstream of BNSF Railroad and an additional 600LF of Winslow levee..

Phase 3 - Channelization Within the Vicinity of BNSF Bridge
Includes removal of sediment within the channel in the vicinity of BNSF Bridge. Sediment removed from the channel will be used in the construction of future phases.

Phase 4 - Reconstruct Winslow Levee and Build New levee along I-40
Includes rebuilding about 9,100 LF of Winslow Levee upstream of I-40, construction of a new levee along the northern side of I-40, reconstruction of Winslow Levee from I-40 up to upstream of the K3 outlet, and modification of the K3 outlet.

Phase 5 - Reconstruct Winslow Levee and Build Setback Levee
Includes about 7,800 LF of reconstruction of the Winslow Levee and construction of a setback levee to replace a segment of the Winslow Levee.

Phase 6 - Reconstruct Winslow Levee
Includes reconstruction of about 3,000 LF of the existing Winslow Levee from the downstream end of the setback levee to the downstream end of the project.

3.0 REPORT SCOPE

The scope of the risk analysis report is to identify cost and schedule risks with a resulting recommendation for 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 cost risks for construction features. The CSRA excludes Real Estate costs, relocations and does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the Micro Computer Aided Cost Estimating System (MCACES) cost estimate, project schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates and schedules were developed and presented by the Los Angeles District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of concerns, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2 USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Mandatory Center of Expertise (MCX). The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. 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 to 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 analysis 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, this risk analysis was 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 MCX.

- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated June 30, 2016.

4.0 METHODOLOGY / PROCESS

Chicago District, USACE performed the initial Cost and Schedule Risk Analysis, relying on the PDT to provide expertise and information gathering. A brainstorming session was held on 7-8 March, 2018 and follow on meetings were held with individual members. The initial risk identification meeting also included qualitative analysis to produce a risk register that served as the draft framework for the risk analysis.

Participants in the risk identification meeting of 7-8 March, 2018 included:

Attendance	Name	Office	Representing
X	Priyanka Wadhawan	CESPL-PM-C	Project Manager
X	Kim Gavigan	CESPL-PM-C	Lead Planner (Planning)
X	Richard Legere	CESPL-PDW-C	Technical Lead
	Mark Masnor	CESWF-PEC-PF	ATR Lead
X	Larry Walsh	CESPL-EDD-D	Cost Engineer
	Darrell Buxton	CESPL-PM-C	Chief, Civil Works Branch
	Paul Underwood	CESPL-EDD	Chief, Design Branch
	Michael Newnam	CESPL-EDD-D	Chief, Cost Engineering
	Adam Bier	CESPL-ED-HH	Senior Hydraulic Engineer
X	David Pham	CESPL-EDD-A	Civil Engineer/Design
X	Mark Chatman	CESPL-ED-GG	Project Geologist
X	Julia Yang	CESPL-ED-GD	Geotechnical Engineer
X	Kirk Brus	CESPL-PD-RL	NEPA Compliance
X	Danielle Galloway	CESPA-PM-LE	Biologist (Plantings)
X	Danielle Storey	CESPL-PD-RN	Archaeologist
	Danny Carassco		Contracting
	Elena Eggers		Office of Council
			Construction
			Operations
			Real Estate
X	Douglas Dahncke	CESPL-ED-GD	Chief, Geotechnical Engineering
X	Mel Lagunzad	CESPL-ED	Technical Services Intern
	Kevin Grove		Regulatory

The draft CSRA model was completed March 2018 and revised in April 2018 by Los Angeles District in response to ATR comments. On May 2018, the estimate was revised to approach the project as one large contract instead of six small contracts. The risk analysis was updated by interviewing key team members (Geotechnical engineering, H&H and Project Management). The risk analysis was updated to mirror the changes in the estimate and resubmitted for re-certification. The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve the desired level of cost confidence. Per regulation and guidance, the P80 confidence level (80% confidence level) is the normal and accepted cost confidence level. District Management has the prerogative to select different confidence levels, pending approval from Headquarters, USACE.

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

The Cost MCX 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 averse 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 selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

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. 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 are provided in Section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative 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.

A formal PDT meeting was held for the purposes of identifying and assessing risk factors. The meeting included capable and qualified representatives from multiple project team disciplines and functions, including project management, cost engineering, design, and project personnel.

The initial formal meetings focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Additionally, numerous conference calls and informal meetings were conducted throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification and risk assessment.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were 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 and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following elements of each risk factor:

- 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

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 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 baseline 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 larger portion of the project cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5.0 PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the project.

a. The Lost Angeles District provided MII MCACES (Micro-Computer Aided Cost Estimating Software) files electronically. The MII and CWE files and resulting independent review, served as the basis for the final cost and schedule risk analyses.

b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level of design.

c. Schedules are analyzed for impact to the project cost in terms of delayed funding, uncaptured escalation (variance from Office of Management and Budget (OMB) factors and the local market) and unavoidable fixed contract costs and/or languishing federal administration costs incurred throughout delay.

d. The Cost Engineering MCX guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.

e. Only high and moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation, and reviewed at each project milestone to determine if they should be placed on the risk "watch list".

6.0 RESULTS

The Cost and Schedule Risk Analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in Appendix A. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

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 feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Contingency and Sensitivity Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project cost at intervals of confidence (probability).

Table 1 provides the construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P50, P80 and P90 confidence levels are also provided for illustrative purposes only.

Cost contingency for the Construction risks (including schedule impacts converted to dollars) was quantified as approximately $19.6 Million at the P80 confidence level (34% of the baseline construction cost estimate).

Table 1. Construction Cost Contingency Summary

Baseline Estimate Cost	**$57,572,000**	
Confidence Level	**Project Cost ($) with Contingency**	**Contingency**
50%	$73,692,160	28%
80%	**$77,202,000**	**34%**
90%	$78,297,920	36%

