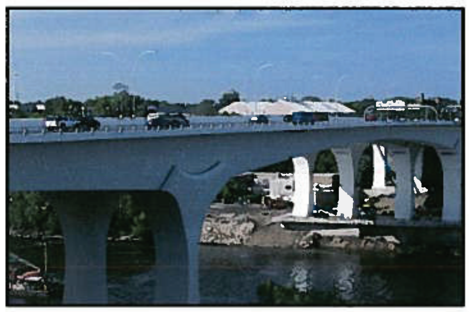
Minnesota Department of Transportation

Cost Estimation and Cost Management



Technical Reference Manual

2008

Foreword

The purpose of this Technical Reference Manual (TRM) is to assist the Minnesota Department of Transportation (Mn/DOT) in achieving accuracy, accountability, and consistency in cost estimation and cost management efforts during the Planning, Scoping, Design, and Letting phases of project development.

Mn/DOTs Mission is to *provide the highest quality, dependable multi-modal transportations system through ingenuity, integrity, alliance and accountability.* Mn/DOT has undertaken several initiatives in an effort to continue to strive for this mission, including the Mn/DOT Cost Estimation Process Improvement and Organizational Integration project. This TRM is one of the outcomes of this multi-year project which involved Mn/DOT personnel from all levels, districts, and functional groups.

The Mn/DOT Cost Estimation Process Improvement and Organizational Integration project has been a comprehensive effort with broad participation of those involved in cost estimating and cost management prior to project letting for construction. The TRM addresses a wide range of topics that include broad policies and organizational issues to detailed estimating tools. That being said, the majority of the TRM was written with the junior estimator in mind. More senior management personnel will find the TRM more useful as a review or reference document. More experienced estimators will find the TRM useful in creating estimating checklists or as a process review checklist. This TRM is organized in four stand-alone sections: Introduction, Essentials, Practice, and Appendices. All users are encouraged to read the Introduction and Essentials sections. The practice sections include guidance for Planning, Scoping, Design, and Letting phases. The Planning, Scoping, and Letting sections focus primarily on the cost estimating practices for those phases, and the Design section is written principally for cost management that is reinforced by cost estimating. Each of these sections is considered standalone and can be used independent of the other sections.

A tremendous amount of effort was put forth to encourage consistency and accuracy in cost estimation and cost management through this TRM. However, this TRM is intended to be a living document. Cost estimating and cost management tools will continue to be developed and added to the TRM. Also, there are some areas which could not be addressed, or addressed sparingly, within the scope of the work. These areas include design-build project delivery, accelerated projects, and accelerated estimates. These limitations should be kept in mind when using the TRM. In striving for continued enhancement in cost estimating, cost management, and project scope development Mn/DOT has established the Office of Project Scope and Cost Management which is charged to serve as the home for resources related to this TRM and information relating to scope and cost management.

Khani Sahebjam, P.E.
Deputy Commissioner and Chief Engineer

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IV. APPENDIX

1 Introduction

The Minnesota Department of Transportation (Mn/DOT) initiated the Cost Estimation Process Improvement and Organizational Integration Project to address the many challenges and difficulties associated with estimating project costs and managing costs during all phases of project development. The purpose of the project is to achieve accuracy, accountability, and consistency in cost estimation (CE) and cost management (CM) efforts during the Planning, Scoping, Design, and Letting phases of project development. In the early phases of this project, subject matter experts in the areas of cost estimating and risk analysis conducted information-gathering sessions and interviews with District representatives. The following observations established the need for guidance in the form of a Technical Reference Manual (TRM):

- The need for a systematic and consistent approach to cost estimating and cost management, as highway projects become more complex than ever and face intense challenges, such as inflation and changing requirements and expectations, from project inception to completion.
- Increased visibility among legislators, public officials, national and local transportation agency representatives, and citizens, leading the Department of Transportation to seek ways to improve their highway construction project and program management efforts.
- The need for organizational support and management support for effective cost estimating and management that is consistent with the findings of a National Cooperative Highway Research Program (NCHRP) guidebook on the subject.

This TRM is intended as a guide for developing and managing project costs. It provides procedures to aid Mn/DOT staff in preparing project cost estimates and managing costs throughout the Mn/DOT project development process. Cost estimating and cost management process models developed with participation from Mn/DOT staff serve as the framework for the content covered in this manual. Cost estimating and cost management policies were also developed, which are integrated into this manual. Although the manual is primarily geared towards Project Managers and Estimators, it is strongly recommended that others involved in Mn/DOT's project development activities familiarize themselves with this document.

The purpose of the project is to achieve accuracy, accountability, and consistency in cost estimation (CE) and cost management (CM) efforts during the Planning, Scoping, Design, and Letting phases of project development.

1.1 Mn/DOT VISION FOR COST ESTIMATION AND COST MANAGEMENT

The potential benefits of this effort include improved delivery of projects and program management, better use of available resources, greater credibility with the public and other stakeholders, and increased satisfaction as a result of more efficiently and effectively meeting public needs.

Mn/DOT management's vision provided an overarching direction to the Cost Estimation Process Improvement and Organizational Integration Project and the development of this TRM. The potential benefits of this effort include improved delivery of projects and program management, better use of available resources, greater credibility with the public and other stakeholders, and increased satisfaction as a result of more efficiently and effectively meeting public needs. The management vision states that *Mn/DOT will manage and control costs through a department-wide priority on cost estimating and cost management, reliable and accurate estimates, statewide uniformity and consistency, improved communication and credibility with external stakeholders, and clear accountability*. The vision further states that *Mn/DOT leadership is committed to developing a standard process and supporting policies, integrating processes and policies across all functions, and making the necessary organizational adjustments to fulfill the vision*. Key components of the Mn/DOT vision include the following:

Department-wide priority on estimating, managing, and controlling costs
- Fully developed and integrated policies, processes, and tools for cost estimation, management, and control
- Baseline estimates that align with early project scope development and include an initial assessment of risk and uncertainty
- Clearly defined and documented cost management approval processes to authorize changes in scope and cost after the baseline estimate is established
- Dedicated resources that are focused on effective scoping, project cost estimating, and cost management

Reliable and accurate estimates
- Well-documented and complete cost estimates
- Clearly spelled-out assumptions, risks, and uncertainties that can be easily communicated

Statewide uniformity and consistency
- Uniform application and consistent statewide use of well-documented processes and tools
- Use of process and tools during Planning, Scoping, Design, and Letting phases

Improved communication and credibility with external stakeholders
- Consistent and clear communication of cost estimates to external stakeholders at milestone points
- The ability to communicate cost estimates with confidence, leading to stronger relationships with external stakeholders, greater possibility for collaboration, and increased funding support of transportation initiatives

Clear accountability

- Accountability for cost estimating and cost management at all levels of the organization
- Defined roles and responsibilities for every person involved
- Accountability that is tracked at key milestones in the process

Figure I.1-1 illustrates how the management vision led to the development of cost estimating and cost management policies and performance measures. The National Cooperative Highway Research Project Report 574[1] served as the key guiding document throughout the effort. Extensive modeling of the existing and the desired cost estimating and cost management processes within Mn/DOT provided key input to the development of this TRM.

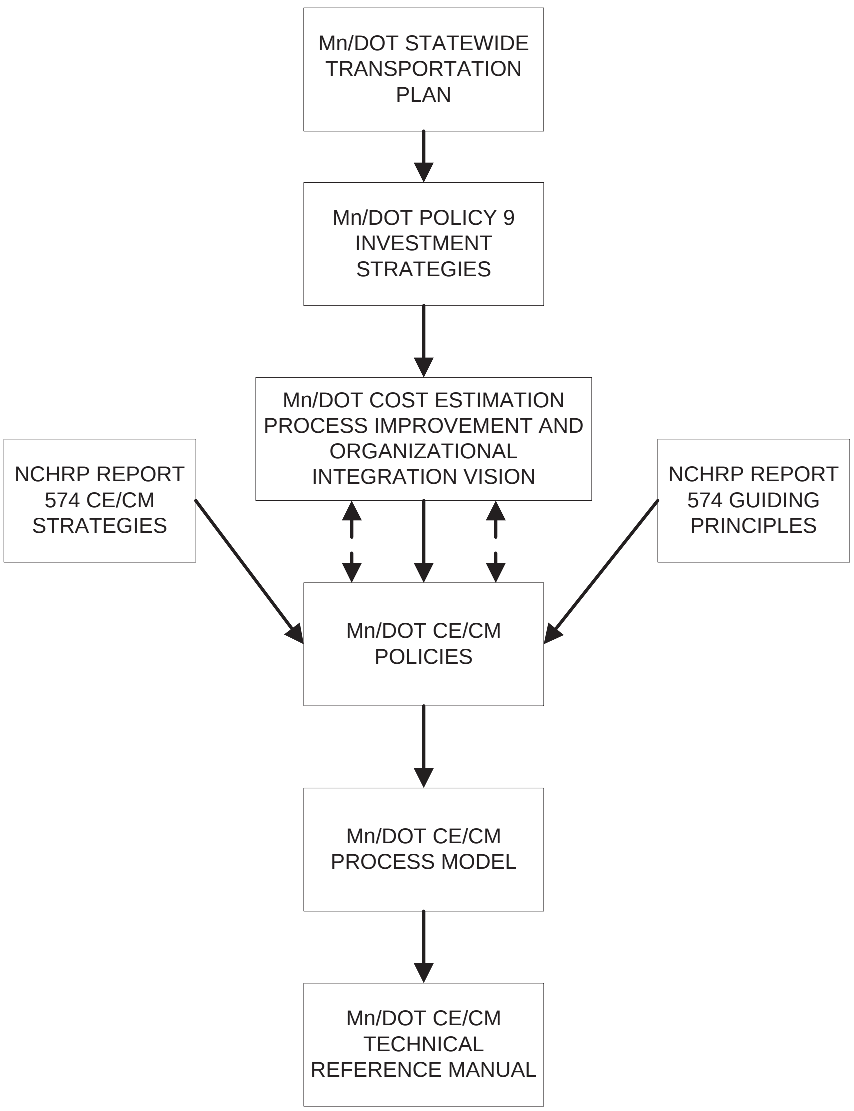

Figure I.1-1. Development of the Technical Reference Manual

1 Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming, and Preconstruction (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf)

I.2 USE OF TECHNICAL REFERENCE MANUAL

This TRM is organized in four sections: Introduction, Essentials, Practice, and Appendices. Depending on the need, the user can go directly to the section of interest, although it is recommended that everyone read the Essentials section at least once before using the manual.

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I.2.1 Section II: Essentials

The first part of the Essentials section describes the approach used and the rationale behind the recommended improvements for cost estimating and cost management within Mn/DOT. Mn/DOT's Highway project development process, the Scoping Process, the Long Range Plan, the Highway Improvement Plan (HIP), and the State Transportation Improvement Program (STIP) are briefly described, all providing a context for the implementation of the new cost estimating and cost management processes. The relationship between CE and CM and project development is depicted in a flowchart. Cost estimating and cost management policies are also discussed, including policy guidance.

The second part of the Essentials section describes the new process of cost estimating and cost management. Key information regarding this process is discussed, including key terms and definitions, risk and contingency, total project cost components, and other important concepts. Finally, the roles and responsibilities of different participants within Mn/DOT who are involved either directly or indirectly in cost estimating and cost management are presented.

I.2.2 Section III: Practice

The practice section of this TRM describes the CE and CM process in detail. This section begins with an overview of the various estimating and risk methodologies. The steps in the preparation, risk evaluation, review, and approval of cost estimates are described for each project development phase:

- Planning;
- Scoping;
- Design; and
- Letting

Finally, the resources and training needs for proper cost estimating and cost management are discussed.

I.2.3 Appendices

The Tool Appendix describes various estimating tools aimed at addressing an Estimator's specific needs. Some of the tools are ready-to-use, while some others may require tailoring to the specific needs of the project or the District. The Appendix also provides a glossary of terms and tips for estimating.

A general framework provided in Table I.2-1 explains the relevance of the various sections and sub-sections in this TRM to the different phases in the project development process.

Table I.2-1. Framework for Layout of TRM

Project Development Phase	Estimate Type, Purpose and Plan/Program Supported	Relevant TRM Sections
Planning	**Conceptual Estimating** Estimate Potential Funds Needed (20-year plan)	Section III.1 and III.2 and Appendix
	Conceptual Estimating Prioritize Needs for Long Range Plans (HIP – 10-year plan)	Section III.1 and III.2 and Appendix
Scoping	**Scope Estimating** Establish a Baseline Cost for Project and Program Projects (HIP and STIP)	Section III.1 and III.3 and Appendix
Design	**Design Estimating** Manage Project Budgets Against Baseline (STIP)	Section III.1 and III.4 and Appendix
Letting	**Plans, Specifications, and Estimate (PS&E) Estimating** Compare with Bid and Obligate Funds for Construction	Section III.1 and III.5 and Appendix

Essentials 2

II.1 PROJECT DEVELOPMENT PROCESS AND INTERACTION WITH COST ESTIMATION AND COST MANAGEMENT PROCESSES

II.1.1 Project Development Process

In the CE/CM context, the Mn/DOT project delivery process is composed of five phases. These phases are Planning, Scoping, Design, Letting, and Construction. As seen in Figure II.1-1, these phases are not necessarily mutually exclusive in time. Guidance for development of a project through these five phases is described in the Scoping Process (Mn/DOT Scoping Process, 2008).

The Mn/DOT Project Planning – Scoping – Design cycle begins with the Project Planning Phase, in which transportation system performance needs are identified and prioritized. The most critical needs are carried forward into the Scoping Phase. During this period, the full range of functional and stakeholder groups are queried to identify potential work to be completed during the project. Decisions are made as to what will be included in the project's definition and what will not be part of its definition. These decisions are documented in a Scoping Report so that they can be conveyed to those who will work on the project. A cost estimate is also developed based on the project's definition. The defined projects are then reviewed during Programming and either included in the STIP or the 10-Year HIP or held for reconsideration the following year. Once the project is programmed in the STIP, the Design Phase commences, in which project development leads up to letting. A simplified drawing in Figure II.1-2 depicts the major activities of the Mn/DOT project development process.

Cost estimating and cost management process models developed with participation from Mn/DOT staff serve as the framework for the content covered in this manual.

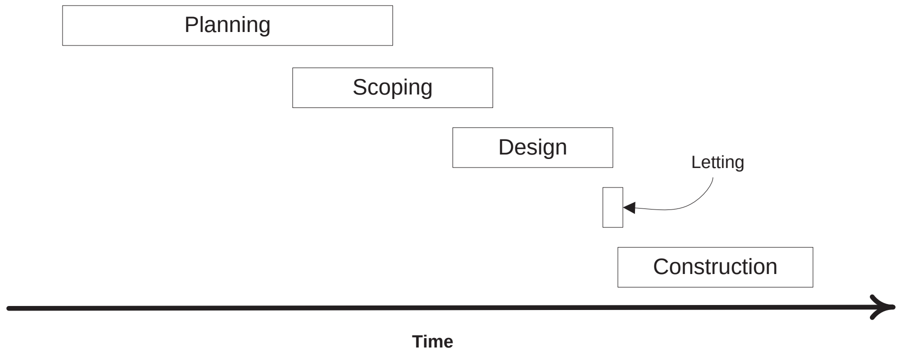

Figure II.1-1. Project Delivery Process

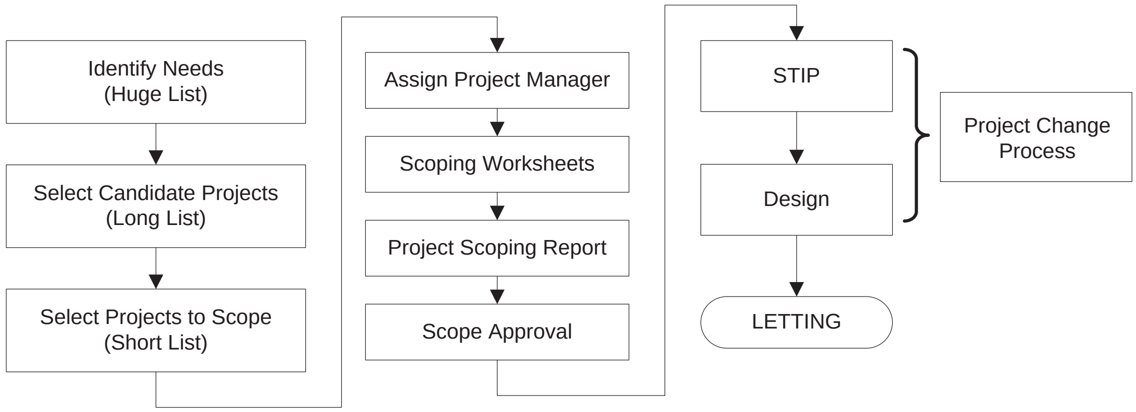

Figure II.1-2. Major Activities of Mn/DOT Project Development Process (Mn/DOT Scoping Process, 2007)

II.1.2 Plans and Programs

Federal and state regulations require that Mn/DOT prepare fiscally constrained plans/programs for projects to be completed by Mn/DOT. These plans/programs are the 20-year Long Range Plan and the four-year STIP. Mn/DOT also internally requires a 10-year HIP. The timing of these plans and programs are shown in Figure II.1-3 in relation to letting (time 0). Similarly to the project development process, these plans/programs are not mutually exclusive. The FHWA stipulates that these plans and programs must be consistent. As indicated by the name, the 20-year plan indicates the Mn/DOT plan for projects over the next 20 years. Years 10 to 20 of this plan may be very conceptual in nature, and this period aligns primarily with the Planning Phase of project development. The first 10 years of the 20-year plan is called the 10-year plan, or HIP. Projects included in the HIP are becoming better defined. Years 5 through 10 generally align with the Scoping Phase of project development. The STIP is years 0 through 4 of both the 20-year plan and the HIP. Prior to entering the STIP, a project must have completed an approved Scoping Report. Projects in the STIP are typically in the Design Phase of project development, in which plan development occurs. The timeline for conducting project planning and scoping depends on the magnitude of the project. A generalized concept of the timeframes showing a variety of project types with varying complexity is presented in Figure II.1-4. It should also be noted that timelines vary between Districts depending upon their unique program needs and District resources.

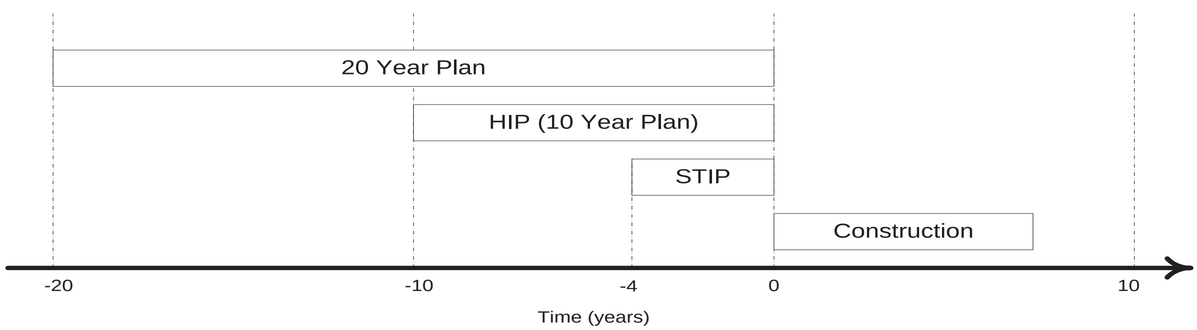

Figure II.1-3. Timing of Mn/DOT Plans and Programs

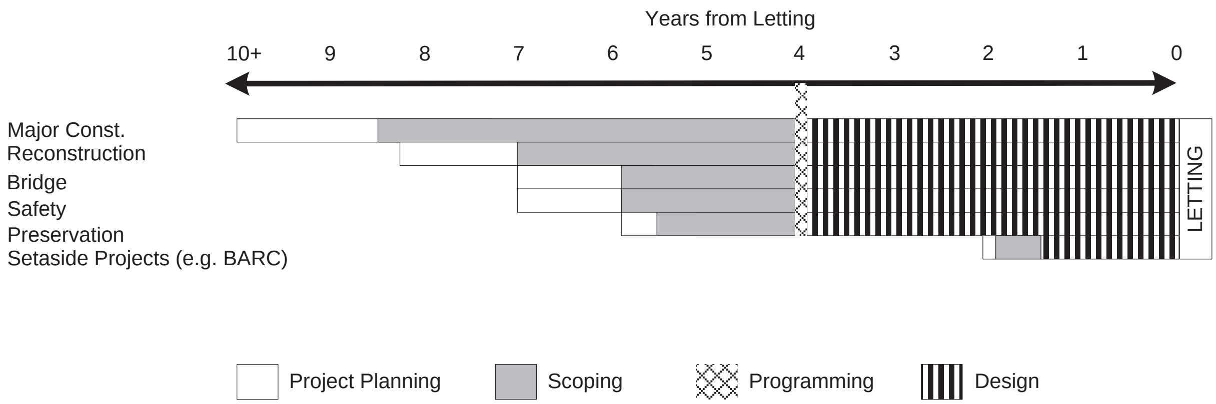

Figure II.1-4. Timeline of Project Development by Project Type

II.1.3 Interaction Between Cost Estimation and Cost Management

Both CE and CM are critical processes that occur multiple times during each project development phase. The flowchart shown in Figure II.1-5 describes the integration of the CE/CM processes with the Mn/DOT project development process phases. The right side of Figure II.1-5 represents the project development process, and the center part of the graphic depicts the CE and CM processes. The project delivery process spans the entire project life, starting from the need for transportation facilities through the construction of these facilities, whereas the CE and CM processes start after the need for transportation facilities is established, that is, during the Planning Phase and spans through the Scoping, Design, and Letting Phases. Generally, the planning and engineering design outputs from the project development process phases become the inputs to the CE and CM estimating processes, and the outputs of the CE and CM processes become inputs to project development for making financial and other decisions. These major inputs and outputs are illustrated in Figure II.1-5. Also depicted in Figure II.1-5 are the estimating types and their purpose, as related to each development phase.

As an example, during the Planning Phase of the project development process, a key input is the definition of a need described by general project concepts and complexity. This input is transformed by the CE and CM processes to generate an output, planning estimates. The Mn/DOT 20-year plan is prepared during the Planning Phase. These planning estimates support projects that are included. Similarly, a Baseline Cost Estimate, Updated Estimates, and Engineer's Estimate represent outputs of the CE/CM process. These estimates are included in plans and programs such as the HIP and STIP. The exchange of information between the project development process and the CE/CM processes is iterative because the project's definition and other project parameters change as the project needs and requirements become better defined. The final output of the Letting Phase is a complete design (final plans and specifications). This output leads to the preparation of the Engineer's Estimate. The Engineer's Estimate is compared to bids.

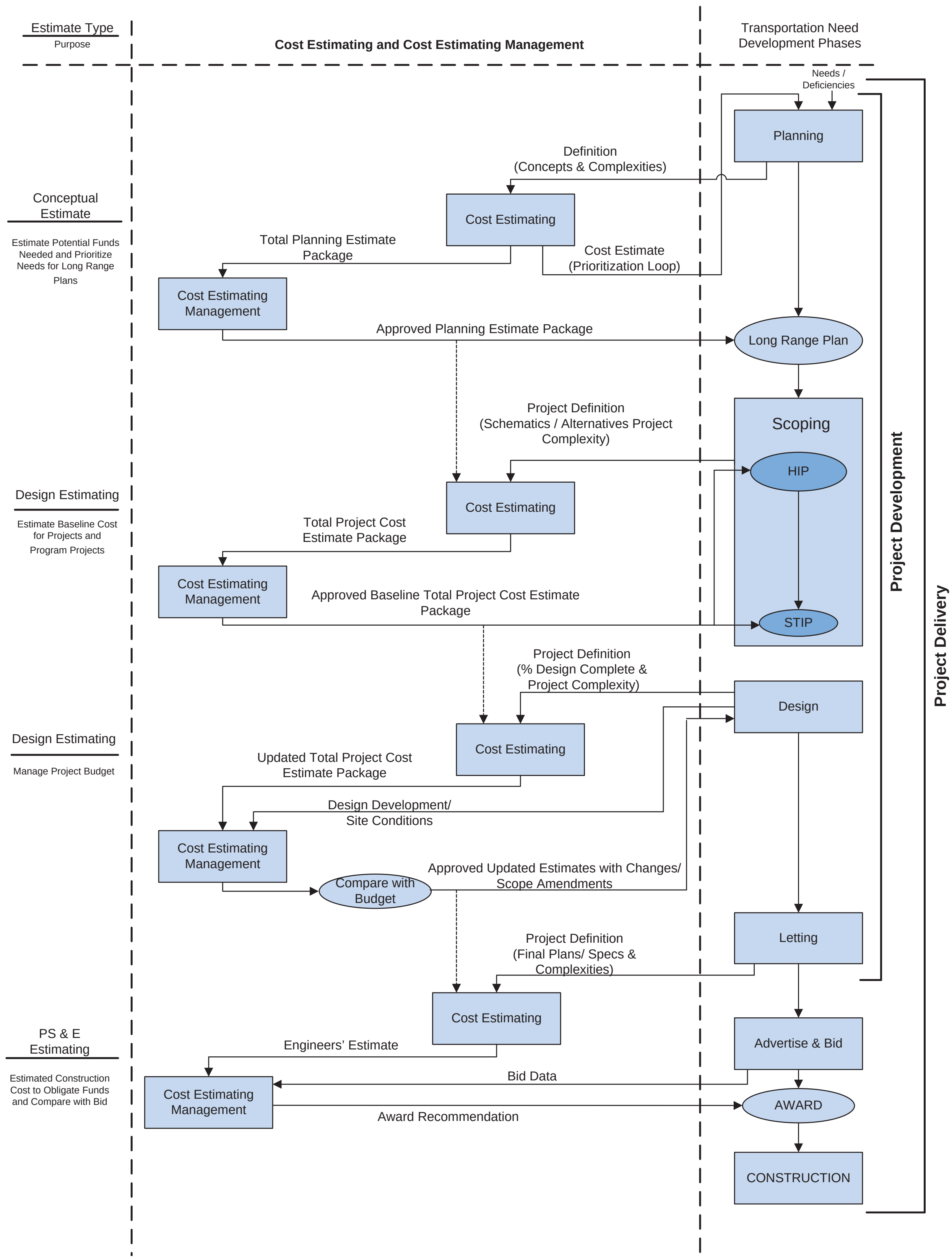

Figure II.1-5. Interaction of the Project Development Process, Mn/DOT Programs, and Cost Estimation and Cost Management

II.2 PROJECT COST ESTIMATION AND COST MANAGEMENT POLICIES

The TRM is supported by Mn/DOT management policies that elaborate upon the Mn/DOT management's vision for cost estimation and cost management. The policies are also derived from the management strategies and guiding principles described in NCHRP Report 574 (see Figure I.1-1 on page 3). The rationale for each policy and its implications for cost estimation and cost management are explained in this section in order to facilitate improved cost estimation and cost management throughout Planning, Scoping, Design, and Letting. Five management policies are defined as follows:

1. Project Cost Estimation Policy
2. Uncertainty, Risk, and Contingency Policy
3. Communications Policy
4. Project Cost Management Policy
5. Program Management Policy

Specific policy guidance was developed for each of these policy areas, some of which is referenced in Section III at appropriate places. Each policy is defined and its content summarized below. The policies provide the overall basis behind the content in the TRM, consistent with the strategic directions of the Minnesota Statewide Transportation Plan and Mn/DOT management's vision of improving cost estimation and cost management.

II.2.1 Project Cost Estimation Policy

To improve the reliability and accuracy of cost estimates, project cost estimation will be the responsibility of each of Mn/DOT's Districts and Mn/DOT's Central Office.

This policy addresses Mn/DOT management's vision of achieving statewide uniformity and consistency of project cost estimates and department-wide priority on estimating, managing, and controlling costs. Cost estimation involves the use of resources, including personnel, that have the necessary knowledge, skills, and abilities to accurately and consistently predict costs. Depending on the project phase, the primary responsibility for cost estimation will reside with either the concerned District or the Central Office (CO). The role of the Central Office will primarily be to provide cost estimating direction, support, and resources, including training opportunities, to the Districts.

Districts will have a dedicated estimating function with the primary responsibility of preparing and refining cost estimates from the Planning through the Design phases of project development. District Estimators with local knowledge will be responsible for all initial cost estimates. The Central Office estimating function is to prepare the Engineer's Estimate based on items and their quantities furnished by the Districts. Project cost Estimators will follow the cost estimating guidelines and processes outlined in this TRM. The cost Estimators will be independent in order to prevent internal and external pressures from having undue influence on the estimates. These estimates include those completed internally, as well as those prepared by consultants.

For statewide consistency, all project-related costs will be expressed as a Total Project Cost Estimate in year-of-construction dollars, regardless of the project development phase. The Total Project Cost Estimate consists of a base estimate and a contingency. Post-letting or construction contingency is included, but separately identified, to account for potential supplemental agreements, change orders, cost overruns, or incentive awards, as applicable. A Project Estimate File will be established and maintained for the life of the project, from Planning to Letting. The basis of the estimate and the inputs to cost estimating will be documented every time a cost estimate is updated.

Year-of-construction cost for each project development phase will be based on annual inflation adjustment guidelines provided periodically by the Office of Investment Management. Inflation factors will reflect the midpoint of the year of construction for projects that span more than one year.

To achieve consistent and accurate cost estimates, project cost estimates will be prepared to coincide with critical points ("gates") during the project development phases. Figure II.2-1 shows the gates in the various project development phases.

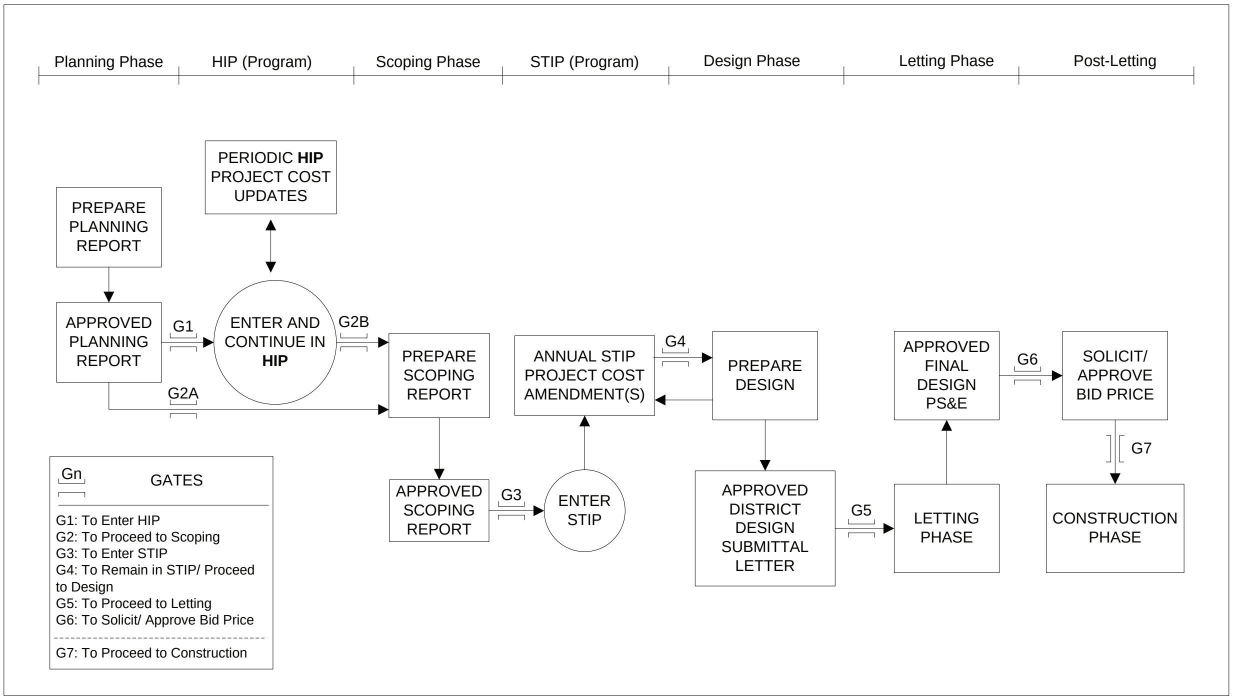

Figure II.2-1. Cost Estimate Review and Approval Gates

There are seven gates shown in Figure II.2-1. Each of these gates will require an estimate approval from the appropriate management staff before the project is allowed to move to the next phase of project development. For example, prior to a project entering the STIP, it will be required to have an approved estimate that is tied to an approved Scoping Report (Gate G3). Likewise, the same project will be required to have approved estimates at each annual STIP update. If a STIP update estimate exceeds the current approved Baseline Cost Estimate, the project will not proceed with design until the cost estimate is brought back in-line with the current Baseline Cost Estimate or receives an approved change request (see the Program Management Policy that follows in this section for more details on this process).

II.2.2 Uncertainty, Risk, and Contingency Policy

The Total Project Cost Estimate for each of the project development phases will include an analysis of uncertainty and risk, and associated contingency estimates.

This policy responds to Mn/DOT management's vision of achieving reliable and accurate estimates and statewide uniformity and consistency of project cost estimates. Uncertainty, risk, and associated contingencies will be acknowledged early for all projects in the project development process, starting with the Planning Phase, and updated in subsequent phases. Regardless of the cost estimation methodology, an element of uncertainty is inherent in any cost estimate. In order to account for as much of the uncertainty associated with a project cost estimate as is practical, project teams will use a risk analysis to estimate the contingency amount to be included in the Total Project Cost Estimate.

The extent of risk analysis, including the possible use of a specialized risk-estimation expert, will be determined by each project's complexity, local impacts, and other considerations.

A contingency estimate based on risk analysis will be developed for all projects. The extent of risk analysis, including the possible use of a specialized risk-estimation expert, will be determined by each project's complexity, local impacts, and other considerations. The specific risk analysis methodology appropriate for each project phase is described in the appropriate section in the TRM (see Section III on pages 74, 140, 212, 292). The contingency estimates will not be incorporated into individual item costs until the beginning of the Letting Phase; instead, contingency will be maintained in a separate cost element (but could be associated with specific item costs). As the project progresses throughout project development and previously anticipated risks fail to materialize or do materialize, the amount of estimated contingency and the base estimate will change accordingly. Any unused contingency will be returned to the District program as the project passes each approval gate (e.g., if there is unused contingency relating to design at the time of project letting, Gate G8, all design contingency will be returned to the program, but the construction contingency will remain with the project).

There will be no program contingency. Unexpected increases in inflation or unexpected events or conditions will be addressed by managing District programs, as performed currently. Funding shortages caused by overestimation of revenues will be addressed through the Fund Balance, contingent on fund availability, or by managing District programs (also see Program Management Policy later in this section).

II.2.3 Cost Estimate Communications Policy

To ensure that project costs are communicated consistently and uniformly statewide, regardless of project development phase, the Total Project Cost Estimate will include contingency and reflect inflation-adjusted costs.

This policy responds to Mn/DOT management's vision of achieving statewide uniformity and consistency, and improved communications and credibility with external stakeholders. To that end, the Total Project Cost Estimate prepared in each phase of project development will be communicated in a one-page summary. The project summary will be updated each time a project development phase is completed or a new cost estimate is prepared and approved. These summaries will serve to communicate project and cost information, both internally and externally, and will be reviewed and approved by District management before they are communicated to external audiences. Mn/DOT management and the Communications Office will be informed when abrupt or unanticipated changes have a significant effect on the Total Project Cost Estimate.

A key perception among various stakeholders about potential projects is the point in time when a project, along with its associated estimate, becomes a commitment by Mn/DOT to see the project through to completion. In order to avoid misperceptions in that regard, the policy guidance makes it clear that a project will not be considered "committed" unless it has been included in the STIP. Prior to inclusion in the STIP, depending on the project phase, a range of potential costs will be used to communicate each project's cost estimate (Planning Phase or early in Scoping Phase).

II.2.4 Project Cost Management Policy

Project-related costs will be managed against a Baseline Cost Estimate, which is the Total Project Cost Estimate at the time the project Scoping Report is approved (Gate G3).

This policy responds to Mn/DOT management's vision of department-wide priority on managing and controlling costs, achieving statewide uniformity and consistency, improving communications and credibility with external stakeholders, and establishing clear accountability for managing costs. Project cost management will start with management of the project's definition and apply to every project including projects funded from set-asides. Project costs will be managed against a Baseline Cost Estimate, established at the time the project is included in the STIP. While each project phase has an associated Total Project Cost Estimate, only the Total Project Cost Estimate after the Scoping Report is approved is designated the Baseline Cost Estimate, against which all subsequent Total Project Cost Estimate costs will be managed.

Once established, the project Baseline Cost Estimate will remain unchanged, so long as the original project purpose and need contained in the Scoping Report does not change. *The Scoping Report will clearly communicate what the project definition includes and what it does not include.* A project that experiences a major change in project definition will be required to have a new Scoping

Report. A Project Change Request Form is also used for minor changes that cause cost increases. Any approved change request and the corresponding cost increases or decreases will be communicated by updating the One Page Project Cost Estimate Summary immediately after the approval, and a new Baseline Cost Estimate will be prepared.

Project Managers will be responsible for cost management after a Project Manager is assigned. Project Managers will seek and obtain approval from the Program Manager and/or Assistant District Engineer for the use of contingency. As uncertainty is resolved through the project development process, unused project contingency will be returned to the District program.

II.2.5 Program Management Policy

Districts will actively manage project costs to deliver Mn/DOT's construction program within State Road Construction budget constraints and program priorities.

This policy responds to Mn/DOT management's vision of department-wide priority on managing and controlling costs, achieving statewide uniformity and consistency, and establishing clear accountability. To that end, projects will be allowed to enter the HIP after a planning-level project cost estimate is established. In addition, projects cannot be included in the STIP without an approved Scoping Report. Project-related costs will be managed against an established Baseline Cost Estimate, which is the Total Project Cost Estimate at the time the project Scoping Report is approved.

Changes will not automatically result in the removal of a project from the STIP. However, the discipline of managing projects within the Baseline Cost Estimate will be established by ensuring that the Scoping Report is accurate and complete, and Gate G3 approval (see Figure II.2-1 on page 12), as well as the performance measures, are rigorously implemented by each District and the Central Office as appropriate. Approved changes, corresponding cost increases, and the impact to the District's Construction Program will be documented and communicated in a timely manner to the appropriate people in the Central Office.

STIP amendments and administrative modifications will follow established federal requirements and processes. The Baseline Cost Estimate will remain unchanged unless the project's original purpose and need defined in the Scoping Report changes. The Scoping Report will mark the end of the discovery process and will clearly communicate what the project's definition includes and what it does not include. Whenever a change is made to the project's original purpose and need contained in the Scoping Report, such change will be considered a change in project definition. A project that experiences a change in project definition must have a new Scoping Report completed. A change request is required if the project's purpose and need do not change, but unanticipated project-related conditions or external events arise that cause a definition expansion and a resulting change in the cost estimate. After a Scope Change or change request, a STIP Review and a Program Evaluation will be required at the District level if the Total Project Cost Estimate is likely to exceed the Baseline Cost Estimate. The Project Manager will present such potential cost increases for review as soon as they are foreseen, but the approval decision will only be effective at quarterly program review meetings. Immediate review/approval/denial may occur only when a project is scheduled for letting before the next Program Evaluation Form meeting.

Approved Scope Changes and change requests, corresponding cost increases, and impacts to the District's Construction Program will be documented and communicated in a timely manner to the appropriate staff in the Central Office.

If at the conclusion of the STIP Review and Program Evaluation Form, the new Total Project Cost Estimate exceeds the Baseline Cost Estimate, the District should down-scope the project so that the Total Project Cost Estimate is less than or equal to the Baseline Cost Estimate. If down-scoping is not feasible or the Total Project Cost Estimate continues to exceed the Baseline Cost Estimate, the District must submit a project change to the Transportation Program Committee (TPC) for review. The TPC will consider the request and make a decision based on factors such as District, region, or state significance, impact, and fairness. If the TPC denies the request to allow an increase in the project Baseline Cost Estimate, the project must be taken out of the STIP. Approved Project Change Request Forms, and corresponding cost increases or decreases, will be communicated by updating the One Page Project Cost Estimate Summary immediately after approval. Approved change requests, corresponding cost increases, and impacts to the District's Construction Program will be documented and communicated in a timely manner to the appropriate staff in the Central Office.

II.3 COST ESTIMATING AND COST MANAGEMENT PROCESSES

II.3.1 Development of Mn/DOT Process Models

Process models are used to describe, communicate, represent, or simulate the function of a real-world process. In simple terms, a process transforms input into outputs by performing specific functions, activities, and/or tasks relevant to the nature of the process. A major challenge in the development of the CE and CM model was to identify all the existing and desired functions and sub-functions relevant to the Mn/DOT CE and CM process. The next step was to integrate the desired CE and CM functions with the pre-construction phases of the Mn/DOT project development process. The Integrated Definition Function Modeling (IDEF0) technique was used for modeling an integrated CE and CM process. The IDEF0 modeling technique provides a graphic description of a process or system, which leads to a better understanding of the process or system.

The modeling approach selected for this project used a series of highly interactive workshops to engage over twenty Mn/DOT staff in creating a new integrated CE and CM process model. The modeling focus covers the four phases of the Mn/DOT project development process. In order to facilitate the interactive nature of the workshops and engage key Mn/DOT staff, three working groups were formed (Estimating, Project Manager, Planning and Investment). These working groups were comprised of personnel from all eight Mn/DOT Districts, as well as Mn/DOT Central Office which are directly or indirectly involved in the CE and CM process. Additionally, representatives from the various functional groups and FHWA participated. The primary responsibility of these working groups was to develop the desired CE and CM process model facilitated by a technical team.

Using the IDEF0 node tree syntax, Figure II.3-1 represents a hierarchical decomposition of the CE and CM process by Mn/DOT's project development phases. This figure shows a three level breakdown of the CE and CM process. The top level represents the context diagram of the IDEF0 model in Figure II.3-1, which is "Perform Cost Estimating and Cost Management (A0)." The first decomposition reflects the CE and CM process corresponding to each major project development phase: "Perform CE and CM during Planning, Scoping, Design, and Letting phase." These four processes are denoted with node tree numbers as A1, A2, A3, and A4 in Figure II.3-1.

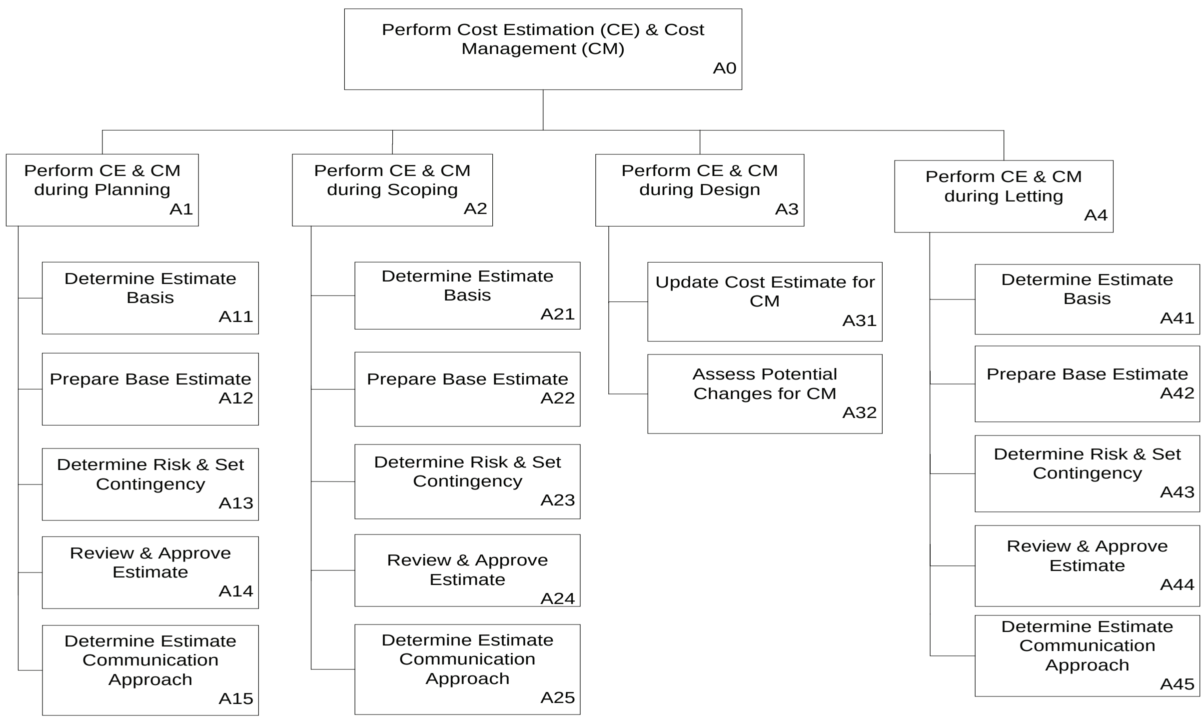

Figure II.3-1. Hierarchical Description of CE and CM Process by Project Phase

The node numbering system is based on the IDEF0 modeling technique. The second decomposition represents the further breakdown of the phase CE and CM processes from the first decomposition. Processes in the second level decomposition represent the main sub-processes to be performed for implementing cost estimation and cost management for each project development process phase and are denoted with node numbers A11, A12, A13, and so on (see Figure II.3-1 above). Each decomposition provides more specific details related to the CE and CM process model. Figure II.3-2 illustrates the complete hierarchical decomposition for the Scoping Phase and focuses on the desired steps (e.g., A211, A212, etc.) in the CE and CM process to achieve the goal of preparing accurate, reliable, and consistent estimates throughout Mn/DOT. These steps are described in detail in the relevant sections, such as the section on CE and CM during the Scoping Phase (Section III.3 on page 109).

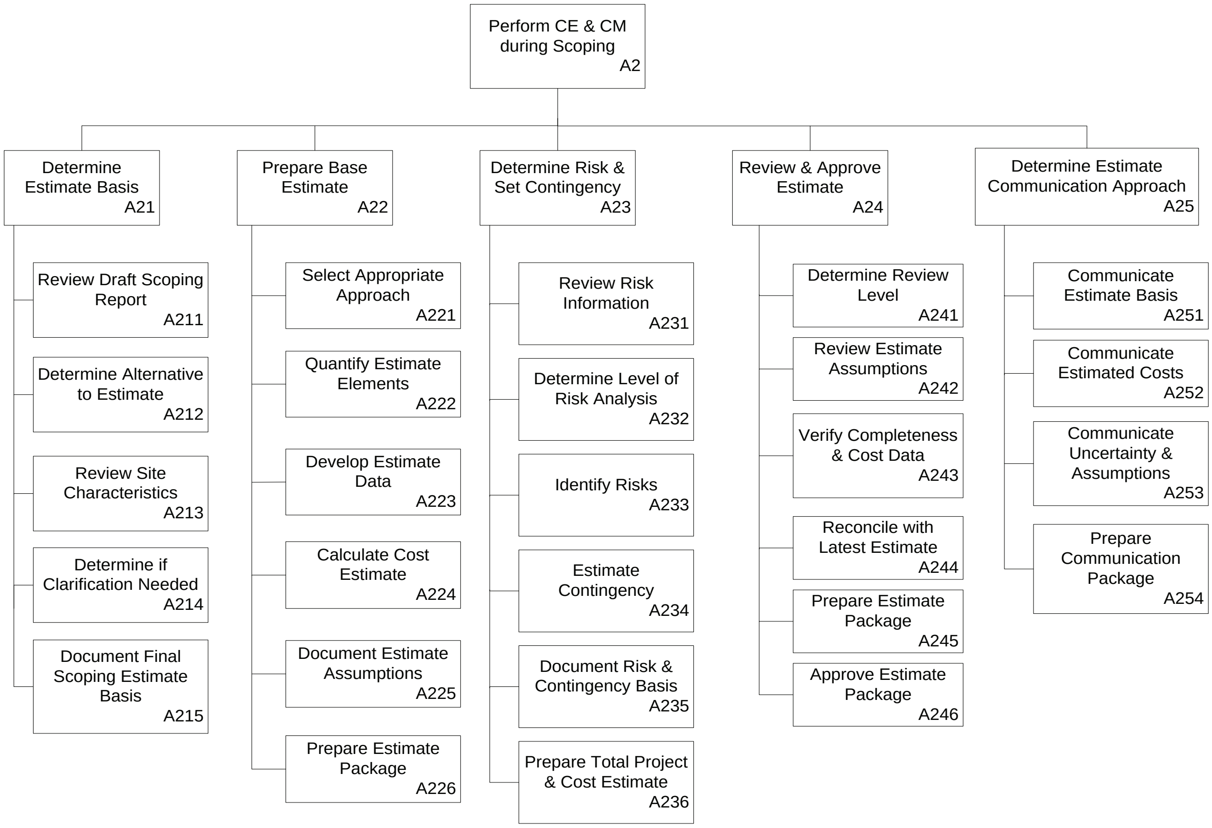

Figure II.3-2. Hierarchical Description of CE and CM Scoping Process by Sub-Processes and Their Steps

II.3.2 Key Information and Process Deliverables

This sub-section covers information that is applicable across all chapters in the Practice section of the TRM. Included in this sub-section are key definitions, risk and contingency, total project cost categories, and other key concepts.

II.3.2.1 Key Definitions

Many terms are used throughout the TRM. Some key terms are defined next. Other terms are defined in Appendix IV.1 of this manual.

Project Development Phases

1. **Planning Phase**: The project development phase that identifies long-term system and corridor improvements. The planning level project estimates prepared in this phase are *Conceptual* cost estimates and are specified in a range that is expressed in inflation-adjusted dollars and are used to support the statewide 20-year Transportation System Plan (TSP). The estimates in the 10-year HIP and District plans are also expressed in inflation-adjusted dollars.

2. **Scoping Phase**: The project development phase that defines the project requirements and risk (or uncertainties) and includes activities such as traffic forecasting, surveying, preparation of environmental documentation, public involvement, identification of right-of-way, and identification of utilities. The *Scope* cost estimate at the end of this phase, including project contingency, is the *Baseline Cost Estimate* for cost management and is expressed in year-of-construction dollars.

3. **Design Phase**: The project development phase that includes activities required for setting construction limits, plan development, right-of-way, and a submittal of final project plans, specifications, and estimate. The *Design* cost estimate at the end of this phase is the equivalent of the District (including Bridge) Engineer's Estimate.

4. **Letting Phase**: The last project development phase that involves the preparation of the *Engineer's Estimate* and core letting activities, such as advertising and bid evaluation leading up to contract award. The PS&E documentation assembled in this phase requires Mn/DOT approval before state funds and federal funds, if any, can be authorized for the project to proceed with contract award and project construction.

Project Cost Estimating and Program Cost Management Terms

1. **Cost Estimating and Cost Management Process Model**: A tool for standardization and documentation of the project cost estimating and cost management activities and deliverables, from the Planning Phase through the Letting Phase.

2. **Program Cost Management**: Managing the HIP and the STIP budgets over time to minimize program disruptions caused by project cost deviations and incorporating approved changes when they occur after the STIP and HIP budgets are approved.

3. **Project Management**: Management of the project scope, schedule, and cost through seamless integration of the project purpose and need, the stakeholder requirements, and the resources for project development, engineering, safety, and quality.

4. **Project Cost Management**: The process for managing the cost estimate through reviews and approvals, communicating estimates, monitoring scope and project conditions, evaluating the impact of changes, and making estimate adjustments as appropriate. Project cost control is the process of controlling deviations from the estimated project costs and monitoring the risks and contingencies associated with changes.

5. **Project Cost Estimating**: The processes for approximating all project costs. Project cost estimating involves the following steps: determine estimate basis, prepare base estimate, determine risk and set contingency, and review total estimate.

Other Related Terms

1. **Risk**: A known or unknown event or condition that cannot be adequately defined or estimated with confidence at the time of preparing an estimate.

2. **Base Estimate**: The most likely project cost estimate in any phase at any time, which normally includes all estimated known project costs, but *does not include project contingency.*

3. **Project Contingency**: An estimate of costs associated with identified risks, the sum of which is added to the base estimate.

4. **Total Project Cost Estimate**: The sum of the project base estimate and the project contingency, in any phase at any time.

5. **Baseline Cost Estimate**: The most likely estimated project cost including project contingency, which is included in the STIP and constitutes the approved project budget against which project costs are managed.

6. **Scope Changes**: Changes in the requirements or specifications on which the design is based. Examples would include changes to project limits, work types, or capacity factors, such as traffic loads, vehicles per lane, or storm water factors.

II.3.2.2 Risk and Contingency

Uncertainty and risk play a major role in cost escalation throughout project development. Cost estimating methods and tools must relate and adapt to the various phases of project development. When estimating costs, particularly on large and complex projects, this becomes even more profound. In the Planning and Scoping Phases of project development, Estimators have very little information with which to work, and the information that they do have is often fraught with uncertainty. The Washington State Department of Transportation (WSDOT) developed a cost estimate classification system based on a similar system developed by The Association for the Advancement of Cost Engineering International (AACEI). This cost estimate classification system has five classifications. It provides an expected range of accuracy for each classification given a project maturity and a representative estimating methodology. Table II.3-1 shows the estimate classification system as it corresponds to the four Mn/DOT project development phases. Planning estimates are based upon the lowest level of project definition, and Letting estimates are closest to full project definition and maturity.

Table II.3-1 conveys a few key concepts. First, it describes a number of end usages for estimates, which relate directly to the procedures and tools described in Section III of this TRM. Second, it describes the methodological approach to the estimate as either *stochastic*[2] or *deterministic*, depending upon the level of design and information available. While other states are using stochastic estimates, this technique has only recently been employed by Mn/DOT. This is an important concept and change.

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2 Stochastic estimates combine traditional estimating methods for known items and quantities with risk analysis techniques to estimate uncertain items, uncertain quantities, and risk events. The stochastic portion of the estimate typically focuses on a few key uncertain variables and combines Monte Carlo sampling and heuristics (rule-of-thumb) to rank critical risk elements. This approach is used to establish the range of the Total Project Cost Estimate and to define how contingency should be allocated among the critical elements. Stochastic estimates apply only to most complex (major) projects, as explained throughout Section III of this TRM.

Table II.3-1. Cost Estimate Classification System

Project Development Phase	Project Maturity (% project definition completed)	Purpose of the Estimate	Estimating Methodology	Estimate Range
Planning	0 to 2%	**Conceptual Estimating** Estimate Potential Funds Needed (20-year plan)	Parametric (Stochastic or Judgment)	-50% to +200%
	1% to 15%	**Conceptual Estimating** Prioritize Needs for Long Range Plans (HIP – 10-year plan)	Parametric or Historical Bid-Based (Primarily Stochastic)	-40% to +100%
Scoping	10% to 30%	**Scope Estimating** Establish a Baseline Cost for Project and Program Projects (HIP and STIP)	Historical Bid-Based or Cost-Based (Mixed, but Primarily Stochastic)	-30% to +50%
Design	30% to 90%	**Design Estimating** Manage Project Budgets Against Baseline (STIP, Contingency)	Historical Bid-Based or Cost-Based (Primarily Deterministic)	-10% to +25%
Letting	90% to 100%	**PS&E Estimating** Compare with Bid and Obligate Funds for Construction	Cost-Based or Historical Bid-Based Using CES (Deterministic)	-5% to +10%

Figure II.3-3 depicts how identifying, quantifying, and managing cost uncertainty relates to cost management. Two primary points are illustrated in Figure II.3-3, which apply to situations where the scope is unchanged and where an estimate includes uncertainty. The first point is that there should be a reduction in the range of cost uncertainty as a project proceeds from concept to completion. The reduction in estimated cost is a result of better defining cost

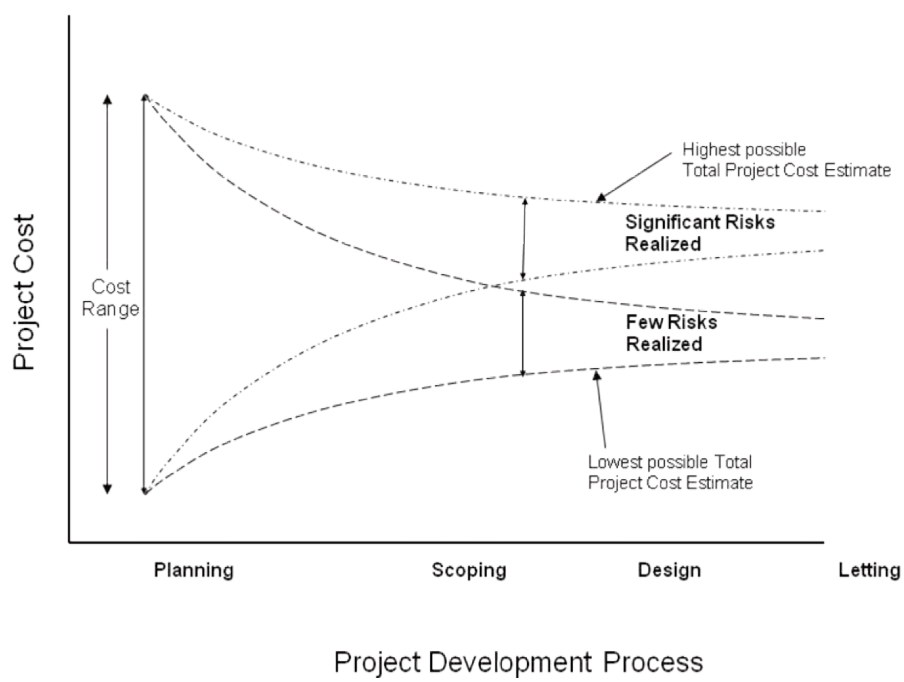


Figure II.3-3. General Refinement of a Cost Estimate

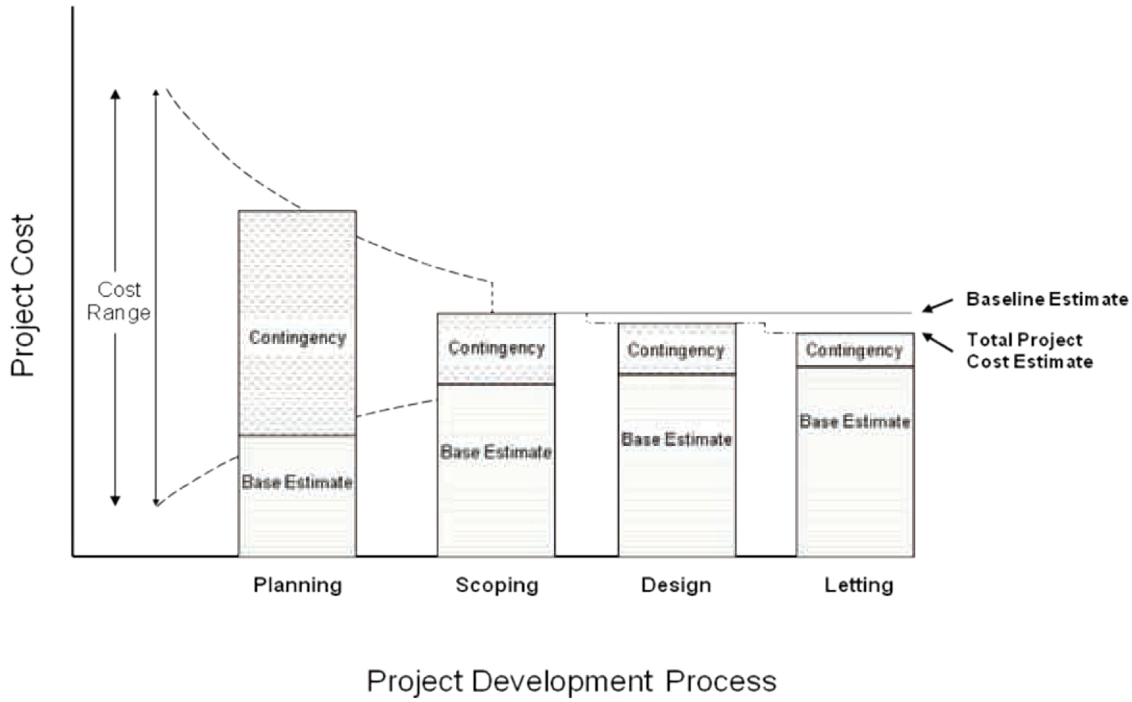


Figure II.3-4. Refinement of a Cost Estimate with Total Project Cost Estimate less than Baseline Cost Estimate

variables and eliminating uncertainty as cost factors are finally incorporated in the project plan. The second point is that, if the problems or uncertainties included in the early stages of a cost estimate do materialize, then a higher range of the cost estimate will be expected. In contrast, when risk management and other cost control processes are used effectively, a lower range of expected costs will likely result.

While Figure II.3-3 is generic for all projects, Figure II.3-4 shows how uncertainty and contingency are being incorporated into the Mn/DOT CE and CM process through the CE and CM Process Model and the Mn/DOT CE and CM policies. A few key points are shown in Figure II.3-4:

- Use of Cost Ranges at the Planning Phase – Planning Phase estimates, particularly on a more complex (major) project will be communicated through a range. Planning Phase estimates contain the most uncertainty of any estimate throughout project development. The FHWA now allows the use of range estimates in Planning Phase documents. As depicted in the cost estimate column at the Planning Phase, the contingency can be very large. In fact, the contingency can potentially be larger than the base estimate if very little is known about the project's definition.

- Application of a Baseline Cost Estimate at the Scoping Phase – As stated earlier in this section, the Scoping Report marks the end of the discovery process. The estimate that is included with the approved Scoping Report sets the Baseline Cost Estimate for cost management. As delineated in Figure II.3-4, the Baseline Cost Estimate is made up of both a base estimate plus a contingency.

- Contingency Resolution throughout the Design and Letting Phases – As the project matures from Scoping through Letting, the contingency is lowered and the base estimate increases. The percentage of the contingency to the base estimate is a function of the project complexity and the level of project definition. Procedures and tools for estimating an appropriate contingency are provided throughout Section III and the Tool Appendices.

- Cost Management to the Baseline throughout the Design and Letting Phases – As stated in the CE and CM Project Cost Management and Program Management Policies earlier in this section, the Baseline Cost Estimate cannot be exceeded after the Scoping Phase without a change request. Figure II.3-4 shows a project in which the Design and Letting Phase cost estimates were less than the Baseline Cost Estimate. In this case, the contingency will be returned to the program as stated in the CE and CM policies. If the Design and Letting Phase cost estimates were higher than the baseline, one of three options would be pursued: 1) the project's definition (scope) would be reduced to meet the baseline cost estimate and the baseline would remain unchanged; 2) a change request *would be approved* by the TPC and the baseline would increase accordingly; or 3) a change request *would not be approved* by the TPC and the project would be removed from the STIP.

II.3.2.3 **Total Project Cost**

Mn/DOT's vision for cost estimating and cost management calls for well-documented and complete cost estimates with clearly spelled-out assumptions and risks that can be easily communicated. The key to realizing that vision is a universal understanding of all components of a project's cost estimate. The components of the Total Project Cost Estimate, Table II.3-2 on page 24, are essential to developing a shared understanding of all the costs that are potentially associated with transportation infrastructure projects. Broadly, the *Total Project Cost Estimate* includes the *Base Estimate*, the *Contingency* to account for the risks associated with the base estimate, and the *Inflation* adjustment amount to express the cost estimate in year of construction dollars.

Base Estimate – The base estimate is the most likely project cost estimate in any phase at any time, not including project contingency. Depending on the size and the complexity of each project, the actual amounts corresponding to each cost component will vary. However, the Estimators as well as the approving authority must consider all the components when estimating and communicating project costs. The base estimate includes the cost components shown in Table II.3-2.

Mn/DOT's vision for cost estimating and cost management calls for well-documented and complete cost estimates with clearly spelled-out assumptions and risks that can be easily communicated.

Table II.3-2. Classification of Total Project Cost Estimate Components

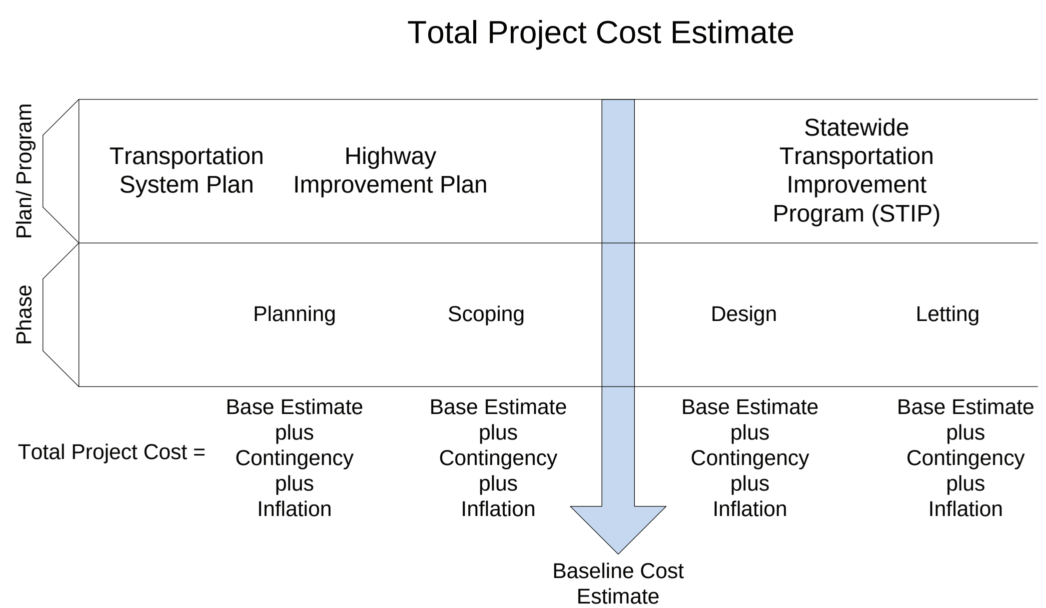
TPCE	Raw Total	Division	Group	Category	Element	Item
Total Project Cost Estimate (inflation applied to year of expenditure)	Total Project Cost Estimate (before inflation)	1.0 Engineering and/or Other Services	1.1 Internal	1.1.1 Project Development	1.1.1.1 Environmental / Historical Studies and Preliminary Design	
					1.1.1.2 Detailed Design	
					1.1.1.3 Communications / Public Information	
					1.1.1.4 Traffic Management: Enforcement and Incident Mgt	
				1.1.2 R/W Engineering / Surveying / Acquisition / Turn-Back		
				1.1.3 Construction	1.1.3.1 Administration / Inspection Testing	
					1.1.3.2 Traffic Management: Extraordinary Enforcement and Incident Mgt.	
					1.1.3.3 Communications / Public Information	
				1.1.4 Pre-Letting Environmental Clean-up / Mitigation		
			1.2 External	1.2.1 Project Development	1.2.1.1 Environmental / Historical Studies and Preliminary Design	
					1.2.1.2 Detailed Design	
					1.2.1.3 Communications / Public Information	
					1.2.1.4 Traffic Management: Enforcement and Incident Mgt.	
				1.2.2 R/W Engineering / Surveying / Acquisition / Turn-Back		
				1.2.3 Construction	1.2.3.1 Administration / Inspection / Testing	
					1.2.3.2 Traffic Management: Extraordinary Enforcement and Incident Mgt.	
					1.2.3.3 Communications / Public Information	
				1.2.4 Pre-Letting Environmental Clean-up / Mitigation		
		2.0 Construction	2.1 Primary Construction Letting(s)	2.1.1 State Share of Letting	2.1.1.1 Construction Element	2.1.1.1.1 Item
			2.2 Incentives			
			2.3 Post-Letting Contract Increases	2.3.1 Supplemental Agreements		
				2.3.2 Change Orders		
				2.3.3 Overruns		
			2.4 Agreements	2.4.1 Detours and Haul Roads not in Letting Contract		
				2.4.2 Local / Municipal		
				2.4.3 Utilities		
				2.4.4 Railroads		
				2.4.5 Supporting Contracts		
				2.4.6 Turn-Backs		
			2.5 Post-Letting Environmental Clean-up / Mitigation			
			2.6 Separate Landscaping Project Letting			
			2.7 State Share of Local Lettings			
		3.0 Right of Way	3.1 Standard Real Estate Purchase	3.1.1 Total Takes		
				3.1.2 Partial Takes		
			3.2 Relocation Costs	3.2.1 Residential		
				3.2.2 Commercial		
			3.3 Eminent Domain Awards			
			3.4 Access Control Purchase			

Contingency – The amount of contingency included in the cost estimate at any time in project development includes the following:

- Pre-Letting letting contingency corresponding to all elements of the base estimate
- Post-Letting letting (construction) contingency/supplemental agreements
  - Change orders
  - Cost overruns
  - Incentives
  - Supplemental Agreements

Inflation – Federal guidelines and good practice require that project cost estimates are expressed in year-of-construction dollars. Therefore, Mn/DOT cost estimating and cost communication policies require that all project costs must be inflated to the midpoint of construction in accordance with the guidance provided by the Mn/DOT Office of Investment Management.

Figure II.3-5 illustrates the concept of the estimate for total project cost. The terms, including the four project development phases, are defined elsewhere in this manual.



Note: The Total Project Cost Estimate in the STIP does not include internal Mn/DOT costs; please see the sub-section titled Relationship to STIP

Figure II.3-5. Relationship of Total Project Cost to the STIP

Some components of the Total Project Cost Estimate are not included in the STIP in order to be consistent with the federal guidelines for the STIP. The costs that are not included in the STIP are as follows:

- Pre-Letting Engineering: Internal—Mn/DOT
- Construction Engineering: Internal—Mn/DOT
- Pre-Letting Communications/Public Information
- Turn-Backs: Before

However, to be consistent with the Cost Estimate Communication Policy and for the purpose of communication with the stakeholders, all actual project costs will be tracked against the Total Project Cost Estimate. This will establish accountability for all project costs and avoid miscommunications about the total cost of the project to the external shareholders. Performance measures are also based on the part of the Total Project Cost Estimate that is in the STIP.

II.3.2.4 Inflation

Federal regulations require that transportation budgets include project cost estimates that are inflation adjusted to the midpoint of construction. To that end, Mn/DOT's Office of Investment Management will periodically provide inflation guidance to all Districts. However, Estimators will have to carefully document how the inflation adjustment guidance is used when estimating project costs. The data used and the assumptions, if any, should also be carefully documented. For example, the Estimator will have to make assumptions about the estimated midpoint of construction. A sensitivity analysis of the effect of changes in the assumptions and the indexes on the cost estimate should also be considered for the purpose of uncertainty and risk analysis.

II.3.2.5 Baseline Cost Estimate

Cost management is not effective unless a baseline cost is fixed. This baseline cost is the benchmark used to manage the project. As seen in Figure II.3-5 , the Baseline Cost Estimate is made at the end of the Scoping Phase and prior to entry into the STIP. It is defined as the most likely estimated project cost including project contingency and future inflation, which is included in the STIP and constitutes the approved project budget against which project costs are managed. The Baseline Cost Estimate is determined in the Scoping Phase and typically in the fifth year from Letting, just prior to programming the project for inclusion in the STIP.

II.3.2.6 Cost Estimate Package

Each phase of the project development process has as a key deliverable an "Approved Cost Estimate Package." This package would contain a summary of the total project cost, detailed cost estimate sheets, estimate basis (definition), estimate assumptions, and risks and contingency evaluation with appropriate documentation. This cost estimate package is reviewed and approved by the Project Manager and District management. The level of detail and contents of the cost estimate package will vary depending on the project phase and level of project definition.

II.3.2.7 Communications Package

A communication package is prepared at the end of each cost estimate cycle. This package is a One-Page Project Cost Estimate Summary of key project elements, such as the project description, project benefits, project risks, cost and schedule information (in ranges, a point estimate, or other descriptive information consistent with the project phase), changes since the last estimate, and other pertinent information. The intent of the communications package is to convey key project information to both internal and external stakeholders in a consistent and easy-to-follow format.

II.3.3 CE and CM Roles and Responsibilities

CE and CM are not processes performed by a single individual. The entire Mn/DOT organization is involved in cost estimating and cost management, either directly or indirectly for each project, as are many external participants. For each step in the CE and CM process, there may be different participant roles and responsibilities. For the purpose of this manual, the participants involved are divided into four areas:

- **Management**: Management is essentially the participants in charge of making high level decisions about projects. They take the role of overseeing all projects and have the authority to approve or disapprove any actions within their jurisdiction.

- **Estimating**: Estimating participants are those who actually produce the estimate, cull the information to produce the estimate, or oversee the estimating process.

- **Project Management**: Project Management includes those participants responsible for the individual projects or sub-projects within a District. They oversee a limited number of projects but are involved in projects in greater depth. Project Management also includes Functional Groups that provide input for their areas of expertise.

- **External Stakeholders**: The participants who are external to Mn/DOT and who are involved with individual projects in some form or fashion.

The entire Mn/DOT organization is involved in cost estimating and cost management, either directly or indirectly for each project.

II.3.3.1 Management

The Commissioner's Staff: The Commissioner`s Staff sets transportation policy and direction, approves the State Transportation Plan, and provides department leadership to help the governor's administration achieve its vision and goals for the state.

Transportation Program Committee (TPC): The TPC sets the goals and objectives of the State Transportation Program, as well as the investment levels for the various parts of the program, that is, preservation, bridge, new construction, safety, and so on. The TPC also approves and disapproves requests to increase costs of projects above their baseline cost estimates.

District Engineer: The District Engineer oversees the design and construction of all projects in his or her jurisdiction. He or she does not focus primarily on one project, but all projects to ensure that they are designed, constructed, or maintained in the best interests of Mn/DOT and the public.

Assistant District Engineer: The Assistant District Engineer assists in the duties of the District Engineer and helps to ensure that project details have not been missed or overlooked.

II.3.3.2 Estimating

Office of Project Scoping and Cost Management: This office plays a key role in ensuring statewide uniformity and consistency and improved communication and credibility with external stakeholders. The Office of Project Scoping and Cost Management is also responsible for estimating costs of major projects as defined by the FHWA and drawing staff from the Districts to that end. The details of how this office comes into being are addressed in the Implementation Plan after discussions with the Project Team and approval from the Policy and Oversight Group.

Central Office Estimator: The Central Office Estimator is consulted throughout the project to ensure the completeness and accuracy of the estimates. They are also accountable for the Estimate Package prepared during the Letting Phase.

District Estimator: The District Estimator is responsible for preparing and communicating all estimates within his or her District.

II.3.3.3 Project Management

Project Manager: The Project Manager is responsible and accountable for completing all phases of a project through completion, once assigned to a project. The Project Manager makes all project level decisions and communicates information to the upper management.

Design: Design Managers are consulted throughout all phases to ensure that a complete and detailed estimate is prepared based on the most current definition of the project.

Right of Way (ROW): The ROW Managers are consulted when determining estimated costs and quantities for obtaining Right of Way for new or expanded construction.

Utilities: The Utilities Managers are consulted when determining the estimated costs and quantities for the new installation, relocation, or addition of utilities on a project.

Materials: The Materials offices is consulted on pavement design, foundation design and material sources, not so much on price.

Construction: Construction is consulted on staging, schedule (contract time), and contract administration issues, including potential incentives and disincentives related to contract time.

Traffic and Safety: The Traffic and Safety Managers are consulted when determining an estimate of traffic control and safety measures needed for a project.

Construction Managers: The Construction Managers are in charge of the actual construction of the project.

Railroad: The Railroad Managers are consulted on all issues pertaining to the railroad. They can verify the completeness of the estimate pertaining to issues such as, but not limited to, new specifications, cost estimates, and timelines.

Maintenance: Once the facility is built, it must be maintained, and this is the responsibility of Maintenance. Even though Maintenance is in charge once the facility is built, Maintenance input is necessary during the project development process.

Geographical Information System (GIS): This is a tool used by Mn/DOT to display various types of data in many functional areas to allow Mn/DOT to make more informed decisions.

Communication/Public Relations: Communication Managers are responsible for developing strategies and methods to inform and update external and internal stakeholders of the department's plans and objectives (both present and future), project information, road conditions and detours, etc.

Planning: Planning Directors are responsible for the development of the 20-Year Plan (long-range), the Ten-Year Plan (HIP), and the STIP.

State Aid: State Aid Managers oversee the development of local projects (county and municipal) that receive federal and state aid. They also act as a liaison between Mn/DOT and local units of government on various transportation issues.

Modal Offices: Modal Offices include Transit, Aeronautics, Railroads, Freight (both Trucking and Waterway), Pedestrians, and Bikeways. These offices need to be included in the project development process.

Bridge: The Bridge Managers are consulted on all issues pertaining to bridges. They can verify the completeness of the estimate pertaining to issues such as, but not limited to, new specifications, material costs, constructability, and timelines. The Bridge office may also provides District Estimators with estimates specifically regarding the bridge or other structures on the project.

Water Resources/Hydraulics: The Water Resources office is consulted pertaining to drainage issues. They may provide quantities and estimates for associated work.

Design-Build (D-B): This is a project delivery method. The statewide responsibility for D-B resides in the Office of Construction and Innovative Contracting. This office assists the Districts in determining if D-B should be used as the delivery method and, if so, also assists in developing the contract documents to be included in the Request for Proposal.

Municipal Agreements: Municipal Agreement Managers need to be consulted to determine the level of cost participation of Mn/DOT on local projects and the local participation on Mn/DOT projects.

Environmental: Environmental Managers need to be consulted for input and estimated costs during project development for such items as the Minnesota State Historic Preservation Office (SHPO), contaminated soils, wetland mitigation, and hazardous materials.

Consultant Services Office: Consultant Services Managers oversee the procurement process to contract for consultants to perform work that is being outsourced by Mn/DOT.

II.3.3.4 External Stakeholders

Legislature: The legislature is involved with Mn/DOT operations through providing funds and demanding accountability. The funds provided may be general funds for the operation of Mn/DOT, for specific projects, or through special appropriations, such as bonding packages. Accountability may be sought through formal or informal processes. The legislature may audit Mn/DOT or simply review previous programs.

Public: Law requires that the public be kept aware and involved throughout the project development process. The involvement of the public can have a significant impact on the project development process, cost estimation, and cost management.

Business: Local businesses, like the public, are kept abreast of the Mn/DOT project development process and can become very active participants.

Local Partners: Local partners may include local municipalities or Metropolitan Planning Offices (MPOs). These partners may bring funding of their own to the Mn/DOT project or through way of an adjacent project that they would like to tie in with the Mn/DOT project. The local partners may also have special project requirements that they would like Mn/DOT to provide in developing the project.

Federal Highway Administration (FHWA): This federal agency oversees Mn/DOT in its use of federal highway funds.

Regulatory Agencies: These are federal, state, and local agencies that need to be consulted during the project development process. They need to be included early in the process so there is a good understanding of the regulatory needs and the accompanying costs. Most often approvals from these agencies are needed to proceed with the projects.

American Consulting Engineering Council (ACEC): ACEC of Minnesota represents its consultant members in many areas, including the legislature. ACEC works with Mn/DOT on many issues related to procurement, quality, and so on. It acts as the consultant industry's voice to Mn/DOT.

Association of General Contractors (AGC): This association represents contractors and suppliers who perform work for Mn/DOT. The association works with Mn/DOT to resolve various industry-wide issues, such as construction specifications, D-B issues, procurement issues, and construction methods.

II.3.3.5 RACI Diagram

A RACI Diagram is a matrix that aids in visually portraying the roles and responsibilities of a person or party involved in a project. The diagram lists the parties involved vertically along the top of the chart, beginning with the higher-level management positions on the left and moving to project level positions and then external stakeholders on the far right. Down the left side of this diagram is a list of duties that can be assigned to each of the positions listed along the top. The assignment of these duties varies between the four different types of roles that make up the acronym RACI. The descriptions of these roles are as follows.

- **"R" Responsible** – All participants who are in charge of completing the task. In essence, this is the doer of the task.
- **"A" Accountable** – The participant who is answerable for the proper completion of the task, that is, the owner. This must be limited to only one person or party. This position must come with some authority.
- **"C" Consulted** – The participants who are consulted for information or input during the completion of a task, that is, a person "in the loop." This is a back-and-forth communication. This may be a subject matter expert, such as someone from a Functional Group, who can provide critical information during performance of the CE/CM process.
- **"I" Informed** – The participants who are continually kept current on the status of the project as the activities of the project are performed, that is, "kept in the picture." For instance, once the cost estimate has been approved, a group may need to be informed; perhaps this group needs to take some action that cannot happen until the estimate has been approved.

The groups at the top of the diagram have their assigned roles listed beneath their heading in the vertical grid lines assigned to them. An example RACI diagram is shown in Figure II.3-6 to better illustrate these points.

ACTIVITIES	Project Manager	District Estimator	O□ce of Project Scoping and Cost Management	Assistant District Engineer	Functional Groups	FHWA
Prepare Estimate	A	R	C		C	
Determine Risk	A	I	R	C	C	C
Submit Estimate	A	R		C	I	I

Figure II.3-6. Example RACI Diagram

Notice that Project Manager is accountable for the proper completion of all of the tasks, yet District Estimator and Office of Project Scoping and Cost Management are responsible for performing some tasks. The rest of the people involved are consulted for information or informed about the progress.

II.3.3.6 Overview of Mn/DOT Roles and Responsibilities

Responsibilities for the CE and CM sub-processes are described using a RACI Chart through each of the four types of roles. Within each of the respective phase chapters, the sub-processes are further defined, and the RACI information is provided as a guide. Additionally, a RACI tool is available for further customization in the Tool Appendix, on page 335. This allows each District to tailor the roles and responsibilities to their individual needs either across the District or for an individual project.

Practice

3

III.1 OVERVIEW OF COST ESTIMATION AND RISK METHODOLOGIES

III.1.1 Introduction

Cost estimating is performed throughout the project development process, as shown in Figure II.1-5 on page 10. The methodology employed for preparing a cost estimate depends upon the purpose of the cost estimate, the project phase in which the cost estimate is being prepared, and the basis or the data available for preparing the cost estimate. A cost estimate can be prepared from the bottom-up, based on individual items representing construction work, or top-down, based on a few key parameters that are known to drive a project's cost.

A cost estimate can be prepared from the bottom-up, based on individual items representing construction work, or top-down, based on a few key parameters that are known to drive a project's cost.

While a cost estimate should always be communicated in year-of-construction dollars, which are typically inflated to the midpoint of construction, the estimate is first prepared based on current-year dollars for a specific location and unique project characteristics. A key concept that is applicable to preparing any estimate is that the reference historic cost data used for pricing the estimate is adjusted or "normalized" to account for the age of the data and the project location and characteristics from which the data is derived, all in relation to the project being estimated. Frequently, historic cost data reflects project specific data that are often different from the time in which an estimate is prepared. A cost index is used to adjust this historical data to reflect current or present-day costs. Historical project cost data usually apply only to the specific locations where the past projects were built. Consequently, the relative difference in the cost of materials, equipment, and labor between locations of past projects and the current project requires an adjustment of cost data when preparing a current project estimate. Project size can affect cost because economies of scale can drive costs higher or lower depending on the volume of materials placed. An adjustment is often applied based on the relative size of past projects compared to the project for which the cost estimate is being prepared. When specific historic bid data is used, this bid data should reflect the quantity of material estimated for the current project.

The structure of the Total Project Cost Estimate is described in Table II.3-2 in Section II on page 24. As estimates are prepared over the project development process, costs are estimated in greater detail. A six-level hierarchical classification structure of Total Project Cost Estimate (TPCE) components is shown in Figure

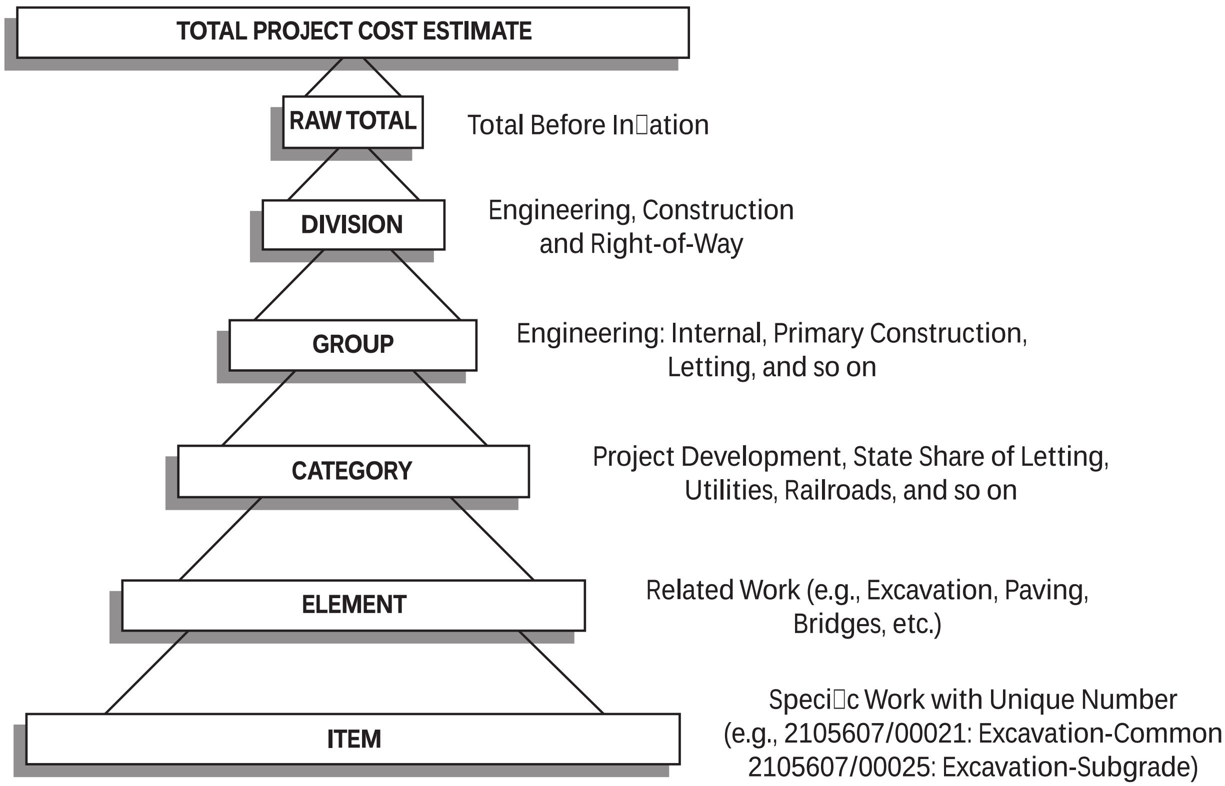


Figure III.1-1. Hierarchical Classification of a Total Project Cost Estimate Components

III.1-1. The majority of cost estimating techniques presented in this manual focus on categories, elements, and/or items. Project costs are summarized at the group, division, and raw total component levels.

As shown in Figure II.1-5 on page 10, cost estimate are also described as Conceptual, Design, and PS&E, depending on the project development phase. The level of project definition also varies depending on the development phase. At one extreme, only major project parameters are known. At the other extreme, every detail that describes the project is known. As a result, different cost estimating techniques are required and are associated with both different development phases and components of the hierarchical classification.

III.1.2 Planning Estimating Techniques

During the Planning Phase of project development, prior to any detailed design work, there is limited information about the project. However, there is the need to establish the approximate cost in order to evaluate alternatives and to make choices between transportation needs. Because there is very little project definition at this phase, *Conceptual Estimates* usually rely on parametric techniques to extrapolate from past experience the economic impact, or costs, of future projects. These techniques are applied using cost estimating relationships developed by planners and estimators or possibly using commercially available estimating tools.

Such estimates are normally prepared prior to the National Environmental Policy Act (NEPA) decision document. The accuracy of these estimates is directly related to the specificity of project definition. The following techniques are used to determine the approximate cost of the project. The estimated dollar amount should be expressed as a range. Two specific techniques are:

1. **Cost per parameter using similar projects** (see Tool C3.3 on page 379): This technique is based on the concept of using the cost of projects that are similar to the project being estimated as the basis for developing the estimate. The similar project has a known cost and project definition. The similar project cost is converted into some reasonable cost parameter, such as dollars per centerline mile or dollars per square foot of bridge deck area, and is used in conjunction with an order of magnitude quantity parameter of the project being estimated, such as centerline miles, to provide a basis for approximating the total cost of the facility.

2. **Cost per parameter using typical sections** (see Tool C3.4 on page 381): This technique is based on the concept of using typical sections/components representing common types of facilities and historical bid cost data to derive key cost parameters. With this technique, the cost parameter is built up using typical items that describe a standard section for a given length, such as one mile. These cost parameters, such as dollars per centerline mile or dollars per square foot of bridge deck area, are used in conjunction with approximate quantities for the project being estimated to provide a basis for approximating the cost of a facility.

Planning estimates are by nature uncertain due to the limited amount of project definition available and the extrapolations that need to be made to historical data. Planning estimates should be communicated in ranges rather than point estimates due to this uncertainty. Ranges for planning estimates are generally calculated through a top-down application of a range percentage that is based on an analysis of past planning estimate accuracy.

III.1.3 Scoping/Design Estimating Techniques

Scope/Design estimating commences when a project enters into the Scoping Phase of project development. However, Design estimating occurs throughout the Design Phase of project development. Scope/Design estimating is critical during Scoping, as this is the time when the baseline project definition, cost, and schedule are determined. Scope/Design estimating techniques must produce consistent and accurate estimates. However, the use of Scope/Design estimating tools will vary depending on the level of project definition, the project type, and the complexity of the project. Computer software is often used to facilitate the application of these types of estimating techniques.

There are a variety of techniques that can be used to support Scope/Design estimating, which can be summarized as follows:

1. **Analogous or Similar Project** (see Tool D2.1 on page 387): This technique relies heavily on one project that is very similar to the project being estimated. The reference (analogous or similar) project is typically one that was previously constructed, is currently under construction, is bid

for construction, or has a completed PS&E level estimate. Items, quantities, and unit costs from the similar project are used as a basis for estimating the current project. Similar costs from the reference project can be used to estimate other groups, categories, elements, and items of total project cost.

2. **Cost Based** (see Tool P1.3 on page 403): This technique relies on the cost based estimating approach wherein construction costs, based on a selected productivity, are estimated for labor, material, equipment, contractor overhead, and contractor profit for each major item. This approach typically produces an accurate estimate and is useful in estimating unique items of work where there is insufficient bid history. The application of cost based estimating during Scoping and Design would be similar to that used during Letting. Thus, tool P1.3 could be used in this context. Estimates of other groups and/or categories of total project cost are estimated from the bottom up. This means that resources associated with certain groups or categories, such as project development and detailed design, are specifically identified for elements and tied to when these resources will be engaged on the project (i.e., a period of time a lead designer will work on a project).

3. **Historical Bid Based** (see Tool D2.4 on page 389): The use of historical data from recently bid contracts is the most common estimating approach. Under this approach, bid data are summarized and adjusted for project conditions (e.g., project location, size, quantities, etc.) and the general market conditions. Items are developed for major elements of work so that quantities and historical unit prices can be applied to these items. Often, percentages are used to estimate items where little or no definition is available. Standard percentages are used to estimate other groups and/or categories of total project cost.

4. **Historical Percentages** (see Tool D2.5 on page 391): This technique is used in conjunction with other tools such as historical bid based estimating. Historical percentages are used to estimate costs for items within an element that are not typically defined early. A percent is developed based on historical cost information from past projects to cover certain items that comprise an element. This percentage is based on a relationship between the sum of the selected items and a total cost category such as direct construction. Historical percentages are used to estimate other groups and/or categories of total project cost.

5. **Parametric Estimating** (see Tool D2.7 on page 394): Parametric estimating techniques are primarily used to support development of scoping or early design estimates where very little project definition is available. Major project parameters are identified. Statistical relationships and/or non-statistical ratios between historical data and other parameters (e.g., tons of asphalt, square foot of bridge deck area) are used to calculate the cost of various items of work. The Length, Width, and Depth, or LWD, is a type of parametric estimating.

6. **Combined**: As described in the section on total project cost, a project's cost estimate could include diverse and largely unrelated components, such as

the roadway, structures, haul roads, utilities, and environmental clean-up. Therefore, the methodology employed for estimating costs is likely to be different depending upon the available data and the project phase in which the cost estimate is prepared. The Estimator needs to diligently document and communicate to the project team the basis as well as the methodology used for estimating the costs associated with groups, categories, elements, and items. Integrating the estimated costs for each into the Total Project Cost Estimate is a significant responsibility that cannot rest on a single Estimator, especially for complex projects.

Scope estimating is used during the Scoping Phase to set a baseline cost for cost management purposes. Unlike Planning estimates, Scope and Design estimates are communicated through a point estimate rather than through a range of costs. Similar to Planning estimates, however, Scope and Design estimates contain uncertainty due to the less-than-complete project definition available and the extrapolations that need to be made to historical data. Therefore, the Scope and Design point estimates should include a contingency amount to account for the uncertainty in the project scope and estimate. Contingency estimating techniques will vary depending on the amount of information available and the estimating tools used, as described in sections III.3 and III.4 on pages 109 and 179 respectively.

Scope estimating is used during the Scoping Phase to set a baseline cost for cost management purposes.

III.1.4 PS&E Estimating Techniques

The PS&E estimate is based upon very definitive contract documents that reflect the projects final design. These construction estimates are used to finalize project funding prior to bid solicitation and as a basis for evaluating the bids.

There are basically three approaches currently used by Mn/DOT for PS&E estimating. They are:

1. **Cost Based** (see Tool P1.3 on page 403): The cost based technique is currently used by the Mn/DOT Central Office to prepare the Engineer's Estimate. This detailed, bottom up estimate approach based on specific crews, equipment, production rates, and material costs is similar to the way a construction contractor would estimate a project. This approach requires the Estimator to have a good working knowledge of construction methods and equipment. Adjustments can be made to historical data to reflect current market conditions (e.g., material cost), location specific characteristics (e.g., haul distances or labor wage rates), and local production rates.

2. **Historical Bid Based** (see Tool P1.4 on page 405): The use of historical bid data from recently awarded contracts is a common estimating approach for some Functional Groups. Under this approach, bid data are summarized and adjusted for project conditions (e.g., project location, size, quantities, etc.) and general market conditions. This approach requires the least amount of time and personnel to develop the estimate and produces a good estimate, as long as noncompetitive bid prices are excluded from the database and appropriately adjusted data is used to build the estimate.

3. **Combined**: Most projects contain a small number of items that together account for a significant portion of the project's construction cost. These significant contract items may include Portland cement concrete pavement, structural concrete, structural steel, asphalt concrete pavement, embankment, or other specialty items. Prices for these items are estimated using the bottom up approach. The remaining items are estimated based on historical bid prices and adjusted as appropriate for the specific project.

The primary purpose of the PS&E estimate is to create an estimate for contractor bid analysis and award recommendation. The estimate of construction costs should be communicated as a point estimate, without contingency. For cost management purposes, a Total Project Cost Estimate will also need to be communicated. Some items in the Total Project Cost Estimate will include contingency (e.g., construction engineering costs). However, the PS&E estimate of construction costs should include contingency, but only embedded in items, as it is based on known quantities from plans and seeks to make a direct comparison with contractors bid costs.

III.1.5 Computer Aided Estimating

Computer software provides Mn/DOT the ability to manage large data sets that support estimate development for all project types and across the range of project complexity. Currently Mn/DOT uses several American Association of State Highway and Transportation Officials (AASHTO) Trns*port products. However, these products are used generally to support PS&E estimating. The two main programs are the Cost Estimating System (CES) and the Proposal Estimating System (PES) (see Tool P1.5 on page 407). CES is used by the Central Office to prepare the Engineer's Estimate using both the cost based and historical bid based techniques. Item data (pay item numbers and quantities) are uploaded from PES to CES to commence the estimating process. The bidding process is then supported by PES. PES is used be some state highway agencies as a support program to aid in preparation of Design estimates when bid based estimating is used. Estimating programs such as CES rely on preloaded templates for creating cost items. Moreover, computer software eases the task of tracking project estimates through all phases of development and can assist in estimate and schedule reviews.

AASHTO recently introduced software to supplement their existing suite of estimating tools. TRAnsportation Cost EstimatoR (TRACER) software is a parametric cost estimating tool created to help plan and budget for highway and bridge construction/renovation projects at the pre-design and preliminary design phases. TRACER was developed by Earth Tech. TRACER uses statistical relationships between major systems of a highway project, termed modules, and the details that describe that system. Mn/DOT has this tool, but it has not been used yet (see Tool C3.5 on page 383).

Mn/DOT Districts currently use a variety of spreadsheet templates to support estimate preparation. Spreadsheet templates provide a rapid and easy means for organizing estimate data and formulating repetitive calculations (see Tool D2.8 on page 397). Templates are excellent and simple tools for ensuring that all components of project cost have been considered and accounted for in the estimate. Because spreadsheets are usually straightforward documents, they are good tools for communicating estimate completeness and allotment of cost to the different portions of work.

III.1.6 Historical Data

Mn/DOT currently uses all the different estimating techniques described under each of the project development phases. Each technique is supported by historic cost data. These data are available from various sources. A tool is provided that summarizes the sources and potential use of historic cost data (see Tool H1.1 on page 373).

Cost based estimating is used in conjunction with CES to prepare the Engineer's Estimate for major items of work. Libraries are used in CES to support estimation of the following estimate components:

- Labor (crew sizes and mix, wage rates, and production rates)
- Materials
- Equipment (type, production rates, and costs)
- Contractor Overhead and Profit

Different website locations provide cost data relevant to the four components of a cost based estimate. Historical bid based estimating is also used to prepare the Engineer's Estimate for minor items of work.

The Mn/DOT intranet (iHub) maintains average bid prices over a period of seven to 12 months. Simple arithmetic averages are used to calculate these bid prices. In addition, Mn/DOT also includes recent bid prices in an Excel spreadsheet. This spreadsheet includes the Engineer's Estimate, and the low, second, and third bids. In addition, these data reflect unique item numbers, descriptions, District location, quarter and year, contract and SP numbers, county, unit of measure, and quantity. Filters are included on the spreadsheet to allow the user to sort the data to suit the user's estimating need. This spreadsheet is best used with historical bid based estimating within the Districts.

The Mn/DOT intranet (iHub) maintains average bid prices over a period of seven to 12 months.

If project-specific bid data is required, then bid abstracts for projects are available on the intranet to capture this specific information. Specific projects are used with Analogous or Similar estimating or when using the LWD approach under the parametric estimating technique.

Mn/DOT stores historical data through the AASHTO Trns*port database referenced as BAMS/DSS. This acronym stands for Bid Analysis Management System/Decision Support System. BAMS/DSS has over five years of historic unit cost information. Using this database, regression-generated best-fit curves can be plotted for specific item numbers. Typically, these plots reflect unit costs versus quantities of materials. These types of curves can be used by Estimators in support of historical bid based estimating.

III.1.7 Risk and Contingency Overview

Uncertainty is inherent in the estimation of any future costs. Uncertainty drives the risks that any project and the project team face. Estimating contingency involves using experienced and knowledgeable individuals and tools to quantify, through a risk analysis, as much of the uncertainty associated with project cost estimates as is practical. Neither the uncertainty nor the risks can be completely eliminated from any cost estimate. Therefore, a reasonable and defensible amount of contingency is included in a project's cost estimate to account for the anticipated risk exposure. The risk exposure and the corresponding contingency typically reduce as a project advances through the different project development phases.

The Mn/DOT CE and CM process describes a three-tier approach to risk analysis and contingency estimation. The three-tier approach stems directly from project complexity. A determination of the project complexity is made in three categories based on the Project Complexity Tool (see Tool R1.1 on page 343)—1) non-complex (minor) projects; 2) moderately complex projects; and 3) most complex (major) projects—and leads to the selection of the risk analysis and contingency estimating approach as shown in Figure III.1-2.

Complexity → Risk Analysis Type → Contingency

Figure III.1-2. Three-Tier Approach Process

Based on an evaluation of where the project falls in the three different levels of complexity, a different "Type" of risk analysis is defined for the project. The three types of risk analysis and contingency estimation correlate directly to the three levels of complexity: Type 1 = non-complex (minor) projects; Type II = moderately complex projects; and Type III = most complex (major) projects. Each of the three risk analysis types are briefly described as follows:

Type I Risk Analysis – Risk Identification and Percentage Contingency

The Type I risk analysis is the simplest form of risk analysis and applies only to minor projects. A Type I risk analysis involves the development of a list of risks and the use of a percentage of project cost to estimate the contingency. The Estimator should use his or her judgment within a percentage contingency range of acceptable standards set by Mn/DOT.

Type II Risk Analysis – Qualitative Risk Analysis and Indentified Contingency Items

The Type II risk analysis correlates to moderately complex projects and involves more rigorous risk identification tools and specific contingency items that complement the percentage-based contingency in the Type I analysis. A probability-impact (P×I) matrix analysis is typically used to qualitatively rank the risks. A risk register is highly recommended to monitor the risks.

Type III Risk Analysis – Quantitative Risk Analysis and Contingency Management

A Type III risk analysis applies to major projects. It will need to be facilitated by individuals trained in quantitative risk management practices. The process generally starts with a risk analysis workshop involving key team members to identify project risks. A stochastic estimate of cost and schedule is then generated and used to estimate an appropriate contingency. The risks and associated contingency are then updated throughout the project development process. Maintenance of a risk register or risk information system to monitor the risks is essential.

The type of risk analysis will determine the selection of appropriate risk-related tools for risk identification, risk analysis, and estimation of contingency. All projects, regardless of project size and project complexity, require some form of risk analysis and risk management planning. The framework of risk analysis remains the same, but the tools and level of effort vary with the risk analysis level.

The three-tier approach stems from a synthesis of risk identification, risk analysis and contingency estimating tools found in the literature and in practice across the U.S. Table III.1-1 summarizes the most frequently applied tools and their relationship to the three-tier approach. A detailed description of the tools can be found in the Tool Appendix (Appendix IV.2 on page 335).

Table III.1-1. Risk Analysis and Contingency Estimation Tools

Tool Name and Appendix Number	Analysis Level		
	I	II	III
Risk Identification			
I2.1 Red Flag Item Lists	●	●	●
I2.3 Risk Checklists	●	●	●
I2.4 Assumption Analysis	●	●	●
I2.5 Expert Interviews		●	●
I2.6 Crawford Slip Methods		●	●
R3.6 Risk Workshops			●
Risk Assessment and Contingency			
R3.2 Contingency Percentage	●	●	●
R3.12 Risk Register	●	●	●
R3.8 PxI Matrix		●	●
R3.3 Contingency Identified		●	●
R3.4 Estimate Ranges – Three-Point Estimates		●	●
R3.5 Estimate Ranges – Monte Carlo Analysis			●

III.1.8 Content Overview

Implementation of the new Mn/DOT CE and CM processes is described in greater detail in the remaining sub-sections of Section III and the Tool Appendix. The four sub-sections correspond to CE and CM for the Planning, Scoping, Design, and Letting Phases, respectively. Each sub-section has a similar structure and layout as follows:

OVERVIEW
- Highway Development Process
- Project Development Phase Process (i.e., Planning, Scoping, Design, or Letting)
- Phase Cost Estimation and Cost Estimate Management Process
- Roles and Responsibilities in Cost Estimating and Cost Management
- Key Implementation Assumptions

DETERMINE ESTIMATE BASIS – (Phase IDEF0 Identifier A21)
- Review Draft Scoping Report (A211)
  - Step Requirements and Issues to Consider (one page)
  - Flowchart describing Information Sources, Tool Selection, Actions, and Results and Tips and Notes regarding Flowchart Content (one page)
- Determine Alternative to Estimate (A212)
  - Step Requirements and Issues to Consider (one page)
  - Flowchart describing Information Sources, Tool Selection, Actions, and Results and Tips and Notes regarding Flowchart Content (one page)
- Repeat for all Sub-process Steps
- Repeat for all Phase Sub-processes

All CE and CM tools are collected in Appendix IV.2 on page 335. Each tool in this appendix is described using the same structure as follows:
- Tool Description
- What is it?
- Why use it?
- What does it do?
- When to use it?
- How to use it (with examples)?
- Tips for use
- Resources for further information about the tool

The Tool Appendix describes over 40 tools using the layout given above. Some tools are currently being used, others will need some development prior to implementation, and some tools will be developed over time.

In each sub-section, the Step is described using a two-page layout. The Step Requirements and Issues to Consider are shown on the left side of the page. The right side of the page shows the Step Flowchart and Tips and Notes that support the flowchart information. The flowchart references a set of tools that can be used to perform the actions of a step. The Tool Appendix provides detailed information on the tool and how to use it.

Section III.6 provides the users with selected resources and training information to aid the user in implementing the Technical Reference Manual.

III.2 PLANNING COST ESTIMATION AND COST MANAGEMENT

III.2.1 OVERVIEW

III.2.1.1 The Highway Project Development Process

The Mn/DOT Project Planning – Scoping – Programming cycle begins with the Project Planning Phase, in which transportation system performance needs are identified and prioritized. The most critical needs are carried forward into the Scoping Phase. During this period, the full range of functional and stakeholder groups are queried to identify potential work to be completed during the project. Decisions are made as to what will be included and what will not be part of the project definition. These decisions are documented so that they can be conveyed to those who will work on the project. A cost estimate is also developed based on the project definition. The projects are then reviewed during the Programming Phase and either included in the STIP or HIP (10-Year Plan) or held for reconsideration the following year.

III.2.1.2 Project Planning Phase

The Project Planning Phase is an extensive and primary phase of the project development process (see Figure II.1-1 on page 7). The purpose of the Project Planning Phase is to identify the needs and deficiencies in the transportation system. Improvement in these needs and deficiencies will make the transportation system better and future oriented. These data are gathered on the basis of system performance, which comes as inputs from various Functional Groups, the Transportation Improvement System (TIS), and public involvement. The list of identified needs and deficiencies is compiled and prioritized so that the most important needs are addressed first. At this early stage, complex projects are identified. Strategic directions for the improvement of transportation system are identified, which will determine projects in the future. These identified needs present challenges to the transportation system and constrains the ability to improve system performance.

Prioritizing projects includes preparation of conceptual estimates to compare to the available funds.

The gathered needs are identified on the basis of the Statewide Transportation Plan, District Long Range Plan, Highway Systems Operation Plan, and Strategic Highway Safety Plan, and on the basis of performance measures. The needs are prioritized on the basis of availability of funds and fiscal constraints. This prioritization is completed by following a series of steps intended to shorten the list of needs. Prioritizing projects includes preparation of conceptual estimates to compare to the available funds. This shortened list will become projects and will be defined to essentially be included in the State Transportation Improvement Program. The needs which are not selected during the prioritization process are added to the list of projects to be considered the next year.

The purpose of the selected projects is based on the long list of needs. Possible alternatives are considered to satisfy the purpose of the various needs. A cost estimate is prepared and expressed in terms of ranges for these projects with available alternatives. If the range is equivalent to the available funds then the projects are transferred to the compiled list or the short list. This is the list of the selected project and these projects are assigned state project number and are entered in the Project and Program Management System (PPMS). The Project Planning Report is made which compiles all the estimates and the proposed alternatives. The Planning phase for any project comes to an end with the assigning of the Project Manager. Irrespective of the complexity of the projects, a Project Planning Report is prepared at the end of the Planning Phase. This report is a summary of the needs considered, factors put forward for selection of needs, decisions made during the process, and conceptual estimates prepared. This report provides a framework for the Project Manager entering into the Scoping Phase of the project. Each selected project is entered into the Program and Project Management System (PPMS) and has a State Project (SP) number assigned to it.

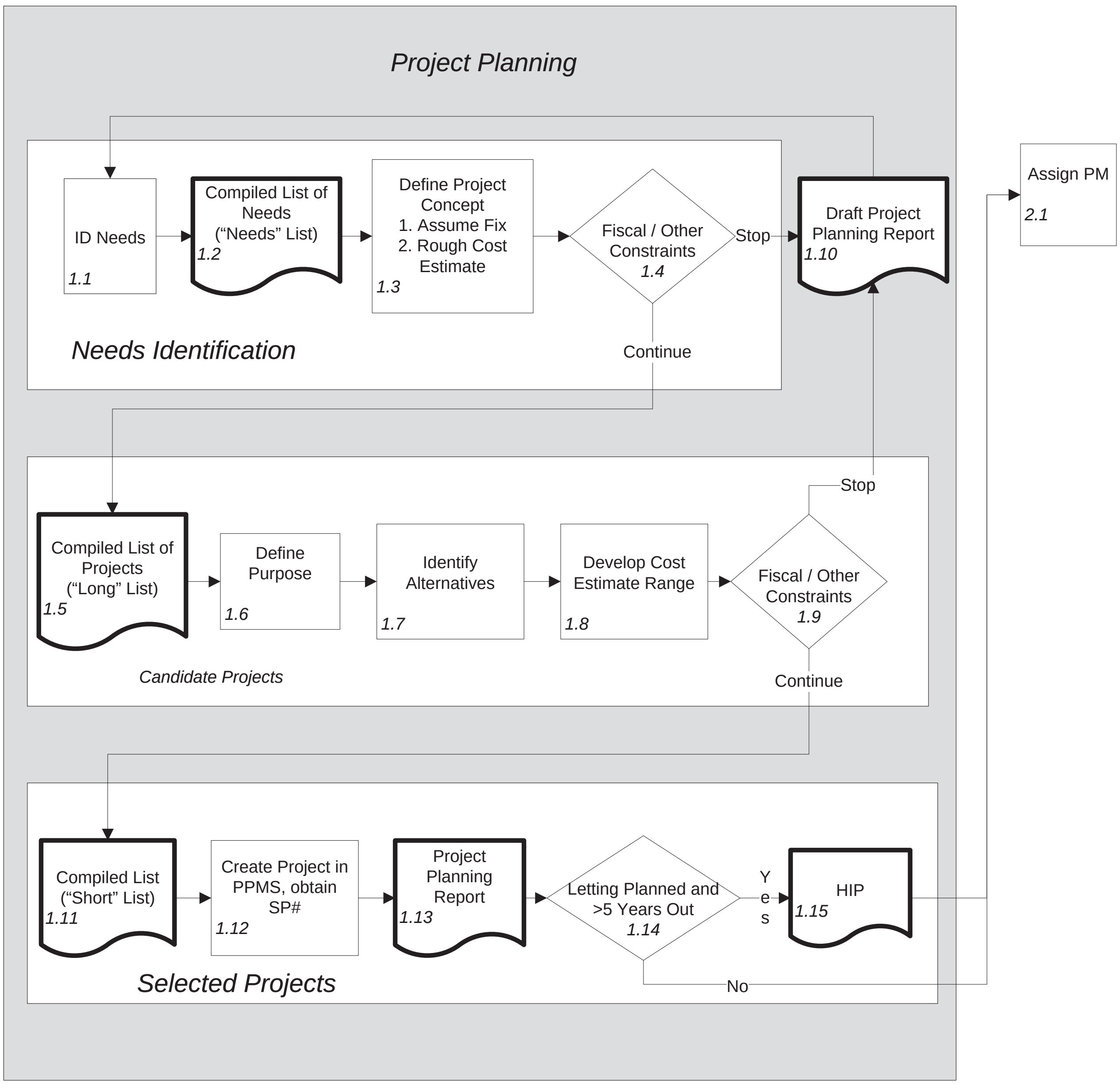


Figure III.2-1. Project Planning Phase

III.2.1.3 Planning Cost Estimation and Cost Management Process

Planning level cost estimates can have a significant effect on the overall transportation program. A key part of the Planning Phase is to identify needs and to develop project cost estimates (see Figure III.2-1 on page 44). The first cost estimate is prepared before even the needs are identified as projects. This estimate is a rough estimate that is prepared on the basis of minimal available data. Figure III.2-1 depicts the process by which identified needs that fit into the fiscal constraints are moved to the list of possible projects. Once the projects are identified, the estimates are prepared again based on previous projects of similar characteristics. The estimates are conceptual estimates but have more detail included than the previous estimate prepared during Need Identification (Figure III.2-1).

Figure III.2-1 provides an overview of the cost estimation and cost management processes followed during the Planning Phase. Conceptual cost estimates prepared during planning have a fundamental purpose to provide an order of magnitude estimate. This estimate is used to determine the funds required to support the projects in long-range plans. These estimates also serve the purpose of ranking the projects on benefit-cost analysis. Figure III.2-2 depicts the five key estimate sub-processes and inputs and outputs. This figure also illustrates the interrelationship between the cost estimating and the planning process.

Key inputs to the cost estimation and cost management processes are the project's definition and type, major project parameters, and project complexity based on location and anticipated requirements. Three major sources of inputs and data are identified for the cost estimation process, namely, input from third parties, input from Functional Groups, and historical data. As minimal information is known about a project's characteristics, the estimate has high variability. This variability often depends on the complexity of the project and the known level of definition of the project. It becomes important for planners and engineers to understand the likely range of the uncertainty associated with these cost estimates and to communicate these uncertainties to the decision makers.

The process of cost estimation and cost management includes sub-processes and steps. To complete a planning level cost estimate successfully, it is important to follow the provided process in Figure III.2-3. These sub-processes and steps are further explained in detail in this section.

The sub-processes are described using the IDEF0 Node Tree concept on page 17, as shown in Figure III.2-3. Guidance is provided on how each sub-process step is performed in terms of inputs required to perform a sub-process step, actions required to perform a process step, outputs from performing the sub-process step, and tools used to facilitate the performance of a step.

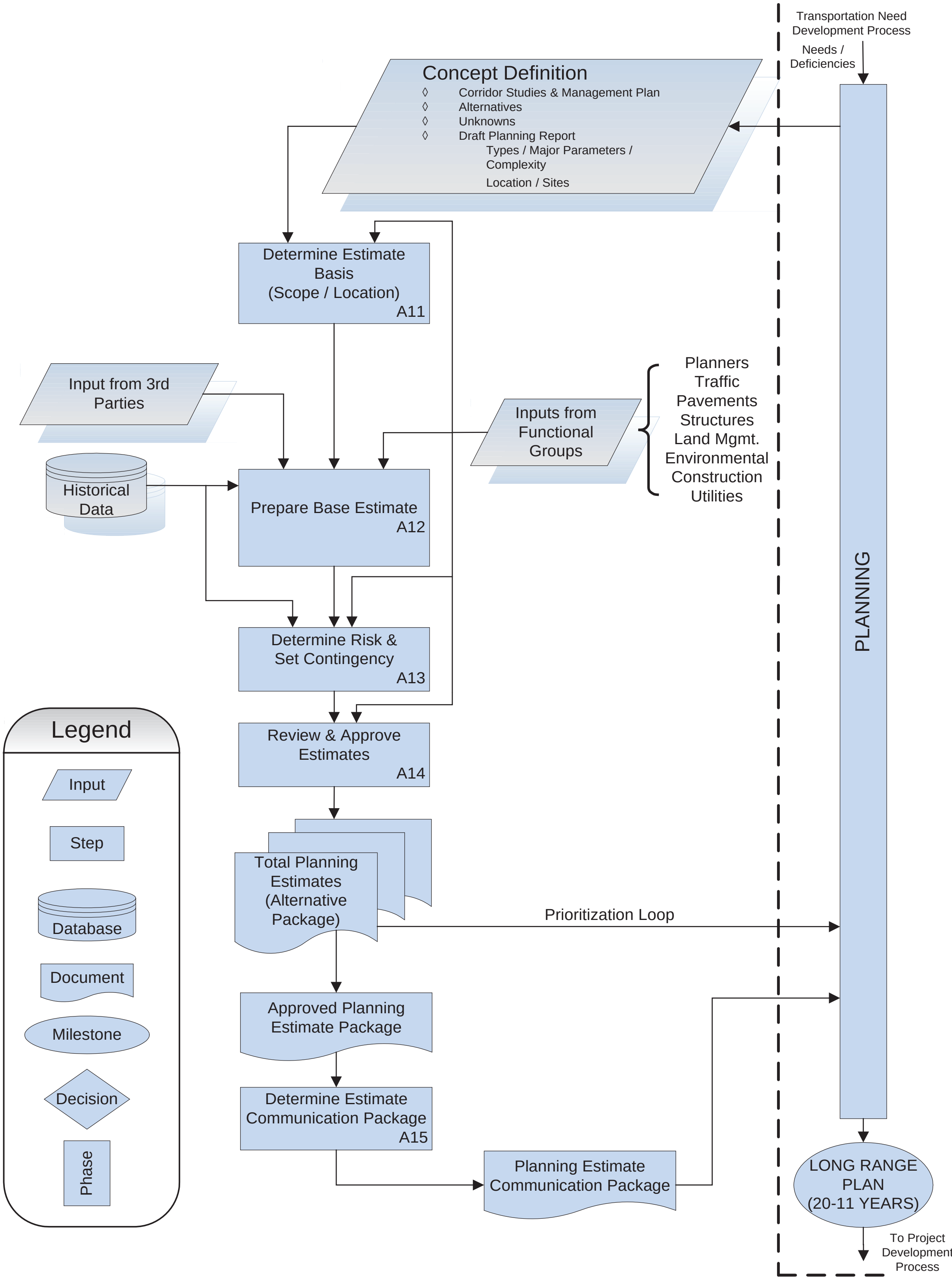


Figure III.2-2. Cost Estimating and Cost Management Flowchart for Planning

III.2.1.4 Overview of Roles and Responsibilities

The primary responsibility for projects in the Planning Phases lies with the Estimator in the District and the District Planner. This Estimator is responsible for completing all of the sub-processes in this phase. The Office of Project Scoping and Cost Management serves as a source of information for the process. The Functional Groups serve as a source of information specific for the project. District management is accountable for the approval of the estimate. The RACI diagram is shown in Table III.2-1.

According to the Scoping Process, a Project Manager is not assigned until the end of the Planning Phase (see Figure III.2-1 on page 44). Other planning personnel may act as the Project Manager during the Planning Phase, such as the Planning Director in the District. If a project is complex and the project requires more of a specific project management focus, the District should consider completing a separate RACI for this project and treating it as a unique project for the roles and responsibilities.

As with other phases, a RACI diagram with roles and responsibilities in greater detail can be completed using the RACI tool (R4.1 on page 347). Completion of this tool takes into consideration the District- specific functions.

The primary responsibility for projects in the Planning Phases lies with the Estimator in the District and the District Planner.

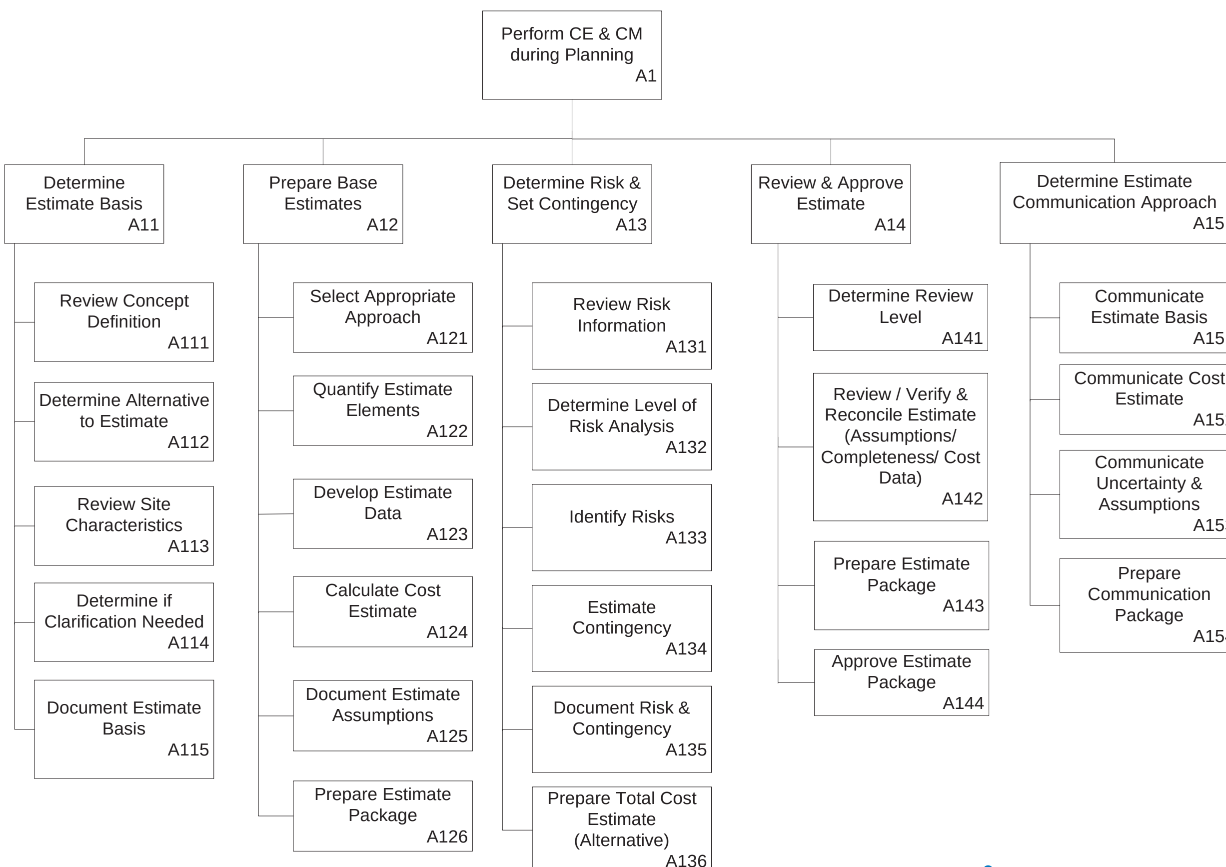


Figure III.2-3. Sub-Processes and Steps for Preparing and Managing Planning Estimates

Table III.2-1. RACI for Preparing CE/CM for Planning (A1)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Determine Estimate Basis (A11)						R	A	C								
Prepare Base Estimate (A12)				C		R	A	C								
Determine Risk and Set Contingency (A13)				C		R	R/A	C						I		
Review & Approve Estimates (A14)			A	C		R	C							I		
Determine Estimate Communication Approach (A15)		I	A	C		R	C			I			I			

LEGEND:

R = Responsible (the doer)
A = Accountable (owner)
C = Consulted (in the loop by providing inputs)
I = Informed (in the picture)

III.2.1.5 Key Approach Assumptions

The estimating and cost management process for planning focuses on preparing multiple estimates in support of the Long Range Plan (years 10 to 20) and those projects that will enter into the Highway Improvement Plan (close to year 10). Most projects that require estimates in the Planning Phase are likely complex projects and, perhaps, some moderately or non-complex projects. The cost estimate and cost management process described in the following sub-sections is based on a complex project in year 11 from the projected letting date. This project will be placed into the HIP at year 9 or 10 from letting. The process for preparing estimates will remain the same for all estimates developed during the Planning Phase. The time and effort required for estimate preparation will vary with the project complexity and the level of definition related to project requirements.

Cost estimates for projects in the Long Range Plan should cover total project cost, as defined in Section II.3.2.3 (see page 23). The Total Project Cost Estimate includes a number of different components. The focus of the cost estimating and cost management procedures covered in this chapter is primarily related to project construction costs. Other components of total project cost require estimates from selected Functional Groups, such as right of way. The cost estimating and cost management sub-processes presented in this chapter generally apply to the preparation of any estimate, although the steps may have to be modified to suit a particular Functional Group application.

III.2.2 DETERMINE ESTIMATE BASIS (A11)

The primary objective of this sub-process is to collect and document all information required to serve as a basis for preparing a Planning cost estimate. The level of concept information varies depending on what point in the Planning process estimates are being prepared (see Figure III.2-1 on page 44). This sub-process has four main steps and a fifth step that is implemented when alternatives are being considered. The steps are as follows:

1. Review Concept Definition – A111
2. Determine Alternative to Estimate (not performed if no alternatives) – A112
3. Review Site Characteristics – A113
4. Determine if Clarification Needed – A114
5. Document Estimate Basis – A115

The primary objective of this sub-process is to collect and document all information required to serve as a basis for preparing a Planning cost estimate.

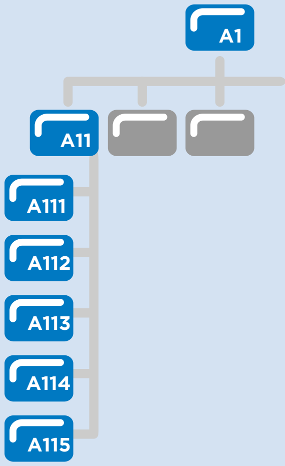
These five steps provide a natural progression of effort to determine the estimate basis for a Planning estimate for a project. They are often performed concurrently and repeated as an estimate is prepared. These five steps require several key external inputs that are necessary for the Estimator to prepare the cost estimate. Some of these key inputs include the following:

- **Concept Definition** – describes the key parameters covering initial fix early in the planning process but eventually a more complete description in a draft Planning Report.

- **Project Characteristics** – description of the type of project and complexity of the project related to the concept, including site location information (e.g., urban versus rural) and/or data that is relevant to preparing the cost estimate.

- **Functional Group Input** – clarifications from Functional Groups regarding definition and requirements for their area of the project.

These key inputs are then used when performing the five steps of this process. The output of this sub-process is the Planning Estimate Basis, which contains information used to prepare an estimate, including any information provided by the Functional Groups and/or conceptual sketches.



Review Concept Definition (A111)

Step Requirements

Several inputs exist for this step. The most important input is the concept definition, but the project characteristics and any Functional Group input are also needed. The concept definition is the compilation of the alternatives, the corridor studies and management plans, the unknowns, and the draft Planning Report. Each Functional Group provides project requirements specific to its individual specialty. Typical project requirements include parameters of project (e.g., boundaries/limits), descriptions of key work (e.g., widen existing roadway, mill and resurface roadway, construct new project), and location of project.

The Estimator performs several actions when completing this step. First and foremost, all available information on the project must be collected and should be contained in the concept definition. The Estimator then reviews all of the information to gain knowledge of the concept. Once the material is reviewed, a plan will be made for how the estimate will be prepared, what other inputs will be required, and what deadlines should be set. If Functional Group input is required, then the Estimator must determine when this input is needed. The Estimator should also identify the project complexity since this will influence the type of information required to complete subsequent sub-processes.

Issues to Consider

Plan and Program Support

- The planning process must be completed before a project is included in the Long Range Plan (years 11 to 20 from the projected letting date). If alternatives are identified, multiple estimates are necessary to evaluate each alternative. An action is to determine if multiple estimates are required. These estimates are performed following the same process steps; however, the level of definition may be less than if there was only one preferred alternative.

Project Characteristics

- A minor or even some moderately complex projects will likely not involve alternatives.

- Major projects require more time and effort to document the estimate basis.

- Typically, more Functional Groups will be involved in major projects.

Functional Group Input

- When multiple Functional Groups are involved in a project, determine when their input is needed to support development of the estimate and communicate time requirements.

Review Concept Definition (A111)

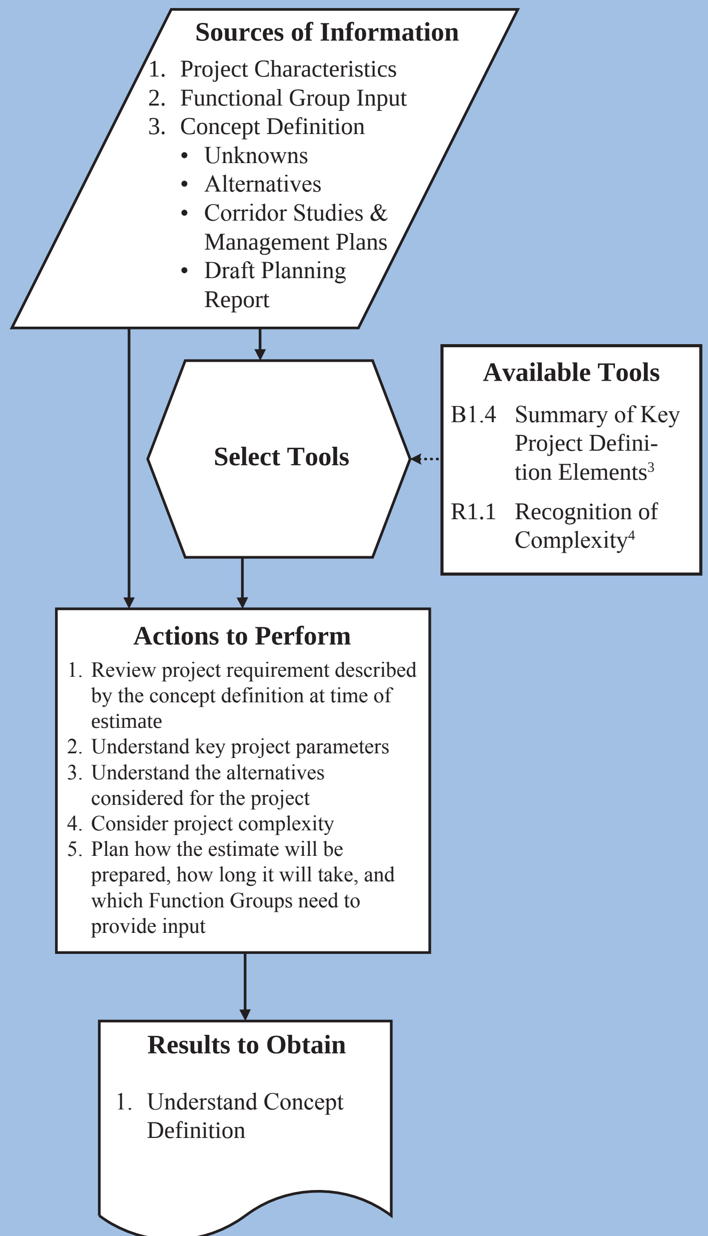
Concept definition evolves as system needs are identified. Corridor studies and management plans may provide general requirements. Many unknowns are yet to be defined. There may be several alternatives to estimate. The final document describing the concept is the Draft Planning Report. Cost estimates are prepared as this report is developed. It contains information that has been developed for the concept.

The Estimator should consider developing a list of key cost categories based on Total Project Cost Estimate requirements as determined for the concept (B1.4 Summary of Key Scope Items).

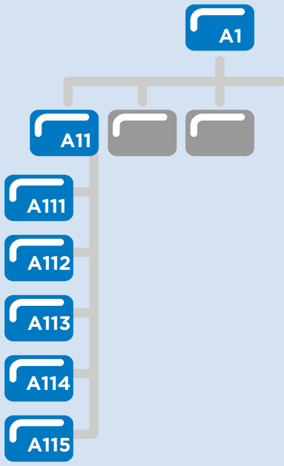
The Estimator should review the complexity definitions to determine the project's level of complexity.

If alternatives are identified, the Estimator should uniquely consider each alternative.

Understanding what is in the concept definition and what is unknown is critical to preparing a reasonable conceptual estimate for planning.



3. For B1.4 Summary of Key Project Definition Elements, see page 363.
4. For R1.1 Recognition of Complexity, see page 343.



Determine Alternative to Estimate (A112)

Step Requirements

Complex projects often have different alternative solutions to meet the purpose and need of the project. Each solution will have a concept definition that describes the requirements of the solution. When alternative solutions are evaluated, the Estimator must determine which alternative should be estimated first. This is the only action needed by the Estimator for this step.

The input for this step is a list of alternatives identified through the Planning process. Once a decision is made on which alterative an estimate will be prepared for, the cost estimating process continues for the selected alternative. Cost estimates will be prepared for each alternative. Final selection of the preferred alternative will likely not occur until a concept is accepted and incorporated into the HIP or after the project moves into the Scoping Phase.

Issues to Consider

Prepare Multiple Cost Estimates to Compare Alternative Concept Definition Solutions

- When preparing cost estimates that are used to compare alternative solutions, it is important to follow the cost estimating sub-processes and associated steps for each alternative. As much as possible, the same estimating tools should be used when preparing multiple estimates so that cost differences between alternatives will truly reflect project definition differences between the alternatives.

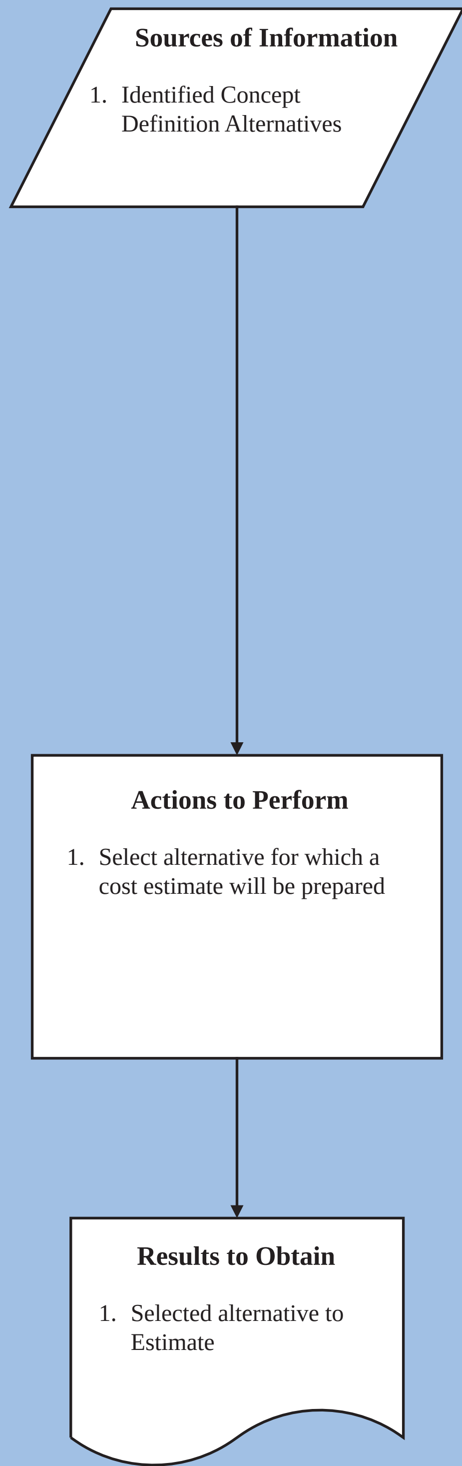
- It is extremely important that each cost estimate is documented in terms of estimate basis and estimate assumptions consistent with the level of information available. However, different alternatives may have different uncertainties associated with them. The risk and contingency analysis should reflect differences due to uncertainty relevant to an alternative.

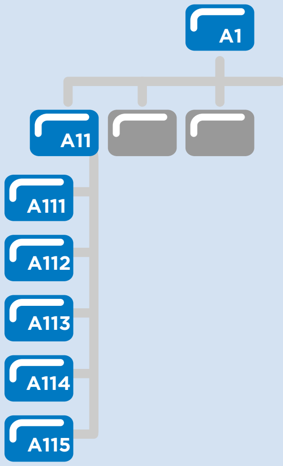
- Review documentation should include a definition and cost estimate comparison to clearly delineate differences between alternatives (see Review and Approve Estimates (A14) on page 88).

Determine Alternative to Estimate (A112)

Any alternative solutions should be clearly identified as the draft Planning Report is prepared. Corridor studies may help identify potential alternatives within a corridor that require separate cost estimates.

If one alternative is considered the base case alternative, this alternative is the first one estimated. Other alternatives can then be compared to this base case alternative.





Review Site Characteristics (A113)

Step Requirements

Even during the Planning Phase, understanding the project site characteristics is critical for the Estimator. The attributes of a project site can significantly impact right of way, utility, environmental, and construction costs. The project characteristics, as described in the draft Planning Report, are one input that provides some understanding of the site. Notes compiled during the review of the concept definition are another source of information to aid the Estimator in understanding the project site characteristics and how the definition of the project relates to these characteristics. However, relying only on project documents can lead to false assumptions about the project site characteristics and their impact on cost.

The Estimator performs several actions when completing this step. First and foremost, the Estimator should review video logs and/or aerial photos to begin visualizing the project. Next if it is at all logistically possible, the Estimator should walk the project site. A site visit provides additional insight and a feel for the project that cannot be obtained through photos or videos. Since Estimators often have a large workload and are governed by time restrictions, they understandably cannot make a site visit for every project; however, the Estimator should fully weigh the benefits and drawbacks before making that decision. Questions should be prepared to guide the Estimator during the site walk-through. The Estimator should make notes as to potential impacts of the site characteristics on the project cost groups and/or categories.

The output of these actions is an understanding of the project site characteristics, their relationship to concept definition, and their impact on cost.

Issues to Consider

Project Characteristics

- Always visit the site for major or complex projects. It is also helpful to visit the site even if the project is moderately complex or non-complex. If time does not permit a site visit, then video logs and/or aerial photos are helpful in developing such information.

- Visits to the project site provide information concerning the presence of wetlands or other issues of environmental concern that would be covered as a cost category.

Functional Group Input

- Visit the site with Functional Group staff to obtain their perspective on site characteristics and their relationship to the concept definition.

Review Site Characteristics (A113)

It is important that the Estimator understands the concept definition and project characteristics prior to initiating a site evaluation. This information will aid the Estimator in preparing questions about the site whose answers determine what may be missing from the definition description. For example, environmental concerns and the need for mitigation may not be identified until a site evaluation, or all utilities may not be identified on the current project site information.

