Mn\DOT CRAVE™

2009 AASHTO VE Conference
August 31st -September 2nd , 2009

Nancy Yoo, P.E. - Program Overview
Ken L. Smith, P.E., C.V.S. – CRAVE ™
Minnie Milkert, P.E. - Lessons Learned

Events Leading to CRAVE Process

- August 1, 2007, I-35W bridge collapsed over the Mississippi River.
- The calamity disrupted transportation, and aimed a spotlight on our nation's public infrastructure system.
- Legislative session begins in January 2008.
- Legislative Audit Determinations:

  -Virtually all trunk highway construction funds will need to be directed to preservation projects.

  -Poor scoping and cost estimating

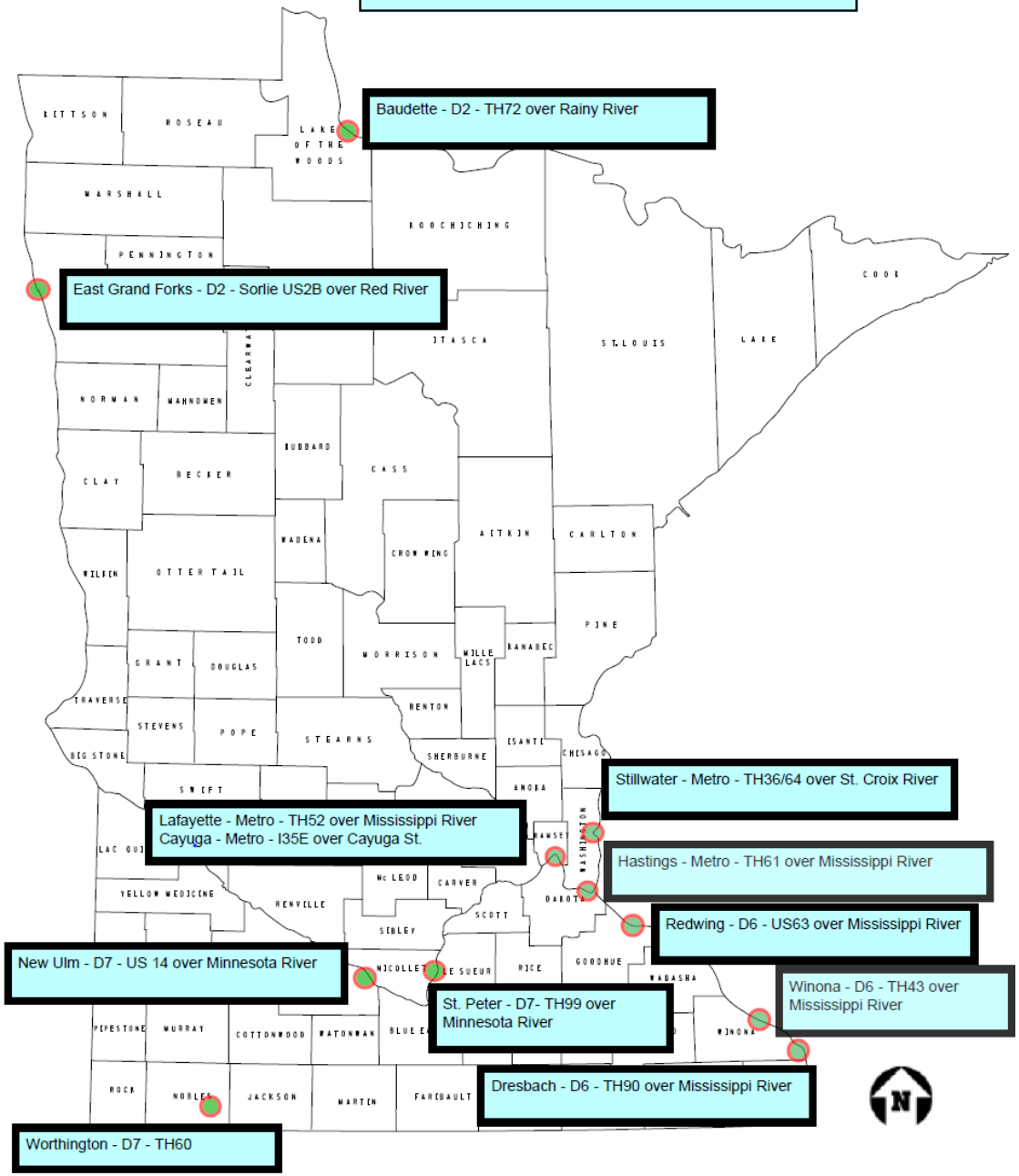
Events Leading to CRAVE Process

- Passage of MN Law 2008, Chapter 152
  - Transportation bond appropriations of over $1.8 billion allocated to DOT over a 10 year-period.
  - Develop a trunk highway bridge improvement program to accelerate repair and replacement of trunk highway bridges throughout the state.
- Cost Estimating, Scoping and Project Delivery Office created.
  - Finish development of Cost Estimating Policy
  - Utilize new Scoping Process
  - Ensure all projects have accurate scope and cost.

