CRAVE
Cost Risk Assessment + Value Engineering

CSVA 2011 Conference
Toronto, Ontario

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Topic Overview

- *marketing statement, what is in it for me, my organization, why should I listen…*
- *what the problem was…*
- *what I will learn…*
- *What we did…*
- *Closing statement…*

Addressing Cost and Schedule Concerns

Usual Questions

- How much will it cost?
- How long will it take?
- Why does it cost that much?
- Why does it take that long?

Analysis Needs

- Risk Identification
- Qualitative and Quantitative Risk Analysis
- Value Engineering &Mitigation Strategies
- Risk Monitoring & Control

What is CRAVE

- CRAVE is used to assist project delivery as well as minimize and mitigate quantified risks
- CRAVE - innovative unique process
  - Cost Risk Analysis + Value Engineering
    - Combines these two tools to assist with project delivery
- Outputs are:
  - Risk management plan
  - Value Engineering recommendations

Why CRAVE

- Risk assessment workshops would provide valuable information about what could go wrong with my project but would fall short of providing solutions on what to do about it
- Great ideas would come up during risk assessment workshops and would be set aside as potential VE ideas and not recorded
- Value Engineering could add risk to delivering a project
- The same team members are required for both process

Proven Process

- Proven results on a wide range of projects, including bridges, highways, heavy and light rail alignments, ports, airports, tunnels, water treatment facilities, and pipelines
- Won national awards for process

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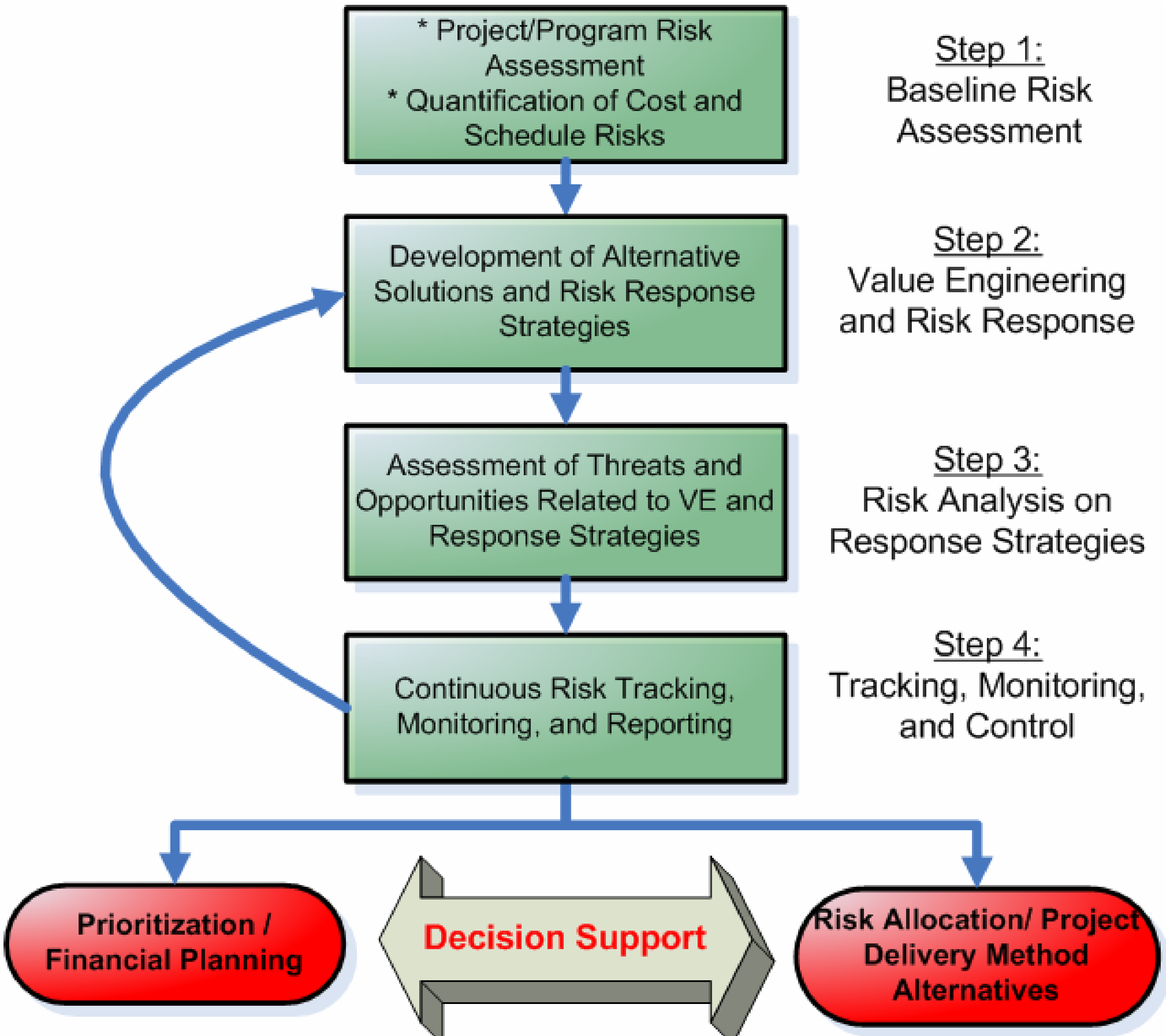
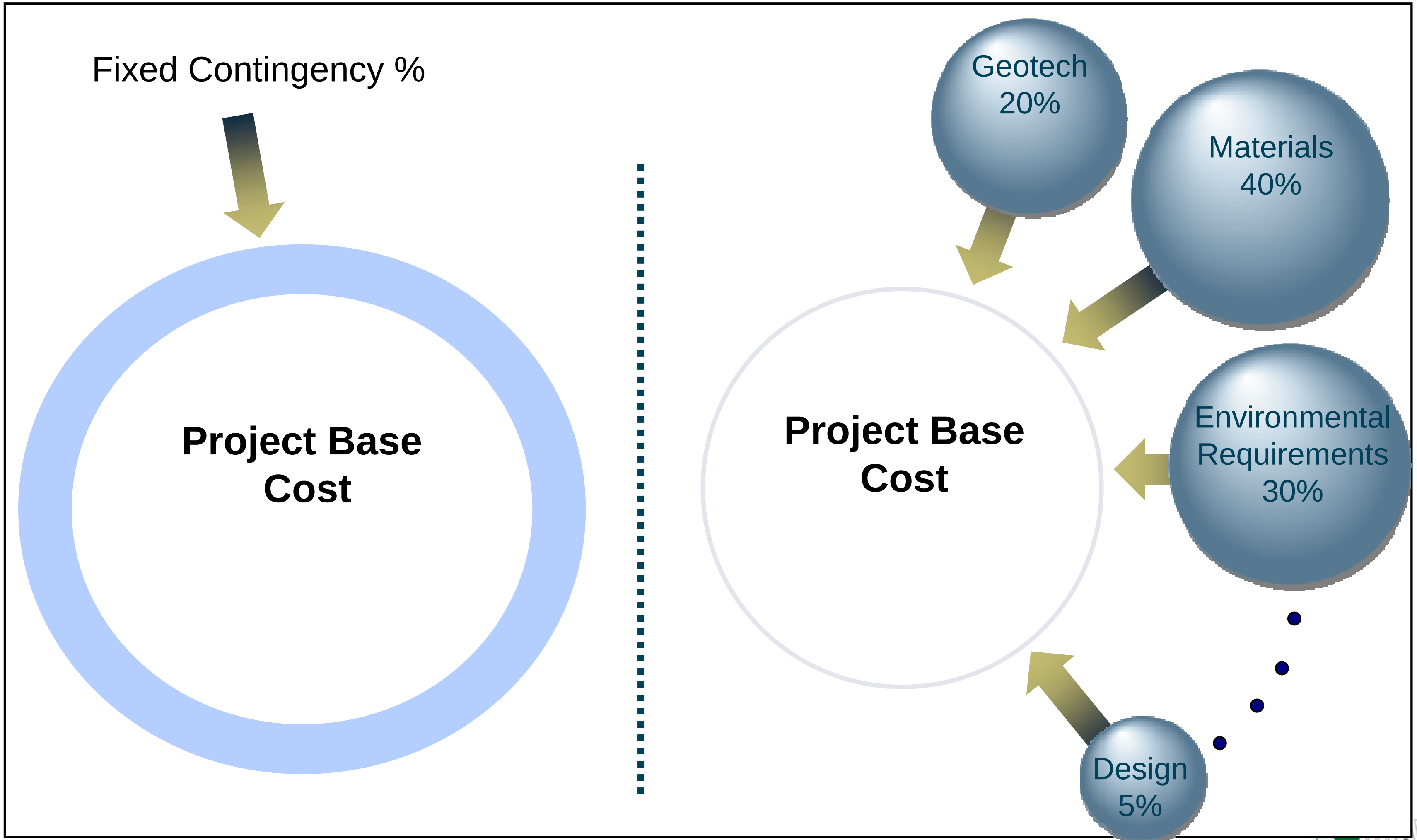
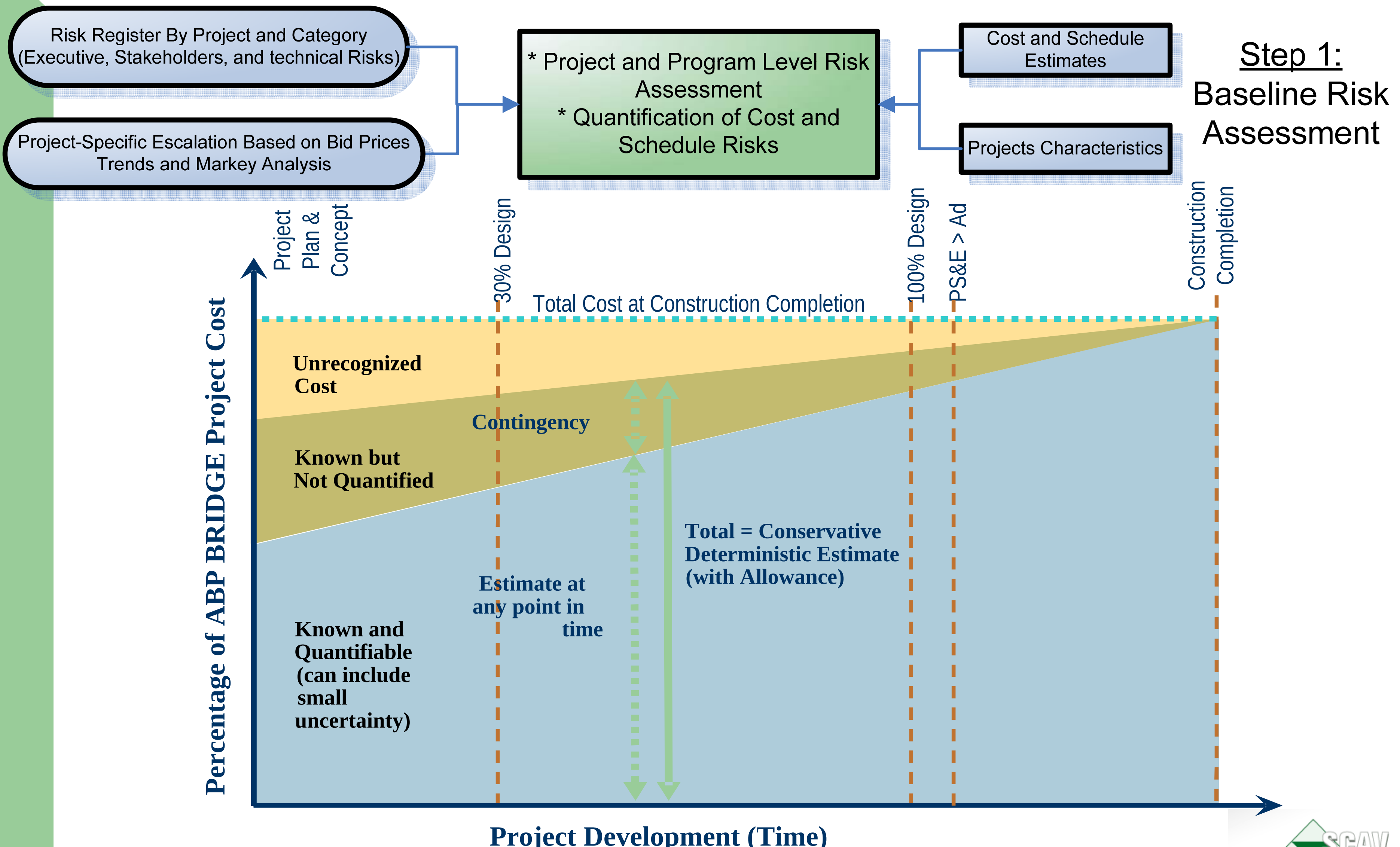
CRAVE How it works