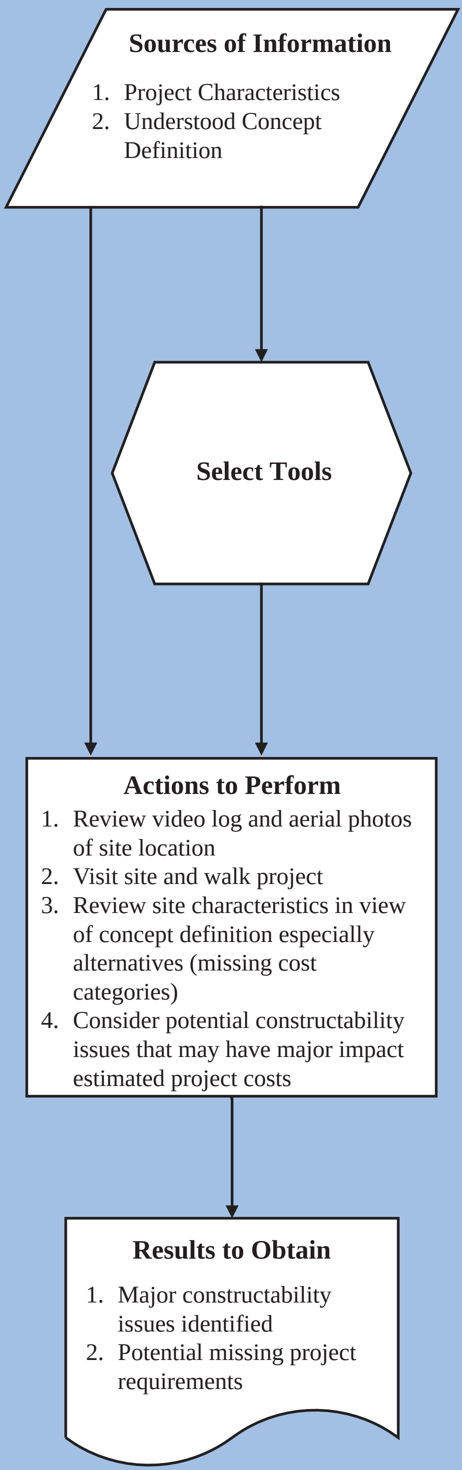
There are several tools available. The best tool to use is a site visit. Video logs and aerial photos can also supplement this effort. These latter two tools may provide some indication of issues that impact project costs.

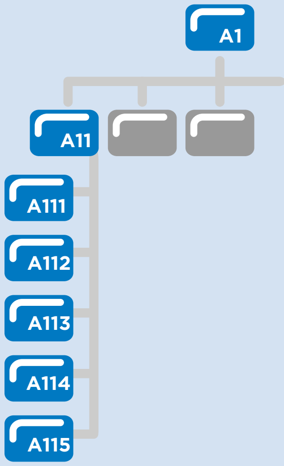
It is critical that the Estimator visit the proposed project site and examine the site conditions and characteristics. Location attributes influence both project definitions and costs. Some questions that should be considered are:

- Will there be potential environmental conditions that must be mitigated?
- What are Right of Way requirements?
- Will utility relocations be required?
- Will detour and haul routes be required?

The Estimator must ensure that all known requirements are included in the estimate basis and that all unknowns are identified for purposes of risk assessment. Including all know requirements in the estimate basis and identifying all possible unknowns are incredibly important parts of this step.

The Estimator should create notes for cost groups and/or categories that should be estimated as part of the Total Project Cost Estimate.





Determine if Clarification Needed (A114)

Step Requirements

The purpose of this step is to, if necessary, request additional information from a Functional Group regarding the project requirements for their area. This request may focus on clarifying existing documentation of the project requirements or ensuring that certain requirements are needed.

The Estimator performs several specific actions. One key action would include clarification of specific concept requirements. A list of questions can be generated after the Estimator reviews the project requirements and visits the project site. Clarifying what is included and what is not included in the concept definition is critical.

This will lead to better understanding of those project requirements that will have a potential impact on the total cost of the project.

Issues to Consider

Project Characteristics

- Check for the availability of complete data related to project requirements and site characteristics. Then, if necessary, request any additional information that will help in completing a conceptual estimate.

Functional Group Input

- The request of clarification can be made in several ways. A meeting with all Functional Groups may be necessary for complex projects. Face-to-face discussion is often the best way to clarify issues. Other means of communication are always available.

- Good communication is required between the Estimator and the Functional Groups. This effort will enhance the level of accuracy in estimates because major project requirements will be properly reflected in the estimate basis.

Determine if Clarification Needed (A114)

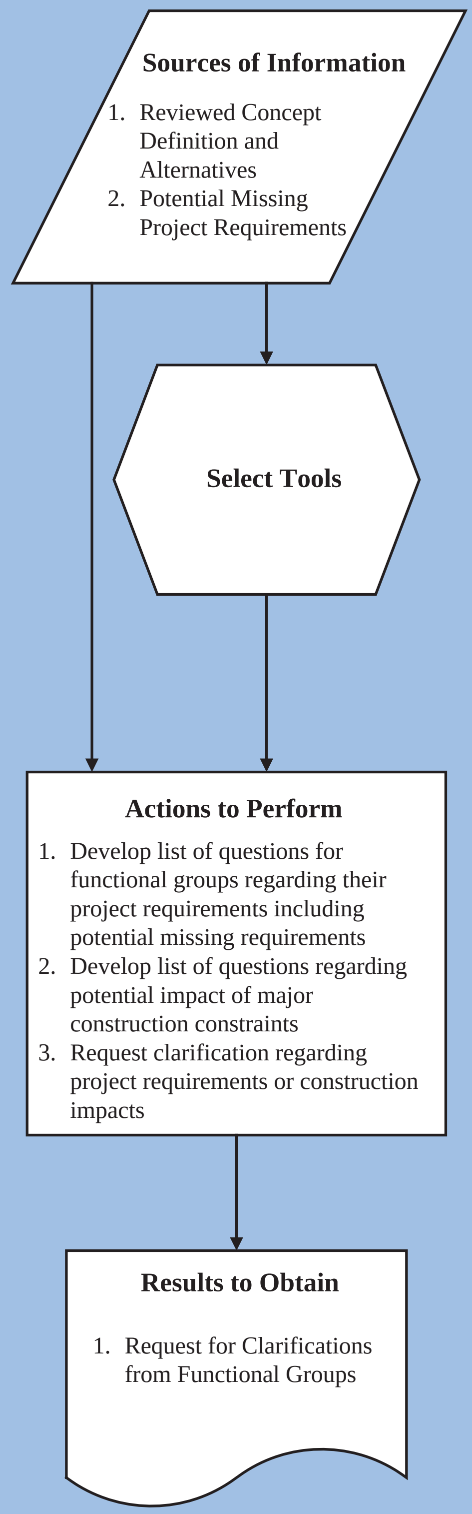
The main sources of information come from a review of the concept definition, including alternatives.

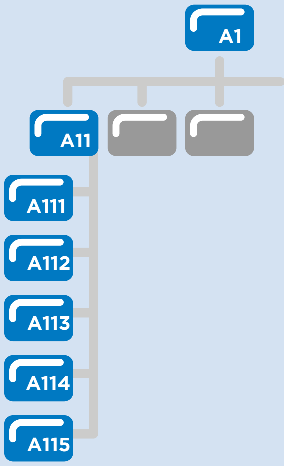
Verification of project requirements is often best achieved through site visits with key Functional Group staff.

Understanding major constructability issues, such as material haul distances, may provide the Estimator with a basis for making gross adjustments to estimated costs.

While questions will always arise as cost estimates are prepared and reviewed, developing a list of key questions needing clarification will save time for the Estimator and planning team in general.

Involvement of all Functional Groups with defining project requirements is critical to ensure cost estimate accuracy. Request for clarifications is a necessary step. Such requests will reduce recycle as the cost estimate is prepared.





Document Estimate Basis (A115)

Step Requirements

The reason for this step is to summarize information used for the Planning estimate for the purpose of reviews and future reference for other cost estimates that will be prepared. The key inputs are the reviewed concept definition, alternatives requiring estimates, and major construction issues. These inputs will also include any clarifications regarding project requirements and construction issues that impact potential project costs. This step is a key to achieving cost estimate consistency.

The main effort or action for the Estimator is to initiate a Project Estimate File starting with sections on project requirements that are used as a basis for preparing Planning cost estimates. Documentation of project requirements is critical when preparing the base cost estimate and determining risks and setting contingency. This step is critical when reviewing the estimate and obtaining management approval. Finally, this step is critical as Planning estimates are updated for incorporation into Long Range Plans.

The output of the actions of this step is the completion of the first section of the Project Cost Estimate File.

Issues to Consider

Project Characteristics

- The level of documentation is likely to increase for projects that are considered major or complex. The Project Estimate File may have more sections to cover the various Functional Group inputs, which describe the estimate basis. This may require more interface with each Functional Group to ensure that project requirements are clearly documented.

- It is important to document the estimate basis for all projects, not just those that are complex.

Alternatives

- Often a transportation need has a number of alternative solutions, especially if the project falls under the complex project description. In this case, the level of definition should be carefully documented for each alternative, clearly noting differences between each alternative.

Document Estimate Basis (A115)

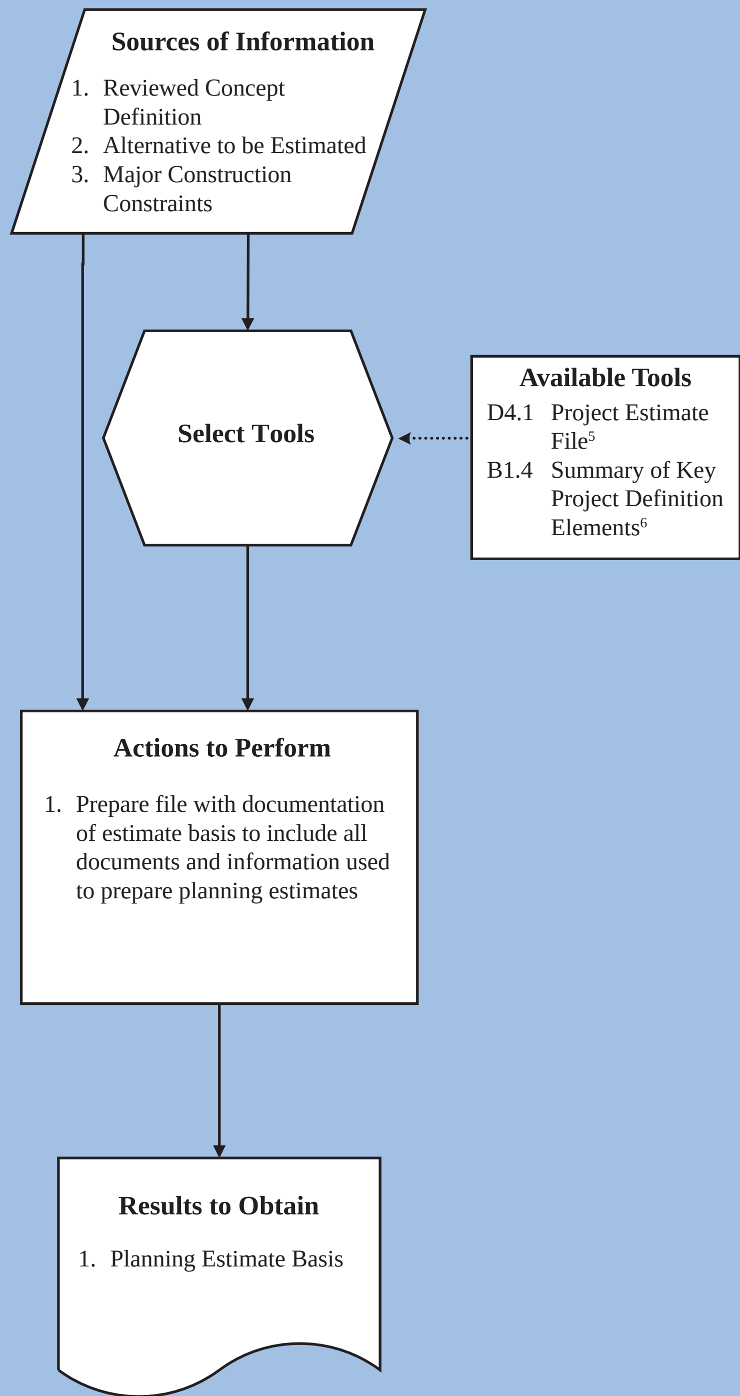
The Estimator compiles information and data from the concept definition review, site visits, and additional input from Functional Groups. The Estimator should ensure that any sketches, specific design parameters, and so on are included in the information and data compiled to support the estimate basis.

The main tool used to support this step is the Project Estimate File. This tool provides guidance on content and structure of documents, information, and data that describe the estimate basis.

A Project Estimate File format should allow for customizing its content to accommodate project type and complexity.

When estimating an alternative, the Estimator should be sure that uncertainty in the estimate basis for each alternative is noted. Different levels of uncertainty may result in differences in contingencies.

This estimate basis becomes a key input to the next sub-process, Prepare Base Estimate.



5. For D4.1 Project Estimate File, see page 339.
6. For B1.4 Summary of Key Project Definition Elements, see page 363.

III.2.3 PREPARE BASE ESTIMATE (A12)

Preparing an accurate base estimate for Planning is critical for developing fiscally constrained Long Range Plans and prioritizing projects for further development in the Scoping Phase. Preparing this estimate covers the development of estimated costs for relative components of a Project's Total Cost Estimate. These components may be estimated using different techniques depending on the level of concept definition, the time the estimate is prepared in the Planning process, and the type and complexity of the project.

The purpose of this step in the Planning Phase is to prepare the most likely cost estimate without contingency. Preparing a planning estimate has two main challenges. The first is the lack of information on the project. This lack of information leaves the Estimator making many assumptions and basing nearly the entire estimate on previous projects using conceptual estimating approaches. The second challenge is the length of time between the planning estimate and construction. It is impossible to perfectly predict inflation, market impacts, or even project definition changes over this span of time. The Estimator must do the best job possible and properly document all work and assumptions used to produce the estimate.

The Total Project Cost Estimate will help planners prioritize projects and determine the projects that can be completed within the funding constraints over a 20-year plan. This sub-process has six steps. The steps are as follows:

1. Select Appropriate Estimation Approach – A121
2. Determine Estimate Components and Qualify – A122
3. Develop Estimate Data – A123
4. Calculate Cost Estimate – A124
5. Document Estimate Assumptions – A125
6. Prepare Estimate Package – A126

These six steps provide a natural progression of effort to prepare a base estimate for Planning. They are often performed concurrently and repeated as each cost component is identified, quantified, and priced. These six steps require several key external inputs that are necessary for the Estimator to prepare the base cost estimate. Some of these key inputs include the following:

- **Planning Estimate Basis** – the accumulated information on project requirements necessary for completing a Planning estimate.
- **Project Characteristics** – description of the type of project and complexity of the project related to the concept, including site location information (e.g., urban versus rural) and/or data that is relevant to preparing the cost estimate.
- **Historical Data** – cost data from previous projects used as a basis for pricing different components of the Total Project Cost Estimate.
- **Functional Group Input** – cost estimates provided by different Functional Groups.

These key inputs are then used when performing the six steps of this process. The output of this sub-process is the Planning Base Estimate Package.

Preparing an accurate base estimate for Planning is critical for developing fiscally constrained Long Range Plans and prioritizing projects for further development in the Scoping Phase.

Select Appropriate Approach (A121)

Step Requirements

Selecting the appropriate approach for preparing an estimate is the foundation for quality and accuracy. In the Planning Phase, the level of project definition is a main factor in deciding what tools are selected. Due to the lack of project definition in this phase, any methods involving items will likely not be possible. Conceptual estimating approaches are used based on dollars-per-lane-mile from past projects or dollars-per-lane-mile based on typical sections. Parametric estimating using the LWD method can be useful, provided similar projects are available. Trns*port software is available for conceptual estimating. If an inappropriate estimating approach is selected (i.e., tool[s]), then estimate accuracy may be compromised or a false sense of accuracy may result.

The input for this step is the Planning Estimate Basis contained in the Project Estimate File produced in the Document Estimate Basis step (A115). Planning estimates are highly dependent on similar projects. Historical data, parametric methods, and even spreadsheets all have their place in an estimator's toolbox; however, each project is unique and necessitates due consideration in deciding the most appropriate estimation approach.

Issues to Consider

Tool Application

- One or more conceptual estimating tools may be used to prepare a Planning estimate
- Spreadsheet (D2.8) workbooks can also be used to document calculations.
- One must be cautious when mixing tools and approaches. The tools listed can either be used independently or in conjunction with one another; however, the Estimator must realize certain methods may require different types of historical data.
- The Tool Appendix provides more description on the potential and suggested uses of each tool, which is helpful in making the decision.

Project Characteristics

- Complexity of the project is a major driving factor for tool selection; hence, project complexity should be considered in conjunction with other project characteristics.
- Project estimation approaches should be selected on the basis of Estimator experience, available data, and project characteristics.
- Major projects require more time and effort to prepare an estimate, so selecting tools that fit the time available is a consideration.

Total Project Cost Estimate

- Tool selection will vary depending on the Total Project Cost Estimate component.

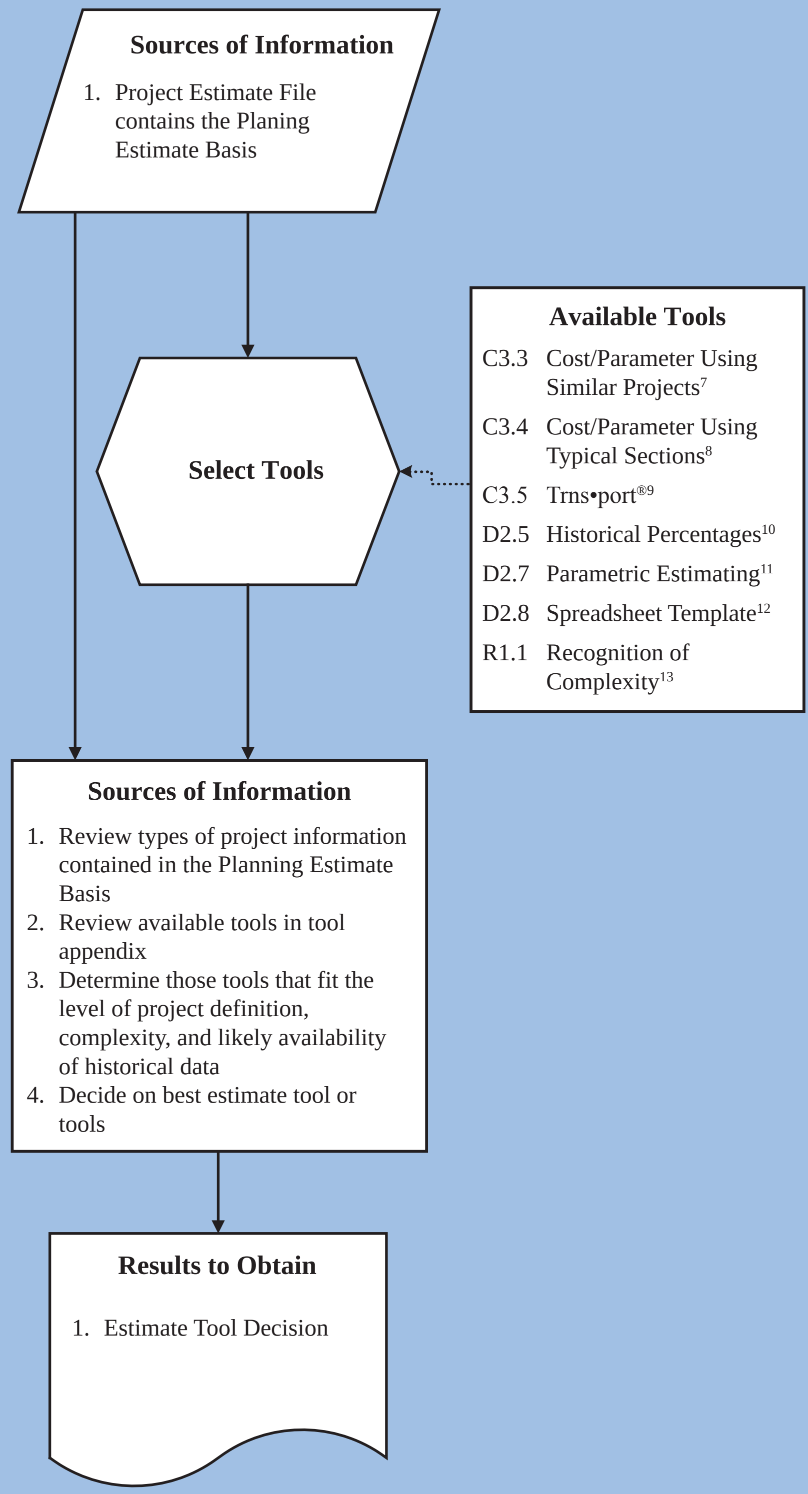
Select Appropriate Approach (A121)

The Planning Estimate Basis contains key information and documents from which the Estimator will use to prepare the estimate. The documents contained in this file are critical to preparing an accurate estimate. Project requirements as defined in the estimate basis and complexity of the project drive estimating tool selection.

Choosing the correct tool or tools to prepare the Planning estimate is key in both producing a quality estimate and spending the appropriate amount of time on the estimate. Notice that several design estimating tools can be used in Planning (D 2.5, D 2.7, D 2.8).

The Estimator must rely on both experience and judgment when selecting the set of tools applicable to the project being estimated. The Estimator may want to discuss tool choice with the Central Estimating Office, especially if using Trns*port software. The availability of historical data will impact this decision. Referencing previous estimates for similar projects can aid in tool selection.

The Estimator makes an initial selection of the tool or tools that will be used. However, as estimate components are quantified and the historical cost basis is determined for the components of the estimate, the Estimator may select a different tool.



7. For C3.3 Cost/Parameter Using Similar Projects, see page 379.
8. For C3.4 Cost/Parameter Using Typical Sections, see page 381.
9. For C3.5 Trns•port®, see page 383.
10. For D2.5 Historical Percentages, see page 391.
11. For D2.7 Parametric Estimating, see page 394.
12. For D2.8 Spreadsheet Template, see page 397.
13. For R1.1 Recognition of Complexity, see page 343.

Determine Estimate Components and Quantify (A122)

Step Requirements

Determining estimate components is an extremely important step in producing consistent and accurate estimates. The Estimator must first determine which components of Total Project Cost Estimate are required to estimate all project costs. The Estimator relies on the Planning Estimate Basis and the tool(s) selected in step A121 to identify required components.

The Estimator determines the appropriate quantity measure and calculates quantities for the appropriate components, as dictated by the estimating tool. At the Planning level, the quantity is relatively straight forward. Typically, the quantity could be the number of lane miles (e.g., traveling lanes or center lanes). This is determined by approximate project boundary limits. In other cases, the quantity could be related to other project features such as square foot of bridge deck area. Even when there are a limited number of components to be estimated, the quantity basis should be documented.

The Estimator must be aware that all assumptions and calculations made during the Planning Phase can change as the Planning process develops better concept definition. For example, the number of lane miles may increase or decrease as the project limits are better defined.

The output of this process is categories and quantities consistent with the estimating tool(s) used.

Issues to Consider

Project Characteristics

- Complex projects that have many components will require Functional Groups to identify estimate categories, elements, and relevant quantities associated with their discipline. The Functional Groups must provide documentation of calculations and assumptions associated with any calculations.

Project Tool and Documentation

- Special care should be taken while operating electronic spreadsheets or other computer-based estimating tools. While they are quite helpful in performing calculations and are an expedient way to update an estimate, it is easy to make a small typing error or miscalculation in a cell that raises or lowers the estimate by an order of magnitude. Always double check entries and use “sanity checks” where possible.

- Proper documentation is necessary as review recommendations may require modifying some of the estimation categories. It is easier to make changes if the entire estimation calculations are well organized.

Determine Estimate Components and Quantify (A122)

The combination of the Planning Estimate Basis, the Functional Group Inputs, and the tools selected should provide all necessary information to quantify all estimate categories and elements.

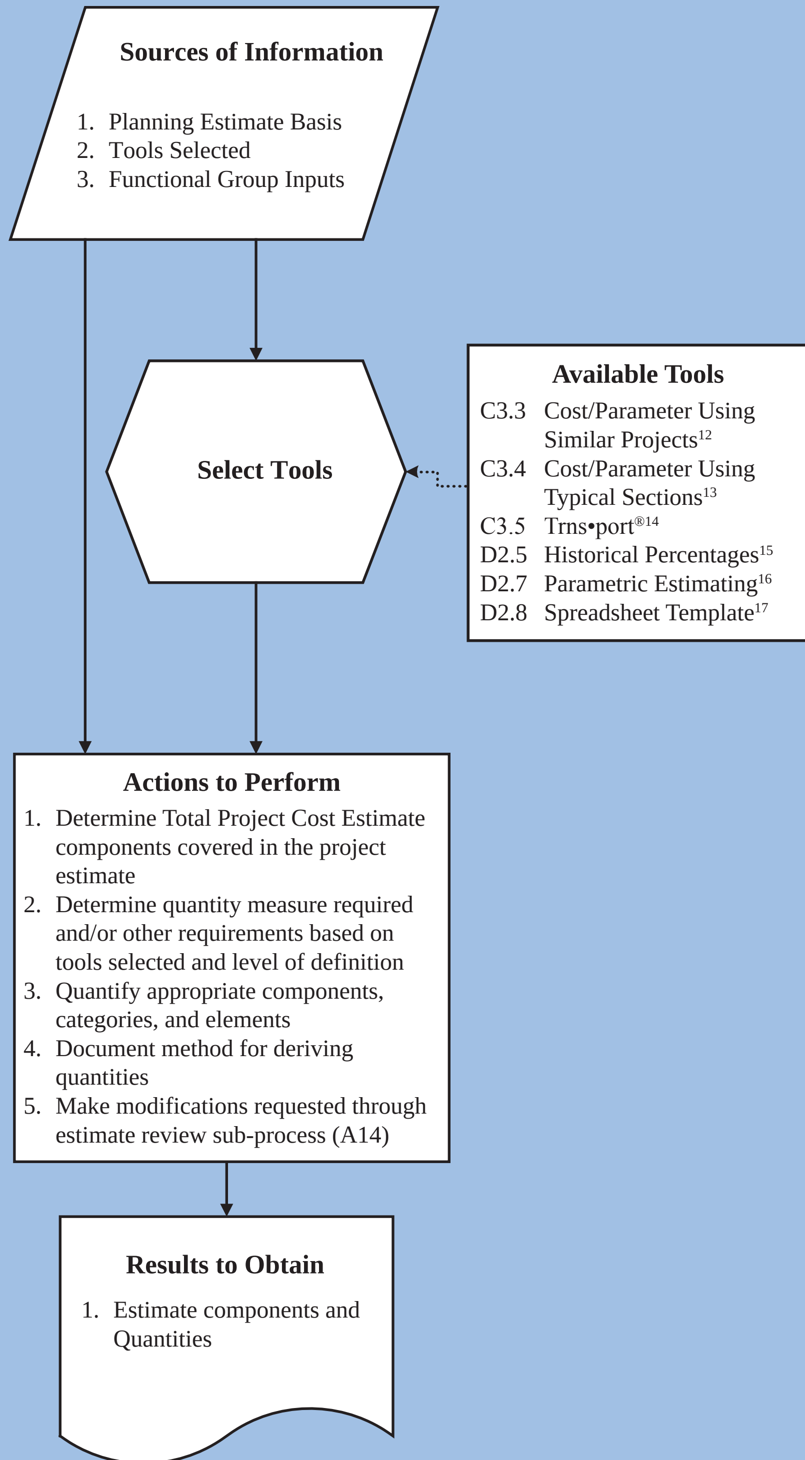
Spreadsheet templates provide a rapid and easy means for organizing estimate data and formulating repetitive calculations. Spreadsheets are also useful for compiling estimate calculations and assumptions, assessing estimate completeness, and communicating the estimate to others.

Trns*port software can provide a basis for estimating costs based on key parameters such as lane miles. Quantities are generated by the software.

Identify the major components of the Total Project Cost Estimate based on the concept definition included in the Project Estimate File. Focus the efforts on these major categories and elements.

Quantity evaluations are closely tied to the estimating approach. Generally, there are a limited number of categories and elements, and the definition of elements within categories is limited so quantities are very broad, such as lane miles or LWD factors or percentages.

Estimate components and their quantities are carried forward to an estimate spreadsheet.



14. For C3.3 Cost/Parameter Using Similar Projects, see page 379.
15. For C3.4 Cost/Parameter Using Typical Sections, see page 381.
16. For C3.5 Trns•port, see page 383.
17. For D2.5 Historical Percentages, see page 391.
18. For D2.7 Parametric Estimating, see page 394.
19. For D2.8 Spreadsheet Template, see page 397.

Develop Estimate Data (A123)

Step Requirements

This step in the Prepare Base Estimate sub-process determines the various cost data that are applied to Total Project Cost Estimate categories and elements. The types and sources of historical data depend on the estimating tool used. For example, cost per parameter estimating requires cost per lane mile based on a similar project or portion of that project. A typical section for pavement type is used in conjunction with historical bid pricing to generate a lane mile value for that section. Finally, if parametric estimating is based on the Length, Width, and Depth (LWD) approach, then a similar project must be found to develop the cost metric applied to the LWD factor.

An important note for the Planning Phase is that the categories identified are not very specific. It is easier and more accurate at this stage to estimate a single category that is comprised of many related elements. For example, if a bridge is part of the project requirements, all bridge elements will not be individually estimated. The bridge cost will be estimated based on a single parameter, such as square foot of bridge deck area, based on historical data from similar types of bridges.

The critical action to perform in this step is to develop the appropriate cost data for each category; however, equal care must be given to adjusting the cost data for project specific characteristics or location if the project is from another District, for age of historical data, and for other factors. The Estimator may also need to modify any necessary cost data based on the feedback from the estimate review sub-process (see A14 on page 88).

The Estimator uses a number of different inputs to accomplish this step, such as cost categories and quantities, project characteristics, and historical data. An important tool used is a spreadsheet template, which is an excellent and simple tool for ensuring all components of total project cost have been considered and accounted for in the estimate. The outputs of this step are cost values and the identification of estimate assumptions.

Issues to Consider

Historical Data

- Historical bid data used for estimating must reflect current costs, that is, costs are updated to reflect inflation when costs are older than three months.

- Historical bid data must be understood in terms of how these data are developed for estimating a current project (e.g., using weighted averages based on low bid only).

Project Characteristics

- Similar project characteristics and requirements are key when using any of the estimating approaches for Planning level estimation.

Develop Estimate Data (A123)

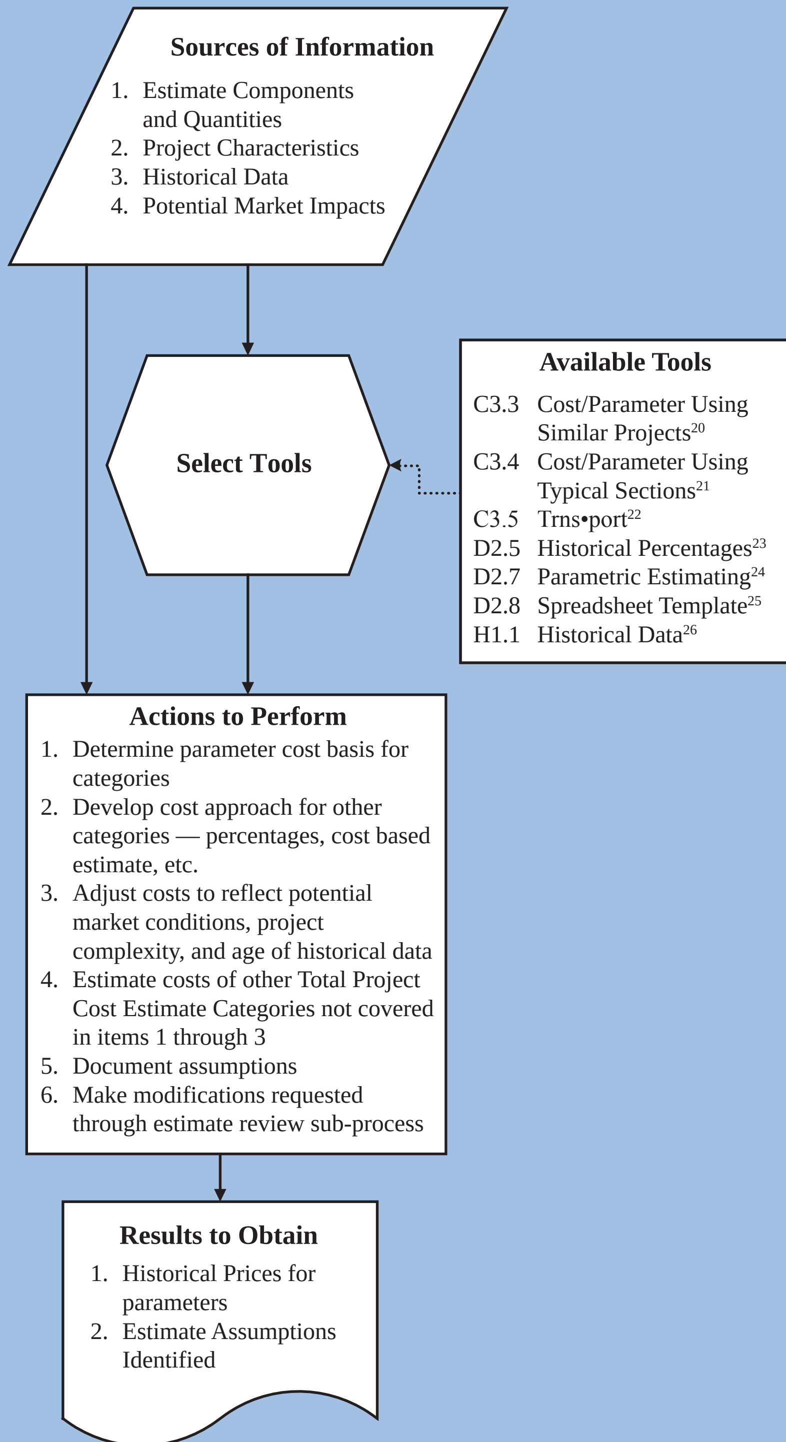
Developing historical cost data for converting quantity information to cost may be the most critical and important action required to prepare a Planning estimate. Without this data, Planning estimates would be nearly impossible to prepare. Consider variability resulting from the source of historical data used and its fit with the project being estimated.

Consider where the project is located and its key features, that is, rural/urban, two lane/four lane, and so on, as these issues will impact cost parameter values.

Trns*port software already includes a built-in database.

Adjusting historical data to fit a project is a challenge. The most significant issue is ensuring that the project from which historical data is used to build parameter values is similar in project definition to the project being estimated. Adjustments for difference in definition can be reflected in the parameter value or considered in contingency evaluations.

Historical data must reflect current day costs prior to applying these data to a project estimate. The Estimator should note estimate assumptions made when adjusting historical data to fit the project being estimated. Also, uncertainty associated with the use of these data must be considered and noted.



20. For C3.3 Cost/Parameter Using Similar Projects, see page 379.
21. For C3.4 Cost/Parameter Using Typical Sections, see page 381.
22. For C3.5 Trns•port, see page 383.
23. For D2.5 Historical Percentages, see page 391.
24. For D2.7 Parametric Estimating, see page 394.
25. For D2.8 Spreadsheet Template, see page 397.
26. For H1.1 Historical Data, see page 373.

Calculate Cost Estimate (A124)

Step Requirements

Calculating the cost estimate is a fundamental step in the Prepare Base Estimate sub-process (A12). The Estimator inserts into the cost estimating spreadsheet quantities and cost data for each estimate category to calculate the base cost of a project. Cost estimates provided by Functional Groups should also be included. The spreadsheet should summarize categories consistent with the components of the Total Project Cost Estimate.

A simple spreadsheet can be used to make the necessary calculations of category costs for a Total Project Cost Estimate and eventually for reviews.

Issues to Consider

Project Definition and Characteristics

- A check is made to ensure that the estimate covers all project requirements that can be adequately defined.

- Sanity checks can now be performed to make sure any large mistakes or miscalculations have not been made on the spreadsheet.

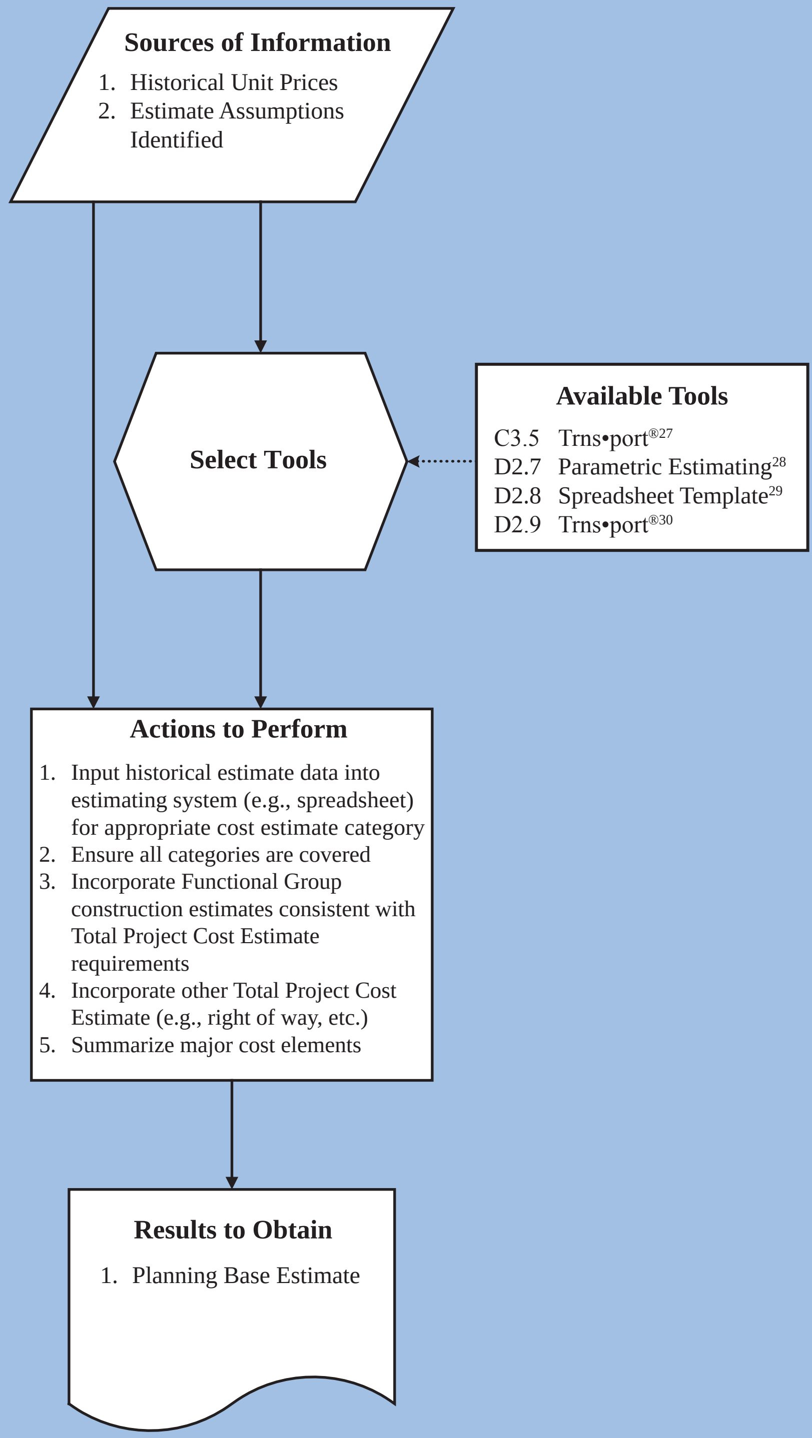
Calculate Cost Estimate (A124)

Formulas used in spreadsheets should be checked to ensure that all costs are properly calculated and aggregated to summary component levels.

Simple spreadsheets can aid in clearly communicating the total estimated cost of the project, as well as revealing what categories are included in the estimate and what they are expected to cost. This allows for easy comparison to historical ratios from past projects for making rapid sanity checks of estimated costs.

This is the time to ensure all project requirements have been accounted for in the estimate. Any exclusions should be noted.

Contingency should not be included in any category cost estimates.



27. For C3.5 Trns•port®, see page 383.
28. For D2.7 Parametric Estimating, see page 394.
29. For D2.8 Spreadsheet Template, see page 397.
30. For D2.9 Trns•port®, see page 401.

Document Estimate Assumptions (A125)

Step Requirements

A project's complexity and size may mean that more issues must be considered in preparing the estimate. Additionally, estimates are commonly prepared in collaboration with many Functional Groups. The decisions and assumptions behind the choices that drive the estimate must be clearly stated and communicated to management. Thus, this step is crucial in preparing an estimate. Good documentation supports the cost estimate's credibility, enables reviewers to effectively assess the quality of the estimate, and aids in the analysis of updates of Planning estimates.

This step brings together all estimate information used to prepare the cost estimate in a structured format. Even in the Planning Phase, the need to assemble backup calculations, assumptions, and other pertinent estimate information is critical to ensure consistency across Districts and within the state.

The output of this step is an updated Project Estimate File, which will now include all identified estimate assumptions.

Issues to Consider

General

- It is particularly important to clearly document data origins and approximations as any Planning estimate updates will be compared to this estimate and will be used to justify the changes in the cost of the project.

Policy Guidance

- Cost estimates for each phase will be documented and will include a description of what the project is and what it is not, as defined in the Draft Planning Report; the assumptions used; the extent to which various estimate inputs are developed; the basis of the estimate; the base estimate; and a separate contingency amount with a description of associated risks.

- The project uncertainties should also be identified and documented. Documenting these uncertainties can aid in defining the unknown aspects of the project, including any potential for an accelerated project delivery effort.

Functional Group Input

- Similar documentation structure of the estimate should be provided by each Functional Group that prepares an estimate for projects.

Document Estimate Assumptions (A125)

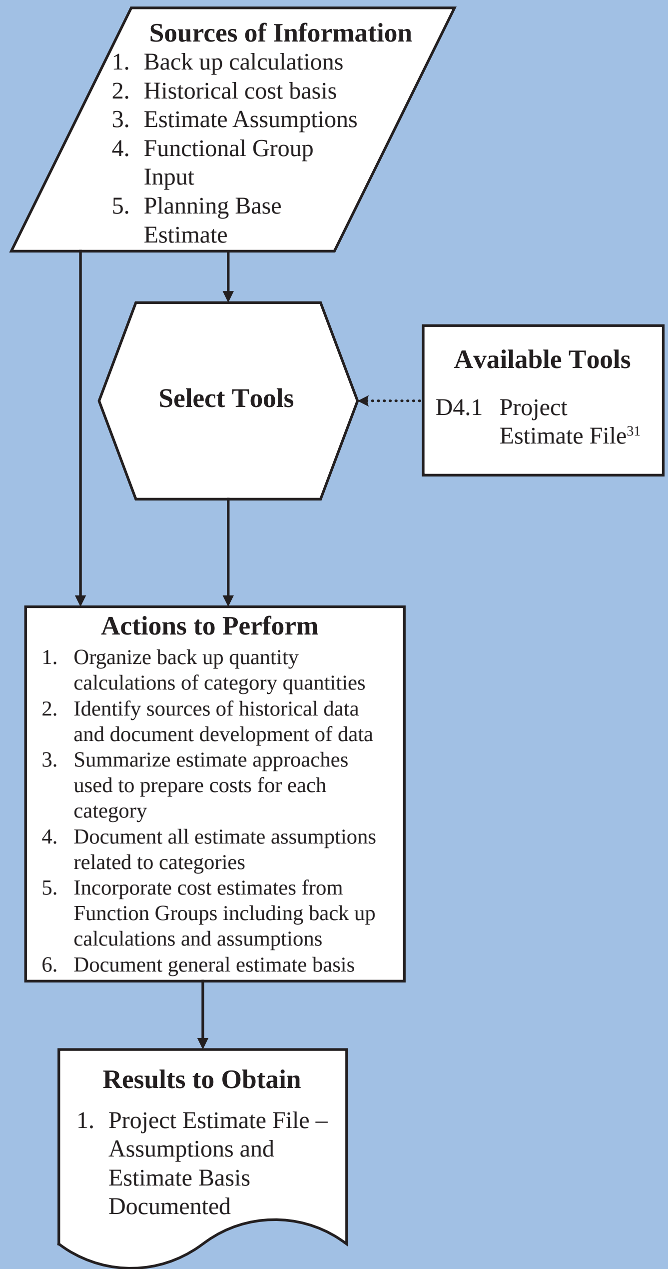
Each project has a Project Estimate File separate from the general project file or the correspondence file. The primary purpose of this file is to ensure that each project has a well-documented and easily retrievable history of the assumptions, methods, and procedures used to estimate the costs associated with the project's specific scope of work.

Traceability is a critical requirement necessary to prepare a credible cost estimate. Traceability allows others to review and validate the estimate. Traceability provides the mechanism to assess cost impact when the planning estimate updates are made.

Traceability is facilitated by clear and concise documentation. Documentation should include estimate basis, assumptions, and calculations. The Project Estimate File should be created to assemble these items in a single location.

Estimate bases and assumptions are at two levels: 1) high-level bases and assumptions that apply to every category of the project estimate; and 2) detailed-level bases and assumptions that apply to individual category estimates.

The Project Estimate File is first populated with the estimate basis used to prepare the estimate (from A11). At this point, the Project Estimate File is further populated with backup calculations, assumptions, and other pertinent cost information.



31. For D4.1 Project Estimate File, see page 339.

Prepare Estimate Package (A126)

Step Requirements

This is the final step in completing the Planning base estimate. All calculations have been made and documented before this step; however, the details, summaries, and assumptions must all be collated into a single, logical volume. After accumulating and organizing this material, the package produced will represent the Total Project Cost Estimate, without contingency, and all supporting information. This document is the Planning Base Estimate Package.

The package provides a record that documents the basic reasons behind the original estimated construction and other cost. Above all, the information must be easy to understand and well-organized for reviewers. Thus, summary level information is often prepared for later estimate reviews and management approvals. The Planning Base Estimate Package should include updates in project requirements, assumptions, quantity and cost calculations, and supporting data.

Issues to Consider

General

- Contingency is not included in the package.

- The collaborative effort required to create an estimate can lead to problems with consistency; therefore, the package preparer must ensure harmony exists between all parts of the estimate before the package is complete.

- This estimate will be the first reference point for other project team personnel as the project moves through the Planning Phase and eventually into the Scoping Phase, which further stresses the importance of making the package easy to use since engineers who did not help create it will soon be using it.

Policy Guidance

- All project-related costs will be expressed as a Total Project Cost Estimate, regardless of the project development phase. The Total Project Cost Estimate consists of a base estimate and a contingency (added in the next sub-process, A13). The base estimate includes all known project costs at the time the estimate is made.

- Inputs from various Functional Groups are important to properly organize and compile estimate documents for future reference.

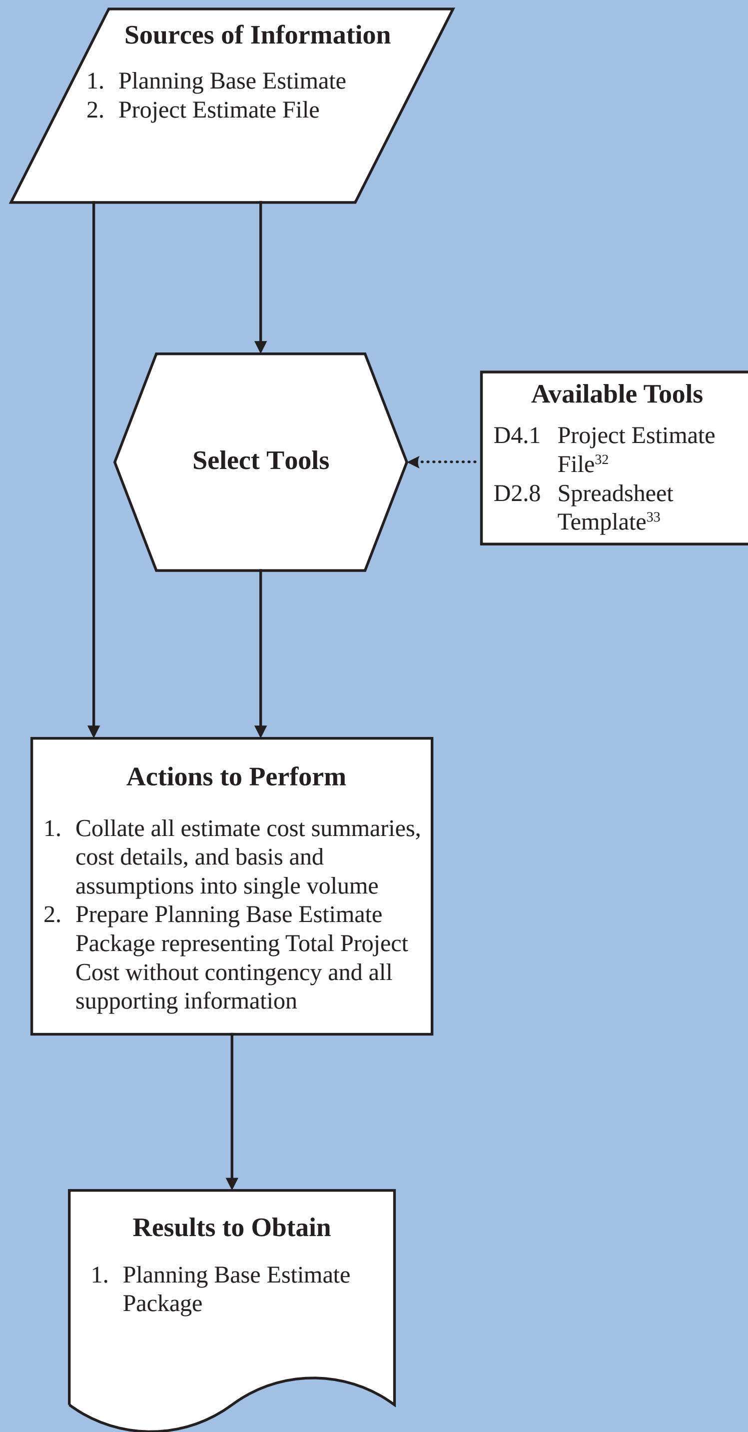
Prepare Estimate Package (A126)

While the Planning base estimate and the Planning Project Estimate File combined have all of the necessary information, they must be merged into a single package. The Planning Base Estimate Package becomes the sole source of all base cost estimate information.

Organization and readability are two of the most important considerations in preparing the base cost estimate package due to the number of project personnel who will need to access and use the information.

The Planning Base Estimate Package should include all required information related to the base cost estimate, including cost summaries, cost details, project requirements used to prepare the estimate, all assumptions, and backup calculations. Uncertain items should be listed clearly.

A short cost estimate summary can be prepared that captures key features of the estimate, such as total project costs, key estimate bases and assumptions, projected year of expenditure period, and other critical items. This document, while part of the package, will aid in efficient management reviews of the cost.



32. For D4.1 Project Estimate File, see page 339.
33. For D2.8 Spreadsheet Template, see page 397.

III.2.4 DETERMINE RISK AND SET CONTINGENCY (A13)

The primary objective of this sub-process is to characterize the estimate uncertainty and develop a contingency amount to add to the base estimate to arrive at the Total Project Cost Estimate. The six sub-process steps are as follows:

1. Review Risk Information – A131
2. Determine Level of Risk Analysis – A132
3. Identify Risks – A133
4. Estimate Contingency – A134
5. Document Risk and Contingency Basis – A135
6. Prepare Total Project Cost Estimate – A136

The first four steps, in combination with the tools in Appendix IV.2, support the development of a contingency estimate. These four steps identify risks and provide a framework to assess the amount of contingency that will properly allow for estimate uncertainty during the Scoping process. Some of these key inputs include the following:

- **Planning-Level Project Definition Assumptions** – an analysis of planning-level assumptions regarding project definition form the basis for risk identification.

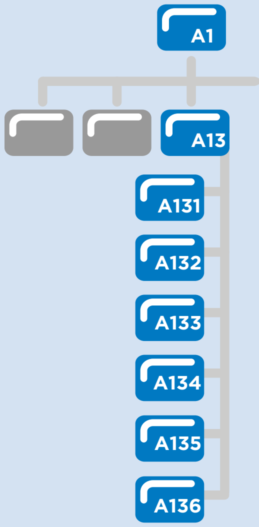
- **Estimating Assumptions and Concerns** – estimating assumptions and estimator issues of concern are also a primary input for risk identification.

- **Individual Expertise** – Since a historical database of risks with accurate probabilities of occurrence and magnitudes of impact is not currently available, risk analysis and setting of contingency will necessarily rely on expert judgment of the Estimator.

- **Project Complexity Categorization** – the level of project complexity, not necessarily the project size, determines the type of risk analysis that will identify risks and estimate contingency.

Use these key inputs when performing the six steps of this process. The output of this sub-process is a contingency estimate, a documentation of the risk and contingency basis, and the total project cost expressed in year of construction dollars. Generally, express the total project cost as a range at this point in the project development process. Add all of these items to the project estimate file at the end of the process. Depending upon the level of project complexity and risk analysis, the outputs will vary from a simple red flag item list (I2.1) with a "top-down" estimate range—three-point estimates (R3.4)—for a range of contingency to a detailed risk register (R3.12) with a "bottom-up" estimate range—Monte Carlo estimates (R3.5)—for a range of contingency.

The primary objective of this sub-process is to characterize the estimate uncertainty and develop a contingency amount to add to the base estimate to arrive at the Total Project Cost Estimate.



Review Risk Information (A131)

Step Requirements

The planning estimate basis and the base estimate package comprise the key inputs for this sub-process step. A determination of project risk stems from a review of the estimating assumptions made by the Estimator and the project definition assumptions made by the planner. The Estimator must make estimating assumptions in a planning level estimate because very little detail will be available regarding project definition. Likewise, the planners must make initial project definition assumptions because limited resources—or no resources—will have been invested in design at this point in the process. Estimating and design assumptions serve as triggers for risk identification when creating a contingency estimate.

Two other sources of risk information are risk checklists and risk analyses from similar projects. However, only review these sources of information after conducting a thorough review of the estimating and design assumptions.

Issues to Consider

Level of Estimating Effort Applied

- Estimators should consider the level of effort that was applied in the base estimate when compiling the estimating assumptions. If the Estimator was afforded sufficient time to complete the estimate, the list of assumptions will likely be complete and comprehensive. If a base estimate was prepared quickly, which is often the case at this stage of project development, the list of assumptions may well be incomplete. In the latter case, risk checklists and similar project analysis will be useful.

Risk Management Plan Outline

- On complex projects in the Planning stage, a final output of the determine risk and set contingency sub-process can be a risk management plan. The risk management plan is scalable in detail depending on project complexity and level of risk exposure. Complete the outline for the risk management plan early in this sub-process step. (See Tool R3.1 Risk Management Plan).

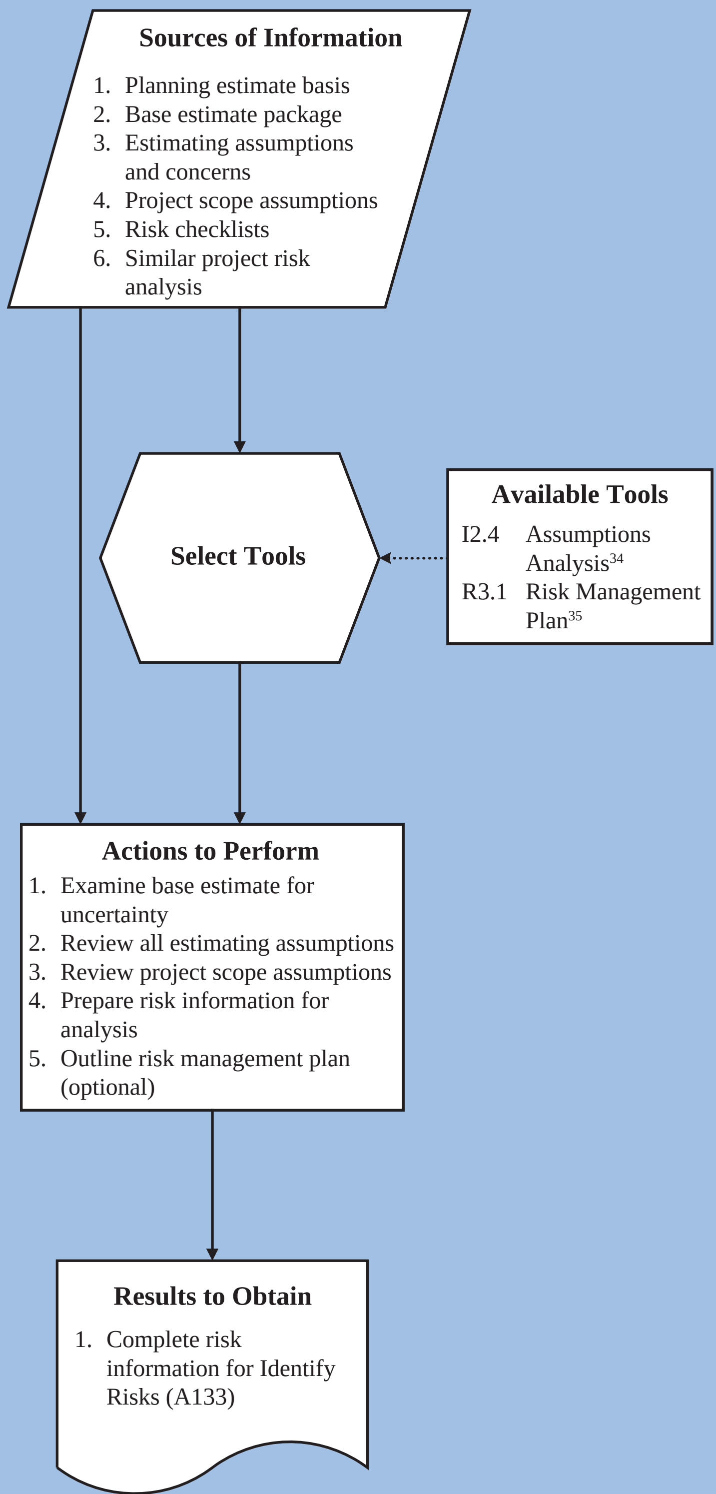
Review Risk Information (A131)

Planning Estimators will concurrently perform portions of the contingency estimate with the base estimate development. However, the final contingency estimate should only occur after the base estimate is complete. A complete Planning estimate basis and base estimate package are necessary to complete the risk analysis and contingency estimate.

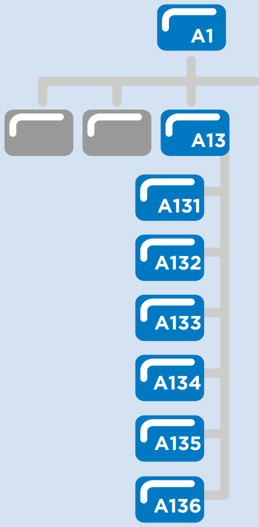
The Risk Identification (A133) and Estimate Contingency (A134) sub-process steps will employ many more tools. The Review Risk Information step focuses on the collection of information for analysis.

On a complex project, begin the risk management plan outline early. Enhancements to the plan can occur throughout the project development process, but the outline for the plan should start early in the process.

Given the nature of information available in the Planning Phase, the Estimator will need to make many assumptions regarding project definition to complete the estimate. When possible, the risk analysis and contingency setting process should involve a consultation with the design team and/or expert offices to verify these assumptions.



34. For I2.4 Assumptions Analysis, see page 419.
35. For R3.1 Risk Management Plan, see page 425.



Determine Level of Risk Analysis (A132)

Step Requirements

The primary inputs for this step are the estimate basis documents and the project complexity tool evaluation (R1.1). A project complexity evaluation will categorize the project as minor, moderately complex, or major (correlating to Type I, II, and III risk analyses, respectively).

Type I Risk Analysis – Risk Identification and Percentage Contingency
The Type I risk analysis applies only to minor projects. It is the simplest form of risk analysis. A Type I risk analysis involves the development of a list of risks and the use of a percentage to estimate the contingency. The Estimator should use his or her judgment within percentage contingency acceptable standards set by Mn/DOT.

Type II Risk Analysis – Qualitative Risk Analysis and Identified Contingency Items
The Type II risk analysis applies to moderately complex projects and involves more rigorous risk identification tools and specific contingency items that complement the percentage-based contingency in the Type I analysis. A risk register containing a probability-impact (P×I) matrix analysis to rank the risks is essential. A qualitative ranking of the risks is a key output.

Type III Risk Analysis – Quantitative Risk Analysis and Contingency Management
A Type III risk analysis applies only to major projects. It will need to be facilitated by consultants who are experts in quantitative risk management practices. The process generally starts with a risk analysis workshop and generates a stochastic estimate of cost and schedule, which are then updated throughout project development.

Issues to Consider

Table III.2-2 Risk Tools for Planning Level Estimates

Risk Analysis Tool	Type I	Type II	Type III
I2.1 Red Flag Item Lists	√	√	√
I2.3 Risk Checklists	√	√	√
I2.4 Assumptions Analysis	√	√	√
I2.5 Expert Interviews		√	√
I2.6 Crawford Slip Methods		√	√
R3.6 Risk Workshop			√
R3.2 Contingency Percentage	√	√	√
R3.12 Risk Register	√*	√	√
R3.8 P×I Matrix		√	√
R3.3 Contingency Identified		√	√
R3.4 Estimate Ranges – Three-Point Estimates		√	√
R3.5 Estimate Ranges – Monte Carlo Estimates			√
R3.1 Risk Management Plan	√*	√*	√

* Optional, but highly recommended.

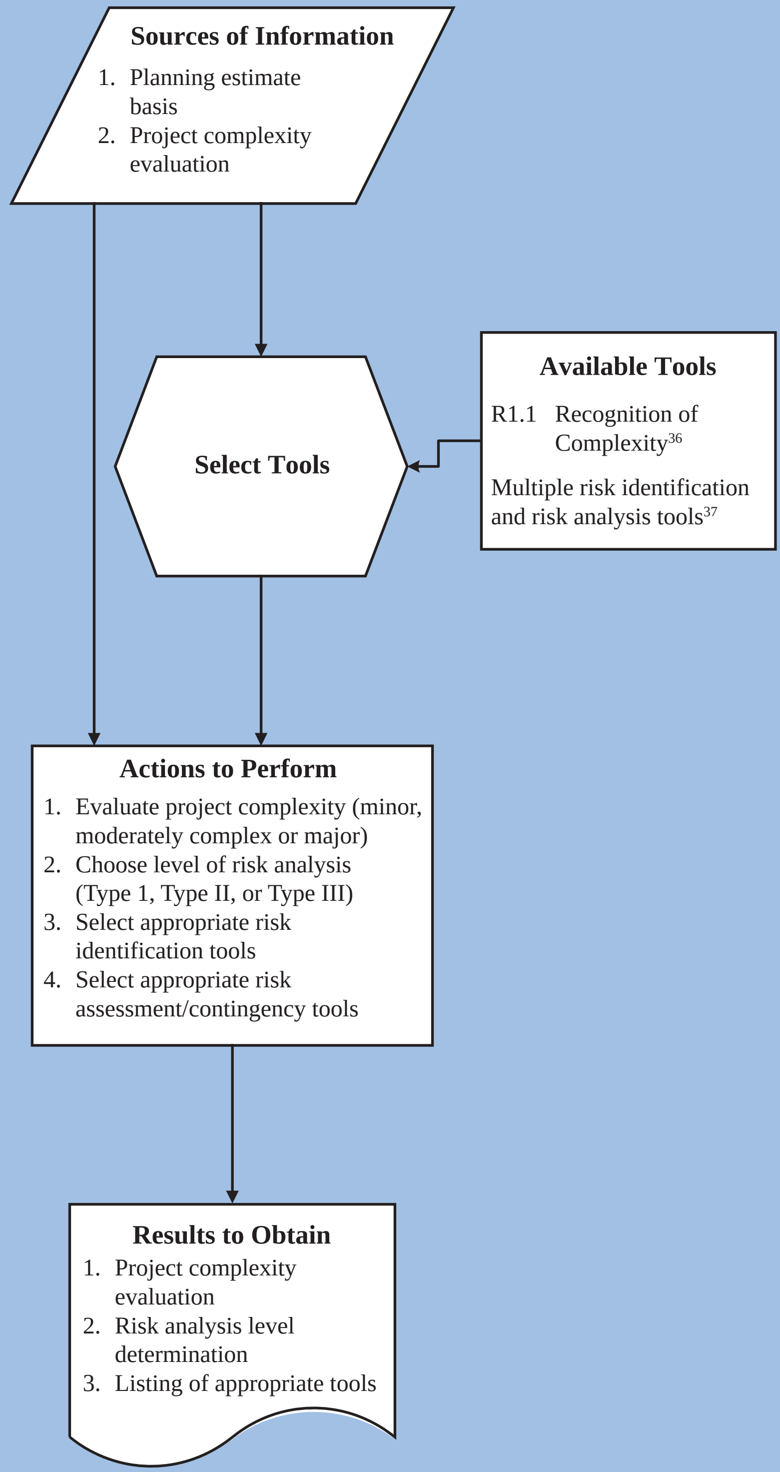
Determine Level of Risk Analysis (A132)

All projects, regardless of project size and project complexity, will require some form of risk analysis and risk management plan. The general risk analysis process remains the same, but the tools and level of effort vary with the risk analysis level.

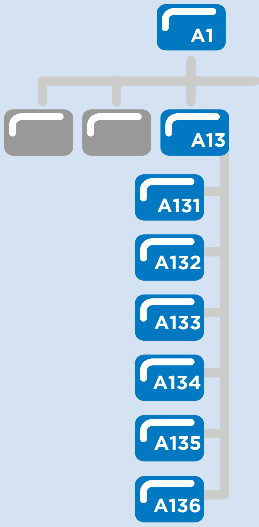
Project complexity is the key driver for the type of risk analysis. Project size is not necessarily a determinant of project complexity. Small projects can be complex and require a more rigorous analysis.

Employ external consultants for Type III risk analyses. Retaining the consultant who conducts the initial risk analysis for updates can help with the continuity of updates, whether periodic or as required by project circumstances.

Risk analysis and risk management planning are iterative and continuous throughout the project development process.



36. For R1.1 Recognition of Complexity, see page 343.
37. See Table III.2-2 on page 78.



Identify Risks (A133)

Step Requirements

The objectives of risk identification are to 1) identify and categorize risks that could affect the project, and 2) document these risks. The outcome of the risk identification is a list of risks. On minor, low-cost projects with little uncertainty (few risks), the risks can simply be kept as a list of red flag items. The Estimator should associate the red flag items with a contingency percentage (Type I risk analysis). On major projects that are by nature uncertain, the risks can feed the rigorous analysis process and stochastic estimate that form the basis for risk monitoring and control throughout the process.

The risk identification process should generally stop short of assessing or analyzing risks, so as not to inhibit the identification of "minor" risks. The process should promote creative thinking and leverage team experience and knowledge.

The final task is to categorize the risks. Use risk checklists and similar project risk analyses for possible categorizations. Mn/DOT may choose to establish a risk breakdown structure to categorize risks similarly across the department and create a historical database.

Issues to Consider

Risks should be Comprehensive and Non-Overlapping

- Perhaps the most challenging aspect of risk identification is in defining issues at an appropriate level of detail. Issues defined too vaguely or too "lumped" are hard to assess. Defining too many separate, detailed risks can lead to overlapping among issues or missing larger issues (i.e., "missing the forest for the trees" problem). To the extent possible, define risks to be independent of each other, thereby eliminating overlap among risks through their descriptions.

Use of Risk Checklists and Similar Projects

- Risk checklists and lists of risks from similar projects can be helpful, but use them only as a "back check" at the end of the risk identification process. Review these lists only at the end of the process as a means of ensuring that the list is not excluding any common risks. Avoid beginning the process with the risk checklists or similar project analyses as the team may overlook unique project risks or include too many risks in the analysis, making it less useful.

Identify Risks (A133)

Risk identification should be a creative brainstorming process. It should not attempt to analyze risk or discuss mitigation procedures, which will be completed in the next steps.

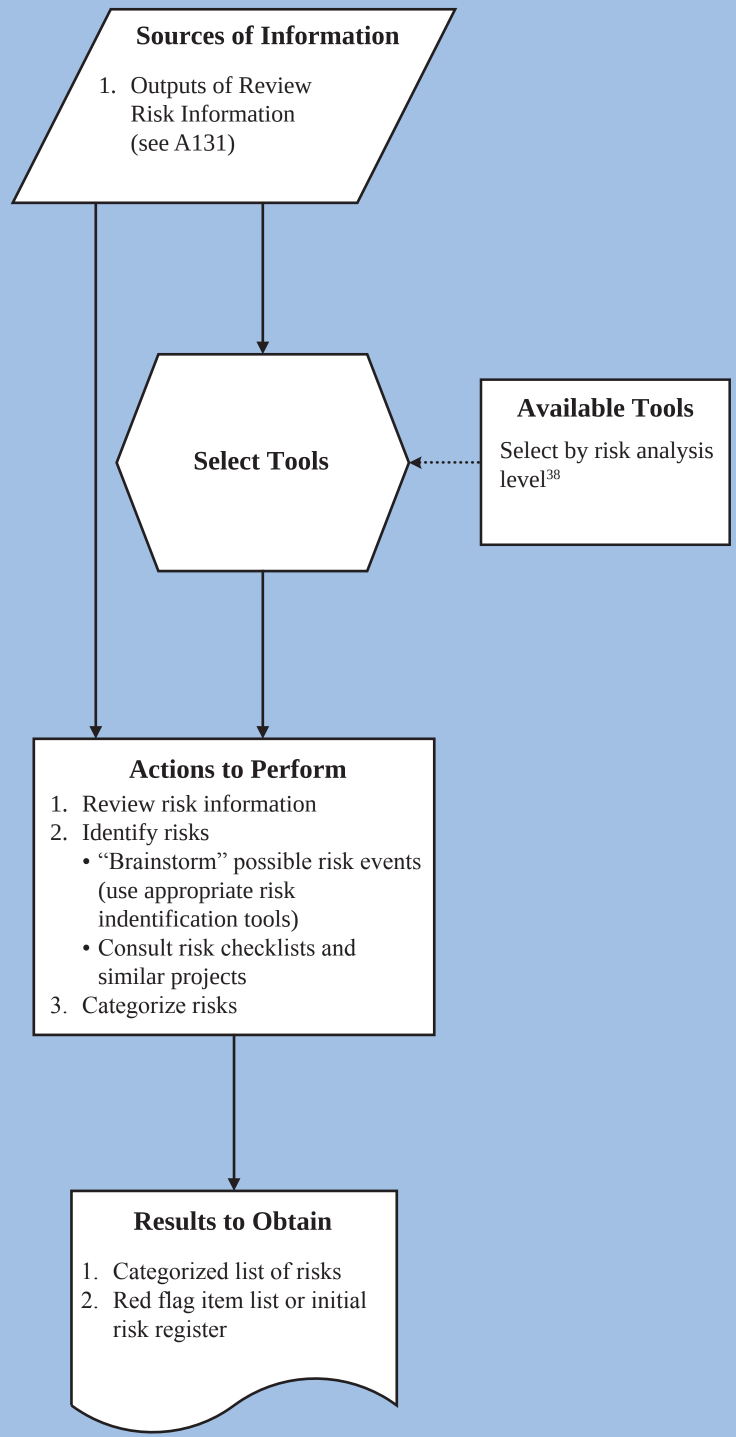
At a minimum, risk information should include assumptions, estimate basis uncertainties, and project issues and concerns from the Estimator, project team, and any participating functional units.

Risk analysis tools will be dependent upon the level of risk analysis. Upon determining the level of risk analysis, consult Table III.2-2 for appropriate risk analysis tools.

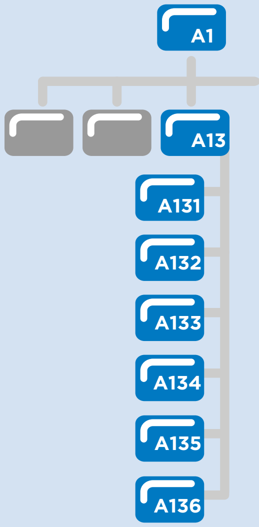
The resultant risk list should be comprehensive and non-overlapping to be most useful in later risk analyses. Combine like risks. Separate overlapping risks.

Use risk checklists and similar projects only at the end of the process to check for missing risks and to help categorize unique project risks.

Upon completion of the risk list, categorize the risks into logical groupings. Use risk checklists and similar project risk analyses for possible categorizations.



38. See Table III.2-2 on page 78.



Estimate Contingency (A134)

Step Requirements

The goal of this sub-process step is to estimate an appropriate contingency for the project. The list of risks and analysis of their likelihood and magnitude of impact forms the basis for this contingency. On minor projects employing a Type I risk analysis, assign this contingency through a simple percentage from historical data and Estimator's judgment. On major projects using a Type III risk analysis, assign the contingency through a stochastic model of cost and schedule using an external consultant to assist in building the model.

An update to the risk ranking is the first step in all three types of risk analyses. Risk assessment is the first step in a formal risk analysis process. Use the P×I tool (R3.8) to assess probability and impact of each risk. Ranges of probability and impacts are useful in initial assessments. Type II and III analyses may require more accurate assessments, but all three types of assessment can begin with a qualitative assessment of frequency and severity.

Issues to Consider

Type I Risk Analysis Contingency

- In a Type I risk analysis, use the list of risks to inform the choice of contingency from the department's pre-determined range of allowable contingencies (see R3.2 Contingency Percentage).

Type II Risk Analysis Contingency

- When choosing the appropriate contingency percentage in a Type II risk analysis, consult the range of contingency from the percentage contingency tool, and then review the top 20 percent of the prioritized risks to ensure that the contingency is adequate. Use an expected value estimate for estimating the top-ranked risks. Calculate the expected value by multiplying the product of the impact should the risk occur by the probability of the occurrence (e.g., $1,000,000 × 0.50 = $500,000). Use additional contingency if warranted by the expected value analysis (see R3.3 Contingency Identified).

Type III Risk Analysis Contingency

- Contingency in a Type III risk analysis involves a quantitative risk analysis and the development of a stochastic estimate for cost and schedule. A Type I or II analysis can be conducted prior to procuring a consultant if desired.

Creating Estimate Ranges

- Since planning estimates rely on very little project definition, communicate planning estimates in ranges. For Type I and Type II risk analyses, a three-point range estimate can be used to generate a credible "top-down" range (see R3.4 Estimate Ranges – Three-Point Estimates). A Type III risk analysis uses a "bottom-up" stochastic model to generate a range estimate, so a three-point range estimate will not be required.

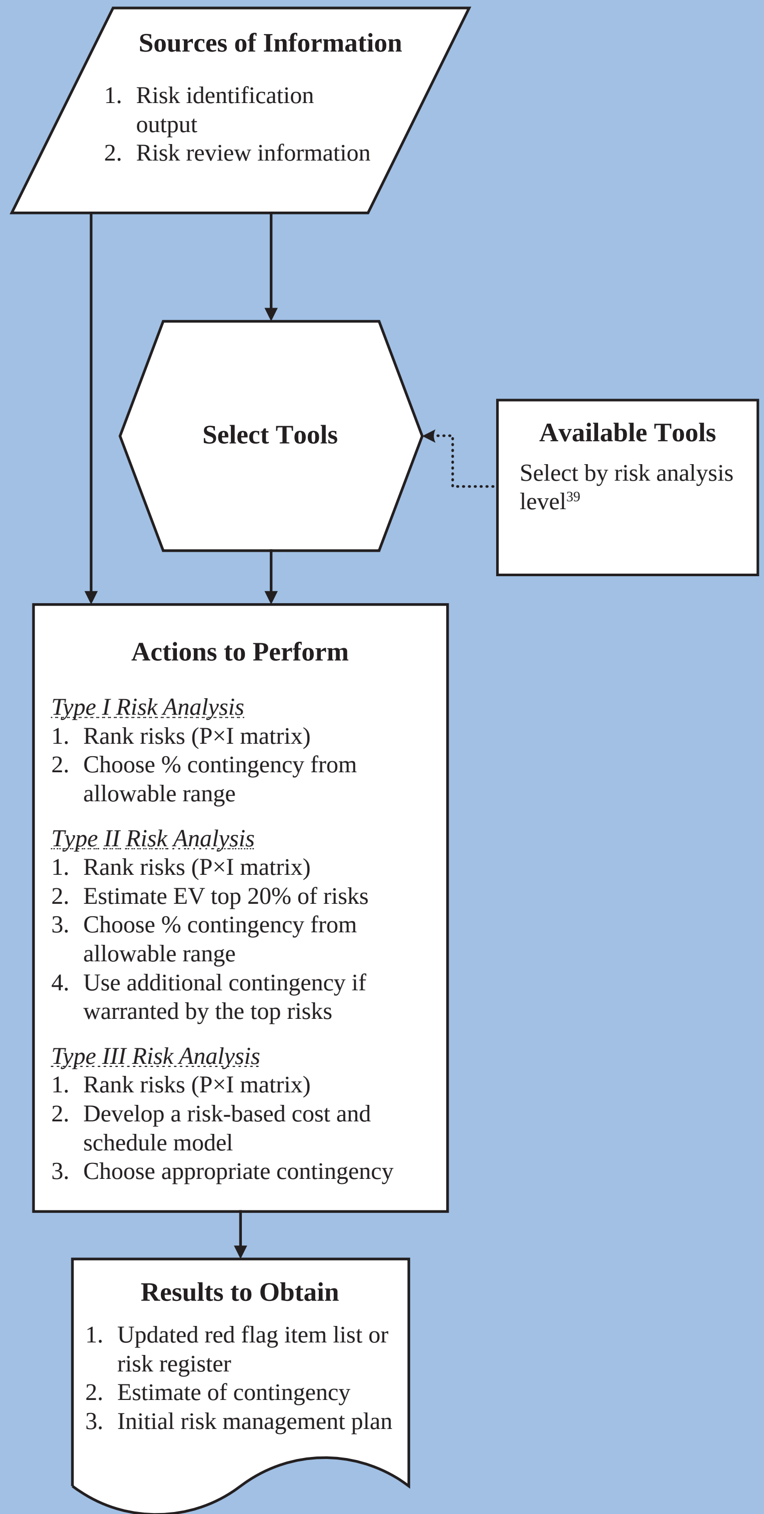
Estimate Contingency (A134)

Inputs for the contingency estimate come from the risk identification output (see A133 on page 80) and risk review information (see A131 on page 76).

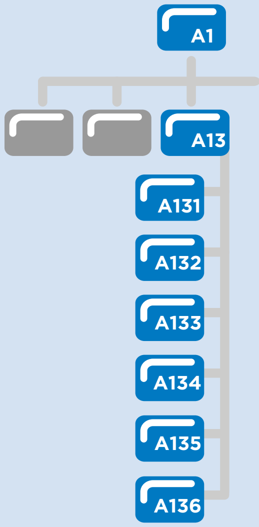
In all cases, relate the list of risks to the contingency amount. In many cases, the tie between the risks and contingency will not be direct, but the list of risks can justify the need for the contingency estimate to both internal and external stakeholders.

For a comprehensive listing of tools corresponding to each risk analysis level, please see Table III.2-2 on page 78.

When choosing the appropriate contingency percentage in a Type I risk analysis, consult the appropriate range of contingency from the percentage contingency tool.



39. See Table III.2-2 on page 78.



Document Risk and Contingency (A135)

Step Requirements

At a minimum, this step requires the Estimator and planners to document a transparent list of risks and uncertainties. Keep the list in the Project Estimate File and summarize it for communication of the cost estimate.

Maintenance of a risk register (R3.12) is a requirement for Type II and III documentation. It is also a good practice for Type I documentation. The register should provide, at a minimum, a detailed description of the risks, their probability of occurrence, their impact if they occur, strategies to manage the risks, an assignment of ownership for the risks, and a schedule for risk resolution. Type I risk analyses can be documented through red flag lists (I2.1), but Type II and III risk analyses should always be documented through a risk register.

A formal risk management plan (R3.1) is a requirement for Type III documentation, but it is also good practice for Type II documentation. The risk management plan generally documents the structure of risk management for each project. The risk management plan includes, at a minimum, the approach to managing the risks, roles and responsibilities, budgeting, timing, reporting formats, and tracking.

Issues to Consider

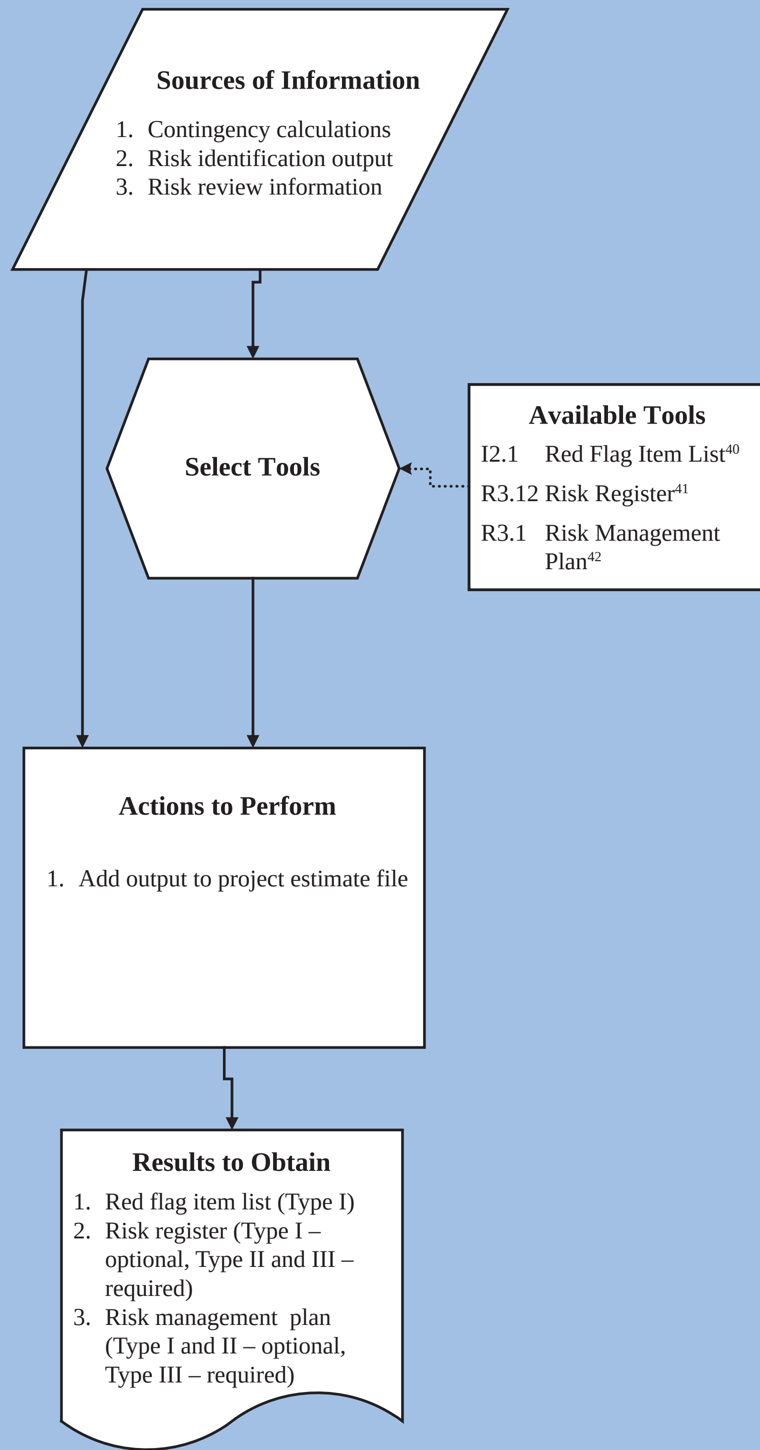
Application for Cost Management

- Documentation of the risk and contingency basis is vital for cost management. As the project progresses through the project development phases, risks will be either realized or resolved. Ideally, the project team will actively manage the risks, and the contingency will be resolved throughout the project development phase. Risks and contingency must be clearly documented with each estimate if they are to be actively managed.

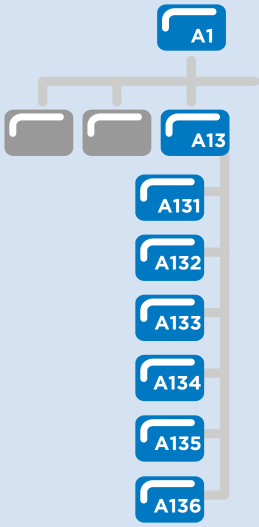
Document Risk and Contingency (A135)

Collate all risk and contingency information for use in cost management throughout the project development process. Each future estimate will involve an update of risks and an update of the contingency estimate. Documentation will allow for active risk management and appropriate contingency resolution.

Risk and contingency documentation is an important step in estimate communication.



40. For I2.1 Red Flag Item List, see page 411.
41. For R3.12 Risk Register, see page 446.
42. For R3.1 Risk Management Plan, see page 425.



Prepare Total Project Cost Estimate (Alternative) (A136)

Step Requirements

This final sub-process step involves adding the base cost estimate and contingency estimate to arrive at a total project cost. Consult the total project cost worksheets for proper format.

In planning estimates, the total project cost should be expressed as a range, as discussed in A134. The output of a Type III risk analysis is a range generated by a stochastic estimate model. In Type I and Type II risk analyses, the range can be generated through the use of a three-point range estimate (see tool R3.4).

Issues to Consider

Categories for Contingency

- Include the contingency in the greatest number of total cost categories that the contingency estimate can support. For example, a Type I analysis using a percentage contingency may include only one item for contingency. A Type II or III analysis may support contingency for individual categories in the total project cost calculations (e.g., separate contingencies for right of way, utilities, etc.). When tying contingency directly to individual categories items, explicitly identify the contingency and do not “bury” it in the category cost basis. For example:

Group	Category	Base Cost	Contingency	Total Cost
Construction	Utilities	$$$	$$$	$$$

Application of Inflation

- The Office of Investment Management provides an overall inflation factor for application to each project. Individual items within a project may include a risk and associated contingency for escalation (e.g., steel bridge costs may have an identified contingency for probable steel escalation). The inflation adjustment is for the overall project inflation and should be added to the project in addition to any identified contingency items. Add the inflation factor after summing the base and contingency estimates. Inflation should be applied to the midpoint of construction to reflect a year-of-construction estimate.

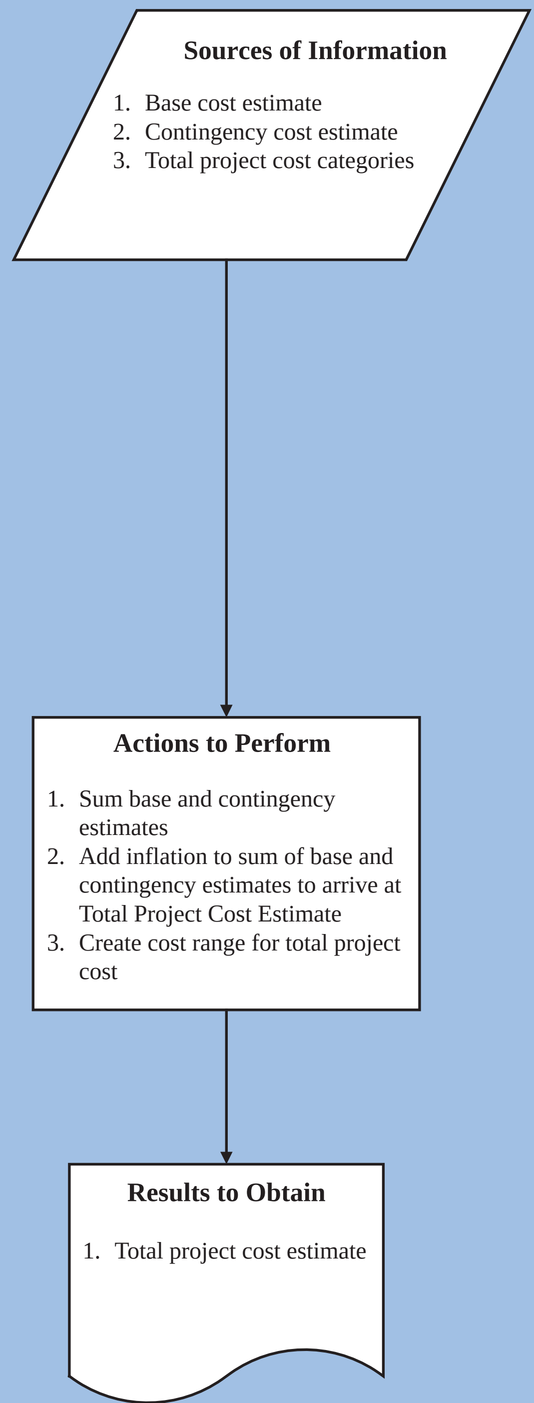
Prepare Total Project Cost Estimate (Alternative) (A136)

Mn/DOT is committed to communication of cost estimates through total project cost, which includes the base estimate plus the contingency. Include contingency in the means by which it was calculated (e.g., by percentage sum or by individual items).

Inflation is added to the estimate in addition to any identified contingency. Inflation is applied to the sum of the base and contingency estimates for the overall project.

Calculate inflation to the midpoint of construction.

In the Planning Phase, use range estimates to express Total Project Cost Estimates.



III.2.5 REVIEW AND APPROVE ESTIMATES (A14)

A purpose of the Review and Approve Estimate sub-process is to ensure that the estimate is as complete and accurate as possible based on the project requirements as described in the Draft Planning Report. This sub-process is critical as it represents final acceptance of the cost estimate before the estimate is released to both internal and external project stakeholders. This sub-process has four steps. The steps are as follows:

1. Determine Level of Review – A141
2. Review/ Verify & Reconcile Estimate – A142
3. Prepare Estimate Package – A143
4. Approve Estimate Package – A144

These four steps provide a natural progression of effort to review and approve the Planning Estimate Package. The first step requires a decision on the level of review required. The level of review is tied to project type and complexity. The second step requires review, verification, and then reconciliation with any previous cost estimate. Noting any changes that have been made or need to be made is essential to the cost management process. Once these two steps are complete, a package can be assembled for final approval of the Planning estimate. There are two key inputs required:

- **Total Planning (Alternative) Estimate Package** – contains the base cost (summary and details) and contingency, all supporting documentation related to estimate basis, assumptions, backup calculations, risks, and other areas of uncertainty.

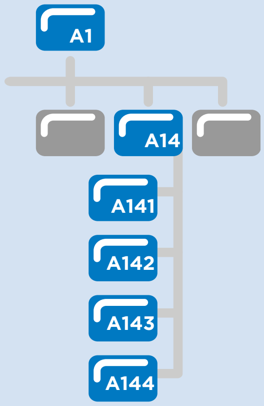
- **Project Characteristics** – description of the type of project and complexity of the project, including site-specific information and/or data that may impact the base cost and contingency.

The key inputs are then used when performing the four steps of this sub-process. The output of this sub-process is a Reviewed and Approved Planning Estimate Package. If the review finds no issues with the estimate, the estimate moves toward approval and then the Determine Estimate Communication Approach sub-process. Sometimes modifications to the estimate will likely be necessary before it can be passed forward, so it might cycle back through the Prepare Base Estimate (A12) and Risk (A13) sub processes before advancing.

The Estimator should review the RACI matrix and determine his or her role in estimate reviews and approvals, as well as the roles of management, other estimating groups, Project Management, and Functional Groups.

It is highly recommended that the accountability for the approval of the estimate be held by someone in District management. Responsibility for the review steps will likely rest with the Estimator. The Project Manager, (someone in the Planning Office such as a Planning Director) should also be accountable and responsible for the review steps.

It is highly recommended that the accountability for the approval of the estimate be held by someone in District management.



Determine Level of Review (A141)

Step Requirements

The primary inputs for this step include the Total Planning Estimate Package and the project complexity definition. The objective of this step is to perform a careful review of the project details and choose the appropriate tools for review. During the risk and contingency process, the project will have been categorized as minor, moderately complex, or major. The level of review correlates directly to these project complexity definitions. Table III.2.-3 below provides guidance on which tools apply to the appropriate review level.

Table III.2-3 Review Tools and Project Complexity

Estimate Review Tools	Minor	Moderately Complex	Major
C4.2 – Estimate Checklist	✓	✓	✓
E3.4 – Round Table Estimate Review		✓	✓
E3.3 – In-House Peer		✓	✓
E3.1 – Formal Committee			✓

Upon choosing the appropriate review tools, plan the review. The review plan should include a schedule for the review and a listing of people who will participate.

Issues to Consider

Policy Implications

- To achieve consistent and accurate cost estimates, Mn/DOT is conducting project cost reviews at critical points or gates during the project development phases. If this project is at one of those gates, be sure to understand and obtain the appropriate review. In the Planning Phase, the final estimate will be the Gate 1 or 2A. Gate 1 is when the project is included in the HIP, and 2A is to proceed with Scoping (see Figure II.2-1 on page 12).

- The Office of Scope and Cost Management will review major District project estimates for completeness and conformance with established cost estimating processes.

- The estimate review in the District should take place before the central review of the estimate.

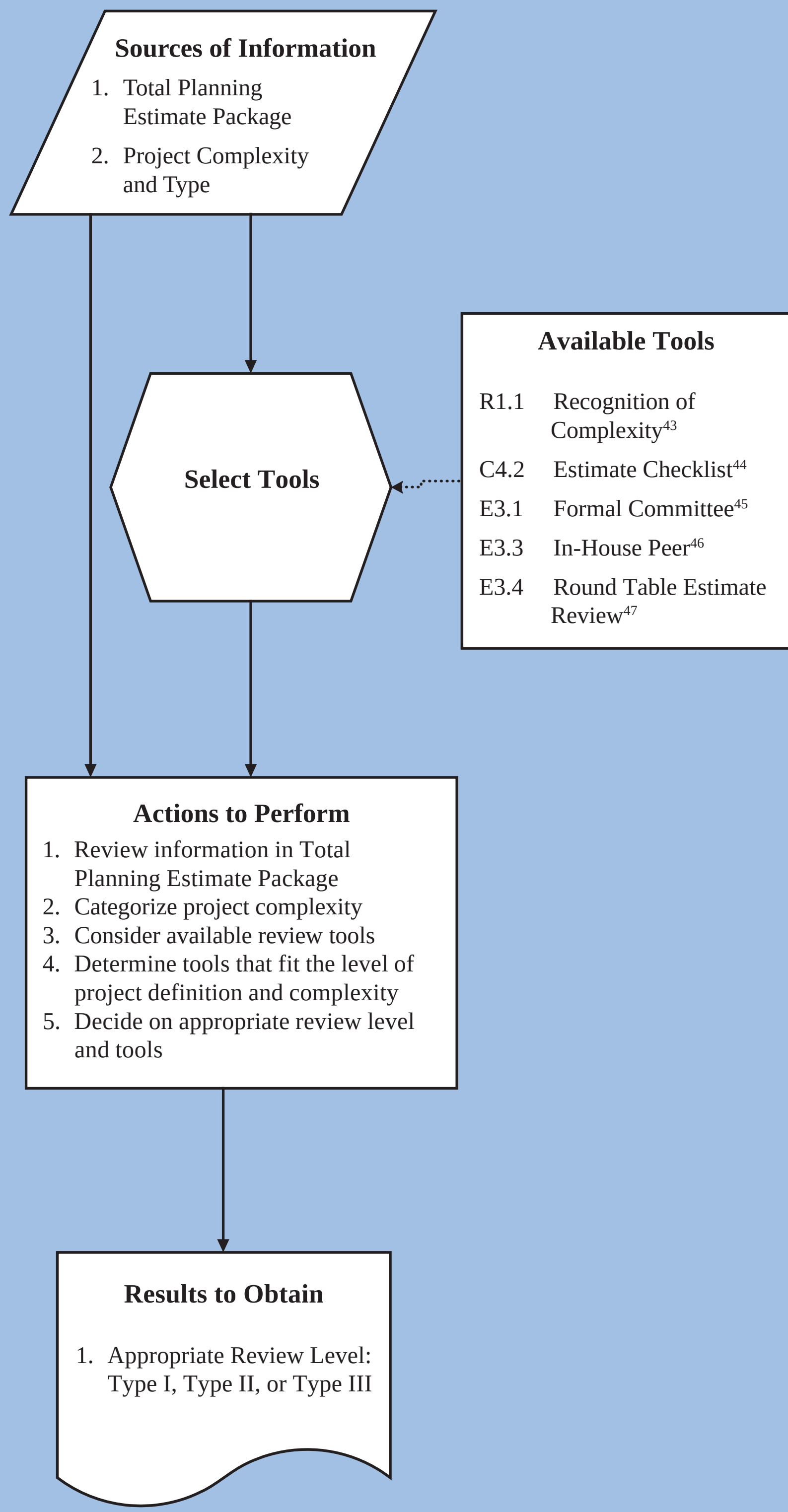
Determine Level of Review Level (A141)

Review the Total Planning Estimate Package and the overall project complexity and type in order to choose an appropriate review level. There are different tools that can be used for the different levels of complexity.

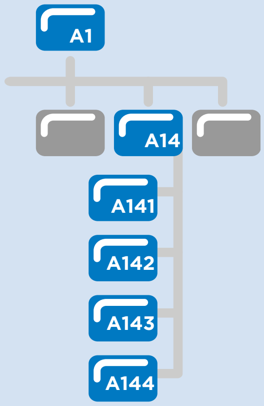
Read through the list of available tools and take them into consideration later on in this step and process.

Using the input information about size and complexity and the available tools list, choose a complexity level and review the information about each tool to decide what tools should be used. Consider the tools that have been previously used in the project development process to perform this function. This may help direct the tool choice at this time.

The output is an appropriate review level and a list of tools to be used in the review process.



43. For R1.1 Recognition of Complexity, see page 343.
44. For C4.2 Estimate Checklist, see page 449.
45. For E3.1 Formal Committee, see page 451.
46. For E3.3 In-House Peer, see page 454.
47. For E3.4 Round Table Estimate Review, see page 456.



Review/Verify & Reconcile Estimate (A142)

Step Requirements

This step requires that an appropriate review level be used to review, verify, and reconcile the estimate to determine if the correct assumptions, calculations, and conclusions were made about the project.

The Estimator or estimating team that prepared the estimate should conduct the first review of the project estimate. This is essentially a screening review that ensures the math is correct, the process is documented, and the estimate was developed following Mn/DOT guidelines. The output of this step will be a detailed list of all estimate changes and/or a list of modification requests.

Verification may be obtained using available tools such as an estimate checklist. However, when considering an estimate checklist, remember that the checklist is intended to guide the Estimator through suggested items and consideration of factors that impact the project costs, but the Estimator should also consider items that are not on the checklist. For instance, the checklist may not include specialty or one-of-a-kind items. It is also important to confirm that everything included in the estimate is correct to the best knowledge of the Estimator.

Finally, the Estimate needs to be reconciled. This reconciliation only takes place if this estimate is not the first estimate being completed for the project. If this is the first estimate being completed, there is no previous estimate to reconcile against. If this is not the first estimate, then this estimate must be reconciled against the previous estimate.

Issues to Consider

To be successful, the review must closely examine the assumptions that form the basis of the estimate, and knowledgeable and experienced individuals from within the agency must conduct the review. When software is used to generate the estimate, the information fed into the computer program must be examined during the review. Conducting reviews at appropriate times during the development of Planning estimates provides assurance that the estimates are reasonably accurate for the existing knowledge of project definition and site conditions.

When verifying the completeness of the data, you should consider any historical data that might be available and also review all calculations made to ensure their correctness. Also, a site visit might aid in verifying the completeness of the data.

Estimator Judgment

- The most indispensable skill for estimate review is judgment. Judgment helps to identify mistakes, detects flawed assumptions, and identifies where the process has missed critical cost drivers.

Policy Implications

- Contingency is not to be incorporated in individual item costs; be sure to review to ensure that this is the case.

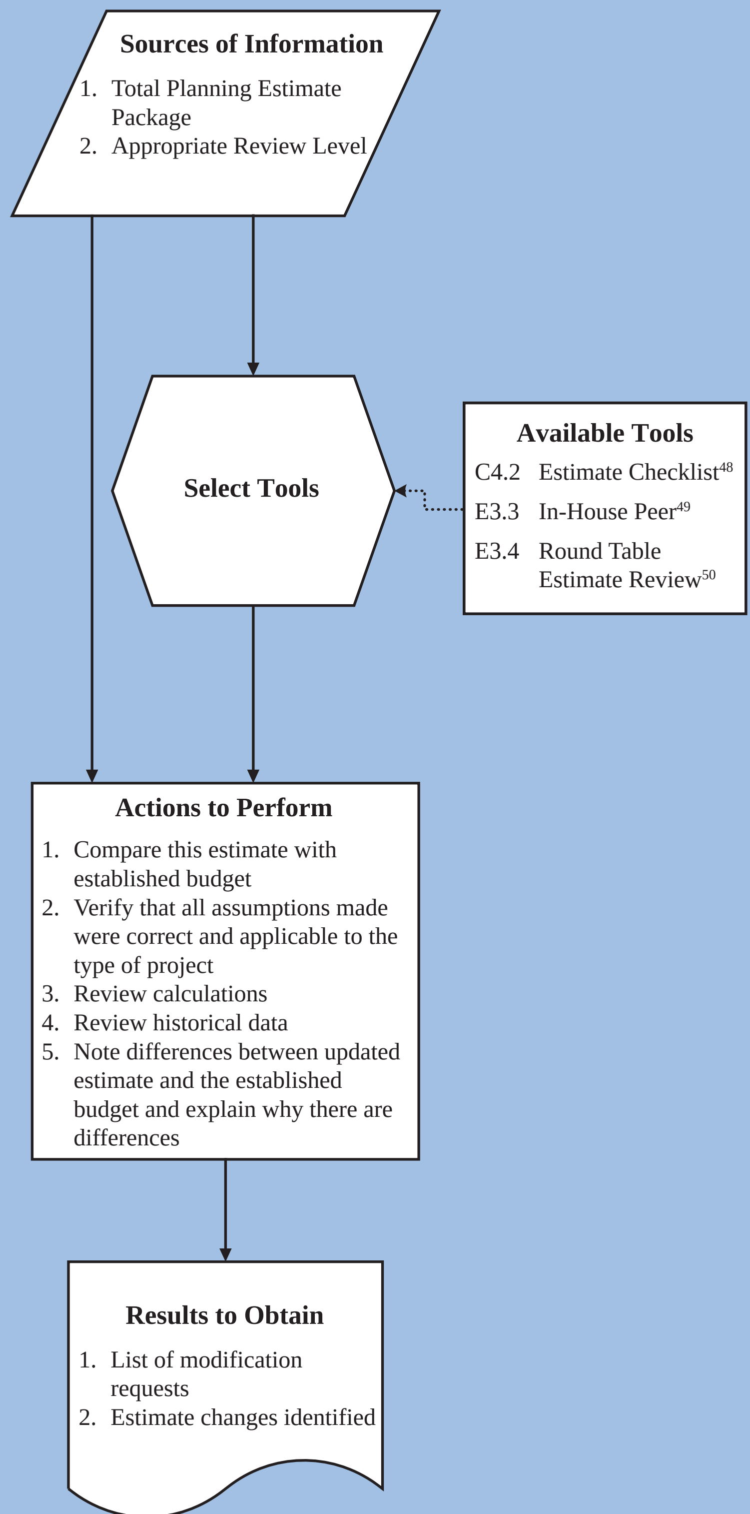
Review/Verify & Reconcile Estimate (A142)

Review the list of available tools and their applicable levels of complexity. Choose the most appropriate tool(s) (see Table III.2-3 on page 90). This choice should be based on level of complexity and previous use of tools, as well as other considerations.

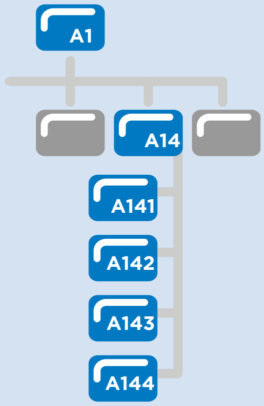
Using the tools and the Total Planning Estimate Package, verify that the data is complete and that the cost estimates are correct. Consider using any historical data or a site visit to accomplish this.

During the review, answer the following questions: 1) Does this estimate have everything in it that is needed for this project? 2) Since this is a very early estimate, is the contingency of an appropriate size for this point in project development and for this type of project?

After reviewing the input information and applying the applicable tools, the Estimator has either confirmed or disaffirmed the assumptions and the completeness of the data in the Total Planning Estimate Package. The Estimator must then neatly compile the reconciled information and changes made into a concise document. Be sure to note any changes and reasons for changes.



48. For C4.2 Estimate Checklist, see page 449.
49. For E3.3 In-House Peer, see page 454.
50. For E3.4 Round Table Estimate Review, see page 456.



Prepare Estimate Package (A143)

Step Requirements

For this step the primary inputs include the Total Planning Estimate and the estimate changes. The Estimator should take this information to prepare a final estimate package that is ready for review.

Issues to Consider

When performing this step, use the estimate checklist to ensure that no important items are overlooked. Be sure that all documentation is clear and concise and that it easily allows the retrieval of key information. All project specifics should be written such that anyone who is not familiar with the project may still have a good understanding of the following:

- what the purpose and need of the project are,
- what the meaning is,
- what the design entails,
- what the associated costs are, and
- what the risks are.

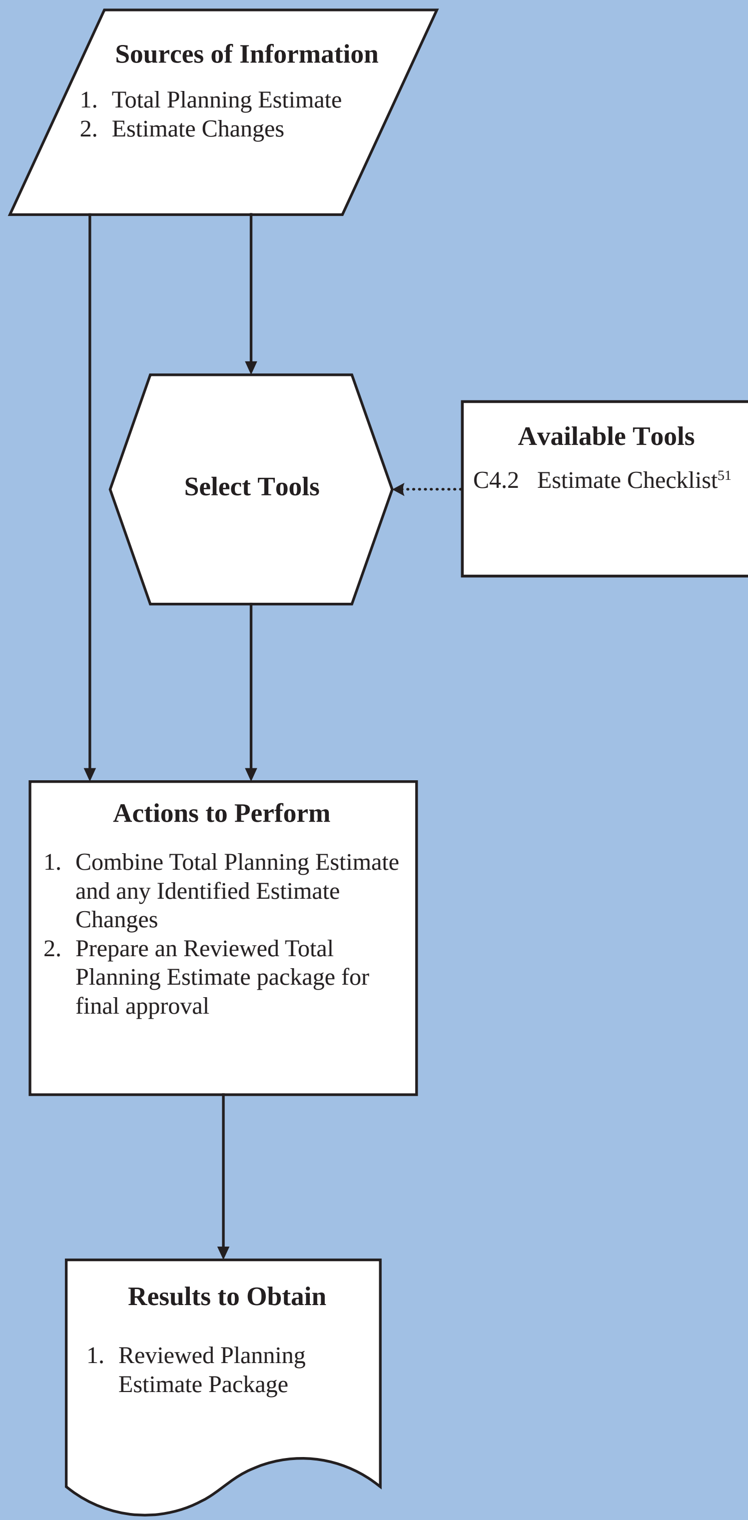
Prepare Estimate Package (A143)

Review the Total Planning Estimate, along with the changes made.

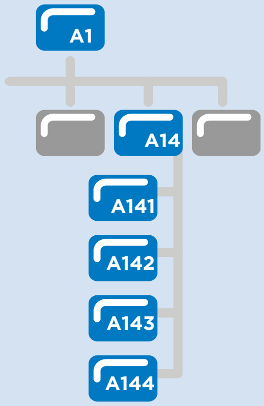
Use the estimate checklist to ensure that no important items are missed in preparing the Reviewed Estimate Package.

Use the input information to prepare a Reviewed Estimate Package that is easy to understand and ready for final approval.

Obtain a Reviewed Estimate Package that clearly defines all project details, assumptions, uncertainties, and reconciled changes for final approval. The output of this step needs to be a concise document, but it also needs to accurately and fairly convey the project and the cost of the project.



51. For C4.2 Estimate Checklist, see page 449.



Approve Estimate Package (A144)

Step Requirements

This step entails inputting the Reviewed Planning Estimate Package and giving it a final formal approval.

Issues to Consider

When presenting the estimate package for review, be sure to present the most important facts of the project in a clear and organized manner.

Policy Implications

- Cost estimates must be approved by District management before they are communicated to external audiences. Therefore, this step must include approval by a member of District management or someone with the authority to do so prior to conveying any of this information to external sources. On this note, be sure to follow the proper lines of communication, which include completion of the communication process (A15).

One very important note—this approval is two-fold:

1. Approval that the estimate was prepared using the appropriate procedure, tools, and knowledge.

2. Approval of the estimate amount.

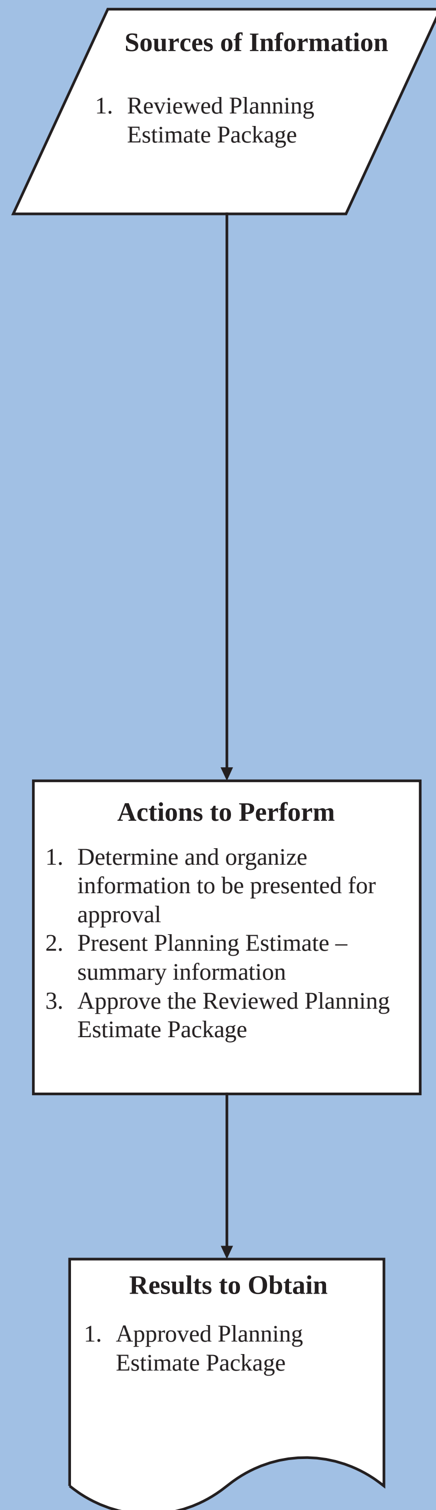
Approve Estimate Package (A144)

Review the Planning Estimate Package and begin to prepare a presentation of the project's most important details and facts.

All information should be presented in a clear and concise manner. The established estimate changes should be identified. When presenting information, be sure to include any key assumptions made and any associated risks or uncertainties with the project.

Address any questions clearly in order to obtain final approval of the Planning Estimate Package. All estimate approvals should be conducted in accordance with applicable Mn/DOT policies.

The output is the Approved Planning Estimate Package. Once the estimate is approved, the estimate can be communicated (see A15 on page 98).



III.2.6 DETERMINE ESTIMATE COMMUNICATION APPROACH (A15)

A purpose of the Determine Estimate Communication Approach sub-process is to provide a vehicle for succinctly conveying key project information to both internal and external project stakeholders. This sub-process has four steps. The steps are as follows:

1. Communicate Estimate Basis – A151
2. Communicate Cost Estimate – A152
3. Communicate Uncertainty and Assumptions – A153
4. Prepare Communication Package – A154

These four steps provide a natural progression of effort to prepare a communication package regarding project definition, cost, schedule, and uncertainty. The first three steps are likely performed at the same time. Once these three steps are complete, a package can be assembled for communicating project information. There is one key input required:

- **Approved Planning Estimate Package** – contains the approved planning estimate (summary and details) with contingency, all supporting documentation related to the estimate basis, assumptions, backup calculations, any estimate changes, risks, and other areas of uncertainty.

Please remember to review the District RACI diagram for roles in this function. The District Estimator is responsible for development of the output of this sub-process. The District Estimators should work with the District Planner and District management when preparing communication information.

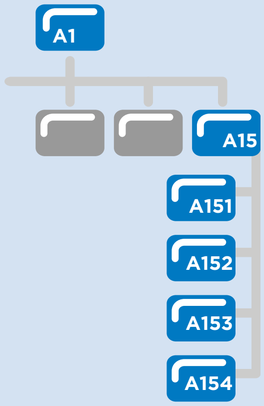
The key input is used when performing the four steps of this sub-process. The output of this sub-process is a Planning Estimate Communication Package. This package will include all of the information required for appropriate development of the Mn/DOT One-Page Project Cost Estimate Summary. No matter the size or complexity of the project, all Mn/DOT projects will have a one-pager.

This one-page communication document is key to communication about the project, both within Mn/DOT and with external stakeholders. This will be the prime source of information about the project for those not closely associated with the project. Therefore, it is imperative that this information be as thorough, concise, and accurate as possible and that it represents the project fairly. Information for this will include, but is not limited to the following:

- the project basis – what is included in the project and what is not;
- the total project cost range;
- the uncertainties about the total project cost;
- the assumptions that are made about the project and project cost;
- the project schedule; and
- the project development status – where the project is in the project development process

By actively providing this information, both internal and external parties can track the progression of the project and realize the impacts that are made on the project by certain actions.

A purpose of the Determine Estimate Communication Approach sub-process is to provide a vehicle for succinctly conveying key project information to both internal and external project stakeholders.



Communicate Estimate Basis (A151)

Step Requirements

The key input for this step is the Approved Planning Estimate Package, which is the output of the Review and Approve sub-process. This document can be quite large, but the Estimator must summarize it for clear estimate communication. The package should be reviewed thoroughly to extract the key information for a summary communication.

Estimate communication will occur internally with Functional Groups and with project team members who will inherit the estimate for later project development and cost control. Communication will also occur with external stakeholders who must understand in simple terms what is in the estimate and what is not.

The final output is a concise and specific breakdown of the project and its estimate basis. This output should communicate the key features of the project and may include mileage, number and/or type of bridges, and amount of right of way. Be sure to note project type and complexity.

Issues to Consider

Importance of Estimate Communication

- Estimate communication is vital to successful cost management, and it is even more important when communicating an estimate basis. The Estimator must communicate the estimate basis accurately to avoid the risk of an increase in cost later in the project development.

Project Characteristics

- Extract only the key project characteristics that comprise the limits of the project and the major cost drivers. If multiple alternatives were considered, be specific as to which project elements were included in the final project definition and estimate.

Functional Group Input

- Be certain to request clarification of Functional Group project definition when the requirements are not clear.

Communicate Estimate Basis (A151)

The Estimator needs only to summarize these elements in the communication of the estimate basis. This should include what the project includes and does not include. This includes major features of the project, specialty features, and features that have been considered.

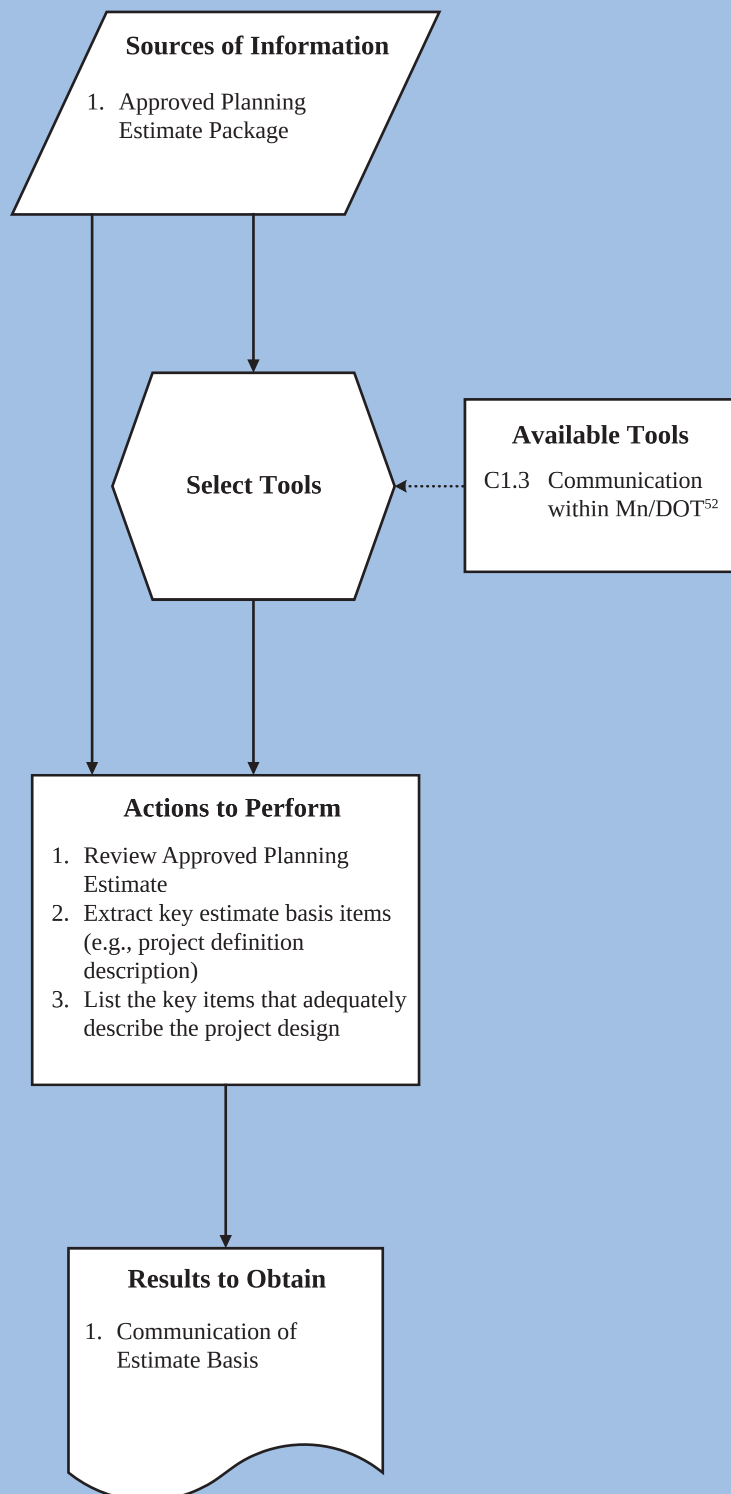
Projects should be communicated within Mn/DOT and within meetings involving the estimator staff and reviewers, as well as with external stakeholders.

Define the details concisely, but as complete as possible. This information will be utilized to communicate both within Mn/DOT and with external participants. Technical terms may be utilized but should be understandable to the traveling public and other external stakeholders.

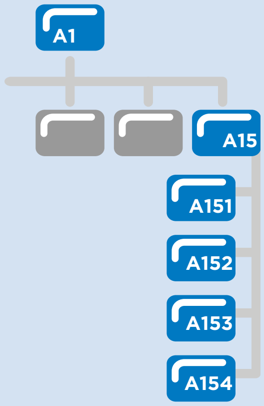
Use a concise bulleted list to communicate the basis of the estimate.

The Estimator should gather all the relevent information required to support the One-Page Project Cost Estimate to communicate the estimate basis.

This estimate basis should be easy to correlate with the communicated costs.



52. For C1.3 Communication within Mn/DOT, see page 471.



Communicate Cost Estimate (A152)

Step Requirements

The key input for this step is the Approved Planning Estimate Package. This package will need to be communicated within Mn/DOT and other appropriate authorities. The package should be reviewed thoroughly to identify all assumptions made in creating the estimate. The assumptions need to be listed and organized into a simple-to-understand format.

The final output is the communication of an easy-to-understand, yet specific, Planning estimate that clearly lists all of the assumptions made about a project. The cost during the Planning Phase of the project should be communicated as a range of cost.

The final output of this step is included in the Mn/DOT One-Page Project Cost Estimate Summary.

Issues to Consider

Project Characteristics

- This step is to simply identify the assumptions and key costs items from the Approved Planning Estimate Package. You do not have to review the tools in this case, just use them appropriately to guide in your preparation. The total project cost must reflect project costs including inflation to the midpoint of construction. This estimate basis needs to be clearly stated.

Functional Group Input

- Request clarification of Functional Group project definition when the requirements are not clear.

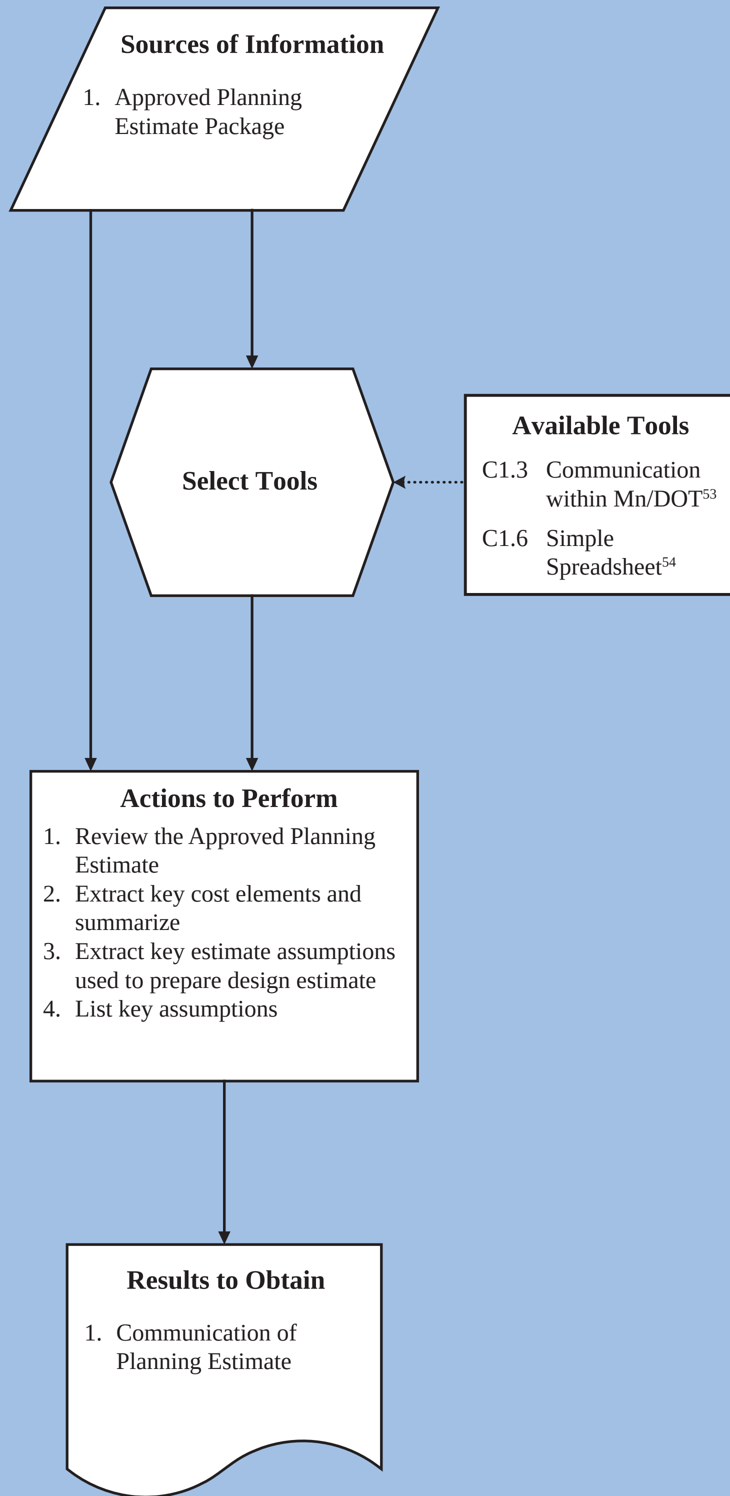
Communicate Cost Estimate (A152)

All projects will be communicated using the Total Project Cos Estimate.

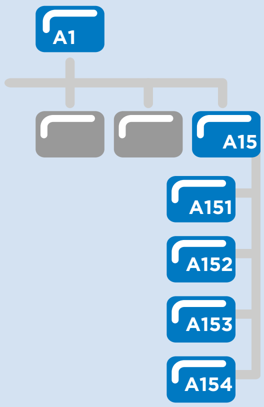
The Estimators should review the Approved Planning Estimate and extract the key cost items along with any assumptions made when preparing them. The Estimator should take care in noting assumptions made during the estimating process. This will make it easier to identify these assumptions during this communication process.

Estimates during this phase are communicated as a range.

The Estimator should gather all the relevent information required to support the One-Page Project Cost Estimate to communicate the estimate basis.



53. For C1.3 Communication within Mn/DOT, see page 471.
54. For C1.6 Simple Spreadsheet, see page 475.



Communicate Uncertainty and Assumptions (A153)

Step Requirements

The key input for this step is Approved Planning Estimate. More specifically, the Document Risk and Contingency Basis step (A135) from the Determine Risk and Set Contingency Estimate sub-process (A13) will provide the input.

Communication of uncertainty creates transparency in the estimating process. Communication of estimate uncertainty is best conveyed through simply listing the assumptions, allowances, unknowns, and contingencies included in an estimate. Rely on the list of risks and contingency estimate in the Document Risk and Contingency Basis sub-process for this information.

The final output is a clearly defined communication of uncertainty concerning a project. These uncertainties are identified in A13. This should include identification of key uncertainty items.

Issues to Consider

Project Characteristics

- Key risks and areas of uncertainty should be identified as bullets. Other information related to the estimate basis and estimate assumptions should also be clearly stated.

Functional Group Input

- Request clarification of Functional Group project definition when the requirements are not clear.

Communicate Uncertainty and Assumptions (A153)

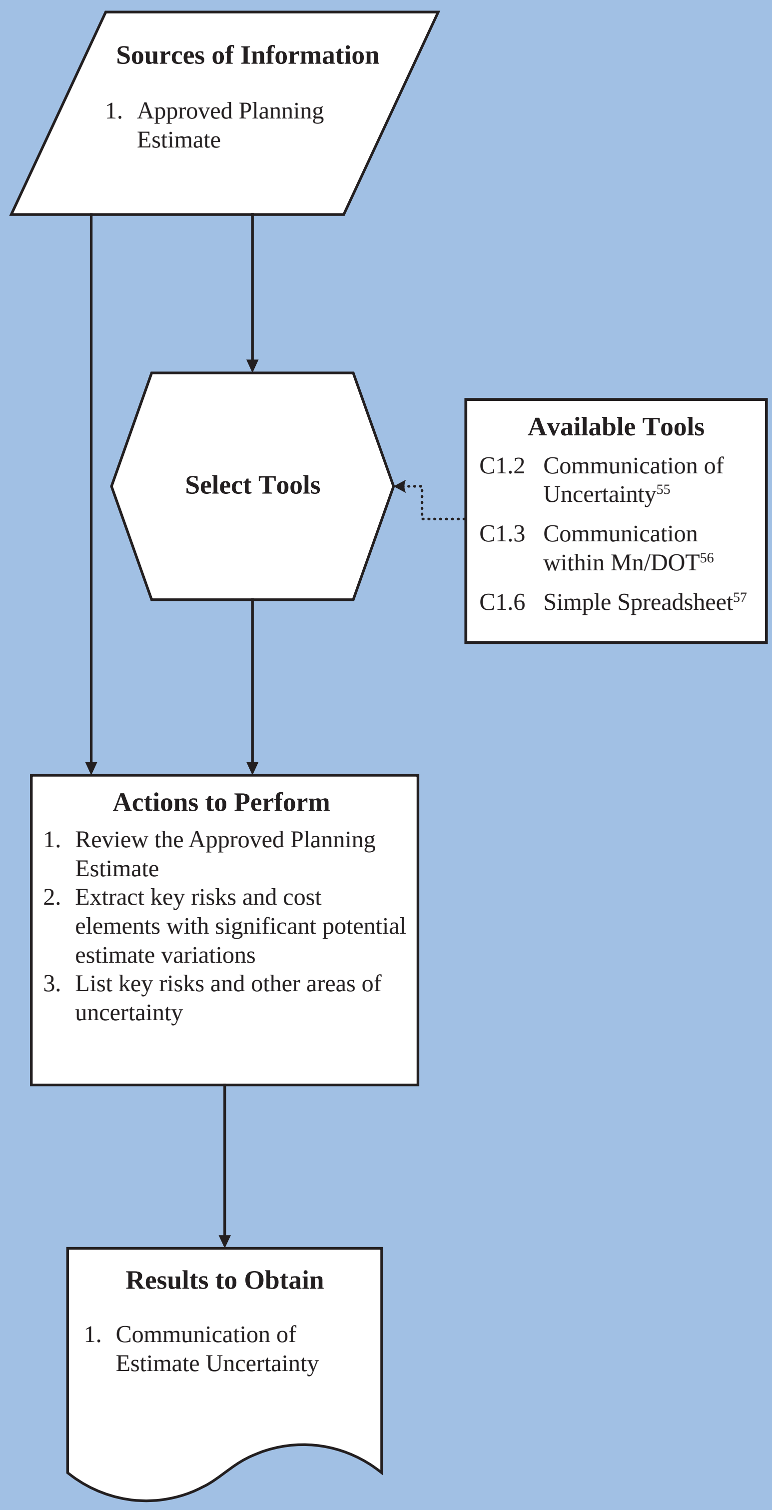
Project uncertainty should be communicated within Mn/DOT and with the public.

A simple list of project risks and the associated contingency should be prepared to clearly define all uncertainties. This simple list should help in the communication of uncertainty externally and internally.

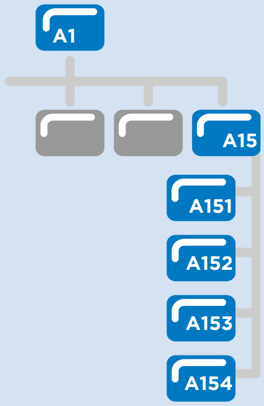
The Estimator should take care to identify assumptions made during the process of identifying and estimating uncertainty.

The Estimator should review the estimate package and extract the key risks and items, identified in A13, that offer significant variation in cost. Transparently convey the uncertainty of the estimate. An estimate with uncertainty is not a bad estimate; it is a realistic estimate. Conveying uncertainty will allow for better decisions to be made from the estimate information.

The Estimator should gather all the relevent information required to support the One-Page Project Cost Estimate to communicate the estimate basis. This should be a few concise sentences, or preferably a bulleted list of the uncertainty associated with the project and the assumptions that are made in preparation of the estimate.



55. For C1.2 Communication of Uncertainty, see page 469.
56. For C1.3 Communication within Mn/DOT, see page 471.
57. For C1.6 Simple Spreadsheet, see page 475.



Prepare Communication Package (A154)

Step Requirements

The key inputs for this step are the Approved Planning Estimate and the communication of the estimate basis and estimate uncertainty. These inputs will not only need to be communicated within Mn/DOT and other appropriate authorities, but also to the general public. Therefore, the Estimator needs to prepare easy-to-understand spreadsheets and diagrams depicting the information about the projects and all risks and assumptions.

Informed partners, both internal and external to Mn/DOT, can become partners in the cost estimation and cost management process. Properly communicating the uncertainty involved in an estimate will help to ensure appropriate decisions are made from the estimate.

Issues to Consider

Project Characteristics

- This step is the final compilation of multiple estimate documents and packages; therefore, all tools listed should be used when deemed appropriate.

Functional Group Input

- Request clarification of Functional Group project definition when the requirements are not clear.

Policy Implications

- Remember that all costs are to be expressed in terms of the Total Project Cost Estimate.

- Cost estimates for each phase will be documented in a the One-Page Project Cost Estimate Summary, which should include the following:
  - a description of what the project is and is not,
  - the assumptions used,
  - the extent to which various estimate inputs are developed,
  - the basis of estimate,
  - the base estimate,
  - the separate contingency amount and a description of associated risks, and
  - incentives, if any are known.

Prepare Communication Package (A154)

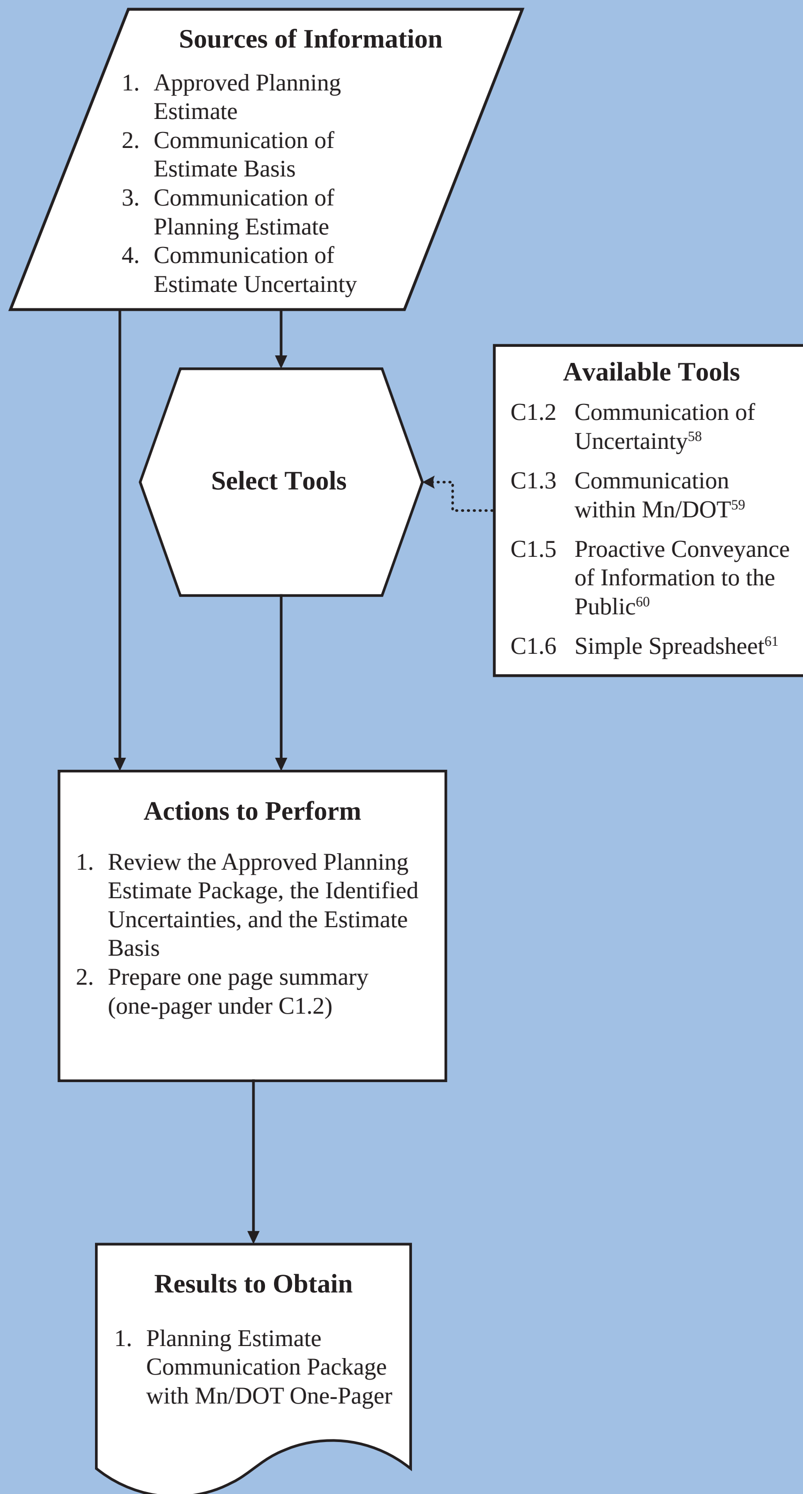
The Estimator does not need to consider the project type and complexity in this step because all projects should undergo this process, and undergo the development of a Mn/DOT one-page communication document.

The communication of the uncertainty should be communicated within Mn/DOT but also to the public. The compiled information needs to be simple and easy to understand.

