

Attachment C -
Project Cost and Schedule Risk Analysis Report

Springfield, Missouri
Flood Risk Management

Draft Feasibility Report and
Environmental Assessment

National Economic Development Plan –
Plan J –
Channel Improvements in Reach E1 and Construction of Detention
Basins on North Branch and South Branch Tributaries

Prepared by:

U.S. Army Corps of Engineers,
Little Rock District

EXECUTIVE SUMMARY

This Attachment presents a recommendation for the project cost contingencies for the Jordan Creek, Springfield, Missouri Flood Risk Management (FRM) Feasibility Study (FS), Plan J, the National Economic Development alternative. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal abbreviated risk analysis study was conducted on December 18, 2012. The purpose of this risk analysis study was to establish project contingencies by identifying and measuring the cost impact of project uncertainties with respect to the estimated project cost. Since the project cost was less than \$40 million, the use of the simplified cost and schedule risk analysis is permissible.

The most likely project cost (at price level) for the Springfield, Missouri flood risk management study NED plan is approximately \$15.9 million. After conducting the abbreviated cost risk analysis study with the project delivery team, the recommended overall project contingency value is \$3.56 million or 22 percent yielding a total project cost of \$19.5 million.

1.0 PURPOSE

Under the auspices of the US Army Corps of Engineers, Little Rock District, this report presents a recommendation for the project cost contingencies for the Jordan Creek Flood Risk Management Feasibility Study in Springfield, Missouri.

2.0 BACKGROUND

The purpose of the Jordan Creek FRM FS is to determine appropriate future actions, if any, concerning channel improvements to Jordan Creek to manage flood risks within Springfield, Missouri. This feasibility study report documents the planning process undertaken to assess potential channel improvements to Jordan Creek.

3.0 REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by the US Army Corps of Engineers Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 111-2-1302, 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 all project features. The study and presentation does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included PDT involvement for the identification and development of the likelihood of risks occurring and the qualitative evaluation of magnitude of the cost of the risk. The analysis process evaluated the most likely MII cost estimate and the likelihood of change on various cost components and the cost impact of the possible changes.

4. DISCUSSION OF CONTINGENCIES.

4.a Cost Risk Methodology.

The cost risk methodology used for this feasibility study was the abbreviated cost risk template obtained from the Civil Works Cost Engineering and Agency Technical Review Mandatory Center of Expertise located within the Walla Walla District Cost Engineering Branch. Major portions of costs from the previously prepared cost estimate were listed in the Input and Results Table by feature and sub-feature level including 01 Lands and Damages. Cost risks associated with seven various categories of risk were considered as to the likeliness of their occurrence and the cost impact if these events happened. These categories were project scope growth, acquisition strategy, construction elements, quantities for current scope, specialty fabrication or equipment, cost estimate assumptions, and external project risks.

The contingencies that evolved using the abbreviated cost risk template and the PDT meeting ranged from 19.36 percent for the earthwork - unclassified excavation to 31.5 percent for the earthwork – rock excavation. The reason for the higher contingency for the rock excavation was that the rock surface is irregular and its quantity was not well defined by detailed investigations.

Feature 01 Lands and Damages cost was given a contingency of 20 percent by the Real Estate Division PDT member. This contingency was entered into the MII cost estimate and carried through for the remainder of the cost estimate and conduct of the study. The likelihood and impact of cost variation was not considered further in the cost risk analysis.

4.b Major Risks

The major cost risks associated with the Springfield FRM study are inflation between the completing of the feasibility study, authorization, and receipt of funds to construct the project and the requirement of the railroad to require a temporary bypass during the replacement of the railroad bridge. The inflation risk is likely and is anticipated to have a significant effect on the cost. Also, another major risk is that the railroad officials would change their mind and require a bypass during the replacement of the railroad bridge over Wilson Creek. This risk is considered unlikely, but if it did occur the cost impact would be critical (greater than a \$1M). See the full completed cost risk template for further information

4.c Minor Risks

Minor risks include encountering unknowns during the construction process. The most common unknown would most probably be abandoned utilities that the utility has forgotten about. The cost impact of these is expected to be negligible. Another unknown is buried concrete foundations. Again, the likelihood is unlikely and cost impact is projected to be negligible.

5.0 SUMMARY

Based on the results of the cost risk analysis study conducted on December 18, 2012 by the Project Delivery Team, an overall project contingency of 23 percent is recommended.