Events Leading to CRAVE Process

- Commissioner orders cost risk assessments on 12 major bridge and roadway projects (total costs in excess of $1.9 billion)
  - Projects in various stages of design
  - Some of the projects border other states
- Value engineering integrated into cost risk assessments
  - In September 2008, we were asked to complete all studies by early December 2008, in time for the 2009 legislative session.
  - Mn/DOT VE Pre-Qualification List
  - HDR hired; Cost Risk Assessment + Value Engineering (CRAVE) process utilized

CRAVE (Cost Risk Assessment & Value Engineering)
11 Bridges + One



Managing the Program one Project at a Time

Hastings

TH 60

Lafayette

Dresbach

St. Croix

St. Peter

Winona

Cayuga

Red Wing

Sorlie

New Ulm

Rainy River

The challenge

- The need to set up and staff 12 Risk assessment and Value Engineering workshops in 3 months
- Staffing the workshops
- Logistics

The Solution was the CRAVE Process

- The risk assessment is performed on the first day of the study
- The Quantified results are modeled
- As part of the VE study the team develops recommendations to mitigate and or avoid risk
- The risk model is re-ran with the VE recommendations and mitigation strategies
- The results are presented on the final day

Comparison of the two processes

Both use a team approach

Cost Risk Assessment		Value Engineering
u Learn about project	⟺	u Investigate
u Identify Risks	⟺	u Functional analysis
u Strategize how to handle	⟺	u Speculate
u Qualify and Quantify	⟺	u Evaluate
u Develop response plans and triggers	⟺	u Develop

What is CRAVE™

- Integrated Process of Cost Risk Analysis & Value Engineering
- CRAVE™ identifies and quantifies opportunities and threats
- 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 me 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
- The same team members are required for both process

CRAVE™ Process Key Steps

Step 1: Baseline Risk Assessment

- Review Baseline Cost
- Review Baseline Schedule
- Identify risks related to baseline project
- Assess and quantify risks in terms of project's cost and schedule

Step 2: Value Engineering & Risk Response

- Develop Value Engineering recommendations that further mitigate or avoid high risk elements
- Develop recommendations that add value by modifying project scope and/or schedule

Step 3: Risk Analysis on Response Strategies

- Identify risks related to Response Strategies
- Assess and quantify threats and opportunities in terms of project's cost and schedule

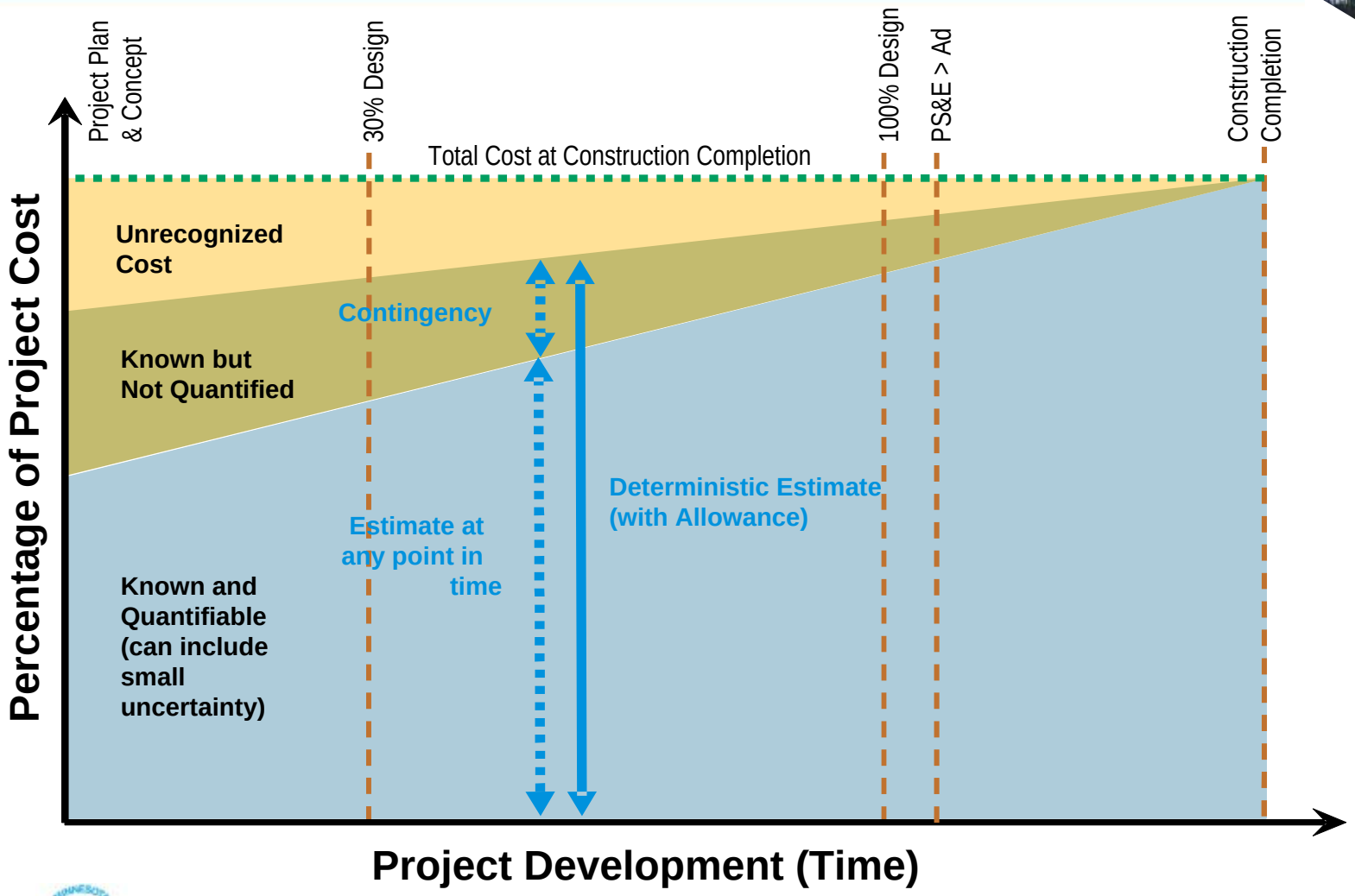
Step 4: Tracking, Monitoring, and Control