The Estimator should prepare the one-page document that clearly defines key project characteristics and uncertainties, including the Total Baseline Cost Estimate.

Consistency is important. Be sure to use the standard Mn/DOT format for the one-page summary, and be sure to include all of the relevant information necessary to complete the form. If there is additional information that should be included but there is not a location for on the standard form, contact the Office of Scoping and Cost Management.

The Estimator should compile all of the acquired information into an effective Planning Estimate Communication Package.



58. For C1.2 Communication of Uncertainty, see page 469.
59. For C1.3 Communication within Mn/DOT, see page 471.
60. For C1.5 Proactive Conveyance of Information to the Public, see page 473.
61. For C1.6 Simple Spreadsheet, see page 475.

III.3 SCOPING COST ESTIMATING AND COST MANAGEMENT

III.3.1 OVERVIEW

III.3.1.1 The Highway Project Development Process

The Mn/DOT Project Planning – Scoping – Programming cycle begins with the Project Planning Phase in which transportation system performance needs are identified and prioritized. The most critical needs are carried forward into the Scoping Phase. During this period, the full range of functional and stakeholder groups are queried to identify potential work to be completed during the project. Decisions are made as to what will be included and what will not be part of the project definition. These decisions are documented so that they can be conveyed to those who will work on the project. A cost estimate is also developed based on the project definition. The defined projects are then reviewed during the Programming Phase and either included in the STIP or HIP (10-Year Plan) or held for reconsideration the following year.

III.3.1.2 Project Scoping Phase

The purpose of the Project Scoping Phase is to extensively investigate all potential issues that could affect the cost and schedule of a project. This effort is to be completed prior to programming so that by the time the project is included in the STIP, cost increases and re-work due to changes are minimized. The Scoping Process is comprehensive in that all Functional Groups and a full range of stakeholders have the opportunity to provide input early in the project development process.

Project alternatives are identified and analyzed and a preferred alternative selected as per the guidance in the Highway Project Development Process (HPDP). Following the selection of a preferred alternative the Project Manager distributes Scoping worksheets to stakeholders and Functional Groups. Issues are returned to the Project Manager, who then compiles them into a draft Project Scoping Report. A meeting is held to discuss the project definition, after which a final Scoping Report is prepared, summarizing both the issues that will be included in the project definition and the issues that will not be included in the project, along with the reason they were rejected. A cost estimate is prepared for the project as shown in Figure III.3-1. The schedule is refined, and PPMS is updated. Finally, the Scoping Report is approved and signed and is ready to be considered for programming and funding.

The purpose of the Project Scoping Phase is to extensively investigate all potential issues that could affect the cost and schedule of a project.

III.3.1.3 Scoping Cost Estimation and Cost Management Process

A key part of the Scoping Process is to develop project cost estimates (see Figure III.3-1). While a number of cost estimates are often prepared during the Scoping Process, the most critical estimate is the estimate that supports programming the project in the STIP. Thus, the main purpose of this Scoping cost estimate is to use this estimate as the baseline cost estimate from which project costs will be managed during the Design Phase of the project.

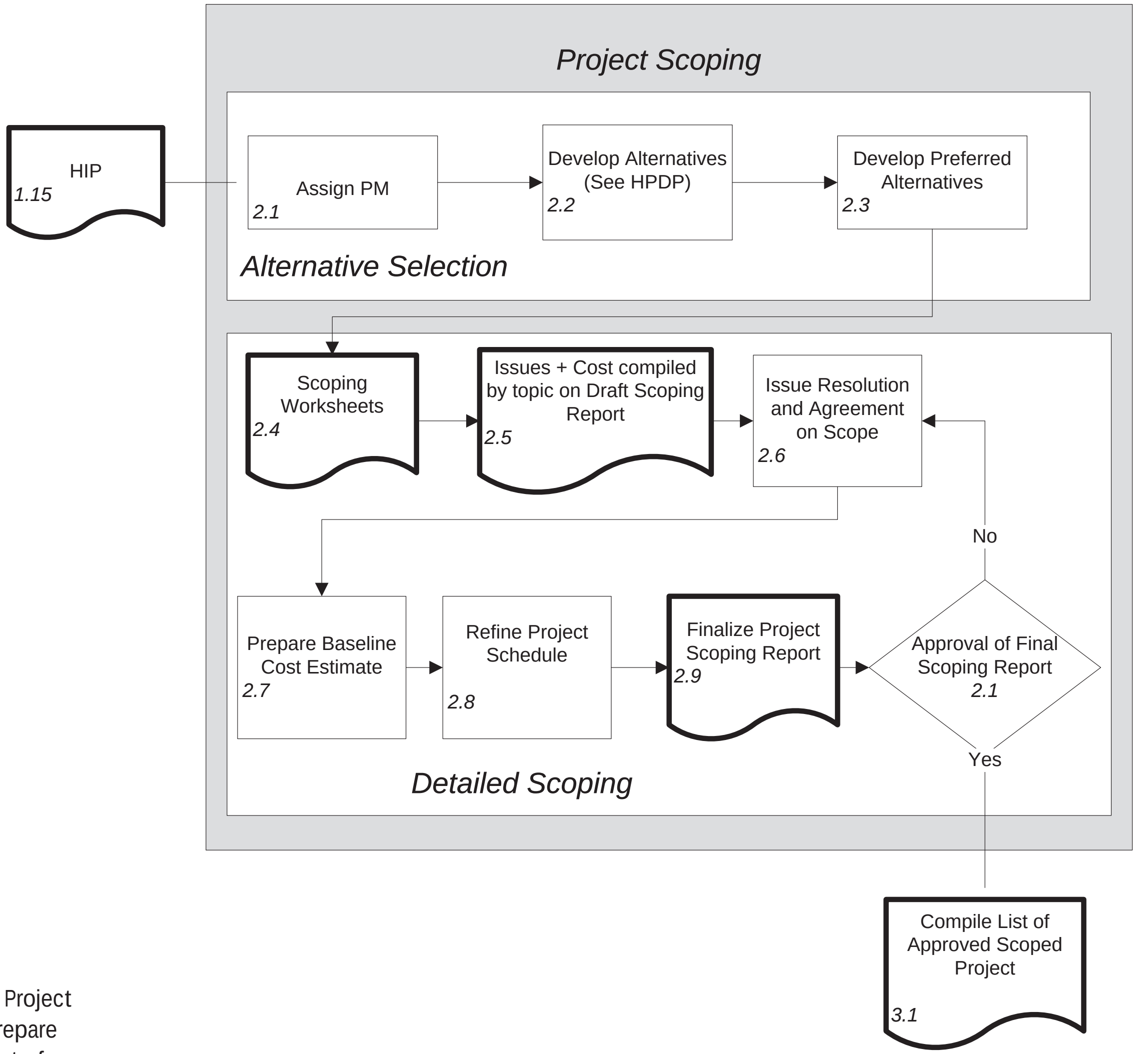


Figure III.3-1. Project Scoping and Prepare Cost Estimate Interface

The cost estimating and cost management process for the Scoping Phase is shown in Figure III.3-2. This figure depicts the five key cost estimate sub-processes and inputs and outputs of the process. This figure also illustrates the interrelationship between the cost estimating and the Scoping Process. The sub-processes are further described using the IDEF0 Node Tree concept, as shown in Figure III.3-3. Guidance is provided on how each sub-process step is performed in terms of inputs required to perform a sub-process step, actions required to perform a sub-process step, outputs from performing the sub-process step, and tools used to facilitate the performance of a step.

III.3.1.4 Overview of Roles and Responsibilities

Responsibilities for the Scoping sub-processes are described using a RACI Chart, Table III.3-1, and as described in Section II. Preparing the cost estimate and managing the cost estimate in Scoping are primarily the responsibilities of the Project Manager and the Estimator in the District. The Functional Groups are consulted as appropriate throughout this process. Functional Groups clarify the project definition, provide estimates for their specialty area, provide input on risks and contingency, and participate in reviews. External stakeholders are informed or consulted as necessary. Accountability for cost estimate

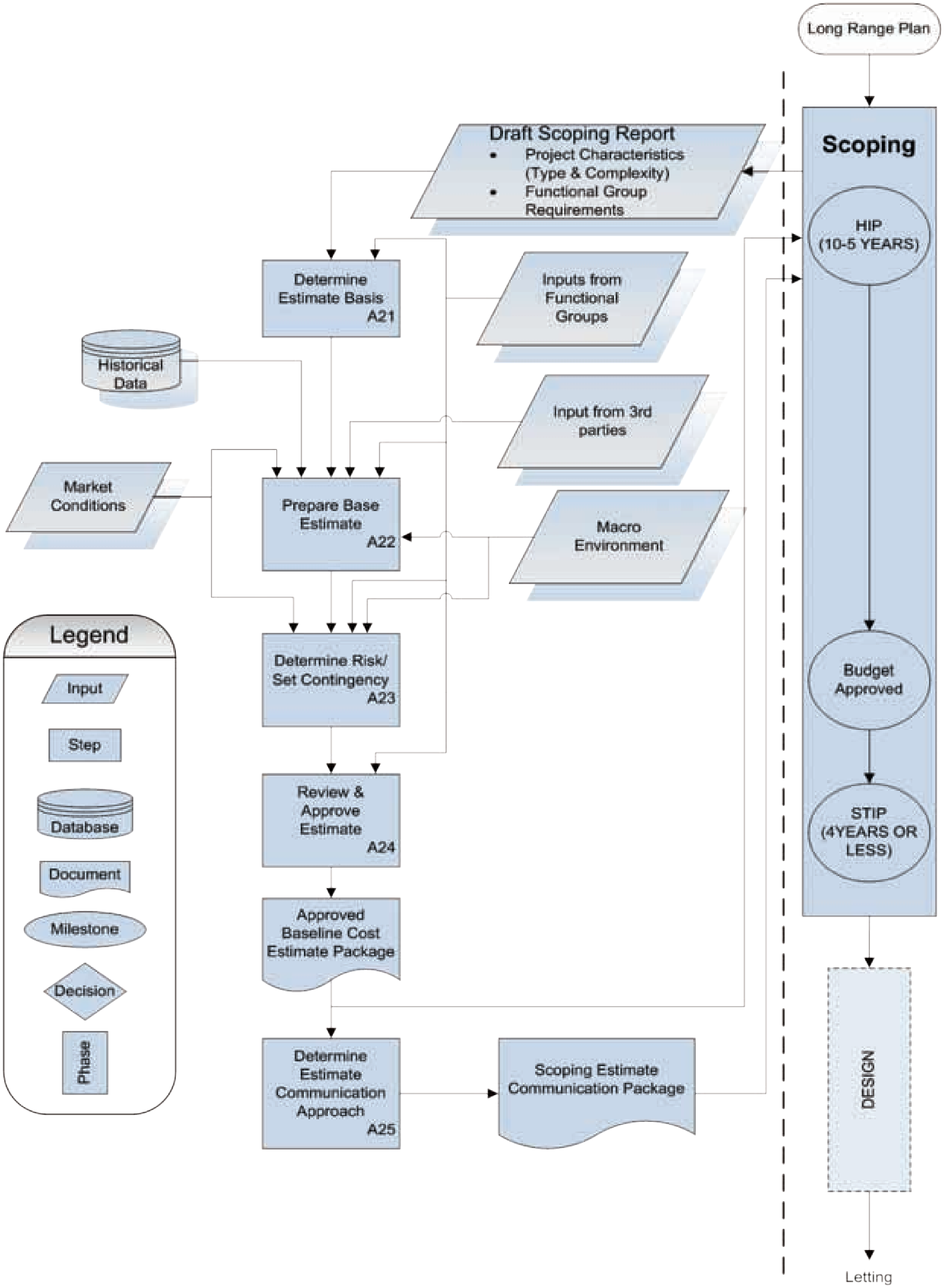


Figure III.3-2. Cost Estimating and Cost Management Flowchart for Scoping reviews and approval falls with District management. External stakeholders are informed through the estimate communication sub-processes.

A RACI Chart may be developed in greater detail for the steps of preparing and managing Scoping estimates. This RACI may be developed for each District individually. A general chart may be developed to cover a majority of the District's projects. Unique RACI Charts may be developed for special projects within the District to meet District needs (refer to Tool R4.1 on page 347 for additional information).

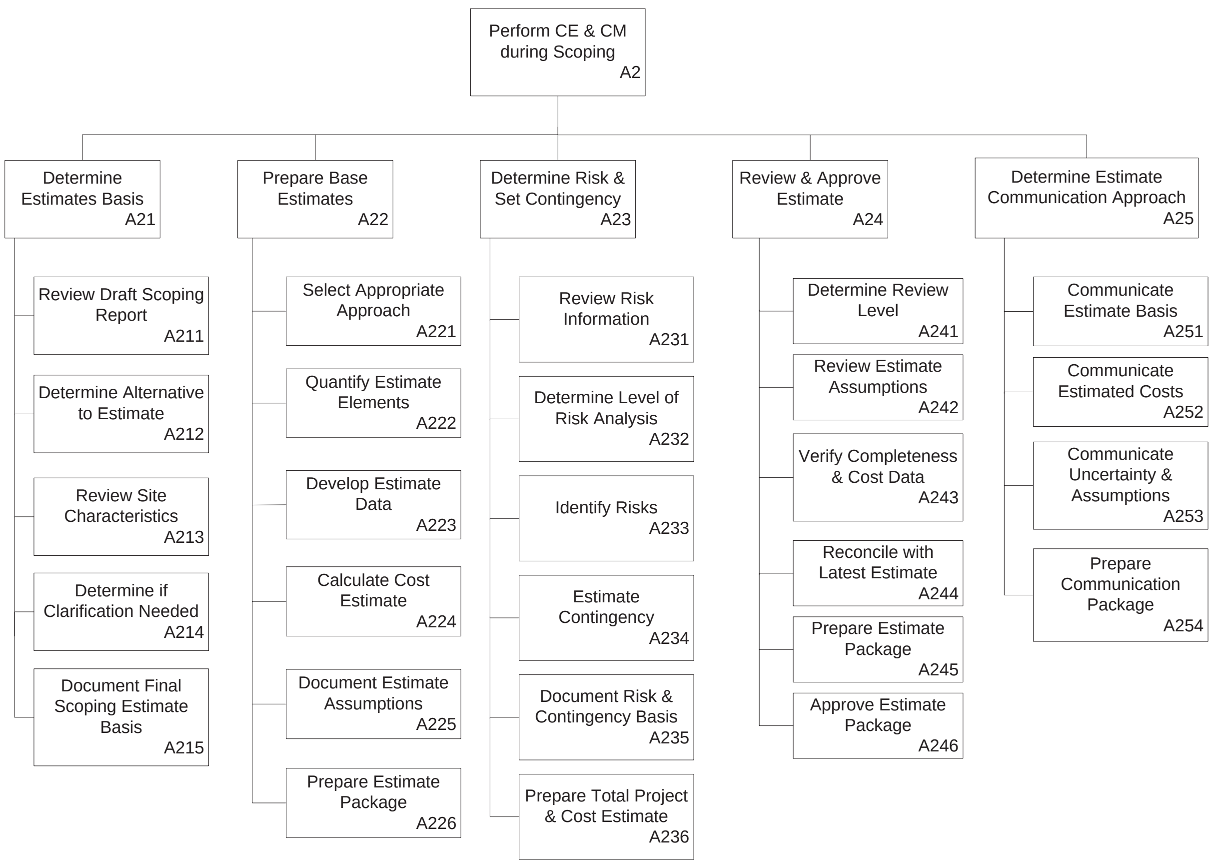


Figure III.3-3. Sub-Processes and Steps for Preparing and Managing Scoping Estimates

Table III.3-1. RACI for Prepare CE/CM for Scoping (A2)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Determine Estimate Basis (A21)			I			R	A	C								
Prepare Base Estimate (A22)				C		R	A	C								
Determine Risk and Set Contingency (A23)			I	C		R	A	C						C		
Review & Approve Estimates (A24)		I	A	C		R	R	C						I		
Determine Estimate Communication Approach (A25)	I	I	A	C		C	R	C		I	I	I	I			

LEGEND:

R = Responsible (the doer)
A = Accountable (owner)
C = Consulted (in the loop by providing inputs)
I = Informed (in the picture)

III.3.1.5 Key Approach Assumptions

The estimating and cost management process for Scoping focuses on preparing a single project estimate in support of the Total Project Cost Estimate that becomes a part of the final approved Scoping Report (Figure III.3-1). The project then is considered for Programming in the STIP. This estimate is based on a preferred alternative and is typically completed in year five from the projected letting date.

Project Scoping can commence as early as 9–10 years from the projected Letting date. While the main focus of the procedures are intended for estimates prepared in year five from Letting, the procedure includes a step to assess whether multiple cost estimates are necessary to support alternative solutions (A212 in Figure III.3-3). In this case, the Project Manager and Estimator would select an alternative to estimate and then follow the same sub-processes and their steps. This approach would be repeated until each alternative has a cost estimate. The estimate approaches (specific tools used) may vary somewhat depending on the level of project definition for the alternatives (see Section III.2 on Cost Estimating and Cost Management during Planning on page 43). A cost estimate comparison spreadsheet should be prepared that shows key cost elements of each alternative estimate. Differences between these estimates should be explained based on differences due to project definition. The development of this comparison is likely an added action that the Estimator will need to perform to complete the overall analysis of alternative solutions and to support the selection of a preferred solution.

Cost estimates for projects in the Highway Improvement Plan and projects that have an approved Scoping Report should cover total project cost as defined in Section II.3.2.3 (see page 23). The Total Project Cost Estimate includes a number of different cost categories. The focus of the cost estimating and estimate management procedures covered in this chapter is primarily related to project construction costs. Other categories of total project cost require estimates from selected Functional Groups, such as right of way. The cost estimating and cost management sub-processes presented in this chapter generally apply to the preparation of any estimate, although the steps may have to be modified to suit a particular Functional Group application.

III.3.2 DETERMINE ESTIMATE BASIS (A21)

The primary objective of this sub-process is to collect and document all information required to serve as a basis for preparing a Scoping cost estimate. This sub-process has four main steps and a fifth step that is implemented when alternatives are being considered. The steps are as follows:

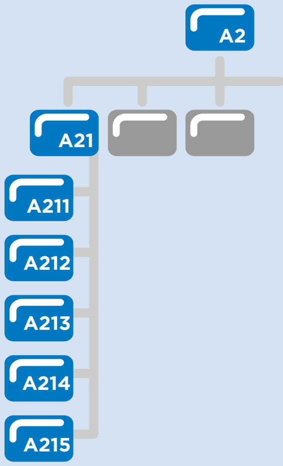
1. Review Draft Scoping Report – A211
2. Determine Alternative to Estimate (not performed if estimating preferred alternative) – A212
3. Review Site Characteristics – A213
4. Determine if Clarification Needed – A214
5. Document Scoping Estimate Basis (include changes if updating an earlier estimate) – A215

These five steps provide a natural progression of effort to determine the estimate basis for a Scoping estimate for a project. They are often performed concurrently and repeated as an estimate is prepared. These five steps require several key external inputs that are necessary for the Estimator to prepare the cost estimate. Some of these key inputs include the following:

- **Draft Scoping Report** – comprehensive draft Scoping Report for a project (see Mn/DOT Scoping Process, 2008)
- **Project Characteristics** – description of the type of project and complexity of the project, including site-specific information and/or data that is relevant to preparing the cost estimate
- **Functional Group Input** – clarifications from Functional Groups regarding definition and requirements for their area of the project

These key inputs are then used when performing the five steps of this process. The output of this sub-process is a Project Estimate File (includes Scope Summary Sheet). The file contains all pertinent project definition information used to prepare the base estimate, including any drawings and information provided by the Functional Groups.

The primary objective of this sub-process is to collect and document all information required to serve as a basis for preparing a Scoping cost estimate.



Review Draft Scoping Report (A211)

Step Requirements

The key input for this step is the draft Scoping Report. This report identifies which Functional Groups are involved in the project based on the Scoping worksheets. Each Functional Group provides project requirements for its group. Typical project requirements include project parameters (project boundaries such as length and width), schematic drawings (plans, typical cross sections, etc), and narrative descriptions of the key project work.

The Estimator performs several actions when completing this step. All Functional Group project requirements from the draft scoping document are reviewed for completeness and understanding. The Estimator should note whether or not the preferred alternative is identified. Confirmation of project complexity should be made, as this will influence the type of information required to prepare the base estimate, to perform the risk and contingency analysis, and to perform estimate reviews. Finally, when Functional Group estimates are required, then the Estimator must establish a schedule identifying when these estimates are needed.

The output of these actions is an understanding of the project requirements and an estimate schedule for Functional Group cost input.

Issues to Consider

Plan and Program Support

- The Scoping process may start when a project is placed in the Highway Improvement Plan (year 9 or 10 from the projected Letting date). If alternatives are identified, multiple estimates may be necessary to evaluate each alternative. An action is to determine if multiple estimates are required, especially if the preferred alternative has not been selected. The estimates for alternatives are performed following the same process steps; however, the level of definition may be somewhat less for the alternatives as compared to a preferred alternative.

- If the preferred alternative is known and a final draft Scoping Report is complete, then a baseline cost estimate is prepared as input to the final Scoping Report. The project then moves to Programming, where it is considered for inclusion in the STIP. This estimate is critical, and adequate project definition is required to set the baseline estimate.

Project Characteristics

- Project complexity is determined during the Planning Phase prior to a project entering into the Scoping process. A minor or even some moderately complex projects will likely not involve alternatives.

- Major projects require more time and effort to document the estimate basis.

- Typically, more Functional Groups will be involved in major projects.

Functional Group Input

- When multiple Functional Groups are involved in a project, establishing an estimate schedule will help ensure that input is received in timely manner.

Review Draft Scoping Report (A211)

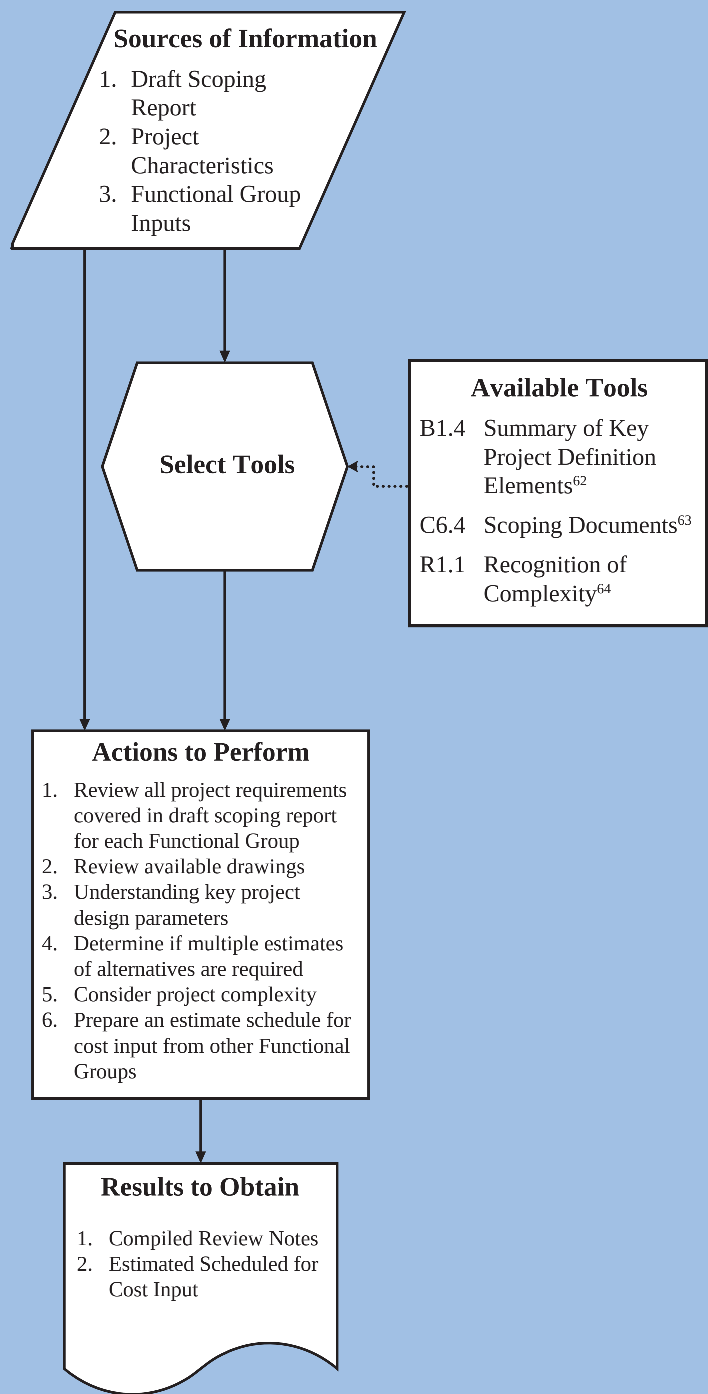
The Estimator should consider the project type and complexity, as this will influence the level of documentation for describing the breadth of the estimate. Functional Group inputs may result from clarification requests.

There are several tools that can assist the Estimator. Scoping documents reflect the project requirements and should come from the draft Scoping Report. A summary of key Scoping items is also generated from the draft Scoping Report. Following the Scoping process ensures that all project definition requirements are covered.

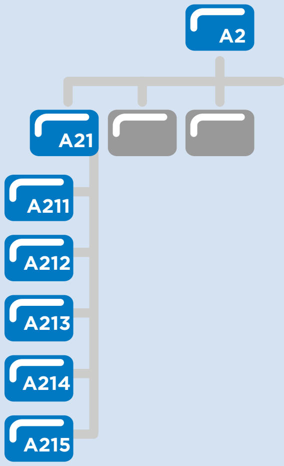
Define the work as completely as possible. What work will be included in the project? What work is excluded due to divergence from the original purpose and need of the project?

Allow sufficient time to prepare the Scoping estimate based on when the estimate is required by District management.

The Estimator should create notes and start assembling materials that describe the estimate basis for the project, that is, the project requirements that are used to prepare the base estimate.



62. For B1.4 Summary of Project Definitoins Elements, see page 363.
63. For C6.4 Scoping Documents, see page 365.
64. For R1.1 Recognition of Complexity, see page 343.



Determine Alternative to Estimate (A212)

Step Requirements

This step is **only initiated** for projects that are in the out years of the Project Scoping Phase when alternative project definition solutions require analysis prior to selecting the preferred alternative. Major construction projects that are in year eight or nine (Figure II.1-1 on page 7) are likely candidates. If alternative solutions are evaluated, then the Estimator must determine which alternative should be estimated first. This is the only action needed by the Estimator.

The input for this step is a list of alternatives identified through a draft Scoping Report. Once a decision is made for which an alternative estimate will be prepared, the cost estimating process continues for the selected alternative. Cost estimates will be prepared for each alternative. These estimates provide useful information to support the decision process when selecting the preferred alternative.

Issues to Consider

Prepare Multiple Cost Estimates to Compare Alternative Project Definition Solutions

- When preparing cost estimates that are used to compare alternative project definition solutions, it is important to follow the cost estimating sub-processes and associated steps for each alternative. As much as possible, the same estimating tools should be used when preparing multiple estimates so that each cost estimate for each alternative reflects the project definition of that alternative. In this way, cost differences between alternatives will truly reflect differences in project definition solutions between the alternatives.

- It is extremely important that each cost estimate is thoroughly documented in terms of estimate basis and estimate assumptions. However, different alternatives may have different uncertainties associated with them. The risk and contingency analysis should reflect differences due to uncertainty relevant to an alternative.

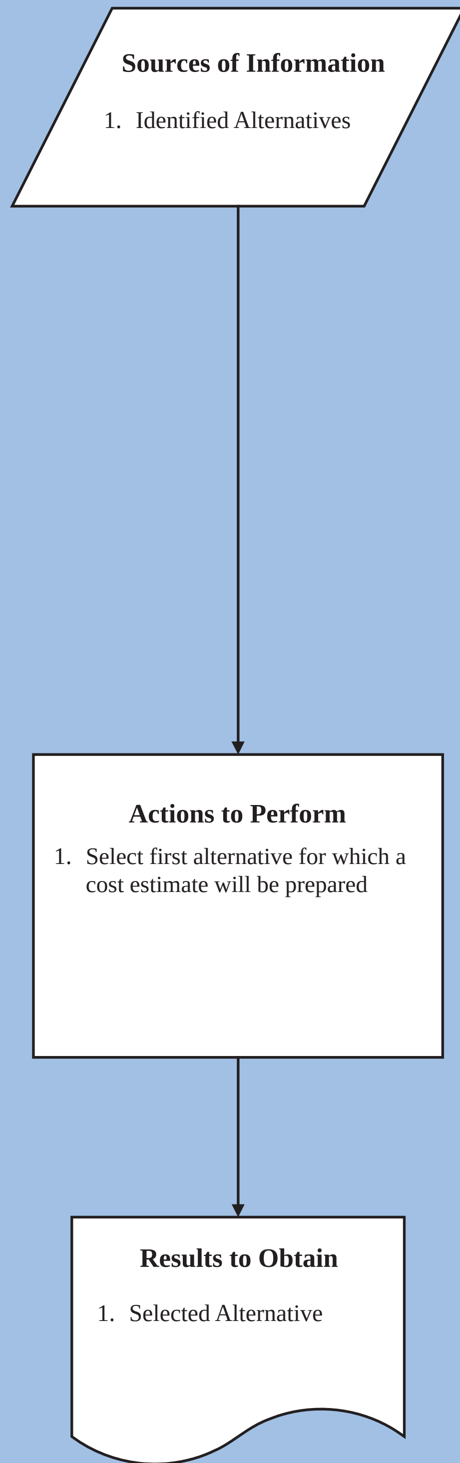
- Review documentation should include a definition and cost estimate comparison to clearly delineate differences between alternatives.

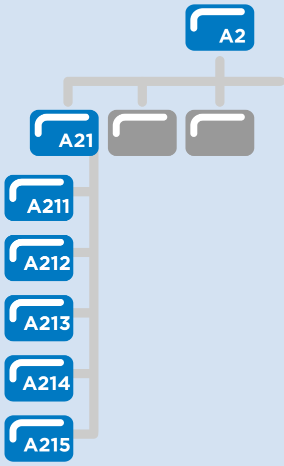
Determine Alternative to Estimate (A212)

Any alternative project definition solutions should be clearly identified during the review of the draft Scoping Report.

The Estimator should work with the Project Manager to determine the base case alternative to be estimated first. Other alternatives can then be compared to this base case alternative.

The first alternative for which a cost estimate will be prepared is identified. If any alternatives have already been identified and prepared, select the next alternative.





Review Site Characteristics (A213)

Step Requirements

Understanding the project site characteristics is a critical step for the Estimator. The attributes of a project site can significantly impact right of way, utility, environmental, and construction costs. The project characteristics, as described in the draft Scoping Report, are a key input that provides understanding of the site. Notes compiled during the review of the Scoping documents are another source of information to aid the Estimator in understanding the project site characteristics and how the definition of the project relates to these characteristics. However, relying only on project documents can lead to false assumptions about the project site characteristics and their impact on cost.

The Estimator performs several actions when completing this step. First and foremost, the Estimator should review video logs and/or aerial photos to begin visualizing the project. Next if it is at all logistically possible, the Estimator should walk the project site. A site visit provides additional insight and a feel for the project that cannot be obtained through photos or videos. Since Estimators often have a large workload and are governed by time restrictions, they understandably cannot make a site visit for every project; however, the Estimator should fully weigh the benefits and drawbacks before making that decision. Questions should be prepared to guide the Estimator during the site walk-through. The Estimator should make notes as to potential impacts of the site characteristics on the project cost categories.

The output of these actions is an understanding of the project site characteristics and their potential impact on project definition and cost.

Issues to Consider

Project Characteristics

- Always visit the site for major or complex projects, and likely more than once, as cost estimates are prepared. It is helpful to visit the site even if the project is moderately complex or non-complex. If time does not permit a site visit, then video logs and/or aerial photos are helpful in developing such information.

- Visits to the project site provide information concerning the presence of utilities, railroads, potential clearance issues, or environmental concerns such as wetlands.

Functional Group Input

- Visit the site with Functional Group staff to obtain their perspective on site characteristics and their potential impact on the project. They can clarify project definition issues as these issues relate to the site.

- Construction staff can help evaluate the potential impact of staging, material storage, hauling of materials, location of batch plants, and other constructability related issues.

Review Site Characteristics (A213)

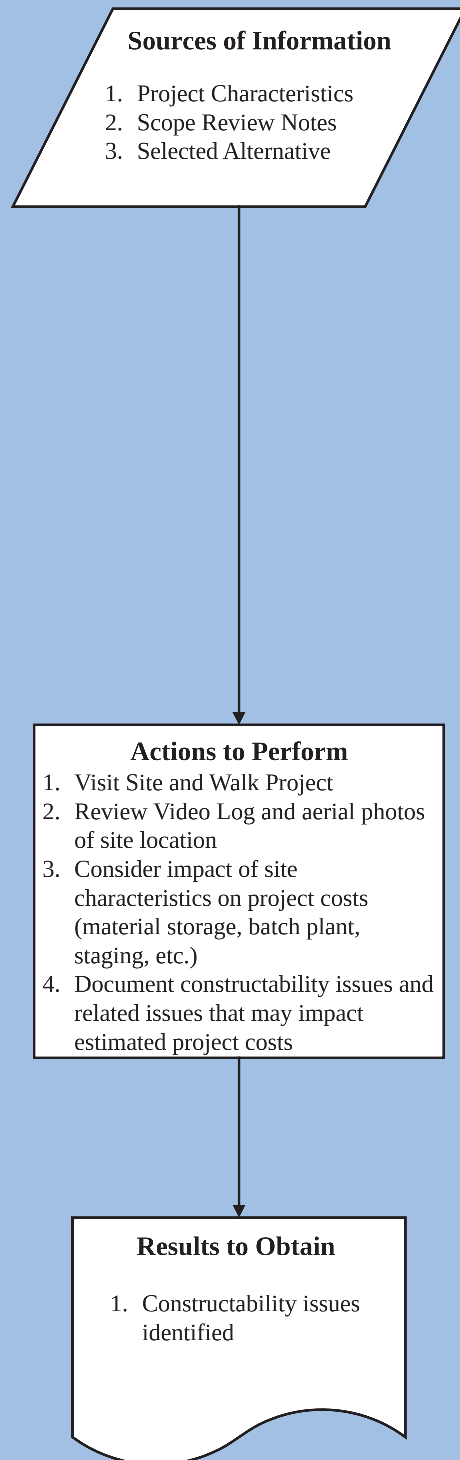
It is important that the Estimator understands the project definition and project characteristics (i.e., type and complexity) prior to initiating a site evaluation. This information will aid the Estimator in preparing questions about the site whose answers may impact project cost.

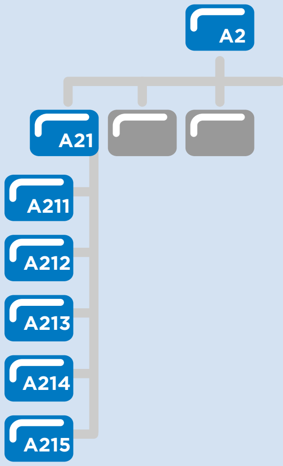
There are several tools available. The best tool to use is a site visit. Such a visit is critical for major or complex projects and likely less critical for moderately complex projects. If time to prepare the estimate is an issue, other tools are video logs or aerial photos of the site area. These latter two tools may provide some indication of issues that impact project costs.

It is critical that the Estimator visit the proposed project site and examine the site conditions and characteristics. Location attributes influence both project definition and costs. Some questions that should be considered are:

- Are there potential environmental conditions that must be mitigated?
- Are there Right of Way issues to consider?
- Is construction access going to require temporary ROW?
- Are there utility relocations required?
- Will there be work time restrictions?
- Will there be sufficient room for contractor material storage?
- Are there detour and haul routes available?

The Estimator should create notes on site issues that may affect project costs covering all pertinent categories and elements of project cost. Categories that may not be clearly identified in the project definition should be noted as well.





Determine if Clarification Needed (A214)

Step Requirements

The purpose of this step is to confirm that the project definition is complete and, if necessary, request additional information from a Functional Group regarding the project requirements for its area. This request may focus on clarifying existing documentation of the project requirements or ensuring that certain requirements are needed.

The Estimator performs several specific actions. One set of actions includes clarification of specific project requirements. A list of questions can be generated after the Estimator reviews the project definition and visits the project site. Another set of questions may clarify impacts of project site characteristics on construction and how these impacts influence project costs. Once potential question areas are identified, a request for clarifications is initiated through the Project Manager.

The output of these actions is a request for clarification regarding project definition or construction-related issues. This will lead to better understanding of those project requirements that will have a potential impact on the cost of the project.

Issues to Consider

Project Characteristics

- Check for the availability of complete data related to project requirements and site characteristics. If necessary, request additional information that will help to complete project definition documentation and estimation.

Functional Group Input

- The request for clarification is made in several ways. A meeting with all Functional Groups may be necessary for complex projects. Face-to-face discussion is often the best way to clarify project definitions and construction-related issues. Other means of communication are always available.

- Good communication is required between the Project Manager, the Estimator, and the Functional Groups. This effort will enhance the level of accuracy in estimates because all project requirements will be properly reflected in the estimate basis.

Determine if Clarification Needed (A214)

The main sources of information come from a review of the draft Scoping Report document input from the various Functional Groups involved in the project. Constructability issues are often best identified through site visits.

The Summary of Key Scope Items (B1.4) tool is useful to ensure all Functional Group input is reviewed for clarification.

While questions will always arise as cost estimates are prepared and reviewed, developing a comprehensive list of questions needing clarification will save time for the Estimator and project team in general.

Involvement of all Functional Groups with project requirements is critical to ensure cost estimate accuracy. Request for clarifications is a necessary step. Such requests will reduce recycle and lost time as the cost estimate is prepared.

Sources of Information

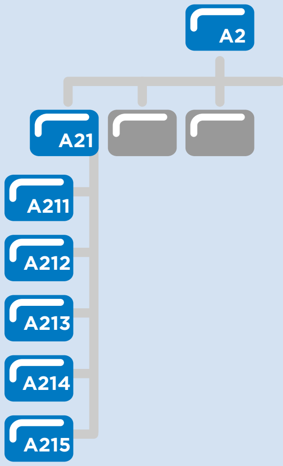
1. Constructability issues
2. Scope Review notes

Actions to Perform

1. Develop list of questions for Function Groups regarding their area of the project
2. Develop list of questions regarding impact of constructability issues on cost estimate categories and elements
3. Request clarification regarding project definition or construction impacts

Results to Obtain

1. Request from Project Manager with input from the Estimator for clarifications from Functional Groups



Determine Scoping Estimate Basis (A215)

Step Requirements

The main purpose of this step is to begin the documentation trail that supports a project estimate. The key inputs are the Scope review notes and constructability issues. These inputs will also include any clarifications regarding project requirements and construction issues that impact potential project costs. This step is a key to achieving cost estimate consistency. A standard project estimate file format should be followed.

The main effort or action for the Estimator is to initiate a Project Estimate File, starting with sections on project requirements that are used as a basis for preparing the cost estimate. Documentation of project requirements is critical when preparing the base cost estimate and determining risks and setting contingency. This step is critical when reviewing the estimate and obtaining management approval. Finally, this step is critical when changes occur in costs due to changing project requirements as the project design is developed and completed.

The output of the actions of this step is the completion of the first section of the Project Cost Estimate File.

Issues to Consider

Project Cost Estimate Baseline

- Since this cost estimate will set a baseline cost for managing the project's definition and cost during the Design phase, the Estimator must place a substantial emphasis on documenting the project requirements for each Functional Group providing these requirements.

- Time to prepare this documentation is necessary and should be included in the time schedule for preparing the cost estimate.

Project Characteristics

- The level of documentation is likely to increase for projects that are considered major or complex. The Project Estimate File may have more sections to cover the various Functional Group inputs that describe the estimate basis. This may require more interface with each Functional Group to ensure that project requirements and constructability issues are clearly documented.

- It is important to document the estimate basis for all projects, not just those that are complex.

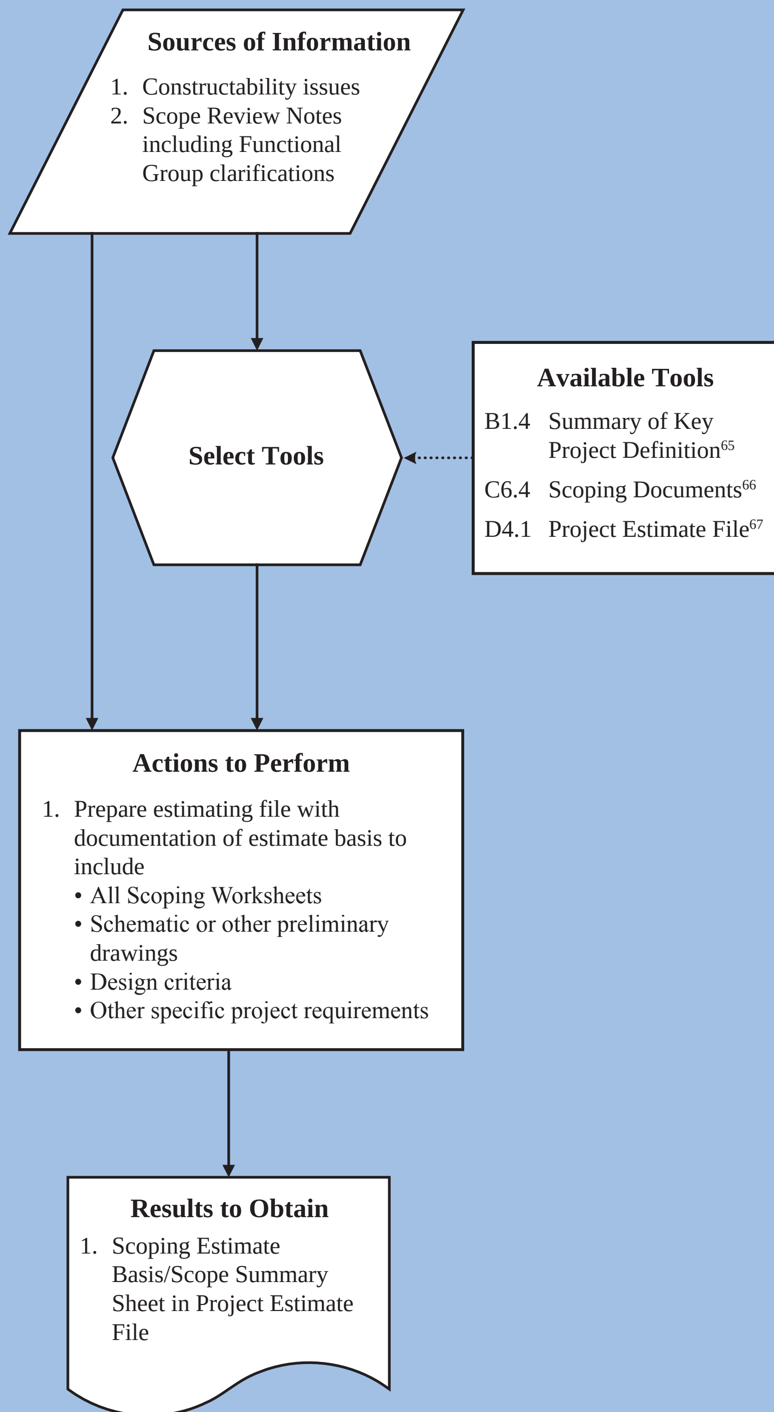
Determine Scoping Estimate Basis (A215)

The Estimator compiles information and data from the Scope review, site visits, and additional input from Functional Groups. The Estimator should ensure that any typical drawings, specific design criteria, and so on are included in the information and data compiled to support the estimate basis.

The main tool used to support this step is the Project Estimate File (D4.1). This tool provides guidance on the content and structure of documents, information, and data that describe the estimate basis. The Project Estimate File is very important in keeping all estimating documents organized. The Scoping Documents (C6.4) and a Summary of Key Scope Items (B1.4) provide a final check to ensure that all known project requirements are included.

A Project Estimate File is populated with estimate basis information. The Project Estimate File format should allow for customizing its content to accommodate project type and complexity.

The first section of the Project Estimate File is completed. This document becomes a key input to the next sub-process, Prepare Base Estimate.



65. For B1.4 Summary of Key Elements I, see page 363.
66. For C6.4 Scoping Documents, see page 365.
67. For D4.1 Project Estimate File, see page 339.

III.3.3 PREPARE BASE ESTIMATE (A22)

Preparing a base estimate covers the development of estimated costs for all categories of the Total Project Cost Estimate. The categories and their elements and/or line items may be estimated using different techniques, depending on the level of project definition and the type and complexity of the project. The number of components estimated may also vary depending on project complexity. The purpose of this step in the Scoping phase is to prepare the most likely cost estimate without contingency. This estimate will serve as the baseline Total Project Cost Estimate when it is approved by District management. This sub-process has six steps. The steps are as follows:

1. Select Appropriate Approach – A221
2. Quantify Estimate Elements – A222
3. Develop Estimate Data – A223
4. Calculate Cost Estimate – A224
5. Document Estimate Assumptions – A225
6. Prepare Estimate Package – A226

These six steps provide a natural progression of effort to prepare a base estimate for Scoping. They are often performed concurrently and repeated as each cost category and its elements are identified, quantified, and priced. These six steps require several key external inputs that are necessary for the Estimator to prepare the base cost estimate. Some of these key inputs include the following:

- **Project Estimate File** – contains the estimate basis, that is, project definition requirements and Scoping summary sheet, which serve as the basis for preparing the base cost estimate.
- **Project Characteristics** – description of the type of project and complexity of the project, including site-specific information and/or data that is relevant to preparing the cost estimate
- **Historical Data** – cost data from previous projects used as a basis for pricing different categories, elements, and/or items of the Total Project Cost Estimate.
- **Functional Group Input** – cost estimates provided by different Functional Groups.
- **Market Conditions** – understanding of the potential market impact on costs for a project in a given location.

These key inputs are then used when performing the six steps of this process. The output of this sub-process is a Scoping Base Cost Estimate Package. The package contains all pertinent project definition requirements, assumptions, and historical cost data used to prepare a base estimate, as well as cost summaries and cost details for the base estimate.

The purpose of this step in the Scoping phase is to prepare the most likely cost estimate without contingency. This estimate will serve as the baseline Total Project Cost Estimate when it is approved by District management.

Select Appropriate Approach (A221)

Step Requirements

This step is important for all projects estimated in the Scoping Phase. Selecting the appropriate approach for preparing a Scoping estimate is the foundation for quality and accurate estimates. In the Scoping Phase, different tools may be required due to the level of project definition available for the proposed categories and their elements that are estimated. If an inappropriate estimating approach is selected (i.e., tool[s]), then estimate accuracy may be compromised.

The input for this step is the Project Estimate File produced in the Document Scoping Estimate Basis step (A215). While no tools exist to assist in making this decision, the Estimator must be aware of the project definition, size, and complexity. While costs based on similar projects, historical data, parametric methods, and even spreadsheets all have their place in an Estimator's toolbox, each project is unique and necessitates due consideration in deciding the approach. The output of this step is the decision regarding which tool or tools are used for preparing the Scoping estimate.

Issues to Consider

Tool Application

- One or more estimating tools may be used to prepare a base estimate (D2.1, D2.4, D2.5, R1.1, D2.7, D2.8, and D2.9).
  - Use historical bid based estimating (D2.4) for 20 percent of work elements that represent 80 percent of the cost, and then use historical percentages to estimate the remaining 20 percent of the costs.
  - When a project is very similar to a previous project recently bid or constructed, use the previous project as a basis for preparing the estimate on the current project, adjusting only for differences in quantities and unit costs (D2.1).
- Spreadsheet (D2.8) workbooks can also be used to document calculations.
- The tools listed can either be used independently or in conjunction with one another; however, the Estimator must realize certain tools require certain information when used appropriately.

Project Characteristics

- Complexity of the project is a major driving factor for tool selection; hence, project complexity should be considered in conjunction with other project characteristics.
- Project estimation approaches should be selected on the basis of
  - Level of project definition
  - Historic data available
  - Project characteristics
- Major projects require more time and effort to prepare an estimate, so selecting tools that fit the time available is a consideration.

Total Project Cost

- Tool selection will vary depending on the Total Project Cost Estimate group and/or category.

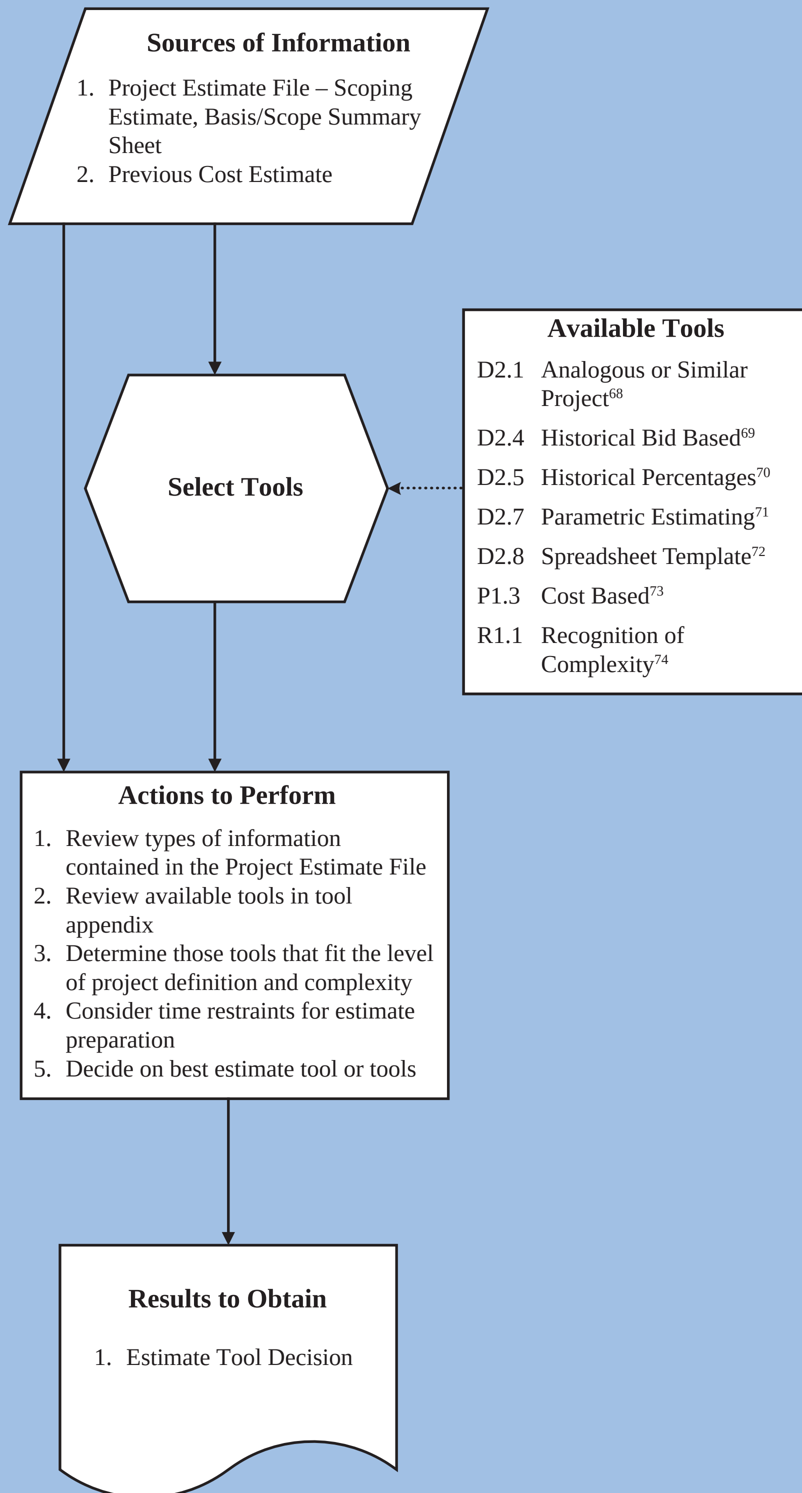
Select Appropriate Approach (A221)

The Project Estimate File contains the estimate basis from which the Estimator will prepare the base estimate. The quality of the documents contained in this file is critical to preparing an accurate estimate. Project requirements as defined in the estimate basis and complexity of the project drive estimating tool selection.

Choosing the correct tool or tools to prepare the estimate is key in both producing a quality estimate and spending the appropriate amount of time on the estimate. Frequently, in the Scoping phase, multiple tools are often needed. The Tool Appendix provides further guidance on which tools are best used on what types of projects.

The Estimator must rely on both experience and judgment when selecting the set of tools applicable to the project being estimated. The Estimator may want to discuss tool choice with the Office of Project Scope and Cost Management. The availability of historical data as well as time restrictions may impact this decision. Referencing previous Scoping estimates for similar projects can aid in tool selection.

The Estimator makes the selection of the tool or tools that will be used. However, as estimate categories, elements, and items are quantified and the historical cost basis is determined for each component or sub-component of the estimate, the Estimator may select a different tool.



68. For D2.1 Analogous or Similar Project, see page 387.
69. For D2.4 Historical Bid Based, see page 389.
70. For D2.5 Historical Percentages, see page 391.
71. For D2.7 Parametric Estimating, see page 394.
72. For D2.8 Spreadsheet Template, see page 397.
73. For P1.3 Cost Based, see page 403.
74. For R1.1 Recognition of Complexity, see page 343.

Quantify Estimate Elements (A222)

Step Requirements

The Estimator must first determine which categories and elements of the Total Project Cost Estimate are required to estimate all project costs. Quantifying estimate categories, elements, and major items is an extremely important next step in producing consistent and accurate estimates. The Estimator relies on the Scoping estimate basis contained in the Project Estimate File and the tool(s) selected in step A221 to identify the different categories, elements, and items that define the project.

The Estimator then determines the appropriate quantity measure and calculates quantities for each element and/or major items as dictated by the estimating tool. Calculations of quantities should be documented, including all backup calculations and assumptions made when determining quantities. The Estimator is responsible for the proper application of every tool and the complete quantification of Total Project Cost Estimate elements and major items. This documentation aids the estimate review sub-process or when the Estimator has to modify elements due to review recommendations. In instances where estimate reviews require modifications to estimate elements, the Estimator must revise these corresponding elements within their Scoping estimate. The accuracy of the quantities is vital to the quality of the estimated costs produced based on them. The Estimator should identify issues that create uncertainty in their quantity calculations.

Issues to Consider

Project Characteristics

- Complex projects that have many components will require Functional Groups to identify estimate elements/major items and quantities associated with their category discipline. The Functional Groups must provide documentation of calculations and assumptions associated with the calculations.

- Moderately or non-complex projects often can be quantified by items for many construction elements.

Project Tool and Documentation

- Special care should be taken while operating electronic spreadsheets or other computer based estimating tools. While they are quite helpful in performing calculations and are an expedient way to update an estimate, it is easy to make a small typing error or miscalculation in a cell that raises or lowers the estimate by an order of magnitude. Always double check entries and use sanity checks where possible.

- Proper documentation is necessary as review recommendations may require modifying some of the estimation elements and/or items. It is easier to make changes if the entire estimation calculations are well organized.

Quantify Estimate Elements (A222)

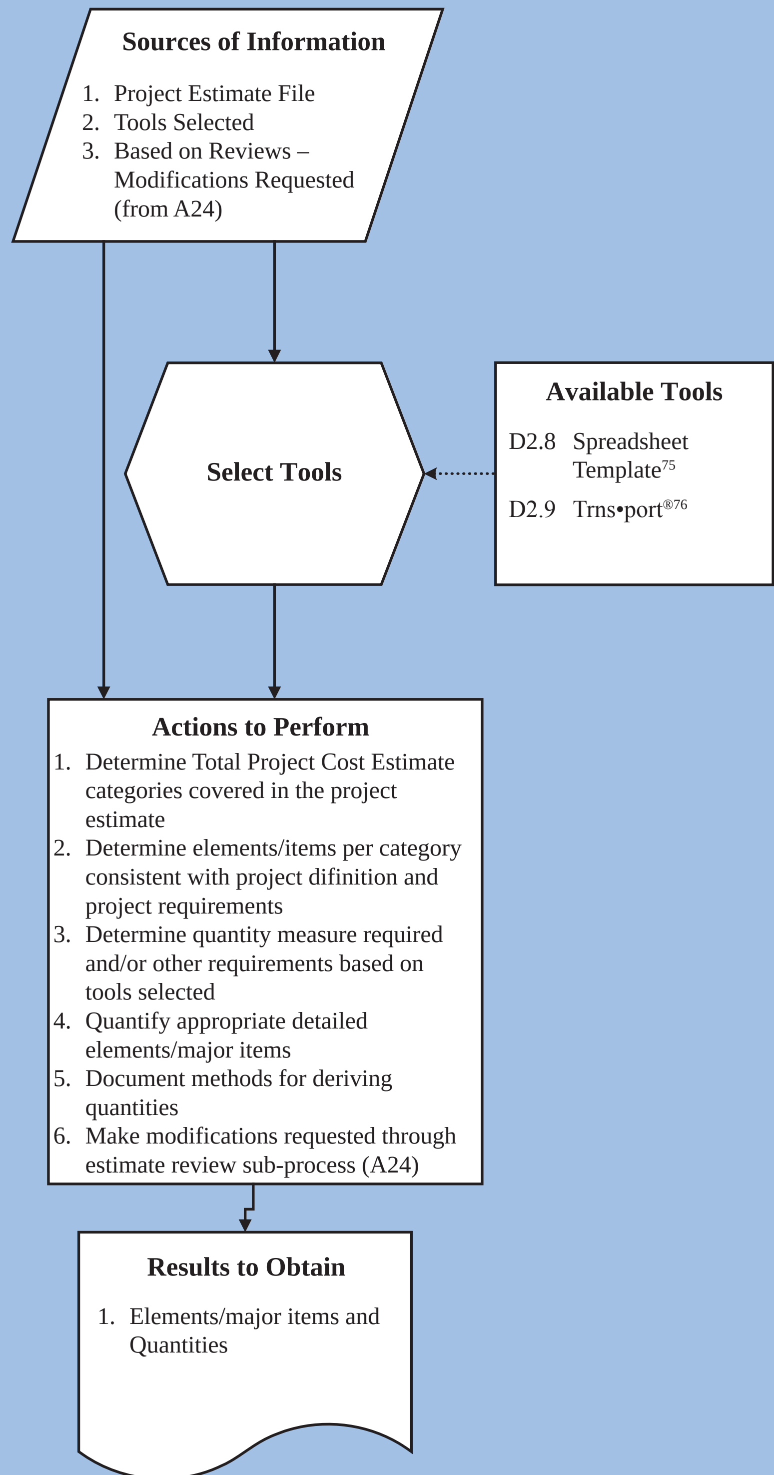
The combination of the Project Estimate File and the tools selected should provide all necessary information to quantify all estimate categories and their elements.

Spreadsheet templates provide a rapid and easy means for organizing estimate data and formulating repetitive calculations. Spreadsheets are also useful for compiling estimate calculations and assumptions, assessing estimate completeness, and communicating the estimate to others.

Identify the major items of work for the type of project being defined. Focus the efforts on these major items. For example, on a paving project, hitting the cost of striping to the exact penny of the final cost means nothing if the paving quantities are incorrectly estimated or the unit cost is significantly off.

Almost as important as the quantification of the elements/items is the documentation of the calculation of element/item quantities. Quantities drive estimated costs and are needed for future reviews and adjustments, as well as for others to fully comprehend the estimated costs.

Elements/items and their quantities are carried forward to an estimate spreadsheet.



75. For D2.8 Spreadsheet Template, see page 397.
76. For D2.9 Trns•port®, see page 401.

Develop Estimate Data (A223)

Step Requirements

This step in the Prepare Base Estimate sub-process determines the various cost data that is applied to elements and major items. The types and sources of historical data depend on the estimating tool used. For example, historical bid based estimating requires history of unit prices for different items. Historical Percentages require bid history, but for similar sets of elements. The cost of this set of elements is summed and converted to a percentage of all other construction costs. If historical data is extracted from a past project, as required using Analogous or Similar Project estimating, the project must be very similar to the project being estimated. Finally, if Parametric Estimating is based on the Length, Width, and Depth (LWD) approach, then a similar project must be found to develop the cost metric applied to the LWD factor.

The critical action to perform in this step is to develop the appropriate cost data for each work element and major item; however, equal care must be given to adjusting the cost data for market conditions, project specific location characteristics, age of historical data, and other factors. The Estimator will also need to modify any necessary cost data based on the feedback from the estimate review sub-process.

The Estimator uses a number of different inputs to accomplish this step, such as elements and major item quantities, project characteristics, historical data, and potential market impacts. An important tool used is a spreadsheet template, which is an excellent and simple tool for ensuring all categories of project cost have been considered and accounted for in the estimate.

Issues to Consider

Historical Data

- Historical bid data used for estimating must reflect current costs, that is, unit costs are updated to reflect inflation when unit costs are older than three months.

- Historical bid data must be understood in terms of how these data are developed for estimating a current project (e.g., using weighted averages based on low bid only).

Project Characteristics

- Market conditions and project location greatly affect the cost data; but factors such as material cost, special machinery, involvement of special agencies, technology, or method of construction should also be considered to make the cost data more accurate.

- List of items with uncertain bid data should be identified for evaluating risk and contingencies.

Develop Estimate Data (A223)

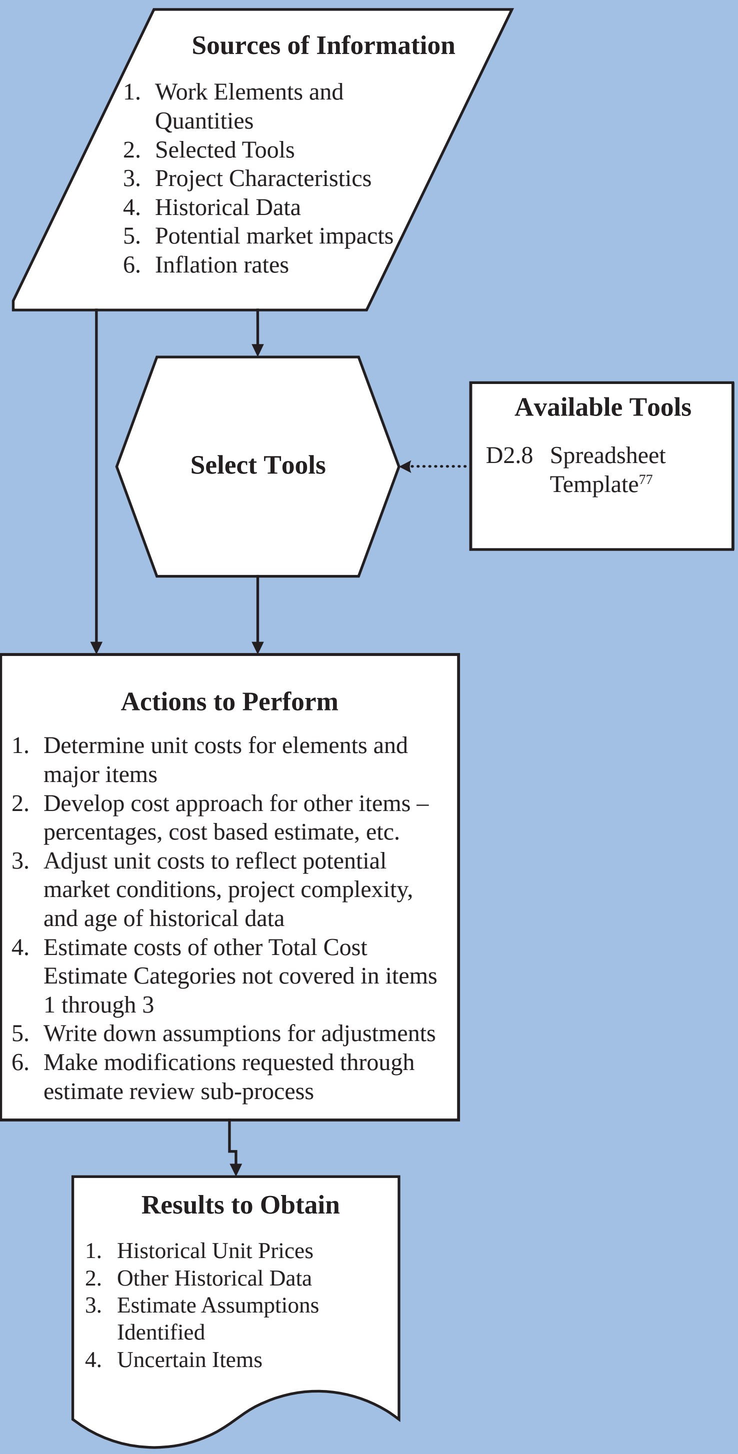
Developing historical cost data for converting quantity information to cost may be the most critical and important action required to prepare a base estimate. The Estimator works with a substantial amount of information. Consider variability resulting from the source of historical data used and its fit with the project being estimated.

Focus on the 80/20 rule that says 80 percent of the costs are in 20 percent of the elements and major items. Spend time developing historical cost data for these critical elements and items.

Look beyond the historical data when estimating the cost. Look for recent trends, such as rising material costs or changes in specifications. Consider where the project is located and its key features, that is, rural/urban, two lane/four lane, and so on.

Adjusting historical data to fit a project is a challenge. Issues to consider are location of material sources and batch plants, haul routes, work zone staging, and any market volatility.

Historical data must reflect current day costs prior to applying these data to a project estimate. The Estimator should note estimate assumptions made when adjusting historical data to fit the project being estimated. Also, uncertainty associated with the use of these data must be considered and noted.



77. For D2.8 Spreadsheet Template, see page 397.

Calculate Cost Estimate (A224)

Step Requirements

Calculating the cost estimate is a fundamental step in the Prepare Base Estimate subprocess (A22). The Estimator inserts into the cost estimating spreadsheet the cost data for each estimate element and major item. After all of the quantities and prices are calculated, these data are combined together in a single spreadsheet and summarized to calculate the base cost of a project. Cost estimates provided by Functional Groups should also be included. The spreadsheet should include detailed cost calculations for elements and major items but also summarized like elements by categories consistent with the concept of Total Project Cost Estimate.

A spreadsheet can be used to make the necessary detailed calculations of work elements, as well as to summarize these elements by categories for representation and eventually for reviews.

Issues to Consider

Project Definition and Characteristics

- This is the best time to ensure all categories, elements, and major items of work are covered. Until now, the data has yet to be compiled together for a single estimate, so a check to make sure all categories are included is necessary.

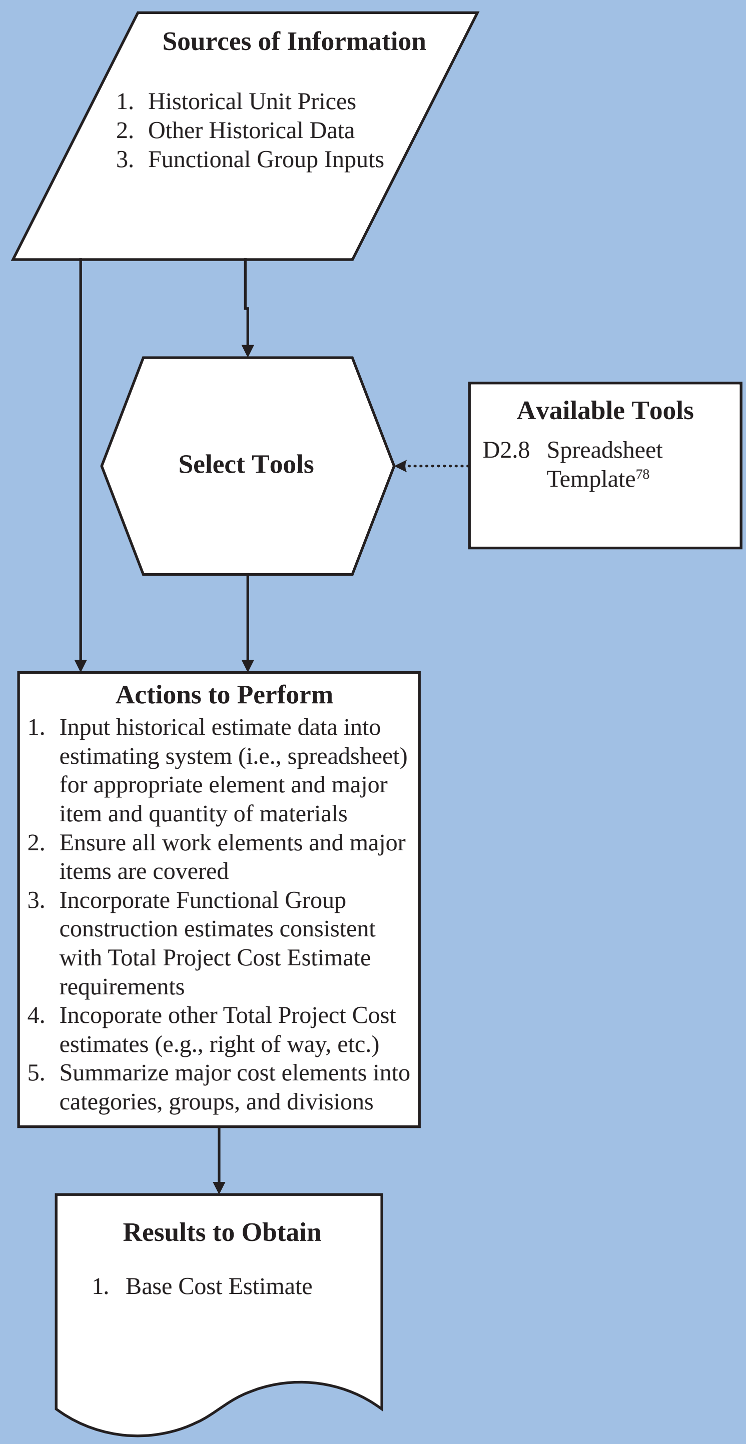
- The cohesiveness of the resulting base cost estimate is imperative. While merging work from different Functional Groups into a single, integrated estimate may be difficult, it must be completed for the comprehension of reviewers and management approval.

Calculate Cost Estimate (A224)

Formulas used in spreadsheets should be checked to ensure that all costs are properly calculated and aggregated to category, group, and division component levels. Spreadsheets aid in clearly conveying total estimated cost of the project, as well as what elements and major items are included in the estimate and what various categories of work are expected to cost. This allows for easy comparison to historical ratios from past projects for making rapid sanity checks of estimated costs.

Sanity checks can be made in a number of ways. The first is looking at values in the spreadsheet to make sure none seem unrealistically large or small. Mn/DOT will likely not be estimating a project with $10 million of silt fence or only $100 of HMAC. This type of sanity check can be completed by anyone. Another type of sanity check is reducing an entire project or item to cost per unit. For example, an estimate reviewer could take the entire cost of a project and divide by the number of lane-miles to see if the estimate is in the ballpark based on his own experience. Sanity checks often rely on the experience and knowledge of the person performing it.

This is the time to ensure all categories of work have been covered. Any categories and their elements excluded should be identified, and any categories and their elements not accounted for need to be calculated, even if the cost is considered an allowance. Contingency should not be included in any item estimates. All base costs should reflect current dollars (i.e., no future inflation added).



78. For D2.8 Spreadsheet Template, see page 397.

Document Estimate Assumptions (A225)

Step Requirements

A project's complexity and size may mean that more issues must be considered in preparing the estimate. Additionally, estimates are commonly prepared in collaboration with many Functional Groups. The basis and assumptions behind the decisions that drive the estimate must be clearly stated and communicated to management. Thus, this step is crucial in preparing a base estimate. Good documentation supports the cost estimate's credibility, enables reviewers to effectively assess the quality of the estimate, aids in the analysis of changes in project cost, and contributes to Mn/DOT historical cost databases for estimating the cost of future projects.

This step brings together all estimate information used to prepare the cost estimate in a structured format. While the level of detail may vary depending on project type and complexity, the need to assemble backup calculations, assumptions, and other pertinent estimate information is critical to ensure consistency across Districts and within the state.

The output of this step is an updated Project Estimate File, which will now include cost summaries and details, backup calculations, estimate assumptions, and cost basis for the estimate. Documentation and preservation of estimate information and supporting data is important, as this data forms historical data for other upcoming projects.

Issues to Consider

General

- It is particularly important to clearly document the changes, data origins, and approximations as any future estimates will be compared to this estimate and will be used to justify the changes in the cost of the project during the Design Phase.

Policy Guidance

- A Project Estimate File will be established that is maintained for the life of the project, from Planning to Letting.

- Cost estimates for each phase will be documented and will include a description of what the project is and what it is not, as defined in the draft Planning Report or **Scoping Report**; the assumptions used; the extent to which various estimate inputs are developed; the basis of the estimate; the base estimate; a separate contingency amount with a description of associated risks; and incentives, if included in the contract. Accelerated project incentives should not be designated as cost escalation or overages later on if the incentive provisions are part of the contract at the time of Letting.

- Project uncertainties should also be identified and documented. Documenting these uncertainties can aid in defining the unknown components.

Functional Group Input

- Similar documentation of estimates should be provided by each Functional Group that prepares an estimate for a project.

Document Estimate Assumptions (A225)

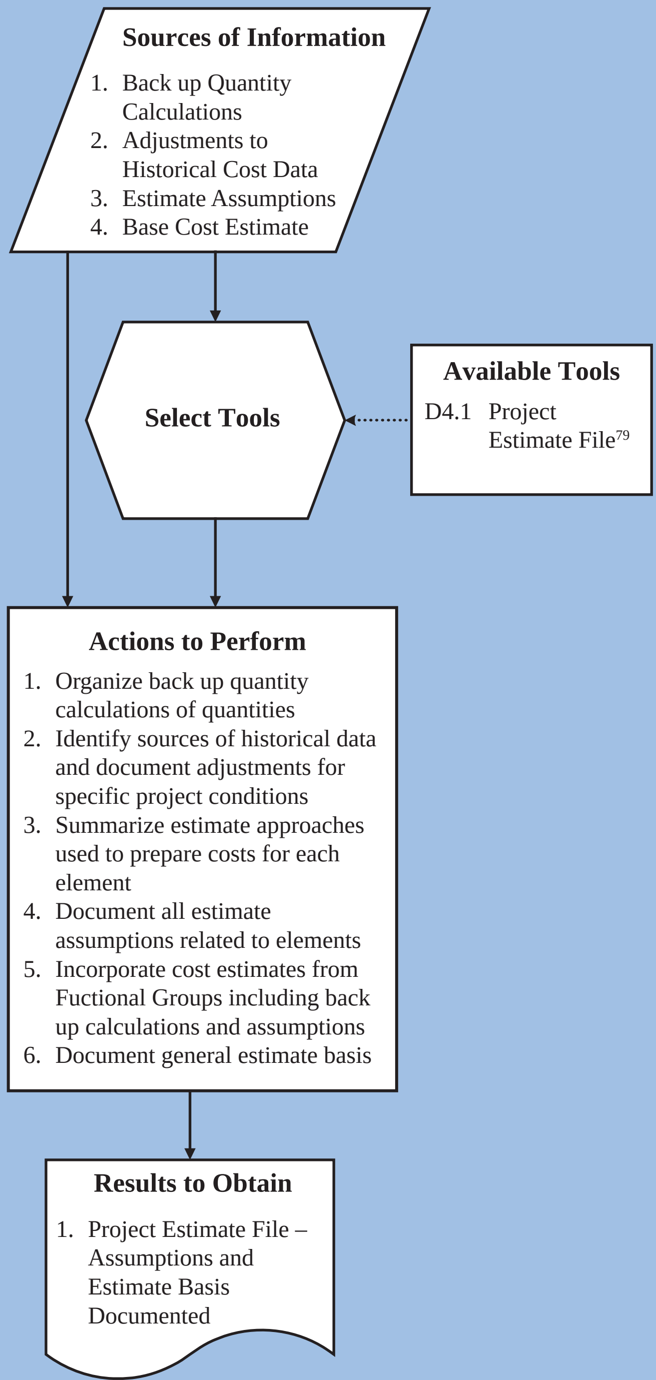
Each project has a Project Estimate File separate from the general project file or the correspondence file. The primary purpose of this file is to ensure that each project has a well-documented and easily retrievable history of the assumptions, methods, and procedures used to estimate the costs associated with the project's specific scope of work.

Traceability is a critical requirement necessary to prepare a credible cost estimate. Traceability allows others to review and validate the estimate. Traceability provides the mechanism to assess cost impacts when the project definition changes or when other project conditions or characteristics change.

Traceability is facilitated by clear and concise documentation. Documentation should include estimate bases, assumptions, and calculations. The Project Estimate File should be created to assemble these items in a single location.

Estimate cost bases and assumptions are at two levels: 1) high-level bases and assumptions that apply to every category/element of the project estimate; and 2) detailed-level bases and assumptions that apply to individual element and item estimates.

The Project Estimate File is first populated with the estimate basis used to prepare the estimate (from A21). At this point, the Project Estimate File is further populated with backup calculations, assumptions, and other pertinent cost information.



79. For D4.1 Project Estimate File, see page 339.

Prepare Estimate Package (A226)

Step Requirements

This is the final step in completing the Scoping estimate, and it will be completed for all estimates. All calculations have been made and documented before this step; however, the details, summaries, and assumptions must all be collated into a single, logical volume. After accumulating and organizing this material, the package produced will represent the total project cost, without contingency, and all supporting information.

The only tools available for use are the Project Estimate File and a Spreadsheet Template; therefore, much of the success of this step is in the hands of the Estimator preparing this package. The Project Estimate File provides a record that documents the basic reasons behind the original estimated construction cost. Above all, the information must be easy to understand and well-organized for reviewers. Thus, summary level information is often prepared for later estimate reviews and management approvals. The estimate package should include updates in project definition, assumptions, quantity and price calculations, and supporting data.

Issues to Consider

General

- Contingency is not included in the base cost estimate package.

- The collaborative effort required to create an estimate can lead to problems with consistency; therefore, the package preparer must ensure harmony exists between all parts of the estimate before the package is complete.

- This estimate will be a reference point for many other project team personnel as the project progresses, thus making the easy retrieval and comprehension of this material paramount.

Policy Guidance

- All project-related costs will be expressed as a Total Project Cost Estimate, regardless of the project development phase. The Total Project Cost Estimate consists of a base estimate and a contingency (added in the next sub-process, A23). The base estimate includes all known project costs at the time the estimate is made.

- The inputs from various Functional Groups should be properly organized and compiled for future reference.

- A clear and easy-to-understand estimation package is particularly important as the project passes to the Design Phase and from one group of personnel to another.

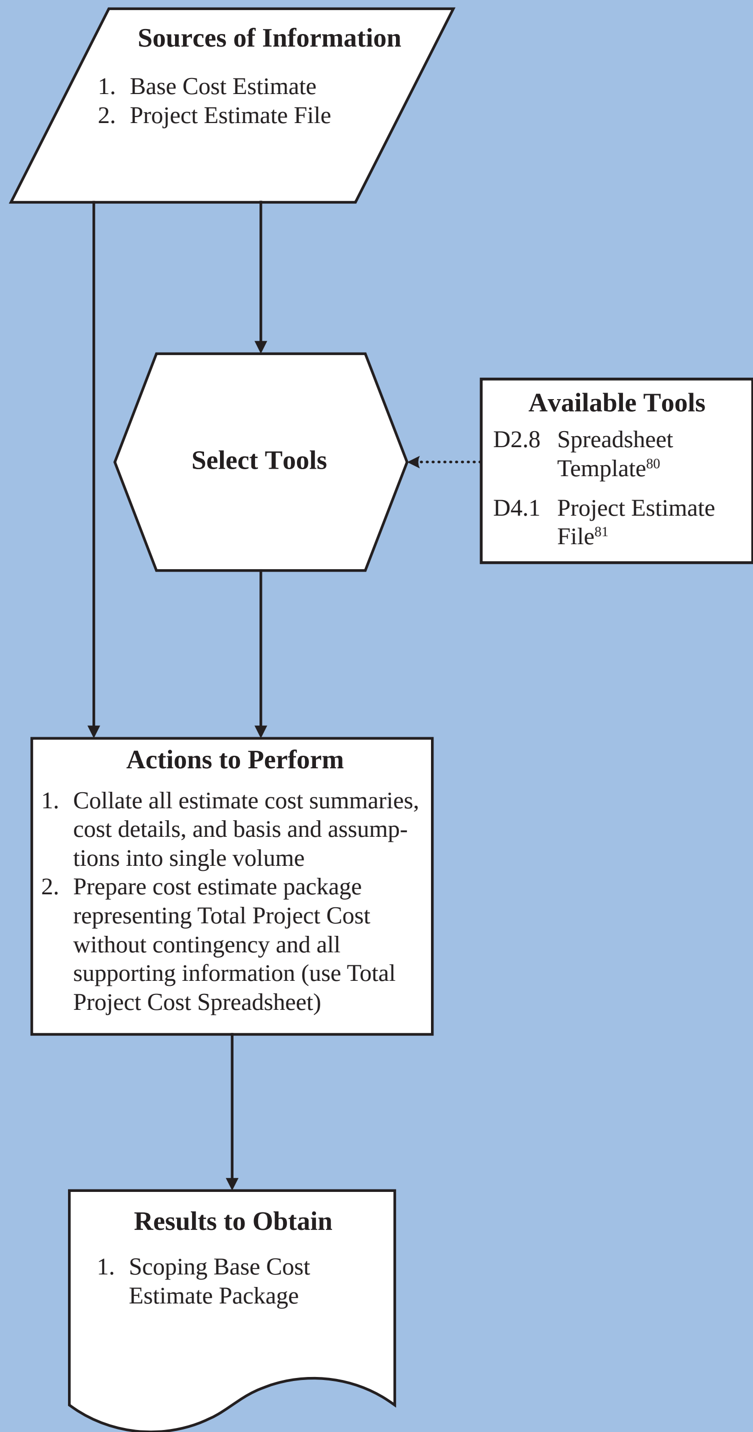
Prepare Estimate Package (A226)

While the base cost estimate and the Project Estimate File combined have all of the necessary information, they must be merged into a single package. The Project Estimate File becomes the sole source of all base cost estimate information, both project definition and cost.

Spreadsheet templates and the Project Estimate File are the two tools that should be used in this step. Organization and readability are two of the most important considerations in preparing the base cost estimate package due to the number of project personnel who will need to access and use the information.

The Scoping Base Cost Estimate Package should include all required information related to the base cost estimate, including cost summaries, cost details, project requirements used to prepare the estimate, all assumptions, and backup calculations.

A short cost estimate summary can be prepared that captures key features of the estimate, such as total project costs, key estimate bases and assumptions, project schedule, and other critical items. This document, while part of the package, will aid in management reviews of the cost.



80. For D2.8 Spreadsheet Template, see page 397.
81. For D4.1 Project Estimate File, see page 339.

III.3.4 DETERMINE RISK AND SET CONTINGENCY (A23)

The primary objective of this sub-process is to characterize the estimate uncertainty and develop a contingency amount to add to the base estimate to arrive at the Total Project Cost Estimate. All projects, regardless of project size and project complexity, will require some form of risk analysis and risk management planning. The six sub-process steps are as follows:

1. Review Risk Information – A231
2. Determine Level of Risk Analysis – A232
3. Identify Risks – A233
4. Estimate Contingency – A234
5. Document Risk and Contingency Basis – A235
6. Prepare Total Project Cost Estimate – A236

Steps 1 through 4, in combination with the tools in the Tool Appendix, support the development of a contingency estimate. These four steps identify risks and provide a framework to assess the amount of contingency that will properly allow for estimate uncertainty during the scoping process. Some of these key inputs include the following:

- **Estimating Assumptions and Concerns** – estimating assumptions and Estimator issues of concern form the basis for risk identification.

- **Functional Group Assumptions and Concerns** – clarifications from Functional Groups regarding design assumptions and issues of concern for their area of the project inform the Estimator of possible risks and the need for contingency.

- **Individual Expertise** – risk analysis and setting of contingency will necessarily rely on individual expert judgment (e.g., the Estimator, Functional Group experts, peer reviewers, District Engineer, etc.). Mn/DOT will develop more historical data regarding contingency estimation and appropriate amounts, but personal expertise will always be a valuable part of the process.

- **Project Complexity Categorization** – the level of project complexity, not necessarily the project size, determines the type of risk analysis that will identify risks and estimate contingency.

Use these key inputs when performing the six steps of this process. The output of this sub-process is a contingency estimate, a documentation of the risk and contingency basis, and the total project cost. Add all of these items to the Project Estimate File at the end of the process. Depending upon the level of risk analysis, the outputs will vary from a simple red flag item list (I2.1) with an associated contingency percentage (R3.2) to a full risk management plan (R3.1) with an associated range estimate based on a stochastic estimating method (R3.5). The development of a risk register (3.12) is a good practice in all cases.

All projects, regardless of project size and project complexity, will require some form of risk analysis and risk management planning.

Review Risk Information (A231)

Step Requirements

The Scoping estimate basis and the base estimate package comprise the key inputs for this sub-process step. The determination of project risk stems from a review of the estimating assumptions made by the project Estimator and the design assumptions made by the Functional Groups. The Estimator must make estimating assumptions in a Scoping level estimate because complete design information will not be available. Likewise, the Functional Groups must make initial design assumptions at the conceptual level that they will refine as the design progresses. Estimating and design assumptions serve as triggers for risk identification when creating a contingency estimate.

Two other sources of risk information are risk checklists and risk analyses from similar projects. However, review these sources of information only after conducting a thorough review of the estimating and design assumptions.

Issues to Consider

Level of Estimating Effort Applied

- Project Estimators should consider the level of effort that was applied in the base estimate when compiling the estimating assumptions. If the Estimator was afforded sufficient time to complete the estimate, the list of assumptions will likely be complete and comprehensive. If a base estimate was prepared quickly (or “under the gun”), then the list of assumptions may well be incomplete. In the latter case, risk checklists and similar project analyses will be useful.

Completeness of the Scoping Documents

- The Mn/DOT Scoping process is comprehensive, but the time available to complete the process can be constrained by time or staff available to complete the daft Scoping Report. In the case where a draft Scoping Report is less than comprehensive, risk checklists and similar project analyses will be useful.

Risk Management Plan Outline

- A final output of the Determine Risk and Set Contingency sub-process is a risk management plan. The risk management plan is scalable in detail depending on project complexity and level of risk exposure. Complete the outline for the risk management plan early in this sub-process step.

Review Risk Information (A231)

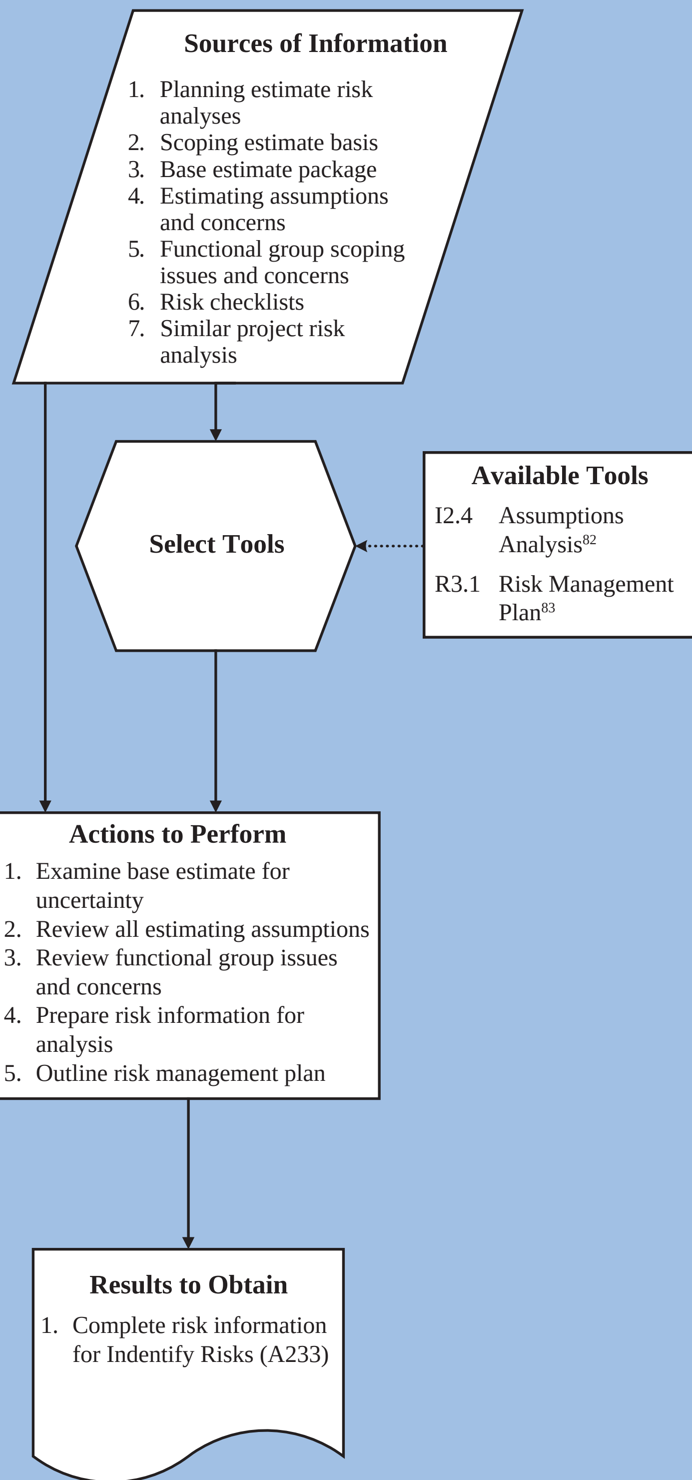
Ideally, a complete Scoping estimate basis and base estimate package should be available for the risk analysis and contingency estimate. While Estimators will perform portions of the contingency estimate concurrently with the base estimate development, the final contingency estimate should only occur after the base estimate is complete.

Be certain to consult previous Planning-level risk analyses.

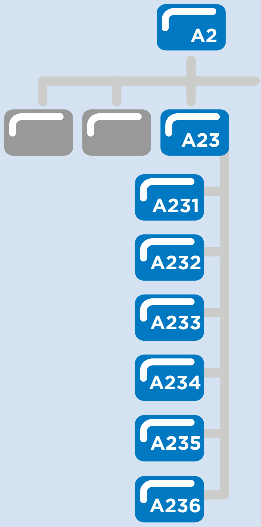
The Risk Identification (A233) and Estimate Contingency (A234) sub-process steps will employ many more tools. The Review Risk Information step focuses on a collection of information for later use.

Begin the risk management plan outline early. Enhancements to the plan can occur throughout the project development process, but the outline for the plan should start early in the estimating process.

The sources of information should be as complete as possible, but Estimators will likely need to contact project team members throughout the Determine Risk and Set Contingency sub-process.



82. For I2.4 Assumptions Analysis, see page 419.
83. For R3.1 Risk Management Plan, see page 425.



Determine Level of Risk Analysis (A232)

Step Requirements

This step defines the level of risk analysis on the basis of project complexity. The primary inputs for this step are the estimate basis documents and the project complexity tool evaluation (R1.1). A project complexity evaluation will categorize the project as major, moderately complex, or minor. These three complexity ratings correlate to a Type I, Type II, and Type III level of risk analysis.

Type I Risk Analysis – Risk Identification and Percentage Contingency

The Type I risk analysis is the simplest form of risk analysis and applies only to minor projects. A Type I risk analysis involves the development of a list of risks and the use of a percentage of project cost to estimate the contingency. The Estimator should use his or her judgment within percentage contingency range of acceptable standards set by Mn/DOT. See the flowchart on the opposite page for example tools.

Type II – Qualitative Risk Analysis and Indentified Contingency Items

The Type II risk analysis correlates to moderately complex projects and involves more rigorous risk identification tools and specific contingency items that complement the percentage-based contingency in the Type I analysis. A risk register containing a PxI matrix analysis to rank the risks is essential. A qualitative ranking of the risks is a key output. See the flowchart on the opposite page for example tools.

Type III – Quantitative Risk Analysis and Contingency Management

A Type III risk analysis applies to major projects. It will need to be facilitated by consultants in the area of quantitative risk management practices. The process generally starts with a risk analysis workshop and generates a stochastic estimate of cost and schedule, which is then updated throughout project development. See the flowchart on the opposite page for example tools.

Issues to Consider

Project Complexity

- Project complexity is the key driver for the type of risk analysis. Project size is not necessarily a determinant of project complexity. Small projects can be complex and require a more rigorous analysis.

Use of Consultants

- Employ external consultants for Type III risk analyses. Retain the consultant who conducts the initial risk analysis for updates, whether periodic or as required by project circumstances.

Resulting Risk Management Plan

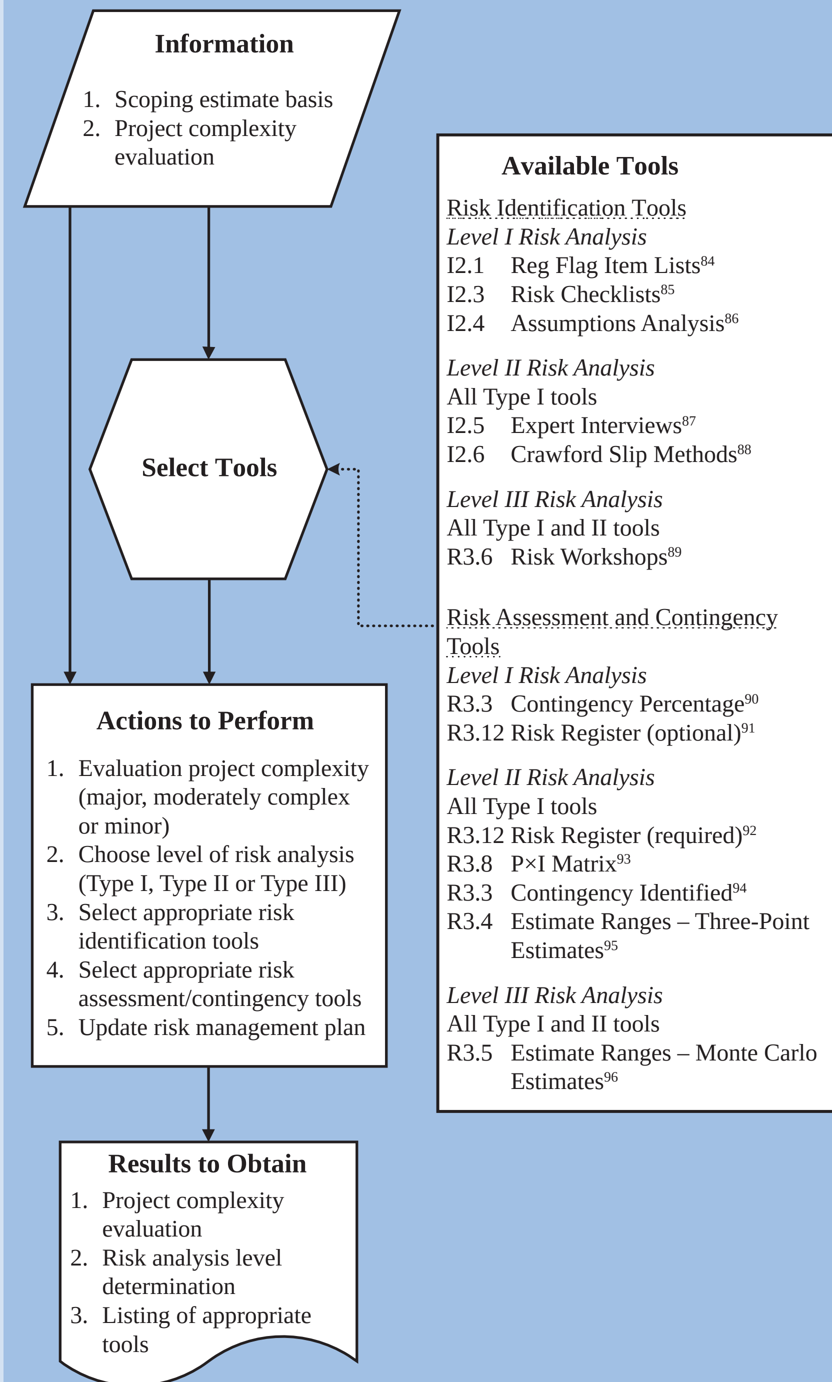
- Develop risk management plans and update them frequently. The level of detail in the risk analysis plan corresponds to the level of risk management.

Determine Level of Risk Analysis (A232)

The level of risk analysis will determine the selection of risk-related tools and risk management planning. Base the level of risk analysis on project complexity rather than project size. Use Tool R1.1, Recognition of Complexity, to aid in selecting level of risk analysisi.

All projects, regardless of project size and project complexity, will require some form of risk analysis and risk management plan. The framework of risk analysis remains the same, but the tools and level of effort vary with the risk analysis level.

Risk analysis and risk management planning are iterative and continuous throughout the process.



84. For I2.1 Reg Flag Item Lists, see page 411.
85. For I2.3 Risk Checklists, see page 413.
86. For I2.4 Assumptions Analysis, see page 419.
87. For I2.5 Expert Interviews, see page 421.
88. For I2.6 Crawford Slip Methods, see page 423.
89. For R3.6 Risk Workshops, see page 440.
90. For R3.2 Contingency Percentage, see page 430.
91. For R3.12 Risk Register (optional), see page 446.
92. For R3.12 Risk Register (required), see page 446.
93. For R3.8 P×I Matrix, see page 443.
94. For R3.3 Contingency Identified, see page 433.
95. For R3.4 Estimate Ranges – Three-Point Estimates, see page 435.
96. For R3.5 Estimate Ranges – Monte Carlo Estimates, see page 437.

Identify Risks (A233)

Step Requirements

The objectives of risk identification are to 1) identify and categorize risks that could affect the project, and 2) document these risks. The outcome of the risk identification is a list of risks. On minor, low-cost projects with little uncertainty (few risks), the risks can simply be kept as a list of red flag items. The Estimator should associate the red flag items with a contingency percentage (Type I risk analysis). On major projects that are by nature uncertain, the risks are inputs to a rigorous analysis process and stochastic estimate that form the basis for risk monitoring and control throughout the process. Moderately complex projects can use a combination of these methods.

The risk identification process should generally stop short of assessing or analyzing risks so as not to inhibit the identification of "minor" risks. The process should promote creative thinking and leverage team experience and knowledge.

The final task is to categorize the risks. Use risk checklists and similar project risk analyses for possible categorizations.

Issues to Consider

Risks should be Comprehensive and Non-Overlapping

- Perhaps the most challenging aspect of risk identification is in defining issues at an appropriate level of detail. Issues defined too vaguely or too "lumped" are hard to assess. Defining too many separate, detailed risks can lead to overlapping among issues or missing larger issues (i.e., "missing the forest for the trees" problem). To the extent possible, define risks to be independent of each other, thereby eliminating overlap among risks through their descriptions.

Combining Risk Identification and Risk Assessment

- In practice, risk identification and risk assessment are often completed in a single step, and this process can be called risk assessment. For example, if a risk is identified in the process of interviewing an expert, it is logical to pursue information on the probability of it occurring, its consequences/impacts, the time associated with the risk (i.e., when it might occur), and the possible ways of dealing with it.

Use of Risk Checklists and Similar Projects

- Risk checklists and lists of risks from similar projects can be helpful, but use them only as a "back check" at the end of the risk identification process. Review these lists only at the end of the process as a means of ensuring that the list is not excluding any common risks. Avoid beginning the process with the risk checklists or similar project analyses as the team may overlook unique project risks or include too many risks in the analysis, making it less useful.

Identify Risks (A233)

Risk identification should be a creative brainstorming process. It should not attempt to analyze risks or discuss mitigation procedures, which will be completed in the next steps.

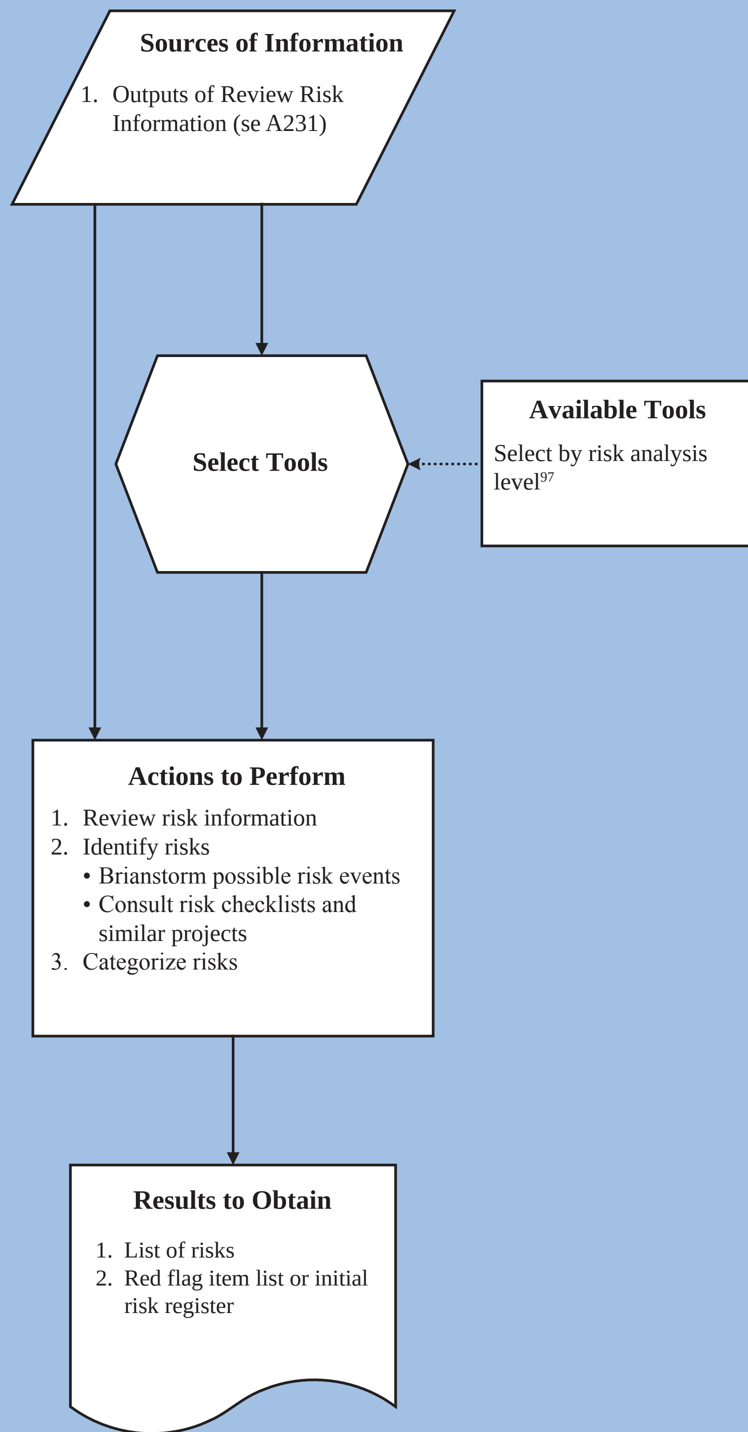
At a minimum, risk information should include assumptions, estimate basis uncertainties, and project issues and concerns from the Estimator, project team, and any participating Functional Groups.

Risk analysis tools will be dependent upon the level of risk analysis. Upon determining the level of risk analysis, consult the flowchart in step A232 for appropriate risk analysis tools.

The resultant risk list should be comprehensive and non-overlapping to be most useful in later risk analyses. Combine like risks. Separate overlapping risks.

Use risk checklists and similar projects only to check for missing risks and to help categorize unique project risks.

Upon completion of the risk list, categorize the risk into logical groupings. Use risk checklists and similar project risk analyses for possible categorizations.



97. See Flowchart A232 on page 145.

Estimate Contingency (A234)

Step Requirements

The goal of this sub-process step is to estimate an appropriate contingency for the project. The list of risks, along with any historical information concerning cost growth, forms the basis for this contingency. On minor projects employing a Type I risk analysis, assign this contingency through a simple percentage from historical data and Estimator's judgment. On major projects using a Type III risk analysis, assign the contingency through a stochastic model of cost and schedule using an external consultant to assist in building the model. Type II risk analyses can use a combination of percentages and probabilistic estimates to estimate the contingency.

Ranking of risks is the first step in all three types of risk analyses. This is the risk assessment step in a formal risk analysis. Use the P×I tool (R3.8) to assess frequency and severity of each risk. Ranges of probability and impacts are useful in initial assessments. Type II and III analyses may require more accurate assessments, but all three types of assessment can begin with a qualitative assessment of frequency and severity.

Issues to Consider

Relate Risk to Contingency

- In all cases, relate the list of risks to the contingency amount. In a Type I analysis, the tie between the risks and contingency is loose, but the list of risks can justify the need for the contingency estimate to both internal and external stakeholders. In the Type III analysis, the tie is direct as the list of risks forms the basis for the stochastic model that drives the contingency estimate.

Type I Risk Analysis Contingency

- In a Type I risk analysis, use the list of risks to inform the choice of contingency from the department's pre-determined range of allowable contingencies (see R3.2 Contingency Percentage on page 430).

Type II Risk Analysis Contingency

- When choosing the appropriate contingency percentage in a Type II risk analysis, consult the range of contingency from the percentage contingency tool, and then review the top 20 percent of the prioritized risks to ensure that the contingency is adequate. Use an expected value estimate for estimating the top-ranked risks. Calculate the expected value by multiplying the product of the impact should the risk occur by the probability of the occurrence (e.g., $1,000,000 × 0.50 = $500,000). Use additional contingency if warranted by the expected value analysis.

Type III Risk Analysis Contingency

- Contingency in a Type III risk analysis involves a quantitative risk analysis and the development of a stochastic estimate for cost and schedule. A consultant will typically be required to conduct this analysis unless Mn/DOT develops in-house expertise in this area. A Type I or II analysis can be conducted prior to procuring a consultant, if desired.

Estimate Contingency (A234)

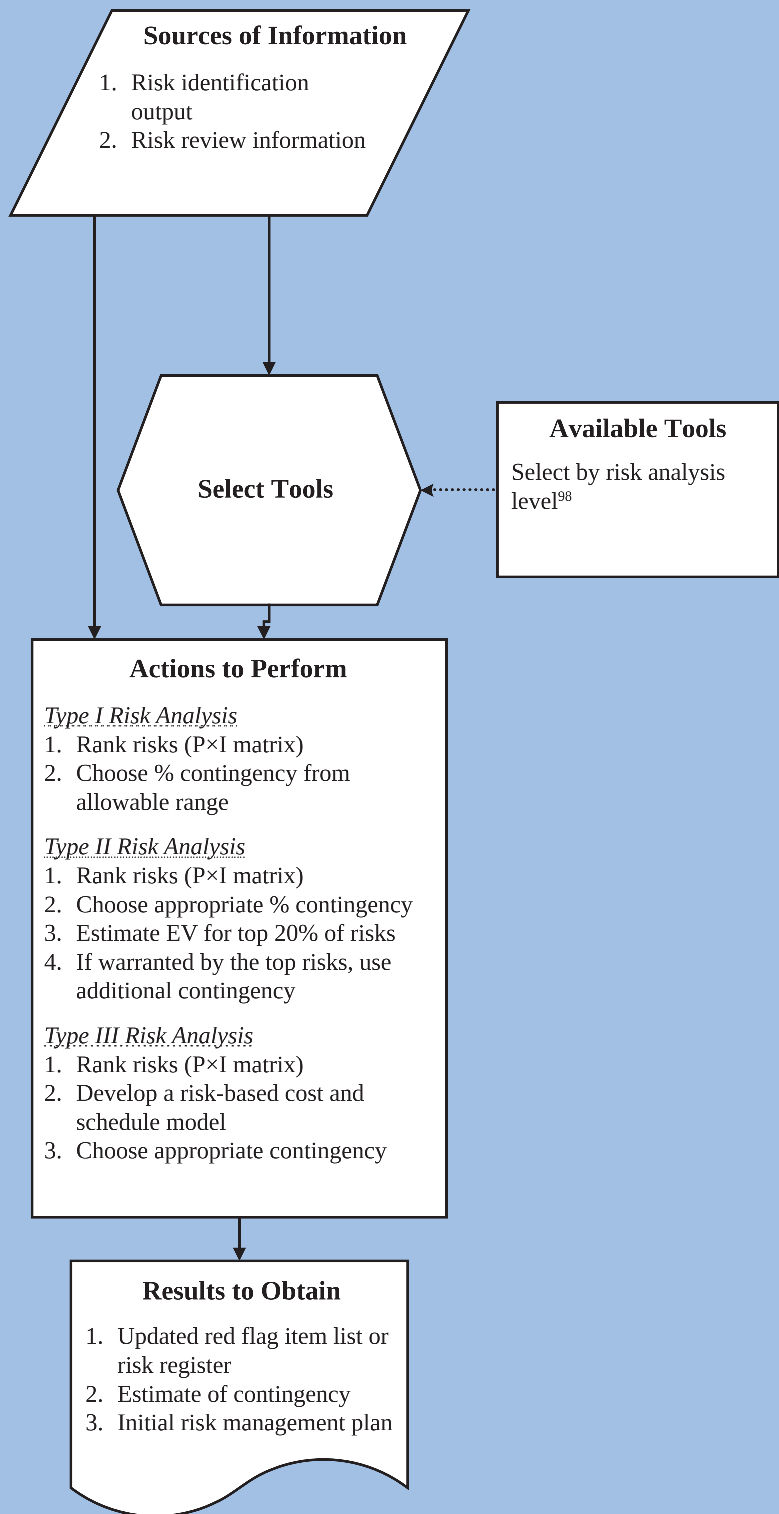
Inputs for the contingency estimate come from the risk identification output (see A233) and risk review information (see A231).

For a comprehensive listing of tools corresponding to each risk analysis level, please see the flowchart in A232.

Use the P×I matrix (probability times impact) to assess and provide an initial risk ranking in all three levels of risk analysis. The Type III risk analysis will use the P×I matrix results as a basis for developing a more rigorous quantitative risk analysis.

When choosing the appropriate contingency percentage in a Type I risk analysis, consult the appropriate range of contingency from the percentage contingency tool.

In a Type III analysis, a risk-based cost and schedule model is the model used to select the appropriate contingency. The Office of Project Scope and Cost Management should be consulted to develop these models.



98. See Flowchart A232 on page 145.

Document Risk and Contingency Basis (A235)

Step Requirements

This step requires the Estimator and project team to document a transparent list of risks and uncertainties. Keep the list in the cost estimate file, and summarize it for communication of the cost estimate.

Maintenance of a risk register (R3.12) is a requirement for Type II and III documentation. It is also a good practice for Type I documentation. The register should provide a detailed description of the risks, their probability of occurrence, their impact if they occur, the strategies to manage the risks, an assignment of ownership for the risks, and a schedule for risk resolution. Type I risk analyses can be documented through red flag lists (I2.1), but Type II and III risk analyses should always be documented through a risk register.

A formal risk management plan (R3.1) is a requirement for Type III documentation, but it is also good practice for Type II documentation. The risk management plan generally documents the structure of risk management for each project. The risk management plan includes, at a minimum, the approach to managing the risks, roles and responsibilities, budgeting, timing, reporting formats, and tracking.

Issues to Consider

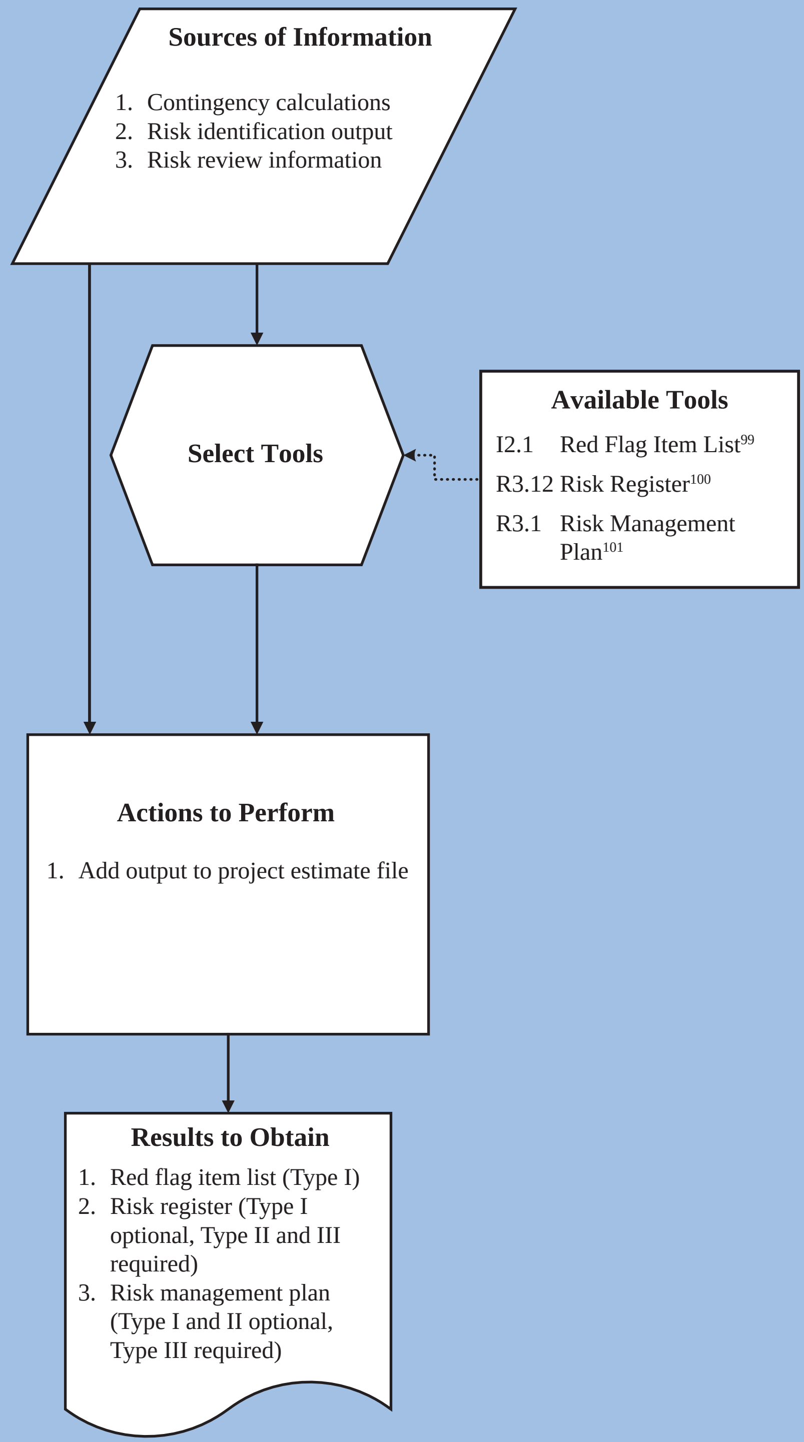
Application for Cost Management

- Documentation of the risk and contingency basis is vital for cost management. As the project progresses through the project development phases, risks will either be realized or resolved. Ideally, the team will actively manage the risks and update the contingency estimate throughout the project development phase. Risks and contingency must be clearly documented with each estimate if they are to be actively managed.

Document Risk and Contingency Basis (A235)

Collate all risk and contingency information for use in cost management throughout the project development process. Each future estimate will involve an update of risks and an update of the contingency estimate. Documentation will allow for active risk management and appropriate contingency resolution.

Risk and contingency documentation is an important step in estimate communication.



99. For I2.1 Red Flag Item List, see page 411.
100. For R3.12 Risk Register, see page 446.
101. For R3.1 Risk Management Plan, see page 425.

Prepare Total Project Cost Estimate (A236)

Step Requirements

This final sub-process step involves adding the base cost estimate and contingency estimate to arrive at a total project cost. Consult the Total Project Cost Estimate Spreadsheets for proper format.

Issues to Consider

Presentation of Contingency

- Contingency will be included in a separate section of the estimate and summarized on the estimate summary sheet. It will not be included in estimate line item costs. In the contingency estimate, include the greatest level of detail that the contingency estimate can support. For example, a Type I analysis using a percentage contingency may include only one item for contingency based on a percentage of the total project cost. A Type I contingency estimate cannot support separate contingency estimates for the categories in the Total Project Cost Estimate summary. A Type II or III analysis may support contingency for various categories of the Total Project Cost Estimate calculations (e.g., separate contingencies for right of way, utilities, etc.). When tying contingency directly to individual line items, explicitly identify the contingency and do not "bury" it in the unit price for the item. For example:

Group	Item	Base Cost	Contingency	Total Cost
Construction	Muck Removal	$$$	$$$	$$$

Application of Inflation

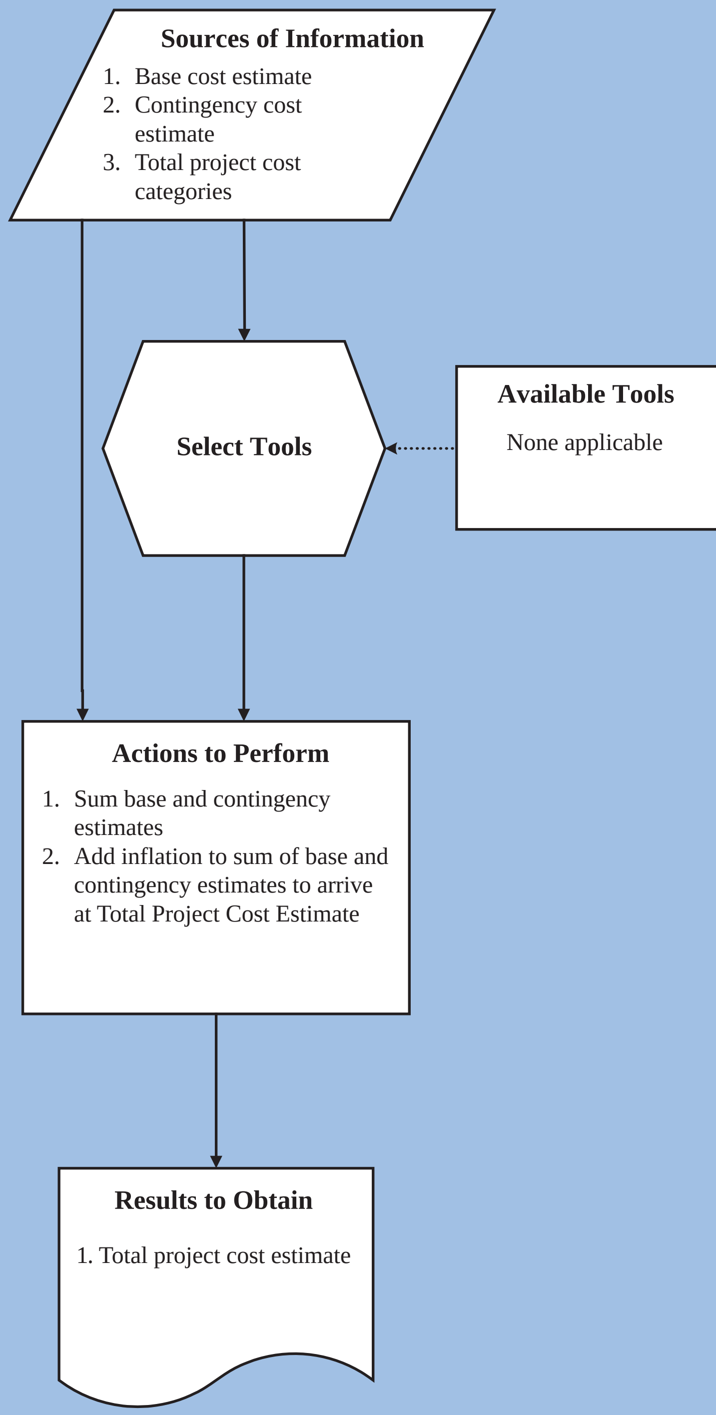
- The Office of Investment Management provides an overall inflation factor for application to each project. Individual items within a project may include a risk and associated contingency for escalation (e.g., steel bridge costs may have an identified contingency for probable steel escalation). The inflation adjustment is for the overall project inflation and should be added to the project, in addition to any identified contingency items. Add the inflation factor after summing the base and contingency estimates. Inflation should be applied to the midpoint of construction to reflect a year-of-construction estimate.

Prepare Total Project Cost Estimate (A236)

Mn/DOT is committed to communication of cost estimates through total project cost, which includes the base estimate plus the contingency. Note how the contingency was calculated in the estimate file.

Inflation is added to the estimate, in addition to any identified contingency. Inflation is applied to the sum of the base and contingency estimates for the overall project.

Calculate inflation to the midpoint of construction.



III.3.5 REVIEW AND APPROVE ESTIMATE (A24)

A purpose of the Review and Approve Estimate sub-process is to ensure that the estimate is as complete and accurate as possible, based on the project requirements as described in the draft Scoping Report. Another purpose is to obtain District management acceptance and buy-in of the total project cost that will become the baseline for managing cost during design. This sub-process is critical as it represents final acceptance of the cost estimate before the estimate is released to both internal and external project stakeholders. This sub-process has six steps. The steps are as follows:

1. Determine Level of Review – A241
2. Review Estimate Assumptions – A242
3. Verify Completeness and Cost Data – A243
4. Reconcile with Latest Estimate – A244
5. Prepare Estimate Package – A245
6. Approve Estimate Package – A246

These six steps provide a natural progression of effort to review and approve the total cost estimate prepared during the Scoping phase. The first step requires a decision on the level of review required. The level of review is tied to project type and complexity. The next three steps would likely be performed at the same time. Once these three steps are complete, a package can be assembled for final approval of the baseline cost estimate. There are two key inputs required:

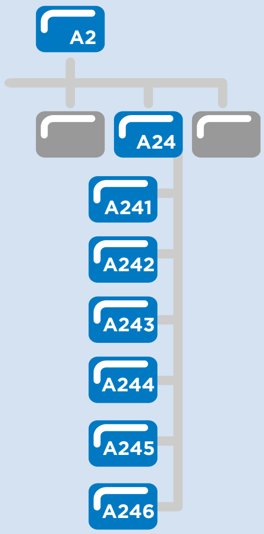
- **Total Project Cost Estimate Package** – contains the base cost (summary and details) and contingency, all supporting documentation related to estimate basis, assumptions, backup calculations, risks, and other areas of uncertainty.

- **Project Characteristics** – description of the type of project and complexity of the project, including site-specific information and/or data that may impact the base cost and contingency.

The Estimator should review the RACI matrix and determine his or her role in this function, as well as the roles of management, other estimating groups, Project Management, and Functional Groups. It is highly recommended that the accountability for the approval of the estimate be held by a District Engineer. Accountability and responsibility for the review steps will likely rest with the Estimator and the Project Manager.

The key inputs are then used when performing the six steps of this sub-process. The output of this sub-process is an Approved Baseline Cost Estimate Package. If the review uncovers issues that need to be addressed, then modifications to the base estimate and contingency may be required. This action would require additional effort under the Prepare Base Estimate and Determine Risk and Set Contingency sub-processes.

A purpose of the Review and Approve Estimate sub-process is to ensure that the estimate is as complete and accurate as possible, based on the project requirements as described in the draft Scoping Report.



Determine Level of Review (A241)

Step Requirements

The objective of this step is to perform a careful review of the project details and to choose the appropriate tools for review. The primary inputs for this step include the total project cost and the project complexity definition. During the risk and contingency process, the project will have been categorized as minor, moderately complex, or major. The level of review correlates directly to these project complexity definitions. Table III.3-2 below provides guidance on which tools apply to the appropriate review level.

Table III.3-2 Review Tools and Project Complexity

Estimate Review Tools	Minor	Moderately Complex	Major
C4.2 Estimate Checklist	√	√	√
E3.3 In-House Peer	√	√	√
E3.4 Round Table Estimate Review		√	√
E3.1 Formal Committee		√	√
E2.1 Expert Team			√

Upon choosing the appropriate review tools, plan the review. The review plan should include a schedule for the review and a listing of people who will participate.

Issues to Consider

Policy Implications

- To achieve consistent and accurate cost estimates, Mn/DOT is conducting project cost reviews at critical points or gates during the project development phases. If this project is at one of those gates, be sure to understand and obtain the appropriate review. In the Scoping phase, the final estimate will be Gate 3 – Enter in the STIP (Figure II.2-1 on page 12).

- The Office of Project Scope and Cost Management will review major District project estimates for completeness and conformance with established cost estimating processes.

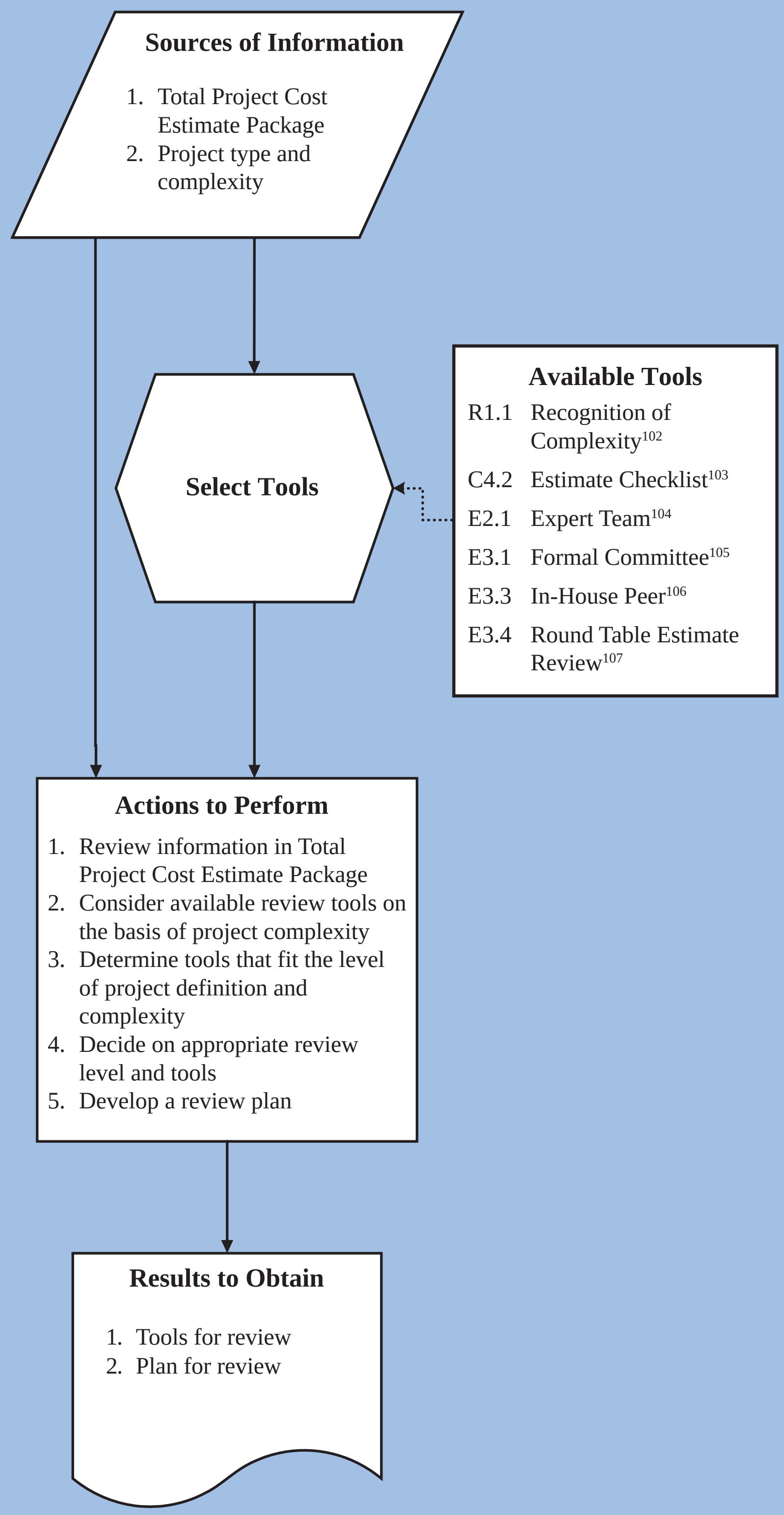
Determine Review Level (A241)

Review the Total Project Cost Estimate Package and the overall project complexity and type in order to choose an appropriate review level.

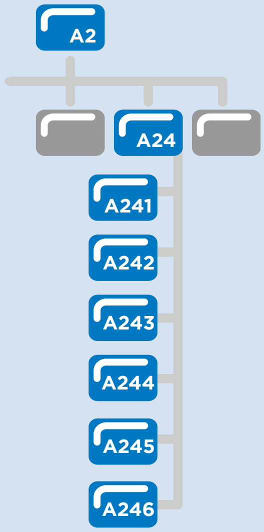
Read through the list of available tools and take them into consideration later in this step and process. Considerations should include project complexity and resources, such as personnel and time.

Decide which tools should be used by reviewing the input information, project complexity, and available tools list. Also, consider if the estimate involves a gate with a required approval.

The output for this step is an appropriate review level and a list of tools to be used in the review process.



102. For R1.1 Recognition of Complexity, see page 343.
103. For C4.2 Estimate Checklist, see page 449.
104. For E2.1 Expert Team, see page 467.
105. For E3.1 Formal Committee, see page 451.
106. For E3.3 In-House Peer, see page 454.
107. For E3.4 Round Table Estimate Review, see page 456.



Review Estimate Assumptions (A242)

Step Requirements

This step requires a review of the estimate assumptions. The Total Project Cost Estimate Package and the list of risks generated in the Determine Risk and Set Contingency sub-process are the main inputs for this review.

Using the selected tools, the Estimator and/or the Project Manager will determine if the necessary assumptions and conclusions were made about the project. Experience is key in this review. While the estimate tool checklist is helpful, an experienced Estimator can review the assumptions to qualitatively determine if enough Scope is available to complete an accurate estimate. If an Estimator was required to make too many assumptions to complete the estimate, it is possible that the Scope was not defined in enough detail to provide sufficient estimating information.

Issues to Consider

Contingency Assumptions

- Determination of risk and setting of contingency is not to be incorporated in individual line item costs, but rather should be contained in an identified contingency amount in the estimate summary. Be certain that contingency is not "buried" in the line item costs.

Review Estimate Assumptions (A242)

Review the Total Project Cost Estimate Package and the chosen review level.

Be sure to consult your District's RACI Chart for the roles and responsibilities associated with this step; there may be a difference in responsibilities depending on the complexity of the project.

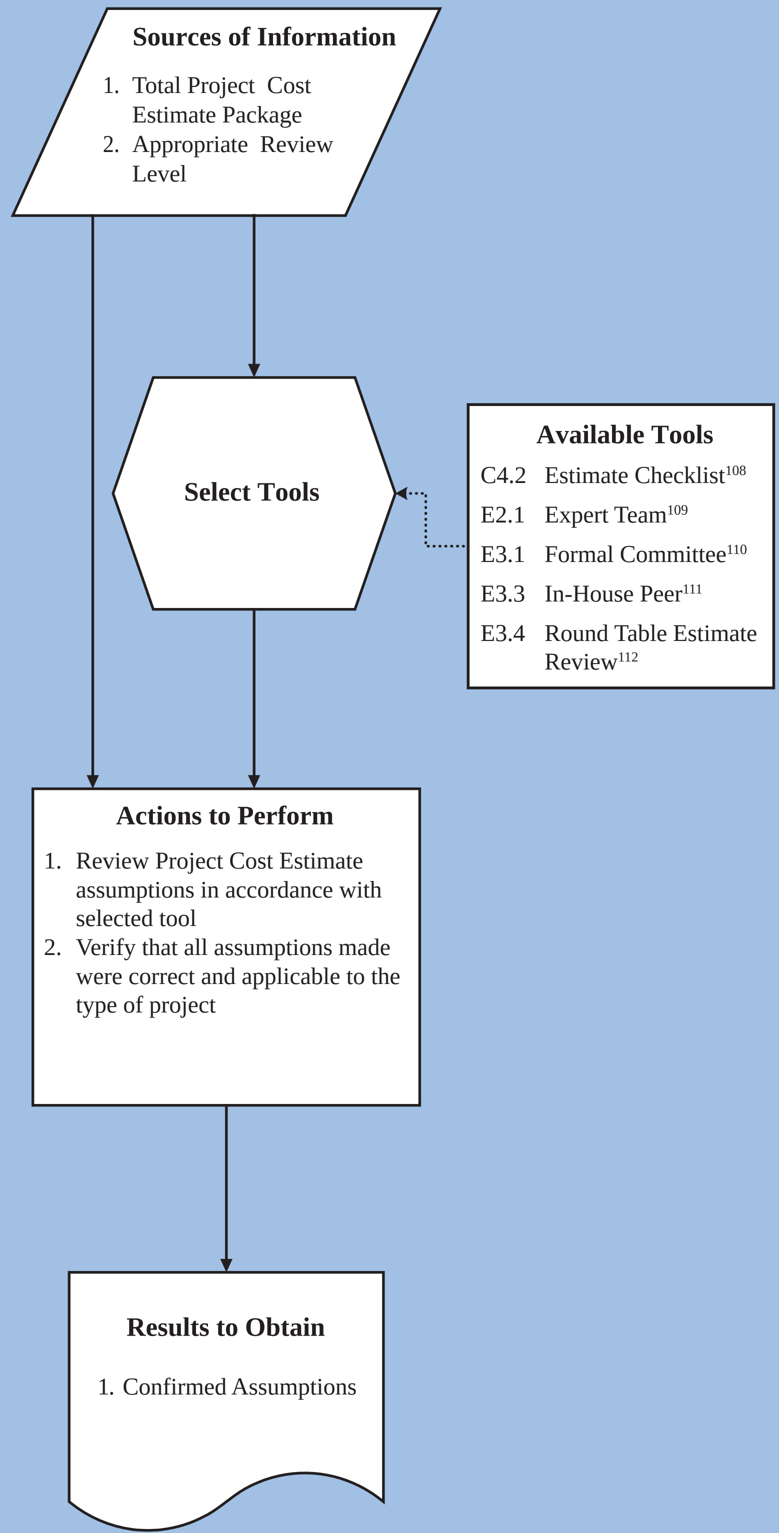
Review the list of available tools and their applicable levels of complexity.

Choose the most appropriate tool(s) (see Table III.3-2 on page 156).

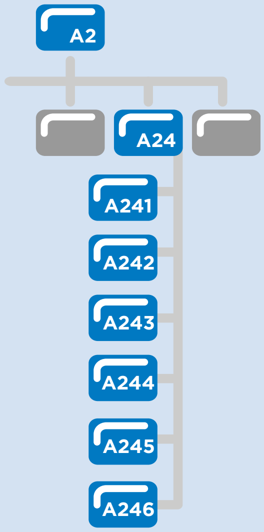
If an expert team is to be utilized in the review process, contact the Office of Project Scope and Cost Management for contacts.

Using the tool descriptions as a guide, review the Total Project Cost Estimate Package to verify the assumptions are correct and documented.

After reviewing the input information and applying the applicable tools, the Estimator has either confirmed or disaffirmed the assumptions in the Total Project Cost Estimate Package.



108. For C4.2 Estimate Checklist, see page 449.
109. For E2.1 Expert Team, see page 467.
110. For E3.1 Formal Committee, see page 451.
111. For E3.3 In-House Peer, see page 454.
112. For E3.4 Round Table Estimate Review, see page 456.



Verify Completeness and Cost Data (A243)

Step Requirements

This step requires a review of the Total Project Cost Estimate Package using the applicable tools to determine if the data in the package is complete and correct.

The Estimator or estimating team that prepared the estimate should conduct the first review of the project estimate. This is essentially a screening review that ensures the math is correct, the process is documented, and the estimate was developed following Mn/DOT guidelines. A second review that is more formal is included in this step and utilizes the tools presented.

Issues to Consider

Use of Historical Data

- When verifying the completeness of the data, consider any historical data that might be available and also review all calculations made to ensure their correctness.

Level of Review Effort

- The formality of a project estimate review and the depth of the review at each stage in project development will vary depending on the project type and complexity, so remember that while a project may warrant one type of review in this stage, that does not mean the same review should have been conducted earlier or in latter phases. A baseline estimate will require the most rigorous review. However, when planning a review, address the key question, “What decisions will be made from this estimate?”

Verify Completeness and Cost Data (A243)

The Total Project Cost Estimate should be used again for the verification of the completeness and cost data.

Select applicable tools based on the pre-determined project complexity.

