Table of Contents

(Risk-Based Estimating Workshops: CRA/CEVP)

sample only

		Page#
Foreword		i
One-Pager		
Executive Summary		
1	Overview	1-1
	Project Summary	
	Project Objectives	
	Workshop Objectives	
	CEVP Methodology	
2	Project Alternative	2-1
	Project Alternative	
	Project Flowchart	
	Assumptions	
	Exclusions	
	Workshop Notes	
3	Base Estimate Review	3-1
	Base Cost Estimate	
	Review and Validation Notes	
Appendix A	Attendees and workshop notes	
Appendix B	Base Cost Estimate – complete spreadsheet	
Appendix C	Inputs Risk Register (risk identification sheets)	
Appendix D	Outputs Risk Register (produced from model)	
Glossary		

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Foreword

For nearly all projects more things might happen than will happen; outcomes vary and cannot be guaranteed to 100% certainty, this is particularly true when a project is early in the design process and not fully defined. While it is not possible to guarantee certainty, through risk-based estimating we can provide probability.

Through a collaborative process between the project team, external risk experts, cost experts and subject matter experts we identify uncertainty ranges and possible risk events that can affect project objectives. The evaluation is conducted for the project commensurate with the level of project development. For this project, risk based-estimating processes followed by the Washington State Department of Transportation (WSDOT) were used. The WSDOT process, termed Cost Estimate Validation Process or CEVP® represents a "snapshot" for that project under the conditions known at that point in time.

This process normally deals with significant project risk events that are identifiable and quantifiable. A focused list of significant risks, drawn from extensive combined experience results in actionable information directed at the most important issues and critical essence of the project. This allows us to wrestle priorities out of complex projects.

Project risk management relies on sound estimating practices for both cost and schedule as well as sound risk assessment practices to fully convey the project characteristics of the subject project at the time of the analysis. The output of the analysis reflects the input that is provided for the project. Even more important than the output is the communication and greater project understanding that is fostered through this process.

Risk assessment is not a measure of estimate accuracy:

The project team must examine each critical item and predict its possible extreme values considering all risks, including compounding effects. It is important to understand that the range, as considered in this method, is not the expected accuracy of each item. ***This is a key issue.*** *Risk analysis is not an analysis of estimate accuracy. Accuracy is dependent upon estimate deliverables and estimate maturity. Contingency, as determined via the use of risk analysis, is not a measure of estimate accuracy. Rather it is a reflection of risk at any specified or desired probability of not completing the project within the estimate.*

AACE International Recommended Practice No.41R-08
RISK ANALYSIS AND CONTINGENCY DETERMINATION USING RANGE ESTIMATING
TCM Framework: 7.6 – Risk Management
June 25, 2008

"One-pager" Summary	**PROJECT NAME** **Project Location** *December 2009*	***Thumbnail project vicinity map goes here.***

Project Description

Describe the project:

What is it intended to do?
Where?
How far along is the project?
What is the current project phase?

sample only

Project Benefits

- Facilitate efficient movement of traffic through…..
- Adds capacity and enhances facilities thereby y; relieving existing and forecast congestion….
- Improves access to and from --- - -- - - -- -- -- and highway system;
- Provides essential access to the emerging - - - - - - - area.

Key Assumptions

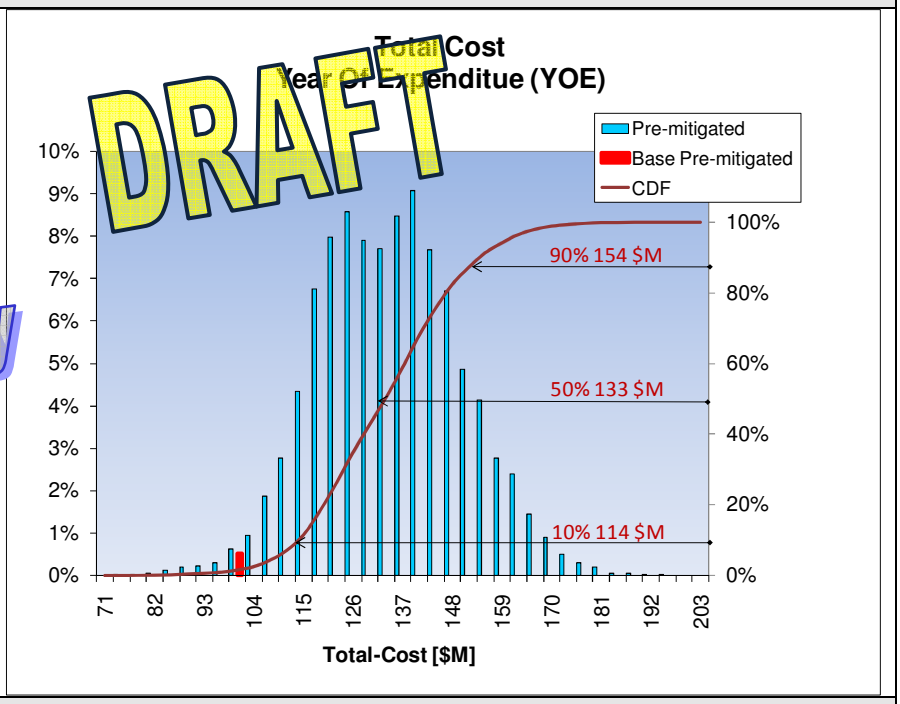
- Assumed a design-bid-build project.
- Funding is available for Preliminary Engineering, Right-Of-Way and Construction.
- Record of Decision anticipated by SEASON and YEAR.
- Design for this project is approximately 5% to 10% complete.

Project History (key dates)

<project team to provide> - examples…

- 1996 ….
- 2000….
- 2009…..

CEVP Cost Range *(opinion of cost range as of Dec 2009 project analysis)*



CEVP Schedule Range (10th to 90th %-ile)

Ad Date	***06/2014 to 07/2015***	*Probable ad date and completion date analysis of project in January 2010.*
Construction Complete	***11/2016 to 02/2018***	

Key Project Cost Risks (estimated ~most likely impact value)

%p	***Threats***
95	ROW Plan delay, (~$3 M)
50	Higher PE costs (~$4M)
40/20	ACME accommodations (~$1M/~$7)
20	Partial R/W acquisitions become full takes (~$6M)
75	RR Crossing foundation/alignment concerns (~$1M)
	Opportunities
20/10	Design near 42nd Av connection (~$2M/~$12M savings)

Key Project Schedule Risks (estimated ~most likely impact value)

%p	***Threats***
95	ROW Plan delay, (~12 months)
75	Construction delays – cumulative (~5 months)
25	NEPA challenges (~12 months)
20	Partial R/W acquisitions become full takes (~6 months)

Level of Project Design

Low — Medium — High

December 2009

WSDOT

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Executive Summary

In this chapter of the report the results from the risk analysis are presented. The reader is encouraged to closely examine each to the graphic outputs and tables since they provide a representation of the project as understood at the time of the analysis.

If we think of risk management as having two pillars, the first pillar is identification and analysis and the second pillar is response and monitor. This chapter provides detailed results of the input including identified risks, their characteristics, and the resulting analysis. From the analysis we have actionable information from which risk responses can be developed to shift odds in favor of project success. This is where the real power of project risk management can be harnessed, in the pro-active engagement of project uncertainty and risk.

Model Results

Figure ES-1 depicts the probabilistic distribution of cost range to complete the total project as understood for this analysis. The range represents the best input that could be provided at this stage in project development. The input was collaboratively developed, reviewed and established by the project team, risk experts, cost experts and subject matter experts for relevant disciplines.

The output indicates the probability for a range, in year-of-expenditure (YOE) dollars that the total project can be completed. The total dollar figure range represents the base cost, base uncertainty (comprised of base variability and market conditions), base schedule, and risk events (threats and opportunities) for the cost and schedule. The output indicates the best opinion of the total project cost range by the workshop group at the time of the analysis. Each percentile figure conveys the probability of not exceeding a dollar amount, for example if we report the dollar figure for the 70th percentile that means there is a 7 out of 10 chance the project can be complete for this amount or less, it also means there is a 3 out of 10 chance the project will exceed this amount. For easy viewing this chapter provides the year-of-expenditure (YOE) outputs, Ad Date, and End Construction Date, and the candidates for risk response actions. Appendix D provides both current year and YOE outputs.

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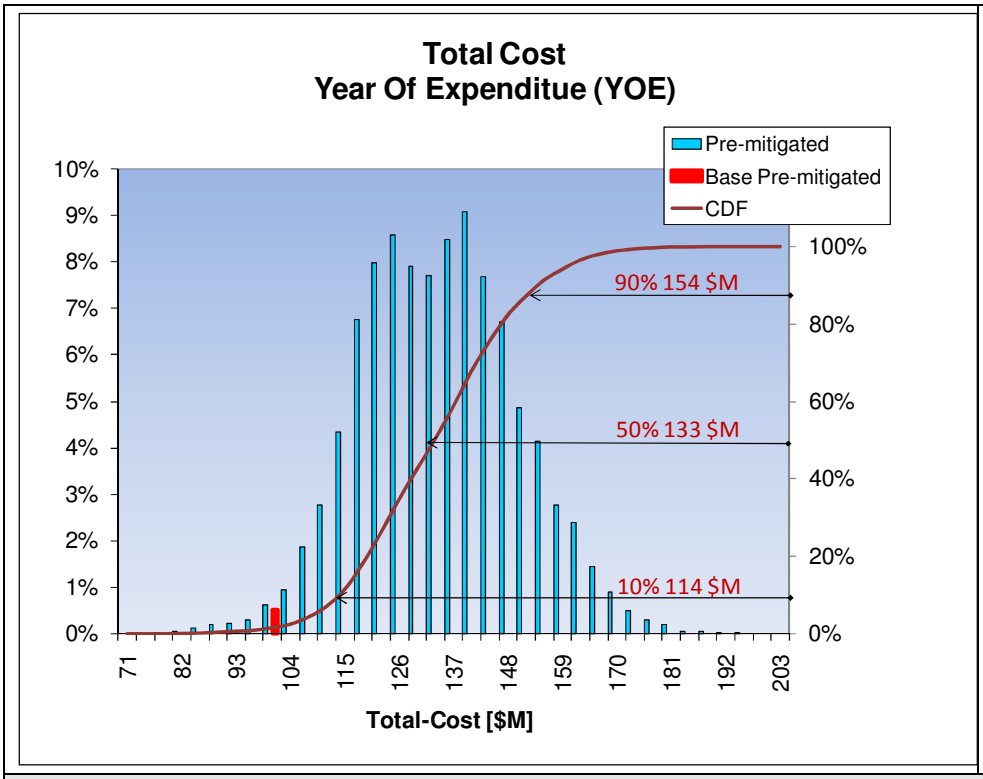

TOTAL BASE ESTIMATE (YOE) Pre-mitigated 99.6 $M	
Statistics	**Pre-mitigated**
Min	71.20 $M
Max	192.03 $M
Median	133.25 $M
10%	113.98 $M
20%	119.59 $M
30%	124.03 $M
40%	128.50 $M
50%	133.25 $M
60%	137.57 $M
70%	141.69 $M
80%	146.73 $M
90%	154.07 $M

Figure ES-1 Total Project Cost Probability Distributions (YOE)

The estimated total project cost ranges from a minimum value of about 72 $M and maximum value of about 190 $M. These extreme values have very little chance to materialize. It is a common practice and more realistic to evaluate the 80 percentile confidence interval, represented by the 10% and 90% figures: The project has one out of ten chances to cost less than 114 $M if project threats are eliminated and no additional expenses incurred, and a large majority of opportunities identified during the workshop materialize. At the same time the project has a nine out of ten chance to cost less than 154 $M. These results reflect the input provided during the workshop and as the project is understood at this early stage of design.

The results presented in Figure ES-1 are based on **pre-mitigated** cost risk analysis. A sound project management process requires answers to the significant risks identified and quantified. It is expected that the project team will, at an appropriate time, re-evaluate the project conditions; cost and schedule associated with it and develop the risk response plan that may reduce the cost and schedule.

The next figures present the cost and schedule distribution of each phase of the project and what can be done in order to reduce the cost and schedule for that phase.

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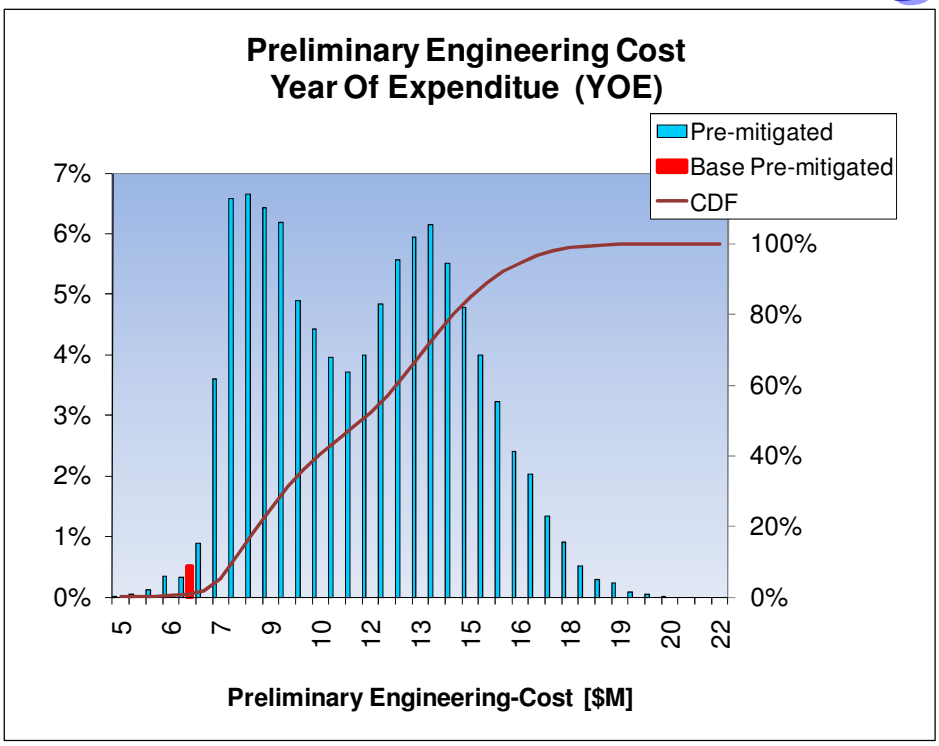

PE Base Estimate (YOE) Pre-mitigated 6.52 $M	
Statistics	**Pre-mitigated**
Min	4.60 $M
Max	20.39 $M
Median	11.54 $M
10%	7.82 $M
20%	8.54 $M
30%	9.29 $M
40%	10.30 $M
50%	11.54 $M
60%	12.54 $M
70%	13.35 $M
80%	14.18 $M
90%	15.33 $M

Figure ES-2 **PE** Cost Probability Distributions (YOE)

The graph is “double hump camel” shaped. Usually this shape is given by the present of a risk of a size close to the base and medium probability of occurrence. In this case our output for the estimated project PE costs reflects a possibility of higher PE cost due to outsourcing. The base estimate assumed 11% PE costs; however PE costs can range up to 20% if fully outsourced (resulting in a net increase of up to 100% additional PE costs).

The end tails are given by the additional PE expenses created by the construction related risks. Threats like “Design Exceptions”, “Bikes and Peds”, and “ACME accommodation” extend the upper end tail.

The decision to have the project designed in house and aggressive and effective risk management practice may keep PE costs low.

