SHRP2 RISK MANAGEMENT TEMPLATE

Risk Management and Analysis Software for Highway Construction Projects

User Guide

Prepared by

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SHRP2 Risk Management Template

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1.0. Preface

Formalized risk management practices are being increasingly adopted by state and local transportation agencies to (i) optimize project performance and (ii) distribute risk between the contractor and the transportation agency. The SHRP2 Risk Management Template, an Excel-based tool, was developed to aid transportation agencies to conduct a risk management process. This tool is based on the concepts presented in the SHRP2 Report S2-R09-RW-2: Guide for the Process of Managing Risk on Rapid Renewal Projects.(1) The SHRP2 R09 publication presents guidance on the application of risk management methods during the project development, delivery and operation phases that are consistent with transportation agency practices.

The SHRP2 Risk Management Template can assist risk management personnel from state and local agencies to optimize project performance (at individual or network level) by identifying, assessing, and mitigating potential risks, including threats and opportunities. These threats and opportunities can result in a significant impact to construction cost, schedule, and traffic disruption.

1.1 Purpose and Objectives

- Facilitate conducting simplified risk management planning for transportation projects.
- Optimize key project performance objectives :
    - Minimize project schedule, in terms of project construction completion (operations start) date;
    - Minimize project cost, in terms of total inflated cost (through construction);
    - Minimize project disruption, in terms of total user impacts (through construction);
- Optimize by minimizing combined project performance, in terms of combination of project schedule (through construction), inflated project cost (through construction), project disruption (through construction) and project longevity (post-construction).

1.2 Background and Limitations

- Ref. SHRP2 R09 "*Guide for the Process of Managing Risk on Rapid Renewal Projects*" ("*Guide*") and related training materials – more discussion and examples are provided in *Guide*.
- Does not evaluate the uncertainty (or range) in project performance, only mean values.

1.3 General Guidance

- Project performance components are separated (ref Ch 2 in the *Guide*):
    - Activities (pieces of project) versus project (combination of all activities).
    - Base (without risk or contingency/float) versus risk (complementary to base, which is intended to be covered by contingency/float),
    - Risk includes opportunities (i.e., simply negative risks).
    - Total is the combination of base and risk.
    - Unmitigated (before additional risk reduction actions) versus mitigated (with additional risk reduction actions).
    - Mean (probability-weighted average value) versus uncertainty/range (likelihoods of various possible values). This template does not include assessment and determination of full uncertainty/range, only mean values.
- Proactive risk mitigation process (ref Ch 2 in the *Guide*):
    - Unmitigated (before additional risk reduction actions)
        - Unmitigated "base" assessment and performance analysis
        - Unmitigated "risks" identification and assessments
        - Unmitigated "total" performance analysis
    - Mitigated (with additional risk reduction actions)
        - Mitigation identification (focusing on key risks), implementation and effectiveness assessments, cost-effectiveness evaluation, and subsequent selection
        - Mitigated "total" performance analysis
- Microsoft Excel workbook template developed to document and automatically conduct analyses

- Input – required inputs are highlighted (in yellow shading), with other cells protected from being changed. User can reformat specific rows or columns if needed
- Output – outputs for each spreadsheet are automatically generated. Template is protected (and most calculations are hidden) to prevent inadvertent changes that could introduce errors in outputs. Print area for each spreadsheet in workbook is pre-set, so that user simply needs to "print" worksheet or entire workbook. However, user can reformat specific rows or columns.

1.4 Template Organization

Some of the risk management steps require an iterative process. The SHRP2 Risk Management Template is comprised of 14 steps including the Home Screen and Summary Report steps. The list of steps, their function and required input are listed below:

1. Project Home: To allow the user to navigate through all the 14 steps of the SHRP2 Risk Management Template.
2. Project Structuring: To provide inputs on cost, schedule, disruption, and operations, maintenance and replacement (as applicable) to determine the base project performance (without risk).
3. Risk Identification: To identify and develop a list of a comprehensive and non-overlapping risks (including opportunities) that could impact the base project performance.
4. Rating Scale: To define a rating system to assess the major impacts of risks (cost, duration, and disruption) and the probability of risk occurrence.
5. Unmitigated Risk Assessment: To assess the probability of risk occurrence and the risk impacts to cost, duration, and disruption, according to the project phase that will be affected by the impact of each risk. Severity is the result of the combined assessment of probability of occurrence and risk impact and is determined by the template.
6. Unmitigated Risk Register: To calculate the severity for each risk in year-of-expenditure millions of dollars. The risk register illustrates the risks in a ranked order according to mean severity.

7. Unmitigated Project Performance: To understand the overall impacts of the unmitigated risks in terms of project cost, schedule and disruption.
8. Unmitigated Risk Ranking Plots: To provide a graphical illustration of the unmitigated risk ranking computed according to mean severity. This is another way of illustrating the unmitigated risk ranking, commonly known as "tornado diagrams".
9. Risk Mitigation Strategies: To select a strategy to mitigate each risk that has been selected for inclusion in the mitigation process and determines the cost effectiveness of implementing the mitigation. This step also allows the user to identify the cost, duration and disruption impacts of implementing the mitigation.
10. Mitigation Strategies Register: To present a list of the risks to be mitigated and the associated mitigation strategies that the user wants to implement.
11. Mitigated Risk Register: To present the mitigated severity of each risk after taking into account any impact modifications associated with implementing the mitigation strategies.
12. Mitigated Project Performance: To understand the overall impacts of the mitigated risks in terms of project cost, schedule and disruption.
13. Mitigated Risk Ranking Plots: To provide a graphical illustration of the mitigated risk ranking computed according to mean severity. This is another way of illustrating the mitigated risk ranking, commonly known as "tornado diagrams".
14. Summary Report: To provide a detailed summary of the risk management analysis conducted by using the SHRP2 Risk Management Template.

Figure 1 presents a layout of the template illustrating the sequential steps involved in the risk management process.

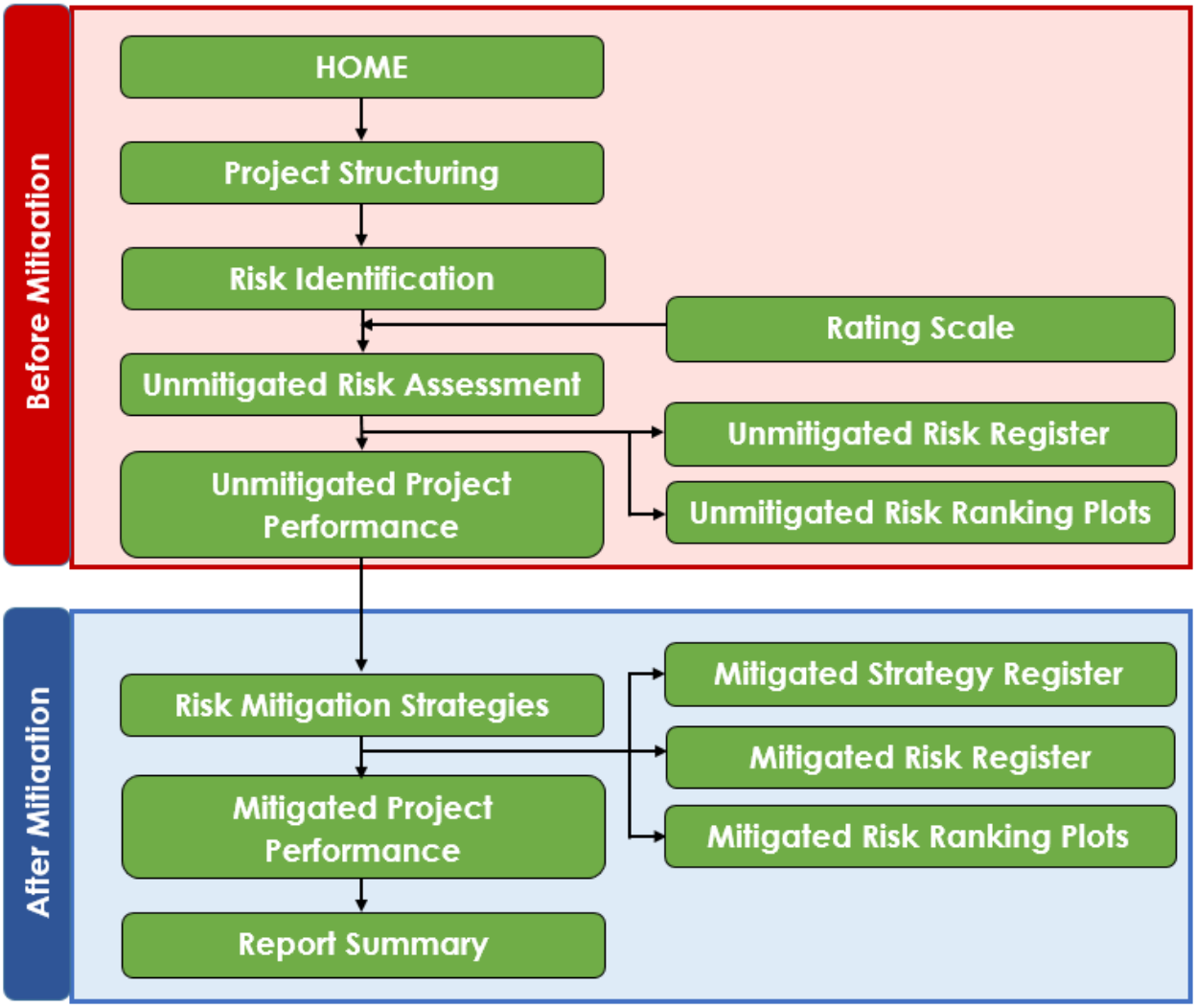


Figure 1. Organization of SHRP2 Risk Management Template

The sequential steps involved in the risk management process and associated concepts are described in detail in the following sections.

2.0. Getting Started

2.1. System Requirements

For uninterrupted and successful analyses, it is recommended that the user access the SHRP2 Risk Management Template from a computer running a Windows 7 (or newer) operating system with the following minimum system specifications:

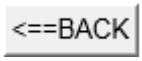
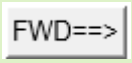
- 2 GHz, dual core processor
- 2 GB RAM
- Spreadsheet: MS Excel 2007 or later

2.2. Accessing the SHRP2 Risk Management Template

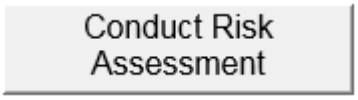
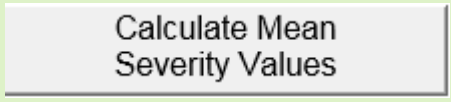
The SHRP2 Risk Management Template can be accessed from the following webpage: http://www.trb.org/Main/Blurbs/168369.aspx.

A summary of the tool's buttons and their functions are presented in *Table 1.*

Table 1. Tool buttons and functions

Template Step	Button	Function
ALL		Navigates the user to the Home page.
ALL (except Home, Project Structuring)		Navigates the user to the previous analysis page (step).
ALL (except Home, Report Summary)		Navigates the user to the next analysis page (step).
ALL		Opens a document that explains the various aspects of the particular template step on which the button is located.
All Forms		Opens a help form explaining the definitions and concepts for the various sections in the particular form on which the button is located.

Template Step	Button	Function
Step 1: Project Structuring	Create Project	Allows the user to enter base project information beginning with general analysis information, such as project delivery method and performance measures. This button should be used when initiating an analysis.
Step 1: Project Structuring	Analysis	Allows the user to enter general analysis information (project delivery method and performance measures).
Step 1: Project Structuring	Schedule	Allows the user to enter project schedule information.
Step 1: Project Structuring	Lag	Allows the user to enter values for lags that may occur between the project schedule activities.
Step 1: Project Structuring	Cost	Allows the user to enter project cost information.
Step 1: Project Structuring	Disruption	Allows the user to enter project disruption information.
Step 1: Project Structuring	OMR	Allows the user to enter project operations, maintenance, and replacement information.
Step 1: Project Structuring, Step 2: Risk Identification, Step 3: Rating Scale, Step 4: Unmitigated Risk Assessment, Step 8: Risk Mitigation Strategies	Clear All	Clears all data generated during the execution of a particular step. Note that this might affect data from other steps as well.

Template Step	Button	Function
Step 2: Risk Identification		Allows the user to enter and create a list of risks that will potentially affect the project performance.
Step 3: Rating Scale		Allows the user to enter values for the rating scales used for cost change, duration change, disruption change, and probability of occurrence in order to determine risk severity.
Step 4: Unmitigated Risk Assessment		Allows the user to assess the probability of occurrence, cost impact, duration impact and disruption impact for each risk included in the analysis.
Step 4: Unmitigated Risk Assessment		Calculates the mean severity value for each risk included in the analysis based on the probability of occurrence, cost impact, duration impact and disruption impact assessments entered. It also displays the results in Step 5: Unmitigated Risk Register.
Step 6: Unmitigated Project Performance		Allows the user to select schedule assumptions (e.g. all risks within a phase will occur concurrently or will occur sequentially) and then calculates the unmitigated project performance (cost, schedule and disruption).

Template Step	Button	Function
Step 8: Risk Mitigation Strategies	Conduct Risk Mitigation	Allows the user to enter mitigation strategies for each risk that was selected to be mitigated. Also allows the user to assess effectiveness of the selected mitigation strategies.
Step 8: Risk Mitigation Strategies	Create Registers	Creates a summary of the mitigation strategies that were selected for implementation for each risk. Also, calculates the mean severity value for each risk after taking into account planned mitigation strategies and displays the results in Step 9: Strategy Register and Step 10: Mitigated Risk Register.
Step 11 Mitigated Project Performance	Update Risk Analysis Summary	Calculates the mitigated project performance (cost, schedule and duration).
Summary Report	UPDATE REPORT	Formats summary tables and updates summary charts on the Summary Report step.
Summary Report	PRINT REPORT	Allows the user to select the specific analysis summary tables to include in a printed report.
Summary Report	PROJECT INFORMATION	Navigates the user to a summary of the general project information.
Summary Report	PROJECT STRUCTURING	Navigates the user to a summary of the base project performance (cost, schedule, disruption).

Template Step	Button	Function
Summary Report	RISK IDENTIFICATION	Navigates the user to a summary of the identified risks in the project by project phase.
Summary Report	UNMITIGATED RISK REGISTER	Navigates the user to a summary of the unmitigated risk register.
Summary Report	UNMITIGATED PROJECT PERFORMANCE	Navigates the user to a summary of the unmitigated project performance.
Summary Report	MITIGATION STRATEGIES REGISTER	Navigates the user to a summary of the mitigation strategies register.
Summary Report	MITIGATED RISK REGISTER	Navigates the user to a summary of the mitigated risk register.
Summary Report	MITIGATED PROJECT PERFORMANCE	Navigates the user to a summary of the mitigated project performance.
Summary Report	PROJECT NOTES	Navigates the user to the Project Notes table where the user can enter any type of notes.
Summary Report	UNMITIGATED RISK RANKING PLOTS - THREATS	Navigates the user to the risk ranking plots summarizing the effect of the unmitigated risks that are categorized as threats.
Summary Report	UNMITIGATED RISK RANKING PLOTS - OPPORTUNITIES	Navigates the user to the risk ranking plots summarizing the effect of the unmitigated risks that are categorized as opportunities.
Summary Report	MITIGATED RISK RANKING PLOTS - THREATS	Navigates the user to the mitigated risk ranking plots summarizing the effect of the mitigated risks that are categorized as threats.

Template Step	Button	Function
Summary Report	MITIGATED RISK RANKING PLOTS - OPPORTUNITIES	Navigates the user to the mitigated risk ranking plots summarizing the effect of the mitigated risks that are categorized as opportunities.
Summary Report	COPY	Copies the summary table or chart that is located adjacent to the button.
Summary Report	BACK TO SUMMARY	Navigates the user back to main view of the Summary Report section.

Table 2. Color codes and descriptions

Text Fields	Function
	The grayed out cells in the various modules indicate output cells. These cells cannot be edited by the user.
	The cells that are represented with a yellow background are input cells wherein the user can enter data.
Header	The cells with this formatting (green background and white text) are non-editable header information cells that provide information on what kind of input is required by the user.
Description	Cells with a white background and black text are non-editable description cells that describe information in the input or output cells next to them. These cells may also be used for providing information about the units.
	These cells contain pop-up information to provide the user with extra information regarding the inputs required in this particular field.

3.0. Project Home

The Project Home screen is where the user opens the SHRP2 Risk Management Template (see Figure 2). The home screen of the template consists of the following sections:

- Project Information
- Risk Management Template Steps
- Project Reset
- Summary Report

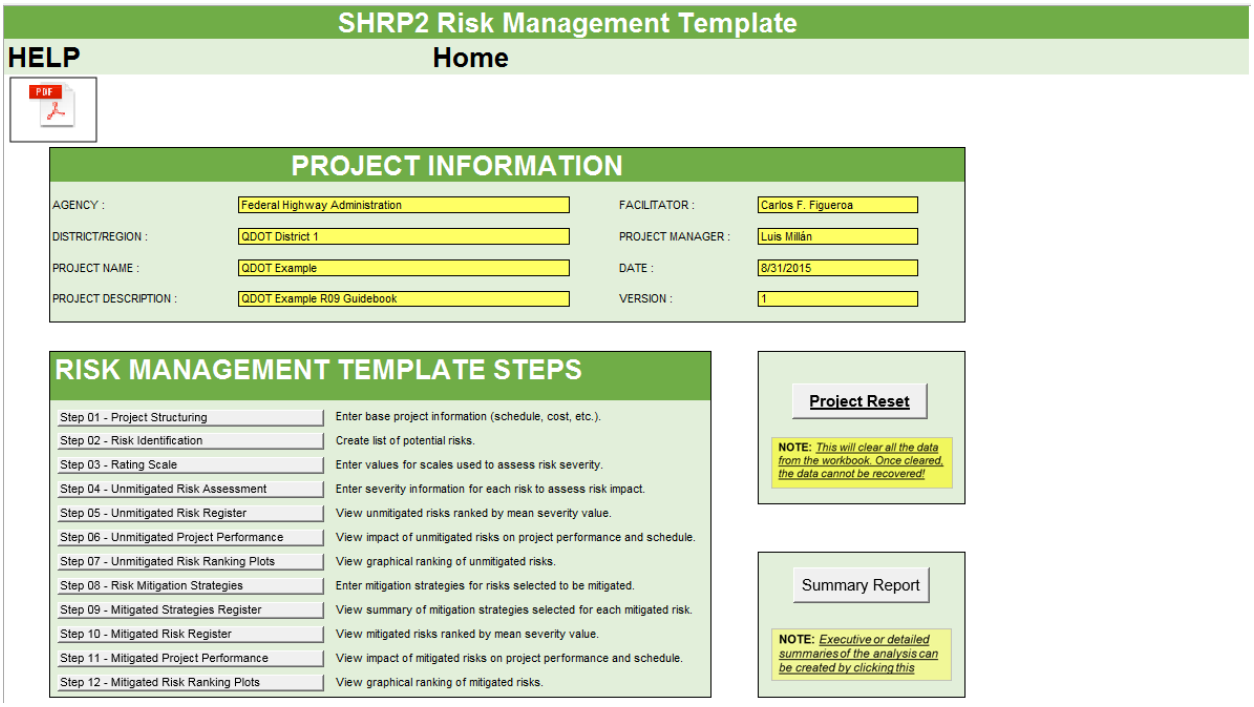


Figure 2. SHRP2 Risk Management Template Home Screen

The user can navigate back to the Project Home screen by clicking on the Home button provided on every step. The various sections in the template are explained below.

3.1. Project Information

The project information section allows the user to input project-specific information (see Figure 3).

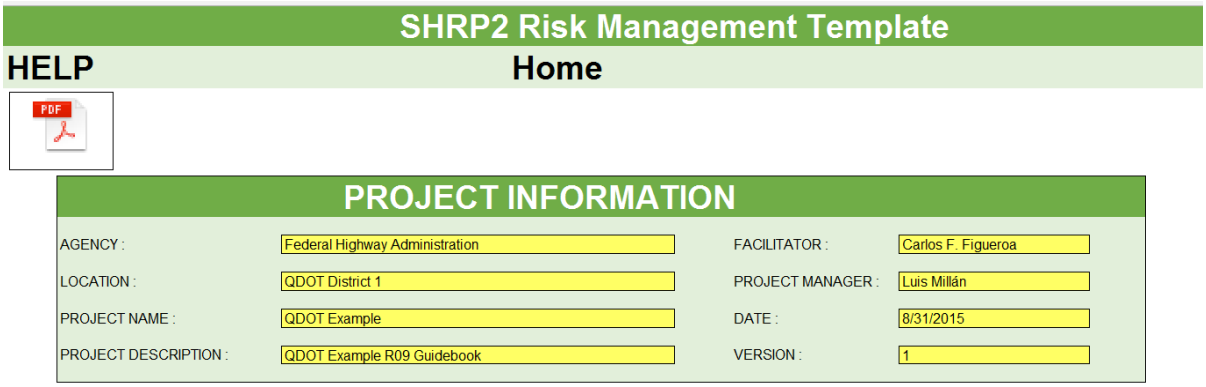


Figure 3. Project Information

The user inputs in the Project Information segment include the following:

- Agency – In this field, the user provides the name of the agency (e.g., state DOTs, MPOs, or other transportation organizations) performing the risk management analysis using the template.
- Location – In this field, the user provides information on the geographic location of the project (e.g. district, region, area).
- Project Name – In this field, the user provides the name/title of the project being analyzed.
- Project Description – In this field, the user provides a brief description of the project being analyzed.
- Facilitator – In this field, the user provides the name of the individual who will perform, or lead the risk analysis workshop on the project under consideration.
- Project Manager – In this field, the user provides the name of the individual who is or will manage the project risks.
- Date – In this field, the user provides the date (in mm/dd/yyyy format) on which the current iteration of the risk analysis began. This assists the user to track the timeline of various versions/iterations of the analysis.
- Version – In this field, the user provides the version number of the risk analysis for the project under consideration. The user can choose a numbering system that will be used to track the risk analysis iterations in the future.

3.2. Risk Management Template Steps

This section allows the user to navigate to any template step associated with the risk analysis (see Figure 4). The risk management template steps are explained in subsequent sections.

