DM1X, APPENDIX AG

RISK MANAGEMENT FOR PROJECT DEVELOPMENT

Portions of this document were developed utilizing the Caltrans "*Project Risk Management Handbook: A Scalable Approach*", June 2012; and FHWA's "*Final Guide for the Process of Managing Risk on Rapid Renewal Projects*", April 2016.

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AG.1 Risk Management Introduction

Every project has risks, regardless of size or complexity, and each risk will have a negative or positive effect on at least one project objective (cost, time, scope, or quality). Thus, risk management, in the context of the planning, design, construction, and operation of a transportation project, is the process to better understand and to optimize project performance by anticipating and planning for potential problems or "threats" and potential improvements or "opportunities". The sections of this document provide the following guidance:

- **Section AG.1, *Risk Management Introduction***, provides PennDOT's definition, objectives, and benefits for risk management.
- **Section AG.2 *Risk Management Levels, Responsibilities, and Project Integration***, provides details for the scalable approach to risk management, which is based on project complexity.
- **Section AG.3, *Risk Management Process***, explains each step of the risk management process.
- **Section AG.4, *How to Use the Appropriate Risk Management Tool***, contains information on how the PennDOT Risk Management Template is used to capture each of the risk management steps.
- **Section AG.5, *Appendices***, contains a glossary, risk response examples, and an outline for a risk management plan.

AG.1.A. Risk Management Defined

Risk can be characterized by probability of occurrence and level of impact on a project. Throughout the project life cycle, a future event that may occur at any time in a project's lifecycle is a risk. It has a probability of occurrence and an uncertain impact if it does occur. However, d*o not confuse risks with issues*. While a risk is an uncertain event that has a probability associated with it, negative issues are problems that the project team is facing right now, requiring an immediate response. Consider risk management as a *proactive* activity, while issue management is *reactive*. In other words, an issue is something that needs to be resolved and a risk is something that could affect your project in the future based on the current phase of project development, delivery and operational management.

Risk vs. Issue Example

Risk – potential weather delays during construction

⇨ account for potential delays in construction schedule

Issue – two weeks of rain have delayed construction

⇨ consider additional shifts, overtime to maintain schedule

A formal risk management approach helps to optimize project performance (i.e., cost and schedule) in planning, design and construction phases. Through risk management, PennDOT can better address the questions of "How much will it cost?" and "How long will it take?" Risk management enables PennDOT to anticipate threats and opportunities and subsequently evaluate and plan for them. This includes mitigating threats and opportunities to project performance in terms of cost (e.g., additional design costs and construction work orders) and schedule (e.g., negative float, delays and missed let dates).

Risk management is an ongoing process, beginning at the conception of a project and continuing through construction and facility operation. The process has basic components as summarized in **Exhibit 1, *Risk Management Features and Questions*.** Each component has a corresponding simple question that can help identify options for how to address that component. Integration of the risk management into PennDOT's project development process is presented in **Section AG.4**.

Risk Management Feature	Simple Question
Risk Management Scalability	What's the **appropriate level of risk management which can be cost effectively applied** for this project?
Risk Identification	What risks might **negatively or positively** affect achieving the project objectives?
Qualitative Risk Analysis	What is the **likelihood** of risk occurrence and level of **impact** of a risk occurring in descriptive or qualitative terms of high, moderate, and low?
Quantitative Risk Analysis	**How** could a risk affect the project in terms of **cost and schedule**?
Planning and Response	**What** can be done to mitigate the risk?
Ownership and Communication	**Who** will be responsible to manage risk, follow up on mitigation actions and coordinate and communicate?

EXHIBIT 1, RISK MANAGEMENT FEATURES AND QUESTIONS

AG.1.B. Risk Management Objectives

PennDOT's objectives for adopting a formal risk management approach include:

- Enhance project team communication regarding risk identification and monitoring;
- Improve project performance by anticipating, managing and mitigating risks;
- Expand project team understanding resulting in fewer surprises;
- Enhance project management and risk management culture;
- Manage public expectations;
- Integrate risk identification with initial project planning;
- Strengthen communication between planning partners, Districts and Central office;
- Improve estimates of project budgets, milestones, and contingencies; and
- Allow better cash flow predictability, balance of let dates, and management of TIP (Transportation Improvement Program).

While risks are typically discussed throughout PennDOT projects, generally documentation and management of those risks is informal. The process of risk management involves formal documentation of risks, assessing likelihood and impact of each risk, establishing the proactive actions to accommodate the threat or opportunity, and monitoring and updating status of the list of risks throughout all phases of a project. This documentation is readily captured in what is called a *Risk Register* that is created early in the project development process. The register should be maintained and monitored throughout the project's life to realize the most benefit.

AG.1.C. Benefits

Risk Management Benefits

- Reduce potential for cost overruns
- Increase on-time delivery
- Fewer surprises

PennDOT's risk management process provides enhanced fiscal management for the planning, design, and construction and system operations programs. Through this process, PennDOT can better predict cash flow needs, balance let dates, maintain the TIP effectively, and system management and preservation. Additionally, important project delivery benefits, such as reducing the potential for cost overruns and increasing the likelihood of on-time delivery through better management, will generally result in fewer surprises.

The Project Team Includes	
Planning Partner (MPO or RPO) Project Stakeholders Planning and Programing Engineer Portfolio Manager Project Manager Design Team Environmental Manager Bridge Engineer	Traffic EngineerTraffic Engineer Geotechnical Engineer Storm Water Management EngineerEngineer Right-of-Way Personnel Utilities Personnel Construction ACE Other Specialists as Required

The PennDOT risk management process includes a simple to use tool, optimizes project performance, and ensures that the process becomes a foundation for successful project management. Through its execution, risk management will be a foundation for successful project management and team collaboration. This collaboration of the various disciplines on the project team is essential so that 1) potential risks are not overlooked, and 2) experienced team members provide an appropriate assessment of risk probability and impact.

PennDOT's Risk Management approach features and benefits are summarized in **Exhibit 2, *Features and Benefits***.

Feature	Benefit
Scalable Approach	The appropriate level of risk management including the level of risk analysis and mitigation is applied based on project size and complexity.
Team	Risk management is based on a prioritization of risks. The expertise of team members is leveraged by having the team identify and assess the risks, as well as identify mitigation strategies within the functional area of their expertise (e.g., design, construction, right-of-way, regulatory permits, drainage, utilities, hydraulics, geotechnical, etc.)
Risk Manager	A Risk Manager is an assigned position on a Complex, high dollar value project (see **Exhibit 3, *Risk Management Level Selection***) to assist the project manager in the development and implementation of the project risk management plan.
Ownership of Risks and Responsibilities	A risk owner is a person or entity (e.g., work unit) that has been given the authority, responsibility, and resources to manage a particular risk and is accountable for doing so**.** This assignment should be made based on who is best able to manage that risk. Risk owners support the project manager/risk manager in risk monitoring and implementation of a selected response. It should not be assumed that risk manager does all the work to manage the risk; but rather serve as a process facilitator.
Risk-Based Decision-Making	Project values such as cost, schedule, and quality should be balanced when making decisions. This practical focus results in a need to have a formal risk management program with objectives to improve project performance (cost, schedule, disruption and longevity).

EXHIBIT 2, FEATURES AND BENEFITS

AG.2 Risk Management Levels, Responsibilities, and Project Integration

This section provides information on PennDOT's approach to a scalable risk management process, who is responsible for risk management on both a project level and Department level, and how risk management is integrated with PennDOT's project development process. The objectives include:

- Providing a consistent methodology for performing project risk management activities;
- Providing techniques and tools for project risk management; and
- Providing information on how project risk management fits with the overall project management process at PennDOT.

AG.2.A. Risk Management Levels – Scalable Approach

PennDOT's risk management process is inherently scalable based on project complexity, which is defined in Publication 10, DM1, Chapter 2. These complexities (Minor, Moderate, and Major) help determine the depth of risk assessment and the appropriate level of risk management in terms of both the number of potential risks captured on a risk register (i.e., fewer for a minor project) as well as the amount of assessment and analysis required.

The PennDOT risk management process includes three levels of risk management based on project complexity and is cross referenced with approximate cost. Level 1 entails the basic level of risk management where the team can select from a list of common risks or add risks not found on the level 1 register. Levels 2 and 3 require a greater level of risk management, but differ in the type of analysis required (qualitative or quantitative).

Exhibit 3, *Risk Management Level Selection*, details the levels of risk management along with the strategies and tools that facilitate each level. A correlation of the risk management process steps for each level of risk management is provided in **Section AG.3**.

Risk Mgmt Level	Complexity*	Project Cost (all phases)	Risk Strategy and Tools	Risk Manager
1	**Non-complex**	<=$5M	Level 1 Register Recommended	Project Manager
		$5M-10M	Level 1 Register	Project Manager
	Resurfacing or preventive maintenance	<=$30M	Level 1 Register Recommended	Project Manager
		>$30M	Level 1 Register	Project Manager
2	**Non-complex**	>=$10M	Level 2 Register, **Qualitative** Analysis, Risk Response	Project Manager
	Moderately Complex	<=$10M	Level 2 Register, **Qualitative** Analysis, Risk Response	Project Manager
3	**Moderately Complex**	>$10M to $100M	Level 3 Register, **Quantitative** Analysis, Risk Response	Project Manager
	Major Complex	<=$25M	Level 3 Register, **Quantitative** Analysis, Risk Response Risk Management Plan (recommended)	Project Manager
		>$25M to $100M	Level 3 Register, **Quantitative** Analysis, Risk Response Risk Management Plan	Assign a Risk Manager or establish assistance within project team
		>$100M	Conduct Risk Workshop FHWA Risk Management Tool or Level 3 Register, **Quantitative** Analysis, Risk Response Risk Management Plan	-Assign Risk Manager -Consider scope of work for project consultant to provide information for the workshop -Establish Risk Management Team

EXHIBIT 3, RISK MANAGEMENT LEVEL SELECTION **Complexity Levels are defined in DM1, Chapter 2.*

AG.2.B. Roles and Responsibilities

Risk management requires effort, teamwork, and forward-thinking. It must be planned, resourced, and facilitated to provide accurate analyses and defendable decisions. For most small projects, the Project Risk Management is typically the responsibility of the Project Manager. However, this responsibility could be an assigned position, or an exclusive position based on the project size, complexity, and cost. **Exhibit 4, *Project Level Risk Roles and Responsibilities*** and **Exhibit 5, *PennDOT Management Level Risk Roles and Responsibilities*** provides the basic team member and PennDOT management roles and responsibilities. It is a useful guide, but is not intended to limit how risk management might be accomplished or adapted on all projects. The key is to ensure risk management is established for a project and then monitored and updated throughout the project.