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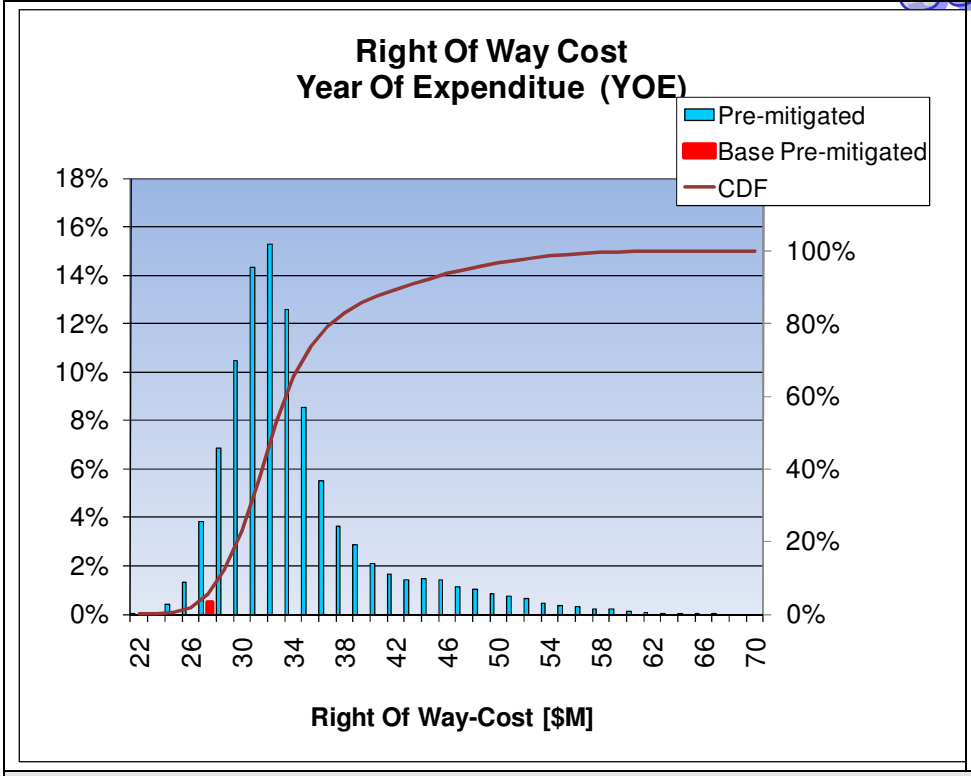

ROW Base Estimate (YOE) Pre-mitigated 20.65 $M	
Statistics	**Pre-mitigated**
Min	17.80 $M
Max	61.61 $M
Median	28.03 $M
10%	23.65 $M
20%	25.01 $M
30%	26.07 $M
40%	27.04 $M
50%	28.03 $M
60%	29.12 $M
70%	30.70 $M
80%	33.35 $M
90%	38.25 $M

Figure ES-3 **ROW** Project Cost Probability Distributions (YOE)

The ROW acquisition brings significant volatility to the estimate, and the base estimate overly optimistic. The estimate shows a minimum cost of about 18 $M and a maximum cost around 60 $M. The long and relatively thick upper tail is given by three risks: (1) "ROW Plan Delay", (2) "Partial Takes becoming total takes", and (3) "Real Estate Market."

The total expected value of ROW risks (Risk median value times its probability of impact) is about 5 $M but all these risks have a long upper end tails which significantly influence the upper end tail of ROW cost distributions. This explains the high upper-end values for the ROW cost estimate.

The good news is that two risks: "ROW Plan Delay" and "Partial Takes become total takes" are manageable. The management team may have some control over these risks and good design and communication with Real Estate services may ameliorate their impact.

The effect of ROW risks is far more reaching because they affect the project schedule as well as the cost, as this report presents later.

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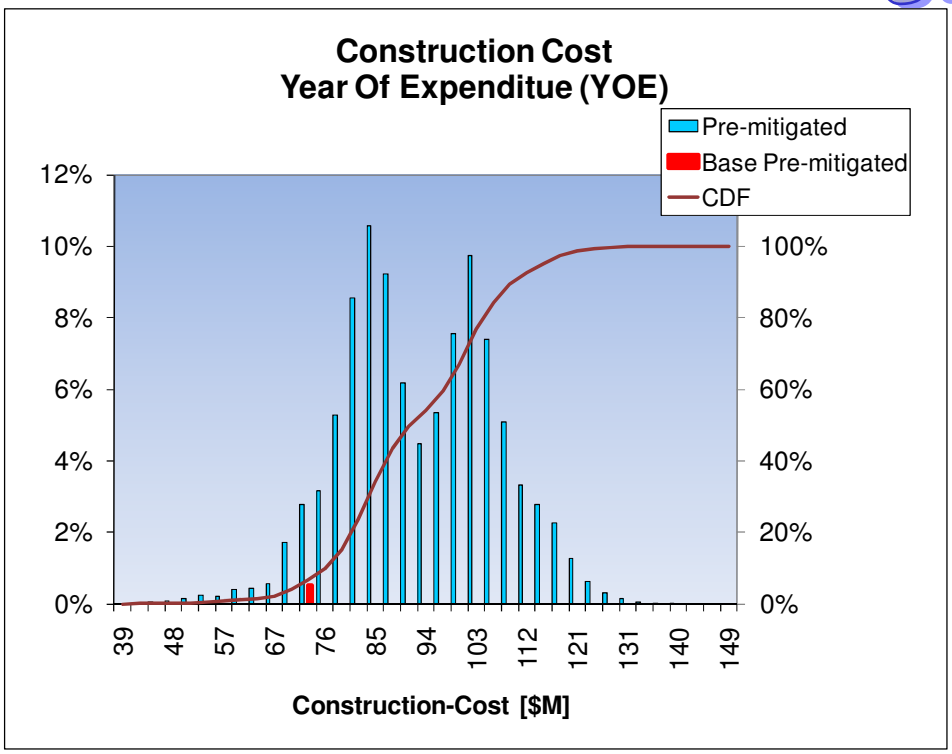

CN Base Estimate (YOE) Pre-mitigated 72.39 $M	
Statistics	**Pre-mitigated**
Min	39.12 $M
Max	139.72 $M
Median	91.18 $M
10%	75.80 $M
20%	80.58 $M
30%	83.66 $M
40%	86.71 $M
50%	91.18 $M
60%	97.32 $M
70%	101.01 $M
80%	104.38 $M
90%	109.86 $M

Figure ES-4 **CN** Cost Probability Distributions (YOE)

The graph for CN shows the same "double hump camel" shape as observed in the PE output. In this case the second hump (higher values of say 83$M to 110$M) is given by the market conditions assessed for the base cost. The workshop had assessed that it is about a 40% chance that bids will come in higher by up to 20%. This market condition reflects concerns that prices may rise and/or we may experience lower competition by the time this project is advertised for bids.

The extended lower end tail is mainly related to the opportunity of "42nd Av change." The better than expected market conditions are represented by histogram shape area around 60 $M to 76 $M.

Advertising the project sooner offers an opportunity to take advantage of a favorable labor market and bidding environment portending lower costs

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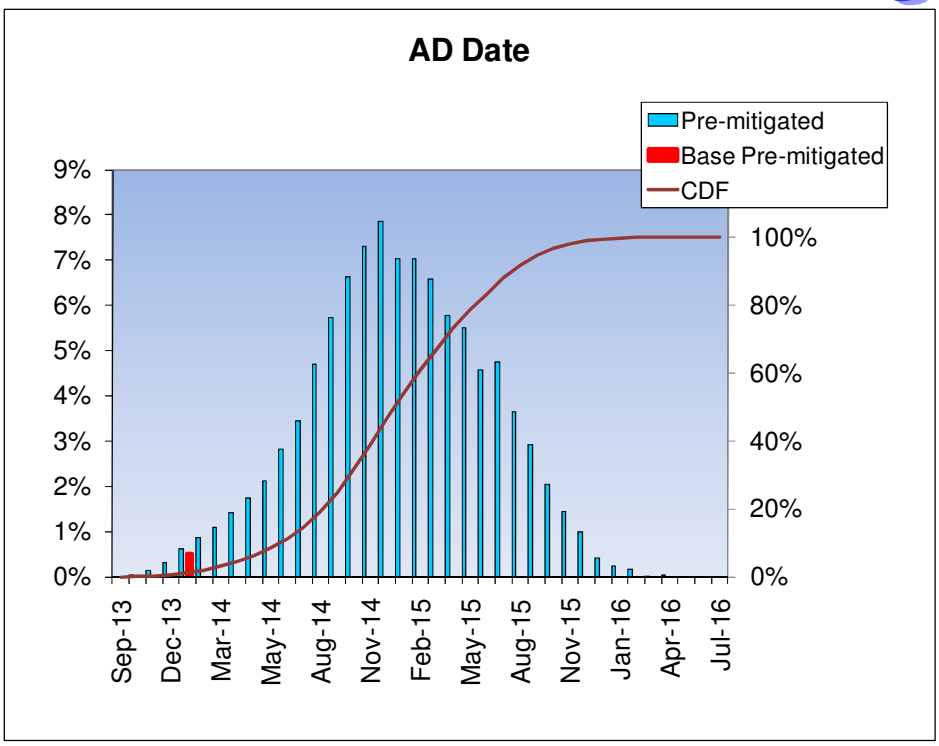

Base Ad Date Pre-mitigated January-2014	
Statistics	**Pre-mitigated**
Min	Sep-13
Max	Apr-16
Median	Dec-14
10%	Jun-14
20%	Aug-14
30%	Oct-14
40%	Nov-14
50%	Dec-14
60%	Feb-15
70%	Mar-15
80%	May-15
90%	Jul-15

Figure ES-5 AD DATE

Without aggressive risk management the chance to meet the target Ad Date is about nil.

The Ad Date is dominated by two risks: (1) “ROW Plan Delay” and (2) the “NEPA challenge” risks. When they occur (in the model at least one of these risks occur every time since one has 95% probability of occurrence and the second one has 25% probability of occurrence) the delay could be up to two years.

These two risks dominate the likelihood of delay of the Ad Date. If the project team can eliminate them the chances dramatically improve project schedule performance. As a reminder the “ROW Plan Delay” is significant on the cost side also. Delays of this size increase the project cost primarily in two ways: (1) the effect of escalation and (2) perhaps the most dangerous effect is pushing the project into worse market conditions which may increase the construction cost by 20%.

The good news is that the project team has a good chance of reducing these risk impacts.

There are some other significant risks that may affect the Ad Date, but their impacts are overpowered by the “ROW Plan Delay” and “NEPA challenge.”

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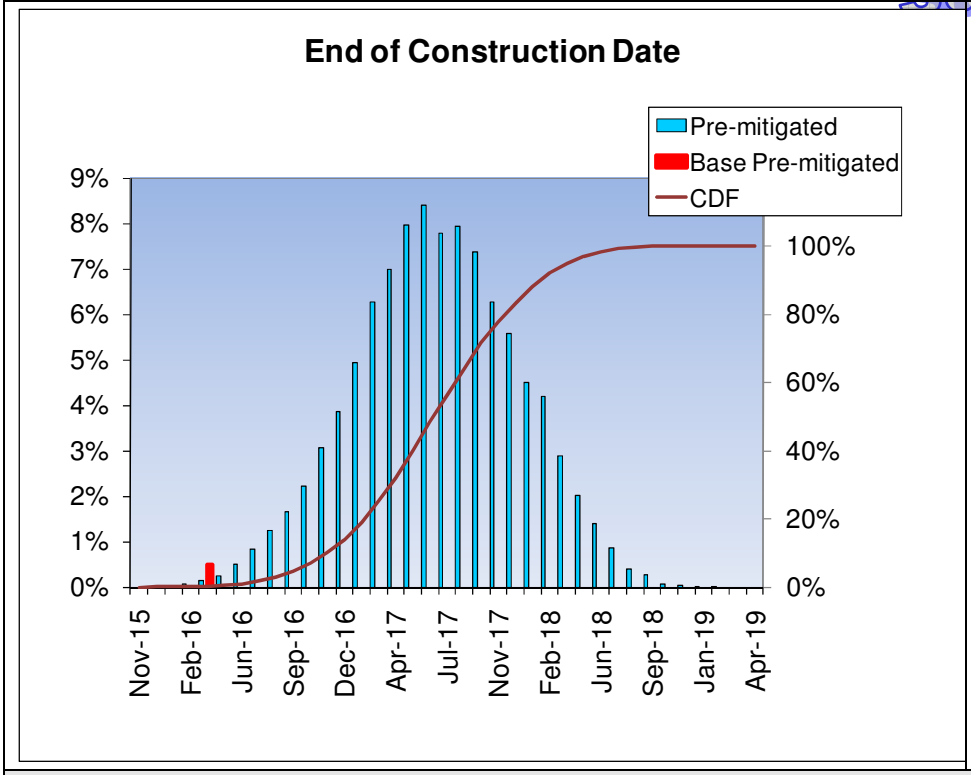

Base End Construction Date Pre-mitigated March-2016	
Statistics	**Pre-mitigated**
Min	Nov-15
Max	Jan-19
Median	Jun-17
10%	Nov-16
20%	Feb-17
30%	Apr-17
40%	May-17
50%	Jun-17
60%	Aug-17
70%	Sep-17
80%	Nov-17
90%	Feb-18

Figure ES-6 END CONSTRUCTION DATE

Because of the End of Construction date depends on the Ad Date their shapes are very similar.

The End of Construction Date diagram shows a wide range because of the domino effect taken from the Ad Date. The distribution does not show any particular characteristic since no dramatic schedule risks affecting just construction phase were identified. The risks “CN Delays” and “Hazardous materials” are blended into the overall delay of the Ad Date and will expand the upper end tail of the End of Construction Date.

The results illustrate that addressing and controlling the two main schedule risks: “ROW Plan Delay” and “NEPA challenge” can dramatically help timely project delivery. The potential delay has triple effects: (1) the project is not delivered on time, (2) the escalation will add several million dollars to the cost of the project and (3) the construction may take place in a less favorable market environment and incur higher prices and low competition.

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Figure ES-7 depicts the cost risks in their order of significance (from the largest bar at the top to the smaller bar at the bottom).

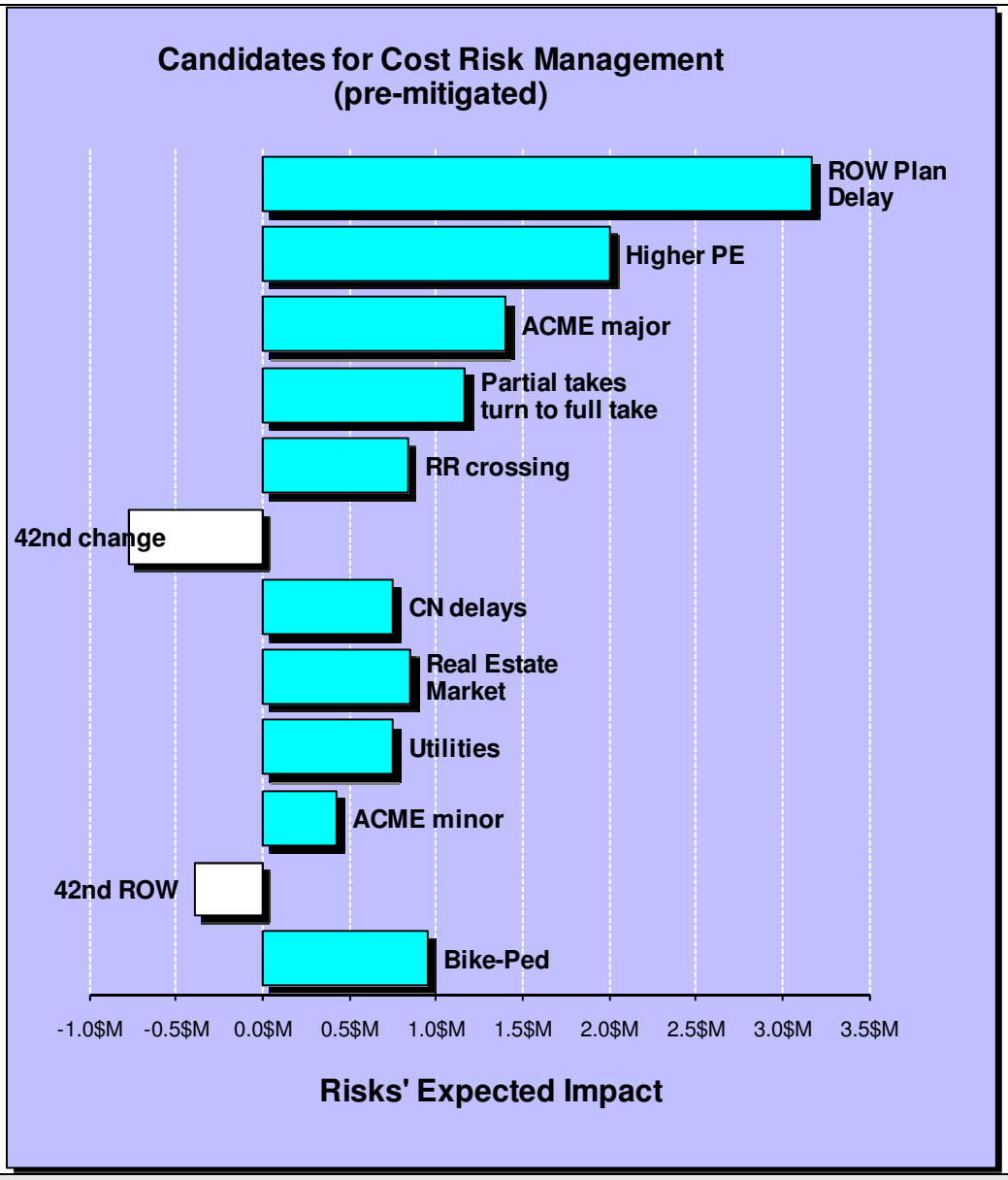

Figure ES-7 Tornado Diagram of Significant COST Risks

Positive values are threats to meeting project objectives and negative values represent opportunities. The tornado diagram presents the dominant risks considering the combined effect of the probability of occurrence and impact. The graph gives readers an "at-a-glance" view of assessed risks but does not convey the catastrophic effects of very high impact risks with very low probabilities of occurrence. For example the "Bikes Pedestrians" risk is at the bottom of list but if this risk occurs the cost may increase by several millions dollar (see figure ES-9).

sample only

Figure ES-8 depicts the schedule risks in their order of significance (from the largest bar at the top to the smaller bar at the bottom).