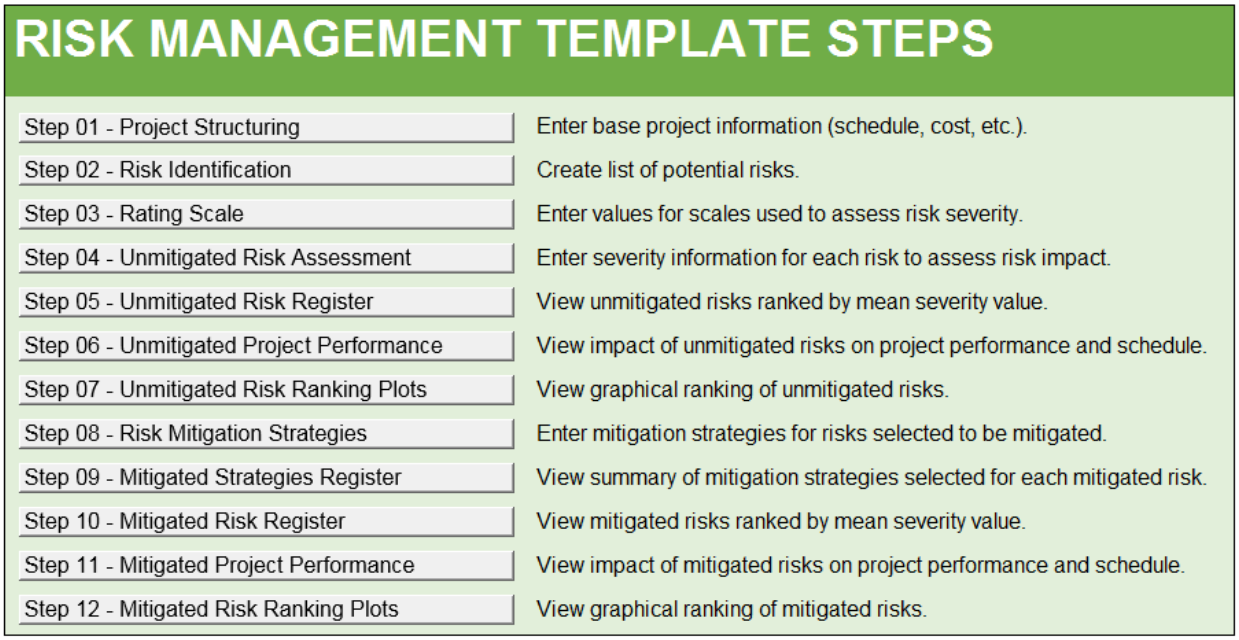


Figure 4. Risk Management Template steps

When starting a new analysis, the user should always begin by completing the modules in the following sequence:

1. Project Structuring
2. Risk Identification
3. Rating Scale
4. Unmitigated Risk Assessment
5. Unmitigated Risk Register
6. Unmitigated Project Performance
7. Unmitigated Risk Ranking Plots
8. Risk Mitigation Strategies
9. Mitigation Strategies Register
10. Mitigated Risk Register
11. Mitigated Risk Project Performance
12. Mitigated Risk Ranking Plots
13. Summary Report

3.3. Project Reset

The project reset button (see Figure 5) allows the user to delete all data from the SHRP2 Risk Management Template.

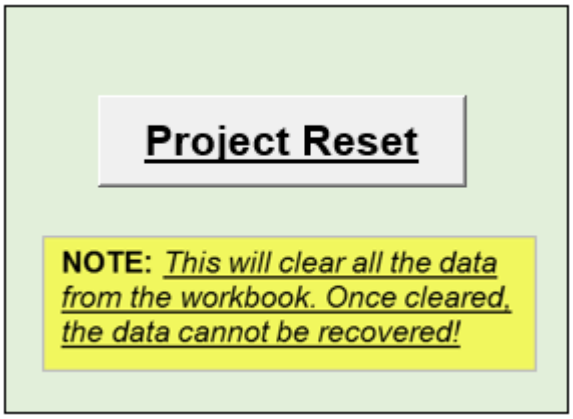


Figure 5. Project Reset Button

When the project reset button is clicked, the user is notified that all information will be deleted (through a warning screen) and has the option of choosing whether to proceed with the reset option (see Figure 6).

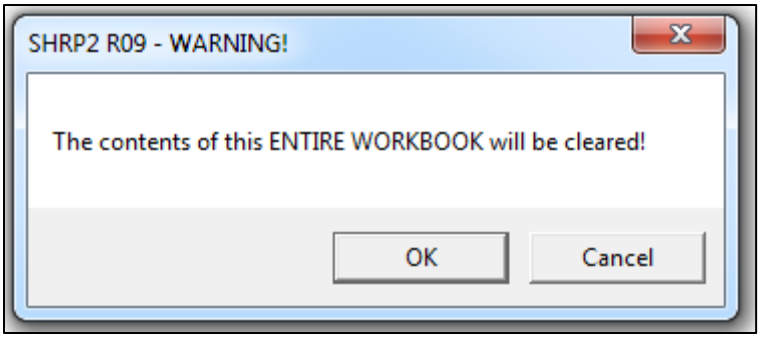


Figure 6. Project reset warning screen

Note: Clicking on the project reset button deletes all data from the SHRP2 Risk Management Template. Once deleted, the data cannot be recovered.

3.4. Summary Report

The summary report button navigates the user to the Summary Report module where the user can create reports that contain executive or detailed summaries of various components of the analysis (see Figure 7).

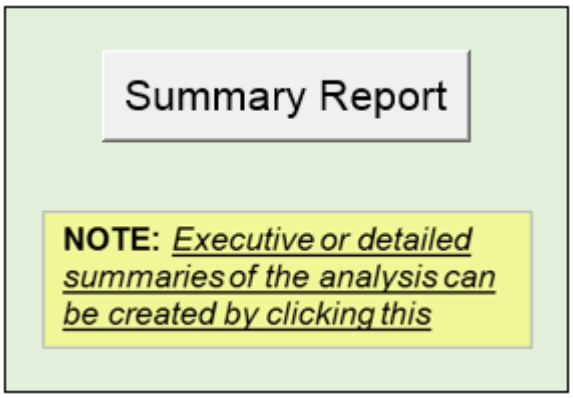


Figure 7. Summary Report Button

4.0. Project Structuring

The project structuring process is used to define the base project (without contingencies) on which the risks can be identified and assessed. The elements used to define a base project scenario include, but are not limited to, project performance measures such as cost, schedule, and disruption (during the project construction period).

The **Project Structuring** step is used to input data on cost, schedule, and disruption for the base project. These inputs are used in the subsequent steps for risk assessment and analysis. The user is able to input the data through the graphical user interface (GUI) forms provided in the template as shown in Figure 8. Alternatively, the user can enter these inputs directly into the Excel sheets of the tool. For convenient and efficient data entry, it is recommended that the GUI forms be used and the sequence outlined in these forms be followed.

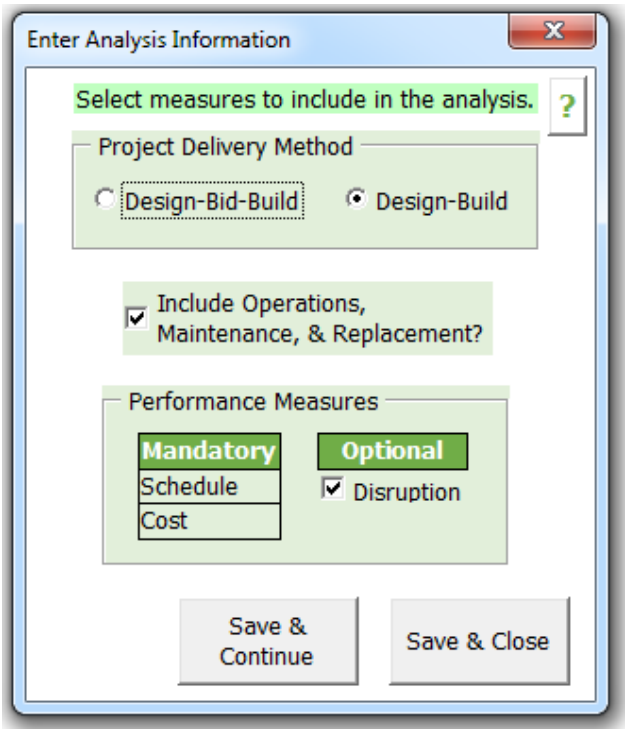


Figure 8: GUI for user input

The sections of the project structuring module include (i) Create Project, (ii) Analysis, (iii) Schedule, (iv) Lag, (v) Cost, (vi) Disruption, and (vii) Operations, Maintenance, and Replacement (OMR) as shown in Figure 9.

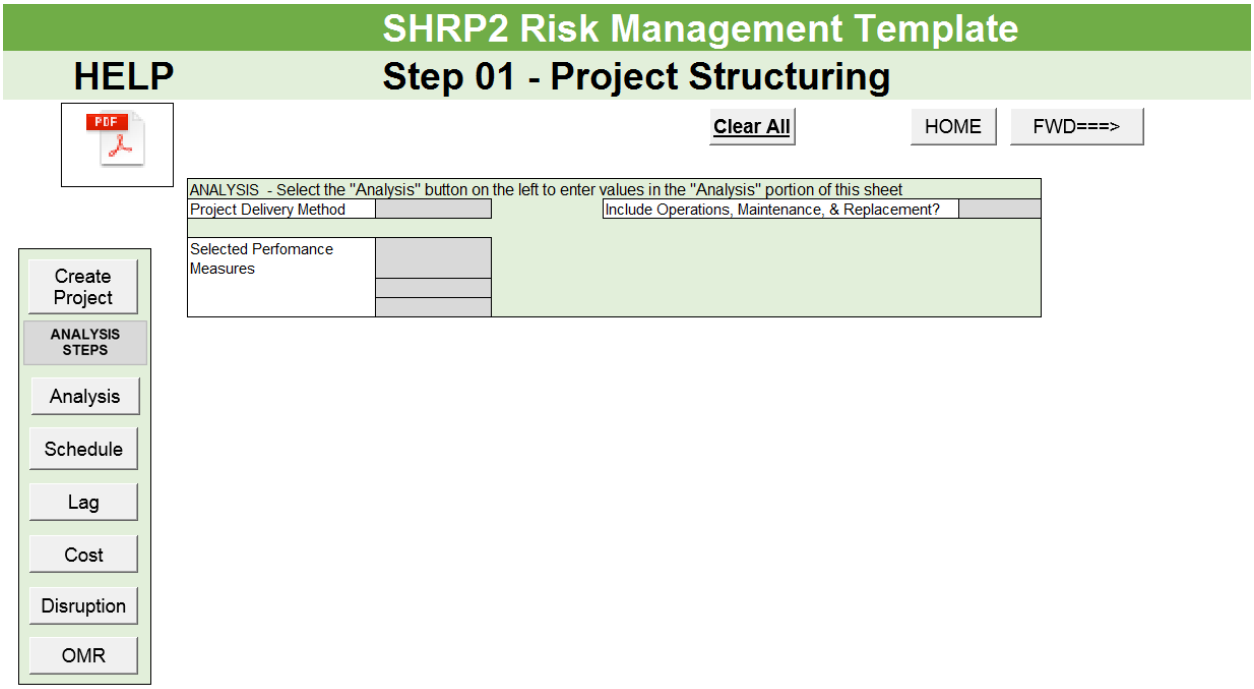


Figure 9. Project Structuring

The navigation buttons on the left side of the screen allows the user to access individual forms to edit the information for a particular section of the project structuring page. Figure 10 shows the navigation buttons. The user can navigate through the different GUI forms and input data as required by using these navigation buttons.

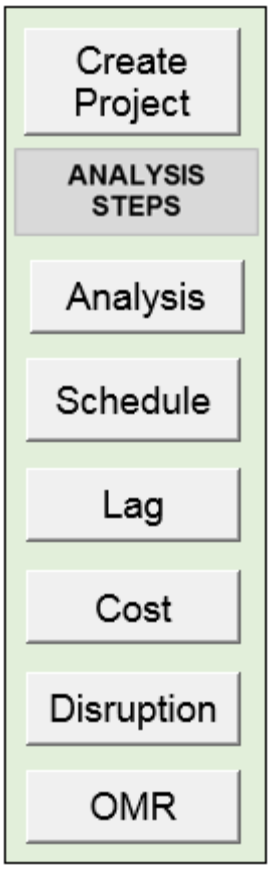


Figure 10. Project Structuring Navigation

4.1. Create Project

The "Create Project" section allows the user to define a base project and input the associated analysis, schedule, lag, cost, disruption, and operations, maintenance and replacement (OMR) data. The Create Project button brings up the Analysis data screen.

4.2. Analysis

The "Analysis" section allows the user to select the project delivery method and performance measures to be included in the risk analysis. The user can choose between the following delivery methods: (i) Design-Build and (ii) Design-Bid-Build. The performance measures are categorized as (i) Mandatory (default selection) and (ii) Optional. While schedule and cost, are mandatory measures, OMR and disruption are optional performance measures.

The user can enter the input values directly into the spreadsheet (see Figure 11) or the GUI form (see Figure 12).

ANALYSIS - Select the "Analysis" button on the left to enter values in the "Analysis" portion of this sheet			
Project Delivery Method	Design-Build	Include Operations, Maintenance, & Replacement?	Yes
Selected Perfomance Measures	Schedule		
	Cost		
	Disruption		

Figure 11. Project Analysis

The GUI form inputs are explained below.

- Project Delivery Method – The user must choose whether the analysis will be based on a Design-Bid-Build (DBB) or a Design-Build (DB) method. This selection has impacts at several junctures later in the analysis process. It will determine the schedule that is used, the types of schedule lags that are possible, and the sequence of the project phases. Once a selection has been made and the analysis begun, changing the delivery method will cause the schedule to be cleared. The user will be warned about this, and can decide to cancel the action. To create a a new delivery method the user will have to create a new template.

Note: Users cannot proceed to other forms without first selecting a delivery method. Changing delivery method will clear the schedule and the user will have to re-enter the schedule information.

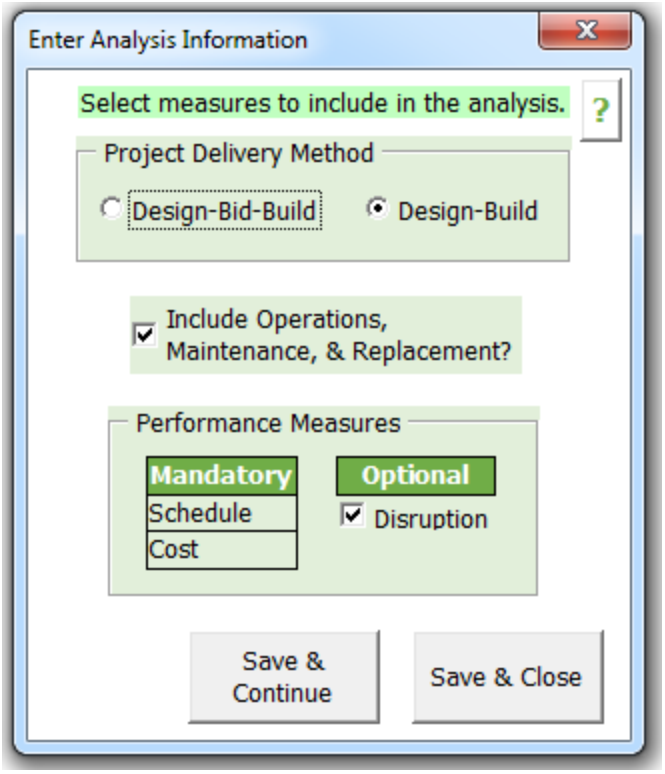


Figure 12. Project Analysis GUI input Form

- Include Operations, Maintenance, & Replacement? – Selecting this option will enable the functionality necessary to measure the impact of risks associated with the OMR project phase.

Note: Once the user selects this option (OMR) and begins the analysis, unselecting this option will cause any values that have been entered into the OMR section of the sheet to be cleared.

- Performance Measures: Disruption – Selecting this option will enable the functionality necessary to measure the disruption impact on the project base performance.

Note: Once the user begins this analysis, unselecting this option will cause all entries in the Disruption section of the sheet to be changed to "0".

4.3. Schedule

The "Schedule" section allows the user to input information about project schedule, including the project start date, and the rest of the schedule

activities. In addition, the user needs to input the agency's anticipated duration in months for the corresponding phases of the project. The user can choose to select the Lag between schedule activities for further analysis, as deemed necessary per the project schedule. Section 4.4 discusses Lag in more detail. **Schedule value is the value in $M/month that represents the cost that will be incurred for every month of the delay. It is a method of adding the duration to cost impacts and obtain a combined severity.**

The schedule is affected by the duration of individual project phases that occur during the course of the project. The typical Design-Bid-Build (D-B-B) project phases included in the SHRP2 Risk Management Template and their definitions are explained in Table 3. It should be noted that the phases as described reflect typical D-B-B projects. The phases can be different with Design-Build (D-B) and Construction Manager/General Contractor (CM/GC) delivered projects.

Table 3. Typical D-B-B Project Phases

Typical Project Phases	Definitions
Planning	This phase involves determining the purpose and need for the project and the early consideration of environmental factors.
Scoping	This phase is used to determine design criteria and design parameters. The users can also prepare preliminary plans, assign geometry, and develop the project delivery strategy and programming.
Environmental Permits	Various environmental analyses, including discipline studies and National Environmental Policy Act of 1969 /State Environmental Policy Act analyses are carried out during this phase.
Preliminary Design/Environmental Process	The design phase involves developing plans (preliminary and final), specifications, and estimates and traffic control plans.
Right-of-way, utilities, and railroads	Determining right-of-way impacts, developing right-of-way plans, and acquiring right-of-way are typical activities that would occur during this phase. This phase also addresses considerations related to developing plans for utility-relocation and coordination with railroads.

Typical Project Phases	Definitions
Procurement	During the procurement stage, the contract documents are prepared and bids and proposals are advertised and received. The contract award also occurs during this phase.
Final Design	During this phase the final design plans for the project are developed.
Construction	The construction phase involves initiating construction operations, and conducting contract management, inspections, and materials testing. Implementation of the traffic control plan during construction also falls within this phase.
Operations	This phase occurs after completion of construction. The facility is open for operation and provides services for customers. The performance of the project is monitored.
Replacement (or decommissioning)	The plans, design, and construction for rehabilitation or replacement of various assets are explored during this phase. The plan for decommissioning, if appropriate, is also considered.

Based on the type of project delivery method (D-B or D-B-B), the schedule for the project is filled out. Figure 13 shows the schedule table for an example Design-Build delivered project.

SCHEDULE		
Project Start Date		12/1/2009
Target Date for Start of Operations	(Open to Traffic Date)	10/30/2012
Schedule Value ($M/month)		0.1

Project Phase	Months/Date	Early Start	Early Finish	Late Start	Late Finish	Float (months)
Planning	0	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.0
Scoping	0	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.0
Design Funding Date	12/1/2009		12/1/2009		12/1/2009	0.0
Design/Environmental Process	12	12/1/2009	11/30/2010	12/1/2009	11/30/2010	0.0
Environmental Permits	6	11/30/2010	6/1/2011	11/30/2010	6/1/2011	0.0
ROW/Util/RR Funding Date	12/1/2009		12/1/2009		11/30/2011	24.0
ROW/Util/RR	12	11/30/2010	11/30/2011	11/30/2010	11/30/2011	0.0
Construction Funding Date	12/1/2009		12/1/2009		11/30/2010	12.0
Procurement	6	11/30/2010	6/1/2011	11/30/2010	6/1/2011	0.0
Final Design	6	6/1/2011	11/30/2011	6/1/2011	4/30/2012	5.0
Construction	16	7/1/2011	10/30/2012	7/1/2011	10/30/2012	0.0
Operations & Maintenance	600	10/30/2012	10/8/2062	10/30/2012	10/8/2062	
Replacement	0	10/8/2062	10/8/2062	10/8/2062	10/8/2062	

Figure 13. Schedule example in Project Structuring step

Note: Enter the dates in "mm/dd/yyyy" format.

The schedule inputs and respective format are presented below:

- Project Start Date – Enter the date when the project will officially begin (usually the date that the planning phase will begin).
- Start of Facility Operation – Enter the date that the completed project will be open for use.
- Schedule Value – Enter a value in millions of dollars per month that represents the cost that will be incurred if a schedule delay(s) causes the project to not open for use by the Target Start Date of Operations.
- Planning – Enter the estimated number of months required to complete the planning phase of the project.
- Scoping – Enter the estimated number of months required to complete the scoping phase of the project.
- Design Funding – Enter the date by which funding will be available to begin the various design aspects of the project.
- Prelim Design/Environmental Process – Enter the estimated number of months required to complete the preliminary project design and work through the initial environmental processes.

- Environmental Permits – Enter the estimated number of months required to complete the environmental permitting process for the project.
- ROW/Util/RR Funding – Enter the date by which funding will be available to begin work on acquiring ROW, and coordinating with utilities and railroads, etc.
- ROW/Util/RR – Enter the estimated number of months required to acquire ROW, and coordinate with utilities and railroads, etc., for the project.
- Final Design – Enter the estimated number of months required to complete the project's final design.
- Construction Funding – Enter the date by which funding will be available to begin the construction phase of the project.
- Procurement – Enter the estimated number of months required to complete the procurement phase of the project.
- Construction – Enter the estimated number of months required to construct the project.
- Include schedule lag – Select this option to enter values for schedule lag(s) that may occur between the phases of the project. The Schedule Lag GUI form will appear immediately after the Schedule GUI form closes. Schedule lag values can be entered directly into the sheet only if this option is selected.
- All schedule values can be entered directly into the sheet; however, data entry will not be possible unless a project delivery method has been selected.