Input & Results Table

Abbreviated Risk Analysis

Project (less than \$40M): **Jordan Creek FRM Study, Springfield, Missouri**
 Project Development Stage: **Feasibility Study**
 Risk Category: **Moderate Risk: Typical Project or Possible Life Safety**

Total Construction Contract Cost = \$ **10,456,080**

	<u>CWWBS</u>	<u>Feature of Work</u>	<u>Contract Cost</u>	<u>% Contingency</u>	<u>\$ Contingency</u>	<u>Total</u>
	01 LANDS AND DAMAGES	Real Estate	\$ 3,824,000	20.00%	\$ 764,800	\$ 4,588,800.00
1	02 01 ROADS, Construction Activities	Automobile Roads	\$ 101,808	27.06%	\$ 27,547	\$ 129,354.60
2	02 02 RAILROADS, Construction Activities	Railroad tracks	\$ 45,192	24.68%	\$ 11,155	\$ 56,346.59
3	02 03 CEMETERIES, UTILITIES, AND STRUCTURES, Construction Activities	Utilities (water, sewer, electric & telephone)	\$ 1,233,000	28.78%	\$ 354,828	\$ 1,587,828.40
4	09 01 CHANNELS	Earthwork - Unclassified Excavation	\$ 2,318,425	19.36%	\$ 448,751	\$ 2,767,175.65
5	09 01 CHANNELS	Earthwork - Rock Excavation	\$ 294,883	31.50%	\$ 92,880	\$ 387,763.39
6	09 01 CHANNELS	Exterior Improvements - Retaining Walls	\$ 338,962	28.78%	\$ 97,545	\$ 436,507.29
7	09 01 CHANNELS	Fabricated Railroad Bridges	\$ 1,996,099	20.41%	\$ 407,355	\$ 2,403,454.29
8	09 01 CHANNELS	Fabricated Automobile Bridges	\$ 382,735	20.41%	\$ 78,107	\$ 460,841.91
9	09 01 CHANNELS	Other (Erosion Control, Turfing, Clearing & Grubbing)	\$ 306,976	23.15%	\$ 71,077	\$ 378,052.97
10	15 FLOODWAY CONTROL AND DIVERSION STRUCTURES	Detention Basin Construction (5) - Earthwork (excavation, disposal &	\$ 2,931,864	23.15%	\$ 678,841	\$ 3,610,705.95
11	15 FLOODWAY CONTROL AND DIVERSION STRUCTURES	Detention Basin Outlet Works (5) (concrete)	\$ 506,136	23.15%	\$ 117,190	\$ 623,325.72
12		Remaining Construction Items	\$ -	0.0%	\$ -	\$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	\$ 844,000	23.15%	\$ 195,419	\$ 1,039,419.06
14	31 CONSTRUCTION MANAGEMENT	Construction Management	\$ 805,000	23.15%	\$ 186,389	\$ 991,389.03

Totals						
	Real Estate	\$	3,824,000	20.00%	\$ 764,800	\$ 4,588,800.00
	Total Construction Estimate	\$	10,456,080	22.81%	\$ 2,385,277	\$ 12,841,357
	Total Planning, Engineering & Design	\$	844,000	23.15%	\$ 195,419	\$ 1,039,419
	Total Construction Management	\$	805,000	23.15%	\$ 186,389	\$ 991,389
	Total	\$	15,929,080		\$ 3,531,885	\$ 19,460,965

Risk Register

Jordan Creek FRM Study, Springfield, Missouri
Feasibility Study
Abbreviated Risk Analysis

Meeting Date: 18-Dec-12

		Risk Level				
		2	3	4	5	5
Very Likely		2	3	4	5	5
Likely		1	2	3	4	5
Possible		0	1	2	3	4
Unlikely		0	0	1	2	3
		Negligible	Marginal	Significant	Critical	Crisis