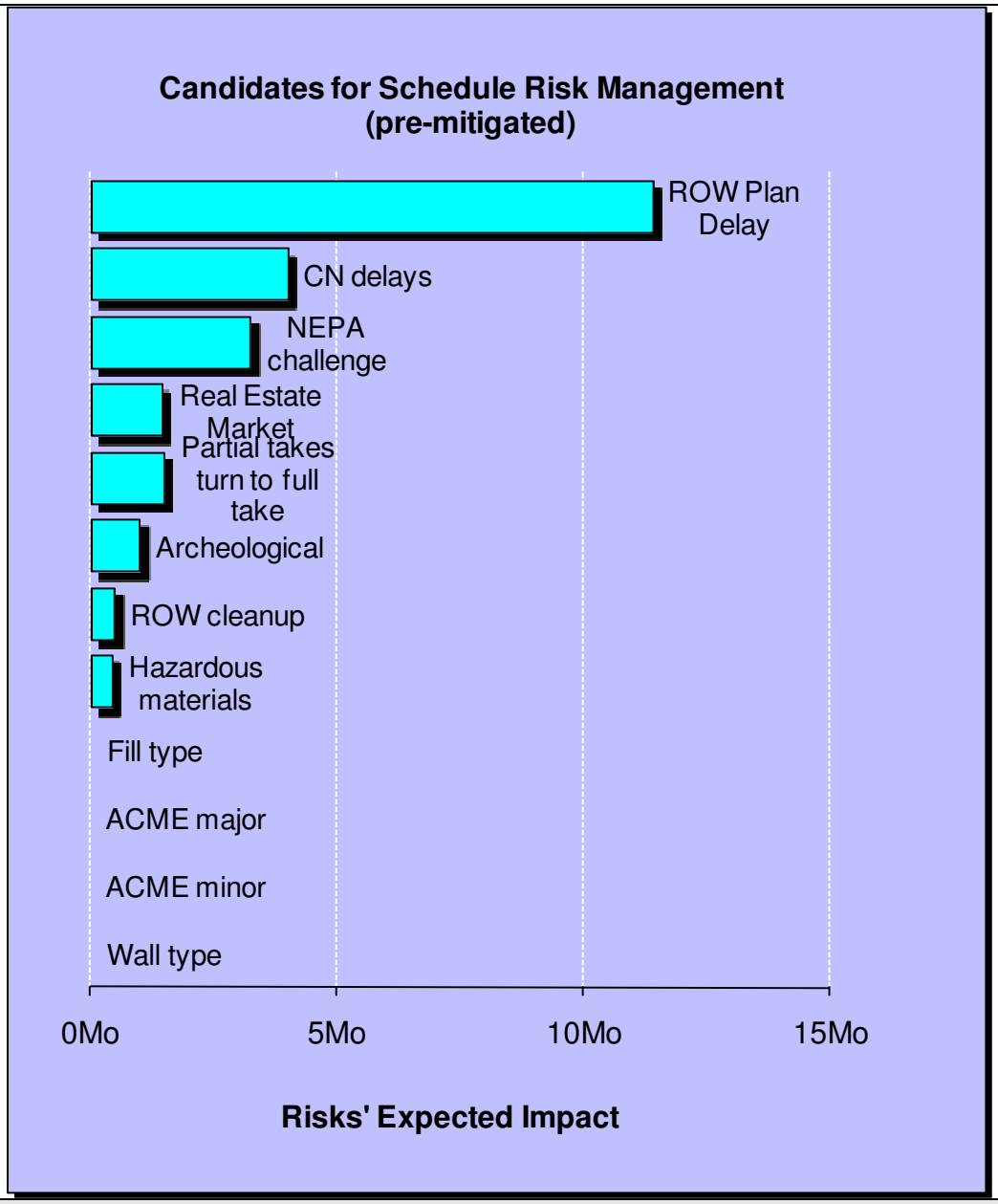

Figure ES-8 Tornado Diagram of Significant SCHEDULE Risks

sample only

Figure ES-9 depicts a “heat map” of significant risks. This graphic clearly conveys the top prospects for risk response actions in the red area. As you move away from the center of the map and out of the red area additional prospects for risk management are shown with their relative potential for benefitting the project.

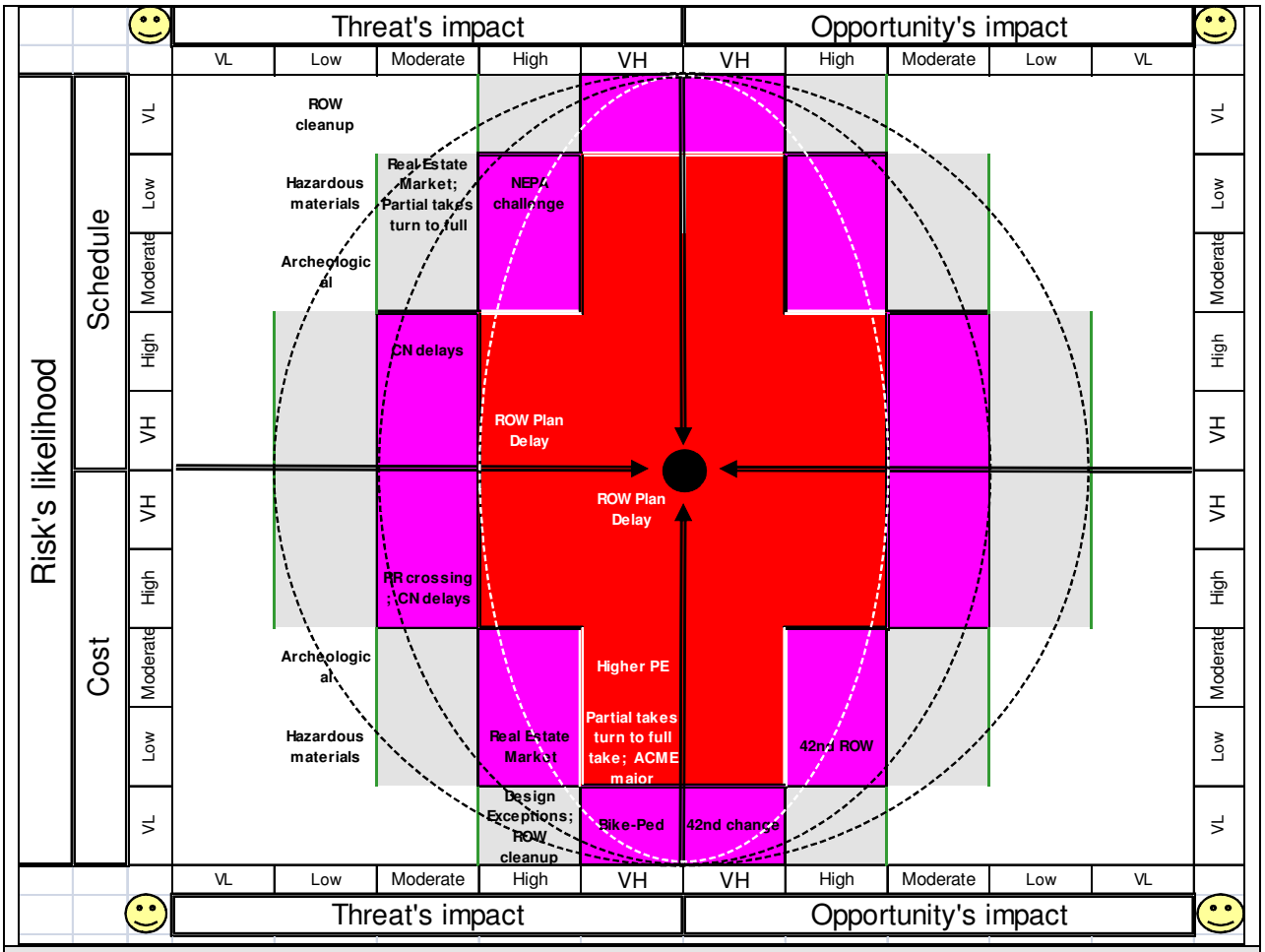

Figure ES-9 Risk Map of Significant Risks

This diagram offers a comprehensive view of project risks. It presents both risk components (cost and schedule) and segregates threats from opportunities. The risk is presented using its probability of occurrence and the impact value. The diagram shows that the “Bike Pedestrians” risk is essential to monitor and control because if this risk occurs the cost of the project will increase by several millions dollar. The “NEPA challenge” risk is critical and the “CN delays” risk is very important. These results provide managers valuable perspectives on the project risks and allow informed decisions for prioritizing and for project risk management.

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1 Overview

Project Summary

Since 1983, the North/South Mountain Highway has been identified as an essential connection from I-2525 and I-695 to US Highway B52 (JenMar Highway), and to central and eastern Yukon. Highway 2525 is designated as a statewide and regional freight route. Areas served by the Mountain Highway are planned to grow significantly in the coming years. The existing Highway 2525 is incapable of handling this increased demand.

The Mountain Highway Project is a phased approach to address existing congestion and safety problems in the Highway 2525 corridor between I-205 and 172nd Avenue (Rock Creek Junction), and to serve the growing demand for regional travel. YUKON and Chilcoot Borough are close to finishing a Supplemental Draft Environmental Impact Statement (SDEIS) for Phase 1, which focuses on building a new road from I-2525 to 159th Av. A Record of Decision is anticipated by summer of 2969.

When the SDEIS is completed, right of way will be acquired and the project will be constructed in segments as funding becomes available (to construct all of Phase 1 at once would cost as much as $1 billion). The Transportation Act of 2929 provides $100 million of funding. This amount, combined with other funds, brings the total project budget to $150 million. YUKON and Chilcoot Borough are working to define what will be built with this funding. This fall, design work and traffic analysis will be conducted to produce a conceptual design, cost estimates and traffic benefits for a new limited access four-lane road from I-2525 to SE 159th Av. Short-term improvements to the existing Highway 2525 intersection with 42nd Av will also be explored. Once this information is gathered, YUKON and Chilcoot Borough will share this information with the public and the Yukon Roads board.

The I-2525 Mountain Highway Project has a scope of work identified for analysis and represents the subject of this report; however it is noted that this analysis comprises a portion of the larger Mountain Highway project. This project is sometimes referred to as the Mountain Mainline Phase 1 project. The project is located in the southern portion of Chilcoot Borough.

sample only

Project Objectives

Objectives for construction of the Mountain Highway Project include:

- facilitate the efficient movement of people and goods between the Chilcoot Borough Industrial Area and the broader region and beyond;
- add needed capacity in the corridor and provide a more appropriate facility for most regional through-trips, thus relieving much existing and forecast congestion on the existing I-2525;
- improve access to and from the Chilcoot Borough Industrial Area and the state and interstate highway system;
- help the economic viability of this major industrial/distribution center;
- provide essential access to the emerging Stone River Employment area.

Workshop Objectives

1. Develop a common understanding among participants of the Cost Estimate Validation Process.

2. Describe Project characteristics, schedule, cost, and risk issues. Identifiable and quantified and explicitly defined risk events replace vaguely defined contingency.

3. Collaboratively review and validate project schedule and cost estimate; the collaborative workshop team is comprised of the YUKON project team, specialty groups and independent project, cost and risk experts.

4. Review project key assumptions and constraints and identify potential risk response strategies.

CEVP Methodology

sample only

This flowchart is an "at-a-glance" reference, please review relevant portions of the WSDOT Guidelines for CRA-CEVP Workshops for more details..

Workshop Request by project team

Project Team includes risk management in their project management plan

Pre-Workshop Activities

(review CRA website, workshop guidelines and other reference materials)

1
PROJECT TEAM
Confirm: Project Title, PIN, WIN, Mileposts are correct and WOA is setup. Complete the workshop request form and send to region CRA coordinator who forwards to the CREM office (form on CREM website).

2
CREM OFFICE
Provides: Orientation to Process
Contacts and negotiates with consultant participants (Risk Lead, Cost Lead, SMEs). Prepare task orders.
Prepare and distribute Prep Session Agenda to participants.

3
PROJECT TEAM
Assemble project information; hosts prep session, invites region participants and others they regularly work with from HQ.
Including: current basis of estimate and project cost estimate, scope and schedule.
Review reports and risk registers from prior workshops and/or VE studies.
Prepare a list of issues of concern See workshop guide for more information.

4
PREP SESSION – CREM/RISK LEAD(s)
Direct PREP SESSION
Risk Lead develops draft project flowchart and makes notes for review and comment.
CREM lead prepares action items.

5
CREM OFFICE
Invite external independent SMEs and HQ specialty groups identified at the Prep Session to participate in the workshop.
Prepare workshop agenda and send Outlook invite to all participants. Arrange Advance Elicitation Interviews

6
PROJECT TEAM
Work with CREM and COST LEAD to begin review of cost estimate.

Workshop

7
CREM Workshop Leader and Region Coordinators direct the workshop. RISK LEAD takes the lead during risk elicitation, the COST LEAD takes the lead during cost review and validation. PROJECT TEAM hosts the workshop.

PROJECT TEAM provides:
Meeting venue; preferably with internet connection.

Visual aids such as:
Aerial photos
Project Exhibits
Story Boards
Plan Sheets
R/W Sheets
Etc.
and
Project information such as:
Basis of Estimate
Reviewed and validated Project Cost Estimate (in Excel Spreadsheet);
Backup documentation for cost estimate
Project Schedule
Environmental Documentation
R/W Parcels information
R/W Cost Estimate
Other Pertinent Information

Typical Workshop Format:

CRA/CEVP workshop process overview
Workshop Introduction

Finalize project flowchart and scenarios with base durations

Confirm validated base estimate

Build Risk Register

Assess uncertainty in cost and schedule

Identify and Evaluate Potential Risk Management Strategies

Set date for mitigation review meeting

CREM lead prepares action items.

Reporting

(Post-Workshop Activities)

8
RISK LEADS
Perform Monte Carlo analysis and prepare a presentation of ***PRELIMINARY RESULTS***.
Prepare ***DRAFT REPORT*** and send to CREM Office and Cost Lead and Project Manager.
Project Manager forwards report to project team for review.

9
PROJECT TEAM
Conducts a thorough and speedy review of the draft report and promptly sends comments to CREM who works with the Cost-Risk-Team to bring draft report to a ***FINAL REPORT.***

The final report is typically finished within 2 weeks after receiving and resolving all comments from the draft report.

10
PROJECT TEAM
RISK RESPONSE
RISK MONITORING and CONTROL
Implement response strategies.
Incorporate into PMP update.
Work with CREM OFFICE to Assess and measure impact of response plan.
Monitor effectiveness of risk response actions.
Maintain and update RMP.

11
CONSULTANTS
Prepare and submit final invoices.

12
CREM OFFICE
Approve invoices for payment, close task orders.

Figure 1-1 CEVP Methodology

Detailed workshop guidelines found at: http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/

sample only

2 Project Alternative

Project Alternative

As indicated in Chapter 1 of this report the Mountain Highway Project scope of work identified for analysis and the subject of this report comprises a portion of the larger Mountain Highway Corridor project. This project is sometimes referred to as Mountain Mainline Phase 1: the project under analysis includes 4-lane mainline. The project is located in the souther portion of Chilcoot Borrough.

A graphic indicating the general vicinity of the project as the subject of the analysis documented in this report is found in Figure 2-2.