Position	Roles and Responsibilities
Project Manager / Risk Manager	• Promote and facilitate risk management for the project; • Coordinate project team meetings to develop the project's risk register and develop and implement the Risk Management Plan; • Track, monitor, and update risks and the effectiveness of risk response actions. ✓ Ensure proactive response to all risks and opportunities that will impact the successful delivery of the project. ✓ Ensure quality of the risk data in the risk register. ✓ Produce risk management reports including risk management results, major issues, and concerns for Department management • Incorporate risk management into project meetings; and • Elevate issues to district management for resolution as necessary. • Encouraging risk management learning among team members from one project to the next (building on what works well and adjusting that which may not)
Project Team Members	• Assist Project Manager /Risk Manager with the identification, assessment, and monitoring of risks; • Suggest appropriate risk response strategies; • Assist in identifying risk owners and developing risk response strategies; and • Perform risk response steps when appropriate.
Risk Owner	• May be a project team member, district discipline lead, or other project stakeholder including local stakeholders; • Assess and suggest appropriate risk mitigation strategies and action plans for assigned risks; • Develop and/or update the identified risk strategy; and • Inform the Project Manager if the risk becomes a real event. Events that have occurred are no longer risks.
District Risk Management Coordinator	• Provide expertise, guidance, and assistance to the Project Manager / Risk Manager; • Assist and coordinate with the Portfolio Manager in obtaining expert services as needed; and • Interface with Central Office.

EXHIBIT 4, PROJECT LEVEL RISK ROLES AND RESPONSIBILITIES

Position	Roles and Responsibilities
Project Team	Participants can include Project Manager, Risk Manager, Project Team Members and Risk Owners. **Monitor, review, update** - Risk monitoring and periodic review and update tasks required input from the various positions: • Identify, analyze, and plan response actions for newly arising risks, and add them to the risk register; • Assign additional risk response actions to the Risk Owner; and • Retire (change status from Active to Retire) risks whose opportunity to impact the project has elapsed, or whose residual impact on the project is deemed to have reached an acceptable level. • Reviews value/benefits from risk management following project completion, identifying and sharing lessons learned
District Design Management	District Design Management can include positions including the Portfolio Manager, Plans Engineer, Design Services Engineer • Support Project Manager with the implementation of risk management requirements; • Provide risk management direction and assistance; • Coordinate with BOPD (Bureau of Project Delivery) to obtain expert risk management services, as needed, and • Consult with the Project Manager on significant risk management issues.
Chief, Highway Delivery Division	• Leads, champions, sponsors and implements risk management at program level by developing and maintaining policies, guidance, procedures, practices, training and expertise; • Provides Central Office risk management coordination; • Supports the District Risk Management Coordinators; • Ensures consistent application of risk management practices; and • Facilitates procurement of risk management specialists as needed.
District Executives	• Ensure that risk management is followed; and • Appoint District Risk Management Coordinator. • Recognize team and individual risk management accomplishments and significant progress
ADEs (Asst. District Engineer)	• Ensure risk management has the resources required to achieve the desired results; • Ensure Project Managers comply with risk management policies; • Ensure risks are communicated; and • Approve exceptions to project risk management requirements.

EXHIBIT 5, PENNDOT MANAGEMENT LEVEL RISK ROLES AND RESPONSIBILITIES

Project Integration

Risk management is an integral component of project management that will help the project manager to better assess and manage key project performance factors. While the formalized approach requires development and maintenance of a risk register, the register becomes a key communication tool to efficiently focus attention on individual risks. Through this sharp focus, risks are controlled so that informed decision making can be provided in a timely manner.

How can you manage a project without managing the risks?

Although risks can and should be discussed with project team members and management at any time during the duration of a project, it is desirable to have "checkpoints" to ensure the project does not unnecessarily proceed on a course of action that may not be feasible and may be changed later by a decision-maker. Thus, integrating risk management into the project development process becomes critical, valuable, and time saving. **Exhibit 5, *PennDOT Management Level Risk Roles and Responsibilities*** provides an outline for integration.

Integrating risk management requires developing an initial risk register as early in the project as feasible, monitoring and developing mitigation strategies for each risk by the assigned risk owner, and discussing the risks at project meetings and when project discipline leads can most effectively discuss and address risk coordination. **Exhibit 6, *Project Risk Management Integration*** provides opportunities within PennDOT's project development process phases where risk management should be incorporated.

Project Phase	Risk Integration
Planning	If project complexity is unknown consider the level 1 register to supplement PennDOT Connects and NEPA screening process, and consider risk mitigation strategies. Communication with local municipalities per PennDOT Connects may help to identify unforeseen risks.
Programming (TIP development)	Risk management tool (especially quantitative analysis) can help project team validate the estimated cost and schedule
Scoping	Risk management can be used to evaluate and support the alternatives analysis
Design Field View	Look to integrate potential risks that are identified in the cost-driver analysis for estimating, construction schedule issues, and constructability review output.
Final Design	Look to integrate potential risks that are identified in the cost-driver analysis for estimating, construction schedule issues, and constructability review output.
PS&E (Engineer's Estimate)	Many of the risks that would occur in the design phase should be retired by this phase.
Construction	The construction team should take a fresh look at any risks that were identified during the design phase and were categorized for occurring during the construction phase. Likewise, risks could be identified and categorized for potential occurrence during the maintenance phase.

EXHIBIT 6, PROJECT RISK MANAGEMENT INTEGRATION

- Create the initial risk register through a Team brainstorming discussion during or immediately after the Scoping Field View. Planning Partners may have developed a planning level risk register as part of Linking Planning and NEPA. This list should be incorporated into the initial design risk register.

- Include project risks as a regular agenda item for project meetings so that mitigation strategies can be incorporated into the project holistically. Remember that the risk register is a living document where risks can be added, along with the appropriate risk owner, and retired as necessary.
- Perform a formal review of the risks as part of the Design Field View, Constructability Review, and the Final Design Office Meeting. The expectation is that functional disciplines are already in attendance at these major milestone meetings and can provide input and perspective for discussions involving risk. This could include a short team brainstorming to make sure there are no new risks or retire those risks that did not occur.
- Components of risk management are already included in other PennDOT project processes such as the cost estimation and cost-driver analysis (Publication 352), scheduling (Publication 615), constructability reviews (Publication 1X), and value engineering (Publication 1X).
- Risk management can be performed by external experts or internal staff.

How to Incorporate Risk Management into a PennDOT Project

The process to incorporate risk management into a PennDOT project consists of a series of steps, which are applied at the outset of the project and verified throughout the project. The major process steps are illustrated in **Exhibit 7, *Risk Management Process Overview*.** Detailed information on the Risk Management Process is provided in **Section AG.3, *Risk Management Process***.

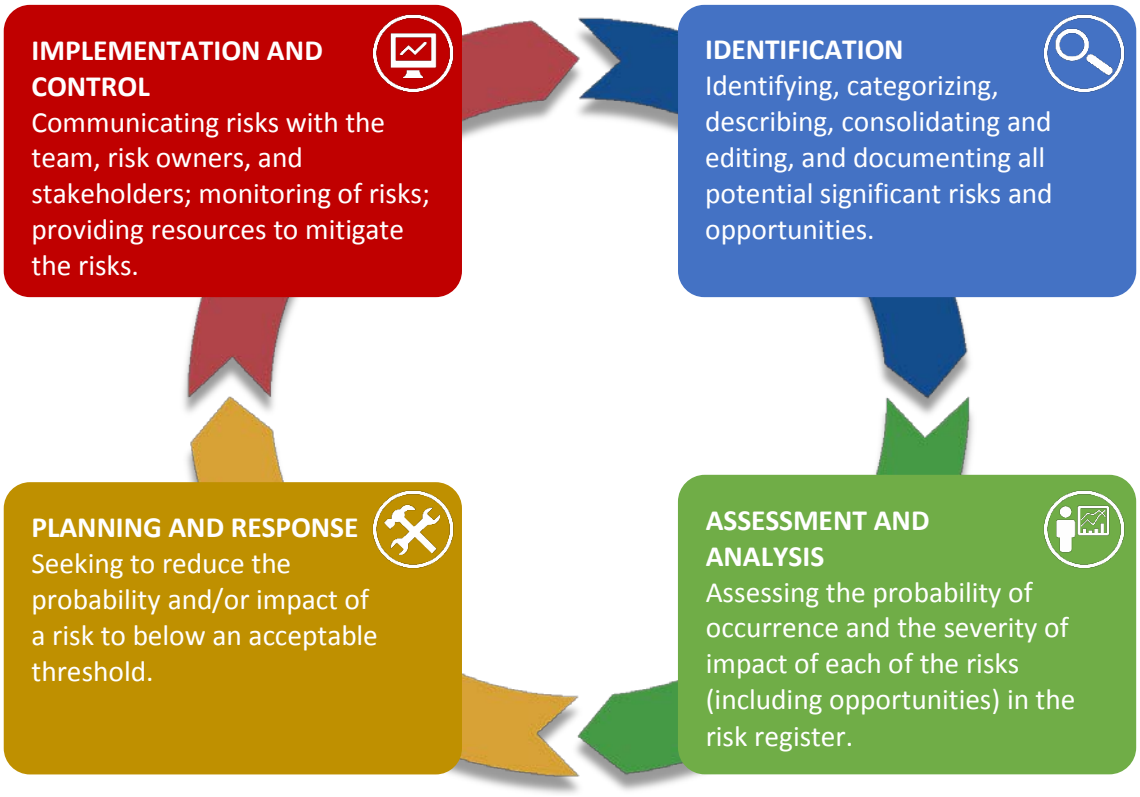

EXHIBIT 7, RISK MANAGEMENT PROCESS OVERVIEW

AG.2.C. Risk Management Tools

The key to successful risk management implementation is the ability to utilize tools that are easy to understand and can be applied to highway projects of varying sizes and types to help proactively identify, plan for, assess, and manage project risks to meet schedule and budget goals. The tools for PennDOT's risk management were developed to meet the scalability requirement levels as shown in **Exhibit 3, *Risk Management Level Selection***.

The recommended levels are to be understood as minimum requirements. The project team may choose to work at a higher scalability level than required. However, the project team should consider other factors to determine what level of risk management effort is needed. These factors may include:

- Project type
- Project location and the community it serves
- Project duration
- Project stakeholders
- Political sensitivity

Any of these factors may warrant employing a higher scalability level.