6.2.1 Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

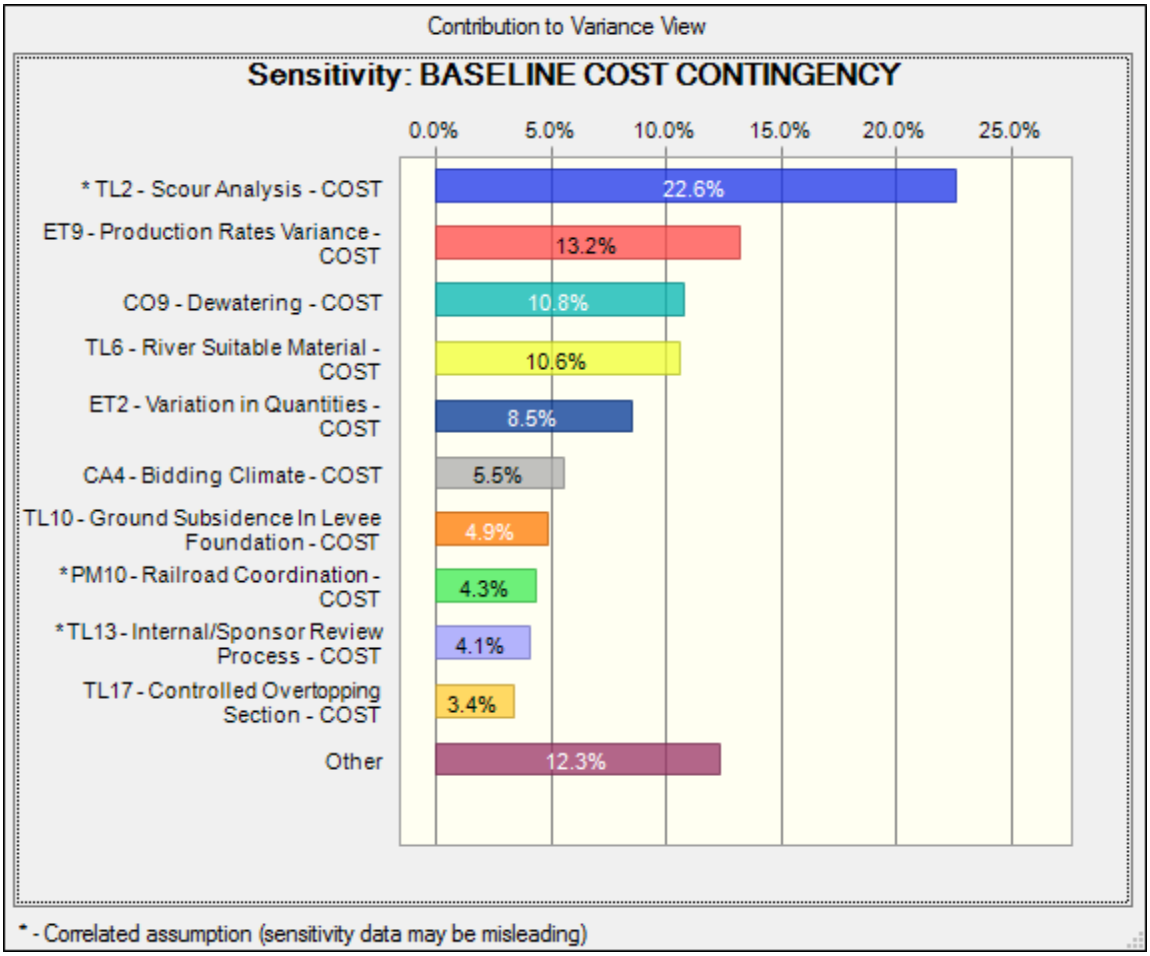
Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

6.2.2 Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers and the respective value variance are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 1 presents a sensitivity analysis for cost growth risk from the high level cost risks identified in the risk register.

Figure 1. Cost Sensitivity Analysis



6.3 Schedule and Contingency Risk Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project duration at intervals of confidence (probability).

Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 21 months based on the P80 level of confidence. These contingencies were used to calculate the projected residual fixed cost impact of project delays that are included in the Table 1 presentation of total cost contingency. The schedule contingencies were calculated by applying the high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

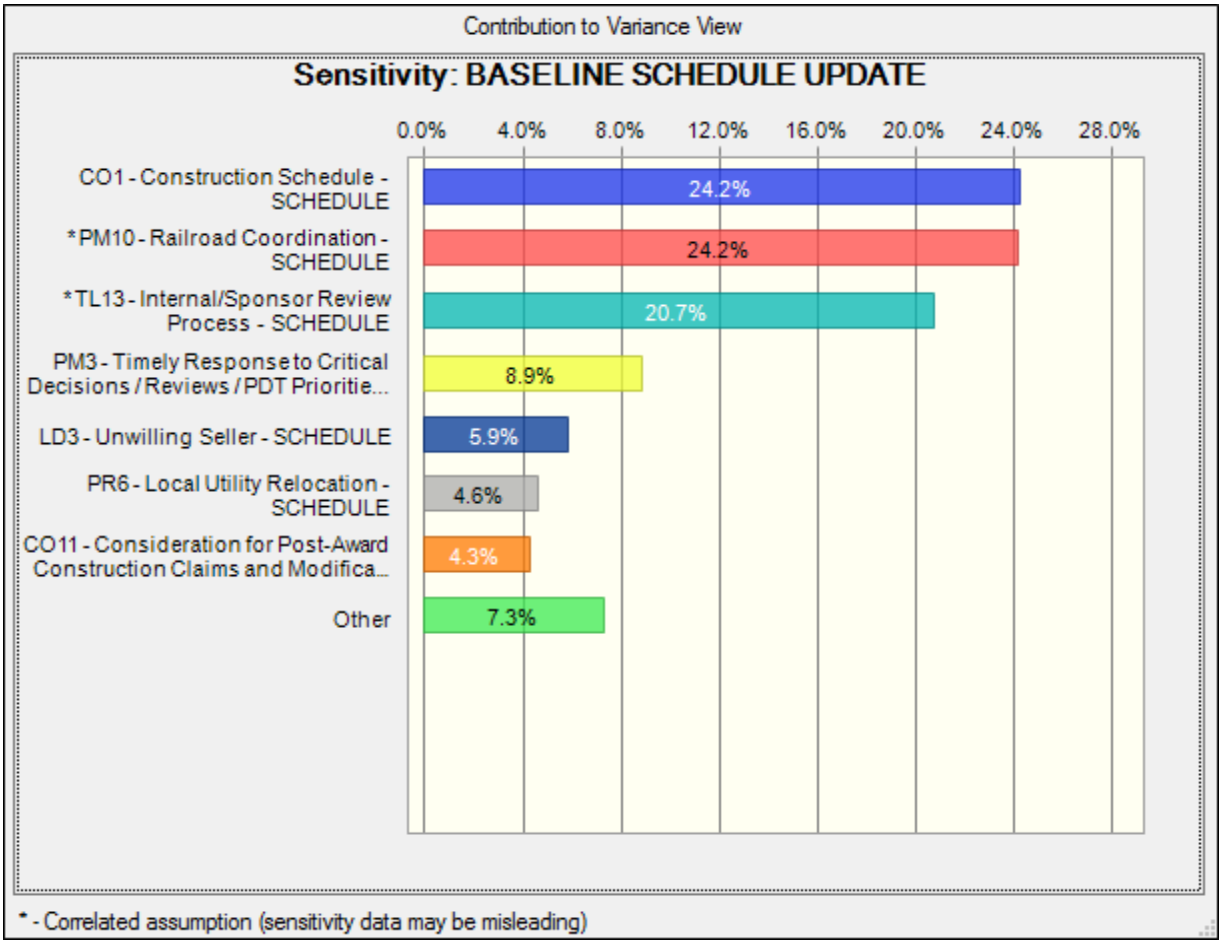
The schedule evaluated was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs.

Table 2. Schedule Duration Contingency Summary

Base Case Schedule	**66 months**	
Confidence Level	**Schedule Duration (Months) w/ Contingency**	**Contingency (months)**
50%	149 months	83 months
80%	153 months	87 months
90%	155 months	89 months

Notes:
1) The schedule evaluated was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented in Table 2.
2) A P100 confidence level is an abstract concept as the nature of risk and uncertainty (specifically the presence of “unknown unknowns”) makes 100% confidence a theoretical impossibility.

Figure 2. Schedule Sensitivity Analysis



7.0 MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. 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. Because of the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1 Major Findings/Observations

Project cost and schedule comparison summaries are provided in Table 3 and Table 4 respectively. Additional major findings and observations of the risk analysis are listed below.

Cost Risks: From the CSRA, the key or greater Cost Risk items for Construction Contracts include:

- TL2 – Scour Analysis – Concern that the scour depth assumptions may be inadequate. Current design uses scour depths from the report completed by ADWR during a 1980 study. Additional analysis may result in design variations within all phases and a detailed scour analysis at I-40, SR 87 and the BNSF Bridge may result in additional project features.

- ET-9 – Production Rates Variance – Concern that hauling productivity rates may be slower than anticipated due to congestion from multiple crews. Construction is limited to a 270 foot corridor with several pieces of heavy construction equipment travelling along the corridor. Excavation and Backfill hauling equipment may interfere. A site construction model may mitigate this risk. Although this may affect cost, project site is large enough to run multiple crews without affecting construction schedule.