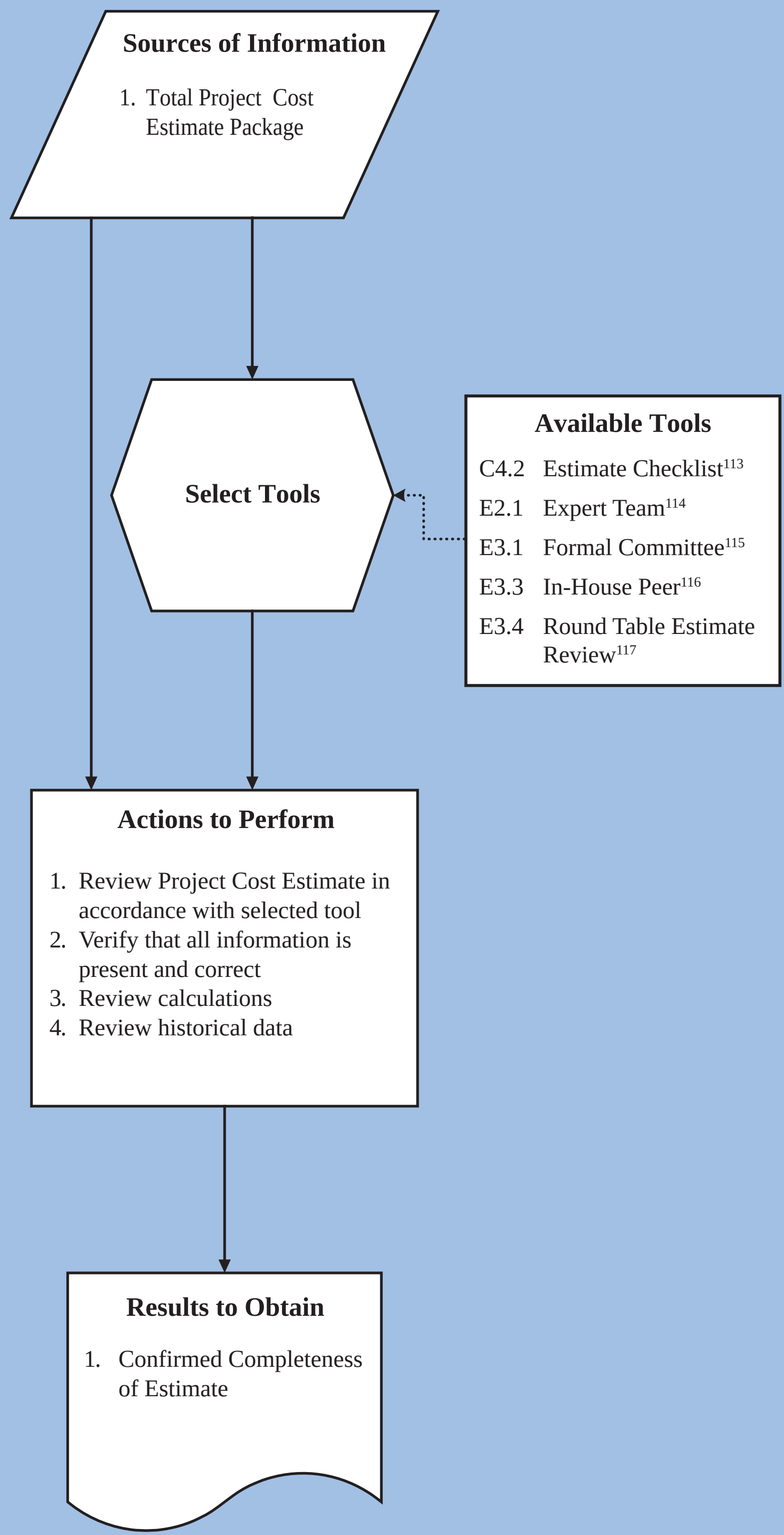
Use of any of the tools available provides a formalized process for review to encourage thoroughness.

The estimate checklist is the most informal of the tools. This tool can be utilized by itself or in combination with the other tools. When used with other tools, the estimate checklist can serve as a preliminary check for the Estimator.

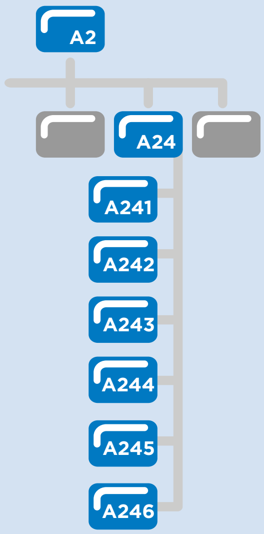
The most resource-intensive tool is the expert team, which should only be used for projects ranked in the highest complexity category.

Using the tools and the Total Project Cost Estimate Package, verify that the data is complete and that the cost estimates are correct. Consider using any historical data or a site visit to accomplish this.

The output of this step should result in a confirmation of the completeness of the data and a verified estimate.



113. For C4.2 Estimate Checklist, see page 449.
114. For E2.1 Expert Team, see page 467.
115. For E3.1 Formal Committee, see page 451.
116. For E3.3 In-House Peer, see page 454.
117. For E3.4 Round Table Estimate Review, see page 456.



Reconcile with Latest Estimate (A244)

Step Requirements

This step requires that the Estimator review not only the current estimate but also the previous estimate in order to attempt to reconcile the differences between the two. Verification may be obtained using available tools such as an estimate checklist. However, when considering an estimate checklist, remember that the checklist is intended to guide the Estimator through suggested items and consideration of factors that impact the project costs. The Estimator should also consider items that are not on the checklist.

Reconciliation forces the Estimator to look at key differences in cost and determine why these differences exist. This may be difficult as more is defined about the project and during the transition of estimating methods and tools. However, an honest effort must be made to determine the differences between previous estimates and the current estimate.

Issues to Consider

Estimator Judgment

- The most indispensable tool for estimate review is judgment. Judgment is what identifies mistakes, detects flawed assumptions, and identifies where the process has missed critical cost drivers.

Reconciliation

- Differences between estimates may be found almost any place; consider comparing the estimates in different ways.
- Review the documentation associated with the estimate; this may highlight differences.
- Costs that may have previously been included as uncertainty and risk may now appear as part of the base estimate.
- If a range estimate was utilized previously, does the current estimate fall reasonably within the range?

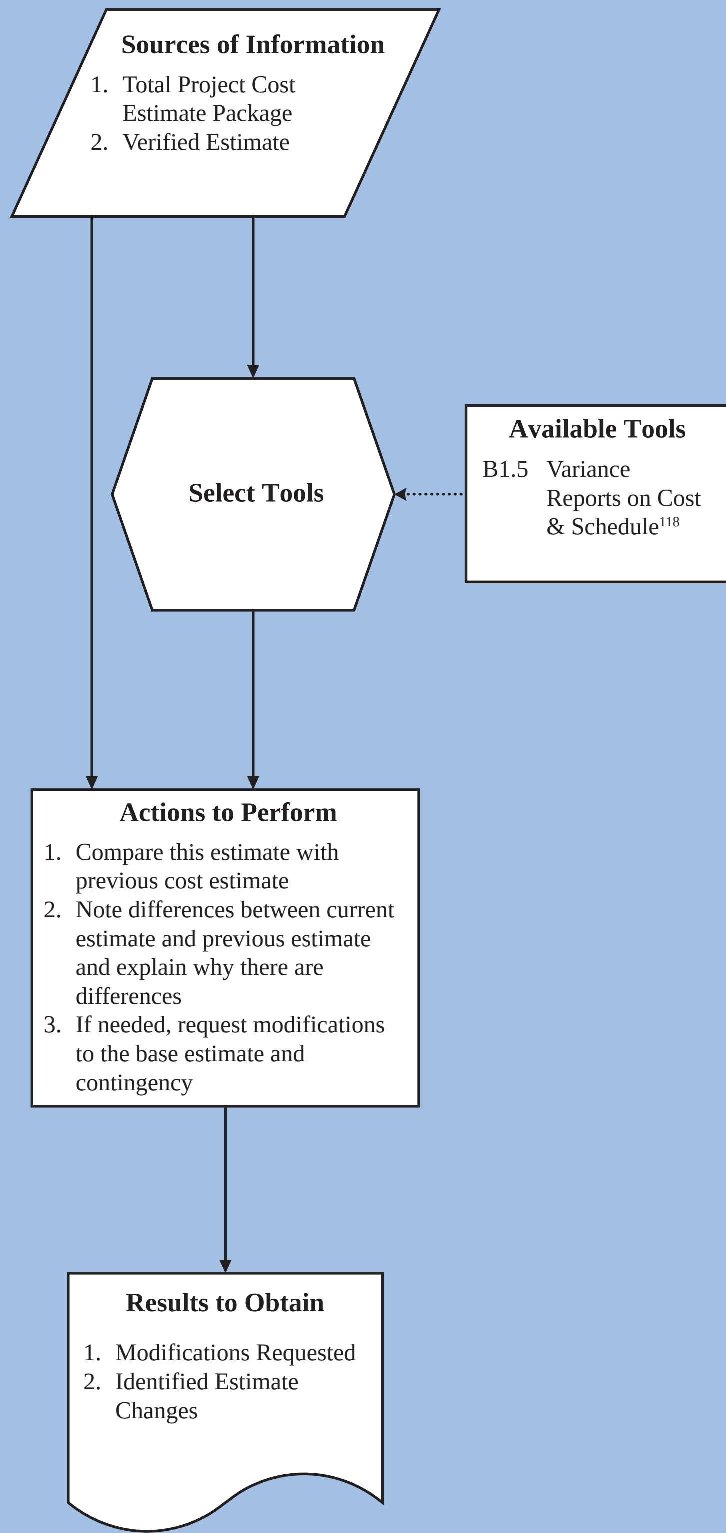
Reconcile with Latest Estimate (A244)

Review both the estimate package and newly obtained verified cost estimate.

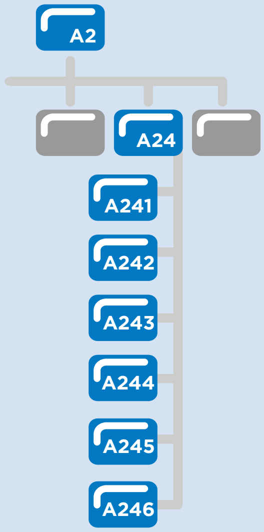
A variance report is used to reconcile the estimates. This report will help identify where there are differences between the estimates. The rationale behind the differences should be highlighted in the backup documentation.

Use the tools to compare the original estimate to the newly verified estimate in order to reconcile any differences between the two.

Neatly compile the reconciled information and changes made into a concise document. Be sure to note any changes and reasons for changes; documentation is important.



118. For B1.5 Variance Reports on Cost & Schedule, see page 477.



Prepare Estimate Package (A245)

Step Requirements

For this step the primary inputs include the Total Project Cost Estimate, the project assumptions, and the estimate changes. The Estimator should use this information to prepare a final estimate package that is ready for review.

Issues to Consider

When performing this step, use the estimate checklist to ensure that no important items are overlooked.

The output of this step may be similar to the One-Page Project Cost Estimate Summary; however, it will have a little more depth. That being said, it should still be a short document that provides management with enough detail to understand the project, yet provides a high-level picture. This will allow management to drill down in any area they see fit during the review and approval process. The contents of this output should include, but are not limited to, the following:

- summary of scope, including key scope items;
- major cost elements;
- risk items;
- cost;
- schedule; and
- amount of project development.

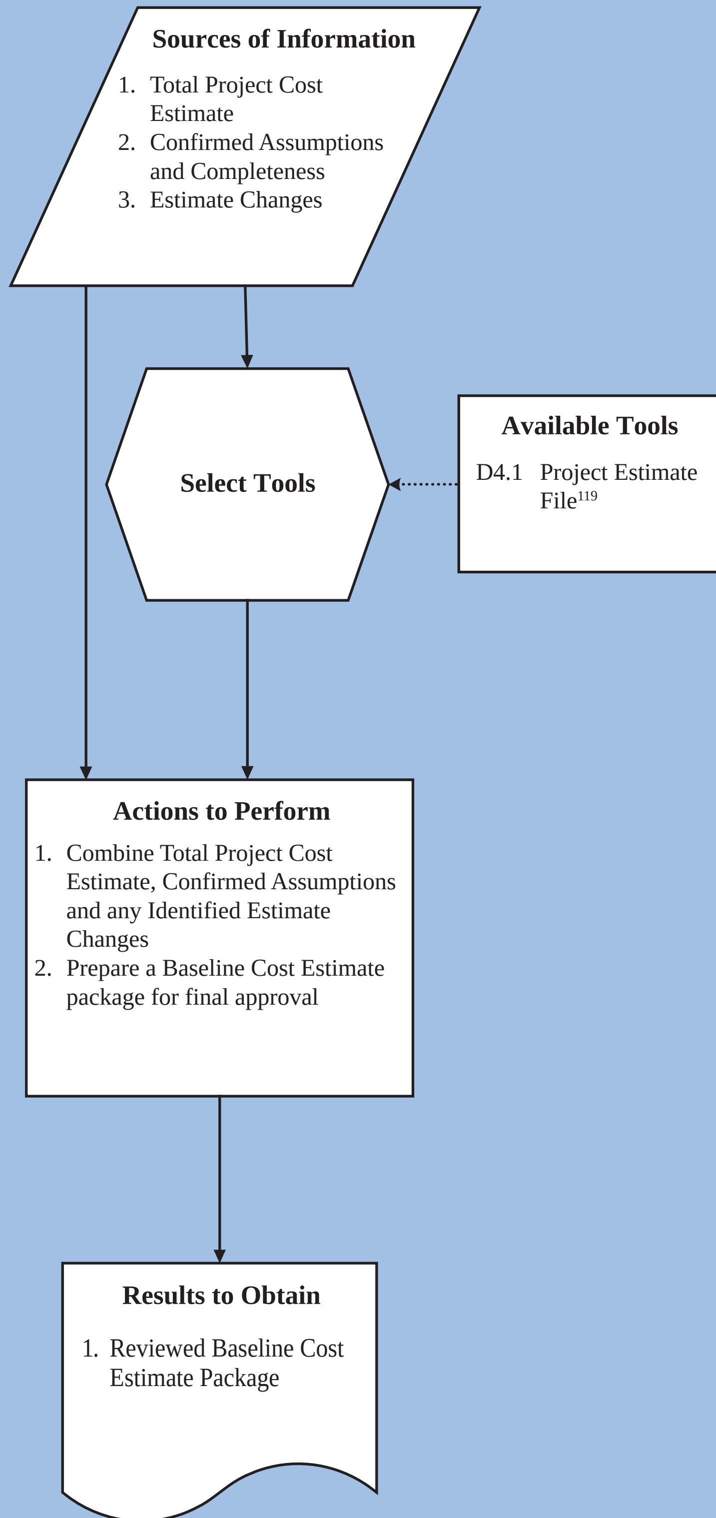
Prepare Estimate Package (A245)

Review the Total Project Cost Estimate along with the confirmed assumptions and reconciled changes made in the previous step.

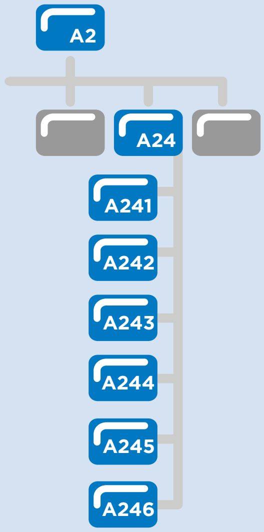
The format of the Project Estimate File should be followed to ensure that all information required is included.

Use the input information to prepare a final Baseline Cost Estimate Package that is easy to understand and ready for final approval.

Obtain a Reviewed Baseline Cost Estimate Package. This baseline is what the project will be measured against for the remainder of the project, unless the appropriate actions are taken to modify the baseline.



119. For D4.1 Project Estimate File, see page 339.



Approve Estimate Package (A246)

Step Requirements

This step entails inputting the final estimate package and giving it a final formal review and approval.

Issues to Consider

When presenting the estimate package for review, be sure to present the most important facts of the project in a clear and organized manner.

Policy Implications

- Cost estimates must be approved by District management before they are communicated to external audiences. Therefore, this step must include approval by a member of District management or someone with the authority to do so prior to conveying any of this information to external sources. On this note, be sure to follow the proper lines of communication, which include completion of the communication process (A25).

- Project costs will be managed against the established baseline cost estimate, which is established at the time the project is included in the STIP.

- While each project phase has an associated Total Project Cost Estimate, only the Total Project Cost Estimate at the time the Scoping Report is approved is designated as the baseline cost estimate.

One very important note—this approval is two-fold:

1. Approval that the estimate was completed using the appropriate procedure, tools, and knowledge.

2. Approval of the estimate amount.

Approve Estimate Package (A246)

Review the final baseline estimate package and begin to prepare a presentation of the project's most important details and facts.

When presenting the information, be sure to include the key assumptions made and the associated risks with the project. Address any questions clearly in order to obtain final approval of the Baseline Cost Estimate Package.

The output is the Approved Baseline Cost Estimate Package.

Sources of Information

1. Reviewed Baseline Estimate Package

Actions to Perform

1. Determine and organize information to present for approval
2. Present Total Project Cost Estimate – summary information
3. Present key assumptions regarding basis and risk and contingency
4. Address questions
5. Obtain management approval – Baseline Cost Estimate Package

Results to Obtain

1. Approved Baseline Cost Estimate Package

III.3.6 DETERMINE ESTIMATE COMMUNICATION APPROACH (A25)

A purpose of the Determine Estimate Communication Approach sub-process is to develop a communication package that succinctly conveys key project information to both internal and external project stakeholders. This sub-process has four steps. The steps are as follows:

1. Communicate Estimate Basis – A251
2. Communicate Estimated Costs – A252
3. Communicate Uncertainty and Assumptions – A253
4. Prepare Communication Package – A254

These four steps provide a natural progression of effort to prepare a communication package regarding project scope, cost, schedule, and uncertainty. The first three steps are likely performed at the same time. Once these three steps are complete, a package can be assembled for communicating project information. There is one key input required:

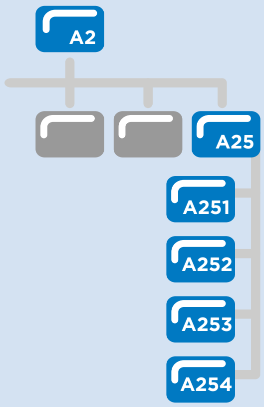
- **Approved Baseline Cost Estimate Package** – contains the approved base cost (summary and details) and contingency, all supporting documentation related to the estimate basis, assumptions, backup calculations, risks, and other areas of uncertainty.

Please remember to review the District RACI diagram for roles in this function. The Project Manager is responsible for development of the output of this sub-process with the support of the project Estimator.

The key input is then used when performing the four steps of this sub-process. The output of this sub-process is a Baseline Estimate Communication Package. This package will include all of the information required for appropriate development of the One-Page Project Cost Estimate Summary. If the estimate being completed is not for the baseline, a communication package must still be developed, and the estimate must still be communicated utilizing the Mn/DOT One-Page Project Cost Estimate Summary.

No matter the size or complexity of the project, all Mn/DOT projects will have a One-Page Project Cost Estimate Summary.

A purpose of the Determine Estimate Communication Approach sub-process is to develop a communication package that succinctly conveys key project information to both internal and external project stakeholders.



Communicate Estimate Basis (A251)

Step Requirements

The key input for this step is the Approved Baseline Cost Estimate Packages, which are the outputs of the Prepare Estimate Basis and Prepare Base Estimates sub-processes. These documents can be voluminous, but the Estimator must summarize them for clear estimate communication. The two packages should be reviewed thoroughly to extract the key information for a summary communication.

Estimate communication will occur internally with Functional Groups and with project team members who will inherit the estimate for later project development and cost control. Communication will also occur with external stakeholders who must understand in simple terms what is in the estimate and what is not. District Public Affairs Coordinators (PAC) and Communications can help Project Managers and Estimators by condensing and clarifying information for the summary.

The final output is a concise and specific breakdown of the project and its estimate basis. Be sure to note project type and complexity.

Issues to Consider

Importance of Estimate Communication

- Estimate communication is vital to successful cost management, and it is even more important when communicating a baseline estimate. The Estimator must communicate the estimate basis accurately to avoid the risk of scope creep later in project development.

Project Characteristics

- Extract only the key project characteristics that comprise the limits of the project and what the scope entails. If multiple alternatives were considered, be specific as to which project elements were included in the final baseline scope and estimate.

Functional Group Input

- Be certain to request clarification of Functional Group scope when the requirements are not clear.

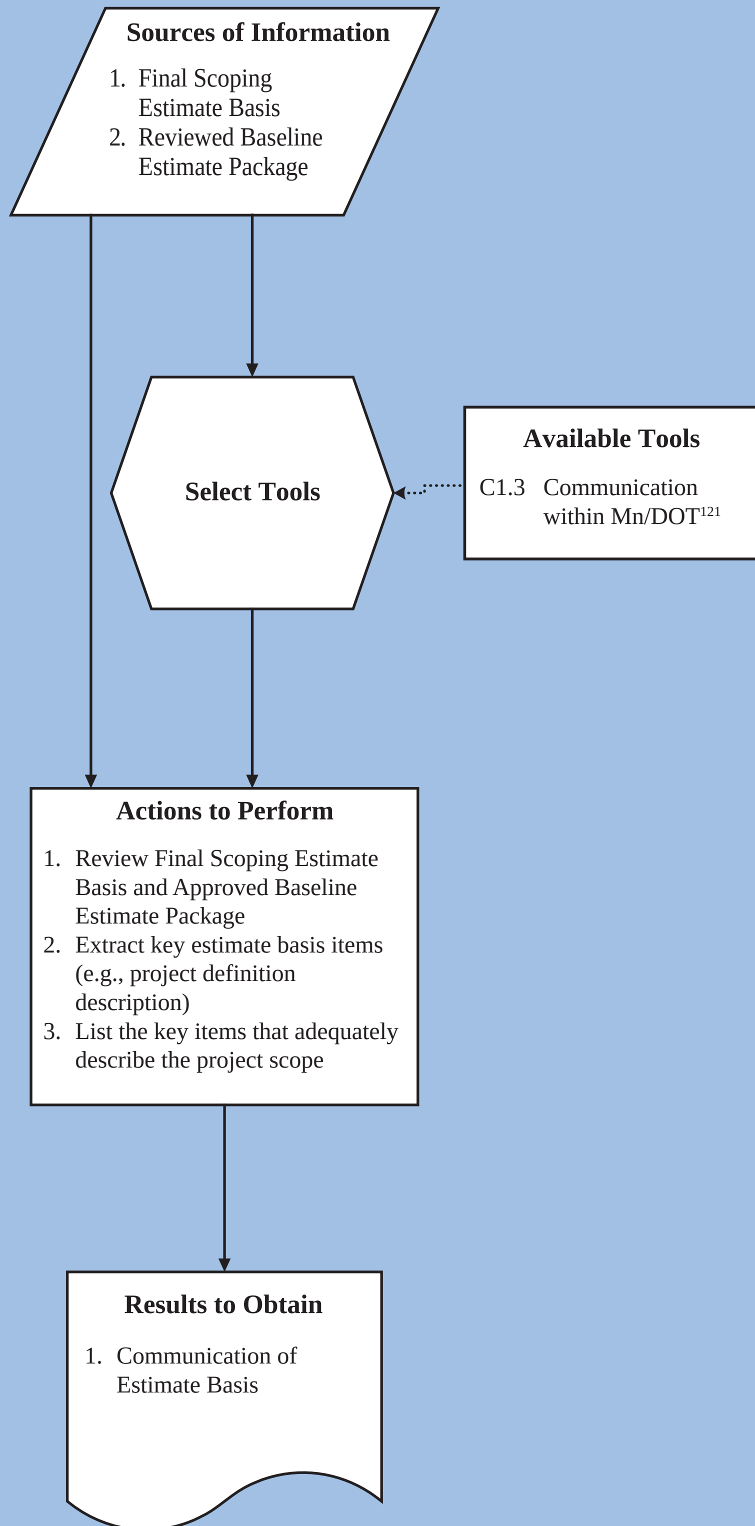
Communicate Estimate Basis (A251)

Project type and complexity should have been reviewed in previous steps. The Estimator needs only to summarize these elements in the communication of the base estimate.

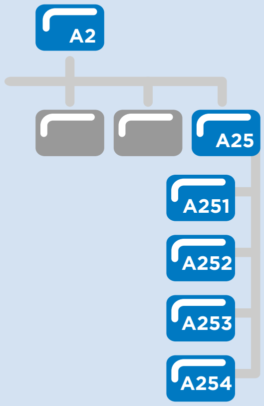
Projects should be communicated within Mn/DOT and within meetings involving the estimator staff and reviewers.

Define the details as concisely, yet completely, as possible. Use a bulleted list to identify and describe key parts of the project (5–6 bullets).

The Estimator should gather all the relevant information required to support the One-Page Project Cost Estimate to communicate the estimate basis.



121. For C1.3 Communication within Mn/DOT, see page 471.



Communicate Estimated Costs (A252)

Step Requirements

The key input for this step is the Approved Baseline Cost Estimate Package. This package will need to be communicated within Mn/DOT and other appropriate authorities. The package should be reviewed thoroughly to identify all assumptions made in creating the estimate package. The assumptions need to be listed and organized into an easily understood format.

The final output is a communication of an easy-to-understand, yet specific, baseline estimate that clearly lists all of the assumptions made about a project.

Issues to Consider

Project Characteristics

- This step is simply identifying the assumptions and key costs items from the estimate package. You do not have to review the tools in this case, just use them appropriately to guide in your preparation. The total project cost must reflect project costs including inflation to the midpoint of construction. This estimate basis needs to be clearly stated.

Functional Group Input

- Request clarification of Functional Group scope when the requirements are not clear.

Communicate Estimated Costs (A252)

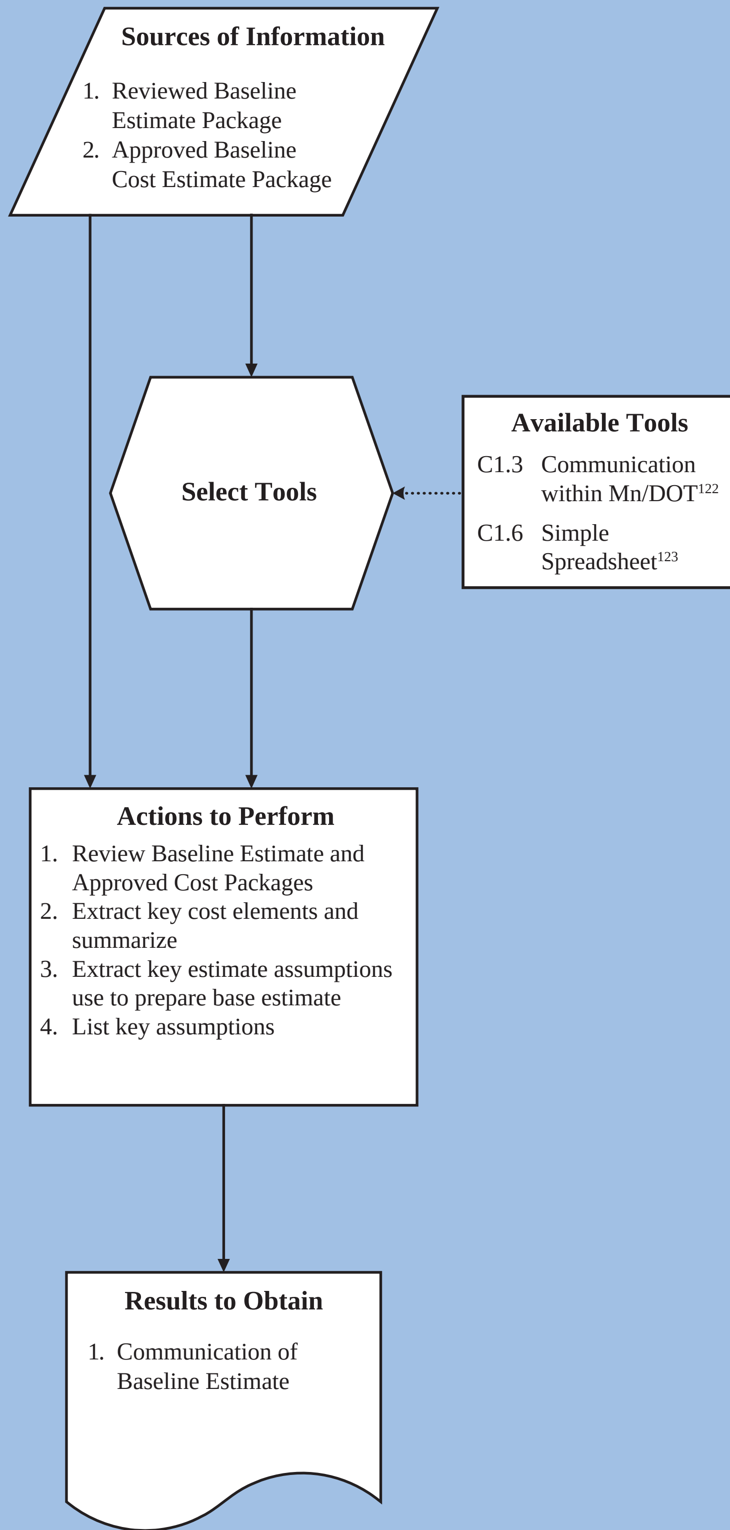
The Estimator does not need to consider the project type and complexity in this step because all projects should undergo this process.

Early in the Scoping Phase, the project cost may still be communicated as a range. If the budget being prepared is for the baseline, this estimate is a single point value.

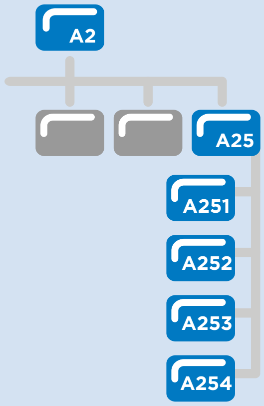
Consider the 80/20 rule that says that 20 percent of the items typically make up 80 percent of the cost of a project.

The Estimator should review both estimate packages and extract the key cost items along with any assumptions made when preparing them.

The Estimator should gather all the relevant information required to support the One-Page Project Cost Estimate to communicate the estimate basis.



122. For C1.3 Communication within Mn/DOT, see page 471.
123. For C1.6 Simple Spreadsheet, see page 475.



Communicate Uncertainty and Assumptions (A253)

Step Requirements

The key input for this step is the Approved Baseline Cost Estimate Package. More specifically, the Document Risk and Contingency Basis step (A235) from the Determine Risk and Set Contingency Estimate sub-process (A23) will provide the input.

Communication of uncertainty creates transparency in the estimating process. Communication of estimate uncertainty is best conveyed through a simple listing of the assumptions, allowances, unknowns, and contingencies included in an estimate. Rely on the list of risks and contingency estimate in the Document Risk and Contingency Basis for this information.

The final output is a clearly defined communication of project uncertainty concerning a project.

Issues to Consider

Project Characteristics

- This step is simply identifying the key areas of uncertainty from the estimate package. You do not have to review the tools in this case, just use them appropriately to guide communication. Key risks and areas of uncertainty should be identified as bullets. Other information related to the estimate basis and estimate assumptions should also be clearly stated.

Functional Group Input

- Request clarification of Scope from Functional Groups when the requirements are not clear.

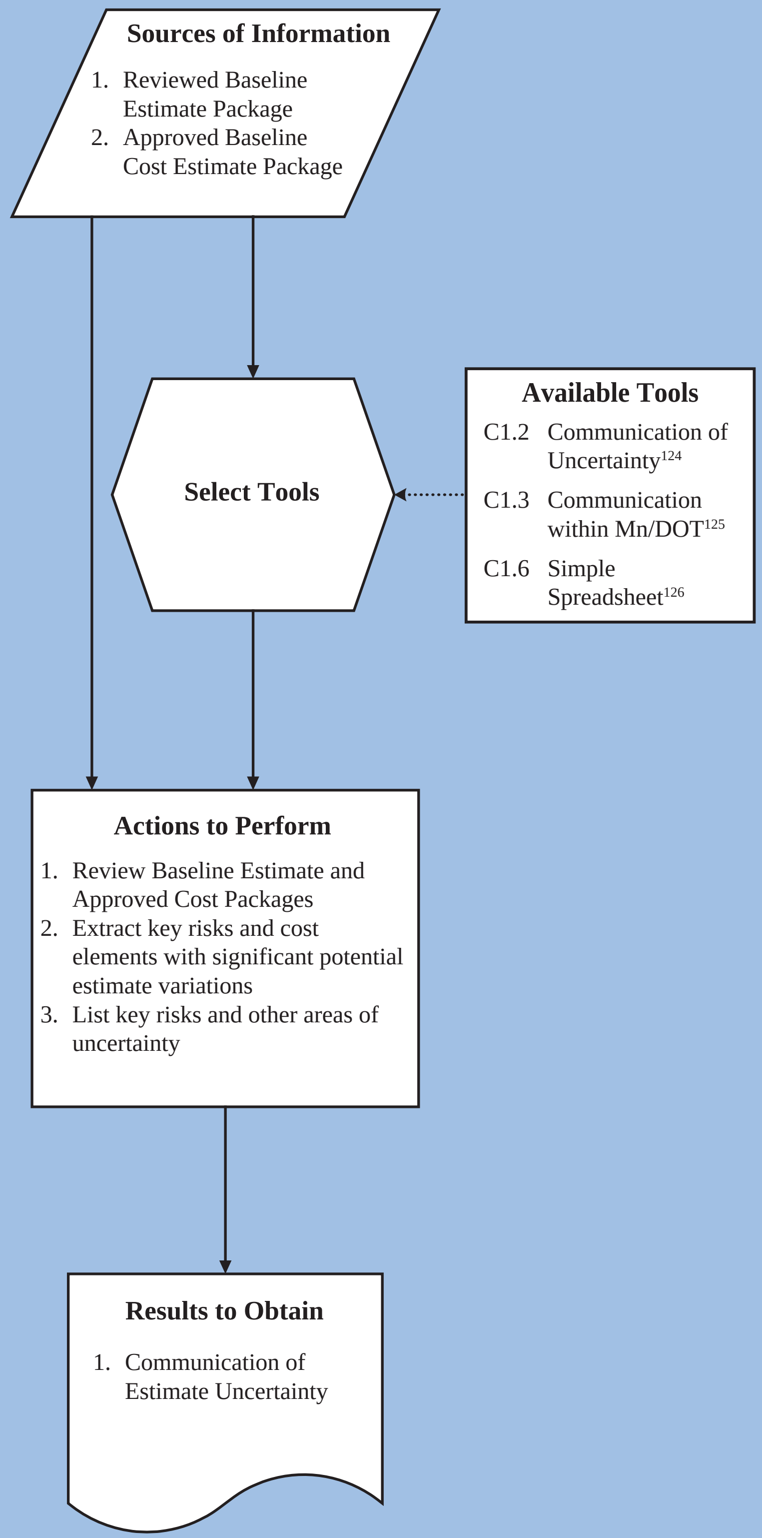
Communicate Uncertainty and Assumptions (A253)

Project uncertainty should be communicated within Mn/DOT and in meetings involving the estimator staff and reviewers. In addition, a simple list of project risks and the associated contingency should be prepared to clearly define all uncertainties.

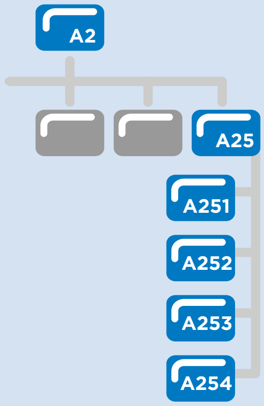
The Estimator should review both estimate packages and extract the key risks and items that offer significant variation in cost. Transparently convey the uncertainty of each estimate. An estimate with uncertainty is not a bad estimate; it is a realistic estimate. Conveying uncertainty will allow for better decisions to be made from the estimate information.

The Estimator should gather all the relevant information required to support the One-Page Project Cost Estimate to communicate the estimate basis.

Uncertainty and assumptions should be communicated as concisely, yet completely, as possible. Consider using a bulleted list.



124. For C1.2 Communication of Uncertainty, see page 469.
125. For C1.3 Communication within Mn/DOT, see page 471.
126. For C1.6 Simple Spreadsheet, see page 475.



Prepare Communication Package (A254)

Step Requirements

Informed partners, both internal and external to Mn/DOT, can become partners in the cost estimation and cost management process. Properly communicating the uncertainty involved in an estimate will help to ensure that appropriate decisions are made from the estimate.

The key inputs for this step are the Approved Baseline Cost Estimate Package and the communication of the estimate basis, baseline estimate, and estimate uncertainty. These inputs will not only need to be communicated within Mn/DOT and other appropriate authorities, but also to the general public. Therefore, the Estimator needs to prepare easy-to-understand spreadsheets and diagrams depicting the information about the projects and all the risks and assumptions.

Issues to Consider

Project Characteristics

- This step is the final compilation of multiple estimate documents and packages; therefore, all tools listed should be used when deemed appropriate.

Functional Group Input

- Request clarification of Functional Group scope when the requirements are not clear.

- District PAC and Communications are resources for preparing and communicating estimates.

Policy Implications

- Remember that all costs are to be expressed in terms of the Total Project Cost Estimate and the year of construction.

- Cost estimates for each phase will be documented and will include the following:
  - a description of what the project is and is not,
  - the assumptions used,
  - the extent to which various estimate inputs are developed,
  - the basis of estimate,
  - the base estimate, and
  - the separate contingency amount and a description of associated risks and inflation.

Prepare Communication Package Step (A254)

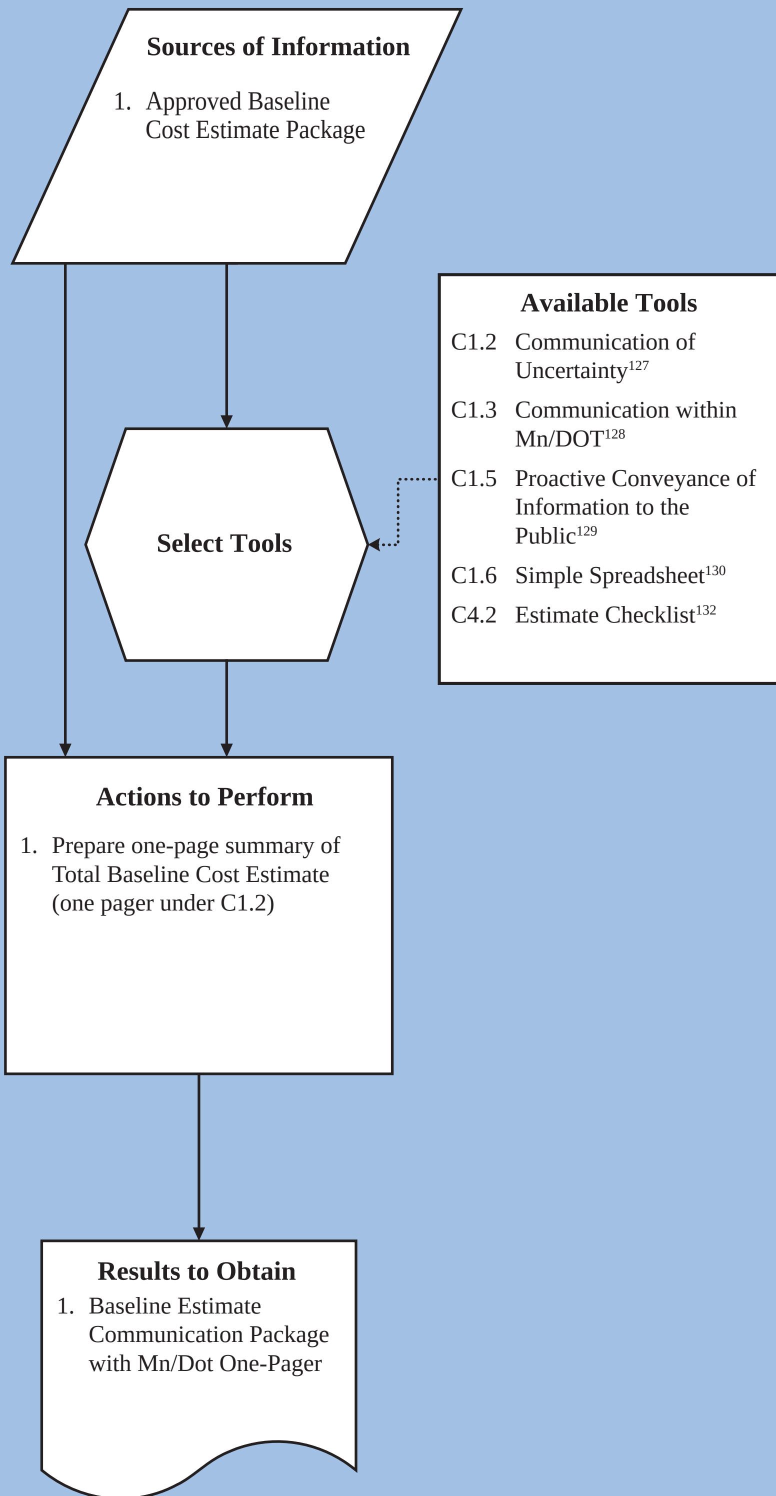
The Estimator does not need to consider the project type and complexity in this step because all projects should undergo this process.

The communication of the uncertainty should be communicated not only within the Mn/DOT, but also to the public. The compiled information needs to be simple and easy to understand.

The Estimator should prepare a One-Page Project Cost Estimate Summary that clearly defines all project characteristics and uncertainties, including the Total Baseline Cost Estimate.

Consistency is important; be sure to use the standard Mn/DOT format for the One-Page Project Cost Estimate Summary. If there is additional information that should be included but there is not a location for on the standard form, contact the Office of Project Scope and Cost Management.

The Estimator should compile all of the acquired information into an effective Baseline Estimate Communication Package including the Mn/DOT One-Page Project Cost Estimate Summary.



127. For C1.2 Communication of Uncertainty, see page 469.
128. For C1.3 Communication within Mn/DOT, see page 471.
129. For C1.5 Proactive Conveyance of Information to the Public, see page 473.
130. For C1.6 Simple Spreadsheet, see page 475.
132. For C4.2 Estimate Checklist, see page 449.

III.4 DESIGN COST ESTIMATING AND COST MANAGEMENT

III.4.1 OVERVIEW

III.4.1.1 The Highway Project Development Process

The Mn/DOT Project Planning – Scoping – Programming cycle begins with the Project Planning Phase in which transportation system performance needs are identified and prioritized. The most critical needs are carried forward into the Scoping Phase. During this period, the full range of functional and stakeholder groups are queried to identify potential work to be completed during the project. Decisions are made as to what will be included and what will not be part of the project definition. These decisions are documented so that they can be conveyed to those who will work on the project. A cost estimate is also developed based on the project definition. The defined projects are then reviewed during the Programming Phase and either included in the STIP or HIP (10-Year Plan) or held for reconsideration the following year.

Design initiates project plan development and begins once the project is incorporated into the STIP. A baseline cost estimate has been established at this point for purposes of cost management. Going forward, there are two phases remaining in project development, the Design Phase and the Letting Phase. The Design Phase is focused on preparing project plans and specifications to 100 percent completion to support preparation of the final PS&E documents for project letting.

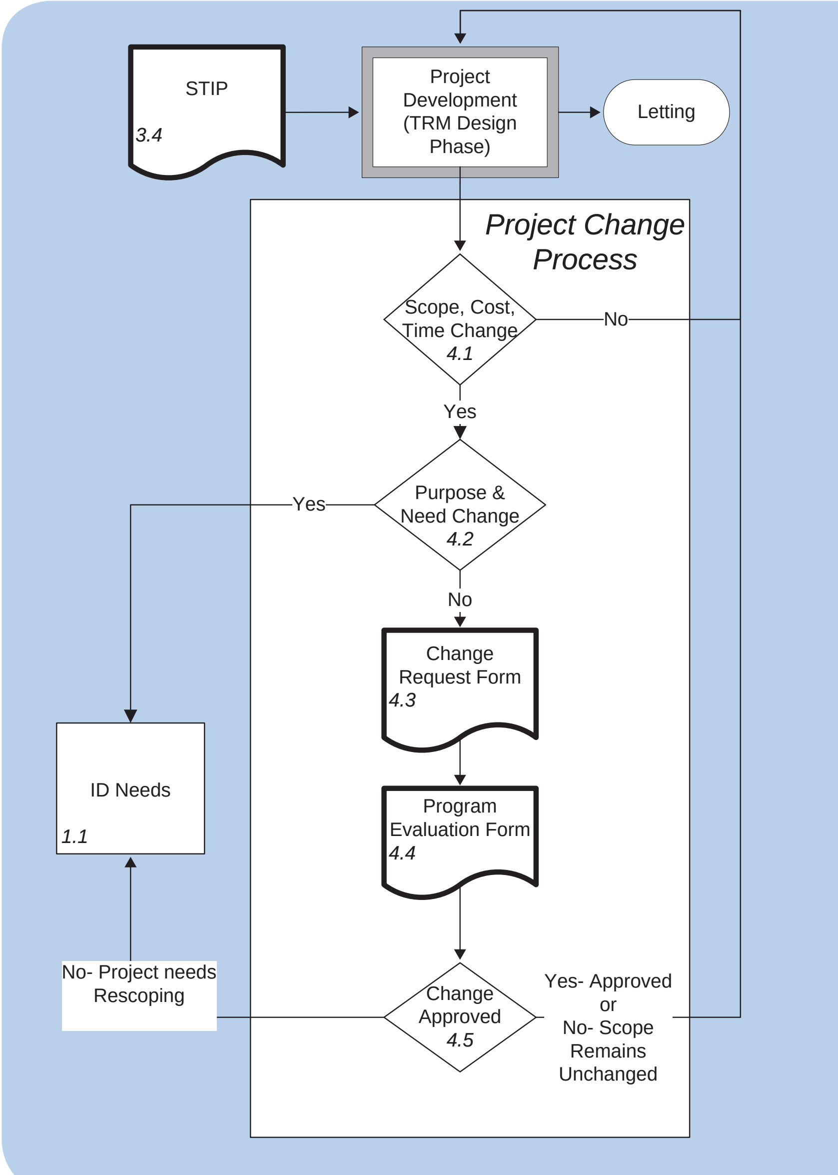


Figure III.4-1. Project Design and Project Change Process

III.4.1.2 Project Development – Design Phase

After the approval of the Scoping Report, projects are analyzed on the basis of performance trends and, depending on the availability of the funds, are selected for inclusion in the STIP by the Area Transportation Partnership (ATP). Projects that are not included in the STIP are considered the next year. Once a project is included in the STIP, the Design Phase commences, as shown in Figure III.4-1. Plan development focuses on detailed design and, if applicable, right-of-way plan development for property acquisition. The designer makes use of Scoping Report information and data to prepare detailed right-of-way and construction plans and mitigation features. Right of way is purchased later in the Design Phase. Most necessary outside agency permits are typically obtained during Design. The Design

Phase sometimes overlaps with the Scoping Phase on small projects and/or in other special cases. In summary, activities that occur during the Design Phase include right-of-way development and acquisition; final pavement and bridge design; and final traffic control plans, utility drawings, hydraulics/drainage design, and updated cost estimates.

During the Design Phase, a primary focus is cost management. Cost management is supported by the Project Change Process as shown in Figure III.4-1. Cost management is concerned with the impact of changes due to additions or deletions to the project baseline definition or changes resulting from design development or site conditions. Change is likely to occur as the project is fully defined through the design effort. Changes may be identified throughout the Design process. A change is related to scope, cost, time, or a combination of the three. Their potential cost impact is determined either through project estimate updates or through an assessment of the impact of an individual change that is significant in terms of its potential dollar magnitude. Once a potential change is identified and the reasons behind the change are documented, a determination is made as to whether or not a Project Change Request is required (see Figure III.4-1). Change Requests proceed through an approval decision. Approval may lead to an addition to the project definition and cost or just cost (if not project-definition related) or time. Time may also be impacted. If a Change Request is not approved, alternative actions are followed, such as, adjusting the design to reduce a project's definition or even removing the project from the STIP if the purpose and need has changed.

III.4.1.3 Design Cost Estimation and Cost Estimate Management Process

Cost estimating and cost estimate management are very important processes required to maintain the project definition and budget for the project. Cost estimating and cost management in the Design Phase are divided in two parts, as shown in Figure III.4-2. One part is updating the project cost estimate, and the other part is assessing potential changes as a result of deviations in the baseline project definition and budget. Updating cost estimates follows sub-processes similar to those in the Scoping phase (see Figure III.4-2). The estimate is updated based on an increased level of detailed design information. Risk and contingencies are updated to derive an updated Total Project Cost Estimate. The updated estimate is compared with the Scoping Phase Total Project Cost Estimate to determine if there are differences between the current estimated cost and the Total Project Cost Estimate baseline. If there are differences, the Project Change process maybe initiated, as shown in Figure III.4-1. An approved change may result in an adjustment to the STIP budget for the project. The updated estimated total cost is then communicated to internal and external stakeholders.

The second part of the cost estimating and cost management process is solely focused on cost management (right side of Figure III.4-2). As the design is detailed, it is continuously reviewed for significant differences from the baseline project definition and cost estimate. Further, site conditions are also reviewed periodically to ensure that new site information is reflected in the design. The

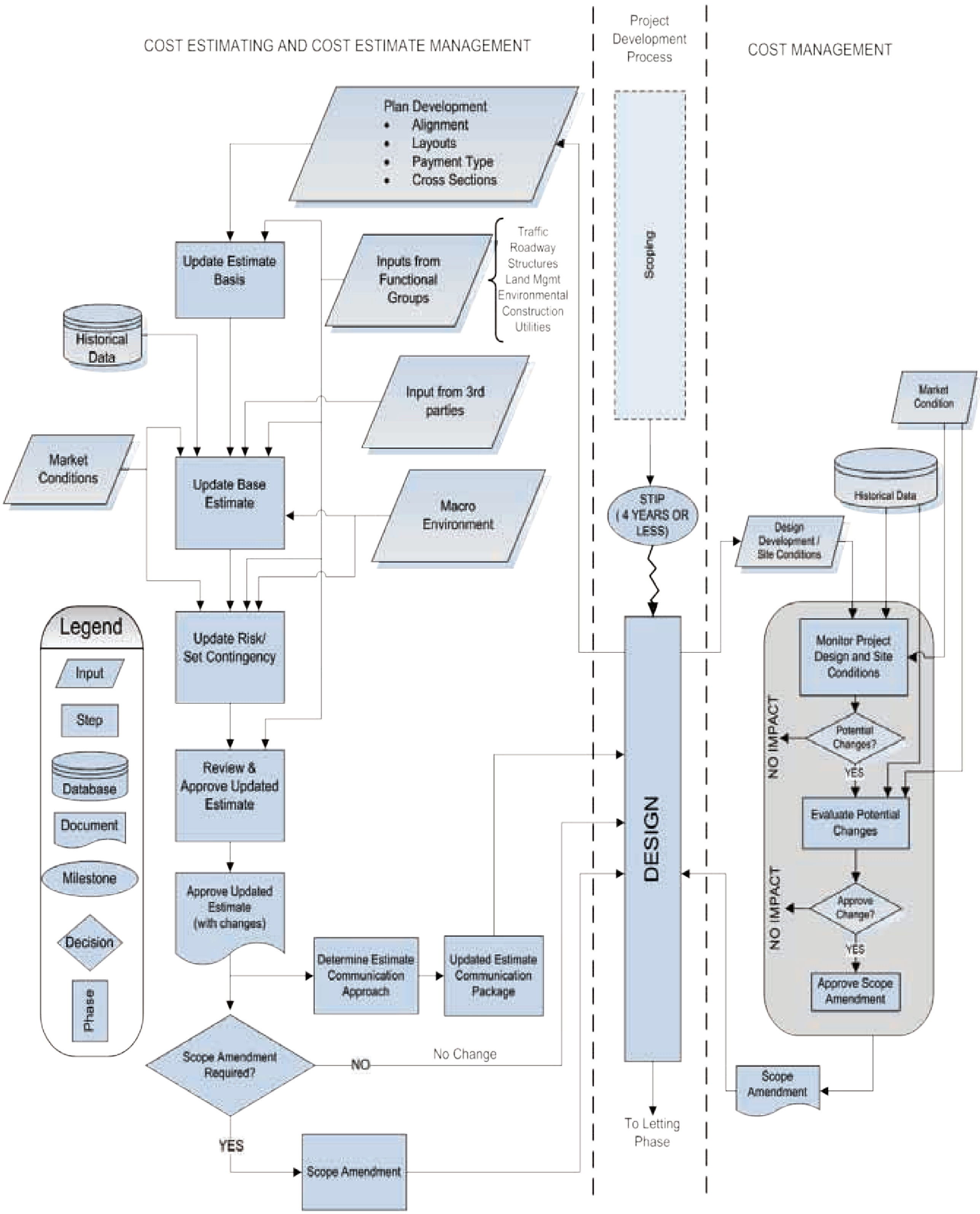


Figure III.4-2. Cost Estimating and Cost Estimate Management Flowchart for Design impact of any significant potential change on project cost and time are studied. If the change warrants a change request, then a Project Change Request Form is prepared for District management approval. If a change request is not warranted, the project design continues as planned.

As explained above, Cost Estimating and Cost Management during Design is comprised of two sub-processes, namely Update Cost Estimate for Cost Management and Assess Potential Changes for Cost Management, as depicted in Figure III.4-3. This division reflects two different approaches to cost management, one through estimate updates and the other through the identification and analysis of individual potential changes.

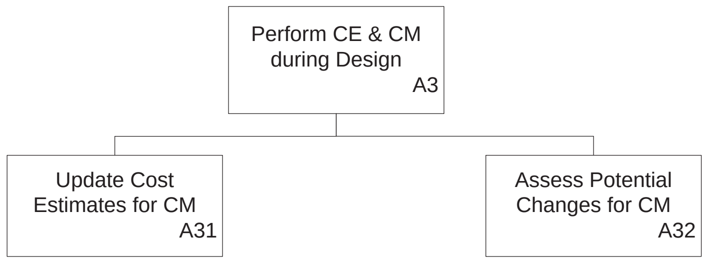


Figure III.4-3. Processes for Updating Cost Estimates and Managing Changes During Design

These two processes are further decomposed into sub-processes and their corresponding steps, as shown in Figure III.4-4 and III.4-5. The estimate basis is first updated prior to updating the base estimate and risk and contingences.

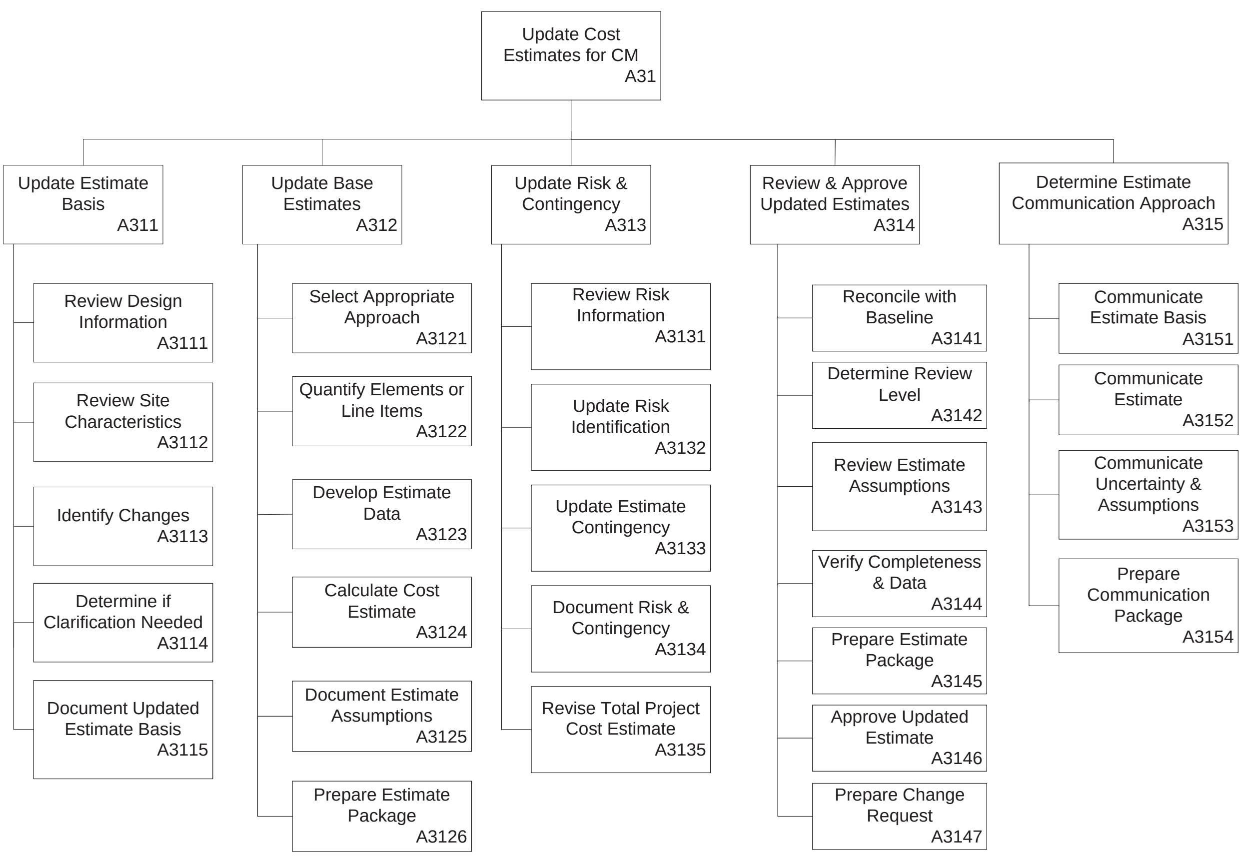


Figure III.4-4. Sub-Processes and Steps for Updating Cost Estimates During Design

Care is taken to document any changes in project requirements or site conditions that may result in an increase in cost or perhaps a decrease in cost. Updated Total Project Cost Estimates are reviewed. A key step is reconciling changes in estimated costs as a result of updates against the Scoping Total Project Cost Estimate. If the cost change is significant, then a change request may be processed for District management approval (see step A3147 in Figure III.4-4). The updated cost estimate is communicated to internal and external stakeholders after the completion of the review and approval sub-process.

Assess Potential Changes for Cost Management, in Figure III.4-5, is performed when there is a significant potential change identified. This change may be due to design development, change in market conditions, or some newly added

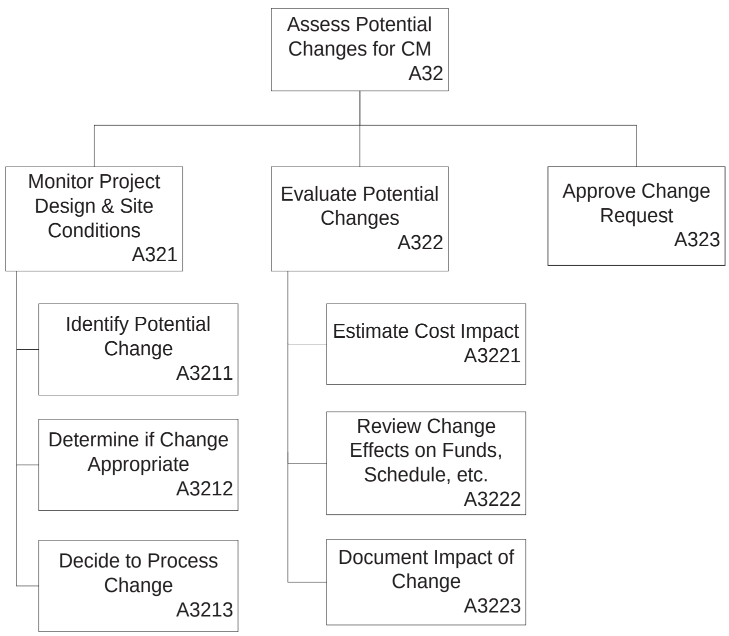


Figure III.4-5. Sub-Processes and Steps for Assessing Potential Changes During Design

work not previously in the project Scoping Report. Assessing potential changes is further comprised of three sub-processes, that is, Monitor Project Design and Site Conditions, Evaluate Potential Changes, and Approve Change Request. In these sub-processes potential significant changes in project requirements and site conditions are closely monitored. The cost impact of a potential change is evaluated, and if estimates indicate a large increase (or decrease) cost, then a Project Change Request Form is processed and maybe approved by project management. An action is required of District management as to whether or not the change request should go forward.

III.4.1.4 Overview of Roles and Responsibilities

There are two distinct processes for cost management during the Design Phase of project development. A RACI Chart is developed for each. Updating of the cost estimate, Table III.4-1, is primarily the responsibility of the Estimator and Project Manager during the Design Phase. Similar to the previous phases, the Functional Groups are consulted throughout the process as appropriate. Functional Groups clarify project definition, provide updated estimates for

Table III.4-1. RACI for Preparing CE/CM for Design (A3)–Update Cost Estimates (A31)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Update Estimate Basis (A311)			I	C		R	A	C					C			
Update Base Estimate (A312)				C		R	A	C								
Update Risk and Contingency (A313)			I	C		R	A	C								
Review & Approve Estimates (A314)		I	A	C		R	R	C						I		
Determine Estimate Communication Approach (A315)	I	I	A	C		C	R	C		I	I	I	I			

LEGEND:

R = Responsible (the doer)
A = Accountable (owner)
C = Consulted (in the loop by providing inputs)
I = Informed (in the picture)

their specialty area, provide input on risks and contingency, and participate in reviews.

The RACI Chart for assessing the potential impact of an individual change, Table III.4-2, is also developed. The accountability for monitoring the project for potential changes falls with the Project Manager. The responsibility for evaluating the change is with the Estimator in the District and Project Manager. Again, the Functional Groups are consulted as appropriate. The final approval of the change, by way of the change request, is at the District management level.

The steps of each of these processes can be tailored to each District by using the RACI tool. A RACI matrix should be completed by key personnel at the District level. Each District may consider using this tool for a majority of their projects and may reevaluate it regularly, as well as consider development of one for special projects.

III.4.1.5 Key Approach Assumptions

The cost estimating and cost management process for Design focuses on managing total project costs against the baseline cost estimate that is approved as part of the Scoping Report (see Scoping Section III.3). As described in Figures III.4-3 to III.4-5, there are two approaches to cost management. One approach

Table III.4.1-2. RACI for Preparing CE/CM for Design (A3)–Assess Potential Changes for CM (A32)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Monitor Project Design and Site Conditions (A321)				C		C	A	R							C	
Evaluate Potential Changes (A322)				C		R	A	C								
Approve Project Change Request (A323)		A	C	C		C	R	C					I	I		

LEGEND:

R = Responsible (the doer)
A = Accountable (owner)
C = Consulted (in the loop by providing inputs)
I = Informed (in the picture)

is a periodic update of the baseline cost estimate. This updated cost estimate serves as the basis for identifying changes in cost from the baseline that may require a project change request. The alternative approach requires assessment of single or multiple individual changes that have a significant project definition and cost impact in relation to the baseline cost estimate. These changes are often identified between periodic cost estimate updates.

Both approaches are described in the sections that follow. When updating a cost estimate, the details of the estimate may be revised in their entirety, or only certain estimate elements may be revised. The sub-processes discussed under the Update Estimate sub-process reflect a project that is four years out from the Letting date. The cost estimate is then updated annually or more often as required. The same sub-processes and their steps are followed with each update. The main differences occur in an increasing level of Design detail. As the project Design nears the Letting Phase, the last updated cost estimate reflects all items that describe the project. This estimate is the District Engineer's Estimate.

Total project cost includes a number of different cost components defined in Section II.3.2.3 (see page 23). The focus of the cost estimating and cost management procedures covered in this section is mainly related to updating construction costs. Other cost categories of the Total Project Cost Estimate, such as right of way, may require estimate updates from some Functional Groups. When updating cost estimates in some categories of total project cost, the updated estimate is likely a combination of actual expenditures and cost to complete the remaining work. This would be the case for pre-letting engineering and right of way once the actual appraisal and acquisition process commences during Design and prior to Letting. The sub-processes presented in this chapter generally apply to updating any cost estimate and cost management effort, although specific steps may have to be modified to suit a particular Functional Group application.

III.4.2 COST MANAGEMENT THROUGH COST ESTIMATE UPDATES

The primary objective of this sub-process is to collect and document all information required to update the Total Project Cost Estimate (baseline cost estimate) during the Design Phase.

As shown in Figure III.4-4, there are five sub-processes and a number of steps required for each of the five sub-processes. The key point that the Project Manager and Estimator must focus on is the identification of changes as estimates are updated. A key step is reconciling an updated cost estimate with the baseline cost estimate (A3141). The intent is to identify changes in cost, either due to project definition additions/deletions or due to design development and site conditions, and document the source of the change and the magnitude of the resulting cost impact. The cost reconciliation step is performed prior to any reviews of an updated estimate. This effort may ultimately lead to a change request (A3147). The sub-process in Figure III.4-4 is repeated periodically as the project moves closer to Letting. The cost-estimate approach will ultimately be historical bid based for all items describing the construction of the project. Preletting engineering costs and right-of-way costs will reflect actual expenditures as the Letting Phase nears. Contingency levels will likely be reduced due to using contingency in the base estimate as risks are realized, or the contingency value itself will reduce if risks are not realized.

III.4.2.1 UPDATE ESTIMATE BASIS (A311)

The primary objective of this sub-process is to collect and document all information required to update the Total Project Cost Estimate (baseline cost estimate) during the Design Phase. This sub-process is performed each time a cost estimate is updated. A particular focus of this sub-process is to document specific changes in the project requirements or site conditions that may impact cost. This sub-process has five main steps. The steps are as follows:

1. Review Design Information – A3111
2. Review Site Characteristics – A3112
3. Identify Changes – A3113
4. Determine if Clarification Needed – A3114
5. Document Updated Estimate Basis (include changes if updating an earlier estimate) – A3115

These five steps provide a natural progression of effort to update the estimate basis for a project Design estimate. These steps are often performed concurrently and repeated as estimate updates are prepared. These five steps require several key external inputs that are necessary for the Estimator to update the cost estimate. Some of these key inputs include the following:

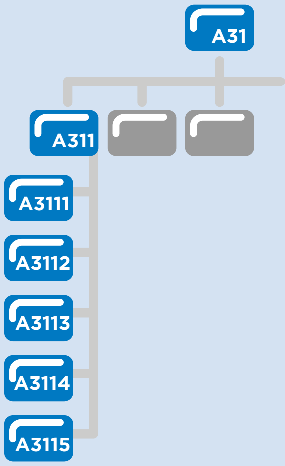
- **Approved Baseline Cost Estimate Package** – includes cost estimate summaries, cost estimate details, estimate project definition basis, estimate assumptions, estimate calculations, and other related information from the Scoping Baseline Total Project Cost Estimate.

- **Design Development** – includes information and data on alignment, layouts, pavement type, cross sections, and so on. This information expands into final project plans and specifications as the design is completed.

- **Project Characteristics** – description of the type of project and complexity of the project, including site-specific information and/or data that is relevant to preparing the cost estimate.

- **Functional Group Input** – clarifications from Functional Groups regarding definition and requirements for their area of the project, especially where changes in project requirements have occurred.

These key inputs are then used when performing the five steps of this process. The output of this sub-process is an Updated Project Cost Estimate File. The file contains all pertinent design information, documents, and data used to update an estimate, including any drawings and other information provided by the Functional Groups.



Review Design Information (A3111)

Step Description

This is a critical step in the sub-process Update Estimate Basis (A311). To update the baseline cost estimate during the Design Phase, it becomes important to study the outputs of the Design process as design development occurs. This review of current design information helps the Estimator identify areas where changes or modifications to the baseline cost estimate may be necessary.

The major inputs to this step are design development details, the Approved Baseline Cost Estimate Package, and Functional Group inputs. Design development begins with increasing information concerning project alignment, plan layouts, pavement type selection, cross sections, railroads, utilities, and right-of-way definition. As Design progresses, preliminary plans are prepared, and eventually final plans and specifications are completed. The Approved Baseline Cost Estimate Package forms the basis for identifying areas in the current estimate where updates will be required due to the increased level of design information.

The inputs are studied and reviewed by the Estimator. Inputs are provided by each Functional Group involved in the project. The Estimator must also completely understand the Approved Baseline Cost Estimate Package and, in particular, the project definition basis for all project requirements covered in the baseline cost estimate.

Issues to Consider

Program Support

- The Design process typically starts in the fourth year of the STIP from the Letting year. Periodic updates of the baseline cost estimate are made each year or more often, depending on district management needs. These updates form the basis for modifications to the baseline cost estimate. The level of detail in the cost estimate updates increases as the Design approaches completion of plans and specifications.

Estimator

- The Estimator continues to review the design data and details as the design progresses and the estimate is periodically updated.

Inputs from Functional Groups

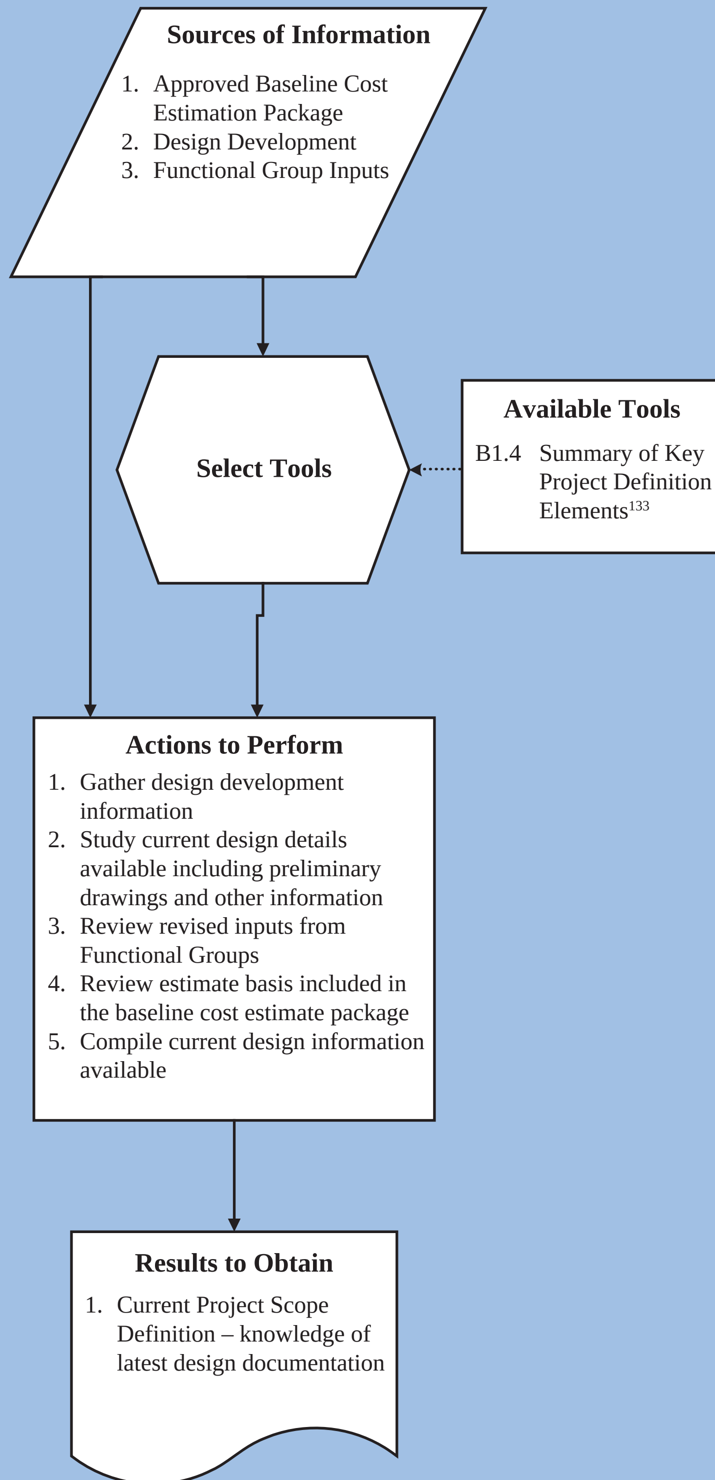
- With the increased project definition that occurs during the Design Phase, the involvement of Functional Groups will also increase; hence, timely inputs from each Functional Group will make the review process easy for the Estimators.

Review Design Information (A3111)

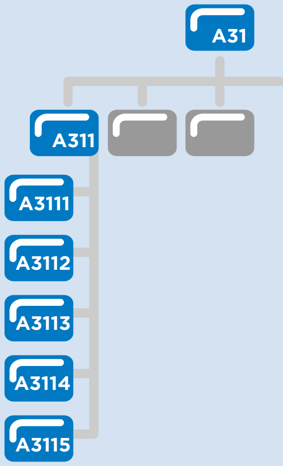
The Estimator is the major focal point for gathering and reviewing current design information. Successful estimate updates require timely input from Functional Groups. The Baseline Cost Estimate Package, which contains the estimate basis prepared during the Scoping Phase, is carefully reviewed.

This is a major and important step for updating the estimate basis. Hence, careful study of the current design documents ensures that the Estimator clearly understands current project definitions. The Summary of Key Project Definition Elements prepared during the Scoping Phase should guide the review, as these items are typically the major cost drivers of the project.

The result of this step is description of the project's current definition given the level of design completion. This current definition provides the Estimator with insights into possible areas where the project requirements have changed in relation to the baseline cost estimate project definition.



133. For B1.4 Summary of Key Project Definition Elements, see page 363.



Review Site Characteristics (A3112)

Step Requirements

Understanding the project site characteristics is a critical step for the Estimator. The attributes of a project site can significantly impact right of way, utility, environmental, and construction costs. The project characteristics are one input that provides some understanding of the site. Notes included in the Approved Baseline Cost Estimate Package are another source of information to aid the Estimator in understanding the project site characteristics and how the current definition of the project relates to these characteristics. However, relying only on project documents can lead to false assumptions about the project site characteristics and their impact on cost.

The site characteristics are thoroughly reviewed during the Scoping Phase; however, to ensure clarity and thoroughness, the Estimator should carefully review previously developed site information. If the Estimator is new to the project and has not worked on the project before, the Estimator should walk the project site. A site visit provides additional insight and a feel for the project that cannot be obtained through photos or videos. The Estimator who prepared the baseline cost estimate should consider walking the site again, especially if the project is complex. Estimators understandably cannot make a site visit for every project due to their current workload or other time restrictions; however, the Estimator should fully weigh the benefits and drawbacks before making the decision not to visit the site. At a minimum, the Estimator should review video logs or aerial photos. These approaches aid the Estimator in visualizing the project. The Estimator should make notes regarding potential changes or modifications to previously identified impacts related to site characteristics on the project cost elements or items.

Issues to Consider

Project Characteristics

- Always visit the site for major or complex projects and likely more than once, as cost estimates are prepared. It is also helpful to visit the site even if the project is moderately complex or non-complex. If time does not permit a site visit, then video logs and/or aerial photos are helpful in developing such information. Repeating this effort is not considered wasted effort. Specifically during Design, a site visit can be useful to identify any issues not identified during Scoping, such as structures to be removed, utilities to be relocated, haul route issues to be dealt with, or even railroad interference to be addressed.

Functional Group Input

- Visit the site with Functional Group staff to obtain their perspective on site characteristics and their potential impact on the project. They can clarify project definition issues as these issues relate to the site, especially as design details improve the description of the project.

- Construction staff can help evaluate the potential impact of staging, material storage, hauling of materials, location of batch plants, and other constructability related issues. Their input becomes more relevant as preliminary drawings are prepared relative to traffic control strategies and construction staging.

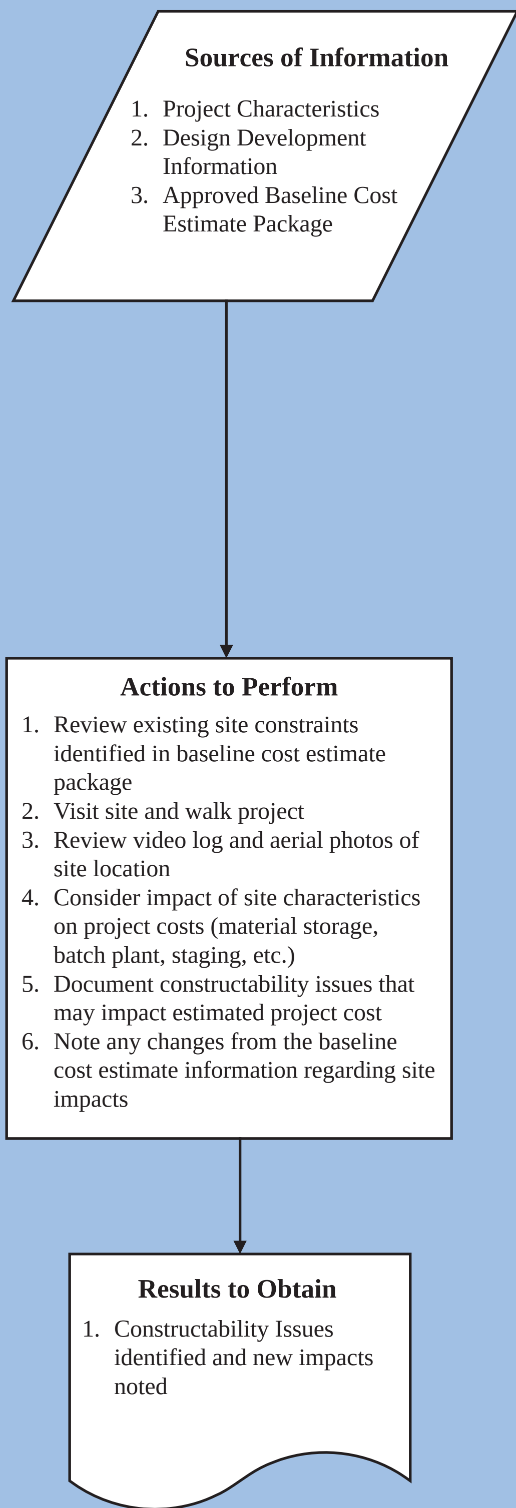
Review Site Characteristics (A3112)

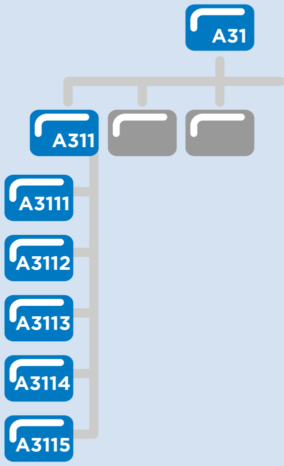
It is important that the Estimator understands the current project definition and project characteristics (i.e., type and complexity) prior to participating in another site evaluation. Further, the Estimator should carefully review any previous information on site impacts related to costs included in the Baseline Cost Estimate Package.

There are several tools available. The best tool to use is a site visit. If time to prepare the estimate is an issue, other tools such as video logs or aerial photos of the site can also be used.

Prior to the site visit, the Estimator should review the specific questions addressed during the Scoping Phase site visit. Additional questions might be raised or considered. Based on the existing information concerning the site and any new information discerned from another site visit, the Estimator should note any changes in site impact information in relation to the baseline cost estimate.

The Estimator should create additional notes on site issues that may affect project cost updates covering all pertinent categories of project cost. Items that were not previously identified in the project definition but are now better defined due to increased Design development information should be noted as well.





Identify Changes (A3113)

Step Requirements

To update the estimate basis, it is necessary to identify the changes made in the project definition during the Design Phase. The Estimator reviews the latest design data and the site characteristics in the previous two steps. In this step, the baseline project definition and current project definition are compared to identify potential changes or modifications that will impact the baseline cost estimate.

The Estimator has all the required information about the design, the parameters, and the specifications of design. All this information is then compared with the project definition, which is documented at the end of the Scoping process. The Approved Baseline Cost Estimate Package is used to measure performance throughout the design. It becomes important to identify even the minor changes in the project definition and design, as minor changes can accumulate and add major costs to construction.

Issues to Consider

Estimators

- By identifying potential changes to the baseline project definition, the Estimator will be better prepared to focus estimate updates on key areas where changes have occurred as design details increase.

- Potential changes may increase or decrease the cost estimate for a project. The impact of a change will not be known precisely until the base estimate is updated and the project risk and contingency are also updated.

Relationship of Potential Changes to Risk and Contingency

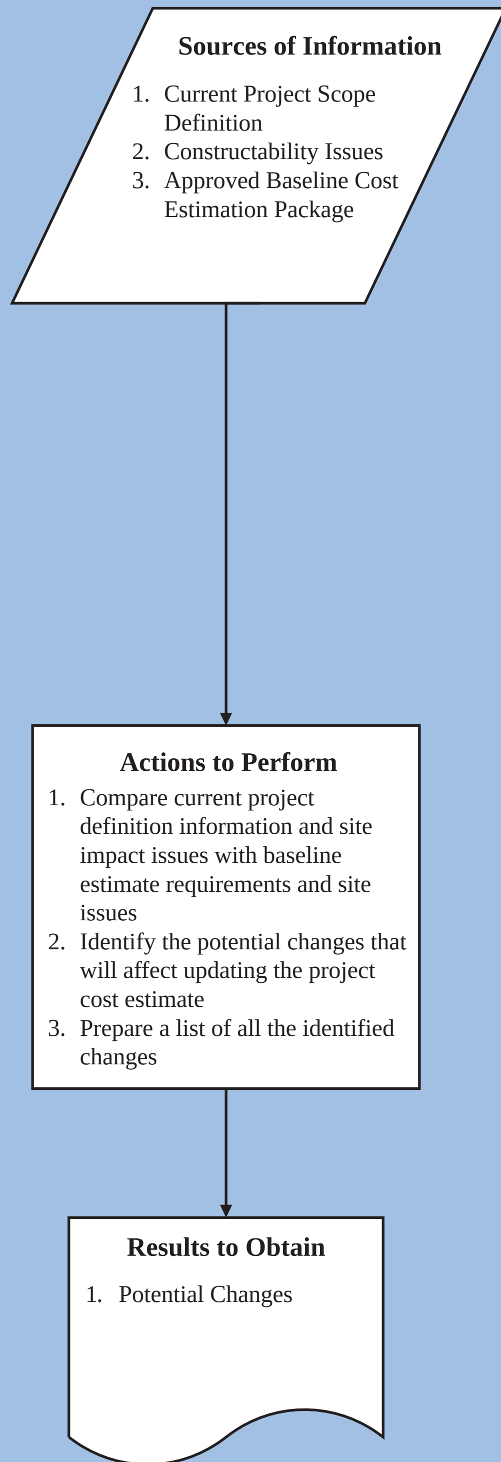
- Potential changes may relate to risks previously identified in earlier estimates. Be cognizant of any risks relating to potential changes and ensure that they are updated as described in A3132.

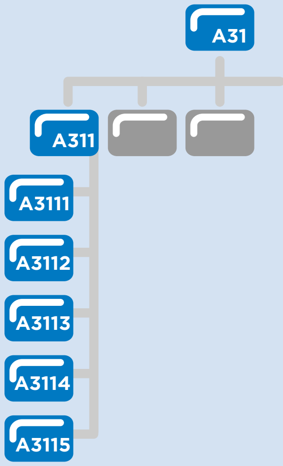
Identify Changes (A3113)

The current project definition and the baseline project definition are compared as the project Design Phase generates design information and increasing levels of detail. The Estimator identifies potential changes that may add to the project cost. The changes that may reduce the cost of the project are also identified in this step.

Repetition of this step can be performed in certain cases of increasing changes in the project definition.

A list of potential changes is prepared at the end of the step. This list becomes part of the project definition basis for updating the cost estimate. It is included when the updated estimate basis is documented in step A3115.





Determine if Clarification Needed (A3114)

Step Requirements

The purpose of this step is to confirm that all information is available regarding the project requirements, especially where potential changes are identified. Additional information may need to be requested from a Functional Group. This request may focus on clarifying existing documentation of the project requirements or ensuring that certain requirements are needed or that a change is necessary. The Project Manager should initiate these requests.

The Estimator performs several specific actions. One set of actions includes clarification of specific project requirements. A list of questions can be generated after the Estimator reviews the project definition, visits the project site, and prepares a list of possible changes. Another set of questions may clarify impacts of project site characteristics on construction and how these impacts influence project costs. Once potential question areas are identified, a request for clarifications can be initiated.

The output of these actions is a request for clarification regarding project definition or construction-related issues that will have a potential impact the cost of the project.

Issues to Consider

Functional Group Input

- The request of clarification can be made in several ways. A meeting with all Functional Groups may be necessary for complex projects. Face-to-face discussion is often the best way to clarify project definition and construction-related issues.

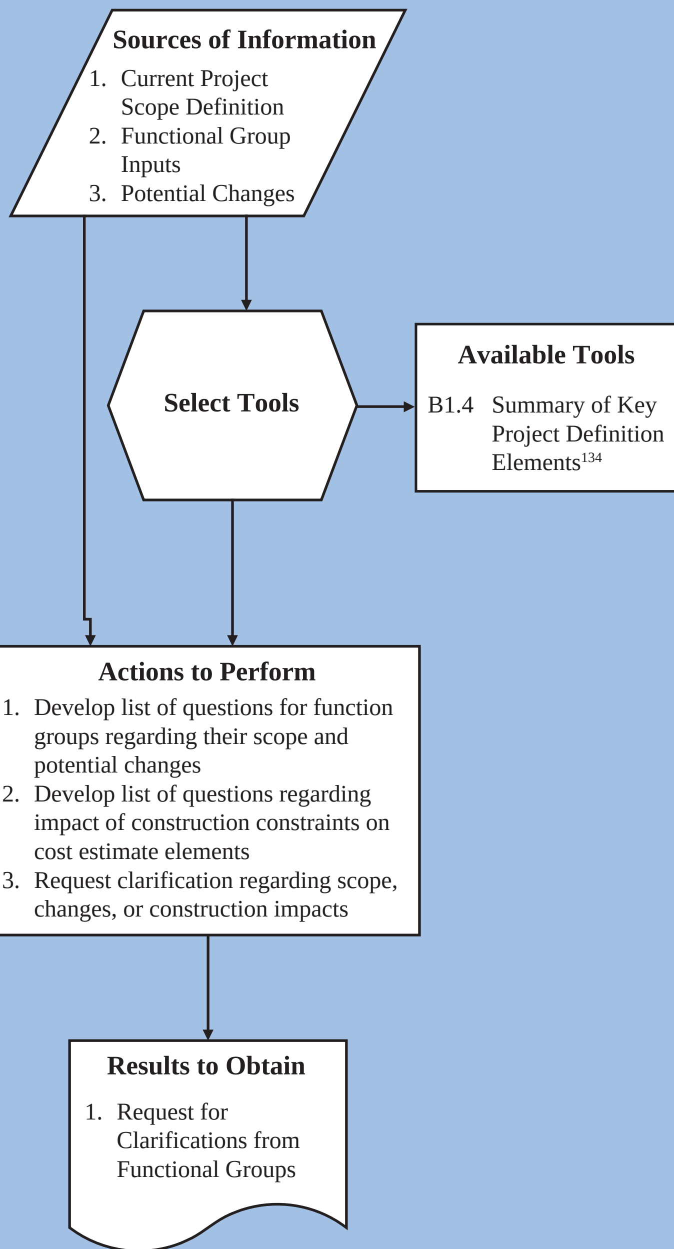
Determine if Clarification Needed (3114)

The main sources of information come from the Functional Groups involved in the project and the potential changes that have been identified. Constructability issues are often best identified through site visits.

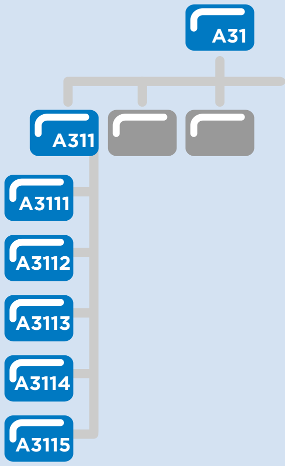
Summary of Key Scope Project Definition Elements (B1.4) is a useful tool to ensure that all Functional Group input is reviewed for clarification.

While questions will always arise as cost estimates are prepared and reviewed, developing a comprehensive list of questions needing clarification regarding the current project definition and potential changes will save time for the Estimator and project team in general.

Involvement of all Functional Groups with project requirements is critical to ensure cost estimate accuracy. Request for clarifications is a necessary step. Such requests will reduce recycle as the cost estimate is prepared.



134. For B1.4 Summary of Key Project Definition Elements, see page 363.



Document Updated Estimate Basis (A3115)

Step Requirements

The main purpose of this step is to continue the documentation trail that supports updating a project estimate. The key inputs are the current project definition, potential changes, and new constructability issues. These inputs will also include any clarifications regarding project requirements, including potential changes, and construction issues that impact potential project costs. This step is a key to achieving cost estimate consistency. The project cost estimate file format that was initiated in the Scoping Phase should be followed.

The main effort or action for the Estimator is to update the Project Estimate File with sections on current project requirements that are used as a basis for updating the cost estimate. Documentation of project requirements is critical when updating both the base cost estimate and risks and contingency. This step is critical when reconciling differences between the updated cost estimate and the baseline cost estimate (see Review and Approve sub-process, A314 on page 224).

Issues to Consider

Project Cost Estimate Baseline

- Since this cost estimate may result in differences when compared to the baseline cost estimate, a change request may result. The Estimator must place a substantial emphasis on documenting any changes in project.

- Time to prepare this documentation is necessary and should be included in the time necessary to update the cost estimate.

Document Quality

- The estimate basis, as incorporated into the Project Estimate File, must be in a form that can be easily checked, understood, verified, and corrected, especially where changes in costs have occurred.

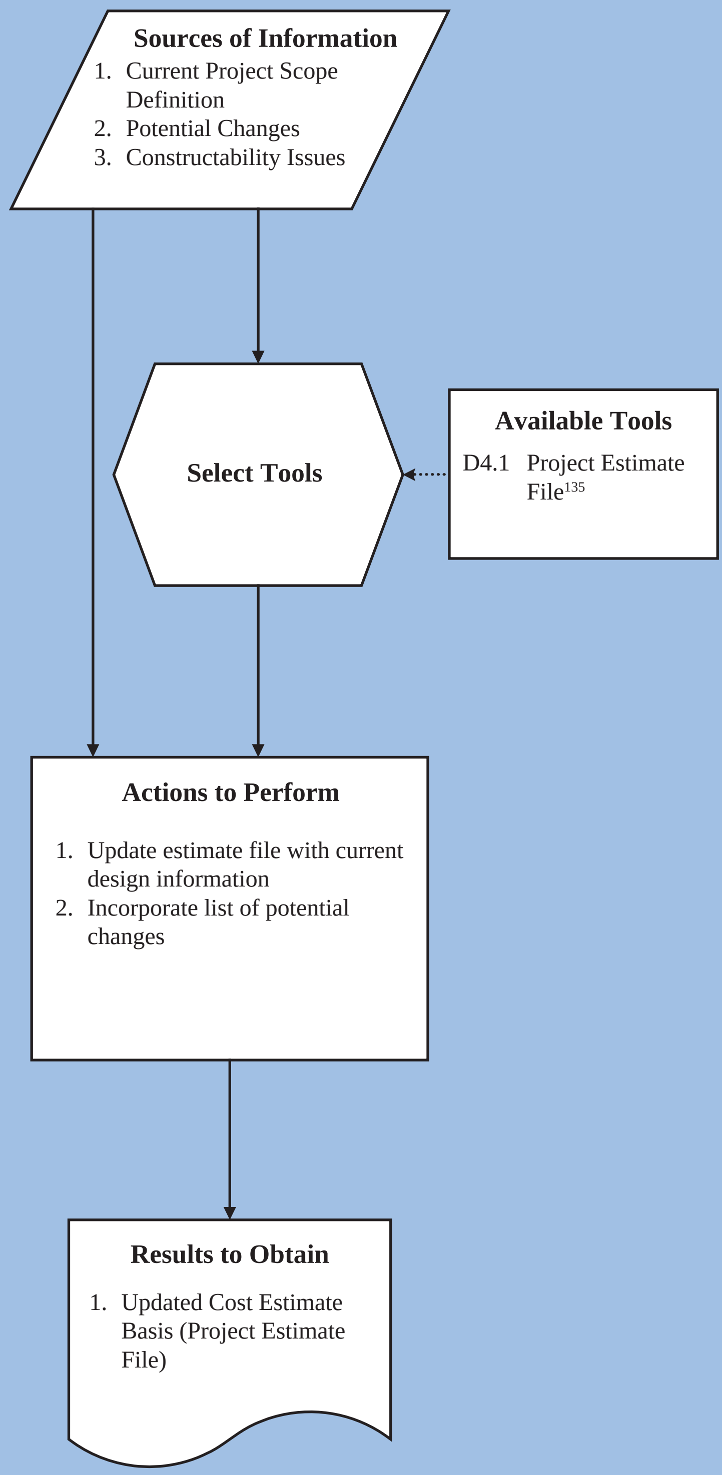
Document Updated Estimate Basis (A3115)

The Estimator compiles updated information and data based on the current project definition, recent site visits, and additional input from Functional Groups. The Estimator should ensure that new information is clearly identified.

The main tool used to support this step is the Project Estimate File (D4.1). The Project Estimate File provides uniformity in the documentation, which helps other Estimators to understand the project definition basis clearly.

A Project Estimate File is updated with more detailed estimate basis information. The documents in the file should include all the available information about the changes, including the changes, the reason for the changes, and even any clarification related to specific changes provided by the Functional Groups. This helps the project team understand the nature of any project changes and who initiated them.

The output of this step is the Updated Cost Estimate Basis, which serves as a key input to the next sub-process, Update Base Estimate.



135. For D4.1 Project Estimate File, see page 339.

III.4.2.2 UPDATE BASE ESTIMATE (A312)

The purpose of this step in the Design Phase is to update the baseline cost estimate (contingency is updated under the next sub-process, A313). This estimate may be a total revision of the existing baseline cost estimate or may focus only on certain major estimate elements. This level of estimating effort is guided by the changes identified in the previous sub-process. Eventually, the updated estimate is completely based on items. Base estimating approaches tend to focus increasingly on historical bid based estimating as periodic updates are performed over the Design Phase. This sub-process has six steps. The steps are as follows:

1. Select Appropriate Approach – A3121
2. Quantify Estimate Elements and Items– A3122
3. Develop Estimate Data – A3123
4. Calculate Cost Estimate – A3124
5. Document Estimate Assumptions – A3125
6. Prepare Estimate Package – A3126

These six steps provide a natural progression of effort to update the base estimate during Design. They are often performed concurrently and repeated as each cost category and its work element or item quantities and prices are revised as necessary. These six steps require several key external inputs that are necessary for the Estimator to update the cost estimate. Some of these key inputs include the following:

- **Approved Baseline Cost Estimate Package** – includes cost estimate summaries, cost estimate details, estimate project definition basis, estimate assumptions, estimate calculations, and other related information from the Scoping Total Project Cost Estimate.

- **Updated Project Cost Estimate File** – contains the updated estimate basis, with specific emphasis on changes in the project requirements that serve as the basis for updating portions of or all of the categories, elements, and items covered in the Scoping Total Project Cost Estimate.

- **Project Characteristics** – description of the type and complexity of the project, including site-specific information and/or data that is relevant to preparing the cost estimate.

- **Historical Data** – updated cost data from previous projects used as a basis for modifying prices of different elements and/or items of the Total Project Cost Estimate categories.

- **Functional Group Input** – updated cost estimates provided by different Functional Groups.

- **Market Conditions** – understanding of the potential market impact on costs for a project in a given location in terms of changes from when the baseline cost estimate was prepared.

These key inputs are then used when performing the six steps of this process. The output of this sub-process is an Updated Cost Estimate Package. The package contains all pertinent project definition requirements, assumptions, and historical cost data used to update the baseline cost estimate, as well as cost summaries and cost details for the updated base estimate. Changes in the estimate are clearly identified as well.

This estimate may be a total revision of the existing baseline cost estimate or may focus only on certain major estimate elements.

Select Appropriate Approach (A3121)

Step Requirements

Selecting the appropriate approach for preparing any estimate is the foundation for quality and accurate estimates. If an inappropriate estimating approach is selected (i.e., tool[s]), then estimate accuracy may be compromised. The input for this step is the Updated Cost Estimate Basis produced in the Document Updated Estimate Basis step (A3115). While no tools exist to assist in making the decision on which tools to use for the estimate, the Estimator must be aware of the project definition, size, and complexity. While bid data based on similar projects, general historical bid data, parametric methods, and even spreadsheets, all have their place in an Estimator's toolbox, each project is unique and necessitates due consideration in deciding the approach.

In the Design Phase, much more is known about the project definition than when the base estimate was completed during Scoping; therefore, while the Scoping estimate may heavily rely on a mixture of bid based, percentages, and parametric estimating, the estimate approach now shifts toward bid based estimating for the majority of elements and items. In fact, as the project design is completed, the updated cost estimate is prepared almost entirely using bid based estimating as all items and their quantities are known.

Issues to Consider

Tool Application

- While multiple estimating approaches can be used, bid based estimating becomes the dominant approach as the design detail provides sufficient information to identify items and their quantities.

- Spreadsheet workbooks are used to easily update previous estimates with new information.

Project Characteristics

- Project estimation approaches should be selected on the basis of experience of the Estimator, data available, and project characteristics.

- Major projects require more time and effort to prepare an estimate update, so selecting tools that fit the time available is a consideration.

Total Project Cost

- Tool selection will vary depending on the Total Project Cost Estimate category.

Select Appropriate Approach (A3121)

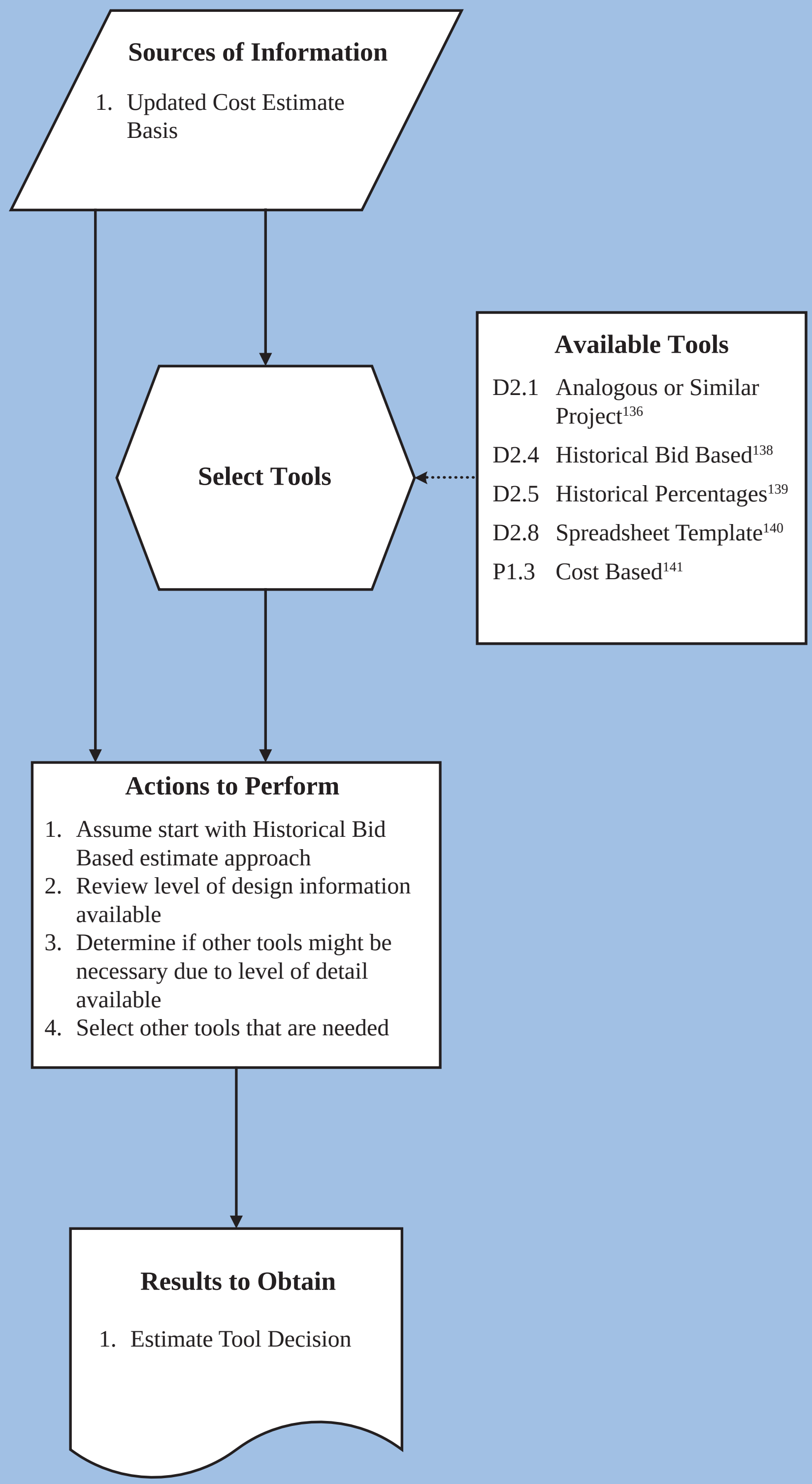
The Updated Cost Estimate Basis contains the information from which the Estimator will prepare the updated estimate. The documents contained in this file are critical to preparing an accurate estimate.

Selecting the appropriate tool or tools is a function of the level of design completion. Historical bid based estimating will always be used. The other tools may be used when there is a lack of definition early in the Design Phase or there is a lack of historical bid data for a particular item.

Cost based estimating is frequently used for elements and items where bid data is insufficient.

The Estimator must rely on both experience and judgment when selecting the set of tools applicable to the project being estimated.

The Estimator makes an initial selection of the tool or tools that will be used. However, as estimate elements and items are quantified and the historical cost basis is determined for the elements and items, the Estimator will likely use historical bid based estimating.



136. For D2.1 Analogous or Similar Project, see page 387.
138. For D2.4 Historical Bid Based, see page 389.
139. For D2.5 Historical Percentages, see page 391.
140. For D2.8 Spreadsheet Template, see page 397.
141. For P1.3 Cost Based, see page 403.

Quantify Estimate Elements and Items (A3122)

Step Requirements

Quantifying estimate elements is an extremely important step in producing consistent and accurate estimates. Before quantifying the elements or items to be updated, the Estimator must be thoroughly familiar with the Scoping cost estimate where the elements were originally quantified to know how to properly update them or perhaps add new elements or items not previously covered. Additionally, the Estimator relies on the Updated Cost Estimate Basis to identify the different work elements and items that govern the estimate update.

The Estimator then determines the appropriate quantity measure and calculates quantities for those elements that require updating of the quantity. New quantity calculations are necessary for items not previously defined. These are most commonly the elements quantified through percentages in previous estimates. Calculations of quantities should be documented, including all backup calculations and assumptions made when determining quantities. The Designer is responsible for complete quantification of every work element or item. This documentation aids the estimate review sub-process or when the Estimator has to modify elements due to review recommendations. The accuracy of the quantities is vital to the quality of the estimated costs produced based on them. The Estimator should identify issues that create uncertainty in their quantity calculations.

Issues to Consider

Project Characteristics

- Complex projects that have many components will require Functional Groups to identify estimate elements and items and quantities associated with their discipline. The Functional Groups must provide documentation of calculations and assumptions associated with the calculations, especially when updating the baseline cost estimate.

Project Tool and Documentation

- The Estimator must clearly identify when another approach to estimating an element or item is used other than historical bid based estimating.

- Proper documentation is necessary as recommendations from estimate reviews may require modifications of some estimate elements or items. It is easy to make changes if all the estimate calculations are well-organized.

Estimate Overlap

- When performing an estimate update, an Estimator must be aware of the interaction of all items with those previously estimated. For instance, when moving from typical sections or percentages in Scoping to individual items in Design, are all items accounted for? Alternatively, if in Scoping the amount of curing compound used on a project was directly related to the square yards of pavement, a change in the pavement quantity also necessitates a change in the curing compound quantity.

- A spreadsheet is an excellent tool for keeping all estimated items organized, thus preventing duplicated items or missing items. However, the best tool for organizing estimate information and data is an attentive Estimator.

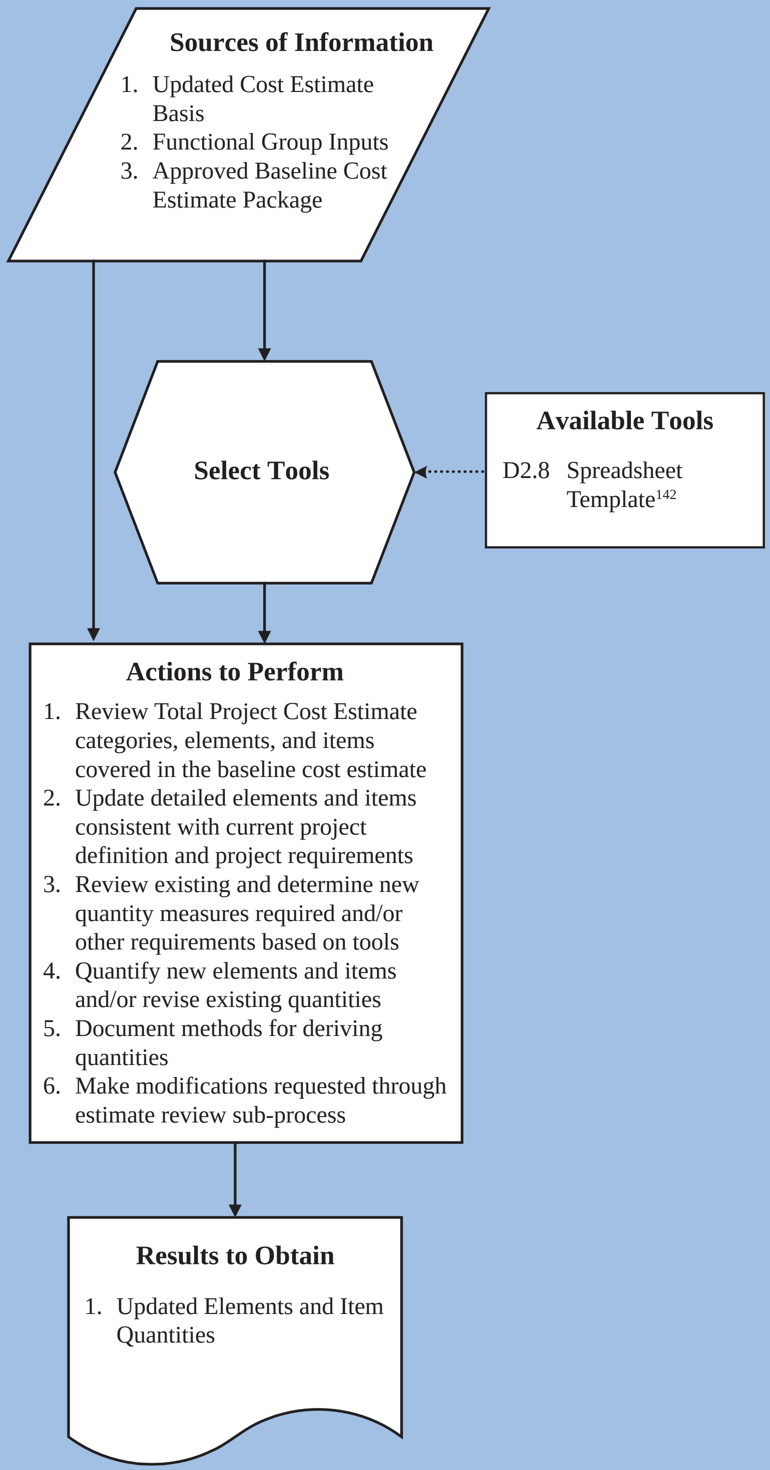
Quantify Estimate Elements and Items (A3122)

The combination of the Updated Cost Estimate Basis, Functional Group inputs, and the Approved Baseline Cost Estimate Package should provide all necessary information to quantify all estimate elements and items.

Spreadsheet templates provide a rapid and easy means for organizing estimate data and formulating repetitive calculations. The usefulness of spreadsheets during an estimate update is a great example of the convenience and utility they provide. Spreadsheets are also useful for compiling estimate calculations and assumptions, assessing estimate completeness, and communicating the estimate to others. If working with a baseline estimate spreadsheet, copy this spreadsheet when preparing to update the estimate.

Review major items of work to be updated. Focus the efforts on these major items. Further expand elements that were previously estimated using historical percentages or parametric estimating approaches into specific items.

Almost as important as the quantification of the elements and items is the documentation of the calculation of element and item quantities. Quantities drive estimated costs and are needed for future reviews and adjustments, as well as for others to fully comprehend the estimated costs. Elements and item quantities are carried forward to an estimate spreadsheet.



142. For D2.8 Spreadsheet Template, see page 397.

Develop Estimate Data (A3123)

Step Requirements

This step in the Update Base Estimate sub-process determines the various cost data that is applied to elements and items. Although this data was already determined for the Scoping estimate and included in the Baseline Cost Estimate Package, cost data should be updated for all elements and items based on more recent historical information. The Scoping estimate occurs as much as a year before the first Design cost estimate and, during this time, Mn/DOT has continuously added to their historical cost database. This recent data should be used so that the updated estimate reflects current dollars at the time of the update.

The types and sources of historical data depend on the estimating tool used. During Design, historical bid data is used more frequently and almost exclusively when the Design is nearing completion. Other data may be required, depending on the estimating tool used, such as historical percentages for a set of similar items.

The critical action to perform in this step is to update the appropriate cost data for each work element and item; however, equal care must be given to adjusting the cost data for market conditions, project specific location characteristics, age of historical data, and other factors. The Estimator will also need to modify cost data based on the feedback from the Estimate Review sub-process (A314). The Estimator uses a number of different inputs to accomplish this update, such as elements and item quantities, project characteristics, historical data, and potential market impacts. An important tool to be used is a spreadsheet template, which is an excellent and simple tool for ensuring all components of project cost have been considered and accounted for in the estimate. The outputs of this step are historical unit prices and other historical data, the identified estimate assumptions, and a list of uncertain items.

Issues to Consider

Historical Data

- Historical bid data used for estimating must reflect current costs, that is, unit costs are updated to reflect inflation when unit costs are older than three months.

- Historical bid data must be understood in terms of how these data are developed for estimating a current project (e.g., using weighted averages based on low bid only).

Project Characteristics

- Market conditions and project location greatly affect the cost data; however, factors such as material cost, special machinery, involvement of special agencies, technology, or method of construction should also be considered to make the cost data more accurate.

Develop Estimate Data (A3123)

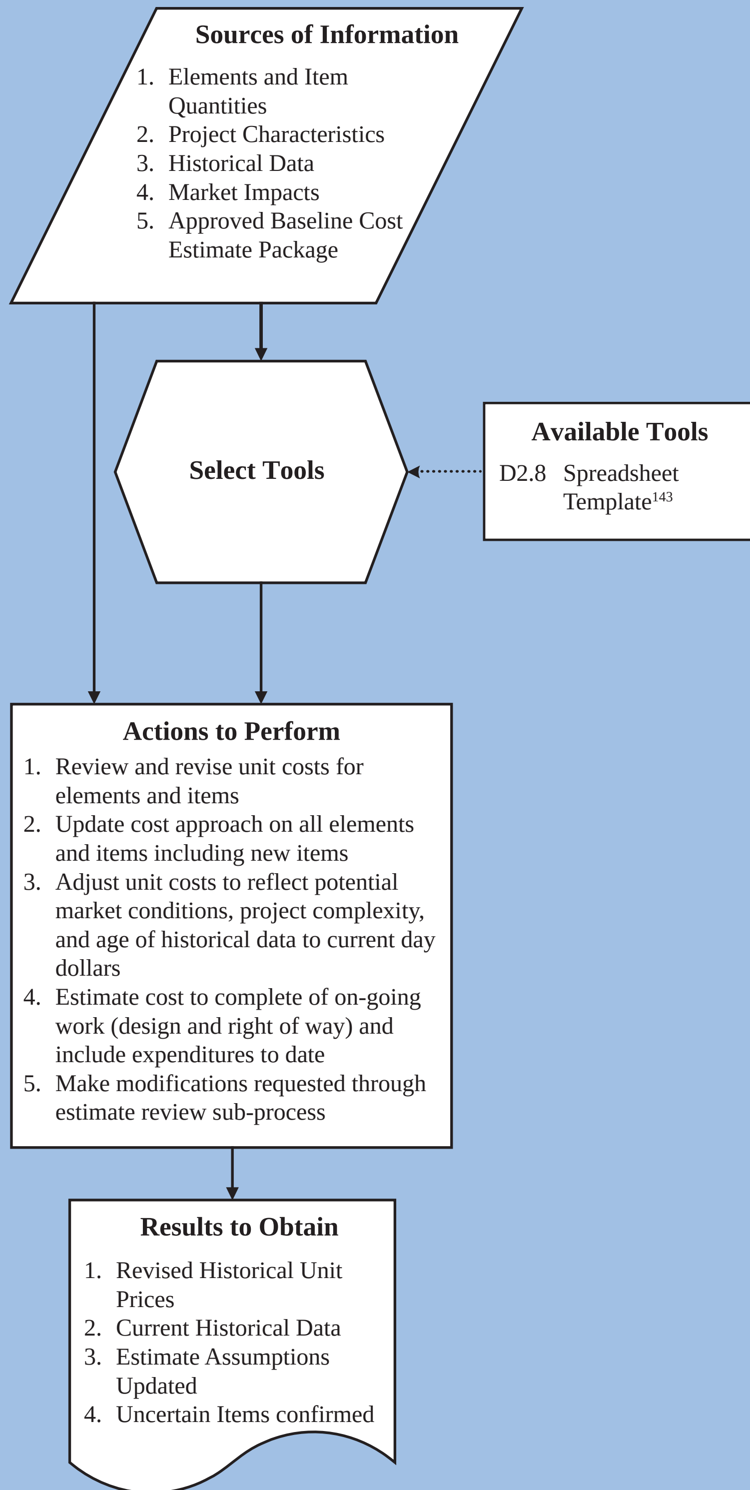
Updating historical cost data for converting quantity information to cost may be the most critical and important action required to update the base estimate. The Estimator works with a substantial amount of information. Consider variability resulting from the source of historical data used and its fit with the project being estimated.

Review carefully the unit costs on those work elements and items that comprise 80 percent of the cost. Spend time focusing on historical cost data for these critical work elements.

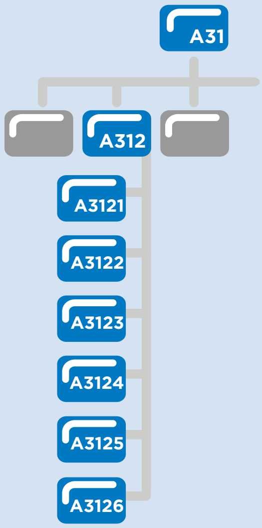
Look beyond the historical data when estimating the cost. Look for recent trends such as rising materials costs or changes in specifications. Consider where the project is located and its key features, that is, rural/urban, two lane/four lane, and so on.

Adjusting historical data to fit a project is a challenge. Issues to consider are location of material sources and batch plants, haul routes and distance, work zone staging, and any market volatility.

Historical data must reflect current day costs prior to applying these data to a project estimate. The Estimator should note estimate assumptions that are made when adjusting historical data to fit the project being estimated. Also, uncertainty associated with the use of these data must be considered and noted.



143. For D2.8 Spreadsheet Template, see page 397.



Calculate Cost Estimate (A3124)

Step Requirements

Calculating the cost estimate is a fundamental step. The Estimator inserts into the cost estimating spreadsheet the cost data for each estimate element and item. After all of the quantities and prices are updated, the baseline cost estimate spreadsheet prepared in the Scoping Phase is updated and summarized to calculate the current base cost of the project. Cost estimates provided by Functional Groups should also be included. These estimates should be updated to reflect current day dollars and the latest design details. The spreadsheet should include detailed cost calculations for elements and items but also summarize like elements and items by categories consistent with the concept of Total Project Cost Estimate.

A simple spreadsheet can be used to make the necessary detailed calculations of elements and items, as well as to summarize these elements and items by categories for a simple representation and eventually for reviews.

Issues to Consider

Project Definition and Characteristics

- Reviewing and updating the spreadsheet is the best time to ensure that all items of work are covered.

- The cohesiveness of the resulting updated cost estimate is imperative. While merging work from different Functional Groups into a single, integrated estimate may be difficult, it must be properly completed for reviewers to easily understand and navigate through the estimate. Future Estimators will also need to follow what has been estimated. Also, one must be careful not to lose any changes during the merging.

Calculate Cost Estimate (A3124)

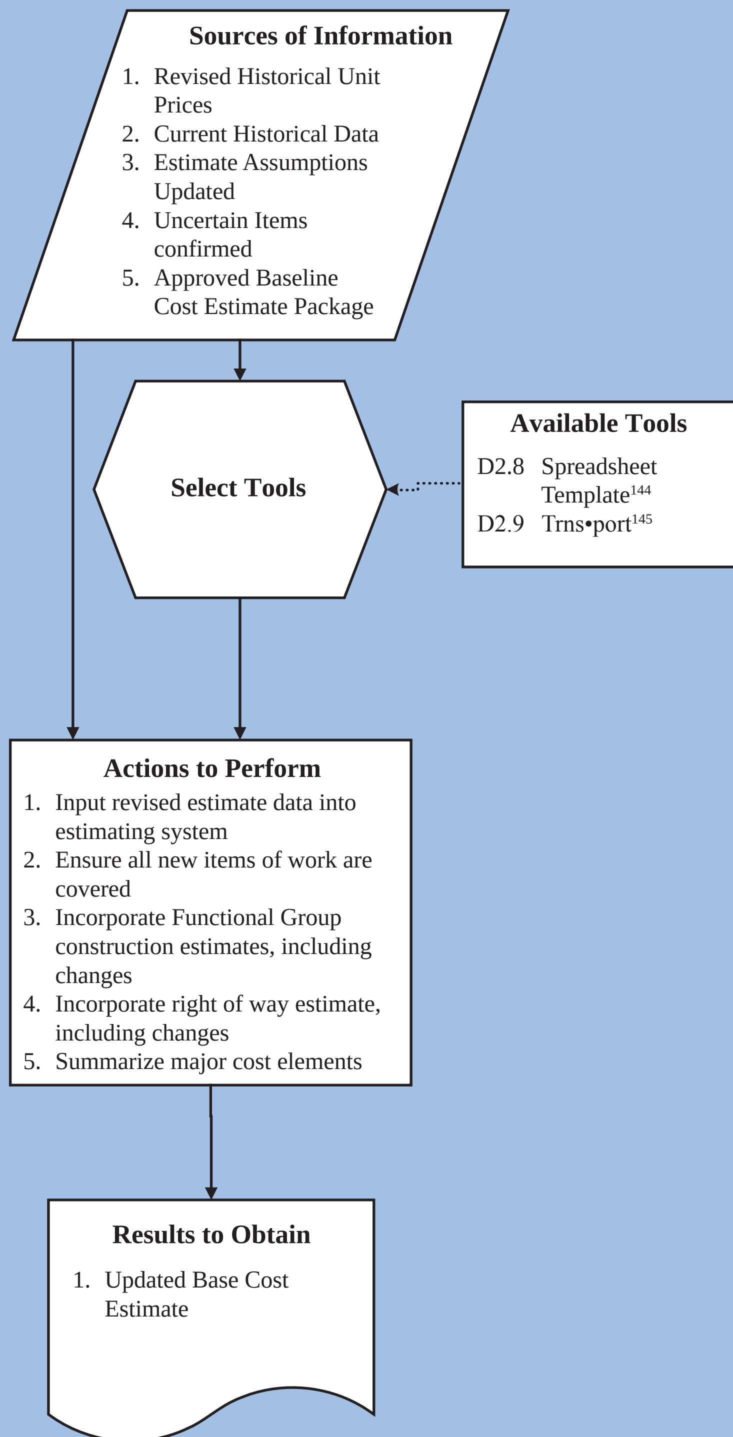
A project schedule is required to confirm the Letting date of the project.

Formulas used in spreadsheets should be checked to ensure that all costs are properly calculated and aggregated to summary levels.

Simple spreadsheets can aid in clearly communicating the total estimated cost of the project, as well as keeping track of which elements and items are included in the estimate and what various categories of work are expected to cost. This allows for easy comparison to historical ratios from past projects for making rapid sanity checks of estimated costs. Spreadsheets also allow for easy updating of the estimate.

An important part of this step is to fully analyze any changes in the estimates. As design estimates are updated, fewer allowances should be required, and more items should be included and estimated using historical bid based approaches. An important difference between the Scoping and Design estimates is that parts of the Scoping estimate using typical sections or percentages will be disaggregated into individual items during the Design estimate as more specific design information becomes available.

Contingency should not be included in any item estimates.



144. For D2.8 Spreadsheet Template, see page 397.
145. For D2.9 Trns•port, see page 401.

Document Estimate Assumptions (A3125)

Step Requirements

A project's complexity and size may mean that more issues must be considered in preparing the estimate. Additionally, estimates are commonly prepared in collaboration with many Functional Groups. The decisions and assumptions behind the decisions that drive the estimate must be clearly stated and communicated to management. Thus, this step is crucial in preparing an updated estimate. Good documentation supports the cost estimate's credibility, enables reviewers to effectively assess the quality of the estimate, aids in the analysis of changes in project cost, and contributes to Mn/DOT historical cost databases for estimating the cost of future projects.

Fewer assumptions should be needed at the Design level than at the Scoping level since the project is further defined. More of the estimate is derived based on item quantity take-offs from the plans and specifications instead of using data from previous similar projects, using historical percentages, or using parametric approaches. This reduces the level of uncertainty (see also A313). Assumptions still need to be documented.

This step brings together all estimate information used to update the cost estimate in a structured format. While the level of detail may vary depending on project type and complexity, the need to assemble backup calculations, assumptions, and other pertinent estimate information is critical to ensure consistency across Districts and within the state.

Issues to Consider

General

- It is particularly important to clearly document the changes, data origins, and approximations as this estimate is being compared to the baseline cost estimate.

- It is important to document how historical bid prices are adjusted to current day dollars.

- It is important to document changes in estimate tools used as the tools may result in changes in cost.

Policy Guidance

- Cost estimates for each phase will be documented and will include a description of what the project is and what it is not; the assumptions used; the extent to which various estimate inputs are developed; the basis of the estimate; the base estimate; a separate contingency amount with a description of associated risks; and the incentives, if included in the contract. Accelerated project incentives should not be designated as cost escalation or overages later on if the incentive provisions are part of the contract at the time of Letting.

- The project uncertainties should also be identified and documented. Documenting these uncertainties can aid in defining the unknown elements of the aspects of the projects.

Functional Group Input

- Similar documentation of the estimate should be provided by each Functional Group that prepares any updated estimate for projects with changes noted in the backup materials.

Document Estimate Assumptions (A3125)

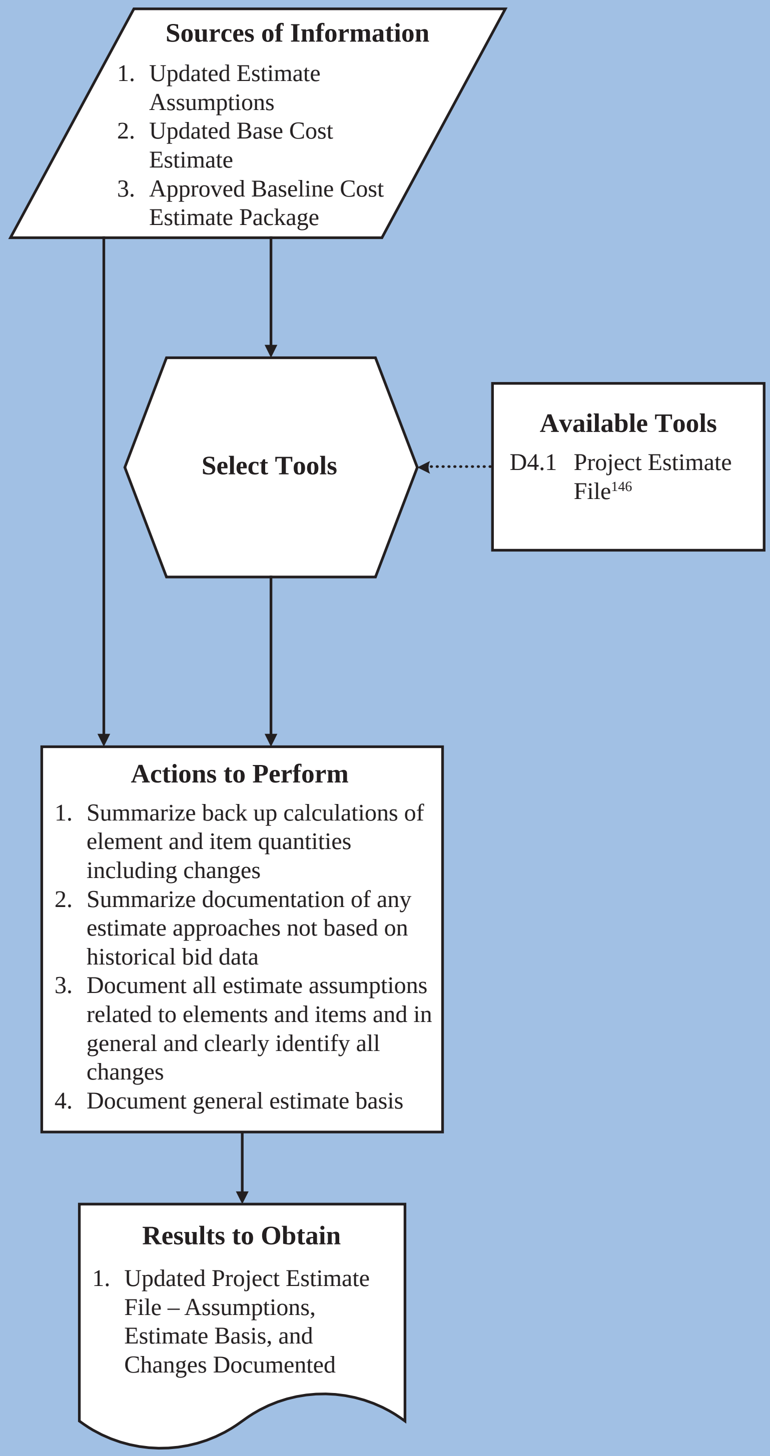
A Project Estimate File is included in the Approved Baseline Cost Estimate Package. The file is updated with revised estimate information, including any changes to the baseline cost estimate.

Traceability is a critical requirement necessary to prepare a credible cost estimate. Traceability allows others to review and validate the estimate. Traceability provides the mechanism to assess cost impact when the project definition changes or when other project conditions or characteristics change.

Traceability is facilitated by clear and concise documentation. Documentation should include an estimate basis, estimate tools used, assumptions, and calculations. The Project Estimate File assembles these items in a single location.

Estimate bases and assumptions are at two levels: 1) high-level bases and assumptions that apply to every element and item of the project estimate; and 2) detailed-level bases and assumptions that apply to individual element and item estimates.

The Project Estimate File is now updated to include all of the work completed to update the estimate basis and update the base estimate.



146. For D4.1 Project Estimate File, see page 339.

Prepare Estimate Package (A3126)

Step Requirements

This is the final step in completing the Design estimate and will again be repeated for all future estimates. All calculations have been made and documented before this step; however, the details, summaries, and assumptions must all be collated into a single, logical volume. After accumulating and organizing this material, the package produced will represent the Total Project Cost Estimate, without contingency, and all supporting information.

The only tool available for use is the updated Project Estimate File; therefore, much of the success of this step is in the hands of the Estimator preparing this package. The Project Estimation File provides a record that documents the basic reasons behind the original estimated construction cost. Above all, the information must be easy to understand and well-organized for reviewers. Thus, summary level information is often prepared for later estimate reviews and management approvals. The Estimate Package should include updates in project definition, assumptions, quantity and price calculations, supporting data, and, most importantly, changes from the baseline cost estimate.

Issues to Consider

General

- Contingency is not included in the Updated Cost Estimate Package.

- The collaborative effort required to create an estimate can lead to problems with consistency; therefore, the package preparer must ensure harmony exists between all parts of the estimate before the package is complete.

- This estimate will be a reference point for many other project team personnel as the project progresses, thus making the easy retrieval and comprehension of this material paramount.

- The Total Project Cost Estimate is expressed in current dollars (without future inflation).

Policy Guidance

- All project-related costs will be expressed as a Total Project Cost Estimate, regardless of the project development phase. The Total Project Cost Estimate consists of a base estimate and a contingency (added in the next sub-process). The base estimate includes all known project costs at the time the estimate is made.

- Complex projects have more inputs to the Project Estimation File than small, simple projects. The inputs are from various Functional Groups; hence, it becomes important to properly organize and compile the set of documents for future reference.

- A clear and easy-to-understand estimation package is particularly important as the project passes to the next phase and from one group of personnel to another.

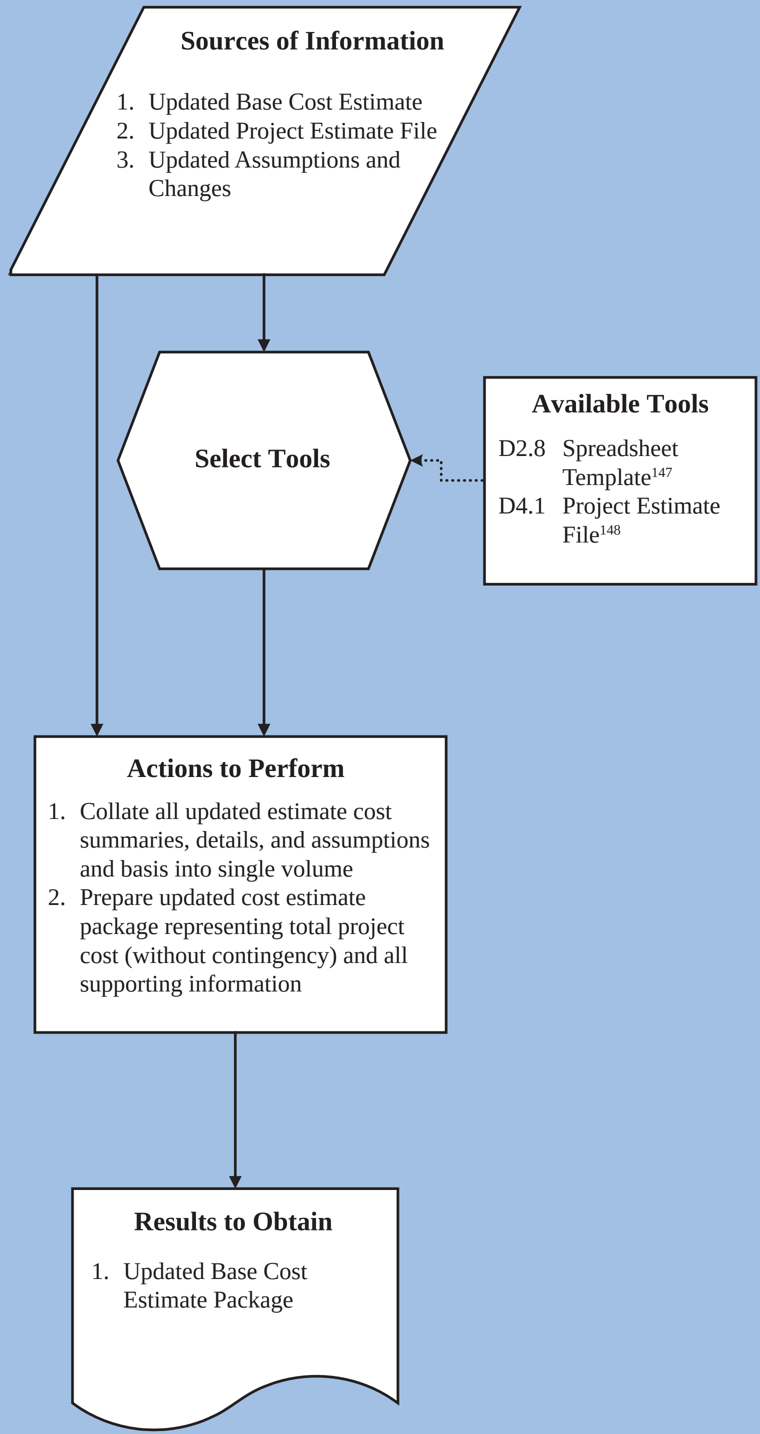
Prepare Estimate Package (A3126)

While the updated base cost estimate and the updated Project Estimate File combined have all of the necessary information, they must be merged into a single package. The Updated Project Estimate File becomes the sole source of all base cost estimate information, both project definition and cost.

Organization and readability are two of the most important considerations in preparing the cost estimate package due to the number of project personnel who will need to access and use the information.

The Updated Base Cost Estimate Package should include all required information related to the base cost estimate, including cost summaries, cost details, project requirements used to prepare the estimate, all assumptions, and backup calculations. A key feature of this package is clearly identifying where changes are included relative to the baseline cost estimate.

A short cost estimate summary can be prepared that captures key features of the updated cost estimate, such as total project costs, key estimate basis and assumptions, project schedule, and other critical items. Again, this summary should identify major changes to the baseline cost estimate. This document, while part of the package, will aid in management reviews of the cost.



147. For D2.8 Spreadsheet Template, see page 397.
148. For D4.1 Project Estimate File, see page 339.

III.4.2.3 UPDATE RISK AND SET CONTINGENCY (A313)

The primary objective of this sub-process is to update the estimate uncertainty and refine a contingency amount to add to the base estimate to arrive at the Total Project Cost Estimate. All projects, regardless of project size and project complexity, will require some form of risk analysis and risk management planning. The five sub-process steps are as follows:

1. Review Risk Information – A3131
2. Update Risk Identification – A3132
3. Update Contingency Estimate – A3133
4. Document Risk and Contingency – A3134
5. Revise Total Project Cost Estimate – A3135

Steps 1 through 3, in combination with the tools in the Tool Appendix, support the development of a contingency estimate. These three steps identify risks and provide a framework to assess the amount of contingency that will properly allow for estimate uncertainty during the Design process. Some of these key inputs include the following:

- **Use of Contingency Estimate from Scoping Estimate** – this section on updating estimate risk and contingency assumes that a contingency estimate for the baseline estimate has been completed in the Scoping process. If this is not the case, please refer to Section A2.3, Determine Risk and Set Contingency, to set an initial contingency.

- **Risk Management Plan, Risk Register, or Red Flag List** – depending upon the level of risk management performed on previous estimates, the estimate file will contain a risk management plan, risk register, or red flag item list.

- **Individual Expertise** – Risk analysis and setting of contingency will necessarily rely on individual expert judgment (e.g., the Estimator, Functional Group experts, peer reviewers, District Engineer, etc.). Mn/DOT will develop more historical data regarding contingency estimation and appropriate amounts, but personal expertise will always be a valuable part of the process.

Use these key inputs when performing the five steps of this process. The output of this sub-process is an updated contingency estimate, a continuing documentation of the risk and contingency basis, and the updated Total Project Cost Estimate. Add all of these items to the Project Estimate File at the end of the process. Depending upon the level of risk analysis, the outputs will vary from a simple red flag item list (I2.1) with an associated percentage contingency (R3.2) to a full risk management plan (R3.1) with an associated range estimate based on a stochastic estimating method (R3.5). The development of a risk register (R3.12) is a good practice in all cases.

Review Risk Information (A3131)

Step Requirements

This sub-process step requires an update of the information in the most recent risk and contingency documentation using the new information in the Design estimate basis and base estimate package. Previous risk and contingency documentation will vary depending upon the level of risk analysis followed in previous estimates. Table III.4-3 summarizes a range of risk documentation.

Table III.4-3. Summary of Risk Analysis Documentation

Risk Analysis Level	Available Risk Information Documentation
Type I Risk Analysis: Risk Identification and Percentage Contingency	I2.1 Red Flag Item List R3.12 Risk Register (optional)
Type II Risk Analysis: Qualitative Risk Analysis and Indentified Contingency Items	R3.12 Risk Register R3.1 Risk Management Plan (optional)
Type III Risk Analysis: Quantitative Risk Analysis and Contingency Management	R3.12 Risk Register R3.1 Risk Management Plan R3.5 Stochastic Estimate Model Output

The determination of new project risks and the update of previous risks stems from a review of the estimating assumptions made by the project Estimator and the design assumptions made by the Functional Groups. The Estimator must make estimating assumptions during Design until the design becomes complete. Likewise, the Functional Groups must make initial design assumptions at the conceptual level that they will refine as the design progresses. Estimating and design assumptions serve as triggers for risk identification when creating a contingency estimate.

Two other sources of risk information are risk checklists and risk analyses from similar projects. However, these sources of information should be considered only after conducting a thorough review of the estimating and design assumptions.

Issues to Consider

Repetitive Nature of Risk Identification

- Risks identification is continuous and iterative. Review all the information from previous risk analyses. Expect that the process and the risk information will be somewhat repetitive. Discussions with the Project Manager will be helpful at this stage.