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level	
Project Scope Growth								
							Max Potential Cost Growth	75%
PS-1	Automobile Roads	• Design confidence?	Scope fixed little growth forecast. Varied from current plans Chemical Plant sits lower	Insert discussions and conclusions here. Include logic and justification for choice of Likelihood & Impact. Raise Road 1'	Likely	Marginal	2	
PS-2	Railroad tracks	• Potential for scope growth, added features and quantities?	Scope fixed little growth forecast.	From change in management - Shoe fly?	Unlikely	Significant	1	
PS-3	Utilities (water, sewer, electric & telephone)	• Potential for scope growth, added features and quantities?	The possibility exists that there are unknown utilities within the expanded channel section.	Lack of Planning and design will add to unknowns. Who does gas? City does other utilities. Rockherst Street Utilities	Likely	Marginal	2	
PS-4	Earthwork - Unclassified Excavation	• Potential for scope growth, added features and quantities?	Channel size increased. Behind retaining wall?	Project size is set and not foreseen to change	Unlikely	Marginal	0	
PS-5	Earthwork - Rock Excavation	• Potential for scope growth, added features and quantities?	Rock within the improved channel section. Volume not known. Assumed 5% rock excavation.	Lack of Planning and design will add to unknowns	Likely	Marginal	2	
PS-6	Exterior Improvements - Retaining Walls	• Potential for scope growth, added features and quantities?	Scope fixed little growth forecast.	Little requirement for additional quantity.	Possible	Significant	2	
PS-7	Fabricated Railroad Bridges	• Potential for scope growth, added features and quantities?	Scope fixed little growth forecast.	Current railroad management has stated no Shoefly required. RR Management may change.	Unlikely	Significant	1	
PS-8	Fabricated Automobile Bridges	• Potential for scope growth, added features and quantities?	Minimal design	None. Existing Bridge is high and its opening has compacity.	Unlikely	Significant	1	
PS-9	Other (Erosion Control, Turfing, Clearing & Grubbing)	• Potential for scope growth, added features and quantities?		Low cost item. Scope and quantity not likely to change.	Unlikely	Negligible	0	
PS-10	Detention Basin Construction (5) - Earthwork (excavation, disposal & compacted fill)	• Investigations sufficient to support design assumptions?	Little concern.		Unlikely	Negligible	0	
PS-11	Detention Basin Outlet Works (5) (concrete)	• Potential for scope growth, added features and quantities?	No design, Oversized concrete outlet structure, but actually a small structure. No defined channel at these location.		Unlikely	Negligible	0	
PS-12	Remaining Construction Items	• Potential for scope growth, added features and quantities?	Zero cost item.		Unlikely	Negligible	0	

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Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
PS-13	Planning, Engineering, & Design	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-14	Construction Management	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0

Acquisition Strategy

							Max Potential Cost Growth	30%
AS-1	Automobile Roads	• Contracting plan firmly established?	Small Business Contractor required by higher authority. New Planning paradigm. Sole Source/Competitive	Lack of Planning and design will add to unknowns. Work is not complicated. PDT and nonfederal sponsor will push for competitive acquisition.	Likely	Significant	3	
AS-2	Railroad tracks	• Contracting plan firmly established?	Small Business Contractor Source Restrictions? Ability to perform? RR Certified Contractor required.		Likely	Significant	3	
AS-3	Utilities (water, sewer, electric & telephone)	• Contracting plan firmly established?	Small Business Contractor required by USACE policy.	City owned or private with restrictions as to who will be allowed to work on their assets.	Likely	Significant	3	
AS-4	Earthwork - Unclassified Excavation	• Contracting plan firmly established?	Small Business Contractor required by USACE policy.	Not complicated work. A knowledgeable contractor should accomplish without any trouble.	Likely	Marginal	2	
AS-5	Earthwork - Rock Excavation	• Contracting plan firmly established?	Small Business Contractor required by USACE policy..		Likely	Significant	3	
AS-6	Exterior Improvements - Retaining Walls	• Contracting plan firmly established?	Small Business Contractor required by USACE policy.	Railroads will only allow certain contractors to work on their tracks	Likely	Significant	3	
AS-7	Fabricated Railroad Bridges	• Contracting plan firmly established?	Small Business Contractor required by USACE policy.		Likely	Significant	3	
AS-8	Fabricated Automobile Bridges	• Contracting plan firmly established?	Small Business Contractor??		Likely	Significant	3	

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Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
AS-9	Other (Erosion Control, Turfing, Clearing & Grubbing)	• Contracting plan firmly established?	Small Business Contractor required by USACE policy.		Likely	Significant	3
AS-10	Detention Basin Construction (5) - Earthwork (excavation, disposal & compacted fill)	• Contracting plan firmly established?	Small Business Contractor required by USACE policy.		Likely	Significant	3
AS-11	Detention Basin Outlet Works (5) (concrete)	• Contracting plan firmly established?	Small Business Contractor required by USACE policy.		Likely	Significant	3
AS-12	Remaining Construction Items	• Contracting plan firmly established?	Small Business Contractor required by USACE policy.		Likely	Significant	3
AS-13	Planning, Engineering, & Design	• Contracting plan firmly established?	8A - x% more	Small business requires extra clauses and work for solicitation.	Likely	Significant	3
AS-14	Construction Management	• Contracting plan firmly established?			Likely	Significant	3

Construction Elements

							Max Potential Cost Growth	25%
CE-1	Automobile Roads	• Accelerated schedule or harsh weather schedule?	Small Business Contractor.	Raising Road	Likely	Negligible		1
CE-2	Railroad tracks	• Accelerated schedule or harsh weather schedule?	Impact Schedule=>Cost	Railroad owners will allow pre-certified contractors to work on their facilities	Unlikely	Significant		1
CE-3	Utilities (water, sewer, electric & telephone)	• Accelerated schedule or harsh weather schedule?	Exact quantity and obstructions in right of way		Likely	Marginal		2
CE-4	Earthwork - Unclassified Excavation	• Accelerated schedule or harsh weather schedule?	Small Business Contractor required by USACE policy.	Assumed contractor is competent;	Likely	Marginal		2