Traditional Vs. Risk-Based Approach

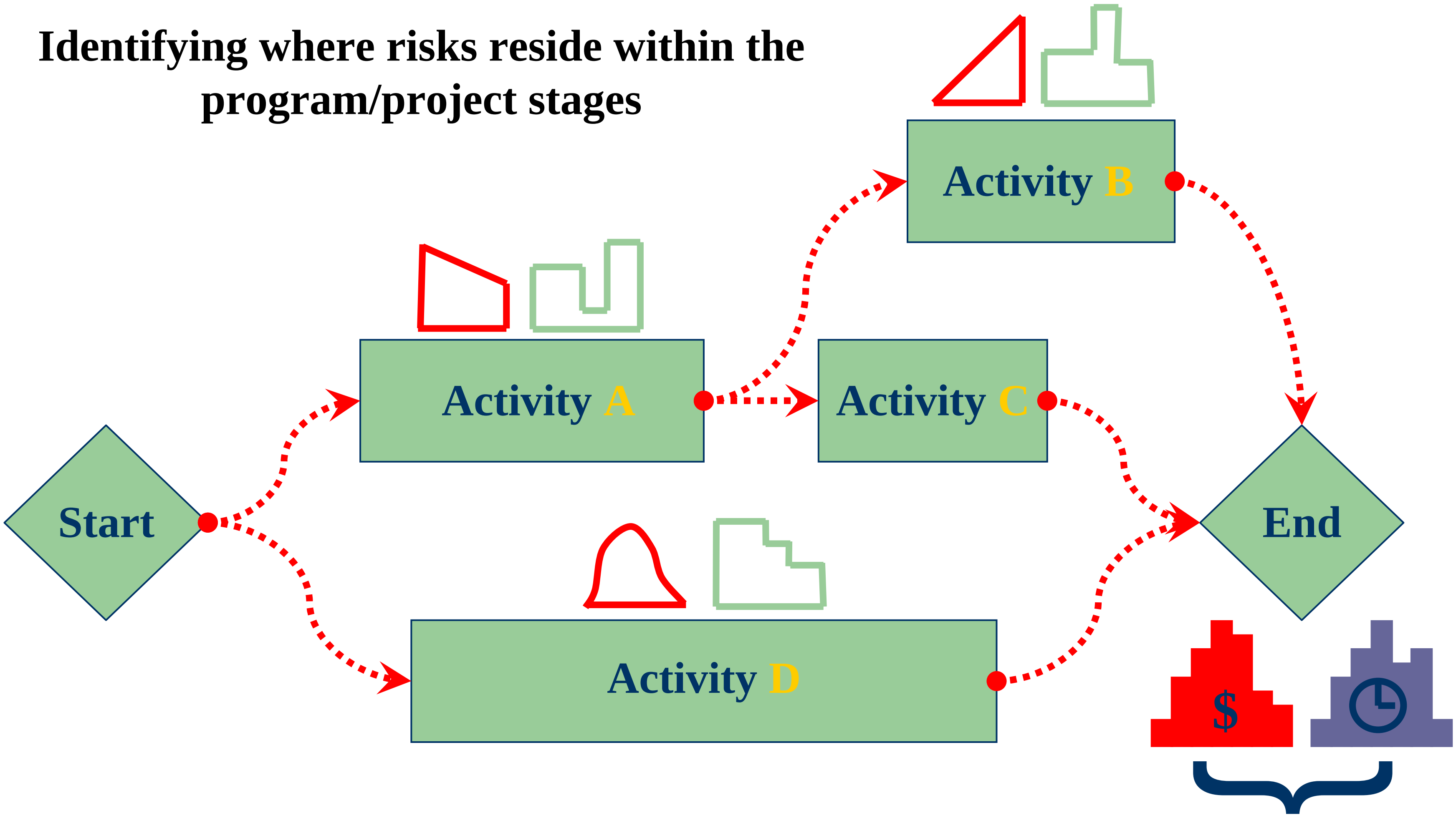


CRAVE Process: Step 1

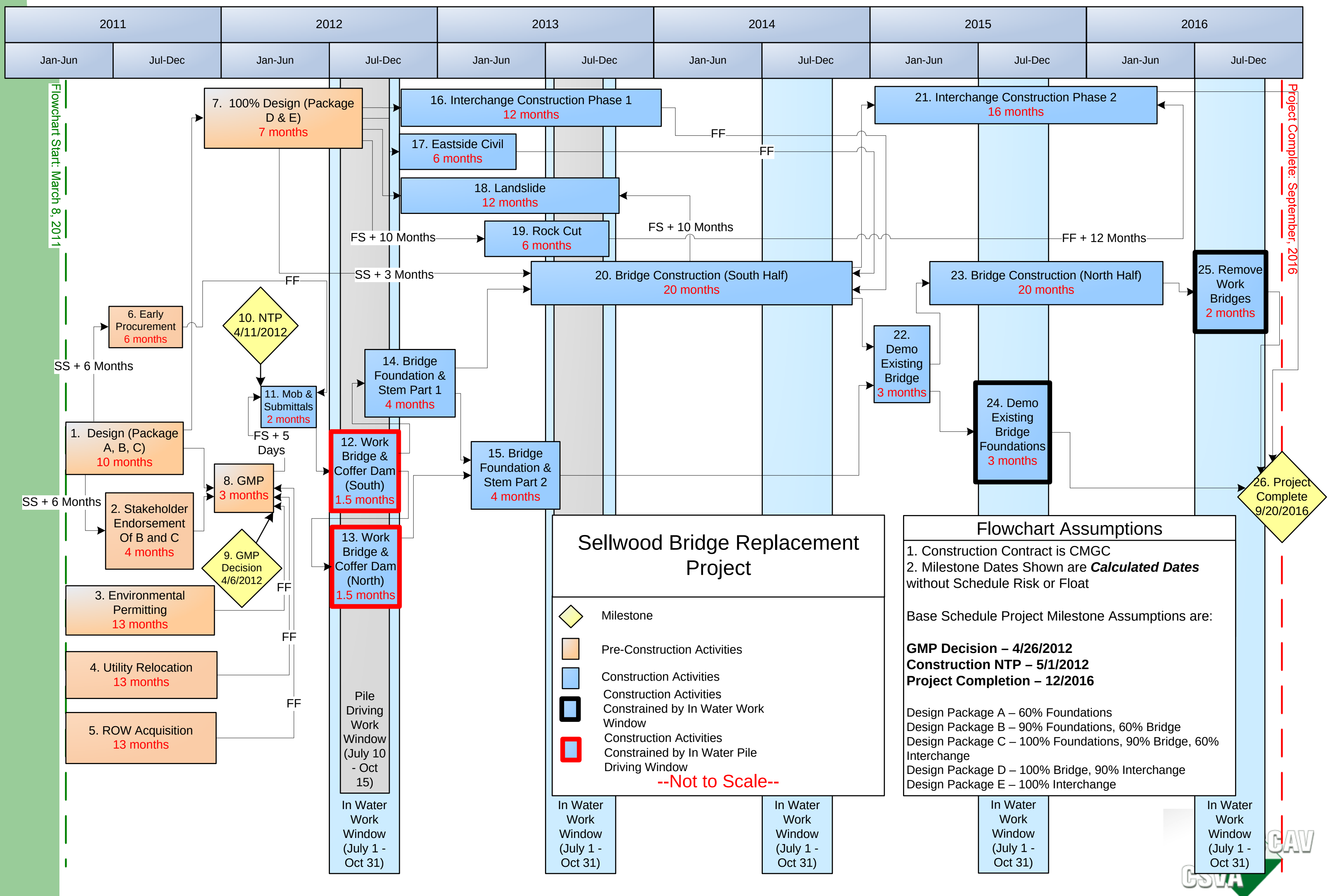


Need for a Solid Flowchart

Identifying where risks reside within the program/project stages



Project Schedule Flowchart



Comprehensive Risk List at Each Stage

Planning / Programming	Preliminary Design / Final Design	A/B/A / Construct
Environment	Geotechnical	Contracts
Right of Way	Structures	Insurance/
Governance/Stakeholders	Pavements	Bonds
Financing	Hydraulics	Construction Methods
Civil & Environmental Justice	Stormwater	MOT
Multi-modal Systems	Tunnels	Market Conditions
Teaming	Intelligent Transportation	Disputes
Options/Alternatives	Permitting	Weather
		Security

Consensus-Based Workshops

- Structured Workshops to Build Consensus Among Various Stakeholders
- Engagement of Internal and External Subject-Matter Experts
- Sessions by Functional Assignment to:
- Identify Risks
- Quantify Risks
- Discuss Risk Response and Mitigation Strategies

Risk Elicitation

- **Focus on issues that matter**
- **Describe the event properly**
- **What will trigger the event?**
- **How likely is it to occur?**
- Is the event dependent on or correlated with other events?
- What are the potential impacts (cost/schedule)?
- If the event occurs what are the impacts
  - on the low end?
  - on the upper end?
  - most likely?

