COST ESTIMATING MANUAL

VDOT GOVERNANCE DOCUMENT

VERSION 2.0
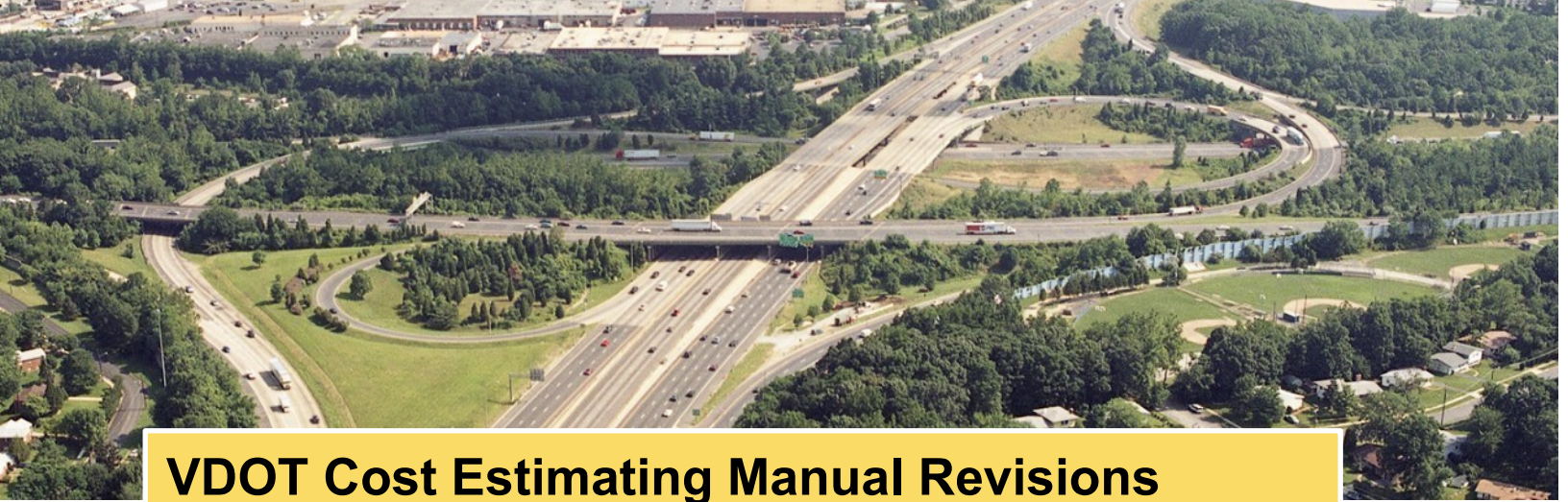**December 1, 2021**

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VDOT Cost Estimating Manual Revisions

Version	Date	Author	Change Description
0	3/31/2021	VDOT Cost Estimation Office	Cost Estimating Manual Draft for Internal District and Division review
0.1	5/4/2021	VDOT Cost Estimation Office	Update after Internal District and Division review
0.2	6/1/2021	VDOT Cost Estimation Office	Update for Internal District and Division review and Industry review
1.0	7/1/2021	VDOT Cost Estimation Office	First Production Version
2.0	12/1/2021	VDOT Cost Estimation Office	Second Production Version

The Cost Estimation Office acknowledges and expresses sincere appreciation for the dedication of the following individuals on the Estimating Manual Working Group. This team moved with urgency and purpose to develop this manual in less than six months.

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This Manual is for the exclusive use by VDOT, localities receiving transportation funding through VDOT, and their consultants for the preparation of cost estimates in the funding application process and the project development process. This manual provides the minimum required guidance and is not a substitute for the application of experience and engineering judgment. Any use of this Manual beyond its intended purpose is prohibited and at the user's sole discretion, risk and responsibility.

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Cost Estimating Manual
Introduction

I. Introduction

I.1. Background

Virginia Department of Transportation's (VDOT) mission is to plan, deliver, operate and maintain a transportation system that is safe; enables easy movement of people and goods; enhances the economy; and improves our quality of life. Reliable cost estimates are crucial to the fulfillment of this mission.

The VDOT Cost Estimating Manual has been developed to provide cost estimating guidance, policies, procedures, processes, tools and systems for all key stakeholders involved in developing, documenting and reviewing cost estimates for VDOT-administered and locally administered projects (LAP). With the creation of VDOT's Cost Estimation Office in 2021 and the issuance of this Cost Estimating Manual, the agency now has a one-stop shop for VDOT cost estimating guidance.

Estimating is part science and part art. It can be a challenge to refine the art of estimating without extensive experience. However, with the use of this manual and application of the standard practices herein, the estimator(s) can develop better and more consistent estimates and be more comfortable doing so.

This manual is not intended to be used as a tool to simply input data to create a cost estimate. It is intended to be used for current and updated VDOT guidance regarding cost estimating.

I.2. Purpose and Use

The purpose of this manual is to provide consistent and structured guidance to develop reliable and accurate cost estimates on VDOT-managed and locally managed projects. This manual is made available to VDOT business partners to utilize throughout the cost estimating process. This manual provides consistent practices and applications of cost estimating methodology. This includes developing, documenting, reviewing, approving and updating cost estimates throughout the project development process, from creating the conceptual estimate to developing the final Engineer's Evaluative Estimate (EE).

The guidance on the cost estimating process provided herein is recommended for use in the development of all cost estimates to the maximum extent possible. VDOT projects are varied across a broad range of scopes and types; and it is acknowledged that the guidance in the manual will not be directly applicable to all projects. For example, the pavement resurfacing program is exempt from specific requirements within the CEM. These projects include all resurfacing contracts developed by District pavement management following current Maintenance Division guidelines and policies.

> **Cost Estimating Manual Usage**
>
> This manual shall be used for all projects with a construction phase (VDOT or locally administered) that are in, or to be entered into, the Six-Year Improvement Program (SYIP) AND that will be reflected on VDOT's Dashboard (see Dashboard business rules) with the exception of major projects over $500M, which have additional requirements.
>
> *Pavement resurfacing projects are exempt.

This manual provides guidance and tools to aid VDOT Project Managers, Estimators, Designers, Consultants and others in preparing and reviewing cost estimates throughout the project development process (PDP) and the funding application process (or similar pre-SYIP processes). In addition to internal VDOT personnel, this manual is to be shared with and used by VDOT business partners (localities, consultants, contractors, et al.) to ensure consistency and a clear understanding of all cost estimating activities.

Users of this manual will include the following:

VDOT Project Development:

VDOT Project Development (including Project Managers, Roadway Designers, Structure and Bridge Designers, Right of Way and Utilities, Environmental, et al.) is responsible for the development of cost estimates during the project development process. This manual will serve as a guide for creating and updating of cost estimates at each project development phase and allocating risk and contingency in a consistent manner. Also, it will serve as a catalog of available tools, technologies and systems.

VDOT Construction:

VDOT Construction is responsible for the development of the Engineer's EE prior to advertisement and will be able to utilize this manual to understand the basis of the design estimate and further the development of the EE.

Localities:

Localities will be able to leverage this manual and the linked sections of the Locally Administered Projects Manual for guidance related to cost estimates for LAP's (including preparing estimates for funding applications).

Consultants:

VDOT's external consultants involved in project development will be able to utilize this manual to understand VDOT's cost estimating guidance, policy, procedures, tools and expectations; when supporting VDOT's projects and programs.

I.3.   Cost Estimating Manual Updates

The Cost Estimating Manual is a living document. The current version developed in the Spring of 2021 and updated in the Fall of 2021 is predominately a compilation of existing VDOT estimating policy, guidance and tools from various sources, and new guidance on specific aspects of VDOT estimating. Estimating techniques, processes, tools and systems are constantly evolving. As this evolution continues, this manual will be periodically updated to reflect the changes. When changes are necessary, VDOT will post the updated version of the manual with the latest revision date(s) listed in the Table of Contents.

Recommended changes, improvements and contributions can be submitted directly to VDOT's Cost Estimating Office for consideration. The Cost Estimation Office places a high value on users' suggestions and recommendations for improvement of this manual. Each suggestion will be thoroughly evaluated and considered. Updates and additions will be prioritized by the Cost Estimation Office with estimate accuracy, consistency, and ease of implementation, given the highest priority.

I.4.   Importance of Cost Estimates – Quality, Documentation and Integrity

VDOT has many customers that rely heavily upon the agency daily including the travelling public and millions of taxpayers throughout the Commonwealth. VDOT's cost estimates ultimately serve these customers, and more directly serve internal and external project stakeholders as detailed below. As one develops and prepares cost estimates, it is important to keep the needs and expectations of these internal and external customers in focus.

Quality estimates for all VDOT-administered projects and LAPs are extremely important. Both the accuracy of the estimates and the documentation of each estimate that is developed or updated is crucial as they are heavily relied on by the VDOT executive team and funding

program managers while making key decisions regarding funding programs and individual projects. For example, on SMART SCALE projects, estimates are used to help determine the score of the project application. This information informs the decision-making processes and key decision makers, including the Commonwealth Transportation Board (CTB). Estimates developed early in the life of a project are also used to establish budgets, manage programs, and control costs. When estimated project costs deviate significantly from what was budgeted, it results in an administrative burden on the agency, and can even result in a project being canceled. Examples of this burden include delays in projects that have a profound impact on VDOT's ability to obligate federal funds, the Department's cash balances, and overall performance that is reported to the public.

To understand how cost overrun situations are handled by VDOT, Virginia Department of Rail and Public Transportation (DRPT) and the CTB on SMART SCALE projects, see the SMART SCALE Cost Overrun Policy. It is important to note that clear estimate documentation is required by the CTB in certain instances, per the above policy.

> **📝 Estimate Integrity**
>
> Estimate integrity is extremely important and the estimator(s) should not reduce the quality of the estimate, or its reliability, due to outside influences.

For guidance on budget adjustments on, the State of Good Repair (SGR) bridge projects, see the SGR Bridge Web Page.

Quality and thorough documentation of the estimate is equally as important as the accuracy of the estimate. This documentation benefits reviewers, approvers, or additional project team members who join after the development process has begun. Additionally, it is important to note clear estimate documentation is required by the CTB in certain instances, per the above policy.

Estimating is a process with an outcome of developing the most probable cost of a project and is not a cost control or budget management tool. Under the direction and control of the VDOT Project Manager, the estimator(s) is charged with this challenging and difficult responsibility of developing and maintaining the estimate throughout the entire project development process.

The integrity of the estimate and the estimator(s) is extremely important and should not be compromised by outside influences including, but not limited to, political pressure, funding constraints or even pressure to remain green on the Dashboard. The VDOT Project Manager and the estimator(s) engaged (designer, consultant, etc.) should not yield to political, social, hierarchical, or economic pressure to keep an estimate above, below, or within a certain range. If the estimate is artificially adjusted up or down from the most probable cost, then it is no longer an accurate estimate. These actions create a multitude of issues that can ripple through the agency and will lead to larger credibility concerns.

If an estimate exceeds the approved budget at any stage in the project development process, efforts shall be made to review a project scope for opportunities to value engineer, modify, or reduce the scope to bring the estimate back in line with the original budget while still meeting the original project objective. Even if these efforts are successful, the project scope and estimate may require reconsideration by the CTB depending on the funding sources. If these efforts are not successful, the project may require action by the CTB to increase funding levels. This process must involve the appropriate VDOT management, including but not limited to the District L&D Engineer, ADA for Project Development, District PIM, District Bridge or Maintenance Engineer, District Engineer/Administrator and the Central Office.

I.5. Key Terms and Definitions

Allowance – An amount included in the Base Estimate to account for costs of known items whose requirements are currently undefined. This cost component covers the "known-unknowns". An allowance is separate from a contingency. As the design progresses, the "known-unknown" allowances will be converted to the "known-known" costs that are accounted for in the defined cost. Examples of allowances in preliminary estimates may be an underground utility extension, erosion and sediment (E&S) measures, maintenance of traffic (MOT), water quality credits and wetland/stream mitigation costs. *See Figure I-1a and I-1b: Defined Cost, Allowance, Risk & Contingency.*

Base Estimate – For preliminary and design estimates, this represents the Preliminary Engineering (PE), Right of Way (RW), and Construction (CN) phase costs that can reasonably be expected to complete the project if executed as planned. It should be unbiased and neutral, not overly optimistic or conservative. The Base Estimate should be in current year dollars, and not include inflation. The Base Estimate = Defined Cost + Allowances and shall specifically exclude contingencies and/or inflation. For PE, the Base Estimate should include applicable administrative, investigative, and design costs to develop the project and progress the plans to Advertisement. For LAPs, this includes VDOT oversight costs. For RW, the Base Estimate should include all applicable RW and utility relocation costs. This may include administration, acquisitions, relocations, and utility relocations. For CN phase, the Base Estimate should include all bid item costs, and other CN phase related costs such as railroad coordination, state forces, state police, contract requirements (incentives/disincentives), or construction engineering inspection (CEI) services.

Baseline Estimate – The estimate that has been established as the baseline against which future estimates are compared to evaluate on-budget performance metrics. The Baseline Estimate includes the Base Estimate (which includes Defined Cost + Allowances), contingencies (risks), and inflation. Baseline Estimates may be changed only by following the established project management procedure (PMO-22.0 Change Management). The Baseline Estimate = Defined Cost + Allowances + Contingencies + Inflation.

Basis of Estimate – A document that provides an auditable trail identifying the logic, data, methodology, assumptions, constraints and calculations used to develop a project cost estimate. The Basis of Estimate should be thoroughly documented in the Project Cost Estimate Package (CEP) and stored in Project Wise or SMART Portal (for funding application estimates).

Contingency – An amount added to a Base Estimate to account for identified and unidentified risks whose likelihood of occurrence and significance of impact are uncertain. This cost component covers the "unknown-unknowns". Contingencies can be assigned to projects, phases, or engineering disciplines within phases. As a project develops, contingencies will typically decrease as risks should be more fully understood through additional design or investigation and properly addressed. Contingencies shall be determined based upon provided guidance described in Chapter 5. For the estimates prepared in AASHTOWare Project Preconstruction, contingency is calculated based on a percentage applied to a group of item codes or entered as a lump sum non-bid item. *See Figure I-1a and I-1b: Defined Cost, Allowance, Risk & Contingency.*

Defined Cost – The portion of the Base Estimate where a probable cost of development and construction can be reasonably determined. These are costs of known items whose requirements have been determined and quantified at the current level of project development. These are the "known-knowns". *See Figure I-1a and I-1b: Defined Cost, Allowance, Risk & Contingency.*

Engineer's Evaluative Estimate – The estimate of probable cost of the construction contract award amount prepared at time of Advertisement. This definitive estimate is based on plan quantities and anticipated work units. It is expressed in current year dollars. For VDOT prepared EEs, these remain confidential in perpetuity. This is the estimate against which bids are compared to approve or reject the low bid for Award. This estimate is prepared based upon publicly available contract documents. VDOT-prepared EEs are prepared by the Central Office Construction Division and loaded into AASHTOWare Project Preconstruction.

Estimate – A quantitative determination of the probable cost of a project. They are determined using proven tools, historical cost data, market trends, and professional judgement. Construction estimates include probable costs of construction, while project estimates include all project related costs to develop and deliver the project as designed. There are multiple types of estimates, each appropriate at defined points of the project lifecycle, and have unique contingencies and allowances based upon project specific complexities. Estimates also include inflation, based upon the project schedule. The following two main categories of estimates are referred to in this manual:

- Funding application estimates are developed for VDOT's numerous application-based funding programs (e.g. SMART SCALE, SGR, Revenue Sharing, TAP, and Safety).

- Project development estimates are developed after project initiation (inclusion in the SYIP).

Inflation – Captures a general increase in the rise and fall of the purchasing value of money as the value of currency fluctuates over time. Inflation rates are applied to estimates to more accurately account for future cost increases, as expressed in current year dollars. Inflation is the final component of the cost estimating process and it is applied to both the Base Estimate (Defined Cost + Allowances), and all contingencies. Inflation, based on VDOT established rates, is currently added to an estimate in the SMART Portal or PCES - Workbook.

Project Complexity Classification – A project classification system VDOT has developed for the purposes of establishing risks and setting contingencies. With this system, a project has three possible classifications: non-complex, moderately complex, and most complex. This classification system is also used to establish CEPs (estimate documentation requirements). Chapter 5 has detailed information on this classification system.

Risk – An identified uncertain event or condition that, if realized, could have a positive or negative effect on the project's objectives. All significant scope assumptions should be included in the risk register. Negative risks that could adversely impact a project are threats, while positive risks that could benefit the project are opportunities. Risks should be accounted for in contingencies. Examples on a widening project is whether noise abatement will be required or a cell tower will need to be relocated. *See Figure I-1a and I-1b: Defined Cost, Allowance, Risk & Contingency.*

Risk-Based Estimating – A methodology that adjusts the Base Estimate to account for project-specific risks to produce a more informed probable cost estimate. Guidelines for applicable and acceptable contingencies are specified for various project risk complexities, which are based on historical data. VDOT has adopted the AASHTO Risk-Based Estimate Process (as described in detail in Chapter 5).

The above list provides only a few key terms. For a complete listing of terms and definitions see Appendix A.

Figure I-1a: Defined Cost, Allowance, Risk and Contingency (Road Widening Project)

DEFINED COST, ALLOWANCE, RISK, CONTINGENCY EXAMPLE GRAPHIC:
ROAD WIDENING PROJECT

PROJECT LENGTH: 1 MILE

12" D.I. Existing Water Line

Proposed 1 Lane Widening

Existing Culvert

Proposed Culvert Extension

Existing Edge of Pavement

Existing Cell Tower

DEFINED COST
- Clearing
- Sawcut
- Excavation
- Stone
- Underdrain
- Asphalt
- Guardrail
- Pavement Markers
- Culvert Extension

ALLOWANCE ADDED TO DEFINED
- Water Relocation
- Maintenance of Traffic (M.O.T.)
- Erosion & Settlement Control

RISK
1. Condition of existing culvert
2. Relocation of cell tower
3. Unsuitable soils above and below subgrade
4. Unknown restrictions on in stream work

CONTINGENCY

Amount Added to Estimate to Cover Risks 1, 2, 3, 4

Risk 1
Risk 2
Risk 3
Risk 4
Allowance
Defined

Contingency = Value assigned to aggregate risk, using VDOT's Risk Based Contingency Estimating process

Figure I-1b: Defined Cost, Allowance, Risk and Contingency (Bridge Project)

DEFINED COST, ALLOWANCE, RISK, CONTINGENCY EXAMPLE GRAPHIC: STAGE CONSTRUCTED BRIDGE REPLACEMENT PROJECT

DEFINED COST

- Support of the existing roadway and portions of the bridge that will remain in service during the widening
- Demo
- Excavation
- Foundation
- Bridge components (steel girders, concrete, etc.)
- Approach roadway fill, drainage structure, etc.
- Pavement
- Guardrail
- Pavement markings

ALLOWANCE ADDED TO DEFINED

- Utilites (assuming utilities on the existing bridge) in this case
- MOT - Temporary signals and pavement markings
- Environmental (in stream work, wetlands, etc.)
- Closure pours and staging
- Provisions for wide loads when no feasible alternative routes are available during construction
- Overhead high voltage power lines that may restrict the use of cranes
- Stormwater upgrades

EXAMPLE PROJECT

Existing Sewer Line

Proposed Bridge Replacement

Existing Stream

Existing Railroad Line

Existing Edge of Pavement

Existing Overhead Power Lines

RISK

1. Karst Geology
2. RR Coordination (Assume a rail & stream below for this example)
3. Condition of Exising Structure
4. Condition of the existing
5. Flood potential during construction
6. Work hour restrictions imposed by localities on the concrete plants or actual bridge construction work
7. Market conditions for labor, equipment, materials and supplies

CONTINGENCY

Amount Added to Estimate to Cover Risks 1, 2, 3, 4, 5, 6, 7

Risk 1
Risk 2
Risk 3
Risk 4
Risk 5
Risk 6
Risk 7
Allowance
Defined

Contingency = Value assigned to aggregate risk, using VDOT's Risk Based Contingency Estimating process

Figure I-2: Basic Keys to Successful Estimating

BASIC KEYS TO SUCCESSFUL ESTIMATING

Gather as much information about proposed project as possible. – Clearly understand the purpose and scope.	Visit the site of the proposed project and gather information.
Communicate with other SMEs who have designed and/or built similar projects in the vicinity. Construction personnel's input early is critical.	Perform a risk assessment applicable to the level of project definition at time estimate is prepared.
Have an independent party perform estimate and compare notes.	The more you know and understand about the project and the site, the more accurate your estimate will be.

I.6.   Roles and Responsibilities

The cost estimating process involves many individuals across the Districts and Central Office depending on the type or complexity of a project. For the purposes of this manual, references to the following roles will be defined as follows.

Estimator(s) – Any member of the project team involved with developing or updating an estimate and the various steps of the estimating process detailed in this manual. An estimator(s) could be one of the various designers, consultants and/or subject matter experts involved on the project, with the Project Manager coordinating activities. Each project will have multiple estimators of various disciplines and they all should be familiar with the guidance of this manual.

Project Manager – The VDOT Project Manager (or a delegate) is responsible for compiling estimate information from the project team, reviewing it for completeness and reasonableness, and uploading the estimate to the Project Cost Estimating System (PCES).

Project Team – Includes all disciplines involved in the project (i.e. preliminary engineering, RW, utilities, roadway, structure and bridge, materials, environmental, hydraulics, consultants, et al.)

Chapter 1 –
General

Chapter in Brief:

In this chapter the reader will be able to gain an overview of the process VDOT uses during project development. This chapter will also introduce the reader to the various types of estimates as well as some of the tools, technology and systems that are used to prepare project cost estimates. Also, the reader will be introduced to the interface with the Right of Way (RW) and Environmental divisions for estimating purposes.

1.1.   Overview

1.2.   Planning / Pre-Scoping / Funding Application Phase

1.3.   VDOT's PDP

1.4.   Post Award

1.5.   Types of Cost Estimates

1.6.   Cost Estimating Process Overview

1.7.   Cost Estimate Update Process (Responsibility and Authority)

1.8.   Project Definition and Estimate Accuracy

1.9.   Estimating Tools, Technology and Systems – General Overview

1.10. Estimating Quantities

1.11. Right of Way Acquisition and Utility Relocation Estimates

1.12. Environmental Estimates

1.13. Major Project Cost Estimating

1.1. Overview

This chapter provides a general outline of the actions required to develop, update, and monitor cost estimates throughout VDOT's Project Development Process. It provides an overview on the cost estimating process, the different types of cost estimates developed, the tools and systems utilized to create and update estimates.

1.2. Planning / Pre-Scoping / Funding Application Phase

The Planning / Pre-Scoping / Funding Application phase involves local governments, regional planning partners, or VDOT creating an initial project scope, schedule and estimate. These initial project plans and estimates are often used to determine the required funding and for short and long-range planning. **Funding application estimates must be reviewed and validated by VDOT and should follow the process detailed in IIM-LD-260/IIM-IID-11.**

Cost estimating activities during the Pre-Scoping / Funding Application Phase include the following:

- Locality/funding applicants or VDOT creating an initial project scope, schedule and estimate

- Submit for funding through SMART Portal application processes (multiple) or other third party controlled processes such as regional authorities or Metropolitan Planning Organization (MPO) processes

- Application review and validation process

- Funding decisions

1.3. VDOT's Project Development Process

The PDP guides VDOT's preliminary engineering process. It establishes guidelines for increased involvement of all stakeholders in the project lifecycle, with the goals of improving project coordination and communication, and ultimately improving the quality of the design-construction process. The Project Development Process flow chart is seen in *Figure 1-1*.

In addition, details on the specific tasks and milestones of the PDP can be found in the Project Tasks and Scheduling Guide.

Figure 1-1: Project Development Process
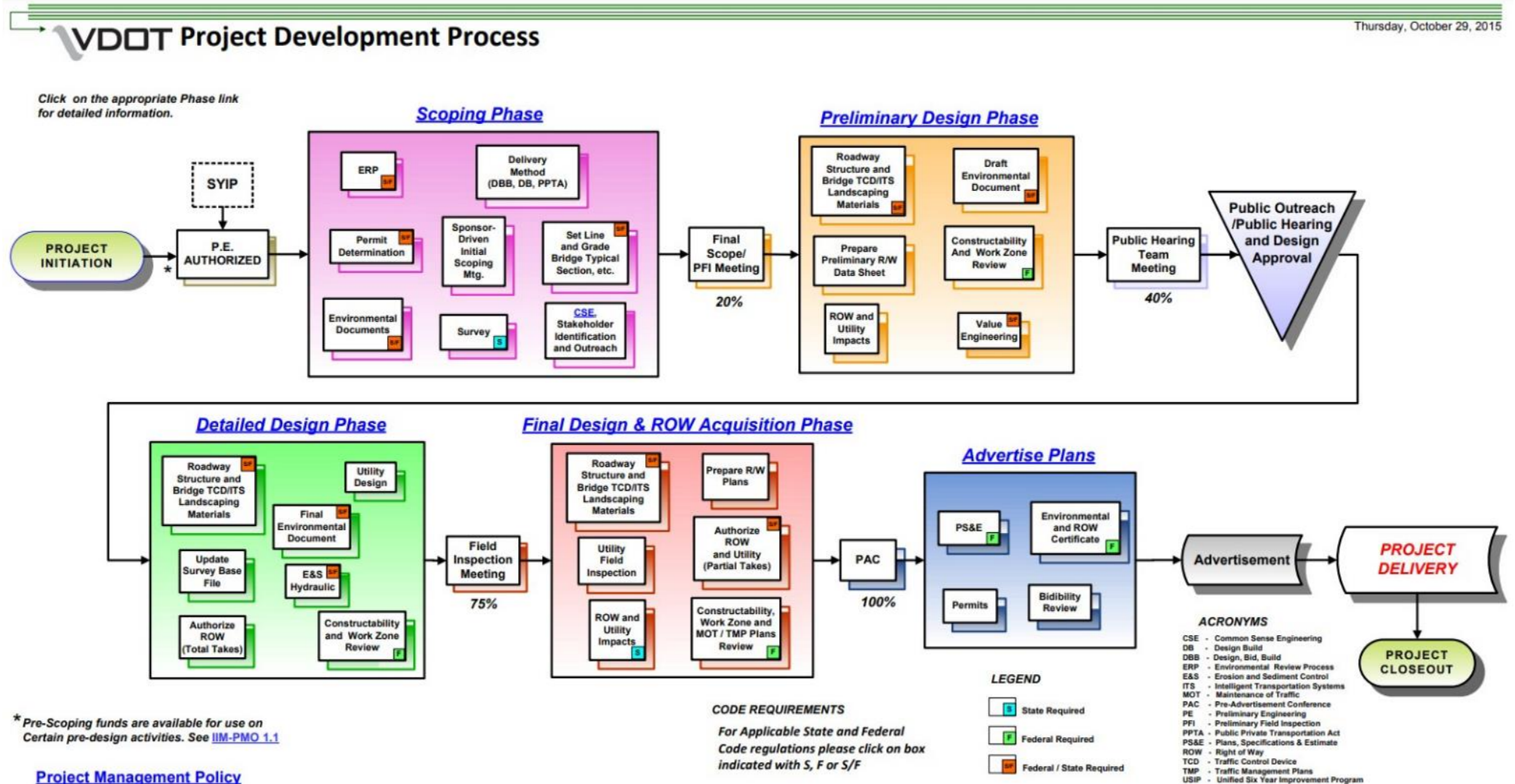
1.3.1. Progression of a Cost Estimate During the Project Development Process

In the Introduction of this manual, we introduced various key terms related to cost estimates such as defined cost, allowance, and contingency. Each of these terms defines a separate and distinct component of a typical estimate. *Figures I-1a and I-1b* depicted these conceptually on a typical road widening and bridge replacement project, while *Figure 1-3* breaks these down further.

During the project development process, the information feeding the estimate progresses as design progresses. As a result, the estimate components referred to as defined costs should increase, and the estimate component referred to as allowance, should decrease. Additionally, the component of the estimate referred to as contingency should also decrease as risks are mitigated and typically reduced with increased investigation, clarity and project definition. The below *Figure 1-2* shows how this progression may take place during the project development process. However, it should be noted that if additional items of work and / or risks are identified later the process, contingencies and allowances could increase, thereby increasing the overall estimated project cost.

Regarding establishing contingencies based on risks, a detailed process has been established for VDOT projects and this process is outlined in Chapter 5 of this manual.

Figure 1-2: Progression of a Cost Estimate

ESTIMATE COMPONENTS AND PROGRESSING OF ESTIMATE AS PROJECT DEFINITION INCREASES

Basic Estimate Components (AASHTO)
- Contingency Costs
- Basic Estimate

Primary Estimate Components (VDOT - 2021 Definitions)

Project Initiation
- Inflation Costs **
- Contingency Costs Project
- Allowance Costs
- Defined Costs

Scoping Meeting — BASELINE ESTIMATE
- Inflation Costs **
- Contingency Costs Project
- Allowance Costs
- Defined Costs

Public Hearing
- Inflation Costs **
- Contingency Costs Project
- Allowance Costs
- Defined Costs

Field Inspection
- Inflation Costs **
- Contingency Costs Project
- Allowance Costs
- Defined Costs

Advertisement Final Submission (FV FOR CN PHASE)
- Contingency Costs Project
- Defined Costs Inflation Costs~0% Allowance Costs~0%

Award
- Contingency Costs CN
- Defined Costs Inflation Costs~0% Allowance Costs~0%

** The inflation component for VDOT project development estimates is typically added to the estimate by VDOT's PCES (Workbook) The inflation component for funding application estimates is typically added to the estimate via the Smart Portal.

Figure 1-3: VDOT Cost Estimate Components

Phase	Phase Items	Base Estimate		Contingency	Inflation	Total BL Estimate
		Defined	**Allowance**			
		D	**A**	**C = C% * (D+ A)**	**I = I% * (D+A+C)**	**T = D + A + C + I**
Preliminary Engineering	Design					
	VDOT Oversight **					
Right of Way	RW Acquisition					
	Out of Plan Utilities					
	VDOT Oversight **					
Construction	Bid Items ***					
	Incidentals	*	*			
	Incentive	*	*			
	State Forces	*	*			
	State Police	*	*			
	Railroad	*	*			
	CEI	*	*			
	CEI VDOT Oversight **	*	*			

*   Mostly Allowance at project selection / Mostly Defined at Final Submission
**   For Locally Administered Projects
***   Includes In-Plan Utilities

1.3.2. Scoping

The scoping phase is the initial step in the PDP which begins with project initiation and PE authorization. The scoping phase involves the Project Manager creating a project team that is responsible for defining the required project deliverables, the working budget and the schedule for designing and developing the project. This phase concludes with the approval of the scoping report by an applicable management representative or equivalent to deliver the project within established technical requirements, on-time and within budget.

This phase concludes at the milestone Scoping Finish / Preliminary Field Inspection (PFI) – Task #22 Finish.

Cost estimating activities during the scoping phase include the following:

- Establish or confirm the project scope and further develop the estimate

- Request an initial RW and Utility estimate (guidance on RW and utility estimate r can be found later in Chapter 1)

- Request an environmental estimate and/or reference Environmental Thresholds and Considerations (internal only)

- Scoping/ PFI Constructability Review

- Update and recommend the estimate in the PCES - System and Update Cost Estimate Workbook

- Document the estimate in Project Cost Estimate Package (CEP)

1.3.3. Preliminary Design

The preliminary design phase consists of advancing the project design, which includes environmental documentation, constructability and work zone review, stage 1 bridge report (if applicable) and obtaining design approval. A preliminary design is prepared and reviewed by all stakeholders on the project.

This phase concludes at the milestone Design Approval / Public Hearing (PH) – Task #49 Finish.

Cost estimating activities during the Preliminary Design Phase include the following:

- Advance the preliminary design and update the estimate accordingly

- Consider converting the estimate to a quantity/bid based estimate in AASHTOWare Project Preconstruction

- Design Approval / Public Hearing Constructability Review

- Update and recommend the estimate in the PCES - System and Update Cost Estimate Workbook

- Document the estimate in CEP

1.3.4. Detailed Design

The detailed design phase includes the creation of a detailed design of all aspects of a project, including traffic control devices/intelligent transportation systems, and landscaping; determining RW and utility impacts, developing E&S/hydraulic plans, performing utility design, authorizing RW (total takes), performing constructability and work zone reviews, developing bridge plans and holding the field inspection (FI) team meeting.

This phase concludes at the milestone FI. - Task #65F Finish.

Cost estimating activities during the Detailed Design Phase include the following:

- Continue to progress the design and update the estimate accordingly
- If not already done, convert the estimate to a quantity/bid based estimate in AASHTOWare Project Preconstruction
- FI Constructability Review
- Update and recommend the estimate in the PCES - System and Update Cost Estimate Workbook
- Document the cost estimate in CEP

1.3.5. Final Design and RW

The final design and RW acquisition phase include finalizing the design of roadways, structures and bridges, traffic control devices/intelligent transportation systems, landscaping, finalizing RW and utility impacts, E&S plans, and utility design. Additionally, this phase includes obtaining environmental permits, holding the utility FI, authorizing RW and utilities (partial takes), performing constructability, work zone, MOT/transportation management plan reviews, and holding the pre-advertisement conference team meeting.

This phase concludes at the milestone Pre-Advertisement Conference (PAC). – Task #71 End

Cost estimating activities during the Final Design/ RW Phase include the following:

- Finalize the design and update the estimate accordingly
- Pre-Advertisement Conference (PAC) Constructability Review
- Update and recommend the estimate in the PCES - System & Update Cost Estimate Workbook
- Document the cost estimate in CEP

1.3.6. Advertisement

The Advertisement phase includes the preparation of the plans, proposal and specifications for the procurement of the construction contract.

The process of advertisement starts with Task 72, Prepare for Advertisement, and concludes with Task 84, an awarded contract.

Cost estimating related activities during the Advertisement Phase include the following:

- Development of the Engineer's EE by the Construction Division
- Plans, Specs and Estimate (PS&E) authorization by the Federal Highway Administration (FHWA) for Advertisement (Federal Aid project)
- Advertisement, bid opening and bid analysis
- Contract award, including generation of the Fund Distribution Sheets
- Contract execution

1.4. Post Award

Post Award cost estimating related activities post award include the following:

- Comparison of the bidder's prices to the VDOT's estimates by item number or category of items, to see where VDOT's estimate most closely matched or deviated from the bidder's estimate. This analysis can be used to influence and improve future estimates.

- Comparison of the final design estimate to the actual construction contract award amount for estimate accuracy and performance metrics.

1.5. Types of Cost Estimates

Table 1-1 details the different types of cost estimates developed by VDOT and their intended use cases.

