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Risk Management During the Cost Estimating Process

2021 DCHWS Seminar Series

Presented by Greg Mah-Hing and Steve Foster

July 14, 2021

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Topics

1. Safety topic
2. What is Risk and why do we manage it?
3. Identification and quantification of risk during progressive phases of design;
4. How to mitigate risk through contract language or added cost;
5. Provide examples of how risk costs are estimated, assigned, and weighted due to probability and impact of risk.
6. How multiple risk components are analyzed and a cost strategy is developed.

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What is Risk and Risk Management

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What is Risk?

- An uncertain event or condition that, if it occurs, has a negative (Threat) or positive (Opportunity) effect on the project's objectives
- When a Risk Event occurs, the negative effect typically results in a negative financial, schedule or project objective.
- The risk analysis process provides a basis for evaluation and treatment of potential events and contingency development
- Risk Management monitors and manages identified events and potential new risk events that may evolve and impact project cost and schedule
- Three forms of risks managed within the risk register:
  - Discrete Risk events May or May Not occur.
  - Uncertainty is a form of risk that is based on accuracy of the estimate as determined by scope maturity and design completeness. It is the Unknown, Knowns.
  - Unknown events. Not initially known but may be revealed later.
- Once identified, there are 3 Key elements of any risk event:
  - IF (Trigger)
  - THEN (Impact)
  - Treatment (Mitigate or Exploit)

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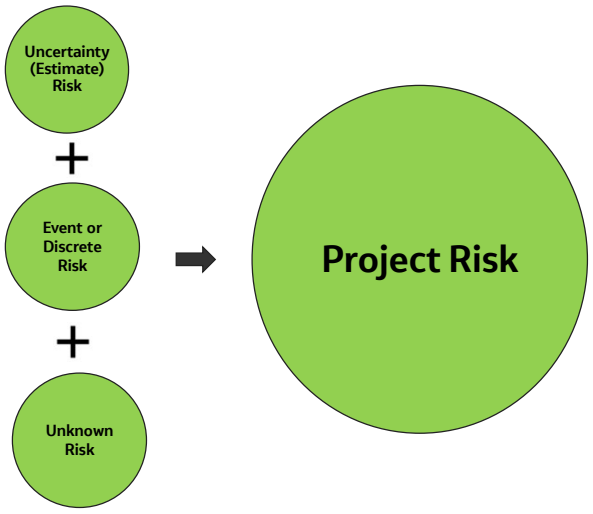
Types of Risk

- **Uncertainty**
  - Cost
  - Schedule
  - Design
- **Discrete Risk/Opportunity Events**
- **Unknowns** (***Events that we do not know about yet***)



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Why do We Manage Risk?

- Minimize or maximize a threat or opportunity
- To identify and manage risk events thru mitigation response planning, utilizing solutions based on the estimated cost of risks.
- To produce the following desired outcomes:
  - Improve Project cost and schedule control
  - Protect Project from financial, schedule losses
  - Allows senior management to make informed decisions on budget threats and opportunities
- Proposal/Bid Stage – The ability to incorporate the estimated cost of risk into a project's cost estimate should be initiated during this phase.

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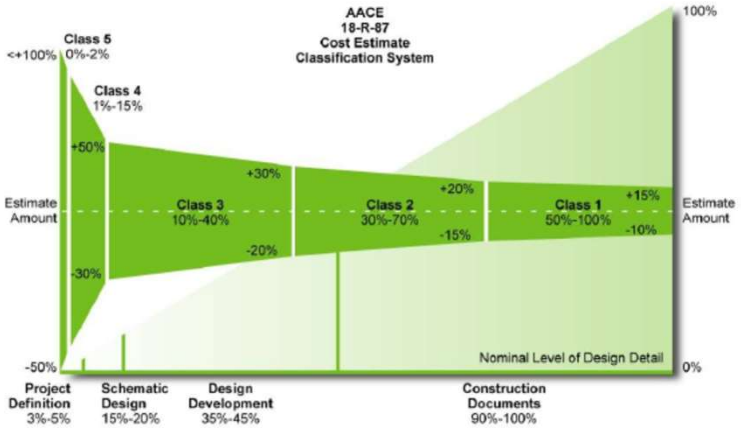
Identification of Risk during Progressive Phases of Design

- Include discussion of risks and unknowns at every level of design review.
- As design progresses, Values for risk and unknowns should decrease.
- Environmental projects, sometimes cost of risk elements do not decrease
- In general, risk development is similar to the estimate classification system



Construction Cost Estimate Accuracy Ranges

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Many Aspects of a Project can create risk

Client	Contract	Regulatory
Economy	Natural Events	Schedule (Delay)
Location	Weather	Procurement
Site Conditions	Technology	Subcontracting
Safety	Engineering	Construction
Production	Material Costs	Stakeholders

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Basic of Risk Assessment - Key Elements & Responses

Key Elements

- **Risk Breakdown Structure**
- **Qualitative Analysis**
- **Quantitative Analysis**
- **Analysis Outputs**
  - Density Chart
  - Sensitivity Analysis
  - Confidence Intervals

Responses

- **Threats**
  - Avoid
  - Mitigate
  - Transfer
  - Accept
  - Share
- **Opportunities**
  - Exploit
  - Enhance
  - Share

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Risk Assessment – Use of a Risk Register

- Risk Register is an industry practice for listing project risks
  - Identify & describe the risk event
  - Action Plan for risk mitigation (Avoid, Transfer, Reduce or Accept the risk)
  - Estimates the cost of risk
- Two types of risk value determination:
  1. Determinate
  2. Probabilistic
- It assigns numerical cost and schedule impacts to risk items to help establish risk reserve (aka: cost contingency or allowance)
- Project Delivery Stage – It helps incorporate cost of risk into a Project's control budget
- Risk Register prepared during the solicitation/bid period is your starting point
- Risk Register should be updated as your Project progresses and situations change.