Quantitative Risk

Project: Floating Bridge and Landings

Sub-Project: FB

Issues with design and constructability of Maintenance facility

Risk ID: FB FB STG 900.07

Risk Trigger:

Pre-Response Quantification

Probability
80%

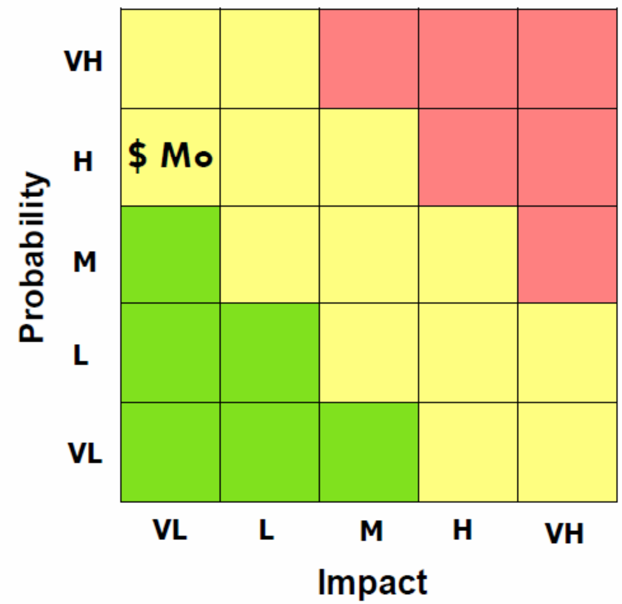
			Cost	
Min ($M)	**Most Likely ($M)**	**Max ($M)**	Expected Value Impact ($M)	**Project Risk Rank**
($0.750)	($0.200)	$0.250	**($0.173)**	9

			Schedule	
Min (MO)	**Most Likely (MO)**	**Max (MO)**	Expected Value Impact (MO)	**Program Risk Rank**
1.00	2.00	3.00	**1.60**	44

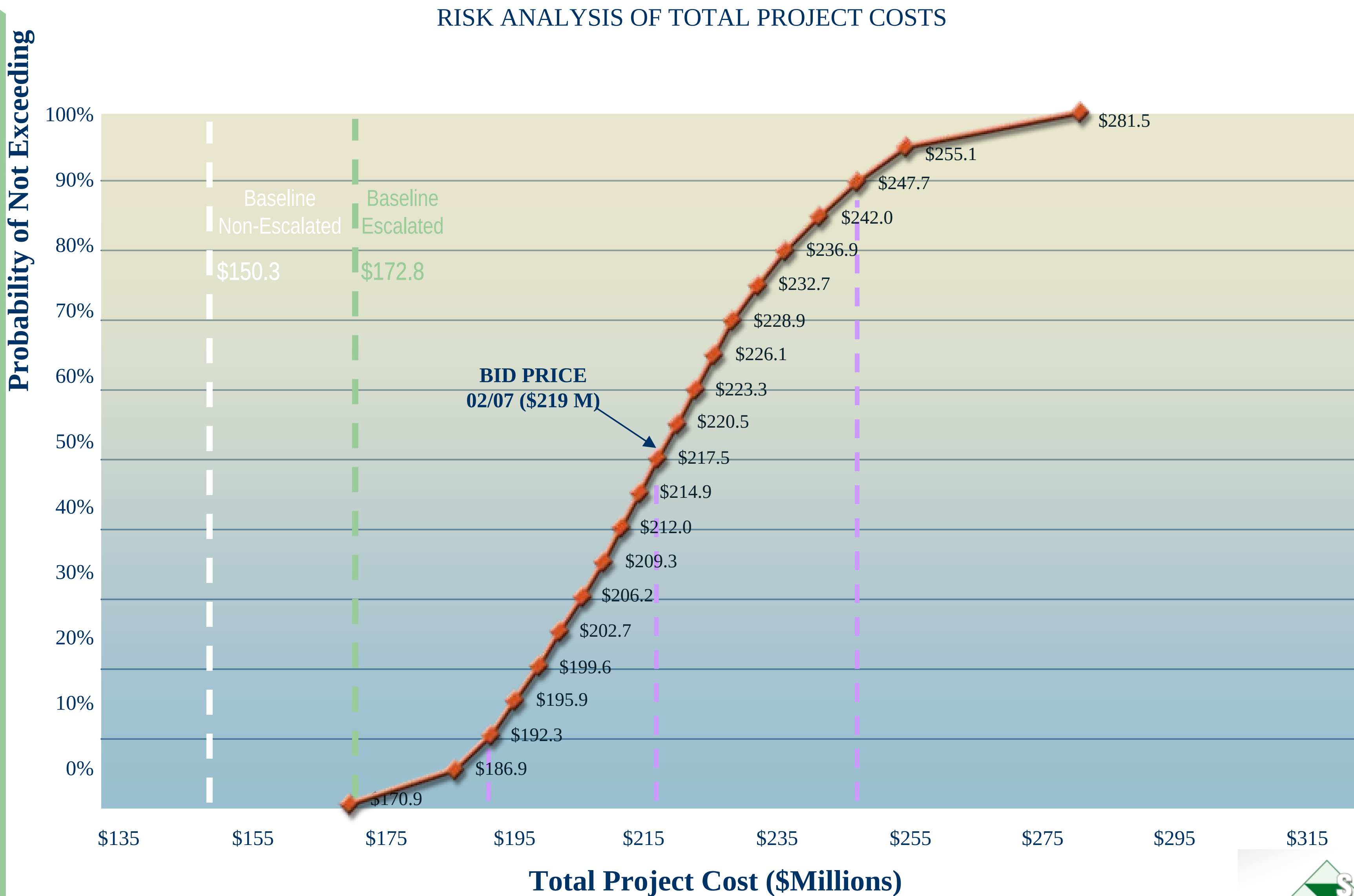
Wall is nearly 70' tall, there could be issues with groundwater, excavation of spoils in front of the wall. Soil is very fine and if it's too saturated may not be able to get equipment into and out of the area. If soldier pile wall is used there could be localized caving due to running of the fine sand, would have to design to seal this off to prevent caving. Risk covers all uncertainties related to the Maintenance Building, Related Walkways and Mooring Dock Facilities. Groundwater is upwelling in the lake and supporting salmon spawning and resource agencies want this to continue. this may require raising the facility and associated docks. By raising it could be less dewatering Medina may push back on a facility that is higher.

Cost: Opportunity

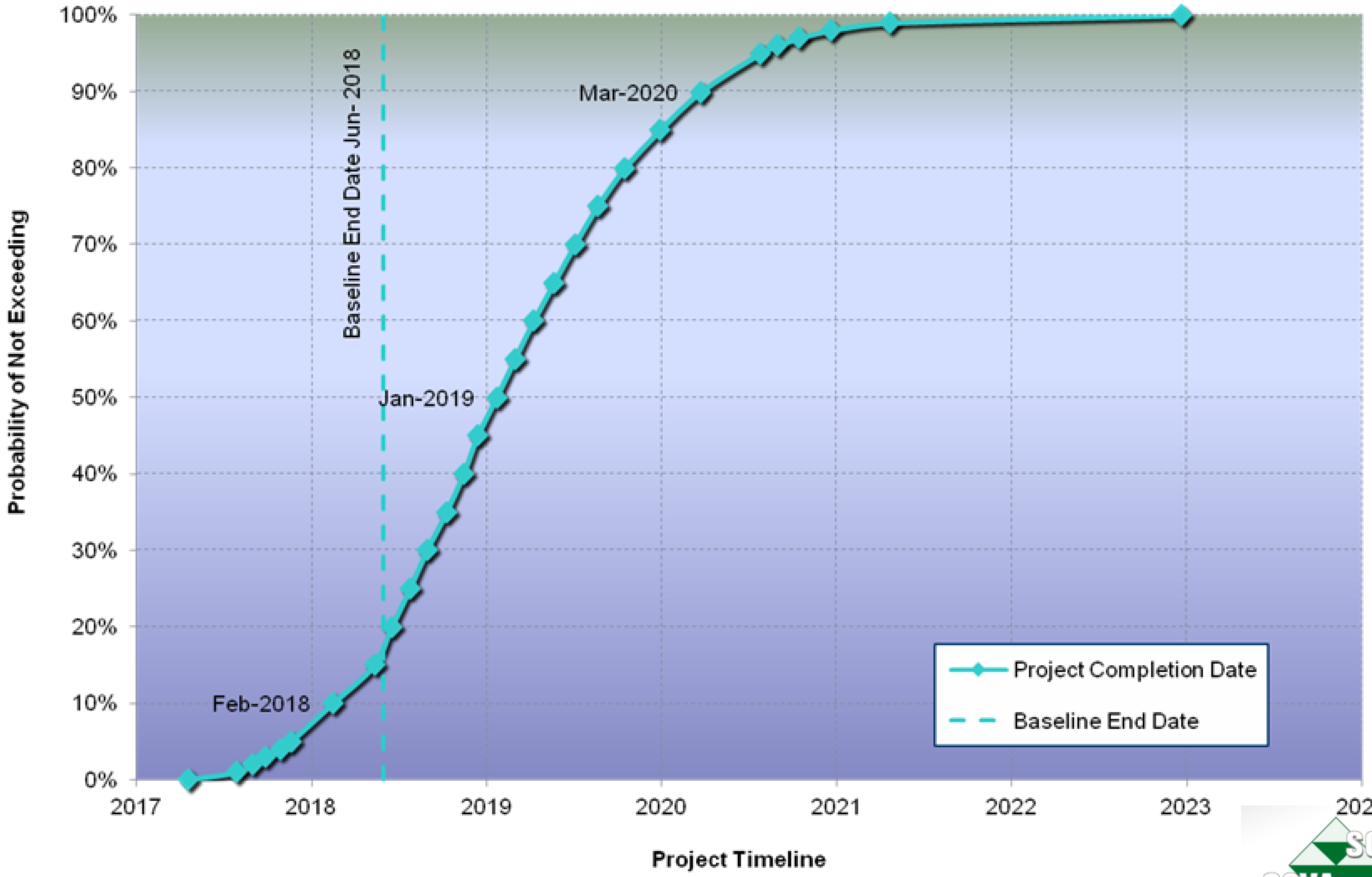
Schedule: Threat



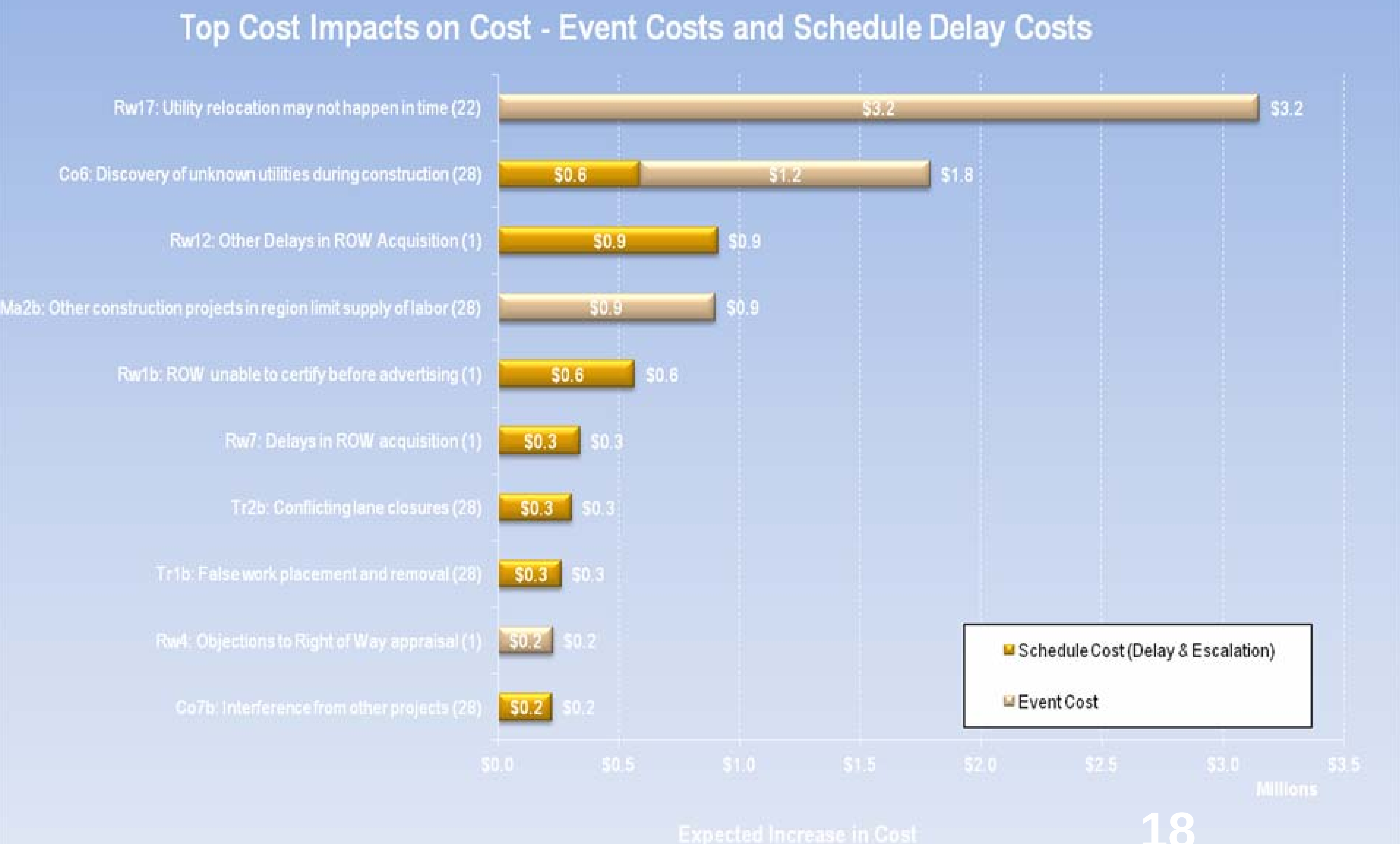
CRAVE Process: Step 1
Non-Mitigated Risk-Adjusted Cost Estimates



