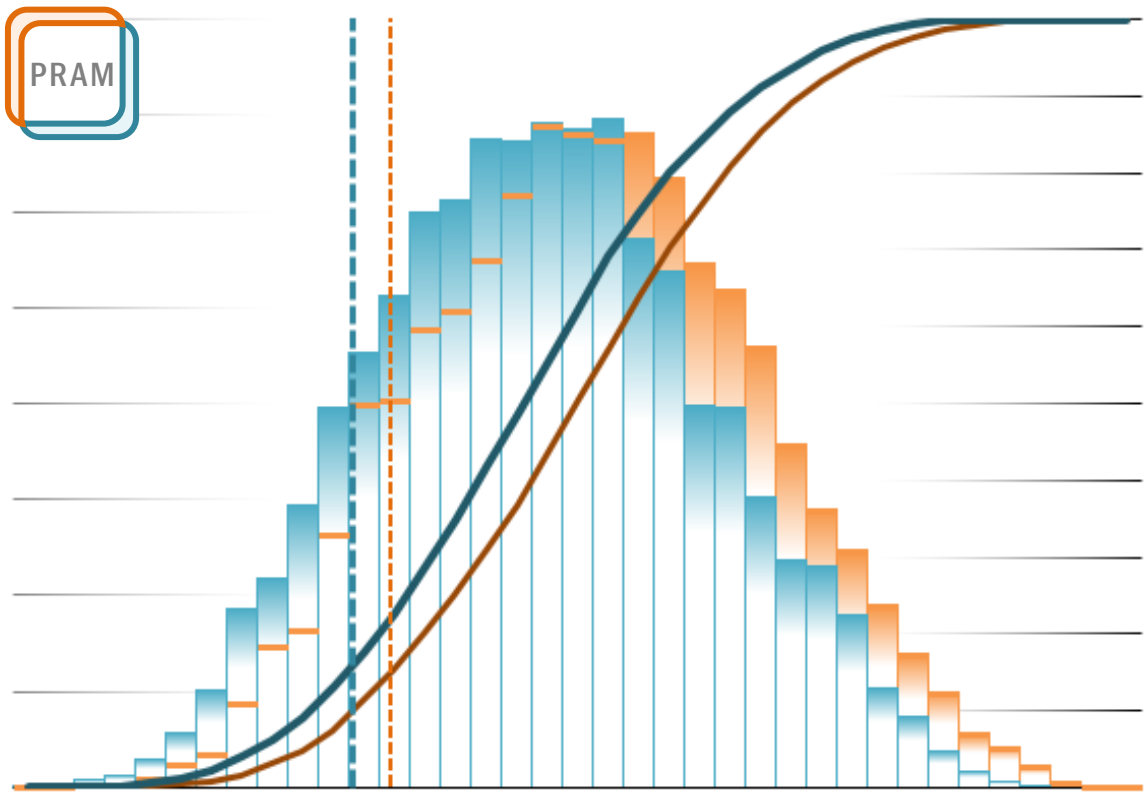
Washington State Department of Transportation

Project Risk Analysis Model

User's Guide



Engineering Analysis Office

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Terms

Base Cost Estimate	The reviewed or validated project cost estimate used in quantitative risk analysis. It represents the reasonably expected cost if the project materializes as planned, including PE, RW, and CN costs. It is unbiased and neutral (neither optimistic nor conservative). It does not anticipate any expense due to risk events, but does include the WSDOT standard contingency percentage.
Base Variability	describes inherent variability, not caused by risk events. Base variability is captured in the model with a modest symmetric range about the estimated value of the form: base value ± x%. Base variability represents ordinary quantity and price variations about the estimate base—typically from ±5% to ±15% depending on level of project development and complexity.
Estimate	A quantitative assessment of the likely amount or outcome. Typically refers to project costs, resources, effort, and durations and is usually preceded by a modifier (e.g., preliminary estimate, conceptual estimate, etc.). An estimate is best expressed as a range, not a single number; it offers an indication of accuracy (i.e., ± x %). An estimate has two components: the base cost estimate component and the risk/uncertainty component.
Impact	A consequence of a risk occurring in terms of cost ($) or months (mo); expressed as a range defined by three values: minimum, maximum, and "most-likely". A threat impact adds cost or delay; an opportunity impact adds value, reduces cost, and/or saves time.
Mitigation	Action taken to reduce the impact or likelihood of an undesirable risk event or events. It is a type of threat response strategy.
Opportunity	An event risk that has the potential to positively impact project objectives.
Probability	An estimated likelihood that a particular risk event will occur. Expressed on a scale of 0 to 100% in this model. Estimates of probability are often subjective, as the combination of tasks, people, and other circumstances are unique to each project.
Qualitative Assessment	An assessment of risk relating to the qualities and subjective elements of the risk — those that cannot be quantified accurately. Qualitative techniques include the identification of risk and risk triggers, recording risk details and relationships, categorization, and prioritization of risks relative to each other and the project.
Quantitative Analysis	The modeling of numerical outcomes by combining actual or estimated values with an assumed or known relationship between values, using arithmetic or statistical techniques, to determine a range of likely outcomes. This follows the Qualitative Assessment, along with determining the probability of occurrence and impact range of each risk.
Risk	Effect of uncertainty on objectives.
Risk Events	Uncertain events that affect the project resulting in impacts to cost, schedule, safety, performance, or other characteristics, but do not include the minor variance inherent in Base Costs.
Risk Register	The risk register serves as a repository for identified project risks. It includes detailed information about the risk and is a "living" document that evolves as the project evolves.
Risk Response	The process of developing response actions to identified risk events that enhance opportunities and reduce threats to project objectives.
Risk Trigger	A measurable or observable event or condition that is a precursor to, or indicator of, a risk's occurrence. An event or condition that causes a risk to occur. A root cause of a risk event.
Threat	An event risk that has the potential to negatively impact project objectives.
Uncertainty	The lack of knowledge of the outcome for a particular element or value.
YOE	Year Of Expenditure. The estimated year that money will be spent to complete project work elements. Typically accounts for inflation.

Additional terms for Risk Management may be found in the
WSDOT Glossary for Cost Risk Estimating Management

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Project Risk Analysis Model: Overview

A probbilistic risk model simulates random project execution events as in the real world. For project risk analysis, attention is focused on events that can significantly affect project cost and schedule objectives.

The Project Risk Analysis Model (PRAM) uses Monte Carlo simulation to generate cost and schedule forecasts from user input cost, schedule, risk, and uncertainty information. It runs thousands of simulations or "project realizations" that virtually execute the project under the influence of all input uncertainties and risks. For each realization some risks occur, some do not; some impacts are high and others are low. Output is a probabilistic range of project cost and schedule outcomes. Few realizations reach the extreme possible limits; most heap somewhere towards the middle.

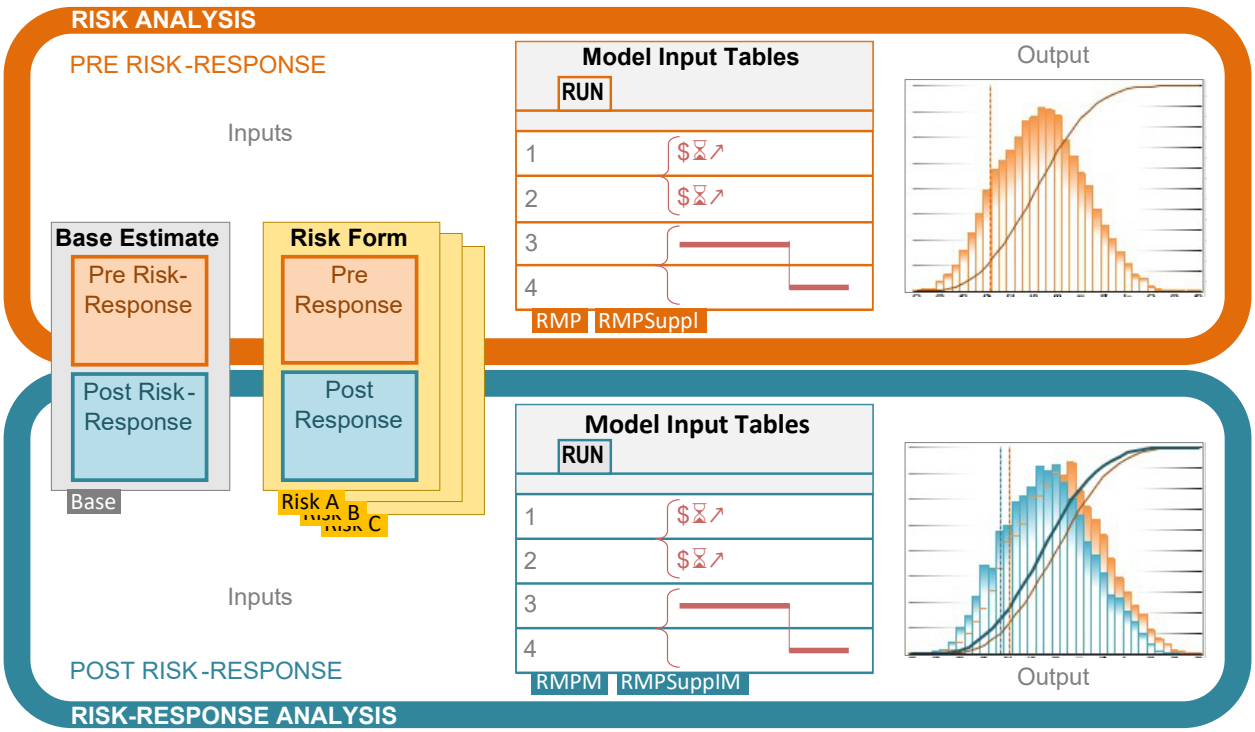
Up to 24 individual risks may be entered into the model. The outputs present statistical summaries, probability distribution histograms, cumulative distribution function S-curves, and percentile tables. The model accommodates either Design Build, DB, or Design Bid Build, DBB, project delivery method, and reports cost and schedule range forecasts for project total and component phases respectively. There are also tornado diagrams, sorting risks by expected value (EV), combining probability and impact, to aid risk response prioritization.

The model duplexes two analyses. The first is for analyzing project exposure to risks as initially identified and assessed, and the second is for analyzing the response to those risks. Comparing the results offers users a quantified measure of the value of proactive risk management on the project. The Base Estimate and Risk input forms serve both analyses. Color-coding is used throughout the model to aid instant recognition of which analysis inputs or results are which:

ORANGE = Risk Analysis (pre risk-response: pre-mitigated risk analysis)

BLUE = Risk-Response Analysis (post risk-response: post mitigated risk analysis)

The following illustration shows the two analyses available in the model, how they are color-coded, and how single input sheets are used for each:



Basic Parts

PREREQUISITES

Project Cost & Schedule Estimate
Current, and purged of all risk contingency

Foundation of any useful analysis

Project Risk Assessment
Identify, describe, and quantify probability & impact of each risk

Most of this effort, all but entering information, may be done before engaging the tool.

INPUTS

Base Estimate
Pre Risk-Response
Post Risk-Response
Base

entered in this sheet

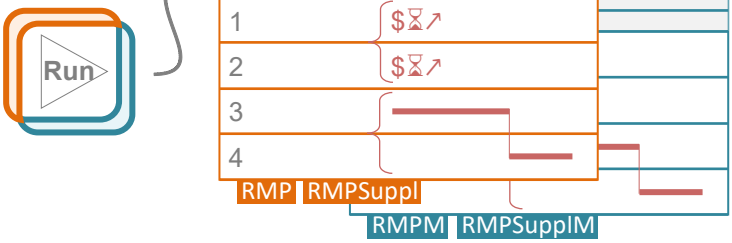
Each sheet handles both pre and post risk-response inputs

Up to 24 risks

Risk Form
Pre Response
Post Response
Risk A
Risk B
Risk C

entered in these sheets

Used to apply any inter-risk conditionality.



A synopsis of base and risk inputs.

Run

OUTPUTS

Expected Value
EV

A summary of risks by relative magnitude.

An aid for optimizing the risk-response effort.

Design-Bid-Build
Pre risk-response results shown

Current Year
Cost

Today's Dollars

Preliminary Engineering
Right of Way
Construction
Total

Cost and date distributions of 10,000 virtual, risk exposed project executions.

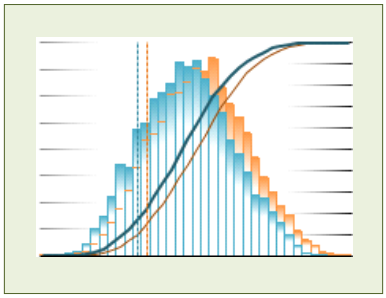
Year of Expenditure
Cost

Inflated Dollars

Contract Ad Date
Ad Date

End of Construction
End CN

Post risk-response results are added to the same reports

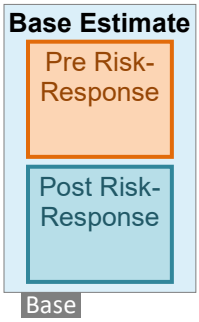


Workbook Sheets

The PRAM workbook contains sheets for data input and for output reports of simulation results. These sheets serve to record the Risk Analysis — pre risk-response — and the Risk-Response 3Analysis entries and results. The respective zones are clearly labeled and color-coded.

INPUTS

Base Estimate (Sheet: Base)

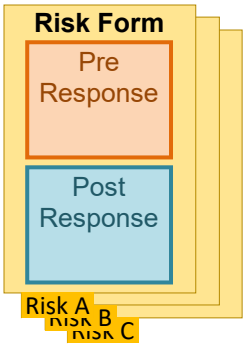


Users enter the expected cost as if the project goes as planned. The BASE Cost is an unbiased neutral estimate of cost and schedule; care should be taken that information entered is neither conservative nor optimistic. For Design-Bid Build, DBB, project delivery, the BASE estimate captures the total estimated project costs including, Preliminary Engineering, right-of-way (ROW), construction, Mobilization, Construction Engineering, Tax, Change Order Contingency, and below the line items (700/800 items). (WSDOT standard construction contingency amount is based upon historical usage). For Design Build, DB, project delivery, the BASE includes Conceptual Design, ROW, and Design/Build.

The upper portion is for the initial Project Risk Analysis. The lower portion accounts for any base estimate adjustments due to risk response strategies — the Risk Response Analysis.

Values are entered in Current Year (CY) dollars.

RISK (Sheets: identifications vary)

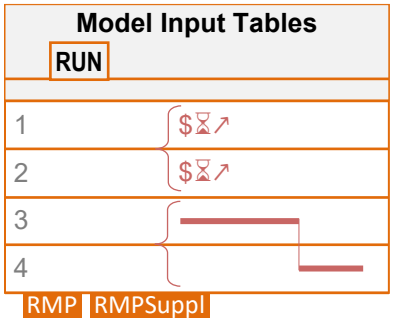


The simulation handles up to 24 discrete risks. Each Risk sheet records an identified risk associated with the project under study: the phase it affects, its details, probability, and quantified consequences. The upper portion of the form is about the risk as it is first identified, with no regard to doing anything about it, i.e., before any response strategy — the pre risk-response values, or pre-mitigated risk. The lower portion details the proposed response strategy and plan, with any expected change to likelihood or impact due to implementation — the post risk-response values, or Post-mitigated Risk.

Project risks can pose a **Threat** of negative impacts to project objectives or present an **Opportunity** that has positive impacts.

Model Input Tables: Inter-Risk Conditionality / Model Input Summary

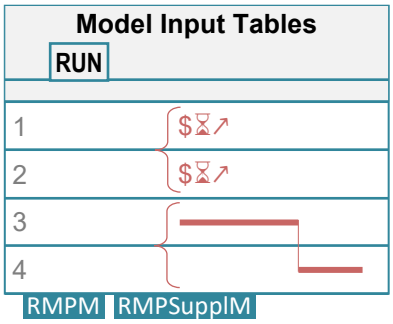
RMP (Risks ordered 1 – 12) & **RMPSuppl** (Risks ordered 13 – 24)



Data entered in the individual forms for Risk Analysis (pre risk-response) appear in these tables. The first twelve risks (1 – 12) are in one, and the second twelve (13 – 24) are in the other. They appear in the same order as workbook sheet tabs (top to bottom vs left to right). At the top of each table is a summary of (pre risk-response) Base Estimate inputs.

This is where to indicate conditionality between risks, to model basic correlations, dependencies, and duration links. See later section for more details. The model-engine uses the inputs from these sheets. Review the inputs before running.

RMPM (Risks ordered 1 – 12) & **RMPSupplM** (Risks ordered 12 – 24)



Data entered in the individual forms for Risk-Response Analysis appear in these tables. The first twelve risks (1 – 12) are in one, and the second twelve (13 – 24) are in the other. They appear in the same order as workbook sheet tabs (top to bottom vs left to right). At the top of each table is a summary of (post risk-response) Base Estimate inputs.

Revise or indicate conditionality between risks accordingly, to reflect the effects of response strategies (more detail provided later in this guide). Review the model inputs here before running.

OUTPUTS

Expected Value (sheet: EV)

Graphs on this sheet sort entered risks by Expected Value (EV) as an aid for optimizing the risk-response effort. Usually, risks at the top warrant more attention, with diminishing benefit for expense likely for those lower on the chart. Limited risk management resources should be applied proportional to a risk's likelihood and impact.

The expected value of individual random variables is the probability-weighted average of input values.

$$Expected\ Value\ = Probability \times \left(\frac{min\ +\ 4(most\ likely)\ +\ max}{6}\right)$$

To that end, EV combines factors into one convenient, probability-weighted number. This is shown as a black circle on the charts. The bars represent the possible impact range (min. and max.), as entered in respective risk sheets. Those to the left of the vertical origin line are opportunities, those to the right are threats.

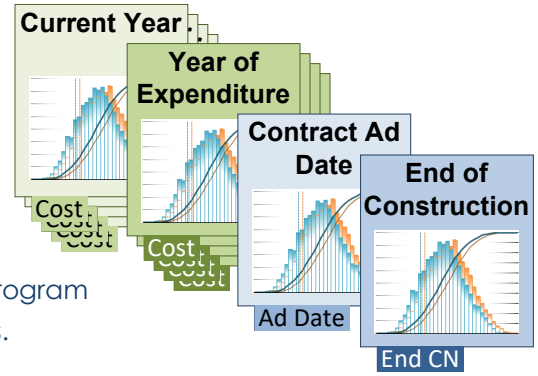
When using, however, be aware that this calculation could de-emphasize a high impact risk having low probability, placing them lower on the chart. Project Managers are advised to look

for these events (sometimes referred to as "Grey Swans[1]") and give them due attention. The extent of bars depicts impact severity, and thus provides some indication of potential "Grey Swans".

There are seven graphs in the EV sheet. The top two show pre risk-response ranking, one for cost and another for schedule. The next two are for after risk-response adjustments. The last three compact results to the top 12 risks. The simulation need not run before viewing the EV summary. This diagram is available as soon as all risks have been entered and quantified. First, select the RMP tab; after the RMP sheet refreshes, go to the EV sheet; it is now current. Any revision of risk entries requires first going to the RMP sheet—and/or the RMPM sheet if working with post-mitigated entries—this will update the data behind the EV charts.

Outputs: Analysis Results

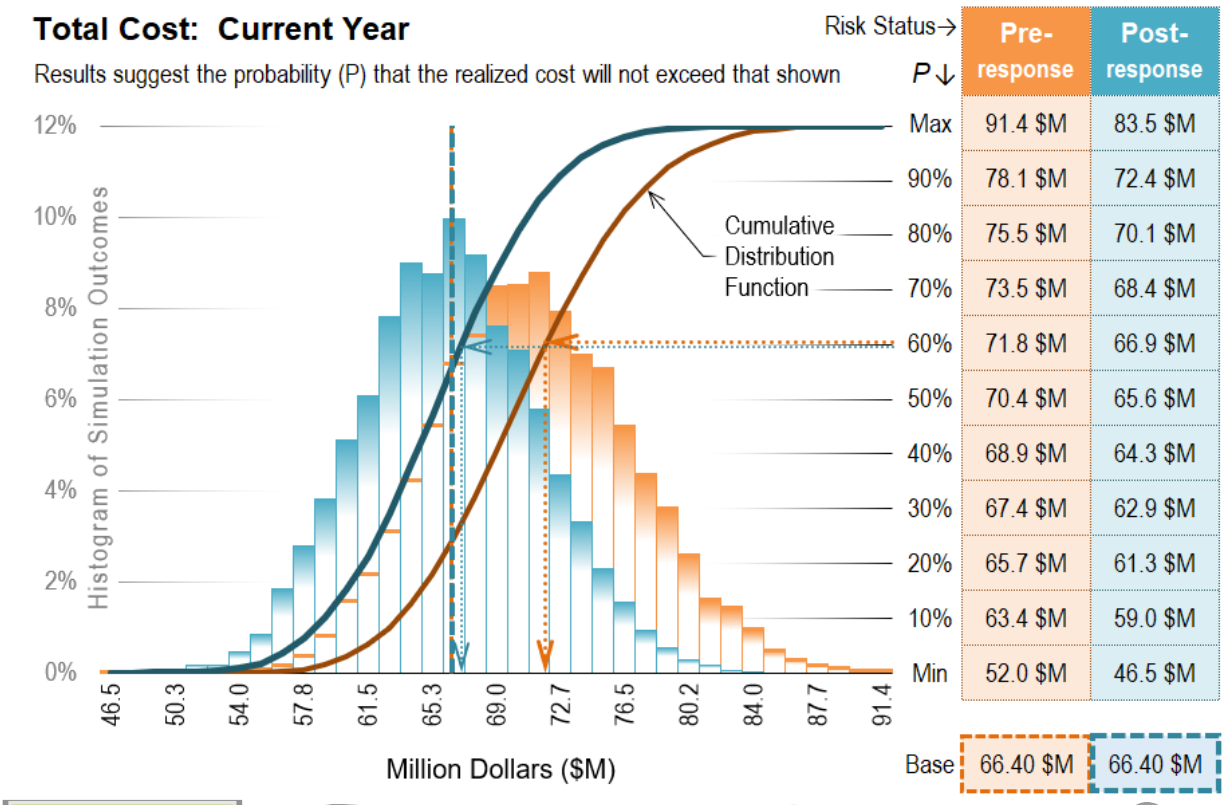
Risk model forecast results are presented in 8 sheets for cost, and 2 for schedule. There are reports for three basic project development phases, and two critical milestone dates, according to respective project delivery method. See table below. Costs are provided in Current Year (CY) dollars, for reporting to Program Management, and in Year-of-Expenditure (YOE) dollars.