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The Risk Register

Deterministic and Probabilistic

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Risk Management

- **Risk Management Planning: Process of how to approach, plan, and execute risk management activities.**
- **Risk Identification: Identify and determine which risk events or opportunities might affect the project and document.**
- **Qualitative Analysis: Assesses impact, likelihood, and priority of risk events (Rank). Includes IF (Triggers), THEN (Impacts) statements. Identify Residual Risks if any.**
- **Quantitative Analysis: Simultaneously and mathematically evaluates the impacts of risk events. Usually performed with embedded programs such as @Risk or Crystal Ball.**
- **Risk Response Planning: Development of options and actions to enhance opportunities and reduce threats. Assignment of risk owner.**
- **Risk Monitoring and Control: Tracks and monitors identified risk events and identifies new risks.**

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Risk Scoring Matrix (example)

Threat			Impact				
			Very Low	Low	Medium	High	Very High
Project Objectives	Safety		Increase of near misses to employee inury or property damage	One or more first aid cases to employee or minor property damage	One or more recordable injuries or property damage <$100K	One or more lost-time injuries or property damage <$500K	One or more permanent disabilities or property damage >$500K
	Cost		< $0.3M (1% of contract value) increase	$0.3M - 1.5M (1 -5% of contract value) increase	$1.5M - $3M (5-10% of contract value) increase	$3M - 4.5M (10-15% of contract value) increase	> $5M (>15% of contract value) increase
	Schedule		<1 month increase	1-2 month increase	2-4 months increase	4-6 months increase	6 months increase
	Environmental		No significant consequences, no impacts; low regulatory burden	Limited and correctable environmental damage; average regulatory burden	Correctable environ- mental damage; high regulatory burden; low to average enforcement penalties	Significant environmental damage; high enforcement penalties	Substantial environmental damage; remediation, enforcement, and/or litigation
	Quality (Technology)		Nuisances in end product	Minor deficiencies in end product	Major deficiencies in end product	End product does not satisfy all requirements	End product is unuseable
	Reputation		Internal negative attention	Special interest group negative attention	Local negative attention	National/regional negative attention	Global negative attention
Most Likely Probability	70-100%	Very High	Medium	Medium	High	High	High
	51-70%	High	Low	Medium	Medium	High	High
	31-50%	Medium	Low	Medium	Medium	Medium	High
	11-30%	Low	Low	Low	Medium	Medium	Medium
	0-10%	Very Low	Low	Low	Low	Low	Medium

Opportunities			Impact				
			Very Low	Low	Medium	High	Very High
Project Objectives	Safety		Decrease of near misses by 10%	Decrease of first aid case metric by 10%	Decrease of recordable injury metric by 10%	Decrease of lost-time injury metric by 10%	Project recognized by peer group/industry
	Cost		< $0.3M (1% of contract value) decrease	$0.3M - 1.5M (1 -5% of contract value)decrease	$1.5M - $3M (5-10% of contract value) decrease	$3M - 4.5M (10-15% of contract value) decrease	> $5M (>15% of contract value) decrease
	Schedule		<1 month decrease	1-2 month decrease	2-4 months decrease	4-6 months decrease	6 months decrease
	Environmental		Full compliance with environmental requirements	Minor reduction of adverse environmental impacts	Project conforms to environmental standard; major reduction of environtal impacts	Project registered to environmental standard; enhanced environment; recognized by client	Project certified to environmental standard; recognized by peer group, industry, or media
	Quality (Technology)		Minor improvement in end product	Major improvements in end product	Innovative end product	Project recognized by client	Project recognized by peer group/industry
	Reputation		Internal positive attention	Special interest group positive attention	Local positive attention	National/regional positive attention	Project recognized by peer group/industry
Most Likely Probability	70-100%	Very High	Medium	Medium	High	High	High
	51-70%	High	Low	Medium	Medium	High	High
	31-50%	Medium	Low	Medium	Medium	Medium	High
	11-30%	Low	Low	Low	Medium	Medium	Medium
	0-10%	Very Low	Low	Low	Low	Low	Medium

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Risk Analysis – Short form (Determinate)

- Used for recurrent projects; similar risk items, team had extensive experience with site and technology.
- Risk analysis approach is determined by contract requirements and/or Sr. Management
- "Estimated Cost" *col. Determines the risk value based on experience.*

IB-RK-PR-7510-IB-F-01 Risk Analysis and Mitigation Plan (RAMP Tool)

Describe Risk						Assess Risk		
Type								
#	Risk Category	Impacted	Risk or Opp	Risk Event (Cause and Consequence)	Status Open/Close	Impact	Probability	Priority
1	HSE	Jacobs	Risk	Cost, schedule and/or liquidated damage (LD) impacts due to COVID-19.	Open	Moderate	Possible	Medium
2	Technical & Engineering	Jacobs	Risk	Our design team is unable to complete all design/engineering work at a cost less than our Oracle Design/Engineering Direct Cost (DC) budget and we experience gross margin erosion	Open	Moderate	Possible	Medium
3	Scope Management	Jacobs	Risk	We do not design to our Oracle Restoration DC Budget. We produce a design which precludes us from executing the restoration work at a cost less than our Restoration DC Budget and we experience gross margin erosion	Open	Moderate	Possible	Medium
4	Schedule	Jacobs	Risk	Government does not meet design review timelines resulting in project delays, LDs, extended GCs, and margin erosion	Open	Moderate	Likely	High
5	Resources & Suppliers	Jacobs + Others	Risk	Delays in equipment manufacture (HVAC, security) and delivery due to coronavirus and manufacturer shutting down resulting in LDs, extended GCs, and margin erosion	Open	Minor	Almost Certain	Medium
6	Legal & Commercial	Jacobs	Risk	Project delays result in LDs, extended GCs, and margin erosion	Open	Minor	Likely	Medium
7	Resources & Suppliers	Jacobs	Risk	Subcontractor unavailability due to emergency work in hurricane area resulting in project delays, LDs, extended GCs, and margin erosion	Open	Moderate	Possible	Medium
8	Resources & Suppliers	Jacobs	Risk	Warranty period (1 year min) results in warranty call backs, remobilization and increased costs.	Open	Moderate	Possible	Medium
9	Resources & Suppliers	Jacobs	Risk	Identifying adequate qualified bidders to be general contractor responsible for construction scope.	Open	Moderate	Possible	Medium