Baseline Risk Assessment
Risk-Adjusted *Schedule Projection*

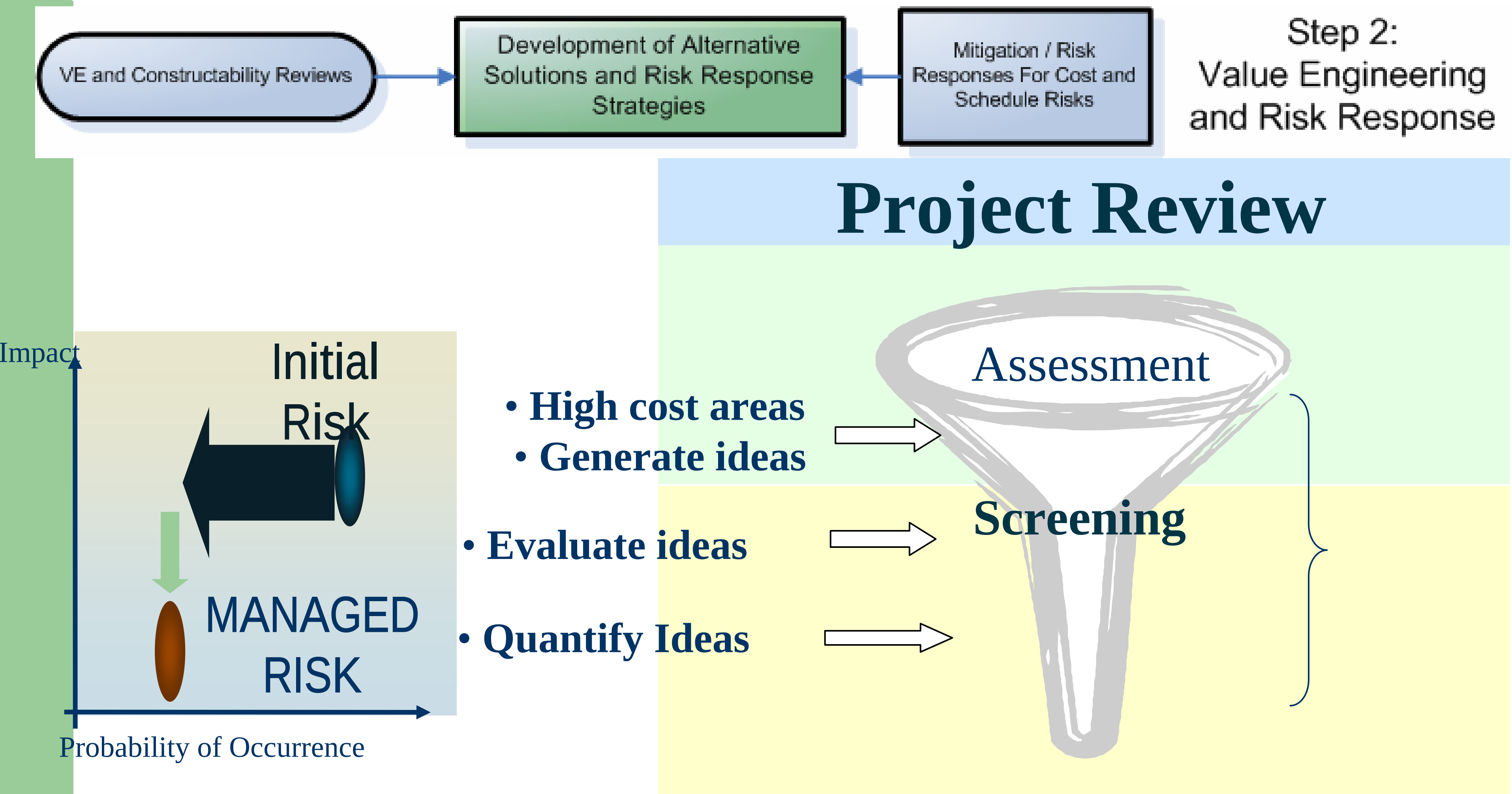


CRAVE Process: Step 1
Prioritization of Risks



CRAVE Process: Step 2

Value Engineering Assessment



WHAT IS VALUE?

Value Engineering has traditionally been perceived as an effective means for reducing project costs.

$$\text{Value} = \frac{\text{Performance}}{\text{Cost}}$$

This only addresses one part of the value equation, often times at the expense of reducing performance.

PERFORMANCE ATTRIBUTES

Establishing the Goals and Objectives of VE Study is critical to its outcome.

Defining "Performance Attributes" will give the VE Team a better understanding of the project's purpose and need.

Typical Highway Performance Attributes

- **Mainline Operations**
- **Local Operations**
- **Maintainability**
- **Construction Impacts**
- **Environmental Impacts**
- **Project Schedule**
- **Reduce Risk**

ALTERNATIVE ANALYSIS

PERFORMANCE ATTRIBUTE MATRIX

Midway Road - CR 712 Proejct

Which attribute provides the greatest benefit to the project relative to purpose and need?

								TOTAL	%
Mainline Operations	**A**	A	A	A	A/E	A	A	6.5	24%
Local Operations		**B**	B	B	B/E	B	B	5.5	20%
Maintainability			**C**	C	E	C	C	4.0	14%
Construction Impacts				**D**	E	D/F	G	1.5	5%
Environmental Impacts					**E**	E	E	6.0	21%
Project Schedule						**F**	G	1.5	5%
Risks							**G**	3.0	11%
								28.0	100%

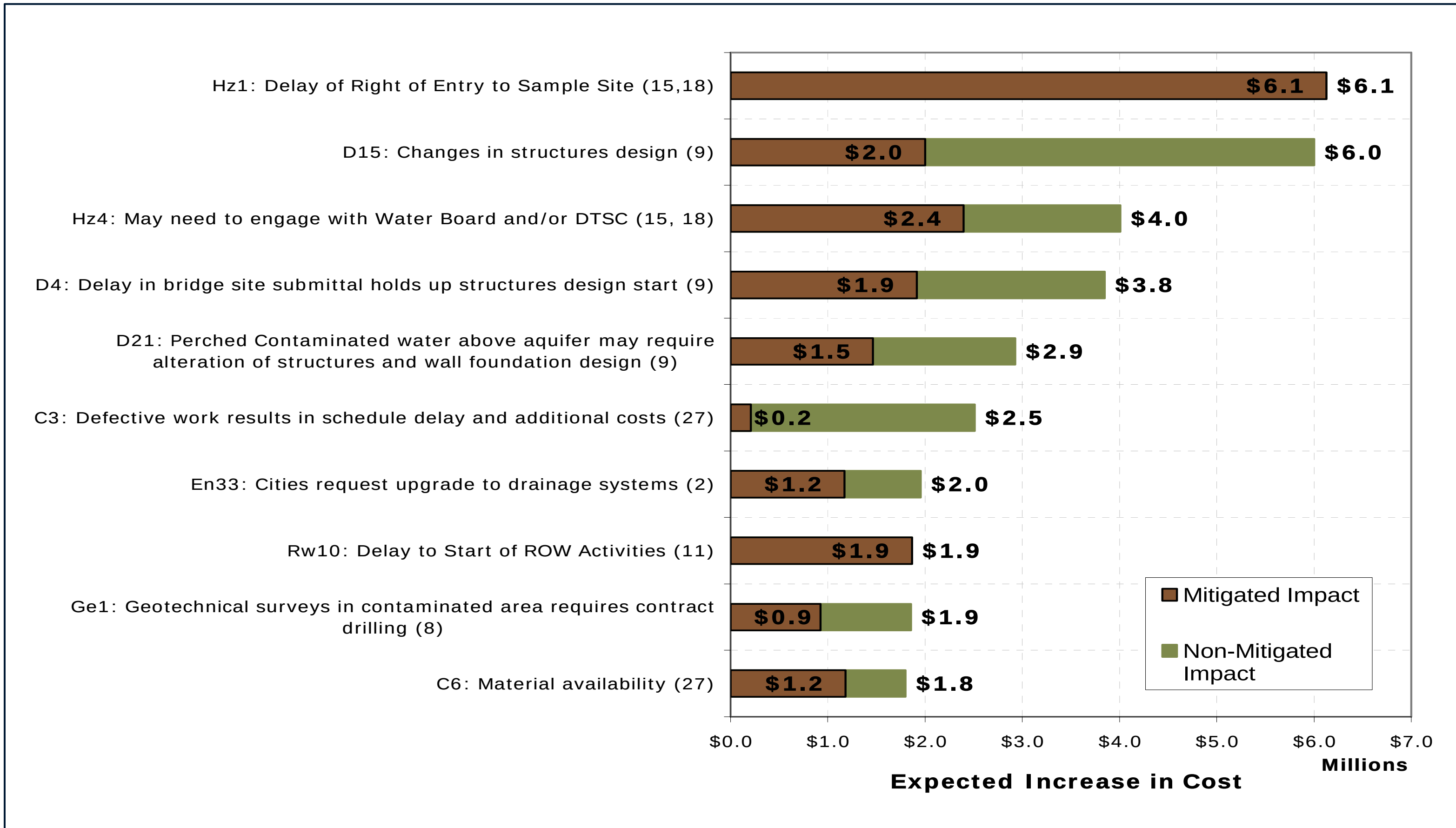
A	More Important
A/B	Equally Important

OVERALL PERFORMANCE		Performance (P)	% Change Performance	Cost (C)	% Change Cost	Value Index (P/C)	% Value Improvement
	Baseline	500		$235.7		2.12	
1	Reduce Risk	529	6%	$235.7	0.0%	2.24	6%
2	Cost Estimate	500	0%	$165.7	29.7%	3.02	42%
3	Construction staging	562	12%	$165.7	29.7%	3.39	60%
4	TH 14/15 I/C	612	22%	$235.3	0.2%	2.60	23%
5	Median Barrier	606	21%	$236.3	-0.2%	2.56	21%
6	Roadway between TH 15 & CSAH 37	562	12%	$232.8	1.2%	2.41	14%
7	Courtland I/C	504	1%	$233.0	1.2%	2.16	2%
8	Nicollet I/C	503	1%	$234.8	0.4%	2.14	1%
9	561st Intersection	599	20%	$235.5	0.1%	2.54	20%
10	Project phasing limits	511	2%	$234.9	0.4%	2.18	3%
Total		**549**	**10%**	**$158.0**	**33.0%**	**3.47**	**64%**

CRAVE Process: Step 3
Quantification Mitigation for Each Risk

Updated Risk Register → Assessment of Threats and Opportunities Related to VE and Response Strategies ← VE Recommendations Cost and Schedule Estimates