Result Worksheet Tab Names			
Delivery Method Phase		Report Sheet	
Design Bid Build	Design Build	Current Year (CY) dollars	Year-of-Expenditure (YOE) dollars
Cost			
Preliminary Engineering	Conceptual Design	**PE-Cost (CY)**	**PE-Cost (YOE)**
Right of Way	Right of Way	**ROW-Cost (CY)**	**ROW-Cost (YOE)**
Construction	Design/Build	**CN-Cost (CY)**	**CN-Cost (YOE)**
Total	Total	**Total-Cost (CY)**	**Total-Cost (YOE)**
Schedule			
Contract Advertisement	D/B Selection	**Ad Date**	
End of Construction	End of Construction	**End CN**	

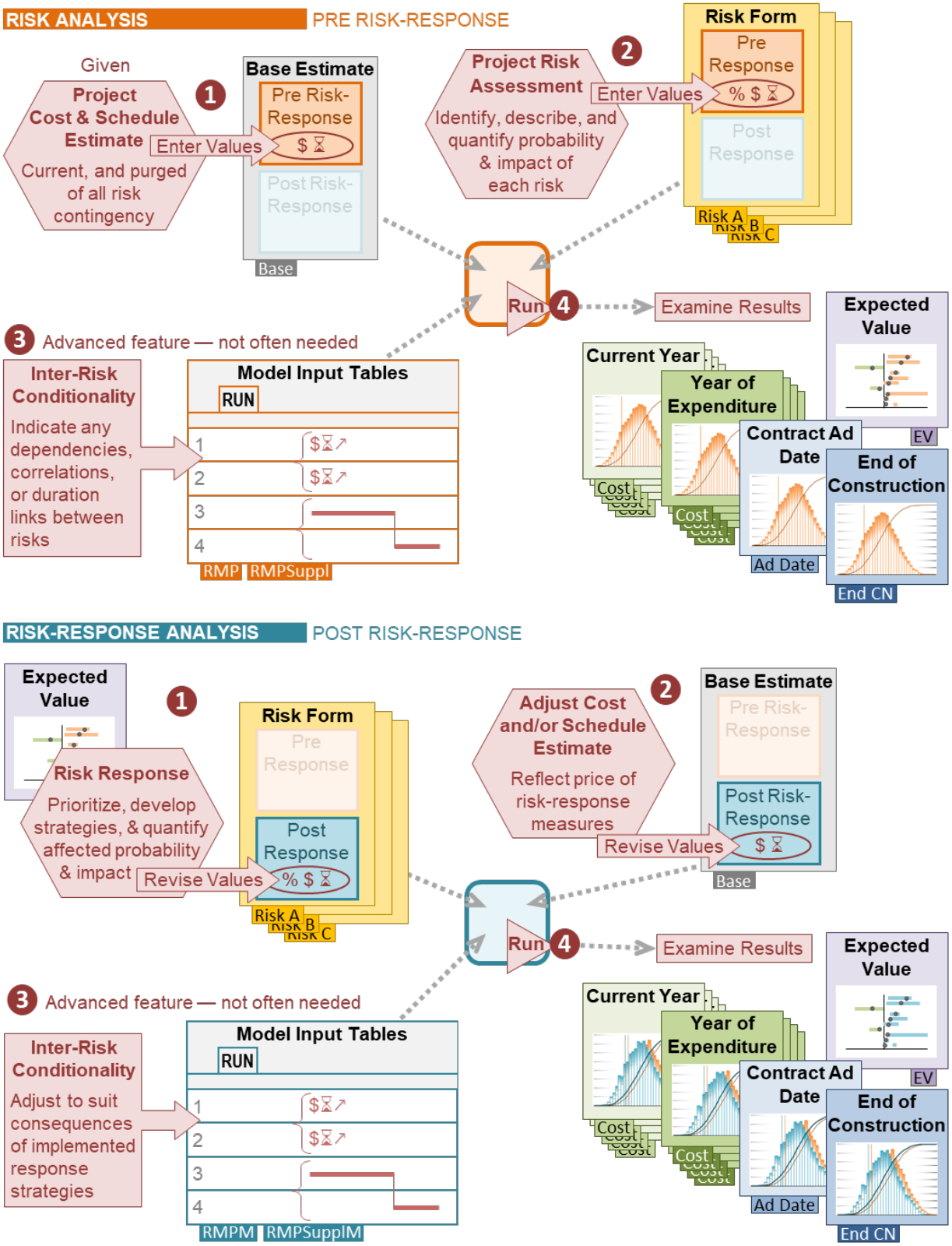
[1] See *CREM Glossary*.

Below is an example Result Sheet (see *Viewing the Results)*:



Total-Cost (CY)

Using the PRAM: Basic Steps



Before Using

The correct application of the Project Risk Analysis Model assumes familiarity with basic risk management theory and technique. Please review WSDOT's Project Risk Management Guide before using the model:

https://wsdot.wa.gov/publications/fulltext/cevp/ProjectRiskManagement.pdf

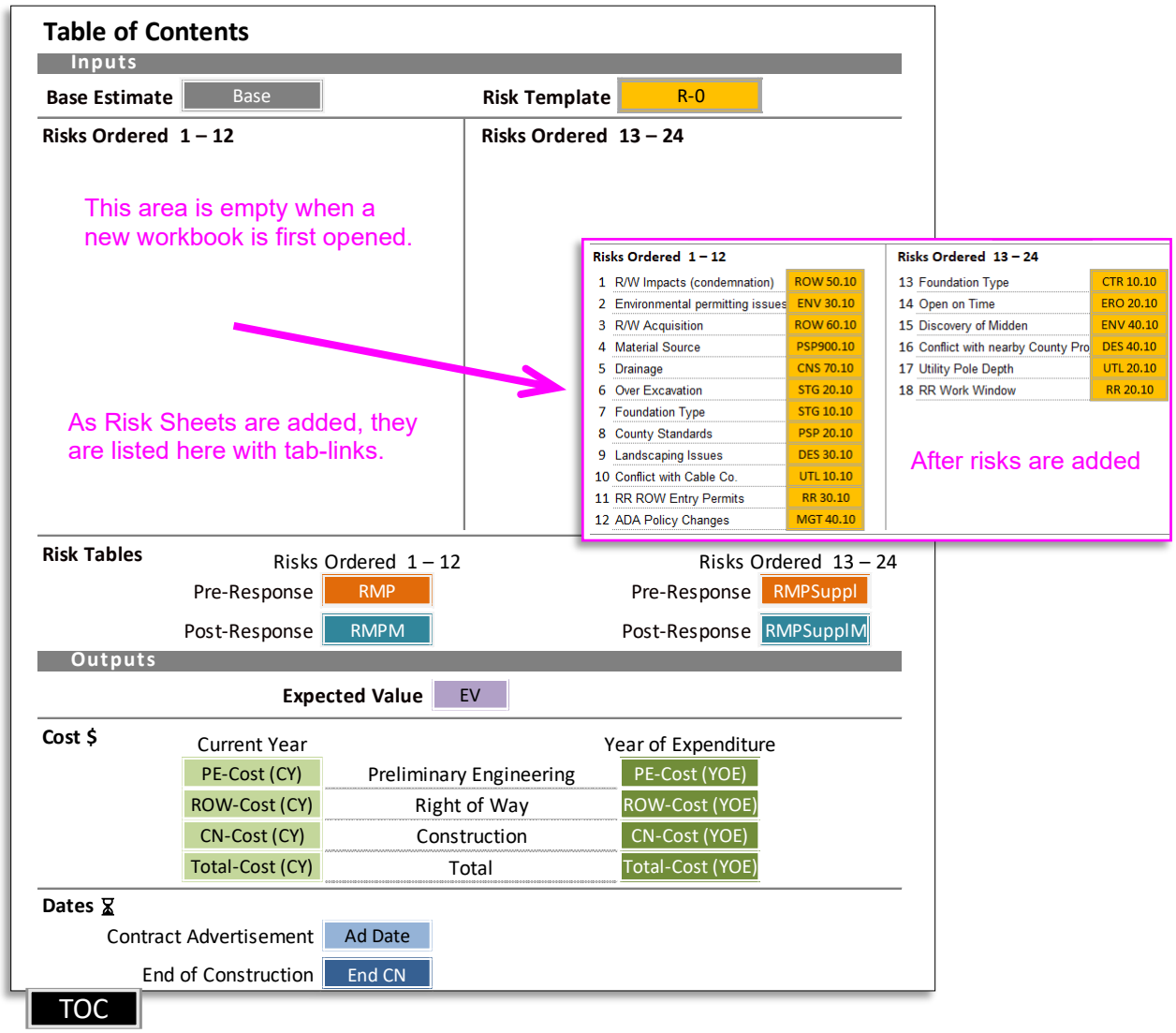
Get the Workbook

The Project Risk Analysis Model workbook is available online here:

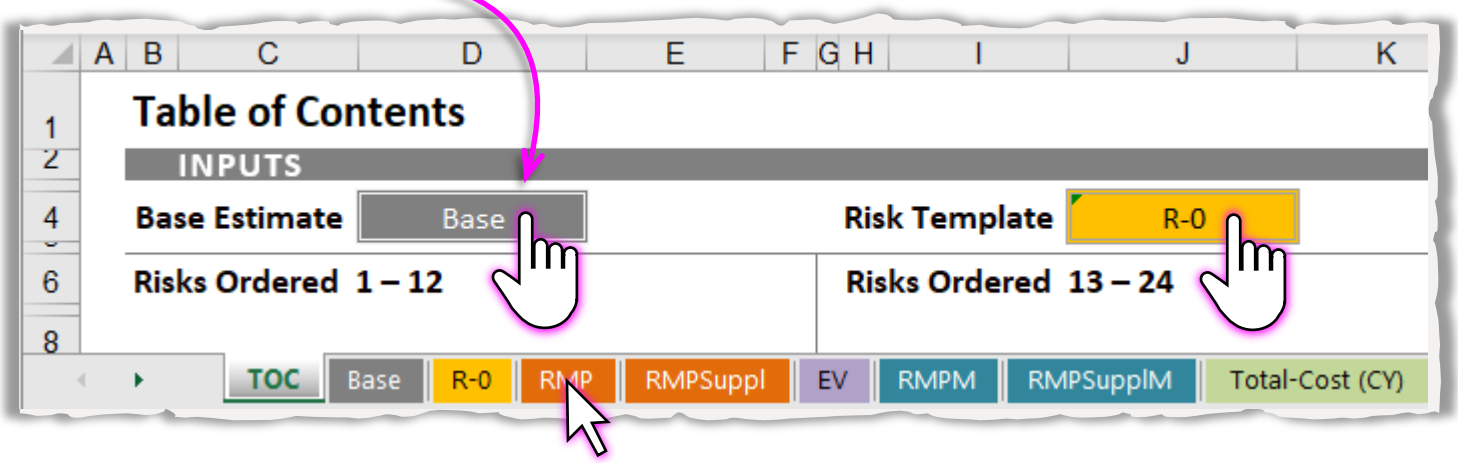
https://wsdot.wa.gov/publications/fulltext/CEVP/ProjectRiskAnalysisModel.xlsm

Open the Workbook / Table of Contents / Navigation

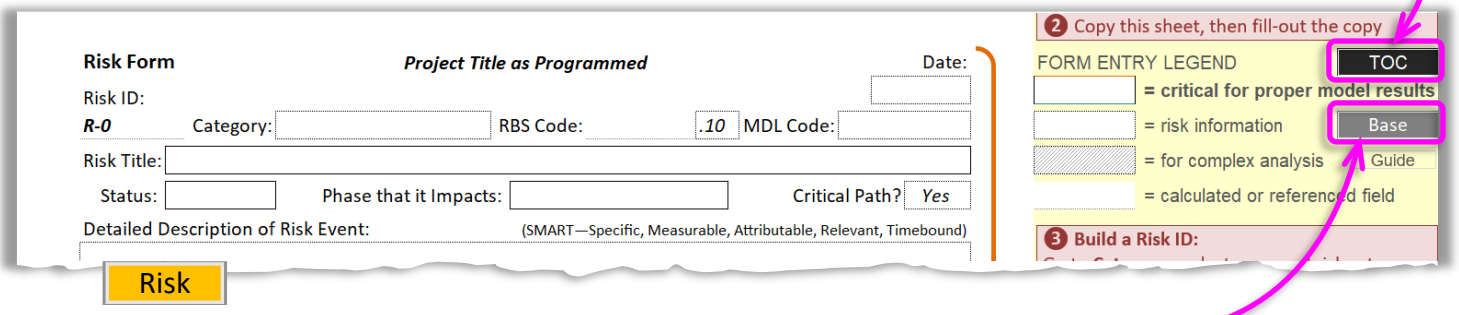
The Project Risk Analysis Model workbook should open at the Table of Contents (TOC) sheet.



Notice the variously colored rectangles that look like the sheet tabs; these are links to respective sheets in the workbook. The user may navigate to sheets in the usual way by selecting tabs at the bottom of the workbook, or go to any sheet in the workbook from the TOC by clicking on these tab-links.

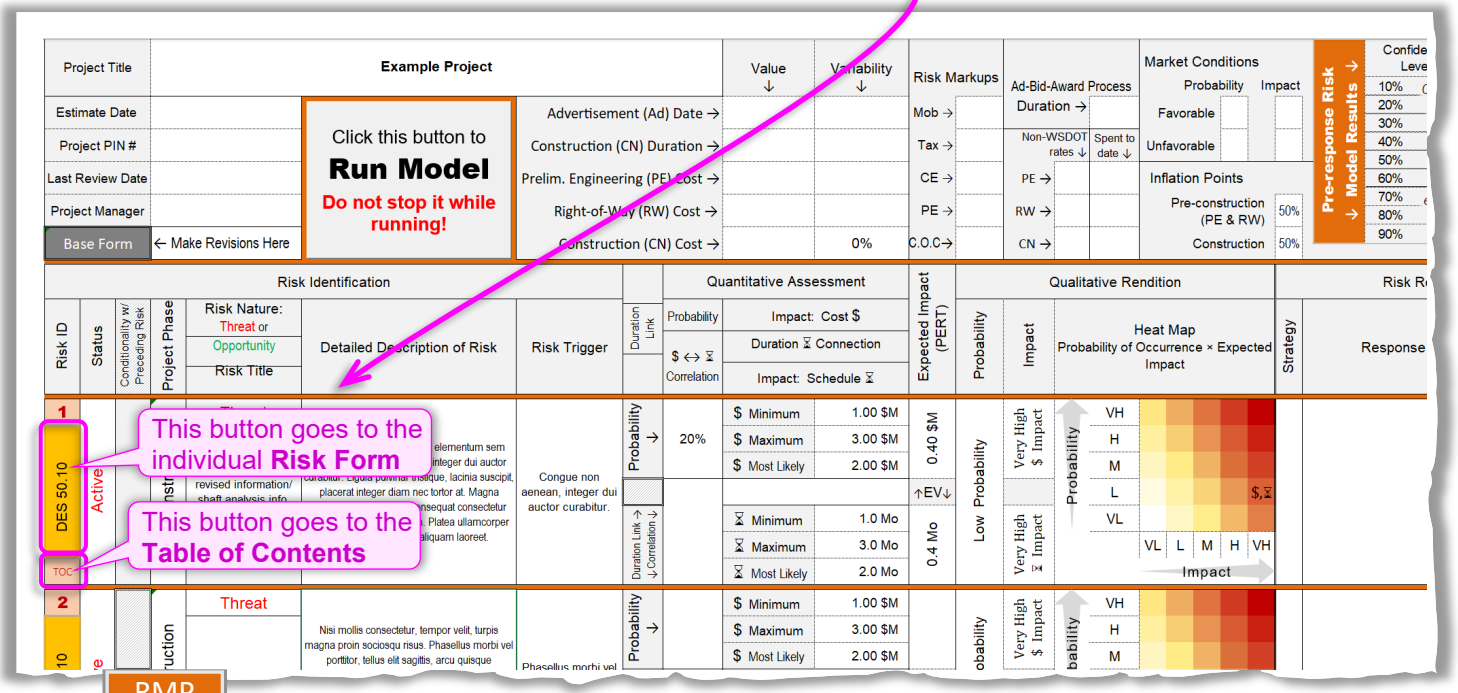


Each destination sheet has at least one TOC tab-link to return the user to the Table of Contents.



Most sheets have tab-links to provide a direct route to other sheets, as well.

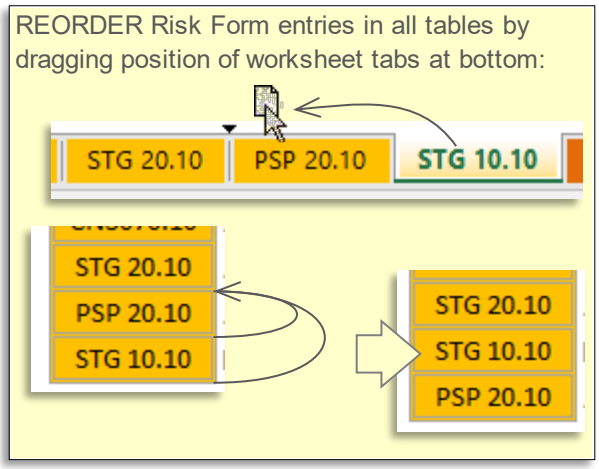
The exception is when in one of the Model Input Tables:



All these navigational shortcuts have an advantage over the traditional sheet selection-by bottom-tab. There can be well over 40 sheets to negotiate in a model fully loaded with project risk sheets (up to 24 modeled risks, estimate sheets, etc.). Getting from one sheet to another can be difficult when limited to scrolling and selecting from a wide array of sheet tabs at bottom.

Reordering and Naming Sheets

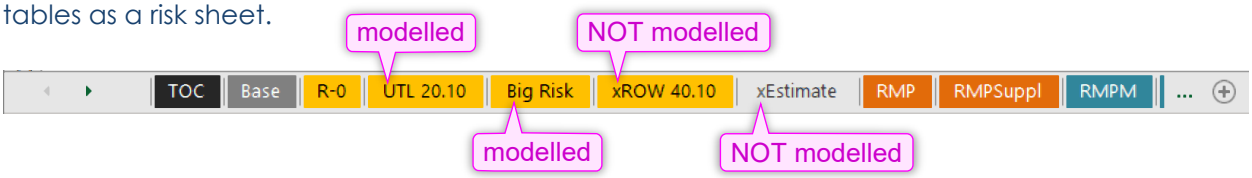
Risks may be entered in any order, but later it may be desired or necessary to change the sequence as listed in the Table of Contents and/or in the Model Input Tables. For purposes of modeling inter-risk conditionality (see *Appendix: Conditionality*) the order of risk entries is crucial; but even for purely esthetic reasons, reordering risks is a simple matter of dragging their respective tabs (at bottom) to the desired sequence.



Be careful when reordering tabs in a workbook that already has inputs for inter-risk conditionality.

The user may reorder risk sheets by dragging their respective sheet tabs, but conditionality indicators will not automatically update to suit a new order. Any that were set before a reordering should be checked afterwards to ensure risks are still connected as intended.

The model assumes that any sheet added to the workbook is a risk input sheet. Although it is recommended that you use conventional Risk IDs (see *Risk Sheets* section), you can use whatever names you wish (the shorter the better); however, if your tab/risk name begins with an "x" it will not be recognized by the model, the TOC, the Expected Value charts, nor the RMP tables as a risk sheet.



This allows you to insert and store any number of sheets in the workbook relevant to the task of risk management on the project: obsolete risks, assumptions, estimates, calculations, decision log, risk response plan details, etc.

Needless to say, adding a sheet that is not a risk form without an "x" as first character in the tab name will be treated by the model as a risk input regardless, giving unexpected or erroneous results, if any.

Risk Analysis Inputs

Entering Data

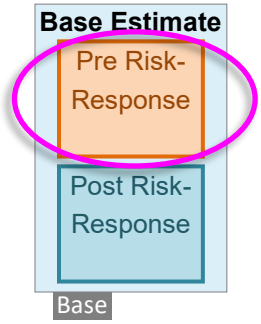
There are two parts to each input worksheet. The first records the values required for a Risk Analysis (pre risk-response) simulation. The second is for Risk-Response Analysis, to model the effect of response strategies. Combining these in one workbook allows for ready comparison and quantification of the value added by active risk management.

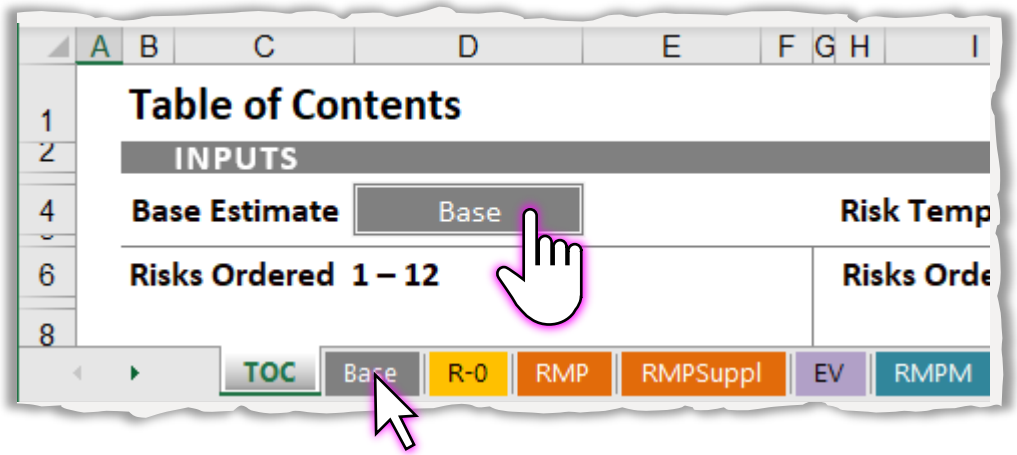
Data may be entered live during a workshop, before, or sometime after active or collaborative risk assessment. It may be copied-in from a list, from separate sheets, imported, or received from remote collaborators, etc. Risk response strategizing may lag the risk analysis, or it may take place on the heels of initial risk elicitation and assessment. Data for each analysis, pre or post response, does not need to be entered in a particular sequence, but care must be taken to assure that it is complete for an analysis, and that it is entered in the right section.

For the purpose of orderly presentation in this guide, we will assume a workflow where Risk Analysis data is entered first, then we will return to make Risk Response Analysis entries. This guide follows the diagram ***Using the PRAM: Basic Steps***.

Base Estimate

Go to the Base sheet.





Enter data in the fields of the upper portion of the sheet, for Risk Analysis (with Pre-mitigated Risks). The orange outlined boxes are critical for the model to calculate results. Leave blank when there is no associated value.

Important, but less critical for modeling, are the lighter-outlined boxes. Hatched fields are for a more complex analysis — see the section, Non-WSDOT Inflation Rates, for more information. Underlined fields are calculated values or information referenced from elsewhere and are auto-filled.

FORM ENTRY LEGEND

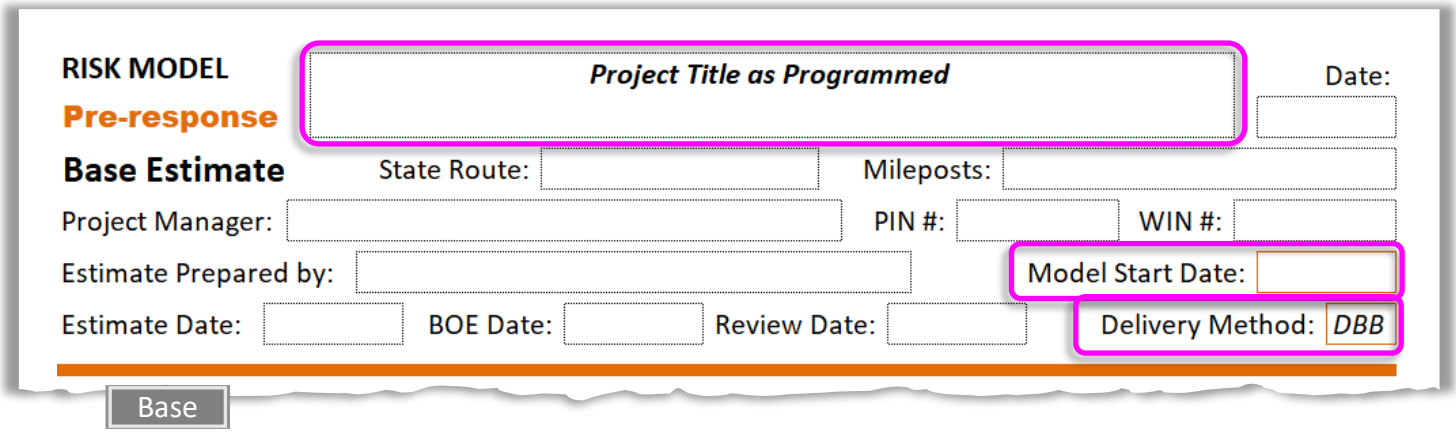
= critical for proper model results

= project information

= for complex analysis

= calculated or referenced field

Project information is at the top.