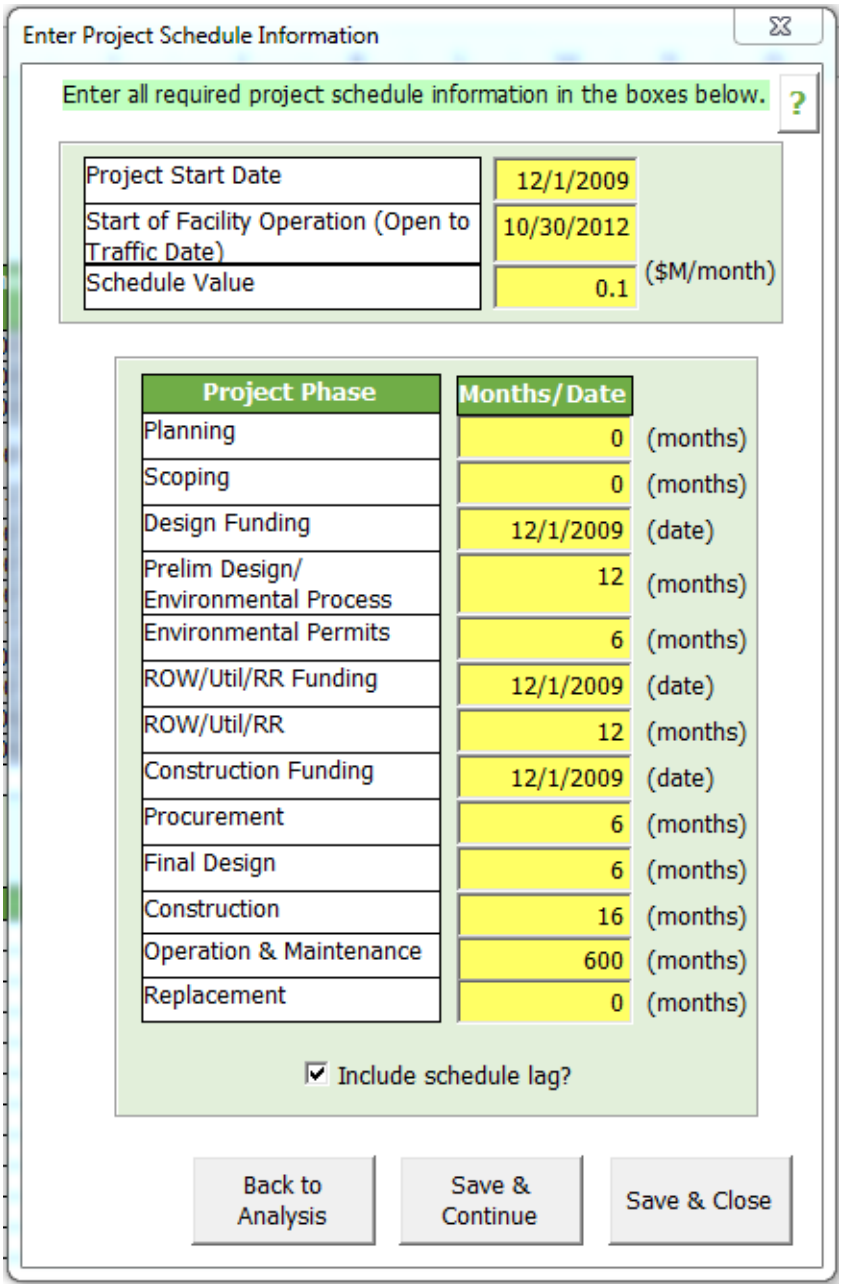


Figure 14. Schedule GUI input Form

Note: Once the user selects the schedule lag option and begins the analysis, all schedule lag entries will be set to "0" if this option is unselected at a later stage of the analysis.

4.4. Lag

The "Lag" section allows the user to enter schedule lag information for the selected project delivery method. The user has to enter lag values between each phase of the project schedule.

Lag is defined as the minimum necessary amount of time between the finish (or start) of one activity prior to the finish (or start) of a succeeding activity in a network. It may be a positive or negative number. Lag times are defined by reference to the type or relationship being utilized (Start to Start, Start to Finish, Finish to Finish, or Finish to Start) and are defined from the perspective of a preceding activity's logic to one of its successors. (2)

The schedule lag section (see Figure 15) presents information on the schedule lag that occurs between different phases of the project.

SCHEDULE LAG

Include Schedule Lag?	Yes

Schedule Lag Parameters - Description	Months
Lag A - Time remaining from the finish of Environmental permitting to Lag B	0.0
Lag B - Time remaining after completion of Environmental Permitting to finish of Procurement	0.0
Lag C - Lag remaining from finish of Environmental permits to Lag D	0.0
Lag D - Time remaining after the completion of Environmental Permitting to the completion of ROW/Utilities/RR	0.0
Lag E - Time remaining to finish ROW/Utilities/RR after the ROW/Utilities/RR funding date	0.0
Lag F - Time elapsed from the completion of ROW/Utilities/RR to start of Construction	6.0
Lag G - Time elapsed after the start of Final Design to start of Construction	1.0
Lag H - Time remaining after the finish of Final Design to finish of Construction	6.0
Lag I - Time remaining after finish of ROW/UTL/RR to finish of Construction	10.0
Lag J - Time remaining after finish of ROW/Utilities/RR to Lag K	6.0
Lag K - Time remaining from finish of ROW/Utilities/RR to finish of Procurement	0.0

Figure 15. Schedule Lag

The number of schedule lags and their relationship between the project phases depends on the selected type of project delivery method.

- For Design-Bid-Build projects: For the example shown in Figure 16 only one lag exists. This lag is the Time remaining to finish ROW/Utilities/RR after the ROW/Utilities/RR funding date [E].

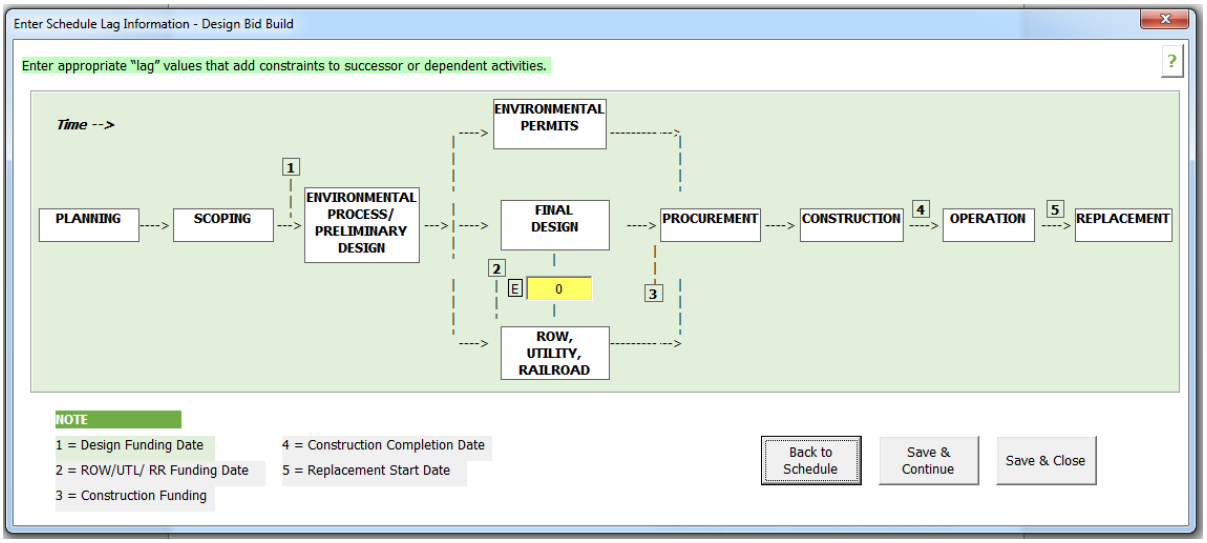


Figure 16. Example of Schedule Lag for D-B-B Project

- For Design-Build projects:
  - With this type of project delivery method, more than one schedule lag could be expected, as shown in the example Figure 17. The user can input various lags depending on the specific project schedule scenario. The following provides a list of the various lags that may be entered for a Design-Build project:

    - Lag A – Lag remaining from the finish of Environmental permitting to Lag B.
    - Lag B – Time remaining after completion of Environmental Permitting to finish of Procurement.
    - Lag C – Lag remaining from finish of Environmental permits to Lag D.
    - Lag D – Time remaining after the completion of Environmental Permitting to the completion of ROW/Utilities/RR.
    - Lag E- Time remaining to finish ROW/Utilities/RR after the ROW/Utilities/RR funding date.
    - Lag F – Time elapsed from the completion of ROW/Utilities/RR to start of Construction.
    - Lag G – Time elapsed after the start of Final Design to start of Construction.
    - Lag H – Time remaining after the finish of Final Design to finish of Construction.

- Lag I – Time remaining after finish of ROW/UTL/RR to finish of Construction.
- Lag J – Time remaining after finish of ROW/Utilities/RR to Lag K.
- Lag K – Time remaining from finish of ROW/Utilities/RR to finish of Procurement.

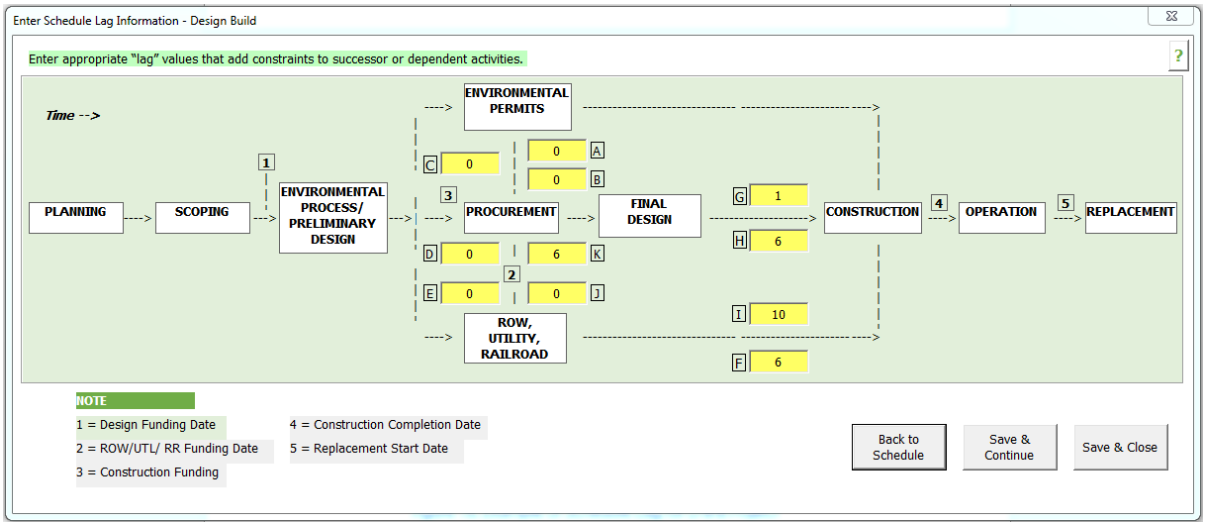


Figure 17. Example Schedule Lag for D-B Project

4.5. Cost

The "Cost" section allows the user to input cost information, including cost per project phase, cost inflation rates, and overhead rates associated with the project.

This section describes the costs incurred during various phases of the project. The user enters the cost for different phases using the cost inflation rates for preconstruction, ROW/Utility/Railroad and Construction; and the overhead rates for preconstruction and construction. The costs in Current Year and Year of Expenditure Dollars are calculated by the template as shown in Figure 18.

BASE COST (in Current Year and Year of Expenditure Dollars)

Project Phase	Base Cost (CY $M)	Base Cost + Overhead Cost (CY $M)	Base Cost + Overhead Cost (YOE $M)
Planning		0.00	0.00
Scoping		0.00	0.00
Design/Environmental Process	1.19	1.19	1.21
Environmental Permits		0.00	0.00
ROW/Util/RR	3.00	3.00	3.14
Procurement		0.00	0.00
Final Design		0.00	0.00
Construction	11.85	11.85	12.67
Total	16.04	16.05	17.02

Cost Inflation Rate (percent/year)	
Preconstruction	3.0
ROW/Utility/RR	3.0
Construction	3.0

Overhead Rate	(CY $ M/month)	
Preconstruction		0.10
Construction		0.23

Figure 18. Project costs per phase in $million

The following expands on the different rates that the user can enter:

- Cost Inflation Rate – Enter the inflation rate, in percent per year, which can apply to the preconstruction, ROW/Utilities/RR, and construction phases of the project.

Figure 19 shows the GUI form to enter the base cost information per project phase, cost inflation rates and overhead rates.

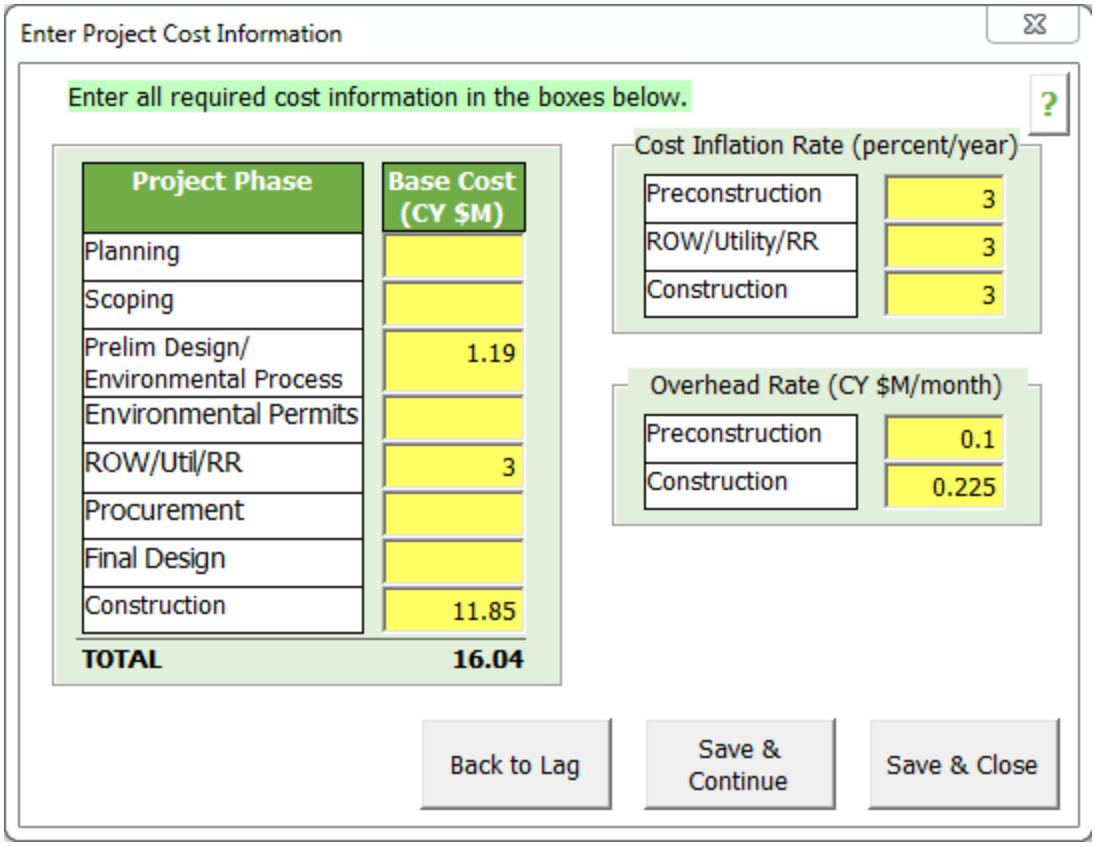


Figure 19. Project Cost GUI input form

Note: For Cost Inflation Rates: Preconstruction consists of all project phases that are not ROW/Utilities/RR or Construction.

- Overhead rate – Enter the overhead rate in current year millions of dollars per month, which will apply to the preconstruction and construction portions of the project. Overhead rate is related to the owner's management cost of the project which might be performed by an independent consultant or performed by internal agency staff. The overhead cost and inflation rate does not apply if an owner agency overhead cost is not included in the project base cost.
- Base Cost by phase – Enter the base cost, in current year millions of dollars, required to complete each listed project phase.

Note: For Cost Overhead Rates: Preconstruction in this case consists of all project phases other than construction, which includes ROW, Utilities and RR.

4.6. Disruption

The "Disruption" section allows the user to input traffic disruption-related information. The inputs include disruption value, agency/user cost discount factor, and disruption for each project phase. **The disruption value is the monetary equivalent of the hours lost due to disruption**. When considering disruption it is important to understand the relationship between the user and agency. **The agency/user cost discount factor is the ratio of the cost of disruption. The value of this ratio is usually 1**. Figure 20 and Figure 21 present information on the disruption segment and disruption through construction, respectively.

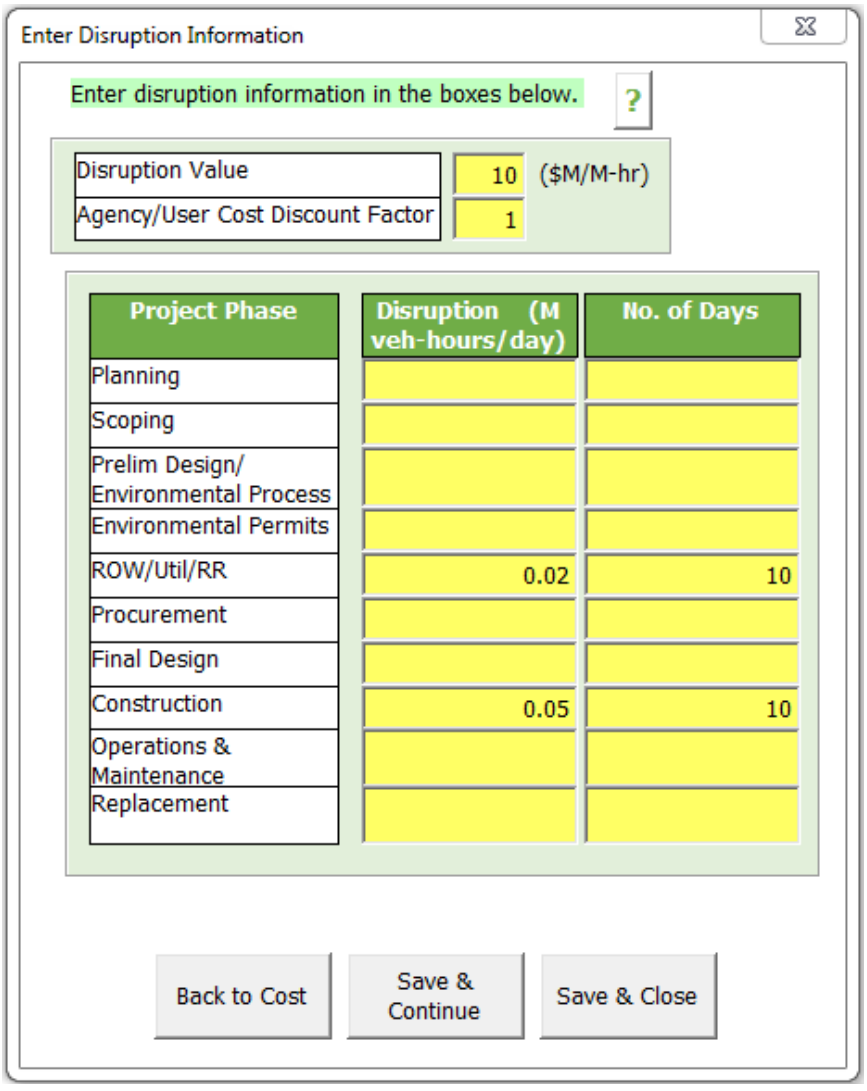


Figure 20. Project Disruption GUI input form

DISRUPTION		
Disruption Value	10	$M/M-hr
Agency/User Cost Discount Factor	1	

Project Phase	Disruption			
	M Veh-Hours/Day	No. of Days	M-Hrs	Cost ($M)
Planning			0.0	0.0
Scoping			0.0	0.0
Design/Environmental Process			0.0	0.0
Environmental Permits			0.0	0.0
ROW/Util/RR	0.02	10	0.2	2.0
Procurement			0.0	0.0
Final Design			0.0	0.0
Construction	0.05	10	0.5	5.0
Operations & Maintenance			1.4	14.0
Replacement			0.7	7.0
Total Disruption through OMR			2.8	28.0

Figure 21. Disruption table per project phase

The following list details the fields used in the disruption section:

- Disruption value – Enter the cost, in current year million dollars per hour, which is incurred when the project causes traffic disruption.
- Agency/User Cost Discount Factor – Enter a value, less than or equal to 1.0, which represents the ratio of the agency to the user cost (traveling public) with regards to disruption. Since most of the cost associated with disruption is borne by the traveling public rather than the transportation agency, this value allows the template user to (reduce the agency disruption cost that is used in the analysis).
- Disruption by phase – Enter an estimate of the disruption, in million vehicle-hours per day, which will be caused in each listed project phase.

All disruption values can be entered directly into the sheet in the Disruption section.

4.7. Operations, Maintenance, and Replacement (OMR)

The "'OMR'" section allows the user to input operation, maintenance, and replacement information for the base project. The inputs include: (i) facility performance period, (ii) discount rate, and (iii) asset life expectancy,

operation & maintenance annual costs, and replacement costs for different assets.

The following list details the fields used in the OMR section:

- Facility Performance Period – This is the overall period that the facility is expected to be in use before the facility replacement is required. This value is used to calculate the number of events of replacement of individual assets in the facility.
- Discount Rate – Enter the discount rate that will be used in calculations of OMR costs to convert calendar year dollars (CY$) into year of expenditure dollars (YOE$).
- Asset Type – Enter a brief description of each asset (for e.g., pavements, bridges, signs, pavement markings, etc.) that will be included in the analysis; up to 5 assets may be included.
- Asset Life Expectancy – Enter the expected useful life, in years, of each listed asset.
- O&M Agency Cost – Enter the cost, in current year millions of dollars per year, which will be incurred by the agency to operate and maintain each listed asset.
- O&M Disruption – Enter the estimated disruption, in millions of hours per year, which will be caused by operating and maintaining each listed asset.
- Replacement Agency Cost – Enter the cost, in current year millions of dollars per replacement event, which will be incurred by the agency to replace each listed asset.
- Replacement Disruption – Enter the estimated disruption, in millions of hours per replacement event, which will be caused by replacing each listed asset.

All OMR input values (see Figure 22 and Figure 23) can be entered directly into the OMR section of the sheet or using the GUI form.