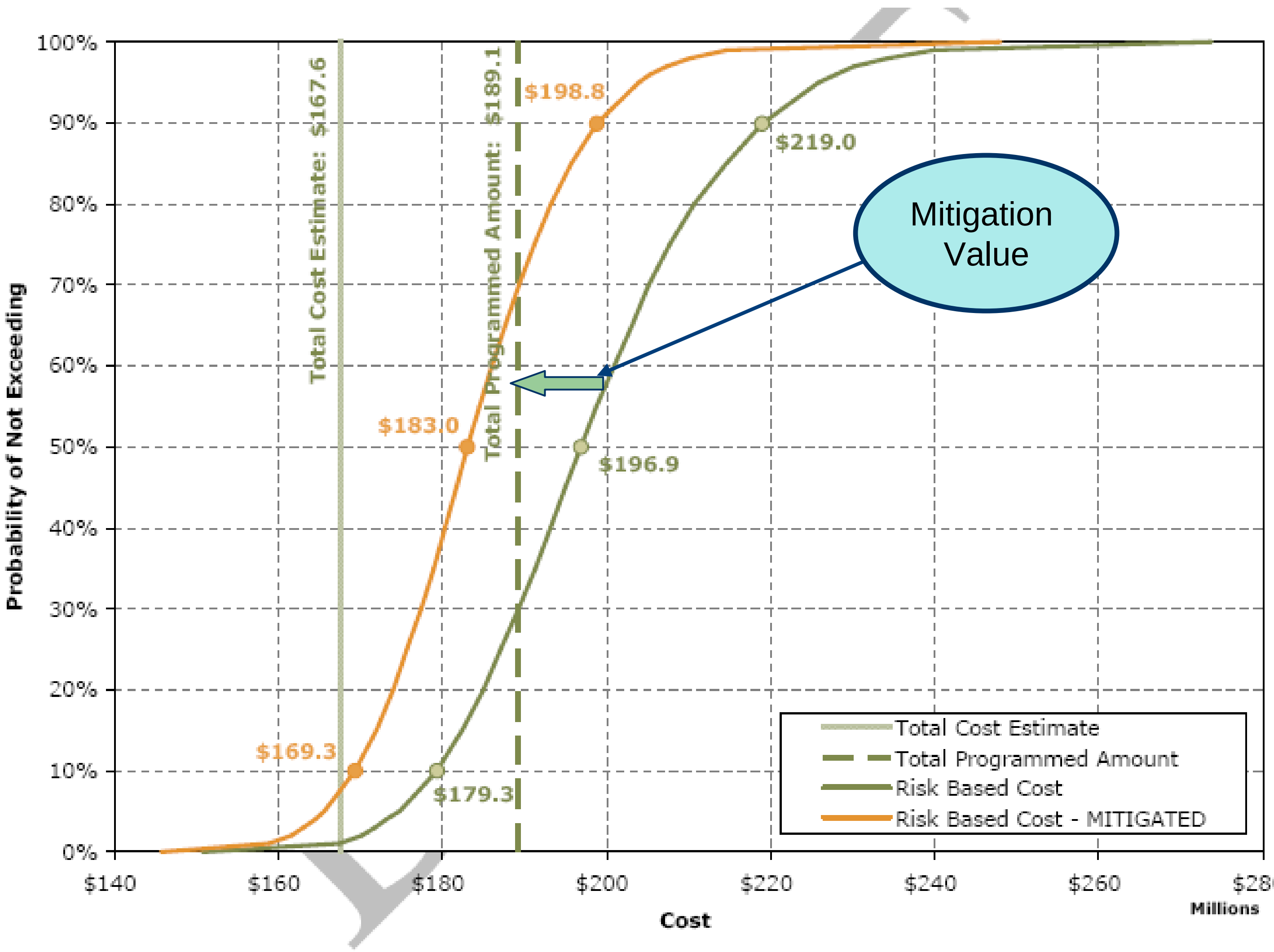
<u>Step 3:</u>
Risk Analysis on Response Strategies



Risk Responses

- **Avoidance** is a change to the project scope to eliminate the impact of a risk.
- **Transference** of a risk to another party who is more capable at handling the risk (such as the contractor or insurance company).
- **Mitigation** is seeking to lessen the impact of a specific risk items, which may involve the consumption of additional time and/or money.
- **Acceptance** is recognition by the project team of a specific risk and decision to not take action to deal with the risk.

CRAVE Process: Step 3
Quantifying Mitigation Strategies at the Project Level



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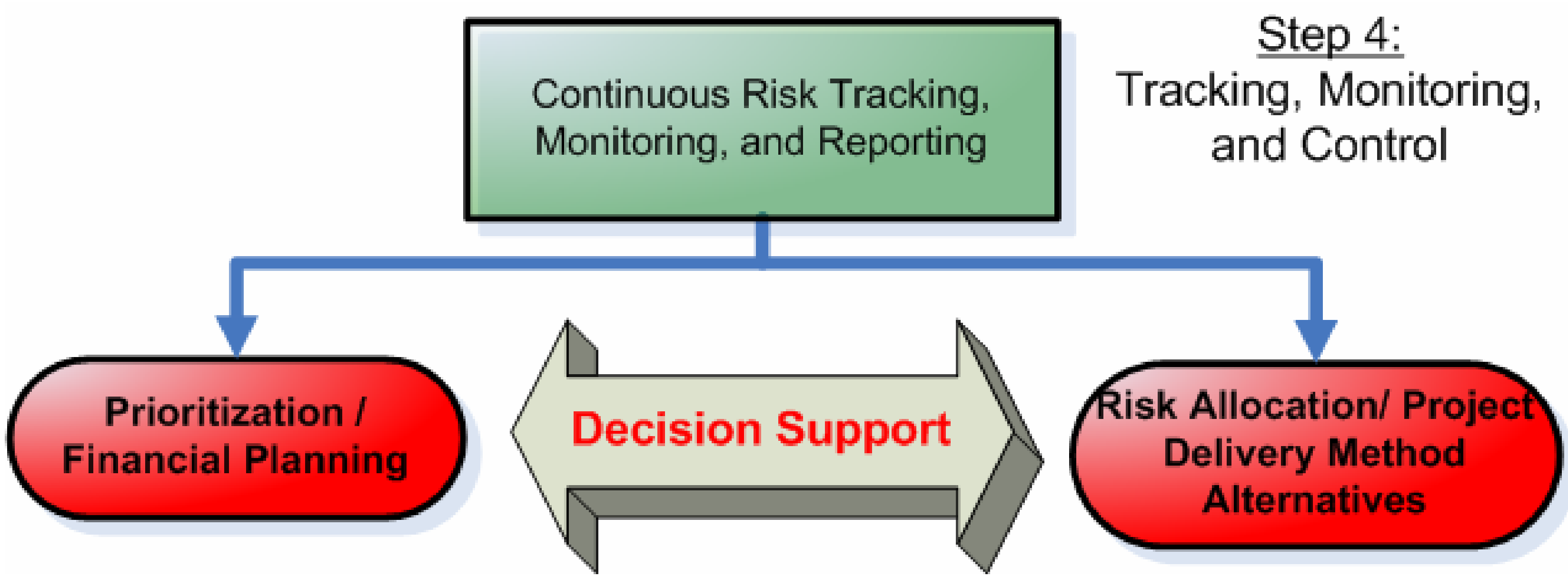
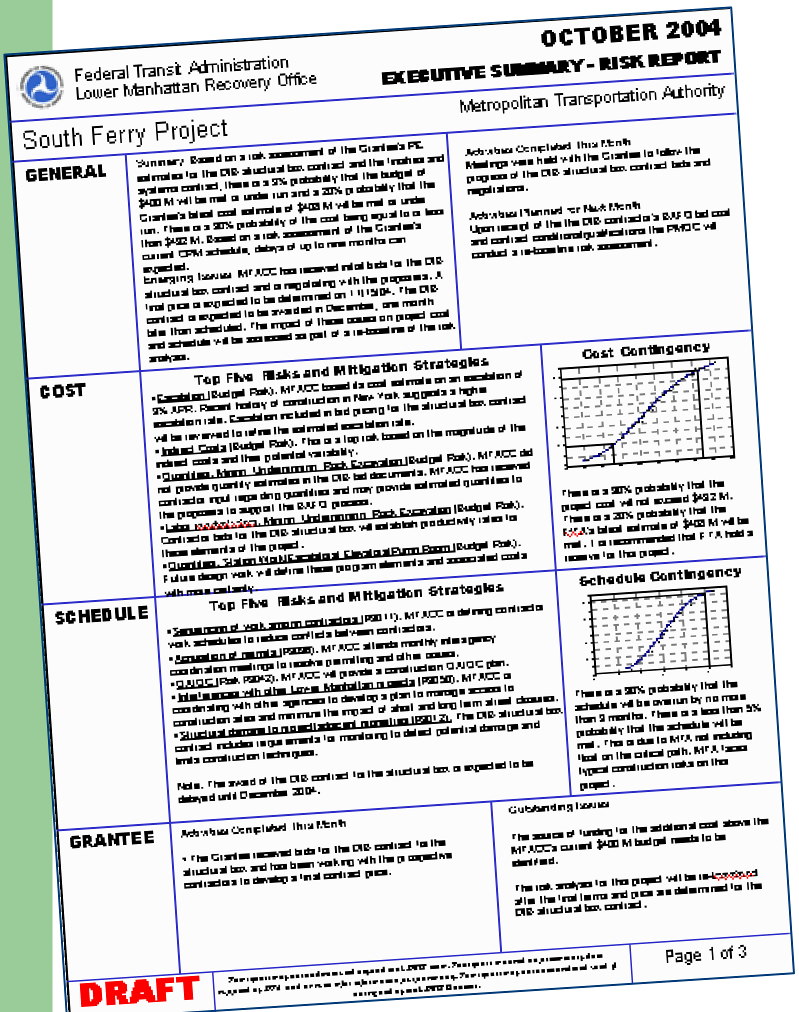
CRAVE Process: Step 4
Tracking, Monitoring, and Control



Avoiding Denial

CRAVE Process: Step 4
Adequate and Continuous Reporting


OCTOBER 2004

Federal Transit Administration
Lower Manhattan Recovery Office

EXECUTIVE SUMMARY - RISK REPORT

Metropolitan Transportation Authority

South Ferry Project

GENERAL

COST

Top Five Risks and Mitigation Strategies

Cost Contingency

SCHEDULE

Top Five Risks and Mitigation Strategies

Schedule Contingency

GRANTEE

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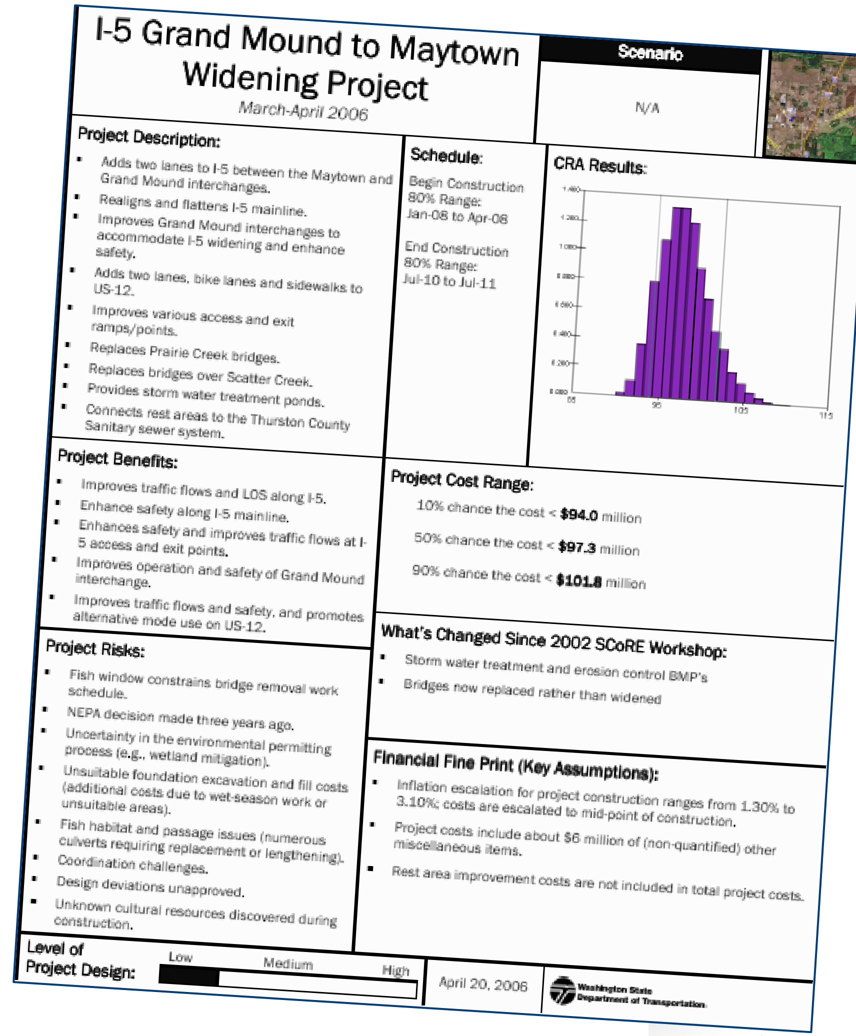
DRAFT