- CO9 – Dewatering – Concern that the contractor may have a problem developing a dewatering plan. It may take time for the contractor to optimize his dewatering system. Risk concerns on phases 2, 3, 4, 5 and 6. Schedule is not impacted since the contractor will be able to accomplish other work while optimizing the dewatering system and diversion of water.

- TL6 – River Suitable Material – Concern on excavated material from the LCR 1,000 ft upstream and 1,500 ft downstream of the BNSF Railroad Bridge suitability for levee construction. Concern is the material is not usable as planned. Excavated volume is sufficient to build most of the levee. If material excavated from the LCR cannot be used for levee construction, additional cost will be incurred as import and export from another source.

- ET2 – Variation in Quantities – Concern that the estimate is based on quantities that are assumed. Quantities are the cornerstone for cost development. If quantities are inaccurate, there will be a lack of confidence in the estimate and the construction schedule. Quantities in the CWE have been verified; however, as more information is made available, the quantities may change. Current estimate assumes that the majority of the material excavated from the channel and the levee can be used for construction of the new levee. Additional information may change this assumption and lead to a variation in quantities.

- CA4 – Bidding Climate – Concern on market conditions at time of bid. Multiple bidders typically compete for USACE contracts. The assumption is that there will be a competitive bidding climate on this project. The last decade has had large economic swings, changing the bidding climate. The PDT is concerned that

there may be inadequate competition for the projects, causing construction costs to go up.

- TL10 – Ground Subsidence in Levee Foundation – Concern that subsidence or other soil instability will be encountered. Seismic refractive profiling completed in 2013 did not indicate any areas of concern, however there is still a risk problematic areas could be identified once additional geotechnical exploration is completed. If encountered, the design of the levee would need to be revised to accommodate the new conditions.

- PM10 – Railroad Coordination – Extensive coordination with the BNSF Railroad is required to implement channelization and other measures. BNSF's approval of removing sediment under their bridge is needed for the project to work. Excavation below the original (design) river depth is not required; however, BNSF may have concerns that the project will adversely impact their bridge structure. Additional structural analysis may be required to mitigate this risk.

- TL13 – Internal/Sponsor Review Process – Concern that scope could change as a result of multiple reviews by the USACE, BNSF, and local sponsor. Risk focus on internal and sponsor reviews.

- TL17 – Controlled Overtopping Section – Controlled overtopping may be needed along the levee near the BNSF Bridge. This feature is currently unaccounted for in the preliminary design. Currently, the estimate includes an allowance to account for this feature. This cost may be over or understated. Current cost is a ROM based on limited information from preliminary hydraulic analysis.

Schedule Risks: The schedule risk indicates some uncertainty of key risk items; time duration growth that can translate into added costs. Over time, risks increase on out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The key or greater Cost Risk items include:

- CO1 – Construction Schedule – Concern that the contractor may take longer to perform the work. Monsoon storms and other natural storm events regularly occur. The project is in the desert, with minimal rainfall and river flow is normally low between April and June with the possibility of monsoonal storms between July and September. The concerns are from a swollen river and possibly biological species (nesting seasons). Rain averages are minimal. Down time due to precipitation should be relatively small between April and June. The PDT has planned the work so that demolition of the existing levee system will not impact the function of the entire levee system. It is possible that contracts could be structured to allow contractors to take advantage of good weather (through contract options), to mitigate this risk.

- PM10 – Railroad Coordination – Extensive coordination with the Railroad is required to implement channelization and other measures. BNSF's approval of removing sediment under their bridge is needed for the project to work. Excavation below the original (design) river depth is not required; however, BNSF may have concerns that the project will adversely impact their bridge structure. Additional structural analysis may be required to mitigate this risk. The Railroad may not allow the work to proceed as planned.

- TL13 – Internal/Sponsor Review Process – Concern that scope could change as a result of multiple reviews by the USACE, BNSF, and local sponsor. Railroad review is under way. Risk focus on internal and sponsor reviews

- PM3 - Timely Response to Critical Decisions/Reviews/PDT Priories – Concern that the project manager has no control over staff priorities. The PDT assumed that the remainder of the design will be done in house where competing priorities may slow work on the project. There is also a possibility that the project may come to a stop until critical input is received.

- LD3 - Unwilling Seller – An unwilling seller could lead to condemnation which impacts implementation schedule and requires PL91-646 compliance.

- PR6 – Local Utility Relocation – There are several utilities which traverse the levee. Utility relocations may delay the schedule. The local sponsor will be relocating high pressure gas and water lines. Utility relocation work needs to be done before construction begins on Phases 4 and 5.

- CO11 – Consideration for Post-Award Construction Claims and Modifications – This item captures the risk that post-award construction modifications or claims may cause a variance to project cost and schedule, in particular related to geotechnical concerns.

Recommendations: The CSRA study serves as a “road map” towards project improvements and reduced risks over time. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

Table 3 Construction Cost Comparison Summary (Uncertainty Analysis)

Most Likely Cost Estimate	$57,572,000		
Confidence Level	**Project Cost**	**Contingency**	**Contingency %**
0%	**$64,480,640**	**$6,908,640**	**12.00%**
10%	**$69,662,120**	**$12,090,120**	**21.00%**
20%	**$70,813,560**	**$13,241,560**	**23.00%**
30%	**$71,965,000**	**$14,393,000**	**25.00%**
40%	**$73,116,440**	**$15,544,440**	**27.00%**
50%	**$73,692,160**	**$16,120,160**	**28.00%**
60%	**$74,267,880**	**$16,695,880**	**29.00%**
70%	**$75,419,320**	**$17,847,320**	**31.00%**
80%	**$77,202,000**	**$19,630,000**	**34.00%**
90%	**$78,297,920**	**$20,725,920**	**36.00%**
100%	**$85,206,560**	**$27,634,560**	**48.00%**

Table 4 - Construction Schedule Comparison Summary (Uncertainty Analysis)

Most Likely Schedule Duration	66 Months		
Confidence Level	**Project Duration**	**Contingency**	**Contingency %**
0%	**71 Months**	**5 Months**	**8.00%**
10%	**78 Months**	**12 Months**	**18.00%**
20%	**80 Months**	**14 Months**	**21.00%**
30%	**81 Months**	**15 Months**	**23.00%**
40%	**82 Months**	**16 Months**	**24.00%**
50%	**83 Months**	**17 Months**	**26.00%**
60%	**84 Months**	**18 Months**	**28.00%**
70%	**85 Months**	**19 Months**	**29.00%**
80%	**87 Months**	**21 Months**	**32.00%**
90%	**89 Months**	**23 Months**	**35.00%**
100%	**98 Months**	**32 Months**	**48.00%**

7.2 Recommendations

Risk Management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute's (PMI) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, *4th edition*, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that the proactive management of risks not conclude with the study completed in this report.

The Cost and Schedule Risk Analysis (CSRA) produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

The CSRA study serves as a "road map" towards project improvements and reduced risks over time. Timely coordination and risk resolution between the Sponsor, Railroad, and USACE is needed in areas of ROW, site access and staging, and funding needs and updates as applicable. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

<u>Risk Management</u>: Project leadership should use of the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

<u>Risk Analysis Updates</u>: Two major risk drivers were mitigated: Funding availability and Local Sponsor Funding. We are currently assuming Federal and Non-Federal funding will be available for the project as needed to meet the schedule. There is a risk that money will not be available as needed. The District management is willing to buy this risk. SPL District is confident that the project will get the funds as requested for construction due to the strong support of the project at Division and HQ level. We are, also, assuming that the County of Navajo (local Sponsor) will be able to provide their share of the cost of the project. The local sponsor understands that this is a cost-

shared project, and have been prompt in providing resources for the study. The community and the Sponsor strongly support the construction of the project. In our recent discussions with them, they have funds set aside for the PED and Construction phases of the project.

Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and reevaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

APPENDIX A

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule			
				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										
PM1	PMP Outdated	Project management plan is a living document that provides authority for the project and defines it. Hasn't been updated since 2016.	Scheduling delays can arise. PDT can lose focus, causing cost and schedule impacts. Even though the project management plan has not been updated since 2016, the array of alternatives and preferred alternatives remains the same.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW	
PM2	PDT Changes	Members of PDT change overtime.	Institutional knowledge of the project gets lost over time. There are only 3 original members from first PDT. There probably will be additional changes to the PDT. Additional design costs would occur as new members get familiar with the project.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
PM3	Timely Response to Critical Decisions / Reviews / PDT Priorities	Project Manager has no control over staff priorities.	The PDT assumes that the remainder of the design work will be done in house. USACE's organizational structure is a weak matrix. The project may move forward without critical technical input, causing additional costs and schedule impacts further down the line and during construction. There is also a possibility that the project may come to a halt/stop until critical input is received.	Likely	Significant	HIGH		Likely	Significant	HIGH	
PM4	Functional and Technical Labor	Concern is that there may be a lack of functional or technical labor, causing delays to the project.	If USACE does not have the technical resources in house to perform the work, we can hire an A/E or utilize resources from another District to perform the work.	Unlikely	Marginal	LOW		Unlikely	Negligible	LOW	
PM5	Critical Staff	The PDT may loose critical staff during the project.	This may impact product submission and schedule. It is unlikely that there will be multiple key people lost on the project.	Very Likely	Marginal	MODERATE		Very Likely	Negligible	LOW	
PM6	Inexperienced Staff	The PDT may have inexperienced staff assigned to the project. This can cause lost time.	Inexperienced staff can affect both the planning and PED phases of the project. It depends on what functional role they are performing. This risk is similar to Critical Staff.	Likely	Marginal	MODERATE		Very Likely	Negligible	LOW	
PM7	Virtual or Remote Staff	USACE is becoming a virtual workspace. PDT members can telework or be working in different Districts. This can impact the project.	We currently have our key planners in Arizona (not the LA District Office) and this has not affected the project. The PDT feels that this does not impact the project.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PM8	Communication Plan	Currently, the project does not have a communication plan in the PMP. This could impact project schedule.	Although there is currently not a communication plan in place, there will probably be one as the project progresses in design development.	Very Likely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PM9	Time to Finish Planning	The current 3x3x3 planning processes require an expedited planning process. There may not be enough time to get all work necessary for the Chief's Report by December 2018.	This is a high priority project for the LA District. The deadline is a fixed date. If additional resources are needed, they could be provided by the PM.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PM10	Railroad Coordination	Extensive coordination with the Railroad is required to implement channelization and other measures.	BNSF's approval of removing sediment under their bridge is needed for the project to work. Excavation below the original (design) river depth is not required; however, BNSF may have concerns that the project will adversely impact their bridge structure. Additional structural analysis may be required to mitigate this risk.	Very Likely	Significant	HIGH		Very Likely	Significant	HIGH	
	CONTRACT ACQUISITION RISKS										
CA1	Acquisition Strategy	Contract acquisition strategy is undefined.	Current estimate follows an open bid process. Project may pursue Trade-Off or LPTA (Best Value) acquisition contract. Trade or other contractural method could affect costs with marginal impact to the schedule.	Unlikely	Significant	MODERATE		Unlikely	Marginal	LOW	
CA2	Number of Contracts	Project is estimated and pursuing one contract, our contracting officer may break down larger contract work further to award multiple small business contracts. POST-BRAINSTORM SESSION UPDATE: Acquisition strategy changed from breaking down the project. PDT is pursuing 1 contract instead of 6 small contracts.	Number of contracts will impact the cost and schedule. Multiple contracts are unlikely, however multiple contracts would result into higher construction costs, more PED and Contracting efforts. This item captures the risk that multiple contracts increase total project cost.	Unlikely	Significant	MODERATE		Unlikely	Critical	MODERATE	

CA3	Sequence of Contract Awards	Contracts build upon each other and need to be done in sequence because excavated material from one contract will be fill material for another contract. POST-BRAINSTORM SESSION UPDATE: Risk not modeled since we are assuming 1 contract.	There could be unplanned costs from importing and exporting material due to material shortages within the separate contracts	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW	
CA4	Bidding Climate	Concern on market conditions at time of bid. Multiple bidders typically compete for USACE contracts. The assumption is that there will be a competitive bidding climate on this project.	The last decade has had large economic swings, changing the bidding climate. The PDT is concerned that there may be inadequate competition for the projects, causing construction costs to go up.	Very Likely	Significant	HIGH		Very Likely	Negligible	LOW	
	TECHNICAL RISKS										
TL1	Topographic Data Outdated	Topographic data is from 2009. LCR is a dynamic channel subject to migration of low flow channel; changes in in-channel sediment and vegetation levels.	Most topographic changes occur during large flood events. There have been no such events since the topographic data was collected.	Likely	Significant	HIGH	$1-2M	Likely	Marginal	MODERATE	1-2 months
TL2	Scour Analysis	Scour depth assumptions may be inadequate. Scour analysis along river system may result into design variations along all reaches. Tying into the bridges/crossings abutments has not been design.	Current design uses scour depths from the report completed by ADWR during a 1980 study. Current level of design is only 15%. Hwy 40, Hwy 87 and BNSF Bridge scour evaluations may result into additional scope features.	Likely	Significant	HIGH		Likely	Negligible	LOW	
TL3	Geotechnical Data	The current design lacks sufficient geotechnical data which can change the levee cross sectional area (design).	Levee design complexity is based largely on geotechnical information that is currently lacking. Exploration and testing of levee materials and foundation is necessary prior to completion of design. Changes in material properties identified during PED can change levee design. This risk is similar to TL1	Very Likely	Critical	HIGH		Very Likely	Significant	HIGH	
TL4	Levee Alignment	The levee could require a different design than assumed during plan formulation.	If undesirable subsurface conditions exist with the current alignment, the levee location (design) could change. Not significant changes to the levee alignment. Only small adjustments to the horizontal alignment.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
TL5	Unanticipated Cultural Mitigation	Additional modelling in PED may show that we are having an adverse effect on Homolovi I.	Initial vegetation removal and additional O&M removal, or cultural mitigation. Cultural mitigation is currently carried in the cost estimate as 1% of the cost of construction.	Likely	Negligible	LOW		Likely	Negligible	LOW	
TL6	River Suitable Material	Concern on excavated material from the LCR 1,000 ft upstream and 1,500 ft downstream of the BNSF Railroad Bridge suitability for levee construction. Concern is the material is not usable as planned.	Excavated volume is sufficient to build most of the levee. If material excavated from the LCR cannot be used for levee construction, additional cost will be incurred as import and export from another source.	Very Likely	Significant	HIGH	$1-3M	Very Likely	Negligible	LOW	
TL7	Off-site Borrow Sources	The current alternative assumes that borrow sources identified by Navajo County will provide material that is suitable for levee construction. Concern is the lack of test data for the offsite borrow resources can show that it is not usable.	If borrow materials are not suitable for levee construction, the distance to a site that will provide useable materials is likely to increase. This is unlikely, however as Navajo County reports using these borrow sources for construction of the existing levee. Currently we are assuming the material is all coming from onsite sources.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
TL8	Seepage Trench Borrow Re-Use	We are currently assuming 100% of the material excavated for the seepage (sub drainage) trench is suitable for re-use in the new levee.	We are assuming this material will replace the unsuitable (30%) material from the existing levee. If the assumption of 100% (approx. 110,000 cy) re-use is incorrect, we have a surplus of material for levee construction. It's an export project.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
TL9	Suitability of existing levee material	We are currently assuming material excavated from the existing levee removal is suitable for re-use in the new levee. The concern is that less of the material may be re-usable.	We are assuming excavated material from the levee is suitable. If the salvage percent assumption is incorrect, additional hauling will be incurred in the project.	Very Likely	Marginal	MODERATE		Very Likely	Negligible	LOW	
TL10	Ground Subsidence In Levee Foundation	We are currently assuming the foundation soils are stable. If foundation soils are not stable, foundation subsidence or other soil instability will be encountered.	If we perform additional geotechnical explorations, the site could be better defined to mitigate this risk. We have about 4 miles of seismic refractive profiling that was done in 2013 for this study and it did not indicate any areas of concern of this type. If it is encountered, we would revise the design to accommodate this condition.	Unlikely	Significant	MODERATE		Unlikely	Negligible	LOW	
TL11	Unexpected Obstructions In The Foundation	The current assumption is that there are no large obstructions in the foundation of the existing levee. An obstruction can be boulders, debris, and cementation.	Human and natural activity in the area over the last 150 years may have deposited or formed these obstructions. The PDT feels that this is extremely unlikely.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	