Table 1-1: Types of Cost Estimates

	Analogous	Parametric	Quantity/Bid Based	Cost Based	Cost Finance Summary (CFS)
Description	Analogous estimating uses a similar past project information to estimate the cost of your current project. Completed projects with a similar size and scope may be used to determine early estimates on current projects.	Parametric estimating is used when quantities are unknown during the early phases of a project. Costs (i.e. cost per lane mile) are determined for the various geometric standards depending on the inputted parameters This estimating method uses a historical database of awarded projects to determine costs based on the inputted parameters.	Quantity/Bid based estimates are utilized once design has advanced to the point where detailed quantification of bid items is possible. VDOT's AASHTOWare Project Preconstruction tool is used to generate quantity/bid based estimates using historical bid prices for the project's bid items.	Cost based (rational) estimates are developed through determining project productivity, estimated labor, materials, equipment, overhead, and margin for specific line items. This method allows the cost estimate to include a project's geography, market factors, material cost changes and other unique variables.	The CFS is utilized by VDOT as a formal method of incorporating design-build (DB) cost elements into a cost estimate. This approach adds DB specific cost and risk factors to typical project estimates. The level of detail varies greatly depending on design maturity as DB projects can be procured at different phases of project development.
Use at VDOT	Analogous estimating may be used when developing Pre-Scoping or Scoping level estimates.	Parametric estimating is used by VDOT Project Development and VDOT business partners to create cost estimates early in the PDP.	Quantity/Bid Based estimating is used by VDOT Project Development on cost estimates at any stage of the PDP but no later than FI (based on current PMO guidance).	Cost based estimating is used by VDOT Construction in the development of the Engineer's EE during the Advertisement Phase.	The CFS estimate is used by VDOT Alternative Project Delivery (APD) during DB project development
Tools Available (Detailed in Chapter 4)	N/A	PCES - Workbook Bridge PCES Web Tool SPLCE Bristol Estimating Tool	AASHTOWare Project Preconstruction ICVT Spreadsheet Bid Tabs Culpeper Estimating Tool Staunton Estimating Spreadsheet	AASHTOWare Estimator AASHTOWare Project Preconstruction Bid Tabs	CFS Spreadsheet Bid Tabs

1.6. Cost Estimating Process Overview

The guidance provided herein will outline the steps of developing and updating cost estimates both during the planning/pre-scoping/funding application phase and during the project development process.

As outlined in more detail in Chapter 2, the cost estimating process for Design-Bid-Build (DBB) projects will follow the following steps:

- Determine the Estimate Basis

- Prepare the Estimate

- Determine Risk and Set Contingency

- Document the Estimate and Utilize the Estimating Checklist

- Quality Review and Approval

- Upload the Estimate into the PCES - System (where inflation is applied)

> 📝 **Cost Estimating Process**
>
> The general steps of cost estimating should follow the same process regardless of the level of project definition and the stage of the estimate development however the accuracy of the estimate will improve as estimate is informed with more detail.

When a project is selected for design-build (DB) delivery, the project estimate will be developed and updated according to the guidelines described in Chapter 3.

1.7. Cost Estimate Update Process (Responsibility and Authority)
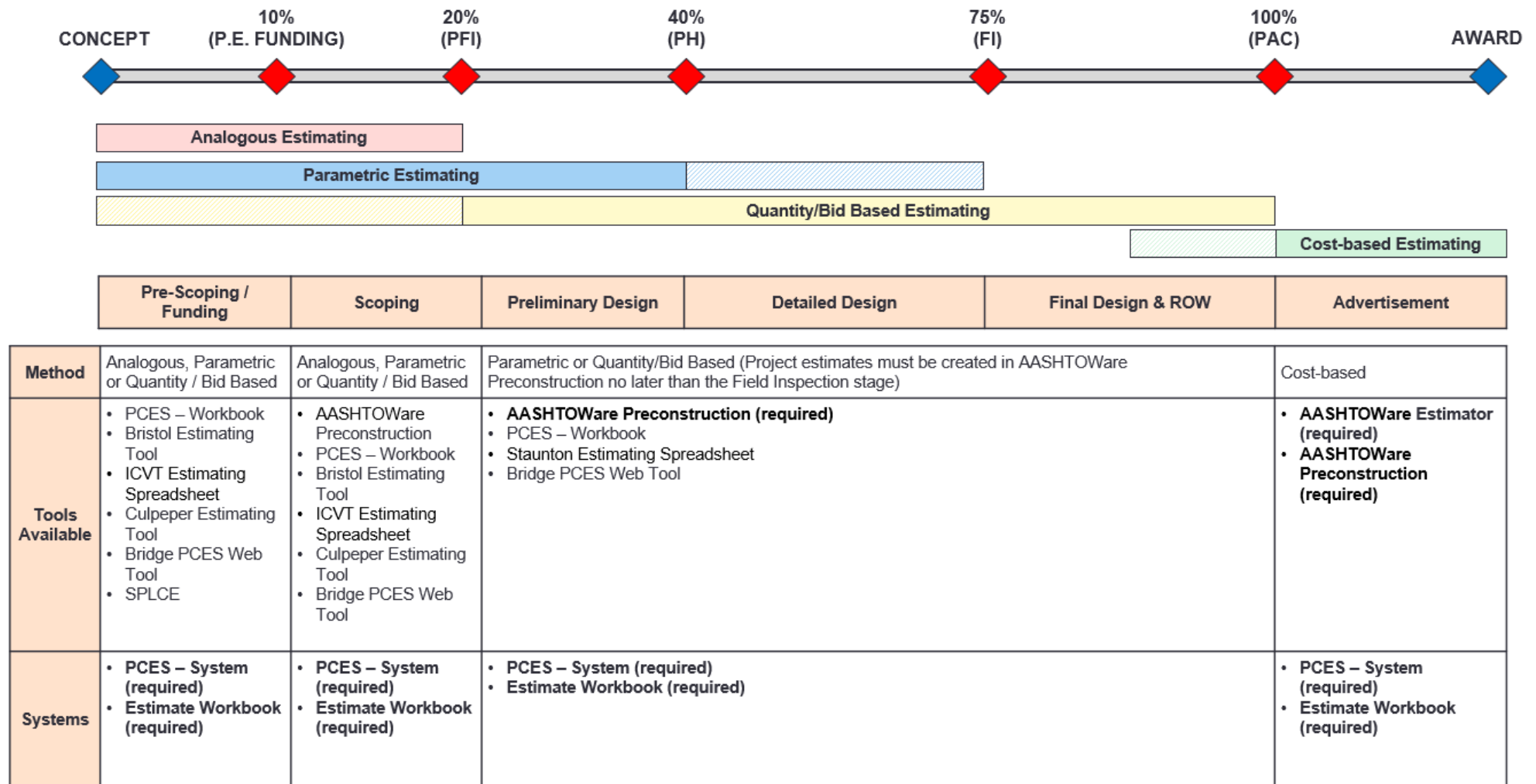
The VDOT Project Manager, as designated by the District's management, has both the authority and responsibility to update estimates at any time during the project development process. Where applicable, estimates should be updated using the Cost Estimate Workbook (for PE, RW, and CN phases), and then uploaded and recommended in the PCES - System. The Project Manager should consult with the estimator(s), consultants, and/or designers prior to adjusting the estimates received.

Estimates should be updated:

- **At each project milestone**, such as but not limited to: Task #36X: Scoping/ PFI, Task #49X: Public Hearing/Willingness, Task #65X: Field Inspection, Task #71X: Pre-Advertisement Conference and Task # 80: Advertisement;

- When **significant changes** affecting cost occur between milestones and/or exceed established thresholds;

- **As needed for development and/or management of the SYIP**, Federal Obligation Plan, and TIP/STIP or as otherwise directed by VDOT Management;

- **As needed to update projects requiring a Financial Plan** in accordance with Section 33.2-368 of the Code of Virginia and the FHWA-VDOT Stewardship and Oversight Agreement, and

- At least **once within each year**.

An overview of the PDP and the various corresponding cost estimating methods and tools, technology or systems available is shown in *Figure 1-4*:

Figure 1-4: Cost Estimating Process Overview at Stages of Project Development

Method	Analogous, Parametric or Quantity / Bid Based	Analogous, Parametric or Quantity / Bid Based	Parametric or Quantity/Bid Based (Project estimates must be created in AASHTOWare Preconstruction no later than the Field Inspection stage)			Cost-based
	Pre-Scoping / Funding	Scoping	Preliminary Design	Detailed Design	Final Design & ROW	Advertisement
Tools Available	• PCES – Workbook • Bristol Estimating Tool • ICVT Estimating Spreadsheet • Culpeper Estimating Tool • Bridge PCES Web Tool • SPLCE	• AASHTOWare Preconstruction • PCES – Workbook • Bristol Estimating Tool • ICVT Estimating Spreadsheet • Culpeper Estimating Tool • Bridge PCES Web Tool	• **AASHTOWare Preconstruction (required)** • PCES – Workbook • Staunton Estimating Spreadsheet • Bridge PCES Web Tool			• **AASHTOWare Estimator (required)** • **AASHTOWare Preconstruction (required)**
Systems	• **PCES – System (required)** • **Estimate Workbook (required)**	• **PCES – System (required)** • **Estimate Workbook (required)**	• **PCES – System (required)** • **Estimate Workbook (required)**			• **PCES – System (required)** • **Estimate Workbook (required)**

1.8. Project Definition and Estimate Accuracy

Estimate accuracy is defined in several different ways depending upon the source. In some cases, the estimate is measured against the low bid (FHWA and VDOT), in other cases it is measured against the final cost of the project. As with many aspects of estimating, estimate accuracy is also an inexact science. Ask any contractor who submitted a low bid only to realize later that the estimate did not include all the project costs. The

> **📝 Communicating Estimate Accuracy**
>
> Preliminary estimates should be expressed as a range or an order of magnitude. These estimates should not be communicated publicly as an exact value until the level of project definition is appropriately progressed (typically at FI).

contractor would quickly advise you that the low bid was not an accurate representation of the cost. Also, measuring the final cost of a project to the estimate may not be an accurate representation of the project estimate accuracy. Many projects that are built have significant cost and scope increases for numerous reasons such as natural occurrences and late adjustments to the project scope by stakeholders. In most cases, these changes in the project during construction are well beyond what was relied upon as the basis of estimate for the original and budget estimate.

It is widely recognized by estimating professionals that estimate accuracy is a function of project definition. The less the project definition, the less accurate the estimate. The more project definition, the greater the estimate accuracy. Association of State Highway Transportation Officials (AASHTO) and other national professional organizations have published information that addresses this fact.

Table 1-2: AASHTO's Project Definition and Accuracy Ranges

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 Judgement)	-50% to +200%
	1% to 15%	Conceptual Estimating – Prioritize Needs for Long-Range Plans (IRP – 10-year plan)	Parametric or Historical Bid-Based (Primarily Stochastic)	-40% to +100%
Scoping	10% to 30%	Design Estimating – Establish a Baseline Cost for Project and Program Projects (IRP 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%
Final Design	90% to 100%	PS&E Estimating – Compare with Bid and Obligate Funds for Construction	Cost-Based or Historical Bid-Based using Cost Estimate System (Deterministic)	-5% to +10%

AASHTO's Project Definition and Accuracy Ranges shown in *Table 1-2* provide an overview of project definition versus estimate accuracy. It is important for the estimator(s), and all who rely on these estimates, to understand the variability of estimate accuracy and its relationship to project definition. As demonstrated in the above table, the accuracy increases as the project definition increases.

Project estimates developed to compare alternatives for multi-alternative Environmental Assessments (EA) or Environmental Impact Statements (EIS), are developed to comply with the National Environmental Policy Act (NEPA). Depending on the study, these estimates may fall in the planning or scoping phases of project development. Due to the constraints of the NEPA process, these estimates are often not as accurate as estimates that may be developed outside of the NEPA process during these phases of project development.

1.9. Estimating Tools, Technology and Systems – General Overview

VDOT has multiple project cost estimating tools and systems for internal and/or external use. These tools and systems assist in developing and tracking cost estimates. The below tools are available to ensure all aspects of the project costs are addressed and improve the accuracy of cost estimates for funding applications and at all phases of the project development process.

A video overview of some of the VDOT tools is available at this link: Review of Cost Estimating Tools.

A detailed description of these tools and user guides or trainings (where available) is provided in Chapter 4.

Table 1-3: Estimating Tools, Technology and Systems:

Technology and Tools	Pre-Scoping /Funding	Scoping	Prelim. Design	Detailed Design	Final Design & RW	Advertise
Required Estimating Tools and Systems						
Cost Estimate Workbook	√	√	√	√	√	√
PCES - System	√	√	√	√	√	√
PCES - Workbook	√	√	√			
AASHTOWare Project Preconstruction		√	√	√	√	√
AASHTOWare Project Estimator						√
SMART Portal	√					
Optional Estimating Tools (Available Externally)						
Bristol Estimating Tool	√	√				
Culpeper Estimating Tool	√	√				
Staunton Estimating Spreadsheet			√	√	√	
Optional Estimating Tools (Internal Use Only)						
ICVT - Lynchburg/NOVA Spreadsheet	√	√	√			
Bridge PCES Web Tool	√	√	√			
SPLCE	√					
DB Cost Finance Summary (CFS)		√	√	√	√	√
Environmental Estimating Workbook	√	√				

1.10. Estimating Quantities

Particular care must be taken when an estimate is developed to the point of a quantity/bid based estimate. VDOT's L&D Division provides specific guidance and tools regarding estimating quantities at this stage in the process. This guidance is provided in Chapter 2E of VDOT's Road Design Manual, in Section 2E.7. This can be reviewed at the following link: Construction Cost Estimate - Estimating Quantities.

1.11. Right of Way Acquisition and Utility Relocation Estimates

This section covers the interface with the RW Division regarding the RW and utility relocations portion of the overall project cost estimate. Acquiring RW and relocating utilities is highly specialized and is governed by numerous of laws, regulations and policies. VDOT's RW and Utility Division are experts at leading VDOT through this process and have published the VDOT Right Of Way Cost Estimate Guide.

The RW and Utility Division has unique expertise in developing cost estimates specific to the required land rights and utility relocations for VDOT projects. It is the responsibility of the VDOT Project Manager to request estimates and estimate updates from the RW and Utility Division. It is the responsibility of the RW and Utility Division to provide the requested estimate in a timely fashion. It is imperative that the scope and size of the project is taken into consideration when requesting a due date on a RW and Utility estimate. These requests for estimates are made with the use of the PM-104 Form.

For the RW and Utility Division to provide accurate and useful estimates, the requester must provide a certain amount of key information (to the maximum extent that this information is available at the current phase of project development) as described below:

1.11.1. Request for RW and Utility Estimates – VDOT Internal

Internal requests for RW and utility relocation estimates should include the following documents and information:

1. Scaled RW plan including:
   - Existing RW and easement lines
     - At pre-scoping level, this may be from County Tax Map Parcel maps and other readily available references (e.g., Geographic Information System, GIS)
     - Once survey is completed, actual limits with metes and bounds oriented and tied to existing topography
   - Proposed RW and proposed easement lines, including proposed utility easement locations, and temporary construction easements
   - Existing features
     - At pre-scoping, most recently available aerial photography
     - Once survey is completed, actual field verified features with identifying labels
   - Parcel numbers
2. RW data sheet or list of all proposed rights-of-way and easements by parcel number with the areas of the acquisition reflected for each acquisition type
3. Scaled utility plans including:
   - All information required for RW plans
   - Proposed improvements

- Locations of all existing utilities with identifying labels, owners, materials, sizes, depths and heights once the survey has been completed, or utility company plans received (SUE level A/B required for PFI stage and later estimates)
- Proposed limits of work

4. PM-104 Form

1.11.2. Request for RW and Utility Estimates – External Submission to VDOT

RW and Utility Relocation estimates prepared by others such as consultants, localities and other state and federal agencies will be reviewed by VDOT Right of Way and Utility estimators. **The submitted estimate must include the following related documents and information (to the maximum extent that this information is available at the current phase of project development)**:

1. All information required for internal requests for estimates as described in the VDOT Internal section, above.

2. Clear descriptions of all assumptions. These must be justifiable.

3. The estimate and plans must be consistent. Estimates for Utilities should be itemized, preferably on VDOT's PCES worksheets.

4. A list of all affected, or potentially affected utilities, including owners. This information is available through the VA811 (Miss Utility) system.

5. SUE (Utility Survey) Quality 'D' is highly recommended for pre-scoping estimates Quality 'D' refers to the approximation of utility layouts based solely on utility company maps.

6. As field survey data is gathered and the design is developed, the accuracy of the identification of impacts to existing utilities must be refined.

7. Parcel by Parcel estimate worksheets reflecting the values estimated for acquisition.

8. Summary of all RW costs to include PE, cost of land/easements, buildings/site improvements being acquired, damages to the remainders, administrative costs, condemnation increment, relocation assistance, demolition costs, hazardous material removal, property management (if applicable), utility costs.

9. The following potential impacts to existing utilities need to be evaluated for every project at every phase of project development

   - Proposed excessive cuts and/or fills
   - Proposed drainage features (pipes, structures, ditches, ponds, etc.)
   - Proposed retaining walls
   - Proposed noise abatement
   - Proposed bridge features (abutments, bridge deck, etc.) - note: The estimator(s) should verify required clearances from utilities with the owner of each utility.
   - Proposed roadway features (sidewalk, SUP, curb and gutter, proposed pavement, etc.)
   - Proposed MOT
   - Proposed traffic signals/equipment
   - Excavation required for any proposed features.
   - Undercuts due to unsuitable soils or any other reason

- Any proposed work to be done within the utility company prescribed proximity of any highly sensitive utility. (e.g., an overhead electric transmission lines, underground electric transmission lines, natural gas transmission lines, petroleum transmission lines, large water transmission lines, large sanitary sewer lines, sanitary force mains, etc.). The estimator(s) should verify required clearances from utilities with the utility owner.
- Any other potential impact to an existing utility

All potential impacts to properties, existing improvements and existing utilities must be identified using the best available information and included in project estimates. VDOT reserves the right to reject any incomplete submission or, at their sole discretion, make assumptions based on experience and professional judgement to account for any omitted impacts.

Evaluation of the risks associated with RW phase estimates should be a collaborative effort by the project team including the RW and utility estimators.

Resources:

[VDOT Right of Way Cost Estimate Guide (Released in June 2021)](#)

[VDOT Right of Way Manual](#)

[VDOT Utility Manual](#)

[VDOT Rail Manual of Instructions](#)

[Staying on Track with Rail Projects Webinar (February 2021)](#)

1.12. Environmental Estimates

This section covers the interface with the Environmental Division regarding the environmental influence on the overall project cost estimate. Environmental coordination and mitigation are highly specialized and is governed numerous laws, regulations and policies. VDOT's Environmental Division is charged with leading VDOT through this process.

The Environmental Division also has unique expertise in development cost estimates specific to the project conditions. It is the responsibility of the VDOT Project Manager to request estimates and estimate updates from the District Environmental Section. The District Environmental Section is responsible for providing the requested estimate in a timely fashion. These requests for estimates are made during the scoping process and are provided by the Project Manager using the [Environmental Scoping Worksheet](#).

Typically, environmental costs are approximately 3% of the total project cost. Environmental features within and surrounding a project site, could drastically influence this general percentage. Examples of project/site conditions where a more detailed environmental estimate should be completed are provided below.

- Roadway on new alignment
- Level of NEPA document
- Adverse effect on historic properties
- Noise barriers required
- Hazardous material site within project limits
- Significant impacts to wetlands and streams

- Threatened and endangered species within project site

As a project is developed and project details are determined, the environmental estimate should be updated. Avoidance of environmental features is often the best option to reduce environmental costs.

Resources:

[Environmental Thresholds and Considerations (internal only)](#)

[Environmental Procedures Management Estimating Tool (internal only)](#)

1.13. Major Project Cost Estimating

A major project or program is defined as a project that receives any amount of federal financial assistance and has an estimated total program cost greater than $500M (expressed in year-of-expenditure dollars), or other projects identified as a major project by the FHWA (USDOT FHWA 2007).

The below FHWA link provides major project specific guidance on cost estimating, financial plans, and project management plans:

Resources:

[FHWA Guidance on Major Projects](#)

Chapter 2 –
Cost Estimating Process
(Design-Bid-Build)

Chapter in Brief:

This chapter provides guidance on estimating from project inception through advertisement for a project delivered via the DBB delivery method.

It also provides a brief overview on the Engineer's EE and other estimating processes that may be necessary during the CN phase of a project.

2.1.   Overview

2.2.   Estimating at Planning / Pre-Scoping / Funding Application Phase

2.3.   Process for Estimating during Project Development Phases

2.4.   Advertisement and Engineer's Evaluative Estimate

2.5.   Estimating during Construction

This chapter provides guidance on the development of the cost estimate and the steps to be taken to create and update the estimate, before and during the project development process, for projects delivered using traditional DBB methods. The process is based on both current VDOT estimating guidance and the cost estimating processes provided by *AASHTO's Practical Guide to Cost Estimating (2013 First Edition)*.

2.1. Overview

As defined by AASHTO, DBB is the traditional method for delivering transportation projects. The owner (or a consultant for the owner) prepares the design and a PS&E package that includes both construction and transportation management plans. Contractors engage in a competitive low-bid process to follow the specifics of the owner supplied plans and specifications. The lowest responsive and responsible bidder is awarded the project once the owner has determined that sufficient funding exists.

As noted in Chapter 1, estimates are updated using the Cost Estimate Workbook (PE, RW, and CN phases), and then uploaded and recommended in the PCES-System at various stages of project development:

The Cost Estimate Workbook is utilized to capture and document the defined costs, allowances and contingencies. **A Cost Estimate Workbook is completed in its entirety, with each of the tabbed workbook pages completed, for all projects where the guidance in this manual is required.**

2.2. Estimating at Planning / Pre-Scoping / Funding Application Phase

2.2.1. Overview

Estimates prepared for funding applications and during pre-scoping are inherently developed with a limited amount of information. However, these estimates are crucial and must be prepared to the best of the estimator's abilities, using the same general process as outlined below for estimates prepared based on greater project definition later in the project development process. The steps are:

- Determine the Basis of Estimate

- Prepare the Estimate

- Determine Risks and Set Contingencies

- Document the Estimate

- Review and Approval

> **Preliminary Estimates**
>
> Estimates at the planning, pre-scoping or funding application phase should follow the same general process as project development estimates

- Upload Estimate and Supporting Documentation to SMART Portal (Funding Application Estimates) or PCES System and Project Wise (Pre-Scoping level Estimates)

2.2.2. Planning / Pre-Scoping Estimating

At the beginning phase of long or short-range plan estimating, multiple high-level scenarios could be considered for solutions to the identified problems. Since extensive data and time is needed to develop detailed estimates for all scenarios, it is customary to utilize a high-level parametric tool to establish estimates. This method allows for the selection of several alternatives that will be carried forward to more refined concepts that will begin the process of preparing a preliminary estimate. The parametric estimate may be combined with other factors, such as changes in travel time and safety improvements to compute a high-level cost benefit analysis in making the alternative selection.

One high level parametric estimating method is the Statewide Planning Level Cost Estimate Tool (SPLCE) and is owned by the Transportation Mobility and Planning Division (TMPD) of VDOT. **This tool should only be used for very high-level estimates and to aid in narrowing down multiple scenarios that are going to be carried forward for a deeper evaluation.**

Once several alternatives have been chosen to move forward, the level of estimating will also be moving towards a more detailed estimate. This estimate may still be difficult to develop but all efforts should be utilized to obtain the best estimate possible. This effort may include a hybrid of multiple estimating tools and techniques for the items that are not included in the base estimate.

A collaborative approach works well at this stage to gather as much information and historical knowledge of the study area as possible. Team members would typically include staff within: Location and Design (L&D), Traffic Engineering, Environmental, RW and Utilities, Structure and Bridge (S&B), Construction and Materials. Another valuable source of information includes staff from the VDOT Residency, town or city public works and designers that have developed detailed construction plans near the study area. To develop an estimate at this stage, CADD sketches are extremely useful in determining measurements of the improvements. Although the sketches are conceptual in nature, they can provide valuable information needed in the estimating process.

The use of USGS data for imagery and existing topography combined with GIS data from localities and utility owners will aid in establishing the impacts that are anticipated to RW and/or existing utilities.

> **Site Visits**
>
> It is imperative that members of the project team developing the estimate go to the site and view the existing conditions firsthand.

In addition to this data, even a very primitive 2D or 3D design will also allow the estimator(s) to identify major items that can greatly affect the estimate. Some of these items may include earthwork, pavement, retaining walls, bridges, lengths of major drainage structures, potential storm water management locations and conceptual MOT. Professional judgement and discuss the best approach with others may be needed to gain insight and utilize others' experience. **For all estimates, the assumptions that are made should be well documented so that they may be verified.**

2.2.3. Funding Application Estimating

Accurate cost estimates are critical since some funding application programs use the estimate in determining the project score. Therefore, any cost estimate increase at a future date could result in the project's funding status being reconsidered. **The cost estimate should be as realistic as possible and should account for applicable allowances and risk contingencies, based on the size and complexity of the project as defined in Chapter 5 of this manual.**

Funding applicants must provide a cost estimate with supporting documentation to be reviewed and validated by VDOT and must follow the process detailed in IIM-LD-260/IIM-IID-11.

In some cases, the estimate at the time of application approval will also become the project's budget, so it is imperative that the estimate be as accurate as possible.

2.2.4. Upload Estimate into SMART Portal (Funding Application Estimates)

The final step of the typical process for estimating during the funding application phase, after the estimate is reviewed and validated, is to upload the estimate to SMART Portal unless the program uses ProjectWise. See Chapter 6 for more details on this process.

Figure 2-1: General Cost Estimating Process
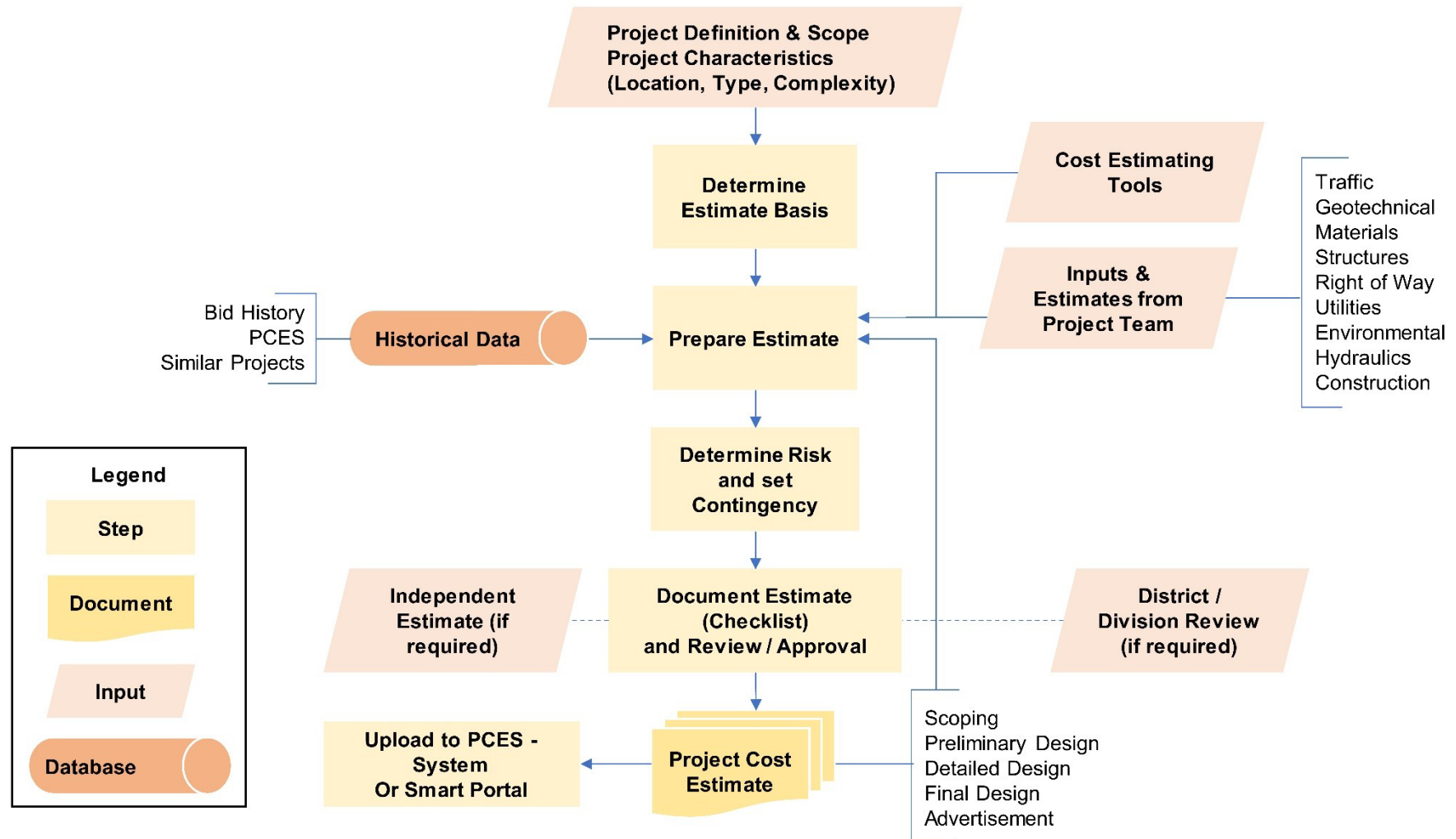
2.3. Process for Estimating during Project Development Phases

2.3.1. Overview

This section outlines the process for creating and/or updating a cost estimate after the project enters the PDP (following Project Initiation and PE Authorization). Estimates are created/updated at the points described previously in Chapter 1. *Figure 2-1* outlines the process of creating and/or updating cost estimates during project development:

2.3.2. Determine Estimate Basis

The first step of the estimating process is to determine the Basis of Estimate. The level of detail available for the Basis of Estimate is expected to vary depending on the project type and the phase of project development. In order, to develop the most accurate estimates, it is crucial

> **Determine Estimate Basis**
>
> A well-documented Basis of Estimate will allow for clear documentation of assumptions throughout the planning phase and the project development process.

for the estimator(s) to thoroughly research and gain as much information as possible about the project, to be included in the Basis of Estimate. The estimator(s) should visit the project site and walk the project limits, taking photographs and keeping notes during the site visit.

The estimator(s) should compile and review all available public records. These records should include items such as:

- Public and private utility records
- Submitted and/or approved site plans for potential development within or near the project
- Corridor studies, if applicable
- Plans and contract documents for projects that have been designed and constructed in the vicinity
- Topography maps of the area and contour data from the county's GIS office
- Drainage studies performed and wetlands maps in the area
- Bridge safety inspection reports
- Tax parcel maps
- Traffic studies
- Geotechnical reports for nearby projects

The estimator(s) should also consult with as many individuals as possible regarding the location of the project. Examples include individuals from:

- L&D
- Construction and/or Project Controls
- Environmental
- S&B
- RW and Utilities
- Geotechnical/Materials
- Local Assistance

- VDOT Residency

- Locality's Department of Public Works and/or Department of Transportation

- Engineers who have designed or are designing projects in the vicinity

- Contractors who have built or are building projects in the vicinity

Performing a considerable amount of research in the front end of the estimating process yields tangible and measurable dividends for the estimator(s) as the actual estimate is prepared. There is typically a large amount of useful information that can be discovered and utilized by the estimator(s) if the effort is applied up front. Facts regarding the project obtained during this research phase should be adequately reflected in the development of defined cost, allowances, risks, and contingencies. **This information should be documented in the Basis of Estimate and incorporated into the CEP detailed in Chapter 6.**

For example, the estimator(s) may learn from speaking to the District Materials Engineer that the area is prone to have a lot of unsuitable materials. This fact should be clearly addressed in the Basis of Estimate and the cost should be reflected as an allowance or risk based contingency. By performing the detailed research up front, the estimator(s) may learn that the county is considering approving a new commercial development adjacent to or nearby the project. This potential development could affect the proposed transportation improvement and should be appropriately addressed in the estimate risks. The estimator(s) cannot know too much about the project or the project vicinity, prior to preparing the estimate. It is always better to know about specific challenges and unique aspects of the project location, before the estimate is prepared, rather than after the estimate has been prepared and published.

The estimator(s) should carefully consider exclusions. An estimate that has a long list of exclusions becomes less useful to decision makers. Decision makers, especially those involved in funds management, need to review the project costs in their entirety. In most cases, the estimate will be more useful if it includes appropriate allowances. A good quality estimate should have evaluated risks and should have risk-based contingencies included in the estimate total.

2.3.3. Prepare Estimate

Depending on the phase of the project development, the amount of information available to the estimator(s) will vary greatly. Estimates should be created and updated using the methods and tools described in Figure 1-4 for each respective phase of project development. Refer to Chapter 4 for more details and links to these tools, technologies and systems currently available. **The estimator(s) should try to quantify as many items of the work, to the maximum extent, and as early as possible.** The more items that are quantified in units and terms that correspond to standard VDOT contract unit prices, the better. There are many tools available to aid the estimator(s) in the development of quantities early in the life of the project. In many cases, these tools develop quantities that are considered rough quantities. As such, the estimator(s) needs to review the output and adjust these early quantities using professional judgement. If the estimator(s) does not have adequate experience to feel comfortable assessing and adjusting these early "rough" quantities, then it is crucial the estimator(s) consult a more experienced individual in that type of work. The quantities developed with limited information should generally be on the high side and refined as more details and design is developed.

> **Prepare Estimate**
>
> The Project Manager is responsible for compiling Estimate information from the estimator(s) and/or Project Team, reviewing and uploading the Estimate.

The Project Manager is responsible for compiling estimate information from the estimator(s) and/or project team, reviewing and uploading the estimate. The Project Manager shall work with the project team, including the required disciplines (traffic, geotechnical, materials, structures, RW, utilities, environmental, hydraulics, construction, et al.) for input into the Base Estimate.

The Project Manager shall use the PM-104 Form to request RW acquisition and utility relocation estimates; and either the Action Item feature in iPM, by means agreed by the project team, or District Standard Operating Procedures, to request estimates from other functional areas. More information regarding RW acquisition and utility relocation estimate requests is provided in Chapter 1.

Base Estimates are created using current year dollars and are to be entered into the Cost Estimate Workbook, where risks and contingencies clearly are documented. The Cost Estimate Workbook also facilitates the addition of incentives / disincentives, and miscellaneous project costs.

Base Estimates are prepared for all three project phases/components: Preliminary Engineering (PE), Right of Way (RW) and Construction (CN).

- PE phase costs include expenses charged by the staff of each discipline through development of the project until award of the construction contract, or completion of an equivalent procurement method. PE phase is closed to charges 90 days after award.

- RW phase costs include all expenses for RW acquisition and out of plan utility relocations, to include VDOT and local agency staff time, as applicable depending on project administration.

- CN phase costs include all expenses incurred from award of the construction contract to construction completion. These expenses include the contract amount, construction contingency, VDOT CEI or equivalent oversight, incentives, and third party costs such as railroads and police.

2.3.4. Determine Risk and Set Contingency

VDOT's Project Risk Management procedures for DBB projects can be found in PMO-15. **The Project Manager, in conjunction with the project team and estimator(s) shall follow the PMO-15 guidance.** Any risks that cannot be clearly, transferred, avoided or mitigated shall be covered in the estimated cost by applying risk-based estimating practices.

> **Determine Risk and Set Contingency**
>
> Detailed guidance on VDOT's Risk-Based Estimating and setting Contingency can be found in Chapter 5.

