

The Commonwealth of Virginia



P3 Risk Management Guidelines

September 2015

Document Version control

Version	Date Issued
1.0	September 2011
2.0	September 2015

TABLE OF CONTENTS

1 INTRODUCTION 5

1.1 PURPOSE 5

1.2 RISK MANAGEMENT FRAMEWORK SUMMARY 5

 1.2.1 *Risk Discussions and Workshops* 5

 1.2.2 *Risk Register* 6

 1.2.3 *Risk Management Plan* 7

 1.2.4 *Communicate and Consult Stakeholders* 7

 1.2.5 *Capture and Feedback Lessons Learned* 8

1.3 APPLICABILITY 8

1.4 GUIDING PRINCIPLES 8

1.5 ROLES AND RESPONSIBILITIES 8

1.6 DEFINITIONS 8

2 SCREENING PHASE 9

2.1 HIGH-LEVEL SCREENING/POLICY REVIEW REPORT RISK MANAGEMENT 9

2.2 DETAIL-LEVEL SCREENING REPORT RISK MANAGEMENT 10

 2.2.1 *Risk Discussions* 10

 2.2.2 *Risk Assessment* 11

 2.2.3 *Outputs* 11

3 DEVELOPMENT PHASE 12

3.1 DEVELOPMENT PHASE RISK MANAGEMENT 12

 3.1.1 *Risk Workshop(s)* 12

 3.1.2 *Risk Assessment* 13

 3.1.3 *Outputs* 17

4 PROCUREMENT PHASE 19

4.1 PROCUREMENT PHASE RISK MANAGEMENT 19

 4.1.1 *Risk Workshop(s)* 19

 4.1.2 *Procurement Risk Assessment* 19

4.1.3	<i>Outputs</i>	21
4.1.4	<i>Contract Finalization Risk Assessment</i>	21
4.1.5	<i>Outputs</i>	22
4.2	HANDOFF FROM VAP3 TO THE AGENCY	22
5	IMPLEMENTATION AND OPERATIONS PHASES	23
5.1	SUGGESTED RISK MANAGEMENT ACTIVITIES	24
5.2	MONITOR AND REVIEW	25
5.3	TRANSITION BACK TO THE AGENCY	25
6	APPENDICES: TABLE OF CONTENTS	26
APPENDIX A:	DEFINITIONS	27
APPENDIX B:	RISK REGISTER GUIDE	31
APPENDIX C:	RISK REGISTER EXAMPLE	36
APPENDIX D:	RISK VALUE AND PROJECT CONTINGENCY	42
APPENDIX E:	MONTE CARLO SIMULATION	43

TABLE OF FIGURES

FIGURE 1	RISK MANAGEMENT FRAMEWORK	6
FIGURE 2	SCREENING PHASE RISK MANAGEMENT	10
FIGURE 3	DEVELOPMENT PHASE RISK MANAGEMENT	13
FIGURE 4	PROCUREMENT PHASE RISK MANAGEMENT	20
FIGURE 5	IMPLEMENTATION AND OPERATIONS PHASES RISK MANAGEMENT	23

TABLE OF TABLES

TABLE 3-1	RAG ANALYSIS OF COST IMPACT	14
TABLE 3-2	RAG ANALYSIS OF SCHEDULE IMPACT	15
TABLE 3-3	TYPICAL RISK ALLOCATIONS FOR A HIGHWAY PROJECT	17

1 INTRODUCTION

In any project context, risk is an event which can, if it occurs, act as a threat and impact overall success of delivery. Public-Private Partnership (P3) projects tend to have a different risk exposure than traditionally delivered projects due to the relative complexity of procuring a single contract for the delivery of multiple and relatively diverse services. These P3 Risk Management Guidelines (Guidelines) introduce the Risk Management Framework, which serves as an effective guide for managing various risks throughout the entire lifecycle from the initial screening to handback at the end of the contract term specified in the Comprehensive Agreement (CA).

These Guidelines were developed by the Virginia Office of Public-Private Partnerships (VAP3) and are part of a suite of documents, including the PPTA Implementation Manual and Guidelines, which assist the Project Team with successful development and implementation of P3 projects. The Project Team is unique for each P3 project and comprised of the VAP3 Project Manager, Agency representatives assigned to the project and external consultants serving various roles on the Project Team. The Risk Management Framework should be utilized by the Project Team as the P3 project follows the guidance described in the VAP3's suite of documents and the Agency's applicable documents.

1.1 PURPOSE

The purpose of these Guidelines is to achieve the following goals and objectives:

- provide practical guidance to the Project Team executing the Risk Management Framework during the whole lifecycle of P3 projects;
- increase consistency and effectiveness of the Risk Management Framework by describing specific Risk Management activities throughout a P3 project's lifecycle;
- provide a consistent set of Risk Management terminology;
- promote effective and early communication and consultation regarding Risk Management with internal and external Stakeholders and experienced professionals;
- establish a confident and rigorous basis for decision-making and planning in regard to risk;
- incorporate best practices to strengthen current Risk Management tools and techniques;
- increase Risk Management accountability of the Agency undertaking a P3 project through the certification of certain risk documents;
- emphasize the performance goals, measures, review and modification process to ensure continuous improvement of the Risk Management Framework; and
- improve transparency by making risk information and reports available on the VAP3 website, project website and/or other appropriate means.

The Guidelines contain a description of the Risk Management Framework separated into chapters according to the five project lifecycle phases: (1) screening phase; (2) development phase; (3) procurement phase; (4) implementation phase; and (5) operations phase. See Figure 1 on the next page.

1.2 RISK MANAGEMENT FRAMEWORK SUMMARY

1.2.1 Risk Discussions and Workshops

A key element of Risk Management is based upon experience, especially the experience of dealing with risk on prior projects. The importance of involving both internal and external Stakeholders and experienced professionals who have varied perspectives on risk is critical. This collaboration can be conducted through risk discussions and Risk Workshops.

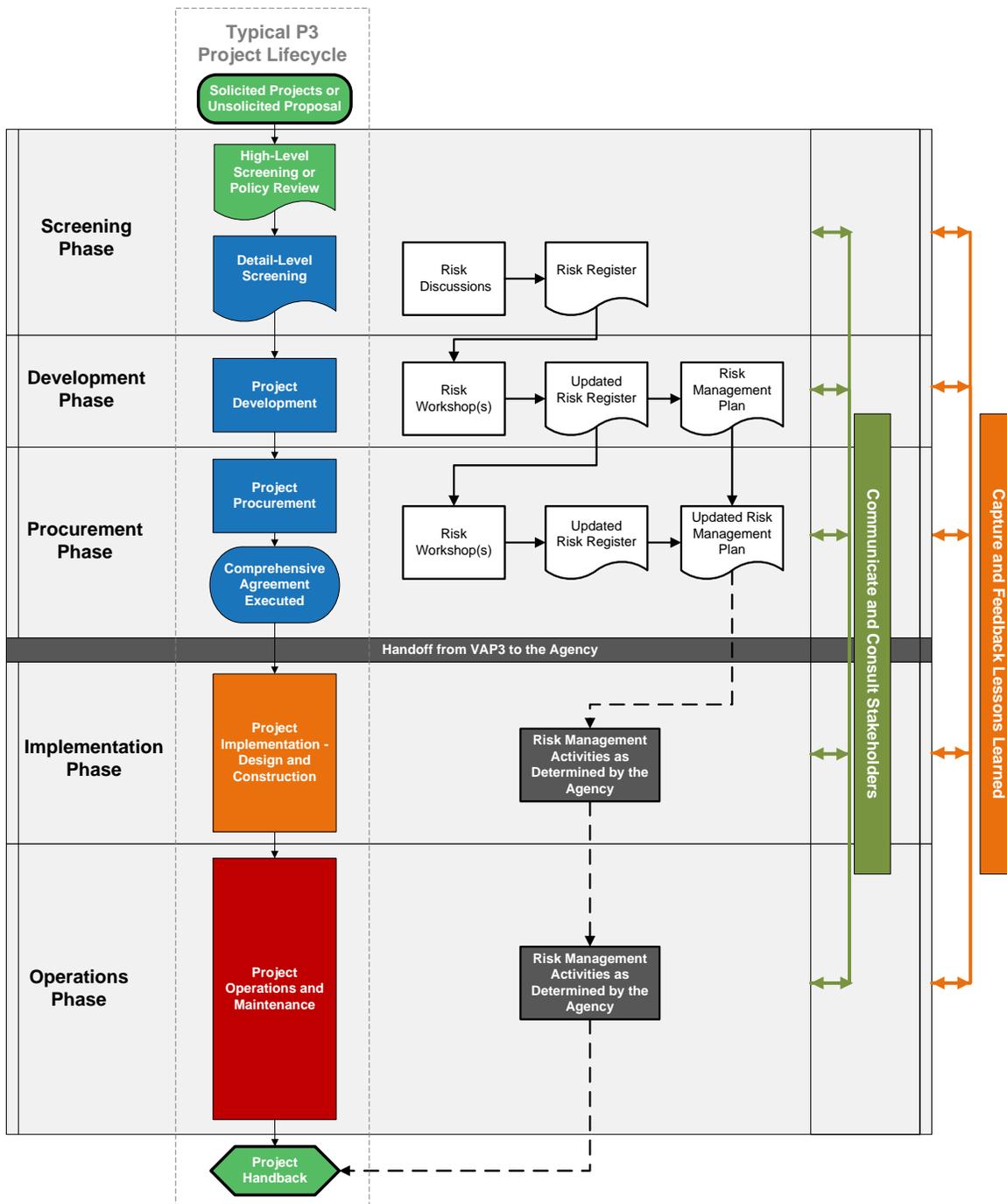


Figure 1 Risk Management Framework

1.2.2 Risk Register

A Risk Register is an essential tool used to capture risk information from risk discussions, Risk Workshops, Risk Assessment, Risk Treatment and Risk Response in one centralized location. A well-developed Risk Register is important for the Agency to have prior to executing a CA to ensure proper Risk Allocation is achieved. In turn, this helps inform whether the project brings the Best Value.

The VAP3 Project Manager creates the initial Risk Register, which begins as a simple list of project specific risks categorized under subheadings. After being created, the Project Team should revisit the Risk Register as often as necessary throughout the project lifecycle in consultation with internal and external Stakeholders and experienced professionals through risk discussions and Risk Workshops. The Risk Register is also used to record all Risk Assessments completed throughout the Risk Management Framework.

1.2.3 Risk Management Plan

The Risk Register and Risk Assessment inform the Risk Management Plan, which is a detailed plan of action for the management of project risks. This plan should include the recommended levels of contingency to maintain for a project in order to reflect its risk exposure.

1.2.4 Communicate and Consult Stakeholders

Collaboration with Stakeholders, internal and external of the Agency, forms a key part of a typical P3 project lifecycle and is described in detail in the P3 Public Engagement Guidelines. In particular, Stakeholder collaboration is a key component of the Risk Management Framework and is an important action within each of the five risk phases. Stakeholder engagement is a series of collaborative opportunities to create understanding about the risk profile of the project and to learn how these parties view the project's risks, impacts, and mitigation strategies. By actively engaging with Stakeholders through consultations, the Project Team will be better positioned to respond, identify and mitigate risk, as well as establish a confident and rigorous basis for decision-making and planning in regard to risk.

The Project Team actively engaging Stakeholders throughout the Risk Management Framework is important for when the Agency issues a finding of public interest (FOPI). The FOPI affirms the risks, liabilities and responsibilities to be transferred, assigned or assumed by a private entity provide sufficient benefits to the public and that proceeding with the development and/or operation of the project through a P3 delivery method is in the public interest. To provide additional information, the Risk Register can serve as input into the FOPI for public documentation of the risks, liabilities and responsibilities to be transferred, assigned or assumed by a private entity.

In addition, the appropriate oversight committee or board should be briefed regarding risk throughout the Risk Management Framework and should be given thorough risk information to be able to make confident decisions regarding the P3 project.

The process of undertaking Risk Management collaboration is context-specific. This means that techniques, methods, approaches and timetables will need to be tailored for the particular situation and the various types of Stakeholders being consulted. Ideally, a good consultation process will be:

- targeted at Stakeholders most likely to be affected by the risk;
- early enough to identify key risks and have an effect on the response strategy;
- effective because relevant information has been disseminated to and gathered from Stakeholders in advance;
- meaningful because the content is presented in an understandable format;
- two-way communication so that both sides have the opportunity to exchange views; and
- proactive and transparent in communicating risk information.

Documenting Stakeholder communication and outcomes is critical to effectively manage the Stakeholder engagement process. The documentation should capture: (1) when, where and the format of meetings; (2) meeting attendees; (3) meeting agenda; (4) meeting results and action items for follow-up; and (5) any commitments to Stakeholders that have been made. It is good practice to follow up with Stakeholders that are consulted.