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Unlikely		0	0	1	2	3
		Negligible	Marginal	Significant	Critical	Crisis

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
CE-5	Earthwork - Rock Excavation	• Accelerated schedule or harsh weather schedule?	Small Business Contractor required by USACE policy. Rock at isolated locations yet to be determined.	Due to irregular surface of rock strata, the exact quantity is not known. Looking at previous data, 5 percent of excavation was judged to be rock.	Likely	Marginal	2
CE-6	Exterior Improvements - Retaining Walls	• Accelerated schedule or harsh weather schedule?		Quantity is small and not anticipated to increase.	Likely	Marginal	2
CE-7	Fabricated Railroad Bridges	• Accelerated schedule or harsh weather schedule?		Work is straight forward. Must be in a minimal amount of time to limit rail interruptions	Unlikely	Negligible	0
CE-8	Fabricated Automobile Bridges	• Accelerated schedule or harsh weather schedule?	None in project.		Unlikely	Negligible	0
CE-9	Other (Erosion Control, Turfing, Clearing & Grubbing)	• Accelerated schedule or harsh weather schedule?	Small Business Contractor required by USACE policy.		Likely	Marginal	2
CE-10	Detention Basin Construction (5) - Earthwork (excavation, disposal & compacted fill)	• Accelerated schedule or harsh weather schedule?	Small Business Contractor required by USACE policy.		Likely	Marginal	2
CE-11	Detention Basin Outlet Works (5) (concrete)	• Accelerated schedule or harsh weather schedule?	Small Business Contractor required by USACE policy.		Likely	Marginal	2
CE-12	Remaining Construction Items	• Accelerated schedule or harsh weather schedule?	No cost with work feature. All cost in other features.		Unlikely	Negligible	0
CE-13	Planning, Engineering, & Design	• Accelerated schedule or harsh weather schedule?	Small Business Contractor required by USACE policy.		Likely	Marginal	2
CE-14	Construction Management	• Accelerated schedule or harsh weather schedule?	Small Business Contractor required by USACE policy.		Likely	Marginal	2
Quantities for Current Scope							
						Max Potential Cost Growth	20%
Q-1	Automobile Roads	• Level of confidence based on design and assumptions?	Scope fixed little growth forecast.		Likely	Marginal	2

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Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Q-2	Railroad tracks	• Level of confidence based on design and assumptions?	Scope fixed little growth forecast.	Assume it's fixed, no shoefly	Unlikely	Significant	1
Q-3	Utilities (water, sewer, electric & telephone)	• Level of confidence based on design and assumptions?	Scope fixed little growth forecast.	Not all locations known. Work would be minimal. Project sponsor is responsible for this work.	Likely	Marginal	2
Q-4	Earthwork - Unclassified Excavation	• Level of confidence based on design and assumptions?	Scope fixed little growth forecast.		Likely	Marginal	2
Q-5	Earthwork - Rock Excavation	• Level of confidence based on design and assumptions?	Total excavation scope fixed little growth forecast.	Little investigations conducted.	Likely	Significant	3
Q-6	Exterior Improvements - Retaining Walls	• Level of confidence based on design and assumptions?	Scope fixed. Little growth forecast.		Likely	Marginal	2
Q-7	Fabricated Railroad Bridges	• Level of confidence based on design and assumptions?	Scope fixed little growth forecast.		Unlikely	Significant	1
Q-8	Fabricated Automobile Bridges	• Level of confidence based on design and assumptions?	None in project.		Unlikely	Significant	1
Q-9	Other (Erosion Control, Turfing, Clearing & Grubbing)	• Level of confidence based on design and assumptions?		Variation always occurs.	Likely	Marginal	2
Q-10	Detention Basin Construction (5) - Earthwork (excavation, disposal & compacted fill)	• Level of confidence based on design and assumptions?	Little design accomplished	Basin size is limited so change in quantity will be limited.	Likely	Marginal	2
Q-11	Detention Basin Outlet Works (5) (concrete)	• Level of confidence based on design and assumptions?	Little design accomplished	Basin size is limited so change in quantity will be limited.	Likely	Marginal	2
Q-12	Remaining Construction Items	• Level of confidence based on design and assumptions?			Likely	Marginal	2
Q-13	Planning, Engineering, & Design	• Level of confidence based on design and assumptions?		Changes occur but will be marginal	Likely	Marginal	2
Q-14	Construction Management	• Level of confidence based on design and assumptions?			Likely	Marginal	2
Specialty Fabrication or Equipment							
						Max Potential Cost Growth	75%
FE-1	Automobile Roads	• Unusual parts, material or equipment manufactured or installed?		Components and/or equipment required will be standard.	Unlikely	Marginal	0