Two tools are provided to assist in the identification, analysis, planning and implementing a plan for risk management. The current Excel version of the risk management tools are provided in the ECMS file cabinet (select top menu ->References, then drop down-> File Cabinet) http://www.dot14.state.pa.us/ECMS/SVCOMFileCabinet?action=SEARCH, Folder _ _ _ - Risk Management.

PennDOT Risk Management Template

The PennDOT Risk Management Template is a risk analysis tool for non-complex, moderately complex, and some major complex projects. Level 1, (**Level 1 Analysis, *page 29***) entails the basic level of risk management with a risk list provided to assist with risk identification. Levels 2 and 3 provide a more detailed level of risk management, but differ in the type of analysis required. Level 2 (**Level 2 Analysis, *page 31***) is typically a qualitative analysis, while the Level 3 is quantitative, providing the opportunity to further define risk impacts in terms of dollars for the budget and days for the schedule. To facilitate convenient data entry, the Excel spreadsheet contains drop-down menus for data selection where applicable, calculations for risk scores, pop-up explanations of data fields, and a guidance worksheet. The template, over time, will help foster good risk management habits and thinking.

Section AG.4, *How to Use the Appropriate Risk Management Tool*, describes how each risk management step can be accomplished and documented by the risk management tool.

FHWA Risk Management Tool

The FHWA risk management tool contains additional features to support a complete risk management planning process. Features include project structuring and cost-benefit analysis for selection of risk responses. This tool is recommended for the complex project which contain a substantial number of risks that can have significant detrimental impact on a budget and schedule. Using this tool will require up front planning and a two-day team charrette, which needs to be accounted for during contract development. While the FHWA tool may also be used and scaled down for non-complex and moderately complex projects, training or consultation with personnel that have experience with the FHWA tool is recommended.

AG.3 Risk Management Process

Exhibit 8, *Risk Management Process*, provides a description for each step in the risk management process. Each step is then explained in greater detail in this section.

Step	Description
Define Project Base	• Define the "base" project scenario against which threat and opportunity can subsequently be identified, assessed, and eventually managed.
Identification	• Identify a comprehensive set of threats and opportunities. This is accomplished by brainstorming scenarios that might change the base project performance. This is also a useful way to temper overly optimistic project planning tendencies. • Categorize each risk by the phase that risk might occur.
Assessment and Analysis	• Assess the "severity"" of each of the threats and opportunities in the risk register, and then prioritize them on that basis. • Generally accomplished by subjectively assessing the risks (i.e., the probability of the scenario occurring and what are the impacts if it does) and then analytically combining the risks to determine changes in performance measures and thereby severity. • Analytically combine the base and risks to determine the project performance measures (e.g., ultimate project escalated cost and schedule).
Risk Management Planning and Response	• Identify and evaluate possible ways to proactively reduce risks and exploit opportunities, focusing on the most severe. • Evaluate each possible action in terms of its cost-effectiveness, considering changes in both base factors (e.g., additional cost) and risks (e.g., reduced probability), and select those that are cost-effective. • Consider subsequently re-analyzing the project performance measures for this risk mitigation program, based on which budgets and milestones can be established.

Risk Management Implementation and Control	• Implement the Risk Management Plan as the project proceeds by monitoring the status of risk mitigation activities and changes in risk and monitoring budget and milestones, especially with respect to contingencies.
	  ✓ This might involve periodic updates at regular intervals or at major milestones or changes.
	  ✓ Example: contingencies might be reduced as engineering reports or designs are completed and risks are avoided or mitigated.

EXHIBIT 8, RISK MANAGEMENT PROCESS

AG.3.A. Initial Project Risk Management Meeting

At the outset of each project, a Project Risk Meeting will be held independently or in conjunction with the project kick-off meeting or Scoping Field View. The first time that the Project Team Members meet, the Project Manager should brief the team on the following:

- ✓ The importance and objectives of the project risk management process;
- ✓ The roles and responsibilities;
- ✓ The risk register;
- ✓ The communication check points;
- ✓ Key risk management activities in the project schedule; and
- ✓ The expectation that risk will be managed, documented and reported via a formal process.

The team will identify what events might occur and thus change the project relative to the base conditions. The threats and opportunities are then listed in the risk register for later risk management activities.

AG.3.B. Define Project Base

Preparing project information for risk management is a necessary and valuable first step in the risk management process. It provides the "base" for identifying threats and opportunities, assessing them, and eventually managing them. It also documents the current state or base line for future reference. Information needed to define the base includes:

- Brief Project Description
- Project Scope, Strategy/Status, and Key Conditions and Assumptions
- Initial cost estimate without contingencies
- Initial design and construction schedules
- Project "Disruption" Estimate

Define Project Base
Defining the project base requires a baseline schedule and cost estimate without contingencies so that the project team can easily separate and compare the base from potential project risks.

Formally, this process is called Structuring. Structuring can help facilitate subsequent risk identification and assessment (especially when a risk is already considered and addressed in the base conditions). For example, if a complex right-of-way issue is already accounted for by an appropriate design schedule, then what might be considered a schedule risk is already a part of the base project conditions and should **not** be considered as a risk. By understanding the structuring of the project, risks can more easily be identified for either qualitative or quantitative risk assessments.

AG.3.C. Identification

Risk identification is an essential step in the risk management process. It determines what might happen that could affect the objectives of the project and how those things might happen. It produces a deliverable — the project risk register – that documents the risks and their characteristics. The risk register is subsequently strengthened through the qualitative or quantitative risk analysis, risk response, and risk monitoring processes. Risk identification is an iterative process because new risks may become known as the project progresses through its life cycle, previously-identified risks may drop out, and other risks may be updated. Great teams ask frequent "what if" questions—this is no different.

A challenge in risk identification is avoiding confusion between **causes** of risk, the actual risks, and the **effects** of risks. A risk may have one or more causes and, if it occurs, one or more effects.

- ***Causes*** are definite events or circumstances in the project or its environment, which give rise to uncertainty. Examples include the need to use an unproven new technology or the lack of skilled personnel. Causes themselves are not uncertain since they are facts or requirements, so they are not the primary focus of the risk management process.
- ***Risks*** are uncertainties which, if they occur, would affect the project objectives either negatively (threats) or positively (opportunities). Examples include the possibility that planned completion targets might not be met, escalation rates might fluctuate, or that requirements may be misunderstood.
- ***Effects*** are unplanned variations from project objectives, which arise as a result of risks occurring. Examples include early milestone completion, exceeding the authorized budget, or failing to meet agreed quality targets. Effects are contingent events, unplanned potential future variations which will not occur unless the risks happen. As effects do not yet exist, and they may never exist, they cannot be managed directly through the risk management process. Including causes or effects in a list of identified risks obscures genuine risks, which may then not receive the appropriate degree of attention they deserve.

One way to clearly separate risks from their causes and effects is to use a description with required elements to provide a **three-part structured "risk statement":**

"As a result of ____(cause), ____(risk) may occur, which would lead to ____(effect)."

Examples Include:

- "As a result of using a new technology (a definite requirement), unexpected design problems may occur (an uncertain risk), which would lead to overspending on the project (an effect on the budget objective)."
- "Because our District has never done an interchange project like this before (fact = cause), we might misunderstand the requirements (uncertainty = risk), and our project would not meet the performance criteria (contingent possibility = effect on objective)."

At the risk identification stage, the impacts on cost and time are not analyzed – this analysis occurs later through either a qualitative or quantitative assessment.

Risk Register Development

A risk register is a tool that project teams can use to document and address project risks throughout the project life cycle. It is a living document – a comprehensive listing of risks and the way they are being addressed as part of the project risk management process. The risk register is maintained as part of the project file that also includes information related to uncertainties in the cost estimate and schedule.

Why use a risk register? - A new project team is formed for every project and disbanded when the project is complete. Also, project team members sometimes change, and the project experiences change over the duration of the project. Communication among project team members about the project objectives, costs, risks, etc., is vital. The risk register communicates project risks and helps the team members understand the status of the risks as a project moves from inception to completion.

How is a risk register used? - A risk register is best used as a living document throughout the project's entire life cycle, from project inception through construction, to record the evolution of project risks. There is no prescription for how extensive a project's risk register should be. The project team should decide the most beneficial use of the risk register, with the shared objective of minimizing the risk impact.

Managers should use the risk register as a management tool to provide a framework for reviews and updating that identifies, assesses, manages, and reduces risks (and exploits opportunities)to acceptable levels. Managers should also use risk registers for learning and application for future projects.

How is a risk register developed? – Development of the risk register, as well as the entire risk management process, is a Team process. The Design Project Manager initiates and "owns" the project risk management process until the project is moved to construction. The Project Manager should involve all functional design units, along with input from construction, in the risk management process from inception to hand-off to the construction team for their information.

Additionally, communication and consultation with project stakeholders is a crucial factor in developing and updating the risk register. It helps everyone to understand the risks and trade-offs that must be made in a project. This communication ensures that all parties are fully informed, and thus avoids unpleasant surprises and unreasonable expectations. The actual risk register is developed by the Team members in a brainstorming session either during or after a field view.

Identifying potential risks (threats and opportunities) can use any combination of the following:

- Challenging of assumptions (i.e., don't assume everything will go as planned),
- Looking for "newness" (e.g. new materials, technology, or processes),
- Knowledge of the project or similar projects (consider referring to past risk registers for similar projects),
- Consultation with others who have significant knowledge of the project or its environment,
- Consultation with others who have significant knowledge of similar projects, and
- The experience of project stakeholders or others in the organization.

When to monitor and update the risk register
• TIP Development (or possibly as early as a planning study) • Scoping Field View • Design Field View • Constructability Review • Value Engineering • FDOM or 90% Plans • Project Status Meetings

The information is entered into the risk register spreadsheet. Each risk is assigned to a member of the project team who becomes its Risk Owner. This fosters a greater understanding and awareness of all risks among the entire team.

The risk register is reviewed and updated throughout the project. Risk registers are developed for all three levels of risk management. Each risk register should be prepared as the initial cost and schedule estimates of a project (at Planning/Programming) are developed.

Application to Different Risk Management Levels

Level 1 - Since Level 1 projects contain minimal risks, the Team can start by brainstorming risks and reviewing and selecting applicable Level 1 risks. These basic risk statements can be further clarified or comments added within the PennDOT tool based on the project. The risk register layout within the PennDOT tool is presented in **Exhibit 14, *Level 1 Risk Register Development***.