1.2.5 Capture and Feedback Lessons Learned

The importance of capturing risk information and experiences during each phase of the project is critical because previous project experience is a key input to the Risk Management Framework. This documentation can best be captured by keeping a current and descriptive Risk Register, which allows for capturing lessons learned and eventually feeding these lessons back into each phase. Beyond the scope of these Guidelines, lessons learned are also captured as a part of the overall project process at the end of the implementation phase. Keeping a good record of the lessons learned in the Risk Register would be a useful input into the overall lessons learned for the project.

1.3 APPLICABILITY

These Guidelines have been specifically developed to apply to projects being considered for delivery as P3s. The examples used in these Guidelines draw from the VAP3's past experience and tend to focus on transportation P3 projects. A typical Risk Management Framework is described in these Guidelines; however, in reality, the framework may differ in particular areas depending on the specific P3 project and how it is developed. Therefore, the VAP3 Project Manager should ensure the Risk Management Framework is carried out in accordance with these Guidelines as much as possible and make a written determination of variance when insufficient information is available to perform a certain Risk Management activity.

1.4 GUIDING PRINCIPLES

As shown in Figure 1, the scope of the Risk Management Framework starts in the screening phase and extends through the execution of the CA and handback of the P3 project. These Guidelines advocate creating a strong Risk Management foundation through activities beginning in the screening phase. One of the limitations to undertaking Risk Management activities is the level and accuracy of information available and the thoroughness of assumptions made by the Project Team. Due to this limitation, the Project Team should ensure the level of assessment reflects the level of available information, especially in the early project development stage.

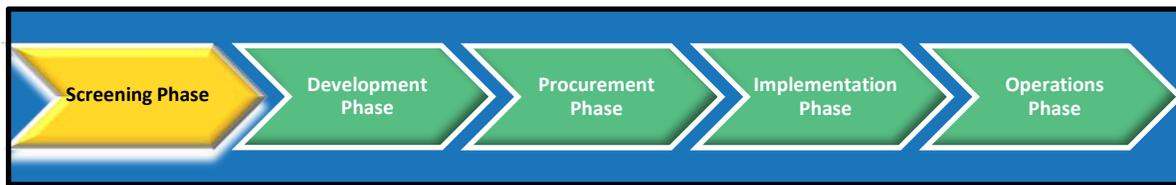
1.5 ROLES AND RESPONSIBILITIES

Risk Management during the screening, development and procurement phases should be spearheaded by the designated VAP3 Project Manager, who works as a member of the Project Team. The VAP3 Project Manager is responsible for working with the Project Team to initiate the Risk Management Framework, ensure Risk Management activities are carried out in accordance with this guidance, and ensure that Risk Responses are implemented. After commercial close, the project is handed off to the Agency's Project Team designated to implement the project. As early as possible before commercial close, the Agency should designate a project manager to be responsible for implementing the Risk Management Plan and conducting Risk Management activities. This early collaboration between the Project Teams that develop and implement the P3 project is important for a well-structured CA and successfully delivered project.

1.6 DEFINITIONS

[Appendix A](#) contains a list of definitions for key terms used throughout these Guidelines.

2 SCREENING PHASE



As a part of the typical P3 project lifecycle, the VAP3 completes two levels of screening reports to assist in determining the suitability of P3 delivery. The first is a High-Level Screening Report for Solicited Projects or a Policy Review Report for Unsolicited Proposals. The subsequent level for both Solicited Projects and Unsolicited Proposals is a Detail-Level Screening Report. Both screening reports for a project are posted to the VAP3 website.

The level of available project information for use during the screening phase can largely vary from project to project. For instance, some projects may have already completed the environmental and planning process, while others may not have started or are in the early stages of these processes. The Risk Assessment during the screening phase should not bias other project processes and is meant to utilize the available project information, including any environmental and planning documents, as input into the evaluation of risk in delivering the project using the P3 delivery method. Beginning this Risk Assessment and engaging in risk discussions during the screening phase is valuable input into the screening reports; however, the specificity of Risk Assessment is highly dependent upon the level of available information. The key advantage to carrying out Risk Assessment during the screening phase is to bring together multiple Stakeholders to discuss the project's objectives and consider the challenges likely to be encountered with a P3 delivery.

2.1 HIGH-LEVEL SCREENING/POLICY REVIEW REPORT RISK MANAGEMENT

Beginning risk discussions and identifying the critical risks during the first level of screening reports assists the VAP3 in responding to criterion regarding the ability to transfer risk in the High-Level Screening or Policy Review Report. This criterion may also include a high-level description of what project risks might exist.

Initial Risk Discussions

Initial risk discussions may be convened by the VAP3 Project Manager, in coordination with the Project Team if it has been formed by the Agency at this point, to review the project from the perspective of risk. The need to engage certain experienced professionals or Stakeholders and organization for these discussions is highly project dependent. These discussions may be valuable in seeking input from various internal and external experienced professionals and Stakeholders regarding the likely major risks for the project from different perspectives.

Identify Critical Risks

The output from this initial review is a list of critical risks for further consideration and discussion regarding ability to transfer risk, which is used as input and recorded in the High-Level Screening or Policy Review Report. In addition to recording this information in the screening report, the VAP3 Project Manager may find starting a Risk Register at this point beneficial; however, the Risk Register is not formally created until the next level of screening report. More details on creating the Risk Register can be found in the next section.

2.2 DETAIL-LEVEL SCREENING REPORT RISK MANAGEMENT

The purpose of Risk Assessment at this point is to assist the VAP3 Project Manager in responding to the Detail-Level Screening Report feasibility criterion under the heading “Project Risks.” This criterion is an opportunity to discuss the potential assignment of risk and mitigation strategies for the project.

Figure 2 provides an overview of the Risk Management process during the screening phase.

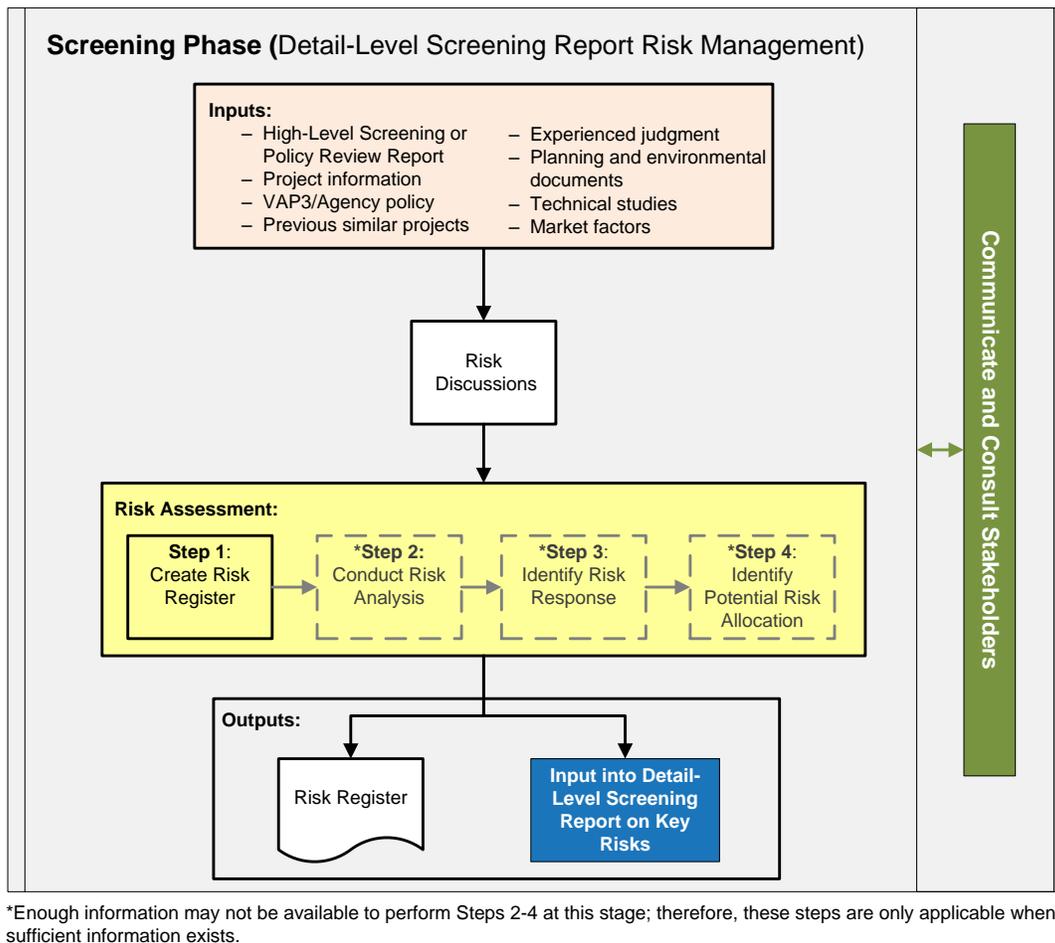


Figure 2 Screening Phase Risk Management

2.2.1 Risk Discussions

Risk discussions are convened by the VAP3 Project Manager, in coordination with the Project Team if it has been formed by the Agency at this point, to review the project from the perspective of risk. These initial discussions may be valuable in seeking input from various internal and external experienced professionals and Stakeholders on the characteristics of the project to identify what are likely to be the major risks. The discussions may be a continuation of dialogue initiated during the prior screening phase and will most likely expand the dialogue to more individuals with different perspectives regarding aspects of the project. Using a highway project as an example, the VAP3 Project Manager may engage the environmental division to discuss the risk of receiving an environmental permit from the Army Corps of Engineers or the Right-of-Way division to discuss the risk of acquiring land for the project.

2.2.2 Risk Assessment

Step 1 – Create Risk Register

Using the High-Level Screening or Policy Review Report, project information, specific project context, previous similar projects, experienced judgment, planning and environmental documents, technical studies, market factors and the risk discussions as inputs, the VAP3 Project Manager creates a Risk Register. A Risk Register template from the VAP3 website is comprised of a set of typical risks identified on previous P3 projects. These are provided as a guide to help expedite the risk identification process and should be deleted or added to reflect the specific scope of the project as closely as possible.

The Risk Register is usually organized into two parts for ease of data input and viewing information. Since the register is organized into two parts, it is important to focus on closing out all risks irrespective of which part the risk is listed. This is especially important to remember after contract execution and initiation of the implementation phase, so that no risks get lost in the transition.

The two parts are:

1. development and procurement risks, which occur prior to contract execution; and
2. implementation and operations risks, which occur after contract execution.

[Appendix B](#) contains a guide to explain the contents of the Risk Register template and [Appendix C](#) serves as Risk Register example.

Steps 2 – 4 (Conduct Risk Analysis, Identify Risk Response and Identify Potential Risk Allocation)

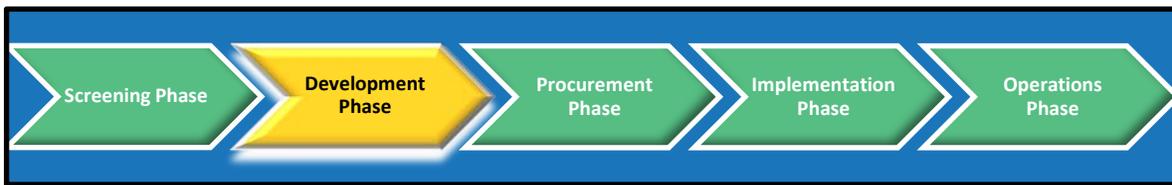
At the screening phase, limited information is usually available to perform Steps 2-4 (Conduct Risk Analysis, Identify Risk Response and Identify Potential Risk Allocation); therefore, the VAP3 Project Manager should make a written determination whether the available information is sufficient to accurately perform Steps 2-4. If the VAP3 Project Manager determines the project has sufficient information, then see the next chapter describing the development phase for more detail on performing Steps 2-4.

2.2.3 Outputs

The primary output of the Risk Management Framework for the screening phase is the initial Risk Register that may be used in the overall analysis of the Detail-Level Screening Report. Including the risk discussion within the Detail-Level Screening Report is critical because the report is the basis for the Agency's decision whether or not to develop the project as a P3. The Risk Register also provides the VAP3 Project Manager a baseline document for use in later stages of development and procurement if the Agency decides to move forward with a P3 delivery for the project.

Furthermore, an important output is the consideration of communication and consultation strategies in order to optimize Stakeholder involvement throughout the next phases of the Risk Management Framework.

3 DEVELOPMENT PHASE



Risk Assessment becomes an important activity for the Project Team once a project has been approved for development through the Agency's concurrence on the Detail-Level Screening Report. If the Project Team was not already formed by the Agency, it should be formed at the beginning of the development phase at the latest. During this phase, the Project Team should be preparing preliminary cost estimates for the project, as well as completing necessary environmental documentation and various technical studies.