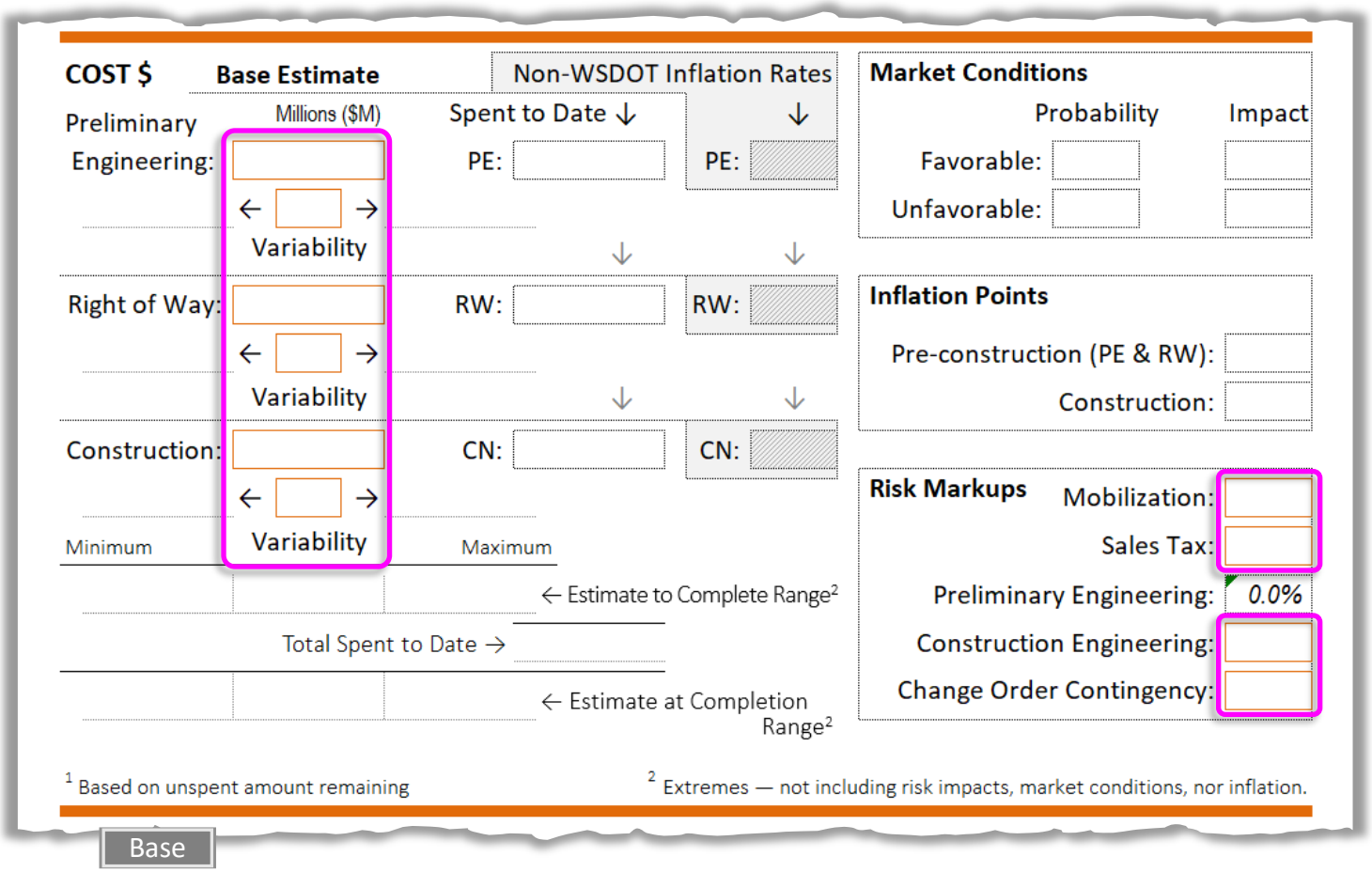
Critical fields include:

- **Project Title**: Enter the complete project title as programmed. This is automatically shown at the head of all risk sheets, etc.
- **Model Start Date**: This is the critical base date entry for modeled contract advertisement and end of construction forecasts—usually today's date.
- **Delivery Method**: This changes labels throughout the model's input and output sheets from those referring to Design-Bid-Build, DBB, terms to those conventional Design-Build, DB Terms; for example, "Preliminary Engineering" becomes, "Conceptual Design", and "Construction" becomes, "Design/Build".

Less critical:

- Date: A project may be analyzed several times over the course of its development. Enter the date of this model to place it in history with others.
- State Route: Enter the route identifier(s) if they are not already in the project title.
- Mileposts: Enter the project milepost limits if they are not already in the project title.
- Project Manager: Enter the name of the project manager.
- PIN #: Enter the Program Item Number.
- WIN #: Enter the Work Item Number.
- Estimate Prepared by: Enter the name of the person who prepared the estimate.
- Estimate Date: Enter the date of the current project estimate.
- BOE, Basis of Estimate Date: Enter the date of the Basis of Estimate form.
- Review Date: Enter the date that the estimate was last reviewed.

COST $ — The next section is for Base Estimate Cost values:



Make cost entries in million-dollar units, and durations in months.

NOTE: Values are displayed in "Millions of dollars" ($M) and "Months" (mo). Less than a million dollars or less than a month is entered as a decimal. Examples:

$200,000 enter as .2 it is displayed as 0.20 $M	*1 week enter as .25 it is displayed as 0.3 mo*
$2,689,123 enter as 2.69 it is displayed as 2.69 $M	*3 months + three weeks enter as 3.75 displayed as 3.8 mo*
$23,000 enter as .023 it is displayed as 0.02 $M	*one and a half years enter as 18 it is displayed as 18.0 mo*

- **Base Estimate:** Enter base cost for each project phase according to project delivery method: Preliminary Engineering (PE) or Conceptual Design (CD), Right of Way (RW), and Construction (CN) or Design/Build (D/B). Do not include ANY misc. allowances in these. The construction figure should already reflect the cost of all Bid Items, Mobilization, Sales Tax, Change Order Contingency, Construction Engineering, 700 & 800 Level Items, etc. DBB — the Total Cost to Complete minus RW & PE costs; DB — the Total Cost to Complete minus RW & CD costs.

- **Variability**: Below each project phase cost and schedule estimate is an input for inherent variability — not caused by risk events. Base variability captures a modest symmetric range (of the form: base value ± x%) about the estimated value, typically from 5% to 15% depending on level of project development and complexity. Cost variability represents quantity and price variations about the estimated base.

- Spent to Date: Project dollars already spent may be accounted for in this column. Put the full budgeted amount in the Base Estimate section—the model will subtract the Spent to Date amount internally, sheltering that from future inflation. The model will report an Estimate at Completion range that includes monies spent to date.

- Non-WSDOT Inflation Rates: By default, the model refers to an internal inflation rate table developed by a third party. The user may opt-out of the table by entering an inflation rate that better suits conditions. (If the model has not been updated for quite some time it is recommended to confirm that the internal inflation tables are current. See *Appendix: Inflation Tables.)*

- Market Conditions: Enter percentages that reflect characteristics or trends in the market. Cost and availability of labor and materials, or the number of contractors available to bid the work, will all effect the market conditions.
  Values reflect the opinion of the project team; an assessment of the bidding environment.
  Enter a Probability for Favorable: (likelihood of better than planned) and Unfavorable: (likelihood of worse than planned). Enter a percentage of construction cost representing the Impact of how much better, or worse the project cost might be due to market conditions, primarily the bidding environment.

- Inflation Points: 50% by default; this directs the model to inflate costs to the midpoint of each phase duration, i.e., 0.5. Inflation point fields are provided for Pre-Construction (Preliminary Engineering and Right of Way acquisition) and Construction activities—respectively for analogous DB phases. This is adjustable for cases where it is expected that most of the funds will be expended much earlier or later in the phase, e.g., 25% for earlier, and 75% for later, etc. Please contact the HQ Engineering Analysis Office (EAO) for assistance if needed.

- Risk Markups: These are applied to a risk's cost impact outcome, per risk, per simulation. Values are typically the same as those used in calculating the construction base cost estimate. This accounts for the subtle sundries connected with correcting the impact of a risk; any additional engineering or sales tax, etc. Enter Project Markup percentages for:

  → Mobilization

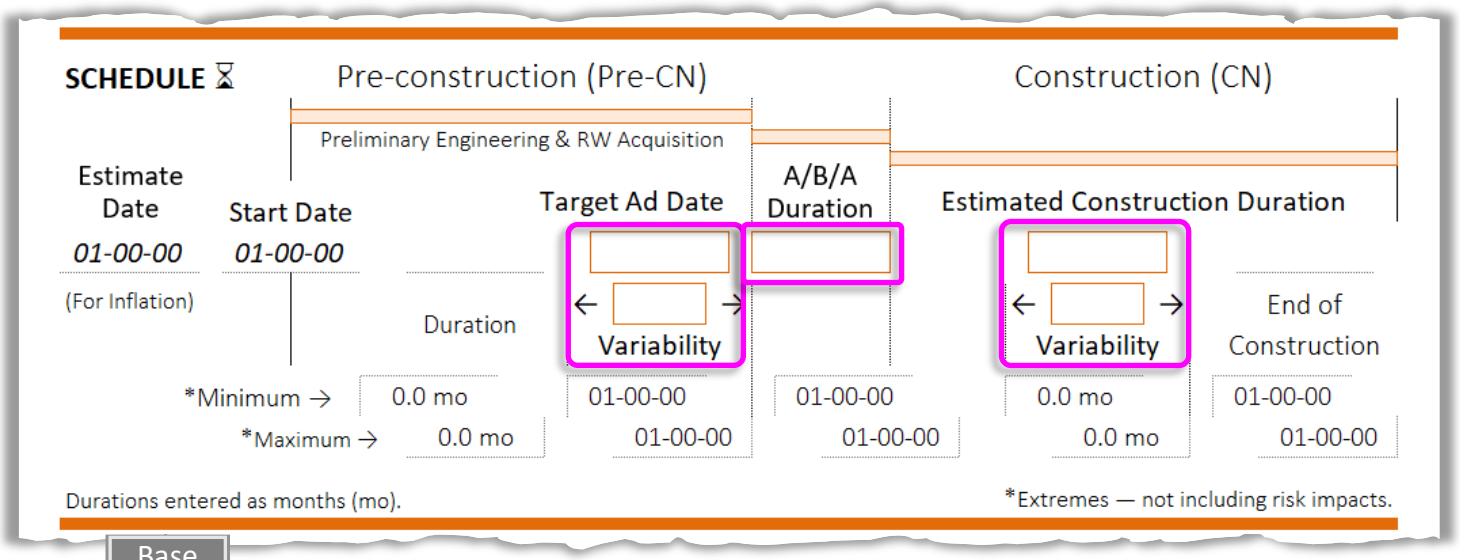
  → Local Sales Tax Rate

  → Preliminary Engineering (Conceptual Design) — this is a calculated field, assuming the user expects the same ratio as entered for estimated PE/CN (CD/DB) for any simulated total risk cost impact (users may overwrite if desired).

  → Construction Engineering

  → Change Order Contingency

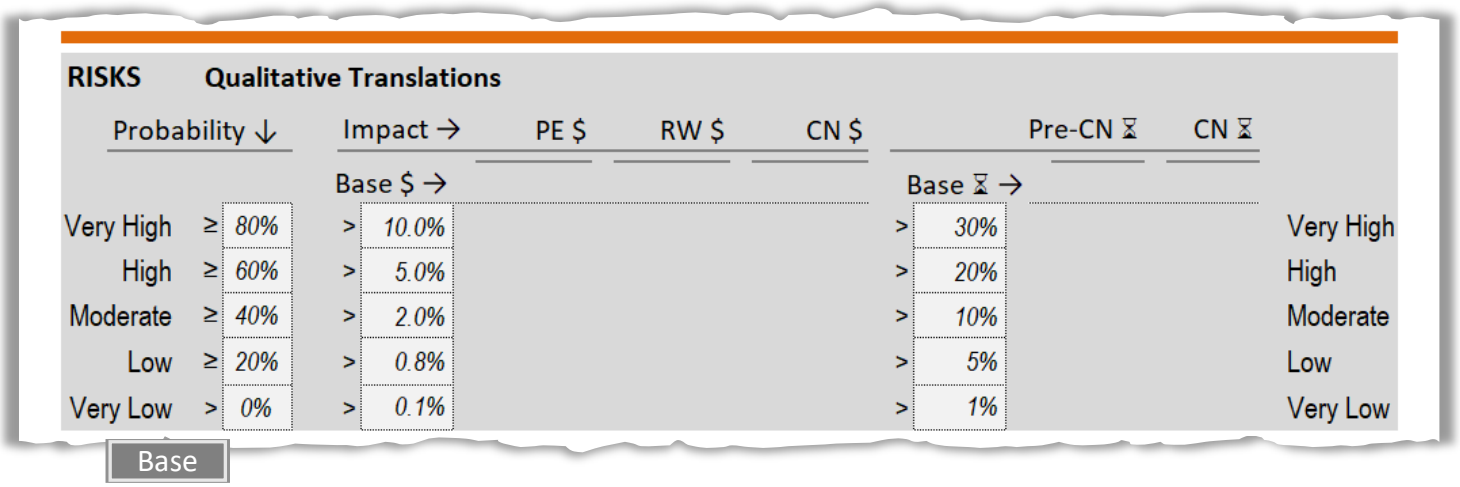
SCHEDULE ⧖ — The next section is for Base Schedule values:



Base

- DBB - **Target AD Date**: enter the planned Advertisement Date of the project.
  DB - **Target RFP Date**: enter the planned Request For Proposal (RFP) Date.
- DBB - **Ad/Bid/Award (A/B/A) Duration**: how many months from the AD date until it is awarded.
  DB - **D/B Selection Duration**: enter how many months for contractor selection process.
- DBB - **Estimated Construction Duration**: how many months the project will be in Construction.
  DB - **Estimated D/B Duration**: enter how many months for contractor to design and build.

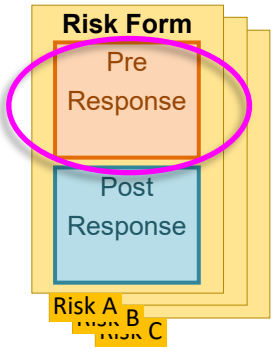
The last section is for qualitative risk probability and impact translation:



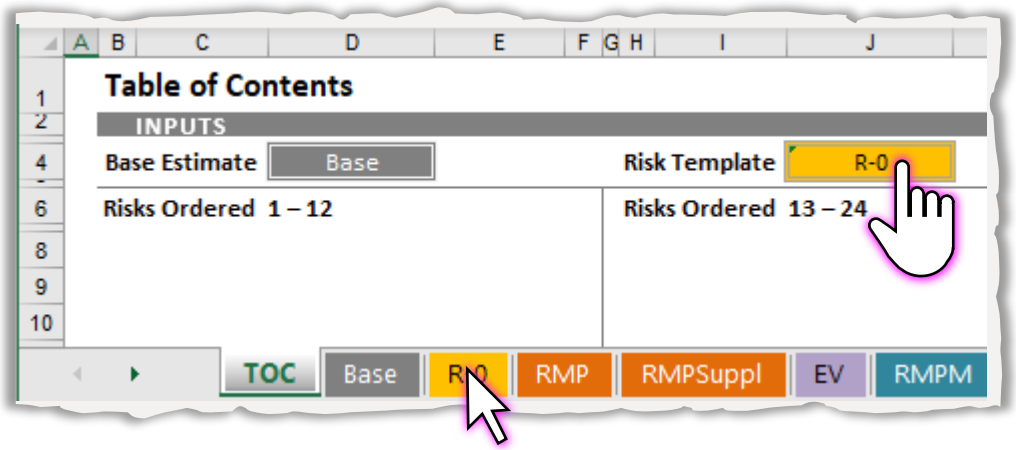
Base

For informational purposes—no entries required, advanced feature. This section shows and controls how the model translates risk probability and impact (quantitative) values into qualitative terms relative to base estimate entries. This governs the Heat Map display in each risk's Qualitative Rendition section. In reverse, it serves as an aid in quantifying risk probability and impact when starting from qualifying terms like "High", "Very Low", etc.

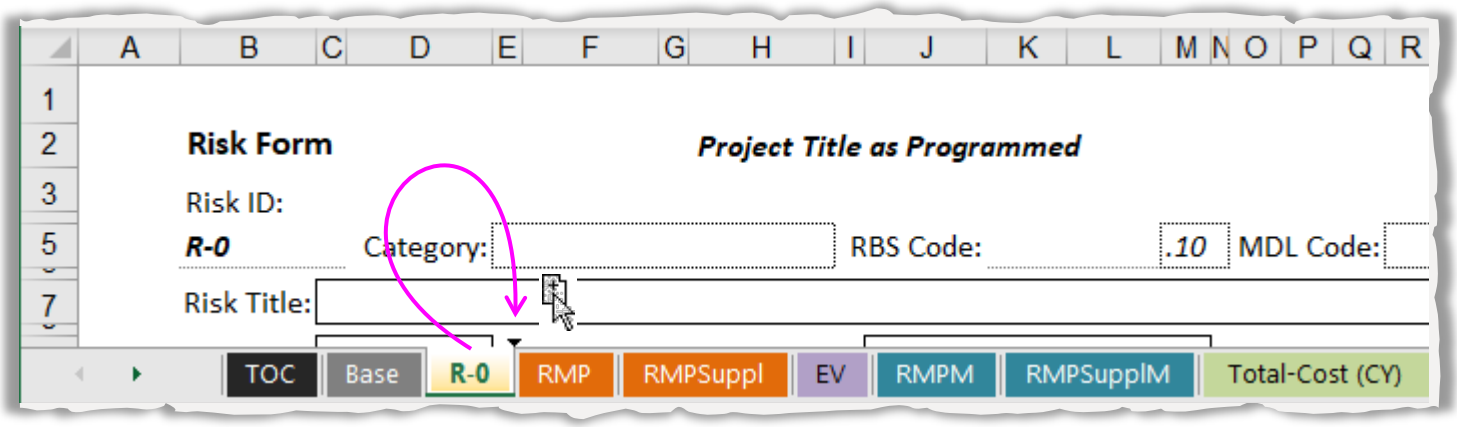
Risk Sheets



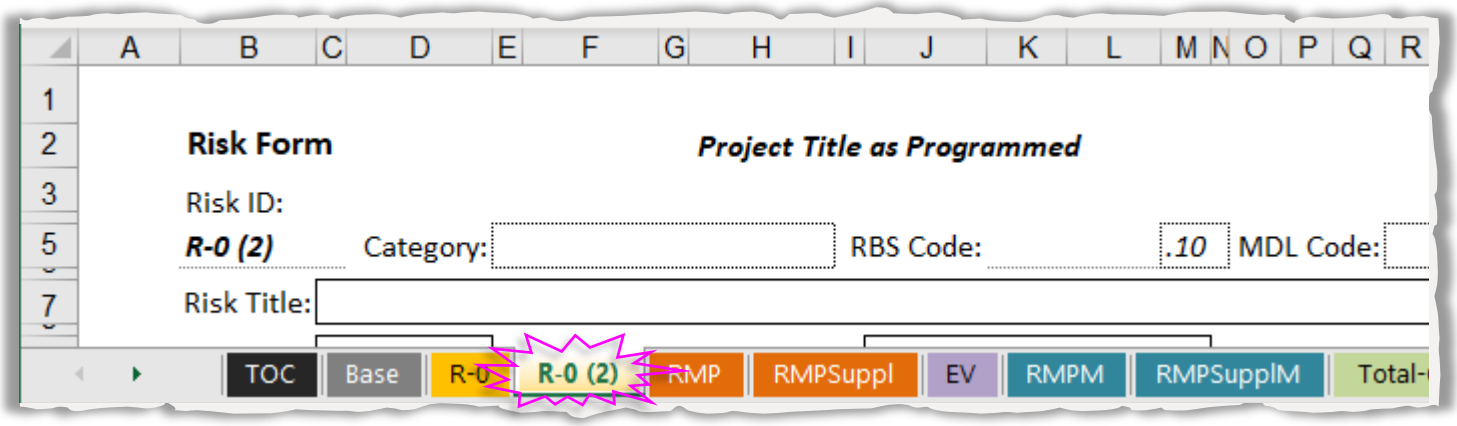
Go to the Risk Form template sheet.



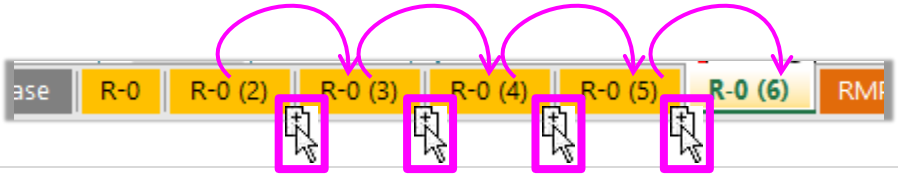
Make a Form for your risk by copying the template "**R-0**".



This can be done several ways, but the easiest is to hold down the Ctrl key then select and drag the "R-0" tab. This will result in a new tab named "R-0 (2)", which you will rename a little later.



You may repeat this as many times as you have risks already identified, or add as you go.



Hint: When adding more risks later, after previous forms have been filled-out, always start by making a copy of a blank template "R-0". This prevents unintentionally using values from a pre-existing (copied) risk form.

FORM ENTRY LEGEND

= **critical for proper model results**

= project information

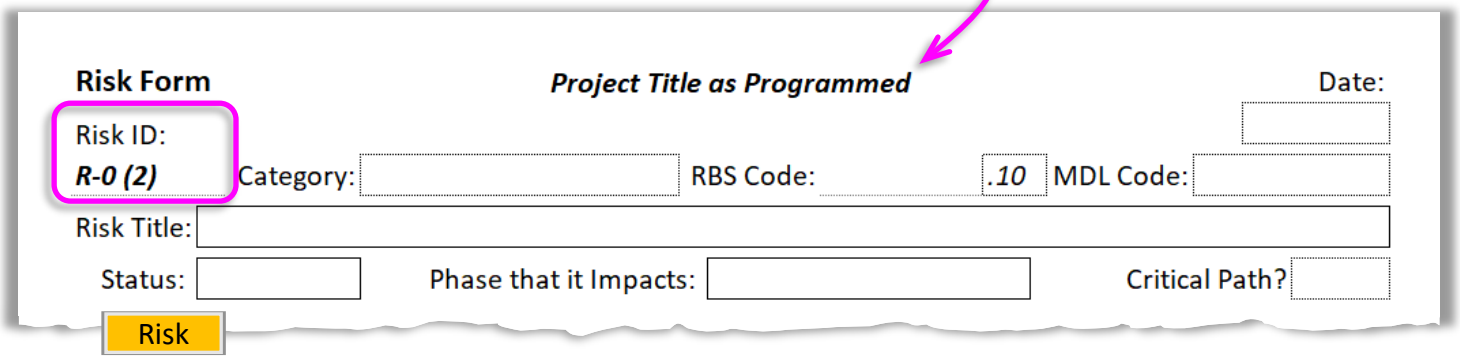
= for complex analysis

= calculated or referenced field

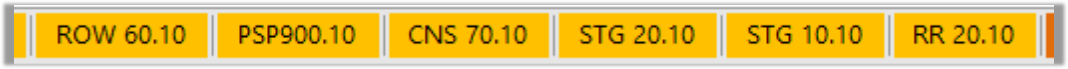
Now go back to tab "R-0 (2)". Enter risk analysis (pre risk-response) values in the upper portion of the Risk Form. Notice that critical entries for simulation are in solid, black or orange outlined boxes. Important, but less critical for modeling, are the lighter-outlined boxes. Hatched fields are for a more complex analysis — see *Appendix: Conditionality* for more information. Underlined fields are calculated values or information referenced from elsewhere and are auto-filled.

The top portion is for risk identification information and is common to both pre and post risk response analyses.

The Project Title is referenced from the Base Estimate form.