Levels 2 and 3 - For Levels 2 and 3 risk management, risk identification involves Team members brainstorming and developing a risk statement that contains the causes and effects encountered for each risk. The risk statements are described in section 3.C. While this approach takes more effort than the Level 1 risk identification, a proper risk statement helps the Team to better assess the risk, develop a response to the risk, and to understand the original intent when the Team reviews the risk register later in the project. Note that the Level 1 Risk Register can also be reviewed for potential risks that were not identified by the project team members.

Risk Identification Methodology

The basic risk identification methodology is described in the following process.

1) Circulate base information to the participants beforehand to ensure participants in risk identification are already familiar with the project scope, strategy, conditions, and assumptions. This will promote more effective discussion and proactive thinking during the risk identification exercise.
2) Before the actual risk identification exercise, ask each expert to document his or her issues or concerns. This helps to ensure participant buy-in and subsequent consensus. In a facilitated meeting or workshop environment with the experts (PennDOT and external experts as necessary), have a qualified facilitator lead the identification of risks, minimizing bias. This is generally done by:
   a) Analysis (e.g., evaluation of scope, key assumptions and conditions, and project strategy or project phase); and
   b) Then, through group brainstorming (e.g., existing concerns of project team and reviewers, issues identified during structuring, and judgment or experience from other similar projects); and
   c) Finally, through comparison with the Level 1 Risk Register. After preliminary brainstorming and developing a list of risks based on the knowledge of the Team members, the Level 1 risks can be used to add any additional risks that may have been overlooked. Reviewing the Level 1 risks serves as memory prompts or shopping lists of issues that have been observed on other projects.

      Note that this review of the Level 1 risks should only be used after the brainstorming and analysis to avoid prepopulating a risk register and therefore stifling creativity and jeopardizing buy-in.

AG.3.D. Risk Assessment and Analysis

After identifying risks and opportunities, the next step is to understand the importance that each risk and opportunity has on the project's performance measures. By assessing the "severity" of each risk an action plan can be developed which assists in making better project decisions.

Qualitative vs. Quantitative
Qualitative - Prioritize risks for further analysis or action by assessing probability of occurrence and impact (low, medium, high).
Quantitative - Analyze the effect of identified risks on overall project objectives with values for cost and schedule impacts.

To assess the "severity" of each risk in the *risk register*, and then prioritize them on that basis is generally done by: 1) subjectively assessing the relevant risk factors (i.e., impacts if the scenario occurs and the probability of the scenario occurring), either qualitatively (e.g., "high" vs. "low", where these descriptors are quantitatively defined by ranges of values) or quantitatively (in terms of mean-values or, for quantitative risk analysis, full probability distributions); and then 2) analytically combining the risk factors to determine changes in project performance measures and thereby severity.

Level 1, 2 or 3-Risk Identification	
Complete the information in the following risk register columns	
Column	**Contents**
Status	Select "Active" or "Retired." A risk is retired when it has no further possibility of impacting the project.
ID #	Enter a unique identifying number for the risk.
Risk Type	Enter either a "Threat" or an "Opportunity,"
Category	Select one of the categories for the risk. (Environmental, Design, ROW-RR-Utilities, Construction, Organizational, PM, External)
Risk Factor or Title	Provide a descriptive title for the risk.
Description	Write a complete description of the event and its potential impacts on the project if this risk were to occur. See Section 3-2 for the structure of the risk statement.
Current Status/ Assumptions	If applicable, describe what we currently know about the risk and any assumptions made.
Risk Owner	Enter the name of the Team member responsible for this risk.
Updated	Enter the date the risk was identified.

EXHIBIT 9, RISK REGISTER COLUMNS AND DESCRIPTION

Level 1 – Risk Register

While the assessment and analysis for Level 1 is not as intensive as Levels 2 and 3, the project team should still consider and weigh potential impacts on cost and schedule, then determine which risk to assign to an owner to monitor and mitigate.

Level 2 - Qualitative Risk Analysis

Qualitative risk analysis, for Level 2 projects, includes methods for prioritizing the identified risks for further action, such as risk response. This analysis assigns a Risk Rating to each risk in the risk register. The risk ratings help to determine where the greatest effort should be focused in responding to the risks. They facilitate structured risk response action and resource allocation. The three ratings for Level 2 projects are:

- "High" –Priority for risk response.
- "Medium" – Risk response as time and resources permit.
- "Low" – No risk response required at this time.

Why is the Qualitative Analysis used? - *Qualitative* analysis involves characterizing the likelihood and consequences in terms of non-quantitative ratings. A risk might be assessed to have a High (H) likelihood of occurrence and a corresponding Medium (M) cost impact and Low (L) schedule impact if it occurs along with a numerical ratings (e.g., 1 through 5). On the benefit side, qualitative assessments may be relatively quick to conduct and provide a simple visual rating (depending on the method used).

Drawbacks of qualitative assessments can include the following:

- Ratings can be vague, if qualitative ratings are not tied to specific values (e.g., what does a "High" likelihood of occurrence really mean?). As a result, different people can interpret qualitative ratings in different ways, which might lead to inaccuracies or problems in developing consensus. This underscores the importance of experience, good judgement, and team discussion.
- If the ratings (e.g., for likelihood and consequence) are not combined, then no overall measure of the risk is possible, which means that the register of risks cannot be ranked or prioritized.

How is the Qualitative Analysis performed? - Qualitative risk analysis for Level 2 projects entails assigning a risk rating to each risk in the risk register. The risk ratings for probability and impact can then be combined for an overall risk ranking (based on risk severity). The risk rankings determine where the greatest effort should be focused in responding to the risks. They facilitate structured risk response action and resource allocation. The overall ranking for each risk is then used to prioritize mitigating actions.

Risk Matrix						
Probability Rating	5 – Very High					
	4 – High					
	3 – Moderate					
	2 – Low					
	1 – Very Low					
		1 Very Low	2 Low	4 Moderate	8 High	16 Very High
		Impact Rating				

EXHIBIT 10, PROBABILITY AND IMPACT RATINGS

The risk matrix in **Exhibit 10** is used to determine the importance of each risk impact based on the probability and impact ratings. Each word descriptor of the rating has an associated number; the product of the probability number and impact number defines the risk score.

For a particular impact, the combination of the probability rating of the risk occurring and the impact rating positions the risk into one of the three colored zones in the risk matrix. The color of the zone indicates the priority of the risk for risk response: red zone signifies high importance, yellow is medium importance, and green is low importance.

For example, a risk having a "Moderate" probability and a "High" impact falls into the red zone. Its impact score is 3 x 8 =24.

When and Why is the Qualitative Analysis updated? - Team members revisit qualitative risk analysis during the project's lifecycle, typically at a project's milestones. When the Team repeats or revisits qualitative analysis for individual risks, trends may emerge in the results. These trends can indicate the need for additional risk management action on particular risks or even show whether a risk mitigation plan is working.

A description of how to input this information into PennDOT's Risk Management tool is presented in **Section AG.4**.

Level 3 - Quantitative Risk Analysis

Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. Quantitative analysis is based on a simultaneous evaluation of the impact of all identified and quantified risks.

This analysis starts with the projects schedule and its cost estimate. The degree of uncertainty in each schedule activity and each line-item cost element is represented by a probability distribution. The probability distribution is usually specified by determining the optimistic, the most likely, and the pessimistic values for the activity or cost element. This is typically called the "3-point estimate". The three points are estimated by the project team or other subject matter experts who focus on the schedule or cost elements one at a time. By evaluating the resulting cost and time estimates for each of these three estimate points, it is possible to answer such questions as:

- How likely is the current plan to come in on schedule or on budget?
- How much contingency reserve of time and/or money is needed to provide a sufficient degree of confidence?

Why is the Quantitative Analysis used? – As the number of project risks increases (Level 2 and 3 projects), the possibility of impacts to the project schedule and cost increases. A quantitative risk analysis is a further refinement to the risk management process which considers numerical values to develop a probabilistic scrutiny of the project. This analysis:

- Quantifies the possible outcomes for the project and assesses the probability of achieving specific project objectives,
- Provides a quantitative approach to making decisions when there is uncertainty, and
- Creates realistic and achievable cost, schedule or scope targets.

How is the Quantitative Analysis performed? - The project risk manager leads the project team in quantifying cost and schedule risks by developing the "3-point estimate".

- The probability of the risk occurring is expressed by two values: "Low" and "High" that cover the range.
- Three-point estimates are used for cost and schedule impacts. The three-point estimate consists of determining the "Low" (optimistic), "High" (pessimistic) and "Most Likely" values for the cost and time. The most likely value may be omitted if it cannot be established credibly.

The cost impacts include direct costs only; they exclude any cost of delay. Schedule impacts are expressed in days of potential delay due to the risk. Some risks may not have both cost and schedule impacts.

A description of how to input this information into PennDOT's Risk Management tool is presented in **Section AG.4**.

When and Why is the Quantitative Analysis updated? - Team members revisit quantitative risk analysis during the project's lifecycle. When the Team repeats quantitative analysis for individual risks, trends may emerge in the results. These trends can indicate the need for additional risk management action on particular risks or even show whether a risk mitigation plan is working.

AG.3.E. Risk Planning and Response

Risk planning and response is the process of developing strategic options, and determining actions, to enhance opportunities and reduce threats to the project's objectives. As described in **Section AG.2**, a project team member is assigned to take responsibility for each risk response. This process ensures that each risk requiring a response has a known owner monitoring the responses, although the owner may delegate implementation of a response to someone else.

Risk Response Strategies

Risk response consists of specific options that are available during a particular project development phase to recover project cost or schedule. Typically, each such option is available only through that particular project phase, and then is no longer available, or its recovery value is substantially reduced, after a particular point. Thus, the risk response is a decision point/strategy to *avoid, transfer (allocate), mitigate, or accept* a project risk. Also note the equivalent strategies for opportunities (i.e., *exploit, share, and enhance*). **Exhibit 11, *Risk Response Strategies*** includes definitions for each of these risk response strategies. **Section AG.5.B.** provides Risk Response Examples. Some actions may use more than one of these strategies. The intent of using these strategies is to spur the development of possible risk management actions.

Implementation of these efforts will require resources (e.g., additional design hours, additional coordination efforts, use of more expensive materials). The results of the management actions will be mitigation of the probability of occurrence of a risk and/or a reduction in the impact. For an opportunity, increase in the probability and impact.