The Risk Management Framework activities in the development phase are meant to happen in parallel with the other project activities underway and use all available project information as input into the Risk Assessment. Since the Risk Management Framework focuses on risks related to delivering the project as a P3, the risk activities should not bias non-risk related activities, especially ones related to the environmental process. Risk Management activities can be highly beneficial during this period as the Agency begins to incur significant project costs using its own resources. The identification of high risk areas can provide an efficient means of targeting the specific risks that are most likely to have an impact on the success of the project. Moreover, Risk Assessment during the development phase allows the VAP3 and Agency to carry out value-based analyses, including the Initial Value for Money (VfM) Analysis, Cost-Benefit-Analysis and/or Opportunity-Cost-Analysis, as appropriate.

Figure 3 on the following page provides an overview of the Risk Management during the development phase.

3.1 DEVELOPMENT PHASE RISK MANAGEMENT

3.1.1 Risk Workshop(s)

A Risk Workshop can be an effective tool for gaining input into the identification of risk and quantification of probability and potential impact. The Risk Workshop during the development phase is the first formal workshop in the Risk Management Framework. A formal workshop is planned, with a detailed agenda, specific purpose and preparatory information distributed in advance. The availability of information from the Agency and other Stakeholders regarding project goals, scope, cost, operational characteristics and physical constraints depends on the workshop's timing relative to the overall project development process. This information is prepared and distributed by the VAP3 Project Manager, in coordination with the Project Team. The information should also be presented at the workshop.

The focus of the workshop should be to identify additional risks, quantify the probability and potential impact of the identified risks, consider mitigations strategies and allocations, and to close any risks that have been mitigated. Maintaining momentum is important at this point so that the rationale for individual risks is not forgotten. If it is not possible to assess all identified risks at the Risk Workshop, the VAP3 Project Manager may identify certain priority areas on which to focus at the workshop. Risks may also be assessed utilizing internal resources and consultant support. All follow up work should be completed within a few weeks of the workshop date.

For consistency, the workshop may be a continuation of dialogue initiated with individuals during the screening phase; however, the workshop should expand the dialogue to more individuals with

varied perspectives regarding aspects of project risks. These individuals should include various internal and external experienced professionals and Stakeholders, such as technical professionals, financial consultants, local representatives, construction managers, and environmental experts. The VAP3 Project Manager should ensure a representative from every key area of the project is present at the workshop in order to have a robust and encompassing risk discussion and output.

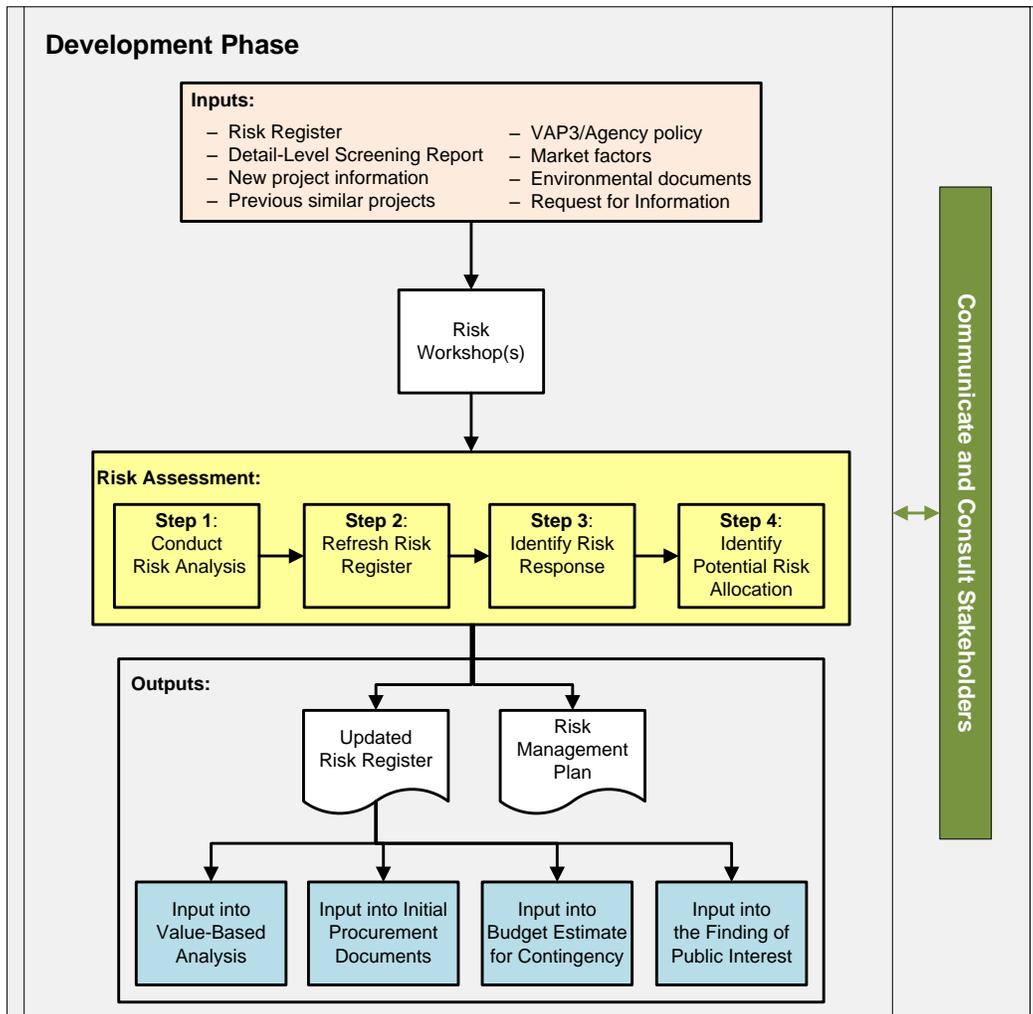


Figure 3 Development Phase Risk Management

3.1.2 Risk Assessment

Step 1 – Conduct Risk Analysis

Quantification of risk is based on professional judgment, previous experience on similar projects and market factors. Experienced professionals and members of the Project Team will first determine a percentage for the probability of the event occurring and then identify cost and schedule impacts associated with the consequence of each risk. The Project Team should decide which Risk Analysis is most appropriate taking into consideration the current status of the overall project process and the accuracy of available project information.

These Guidelines describe three types of Risk Analysis:

- Red-Amber-Green (RAG) Analysis;

- Expected Value Analysis; and
- Monte Carlo Simulation.

RAG Analysis

A RAG Analysis is performed by applying ranges for probability and risk impact as a percentage of project cost or time delay to the project schedule. This analysis allows the Agency and VAP3 to sum up all the expected risk impacts to give a total value of project risk. The three components of the RAG Analysis are: (1) probability range, (2) cost impact and (3) schedule impact. The purpose of probability and impact ranges is to establish the relative importance of each risk, not to calculate an exact risk value. Because of the approximate nature of this analysis, the overall result should be carefully reviewed and is likely to require further analysis to ensure accuracy. One approach to analyzing the results is to consider empirical research data for historic project cost and schedule overruns.

Probability range is the probability any risk event will occur and have a negative impact on the project. As a general rule, any risk with a probability of greater than 90% should be included in the cost estimate and tracked on the Risk Register. Also, any risk event that has a probability of less than 10% should be identified on the Risk Register but need not be quantified unless circumstances change to increase the probability of occurrence to the project. For this guidance, the probability ranges of a risk occurring are:

- Greater than 90%;
- 70% to 90%;
- 50% to 70%;
- 30% to 50%;
- 10% to 30%; and
- Less than 10%.

Cost impact is the additional cost of labor, equipment, materials, financing and/or other costs that are incurred when the risk event occurs and additional work or funding is needed as a direct result. For example, if actual ground conditions differ from the design and the design requires additional foundations, then the cost impact is the cost of additional materials plus the additional labor and equipment needed to carry out the extra work. The value is a percentage of the baseline project estimate. For this guidance, the expected risk impact for cost is categorized based on Table 3-1. At this point of analysis, the impact is classified as High, Medium or Low.

Table 3-1 RAG Analysis of Cost Impact

Scale		Cost Impact			
		Greater than 25%	10% to 25%	Less than 10%	
		3	2	1	
Probability	Greater than 90%	Include in cost estimate			
	70% to 90%	5	High	High	Medium
	50% to 70%	4	High	High	Medium
	30% to 50%	3	High	Medium	Low
	10% to 30%	2	Medium	Medium	Low
	Less than 10%	1	Low		

Schedule impact is the delay an event, if manifested, may cause to the baseline project schedule. In the same example, the foundation may take four instead of three weeks to build, so the schedule impact is one week. The value is the period of time the project would be delayed if a particular risk

event were to occur. For this guidance, the expected risk impact for schedule is categorized based on Table 3-2. At this point of analysis, the impact is classified as High, Medium or Low.

Table 3-2 RAG Analysis of Schedule Impact

Scale			Schedule Impact		
			Greater than 6 months	1 to 6 months	Less than 1 month
			3	2	1
Probability	Greater than 90%		Include in cost estimate		
	70% to 90%	5	High	High	Medium
	50% to 70%	4	High	High	Medium
	30% to 50%	3	High	Medium	Low
	10% to 30%	2	Medium	Medium	Low
	Less than 10%	1	Low		

The RAG Analysis valuations are recorded by the VAP3 Project Manager in the Risk Register and notes should be included to document data sources or use of experienced judgment. If available, historic data from similar previous projects, their Risk Registers and details of specific risk events can be used. Moreover, many risk events are likely to have an impact on both cost and schedule. The Risk Register allows a separate analysis of both of these factors; therefore, it is important not to “double count” the impact of the risk (see [Appendix D](#) for more detail).

Expected Value Analysis

The Expected Value Analysis is recommended over the RAG Analysis if the amount of project information is sufficient to allow the evaluators to confidently assign the following probability and risk impact values:

- probability, the probability of occurrence (between 10% and 90%);
- cost impact, a minimum (Min), maximum (Max) and most likely (ML) cost impact of the risk in terms of dollars; and
- schedule impact, a Min, Max and ML schedule impact of the risk in terms of months.

The Expected Value Analysis evaluates these values based on the formula:

$$\text{Risk Value} = \text{Probability} \times \text{Risk Impacts}$$

To calculate the risk impact in the expected value formula, this guidance recommends the program evaluation and review technique (PERT) formula, which is a common statistical tool used in project management. PERT has been tailored to risk by substituting in the cost and schedule impact. The PERT formula is substituted for risk impact in the expected value formula to produce the equation:

$$\text{Risk Value} = \text{Probability} \times (\text{Min} + \text{Max} + (4 \times \text{ML})) / 6$$

This equation is embedded in the Risk Register template and can be used to assign a risk value to each risk identified in the register. The valuations are recorded by the VAP3 Project Manager in the Risk Register and notes should be included to document data sources or use of experienced judgment. The probability and cost or schedule impact ranges identified for the RAG Analysis can be used to extrapolate a high, medium and low risk value.

Monte Carlo Simulation

For a Monte Carlo Simulation, risks associated with a range of probabilities are quantified by developing a probabilistic model. The simulation produces a deterministic sample set of likely project outcomes and the probabilities of their occurrence. The sample set can then be used to develop distributions, ranges for cost and schedule impacts, and identification of high, medium and low risk values.

The Project Team may decide to adopt a Monte Carlo Simulation if the amount of project information is sufficient to allow the simulation to be accurately run. Due to the limited project information usually available during early project development, a Monte Carlo Simulation is less commonly used at this phase. The Project Team may decide a Monte Carlo Simulation on all risks is not appropriate at this phase, but may want to simulate certain high risk items where impacts are deemed severe and where more technical analysis is required to analyze the drivers of such risk.

Additional resources will most likely be needed to perform this type of analysis. Monte Carlo Simulation is performed after the workshop once all the input values, assumption curves and allocations have been identified. Steps 2-4 below would be required before the simulation can be performed. The valuations are recorded by the VAP3 Project Manager in the Risk Register and notes should be included to document data sources or use of experienced judgment.

[Appendix C](#) contains examples of the three types of Risk Analyses and the content to be documented in the Risk Register. [Appendix E](#) contains further detail regarding the Monte Carlo Simulation and introduction of the assumption curves commonly used.

Step 2 – Refresh Risk Register

The Risk Register should be updated by the VAP3 Project Manager, in coordination with the Project Team, to include risk information from the Risk Workshop and Risk Analysis and then posted on the project and/or VAP3 website. The VAP3 Project Manager may consider engaging specific private industry individuals by sharing the register with them via email and asking for comments. Engaging the private sector pre-procurement creates a collaborative Risk Assessment process, which is strengthened by input from another perspective. The register should also be updated throughout the development phase to include closing out risks no longer relevant, adding new risk events and adding new results of the Risk Analysis.

A Project Team member should be assigned as a Risk Owner for each risk that has been identified in the register. A Risk Owner should be assigned based on his or her area of expertise and ability to manage the risk. Risk Owners are responsible for reviewing progress against the Risk Response in the Risk Register and should have open access to the Risk Register so that they can suggest and make adjustments in coordination with the VAP3 Project Manager.