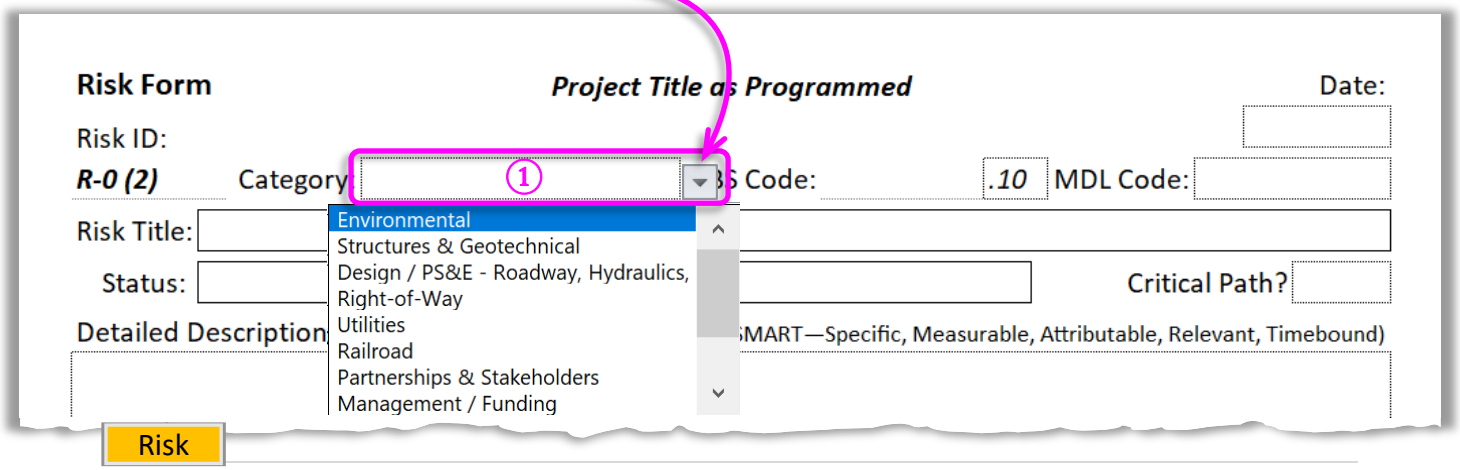


- Risk ID: (auto-filled) copies what you enter as the tab name. Recommendation — use a Risk Breakdown Structure (RBS) code (see *Appendix*) as a Risk ID / tab name. Examples below:

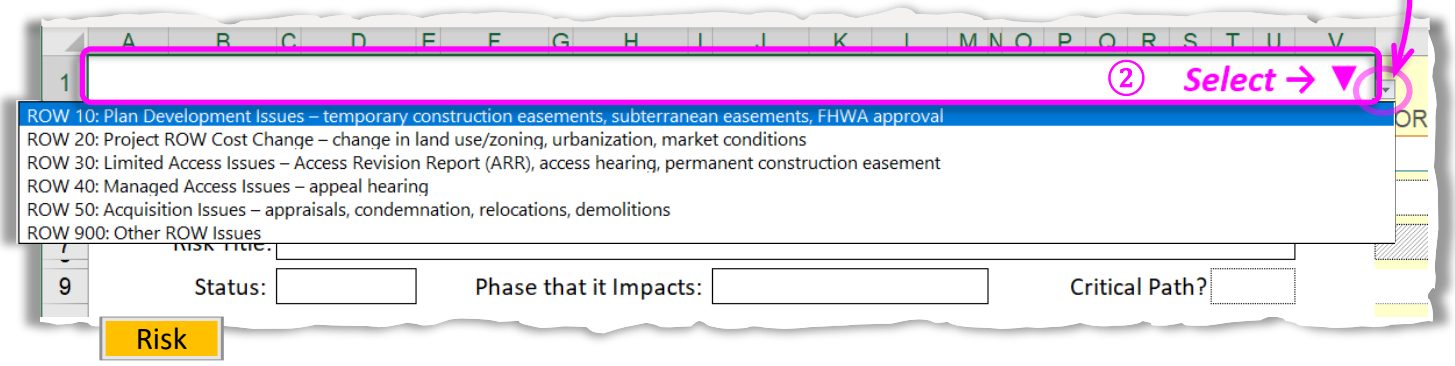


Building an RBS Risk ID

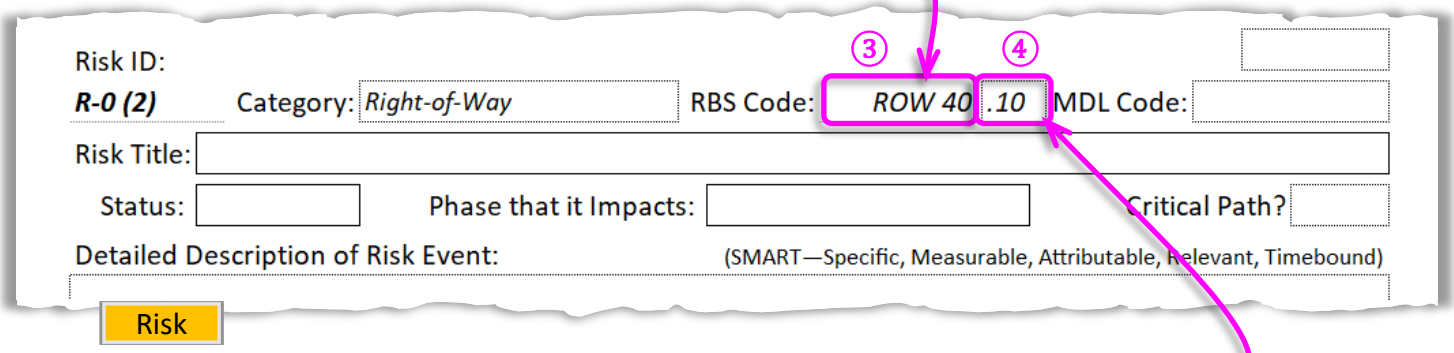
① First select a general Category: Select from the drop-down menu.



② Then select a subcategory from the drop-down menu, accessed from the upper-right corner of the sheet. Example (Right-of-Way):

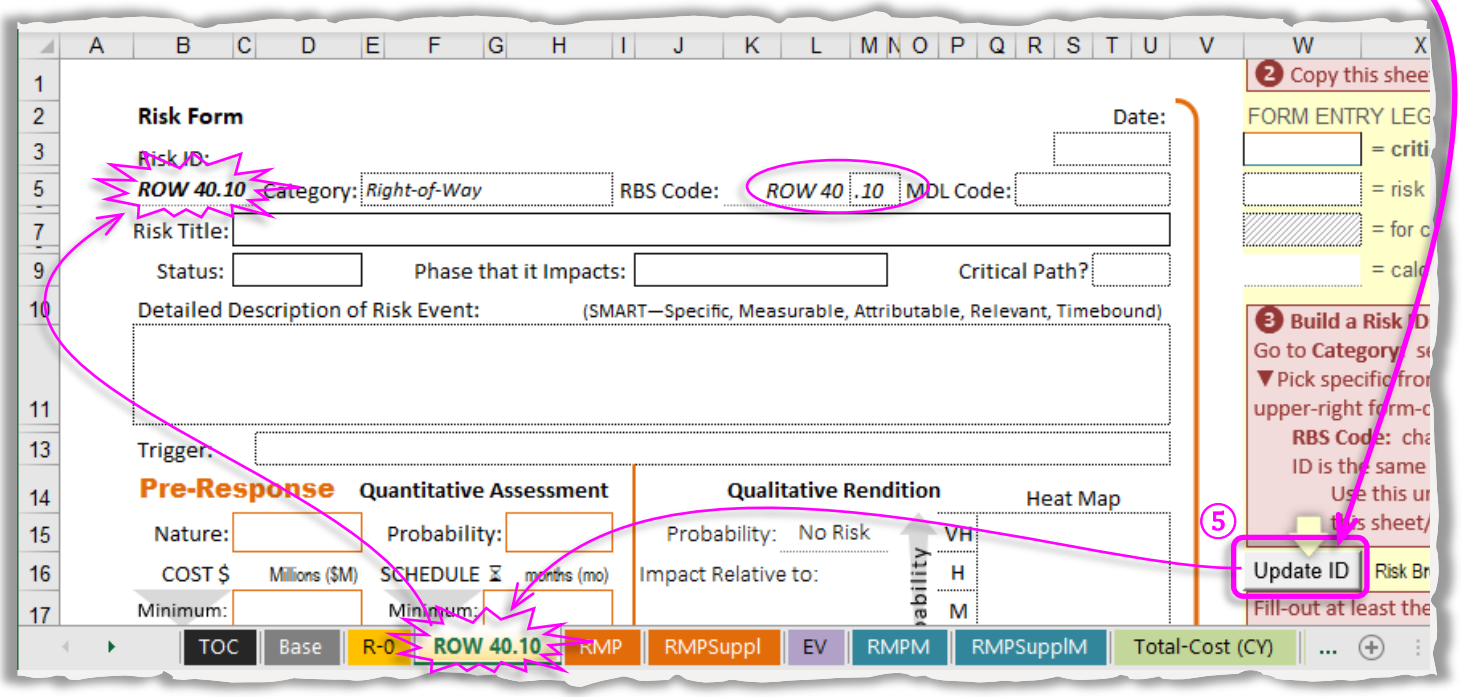


③ The result will appear in the RBS Code field:

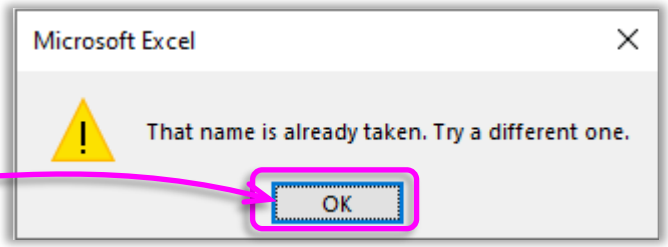


④ Change the decimal place if the ID code is the same as a previously entered risk. (The drop-down will provide the next increment).

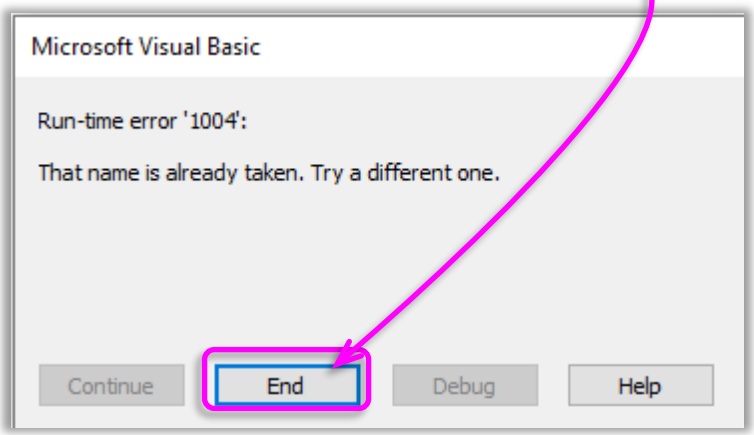
⑤ Change the name of the sheet tab, either manually, or by pressing the Update ID button.



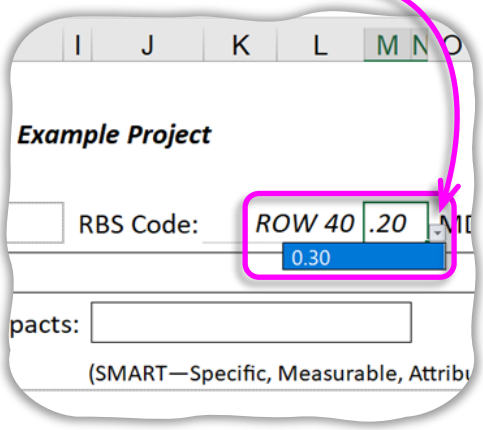
Of course, Excel does not allow duplicate tab names. If you try while changing a tab name directly, you will get the warning at right. Press "OK" and try a different name.



If you press the "Update ID" button Update ID and get the message box below, hit "End…"

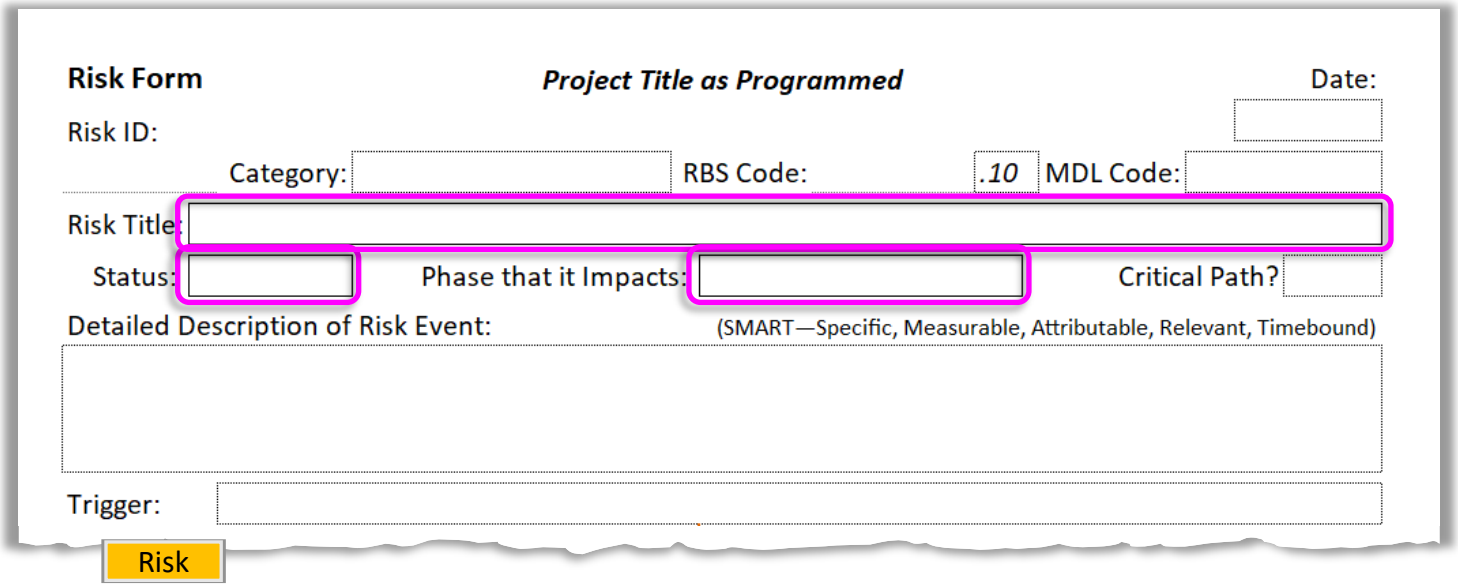


…then increment the decimal on a conventional ID using the convenient drop-down.



Press the update button Update ID again (depending on how many times a certain RBS code has already been used, you may need to run through the previous steps a few times).

Continue filling top section of Risk Form



- Date: Enter date the risk was identified and assessed.
- Category: (drop-down) Select from among the following:

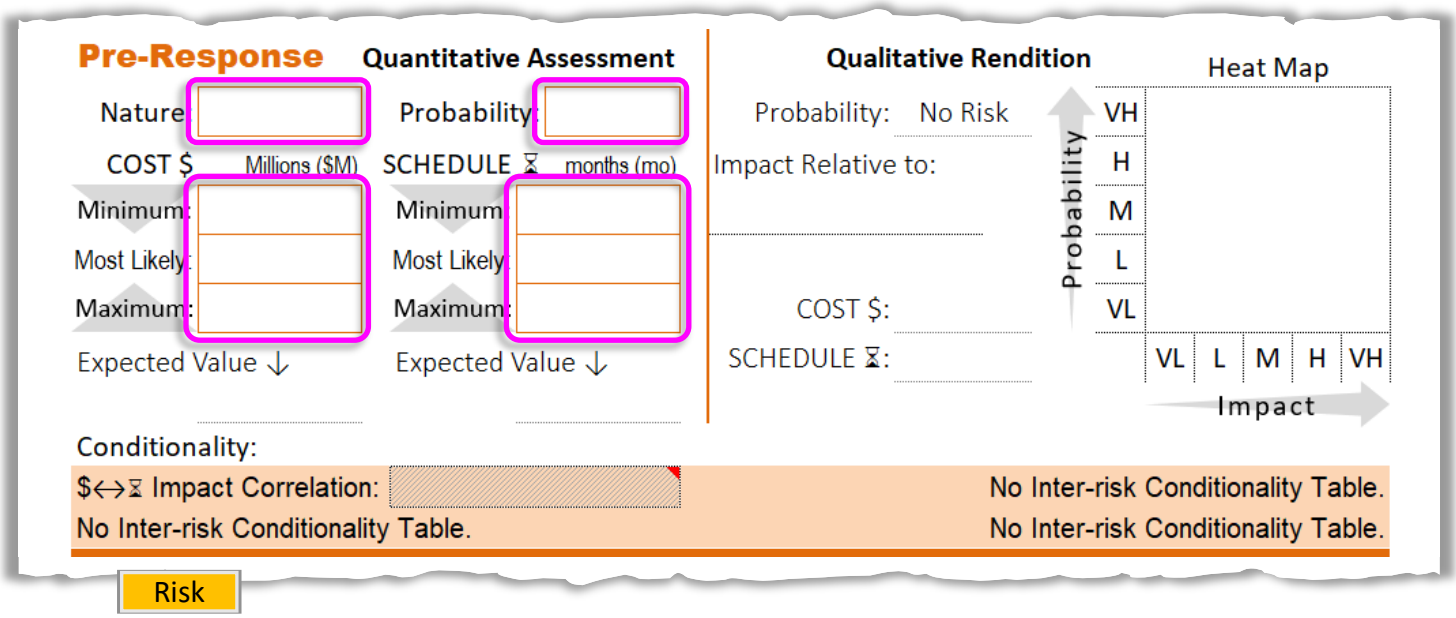
∘ Environmental	∘ Utilities	∘ Design / PS&E - Roadway, Hydraulics, etc.
∘ Structures & Geotechnical	∘ Right-of-Way	∘ Management / Funding
∘ Partnerships / Stakeholders	∘ Railroad	
∘ Contracting & Procurement	∘ Construction	

- RBS Code: (auto-filled) See *Risk ID* above. See *Building an RBS Risk ID* and *Appendix: Risk Breakdown Structure (RBS)*.
- MDL Code: (optional) is the Master Deliverable List ID of the affected deliverable.
- **Risk Title**: Enter a concise, descriptive title for the risk (the shorter the better).
- **Status**: (drop-down) marks change of risk potential as project progresses. Select:
  Active – The risk is included in the simulation; it should get a response; it should be monitored and controlled.
  Retired – The risk is excluded from the simulation; it is no longer relevant; it poses no threat (or opportunity) to the project. It is still listed in the Model Input Tables (RMP sheets).
- **Phase that it Impacts**: (drop-down) depends on chosen delivery method, see *Base Sheet* section; select the phase which the risk is likely to impact:

Design-Bid-Build	Design-Build
Pre-construction	Owner Concept
ROW	ROW
Construction	Design/Build

- Critical Path? (drop-down) The default is "Yes". Select Yes or No to indicate whether or not this risk affects an activity that has impact on the critical path of the project schedule.
- Detailed Description of Risk Event: Concisely describe the risk with enough detail so that its nature is clear to later readers. Description of risks are: Specific, Measurable, Attributable, Relevant, and Time-bound (SMART). The note fields at the bottom half of the worksheet can be used for additional details.
- Trigger: Enter a brief description of any event that must occur to initiate the risk's potential.

The next section is for entering data for the initial risk analysis:



Quantitative Assessment

- **Nature**: (drop-down) select whether the risk poses a:

  Threat – If the risk occurs, it will negatively affect project objectives.
  Opportunity – If the risk occurs, it will positively affect project objectives.

- **Probability**: Quantify the likelihood of the risk occurring. Enter a percentage %. Of course, 100% means the risk should be part of the Base Estimate, 50% is a coin toss — it could go either way, and 0% means there is no risk at all. The following guide offers qualitative renderings of probability ranges:

  0%—Very Low—**20%**—Low—**40%**—Moderate—**60%**—High—**80%**—Very High—**100%**

Make the following entries for Cost and Schedule in million-dollar units, or in months, respectively.

NOTE: Values are displayed in "Millions of dollars" ($M) and "Months" (mo). Less than a million dollars or less than a month is entered as a decimal. Examples:

$200,000 enter as .2 it is displayed as 0.20 $M	*1 week enter as .25 it is displayed as 0.3 mo*
$2,689,123 enter as 2.69 it is displayed as 2.69 $M	*3 months and three weeks enter as 3.75 displayed as 3.8 mo*
$23,000 enter as .023 it is displayed as 0.02 $M	*one and a half years enter as 18 it is displayed as 18.0 mo*

**COST $** — Expected impact range if risk occurs, in millions of dollars ($M). If the risk presents only a schedule impact, leave these blank.

- **Minimum**: Quantify and enter the value of the least cost impact.
- **Most Likely**: Quantify and enter the value of the most likely cost impact.
- **Maximum**: Quantify and enter the value of the greatest cost impact.

SCHEDULE ⧖ — Expected impact range if risk occurs, in months (mo). If the risk presents only a cost impact, leave these blank.

- **Minimum**: Quantify and enter the value of the least schedule impact.
- **Most Likely**: Quantify and enter the value of the most likely schedule impact.
- **Maximum**: Quantify and enter the value of the greatest schedule impact.

Pre-Response: Qualitative Rendering

This section interprets quantitative inputs of probability and impact into familiar qualitative terms and plots a depiction on an intuitive heat map. This is governed by settings in the Base Sheet, *RISKS Qualitative Translations* section.

- Impact Relative to: (auto-filled & drop-down) by default this plots the risk impacts relative to the phase selected in Phase that it impacts entry (above). The user may select "Project" from the drop-down to scale this risk's potential to the entire project instead of just its phase. The selection has no effect on the simulation.

Conditionality:

- $↔⧖ Impact Correlation: (drop-down) selection is for a more complex analysis; informs the simulation of correlation between the risk's cost impact and its schedule impact. See *Appendix: Conditionality* for more information.
- Supplemental Risk Information: (This box is located lower down on the form). Enter further notes or clarifications about the risk, its trigger(s), etc.

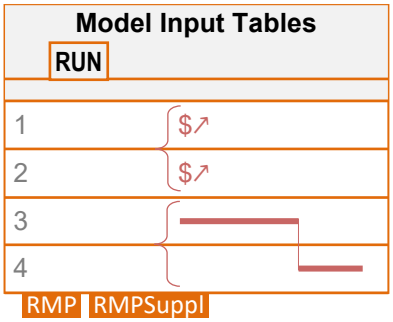
In practice, the user may continue to the Post-Response half of the Risk Form if data is available, but for orderly presentation in this guide, we will assume a project execution modelling workflow that focuses on a complete project risk analysis first, followed by a complete risk response analysis. This guide follows the diagram ***Using the PRAM: Basic Steps***.

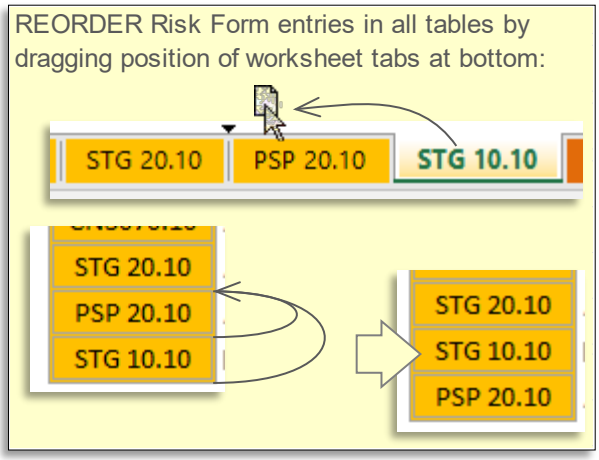
Enter the Next Risk

Go to the next blank Risk Form, or make another copy of the Risk Form template sheet, "**R-0**". Follow the same data entry instructions as above. Do this for each identified/assessed risk (up to 24). After all significant risks have been entered, go to the following step.

Model Input Tables

Go to the **RMP and RMPSuppl** sheets - this is where the model retrieves data, and from where the simulation is launched. All of the values necessary for modeling project execution are gathered from the various input forms and presented here in tables. This layout lends easy scanning for input errors, and it is recommended to do so before running the model. Base Estimate inputs are at the top of each sheet. The sheet titled **RMP** holds risks 1 – 12, and the sheet titled **RMPSuppl** holds risks 13 – 24. (If there are less than 13 risks, then only the RMP sheet is used.)