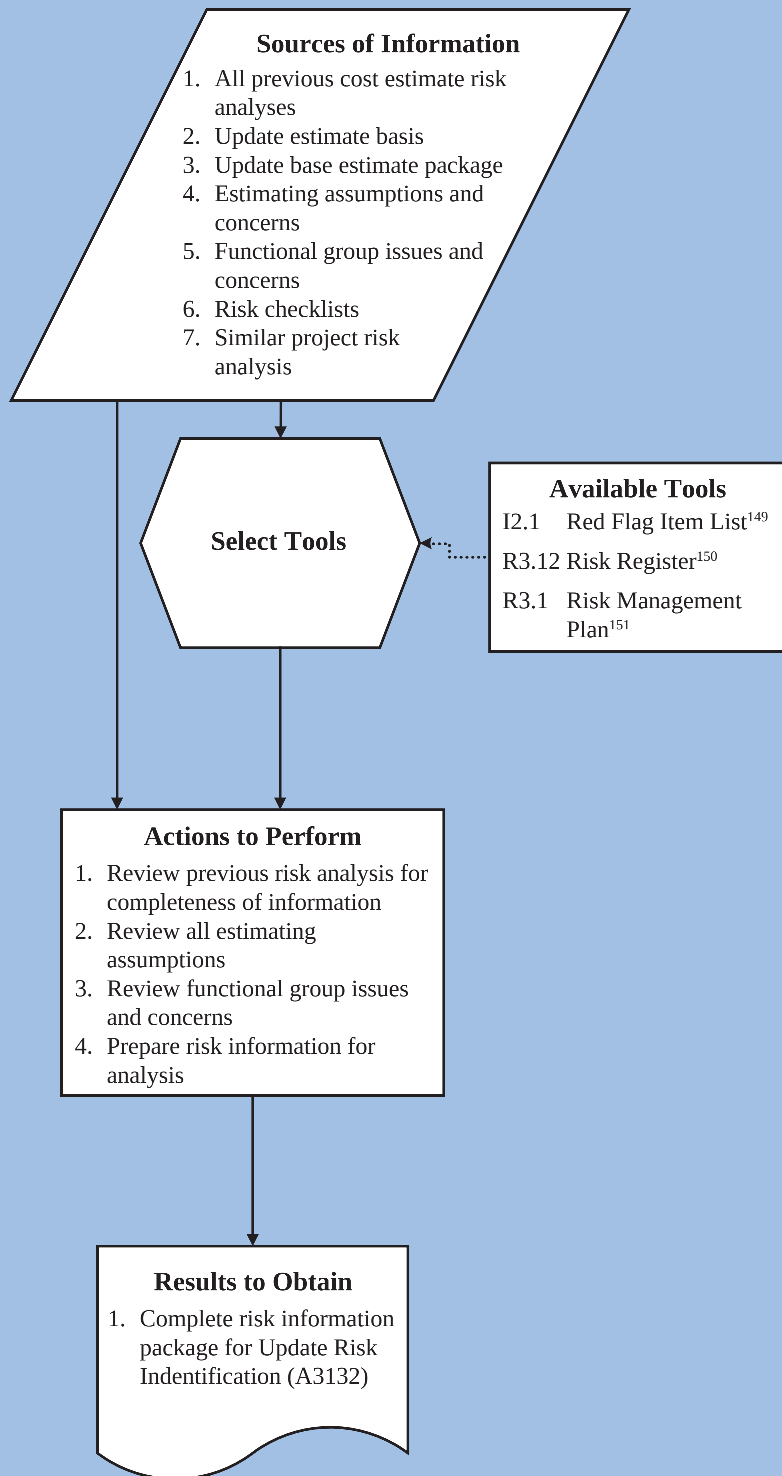
Review Risk Information (A3131)

Ideally, a complete estimate basis and base estimate package should be available for the risk analysis and contingency estimate. While Estimators may concurrently perform portions of the contingency estimate with the base estimate development, the final contingency estimate should only occur after the base estimate is complete.

Be certain to consult any previous risk analyses. The use of a risk register throughout project development will ensure this occurs.

The Review Risk Information step focuses on a collection of information for later use. Do not conduct risk analysis in this step, but rather ensure that all information is packaged for the risk analysis.

The sources of information should be as complete as possible, but Estimators will likely need to contact project team members throughout the Determine Risk and Set Contingency sub-process.



149. For I2.1 Red Flag Item List, see page 411.
150. For R3.12 Risk Register, see page 446.
151. For R3.1 Risk Management Plan, see page 425.

Update Risk Identification (A3132)

Step Requirements

The objectives of risk identification are to 1) identify and categorize risks that could affect the project, and 2) document these risks. The outcome of the risk identification is a list of risks.

Use the output of step A3131, Review Risk Information, to begin the process. This information will include risk lists from previous risk analyses.

Risk Identification is correlated to the risk analysis level as described below. Refer to section A232, Determine Level of Risk Analysis, for a complete explanation of risk analysis levels.

- **Type I Risk Analysis** – Risk Identification and Percentage Contingency

- **Type II Risk Analysis** – Qualitative Risk Analysis and Indentified Contingency Items

- **Type III Risk Analysis** – Quantitative Risk Analysis and Contingency Management

After reviewing previously identified risks, indentify new risks using the appropriate risk identification tools. Risk identification should be continuous. It is by nature a repetitive exercise, and many of the risk identification tools used in previous risk analyses will be used again. Categorize the risks into logical categories at the end of the step.

Issues to Consider

Resolution of Previously Identified Risks

- Risks involve future uncertain events. Risks occur or they do not. Risks identified in the Planning and Scoping phases may no longer exist at the Design Phase. If a risk event occurred, it should have been incorporated into the base estimate. If the risk did not occur, it can be retired from consideration. If the risk is pending, it should continue to be carried in the risk analysis and contingency.

- An analysis of risk categories can assist in risk resolution. For example, most risks related to project definition will be resolved as Design progress; yet, other risks, like market conditions, may still need contingencies even as the project nears Letting.

Use of Risk Checklists and Similar Projects

- Risk checklists and lists of risks from similar projects can be helpful, but use them only as a "back check" at the end of the risk identification process. Review these lists only at the end of the process as a means of ensuring that the list is not overlooking any common risks. Avoid beginning the process with the risk checklists or similar project analyses as the team may overlook unique project risks or include too many risks in the analysis, making it less useful.

Update Risk Identification (A3132)

Focus on risk identification. Do not attempt to analyze risks or discuss mitigation procedures in this step. Completely identify risk in this step. Risks analysis and planning will occur in later steps.

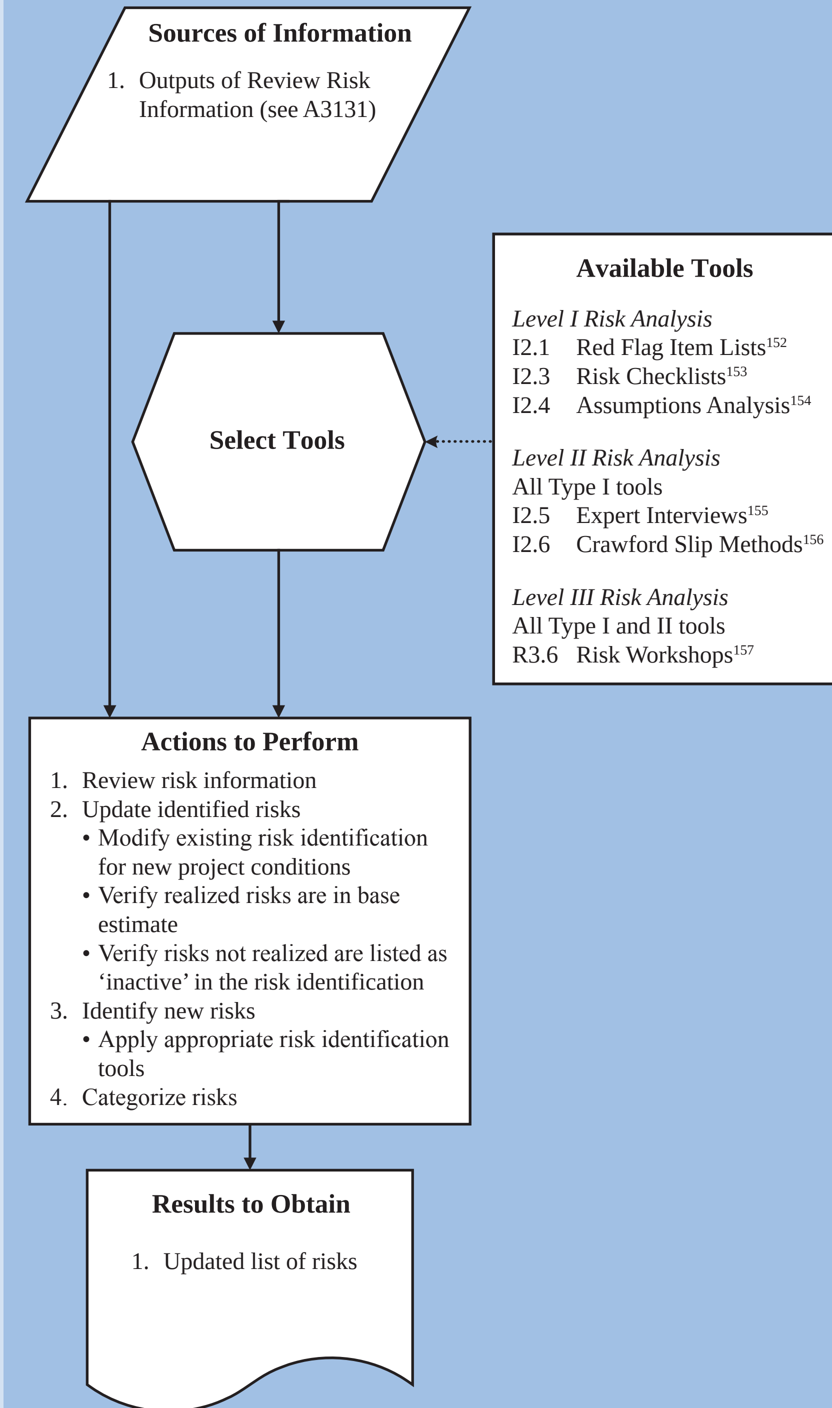
Risk analysis tools will be dependent upon the level of risk analysis. Upon determining the level of risk analysis, consult flowchart for appropriate risk analysis tools.

Risk analysis is continuous and repetitive. Challenge team members to identify new risks and not to rely on previous identification exercises.

The resultant risk list should be comprehensive and non-overlapping to be most useful in later risk analyses. Combine like risks. Separate overlapping risks.

Use risk checklists and similar projects only to check for missing risks and to help categorize unique project risks.

Upon completion of the risk list, categorize the risk into logical groupings. Use risk checklists and similar project risk analyses for possible categorizations.



152. For I2.1 Red Flag Item Lists, see page 411.
153. For I2.3 Risk Checklists, see page 413.
154. For I2.4 Assumptions Analysis, see page 419.
155. For I2.5 Expert Interviews, see page 421.
156. For I2.6 Crawford Slip Methods, see page 423.
157. For R3.6 Risk Workshops, see page 440.

Update Contingency Estimate (A3133)

Step Requirements

The goal of this sub-process step is to update the contingency estimate for the project. Relate the contingency to the project risks. The update to the list of risks, along with any historic contingency trend information, forms the basis for this contingency.

On minor projects employing a Type I risk analysis, assign this contingency through a simple percentage from historical data and Estimator's judgment. On major projects using a Type III risk analysis, assign the contingency through a stochastic model of cost and schedule. Consider using an external consultant to assist in building the model.

An update to the risk ranking is the first step in all three types of risk analyses. This is the risk assessment step in a formal risk analysis. Use the PxI tool (R3.8) to assess frequency and severity of each risk. Ranges of probability and impacts are useful in initial assessments. Type II and III analyses may require more accurate assessments, but all three types of assessment can begin with a qualitative assessment of frequency and severity.

Issues to Consider

Resolution of Contingency

- Contingency represents a valuable resource, and it must be managed accordingly. As the project progresses through project development, the contingency will be resolved (or reduced). If a risk is realized, increase the base estimate and decrease the contingency. If a risk is mitigated (avoided at a cost), add the mitigation cost to the base estimate and decrease the contingency. If a risk is avoided, reduce the contingency.

Type I Risk Analysis Contingency

- In a Type I risk analysis, use the list of risks to inform the choice of contingency from the department's pre-determined range of allowable contingencies.

Type II Risk Analysis Contingency

- When choosing the appropriate contingency percentage in a Type II risk analysis, consult the range of contingency from the percentage contingency tool, and then review approximately the top 20 percent of the prioritized risks to ensure that the contingency is adequate. Use an expected value estimate for estimating the top-ranked risks. Calculate the expected value by multiplying the product of the impact should the risk occur by the probability of the occurrence (e.g., $1,000,000 x 0.50 = $500,000). Use additional contingency above the allowable range if warranted by the expected value analysis.

Type III Risk Analysis Contingency

- Contingency in a Type III risk analysis involves a quantitative risk analysis and the development of a stochastic estimate for cost and schedule. A consultant will be required to conduct this analysis as Mn/DOT does not have in-house expertise in this area. A Type I or II analysis can be conducted prior to procuring a consultant, if desired.

Update Contingency (A3133)

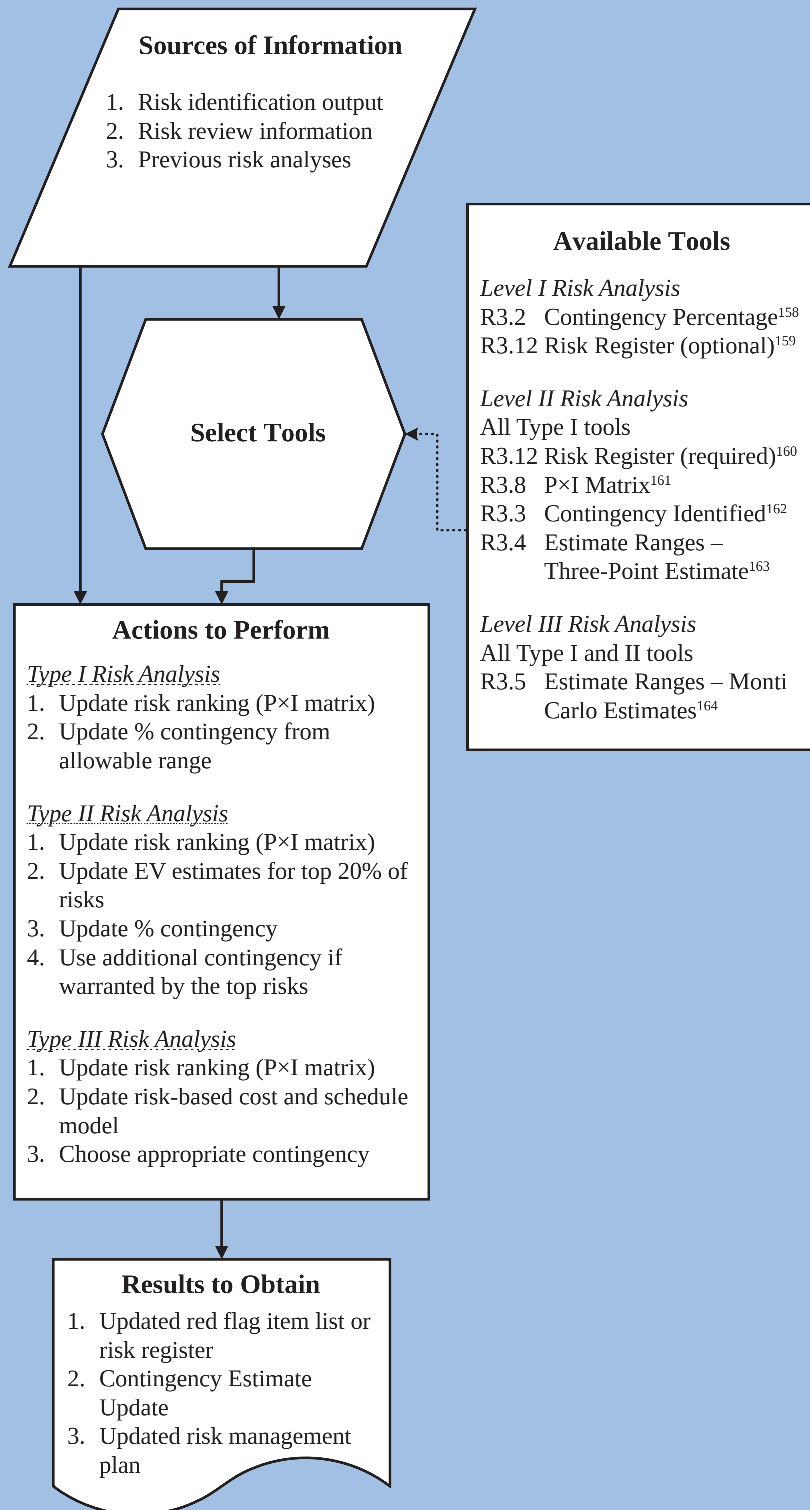
Inputs for the contingency estimate come from the risk identification output (see A3132) and risk review information (see A3131).

Update the PxI matrix (probability times impact) to assess and provide an initial risk ranking in all risk analyses. The Type III risk analysis will use the PxI matrix results as a basis for developing a more rigorous quantitative risk analysis.

Ideally, contingency will be resolved (or reduced) at each estimate update. However, if significant new risks are realized, the contingency may need to be increased in rare circumstances.

When choosing the appropriate contingency percentage in a Type I risk analysis, consult the appropriate range of contingency from the contingency percentage (see tool R3.2).

At this time, Mn/DOT does not have in-house experts for conducting quantitative (Type III) risk analyses. Upon collecting all risk information, select a consultant to assist in developing a risk-based cost and schedule model. Use the model to select the appropriate contingency. Ideally, use the same consultant for model updates throughout project development.



158. For R3.2 Contingency Percentage, see page 430.
159. For R3.12 Risk Register (optional), see page 446.
160. For R3.12 Risk Register (required), see page 446.
161. For R3.8 P×I Matrix, see page 443.
162. For R3.3 Contingency Identified, see page 433.
163. For R3.4 Estimate Ranges – Three-Point Estimate, see page 435.
164. For R3.5 Estimate Ranges – Monti Carlo Estimates, see page 437.

Document Risk and Contingency (A3134)

Step Requirements

At a minimum, this step requires the Estimator and project team to update list of risks and uncertainties. Keep the list in the cost estimate file and summarize it for communication of the cost estimate.

Maintenance of a risk register (R3.12) is a requirement for Type II and III documentation. It is also a good practice for Type I documentation. The register should provide, at a minimum, a detailed description of the risks, their probability of occurrence, their impact if they occur, the strategies to manage the risks, an assignment of ownership for the risks, and a schedule for risk resolution. Type I risk analyses can be documented through red flag lists (I2.1), but Type II and III risk analyses should always be documented through a risk register.

A formal risk management plan (R3.1) is a requirement for Type III documentation, but it is also good practice for Type II documentation. The risk management plan generally documents the structure of risk management for each project. The risk management plan includes, at a minimum, the approach to managing the risks, roles and responsibilities, budgeting, timing, reporting formats, and tracking.

Issues to Consider

Application for Cost Management

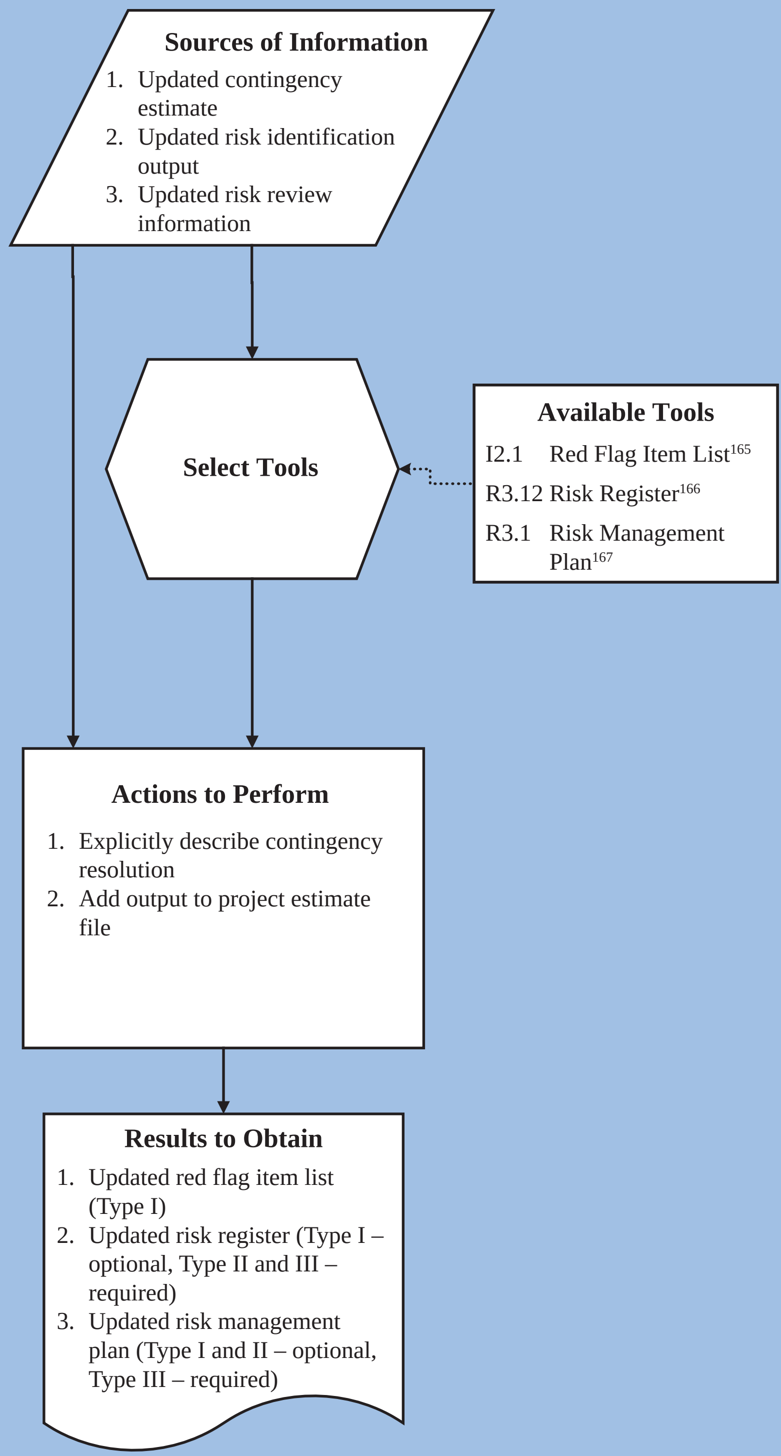
- Documentation of the risk and contingency basis is vital for cost management. As the project progresses through the project development phases, risks will either be realized or resolved. Ideally, the team will actively manage the risks and update the contingency estimate throughout the project development phase. Risks and contingency must be clearly documented with each estimate if they are to be actively managed.

Document Risk and Contingency (A3134)

Provide an explicit update for risk and contingency resolution. Describe which risks have been realized, mitigated, or avoided. Describe any new risks that have been identified. Summarize the resulting changes to the contingency estimate.

Collate all risk and contingency information for use in cost management throughout the project development process. Each future estimate will involve an update of risks and an update of the contingency estimate. Documentation will allow for active risk management and appropriate contingency resolution.

Risk and contingency documentation is an important step in estimate communication.



165. For I2.1 Red Flag Item List, see page 411.
166. For R3.12 Risk Register, see page 446.
167. For R3.1 Risk Management Plan, see page 425.

Revise Total Project Cost Estimate (A3135)

Step Requirements

This final sub-process step involves adding the base cost estimate and contingency estimate to arrive at a total project cost. Consult the Total Project Cost Estimate Spreadsheets for proper format.

Issues to Consider

Presentation of Contingency

- Contingency will be included in a separate section of the estimate and summarized on the estimate summary sheet. It will not be included in estimate line item costs. In the contingency estimate, include the greatest level of detail that the contingency estimate can support. For example, a Type I analysis using a percentage contingency may include only one item for contingency based on a percentage of the total project cost. A Type I contingency estimate cannot support separate contingency estimates for the categories in the Total Project Cost Estimate Summary. A Type II or III analysis may support contingency for various categories of the Total Project Cost Estimate calculations (e.g., separate contingencies for right of way, utilities, etc.). When tying contingency directly to individual line items, explicitly identify the contingency and do not "bury" it in the unit price for the line item. For example:

Group	Item	Base Cost	Contingency	Total Cost
Construction	Muck Removal	$$$	$$$	$$$

Application of Inflation

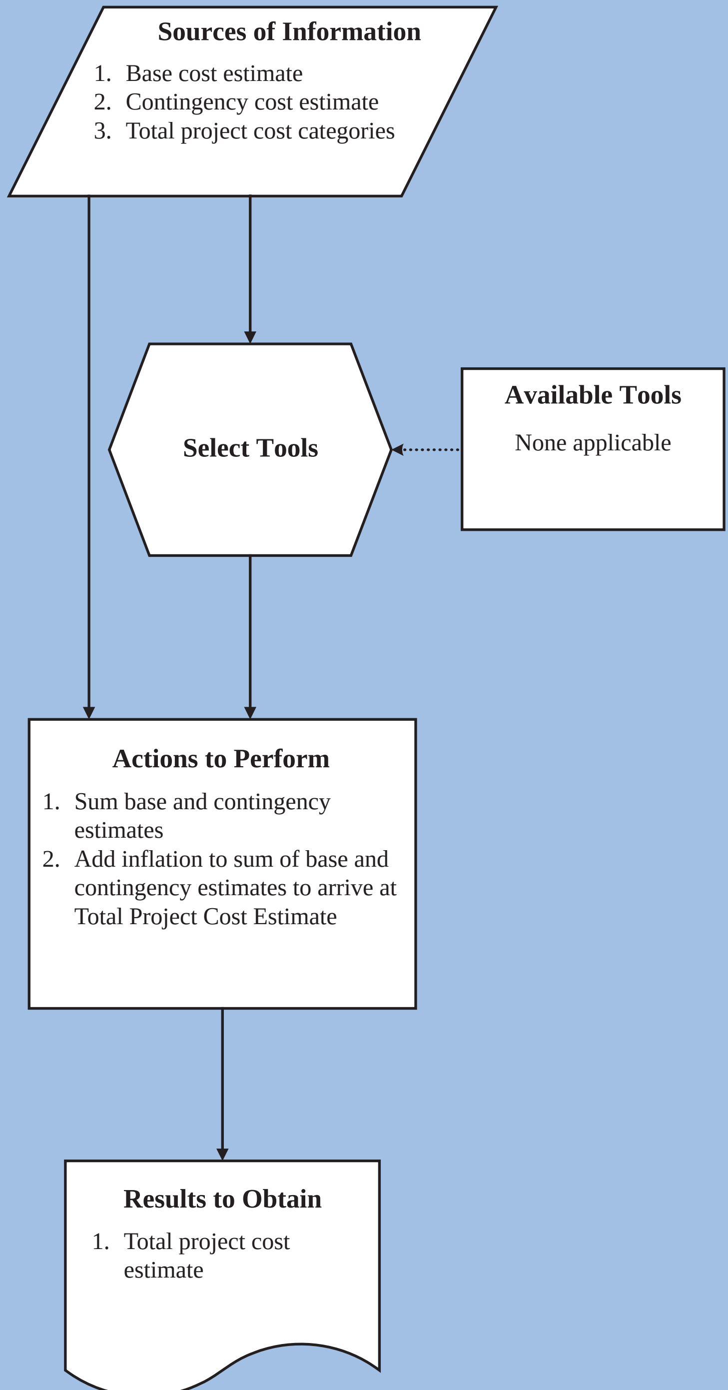
- The Office of Investment Management provides an overall inflation factor for application to each project. Individual items within a project may include a risk and associated contingency for escalation (e.g., steel bridge costs may have an identified contingency for probable steel escalation). The inflation adjustment is for the overall project inflation and should be added to the project in addition to any identified contingency items. Add the inflation factor after summing the base and contingency estimates. Inflation should be applied to the midpoint of construction to reflect a year-of-construction estimate.

Revise Total Project Cost Estimate (A3135)

Mn/DOT is committed to communication of cost estimates through total project cost, which includes the base estimate plus the contingency. Include contingency in the means by which it was calculated (e.g., by percentage sum or by individual items). Communication of contingency resolution from the last published estimate is an important element of this process.

Inflation is added to the estimate, in addition to any identified contingency. Inflation is applied to the sum of the base and contingency estimates for the overall project.

Calculate inflation to the midpoint of construction.



III.4.2.4 REVIEW AND APPROVE UPDATED ESTIMATES (A314)

A purpose of the Review and Approve Estimate sub-process is to ensure that the estimate is as complete and accurate as possible based on the project requirements as described in the current plans and specifications. This sub-process is critical as it represents final acceptance of the cost estimate before the estimate is released to both internal and external project stakeholders. This sub-process has seven steps. The steps are as follows:

1. Reconcile with Latest Estimate – A3141
2. Determine Level of Review – A3142
3. Review Estimate Assumptions – A3143
4. Verify Completeness and Cost Data – A3144
5. Prepare Estimate Package – A3145
6. Approve Updated Estimate Package – A3146
7. Prepare Project Change Request – A3147

These seven steps provide a natural progression of effort to review and approve the total cost estimate update during the Design Phase. The first step requires reconciliation with the baseline cost estimate, and noting any changes that have been made or need to be is essential to the cost management process. The second step requires a decision on the level of review required. The level of review is tied to project type and complexity. The next two steps would likely be performed at the same time. Once these two steps are complete, a package can be assembled for final approval of the baseline cost estimate. There are two key inputs required:

- **Updated Total Project Cost Estimate Package** – contains the updated base cost (summary and details) and contingency, all supporting documentation related to estimate basis, assumptions, backup calculations, risks, and other areas of uncertainty.

- **Project Characteristics** – description of the type of project and complexity of the project, including site-specific information and/or data that may impact the base cost and contingency.

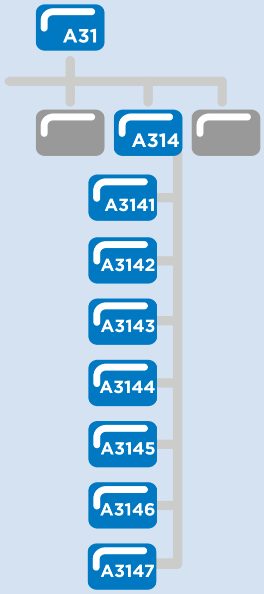
- Approved Baseline Cost Estimate Package (see page 187)

The Estimator should review the RACI matrix and determine his or her role in this function, as well as the roles of management, other estimating groups, Project Management, and Functional Groups.

It is highly recommended that the accountability for the approval of the estimate be held by someone in District management with a gated process for a signature needed to advance project to the next step. Accountability and responsibility for the review steps will likely rest with the Estimator and the Project Manager.

The key inputs are then used when performing the seven steps of this sub-process. The output of this sub-process is an Approved Updated Baseline Cost Estimate Package. If the review finds no issues with the estimate, the estimate moves toward approval and then the Determine Estimate Communication Approach step. Sometimes modifications to the estimate will be necessary before it can be passed forward, so it might cycle back through the prepare estimate and risk steps before advancing.

The Review and Approve Estimate sub-process is critical as it represents final acceptance of the cost estimate before the estimate is released to both internal and external project stakeholders.



Reconcile with Latest Estimate (A3141)

Step Requirements

This step requires that the Estimator review not only the Updated Total Project Cost Estimate but also the previous Total Project Cost Estimate Package in order to attempt to reconcile the differences between the two.

Verification may be obtained using available tools, such as an estimate checklist. However, when considering an estimate checklist, remember that the checklist is intended to guide the Estimator through suggested items and consideration of factors that impact the project costs; the Estimator should also consider items that are not on the checklist.

The output of this step will be a detailed list of all estimate changes and/or a detailed description of any potential required changes in the Scope of the project.

Issues to Consider

Estimator Judgment

- The most indispensable tool for estimate review is judgment. Judgment is what identifies mistakes, detects flawed assumptions, and identifies where the process has missed critical cost drivers.

Policy Implications

- The baseline cost estimate will remain unchanged unless the project's original purpose and need defined in the Scoping Report change.

- A Scope Change occurs whenever a change is made to the project's original purpose and need contained in the Scoping Report. A project that experiences a Scope Change must have a new Scoping Report completed.

- A Project Change Request is required if the project's purpose and need do not change, but unanticipated project-related conditions or external events arise that cause a Scope expansion or contraction and a resulting change in the cost estimate.

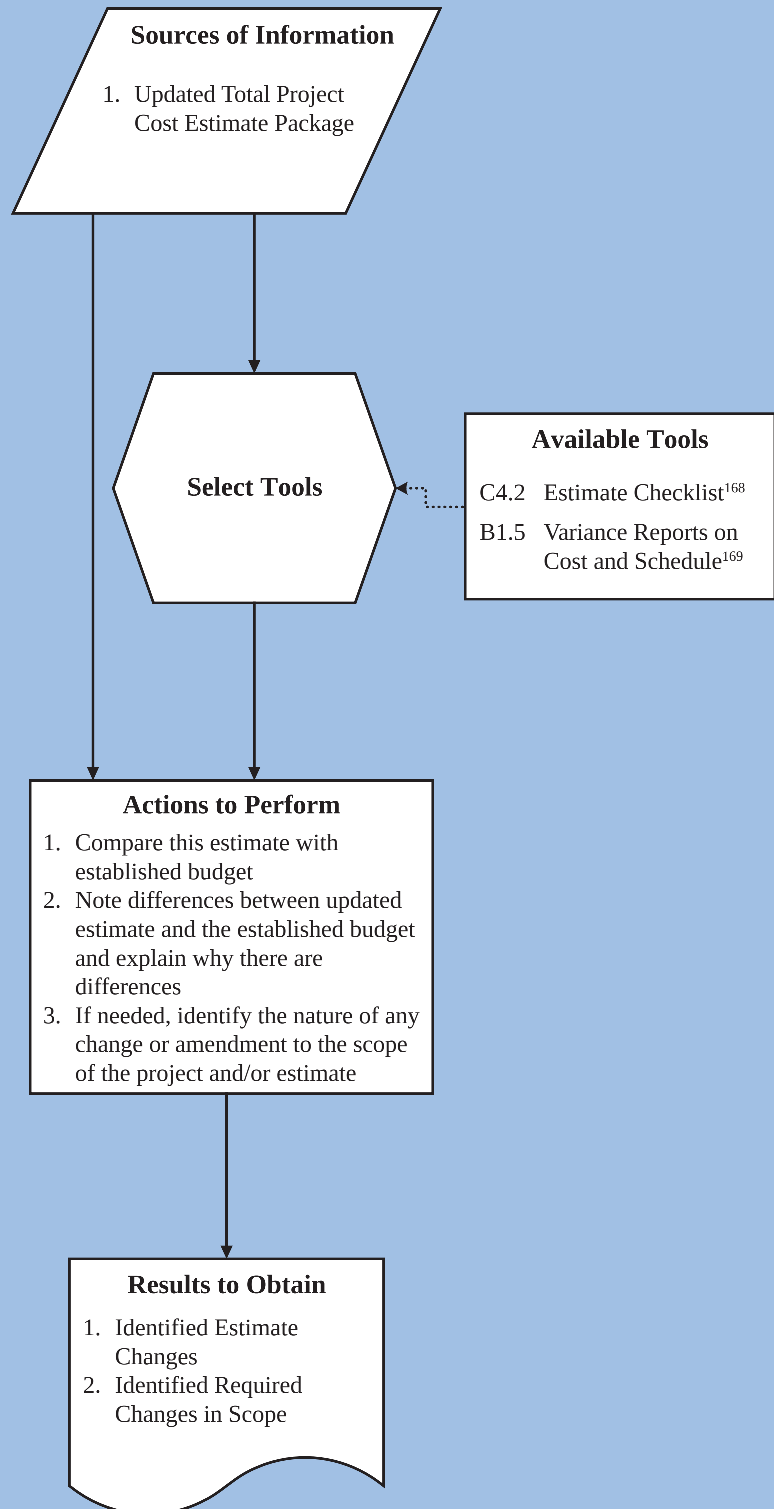
Reconcile with Latest Estimate (A3141)

Review the Updated Total Project Cost Estimate, carefully taking note of any changes from the original cost estimate and/or project definition. Review both the Total Project Cost Estimate as a whole, as well as individual pieces of this total project cost to check for differences. Also, look at individual pieces of the construction cost estimate. Though the totals may be similar, there may be changes in the individual items that need to be reconciled.

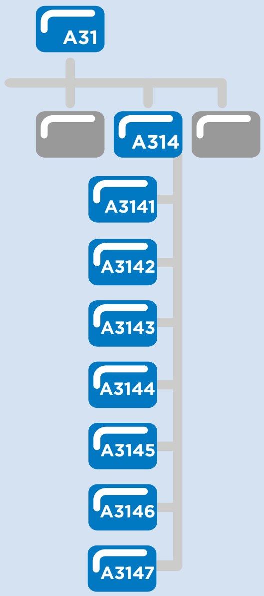
Based on the noted differences, use available Mn/DOT resources, policies, and listed tools, where appropriate, to aid in reconciling the latest baseline cost estimate.

Using the applicable tools, compare the original estimate to the updated estimate to reconcile any differences between the two. When making changes, be sure to adhere to all Mn/DOT policies.

Neatly compile the reconciled information and changes made into a concise document. Be sure to note any changes and reasons for changes. This is important throughout the remainder of this process, as well as in the communication process.



168. For C4.2 Estimate Checklist, see page 449.
169. For B1.5 Variance Reports on Cost and Schedule, see page 477.



Determine Level of Review (A3142)

Step Requirements

The primary inputs for this step include the Updated Total Project Cost and the project complexity definition. The objective of this step is to perform a careful review of the project details and choose the appropriate tools for review. During the risk and contingency process, the project will have been categorized as minor, moderately complex, or major. The level of review correlates directly to these project complexity definitions. Table III.4-4 below provides guidance on which tools apply to the appropriate review level.

Table III.4-4 Review Tools and Project Complexity

Estimate Review Tools	Minor	Moderately Complex	Major
C4.2 Estimate Checklist	✓	✓	✓
B1.5 Variance Reports on Cost and Schedule	✓	✓	✓
E3.3 In-House Peer	✓	✓	✓
E3.4 Round Table Estimate Review		✓	✓
E3.1 Formal Committee		✓	✓
E2.1 Expert Team			✓

Upon choosing the appropriate review tools, plan the review. The review plan should include a schedule for the review and a listing of people who will participate.

Issues to Consider

Policy Implications

- To achieve consistent and accurate cost estimates, Mn/DOT is conducting project cost reviews at critical points or gates during the project development phases. If this project is at one of those gates, be sure to understand and obtain the appropriate review. In the Design Phase, the final estimate will be the Gate G5 (see Figure II.2-1 on page 12).

- The Project Scope and Cost Management office may review major District project estimates for completeness and conformance with established cost estimating processes.

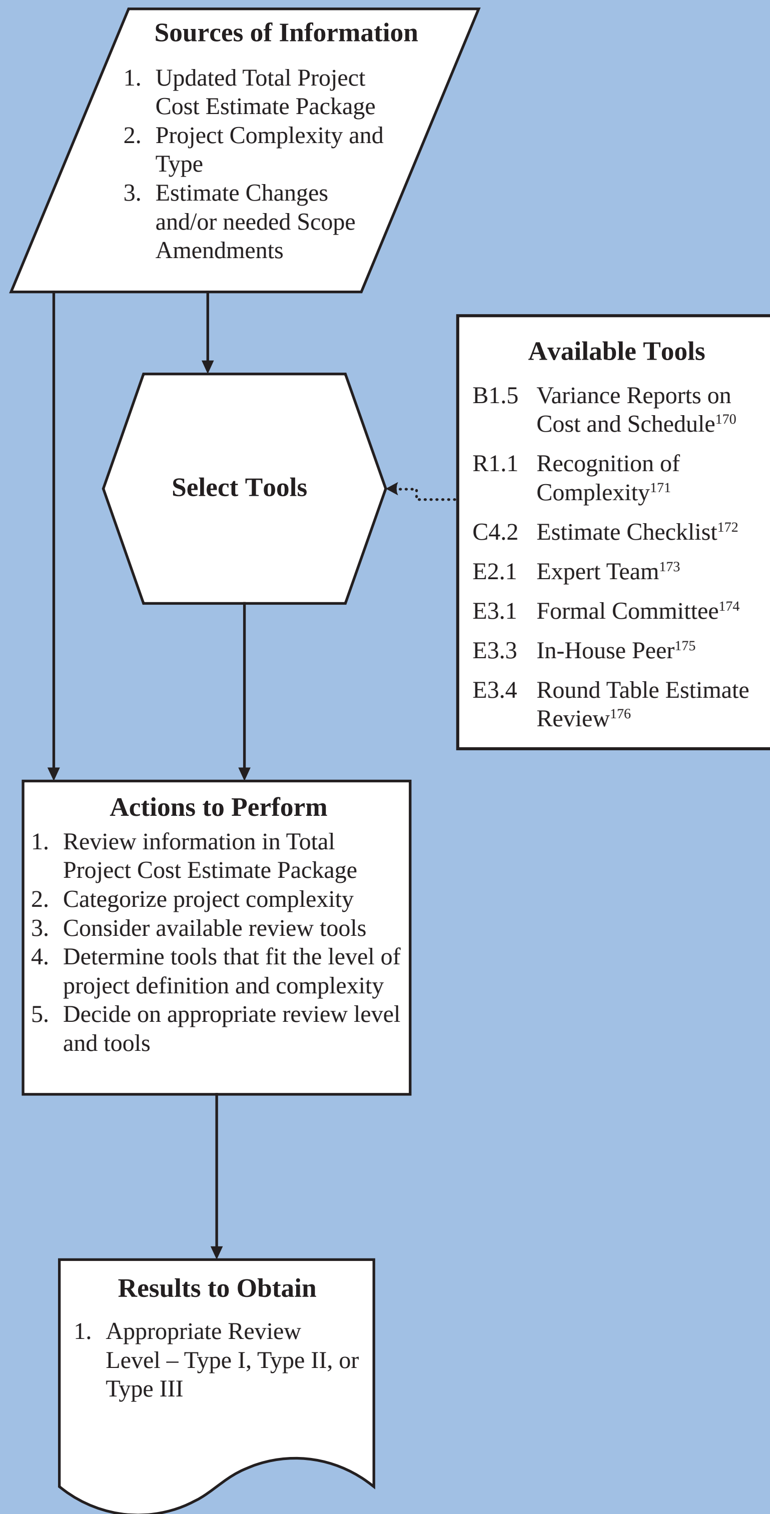
Determine Level of Review (A3142)

Review the Updated Total Project Cost Estimate Package and the overall project complexity and type in order to choose an appropriate review level. There are different tools that can be used for the different levels of complexity.

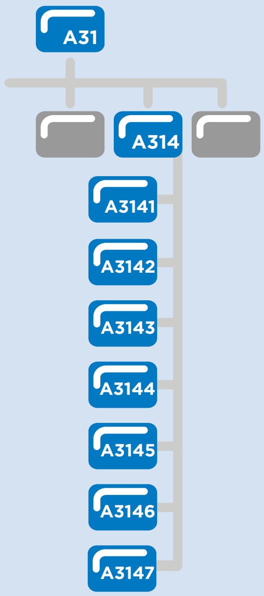
Read through the list of available tools and take them into consideration later in this step and process.

Using the input information about size and complexity and the available tools list, review the information about each tool to decide which tools should be used. Consider the tools that have been previously used in the project development process to perform this function. This may help direct the tool choice at this time.

The output is an appropriate review level and a list of tools to be used in the review process.



170. For B1.5 Variance Reports on Cost and Schedule, see page 477.
171. For R1.1 Recognition of Complexity, see page 343.
172. For C4.2 Estimate Checklist, see page 449.
173. For E2.1 Expert Team, see page 467.
174. For E3.1 Formal Committee, see page 451.
175. For E3.3 In-House Peer, see page 454.
176. For E3.4 Round Table Estimate Review, see page 456.



Review Estimate Assumptions (A3143)

Step Requirements

This step requires that an appropriate review level and the Updated Total Project Cost Estimate Package be reviewed using the list of applicable tools to determine if the correct assumptions and conclusions were made about the project.

Issues to Consider

In this step, all of the information in the Updated Total Project Cost Estimate Package should be considered to ensure that the correct assumptions were made. This can easily be accomplished by using the tools available for the review and approval process.

To be successful, the review must closely examine the assumptions that form the basis of the estimate, and knowledgeable and experienced individuals from within the agency must conduct the review. When software is used to generate the estimate, the information fed into the computer program must be examined during the review. Conducting reviews at appropriate times during the development of Programming estimates provides assurance that the estimates are reasonably accurate for the existing knowledge of project definition and site conditions.

Policy Implications

- Contingency is not to be incorporated in individual line item costs; be sure to review to ensure that this is the case.

Change

- The focus of this estimate may be in one of two different areas. This purpose may be to estimate all of the costs associated with this project, or it may be to estimate only what has changed since the previous estimate. Details or the level of information may have changed for certain items since the previous estimate. The entire project does not always have to be re-estimated; the Estimator may chose to focus only on the areas of change.

Review Estimate Assumptions (A3143)

Review the Updated Total Project Cost Estimate Package based on the chosen review level.

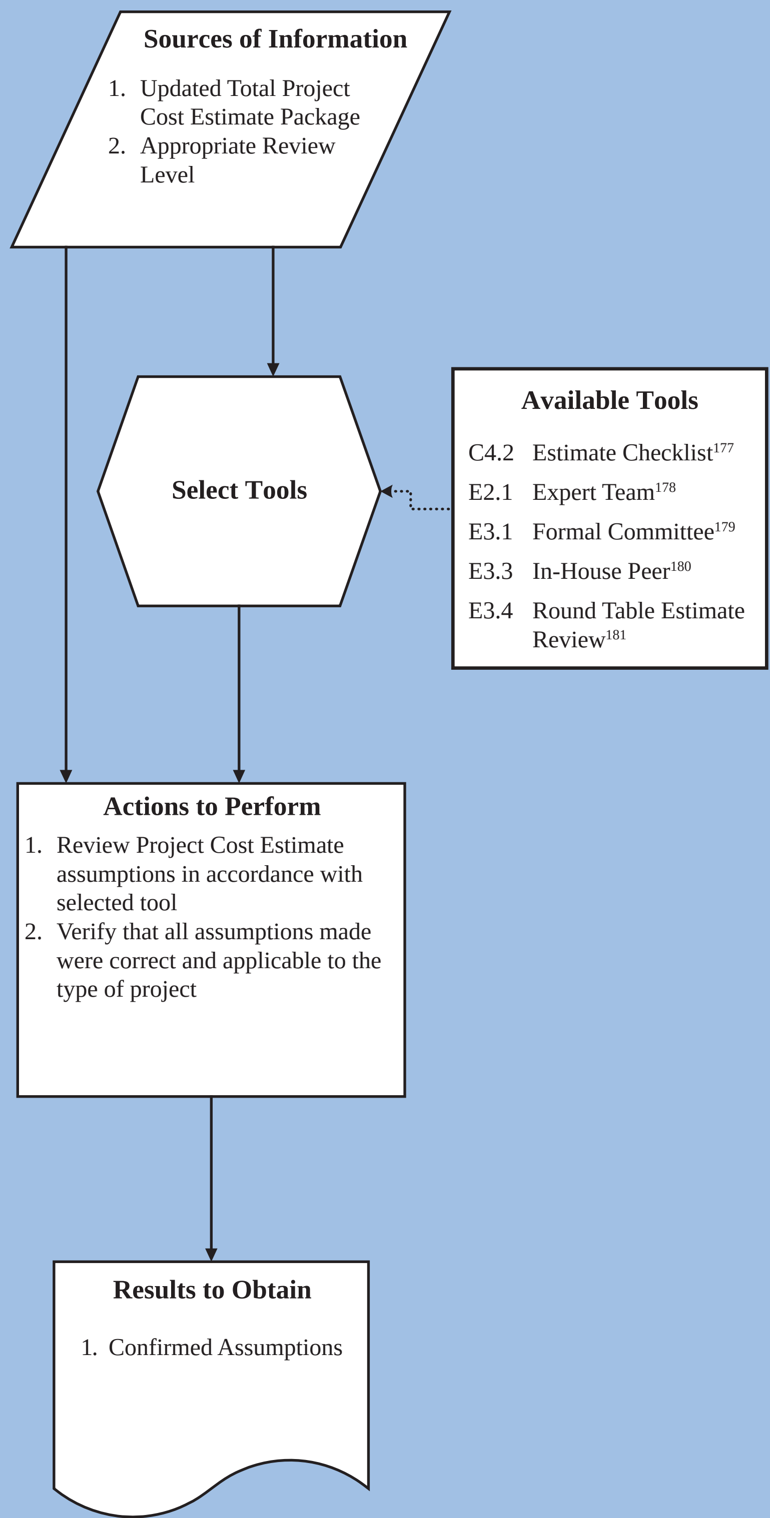
Review the list of available tools and their applicable levels of complexity. Choose the most appropriate tool(s) (see Table III.4-4). This choice should be based on level of complexity and previous use of tools, as well as other considerations.

Utilize the Office of Project Scope and Cost Management resources to contact and engage these outside parties for review tools that may require the presence of parties outside the District or outside of Mn/DOT.

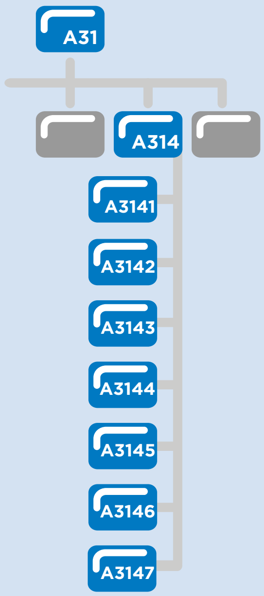
Major complexity projects are not just in the metro area; these projects can occur in outstate Districts. It is best to appropriately acknowledge the level of complexity of the project and work with the appropriate tools, even if it is not the norm of the District.

Using the tool descriptions, review the Updated Total Project Cost Estimate Package to verify that the assumptions are correct and documented.

After reviewing the input information and applying the applicable tools, the Estimator has either confirmed or disaffirmed the assumptions in the Updated Total Project Cost Estimate Package.



177. For C4.2 Estimate Checklist, see page 449.
178. For E2.1 Expert Team, see page 467.
179. For E3.1 Formal Committee, see page 451.
180. For E3.3 In-House Peer, see page 454.
181. For E3.4 Round Table Estimate Review, see page 456.



Verify Completeness & Cost Data (A3144)

Step Requirements

This step requires that an appropriate review level and the Updated Total Project Cost Estimate Package be reviewed using the list of applicable tools to determine if the data in the package is complete and correct.

The Estimator or estimating team that prepared the estimate should conduct the first review of the project estimate. This is essentially a screening review that ensures the math is correct, the process is documented, and the estimate was developed following Mn/DOT guidelines.

It is always necessary to independently verify that an estimate is complete, that it matches the project definition, and that it is consistent with known site conditions. Because the outcome of this process is the Approved Updated Cost Estimate that will be used as a cost performance measure throughout the project, the review step at this time is even more critical. A second autonomous set of eyes reviewing the estimate will afford managers and decision makers an opportunity to capture a different perspective, or at least a second opinion.

Issues to Consider

- When verifying the completeness of the data, you should consider any historical data that might be available and also review all calculations made to ensure their correctness. Also, a site visit might aid in verifying the completeness of the data.

- The formality of a project estimate review and the depth of the review at each stage in project development will vary depending on the project type and complexity, so remember that while a project may warrant one type of review in this stage, that does not mean the same review should have been conducted in earlier or latter phases.

- Based on project complexity (Tool R1.1), if the project is considered minor or non-complex, use the In-House Peer Review. For major or very complex and high-profile projects, seriously consider an external review of the estimate using an expert team of qualified professionals. The expert team can complement reviews conducted using a formal committee or a round-table approach. Moderately complex projects may be reviewed using any one of the internal or external review tools.

Verify Completeness & Cost Data (A3144)

The Updated Total Project Cost Estimate should be used again for the verification of the completeness and cost data.

From the list, select the applicable tools based on the predetermined project complexity. There are a number of tools available for this; utilize one or more as appropriate. These tools can be utilized individually or harmoniously.

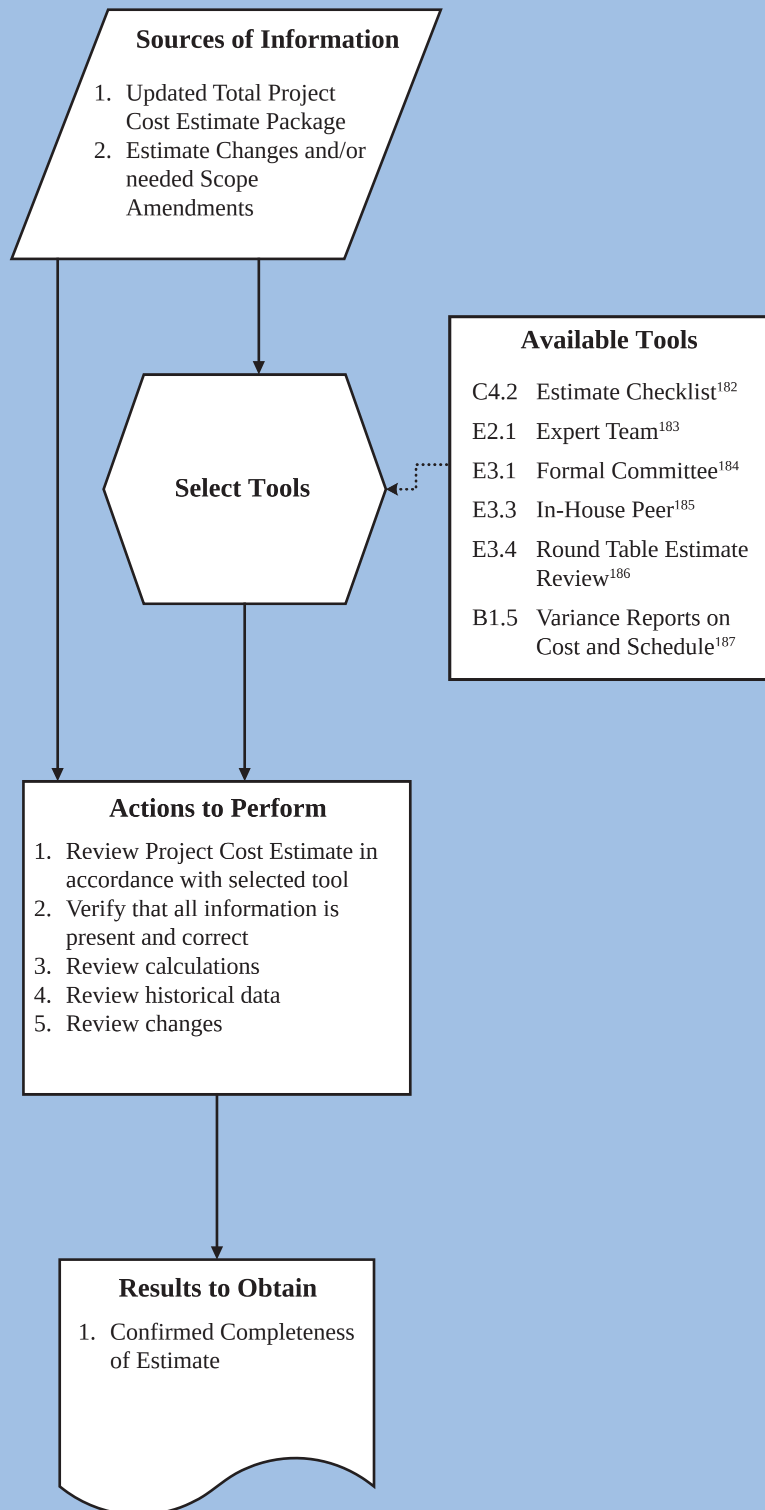
Contact the Office of Project Scope and Cost Management for resources external to the District.

When utilizing a computer program to develop the estimate, ensure that all equations are correct.

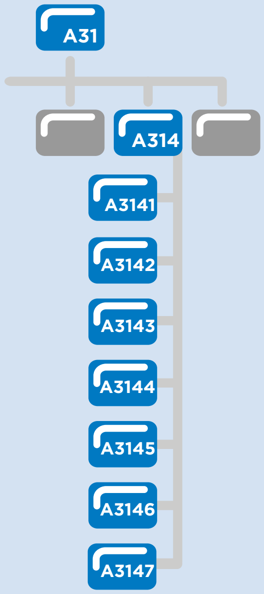
It may seem very elementary, but check the input and output values. Does it all make sense? Remember to do this for quantities as well as dollar values. Also, remember to make sure no numbers are transposed in the input values.

Using the tools and the Updated Total Project Cost Estimate Package, verify that the data is complete and that the cost estimates are correct. Consider using any historical data or a site visit to accomplish this.

The output of this step should result in a confirmation of the completeness of the data and a verified estimate.



182. For C4.2 Estimate Checklist, see page 449.
183. For E2.1 Expert Team, see page 467.
184. For E3.1 Formal Committee, see page 451.
185. For E3.3 In-House Peer, see page 454.
186. For E3.4 Round Table Estimate Review, see page 456.
187. For B1.5 Variance Reports on Cost and Schedule, see page 477.



Prepare Estimate Package (A3145)

Step Requirements

For this step the primary inputs include the Total Project Cost Estimate, the project assumptions, and the changes in the estimate. The Estimator should use this information to prepare a final estimate package that is ready for review.

Issues to Consider

When performing this step, use the estimate checklist to ensure that no important items are overlooked. Be sure that all documentation is clear and concise and that it allows the easy retrieval of key information. All project specifics should be written such that anyone who is not familiar with the project may still have a good understanding of the following:

- what the project definition is and is not,
- what the design entails,
- what the associated costs are, and
- what the risks are.

The Estimator should also note whether a completely new estimate was completed for the entire project or was completed only for certain aspects of the project where changes took place as the plans became more complete. It is acceptable to only complete a new estimate when changes have occurred and maintain the previous estimate information when there is no new information. However, when doing this, care should be taken that items are not missed or double counted.

Prepare Estimate Package (A3145)

Review the Updated Total Project Cost Estimate, along with the confirmed assumptions, the reconciled changes made, and the identified Project Change Request needed (if needed).

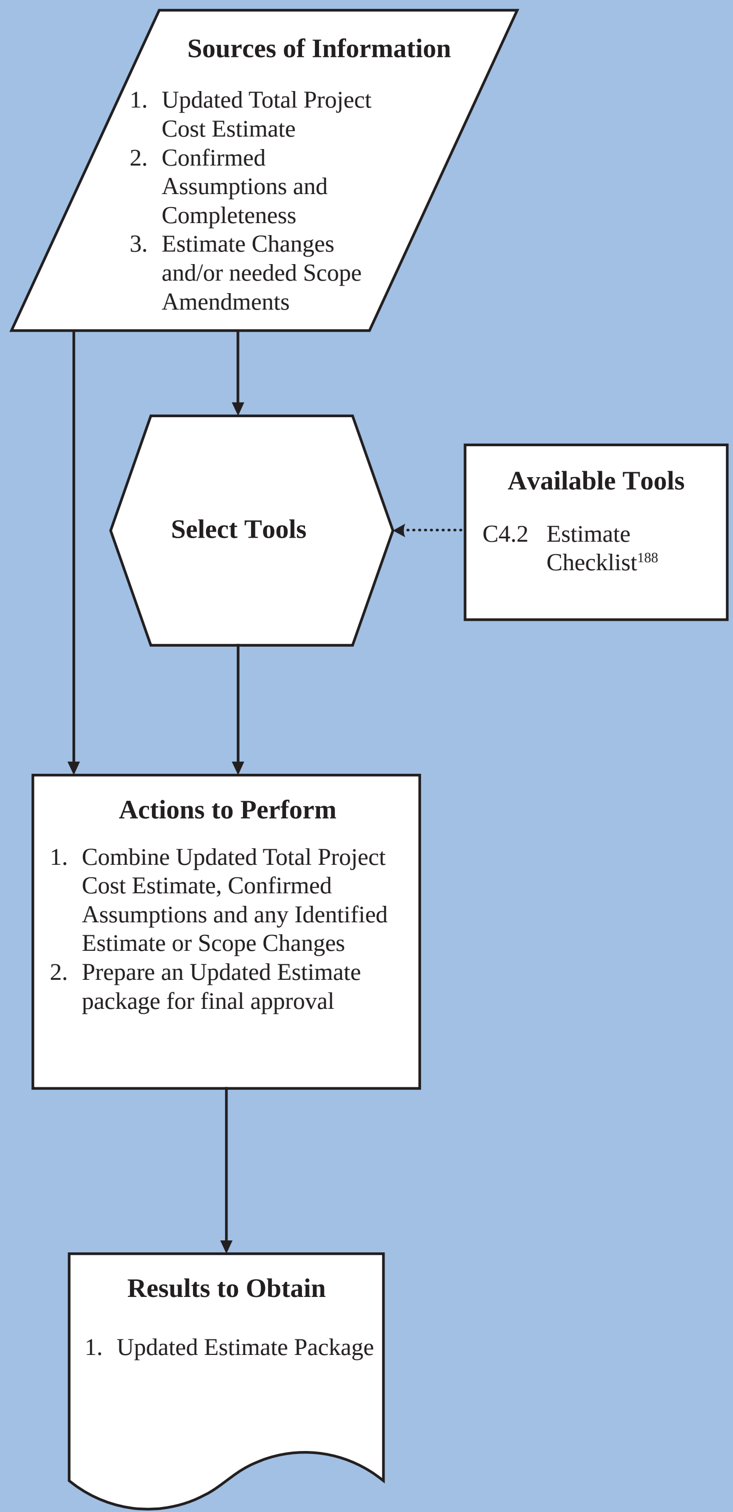
Use the estimate checklist to ensure that no important items are missed in preparing the Updated Estimate Package.

Use the input information to prepare a final Updated Estimate Package that is easy to understand and ready for final approval.

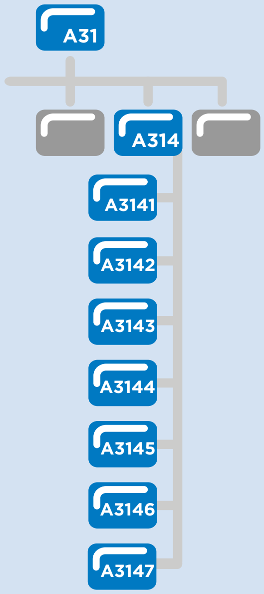
Obtain an Updated Estimate Package with changes that clearly defines all project details, assumptions, uncertainties, and reconciled changes for final approval.

If only changes were estimated, this should be clearly noted in the documentation.

The output of this step will form the basis of the approval of the cost estimate; it needs to be a concise document, but it also needs to accurately and fairly convey the project changes and the cost of the project.



188. For C4.2 Estimate Checklist, see page 449.



Approve Updated Estimate Package (A3146)

Step Requirements

This step entails inputting the final estimate package and giving it a final formal review and approval. The estimate may have been completed only for items where changes have occurred. This should be clearly detailed for approval.

Issues to Consider

When presenting the estimate package for review, be sure to present the most important facts of the project in a clear and organized manner.

Policy Implications

- Cost estimates must be approved by District management before they are communicated to external audiences. Therefore, this step must include approval by a member of District management or someone with the authority to do so prior to conveying any of this information to external sources. On this note, be sure to follow the proper lines of communication, which include completion of the communication process (A315).

- Project costs will be managed against the established baseline cost estimate, which is established at the time the project is included in the STIP.

- While each project phase has an associated Total Project Cost Estimate, only the Total Project Cost Estimate at the time the Scoping Report is approved is designated the baseline cost estimate. After the establishment of the baseline cost estimate, changes will need to be approved. The appropriate approval process must be followed.

- Project Managers must seek and obtain approval from the Program Manager and/or Assistant District Engineer (ADE) for the use of contingency.

One very important note—this approval is two-fold:

1. Approval that the estimate was done using the appropriate procedure, tools, and knowledge.

2. Approval of the estimate amount.

3. Approves any shifts of contingency to base.

Approve Updated Estimate Package (A3146)

Review the Updated Cost Estimate Package and begin to prepare a presentation of the project's most important details and facts.

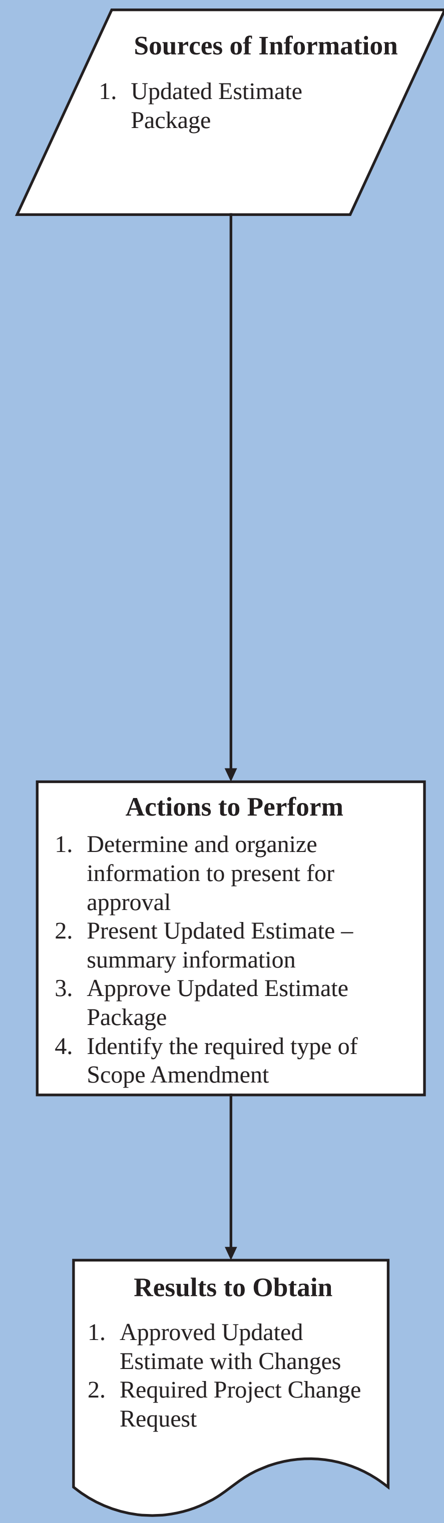
All information should be presented in a clear and concise manner. The established estimate changes and/or the needed Project Change Request should be identified. When presenting information, be sure to include any key assumptions made and any associated risks or uncertainties with the project.

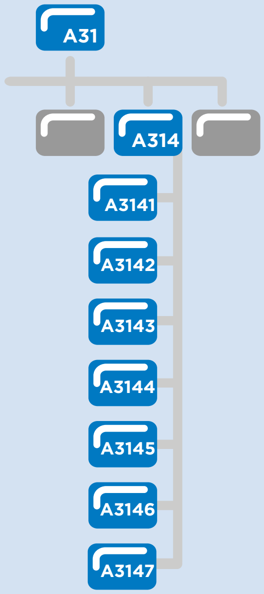
Special care should be taken to identify estimates that were performed only on changes in project information versus entirely new estimates. When estimates are completed only for changes, these change areas should be clearly identified.

Address any questions clearly in order to obtain final approval of the Baseline Cost Estimate Package. All estimate approvals should be conducted in accordance with applicable Mn/DOT policies.

The output is the Approved Updated Cost Estimate Package with changes and, if needed, a detailed description of the required Project Change Request.

Once the estimate is approved, a Project Change Request Form should be completed, if required. Finally, the estimate should be communicated (see A315).





Prepare Project Change Request (A3147)

Step Requirements

The primary input for this step is the Approved Updated Cost Estimate with changes and the Project Change Request Form. Review the newly updated estimate and all of its changes. Then complete the following steps.

- Determine Type of Change
  - Project Definition related
  - Design Development
  - Site Conditions
  - Market Conditions
  - Estimate Variations
- Determine if the Change is Appropriate
  - Depending on the complexity of the issue, this step may require the evaluation of the original Scoping committee.
- Complete Draft Project Change Request Form
- Document Change and Effects in Project Change Request
- Obtain Approval for Change Request
  - If there is more than one Project Change Request for a project, they should be sequentially numbered.

Issues to Consider

No matter how well Scoping is performed, there will be instances where conditions change or where something that was not known during Scoping will be discovered during the Design process. These instances will require a change to the Scope of the project. The Project Change Request process allows the impacts of these proposed changes to be evaluated, documented, and approved.

The Project Manager determines the appropriateness of the change and evaluates the impacts of the proposed change in terms of cost, schedule, letting, and re-work by other sections. The impacts are documented in a Project Change Form, which must be approved by the ADE (or other). Below are a few minimum criteria to be used to evaluate whether a change in the project constitutes a legitimate Change and will require a Project Change Request:

- causes a public commitment or expectation to change;
- causes the estimate to deviate by $_ (or _ %) from what is shown in the approved Project Scoping Report (these values should be determined by the District);
- causes a change in Letting date;

- causes change in major project elements (e.g., typical section, length); and/or

- causes re-work by a previous project development stage.

Prepare Project Change Request (A3147)

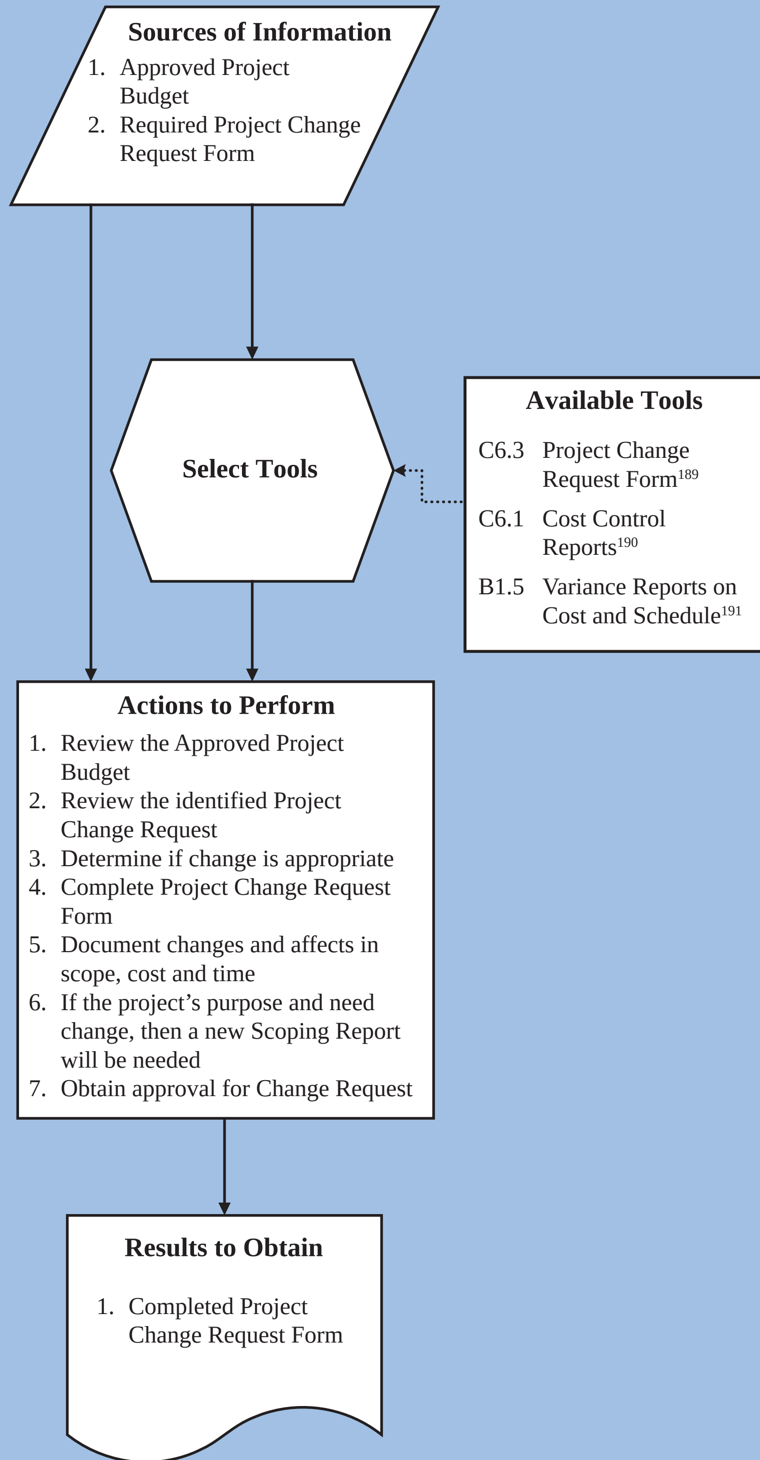
Review the Approved Updated Cost Estimate Package with changes and begin to prepare a Project Change Request process. Use Mn/DOT's standard Project Change Request Form.

Using the available tools and the Project Change Request Form, carefully review the proposed changes in Scope. This step is important because it can directly impact the credibility of Mn/DOT in the eyes of the public or other local partners.

When performing the actions listed, be sure to remember that the impact to the schedule will have to be evaluated as well.

All Project Change Request approvals should be conducted in accordance with applicable Mn/DOT policies.

The output is a request for District Management's approval of the change.



189. For C6.3 Project Change Request Form, see page 483.
190. For C6.1 Cost Control Reports, see page 479.
191. For B1.5 Variance Reports on Cost and Schedule, see page 477.

III.4.2.5 DETERMINE UPDATED ESTIMATE COMMUNICATION APPROACH (A315)

A purpose of the Determine Estimate Communication Approach sub-process is to provide a vehicle for succinctly conveying key project information to both internal and external project stakeholders. This sub-process has four steps. The steps are as follows:

1. Communicate Estimate Basis – A3151
2. Communicate Estimated Costs – A3152
3. Communicate Uncertainty and Assumptions – A3153
4. Prepare Communication Package – A3154

These four steps provide a natural progression of effort to prepare a communication package regarding project definition, cost, schedule, and uncertainty. The first three steps are likely performed at the same time. Once these three steps are complete, a package can be assembled for communicating project information. There is one key input required:

- **Updated Baseline Cost Estimate Package with Changes** – contains the approved base cost (summary and details) and contingency, all supporting documentation related to the estimate basis, assumptions, backup calculations, any estimate changes, risks, and other areas of uncertainty.

Please remember to review the District RACI diagram for roles in this function. The Project Manager is responsible for development of the output of this sub-process with the support of the Estimator in the District.

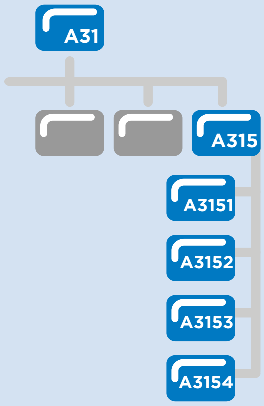
The key input is used when performing the four steps of this sub-process. The output of this sub-process is an Updated Baseline Estimate Communication

Package. This package will include all of the information required for appropriate development of the Mn/DOT One-Page Project Cost Estimate Summary. No matter the size or complexity of the project, all Mn/DOT projects will have a one-pager.

This One-Page Project Cost Estimate Summary is key to communication about the project, both within Mn/DOT and with external stakeholders. This will be the prime source of information about the project for those not closely associated with the project. Therefore, it is imperative that this information is as thorough, concise, and accurate as possible and that it represents the project fairly. Information for this will include, but is not limited to the following:

- the project basis – what is included in the project and what is not;
- the total project cost estimate;
- the uncertainties about the total project cost;
- the assumptions that are made about the project and project cost;
- the project schedule;
- the project development status – where the project is in the project development process; and
- the changes since the last One-Page Project Cost Estimate Summary – this may include risks that have been realized and mitigated or retired.

The One-Page Project Cost Estimate Summary will be the prime source of information about the project for those not closely associated with the project.



Communicate Estimate Basis (A3151)

Step Requirements

The key input for this step is the Approved Updated Estimate Package with changes, which is the output of the Review and Approve sub-process. This document can be extensive, but the Estimator must summarize it for clear estimate communication. The package should be reviewed thoroughly to extract the key information for a summary communication.

Estimate communication will occur internally with Functional Groups and with project team members who will inherit the estimate for later project development and cost control. Communication will also occur with external stakeholders who must understand in simple terms what is in the estimate and what is not.

The final output is a concise and specific breakdown of the project and its estimate basis. Be sure to note project type and complexity.

Issues to Consider

Importance of Estimate Communication

- Estimate communication is vital to successful cost management, and it is even more important when communicating an estimate basis. The Estimator must communicate the estimate basis accurately to avoid the risk of project growth later in development.

Project Characteristics

- Extract only the key project characteristics that comprise the limits of the project and the major cost drivers. If multiple alternatives were considered, be specific as to which project elements were included in the final baseline scope and estimate.

Functional Group Input

- Be certain to request clarification of Functional Group scope when the requirements are not clear.

Communicate Estimate Basis (A3151)

Project type and complexity should have been reviewed in previous steps.

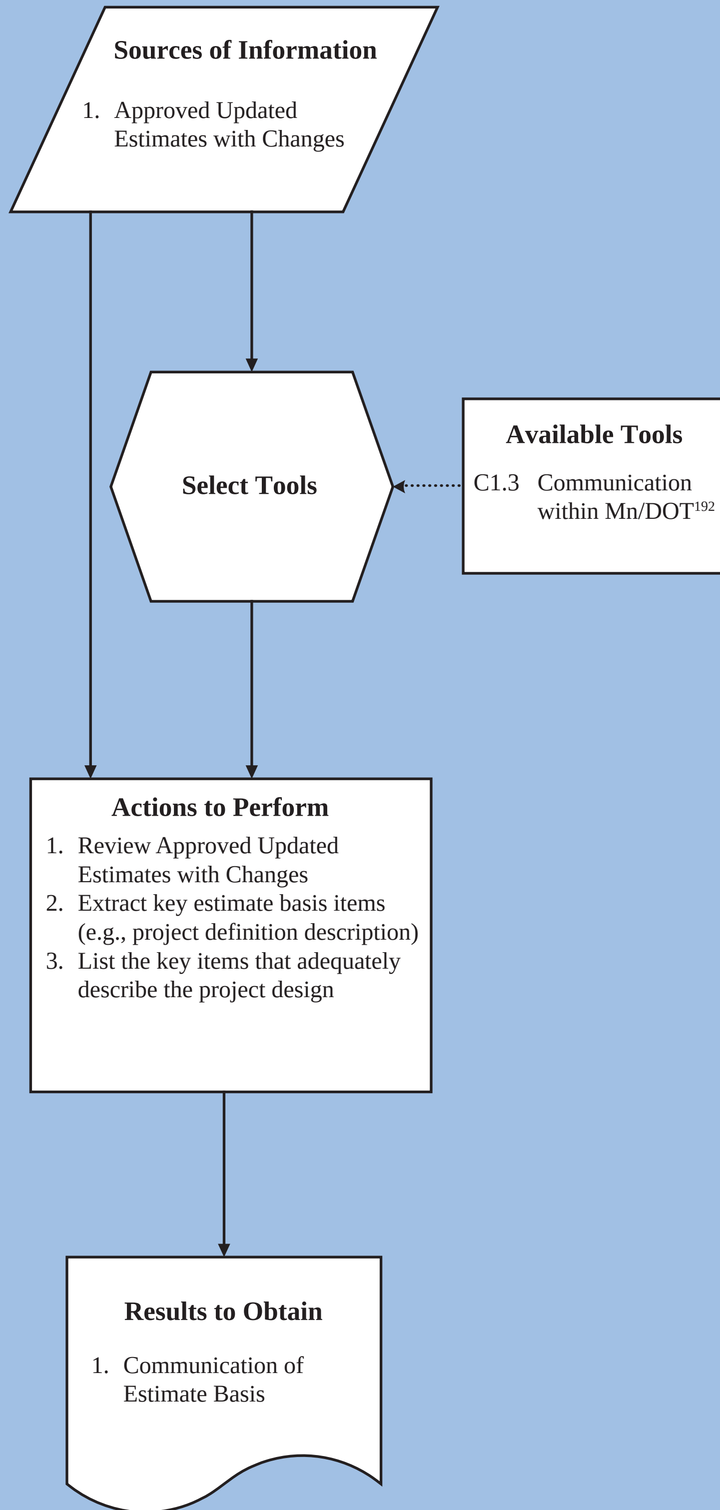
The Estimator needs only to summarize these elements in the communication of the estimate basis. This should include what the project includes and does not include.

Projects should be communicated within Mn/DOT and within meetings involving the estimator staff and reviewers, as well as with external stakeholders.

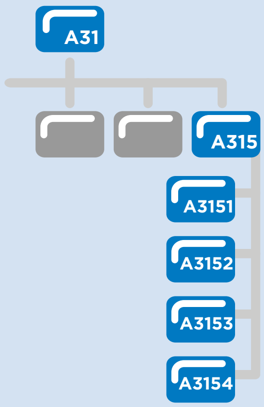
Define the details concisely, yet as completely, as possible; consider using bullets rather than running text. This information will be utilized to communicate both within Mn/DOT and with external participants. Technical terms may be utilized but should be understandable to the traveling public and other external stakeholders.

A focus of the communication should be the basis of the estimate and purpose. Was a new estimate completed on all items of the project or just a select few based on changes made during the design process?

The Estimator should gather all the relevant information required to support the One-Page Project Cost Estimate to communicate the estimate basis.



192. For C1.3 Communication within Mn/DOT, see page 471.



Communicate Estimated Costs (A3152)

Step Requirements

The key input for this step is the Approved Updated Estimate Package with changes. This package will need to be communicated within Mn/DOT and other appropriate authorities. The package should be reviewed thoroughly to identify all assumptions made in creating the estimate. The assumptions need to be listed and organized into a simple-to-understand format.

The final output is a communication of an easy-to-understand, yet specific, Design estimate that clearly lists all of the assumptions made about a project and all known costs.

By actively providing this information, both internal and external parties can track the progression of the project and realize the impacts that are made on the project.

Issues to Consider

Project Characteristics

- This step is to simply identify the assumptions and key cost items from the Approved Updated Estimate Package. The Total Project Cost Estimate must reflect project costs including inflation to the midpoint of construction. This estimate basis needs to be clearly stated.

Functional Group Input

- Request clarification of scope from Functional Groups when the requirements are not clear.

Communicate Estimated Costs (A3152)

The Estimator does not need to consider the project type and complexity in this step because all projects should undergo this process.

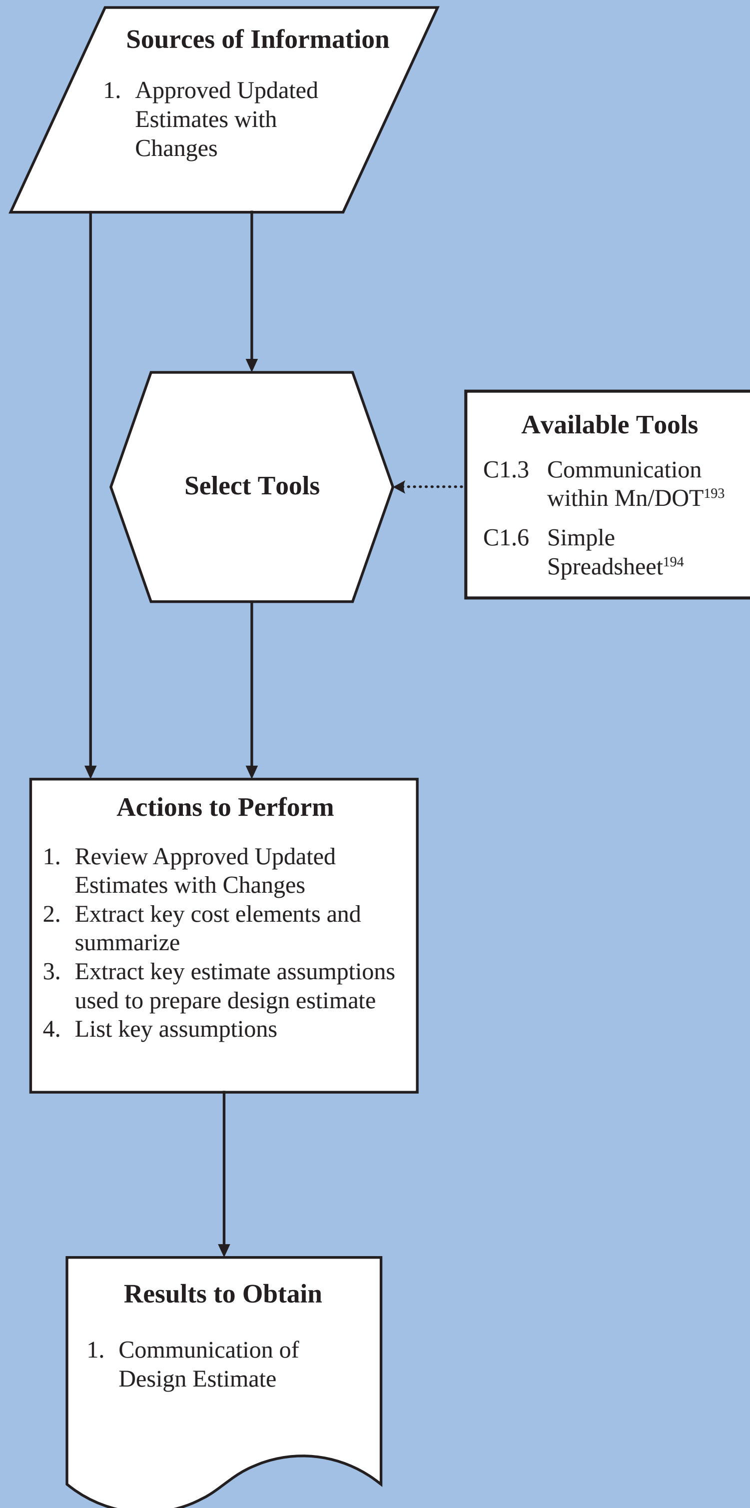
All projects will be communicated using the Total Project Cost Estimate.

The Estimators should review the approved estimate with all changes and extract the key cost items, along with any assumptions made when preparing them. The Estimator should take care in noting assumptions made during the estimating process. This will make it easier to identify these assumptions during this communication process.

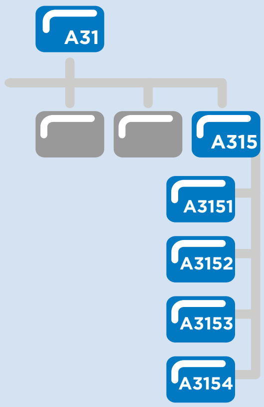
The format for communicating the estimate should be dictated by the One-Page Project Cost Estimate Summary in terms of length and format of information; this may include bullets rather than running text. Be sure to follow the specified format.

If only changes are estimated, this should be clearly communicated, and the estimates for these specific items may need to be detailed in the communication format.

The Estimator should gather all the relevant information required to support the One-Page Project Cost Estimate to communicate the estimate basis.



193. For C1.3 Communication within Mn/DOT, see page 471.
194. For C1.6 Simple Spreadsheet, see page 475.



Communicate Uncertainty and Assumptions (A3153)

Step Requirements

The key input for this step is Approved Updated Estimate with changes. More specifically, the Document Risk and Contingency Basis step (A3135) from the Determine Risk and Set Contingency Estimate sub-process (A313) will provide the input.

Communication of uncertainty creates transparency in the estimating process. Communication of estimate uncertainty is best conveyed through simply listing the assumptions, allowances, unknowns, and contingencies included in an estimate. Rely on the list of risks and contingency estimate in the Document Risk and Contingency Basis sub-process for this information.

The final output is a clearly defined communication of project uncertainty concerning a project.

Issues to Consider

Project Characteristics

- This step is simply identifying the areas of uncertainty from the Estimate File. You do not have to review the tools in this case, just use them appropriately to guide in your preparation. Key risks and areas of uncertainty should be identified as bullets. Other information related to the estimate basis and estimate assumptions should also be clearly stated.

Functional Group Input

- Request clarification of Scope from Functional Groups when the requirements are not clear.

Changes

- When the estimate is completed with a focus only on the changes that may have been made during the Design process, special care needs to be taken with updating the communication piece for the uncertainty. It must be clearly defined if contingency is being utilized or retired as the changes are estimated.

Communicate Uncertainty and Assumptions (A3153)

Project uncertainty should be communicated within Mn/DOT and with the public.

A simple list of project risks and the associated contingency should be prepared to clearly define all uncertainties. This simple list should help in the communication of uncertainty, both externally and internally.

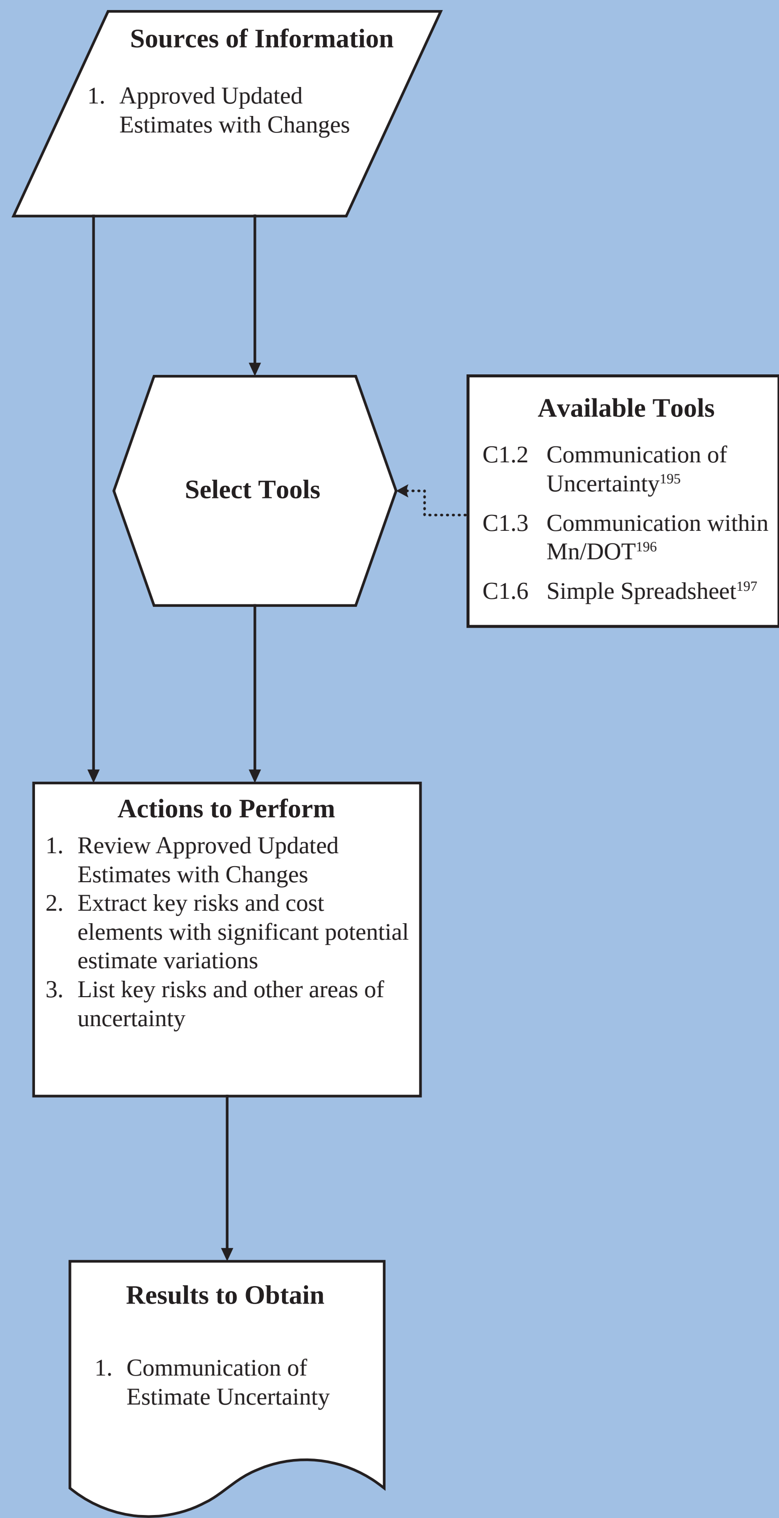
The Estimator should take care to identify assumptions made during the process of identifying and estimating uncertainty.

When preparing communication of the uncertainty, be aware that some uncertainties may have been realized or retired since the previous communication effort. This may need to be noted in preparation of this communication piece.

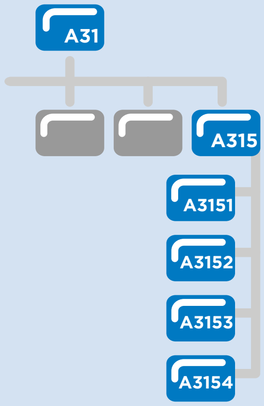
The Estimators should review both estimate packages and extract the key risks and items that offer significant variation in cost. Transparently convey the uncertainty of each estimate. An estimate with uncertainty is not a bad estimate; it is a realistic estimate. Conveying uncertainty will allow for better decisions to be made from the estimate information.

Bullets may be utilized rather than running text in communications.

The Estimator should gather all the relevent information required to support the One-Page Project Cost Estimate to communicate the estimate basis.



195. For C1.2 Communication of Uncertainty, see page 469.
196. For C1.3 Communication within Mn/DOT, see page 471.
197. For C1.6 Simple Spreadsheet, see page 475.



Prepare Communication Package (A3154)

Step Requirements

Informed partners, both internal and external to Mn/DOT, can become partners in the cost estimation and cost management process. Properly communicating the uncertainty involved in an estimate will help to ensure that appropriate decisions are made from the estimate.

The key inputs for this step are the Approved Updated Estimate with changes; the communication package from Scoping; and the communication of the estimate basis, baseline Design estimate, and estimate uncertainty. These inputs will not only need to be communicated within the Mn/DOT and other appropriate authorities, but also to the general public. Therefore, the Estimator and/or Project Manager needs to prepare easy-to-understand spreadsheets and diagrams depicting the information about the projects and all risks and assumptions.

Issues to Consider

Project Characteristics

- This step is the final compilation of multiple estimate documents and packages; therefore, all tools listed should be used when deemed appropriate.

Functional Group Input

- Request clarification of scope from Functional Groups when the requirements are not clear.

Policy Implications

- Remember that all costs are to be expressed in terms of the Total Project Cost Estimate.

- Cost estimates for Design will be documented and will include the following:
  - a description of what the project is and is not,
  - the assumptions used,
  - the extent to which various estimate inputs are developed,
  - the basis of estimate,
  - the base estimate,
  - the separate contingency amount and a description of associated risks,
  - the incentives, and
  - the changes – what and why.

Prepare Communication Package (A3154)

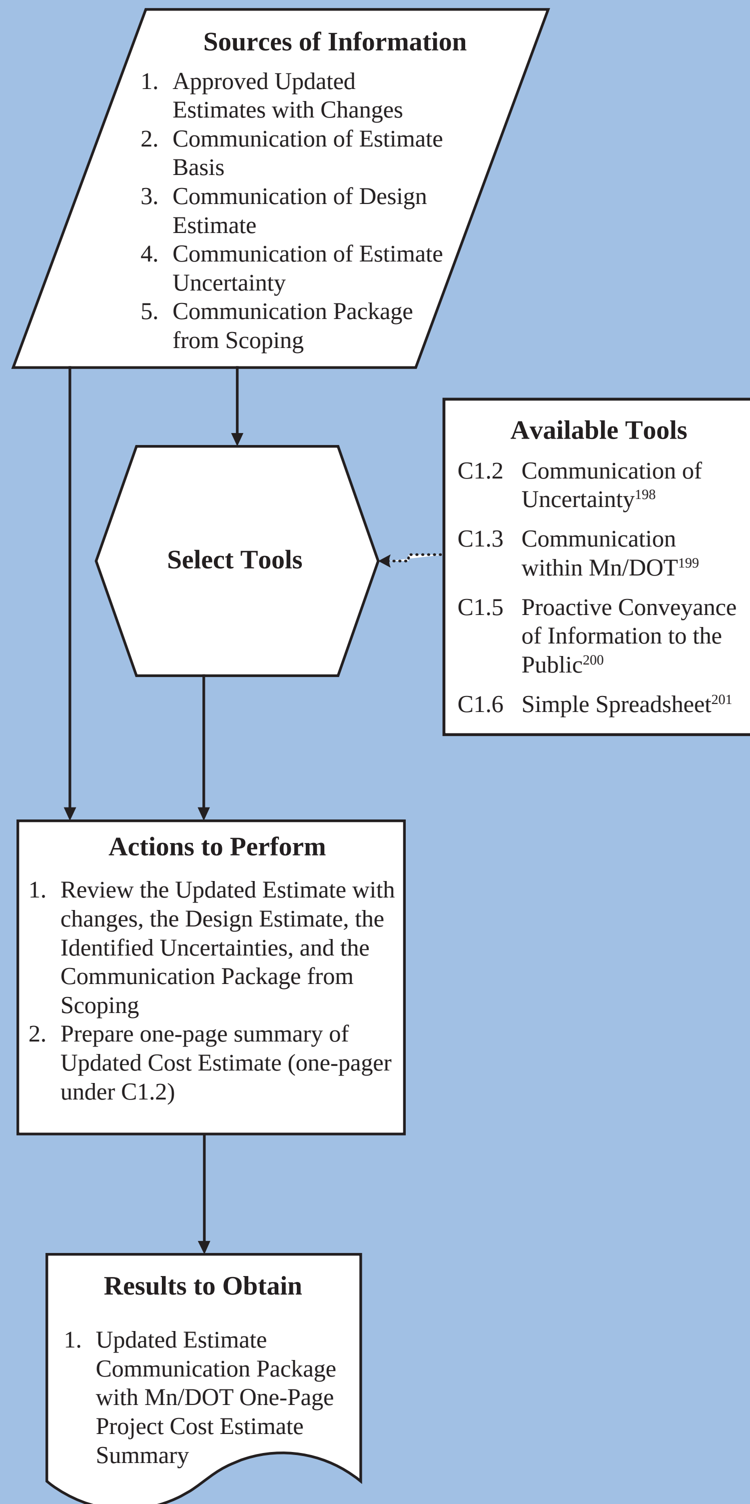
The Estimator does not need to consider the project type and complexity in this step because all projects should undergo this process in the development of a Mn/DOT One-Page Project Cost Estimate Summary.

The uncertainty should be communicated within Mn/DOT, but also to the public. The compiled information needs to be simple and easy to understand.

The Estimator should prepare a one-page document that clearly defines all project characteristics and uncertainties, including the Total Project Cost Estimate. This may simply be an update of the previous one-pager or an entirely new one-pager, depending on the extent of new information.

Consistency is important; be sure to use the standard Mn/DOT format for the One-Page Project Cost Estimate Summary, and to include all of the relevant information as necessary to complete the form. If there is additional information that should be included but there is not a location for on the standard form, contact the Project Scope and Cost Management Office.

The Estimator should compile all of the acquired information into an effective Updated Baseline Estimate Communication Package including an updated Mn/DOT One-Page Project Cost Estimate Summary.



198. For C1.2 Communication of Uncertainty, see page 469.
199. For C1.3 Communication within Mn/DOT, see page 471.
200. For C1.5 Proactive Conveyance of Information to the Public, see page 473.
201. For C1.6 Simple Spreadsheet, see page 475.

III.4.3 COST MANAGEMENT THROUGH ASSESSMENT OF CHANGES

As shown in Figure III.4-5, there are three sub-processes and a number of steps required for each of the three sub-processes that cover this cost management (CM) approach. Individual changes can be identified at any time during Design by any project team member and/or Functional Group. Further, these changes may occur between estimate updates. The intent of CM is to determine quickly if the change should be accepted and approved for inclusion in the baseline cost of a project. However, caution should be taken to only focus on changes that might have a significant cost and time impact. Minor changes are covered in periodic cost estimate updates. This cost management approach is highly correlated with the change request process described in the Scoping Process Manual and as reflected in Figure III.4-1.

III.4.3.1 MONITOR PROJECT DESIGN AND SITE CONDITIONS (A321)

The primary objective of this sub-process is to assess potential changes in a project's definition or site conditions in relation to the baseline definition, cost, and time when they are identified during the Design Phase. This sub-process is performed continuously by all members of the project team. Ultimately, the Project Manager must determine if the change should be evaluated from a cost and time impact perspective. This sub-process has three main steps. The steps are as follows:

1. Identify Potential Change – A3211
2. Determine If Change is Appropriate – A3212
3. Decide to Process Change – A3213

These three steps require several key external inputs that are necessary for the project team to consider the potential change. Some of these key inputs include the following:

- **Design Development** – includes current information and data on alignment, layouts, pavement type, cross sections, and so on. This information expands into final project plans and specifications as the design is completed.

- **Site Conditions** – includes site-related issues that may impact costs, such as current market conditions, new information about environmental issues requiring mitigation, and so on.

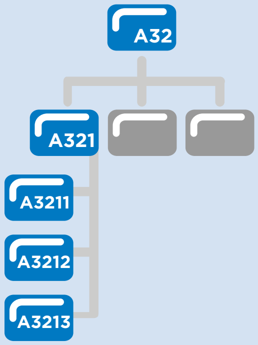
- **Functional Group Input** – clarifications from Functional Groups regarding definition and requirements for their area of the project, especially where changes in project requirements have occurred.

- **Approved Baseline Cost Estimate Package** – includes cost estimate summaries, cost estimate details, estimate scope basis, estimate assumptions, backup calculations, and other related information for the Baseline Total Project Cost Estimate.

- **Approved Updated Cost Estimate Package** – includes updated cost estimate summaries, updated cost estimate details, updated estimate definition basis, updated estimate assumptions, updated backup calculations, and other related information compared to the Baseline Total Project Cost.

These key inputs are then used when performing the three steps of this process. The output reflects a decision. The decision has three outcomes: 1) change is not acceptable and not evaluated further; 2) the potential change is evaluated further; or 3) additional clarification is needed from the Functional Groups before making a final decision.

The primary objective of this sub-process is to assess potential changes in a project's definition or site conditions in relation to the baseline definition, cost, and time when they are identified during the Design Phase.



Identify Potential Change (A3211)

Step Requirements

As the Design progresses for a project, there may be changes in the project that alter the definition, cost, and/or time. If not identified, these changes may impact project performance and may increase costs. Timely identification and management of such changes are the fundamental focus of cost management.

As the design is prepared, changes may occur that may not be covered in the baseline project definition. The Project Manager and Functional Groups must be constantly aware of these potential changes in a project's definition. Any potential change must be consistent with the project's need and purpose. Potential changes can be initiated by any Functional Group, so their input is critical.

A potential change should be significant in terms of its cost and time impact. The output of this step is the list of potential changes that should be considered for a change request.

Issues to Consider

Scoping Process Manual

- This step amplifies on the Project Change Process.

Project Team

- There will be little room for making changes in the project cost estimate in the next phase, Letting. Hence, it is important at this stage to identify all potential changes that affect the cost of the project.

Types of Changes

- Project Definition (Scope)
    - At-grade intersection to grade separated intersection
- Design Development
    - Increase asphalt pavement thickness one inch to ensure added pavement life
    - Increase in excavation quantity over previous estimate
- Site Conditions
    - Increase haul distance for aggregate
    - Wetland requirements greater than anticipated
- Market Conditions
    - Increased number of bidders anticipated
- Estimate Quantities and Pricing
    - Increase/decrease in quantities of other items
    - Modifications to unit cost to reflect current pricing resulting in an increased/decreased cost

- Risk Impacts – Retire risk (decrease) or risk impact difference (increase)

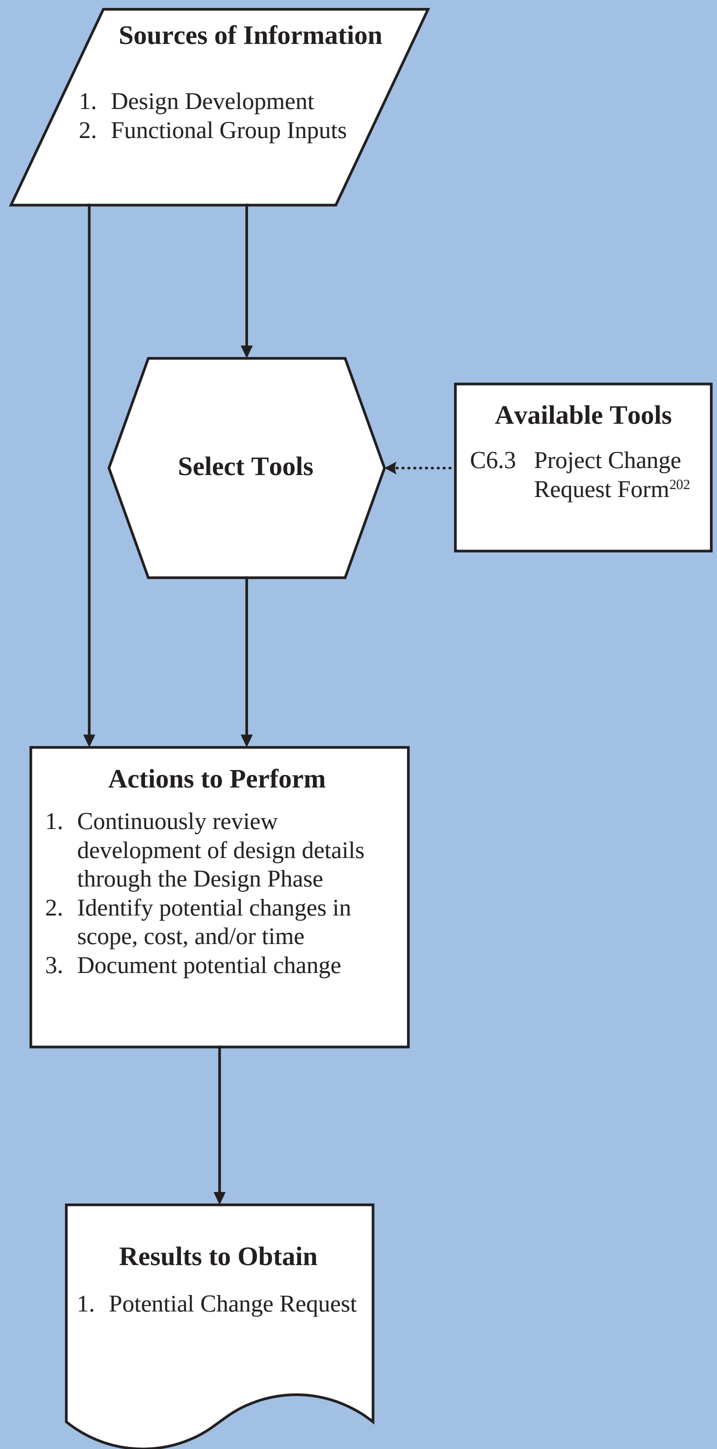
Identify Potential Change (A3211)

The project team must continuously monitor the design and determine if there is a potential change. There are different types of changes. The source of the change could result from design development or as added project definition (scope) from local agency input. The key consideration is to identify the change before any design work is performed related to the change.

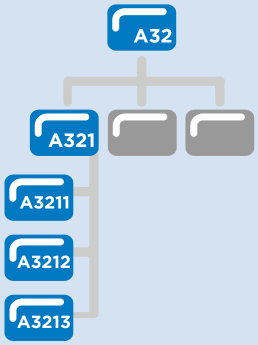
There are several tools that can be used to aid in documenting a potential change request. The key tool is the Project Change Request Form (C6.3).

Only those changes that may have a significant impact on cost should be considered by the Project Manager and Functional Groups.

Documenting a potential change does not mean that it is accepted, only that the change is subject to further evaluation.



202. For C6.3 Project Change Request Form, see page 483.



Determine if Change is Appropriate (A3212)

Step Requirements

This step evaluates whether or not a potential change is truly a change to the baseline definition. The key inputs to this step are the Approved Baseline Cost Estimate Package, the approved updated estimates, and any potential project definition changes. The Approved Baseline Cost Estimate Package contains information about the baseline definition. It also contains the details about the estimate basis. The Approved Updated Estimate Package contains the most current information on the project's definition, including any previous changes.

These two sets of data are used to compare the current and the baseline definition and cost estimates. The Functional Groups must determine if any potential change is really a change in the baseline definition. This type of analysis may lead to a recommendation as to whether the Scope Change should be processed or not processed.

Issues to Consider

Scoping Process Manual

- This step amplifies on the Project Change Process.

Complex Projects

- It is generally seen that complex projects involve many changes with increases in project and design definitions; hence, complex projects should be given special consideration during this step to avoid increases in budget.

Project Manager

- Project Manager should make sure to react timely to the changes occurring and to the information available to better manage the project.

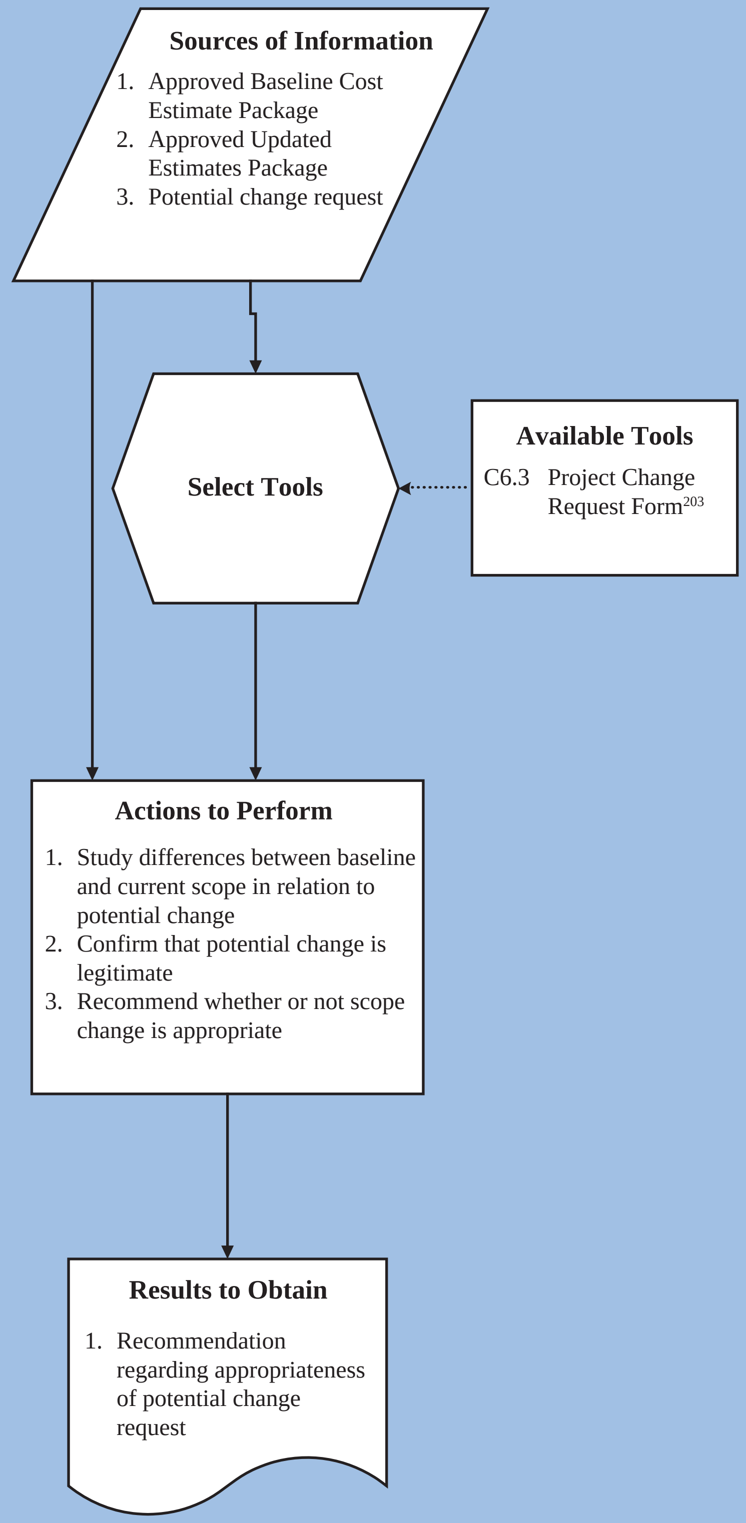
- The Project Manager and Functional Groups should not misjudge the important changes, especially when the project is facing potential budget increases.

Determine if Change is Appropriate (A3212)

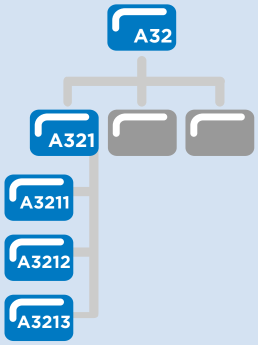
The Approved Baseline Cost Estimate Package from the Scoping Phase and the Approved Updated Estimate Package from the Updated Cost Estimate sub-process for CM are the two inputs in this step. The Project Manager and Functional Groups should study the differences in these documents to understand any changes that have already been documented during the Design Phase.

The Project Change Request Form can provide a record of a potential change that is being considered for inclusion in the project.

The project team should consider only potential changes that would add value to the project without changing the need and purpose.



203. For C6.3 Project Change Request Form, see page 483.



Decide to Process Change (A3213)

Step Requirements

This is the decision-making step for the Monitor Project Design and Site Condition sub-process (A321). This step has only one input, which is a recommendation regarding the appropriateness of the potential change.

This step is performed through a collective effort of the Project Manager and Functional Groups to “qualify” the change identified and studied based on its merits for the project. A decision is made after meetings with all Functional Groups. Discussions are focused on each recommended potential change. The Project Change Request Form can be used in this step to document the potential change.

The output of this step is the decision to proceed with further evaluation of the potential change or to drop the change from consideration or request further information concerning the details of the change before a decision is made.

Issues to Consider

Scoping Process Manual
- This step amplifies on the Project Change Process.

Project Team
- As a collective effort, it is important that all the groups are completely involved.

- The efficiency of decision making depends on the knowledge and skills of the Project Manager and Functional Groups.

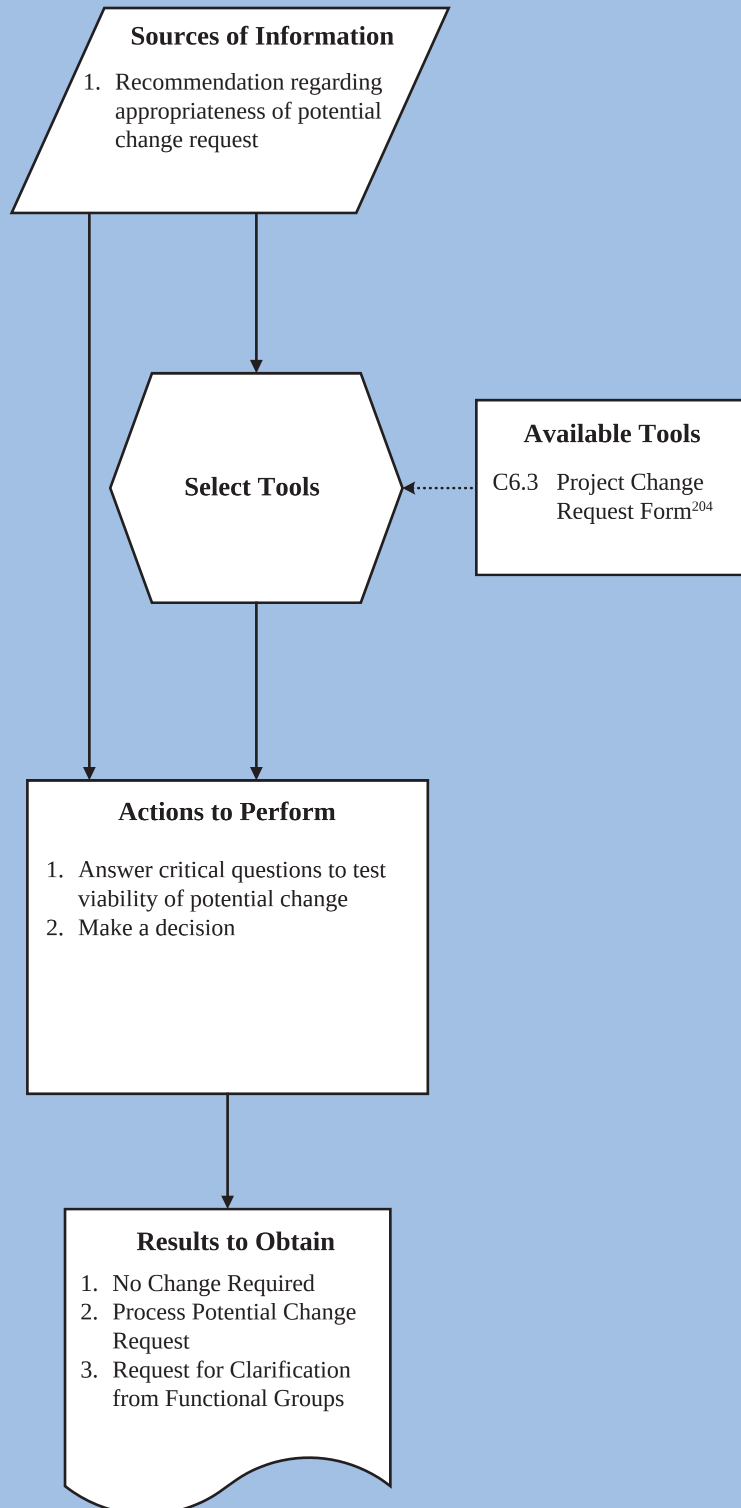
Decide to Process Change (A3213)

This is a decision-making step for changes that are being considered and may be potentially evaluated in more detail. The project team does not want to spend time on processing a change unless it is absolutely needed or knowledge of the cost and time impact of the change is necessary before making a final decision to proceed with the change.

Documenting the potential change is important, regardless of whether the change moves forward.

The Project Manager and Functional Groups should ask questions about the change, such as the following: Does it affect the project's need and purpose? Does it add value and increase the benefit of the project?

At times, more information may be required to make this decision. If the change is viable, then a cost estimate for the change should be developed to aid in making a final evaluation in the next sub-process.



204. For C6.3 Project Change Request Form, see page 483.

III.4.3.2 EVALUATE POTENTIAL CHANGES (A322)

The primary objective of this sub-process is to evaluate the cost, time, and other impacts of potential changes in project definition or changes in site conditions when identified and in relation to the baseline definition, cost, and time. This sub-process is performed only for significant potential changes in cost and/or time. This sub-process has three main steps. The steps are as follows:

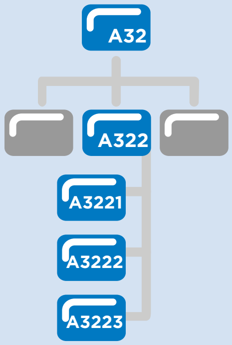
1. Estimate Cost Impact – A3221
2. Review Impact of Change – A3222
3. Document Impact of Change – A3223

These three steps require several key inputs that are necessary for the Project Manager to consider a potential change. Some of these key inputs include the following:

- **Potential Definition Change** – includes documentation of the design requirements describing the change (includes plans, layouts, and other design data related to the change).
- **Historical Data** – cost data from previous projects used as a basis for pricing different elements and items of the potential Scope Change.
- **Market Conditions** – includes site-related issues that may impact costs, such as pricing changes, potential bidders, material supply problems, and so on.
- **Functional Group Input** – clarifications from Functional Groups regarding requirements for their area of the project, especially where changes in project requirements have occurred.
- **Approved Baseline Cost Estimate Package** – includes cost estimate summaries, cost estimate details, estimate scope basis, estimate assumptions, estimate calculations, and other related information for the Baseline Total Project Cost Estimate.
- **Approved Updated Cost Estimate Package** – includes updated cost estimate summaries, updated cost estimate details, updated estimate scope basis, updated estimate assumptions, updated calculations, and other related information for the Baseline Total Project Cost Estimate.

These key inputs are then used when performing the three steps of this sub-process. The output is a completed Project Change Request Form.

This sub-process is performed only for significant potential changes in cost and/or time.



Estimate Cost Impact (A3221)

Step Requirements

Following the identification and analysis of potential changes identified, each change must be quantified in terms of cost. Changes affect the estimate of any project, and the cost impact of any change must be given due consideration with the estimate being adjusted if the change is approved.

When calculating cost impact of changes, the Estimator must fully understand how each change interacts with the baseline cost estimate. The change may add to the project's definition and not impact other areas of the project. Alternatively, the change may impact other areas of the project that are already included in the current estimate. Thus, the Estimator must know what to remove from the previous estimate so that no overlap occurs, resulting in overestimation. The Estimator must allocate sufficient time to prepare the cost estimate for the change. The actions taken for preparing this estimate are the same as those sub-processes followed to prepare the baseline estimate as well as updated estimates.

The output of this step is a cost estimate that reflects a definition of the change identified in the project.

Issues to Consider

Adjusting the Baseline

- Ideally, no project would ever have changes from the baseline, but this is not always the case. Changes are acceptable as long as they are identified and properly quantified, add value, and can be funded.

- As mentioned above, some changes result from additions to the project definition while others result from modifying elements and items of the project previously estimated. An intricate understanding of any change is absolutely necessary for this step to be accurate.

- Changes should be addressed as soon as they are identified. Adjusting estimates for budgeting purposes becomes increasingly difficult as the project nears Letting. Obtaining approval for additional funds is not an easy process and should be performed as early as possible.

Change Characteristics

- Depending on the magnitude of the change, this step varies in level of effort. Larger changes may demand more interaction with the Functional Groups to evaluate the cost impact.

Estimate Cost Impact (A3221)

The Estimator should use any source of information to prepare the cost estimate for the change. Cost data within the baseline or updated estimate is often used if similar items are already included in the latest estimate.

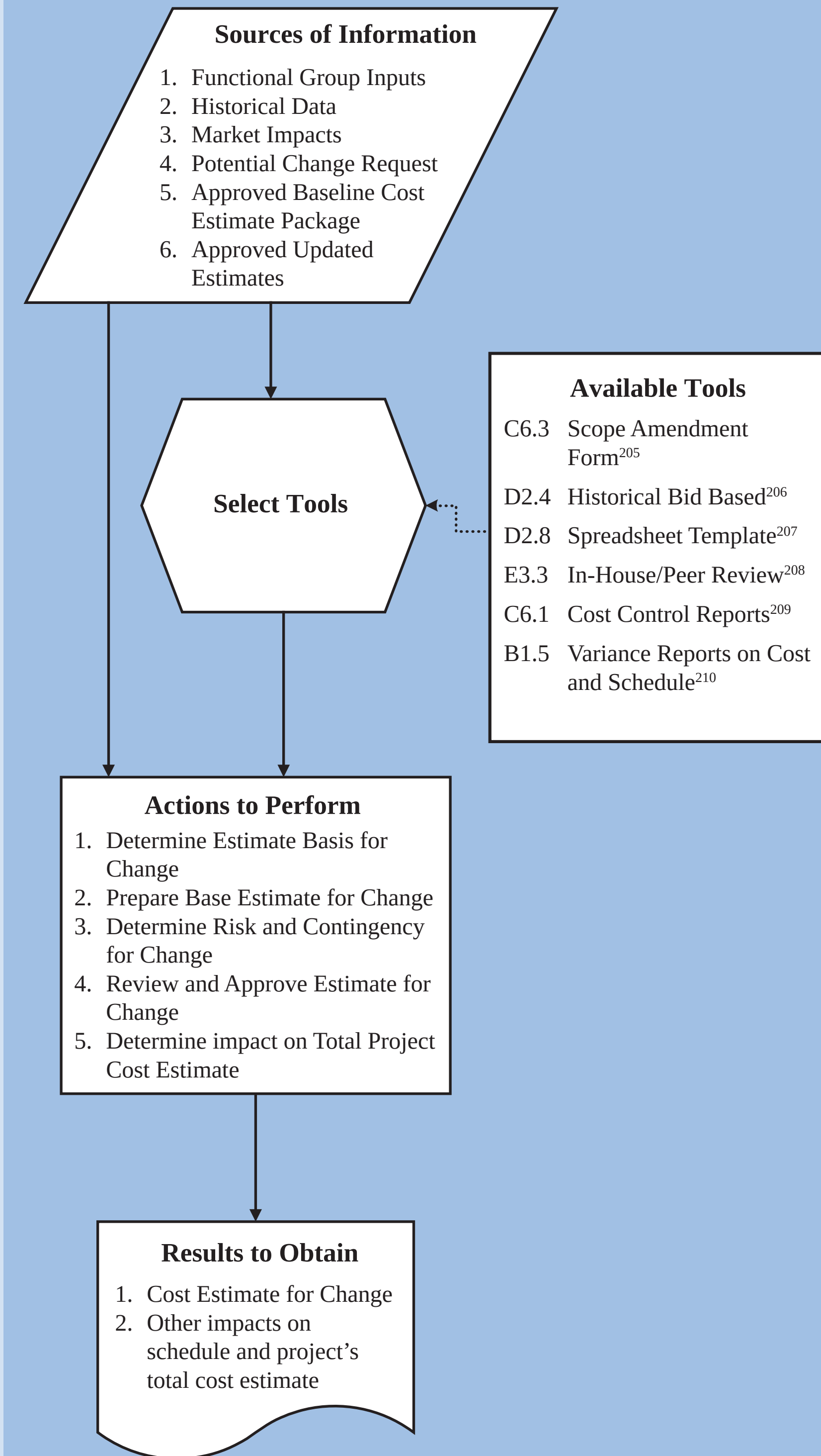
A variety of tools can be used to prepare the cost estimate for any given change. The tools selected should be consistent with the information available that describes the requirements of the change and any tools used to prepare the latest cost estimate. The impact of a change can be summarized in a Cost Control Report (C6.1) or through a Variance Report (B1.5).

The Estimator should follow all the actions shown. The level of effort would correspond to the magnitude of the change. Any change has risks associated with it. The action of determining risks and contingency for a change should not be skipped. The cost estimate should be reviewed as well.

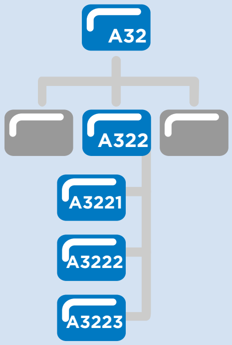
Documentation of the estimate basis for the change, as well as any assumptions, calculations, and so on, is important for traceability.

The Project Manager and Estimator should note the impact of the change on other areas related to the project.

The cost estimate for the change moves forward for further review of funds, scheduling, and any other altered project requirements.



205. For C6.3 Project Change Request Form, see page 483.
206. For D2.4 Historical Bid Based, see page 389.
207. For D2.8 Spreadsheet Template Various Risk Tools, see page 397.
208. For E3.3 In-House/Peer Review, see page 454.
209. For C6.1 Cost Control Reports, see page 479.
210. For B1.5 Variance Reports on Cost and Schedule, see page 477.



Review Impact of Change (A3222)

Step Requirements

This step is specifically focused on analyzing all of these potential effects that would result from incorporating the change into the project. A change in the project definition not only affects the cost of the project but also the funds needed for the project and the project schedule. Changes in the duration of the project, as well as any potential impacts on the Letting date, must be reviewed.

Other items to be reviewed in this step include, but are not limited to, changes in right of way, environmental impact, and commitments to the public. The change may also impact the STIP budget for the project.

This step provides input for making a final decision after all information concerning the change is documented.

Issues to Consider

Scoping Process Manual

- This step amplifies on the Project Change Process.

Functional Group Inputs

- Inputs from Functional Groups are necessary to explain the nature of the change and its impact on project funds and time requirements.

Complex Projects

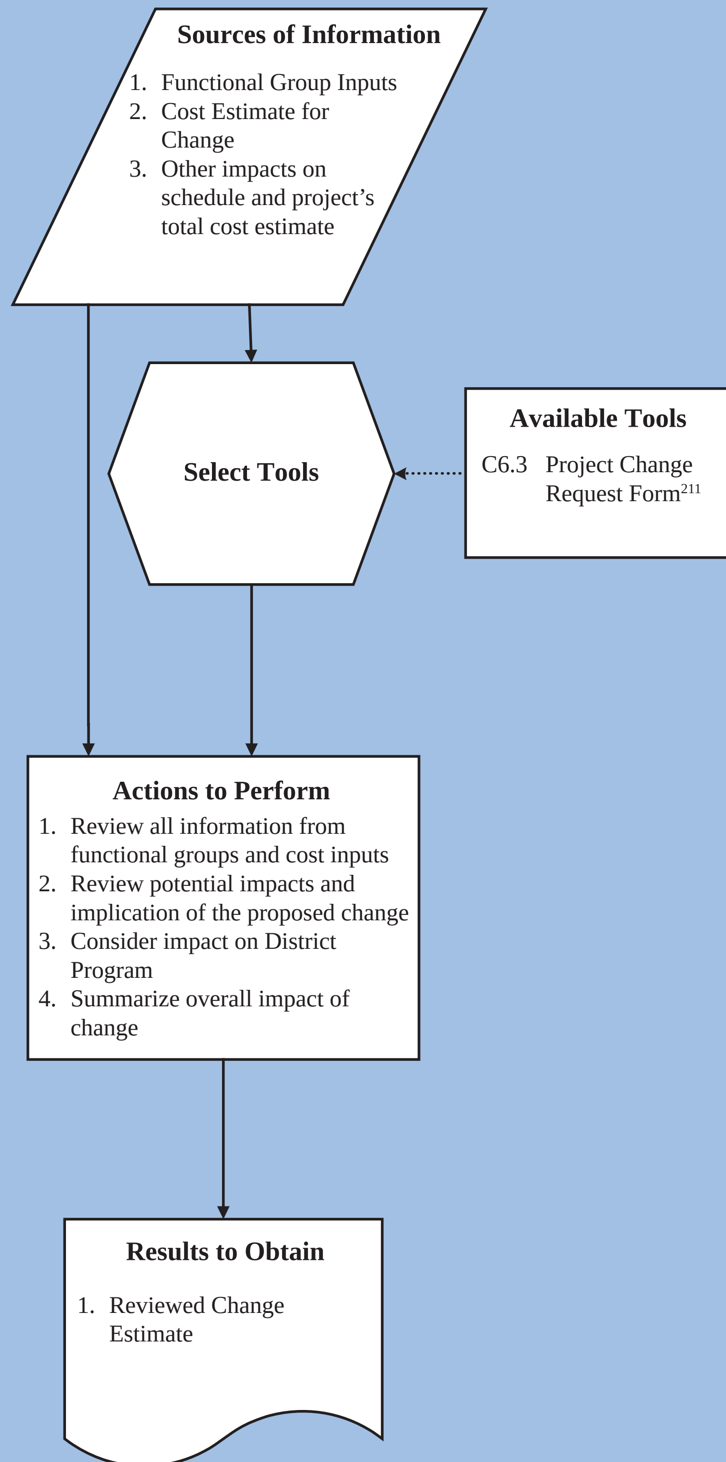
- For projects in urban areas, the Project Manager should make sure that the project does not extend the project's duration due to change in definition. The schedule estimate should reflect an efficient construction approach.

Review Impact of Change (A3222)

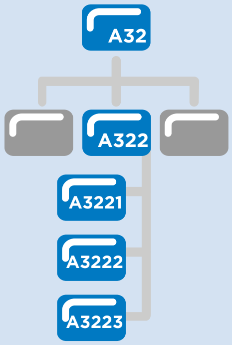
Functional groups can explain their input to support the requirements behind the change and the various impacts of modifying project requirements.

Understanding all the ramifications of a change is critical to ensure that the change is a valuable addition or a necessary deletion from the project.

Evaluate the impact of any project change on the District's program using the Program Evaluation Form as required by the Project Change Process outlined in the Scoping Process Manual.



211. For C6.3 Project Change Request Form, see page 483.



Document Impact of Change (A3223)

Step Requirements

This step documents all the implications of a change. The potential impacts are evaluated in the previous step, Review Impact of Change (A3222).

The input to this step is the Reviewed Change Estimate. The Project Change Request Form is used in this step. The document contains information about impacts of the change, such as design details regarding change, effects on budget and cash flow, and critical stages during construction at which special attention may be necessary. The document also contains the benefit of the change, explaining why the change is necessary.

This document is important as this will form the basic data to approve the change request. This document also forms a basis of communication between the Project Manager and the Functional Groups regarding the change. Hence, proper documentation of all the necessary data is important.

Issues to Consider

Scoping Process Manual

- This step amplifies on the Project Change Process.

Project Manager

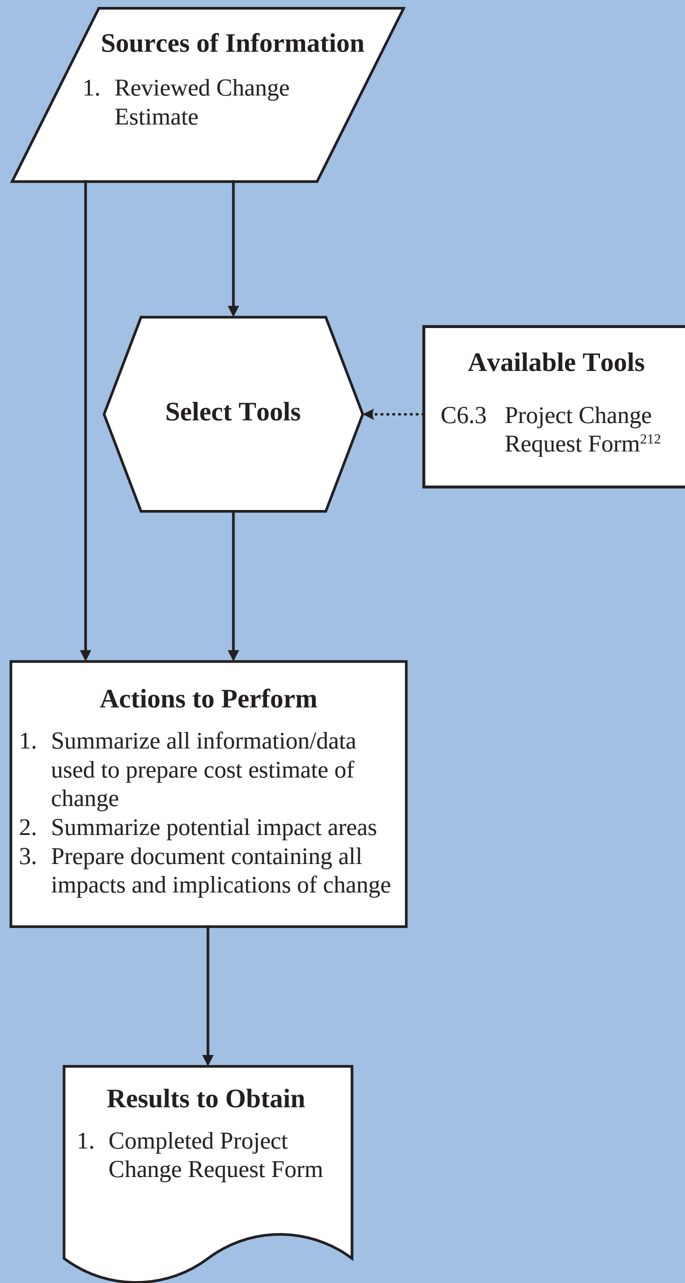
- The Project Manager should confirm that the document includes all the required details related to the impact the change has on the project.

Document Impact of Change (A3223)

The Project Manager ensures that all required information about the impacts and implications of the Scope Change are covered.

The document prepared in this step will form the basis to make a decision in the next sub-process, A323. The decision will include accepting or rejecting any change requests.

Documentation of backup information and data is important when reviewing and justifying the change request with District management.



212. For C6.3 Project Change Request Form, see page 483.

III.4.3.3 APPROVE PROJECT CHANGE REQUEST (A323)

The objective of this sub-process is to approve change requests identified and evaluated for project definition and cost estimate changes from the Monitor Project Design and Site Conditions (A321) and Evaluate Potential Changes (A322) sub-processes.

This sub-process has no steps. It requires a decision to approve or not approve a change request and, therefore, requires no further decomposition of individual steps.

The main input is a completed Project Change Request Form ready for the signature of the Project Manager and the Assistant District Engineer. The material and documents required to make a decision on change described on the Project Change Request Form are prepared in the preceding sub-processes. The actions to be taken during this sub-process are as follows:

- Review the details of the change as described in the Project Change Request Form.

- Decide if the change is in fact necessary, adheres to the need and purpose of the project, and can be funded.

- If the results are positive, the Project Change Request Form is signed and moves forward for program consideration (see Program Evaluation Form).

The output of this step is a completed Project Change Request Form that is either approved or not approved. Work related to the change request should not begin until the change request is formally approved and included in the District program for the project.

III.5 LETTING COST ESTIMATING AND COST MANAGEMENT

III.5.1 OVERVIEW

III.5.1.1 The Highway Project Development Process

The Mn/DOT Project Planning – Scoping – Programming cycle begins with the Project Planning Phase in which transportation system performance needs are identified and prioritized. The most critical needs are carried forward into the Scoping Phase. The defined projects are then reviewed during the Programming Phase and either included in the STIP or HIP (10-Year Plan) or held for reconsideration the following year. When the project is included into the STIP project plan development commences.

The Design Phase initiates plan development. The design is completed with the Letting Phase. Final project designs are prepared during the Design Phase. The baseline cost estimate is continuously reviewed as estimates are updated throughout Design until a final cost estimate is prepared in the District that includes all construction items. As the project advances to the Letting Phase, the Engineer's Estimate is prepared. The Engineer's Estimate reflects the project definition covered in the final contract plans and specifications. The intent of this phase is to advertize and bid the project and award the project to the successful bidder.

III.5.1.2 Project Development – Letting Phase

The final design documents include a schedule of items and their quantities prepared by the Districts and other Functional Groups. These items are then converted to construction costs. This Engineer's Estimate is prepared for final contract review in preparation for advertisement, obligation of construction funds, and evaluation of contractor's bids for construction of the project. The Central Office estimating group prepares the estimate for many items. Some item estimates are also prepared by Functional Groups, depending upon the project definition (e.g., bridge estimates, etc.).

The primary focus of the Letting Phase is to prepare the Engineer's Estimate and to evaluate contractor bids in relation to the Engineer's Estimated cost. The duration of this phase is very short, typically between three and six months. This is the final phase of project development prior to construction. This phase includes advertisement, collection of bids, evaluation of bids, and award or rejection of bids. The Engineer's Estimate is prepared to emulate a contractor's bid. Thus, current market conditions play an important role in preparing this estimate.

III.5.1.3 Cost Estimation and Cost Management During Letting

The cost estimating and cost management process for Letting is described in the flowchart shown in Figure III.5-1.