Step 3 – Identify Risk Response

Professional judgment, lessons learned and feedback, experience from previous projects, VAP3 and Agency policies, and the intended procurement strategy should be used to assist in the determination of planned mitigation strategies. A standard set of response strategies to be assigned include:

- mitigation, meaning to develop a strategy to reduce the impact of a particular risk;
- avoidance, meaning to alter the scope of the project in order to eliminate the risk;
- transference, meaning to transfer the risk to an entity under contract;
- acceptance, meaning to take ownership of the risk and address it as if it were to occur; and
- sharing, meaning to share the impact of the risk with an entity under contract.

If the cost of mitigating a particular risk is comparable to the potential cost of its impact, then it is worth revisiting the Risk Response strategy or developing alternative mitigation options. A description may be added for more detail. It is particularly important to provide detail about Agency mitigations as these strategies can be estimated and compared to the calculated risk impact. Future mitigation activities should not be taken into account when determining risk probability and impact values. The Risk Assessment should reflect the level of information known by the Agency at that time. Risk probability and impact values should be re-evaluated once mitigations have been completed.

Step 4 – Identify Potential Risk Allocation

A core principle of Risk Management is that some parties are better able to manage risks than others. This may be for a number of reasons, such as a party's level of experience, access to information and resources. By considering the most cost effective allocation and who is best able to manage a particular risk, the Project Team should assign each risk to the Agency, the concessionaire or shared. The Project Team may decide to start Risk Allocation using "typical" allocations based on the assumed P3 delivery method. While starting with typical allocations is helpful guidance, the Project Team should be careful to only use this as a starting point because projects may vary depending on sector and the Agency's risk preference.

Table 3-3 below is an example of typical Risk Allocations based on best practice for a transportation highway project.

Table 3-3 Typical Risk Allocations for a Highway Project

Risk	Delivery Method		
	Design-Bid-Build	Design-Build	Design-Build-Finance-Operate- Maintain (P3)
Change in Scope	Public	Public	Public
NEPA Approvals	Public	Public	Public
Permits	Public	Shared	Shared
Right of Way	Public	Public	Shared
Utilities	Public	Shared	Shared
Design	Shared	Private	Private
Ground Conditions	Public	Public	Shared
Hazmat	Public	Shared	Shared
Construction	Shared	Shared	Private
QA / QC	Public	Shared	Private
Final Acceptance	Public	Private	Private
O&M	Public	Public	Private
Financing	Public	Public	Private
Force Majeure	Public	Shared	Shared
Traffic and Revenue	Public	Public	Private

Once the Risk Allocation has been created, the Risk Assessment findings should be revisited to ensure the values are accurately reflective of the intended Risk Allocation. Historic data from past projects may be helpful in assessing the value of transferred risks.

3.1.3 Outputs

The output and details of the Risk Analysis, along with the other Risk Assessment information, should be captured by the VAP3 Project Manager in the Risk Register. The Risk Register should be posted to the project and/or VAP3 website. Using this Risk Assessment information and Risk Register, the VAP3 Project Manager leads the Risk Management Plan development in collaboration

with as many members of the Project Team as needed. It should be consulted and revised throughout the development and procurement phases and endorsed by the Agency Administrator before handoff from VAP3 to the Agency. After endorsement, the plan guides the Project Team through implementation, operations and handback.

The Risk Management Plan is a detailed plan of action for the management of project risk. The plan incorporates the thoughtful and collaborative development, implementation, and monitoring of Risk Response and Risk Treatment strategies. The process is to: (1) develop and document an organized, comprehensive, and interactive Risk Management strategy; (2) determine the methods to be used to execute a Risk Management strategy; and (3) plan for adequate resources. The plan explains how the Project Team manages risk, provides guidance and requirements, and serves as a communication tool for those who wish to be informed of a project's Risk Management approach. The Risk Management Plan may be specific in some areas and general in others.

Every project should have a formal plan, but the level of detail varies with the project complexity. Most Risk Management Plans should include an outline similar to the following:

- Introduction
- Summary
- Definitions
- Organization and roles
- Risk Management approach
- Risk identification
- Risk Assessment/Risk Analysis
- Risk Response actions/allocation
- Risk Monitoring
- Risk identification

The outputs of the process described above will be useful for several parts of the project development process:

- for calculation of risk adjusted cost, revenue and schedule as part of the value-based analyses;
- for calculation (or update) of capital and operations and maintenance contingencies;
- to provide a quantifiable basis for deciding whether to carry out costly mitigations, such as additional site survey; and
- to help to inform the early development of procurement documentation.

All of the above will help the Agency and VAP3, along with other critical assessment documents not risk related, when the Agency issues a FOPI and makes a recommendation whether to move into procurement.

4 PROCUREMENT PHASE



An increased level of project definition and more robust input from the Proposers during confidential one-on-one meetings during the procurement phase provides an opportunity for the Agency to reassess project risks. Risk Analysis has a number of benefits throughout the procurement process, including:

- enabling updated project cost, revenue and schedule risk adjustments;
- providing input into the cost analysis;
- helping identify, develop and optimize commercial Risk Allocation in the CA; and
- increasing overall confidence in appropriate allocation of commercial project risks.

Figure 4 on the following page provides an overview of the Risk Management process during the procurement phase.

4.1 PROCUREMENT PHASE RISK MANAGEMENT

4.1.1 Risk Workshop(s)

The VAP3 Project Manager should first review the Risk Management activities and Risk Analyses that have been conducted. At this point, at least a RAG Analysis should have been previously conducted for every P3 project regardless of size and complexity. At a minimum during the procurement phase, the Project Team should perform either an Expected Value Analysis or Monte Carlo Simulation. If either of these analyses was performed prior to procurement, then the VAP3 Project Manager may decide to update the Risk Analysis via targeted meetings with internal and external experienced professionals and other Stakeholders rather than in a formal Risk Workshop. If the prior Risk Analysis was a RAG Analysis, then the VAP3 should conduct a Risk Workshop to quantify risk event probability, as well as cost and schedule impacts.

4.1.2 Procurement Risk Assessment

Step 1 – Update Risk Identification and Quantitative Risk Analysis

The VAP3 Project Manager should first review new information that might have become available as a result of further design studies and input from the Risk Workshop, if conducted. This new information is likely to require a review of the identification and quantification of the previously identified risks. If additional risks are identified, they must be added to the Risk Register by filling in the risk category, risk topic, impact phase and risk description columns. Changes in the base cost estimate or the schedule may alter the percentage cost risk impact or number of months delay respectively. It is the responsibility of the VAP3 Project Manager to make these changes to the Risk Register through discussion with the Risk Owners and members of the project team.

Step 2 – Update Risk Response

After updating the information in Step 1, the VAP3 Project Manager, in coordination with the Risk Owners, should update the Risk Register to reflect mitigations carried out and new mitigation strategies. Other forms of response may also be deployed and recorded in the Risk Register.

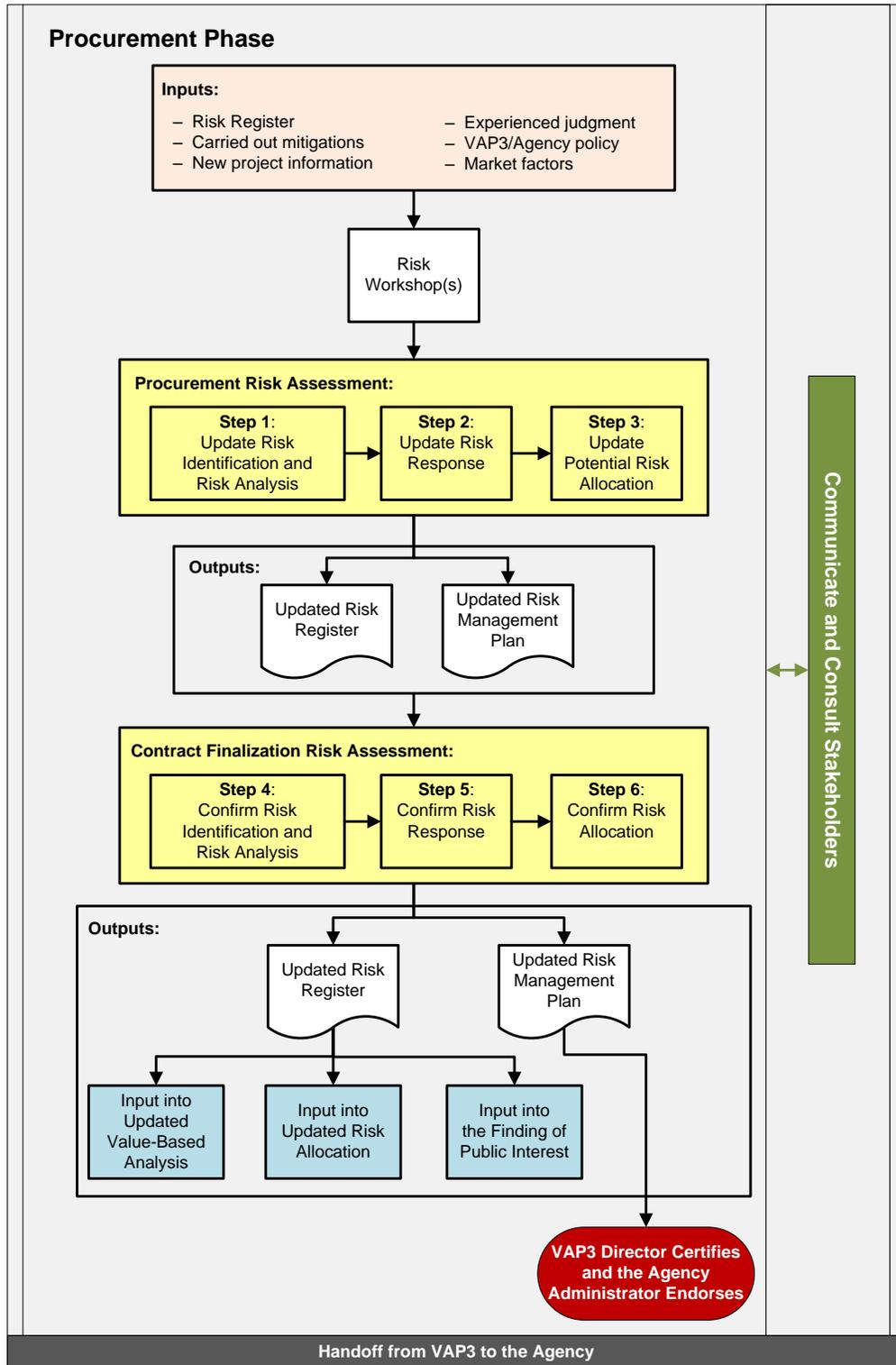


Figure 4 Procurement Phase Risk Management

Step 3 – Update Potential Risk Allocation

The undertaking of Risk Allocation becomes more significant during procurement as risk transfer has to be fully defined in the CA. The allocations listed in the Risk Register must align with the CA

and technical requirements. It is recommended to record, in the Risk Register notes column, the section reference of the CA that relates to the resolution of a particular risk event.

Informed Risk Allocation is often a direct result of industry briefings and formal discussions (i.e., proprietary meetings) between the VAP3, the Agency and short-listed Proposers, as well as input from public commentary (i.e., public hearings and citizens information meetings) and Stakeholder consultation. If a Monte Carlo Simulation is performed, then any change in Risk Allocation at this point must be adjusted in the Risk Analysis and the simulation re-run, which will yield different results. A change in allocation may not change the impact value of risk, but it will change each party's risk exposure. For example, changing an allocation of risk from "transferred" to "shared or retained by Agency" will increase the Agency's total risk exposure.

4.1.3 Outputs

The procurement phase represents an opportunity to update the quantification of risks. Input information should be well developed by this stage and be appropriate for an expected value or Monte Carlo Simulation. The output and details of the Risk Analysis, along with the other Risk Assessment information, should be captured by the VAP3 Project Manager in the Risk Register. Using this Risk Assessment information and Risk Register, the VAP3 Project Manager leads the update to the Risk Management Plan.

The outputs of the Risk Management Framework are useful for several parts of the procurement process and should help the Agency to decide whether or not to proceed with the procurement and select a preferred Proposer. More specifically the outputs can be used for:

- an update to estimated project costs;
- calculation of risk adjusted costs and scheduling of project milestones;
- revision of the Agency's contingency amount; and
- consideration of risks and potential allocations as input for forums and meetings.

4.1.4 Contract Finalization Risk Assessment

From a Risk Management perspective, this Risk Assessment involves an update and record of risks in the Risk Register so that an up-to-date Risk Register can be reviewed and certified by the VAP3 Director for transmittal to the Agency for review and endorsement. New inputs may arise from the selection of the preferred Proposer and finalization of the contract so these risks should be identified and analyzed. Most of the development phase risks should be closed out during this assessment.