Action Plan			
	Implementation		
Specific Action	Person Responsible	Target Completion Date	Action Status
AVOID the risk. Include a qualification in our proposal indicating: • We have not included cost and/or schedule impacts for COVID-19. • Our proposal is based upon the Government considering these impacts a valid basis for equitable adjustment to our fixed price and	Proposal Manager, PM	N/A	
Review weekly report on cost controls and design budget	DM	01-Aug-2021	
Designate design integrator who is in regular contact with general contractor to ensure the final design is in line with the bid provided by the DC	DM	01-Oct-2020	
Identify review timeline assumptions in the proposal	DM	15-Aug-2020	
Identify long lead time items early in the design to allow submittal approval and orders to be placed prior to design completion	DM, General Contractor	31-Jan-2021	
Track schedule closely and immediately notify Navy of compensatory delays	PC	N/A	
Keep in close contact with subcontractor onsite, including regularly scheduled weekly project meetings	PM	N/A	
Keep good documentation on warranty items and good onsite QC during construction	QC	N/A	
Best value determination requirements, one-on one meetings/calls with the subcontractors	DM	24-Jul-2020	

Use 3 point estimating	Risk Allowance						
				643,364	Estimated Cost and Time Impact after Mitigation Actions		
Probability (%)	Cost (Minimum)	Cost (Most Likely)	Cost (Maximum)	Estimated Cost	Cost Estimating Assumptions	Time Impact of Risks	Date last reviewed
70%	85,000	117,152	156,000	82,600	Time only for "Acts of God", 20 days LDs & GCs	20 days	20-Jul-2020
30%	70,164	87,706	122,788	27,189	4 weeks additional design costs for 6 designers	N/A	20-Jul-2020
20%	680,000	750,000	850,000	161,000	Construction costs for change	N/A	20-Jul-2020
50%	63,734	79,668	912,564	107,914	2 weeks LDs & GCs	14 days	20-Jul-2020
50%	70,000	79,668	111,535	41,684	2 weeks LDs & GCs	14 days	20-Jul-2020
30%	67,690	139,396	223,075	47,406	4 weeks LD & GCs	28 days	20-Jul-2020
20%	67,832	79,668	111,535	16,601	Delays due to no subcontractors available to come onsite, 2 weeks LDs & GCs	14 days	20-Jul-2020
50%	29,745	51,827	72,558	26,601	Oversight and coordination on warranty issues, 20 hrs of support plus costs to fix issues	N/A	20-Jul-2020
20%	0	0	0	0	5% increase in construction cost if inadequate competition	N/A	20-Jul-2020

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Risk Register – Mitigation thru Contract Language or Cost Reserve

- During contract negotiations is the best time to mitigate risk. Clearly agree on scope - quantities, contaminant, clean-up levels, etc.
- Currently we perform many projects under a negotiated Guaranteed Maximum Price contract.
- Cost reserves are best determined by performing estimates to represent best case, most likely, and worst case scenarios.
- Current market – contractors are not taking risks. For example, if they receive three electrical bids, they might name the low bidder but actually use the second bidders proposed amount.

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Monte Carlo Process

- Determined by Sr. Management
- Usually reserved for larger more complex projects
- Utilizes software such as @Risk or Crystal Ball
- Statistical vs. Determinate

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Monte Carlo Analysis Process

- Define risk events (if, then, treatment)
- Determine risk score (probability and impact)
- Determine appropriate distribution variable (Curve)
- Evaluate and define variable range (Low/High)
- Determine Probability of Occurrence %
- Evaluate event correlations
- Run Monte Carlo simulation (Typically 10,000 iterations)
- Evaluate results and select Confidence % and cost impacts
- Review potential residual and schedule Impacts.
- Document basis
- Risk / Opportunity Information Sheet (ROIS)

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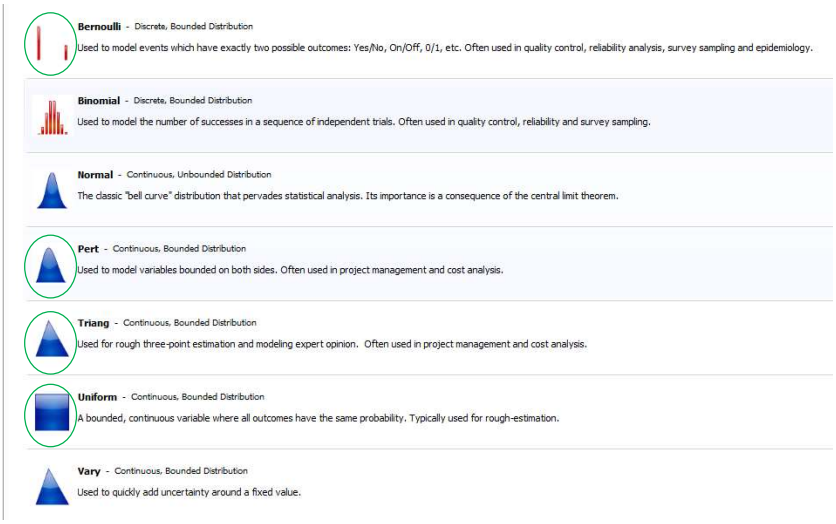
Risk Register – Examples of Typical Distribution Curves