I-5 Grand Mound to Maytown Widening Project

March-April 2006

Scenario
N/A

Project Description:

- Adds two lanes to I-5 between the Maytown and Grand Mound interchanges.
- Realigns and flattens I-5 mainline.
- Improves Grand Mound interchanges to accommodate I-5 widening and enhance safety.
- Adds two lanes, bike lanes and sidewalks to US-12.
- Improves various access and exit ramps/points.
- Replaces Prairie Creek bridges.
- Replaces bridges over Scatter Creek.
- Provides storm water treatment ponds.
- Connects rest areas to the Thurston County Sanitary sewer system.

Schedule:

Begin Construction
80% Range:
Jan-08 to Apr-08

End Construction
80% Range:
Jul-10 to Jul-11

CRA Results:

Project Benefits:

- Improves traffic flows and LOS along I-5.
- Enhance safety along I-5 mainline.
- Enhances safety and improves traffic flows at I-5 access and exit points.
- Improves operation and safety of Grand Mound interchange.
- Improves traffic flows and safety, and promotes alternative mode use on US-12.

Project Cost Range:

10% chance the cost < **$94.0** million

50% chance the cost < **$97.3** million

90% chance the cost < **$101.8** million

Project Risks:

- Fish window constrains bridge removal work schedule.
- NEPA decision made three years ago.
- Uncertainty in the environmental permitting process (e.g., wetland mitigation).
- Unsuitable foundation excavation and fill costs (additional costs due to wet-season work or unsuitable areas).
- Fish habitat and passage issues (numerous culverts requiring replacement or lengthening).
- Coordination challenges.
- Design deviations unapproved.
- Unknown cultural resources discovered during construction.

What's Changed Since 2002 SCoRE Workshop:

- Storm water treatment and erosion control BMP's
- Bridges now replaced rather than widened

Financial Fine Print (Key Assumptions):

- Inflation escalation for project construction ranges from 1.30% to 3.10%; costs are escalated to mid-point of construction.
- Project costs include about $6 million of (non-quantified) other miscellaneous items.
- Rest area improvement costs are not included in total project costs.

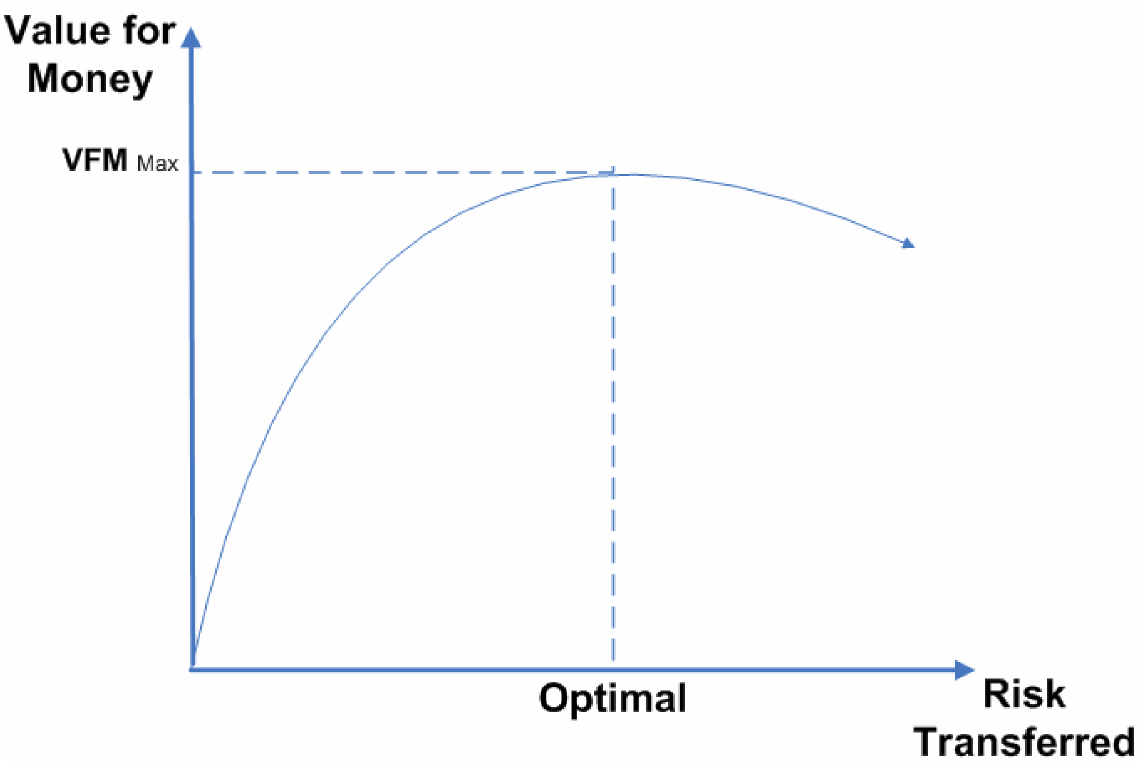
Level of Project Design: Low Medium High

April 20, 2006

Washington State Department of Transportation

Transparency and accountability

CRAVE Process: Step 4
Informed Risk Allocation



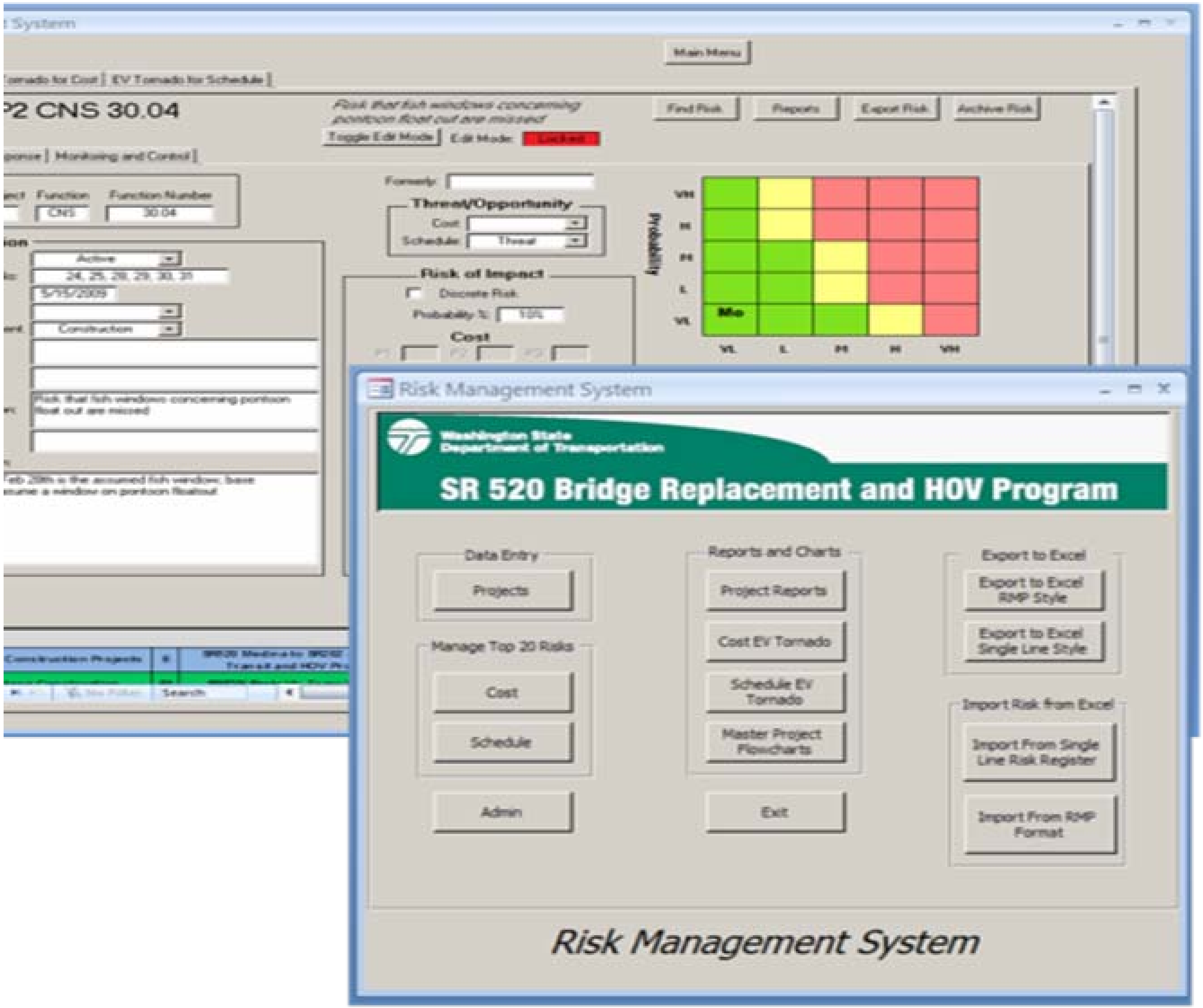
Contractors do not take risks

They Price it !