For Threats	For Opportunities
Avoid. • Remove threat cause or change project approach. • Not all threats can be avoided or eliminated, and for others, this approach may be too expensive or time-consuming.	***Exploit.*** • Exploit is an aggressive response strategy, best reserved for those "golden opportunities" having high probability and impacts.
Transfer. • Find another party willing to take responsibility for its management and bear the liability of the threat should it occur. • Ensure that the threat is owned and managed by the Team member or stakeholder best able to deal with it effectively. • Usually involves payment of a premium, and the cost-effectiveness of this must be considered.	***Share.*** • Allocate ownership of an opportunity to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does occur. • Allow sharing in the potential benefits (e.g. Construction Value Engineering Proposals).
Mitigate. • Reduce the probability and/or impact of an adverse event (threat) to acceptable threshold. • Take early action to reduce the probability and/or impact of a threat is often more effective than repairing damage after risk has occurred. • May require resources or time and is a tradeoff between doing nothing versus mitigation cost.	***Enhance.*** • Modify the "size" of the positive risk. • Increase probability and/or impact, and maximizing benefits realized for the project. • If the probability can be increased to 100 percent, this is effectively an exploit response.
Acceptance. • When it is not possible or practical to respond to the risk by the other strategies, or a response is not warranted by the importance of the risk. • When the project manager and the project team decide to accept a risk, they are agreeing to address the risk if and when it occurs. • A contingency plan or workaround plan may be developed for that eventuality.	

EXHIBIT 11, RISK RESPONSE STRATEGIES

Risk Assessment Bias

Bias must be recognized and addressed. The goal of risk-factor assessment is to obtain accurate, defensible assessments. As mentioned previously, subjective assessments are usually required to assess risks (likelihood of occurrence and impact) but are subject to bias. Bias essentially comes in two forms (Roberds, 1990):

- "Motivational bias" occurs when someone says something that contradicts what they believe. This bias can be difficult to detect and counter but is often present when participants have a high stake in a project's continued survival or other conflict of interest. It can also occur when experts intentionally inject some conservatism into their assessments or intentionally exclude some scenarios.
- "Cognitive bias" occurs when someone believes something that is inconsistent with the facts. Most people will overestimate what they know about a particular topic, which leads to over-optimism and to underestimating uncertainty.

Risk bias can be addressed by ensuring and facilitating open discussions with Team members during the assessment and encouraging participants to share the basis and assumptions of their input. Project teams tend to be overly optimistic in the early phases of project development. Risk management helps to temper or tamp down this natural tendency.

Responding to Risks

Following identification and analysis of project risks, the project team acts in response to the risks to improve the odds in favor of project success. Ultimately, it is not possible to eliminate all threats or take advantage of all opportunities – but they will be documented to provide awareness that they exist and have been identified. Successful risk response will change/update the risk profile through the project life cycle, and risk exposure will often diminish. Risk response involves:

- ***Prioritizing*** and determining which risks warrant a response and identifying which strategy is best for each risk;
- ***Assigning*** an action to the Risk Owner to identify options for mitigating the probability or impacts of each threat or increasing the probability/impact of an opportunity. The Risk Owner takes the lead and can involve experts available to the project;
- ***Evaluating*** each option for potential mitigation of the risk and cost of implementing the option.
- ***Selecting*** the best option for the project;
- ***Adjusting*** project budget and schedule; justify changes for as necessary; and
- ***Assigning*** an action to the Risk Owner to execute the selected response action. The Risk Owner is the lead and may assign specific tasks to other resources to have the response implemented and documented.

If the project team judges that a risk should be accepted, it may assign an action to the Risk Owner to prepare a contingency plan if deemed necessary. Accepted risks should be communicated as necessary to higher levels of management, particularly when there is a "need to know".

Project Contingency

Even after proactive risk management, there will be residual risks, which PennDOT must accept and thus accommodate in the budget and schedule. Typically, this is done by establishing and controlling contingencies for cost and for schedule, over and above the base cost and schedule. These contingencies can be established at various levels of conservatism or levels of confidence in their sufficiency—the higher the level of conservatism, the higher the chance that the contingencies will be sufficient. However, the more funds that must be committed to the project means those funds are not made available for other projects. This underscores the need for a balanced approach, judgement, and big picture thinking.

AG.3.F. Risk Management Implementation and Control

The implementation and control of a Risk Management Plan consists of three main elements designed to optimize project performance:

1) plans for individual risk reduction actions;

2) protocols for contingency management; and

3) protocols for recovery plans.

Because project conditions, and hence risks, inherently change as a project moves through the development process, the Risk Management Plan is intended to be an evolving document, adjusting as the project develops. This in turn requires monitoring (e.g., of the progress and results of specific risk reduction action, of specific risks in the risk register, and of contingency) and periodic updating (e.g., of residual risks, of risk reduction plans, and of contingency requirements).

Risk Perspective Can Enhance Decisions

When considering risk mitigation methodology:

- Recognize the impacts of the decision;
- The impact of responding to a risk may make sense in the short term (e.g. Saves design costs, allows Team to meet schedule), but risk impact should be considered in context of the entire project.

For example, the impact of a few unknown conditions can affect construction where the window of an environmental activity requires the project to be suspended. While the direct cost to resolve an unknown condition may be less than the cost of a site visit, *the overall impact of the change may be a significant delay to the contract if not recognized.*

It is the risk manager who has the overall responsibility for implementing the plan. For small projects, Level 1 and 2, the risk manager might simply be the project manager, whereas for larger projects (which might require significant effort) it could be another person. The risk manager will then typically delegate responsibility for various elements of the plan to those who are in the best position to monitor and complete them. The risk manager will then follow-up to ensure that those delegated elements have been completed. This needs to be done as efficiently as possible to prevent wasting precious resources. For example, it is envisioned that risk management status will be incorporated into regular project status meetings. Similarly, risk management status should be incorporated into project status meeting minutes, and distributed in a timely fashion. Delegation and tracking should be as efficient as possible.

Risk Reduction Actions – A set of actions are specified for reducing individual risks. These actions must be successfully carried out to realize any risk reduction, although the actual amount of risk reduction, and typically to a lesser extent their cost and schedule to implement, will be uncertain beforehand. However, such actions can be adjusted (e.g., stopped) as their projected performance or need changes.

Risk Monitoring and Updating

Continuous monitoring by the project risk manager and the project team ensures that new and changing risks are detected and managed and that risk response actions are implemented and effective. Risk monitoring continues for the life of the project. Because project conditions, and hence risks, inherently change as a project moves through the development process, the Risk Management Plan is intended to be an evolving document (and strategy), adjusting and adapting as the project develops.

Risk Monitoring and Updating

Risk monitoring and updating should occur at project status meetings and at the following project development milestones:

- Scoping Field View
- Design Field View
- Constructability Review
- Value Engineering
- FDOM or 90% Plans
- Project status meeting

When and Why is the risk register updated? - Risk identification, and therefore maintaining the risk register, is an iterative process because new risks may become known as the project progresses through its life cycle, previously-identified risks are retired, and other risks may be updated. Risks change as the base project evolves, as conditions change, and new information becomes available. Eventually, each risk happens (and is mitigated) or does not happen (and can be "retired"). Generally, specific types of risk can only happen during specific project phases, after which they cannot occur. For example, a design risk will generally occur during the design phase, after which it can no longer occur. If the risk does not happen during design, its chance of occurrence drops to zero, and it can be "retired" after design. Thereafter, a review and discussion of the risk register at the beginning of each subsequent phase of the project is highly recommended.

Development of the Risk Management Plan

Developing a formal risk management document is a matter of documenting the process and decisions made throughout the process. As discussed previously, this is a living document which should be updated as the project progresses. Level 1 and 2 projects might use a risk register as the only formal Risk Management Plan, whereas Level 3 projects should have a formal Risk Management Plan following the outline provided in **Section 5.C**.

Level 3-What's in the formal Risk Management Plan? - The ***risk management plan*** report documents specific actionable items to deal with threats and opportunities. Additionally, it provides a consistent format for assigning and documenting these resources. The plan consists of management actions to:

- ✓ proactively mitigate specific high-priority risks;
- ✓ establish and maintain adequate budget and schedule to accommodate remaining risks; and
- ✓ modify the project as necessary if the established budget or schedule is inadequate despite proactive management actions.

Risk Management Plan Essentials

Answers the essential questions about risk management:

- Who will manage the risk?
- What will be done?
- When will it be done?
- How will they do it?
- What resources are likely to be required?
- What are the likely benefits?

A Risk Management Plan should contain the following items:

1. Introduction (brief project summary with respect to risk management and any notes relevant to project structuring, contingencies, and base assumptions)
2. Risk management strategy and approach
   a. Team member risk management roles and responsibilities (e.g., who is assuming the role of risk manager)
   b. Communication strategy (basic, what are the communication needs and how will each be met)
3. Risk register including
   a. Risk identification
   b. Risk assessment, and analysis
   c. Risk Response Planning (risk owners identified and responsible if a risk is triggered)
4. Implementation strategy (including risk monitoring and updating, information gathering and distribution)
5. Supporting documentation and reports (can include output from risk management workshops, meetings, etc.)

AG.4 How to Use the Appropriate Risk Management Tool

For development of a risk management assessment, PennDOT has included two tools. The first tool is an Excel template, initially developed be Caltrans and adapted to be PennDOT specific, which provides for the creation of the Risk Register (needed for Levels 1, 2, and 3 analyses), the Qualitative analysis (Level 2), and the Quantitative analysis (Level 3). Additionally, the FHWA Risk Management tool is provided for complex projects with many risks. It is recommended that this tool be used with the assistance of HDTS. These tools are in the ECMS file cabinet (select top menu ->References, then drop down-> File Cabinet)

http://www.dot14.state.pa.us/ECMS/SVCOMFileCabinet?action=SEARCH Folder _ _ _ - Risk Management.

Exhibit 12, *Risk Management Process and Levels* provides a correlation of the risk management process steps for each level of risk management.

Entering Data into the Risk Register

The sections below walk through the data entry process for the PennDOT risk management Tool for each of the risk management levels. Although the tool has separate tabs for the Level 1, 2, and 3 analysis types, creation of the Risk Register is the same for each and described only in the level 1 analysis.

Level 1 Analysis

Upon completion of the Risk Identification, the Team or project manager can start developing the risk register by completing the information in the following risk register columns.

Definitions for each of these columns are provided in **Exhibit 13**. The columns are illustrated in **Exhibit 14**, circled in blue.