With issuance of this manual, VDOT is adopting a modified version of AASHTO's Risk-Based Estimating practices. This process is detailed in Chapter 5 of this manual.

2.3.5. Document Estimate/Utilize Checklist

After the Base Estimate is completed and contingencies are incorporated, the Project Manager and/or estimator(s) shall **document all assumptions made in the creation of the estimate in the Cost Estimate Workbook and/or the CEP.**

For the purposes of tracking major item costs, the application of contingencies, and historic progression of estimates, the **Project Manager should record the estimates and applicable details in the appropriate tab of the Cost Estimate Workbook and should maintain this document with the project records throughout the life of the project.**

Following the documentation of the assumptions made, the Project Manager and/or estimator(s) should utilize an estimating checklist to ensure all essential estimate elements have been reviewed and captured. A review of the checklist by the estimator(s), may prompt the estimator(s) to go back and edit the estimate accordingly.

The following information should be documented each time an estimate is established or updated:

- Type of cost estimate (parametric, quantity/bid-based, cost based) or combination thereof

- Overall project scope and exclusions for each estimate component

- Cost estimate assumptions for each estimate phase/component (PE, RW, CN)

- Documents and tools utilized to prepare the estimate

- Cost data source(s) for each estimate component (Bid Tabs, Similar Projects, etc.)

Proper estimate documentation shall be included in the Cost Estimate Workbook and/or the CEP.

Documentation of the estimate is key to the overall estimating process. This documentation has many benefits. It memorializes the information used to develop the cost estimate at that point in time. It also serves to provide justification of the estimated amount in the event the estimate is called in to question in the future. An estimate without proper documentation is in an indefensible position if it is challenged.

2.3.6. Review and Approval

Following the creation or update of the estimate, proper documentation and utilization of an estimate checklist (see Appendix B), the Project Manager shall follow the quality management guidelines detailed in Chapter 6.

2.3.7. Upload Estimate into PCES – System (Project Development Estimates)

The final step of the typical process for estimating during project development is to upload and recommend the estimate into the PCES – Workbook and PCES – System.

For estimates created using the PCES – Workbook, the Project Manager should follow the process described in the PCES Manual to upload and recommend the estimate to the PCES – System.

For estimates created using other tools or methods than the PCES – Workbook, the project estimate, without inflation, should be manually entered by the Project Manager into the PCES – Workbook using the manual selection as described in the PCES Manual. Inflation will then be added to the estimate based on the year of advertisement. **The Project Manager should then follow the process described in the PCES Manual to upload and recommend the estimate to the PCES – System.**

Consultants working on projects for VDOT have limited access to PCES and can upload estimates into the 'Pending Approval' section of PCES for the Project Manager's review and approval. **The Project Manager reviews and approves the consultant's pending estimate, uploads and selects the estimate as 'Recommended' for the appropriate milestone stage in PCES.**

For the Scoping/PFI estimate, upload, select and recommend the scoping estimate in PCES as soon as the Scoping process is complete and the scoping task in the PWA Project Schedule has actual finish dates. The scoping estimate shall be uploaded into PCES and recommended within ten (10) working days after the actual finish date of the scoping task (Task #22). This

scoping estimate then becomes the Baseline Estimate in the Dashboard. If a scoping estimate is not uploaded and recommended within this timeframe, Dashboard will assign the most recent uploaded and recommended estimate as the scoping estimate.

2.4. Advertisement and Engineer's Evaluative Estimate

2.4.1. Overview

When submitting a project for advertisement (at the conclusion of PAC), the final design estimate is turned over to the Construction Division where the Engineer's EE will be developed. The Engineer's EE is a cost-based estimate developed through the utilization of project productivity, estimated labor, materials, equipment, contract documents and CABB questions for specific line items.

FHWA's guidance on the Engineer's EE can be found in FHWA's Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation.

2.4.2. Developing the Engineer's Evaluative Estimate

Detailed instructions on the development of VDOT's Engineer's EE can be found in the Guidelines and Procedures for Estimating.

2.4.3. Comparing the Engineer's EE with Bids

Detailed instructions on VDOT's bid review process can be found in the Guidelines and Procedures for Estimating.

2.5. Estimating during Construction

2.5.1. Overview

The Construction Project Manager is responsible for overall management of the construction budget with support from the project team members. Complete and up to date construction budgets are required on all projects.

Detailed procedures on the actions required to maintain and monitor construction-phase estimates, budgets and expenditures can be found in PMO-10.2.

2.5.2. Change Orders

Detailed instructions on the development of independent government estimates (IGE) for change orders during construction can be found in IIM-CD-2020-02-01.

Resource: Heavy Construction Costs with RS Means data

Chapter 3 –
Cost Estimating Process
(Design-Build)

Chapter in Brief:

In this chapter the reader will learn how the project cost estimating is addressed once it has been determined that the project will be delivered via the DB project delivery method.

Most of the cost estimating processes remain consistent with the traditional delivery method. However, once the delivery decision is made, the cost estimate must take into consideration the breakdown and allocation of the costs specific to DB.

3.1   Overview

3.2   Design-Build Procurement

3.3   Design-Build Estimates

3.4   Design-Build Risks and Risk-Based Estimating

3.5   Engineer's EE on Design-Build Projects

3.1   Overview

DB is a project delivery method in which an agency contracts with a single entity to complete design and construction for a project. The level of preliminary engineering effort required before a DB contract is advertised should be sufficient to allow the Department to determine a clear scope, schedule, and reasonable cost estimate that meet all Federal and State laws and regulations. These efforts vary depending on project size, scope, and complexity. The Project Manager and Alternative Project Delivery (APD) Project Manager will coordinate to determine the appropriate level of efforts prior to start of the preliminary engineering design on a project by project basis. The design-builder is the engineer of record and is responsible for completing the final design and is responsible for any design errors or omissions that may occur. The design-builder is also responsible for risks associated with construction including, but not limited to, right-of way acquisition, utility relocations, quantities, constructability, water quality permits, noise abatement etc., which are normally retained by the Department in the traditional DBB project delivery method.

The Alternative Project Delivery (APD) Division is responsible for managing the procurement for each DB project. This includes coordination the development of the contract documents necessary for advertising Request for Qualifications (RFQ), Request for Proposals (RFP), coordinating the evaluation of the proposals, and awarding the DB contract.

3.2   Design-Build Procurement

The APD Division, in conjunction with the Districts, TMPD, L&D and the Infrastructure Investment Division (IID), will review each annual update of the SYIP to develop a prioritized list of potential DB candidate projects. The Division Administrator of APD will assign an APD staff member as Project Manager (PM-APD) for the contract development and solicitation of the DB contract. The pertinent District Engineer/Administrator will assign a District staff member as Project Manager (PM-D). For all potential DB candidate projects a Request for DB Procurement form will be submitted to APD by the District to initiate the consideration process.

VDOT DB processes and procedures are outlined within the Alternative Project Delivery Division Design-Build Procurement Manual located on the VDOT DB web page along with the Design-Build Evaluation Guidelines.

3.3   Design-Build Estimates

Cost estimates for DB projects will follow the process outlined in Chapter 2 until the project is selected to be procured as a DB project.

DB project estimates will be developed using the Cost Finance Summary (CFS) estimating spreadsheet. The CFS spreadsheet takes the traditional parametric or quantity/bid-based estimates and incorporates DB specific cost items into the estimate. The key objective of the CFS spreadsheet is to account for all project costs and to differentiate between VDOT's cost and the design-builder's cost to help determine the anticipated contract value (bid). Items include, but are not limited to, DB risk, stipend, early completion incentives, price adjustments for asphalt fuel and steel, QA/QC and any costs associated with railroads and state police as applicable.

> **Design-Build Estimates**
>
> Once the project is selected for DB delivery, APD will work closely with the District Project Development team on developing and updating the cost Estimate.

The estimator(s) preparing an estimate for a DB project should be extremely knowledgeable and fully understand the unique nature of the requirements of the costs associated with a DB project estimate.

On all DB projects, a cost estimate shall be provided for the project using the DB CFS spreadsheet. The estimate should be as detailed as possible and include design, RW, utility relocation, mitigation, construction, DB risk, QA/QC, and VDOT contract administration to include the Department's services for Independent Assurance and Independent Verification. These items shall be divided into VDOT and design-builder's costs. The cost estimate for the project's major items, including, but is not limited to the following: excavation, pavement, drainage, signals, bridges, guardrail, noise abatement, retaining walls, E&S controls, etc. should be developed utilizing AASHTOWARE Project Preconstruction software. The estimate in VDOT's SYIP, TIP and STIP shall match the most current cost estimate prior to submitting the RFP submittal to FHWA.

Additional details on the RFQ/RFP process for DB projects can be found in IIM-APD-1.3.

Details on how to determine the proposal payments (stipends) for shortlist offerors on DB procurements can be found in IIM-APD-5.

There is existing guidance within the Road Design Manual (page H-13 of Appendix H) on DB cost estimates, released prior to the Cost Estimating Manual.

Figure 3-1: Estimating Process for DB Projects
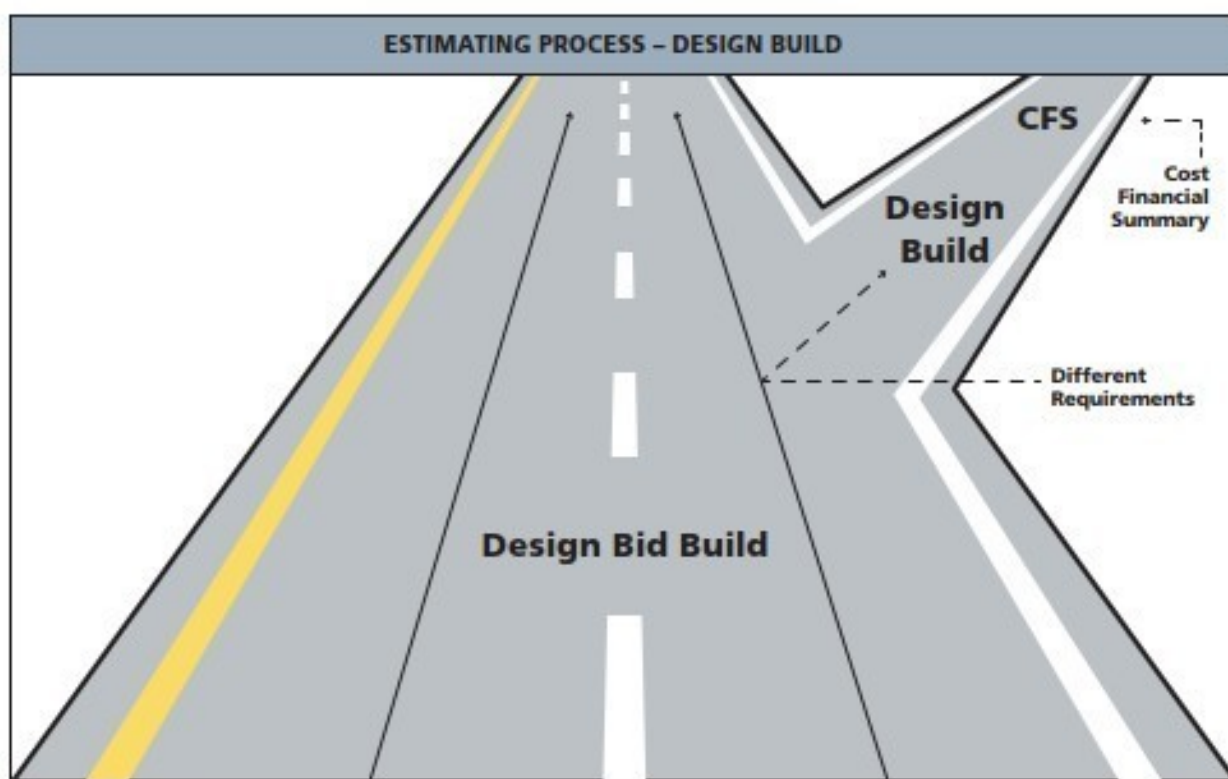
3.4 Design-Build Risks and Risk-Based Estimating

The estimator(s) for the DB estimate should conduct a risk-based estimate in accordance with the procedures outlined in Chapter 5 prior to completing the CFS and the Cost Estimate Workbook.

Design-Build Risks

For all DB projects, a Type II – Risk-Based Deterministic Contingency is highly recommended.

On VDOT projects, an additional cost related to DB risk is added to the project estimate. This cost is set based on the level of risk on a project by

project basis. DB risk is the amount of contingency applied to a DB estimate to capture the risk associated with a design-builder developing a lump sum price, to design and construct a project without the benefit of final 100% design plans or final quantities. The DB risk amount is in addition to contingency amounts used to develop the design and construction estimate. On a project by project basis and based on the project's complexities and other relevant factors, APD along with input from the Project Manager will determine the appropriate DB risk percentage.

3.5   Engineer's Evaluative Estimate on Design-Build Projects

The Construction Division will develop the Engineer's EE on DB projects according to the guidance laid out in Chapter 2.

Chapter 4 –

Tools, Technology, Systems and the Use of Bid Tabs

Chapter in Brief:

In this chapter the reader will be introduced to the cost estimating tools and systems currently in use by VDOT. This includes VDOT developed tools and commercially available tools.

Bid Tabs are used extensively by estimators while preparing estimates at all stages of the project lifecycle. This chapter contains an in-depth look at the use of Bid Tabs, and how to get the most out of this valuable data.

4.1.   Estimating Tools, Technology and Systems

4.2.   Use of Bid Tabs

4.3.   Statistical Use of Bid Tabs

4.4.   Summary of Bid Tab Tools

4.1. Estimating Tools, Technology and Systems

4.1.1. Overview

In the spring of 2021, when VDOT's first Cost Estimating Manual was developed, there existed a variety of estimating tools and estimating systems. These tools and systems, each with a specific purpose, are being used at different levels by the agency's estimators, Project Managers, consultants, and others across the Commonwealth.

The tools currently available are powerful and useful in preparing estimates for VDOT's projects. These tools and the estimators who use them are the backbone of VDOT estimating. Some of the tools are designed for widespread use and are universally applicable. Some of the tools are "home grown" and were developed to meet a specific need by the developer of the tool. Many of these tools are available to both VDOT personnel and the general public. However, VDOT's internal estimating systems are only available to those individuals with a VDOT account. Additionally, there are some systems listed below that are only available to those with a VDOT account and specific system access (e.g., AASHTOWare Estimator).

Estimating tools are very diverse in what they are best used for and what they provide. In *Table 4-1* and the sections that follow, some of VDOT's estimating tools are listed and then described. First, are the tools required for project development, followed by optional or more specific tools that are available to external users. The final group includes tools that are only available to internal users or certain sections. To select the

> **Estimating Tools**
>
> The estimator(s) should consider the stage of project development, the scope of the project, VDOT policy requirements, as well as past experience with various tools that are available. In most cases, multiple tools must be used to generate the total project estimate.

most appropriate tool, the estimator(s) must know what each tool is able to accomplish. Some tools are specific to PE, RW, or CN phase estimates. Some tools develop a parametric estimate; some assist in developing quantities; others provide unit cost recommendations; and some do both. Some tools are best for a limited scope of work (such as bridge projects with minimal approach work).

Many other spreadsheets and methods have been developed by various work groups over the years and have been successfully used, particularly for the detailed computation of quantities. These spreadsheets are often specific to each project, work group, or estimator(s), and are not covered in this listing.

There are also several tools that can be used to review Bid Tab records. These unit cost sources are covered at the end of this chapter in Use of Bid Tabs section and in Appendix C.

The below compilation of VDOT's estimating tools is the agency's baseline of the tools that are currently available and being used as of July 2021. This listing includes some general information regarding each tool and in most cases, a link to the tool is provided. Where available, a manual / users guide / training is also provided. It is important for the reader to know that each tool is unique and not every tool has readily available manuals, user guides, and/or training. Although this list is not all inclusive, it is the most current and most comprehensive listing of VDOT's available estimating tools. The reader is encouraged to review the manuals, and available training, to gain a better understanding of a specific tool.

Table 4-1: Listing of Technology, Tools and Systems

Technology, Tools and Systems
Required Estimating Tools and Systems
Cost Estimate Workbook
PCES - System
PCES - Workbook
AASHTOWare Project Preconstruction
AASHTOWare Project Estimator
SMART Portal
Optional Estimating Tools (Available Externally)
Bristol Estimating Tool
Culpeper Estimating Tool
Staunton Estimating Spreadsheet
Optional Estimating Tools (Internal Use Only)
ICVT - Lynchburg/NOVA Spreadsheet
Bridge PCES Web Tool
SPLCE
DB Cost Finance Summary (CFS) Spreadsheet
Environmental Estimating Workbook

Required Estimating Tools and Systems

4.1.2. Cost Estimate Workbook:

The Cost Estimate Workbook is utilized to capture and document the base project estimate and contingencies. A Cost Estimate Workbook is completed in its entirety, with each of the tabbed workbook pages completed, for where the guidance in this manual is required.

When to use: On all applicable projects (See Section I.2 above) that are to be entered into PCES and / or Smart Portal.

What it does: It provides a standardized format for estimates, which breaks down PE, RW, and CN phase estimates by discipline. It allows for contingencies to be applied and assumptions listed for each discipline. It also allows estimates to be saved for each project stage, so the estimate can be tracked over the life of the project.

What you need: Users must provide estimate totals for each discipline. This tool does not assist in generating estimates, but only in compiling and documenting estimates and contingencies. Other tools must be used to generate estimates, which should be described in the assumptions.

Benefits:

- It provides a consistent, Commonwealth wide format for breaking down and documenting estimates, including contingencies and assumptions.

- Allows for contingencies to be applied differently for each discipline, while many other tools only allow for contingencies by phase. Provides some project-specific (risk-based) guidance for the use of contingencies.

- The capability to track the estimate over the life of the project allows the source of estimate changes to be more readily identified.

Potential Limitations:

- It does not provide any estimating assistance or estimate validation, rather it serves as a summary and documentation of the major items of the estimate.

- Depending on the estimate methods used, the estimate quality may vary widely. The quality of the estimate can be ascertained if the assumptions are clearly stated. Like all tools, it is only as good as the information used.

Update Frequency: The Cost Estimate Workbook will be updated as needed to stay current other related, VDOT estimating policy, tools and systems.

Manual/Training: Cost Estimate Workbook Overview Training Module

Instructions for using the Cost Estimate Workbook can be found under the 'Instruction and Descriptions' tab.

Tool Link: Cost Estimate Workbook

Responsible Section (Point of Contact): Central Office L&D (Vernon Heishman)

4.1.3. Project Cost Estimating System (PCES) - WORKBOOK:

The Project Cost Estimation System (PCES) - Workbook is VDOT's parametric cost estimating tool. The PCES - Workbook is a parametric estimating tool utilized when quantities are unknown during the planning and scoping phase of a project.

When to use: It is utilized when quantities are unknown during the planning and scoping phase of a project.

What it does: Calculates project costs based on lane mileage, typical section, and other input parameters.

What you need: Length of project, typical section, and Average Daily Traffic (ADT).

Benefits:

- Can be used with little project definition.

Potential Limitations:

- Aside from the PCES User Manual, it can be difficult to understand what items are included and which ones are not.
- Baseline cost methodology does not accurately reflect widening existing pavement.
- PE and RW estimate calculator can underrepresent current costs.
- Not designed to estimate innovative intersections such as roundabouts.

Update Frequency: Yearly or as needed.

Manual/Training: PCES Manual

Tool Link: PCES - Workbook (internal only) (VDOT); Local Government Users, need to follow this link.

Responsible Section (Point of Contact): Central Office Construction Division (JuYin Chen)

4.1.4. Project Cost Estimating System (PCES) - SYSTEM:

The Project Cost Estimating System (PCES) - System is the application used to document and share project cost estimate information.

When to use: Required system to be used to capture and store cost estimate history for SYIP, Project Pool, etc. If PCES - Workbook is not used to develop the estimate, the Project Manager should select manual entry and input the estimate into PCES - Workbook to be uploaded to PCES - System.

What it does: Stores project cost estimate data and history for SYIP, Project Pool, etc.

What you need: Complete cost estimate and all steps of process outlined in Chapter 2 (DBB) or Chapter 3 (DB) completed.

Manual/Training: PCES Manual

Tool Link: PCES - System (internal only) (VDOT); Local Government Users, need to follow this link.

Responsible Section (Point of Contact): Central Office Construction Division (JuYin Chen)

4.1.5. AASHTOWare Project Preconstruction:

AASHTOWare Project Preconstruction, formerly known as Transport, is VDOT's quantity/bid-based cost estimating tool. This tool utilizes statistical modeling and user-defined project parameters to develop baseline pay item pricing for quantity/bid-based cost estimates.

When to use: For more detailed stages of design, when detailed quantities are available for the project. It is required to be used for the construction estimate for advertised projects. It is used to generate the project proposal for advertisement. The option to use AASHTOWare Project Preconstruction in conjunction with PCES is available in early stages of project development, but project estimates must be created in AASHTOWare Project Preconstruction, including the CEI cost, no later than the FI stage (per PMO 3.6).

What it does: Generates a construction estimate based on quantities and item codes entered. It recommends unit costs based on bid histories, quantities, and district and compiles the construction totals. It breaks the estimate down between the bid costs, non-bid costs, CEI, and contingency.

What you need: The estimator(s) must have an account to use this web-based system. The estimator(s) must provide detailed quantities by pay item. Also, the estimator(s) must provide lump sum or non-standard unit costs as well as CEI, construction contingency, and other additives. It is important to enter the project data and cost data completely and in the correct format. The estimator(s) may need to review the AASHTOWare Project Preconstruction User's Manual.

Benefits:

- Provides unit costs based on recent bid histories. It allows for instant updating of all unit costs as well to reflect the most recent bid trends. Unit costs account for quantity and district, and reflect a 25-month regression model, with outliers removed.

- The format of the estimate translates most easily to a construction contract, reflecting actual pay items and specification numbers.

Potential Limitations:

- This tool is mostly limited to providing unit costs. Quantities must be derived separately, and accuracy is dependent on the methods used. It can be easier to forget major items due to the nature of this tool if the final estimate is not carefully reviewed.

- Requires that the estimate be broken down into pay item quantities, which can be difficult to do in earlier phases with limited information.

- Does not break down the construction estimate by discipline as required in the Cost Estimate Workbook. However, categories can be used to accomplish this breakdown.

- The ease and quality of unit costs generated means the estimator(s) may be tempted to not review or independently verify unit costs. The estimator(s) must review unit costs to ensure that they are reasonable. This is crucial for estimate accuracy and reliability.

- Contingency is limited to a lump sum or percentage cost of the bid total. This is more in line with a construction contract contingency and is not the best way to enter or document design contingency.

Update Frequency: Pricing models are updated each month based on the latest 25 month bid history. It may take up to 60 days for the latest bids to be entered into the system.

Tool Link: AASHTOWare Project Preconstruction

Manual Link: Preconstruction Manual

Responsible Section (Point of Contact): Central Office Construction Division (Tracey Bowman)

4.1.6. AASHTOWare Estimator:

AASHTOWare Estimator is used by the Construction Division to aid the creation of the Engineer's EE.

When to use: After advertisement and before bids are received. Used to generate the Engineer's EE prior to bidding, for bid price evaluation to support award or rejection recommendations.

What it does: Generates detailed estimates primarily using material, labor, and equipment cost-based techniques for the independent, Engineer's EE. The estimate data is then entered into Preconstruction.

What you need: The estimator(s) must provide quantities and item codes to the construction estimator(s). More information is required if non-standard items are used. Wage rates, equipment rates, and steel and asphalt market trends are also reviewed and updated periodically.

Benefits:

- The estimate generated reflects materials, labor, and equipment costs. The estimating methods more closely approximate methods used by potential bidders, as opposed to strict unit cost methods.

Potential Limitations:

- This tool is limited to providing costs from established quantities with a high level of certainty. Quantities must be derived separately, and accuracy is dependent on the methods used. It can be easier to miss items due to the nature of this tool if the quantities and scope have not been carefully reviewed already.

Update Frequency: Labor, equipment, and material trends are updated periodically.

Tool Link: Direct installation only

Responsible Section (Point of Contact): Central Office Construction Division (Harold Caples)

4.1.7. SMART Portal:

The SMART Portal application provides public access to applications that have been submitted for various funding programs available through the Virginia Department of Transportation (VDOT) and Department of Rail and Public Transportation (DRPT). These programs include SMART SCALE, Transportation Alternatives Set-Aside (TA), Revenue Sharing (RS), Virginia Highway Safety Improvement Program (VAHSIP), and SGR Bridges and Paving. It also includes the Non VDOT Advertised Projects (NVAP) application which supports required information updates for VDOT's Dashboard as well as the Pre-Scoping module which supports year-round collaboration on candidate projects between VDOT staff and the applicant community.

When to use: The portal is used by VDOT staff in connection with defined application intake cycles each year typically through early Spring to late Fall. The NVAP and Pre-Scoping applications are available year-round for usage.

What it does: The application provides a funding application collaboration and intake mechanism between localities,

regional planning bodies, transit providers, and VDOT/DRPT staff. Regarding estimates, the Portal includes a Funding/Delivery "pearl" in each application that takes base current year cost estimates and project risk/contingency, etc. and applies uniform statewide inflation.

What you need: Module requires users to identify key pieces of information and supporting documentation to complete review of proposed projects; requires basic information on proposed project(s) plus supporting documentation similar to funding applications (ex. Sketches, planning documents, etc.).

Benefits:

- Enables collaboration on project proposals to identify potential project risks and review proposed project scopes, schedules, and estimates. Central repository of project funding applications that hosts original assumptions on project scope, schedule, and estimate for reference.

Potential Limitations:

- Not an estimate tool, only impact on estimates is ability to input defined costs, risks, etc. and apply inflation based on schedule

- Subject to technical enhancements as policy and process considerations evolve

Update Frequency: Module is scheduled for update on biennial basis depending on funding application program and SYIP needs

Manual/Training: User Guide in development

Tool Link: [SMART Portal](#)

Point of Contact: Central Office ([Jason Robinson](#))

Optional Estimating Tools (Available Externally)

4.1.8. Bristol Estimating Tool:

The tool was developed by the Bristol district staff to come up with a way to determine approximate project items and quantities at the early stages of a project's development.

When to use: Pre-scoping and scoping level estimates prior to using AASHTO Preconstruction. This tool is recommended for budget initiation / SMART SCALE. Also used for quick checks for changes or alternatives.

What it does: Project-specific CN Phase estimates based on measured components. Does not provide unit costs.

What you need: Pre-scoping level scale drawing required to input accurate lengths and areas. Must have well defined project limits and scope of work. Conceptual pavement design required.

Project :	0000-000-000	
UPC:	XXXXX	
Date:	6/21/21	
Estimator:	Name	

For Recent Bid History Click Link

FOR USE IN PRE-SCOPING AND SCOPING CONSTRUCTION ESTIMATES

(This is not intended to be a detailed pay item breakdown. It is intended to be tool that assists users in preparing early estimates prior to having developed plans. TRNSPRT should be utilized by the PFI stage.)

ITEM	Unit	Quantity	Unit Price	Amount
Sub-Total				$0
Drainage Items Contingency		-		$0
PAVEMENT ITEMS				
SURFACE COURSE	TONS	1162	$110	$127,776
INTERMEDIATE COURSE	TONS	1619	$100	$161,920
BASE COURSE	TONS	3238	$90	$291,456
SUBBASE COURSE	TONS	5037	$20	$100,742
No.1 STONE	TONS	0	$25	$0
DEMOLITON OF PAVEMENT	SY	0	$10	$0
PLANNING 0"- 2" FOR OVERLAY SECTION	SY	0	$2	$0
Sub-Total				$681,894
Pavement Items Contingency		-		$34,095
INCIDENTAL ITEMS				

| Instructions | Total Project Summary | Alignment 1 Summary | Alignment 1 Calculation | Alignment 2 Summary |

Benefits:

- Provides a project specific, quantity-based estimate with less effort than Preconstruction. The tool handles all quantity calculations and makes assumptions to minimize effort. This makes it feasible to provide a higher quality estimate with less information.

- Estimate input is mostly limited to typical section details, minimizing the amount of quantity take-offs needed.

Potential Limitations:

- Some assumptions and details are tailored to the Bristol District only. Earthwork assumes more mountainous terrain.

- Suggests lump sum costs for MOT based on project size/complexity. Traffic device costs are more conceptual in nature.

- Does not estimate PE or RW costs. Does not provide unit price recommendations.

Update Frequency: The unit prices are updated periodically on an as needed basis by the Bristol District. As such, it is highly recommended that the default unit prices in the tool are either updated, or verified by the user, to ensure they are appropriate before using the tool.

Manual/Training: Training Modules

Tool Link: Bristol Estimating Tool

Responsible Section (Point of Contact): Bristol L&D (Chase Buchanan)

4.1.9. Culpeper Estimating Tool:

When to use: Pre-scoping and scoping level estimates prior to using AASHTOWare Project Preconstruction. This tool is recommended for budget initiation / SMART SCALE.

What it does: Project specific PE and CN phase estimates based on measured components. Suggests unit costs for a typical project in Culpeper District.

What you need: Pre-scoping level scale drawing required to input accurate lengths and areas. Must have well defined project limits and scope of work. Conceptual pavement design required.

Benefits:

- Provides a project specific, quantity-based estimate with less effort than Preconstruction. The tool handles all quantity calculations and makes assumptions to minimize effort. This makes it feasible to provide a higher quality estimate with less information.

- Provides a more detailed PE estimate than most other existing tools.

- The tool allows documentation of assumptions throughout, including scope, quantities, and unit costs.

Potential Limitations:

- Costs, some assumptions and details are tailored to the Culpeper District only

- Does not estimate for RW and utilities, hydraulics, structures, signals, or survey, which must be computed separately and entered in.

- Suggested costs for MOT, signs and pavement markings based on percentages.

- Makes many assumptions to calculate pay quantities from limited information.

Update Frequency: Every two years for SMART SCALE or as needed. or as needed. Users must check the suggested costs, evaluate their applicability, and update before using.

Manual/Training: Not yet available

Tool Link: Culpeper Estimating Tool

Responsible Section (Point of Contact): Culpeper L&D (Justin Warfield)

4.1.10.   Staunton Estimating Spreadsheet:

This project estimating spreadsheet uses regression based statistical models, as well as geographically based models to generate quantity-based estimates for VDOT road or bridge projects.

When to use: For more detailed stages of design, when detailed quantities are available for the project. It can be used before entering the project into AASHTOWare Project Preconstruction, although it often may be simpler to just move into Preconstruction at that point. It can also be used to validate and review a Preconstruction estimate, specifically for unit costs.

What it does: It provides unit costs and item tabulation for CN Phase estimates. It is a similar tool to AASHTOWare Project Preconstruction but provides more detailed information on unit costs. It is in a spreadsheet format.

What you need: Detailed quantities by pay item. Must also provide any lump sum or non-standard unit costs, as well as CEI, construction contingency, and other additives.

Benefits:

- Provides unit costs based on recent bid histories. More information on unit costs is available than in AASHTOWare Project Preconstruction.

- The spreadsheet format may be more usable for projects not entered in Preconstruction or involving persons who do not have access to Preconstruction.

Potential Limitations:

- This tool is mostly limited to providing unit costs. Quantities must be derived separately, and accuracy is dependent on the methods used. It can be easier to forget major items due to the nature of this tool if the final product is not carefully reviewed.

- In many cases, it would be more convenient to start using AASHTOWare Project Preconstruction when the project design is ready for a quantity-based estimate.

- Except for normal CEI costs, and construction contingency, there is less capability to account for non-bid items, and contract requirements.

Update Frequency: Every month with latest Bid Tabs.

Manual/Training: Training Modules

Internal Manual
External Manual

Tool Link: External Tool Link

Internal Tool Link

Responsible Section (Point of Contact): Staunton L&D and Bridge (John-Allen Ennis)

Optional Estimating Tools (Internal use only)

4.1.11. ICVT - Lynchburg/NOVA Estimating Spreadsheet:

The Independent Cost Validation Tool (ICVT) is an alternative quantity/bid based cost estimating tool.

When to use: Pre-scoping to PFI or until a detailed AASHTOWare Project Preconstruction estimate is developed

What it does: It provides unit costs and item tabulation for CN phase estimates.

What you need: Length of project and typical section at a minimum. More information yields more accurate results. Locations of major stream crossings and an assumption on if bridge or culvert.

Benefits:

- Attempts to match output from the SMART Portal.

- Calculation methodology is generally transparent to understand what is included and excluded.

- Flexibility to account for different contingency methods, inflation methods, LAP vs. VDOT administration, and DBB vs. DB.

- Useful to quickly validate concepts or SMART SCALE applications that do not have previous engineering performed.

- Provides a visual warning when suggested unit prices are unusual.

- Includes an optional estimate basis checklist based off NCHRP 20-7.

Potential Limitations:

- Not as detailed when compared to a bid quantity takeoff such as Preconstruction or Staunton Tool.

- PE cost calculation taken from FMIS2 may not work for all Districts.

- LAP oversight calculator does not reflect recent change to estimate based off anticipated man hours.

Update Frequency: As often as necessary. Goal is for unit prices to be updated every 6-12 months. Each District has a separate unit cost tab that can be updated at their own convenience.

Manual/Training: Not yet available, but training module under development.

Tool Link: NOVA ICVT Estimating Tool (Inside VDOT, internal only)

Responsible Section (Point of Contact): NOVA L&D Timothy Belcher or Robin Youmans

4.1.12. Bridge PCES Web Tool:

When to use: To estimate preliminary bridge cost before detailed structural design has been performed.

What it does: Based on bridge dimensions, calculates cost and then adjusts cost based on selected factors.

What you need: Length and width of bridge, skew angle, and District the bridge is located in.

Benefits:

- Very user friendly and transparency on adjustment factors makes calculations possible to follow.

- Explains what costs are not included.

Potential Limitations:

- Inflation method does not match SMART Portal

Update Frequency: Not yet available

Manual/Training: Not yet available

Tool Link: Internal Link and click "Bridge Estimate Sheet"

Local Government Users (Local government users)

Responsible Section (Point of Contact): Central Office Structure and Bridge (Todd Springer)

4.1.13. Statewide Planning Level Cost Estimate (SPLCE):

When to use: Best for quick planning level estimates, including long range planning and high-level alternatives analysis. Many different alternatives and estimates can be generated quickly. This tool is not site specific, it shall not be used for pre-scoping, or for funding requests, which will determine the project budget, since it is not site specific.

What it does: It creates a parametric PE, RW, and CN phase estimate based on project length with some adjustments.

What you need: Requires length of project in miles, a known typical section, plus other proposed improvements as noted in the spreadsheet.

Benefits:

- It provides high level parametric estimates with less required information and less effort than other tools (although estimate accuracy is limited)

- It provides high level parametric estimates for different treatments that may not be available in PCES (Park and Rides, roundabouts, interchanges, bike/ped improvements, etc.)

Potential Limitations:

- The estimate is within a wide range. Unless the estimator(s) has significant experience and can exercise judgement, it may be difficult to refine the cost.