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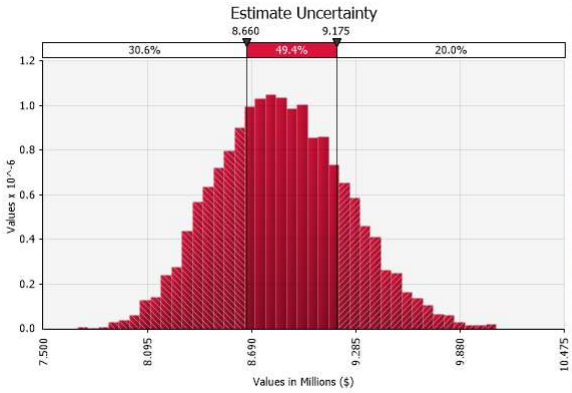
Monte Carlo Analysis – Density Chart and Statistics



Statistics	Estimate Uncertainty
Cell	Y10
Minimum	$7,692,488.04
Maximum	$10,085,974.36
Mean	$8,860,125.91
90% CI	± $6,090.44
Mode	$8,755,333.84
Median	$8,848,073.87
Std Dev	$370,238.42
Skewness	0.1639
Kurtosis	2.7963
Values	10000
Errors	0
Filtered	0
Left X	$8,660,000.00
Left P	30.6%
Right X	$9,175,288.06
Right P	80.0%
Dif. X	$515,288.06
Dif. P	49.4%

1. 90% Confidence Range - $ Value
2. Confidence Interval - %
3. Sample Densities (Stacks & Left Col.)
4. Confidence Interval %'s
5. Sample Range in $
6. Cumulative Curve

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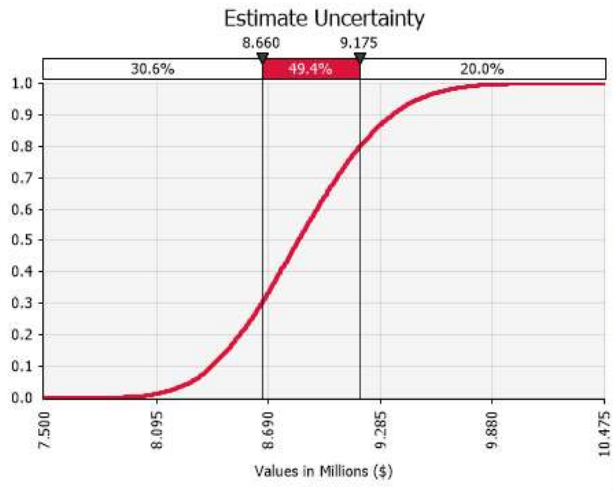
Monte Carlo Analysis – Cumulative Distribution & Percentiles



Statistics	Estimate Uncertainty
25%	$8,598,329.81
30%	$8,653,501.09
35%	$8,703,325.12
40%	$8,751,196.78
45%	$8,802,823.27
50%	$8,848,073.87
55%	$8,896,114.00
60%	$8,947,362.94
65%	$8,999,328.82
70%	$9,053,723.68
75%	$9,109,440.21
80%	$9,175,288.06
90%	$9,348,544.83
95%	$9,490,089.61
97.5%	$9,617,019.54
99%	$9,742,287.63

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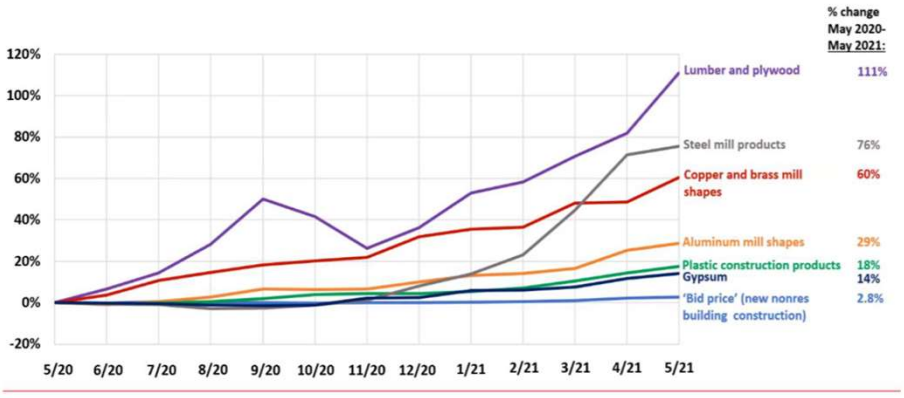
Material Pricing Index, May 2020 – May 2021



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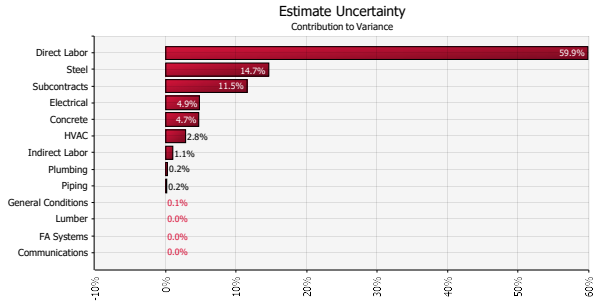
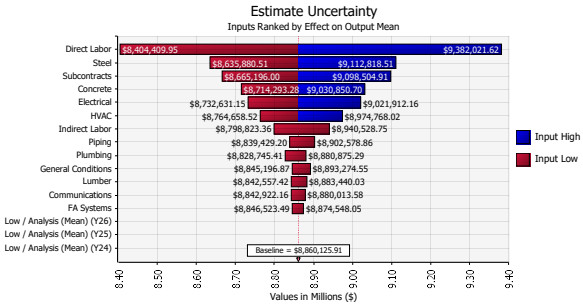
Monte Carlo Analysis – Uncertainty Sensitivity Analysis & Ranking

Two Formats





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Monte Carlo Analysis – Risk Pre and Post Simulation