TL12	Technical Deficiencies Discovered During Bidding	The base assumption is that the bidding goes smoothly with no amendments. Concern is that bidders will uncover deficiencies in the project during bidding that will impact the costs.	If BCOES, ATR, IEPR review processes are rigorous and thereby risk is mitigated. This is similar to CO11.	Very Unlikely	Significant	LOW		Unlikely	Marginal	LOW	
TL13	Internal/Sponsor Review Process	Concern that scope could change as a result of multiple reviews by the COE, BNSF, and local sponsor. POST-BRAINSTORM SESSION UPDATE: Railroad review is under way. Risk focus on internal and sponsor reviews.	There is a risk that there could be a cost growth due to coordination/communication challenges as products are developed by several sources.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
TL14	Archeological Sites and Levee Corridor	The current design will impact local archeological sites. This could impact the project.	The risk is getting the programmatic agreement signed, a cultural resources agreement in place, before construction. This could take more time than anticipated.	Very Likely	Negligible	LOW		Very Likely	Marginal	MODERATE	3 mo. MAX
TL15	Levee Height	H&H analysis may increase the levee height to meet it's intended purpose.	PDT believes that the current height is conservative. However, additional modeling may increase levee height in specific areas. The levee is known to be 3/10 FT below the height required.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
TL16	Future Sedimentation in the Channelized Area	H&H analysis may show and increase of sedimentation in the LCR.	This is an O&M cost. Intent is to maintain design conveyance (LCR flow).	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
TL17	Controlled Overtopping Section	Controlled overtopping may be needed along the levee near the BNSF bridge. This feature is currently unaccounted for in the preliminary design.	Currently, the estimate includes an allowance to account for this feature. This cost may be over or understated. Current cost is a ROM based on limited information from preliminary hydraulic analysis.	Very Likely	Marginal	MODERATE		Very Likely	Negligible	LOW	
TL18	Toe Protection Interface with Bridges Abutments	POST-BRAINSTORM SESSION UPDATE: Toe protection interface with Hwy 40, Hwy 87 and BNSF bridges is currently unaccounted for in the preliminary design.	Currently, the estimate does not include an allowance to account for this feature. This cost may be over or understated. This risk may or may not occur. Risk is Correlated with Scour Design (TL2)	Very Likely	Marginal	MODERATE		Very Likely	Negligible	LOW	
	LANDS AND DAMAGES RISKS										
LD1	HTRW	Unknown HTRW issues can exist on the site. This can affect new structures or alignments.	Phase I, ESA completed. No evidence to suggest extensive HTRW issues. Low possibility due to presence of former Railroad alignment near BNFS bridge.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
LD2	Sponsor Participation	Some of the LERRDS required may be on land controlled by American Indians; unrecorded patents that may arise when title work is completed. A PPA has not been executed.	Most of the landowners would welcome a flood control project in their area. If the sponsor is unwilling to participate, it may lead to reformulation of the plan.	Likely	Negligible	LOW		Likely	Negligible	LOW	
LD3	Unwilling Seller	Some of the land for the levee alignment is privately held by an unwilling seller.	An unwilling seller could lead to condemnation which impacts implementation schedule and requires PL91-646 compliance.	Unlikely	Negligible	LOW		Unlikely	Significant	MODERATE	
	REGULATORY AND ENVIRONMENTAL RISKS										
REG1	Homolovi I Burial Site	Flow 2D model demonstrated an unlikely scenario where the water surface profile at Homolovi I could be higher than the existing conditions. Increased flooding impacts are Homolovi I.	Affected Tribes (especially the Hopi Tribe) and the SHPO and AZ State Parks could oppose the project due to cultural impacts or will be looking for high value mitigation measures that may not be commensurate with the slight increase in flood risk. Risk is similar to TL-5, Unanticipated Cultural Mitigation.	Likely	Negligible	LOW		Likely	Negligible	LOW	
REG2	Section 106 Survey	Conduct pedestrian cultural and archaeological survey of areas proposed to be impacted for project construction. (Section 106 must be completed prior to CWRB either thru completing a survey and consultation or through an agreement document postponing surveys and consultation on project effects until PED)	Significant cultural resources could be located during the survey that would require the preparation of a Memorandum of Agreement (MOA) prior to CWRB. This work is already done.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
REG3	Construction Access @ BNSF Bridge	Movement of heavy construction equipment under the BNSF Railroad Bridge, as is proposed in the alternative descriptions, may prove to be infeasible. This risk deals with the environmental impacts of moving the construction access.	If access beneath the BNSF Bridge proves to be infeasible, alternative access routes might have rather large impacts. The project cost estimates, noise impacts and air quality impacts would also be affected. The PDT does not believe that there would be adverse environmental impacts if access was moved.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
REG4	Encountering Endangered Species	Project may be impacted by endangered species: Flannel Mouth Sucker (state species of special concern) and Yellow-billed Cuckoo (Federal threatened species).	The PDT believes construction can avoid the Flannel Mouth and Yellow-billed Cuckoo through implementation of BMPs. Area will be surveyed prior to construction. It is unlikely that that federally endangered species are found; the concern revolves around encountering state endangered species.	Unlikely	Marginal	LOW		Unlikely	Critical	MODERATE	