Defining Risk Management

Risk Management is the systematic process of identifying, assessing, and responding to risks in order to manage or reduce potential adverse effects on the achievement of program and project goals

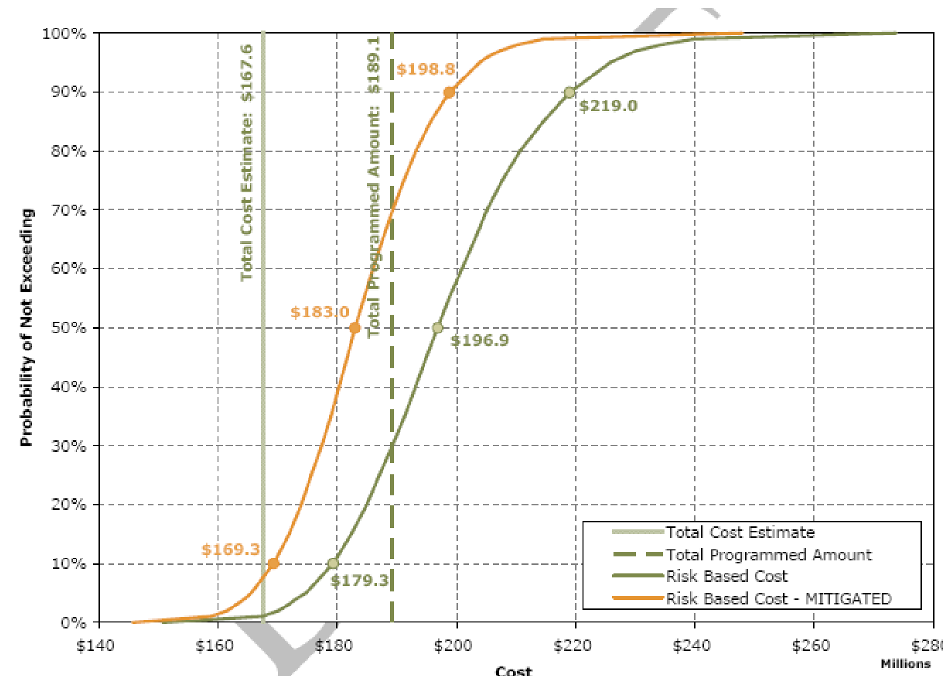
Managing Threats and Opportunities



CRAVE


• Project/Program Assessment
• Quantification of Cost and Schedule Risk
Step 1: Baseline Risk Assessment
Development of Alternative Solutions and Strategies
Step 2: Value Engineering and Risk Response
Assessment of Threats and Opportunities Related to VE and Response Strategies
Step 3: Risk Analysis on Response Strategies
Continuous Risk Tracking, Monitoring and Reporting
Step 4: Tracking, Monitoring and Control
Prioritazation/ Financial Planning
Decision Support
Risk Allocation/ Project Delivery Methods Alternatives


ACEC
of Minnesota
Grand Award
HDR Engi
National Value Engineering Award
Most Improved Process
Minnesota Department of Transportation & HDR Engineering
CRAVE Process

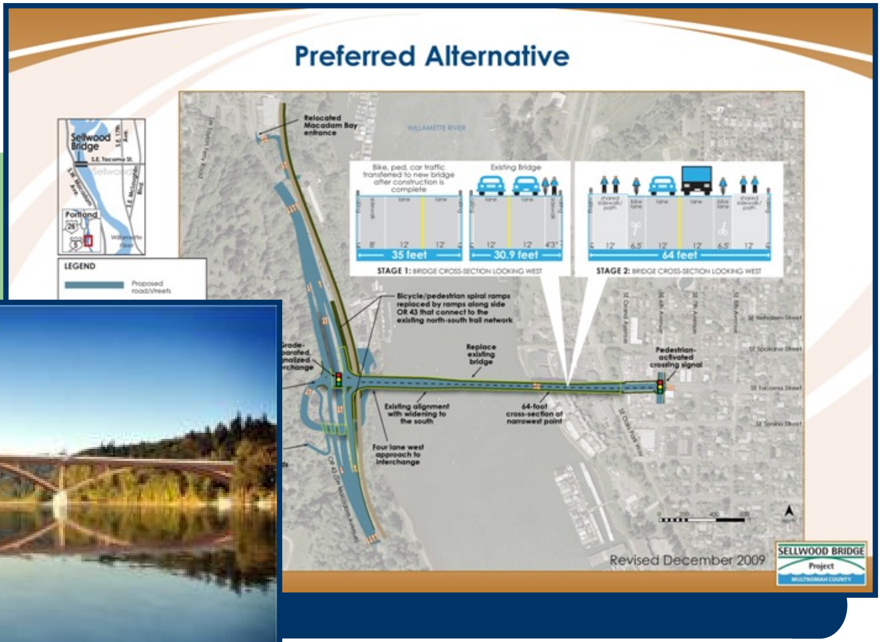

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Not Exceeding
Total Cost Estimate: $167.6
Total Programmed Amount: $189.1
$198.8
$219.0
$183.0
$196.9
$169.3
$179.3
Total Cost Estimate
Total Programmed Amount
Risk Based Cost
Risk Based Cost - MITIGATED
$140
$160
$180
$200
$220
$240
$260
$280
Millions
Cost