Risk Breakdown Structure (RBS)	Risk No.	[redacted]	Probability	Impact	Ranking	Best Case	Most Likely	Worst Case	Analysis (Mean)	Probability %	1 = Yes 0 = No	P Value %	P Value $	Residual %	Residual $	Sched. Impact	Total $
Risk - Pre-Mitigation						**$1,466,000**	**$1,763,865**	**$2,386,000**	**$1,817,910**		**2**		**$523,194**		**$0**	**$0**	**$523,194**
Risk - Pre-Mitigation	RPreM-1		Very Low	Very Low	Low	$25,000	$35,000	$50,000	$35,833	60%	1	80%	$40,078		$0	$0	**$40,078**
Risk - Pre-Mitigation	RPreM-2		Very Low	Very Low	Low	$500,000	$650,000	$900,000	$666,667	30%	0	80%	$0		$0	$0	**$0**
Risk - Pre-Mitigation	RPreM-3		Very Low	Very Low	Low	$400,000	$450,000	$550,000	$458,333	50%	1	80%	$483,116		$0	$0	**$483,116**
Risk - Pre-Mitigation	RPreM-4		Very Low	Very Low	Low	$15,000	$25,365	$40,000	$26,077	25%	0	80%	$0		$0	$0	**$0**
Risk - Pre-Mitigation	RPreM-5		Very Low	Very Low	Low	$70,000	$80,000	$110,000	$83,333	20%	0	80%	$0		$0	$0	**$0**
Risk - Pre-Mitigation	RPreM-6		Very Low	Very Low	Low	$89,000	$95,000	$130,000	$99,833	45%	0	80%	$0		$0	$0	**$0**
Risk - Pre-Mitigation	RPreM-7		Very Low	Very Low	Low	$25,000	$28,500	$56,000	$32,500	25%	0	80%	$0		$0	$0	**$0**
Risk - Pre-Mitigation	RPreM-8		Very Low	Very Low	Low	$142,000	$150,000	$240,000	$163,667	24%	0	80%	$0		$0	$0	**$0**
Risk - Pre-Mitigation	RPreM-9		Very Low	Very Low	Low	$200,000	$250,000	$310,000	$251,667	40%	0	80%	$0		$0	$0	**$0**
Risk - Post-Mitigation						**$1,307,000**	**$1,538,000**	**$2,146,000**	**$1,600,833**		**2**		**$466,687**		**$0**	**$0**	**$466,687**
Risk - Post-Mitigation	RPostM-1		Very Low	Very Low	Low	$25,000	$30,000	$40,000	$30,833	60%	1	80%	$33,312		$0	$0	**$33,312**
Risk - Post-Mitigation	RPostM-2		Very Low	Very Low	Low	$400,000	$500,000	$750,000	$525,000	30%	0	80%	$0		$0	$0	**$0**
Risk - Post-Mitigation	RPostM-3		Very Low	Very Low	Low	$345,000	$400,000	$500,000	$407,500	50%	1	80%	$433,375		$0	$0	**$433,375**
Risk - Post-Mitigation	RPostM-4		Very Low	Very Low	Low	$12,000	$20,000	$35,000	$21,167	25%	0	80%	$0		$0	$0	**$0**
Risk - Post-Mitigation	RPostM-5		Very Low	Very Low	Low	$70,000	$80,000	$100,000	$81,667	20%	0	80%	$0		$0	$0	**$0**
Risk - Post-Mitigation	RPostM-6		Very Low	Very Low	Low	$88,000	$94,500	$125,000	$98,500	45%	0	80%	$0		$0	$0	**$0**
Risk - Post-Mitigation	RPostM-7		Very Low	Very Low	Low	$25,000	$28,500	$56,000	$32,500	25%	0	80%	$0		$0	$0	**$0**
Risk - Post-Mitigation	RPostM-8		Very Low	Very Low	Low	$142,000	$150,000	$240,000	$163,667	24%	0	80%	$0		$0	$0	**$0**
Risk - Post-Mitigation	RPostM-9		Very Low	Very Low	Low	$200,000	$235,000	$300,000	$240,000	40%	0	80%	$0		$0	$0	**$0**

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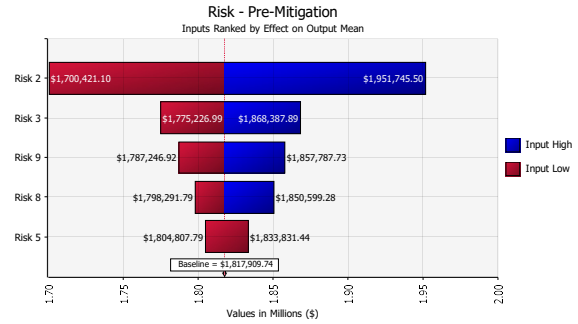
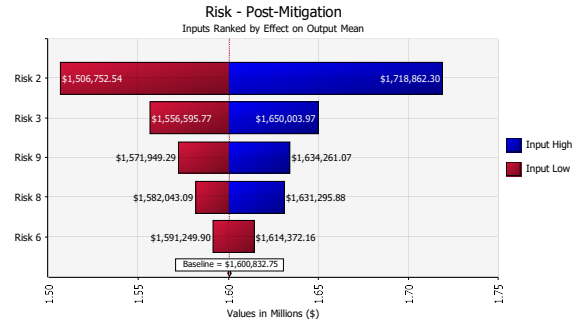
Monte Carlo Analysis – Risk Sensitivity Analysis & Ranking