- Construction estimates are generic and do not consider specific site conditions. Estimates do not differentiate between new construction and reconstruction. Estimates are primarily for linear projects based on length of project (although some other types of improvements are addressed).

- PE and RW/Utilities costs are a percentage of the construction costs, which is not project specific and may vary widely.

- Costs not updated as frequently as other tools, may not reflect latest trends.

Update Frequency: Infrequently (Roadway spreadsheet: 2015; Bike/ped: 2017) and must be inflated.

Manual/Training: Not yet available

Link: Available by request by TMPD

Responsible Section (Point of Contact): Central Office TMPD (Gary Wilmouth)

4.1.14. DB Cost Finance Summary (CFS) Spreadsheet:

When to use: The CFS is used on all DB projects and serves as a formal method of incorporating DB cost elements into a cost estimate.

What it does: The CFS adds DB specific cost and risk factors to typical project estimates. The level of detail varies greatly depending on design maturity as DB projects can be procured at different phases of project development. The key objective of the CFS spreadsheet is to account for all project costs and to differentiate between VDOT's cost and the design-builder's cost to help determine the anticipated contract value (bid). Items include, but are not limited to, DB risk, stipend, early completion incentives, price adjustments for asphalt fuel and steel, QA/QC and any costs associated with railroads and state police as applicable.

What you need: The estimator(s) for the DB Estimate should conduct a risk-based estimate in accordance with the procedures outlined in Chapter 5 prior to completing the CFS and the Cost Estimate Workbook. For all DB projects, a Type II – Risk-Based Deterministic Contingency is highly recommended. The Estimate for the project may be developed utilizing other tools such as PCES - Workbook or AASHTOWare Project Preconstruction.

Benefits:

- Incorporates DB specific costs into the estimate that are not normally considered for a traditional DBB construction project.

- Mechanism to account for all project costs and to differentiate between VDOT's cost and the design-builder's cost to help determine the anticipated contract value (bid).

Potential Limitations:

- Determining the cost related to DB risk to capture the risk associated with a design-builder developing a lump sum price to design and construct a project without the benefit of final 100% design plans or final quantities is subjective in nature and relies on engineering judgement. The appropriate amount of DB risk is determined on a project-by-project basis based on the project's complexities and other relevant risk factors.

Update Frequency: Infrequently, the format of the CFS template is reviewed and revised as necessary on a yearly basis.

Manual/Training: Not available

Link: Available by request

Responsible Section (Point of Contact): Alternative Project Delivery Division (Jeffrey Roby)

4.1.15. Environmental Estimating Workbook:

When to use: Pre-scoping to PFI or until a detailed AASHTOWare Project Preconstruction Estimate is developed.

What it does: Provides unit costs for environmental PE and CN phase Estimates.

What you need: Project location and scope. More details yield more accurate results.

Benefits:

- More accurate than a base 3% estimate

- Provides flexibility to account for site-specific conditions

Potential Limitations:

- Estimates are not necessarily accurate for LAP projects

- Does not include ECI costs

Update Frequency: Hourly rates are updated every 1 to 2 years

Manual/Training: Environmental Estimating Workbook Job Aid (internal only)

Link: Environmental Estimating Workbook (internal only)

Responsible Section (Point of Contact): CO Environmental EPM Program Manager (Heather Williams)

4.2. Use of Bid Tabs

Introduction to Bid Tabs

The Bid Tabs can be a powerful tool in estimating, claims, and change order analyses. Bid Tabs are a set of bids (unit costs) associated with contracts that have been previously awarded. It is historical data from a specific period of time. The VDOT Bid Tabs can be found in the external VDOT website located here: VDOT Bid Tabulations. The use of Bib Tabs varies widely between individual users within VDOT, to VDOT districts and divisions. For instance, these are used to generate the published "Unit Cost Averages" found on the Construction Division website (VDOT Resource Information). This resource includes:

- 1-year and 2-year statewide and district averages
- 3-month district averages

They can be used by individuals researching specialty items – either rarely used ones or non-standard bid items with specific descriptions. These are updated after the CTB and/or Commissioner's Ballot has been approved for each letting. *Figure 4-1* represents a sample of what a Bid Tab looks like in its raw form.

Figure 4-1: Sample Bid Tab

The basic format is a PDF file (TXT file for older Bid Tabs) with contract information in the header, and item codes, item description, unit of measure, contract quantity, followed by the bids (unit cost) for each of the 3 bidders. For example, in *Figure 4-1* we see that for Item ID # 00120, REGULAR EXCAVATION, for which there are 6467 CY, the bids were as follows:

- Bidder 1 (Allan Myers VA Inc.) Bid $50.00 Per CY
- Bidder 2 (Curtis Contracting, Inc.) Bid $104.52 Per CY

- Bidder 3 (Abernathy Construction Corporation) Bid $60.00 Per CY

Bidder 1 was the low bidder for that particular contract, Bidder 2 was the 2nd lowest bidder, and Bidder 3 was the 3rd bidder. The contractor with the lowest total bid does not always have the lowest bid for each item. They have the overall low bid, but the bids can vary from item to item. For instance, in *Figure 4-1*, we see that for item #108, NS MONITORING CONDITION SURVEY AND INSTRUMENTATION, Bidder 1 was actually the highest bid at $97,500, while Bidder 2 was the lowest at $34,687.09.

Standard Item codes have set item descriptions (e.g., Item #13108- CG-12 DETECTABLE WARNING SURFACE). However, Non-standard item descriptions are made from the combination of 2 descriptions:

1. The Stock NS Base Description, (e.g., Item #68910- NS BR. SUPERSTR. WID./REPAIR, method of measure is SY).

2. The user defined specific description for that particular use of the nonstandard item. It could be anything from patching to a special overlay, to a surface treatment, to shotcrete, etc.

Here is an example from a recent contract:

- Item 68910: NS BR. SUPERSTR. WID./REPAIR TYPE A MILLING 2 1/2"

The "TYPE A MILLING 2 1/2" " was user defined in Pre-CON.

This is the basic format of Bid Tabs. It is repeated for all VDOT let projects except for Administrative Services Division (ASD) projects, which can be in different formats.

Using Bid Tabs

The use of Bid Tabs currently varies widely between individual users within VDOT, to VDOT districts and divisions. For instance, these are used to generate the published "Unit Cost Averages" Found on the Construction Division website (VDOT Resource Information). They can also be used by individuals researching them to find specialty items, either rarely used ones, or non-standard bid items with specific description. For example, Item # 11070 has the Non-Standard Item Description of NS SAW-CUT ASPH CONC, but (in one instance) secondary description of FULL DEPTH. Searching for item # 11070, would not be overly helpful, but looking through the Bid Tabs to find both item # 11070 AND description NS SAW-CUT ASPH CONC FULL DEPTH would yield useful information that could help the user develop costs for that specific item. Since Item 11070 is nonstandard, and can include other secondary descriptions, you will see variations of that bid item, such as:

- NS SAW-CUT ASPH CONC 10" DEPTH
- NS SAW-CUT ASPH CONC (FULL DEPTH)
- NS SAW-CUT ASPH CONC SAW CUT TO 12" DEPTH
- NS SAW-CUT ASPH CONC 10" - 14" DEPTH
- NS SAW-CUT ASPH CONC SAW and SEAL
- NS SAW-CUT ASPH CONC *FULL DEPTH
- NS SAW-CUT ASPH CONC (2" DEPTH)
- NS SAW-CUT ASPH CONC .. ..
- NS SAW-CUT ASPH CONC FULL DEPTH SAW CUT

In fact, to find "FULL DEPTH", you may need to search carefully to find all permutations of the item description containing the term "FULL DEPTH", using wildcards to capture all relevant items. This is typical for all nonstandard items, for which users can enter secondary descriptions. Those are nonstandard and are completely up to the user.

In some cases, the secondary description can be helpful in determining unit prices, even if the actual bid item is Lump Sum (LS). For instance, Item # 67900 is NS DISM. and REM. EXIST. STR. The secondary description is the VA Structure number. In the example in *Figure 4-2* below, the secondary description is EXIST. STR. NO. 1037. You can tell from the heading that the structure is in Franklin County. Using tools on the S&B Website (Tableau - Inside VDOT, internal only or Staunton Apps), you can find the existing structure information and determine the square foot (SF) cost of demolition. This can be helpful in estimating other projects, though they should have similar characteristics: (e.g. highway crossing, stream crossing RR crossings, staged construction, et al.). There can be instances where a similar approach can be used for other bid items.

Figure 4-2: Bid Tabs Descriptions

Contract ID: C0000111309B16
Letting Date: October 21, 2020
Call Order: D27
Contract Time: 09/03/21 COMPLETION DATE
Contract Description: SGR - SUPERSTRUCTURE REPLACEMENT OVER THARP CREEK

Counties: FRANKLIN
District(s): SALEM / ROCKY MOUNT
Project(s): 0040-033-832, B616, STP-BR02(443);
Min: Max:

Line No / Item ID Item Description	Alt Set / Alt Member	Quantity and Units	(1) W. C. ENGLISH, INCORPORATED Unit Price	Ext Amount	(2) BURLEIGH CONSTRUCTION CO., INC. Unit Price	Ext Amount	(3) HAYMES BROTHERS, INC. Unit Price	Ext Amount
SECTION: 0001	REGULAR BID ITEMS		Cat Alt Set:		Cat Alt Member:		LCC:	
0320 65211 CORROSION RESISTANT REINF. STEEL CL. I		980.000 LB	2.28000	2,234.40	3.20000	3,136.00	3.00000	2,940.00
0330 67900 NS DISM. & REM. EXIST. STR. STR. NO. 1037		(1) LS	119,500.00000	119,500.00	145,000.00000	145,000.00	100,000.00000	100,000.00
0340 67910 NS NBIS ACCESS, UNDER BRIDGE STR. NO. 1037		1.000 DAY	6,800.00000	6,800.00	8,000.00000	8,000.00	6,000.00000	6,000.00
0350 68476 NS ENV.& WORKER PROTECTION STR. NO. 1037		(1) LS	2,200.00000	2,200.00	2,000.00000	2,000.00	5,000.00000	5,000.00
0360 68490 NS DISPOSAL OF MATERIAL STR. NO. 1037		(1) LS	825.00000	825.00	2,000.00000	2,000.00	7,500.00000	7,500.00
0370 70116 NS ASBESTOS REMOVAL STR. NO. 1037		(1) LS	2,200.00000	2,200.00	1.00000	1.00	7,500.00000	7,500.00
Section Totals:				$771,129.52		$827,806.20		$865,051.90
Life Cycle Costs:								
Section Total with LCC:				$771,129.52		$827,806.20		$865,051.90
Contract Item Totals				$771,129.52		$827,806.20		$865,051.90

Be careful when using non-standard items for prices on items where the bid is LS and you have no way of estimating the quantity or the specific item of work that was the basis for the bid. For example, NS ASBESTOS REMOVAL STR. NO 1037 might involve 100 LF of asbestos containing conduit under a bridge deck or just 10 asbestos containing pads under the bridge railing. Also note the wide range of prices for the asbestos removal item. The bidder that bid $1 obviously unbalanced his bid and put his expected cost of that item somewhere else in his bid. If one reviews the full tabulations of all bidders for the project and throws out the obvious bids that are too high or low, a more realistic price can be obtained.

There are some best practices when using Bid Tabs, whether it is for pre-bid estimating or post bid uses (Claims or Change Order analysis). There are several criteria that you should consider when evaluating Bid Tabs to be used in developing a cost (See *Table 4-2*).

Table 4-2: Criteria to Consider when Evaluating Bid Tabs

#	Criteria
1	Geography
2	Quantity
3	Unit of Measure
4	Historic Inflation
5	Project Characteristics

Geography

Since different parts of the state have different cost/economic profiles, it is evident that unit costs in some portion of the state would trend higher or lower than others. For instance, the cost of Item #120-REGULAR EXCAVATION would be expected to be higher in Nova District (Distr. #9) than in Bristol District (Dist. #1). There are various reasons for this, such as the proximity of disposal sites for excess materials or the types of equipment that can typically be used on most of those construction sites. For Example, the use of a "Pan" (e.g., CAT 623) versus using an excavator or loader to cut and load into dump trucks for hauling, which is more labor intensive. This is just one example, and there are many more that could be discussed, but the takeaway from this is the geography is a pertinent issue. So much, that even in the parametric estimating system of PCES, there was a cost coefficient for each district; 1.00 being the statewide average, some were greater than 1.00, and some were less than 1.00. So, if you are researching a cost in Culpeper District, it would be best to stay with Bid Tabs originating within Culpeper district. An even more accurate data set would be to stay within the county in which your project lies. Often, this yields a dataset that is too small to be useful when applying the other criteria.

Sometimes the dataset for projects in the district under consideration does not have the bid item you are researching with a similar quantity. In that case, the next best dataset to use is the district closest to your project with the geographic characteristics most like the project location. As an example, when trying to find a price appropriate for Staunton District, using a price from Culpeper District projects would be most appropriate for projects in the northern part of Staunton District and using a price from Lynchburg or Salem Districts would be most appropriate for projects in the southern part of Staunton District. If a reasonable number of projects are still not available, it may be necessary to broaden the search by including the next closest districts.

Quantity

The quantity of an item has a very important impact on the overall cost in the unit cost of that item. If you look at the cost distribution of unit prices versus quantity for almost any item, except for lump sum items, they follow a nonlinear distribution (See *Figure 4-3*). Nonlinear means that a best fit line drawn to represent a mathematical model that fits the scatter plot of bid price vs. quantity follows a nonlinear curve (logarithmic, exponential, trigonometric, etc.). In this case (Item #140 BORROW EXCAVATION) the smaller quantities have a much higher unit cost than much larger quantities. This is often referred to as "economy of scale". There are several reasons, but one example is the dilution of fixed costs. Let's look at bridge deck concrete, Item Code # 60409 (CONC. CLASS A4 MOD. LOW SHRINKAGE). This item has several fixed costs:

- Bridge screed, generators, vibrators and misc. support equipment

- SIP formwork, overhang bucks and forms
- Safety railing
- Work bridge
- Wet burlap, poly, and foggers for wet curing
- Concrete pump truck
- Minimum crew size for each concrete placement
- Mechanic and backup equipment for emergency support

Figure 4-3: Quantity Scatter Plot
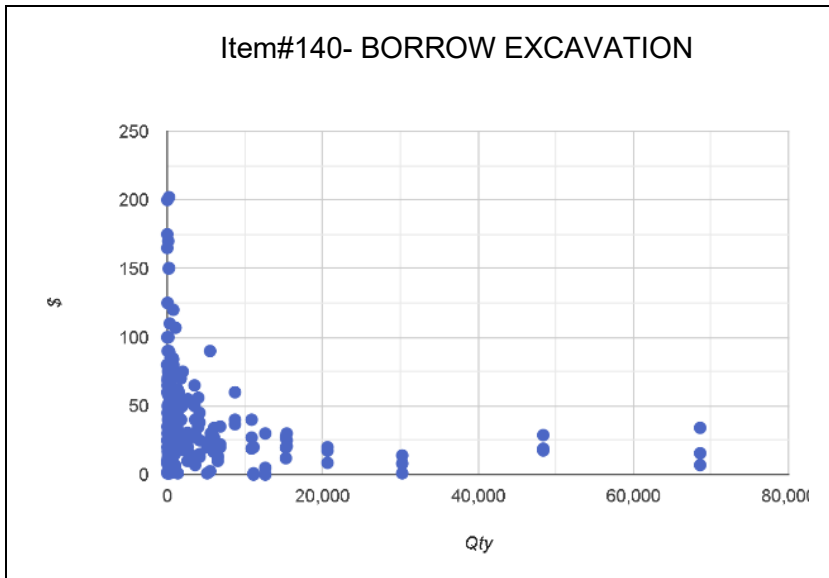
As you can see in *Figure 4-4*, the cost for a very small Unit price, say 26 CY is approximately $2204, while a much larger quantity, for example, 1295 CY has a unit price of approximately $707. The basic concept is $Unit\ Cost = Material\ Cost + \frac{Fixed\ Cost}{Quantity}$

Figure 4-4: Unit Cost
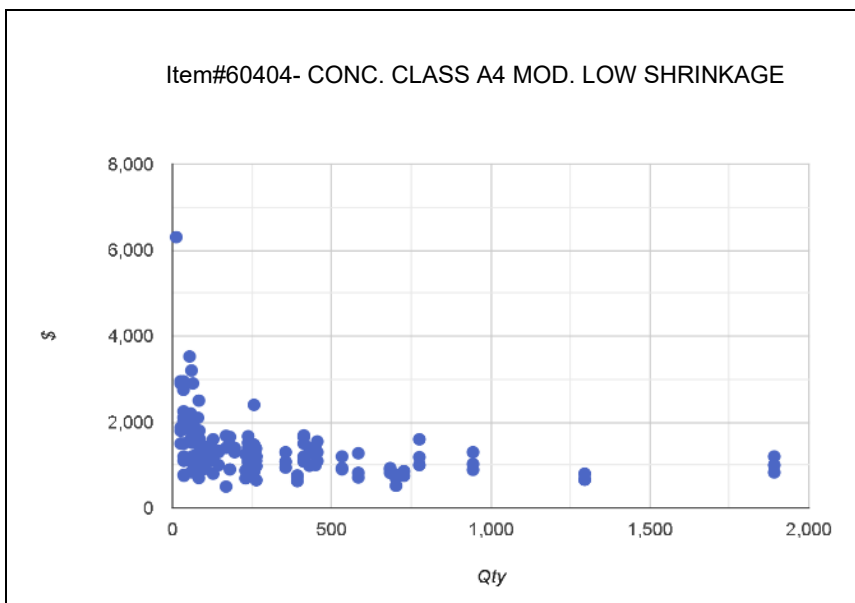
The Material Cost will have some markup, but in the extremes, if a quantity is very small, the fixed costs are not reduced by much, hence a much larger unit cost. At the other extreme, if there is a very large quantity, the fixed costs become a very small additive to the material cost. This relationship is what lends itself to the nonlinear relationship. It is not just the total quantity that affects the unit cost but the quantity per pour. Staged construction increases the unit cost significantly because it requires additional pours to place the same amount of concrete than it would if the entire width of the bridge deck could be poured at once. Each pour requires two side forms, so the forming is almost doubled for a bridge constructed in two stages. A bridge with two stages and a closure pour between them will have an even higher unit cost. Multi-phased operations can affect other bid items as well. In general, multi-phased operations have higher costs because of reduced production.

Now that we have established the importance that the quantity plays in establishing a unit price, when searching Bid Tabs for projects to research, it is important to also look for similar quantity ranges. For instance, if you had 5000 CY of borrow (Item #00140), you would not base your unit price on a project or projects with quantities that are an order of magnitude larger than this. If you do, you will greatly underestimate this line item of your estimate. As an illustration, see the cost comparison (*Table 4-3)* of Unit prices for Item #00140 (BORROW EXCAVATION). These are taken from Bid Tab research in Lynchburg District (Dist. 3). If you had 5000CY and used the unit price derived from the Quantity range of 10,000-50,000, you would have underestimated this item by 5000CY* $(38.20-14.86)/CY=$116,700. Conversely, if the situation were reversed and you used a unit price derived from small quantities for a large quantity, you would overestimate the item. In the case shown in *Table 4-3* this would be an overestimation of $116,700. This can create budget issues for the project, especially later in the project development phase. Quantity range should be adjusted based on obtaining available data to determine a reasonable amount of data points. If there are only a few data points in a chosen quantity range, one may want to increase the range of quantity being searched.

Table 4-3: Unit Prices for Item #00140

Quantity Range	Avg Unit Price
1000-9000CY	$38.20
10,000-50,000CY	$14.86

Unit of Measure

This one seems self-explanatory, but it is often overlooked. When looking for specific unit costs, be sure that the units of measure match one another. if you are matching item codes, this will not be a problem. For instance, the bid item for Item # 26118 (DRY RIPRAP CL.I 18") is SY. However, if you search for "DRY RIPRAP CL.I 18"", then you'll get 2 bid items, 26118 and 26119. One is SY and one is TON. Combining these two unit costs in any way will yield useless results. This is only one example. There are many others that share SY/Ton. There are various duplicate items that have different units of measure *Table 4-4* shows some of the relationships that are shared for the same item (different item numbers, but same descriptions).

Table 4-4: Duplicate Items Example

#	Units of measure
1	SY & Ton
2	LS, Acre, & Unit
3	SY & Acre
4	SF & CF

It is especially important to be aware of this when researching Non-standard items, which can cover all NS Items. For example, the item series NS BR.SUPERSTR. WID./REPAIR (Item # 68902-68910) covers almost every conceivable unit of measure, with very few exceptions. However, if one were not paying careful attention, you could easily see similar items (a NS Shotcrete item) and mix prices for CF and SF. *Table 4-5* below lists several items where multiple units of measure are possible.

Table 4-5: Items with Possible Multiple Units of Measure

| Item Type	Potential Units
Rip Rap	Ton & SY
Concrete Encasement	LF & CY
Clearing & Grubbing	LS, Acre, & Unit
Erosion Control Mulch	SY & Acre
All Select Materials	Ton & CY
Erosion Control Stone	Ton & SY
Fertilizer	Ton & LB
Topsoil	Acre or CY
Allaying Dust	HR & Ton

Historic Inflation

It is important to remember that when reviewing Bid Tabs, you may be looking back in history a month or two or well over a year. This is especially true when searching for a very specific quantity range or specialty bid items. When doing so, you will end up with costs from entirely different eras. The differences may be negligible, for bids a month apart, but for bids 1 or 2 years apart, it could yield inaccurate results. As an extreme analogy, think about home prices, which are always inflation adjusted. Your grandparents likely paid ~$12,000 for their first home in 1960. To average that with today's median home value (in Virginia, 2020) of $308,819 would yield a useless result. But, if that cost were inflation adjusted based on historic inflation, then the result would be much more meaningful. Using an appropriate inflation rate to adjust that 1960 value of $12,000 would make it equivalent to approximately $105,600 in 2020 dollars. This is a more meaningful figure. The same applies when you research Bid Tabs and take a 2021 value and mingle it with a 2019 value.

The key is to use a "historic" inflation, meaning one that has been analyzed using past economic factors, not an arbitrary percent value. In the example above, the proper index is the Consumer Price Index (CPI). This is not the correct index to use for road and bridge construction. Even the producer price index is not an appropriate index, as it involves too many retail and other consumable goods. The most applicable index is the FHWA National Highway Construction Cost Index (NHCCI), which can be found here. Like most Indices, you'll need to use the ratio of the current index to the index of the time of the bid to calculate the inflation

adjustment. Take note that inflation is not always positive. It can go up, and it can just as easily go down. *Figure 4-5* shows a snapshot of the trend of the HCCI from 2004 to 2020.

Figure 4-5: HCCI Trend (2004-2020)
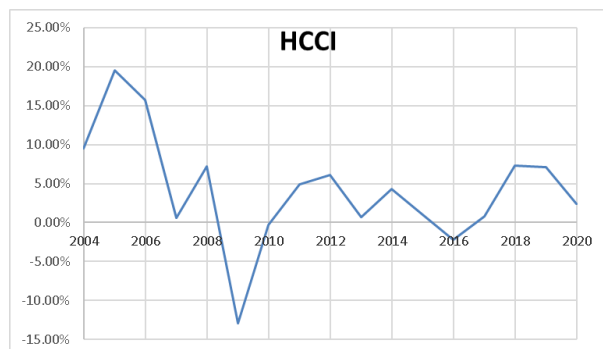
Project Characteristics

Although this is slightly tied to geography, it is distinctly different. By project characteristics, we are talking primarily of the urban/rural nature of projects. You can easily be within the same district, or even the same county, and have distinctly different project characteristics. Loudoun County (NoVA District) has both Rural and Urban areas, as does Spotsylvania County in Fredericksburg district, just to name a couple. MOT, time of day restrictions, such as lane closures permitted only between 9 AM and 3 PM, production (i.e., the amount of work a contractor can get done in a workday) and many other aspects are vastly different between the two. Other characteristics, such as Railroad involvement, working over water, multi-phased construction, interstate vs low ADT secondary, night work, and other aspects can affect all unit prices. If you can match those, the unit prices will be more accurate. Sometimes this is not possible, as detailed knowledge of the projects is required. However, by looking at the entire contract, you can often discern some of these characteristics to determine if you are pulling unit costs for a rural secondary stream crossing for a project that is in a high ADT urban interstate over an Amtrak line.

Although the quantities might be similar using prices from a turn lane or traffic signal project to estimate the unit price for a bridge replacement project, the nature of the work is considerably different, such that the prices may not be comparable. Another key characteristic for grading projects is the expected type of excavation. Excavating rock beside a busy highway or in an urban area is much more expensive than excavating soil in a rural area on new location. The bid item is unclassified excavation so one cannot tell whether the project you are using for comparison involved rock or dirt excavation. Prices for utilities and storm drainage are also affected by the nature of the excavation, soil type and pipe depth in the ground required for them.

Sample Size

Although trying to meet all the criteria in *Table 4-2* would be ideal, in reality you may end up with a very small sample size. Small sample sizes do not always yield the best results. They may be good to verify other sources (e.g., Precon unit prices, etc.), but may not be the best basis for the establishment of a blanket unit price. When zeroing in, it is best to start with fewer criteria and gradually add additional criteria. Trying to apply all these criteria at once may yield no results at all, leading the user to believe no viable bid can be found within the Bid Tabs being sampled.

For further information and guidance refer to the Appendix C.

4.3. Statistical Use of Bid Tabs

In previous sections we discussed the analysis of Bid Tabs, and how to best use those results to meet your needs. There are several statistical methods that can be used to help you can analyze the Bid Tabs to generate unit costs.

Average

The most used unit cost is the "average". This is calculated by taking all the unit costs and averaging them together. There is no consideration given for quantity. VDOT publishes the averages on the website (VDOT Resource Information). They list 2yr Statewide and District Averages, as well as various groups of 3-month averages. The use of averages is widespread but has the potential to greatly under or over estimate small and large quantity ranges respectively. In *Figure 4-6*, you can see the scatter plot of Item # 16390 (ASPH. CONC. BASE COURSE TY. BM-25.0A). The maroon line is the average of $128.23/Ton. As you can see, for smaller quantities, this can result in considerable underestimation. Conversely, for much larger quantities, the estimate can be more than double the unit price (in this specific example).

Figure 4-6: Average Use
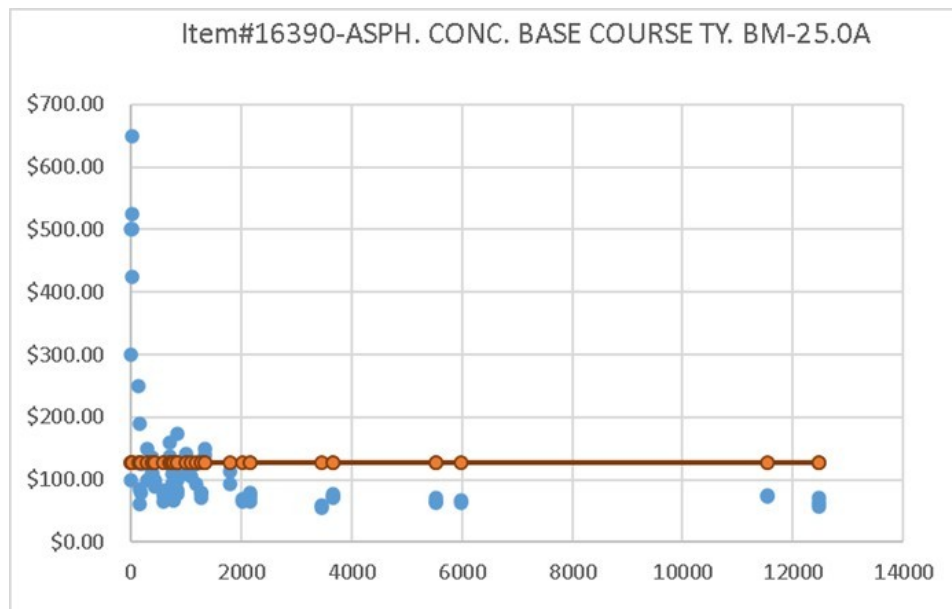
Weighted average

The weighted average is calculated by multiplying the quantity by the unit price, then dividing the sum of all those numbers by the sum of the quantities in the sample. For example, in *Table 4-6* we have a sample of unit prices and quantities. Using those values, we can easily calculate an average of $102.00. The weighted average is $\frac{[(50*\$125)+(75*\$110)+(100*\$105)+(500*\$95)+(1000*\$75)]}{(50+75+100+500+1000)}$ =$85.51. In the example in *Figure 4-6*, the weighted average is $77.15. The issue with a weighted average is that it is widely misunderstood and rarely used correctly. It does take into account the heavier importance of much larger quantities (i.e., weighting), but the issues of underestimating smaller quantities remain.

Table 4-6: Sample of Unit Prices and Quantities

Quantity	Unit Cost
50	$ 125.00
75	$ 110.00
100	$ 105.00
500	$ 95.00
1000	$ 75.00

Linear Regression

Regression is a statistical and mathematical method of "best fitting" an equation to a set of data. This is used to predict other values either within the data set (interpolation) or outside the data set (extrapolation). Linear regression is the simplest method. It uses a straight line as the "best fit" mode in *Figure 4-7* below, you can see the same dataset for Item 16390 with a linear regression model applied.
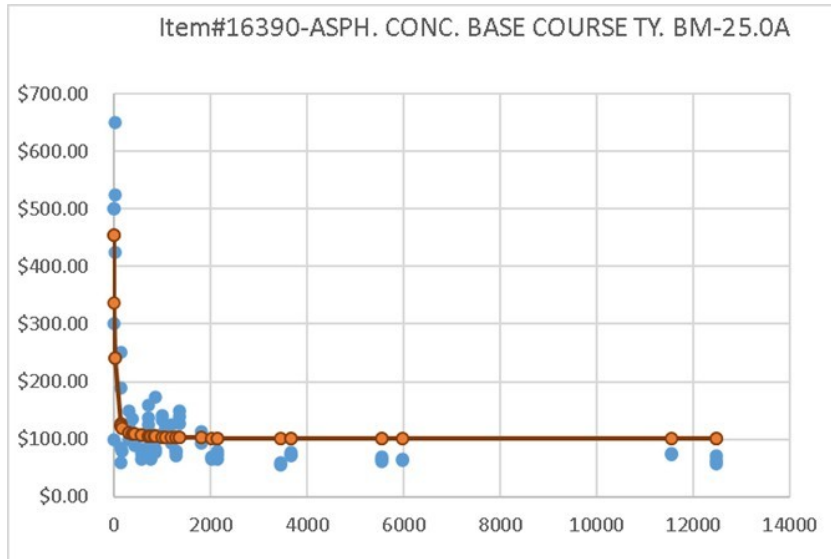
Figure 4-7: Linear Regression
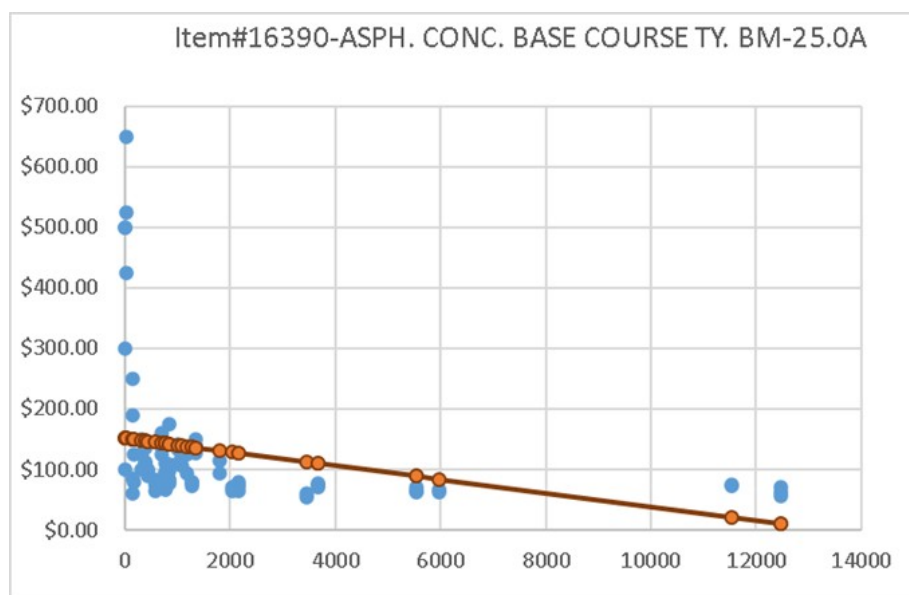
As you can see, this method has many shortcomings for the type of data we typically see with Bid Tab pricing. The data does not lend itself to a linear regression model. As with the average method, it greatly underestimates smaller quantities. It does accommodate larger quantities, however if you use this to extrapolate beyond the maximum of your data sample, it can easily yield negative numbers. If you have a small compact data set, perhaps zeroing in using the criteria from Section 2, this may still be a viable method.

Non-Linear Regression

Nonlinear regression is a regression model that is much more complicated than simple linear regression. It can take on many forms, such as exponentials, polynomials, logarithmic, etc. The common theme is that it is not a straight line; the line curves to match the trends of the data. In the case of bid data, it is consistent in its shape. Using a consistent nonlinear regression model of $y = C_1 + \frac{C_2}{x}$, the regression line can closely match the data. Keeping with our sample dataset of Item # 16390, *Figure 4-8* shows a Nonlinear regression model superimposed on the

scatter plot. In this case, interpolation and extrapolation are both acceptable. The model still overestimates the larger quantities, but by a much smaller margin than the average, and it does not underestimate the smaller quantities. It should not yield negative values, like the linear model can on occasion.

Figure 4-8: Non-Linear Regression

Item#16390-ASPH. CONC. BASE COURSE TY. BM-25.0A

Using these Results

Any of these methods discussed above (Average, Weighted average, Linear Regression, Nonlinear Regression) may be useful, or they may not. Any of them can be improperly used. Looking at scatter plot in conjunction with these is helpful in deciding which one is yielding the most accurate value. All of them can be helpful in the right circumstances, but none are right 100% of the time, and using an average all the time to estimate large and small projects is not a best practice. As a comparative example to how these differences in cost can impact an estimate, look at the differences in the unit prices based on the 4 different statistical modes previously discussed. The item code being analyzed is Item #10642, ASPHALT CONCRETE TY. BM-25.0A. The bid history was confined to the Lynchburg district, for the past 24 months (3/22/2021 to 3/22/2019), which yielded 44 bids from 14 to 19,177 Tons.

Table 4-7:

Item#10642-ASPHALT CONCRETE TY. BM-25.0A				
Unit Costs by Model				
Quantity (CY)	Average	Weighted Average	Linear Regression	Non-Linear Regression
25	$168.46	$ 89.93	$ 159.06	$ 270.66
100	$ 168.46	$ 89.93	$ 158.61	$ 151.15
500	$ 168.46	$ 89.93	$ 156.21	$ 119.28
10,000	$ 168.46	$ 89.93	$ 99.21	$ 111.71
27,500	$ 168.46	$ 89.93	$ (5.79)	$ 111.45

In *Table 4-7*, you see that the unit prices vary considerably, depending on the quantity and the model chosen. Note, as we discussed earlier, the Linear Regression model has yielded a negative unit price, which is obvious unusable. If we take the next step and calculate the overall quantity cost, we see that the differences in the unit price multiplied by the quantities can account for a substantial difference in overall costs for a single Quantity (*Table 4-8*).