Cost Estimation and Cost Management is a very important process in the Letting Phase. The Final Project Design forms the major input to this process and

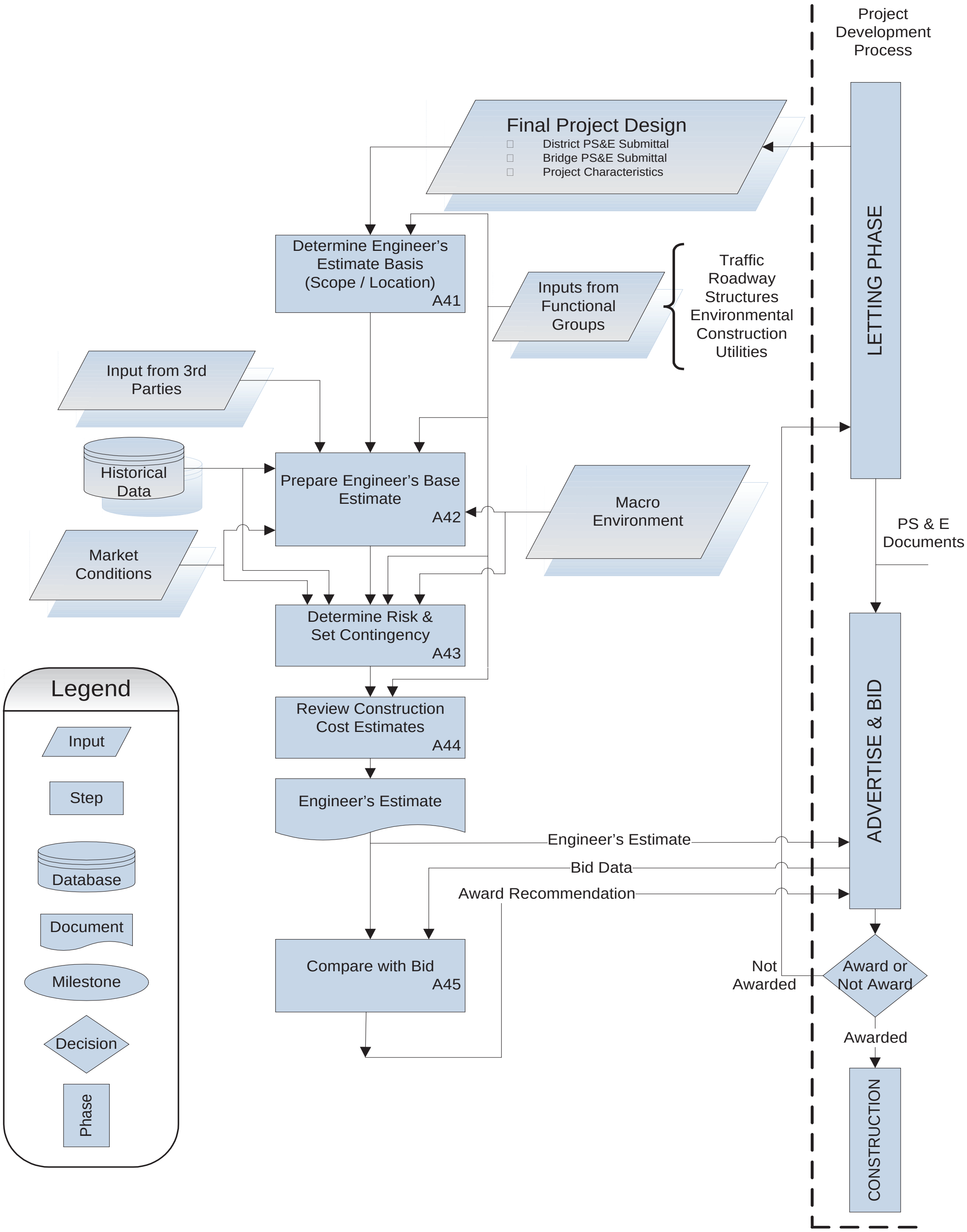


Figure III.5-1. Cost Estimating and Cost Management during Letting

forms the basis for the Letting Phase Engineer's Estimate. The flowchart in Figure III.5-1 shows that considerations of market conditions and the macro environment are critical inputs for preparing this estimate. Project risks that have not been avoided or completely mitigated through the design process must be translated into item adjustments. These types of item adjustments reflect uncertainty associated with item risk and expressed as contingency. By incorporating an adjustment for contingency into an item, the item can be compared directly with contractor bids for the item. As opposed to the Scoping and Design phases, contingency is not included as a separate cost element except for cost to cover changes during construction and potential incentives. The Engineer's Estimate is reviewed with District staff and compared to the final item estimate prepared by the District. Necessary modifications are made. There may be major differences between the District final cost estimates and the Engineer's Estimate. If major differences are found, then they are reconciled and the Engineer's Estimate is finalized.

In the Letting Phase, cost management covers the important step of obtaining appropriate approval for the Engineer's Estimate. After receiving the bids from the contractors, the bids are evaluated and compared to the Engineer's Estimate. If the bids are within acceptable limits, then the recommendation is to award the contract. If not, a decision has to be made as to whether or not the contract will be awarded.

Letting cost estimating and cost management is divided into sub-processes and steps. Figure III.5-2 shows a graphical representation of the sub-processes of this phase. Following the first four sub-processes and steps ensures the successful completion of the preparation of the Engineer's Estimate. In the last and the final sub-process of this phase, bids are received and compared to the Engineer's Estimate to determine differences between them.

III.5.1.4 Overview of Roles and Responsibilities

The roles and responsibilities in the Letting Phase are different from the other phases in one very important way: the Estimator in the Central Office becomes the primary source of responsibility for the Engineer's Estimate. In previous phases, the responsibility and accountability for cost estimating and cost management are principally in the District office.

The District office and the Functional Groups may be consulted in a number of the processes, especially if there is information that is pertinent to the outcome of the cost estimate or management of the cost; however, this information should all be included in the final project plans and specifications. One key information exchange occurs in the final sub-process, which is comparing the bids with the Engineers Estimate. The outcome of this process, the decision regarding the award of the project, has a substantial impact on the Districts' programs. If the project is awarded but the award cost differs from the approved budget in the STIP, the District will need to reconcile the program. If there is a decision of no award, the District will need to modify the program and take the necessary actions required.

As with other phases, the RACI diagram, shown in Table III.5-1, should be completed at the Central Office and should contain greater depth in terms of role and responsibility definition. However, it should be noted that due to the potential impact to the Districts, especially in terms of cost estimate reviews, completion of the RACI should involve District personnel. All completed RACI Charts should be reviewed to ensure that the proper parties are responsible, accountable, consulted, and informed throughout the Letting process.

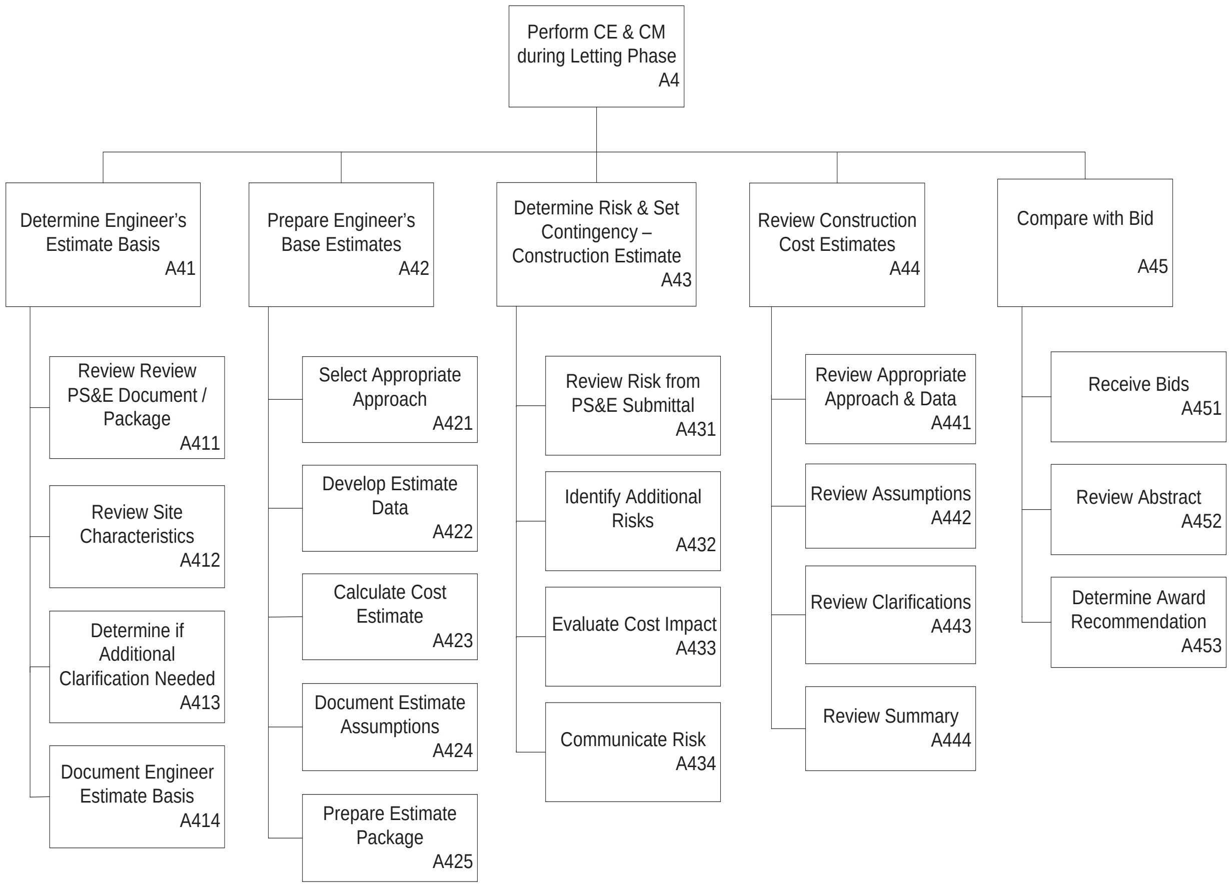


Figure III.5-2. Sub-Process and Steps for Cost Estimation and Cost Management during Letting

III.5.1.5 Key Approach Assumptions

The cost estimating and cost management process for Letting focuses on preparing the Engineer's Estimate with the purpose of comparing estimated project construction costs by item to bid costs by item provided by contractors. All potential risks and associated estimated contingencies are embedded into the appropriate item costs.

Sufficient funds must be available in the STIP to award the project. If not, a change request may be required. Thus, the Engineer's Estimate determines direct construction costs. The cost of construction engineering must also be estimated, but this cost category is not part of the contractor's bid. Engineer's Estimates are prepared by the Central Office and certain Functional Groups.

III.5.2 DETERMINE ENGINEER'S ESTIMATE BASIS (A41)

The primary objective of this sub-process is to collect and document all information required to serve as a basis for preparing an Engineer's Estimate completed by the Central Office. This sub-process has four steps:

1. Review PS&E Document Packages – A411
2. Review Site Characteristics – A412
3. Determine if Additional Clarification Needed – A413
4. Document Engineer's Estimate Basis – A414

Table III.5-1. RACI for Prepare CE/CM for Letting (A4)

	Management			Estimating			Project Management		External Stakeholders							
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Determine Engineer's Estimate Basis (A41)				A	R		C	C								
Prepare Engineer's Base Estimate (A42)				A	R	C	C	C								
Determine Risk and Set Contingency Construction Estimate (A43)				A	R		C	C								
Review Construction Cost Estimates (A44)		I	I	A	R	C	C									
Compare with Bid (A45)		I	I	A	R	I	I	C								

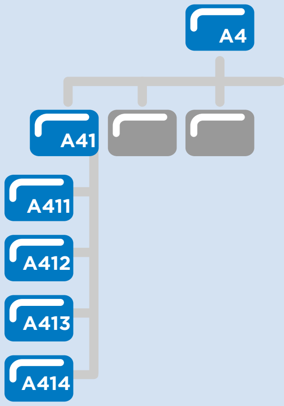
LEGEND:

R = Responsible (the doer)
A = Accountable (owner)
C = Consulted (in the loop by providing inputs)
I = Informed (in the picture)

Due to the nature of estimating, these steps are often completed simultaneously as the estimate is prepared; however, this sequence is nonetheless the natural progression an estimate follows. These steps require several key inputs that are necessary for the Estimator to prepare the cost estimate. Some of these key inputs include the following:

- **Final Project Design** – PS&E from the District Office and/or Functional Groups.
- **Design Clarifications** – All necessary details and descriptions of the plans to be provided by either the District Office and/or Functional Groups (e.g. Specialty Offices).

These key inputs are then used when performing the four steps of this sub-process. The output of this sub-process is the Engineer's Estimate Basis File. The file contains all pertinent information used to prepare an estimate. More specifically, it includes information that will be available to the bidders (e.g., items and quantities, final plans and specifications).



Review PS&E Document Packages (A411)

Step Requirements

The key input for this step is a complete project design, specifically the plans and specifications including a listing of items. These documents fully define project construction, from the basic project parameters and drawings to the details about what materials to use and what the existing conditions are like. The Districts provide the final design package while the Bridge Office provides the final bridge Design package.

The Estimator in the Central Office performs several actions when completing this step. First, all documents are reviewed for completeness and understanding. The Estimator should also note if there are any alternatives to be bid. An understanding of project complexity will influence the preparation time for the estimate and resources required to meet the Letting date.

The output of these actions is an understanding of the construction project requirements in the form of items to be estimated and the project definition content of the items.

Issues to Consider

Plan and Program Support

- Technical memos transmit official plans and specifications from the District and Bridge Offices.

- The Letting process begins when an Mn/DOT District is ready to release a project for advertisement and bid. The process is initiated almost immediately after the final design is complete. Time is provided to prepare and complete the Engineer’s Estimate prior to advertising for and receiving the bids.

- If alternate bids are necessary, multiple estimates may be needed to evaluate each alternative. An action is to determine if multiple estimates are required.

Project Characteristics

- Major projects require more time and effort in this step.

- Typically, more Estimators in the Central Office will be involved for major projects.

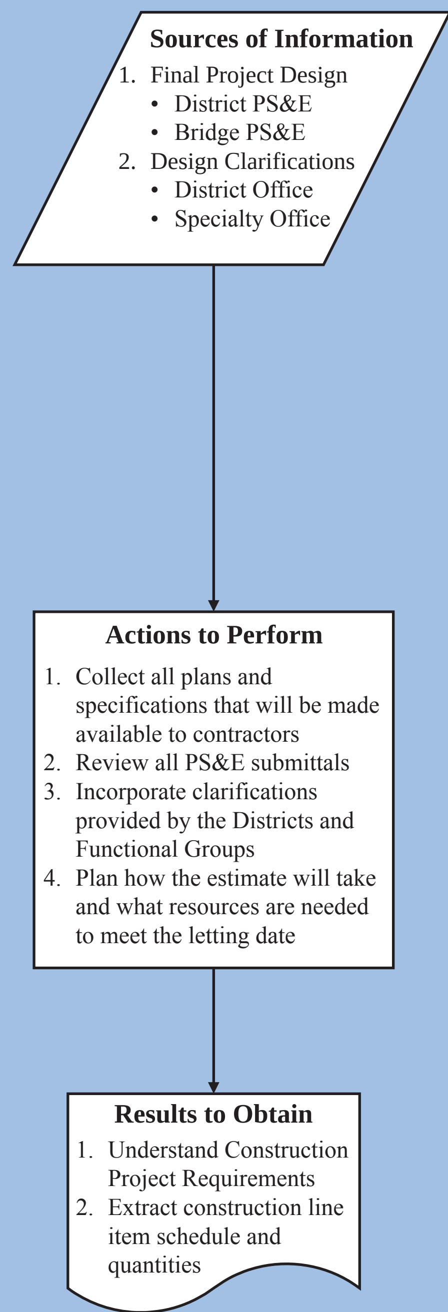
Review PS&E Document Packages (A411)

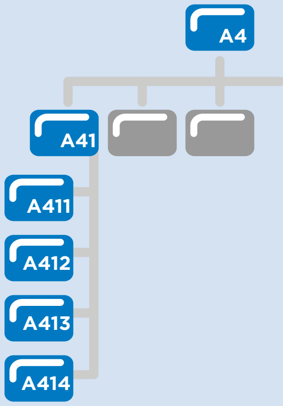
The critical Design inputs include the District PS&E submittal covering all Functional Groups. The Bridge PS&E may be submitted separately for those projects that have only structures.

One must be cautious when referring to any previous project definition related documents or information that will not be available to the contractor. This may negatively influence the Engineer's Estimate since the objective is to prepare a construction cost estimate for the project that is a fair representation of what the contractor would bid for the project.

Be sure all PS&E submittals are complete.

Allow sufficient time to prepare the Engineer's Estimate based on when the estimate is required to meet the proposed letting date.





Review Site Characteristics (A412)

Step Requirements

Understanding the project site characteristics is a critical step for the Estimator in the Central Office. The attributes of a project site can significantly impact all estimated costs of construction. The project characteristics are one input that provides some understanding of the site.

The Estimator performs several actions when completing this step. First and foremost, the Estimator should review video logs and/or aerial photos to begin visualizing the project. Next, if it is at all logistically possible, the Estimator should walk the project site. A site visit provides additional insight and a feel for the project that cannot be obtained through photos or videos. Since the Central Office is not near all proposed projects, Estimators understandably cannot make a site visit for every project; however, the Estimator should fully weigh the benefits and drawbacks before making that decision. Also, the Estimator should have knowledge of the plans and specifications to understand the project requirements. Questions can be prepared to guide the Estimator during the site walk-through. The Estimator should make notes as to potential impacts of the site characteristics on item costs.

Issues to Consider

Project Characteristics

- Always review video logs and/or aerial photos to gain a preliminary understanding of the site. Then if time permits, visit the site for major or complex projects prior to preparing the cost estimate.

- Visits to the project site provide information concerning traffic control, haul routes, and construction staging and the potential impact these areas have on construction productivity and costs.

Functional Group Input

- Construction staff can help evaluate the potential impact of staging, material storage, hauling of materials, location of batch plants, and other constructability related issues, all of which are exceedingly important in this step since this estimate is completed as though the bidders prepared it.

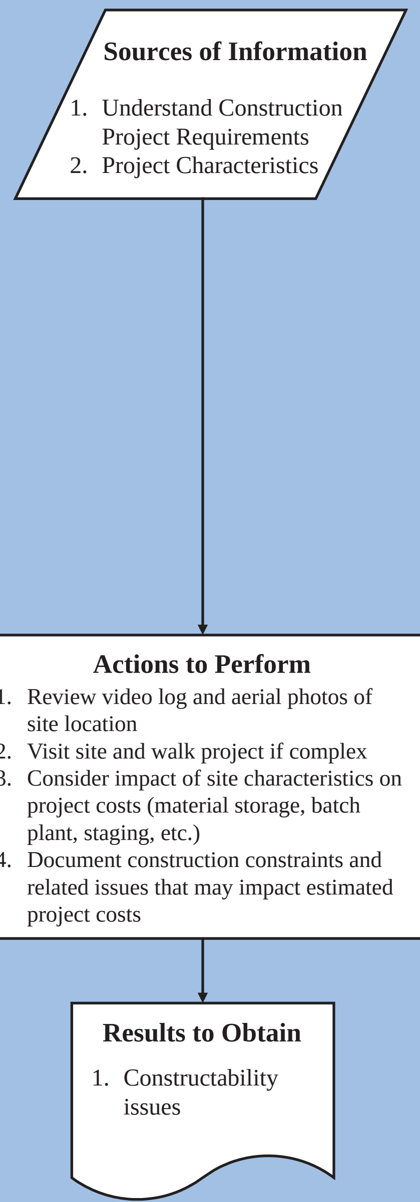
Review Site Characteristics (A412)

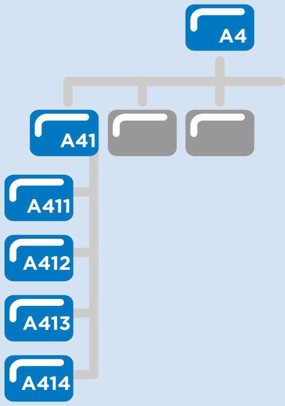
It is important that the Estimator understands the project plans and project characteristics prior to initiating a site evaluation. This information can aid the Estimator in preparing questions about the site.

There are several tools available. The best tool to use is a site visit. Such a visit is critical for major or complex projects and likely less critical for moderately complex projects. If time to prepare the estimate is an issue, other tools include video logs or aerial photos of the site area. These latter two tools may provide some indication of issues that impact project costs.

It is critical that the Estimator visit the proposed project site and examine the site conditions and characteristics. The Estimator can work with the Construction Division when addressing the location attributes that influence construction costs. Some questions that should be considered are:

- What areas require environmental mitigation?
- What existing structures need to be removed?
- Where are likely construction access points?
- What utility relocations are required, and how complex are these relocations?
- How will work time restrictions impact productivity?
- Where will the contractor store materials or locate a batch plant?
- What are required detour and haul routes?





Determine if Additional Clarification Needed (A413)

Step Requirements

The purpose of this step is to confirm that the final plans and specifications are complete and, if necessary, request additional information to ensure proper interpretation of the PS&E submittals from the District, Bridge, or other Functional Groups. This request may focus on clarifying existing documentation of the project requirements, especially in terms of item content, or confirming that certain requirements are needed. Missing information may be uncovered as well.

The Estimator in the Central Office performs several specific actions. One set of actions would include clarification of specific project requirements. A list of questions can be generated after the Estimator reviews the project plans and specifications. Another set of questions may clarify impacts of project site characteristics on construction and how these impacts may influence item costs. Once potential question areas are identified, a request for clarifications can be initiated.

The output of these actions is a request for clarification regarding project plans and specifications and/or construction-related issues. This will lead to a better understanding of those project requirements that will have a potential impact on the cost of the project.

Issues to Consider

Project Characteristics

- Check for the availability of complete data related to project characteristics and site characteristics. If necessary, request additional information that will help in completing the Engineer’s Estimate.

Functional Group Input

- The request of clarification can be made in several ways. A meeting with District staff may be necessary on complex projects. Face-to-face discussion is often the best way to clarify details related to final plans and specifications and construction-related issues. Phone conversations or video conferences are also excellent substitutes if time restrictions or travel issues do not permit face-to-face meetings.

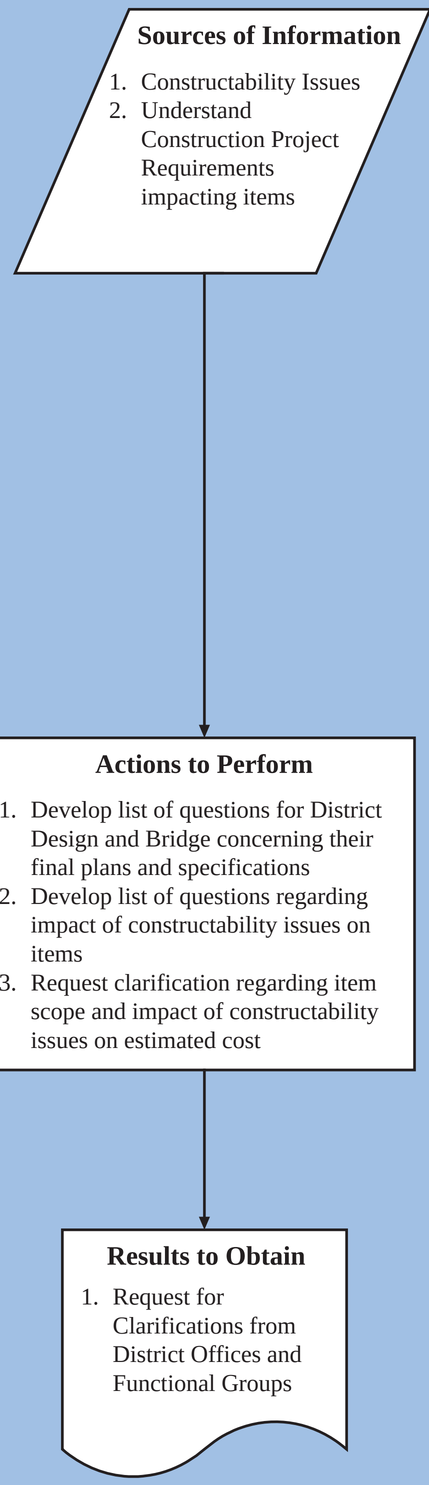
- Good communication is required between the Estimator in the Central Office and the Districts and Functional Groups. This effort will enhance the level of accuracy in estimates because all project requirements will be properly reflected in the estimate basis.

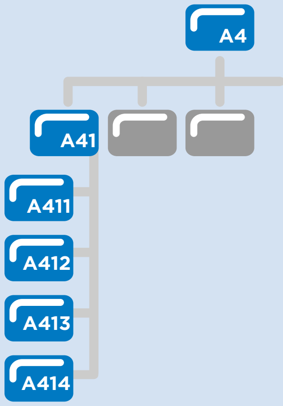
Determine If Additional Clarification Needed (A413)

The main sources of questions come from a review of the final plans and specifications submitted by the District Office and Functional Groups. Constructability issues are often best identified through site visits and in consultation with the District Construction Division.

While questions will always arise as cost estimates are prepared and reviewed, developing a comprehensive list of questions needing clarification will save time for the Estimator in the Central Office.

While PS&E submittals represent the final design documents, questions still may arise. Request for clarifications is a necessary step. Such requests will reduce recycle as the cost estimate is prepared and reviewed.





Document Engineer’s Estimate Basis (A414)

Step Requirements

The main purpose of this step is to prepare documentation that supports the Letting estimate. The key inputs are any constructability issues and construction project requirements in the form of a schedule of items. Any notes concerning the plans and specifications as they relate to cost estimating are included. This step is a key to achieving cost estimate consistency.

The main effort or action for the Estimator in the Central Office is to create the Engineer’s Estimate Basis File, including project requirements that are used as a basis for preparing the Letting estimate. Documentation of project requirements is critical when preparing cost estimates and determining risks and contingency adjustments for specific items. This step is critical when reviewing the Engineer’s Estimate, especially in relation to the final cost estimate prepared by the District.

Issues to Consider

Project Characteristics

- The level of documentation is likely to increase for projects that are considered major or complex. This effort may influence the time to prepare the Engineer’s Estimate.

- The main items incorporated into the file would be items and their quantities for which costs are estimated. The plans and specifications are referenced as part of this file, although they are likely not physically part of the file.

- It is important to document the Engineer’s Estimate basis for all projects, not just those that are complex.

Estimate Use

- This cost estimate is used to predict the bids submitted by potential contractors. The Engineer’s Estimate cost is used for funding purposes and to help determine whether or not the low bid is acceptable. If the bidders are too far above this estimate, then the bids may not be accepted, and the project Letting might be delayed.

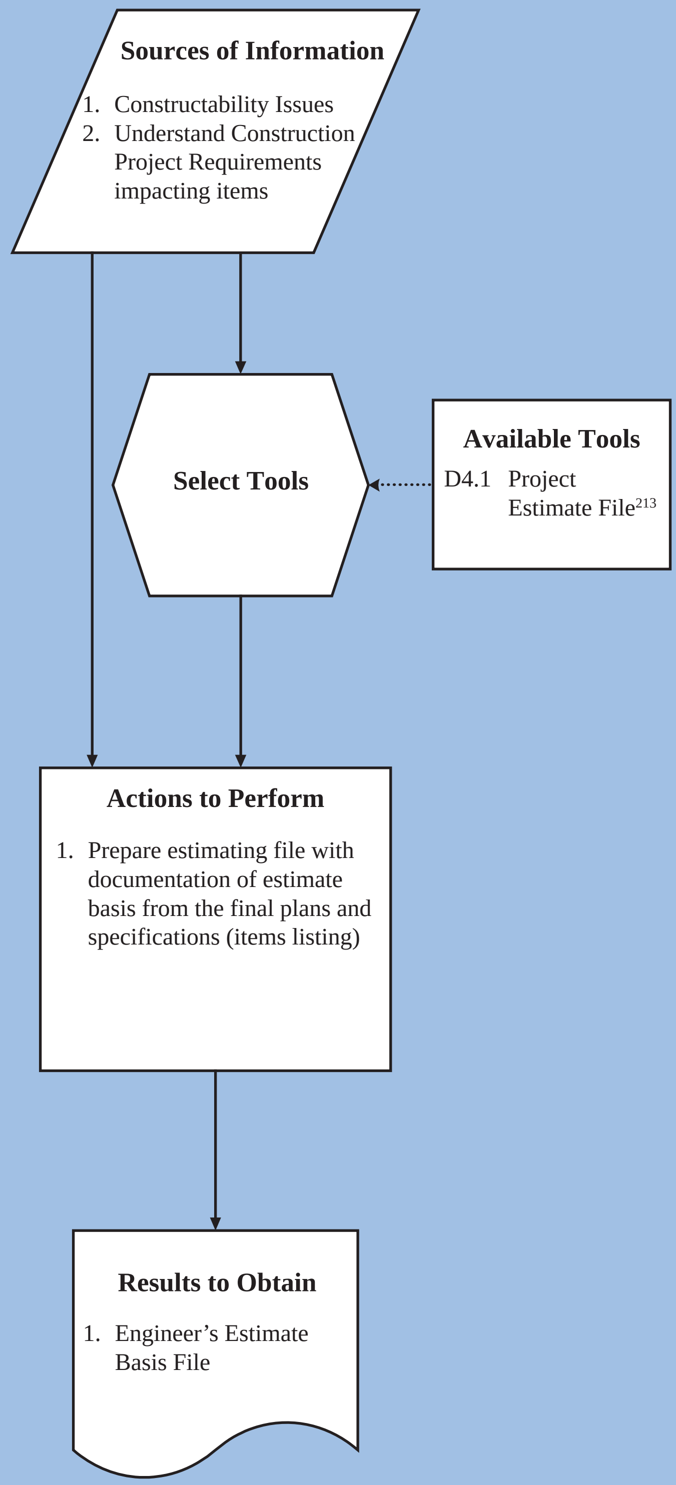
- The Engineer’s Estimate is prepared independently of any previous estimates. The file should contain only project requirements related to the PS&E submittals.

Document Engineer's Estimate Basis (A414)

The Estimator in the Central Office compiles information and data from the PS&E submittals, site visits, and additional input from the Districts or specialty offices. The Central Office staff should ensure that the schedule of items and supporting documentation are referenced in the Engineer's Estimate Basis File.

The Project Estimate File can be customized to fit the project type and characteristics.

The Engineer's Estimate Basis File is completed and becomes a key input to the next sub-process, Prepare Engineer's Base Estimate.



213. For D4.1 Project Estimate File, see page 339.

III.5.3 PREPARE ENGINEER'S BASE ESTIMATE (A42)

An Engineer's base estimate covers the estimated costs for all items of the construction estimate. These items may be estimated using different techniques, depending on the type and complexity of the project. The number of items estimated may also vary depending on project complexity. This estimate is intended to reflect the most likely construction estimates soon to be submitted by the bidders. This estimate will serve as a reference point for cost management when awarding the project. This sub-process has five steps. The steps are as follows:

1. Select Appropriate Approach – A421
2. Develop Estimate Data – A422
3. Calculate Cost Estimate – A423
4. Document Estimate Assumptions – A424
5. Prepare Estimate Package – A425

These steps provide a natural progression of effort to prepare an Engineer's base estimate for Letting. All five steps are often performed concurrently and repeated as the estimate progresses and data is further developed. These five steps require several key external inputs that are necessary for the Estimator to prepare the cost estimate. Some of these key inputs include the following:

- **Engineer's Estimate Basis File** – contains all pertinent information used to prepare an estimate, including the item schedule with quantities.
- **Project Characteristics** – description of the type of project and complexity of the project, including site-specific information and/or data that is relevant to preparing the cost estimate.
- **Historical Data** – cost data from previous bids and labor, material, and equipment data for different items.
- **Market Conditions** – understanding of the potential market impact on construction costs for a given location.

These key inputs are then used when performing the five steps of this process. The output of this sub-process is the Engineer's Estimate Package. The package contains all pertinent information and cost data used to prepare an item estimate, as well as cost summaries and item cost details for the Engineer's Estimate.

An Engineer's base estimate covers the estimated costs for all items of the construction estimate. These items may be estimated using different techniques, depending on the type and complexity of the project.

Select Appropriate Approach (A421)

Step Requirements

This step is important for all projects estimated in any phase. Selecting the appropriate approach for preparing a Letting estimate is the foundation for quality and accurate estimates. In the Letting Phase, the majority of item estimates are prepared using cost based or historical bid based approaches. The advantage of using cost based estimating is that labor, material, and equipment costs can better reflect current market values. Also, site conditions can better be accounted for when using cost based estimating since cost data from a project with similar site conditions can be used. Historical bid prices have these costs embedded in the unit cost, so it is often difficult to properly reflect current market conditions.

The two inputs for this step are the Engineer's Estimate Basis File produced in the Document Engineer Estimate Basis step (A414) and the items and quantities already prepared by the District and Bridge offices.

Issues to Consider

Tool Application

- Select either cost based or historical bid based estimating to prepare item cost estimates.

- The Cost Estimating System is used to calculate costs and summarize cost estimate information.

Project Characteristics

- Project estimation approaches should be selected on the basis of experience of the Estimator and historical data available.

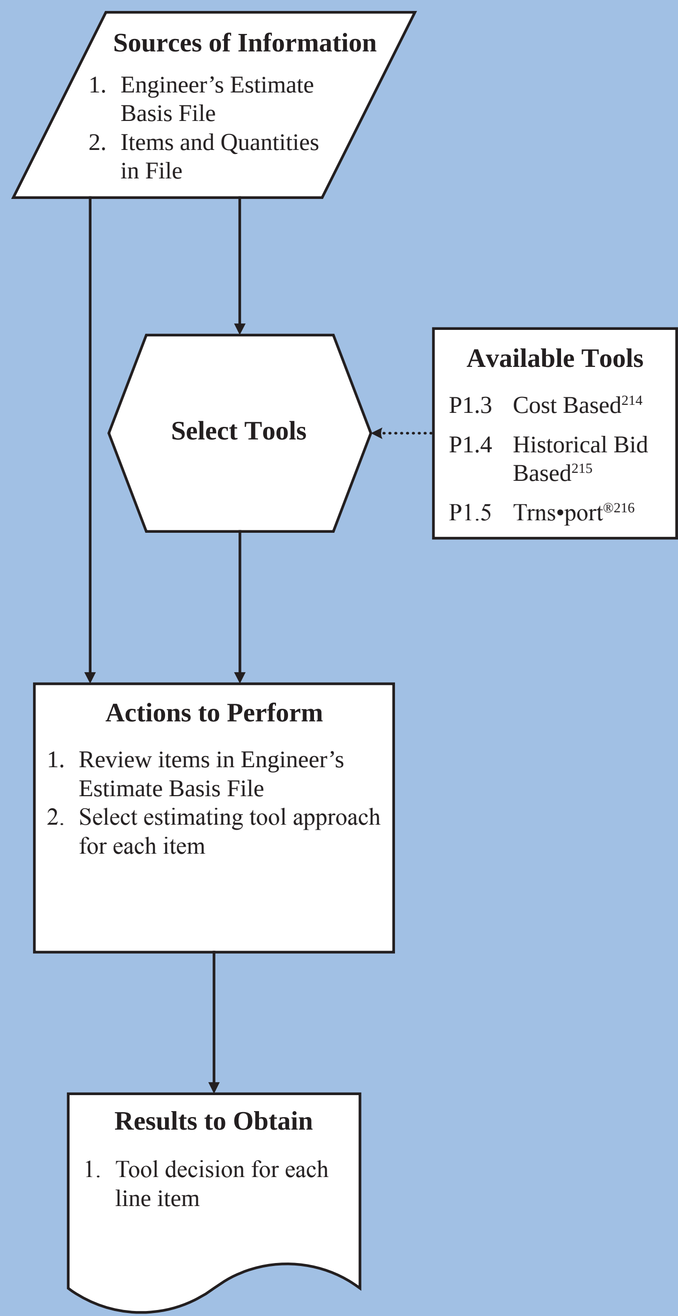
- Major projects require more time and effort to prepare an estimate.

Select Appropriate Approach (A421)

The Engineer's Estimate Basis File contains the estimate basis from which the Estimator will prepare the estimate. The documents contained in this file are critical to preparing an accurate estimate. Project requirements as defined in the estimate basis and complexity of the project drive estimating tool selection.

The Estimator must rely on both experience and judgment when selecting the tool applicable to estimating different items. The availability of historical data may impact this decision.

Central Office estimating staff input items and quantities into PES. These data are exported to CES for estimating item costs.



214. For P1.3 Cost Based, see page 403.
215. For P1.4 Historical Bid Based, see page 405.
216. For P1.5 Trns•port®, see page 407.

Develop Estimate Data (A422)

Step Requirements

This step in the Prepare Engineer's Base Estimate sub-process determines the various cost data that is applied to items. The types and sources of historical data depend on the estimating tool used. For example, historical bid based estimating requires recent history of unit prices for different items. Cost based estimating requires data sources for material prices, equipment production rates and cost, and labor data such as wage rates, crew sizes, and production rates.

The critical action to perform in this step is to develop the appropriate cost data for each item; however, equal care must be given to adjusting the cost data for market conditions, project-specific location characteristics, age of historical data, and other factors. The Estimator in the Central Office will also need to address risks. The Estimator may modify any necessary cost data based on feedback from the estimate review sub-process.

The Estimator uses a number of different inputs to accomplish this step, such as items and quantities, knowledge of project characteristics, historical data, and potential market impacts.

Issues to Consider

Historical Data

- Historical bid data used for estimating must reflect current costs, that is, unit costs are updated to reflect inflation when unit costs are older than three months.

- Historical bid data must be understood in terms of how these data are developed for estimating a current project (e.g., using weighted averages based on low bid only).

- Historical data for labor, material, and equipment must reflect the current characteristics of the item being estimated.

Inflation Rate

- If the Estimator adjusts item cost data when construction is longer than one season, the Estimator needs to use a future inflation rate supplied by the Office of Investment Management.

Project Characteristics

- Market conditions and project location greatly affect the cost data; however, factors such as material cost, special equipment, or construction method should also be considered to make the cost data more accurate.

Develop Estimate Data (A422)

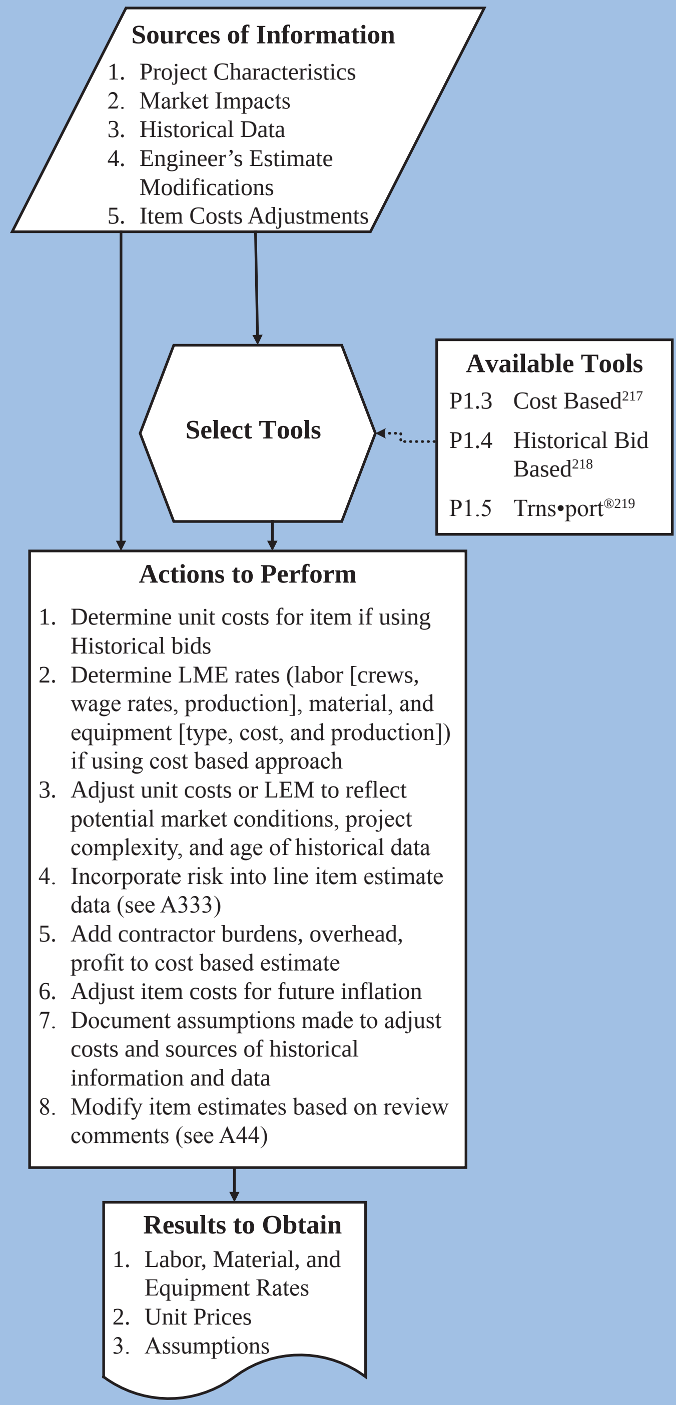
The Estimator works with a substantial amount of information. Consider variability resulting from the source of historical data used and its fit with the project being estimated.

Spend time developing historical cost data for critical items. Review both state and local bid data. Check recent bids tabulations and comparisons with other Engineer's Estimates to identify problem areas with historical data.

Look beyond the historical data when estimating the cost. Look for recent trends such as rising material costs or changes in specifications. Consider where the project is located and its key features, that is, rural/urban, two lane/four lane, and so on.

Adjusting historical data to fit a project is a challenge. Issues to consider are location of material sources and batch plants, haul distances and routes, work zone staging, and any market volatility.

Historical data must reflect current-day costs prior to applying these data to a project estimate. The Estimator should note estimate assumptions that are made when adjusting historical data to fit the project being estimated. Also, uncertainty associated with an item cost must be incorporated into the item estimate.



217. For P1.3 Cost Based, see page 403.
218. For P1.4 Historical Bid Based, see page 405.
219. For P1.5 Trns•port®, see page 407.

Calculate Cost Estimate (A423)

Step Requirements

Calculating the cost estimate is a fundamental step in the Prepare Engineer’s Base Estimate sub-process. The Estimator in the Central Office inserts into the Trns•port Cost Estimating System the cost data for each item estimate. CES then generates the construction cost estimate and provides various reports.

Different reports can aid in the estimate review process.

Issues to Consider

Project Definition and Characteristics

- This is the best time to ensure all items are covered by reviewing the plans and specifications to ensure that the work is properly reflected in the items.

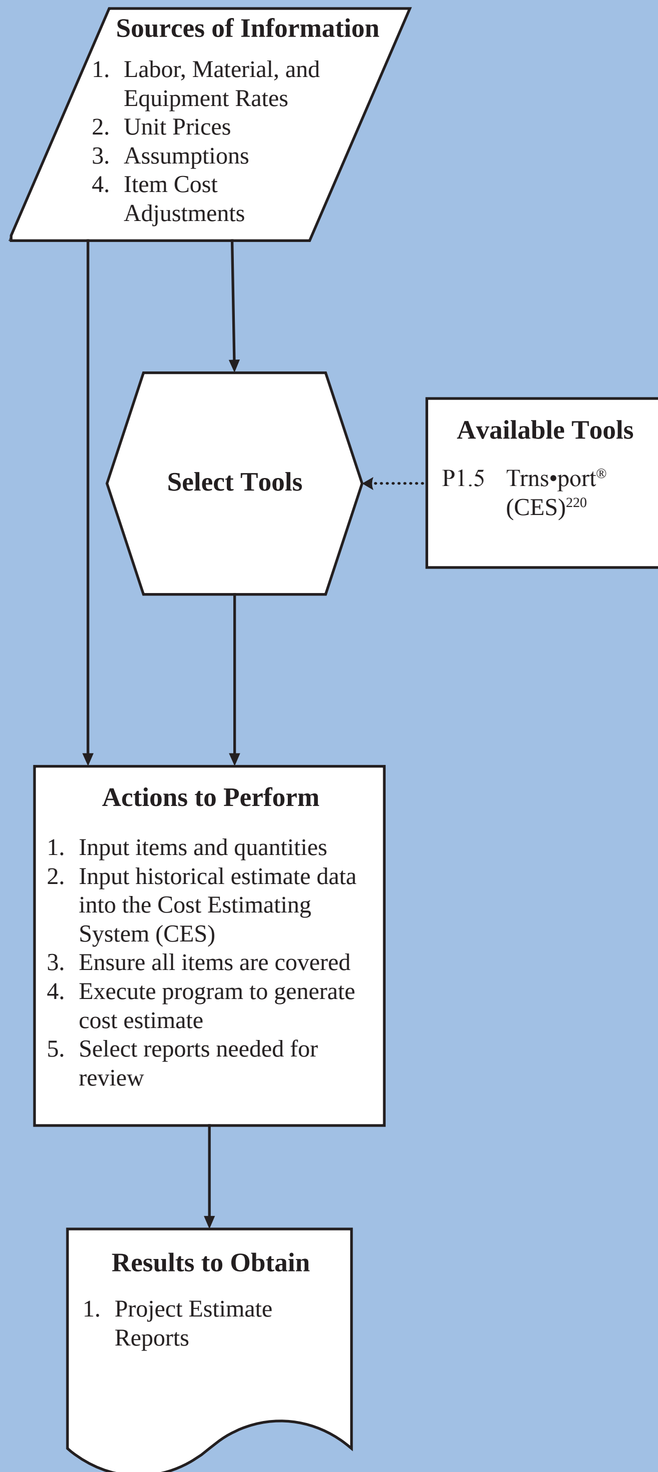
Calculate Cost Estimate (A423)

CES is the software used to compile and calculate cost estimate data for item estimates.

This is the time to ensure all items have been accounted for in the estimate. Any items excluded should be identified, and any item not accounted for needs to be calculated.

Ensure that work contained in an item reflects all the work required per the plans and specifications.

Contingency should be embedded into item estimates to reflect risks related to the item. Future inflation should be included if construction is to last longer than one season.



220. For P1.5 Trns•port® (CES), see page 407.

Document Estimate Assumptions (A424)

Step Requirements

A project's complexity and size may mean that more issues must be considered in preparing the estimate. Good documentation supports the cost estimate's credibility, enables reviewers to effectively assess the quality of the estimate, aids in the analysis of changes in construction cost, and contributes to Mn/DOT historical cost databases for estimating the construction cost of future projects. Furthermore, bidders will also be making assumptions. Identifying similar assumptions is crucial for this estimate to reflect those estimates provided by bidders.

This step brings together all information used to prepare the Letting estimate in a structured format. While the number of items varies depending on project type and complexity, the need to assemble backup calculations, assumptions, and other pertinent estimate data is critical to ensure consistency across projects, as well as a universal understanding of the estimate.

The output of this step is documented estimate assumptions. Documentation and preservation of supporting data are important as this data forms historical data for other upcoming projects.

Issues to Consider

General

- It is particularly important to clearly document the changes, data origins, and approximations, as discrepancies between this estimate and the estimate from the bidders will need to be analyzed.

Policy Guidance

- Cost estimates for each phase will be documented. Accelerated project incentives that are part of the contract at Letting should not be designated as cost escalation or overages during the project. These incentives are expected and should be accounted for as a pre-letting contingency.

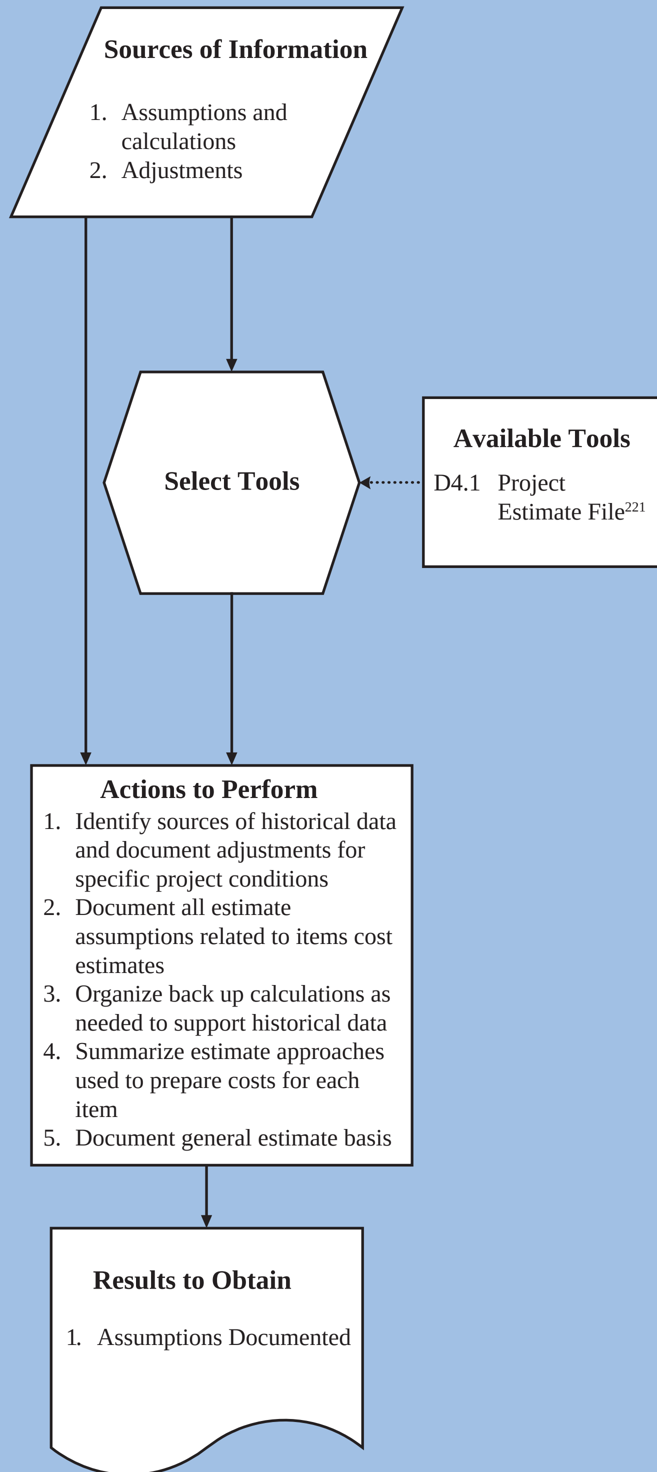
Document Estimate Assumptions (A424)

The primary purpose of the Engineer's Estimate Basis File is to ensure that each project has a well-documented and easily retrievable history of the assumptions, methods, and procedures used to estimate the construction costs at the time of Letting.

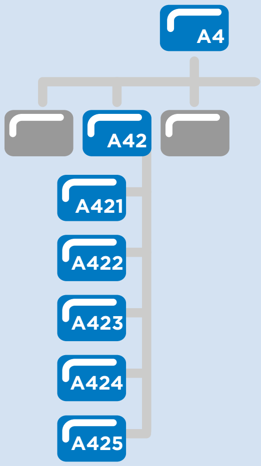
Traceability is a critical requirement necessary to prepare a credible cost estimate. Traceability allows others to review and validate the estimate. Traceability provides the mechanism to assess differences between the contractor's bid and the Engineer's Estimate.

Traceability is facilitated by clear and concise documentation. Documentation should include the estimate basis, assumptions, and calculations. The Engineer's Estimate Basis File should be created to assemble these items in a single location.

Estimate bases and assumptions are at two levels: 1) high-level and assumptions that apply to every item in the construction estimate; and 2) detailed-level bases and assumptions that apply to individual item estimates.



221. For D4.1 Project Estimate File, see page 339.



Prepare Estimate Package (A425)

Step Requirements

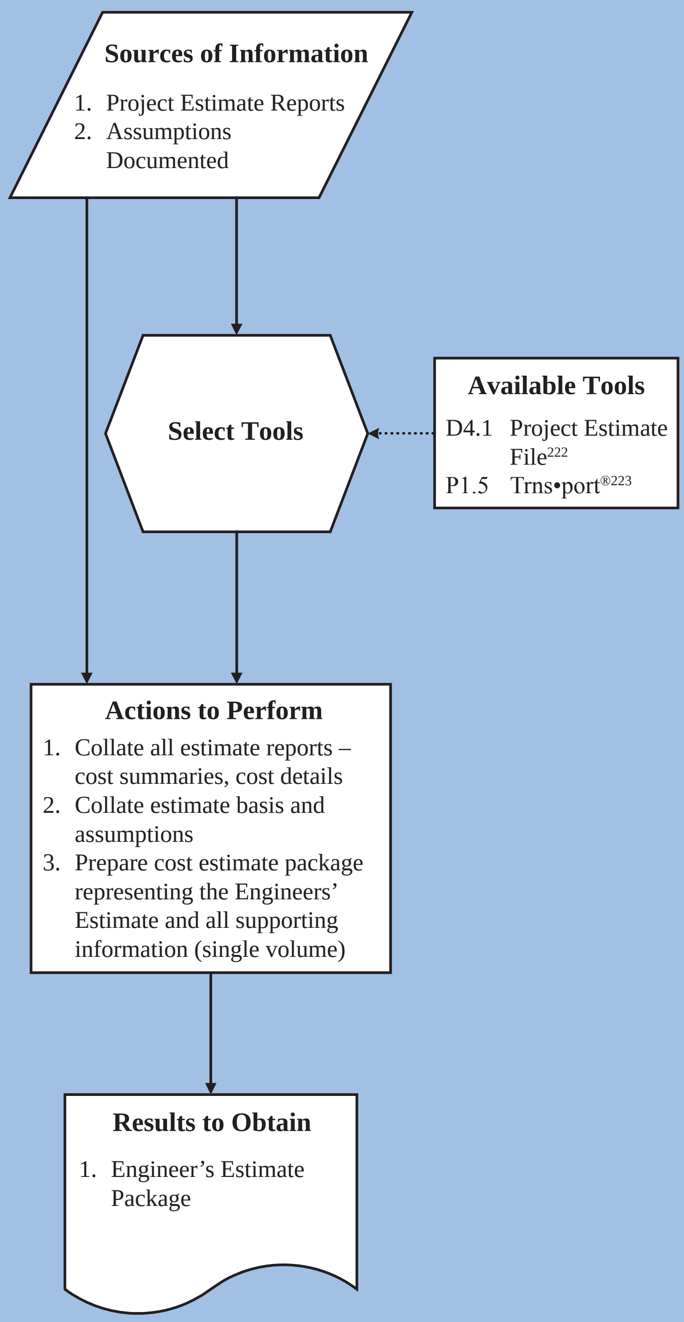
This is the final step in completing the Engineer’s Estimate Package. All calculations have been made and documented before this step; however, the details, summaries, and assumptions must all be collated into a single, logical volume. After accumulating and organizing this material, the package produced will represent the construction cost and all supporting information.

The Engineer’s Estimate Basis File provides a record that documents the basic reasons behind the estimated construction cost. Above all, the information must be easy to understand and well-organized for reviewers. Thus, summary level information is often prepared for any necessary reviews. The Estimate Package should include final plans and specifications, assumptions, quantity and price calculations, and supporting data and cost summaries generated by CES.

Prepare Estimate Package (A425)

The Engineer's Estimate Package should include all required information related to the estimate, including cost summaries, cost details, plans and specifications, all assumptions, and backup calculations.

A short cost-estimate summary can be prepared that captures key features of the estimate, such as element costs related to a set of items, key estimate bases and assumptions, construction duration, and other critical items. This document, while part of the package, will aid in management reviews of the cost.



222. For D4.1 Project Estimate File, see page 339.
223. For P1.5 Trns•port®, see page 407.

III.5.4 DETERMINE RISK AND SET CONTINGENCY – CONSTRUCTION ESTIMATE (A43)

The primary objective of this sub-process is to evaluate the residual risks that have not been avoided or completely mitigated through the Design process and incorporate the costs for these risks in the Engineer's Estimate. The four sub-process steps are as follows:

1. Review Risk Information from PS&E Submittal – A431
2. Identify Additional Risks – A432
3. Evaluate Cost Impact – A433
4. Communicate Risk – A434

The first three steps, in combination with the tools in the Tool Appendix, support the development of the cost impacts that must be incorporated into the item estimates. These three steps identify required adjustment to unit prices relating to these residual risks and provide a framework to assess any required adjustment to unit price cost estimates relating to these residual risks in the Engineer's Estimate. Some of the key inputs include the following:

- **Final Project Design** – the District PS&E submittal and the Bridge Office PS&E submittal must be analyzed for any risks that the contractors will need to incorporate into their bids.

- **Risk Management Plan, Risk Register, or Red Flag Item List** – depending upon the level of risk management performed on previous estimates, the estimate file will contain a risk management plan, risk register, or red flag item list.

- **Market Impacts** – the current market conditions (e.g., number of expected bidders, availability of subcontractors in the region, availability of materials, etc.) can create risk and an associated increase or decrease in contractors' unit cost estimates.

- **Individual Expertise** – risk analysis and the adjustment of unit costs for any associated uncertainty will necessarily rely on the expert judgment of the Letting Estimator.

Use these key inputs when performing the four steps of this process. The output of this sub-process is a set of updated unit prices and a continuing documentation of the risk and contingency basis. Add all of these items to the Project Estimate File at the end of the process for purposes of analysis of bids, cost analysis of changes during construction, and documentation for future estimates.

Those risks that cannot be avoided or completely mitigated through Design must be transferred to the contractor. Therefore, this step will result in the final resolution of risks through the incorporation of their impacts in the unit prices. This step must document the risk analysis and contingency process through an update of risk documentation. In its simplest form, the risk documentation is completed by clearly retiring risks on the red flag item list (I2.1) or the risk register (R3.12) and incorporating this information into the project estimate file.

This step must document the risk analysis and contingency process through an update of risk documentation.

Review Risk Information from PS&E Submittal (A431)

Step Requirements

This sub-process step requires a thorough review of the information in the most recent risk and contingency documentation used in the Design Phase and any estimating assumptions made in the PS&E submittal. Previous risk and contingency documentation will vary depending upon the level of risk analysis followed in previous estimates. Table III.5-2 summarizes a range of risk documentation.

Table III.5-2. Summary of Risk Analysis Documentation from Previous Risk Analyses

Risk Analysis Level	Available Risk Information Documentation
Type I Risk Analysis: Risk Identification and Percentage Contingency	I2.1 Red Flag Item List R3.12 Risk Register (optional)
Type II Risk Analysis: Qualitative Risk Analysis and Indentified Contingency Items	R3.12 Risk Register R3.1 Risk Management Plan (optional)
Type III Risk Analysis: Quantitative Risk Analysis and Contingency Management	R3.12 Risk Register R3.1 Risk Management Plan R3.5 Stochastic Estimate Model Output

The updating of previous risks and the determination of any new risks stems from a review of the estimating assumptions made by the Estimators (including Functional Group Estimators). During Design, the project and Functional Group Estimators must make estimating assumptions. Estimating assumptions at the PS&E level should be minimal as the design is 100 percent complete, but any noted assumptions at this point must be reviewed to determine the level of risk inherent in the final design.

Two other sources of risk information are risk checklists and risk analyses from similar projects. However, these sources of information should be considered only after conducting a thorough review of the estimating and design assumptions.

Issues to Consider

Use of Risk Analysis Categories

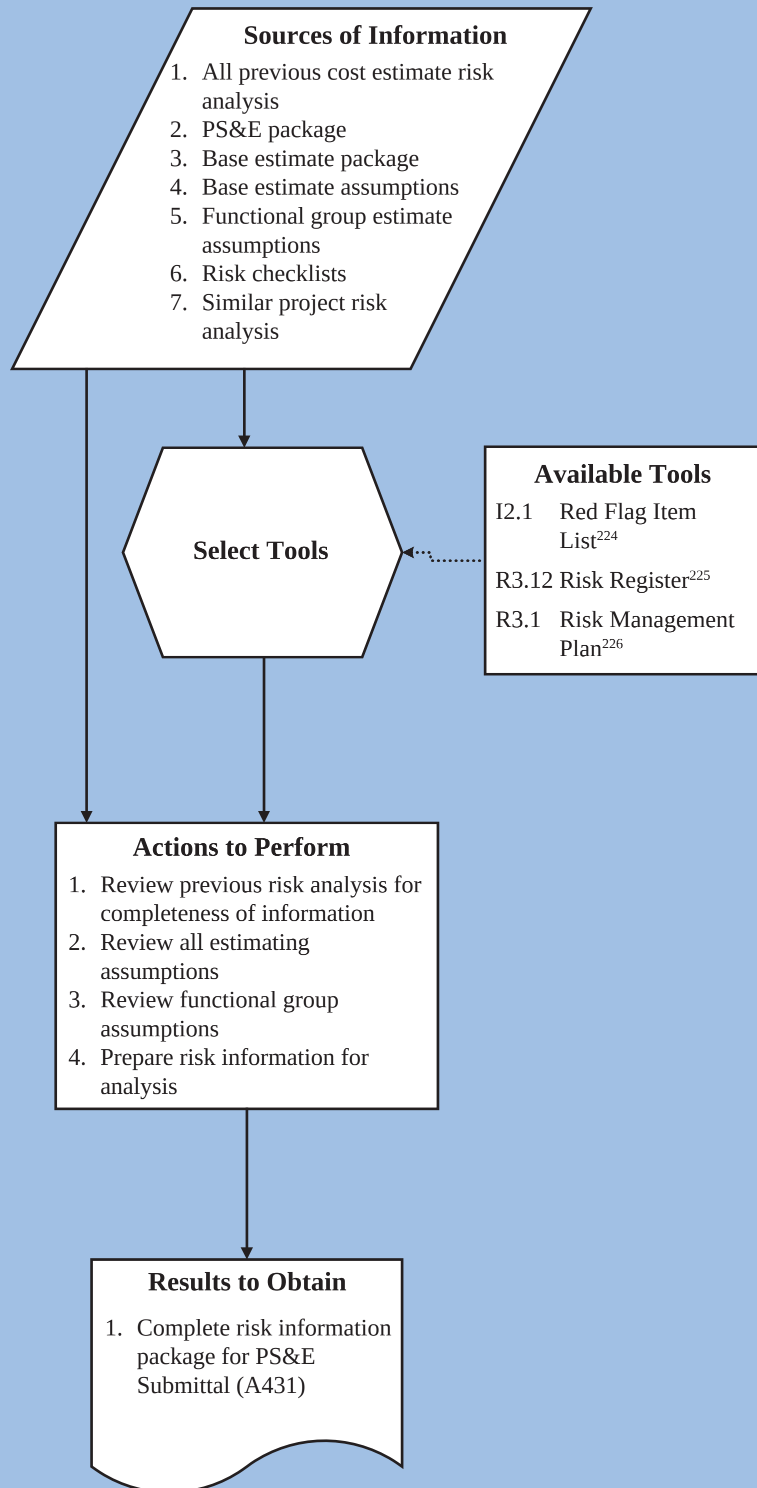
- The Type I, Type II, and Type III risk analyses used in the Planning, Scoping and Design estimates ceases at the Letting Phase. Risk analyses on projects of all complexity levels will be completed through the same process explained in the steps that follow. However, the output from the previous analyses (e.g., red flag item lists, risk registers, etc.) will be relied upon for risk identification. These outputs will also be updated for monitoring purposes during the Letting Phase.

Review Risk Information from PS&E Submittal (A431)

Ideally, a complete estimate basis and base estimate package should be available for the risk analysis and contingency estimate. While Estimators may concurrently perform portions of the contingency estimate with the base estimate development, unit cost adjustments should only occur after the base estimate is complete.

Be certain to consult any previous risk analyses. The use of a risk register throughout project development will ensure this occurs.

The Review Risk Information step focuses on a collection of information for later use. Do not conduct risk analysis in this step, but rather ensure that all information is packaged for the risk analysis.



224. For I2.1 Red Flag Item List, see page 411.
225. For R3.12 Risk Register, see page 446.
226. For R3.1 Risk Management Plan, see page 425.

Identify Additional Risks (A432)

Step Requirements

The objectives of risk identification at the Letting Phase are to identify any risks that might impact contractors' bids and categorize them to the appropriate sections or line items in the Engineer's Estimate. The outcome of the risk identification is a list of risks.

Use the output of step A431, Review Risk Information, to begin the process. This information will include risk lists or risk registers from previous risk analyses. It should also contain any standard risk checklists or similar project analyses.

After reviewing previously identified risks, indentify any new risks that may be apparent in the review of the PS&E package. This should be an objective review of the project from the point of view of a contractor's who will be bidding the project.

In the previous project development phases, project complexity related risk analysis to categories of Type I, Type II or Type III. These categories are not as relevant for risk identification at the Letting Phase. In essence, each risk identification exercise is treated similarly in Letting because the design is complete. The information from each of the previous analyses is reviewed, but the process for final risk identification at the Letting Phase is the same for all three categorizations.

Issues to Consider

Resolution of Previously Identified Risks

- Risks involve future uncertain events. Risks occur or they do not. Risks identified in the Planning, Scoping, and Design Phases may no longer exist at the Letting Phase. If a risk event occurred, it should have been incorporated into the base estimate. If the risk did not occur, it can be retired from consideration. If it still exists, it will be incorporated into the Engineer's Estimate.

Use of Risk Checklists and Similar Projects

- Risk checklists and lists of risks from similar projects can be helpful, but use them only as a "back check" at the end of the risk identification process. Review these lists only at the end of the process as a means of ensuring that the list is not excluding any common risks. Avoid beginning the process with the risk checklists or similar project analyses as the team may overlook unique project risks or include too many risks in the analysis, making it less useful.

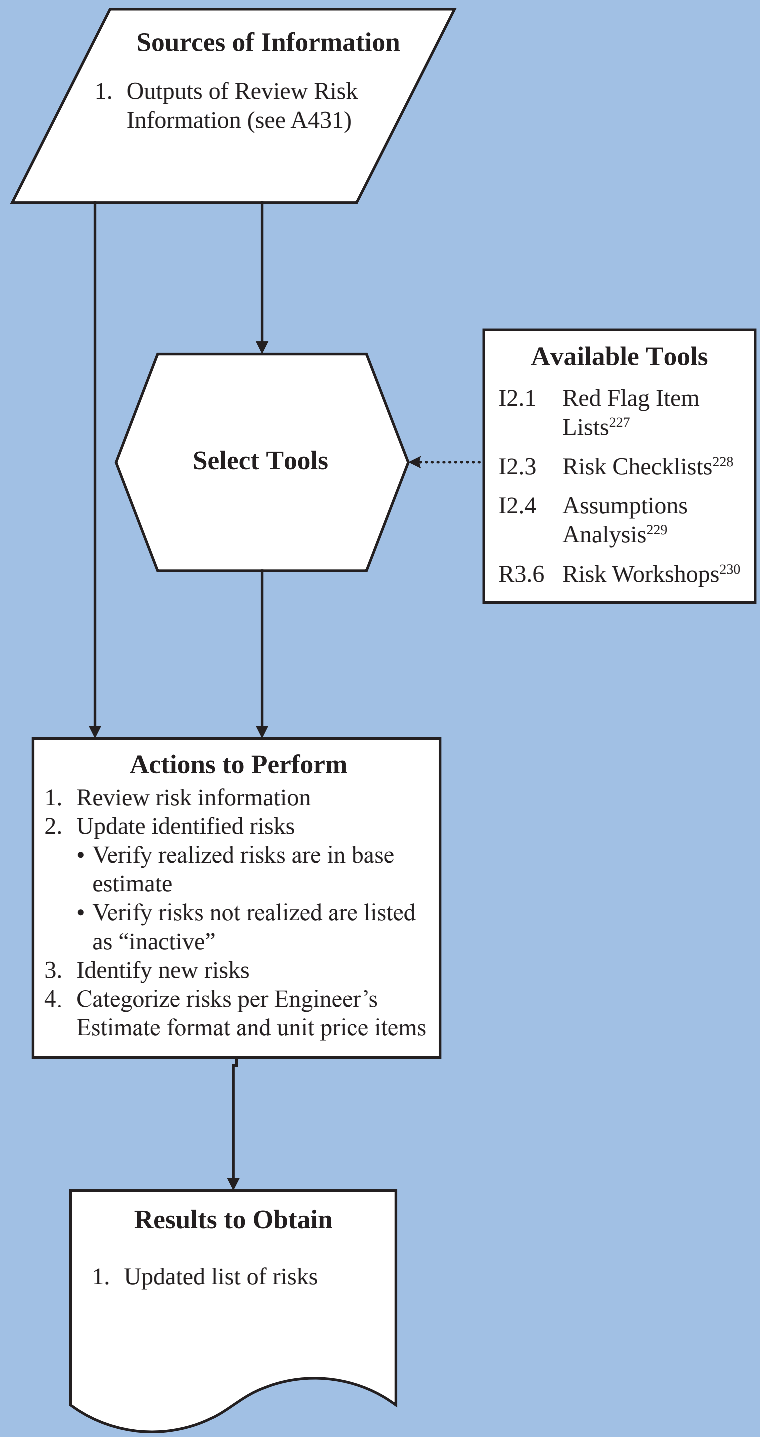
Identify Additional Risks (A432)

Focus on risk identification. Do not attempt to analyze risks or discuss mitigation procedures in this step. Completely identify any new or residual risks in this step. Risk analysis and planning will occur in later steps.

Assumptions analysis will be the primary tool used for risk analysis at the Letting Phase. On the most complex projects, a risk identification workshop may be considered.

Use risk checklists and similar projects only to check for missing risks and to help categorize unique project risks.

Use the Engineer's Estimate format and unit price line items to categorize risks.



227. For I2.1 Red Flag Item Lists, see page 411.
228. For I2.3 Risk Checklists, see page 413.
229. For I2.4 Assumptions Analysis, see page 419.
230. For R3.6 Risk Workshops, see page 440.

Evaluate Cost Impact (A433)

Step Requirements

The goal of this sub-process step is to analyze any residual project risks that have been allocated to the bidders through the documents and adjust the associated line item unit prices in the Engineer's Estimate to reflect them. Risk that have not been avoided or mitigated during design (residual risks) will be allocated to the contractor and must be accounted for in the estimate pricing.

Unlike the previous Planning, Scoping, and Design estimates, the Engineer's Estimate will not contain a specific category for contingency. The Engineer's Estimate will incorporate risks into the unit prices for ease of comparison with the contractor's bids. The only exception is the contingency for construction changes and incentives after award.

The general approach is the same for all cases (Type I, Type II, and Type III risk analysis). The Letting Estimator should examine the magnitude of the identified risks in direct monetary terms. Monte Carlo methods and PxI matrices are no longer applied for risk analysis as they were in previous estimates. Rather, the Estimators must rely on historic costs from similar projects and experienced judgment to determine the unit prices.

Issues to Consider

Risks from the Contractor's Perspective

- Until this point, a large portion of risk analysis by the planning and design team will have dealt with risk or uncertainty in the Design process. At this point, the Letting Phase Estimator must view the project through the contractor's eyes when analyzing risks. Reviewing the detailed contract special provisions can be helpful. Contractors price risks based upon their ability to manage and profit from them. If the designs or contract provisions are placing onerous risks on the contractor, their only choice is to place contingency in their bid as a mitigation strategy.

Market Conditions

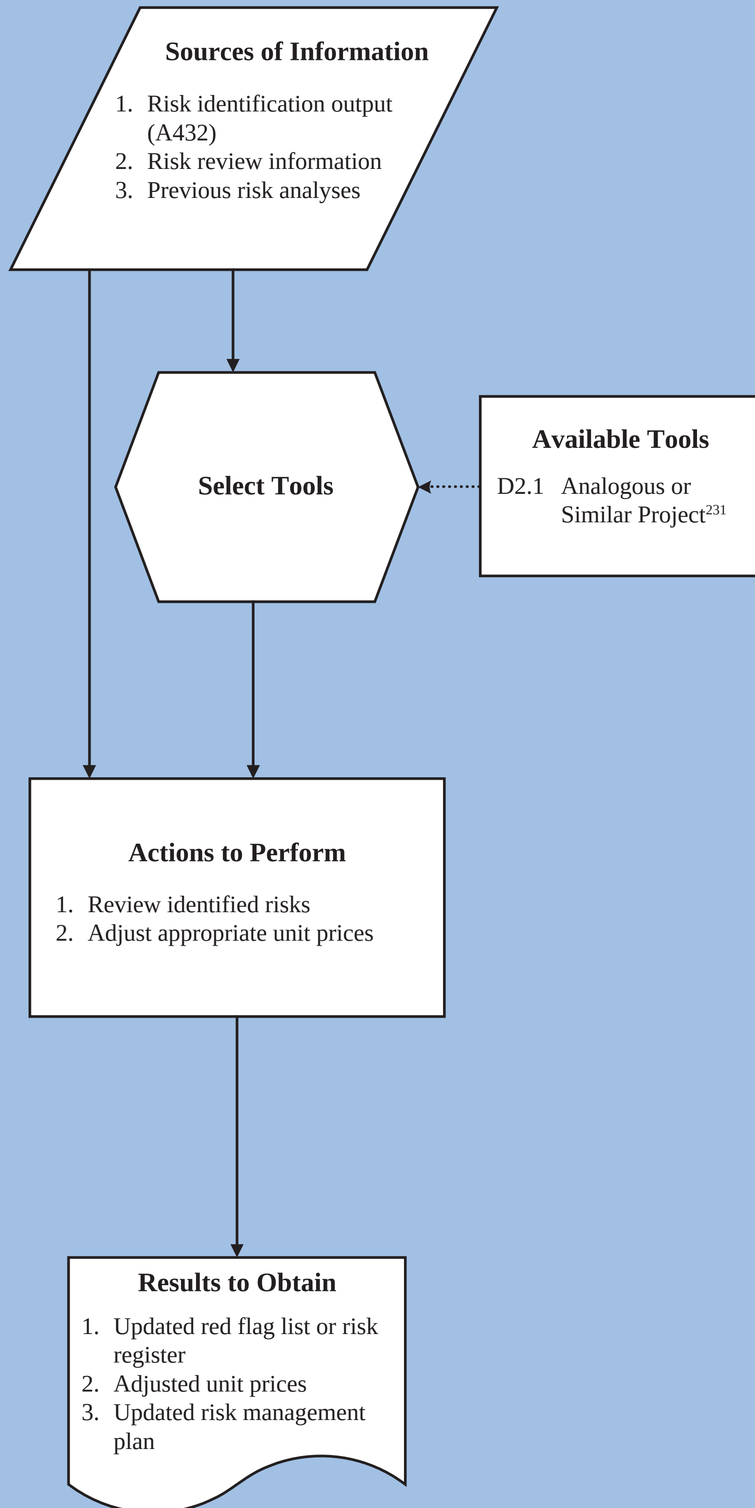
- The number of bidders and the number of material suppliers can significantly influence prices. This is especially true for specialty or unusual work. There is strong evidence that bid prices decrease as the number of bidders increase. Contractors vary in their ability to manage risks and their willingness to accept them. Letting Estimators must be particularly careful in pricing risks when a small pool of bidders is available.

Evaluate Cost Impact (A433)

Inputs for the construction estimate come from the risk identification output (see A432) and risk review information (see A431).

Ideally, contingency will be resolved (or reduced) at each estimate update. However, if significant new risks are realized, they must be accounted for in the Engineer's Estimate.

The risk analysis tools that were used in Planning, Scoping, and Design estimates (e.g., PxI matrices, Monte Carlo analysis, etc.) will not be used in the Engineer's Estimate. Tools for the Engineer's Estimate can include similar project analysis, expected value calculations, and, most importantly, experienced Estimator's judgment.



231. For D2.1 Analogous or Similar Project, see page 387.

Communicate Risk (A434)

Step Requirements

This step requires the Letting Phase Estimator to update list of risks, describe how the risks were incorporated in the Engineers Estimate, and make final documentation of the risk analysis in the estimate file. In its simplest form, the risk communication is completed by documenting the retirement of risks on the red flag item list or the risk register and incorporating this information into the Project Estimate File.

Time must be taken to document the risk analysis and unit price adjustments made in the Letting Phase. The documentation will be important for comparing the Engineer's Estimate to the bids received and also for maintaining the historical database of unit prices.

This step will complete the risk management process for the Letting Phase. It is imperative that the Estimator document how each of the risks was resolved for future management of the project. The Estimator should make a final update of the risk register (or list of red flag items). No risk should be listed as "active" on the risk register when the Engineer's Estimate is complete. If a formal risk management plan is in place for the project, the associated steps for the Letting Phase must be completed and documented. The Estimator can look to the Project Manager and the Central Office for help in "closing the loop" on the risk management process for Design, but it is critical that no risks are left unaddressed or undocumented at the time of Letting.

Issues to Consider

Documentation for Bid Comparison

- The Estimator must document any changes that were made to unit prices as a result of the risk analysis. This documentation will serve to help compare the Engineer's Estimate to the bids received. The documentation will help to explain any variance between the Engineer's Estimate and the low bid and/or help to explain any variance within the biding pool.

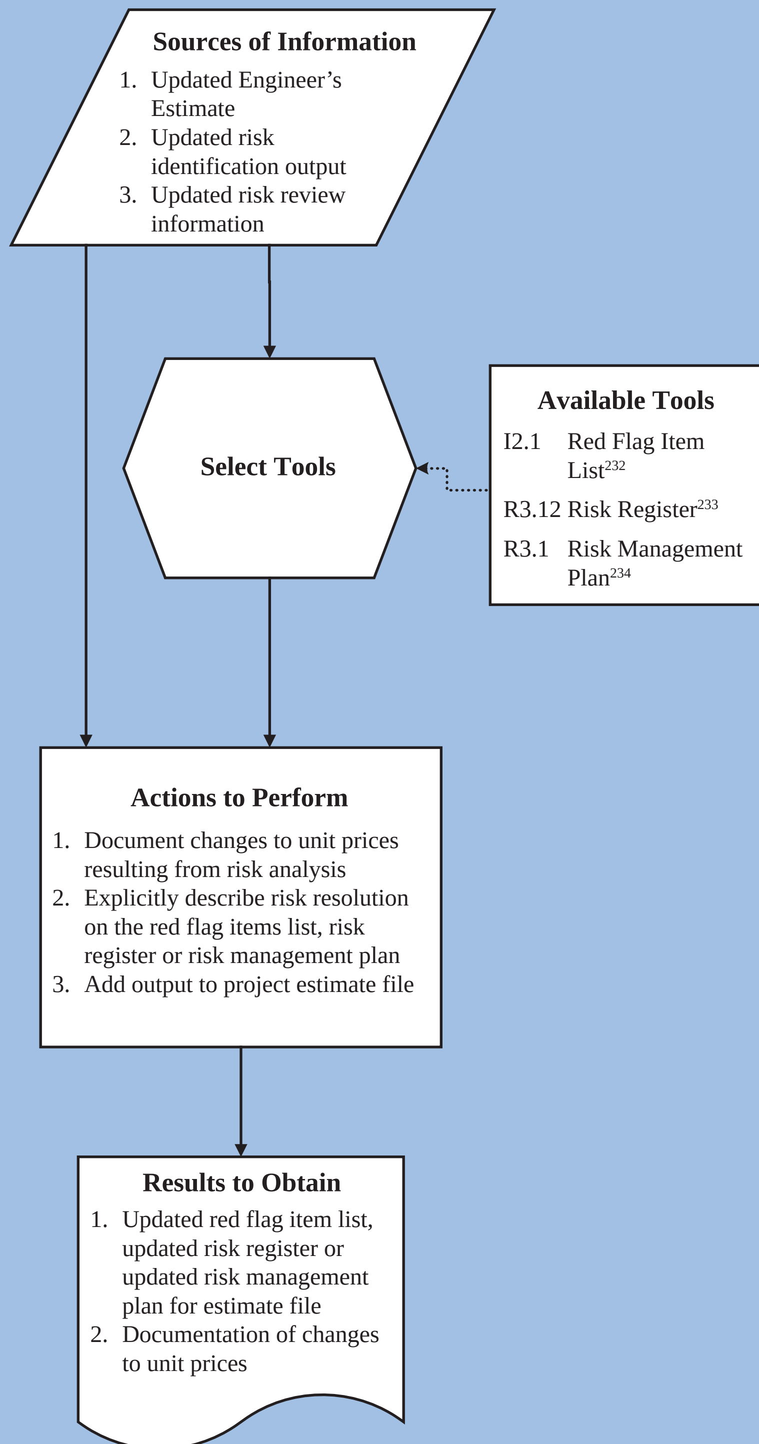
Communicate Risk (A434)

Provide an explicit update for contingency resolution. Describe which risks have been realized, mitigated, or avoided. Describe any new risks that have been identified.

Clearly document the unit price adjustments that were made to reflect the risks. Describe the basis or method behind the adjustment.

Collate all risk and contingency information used in cost management throughout the project development process.

Document that all risks found on red flag item lists or in risk registers have been avoided, resolved, or accounted for in the Engineer's Estimate. Close the loop on the risk management process by ensuring that no risks are active at the time of letting. Documentation in the estimate file will serve as the communication of this sub-process step.



232. For I2.1 Red Flag Item List, see page 411.
233. For R3.12 Risk Register, see page 446.
234. For R3.1 Risk Management Plan, see page 425.

III.5.5 REVIEW CONSTRUCTION COST ESTIMATE (A44)

A purpose of the Review Construction Cost Estimate sub-process is to ensure that the estimate is as complete and accurate as possible based on the project requirements as described in the plans and specifications. This sub-process is critical because it will become the foundation for reviewing bids during Letting. This sub-process has five steps. The steps are as follows:

1. Determine Level of Review – A441
2. Review Appropriate Approach and Data – A442
3. Review Assumptions – A443
4. Review Clarifications – A444
5. Review Summary – A445

The first step is to ensure that the District is contacted once the independent estimate is completed by the Central Office and informed of the outcome of the estimate in relation to the last estimate completed by the District. During this conversation the designated District representative and the Central Office staff will determine if additional review is required. This step must be completed prior to advertisement of the project.

The last four steps provide a natural progression of effort to review the construction cost estimate during the Letting Phase if one is warranted. The first step requires comparison between the Engineers Estimate Package and the Updated Project Estimate from the Design Phase. This step will address any changes that have been made or need to be, which is essential to the cost management process. The next two steps would likely be performed at the same time as step one. They entail reviewing the assumptions and clarifications in the construction cost estimate. Once these three steps are complete, a review summary can be assembled and final modifications to the Engineers Estimate and Baseline can be made. There are two key inputs required:

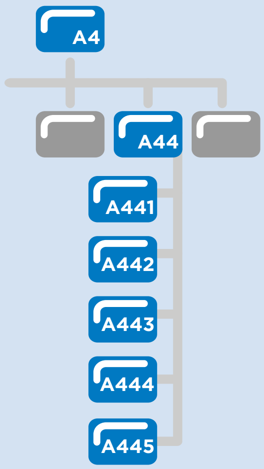
- **Approved Updated Total Project Cost Estimate Package** – contains the updated base cost (summary and details) and contingency, all supporting documentation related to estimate basis, assumptions, backup calculations, risks, and other areas of uncertainty. This is the result of the Design Phase.

- **Project Characteristics** – description of the type of project and complexity of the project, including site-specific information and/or data that may impact the base cost and contingency.

The Estimator should review the RACI matrix and determine his or her role in this function, as well as the roles of management, other estimating groups, Project Management, and Functional Groups.

The key inputs are used when performing the four steps of this sub-process. The outputs of this sub-process are an Engineers Estimate with modifications and possible adjustments to the STIP budget through the Project Change Request process. If the review finds no issues with the estimate, it is then used in the next sub-process, Compare with Bids. If issues are found, they must be resolved.

A purpose of the Review Construction Cost Estimate sub-process is to ensure that the estimate is as complete and accurate as possible based on the project requirements as described in the plans and specifications.



Determine Level of Review (A441)

Step Requirements

There are two objectives for this step. The first objective is to determine the level or review by the District. This is determined by the Central Office contacting the designated District representative with the outcome of the Engineers Estimate and how it compares to the final estimate completed by the District. Based on this confidential discussion one of three outcomes may occur.

1. The estimates from the District and Central Office may agree and the determination may be that no further review is warranted.

2. The estimates from the District and the Central Office may not agree and additional review is warranted. Based upon this review the District will need to consider how this difference may impact their program.

3. The estimates from the District and Central Office may agree, however, for learning purposes the District and Central Office staff may want to conduct a review.

The second objective of this step is to perform a careful review the project details and choose the appropriate tools for review if the outcome of the first objective is that the project requires further review by the District. The primary inputs for this step include the Total Project Cost and the project complexity definition. During the risk and contingency process, the project will have been categorized as minor, moderately complex, and major. The level of review correlates directly to these project complexity definitions. Table III.5-3 below provides guidance on which tools apply to the appropriate review level.

Table III.5-3: Review Tools and Project Complexity

Estimate Review Tools	Minor	Moderately Complex	Major
C4.2 Estimate Checklist	✓	✓	✓
E3.3 In-House Peer	✓	✓	✓

Upon choosing the appropriate review tools, plan the review. The review plan should include a schedule for the review and a listing of people who will participate.

Issues to Consider

By law the final estimate completed by the Central Office is considered confidential and must remain so until after the award of the project.

Determine Level of Review (A441)

This step must happen before the project is advertised.

The purpose of this step is not to change any estimates but to provide the appropriate District representative(s) with greater knowledge.

During the review the participants may consider only reviewing certain items. This may include items where there is disagreement or the approximately 20% of the items that make up 80% of the cost.

Review the total project cost estimate package and the overall project complexity and type in order to choose an appropriate review level.

Read through the list of available tools and take them into consideration latter in this step and process. Considerations should include project complexity and resources such as personnel and time.

The output for continued review from this step is an appropriate review level and a list of tools to be used in the review process.

Sources of Information

1. Total Project Cost Estimate Package
2. Project type and complexity

Actions to Perform

1. Contact designated District Representative with outcome of estimate
2. Discuss differences and similarities of estimates
3. Determine if additional review is warranted by District
4. If “no” to 3 proceed to III.5.6 compare with bid (A45)
5. If “yes” to 3 continue below

Select Tools

Available Tools

R1.1 Recognition of Complexity[235]

C4.2 Estimate Checklist[236]

E2.1 Expert Team[237]

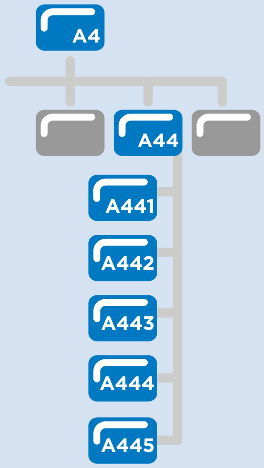
Actions to Perform

1. Review information in Total Project Cost Estimate Package
2. Consider available review tools on the basis of project complexity
3. Determine tools that fit the level of project definition and complexity
4. Decide on appropriate review level and tools
5. Develop a review plan

Results to Obtain

1. Tools for review
2. Plan for review

235. For R1.1 Recognition of Complexity, see page 343.
236. For C4.2 Estimate Checklist, see page 449.
237. For E2.1 Expert Team, see page 467.



Review Appropriate Approach and Data (A442)

Step Requirements

This step requires that the Estimator review not only the Updated Total Project Cost Estimate, but also the Engineers Estimate, in order to attempt to address the differences between the two.

Review the approach of the estimate and data using available tools, such as an estimate checklist. However, when considering an estimate checklist, remember that the checklist is intended to guide the Estimator through suggested items and consideration of factors that impact the project costs; the Estimator should also consider items that are not on the checklist. Determine what the differences are and if they have been addressed previously or if they still require identification. List all variations from the Engineers Estimate in a concise format that clearly details all known differences in an easy-to-understand manner.

The output of this step will be a detailed list of all estimate differences for use in the review summary.

Issues to Consider

Estimator Judgment

- The most indispensable tool for estimate review is judgment. Judgment is what identifies mistakes, detects flawed assumptions, and identifies where the process has missed critical cost drivers.

Policy Implications

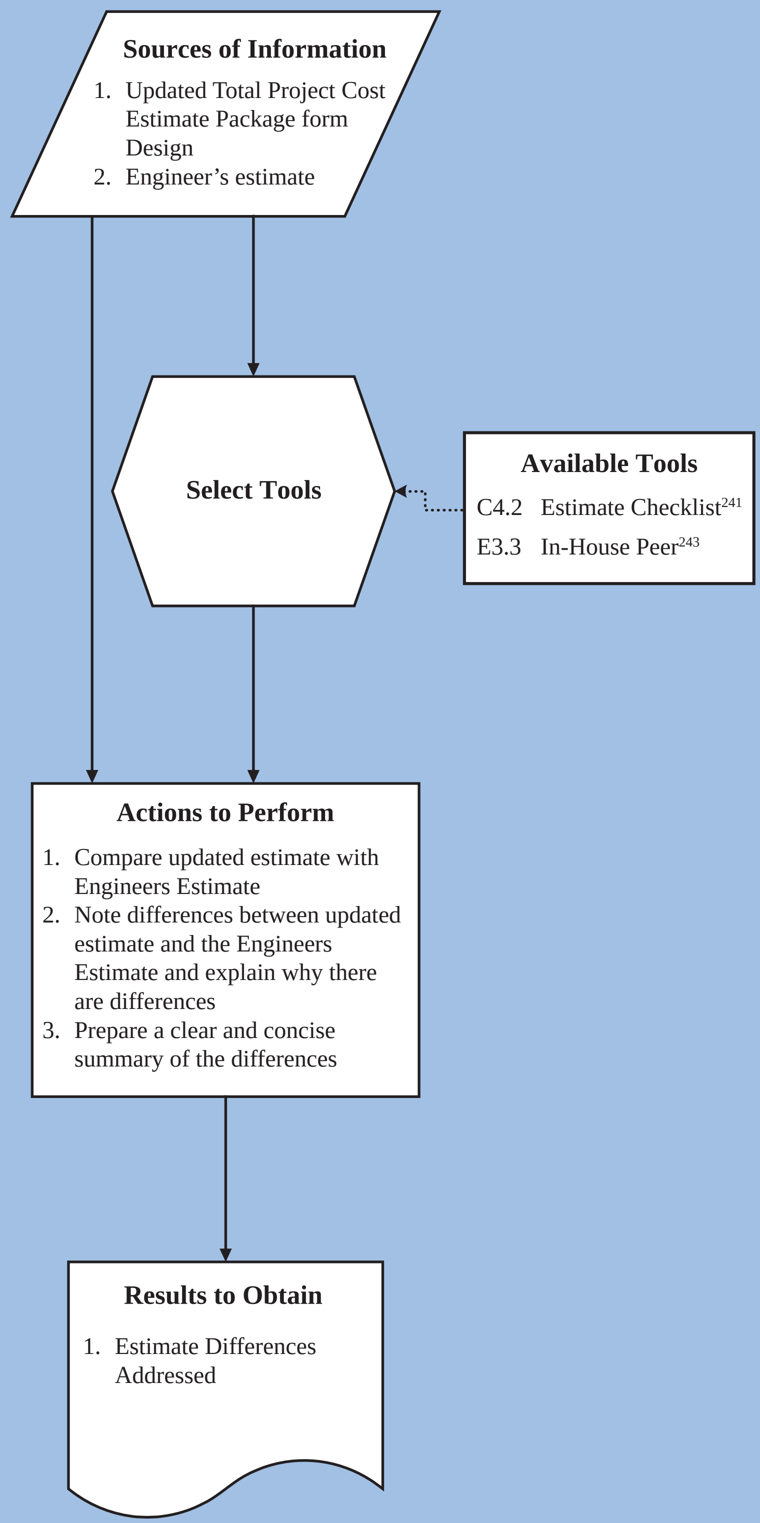
- The Baseline Cost Estimate will remain unchanged unless the project's original purpose and need are defined in the Scoping Report change.

Review Appropriate Approach and Data (A442)

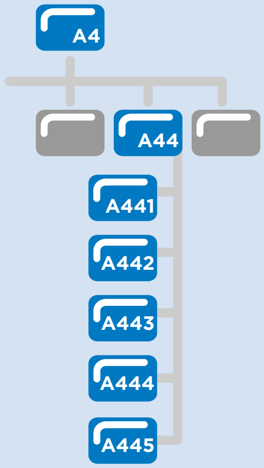
Review the Updated Total Project Cost Estimate, carefully taking note of any changes from the original Engineers Estimate and/or project definition. Review both the Total Project Cost Estimate as a whole, as well as individual pieces of this Total Project Cost Estimate, to check for differences. Though the totals may be similar, there may be changes in the individual items that need to be addressed and noted.

Using the available tools and other Mn/DOT resources, conduct this review diligently so that no piece of information is overlooked. Extra care is needed here so that the comparison with construction bids later on is as accurate as possible.

Neatly compile the noted differences into a concise document. Be sure to note any differences and reasons for them. If reasons are unknown, seek them out so that they can be included in the review summary of this step.



241. For C4.2 Estimate Checklist, see page 449.
243. For E3.3 In-House Peer, see page 454.



Review Estimate Assumptions (A443)

Step Requirements

This step requires that the Engineers Estimate be reviewed using the list of applicable tools to determine if the correct assumptions and conclusions were made about the project. The output should be a clear list of assumptions made when preparing the estimate and a confirmation of their correctness.

Issues to Consider

In this step Estimators need to consider all of the information in the Engineer's Estimate and ensure that the correct assumptions were made. This can be easily accomplished by using the tools available for the review process.

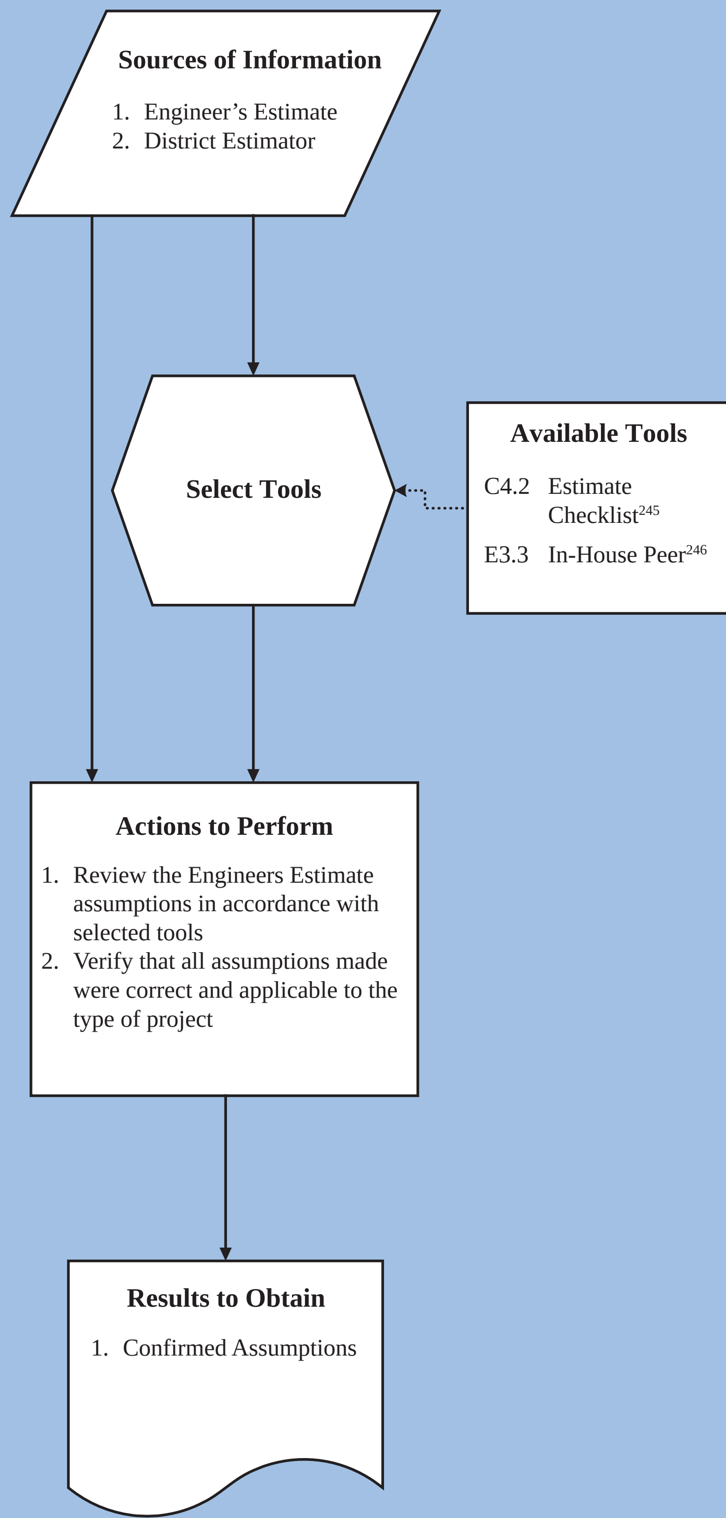
To be successful, the review must closely examine the assumptions that form the basis of the estimate, and knowledgeable and experienced individuals from within the agency must conduct the review.

Review Estimate Assumptions (A443)

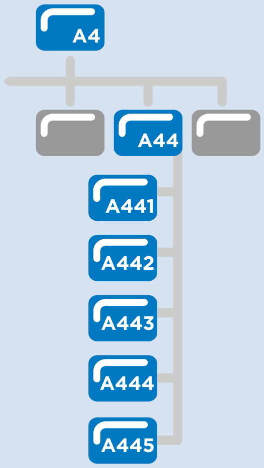
Review the Engineers Estimate to identify all assumptions made. Note these assumptions and all data associated with them.

Review all of the identified estimate assumptions, and confirm that they still remain correct and reasonable. Take great care when checking these, as this is most likely the last opportunity.

After reviewing the input information and applying the applicable tools, the Estimator has either confirmed or disaffirmed the assumptions in the Engineers Estimate.



245. For C4.2 Estimate Checklist, see page 449.
246. For E3.3 In-House Peer, see page 454.



Review Clarifications (A444)

Step Requirements

This step requires that the Engineers Estimate be reviewed using the list of applicable tools to determine if the clarifications within the Estimate are complete and correct. Also, it is important to ensure that the clarifications are clear and to the point so that anyone who is not familiar with the project can understand their meanings. This will avoid possible areas of misunderstanding later in the development of the project. The output of this step should be a clear list of clarifications made during the development of this estimate and a confirmation of their correctness.

Issues to Consider

- When verifying the completeness of the estimate, Estimators should consider any historical data that might be available to aid in reviewing clarifications made. This might offer an extra opportunity to identify possible areas of ambiguity. Also, a site visit might also aid in verifying the correctness of the estimate.

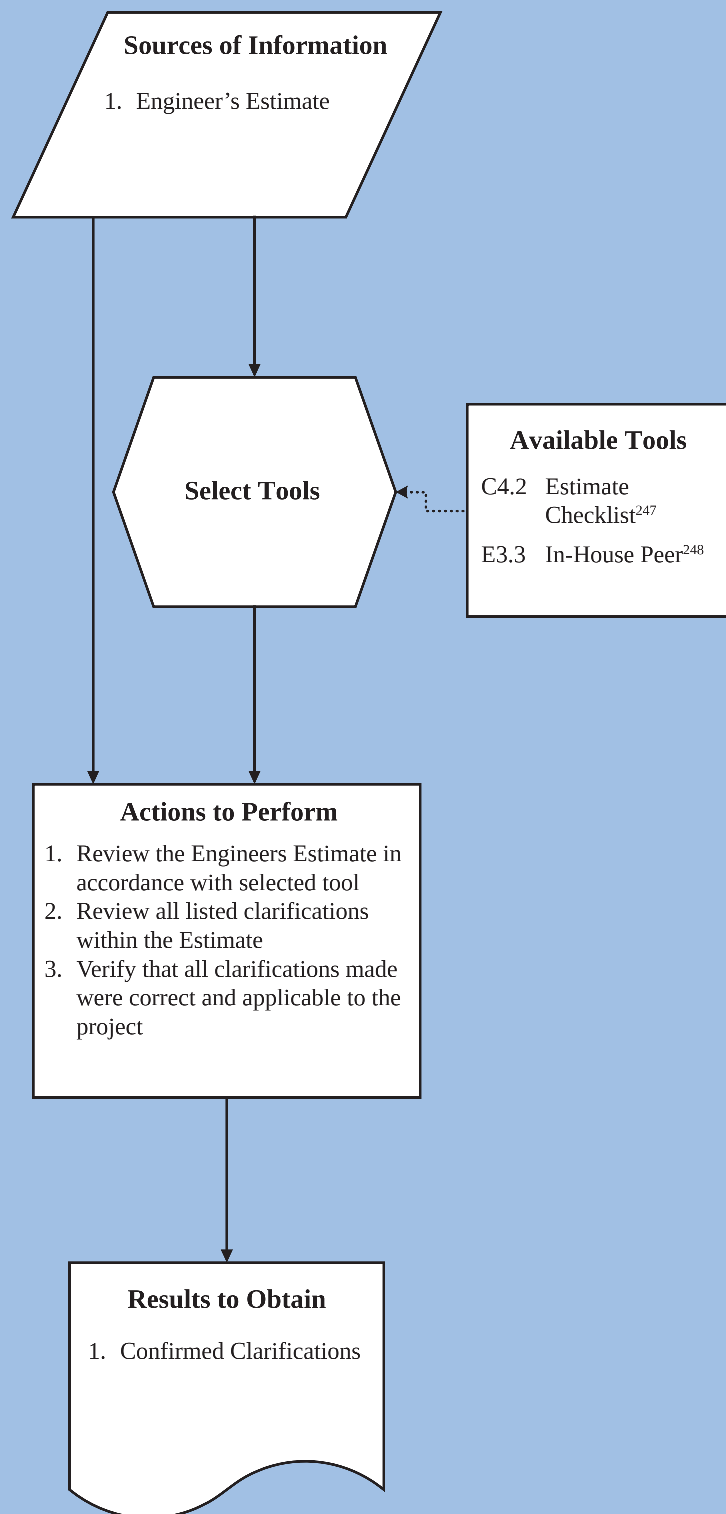
Review Clarifications (A444)

The Engineer's Estimate should be used again for the review of clarifications. Identify all clarifications made. Note these and all data associated with them.

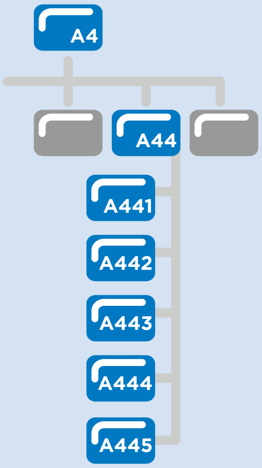
Contact the Office of Project Scope and Cost Management for resources external to Mn/DOT.

Using the tools and the Engineers Estimate, verify that the clarifications are clear and complete. Consider reviewing similar projects to determine if any information might be missing or incorrect. Also, a site visit might be useful to ensure that no other issues will arise.

The output of this step should result in a confirmation of the clarifications within the estimate.



247. For C4.2 Estimate Checklist, see page 449.
248. For E3.3 In-House Peer, see page 454.



Review Summary (A445)

Step Requirements

For this step the primary inputs include the Engineer's Estimate, modifications made to it, and the confirmed project assumptions and clarifications. The Estimator should then take this information to prepare a review summary that clearly lays out the details of the project. The Estimator should then compare this summary with the baseline and determine if adjustments are needed.

Issues to Consider

When performing this step, use the estimate checklist to ensure that no important items are overlooked. Be sure that all documentation is clear and concise and that it allows for the easy retrieval of key information. All project specifics should be written such that anyone who is not familiar with the project may still have a good understanding of the following:

- what the project definition is and is not,
- what the design entails,
- what the associated costs are,
- what the risks are, and
- how it compares with the baseline.

It is always necessary to independently verify that an estimate is complete and that it matches the project definition and is consistent with known site conditions. Because the outcome of this process is the Engineers Estimate, the review step at this time is even more critical. A second autonomous set of eyes reviewing the estimate will afford managers and decision makers an opportunity to capture a different perspective, or at least a second opinion.

Review Summary (A445)

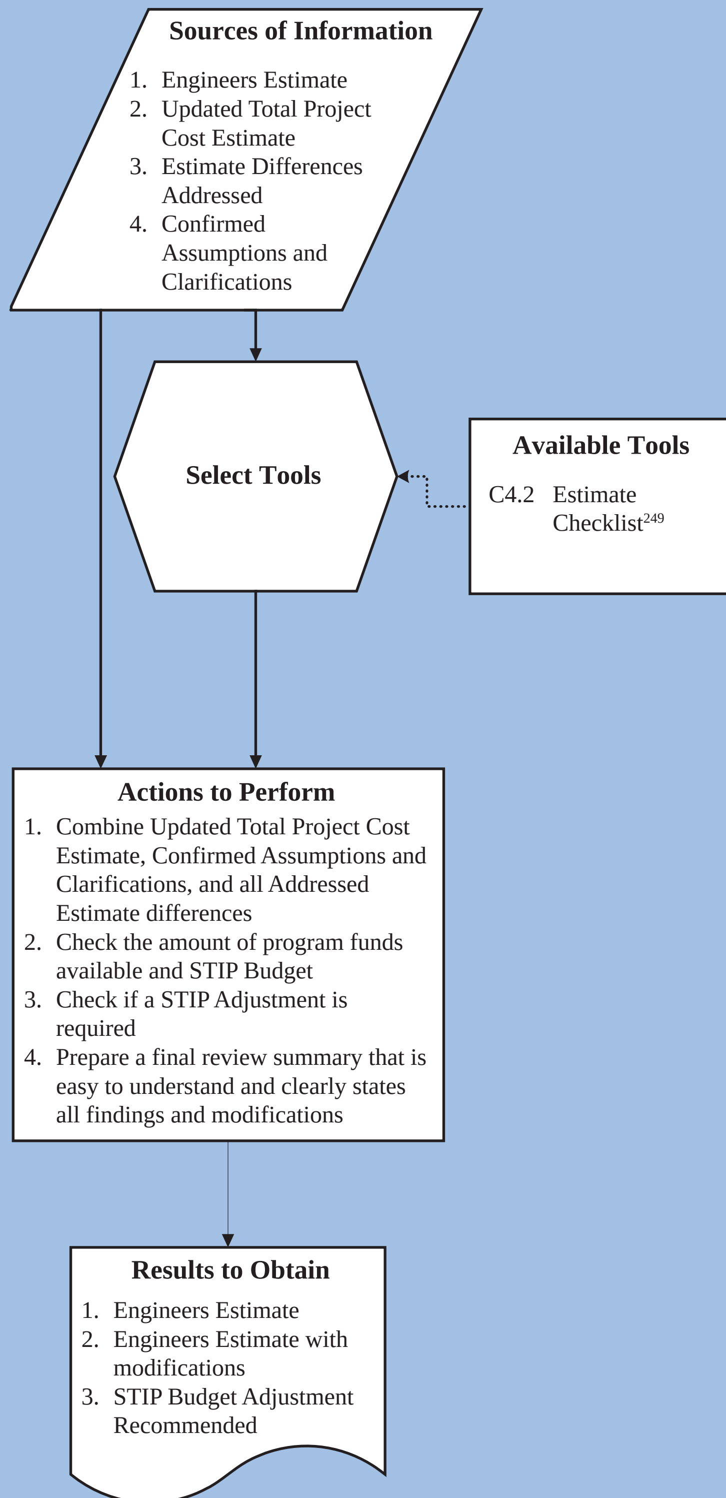
Review the Updated Total Project Cost Estimate, along with the addressed differences, confirmed assumptions, and clarifications.

Use the estimate checklist to ensure that no important items are missed in preparing the review summary.

Districts review the amount of program funds available for this project. Determine the baseline and decide whether it will suffice or will need to be adjusted.

Use the input information to prepare a final review summary that is easy to understand and ready for comparison with bids.

The output of this step will be the basis of comparison with contractor bids. It needs to be a concise document, but it also needs to accurately and fairly convey the project and the cost of the project.



249. For C4.2 Estimate Checklist, see page 449.

III.5.6 COMPARE WITH BIDS (A45)

The purpose of the Compare with Bid sub-process is to provide a vehicle for reviewing and succinctly conveying project bidding information to both internal and external project stakeholders. This sub-process has three steps. The steps are as follows:

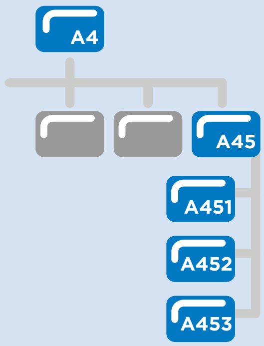
1. Receive Bids – A451
2. Review Abstract – A452
3. Determine Award Recommendation – A453

These three steps provide a natural progression of effort to determine an award recommendation for a project.

The contractors' bids will be used when performing the three steps of this sub-process. The submitting contractors should be qualified to perform the scope of the work in question. The output of this sub-process is an award recommendation. This recommendation should be based not only on the lowest price, but also on verification of contract documents. The decision should also take into consideration the difference of the bid amount from the budgeted amount.

The decision must be communicated to the appropriate offices and District. If the award amount is different from the budgeted amount, the District may be required to find additional funds or redistribute extra funds elsewhere. Either way, this impacts the entire District program and is important information to share.

The purpose of the Compare with Bid sub-process is to provide a vehicle for reviewing and succinctly conveying project bidding information to both internal and external project stakeholders.



Receive Bids (A451)

Step Requirements

The key input for this step is the original Engineers Estimate and the submitted contractors' bids. The bids should be received through the Mn/DOT construction office and should be reviewed thoroughly to identify all major cost components. These need to be listed and organized into a simple-to-understand format.

The final output is a portion of the abstract of the different contractor bids that clearly lists all of the contractor qualifications; all cost components, including the Engineers Estimate and the bid from each contractor; and any other important details about the project. This abstract is posted once the project has been awarded and is a public document.

Issues to Consider

Project Characteristics

- This step is a requirement for all projects and should not be taken lightly. Errors made here can result in disastrous circumstances further down the road.

Guidelines

- Mn/DOT follows FHWA guidelines for all projects

  - Contract Administration Core Curriculum Participant's Manual and Reference Guide 2006 http://www.fhwa.dot.gov/programadmin/contracts/core03.cfm#s3A14

  - Construction Program Guide - Bid Analysis and Award of Contact http://www.fhwa.dot.gov/construction/cqit/award.cfm

  - Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation http://www.fhwa.dot.gov/programadmin/contracts/ta508046.cfm#s5

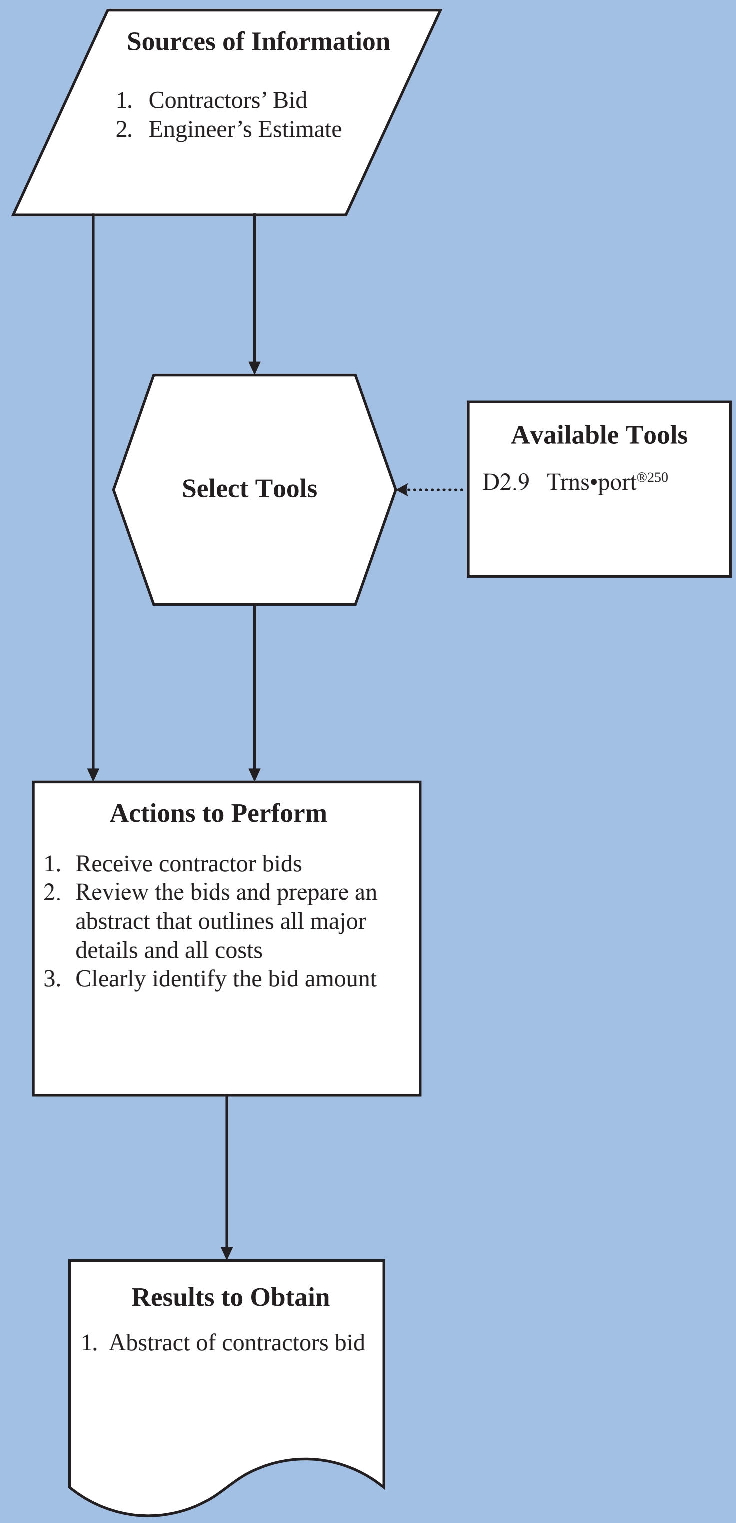
  - Title 23 Sec. 635.114 Award of contract and concurrence in award. http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=23&PART=635&SECTION=114&YEAR=2001&TYPE=TEXT

- Review Division 1, General Requirements and Covenants, of the Mn/DOT Standard Specifications for Construction

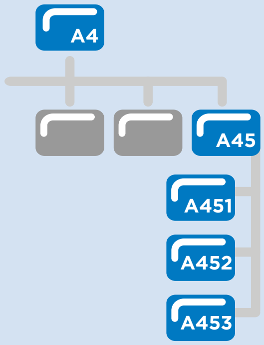
Receive Bids (A451)

The Estimators should review the contractors' bids and extract all cost items along with any important details. This information will constitute the basis of the abstract that is published. All of the bid items are identified in this document, and all of the contractors' bids for each line item are identified. This document also contains the Engineer's Estimate for each line item. This will enable the Estimator to compile all of the acquired information into an the One-Page Project Cost Estimate Summary to communicate the different contractor bids.

Remember, this document is a public document, so care should be taken in extracting the required data.



250. For D2.9 Trns•port®, see page 401.



Review Abstract (A452)

Step Requirements

The key input for this step is the abstract of contractor bids. The abstract should be compared with the original Engineers Estimate. The differences between the documents should be noted and clearly indicated, defining all of these differences.

The final output is a clearly defined abstract of differences between the bid amount and the final Engineers Estimate concerning a project.

Issues to Consider

Project Characteristics

- This step is simply reviewing the abstracts of the contractors' bids and noting differences.

Guidelines

- Mn/DOT follows FHWA guidelines for all projects

  - Contract Administration Core Curriculum Participant's Manual and Reference Guide 2006 http://www.fhwa.dot.gov/programadmin/contracts/core03.cfm#s3A14

  - Construction Program Guide - Bid Analysis and Award of Contact http://www.fhwa.dot.gov/construction/cqit/award.cfm

  - Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation http://www.fhwa.dot.gov/programadmin/contracts/ta508046.cfm#s5

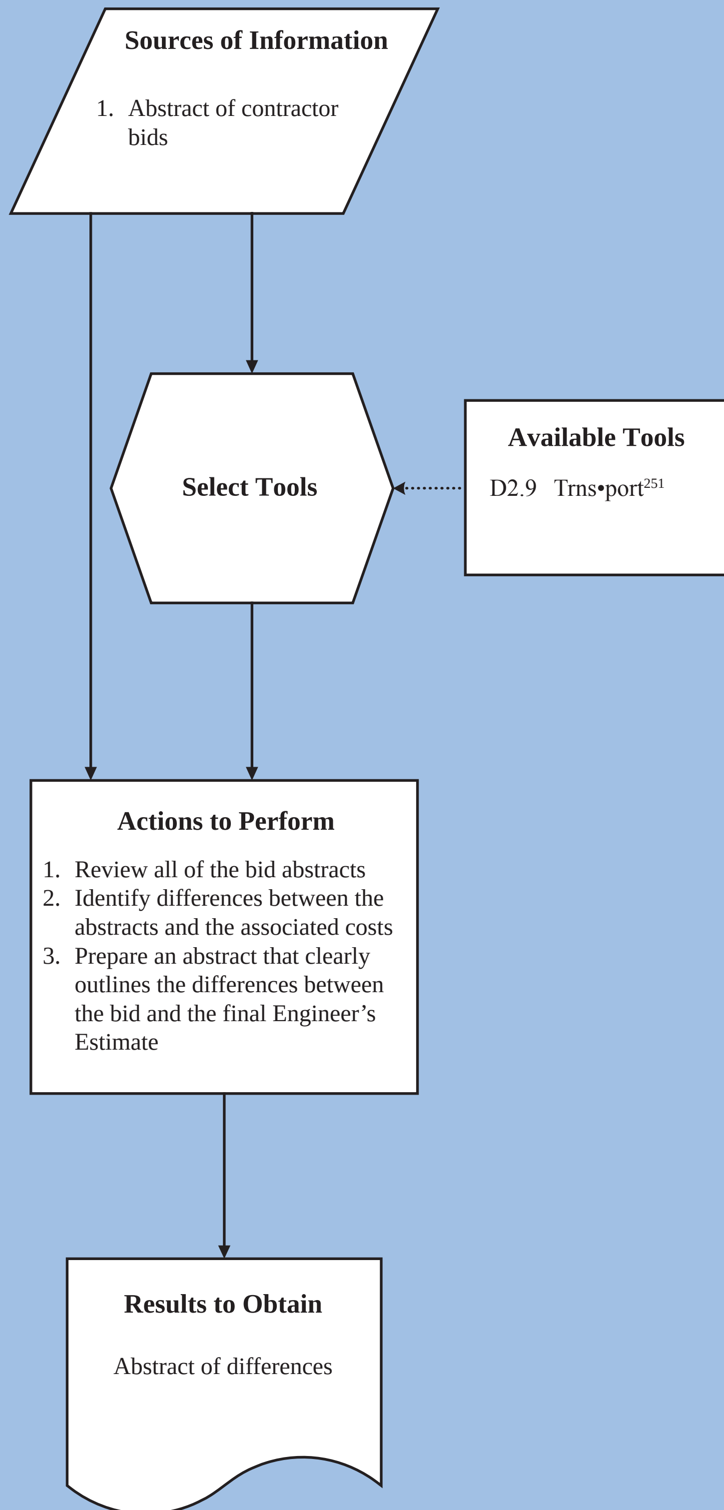
  - Title 23 Sec. 635.114 Award of contract and concurrence in award. http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=23&PART=635&SECTION=114&YEAR=2001&TYPE=TEXT

- Review Division 1, General Requirements and Covenants, of the Mn/DOT Standard Specifications for Construction

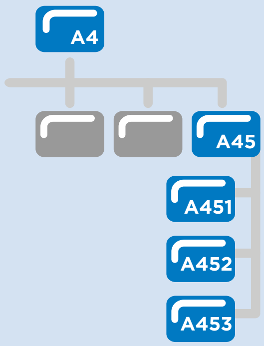
Review Abstract (A452)

The Estimators should review both the abstract of contractors' bids and the final Engineers Estimate and extract all items that offer significant variation in cost. These variations should be noted and clearly identified. Internally to Mn/DOT, this will help with future estimates.

The Estimator should compile and convey all of the information in an easy-to-follow format that clearly points out key areas of cost variation.



251. For D2.9 Trns•port®, see page 401.



Determine Award Recommendation (A453)

Step Requirements

This step entails reviewing the prepared abstracts of contractor bids to determine a final award. With this step, the Estimator will need to determine if the chosen bids falls within the acceptable range and/or if a re-advertisement for bids will be required.

The key input for this step is the abstract of the differences between the contractor's bid and the final Engineers Estimate. This input will not only need to be communicated within Mn/DOT and other appropriate authorities, but also to the general public. Therefore, the Estimator needs to prepare easy-to-understand spreadsheets and diagrams depicting the information about the awarded bids and costs.

Issues to Consider

Project Characteristics

- This step is the final review and award of contractor bids; therefore, all tools listed should be used when deemed appropriate.

Functional Group Input

- Request clarification of Functional Group scope when the requirements are not clear.

Policy Implications

The bid analysis process is an examination of the unit bid prices for reasonable conformance with the Engineer's estimated prices. Beyond the comparison of prices, other factors that a bid analysis may consider include the following:

- number of bids,
- distribution or range of the bids,
- unbalancing of bids,
- identity and geographic location of the bidders,
- urgency of the project,
- current market conditions and workloads,
- comparison of bid prices with similar projects in the Letting,
- justification for significant bid price differences,
- potential for savings if the project is re-advertised, and
- other factors as warranted.

Not all of these factors need to be considered for bids that indicate reasonable prices or show good competition. However, when the low bid differs from the Engineer's Estimate by an unreasonable amount, a thorough analysis of all bids should be undertaken to justify award of the contract verses re-advertisement.

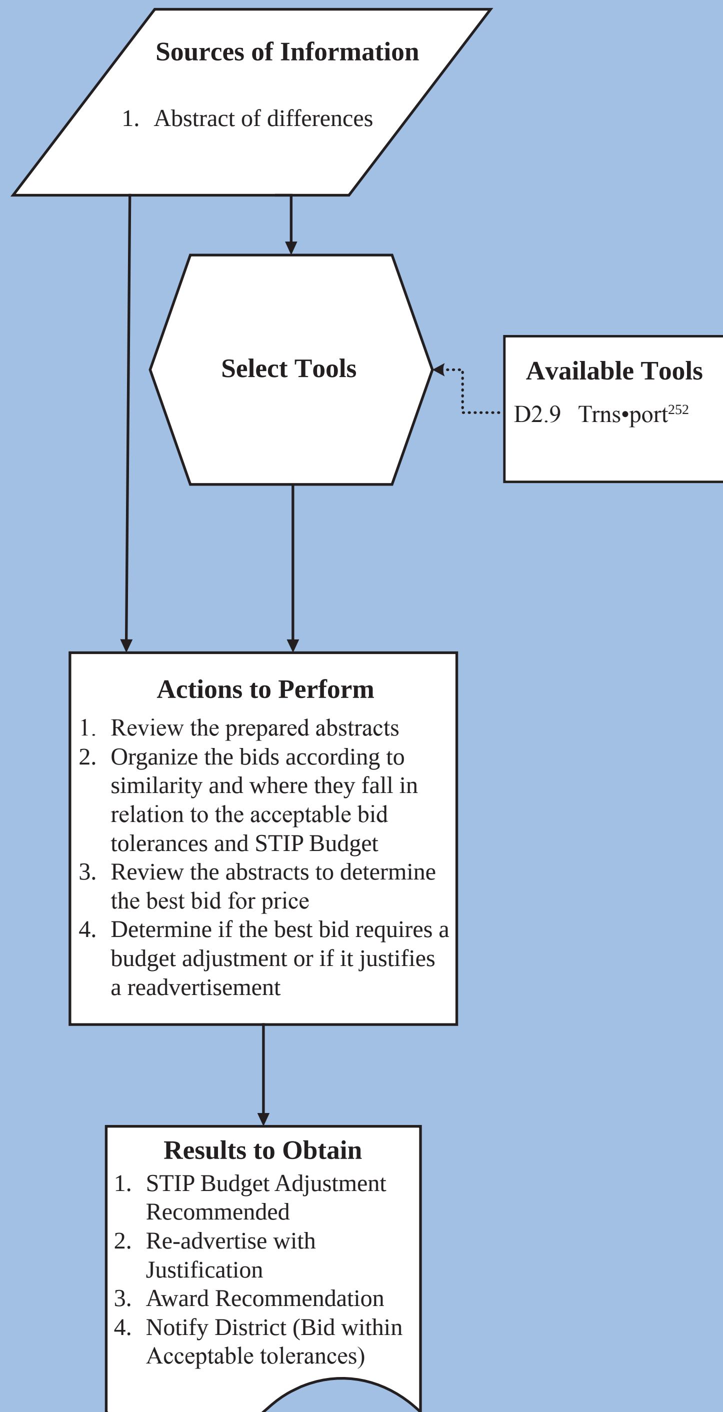
Determine Award Recommendation (A453)

The Estimator should review all FHWA and Mn/DOT guidelines regarding this subject, many are referenced throughout the Compare with Bid (A45) process.

The Estimator should review the abstract of the differences from the Engineer's Estimate and organize them according to what it being performed for the dollar amount submitted.

The Estimator should then check to see which bids fall within the range of acceptable bid tolerances of the STIP budget. If the low bid requires an adjustment to the STIP, then follow appropriate Mn/DOT guidelines to do so. If the received bids necessitate a re-advertisement of bidding, then provide adequate justification and do so according to Mn/DOT policies.

The Estimator should compile all of the acquired information into an effective, easy-to-understand format that will be shared within Mn/DOT and with the public for the awarded projects.



252. For D2.9 Trns•port, see page 401.

III.6 ESTIMATING RESOURCES AND TRAINING

The success of CE and CM will be enhanced when the appropriate resources are available to aid users of the TRM with implementation and application. Two general resource areas are the new State Project Scope and Cost Management Office and the CE and CM training courses. These resources offer substantial support for the application of the TRM and provide a location for information and assistance when preparing estimates and performing CM.

The success of CE and CM will be enhanced when the appropriate resources are available to aid users of the TRM with implementation and application.

III.6.1 State Project Scope and Cost Management Office

Mn/DOT's management vision for implementing the CE and CM process includes the necessary organizational adjustments to fulfill this vision (see Section I on page 2). Organizational adjustments result from a commitment to manage and control costs through a department-wide priority on CE and CM, reliable and accurate estimates, statewide uniformity and consistency, improved communication and credibility with external stakeholders, and clear accountability. One organizational change is the creation of the State Project Scope and Cost Management Office. Another organizational change is the focus on District Estimators. Other changes focus on alignment with Functional Groups and engagement with the Communications Office and external stakeholders.

III.6.1.1 State Project Scope and Cost Management Office

This office will play a key role in ensuring statewide uniformity and consistency and improving communications and credibility with external stakeholders. This office will also be responsible for estimating costs of major projects as defined by the Federal Highway Administration and will draw on staff from the Districts to that end.

Key functions of this office with respect to CM and CE are:

- Coordinating CE/CM process and providing estimating support
- Coordinating Functional Group estimates to support District Estimators
- Coordinating CE/CM training
- Maintaining the CE/CM manual
- Maintaining and developing CE/CM tools
- Supporting risk analysis and contingency estimates for Districts
- Coordinating risk analysis consultants on major projects
- Coordinating estimate reviews as necessary
- Collecting and reporting CE/CM performance measurement data
- Communicating changes to the CE/CM process, including changes to the website
- Coordinating data with Final Estimate's office

III.6.1.2 District Estimators

District Estimators will play a key role in ensuring reliable and accurate estimates and tracking estimate evolution throughout project development. By residing in the Districts, the Estimators will have close contact with the local stakeholders.

Key functions of the District Estimators will be as follows:

- Estimate involvement throughout project development (Planning to Letting)
- Lead project estimates with focus on estimate pricing
- Estimate appropriate items
- Coordinate input from Functional Groups
- Maintain estimate files
- Define risk and contingency amounts
- Communicate estimates

III.6.1.3 Alignment with Functional Groups

Functional Groups will continue to contribute to project cost estimates as they have in the past. However, District and/or State Estimators will have to collate the estimates for functional elements of the new Total Project Cost Estimate (TPCE). This effort will require collaboration with Functional Group representatives to ensure that their cost estimates are consistent with the guidelines in this TRM. The District or State Estimator will have the final authority to amend the estimates as necessary.

Key functions of the estimating staff within Functional Groups are:

- Develop project estimates for functional disciplines, particularly in planning phases to support the TPCE concept
- Manage Functional Group historical data relating to TPCEs
- Develop data for all categories in support of TPCEs
- Track TPCE data across gates in all phases

III.6.1.4 Engagement with the Communications Office and External Stakeholders

In order to build credibility with the stakeholders, Cost Estimators, Project Managers, and Program Managers will have to establish communication channels with the Communications Office and external stakeholders. This is critical to the success of implementing the new CE and CM process.

III.6.2 Training

Implementation of the TRM requires education of its content and how to apply it. Two training courses are available to help users of the TRM with implementation. One course focuses specifically on cost estimating while the other course is concerned with cost management. The content of both courses ties directly to the TRM.

III.6.2.1 Cost Estimating Course

This course is designed for two full days. Seven modules are covered. They are described below in outline form.

MODULE 1 Introduction

Overview and Participant Introductions

Course Learning Objectives – at end of class student will know:

- The importance of cost estimating
- How cost estimating fits into the project development process
- Factors that influence consistency and accuracy of cost estimates
- Cost estimating process steps
- Methods, techniques, and tools used to prepare cost estimates

Cost Estimating: Why, When, Who, What, and How

Purpose and Objective of Cost Estimating

Management Commitment to Cost Estimating and Cost Management

Warm-up Exercise

MODULE 2 Mn/DOT Project Development Process and Cost Estimating and Cost Management Integration

Learning Objective:

- Identify how cost estimating and cost management (CE/CM) fit into the project development process
  - Review project development process phases
  - Understand relationship between cost estimating and cost management and project development process
  - Understand key terms

Topics include CE/CM policies; responsibility for CE/CM; estimate preparation; estimate management; definition of the project development process; the relationship of CE/CM (overall flowchart) to the process; and the significance, importance, and purpose of CE/CM, including key terms.

MODULE 3 CE/CM Overview Including Tool Appendix in TRM

Learning Objective:

- Apply cost estimating process, sub-processes, and steps
  - Identify types of estimate and estimating data
  - Identify sub-processes
  - Identify components of sub-process steps, including key inputs and outputs
  - Understand relationship of sub-processes and Tool Appendix

Topics include types of estimates, types of estimating data, general estimating sub-processes, overview of sub-process steps, key inputs for steps, key outputs for steps, and use of tools and Tool Appendix to support process steps.

MODULE 4 Determine Estimate Basis/Prepare Base Estimate for all Project Development Phases

Learning Objectives:

- Apply cost estimating sub-process steps
  - Understand Determine Estimate Basis and Prepare Base Estimate sub-process steps
- Apply techniques and tools used to prepare cost estimates
  - Use of techniques and tools relevant to Determine Estimate Basis and Prepare Base Estimate

Topics include project definition inputs; estimate documentation; and estimating methodologies, tools, tips, and exercise—all in relation to sub-process steps and Planning, Scoping, Design, and Letting.

MODULE 5 Determine Risk and Set Contingency for all Project Development Phases

Learning Objectives:

- Apply cost estimating sub-process steps
  - Understand Determine Risk and Set Contingency sub-process steps
- Apply techniques and tools used to prepare cost estimates
  - Use of techniques and tools relevant to Determine Risk and Set Contingency

Topics include risk and contingency definitions; relationship between risk and contingency; risk identification; risk assessment; risk analysis; contingency estimation; and risk management, tools, tips, and exercise—all in relation to sub-process steps and Planning, Scoping, Design, and Letting.

MODULE 6 Review and Approve/Communicate Estimate for all Project Development Phases

Learning Objectives:

- Apply cost estimating sub-process steps
  - Understand Review and Approve/Communicate Estimate sub-process steps
- Apply techniques and tools used to prepare cost estimates
  - Use of techniques and tools relevant to Review and Approve/ Communicate Estimate

Topics include levels of review; and review and communication methodologies, tools, tips, and exercise—all in relation to sub-process steps and Planning, Scoping, Design, and Letting.

MODULE 7 Wrap Up

Course Learning Objectives – at end of class student will know:

- The importance of cost estimating
- How cost estimating fits into project development
- Factors that influence consistency and accuracy of cost estimates
- Cost estimating process steps
- Methods, techniques, and tools used to prepare cost estimates
- Ten Key Principles
- Five estimating key principles

The focus in the cost estimating course would be on sub-processes in the TRM, Sections III.2 through III.5. The introductory and two overview modules provided present the general information about cost estimating and cost management covered under Section I and II of the TRM (Modules 1 through 3). The content of Modules 4 through 6 focuses on the individual sub-processes, and the content covers the four project phases, specifically highlighting differences in application within each phase. The same project problem exercise is used across all sub-processes (Modules 4, 5, and 6) to illustrate the implementation of key concepts when applying cost estimating on a project.

III.6.2.2 Cost Management Course

This course is designed for one full day. Six modules are covered. They are described below in outline form.

MODULE 1 Introduction

Overview and Participant Introductions

Course Learning Objectives – at end of class student will know:

- The importance of cost management
- How cost estimating fits into project development and the Scoping Process
- Cost management process steps
- Methods, techniques, and tools used to perform cost management

Cost Management: Why, When, Who, What, and How

Purpose and Objective of Cost Management

Management Commitment to Cost Estimating and Cost Management

Warm-up Exercise

MODULE 2 Mn/DOT Project Development Process (PDP) and CM/CE Integration (cost management emphasis)

Learning Objective:

- Identify how cost estimating and cost management (CE/CM) fit into project development
  - Review project development process phases
  - Understand relationship between cost estimating and cost management and project development process
  - Understand relationship between cost management and the change request Process

Topics include CE/CM policies; responsibility for CE/CM; preparation of change request; management of costs; definition of project development process; relationship of CE/CM (overall flowchart) to the process; and significance, importance, and purpose of CE/CM.

MODULE 3 CE/CM Overview Including Tool Appendix (cost management emphasis)

Learning Objective:

- Apply cost management process sub-processes and steps
  - Identify timing of cost management in relation to the change request process
  - Identify CM related sub-processes
  - Identify components of CM sub-process steps, including key inputs and outputs
  - Understand relationship to Tool Appendix

Topics include cost management in PDP; requirements for cost management; general cost management sub-processes; overview of sub-process steps; key inputs for steps; key outputs for steps; and use of tools and Tool Appendix to support process steps.

MODULE 4 Cost Management during Design Phase

Learning Objectives:

- Apply cost management sub-process steps
  - Use of cost management based on updating cost estimates
  - Use of cost management based on individual changes
- Apply techniques and tools used to prepare cost estimates
  - Use of techniques and tools relevant to cost management and the change request process

Topics include how to define potential changes, how to identify potential changes, how to evaluate impact of potential changes, and how to document and report potential changes, all in relation to the baseline cost estimate.

MODULE 5 Cost Management during Planning, Scoping, and Letting Phases

Learning Objectives:

- Apply cost management to cost estimate development
  - Use of cost management as cost estimates are prepared

Topics include discussions on cost management applications in other project phases, how cost management in these phases relates to cost estimating, and why cost management is relevant to other project development phases.

MODULE 6 Wrap Up

Course Learning Objectives – at end of class student will know:

- The importance of cost management
- How cost management fits into project development and the Scoping Process
- Cost management process steps
- Methods, techniques, and tools used to perform cost management
- Ten Key Principles
- Five cost management principles

The focus in the cost management course is on the sub-process related to this issue during the Design Phase. A short module would be included to cover cost management in other project phases. The introduction (Module 1) and the overview (Modules 2 and 3) are similar to these same modules in the cost estimating course with a slightly different emphasis toward cost management. For some participants, these modules would be a review due to the similarity to the content in the cost estimating course introduction and overview. The content of Modules 4 and 5 focus cost management applications first in the Design phase and then in the other phases. The tie to the Scoping process will be emphasized. A project problem exercise is used to illustrate the implementation of key concepts.

Appendix: Glossary of Terms

4.1

IV.1 Glossary of Terms

Base Estimate: The most likely project cost estimate in any phase at any time, which normally includes all estimated known project costs, but does not include project contingency.

Baseline Cost Estimate: The most likely Total Project Cost Estimate including project contingency, which constitutes the approved project budget for cost management. The baseline will be set based on an approved Scoping Report estimate.

Communications Package: A one-page summary of key project elements, such as the project description, benefits, risks, cost, and schedule. This conveys information to the stakeholders.

Cost Control: The process of controlling deviations from the estimated project costs and monitoring the risks and contingencies associated with changes. Two principles apply: 1) there must be a basis for comparison (e.g., the baseline cost estimate); and 2) only future costs can be controlled.

Cost Estimating and Cost Management Process Model: A tool for standardization and documentation of the project cost estimating and cost management activities and deliverables, from the Planning Phase through the Letting Phase.

Cost Management: The process for managing the cost estimate through conducting reviews and approvals, communicating estimates, monitoring scope and project conditions, evaluating the impact of changes, and making estimate adjustments as appropriate.

Design Phase: The project development phase that includes activities required for setting construction limits, plan delivery, right of way, and a submittal of project plans, specifications, and estimate. The Design cost estimate at the end of this phase is the equivalent of the District (including Bridge) Engineer's Estimate.

District Cost Estimator: Personnel dedicated to project cost estimation from Planning to Letting, residing in the District.

Estimate Range: A range of estimated project cost that communicates the uncertainty associated with estimates prepared prior to setting the baseline cost estimate.

Gate: A predefined milestone in the project development process for project review and approval. There are several gates in the project development process where a Go/No-Go decision is made for the project, so the project either moves forward with approval or is sent back into the project development process for additional work needed for approval.

Letting Phase: The last project development phase that involves the preparation of the Engineer's Estimate and core letting activities such as advertising and bid evaluation leading up to contract award. The plans, specifications, and estimate (PS&E) documentation put together in this phase requires State DOT approval before state funds and federal funds, if any, can be authorized for the project to proceed with contract award and project construction.