- Identify Risk Owners, Monitoring Frequency
- Continuously update risk management plan
- Document and report progress
- At Key Milestones, Update Cost and Schedule

Who Needs to Participate

- Project Manager
- Disciplines
  - Construction
  - Bridge & Structures
  - Environmental
  - Right of Way
  - Geotechnical
  - Construction
  - Utilities
  - Local agencies
  - Others depending on project scope

Assessment of Baseline Cost



Traditional Vs. Risk-Based Approach

Fixed Contingency %

Project Deterministic Estimate

Project Base Cost

Geotech 20%

Enviro 40%

ROW 30%

10% Unknown

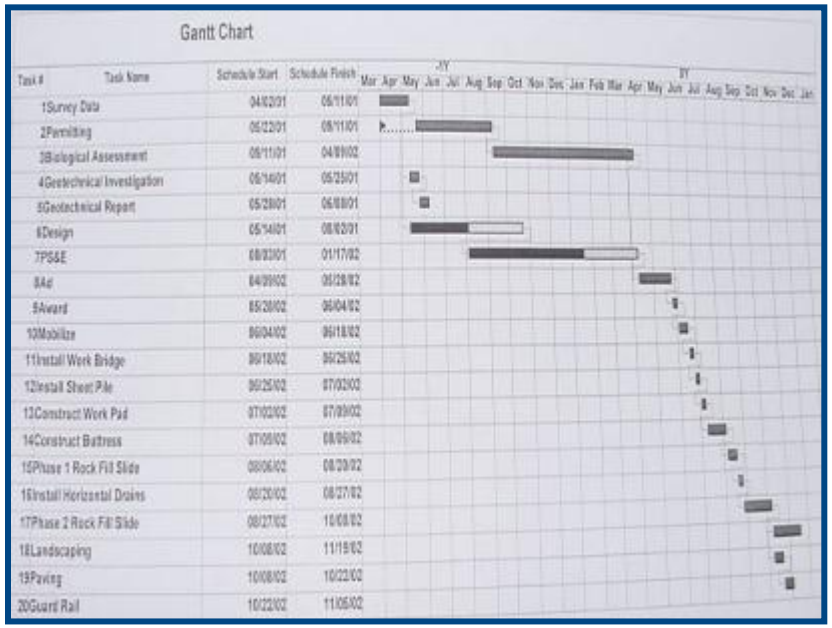
Base Cost

- The Base Cost represents the cost which can **reasonably be expected if the project materializes as planned.**
- Base Costs are initially estimated by the Project Team and reviewed during the Risk Workshop by the Subject Matter Experts.

	DRAFT 7-14-08 - Subject to Change	2008 Base Costs
Phase	**Cost Elements**	
Phase 1 - Bigelow to Paul Ave.	Pre-Letting Engineering: Internal - Mn/DOT	1,471
	Pre-Letting Engineering: External - Consultants	600
	Construction Engineering: Internal - Mn/DOT	2,539
	Construction Engineering: External - Consultants	200
	Project Construction Cost	31,755
	Detour and Haul Roads	1,240
	Right of Way	5,370
	Utilities	120
	Railroads	500
	Municipal/Local Issues	0
	Turn-Backs: After	0
	Landscaping	309
	Environmental Clean-Up/ Mitigation	2,341
	Incentives	1,197
	Change Orders/ Cost Overruns	5,911
	Phase 1 Totals	53,552

Risk Management

- **Risk Management is** an integral component of **day-to-day project management**.
- Project teams implement and **continuously update the Risk Management Plan** throughout the project