Table 4-8:

Item#10642-ASPHALT CONCRETE TY. BM-25.0A				
Total Item Cost				
Quantity (CY)	Average	Weighted Average	Linear Regression	Non-Linear Regression
25	$ 4,211.41	$ 2,248.30	$ 3,976.50	$ 6,766.40
100	$ 16,845.63	$ 8,993.21	$ 15,861.00	$ 15,114.65
500	$ 84,228.13	$ 44,966.07	$ 78,105.00	$ 59,638.65
10,000	$ 1,684,562.50	$ 899,321.44	$ 992,100.00	$ 1,117,083.65
27,500	$ 4,632,546.88	$ 2,473,133.95	$ (159,225.00)	$ 3,065,008.65

By looking at the differences, or delta, between each of the models, as compared to the average model. *Table 4-9* shows the delta of each quantity total, as it compares to the total for the average unit price for each quantity. Notice the magnitude of the overall differences in each range.

Table 4-9:

Item#10642-ASPHALT CONCRETE TY. BM-25.0A				
Total Item Cost Delta				
Quantity (CY)	Average	Weighted Average	Linear Regression	Non-Linear Regression
25	$ -	$ (1,463.99)	$ 271.22	$ 3,061.12
100	$ -	$ (5,855.95)	$ 1,039.86	$ 293.52
500	$ -	$ (29,279.73)	$ 3,999.32	$ (14,467.03)
10,000	$ -	$ (585,594.56)	$ (490,013.64)	$ (365,029.98)
27,500	$ -	$ (1,610,385.03)	$ (4,235,037.50)	$ (1,010,803.85)

For instance, the weighted average consistently underestimates for all quantity ranges when compared to the average, and non-linear regression. *Table 4-9* illustrates the magnitude of each of the model impacts on each quantity. For example, if you used the average for 10,000 Tons, instead of non-linear regression, you would have overestimated by $365,029.98, and if you have used the Weighted Average instead of the Average for 25 tons, you would have overestimated by $1463.99.

Because bidders allocate costs differently among bid items to minimize risk and maximize cash flow, using the lowest cost for each item will likely result in an estimated cost lower than the low bid on a specific project. Using only the low bid prices may be the best approach for analyzing work orders but not building cost estimates. Alternatively, using an average unit cost from the three lowest bidders on a project will likely result in unit costs that exceed the low bid prices most of the time since two of the three bidders were not awarded the project. This method may be the best approach for estimating future projects but not for analyzing work orders. When the dataset is large the differences in the approaches are small but when there is little data for a specific bid item the Bid Tab user needs to look at the total projects bids to see if bids have been significantly unbalanced and the price of any specific item is out of normal ranges.

4.4.   Summary of Bid Tab Tools

This section on the use of bid tabs is intentionally general and applicable to using all bid tab information. The VDOT estimator(s) has three primary bid tab tools available for use. These tools are:

- AASHTOWare Project Preconstruction

- Bid Express

- VDOT Statewide Bid Tab Query (Formerly Staunton Bid Tabs)

Detailed information, links, and guidance for each of these three bid tab tools are provided in Appendix C.

For access to the Bid Express website, please email Mary "Kiwi" Roane with the following user's information: (1) name, (2) email address, and (3) phone number. If there are multiple requests, please include the list within the email with the same information for each potential user.

Chapter 5 –

Risk-Based Contingency Estimating

Chapter in Brief:

In this chapter the reader is provided with VDOT's process of establishing contingencies based upon project risks.

The reader is introduced to the three project complexity classifications (Non-Complex, Moderately Complex, and Most Complex). VDOT has adopted a modified version of AASHTO's Risk Based Estimating process. This process is defined and step by step guidance is provided in this Chapter.

5.1.   Introduction

5.2.   Overview

5.3.   Key Inputs

5.4.   Determine Risk and Set Contingency

5.1.   Introduction

This section deals with one of the more difficult and more critical aspects of cost estimating for transportation projects. A significant portion of the overall quality of the estimate accuracy, and reliability of the estimate, will depend on the estimator's ability to thoroughly identify risks, classify the risks, and adjust the estimate contingency appropriately based on an analytical approach. This is particularly crucial when preparing estimates for projects with little definition or design.

VDOT has adopted AASHTO's Risk-Based Contingency Estimating practice, with some customization to meet VDOT's needs. Special recognition goes to AASHTO and AASHTO's Technical Committee on Cost Estimating for being forerunners in this field and incorporating it into *AASHTO's Practical Guide to Cost Estimating (2013 First Edition – Chapter 5)*. Much of the information herein is directly or indirectly from AASHTO's guidance on this subject. This resource can be purchased directly from AASHTO at the link above.
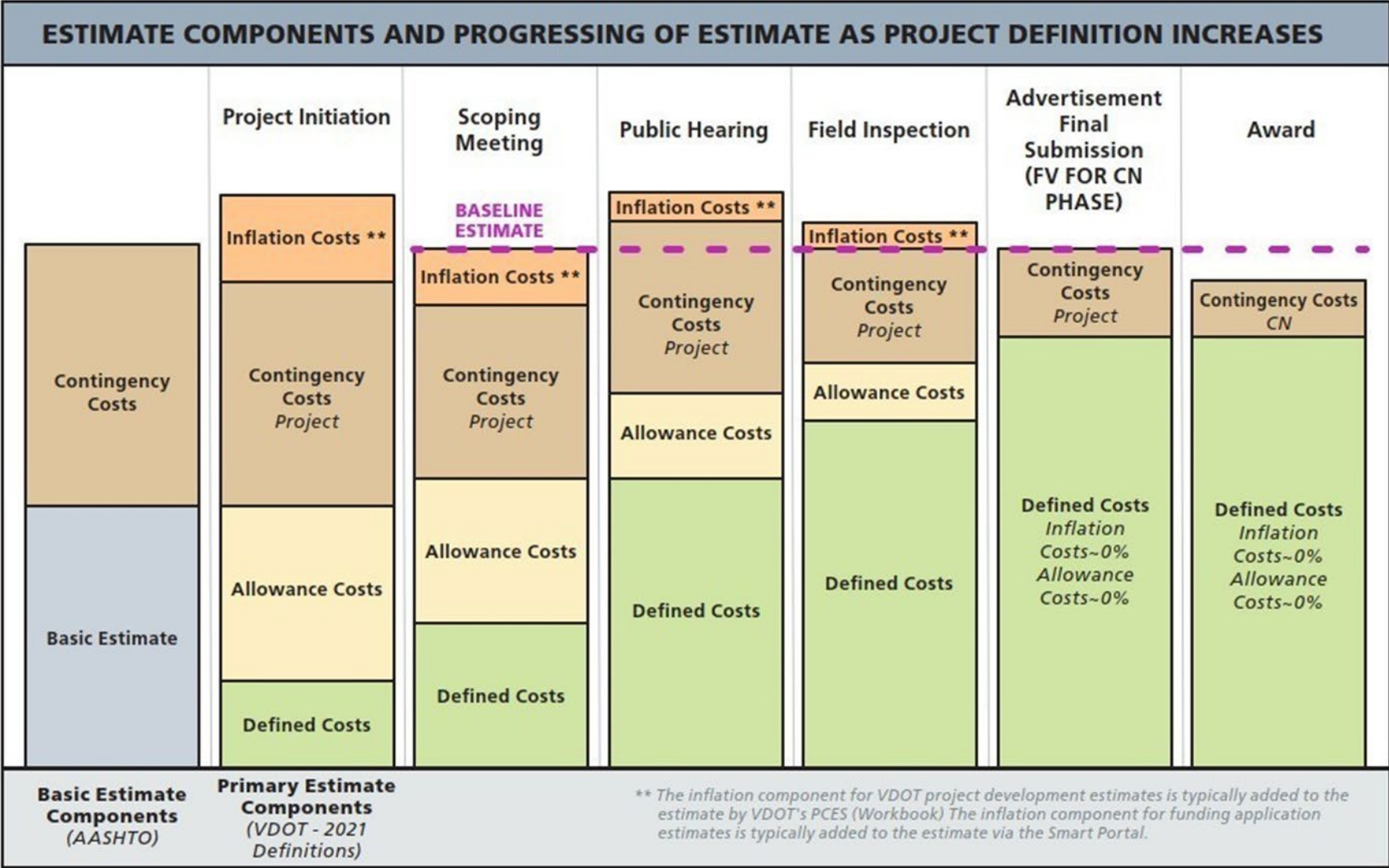
5.2.   Overview

Risk-based cost estimates apply risk identification and uncertainty analysis techniques to estimate project contingency. Risks are uncertain events or conditions that could affect the project cost if they occur. Risk-based estimates produce an expected value and a range of project costs. They also provide a ranking of risks to monitor during the PDP to help manage contingency and prevent cost and schedule growth in future estimates. Estimator(s) will typically use risk-based estimating throughout the project development process. However, estimator(s) can apply risk-based estimates at any point when there is significant uncertainty in the project definition or estimating information.

What is it?

In its simplest terms, risk-based estimates use risk analysis to forecast costs of unknown, or uncertain items. They combine traditional estimating methods with risk analysis processes to estimate the uncertain items of work, any uncertain quantities, and possible risk events (AACEI Risk Committee 2000; Molenaar et al. 2010). Risk-based cost estimates strip all contingency from the line items in the Base Estimate and estimate contingency values explicitly. **The Base Estimate (Defined Cost + Allowances) should contain items without contingency** (i.e., no conservatism or "fudge factor" should be included on individual items).

Figure 5-1 provides a graphical depiction of risk-based estimates varying with project phase. This illustrates key points relating to risk-based estimates. First, an estimate at any given point is made up of defined costs, allowances, and a contingency component. As the project progresses in development, the contingency amount is expected to decrease because the project information is refined, and more details become available. Typically, the Base Estimate (Defined Costs + Allowances) increases as some of the contingency is reduced and is included in the Base Estimate (Defined Costs + Allowances).

Figure 5-1: Refinement of a Cost Estimate (Risk-Based Contingencies)

ESTIMATE COMPONENTS AND PROGRESSING OF ESTIMATE AS PROJECT DEFINITION INCREASES

** The inflation component for VDOT project development estimates is typically added to the estimate by VDOT's PCES (Workbook) The inflation component for funding application estimates is typically added to the estimate via the Smart Portal.

5.3.   Key Inputs

The key inputs to a risk-based estimate are an identification and quantification of uncertainty surrounding the project scope (i.e., items of work, quantities of work, rates of production, etc.) and uncertainty surrounding risk events (i.e., a change in design standards, discovery of hazardous material, etc.). Risk-based estimates account for the potential impacts of uncertainty in both areas. Sources for these key inputs include:

- A definition of project complexity.

- A list of design and estimating assumptions and concerns.

5.3.1.   Project Complexity

Project complexity is a primary input to risk-based estimating. Project complexity drives the level of effort and choice of tools for a risk-based estimate (Molenaar et al. 2010 and Anderson et al. 2008). Project complexity is described in several ways. Some descriptions rely on project attributes to convey the project complexity. For example, attributes related to roadways, traffic control approaches, structures, RW, utilities, environmental requirements, and stakeholder involvement are often used to distinguish different levels of project complexity.

VDOT has prepared the Project Complexity Classification for the Cost Estimating Process in *Table 5-1* based on existing processes and business needs.

- Non-Complex projects, such as maintenance projects, may require only a listing of major risks and a top-down contingency estimate based on a percentage of the Base Estimate.

- Moderately Complex projects, such as minor roadway relocations, will typically require a qualitative risk assessment and top-down percentage contingency estimate. However, these projects may also require a deterministic examination of individual risks to ensure that the top-down percentage contingency is adequate (Molenaar et al. 2010).

- Projects in the Most Complex category may include new highways, major relocations, or reconstruction. These highly complex projects require a bottom-up, deterministic-based approach to estimating contingency.

The sections that follow explain these two methods that VDOT has adopted, Type I: Risk-Based Percentage Contingency Estimates and Type II: Risk-Based Deterministic Contingency Estimates.

Table 5-1: VDOT Project Complexity Classification for the Cost Estimating Process

Most Complex	Moderately Complex	Non-Complex
Most VDOT Tier 2 Projects (See IIM-LD-249)	**Higher Risk VDOT Tier 1 Projects Such As:**	**Most VDOT Tier 1 Projects (See IIM-LD-249)**
Medium to high complexity and schedule risks	T1 Projects under $10M with higher risks	Very low to medium complexity schedule risks
Special provisions for special time related conditions	T1 projects with multiple and potentially challenging RW needs	Short straightforward operations, typically single season and schedule type work
Multi-season projects with multiple concurrent operations and work paths	T1 projects with significant utility relocations	Simple repairs, multiple locations, flexible schedule
Challenging work and conditions	T1 projects with multiple and significant environmental impacts	Familiar work, favorable conditions
Several major subcontractors, multiple crews	T1 projects in rural areas close to sensitive areas (military bases, government facilities, major airports)	Simple low risk rehab projects
Major reconstruction / realignment	T1 projects in highly urban locations - multiple businesses along project	Drainage improvements
Major intersection improvements	T1 bridge projects with significant approach work	Trench widening projects
New roadway / bridge construction, not meeting the Moderately Complex criteria	**Lower Risk VDOT Tier 2 Projects Such As:**	Maintenance project schedule work (pavement, bridge, guardrail)
Large, very complex single-contract projects	T2 projects over $10M with lower risks	Intersection improvements, including signals
Multiple, roadways, bridges and ramps	T2 projects with few (if any) RW needs	Minor reconstruction projects
Projects with major traffic impacts	T2 projects with only minor utility relocations	Bridge or large culvert only projects with minimal approach work, no RW or utilities, and on secondary roads.
Projects that require RW from Federal government agencies.	T2 projects with few (if any) environmental impacts	Pavement markings and markers
T2 bridge projects involving large and/or complex structures	T2 projects in rural areas not near sensitive areas (military bases, government facilities, major airports)	
	T2 bridge projects with approach work, RW, utilities, environmental, and/or staging, etc.	

5.3.2.   Design and Estimate Assumptions and Concerns

The other two primary inputs for a risk-based estimate stem from a review of the assumptions made by the designer in the project definition and the assumptions made by the estimator(s) to create the estimate. The designers should make initial project definition assumptions during the pre-scoping or scoping phases, or both. Risk-based estimates are often made when limited resources or no resources have been invested in design. This is the nature of conceptual design, and it drives uncertainty in the project scope and project cost estimate. Likewise, estimators must make estimating assumptions in early estimates because very little detail will be available regarding project definition. 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. Estimators that maintain historical risk checklists will improve their chances of identifying potential risks on future projects. However, these historical checklists should not be the primary sources of information. Preferably, they should only be used after conducting an independent and thorough review of the project complexity and the estimating and design assumptions.

5.4.   Determine Risk and Set Contingency

Determining risk and setting contingency requires experience, judgment, and the proper tools to quantify as much of the project cost estimate uncertainty as practical. An estimator(s) can never eliminate the uncertainty or the risks from any cost estimate. Therefore, an estimator(s) needs to include a reasonable contingency amount in a project cost estimate to account for

Setting Contingency

Establishing a reasonable contingency requires considerable human and engineering judgment. The sliding scales provided herein are not to be used as the sole source of setting a contingency.

the risk exposure. A reasonable contingency amount must provide coverage for possible cost overruns, and the estimator(s) must be able to explain why the specific contingency amount is included in the estimate. The risk exposure and the corresponding contingency amount typically decrease as a project advances through project development phases.

This section separates risk identification from risk-based estimating of contingency. Risk identification is common to all risk-based estimating approaches. After discussing Risk identification as the approach to determining risk, this chapter explains the two risk-based approaches to setting contingency that VDOT has adopted:

• Type I – Risk-Based **Percentage** Contingency

• Type II – Risk-Based **Deterministic** Contingency

5.4.1.   Determine Risks

Risk identification is the first step in all risk analysis approaches. It should involve all members of the project team, as risk events can come from any functional area or stakeholder group. Risk identification tools, such as risk checklists, can be helpful. However, brainstorming in a risk identification workshop setting is perhaps the best approach to risk identification. It will produce a project-specific list of risks and prompt the discussion of critical project elements.

VDOT's Project Risk Management Procedure for DBB projects can be found in PMO-15. **For all DBB projects VDOT's estimators must follow the procedures outlined in PMO-15 as the first step in the risk-based estimating process.**

VDOT's Project Risk Management Procedure for DB projects can be found in IIM-APD-1.3 and the APD Design-Build Risk Analysis Process. **For all DB projects VDOT's estimators must**

follow the procedures outlined in these as the first step in the risk-based estimating process.

Attempting to shortchange or skip the risk assessment process, and blindly applying contingency to the Base Estimate can and often does have severe consequences to VDOT and project sponsors and stakeholders. It is the Project Manager's responsibility to ensure this crucial process is performed by the estimator(s) or consultants developing and updating VDOT's estimate. **Documentation of the process shall be prepared and retained for each estimate.** This documentation must be properly labeled and kept with the project records in PCES, ProjectWise, SMART Portal or the current VDOT document management system.

The risk identification process identifies and categorizes risks that could affect the project. It documents these risks and, at a minimum, produces a list of risks that can be assigned to a team member to be tracked throughout the project development and delivery process. Risk identification is a continuous process, and there should be a continual search for new risks that could affect the project. *Table 5-2* provides an example categorization of risks.

The tools and techniques outlined in this section support the risk identification process, but it will be the people involved in the risk analysis who are most critical to the success of the process.

Establishing risk-based contingencies is one of the more difficult and more critical aspects of cost estimating for transportation projects. This is

> **📋 Risk and Contingency**
>
> It is essential that those selected to participate in the risk analysis process be the most experienced and knowledgeable individuals in the particular type of project being estimated.

especially challenging for estimates developed in the early phases of project development. The methods outlined herein will yield more consistent results and clear traceable documentation for those who follow and rely upon the estimate data.

Table 5-2: Common Risks and Risk Categories

From AASHTO's Practical Guide to Cost Estimating (2013 First Edition – Chapter 5)

Environmental Risks	**External Risks**
• Delay in review of environmental documentation • Challenge in appropriate environmental documentation • Defined and non-defined hazardous waste • Environmental regulation changes • Environmental impact statement (EIS) required • NEPA/404 Merger Process required • Environmental analysis on new alignments required	• Stakeholders request late changes • Influential stakeholders request additional needs to serve their own commercial purposes • Local communities pose objections • Community relations • Conformance with regulations/guidelines/design criteria • Intergovernmental agreements and jurisdiction
Third-Party Risks	**Geotechnical and Site Risks**
• Unforeseen delays due to utility owner and third-party • Encounter unexpected utilities during construction • Cost sharing with utilities not as planned • Utility integration with project not as planned • Third-party delays during construction • Coordination with other projects • Coordination with other government agencies	• Unexpected geotechnical issues • Surveys late or in error, or both • Hazardous waste site analysis incomplete or in error • Inadequate geotechnical investigations • Adverse groundwater conditions • Other general geotechnical Risks
RW /Real Estate Risks	**Design Risks**
• Railroad involvement • Objections to RW appraisal take more time or money, or both • Excessive relocation or demolition • RW acquisition problems • Difficult or additional condemnation • Accelerating pace of development in project corridor • Additional RW purchase due to alignment change	• Design is incomplete/design exceptions • Scope definition is poor or incomplete • Project purpose and need are poorly defined • Communication breakdown with project team • Pressure to deliver project on an accelerated schedule • Constructability of design issues • Project complexity (scope, schedule, objectives, cost, and deliverables are not clearly understood)
Organizational Risks	**Construction Risks**
• Inexperienced staff assigned • Losing critical staff at crucial point of the project • Functional units not available or overloaded • No control over staff priorities • Lack of coordination/communication • Local agency issues • Internal red tape causes delay getting approvals, decisions	• Pressure to deliver project on an accelerated schedule • Inaccurate contract time estimates • Construction QC/QA issues • Unclear contract documents • Problem with construction sequencing/staging/phasing • Maintenance of traffic/work zone traffic control

Table 5-3 provides some typical risks that are representative of each of the three levels of project complexity.

Table 5-3: Examples of Representative Risks for Project Complexities

*From AASHTO's Practical Guide to Cost Estimating (2013 First Edition – Chapter 5)*

Project Type	Most Complex	Moderately Complex	Non-Complex
Representative Risks	• Unresolved constructability issues • Design complexity • Political factors • Complex environmental requirements	• Geotechnical issues • Changes in materials/foundation • Delays in permitting process • Bridge redesign/analysis	• Contractor delays • Changes in program priorities • Errors in cost estimating • Inaccurate technical assumptions

5.4.2. Set Contingency

VDOT has adopted a tiered approach to risk analysis and contingency estimation. The tiered approach stems directly from project complexity. A determination of the Project Complexity is made based on the three categories in *Table 5-1*. This leads to the selection of a risk analysis and contingency estimating approach as shown in *Figure 5-2.*

Once this determination is made, the project risk analysis and contingency estimation follow the process outlined in *Figures 5-3 through 5-5 – Risk and Contingency Process and Sliding Scales* as described in the detailed steps below.

Figure 5-2: Tiered Approach to Contingency Estimation
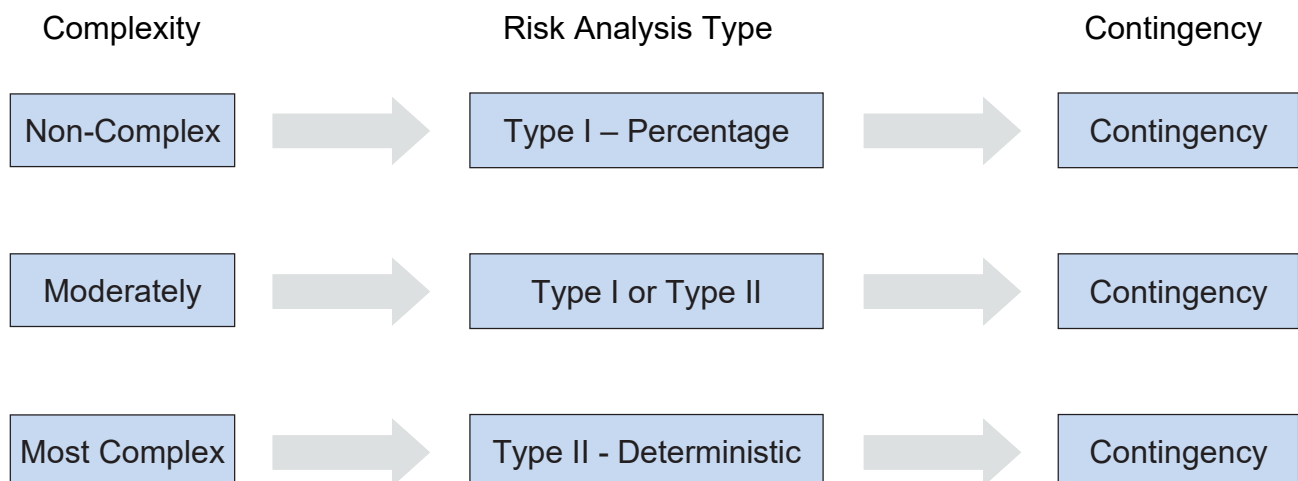
Based on an evaluation of where the project falls in the three different levels of complexity, a different type of risk analysis is defined for the project. The two types of risk analysis and contingency estimation are aligned with one of the three levels of complexity from *Table 5-1*:

- Non-complex projects.
- Moderately complex projects.
- Most complex projects.

The two risk analysis types can be briefly described as follows:

- **Type I - Risk-Based Percentage Contingency**: The Type I risk-based approach is the simplest form of risk analysis and should be used for non-complex projects. A Type I risk analysis involves the development of a list of risks and the use of a top-down percentage of project cost to estimate the contingency. See below Section 5.4.3 for more detailed information on this approach.

- **Type II - Risk-Based Deterministic Contingency**: The Type II risk-based approach correlates to moderately complex projects and most complex projects and involves more rigorous risk identification tools. It involves a top-down percentage contingency estimate that is supplemented with a bottom-up estimation of specific contingency items. See below Section 5.4.4 for more detailed information on this approach.

The type of risk analysis will determine the selection of appropriate risk-related tools for risk identification, risk analysis, and estimation of contingency. The basic risk analysis steps remain the same, but the tools and level of effort vary with the risk analysis level.

> **Risk Analysis and Management**
>
> All projects, regardless of project size and project complexity, require some form of risk analysis and risk management planning.

To determine the appropriate risk-based contingency, the estimator(s) must separate the Base Estimate from the contingency estimate, choose the appropriate category of project complexity, and know the phase of project development at the time of the estimate. Application consists of the following steps:

Step 1: Start with Unadjusted Defined Costs (Including Allowances):

Remove all contingencies and conservative biases from the Base Estimate.

Step 2: Classify Project Based on Complexity:

Classify the project by complexity as Non-Complex, Moderately Complex, or Most Complex based on _Table 5-1._

Step 3: Determine Current Phase of Project Development:

- Planning / Pre-Scoping
- Scoping / PFI
- Preliminary Design / Public Hearing
- Detailed Design / FI / RW
- Final Design / PAC

Step 4: Risk Identification / Risk Management:

Perform a risk identification/risk analysis per applicable VDOT Risk Management guidance (shown below) to determine potential risks that could impact the project. If the project does not require a risk analysis, then go to Step 5A and then to Step 7.

- DBB Projects: PMO-15
- DB Projects: IIM-APD-1.3 and the APD Design-Build Risk Analysis Process

Step 5: Establish Contingency:

Determine appropriate contingency to add to the Base Estimate using the sliding scales in _Figures 5-3 to 5-5_ as a guide.

Step 5A: Start by using the Most Likely Estimate (MLE) percent contingency from the appropriate sliding scale. (If no risk analysis is required by VDOT processes, then proceed to Step 7). This process is used for many Non-Complex and some Moderately Complex projects.

Step 5B: Compare contingency estimate derived from Step 5A with Type II deterministic contingency performed in Step 4 (if Type II risk analysis was performed).

Step 5C: Exercise professional judgement and determine if the MLE is reasonable and acceptable. If MLE is reasonable and acceptable, go to Step 7, If NO, go to Step 6.

> **Deterministic Contingency Estimates**
>
> A Type II - Risk-Based Deterministic Contingency estimate is required on Most Complex projects and on Tier 2 or DB Moderately Complex projects.

Step 6: Adjusting the Contingency from the MLE Using Engineering Judgment:

Step 6A: Contingency between LOW and HIGH on the applicable sliding scale:

If the estimator(s) determines that the MLE derived in Step 5 is not acceptable, then the estimator(s) should adjust the contingency to an amount between the LOW percentage and the HIGH percentage for the applicable phase of project development. The estimator(s) shall document within the CEP and the Cost Estimate Workbook, the justification for deviating from MLE and adjusting the contingency to an amount between the LOW percentage and the HIGH percentage on the sliding scale. Proceed to Step 7.

Step 6B: Contingency above or below LOW and HIGH on the applicable sliding scale:

If the estimator(s) determines that the MLE derived in Step 5 is not acceptable, AND determines the amount between LOW percentage and the HIGH percentages is not acceptable, the estimator(s) shall determine a justifiable contingency and present the recommended contingency to the District L&D Engineer, S&B Engineer or equivalent VDOT management level, for review and consideration. The estimator(s) shall reach concurrence on an acceptable contingency with the appropriate VDOT manager. In the CEP and/or the Cost Estimate Workbook, the estimator(s) shall document the justification for deviating from the MLE and adjusting the contingency above or below the LOW and HIGH percentages. The documentation shall include the concurrence of the applicable VDOT manager. Proceed to Step 7.

Step 7: Apply Contingency:

If the MLE determined in Step 5 is deemed acceptable by the estimator(s), then apply the percentage to the Base Estimate for the establishment of the contingency. Otherwise follow Step 6A and/or 6B below.

Per Step 6A, if the contingency is determined to be between the LOW percentage and HIGH percentage reflected on the sliding scale, the estimator(s) documents justification of contingency and establishes the contingency based on the documented and justified percentage.

Per Step 6B, if contingency is determined to be above or below the LOW percentage and the HIGH percentage reflected on the applicable Sliding Scale, the estimator(s) documents the concurrence of appropriate VDOT management, documents the justification of contingency, and establishes the contingency based on the documented and justified percentage.

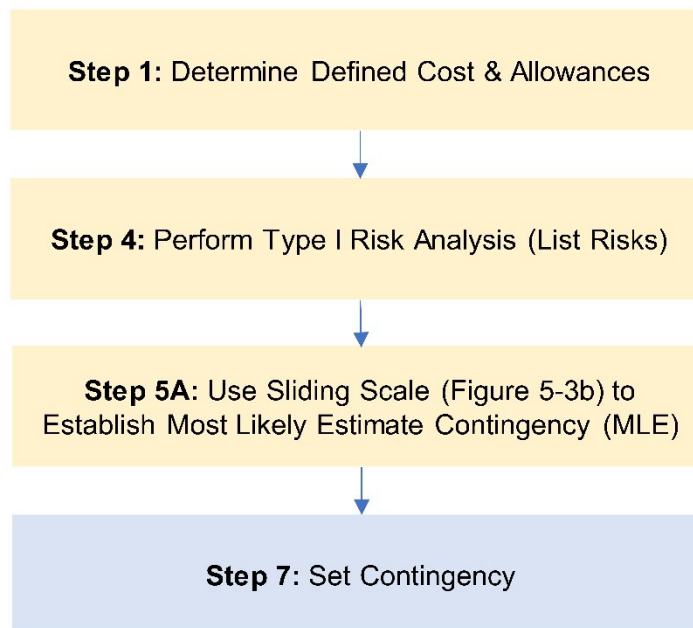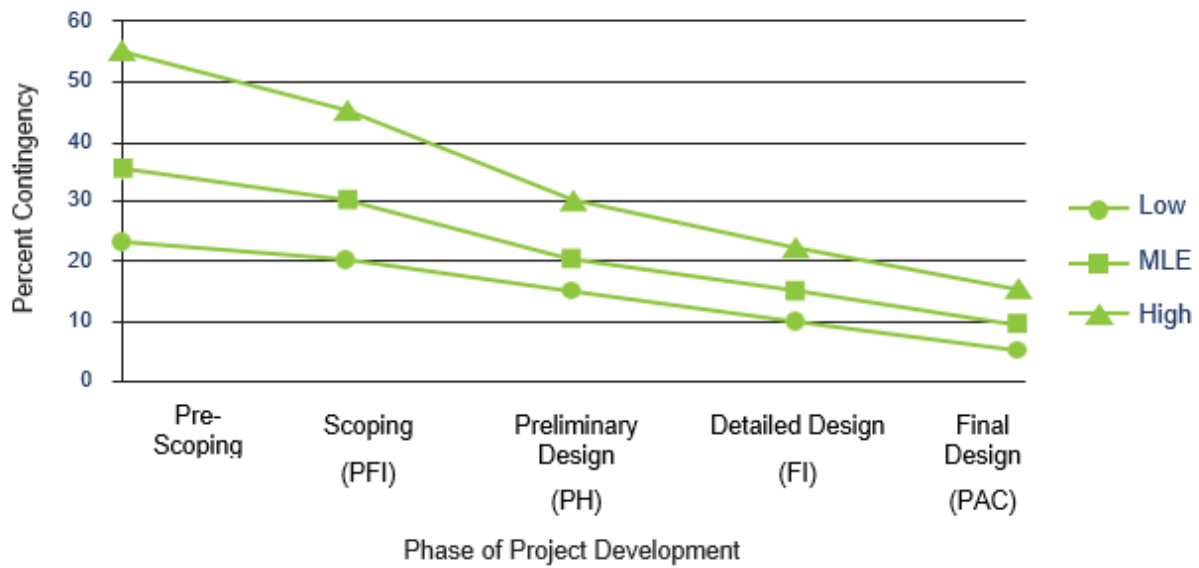## Figure 5-3a: Risk and Contingency Process and Sliding Scale – Non-Complex

Step 1: Determine Defined Cost & Allowances

↓

Step 4: Perform Type I Risk Analysis (List Risks)

↓

Step 5A: Use Sliding Scale (Figure 5-3b) to Establish Most Likely Estimate Contingency (MLE)