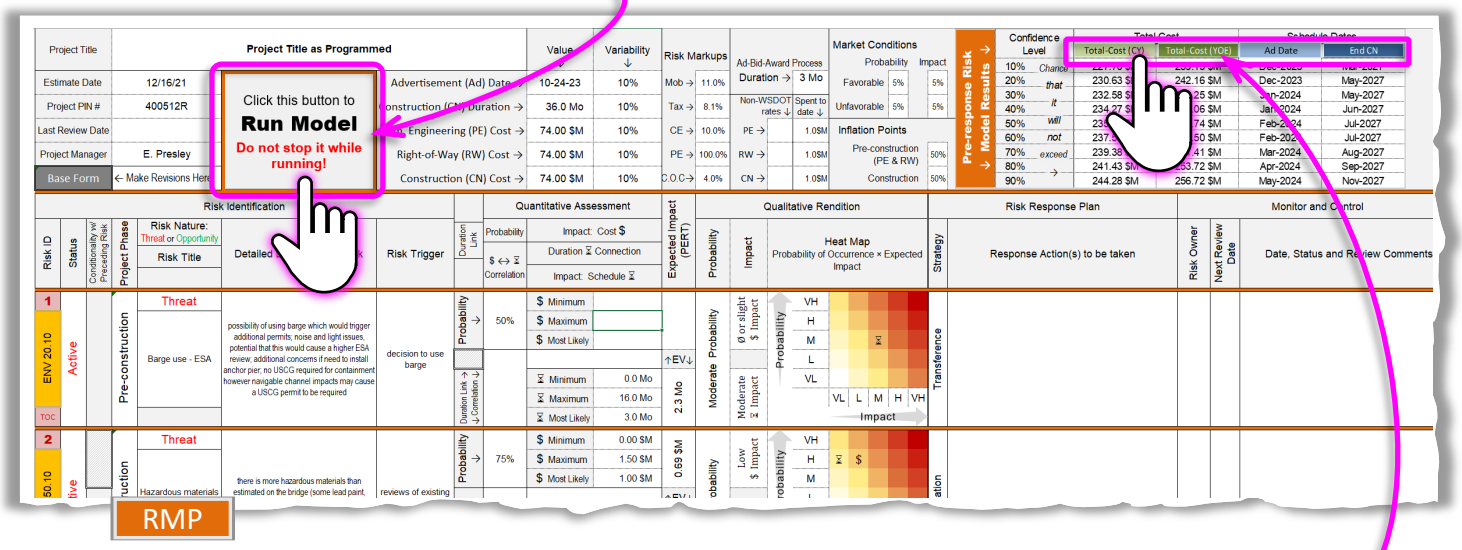
If for some reason the order of risks as they appear here is not as desired, it may easily be changed. (The Table of Contents order will follow also).

Conditionality (between risks)
Although not crucial to generating meaningful results in many cases, at this point the user may consider setting risk conditionality. See the later section on this topic for more details. The risks need to be in a particular order to suit conditionality.

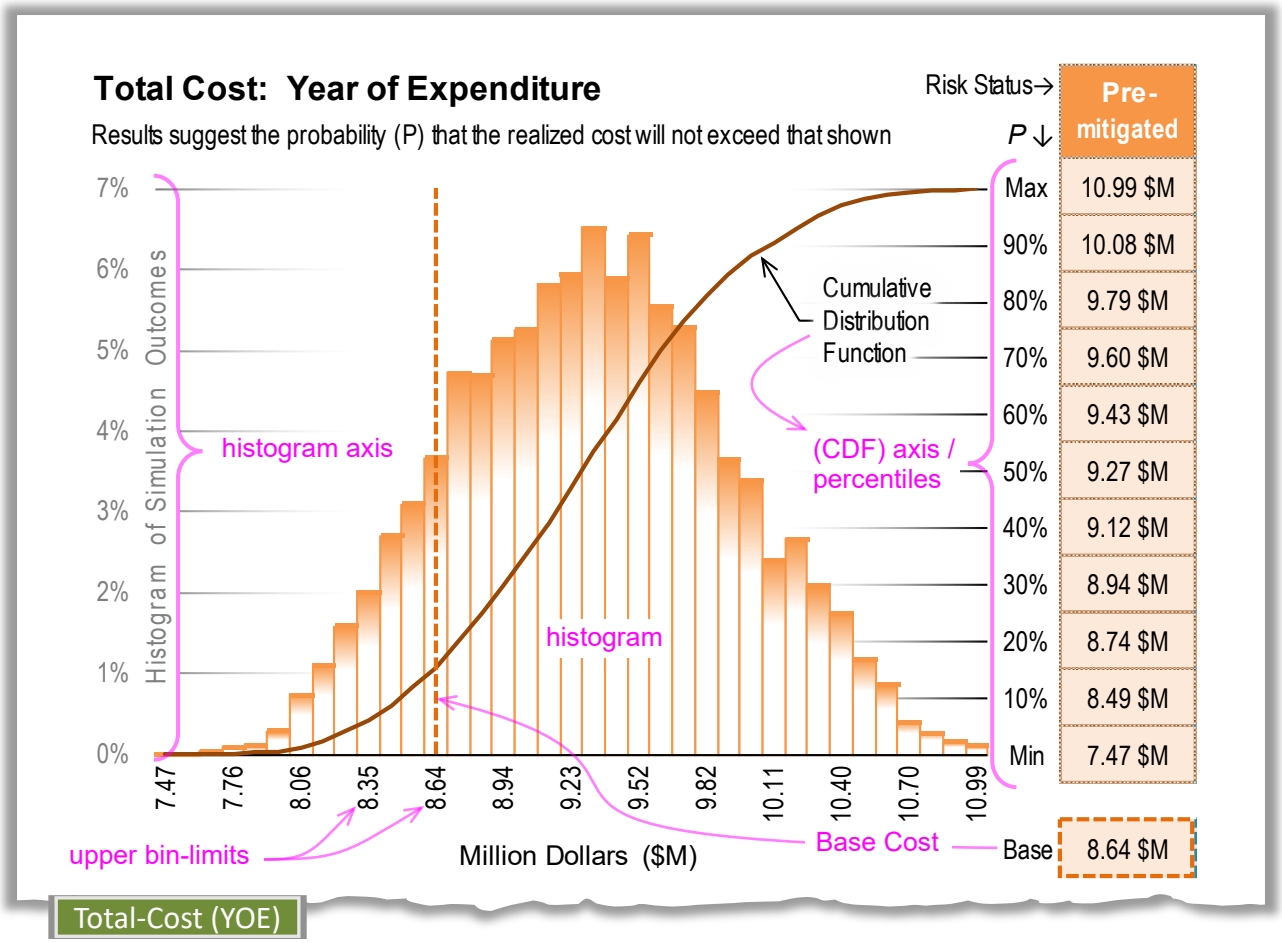
The user may reorder risk sheets by dragging their respective sheet tabs, but conditionality indicators will not automatically update to suit a new order. Any that were set before a reordering should be checked afterwards to ensure risks are still connected as intended.

Run the Project Risk Analysis Model

After checking the entries and setting conditionality, find the **Run Model** button near the top of the RMP sheet, "click" the button. The program will take a few minutes to run.



After running, the view orients on a basic output presentation at the top-right of the sheet. "Clicking" one of the green or blue tab-links near the top takes you to the respective output sheet, for example:



See Risk Analysis Output, below.

Risk Analysis Output

The model simulates 10,000 project realizations under the influence of entered risks, with resulting phase costs and dates. It renders these results into frequency distribution histograms of cost and date ranges. It does this by collecting resultant values into uniform bins (incremental ranges), then graphing them as columns, each with a height relative to the number of total outcomes that fall within the bin bounds. Bin maximums, in dollars or dates, mark the horizontal axis, with percent of outcomes shown on the vertical axis at left.

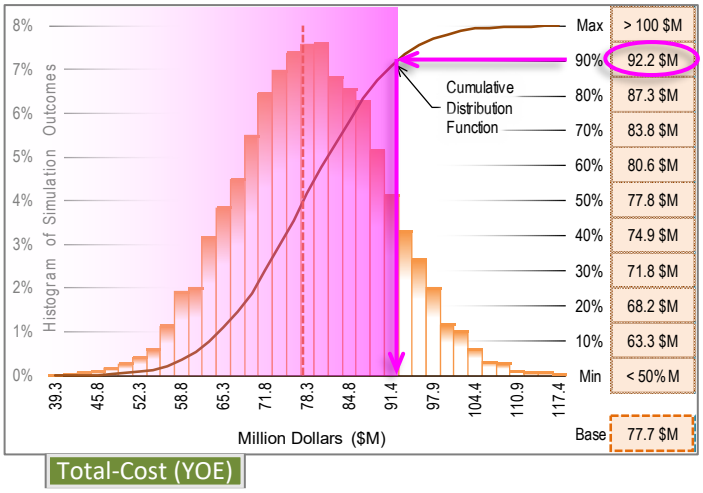
A typical graph looks like a mound, forecasting that the actual, real-life outcome will itself be somewhere near the middle of the mass. The table at right shows outcome values at regular percentiles, suggesting a confidence level that the project will be delivered under that value.

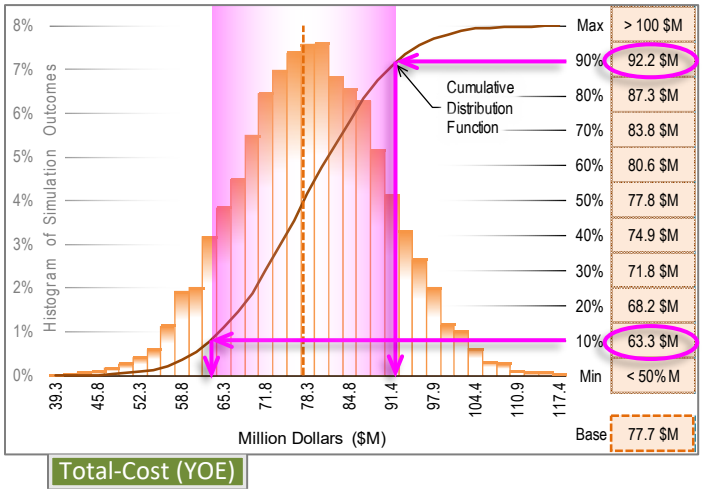
The results are also depicted with a Cumulative Distribution Function S-curve, which is the running total number (y) of outcomes with values at or below each upper bin limit (x). This shape lends insight into the aggregate project estimate simulated outcome.

For reference, the original base estimate appears as a vertical, dashed line, with input value shown below the table.

Confidence

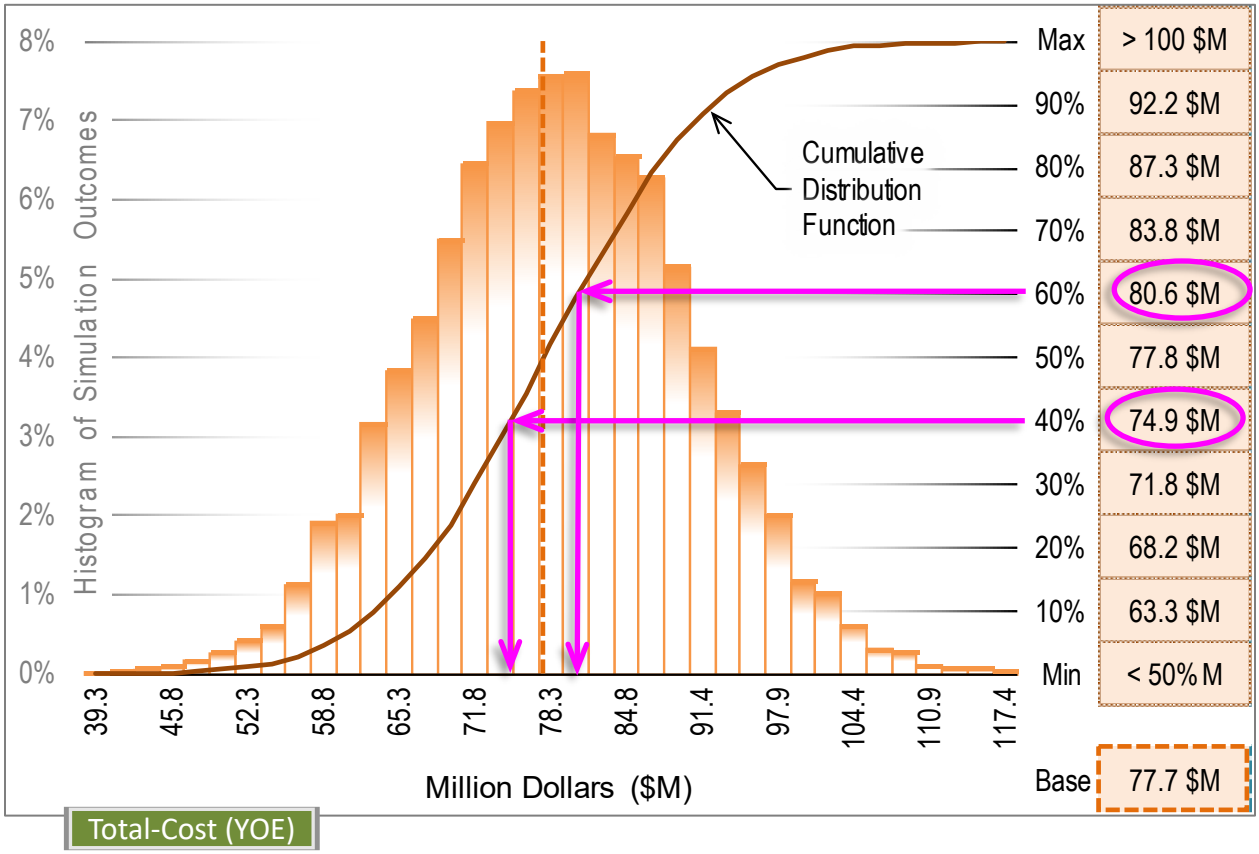
The model output not only forecasts a range of project outcomes, but also provides probability statistics that can be used to report a maximum outcome or narrower range at a select confidence level or interval. The first example below reports a 90% confidence that the project will be delivered at or below $92.2 million. The second example reports 80% confidence that the project will be delivered between $92.2 and $63.3 million.





Risk Reserve

Another use of model output is calculation of risk reserve. This depends on the risk tolerance of the agency. Direction for WSDOT (Executive Order 1053) is the sixtieth (60th) percentile minus the fortieth (40th). In the example below, Risk Reserve = 80.6 $M – 74.9 $M = 5.7 $M.



Notes

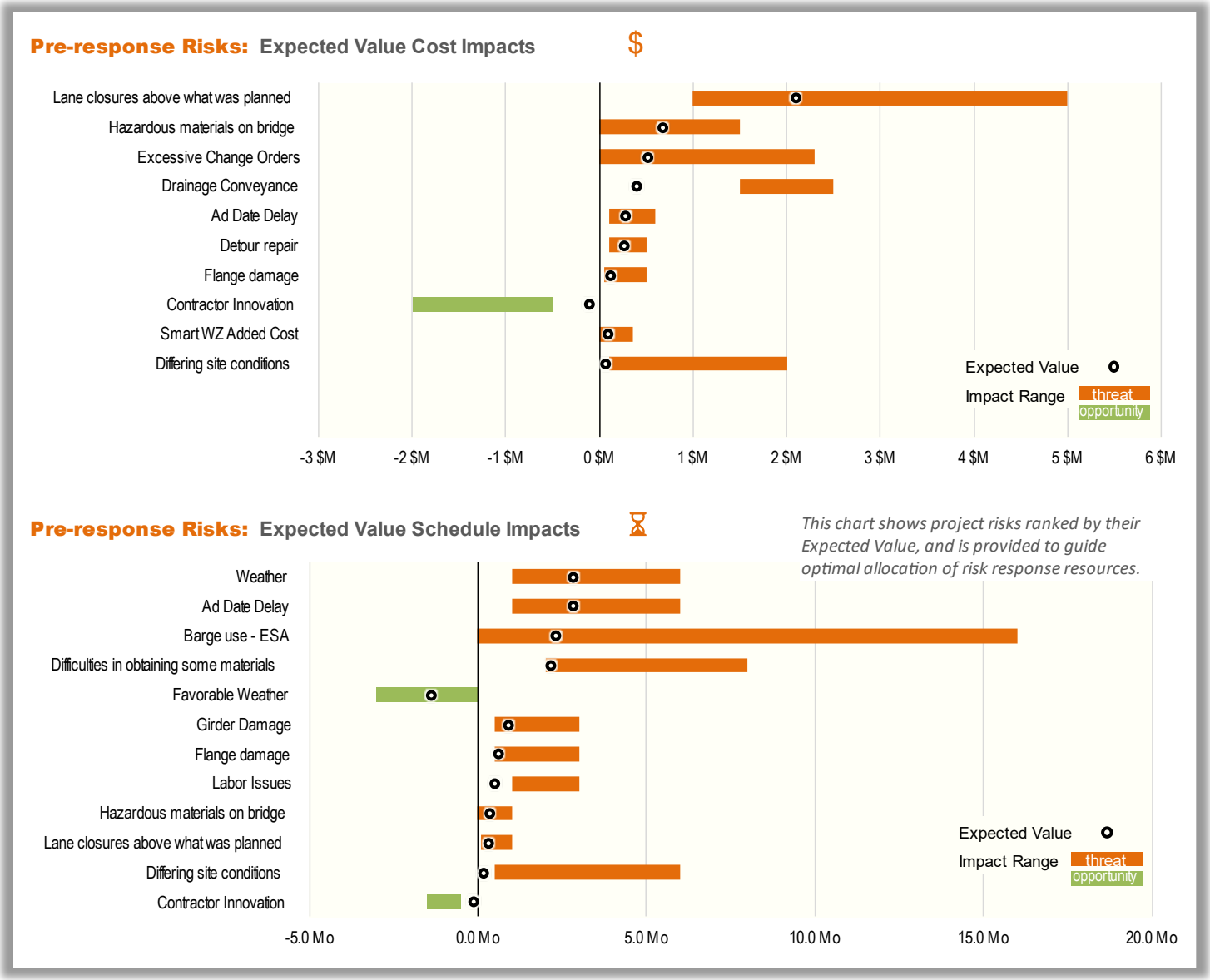
Tabular minimum and maximum values are not the limits of what is possible, but the range of this particular model run. The program replicates risk by generating random numbers. It does this fresh each run, so no two outcome sets will be the same; but the governing input bounds are the same, so the outputs will be similar. A subsequent run will likely show slightly different values.

Risks or market conditions with significant impact and probability may give the histogram another hump (mode), which is expected.

Risk Response

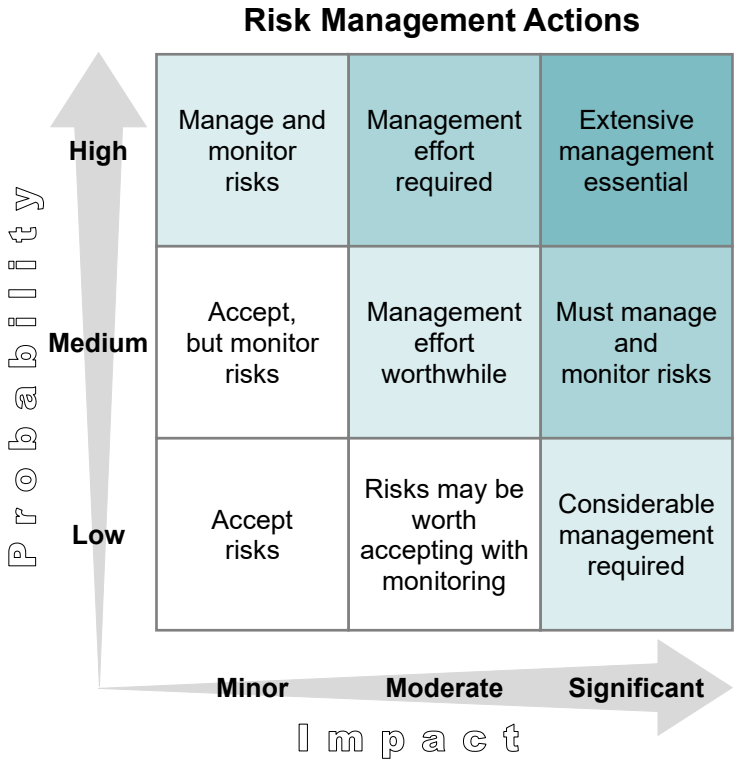
Risk response is where the true value of project risk management is realized. The Expected Value (EV) diagram sheet provides information for deciding how to prioritize and allocate risk management effort and resources.

In the example below, one would start at the top and go down as far as response is warranted, and resources allow; however, make exception for risks with low probability yet high impact—respecting Murphy's Law, "Anything that can go wrong will go wrong." Those that can go more wrong, that is, those having greater consequence should be given due attention despite likelihood.



Right-sizing the Risk Response

Response to a risk should be proportional to its likelihood and consequence.



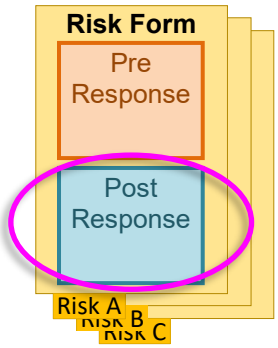
This activity is dedicated to risk response strategizing, and the orderly recording of the decisions, plans, and actions intended to counter the risks, either to lessen detrimental effects and likelihood of threats, or by taking advantage of opportunities.

While much of the brainstorming and ideas about how to respond to a risk naturally flow on the heels of identifying the risk in the first place, this guide assumes a workflow where all risk response is deferred until after the initial risk analysis is complete. This guide follows the diagram ***Using the PRAM: Basic Steps***.

Risk Response Strategies	
Threat Responses	**Opportunity Responses**
Avoid – actions to eliminate the risk and protect project objectives from risk impact. Example actions: • Change scope • Change requirements • Revise resource allocations such as cost or time.	**Exploit** – response actions taken to ensure the benefits of the opportunity are realized. Example actions: • Change timing of ad or construction • Modify work restrictions • Employ expertise that can make sure the opportunity is realized
Mitigate – reduce probability of occurrence or intensity of the impact. Mitigation is risk and project specific. Example actions: • Adjust activities and schedule • Change requirements • Perform additional investigation	**Enhance** – actions take to enhance an opportunity; actions that can increase probability or beneficial impacts. Example actions: • Adjust activities and schedule • Change requirements • Add features to trigger opportunity
Transfer – transfer activity to other responsible parties best able to address the risk and associated work. Example actions: • Contract work • Assign to other stakeholders • Procure insurance	**Share** – opportunity risks may be shared with parties positioned to help secure the benefits of the opportunity risk. Example actions: • Share ownership and allocate benefits among parties best able to make sure the opportunity is realized.
Acceptance of the risk All projects live with some level of risk and uncertainty. In many cases, even for identified risk events, the decision is made to accept the risk. The planned project is not changed due to the possibility of the risk occurring, nor is any response strategy adopted other than agreeing to address the risk if it occurs. Project managers should always monitor risks and project health during execution. If a risk appears imminent, communicate with leadership.	

Just as in quantifying risk analysis, the model needs numerical values to input, so the response activity includes quantifying changes resulting from response actions (assuming diligent risk plan execution and follow-through—risk monitoring and control). The post risk-response probability and impacts are entered in the model, and after running, will quantify the value of the risk (management) response itself.

Risk-Response Analysis Inputs



Risk Forms

Use the same Risk Forms used for input to the risk analysis, to input for analyzing risk-response.

Return to the risk sheets and go down to the **Post-Response** section. Make entries in fields as performed previously for the risk analysis.

Response Strategy: Risk Owner:

Response Description:

Post-Response **Quantitative Assessment**

Nature Probability

COST $ Millions ($M) SCHEDULE ⧖ months (mo)

Minimum: Minimum:

Most Likely Most Likely

Maximum Maximum

Expected Value ↓ Expected Value ↓

0.00 $M 0.0 mo

Qualitative Rendition

Probability: No Risk

Impact Relative to:

COST $:

SCHEDULE ⧖:

Heat Map

Probability: VH H M L VL

Impact: VL L M H VH

Conditionality:

$↔⧖ Impact Correlation:

No Inter-risk Conditionality Table. No Inter-risk Conditionality Table.

No Inter-risk Conditionality Table. No Inter-risk Conditionality Table.

Response Action(s) to be taken: (Include advantages & disadvantages) Action by date:

Risk

- **Risk Response**: (drop-down, governed by risk Nature) select from the respective strategies:

If a **Threat**:	If an **Opportunity**:
Avoidance	Exploitation
Transference	Share
Mitigation	Enhancement
Acceptance	Acceptance
Retired	Retired

Selecting "Acceptance" automatically populates the quantitative assessment fields with the values from the above, pre-response section. "Retired" allows you to omit the risk from the post-response model run, in cases where the risk has been dealt with, keeping it active in pre-response, and sparing the need to put zeros in the probability and impact fields.

- Risk Owner: Enter the name of the person responsible for managing this risk.
- Response Description: Enter a concise description of the response and reason for the strategy.