OPERATION, MAINTENANCE & REPLACEMENT

Facility Performance Period	50.0	years
Discount Rate to convert CY $ to YOE $ (Net Discount Rate)	5.0	%

Facility Asset Type	Asset Life Expectancy (yr)	Operations & Maintenance		Replacement	
		Agency O&M Costs (CY $M/yr)	Disruption (Million-Hr/yr)	Agency Costs (CY $M/event)	Disruption (Million-Hr/event)
Asset 1	50.0		0.028		
Asset 2	50.0				0.700
Asset 3					
Asset 4					
Asset 5					
Total YOE $M		0.0	14.0	0.0	7.0
Total CY $M		0.0	5.1	0.0	6.6

Figure 22. OMR summary Information

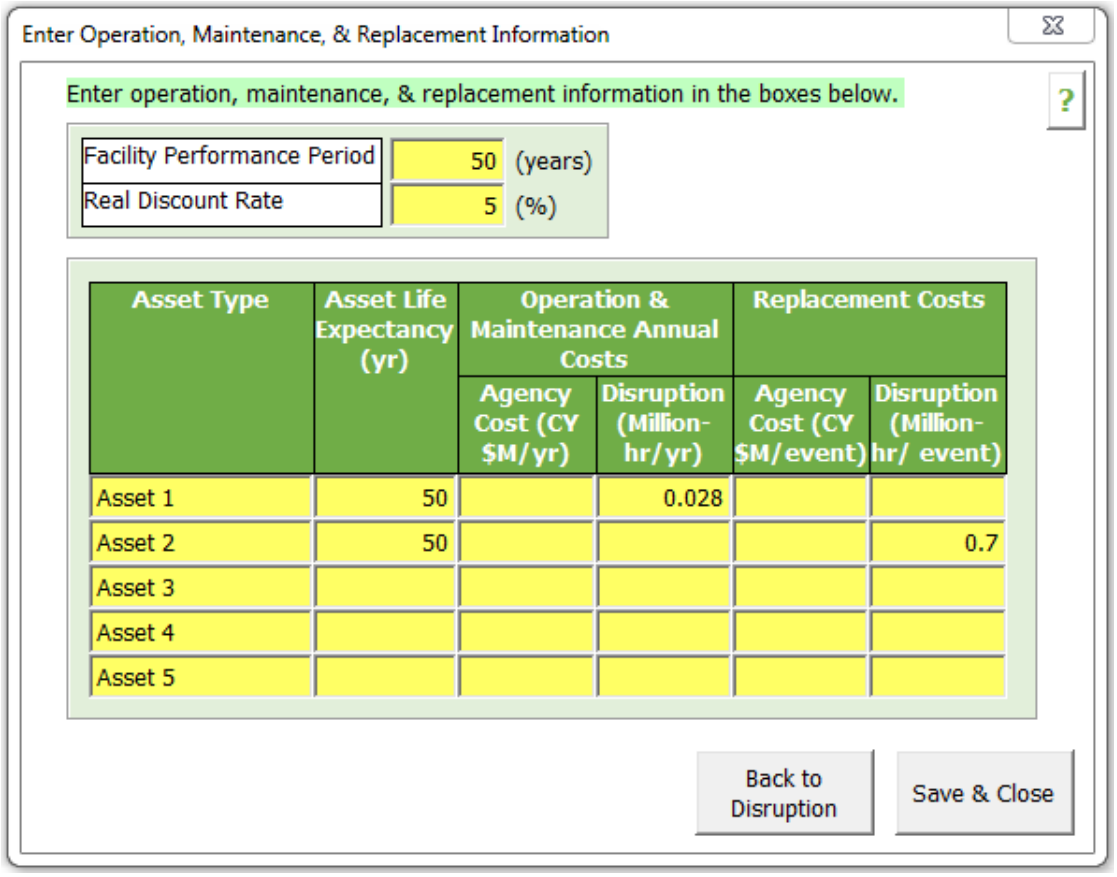


Figure 23. OMR GUI input form

The following is a list and explanation of the various units used in this section:

- CY – This is the current year cost (present value) of the particular asset, i.e. un-escalated or discounted values.
- YOE – The year of expenditure is the escalated cost of the expenditure of the asset during the year the money is actually spent on that particular asset.
- $M – Millions of dollars
- M-Hr – Millions of hours
- Veh-Hours – Vehicle hours

Figure 24 presents the base project information summary for cost in current year, year of expenditure, durations and early start and early finish dates per project phase. It also presents the total project base cost, base construction completion date, construction duration, and total project base disruption

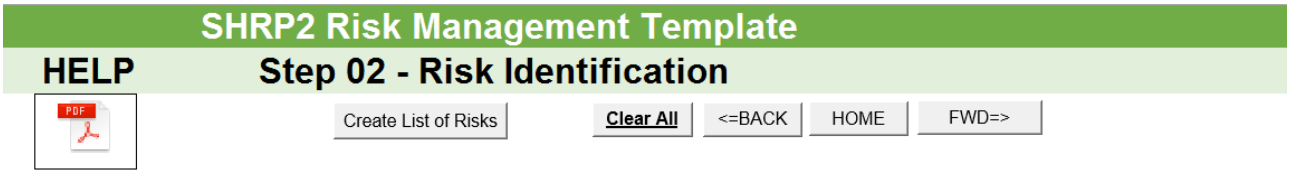
SUMMARY					
Project Phase	**Total CY Cost ($M)**	**Total YOE Cost($M)**	**Duration (months)**	**Early Start**	**Early Finish**
Planning	0.00	0.00	0	12/1/2009	12/1/2009
Scoping	0.00	0.00	0	12/1/2009	12/1/2009
Design/Environmental Process	1.19	1.21	12	12/1/2009	11/30/2010
Environmental Permits	0.00	0.00	6	11/30/2010	6/1/2011
ROW/Util/RR	3.00	3.14	12	11/30/2010	11/30/2011
Final Design	0.00	0.00	6	6/1/2011	11/30/2011
Procurement	0.00	0.00	6	11/30/2010	6/1/2011
Construction	11.85	12.67	16	7/1/2011	10/30/2012
Operations & Maintenance	0.00	0.00	600	10/30/2012	10/30/2062
Replacement	0.00	0.00	0	10/30/2062	
Base Cost (YOE $M)	17.02	(through Operations, Maintenance, & Replacement)			
Base Construction Completion Date	10/30/2012				
Months to Construction Completion	35.00				
Base Disruption ($M)	18.70	(through Operations, Maintenance, & Replacement)			

Figure 24. Project Information Summary

5.0. Risk Identification

Risk Identification is the second step of the risk management process and SHRP2 risk management template. This step allows the user to identify and develop a list comprehensive and non-overlapping set of risks (threats and opportunities) that could be associated with different phases of the base project. A risk label is automatically assigned based on the project phase in which the risk is anticipated to occur.

The Risk Identification step allows the user(s) to list all risks that could possibly occur during the execution of any phase of the project. The user can refer to this list at any time during the analysis and include (or remove) additional risks that were not earlier selected for risk analysis. Figure 25 presents the input screen for risk identification.



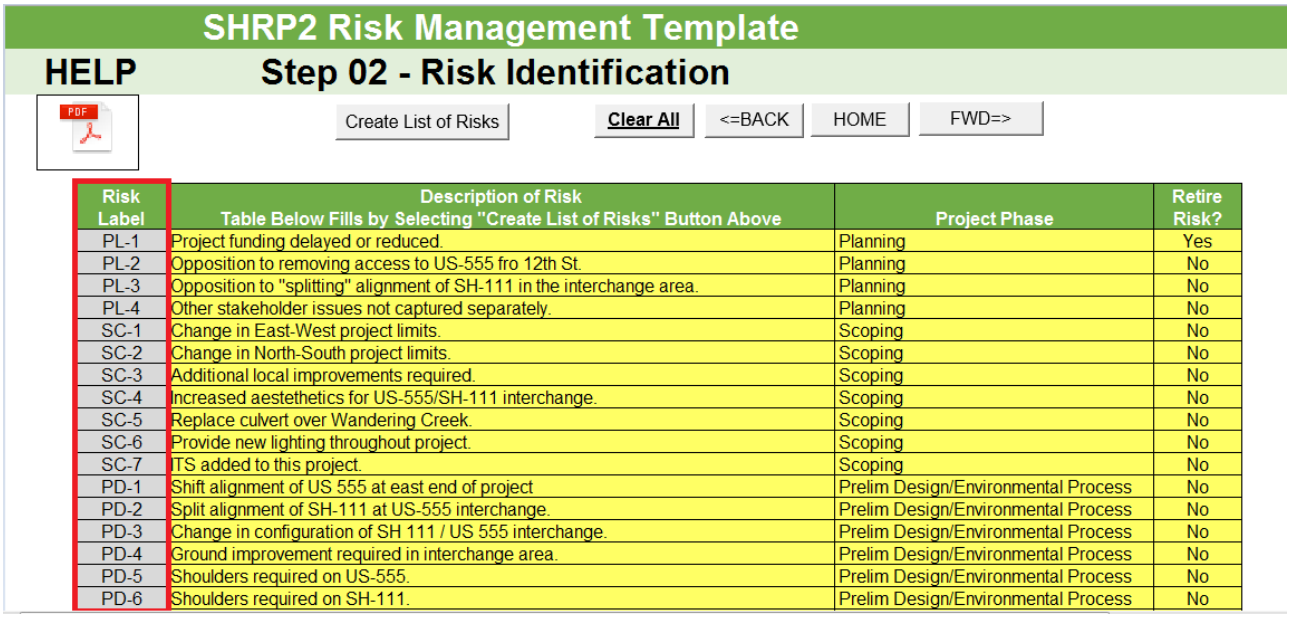
Risk Label	Description of Risk Table Below Fills by Selecting "Create List of Risks" Button Above	Project Phase	Retire Risk?
PL-1	Project funding delayed or reduced.	Planning	Yes
PL-2	Opposition to removing access to US-555 fro 12th St.	Planning	No
PL-3	Opposition to "splitting" alignment of SH-111 in the interchange area.	Planning	No
PL-4	Other stakeholder issues not captured separately.	Planning	No
SC-1	Change in East-West project limits.	Scoping	No
SC-2	Change in North-South project limits.	Scoping	No
SC-3	Additional local improvements required.	Scoping	No
SC-4	Increased aestethetics for US-555/SH-111 interchange.	Scoping	No
SC-5	Replace culvert over Wandering Creek.	Scoping	No
SC-6	Provide new lighting throughout project.	Scoping	No
SC-7	ITS added to this project.	Scoping	No
PD-1	Shift alignment of US 555 at east end of project	Prelim Design/Environmental Process	No
PD-2	Split alignment of SH-111 at US-555 interchange.	Prelim Design/Environmental Process	No
PD-3	Change in configuration of SH 111 / US 555 interchange.	Prelim Design/Environmental Process	No
PD-4	Ground improvement required in interchange area.	Prelim Design/Environmental Process	No
PD-5	Shoulders required on US-555.	Prelim Design/Environmental Process	No
PD-6	Shoulders required on SH-111.	Prelim Design/Environmental Process	No
PD-7	Additional cost for signalized intersections.	Prelim Design/Environmental Process	No
PD-8	Change in pavement section and/or type.	Prelim Design/Environmental Process	No

Figure 25. Risk Identification input form

5.1. Risk Label

The 'Risk Label' is a unique identifier assigned to every risk identified by the user during the risk identification process. This identifier is automatically generated by the SHRP2 Risk Management Template and is comprised of two letters followed by a hyphen and a number. The first two letters in a risk label correspond to the project phase of the particular risk, while the number

in a risk label corresponds to the order in which the risk was input by the user. This number is specific to the project phase for that risk. For example, PL-1 corresponds to the first risk input by the user and is associated with the planning phase. Similarly, PL-2 corresponds to the second risk entry associated with the planning phase. Figure 26 and Figure 27 present the risk labels and the associated risk descriptions, respectively. It should be noted that the user will not be able to delete or change a risk label once it is created. The user should also recognize that the risk labels are not altered by the tool and remain associated with the designated risk throughout the risk analysis process.



SHRP2 Risk Management Template

HELP **Step 02 - Risk Identification**

Create List of Risks | Clear All | <=BACK | HOME | FWD=>

Risk Label	Description of Risk Table Below Fills by Selecting "Create List of Risks" Button Above	Project Phase	Retire Risk?
PL-1	Project funding delayed or reduced.	Planning	Yes
PL-2	Opposition to removing access to US-555 fro 12th St.	Planning	No
PL-3	Opposition to "splitting" alignment of SH-111 in the interchange area.	Planning	No
PL-4	Other stakeholder issues not captured separately.	Planning	No
SC-1	Change in East-West project limits.	Scoping	No
SC-2	Change in North-South project limits.	Scoping	No
SC-3	Additional local improvements required.	Scoping	No
SC-4	Increased aestethetics for US-555/SH-111 interchange.	Scoping	No
SC-5	Replace culvert over Wandering Creek.	Scoping	No
SC-6	Provide new lighting throughout project.	Scoping	No
SC-7	ITS added to this project.	Scoping	No
PD-1	Shift alignment of US 555 at east end of project	Prelim Design/Environmental Process	No
PD-2	Split alignment of SH-111 at US-555 interchange.	Prelim Design/Environmental Process	No
PD-3	Change in configuration of SH 111 / US 555 interchange.	Prelim Design/Environmental Process	No
PD-4	Ground improvement required in interchange area.	Prelim Design/Environmental Process	No
PD-5	Shoulders required on US-555.	Prelim Design/Environmental Process	No
PD-6	Shoulders required on SH-111.	Prelim Design/Environmental Process	No

Figure 26. Risk Labels

SHRP2 Risk Management Template

HELP **Step 02 - Risk Identification**

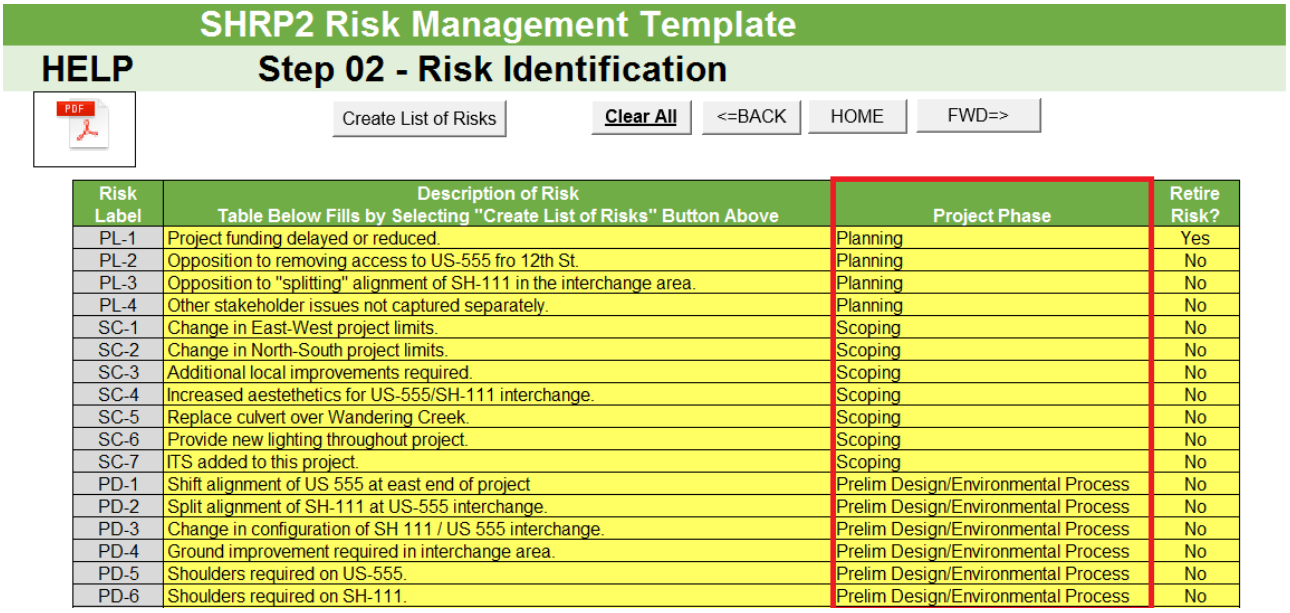
Create List of Risks | Clear All | <=BACK | HOME | FWD=>

Risk Label	Description of Risk Table Below Fills by Selecting "Create List of Risks" Button Above	Project Phase	Retire Risk?
PL-1	Project funding delayed or reduced.	Planning	Yes
PL-2	Opposition to removing access to US-555 fro 12th St.	Planning	No
PL-3	Opposition to "splitting" alignment of SH-111 in the interchange area.	Planning	No
PL-4	Other stakeholder issues not captured separately.	Planning	No
SC-1	Change in East-West project limits.	Scoping	No
SC-2	Change in North-South project limits.	Scoping	No
SC-3	Additional local improvements required.	Scoping	No
SC-4	Increased aestethetics for US-555/SH-111 interchange.	Scoping	No
SC-5	Replace culvert over Wandering Creek.	Scoping	No
SC-6	Provide new lighting throughout project.	Scoping	No
SC-7	ITS added to this project.	Scoping	No
PD-1	Shift alignment of US 555 at east end of project	Prelim Design/Environmental Process	No
PD-2	Split alignment of SH-111 at US-555 interchange.	Prelim Design/Environmental Process	No
PD-3	Change in configuration of SH 111 / US 555 interchange.	Prelim Design/Environmental Process	No
PD-4	Ground improvement required in interchange area.	Prelim Design/Environmental Process	No
PD-5	Shoulders required on US-555.	Prelim Design/Environmental Process	No
PD-6	Shoulders required on SH-111.	Prelim Design/Environmental Process	No

Figure 27. Risk Descriptions

5.2. Project Phase Inputs

Each risk must be assigned a project phase listed to be included in the analysis. Each entry box under the "Project Phase" heading features a drop-down menu that lists all possible phase names. Each cell in the "Project Phase" column on the sheet (see Figure 28) also features a drop-down menu with the same list of phase names. The user must select a phase from this list; any other entry will trigger an error message and the user will not be able to proceed until the entry is valid.


SHRP2 Risk Management Template

HELP Step 02 - Risk Identification

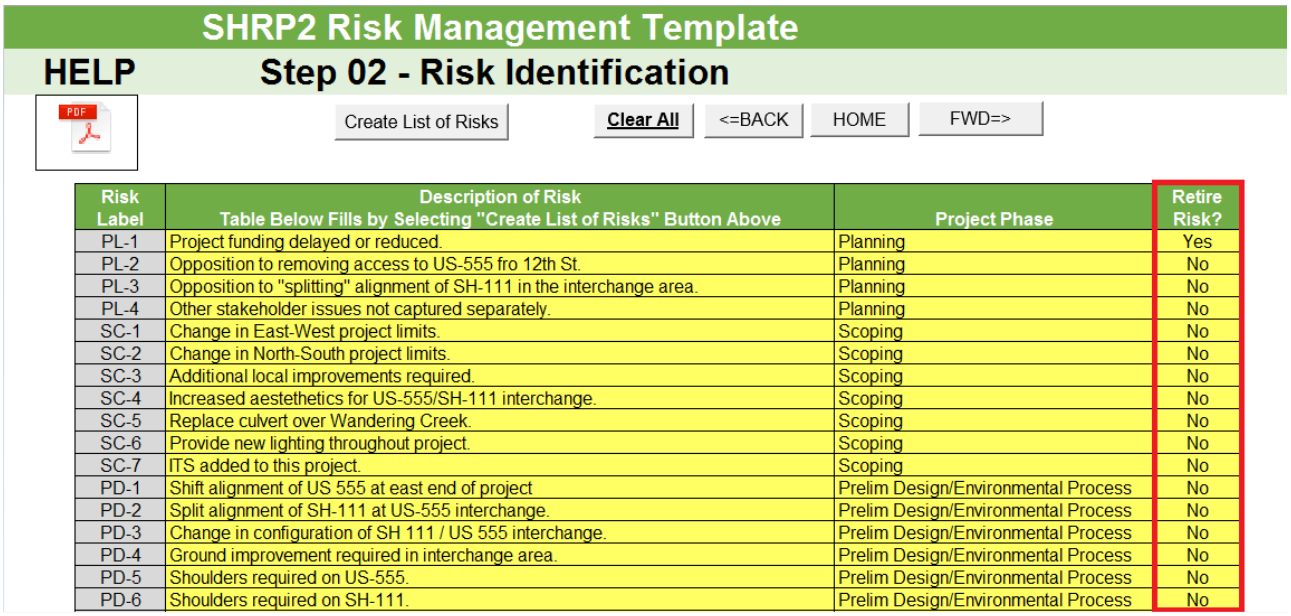
Create List of Risks | Clear All | <=BACK | HOME | FWD=>

Risk Label	Description of Risk Table Below Fills by Selecting "Create List of Risks" Button Above	Project Phase	Retire Risk?
PL-1	Project funding delayed or reduced.	Planning	Yes
PL-2	Opposition to removing access to US-555 fro 12th St.	Planning	No
PL-3	Opposition to "splitting" alignment of SH-111 in the interchange area.	Planning	No
PL-4	Other stakeholder issues not captured separately.	Planning	No
SC-1	Change in East-West project limits.	Scoping	No
SC-2	Change in North-South project limits.	Scoping	No
SC-3	Additional local improvements required.	Scoping	No
SC-4	Increased aestethetics for US-555/SH-111 interchange.	Scoping	No
SC-5	Replace culvert over Wandering Creek.	Scoping	No
SC-6	Provide new lighting throughout project.	Scoping	No
SC-7	ITS added to this project.	Scoping	No
PD-1	Shift alignment of US 555 at east end of project	Prelim Design/Environmental Process	No
PD-2	Split alignment of SH-111 at US-555 interchange.	Prelim Design/Environmental Process	No
PD-3	Change in configuration of SH 111 / US 555 interchange.	Prelim Design/Environmental Process	No
PD-4	Ground improvement required in interchange area.	Prelim Design/Environmental Process	No
PD-5	Shoulders required on US-555.	Prelim Design/Environmental Process	No
PD-6	Shoulders required on SH-111.	Prelim Design/Environmental Process	No

Figure 28. Project Phase Selection

5.3. Retire Risk

The 'Retire Risk' option allows the user to retire a risk from the analysis. This commonly occurs as project phases occur, anticipated risks do not occur and risk mitigation measures are implemented by the project team. (Any risk created by the user is included in the risk analysis as a default, and the 'Retire Risk' option provides an opportunity to include a previously entered risk by selecting a "No" label. The user can also choose to retire risks (i.e., to exclude the risks from the risk analysis) by selecting "Yes" for each risk that the user wants to exclude from further analysis in the subsequent steps of the tool. At any time during the risk analysis process, the user can change the 'Retire Risk' entry corresponding to a risk to "No" and once again include the particular risk for future analysis**. If the entry is changed, the user will need rerun the analysis**. Figure 29 presents the risk retirement option under the risk identification step. During the course of the analysis, certain risks could have little to no impact on the project and the user can choose to retire these risks.