Pre and Post Mitigation





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Monte Carlo Analysis

Comparison of Uncertainty Analysis and Risk Mitigation Results

Class 3 Estimate, Pre-Mitigation			
Base Estimate	**$ 8,660,000.00**		
Estimate Contingency	80% Confidence	$515,288.06	6%
Risk Contingency		*$ 523,194.36*	*6%*
Total Contingency		**$ 1,038,482.42**	**12%**
Total Project Cost	**$ 9,698,482.42**		
Class 2 Estimate, Post Mitigation			
Base Estimate	**$ 8,660,000.00**		
Estimate Contingency	80% Confidence	$343,459.27	4%
Risk Contingency		*$ 466,678.51*	*5%*
Total Contingency		**$ 810,137.78**	**9%**
Total Project Cost	**$ 9,470,137.78**		
Difference	**($228,344.64)**		

- **Estimate changed from Class 3 to Class 2**
  - More information
  - Less uncertainty
  - Firmer pricing via quotes
- **Risk Mitigation**
  - Improved estimate
  - Highest level risks (Tornado Chart) evaluated and mitigated

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Conclusion

- Every project is subject to Uncertainty and Risk
- Begin risk identification as early as possible
- Two types of risk
  - Internal
  - External (Sometimes referred to as Programmatic)
- When evaluating total project contingency, consider:
  - Uncertainty
  - Discrete Risks
  - Unknown (May be revealed as project progresses)
- Calculate contingency using either Statistical and Determinate methods
- Begin risk mitigation strategies early
- Monitor, Manage and update the Risk Register often
- Risk Management is a Team Effort

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Questions

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Jacobs Challenging today. Reinventing tomorrow.

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Welcome

Challenging today.
Our unique approach to challenge what's accepted, using our expertise and knowledge to rethink the way we solve problems.

Reinventing tomorrow.
The outcome, from the innovations we build for our clients to the positive impact our solution have on the world.

To create a more connected, sustainable world.

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Our Values

To create a more connected, sustainable world.

We do things right.
We challenge the accepted.
We aim higher.
We live inclusion.

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Risk and Opportunity Information Sheet (ROIS)

Page 1

Risk and Opportunity Information Sheet								Risk No.:	
Risk Information									
Project Name:	SLDA		Revision:	0	Date Opened:		Last Update:	Status:	Open
Title:								Review Frequency:	Monthly
WBS:					Probability:	BLANK	Impact: BLANK	Risk Level:	BLANK
WBS Title:					Risk Owner:	Jacobs		Contact #:	
CAM:					Contact Name:			Contact #:	
Organization / Group:									
Group:	BLANK	BLANK							
Work Area:	BLANK	BLANK							
Category:	BLANK	0							
Phase:	BLANK	0							
Treatment:	BLANK	BLANK							
Int./Ext.	BLANK	BLANK							
T/O	BLANK	BLANK							
Risk Statement									
IF (Drivers)									
THEN (Impacts)									
MITIGATIONS									
Background Discussion:									
Basis of Cost Impact:					**Basis of Schedule Impact:**				

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Risk and Opportunity Information Sheet (ROIS)

Page 2

Risk and Opportunity Information Sheet						Risk No.:	0
Risk Value							
Most Likely $ (Impact $)			Distribution:	Pert	Probability (%):	50%	
Date of Initial Approval:				Date Closed:			
Description	**Values**	**Transfer No.**	**Amount**	**Date**	**Balance Rem.**	**Reason**	
Most Likey Risk $	$0	1			$0		
Confidence %		2			$0		
Risk $ at Confidence		3			$0		
Residual Risk $		4			$0		
Schedule Risk $		5			$0		
Total Cont. Requested	$0	6			$0		
Approved Risk $:		7			$0		
Schedule Risk (Mo.)		8			$0		
Approved Contingency:		$0	$0		$0		

STATUS UPDATES		
No.	**Date**	**Update Discussion**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Basis of Risk/Opportunity Closure:

Notes:

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Risk Checklist

Line No.	(1) RBS_L1	Description	Used "X"	Potential Impact Low <5%	Med	High >10%	Estimated Likelihood Low <5%	Med	High >50%	Notes
1	Technical, risks associated with the scope and technical aspects of the facility									
2	01	Scope Definition								
3		Does contract include a clearly defined scope?								
4		Does the project have an execution plan?								
5		Is scope is incomplete								
6		Tasks get added during project without approval (scope creep)								
7		Stakeholders demand additional scope								
8		Project sponsor has different expectation of scope								
9		Subconsultant/subcontractor scope definition is not clear								
10		Project sponsor/executive demand additional scope without supplying additional funds								
11										
12	02	Quality								
13		Quality of product/service does not meet expectations								
14		Technical expertise of checking/reviewing not adequate								
15		Technical errors								
16		Technical omissions								
17		Required technical training or learning curve is longer than anticipated								
18		Design is not feasible								
19		Design is not practical								
20		Design is difficult or impossible to build								
21		Design lacks features or flexibility								
22		Design standards are not met								
23		Standards/specifications change during project								
24		Contractor does poor quality work								
25		Contractor uses poor quality suppliers								
26		Technological change impacts deliverables								
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- Used as an aid to risk identification
- Typically includes historical risks
- Provides a tracking mechanism for initial Impact and Likelihood Assessments

Risk Register

Group	Risk No.	Threat/ Opportunity	Risk Status	Risk Breakdown Structure	Treatment Type
PROJECT & PROGRAM MGMT					
PROJECT & PROGRAM MGMT	PPM-1	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-2	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-3	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-4	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-5	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-6	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-7	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-8	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-9	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-10	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-11	T	Active	Blank	Accept
PROJECT & PROGRAM MGMT	PPM-12	T	Active	Blank	Accept