Post-Response: Quantitative Assessment

- **Nature**: (drop-down) this is usually the same as above — Threat or Opportunity.
- **Probability**: Adjust the probability according to the response strategy and plan. Assess performance and quantify the remaining probability assuming the plan will be fully executed and the risk effectively managed.

COST $ — Adjust the expected **Minimum**, **Most Likely**, and **Maximum** cost impact values according to the proposed response strategy and plan. Assess performance and quantify the remaining impact assuming the plan will be fully executed and the risk effectively managed.

SCHEDULE ⧖ — Adjust the expected **Minimum**, **Most Likely**, and **Maximum** schedule impact values according to the proposed response strategy and plan. Assess performance and quantify the remaining impact assuming the plan will be fully executed and the risk effectively managed.

Post-Response: Qualitative Rendition: This provides a qualitative, visual interpretation of risk probability and impact. The user may compare this heat map with the one above to observe difference in symbol placement proportional with anticipated post-response probability and impact quantifications.

- Impact Relative to: (auto-filled & drop-down) by default this follows the Phase that it impacts: entry (near the top of the form) and governs the Quantitative Rendition Heat Map to graph impacts relative to the phase. One may select "Project" from the drop-down to scale this risk's potential to the entire project instead of just the phase. The selection has no effect on the simulation.

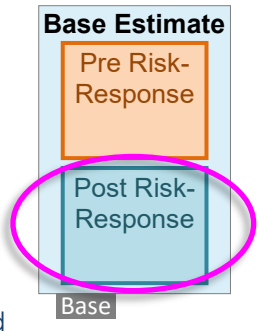
Conditionality:

- $↔⧖ Impact Correlation: (drop-down) selection is for a more complex analysis; informs the simulation of correlation between the cost impact and the schedule impact of the risk. See *Appendix: Conditionality* for more information. Revise this entry if affected by the response strategy and plan.
- Response Action(s) to be taken: Describe the action you will undertake in response to the identified risk.
- Action by date: Enter the date by which response action(s) need to be taken.
- Supplemental Risk Information: Enter further notes or clarifications about the risk, its trigger(s), etc. (This is further down the page and not shown above).

- Response Details: Enter further notes or clarifications about the risk response strategy, basic outline of the practical steps involved with monitoring and controlling the risk, etc. (This is further down the page and not shown above).
- Risk Monitoring and Control: As project execution progresses, journal the actions taken, status, and review comments regarding this risk. Date and stack entries on top of one another to retain history. (This is further down the page and not shown above).
- Next review date: Enter the date when the risk is due for review as part of risk monitoring and control. (This is further down the page and not shown above).

Base Estimate sheet Post Risk-Response

The same worksheet for project risk analysis Base Estimate entries is used to input for Post Risk-Response modelling — on the lower section of the page.



After carefully developing response strategies for all risks as warranted, and quantifying the expected, remaining probabilities and impacts, one may find that some of the responses, however beneficial in the long run, come at a price up-front. Of course, an estimated benefit/cost ratio less than 1 is not optimal use of resources.

There may also be instances where brainstorming about risks and risk-response has led to some impromptu Value Engineering (VE) — or VE may be integrated and result in scope adjustment and/or quantified costs or savings to the project.

The Response Base Estimate is to account for any changes to the initial Base Estimate. The total of all response expenses, per project phase, should be added to the respective phase estimate. When there is no change, values are referenced in from the initial Base fields, above. These may be revised/over-written; doing so automatically highlights the change for ease of comparing the two estimates.

RISK MODEL
Post-response
Project Title as Programmed
Date:

Base Estimate
State Route: Mileposts:
Project Manager: PIN #: WIN #:
Estimate Prepared by: Model Start Date: *08-01-22*
Estimate Date: BOE Date: Review Date: Delivery Method: *DBB*

COST $ **Base Estimate** Non-WSDOT Inflation Rates

	Millions ($M)	Spent to Date ↓	↓
Conceptual Design:	*0.90 $M*	CD: *0.11 $M*	CD:
0.71 $M ←	*10%*	→ 0.87 $M	
	Variability		
Right of Way:	*1.05 $M*	RW:	RW:
0.95 $M ←	*10%*	→ 1.16 $M	
	Variability		
Design/Build:	*7.12 $M*	D/B:	D/B:
6.76 $M ←	*5%*	→ 7.48 $M	

Minimum — Variability — Maximum

8.42 $M | 8.96 $M | 9.50 $M ← Estimate to Complete Range[2]

Market Conditions

	Probability	Impact
Favorable:	*5%*	*5%*
Unfavorable:	*15%*	*15%*

Inflation Points

Owner Concept (CD & RW):	*50%*
Design/Build:	*50%*

Risk Markups

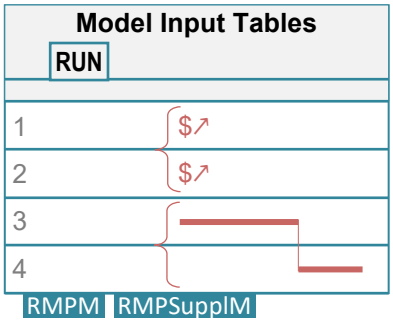
Mobilization:	*10.0%*
Sales Tax:	*8.00%*
Preliminary Engineering:	*12.6%*

Base

RMPM and RMPSupplM sheets

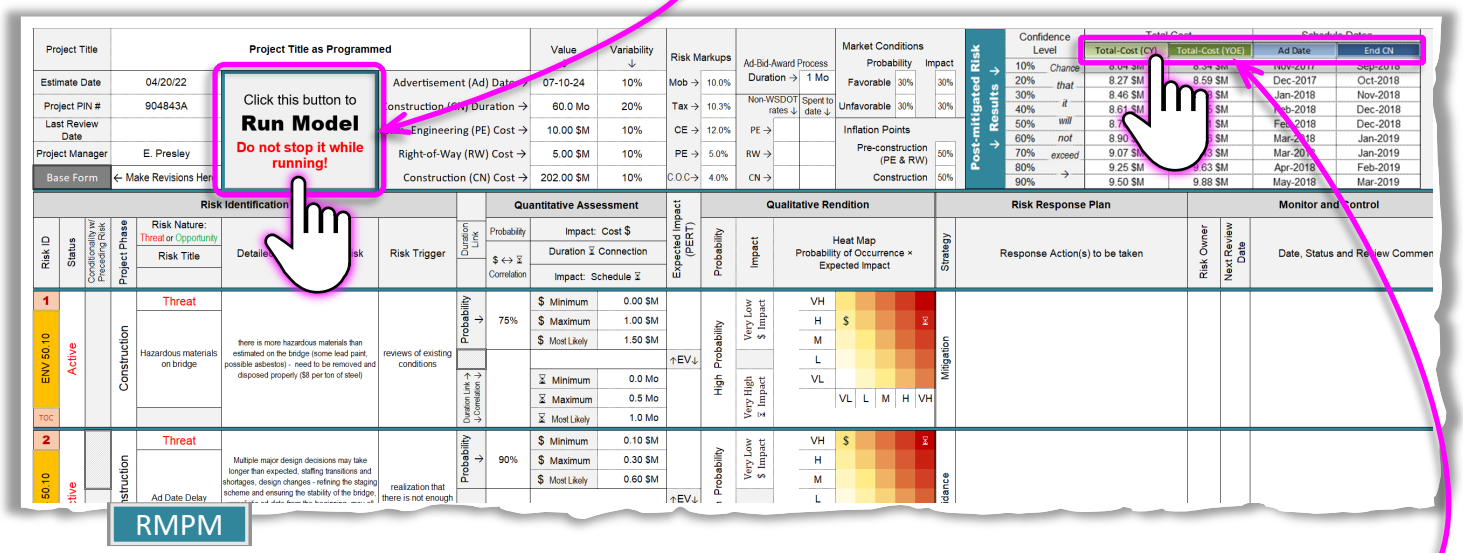
At this point, go to the post risk-response Model Input Tables and adjust any inter-risk conditionality that may have changed due to response plans affecting one or more of the associated risks.

It is also possible that response strategies now anticipate a significant conditionality between risks. Read the Conditionality section, later in this guide, before making these settings.

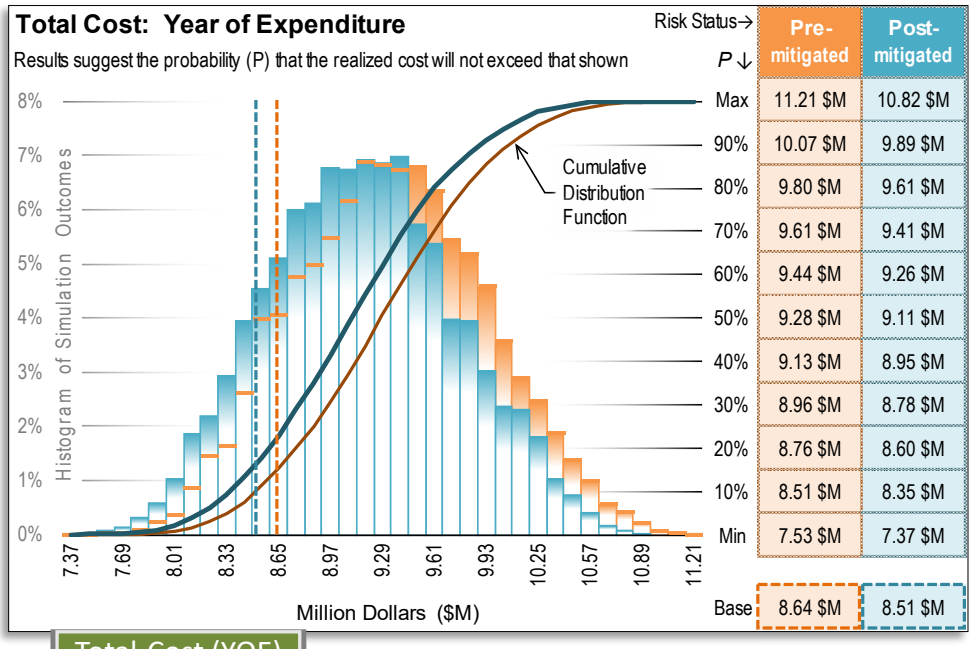


Running the Risk Response Model

After adjusting conditionality and checking the Base and Risk entries, "click" the **Run Model** button near the top of the RMPM sheet. The program will take a few minutes to run.



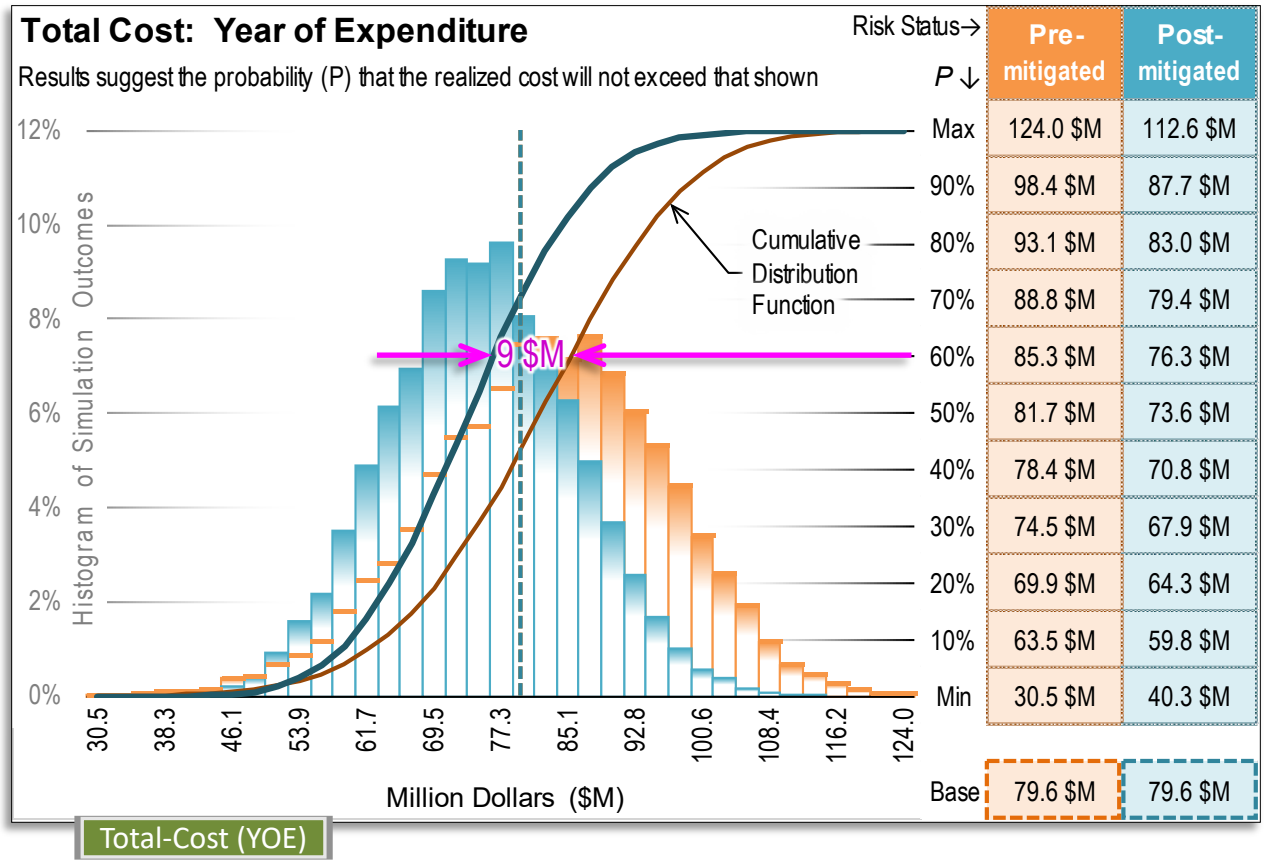
After running, the view orients on a basic output presentation at the top-right of the sheet. "Clicking" the green or blue "buttons" near the top, will take you to the respective output sheet, for example:



After running the risk-response analysis — the second part of this comprehensive risk management process — using the initial risk analysis result as a backdrop, the tool displays pre and post results in the same report. This facilitates ease of comparison, the difference being the speculated value of active risk management on the project (at a select percentile). Color-coding provides instant recognition of pre-response and post-response results:

ORANGE = Risk Analysis (pre risk-response) results
BLUE = Risk-Response Analysis (active risk management) results

The following example shows results of pre and post risk response analysis:



The difference between a select percentile offers a quantification of the value of diligent risk management on the project. For example, the sixtieth (60th) as shown above, promises $9 million, that is $85.3 minus $76.3 million.

Notes

It is expected that the graph of the risk analysis results alone will look somewhat different after the risk-response analysis run. Besides the obvious addition of another histogram and S-curve, the bin limits will adjust to cover the whole outcome spectrum of both runs, likewise the y-axis/% labels. This is because the report uses the same number of bins to cover the added range. It is a graphical artifact and makes no difference to the validity of the statistics presented in either set.

The risk-response result plots on top of the risk analysis. In many response scenarios, the base estimate does not change. In that case the base estimate appears as only a dashed, blue, vertical line (the orange is underneath it at the same value).

Appendix: Risk Breakdown Structure (RBS)

The Risk Breakdown Structure (RBS) provides a consistent approach for organizing risks.

Download a copy here: *https://wsdot.wa.gov/sites/default/files/2021-10/RiskBreakdownStructure.pdf*

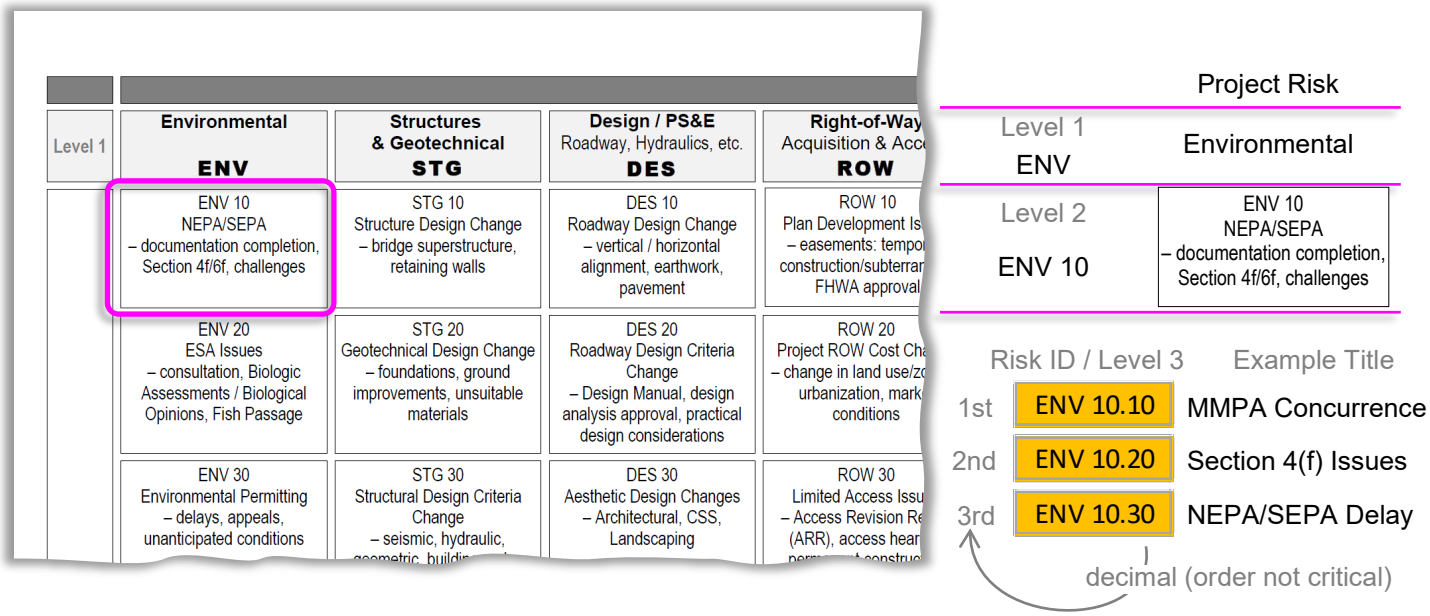
The RBS is a list of common transportation project risks organized in a hierarchical matrix by category and subcategory. Besides promoting a consistent risk identification system, it can serve as a prompt for risk elicitation.

The RBS provides several functions and benefits to the project team and to management, including:

1) Consistency with taxonomy (wording)
2) Organizes risk events into common categories
3) Helps identify trends with respect to common usage of risk event categories and event types, along with their probability and impact values
4) Helps to identify common risk events among projects that the Region and Headquarters offices should be aware of due to their potential cumulative effects, for example, negotiating agreements with agencies or other municipalities
5) Provides a basis to work from for risk assessment and risk elicitors during workshops
6) Provides a basis for development of independent risk surveys for those unable to attend a workshop

For more information regarding the RBS, see the *Project Risk Management Guide* for additional details.

Risk Breakdown Structure — Example application



RISK BREAKDOWN STRUCTURE

Major Project Risks

Level 1	Environmental **ENV**	Structures & Geotechnical **STG**	Design / PS&E Roadway, Hydraulics, etc. **DES**	Right-of-Way Acquisition & Access **ROW**	Utilities **UTL**	Railroad **RR**	Partnerships & Stakeholders **PSP**	Management / Funding **MGT**	Contracting & Procurement **CTR**	Construction **CNS**
Level 2	ENV 10 NEPA/SEPA – documentation completion, Section 4f/6f, challenges	STG 10 Structure Design Change – bridge superstructure, retaining walls	DES 10 Roadway Design Change – vertical / horizontal alignment, earthwork, pavement	ROW 10 Plan Development Issues – temporary construction easements, subterranean easements, FHWA approval	UTL 10 Plan Development Issues – design coordination, agreements	RR 10 Plan Development Issues – design coordination, agreements, right-of-entry	PSP 10 Tribal Issues	MGT 10 Project Management Issues – change in managers / other key leadership	CTR 10 Project Delivery Method – changes or issues	CNS 10 Traffic Control & Staging – MOT / WZTC, multimodal traffic management
	ENV 20 ESA Issues – consultation, Biologic Assessments / Biological Opinions, Fish Passage	STG 20 Geotechnical Design Change – foundations, ground improvements, unsuitable materials	DES 20 Roadway Design Criteria Change – Design Manual, design analysis approval, practical design considerations	ROW 20 Project ROW Cost Change – change in land use/zoning, urbanization, market conditions	UTL 20 Practical Issues (in the field) – relocation, conflicts, discoveries	RR 20 Construction Coordination Issues – flagging, work restrictions / windows, right-of-entry requirements	PSP 20 Public Involvement Issues	MGT 20 Delay – indecision, submittal review	CTR 20 Contract Language Issues – contract packaging, warranties, liquidated damages, DBE, insurance/bonding	CNS 20 Construction Permitting – work restrictions
	ENV 30 Environmental Permitting – delays, appeals, unanticipated conditions	STG 30 Structural Design Criteria Change – seismic, hydraulic, geometric, building codes	DES 30 Aesthetic Design Changes – Architectural, CSS, Landscaping	ROW 30 Limited Access Issues – Access Revision Report (ARR), access hearing, permanent construction easement		RR 30 Property Rights Issues – challenges in acquiring from RR, considerations for delivery method (DB vs DBB)	PSP 30 Scope / Design Changes – artwork, shared-use pathways, arterial/intersection improvements	MGT 30 Funding – availability, cash flow restrictions	CTR 30 Contract Procurement Process Issues – addenda / extensions, protests	CNS 30 Work Window Coordination – weather, in/over-water
	ENV 40 Discoveries – cultural resources (Section 106), historic property impacts & mitigation	STG 40 Geotechnical Design Criteria Change – soil stabilization, hydraulic, codes	DES 40 Hydraulic Design Changes – flow control, water quality, criteria changes	ROW 40 Managed Access Issues – appeal hearing			PSP 40 Interagency Issues (Sound Transit, USFS, cities, counties, etc.) – design coordination, agreements	MGT 40 Political / Policy Changes	CTR 40 Market Conditions – non-competitive bidding environment, lack of qualified bidders, bids exceed upset price or budget	CNS 40 Schedule Uncertainty (general)
	ENV 50 Hazardous Materials – groundwater / soil contamination, building / structure abatement		DES 50 Traffic Design Changes – ITS, Illumination, Signals, intersections	ROW 50 Acquisition Issues – appraisals, condemnation, relocations, demolitions			PSP 50 Multimodal Considerations – design coordination, agreements, bicycle, pedestrians, transit	MGT 50 State Workforce Limitations	CTR 50 Procurement Delays & Premiums – specialty materials / equipment, "Buy America"	CNS 50 Marine / Over-Water
	ENV 60 Habitat Mitigation Issues – wetlands / stream / floodplain		DES 60 WSDOT Initiated Changes – maintenance request, change to purpose and need					MGT 60 Project Phasing / Packaging Changes	CTR 60 Contractor Performance Issues – productivity, quality	CNS 60 Constructability (non-geotech or marine) – site access, staging / material handling, differing site conditions, etc.
	ENV 70 Environmental Justice (disadvantaged communities) – traffic mgmt, access, temp construction impacts		DES 70 Tolling Design Changes – infrastructure requirements, toll collection, back-office					MGT 70 Inadequate Quality Verification – VECP, ATC, review error	CTR 70 Labor Issues – availability of specialty labor, labor / productivity disruptions	CNS 70 Material Handling / Earthwork Issues – re-use, haul, disposal
	ENV 80 Construction Impacts – water quality, TESC		DES 80 External Initiated Changes (contractor or other party) – innovation, ATC						CTR 80 Schedule Uncertainty – timing of award	CNS 80 Adjacent Projects – coordination among contractors, limited staging, sequencing
	ENV 90 Noise (permanent mitigation)		DES 90 ADA – curb ramp modifications require R/W, MEF approval							CNS 90 Site Security – vandalism, encampments, damage
										CNS 100 Construction Accidents
	ENV 900 Other ENV Issues	STG 900 Other STG Issues	DES 900 Other DES Issues	ROW 900 Other ROW Issues	UTL 900 Other UTL Issues	RR 900 Other RR Issues	PSP 900 Other PSP Issues	MGT 900 Other MGT Issues	CTR 900 Other CTR Issues	CNS 900 Other CNS Issues – change orders, disputes, claims

Using the Risk Breakdown Structure (RBS)

Each project is unique and has a specific project risk profile. Examples provided are an aid to identify risk types and are not to be considered complete or exclusive. Develop project risk registers by identifying and assessing risks for the project under review.