The remaining columns, circled in gold, on **Exhibit 14, *Level 1 Risk Register Development*** provide locations for identifying how each risk may affect the project. The "Potential for Impact on" categories include Cost and Schedule.

An "X" is placed in the appropriate column(s) to indicate a potential project impact for a particular risk. Mitigation strategies for each potential impact should be developed and carried through the project with documentation in project status meetings, and at project milestone meetings.

Risk Management Level	Identification	Assessment and Analysis	Planning and Response	Implementation and Control
Level 1 **Tool:** L1 Register	Select **Status** as "active" for each risk. Add risks specific to the project. Select **Category** to indicate phase when risk impact will occur. Filter **Status** column for "active" **Risks**. Remove filter to add **Risks** at milestone reviews.	Indicate Potential for impact on **Cost** and/or **Schedule**	Add mitigation or specify a risk owner as needed in the **Comments / Assumptions**.	Monitor and provide Updated date for when risk **Status** or **Comments/ Assumptions** change.
Level 2 **Tool:** L2 Qualitative	Brainstorm risks, develop **Risk Statement** (cause, uncertain event, effect), then **Risk Title** (short description). Select **Category** Review/copy L1 Register **Risks** for any applicable risk that should also be considered. Develop **Risk Statement**s for any new or additional risks.	Determine **Probability**, **Cost Impact**, and **Time Impact** through qualitative ratings ("Very Low", "Low", "Moderate", "High", "Very High"). Analyze results of **Cost Score** by color (Green, Yellow, Red) and numerically for multiple reds to differentiate level of severity. Consider the Red and Yellow **Time** and **Cost Scores** for mitigation.	Select a **Strategy**: For Threats: Avoid, Transfer, Mitigate or Accept For Opportunities: Exploit, Share, Enhance or Accept Develop the **Response Actions**. Assign a **Risk Owner**.	Communicate risks with the Team, risk owners, and stakeholders; monitoring of risks; providing resources to mitigate the risks. – Change **Status** (column 1) to "Retired" as project enters a new phase unless risk may occur in a subsequent project phase. – Update **Current Status/ assumptions**, and enter **Updated** dates.
Level 3 **Tool:** **L3** Quantitative	Brainstorm risks, develop **Risk Statement** (cause, uncertain event, effect), then **Risk Title** (short description). .Select **Category**. Review/copy L1 Register **Risks** for any applicable risk that should also be considered. Develop **Risk Statement**s for added risks.	Determine ranges for **Probability**, **Cost Impact ($)**, and **Time Impact (days)**. Cost and time impacts require data for the low and high range, and/or the most likely. Analyze results of probable **Cost Impact**, and **Time Impact**. The highest values on the register should be considered for mitigation.	Select a **Strategy**: Threats: Avoid, Transfer, Mitigate or Accept Opportunities: Exploit, Share, Enhance or Accept Develop the **Response Actions**. Assign a **Risk Owner**. Develop a Risk Mgmt. Plan.	Communicate risks with the Team, risk owners, and stakeholders; monitoring of risks; providing resources to mitigate the risks. – Change **Status** (column 1) to "Retired" as project enters a new phase unless risk may occur in a subsequent project phase. – Update **Current Status/ assumptions**, and enter **Updated** dates.

EXHIBIT 12, RISK MANAGEMENT PROCESS AND LEVELS

Level 1 Risk Register	
Column	Contents
Status	Select "Active" or "Retired." A risk is retired when it has no further possibility of impacting the project.
ID #	Enter a unique identifying number for the risk.
Risk Type	Indicate either a Threat of Opportunity
Category	Select one of the categories for the risk. (Environmental, Design, RW-RR-Utilities, Construction, External, Organizational, or PM)
Risk Factor	Provide a descriptive title for the risk.
Comments/Assumptions	If applicable, describe what is currently known about the risk and any assumptions made. This can be a useful "risk diary"
Risk Owner	Enter the name of the Team member responsible for the risk
Update	Enter the date the risk was identified/created.

EXHIBIT 13, LEVEL 1 RISK REGISTER COLUMNS

LEVEL 1 RISK REGISTER	Project Name:	"Example Project"	MPMS No:		Project Manager:	"PM Name"	
Risk Selections Select "Active" Status for applicable risks; Filter Status to review currently "active risk", remove filter when updating and selecting additional risks as project develops					Potential for Impact On:		
Status	ID #	Category	Risk Factor	Comments/Assumptions	Cost	Schedule	Risk Owner	Updated
Active	1	Design	Design incomplete at PS&E					
	2	Design	Unexpected geotechnical or groundwater issues					
	3	Design	Changes to materials/geotechnical/foundation					
	4	Design	Foundation and geotechnical tasks (foundation drilling and material testing) not identified and included in project workplan					
	5	Design	Inaccurate assumptions on technical issues in planning stage					
	6	Design	Additional survey required					
	7	Design	Bridge site data incomplete					
	8	Design	Existing structures planned for modification not evaluated for scour potential and structural capacity					

EXHIBIT 14, LEVEL 1 RISK REGISTER DEVELOPMENT

Level 2 Analysis

The level 2 Qualitative analysis has two options. **The first option** includes a risk rating, which is assigned to each risk in the risk register. The risk priority ratings determine where the greatest effort should be focused in responding to the identified risks. The priority ratings facilitate structured risk response action and resource allocation. The three Level 2 ratings for Cost and Time Scores are:

- Red "High" – Primary priority for risk response.
- Yellow "Medium" – Risk response as time and resources permit.
- Green "Low" – No risk response required at this time.

As presented in **Exhibit 16, *Risk Management Tool Qualitative Analysis With Risk Rating***, the columns include the following information:

Level 2 Risk Response Columns	
Column	**Contents**
Risk Rating	Select “High”, “Medium”, or “Low” as a measure of the importance of this risk for response action.
Rationale	Describe the reasons the team selected this risk rating.
Risk Response Strategy	Enter a strategy – Avoid, Transfer, Mitigate, Exploit, Share, Enhance, or Accept. Definitions are provided in Exhibit 11.
Risk Response Actions	Identify the course of action to minimize the impact (or maximize the benefit) to the project

EXHIBIT 15, LEVEL 2 RISK RESPONSE COLUMNS

LEVEL 2 - RISK REGISTER Qualitative, 3 Ratings		Project Name:	Example Project			MPMS No:		Project Manager:	PM Person		
Risk Identification						Risk Rating		Risk Response			
Status	ID #	Type	Category	Title	Risk Statement	Current status/assumption	Priority Rating	Rationale for Rating	Strategy	Response Actions	Risk Owner	Updated
Active	160	Threat	Design	Survey File	Inaccuracies or incomplete information in the survey file could lead to rework of the design.		Medium		Mitigate	Verify that the survey file is accurate and complete	Sam Owner	10/12/2015
Active	161	Threat	Environmental	Challenge to EIR	Potential lawsuits may challenge the environmental report, delaying the start of construction or threatening loss of funding.		Low		Mitigate	Address concerns of stakeholders and public during environmental process	EIR Person	11/23/2015
Active	162	Threat	ROW	Delay of ROW Acquisition	Due to the large number of parcels and businesses, may have to use the condemnation process to acquire R/W, which could delay start of construction by up to one year, increasing construction costs and extend the time for COS.		High		Accept		ROW Person	11/23/2015
Active	163	Threat	Construction	Buried Objects	Unanticipated buried man-made objects uncovered during construction require removal and disposal resulting in additional costs.		Medium		Accept	Include a Supplemental Work item to cover this risk.	PM	11/24/2015

Risk Rating		Risk Response	
Priority Rating	Rationale for Rating	Strategy	Response Actions
Medium		Mitigate	Verify that the survey file is accurate and complete
Low		Mitigate	Address concerns of stakeholders and public during environmental process
High		Accept	
Medium		Accept	Include a Supplemental Work item to cover this risk.

EXHIBIT 16, RISK MANAGEMENT TOOL QUALITATIVE ANALYSIS WITH RISK RATING

Mitigation strategies for each risk should be carried through the project with documentation in project status meetings, and at project milestone meetings.

The second option includes a risk impact rating, which is assigned to each risk in the risk register. To accomplish this analysis, the project team assesses each identified risk in turn and determines:

- The **rating for the probability of the risk occurring**, and
- The **rating of cost and time impact of each risk**, should it occur.

To assist with this identification, **Exhibit 17, *Definitions of Impact and Probability Ratings*** provides a standard definition of risk probability and impact ratings. The cost impact ratings may be easier to apply if expressed in terms of dollars. The ratings for the project serve as a consistent frame of reference for the project team in assessing the risks during the life of the project.

This Exhibit is intended as a guide – the project team may define dollar and time ranges as appropriate for the project. The impacts are to the overall project. Schedule delay applies to risks that are on the critical path (the longest path). During the Planning and Design phases, delays that impact the project let date may be of primary interest. During construction, delays impact project completion.

Rating →	Very Low	Low	Moderate	High	Very High
Cost Impact of Threat	Insignificant cost increase	<5% cost increase	5 – 10% cost increase	10 – 20% cost increase	>20% cost increase
Cost Impact of Opportunity	Insignificant cost reduction	<1% cost decrease	1 – 3% cost decrease	3 – 5% cost decrease	>5% cost decrease
Schedule Impact of Threat	Insignificant slippage	<1 month slippage	1 – 3 months slippage	3 – 6 months slippage	>6 months slippage
Schedule Impact of Opportunity	Insignificant improvement	<1 month improvement	1 – 2 months improvement	2 – 3 months improvement	>3 months improvement
Probability	1–9%	10–19%	20–39%	40–59%	60–99%

EXHIBIT 17, DEFINITIONS OF IMPACT AND PROBABILITY RATINGS

The entries into the tool are slightly different then option one. The description of the column entries are presented in **Exhibit 18, *Level 2, Option Two, Risk Tool Column Definitions***, the columns include the following information:

Level 2 Risk Ratings and Response	
Column	**Contents**
Risk Rating	The **Cost Score** and **Time Score** are derived when the user selects: "Very High"= 5, "High"=4, "Medium"=3, "Low"=2 or "Very Low"=1 **Probability**: "Very High", "High", "Medium", "Low" or "Very Low" **Cost Impact**: "Very High", "High", "Medium", "Low" or "Very Low" **Time Impact**: "Very High", "High", "Medium", "Low" or "Very Low"
Rationale	Describe the reasons the Team selected this risk rating.
Risk Response Strategy	Enter a strategy – Avoid, Transfer, Mitigate, Exploit, Share, Enhance, or Accept. Definitions are provided in **Exhibit 16**.
Risk Response Actions	Identify the course of action to minimize the impact (or maximize the benefit) to the project—note: you will usually find it helpful to list each action or step with a verb in order to make it actionable and clear. See examples on next page: verify, address, include.