CSVA

Multnomah County
Sellwood Bridge Project

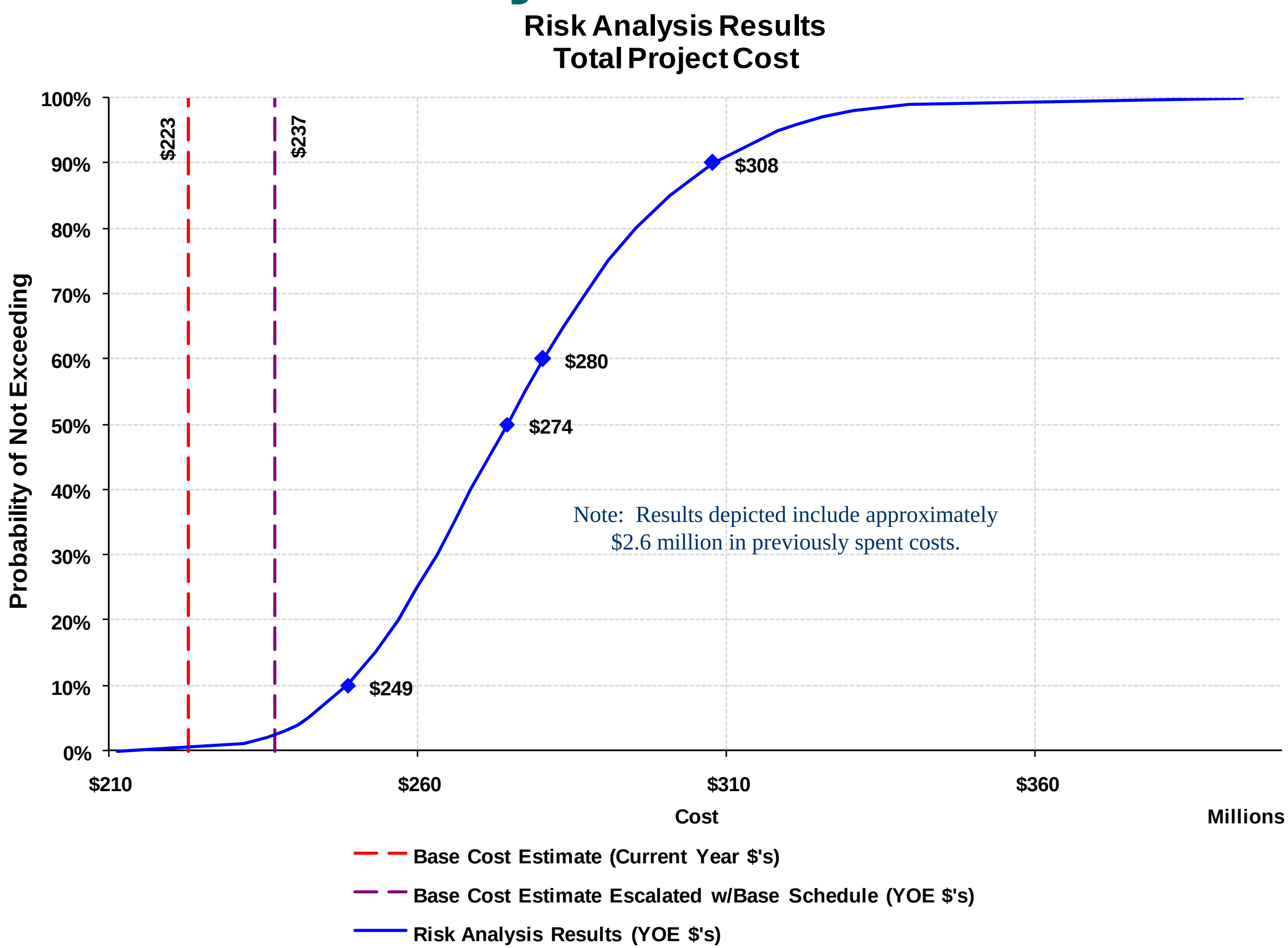
Sellwood Bridge Project

CRAVE

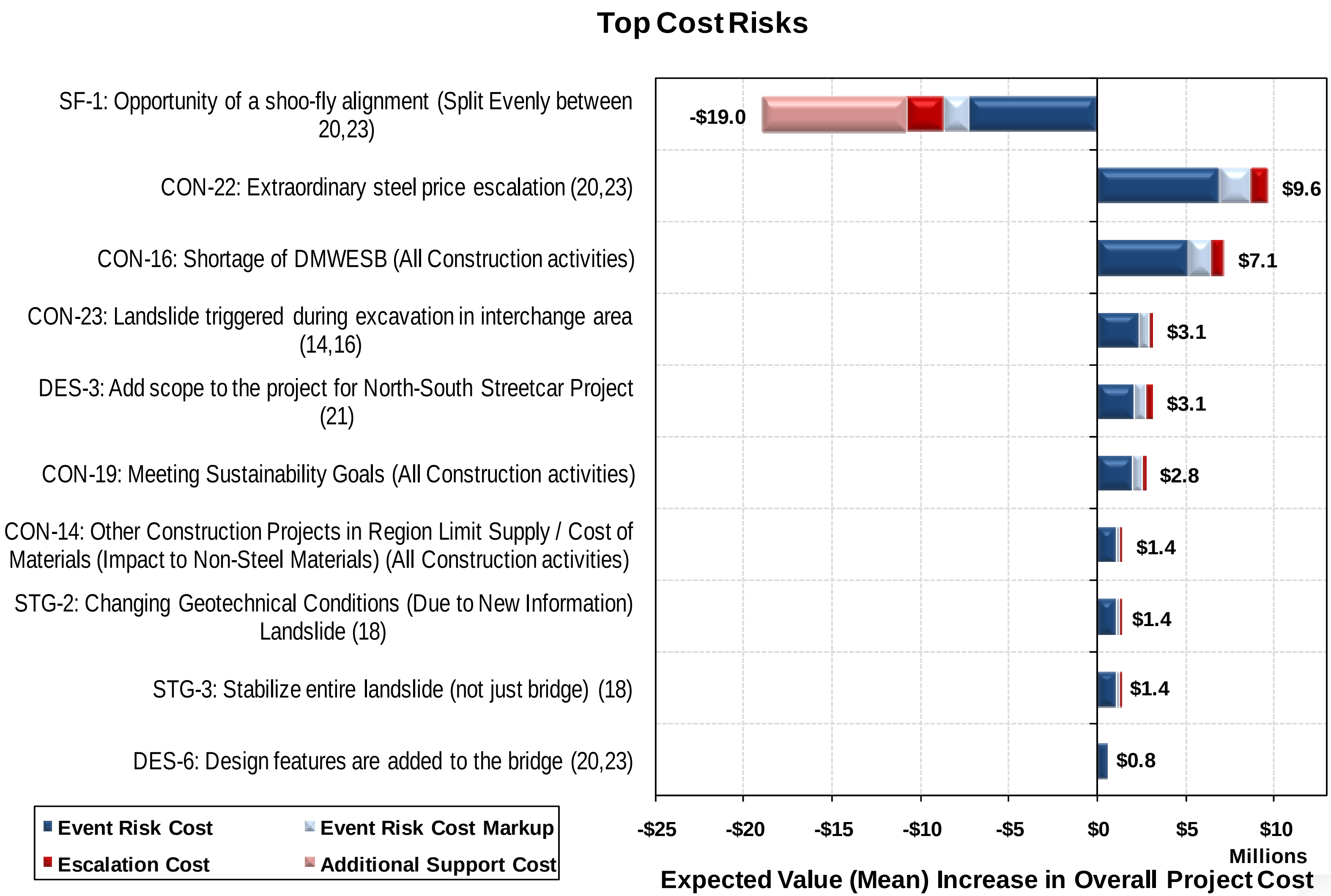


April 26, 2011

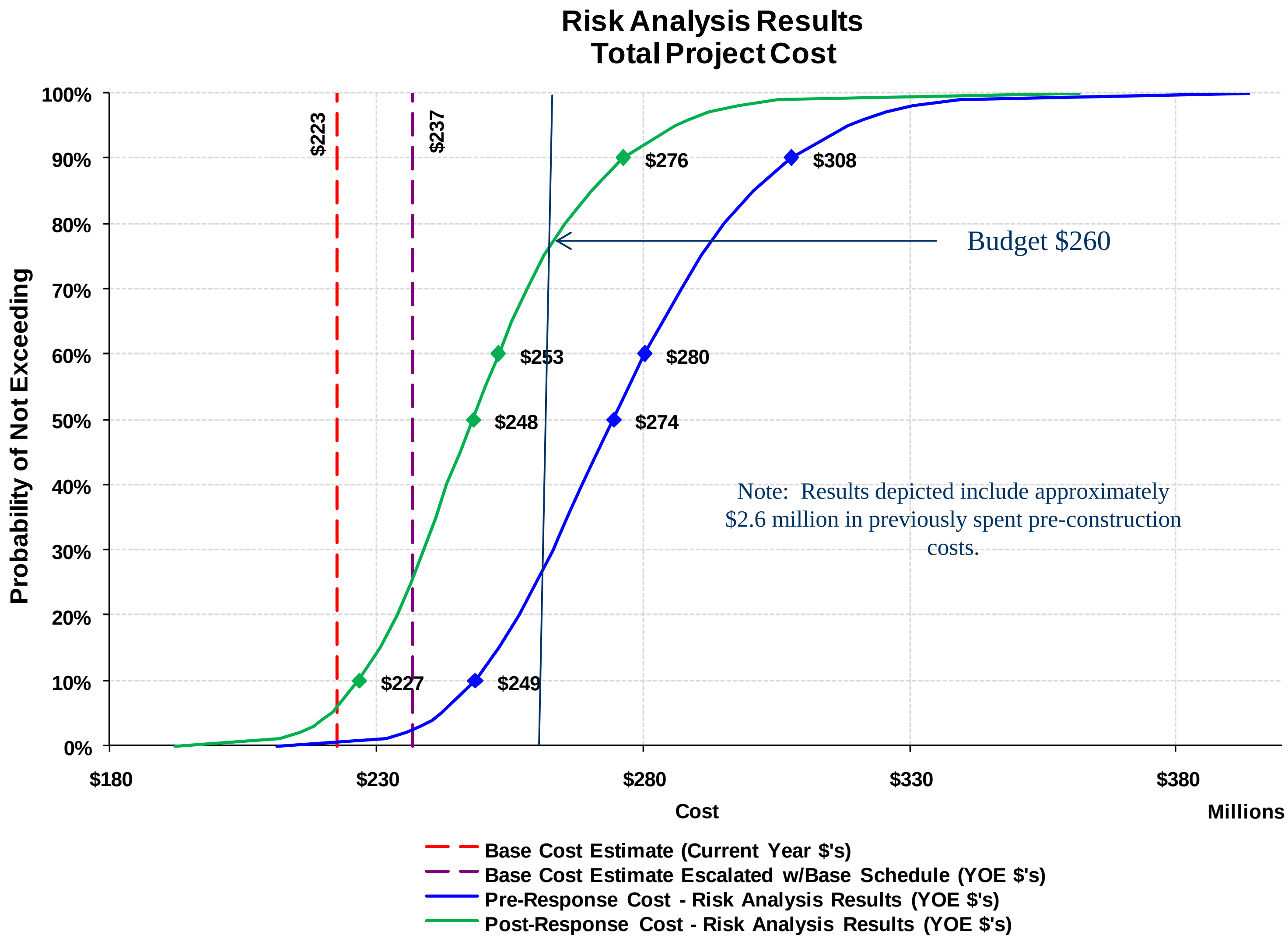
Probabilistic Cost Curves – Total Project Cost



Tornado Chart – Top Risks Impacting Project Costs



Probabilistic Cost Curves – Project Total Cost



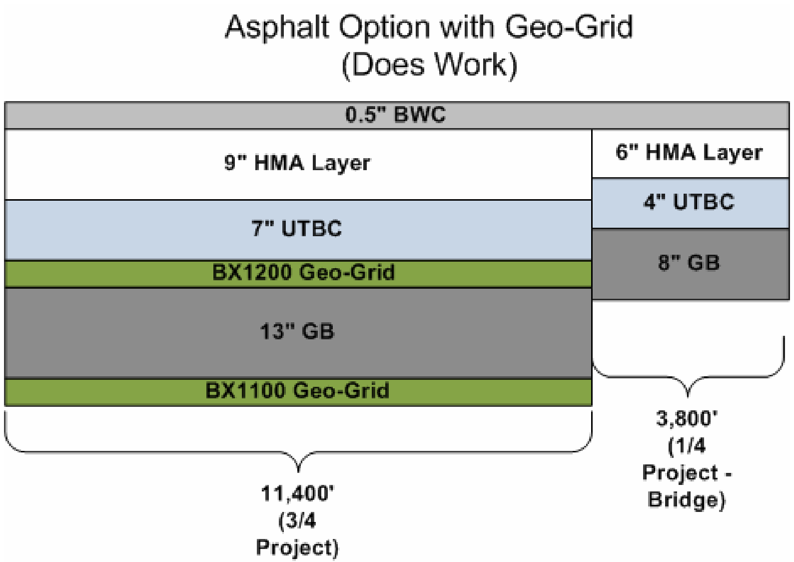
Value Engineering Study

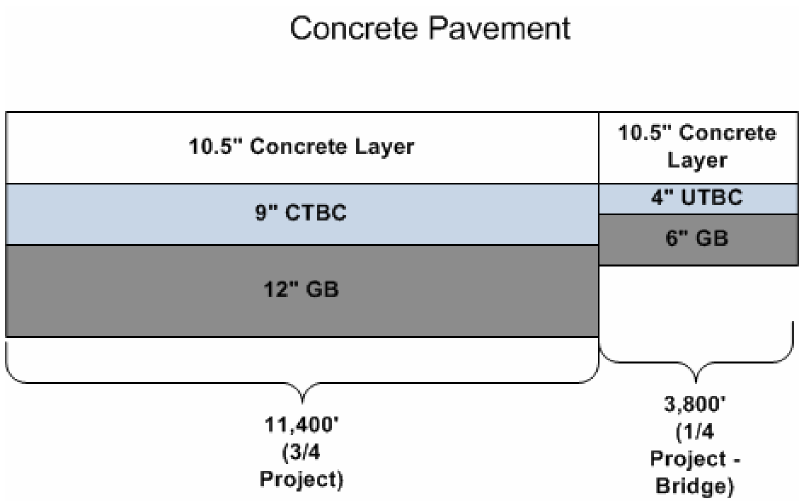
SR 193 Extension 2000 West to I-15

SR 193 EXTENSION
2000 West to State St.
DAVIS COUNTY

UDOT
CONNECTING COMMUNITIES

Recommendation #10 Pavement Type





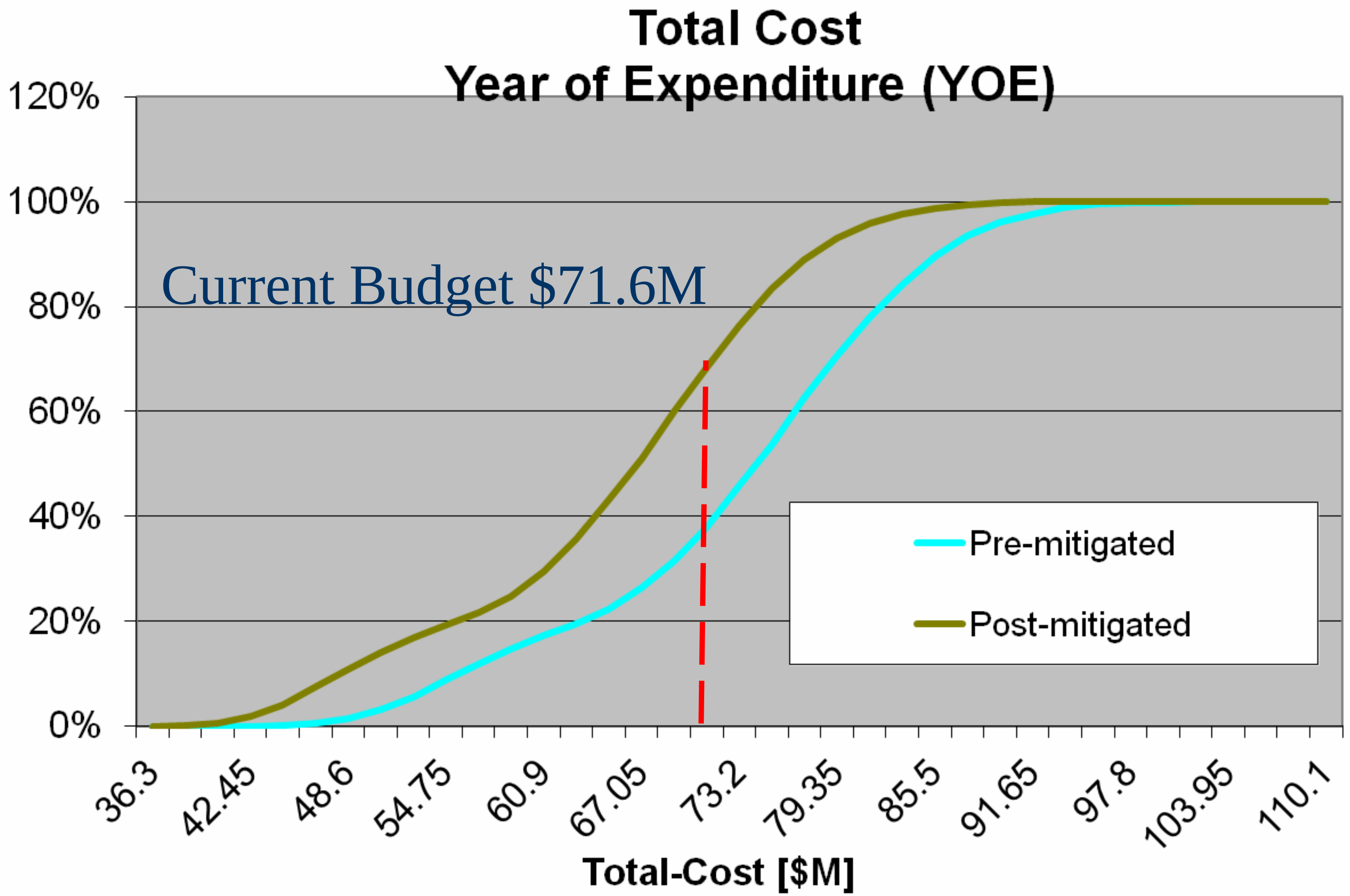
$$Value = \frac{Performance}{Cost}$$

HMA $\frac{500}{8.7} = 57.5$

PCCP $\frac{683}{10.3} = 61.9$

PCCP is a 8% improvement in value

Post Response Cost Risk



CRAVE™ Results

40 Year pavement with a better than 65% chance of not exceeding current budget

Statistics	Pre-mitigated	Post-mitigated
Min	41.91 $M	38.15 $M
Max	101.93 $M	95.47 $M
Median	73.44 $M	67.87 $M
10%	55.02 $M	49.10 $M
20%	61.95 $M	56.24 $M
30%	67.62 $M	62.09 $M
40%	70.84 $M	65.22 $M
50%	73.44 $M	67.87 $M
60%	75.93 $M	70.10 $M
70%	78.50 $M	72.55 $M
80%	81.26 $M	75.22 $M
90%	85.08 $M	78.72 $M

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Contact Information

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