The RBS provides several functions and benefits, including:

1) Consistent risk organization, approach and taxonomy (wording).
2) Common standard categories.
3) Allows for identification of trends (risk event categories, types and characteristics).
4) Offers a basis for initiating risk identification and elicitation.
5) Eases the ability to conduct risk surveys for those unable to attend workshops

For more information regarding the RBS, see the Project Risk Management Guide.

Note: decision-makers may have other enterprise level considerations that are difficult to quantify, such as: trust, credibility, safety, and reputation of the organization.

ATC Alternative Technical Concept
CSS Context Sensitive Solution
DB Design - Build
DBB Design - Bid - Build
DBE Disadvantaged Business Enterprise
ESA Endangered Species Act
ITS Intelligent Transportation System
MEF Maximum Extent Feasible
MOT Maintenance of Traffic
NEPA National Environmental Policy Act
SEPA State Environmental Policy Act
TESC Temporary Erosion & Sediment Control
VECP Value Engineering Change Proposal
WZTC Work Zone Traffic Control

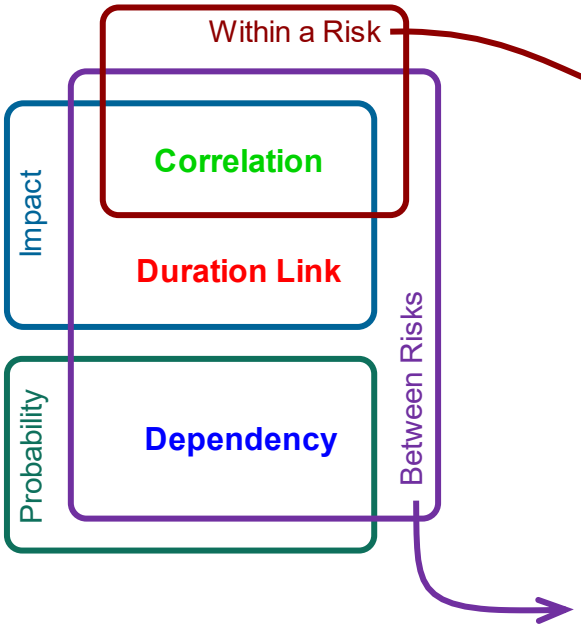
Appendix: Conditionality

Refining the base estimate and identifying significant risks are most essential to project risk analysis, but a thorough assessment gives some attention to interactions between risks. To a degree, this model can accommodate some common risk relationships. The "Conditionality" risk relationships described here are limited to the model's capability. Further study of this subject equips one for more comprehensive risk assessment. Awareness of conditionality informs and forewarns the project team, allowing more pro-active, response options. The types of conditionality covered here are Correlation, Dependency, and Duration Link.

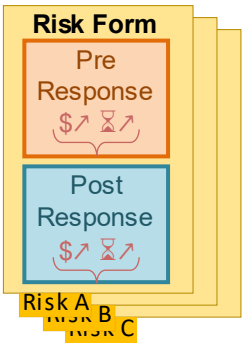
Conditionality

As handled by the model

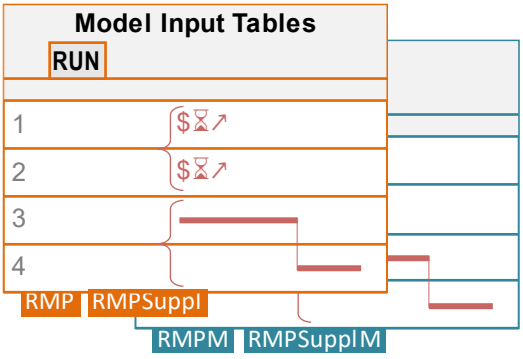
Types by risk component and extent:



Where to enter:



Correlation between cost $ and schedule ⧖ impact within a risk event is recorded in the Risk Form. (This is the only conditionality that is captured in the Risk Form).



Conditionality between risks: Correlation, Duration Link, and Dependency are entered in the Risk Tables.

Correlation

Describes an expected parity or disparity of impact severity. Positive Correlation marks the expectation that if a certain risk occurs and its impact is high (↗), then the impact of a certain other risk, if it occurs, will tend toward the high end of its input range (↗); similarly, if it strikes low (↘), the other will tend low (↘). Negative Correlation marks the expectation that if a certain risk occurs and its impact is high (↗), then the impact of a certain other risk, if it occurs, will tend toward the low end of its input range (↘); if it hits low (↘), the other will tend high (↗).

Shorthand:

Positive Correlation: ↗↗ or ↘↘

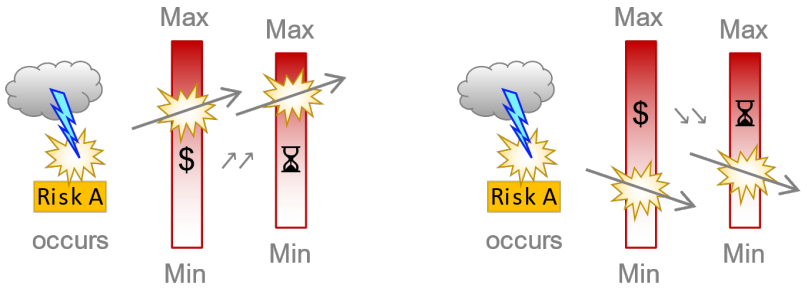
Negative Correlation: ↗↘ or ↘↗

Examples

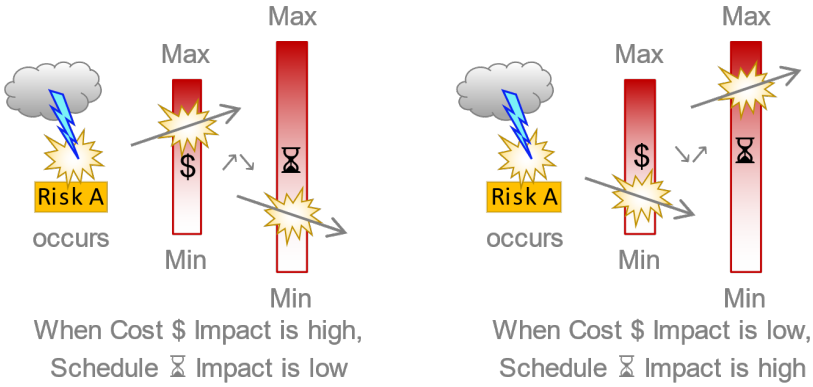
1) Zebra herds crossing a river in Africa. High water means crocodiles are less visible and more mobile. The expectation is that when crossing, if the water is high, death by predation is high — positive correlation. This expectation is reasonable even if there happen to be no crocodiles at the crossing that year, or they are already full — no actual crocodile strikes. If the crossing meets shallow water, the expectation is fewer zebras lost.
2) The higher the Nile floods, the more arable land is available for cultivation — positive correlation.
3) As prices go up, consumption goes down — negative correlation.
4) More excavation may be required at this end of the project, but if the material is suitable, it means less importation for the fill at the other end — negative correlation.

Correlation between Cost and Schedule Impacts (within a single risk)

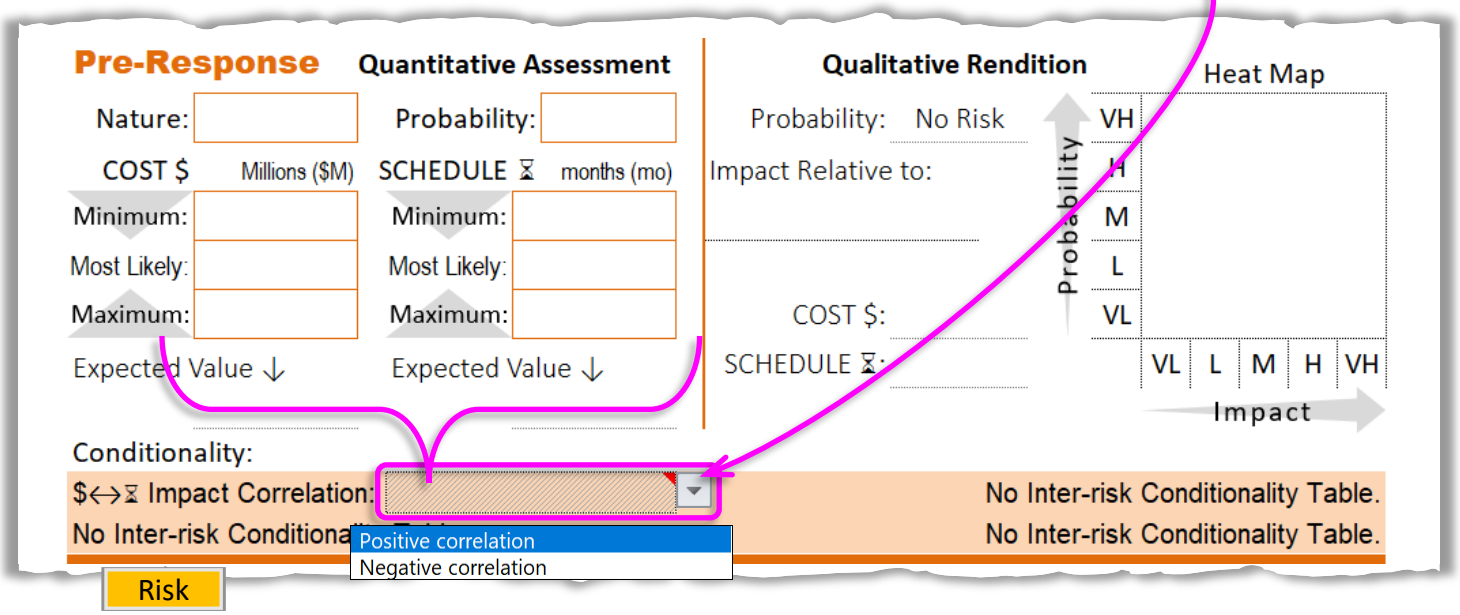
Risk A with Positive Cost and Schedule Impact Correlation: $ ↗⧖↗ or $↘⧖↘



Risks A with Negative Cost and Schedule Impact Correlation: $ ↗⧖↘ or $↘⧖↗

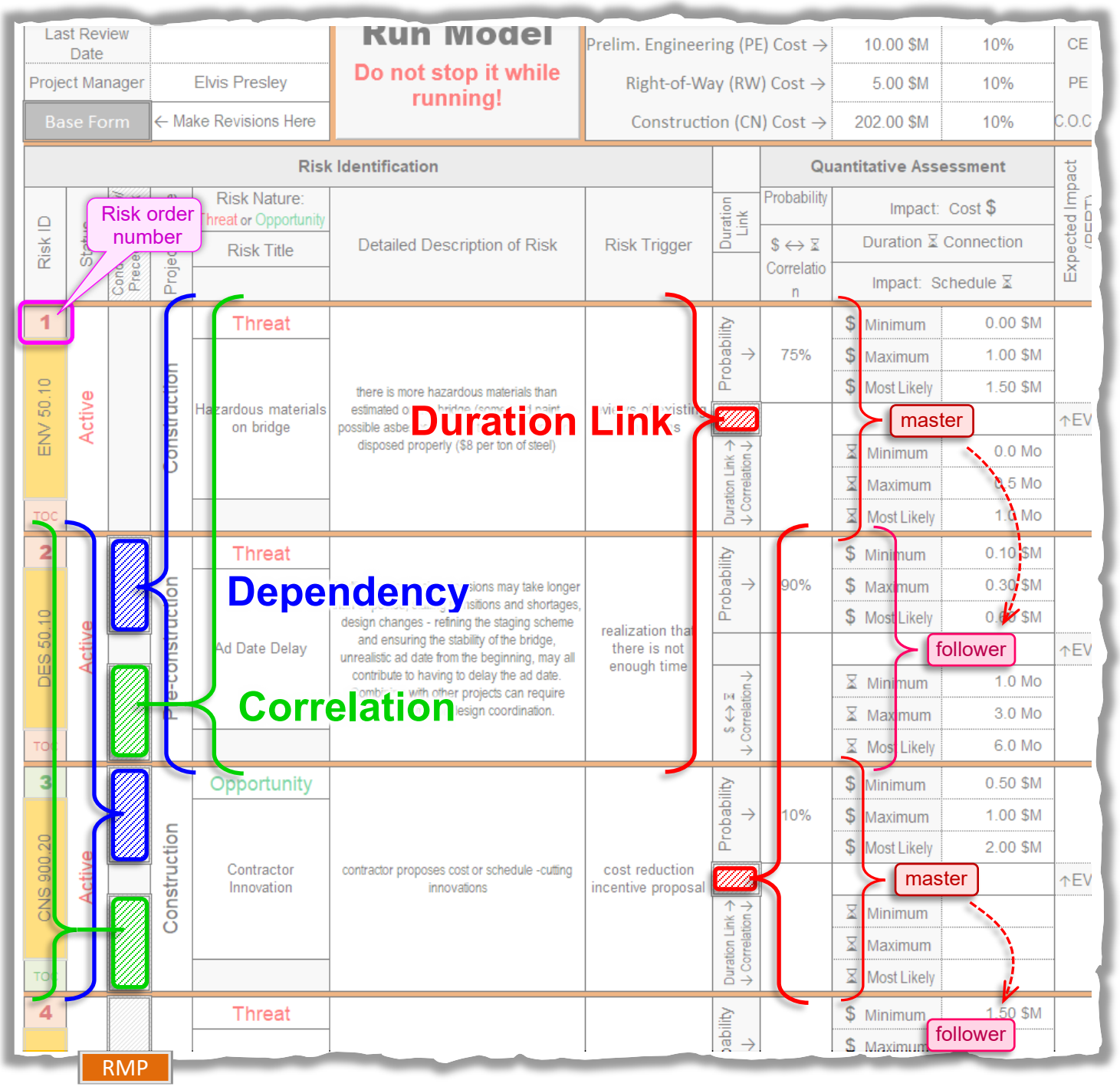


Correlation within a single risk, between cost impact ($) and schedule impact (⧖) — Positive: $↗⧖↗ or $↘⧖↘, or Negative: $↗⧖↘ or $↘⧖↗ — is noted on the individual risk sheet.



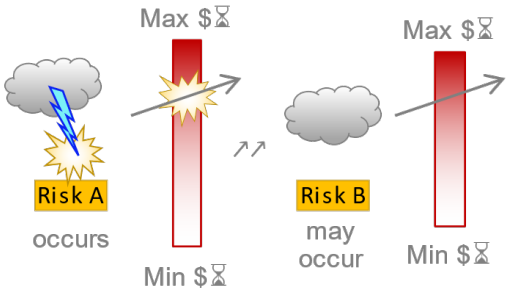
The default value is <blank> (no, unknown, or uncertain correlation). The dropdown selections affirm correlation while telling which type.

Where to enter inter-risk conditionality:

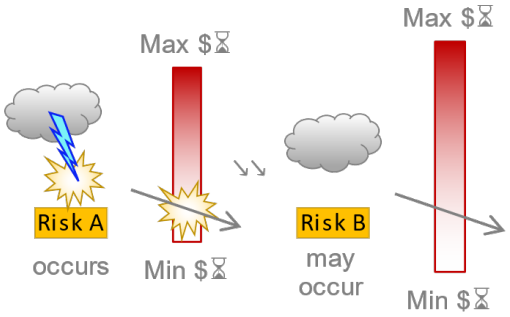


Correlation between Risk Impacts (between risks)

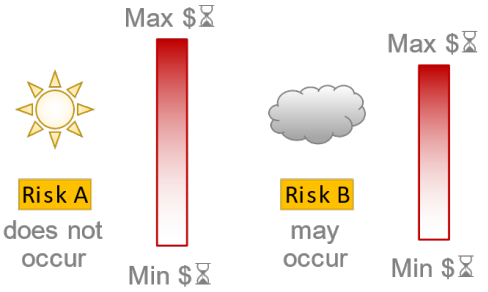
Risks A and B with Positive Impact Correlation: $⧖↗$⧖↗ or $⧖↘$⧖↘



If Risk B occurs, the impact will be high

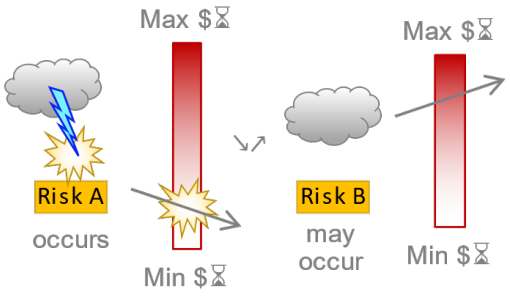


If Risk B occurs, the impact will be low

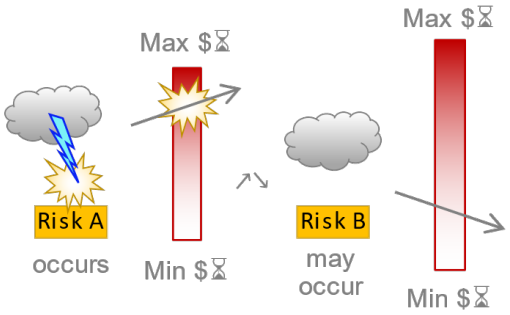


If Risk B occurs, the impact is free-range

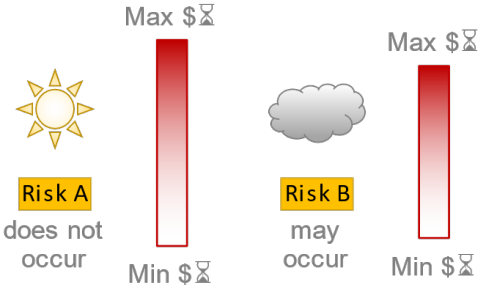
Risks A and B with Negative Impact Correlation: $⧖↗$⧖↘ or $⧖↘$⧖↗



If Risk B occurs, the impact will be high

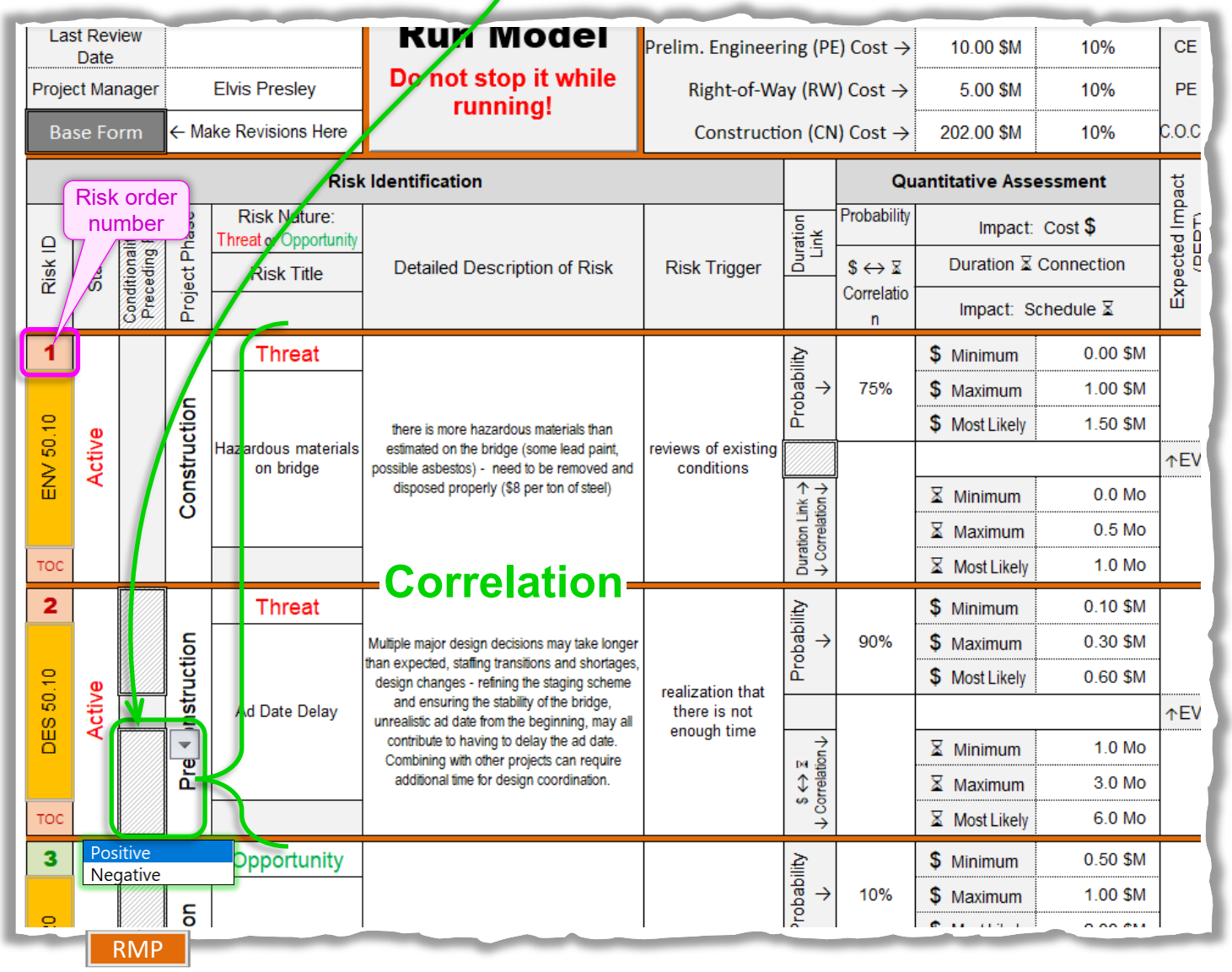


If Risk B occurs, the impact will be low



If Risk B occurs, the impact is free-range

Impact correlations between risks are set in the Model Input Tables: (in lower field)



Note: The program assumes the **correlation between risks is driven by the preceding risk of a sequence on the list**: #1 governs #2, #17 governs #18, etc. **— risks must be ordered accordingly**. Note: the first batch of 12 risks cannot be connected to the second batch, 13 – 24, so #12 cannot govern #13.

The user may reorder risk sheets by dragging their respective sheet tabs, but conditionality indicators will not automatically update to suit a new order. Any that were set before a reordering should be checked afterwards to ensure risks are still connected as intended.

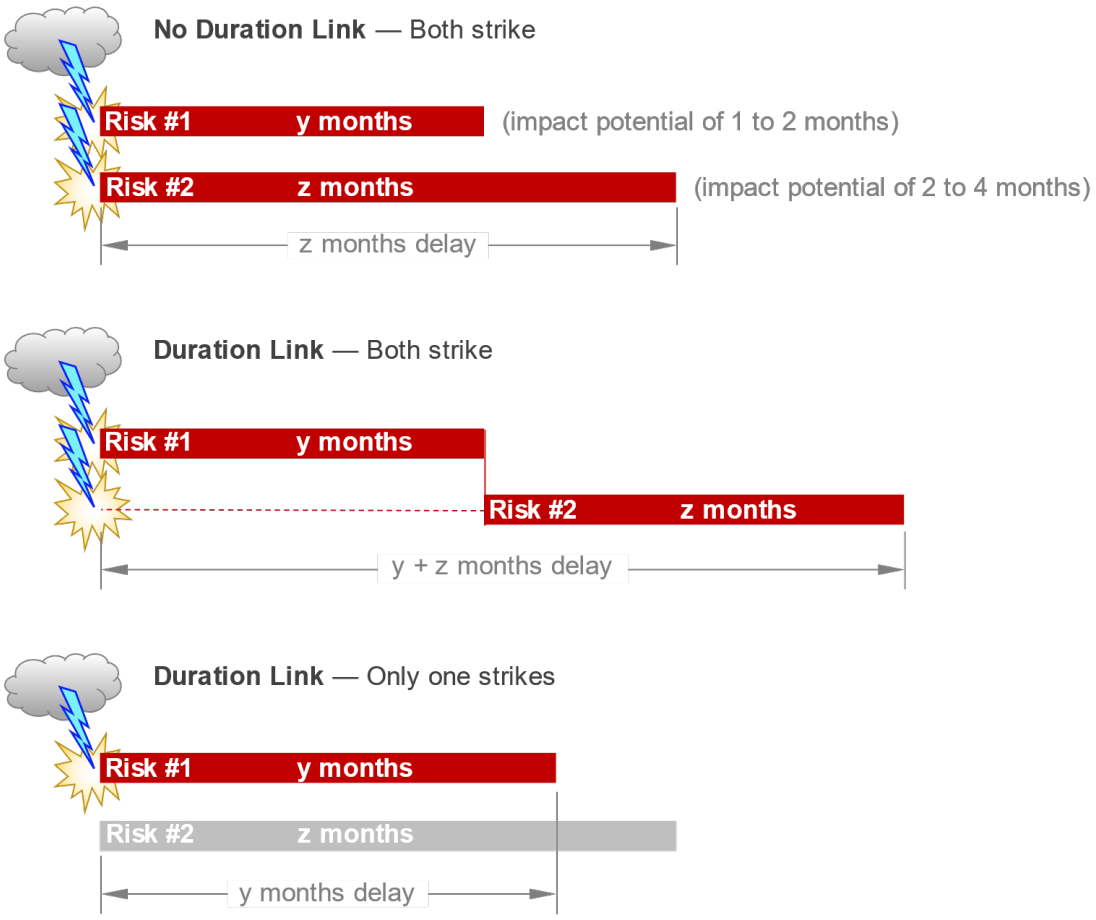
The initial risk randomly selects an impact severity within its input range — if it randomly occurs. If the initial risk does not occur, then the following risk is free to impact randomly over the full range of its input bounds — if it strikes.