Project Flowchart (Simplified Project Gantt Chart for Analysis)

For the purposes of this study the timeline depicted in Figure 2-1 was assumed:

Task Name	Start	Finish
Mountain Mainline Phase 1	**Wed 12/9/09**	**Mon 3/21/16**
Preliminary Engineering	Wed 12/9/09	Mon 8/26/13
Right-Of-Way	Wed 11/24/10	Mon 8/26/13
Pre-ad count-down	Tue 8/27/13	Fri 1/10/14
AD DATE	**Fri 1/10/14**	**Fri 1/10/14**
Bid Opening	Mon 2/24/14	Mon 2/24/14
CN START (estimated)	**Fri 5/16/14**	**Fri 5/16/14**
Construction Complete	Mon 5/19/14	Mon 3/21/16

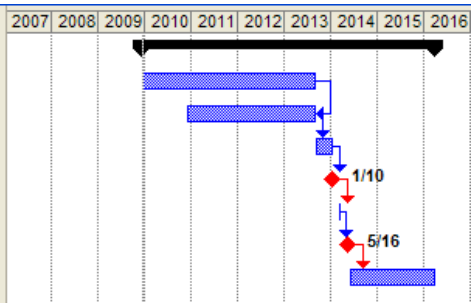

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Figure 2-2 Vicinity Map of Project and CEVP Study Area

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Assumptions

For the purposes of this MONTH YEAR analysis the following assumptions are noted:

- The project contracting method is assumed a standard design-bid-build using in-house design staff, a cost risk is captured should it be determined there is a need to use external design resources for preliminary engineering.
- There is an unconstrained funding scenario –that money is available when needed for Preliminary Engineering, Right-Of-Way and Construction.
- A Record Of Decision (ROD) is anticipated by SEASON YEAR.
- Design is approximately 15% complete.

Exclusions

The following items are excluded from consideration in this analysis and report:

-

Workshop Notes

sample only

3 Base Estimate Review

Base Cost Estimate

The Motley Road Crew prepared an estimate for the project commensurate with the level of development at the time of the workshop (December 2009). The estimate represents their opinion of project cost with the scope of work and assumptions made for the purposes of the analysis. The estimate then underwent a critical review by an independent cost estimating expert in the highway construction industry.

Both the Motley Road Crew numbers and independent expert numbers were reviewed on day one of the workshop (MMMMM DD, YYYY). Through collaborative discussion and efforts the project estimate was reviewed for omissions and duplications, contingencies, uncertainty and validation of major base quantities and unit costs to the base project assumptions. The validated base cost estimate for the purposes of this workshop and risk analysis was established and is provided in full in APPENDIX B of this report.

During the course of the collaborative review a base uncertainty was discussed and determined. Base uncertainty combines two elements: (1) base variability and (2) market conditions. Base variability is established as ±10% for the purposes of this analysis; market conditions capture the fact we do not know the future with 100% certainty –things may go better than planned, or things may go worse than planned. Market conditions were a topic of considerable discussion on the afternoon of day 1 (MMMMMM DD, YYYY). After a good deal of discussion among the independent risk experts, cost lead/subject matter expert, Motley Road Crew project staff, and cost estimating expert, the market conditions for the base cost were established for the purposes of this analysis and are summarized in Table 3-1.

TABLE 3-1 Mountain Highway Base Market Conditions

Base Cost Market Conditions			
Better than planned (more competition, lower costs)	**10%**	**10%**	*Market condition figures were arrived at through independent poll of those present during the discussion. The high and low figures were excluded and the remaining figures were averaged resulting in the numbers in this table.*
Worse than planned (less competition, higher costs)	**40%**	**20%**	
	probability	impact	

It should be noted that the project owner can explore strategies to mitigate market condition impacts, some strategies include: make the project attractive for contractors to bid on through attention to work packaging – there may be opportunities to package the work into projects that are more attractive to contractors; consider the timing of advertisement to attract bidders; do not overload the bidding market by advertising multiple projects of the same type at the same time in the same area; and accelerate pre-construction activities to get the contract to ad ASAP in an attempt to take advantage of current and near-term labor market and overall market conditions.

sample only

Significant revisions to the project team's estimate for the purposes of the CEVP base cost estimate include the revision of the project contingency of 40% to a line item for design allowance (known but un-quantified elements) of 15% of the bid item subtotal and a line item for the standard 4% allowance for changes. This change resulted in the removal of $8.3 Million contingency from the CEVP base cost which will be addressed in the risk analysis. The other significant change to the base cost estimate was the revision of Preliminary (Design) Engineering. The basis of the cost estimate is for the Motley Road Crew to perform the design with "in-house" staff and therefore during the cost validation the estimate for PE was changed to 11% from 20% of the construction cost estimate. Preliminary Engineering estimate was reduced by $6.9 Million as the result of the reduced base construction estimate and the revised PE percentage estimate. The possibility of consultant design is addressed in the risk analysis.

Table 3-2 summarizes the main elements of the Motley Road Crew cost estimate and the final estimate that was established following the workshop review and validation to be used for analysis.

TABLE 3-2 Mountain Highway Summary of Base Cost Estimate
(figures are rounded in current year dollars)

ITEM	**Motley Crew Estimate** November 33, 2009 (pre-workshop) $MILLION	**Reviewed/Validated** December 33, 2009 (estimate for analysis) $MILLION
Estimated Bid Item Sub-Total	**46.9**	**49.0**
Allowances (known but unquantified items est. at 15%)	**0.0**	**2.0**
Contingencies[1]	**22.8**	**1.0**
Construction Engineering[2]	**9.4**	**7.0**
Preliminary Engineering[3]	**11.8**	**6.0**
Right-Of-Way	**19.0**	**19.0**
TOTAL	**110.3**	***84.0***
Figure used as base cost estimate for risk analysis ☞		

[1]MRC assumed 40% contingency –replaced with allowances and risks; 4% contingency is kept per standard MRC practice.
[2]MRC pre-workshop assumed 15% CE; revised at workshop to 12% CE.
[1]MRC pre-workshop assumption was 20% of construction for PE, at the workshop this was revised to 11%. Note: PE includes "other items" (utility reimbursements, environmental mitigation).

sample only

Review and Validation Notes

Overall this project is a relatively standard and straight-forward construction project involving standard construction items. For the purposes of this analysis it is assumed that this will be a "Design-Bid-Build" project. The following major items of works and major cost items were reviewed and discussed during the workshop:

Mobilization and Traffic Control

Mobilization was adjusted to 11% the CEVP workshop and the formula was revised to apply the percentage of total biddable items.

Traffic Control is estimated as a percentage of the itemized construction items at this stage of design development. During the validation process, the CEVP team increased the traffic control percentage to 8% from 7% to reflect the cost of Whitehorse area traffic, the TCS requirement and the inclusion of Railroad flaggers in this item. The offsetting consideration was the fact that most of the new roadway is a new alignment.

Erosion Control

The estimate for erosion control was validated at 2% of the itemized construction items. A higher percentage was discussed but the CEVP team confirmed that the 2% estimate reflected Motley Road Crew experience in this area.

Roadwork

During the course of review it was clarified that the bid item: "Removal of Structures and Obstructions" did not include the demolition for required right-of-way acquisitions.

The estimate for "Clearing and Grubbing" was revised reduced to $2,500 per acres because there only a few trees and shrubs and topsoil will be salvaged for landscaping.

"Embankment In Place" and "Stone Embankment" quantities were revised in the base estimate to reflect 40% of the total as common material and 60% as stone. The revised quantities resulted in revision to the risk items for imported material changes and delays. The unit prices for both items were revised to current unit prices.

Drainage and Sewers

Water quality lump sum estimate includes median filter drains and ponds. The unit prices for the itemized conveyance bid items were adjusted to current unit price history.

Bridges and Structures

Assumptions include: pre-stressed concrete girders on pile foundations (a risk was included in the risk register for the possibility that shafts may be required). The I-2525 overcrossing at 42nd Av assumes 2-lanes with a multi-use path. The estimated quantity

sample only

for the Railroad Bridge is adjusted by the inclusion of additional length in "Other" items. The additional length is included in the base project assumptions; however the project team wanted the quantity separated.

The estimated cost for MSE walls was validated at $60 per square foot of wall face (a reduction from $80/sf); however a separate line item was added to identify the moment slab and barrier on a portion of the MSE walls. The estimated cost of the moment slab and barrier was established at $240 per linear foot.

Wearing Surfaces

During the workshop different grades/higher grades of asphalt were separated in the cost estimate. PG64-22 was estimated at $470/ton and PG70-28 was estimated at $550 per ton. The ½" Dense HMAC was adjusted to $22/ton to reflect current unit prices and the quantity of HMAC.

Permanent Traffic Control and Illumination Systems

There cost estimate for traffic items was provided by the traffic design team. Some members of the CEVP team believe that the estimates may be conservative and that there are some opportunities here for lower costs.

Other

The line item for "HAZMAT" was identified as specifically the replacement and abandonment of 15 existing wells at $10,000 per each.

The estimated cost for 2 acres of wetland mitigation was validated and moved to the PE/Right of Way section since this will be a direct owner cost not a construction contractor cost.

Construction Engineering

The construction engineering estimate was validated at 12.5% to 13% of the construction and 4% contingency total.

Preliminary engineering

As noted above, the basis of the CEVP estimate is Chilcoot Borough self performing the design. The estimate was established at 11% of the estimate bid cost.

Right of Way

The estimated base Right of Way cost includes approximately 30% condemnation or settlement costs. The acquisition cost is based upon current values not county assessments.

A line item was added to account for the airspace right of way needed from the railroad. It was estimate at $1 Million, however could be significantly lower.

Appendix A ATTENDANCE

Sign-In/Attendance sheets are provided in this appendix.

Date	Event
October DD, YYYY	Process Orientation (CRA/CEVP Training)
November DD, YYYY	Prep Session
November DD, YYYY	Advance Elicitation Interviews
MMMMMM DD, YYYY	Workshop

SCAN SIGN-IN SHEET FROM CLASS ATTENDEES

Mountain Highway Project PREP SESSION ATTENDANCE
MMMMMM DD, YYYY
1:00 pm to 4:00 pm

SCAN SIGN-IN SHEET FROM PREP-SESSION ATTENDEES

Mountain Highway Project ADVANCE ELICITATION INTERVIEWS (AEI) ATTENDANCE
MMMMMM DD, YYYY

SCAN SIGN-IN SHEET FROM AEI ATTENDEES

Mountain Highway Project WORKSHOP ATTENDANCE
MMMMMM DD, YYYY

SCAN SIGN-IN SHEET FROM WORKSHOP ATTENDEES

Appendix B

Base Cost Estimate B-2

BASE COST ESTIMATE

BASE COST ESTIMATE

Appendix C - INPUTS

Base input C-2

Risk Breakdown Chart for this project C-3

Risk ID Sheets (21) C-4

Project Title	SAMPLE			Value	Variability	Risk Markups		WSDOT Escalation tables built-in.		
Estimate Date	10/10/09		Target AD date	01/10/14	10%	Mob	10.0%	A/B/A Duration		3Mo
Project PIN #	1234567	The above macro should be activated to generate the final results. Do not stop it if it is running.	Estimated CN Duration	23.0Mo	10%	Tax	8.0%	Non-WSDOT rates		YOE
Last Review Date	12/21/09		Estimated PE Cost	6.00 $M	10%	CE	12.0%	PE	4%	6.5$M
Project Manager	E. Presley		Estimated ROW Cost	19.00 $M	10%	PE	11.0%	ROW	4%	20.7$M
			Estimated CN Cost	59.00 $M	10%	C.O.C	4.0%	CN	4%	72.4$M

Escalation Points		Base Cost Market Conditions		
Define escalation point of the activity cost. For example 50% means that the escalation point for that activity is the mid-point activity. 50% is the default value. If it is decided that the escalation point is at three quarters of respective activity		Better than planned	10%	10%
		Worse than planned	40%	20%
			Probability	Impact
Preconstruction activities (ROW and PE)	**0.8**			
Construction	**0.5**			

Figure C-1 Base Project Information

RISK BREAKDOWN STRUCTURE

Level 1: Project Risk

Level 2	Environmental ENV	Strctures Geotech STG	Design / Roadway / Hydraulics DES	Right-of-Way ROW	Utilities UTL	Railroad RR	Prtnrshp Stkhldrs PSP	Mgmnt / Funding MGT	Cntrcting Prcrmnt CTR	Cnstrctn CNS
	ENV 10 Noise Wall	STG 10 RR Crossing	DES 10 DE-1 Add'l R/W RETIRED	ROW 10 ROW Plan Delay	UTL 10 Utilities	NO	PSP 10 Unknown public opposition emerges RETIRED	NO	NO	CNS 10 Subsurface
	ENV 20 Permitting (superfund) RETIRED	STG 20 Wall Type	DES 20 Design Exceptions	ROW 20 ROW Property Cleanup		RISKS		RISKS	RISKS	CNS 20 CN delays
	ENV 30 Archaeology	STG 30 Fill Type	DES 30 Bike- Ped Path	ROW 30 Real Estate Market		IDENTIFIED		IDENTIFIED	IDENTIFIED	CNS 30 RETIRED
	ENV 40 NEPA Challenge	STG 40 ACME minor	DES 40 Drainage RETIRED	ROW 40 Partial takes turn to full takes						CNS 40 Hazardous materials
		STG 50 ACME major	DES 50 42nd ROW Opportunity (minor)							*CNS 50 Inflation/Deflation capture in mkt conditions*
			DES 60 42nd Design Change Opportunity (major)							
			DES 70 Higher PE Cost							

Active Significant risks by specialty

TTL	ENV	STG	DES	ROW	UTL	RR	PSP	MGT	CTR	CNS
21	3	5	5	4	1	0	0	0	0	3

= Mutally Exclusive = Mutally Inclusive

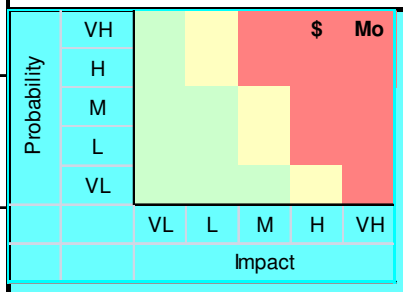
Risk #	Pre-mitigated Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
ROW 10	Active		ROW	Threat	Scheduling is a major risk as Right of Way and Utility relocates are dependent on other units to complete their design work prior to right of way beginning. This can be measured by the slippage in the date R/W and utility design/accommodation can begin their process.	Des Doc Pkg	Cost	95%	MIN	0.00$M
				ROW Plan Delay					MAX	8.00$M
									Most Likely	3.00$M
							0		Master Duration Risk	
							Schedule		MIN	0.0Mo
									MAX	24.0Mo
				Threat					Most Likely	12.0Mo

If there is not enough time to negotiate it can lead to additional condemnations. Leading to additional acquisition costs (court costs and fees to property owners). Possible additional relocation costs.

IF Design Documentation Pkg slips at all the ROW critical path slips. (includes Design Exceptions for Geometric Design may impact R/W if not approved).

POTENTIAL RESPONSE ACTIONS: Research the possibilty of advance acquisition for corridor preservation. Convene a property owners forum to explain the project and identify willing sellers. Accelerate schedule for Des Doc, ROW plans and ROW acquisition.

Risk Matrix



RISK 1 in the model:

This risk is <u>Mutually Inclusive</u> with DES 20 and DES 30

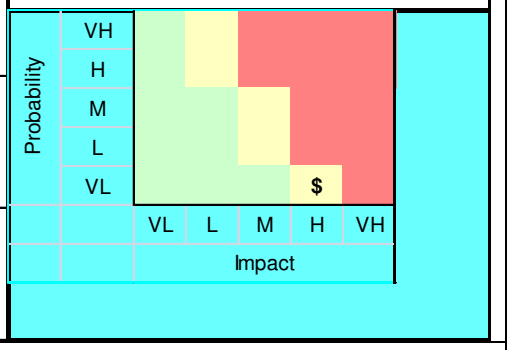
Pre-mitigated										
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
DES 20	Active	DEP-INCL	Construction	Threat	Design exception required for reduced spirals, horizontal curves, and super transitions, shoulder width on the new mainline at the west transition to existing structure. There is a risk that the Design Exceptions will not be approved.	DE is reviewed and denied by Region and Tech Services	Cost	10%	MIN	0.50$M
				Design Exceptions					MAX	4.00$M
									Most Likely	2.00$M
							###		0	
							Schedule		MIN	
									MAX	
									Most Likely	

Roadway width, structure locations, structure dimensions, would impact design and construction costs.