REG5	Herbicide	The contractor will need a permit to spray herbicide on the project site. This license takes time.	The contractor will need to get a license to apply a registered chemical. The permit is through the State of Arizona. Contractors that perform this work will typically already have this license.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
REG6	Undiscovered HTRW	Characterization and removal of HTRW, not found in Phase 1, could delay the project.	This is similar to LD1	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
REG7	Paleontology (Fossils)	If fossils are found, it could delay the project	Local bedrock is not fossiliferous.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
	CONSTRUCTION RISKS										
CO1	Construction Schedule	There is a risk that the contractor may take longer to perform the work.	Monsoons and other natural storm events regularly occur. The project is in the desert, with minimal rainfall and river flow is normally low between April and June with the possibility of monsoons between July and September. The concerns are from a swollen river and possibly natural species (nesting seasons). Rain averages are minimal. Down time due to precipitation should be relatively small between April and June. The PDT has planned the work so that demolition of the existing levee system will not impact the function of the entire levee system. It is possible that contracts could be structured to allow contractors to take advantage of good weather (through contract options), to mitigate this risk.	Unlikely	Significant	MODERATE		Likely	Crisis	HIGH	
CO2	Inefficient Contractor	Concern is that inefficient contractors or subcontractors will cause delays to the contract.	Both large and small prime contractors have been known to cause delays. There is also a risk that inefficient subcontractors can cause delays. Worst case scenario: we get 1 bad contractor and have to add 1 new contract.	Likely	Marginal	MODERATE		Likely	Critical	HIGH	6-12 mo.
CO3	Subcontractor Availability	This is primarily an earthwork job. There may not be enough earthwork contractors locally to perform the work.	The PDT believes that there are not earthwork contractors in the area. This will impact the cost. Skilled labor shortage. There will be additional cost to labor and mobilization / demobilization. The cost estimate takes into account the distance to Phoenix for labor and equipment.	Very Likely	Significant	HIGH		Very Likely	Negligible	LOW	
CO4	Availability of Contractors	The population of Winslow is approximately 10,000 people. There are not too many local contractors available to perform the work.	This risk is already accounted for under subcontractor capabilities.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
CO5	Contractor Permit and Licensing	There may be permits and licensing that take excessive amounts of time.	There are five different utility companies, BNSF and ADOT. The contractor may need additional training to work in the right of way. This does not take a lot of time. NPDES, SWPPP, Reclaimed Water Permit is needed for all contracts (except 1).	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO6	Site Access Restrictions	There may be reduced access to the site that can cause delays to the project.	There is an existing ingress/egress ramp at 35.007037, -110.655349 that can be used to access the site along SR 87.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO7	Unknown Utilities	There may be unknown utilities on the project footprint.	The PDT (office of counsel and real estate) have done an extensive review and identified existing utilities in 2015. REF IFR Real Estate Appendix and Design (LOOK UP PLATE NUMBER)	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
CO8	Weather Delays	There are times when dust storms or inclement weather may stop construction. This can cause delays to construction activities.	Dust storms are short lived. Closures to the highways are 4-8 hours on the average. This may account to a lost work day or two per year.	Very Likely	Negligible	LOW		Very Likely	Negligible	LOW	
CO9	Dewatering	The contractor may have a problem coming up with a dewatering plan.	It may take time for the contractor to optimize his dewatering system. Risk concerns on Phases 2, 3, 4, 5 and 6. Schedule is not impacted since the contractor will be able to accomplish other work while optimizing the dewatering system and diversion of water.	Very Likely	Marginal	MODERATE		Very Likely	Negligible	LOW	
CO10	Differing Site Conditions	The primary issue that may arise from this risk is related to geotechnical concerns.	This risk is already accounted for under CO11	Very Likely	Significant	HIGH		Very Likely	Significant	HIGH	
CO11	Consideration for Post-Award Construction Claims and Modifications	This item captures the risk that post-award construction modifications or claims may cause a variance to project cost and schedule, in particular related to geotechnical concerns.	Possible claims and modifications may rise affecting the cost and/or causing schedule delays. The contractor may have an advantage if a modification arises because skilled labor is likely to be transferred and additional costs resulting from time delays may be incurred (unless a unilateral MOD is issued which is not likely).	Very Likely	Significant	HIGH		Very Likely	Marginal	MODERATE	
CO12	Levee Construction Phasing	There is a concern that construction becomes delayed long enough (during construction) and there is a hole in the levee system that has to be temporarily closed until the contractor can resume the work.	You don't know how big the hole is going to be or where it is going to be. There would be an emergency action plan (EAP) to ensure a functional levee in the construction contracts. The local sponsor owns the levee and has the crews and equipment to do this. Another way to mitigate this risk is to require the contractor to have an emergency crew available 24/7 at a pre-agreed upon rate, to patch up these openings.	Unlikely	Marginal	LOW	$360k/event to fill & Remove	Unlikely	Negligible	LOW	

	ESTIMATE AND SCHEDULE RISKS										
ET1	Parametric Estimates	The current working estimate utilizes parametric cost items which may not be accurate.	The estimate has undergone many revisions and most construction items have been replaced with crews and quantities. This is a risk from a previous risk register completed by the PDT.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
ET2	Variation in Quantities	The estimate is based on quantities that are assumed.	Quantities are the cornerstone for cost development. If quantities are inaccurate, there will be a lack of confidence in the estimate and the construction schedule. Quantities in the CWE have been verified; however, as more information is made available, the quantities may change. Current estimate assumes that the majority of the material excavated from the channel and the levee can be used for construction of the new levee. Additional information may change this assumption and lead to a variation in quantities.	Likely	Significant	HIGH		Likely	Negligible	LOW	
ET3	Utility Relocations	The estimate includes utility relocation costs. There is a risk that there may be additional relocations unforeseen.	Costs have been provided by the utility companies as ROM estimates. These may change as design develops. Relocations will be done by the utility company and should not affect the construction schedule as part of LERRDS.	Likely	Marginal	MODERATE		Likely	Negligible	LOW	
ET4	Heavy Equipment Access	There may be restrictions to heavy equipment access.	The PDT has examined the site and found multiple access points for heavy equipment. Even if access became an issue, new access points could be developed to mitigate this risk.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
ET5	Escalation exceeds CWCCIS rates	Risk that CWCCIS factors may not reflect future market conditions.	CWCCIS factors are used in the TPCS to inflate the baseline estimate to mid-point of construction. On the CWCCIS tables, all factors forward of the issue date are based on OMB projections. This is generally 1-2% per year. The actual inflation (all prior to the issue date) captured by CWCCIS averages 3-4% per year in general. The risk issue comes out from commodities or construction activities that the costs can increase higher than the inflation rate captured for the commodity This item captures the risk that there will be significant cost increase due to inflation above CWCCIS rates.	Very Likely	Significant	HIGH		Very Likely	Negligible	LOW	
ET6	Quantity Development	The geotechnical assumptions can impact the quantities	This risk is similar to TL6,7,8 & 9.	Very Likely	Significant	HIGH		Very Likely	Negligible	LOW	
ET7	Hauling Productivity Rates	The CWE includes productivity rates based on calculated cycle times and haul distances. There is a risk that they may change.	CWE assumes no more than two miles to the nearest disposal and stockpile site. This assumption appears reasonable for the current market conditions. Other disposal sites may increase the haul distance.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW	
ET8	Construction Productivity Rates	The CWE includes equipment selection assuming a "well equipped" contractor. There is a risk that the contractor may use the equipment that he has, in lieu of something more productive to save $$.	Estimate assumed readily available equipment : loader/hwy trucks and small conventional scrapers. Variation in production rates due to slower equipment selection is unlikely. Cost impacts are likely, but schedule impacts are unlikely; construction schedule already reflects unknows.	Likely	Marginal	MODERATE		Very Unlikely	Marginal	LOW	
ET9	Production Rates Variance	Hauling productivity rates may be slower than anticipated due to congestion from multiple crews.	Consruction is limited to a 270 foot corridor with several heavy construction equipment travelling along the 270 foot corridor. Excavation and Backfill hauling equipment may interfere. A site construction model may mitigate this risk. Although this may affect cost, project site is large enough to run multiple crews without affecting construction schedule.	Likely	Marginal	MODERATE		Likely	Negligible	LOW	
ET10	Soil Cement Plant Costs	Soil cement is a primary cost driver on the project. The plant costs have been derived from the EP for equipment for the region.	The risk is that the CWE may be higher or lower than actual costs. This risk could be mitigated by obtaining multiple plant costs.	Likely	Marginal	MODERATE		Likely	Negligible	LOW	
ET11	Availability of Skilled Labor	The population of Winslow is approximately 10,000 people. There may be insufficient skilled labor locally available to perform the work.	Since the site is relatively remote, skilled labor shortage may cause a problem. It is likely that labor will come from Flagstaff or Phoenix.	Likely	Marginal	MODERATE		Likely	Negligible	LOW	