Risk Register

Group	Risk No.	Risk Name	Cause (IF)	Impact (THEN)	Mitigation / Treatment Plan
PROJECT & PROGRAM MGMT					
PROJECT & PROGRAM MGMT	PPM-1	Risk 1			
PROJECT & PROGRAM MGMT	PPM-2	Risk 2			
PROJECT & PROGRAM MGMT	PPM-3	Risk 3			
PROJECT & PROGRAM MGMT	PPM-4	Risk 4			
PROJECT & PROGRAM MGMT	PPM-5	Risk 5			
PROJECT & PROGRAM MGMT	PPM-6				
PROJECT & PROGRAM MGMT	PPM-7				
PROJECT & PROGRAM MGMT	PPM-8				
PROJECT & PROGRAM MGMT	PPM-9				
PROJECT & PROGRAM MGMT	PPM-10				
PROJECT & PROGRAM MGMT	PPM-11				
PROJECT & PROGRAM MGMT	PPM-12				

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Risk Register

Group	Risk No.	Date Initiated	Target Date	Date Resolved	Risk Owner	Telephone
PROJECT & PROGRAM MGMT						
PROJECT & PROGRAM MGMT	PPM-1					
PROJECT & PROGRAM MGMT	PPM-2					
PROJECT & PROGRAM MGMT	PPM-3					
PROJECT & PROGRAM MGMT	PPM-4					
PROJECT & PROGRAM MGMT	PPM-5					
PROJECT & PROGRAM MGMT	PPM-6					
PROJECT & PROGRAM MGMT	PPM-7					
PROJECT & PROGRAM MGMT	PPM-8					
PROJECT & PROGRAM MGMT	PPM-9					
PROJECT & PROGRAM MGMT	PPM-10					
PROJECT & PROGRAM MGMT	PPM-11					
PROJECT & PROGRAM MGMT	PPM-12					

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Risk Register - Cost

Group	Risk No.	[redacted]	Probability	Impact	Ranking	Best Case	Most Likely	Worst Case	Analysis	Probability %	1 = Yes 0 = No	P Value %	P Value $	Residual %	Residual $	Sched. Impact	Total $
PROJECT & PROGRAM MGMT						**2,350,000**	**2,625,365**	**3,390,000**	**$2,706,910**	**%**	**3**	**%**	**2,102,827**	**%**	**1,500**	**1,361**	**2,105,688**
PROJECT & PROGRAM MGMT	PPM-1		Very Low	Low	Low	$10,000	$15,000	$20,000	$15,000	60%	1	80%	$16,722	10%	$1,500	$1,361	**$19,583**
PROJECT & PROGRAM MGMT	PPM-2		Medium	High	Medium	$25,000	$35,000	$50,000	$35,833	50%	1	70%	$38,413		$0	$0	**$38,413**
PROJECT & PROGRAM MGMT	PPM-3		Very High	High	High	$500,000	$650,000	$900,000	$666,667	30%	0	70%	$0		$0	$0	**$0**
PROJECT & PROGRAM MGMT	PPM-4		High	Medium	Medium	$1,800,000	$1,900,000	$2,380,000	$1,963,333	80%	1	80%	$2,047,692		$0	$0	**$2,047,692**
PROJECT & PROGRAM MGMT	PPM-5		Low	High	Medium	$15,000	$25,365	$40,000	$26,077	40%	0	85%	$0		$0	$0	**$0**
PROJECT & PROGRAM MGMT	PPM-6		Very Low	Very Low	Low				$0		0		$0		$0	$0	**$0**
PROJECT & PROGRAM MGMT	PPM-7		Very Low	Very Low	Low				$0		0		$0		$0	$0	**$0**
PROJECT & PROGRAM MGMT	PPM-8		Very Low	Very Low	Low				$0		0		$0		$0	$0	**$0**
PROJECT & PROGRAM MGMT	PPM-9		Very Low	Very Low	Low				$0		0		$0		$0	$0	**$0**
PROJECT & PROGRAM MGMT	PPM-10		Very Low	Very Low	Low				$0		0		$0		$0	$0	**$0**
PROJECT & PROGRAM MGMT	PPM-11		Very Low	Very Low	Low				$0		0		$0		$0	$0	**$0**
PROJECT & PROGRAM MGMT	PPM-12		Very Low	Very Low	Low				$0		0		$0		$0	$0	**$0**

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Risk Register - Schedule

Probability	Impact	Comb. Ranking	Best Case	Most Likely	Worst Case	Potential Duration	P Value %	P Value (Days)	Duration Impact (g-b)	Cost/Day Impact	Schedule Impact Cost
			a	b	c	d	e	f	g		
				Days		196		215.1	22.1		$277,918
Medium	Medium	Medium	5	8	12	8.2	80%	9.4	1.4	$1,000	$1,365
Very Low	High	Low	20	50	60	46.7	80%	53.3	3.3	$ 20,000.00	$65,109
High	Very High	High	55	60	90	64.2	80%	69.1	9.1	$ 15,000.00	$136,543
Medium	High	Medium	35	45	65	46.7	80%	51.6	6.6	$ 10,000.00	$66,231
Low	Medium	Medium	25	30	35	30.0	80%	31.7	1.7	$ 5,000.00	$8,669
Very Low	Very Low	Low				0.0		0.0	0.0		$0
Very Low	Very Low	Low				0.0		0.0	0.0		$0