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Unlikely		0	0	1	2	3
		Negligible	Marginal	Significant	Critical	Crisis

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
FE-2	Railroad tracks	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Significant	1
FE-3	Utilities (water, sewer, electric & telephone)	• Unusual parts, material or equipment manufactured or installed?		Components and/or equipment required will be standard.	Unlikely	Marginal	0
FE-4	Earthwork - Unclassified Excavation	• Unusual parts, material or equipment manufactured or installed?		Components and/or equipment required will be standard.	Unlikely	Marginal	0
FE-5	Earthwork - Rock Excavation	• Unusual parts, material or equipment manufactured or installed?		Components and/or equipment required will be standard.	Unlikely	Marginal	0
FE-6	Exterior Improvements - Retaining Walls	• Unusual parts, material or equipment manufactured or installed?		Components and/or equipment required will be standard.	Unlikely	Marginal	0
FE-7	Fabricated Railroad Bridges	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Marginal	0
FE-8	Fabricated Automobile Bridges	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Marginal	0
FE-9	Other (Erosion Control, Turfing, Clearing & Grubbing)	• Unusual parts, material or equipment manufactured or installed?		Components and/or equipment required will be standard.	Unlikely	Marginal	0
FE-10	Detention Basin Construction (5) - Earthwork (excavation, disposal & compacted fill)	• Unusual parts, material or equipment manufactured or installed?		Components and/or equipment required will be standard.	Unlikely	Marginal	0
FE-11	Detention Basin Outlet Works (5) (concrete)	• Unusual parts, material or equipment manufactured or installed?		Components and/or equipment required will be standard.	Unlikely	Marginal	0
FE-12	Remaining Construction Items	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Marginal	0
FE-13	Planning, Engineering, & Design	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Marginal	0
FE-14	Construction Management	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Marginal	0

Cost Estimate Assumptions							Max Potential Cost Growth	35%
CT-1	Automobile Roads	• Assumptions regarding crew, productivity, overtime?	Cost variation	Features are standard.	Likely	Marginal	2	

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Likely		1	2	3	4	5
Possible		0	1	2	3	4
Unlikely		0	0	1	2	3
		Negligible	Marginal	Significant	Critical	Crisis

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
CT-2	Railroad tracks	• Reliability and number of key quotes?			Likely	Marginal	2
CT-3	Utilities (water, sewer, electric & telephone)	• Reliability and number of key quotes?		Features are standard.	Likely	Marginal	2
CT-4	Earthwork - Unclassified Excavation	• Reliability and number of key quotes?		Features are standard.	Likely	Marginal	2
CT-5	Earthwork - Rock Excavation	• Reliability and number of key quotes?			Likely	Marginal	2
CT-6	Exterior Improvements - Retaining Walls	• Reliability and number of key quotes?		Features are standard.	Likely	Marginal	2
CT-7	Fabricated Railroad Bridges	• Reliability and number of key quotes?		Standard desgn. Fixed length. Contractor precertified or approved by railroad owner.	Likely	Marginal	2
CT-8	Fabricated Automobile Bridges	• Reliability and number of key quotes?		No new bridges for automobiles. Only foundation strengthening at one bridge.	Likely	Marginal	2
CT-9	Other (Erosion Control, Turfing, Clearing & Grubbing)	• Reliability and number of key quotes?	Standard work effort. Fixed quantity.		Likely	Marginal	2
CT-10	Detention Basin Construction (5) - Earthwork (excavation, disposal & compacted fill)	• Reliability and number of key quotes?		Design not fixed.	Likely	Marginal	2
CT-11	Detention Basin Outlet Works (5) (concrete)	• Reliability and number of key quotes?		Conservative quantities prepared by designer.	Likely	Marginal	2
CT-12	Remaining Construction Items	• Reliability and number of key quotes?	No cost assigned to this feature.		Likely	Marginal	2
CT-13	Planning, Engineering, & Design	• Reliability and number of key quotes?			Likely	Marginal	2
CT-14	Construction Management	• Reliability and number of key quotes?			Likely	Marginal	2

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		Negligible	Marginal	Significant	Critical	Crisis