↓

Step 7: Set Contingency

Figure 5-3b: Risk and Contingency Process and Sliding Scale – Non-Complex

High	55%	45%	30%	22%	15%
MLE	35%	30%	20%	15%	8%
Low	23%	20%	15%	10%	5%

Figure 5-4a: Risk and Contingency Process and Sliding Scale – Moderately Complex
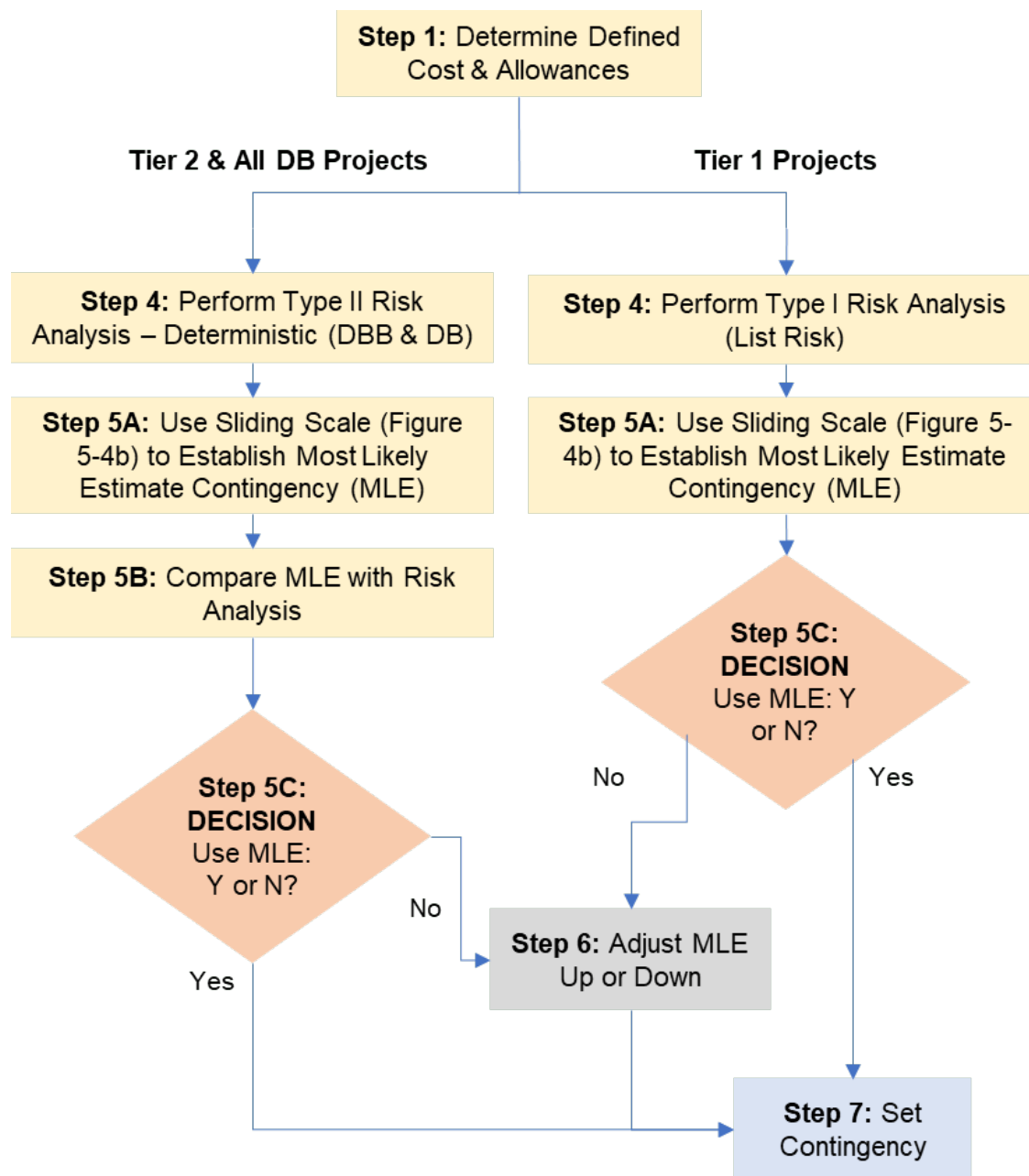
Figure 5-4b: Risk and Contingency Process and Sliding Scale – Moderately Complex
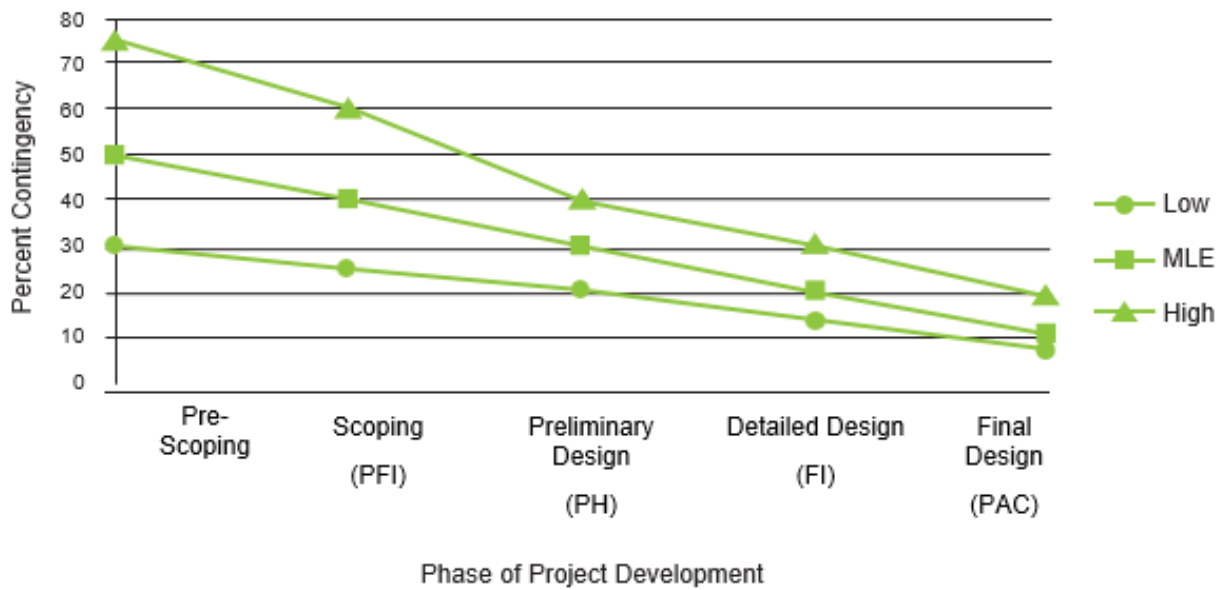
High	75%	60%	40%	30%	18%
MLE	50%	40%	30%	20%	10%
Low	30%	25%	20%	12%	7%

Figure 5-5a: Risk and Contingency Process and Sliding Scale – Most Complex
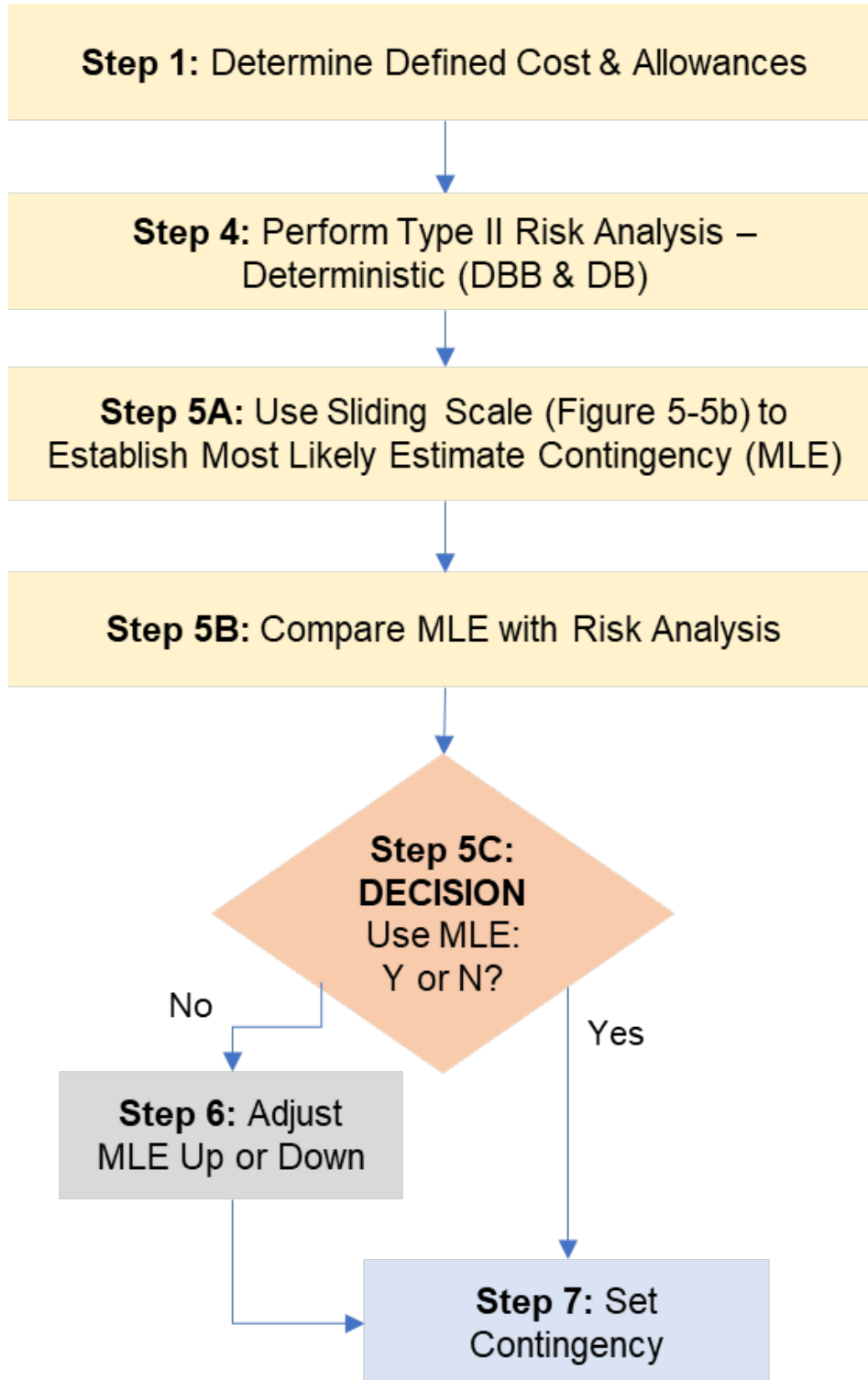
Figure 5-5b: Risk and Contingency Process and Sliding Scale – Most Complex
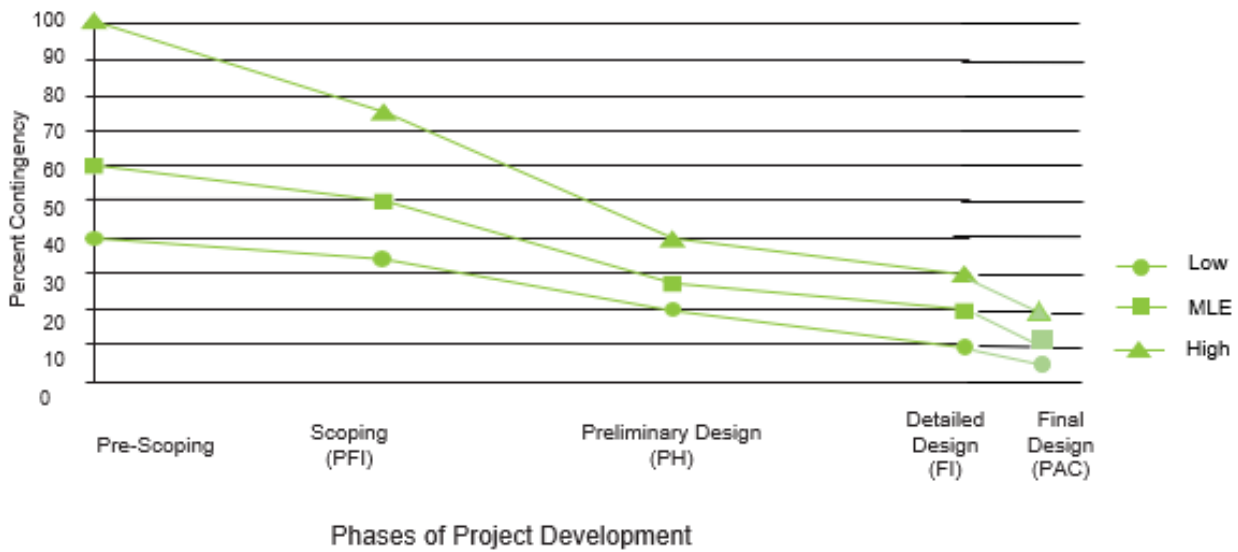
High	100%	75%	40%	30%	18%
MLE	60%	50%	30%	20%	10%
Low	40%	33%	20%	12%	7%

Figure 5-6: Establishing Appropriate Contingency

RISK BASED ESTIMATING – ESTABLISHING APPROPRIATE CONTINGENCY
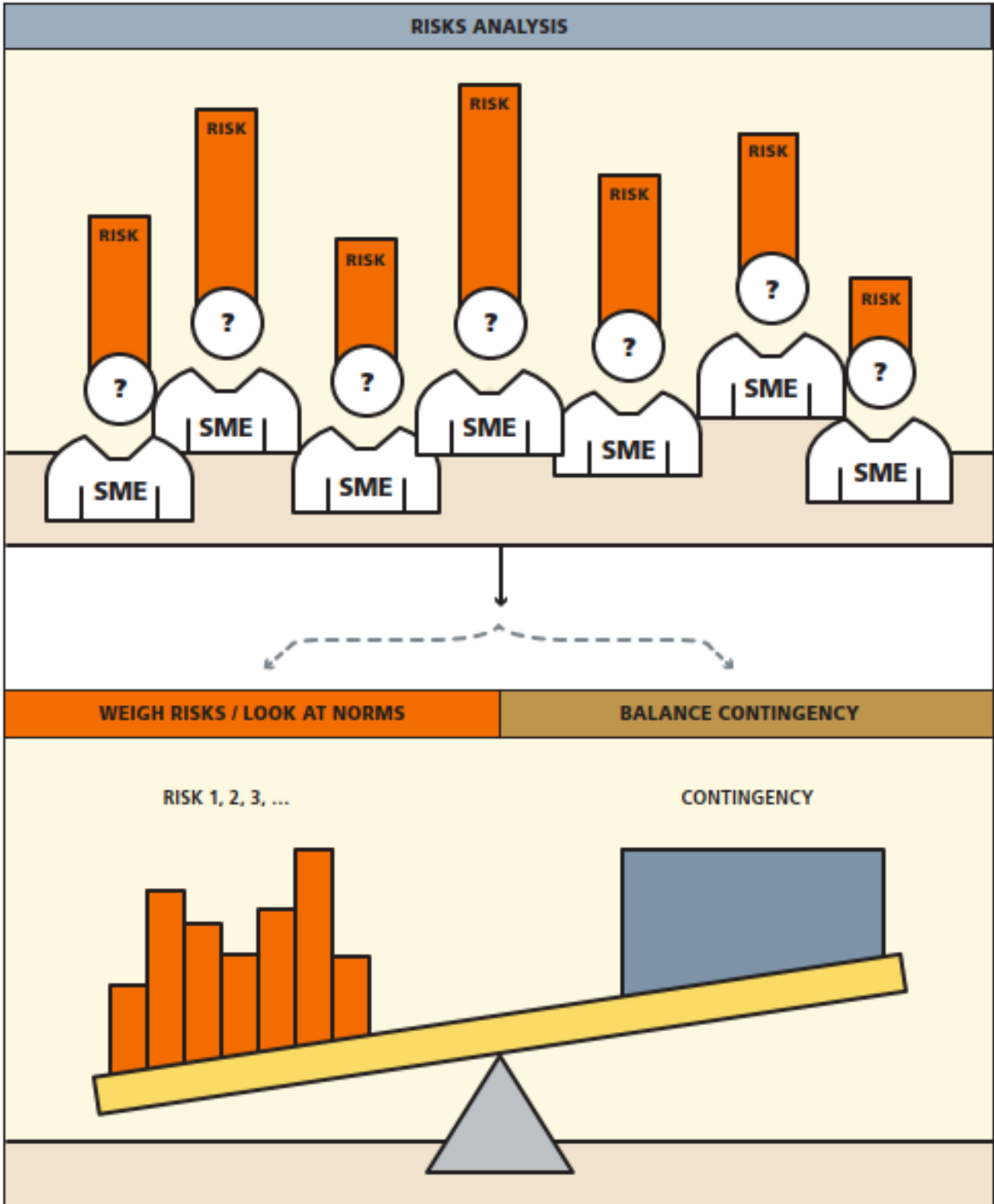
5.4.3. Risk-Based Percentage Contingency Estimates

In the case of non-complex and some moderately complex projects, transportation estimators commonly determine contingency estimates from a percentage of the Base Estimate. Many states apply a predetermined contingency on their projects (Molenaar et al. 2010). However, this predetermined contingency varies greatly from state to state. The definition of what contingency covers also varies from state to state, and even within agencies across regions or functional units. To better account for the unique effects of project complexity and phase in project development, VDOT has adopted AASHTO's sliding-scale contingency approach that is based on a Delphi study of 23 professional estimators from DOTs around the country (Olumide et al. 2010). This guide recommends the use of the sliding-scale contingency amounts shown in *Figures 5-3b to 5-5b.*

Note: VDOT is currently using this guidance from AASHTO with some customization, however as more data is collected and analyzed, the percentages in Figures 5-3b through 5-5b will be adjusted.

The application of the contingency charts is straightforward. However, the contingency values are not insignificant, as seen in the *Figures 5-3b, 5-4b, and 5-5b.* Most likely values for contingency at the pre-scoping / funding application stage are 35 %, 50 %, and 60 % on non-complex, moderately complex, and complex projects, respectively. These values were created with the understanding that the Base Estimate will contain no line-item contingencies or conservative estimates. If estimators include contingencies within the Base Estimate, these Base Estimate contingencies will be burdened again with the sliding-scale contingency factors, thus creating an excessively high estimate. Estimators must be diligent in removing all conservatism from the Base Estimate at all phases when applying this approach.

The implied retirement of contingency is a benefit of applying this approach. For example, the most likely value for contingency will change from 35 percent to 10 percent as project development proceeds from pre-scoping to final design on a non-complex project. This reduction in contingency values implies that the Base Estimate accuracy will increase by these same percentages if the pre-scoping estimate is correct. Although the risk-based percentage contingency approach does not directly correlate risks to contingency amounts, estimators can keep a list of risks and key design and estimating assumptions throughout the process. These risks and assumptions should be resolved as the design progresses and the contingency decreases. If risks are not resolved, the estimator(s) can choose to maintain a contingency at the higher end of the suggested range.

5.4.4. Risk-Based Deterministic Contingency Estimates

The risk-based deterministic approach correlates to moderately and most complex projects and involves more rigorous risk identification tools. It involves a top-down percentage contingency estimate that is supplemented with a bottom-up estimation of specific contingency items. The percentage contingency is completed in the same fashion as described in the previous section. The top-down percentage contingency approach is then supplemented with an estimate of the probability and impact of specific risks to the maximum extent possible at the current level of project development to ensure that the contingency percentage is adequate.

Risk-based deterministic approaches assign a risk factor to various project elements based on historical knowledge of the relative risk of various project elements. For example, pavement material cost may exhibit a low degree of cost risk, whereas acquisition of rights-of-way may display a high degree of cost risk. Project contingency is determined by multiplying the estimated cost for each risk by its respective probability of occurrence. *Table 5-4* provides an example of a deterministic risk-based analysis for the calculation of contingency through the

expected value for each identified risk. This method profits from its simplicity and the fact that it produces an estimate of cost contingency. However, the project team's knowledge of risk is only implicitly incorporated in the various risk factors.

Table 5-4: Simplified Deterministic Risk-Based Analysis Example

From AASHTO's Practical Guide to Cost Estimating (2013 First Edition – Chapter 5)

Project Cost Element	Estimated Impact	Probability of Occurrence	Cost Contingency
Initial Purchase of RW	$1,200,000	20%	$240,000
Known Hazardous Substance	$125,000	10%	$12,500
Coordination with Railroad Agencies	$50,000	10%	$5,000
Treatment of Water Discharged from Site	$400,000	3%	$12,000
TOTAL			$269,000

The simplified deterministic example provided in *Table 5-4* should not be the sole determinant of project contingency, but rather it should be used as a "cross-check" for the sliding-scale contingency approach described in the previous section. If the two analyses result in different contingencies, the estimator(s) should exercise professional judgement and consults VDOT management (see Step 6 above) to establish the most appropriate contingency.

A primary benefit of using the deterministic contingency approach is a quantification of the potential risk impact through its expected value (probability x impact). By quantifying the probability and impact of potential risks, the project team can better understand the potential risk effects. The analysis allows the team to better manage its resources when mitigating or managing the risks. From the example in *Table 5-4*, it is apparent that the team should focus on mitigating the risks stemming from the initial RW purchase. The analysis also shows that impact of water discharged from the site ($400k) is larger than the impact of the treatment of a known hazardous substance ($125k). However, factoring the probability of occurrence into the analysis shows that the contingency required for each item is essentially equal ($12.5k and $12k). Using a probability x impact analysis (i.e., expected value) for contingency shows that the team should treat these items equally in its efforts to mitigate and manage them.

Two primary errors can occur when using the deterministic risk-based contingency approach. These errors occur if the list of risks is not (1) comprehensive, and (2) overlapping. If the list of risks is not comprehensive, the resulting contingency estimate will be low. This error is easily mitigated by using the sliding-scale contingencies from the previous section when the deterministic value is lower than the sliding-scale value. If the list of risks is overlapping, there is a chance that the deterministic approach may "double-up" the contingency for these overlapping items and result in a contingency value that is too high. To mitigate this potential error, estimators should strive to make the risks independent.
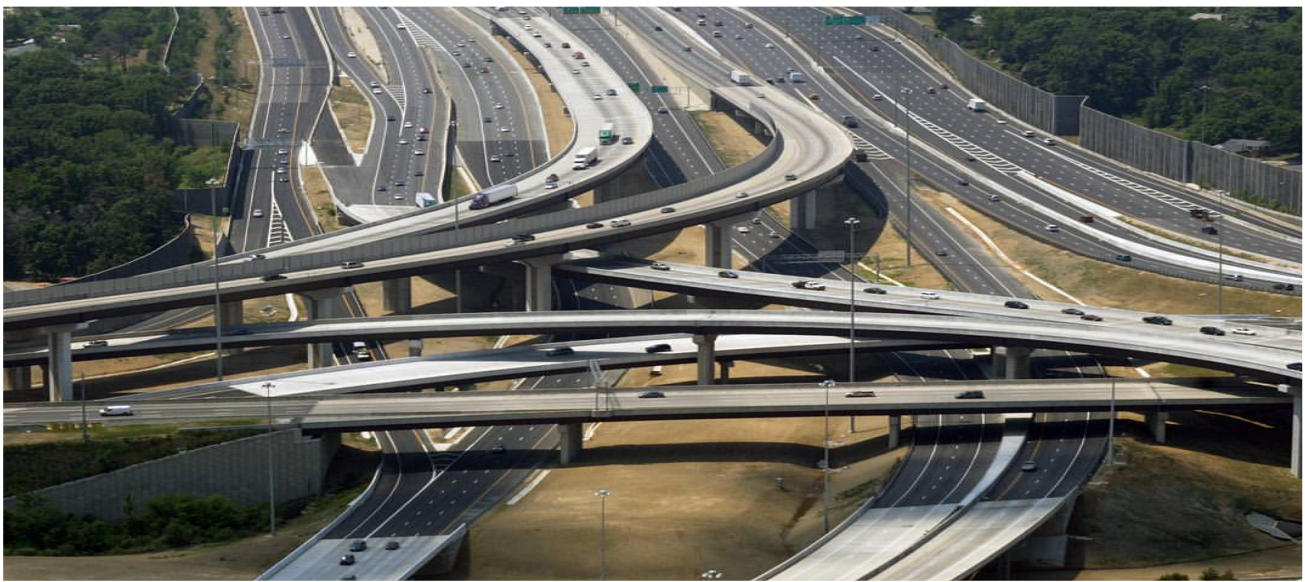
Chapter 6 –
Quality Management – Estimate Review & Approval Process

Chapter in Brief:

In this chapter the reader is provided with an overview of VDOT's requirements for Project Cost Estimate Packages (CEP) that provide supporting detail of an estimate.

It also provides VDOT's current validation processes for funding application estimates (IIM-LD260/IIM-IID-11) and the review and approval process for estimates prepared during the PDP (PMO 3.6).

6.1   Overview

6.2   Funding Application Estimates

6.3   Project Development Estimates

6.4   Project Cost Estimate Package

6.5   Estimate Quality - Authority and Responsibility

6.1   Overview

This chapter provides VDOT's estimate review and approval Process for cost estimates. Not all estimates are the same and therefore VDOT has specific review and approval processes for different categories of project estimates. VDOT project cost estimates generally fall into the following two categories, depending upon several factors. These two categories are:

- **Funding Application Estimates:** Estimates developed for VDOT's numerous application-based funding programs (e.g. SMART SCALE, SGR, Revenue Sharing, TAP, and Safety).

- **Project Development Estimates:** Estimates developed after Project Initiation (inclusion in the SYIP).

Each category of estimate will be addressed individually herein:

6.2   Funding Application Estimates

These estimates are developed and submitted, along with a host of other required data, with the applications for funding. These estimates are part of a larger process, and relied upon to make funding decisions, establish budgets, program funds, and manage funds.

> **Independent Cost Estimates**
>
> Independent cost estimates are highly recommended for Moderate and Most complex projects, with limited project definition.

For preliminary estimates on moderate and most complex projects that will be used to apply for funding for such programs as SMART SCALE and SGR Bridge, at least two independent estimates should be performed. A different estimator should be used for each estimate, and when possible, a different approach should be used for each estimate. A comparison of the two estimates should be completed, and a brief explanation of how these two estimates affected the final estimate, should be documented in the CEP.

VDOT uses the SMART Portal to collect and store these estimates for projects in certain funding programs.

The SMART Portal is used for the following application processes: SMART SCALE, Revenue Sharing, Virginia Highway Safety Improvement Program (VAHSIP) SGR Bridge (Local), SGR Pavement (Local) and Transportation Alternatives.

All estimates developed for funding applications, regardless of funding application process, shall follow the procedures outlined in District and Central Office Project Application Review and Validation (IIM-LD260/IIM-IID-11).

The same requirements apply for estimates associated with new projects being considered for funding through programs that do not take in applications through the SMART Portal (such as Interstate, SGR Bridge and Paving, et al.).

Additionally, each Funding Application estimate uploaded to the SMART Portal shall include a CEP. Detailed requirements of the CEP for each Project Complexity Classification (Non-Complex, Moderately Complex, Most Complex) are provided at the end of this section.

6.3   Project Development Estimates

Throughout the project development phase of a project, estimates are further refined for the defined phases (PE, RW, CN) as detailed in the previous chapters.

All estimates developed or updated during the project development phase of a project, regardless of milestones, shall follow the procedures outlined in Project Development Budget and Estimate PMO-3.6

Additionally, each project development estimate uploaded into the PCES - System shall include an applicable CEP. Detailed requirements of the CEP for each project complexity classification (Non-Complex, Moderately Complex, Most Complex) are provided in this section.

6.4   Project Cost Estimate Package

Thorough estimate documentation, supporting the actual cost estimate developed, is crucial to understanding and communicating the estimate. This documentation is useful to all project participants, including the professionals who developed the estimate. In the event of turnover on a project team, it enables those who follow to gain a better understanding of the previously developed project costs, and how these costs were developed. VDOT's requirements for CEP for each project complexity classification are:

See *Table 5-1* for VDOT's Project Classification for the Cost Estimating Process.

Sample CEPs can be viewed and downloaded at the following link: Pre-Scoping Estimate and Field Inspection Estimate

The CEPs are to be stored in ProjectWise within the Estimate folder(s) for the specific project.

6.4.1. Non-Complex Project CEP Requirements:

CEPs for non-complex projects should be stored in ProjectWise in a folder labeled "Estimate". It will be the responsibility of the VDOT Project Manager to request access, through VDOT's CADD Support, to the estimate folder(s) for the appropriate individuals.

- Cost Estimate Workbook **
- Estimator(s), reviewer(s), and project team
- Basis of Estimate
    - For information used, and not included in CEP, provide detailed description and links (including PM-100 scoping report if applicable)
- Estimate type (analogous, parametric, quantity/bid based, cost based, etc.)
- Risk registry (if applicable) **
- Assumptions (including year of advertisement and how inflation is covered in estimate)
- Exclusions
- Brief narrative (1 page or less)
    - Statement of estimating process and tools used
    - Date(s) of site visits and participants **
    - Challenges encountered during estimate development **
    - If updating from a previous estimate, provide information on previous estimate and highlight major changes **
- Completed checklist
- A dated printout of actual estimate in PDF

**These components are not required for the following Non-Complex and/or no-plan projects with an estimated total project cost under $750K.
- SGR Paving Schedule

- Traffic Operations/Maintenance (Rumble strips, guardrail, flashing yellow arrows, striping, signals, bridge maintenance, ADA ramps, etc.)
- Bridge Maintenance (painting, cleaning, maintenance, etc.).

**If an estimate update, places the project above the $750K, all components of the CEP are required

6.4.2. Moderately Complex Project CEP Requirements:

CEPs for moderately complex projects should be stored in ProjectWise in a folder labeled "Estimate". It will be the responsibility of the VDOT Project Manager to request access, through VDOT's CADD Support, to the estimate folder(s) for the appropriate individuals.

- Cost Estimate Workbook
- Estimator(s), reviewer(s), and project team
- Basis of Estimate
  - For information used, and not included in CEP, provide detailed description and links (including PM-100 scoping report if applicable)
- Estimate type (analogous, parametric, quantity/bid based, cost based, etc.)
- Risk registry and risk management documentation
- Assumptions (including year of advertisement and how inflation is covered in estimate)
- Exclusions
- Narrative (1 to 2 pages +/-)
  - Graphic (or reference to plan set) depicting overall project limits and proposed improvements
  - Statement of estimating process and tools used
  - Date(s) of site visits and participants
  - Challenges encountered during estimate development
  - If updating from a previous estimate, provide information on previous estimate and highlight major changes.
- Completed checklist
- A dated printout of actual estimate in PDF

6.4.3. Most Complex Project CEP Requirements:

CEPs for all most complex projects should be stored in ProjectWise in a folder labeled "Estimate". It will be the responsibility of the VDOT Project Manager to request access, through VDOT's CADD Support, to the estimate folder(s) for the appropriate individuals.

- Cost Estimate Workbook
- Estimator(s), reviewer(s), and project team
- Basis of Estimate
  - For information utilized, and not included in CEP, provide detailed description and links (Including PM-100 scoping report if applicable)
- Estimate type (analogous, parametric, quantity/bid based, cost based, etc.)
- Risk registry and risk management documentation
- Assumptions (including year of advertisement and how inflation is covered in estimate)
- Exclusions
- Complete Narrative
  - Graphic (or reference to plans) depicting overall project limits and proposed improvements
  - Statement of estimating process and tools used
  - Date(s) of site visits and participants
  - Challenges encountered during estimate development
  - If updating from a previous estimate, provide information on previous estimate and highlight major changes.
  - Most significant factor(s) known at this time that may significantly alter project costs.
  - Independent Cost Estimate:
    - Performed by
    - Results and comparisons to Independent Cost Estimate
    - If no Independent Cost Estimate performed, provide confidence level of estimate (Very High, High, Moderate, Low, Uneasy, Very Uneasy)
- Completed checklist
- A dated printout of actual estimate in PDF

6.5 Estimate Quality - Authority and Responsibility

It is the responsibility of VDOT's Responsible Charge Engineers, Project Manager(s), and Program Manager(s), assigned to a project, to ensure VDOT's estimating policies and guidance are adhered to, and that quality estimates are developed. This responsibility is carried throughout the funding application and project development process. This is equally applicable to all funding application processes and/or programs. VDOT's District management has direct oversight authority and responsibility for their District's staff, and for the programs (including estimate development), within their respective District.

It is the responsibility of the Cost Estimation Office, along with other applicable Central Office Divisions (i.e., L&D, S&B, Construction Division, APD, TMPD, Materials, LAD, RW, IID, et. al.) to provide estimating guidance, policy, tools, training, assistance and other resources needed to support the Districts' staff in the development of estimates.

Chapter 7 –
Training & Continuing Education

Chapter in Brief:

This chapter provides an overview of VDOT's currently available training resources on cost estimating. A portion of this training is available publicly through the VDOT's website. Other courses are only available to individuals who have access to VDOT University.

7.1.   Links to Existing Training

This chapter outlines existing available training resources within the organization and those provided by AASHTO. Additional training related to cost estimating, estimating tools, and this manual will be provided by and/or coordinated by the Cost Estimation Office.

7.1. Links to Existing Training

Externally Available Estimating Training Resources:

- **Overview of the Estimating Process**
    - PMO3.6 Guidance – Estimate Process
    - Review of Cost Estimating Tools
- **Cost Estimate Workbook modules**
    - Cost Estimate Summary Workbook
    - Contingency Module Narrative
- **Bristol Estimating Tool**
    - Module 1 - Overview
    - Module 2 - Field Data Collection Sheet and Item Checklist
    - Module 3 - Total Project Summary
    - Module 4 - Alignment Calculations
    - Module 5 - Earthwork
    - Module 6 - Project Example with Multiple Alignments
    - Module 7 - Alignment Summaries
- **Staunton Estimating Spreadsheet**
    - Introduction
    - General Setup
    - Prepare and Run Basic Estimates
    - Pricing Models
    - Features and Functions
- **AASHTO Cost Estimating Training Series**
    - This new series, based on the *AASHTO Practical Guide to Cost Estimating*, covers both Cost Estimation and Cost Management. The goal of the Cost Estimation courses is to improve consistency and accuracy of cost estimates regardless of when they are prepared in the project development process.
    - Cost Estimation: 1- Introduction to Cost Estimating (1 PDHs)
    - Cost Estimation: 2 - Conceptual Estimating (2.5 PDHs)
    - Cost Estimation: 3 - Bid-based Estimating (2 PDHs)
    - Cost Estimation: 4 - Cost-based Estimating (2 PDHs)
    - Cost Estimation: 5 - Risk-based Estimating (2 PDHs)
    - Cost Management: 6 - Basics and Inflation (1.5 PDHs)
    - Cost Management: 7 - Letting Strategies (1 PDHs)
    - Cost Management: 8 - Contractor Bids (1.5 PDHs)

- [Cost Management: 9 - Performance Measures Estimating (1 PDHs)](#)

Internal Estimating Training Resources:

- **Project Management Training modules**

  - [Training Videos - All Links (virginia.gov)](#)

- **VDOT University – Only available with VDOT University Account**

  - Project Cost Estimating System (PCES) for Localities

    - Only accessible with VDOT University account

  - AASHTOWare – Project Preconstruction (Virtual Class)

    - Only accessible with VDOT University account

- **Essentials of Engineering Excellence (E3) Program (Estimating Classes)**

  - The Essentials of Engineering Excellence (E3) Program is a training and education partnership between VDOT and the University of Virginia Center for Transportation Studies. The goal of E3 is to provide technical training and development for VDOT transportation engineers, and a pathway for specialized training, career advancement and the option of pursuing a master's degree.

Accessing VDOT University for External Stakeholders:

For external stakeholders who do not have a VDOT University Account, you can register for one at this [location](#):

When you see this Log In dialog box, click on "Register" to create your account.
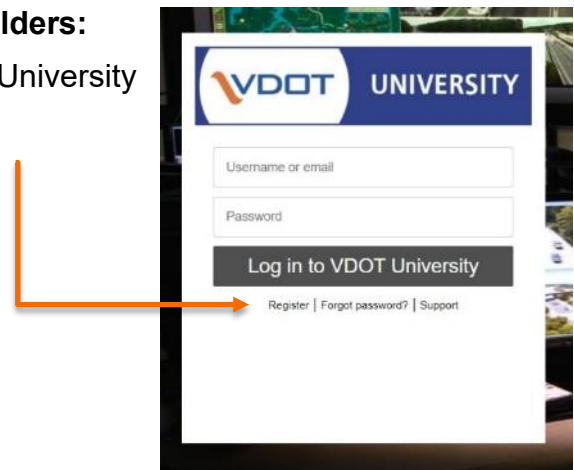
Appendix

Appendix A

Full Definitions and Abbreviations

Appendix A – Full Definitions and Abbreviations

Full Definitions:

Accuracy – Accuracy is the level of correctness. AASHTO and FHWA defines accuracy as the measurement of how close estimates are to the low bid. Another common measure of Accuracy is how close the estimate is to the Actual Cost.

Accuracy Range – Expresses both the high and low acceptable estimate accuracy boundaries. These change over time, becoming more stringent as the plan develops and risks are addressed. The Cone of Uncertainty graphically depicts the Accuracy Range throughout the project development process.

Actual Cost – The total of all costs incurred by the project owner at the time the project is delivered to and accepted by the owner under the specific definition of final acceptance. This includes the total PE, RW, and CN phase costs. The Actual Costs are not fully known until all project risks have been fully mitigated or realized by the project owner. The Actual Costs are all project expenditures that are reconciled at project closeout.