EXHIBIT 18, LEVEL 2, OPTION TWO, RISK TOOL COLUMN DEFINITIONS

The risk matrix in **Exhibit 19, *Level 2 Risk Probability and Impact Matrix*** is used to determine the importance of each risk impact based on the probability and impact ratings. Each word descriptor of the rating has an associated number; the product of the probability number and impact number defines the risk score.

Probability Rating						
	5 – Very High					
	4 - High					
	3 - Moderate					
	2 - Low					
	1 – Very Low					
		1 Very Low	2 Low	4 Moderate	8 High	16 Very High
		Impact Rating				

EXHIBIT 19, LEVEL 2 RISK PROBABILITY AND IMPACT MATRIX

For a particular impact, the combination of the probability rating of the risk occurring and the impact rating positions the risk into one of the three colored zones in the risk matrix. The color of the zone indicates the priority of the risk for risk response: red zone signifies high importance, yellow is medium importance, and green is low importance. For example, a risk having a “Moderate” probability and a “High” impact falls into the red zone. Its impact score is 3 x 8 =24. The qualitative analysis is entered into the following columns as shown in **Exhibit 20**.

Risk response strategies and actions are the same as described previously in this section. Mitigation strategies for each risk should be carried through the project with documentation in project status meetings, and a project milestone meetings. The Risk Probability and Impact matrix is highly visual and may have value in making presentations, communicating with management, etc.

Level 2 – Risk Probability and Impact Columns	
Column	Contents
Probability	Select the probability level from the drop-down list.
Cost Impact	Select the cost impact level from the drop-down list.
Time Impact	Select the time impact level from the drop-down list.
Rationale	Describe the rationale for these assessments.

EXHIBIT 20, RISK PROBABILITY AND IMPACT COLUMNS

LEVEL 2 - RISK REGISTER Qualitative, w Impacts				Project Name:	Example Project		MPMS No:		Project Manager:	PM Person						
Risk Identification							Risk Assessment						Risk Response			
Status	ID #	Type	Category	Title	Risk Statement	Current status/assumptions	Probability	Cost Impact	Cost Score	Time Impact	Time Score	Rationale	Strategy	Response Actions	Risk Owner	Updated
Active	160	Threat	Design	Survey File	Inaccuracies or incomplete information in the survey file could lead to rework of the design.		3-Moderate	2 -Low	6	4 -Moderate	12		Mitigate	Verify that the survey file is accurate and complete	Sam Owner	10/12/2015
Active	161	Threat	Environmental	Challenge to EIR	Potential lawsuits may challenge the environmental report, delaying the start of construction or threatening loss of funding.		1-Very Low	4 -Moderate	4	8 -High	8		Mitigate	Address concerns of stakeholders and public during environmental process	EIR Person	11/23/2015
Active	162	Threat	ROW	Delay of ROW Acquisition	Due to the large number of parcels and businesses, may have to use the condemnation process to acquire R/W, which could delay start of construction by up to one year, increasing construction costs and extend the time for COS.		3-Moderate	4 -Moderate	12	8 -High	24		Accept		ROW Person	11/23/2015
Active	163	Threat	Construction	Buried Objects	Unanticipated buried man-made objects uncovered during construction require removal and disposal resulting in additional costs.		3-Moderate	4 -Moderate	12	4 -Moderate	12		Accept	Include a Supplemental Work item to cover this risk.	PM	11/24/2015
Active	164	Threat	Design	Supplemental Environmental Rewew	A design change that is outside of the parameters contemplated in the Environmental Document triggers a additional review which causes a delay due to the public comment period.		3-Moderate	4 -Moderate	12	8 -High	24		Avoid	Monitor design changes against ED to avoid reassessment of ED unless the opportunity outweighs the threat	esign Manager	11/24/2015
Active	165	Threat	Environmental	Nesting birds	Nesting birds, protected from harassment, may delay construction during the nesting season.		2-Low	2 -Low	4	8 -High	16		Mitigate	Schedule contract work to avoid the nesting season or remove nesting habitat before starting work.	PM/RE	11/24/2015
Active	166	Threat	ROW	Additional ROW	Due to the complex nature of the staging, additional right of way or construction easements may be required to complete the work as contemplated, resulting in additional cost to the project.		3-Moderate	8 -High	24	8 -High	24		Mitigate	Re-sequence the work to enable ROW Certification	ROW Person	11/24/2015
Active	167	Threat	Construction	Hazardous Materials	Hazardous materials encountered during construction will require an on-site storage area and potential additional costs to dispose		2-Low	2 -Low	4	1 -Very Low	2		Accept	Ensure storage space will be available	PM	11/24/2015

Risk Assessment						Risk Response	
Probability	Cost Impact	Cost Score	Time Impact	Time Score	Rationale	Strategy	Response Actions
3-Moderate	2 -Low	6	4 -Moderate	12		Mitigate	Verify that the survey file is accurate and complete
1-Very Low	4 -Moderate	4	8 -High	8		Mitigate	Address concerns of stakeholders and public during environmental process
3-Moderate	4 -Moderate	12	8 -High	24		Accept	
3-Moderate	4 -Moderate	12	4 -Moderate	12		Accept	Include a Supplemental Work item to cover this risk.
3-Moderate	4 -Moderate	12	8 -High	24		Avoid	Monitor design changes against ED to avoid reassessment of ED unless the opportunity outweighs the threat
2-Low	2 -Low	4	8 -High	16		Mitigate	Schedule contract work to avoid the nesting season or remove nesting habitat before starting work.
3-Moderate	8 -High	24	8 -High	24		Mitigate	Re-sequence the work to enable ROW Certification
2-Low	2 -Low	4	1 -Very Low	2		Accept	Ensure storage space will be available

EXHIBIT 21, LEVEL 2 RISK QUALITATIVE ANALYSIS WITH IMPACT RATING

Level 3 Analysis

Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. The degree of uncertainty in each schedule activity and each line-item cost element is represented by a probability distribution. To perform this analysis, the project risk manager leads the Team in quantifying cost and schedule risks.

- The probability of the risk occurring is expressed by two values: "Low" and "High" that cover the range.
- Three-point estimates are used for cost and schedule impacts. The three-point estimate consists of determining the "Low" (optimistic), "High" (pessimistic) and "Most Likely" values for the cost and time. The most likely value may be omitted if it cannot be established credibly, leaving a range of low to high.

The qualitative risk analysis information is entered into the following columns as defined in **Exhibit 22** and indicated in **Exhibit 23**.

Level 3 – Risk Probability and Impact Columns	
Column	**Contents**
Probability	Enter the "Low" to "High" values.
Cost Impact	If there is a cost impact, enter a "Low" and "High" cost. If there is reason for a credible "Most Likely" cost, enter it; otherwise, leave this entry blank. If no cost impact, leave these cells blank.
Time Impact	If there is a time impact, enter a "Low" and "High" time in days. If there is reason for a credible "Most Likely" time, enter it; otherwise, leave this entry blank. If there is no time impact, leave these cells blank.
Rationale	Describe the rationale or basis for these assessments. Try to be specific and as concise as reasonably possible.

EXHIBIT 22, LEVEL 3 RISK PROBABILITY AND IMPACT COLUMNS

"Probable Cost" is calculated from the average value of the Probability range multiplied by the average value of the Cost Impact range.

"Probable Time" is calculated from the average value of the Probability range multiplied by the average value of the Time Impact range.

The risks are prioritized for risk response in descending order of their "Probable Cost" and/or "Probable Time".

Risk response strategies and actions are the same as described previously in this section. Mitigation strategies for each risk should be carried through the project with documentation in project status meetings, and at project milestone meetings. For complex projects a formal risk report should be developed.

LEVEL 3 - RISK REGISTER Quantitative	Project Name:	Example Project	MPMS No:		Project Manager:	PM Person														
							Risk Assessment													
Risk Identification							Probability		Cost Impact ($)				Time Impact (days)					Risk Response		
Status	ID #	Type	Category	Title	Risk Statement	Current status/assumption	Low	High	Low	Most likely	High	Probable	Low	Most likely	High	Probable	Rationale	Strategy	Response Actions	Risk Owner	Updated
Active	160	Threat	Design	Survey File	Inaccuracies or incomplete information in the survey file could lead to rework of the design.		40	60	$ 100,000		$ 300,000	$ 100,000						Mitigate	Verify that the survey file is accurate and complete	Sam Owner	10/12/2015
Active	161	Threat	Environmental	Challenge to EIR	Potential lawsuits may challenge the environmental report, delaying the start of construction or threatening loss of funding.		0	10	$ 500,000	$ 800,000	$ 1,200,000	$ 42,000	60		150	5		Mitigate	Address concerns of stakeholders and public during environmental process	EIR Person	11/23/2015
Active	162	Threat	ROW	Delay of ROW Acquisition	Due to the large number of parcels and businesses, may have to use the condemnation process to acquire ROW, which could delay start of construction by up to one year, increasing construction costs and extend the time for completion		40	60	$ 500,000	$ 750,000	$ 2,000,000	$ 542,000	180		365	136		Accept		ROW Person	11/23/2015
Active	163	Threat	Construction	Buried Objects	Unanticipated buried man-made objects uncovered during construction require removal and disposal resulting in additional costs.		20	40	$ 200,000		$ 400,000	$ 90,000						Accept	Include a Supplemental Work item to cover this risk.	PM	11/24/2015
Active	164	Threat	Design	Supplemental EIR	A design change that is outside of the parameters contemplated in the Environmental Document triggers additional review which causes a delay due to the public comment period.		10	30	$ 100,000	$ 200,000	$ 400,000	$ 47,000	0		60	6		Avoid	Monitor design changes against ED to avoid reassessment of ED unless the opportunity outweighs the threat	Design Manager	11/24/2015
Active	165	Threat	Environmental	Nesting birds	Nesting birds, protected from harassment, may delay construction during the nesting season.		0	20	$ 150,000		$ 300,000	$ 23,000	0		30	2		Mitigate	Schedule contract work to avoid the nesting season or remove nesting habitat before starting work.	PM/RE	11/24/2015
Active	166	Threat	ROW	Additional ROW	Due to the complex nature of the staging, additional right of way or construction easements may be required to complete the work as contemplated, resulting in additional cost to the project.		40	60	$ 500,000	$ 750,000	$ 1,000,000	$ 375,000						Mitigate	Re-sequence the work to enable ROW Certification	ROW Person	11/24/2015
Active	167	Threat	Construction	Hazardous Materials	Hazardous materials encountered during construction will require an on-site storage area and potential additional costs to dispose		20	40	$ 100,000		$ 300,000	$ 60,000						Accept	Ensure storage space will be available	PM	11/24/2015