Step 4 – Confirm Identification and Quantitative Risk Analysis

The VAP3 Project Manager reviews the most recent Risk Register and updates it by adding any new risks that may have arisen and closing out any risk that no longer apply. New risks may arise as a result of internal audits, Stakeholder consultation, public comment and contract finalization. At this point some of the typical planning and approval risks retained by the Agency may be closed (e.g., NEPA approvals, funding availability, etc.).

The VAP3 Project Manager, assisted by the Risk Owners, may review the current estimates of probability and cost/schedule impacts, especially if some mitigation activities were recently undertaken that reduced uncertainty. If a Monte Carlo Simulation was undertaken, then this analysis may be re-run to see what the impact these changes have on the risk impacts.

Step 5 – Confirm Risk Response

Each risk event is likely to have a fixed Risk Response strategy at this stage of the process. The Project Team should confirm the Risk Response strategies for Transferrable Risks and Shared Risks are clearly communicated in the CA. Retained Risks should have a detailed mitigation strategy described within the Risk Register and the Risk Management Plan. The Project Team should ensure key stakeholders are aware of the Retained Risks and associated mitigation strategies before finalizing the CA.

Step 6 – Confirm Risk Allocation

The Risk Register allows the VAP3 Project Manager to add notes regarding Risk Allocations and mitigations. If the risk is to be transferred or shared, then this column should contain a reference to the relevant section of the CA describing the contractual mechanism. If the risk has been avoided, accepted or mitigated, notes should be entered. It is important to keep track of any changes in Risk Allocation that arise during contract finalization. If the Risk Register is up to date and quantified it may also provide the team with a useful tool to review the impact of negotiated terms.

4.1.5 Outputs

The main output from the contract finalization Risk Analysis is the updated Risk Register and Risk Management Plan, in coordination with the terms in the CA. These documents should specifically highlight risks that depart from traditional delivery practices. The VAP3 Director should certify the Risk Management Plan and Agency Administrator should endorse it before commercial close in order to timely transmit it to the implementation phase team. The updated Risk Register, Risk Management Plan and CA can be used as input into the final FOPI to be issued by the Agency and the updated value-based analyses, if applicable.

4.2 HANDOFF FROM VAP3 TO THE AGENCY

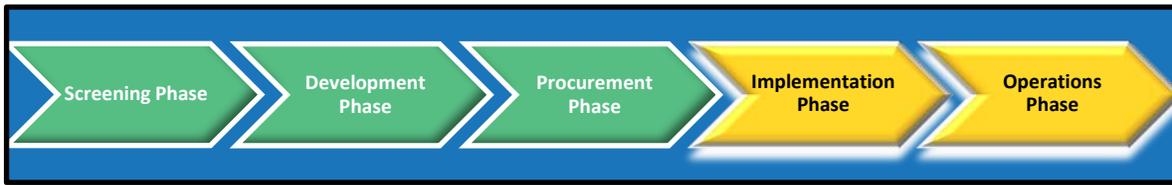
The Agency designated project manager, as lead of the implementation phase team, should be well engaged as early as possible during the Risk Management Framework to facilitate a smooth transition and transfer of critical risk related project information (i.e., qualitative risks that help inform the appropriate oversight board and the Agency's decision to execute the contract) and an understanding of risk terms in the CA.

The VAP3 Project Manager is responsible for ensuring that the Risk Register is up to date and suitable for use during implementation and operation. A summary of retained risks will be particularly useful for handoff from VAP3 to the Agency for Risk Management activities determined by the Agency. The risk discussion will most likely be a part of a larger project briefing by VAP3 to the Agency at the time of handoff.

At commercial close, many procurement and commercial risks may be closed out. The final Risk Register will contain implementation and operations risks owned by the Agency, owned by the concessionaire and shared by the Agency and concessionaire. This information is: (1) critical for the Agency's implementation team; (2) certified by the VAP3 Director; and (3) transmitted to the Agency Administrator for review, endorsement and implementation as certified.

There may be a delay between a P3 project's commercial and financial closings. This is common for P3 projects where private sources of financing are involved, but the time period can vary considerably. If financial close is delayed by more than four months, then the VAP3 Project Manager can refresh the Risk Register following steps 4-6 above. This update could be imperative if there are date-specific financial Risk Allocations in the CA.

5 IMPLEMENTATION AND OPERATIONS PHASES



This section provides guidance on the Risk Management Framework after commercial close when the project is handed off to the Agency for implementation and operations. The Agency leads Risk Management during these phases and this guidance serves as a recommendation. The purpose of Risk Management during the implementation and operations phases is not to duplicate or override planned processes specified in the Agency endorsed Risk Management Plan, but rather to identify potential events that exceed the parameters of the plan and what may normally be expected to occur, as well as encourage appropriate channels of communication to capture and feedback lessons learned. Figure 5 is an overview of the Risk Management Framework during the implementation and operations phases.

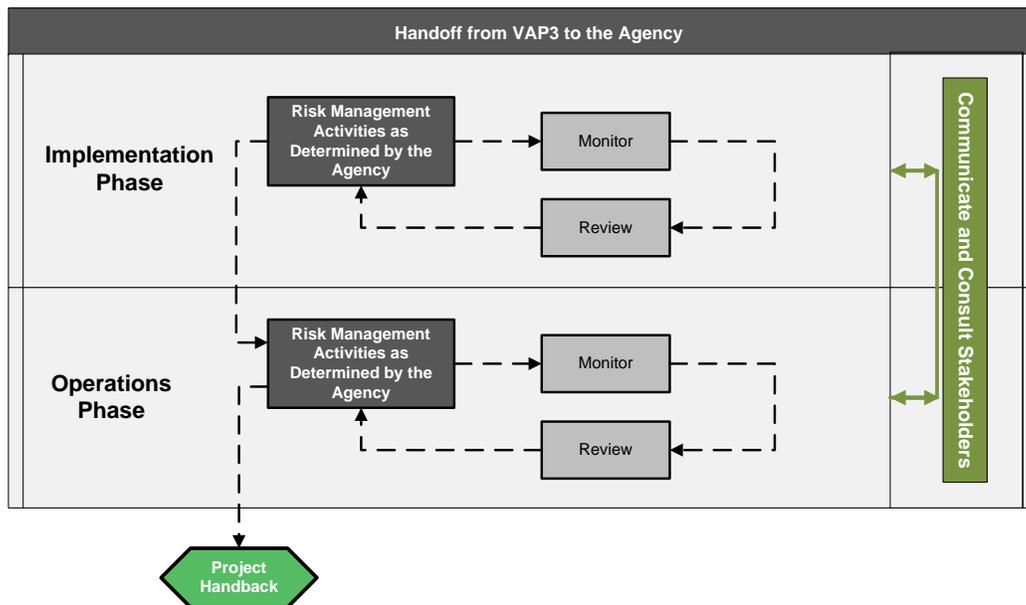


Figure 5 Implementation and Operations Phases Risk Management

Transition from Implementation Phase to Operations Phase

The Agency should ensure processes and resources are in place for the operations phase well in advance of implementation phase completion. This process should start six months before the planned commencement of operations and include an operations phase risk manager. This person should have an adequate transition period prior to handoff in order to fully understand and take ownership of the identified risks and planned responses. The duration of this period will depend on the specific characteristics and risk profile of the project. For instance, some projects may require the concessionaire to begin operations prior to substantial completion of implementation for the whole project. For this type of transition, a parallel system of Risk Management should be put in place so that implementation Risk Management continues for the scope of work or services still being implemented and the operations Risk Management begins the completed work or services.

5.1 SUGGESTED RISK MANAGEMENT ACTIVITIES

The updated Risk Register and Agency endorsed Risk Management Plan from the procurement phase provide the foundation for the Risk Register during the implementation and operations phases. The Risk Register should be tracked and periodically updated by the Agency assigned risk manager. Furthermore, the CA typically includes requirements for the concessionaire to prepare an operations and maintenance plan, including a Risk Register, and submit it to the Agency for review and approval. The implementation and operations risk managers should review the concessionaire's Risk Register and compare it to the latest updated Risk Register. A coordination meeting initiated by the Agency and attended by the concessionaire may be useful to discuss the Risk Register and Risk Management Plan.

Since the Risk Register is organized into two parts, it is important to focus on closing out all risks irrespective which part the risk is listed. This is especially important to remember after contract execution and initiation of the implementation phase so that no risks get lost in the transition. Therefore, the implementation and operations project teams should check that all the risks identified as having a potential impact before commercial close have been closed out. The remaining risks should be those that have potential impact during implementation and operations.

The Agency should ensure that it has fully identified all the risks that it bears a responsibility. This process should begin before commencement of the implementation and operations phases so that the Agency is fully prepared. It is valuable to engage experienced members within the Agency in a Risk Workshop to ensure that any new risks as a result of changes in project goals, Stakeholder interests or other aspects of the project have been identified and added to the Risk Register. New risks should be added or existing risks further refined in more detail as their potential impact approaches actuality.

It is recommended that the Agency designated project manager reviews risk responses and ensures he or she has a good understanding of how each risk is to be allocated. Transferable Risks should contain a reference to the section of the CA that requires the concessionaire to accept that risk. Shared Risks should also be clearly addressed in the CA and the Agency designated project manager should understand how the "sharing" works. If there is uncertainty around the relationship between Risk Responses and the terms of the final CA, then it is highly recommended that the Agency designated project manager convenes a Risk Workshop to clarify these issues and include the senior members of the team that drafted and approved the CA and the technical requirements.

During the implementation phase, the primary focus will be on implementation risks but that should not preclude occasional review of operations risks, especially as time approaches completion of the work or services. Some examples of risks that should be considered at this phase include:

- Approval of Deliverables – such as management plans, baseline schedules, etc.
- Reputation – any perception of failure (e.g., tolling administration for highway projects) can have a damaging impact on the Agency's reputation
- Technical issues – specific to the project, cost overruns, delays, etc.
- Errors, inconsistencies and inefficiencies in the contract – may only come to light when the contract is actively used by all the parties (e.g., change control and reporting requirements)
- External impacts – actions by Stakeholders that impact the project
- Funding issues – withdrawal of funding, bankruptcy by one or more party involved or some other impact from a parent company or other area of their business
- Economic impacts – sudden increase in inflation or interest rates, general recession

Operational risks are events that have a negative impact on the goals of the project after the implementation is complete. Examples for transportation highway projects include traffic flow and safety issues, such as incident and adverse weather response.

5.2 MONITOR AND REVIEW

It is essential that the Agency continues to monitor risks throughout the implementation and operations phases. Following contract execution, the project team should develop separate key deliverables matrices for the implementation and operations phases. These matrices are a tool for all parties to monitor the responsibilities outlined in the CA and should be dynamically updated as needed for clarification and adjustments to regulatory changes.

Risks that are retained by the Agency or are shared have to be proactively monitored so that they can either be prevented from occurring or their impacts reduced. Risks that have been transferred also need to be monitored because the CA may be open to interpretation, resulting in a potential claim from the concessionaire at a later date. Claim management and control techniques, such as an event log, may be implemented to assist with this. Developing a concessionaire event log and procedure early in the implementation phase will help the Agency record issues contemporaneously and counter claims of delay, disruption and out of sequence work. Monitoring and recording an owner's as-built schedule during the implementation and operations phases is a claim prevention technique that should be used to prevent a one-sided view of historical information.

The implementation and operations phase team should review the Risk Register and Risk Management Plan at least quarterly as part of its normal management process. More frequent reviews may be necessary during rapid periods of change. The focus of review should be whether the Risk Response activities have been carried out, if any new risks need to be added, re-evaluated or closed. The benefit of maintaining a detailed Risk Register is a clearly documented risk history, which is widely beneficial in the event of a loss of personnel and for capturing lessons learned. Furthermore, as risks are closed out, the Agency can release any contingency amounts that have been retained and re-program these funds.

Throughout the implementation phase, each risk should have a clearly identified Risk Owner who is responsible for ensuring that the risk response activity is carried out. The Agency designated project manager may ask Risk Owners for information to update the register as soon as events change rather than waiting for the quarterly review. Such a request may help to instill a culture of proactive review and update.

5.3 TRANSITION BACK TO THE AGENCY

The operations phase of a P3 project is characterized by a highly challenging period of change at the startup of operations followed by many years of operations and ended by a series of planned activities that ensure the facility is handed back to the Agency in accordance with the requirements of the CA. Towards the end of the operations phase, risks associated with asset condition will become more important as both Agency and concessionaire prepare for handback. As well as ensuring asset condition at handback, preparations will also be made for a transition of general operations from the concessionaire back to the Agency. The CA typically contains requirements for a transition plan that includes meetings between the concessionaire and Agency and the transfer of certain documentation.