	Programmatic Risks	(External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR1	Public Opposition	There may be public opposition to the TSP.	Public / stakeholder opposition to a Tentatively Selected Plan (TSP) that does not remove their homes and businesses from the FEMA 100-year floodplain. There are some homes that will still be in the floodplain, after the project is completed. Still, there appears to be overwhelming support for the project from the local community.	Very Unlikely	Negligible	LOW		Very Unlikely	Negligible	LOW	
PR2	Funding Availability	We are currently assuming Fed and Non-Fed funding will be available for the project as needed to meet the schedule. There is a risk that money will not be available as needed. POST-BRAINSTORM SESSION UPDATE - MITIGATED: The District management is willing to buy this risk. The Executive Office is confident that the project will get the funds as requested for construction due to the strong support of the project at Division and HQ level.	We are assuming that we will get money as needed. The PDT has concerns that this may not be the case. If funding is not available as needed, the construction duration will be extended and costs will go up. Lack of funding stream may **stop the project.**	Very Likely	Significant	HIGH		Very Likely	Crisis	HIGH	
PR3	Political/Legal Opposition	Concern is that additional features may be required to reduce flooding at Homolovi I site	Consultation meetings were held with local tribes but the PDT feels there is still a possibility of litigation if the final design does not address flooding concerns of tribal interests.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE	
PR4	Local Sponsor Funding Issues	We are assuming that the County of Navajo will be able to provide their share of the cost of the project. There is a risk that they may not be able to come up with the remainder of the project cost. POST-BRAINSTORM SESSION UPDATE - MITIGATED: The local sponsor understands that this is a cost-shared project, and have been prompt in providing resources for the study. The community and the Sponsor strongly support the construction of the project, and have been setting aside funds for the construction.	The local sponsor has been prompt in providing resources for the ongoing study. The schedule is impacted if funding is not available. **This risk is a show-stopper**.	Unlikely	Marginal	LOW		Unlikely	Critical	MODERATE	
PR6	Local Utility Relocation	There are several utilities which traverse the levee. This can delay the schedule.	The local sponsor will be relocating high pressure gas and water lines. Utility work needs to be done before construction begins on Phases 4 and 5.	Likely	Negligible	LOW		Likely	Crisis	HIGH	
PR5	Labor Disputes	There is a potential that labor disputes may affect the project.	Winslow is located in Navajo County, AZ. Skilled labor is assumed to come from Phoenix, in Maricopa County, AZ. Phoenix has a population of about 1.6M. Arizona is a "right to work" state with about 5% of the workforce being union members. Labor disputes are not likely to affect the project.	Unlikely	Marginal	LOW		Unlikely	Negligible	LOW	

Attachment 3
MCACES (Mii) Construction Cost Estimate

Assumes crews working 6 days a week (10 hr/day) in any given year. Overtime included in the estimate.

Estimated by Larry Walsh and Juan Dominguez
Designed by David Pham and Funkee Ojuri - Design Team
Prepared by Cost and Specifications Section
Preparation Date 5/5/2018
Effective Date of Pricing 10/1/2017
Estimated Construction Time 900 Days

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Designed by
David Pham and Funkee Ojuri - Design Team
Estimated by
Larry Walsh and Juan Dominguez
Prepared by
Cost and Specifications Section

Design Document
Document Date 3/22/2018
District Los Angeles District
Contact Larry Walsh and Juan Dominguez x3737
Budget Year 2018
UOM System Original

Direct Costs
LaborCost
EQCost
MatlCost
SubBidCost
UserCost1

Timeline/Currency
Preparation Date 5/5/2018
Escalation Date 10/1/2017
Eff. Pricing Date 10/1/2017
Estimated Duration 900 Day(s)

Currency US dollars
Exchange Rate 1.000000

Costbook CB16EN: 2016 MII English Cost Book

Labor AZ11172017: Labor Library - AZ: Pima (11172017)
Note: http://www.wdol.gov is the website for current Davis Bacon & Service Labor Rates. Fringes paid to the laborers are taxable. In a non-union job the whole fringes are taxable

Labor Rates
LaborCost1
LaborCost2
LaborCost3
LaborCost4

Equipment EP16R07: MII Equipment 2016 Region 07

07 WEST

Sales Tax	7.95
Working Hours per Year	1,630
Labor Adjustment Factor	1.13
Cost of Money	1.88
Cost of Money Discount	25.00
Tire Recap Cost Factor	1.50
Tire Recap Wear Factor	1.80
Tire Repair Factor	0.15
Equipment Cost Factor	1.00
Standby Depreciation Factor	0.50

Fuel

Electricity	0.112
Gas	2.690
Diesel Off-Road	2.490
Diesel On-Road	3.000

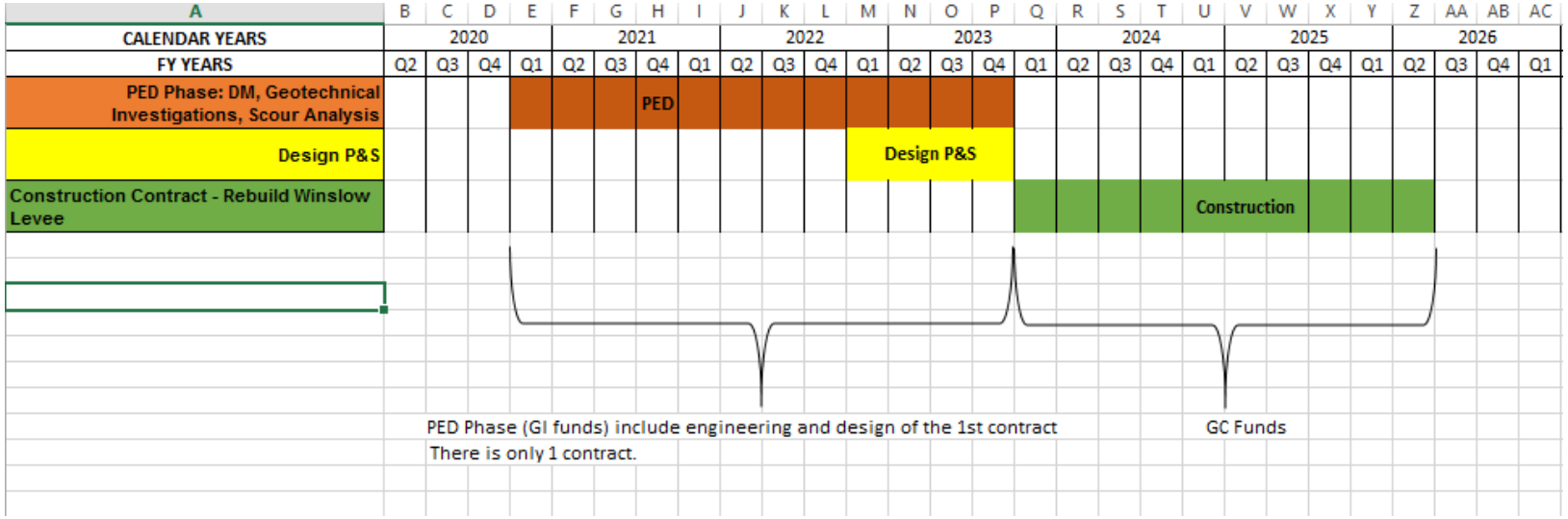
Shipping Rates

Over 0 CWT	28.91
Over 240 CWT	21.98
Over 300 CWT	18.50
Over 400 CWT	16.24
Over 500 CWT	19.65
Over 700 CWT	18.73
Over 800 CWT	10.52