Allowance – An amount included in the Base Estimate to account for costs of known items whose requirements are currently undefined. This cost component covers the "known-unknowns". An allowance is separate from a contingency. As the design progresses, the "known-unknown" allowances will be converted to the "known-known" costs that are accounted for in the Defined Cost. Examples of allowances in preliminary estimates may be an underground utility extension, E&S measures, MOT, Water Quality Credits and Wetland/Stream mitigation costs. *See Figure I-1a and I-1b: Defined Cost, Allowance, Risk & Contingency.*

Anchoring – A cognitive bias where one unintentionally assigns undeserved weight to preliminary information when making future decisions or evaluating future actions. An example is someone becoming overly attached to a specific Preliminary Estimate without considering the associated Accuracy Range or Confidence Level of the estimate. Anchoring can surface later in development when the estimate is rightfully adjusted, and suddenly the project is viewed as unexpectedly expensive or a bargain, a view that is rooted in the assumption that the Preliminary Estimate was more accurate than the accepted Accuracy Range at that point of project development.

Base Estimate – For Preliminary and Design Estimates, this represents the Preliminary Engineering (PE), Right of Way (RW), and Construction (CN) phase costs that can reasonably be expected to complete the project if executed as planned. It should be unbiased and neutral, not overly optimistic or conservative. The Base Estimate should be in current year dollars, and not include inflation. The Base Estimate = Defined Cost + Allowances and shall specifically exclude contingencies and/or inflation. For PE, the Base Estimate should include all applicable administrative, investigative, and design costs to develop the project and progress the plans to Advertisement. For LAPs, this includes VDOT oversight costs. For RW, the Base Estimate should include all applicable RW and utility relocation costs. This may include administration, acquisitions, relocations, and utility relocations. For CN phase, the Base Estimate should include all bid item costs, and other CN phase related costs such as Railroad Coordination, State Forces, State Police, Contract Requirements (incentives/disincentives), or CEI services.

Baseline Estimate – The estimate that has been established as the baseline against which future estimates are compared to evaluate on-budget and estimate performance metrics. The Baseline Estimate includes the Base Estimate (which includes Defined Cost + Allowances), Contingencies (risks), and Inflation. Baseline Estimates may be changed only by following the

established project management procedure ([PMO-22.0 Change Management](#)). The Baseline Estimate = Defined Cost + Allowances + Contingencies + Inflation.

Basis of Estimate – A document that provides an auditable trail identifying the logic, data, methodology, assumptions, constraints and calculations used to develop a project cost estimate. The Basis of Estimate should be thoroughly documented in the Project CEP and stored in Project Wise or SMART Portal (for funding application Estimates).

Benefit-Cost Ratio – A calculated number that systematically compares the benefits of a project to its cost. This analysis highlights the interdependent relationship between the project scope and estimate. A Cost-Benefit Ratio is required on certain funding source project applications, such as SMART SCALE.

Bid Item Estimate – Includes specific bid item costs in a VDOT project cost estimate that account for contractor pay items as defined by the Road and Bridge Specifications under the Method of Measurement and Payment section.

Budget – A project Budget is the total amount of money allocated to develop and deliver the project. Pending the funding source, the project Budget is typically established from the appropriate project estimate and reflected in the SYIP.

Budget Increase – At certain project milestones and during updates to the SYIP, a budget increase may be requested per the processes associated with the applicable funding program. If a budget increase is approved, funding will be added to the project. It is imperative a reliable project estimate is developed to determine the appropriate budget increase amount.

Cone of Uncertainty – The Cone of Uncertainty is a graphic depiction of the acceptable estimate accuracy ranges throughout the project development process. Over time, as the project plan progresses and risks continue to be addressed, the accuracy range will tighten. The Cone of Uncertainty is an important tool to manage both project and program estimate accuracy expectations.

Confidence Level – The calculated or assigned probability that a result will be within the anticipated Accuracy Range. For example, the probability an estimate will fall within the Cone of Uncertainty.

Construction Contingency – A contingency that may be allocated to the project budget at time of award. Typically, this is up to 5% for Tier 1 projects and up to 10% for Tier 2 projects of the awarded contract amount. The construction contingency may be included in VDOT's CN phase budget and listed on the Fund Verification Sheet. It is intended to address change orders and other miscellaneous undefined items that may arise during construction.

Construction Engineering Inspection Costs – CEI costs are those associated with the contract administration, inspection, and oversight of construction to ensure procedures and materials comply with plans and applicable specifications. For DBB projects, CEI costs should be included in the CN Phase estimate but are typically not included in the Bid Item estimate.

Construction Phase – The CN Phase encompasses all activities to build and complete construction of the project according to approved plans and applicable specifications. CN includes, but not limited to, administration, material procurement, Bid Item costs, Non-Bid Item costs, and CEI.

Contingency – An amount added to a Base Estimate to account for identified and unidentified risks whose likelihood of occurrence and significance of impact are uncertain. This cost component covers the "unknown unknowns". Contingencies can be assigned to projects, phases, or engineering disciplines within phases. As a project develops, contingencies will

typically decrease as risks should be more fully understood through additional design or investigation and properly addressed. Contingencies shall be determined based upon provided guidance described in Chapter 5. For the estimates prepared in AASHTOWare Project Preconstruction, contingency is calculated based on a percentage applied to a group of item codes or entered as a lump sum non-bid item. *See Figure I-1a and I-1b: Defined Cost, Allowance, Risk & Contingency.*

Contract Requirements (Incentive/Disincentive) Costs – Contract requirements are specific costs associated with incentives and/or disincentives, including possible bonuses that are included in the contract. These costs are excluded from the bid item estimate; however, they should be included in the CN Phase estimate.

Contract Value – Contractually defined amount to be paid to contractor for services provided. This is detailed on the signed C-7 form.

Defined Cost – The portion of the Base Estimate where a probable cost of development and construction can be reasonably determined. These are costs of known items whose requirements have been determined and quantified at the current level of project development. These are the "known-knowns". *See Figure I-1a and I-1b: Defined Cost, Allowance, Risk & Contingency.*

Design Approval – Design approval is securing the approval of the project's Location and Design (or Design only) by the appropriate authority, be it a VDOT District Engineer/Administrator, the VDOT State L&D Engineer, CTB, City Council, or Local Board of Supervisors. Design approval is accounted in the project schedule as PWA Project Task 49. Design approval is often the first opportunity with a well-defined estimate where funding could be added or removed from a project.

DB Risk – The amount of contingency applied to a DB estimate to capture the risk associated with a design-builder developing a lump sum price to design and construct a project without the benefit of final 100% design plans and final quantities. The DB risk amount is in addition to contingency amounts used to develop the design and construction estimate. APD along with input from the Project Manager will determine the appropriate DB risk percentage to use on a project by project basis based on the project's complexities and other relevant factors.

DB Risk Analysis – A risk analysis meeting is conducted prior to request for proposal (RFP) release to identify major project risks, propose mitigating actions and allocate risks to the design-builder, VDOT or both. This risk assessment is instrumental in determining the appropriate scope of work and risk mitigation strategies required for the successful delivery of the project.

DB RFQ Estimate – An estimated contract value is developed for the Request for Qualifications (RFQ) using the DB Cost Finance Summary (CFS) sheet provided by APD. The estimate includes design, RW, utility relocation, construction, DB risk, QA/QC, price adjustments (asphalt, fuel, and steel) and contract administration. These items are divided into VDOT and design-builder costs. The estimate for the project may be developed utilizing PCES - Workbook or AASHTOWare Project Preconstruction.

DB RFP Estimate – A cost estimate is provided for the project using the DB Cost Finance Summary (CFS) spreadsheet provided by the PM-APD. The estimate should be as detailed as possible and include design, RW, utility relocation, construction, DB risk, QA/QC, and VDOT contract administration to include the Department's services for Independent Assurance and Independent Verification. These items are divided into VDOT and design-builder costs. The cost estimate for the project's major items, which includes, but is not limited to the following: excavation, pavement, drainage, signals, bridges, guardrail, noise abatement, retaining walls,

E&S control, etc. should be developed utilizing AASHTOWare Project Preconstruction software. The estimate in VDOT's SYIP, TIP and STIP must match the most current cost estimate prior to submitting the RFP submittal to FHWA.

Design Estimate – A Design Estimate is the probable cost of construction estimate prepared during the design phase once plan quantities become available. Typically, this begins at or around Public Hearing. For VDOT-Administered projects, these estimates are calculated in AASHTOWare Project Preconstruction. All Design Estimates must be uploaded and recommended into the PCES - System.

Engineer's Evaluative Estimate – The estimate of probable cost of the construction contract award amount prepared at time of Advertisement. This definitive estimate is based on plan quantities and anticipated work units. It is expressed in current year dollars. For VDOT prepared EEs, these remain confidential in perpetuity. This is the estimate against which bids are compared to approve or reject the low bid for award. This estimate is prepared based upon publicly available contract documents. VDOT prepared EEs are prepared by CO Construction Division and loaded into AASHTOWare Project Preconstruction.

Estimate – A quantitative determination of the probable cost of a project. They are determined using proven tools, historical cost data, market trends, and professional judgement. Construction estimates include probable costs of construction, while project estimates include all project related costs to develop and deliver the project as designed. There are multiple types of estimates, each appropriate at defined points of the project lifecycle, and have unique contingencies and allowances based upon project specific complexities. Estimates also include inflation, based upon the project schedule. The following two main categories of estimates are referred to in this manual:

- Funding Application estimates are developed for VDOT's numerous application-based funding programs (e.g., SMART SCALE, SGR, Revenue Sharing, TAP, and Safety).

- Project Development estimates are developed after project initiation (inclusion in the SYIP).

Fund Verification – VDOT requires verification of funds prior to authorizing, or opening, each project phase of PE, RW, and CN. The project estimate should be updated prior to fund verification. It is imperative that a reliable project estimate is developed for Fund Verification. IIM-IID-1.5, entitled "Funding Verification for Construction Program Projects" contains additional information.

Fund Distribution Sheet (FDS) – At the time of contract execution, CO Construction distributes the FDS that details all budgeted costs within CN Phase.

Funding – The means by which the money required to develop and deliver the project is secured. Projects may have allocations from multiples funding sources, which are coordinated through IID, and reflected in the SYIP.

Inflation – Captures a general increase in the rise and fall of the purchasing value of money as the value of currency fluctuates over time. Inflation rates are applied to estimates to more accurately account for future cost increases, as expressed in current year dollars. Inflation is the final component of the cost estimating process and it is applied to both the Base Estimate (Defined Cost + Allowances), and all contingencies. Inflation, based on VDOT established rates, is currently added to an estimate in the SMART Portal or PCES - Workbook.

Locally Administered Project – A Locally Administered Project (LAP) is administered in whole, or in part, by the locality. VDOT provides oversight of the project as outlined in the LAP Manual. Each of the project phases (PE, RW, CN) may have VDOT oversight costs.

Market Conditions – The enterprise environmental factors that can economically impact a project or program. While these are outside of VDOT's control, they can directly influence, constrain, or control the project or program. Examples include consequences of supply and demand that determine prices and unit costs. These can directly impact the bidding environment, labor market, supply costs, and resource availability.

Optimism Bias – Optimism Bias is the cognitive predisposition to assume your chances of realizing negative risks are lower than reality, coupled with the assumption that your chances of realizing positive opportunities are greater than reality. This natural and institutional bias can unintentionally set unrealistic expectations, both at the project and program levels.

On-Budget – A Dashboard performance metric that details whether a project's estimate scores a Green, Yellow, or Red light based upon established Dashboard logic and rules. This On-Budget metric can be used to evaluate individual projects, the entirety of VDOT's program, and most desired subcategories in-between.

Parametric Estimate – A method of estimating that uses an algorithm to calculate probable cost of construction, based upon historical data and predefined project parameters. Parametric estimating tools are often used for Preliminary Estimates. PCES - Workbook is an example of a parametric estimating tool.

Precision – The degree to which estimates are expected to be close to each other. Precision answers the questions of do repeatable estimating processes and tools produce similar results; while accuracy measures the level of correctness as previously defined.

Preliminary Engineering (PE) Phase – The Preliminary Engineering (PE) Phase encompasses the location, design, and related work to prepare and advance the project to construction. PE includes, but is not limited to, administrative tasks, project management, all field investigations, and all engineering discipline specific tasks that support or advance project design and preparation of Plans, Specifications, and Estimates (PSE).

Preliminary Estimate (or Planning Estimate) – A preliminary estimate is the probable project cost estimate prepared during the early stages of project development when quantities are not yet known. Various parametric tools are typically used to develop preliminary estimates that provide an order of a magnitude for project and program planning. Preliminary estimates are based on relatively little information and are inherently less accurate than estimates developed later in the project development process. The preliminary estimate is the least accurate estimate and the Engineer's Evaluate Estimate is the most accurate estimate. All preliminary estimates must be uploaded and recommended into PCES - System. The first preliminary estimate should be uploaded and recommended into PCES - System when the UPC is created so that the estimate will be included in an update to the SYIP. Preliminary estimates may establish the project Baseline Estimate on 603 construction funding sources as outlined in IIM-LD-260/IIM-IID-11, including SMART SCALE, State of Good Repair, interstate, and safety program funded projects.

Professional Judgement – Professional judgement is applying one's knowledge, skills, and experience through the lens of industry standards and best practices to develop an expert opinion or make a decision regarding an engineering situation where there is room for subjective thought.

Project Complexity Classification – A project classification system VDOT has developed for the purposes of establishing risks and setting contingencies. With this system, a project has three possible classifications: Non-Complex, Moderately Complex, and Most Complex. This classification system is also used to establish CEPs (estimate documentation requirements). Chapter 5 has detailed information on this classification system.

Project Cost – the Project Cost is the total cost required to procure or produce all the needed materials, products, resources, and services to successfully develop and deliver the project as designed. This includes all costs for all three project phases: PE, RW, and CN.

Project Cost Estimate Package – A package that contains the details of the Basis of Estimate among other information detailed in Chapter 6. This includes assumptions and notes sufficient for an independent reviewer to understand the overall project estimate. This package must be updated with each milestone estimate prepared during the project development process. All files are to be appropriately stored in Project Wise or the current VDOT document management software. For Funding Application estimates, the CEP is to be uploaded and stored in Smart Portal.

Project Closeout – Project closeout is the process of closing and archiving of phases and projects in all VDOT project management and financial systems including, but not limited to, FHWA Fiscal Management Information System (FMIS), CARDINAL, Project Pool and the Project Closeout Application.

Railroad Coordination Costs – Railroad Coordination Costs are a specific cost item in an Estimate to account for railroad coordination and flagging. For VDOT administered projects, these costs are established through coordination with the Rail Program Area in the RW and Utilities Division and per the VDOT Rail Manual of Instructions.

Right of Way (RW) Phase – The RW Phase encompasses securing of all rights-of-way and easements required to complete the project and clearing the project site from all utility conflicts so construction may commence. RW includes, but not limited to, administrative tasks, appraisals, negotiations, acquisitions, relocations, and utility relocations.

Risk – An identified uncertain event or condition that if it is realized, could have a positive or negative effect on the project's objectives. All significant scope assumptions should be included in the risk register. Negative risks that could adversely impact a project are threats, while positive risks that could benefit the project are opportunities. Risks should be accounted for in contingencies. One example on a widening project is whether noise abatement will be required, or a cell tower will need to be relocated. *See Figure I-1a and I-1b: Defined Cost, Allowance, Risk & Contingency.*

Risk-Based Estimating – A methodology that adjusts the Base Estimate to account for project specific risks to produce a more informed probable cost estimate. VDOT has adopted the American Association of State Highway Transportation Officials (AASHTO) Risk-Based estimate process (as described in detail in Chapter 5).

Risk Matrix – A risk matrix is a chart used to qualitatively analyze individual risks by rating the risk's probability against its impact.

Risk Register – A dynamic tool used by Project Managers and project teams to actively track and monitor project risks throughout the life of the project.

Rough Order of Magnitude – A Rough Order of Magnitude (ROM) is an estimation of a project's level of effort and cost to complete. This estimate is prepared when most information is not yet known and provides a scale of cost for the project. Typically, a ROM is based on experience, costs of similar projects, and professional judgement.

Scope Creep – Changes or modifications that expand a project scope that have not gone through approved changed management procedures. This uncontrolled scope expansion can quickly jeopardize the project schedule and budget.

Scoping – Scoping is both a PDP phase and the PWA Project Task 22. Scoping is complete when the PM-100 form is completed and approved. At this time, the project's risks should have been qualitatively identified, and then quantitatively converted to time and money. Completion of Task 22 establishes the project management's triple constraint of budget, scope, and schedule. This includes the project's schedule and estimate baselines, which are that by which the project's future performance is measured against in Department metrics.

State Police Costs – State Police costs are a specific cost item in an estimate to account for the cost of State Police services not directly borne by the contractor as part of their bid item costs. These costs are excluded from the bid item estimate; however, they should be included in the CN Phase estimate.

State Force Costs – State force costs are a specific cost item in an estimate to account for the cost of state force services not directly borne by the contractor as part of their bid item costs. These costs are excluded from the bid item estimate; however, they should be included in the CN Phase estimate.

VDOT Administered Project – A VDOT administered project is a project whose phases (PE, RW, and/or CN) is administered by VDOT.

VDOT Oversight Costs – VDOT oversight costs are required for VDOT oversight of LAPs as outlined in the Locally Administered Project Manual.

Table A-1: Abbreviations and Acronyms

Abbreviations & Acronyms	Definition
ADA	Assistant District Administrator
APD	Alternative Project Delivery Division
CEI	Construction Engineering and Inspection
CEP	Project Cost Estimate Package
CFS	Cost Finance Summary
CN	Construction Phase
CTB	Commonwealth Transportation Board
DB	Design-Build
DRPT	Virginia Department of Rail and Public Transportation
ECI	Environmental Compliance Inspector
EE	Engineer's Evaluative Estimate
FHWA	Federal Highway Administration
FI	Field Inspection milestone
GIS	Geographic Information System
IID	Infrastructure Investment Division
LAP	Locally Administered Project
L&D	Location and Design
MLE	Most Likely Estimate (in risk-based contingency estimating)
MOT	Maintenance of Traffic
MPO	Metropolitan Planning Organization
PAC	Pre-Advertisement Conference
PCES	Project Cost Estimating System
PDP	Project Development Process
PE	Preliminary Engineering Phase
PFI	Preliminary Field Inspection
PH	Public Hearing
PS&E	Plans, Specifications and Estimate
RFP	Request for Proposals
RFQ	Request for Qualifications
RW	Right of Way
RW	Right of Way Phase
S&B	Structure and Bridge
SGR	State of Good Repair
SPLCE	Statewide Planning Level Cost Estimate
SUE	Subsurface Utility Engineering
SUP	Shared Use Path
SYIP	Six-Year Improvement Program

Abbreviations & Acronyms	Definition
TIP	Transportation Improvement Program
TMPD	Transportation and Mobility Planning Division
VDOT	Virginia Department of Transportation

Appendix B

Estimate Checklist

Appendix B – Estimate Checklist

A comprehensive Estimate Checklist is currently under development. The Estimate Checklist will be an excel based tool (to be filtered by specific project components) to be utilized by the estimator(s) and the Project Manager to ensure that the estimate includes key components and factors of the estimate.

A checklist for preliminary (conceptual level) estimates has been developed by Culpeper District and can be found on the following pages.

Link to the Concept Checklist (Internal Link)

CONCEPT ESTIMATE REVIEW CHECKLIST

Culpeper District

PROJECT INFORMATION		
Enter project description		✓-it appears to the reviewer that item is included
County		**✗**- item does not appear correct in estimate- revise estimate or document in the Design Assumptions
Estimate by		N/A- it is obvious that this item does not apply (or else documentation is included in the Design Assumptions)
Review by		
Date		

PRELIMINARY ENGINEERING ESTIMATE

✓ or ✗	PE ESTIMATE ITEMS	Notes
	A.1	Project length is not too short for estimates based on mile/feet norms (should be >2000' with Culpeper PE tool)	
	A.2	PE estimates account for consultant vs. VDOT staff work for major items and assumption is documented	
	A.3	Estimate includes all aspects of engineering design (roadway, drainage, SWM, TCD, MOT, E&S)	
	A.4	Reasonable design complexity and manhour rates selected when using the Culpeper PE tool	
	A.5	Specialty design disciplines are included (lighting, signals, water/sewer utilities, landscaping, noise/retaining wall, bridges)	
	A.6	Preliminary engineering costs for railroad coordination included	
	A.7	Nutrient credits included as recommended by the Hydraulics Engineer	
	A.8	Survey costs included and approved by District Survey Manager (photogrammetry/utilities/processing/RW plans/test holes/etc)	
	A.9	All Environmental costs are included (NEPA document, stream/wetland mitigation, CR studies, noise studies, hazmat, etc)	
	A.10	Detailed Environmental estimate provided if costs > $50,000, and is included with the supporting estimate files	
	A.11	Costs included for soils investigation and geotechnical testing and design	
	A.12	Costs included for projects with exceptional public outreach (paid advertising or many meetings/workshops)	
	A.13	Traffic studies are included (signal warrants, IJR/IMR, intersection analysis, etc) or already finished (most new projects)	
	A.14	VDOT review and coordination is fully accounted for (project management, section and C.O. reviews, contract dev., etc)	
	A.15	Contingency and inflation for PE is appropriately considered and documented (inflation not needed for Smart Scale)	
	Note		
	Note		

RIGHT OF WAY ESTIMATE

✓ or ✗	PROPERTY ACQUISITION ITEMS	Notes
	B.1	RW Estimate documentation is provided (preferably from VDOT RW/Utilities via PCES or other document)	
	B.2	RW Estimate includes all items: damages, condemnation, administrative costs, areas for fee R/W, perm. & temp. easements	
	B.3	Donated R/W includes administrative costs and the accepted risk is documented and communicated.	
	B.4	Residential and business relocations are included in the estimate as needed.	
	B.5	Contingency and inflation for RW is appropriately considered and documented (inflation not needed for Smart Scale)	
	Note		
	Note		

✓ or ✗	OUT-OF-PLAN UTILITY ITEMS	Notes
	C.1	All out-of-plan utility impacts included in estimate, to a conservative degree unless otherwise documented	
	C.2	Assumed narrowly avoided high cost utilities are documented and possible avoidance mitigation options listed for worst case	
	C.3	Utility estimate includes inspection and administrative costs	
	C.4	Contingency and inflation for utilities is appropriately considered and documented (inflation not needed for Smart Scale)	
	Note		
	Note		

CONSTRUCTION ESTIMATE

✓ or ✗	GRADING ITEMS	Notes
	D.1	Is clearing/grubbing included?	
	D.2	Is regular excavation/borrow included?	
	D.3	Is adjustment made for possible rock excavation?	

|			
	D.4	Is contingency made for unsuitable excavation?	
	D.5	If slopes steeper than 2:1 are assumed, is slope stabilization accounted for in accordance with material recommendations?	
	Note		
	Note		
✓ or ✗	**DRAINAGE ITEMS**		**Notes**
	E.1	Is a drainage estimate provided by the Hydraulics Engineer and saved with the supporting estimate files?	
	E.2	Does the drainage estimate include closed drainage, driveway culverts, inlets, underdrain, etc?	
	E.3	Are stormwater management facilities accounted for?	
	E.4	Is construction and/or removal of large drainage structures accounted for?	
	E.5	Have nutrient credits been removed from the drainage estimate and included in PE?	
	E.6	Does the drainage estimate account for atypical design such as shoulder gutter or tilted plane roundabout slot drains?	
	E.7	Are erosion & sediment control measures accounted for?	
	Note		
	Note		
✓ or ✗	**PAVEMENT ITEMS**		**Notes**
	F.1	Does pavement width account for shoulders, bike lanes, turn lanes, intersection radii, asphalt under MS-1, etc?	
	F.2	Does pavement length accommodate superelevation & grade transitions?	
	F.3	Are commercial entrances and parking lot reconstruction/replacement/relocation accounted for?	
	F.4	Are private entrance impacts accounted for?	
	F.5	Are overlay sections accounted for with milling and paving? Does overlay depth account for cross slope correction?	
	F.6	Is demolition of pavement accounted for, including entrances, connections, and parking areas?	
	F.7	Is the road realigned? Is obscuring roadway needed?	
	F.8	Is significant saw-cut expected and accounted for (especially for widening jobs)?	
	F.9	Does the estimate use the pavement design provided by the Materials Engineer? Is the pavement section reasonable?	
	F.10	Are the material weights used for estimating reasonable?	
	F.11	Does the aggregate quantity include base under curb & gutter, entrance aprons, etc?	
	F.12	Is inside and outside truck apron included as needed (primarily roundabouts)?	
	F.13	Is shared-use path or separated bike lanes included in asphalt calculations?	
	F.14	Are rumble strips being replaced or newly installed?	
	Note		
	Note		
✓ or ✗	**ROADWAY INCIDENTAL ITEMS**		**Notes**
	G.1	Are concrete items such as curbing, gutter, medians, sign islands, entrance aprons, etc included?	
	G.2	Is asphalt curbing included on shoulder fill sections where recommended by hydraulics?	
	G.3	Is shoulder gutter included for bifurcated arterial highway medians if need is likely? (RCUT projects especially)	
	G.4	Is sidewalk accounted for in sufficient extent as shown on the drawing?	
	G.5	Is estimate sufficient to upgrade all curb cuts within the project limits per ADA and DOJ requirements?	
	G.6	Are stairs and handrails included where necessary and logical?	
	G.7	Is sufficient handrail included to protect users from dropoff and slope hazards? Is the correct type (HR-2 vs. 3) counted?	
	G.8	Is impacted private sidewalk and steps replaced and connected to proposed facilities?	
	G.11	Is guardrail or barrier included where it appears to be warranted? Is impacted guardrail removal and replacement included?	
	G.12	Do barrier costs include terminals, fixed object attachments, powder coating, etc, as needed?	
	G.13	Is median barrier included where appropriate?	
	G.14	Is removal of other significant items such as guardrail, large structures, etc, included?	
	G.15	Is fencing included where private fence impacts are significant? Does cost account for bracing/gates/board fence?	
	G.16	Is fencing included for SWM basins (per ponded depth), or for limited access lines?	
	G.17	In residential areas with a high number of mailboxes, has their relocation been accounted for?	
	G.18	Are building demolitions included in the estimate? Parcel clearing? Removal of tanks, major signs, etc? Well closings?	
	G.19	Are amenities included as needed for park & ride and streetscape projects? (shelters, charging, trashcans, bike racks, furniture)	
	Note		
	Note		
✓ or ✗	**STRUCTURE & BRIDGE ITEMS**		**Notes**

✓ or X			Notes
	H.1	Is retaining wall included as a mitigation option for constrained areas? Is an appropriate type used in the estimate?	
	H.2	Are all components of retaining wall work (concrete, excavation, backfill, handrail, guardrail) included in the estimate?	
	H.3	Is the bridge estimate provided by the Bridge Engineer and saved with the supporting estimate files?	
	H.4	Are temporary bridges and structures accounted for?	
	H.5	Is removal of existing structures accounted for?	
	H.6	Does bridge estimate include MOT, temporary paving & grading? Has any overlap with the road estimate been subtracted out?	
	Note		
	Note		
✓ or X	**TEMPORARY TRAFFIC & CONSTRUCTION ITEMS**		**Notes**
	I.1	Does the estimate appear sufficient to accommodate Maintenance of Traffic (% or other method)? Review on large projects.	
	I.2	Is the MOT estimated adjusted downward for significant work (such as bridges) out of traffic?	
	I.3	Are temporary signals or temporary signal modifications included in the estimate?	
	I.4	Is field office accounted for?	
	I.5	If the project has signal work, nightwork, or interstate work, is police included?	
	I.6	Are additional safety items included as needed, such as temporary barrier, attenuators, or sheet piling?	
	I.7	If a temporary diversion is needed, is temporary pavement and grading added?	
	I.8	Can roundabout truck aprons be built out of traffic? If not, is the diversion accounted for in the estimate?	
	Note		
	Note		
✓ or X	**PLANTING ITEMS**		**Notes**
	J.1	Is roadside development (seeding) included in the estimate?	
	J.2	Does the estimate include measures to protect slopes and promote turf establishment (topsoil, temporary seed, etc)?	
	J.3	Is landscaping considered in the estimate? Consider roundabouts and sensitive urban areas.	
	Note		
	Note		
✓ or X	**PERMANENT TRAFFIC CONTROL DEVICE ITEMS**		**Notes**
	K.1	Is signing accounted for, including new, removed, and modified overhead structures?	
	K.2	For smaller projects with overhead sign impacts or work, has the scope been reviewed with TE and documented?	
	K.3	Are pavement markings accounted for, and not just line markings if symbol markings, gores, etc are needed?	
	K.4	Are special treatments for bicycle facilities included? (green pavement, flexible posts, etc)	
	K.5	Are proposed signals included in the estimate? Are existing signal removals/modifications included?	
	K.6	Are signal modifications included as needed for bicycle and pedestrian facilities? Are APD/APS upgrades included?	
	K.7	Is the signal estimate provided by the Traffic Engineer and saved with the supporting estimate files?	
	K.8	Is roundabout lighting included and in-line with recent projects?	
	K.9	Is lighting included for medium and high density park & ride lots?	
	K.10	Is lighting included at other locations recommended by Traffic Engineering (interchanges, etc)?	
	K.11	Have impacts to traffic cameras and other ITS infrastructure been accounted for?	
	Note		
	Note		
✓ or X	**IN-PLAN UTILITY ITEMS**		**Notes**
	L.1	Is the water utility estimate provided by the Utilities Coordinator and saved with the supporting estimate files?	
	L.2	Is the sanitary sewer utility estimate provided by the Utilities Coordinator and saved with the supporting estimate files?	
	Note		
	Note		
✓ or X	**ENVIRONMENTAL MITIGATION CONSTRUCTION ITEMS**		**Notes**
	M.1	Are noise walls included in the estimate as coordinated with the Environmental section?	
	M.2	Have underground tank removals and possible contaminated soil remediation been accounted for?	
	M.3	Have on-site stream and wetland remediation/mitigation been included when indicated by the Environmental section?	
	M.4	Have specialty Environmental estimates been saved with the supporting estimate files, and not double counted with PE?	
	Note		
	Note		
✓ or X	**NON-BID INCIDENTAL ITEMS**		**Notes**

N.1	Is the railroad construction estimate provided by the Railroad Coordinator and saved with the supporting estimate files?	
N.2	Are RW Monuments considered on projects where they may be non-negligible?	
Note		
Note		

✓ or ✗	CONTRACT OVERHEAD AND ADDITIVES	Notes
O.1	Is mobilization and construction surveying included?	
O.2	Has design contingency been added by work category, appearing reasonable based on level of risk and level of development?	
O.3	Is design contingency within the suggested contingencies or otherwise documented?	
O.4	Is CEI included and sufficient for the project size (typically 20% if <$20M)? Has Construction reviewed very large projects?	
O.5	Have some incentives been included, and has construction reviewed very large projects or projects with major impacts?	
O.6	Has a minimum 5 to 10% contract contingency for claims and work orders been included over all bid items?	
O.7	Have all non-bid items been properly added and excluded from mobilization, CEI, contract contingency calculations?	
O.8	Has sufficient inflation been included for projects not applied for via the Portal (not needed for Smart Scale)?	
O.9	Is the final estimate in the format prescribed by Central Office L&D?	
Note		
Note		
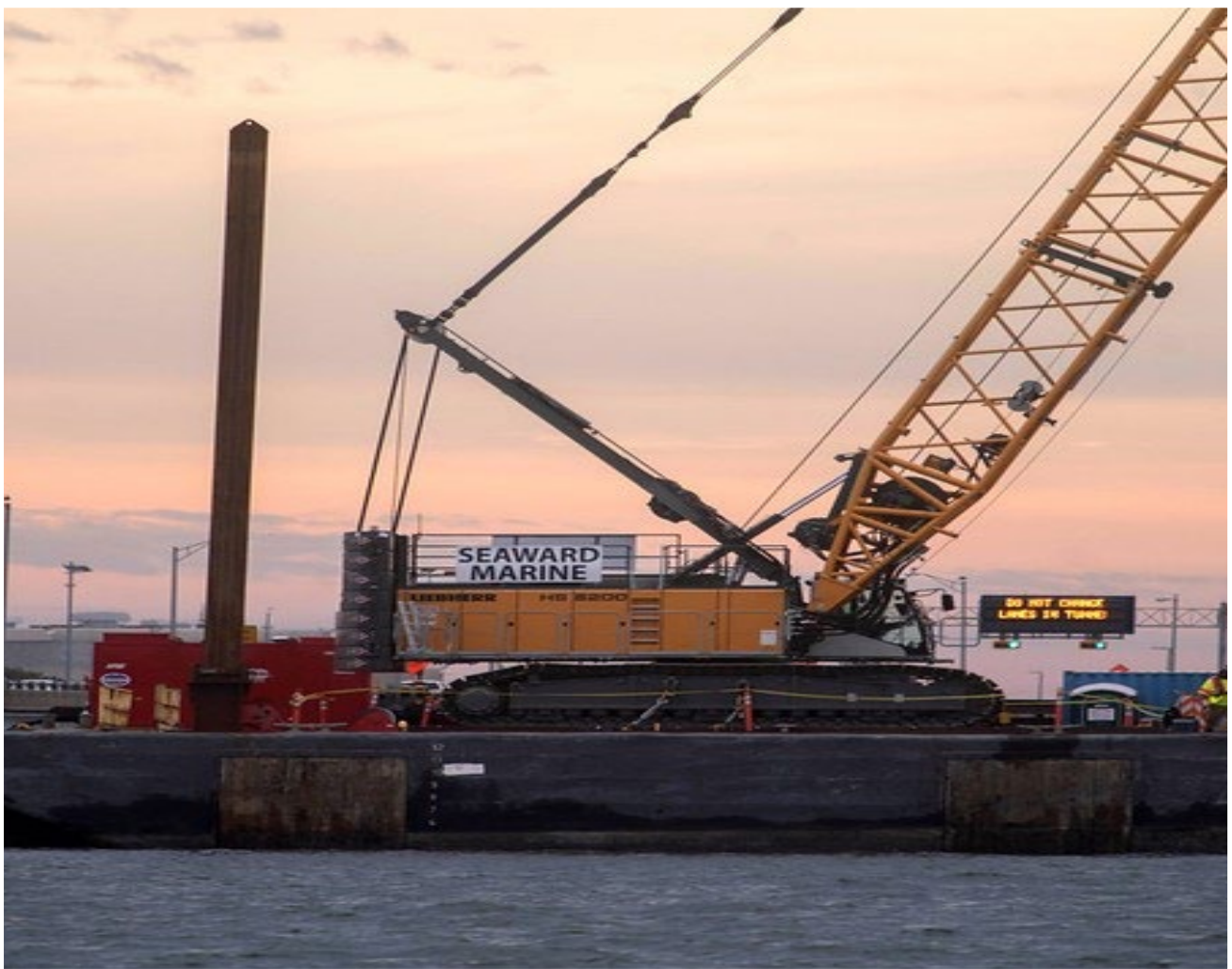
Appendix C

Use of Bid Tab Tools

Appendix C – Use of Bid Tab Tools

Tools for Bid Tab research

In [Chapter 4](#), we discussed researching Bid Tabs and some best practices when doing so. One could use the text files published on the VDOT website, but this would be time consuming and you would need to open multiple files to cover just a short period of time, as these are separated into individual months (per letting). There are software other tools available internally to research Bid Tabs to helps users develop unit costs (Although AASHTOWare Project Preconstruction does provide unit costs for bid items, it does not directly provide the ability for users to research raw bid tabs):

1. [Bid Express](#)

2. VDOT Statewide Bid Tab Query (formerly Staunton Bid Tabs).

   - [For Users on The Internal VDOT Network](#)

3. AASHTOWare Project Preconstruction:

   - [For Internal VDOT Users](#)

   - [For Consultants and External Users:](#)

Bid Express Overview and Guide

Bid Express is a proprietary software product that is used for a variety of functions. Its primary function in this case is to receive contractor bids electronically. Therefore, it is the primary recipient of the Bid Tabs, thus the "Bid Tabs". Users will need a login to access the site, which may require a paid subscription. Once in the Bid Express web application, go to the "Bid Tab Analysis" tab. (See *Figure C-1*). There are options available to export results to CSV or Tab separated text files, which can be exported into Excel, or other software for additional analysis.