Risk Assessment										
Probability		Cost Impact ($)				Time Impact (days)				
Low	High	Low	Most likely	High	Probable	Low	Most likely	High	Probable	Rationale
40	60	$ 100,000		$ 300,000	$ 100,000					
0	10	$ 500,000	$ 800,000	$ 1,200,000	$ 42,000	60		150	5	
40	60	$ 500,000	$ 750,000	$ 2,000,000	$ 542,000	180		365	136	
20	40	$ 200,000		$ 400,000	$ 90,000					
10	30	$ 100,000	$ 200,000	$ 400,000	$ 47,000	0		60	6	
0	20	$ 150,000		$ 300,000	$ 23,000	0		30	2	
40	60	$ 500,000	$ 750,000	$ 1,000,000	$ 375,000					
20	40	$ 100,000		$ 300,000	$ 60,000					

EXHIBIT 23, PENNDOT RISK MANAGEMENT TOOL LEVEL 3-QUANTITATIVE ANALYSIS

AG.4.B. Risk Analysis (FHWA tool)

Using the FHWA tool, the Team can perform an analysis of the risk ranking based on severity, which will help to identify the risks and opportunities that will be selected for Risk Response/Mitigation. The anticipated cost and schedule performance can provide the total project performance if none of the risks are mitigated. The Team can select risks to mitigate, identify costs associated with the mitigation as well as the amount of risk reduction, and then review the "mitigated" project performance.

Why was this tool developed? - To support a systematic approach to the practice of risk management for rapid renewal projects SHRP2 undertook a research project titled Guide for the Process of Managing Risk on Rapid Renewal Contracts (Project R09). The resulting Guide explains risk and how it can impact projects and defines a systematic approach to risk management. The Guide identifies six steps necessary to a formal risk management approach, provides case study examples for each step of the process, and includes extensive checklists and supplemental materials for conducting risk management on relatively simple rapid renewal projects. The supplements include annotated training materials, an animated presentation introducing the risk management process, forms for documenting the process, and a Microsoft Excel template (with User's Guide) that presents a hypothetical project using sample data to provide an example of how to document the process and automatically conduct the necessary analyses for successful rapid renewal risk management.

Can the project team use this product independently? – Yes, it can be done and should be considered for applicable projects if there is expected benefit in doing so. The product includes a user's guide that will allow a project team to work through the risk management template. However, to expedite the project, it is recommended that trained HDTS staff, or a trained consultant work with the project team in developing the template. Utilization of this tool requires some upfront data gathering (project description, parameters and assumptions, design and construction schedules, and initial project costs without contingencies), and a two-day Team charrette. For additional alternatives, anticipate extending the charrette ½ to one day per additional alternative.

Details on the FHWA SHRP2 Risk Management tool are provided in the ECMS file cabinet (select top menu ->References, then drop down-> File Cabinet)

http://www.dot14.state.pa.us/ECMS/SVCOMFileCabinet?action=SEARCH Folder _ _ _ - Risk Management.

AG.5 Appendices

AG.5.A. Glossary

Base - value exclusive of threat and opportunity (i.e., per specific set of assumptions).

Bias - Error in value (e.g., due to conservatism).

Contingency - Value in addition to base cost and schedule intended to cover risks and other uncertainties (e.g., for project cost and for project schedule).

Contingency Plan - A set of predefined actions to be taken when a negative risk occurs.

Impact - Effect or consequence of an action or the failure to take action.

Mitigation - The act of alleviating a harmful circumstance. **Risk mitigation** seeks to reduce the probability and/or impact of a threat to below an acceptable threshold or to enhance/exploit the probability/ and/or impact of an opportunity.

Opportunity - A risk that will have a positive impact on a project objective if it occurs.

Probability - Likelihood of the occurrence of any event.

Qualitative Risk Analysis – The process of prioritizing risks by assessing the probability and impact of project risk(s) to classify risks qualitative of high, moderate, and low for prioritized risk response planning.

Quantitative Risk Analysis - The process of analyzing the values of cost and time. The results of a qualitative analysis can help differentiate risk that may have a an identical qualitative results (e.g., a qualitative analysis for low probability and high impact results in medium severity; high probability and low impact also results in medium severity).

Recovery - Actions to reduce project cost and/or schedule (e.g., scope reductions), typically in reaction to exceeding available contingency.

Residual Risk - Risks that remain even after developing responses to the project's original risks.

Risk - A defined uncertainty that can impact the outcome of a project including cost, schedule, scope or quality. A risk has a cause and, if it occurs, a consequence. (**Project Risk** - An uncertain event or condition that, if it occurs, has a positive or negative impact on at least one project objective.)

Risk Allocation - Placing responsibility for a risk to a party through a contract. The fundamental tenets of risk allocation include allocating risks to the party best able manage them, allocating risks in alignment with project goals, and allocating risks to promote Team alignment with customer-oriented performance goals.

Risk Analysis - process of calculating project performance including risks, and often the sensitivity of that performance to the various risks (i.e., to prioritize the risks for further assessment or for risk mitigation), based on previous structuring and risk identification and assessment. As used elsewhere,

sometimes refers broadly to identification and assessment, as well as analysis, of risks, interchangeably with risk assessment.

Risk Assessment - A component of risk management that bridges risk identification and risk analysis in support of risk allocation.

Risk Avoidance - Changing the project plan to eliminate the risk or to protect the project objectives from its impact. It is a tool of the risk response planning process.

Risk Documentation - Recording, maintaining, and reporting assessments; handling analysis and plans; and monitoring results. It includes all plans, reports for the project manager and decision authorities, and reporting forms that may be internal to the project manager.

Risk Event - A discrete occurrence that may affect a project in either a positive or negative way.

Risk Identification - Determining which risks might affect the project and documenting their characteristics. Tools used include brainstorming and checklists.

Risk Manager - Facilitates the risk management process and acts as gatekeeper for the risk register.

Risk Management - The systematic process of planning for, identifying, analyzing, responding to, and monitoring project risk. Risk management involves people, processes, tools, and techniques that will help the project manager maximize the probability and consequences of positive events and minimize the probability and consequences of adverse events. Project risk management is most effective when first performed early in the life of the project and is a continuing responsibility throughout the project.

Risk Management Plan - Documents how the risk processes will be carried out during the project. This is the output of risk management planning. (PMI)

Risk Owner - A person assigned to monitor the risk(s) and inform the project manager of any changes in the status of the risk.

Risk Register - A document detailing all identified risks, including description, cause, probability of occurrence, impact(s) on objectives, proposed responses, owners, and current status.

Risk Template - The PennDOT Risk Management tool that contains a risk register for each of the three levels of risk management.

Risk Trigger - Symptoms and warning signs that indicate whether a risk is becoming a near-certain event and a contingency plan/response plan should be implemented.

Severity (or risk severity) - a measure of a risk's impact on project performance, e.g., by combining values of changes in cost and schedule due to that risk.

Structuring - process of defining base project performance, e.g., by reviewing/abstracting available detailed project performance estimates, adequately for purpose of risk management process.

Threat - A risk that will have a negative impact on a project objective if it occurs.

AG.5.B. Risk Response Examples

The following list provides a few risks along with various responses such as mitigate, avoid or accept.

	Risk Statement	Risk Response
Design	Inaccuracies or incomplete information in the survey file could lead to rework of the design.	**Mitigate**: Work with Surveys to verify that the survey file is accurate and complete. Perform additional surveys as needed.
	A design change that is outside of the parameters contemplated in the Environmental Document (ED) triggers a review which causes a delay due to the public comment period.	**Avoid**: Monitor design changes against ED to avoid reassessment of ED unless the opportunity outweighs the threat.
Environmental	Potential lawsuits may challenge the environmental report, delaying the start of construction or threatening loss of funding.	**Mitigate**: Address concerns of stakeholders and public during environmental process. Schedule additional public outreach.
	Nesting birds may delay construction during the nesting season.	**Mitigate**: Schedule contract work to avoid the nesting season or remove nesting habitat before starting work.
Right-of-Way	Due to the complex nature of the staging, additional right-of-way or construction easements may be required to complete the work as contemplated, resulting in additional cost to the project.	**Mitigate**: Re-sequence the work to enable right-of-way certification.
	Due to the large number of parcels and businesses, the condemnation process may have to be used to acquire right-of-way, which could delay start of construction by up to one year, increasing construction costs and extending the time completion.	**Mitigate**: Work with right-of-way and project management to prioritize work and secure additional right-of-way resources to reduce impact.
Construction	Hazardous materials encountered during construction will require an on-site storage area and potential additional costs to dispose.	**Accept**: Ensure storage space will be available.
	Unanticipated buried man-made objects uncovered during construction require removal and disposal resulting in additional costs.	**Accept**: Include a Supplemental Work item to cover this risk.

AG.5.C. Risk Management Plan Outline

1. **Introduction**

   Project Name and Location

   Brief project summary with respect to risk management

   Potential macro-level risks and any considerations for mitigation/minimization

2. **Risk Management Strategy and Approach**

   Provide a brief summary overview of the strategy that will be used to manage, mitigate and minimize potential risks, involved with the particular risk.

   Team member risk management roles and responsibilities (e.g., who is assuming the role of risk manager)

   Communication strategy – basic listing of communication needs and how each will be met

3. **Risk Register**
   a. **Risk Identification (Reference Risk Model/Register)**

      Using this guide, procedures and risk register model, identify all potential risks.

   b. **Assessment and Analysis**

      Qualitative (level 2) Use the techniques outlined in this guide to perform the assessment.

      Quantitative (level 3) When necessary, use the techniques outlined in this guide to perform the assessment.

   c. **Risk Response Planning (Reference Risk Model/Register)**

      Determining who, what group or groups will have responsibility for avoiding or mitigating identified risks. Risk owners identified and responsible if a risk is triggered.

4. **Implementation**

   Including risk monitoring and updating, information gathering and distribution.

5. **Supporting documentation and reports.**

   Include output from risk management workshops, photographs, meetings, newspaper articles, community documents (e.g., local government meeting minutes) etc.