Date	Author	Note
2/9/2018 9:21:41 AM	Walsh	**AZ Transaction Privilege Tax (Feb 2018)** State and County rate - Contracting - Prime (a) - 6.1% City of Winslow rate - 1% Total tax - 7.1% Deductions are allowable from gross income to arrive at taxable income. A 35% standard deduction is allowed for all income taxable as construction contracting. 7.1% * 65% = 4.615 Privilage tax = 4.615%

Description	DirectCost	ProjectCost
Project Summary Report	29,240,864	42,343,616
11 RECONSTRUCT WINSLOW LEVEE	29,090,864	42,193,616
1101 WINSLOW LEVEE	29,090,864	42,193,616
110101 GENERAL REQUIREMENTS	1,020,658	1,417,286
110102 CLEARING AND GRUBBING - Saltcedar Removal	1,148,434	1,594,715
110103 DEWATERING - for Toe-Down work	3,685,330	6,566,447
110104 DIVERSION AND CONTROL OF WATER	866,260	1,202,889
110105 DEMOLISH AND REPLACE -- RCB Box Culvert	313,430	558,464
110106 DEMOLITION -- Abandoned Bridge Pier	13,590	24,214
110107 REMOVAL - Concrete Rubble - Load/Haul to Stockpile Site	122,958	170,739
110108 REMOVAL - Riprap - Small in size - Load/Haul to Stockpile Site to be reused as bedding or fill	157,001	218,012
110109 COMPACT EXISTING -- Over-Excavate or Disc / Grade /Compact Existing footprint of levee (upper 2 ft)	247,801	344,097
110110 EXCAVATE - Toe-Down	1,244,194	1,727,689
110111 EXCAVATE - Channel	520,124	722,244
110112 EXCAVATE - Key	104,380	144,942
110113 EXCAVATE - Trench Drain	365,763	507,899
110114 EXCAVATE - Existing Levee	1,425,524	1,979,483
110115 FILL - Trench Drain, GRAVEL	1,441,698	2,001,942
110116 FILL - Trench Drain, SAND	1,107,836	1,538,341
110117 FILL - Trench Drain, SOIL	121,798	169,128
110118 FILL - Toe	919,815	1,277,256
110119 FILL - Levee	1,516,076	2,105,223
110120 STONE - Launching Stone (-48")	1,424,878	1,978,586
110121 STONE - Launching Stone (-24")	1,229,994	1,707,970
110122 RIPRAP, Filter/Geotextile Fabric	79,966	111,041
110123 RIPRAP BEDDING, 6"	738,625	1,025,655
110124 RIPRAP 24"	4,182,320	5,807,571
110125 SOIL CEMENT	3,083,664	4,281,977
110126 GRAVEL -- 4" Gravel Mulch/Layer - Landside Slope Protection	291,676	405,022
110127 ABC 4" Layer - Aggregate Base Course (4" layer) - O&M Road on top of levee and Landside	312,095	433,376
110128 V-DITCH (triangular cut 3 ft wide at top, 8" deep, 2:1 slopes, 4" thick)	344,439	613,715
110129 CONTROLLED OVER-TOPPING SECTION ALONG PHASE 2 (Not in Preliminary Design) -- PDT coordinated with USACE HQ to defer design of the section until PED	844,261	1,172,341
110130 LANDSCAPE	216,273	385,350
18 CULTURAL RESOURCES	150,000	150,000
1801 Cultural Resource Preservation	150,000	150,000

Attachment 4
Project Schedule

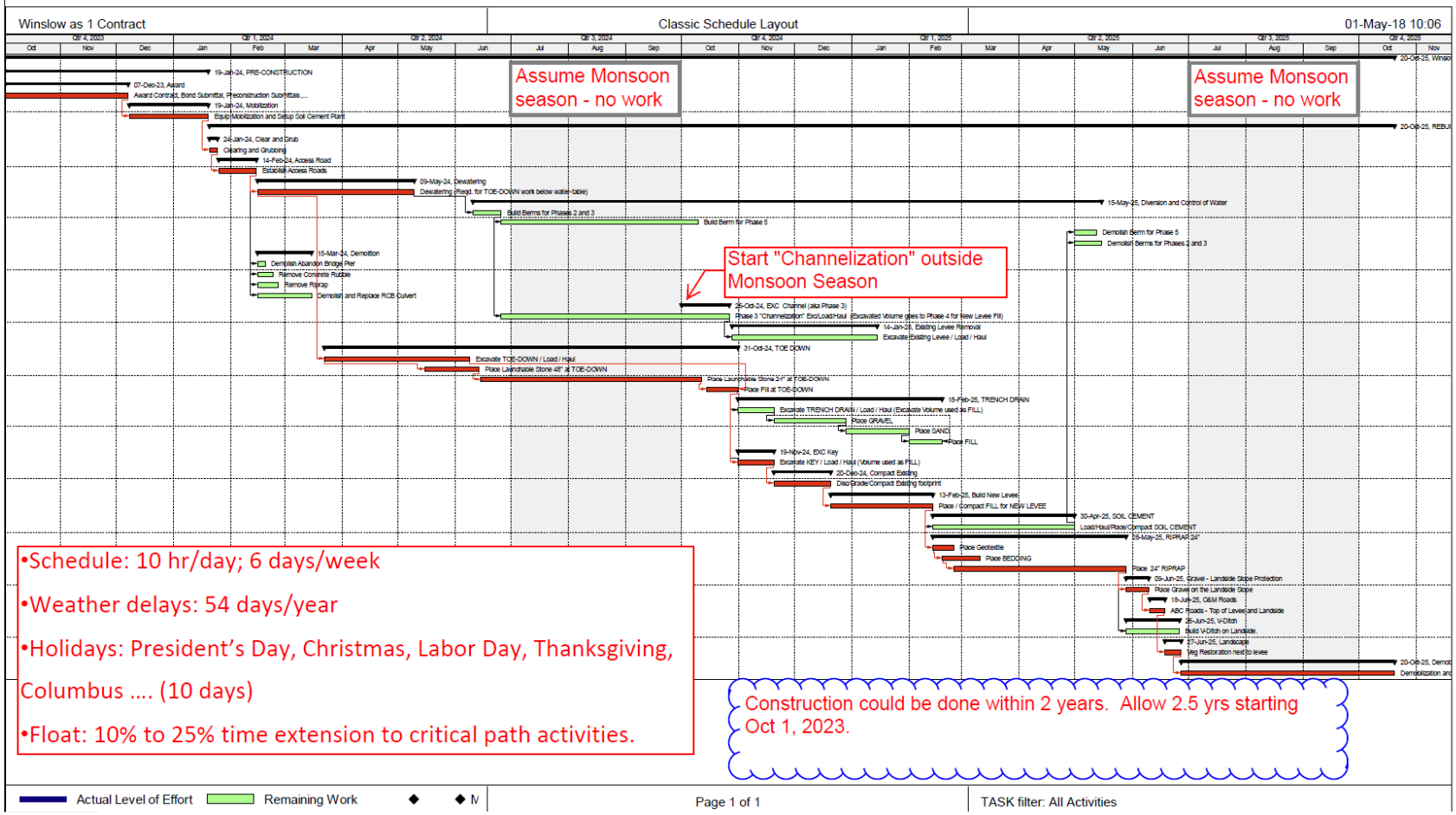


PED Phase (GI funds) include engineering and design of the 1st contract

GC Funds

There is only 1 contract.

Attachment 5
Construction Schedule



- Schedule: 10 hr/day; 6 days/week
- Weather delays: 54 days/year
- Holidays: President's Day, Christmas, Labor Day, Thanksgiving, Columbus …. (10 days)
- Float: 10% to 25% time extension to critical path activities.

Construction could be done within 2 years. Allow 2.5 yrs starting Oct 1, 2023.