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
External Project Risks							
						Max Potential Cost Growth	40%
EX-1	Automobile Roads	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-2	Railroad tracks	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-3	Utilities (water, sewer, electric & telephone)	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-4	Earthwork - Unclassified Excavation	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-5	Earthwork - Rock Excavation	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-6	Exterior Improvements - Retaining Walls	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-7	Fabricated Railroad Bridges	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-8	Fabricated Automobile Bridges	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-9	Other (Erosion Control, Turfing, Clearing & Grubbing)	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-10	Detention Basin Construction (5) - Earthwork (excavation, disposal & compacted fill)	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-11	Detention Basin Outlet Works (5) (concrete)	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-12	Remaining Construction Items	• Potential for severe adverse weather?	No cost with this feature of work.		Likely	Marginal	2
EX-13	Planning, Engineering, & Design	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2
EX-14	Construction Management	• Potential for severe adverse weather?		Inflation, Authorization, funding, etc.	Likely	Marginal	2

WBS Risk Matrix

Jordan Creek FRM Study, Springfield, Missouri
 Feasibility Study
 Abbreviated Risk Analysis

	<u>Potential Risk Areas</u>													
	<i>Automobile Roads</i>	<i>Railroad tracks</i>	<i>Utilities (water, sewer, electric & telephones)</i>	<i>Earthwork - Unclassified Excavation</i>	<i>Earthwork - Rock Excavation</i>	<i>Exterior Improvements - Retaining Walls</i>	<i>Fabricated Railroad Bridges</i>	<i>Fabricated Automobile Bridges</i>	<i>Other (Erosion Control, Turfing & Clearing)</i>	<i>Detention Basin Construction (5) Earthwork</i>	<i>Detention Basin Outlet Works (5) (concrete)</i>	<i>Remaining Construction Items</i>	<i>Planning, Engineering, & Design</i>	<i>Construction Management</i>
Project Scope Growth	2	1	2	-	2	2	1	1	-	-	-	-	-	-
Acquisition Strategy	3	3	3	2	3	3	3	3	3	3	3	3	3	3
Construction Elements	1	1	2	2	2	2	-	-	2	2	2	-	2	2
Quantities for Current Scope	2	1	2	2	3	2	1	1	2	2	2	2	2	2
Specialty Fabrication or Equipment	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Cost Estimate Assumptions	2	2	2	2	2	2	2	2	2	2	2	2	2	2
External Project Risks	2	2	2	2	2	2	2	2	2	2	2	2	2	2

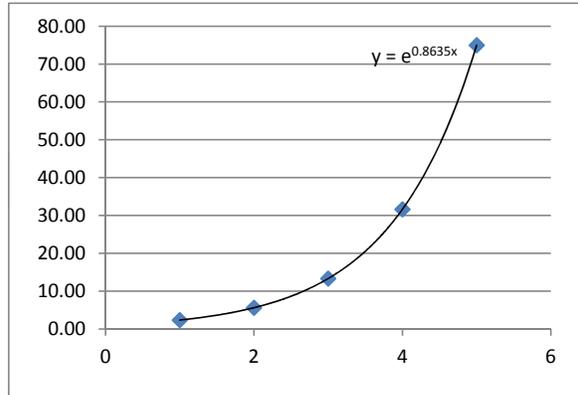
Typical Risk Elements

Cost Growth

Project Scope Growth

x	y	
0	0	0.00%
1	2.37	2.37%
2	5.62	5.62%
3	13.34	13.34%
4	31.63	31.63%
5	75.00	75.00%

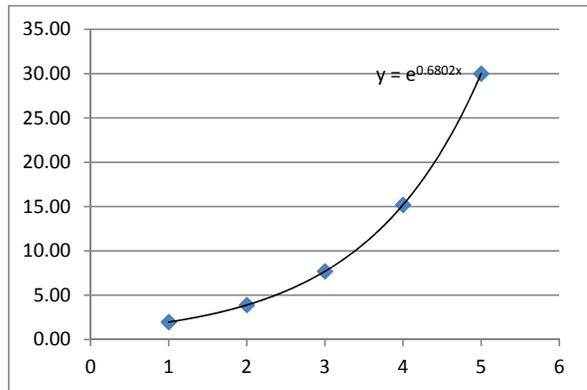
$y = a^x$
 $a = y^{(1/x)}$
 $a = 2.371441$



Acquisition Strategy

x	y	
0	0	0.00%
1	1.97	1.97%
2	3.90	3.90%
3	7.70	7.70%
4	15.19	15.19%
5	30.00	30.00%

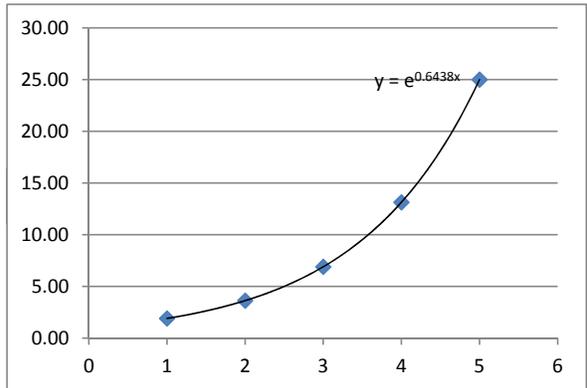
$y = a^x$
 $a = y^{(1/x)}$
 $a = 1.97435$