The effective execution and maintenance of the transition plan can potentially mitigate many of the Agency's risks at this point. For example, on a transportation highway project, the risk that the Agency will inherit an Electronic Toll and Traffic Management system that it does not have trained staff to operate may be mitigated by the transfer of operational guidance from the concessionaire to Agency personnel. The Agency can also request from the concessionaire, any Risk Registers that the concessionaire may have been maintaining. Such documents could be very useful to the Agency once it takes over responsibility for the facility. A collaborative approach to the transition should benefit both parties, but it is recommended that the Agency takes the initiative because it is going to be responsible once the concessionaire's responsibilities end.

6 APPENDICES: TABLE OF CONTENTS

APPENDIX A: DEFINITIONS	27
APPENDIX B: RISK REGISTER GUIDE	31
APPENDIX C: RISK REGISTER EXAMPLE	36
APPENDIX D: RISK VALUE AND PROJECT CONTINGENCY	42
APPENDIX E: MONTE CARLO SIMULATION	43

Appendix A: DEFINITIONS

- **Agency** means any Agency of the Commonwealth of Virginia.
- **Agency Administrator** means the Commissioner, Director or the Chairman of the Board of Commissioners who is responsible for making decisions for his/her respective Agency.
- **Best Value** means the most overall public benefits as determined through an evaluation of the amount of the concession payment and other appropriate considerations in proposals received from Proposers. Such other appropriate considerations may include, but are not limited to, qualifications and experience of the private sector, expected quality of services to be provided, the history or track record of the private sector in providing the services, timelines for the delivery of services, performance standards and revenue sharing. Such appropriate considerations may also include, but are not limited to, policy considerations that are important, but not quantifiable, such as retaining a desired level of oversight over the project, ensuring a certain level of maintenance and operations for the project, considerations relative to the structure and amount of the toll rates, economic development impacts and considerations, or social and environmental benefits and impacts.
- **Comprehensive Agreement (CA)** means the Comprehensive Agreement between the private entity and the Agency.
- **Cost-Benefit-Analysis** is an evaluation tool comparing proposed Total Benefits to the proposed Net Total Cost of a Qualified Project. The evaluation provides information to decision-makers on whether a Qualified Project is worth pursuing to procurement.
- **Detail-Level Screening Report** means the form on which the VAP3 documents its findings and recommendations regarding the Detail-Level Screening process for a candidate P3 project.
- An **Expected Value Analysis** is based on the formula: Risk Value = Probability x Risk Impact. The analysis assigns the cost and schedule impact values in terms of a Minimum (Min), Maximum (Max) and Most Likely (ML) cost impact of the risk.
- **High-Level Screening Report** means the form on which the VAP3 documents its findings and recommendation regarding the High-Level Screening process for a candidate P3 project.
- **Interim Agreement** means an agreement, including a memorandum of understanding or binding preliminary agreement, between the private entity and the Responsible Public Entity that provides for the completion of studies and any other activities to advance the development and/or operation of a P3 project.
- **Operations and Maintenance (O&M)** means the operational and ongoing maintenance requirements of a facility.
- **Opportunity-Cost-Analysis** is an evaluation tool that compares the Qualified Project with the next best alternative that was not chosen. The opportunity cost analysis is what action you would have taken if you didn't make the choice you did. The evaluation provides information to decision-makers demonstrating if the proposed Qualified Project is worthwhile in pursuing and has inherent value that is greater than the next best alternative.
- **Policy Review Report** means the form on which the VAP3 documents its findings and recommendations regarding the Policy Review process for an Unsolicited Proposal.

- **Public-Private Partnership (P3)** means a project or service which is funded and operated through a partnership of government and one or more Private Entities.
- The **Project Team** is comprised of a VAP3 Project Manager, Agency representatives assigned to the P3 project and external consultants assigned a role on the Project Team.
- **Proposal** means the documents submitted by a Proposer to develop and/or operate a P3 project submitted by a private entity in response to procurement documents.
- **Proposer** means the private entity submitting an Unsolicited Proposal, or a Proposal for a P3 project.
- A **Red-Amber-Green (RAG) Analysis** is performed by applying ranges for probability and risk impact as a percentage of project cost or time delay to the project schedule. This analysis allows the Agency and VAP3 to sum up all the expected risk impacts to give a total value of project risk.
- **Residual Risk** is the risk leftover after implementation of a risk treatment option. Thus, it is the remaining risk value after measures have been taken to reduce the risk, remove the source of the risk, modify the consequences, change the probabilities, transfer the risk, and/or retain the risk.
- **Retained Risks** means the Project Risks which are most efficiently managed directly by the Agency and would not be transferred under a P3 project because the Agency has determined that to do so would not provide best value. Examples of Project Risks that are retained or at least shared under almost all P3 projects include the risk of pre-existing hazardous materials, the risk of failure to obtain Right of Way by certain specified dates and the risk of Force Majeure.
- **Revenue Risk** means the risks associated with the realization of tolling revenues.
- **Risk Allocation** is the assignment of roles and responsibilities for each identified risk.
- **Risk Analysis** is a process that is used to understand the nature, sources, and causes of the identified risks and to estimate the level of these risks. It is also used to study impacts and consequences and to examine the controls that currently exist.
- **Risk Assessment** means the overall process of Risk Identification, Risk Analysis and risk evaluation, including Risk Response.
- **Risk Avoidance** means a purposeful decision or strategy to avoid, withdraw from or not to become involved with a risk event or project related activity.
- **Risk Context** means the process of establishing the goals, objectives, strategies, scope and parameters of an activity, or part of the organization to which the risk management process is to be applied on a given project. The process should occur at the onset of considering a given project, involve key Stakeholders, and be undertaken with full consideration of the need to balance costs, threats, and opportunities.
- **Risk Identification** is a process that is used to find, recognize, and describe the risks that could affect the achievement of the project goals and objectives.

- **Risk Management** entails the comprehensive and systematic approach to identification, analysis, evaluation, assessment, response and treatment of risks and responsibilities to the parties involved at early stages of project development, and the subsequent management, review and monitoring of these and other identified risks throughout the project development process. It is an integral component of good management practices, allows for informed decision-making, proactive mitigation of threats, and capitalizing on the opportunities related to an Agency's project objectives, and should be dynamic, responsive, inclusive; create and protect value; and support and encourage continual improvement.
- **Risk Management Framework** means the systematic process of deciding how to approach, plan, and execute Risk Management strategies throughout the life of a project. It is intended to minimize or eliminate the consequences of adverse risk events.
- **Risk Management Plan** is a detailed plan of action for the management of project risks. The VAP3 Project Manager leads the development of this plan. The Risk Management Plan is the process to develop and document an organized, comprehensive, and interactive risk management strategy; determine the methods to be used to execute a risk management strategy; and plan for adequate resources.
- **Risk Mitigation** means an elimination or reduction in the probability and/or impact of a given risk occurrence or event.
- **Risk Monitoring** means to supervise and to continually check and critically observe. It means to determine the status and to assess whether or not required or expected performance levels are actually being achieved.
- **Risk Owner** is a person or entity that has been given the authority to manage a particular risk and is accountable for doing so.
- **Risk Register** means a detailed table or chart that lists the conceivable quantifiable risks for each project. These risks range from cost overrun and design risks to planning and regulatory risks. Each project risk is described in detail along with the probability of the risk occurring and a range of probable cost and time impacts as a consequence of the risk occurring.
- **Risk Response** means the process of developing options and actions to enhance opportunities and reduce threats to project objectives. Risk Response documentation should consider possible actions to the identified risk by satisfying the following questions. Can the identified threat be avoided, transferred, mitigated or is it to be accepted? Can the identified opportunity be exploited, shared or enhanced?
- **Risk Sharing** (Shared Risk) means risks that are allocated among two or more parties, where the threat of a loss or the benefit of the gain of a particular risk is proportionally shared as determined by the agreed allocation.
- **Risk Treatment** involves selecting and implementing one or more treatment options. There are many treatment options: risk avoidance, risk transfer, risk sharing, risk acceptance, removing the source of the risk, modifying the consequences, and changing the probabilities. Once a treatment has been implemented, it becomes a control or it modifies existing controls.
- A **Risk Workshop** is a purposefully planned meeting event with a detailed agenda and specific purpose. Workshops may include project team members, technical professionals and

Stakeholders. A Risk Workshop can be scaled for use on the simplest to the most complex projects and be tailored to specific areas of risk.

- **Solicited Project** means a project developed and procured by the Agency in coordination with the VAP3 through the issuance of procurement documents.
- **Stakeholder(s)** means individuals and/or organizations who may affect, be affected by, or perceive themselves to be affected by a decision(s) associated with the project, its objectives and goals.
- **Transferable Risks** mean those risks that are selected to be transferred from the Agency to the private sector delivering the project under a P3 arrangement because to do so would provide value.
- **Unsolicited Proposal** means a Proposal to develop and/or operate a P3 project submitted by a private entity not in response to procurement documents.
- **Value-for-Money (VfM)** means the process used to compare the impacts of a P3 project against those for the traditional public delivery alternative. The methodology for carrying out a VfM is discussed in the Value for Money Guidelines.
- **VAP3** means the Virginia Office of Public-Private Partnerships established under the guidance of the Commonwealth's Secretary of Transportation which is responsible for developing, implementing and administering the procurement of P3 projects. Formerly known as the Virginia Office of Transportation Public-Private Partnerships.
- **VAP3 Director** means the highest ranking individual within the VAP3 responsible for overseeing all aspects of the P3 program.
- **VAP3 Project Manager** means the individual within the VAP3 responsible for managing P3 related project activities, including the screening reports, Risk Management information and procurement documents.

Appendix B: RISK REGISTER GUIDE

The [Risk Register template](#) can be obtained on the VAP3 website and used as a basis to create a project specific register. This template has example risks, which can easily be deleted. The Risk Register is a Microsoft Excel spreadsheet containing two separate spreadsheet tabs:

1. development and procurement risks, which occur prior to contract execution; and
2. implementation and operations risks, which occur after contract execution.

See [Appendix C](#) for examples of the Risk Register content by focusing on two common risk examples for transportation highway P3 projects.

Risk Register Format

A title block is provided for the user to enter the project title and the name of the project manager. Headings and footers describe the phase, page number and date of printing. The title block and header also allows the user to define the stage of assessment.

The Risk Register is divided into “risk categories” for the major types of risk found in P3 projects. As an example, Table B-1 shows potential risk categories for a highway project.

Table B-1: Potential Risk Categories for a Highway Project

Planning and Approvals	Design
Legislative / Policy	Construction
Commercial / Procurement	Operations
Funding / Finance	Ordinary Maintenance
Environmental / Permitting	Major Maintenance
Geotechnical	Stakeholder Influence
Right of Way / Utilities	Force Majeure

Risk Register Content

The following is a description of the content in the Risk Register for both tabs described above. The tabs vary slightly and these differences are discussed below in more detail.

The Figure B-1 and B-2 on the next two pages are snapshots of the Risk Register template.

Agency Risk Register
[Procurement Approach]
 Project: *[Name]*
 Project Manager: *[Name]*
 Development Stage: *[Decision]*

Risk Information		Risk Analysis										Response						Risk Tracking						Notes																	
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Risk Description (5)	Consequence of Risk (6)	Probability Range (7)			RAG Analysis (8a)			Schedule Impact			Cost Impact			Expected Value Analysis Schedule			Monte Carlo Simulation (10c)		Risk Response Method (12)	Risk Allocation (13)	Risk Allocation Notes (14)	Monitoring and Control (14)			Risk Closure Notes (15)	Lessons Learned/Contract Notes (16)											
						Consequence	Probability Rank	Consequence Rank	Impact Rank	Risk Impact	Consequence	Probability Rank	Consequence Rank	Impact Rank	Risk Impact	Min (\$000)	Most Likely (\$000)	Max (\$000)	Risk Value (\$000)	Min (Mos.)	Most Likely (Mos.)	Max (Mos.)	Distribution Type	Modeling Notes																	
1.01	Implementation	Labor	Implementation				0	0	0	0		0	0	0	0		0			0	0	0	0.0																		
1.02	Implementation	DBE / SWAM Goals	Implementation				0	0	0	0		0	0	0	0		0			0	0	0	0.0																		
1.03	Implementation	QA/QC	Implementation				0	0	0	0		0	0	0	0		0			0	0	0	0.0																		
1.04	Implementation	Traffic Management	Implementation				0	0	0	0		0	0	0	0		0			0	0	0	0.0																		
1.05	Implementation	Environmental Compliance	Implementation				0	0	0	0		0	0	0	0		0			0	0	0	0.0																		
1.06	Implementation	Subsurface Conditions	Implementation				0	0	0	0		0	0	0	0		0			0	0	0	0.0																		

Figure B-2 Implementation and Operations/Maintenance Risk Register

Risk Information

Each risk has its own risk number (column 1). The risks provided in the template are described by risk category (column 2), risk topic (column 3) and impact phase (column 4). The impact phase is any one of the five risk phases, excluding the screening phase, and relates to the timing of the impact of the risk event, should it occur. If a risk has potential impact in more than one phase, a new line has to be added with identical category and topic, but with a different impact phase selected. Each risk has a risk description (column 5), which is an elaboration of the category/topic to describe the risk event. It should contain sufficient detail to be understood by any reader.