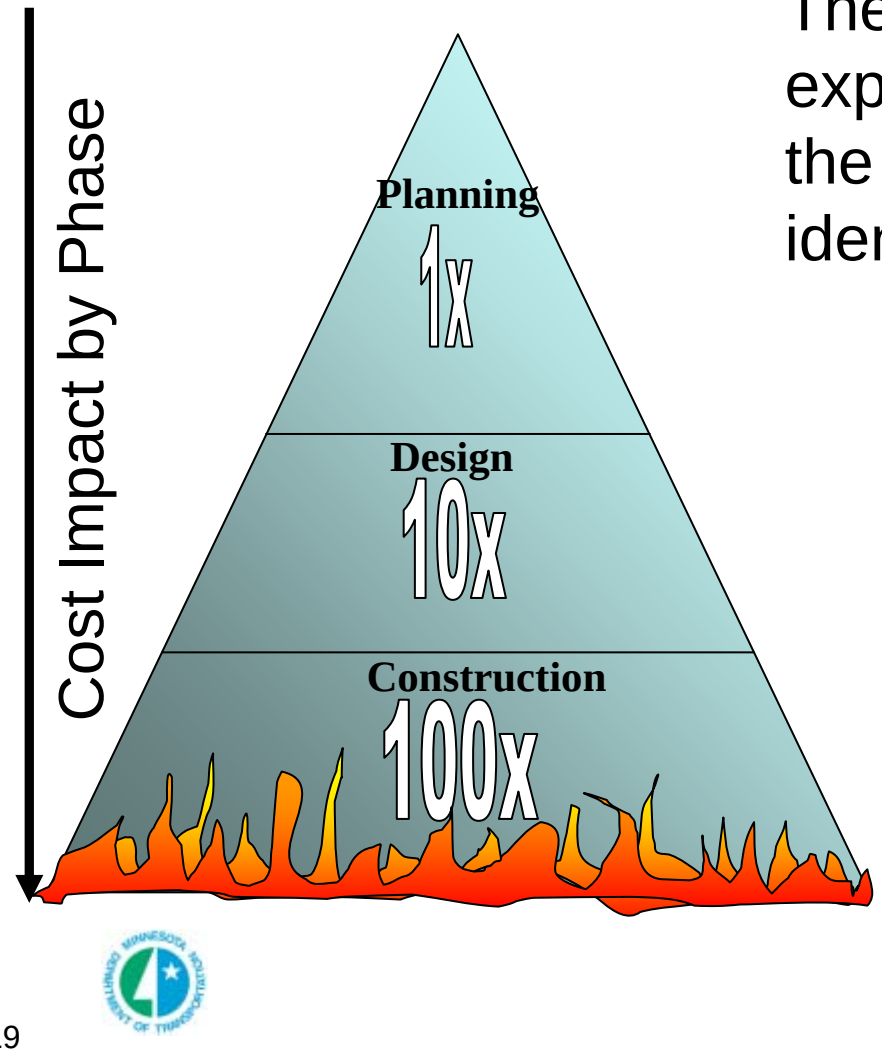


Why Risk Management?

- **Maximizing** the probability and consequences (impacts) of **positive** risk events (***opportunities***).

- **Minimizing** the probability and consequences (impacts) of **negative** risk events (***threats***).

When to Use



The cost to fix an issue exponentially increases the later in the project lifecycle that it is identified and resolved.

- An issue *identified* in the planning phase costs a factor of **1x** to fix

- An issue *identified* in the design phase costs a factor of **10x** to fix

- An issue *discovered* during construction costs a factor of **100x** to fix

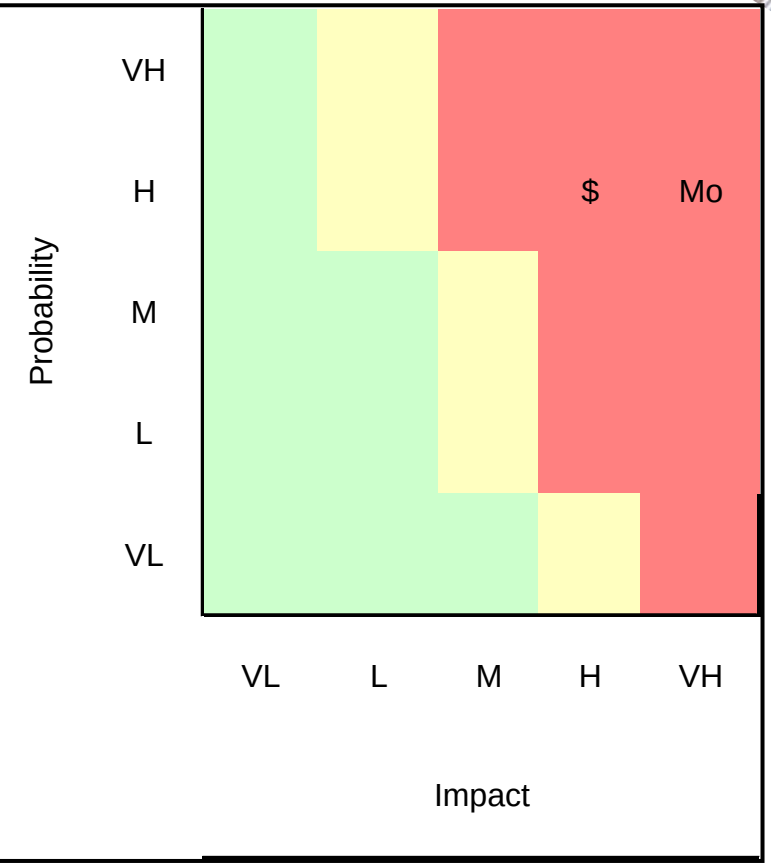
Elicit Risks

Caution needs to be exercised when eliciting risks. While the Risk Lead must be thorough in making sure to capture uncertainty and risk, he or she must also guard against the potential of double-counting.