Planning Phase: The project development phase that identifies long-term system and corridor improvements. The Planning level project estimates prepared in this phase are conceptual cost estimates that are expressed in inflation-adjusted dollars and are used to support the statewide 20-year Transportation System Plan (TSP). The estimates in the 10-year Highway Improvement Plan (HIP) and District plans are also expressed in inflation-adjusted dollars.

Market Conditions: A reflection of a moment of the market. Current market conditions reflect today's conditions, which can be a result of market fluctuations in the past few months and can affect the coming phases of the project.

Project Contingency: An estimate of costs associated with identified risks, the sum of which is added to the base estimate.

Project Cost Estimate File: A file that contains details about the basis of estimate and the backup calculations that support a project's cost estimate and is maintained from the time that a project is identified all the way through construction.

Project Cost Estimating: The processes for approximating all project costs included in the total project cost. Project cost estimating involves the following steps: determine estimate basis, prepare base estimate, determine risk and set contingency, and review total estimate.

Project Cost Management: The process for managing the cost estimate through conducting reviews and approvals, communicating estimates, monitoring scope and project conditions, evaluating the impact of changes, and making estimate adjustments as appropriate. Project cost control is the process of controlling deviations from the estimated project costs and monitoring the risks and contingencies associated with changes.

Project Definition: The clear and accurate description of a project, which defines the needs, the phases, and the work to be performed.

Project Evaluation Form: The process of making changes to the program, resulting from either a Scope Change or Scope Amendment.

Project Management: Management of the project scope, schedule, and cost through seamless integration of the project purpose and need, the stakeholder requirements, and the resources for project development, engineering, safety, and quality.

Project Summary Sheet: A short summary that tracks project purpose and need, cost, and status at any point during project development, used for internal and external communications. The Project Summary Sheet is part of the Project Cost Estimate File.

Program Cost Management: Managing the HIP and the State Transportation Improvement Plan (STIP) budgets over time to minimize program disruptions caused by project cost deviations and incorporating approved changes when they occur after the STIP and HIP budgets are approved.

Qualitative Risk Analysis: Performing a qualitative analysis of risks and conditions to prioritize their effects on project objectives. It involves assessing the probability and impact of project risk(s) and using methods such as the probability and impact matrix to classify risks into categories of high, moderate, and low for prioritized risk response planning.

Quantitative Risk Analysis: Measuring the probability and consequences of risks and estimating their implications for project objectives. Risks are characterized by probability distributions of possible outcomes. This process uses quantitative techniques such as simulation and decision tree analysis.

Right of Way: A linear corridor of land used for transportation or other facilities, such as highways, roads, streets, railroads, trails, light-rail, and utilities.

Risk: A known or unknown event or condition that cannot be adequately defined or estimated with confidence at the time of preparing an estimate.

Risk Assessment: The analysis of risk and its effects on the project. Risk assessment involves the quantitative or qualitative analysis that assesses impact and probability of a risk.

Risk Identification: The process of determining which risks might affect the project and documenting their characteristics.

Risk Management: The compilation of all the steps associated with managing risks: risk identification, risk assessment, risk analysis (qualitative or quantitative), risk planning, risk allocation, and risk monitoring control.

Risk Register: A document that lists all identified risks, along with a brief description of each risk, probability of occurrence, impact on the project, responsibility for mitigation, mitigation strategy, and current status.

Scope Amendment: An adjustment in the scope that does not change the project's original purpose and need contained in the Scoping Report. Such adjustments are usually the consequence of unanticipated project-related conditions or external events that arise and cause a scope expansion and a resulting change in the cost estimate.

Scope Changes: Changes in the requirements or specifications on which the design is based. Examples would include changes to project limits, work types, or capacity factors, such as traffic loads, vehicles per lane, or storm waters.

Scoping Phase: The project development phase that defines the project requirements and risk (or uncertainties) and includes activities such as traffic forecasting, surveys, preparation of environmental documentation, public involvement, identification of right-of-way, and identification of utilities. The Design cost estimate at the end of this phase, including project contingency, is the baseline cost estimate for cost management and is expressed in year-of-construction dollars.

Scoping Report: A key document defined in the Scoping Process Manual and maintained throughout the Scoping Phase. The Scoping Report describes the project scope.

Technical Reference Manual: A guide that provides direction on implementation of policies, models, tools, methods, and processes.

Total Project Cost Estimate: The sum of the project base estimate and the project contingency, in any phase at any time.

Appendix: Cost Estimating and Cost Management Tools

4.2

IV.2 Cost Estimating and Cost Management Tools

Background

The tools described in this Tool Appendix of the Technical Reference Manual (TRM) are adapted from the Tool Appendix included in NCHRP Report 574, *Guidance for Cost Estimating and Management during Planning, Priority Programming, and Preconstruction*. Report 574 Tool Appendix has 72 different tools that are described in terms of over 90 different applications. The tools included in this TRM appendix were selected based on an extensive assessment process with a group of Mn/DOT staff. The 72 tools from the NCRHP Report 574 were rated by a number of different staff as to their potential impact on supporting the implementation of the new cost estimating and cost management process. Comments were solicited on each tool. This rating helped to prioritize the 72 tools. A workshop was conducted to finalize a set of tools to be included in the TRM based on tool priority and applicability to Mn/DOT. Workshop participants thoroughly discussed each tool and then decided whether or not the tool would be included in the TRM. During the development of the Mn/DOT Cost Estimating and Cost Management Process and TRM, a number of the Report 574 tools were refined, and a number of new tools were developed. The new tools were primarily developed to support risk and contingency.

The tools in this appendix represent the final set of tools selected by Mn/DOT for the first version of this TRM. It is expected that the Tool Appendix will change and evolve. New tools will be added, existing tools will be refined, and some tools will be retired.

Tool Appendix Layout and Structure

The tools are categorized by sub-processes. Within each sub-process, a tool is collected under a specific phase if the tool is used only in one phase. In instances where a tool is used in several sub-processes, the tool is included under an "All Sub-Processes" category.

The tool identification system of this Tool Appendix follows the Report 574 approach. In Report 574 and prior to discussing a specific tool or set of tools, a general method associated with the tool(s) is first described. For example, **Estimate Review – Internal** is a general method that has three tools associated with it: **Formal Committee**, **Round Table**, and **In-House/Peer**. Each general method and its tools are described using an alpha-numeric system in Report 574. A letter and number describe the general method, such as **E3 Estimate Review – Internal**. The tools used to perform the general method are described using the method designator and a decimal number system. For example, **Formal Committee** is **E3.1**. The approach followed in the TRM Tool Appendix focuses only on the tool, with no specific discussion of the method. The TRM fully develops the description of the review sub-process, so a discussion of specific methods is not necessary. However, the alpha-numeric system is used to ensure consistent referencing to the tools contained in Report 574. When new tools are added, they are added under an existing method. For example, the **R3 Risk Analysis** method has several new tools designated as **R3.6**, **R3.8**, and **R3.12**. When a new tool was added, such as a **Historical Data** tool, this tool was given an identifier consistent with the Report 574 format, such as **H1.1** in this case.

This Tool Appendix describes all the tools referenced in the TRM Section III.2 through III.5. The material presented in this appendix is a synopsis and distillation of good practices currently being used by state highway agencies, only adapted to fit within the Mn/DOT culture. Utilization of individual tools in an "al la Carte" fashion will have limited impact on improving the accuracy of cost estimates and managing project costs. To be effective, appropriate tools should be used to support the structured estimating approach presented in the body of this TRM.

A common informational structure for describing each tool is the following:

- What is the tool?
- What is the tool used for, and why is the tool used?
- What does the tool do or create?
- When should the tool be used?
- How should the tool be used (includes examples or applications of the tool)?
- What tips will lead to successful use of the tool?
- Where can the user find more information to support development of a specific tool?

This structure is also consistent with the structure of the tools described in the Report 574 Tool Appendix. However, for each tool, a "How to" section was added to assist Mn/DOT in the implementation of the tool in the context of where it is used in the CE and CM sub-processes within the TRM. Examples are used to illustrate a Mn/DOT approach when this information is available. Examples from other applications of the tools are used as necessary to better understand the "How to" steps. Because Mn/DOT has not applied many of these tools in earnest at the time of the TRM publication, examples from other states are used. These examples can be replaced with Mn/DOT-specific examples in the future.

Tool Selection and Use

In Sections III.2 through III.5, tools are identified in relation to each of the sub-processes that are implemented over the Planning, Scoping, Design, and Letting phases of project development respectively. The tools specifically tie to sub-process steps where they are most likely used. In some cases, tool selection is influenced by project complexity. In every case, the discussion of the tool application in Sections III.2 through III.5 is modified to fit the level of project definition that corresponds to a phase.

Many of the tools that are identified for use in the context of CE and CM are equally applicable to other total project cost categories. These tools are described in the Tool Appendix in general terms with some reference to their use for estimating other categories of total project cost other than construction.

The tools' descriptions are hyperlinked so that the user can move from the body of the TRM to the Tool Appendix.

Contents

D4.1 Project Estimate File

Estimates are usually created by the collaborative effort of many individuals, and in order to be able to follow the assumptions upon which the estimate is based and to preserve the information for future efforts, there should be a structured system for accumulating all estimates and their supporting documentation. Construction contractors use their project estimates both to create the budgets for successful bids and as reference sources for developing future estimates. Mn/DOT needs information systems that allow easy retrieval of historical estimate information and that allow multiple individuals to work productively on a single estimate.

What is it?

The development team and the Estimators prepare and maintain a master reference file that contains the critical scope, policy, and supporting information (assumptions, methods, and procedures), which is used to prepare the project estimate. This master file is maintained as a permanent reference file. When costing an item, the Estimator must reference specific cost impacting information documented in the file.

Why use it?

Good documentation supports the cost estimate's credibility, aids in the analysis of changes in project cost, enables reviewers to effectively assess the estimate, and contributes to the population of Mn/DOT databases for estimating the cost of future projects. Each project should have an individual Project Estimate File that is separate from the general project file or the correspondence file. The primary purpose of this requirement is to ensure that each project has a well-documented and easily retrievable history of the assumptions, methods, and procedures used to estimate the costs associated with the project's specific scope of work. Having this information contained in one location and separated from other project documentation will help ensure that the estimate information is readily accessible and uncluttered with other project information.

What does it do?

A Project Estimate File provides a corporate memory and historical database for cataloging the basic reasons behind the original estimated cost and reasons for subsequent cost revisions. Additionally, it usually provides other project descriptive information. Examples of other descriptive information include trends that affect the item cost, cost from similar past projects, and external factors that limit construction operations. This historical file allows easy comparison of the current estimate to previous estimates and resolution of discrepancies.

When to use it?

The project estimate information should be retained in the central filing system from the time the initial project estimate is prepared until project close-out. The Project Estimate File should include all cost estimates prepared for the project up to and including the completed Contract Plans (PS&E) Estimate. Archiving the cost estimate files is good practice, as they can be useful in reconciling completed project cost and responding to inquiries.

How to use it?

For each work (bid) item element, describe the derivation of its estimated cost in sufficient detail to allow an independent reviewer to determine whether the estimate is complete, accurate, and realistic. The following information should be provided:

- Item Number and Title.
- Item description and any tailoring used for this estimate.
- Discuss Methodology. Describe how the item's costs were estimated. Depending on the choice of methodology, the Estimator could include one or more of the following practices:
  - The use of unit prices from the Department's historical bid tab database is the most common approach. Under this approach, bid data are summarized and adjusted for project conditions (e.g., project location, size, quantities, etc.) and the general market conditions.
  - The actual cost approach (a bottom-up estimate) takes into consideration factors related to actual performance of the work (i.e., the cost of labor, equipment, and materials; sequence of operations; and production rates). This approach requires the Estimator to have a good working knowledge of construction methods and equipment.
- Explain how all lump sum items are handled.
- Identify the base year of the cost calculation. For long duration projects, it is good practice to present the item's estimated cost in Constant Year dollars, both total dollars and distributed across fiscal years.
- Explain environmental items (requirements) in detail and with extreme clarity.
- Provide a description of how indirect costs are determined.
- Provide a written description for each contingency allowance assigned to the various parts of the estimate. If extraordinary conditions exist that call for higher contingencies, the rationale will be documented.
- List all uncertainties and risks associated with the estimate (confidence level for the estimate).
- Identify level of knowledge about scope.
- Include level of risk.
- Provide level of estimate detail.
- Discuss techniques used to complete the estimate,
- Explain experience of those who developed the estimate,
- Include Cost Tractability. When a prior cost estimate exists, a cost track should be prepared. The cost track should provide a concise explanation for any cost change to an item from the prior estimate.
- List all participants in the development of the estimate.

Example

D4.1 PROJECT ESTIMATE FILE
TYPICAL OUTLINE

TOTAL PROJECT COST ESTIMATE SUMMARY

- Total Project Cost Estimate Summary One Page (Category Level with some Elements of total project cost)
- Key Project Requirements
- Key Estimate Assumptions
- Major Risks

TOTAL PROJECT COST ESTIMATE DETAILS (changes with project development phase)

- Estimate Basis
  - Project Description (narrative description of project requirements)
  - Drawings (schematic, preliminary, final)
  - Specifications
- Cost Estimate
  - Cost Estimate Summary (categories and some elements)
  - Cost Estimate Details (categories, elements and line items)
  - General Estimate Basis (impacts all cost in estimate)
  - Assumptions (as required for different category, element, or item estimate)
  - Backup Calculations (for different category, element, or item estimate)
  - Review notes and recommended changes
- Risk Analysis
  - Risks (red flag items, risk register, etc)
  - Contingency (contingency basis and calculation)

Notes:

Figure D4.1-1. Project Estimate File – Typical Outline

TIPS

The Project Estimate File should, at a minimum, include any assumptions that have been made, current project scope, maps, photos, as-built plans, functional classification, design criteria, and a copy of or reference to the cost data that was used to develop the estimate. This basic information should be included in each Project Estimate File regardless of project development stage. The creation of the file begins with the very first estimate. A sheet should be placed in the front of each estimate file so the Project Manger can record the date and current project milestone or project development stage each time the project estimate is changed, updated, or reviewed. A signature line should also be included to document the Project Manager's review of the estimate file.

When items are estimated by percentages of other costs, as is often done for miscellaneous and utility costs, variations to normal the percentage should also be documented in the Project Estimate File. Some projects that are not complex and have a small scope of work may warrant the inclusion of a cost adjustment factor to compensate for the short project development time and project uncertainties. These cost adjustment factors should be well-documented in the Project Estimate File and have a reproducible basis. These factors should only be applied to projects that fall into the small, non-complex category. They should not be applied to all project estimates as a matter of common practice. A cost adjustment factor will never be considered as an acceptable substitute for preparing a well-documented and accurate estimate if adequate project information is available.

Depending on the level of project development that has taken place, the amount and type of documentation contained in the Project Estimate File will vary. Information used to develop the initial estimate, such as cost per mile factors or generic factors should be well-documented and included in the Project Estimate File. This information may consist of references to software databases, bid tabulation data, unit bid price book data, or some other reputable resources. Additionally, any deviations that are determined to be warranted by the Estimator from the generic cost factors should be well-documented in the Project Estimate File.

The estimating procedures manual should also establish general guidelines for the contents of the file.

The documents that serve, as the basis for the Estimators should:

- provide a description of site conditions (railroad through or adjacent, utilities, need for stage construction),
- describe assumed construction methods and alternatives considered,
- explain the decision criteria used for evaluating alternatives,
- list and explain all general assumptions that apply to all alternatives,
- list and explain all specific assumptions (e.g., excavation costs assume 30 percent rock), and
- include a full listing of the item take-offs (quantities).

R1.1 Recognition of Complexity

Project complexity significantly influences the methods and tools an Estimator uses to prepare and manage project cost estimates. Project complexity can also be used to identify proper risk management techniques. Mn/DOT is using this tool to create a standard definition for project complexity in order to communicate the issue to project team members and stakeholders.

What is it?

Recognition of complexity through a formal definition results in a classification of project complexity that can be applied to all projects. Mn/DOT is using three definitions for project complexity: 1) Minor Projects; 2) Moderately Complex Projects; and 3) Major Projects. These complexity definitions drive the choice of many other tools. For example, the Level I through Level III risk analyses correlate directly to the three levels of project complexity.

Complexity definitions can also include a definition of project type (such as new or reconstruction), project setting (rural or urban), project location, available level of design detail, and other factors. The goal is to explicitly define project complexity through the use of this classification system.

Why use it?

Providing a standard definition of project complexity promotes transparent communication of a project's characteristics. It can be used to assist in selecting appropriate estimating methods and tools or to invoke specific cost estimating management or risk management procedures. It helps to ensure that projects of varying complexity levels are subject to appropriate reviews and attention. This allows for a common language for communication regarding project complexity.

What does it do?

This tool defines complexity based on specific criteria. The definitions help classify projects according to the complexity level, which in turn helps to identify the appropriate strategies, methods, and tools for cost estimating, cost management, and risk management.

When use it?

Complexity must be defined early in the project development process and revisited as design develops or if any major changes in scope are realized. Understanding project complexity is a key element of the approach for preparing estimates during all phases of project development.

How to use it?

Refer to the Tables R1.1.1 through R1.1.3 on the following pages. First, review the project using Table R1.1.1 for Minor projects. If the project meets all of these criteria, it can be considered Minor. If the project exceeds one or more criteria, it cannot be considered Minor and should be reviewed using Table R1.1.2 for Moderately Complex projects. If the project meets all of these criteria, it can be considered Moderately Complex. If the project exceeds one or more criteria, it should be considered Major. Table R1.1.3 can be reviewed to verify that the project should be classified as Major.

Examples

Mn/DOT will be using a set of complexity definitions developed by the Pennsylvania Department of Transportation (PADOT) and cited in the NCHRP Report 574 Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction. Tables R1.1.1 through R1.1.3 should be used for defining project complexity.

Table R1.1-1. Criteria for Major Projects (NCHRP Report 574 and PennDOT)

Most Complex (MAJOR) Projects	
Roadway	• New highways; major relocations • New interchanges • Capacity adding/major widening • Major reconstruction (4R; 3R with multi-phase traffic control) • Congestion management studies are required
Tra c Control	• Multi-phased traffic control for highway or bridge construction that would mandate CPM during construction • Major ITS (electronic surveillance, linkages) corridor project

Structures	• Replacement, new, or rehabilitation of:
	  • Unusual (non-conventional, like segmental, cable stayed, major arches or trusses, steel box girders, movable bridges, etc.)
	  • Complex (sharp-skewed (less than 70 degree) superstructure, non-conventional piers or abutments, horizontally curved girders, three-dimensional structural analysis, non-conventional piles or caisson foundations, complex seismic analysis, etc.)
	  • Major (bridge cost of $5 million or more – Federal definition)
	  • Unusual formations (caissons, uncommon piles, mines, Karst situation)

Right-of-Way	• Right-of-Way plans are needed and numerous relocations of residences or displacement of commercial and/or industrial properties are required. • Anywhere from a few to over 20 property owners are involved. • Major involvement of environmental clean-up. • Before and after analysis
Utilities	• Major utility (transmission lines, substations) relocations or heavy multi-utility coordination is involved.
Environmental	• Environmental Impact Studies or complex Environmental Assessment without mitigated finding of no significant impact are required. • Studies of multiple alternatives • Continued involvement by officials in analyzing and selecting alternates • Other agencies are heavily involved to protect air, water, game, fish, threatened and endangered species, cultural resources (historical, archaeological, parks, wetlands, etc.), etc.
Stakeholders	• Controversial (lack of consensus) and high-profile projects (fast-track design/construction, high public impact, high interaction of elected officials, etc.) • Major coordination among numerous stakeholders is required.

Table R1.1-2. Criteria for Moderately Complex Projects (NCHRP Report 574 and PennDOT)

Moderately Complex Projects	
Roadway	• 3R and 4R projects which do not add capacity • Minor roadway relocations • Certain complex (non-trail enhancements) projects • Slides, subsidence
Tra□c Control	• Non-ITS but major safety improvements • Interconnected traffic control/management projects
Structures	• Non-complex (straight geometry with minimal skew; designs using AASHTO description factors; minimal seismic analysis; footings on rock or conventional piles and abutments) bridge replacements with minor (<610m [2,000 ft]) roadway approach work • Bridge rehabilitation that requires re-analysis of bridge capacity • Bridge mounted signs • Tie back walls • Noise walls • Proprietary/non-proprietary walls
Right-of-Way	• Right-of-Way plans needed with less than 20 moderate to significant claims and very few relocations or displacements
Utilities	• Some utility relocations, most of it prior to construction, but no major utility relocations
Environmental	• Categorical exclusion level 2 or mitigated Environmental Assessment projects • Cultural resources (historical, archeological, etc.); coordination with Museum Commission, FHWA, and/or Advisory Council • Wetland mitigation • Parkland involvement • Water and air pollution mitigation • Major coordination with Game or Fish and Boat commissions • Endangered species
Stakeholders	• Involvement of public and public officials is moderate due to non-controversial project type. • General communication about project progress is required

Table R1.1-3. Criteria for Minor Projects (NCHRP Report 574 and PennDOT)

Non-Complex (MINOR) Projects	
Roadway	• Maintenance betterment projects
	• Overlay projects, simple widening without right-of-way (or very minimum right-of-way) take little or no utility coordination
	• Non-complex enhancement projects without new bridges (e.g., bike trails)
Traffic Control	• Single traffic control/management projects
	• Non-ITS but minor safety improvements
Structures	• Bridge resurfacing or repairs that do not require re-analysis of bridge capacity
	• Pipes, box culverts, or minor culvert replacements where design can be picked directly from design manual or standards or using simple software where detailed interpretation is not necessary
	• Sign structures for which the design can be picked up directly from either the standards or using design computer software
	• Noise walls or retaining walls for which the design can be picked up directly from either the standards or using design computer software
Right-of-Way	• Involve minor right-of-way acquisitions with no displacements, maintain existing access control
Utilities	• Minimal, if any
Environmental	• Categorical Exclusion (level 1A or 1B)
	• Minimum interaction with environmental and permitting agencies
	• Minor environmental impacts, as appropriate have a Statewide Wetland Finding
	• Do not involve cultural resources, hazardous waste, Section 4(f) evaluations, or substantial flood plain encroachments
Stakeholders	• No public controversy

RESOURCE

PennDOT has established a system to define the level of complexity. See PennDOT's Design Manual: Part 1A: Transportation Engineering Procedures, Publication 10A, available from PennDOT.

TIP

Use the complexity definitions early in the project development process as a basis to select the methods and tools for project cost estimating and cost management. Reassess project complexity at key milestones. If the project becomes more or less complex as it proceeds through development, the definitions can be used to ensure that appropriate resources are employed.

R4.1 RACI

This tool addresses Mn/DOT management's vision of defining clear accountability for the steps in the CE/CM process throughout project development. Widely known as the RACI chart, this tool helps project teams define the roles and responsibilities of project team members.

What is it?

A RACI chart is a framework that is well-known in project management literature and practice. It is used to explicitly define and document the roles and responsibilities of project team members and stakeholders. The RACI chart is typically prepared when a project team is first formed and maintained thereafter. Example worksheets of RACI charts with steps in the cost estimating process are provided below. Additional columns can be included in the worksheets as deemed appropriate.

Why use it?

Projects, large or small, are collaborative efforts that call for groups of individuals to work together in teams. Project team members typically have multiple responsibilities, some outside of the project. Therefore, it is imperative that the project team uses some mechanism to understand the roles and responsibilities of individual team members on the project. The RACI chart constitutes one such mechanism to help project team members understand their roles, responsibilities, and accountabilities to various tasks during project development and execution.

What does it do?

The RACI chart defines clear accountability by defining the roles and responsibilities for each task or step or sub-process in the cost estimation process. The R stands for designating the individual(s) responsible for performing the task. The A stands for designating the individual accountable for the task (i.e., the individual who has the final authority for directing the work or making key decisions). The C stands for designating individual(s) who must be consulted when performing the task, especially before finalizing key decisions. Finally, the I stands for individual(s) who must be informed when performing the task. Informing stakeholders is a one-way communication for the purpose of a RACI chart.

One individual should typically be accountable for each distinct task or step or sub-process. However, multiple individuals can be responsible or have to be consulted or informed. In order to keep the RACI chart manageable, the project team needs to keep the total number of people associated with a task or a step to a minimum.

When use it?

There are two occasions when a RACI chart should be formed: 1) early in implementation of this reference manual by each District, and 2) for specific special projects. Once produced, the RACI chart should be reviewed periodically.

Development of a RACI chart by each District early in implantation of this reference manual allows for tailoring of the CE/CM process to each District. It is recognized that not all Districts are the same; while the Functional Groups may be similar, within each District, there are slight differences. By allowing for this tailoring, the RACI roles can be assigned as most appropriate.

Sometimes a District may encounter a special project. This project may be special for a variety of reasons, perhaps size, funding source, elements, or any other number of reasons. The definition of special is left to the District. For these special projects, the District may decide that a special RACI chart is needed for the CE/CM process. A RACI chart must be prepared when a project team is first formed, especially for large or complex projects on which communication plays a decisive role in project success. The chart should be reviewed and updated periodically, particularly at the gates in project development and other subsequent milestones. For smaller projects involving a handful of project team members who have a history of working together without conflict, maintaining and updating a formal RACI chart may not be necessary.

How to use it?

Development of the RACI should be a group effort. A meeting should take place where the only agenda item is to complete the RACI chart(s). Players from Management, Estimating, and Project Management should be in attendance. Blank charts are provided within this tool description to be utilized for development of the RACI. There is one blank chart for each of the four phases (x-axis in Figure R4.1-1)—Planning, Scoping, Design, and Letting—in each of the four areas of roles (y-axis in Figure R4.1-1)—management, Estimating,

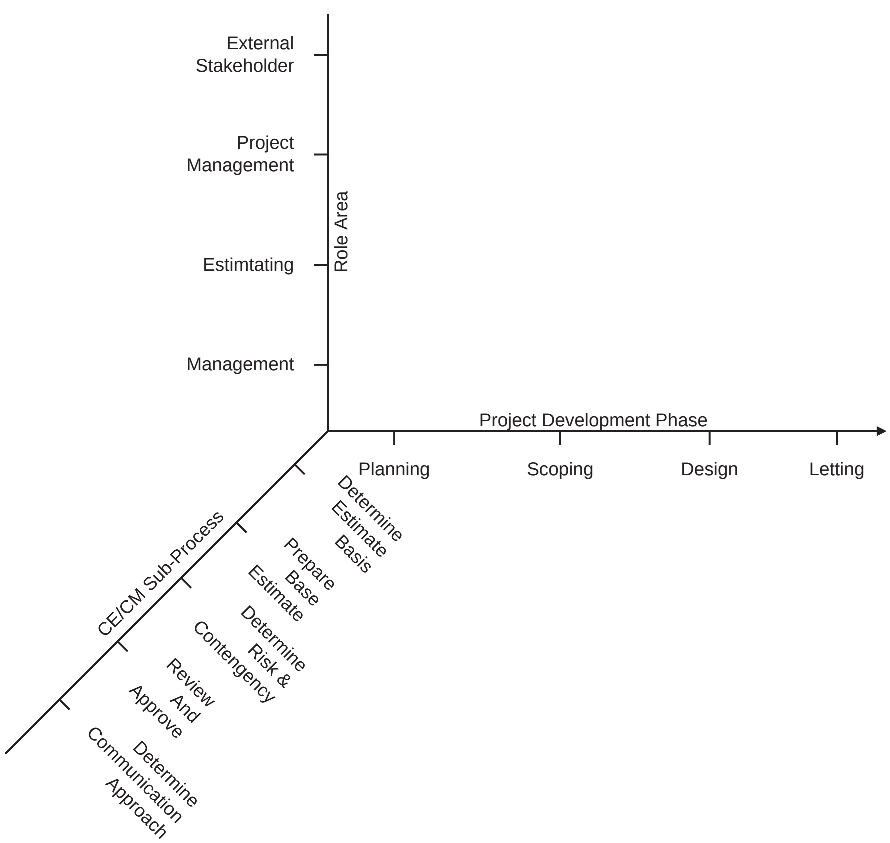


Figure R4.1-1 Three Dimensional RACI Concept

Project Management, and External Stakeholders, as discussed in Section I for each of the sub-processes (z-axis in Figure R4.1-1). Each chart should be completed by each District; this enables the customization of the CE/CM process to each District. Additionally, the District may consider completing the necessary RACI charts individually for special projects.

Before assigning roles, the outcomes of the meeting, as well as the process for which the RACI is being completed, should be discussed and understood by all. Typically the first role assigned is the responsible individual(s), R. This is the doer of the step. There may be multiple R's for each step, but this should be limited to those actually doing the step. If there are too many R's, then the step may not get completed. If there are no R's, then this step will never get completed, as everyone is waiting to approve, consult, or inform.

Next, for each step, assign the role of the accountable individual, A. This may or may not be the same as R, but remember there can only be one A for each step. Since this is the position that is ultimately answerable for the step, there should be some authority with the assignment of this role. If there is no A for each step, then there is no personal consequence for getting the job done, or done right. There must be at least one A for each step.

Finally, complete the consulted, C, and informed, I, roles for each step. When assigning C's and I's, consider whether this a two-way or one-way communication? Consulting is a two-way communication, and consultation must take place prior to completing the step. Informing is a one-way communication; the communication takes place after the step is completed and is for informational purposes. If there are large numbers of C's for a step, consider whether all of these positions really need to be consulted? An answer of "yes" is acceptable, but make sure that there is benefit added from the exchange. If there are a lot of I's, consider whether all of the individuals need to be informed routinely or just in special circumstances. If information is only required in special circumstances, be sure to note those times. If there are no C's or I's, consider whether this is because there is a lack of communication or because no C's or I's are required?

Once the roles have been assigned for each step and there is a consensus that they are properly assigned, look at the completed charts and each of the vertical columns. For each column, consider the following:

- Are there too many R's? Having a high number of R's may be too much work for any one person if there are other roles that this position plays within the organization.

- Does any one column have no empty spaces or very few? Again, if the sole role of this person within Mn/DOT is to work with the CE/CM process, this may be acceptable, but consider the work load. This person may be working on multiple projects or may have too much involvement?

- Are there too many A's assigned to any one person? There is a need to push accountability to the lowest level possible within Mn/DOT while maintaining the necessary authority associated with the accountability.

Mn/DOT Example

Figure R4.1-2 shows a RACI chart for five main CE/CM steps *in the Scoping Phase* – A21, A22, A23, A24, and A25. The four main management groups for these steps are Mn/DOT management, estimating, project management, and external stakeholders. As an illustration, the RACI assignments for step A22 are further defined in terms of the steps A221, A222, A223, A224, A225, and A226.

	Management Groups															
	Management			Estimating			Project Management		External Stakeholders							
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Determine Estimate Basis (A21)				C		R	R									
Prepare Base Estimate (A22)				C		R	C	C								
Select Appropriate Approach (A221)																
Quantify Estimate Elements (A222)																
Develop Estimate Data (A223)																
Calculate Cost Estimate (A224)																
Document Estimate Assumptions (A225)																
Prepare Estimate Package (A226)																
Determine Risk and Set Contingency (A23)				C		R	C	C								
Review & Approve Estimates (A24)			A	C		R	R							I		
Determine Estimate Communication Approach (A25)		I	A	C		R	R									

Figure R4.1-2 RACI Diagram Template for Management Group

In addition to the management groups, there are many different Functional Groups in state transportation agencies. The skills, the knowledge, and the capabilities for carrying out the function reside within these groups that can provide valuable input to cost estimation and cost management. Functional Group input is critical for the steps or sub-processes, such as A221, A222, A223, A224, A225, and A226, for which the roles and responsibilities can be defined in the chart shown in Figure R4.1-3.

	Functional Groups																
	Design	ROW	Utilities	Materials	Traffic and Safety	Construction	Railroad	Maintenance	GIS	Communication/PR	Planning	State Aid	Modal Offices	Bridge	Water Resources	Design-Build	Agreements
Select Appropriate Approach (A221)																	
Quantify Estimate Elements (A222)																	
Develop Estimate Data (A223)																	
Calculate Cost Estimate (A224)																	
Document Estimate Assumptions (A225)																	
Prepare Estimate Package (A226)																	

Figure R4.1-3 RACI Diagram Template for Functional Group

TIPS

When using RACI charts, it is important to keep in perspective the purpose of using this tool. Defining roles and responsibilities at a strategic level for the key tasks or steps or sub-processes is usually adequate for defining accountability. Project teams sometimes continue expanding the RACI chart to define roles and responsibilities at a tactical level for narrowly defined short-term tasks or steps in the process. Although some such tasks are potentially critical for the overall CE/CM effort, careful judgment must be exercised when defining additional tasks to be included in a RACI chart. Keeping the number of rows and the number of people associated with each row to a minimum will help keep the team focused and make the use of the RACI chart effective.

When completing a RACI chart, first assign R's. This should be followed by A's, and finally C's and I's should be assigned.

RESOURCE

Smith, Michael L. and Erwin, James. Role & Responsibility Charting (RACI).

Blank RACI Charts

The following blank charts are provided so that each district may complete the RACI for each phase for each step in the process.

RACI for CE/CM for Scoping (A2)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioners Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Determine Estimate Basis (A21)				C		R	R									
Prepare Base Estimate (A22)				C		R	C	C								
Determine Risk and Set Contingency (A23)				C		R	C	C								
Review & Approve Estimates (A24)			A	C		R	R							I		
Determine Estimate Communication Approach (A25)		I	A	C		R	R									

RACI for CE/CM for Scoping (A2) for Determine Estimate Basis (A21)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Review Draft Scoping Document (A211)																
Determine Alternative to Estimate (A212)																
Review Site Characteristics (A213)																
Determine if Clarification Needed (A214)																
Determine Scoping Estimate Basis (A215)																

RACI for CE/CM for Scoping (A2) for Determine Estimate Basis (A21) for Functional Groups Only

	Functional Groups																
	Design	ROW	Utilities	Materials	Traffic and Safety	Construction	Railroad	Maintenance	GIS	Communication/PR	Planning	State Aid	Modal Offices	Bridge	Water Resources	Design-Build	Agreements
Review Draft Scoping Document (A211)																	
Determine Alternative to Estimate (A212)																	
Review Site Characteristics (A213)																	
Determine if Clarification Needed (A214)																	
Determine Scoping Estimate Basis (A215)																	

RACI for CE/CM for Scoping (A2) for Prepare Base Estimates (A22)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Select Appropriate Approach (A221)																
Quantify Estimate Elements (A222)																
Develop Estimate Data (A223)																
Calculate Cost Estimate (A224)																
Document Estimate Assumptions (A225)																
Prepare Estimate Package (A226)																

RACI for CE/CM for Scoping (A2) for Prepare Base Estimates (A22) for Functional Groups Only

	Functional Groups																
	Design	ROW	Utilities	Materials	Traffic and Safety	Construction	Railroad	Maintenance	GIS	Communication/PR	Planning	State Aid	Modal Offices	Bridge	Water Resources	Design-Build	Agreements
Select Appropriate Approach (A221)																	
Quantify Estimate Elements (A222)																	
Develop Estimate Data (A223)																	
Calculate Cost Estimate (A224)																	
Document Estimate Assumptions (A225)																	
Prepare Estimate Package (A226)																	

RACI for CE/CM for Scoping (A2) for Determine Risk & Set Contingency (A23)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Review Risk Information (A231)																
Determine Level of Risk Analysis (A232)																
Identify Risk (A233)																
Estimate Contingency (A234)																
Document Risk & Contingency Basis (A235)																
Prepare Total Project Cost Estimate (A236)																

RACI for CE/CM for Scoping (A2) for Determine Risk & Set Contingency (A23) for Functional Groups Only

	Functional Groups																
	Design	ROW	Utilities	Materials	Traffic and Safety	Construction	Railroad	Maintenance	GIS	Communication/PR	Planning	State Aid	Modal Offices	Bridge	Water Resources	Design-Build	Agreements
Review Risk Information (A231)																	
Determine Level of Risk Analysis (A232)																	
Identify Risk (A233)																	
Estimate Contingency (A234)																	
Document Risk & Contingency Basis (A235)																	
Prepare Total Project Cost Estimate (A236)																	

RACI for CE/CM for Scoping (A2) for Review & Approve Estimates (A24)

	Management			Estimating			Project Management			External Stakeholders						
	Commissioner's Sta	District Engineer	Assistant District Engineer	State Estimation Oce	Central Oce Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Determine Review Level (A241)																
Review Estimate Assumptions (A242)																
Verify Completeness & Cost Data (A243)																
Reconcile with Latest Estimate (A244)																
Prepare Estimate Package (A245)																
Approve Estimate Package (A246)																

RACI for CE/CM for Scoping (A2) for Review & Approve Estimates (A24) for Functional Groups Only

	Functional Groups																
	Design	ROW	Utilities	Materials	Traffic and Safety	Construction	Railroad	Maintenance	GIS	Communication/PR	Planning	State Aid	Modal Offices	Bridge	Water Resources	Design-Build	Agreements
Determine Review Level (A241)																	
Review Estimate Assumptions (A242)																	
Verify Completeness & Cost Data (A243)																	
Reconcile with Latest Estimate (A244)																	
Prepare Estimate Package (A245)																	
Approve Estimate Package (A246)																	

RACI for CE/CM for Scoping (A2) for Determine Estimate Communication Approach (A25)

	Management			Estimating			Project Management			External Stakeholders								
	Commissioner's Staff	District Engineer	Assistant District Engineer	State Estimation Office	Central Office Estimator	District Estimator	Project Manager	Functional Groups	Consultants	Legislature	Public	Business	Local Partners	FHWA	Regulatory Agencies	Consulting Engineering Council
Communicate Estimate Basis (A251)																		
Communicate Estimated Costs (A252)																		
Communicate Uncertainty and Assumptions (A253)																		
Prepare Communication Package (A254)																		

RACI for CE/CM for Scoping (A2) for Determine Estimate Communication Approach (A25) for Functional Groups Only

	Functional Groups																
	Design	ROW	Utilities	Materials	Traffic and Safety	Construction	Railroad	Maintenance	GIS	Communication/PR	Planning	State Aid	Modal Offices	Bridge	Water Resources	Design-Build	Agreements
Communicate Estimate Basis (A251)																	
Communicate Estimated Costs (A252)																	
Communicate Uncertainty and Assumptions (A253)																	
Prepare Communication Package (A254)																	

B1.4 Summary of Key Project Definition Elements

Development and tracking key project definition elements can aid in budget control by immediately indicating changes in those items as the project progresses through the Mn/DOT project development process. Listing these key elements at each project development phase and with each estimate assists in communication among all team members.

What is it?

A summary of key project definition elements is a list/outline of the most important elements of a project. These elements should be identified early, during the project Scoping Process (see also C6.4). These items ultimately drive project costs and project duration.

Why use it?

Defining the project clearly lays the groundwork for accurate estimating and more efficient project delivery by determining and setting project limits. Communication of these key elements allows for tracking of project definition changes, as well.

What does it do?

Summarizing key project definition elements provides the project team members with a high-level checklist describing the estimate basis. Each key element represents a group of items. Early estimates can be prepared for each key element of the project. When a new element arises, the team will immediately be aware of the change.

When use it?

The list of key project definition elements should be completed as early as possible in the project development process, preferably during the Scoping Process. This list should be derived as the Scoping Documents are reviewed and the project requirements are identified. The list of elements can be useful for cost estimate reviews with District management as these elements reflect the major cost drivers of the project.

How to use it?

As the estimate basis for a project is compiled, the Estimator identifies the key elements that drive project costs. These elements become a checklist, such as that shown in Figure B4.1-1. Once quantities and their costs are known, these values can be added to better describe the impact of each project definition element. This checklist is useful for estimate reviews with District management.

TIP

As a means to monitor budget and schedule variances, compare baseline and current project scope at key project development milestones and when changes arise.

Example

Purpose of this Form: To provide a summary record of a project's definition associated with each project cost estimate that Mn/DOT prepares.

Directions for completing this Form: This form is set up as a checklist of the possible elements that may be included in a roadway/bridge construction project. The checklist also includes a column/space for approximate quantities and/or comments regarding each element (added as the cost estimating process is completed). The estimating approach determines the quantities in specified units for these key project elements. In this form, units and quantities should be identified in general terms that define the project in a way that can be easily understood by people who currently are not directly working on the project.

Date:

State Project number if known:

From:

To:

Brief Project Description:

Total Project Cost Estimate:

Summary Author/Estimator:

	Project Definition		
Element	**Includes**	**Doesn't Include**	**Quantity/Comment**
Grading	☐	☐	Added once cost estimate is prepared
Aggregates	☐	☐	
Paving	☐	☐	
Bridge Approach Panels	☐	☐	
Mobilization	☐	☐	
Removal/Salvage	☐	☐	
Drainage	☐	☐	
Traffic Control	☐	☐	
Turf/Erosion	☐	☐	
Signing	☐	☐	
Lighting	☐	☐	
Temporary Construction	☐	☐	
Utilities	☐	☐	
Aesthetics	☐	☐	
Retaining Walls	☐	☐	
Noise Walls	☐	☐	
Bridges	☐	☐	
Signals/Traffic	☐	☐	
Management Systems	☐	☐	
Right-of-Way	☐	☐	
Other Elements	☐	☐	
Project Development/Delivery	☐	☐	

Figure B1.4-1. Key Definition Element Summary Form

C6.4 Scoping Documents

Mn/DOT has developed a Scoping Process that focuses on the Planning – Scoping – Programming cycle. Through this process, transportation system performance needs are identified and prioritized. The most critical needs are carried forward into the Scoping Phase. The output of the Scoping Process creates various documents that describe the project's requirements. These "Scoping Documents" provide the necessary information and data for Estimators to define the basis for preparing a cost estimate. They are also an excellent source of information for understanding the uncertainty involved in a project; thus, they are very helpful in determining risks and setting an appropriate project contingency once the baseline estimate is prepared.

What is it?

Scoping Documents capture information and data that Mn/DOT uses to explicitly define and document the requirements for a project. They are generated during the Scoping Process based on issues identified on Functional Group worksheets. These worksheets result from performing the various tasks required of the Scoping Process.

Why use it?

Scoping Documents provide critical information that represents the project requirements. They are prepared before any major design efforts take place. They are used in the cost estimating process to define the estimate basis and aid in assessing project uncertainty.

What does it do?

The development of Scoping Documents provides consistency in project definition early in the Mn/DOT project development process. Completion of Scoping Documents for each project assists the Estimator in preparing the estimate basis for the baseline cost estimate, for defining risks and contingency, and for tracking changes during the Design Phase. These documents support the purpose and need of the project and serve as a reminder of the project intentions throughout the Design Phase. Scoping Documents aid in the identification of critical elements that are included in cost estimates, and they form the basis for project schedules.

When use it?

Scoping Documents are completed during the Scoping Phase of project development to establish a baseline project definition for the project and a basis for the Total Project Cost Estimate. These documents also represent the basis for detailed design that occurs during the Design Phase of the project. They also provide a mechanism to check for or identify project changes as the design is prepared.

How to use it?

Scoping Documents serve as the basis for preparing cost estimates. These documents are prepared as a part of the Scoping Process and documented in the draft Scoping Report. The Estimator extracts pertinent information from the Scoping Documents, such as the following:

- Functional Group involvement in the project by reviewing completed Scoping worksheets (see Figure 6.4-1)
- Typical drawings, for example, cross sections (see Figure 6.4-2)
- Key design features of the facility (see Figure 6.4-3)
- Information that is not in the scope of the project (see Figure 6.4-4)

The Estimator should note those items that are included in the Project Estimate File.

Examples

SP (TH) #: Prj Mgr: Prj Limits:

Person completing this form: Date:

DESIGN SCOPING WORKSHEET

To 'check' in the check boxes, double click and click on 'checked' in the Default value box

The purpose of this form is to record notes on issues that may affect the scope of the project.

ITEM	ITEM NEEDED			NOTES (or see below) (Location, Quantity/Cost estimate and other comments)
	Need	Want	Not	
Design Exception	☐	☐	☐	
CSS Design Flexibility	☐	☐	☐	
Hor. Curve Correction	☐	☐	☐	
Vert. Curve Correction	☐	☐	☐	
Crown Correction	☐	☐	☐	
Super Correction	☐	☐	☐	
Side Slope Correction	☐	☐	☐	
Shlder slope correction	☐	☐	☐	
Flatten Entrance Slopes	☐	☐	☐	
Sight-line Obstr. Correction	☐	☐	☐	
Guardrail	☐	☐	☐	
Curb & Gutter	☐	☐	☐	
Ped. Ramps/Accomodation	☐	☐	☐	
Retaining Walls	☐	☐	☐	
Municipal Agreements	☐	☐	☐	
RR Agreements	☐	☐	☐	
Utilities Relocation	☐	☐	☐	
69kV lines Steel Poles	☐	☐	☐	
	☐	☐	☐	

Note: any out-of-the ordinary major quantity item needs a quantity and cost estimate

Comments:

RETURN FORM TO PROJECT MANAGER BY:

Project Charge ID:

Figure C6.4-1. Standard Scoping Worksheets Form Completed By Functional Groups

TYPICAL SECTION

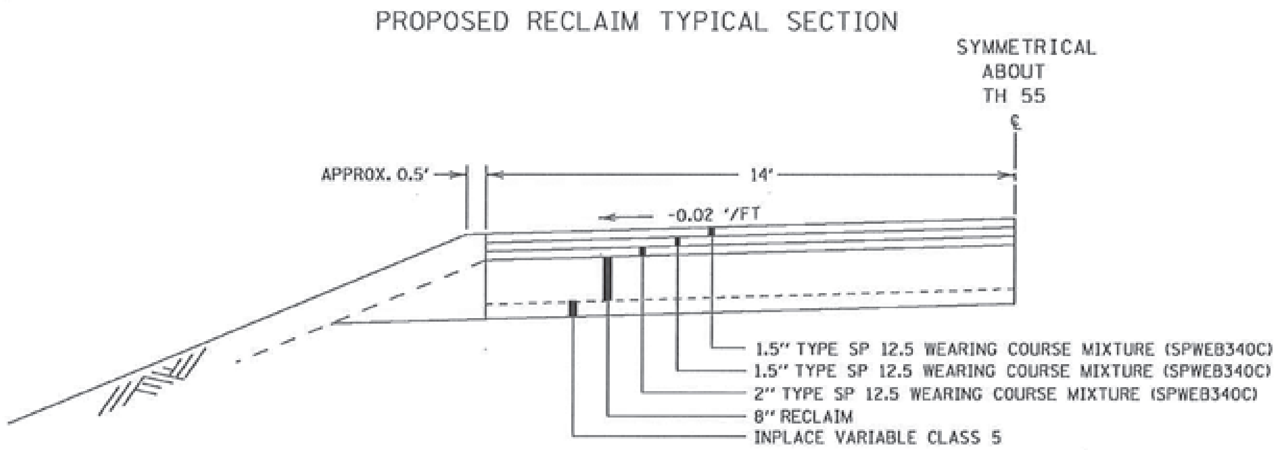


Figure C6.4-2. Typical Cross Section of New Pavement Section

PROPOSED PROJECT ELEMENTS:
Describe the work that will be included in this project under the appropriate heading...

Standards to follow in design: ☒ Preservation ☐ New Construction/Reconstruction
☐ NHS ☒ non-NHS
Geometric Design Table required? ☒ Yes ☐ No
Forecast necessary? ☒ Yes ☐ No

Driving Lanes
12' inplace
3" Mill 8" Reclaim with 5" Bituminous Overlay
Super correction will be updated to current standards

Shoulders, Turn Lanes, Ramps
2' inplace shoulder
3" Mill 8" Reclaim with 5" Bituminous Overlay

Figure C6.4-3. General Statements Regarding Project Requirements

WORK ITEMS CONSIDERED BUT REJECTED:

- Turn lanes at the county roads were considered but ADT on CR's range from 45 – 80 and they have no crash history.
- Safety in slope upgrade was rejected. Crash history does not warrant the expense. However rumble stripEs were added as a safety improvement.
- Profile correction was rejected. Crash history does not warrant the expense.
- Edge drains have been considered but it has been determined that they are not needed.
- TH 55 CL culvert connection with the RR culvert at 315+77. The RR just replaced their culverts and our box is in good shape.
- Widening shoulders from the Douglas County line to N. Jct. 114 to 4' paved and 6' usable and 6' paved and 7.5' usable between TH 114 junctions was rejected based on cost.
- Access closure at RP 51.90 was discussed but due to low ADT and no crash history it was decided not to pursue this.
- Sidewalk was considered in Farwell and Kensington but was rejected due to the precedence this would set and the cost of paying for sidewalk system wide.
- Replacement of curb and gutter in Kensington was deemed not needed. City should remove weeds to prevent curb deterioration.

Figure 6.4-4. Work Not Included in the Project's Definition

TIPS

Scoping Documents are a key tool to determine the estimate basis. Use the project Scoping Documents in a team environment with all of the appropriate Functional Groups represented to minimize the chance of any scope oversights. Scoping Documents permit some flexibility for special case projects, considering both the very straightforward and the more complex projects.

The Estimator must review all Scoping Documents and determine what documents are necessary to support the preparation of the baseline estimate. For example, typical sections provide pavement thickness for estimating quantities.

RESOURCE

Mn/DOT Scoping Process, January 2008.

G1.1 Checklist

A checklist is a tool commonly used by Estimators to begin an estimate or ensure that an estimate adequately addresses the project's definition. Checklists are valuable tools when creating conceptual project estimates when little or no engineering data is available. Checklists are also valuable quality control tools when completing estimates at any phase of project development. Checklists can be used in conjunction with a gated process to ensure that all relevant project requirements are estimated before a project moves onto the next phase of project development.

What is it?

A checklist is a form that indicates the completion or non-completion of specified project milestones. The checklist is often for personal reference of the Estimator to ensure that the requirements of the project are completed. The Estimator is not supposed to submit the checklist with the Mn/DOT estimate. Checklists are typically developed through experience with many estimates. Checklists often address items that are commonly overlooked or have high cost value. Checklists can be used in a gated process to ensure that a project will not move to the next stage of project development without the completion of critical estimating milestones.

Why use it?

In order for a project to progress smoothly, critical cost estimating items must be completed or accounted for before another phase may begin. The checklist is a simple tool for identifying the level of progress that has or has not been made on the project. A checklist helps to ensure that major categories and elements of total project cost are not forgotten as a project moves through the development process.

What does it do?

A checklist can assist Estimators in assuring that an estimate is complete. A checklist can input for supporting a "Go" or "No-Go" decision for moving a project to the next phase of development. After each phase or activity is completed, the item will be "checked off" on the checklist, and the next set of responsibilities will be addressed. A checklist can also be used to help set reasonable contingencies because they can give some indication about the unknowns in a project.

When use it?

Checklists can be used on every project. A checklist can be developed during the Planning Phase. The checklist can be utilized from the Planning Phase through the Letting Phase of a project. It is often valuable to develop checklists that correspond to major milestones in project development, such as at the end of the Planning and Scoping phases.

TIP

A checklist is a simple tool for managing a current project, as well as for reviewing completed projects. For future reference, add extra notes and lessons learned to the checklist as the project progresses.

How to use it?

By using checklists the Estimator confirms the completion of all the involved in estimation of cost data. Checklists should be referred at the start of the estimation to recall the milestones of the estimate. After the estimate is made the checklist is marked to verify the completion of the important milestones. The confirmation can also be marked during the estimation process. The use of checklist depends upon the Estimator, he can use it the way he is more comfortable with it. More items can be added and removed from the checklist as it proceeds ahead in the project development process, hence it is important for the Estimator to take note of the changes in the checklists.

Example

Example to be furnished or developed by Mn/DOT.

13.1 Environmental Assessment

In Mn/DOT, Environmental assessments are an integral component of the project delivery process. Mitigation of environmental issues is a cost to the project. Environmental assessments identify potential project definition issues related to ensuring an appropriate cost is included in the project estimate to cover environmental mitigation.

What is it?

An environmental assessment is a concise public document that Mn/DOT prepares under the National Environmental Policy Act (NEPA) to provide sufficient evidence and analysis to determine whether a proposed agency action would require preparation of an environmental impact statement (EIS) or a finding of no significant impact (FONSI).

The National Environmental Policy Act [42 U.S.C. 4321 et seq.] was signed into law on January 1, 1970. The Act establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and it provides a process for implementing these goals within the federal and state agencies. Many times environmental issues driven by parties external even to the general location of a project can cause additions to project requirements that significantly affect project cost.

Why is it?

A study made by the U.S. General Accounting Office identified that expediting the authorizations from environmental and resource agencies is one of the most promising approaches for reducing the time it takes to plan, design, gain approval for, and build a federally funded highway project. For projects in which the environmental impact is considerable, mitigation measures may pose a significant cost. Failing to consider these regulations may jeopardize not only the original budget, but also the whole project.

What does it do?

Environmental considerations are evaluated from the inception of a project and are constantly reviewed during all phases of project development. However, the impact of environmental regulations on a project is most critical during the Planning and Scoping phases. The NEPA process must be completed and all potential impacts considered prior to full design of the project. This may require that several alternatives be investigated and related costs compared in terms of potential mitigation solutions to address environmental issues.

When is it used?

Environmental impact assessment (EIA) is no longer an option but a sound precaution and a proactive measure. Increasingly, successful project development is viewed in terms of its final result–its operational *environmental* performance, its acceptance by stakeholders, its contribution to sustainable development, and, critically, the scale or magnitude of *environmental* impact over all life-cycle phases. For astute proponents, the evidence suggests that EIA follow-up has a valuable role to play in good project developmental practice.

How to use it?

Mn/DOT must follow its procedures and policies related to environmental issues as these issues impact project requirements.

Example

The Federal Highway Administration document *Major Project Program Cost Estimating Guidance*, June 4, 2004, specifically calls attention to environmental work that affects project cost.

Environmental Work: Although the intent of a project may be to avoid environmentally sensitive resources, some degree of environmental consideration and analysis is required for all major projects. If work associated with the alternative in the NEPA document is not included as part of the cost estimate, the NEPA document should note where the cost for the outstanding cost element could be found. For example, this could be short-term improvements that are already included in the Statewide Transportation Improvement Program (STIP). Any additional environmental avoidance, minimization, mitigation, remediation, and enhancement costs must also be included in the cost estimate. Costs to mitigate impacts to natural resources, cultural resources, neighborhoods, and so on must either be individually estimated or included in a contingency amount. Although large contingencies may be appropriate if no resource surveys have been conducted, resource surveys conducted as part of the NEPA process provide valuable information for refining cost estimates. Additionally, some major projects may have enhancement work that is not directly related to the project. This may include other transportation modes and non-transportation related work. These costs must be captured and included in the cost estimate. A major project that has a potentially significant effect or impact on environmental resources or has opposition from environmental or community groups or regulatory agencies tends to include more environmental mitigation, which results in higher costs than those projects with relatively little impact or opposition. Moreover, contingencies should be included for projects that include Intelligent Transportation System attributes, as well as in those States that are implementing Context Sensitive Strategies/Context Sensitive Design since very little historical data exists or is included in previous cost figures.

TIP

Federal, state, tribal, or local agencies having special expertise with respect to an environmental issue or jurisdiction by law may be a cooperating agency in the NEPA process. A cooperating agency has the responsibility to assist the lead agency by participating in the NEPA process at the earliest possible time; participating in the Scoping process; developing information and preparing environmental analyses that include portions of the environmental impact statement wherein the cooperating agency has special expertise; and making available staff support at the lead agency's request to enhance the lead agency's interdisciplinary capabilities.

RESOURCE

www.epa.gov/compliance/basics/nepa.html#requirement

H1.1 Historical Data

The use of historical data plays a vital role in developing estimates at every project development phase. Mn/DOT maintains information on various historical data for use when estimating construction costs. The Estimator can use these available historical data to prepare cost estimates but must adjust these data to fit current project characteristics, location, and market conditions.

What is it?

Historical data is the collection of estimate and bid data based on construction projects undertaken in recent years. Cost estimating based on historical data is the most reliable and efficient method of estimation as it provides rational estimates for typical projects. Historical data can be divided into two main groups: Historical bid data and Historical cost data. The difference between these is simple; Bid data comes from the estimates, whereas cost data comes from the actual work completed.

Historical bid data comes from the bids submitted by the contractors who wish to be awarded the contract. This data is sorted and compiled by Mn/DOT and can be found at Bid Analysis Management/Decision Support System (BAMS/DSS) for the use of all Mn/DOT Estimators.

Historical cost data is the actual amount of each item. This is the cost at which a previous project was awarded to the contractor. As most of the items are the same in the projects, this data becomes useful for the estimation of upcoming projects. The cost data is often viewed as more useful than the bid data since it is the actual cost instead of a prediction.

Why use it?

Developing the cost of each item in an estimate is very difficult and time consuming. By using historical data, the Estimator can both save time and ensure accuracy. Similar projects with similar line items, quantities, and locations can generally be estimated quickly by utilizing historical bid data from previous projects. This bid data can also be used to conduct research and find out the success or failure of the projects, and it can help improve the process of highway construction and estimation.

What does it do?

Historical data is merely a collection of datasets to be referenced by Estimators. It gives Estimators a basis for what cost data to apply to an estimate. The estimation process with the use of historical data involves selection of relevant data; this is analyzed to project estimated costs for the current projects. Historical data sets a baseline for the Estimator as he or she now knows about similar projects constructed in the recent past.

When use it?

It is generally seen that the more historical bid data that is used, the more accurate the estimates are for the current projects. Historical data can be used when the previous bid histories are available in enough quantity to support the current project calculations. This data can be utilized when there is adequate resemblance between the current project and the previous projects. It is not necessary that the projects should be similar; historical data can be utilized even if the components of the projects are same.

How to use it?

The first step of using historical data is that the Estimator must find a similar project to use for comparison. After the identification of the project, the Estimator must note any reasons the cost data may be different on the project he or she is estimating compared to the one that is being used as a reference. This could range from new innovations in techniques or equipment, economy of scale, an increase in minimum wage, or even different crew efficiencies due to the time of year of construction. The significance is that the Estimator fully analyzes the project he or she is pulling data from and also the one he or she is estimating. Once the differences and similarities are accounted for, the Estimator then inflates the cost data to present-day dollars. Finally, the cost information can be applied to the project being estimated.

Examples

Historical data for bid based estimating can be found at the following intranet/internet locations:

- Average Bid Prices
  - http://tchw2ks009/estimating/reports/AVGPR052006.PDF

- Historical Item Data (see Figure H1.1-1)
  - http://tchw2ks009/estimating/reports/HistoricalPrices.xls
  - http://bidlet.dot.state.mn.us/propSearch.aspx

- Abstracts
  - http://tchw2ks009/estimating/itemRpt/abstract.aspx
  - http://www.dot.state.mn.us/bidlet/abstract.html

Historical data for bid based estimating can be found at the following intranet/internet locations or from other sources as indicated:

Labor

- Minnesota Department of Labor and Industry Prevailing Wage Rates
  http://workplace.doli.state.mn.us/prevwage/highway.php

Production Rates

- Contract Time: http://www.dot.state.mn.us/const/determinecontracttime.html
- Resident Engineers

Equipment

- The Commissioners Equipment Rental Schedule
  http://www.dot.state.mn.us/tecsup/tmemo/active/tm06/01ts01.pdf
- The Department of Labor Truck Rental Rates
  http://www.doli.state.mn.us/pdf/truckrentalrate082806.pdf
- Rental Rate Blue Book, Volume 3 as published by Primedia Information, Inc.
- Joe Tummers – 651-366-4693

	A	B	C	D	E	F	G	H	I	J	K
1	Item	Item Description	Dis	Quarte	Contract	County	SP	Unit	QTY	Awarded Price	Second
2	2011601/00001	CONSTRUCTION LAYOUT STAKING	3	2003Q2	030050	STEARNS	7380-206	LS	1	$84,900.00	
3	2011601/00001	CONSTRUCTION LAYOUT STAKING	4	2003Q3	030165	DOUGLAS	2101-20	LS	1	$10,000.00	
4	2011601/00001	CONSTRUCTION LAYOUT STAKING	7	2003Q2	030080	BLUE EARTH	0703-16	LS	1	$20,000.00	
5	2011601/00001	CONSTRUCTION LAYOUT STAKING	M	2003Q2	030073	HENNEPIN	2723-109	LS	1	$66,000.00	
6	2011601/00001	CONSTRUCTION LAYOUT STAKING	2	2003Q2	030067	BELTRAMI	0416-31	LS	1	$40,000.00	
7	2011601/00002	TUNNEL CONSTRUCTION LAYOUT STAKING	M	2005Q2	050073	HENNEPIN	2771-31	LS	1	$67,000.00	
8	2011601/00003	CONSTRUCTION SURVEYING	1	2003Q1	030027	KOOCHICHING	3609-30	LS	1	$18,700.00	
9	2011601/00003	CONSTRUCTION SURVEYING	1	2003Q1	030054	CARLTON	0906-42	LS	1	$83,000.00	$
10	2011601/00003	CONSTRUCTION SURVEYING	1	2003Q2	030082	CARLTON	0901-72	LS	1	$30,837.00	
11	2011601/00003	CONSTRUCTION SURVEYING	1	2003Q2	030125	VARIOUS	8821-73	LS	1	$9,500.00	
12	2011601/00003	CONSTRUCTION SURVEYING	1	2003Q3	030207	ST LOUIS	6920-37	LS	1	$275,000.00	$
13	2011601/00003	CONSTRUCTION SURVEYING	1	2003Q4	030227	ITASCA	3108-56	LS	1	$105,000.00	$
14	2011601/00003	CONSTRUCTION SURVEYING	1	2004Q2	040008	ITASCA	3108-63	LS	1	$50,204.00	
15	2011601/00003	CONSTRUCTION SURVEYING	1	2004Q2	040083	LAKE	3805-90	LS	1	$10,000.00	
16	2011601/00003	CONSTRUCTION SURVEYING	1	2004Q2	040128	KOOCHICHING	8821-74	LS	1	$16,520.00	
17	2011601/00003	CONSTRUCTION SURVEYING	1	2004Q3	040161	ST LOUIS	6903-13	LS	1	$30,000.00	
18	2011601/00003	CONSTRUCTION SURVEYING	1	2004Q3	040162	ST LOUIS	6928-26	LS	1	$65,000.00	
19	2011601/00003	CONSTRUCTION SURVEYING	1	2004Q3	040158	ST LOUIS	6917-119	LS	1	$140,000.00	
20	2011601/00003	CONSTRUCTION SURVEYING	1	2004Q3	040170	COOK	1603-39	LS	1	$15,000.00	
21	2011601/00003	CONSTRUCTION SURVEYING	1	2004Q4	040209	ST LOUIS	6912-66	LS	1	$36,600.00	
22	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q1	050023	AITKIN	0112-34	LS	1	$20,380.00	
23	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q1	050004	LAKE	3802-20	LS	1	$14,500.00	
24	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q1	050025	ITASCA	3104-52	LS	1	$77,677.13	
25	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q1	050035	ITASCA	3108-62	LS	1	$48,500.00	
26	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q1	050049	AITKIN	0110-29	LS	1	$17,750.00	
27	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q2	050071	LAKE	3803-32	LS	1	$187,000.00	$
28	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q2	050113	KOOCHICHING	8821-125	LS	1	$45,000.00	
29	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q2	050116	ITASCA	3105-15	LS	1	$10,000.00	
30	2011601/00003	CONSTRUCTION SURVEYING	1	2005Q3	050160	CARLTON	8821-139	LS	1	$3,536.99	
31	2011601/00003	CONSTRUCTION SURVEYING	1	2006Q1	060029	PINE	5880-169	LS	1	$54,000.00	
32	2011601/00003	CONSTRUCTION SURVEYING	1	2006Q2	060036	ITASCA	3116-106	LS	1	$140,000.00	$

Figure H1.1 Mn/DOT Historical Item Data Excel Spreadsheet

Material

- Call Suppliers: http://bidlet.dot.state.mn.us/vendor.aspx
- Materials Engineers

Contractor Overhead and Profit

- Mn/DOT Standard Specification 1904
  http://www.dot.state.mn.us/tecsup/spec/2005/1100-1911.pdf
  - Labor – 62% of taxable wages + fringes
  - Equipment – 0%
  - Material – 15%
  - Subcontractor – 10%

Other useful web pages are:

- Bid Letting: http://www.dot.state.mn.us/bidlet/
- Construction Tools: http://www.dot.state.mn.us/const/tools/index.html
- Cost Estimating: http://tchw2ks009/estimating/index.aspx

TIPS

The use of historical data must fit the estimating approach and tool that the historical data supports, such as for Bid Based Estimating or Cost Based Estimating.

The project data should be captured so that it can be used as historical data in the future. The proper use of historical data depends on the capability and experience of the Estimator.

Understanding the differences and similarities is an important step to utilize historical data and should be performed with great concern. The Estimator should be careful with quantity variability of the historical data when applied to a project.

RESOURCE

Information regarding historical data can be found through the Central Office Estimating Group.

13.3 Market Conditions

The price for a commodity or service is dependent upon the market conditions and the situations of the contractor and Mn/DOT, as well as the cost to actually secure the necessary materials and perform the work. Existing and projected market forces can have a substantial impact on the cost of a project. The actual impact of such forces can vary significantly depending on the specific date a contract is advertised and bid, and on the type of materials that are required to construct the work. Many market condition circumstances are beyond the control of Mn/DOT and will affect all purchasers of construction services, but not always in the same way, with the difference primarily being in the risk shifting contract clauses.

What is it?

This is a tool that establishes an approach to analyzing market capability to respond to the project as designed and packaged for bid. The approach seeks to provide management with assurance that cost impacts driven by market conditions, both global pressures on material prices and the local construction situation, have been considered in developing the project's design, contract packaging, and estimated cost.

Why use it?

It is necessary to consider changes in the contracting situation and in general economic conditions when developing a cost estimate, and this is particularly true whenever historical prices are being used. Contractors usually enter into contracts with Mn/DOT that fix the price over the term of a project, but for some materials the contractor cannot secure fixed prices from the suppliers. Thus, project bidders must account for the risk of fluctuating material prices in their bids.

What does it do?

Contracting firms must develop strategies to minimize their risks, and a primary strategy involves increased cost to the project owner. In the case of risks that cannot be quantified, such as volatility of material prices or even the availability of materials, the cost increase can be significant. Additionally, if the contractor perceives that an owner is seeking through contract language to shift risk to the contractor, sufficient additional cost will be included in the bid to cover that added financial exposure. This tool encourages an approach that continually analyzes market forces, that is, cost of materials, competition among contractors (such as the number of potential bidders), and the impact of market changes on project cost.

When use it?

Market conditions are volatile and will most likely change between the initiation of a project and the issuance of bid documents; therefore, an approach to evaluating market conditions and their effect on the estimate must

TIP

A market survey should be carried out on complex projects to determine where the bidders will come from, asking questions such as, "Is the local market sufficiently large to accommodate the project?" or "Will the major subcontractors be at capacity and therefore likely to bid high, if at all?"

Also, a read of the market prior to finalizing the PS&E estimate is useful for validating the estimate and can be included in a risk assessment to determine a range of expected bids.

Three circumstances are worthy of special consideration:

- changes in the level of competition,
- limited competition, and
- differing economic conditions

Consider market impacts when conducting risk analyses, especially early in project development. Market impacts can be captured in project contingencies until the project is closer to the Letting date.

Continuously update the estimate to reflect current market conditions and review cost indices tracked by Mn/DOT to support cost estimate updates.

be continuous through all phases of project development. When a change in market conditions is identified, the estimated must be adjusted to reflect the new conditions.

How to use it?

Review the following factors when preparing estimates and adjusting bid prices for the current project:

- **Acquisition Strategy Analysis:** A separate analysis should consider the most economical and advantageous way of packaging the contracts for advertisement.

- **Bidding Climate Impact:** Estimators should consider the economic impact of the project on the local economy. For example, material suppliers that would normally compete with one another may need to combine resources in order to meet the demand of the major project. Extremely large construction packages also have the potential to reduce the number of contractors that have the capacity or capability to do the work and, therefore, bid on the work. In this instance, the project may need to be split into smaller contracts to attract additional bidders and improve competition. In addition, the timing of the bid solicitations can also have an effect on the cost. Cost estimates should consider availability of labor and time of year construction will occur.

- **Industry Capacity:** The number of potential qualified contractors that are able to bid on a project is limited as project size increases. Contractors who bid on major projects often bid on projects throughout the country. If other major projects are being advertised concurrently, this may have a limiting effect of competition and would result in higher bids.

- **Highly Specialized Designs and Technology:** Cost estimates should consider the impact of any requirement to use first-of-a-kind technology, new materials, or innovative construction methods.

Trends in market conditions should be extrapolated to predict material prices and availability at the time of the project. Material price indices should be monitored.

C3.3 Cost/Parameter Using Similar Projects

This tool is based on the concept of using the cost of projects that are similar to the project being estimated as the basis for developing the estimate. The similar project has a known cost and definition. The similar project cost is converted into some reasonable cost parameter, such as dollars per centerline mile or dollars per square foot of deck area, and is used in conjunction with an order of magnitude quantity parameter derived from the project being estimated, such as centerline miles, to provide a basis for approximating the total cost of the facility.

What is it?

Early in program (or project) development, there is very limited definitive scope definition as to how a transportation need should be addressed. Because there are often similarities between a current need and a recently programmed, designed, or completed project, the cost basis for estimating the future program area (a project or groups of projects) is the relationship to the similar project for which there is cost data. The cost of the similar project is often expressed in terms of a cost per mile.

Why use it?

The purpose of this tool is to rapidly assess the approximate costs for addressing transportation needs based on limited design information.

What does it do?

This tool provides an easy way to quickly approximate the conceptual cost of a potential transportation program (project or groups of projects). The concept is based on identifying an existing project that is almost identical in scope to the project that is being estimated. The tool relies on historical cost data. This historical data has to be modified to fit any differences in definition, location, and other project characteristics that might exist between the similar project and new project or program area. The time of the reference project is important as cost data from this project may require adjustment to current day dollars.

When use it?

This tool is used for preparing conceptual estimates during the Planning Phase of program (project) development.

How to use it?

Mn/DOT retains cost data from a previously completed project(s). When a conceptual estimate is needed for an early approximation of a transportation project, cost data from a similar project(s) in the past must be collected. The Estimator must review the previous project(s) and cost data to determine the best way of relating the costs of the past project(s) to the new one. Most commonly, this is accomplished through the lane-mile method or even by

TIPS

Applying this tool requires the user to match basic project definition elements to projects that are deemed similar in definition to the transportation program or project being estimated. The user must ensure that all elements are covered in relation to the similar project, and if there is not a perfect match, appropriate adjustments in cost should be made. For example, if the similar project has fewer structures than the transportation need being estimated, an appropriate adjustment in the cost estimate should be made to account for fewer structures. There may also be location differences that must be accounted for when using costs of similar projects.

This tool is useful for developing quick estimates for a program or project provided the level of project definition similarity is very high. The cost of the similar project should include all elements, including engineering costs, Right-of-Way (ROW), utility adjustments, construction engineering, and construction. If one of these elements is not in the scope of the new transportation need then the cost for this element must be deleted from a past project estimate. Alternatively, cost for elements could be added to adjust for differences between a similar past project and a new transportation need. Contingencies should be included as a separate element to cover uncertainties related to project definition and the cost estimate technique used. Simple spreadsheets can be used to summarize cost estimate elements when using this tool.

square foot of deck area for certain items, such as bridges. The Estimator should consider the project's size, location, and definition describing previous project. Sometimes data from a few previous projects are used to estimate costs for the current project. For instance, one highway project may be built in a similar location, such as an urban area, but may not have any bridges, whereas another project may have similar bridges but may be built in a rural area. All of the data from the past projects must be inflated to current-day dollars before any cost values are calculated for the new project. After the inflation adjustment, the cost per lane-mile or square foot of deck area of the past project(s) can be applied to the new project.

In summary, the typical steps for developing this type of estimate are as follows:

1. Define key parameters used for basis estimate (center lane miles, bridge deck area, etc.).
2. Calculate total quantity of parameters (e.g., lane miles for the project based on proposed limits).
3. Find similar project and cost history.
4. Adjust cost history to current-day dollars.
5. Calculate cost per parameter for past project (e.g., lane-mile).
6. Apply historical cost per parameter (lane mile) to current project quantity parameters.
7. Adjust cost history for current project definition, conditions, and characteristics.

Example

TH 2 10.9 to 16.06

Reconstruction

T. H. #	Length in Miles	Location	Contract Amount	$ Per Mile	Type of Repair / Costs / Other	Year
2	4.5	Bemidji - Grace Lake	$3,734,756.99	$829,946.00	Grade and pave to four lanes	1995-1996
32	1.69	In Thief River Falls 5703-33	$3,275,825.00	$1,938,357.99	Reconstruct	1992
32	3.135	In Red Lake Falls	$3,315,468.00	$1,057,565.55	Reconstruct	1992
75, 175	1.56	Hallock	$3,476,319.00	$2,228,409.62	58 - 34 Oil	2002
1	1.214	In Thief River Falls	$1,664,879.00	$1,371,399.51	58 - 34 Oil	2002
2	0.765	In East Grand Forks	$4,014,751.67	$5,248,041.40		2002
2		Jct. 222 to 3.6 miles E.	$3,131,000.00	$869,722.00	Unbonded; overlay Str Conc 98.65/ sq. m, Lane Pavement 250mm 9.35/ sq. m, Lane Pavement 20mm 5.85/ sq. m	
11		Roseau 1.12 miles	$3,493,950.00		S. P. 12.5, 3. F, 14,079 ton - $42/ton, (3,F), Common ex. $5.30/yd.	2005
64	3.9	Akeley to Co Rd 33	$3,026,749.00	$776,089.00	3,C $24 / ton, 44,981 ton, Subgrade Ex $1.50/ cubic yd, 51,000 cubic yds, Common Ex $1.50 / cubic yd, 240,452 cubic yds, Much Ex $1.70/ cubic yd, 112,379 cubic yds	2005
64	5.988	Jct. 87 to Co. Rd 33	$2,851,304.00	$476,169.00	SP 12.5, 28,426 ton @ 30.21 Select Gran. 98,320 @ 1cent per yd cubed	
2	0.5	In Crookston 6002 - 54 Main to Robert	$2,046,183.00	$4,092,366.00	Reconstruct	1997
2	0.786	Crookston 6002-58 Groveland to Broadway	$3,256,000.00	$4,142,493.64	Reconstruct	1998
2	0.75	Crookston 6002-59 E. and Bridge to 1.2 km E.	$1,998,000.00	$2,664,000.00	Reconstruct	1999

Figure C3.3. Cost/Parameter based on Similar Projects – District Example

C3.4 Cost/Parameter Using Typical Sections

This tool is based on the concept of using typical sections/components representing common types of facilities and historical cost data to derive key cost parameters. These cost parameters, such as dollars per centerline mile or dollars per square foot of deck area, are used in conjunction with gross quantities to provide a basis for approximating the partial cost of a facility.

What is it?

Early in program (or project) development, very limited definition is available for solving a potential transportation need. The proposed facilities are often described in terms of a parameter, such as centerline miles of roadway improvement, additional number of lanes, type of construction (new or reconstruction), or number of bridges. For example, typical pavement type sections are used as the basis for estimating pavement construction cost for a given or standard pavement length and thickness and for a typical shoulder width. Historical cost data is provided in terms of cost factors (e.g., dollars per centerline mile) and percentages for certain scope categories. The costs per parameter are often built up using specific items from historical bid data. Historical data may reflect average costs and are not necessarily specific to any one area within a state. However, data can be used for a specific District to provide a location specific cost parameter.

Why use it?

The purpose of this tool is to develop approximate total project costs for a transportation need or needs so that estimates of funds required for long-range plans can be determined.

What does it do?

This tool is easy to use and provides a quick approximation of the conceptual cost for addressing a transportation need or correcting a deficiency. The concept is based on identifying those cost elements that are likely to be a substantial portion of a project's total cost. The tool relies on historical bid data for developing standardized or typical configurations that represent types of transportation facilities.

When use it?

This tool is used for preparing a transportation program (project) conceptual estimate during the planning phase of program (project) development.

How to use it?

Applying this tool requires the Estimator to match basic definition elements to typical configurations and/or sections representing different types of transportation need solutions. The user also must ensure that all scope items are covered and that the database provides sufficient information to estimate all

TIP

Applying this tool requires the Estimator to match basic items to typical configurations and/or sections representing different types of transportation need solutions. The Estimator also must ensure that all project definition elements are covered and that the database provides sufficient information to estimate all pertinent elements for the proposed solution. The estimate must cover all categories of total project cost that apply, such as ROW, engineering, and utility relocation. Cost adjustments may also be necessary when the project definition is different from that used to make the estimate or when unique conditions exist. Simple spreadsheets can be used to make calculations and summarize cost estimate elements.

pertinent elements or typical items that comprise an element for the proposed solution, such as pavement section, ROW, engineering, and utility relocation. Cost adjustments may also be necessary when the definition of a current project is different than the past project. Other cost adjustments may be necessary for existing project conditions and characteristics.

Since Mn/DOT does not have published cost per parameter based on typical sections, the Estimator can develop these data for a specific application. Typically, the steps are as follows:

1. Create a typical section for an element over common parameter (e.g., a one mile pavement section including structure, sub-grade materials, etc.).
2. Identify typical item costs that reflect the items that comprise the element.
3. Find historic cost data for the items.
4. Develop quantities for the standard section and apply item cost data.
5. Summarize cost for total parameter (e.g., lane-mile).
6. Calculate parameter quantity for current project.
7. Apply cost per parameter factor to current quantity.

Example

Example to be furnished or developed by Mn/DOT.

C3.5 Trns•port® TRACER

Trns•port® is the AASHTO sponsored transportation agency management software. It is a robust transportation program management system. It utilizes the most current information systems technology and is based on the experience and needs of AASHTO's member agencies.

Trns•port® capabilities encompass the full functionality of a construction contract management system. It is an integrated system consisting of eleven modular components, which can be used individually or in combination, as appropriate. Each module addresses the needs of the highway agency at a particular milestone in the construction contracting life cycle, representing three functional areas: preconstruction, construction, and decision support.

AASHTO recently introduced another software to the suite of estimating tools. TRAnsportation Cost EstimatoR (TRACER) software is a parametric cost estimating tool created to help plan and budget for highway and bridge construction/renovation projects during the Planning Phase. TRACER was developed by Earth Tech.

Mn/DOT owns a license to use this software, but it has not been fully tested for implementation within Mn/DOT. This tool is provided for future consideration.

What is it?

TRACER is a new, computer based tool developed to support parametric estimating. The database that supports this tool is the RS Means Heavy Construction Cost Data manual. TRACER automatically obtains the unit rate and other data from RS Means. Engineering assumptions can be easily modified as site conditions change. It is an ordinary practice for Mn/DOT to use lane-mile costs for cost estimates in the Planning Phase. When run, the TRACER model generates the list of line items that will typically be used in projects of this nature with their quantities, unit cost, and total cost

Why use it?

In Planning, if quick estimates are desired using major project parameters, TRACER can be used. Minimal input is required to generate a construction cost estimate. TRACER uses pre-engineered model parameters and construction criteria to estimate construction costs with limited design information. The parametric cost approach to estimating is different from previous methods as it allows the Estimators to input a minimum amount of information to create an accurate cost estimate. This is achieved by establishing default quantities based on similar projects from the historical data and experienced engineering assumptions.

What does it do?

TRACER uses statistical relationships between major systems of a highway project, termed modules, and the details that describe that system. For example, a bridge module is available to estimate the cost of a bridge. The user then provides the system definition for the bridge. In this case three basic elements are required: bridge size (length and width), separation type (over highway and height), and definition (superstructure and substructure type). This is the only input required. TRACER then generates all direct construction costs. Contractor overhead and profit must be added. A template is provided to insert these values. TRACER costs can be adjusted for different locations. Additional project knowledge can be incorporated to further refine the accuracy of the cost estimate.

When use it?

TRACER is best suitable when the data available about the project is minimal. It provides a conceptual. TRACER is probably most applicable during the Planning Phase of project development. In this way, TRACER can be an efficient tool for quickly estimating project costs for purposes of long-range planning and consistently estimating the cost of alternatives, as required.

How to use it?

This AASHTO estimating software is included for future consideration. The output of the TRACER estimate would have to be validated against Mn/DOT Planning estimates. A procedure would have to be prepared to guide the use of this tool.

TIP

TRACER only estimates construction costs. Other categories of total project costs would have to be added to the construction cost estimate to derive a Total Project Cost Estimate.

RESOURCE

Contact the Central Office Estimating Group.

Example

When using TRACER, the Estimator needs to check the results against past history to verify the estimate. Several screen captures are shown in Figures C3.5-1 through C3.5-3.

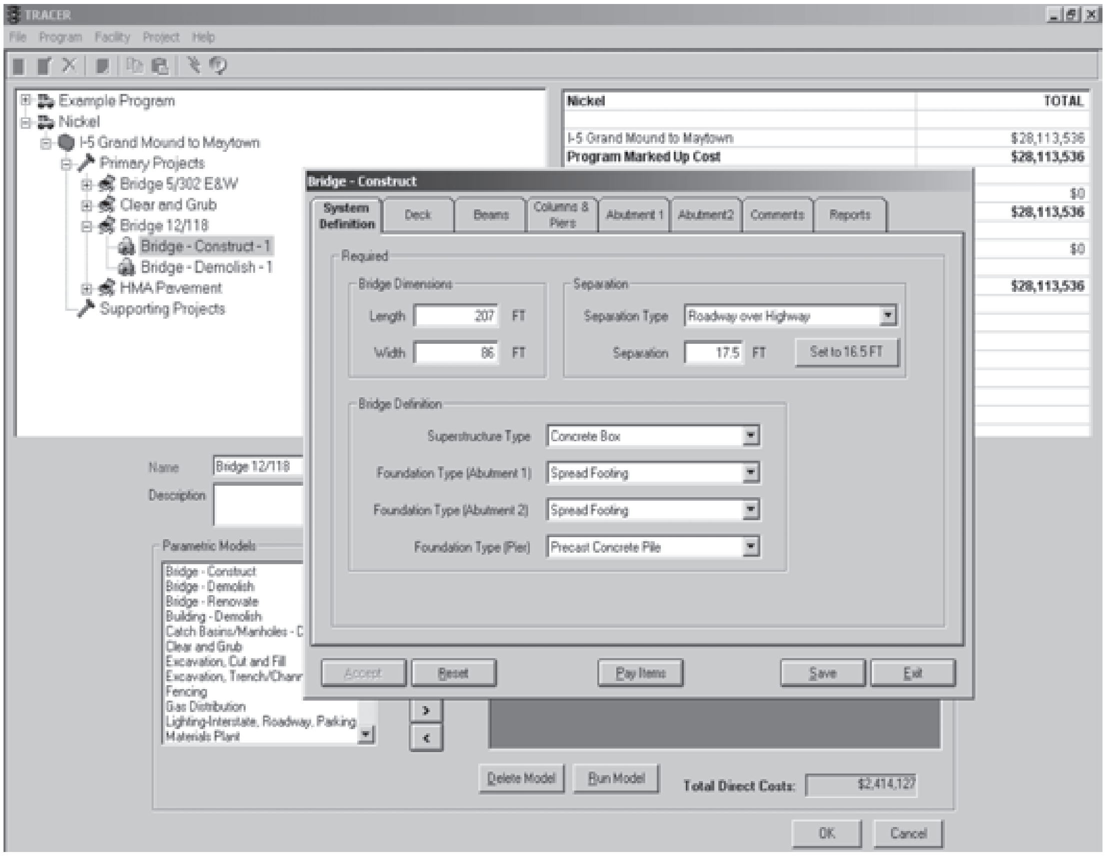


Figure C3.5-1. System Definition Input for a Bridge over a Roadway

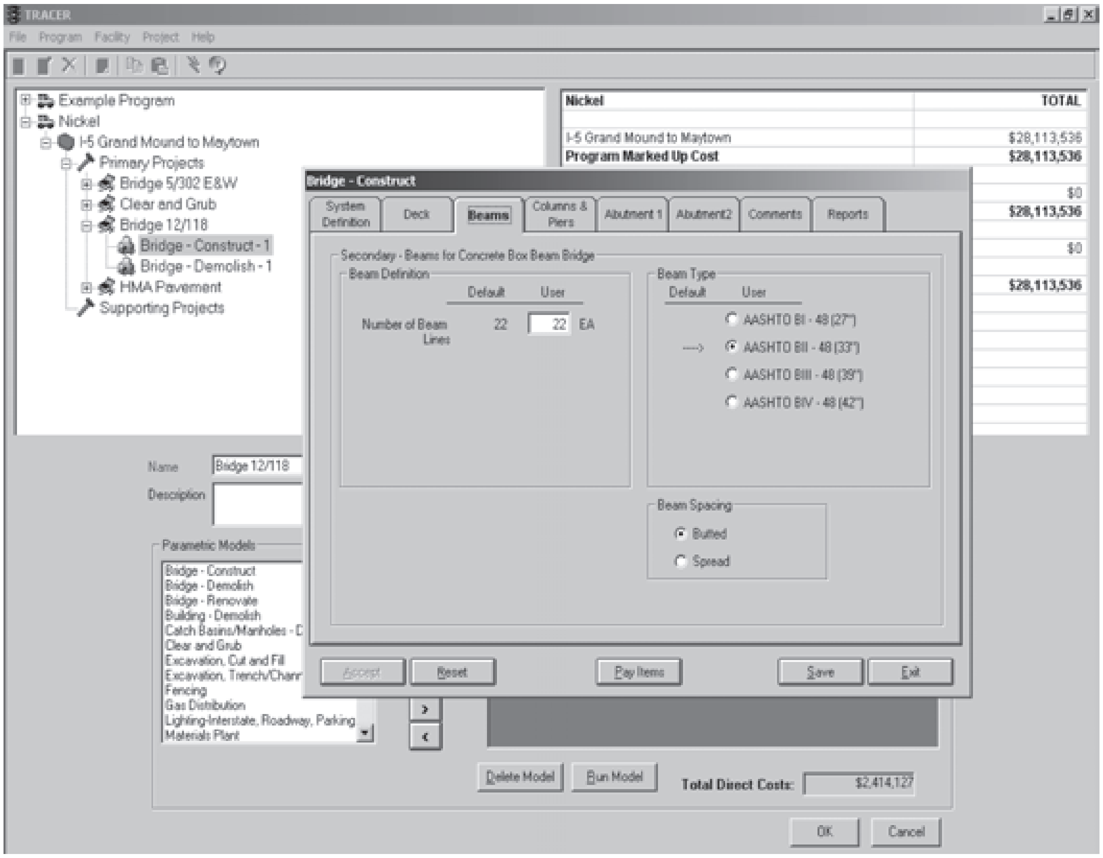


Figure C3.5-2. Additional Information created by the Bridge System Definition (Beams)

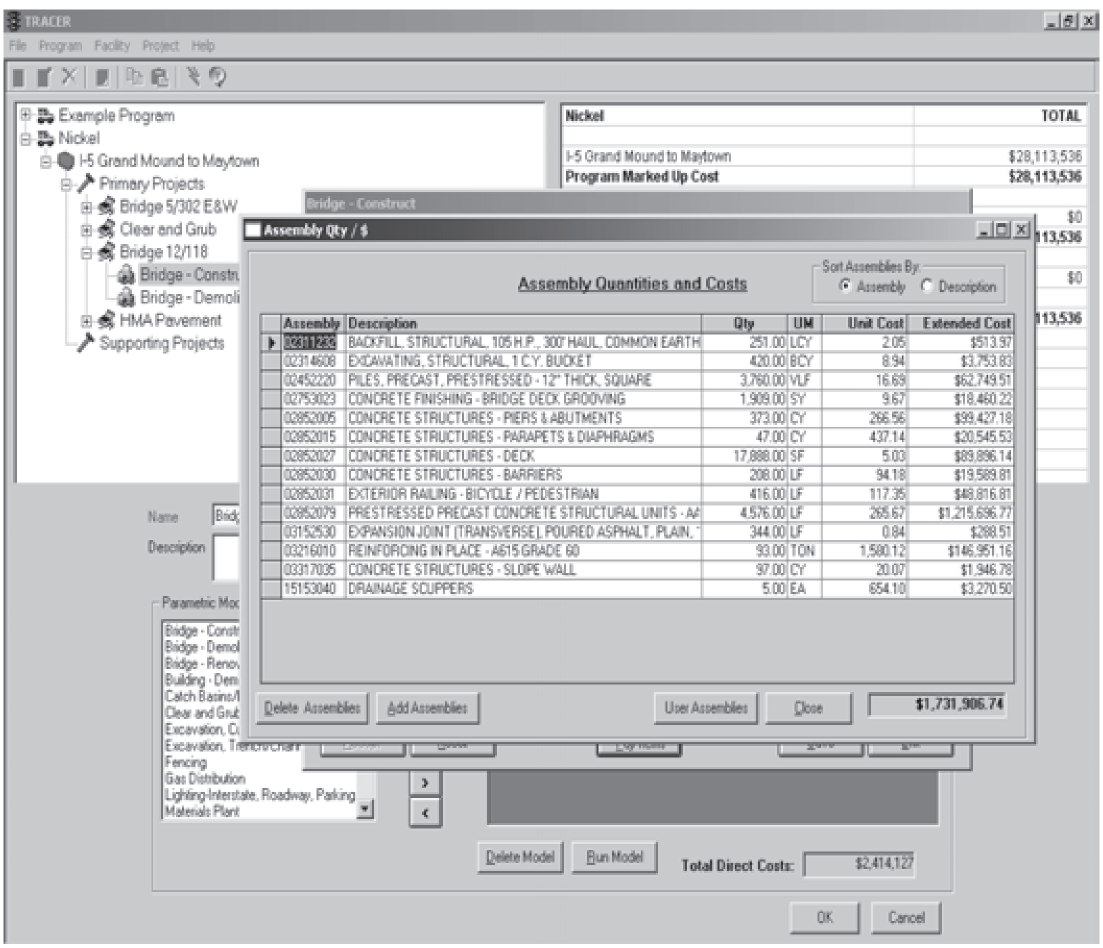


Figure C3.5-3. Direct Construction Cost Output for this Bridge (without Markups)

D2.1 Analogous or Similar Project

This tool relies heavily on matching a previous project that is very similar to the project being estimated. The reference (analogous or similar) project is typically a project that was previously constructed, is currently under construction, has been bid for construction, or has a completed PS&E level estimate. Line items, quantities, and unit costs are used as a basis for estimating the current project. Similar costs from the reference project are often used to estimate pre-letting engineering and construction engineering costs for a current project.

What is it?

Analogous estimating is an estimating tool that uses the values of parameters, such as scope, cost, and time, or measures of scale, such as size, quantities, and complexity, from a similar previous project as the basis for estimating the same parameters or measures for a future project. This tool is a form of expert judgment. It is most reliable when previous projects are, in fact, very similar in terms of major parameters and not just in appearance. Future projects often have common elements associated with other completed or ongoing projects.

Why use it?

This tool provides a quick and cost effective approach to prepare an estimate early in project development. The availability of information based on real project experience is an invaluable input for determining future project cost. Identifying similarities in a completed or current project and comparing those projects to one that is being estimated can provide excellent cost history for estimating purposes. Further, using lessons learned to adjust a project estimate that is based on similar past projects can improve estimate accuracy.

What does it do?

This tool provides an approach to preparing an estimate for Scoping that has sufficient reliability and accuracy for use in Programming a project. Further, the tool provides sufficient detail to subsequently track changes in quantities and unit costs as the project is designed.

When use it?

Analogous or similar project estimating is perhaps best used in the Scoping Phase of project development. It can be used early in Design, as well.

How to use it?

Suggested steps for applying this tool are shown below:

- Identify analogous project – one that is very similar in terms of project definition and within the same location (e. g., same District).
- Identify items that apply to current project – use standard item number and descriptions to guide selection of pertinent items.

TIP

The user of this tool must confirm that the reference project is, in fact, similar to the project being estimated and not just similar in appearance. Thus, the Estimator must make a careful assessment of the definitions and site conditions of both the project being estimated and the reference project. Adjustments may be required to the reference project's definition and cost data to fit the project being estimated.

Differences between the reference (or analogous/similar) project and the current project should be carefully documented as part of the estimate backup calculations.

RESOURCE

NCHRP Report 574 Tool Appendix

- Calculate quantities for current project.
- Adjust analogous projects' unit prices to reflect project specific conditions, quantity differences, time basis, location, size of project, and market conditions.
- Apply final unit prices to quantities of project being estimated.

The obvious advantage is that this tool is quick and easy to use. Estimate accuracy increases when the previous project is highly similar to the project being estimated. If all data from the previous project is used, the likelihood of missing items is reduced. The main disadvantage of using a previous project is when the previous project is not highly similar. Time is required to research a previous project to confirm similarities to the current project.

Previous projects can be an excellent source of data for estimating a current project. The key to using this tool is that the previous project must be very similar in project definition to the one that is being estimated. It is helpful if this project is located in the same District in which the current project will be constructed. The previous project could be one that was recently constructed, one that is under construction, or one where bids have been received.

The concept here is to use items and unit bid prices from the previous project to estimate the current project. If quantities are not available for certain items, quantities from the previous project can be used. Whenever a previous project is used, appropriate adjustments must be made to best reflect the project being developed. Judgment must be used to make these types of adjustments. Discussing these adjustments with Functional Groups will help verify any modifications made to data from the analogous or similar project.

Example

Example to be furnished or developed by Mn/DOT.

D2.4 Historical Bid Based

(see also P1.4)

Historical bid based estimating is an approach that relies heavily on items with quantities and good historical bid data for determining item cost. The historical data normally is based on bids from recent projects. The Estimator must adjust the historical data to fit the current project characteristics and location. With the use of historical bids and projects completed in the recent past, project Estimators can easily prepare cost estimates.

What is it?

The most common method used by Mn/DOT in developing estimates for transportation projects is historical bid based estimating. The tool requires the Estimator to identify items and quantities for each item so historical unit bid prices can be used to calculate item costs for the project.

Why use it?

Historical bid-based estimating is an efficient method for developing an estimate for items that have adequate historical pricing data available. Implementing a bid history based estimating process enables Mn/DOT to estimate the cost of proposed work using a minimum of resources. Similar projects with similar items, quantities, and locations can generally be estimated quickly utilizing historical bid data and engineering judgment. Preparing estimates quickly may be a driver when the agency is developing a number of project estimates for programming purposes. The tool can be used at this stage in project develop for standard type projects where project definition is relatively consistent for that type of project, such as a hot mix asphalt pavement overlay.

What does it do?

Creating cost estimates from historic bid prices is a relatively straightforward and quick process. After identifying items and determining their quantities from the available plans, the Estimator matches item numbers and quantities with the appropriate historical unit-bid prices or average historic unit-bid prices. To generate unit price data, Mn/DOT has systematically compiled bid data from past project lettings. This data is broken down by bid item (see tool H1.1). Average prices can also be calculated for the Estimator's use. There are different methods for sorting the data collected from bid documents.

When use it?

Historical bid based estimating can be used during the Scoping Phase and throughout the Design Phase of project development as long as the project's definition can be described in terms of items for which quantities can be developed.

TIP

When using historical data the following tips should be considered:"

- For the historical bid based estimating to be successful, it is necessary that the bid data is complete and consistent.
- The bid data should be captured and updated on a regular basis. This will provide adequate data to review.
- If the quantity of any item is too small or too high with respect to a previous project, special care should be taken when using a historic unit price.
- Items that do not quantify for evaluation by historical data should be calculated by other methods.
- Estimators should use their experience and skills to identify the items that may be affected by external factors, such as material availability and/or other special conditions.

How to use it?

The following steps should be followed when using historical bid based estimating:

- Determine elements/items that can be estimated based on historical bid cost.
- Scan the Mn/DOT database to find projects that are similar to the current project.
- Study and analyze the changes, bids, and unit prices of the historical data selected.
- Relate the unit prices to the current project by considering the characteristics of the project.
- Select the unit rates that apply to the current project and can be used to calculate the cost estimate.
- Apply any inflation factors to the unit prices for each item.
- Use this data to calculate the cost estimate by using the tool spreadsheet template (D2.8).
- Consider other regional, local, political, and material factors that may affect the estimate of the project.
- Perform final calculations by adding extra costs to the estimated values.

RESOURCE

AASHTO Subcommittee on Design Technical Committee on Cost Estimating Publication.

The main advantage of using historical bid based estimating is that this technique is an efficient method with adequate historical bid data. It also requires minimum resources. Estimates can be prepared quickly. Some disadvantages include the need to maintain a database of historic bid data. Bid items must be consistent among all projects. Unique items or non-standard items and lump sum items are difficult to estimate with this technique as historical data is not usually available. Project conditions from previous projects may not apply to the project being estimated, so bid data may be inaccurate without appropriate adjustments.

Example

Example to be furnished or developed by Mn/DOT.

D2.5 Historical Percentages

Historical percentages are used to estimate costs for categories and/or their work elements that are not typically well defined at the Scoping Phase of a project. A percent is developed based on historical cost information from past projects to cover very specific work elements. This percentage is based on a relationship between the selected work elements and a total cost category, such as project construction cost. Other total project cost categories are often estimated using percentages. For example, contractor mobilization is estimated using a standard percentage that varies with project dollar size. Construction engineering can be estimated based on project construction costs. Pre-letting engineering is often estimated based on a historical percent of the total construction cost.

What is it?

During the early phases of project development, not all work elements can be identified sufficiently to be quantified. Estimating quantities and unit prices for these elements are difficult due to this lack of project definition. One tool that is often used to estimate known but not quantified work elements is developing historical percentages to cover those items. Historical percentages can be developed using projects that are relatively similar in definition and complexity. This tool relies on Mn/DOT standard item numbers to aid in preparing such percentages. Historical percentages can be developed for estimating project construction costs, such as mobilization (item number 20211501/00010), construction engineering (internal), and pre-letting engineering (internal).

Why use it?

There are circumstances when the project Estimator simply does not have sufficient time and information to detail all work elements into specific items and develop quantities for these items. With a good database of historical bid prices used on past projects combined with standard items for construction elements, developing percentages for a group of similar items (i.e., typical elements) may take less time and be just as accurate as trying to estimate quantities for all element items.

What does it do?

Cost estimates contain many items when fully detailed through the Engineers' Estimate at the end of final design. However, early in project development, identifying and quantifying all items is difficult at best. This tool provides a methodology for estimating costs for these unidentified items for which quantities are difficult to determine.

When use it?

Historical percentages are best applied when there are a large number of items that cannot be quantified due to lack of design information. This tool can also be used when time to prepare the estimate is a constraint. Historical percentages are commonly used for estimating contractor mobilization, construction engineering, and pre-letting engineering costs. This tool is most applicable in the Mn/DOT Scoping and early Design phases of project development. This tool could be used in the Planning Phase to estimate categories of total project cost.

How to use it?

The following approach to developing and applying this tool may be useful:

- Identify construction elements that can be estimated using a percentage
- Find several different projects that are similar
- Identify standard item numbers for the elements and the actual cost for those item numbers
- Calculate the sum cost of these item numbers and determine percent of sum to the total construction costs (e.g., percent of project construction cost without the elements); repeat this for several different but similar projects
- Select percent that best fits the project being estimated
- Apply to project and incorporate the element into the cost estimate

A main advantage of using the percentage approach is ease of use and quick response time in relation to developing quantities for each item that is covered under the percentage. The main disadvantages are lack of accuracy, time required to research and develop the percentage, and uncertainty associated with reflecting the true scope of the project estimated for the items covered under the percentage.

RESOURCE

See Ed Katzmark, Metro District

TIP

The project from which historical percentages are developed should be very similar in definition and complexity to the project being estimated. The elements that are represented by the percentage should be based on a similar set of standard item numbers. Several projects should be used to develop the percentages so that a range of percentages can be reviewed prior to selecting the specific percentage that is applied by the Estimator.

The percent selected must be consistent with the project's definition, complexity, and schedule for the project being estimated. As the dollar size of the project increases, historical percentages for elements normally decrease. Construction execution can also impact mobilization and construction engineering costs, so care must be taken when selecting percentages for these items.

Example

A typical list of percentages used in the Metro District is shown in Figure D2.5-1.

Average Percentage Breakdown of Major Project Items

by Project Type and Group Number

From 2001 to 2007

MISC	MOB	REM	GRA	AGG	PAVB	PAVC	PAV	DRA	TRA	CON	TUR	MISC	Sample Size
1	12.4	0.0	0.0	0.0	72.1	0.0	72.1	0.0	15.5	0.0	0.0	0.0	1
2	4.0	7.5	1.5	1.5	11.4	11.8	23.1	5.8	11.9	35.7	0.7	8.3	3
3	20.3	10.6	11.1	3.5	10.4	3.3	13.7	4.2	26.5	7.9	2.4	0.1	2
Project Type Average	12.2	6.0	4.2	1.7	31.3	5.0	36.3	3.3	18.0	14.5	1.0	2.8	6

NCRU	MOB	REM	GRA	AGG	PAVB	PAVC	PAV	DRA	TRA	CON	TUR	MISC	Sample Size
2	5.0	4.2	56.0	3.8	19.0	0.0	19.0	8.2	1.5	0.3	1.9	0.1	1
Project Type Average	5.0	4.2	56.0	3.8	19.0	0.0	19.0	8.2	1.5	0.3	1.9	0.1	1

NCUR	MOB	REM	GRA	AGG	PAVB	PAVC	PAV	DRA	TRA	CON	TUR	MISC	Sample Size
2	7.1	2.9	27.2	7.9	19.7	3.9	23.5	13.1	2.2	6.1	6.6	3.5	4
3	1.4	3.3	30.4	7.7	13.4	0.0	13.4	23.8	0.7	14.1	4.5	0.7	1
4	8.5	4.3	53.5	1.6	6.3	5.9	12.2	12.9	1.3	2.6	2.4	0.8	1
Project Type Average	5.7	3.5	37.0	5.7	13.1	3.3	16.4	16.6	1.4	7.6	4.5	1.7	6

RCRU	MOB	REM	GRA	AGG	PAVB	PAVC	PAV	DRA	TRA	CON	TUR	MISC	Sample Size
1	5.2	6.2	15.1	12.9	42.0	0.0	42.0	8.2	5.3	0.2	3.7	1.1	3
2	6.2	5.6	22.3	6.7	30.4	3.6	34.0	7.0	9.5	2.6	3.8	2.4	7
3	8.9	3.9	33.3	3.8	18.6	0.5	19.1	3.0	15.7	2.6	1.7	8.2	2
4	16.7	5.1	38.1	4.3	14.9	3.4	18.3	4.7	7.9	0.2	1.7	3.2	2
5	31.4	5.5	12.0	0.7	10.1	10.6	20.7	7.1	14.5	5.7	2.0	0.0	1
Project Type Average	13.7	5.2	24.2	5.7	23.2	3.6	26.8	6.0	10.6	2.2	2.6	3.0	15

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Figure D2.5-1. Typical Historical Percentages for Estimate Elements

D2.7 Parametric Estimating

Parametric estimating techniques are primarily used to support development of Scoping or early Design phase estimates where there is limited project definition. Statistical relationships and/or non-statistical ratios between historical data and other parameters (e.g., tons of asphalt, square foot of bridge deck) are used to calculate the cost of various items of work.

TIP

The Estimator needs to ensure that all project costs are covered, especially those costs that may not be generated using the parametric approach, such as ROW.

Identification of those project elements that contribute to the major fraction of a project's total cost is critical to this tool. The tool relies on cost predictions for items of work based on statistical predictions. Hence, identification and inclusion of cost items that contribute to 80 percent of the cost for each estimate are crucial for its success. The standardization of such elements in relation to project types is to a large extent the basis of implementing this tool. The tool can handle (model) additional items that may not be standard, as long as historical information is available.

What is it?

Scoping project definition is usually very ambiguous. However, it is often the case that the project is similar to previous projects that are either under design or under construction or that have been recently completed. The cost history from these projects can serve as a basis for developing a uniform, repeatable estimating tool. Parametric estimating provides reasonable estimate accuracy in a timely manner. Statistical relationships and/or non-statistical ratios between historical data and other parameters form the basis for parametric estimating.

Why use it?

The purpose of parametric estimating is to develop early project estimates when information is restricted to only approximate dimensions of facility features. An item-level quantity approach based on predicting item quantities from preliminary quantity information is another potential parametric approach. While parametric estimating can be used in the Planning Phase, this tool can provide a more detailed cost breakdown as compared to the traditional cost per lane mile estimation with an aim to improve accuracy and alleviate cost overruns. The tool is developed to provide simplified, reliable, early estimates that are based on current prevailing costs. The potential to separate quantity uncertainty from price uncertainty provides a better platform to track and analyze the effects of changes during project development.

What does it do?

A major fraction of a transportation project's costs is often attributed to one element, and many projects may have a common critical cost element. One parametric approach takes advantage of this fact and seeks to quantify the critical element in a unit volume. All pavements are three-dimensional (length, width, and depth), and these parameters are typically known fairly early in project development. The concept is to develop factors based on roadway sections for different dimensions and associate them with a historical cost database considering all major items to construct the roadway. The individual factors are extracted as applicable to the project and then cumulated for all elements in the estimate to derive a single factor that is multiplied with a cost multiplier (ratio) closely representing a past project of similar type and scope. This tool, however, estimates cost for roadway construction only and does not include other project categories, such as Right-of-Way or bridges.

When use it?

This tool is used early in project estimating, through Scoping and the early Design phases of project development. It can also be used to prepare Planning phase estimates. Parametric estimating may be best used on less complex projects that tend to be more standard in terms of project components, such as preservation projects (overlays) or bridge rehabilitation projects.

How to use it?

Minnesota Department of Transportation has a parametric cost estimating tool available based on the physical dimensions of a project's roadway that is, length, width, and depth (LWD) methodology. A formulated Excel worksheet is completed to document and calculate the cumulative project paved roadway segment (mainline, shoulders, ramps, etc., by square foot and depth) volumes expressed as an LWD factor with separate entries for different pavement depths and location descriptions.

A project LWD factor is multiplied by an appropriate selected LWD Cost Multiplier that has similar characteristics from a past project to generate a cost for only the roadway construction. This is selected from an LWD database with a request from cost estimate support personnel. Common roadway items that are covered in a Cost Multiplier include mobilization, removals/salvage, grading, aggregates, paving, drainage, concrete items, traffic control, turf/ erosion, and some minor miscellaneous items.

Other items not essential to constructing the roadway but that may be required for a project, such as bridges, signals, noise and retaining walls, overhead sign bridges, traffic management systems, or other un-specified needed elements, are not included in the LWD Cost Multiplier. These items are easily estimated separately and are also documented on the estimate worksheet.

Other external project costs that are not a direct construction cost, such as Right-of-Way, Railroad Agreements, or major utility relocations, are identified, estimated, and also documented on the same estimate form. All known project information is also documented on a separate Project Planning or Scoping Report for every project for approval signatures when the estimate is complete. The combination of LWD factors, cost multipliers, and other needed project features, such as bridges and signals, are added to determine total project cost.

A centralized District database is maintained to document, track, and retrieve historic LWD Cost Multipliers, percentages, cost per mile, and lane miles from past and current projects within a five-year time frame. These cost multipliers and other data are extracted from successful bids of let projects that have useful pavement information for the database and are supplied upon request on a project-by-project basis. The tool inputs are through formulated Excel spreadsheets and MS Word templates, while databases use a simple Access input-output template.

RESOURCE

See Ed Katzmark's Excel Spreadsheet File:

Ed Katzmark v3-LWD_COST_ ESTIMATE_TEMPLATE.

Examples

Screen captures from Excel spreadsheet estimating software are provided in Figures D2.7-1 through D2.7-3.

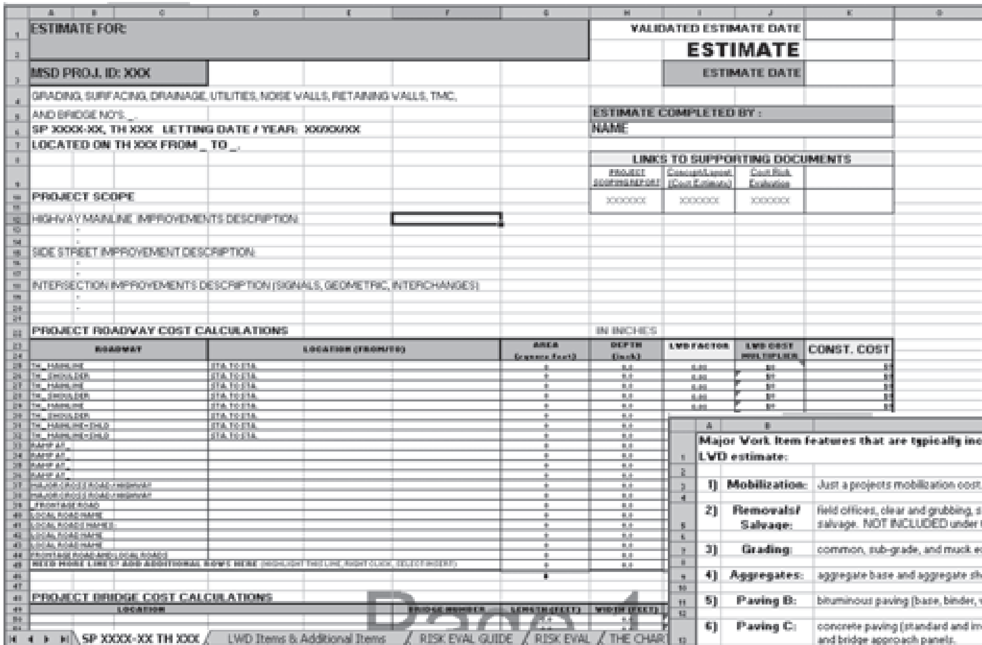

Figure D2.7-1. LWD Project Estimating Tool – Spreadsheet Part A

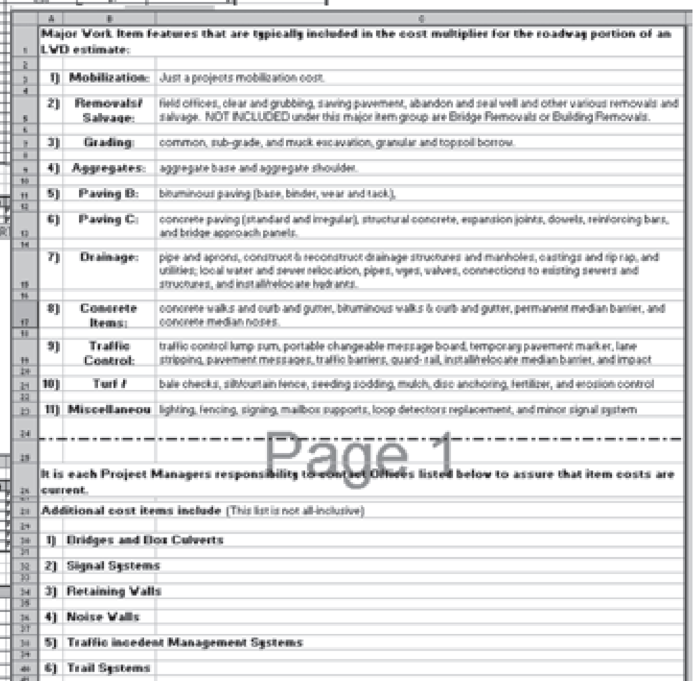

Figure D2.7-3. LWD Project Estimating Tool - Content

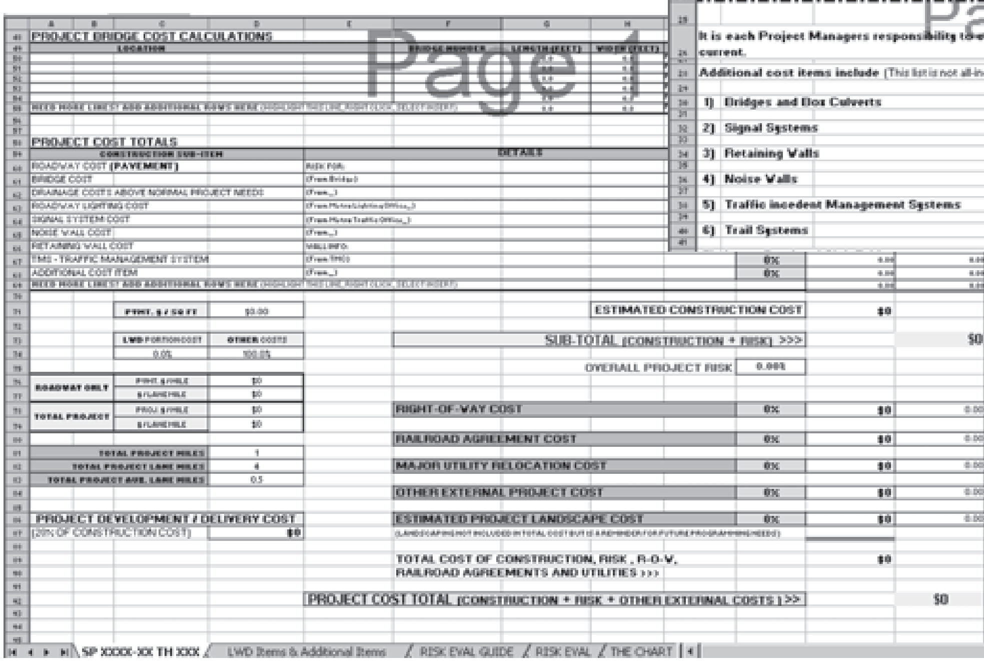

Figure D2.7-2. LWD Project Estimating Tool – Spreadsheet Part B

D2.8 Spreadsheet Template

Spreadsheet templates provide a rapid and easy means for organizing estimate data and formulating repetitive calculations. Templates are excellent and simple tools for insuring that all components of project cost have been considered and accounted for in the estimate. Because spreadsheets are usually straightforward documents, they are good tools for communicating estimate completeness and the allocation of cost to different elements and/or items.

What is it?

Spreadsheets templates use standard items an Estimator should consider when calculating the cost of a project. When constructed in an electronic spreadsheet program, they provide the computing power of other software combined with text editing and formatting capabilities at high speed and low cost. Electronic spreadsheet templates can store both the formulas and the computed values returned by the formulas.

Why is it used?

By using a spreadsheet template to guide estimate development, Mn/DOT can improve estimate accuracy by insuring that critical cost categories, elements, and items are included in the total project cost and that the Estimator considers significant impacting factors when preparing estimates. Furthermore, a well-designed spreadsheet will clearly communicate the total estimated cost of the project, as well as the items included in the estimate and the expected costs of the various categories and elements. This allows for easy comparison to historical values for making rapid "sanity checks" of estimated costs.

What does it do?

Spreadsheet templates do two things: 1) provide estimate development guidelines that facilitate creation of a complete estimate; and 2) support the evaluation of cost and schedule credibility. They serve to document the estimate and provide an easy-to-read format, which facilitates communication about the project costs in a uniform and structured manner. Monte Carlo simulation can also be added to spreadsheets for doing probabilistic estimating or risk analysis.

When use it?

Different spreadsheet templates can be used in the course of project development as scope is quantified and additional information becomes available. However, templates should be designed so that major categories can easily be expanded as project detail is better defined. Spreadsheet templates are also excellent tools for supporting and documenting quantity takeoff. Spreadsheet templates can support estimates in the Scoping and Design phases, as well as in Planning.

How to use it?

The following steps should be followed by the Estimator for preparing the Total Project Cost Estimate:

- Identify the categories, elements, and/or items covered in the estimate.
- Select predefined or input categories, elements, and/or items.
- Input quantity information for each element and/or item.
- Refer to historical data to determine the unit cost for elements and items that comprise the project. A historical cost database spreadsheet can be directly linked to this cell, which will automatically capture unit price values.
- Enter historical unit price data for the elements and/or items.
- Check the values of the data entered.
- Generate the estimated cost for categories, elements, and/or items contained on the spreadsheet.
- Prepare a summary report with the help of the spreadsheet template.
- Include the report and estimation support documents in the Project Estimate File.

Spreadsheets are used mostly to support historical bid based estimating. They can be used for all types of projects. The can be used to store backup information that supports estimated quantities and/or unit prices.

TIPS

When using spreadsheets for estimating the following tips should be considered:

- Computer spreadsheets, such as Excel, require less initial investment than commercial estimating software and tend to be very flexible. The list of included items on a spreadsheet is often not exhaustive, and space should be provided in each section of the spreadsheet to allow the entry of additional cost items that may be unique to a particular project.
- Spend time setting up calculations.
- Ensure that spreadsheet supports requirements.
- Use tabs to perform different functions.
- Verify that calculations are made correctly and cost summaries reflect all costs.

Examples

Examples for Spreadsheet Templates.

	A	B	C	D	E	F	G	H	I
1			SP	Cost Summary					
2									
3		TH	Project Length:	Project Description:		Estimate's Completion Date:			Letting Date:
4									
5									
6	DIVISION	GROUP	CATEGORY	DETAILS	PREVIOUSLY INCURRED EXPENSES	2003 ESTIMATED REMAINING EXPENSES	2003 CONTINGENCY	TOTAL (2003 year dollar)	CONSTRUCTION YEAR DOLLAR (WITH REMAINING EXPENSES & CONTINGECY INFLATED)
7					EXPENSES				
8	Engineering							$0	$0
9		Pre-Letting	(12% of Construction Total)					$0	$0
10			Environmental Studies					$0	$0
11				Internal				$0	$0
12				External				$0	$0
13			Predesign/project development					$0	$0
14				Internal				$0	$0
15				External				$0	$0
16			Detailed Design					$0	$0
17				Internal				$0	$0
18				External				$0	$0
19			Traffic Management					$0	$0
20				Internal				$0	$0
21				External				$0	$0
22			Comm/Public Involvement					$0	$0
23				Internal				$0	$0
24				External				$0	$0
25			R/W Engineering					$0	$0
26				Internal				$0	$0
27				External				$0	$0
28		Construction	(8% of Construction Total)					$0	$0
29			Administration					$0	$0
30				Internal				$0	$0
31				External				$0	$0
32			Traffic Management					$0	$0
33				Internal				$0	$0
34				External				$0	$0
35					$0	$0			
36	ENGINEERING TOTAL (20 % of Construction Total)					$0	$0	$0	$0
37	Right of Way							$0	$0
38		Standard Real Estate Purchase						$0	$0
39			Total Takes					$0	$0
40				(Insert Details)				$0	$0
41			Partial Takes					$0	$0
42		Relocation Costs						$0	$0
43			Residential					$0	$0
44				(Insert Details)				$0	$0
45					$0	$0			
46	ROW TOTAL					$0	$0	$0	$0
47	Constructio							$0	$0

Figure D2.8-1. Total Project Cost Estimate – Summary Format

	A	B	C	D	E	F	G	H	I
46	ROW TOTAL					$0	$0	$0	$0
47	Constructio n							$0	$0
48		Preconstruction Cost						$0	$0
49			Agreements					$0	$0
50			Utilities	(Insert Details)				$0	$0
51			Municipal/Local Issues	(Insert Details)				$0	$0
52			Railroad	(Insert Details)				$0	$0
53			Environmental Mitigation					$0	$0
54			Environmental Clean-Up					$0	$0
55			Pre-Letting Traffic Mgmt	Enforcement and Accident Mgmt				$0	$0
56					$0	$0	$0	$0	$0
57		Construction Cost						$0	$0
58			Project Construction Costs					$0	$0
59			State Share of Letting Costs	(Insert Details)				$0	$0
60			Detours and Haul Roads	(Insert Details)				$0	$0
61			Construction Traffic Mgmt	Extraordinary Reinforcement				$0	$0
62				Accident Management				$0	$0
63			Const Comm/Public Involvement					$0	$0
64			Turn-Backs: Before					$0	$0
65			Landscaping					$0	$0
66			Environmental Mitigation					$0	$0
67			Environmental Clean-Up					$0	$0
68				(Insert Details)				$0	$0
69					$0	$0	$0	$0	$0
70		Post Letting Cost						$0	$0
71			SA/Overruns					$0	$0
72				(Insert Details)				$0	$0
73			Change Orders					$0	$0
74				(Insert Details)				$0	$0
75			Incentives	(Insert Details)				$0	$0
76			Construction Traffic Mgmt	Extraordinary Reinforcement				$0	$0
77				Accident Management				$0	$0
78			Detours and Haul Roads	(Insert Details)				$0	$0
79					$0	$0	$0	$0	$0
80		Post Construction Cost						$0	$0
81								$0	$0
82			Turn-Backs: After	(Insert Details)				$0	$0
83			Landscaping					$0	$0
84				(Insert Details)				$0	$0
85					$0	$0	$0	$0	$0
86					$0	$0			
87	CONSTRUCTION TOTAL					$0	$0	$0	$0
88									
89	Total Base Cost					$0			
90	Contingency						$0		
91	Total Project Cost Estimate							$0	$0
92									
93				inflation used	5%				
94	Number of years between 2003 and Construction year								
95									

Figure D2.8-2. Total Project Cost Estimate – Summary Format

District Example

S.P. 2107-09 T.H. 55

ITEM	COST/UNIT	#UNIT		ITEM TOTALS	TOTALS	
	update prices					
- MOBILIZATION				$300,000.00		
- FIELD LABORATORY	$14,000.00	1	each	$14,000.00		
- MAINLINE BIT 3,C (5")	$42.00	58200	ton	$2,444,400.00		
- RECLAIM 8"	$1.00	212000	sy	$212,000.00		
- MAINLINE TACK	$1.00	14800	gal	$14,800.00		
- 3" MILL	$1.25	212000	sy	$265,000.00		
- REMOVE CULVERT	$10.00	2030	lin ft	$20,300.00		
- LOW VOLUME ENT (bit & tack) (50 ton)	$2,000.00	34	each	$68,000.00		
- PRIVATE ENT (bit & tack) (20 ton)	$800.00	35	each	$28,000.00		
- PRIVATE ENT (CLASS 5) (11 CY)	$230.00	35	each	$8,050.00		
- FIELD ENT (CLASS 5) (20 CY)	$420.00	27	each	$11,340.00		
- PIPE REPLACEMENT CL 24"	$50.00	1428	lin ft	$71,400.00		
- PIPE REPLACEMENT CL 30"	$70.00	204	lin ft	$14,280.00		
- PIPE REPLACEMENT CL 36"	$80.00	568	lin ft	$45,440.00		
- PIPE REPLACEMENT CL 48"	$100.00	86	lin ft	$8,600.00		
- PIPE REPLACEMENT CL 60"	$200.00	120	lin ft	$24,000.00		
- PIPE REPLACEMENT CL 72"	$300.00	140	lin ft	$42,000.00		
- PIPE REPLACEMENT CL 24" APRONS	$600.00	38	each	$22,800.00		
- PIPE REPLACEMENT CL 30" APRONS	$700.00	6	each	$4,200.00		
- PIPE REPLACEMENT CL 36" APRONS	$850.00	8	each	$6,800.00		
- PIPE REPLACEMENT CL 48" APRONS	$1,200.00	2	each	$2,400.00		
- PIPE REPLACEMENT CL 60" APRONS	$1,500.00	1	each	$1,500.00		
- PIPE REPLACEMENT CL 72" APRONS	$2,500.00	1	each	$2,500.00		
- GRANULAR BEDDING (for culverts)	$20.00	1510	cy	$30,200.00		
- SUBGRADE EXCAVATION (for culverts)	$4.50	18700	each	$84,150.00		
- SELECT GRANULAR (for culverts)	$9.00	17000	each	$153,000.00		
- PIPE REPLACEMENT ENTRANCES	$30.00	252	lin ft	$7,560.00		
- PIPE REPLACEMENT ENTRANCES APRS	$200.00	10	each	$2,000.00		
- DITCH CLEANING	2	2570	lin ft	$5,140.00		
- 4" SOLID LINE WHITE-PAINT	$0.07	136120	lin ft	$9,528.40		
- 4" SOLID LINE YELLOW-PAINT	0.07	64400	lin ft	$4,508.00		
- 4" BROKEN LINE YELLOW-PAINT	0.07	10800	lin ft	$756.00		
- TRAFFIC CONTROL				$100,000.00		
- EROSION CONTROL	13000	13	mile	$167,700.00		
- TURF ESTABLISHMENT	$6,000.00	12.9	mile	$77,400.00		
- MINOR ITEMS				$250,000.00		
CONSTRUCTION SUBTOTAL W/O OPTIONS	SUBTOTAL				$4,523,752.40	
OPTIONS						
- REPLACE BRIDGE AT RP 47.953 (incl Rem)				$400,000.00		
- PIPE CONNECT WITH RR Mn/DOT COST	$100,000.00	1	each	$100,000.00		Dependant on RR interest in joint project They are considering.
- PIPE CONNECT WITH RR Mn/DOT COST	$100,000.00	1	each	$100,000.00		Dependant on RR interest in joint project They are considering.
- PIPE CONNECT WITH RR Mn/DOT COST	$75,000.00	1	each	$75,000.00		Dependant on RR interest in joint project They are considering.
CONSTRUCTION SUBTOTAL WITH OPTIONS	TOTAL				$5,198,752.40	
RISK FACTOR 10%					$519,875.24	
TOTAL CONSTRUCTION COSTS W/OPTIONS	TOTAL				$5,718,627.64	
OTHER PRELETTING COSTS						
-RW					$10,000.00	
POST LETTING COSTS						
-INCENTIVES					$210,000.00	
-SA/OVERRUNS					$370,000.00	
TOTAL PROJECT COSTS W/OPTIONS	TOTAL				$5,938,627.64	

This estimate uses the most current Average bid prices available which are 2006. 2007 Bituminous prices were checked and adjusted accordingly.
This is a 2007 bid year estimate.
Incentives 80% for ride and 1% for density

Figure D2.8-3. Typical Detailed Spreadsheet Format

D2.9 Trns•port® PES

(see also C3.5 and P1.5)

Trns•port® is the AASHTO sponsored transportation agency management software. It is a robust transportation program management system. It utilizes the most current information systems technology and is based on the experience and needs of AASHTO's member agencies.

Trns•port® capabilities encompass the full functionality of a construction contract management system. It is an integrated system consisting of eleven modular components, which can be used individually or in combination, as appropriate. Each module addresses the needs of the highway agency at a particular milestone in the construction contracting life cycle, representing three functional areas: preconstruction, construction, and decision support.

Mn/DOT uses the AASHTO Trns•port® primarily in the Letting Phase. The Proposal and Estimates System (PES) is one modular that has potential for use as an estimating support tool during the Design Phase.

What is it?

The Trns•port® PES can address the needs of Mn/DOT during the Design Phase of project development. It is an interactive system to manage project and estimate-related information during the Design Phase. PES also supports preparation of the Engineers' Estimate for construction projects during the Letting Phase. PES provides design, project construction administration, and estimation sections with tools to assist in project definition, funding specification, project cost estimation, contract proposal creation, and bid letting packaging.

Why is it?

The Trns•port® PES module is designed for flexibility in project definition and its associated funding requirements, such as creating proposals, using multiple funding units, differentiating between construction engineering and contingency percents, identifying special provisions and supplemental specifications, processing addendums, and providing alternate specifications at both the category and line item levels, to track and manage project scope and cost information. The Trns•port® PES module is easy to use and operate. The data can be exported or imported to other Trns•port® systems or other equivalent systems in a variety of formats. The data can be entered or edited in a simple spreadsheet format using Stand Alone PES Worksheet (SAPW). SAPW allows the remote offices to enter, build, and edit the project data with fine tuning and make it available in PES. Further, changes in the cost estimate can be easily incorporated as modifications or new information to existing data is added.

What does it do?

The Trns•port® PES module is an interactive, online system that enables management of project information during the Design Phase of a highway construction project development. PES permits the flexible definition of a project and its associated

RESOURCE

Central Office Estimating Group

Additional information assistance can be found using the following website:

dot.state.ny.us/trns-port/about.html

TIP

The Estimator can use different reports generated by the PES module:

- detailed cost estimate and funding summary,
- proposal schedule,
- special provisions listing, and
- Proposal schedule with estimated prices.

The Estimator must check all input and output to ensure that the estimated costs for major items are within expected agency tolerances for the project type being estimated. This check can follow the Puerto principle in that 80 percent of the estimated cost of construction is covered in 20 percent of the items. Comparing the overall estimate with estimates from similar type projects recently bid or completed is another method of checking an estimate.

funding requirements to track and manage project cost information and set up the estimate for the Design Phase. The data can be conveniently entered in the tabbed folder windows. It allows for data to be entered at the project, category, and item level, and grouping of multiple projects is also possible to track all related costs and funding sources. It contains tabs from general data to specific data, such as categories of cost, funding, and worksheets. The worksheets form the major portion of the PES as they are used to specify all work items. Quantity, price, and other information are also entered at this point. It has import capabilities for receiving item and quantity data from design systems and can exchange data with the CES and other estimating modules of Trns•port® (see P1.5). Trns•port® PES module also prepares a Detail Estimate Report, which can be of prime, project, or proposal level.

When use it?

The PES module of Trns•port® is most frequently used to support the project Letting Phase. However, it is also an excellent tool for use in the development of an estimate during the Design Phase, especially as estimate updates move toward item-level estimating during the late phases of Design.

How to use it?

The use of PES would require some training and development as its current application is limited in setting up the Engineers' Estimate for Letting. The schedule of items and their quantities are loaded into PES based on the final PS&E submittal from the Districts. Within the District, it could be used to build a Design estimate. Quantities can be entered for each item number, and unit costs can be estimated. PES makes the extensions and summarizes the cost estimates.

Example

Example to be furnished or developed by Mn/DOT.

P1.3 Cost Based

At the Letting Phase of project development, there exists complete project definition to generate detailed estimates from final plans and specifications. These estimates are based on a schedule of line items and calculated quantities for each line item. Cost based estimating is the primary tool used to develop costs for the Engineers' Estimate. Cost based estimating is similar to what contractors use to prepare estimates to support their bids. Mn/DOT performs detailed bottom-up estimates for items, using historic databases to track costs based on crews, equipment, and production. Mn/DOT Central Office has historic data on the different costs that are estimated using this approach. Cost based estimating is used in conjunction with the Trns•port Cost Estimating System or CES (see P1.5).

What is it?

Cost Based estimating is a tool to compute the unit cost for items of work based on estimating the cost of each component to complete the work and then adding a reasonable amount for a contractor's overhead and profit. A schedule of items and their quantities is provided in the PS&E submittal provided by the District Design Office. These quantities can then be used to estimate costs for such construction components as labor, materials, and equipment in order to arrive at a realistic unit cost for an item.

Why use it?

The unique character of projects, geographical influences, and market factors, as well as the volatility of material prices, often makes historical pricing an unreliable method of estimating project costs. Cost based estimating may provide more accurate and defendable costs to support the decision for contract award/rejection and any future price negotiations with the contractor. At the Letting Phase, work items are well defined so that the construction operations involved with a work item can be visualized to support the development of cost based estimates.

What does it do?

Cost based estimates contain six basic elements: time, equipment, labor, material, overhead, and profit. Generally, a work statement and set of drawings or specifications are used to "take off" material quantities required for each discrete task performed in accomplishing a given construction operation. From these quantities, direct labor, materials, and equipment are derived. Contractor overhead and profit are then added. The total cost divided by the quantity gives the unit price for the work item. This is performed automatically in the Cost Estimating System (see P1.5). This is necessary for Mn/DOT to compare the Engineers' Estimate with the unit price bid by the contractor for the same item.

When use it?

This tool is used most often in the Letting Phase by the Central Office. It can be used in the Design Phase for elements or items where there is no historic bid data available.

How to use it?

Using cost based estimating begins with identifying the source of cost data. Mn/DOT has templates or catalogues loaded in the CES software. Tables are available to estimate production rates and equipment requirements for items.

TIP

The Estimator needs to locate sources of information related to production rates and crews for line items estimated using this approach. This may require contacting local contractors or using a database such as RS Means Heavy Construction Cost Data (see product details below).

The Estimator will have to call suppliers of materials to obtain unit costs for materials and similar resources for determining equipment production and rental rates. The Estimator should have construction experience so a line item can be visualized in terms of the operations needed to construct the work.

P1.4 Historical Bid Based

Historical bid based estimating is used by Mn/DOT for certain items that are not critical items in terms of cost. This approach relies heavily on good historical bid data for estimating item cost. The historical data normally is based on bids from recent projects. The Estimator adjusts the historical data to fit the current project characteristics, location, and construction date.

What is it?

The use of historical bid data from recently awarded contracts is a common estimating approach for some items. Under this approach, bid data are summarized and adjusted for project conditions (e.g., project location, size, quantities, etc.) and general market conditions. This approach requires the least amount of time and personnel to develop the estimate and produces a good estimate, as long as noncompetitive bid prices are excluded from the database and appropriately adjusted data is used to build the estimate.

Why use it?

Historical bid-based estimating is typically the most efficient method for developing an estimate for items when adequate historical pricing data is available. Implementing a bid history based estimating process enables Mn/DOT to estimate the cost of proposed work using a minimum of resources. Similar projects with similar line items, quantities, and locations can generally be estimated quickly utilizing historical bid data from previous projects and engineering judgment.

A bid history is essential for analysis of contract bids. Maintaining a strong bid history can discourage undesirable bidding practices. A bid history is also valuable for use in evaluating contractor proposed changes, such as value engineering/analysis proposals.

What does it do?

This method uses data from recently bid contracts as a basis for the unit prices on the project being estimated. Data from previous projects is typically stored in a database for three to five years to provide the historical data to the Estimator (see tool H1.1 on page 373). The more data that are available and organized by project type, size, and location, the better resource the Estimator has to produce an estimate that reflects the known scope and site conditions of the new project. Unit prices are adjusted for the specific project conditions in comparison to the previous projects. Adjustments are generally made based on the project location, project size, project risks, quantities, general market conditions, and other factors. The Estimator has to rely on engineering judgment and experience to make these adjustments.

When to use it?

This technique can be used as early as the Scoping Phase but is validated to a greater extent in the Letting Phase when preparing the Engineers' Estimate.

How to use it?

The process of historical bid based estimation starts with the identification of the elements/ items of historical bid cost data that can be calculated using this approach. The database is scanned to find a project with similar data as required for the current project. The bid data, unit price data and other relevant information is then studied, analyzed and related to the unit prices of the current project by considering the characteristics of the project. Feasible unit rates are selected and applied to the current project to calculate the cost estimate. The tool spreadsheet template (D2.8 on page 397) is used to calculate the cost estimate and to apply the cost inflation factors. The local, political, regional and material factor are considered and applied to the estimate of the project. At the end a final check is given to the estimate and extra costs are added to the estimated values. Some of the advantages of using this method are, use of minimum resources, easy and efficient method and the estimates can be prepared quickly. The disadvantages include the maintenance and update of a database to support the estimates and the details for new and unique items are not available I the database.

TIPS

There are several historical databases available that provide current values for estimating costs of the various units of work for a project. The databases are compiled from records of actual project costs, as well as ongoing price quotations from suppliers, and are published annually in the form of books, CDs, and computer-based extranets. There is, however, a danger of applying any historical database pricing without first adjusting the data for the particular aspects of the project under consideration. In construction every project is unique, with a distinct set of local factors (such as size of project, desirability, level of competition, flexibility of specifications, work site, and hour restrictions) that come into play in bidding. When an estimating system that is attached to a price database is used, the Estimator should still review each line item price to determine if it is applicable to the project being estimated. Blindly applying database prices can lead to inaccurate estimates.

Location factors should also be applied, but only after first considering the project size and particular nature, to determine where the bidders will come from. If it is a large project in a small town, the location factor for that town will likely not apply, as the bidders will be coming from elsewhere. The bids may as a result be much higher than the factor would indicate as the wages will be based on another location and the bidders may have to pay accommodation and travel costs for some of their workers.

P1.5 Trns•port® CES

Trns•port® is the AASHTO sponsored transportation agency management software. It is a robust transportation program management system. It utilizes the most current information systems technology and is based on the experience and needs of AASHTO's member agencies.

Trns•port® capabilities encompass the full functionality of a construction contract management system. It is an integrated system consisting of eleven modular components, which can be used individually or in combination, as appropriate. Each module addresses the needs of the highway agency at a particular milestone in the construction contracting life cycle, representing three functional areas: preconstruction, construction, and decision support.

Mn/DOT uses the AASHTO Trns•port® primarily in the Letting Phase. The PES and the CES are used in the Letting Phase with CES being the primary estimating support software. CES is supported by the AASHTO BAMS/DSS database.

What is it?

The CES module is a network-dependent module that is fully integrated with the other database-oriented Trns•port modules. It provides a highly productive environment to prepare bid based and cost based estimates. CES provides a full range of cost estimating capabilities to support the preparation of the Engineers' Estimate required for award approval.

Why use it?

CES is an integral part of the Trns•port® system, using historical cost information from DSS and providing the cost estimate for the Letting Phase. The CES estimating module can facilitate the use of several estimating tools, such as historical bid based and cost based approaches (see P1.3 and P1.4). This software allows the Estimator to build an Engineers' Estimate once the final design package is submitted to the Letting Phase. When linked to a historical cost database, selecting or building unit cost information can be more efficient because the user works within the software to find the appropriate historic data that best fits the element being estimated. The CES module can be used to eventually develop the Engineers' Estimate and support preparation of bid documents. This computer-based tool allows customization to improve accuracy and also generates an array of reports to help document and track project costs.

What does it do?

The CES uses bid data and other data to create an estimate, and it can be sent to PES. It is also equipped with tools that, coupled with its integration with the other Trns•port® components, include the uploading of historical labor, equipment, material, and crew data for more detailed cost based estimates.