Risk Analysis

Each risk has a consequence (column 6), which should be a brief description of the potential consequence if the event should occur and provide a logical link between the event and its impacts. The consequence typically impacts cost or schedule but can be as specific as a safety, environmental, or reputation impact.

The Red-Amber-Green (RAG) risk analysis involves the selection of a probability range in column 7 and cost and schedule consequence ranges from columns 8a and 8b respectively. At this stage of analysis, the assessment is limited to percentage ranges provided in drop-down menus in the Risk Register. The cost impact is a percentage of total project costs. Implementation phase schedule impacts are defined as a range of months delaying completion. Development phase cost impacts are defined as a percentage of project funds to reach financial close and schedule impacts are defined as a range of months delaying financial close.

The spreadsheet contains a formula that calculates cost and schedule risk impact. The Risk Register contains a macro to automatically color the risk impact column based on the RAG Analysis described in the guidance. Colors may assist in the communication of risk results.

An Expected Value Analysis requires the estimation of a range of dollar values for cost and schedule impact. The range is defined by three values: a minimum (Min), most likely (ML) and maximum (Max). Columns 9, 10a and 10b allow the quantification of probability, cost consequence and schedule consequence in a similar manner to that described above but without the restriction of drop down menus. The Risk Register contains a simplified formula that combines the input values for probability and impact to calculate the risk value for use in this Risk Analysis. This formula is discussed in the guidance. As with the qualitative risk analysis, a total value for cost and schedule impact can be obtained by summing the “risk value” columns. Also, filters can be applied to the Risk Register to calculate separate amounts for the different Risk Response methods, including retained and transferred risks.

Schedule impact may not be applicable for risks during the operations phase. Instead, an additional column 9.1 is provided as a free text box to describe the frequency of the risk impact. Typical frequency options include: every year, once over the whole analysis period, every 10 years, in the first 3 years of the analysis period, and in the last three years of the analysis period. This determination has been found to be useful during Risk Workshops to help attendees quantify risk impacts without getting confused about whether the event is annual or occurs at longer intervals through the operations period. Further analysis can be performed to annualize the risk values, or adjust different parts of the operations phase cost/revenue estimate.

A Monte Carlo Simulation uses the same quantitative input data as the Expected Value Analysis, but instead of using a simple formula to approximate a weighted distribution of impact values, specialist software is used to perform a Monte Carlo Simulation (see [Appendix E](#) for discussion on the Monte Carlo Simulation), resulting in a range of probabilities and impacts. Consequentially, columns 9, 10a and 10b can be ignored. Instead column 10c is used if a Monte Carlo Simulation is performed as the definition of assumption curve replaces the simplified formula used in the

Expected Value Analysis. Column 10c defines the assumption curve for each individual risk and any important modeling notes.

Risk Response, Assignment and Allocation

Having identified and assessed the risks, the VAP3 Project Manager and project team determine what the Agency's initial response is likely to be. Column 11 allows the user to define an overall Risk Response strategy from a drop-down menu of five options (1) avoidance; (2) transference; (3) acceptance; (4) mitigation; and (5) sharing. These options are described in Section 3.1.2 – Step 3.

Column 12 allows the user to select a party that is to be allocated the risk. The menu of options includes: (1) the Agency (for retained risks); (2) the contractor (for transferred risks under a design-bid-build or design-build approach); (3) the concessionaire (for transferred risks under a design-build-finance-operate-maintain approach); and (4) shared. A table of typical allocations for different methods of procurement for transportation highway projects is provided in the guidance. Risk Allocation notes to explain key assumptions and rationale for the allocation should be added to column 13.

As the project progresses, more information is likely to be available for a determination of Risk Response and allocation. These columns should be updated and notes added.

Risk Tracking

The column 14 provides the user with an opportunity to track risks via a record of risk owner, a more detailed description of response/mitigation strategy, estimated mitigation cost (if known), risk review date, status/comments and whether the risk is on the critical path or not. Critical path risks may require a more detailed analysis of schedule risk impacts.

Notes

If risks are closed during later stages of analysis this can be shown in column 15 and the entire risk row can be "grayed out". This approach is better than deleting the risk row entirely so that you have a record of having considered the issue, which is important for capturing and feeding back lessons learned. The reason for closure should be added to column 15. Notes may be added to column 16 to state any lessons learned regarding a specific risk or the Risk Management Framework and/or the relevant section in the contract documents, which discusses the Risk Allocation.

Appendix C: RISK REGISTER EXAMPLE

The purpose of this Appendix is to walk the user through the Risk Register by focusing on two common risk examples for transportation highway P3 projects: (1) ROW acquisition; and (2) ground conditions. See [Appendix B](#) for a detailed guide of the Risk Register and its contents.

Screening Phase

During the screening phase, a high level summary of risks may be similar to the example below.

Figure C-1: Risk Register Risk Information Example

Risk Information				
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Risk Description (5)
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	The project is to be constructed in an area that is developing rapidly so land prices are highly volatile. As a result, the cost of ROW acquisition could be significantly higher than in the current estimate.
2.00	Implementation	Ground Conditions	Implementation	The project is in marshy ground that is prone to flooding and there have not been many boreholes. Later investigations may uncover worse ground than that assumed in preliminary engineering. Excavations at the site of major may result in foundations have to be reinforced / redesigned

Potential Risk Response and Risk Allocation (only if enough information is available)

The examples below are possible Risk Response and allocation strategies, which may be discussed if sufficient information is available at this early phase.

Figure C-2: Potential Risk Response and Risk Allocation Example

Risk Information				Response		
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Risk Response Method (12)	Risk Allocation (13a)	Risk Allocation Notes(13b)
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	Mitigation	Agency	It may be possible to transfer this risk in a PPTA contract but a high risk premium may be included by Offerors if they feel unable to control or influence the underlying economic drivers. It may be more cost effective for the Agency to accept this risk and try to mitigate it.
2.00	Implementation	Ground Conditions	Implementation	Transference	Concessionaire	Risk may be transferred via clear terms in the Agreement

Development Phase

Risk Analysis

RAG Analysis

The RAG Analysis example below reflects two risks with sufficient information to allow the evaluators to confidently value these risks.

Figure C-3: RAG Analysis Example

Risk Information				Risk Analysis					
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Consequence of Risk (6)	RAG Analysis				
					Probability Range (7)	Cost Impact (8a)		Schedule Impact (8b)	
						Consequence	Risk Impact	Consequence	Risk Impact
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	Higher prices in future would result in increase in project costs.	10% to 30%	Less than 10%	Low	Less than 1 month	Low
2.00	Implementation	Ground Conditions	Implementation	Change in design during early stages will require update of cost estimate. Changes on site could result in increase in project costs and potential delay to construction.	30% to 50%	Less than 10%	Low	1 to 6 months	Medium

As explained in these Guidelines, this is a very approximate method of calculating risk adjustments and is likely to require further analysis to ensure that the results are sensible. For example, the ROW Acquisition risk identified during the screening phase was assessed as having a potential impact of less than 10% of project cost. If the project was estimated to be approximately \$500m constructed value, then this range would be up to \$50m. The less than 10% range may have been chosen without fully appreciating the proportion of ROW cost to total project cost. For a \$500m project, the ROW costs might only be \$50m so the upper range of 10% (\$50m) now seems very high. This would in effect be a doubling of expected costs for that line item. This review may lead to a reduction in the likely range of risk impacts. An alternative approach would be to apply the percentages to the part of the project that is affected. For example, taking less than 10% of the cost of ROW, estimated to be \$50m in total, will return cost impacts up to \$5m.

The Risk Register is a continual process of updating throughout the entire project lifecycle. Thus, all fields in the register should be reviewed and updated as needed. This section focuses on examples of the new information to be entered into the register at the development phase.

It may help to consider previous projects or historical empirical data from the various studies that have been carried out on cost and schedule overruns. For example, for a \$500m project, the total cost risk value may be between \$25m and \$75m. A quick calculation shows that this is between 5% and 15% of total cost. A review of studies that are relevant to the project being analyzed may show that average cost overruns are typically around 25% to 30%. This result suggests that the 5% to 15% range is low so it may be that some major risks have been missed or the estimated impacts may be too optimistic.

Expected Value Analysis

An Expected Value Analysis requires the estimation of a range of dollar values for cost and schedule impact. Examples for both cost and schedule impacts are shown below.

Figure C-4: Expected Value Analysis Cost Impact Example

Risk Information				Risk Analysis				
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Expected Value Analysis				
				Probability (9)	Cost Impact (10a)			
					Min (\$000)	Most Likely (\$000)	Max (\$000)	Risk Value (\$000)
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	20%	200	1,000	5,000	307
2.00	Implementation	Ground Conditions	Implementation	20%	5,000	20,000	50,000	4,500

Figure C-5: Expected Value Analysis Schedule Impact Example

Risk Information				Risk Analysis				
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Expected Value Analysis				
				Probability (9)	Schedule Impact (10b)			
					Min (Mos.)	Most Likely (Mos.)	Max (Mos.)	Risk Value (Mos.)
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	20%	1	3	6	0.6
2.00	Implementation	Ground Conditions	Implementation	20%	3.0	12.0	18.0	2.3

Monte Carlo Simulation

In the Monte Carlo Simulation example shown below, it is determined that the ROW acquisition risk is likely to be a uniform distribution between the values of \$200k and \$5,000k. A most likely value is not required for the uniform distribution. The simulation software will randomly pick numbers between \$200k and \$5,000k and multiply each one by the defined probability (20%). At the same time, the simulation will pick impact numbers for all of the other risks, depending on the distribution type that has been defined. The Ground Conditions example is triangular

distribution which does require a most likely value to define the apex of the triangle. The simulation will pick that number more often than numbers above and below it. See [Appendix E](#) for more information about the Monte Carlo Simulation.

Figure C-6: Monte Carlo Simulation Cost Impact Example

Risk Information				Risk Analysis						
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Expected Value Analysis				Monte Carlo Simulation (10c)		
				Probability (9)	Cost Impact (10a)			Risk Value (\$000)	Distribution Type	Modeling Notes
					Min (\$000)	Most Likely (\$000)	Max (\$000)			
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	20%	200		5,000	2,600	Uniform	Monte Carlo with 10,000 iterations
2.00	Implementation	Ground Conditions	Implementation	20%	5,000	20,000	50,000	4,500	Triangular	Monte Carlo with 10,000 iterations

Potential Risk Response and Risk Allocation

As the project progresses, more information is likely to be available for a determination of risk response and allocation. These columns should be updated as before with notes added to explain key assumptions and rationale for the allocation. An update example is shown below.

Figure C-7: Updated Risk Response and Allocation Example

Risk Information				Response		
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Risk Response Method (11)	Risk Allocation (12)	Risk Allocation Notes(13)
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	Mitigation	Agency	Sponsoring Agency is carrying out research into ROW costs and reviewing economic projections of future ROW costs.
2.00	Implementation	Ground Conditions	Implementation	Transference	Concessionaire	Previous experience on PPTA projects has indicated that the Agency has successfully transferred this risk in the past and feedback from Proposers indicated that they were able to manage it without a significant premium to their bid.

Procurement Phase

During the procurement phase, the Risk Register is again updated and thus all fields in the register should be reviewed and updated as more accurate cost data, draft contract documents, and

feedback from the industry becomes available. This section focuses on examples of the new information to be entered into the register at the procurement phase.

During this phase, it may be possible to close some of the risks. For example, project approval risks during the development phase are shown below.

Figure C-8: Risk Closure Notes Example

Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Cash Flow Impact (4.1)	Risk Description (5)	Consequence of Risk (6)	Risk Response Method (11)	Risk Allocation (12)	Risk Closure Notes (15)
1.01	Development	Environmental Approval	Development	Development Funds	Delay in achieving Record of Decision (or equivalent).	Increased project cost due to inflation and mismatch between funding sources and uses.	Acceptance	Agency	RISK CLOSED Record of Decision was received from the FHWA on <DATE>.
1.02	Development	Ability to Toll	Development	Development Funds	Agency is unable to get approval for tolling the facility.	Project no longer feasible without additional funds from elsewhere other than toll revenue.	Acceptance	Agency	RISK CLOSED Approval to toll has been received.

Also throughout the development phase, Risk Allocations can be documented in the Risk Register Lessons Learned/Contract notes column. A specific reference to the relevant section of the CA is beneficial to keep track of Risk Allocations during negotiations and to document the Risk Allocation in the executed CA, which serves as a reference for the Agency’s project manager(s) during the implementation and operations phases.