SHRP2 Risk Management Template

HELP Step 02 - Risk Identification

Create List of Risks | Clear All | <=BACK | HOME | FWD=>

Risk Label	Description of Risk Table Below Fills by Selecting "Create List of Risks" Button Above	Project Phase	Retire Risk?
PL-1	Project funding delayed or reduced.	Planning	Yes
PL-2	Opposition to removing access to US-555 fro 12th St.	Planning	No
PL-3	Opposition to "splitting" alignment of SH-111 in the interchange area.	Planning	No
PL-4	Other stakeholder issues not captured separately.	Planning	No
SC-1	Change in East-West project limits.	Scoping	No
SC-2	Change in North-South project limits.	Scoping	No
SC-3	Additional local improvements required.	Scoping	No
SC-4	Increased aestethetics for US-555/SH-111 interchange.	Scoping	No
SC-5	Replace culvert over Wandering Creek.	Scoping	No
SC-6	Provide new lighting throughout project.	Scoping	No
SC-7	ITS added to this project.	Scoping	No
PD-1	Shift alignment of US 555 at east end of project	Prelim Design/Environmental Process	No
PD-2	Split alignment of SH-111 at US-555 interchange.	Prelim Design/Environmental Process	No
PD-3	Change in configuration of SH 111 / US 555 interchange.	Prelim Design/Environmental Process	No
PD-4	Ground improvement required in interchange area.	Prelim Design/Environmental Process	No
PD-5	Shoulders required on US-555.	Prelim Design/Environmental Process	No
PD-6	Shoulders required on SH-111.	Prelim Design/Environmental Process	No

Figure 29. Risk Retirement Selection

5.4. Data Entry Options

Although it is recommended that the user uses the GUI input form for data entry, the user has the option of entering risks directly into the Excel sheet. While entering risks directly into the sheet, the user should begin by entering the risk description and then selecting the project phase. Once the project phase has been selected, the template will automatically create a risk label corresponding to the risk description entered and will automatically assign a "No" label to the "Retire Risk" selection.

Note: The risk label is a system-generated identifier and cannot be created by the user.

5.5. Clearing Data Entries

The "Clear All" button deletes all risks listed on the Risk Identification step. It also clears the data shown on the Risk Assessment, Risk Register, Unmitigated Project Performance, Risk Mitigation Strategies, and Mitigated Project Performance steps. This button should only be used when the user desires to completely re-do the analysis. Figure 30 presents the warning screen that the user receives when clicking the "Clear All" button.

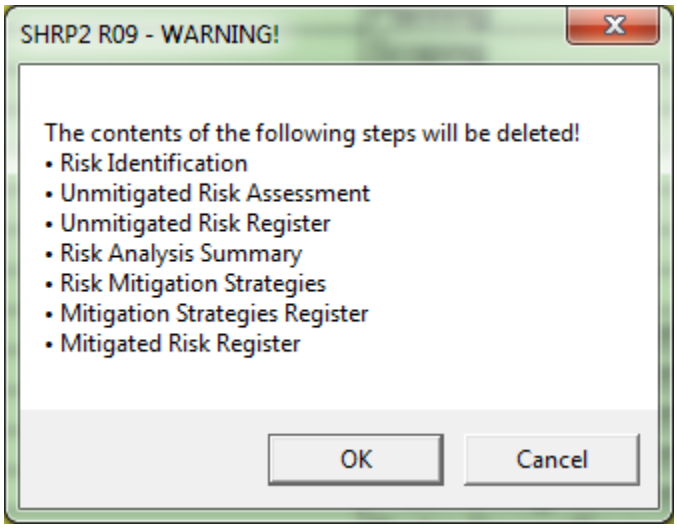


Figure 30. User Warning

6.0. Rating Scale

Rating scale information is addressed in this step. The following rating categories are considered:

- Cost Change
- Schedule Change
- Disruption Change
- Probability of occurrence

The base values for cost (in CY $million), schedule (in months), and disruption (in million person-hours lost) are also entered (see Figure 31).

The risk scale requires the data entry type to be an absolute value or a percentage of the base value. In both cases, the ranges are provided by the user and a calculated mean value is used for analysis in the subsequent steps.

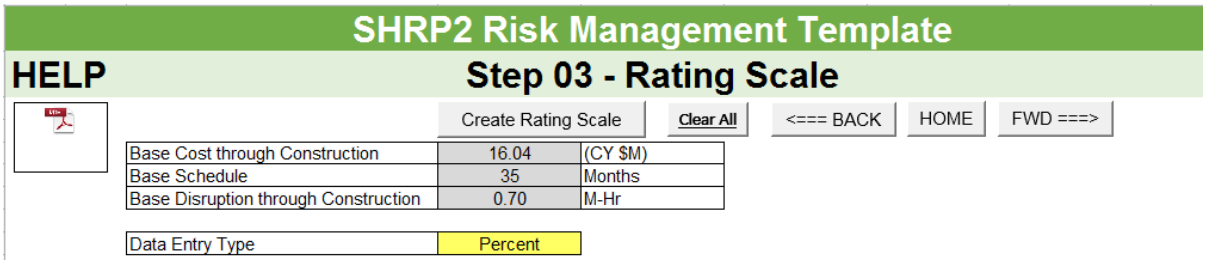


Figure 31. Rating scale base information

6.1. Risk Scale Entries

The Risk Scale module allows the user to define an adjectival rating system to assess the major impacts of risks (cost, duration, and disruption), and the probability of risk occurrence. The rating system on the impacts of risks determines the magnitude of effect (severity) that the risk will have on the project. The rating system for probability of risk occurrence can be defined as the probability of given risk occurring during the course of the project. By clicking on the "Create Rating Scale" button, the user can access the various rating scales (as shown in Figure 32 through Figure 35). The user can set values for each of the 5 adjectival ratings (ranging from very high to very low) for every type of risk impact and its probability of occurrence. Based on the defined set of adjectival ratings, the user can then assign a rating to the cost, duration, and disruption component of each risk, as well as to the

probability of risk occurrence, using the methodology described below. The distinction between the nature of the occurences i.e. opportunities or threats is carried out in Step 4 where the user is provided an option to select for risk occurrence and probability of occurrence.

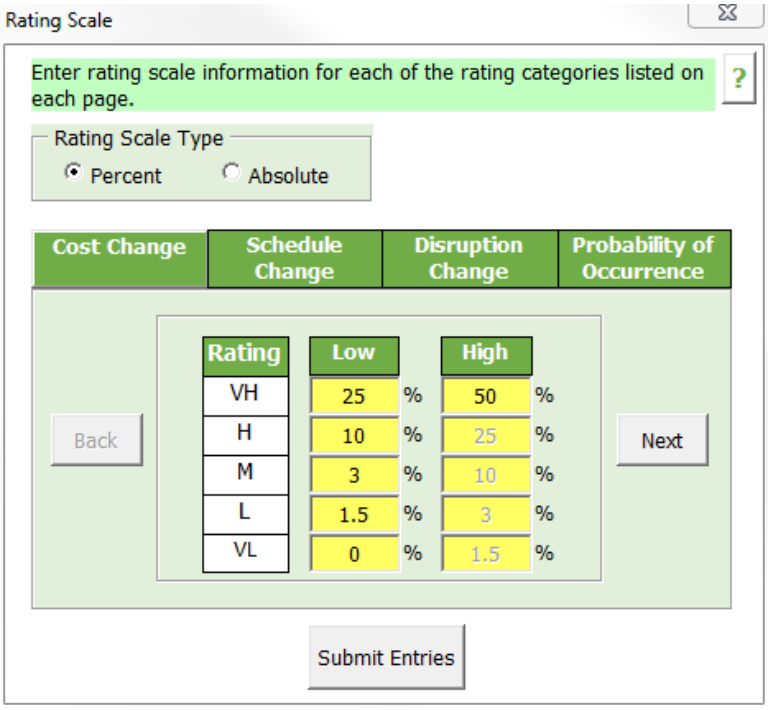


Figure 32. Percent Cost Change GUI input form

COST CHANGE

Adjectival Rating	Percent of Base Cost		Absolute Value (CY $M)		Expected Mean Value	
	Low	High	Low	High	Percent	Absolute
VH	24.94	49.88	4.00	8.00	37.41	6.00
H	9.98	24.94	1.60	4.00	17.46	2.80
M	3.12	9.98	0.50	1.60	6.55	1.05
L	1.25	3.12	0.20	0.50	2.18	0.35
VL	0.00	1.25	0.00	0.20	0.62	0.10

Figure 33. Percent Cost Change (Form)

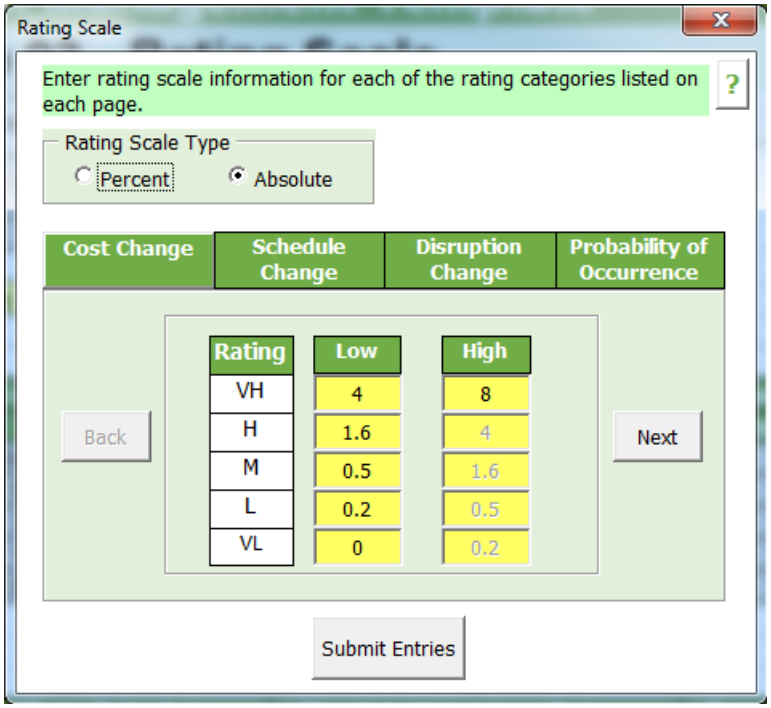


Figure 34. Absolute Cost Change GUI input form

COST CHANGE

Adjectival Rating	Percent of Base Cost		Absolute Value (CY $M)		Expected Mean Value	
	Low	High	Low	High	Percent	Absolute
VH	24.84	49.69	4.00	8.00	37.27	6.00
H	9.94	24.84	1.60	4.00	17.39	2.80
M	3.11	9.94	0.50	1.60	6.52	1.05
L	1.24	3.11	0.20	0.50	2.17	0.35
VL	0.00	1.24	0.00	0.20	0.62	0.10

Figure 35. Absolute Cost Change (Form)

7.0. Unmitigated Risk Assessment

The Unmitigated Risk Assessment step is used to assess the various risks associated with the project by determining their severity. Figure 36 presents a view of the unmitigated risk assessment form.

SHRP2 Risk Management Template

HELP **Step 04 - Unmitigated Risk Assessment**

Conduct Risk Assessment | Calculate Mean Severity Values | Clear All | <=== BACK | HOME | FWD===>

Risk Label	Risk Description	Probability of Occurrence			Mean Cost Change (CY $M)					Mean Duration Chang			
		Adjectival	Numerical	Mean Value	Risk Type	Adjectival	Numerical	Mean Value	Affected Phase	Risk Type	Adjectival	Numerical	Mean Value
PL-1	Project funding delayed or reduced.			0.00				0.00					0.00
PL-2	Opposition to removing access to US-555 fro 12th St.	L		12.50	Threat	VL		0.10	Construction			0.00	0.00
PL-3	Opposition to "splitting" alignment of SH-111 in the interchange area.			0.00				0.00					0.00
PL-4	Other stakeholder issues not captured separately.			0.00				0.00					0.00
SC-1	Change in East-West project limits.			0.00				0.00					0.00
SC-2	Change in North-South project limits.			0.00				0.00					0.00
SC-3	Additional local improvements required.	L		12.50	Threat	L		0.35	Construction	Threat	L		0.63
SC-4	Increased aestethetics for US-555/SH-111 interchange.			0.00				0.00					0.00
SC-5	Replace culvert over Wandering Creek.	M		30.00	Threat	L		0.35	Construction			0.00	0.00
SC-6	Provide new lighting throughout project.	H		55.00	Threat	M		1.05	Construction			0.00	0.00
SC-7	ITS added to this project.			0.00				0.00					0.00
PD-1	Shift alignment of US 555 at east end of project	VL		2.50	Threat	M		1.05	ROW/Util/RR	Threat	M		2.50
PD-2	Split alignment of SH-111 at US-555 interchange.			0.00				0.00					0.00
PD-3	Change in configuration of SH 111 / US 555 interchange.		0.00	0.00			0.00	0.00				0.00	0.00
PD-4	Ground improvement required in interchange area.	L		12.50	Threat	M		1.05	Construction	Threat	L		0.63
PD-5	Shoulders required on US-555.	VL		2.50	Threat	H		2.80	Construction	Threat	M		2.50
PD-6	Shoulders required on SH-111.	VL		2.50	Threat	H		2.80	Construction	Threat	M		2.50
PD-7	Additional cost for signalized intersections.			0.00				0.00					0.00
PD-8	Change in pavement section and/or type.	M		30.00	Opportunity	M		-1.05	Construction			0.00	0.00
PD-9	Rehabilitate instead of reconstruct existing roadway (e.g.,			0.00				0.00					0.00

Figure 36. Unmitigated Risk Assessment Form

7.1. Conducting Unmitigated Risk Assessment

The Unmitigated Risk Assessment step allows the user to assess the probability of risk occurrence and the severity of each type of risk impact (cost, duration, and disruption). It also allows the user to identify the project phase that will be affected by each impact type for each risk. The list of risk labels and descriptions presented in this step consists of those risks from the Risk Identification step that have a "No" value in the "Retire Risk" column. Figure 37 highlights the button used to conduct the risk assessment.

Note: The Risk Label and Risk Description cannot be edited by the user. A risk can be added/edited/deleted only in the Risk Identification step.

Figure 37. Conducting Unmitigated Risk Assessment

The unmitigated risks are assessed based on their probability of occurrence and severity of impacts, which can either be predefined based on an adjectival scale ranging from very high to very low, or can be defined as a numerical value. Based on the adjectival or numerical value entered by the user, a mean value is populated for probability of occurrence, cost change, schedule change, and disruption change.

Note: The user is provided the option to enter the probabilities in numerical/adjectival formats. It should be noted that the numerical entry takes precedence over the adjectival entry.

The mean probability of occurrence value is then used by the tool for further computations. The risks are defined at the impact level based on risk type (threat or opportunity). In other words, a risk could have a positive impact on one performance measure while having a negative impact on a different performance measure. For example, the use of accelerated construction measures may have positive impact by reducing the project duration, but at the same time may lead to increased project cost. For every risk, the user is expected to enter the project phase affected by that risk.

Note: This affected project phase is different from the project phase listed for each risk in the Risk Identification step. The project phase in the Risk Identification step refers to the phase in which the risk will occur, while the affected project phase refers to the project phases that will be affected by the given risk impact. For example, a risk may occur during the planning phase, but the risk's cost impact will affect the final design phase, and the duration impact will affect the construction phase.

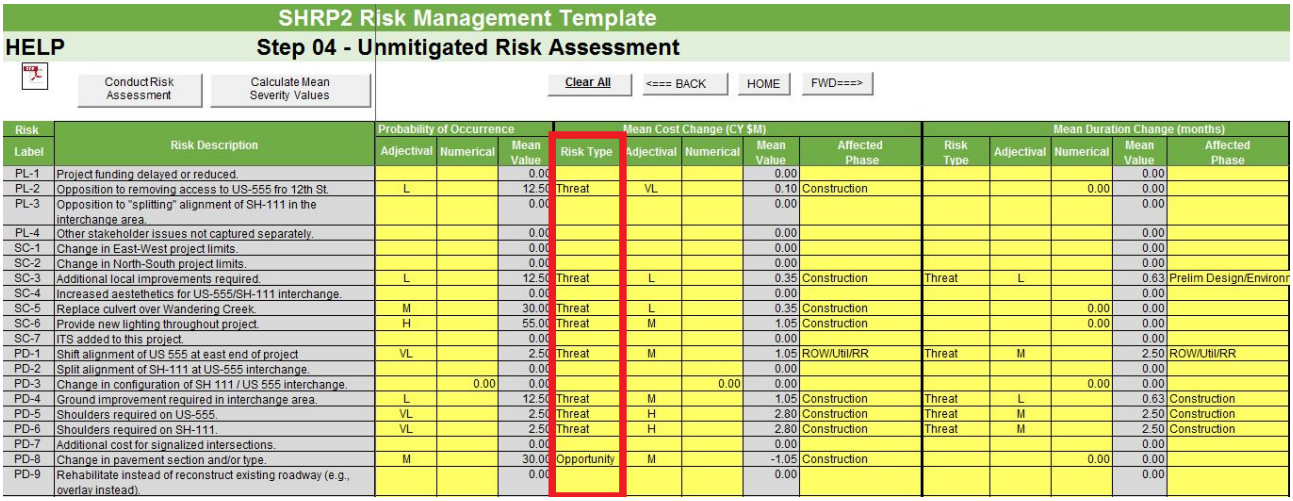
7.2. Unmitigated Risk Assessment Data Entries

The user inputs for this step include probability of occurrence and risk type. The probability of occurrence values can either be an adjectival rating or a

numerical rating. For the adjectival rating, the user can select one of 5 ratings (i.e., VH, H, M, L, VL), each of which corresponds to values inputted in the Risk Scale step. **Generally, the numerical rating should only be used if the user has detailed information about the risk that will allow the user to provide a specific probability for the given risk.**

After entering the probability of occurrence, the user should enter data for the mean cost change, mean schedule change, and mean disruption change. For these inputs, the user should then select one of the following two risk type entries (see Figure 38 and Figure 39):

- Threat – Indicates that the mean cost change, mean duration change, or mean disruption change, is likely to have a negative impact on the cost, schedule, or disruption of the affected phase.
- Opportunity – Indicates that the mean cost change, mean duration change, or mean disruption change, is likely to have a positive impact on the cost, schedule, or disruption of the affected phase.



SHRP2 Risk Management Template

HELP — Step 04 - Unmitigated Risk Assessment

Conduct Risk Assessment | Calculate Mean Severity Values | Clear All | <=== BACK | HOME | FWD===>

Risk Label	Risk Description	Probability of Occurrence			Mean Cost Change (CY $M)					Mean Duration Change (months)				
		Adjectival	Numerical	Mean Value	Risk Type	Adjectival	Numerical	Mean Value	Affected Phase	Risk Type	Adjectival	Numerical	Mean Value	Affected Phase
PL-1	Project funding delayed or reduced.			0.00				0.00					0.00	
PL-2	Opposition to removing access to US-555 fro 12th St.	L		12.50	Threat	VL		0.10	Construction			0.00	0.00	
PL-3	Opposition to "splitting" alignment of SH-111 in the interchange area.			0.00				0.00					0.00	
PL-4	Other stakeholder issues not captured separately.			0.00				0.00					0.00	
SC-1	Change in East-West project limits.			0.00				0.00					0.00	
SC-2	Change in North-South project limits.			0.00				0.00					0.00	
SC-3	Additional local improvements required.	L		12.50	Threat	L		0.35	Construction	Threat	L		0.63	Prelim Design/Environr
SC-4	Increased aestethetics for US-555/SH-111 interchange.			0.00				0.00					0.00	
SC-5	Replace culvert over Wandering Creek.	M		30.00	Threat	L		0.35	Construction			0.00	0.00	
SC-6	Provide new lighting throughout project.	H		55.00	Threat	M		1.05	Construction			0.00	0.00	
SC-7	ITS added to this project.			0.00				0.00					0.00	
PD-1	Shift alignment of US 555 at east end of project	VL		2.50	Threat	M		1.05	ROW/Util/RR	Threat	M		2.50	ROW/Util/RR
PD-2	Split alignment of SH-111 at US-555 interchange.			0.00				0.00					0.00	
PD-3	Change in configuration of SH 111 / US 555 interchange.		0.00	0.00			0.00	0.00				0.00	0.00	
PD-4	Ground improvement required in interchange area.	L		12.50	Threat	M		1.05	Construction	Threat	L		0.63	Construction
PD-5	Shoulders required on US-555.	VL		2.50	Threat	H		2.80	Construction	Threat	M		2.50	Construction
PD-6	Shoulders required on SH-111.	VL		2.50	Threat	H		2.80	Construction	Threat	M		2.50	Construction
PD-7	Additional cost for signalized intersections.			0.00				0.00					0.00	
PD-8	Change in pavement section and/or type.	M		30.00	Opportunity	M		-1.05	Construction			0.00	0.00	
PD-9	Rehabilitate instead of reconstruct existing roadway (e.g., overlay instead).			0.00				0.00					0.00	

Figure 38. Risk type selection (Threat or Opportunity)

The user can add values directly onto the excel spreadsheet or use the user interface (GUI) via the "Conduct Risk Assessment" button to input values to assess the impacts of the risks.