Most Likely impact assumes additional shoulder width or alignment change and Maximum assumes both. This risk is related to ROW changes driven by Design Exceptions.

MUTUALLY INCLUSIVE WITH ROW-10.1 (Schedule Design Changes)

Risk Matrix



RISK 2 in the model:

This risk is <u>Mutually Inclusive</u> with Risk 1 in the model, ROW 10.

Pre-mitigated										
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
DES 30	Active	DEP-INCL	Construction	Threat	Existing alternative does not provide for full bike/ped circulation along the proposed facility. It is assumed that the existing sidewalks along Capitol Industrial area and bike shoulders on the new mainline facility provide a sufficient network. Building a multiuse path would result in additional ROW, costs, and additional structure width to facilitate the multiuse path.	Challenge to Scope	Cost	15%	MIN	4.00$M
									MAX	10.00$M
									Most Likely	6.00$M
				Bike-Ped			0		Master Duration Risk	
							Schedule		MIN	
									MAX	
									Most Likely	

The max estimated impact for the multi-use path assumes additional structure over the RR xing; additional R/W costs and the path itself.

Added costst may include 2 miles of new multi-use path and additional structure wideth over RR $4-6M. Also chance for additional costs across I-2525, could lead to another structure and additional mile of multi-use path, $4-6M.

MUTUALLY INCLUSIVE WITH ROW-10 (Schedule Design Changes)
POTENTIAL RESPONSE STRATEGIES INCLUDE: Early engagement with bike communities.

Risk Matrix

Probability	VL	L	M	H	VH
VH					
H					
M					
L					
VL					$

Impact

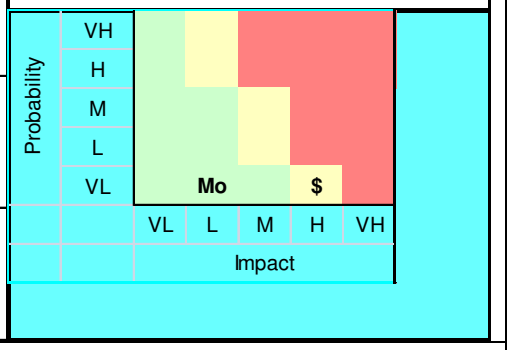
RISK 3 in the model:

This risk is <u>Mutually Inclusive</u> with Risk 1 in the model, ROW 10 .

Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
ROW 20	Active		ROW	Threat	There may be items that we are required to cleanup and/or move that are not apparent in buildings that will not be discovered until we actually begin acquisition; also includes utility easements.	Discovery during property investigations	Cost	15%	MIN	0.00$M
				ROW cleanup					MAX	4.00$M
									Most Likely	2.00$M
							###		0	
							Schedule		MIN	0.0Mo
									MAX	12.0Mo
				Threat					Most Likely	2.0Mo

Risk Matrix



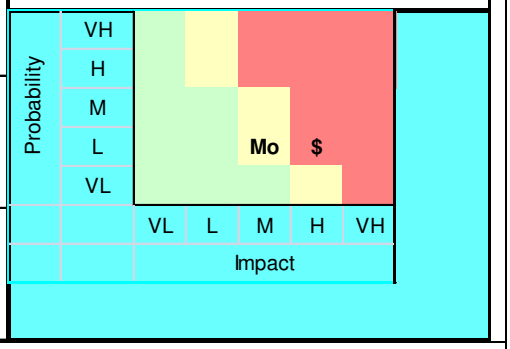
RISK 4 in the model:

This risk is independent.

Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
ROW 30	Active		ROW	Threat	Property costs may increase markedly before and during the project with right of way costs increasing significantly. New construction between now and initiation of acquisition can significantly increase property costs. Demolition costs can escalate depending on a number of items such as materials used in costruction (asbestos, et al) may require disposal in special land fills at increased costs. Rail Roads are Federally controlled and have special requirements. Rail Road properties can take additional time and money to acquire. During construction additional requirements will be made.		Cost	30%	MIN	0.00$M
				Real Estate Market					MAX	9.00$M
									Most Likely	2.00$M
							0		Master Duration Risk	
							Schedule		MIN	1.0Mo
									MAX	12.0Mo
				Threat					Most Likely	4.0Mo

Risk Matrix



RISK 5 in the model:

This risk is independent.

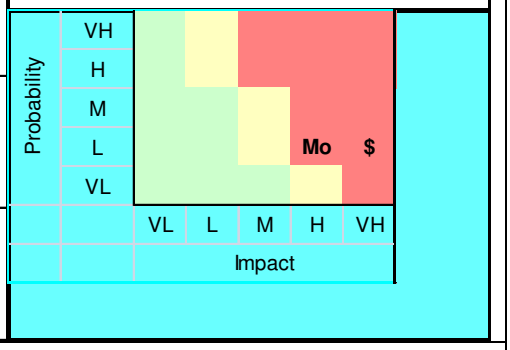
Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
ROW 40	Active		ROW	Threat	A property owner may request we aquire the entire property. Additionally, a design change or additional information may result in an entire acquisition. The cost estimate used here is potential additional costs.	Design Change or Property owners request.	Cost	25%	MIN	0.00$M
									MAX	28.00$M
									Most Likely	6.00$M
				Partial takes turn to full take			###		0	
							Schedule		MIN	0.0Mo
									MAX	12.0Mo
				Threat					Most Likely	6.0Mo

several major industrial businesses

POTENTIAL RESPONSE ACTIONS: Modify design to minimize/avoid impacts to subject properties (esp. Gamma and Beta).

Risk Matrix



RISK 6 in the model:

This risk is independent.

	Pre-mitigated									
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
DES 50	Active		ROW	Opportunity	(1) Modify 42nd Drive to avoid imipacting Gemtop buidling. Creating a 90 degree intersection between the new overcrossing and 42nd drive.	Exec decision made prior to DAP; base design exceeds budget	Cost	20%	MIN	1.00$M
				42nd ROW					MAX	3.00$M
									Most Likely	2.00$M
							0		Master Duration Risk	
							Schedule		MIN	
									MAX	
									Most Likely	

ROW impacts to building on the Gamma property could be minimized if 42nd alignment is modified to reduce ROW impacts; requires some design exceptions. Potential threat to the schedule depending on if the ROW aquisition is delayed until a later stage to entertain this option.

Anticipated ROW savings $1M, roadway savings $1M (most likely).

MUTUALLY EXCLUSIVE WITH MODIFY 42nd (2)
(75% BASE; 20% 42nd (1); 5% 82nd (2))

Risk Matrix

Probability	VL	L	M	H	VH
VH					
H					
M					
L				$	
VL					

Impact

RISK 7 in the model:

This risk is <u>Mutually Exclusive</u> with Risk 8 in the model, DES 60.

	Pre-mitigated									
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
DES 60	Active	DEP-EXCL	Construction	Opportunity	(2) Opportunity to modify connection between Capitol and 42nd Dr. This would defer the construction of the 42nd Dr overcrossing and assumed ROW impacts	Base design exceeds budget	Cost	6%	MIN	10.00$M
									MAX	20.00$M
				42nd change					Most Likely	12.00$M
							###		0	
							Schedule		MIN	
									MAX	
									Most Likely	

Defers construction of 42nd overcrossing of I-2525 and defers associated Roadway work on 42nd Av. Saves $ now but reduces opearatinal benefits until overcrossing can be constructed.

Most Likely costs deferred to later phases; $8 M+ in structures (this assumes building new ped structure) $3-5M in roadway and additional savings in R/W and other areas. Costs dependent on how Capitol and 42nd Drive would be configured.

MUTUALLY EXCLUSIVE WITH MODIFY 42nd (1)
(75% BASE; 20% 42nd (1); 5% 42nd (2)) THIS EVENT WOULD LIKELY OCCUR IF FUNDING BECAME INSUFFICIENT.

Risk Matrix

Probability	VL	L	M	H	VH
VH					
H					
M					
L					
VL					$

Impact

RISK 8 in the model:

This risk is <u>Mutually Exclusive</u> with Risk 7 in the model, DES 50.

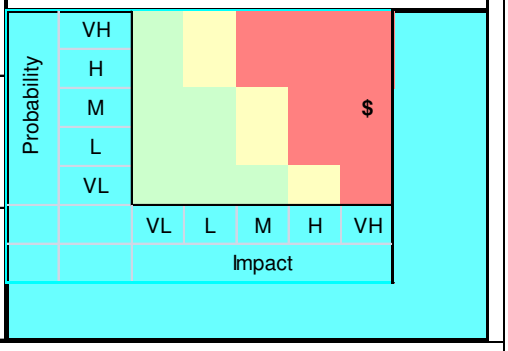
Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
DES 70	Active		Pre-construction	Threat	Base Estimate assumes 11% PE costs however can range from 15%-20% if fully outsourced (resulting in a net increase of up to 100% additional PE costs).	Exec resourcin g decision	Cost	50%	MIN	2.00$M
									MAX	6.00$M
				Higher PE					Most Likely	4.00$M
							0		Master Duration Risk	
							Schedule		MIN	
									MAX	
									Most Likely	

This is based off an assumed $59M in construction costs.

There is a possiblity that outsourcing may cause delays to project initiation however the work schedule may be compressed due to additional staff.

Risk Matrix



RISK 9 in the model:

This risk is independent.

	Pre-mitigated									
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
CNS 10	Active		Construction	Threat	During construction unanticipated subsurface stability issues are encountered and were not accounted for in the design or addressed by the contract documents. This risk may be influenced by bid date.	discovery during construction	Cost	40%	MIN	1.00$M
									MAX	2.00$M
									Most Likely	1.20$M
				Subsurface			###		0	
							Schedule		MIN	
									MAX	
									Most Likely	

Risk Matrix

Probability						
VH						
H						
M				$		
L						
VL						
		VL	L	M	H	VH
		Impact				

RISK 10 in the model:

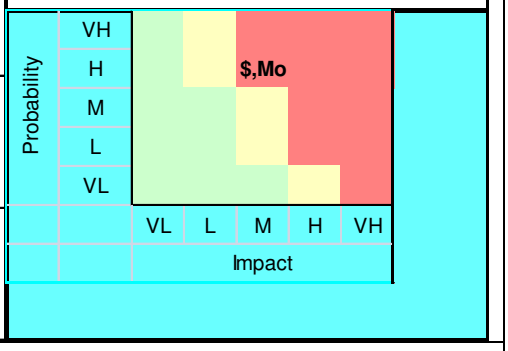
This risk is independent.

Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
CNS 20	Active		Construction	Threat	Results from indirect impacts caused by various "unreasonable delays" that could occur. Some delays can cause other additional delays leading to significant time impacts, such as a contractor losing a field season; subcontractor; supply source; etc. This risk is on top of normal impacts associated with delays, i.e. home and field office overhead, equipment standby, inefficiencies, etc.	miss milestone emerging schedule challenge	Cost	75%	MIN	0.00$M
				CN delays					MAX	2.00$M
									Most Likely	1.00$M
							0		Master Duration Risk	
							Schedule		MIN	2.0Mo
									MAX	10.0Mo
				Threat					Most Likely	5.0Mo

Could RR delays, utilities, unforeseen site conditions, weather, design during construction, etc.

Risk Matrix



RISK 11 in the model:

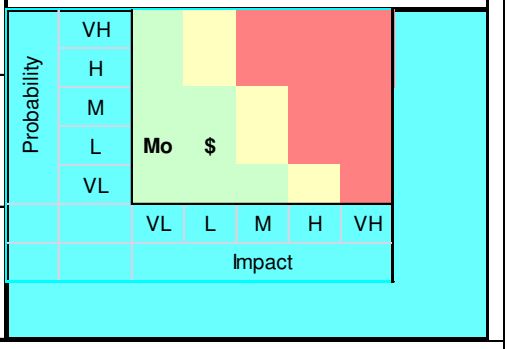
This risk is independent.

Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
CNS 40	Active		Construction	Threat	Subsurface contaminants (not discovered during pre-construction investigations); the designated route crosses industrial lands and retired landfill. There may be undiscovered storage tanks, undisclosed hydrocarbons, or other surprises.	discovery during construction	Cost	20%	MIN	0.00$M
				Hazardous materials					MAX	2.00$M
									Most Likely	0.50$M
							###		0	
							Schedule		MIN	1.0Mo
									MAX	4.0Mo
				Threat					Most Likely	2.0Mo

Areas of most concern are near the old landfill.

Risk Matrix



RISK 12 in the model:

This risk is independent.

Pre-mitigated										
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
ENV 10	Active		Construction	Threat	Early noise wall analysis indicates a wall will likely be required near Capitol (by the school) up to 1200 feet or more (average height 10 feet). Will require additional R/W.	Sound Analysis	Cost	30%	MIN	0.75$M
				Noise wall					MAX	3.00$M
									Most Likely	1.00$M
							0		Master Duration Risk	
							Schedule		MIN	
									MAX	
									Most Likely	

Risk Matrix

Probability	VH	H	M	L	VL
				$	

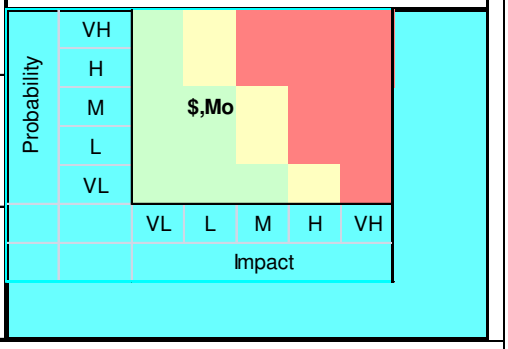
	VL	L	M	H	VH
Impact					

RISK 13 in the model:

This risk is independent.

	Pre-mitigated									
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
ENV 30	Active		Construction	Threat	Discovery of an archaeological resource during construction. Artifacts exposed during grading within ROW. HISTORIC: Potential impacts on cultural or historic properties identified during environmental review could result in the need for additional documentation and/or mitigation measures. Could affect Section 106 review process.	discovery during construction	Cost	50%	MIN	0.25$M
				Archeological					MAX	1.00$M
									Most Likely	0.50$M
							###	Positive correlation	0	
							Schedule		MIN	1.0Mo
									MAX	3.0Mo
				Threat					Most Likely	2.0Mo

Risk Matrix



RISK 14 in the model:

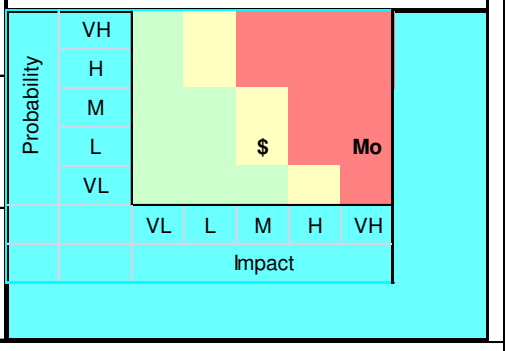
This risk is independent.

Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
ENV 40	Active		Pre-construction	Threat	This is a complex project that has been under study for 20 years. Neighbors have specific concerns noise. There are opponents in the region to construction of any major new infrastructure projects	ROD and Review	Cost	25%	MIN	0.50$M
									MAX	2.00$M
									Most Likely	1.00$M
				NEPA challenge			0		Master Duration Risk	
							Schedule		MIN	6.0Mo
									MAX	24.0Mo
				Threat					Most Likely	12.0Mo

Additional costs due to staff time and legal fees.

Risk Matrix

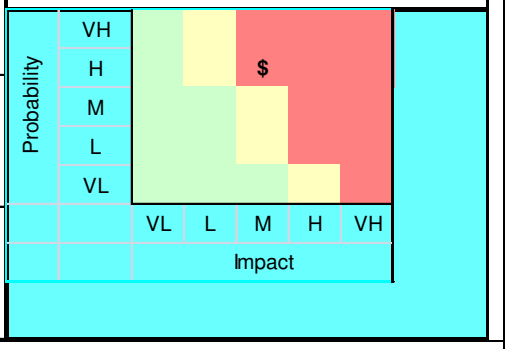


RISK 15 in the model:

This risk is independent.