Figure C-9: Lessons Learned/Contract Example

Risk Information				Response			Notes
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Risk Response Method (11)	Risk Allocation (12)	Risk Allocation Notes(13)	Lessons Learned/Contract Notes (16)
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	Mitigation	Agency	Sponsoring Agency is carrying out research into ROW costs and reviewing economic projections of future ROW costs.	Risk allocation is defined in Invitation to Offerors (ITO) Section 4.3.2
2.00	Implementation	Ground Conditions	Implementation	Transference	Concessionaire	Previous experience on PPTA projects has indicated that the Agency has successfully transferred this risk in the past and feedback from Proposers indicated that they were able to manage it without a significant premium to their bid.	Risk allocation is defined in CA Section 8.06

Implementation and Operations Phases

The Risk Register is a continual process of updating throughout the entire project lifecycle. Thus, all fields in the register should be reviewed and updated as more risk information, including the

executed CA and Agency endorsed Risk Management Plan, becomes available. During the implementation and operations phases the Risk Register should also be updated to reflect lessons learned and risk monitor and review information.

This section focuses on an example of risk monitor and review information. This information may be added during any risk phase, but the example used here is for typical monitoring and control information during the implementation phase.

Figure C-10: Monitor and Review Example

Risk Information				Response		Risk Tracking					
Risk Number (1)	Risk Category (2)	Risk Topic (3)	Impact Phase (4)	Risk Response Method (11)	Risk Allocation (12)	Monitor and Review (14)					
						Risk Owner	Response Action/ Strategy to Mitigate Risk	Planned Mitigation Cost (\$)	Risk Review Dates	Status and Review Comments	Is Risk on Critical Path?
1.00	Right of Way (ROW) / Utilities	ROW Acquisition	Implementation	Mitigation	Agency	B. Smith	Research historic ROW costs in project location. Economic research into development trends over next 5 years.	100,000	December 1, 20XX	Not Started	No
2.00	Implementation	Ground Conditions	Implementation	Transference	Concessionaire	J. Bloggs	Geotechnical investigation - bore hole data should be prepared and issued to Proposers with the RFDP.	500,000	December 1, 20XX	Not Started	No

Appendix D: RISK VALUE AND PROJECT CONTINGENCY

Many risk events are likely to have an impact on both cost and schedule. The Risk Register allows a separate analysis of both of these factors; therefore, it is important not to “double count” the impact of the risk. This Appendix discusses risk value in terms of cost and schedule, as well as contingency.

Cost Impact

The cost impact value as described in Section 3.1.2 is a percentage of the baseline project estimate and thus this risk value is already in terms of cost.

Schedule Impact

Schedule impact is quantified in units of time, but delays also have a cost associated with them. In order to get a complete picture of total potential project cost, the Agency can calculate the dollar value of schedule impacts by calculating a “per week” value for indirect costs and multiplying this unit rate by the expected schedule impact / delay associated with the event.

“Per week” indirect cost rates will vary depending on the location, scale and complexity of the project. Indirect costs also vary depending on what stage the project is under consideration, but for this level of analysis it is suggested that an average rate is used for events during the implementation of the scope of work or services and a second value is used for events during operations. Historic data may be used to verify the amounts. Two rates should be calculated: one for Agency indirect costs (including independent oversight / implementation or operations management) and one for the contractor. Both rates should be applied so that the total cost of delay is the sum of the Agency’s indirect costs and the contractor’s indirect costs.

Project Contingency

Contingency is often applied as a percentage of cost to individual line items of scope. Contingency may be positive and/or negative and should be used to calculate a “range” of project costs, but for budgeting purposes the higher amount is typically used. The guidance assumes that contingency is already included in the base estimate, prior to undertaking a quantified Risk Analysis. The expected value of risks therefore has to be added in order to provide the Agency with a total project estimate.

Combining Contingency and Risk Value

The guidance assumes that the total expected value of risk (retained and shared) is added to the base estimate which already includes contingency amounts.

The project team should ensure:

- the contingency as defined above is in the base estimate; and
- the contingency amount does not overlap with any of the quantified risks.

Appendix E: MONTE CARLO SIMULATION

A Monte Carlo Simulation produces a deterministic sample set of likely project outcomes and the probabilities of their occurrence. The sample set is used to develop distributions and ranges for cost and schedule impacts. The simulation provides a range of risk values depending on what confidence threshold is required. For all iterations, the simulation calculates multiple results using a different set of random probabilities. The preferred number of iterations need to be specified in the model and can vary from thousands to tens of thousands depending on the number of risks and the risk impact ranges specified. It is recommended that the iteration be set to 10,000.

The process is as follows:

1. quantify probability, cost and schedule impact as per the Expected Value Analysis;
2. select a distribution type (also known as an assumption curve) from the drop down menu according to the nature of the risk being analyzed; and
3. perform a Monte Carlo Simulation of cost and schedule impact using specialist software such as @RISK or Crystal Ball.

Risk Distribution Type

In step 2 above, risk modeling software allows the user to select any type and enter the parameters developed during the Risk Assessment. The following descriptions and figures provide an introduction to four commonly used assumption curves for individual risk distributions:

- Uniform Distribution: This distribution is used when it is impossible to estimate a most likely impact of a cost or schedule risk. The minimum and maximum impact is used to create a uniform distribution where there is considerable uncertainty on the cost and duration of a risk event.
- Discrete Distribution: This distribution is used when a risk event can only have very specific impacts. In such cases, a continuous distribution cannot be used to represent the risk event.
- Triangular: This distribution is used when the user defines discrete minimum, most likely and maximum values.
- Continuous Distribution: (also known as program evaluation and review technique (PERT)) This distribution is used when the minimum, maximum and most likely are all defined. It is important that variability of the risk impacts is fairly accurate in order to generate a realistic curve representation.

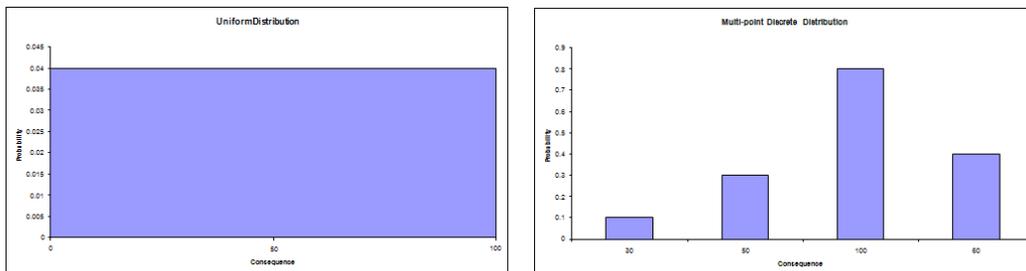


Figure E-1: Uniform and Discrete Risk Distributions

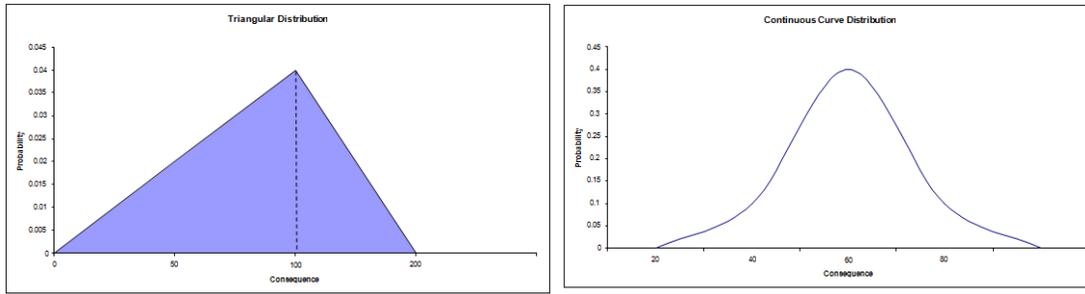


Figure E-2: Triangular and Continuous Risk Distributions

Monte Carlo Outputs

Over 10,000 iterations the total value of risk will emerge from the simulation in the form of several types of charts, including: histogram, S-Curve and tornado charts. These charts display the outcomes of many different scenarios that result from a Monte Carlo Simulation and can be used to select risk values for different confidence levels. The main output of the simulation is total values for retained, transferred and shared risks (i.e. an accumulation of all risks on the register). These values can be used in the cost analysis, which includes the VfM Assessment of risk adjusted cost and schedule for highway projects. Figures E-3, E-4 and E-5 below have been taken from an actual project Risk Assessment and are used as examples of impact distribution and regression sensitivity graphs.

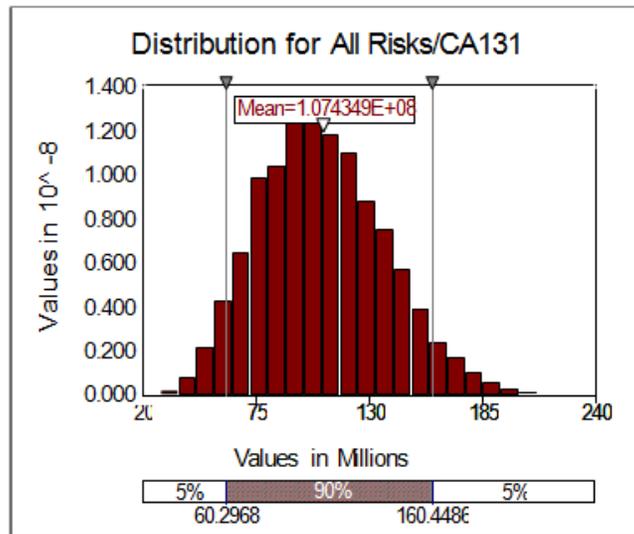


Figure E-3: Risk Distribution Histogram

In Figure E-3 above, the 50th percentile (also known as the P50), mean and 80th percentile (P80) output values are shown since these are the most commonly reported statistics. The mean represents the average of all generated outputs which is not the same as the P50 unless the distribution is symmetrical. The P80 is widely used in Risk Analysis to show a confidence level of 80% that a variable will not exceed the estimated value. Figure E-4 shows an alternative method of displaying cumulative risks through the use of an S-Curve. The S-Curve is used to set the confidence level required for the project.

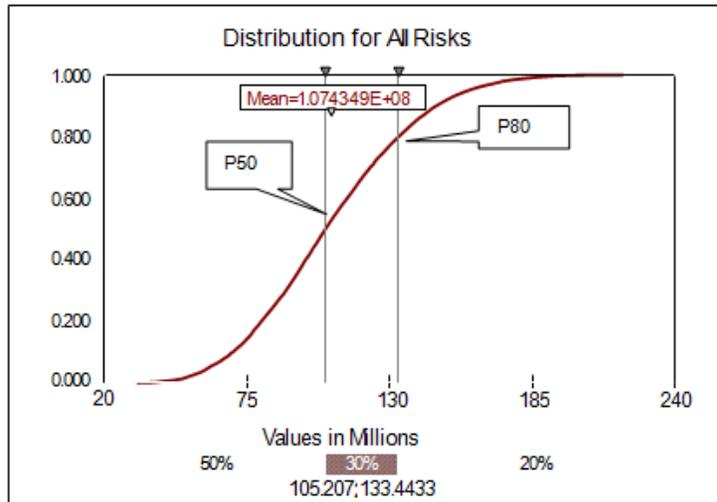


Figure E-4: Risk Distribution “S-Curve” Showing Confidence Levels

Tornado diagrams may be utilized to display individual risks in order of priority based on the significance of their impact on the total project estimate. The same information can also be shown as a scatter plot. An example of a tornado diagram is shown below in Figure E-5.

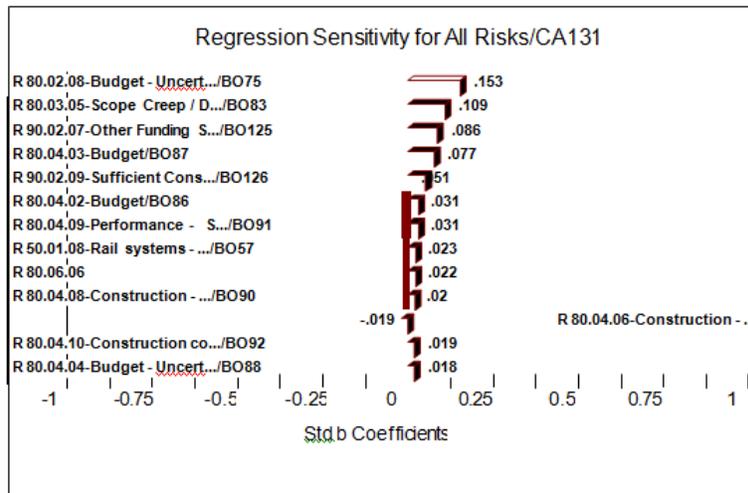


Figure E-5: Tornado Diagram

Risk simulation software allows a variety of results to be presented in numerous ways. For example, separate charts may be generated to separate out retained risks, transferred risks and shared risks.