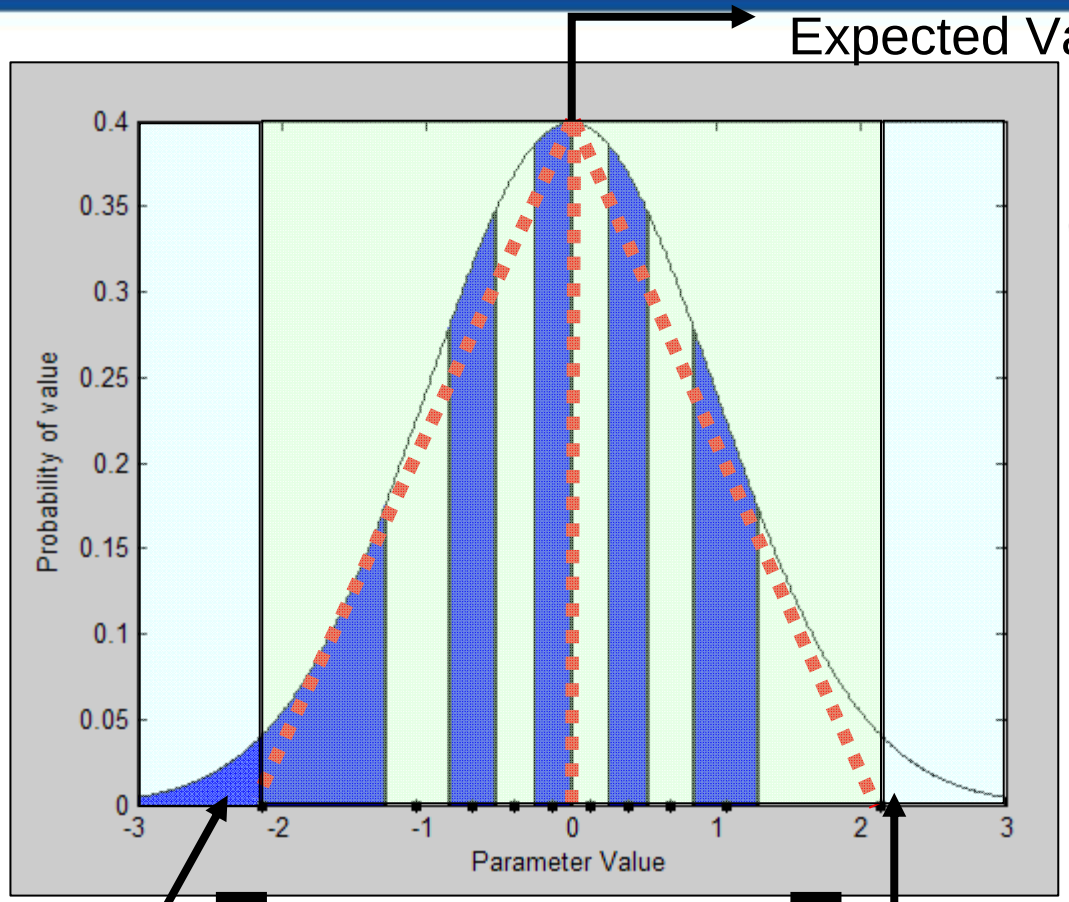
The use of an expert risk elicitor is strongly advised

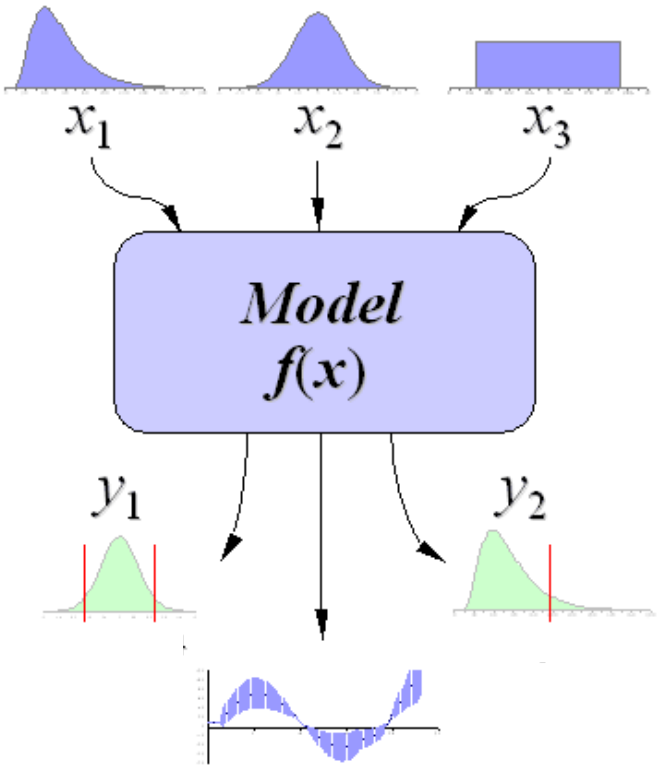
Quantitative Risk

Cost	75%	MIN	5.00$M	8$M	High	High
		MAX	25.00$M			
		BEST GUESS	10.00$M			
2		0				
Schedule		MIN	12.0Mo	27.0Mo	High	Very High
		MAX	48.0Mo			
		BEST GUESS	36.0Mo			