The reference data used to generate estimates in CES are stored and maintained in the computer, including wages, equipment costs, material costs, production rates, and historical bid data. The Estimator will automatically apply weighted average price to items, providing statistically valid estimates. If the historical data set is sufficiently large, regression coefficients can be calculated and applied.

When use it?

CES is primarily used for preparing the Engineers' Estimate in the Letting Phase. It can be used in other phases, but development and training will be required for other applications.

How to use it?

The Mn/DOT Central Office has extensive knowledge on how to use CES for preparing an Engineers' Estimate. The primary estimate approach is cost based with some bid based estimating for minor cost item numbers.

TIP

The information generated by the CES module for cost based estimating includes:

- detailed job estimate snapshots,
- labor,
- equipment,
- materials,
- cost sheets,
- crews, and
- Programs.

The CES module has the following features:

- Master data for producing estimates is stored and maintained in catalog forms.
- Reference data is easily shared among several project participants using the same platform.
- Historical pricing information can be applied automatically because CES is supported by the BAMS/DSS database.
- Reference prices may be used or ad hoc data entry is permitted when historical data is not available.

Cost based estimation techniques are flexible yet structured and simple.

In-built estimate verification processes improve accuracy.

The Estimator must ensure that all project costs are covered.

The Estimator must check all input and output to ensure that the estimated costs for major items are within expected agency tolerances for the project type being estimated. This check can follow the Pareto principle in that 80 percent of the estimated cost of construction is covered in 20 percent of the items. Comparing the overall estimate with estimates from similar type projects recently bid or completed is another method of checking an estimate. Finally, using the statistical techniques in the CES may help identify item estimates that are outside normal cost ranges for that item.

C1.7 Year-of-Construction Costs

Project cost estimates are created at a specific point in time. The estimated cost is typically based on prices as of the date the estimate is created even though construction is to occur at some future date. Economic comparisons between alternatives are most commonly performed in current dollars during Planning, Scoping, and Design. However, estimates should be communicated to project stakeholders in year-of-construction costs because that is what the project will actually cost when it is complete, so that is the number that many stakeholders will use to measure success. Therefore, for the estimate to reflect actual construction cost there must be an adjustment for inflation between the two points in time.

What is it?

Year-of-construction cost is the estimated cost adjusted for the difference in time between when the estimate is created and the date when the project is to be constructed. Year-of-construction cost estimates take the "time value of money" into account. Project costs should be adjusted for inflation with respect to time due to factors such as labor rates, material cost, and interest rates. Estimated cost is most commonly inflated to the expected midpoint of construction date.

Why use it?

Using year-of-construction cost will more accurately reflect the future project cost. Funds available for projects often do not increase with inflation, but actual project costs do. Inflation continually reduces the Mn/DOT's capacity to preserve, maintain, and modernize the transportation system. While it is common to communicate a net present value for estimates when comparing projects or design alternatives, it is not a good idea to communicate the estimate to external parties in anything but year-of-construction costs.

What does it do?

Mn/DOT can be prepared in advance to evaluate the construction cost for the project at its programmed date. This tool improves estimate accuracy by identifying the effect of inflation on project cost. Implications for decision making regarding transportation infrastructure based on budget will be clear to the public, and concerns about strategic misrepresentation (or lying) will be dismissed. It defines an estimated cost made in current dollars in terms of cost at the time of construction.

When is it used?

Year-of-construction cost recognizes the cost escalation effect of inflation across the time period of development and construction. Estimates should be communicated in year-of-construction costs from the earliest points in the project development process. This is very important for projects having long development and/or construction periods.

TIP

Use discipline in communicating year-of-construction costs at each phase of the project development. Federally funded local projects may either be adjusted for inflation, as described above, or capped at a fixed level of federal funds.

Project costs estimates provided in the STIP should be calculated in year-of-construction costs.

How to use it?

The year-of-construction cost will vary depending on the point in time the estimate is created and the year of construction and economic variations caused by external factors, such as inflation. To calculate the year-of-construction cost, adjustments should be made from current dollar estimates by applying a cumulative inflation factor for the year of construction. This inflation adjustment should be made once the base estimate and contingency is determined. Inflation factors are developed by the Office of Investment Management and approved by the Transportation Program Investment Committee.

Examples

Table C1.7-1, which is a Mn/DOT table, illustrates a consistent standard to be applied in adjusting project estimates. Shorter-term inflation rates are higher because they can be more volatile. Longer-term rates are lower because the economic cycles are expected to dampen the rates over time. The table has limited life and must be updated on a periodic basis.

Table C1.7-1. Inflation Adjustments – Inflation Factors for Current WP/SP shifted to be Consistent with 02-04 STIP Guidance

	STATE FISCAL YEAR									
	01	02	03	04	05	06	07	08	09	10
Current WP/SP	--	--	.06	.06	.0325	.0325	.0325	.03	.03	.03
FY 02-04 STIP		--	.06	.06						
CUMULATIVE	1.06	1.1236	1.160	1.1978	1.237	1.274	1.312	1.351		
		1.12	1.16	1.20	1.24	1.27	1.31	1.35		

WP/SP- Work Plan / Strategic Plan

RESOURCE

Several resources that are helpful for inflation calculations are:

- Office of Investment Management
- Construction Cost Index: http://tchw2ks009/estimating/reports/CostIndexQ12007.pdf
- Fuel and Steel Escalation Data: http://www.dot.state.mn.us/bidlet/escalation.html

12.1 Red Flag Items

A red flag item list is created at the earliest stages of project development and maintained as a checklist during project development. It is perhaps the simplest form of risk identification and risk management. The list helps Estimators to better understand the required contingency and helps managers to more effectively control scope growth throughout the project development process. Not all projects will require a comprehensive and quantitative risk management process. A red flag item list can be used in a streamlined qualitative risk management process.

What is it?

A red flag item list is a technique used to identify risks and focus attention on critical items with respect to critical cost and schedule impacts to the estimate. Issues and items that can potentially impact project cost or schedule in a significant way are identified in a list—or "red flagged"—and the list is kept current as the project progresses through development.

Why use it?

By listing items that can potentially impact a project's cost or schedule, and by keeping the list current, the project team has a better perspective for setting proper contingencies and controlling cost escalation. Occasionally, items that are considered a risk are mentioned in Planning but soon forgotten. The red flag item list facilitates communication between Estimators and Designers concerning these impacting items. By maintaining a running list, these items will not disappear from consideration and then later cause problems.

What does it do?

At the earliest stages of project development, an agency develops a list of impacting items, based primarily on engineering judgment or historical records of problems. The red flagging of these items may not involve any formal qualitative or quantitative risk analysis of the factors, but it keeps the team mindful of their existence. The list also helps the team to remove contingency from the project cost estimate as the design progresses and risk issues are resolved.

When use it?

The composition of a red flag item list is done in the earliest stages of project development. The list should then be updated at each major milestone or as new items are identified. The list will be most useful if it is maintained and updated throughout the project development process.

How to use it?

Red flag item lists should be developed by different members of the team in collaboration. The list should be shared by Designers and Estimators.

Example

The following figure provides an example from the Ohio DOT:

> **301.6 Red Flags**
>
> **Red flags**, *including environmental and engineering issues, are locations of concern within the study area. Red flags do not necessarily identify locations that must be avoided, but rather, identify locations that will entail additional study, coordination, design, right-of-way, or construction cost. Locations that must be avoided are referred to as "fatal flaws." The Project Manager should ensure consultation with the appropriate specialists to determine the level of concern for each red flag item. Both environmental and design red flags are identified on the red flag summary.*

Figure I2.1-1. Ohio DOT Red Flag Example

RESOURCES

Caltrans Office of Statewide Project Management Improvement (2007). Project Risk Management Handbook: Threats and Opportunities, 2nd ed., May 2007, Caltrans, Sacramento, CA. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

Curran, Michael W. (1998). Professional Practice Guide 2: Risk Association for the Advancement of Cost Engineering International.

FHWA (2004). Major Project Program Cost Estimating Guidance.

Grey, S. (1995). Practical Risk Assessment for Project Managers. John Wiley and Sons, Chichester, England.

Molenaar, K. R. (2005). "Programmatic Cost Risk Analysis for Highway Mega-Projects," *Journal of Construction Engineering and Management*, Vol. 131, No. 3.

NCHRP (2005). NCHRP Project 20-7/172 Final Report, Recommended AASHTO Design-Build Procurement Guide, Washington, D.C.

TIP

The list of red flag items should be developed in an interdisciplinary team environment. This activity works well during the Scoping Process. Consider brainstorming sessions with representatives from multiple discipline areas for creation of a list of red flag items. In addition to Scoping Documents or lists of standard items, individuals should use their own knowledge of the project and consult with others who have significant knowledge of the project or its environment.

12.3 Risk Checklists

Risk checklists are a tool for risk identification that can be used at the earliest stages of risk identification to learn from past projects and past team member experience. The list helps Estimators to better understand the required contingency and helps Managers to more effectively control scope growth throughout the project development process. The use of a risk checklist is the final step of risk identification to ensure that common project risks are not overlooked.

What is it?

Risk checklists are a historic list of risks identified or realized on past projects. Risk checklists are meant to be shared between Estimators and discipline groups on all projects.

Why use it?

The benefit of maintaining risk checklists is to capture corporate knowledge within a state highway agency and ensure that common risks are not overlooked in the estimating or risk management process. Risk checklists are simple to maintain if the agency has a central estimating or risk management function. Risk checklists can also be maintained by individual Estimators or Project Managers.

What does it do?

Risk checklists serve as a final step in the risk identification process to ensure that common risks are not overlooked.

When to use it?

Risk checklists should be used only after the team has identified risks on its own (e.g., through an examination of scope and estimating assumptions, the brainstorming of issues and concerns, or the creation of a red flag list). Risk checklists should not be used as the first step in risk identification because they may not contain important project-specific risks. If a project team relies too heavily on a risk checklist, it could easily overlook project-specific risks, and the risks may not be phased correctly for the unique aspects of the project.

How to use it?

A risk checklist should be reviewed at the start of a project and potentially several more times throughout the project. The list should be reviewed by a project team, and the risks that may have impacts should be documented and added to the risk register and possibly marked for quantitative analysis.

Examples

California DOT has developed a sample list of risks in its Project Risk Management Handbook. This sample list of risks can be used as the basis for creating a list of red flag items for an individual project. The Caltrans list is quite comprehensive, and any single project's list of risks should not include all of these elements.

Caltrans Sample Risk List (Caltrans 2007)

Technical Risks

- Design incomplete
- Right-of-Way analysis in error
- Environmental analysis incomplete or in error
- Unexpected geotechnical issues
- Change requests because of errors
- Inaccurate assumptions on technical issues in planning stage
- Surveys late and/or surveys in error
- Materials/geotechnical/foundation in error
- Structural designs incomplete or in error
- Hazardous waste site analysis incomplete or in error
- Need for design exceptions
- Consultant design not up to Department standards
- Context sensitive solutions
- Fact sheet requirements (exceptions to standards)

External Risks

- Landowners unwilling to sell
- Priorities change on existing program
- Inconsistent cost, time, scope, and quality objectives
- Local communities pose objections
- Funding changes for fiscal year
- Political factors change
- Stakeholders request late changes
- New stakeholders emerge and demand new work
- Influential stakeholders request additional needs to serve their own commercial purposes
- Threat of lawsuits
- Stakeholders choose time and/or cost over quality

Environmental Risks

- Permits or agency actions delayed or take longer than expected
- New information required for permits
- Environmental regulations change
- Water quality regulation changes
- Reviewing agency requires higher-level review than assumed
- Lack of specialized staff (biology, anthropology, archeology, etc.)
- Historic site, endangered species, wetlands present
- EIS required
- Controversy on environmental grounds expected
- Environmental analysis on new alignments is required
- Formal NEPA/404 consultation is required
- Formal Section 7 consultation is required
- Section 106 issues expected
- Project in an area of high sensitivity for paleontology
- Section 4(f) resources affected
- Project in the Coastal Zone
- Project on a Scenic Highway

- Project near a Wild and Scenic River
- Project in a floodplain or a regulatory floodway
- Project does not conform to the state implementation plan for air quality at the program and plan level
- Water quality issues
- Negative community impacts expected
- Hazardous waste preliminary site investigation required
- Growth inducement issues
- Cumulative impact issues
- Pressure to compress the environmental schedule

Organizational Risks

- Inexperienced staff assigned
- Losing critical staff at crucial point of the project
- Insufficient time to plan
- Unanticipated project manger workload
- Internal “red tape” causes delay getting approvals, decisions
- Functional units not available, overloaded
- Lack of understanding of complex internal funding procedures
- Not enough time to plan
- Priorities change on existing program
- New priority project inserted into program
- Inconsistent cost, time, scope and quality objectives

Project Management Risks

- Project purpose and need is poorly defined
- Project scope definition is poor or incomplete
- Project scope, schedule, objectives, cost, and deliverables are not clearly defined or understood
- No control over staff priorities
- Too many projects
- Consultant or contractor delays
- Estimating and/or scheduling errors
- Unplanned work that must be accommodated
- Communication breakdown with project team
- Pressure to deliver project on an accelerated schedule
- Lack of coordination/ communication
- Lack of upper management support
- Change in key staffing throughout the project
- Inexperienced workforce/ inadequate staff/resource availability
- Local agency issues
- Public awareness/support
- Agreements

Right-of-Way Risks

- Utility relocation may not happen in time
- Freeway agreements
- Railroad involvement
- Objections to Right-of-Way appraisal takes more time and/or money

Construction Risks

- Inaccurate contract time estimates
- Permit work windows
- Utility
- Surveys
- Buried man-made objects/ unidentified hazardous waste

Regulatory Risks

- Water quality regulations change
- New permits or new information required
- Reviewing agency requires higher-level review than assumed

Sample Risk Checklist from the Minnesota DOT:

No. of lanes

- Traffic volumes
- Level of Service LOS analysis
- Lane continuity
- High-occupancy vehicle, single-occupancy vehicle, etc.
- Policies, purpose, and need

Access

- Functional classification of roadways
- Traffic volumes
- Traffic movements
- Traffic forecasts
- Right-of-way impacts
- Environmental issues
- Existing interchange/conditions
- Municipal land use planning
- Design speed/engineering standards
- Access category
- Bike/Pedestrian
- Crash data

Horizontal

- Right-of-Way impacts
- Environmental issues
- Soils
- Utilities
- Existing conditions
- Topography
- Pavement condition
- Staging/Detour
- Municipal community planning
- Design speed
- Enforcement issues
- Engineering standards
- Park & Ride
- HOV/Transit elements

Vertical

- Design speed/engineering standards
- Soils – rock, muck, water
- Utilities
- Topography
- Bridges
- Municipal community planning
- Noise
- Adjacent land use
- Drainage
- Airports

Bridge

- Cross section – mainline
- Cross section – cross street
- Profiles
- Skew
- Type selection
- Aesthetics
- Bike/Pedestrian trails
- Airport location
- Lighting & signing
- Soils/Foundations
- Waterway analysis
- Bridge clearance (overlays)
- Utilities
- Staging/Detour

- Bridge approach costs
- Temps and shoo fly

Retaining walls

- Type
- Cross sections
- Aesthetics
- Drainage
- Right-of-Way impacts
- Utilities
- Soils/Foundations

Traffic

- Design speed
- Functional classification
- Roadway type
- Access locations
- Traffic movements
- Traffic volumes
- LOS analysis
- Signal warrant analysis
- Crash data
- Safety systems
- Lighting warrants
- Signing
- Striping determination
- Airports
- Foundation analysis

WRE

- Alignments
- Profiles
- Cross sections
- Drainage areas
- Existing conditions
- Impervious areas
- Banking
- Waterway analysis
- DNR
- Corps
- Watersheds/WCA/BWSR
- NPDES/PCA/MS4
- City/County coordination
- Right-of-Way impacts
- Soils
- Drinking water areas
- Airports
- Ponding

Pavement

- Soils
- Cross sections
- Traffic volumes
- Vehicle classification
- Profiles
- Water table
- Drainage
- Pavement selection
- Shoulder use
- Traffic staging/control
- Dynamic shoulders
- Transit shoulders
- Pavement condition

Utilities

- As-builts (Mn/DOT and city)
- Surveys
- Gopher 1
- Aerial photography
- R/W maps
- Plats
- Site plans
- Coordinate with city/county
- Permits
- Alignments
- Profiles
- Cross sections
- Drainage elements
- Retaining walls
- Noise walls
- Bridges
- Construction staging

Railroad

- Aerial photos
- Alignments
- Profiles
- Cross sections
- Drainage
- Retaining walls
- Noise walls
- Bridges
- R/W maps
- Plats
- Railroad office coordination
- Construction staging

Earthwork

- Alignments
- Profiles
- Soil borings
- Intersections
- Drainage elements
- Subsurface drains
- Foundation analysis
- Contaminated soils – remediation

Noise walls

- Alignments
- Profiles
- Land use maps
- Traffic volumes
- LOS
- Traffic classifications
- Utilities
- R/W impacts
- Municipal consent
- Historic property review
- Drainage elements
- Airports
- Aesthetics
- Wall type
- Foundation analysis

Maintenance

- Maintenance elements/issues
- Drain tile
- Anti-icing
- HOV bypass
- Snow storage
- Snow control

Transportation Management System

- TMS, ITS, IVHS elements

Construction

- Innovative construction services
- Detours
- Staking
- Extraordinary enforcement
- Extraordinary public relations
- Seasonal impacts
- Vibration and noise

Surveys

- Survey

RESOURCES

Caltrans Office of Statewide Project Management Improvement (2007). Project Risk Management Handbook: Threats and Opportunities, 2nd ed., May 2007, Caltrans, Sacramento, CA. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

Molenaar, K. R. (2005). "Programmatic Cost Risk Analysis for Highway Mega-Projects," Journal of Construction Engineering and Management, Vol. 131, No. 3.

TIP

This method is only truly useful when the project team members think about every item on the list as a jumping off point for further risks. Each item must be thought about in detail to ensure that the risk is truly a project risk. The thought process should be documented in order to build on this in future discussions of the risks.

12.4 Assumption Analysis

During the course of developing design or creating an estimate many assumptions must be made. This is particularly true in the early phases of project development. Assumptions can carry risks. An analysis of each assumption for its possible impacts on cost and schedule can be critical to creating an accurate project estimate.

What is it?

Assumption analysis is taking a close look at the assumptions in the cost and schedule estimates, documenting these assumptions as potential risks, and analyzing them. Each assumption should be examined for validity, accuracy, consistency, completeness, and context. If uncertainties in these assumptions are identified, then risks should be developed surrounding these uncertainties.

Why use it?

Assumptions hold within them substantial risks in most cases. The documentation of these assumptions and the potential items that may cause these assumptions to change will assist in the risk identification process.

What does it do?

Documenting assumptions and associated risks identifies some risks that may be buried within the cost or schedule estimates. The team can identify these risks and also generate additional uncertainties that may stem from assumptions.

When use it?

Use assumption analysis during the risk identification process. Risk identification can occur at a set time or anytime the project development team makes an assumption that can significantly impact the project cost or schedule estimates. While ideally these assumptions should be analyzed as soon as the assumptions are identified, it is more efficient to make the analysis during the risk analysis process after a number of assumptions have been gathered and documented. This will allow a larger group to participate in the analysis and may also lead to better brainstorming of potential risks stemming from those assumptions.

How to use it?

Assumption analysis should be used to bring assumptions in front of a larger group in order to analyze them and produce potential risks. Assumption analysis can also be used as a way to brainstorm additional risks.

Example

The following is a list of assumptions that may generate potential risks, taken from the Washington State Department of Transportation "Basis of Estimate" document (Washington State DOT 2008).

- Construction funding will occur all at once
- Will need to replace bridge SR###/Bridge No.
- Storm water retrofit of ######
- Environmental regulations don't change
- Today's dollars, unknown inflation rate and energy cost
- Midpoint of construction will not change
- Undeveloped properties remain undeveloped. At this time there are no known proposed developments on the properties, although some of the properties are for sale.
- There are good soils
- Captured major bid items
- Traffic control cost based on past experience and region philosophy doesn't change
- Right-of-Way is not needed to relocate the gas line

TIPS

Identification of assumptions can come from many sources. Planners and designers often document assumptions in their designs before they complete their full technical analyses. Estimators often document assumptions regarding project scope or costs when they are compiling conceptual estimates without significant design information. Be certain to review these documented assumptions.

However, many assumptions often go undocumented and can only be found through direct discussions with project team members (e.g., planners, designers, estimators, etc.). When identifying risks, be certain to contact the team members directly and ask them if they needed to make assumptions in their plans, designs, or estimates that might result in cost or schedule increases if the assumptions prove to be incorrect.

RESOURCES

National Highway Institute (2006). Risk Management Instructor Guide, NHI Course 134065, National Highway Institute, Washington, D.C.

Washington State DOT (2008). Basis of Estimate

<http://www.wsdot.wa.gov/NR/rdonlyres/76111703-D435-4CB7-A965-1297F7F00599/24275/BasisofEstimateFormAug2006rev.doc> (Viewed June 1, 2008).

12.5 Expert Interviews

Expert interviews serve to provide the project team and risk analysts with additional input from expert sources. Using their insights and expertise, experts may identify risks that are not apparent to the project team. They can also assist with subsequent risk assessments.

What is it?

Expert interviews are simply the solicitation of expert opinions. Interview questions are generally open ended, and the discussion can cover all areas that the expert may be knowledgeable about. Documentation of the discussion is important, as the discussion may reveal a number of different risks, and the expert may provide information beyond the identification of the risk, such as probability and impact. The Washington State DOT has important guidelines (Washington State 2008) they follow when selecting a subject matter expert:

> "Subject matter experts (SMEs) are people who are qualified in their fields to make reasonable subjective assessments on project costs and schedules without bias; subject matter experts provide relevant technical, management, and political insight to the project and critically examine the project estimate to validate cost and quantity components. Subject matter experts use their real-world construction, risk analysis, and cost estimating knowledge to identify and quantify uncertainties. Subject matter experts must not have personal agendas and must be willing to work as part of a team. Subject matter experts can be internal or external and can be local or national."

Why use it?

Simply put, expert interviews provide additional informed minds to generate a comprehensive list of risks. As experts, they can provide knowledge and experience in specific fields that may not be available to the project team.

What does it do?

The expert interviews provide risks that are well developed and informed. The interviews also provide for a way to begin describing, whether qualitatively or quantitatively, the probability and impact of risks.

When use it?

Subject matter experts should be brought in early in the process but generally not until sufficient scope has been defined to warrant their expert opinions. Experts can be utilized during risk identification, risk assessment, planning, or any other point where the project team would appreciate additional opinions.

TIPS

While reviewing the expert interview documentation, make sure not to include any of the team's own biases. Let the information speak for itself, and if necessary, talk to the expert about his or her opinion and clarify any confusion.

How to use it?

Use the expert interviews to their potential by allowing the expert to speak freely and try to draw as much information from the documentation as possible. It is best if the experts remain on-call to clarify risks that have been indentified earlier or to help identify new risks.

RESOURCES

National Highway Institute (2006). Risk Management Instructor Guide, NHI Course 134065, National Highway Institute, Washington, D.C.

Washington State DOT (2008). A Policy for Cost Risk Assessment http://www.wsdot.wa.gov/NR/rdonlyres/EF230F3B-1FC1-4A2A-9FC9-B66CF0300E1E/0/PolicyforCostRiskAssessment20050805.pdf (Viewed June 1, 2008).

12.6 Crawford Slip Method

The Crawford Slip method is a risk identification tool. Apply the tool in a group setting to generate a large number of risks quickly. This method allows for individuals to identify risks in a group setting without the influence from other team members. The method can be helpful for eliciting risks from an entire group without one group member dominating. However, it can also provide an overwhelming number of risks to analyze.

What is it?

The Crawford Slip is a rapid, independent brainstorming session. A facilitator begins by introducing the process to the team members. For ten minutes, each participant writes down one risk each minute. After each minute, the current risk is set aside and each member starts a new one. This forces each participant to write down one, and only one, risk during each minute. At the end of the ten minutes, the facilitator collects all of the risks. The facilitator later collates and organizes the risks, eliminating duplicates. This can be done by the facilitator alone or in a group setting.

Why use it?

The Crawford Slip solicits each participant's opinion of project risks independently. The benefit of this is that each mind is working independently to generate different risks, rather than being guided by the opinion of the group.

What does it do?

The Crawford Slip generates a large number of potential risks. With a group of 10 participants, within 10 minutes the group will have generated 100 risks, excluding any duplicates. This creates a significant amount of information for the facilitator to sift through to identify risks.

TIPS

Since the Crawford Slip method generates a large number of risks, allow for time to collate like risks. This can be done independently by the facilitator or it can be done in a group setting.

Do not rely solely on the Crawford Slip for risk identification. While it is a powerful tool, it cannot be comprehensive of risks on the project because of the nature in which risks are identified.

RESOURCES

National Highway Institute (2006). Risk Management Instructor Guide, NHI Course 134065, National Highway Institute, Washington, D.C.

When use it?

Use the Crawford Slip method when the project team needs to generate risks in a short period of time. The process will create a large number of risks, but it may not be as thorough as some of the other risk identification tools. The risks identified in this process can later be examined in more detail to identify further potential risks.

How to use it?

Use the Crawford Slip as a starting point for risk identification. The results of the Crawford Slip can be presented to the group afterward to clarify the intention of the risk identifiers, as well as to evaluate each risk as a group.

R3.1 Risk Management Plan

A formal risk management plan is a detailed documentation of a plan of action for the management of risk. Risk planning involves the thoughtful development, implementation, and monitoring of appropriate risk response strategies. It is the process to develop and document an organized, comprehensive, and interactive risk management strategy; determine the methods to be used to execute a risk management strategy; and plan for adequate resources.

The risk management plan may be specific in some areas and general in others. The key to this tool is its scalability. Every project should have a formal risk management plan, but the level of detail varies with the project complexity.

What is it?

The formal risk management plan is a document that gives a summary of the project and outlines the different steps of the risk management process and how the agency is approaching them. The risk management plan employed will vary based on the complexity of the project, but most projects should include an outline similar to the following:

1. Introduction
2. Summary
3. Definitions
4. Organization and roles
5. Risk management strategy and approach
6. Risk identification
7. Risk assessment and analysis
8. Risk mitigation and planning
9. Risk allocation
10. Risk monitoring and control

Why use it?

A risk management plan is a form of documentation, as well as a communication tool for those who wish to be informed of a project's risk management approach. The plan formalizes the ideas presented during the risk management process and may clarify some of the assumptions the project team has regarding the risk management process.

What does it do?

The risk management plan provides guidance for the project team members at all steps of the process. The risk management plan also provides documentation of the process for use throughout the project, as well as on future projects.

When use it?

The formal plan should be developed during the Planning and Scoping Process and updated during subsequent project development phases.

How to use it?

The risk management plan is developed early in the project by collaboration with as many members of the team as possible. The guide should be consulted and revised throughout the project development process to guide the project through to completion.

Examples

Caltrans has developed a strong risk management plan template that it uses on its projects to define how the risk management process will be carried out. This template follows and is available at the following URL:

http://www.dot.ca.gov/hq/projmgmt/documents/prmhb/risk_management_plan_template_sample_20070502.doc.

RISK MANAGEMENT PLAN

District________EA________________________

County________Route:__________PM________

Purpose

This document describes how Risk Management will be structured and performed on this project. The risk management plan includes methodology, roles and responsibilities, budgeting, timing, risk categories, definitions of risk probability and impact, probability and impact matrix, reporting formats, and tracking. The Caltrans Project Risk Management Handbook will be utilized as primary reference and guideline.

Approved By:

____ ________________

Project Manager Date

Figure R3.1-1. Caltrans Risk Management Plan Template

ROLES AND RESPONSIBILITIES

Project Manager responsibilities include:

- Incorporate the resources and time required to execute the Risk Management Plan in the project budget and schedule
- Develop, distribute and implement this Risk Management Plan
- Develop and update the Risk Register with the support of the Project Team and incorporate it into the work plan
- Coordinate with the risk owners to monitor risks and implement risk response strategies

Project Manager Support or Risk Officer responsibilities include:

- Support the Project Manager in developing and updating the Risk Management Plan and the Risk Register
- Maintain updates to the Risk Management Plan and the Risk Register
- Maintain a list of risk and response strategies of all the projects in the district
- Update the Sample Risk List and the lessons learned database (http://pd.dot.ca.gov/pm/PMPI/LessonsLearned/index.asp)

Project Team responsibilities include:

- Identify the risk and describe it
- Assess the probability that a risk will occur and specify the criteria used to assess the probability
- Assess the impact of risks on project cost, time, scope, and quality objectives, and specify the criteria used to assess the impact
- Help identify the risk owners and assist in developing the risk response strategies (Project Team members may be assigned as "Risk Owner")
- Perform the risk response steps assigned
- Assist the PM in activities associated with Risk Monitoring and Control

Risk Owner responsibilities include:

- Develop and/or update the assigned risk response strategy
- Monitor the risk assigned and inform PM of any threats or opportunities to the project. This includes monitoring the risk trigger and informing the PM, if the risk becomes a real event.

Figure R3.1-1. Caltrans Risk Management Plan Template (continued)

RISK REGISTER

The Risk Register documents the identified risks, the assessment of their root causes, areas of the project affected (WBS elements), the analysis of their likelihood of occurring and impact if they occur and the criteria used to make those assessments and the overall risk rating of each identified risk by objective (e.g. cost, time, scope and quality). (Appendix D, Project Risk Management Handbook).

Importantly, it includes the risk triggers, response strategies for high priority risks, and the assigned risk owner who will monitor the risk.

Risk Identification Methods Used

The risk breakdown structure (Appendix B, Project Risk Management Handbook) and Sample Risk List. (Appendix C, Project Risk Management Handbook) will be used as reference tools to help identify and categorize risks.

Risk Analysis Methods Used

Qualitative Risk Analysis attempts to rank the risks into high, medium and low risk categories based on their probability of occurring and impact on an objective. (The objective with the most impact, at a minimum).

This project will __________ will not __________ use qualitative risk analysis

This project will __________ will not __________ use District RM Web tool

Quantitative Risk Analysis attempts to estimate the risk that the project and its phases will finish within objectives taking into account all identified and quantified risks, estimates the contingency needed for cost and schedule and identifies the best decisions using decision tree analysis. (See Project Risk Management Handbook for additional information and when to use Quantitative Risk Analysis).

This project will __________ will not __________ use quantitative cost risk analysis

This project will __________ will not __________ use quantitative schedule risk analysis

This project will __________ will not __________ use decision tree analysis

This project will __________ will not __________ use other quantitative methods

Period of Risk Management Meetings and Full Review of Project Risk

Meetings for the purpose of discussing and making decisions on Project risk will be held:

Weekly __________ Bi-Weekly __________ Monthly __________ Other__________

The risk management identification, analysis and response planning process shall occur during project initiation document (PID). A full review and update of risk register will occur at the beginning of each subsequent phase of the project.

Figure R3.1-1. Caltrans Risk Management Plan Template (continued)

BUDGET ALLOCATED FOR RISK MANAGEMENT

Staff allocated and assigned for risk management activities include:

PMSU Chief	@	____________________	Hrs
Risk Officer	@	____________________	Hrs
PM	@	____________________	Hrs
Environmental	@	____________________	Hrs
Design	@	____________________	Hrs
R/W	@	____________________	Hrs
DES/Structure	@	____________________	Hrs
Const.	@	____________________	Hrs
Traffic Operations	@	____________________	Hrs
Maintenance	@	____________________	Hrs
	@	____________________	Hrs
Total:		____________________	Hrs

________Hrs. × $ ________ /Hr =________

A total of $________________ is allocated for Risk Management on this project.

Figure R3.1-1. Caltrans Risk Management Plan Template (continued)

TIPS

Use a risk management plan no matter how small the project. The detail included in the plan can be minimized, but the value that the formalized plan provides is important for successful risk management.

RESOURCES

http://www.dot.ca.gov/hq/projmgmt/documents/prmhb/risk_management_plan_template_sample_20070502.doc.

Guide to Risk Assessment and Allocation for Highway Construction Management, October 2006.

R3.2 Contingency Percentage

On non-complex projects utilizing a Level I risk analysis, add a contingency as a percentage of the base estimate to arrive at the Total Project Cost Estimate. While Estimators must include a contingency with each estimate, non-complex projects do not warrant a detailed risk analysis and contingency development. However, Estimators should clearly document the contingency percentage. Base the documentation on historic ranges of contingency and a list of risks for the particular project. As the project proceeds with development, the estimated contingency percentage reduces because the level of uncertainly associated with the project also reduces. If extraordinary conditions exist that call for higher contingencies than what have historically been used, document the basis and rationale in the estimate.

What is it?

Recognizing that cost estimation is inherently difficult because Estimators are trying to predict the future, it is prudent to provide contingency in all estimates, particularly Planning, Programming and preliminary Design estimates. The contingency amount can be set as a percentage of the project's base cost estimate with the percentage being established by analysis of historical cost experience from past projects.

Why use it?

At any stage in the development of a project, cost estimates will be composed of three components for which there are differing amounts of information: 1) known and quantifiable costs, 2) known but not quantified costs, and 3) costs that are unknown and therefore cannot be quantified in advance. The base estimate includes the known and quantifiable costs. The contingency percentage is intended to include both the known but not quantified and the unknown costs.

What does it do?

A contingency percentage in an estimate is meant to provide funds for cost growth resulting from necessary but unforeseeable items, such as project scope changes, underestimation of real project costs, or errors in projecting the rate of inflation. Increases in the prices for construction services due to inflation are not to be considered covered by the contingency amount. Inflation should be handled by applying an appropriate inflation rate to the calculated project cost.

When use it?

The contingency percentage added to an estimate is a valid means of reflecting the uncertainties that remain in the project as Design progresses. Include a contingency percentage in every project estimate from the earliest planning stage of project development to the final PS&E; however, as shown in Figure R3.3.1 and Table R3.3.1, the magnitude of the contingency decreases as the scope is defined and the Design progresses.

How to use it?

Contingency percentage is the most prevalent approach that project teams use when resources for more sophisticated risk and contingency analysis are limited or unavailable. In its simplest form, a reference table or graph is provided to the project teams for estimating contingency as a percentage of the base estimate. Based on the project's level of design completion or other factors such as development milestones, the Estimator or the Project Manager determines the corresponding contingency percentage to include in the cost estimate.

Examples

Figure R3.3.1 and Table R3.3.1 illustrate the contingency percentages that are used by the Ohio and California state DOTs, respectively.

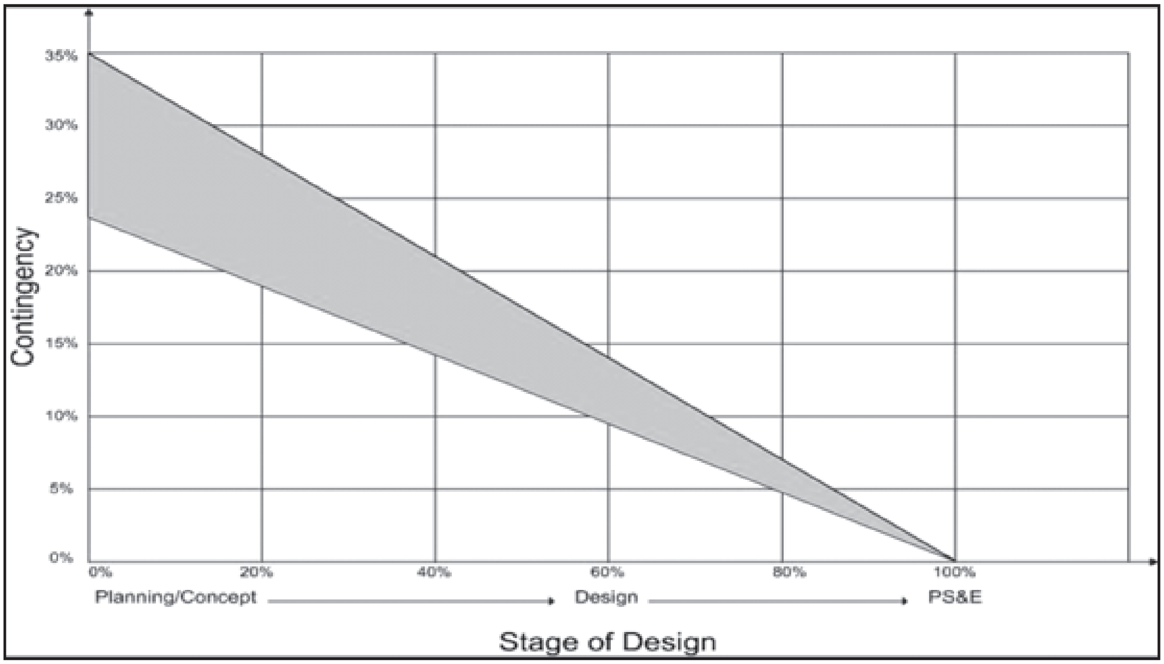

Figure R3.2-1 Ohio DOT Design Completion Contingency Guidelines for Cost Estimating of Major Projects

Table R3.2.1 Caltrans Contingency Percentages

Design/Esitmation Milestone	Percent Contingency
Project Feasibility Cost Estimate	30% to 50%
Project Study Report Cost Estimate	25%
Draft Project Report Cost Estimate	20%
Project Report Cost Estimate	15%
Preliminary Engineer's Cost Estimate	10%
Final Engineer's Cost Estimate	5% or less

Adapted from Chapter 20 of the Caltrans Project Development Procedures Manual (available online at http://www.dot.ca.gov/hq/oppd/pdpm/pdpmn.htm).

TIPS

When using a contingency percentage, two steps are needed to make the process work effectively:

1. Define the purpose of the contingency amount carefully. Estimators and management must understand that the contingency is intended to account for specific unforeseen, unexpected, unidentified, or undefined costs. The project risks that cause the occurrence of these costs must be delineated in the state highway agency's estimation manual with the percentages.

2. Establish contingency percentages on actual experience (i.e., historical data). It is important for both Estimators and management to know the level of accuracy achieved with the prescribed contingency.

RESOURCES

FHWA (2004). "Contingency Fund Management for Major Projects." www.fhwa.dot.gov/programadmin/mega/contingency.htm.

FHWA (2004). "Major Project Program Cost Estimating Guidance." www.fhwa.dot.gov/programadmin/mega/cefinal.htm.

Chapter 20 of the Caltrans Project Development Procedures Manual, www.dot.ca.gov/hq/oppd/pdpm/pdpmn.htm.

Caltrans Office of Statewide Project Management Improvement (2007). Project Risk Management Handbook: Threats and Opportunities, 2nd ed., May 2007, Caltrans, Sacramento, CA. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

Caltrans (1998). State Administrative Manual, Chapter 6000, Section 6854: CONSTRUCTION. http://sam.dgs.ca.gov/TOC/6000/6854.htm.

Ohio DOT (2007). Ohio Procedure for Budget Estimating. www.dot.state.oh.us/contract/estimating/default.htm.

U.S. Army Corps of Engineers. "Military Program-Specific Information—REF8011G," http://bp.usace.army.mil/robo/projects/pmbp_manual/PMBP_Manual/REF8011G.htm.

Uppal, Kul B. (Ed.) (2005). Professional Practice Guide #8: Contingency (CD), Association for the Advancement of Cost Engineering (AACE) International. www.aacei.org/technical/ppg.shtml.

R3.3 Contingency Identified

On moderately complex projects utilizing a Level II risk analysis, add a contingency based on identified line items to the base estimate to arrive at the Total Project Cost Estimate. This tool should start with the percentage contingency (Tool R3.2) and then add any additional identified contingency items to arrive at the final contingency. The Estimator must use his or her judgment to determine if these identified contingency items can be captured within the standard percentage contingency or if they provide justification for the specific project contingency to exceed the standard percentage contingency.

What is it?

This tool creates a process whereby the contingency amount included in an estimate is set on the basis of identified risks and the probability of their occurrence. This contingency-identified tool should ideally be used in conjunction with a comprehensive risk management process. When used in conjunction with a qualitative risk assessment or expected values for the risk items, the contingency is set using the cost Estimator's judgment with the information generated from the risk identification and analysis process, and in accordance with SHA policy. The specific identified contingency items can then be used for contingency management and resolution throughout the project development process. In other words, as the risks are realized or resolved, the identified contingency amount can be added to the base estimate or removed from the Total Project Cost Estimate, respectively.

Why use it?

The identification of project risks gives the Estimator a much firmer basis for developing a reliable contingency amount than the typical top-down assignment of a percentage based on the estimated direct cost of the project. It also provides for a sound contingency resolution process to manage the total project cost.

What does it do?

Because risks are specifically delineated as a project is developed, specific strategies can be implemented to mitigate, transfer, or avoid significant risks. In addition, with the risks identified and quantified, control and tracking procedures can be implemented to monitor risk items on an ongoing basis.

When use it?

The tool should be employed early and risks tracked throughout the project development process. Projects of an unusual or complex nature require a more in-depth evaluation of potential risks and their contributions to estimated cost. The opportunities to expand the identification and quantification of risks should be pursued as design progresses and more is known about potential risk factors.

TIPS

To successfully attack the effects of project risk, risk analysis must take a broad view of risk; concentration on the technical risks can lead to oversights in other project dimensions. The analysis should consider local authority/agency impacts, industry and market risks, elements of political uncertainty, and public and/or permit approval processes that might impact timing.

Scope changes must also be considered from a broad perspective. Identification of risk goes beyond the internal "project risks," such as pile driving depth, and includes exogenous factors, such as market conditions, business environment, global construction activities/demand, macroeconomic environment, and weather. Namely, any major uncertainties that might influence the primary project outcomes of cost, schedule, or quality should be included.

RESOURCES

Caltrans O□ce of Statewide Project Management Improvement (2007). Project Risk Management Handbook: Threats and Opportunities, 2nd ed., May 2007, Caltrans, Sacramento, CA. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

Washington State Department of Transportation (2008). A Policy for Cost Risk Assessment <http://www.wsdot.wa.gov/NR/rdonlyres/EF230F3B-1FC1-4A2A-9FC9-B66CF0300E1E/0/PolicyforCostRiskAssessment20050805.pdf> (Viewed June 1, 2008).

How to use it?

We use identified contingency as an overarching principle of contingency estimation. At every stage of the project, risks must be identified and contingency extracted. This extraction leads to greater understanding of the cost and uncertainty in a project.

When choosing the appropriate contingency percentage in a Type II risk analysis, consult the range of contingency from the percentage contingency tool and then review the top 20 percent of the prioritized risks to ensure that the contingency is adequate. Use an expected value estimate for estimating the top-ranked risks. Calculate the expected value by multiplying the product of the impact should the risk occur by the probability of the occurrence (e.g., $1,000,000 x 0.50 = $500,000). Use additional contingency if warranted by the expected value analysis.

Example

The Cost Estimating Validation Procedure (CEVP®) developed by the Washington State Department of Transportation (WSDOT) is a peer-level review on the scope, schedule, and cost estimate for transportation projects throughout the state of Washington. The objective of the CEVP® process is to evaluate the quality and completeness, including anticipated uncertainty and variability, of the projected cost and schedule.

The outcomes of the CEVP® process include the following:

1. An estimate validation statement in the form of a CEVP® Project Summary Sheet that more accurately represents the project cost ranges and the uncertainty involved (See C1.2 Communication of Uncertainty).

2. Findings and recommendations that allow WSDOT project teams and senior management to better understand the basis, content, and variability of cost estimates.

3. Identification and characterization of the high-risk project elements, which will enable project teams to address appropriate mitigation strategies.

The Caltrans Risk Management Handbook calls for a quantitative assessment of project risk items representing the highest degree of exposure. This quantification is important for adjusting/updating the contingency amount to be included in the project estimate (Caltrans 2007, www.dot.ca.gov/hq/projmgmt/documents/prmhb/project_risk_management_handbook.pdf).

R3.4 Estimate Ranges — Three-Point Estimates

Expressing a cost estimate in terms of an estimate range transparently communicates the uncertainty associated with an estimate. The generation of a range can be as simple as applying a historic plus-minus factor to estimated cost (i.e., -10% to +20%). Alternatively, an estimate range may be generated through sophisticated probabilistic models or simply as a three-point estimate ranging from an optimistic amount to a pessimistic amount and a most likely amount in between.

What is it?

A project cost estimate is a prediction of the quantities, cost, and/or price of resources required by the scope of an activity or project. As a prediction, an estimate must address risks and uncertainties. Consequently, engineers realize that any estimate can lead to a potential range of final costs. When appropriate, the estimate itself can be expressed as a cost range. Communication of the estimate as a range is simply a statement of project cost variability.

Why use it?

Properly communicating the uncertainty involved in an estimate will help to ensure that decisions based upon the estimate are appropriate considering its precision. Estimate ranges better convey the uncertain nature of project costs, particularly in the conceptual phase of project development and even during later project development phases.

Currently, most project cost estimates are conveyed in terms of a single point value. The use of a point estimate early in the project development process can lead to a false sense of precision and accuracy as even the best engineers cannot predict all future events that can and will impact a project's cost. Through use of an estimate range, the agency can convey the certainty and uncertainty that is inherent in the project and educate the stakeholders about cost variability. This is also helpful within the agency to demonstrate the certainty and uncertainty about the project to other personnel who may not be intimately familiar with the project.

What does it do?

The communication of a range of values representing the possible array of ultimate project costs creates a better understanding of estimate precision. The optimistic and pessimistic values at the ends of the range do not necessarily represent the very least or the very most that the project will cost, but typically the most probable range of project costs. The size of the range will be determined by the identified uncertainties. The interpretation and use of the range depends on how aggressive the agency is with the results.

TIPS

While estimate ranges transparently convey the uncertainty involved in a project, they can be misunderstood. The range theoretically shows the highest probable cost for a project. If people focus on the high end of the range, the project can be slowed or stopped. The range should be used as part of a comprehensive risk management plan. If the risks and uncertainties that are driving the range can be understood, they can likely be mitigated and the project can be completed at the lowest possible cost.

RESOURCES

Caltrans Office of Statewide Project Management Improvement (2007). Project Risk Management Handbook: Threats and Opportunities, 2nd ed., May 2007, Caltrans, Sacramento, CA. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

When use it?

Ranges may be considered throughout project development but should be utilized on projects in earlier stages of development to communicate the level of known's and unknowns (risks) about the project.

How to use it?

Federal planning regulations indicate that a three-point estimate or cost ranges/cost bands in the outer years of the metropolitan transportation plan are acceptable. Therefore, single point estimates should be avoided before sufficient detail about the project is known, when it is unrealistic to prepare a reasonably accurate single-point estimate. A three-point estimate is prepared at any point in this period by estimating the lowest possible, the most likely, and the highest probable cost estimate based on a combination of available project data and informed judgment.

Example

Caltrans uses three-point estimates for some elements of project costs and is planning to make wider use of this technique. Although the math may appear complex at first glance, it is easy to implement with a simple spreadsheet. The three point estimating process uses these steps:

1. Have subject matter experts develop three estimates for each item of work:
   a. An optimistic estimate (o): the lowest credible cost assuming that everything goes right.
   b. A most-likely estimate (m): the expert's best guess of the cost.
   c. A pessimistic estimate (p): the highest credible cost, assuming that virtually everything goes wrong.

2. The average cost of the item is (o+4m+p)/6. The average is always greater than the most likely estimate. This is because there is a finite lowest-possible cost. Even in the most optimistic situation, the work package will have a cost that is greater than zero. At the other end of the scale, there is no highest-possible cost. It is always possible to spend more money.

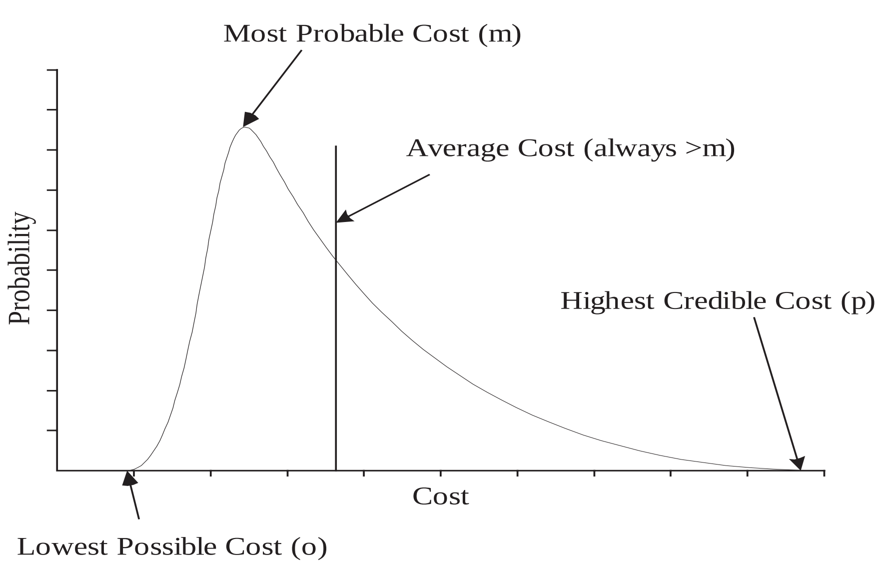

Figure R3.4-1. Caltrans Three-Point Estimate to Generate Estimate Range

R3.5 Estimate Ranges — Monte Carlo Analysis

Expressing a cost estimate in terms of an estimate range transparently communicates the uncertainty associated with an estimate. Monte Carlo analysis is part of a sophisticated probabilistic model process that can be used to generate a range estimate through simulation methods. The use of Monte Carlo analysis is typically facilitated by experts in this field who work closely with Estimators, project team members, and subject matter experts.

What is it?

Monte Carlo analysis is a computerized probabilistic simulation modeling technique that uses random number generators to draw samples from probability distributions. Monte Carlo analysis uses repetitive trials to generate overall probability distributions for project cost or schedule. It relies upon multiple inputs of probabilities for risk events and for uncertainty in cost and duration of line items. A trial consists of the simulation engine selecting a value for each of the line items based on their probabilities and generating a final estimate based on that trial. This process is repeated many times (usually several thousand) to generate a distribution for the total cost or schedule.

Why use it?

Monte Carlo analysis has many advantages. It can determine risk effects for cost and schedule models that are too complex for common analytical methods. The output of a Monte Carlo simulation can provide a graphical distribution of project cost or schedule. This distribution can be used to generate an estimate range. It can also be used to calculate a contingency. Monte Carlo analysis can explicitly incorporate the risk knowledge and judgment of the Estimators, project team, and subject matter experts for both cost and schedule risk events. They have the ability to reveal, through sensitivity analysis, the impact of specific risk events on the project cost and schedule.

What does it do?

The tool allows the project team to visualize the uncertainty relating to the total project cost and schedule. Monte Carlo analysis can be used to determine project cost and schedule ranges and the most likely values for each. Figure R3.5-1 shows typical probability outputs from a Monte Carlo analysis. The histogram is useful for understanding the mean and dispersion of the results. The cumulative chart is useful for determining project budgets and contingency values at specific levels of certainty or confidence. In addition to graphically conveying information, Monte Carlo analyses produce numerical values for common statistical parameters, such as the mean, standard deviation, distribution range, and skewness.

TIPS

Monte Carlo analysis can provide insights into complex projects that might not be apparent through conventional estimating and scheduling techniques. It can provide cost and schedule ranges with graphical outputs. It can also provide insights into which risks have the greatest influence on these ranges. All too often, however, the output is used only for go/no-go decisions or a one-time generation of a baseline cost. Estimators and Project Managers should leverage this information in a holistic risk management process. The results can be better project performance interims of cost, time, and utilization of resources, but only if it is used to help actively manage the project development process and control project costs.

Monte Carlo analyses should only be conducted or facilitated by trained professionals. It is important to understand that the output of the model is only as accurate as the assumptions used to generate the output and the ability of the model to represent the actual project.

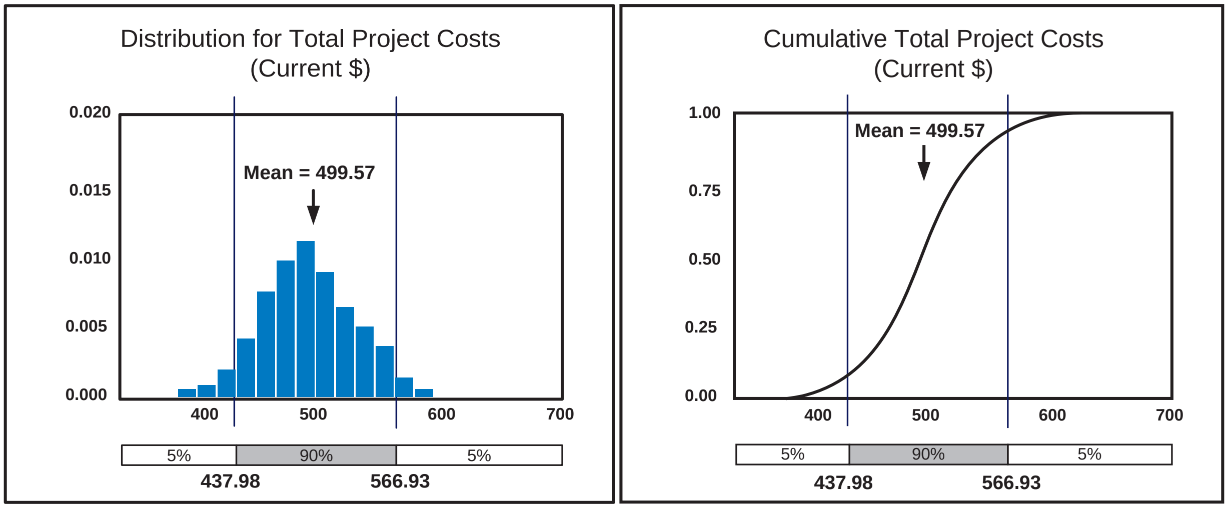

Figure R3.5-1. Typical Monte Carlo Output for Total Costs

RESOURCES

Caltrans Office of Statewide Project Management Improvement (2007). Project Risk Management Handbook: Threats and Opportunities, 2nd ed., May 2007, Caltrans, Sacramento, CA. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

Federal Transit Authority (2004). Risk Assessment Methodologies and Procedures. Report for the Federal Transit Administration, Project Management Oversight under Contract No. DTFT60-98-D-41013, Washington, D.C.

Federal Highway Administration (2004). Major Project Program Cost Estimating Guidance, Federal Highway Administration, Washington, D.C.

Molenaar, K.R. (2005). "Programmatic Cost Risk Analysis for Highway Mega-Projects," ASCE Journal of Construction Engineering and Management, 131(3), 343-353.

When use it?

Monte Carlo analysis is applied on complex projects and is used as the basis for a Type III risk analysis. The tool requires that the project team be familiar with all project risks and be able to quantitatively describe the risks. Monte Carlo analysis also requires knowledge and training for successful implementation. Input to Monte Carlo analysis requires the user to know and specify probability distribution information, mean, standard deviation, and distribution shape. While complex and requiring significant modeling experience, Monte Carlo analyses are the most common tool for quantitative risk analysis because they provide detailed, illustrative information about risk impacts on the project cost and schedule.

How to use it?

Monte Carlo analysis can be used to generate a number of different decision-making tools for the project team. In order to produce these tools, the input must be assessed to accurately model project risks. Each risk can be given a different risk profile indicating where the most likely and least likely values are. Among these different distributions are Triangular, Uniform, Normal, BetaPert, BetaPert modified, LogNormal, Discrete, Trigen, and any custom-defined distribution.

In addition to the total cost ranges shown in Figure R3.5-1, an additional output of a Monte Carlo analysis is a tornado diagram. The tornado diagram is a graphic depiction of a sensitivity analysis. The tornado diagram can be used to show which risks will have the greatest positive or negative effect on project cost and schedule. Figure R3.5-2 below indicates the correlation that project risks have to the total project schedule. The risks with the longest bars have the largest impact on the overall cost or schedule variability.

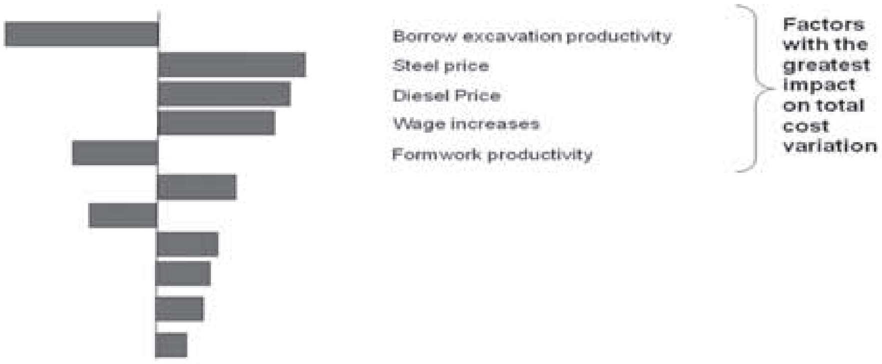

Figure R3.5-2. Example Tornado Diagram Output from a Monte Carlo Analysis

Several commercial software packages exist to help teams run Monte Carlo analyses. The two most commonly use are "@Risk" and "Crystal Ball." As well as software that integrates within existing spreadsheet programs, spreadsheet macros can be developed to produce simple Monte Carlo analyses. For example, the Washington State Department of Transportation has developed its own Monte Carlo analysis package in Microsoft Excel using macros. Additionally, some stand-alone software exists to generate cost and schedule Monte Carlo simulations. The most common stand-alone software is "Pertmaster."

Example

WSDOT has developed a risk-based approach to cost estimating in CEVP®. CEVP® is used to convey project cost through estimate ranges. Figure R3.5-3 provides an example of how CEVP® is used to convey an estimate range. The project represented has a 10 percent chance of being completed for $651 million or less, while there is a 90 percent chance that the project will cost $693 million or less. However, there is a chance that the project will cost as little as $640 million and as much as $720 million.

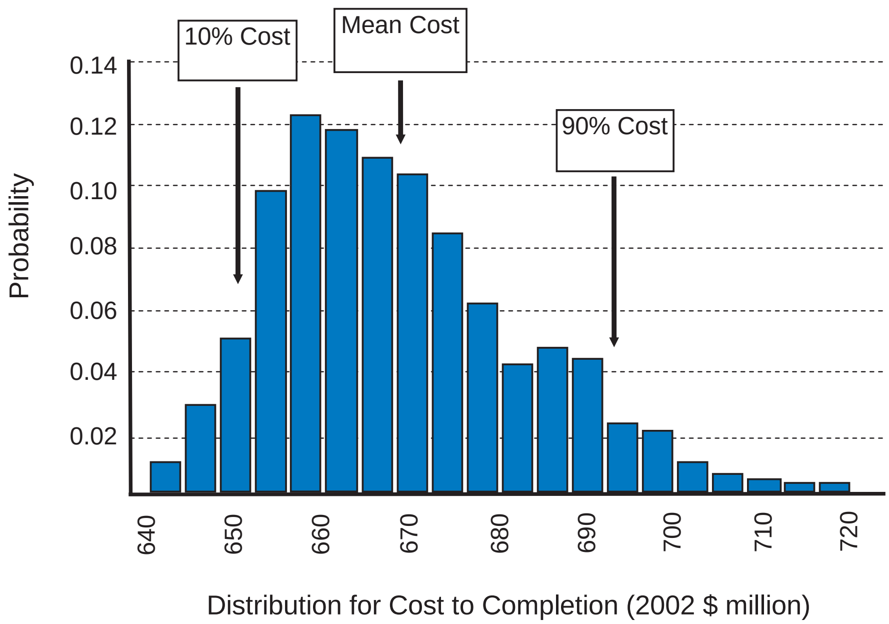

Figure R3.5-3. Example of an Estimate Range

RESOURCES

Project Management Institute (2004). A Guide to Project Management Body of Knowledge (PMBOK® Guide), The Project Management Institute, Newton Square, PA.

Washington State Department of Transportation (2008). CEVP® and Cost Risk Assessment (CRA) website. <http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/> (Viewed June 1, 2008).

R3.6 Risk Workshops

Risk workshops are formal meetings in which Estimators, project team members, subject matter experts, and risk analysis facilitator's work together to identify and analyze project risks. Project stakeholders can also be invited to identify risks, if appropriate. The workshops can focus on either qualitative or quantitative risk analysis techniques. Qualitative analyses typically identify and rank risks. Quantitative analyses typically identify risks, quantify uncertainty in project performance (e.g., for generating ranges for total project cost and schedule), and also quantify the significance of each risk (e.g., for subsequent risk management cost-benefit analysis).

TIP

Workshop pre-planning and proper facilitation are keys to success. The workshops generally begin with a presentation of the project background and issues. This presentation should be concise so that workshop participants can move on to the workshop objectives. Risk identification and quantification are typically the primary objectives of the workshops. Without proper facilitation, participants can deviate from these objectives to risk mitigation, value engineering, or issue solving rather than identifying and quantifying them for later mitigation efforts.

What is it?

These workshops are conducted to identify and rank project risks (or quantify uncertainty in the case of a quantitative analysis). They can involve a variety of Estimators, project team members, project stakeholders, discipline experts, and risk analysis facilitators.

Why use it?

A comprehensive risk analysis requires the elicitation of risks from all project team members, as well as other stakeholders that can potentially influence the project. A focused workshop works well to assemble all those who can influence the project with the goal of identifying risks and helping the project team understand and plan for project uncertainty.

What does it do?

The products of risk workshops vary depending upon the complexity of the project being studied, the current phase in the project development process, and time available for the workshop. Common products are listed below from least to most complex:

- a listing of project risks with complete descriptions,
- a quantification of risk for both frequency and impact,
- a range of project cost and schedule to support contingency estimates,
- initial risk mitigation plans, and
- preliminary risks register and risk management plan.

In addition to these products, risk workshops generally help to align project team members' understanding of project risks and focus resources in the areas that are most affected.

When use it?

Risk workshops are valuable in each project development phase. In the earliest phases, they benefit risk identification, and in the latest stages they benefit risk management. When used, the workshops must be conducted well in advance of finalizing the cost estimate because Project Managers and cost Estimators need sufficient time to incorporate the findings into the project plans and estimates. Risk workshops involving expert facilitators are typically required for large or complex projects that meet one or more of the following criteria:

1. Project is unique or unusual and has no historical basis of estimate.
2. Project has a high degree of local impacts or political interest.
3. Project has multiple solutions that meet the stated intent in the planning report, with potentially significant difference in the scope or cost or risk for each alternative.
4. Project is complex and may include any or all of the following:
   - few alignment or bypass sections,
   - capacity improvements that widen an existing highway,
   - multiple permanent structures,
   - interchanges on multilane facilities,
   - difficulty in acquiring material,
   - major traffic control activities,
   - schedule that spans many years,
   - major reconstruction,
   - extensive or expensive environmental or geotechnical scope, and/or
   - numerous right-of-way and/or utility issues.
5. Project is estimated to cost more than X% of the District program budget.

How to use it?

To be effective, risk workshops must be conducted only after adequate preparation, which includes preparation of an agenda and objectives for the workshop. Figure R3.6-1 illustrates how WSDOT uses this tool.

Example

The Washington State Department of Transportation addresses risk issues in its project cost estimation process by conducting risk workshops. This workshop approach to risk management was first implemented in 2002 as CEVP®. The CEVP® workshop is a collaborative effort where project teams, engineers, risk managers, and subject matter experts from private firms come together with WSDOT engineers to scrutinize transportation projects and relevant project information that would help in evaluating the cost and schedule estimates.

RESOURCE

Washington State Department of Transportation (2008). CEVP® and Cost Risk Assessment (CRA) website. <http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/> (Viewed June 1, 2008).

They brainstorm and contribute to the effort of identifying and assessing the risks on a project. The first series of CEVP® workshops were conducted on 12 mega projects in 2003. The CEVP® was scaled down in 2003 to a less intense version known as the "Cost Risk Assessment" (CRA), with procedures similar to the CEVP. Figure R3.6-1 illustrates how WSDOT uses this tool.

Figure R3.6-1. Example of WSDOT Cost Risk Analysis/Cost Estimating Validation Process® Workshop

R3.8 Probability × Impact Matrix (P×I)

A P×I matrix is used for qualitative analysis of risks on a project. It is formed by combining each risk's probability of occurrence (frequency) with its impact (severity) on project objectives to rank risks or determine the level of priority to be assigned to that risk on the project (e.g., high, medium, low, etc.). These assessments can be used as a first step in a quantitative analysis.

What is it?

The P×I matrix is formed using each project risk's probability and its corresponding impact. These matrices can take many forms, but a simple illustration is shown in Figure 3.8-1. For each of the project objectives, the combinations could fall into one of these three categories:

- RED: Indicates that the activity is high risk. High risk events are so classified either because they have a high likelihood of occurrence coupled with, at least, a moderate impact, or they have a high impact with, at least, moderate likelihood. In either case, specific directed management action is warranted to reduce the probability of occurrence or reduce the risk's negative impact.

- YELLOW: Indicates that the activity is moderate risk. Moderate risk events are either high likelihood/low consequence events, or they are low likelihood/high consequence events. An individual high likelihood/low consequence event by itself would have little impact on project cost or schedule outcomes. However, most projects contain a myriad of such risks (material prices, schedule durations, installation rates, etc.); the combined effect of numerous high likelihood/low consequence risks can significantly alter project outcomes. Commonly, risk management procedures accommodate these high likelihood/low consequence risks by determining their combined effect and developing cost and/or schedule contingency allowances to manage their influence. Low likelihood/high consequence events, on the other hand, usually warrant individualized attention and management. At a minimum, low likelihood/high consequence events should be periodically monitored for changes in either their probability of occurrence or in their potential impacts. Some events with very large, albeit unlikely, impacts may be actively managed to mitigate the negative consequences should the unlikely event occur.

- GREEN: Indicates that the activity is low risk. Risks that are characterized as low risk can usually be disregarded and eliminated from further assessment. As risk is periodically reassessed in the future, these "low" risks are resolved with minimal effort, retained, or elevated to a higher risk category.

The assessment guide in Figure 3.8-2 illustrates the key elements of a probability and impact analysis.

Why use it?

Each risk is likely to have a different probability of occurrence and a corresponding impact on the project. Therefore, the project team members need to consider the interaction between the probability and the impact when evaluating the risks. The P×I matrix facilitates such evaluation.

What does it do?

The P×I matrix helps a project team rank the myriad risks faced by a project so that the Project Manager can direct the majority of the available resources to the high and medium impact items.

When use it?

A P×I matrix can be used when evaluating project risks in any phase of the project. It is typically used in conjunction with the risk register. The P×I matrix can be used as the sole tool for ranking risks in a qualitative analysis. In a quantitative risk analysis, the P×I matrix can be used for an initial assessment of risks before a more precise measure of probability and impact is made for probabilistic calculations.

How to use it?

The Estimator, project team member, or appropriate subject matter expert uses his or her professional judgment to determine the probability of occurrence and the corresponding likely impact for each risk. This is typically done using adjectives (e.g., high, medium, low, etc.) rather than direct probabilities (e.g., 10 percent, 25 percent, etc.) or impacts (e.g., $1 million, 3 months, etc.). The adjectives correspond to color coding for graphical presentation. This information is used to prioritize the risks so that the project team can effectively allocate the resources to the risks that have the highest potential to adversely affect the project.

TIPS

The P×I matrix is most effective when used to prioritize the limited resources at a project team's disposal. A key requirement of successful use of this tool is the involvement of subject matter experts who can provide informed judgments about the probabilities of occurrence and the likely impact based on past experience, as well as data, when available.

RESOURCES

Caltrans Office of Statewide Project Management Improvement (2007). Project Risk Management Handbook: Threats and Opportunities, 2nd ed., May 2007, Caltrans, Sacramento, CA. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

U.S. Department of Energy (2003). Project Management Practices: Risk Management. U.S. Department of Energy, Office of Management, Budget and Evaluation, Office of Engineering and Construction Management, Washington, D.C.

Example

Figure 3.8-1 shows a sample P×I matrix with brief descriptions for the various combinations of probabilities of occurrence and impact. This example was taken from the Caltrans Risk Management Handbook.

	Very Low	Low	Moderate	High	Very High
Cost Impact	Insignificant cost increase	<5% cost increase	5-10% cost increase	10-20% cost increase	>20% cost increase
Schedule Impact	Insignificant slippage	<5% project slippage	5-10 % project slippage	10-20% project slippage	>20% project slippage
Scope Impact	Change is barely noticeable	Minor areas are affected	Change requires TBPOC approval	Change not acceptable to TBPOC	Material termination of project
Probability	1–19%	20–39%	40–59%	60–79%	80–99%

Note: TBPOC stands for the Toll Bridge Program Oversight Committee

Figure 3.8-1. Sample P×I Matrix

Figure 3.8-2 shows a color-coded assessment guide that project teams can use for rank-ordering project risks. This example is taken from the U.S. Department of Energy.

Level	Likelihood
A	Remote
B	Unlikely
C	Likely
D	Highly Likely
E	Near Certainty

ASSESSMENT GUIDE

Likelihood					
E	M	M	H	H	H
D	L	M	M	H	H
C	L	L	M	M	H
B	L	L	L	M	M
A	L	L	L	L	M
	a	b	c	d	e

Consequence

RISK ASSESSMENT

High (Black)

Unacceptable. Major disruption likely. Different approach required. Priority management attention required

Moderate (White)

Some disruption. Different approach may be required. Additional management attention may be need

Low (Blue)

Minimum impact. Minimum oversight needed to ensure risk remains low

Level	Schedule	and/or	Cost
a	Minimal or no impact		Minimal or no impact
b	Additional resources required; able to meet		<5%
c	Minor slip in key milestones; not able to meet need date		5-7%
d	Major slip in key milestone or critical path impacted		7-10%
e	Can't achieve key team or major program milestone		>10%

Figure 3.8-2. Definition of Impact and Probability Levels

R3.12 Risk Register

A risk register is a tool that project teams can use to address and document project risks throughout project development. The risk register should be maintained as part of the project file that also includes information related to the cost estimate.

What is it?

The risk register is a living document throughout project development that describes all identified risks, causes, probability of occurrence, impact(s) on project/agency objectives, team responses, individual(s) assigned to monitor the evolution and the resolution of each risk, and current status. It is a comprehensive listing of risks and the manner in which they are being addressed as part of the holistic risk management process. It is generally organized in the form of a spreadsheet so that it can be easily categorized and updated throughout the project development process.

Why use it?

A new project team is formed for every project and disbanded when the project is complete. Although not desirable, project team members sometimes change, and the project itself experiences changes over the course of the project. Therefore, communication between project team members about the project objectives, costs, risks, etc., is key. The risk register serves the purpose of communicating project risks and helping the team members understand the status of the risks as a project moves from inception to completion.

What does it do?

The risk register documents the identified risks, the assessment of their root causes, the areas of the project affected (e.g., work breakdown structure elements), the analysis of their likelihood of occurring, their impact should they occur, the criteria used to make those assessments, and the overall risk rating of each identified risk by objective (e.g., cost, time, scope, and quality). It includes the risk triggers, the response strategies for high-priority risks, and the assigned risk owner who will monitor the risk.

When use it?

A risk register should be prepared in conjunction with the first published cost and schedule estimate of a project. Thereafter, a full review and update of the risk register should be undertaken at the beginning of each subsequent phase of the project and during each phase as deemed necessary by the project team or the project approving authority.

How to use it?

A risk register is best used as a living document throughout project development to document the evolution of project risks. There is no prescription for how extensive a project team's risk register should be. Based on the example, the project team needs to decide upon the most beneficial use of the risk register, with the objective of minimizing the risk impact.

TIPS

A risk register is an important part of the project file for all projects, regardless of size or type. The level of detail in the risk register can vary depending upon the project size, complexity, etc.

RESOURCES

Caltrans Office of Statewide Project Management Improvement (2007). Project Risk Management Handbook: Threats and Opportunities, 2nd ed., May 2007, Caltrans, Sacramento, CA. http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

Washington State Department of Transportation (2008). CEVP® and Cost Risk Assessment (CRA) website. <http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/> (Viewed June 1, 2008).

Project Management Institute (2004). A Guide to Project Management Body of Knowledge (PMBOK® Guide), The Project Management Institute, Newton Square, PA.

Example

Figure 3.12-1 shows an example risk register from the Caltrans Project Risk Management Handbook. Caltrans project teams use this tool per the formal guidance at http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm.

DIST- EA	06-12345					Project Name:			Project Manager:
						Co - Rte - PM:			Telephone:
ITEM	ID #	Status	Threat / Opport-unity	Category	Date Risk Identified	Risk Discription	Root Causes	Primary Objective	Overall Risk Rating
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	i)
1	06-12345-01	Active	Threat	CON	03/26/07	Risk Description	Root Cause(s)	TIME	Probability 4=High (40-59%) High Impact 8 =High
2									Probability Impact
3									Probability Impact
4									Probability Impact

Figure 3.12-1. Sample Risk Register (Caltrans)

						Date Created:
Cost/Time Impact Value	Risk Owner	Risk Trigger	Strategy	Response Actions w/ Pros & Cons	Adjusted Cost/Time Impact Value	WBS Item
(j)	(k)	(l)	(m)	(n)	(o)	(p)
Cost/Time Impact Value	Risk Owner (545) 454-5454 (212) 121-2121 Risk Owner@dot.ca.gov	Risk Trigger(s)	AVOID	Response Actions	Adjusted Cost/Time Impact Value	165 PERFORM ENVIRONMENTAL STUDIES AND PREPARE DRAFT ENVIRONMENTAL DOCUMENT Additional

Figure 3.12-1. Sample Risk Register (Caltrans) (continued)

C4.2 Estimation Checklist

Checklists are intended to serve as guides in preparing, checking, and reviewing cost estimates for errors and omissions. Effective use of estimation checklists will minimize omissions and duplications. They are not, however, a substitute for the exercise of sound engineering judgment by the Estimator or the reviewers. The estimation professionals must independently evaluate supporting data upon which the estimates are based, but the checklist helps to ensure estimate completeness.

What is it?

Checklists are templates that Estimators and reviewers use to ensure a complete estimate. They guide the Estimator through suggested items and consideration of factors that impact project cost.

Why use it?

While Estimators and Project Managers are generally very familiar with assembling cost data and developing an estimate, the estimation process requires consideration of a very large number of work items and the factors that impact the cost of individual items, as well as factors that impact the cost of the project in general. Checklists serve to delineate the large number of factors that must be considered during estimate preparation. Therefore, they are an excellent means of avoiding omissions and for calling attention to the interaction between factors that can impact cost.

What does it do?

Checklists guide the Estimator through suggested work items and cost factors. A checklist serves to ensure that all cost categories are accounted for in an estimate. The answers to the checklist questions will provide an overview of the estimate's completeness and focus the Estimator's attention on critical questions. The checklists can be divided into major work areas, such as roadway and structural, to support specific parts of project estimate development.

When use it?

Checklists can support estimate creation at all stages of project development. The purpose of a checklist is to assist the Estimator in planning, formatting, and developing a complete estimate. Checklists should be as inclusive as possible, with questions that specifically probe the estimate at the different stages in project development.

How to use it?

A checklist should contain the various items included on a project, as well as the units of measurement to be used in estimating the items. A list of items that may appear on a checklist for estimating a Mn/DOT project could include but is not limited to the following:

- Clearing and grubbing (acre or hectare)
- Earthwork (cy or m3) – unclassified, borrow, undercut, etc.
- Fine grading (sy or m2)
- Drainage (per mile or kilometer)
- Paving (ton or mtn, w/pavement design, or sy/m2 without)
- Stabilization (sy or m2)
- Shoulder drains (lf or meter)
- Curb and gutter (lf or meter)
- Guardrail (lf or meter)
- Anchor units (each type)
- Fencing (mile or kilometer)
- Interchange signing (type and location)
- Traffic control plan (TCP) (per mile or kilometer)
- Thermo and markers (per mile or kilometer)
- Utilities (lf or meters)
- Erosion control (acres or hectares)
- Traffic signals (each and location)
- Retaining walls/noise walls (sf or m2, with avg. height)
- Bridges (individual location)
- Reinforced concrete (RC) box culverts (individual location)
- Railroad crossing (each – with or without gates)

When compiling the estimate, use the list of items on the checklist to ensure that they have not been overlooked in the determination of the estimate.

TIPS

There can be many individual checklists to support different phases of estimate preparation and specific cost areas: a plan review checklist; a site checklist; a checklist for developing quantities; and a checklist to consider construction noise, dust, and other construction nuisance issues.

Example

Example to be furnished or developed by Mn/DOT.

E3.1 Formal Committee

Mn/DOT uses an "estimate review committee" approach to enhance estimate accuracy. The formal committee reviews each estimate at different stages in project development and prior to the bid letting. The committee structure usually consists of six people, including the state construction engineer, an FHWA representative, a contract administration engineer, a state maintenance engineer, and two project/field engineers.

What is it?

A formal committee estimate review is a cost estimate validation tool. This cost validation tool entails an objective review of the estimate by a group of experienced third-party Mn/DOT individuals who did not participate in development of the estimate.

Why use it?

The most effective means of improving estimate quality is not to refine estimation methods or computer software, but to refine the methods of identifying errors and omissions. This is a tool to ensure that estimation criteria and requirements have been met and that a well-documented, defensible estimate has been developed.

What does it do?

The review committee seeks to subjectively determine estimate accuracy based on the totality of the information available. In particular, the committee does the following:

- Determines whether the estimate satisfies the project criteria: The committee seeks to ensure that the estimate conforms to the project scope and design documents.

- Appraises the estimate methodology: The committee must be able to follow and check the estimate methodology. Steps to do this would include verifying estimation techniques and sources of estimate data. The committee should be able to clearly understand the origin of all numerical data in the estimate.

- Identifies uncertainties: The committee should confirm all uncertainties documented in the estimate and identify other uncertainties in the estimate that were missed or glossed over. It is good to note these uncertainties at this time so that an accurate estimate can be developed.

- Documents the findings: The findings of the estimate review must be documented. The committee may use an estimate review checklist or prepare a concise written report that documents the findings. A sample estimate review checklist is presented in the example part of this section.

When use it?

Reviews are typically employed on plans, specifications, and estimates (PS&E). However, as the project design is developed and the revised estimates are generated, it is good practice to conduct a review of the revised estimate, particularly at the major design development stages, 30 percent and 60 percent. These earlier reviews can provide real benefit because they often discern cost drivers that can be addressed by design changes and, in so doing, reduce project cost.

Example

Here is an example of a checklist used by a formal committee when conducting a review.

TIPS

The reviewer must try very hard to eliminate confusion in the contract documents and specifications. Check the estimated cost of any items that represent unfamiliar work or items for which there is only a limited database of historical information. Investigate whether the percentages used to estimate overhead and other costs besides the direct cost are realistic.

It is good practice to include younger Mn/DOT staff as members of the committee so that they can learn from the discussion, but many times they will also contribute a completely new perspective.

REVIEW CHECKLIST

- Review Date:
- Review Location:
- Project Name:
- Reviewers' Names and Organizations:
- Background Data and Conditions:
- Is there complete technical scope documentation, including the following elements?
  - Description of the work to be performed;
  - Performance criteria and requirements;
  - Discrete tasks and deliverables;
  - Resource requirements;
  - Sequence of events and discrete milestones;
  - Work not included in the scope.
- Have milestone descriptions been developed for each milestone associated with the project?
- Does the technical scope documentation for the estimate include descriptions of support associated with the work to be performed?
- Is the technical scope for the estimate consistent with the site, regulatory requirements and constraints (e.g., permit conditions, regulations) identified during the Planning Process?

Cost Estimate

- Are appropriate historical cost data used in the estimate?
- Are direct costs that are associated with individual activities included in the cost estimate clearly and individually identified?
- Are indirect, overhead, or other costs clearly and individually identified?

- Has the cost estimate been updated in a timely manner in response to relevant changes in its basis, background data, or assumptions?
- Are an appropriate change control document and an estimate development history attached to the cost estimate?
- Does the estimate development history include an itemized and chronological list of the changes made to the cost estimate since initiation of its preparation, along with the rationale for each change?
- Are activities, quantities, and unit costs associated with the work to be performed clearly identified and defined in the cost estimate?
- Are the assumptions and exclusions upon which the cost estimate is based clearly identified and defined in the estimate?
- Are time and cost assumptions and cost elements associated with each activity clearly identified, defined, and documented in the estimate?

Cost elements for program activities include the following:

- Unit of measure
- Material cost
- Overhead rate
- Total overhead allocated
- Are significant Estimator findings identified during preparation of the estimate documented?
- Have factors been used to adjust the costs? If so, have they been adequately documented and appropriately applied?
- Have escalation factors been used to escalate the estimate?
- Are the escalation factors adequately documented and appropriately applied?
- Are indirect rates used in the estimate adequately documented and appropriately applied?
- Are estimate summary and detailed reports included, and do they provide cost totals for each cost element in the estimate?
- Is a schedule included with the estimate?
- Are activities included in the schedule consistent with those included in the technical scope?
- Are milestones and deliverables included in the schedule consistent with those included in the technical scope documentation and the estimate?

E3.3 In-House/Peer

An objective estimate review can be accomplished by a group of experienced third-party Mn/DOT individuals who did not participate in development of the estimate. For large or complex projects, the review is usually conducted with the project team and Estimator so that the reviewers can better understand the execution plan, estimate basis, and project challenges in regards to scope and costs.

What is it?

A peer review typically involves an estimate validation by a Mn/DOT Estimator who has not worked on the estimate being reviewed. The reviewer must have the experience and knowledge to carefully appraise the materials presented. In the case of larger projects, this peer validation may involve a peer team.

Why use it?

The foundation of a good estimate is the formats, procedures, and processes used to arrive at the cost. Poor estimation includes general errors and omissions from plans and quantities, general estimation procedure, and technique inadequacies. It is easy for individuals at Mn/DOT to conduct an estimate review because they are familiar with the formats, procedures, and processes that Mn/DOT has in place and, therefore, can easily spot deficiencies.

What does it do?

A peer review checks the estimate for completeness and correctness, including, but not limited to, the following:

- Check mathematical extensions and correctness.
- Check takeoff for omissions or oversights.
- Check for conformity between amounts of work (item quantities) with the schedule durations to determine correctness.
- Check the calculations of the indirect costs.
- Examine the estimate for buried contingency.

Compare the estimate with any similar project for an order of magnitude check.

When use it?

Each time a revised estimated is generated, there should be a review. An estimate review is the best means for ensuring accuracy and minimizing the potential for unanticipated surprises concerning the financial condition of the project.

TIPS

The peer review should consider the following:

- What is the basis for the assumptions made in developing the estimate?
- Are the assumptions made in the estimate consistent with the technical scope and schedule of the project?
- Are the activity durations in the schedule consistent with the estimated cost?
- Are indirect rates, escalation factors, and other factors used appropriately?
- Have the findings and recommendations of the peer review been documented in a peer review document?
- Is the peer review document included with the cost estimate documentation?
- Have the findings and recommendations of the peer review been addressed in revisions to the cost estimate?
- Are activities included in the schedule consistent with those included in the technical scope documentation and estimate?

Example

Example to be furnished or developed by Mn/DOT.

E3.4 Round Table Estimate Review

Some Mn/DOT estimate reviews can have a round-table structure, in which the Estimators sit down with the reviews. Much like the other estimate reviews, the round-table review examines the estimate and the basis. However, unlike other estimate reviews, the round-table review has the advantage of bringing a greater body of knowledge and experience to the review to encourage a dialogue.

What is it?

A round-table estimate review is like the process used by contractors to validate their cost estimates before a bid letting. The project team assembles and has a detailed discussion of the schedule, conditions, and expected construction methods for the major cost items, as well as all known site conditions. Only after that discussion does the actual review of total cost and item cost begin. The cost review is top down by broad classes: direct cost total and major items, Mn/DOT field support cost, Mn/DOT administrative support cost, and included contingency.

Why use it?

All project estimates are very complex in terms of the factors that can determine work item costs, and Estimators must make numerous judgments based on perceptions of work conditions and the physical conditions at the project site as the estimate is developed. Therefore, it is good practice to capture a different perspective from Mn/DOT experts in order to validate the Estimator's assessment.

What does it do?

Using a committee to review an estimate brings knowledge from Mn/DOT experts with a broad base of experience. The reviewers who compose the committee should represent diverse sections of Mn/DOT, having specific knowledge of cost-impacting factors—for example, personnel from the Mn/DOT's right-of-way section for reviews during planning and design development and personnel from the construction office for a review of PS&E.

When use it?

Periodic reviews of estimates are important because conditions and underlying assumptions for the original and subsequent estimates often change; thus, estimates need to be revised to account for these changes. When estimates are revised, there should be a review because reviews are the best means for ensuring accuracy and minimizing the potential for unanticipated surprises concerning the financial condition of the project.

Example

The following is one example of a Round Table review document. This document should be completed as part of the review. The project team should present information to the reviewers that aids in completion of the example document.

1. Project Review Information

Project Name: ___________________________________

Review Date: ___________________________________

Review Location: ___________________________________

Reviewers' Names and Titles:

___________________________________ ___________________________________

___________________________________ ___________________________________

___________________________________ ___________________________________

___________________________________ ___________________________________

___________________________________ ___________________________________

___________________________________ ___________________________________

2. Summary Project Description

Please use the items below to present a project summary and provide a very brief written description. Please reference appropriate sections in the Scoping Document for more information, if applicable.

Summary of Scope (including alternatives):

Design:

- Design level: ___________________________________
- Structural: ___________________________________
- Foundations: ___________________________________
- Drainage: ___________________________________
- Pavement: ___________________________________
- Materials: ___________________________________
- Maintenance: ___________________________________
- Compliance with design standards: ___________________________________

Environmental:

- Environmental documentation: ___________________________________
- Wetlands: ___________________________________
- Streams: ___________________________________
- ESA: ___________________________________
- Floodplain: ___________________________________
- Stormwater: ___________________________________
- Contaminated/hazardous waste: ___________________________________
- Section 106: ___________________________________
- 4(f): ___________________________________
- Permitting (incl. 404): ___________________________________

Right-of-way and other agreements

- Right-of-Way: ______________________________
- Utilities: ______________________________
- Railroad: ______________________________
- Other stakeholders: ______________________________

Procurement:

- Delivery method: ______________________________
- Contract packaging: ______________________________
- Market: ______________________________

Construction:

- Construction access/restrictions (including shifts): ______________________________
- Maintenance of traffic: ______________________________
- Construction phasing: ______________________________

Project Schedule:

- Design schedule: ______________________________
- Construction schedule: ______________________________

3. Categorization of Project Complexity

Project complexity significantly influences the methods and tools used for cost estimating. This section of the Report Card categorizes project complexity using the complexity definitions in Appendix A. Please refer to the Appendix A and categorize the project as one of the following:

☐ Most Complex (MAJOR) Project ☐ Moderately Complex Project ☐ Non-Complex (MINOR) Project

Comments: ______________________________

____

____

4. Estimate Basis Review

Please use the following scale of evaluation for Sections 4, 5 and 6.

Scale of Evaluation	
Grade	**Description**
A	Excellent Treatment of Issue
B	Very Good Treatment of Issue
C	Good Treatment of Issue
D	Fair Treatment of Issue
F	Poor Treatment of Issue

Step	Issue	Grade	Comments and Action Items
Review Scoping Document	1. Functional Group Scoping Worksheets identify technical requirements for each group relevant to project for this estimate. a. Items pertinent to project listed on worksheets checked b. Drawings available (schematics – plans, cross sections, others,) c. Key parameters provided d. Consistent with project purpose and need e. Missing information identified 2. Level of project complexity is identified. 3. Preferred alternative is selected.	________	
Review Site Characteristics	4. Estimator visited the project site to review site characteristics and their potential impact on estimate elements and cost basis. 5. Estimator used video logs and aerial photos to assess potential impact of site characteristics on estimate elements and cost basis. 6. Results of site visit are documented. 7. Technical scope for the estimate is consistent with the site, regulatory requirements and constraints (i.e., permit conditions, regulations) identified during the Scoping Process.	________	
Determine if Clarification Needed	8. Estimator has considered the need for additional information from various Functional Groups (e.g., clarification of group requirements, etc.). 9. Estimator has asked for clarifications from the various Functional Groups, where necessary. 10. Functional Groups have provided the requested additional information.	________	
Document Scoping Estimate Basis	11. Estimate development history is documented that itemizes and chronologically lists changes made to any previous cost estimate for this project, and includes the rationale for each change. 12. A Project Estimate File is prepared that includes documentation of the estimate basis.	________	

Summary Estimate Basis Review Grade

☐ A – Excellent Treatment of Issue	☐ C – Good Treatment of Issue	☐ F – Poor Treatment of Issue
☐ B – Very Good Treatment of Issue	☐ D – Fair Treatment of Issue	

Summary Estimate Basis Review Comments and Action Items

5. Base Estimate Preparation Review

Step	Issue	Grade	Comments and Action Items
Select Appropriate Approach	1. Estimate approach(es) used to prepare cost estimate are documented (e.g., historical bid based, cost based, similar project, parametric (LDW), percentages, etc.).	________	
	2. Estimate approach(es) align with the type of project definition/information/requirements available and the complexity of the project.		
Quantify Estimate Elements	3. Documentation provided to substantiate number of estimate elements considered.	________	
	4. Documentation provided to support quantity calculations for key estimate elements.		
Develop Estimate Data	5. Cost basis is appropriate and consistent with estimate approach(es) (e.g., use of historic bid prices, etc.).	________	
	6. Documentation is provided justifying adjustments made to cost basis for estimate elements.		
	7. Documentation is provided to support development of cost basis for estimate elements.		
	8. Estimator incorporates cost estimate information from Functional Groups.		
	9. Estimator identifies inflation guidance for year-of-construction cost calculation.		
Calculate Cost Estimate	10. Estimator checks to ensure that all work items are included in estimate including cost estimate input from Functional Groups.	________	
	11. Estimator verifies that all estimate elements are input correctly.		
	12. Estimate system calculates base cost and summarized estimate elements.		
	13. Estimator ensures that other/all categories representing the total project cost are included.		
Document Estimate Assumptions	14. Assumptions and exclusions upon which the cost estimate is based are clearly identified, defined, and documented in the estimate backup.	________	
	15. Adjustments to historical cost data used as the cost basis for estimate elements are clearly documented.		
	16. Escalation factors have been used to escalate the estimate.		
	17. Base estimate does not include any contingency.		

Step	Issue	Grade	Comments and Action Items
Prepare Estimate Package	18. Documentation of estimate basis and all assumptions is covered including why each assumption was made and how.	________	
	19. Identify uncertain items and list them.		
	20. Escalation factors are adequately documented and appropriately applied.		
	21. Project schedule is included with the estimate.		
	22. Cost summaries are included such as:		
	a. Summary of total cost by category		
	b. Detailed cost summaries by major line item		
	23. Base estimate package is prepared.		
	a. Total cost summary		
	b. Detail cost summaries		
	c. Estimate basis		
	d. Estimate assumptions		
	e. Uncertain items listed		
	f. Other supporting documentation		

Summary Estimate Basis Review Grade

- ☐ A – Excellent Treatment of Issue
- ☐ B – Very Good Treatment of Issue
- ☐ C – Good Treatment of Issue
- ☐ D – Fair Treatment of Issue
- ☐ F – Poor Treatment of Issue

Summary Estimate Basis Review Comments and Action Items

6. Risk and Uncertainty Review

Step	Issue	Grade	Comments and Action Items
Review Risk Information	1. Review previous estimates for list of risk items. 2. The current estimate explicitly identifies contingency. 3. The current estimate has been reviewed for any contingency "buried" in line items or not explicitly identified. 4. All contingency items have been listed separately and summed for the total cost summary.	________	
Determine Level of Risk Analysis	5. A detailed approach to risk analysis has been defined. For example: • Type I – Percentage Contingency Applied • Type II – Individual Risk Factors Applied • Type II – Complete Uncertainty Analysis	________	
Identify Risks	6. A list of risk has been compiled through a review of: • Key estimate basis assumptions • Key base estimate assumptions • Any project team issues or concern (all major disciplines should be consulted) • Market conditions 7. A checklist of risks has been consulted to ensure that no common risks have been overlooked. [3]	________	
Estimate Contingency	8. The estimate contains an explicit contingency estimate that is based on the identified risks. [4] 9. The contingency estimate has been compared to other contingency estimates on similar projects.	________	
Document Contingency Estimate	10. The contingency estimate has been adequately documented. • Risks and uncertainties have been documented. • The method of calculating contingency has been documented.	________	
Prepare Total Project Cost Estimate	11. The total project cost (base plus contingency) has been completed.	________	

3. Note: For a comprehensive risk checklist, please see Appendix B — Risk Identification on page XX.
4. Note: Projects categorized as Non-Complex and Moderately Complex Projects most frequently use a Type I contingency estimate, which involves a listing of risks and the application of a graduated contingency estimate. Appendix C – Percent-Contingency contains examples of graduated contingency estimates that can be used for a Type I contingency estimate.

Summary Estimate Basis Review Grade

☐ A – Excellent Treatment of Issue ☐ C – Good Treatment of Issue ☐ F – Poor Treatment of Issue
☐ B – Very Good Treatment of Issue ☐ D – Fair Treatment of Issue

Summary Estimate Basis Review Comments and Action Items

7. Summary of the Total Cost Estimate

The 2009-2010 bonding projects will be based on Total Cost Estimates that identify elements of both base estimate items and contingency estimate items. The following items have been identified as categories of total cost and must be categorized separately in the estimate.

Base Estimate Elements

1. Pre-Letting Engineering: Internal—Mn/DOT
2. Pre-Letting Engineering: External—Consultants
3. Construction Engineering: Internal—Mn/DOT
4. Construction Engineering: External—Consultants
5. Project Construction Cost
    - Per Scoping Report (e.g., roads, bridges, approaches, and other structures)
    - Contractor Work (e.g., staking, creation of machine control, landscaping, and retaining walls)
6. Detours and Haul Roads
7. Pre-Letting Traffic Management: Enforcement and Incident Mgt
8. Construction Traffic Management: Extraordinary Enforcement and Incident Mgt
9. Pre-Letting Communications/Public Information
10. Construction Communications/Public Information
11. Right-of-Way
12. Utilities
13. Railroads
14. Municipal/Local Issues
15. Turn-Backs: Before
16. Turn-Backs: After
17. Landscaping
18. Environmental Clean-Up/Mitigation
19. Incentives (moves to construction contingency after Letting)

Contingency

Pre-Letting Contingency:

- Total for Base Estimate Elements

Post-Letting (Construction) Contingency:

- Supplemental Agreements
    – Change Orders
    – Cost Overruns
    – Incentives

Total Project Cost Estimate[5] = Base Estimate + Contingency

5. The Total Project Cost Estimate at the time the Scoping Report is approved is designated the Baseline Cost Estimate.

8. Project Report Card and Action Items

Project Information	Estimate Basis Review
	Grade _____ Comments and Action Items:
Overall Estimate	**Base Estimate Review**
Grade _____ Comments and Action Items:	Grade _____ Comments and Action Items:
Project Complexity Rating	**Risk and Contingency Estimate Review**
☐ Most Complex (MAJOR) Project ☐ Moderately Complex Project ☐ Non-Complex (MINOR) Project Comments:	Grade _____ Comments and Action Items:

TIPS

An estimate review does not dig into every detail of the estimate, but it should always test the vital few items and assumptions. The Italian economist Vilfredo Pareto observed that 20 percent of something is always responsible for 80 percent of the results. That observation is recognized today as a universal principle called the 80/20 rule, or Pareto principle. The Pareto principle should guide the estimate review. Applying the rule allows the reviewers to set priorities. After a general overview analysis of the estimate, the reviewers should concentrate on the items that are the project's primary cost drivers. The reviewers should carefully examine the selected items based on a list of important issues:

- correctness of quantities;
- appropriateness of unit cost;
- validity of assumed construction method, considering site conditions and project phasing;
- consideration of external market factors that could affect cost (this is critically important in the cast of large, complex projects);
- unforeseen engineering complexities;
- changes in economic and market conditions;
- changes in regulatory requirements;
- pressures by local government or other stakeholders;
- transformation of community expectations;
- market availability of materials and/or equipment;
- concise explanation of how contingency amounts were developed; and
- construction schedule.

There should be comparisons of costs to benchmark ratios and factors for similar projects.

E2.1 Expert Team

Very complex and high-profile projects should have an external review of the estimate by qualified professionals. The most indispensable tool for estimate review is judgment. Judgment is what identifies mistakes, detects flawed assumptions, and identifies where the process has missed critical cost drivers. The surest way of conducting a successful external review is by selecting a panel of independent reviewers that have as broad a range of engineering experience as the project demands.

What is it?

External reviews concentrate on the estimation process and methodology. They are applied based on project scope and design development at the point in time when the review is conducted. An external review should include a risk analysis that identifies the critical elements of the estimate and possible impacting risks.

Why use it?

Large projects with multiple interacting activities, urban projects with numerous stakeholders, and projects using new technology all test the Estimator's ability to properly account for all cost drivers when developing a project estimate. Therefore, a review that brings a viewpoint completely external to that of the state highway agency should be part of an inclusive review process. This includes a requirement for internal reviews of the estimate calculations and the applied unit costs.

What does it do?

The reviewers seek to assess the reasonableness of the assumptions supporting the cost and schedule estimates and assess the rationale for the methodology used. Reviewers receive a briefing from the project team and the Estimators and are given access to all available project documentation. By applying parametric techniques or ratios to analyze costs and schedule reasonableness, they check the completeness of the estimate. However, they usually do not perform quantity takeoffs or estimate individual items. The result is a report that details findings and recommendations. In the case of a very complex project with critical cost drivers, it is sometimes necessary for the reviewers to develop an independent, bottom-up estimate of their own to ensure estimate reasonableness. This may or may not involve quantity takeoffs but usually does necessitate vendor quotations and productivity analysis of the critical cost items.

When use it?

Independent external reviews are more typically employed on PS&E of large, complex projects. However, having such reviews conducted much earlier in the Design Process can provide real benefits because they often discern cost drivers that can be addressed by design changes, thereby reducing project cost.

TIP

The reviewers need to be experienced professionals who have an understanding of engineering and construction complexities. Market conditions or changes in the macro-environment can affect the costs of a project, particularly large projects. Often, only large contractors or groups of contractors can handle the construction tasks or even obtain bonding for a large project. The size of the project affects competition for a project and the number of bids that a state highway agency receives for the work. External independent reviews are usually more attuned to the impacts of such factors on project cost.

Examples

Several state highway agencies have used retired heavy construction personnel to conduct estimate reviews and, in some cases, have even staged mock bids. As an after-the-fact example, on December 13, 2001, Maryland DOT opened bids for the Woodrow Wilson Bridge superstructure contract. A single $860 million bid was received. That amount was more than 75 percent higher than the Engineer's Estimate for the contract. Maryland formally rejected the bid because it far exceeded the project's budget. An independent review committee (IRC) was organized to identify and evaluate the reasons for the large discrepancy between the Engineer's Estimate and the bid submitted. The IRC determined that the owner-produced estimate was technically solid, based on tangible factors like the cost of steel, concrete, and other materials. But certain significant factors, particularly for large construction projects, are difficult to quantify in an estimate. The IRC went on to state that the estimate did not sufficiently take into account the intangibles of market factors, specifically the following:

- Contractors capable of bidding a project of that size were seeking larger margins to protect themselves due to recent experiences on other mega-projects and to associate project risks.

- There were several other large bridge projects bidding in the same period, a completely external factor that caused a lack of competition.

- Equipment demands on projects of this size are substantial. Maryland DOT took the advice of the IRC and repackaged the contract and rebid the project approximately a year later as three independent contracts. The first contract rebid came in 11% over the estimate, but there were five bidders, and it was a workable bid. The other two contracts both came in below the estimates, one by 28% and the other by 25%.

C1.2 Communication of Uncertainty

Properly communicating the uncertainty involved in an estimate will help to ensure that appropriate decisions are made from the estimate. Estimate uncertainty can be communicated by providing a range estimate rather than a point estimate. Communication of estimate uncertainty can also be conveyed by simply listing the assumptions, allowances, unknowns, and contingencies included in an estimate.

What is it?

Communication of estimate uncertainty involves an explicit means of conveying the accuracy of an estimate. There are numerous means of conveying uncertainty. Presenting a cost range is common early in project development, and presenting a contingency is common during final engineering. At any point in the process, a list of allowances or project unknowns can be used to convey uncertainty. All means are intended to let designers and decision makers know the accuracy of, or potential error in, a cost estimate.

Why use it?

Projects are not well defined in the early stages of their development. Identification and communication of the project's early stage uncertainty and the fact that unknowns can impact scope and estimated costs will help in managing project expectations.

What does it do?

Communication of uncertainty creates transparency in the estimation process. It buffers Estimators by conveying that estimates are not absolute, but rather are predictions based upon the best information known at the time. This tool allows for more prudent decisions to be made from cost estimates.

When use it?

The identification and communication of the uncertainty in relation to project scope and cost unknowns helps in managing project cost in all phases of project development, but particularly in the Programming and preliminary Design Phase. As the project moves from Programming through preliminary Design, the amount of uncertainty in the estimate should diminish. Good cost management techniques communicate specifically how the Design Process has removed the uncertainty.

How to use it?

In order to convey uncertainty concisely to the project team and any number of stakeholders, prepare a short document that satisfies at least the following guidelines:

- Include summary information about the project.

TIP

Transparently convey the uncertainty of each estimate. An estimate with uncertainty is not a bad estimate; it is a realistic estimate. Conveying uncertainty will allow better decisions to be made from estimate information.

- Provide a cost range, rather than a point estimate, for both cost and schedule.
- List the risks associated with the project so that readers understand what is driving the uncertainty in an estimate.
- List reasons for uncertainties.
- List changes from periodic or milestone estimates.

Example

Figure C1.2-1 is an illustration of a typical one-pager being developed by Mn/DOT.

PROJECT SUMMARY
<<Highway>>
<<Project Title and Location>>
<<Project Website *(if applicable)*>>

(Project Map)

Schedule:

Environmental Document Approved:
Municipal Consent (if applicable):
Geometric Layout Approved:
Construction Limits Established:
Original Letting *(as of Dec. 2008)*:
Current Letting *(if changed from Dec. 2008)*:
Construction:
Others Important Project Milestones (if applicable):

Project History: *(for bridge projects please include the bridge condition such as year built, NBIS condition rating, previous work on bridge, need for project)*

Project Benefits:
-

Project Risks:
-

- **Project Description:**

Total Project Cost Estimate (millions)
Date entered into STIP: (*date of approved STIP)*

	Baseline Est.	Current Est.
Construction Letting:	$	$
Other Construction elements:	$	$
Engineering:	$	$
Right of Way:	$	$
Total:	**$**	**$**

(Cost estimates should be adjusted to year of expenditure using current inflation rates provided by OIM)

Recent Changes and Updates *(including reasons for delay from original year in STIP, if applicable):*
-

Key Cost Estimate Assumptions:
-

Design Completed (Scale 0-100%):

(Phase-by-phase scale, colored to the percentage of completion. See examples.)

Minnesota Department of Transportation
District 7
501 South Victory Drive
Mankato, MN 56001-5302
(507) 304-6100 / (800) 657-3747
District Engineer:
Project Manager:
Original date of posting: Month date, Year
Revised: Month date, Year

Figure C1.2-1. One Pager for Highway 60 Project

C1.3 Communication within Mn/DOT

Developing a project-specific communication plan that includes all types of internal communication among project team members is required for successful project execution. This communication plan should include issues related to cost estimation practice and cost estimation management.

What is it?

Communication is the exchange of specific information. Both cost estimation management and cost estimation practice involve many information exchanges. Timely and accurate information transmission is often attributed to efficient project organizational structures. Cost estimation management and cost estimation practice involve multiple participants within Mn/DOT, often at different locations, such as in Districts or headquarters. Even within Districts, there may be multiple office locations. Hence, there is a need to establish channels for efficient communication.

Why use it?

Communication tools and techniques ensure the timely and appropriate generation, collection, storage, and retrieval of project information. A project communication plan has to be developed identifying who is responsible for what information or data, and how and when this project participant can be reached to obtain that specific information. Mn/DOT has many different teams working on different aspects of a project, such as pavement design and estimation, right-of-way estimation, bridge design and estimation, and project risk analysis. The Estimator must consult with such teams to incorporate current cost into the estimate. This communication interaction should be covered in the project communication plan.

What does it do?

A communication plan establishes a logical channel for project participants internal to Mn/DOT to interact with each other. A good plan will eliminate ambiguities like where to find what information and who to consult for a specific problem in relation to the many different aspects of the project (including cost estimation management and cost estimation practice). In particular, the communication plan should identify who needs to be notified when changes are made that impact scope, cost, and/or schedule.

When use it?

An internal communication plan is used during all phases of the project development. However, this plan must be created as early as possible and may have to be updated as newer participants join the project team. The project team must be informed of any changes.

TIP

A formal list of all project participants and their contact information must be created for every project, along with the participants' duties and responsibilities. A portion of this list must be dedicated to communication related to cost estimation practice and cost estimation management. Educate and train project participants on the importance of e□cient communication. Ensure project participant awareness of the project communication plan.

How to use it?

Lead project personnel should assign team members to create a project team member analysis with input from all participants; at this point a communication matrix can be formulated. This process involves collection of data, such as different modes of communicating with different team members, period of unavailability, and alternative contact information. Subsequently, a communication matrix should be formulated matching the work breakdown structure (WBS) with all deliverables and timelines clearly indicated. This will help eliminate ambiguities in determining responsible participants at any point in the project and will help reduce any delays caused by a communication blackout. The table should address communication between and among the teams, as well as communication protocols. In addition, the table helps to ensure that communication is open, honest, continuous, and efficient.

Example

Example to be furnished or developed by Mn/DOT.

C1.5 Proactive Conveyance of Information to the Public

Proactive conveyance of information to the public is an important tool in cost estimation management. An informed public can become partners in cost estimation management. Additionally, Mn/DOT has been entrusted with resources from the public and has the responsibility to communicate how it is managing the resources to maximize the state's transportation system. Cost estimation practice and cost estimation management are vital processes to manage these resources. Transparency and proactive conveyance of estimate information can assist in cost estimation management.

What is it?

This tool is a proactive approach for conveying cost estimate information to the public. It includes an action plan established for taking a proactive rather than defensive (or reactive) posture in gathering and transmitting information.

Why use it?

Public input can be vital to successful project completion. The public is the customer of Mn/DOT; if the public does not agree with the project or some aspects of the project, there can be major impacts to project cost, schedule, and scope. Open and honest communication with the public can limit problems that impact project development.

What does it do?

A communication plan and the activation of the plan can create an open and honest dialogue between Mn/DOT and the public. It creates accountability in cost estimation management for both Mn/DOT and the public. This open exchange creates a positive atmosphere in which the Mn/DOT and public can express goals, questions, comments, and concerns. Not only does this allow for an exchange of information, but it also produces an air of accountability. The plan needs to be developed and followed actively throughout project development.

When use it?

To be effective, the plan needs to be instituted in the earliest stages of project development. Communication plans may be standard for all projects, but large, complex, and sensitive projects require more extensive information exchanges than small, simple projects.

How to use it?

Mn/DOT projects need to have public awareness plans that make information available to the public for not only large projects, but also regarding smaller, less controversial projects. This does not have to be a high-cost initiative on all projects. Consider using local and regional media, local schools, fairs, malls, focus groups, sponsorship of teams in walk-a-thons or benefit races, advisory groups, town hall meetings sponsored by local organizations, billboards, flyers, logo design competitions, or appearances at local civic club meetings. Also consider using a website to convey this information. A website enables the public to track any project and allows for open communication between Mn/DOT and the public.

Example

Example to be furnished or developed by Mn/DOT.

C1.6 Simple Spreadsheet

Spreadsheets and checklists are excellent and simple methods for ensuring that all components of project cost have been considered and accounted for in the estimate. Spreadsheets and checklists, which identify the elements and activities included in (and excluded from) the estimate, can effectively communicate project cost and the distribution of that cost.

What is it?

Spreadsheets are formatted standard lists of items that an Estimator should consider when calculating the cost of a project. Because spreadsheets are usually straightforward documents, they are very good tools in communicating estimate completeness and the allotment of costs to the different portions of work.

Why use it?

A well-designed spreadsheet will clearly communicate the total estimated cost of the project, as well as what is included in the estimate and what the various categories of work are expected to cost. A secondary objective is to guide Mn/DOT toward improved estimation processes and practices.

What does it do?

The objective of a spreadsheet is to provide guidelines that (1) facilitate creation of a complete estimate and (2) support the evaluation of cost and schedule credibility. Spreadsheets serve to document estimate completeness in an easy-to-read format, which facilitates project cost communication in a uniform and structured manner.

When use it?

Different spreadsheet formats (with different levels of detail) are used in the course of project development as project scope is quantified and additional information becomes available. However, spreadsheets should be designed so that major categories can easily be expanded as project detail is better defined.

How to use it?

The detail of an estimation spreadsheet will vary by project type and by the point in time when the estimate is being created. In the earliest stages of project development, there is limited project definition and design knowledge. Some

TIP

The calculation of estimated costs during the early phases of project planning usually employs parametric techniques based on historical cost data. Therefore, to be truly effective, the Mn/DOT has a cost databases for organizing and retaining information on completed projects.

examples of cost items that would appear on an early stage spreadsheet would be:

- grading and drainage,
- base and pavement,
- lump items,
- miscellaneous, and
- engineering and construction.

The spreadsheet also requires calculation of a total cost and a total cost per mile to provide transparency in comparing the cost to similar projects, thereby assessing reasonableness. These basic categories can be expanded as additional information about the project is developed.

Example

Example to be furnished or developed by Mn/DOT.

B1.5 Variance Reports on Cost & Schedule

Variance reports capture changes in cost and schedule and provide a mechanism for budget control through tracking changes and alerting project personnel of changes.

What is it?

This is a tool for alerting project personnel, particularly the Project Manager, to deviations from the project budget or baseline cost. It enhances the Project Manager's ability to control project cost and schedule.

Why use it?

Early identification of differences in project cost and schedule can help to ensure proper resource allocation. Discrepancies between the baseline cost and schedule can be harmful to the project. If a project's costs increase, additional funds will need to be allocated. If a project's schedule increases, additional funds may also have to be allocated to compensate for inflation, rising land values, or other time-related factors. If the project costs decrease, the additional resources can be allocated elsewhere; however, care should be taken to not redirect money that will have to be requested later due to not realizing that the deviations were inaccurate or not recognizing that unfavorable differences in funds (an increase in funding needs) were a possibility in the future. If the project schedule decreases, the availability of funds, as well as other resources, needs to be assessed given the new timeframe.

What does it do?

Variance reports create a transparent notification system for alerting project personnel of deviations in project baseline costs and/or schedule.

When to use it?

Variance reports need to be completed regularly throughout project development. However, their use is most important during the Design Phase when managing project costs against the baseline cost estimate. Variance reports support project change requests (see tool C6.3).

How to use it?

Variance reporting commences with the estimate reconciliation step in the Review and Approve sub-process. The purpose of this step is to compare a current estimate with the baseline cost estimate. Deviations from the baseline are noted and must be explained. Be sure to generate variance reports at key project milestones or when significant changes in the project occur. This will aid in helping to monitor and control costs.

RESOURCES

NCHRP Report 574
Tool Appendix

Example

The variance reports help the Project Manager's to control the cost and schedule variance of the project at the stages of project. Figure B1.5-1 includes the details of the project. The information is filled in the columns and the difference between the baseline cost estimate and the updated cost estimate is calculated. An explanation is also provided in the table to support the reasons behind the cost increase or decrease. This difference marks the variances in the project and helps to ensure proper resource allocation. This removes the discrepancies from the project and controls the cost and variances. Figure B1.5-1 is used at the planning phase of the project when there is not baseline cost estimate set. After the scoping phase, the baseline cost estimate is available, figure B1.5-1 is used to calculate the variances and control the cost and schedule of the project.

Estimate Reconciliation

SP Number: Estimate Completion Date:

Project Location:

Project Description: Reporting Date:

Components	Baseline Cost Estimate				Updated Cost Estimate				Difference				Explanation
	Base	Contingency	Total (Current Yr.)	Construction Year	Base	Contingency	Total (Current Yr.)	Construction Year	Base	Contingency	Total (Current Yr.)	Construction Year	
DIVISION													
GROUP													
CATEGORY													
ELEMENT													
ITEM													
TOTAL													

Figure B1.5-1. Estimate Reconciliation Spreadsheet

TIPS

Consider different variance report details and intervals depending on the level of complexity of the project or phase of project development. Intervals should be closer together on highly complex projects or projects that are in a phase of high activity, such as during the Design Phase. Even during periods of inactivity, projects should be regularly examined to ensure that there are no variances in project costs or schedule.

Variances should be reported to appropriate levels of management if the magnitude of the deviation warrants.

Consideration should be given to the impact of multiple small deviations that alone do not account for much difference from the budget or schedule but collectively amount to a problem. Safeguards should be in place to watch for this type of activity. Regular estimate updates will help uncover the impact of small deviations from the baseline cost estimate.

C6.1 Cost Control Reports

Cost control is the primary objective of cost management. Managing to a baseline cost estimate is one of the most common measures of cost management success. As a project moves forward through its development stages, cost control reports provide a benchmark against the project baseline. They create a standard tool that can be used by the Project Manager and Functional Groups to track cost growth or cost decreases and provide immediate feedback for District management.

What is it?

A cost control report is an estimate reporting system that requires project team members to document summary-level estimates at critical points in the project development process. It provides project and District management with estimate totals as the project moves through critical milestones during its development. These milestones or gates have been predetermined by Mn/DOT.

Why use it?

Cost control report provide a simple and concise tool for managers and project team members to monitor and react to changes in cost as projects transition through critical phases in their development process.

What does it do?

Cost control reports create transparency and accountability in the management of a baseline cost estimate. The use of cost control reports permits quick identification of cost increases as they occur. When standardized, cost control reports allow for comparison of cost changes by categories of total project cost captured in the reports. They create accountability for the project team for changes in the estimates from one milestone to the next.

When use it?

The effort to manage project costs begins once a baseline cost estimate is set during the Scoping Phase. It is frequently updated during the Design and Letting Phases.

How to use it?

The success of Cost Containment Table depends on the quality and completeness of the information entered in the table. The cost containment table should be completed at every important phase of the project with correct and complete information. The cost containment table will become a tool to check the deviation of cost at the different phases of the project. It also preserves the history of the cost deviations; hence the sections of the table become an important input data.

Example

The primary purpose of the cost control report is to compare the cost with the Baseline Cost Estimate and maintain the cost in its permissible limits. Figure C6.1-1 is an example of a typical cost control table. This table includes the details about the project such as the project location, S.P. number, the description of the project and the reporting date. The components are marked as division, group, category, element and item depending upon the details included. The costs are calculated and noted during the important phases of the project where there are chances of the project getting diverted from the baseline cost estimate. The difference of the estimate, from this baseline cost estimate, is noted and specific reasons are provided in the explanation column.

Detailed Cost Tracking

SP Number:

Project Location:

Project Description:

Estimate Completion Date:

Reporting Date:

Components	Actual Cost To Date	Estimated Cost to Complete	Updated Total Project Cost	Baseline Cost Estimate	Difference	Explanation
DIVISION GROUP CATEGORY ELEMENT ITEM						
TOTAL						

Figure C6.1-1. Cost Tracking Example

Figure C6.1-2 registers cost for all the important costs from the engineering costs to the construction and letting costs. After the project enters in STIP project managers keep a clear view on the estimates and its variations. The cost control policies are applied if the variation is not acceptable considering the availability of funds. Supporting comments are placed for the variations in the cost.

Cost Control Table							
District:				Program Yr:			
County:				Project:			
				Short Title:			
Summary Level Cost Estimate	Milestone Estimate						
Components	Baseline Cost Estimate STIP- Yr. 5 ($)	Estimate Update Yr. - 4 ($)	Estimate Update Yr. - 3 ($)	Estimate Update Yr. - 2 ($)	Estimate Update Yr. - 1 ($)	Engineer's Estimate ($)	Bid Amount ($)
Engineering							
• Project Development							
• Construction							
Right-of-Way							
• Standard R/W Procedure							
• Prelocation							
Construction							
• Pre Construction Costs							
• Primary Construction Costs							
• Post Letting Costs							
Total Project Cost							
Comments							

Figure C6.1-2 Cost Control Example

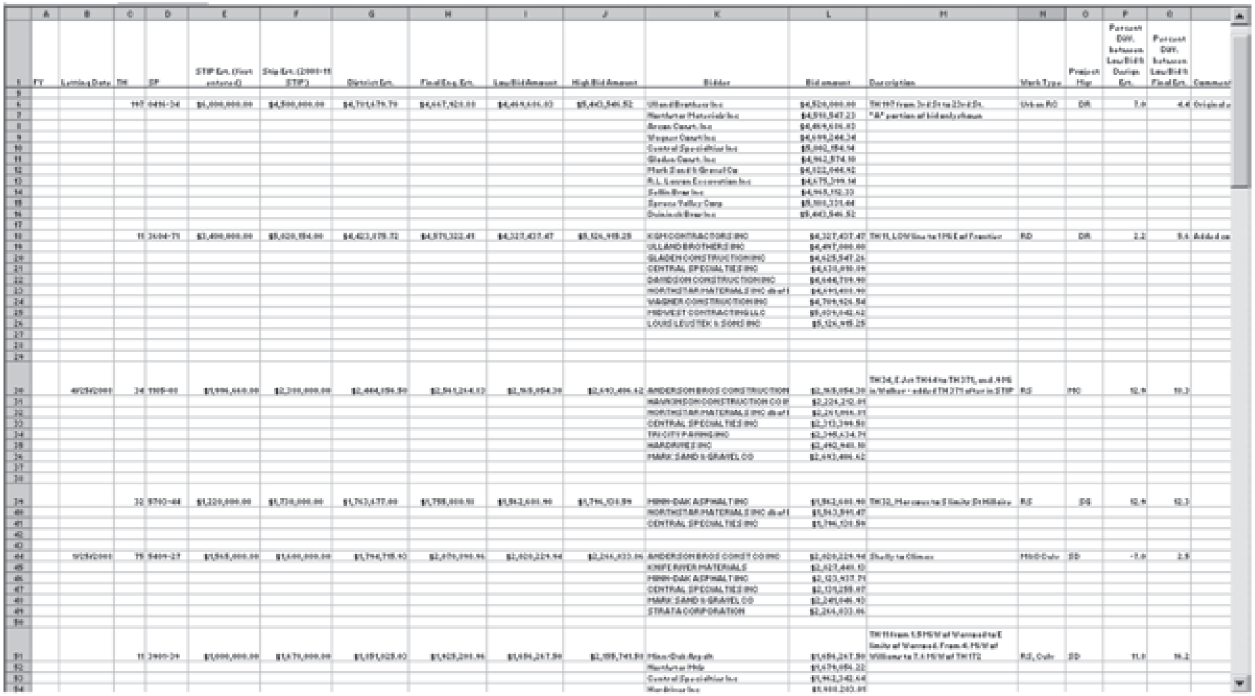

Figure C6.1-3 Cost Control – District Example

RESOURCES

NCHRP Report 574
Tool Appendix

TIPS

A cost control report requires updating at each predetermined project milestone or gate. At each project milestone point where the report is used, the estimate must be broken down into specified components of total project cost. If substantial changes are present, they can then be easily identified indicating a need for further review.

Cost control reports should be only one tool in managing cost escalation. A drawback of the cost control report is that it only provides a "rearview mirror" look at cost escalation. While knowing that there is a problem at critical project milestones is essential, project teams should strive to anticipate cost escalation whenever possible and mitigate their effects before they occur.

C6.3 Project Change Request Form

While managing a project to the baseline cost estimate is the goal of every Project Manager, project changes are sometimes unavoidable. There are many types of potential changes. Project definition (or scope) changes typically add to a project's requirements such as changing an at grade intersection to a grade separated intersection. Design development changes result from more specific detailed designs that may add or reduce quantities of materials such as an increase in asphalt pavement thickness due to more refined material properties or an increase in excavation quantities over previous estimates due to improved understanding of the characteristics of the excavated materials. Another type of change may be related to site specific conditions such as increased haul distances for aggregate or increases in wetland requirements that are greater than anticipated. Market conditions may impact estimated unit cost as a result of a reduced number of potential bidders. Estimate quantities and pricing may increase or decrease as estimates are refined. Modifications to unit costs to reflect current pricing may result in cost increases or decreases. Risk impacts may reduce cost if risks do not materialize and are retired or increase in cost if the cost of risk mitigation was higher than estimated. Finally, if the letting date is revised, there is a potential cost impact due to a schedule (or time) change. Changes should be documented and justified.

What is it?

A Project Change Request Form is a cost management tool that creates a standard procedure for reporting project changes. It creates transparency and accountability. It also allows Mn/DOT to view trends that may allow for better project definition on future projects and in future estimates. The Project Change Process is documented in the current Mn/DOT Scoping Process procedure. This form provides a permanent record of the change requests that occur during project development. To create accountability, it also records who authorized the changes.

Why use it?

Changes to a project definition almost always result in cost increases. Therefore, the requirement for formal management approval of any change request serves to limit changes, as all such potential changes must be carefully reviewed. Controlling project changes serves to control cost growth. An additional reason for tracking changes to the project is to insure that no changes take place without the full knowledge of the Project Manager and other Functional Group managers.

What does it do?

Project Change Request Forms make possible easy comparison of the current project definition, cost, and time with the established baseline of the project. The form should require that the documented change, as well as any impacts of the change to project definition, cost, and time, be specifically acknowledged.

An explanation is required with each change. Appropriate approvals should be required depending on the size and nature of changes.

When use it?

Changes should be tracked throughout project development. However, the most important time that changes are tracked is after the baseline cost estimate is approved during the Scoping Phase. Thus, this form is used throughout the Design Phase as the design is prepared and cost estimates are updated.

How to use it?

The use of this form is described in the Mn/DOT Scoping Process procedure.

Example

Typical Project Change Request and Program Evaluation Forms are shown below:

SCOPE AMENDMENT #XX
SP XXXX-XX, T.H. XX
Short Descriptive Name of Project

The purpose of the Scope Amendment form is to document and obtain approval for scope changes.

SCOPE CHANGE
The following items need to be added to or removed from the scope of the project:

REASON FOR CHANGE
The change is necessary because:

COST ESTIMATE
The cost estimate for the original project was:
The cost estimate for the modified scope is:
☐ The district financial manager has been informed and agreed to accomodate the new estimate.

SCHEDULE
The section leaders and CO Functional Groups have reviewed the modified scope and its effect on the schedule.
☐ The modified sope will have no significant impact on the project schedule and will cause no re-work by previous project development stages.
☐ The impact to the schedule has been resolved by the section leaders and CO Functional Groups.
☐ The impact to the schedule requires a change in letting date to _____.
  ☐ The district scheduling manager agreed to accomodate the new letting date.

ENVIRONMENTAL DOCUMENTATION
The preliminary design group has evaluated the apparent SEE impacts of the modified scope and determined that:
☐ Environmental documentation has yet to be prepared and this change will be reflected.
☐ The modifications do not require an amendment to the completed environmental doc.
☐ The modifications require an amendment to the completed environmental doc.
☐ The modification requires preparation of a higher level environmental document.

PUBLIC COMMITMENT
☐ This change will not cause a public commitment or expectation to change.
☐ This change will cause a public commitment or expectation to change. Local partners have been contacted.

CONSTRUCTION LIMITS
☐ Construction limits have not yet been established for the project.
☐ The modifications will not change construction limits.
☐ The modification will affect established construction limits. The impact to the schedule has been resolved.

COMMENTS/NOTES:

RECOMMENDED BY:

______________________________ ______________
- Project Manager Date

APPROVED BY:

______________________________ ______________
– Assistant District Engineer Date

Figure C6.3-1 Project Change Request Form

PROJECT MODIFICATION PROGRAM EVALUATION DOCUMENT

This form documents how proposed project scope and cost estimate modifications affect overall project delivery/implementation and impact upon other projects in the District/Division construction program/STIP. The form ensures full visibility of these changes/impacts and the required coordination/approvals necessary to effect changes to the District/Division construction program/STIP.

Trunk Highway:

Project Description:

SP Number:

Today's Date:

PART A: PROPOSED PROJECT MODIFICATIONS (to be completed by Project Manager)

Change Type

The following changes are proposed to the District Program:

- ☐ Project cost estimate change not resulting from scope modifications (e.g. inflation)
- ☐ Project cost estimate change resulting from scope modifications
- ☐ Project letting date change within planned fiscal year
- ☐ Project letting date change to a new fiscal year
- ☐ Project Fiscal Year changes, but the letting stays the same
  - ☐ Project becomes ELLA
  - ☐ Project no longer identified as ELLA

Change Justification

The change is necessary because:

Cost Estimate

Original cost estimate for the project was: $

New/revised cost estimate for the project is: $

Letting

Current letting date is:

Proposed letting date is:

Section leaders have reviewed and approved of the letting. ☐yes ☐no

CO balanced letting people have okayed the proposed letting. ☐yes ☐no

Public Commitment

Will proposed change result in a public commitment or expectation change? ☐yes ☐no

Have local partners and public been contacted about proposed change? ☐yes ☐no

Figure C6.3-2 Program Evaluation Form – Page 1 of 2

Recommended Strategies to Accommodate Proposed Change to the Program

Provide financial strategy to maintain fiscal constraint of the STIP in order to accommodate proposed changes to this project. Strategy must identify impacts on other programmed projects and actions required by the district to address them, as applicable.)

Requested By:

____________________________________ __________________

XXX - Project Manager Date

PART B: EVALUATION OF PROPOSED PROJECT MODIFICATIONS ON DISTRICT/DIVISION CONSTRUCTION PROGRAM (to be completed by Program Manager)

Does proposed change to project and financial strategy maintain fiscal constraint of the STIP? ☐yes ☐no

Will the proposed financial strategy impact another project or other program area? ☐yes ☐no

Does proposed change to project require a revision or amendment to the STIP (e.g., type of work, cost increase, etc.)?

☐Revision

☐Amendment

Is project located within a 20-year metropolitan planning area? ☐yes ☐no

Is project exempt from an air quality conformity analysis (i.e., Clean Air Act Amendments of 1990 and Environmental Protection Agency's 40 CFR parts 51 and 93)? ☐yes ☐no

Recommend revision or amendment to STIP and approval of proposed changes to the project? ☐yes ☐no

If yes, strategy and actions required to be taken by district to accommodate proposed changes to the project. For an amendment, this would be the statement of justification.

Recommended By:

____________________________________ __________________

XXX – Program Manager Date

PART C: DISTRICT APPROVAL OF PROGRAM CHANGES

I have reviewed this request and approve the proposed changes to the project and the resulting impacts on the STIP.

Approved By:

____________________________________ __________________

XXX – Program Delivery Manager/Engineer Date

Page 2 of 2

Figure C6.3-2 Program Evaluation Form – Page 2 of 2

TIPS

Scope Change Forms should explicitly require all the information needed to track project changes, including scope, schedule, and cost impacts, as well as explanations and approvals. Forms should be standard; however, there should be the ability to deviate from the form for special project circumstances.

RESOURCES

Resources include NCHRP Report 574 and Mn/DOT Scoping Process Manual, January 2007.

Appendix: Tips for Estimating 4.3

IV.3 Tips for Estimating

This appendix is a compilation of tips and watch outs to be used in all phases of cost estimation and cost management. It is divided into two basic sections. First are general tips that can be applied to all phases of cost estimating and the cost management process as a whole. These tips can be used from Planning through Letting and represent general advice that a responsible Estimator will always consider. Second are tips and watch outs for the Planning, Scoping, Design, and Letting Phases individually. Each phase is inherently different from the others; therefore, they all have unique obstacles to overcome while estimating during any given phase.

The tips include suggestions on what additional things to consider, who to consult, and where to look for information. Each tip can be used to either increase the quality of the estimate or reduce the time spent on the estimate. "Watch outs" are cautions of different situations that can be detrimental to an estimate. They generally include warnings about improper use of information, external factors that can affect an estimate, or even common pitfalls Estimators have encountered in the past. While this list is a good compilation of pointers and warnings, the best advice will come from an experienced Estimator who has worked on a similar project.

GENERAL TIPS

Tips for Cost Estimating

1. Read the Mn/DOT Statewide Scoping Process Manual and seek clarifications if necessary. Review the relevant Scoping worksheets that apply to your project.

2. When determining the estimate basis for a project, complete the following:
   - Visit the site in person.
   - Review all available documents and design parameters relating to project definition.
   - Account for unique project location characteristics.
   - Review aerial photos and/or video logs.

- Document the key estimating assumptions, including factors that need further investigation.

- Establish an estimate file in which estimate calculations will be placed over the life of the project.

3. Consider risk and contingency for project uncertainties, and consider the impact of factors that are off the roadway section (e.g., potential third-party impacts on project definition or schedule), such as municipal consent, inflation, utilities, and fluctuating market conditions. Consider how such factors impacted projects in the past, and consider their potential impact in the context of your project. Use risk checklists at the end of any risk identification process to be certain that no major risks or uncertainties were overlooked.

4. When preparing the cost estimate, document the level of detail to which the design basis and the project definition are complete. Document the base estimate in each account and the contingency amount separately to facilitate tracking of deviations.

5. When reviewing the total estimate, engage knowledgeable and experienced individuals who are independent from the project and perform reviews in each project development phase.

6. Use the tools and documents that have been prepared by others to your advantage. Review estimates from similar projects for items and costs. They can be used as a starting point for future projects. Use the spreadsheets and databases others have developed to build your estimate.

7. Use the expertise of Functional Groups to provide input to your estimate. Each one will have a significant effect on a project's costs. The information obtained from them can greatly increase the accuracy of a Planning estimate. Be sure to inform the Functional Groups about any unique project items or uncertainties that might affect their estimates.

8. Economy of scale plays a large factor in estimating projects. When using a previous project's data to determine unit prices, be sure both projects are similar in size for the given item.

9. Have someone check your work. One of the easiest and often overlooked ways to eliminate errors is simply to have your estimate reviewed by an experienced co-worker. Have them look at the spreadsheets as well as your backup calculations.

10. Become familiar with the region in which the project will be constructed and any unique local policies. Also, market conditions may be different across the state, which will affect the estimate, and knowing the general locations of materials could be beneficial. Even a basic familiarity with contractors can help plan for future issues.

11. Use checklists and the end of the process to make sure no basic items are left out of an estimate.

12. Make sure enough resources are dedicated to the project. An estimate should not be denied accuracy due to lack of employees working on it.

13. Ample time should be spent estimating the most costly items. Rethink these items over and over because they are the bulk of where the cost comes from.

Tips for Cost Management

1. Obtain approvals at milestone points during project development. Consider using peer reviews prior to key milestones if agency procedures do not have an approval point but the project team sees value in a peer review involving knowledgeable and experienced individuals from outside the project team.

2. Remain very open with everyone, and foster disciplined communication of the uncertainty, importance, and meaning of any estimate.

3. Promote objectivity/impartiality by protecting Estimators from internal and external pressures to deviate from established estimating guidelines or approved Planning/Scoping Reports.

4. Document updates to the base estimate and the use of project contingency in each project development phase, with reference to the scope, cost, and schedule that correspond to the prior approved estimate.

5. Return any unused contingency to the district program. If a contingency indentified in the Planning or Scoping phases is not needed at the Design or Letting phases, do not increase the project scope.

6. Keep District/Bridge management informed about project changes and external impacts that affect the baseline/project budget, and have procedures in place that restrict changes unless approved by the appropriate authority.

PHASE TIPS

Planning Phase

Tips

1. Although the project has not been fully defined, do your best to determine the full scope of the project before putting an estimate together. Try to come up with as comprehensive a list as you can, time permitting, of all of the elements that will be required in the project.

2. Visit the site in person. Become familiar with not only the roadway and operational issues, but other site conditions, as well. Utilities, bridges, sidewalks, buildings, cut and fill slopes, waterways, and other site conditions will have an effect on project costs, and the more familiar the Estimator is with a given site, the more likely these items will be considered.

Watch Outs

1. Unit prices can vary greatly over time based on market conditions. Petroleum products, concrete, and steel prices have probably been the most volatile recently. It is important to review the unit prices, especially for larger cost items on a project, to reflect current trends. Yes, this is important in all phases, but most prominently in Planning since the construction date is so far into the future.

2. Planning estimates may sit on the shelf for many years before moving to Scoping, Design, and construction. Planning estimates should be reviewed and refreshed regularly to reflect potential changes in scope, unit prices, regulatory requirements, etc. This is also a good time to review the assumptions and revise as necessary.

3. The estimating tools available can provide very precise numbers. The total cost is usually displayed to the nearest dollar, sometimes even to the penny, with many tools. When these estimates are shared within the organization, or even outside the organization, the impression given is that the estimate is very accurate. Planning estimates should always be rounded up to the nearest thousand, ten thousand, or hundred thousand dollars, depending on the relative magnitude of the cost.

Scoping Phase

Tips

1. When preparing the base estimate in the Scoping Phase, recognize complexity and the work that needs to be done to minimize uncertainty, such as stakeholder involvement and permits to be documented. If appropriate, call suppliers or specialists to get ideas about cost, contact city/county engineers to discuss local issues, such as utility work and coordination, and use the expertise of offices within the agency, such as right-of-way, materials, central office estimating group, and bridge office. Keep in mind that operations and maintenance personnel are aware of problems that are not apparent from a cursory site review.

2. Once again, a site visit and investigation can be quite valuable. The more familiar an Estimator is with the site, the more likely he will not miss anything while estimating the project. During Scoping, all existing structures, utilities, and any other potential obstructions should be noted and quantified.

3. Understand the current design standards and their project impacts. Anticipating potential design changes by staying actively engaged in design development can help while performing a Scoping estimate.

4. Define the work as completely as possible. What work will be included in the project? What work is excluded?

5. Identify the major items of work for the type of project being scoped. Focus the efforts on these major items. For example, on a paving project, hitting the cost of striping to the exact penny of the final cost means nothing if the paving quantities are misestimated or the unit cost is way off.

6. Do a constructability review on the project. Can the project be constructed as planned? Will there be adequate time to complete the project without carrying into another season beyond what is planned? Are there local contractors who can perform the work?

Watch Outs

1. Watch out for traffic problems that will be caused by construction. If detour routes are necessary or available, will the estimate include addressing damage done to the detour route by the added traffic? If detour routes are not available, will daytime lane closures be allowed? If night work is necessary, address in the estimate.

2. What utility impacts are there? Utility impacts can be direct costs to a project and may result in change orders due to delays when the utility work is concurrent with the highway construction. This holds true for both public and private utilities.

3. Watch out for areas within the project limits with a high number of accidents. These areas may need safety improvements that weren't initially identified.

4. The same personnel who originally scoped the project should not be the only ones estimating it. More people and fresh perspectives should always be welcomed.

5. Not including enough risk on major improvement projects can be a problem during Scoping. What can't be seen is a significantly higher risk than what can be seen. There may be much more work than what is originally apparent to the eye.

Design Phase

Tips

1. Get rights of entry for all properties adjacent to the project, not only those that seem to be necessary early in a project. Repeatedly sending a real estate services employee to obtain these documents is costly and can impact the schedule.

2. Understand the staging needed to construct the project. Work with the proper Functional Groups to verify traffic control strategy.

3. Do your research. If there are material sources near your project site, you can often get a better price. If you need fill, and another project has excavation to waste, maybe their excavation can be stockpiled for your fill needs (results in haul and placement costs only). Don't forget your local agency projects. Develop a good relationship with the cities and counties you work in.

4. Consider the timing of your advertisement. If you advertise in late fall or winter, you may have a lower estimate. Demand is typically lower in these months, resulting in lower prices. Contractors usually have more crews free during this time, and you may also end up with their best or most experienced crew on off-season work.

5. Ask the experts. Do not be afraid to call suppliers, specialists, or contractors to get an idea about cost. And don't be afraid to change their numbers to fit your situation (remoteness, limitations, working days, work hours).

Watch Outs

1. Assuming the Scoping estimate and project definitions are correct is not a good way to begin the Design Phase. When you start a project, look with fresh eyes and identify all substandard conditions. Coordinate with the appropriate entities to determine if deviations will be approved.

2. Not enough contact with Functional Groups is a poor reason for the estimate to lose accuracy. Do not be afraid to ask questions. Spend time getting to know those in Functional Groups who will be reviewing the project.

3. Be sure to pay enough attention to lump sum items. These have the greatest potential for cost overruns.

4. Be aware of structures. Work with the Functional Group to confirm the estimate for any structures. Re-confirm structure estimate after geotechnical report is complete.

5. Do not take the historical bid data at face value and simply average the prices shown. There are always circumstances that should be taken into account.

6. Avoid dictating the methods the contractor is to use on items that do not require it. It limits his flexibility and raises your cost. The contractor will find the cheapest way to perform the project since the lowest estimate will be awarded the project.

Letting Phase

Tips

1. Do not use any documents for the Letting estimate that the contractor will not have. If you need additional documentation to complete an estimate, it may be an indication that the plans and specifications are not complete.

2. Use historical data from the region the project will be performed in, if at all possible. These historical bids are probably from the same contractors who will bid on this project, as well.

3. Construction staff can help evaluate the potential impact of staging, material storage, hauling of materials, location of batch plants, and other constructability related issues, all of which are exceedingly important in this step since this estimate is completed as though the bidders prepared it.

Watch Outs

1. Recent drastic changes in material cost or availability may cause a knee-jerk reaction with the contractors while preparing their bids. The Mn/DOT Estimator should think like a contractor.

2. Previous estimates using elements and categories should now all be reduced to items. Be sure you know what all was included in the aggregations before splitting them into items. This is an easy way to miss items.