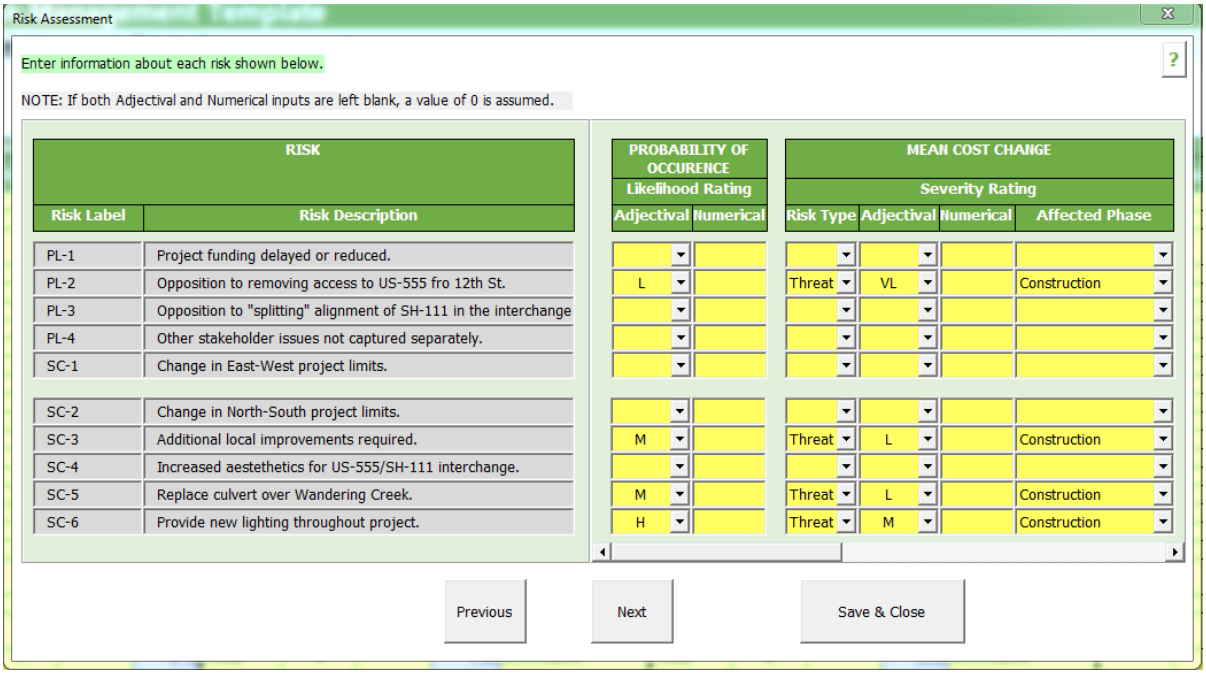


Figure 39. Risk type GUI input Form

7.3. Unmitigated Mean Severity Calculations

The "Calculate Mean Severity" button (see Figure 40) allows the template to perform the necessary calculations to determine the combined severity of each risk, in year of expenditure millions of dollars, based on the information that was entered during risk assessment. Once the user clicks on the button the template goes to Step 5-Unmitigated Risk Register where the user can see all unmitigated risks assessed and ranked by mean severity.

Note: The user should click on the "Calculate Mean Severity Values" button whenever any risk assessment information is modified.

Note: The "Clear All" button deletes all user-entered data on the Risk Assessment, Risk Register, Risk Analysis Summary, Risk Mitigation Data, and Final Analysis Summary sheets. BUT NOT THE PROJECT INFORMATION AND OTHER BASE PROJECT INFORMATION.

SHRP2 Risk Management Template

HELP **Step 04 - Unmitigated Risk Assessment**

Conduct Risk Assessment | Calculate Mean Severity Values | Clear All | <=== BACK | HOME | FWD===>

Risk Label	Risk Description	Probability of Occurrence			Mean Cost Change (CY $M)				
		Adjectival	Numerical	Mean Value	Risk Type	Adjectival	Numerical	Mean Value	Affected Phase
PL-1	Project funding delayed or reduced.			0.00				0.00	
PL-2	Opposition to removing access to US-555 fro 12th St.	L		12.50	Threat	VL		0.10	Construction
PL-3	Opposition to "splitting" alignment of SH-111 in the interchange area.			0.00				0.00	
PL-4	Other stakeholder issues not captured separately.			0.00				0.00	
SC-1	Change in East-West project limits.			0.00				0.00	
SC-2	Change in North-South project limits.			0.00				0.00	
SC-3	Additional local improvements required.	L		12.50	Threat	L		0.35	Construction
SC-4	Increased aestethetics for US-555/SH-111 interchange.			0.00				0.00	
SC-5	Replace culvert over Wandering Creek.	M		30.00	Threat	L		0.35	Construction
SC-6	Provide new lighting throughout project.	H		55.00	Threat	M		1.05	Construction
SC-7	ITS added to this project.			0.00				0.00	
PD-1	Shift alignment of US 555 at east end of project	VL		2.50	Threat	M		1.05	ROW/Util/RR
PD-2	Split alignment of SH-111 at US-555 interchange.			0.00				0.00	
PD-3	Change in configuration of SH 111 / US 555 interchange.		0.00	0.00			0.00	0.00	

Figure 40. Mean Severity Value calculations

8.0. Unmitigated Risk Register

This step provides the user with the necessary information to identify the risks that need to be mitigated in a priority listing. The step presents the severity of each risk on the overall project performance, in year of expenditure millions of dollars, and then displays the risks in a ranked order.

Note: The order of the risk ranking is determined by the percent of total severity that is calculated based on each risk's individual severity.

The risks are ranked separately based on the risk type (threat or opportunity). This step is meant for output purposes only, and the user cannot make any changes, except to choose the different risks that the user wishes to address during the risk mitigation plan. This can be done via the "Select Risk for Mitigation" option (the default option for every risk is "No"). The user can select a specific risk for mitigation by changing this option to "Yes". Figure 41 presents the results for an unmitigated risk register.

SHRP2 Risk Management Template

HELP | **Step 05 - Unmitigated Risk Register**

<=== BACK | HOME | FWD ===>

Risk Label	Risk Description	Risk Type	Mean Cost Impact (CY $M)	Mean Duration Impact (months)	Mean Disruption Impact (M-Hr)	Mean Change to Critical Path Schedule	Mean Severity (YOE $M)	Percent of Total Severity	Risk Ranking based on Mean Severity	Select Risk for Mitigation
SC-6	Provide new lighting throughout project.	Threat	0.6	0.0	0.00	0.0	0.6	9.7%	1	Yes
PR-1	Uncertainty in construction-cost inflation rate	Threat	0.6	0.0	0.00	0.0	0.6	9.7%	2	Yes
RR-1	Uncertainty in ROW inflation rate	Threat	0.6	0.0	0.00	0.0	0.6	9.5%	3	Yes
RR-3	Unwilling sellers	Threat	0.6	0.0	0.00	0.0	0.6	9.5%	4	Yes
CR-2	Additional Maintenance of Traffic required	Threat	0.2	0.1	0.03	0.0	0.5	7.6%	5	Yes
RR-2	Accelerating pace of development in interchange area	Threat	0.3	0.8	0.00	1.0	0.5	7.1%	6	Yes
PD-11	Cannot use City sewer system for project runoff (or City charges for use).	Threat	0.3	0.2	0.00	0.0	0.3	5.3%	7	Yes
RR-8	QDOT helps City pay for water and sewer-line relocation	Threat	0.3	0.0	0.00	0.0	0.3	5.3%	8	Yes
PD-13	Change in environmental documentation.	Threat	0.1	1.0	0.00	1.0	0.3	4.1%	9	Yes
CR-4	Unable to construct interchange embankments as rapidly as assumed	Threat	0.1	0.8	0.00	1.0	0.2	3.6%	10	Yes
CR-3	Problems with planned accelerated bridge construction (ABC) technique	Threat	0.2	0.3	0.00	0.0	0.2	3.4%	11	Yes
PD-4	Ground improvement required in interchange area.	Threat	0.1	0.1	0.00	0.0	0.2	2.3%	12	Yes
PD-12	Structures impacted by Main Street realignment are eligible for Historic Register.	Threat	0.1	0.3	0.00	0.0	0.1	2.3%	13	Yes
PD-14	Delays completing environmental documentation.	Threat	0.0	0.8	0.00	1.0	0.1	2.0%	14	Yes
SC-3	Additional local improvements required.	Threat	0.1	0.2	0.00	0.0	0.1	1.9%	15	Yes
SC-5	Replace culvert over Wandering Creek.	Threat	0.1	0.0	0.00	0.0	0.1	1.9%	16	Yes
PD-16	Additional wetland mitigation required for planned alignment.	Threat	0.1	0.0	0.00	0.0	0.1	1.9%	17	Yes
RR-7	Telecom utility wants a cost-sharing agreement	Threat	0.1	0.0	0.00	0.0	0.1	1.9%	18	Yes
PD-5	Shoulders required on US-555.	Threat	0.1	0.1	0.00	0.0	0.1	1.3%	19	Yes
PD-6	Shoulders required on SH-111.	Threat	0.1	0.1	0.00	0.0	0.1	1.3%	20	Yes
CR-5	Difficult foundation installation	Threat	0.0	0.1	0.00	0.0	0.1	0.9%	21	Yes
PD-15	Encounter unanticipated contamination in interchange area.	Threat	0.0	0.0	0.00	0.0	0.0	0.7%	22	Yes

Figure 41. Unmitigated Risk Register

The following explains the information shown in this step and associated data/calculations:

- Risk Label and Risk Description – Displays the labels and descriptions for all risks that were assessed on the Risk Assessment step.
- Risk Type – Each risk is assigned an overall risk type that is based on the mean severity value.

Note: A risk is an overall threat if the mean severity value is positive and it is an overall opportunity if the mean severity value is negative.

- Mean Cost Impact (current year millions of dollars) –The cost impact is equal to the product of the risk probability of occurrence and the mean value of the cost change.
- Mean Duration Impact (months) – The duration impact is equal to the product of the risk probability of occurrence and the mean value of the duration change.
- Mean Disruption Impact (millions of hours) – The disruption impact is equal to the product of the risk probability of occurrence and the mean value of the disruption change.
- Mean Change to Critical Path Schedule – This is the calculated impact of each risk on the project's critical path. It is possible for a risk to have a positive value (increase duration) for mean duration impact and yet not have any impact on the critical path because of available float in the schedule.

Note: Float can be defined as the amount of time an activity can be delayed from the early start without changing the completion date of the project. If an activity has float it is not considered part of the critical path.

- Mean Severity (year of expenditure, millions of dollars) – The mean severity value calculations take into account inflation rates, the costs of schedule delay, overhead costs, the effect of disruption (if selected as a performance measure during project structuring), and the impact of delay in the start date of operations. This value can be either negative or positive depending on the values of cost, duration, and disruption impacts that were entered during the risk assessment.

- Percent of Total Severity – The total severity is summed separately for threats and opportunities and is the percent severity of the total threat or opportunities for the project.
- Risk Ranking based on Mean Severity – The risks are ranked based on their total percent severity within a particular risk type. The larger the positive mean severity, the higher the risk ranking for threats, and the larger the negative mean severity, the lower the risk ranking for opportunities.
- Select Risk for Mitigation – The status of each risk with regards to whether it has been selected for mitigation. The default value is "No", which can be modified to "Yes" by the user if the user wants to include this risk for mitigation.

9.0. Unmitigated Project Performance

The Unmitigated Project Performance step presents a summary of the risk analysis prior to beginning the risk mitigation process. The summary is presented in two tables, with the unmitigated cost, duration, and disruption impacts displayed in one table for Base, Risk and Total (Base + Risk) (Figure 43); and the Base project schedule and the risk-modified project schedule presented in another (Figure 44). These tables allow the user to understand the overall impacts of the risks computed in the earlier steps.

9.1. Schedule Duration Assumption

To generate the risk analysis unmitigated performance summary, the user must select one of the following assumptions related to occurrence of risks within each project phase:

- **Concurrent** – All risks within each project phase occur simultaneously. The template uses the longest positive (threat) and negative (opportunity) risk duration impact of all risks associated with a phase to calculate the schedule duration for that phase.
- **Sequential** – All risks within each project phase occur one after the other. In this case the template uses the sum of all positive (threat) and the sum of all negative (opportunity) risk duration impacts associated with a phase to calculate the schedule duration for that phase.
- **Combination** – Some risks within each project phase occur concurrently, while others occur sequentially. The schedule duration for a particular phase, in this case, is calculated as the average of the sums and maximums of all positive (threat) and negative (opportunity) risk duration impacts associated with that phase.

Figure 42 presents these options for schedule duration assumptions for calculating risk impacts.

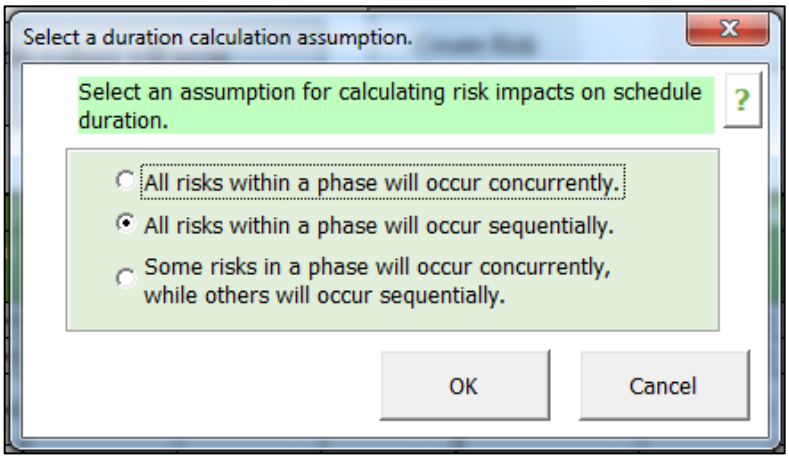


Figure 42. Schedule duration assumptions for Risk Impacts calculations

Note: The risk-related duration impacts are calculated differently for each assumption. The selected assumption will be used for the calculations performed in this step (Unmitigated Project Performance) as well as for the calculations performed on the Mitigated Project Performance step.

9.2. Unmitigated Project Performance and Schedule

The Unmitigated Project Performance table (see Figure 43) lists each project phase and the associated base, risk, and total (base + risk) impacts for each phase. The three types of impacts are explained below:

- **Base** – The cost, duration, and disruption performance (without risk, contingency or float) that were entered or calculated in the Project Structuring step are presented under the "Base" category.
- **Risk** – The cost, duration, and disruption values shown under the "Risk" category is the total (for every project phase) of each impact type (cost, duration and disruption) from the Unmitigated Risk Register step (cost, duration, disruption performance for risks only).
- **Total** – The cost, duration, and disruption values shown under the "Total" category are the sum of the respective base and risk values for each project phase. The final cost value (YOE $M) (last column) is the total project phase cost that has been adjusted with the inflation rates entered in the Project Structuring step.

SHRP2 Risk Management Template

HELP **Step 06 - Unmitigated Project Performance**

Schedule Duration Assumption:
Some risks in a phase will occur concurrently, while others will occur sequentially.

Create Risk Analysis Summary | <==BACK | HOME | FWD==>

Unmitigated Project Cost, Duration, and Disruption Performance

Project Phase	Base			Risk			Total (Base + Risk)			
	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (YOE $M)
Planning		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Scoping		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prelim Design/Environmental Process	1.19	12	0.00	0.13	1.47	0.00	1.32	13.47	0.00	1.34
Environmental Permits		6	0.00	0.00	0.31	0.00	0.00	6.31	0.00	0.00
ROW/Util/RR	3.00	12	0.20	2.63	1.13	0.00	5.63	13.13	0.20	5.91
Final Design		6	0.00	0.00	0.75	0.00	0.00	6.75	0.00	0.00
Procurement		6	0.00	0.26	0.29	0.00	0.26	6.29	0.00	0.27
Construction	11.85	16	0.50	2.52	0.85	0.00	14.37	16.85	0.50	15.47
Operations & Maintenance	0.00	600	1.40	0.00	0.00	0.00	0.00	600.00	1.40	0.00
Replacement	0.00	0	0.70	0.00		0.00	0.00	0.00	0.70	
Total	**16.04**		**2.80**	**5.54**		**0.00**	**21.58**		**2.80**	**23.00**

Figure 43. Unmitigated Project Performance Table

The total cost, schedule and disruption impacts for all phases in each of the base, risk and total categories are presented at the bottom of the Unmitigated Project Performance Table.

The Project Schedule Table (see Figure 44) displays the base project durations and the project dates after accounting for the impact of risks on the schedule. The schedules after risk assessment reflects the start/finish dates and float time adjusted based on the schedule-related impacts of the risks that have been included in the analysis. This table also shows the mean severity values per phase.

Project Schedule Performance (Base vs. Unmitigated)

Project Phase	Base Project Schedule Performance						Unmitigated Project Schedule Performance						Mean Severity YOE ($M)
	Duration (Months/Date)	Early Start	Early Finish	Late Start	Late Finish	Float (months)	Duration (Months / Date)	Early Start	Early Finish	Late Start	Late Finish	Float (months	
Planning	0.00	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.00	0.00	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.00	0.01
Scoping	0.00	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.00	0.00	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.00	0.89
Design Funding Date	12/1/2009		12/1/2009		12/1/2009	0.00	12/1/2009		12/1/2009		12/1/2009	0.00	0.00
Prelim Design/Environmental Process	12.00	12/1/2009	11/30/2010	12/1/2009	11/30/2010	0.00	13.47	12/1/2009	1/14/2011	12/1/2009	1/14/2011	0.00	1.37
Environmental Permits	6.00	11/30/2010	6/1/2011	11/30/2010	6/1/2011	0.00	6.31	1/14/2011	7/25/2011	2/8/2011	8/19/2011	0.81	0.07
ROW/Util/RR Funding Date	12/1/2009		12/1/2009		11/30/2011	24.00	12/1/2009		12/1/2009		2/17/2012	26.59	0.00
ROW/Util/RR	12.00	11/30/2010	11/30/2011	11/30/2010	11/30/2011	0.00	13.13	1/14/2011	2/17/2012	1/14/2011	2/17/2012	0.00	2.48
Construction Funding Date	12/1/2009		12/1/2009		11/30/2010	12.00	12/1/2009		12/1/2009		2/8/2011	14.30	0.00
Procurement	6.00	11/30/2010	6/1/2011	11/30/2010	6/1/2011	0.00	6.29	1/14/2011	8/19/2011	2/8/2011	8/19/2011	0.00	1.01
Final Design	6.00	6/1/2011	11/30/2011	6/1/2011	4/30/2012	5.00	6.75	8/19/2011	3/11/2012	8/19/2011	8/13/2012	5.10	0.00
Construction	16.00	7/1/2011	10/30/2012	7/1/2011	10/30/2012	0.00	16.85	9/18/2011	2/11/2013	9/18/2011	2/11/2013	0.00	0.91
Operations & Maintenance	600.00	10/30/2012	10/8/2062	10/30/2012	10/8/2062		600.00	2/11/2013	1/20/2063	2/11/2013	1/20/2063		
Replacement	0.00	10/8/2062	10/8/2062	10/8/2062	10/8/2062		0.00	1/20/2063	1/20/2063	1/20/2063	1/20/2063		
Project Start Date	**12/1/2009**						**12/1/2009**					**Total**	6.75
Construction Finish Date	**10/30/2012**						**2/11/2013**						
Project Duration (months)	**35.00**						**38.45**						

Figure 44. Unmitigated Project Schedule Performance Table

10.0. Unmitigated Risk Ranking Plots

The Unmitigated Risk Ranking Plots step presents a visual illustration of the various unmitigated risks on the Unmitigated Risk Register step, ranked by the percent of total mean severity. The unmitigated risk ranking plots present the relationship between risk labels and percent of total mean severity calculated previously. These plots allow the user to better understand the magnitude of the impact of the more severe risks.

The plots are categorized and presented based on the risk type, i.e. threats or opportunities. Figure 45 presents the unmitigated risk charts.

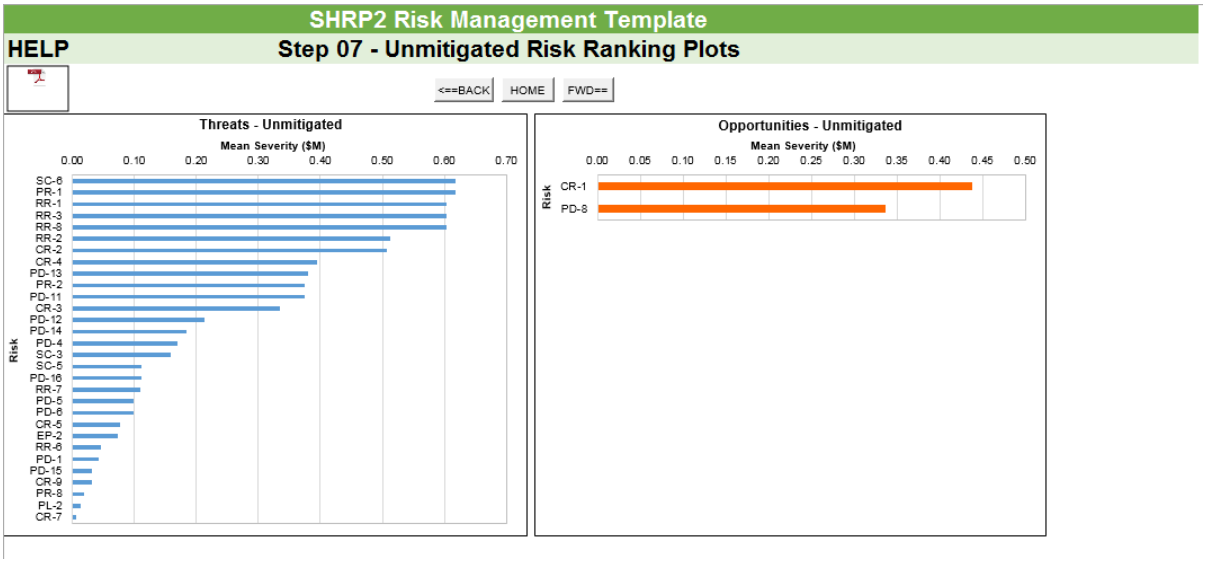


Figure 45. Unmitigated Risk Ranking Plots

11.0. Risk Mitigation

The Risk Mitigation step involves identifying the risk management strategies for the risks that were chosen for mitigation in the Unmitigated Risk Register step. The Risk Mitigation step allows the user to enter strategies to mitigate each risk that has been selected for inclusion in the mitigation process. When the user identifies mitigation strategies that are specific to each risk, the costs and benefits associated with each strategy are calculated and displayed, thereby allowing the user to determine the most effective strategy to mitigate the risk under consideration. Figure 46 presents the risk mitigation options available to the user.