Duration Link

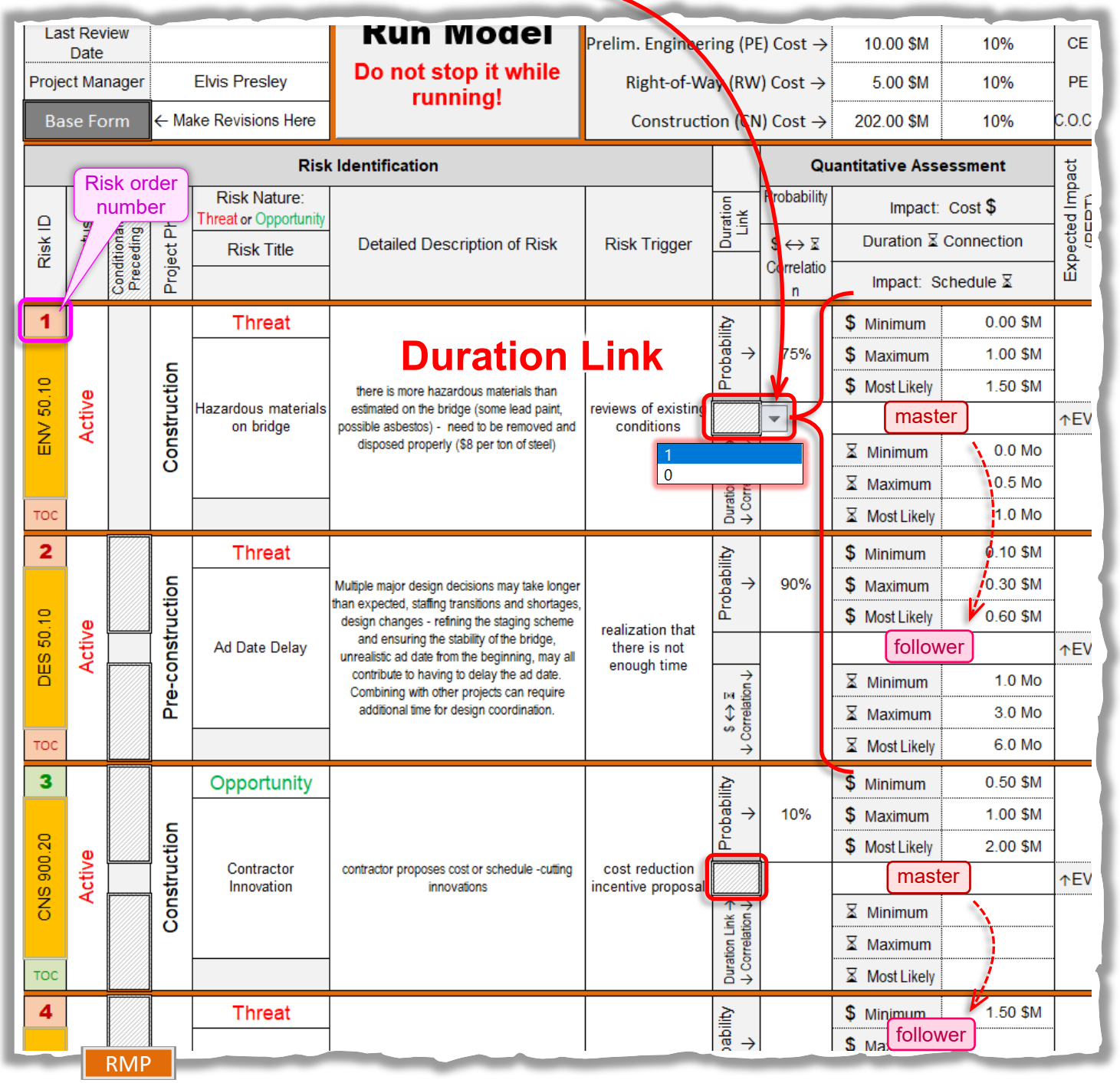
This simply means that if both risks occur the program adds both their duration impacts against the schedule base estimate (in "series"). This again is about impact or consequence, not about probability of occurrence.

Illustration

y and z depict randomly generated durations, selected within entered (quantified) impact bounds (minimum, maximum, and most-likely).



Duration Link is set in the Model Input Tables:



The default value is "0" (no, or unknown Duration Link). The dropdown selection of "1" affirms a link with the risk just below on the list. Indicator fields confirm the link.

The model is limited to pairs of sequential risks, as listed in the Model Input Tables. One signifies duration link from a "Master Duration Risk" on the list to the next down on the list. Link #1 and #2 from #1, #17 and #18 from #17, etc. **— risks must be ordered accordingly**. Caution: the first batch of 12 risks cannot be connected to the second batch, 13 – 24, so #12 cannot link #13.

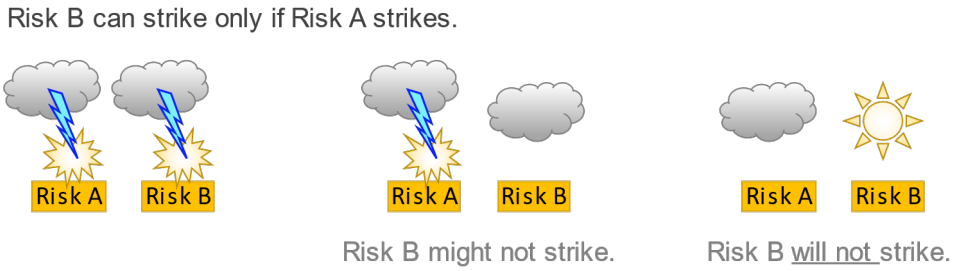
The user may reorder risk sheets by dragging their respective sheet tabs, but conditionality indicators will not automatically update to suit a new order. Any that were set before a reordering should be checked afterwards to ensure risks are still connected as intended.

Dependency

Unlike the previous two conditionality types dealing with risk impacts, this one is a probability relationship. The model's default, also known as "mutually inclusive", allows all risks to occur or not, as random numbers dictate; however, the simulation may be sensitized for two other scenarios. One where a risk can only happen if some other does, and a (lopsided) "mutually exclusive", where a risk cannot happen if the preceding risk does.

The model default value, <blank>, is that each risk probability is independent. The dropdown selections affirm dependency while telling which type:

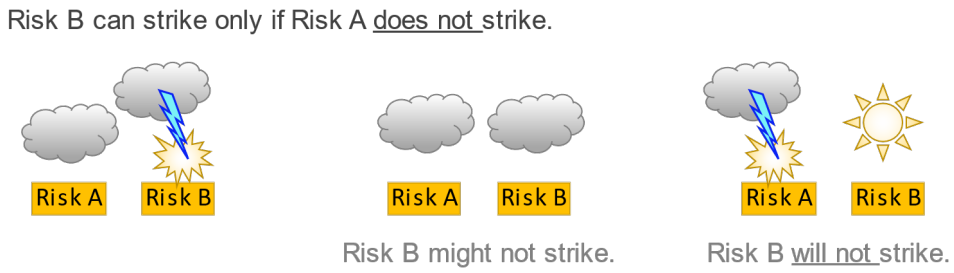
DEP-INCL = (Dependent-Inclusive) Yes, this risk is dependent on the preceding risk and may only occur if the preceding risk does occur.



Example

Best route of excavation is near abandoned, buried vessels; contents vary from benign to toxic. Puncturing a vessel full of potable water is its own unfavorable impact, let alone having to deal with toxic waste; but if no tanks or lines are discovered, the hazmat suits can be stowed.

DEP-EXCL = (Dependent-Exclusive) Yes, this risk is dependent on the preceding risk and may only occur if the preceding risk does not occur.



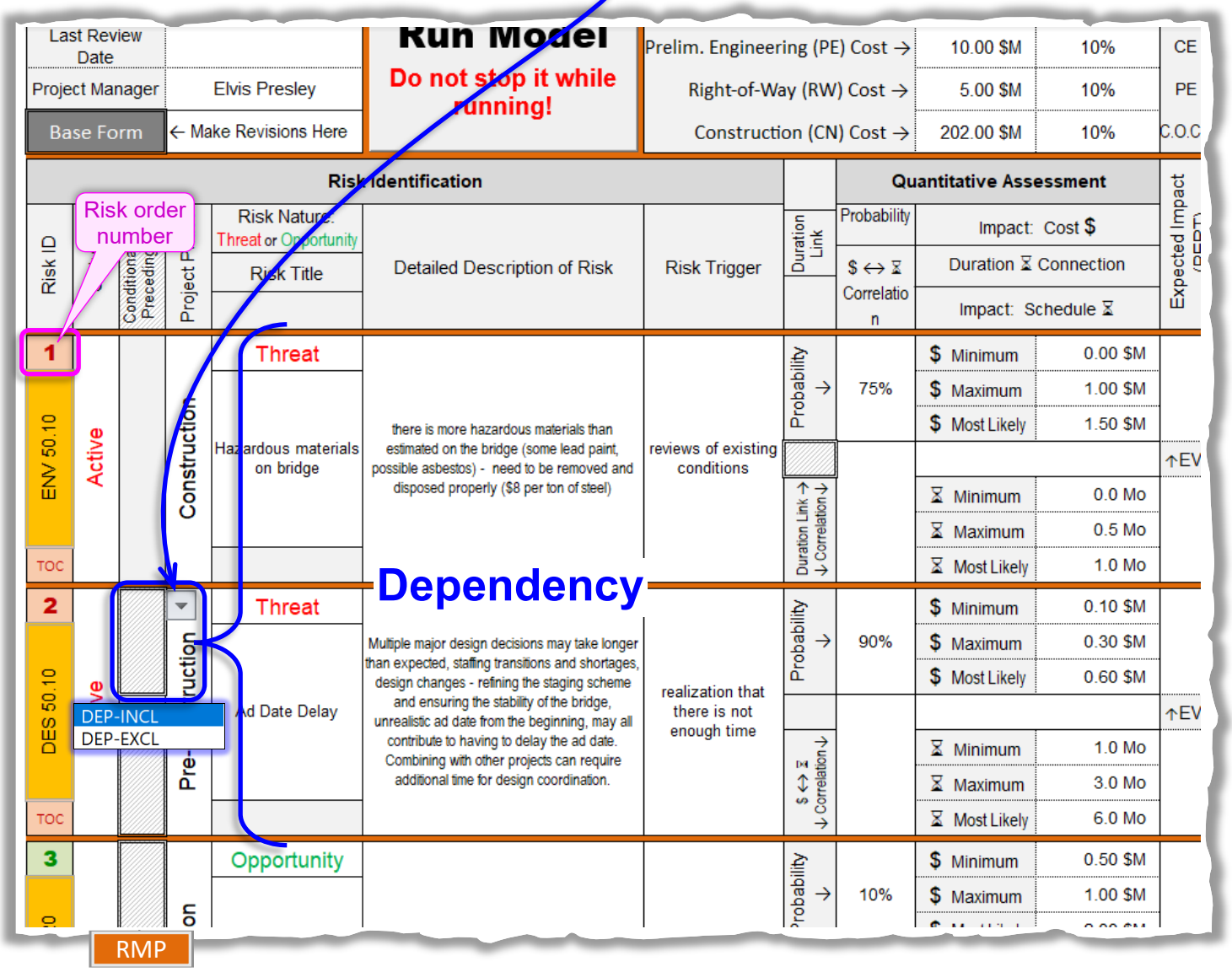
Example

We will need increased capacity for de-watering if it rains heavy, but we will need water tanks and sprayers for dust control if it does not rain at all.

Example

An almost empty canteen while on expedition may mean perishing of dehydration, but one could resort to local sources. The more one drinks from these however, the greater the chance of contracting some other malady. Welcome to the jungle!

Dependency is set in the Model Input Tables: (in the upper field)

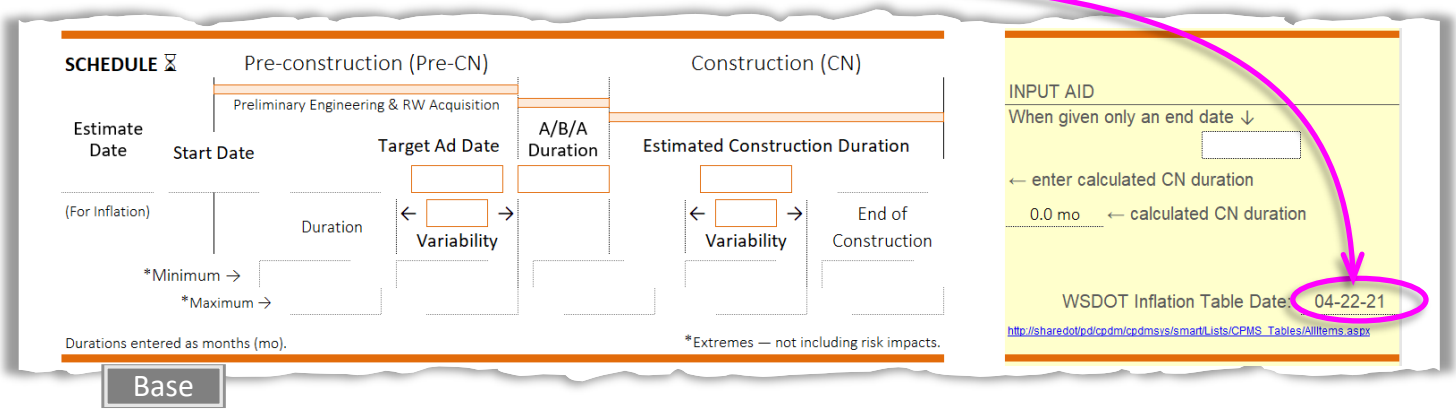


Note: the program assumes that **dependency between risks is driven by the preceding risk of a sequence on the list**: #1 governs #2, #17 governs #18, etc. — **risks must be ordered accordingly**, with the selection made from the lower risk. Caution: the first batch of 12 risks cannot be connected to the second batch, 13 – 24, so #12 cannot govern #13.

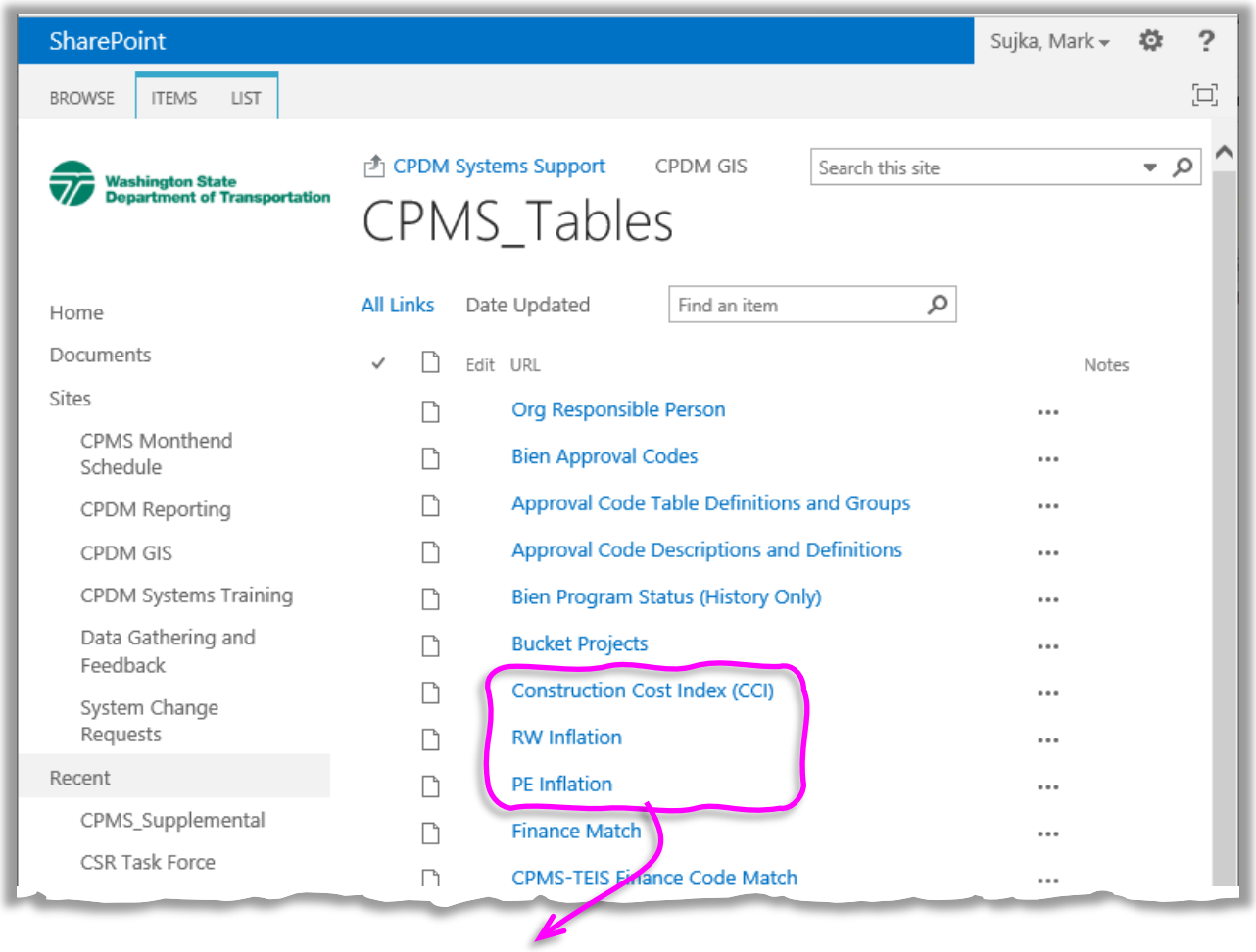
The user may reorder risk sheets by dragging their respective sheet tabs, but conditionality indicators will not automatically update to suit a new order. Any that were set before a reordering should be checked afterwards to ensure risks are still connected as intended.

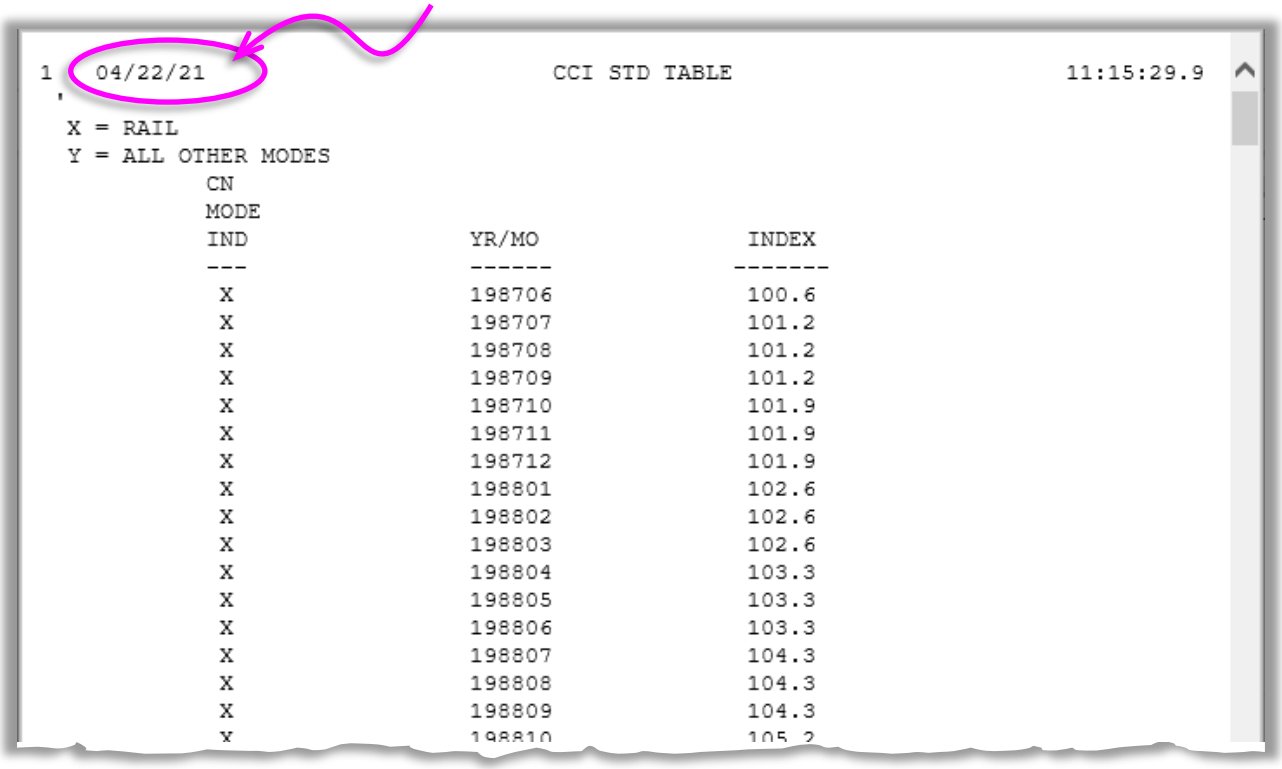
Appendix: Inflation Tables

WSDOT employs third party inflation forecasts for Preliminary Engineering (or Conceptual Design work), Right-of-Way, and Construction (or Designing/Building). If the model has not been updated for quite some time it is recommended to confirm that the internal inflation tables are current. The date of the tables is located next to the Schedule section on the Base Input sheet, here:



Compare this with the date found here:
http://sharedot/pd/cpdm/cpdmsys/smart/Lists/CPMS_Tables/AllItems.aspx





1 04/22/21 CCI STD TABLE 11:15:29.9

X = RAIL
Y = ALL OTHER MODES

CN MODE IND	YR/MO	INDEX
X	198706	100.6
X	198707	101.2
X	198708	101.2
X	198709	101.2
X	198710	101.9
X	198711	101.9
X	198712	101.9
X	198801	102.6
X	198802	102.6
X	198803	102.6
X	198804	103.3
X	198805	103.3
X	198806	103.3
X	198807	104.3
X	198808	104.3
X	198809	104.3
X	198810	105.2

If the above date is more recent than that shown in the model, download a fresh model and see if it is up to date.

https://wsdot.wa.gov/publications/fulltext/CEVP/ProjectRiskAnlysisModel.xlsm

If not, contact HQ at *VERA@wsdot.wa.gov*.

If the freshly downloaded model's inflation table is up to date, then drag-and-drop your Base and Risk sheets into the new model workbook—or contact HQ for assistance.

WSDOT Sources for Inflation Tables (as of July 2022)

- **Preliminary Engineering** (design) phase – **IHS Markit** forecast for Engineering, Architectural, and Surveying salaries. PECI
- **Right-of-Way** phase – **Moody's** forecast of the Federal Housing and Finance Administration housing price index for the state of Washington (Freddie Mac, Fannie Mae). RWCI
- **Construction** phase – **IHS Markit** Forecast of the Construction Cost Index. CCI