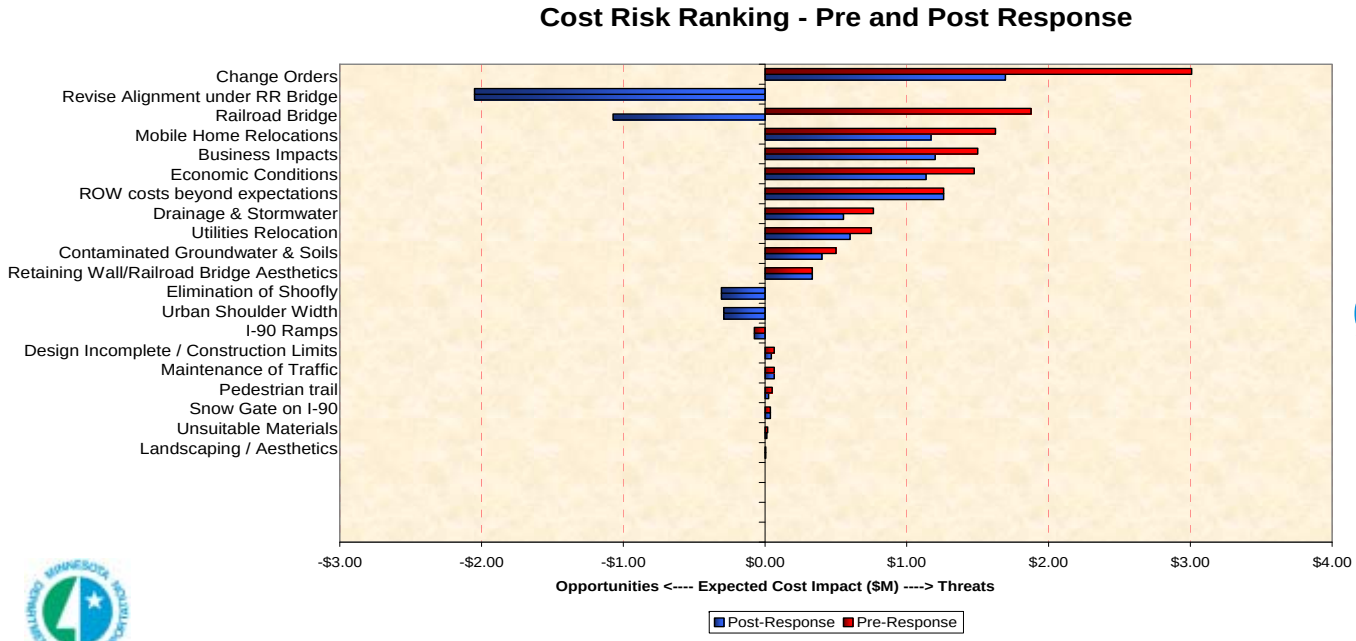
What is Monte Carlo?





Prioritizing Risk

- We often spend a considerable amount of resources on a risk that may not have large impact
- By quantifying your project risks you can apply the limited resources to the risks that can provide the largest return
- Tornado Diagrams are a great way to see this graphically

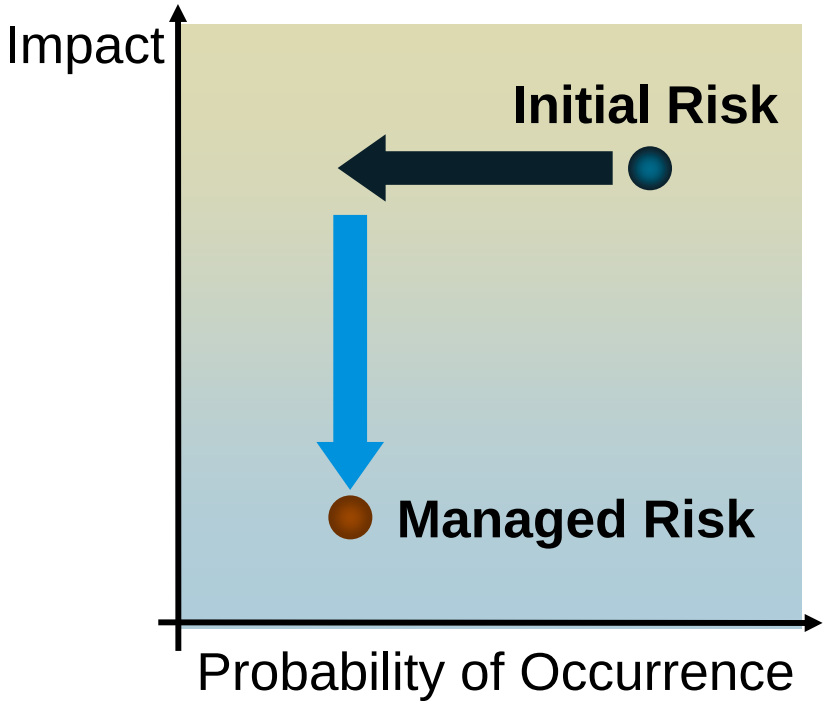


"What gets measured, gets managed"

Goal of Risk Management

- Risk Assessment's aim is to assess potential impact of various scope, event, and budget risks on the project's cost and schedule.

- Risk Management's aim is to identify opportunities and mitigation strategies to reduce both the likelihood of an event occurrence and the potential effect if it occurs.