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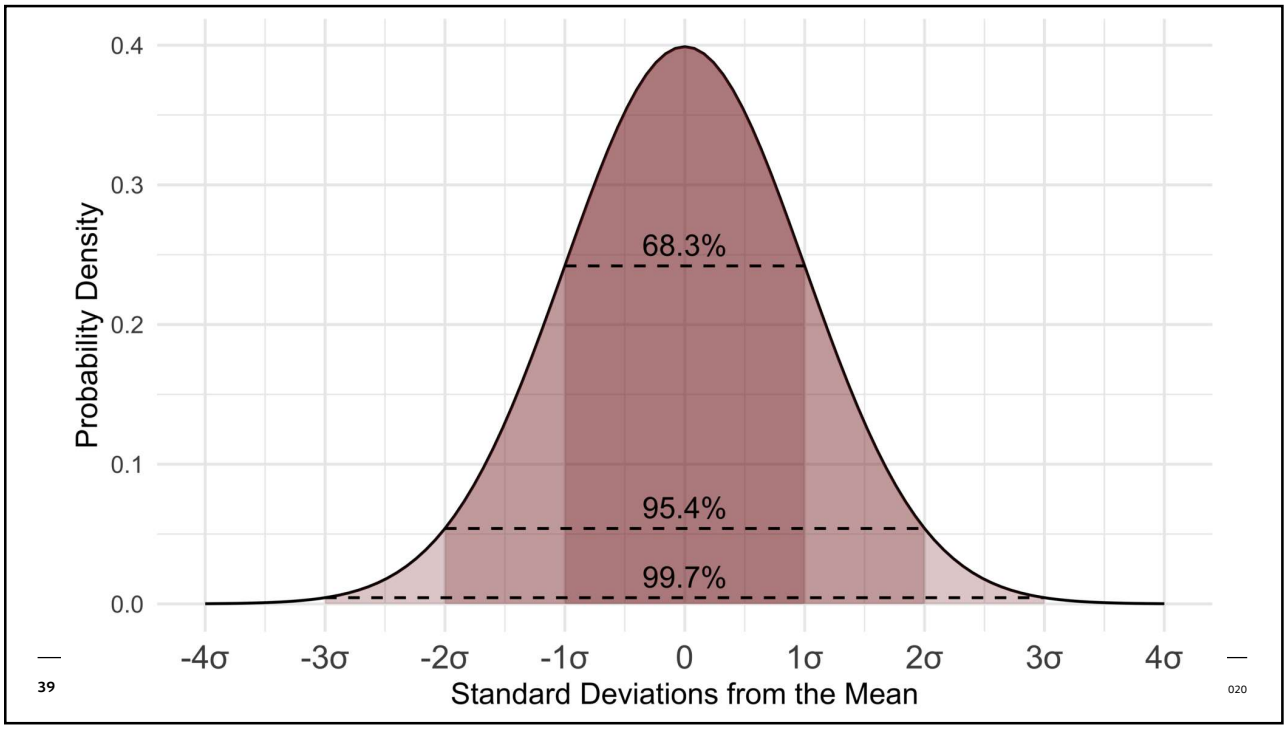

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Presenter Bios

▪ Greg Mah-Hing, PE

- Birthplace and permanent residence: San Francisco, attended University of California, Berkeley; B.S. in Civil Engineering
- PE License – California Civil Engineer #30652, 1979
- Thirteen years as Project Engineer and Project Manager for heavy civil contractor specializing in deep excavations, tunnels, utilities and cross country pipelines. Performed cap of PCB contaminated site in late 1980's.
- Twenty years with CH2M/ Jacobs as Manager of Estimating for the Environmental Services Group. Manager responsible for global estimating services including proposal development and bidding strategy for cost-reimbursable, fixed-price and unit price contracts for hazardous waste and contaminated site cleanup, munitions cleanup, nuclear, water/wastewater treatment plant, utility, federal facilities and construction management projects. Supervise estimating effort for clients, provide guidance on project design, quantity take-offs, estimate structure, project schedule, contract interpretation and pricing. Integrate value engineering.
- Recent international work includes projects in Crete, Kuwait, Manila and other Southeast Asia locations.
- Construction Manager for $1.6 B San Francisco-Oakland Bay Bridge Skyway; also construction manager for Los Angeles Red Line Tunnel Project (CH2M HILL).
- Other positions include Estimating Manager for OHM Remediation covering the Western States through the Pacific area (7 years) and Chief Estimator for Bechtel National (3 years).
- Co-author AACE Recommended Practice 107R-19, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Environmental Remediation Industries.

▪ Steve Foster

- Permanent residence: Knoxville, TN. Attended Washington State University, in Pullman, WA. Receiving a B.S. in Construction Management.
- Journeyman electrician in the IBEW.
- ASPE Certified Professional Estimator (CPE) earned in 1988.
- Thirty-six years in Construction Management including Estimating, Risk Management, Project Controls, and Project Management.
- Ten years as construction superintendent and journeyman electrician working on commercial high-rise buildings, hospitals, refineries, and pulp & paper.
- Global Director of Estimating, Oil, Gas & Chemical Group, CH2M. Estimating and Risk Analysis.
- Domestic projects include: Semi-Conductor Design Build, Nuclear Site Cleanup, Oil, Gas, & Chemical, Commercial, Federal, State, and Military Construction. Estimating and Risk Analysis.
- Manager of Estimating at the following nuclear sites: Hanford, WA., Caulk River, Canada, and Harwell / Winfrith nuclear sites in the UK. Estimating, Risk Management, and EVMS.
- Supported and trained international partners at the ITER nuclear site in France.

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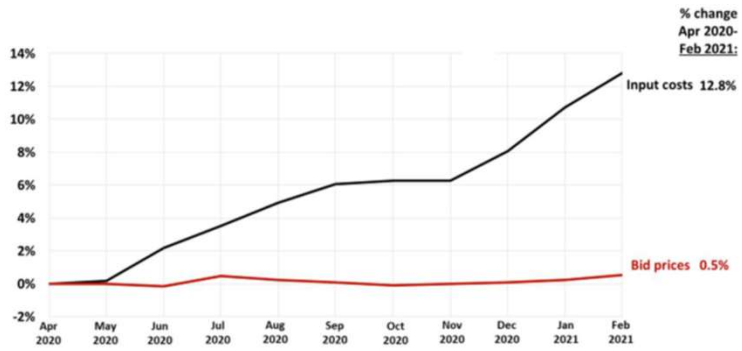
Change in construction input costs and bid prices

April 2020-February 2021



Source: Bureau of Labor Statistics, producer price indexes (PPIs) for new nonresidential building construction (bid prices) and inputs to nonresidential construction (input costs), not seasonally adjusted

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