Construction Elements

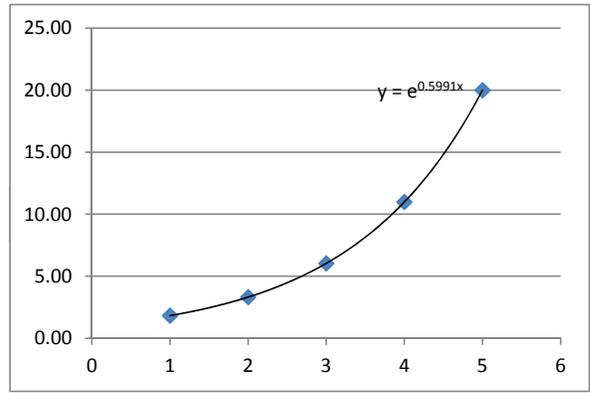
x	y	
0	FALSE	0.00%
1	1.90	1.90%
2	3.62	3.62%
3	6.90	6.90%
4	13.13	13.13%
5	25.00	25.00%

$y = a^x$
 $a = y^{(1/x)}$
 $a = 1.903654$

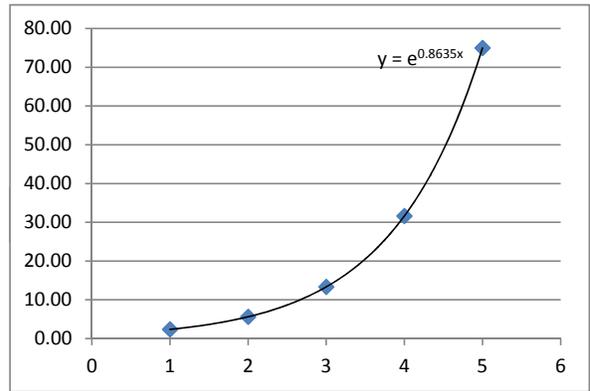


Cost Growth

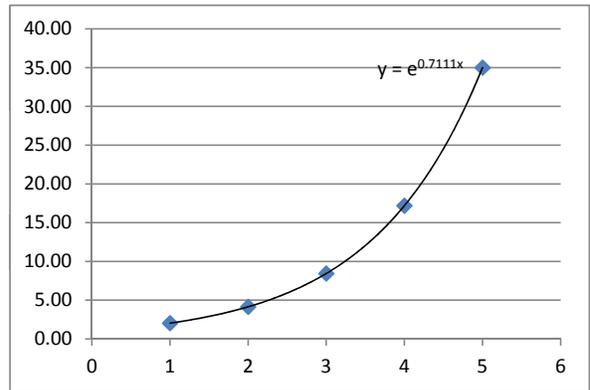
Quantities	Max Potental Cost Growth		20 %
	x	y	
	0	0	0.00%
	1	1.82	1.82%
	2	3.31	3.31%
	3	6.03	6.03%
	4	10.99	10.99%
	5	20.00	20.00%
	y	=	a^x
	a	=	y^(1/x)
	a	=	1.820564



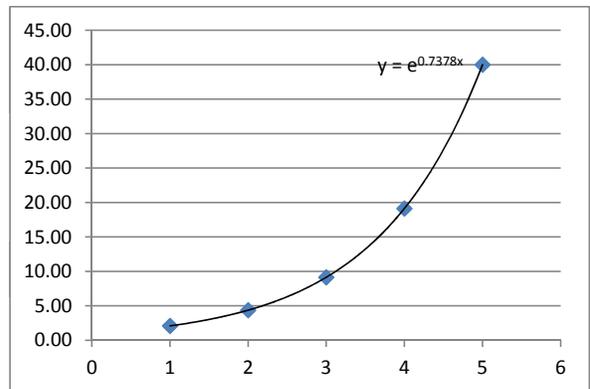
Fab or Equip	Max Potental Cost Growth		75 %
	x	y	
	0	0	0.00%
	1	2.37	2.37%
	2	5.62	5.62%
	3	13.34	13.34%
	4	31.63	31.63%
	5	75.00	75.00%
	y	=	a^x
	a	=	y^(1/x)
	a	=	2.371441



Cost Est Assumptions	Max Potental Cost Growth		35 %
	x	y	
	0	0	0.00%
	1	2.04	2.04%
	2	4.15	4.15%
	3	8.44	8.44%
	4	17.19	17.19%
	5	35.00	35.00%
	y	=	a^x
	a	=	y^(1/x)
	a	=	2.036168