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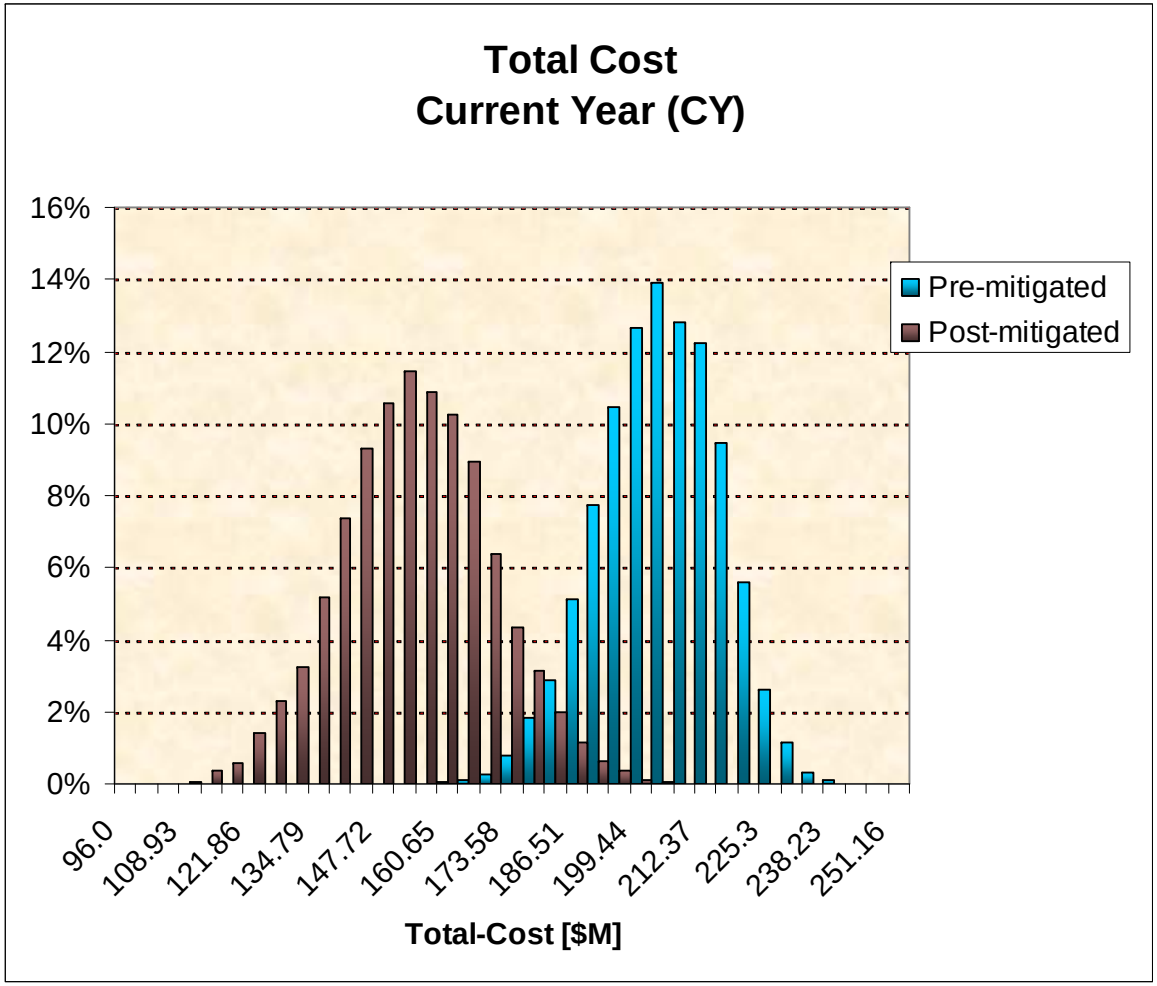
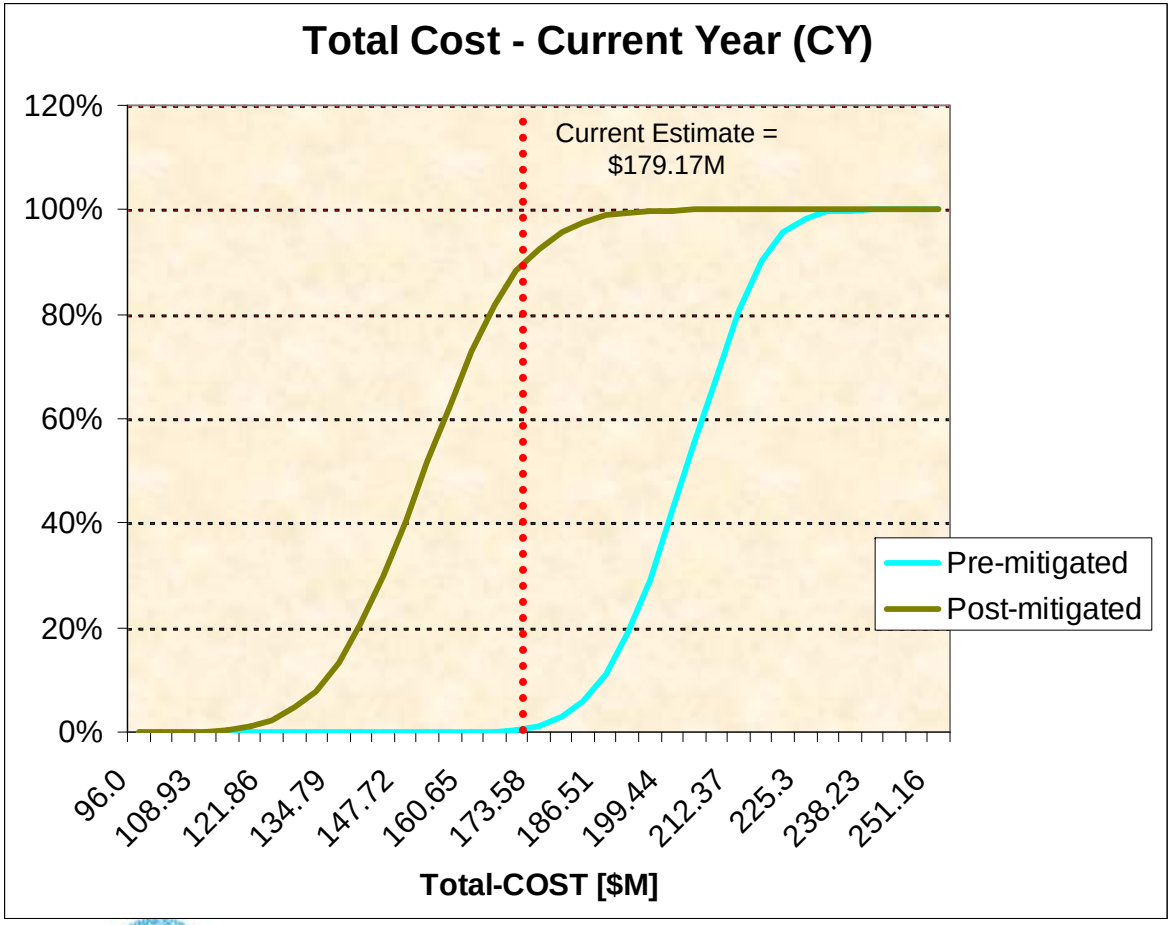
Post-Mitigation + VE Recommendations