	Pre-mitigated									
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
STG 10	Active		Construction	Threat	Risk includes foundation and/or alignment concerns. Foundation, piles for the I-2525 are likely however at the RR crossing we may need to go to shafts. Assumes bridge cost increase could be approximately 10% to 20% over base cost. RR - without having hard data regarding the alignment design - greater skew = greater bridge length - cannot violate RR clearance requirements. The foundation controls the lateral clearance.	R/W and utility conflicts - and sub-surface conditions .	Cost	75%	MIN	0.25$M
				RR crossing					MAX	2.50$M
									Most Likely	1.00$M
							###		0	
							Schedule		MIN	
									MAX	
									Most Likely	

Risk Matrix



RISK 16 in the model:

This risk is independent.

	Pre-mitigated									
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
STG 20	Active		Construction	Threat	Assumed wall for the base is fill walls and MSE; however there is a risk that could have to go to a wall with a smaller footprint (such as cantilever or soldier pile - tie back);	sub-surface conditions; ROW; topography; utilities.	Cost	50%	MIN	0.80$M
				Wall type					MAX	1.20$M
									Most Likely	1.00$M
							0		Master Duration Risk	
							Schedule		MIN	
									MAX	
									Most Likely	

Risk Matrix

Probability						
VH						
H						
M				$		
L						
VL						
		VL	L	M	H	VH
		Impact				

RISK 17 in the model:

This risk is independent.

Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
STG 40	Active		Construction	Threat	The need to accommodate ACME access to the facility - requires structure; may affect local street access for movement between facilities. Assumes bridge dimensions of 120' X 40' to 160' X 60'. May require adjustment to mainline profile to accommodate verticall clearance requirements.	ACME agreement with city and need for access	Cost	30%	MIN	0.50$M
				ACME minor					MAX	4.00$M
									Most Likely	1.00$M
							###		0	
							Schedule		MIN	
									MAX	
									Most Likely	

Bridge and frame structure to allow movement to other portions of property.

THIS WILL BECOME TWO MUTUALLY EXCLUSIVE RISKS (50% base/40% minor/10% major)

Risk Matrix

Probability	VL	L	M	H	VH
VH					
H					
M			$		
L					
VL					

Impact

RISK 18 in the model:

This risk is <u>Mutually Exclusive</u> with risk 19, STG 50.

Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
STG 50	Active	DEP-EXCL	Construction	Threat	The need to accommodate ACME access to the facility - will require modified structure and significant realignment of road for the project. Additional retaining wall and structure to accommodate the ACME rail spur - potential R/W impacts and reduced operating speed.	ACME agreement with city and need for access	Cost	20%	MIN	6.00$M
									MAX	8.00$M
				ACME major					Most Likely	7.00$M
							0		Master Duration Risk	
							Schedule		MIN	
									MAX	
									Most Likely	

Larger portion of mainline would not match future buildout.

Roadway Costs $2-3 M; Rail spur structure $1M; Retaining walls along Industrial Way and/or test track $2-4M;

THIS WILL BECOME TWO MUTUALLY EXCLUSIVE RISKS (50% base/40% minor/10% major)

Risk Matrix

Probability	VL	L	M	H	VH
VH					
H					
M					
L					$
VL					

Impact

RISK 19 in the model:

This risk is <u>Mutually Exclusive</u> with risk 18, STG 40.

	Pre-mitigated									
Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
STG 30	Active		Construction	Threat	Base assumes 40% offsite borrow material - some risk this quantity may have to go to granular backfill.	Time of year; construction season an schedule	Cost	25%	MIN	0.50$M
									MAX	1.50$M
									Most Likely	1.00$M
				Fill type			###		0	
							Schedule		MIN	
									MAX	
									Most Likely	

Sub-surface conditions causing long-term settlement - requiring pre-loading and affect timing of work; west end of the project.

Using all stone embankment reduces/avoids potential construction delays to embankment/earthwork. Overall quantity of fill materials may be reduced by using all stone embankment (because of smaller footprint).

Risk Matrix

Probability	VL	L	M	H	VH
VH					
H					
M					
L			$		
VL					

Impact

RISK 20 in the model:

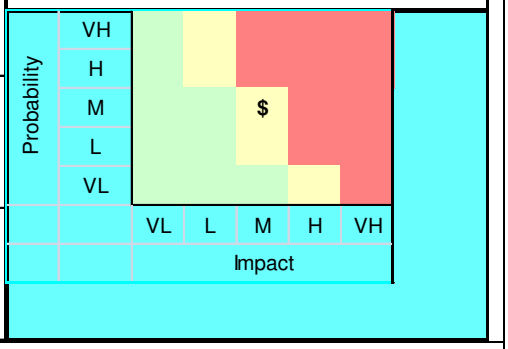
This risk is independent.

Pre-mitigated

Risk #	Status	Dependency	Project Phase	Summary Description Threat and/or Opportunity	Detailed Description of Risk Event (Specific, Measurable, Attributable, Relevant, Timebound) [SMART]	Risk Trigger	Type	Probability Correlation	Risk Impact ($M or Mo)	
(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)	[10a]	(11)
UTL 10	Active		Pre-construction	Threat	Utility impacts association with the project cannot be quantified until discovery by utility locates. ROW documentation and specific utility design conflicts. High likelihood that Utility Relocation phase will be triggered by hidden utility relocation.	unknown utilities discovered	Cost	50%	MIN	0.00$M
				Utilities					MAX	5.00$M
									Most Likely	1.00$M
							0		Master Duration Risk	
							Schedule		MIN	
									MAX	
									Most Likely	

Primary areas of concern include: cable hub and/or associated fiber-optic conduits (associated with MSE walls at the RR structure). General risk due to lack of information about utilities in the corridor.

Risk Matrix



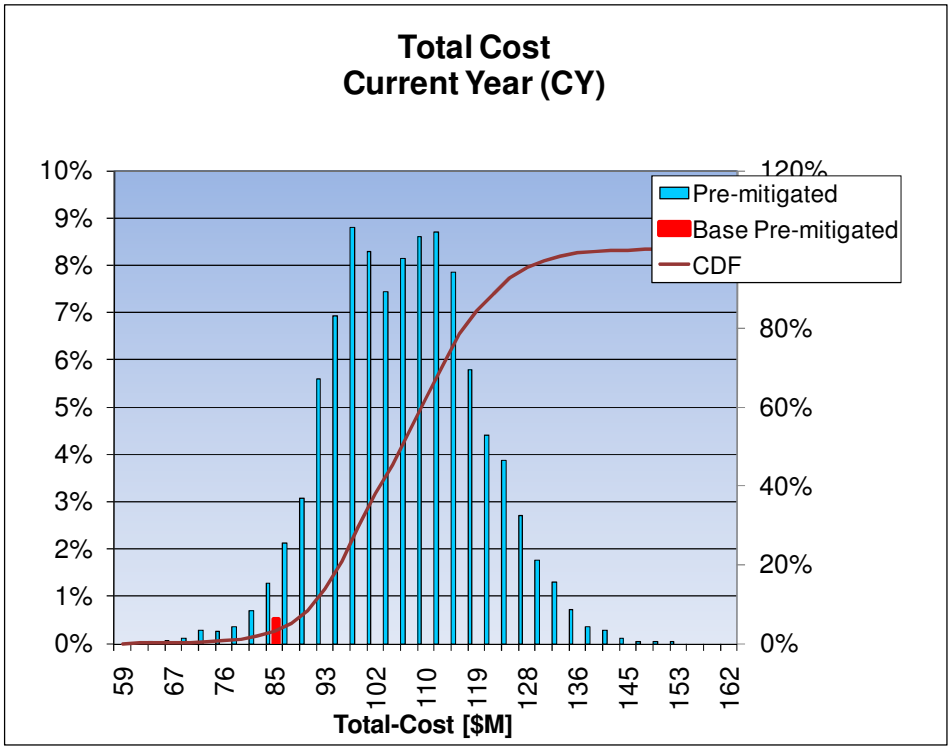
RISK 21 in the model:

This risk is independent.

Appendix D

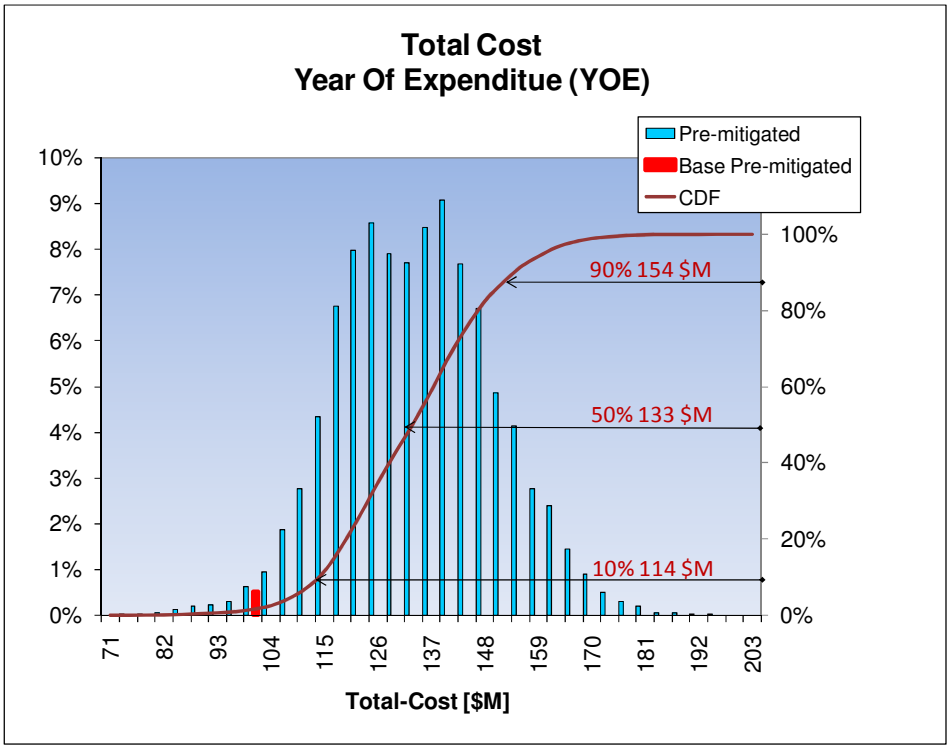
Model outputs (cy and yoe) D-2

Risk Management Plan Spreadsheet D-10



Total Base Estimate (CY) Pre-mitigated 84.00 $M	
Statistics	**Pre-mitigated**
Min	58.91 $M
Max	153.14 $M
Median	106.36 $M
10%	91.37 $M
20%	95.76 $M
30%	99.09 $M
40%	102.69 $M
50%	106.36 $M
60%	109.65 $M
70%	112.93 $M
80%	116.80 $M
90%	122.59 $M

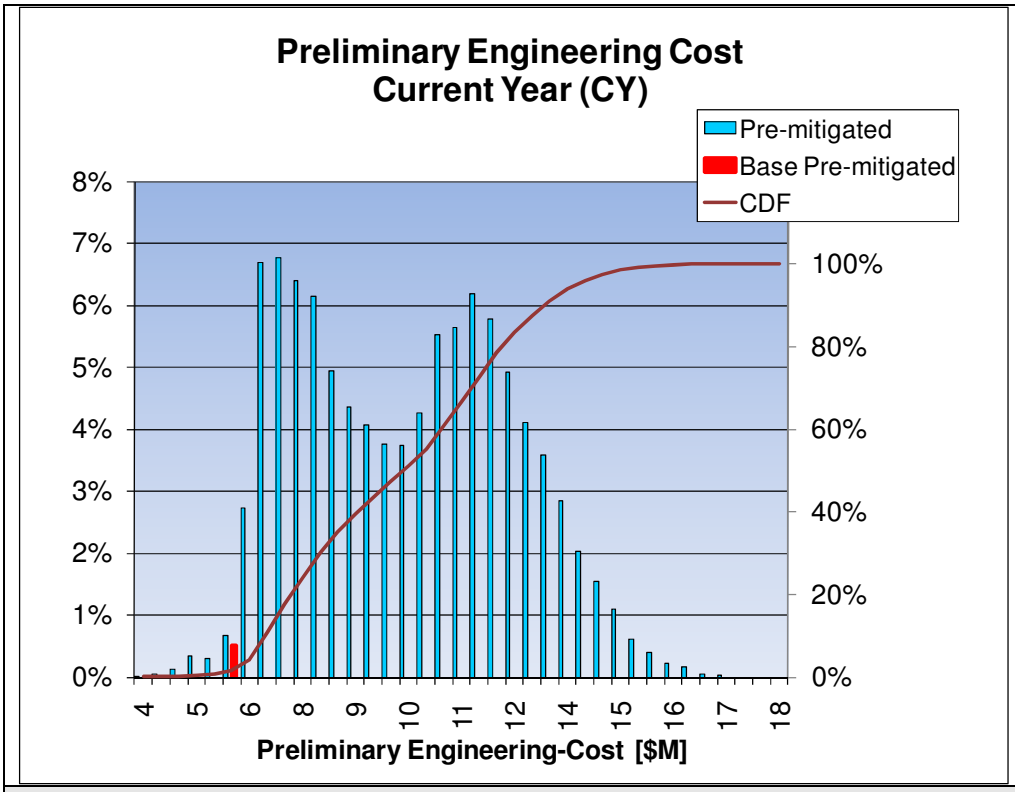
(a) Total Project Cost Range - Current Year $ (CY) December 2009



TOTAL BASE ESTIMATE (YOE) Pre-mitigated 99.6 $M	
Statistics	**Pre-mitigated**
Min	71.20 $M
Max	192.03 $M
Median	133.25 $M
10%	113.98 $M
20%	119.59 $M
30%	124.03 $M
40%	128.50 $M
50%	133.25 $M
60%	137.57 $M
70%	141.69 $M
80%	146.73 $M
90%	154.07 $M

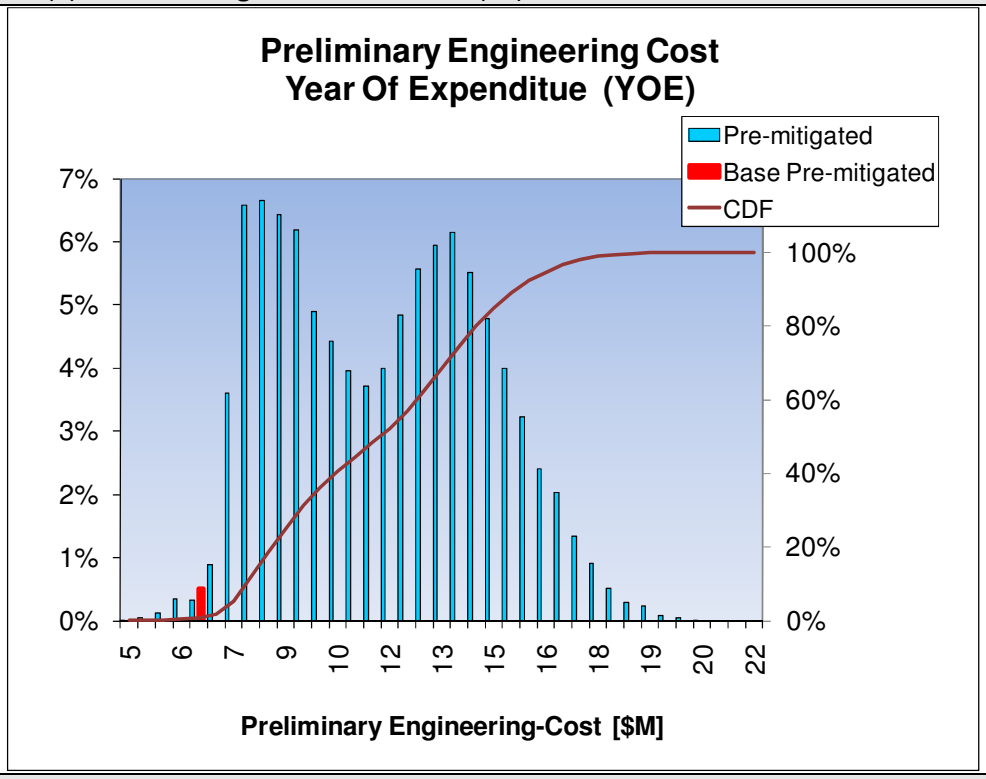
Total Project Cost Range - Year-Of-Expenditure $ (YOE)

Figure D-1 (a) and (b) Total Project Cost Probability Distributions (CY and YOE)



PE Base Estimate (CY) Pre-mitigated 6.00 $M	
Statistics	**Pre-mitigated**
Min	3.88 $M
Max	17.06 $M
Median	9.80 $M
10%	6.66 $M
20%	7.26 $M
30%	7.88 $M
40%	8.75 $M
50%	9.80 $M
60%	10.65 $M
70%	11.34 $M
80%	12.02 $M
90%	12.98 $M