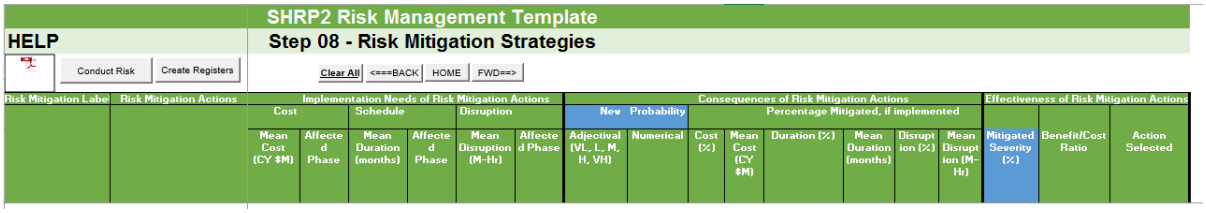


Figure 46. View of Risk Mitigation Strategy Options

11.1. Risk Mitigation Parameters

The following parameters are associated with the Risk Mitigation step:

- Risk Mitigation Label – This is a unique label that is assigned to every mitigation strategy associated with a particular risk. This label adds an underscore and a single digit number to the end of the original risk label. For example, if the risk being mitigated has a label that reads "PL-1", the first strategy would be labeled "PL-1_1".
- Risk Mitigation Actions – This is the description of each mitigation strategy that is provided by the user to mitigate the various risks.
- Implementation Needs of Risk Mitigation Actions – This represents the mean cost, duration, and disruption needs required to implement the given mitigation strategy.
- Affected phase – The various project phases in which the cost, duration, and disruption implementation needs will occur.
- Consequences of Risk Mitigation Actions – This describes the effect of the mitigation strategy on the risk's original impacts and probability of occurrence. The following definitions are included in this section:

  - New Probability – This is the new probability of risk occurrence after factoring in the likely effect of the risk mitigation strategy.
  - Percentage Mitigated, if implemented – The estimated percent mitigation, and corresponding numerical value, of the original cost, duration, and disruption impacts of the given risk that will occur by implementing the specified mitigation strategy.
- Effectiveness of Risk Mitigation Actions – This provides the user with key information to help them evaluate the effectiveness of the given mitigation strategy, which includes:
  - Mitigated Severity – The percent of a risk's original mean severity that will be mitigated after implementing the user-defined mitigation strategy. The value is displayed as a number between 0 and 1. 0 implies that there has been no effect on severity of the risk whereas 1 implies that the risk severity has been completely mitigated.
  - Benefit/Cost Ratio – The ratio of the benefits (reduced impacts and/or probability of occurrence) of a mitigation strategy to its costs (impacts of implementing the strategy).
  - Select Action – This option allows the user to select a particular mitigation strategy for implementation.

11.2. Risk Mitigation Strategies

Clicking on the "Conduct Risk Mitigation" button opens the "Risk Mitigation Strategies" GUI input form. Prior to opening the Risk Mitigation GUI input form, the Template checks the user inputs to verify that at least one risk has been selected for mitigation on the Unmitigated Risk Register step. If no risk has been selected, an error message will appear instructing the user to return to the Unmitigated Risk Register and select at least one strategy (see Figure 47).

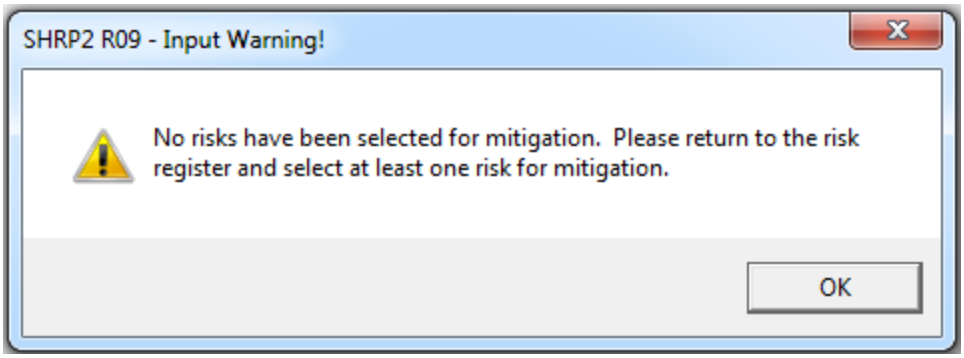


Figure 47. Risk Mitigation Input Warning

In the "Risk Mitigation Strategies" GUI input form, the user can enter information about the impact of implementing each mitigation strategy and the consequences of the strategy on the original risk. This form allows the user to enter information for one risk at a time. To help the user with data entry on the risk mitigation strategies, key information about each risk is displayed at the top of the form (for example, risk label, risk description, risk type, mean severity value, etc., for the risk being mitigated).

Once the "Risk Mitigation Strategies" GUI input form (see Figure 48) is opened, the user can see the key information on the risk to be mitigated. The form allows the user to define up to four mitigation strategies per risk. A "Do Nothing" strategy is included in every risk mitigation evaluation by default.

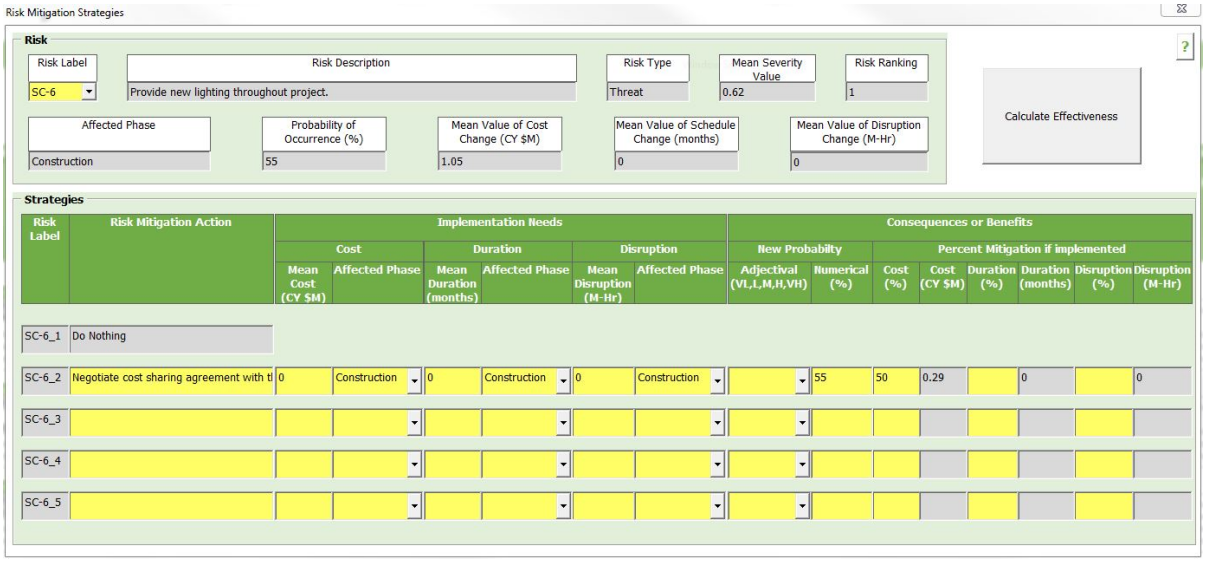


Figure 48. Risk Mitigation Strategies GUI input form

After defining all the strategies for mitigating a particular risk, the user should click the "Calculate Effectiveness" button. This button opens a "Select Strategy" GUI input form (see Figure 49), which displays information (Mitigated severity, Benefit/Cost ratio, and Select Action) on the key effectiveness for each mitigation strategy. Based on the information displayed in the "Select Strategy" GUI input form, the user must select the optimal strategy that the user wants to implement in order to mitigate the given risk.

After clicking on the "Save & Continue" button, the "Select Strategy" GUI input form closes and the "Risk Mitigation Strategies" GUI input form is updated to display the information for the next risk to be mitigated. The user can navigate among the various risks and select the desired risk label at any time during the risk mitigation process.

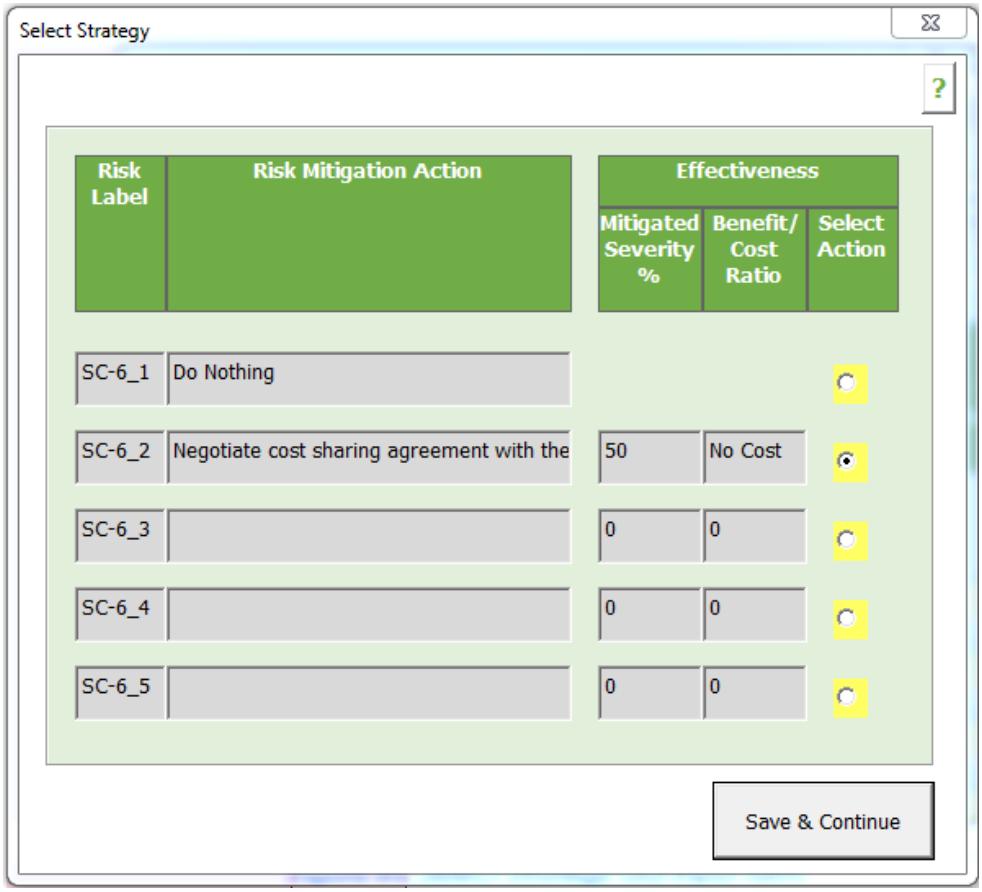


Figure 49. Select Strategy GUI input form

Note: User inputs are saved only when the "Save & Continue" button is clicked.

11.3. Create Registers

After selecting the risk mitigation strategies, the user should click on the "Create Registers" button. This button populates the risks and associated mitigation strategies in the corresponding Mitigations Strategy Register and Mitigated Risk Register steps.

12.0. Mitigation Strategies Register

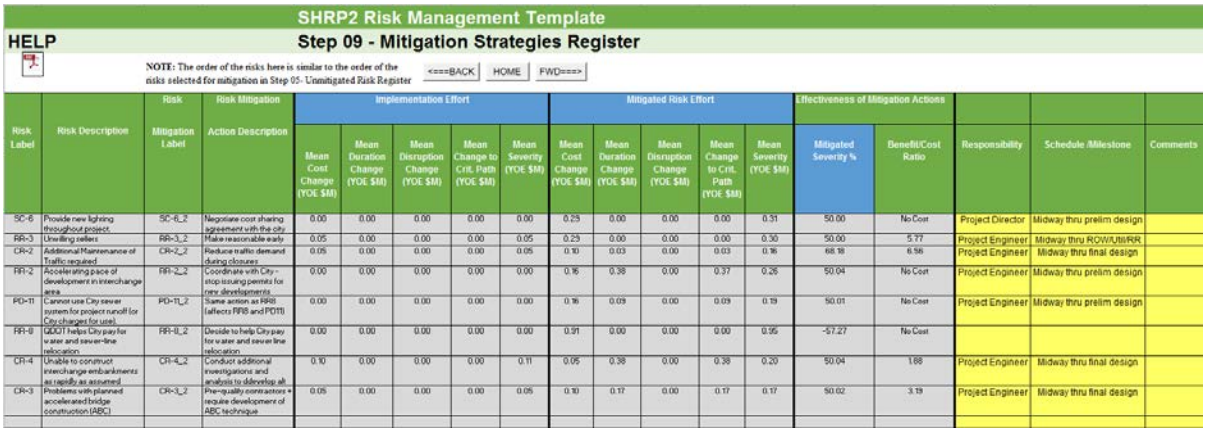
The Mitigation Strategies Register step presents a list of the risks to be mitigated and the associated mitigation strategy selected by the user. The list of risks includes key information about the Implementation Efforts and Mitigated Risk Efforts for each mitigation strategy. This step presents the user-input information and calculations from prior steps.

The information presented in the Mitigation Strategies Register is as follows:

- Risk Label and Risk Description –Identifying information for each risk that was entered originally on the Risk Identification step. Only risks that were selected for mitigation are shown in the Mitigations Strategies Register.
- Risk Mitigation Label and Risk Mitigation Action – Identifying information for the mitigation strategy that was selected to be implemented on the particular risk.
- Implementation Effort– This section presents the cost, duration, and disruption impacts of implementing the selected mitigation strategy for each risk. The mean change to the project critical path that will result from strategy implementation and the mean severity of the implementation impacts are also shown for each risk.
- Mitigated Risk Effort – This section presents the estimated cost, duration, and disruption mitigations (reductions or increases) that will result based on new probability and any change in cost, duration or disruption values. Also shown for each risk are the mean change to the project critical path that will result from impact mitigation and the mean severity of the impact mitigations.
- Effectiveness of Mitigation Actions – This section presents the mitigated severity, which is displayed in terms of a number between 0 and 1 that indicates the percent of mitigation original risk severity after strategy implementation, and the ratio of implementation benefits (risk impact mitigations) to implementation costs (impacts of strategy implementation). These values show measures of strategy effectiveness in mitigating (reducing or increasing) the overall impact of each risk.
- Responsibility – This represents the person(s) responsible for the particular risk mitigation strategy.

- Schedule/Milestone – This section shows the schedule for the implementation of the mitigation strategy.
- Comments – This allows the user to enter any additional comments if necessary.

Figure 50 presents the Mitigation Strategies Register.



SHRP2 Risk Management Template

HELP — **Step 09 - Mitigation Strategies Register**

NOTE: The order of the risks here is similar to the order of the risks selected for mitigation in Step 05- Unmitigated Risk Register <===BACK HOME FWD===>

Risk		Risk	Risk Mitigation	Implementation Effort					Mitigated Risk Effort					Effectiveness of Mitigation Actions				
Risk Label	Risk Description	Mitigation Label	Action Description	Mean Cost Change (YOE $M)	Mean Duration Change (YOE $M)	Mean Disruption Change (YOE $M)	Mean Change to Crit. Path (YOE $M)	Mean Severity (YOE $M)	Mean Cost Change (YOE $M)	Mean Duration Change (YOE $M)	Mean Disruption Change (YOE $M)	Mean Change to Crit. Path (YOE $M)	Mean Severity (YOE $M)	Mitigated Severity %	Benefit/Cost Ratio	Responsibility	Schedule /Milestone	Comments
SC-6	Provide new lighting throughout project.	SC-6_2	Negotiate cost sharing agreement with the city	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.31	50.00	No Cost	Project Director	Midway thru prelim design	
RR-3	Unwilling sellers	RR-3_2	Make reasonable early	0.05	0.00	0.00	0.00	0.05	0.25	0.00	0.00	0.00	0.30	50.00	5.77	Project Engineer	Midway thru ROW/Util/RR	
CR-2	Additional Maintenance of Traffic required	CR-2_2	Reduce traffic demand during closures	0.05	0.00	0.00	0.00	0.05	0.10	0.03	0.00	0.03	0.16	68.18	6.56	Project Engineer	Midway thru final design	
RR-2	Accelerating pace of development in interchange area	RR-2_2	Coordinate with City - stop issuing permits for new developments	0.00	0.00	0.00	0.00	0.00	0.16	0.38	0.00	0.37	0.26	50.04	No Cost	Project Engineer	Midway thru prelim design	
PD-11	Cannot use City sewer system for project runoff (or City charges for use)	PD-11_2	Same action as RR8 (affects RR8 and PD11)	0.00	0.00	0.00	0.00	0.00	0.16	0.09	0.00	0.09	0.19	50.01	No Cost	Project Engineer	Midway thru prelim design	
RR-8	ODOT helps City pay for water and sewer line relocation	RR-8_2	Decide to help City pay for water and sewer line relocation	0.00	0.00	0.00	0.00	0.00	0.91	0.00	0.00	0.00	0.95	-57.27	No Cost			
CR-4	Unable to construct interchange embankments as rapidly as assumed	CR-4_2	Conduct additional investigations and analysis to develop alt	0.10	0.00	0.00	0.00	0.11	0.05	0.38	0.00	0.38	0.20	50.04	1.68	Project Engineer	Midway thru final design	
CR-3	Problems with planned accelerated bridge construction (ABC)	CR-3_2	Pre-qualify contractors + require development of ABC technique	0.05	0.00	0.00	0.00	0.05	0.10	0.17	0.00	0.17	0.17	50.02	3.19	Project Engineer	Midway thru final design	

Figure 50. Mitigation Strategies Register

13.0. Mitigated Risk Register

The Mitigated Risk Register step, identical to the Unmitigated Risk Register step, presents to the user the remaining impact of each risk after taking into account any impact mitigations (reduction or increases) associated with implementing mitigation strategies. The "Retire Risk" option in this step allows the user to exclude a risk from the remainder of the analysis. This action should be taken in cases where the mitigation has reduced the impact of a risk to a negligible value, or if the user only wishes to include the other significant severe risks in the analysis. While the default value of this option is "No" (i.e. risk is not retired), the user can exclude risks from further analysis by selecting "Yes".

The risks are ranked based on the mean severity of each risk on the overall project (in YOE $M).

Note: The order of the risk ranking is determined by the percent of total severity that is calculated based on each risk's individual severity.

The risks are ranked separately based on the risk type (threat or opportunity). This step is intended for output purposes only and the user cannot make any changes, except on the Retire Risk column. Figure 51 presents the Mitigated Risk Register.

SHRP2 Risk Management Template

HELP **Step 10 - Mitigated Risk Register**

<===BACK | HOME | FWD===>

Risk Label	Risk Description	Risk Type	Mean Cost Impact (CY $M)	Mean Duration Impact (months)	Mean Disruption Impact (M-Hr)	Mean Change to Critical Path Schedule	Mean Severity (YOE $M)	Percent of Total Mean Severity	Risk Ranking based on Mean Severity	Retire Risk ?
RR-8	QDOT helps City pay for water and sewer-line relocation	Threat	0.91	0.00	0.00	0.00	0.95	0.18	1	No
RR-1	Uncertainty in ROW inflation rate	Threat	0.58	0.00	0.00	0.00	0.62	0.11	2	No
PR-1	Uncertainty in construction-cost inflation rate	Threat	0.58	0.00	0.00	0.00	0.62	0.11	3	No
PR-2	Uncertain Design/Build contracting market conditions at time of bid	Threat	0.30	0.25	0.00	0.00	0.32	0.06	4	No
SC-6	Provide new lighting throughout project.	Threat	0.29	0.00	0.00	0.00	0.31	0.06	5	No
RR-3	Unwilling sellers	Threat	0.29	0.00	0.00	0.00	0.31	0.06	6	No
RR-2	Accelerating pace of development in interchange area	Threat	0.16	0.38	0.00	0.37	0.26	0.05	7	No
CR-4	Unable to construct interchange embankments as rapidly as assumed	Threat	0.05	0.38	0.00	0.38	0.20	0.04	8	No
PD-11	Cannot use City sewer system for project runoff (or City charges for use).	Threat	0.16	0.09	0.00	0.09	0.19	0.03	9	No
PD-13	Change in environmental documentation.	Threat	0.13	1.00	0.00	0.00	0.17	0.03	10	No
CR-3	Problems with planned accelerated bridge construction (ABC) technique	Threat	0.10	0.17	0.00	0.17	0.17	0.03	11	No
CR-2	Additional Maintenance of Traffic required	Threat	0.10	0.03	0.00	0.03	0.16	0.03	12	No
PD-12	Structures impacted by Main Street realignment are eligible for Historic Register.	Threat	0.13	0.31	0.00	0.00	0.15	0.03	13	No
PD-4	Ground improvement required in interchange area.	Threat	0.13	0.08	0.00	0.00	0.14	0.03	14	No
SC-3	Additional local improvements required.	Threat	0.11	0.19	0.00	0.00	0.12	0.02	15	No
SC-5	Replace culvert over Wandering Creek.	Threat	0.11	0.00	0.00	0.00	0.11	0.02	16	No
PD-16	Additional wetland mitigation required for planned alignment.	Threat	0.11	0.00	0.00	0.00	0.11	0.02	17	No
RR-7	Telecom utility wants a cost-sharing agreement	Threat	0.11	0.00	0.00	0.00	0.11	0.02	18	No
PD-5	Shoulders required on US-555.	Threat	0.07	0.06	0.00	0.00	0.08	0.01	19	No
PD-6	Shoulders required on SH-111.	Threat	0.07	0.06	0.00	0.00	0.08	0.01	20	No
CR-5	Difficult foundation installation	Threat	0.04	0.08	0.00	0.00	0.05	0.01	21	No
PD-15	Encounter unanticipated contamination in interchange area.	Threat	0.03	0.00	0.00	0.00	0.03	0.01	22	No
CR-9	Limited construction staging area in vicinity of interchange	Threat	0.03	0.00	0.00	0.00	0.03	0.01	23	No
PD-1	Shift alignment of US 555 at east end of project	Threat	0.03	0.06	0.00	0.00	0.03	0.01	24	No
PD-14	Delays completing environmental documentation.	Threat	0.00	0.75	0.00	0.00	0.02	0.00	25	No
PR-7	Issues with D/B design or submittals	Threat	0.00	0.75	0.00	0.00	0.02	0.00	26	No
PL-2	Opposition to removing access to US-555 fro 12th St.	Threat	0.01	0.00	0.00	0.00	0.01	0.00	27	No
EP-2	Delay obtaining the 404 permit	Threat	0.00	0.31	0.00	0.00	0.01	0.00	28	No
RR-6	Other delays to ROW planning	Threat	0.00	0.19	0.00	0.00	0.01	0.00	29	No
PR-8	Other problems with D/B contract procurement	Threat	0.00	0.08	0.00	0.00	0.00	0.00	30	No
CR-7	Colder-than-usual winter	Threat	0.00	0.02	0.00	0.00	0.00	0.00	31	No
PD-8	Change in pavement section and/or type.	Opportunity	-0.32	0.00	0.00	0.00	-0.34	0.56	1	No

Figure 51. Mitigated Risk Register

The following explains the information shown in this step, and associated data/calculations:

- Risk Label and Risk Description – The labels and descriptions for all risks that were assessed on the Unmitigated Risk Register sheet are displayed.
- Risk Type – Each risk is assigned an overall risk type that is based on the mean severity.