Total Project Cost Range		
	Pre-mitigated	Post-mitigated
Min	157.28 $M	101.31 $M
Max	242.09 $M	217.80 $M
Median	202.12 $M	148.60 $M
10%	185.73 $M	129.93 $M
20%	191.61 $M	135.95 $M
30%	195.77 $M	140.45 $M
40%	199.01 $M	144.49 $M
50%	202.12 $M	148.60 $M
60%	205.09 $M	152.73 $M
70%	208.39 $M	157.81 $M
80%	211.93 $M	166.70 $M
90%	216.70 $M	181.27 $M

Post-Mitigation + VE Recommendations



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Lessons Learned

- Do not short change the process
- Additional studies may be required as projects progress
- Use VE team set up check list and Request for VE form, circulate check list of items and information needed for the team
- Have project team prepare and deliver an accurate overview of the project
- Accurate cost estimate validated prior to study

Lessons Learned

- Project team selection is critical
- Subject matter experts from around the nation filled in as CRAVE team members; their expertise was invaluable and allowed Mn/DOT personnel to stay in their office to deliver critical bonding projects.
- Having the economist at the CRAVE workshop definitely accelerated the completion of the CRAVE studies.
- CRAVE training that followed the studies helped reinforce the participant's understanding of the risk assessments and risk management plan.

11 Bridges + 1 (TH 60)
Chapter 152
Cost Risk Assessment Value Engineering (CRAVE) Plan

Location	Dist	Study Facility Location	Mid - Year Construction Date	15-Sep	22-Sep	29-Sep	06-Oct	13-Oct	20-Oct	27-Oct	03-Nov	10-Nov	17-Nov	24-Nov	01-Dec	08-Dec		18/19 Feb
Hastings	Metro	Hastings City Hall	2011					Ken Smith	Consultants Unavailable	Design Engineers Meeting		Veterans Day is on Tuesday		Thanksgiving week				Final Presentation
Lafayette St. Paul	Metro	Maryland Truck Station	2012	HDR-Ken Smith														
TH 99 St. Peter	D7	Maryland Truck Station	2013								Cost Risk				VE-Ken Smith			
Dresbach La Crescent	D6	OnAlaska Wisconsin	2014				Don Owings											
St. Croix	Metro	Oakdale Bridge Office	2015										HDR-Ken Smith					
Winona	D6	Winona / Rochester MN	2016										Don Owings					
Cayuga St. Paul	Metro	Maryland Truck Station	2016	HDR-Ken Smith														
Red Wing	D6	Red Wing / Rochester MN	2018										Don Owings					
US 14 New Ulm	D7	Maryland Truck Station	2018								Cost Risk				VE-Ken Smith			
Rainy River Baudette	D2	Maryland Truck Station	2019								Cost Risk				VE-Ken Smith			
~~Kennedy~~ Sorlie E Grand Forks	D2	Maryland Truck Station	2019								Cost Risk				VE-Ken Smith			
TH 60 Worthington	D7	Mankato	multiple lettings 2010, 2011 & 2012													Ken Smith		

Note: These projects will be studied in a split CRAVE study at Maryland Ave. Truck Station. 4 days of Cost Risk Assessment Nov. 3 thru 6 followed by 5 days of Value Planning Dec. 1 thru 5. St. Peter - Monday, Nov. 3 & Dec. 1; New Ulm - Tues Nov. 4 & Dec. 2; Rainy River - Wed. Nov. 5 & Dec. 3; Kennedy - Thurs. Nov. 6 & Dec. 4. Final presentation

Note: These projects will be studied consecutively, Mon/Tues in Winona, Wed/Thurs in Red Wing, Fri "Presentation of Findings" in Rochester.

Note: Roadway project

Revised 06/15/09

Lessons Learned

- **Planning**
  - Hiring the consultant and the contracting process
  - Selecting the teams
  - 4500+ e-mails
  - Hundreds of phone calls
  - Scheduling hotels and working lunches
  - Reserving vehicles for the site visit
  - BlackBerry
  - Even considered the state plane

Lessons Learned

- The CRAVEs would not have been a success without support from everyone – team members, consultant and management.
- Selecting teams was difficult with the high work load. First time using consultant team members. This worked very well.
- Admin and contract follow up. Important to have a good scope of services, cost estimate, agenda, etc. for getting the contract through quickly.

Lessons Learned

- Follow up with PM's for decisions
- Have forms ready to go
  - VE request form for project info
  - Checklist to make sure nothing gets missed
  - DRAFT VE report comments form
  - PM Decision matrix

We are seeing a cultural change from: "have to do" to "want to do"

QUESTIONS?