External Risks	Max Potental Cost Growth		40 %
	x	y	
	0	0	0.00%
	1	2.09	2.09%
	2	4.37	4.37%
	3	9.15	9.15%
	4	19.13	19.13%
	5	40.00	40.00%
	y	=	a^x
	a	=	y^(1/x)
	a	=	2.091279



Calculations

	Project Scope Growth		Acquisition Strategy		Construction Elements	
	75%		30%		25%	
Automobile Roads	5.62%	\$ 5,725	7.70%	\$ 7,835	1.90%	\$ 1,938
Railroad tracks	2.37%	\$ 1,072	7.70%	\$ 3,478	1.90%	\$ 860
Utilities (water, sewer, electric & telephone)	5.62%	\$ 69,341	7.70%	\$ 94,893	3.62%	\$ 44,683
Earthwork - Unclassified Excavation	0.00%	\$ -	3.90%	\$ 90,374	3.62%	\$ 84,017
Earthwork - Rock Excavation	5.62%	\$ 16,583	7.70%	\$ 22,695	3.62%	\$ 10,686
Exterior Improvements - Retaining Walls	5.62%	\$ 19,062	7.70%	\$ 26,087	3.62%	\$ 12,284
Fabricated Railroad Bridges	2.37%	\$ 47,336	7.70%	\$ 153,623	0.00%	\$ -
Fabricated Automobile Bridges	2.37%	\$ 9,076	7.70%	\$ 29,456	0.00%	\$ -
Other (Erosion Control, Turfing, Clearing & G	0.00%	\$ -	7.70%	\$ 23,625	3.62%	\$ 11,124
Detention Basin Construction (5) - Earthwork	0.00%	\$ -	7.70%	\$ 225,640	3.62%	\$ 106,248
Detention Basin Outlet Works (5) (concrete)	0.00%	\$ -	7.70%	\$ 38,953	3.62%	\$ 18,342
Remaining Construction Items	0.00%	\$ -	7.70%	\$ -	0.00%	\$ -
		\$ 168,196.08		\$ 716,658.62		\$ 290,182.42
		\$ 10,456,080.00		\$ 10,456,080.00		\$ 10,456,080.00
		1.61%		6.85%		2.78%

Calculations

Jordan Creek FRM Study, Springfield, Missouri Feasibility Study Abbreviated Risk Analysis									
<u>Quantities for Current Scope</u>		<u>Specialty Fabrication or Equipment</u>		<u>Cost Estimate Assumptions</u>		<u>External Project Risks</u>		<u>Σ</u>	<u>Σ of \$</u>
20%		75%		35%		40%		300%	
3.31%	\$ 3,374	0.00%	\$ -	4.15%	\$ 4,221	4.37%	\$ 4,453		\$ 27,547
1.82%	\$ 823	2.37%	\$ 1,072	4.15%	\$ 1,874	4.37%	\$ 1,976		\$ 11,155
3.31%	\$ 40,867	0.00%	\$ -	4.15%	\$ 51,120	4.37%	\$ 53,925		\$ 354,828
3.31%	\$ 76,843	0.00%	\$ -	4.15%	\$ 96,121	4.37%	\$ 101,395		\$ 448,751
6.03%	\$ 17,794	0.00%	\$ -	4.15%	\$ 12,226	4.37%	\$ 12,897		\$ 92,880
3.31%	\$ 11,235	0.00%	\$ -	4.15%	\$ 14,053	4.37%	\$ 14,824		\$ 97,545
1.82%	\$ 36,340	0.00%	\$ -	4.15%	\$ 82,758	4.37%	\$ 87,298		\$ 407,355
1.82%	\$ 6,968	0.00%	\$ -	4.15%	\$ 15,868	4.37%	\$ 16,739		\$ 78,107
3.31%	\$ 10,175	0.00%	\$ -	4.15%	\$ 12,727	4.37%	\$ 13,425		\$ 71,077
3.31%	\$ 97,175	0.00%	\$ -	4.15%	\$ 121,555	4.37%	\$ 128,224		\$ 678,841
3.31%	\$ 16,776	0.00%	\$ -	4.15%	\$ 20,984	4.37%	\$ 22,136		\$ 117,190
3.31%	\$ -	0.00%	\$ -	4.15%	\$ -	4.37%	\$ -		\$ -
	\$ 318,369.68		\$ 1,071.70		\$ 433,507.00		\$ 457,291.25	\$ 2,385,276.76	\$ 2,385,277
	\$ 10,456,080.00		\$ 10,456,080.00		\$ 10,456,080.00		\$ 10,456,080.00	\$ 10,456,080.00	\$10,456,080.00
	3.04%		0.01%		4.15%		4.37%	22.81%	22.81%