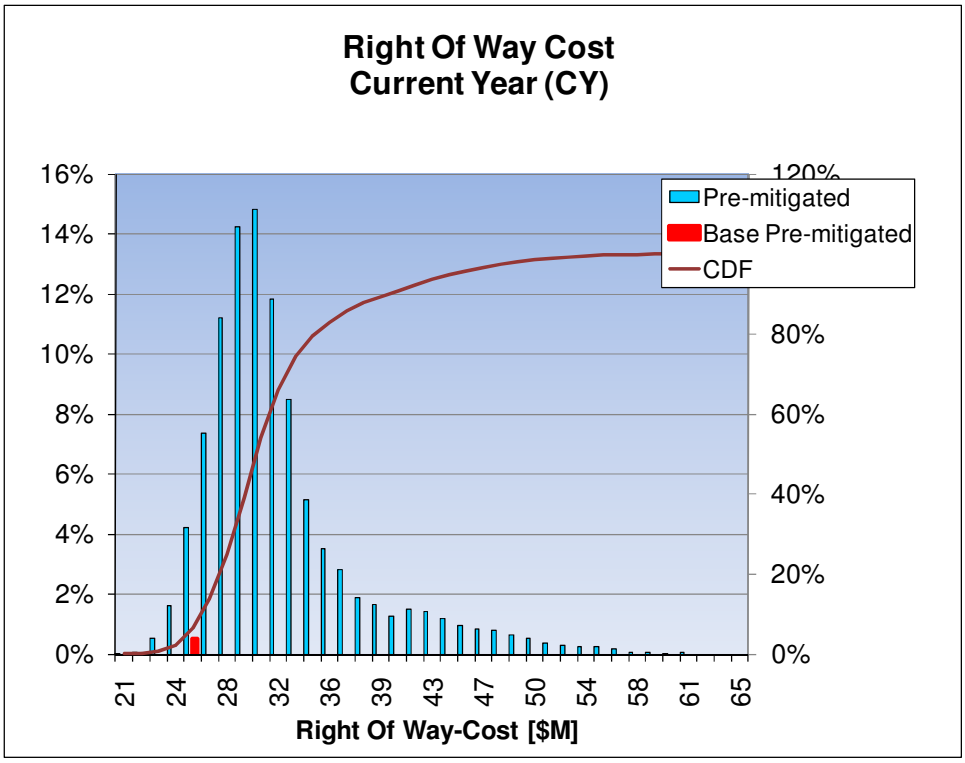
(a) **PE Cost Range - Current Year $** (CY) December 2009



PE Base Estimate (YOE) Pre-mitigated 6.52 $M	
Statistics	**Pre-mitigated**
Min	4.60 $M
Max	20.39 $M
Median	11.54 $M
10%	7.82 $M
20%	8.54 $M
30%	9.29 $M
40%	10.30 $M
50%	11.54 $M
60%	12.54 $M
70%	13.35 $M
80%	14.18 $M
90%	15.33 $M

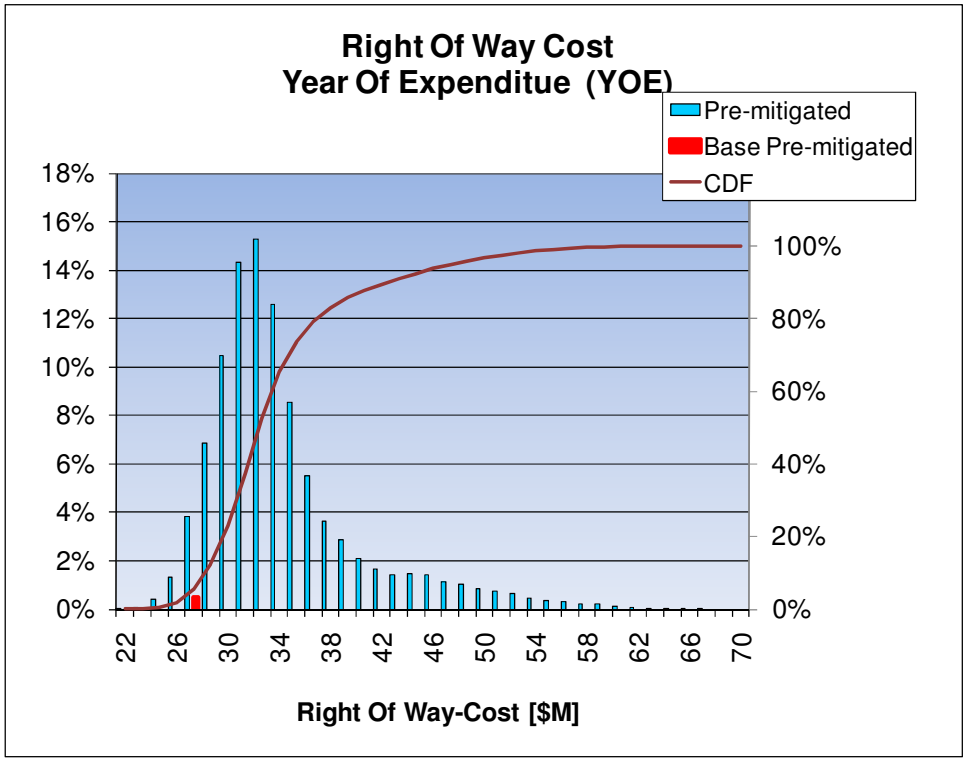
(b) **PE Cost Range - Year-Of-Expenditure $** (YOE)

Figure D-2 (a) and (b) **PE** Cost Probability Distributions (CY and YOE)



ROW Base Estimate (CY) Pre-mitigated 19.00 $M	
Statistics	**Pre-mitigated**
Min	15.46 $M
Max	52.39 $M
Median	23.74 $M
10%	20.11 $M
20%	21.22 $M
30%	22.12 $M
40%	22.95 $M
50%	23.74 $M
60%	24.70 $M
70%	26.03 $M
80%	28.25 $M
90%	32.44 $M

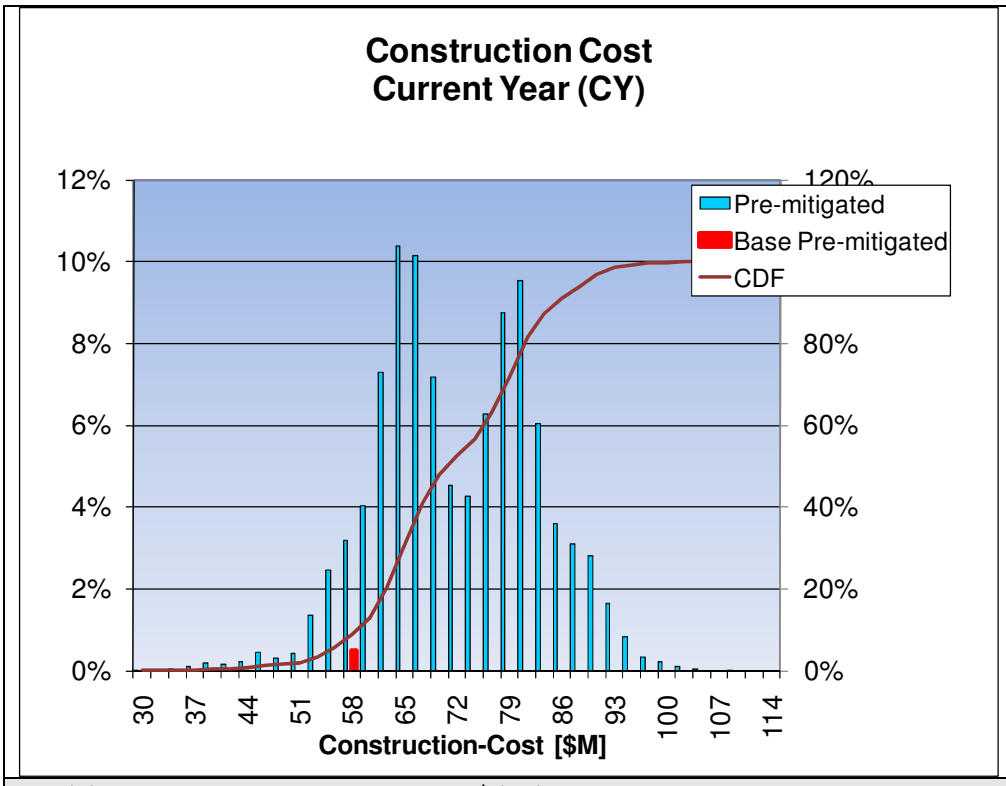
(a) **RW Cost Range - Current Year $** (CY) December 2009



ROW Base Estimate (YOE) Pre-mitigated 20.65 $M	
Statistics	**Pre-mitigated**
Min	17.80 $M
Max	61.61 $M
Median	28.03 $M
10%	23.65 $M
20%	25.01 $M
30%	26.07 $M
40%	27.04 $M
50%	28.03 $M
60%	29.12 $M
70%	30.70 $M
80%	33.35 $M
90%	38.25 $M

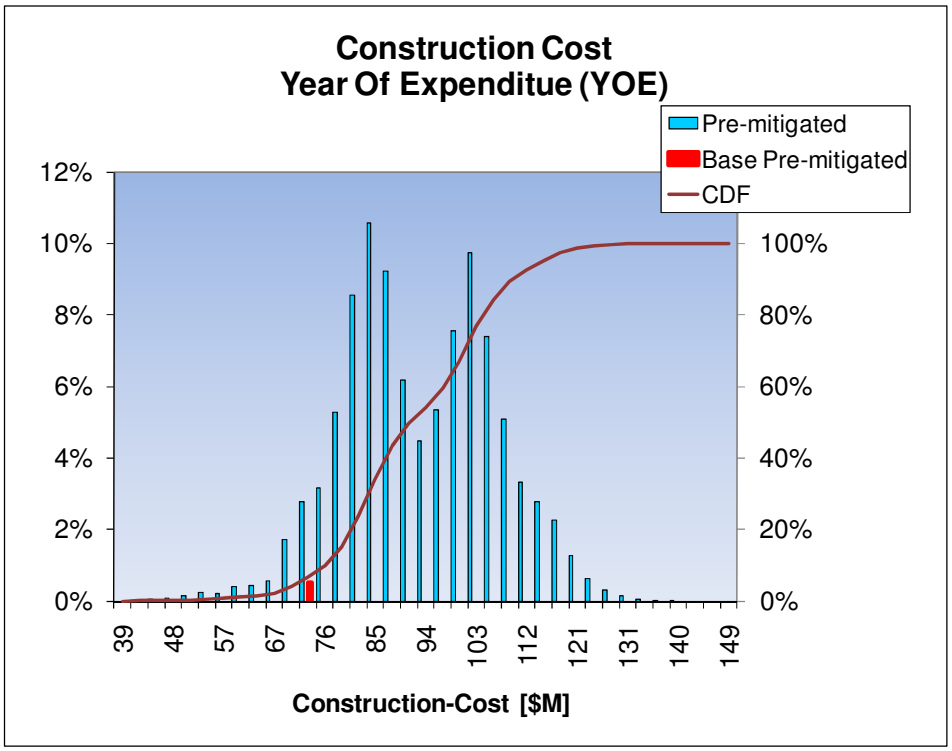
(b) **RW Cost Range - Year-Of-Expenditure $** (YOE)

Figure D-3 (a) and (b) Total Project Cost Probability Distributions (CY and YOE)



CN Base Estimate (CY) Pre-mitigated 59.00 $M	
Statistics	**Pre-mitigated**
Min	30.37 $M
Max	106.71 $M
Median	70.53 $M
10%	58.89 $M
20%	62.67 $M
30%	64.92 $M
40%	67.12 $M
50%	70.53 $M
60%	75.71 $M
70%	78.49 $M
80%	80.85 $M
90%	85.11 $M

(a) **CN** Cost Range - Current Year $ (CY) December 2009



CN Base Estimate (YOE) Pre-mitigated 72.39 $M	
Statistics	**Pre-mitigated**
Min	39.12 $M
Max	139.72 $M
Median	91.18 $M
10%	75.80 $M
20%	80.58 $M
30%	83.66 $M
40%	86.71 $M
50%	91.18 $M
60%	97.32 $M
70%	101.01 $M
80%	104.38 $M
90%	109.86 $M

(b) **CN** Cost Range - Year-Of-Expenditure $ (YOE)

Figure D-4 (a) and (b) **RW** Cost Probability Distributions (CY and YOE)

Figure D-5 depicts a “heat map” of significant risks. This graphic clearly conveys the top prospects for risk response actions in the red area. As you move away from the center of the map and out of the red area additional prospects for risk management are shown with the relative potential for benefitting the project.