Note: A risk is an overall threat if the mean severity is positive and it is an overall opportunity if the mean severity is negative.

- Mean Cost Impact (current year millions of dollars) –The cost impact is equal to the product of the risk probability and the mean value of the cost change based on present value.

- Mean Duration Impact (months) – The duration impact is equal to the product of the risk probability and the mean value of the duration change.
- Mean Disruption Impact (millions of hours) – The disruption impact is equal to the product of the risk probability and the mean value of the disruption change.
- Mean Change to Critical Path Schedule – This is the calculated impact of each risk on the project's critical path.

Note: It is possible for a risk to have a positive value (increase duration) for mean duration impact and yet not have any impact on the critical path because of available float in the schedule.

- Mean Severity (YOE $M) – The mean severity calculations take into account inflation rates, the costs of schedule delay, overhead costs, the effect of disruption (if selected as a performance measure during project structuring), and the impact of delay in start date of operations. This value can be either negative or positive depending on the values of the cost, duration, and disruption impacts that were entered during the Unmitigated Risk Register.
- Percent of Total Severity (Percent) – The total severity is summed separately for threats and opportunities and is the percent of total severity of the total threats or opportunities.
- Risk Ranking based on Mean Severity– The risks are ranked based on their total percent severity within a particular risk type. The larger the positive mean severity value, the higher the risk ranking for threats, and the larger the negative mean severity value, the lower the risk ranking for opportunities.
- Retire Risk – Allows the user to exclude a risk from the remainder of the analysis. The default value is "No", which can be modified to "Yes" by the user if the user wants to retire this risk.

14.0. Mitigated Project Performance

The Mitigated Project Performance step presents a summary of the risk analysis after the completion of the risk mitigation process. The summary is presented in two sections (tables), with the mitigated cost, duration, and disruption cost impacts displayed in one section, and the base project schedule and the risk-modified project schedule presented in another. These sections allow the user to understand the overall impacts of the mitigation strategies that have been selected to mitigate the various risks.

14.1. Schedule Duration Assumption

To maintain consistency throughout the template, the duration assumption value is carried over from the Unmitigated Project Performance step. The user cannot make changes to this assumption in the Mitigated Project Performance step. Figure 52 presents the schedule duration assumption option available to the user. **Section 9.1 provides information of the various schedule assumptions that the user is provided**. **Once selected in the earlier step, this schedule assumption is carried over into this section as well.**

SHRP2 Risk Management Template

HELP **Step 11 - Mitigated Project Performance**

Schedule Duration Assumption:
Some risks in a phase will occur concurrently, while others will occur sequentially.

Update Risk Analysis Summary | <==BACK | HOME | FWD==>

Mitigated Project Cost, Duration, and Disruption Performance

Project Phase	Base + Implementation			Residual Risk			Total (Base + Implementation + Residual Risk)				Mean Severity
	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (YOE $M)	YOE ($M)
Planning	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Scoping	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.22
Prelim Design/Environmental Process	1.19	12.00	0.00	0.13	1.47	0.00	1.32	13.47	0.00	1.34	0.95
Environmental Permits	0.00	6.00	0.00	0.00	0.31	0.00	0.00	6.31	0.00	0.00	0.07
ROW/Util/RR	3.05	12.00	0.20	2.35	0.70	0.00	5.40	12.70	0.20	5.67	1.82
Final Design	0.20	6.00	0.00	0.00	0.75	0.00	0.20	6.75	0.00	0.21	
Procurement	0.00	6.00	0.00	0.22	0.29	0.00	0.22	6.29	0.00	0.23	0.83
Construction	11.85	16.00	0.50	1.88	0.38	-0.02	13.73	16.38	0.48	14.76	0.42
Operations & Maintenance	0.00	600.00	1.40	0.00	0.00	0.00	0.00	600.00	1.40		
Replacement	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.70		
Total (through Construction)	**16.29**		**0.70**	**4.58**		**-0.02**	**20.87**		**0.68**	**22.21**	
Total (through Replacement)	**16.29**		**2.80**	**4.58**		**-0.02**	**20.87**		**2.78**	**22.21**	

Figure 52. Schedule Duration Assumption

14.2. Mitigated Project Performance and Schedule

The Mitigated Project Performance section (see Figure 53) lists each project phase and the associated base, residual risk, and total (base + residual risk) impacts for each phase. The following explains the three types of impacts:

- **Base** – The cost, duration, and disruption performance (without risk, contingency, or float) that were entered or calculated in the Project Structuring step are presented under the "Base" category.

- **Residual Risk** – The cost, duration, and disruption values shown under the "Risk" category is the total (for every project phase) of each impact type (cost, duration, and disruption) from the Mitigated Risk Register step.
- **Total** – The cost, duration, and disruption values shown under the "Total" category are the sum of the respective base and risk values for each project phase. The final cost value (YOE $M) (last column) is the total project phase cost that has been adjusted with the inflation rates entered in the Project Structuring step.

SHRP2 Risk Management Template

HELP **Step 11 - Mitigated Project Performance**

Schedule Duration Assumption:
Some risks in a phase will occur concurrently, while others will occur sequentially.

Update Risk Analysis Summary | <==BACK | HOME | FWD==>

Mitigated Project Cost, Duration, and Disruption Performance

Project Phase	Base + Implementation			Residual Risk			Total (Base + Implementation + Residual Risk)			
	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (CY $M)	Duration (months)	Disruption (M-hrs)	Cost (YOE $M)
Planning	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scoping	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prelim Design/Environmental Process	1.19	12.00	0.00	0.13	1.47	0.00	1.32	13.47	0.00	1.34
Environmental Permits	0.00	6.00	0.00	0.00	0.31	0.00	0.00	6.31	0.00	0.00
ROW/Util/RR	3.05	12.00	0.20	2.35	0.70	0.00	5.40	12.70	0.20	5.67
Final Design	0.20	6.00	0.00	0.00	0.75	0.00	0.20	6.75	0.00	0.21
Procurement	0.00	6.00	0.00	0.22	0.29	0.00	0.22	6.29	0.00	0.23
Construction	11.85	16.00	0.50	1.88	0.38	-0.02	13.73	16.38	0.48	14.76
Operations & Maintenance	0.00	600.00	1.40	0.00	0.00	0.00	0.00	600.00	1.40	
Replacement	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.70	
Total (through Construction)	**16.29**		**0.70**	**4.58**		**-0.02**	**20.87**		**0.68**	**22.21**
Total (through Replacement	**16.29**		**2.80**	**4.58**		**-0.02**	**20.87**		**2.78**	**22.21**

Figure 53.Mitigated Project Performance Table

The total cost and disruption impacts for all phases in each of the base, risk, and total category have been presented at the bottom of the Mitigated Project Performance section (table).

The Project Schedule section (table) (see Figure 54) displays the Unmitigated Project Schedule Performance and the project dates after accounting for the impact of the mitigation strategies implemented for the various risks on the schedule . The schedules after risk mitigation reflects the start/finish dates and float time adjusted based on the gross schedule-related impacts of the strategies that have been included in the analysis.

Project Schedule Performance (Unmitigated vs. Mitigated)

Project Phase	Unmitigated Project Schedule Performance (from step 6)						Mitigated Project Schedule Performance						Mean
	Duration (Months/ Date)	Early Start	Early Finish	Late Start	Late Finish	Float (months)	Duration (Months/ Date)	Early Start	Early Finish	Late Start	Late Finish	Float (months)	Severity YOE($M)
Planning	0.00	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.00	0.00	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.00	0.01
Scoping	0.00	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.00	0.00	12/1/2009	12/1/2009	12/1/2009	12/1/2009	0.00	0.58
Design Funding Date	12/1/2009		12/1/2009		12/1/2009	0.00	12/1/2009		12/1/2009		12/1/2009	0.00	0.00
Prelim Design/Environmental Process	13.47	12/1/2009	1/14/2011	12/1/2009	1/14/2011	0.00	13.47	12/1/2009	1/14/2011	12/1/2009	1/14/2011	0.00	1.18
Environmental Permits	6.31	1/14/2011	7/25/2011	2/8/2011	8/19/2011	0.81	6.31	1/14/2011	7/25/2011	1/26/2011	8/6/2011	0.39	0.07
ROW/Util/RR Funding Date	12/1/2009		12/1/2009		2/17/2012	26.59	12/1/2009		12/1/2009		2/4/2012	26.17	0.00
ROW/Util/RR	13.13	1/14/2011	2/17/2012	1/14/2011	2/17/2012	0.00	12.70	1/14/2011	2/4/2012	1/14/2011	2/4/2012	0.00	2.27
Construction Funding Date	12/1/2009		12/1/2009		2/8/2011	14.30	12/1/2009		12/1/2009		1/27/2011	13.88	0.00
Procurement	6.29	1/14/2011	8/19/2011	2/8/2011	8/19/2011	0.00	6.29	1/14/2011	8/6/2011	1/27/2011	8/6/2011	0.00	1.01
Final Design	6.75	8/19/2011	3/11/2012	8/19/2011	8/13/2012	5.10	6.75	8/6/2011	2/27/2012	8/6/2011	7/17/2012	4.63	0.00
Construction	16.85	9/18/2011	2/11/2013	9/18/2011	2/11/2013	0.00	16.38	9/5/2011	1/15/2013	9/5/2011	1/15/2013	0.00	0.20
Operations & Maintenance	600.00	2/11/2013	1/20/2063	2/11/2013	1/20/2063		600.00	1/15/2013	12/24/2062	1/15/2013	12/24/2062		
Replacement	0.00	1/20/2063	1/20/2063	1/20/2063	1/20/2063		0.00	12/24/2062	12/24/2062	12/24/2062	12/24/2062		
Project Start Date	**12/1/2009**						**12/1/2009**					Total	5.33
Construction Finish Date	**2/11/2013**						**1/15/2013**						
Project Duration (months)	**38.45**						**37.55**						

Figure 54. Mitigated Project Schedule Performance Table

15.0. Mitigated Risk Ranking Plots

This step presents a visual illustration of the various mitigated risks on the Mitigated Risk Register step ranked by the percent of total mean severity. The risk ranking plots present the relationship between risk labels and percent of total mean severity calculated in the mitigated risk register step. These charts allow the user to better understand the magnitude of the impact of the more severe risks.

The charts (see Figure 55) are categorized based on the risk type, i.e. threats or opportunities.

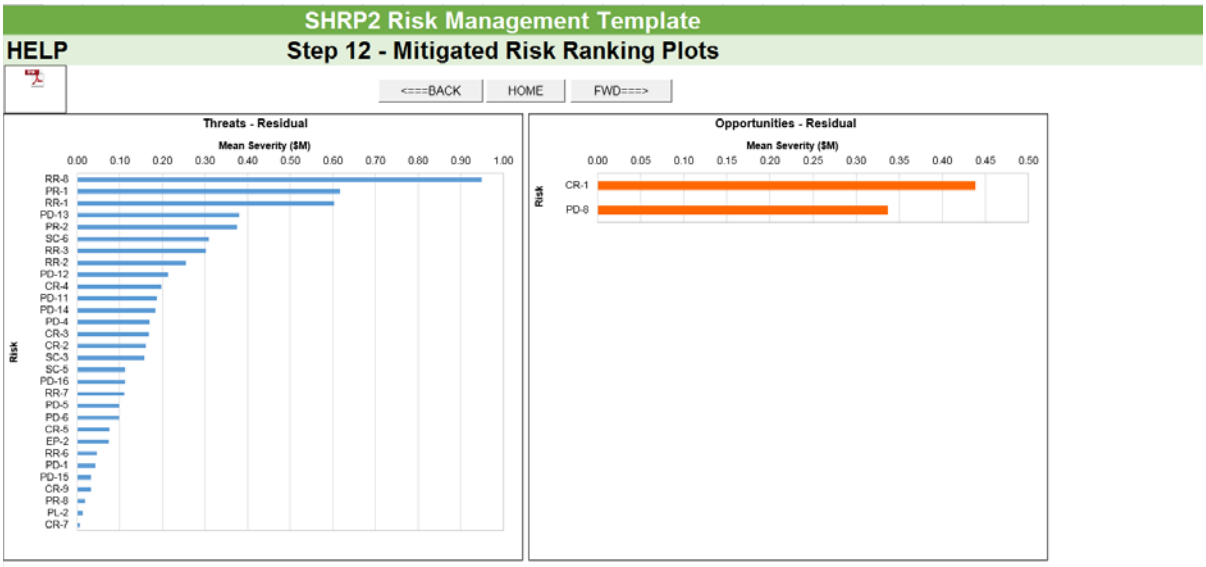


Figure 55. Mitigated Risk Ranking Plots

16.0. Summary Report

This step provides a detailed summary of the risk management analysis. In this step, the tables and charts from the earlier steps are organized in a printable format. It should also be noted that the tables with information from the Project Structuring and Risk Identification steps are summary tables and do not present all the data entries and calculations performed in those steps.

The report summary segment of this step contains buttons that allow the user access to different summary tables and charts. Figure 56 illustrates the Summary Report Main Screen.

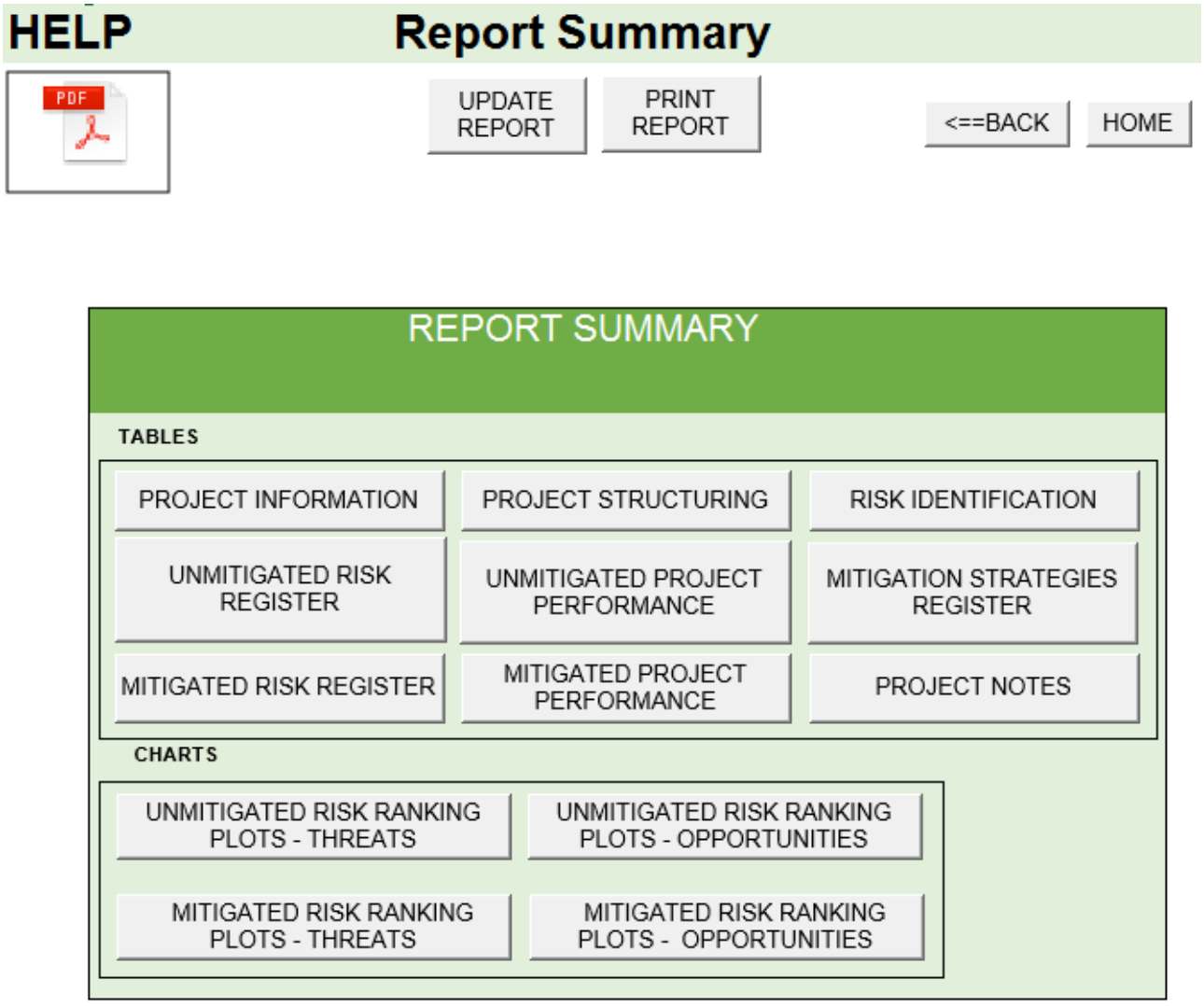


Figure 56. Summary Report Main Screen

The "Update Report" button updates the summary charts and summary report to reflect changes that have been made during analysis. The "Print Report" button (see Figure 57) opens a form that allows the user to select the tables or charts to be printed in a report form. Using this option, the user can create a detailed report or a customized executive summary report.

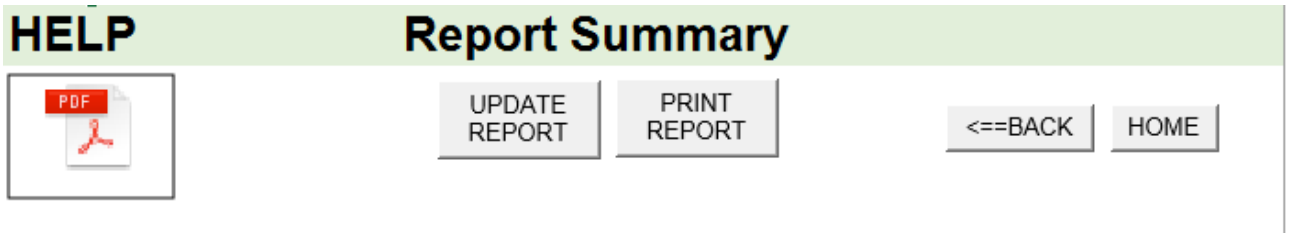


Figure 57. "Update Report" and "Print Report" buttons

Pressing the "Print Report" button on the form takes the user to the "Print Preview" screen (see Figure 58) where the user can select to print the specific results of the analysis, if not all.

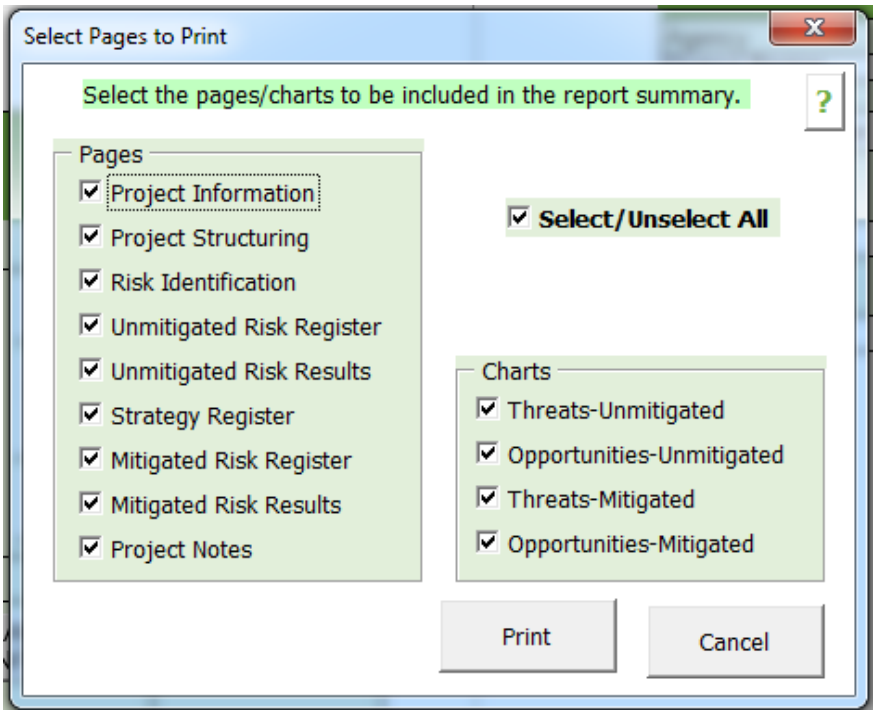


Figure 58. Print Selection of Reports

Each table or chart features a "Copy" button that allows the user to copy the selected table or chart. This selected table or chart can be pasted wherever the user requires. The "Back to Summary." button allows the user to navigate back to the Summary Report Main Screen of this step (see Figure 59).

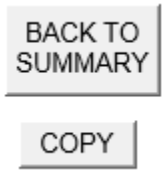


Figure 59. Navigation Buttons in the Summary Report step

Note: In the case of the Unmitigated Risk Register, Mitigation Strategies Register, or Mitigated Risk Register tables, the "Copy" button only copies that part of the table that has entries.

References

1. Roberds, William; McGrath, Travis; Molenaar, Keith; Loulakis, Michael; and Ferragut, Ted. Guide for the Process of Managing Risk on Rapid Renewal Projects. No. SHRP2 Renewal Project R09. 2013.

2. *Delay Analysis in Construction Contracts* by P.J. Keane and A.F. Caletka,