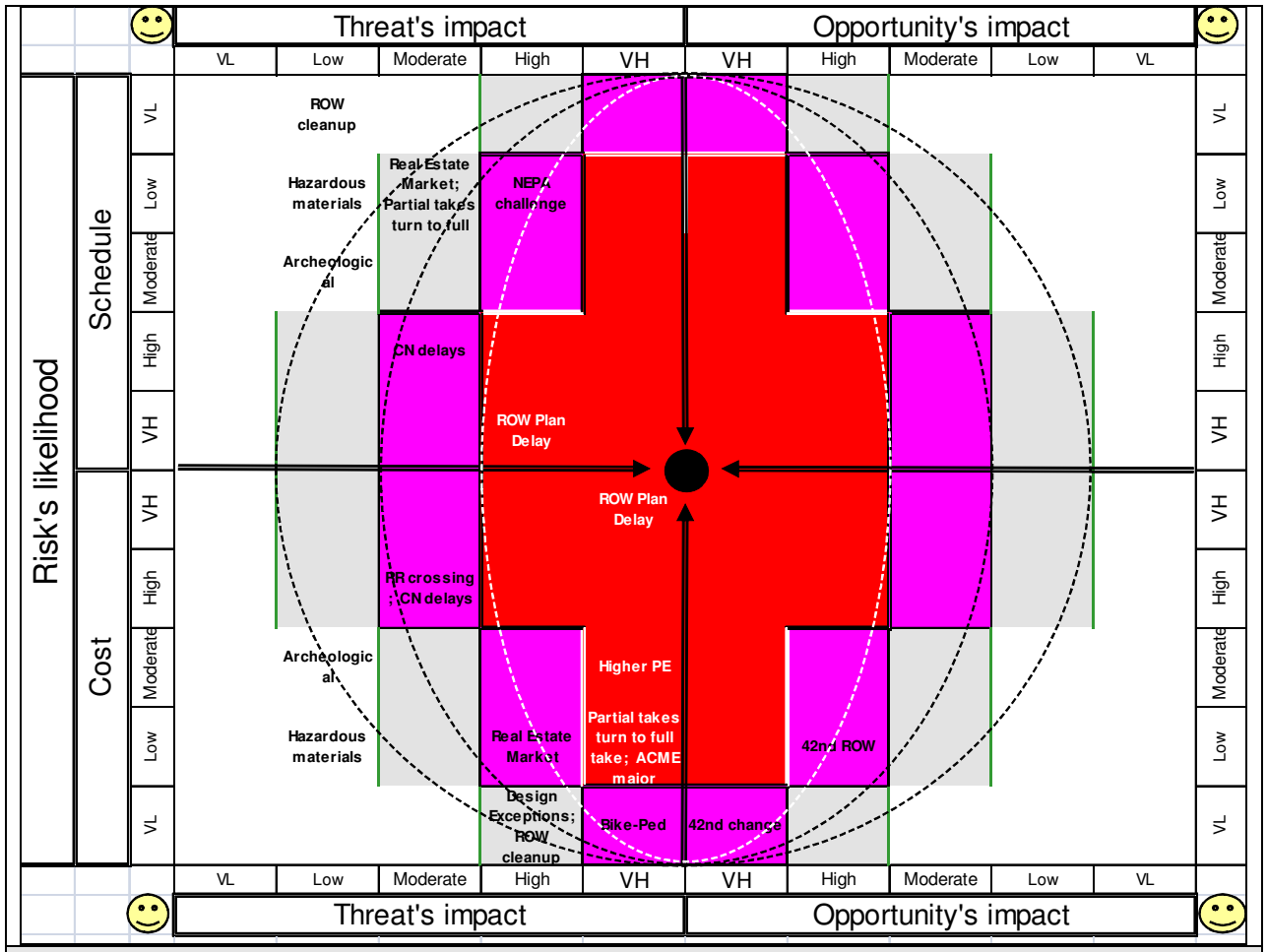


Figure D-5 Risk Map of Significant Risks

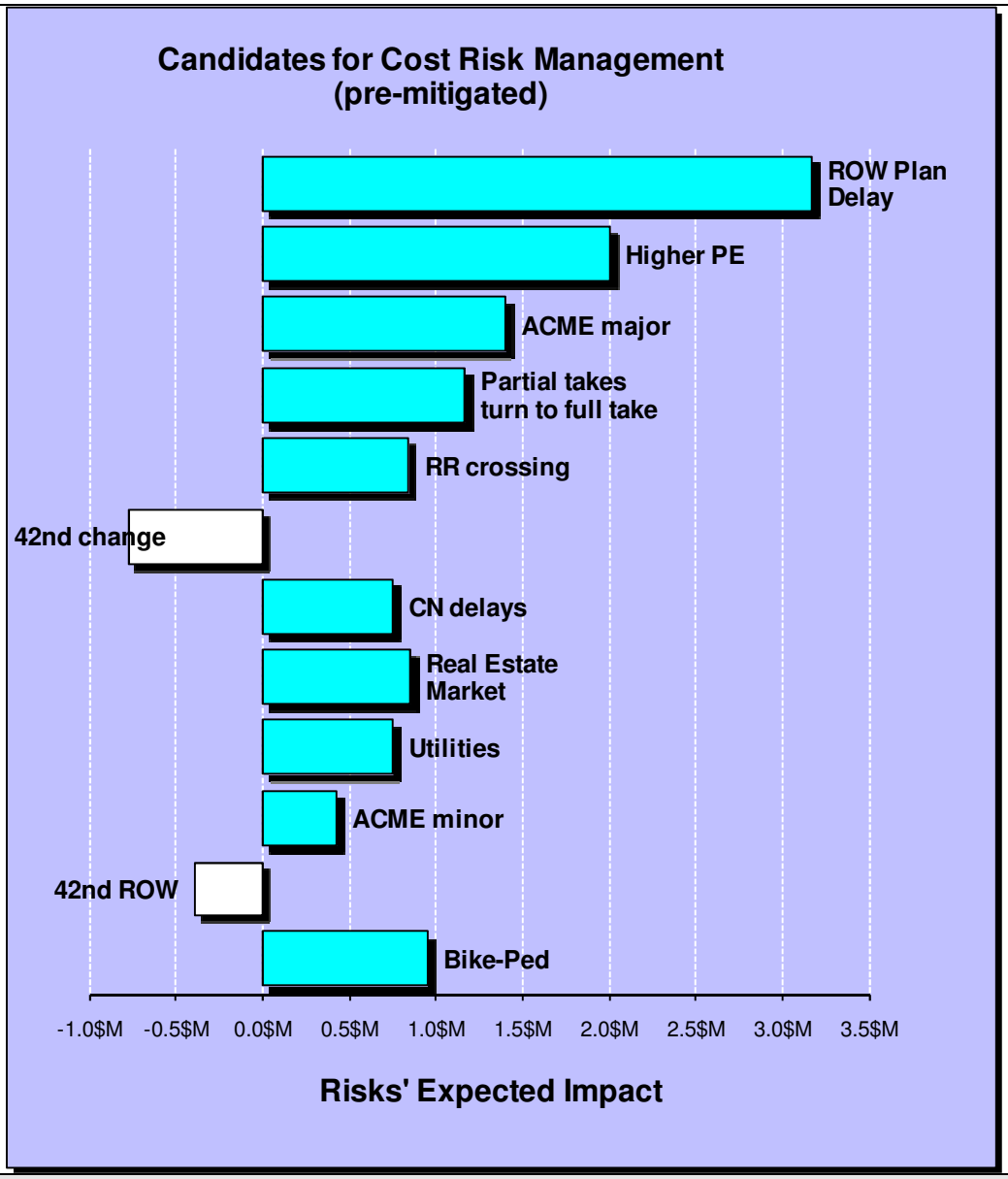


Figure D-6 Tornado Diagram of Significant **Cost** Risks

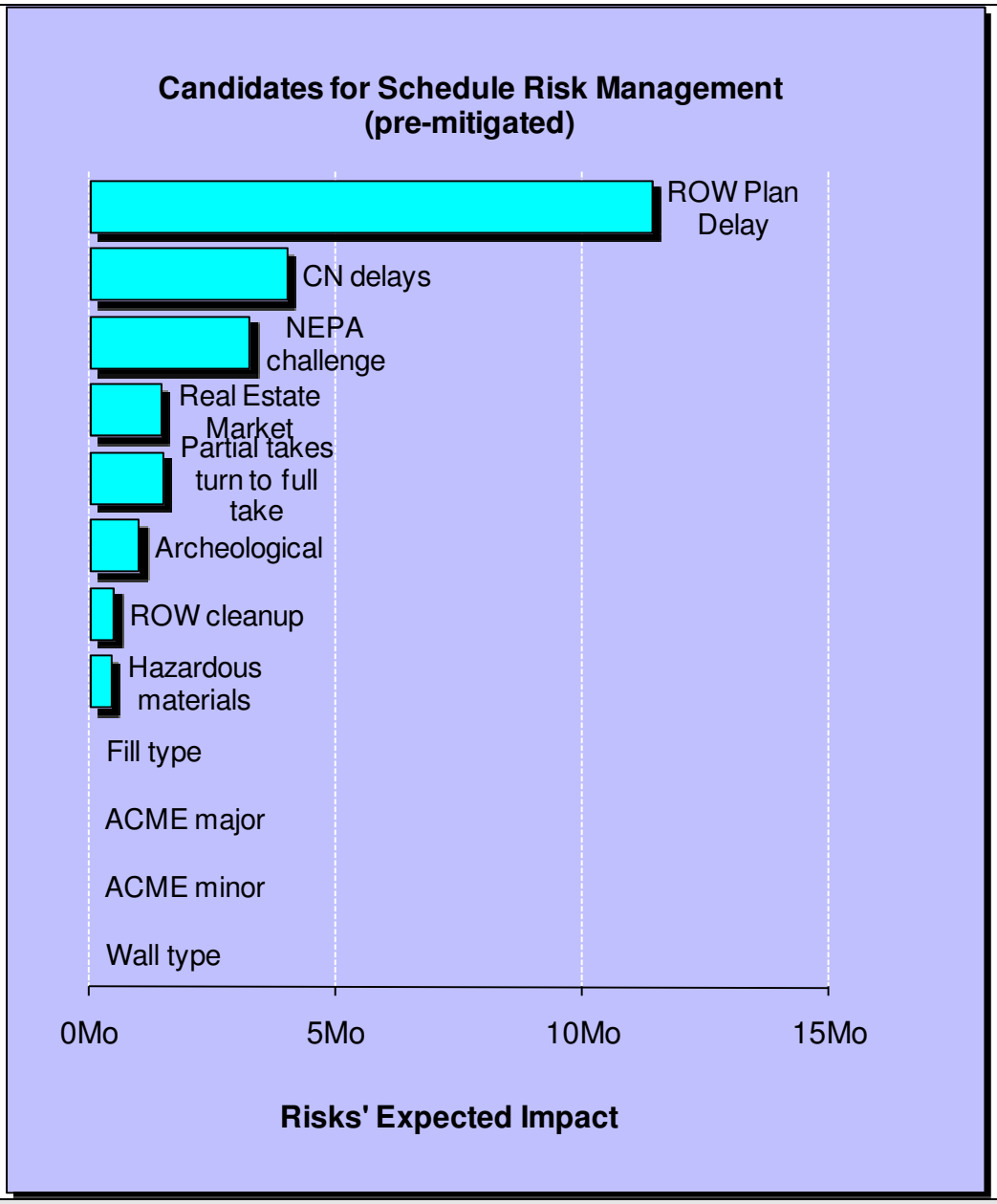


Figure D-6 Tornado Diagram of Significant **Schedule** Risks

Project Title	SAMPLE			Value	Variability	Risk Markups		WSDOT Escalation tables built-in.			%	Total Cost CY [$M]	Total Cost YOE [$M]	Escalation rates update	Ad Date	®	End Construction date	WSDOT Ovidiu Cretu 360-705-7599
Est. Date	10/10/09	Click It when ready	Target AD date	01/10/14	10%	Mob	10.0%	A/B/A Duration	3Mo		50	106.36	133.25		December 31, 2014	50%	June 28, 2017	
Project PIN #			Estimated CN Duration	23.0Mo	10%	Tax	8.0%	on-WSDOT rat	YOE		60	109.65	137.57		February 11, 2015	60%	August 12, 2017	
Last Review Date		The above macro should be activated to generate the final results. Do not stop it if it is running.	Estimated PE Cost	6.00 $M	10%	CE	12.0%	PE	4%	6.5$M	70	112.93	141.69		March 28, 2015	70%	September 26, 2017	
Project Manager			Estimated ROW Cost	19.00 $M	10%	PE	11.0%	ROW	4%	20.7$M	80	116.80	146.73		May 21, 2015	80%	November 22, 2017	
			Estimated CN Cost	59.00 $M	10%	C.O.C	4.0%	CN	4%	72.4$M	90	122.59	154.07		July 24, 2015	90%	February 3, 2018	

	Risk Identification						Quantitative Analysis							Qualitative Display of the Best Guess Impact			Risk Response Plan	Monitoring and Control	Critical Issue
1	Active		ROW	Threat ROW Plan Delay Threat	Scheduling is a major risk as Right of Way and Utility relocates are dependent on other units to complete their design work prior to right of way beginning. This can be measured by the slippage in the date R/W and utility design/accommodation can begin their process.	Des Doc Pkg	Cost 0 Schedule	95%	MIN 0.00$M MAX 8.00$M Most Likely 3.00$M Master Duration Risk MIN 0.0Mo MAX 24.0Mo Most Likely 12.0Mo	3.17$M 11.4Mo	Very High High	Very High High	Probability: VH, H, M, L, VL Impact: VL, L, M, H, VH Mo, $	Mitigation				YES
2	Active	DEP-INCL	Construction	Threat Design Exceptions	Design exception required for reduced spirals, horizontal curves, and super transitions, shoulder width on the new mainline at the west transition to existing structure. There is a risk that the Design Exceptions will not be approved.	DE is reviewed and denied by Region and Tech Services	Cost 2 Schedule	10%	MIN 0.50$M MAX 4.00$M Most Likely 2.00$M 0 MIN MAX Most Likely	0.21$M 0.0Mo	Very Low Very Low	High NO RISK	Probability: VH, H, M, L, VL Impact: VL, L, M, H, VH $	Acceptance				YES
3	Active	DEP-INCL	Construction	Threat Bike-Ped	Existing alternative does not provide for full bike/ped circulation along the proposed facility. It is assumed that the existing sidewalks along Capitol Industrial area and bike shoulders on the new mainline facility provide a sufficient network. Building a multiuse path would result in additional ROW, costs, and additional structure width to facilitate the multiuse path.	Challenge to Scope	Cost 0 Schedule	15%	MIN 4.00$M MAX 10.00$M Most Likely 6.00$M Master Duration Risk MIN MAX Most Likely	0.95$M 0.0Mo	Very Low Very Low	Very High NO RISK	Probability: VH, H, M, L, VL Impact: VL, L, M, H, VH $					YES
4	Active		ROW	Threat ROW cleanup Threat	There may be items that we are required to cleanup and/or move that are not apparent in buildings that will not be discovered until we actually begin acquisition; also includes utility easements.	Discovery during property investigations	Cost 4 Schedule	15%	MIN 0.00$M MAX 4.00$M Most Likely 2.00$M 0 MIN 0.0Mo MAX 12.0Mo Most Likely 2.0Mo	0.30$M 0.5Mo	Very Low Very Low	High Low	Probability: VH, H, M, L, VL Impact: VL, L, M, H, VH Mo, $					YES

5	Active		ROW	Threat Real Estate Market Threat	Property costs may increase markedly before and during the project with right of way costs increasing significantly. New construction between now and initiation of acquisition can significantly increase property costs. Demolition costs can escalate depending on a number of items such as materials used in costruction (asbestos, et al) may require disposal in special land fills at increased costs. Rail Roads are Federally controlled and have special requirements. Rail Road		Cost 0 Schedule	30%	MIN 0.00$M MAX 9.00$M Most Likely 2.00$M Master Duration Risk MIN 1.0Mo MAX 12.0Mo Most Likely 4.0Mo	0.85$M 1.5Mo	Low	High Moderate	Probability VH H M L VL VL L M H VH Impact Mo $								YES
6	Active		ROW	Threat Partial takes turn to full take Threat	A property owner may request we aquire the entire property. Additionally, a design change or additional information may result in an entire acquisition. The cost estimate used here is potential additional costs.	Design Change or Property owners request.	Cost 6 Schedule	25%	MIN 0.00$M MAX 28.00$M Most Likely 6.00$M 0 MIN 0.0Mo MAX 12.0Mo Most Likely 6.0Mo	2.17$M 1.5Mo	Low	Very High Moderate	Probability VH H M L VL VL L M H VH Impact Mo $								YES
7	Active		ROW	Opportunity 42nd ROW	(1) Modify 42nd Drive to avoid imipacting Gemtop buidling. Creating a 90 degree intersection between the new overcrossing and 42nd drive.	Exec decision made prior to DAP; base design exceeds budget	Cost 0 Schedule	20%	MIN 1.00$M MAX 3.00$M Most Likely 2.00$M Master Duration Risk MIN MAX Most Likely	0.40$M 0.0Mo	Low	High NO RISK	Probability VH H M L VL VL L M H VH Impact $								YES
8	Active	DEP-EXCL	Construction	Opportunity 42nd change	(2) Opportunity to modify connection between Capitol and 42nd Dr. This would defer the construction of the 42nd Dr overcrossing and assumed ROW impacts	Base design exceeds budget	Cost 8 Schedule	6%	MIN 10.00$M MAX 20.00$M Most Likely 12.00$M 0 MIN MAX Most Likely	0.78$M 0.0Mo	Very Low	Very High NO RISK	Probability VH H M L VL VL L M H VH Impact $								YES
9	Active		Pre-construction	Threat Higher PE	Base Estimate assumes 11% PE costs however can range from 15%-20% if fully outsourced (resulting in a net increase of up to 100% additional PE costs).	Exec resourcing decision	Cost 0 Schedule	50%	MIN 2.00$M MAX 6.00$M Most Likely 4.00$M Master Duration Risk MIN MAX Most Likely	2.00$M 0.0Mo	Moderate	Very High NO RISK	Probability VH H M L VL VL L M H VH Impact $								YES
10	Active		Construction	Threat Subsurface	During construction unanticipated subsurface stability issues are encountered and were not accounted for in the design or addressed by the contract documents. This risk may be influenced by bid date.	discovery during construction	Cost 10 Schedule	40%	MIN 1.00$M MAX 2.00$M Most Likely 1.20$M 0 MIN MAX Most Likely	0.52$M 0.0Mo	Moderate	Moderate NO RISK	Probability VH H M L VL VL L M H VH Impact $								YES

11	Active		Construction	Threat CN delays Threat	Results from indirect impacts caused by various "unreasonable delays" that could occur. Some delays can cause other additional delays leading to significant time impacts, such as a contractor losing a field season; subcontractor; supply source; etc. This risk is on top of normal impacts associated with delays, i.e. home and field office overhead, equipment standby, inefficiencies, etc.	miss milestone emerging schedule challenge	Cost 0 Schedule	75%	MIN MAX Most Likely Master Duration Risk MIN MAX Most Likely	0.00$M 2.00$M 1.00$M 2.0Mo 10.0Mo 5.0Mo	0.75$M 4.0Mo	High	Moderate Moderate	Probability VH H M L VL VL L M H VH Impact $,Mo									YES
12	Active		Construction	Threat Hazardous materials Threat	Subsurface contaminants (not discovered during pre-construction investigations); the designated route crosses industrial lands and retired landfill. There may be undiscovered storage tanks, undisclosed hydrocarbons, or other surprises.	discovery during construction	Cost 12 Schedule	20%	MIN MAX Most Likely 0 MIN MAX Most Likely	0.00$M 2.00$M 0.50$M 1.0Mo 4.0Mo 2.0Mo	0.13$M 0.4Mo	Low	Low Low	Probability VH H M L VL VL L M H VH Impact $,Mo									YES

Glossary

Glossary of key terms, a comprehensive glossary of terms can be found at:

http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/