Figure C-1:
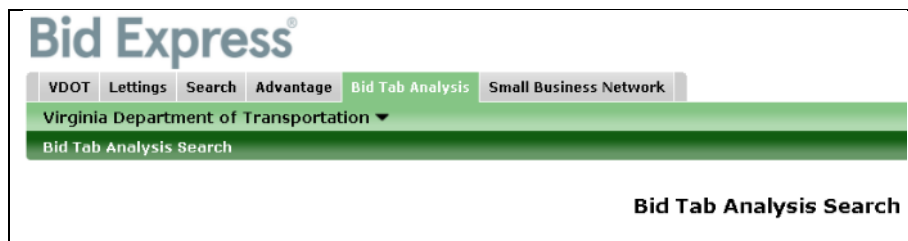
Searching for a specific Item code.

Figure C-2 below, illustrates how to search   for a specific item code; in this case item 60409, CONC. CLASS A4 MOD. LOW SHRINKAGE.

Figure C-2:

You can expand the results display by clicking on the plus sign (+) next to the item number, revealing the entries that make up the 132 bids listed under bid count, as illustrated in *Figure C-3* below.

Figure C-3:

In the case of item codes less than 5 digits, leading zeroes are required. For example, if searching for item code 120, REGULAR EXCAVATION, you would need to use 00120. If you enter 120, then you would get item codes that start with 120. That is, the results would be 120x or 120xx.

Figure C-4:

Figure C-4 demonstrates a set of results using 120 as a search criterion. The results are grouped by item code, which can be expanded by clicking on the Plus (+) next to each item code. "At a glance" statistics are available for each group, including Average, minimum and maximum bids, and number of bids.

The results for a specific item code, which are made visible by expanding a section by clicking on the plus sign (+). Once expanded, all results are displayed. You can also expand what information is displayed by clicking on the total number of bids. In *Figure C-2*, If you click on "132 Bids", you will get a listing of all results, in a refreshed window. If you click on any of the numbers below that, which are individual contracts, you will see that list of bidders. *Figure C-5* illustrates several contracts displayed by expanding all results. All bidders are listed on the right-hand side. These can be toggled on and off from the results list via the check boxes next to their names.

Figure C-5:
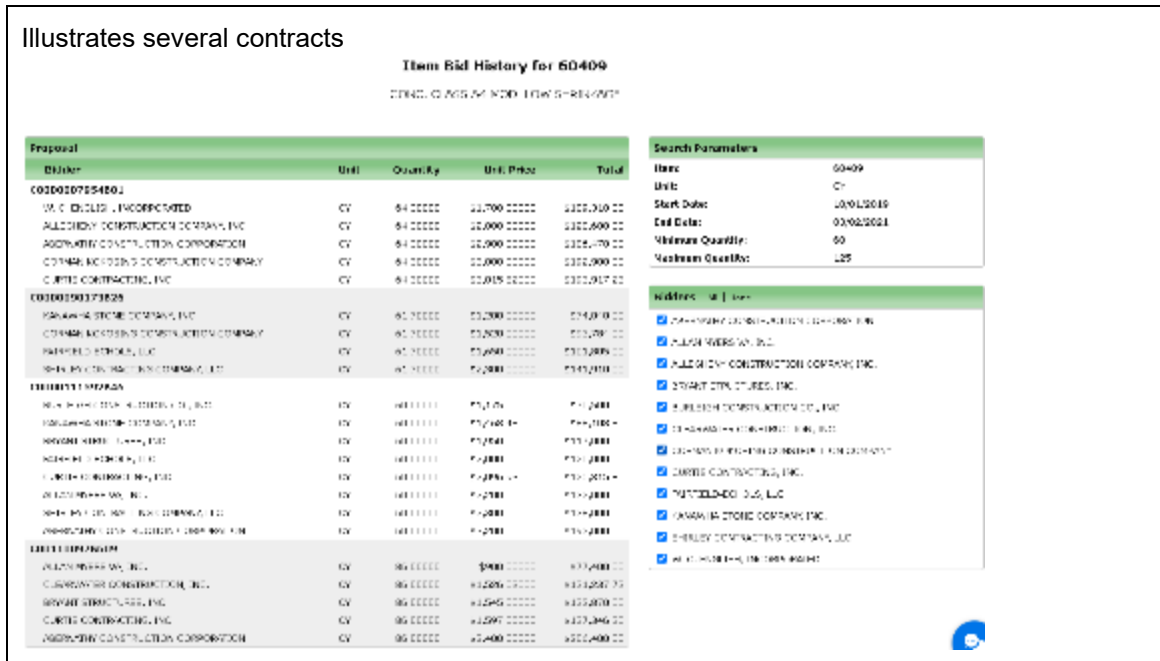
Illustrates several contracts

A set of results using 120 as a search criterion. The results are grouped by item code, which can be expanded.

You can also view the entire proposal, and all bids by clicking on the order number-Contract ID. *Figure C-6* below illustrates a portion of a contract viewed by clicking on a specific Contract ID.

Figure C-6:

If you click on the date next to any of the entries in the original list of expanded results, the results window will display the lettings that contain that bid item on that date, as shown in *Figure*

C-7. As shown in *Figure C-6*, you can display specific contract information by clicking on the Proposal or contract ID number in the left-hand column.

Figure C-7:

Searching for an Item Description

Bid Tabs may also be searched by item description. The results are grouped by item number, if the text entered is general enough to produce more than one item numbers. *Figure C-8* shows a search for the Term "guardrail", also during a specific date range. This produced 10 different item numbers. As previously discussed, those can be expanded for further investigation.

Figure C-8:

Query by Ranges

This system allows you to query by several different types of ranges (Figure C-.9):

Figure C-9:

Some of the ranges available are:

- Date range

- This is the range of dates for lettings. When you open the page, it defaults to a specific range, of approximately 3 months with the ending date being the current date. If you wish to widen the date range, you will need to change the beginning date.

- Quantity Range

- You can narrow down the range of quantities to zero in on prices more compatible with the quantity be researched.

- Price Range

- This is the range of unit prices of the bid items, not the contracts being queried. This means if you are querying by item description, here you may have multiple item codes in the results list. Some of these may not closely align, and some may have different units of measure. Care should be taken when looking strictly at unit prices, without closely reviewing the units of measure and descriptions.

Query by County

You can search by a county or a portion of that name. For instance, if you enter "CHA", you could get "CHArlotte" County, or "BuCHAnan" County, or "CHArles City" County. Figure C-10 demonstrates how this criterion is entered.

Figure C-10:

Query by Units

You can search by units to help narrow down search results. For example, in Section **Searching for an Item Description**, we searched for the item description "Guardrail" that returned 10 item codes. This had a mixture of LF and EA as units of measure. You could add one of these as a search criterion to further refine the results. Some available units of measure are the following:

- LF: Linear Feet

- IN: Inches

- MI: Miles

- SF: Square Feet

- SY: Square Yard

- ACRE: Acres

- CF: Cubic Feet

- CY: Cubic Yard

- GAL: Gallons

- TON: Tons

- LB: Pounds

- EA: Each

- LS: Lump Sum

- HR: Hours

- DAY: Days

- MO: Months

- UNIT: Units

- MFBM: Multiple of the foot, board measure

VDOT Statewide Bid Tab Query (*Formerly Staunton Bid Tabs*) **Overview and Guide**

This application was developed by VDOT to provide an analysis tool for Bid Tabs, which did not exist at the time of its inception. It is powered by Bid Tabs supplied by Central Office Construction Division monthly. It offers a variety of searching criteria, and statistical analysis for queries and scatter plotting of results. It includes the capability of inflation adjusting past entries per the HCCI inflation index. Results from the system can be copied and pasted into to other applications (Word, Excel, etc.) for additional analysis. All functionality, including hyperlinks will transfer with this operation.

To give an overview of the functionality of the VDOT Statewide Bid Tab Query (formerly Staunton Bid Tabs) system, and how it can be used, we will now walk through some examples.

Searching for a specific Item code

In *Figure C-11* below, you can see that we searched for Item code 21020, MEDIAN STRIP MS-1, in Richmond (4) District. You can see that the search resulted in 17 records, and the DB is current to the 2/24/2021 letting. You can click on the Item code (leftmost column) for regression model pricing, or the Contract ID (rightmost column), for the entire contract, with all bid items, and all 3 low bids (See *Figure C-12*).

Figure C-11:

If you scroll to the bottom of the page, there will be some additional statistics.

Figure C-12:

These are only visible if the item codes and units of measure are consistent for all results. *Figure C-13* shows these figures and calculations.

Figure C-13:
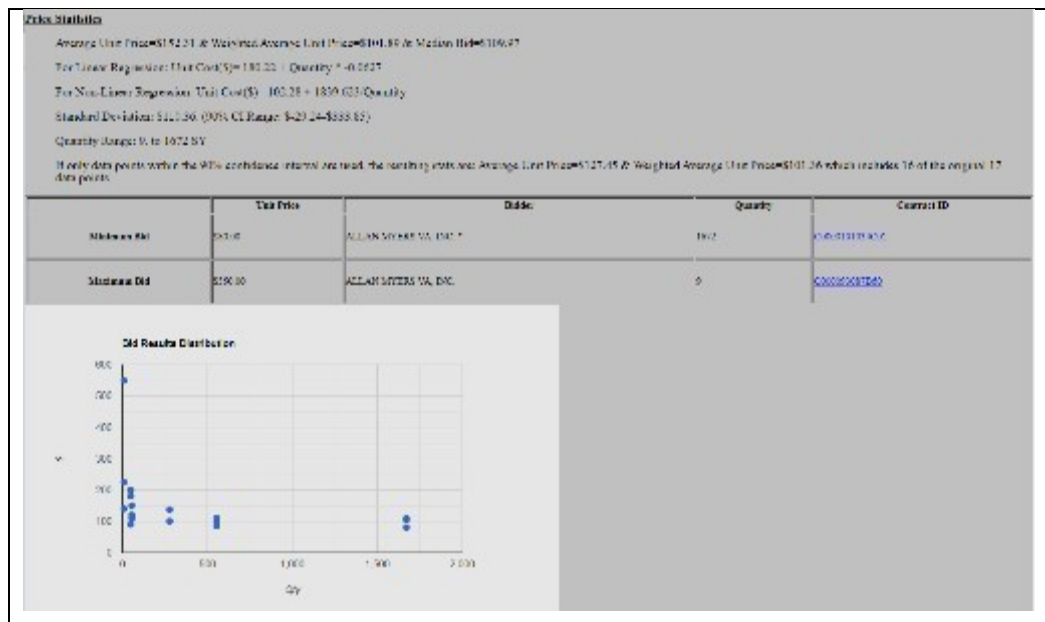
The statistics developed are:

- Average, weighted average, and Median Bid

- Development of both Linear and Non-Linear Regression equations, standard deviation and the results within the 90% confidence Interval

- Quantity Range

- Adjusted average, weighted average, for 90% confidence interval

- If inflation is applied, the average, weighted average, and regression models for those are also calculated.

Searching for an Item Description

In the next example, we will be using wildcards to choose a nonstandard item. You can use the "Item Description" Field and wildcards to search for a specific. Item description. For instance, you can enter %TYPE B PATCHING (VES)% to return all items with this string in the Item descriptions. The item codes may be different. If that is the case, there will be no statistical analysis at the end of the results table. *Figure C-14* below shows this sample query. To generate statistics, simply add the item code of choice.

Figure C-14:

Query by Ranges

This system allows you to query by several different types of ranges (*Figure C-15*):

Figure C-15:

- Quantity ranges for a specific Item code

  - Helpful to zero in on a specific range of quantities to obtain prices that are more aligned with the quantity being researched.

- Contract let between 2 specific Dates

  - Can help the user find a specific contract, if the contract ID or order number, or a portion thereof are not known. It may also be used to limit results to more recent results. For instance, if a user searched on Jan 1,2021 and used the date range of 7/1/2020 to 2/1/2021, then the results would basically be 6 months, since no "future" bids could be retrieved.

- Contract Totals between dollar ranges

  - Sometimes, there is an interest in narrowing down the results to contracts of a similar size. For instance, very small contracts often have larger unit costs, than extremely large contracts even if the quantities are of similar values. The contract value referenced is that of the low bidder.

By searching between these ranges (each by themselves, or in combination with other fields) the user can develop more pertinent results for their use.

Query using Wildcards

For text fields, users can query for results using wildcards to help by searching for a portion of the intended results. For the fields of:

- Order Number
- Bidder
- Vendor Number
- Item Description
- Contract ID
- Contract Description
- Project Number

For example, if you knew the UPC number of a project, you could bracket that with the "%" wildcard in the Contract ID field to find that project, as the UPC is often a portion of the contract ID. For Example, in *Figure C-16*, we searched for %97111%, which returned Contract ID C0000097111B621, and any results associated with any other criteria that may have been used (e.g. item code, item descriptions, etc.).

Figure C-16:

You can also use the "_" character as a wildcard to represent a single character, where the "%" character represents any number of characters. For instance, using A_3 in the Order Number Field will yield any Order number beginning with A and ending in 3 (e.g., A13, A23, A33…A93). Whereas, using A% will result in any Order number beginning with "A". (A01, A02, A03…A99).

Additional Functionality

Beyond being able to Query Bid Tabs, the VDOT Statewide Bid Tab Query (formerly Staunton Bid Tabs) has additional functionality to enhance queries, or fine tune results to the user's requirements.

- Applying Inflation: As discussed in Section **Query using Wildcards**, applying an historic inflation rate to older bids is essential to producing meaningful results, especially when blending older and newer bids for statistical analysis. By clicking the "Apply Inflation" checkbox applies the HCCI inflation index to any older bids to convert them to present day dollars. *Figure C-17* shows the "Apply Inflation" Checkbox "checked".

Figure C-17:

- Selecting Low Bidders only: This selection, available under the "Custom Additions" dropdown box allows only the successful low bidders to be displayed. Since this is an "Addition", it can only be used in conjunction with other search criteria (e.g., a specific item code, or an item code description, etc.). *Figure C-17* shows this option selected from the dropdown box.

- Exclude High and Low Bids from Stats: This checkbox will eliminate the highest and lowest from being used in the calculations of the statistics. *Figure C-17* shows the "Exclude High & Low Bids from Stats" Checkbox "checked".

- Bid Tabs Searched: This dropdown allows the user to select the database from which results will be queried. "Current" is the dataset encompassing no more than 3 years. At the point in which it hits 3 years of data, the oldest year is archived into its own separate database file. This is done as the current file is used for preliminary cost estimating, and the development of regression models that powers the Staunton Estimating Tool/Spreadsheet (Downloadable Here, Item #7). This keeps the data current and regression models more accurate. The user can search all archived Bid Tabs at one time by selecting the "All" option in the "Bid Tabs Searched" dropdown box. This includes all Bid Tabs dating back to 1998. *Figure C-18* illustrates these options.

Figure C-18:

- Any work followed by a magnifying glass icon (🔍) opens additional apps to search item codes, bidders, Vendor Numbers, Item Descriptions, Contract IDs, Contract Descriptions, or Project Numbers contained int eh "Current" Database.

AASHTOWare Project Preconstruction Overview and Guide

This application is an AASHTOWare product. It is used primarily for the development of preliminary engineering estimates throughout the project development process, up to and including the PAC Phase, just prior to project advertisement. This application requires an approved logon, requested through SARA.

There is an extensive manual for the use of Preconstruction. To give a brief overview of some of the functionality of the Preconstruction Application, and how it can be used. Links to the Preconstruction manual are available in Chapter 4 of this manual. We will now walk through some examples, to demonstrate some of the functionality of Preconstruction.

Searching for a specific Item.

Once an estimate is set up and you are importing bid items, often you will need to search for an item. This can be by item code, or item description. Once an item has been added, and a category selected, you can search for the correct item by item description. In the example in *Figure C-19*, the category of "0100 – BRIDGE ITEMS" was selected, and when a portion of the item description was entered, the corresponding items that contain a portion of that description begin to populate. As you can see in *Figure C-19*, for this category, the string "concrete" yields 153 results.

Figure C-19:
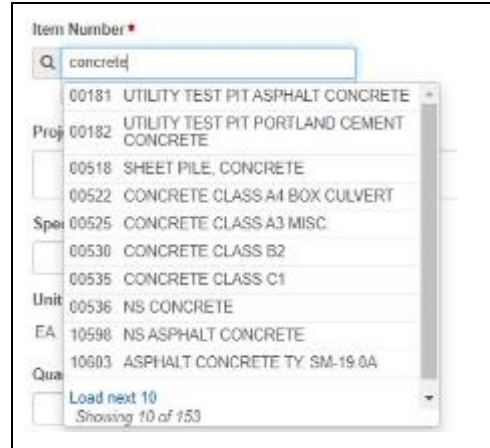
You could also directly enter the item code, which would populate the item description as well, as demonstrated in *Figure C-20*.

Figure C-20:
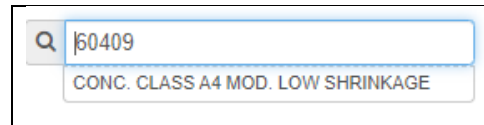
In the case of non-standard items, those have a portion of the item description populated, then supplemental description would be needed. IN Figure C-21, Item 68900, the non-standard item NS REM. PORT of EX. STR is selected. This usually is followed by the Virginia Structure Number, or "NO. XXXX".

Figure C-21:
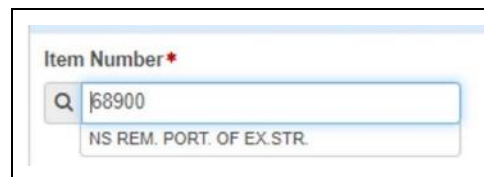
This text, or any other additional description for non-standard items goes into the "Project Item Supp. Description", as shown in Figure C-22. Non-standard items are generally easily identifiable, as they begin with "NS".

Figure C-22:

Pricing Items

Once an estimate has been populated with all intended items and quantities, they need to have unit prices assigned to them to generate a total cost for each item, and thereby the cost for the project. Before pricing the items, it is important to discuss the "Price Lock Flag" *(See Figure C-23)*. This should not be checked except for non-standard items, or unit costs for which you have overridden the initial Preconstruction unit price.

Figure C-23:

To begin with Item pricing, go to the top of the page (See Figure C-24) and click "Item Pricing".

Figure C-24:

In order to price an item, they must be "unlocked". You can tell if an item is locked or unlocked by looking at the padlock icon to the right of the estimated price. If it is closed, as shown for item 60409-CONC. CLASS A$ MOD LOW SHRINKAGE in Figure C-25, then the Est. Price is grayed out. If it is open, as shown for Item 60490, BRIDGE DECK GROOVING, then when the pricing routine is run, the price will be updated. You can lock and unlock prices as needed, by clicking on the pad lock icon. Once you have run the pricing routine, a new total will be displayed in the upper left-hand corner of the page.

Figure C-25:

Pricing Methodology

AASHTOWare Project Preconstruction comes with the pricing models incorporated into it based on VDOT Bid Tabs. The rules for creating those models are:

1. Top 3 bidders

2. Most recent 24 months of data. Only those with 30 data points over 24 months will be used.

3. Pricing contingent on district.

4. Remove 10% outliers

5. A minimum of 20 data points required for some models.

6. Exclude regression models where the cost increases as the quantity increases. (refer to section **Searching for an Item Description**)

7. There are additional statistical checks that are applied but are beyond the scope of this document.

The pricing models are generated based on a linear regression model. As discussed in Chapter 4, this type of model is susceptible to issues if the quantities are extrapolated beyond the range of quantities used to generate the regression model. Preconstruction will notify the user if their quantity is outside of the range used to develop the regression model, so that they can research prices elsewhere. Section 7 of the Preconstruction Manual gives guidance on this.

Preconstruction can also use counties within districts to assign prices. This will be noted once a price is assigned.

Users can view scatter plots of the data used to generate the regression model. This can be accomplished by the following steps, inside an open project:

8. Select item pricing link

9. Expand the category you wish to view

10. Select the "RW Action Button" (See Figure C-26)

11. Select "Open Scatter Plot" ((See Figure C-26)

Figure C-26:
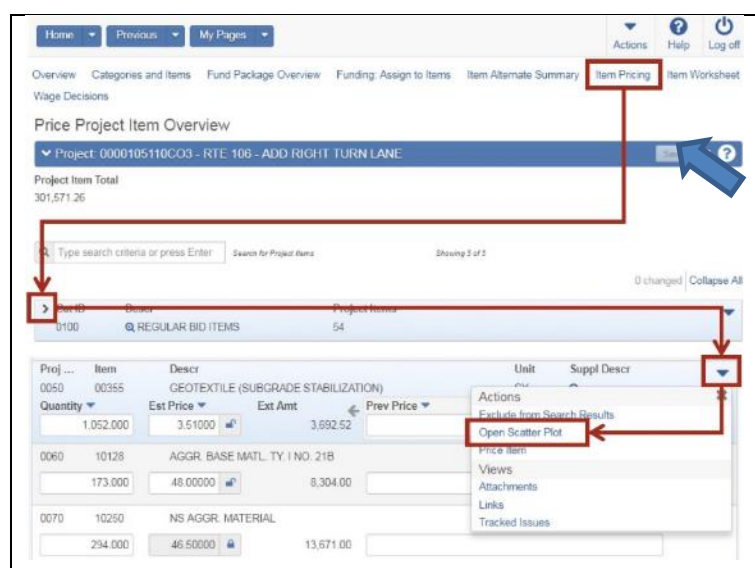
This opens an interactive window in which the user can hover over the dots in the scatter to reveal additional information in the upper right-hand portion of the graphs, as shown in *Figure C-27*. This includes information such as:

- Bid Price

- Quantity

- Bidder/Vendor

- Contract ID

- Season (e.g. Winter, Spring, Summer or Fall)

- Work Type/Category (See Section 10.12 Of the Preconstruction Manual for a Listing)

- County

- Letting Date

Figure C-27:
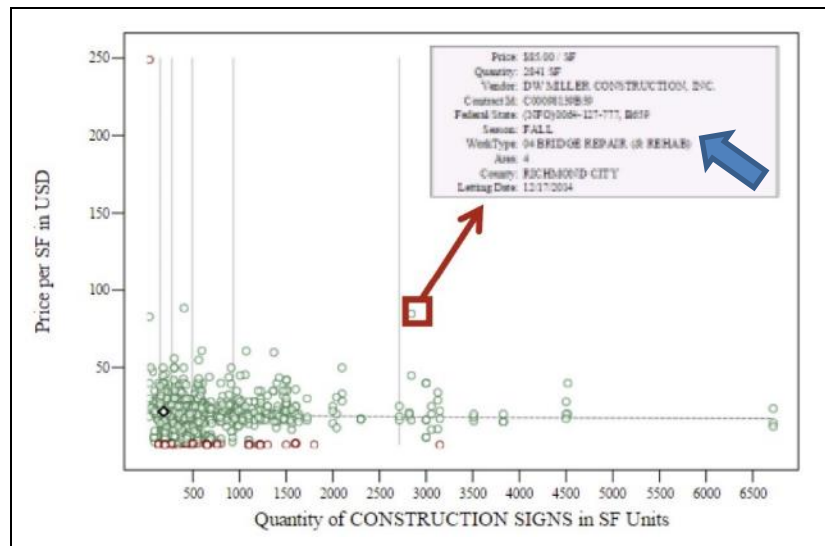
Although preconstruction does not have a specific tool for searching Bid Tabs, the scatter plot tool does allow the user to research how prices were developed and research the source data (Bid Tabs) that were used to calculate the prices.

Appendix D

Bid Item Codes

Appendix D – Bid Item Codes

The following are links to VDOT standard and non-standard bid item codes:

- [2016 standard and non-standard item code table in spreadsheet](#)

- [2016 Standard and non-standard item code table in PDF format](#)

- [2007 standard item code table in spreadsheet](#)

- [2007 non-standard item code table in spreadsheet](#)

In addition, District and Statewide average bid prices **(including 3-month District averages)** for these items can be found on the [VDOT Construction website](#).

Appendix E

Key Factors and Considerations Influencing Cost Estimates

Appendix E – Key Factors and Considerations Influencing Cost Estimates

This appendix raises awareness of both internal and external factors that have the potential to influence cost estimates.

Overview:

There are various factors associated with a project that can have an impact on cost estimate development. The estimator(s) should accurately understand and document the impacts that these factors are anticipated to have on the cost estimate. The following are some common factors that should be examined to determine whether they influence a project's cost estimate.

Project Specific Considerations

Roundabout Projects:

- Even in a rural environment, roundabouts are typically constructed to urban (curbing and closed drainage) standards.

- Do not forget to consider lighting and landscaping, which are often included at roundabouts.

- The location of the truck apron can have a big impact on MOT costs and could dictate whether a temporary diversion is needed to construct the concrete apron out of traffic. Roundabouts at existing signalized intersections may need temporary signalization.

- PE costs for roadway design may be higher for roundabouts than other similarly sized intersection projects, due to the iterative design process often needed to meet all roundabout design requirements.

Maintenance of Traffic:

- Multiple phases, detours, etc. can greatly affect the cost and schedule. Sometimes MOT/Traffic Management needs to be considered early in the process (Scoping / Preliminary Design phases), particularly when road closures are an option. The duration of a closure, or the project duration (if phasing is used in lieu of a closure), can have significant cost implications, significant and variable risks (particularly related to public involvement) and can be driving factors in the progression of design.

Roadway Widening Projects:

- Pay particular attention to bid costs that are variable and hard to predict early in the design phase. An example is pavement build-ups for a road widening project. These costs are always challenging to quantify and can add significant costs, especially if there's a crown shift involved. Also, matching pavement layers (for subsurface drainage) for a widening can add substantial cost.

Intersection Improvement Projects:

- Generally- the scope of work can be harder to define for an intersection improvement project and is more prone to scope creep. The scope needs to be discussed and determined in detail early on so that appropriate estimates can be generated.

  - What is the limit and design standards for any improvements to the mainline roadway?

  - Are some or all existing conditions being improved, and if not, are design exceptions/waivers required and would they be likely approved?

  - Converting an existing intersection to an RCUT, for example, costs significantly more to improve the entire project limits to current standards, compared to doing a limited scope improvement with design exceptions for existing conditions.

- There could be outstanding issues (such as sight distance, etc.) that can be missed in early reviews that may need to be addressed, precluding a limited scope project.

- Stormwater management is easily missed in early design of intersection improvements. A limited scope improvement may appear that it can be done without RW and utility impacts, but stormwater management requirements may change that.

Major Earthwork Projects:

- Recommendations based on unsuitable or rock excavation may not be available until more detailed design stages, but it may be necessary to account for possible impacts in earlier estimates.

- Additional considerations for major earthwork estimating can be found in Appendix G.

Projects with Stormwater Management Impacts:

- Often missed in preliminary project estimates. If not carefully included in the estimate, it can result in multiple cost increases, including design and construction of the facility, associated RW / utility impacts, and environmental impacts.

Projects with RW Acquisitions:

- Need to be very careful when assuming proffers in the RW estimate. Even if a proffer seems likely, the developer may fold, or plans may change. When proffers are assumed in the estimate, the risk needs to be considered as part of the risk identification and note that there are still administrative costs associated with the acquisition.

- When doing early RW estimates, especially when assuming that the project will be within the existing RW, consider temporary and permanent easements, stormwater management, utility easements, and other impacts that may increase the number of parcels impacted and associated administrative costs, even if the impact to that parcel is small.

Projects with Railroad Impacts:

- Even minor impacts or impacts adjacent to a railroad can result in significant engineering and flagging costs and needs to be coordinated with the rail section from an early stage and included in the estimate (see VDOT Rail Manual of Instructions).

Projects with Nighttime operations

- Nighttime operations can greatly affect unit prices since concrete and asphalt plants will need to remain operational outside of normal hours.

Project Factors to Consider:

Below is a list of some potential factors specific to each project to consider throughout the cost estimating process as documented in *AASHTO's Practical Guide to Cost Estimating (2013 First Edition)*.

Geographic Considerations

Geographic considerations can have a profound effect on the selection of unit bid prices. A project's location, whether in an urban, suburban, or rural setting, and in relation to material supply sources and available labor should be considered in establishing prices for an estimate.

A project in an urban setting generally has to contend with construction operations occurring in more confined workspaces, greater volumes of traffic, limited hours of operations, and nighttime work requirements. Some of these factors may be offset by availability of local contractors, materials, equipment, and personnel.

Projects located in rural settings may have less-restricted work areas, less traffic to contend with, and additional hours to complete the work—all factors that increase productivity. On the other hand, materials, equipment, and personnel may all have to be brought in from out of the area, which may increase costs related to transportation, support, wages, and per diem.

On projects that use large quantities of aggregates, whether for base, surface, or earthwork, or some combination thereof, the distance to material sources has a large impact on costs. Material sources in close proximity to the work reduce trucking and material handling costs and can increase production rates. On rural projects, the cost of erecting a concrete batch plant or hot mix asphalt plant may increase unit bid prices.

Terrain may also be a consideration in establishing an item's cost. Mountainous terrain and steep grades cause production rates to fall, whereas level terrain and straight roadways generally have the opposite effect.

Other location-related considerations that affect costs could occur due to local policies, taxes, restrictions, and air (attainment vs. not-attainment areas) and water quality. In some locations, locally specific rules and regulations governing noise, pollution, disposal of materials, working hours, and the construction season all increase the cost of construction. Another example of a location-related consideration is that of projects located on tribal lands. Tribes may impose Tribal Employment Rights Office Taxes for projects on tribal lands. These taxes generally range from 1 to 4 percent of the cost of the construction on the tribal lands but vary from tribe to tribe.

Quantity Considerations

The plan or expected quantity of a given work item affects the unit cost of constructing or supplying the item. This is not just a supply and demand issue, but one of production efficiency and the ratio of fixed cost to variable cost in producing an item. Generally speaking, the unit price for larger quantities of a given material will be less than smaller quantities. Suppliers offer discounts for larger quantity orders, and mobilization, overhead, and profit are all spread out over a larger quantity, thereby reducing their effect on a per-unit basis. Waste is also spread over a larger quantity, thereby having a smaller impact on unit cost. Larger quantities give rise to efficiency by allowing suppliers to gain experience and expertise in completing the work.

In some instances, projects with extremely large quantities of certain materials may actually cause an increase to the unit bid price. A project with numerous or large structures may affect both the production and delivery for specified steel, asphalt, or cement.

Generally, small quantity items are less cost effective to construct and hence lead to higher unit prices. Not only do suppliers charge more for smaller purchases, but in some instances, the lot size or the amount that has to be purchased is greater than the needed quantity. Small quantities do not generally allow for high production rates or other efficiencies, again causing a higher unit cost. Smaller-quantity items are frequently subcontracted out; this practice increases contractors' overhead, and they usually apply a markup to the items.

Item Availability

Materials that are readily available or ones that are commonly used are generally less expensive to purchase and install or construct. The contracting community is familiar with these types of items, and this experience reduces costs and risks. Non-standard pay items or materials that are in short supply are usually more expensive, and this should be considered in establishing the unit price.

Scheduling/Lead Time

To be efficient, a contractor needs to schedule its resources including labor, equipment, and supplies. When a contractor can plan for and maximize resource utilization, the contractor can be more competitive pricing the work. Transportation agencies should strive to let projects early or well before the work is scheduled to commence so as to allow contractors ample lead time for planning and scheduling resources as well as time to obtain permits and process materials. Lead time needs to be considered in the estimating process by estimating the project based upon when it will be built. For example, a project that is two seasons long and has the majority of its paving in the second year should attempt to account for this fact in the unit prices.

Difficult Construction/Site Constraints

Difficult construction and site constraints will increase the cost of construction for a contractor. Placing piles under water, working near active railroads or adjacent to historic buildings (possibly fragile), constructing on or near environmentally hazardous sites, and having limited room to construct an item are all examples of constraints that should be considered when deriving an estimated unit price.

Lump-Sum Items

From an estimating standpoint, use of lump-sum bid items should be avoided or minimized where possible. If the work to be performed can easily be quantified, then a payment method that includes a quantity should be used. However, lump-sum bid items are often used when an item of work can be easily defined but not all the components or details can be clearly determined. This fact can make estimating lump-sum items difficult for the estimator. The more information and breakdown of a lump-sum item that an estimator possesses, the greater the likelihood that an accurate lump-sum estimate can be developed. In any case, an estimator should try to define a lump-sum item in terms of its simplest, most basic components and should consider other factors that may not be easily estimated. By breaking out a lump-sum item into smaller items of work for which the estimator may have historical data and then applying reasonable estimated prices to those sub-units, the estimator can more accurately establish a price for the overall lump-sum item.

Since breaking out a lump-sum item into smaller components is difficult and time consuming, many DOTs apply percentages or ranges to some lump-sum items based upon historical data for similar project conditions. When determining estimates in these instances, the more consideration that can be given to an item's many components, the greater confidence in determining a reasonable estimated price there will be. Estimating methods other than historical bid-based techniques may be more applicable for lump-sum items.

Using lump-sum items typically transfers risk to a contractor. Contractors cannot necessarily rely on overruns to cover work that they, and possibly the DOT, did not foresee.

Different DOTs use the lump-sum method of payment for different items or types of work. The items of work discussed next are some representative examples of what some states use when applying the lump-sum method of payment.

Mobilization

Mobilization is a contract pay item used to cover a contractor's preconstruction expenses and the costs of preparatory work and operations. Since there is no clear list of what this work effort would cover, and each contractor has the ability to adjust its bid as needed to cover these expenses, there are no definite rules as to what percentage or value should be used per project. Mobilization costs are most often dependent on the amount and size of equipment and

staff the contractor will need to relocate for the project. Many projects will require that the contractor mobilize the crew and equipment multiple times.

Another major factor to consider when estimating mobilization costs is the contract specifications in regard to mobilization. Do the specifications include payment restrictions or limits? When will the contractor receive partial or full payment for mobilization? How much of the mobilization cost will the contractor be required to finance? Full payment up front may result in higher mobilization prices and bid item unbalancing for other bid items. The specifications may play a significant role in determining an estimated value for mobilization.

Consideration should be given to the location of a project, the complexity of a project, work requiring specialized equipment, the type of work, and the working season. If the project will extend over more than one construction season, this should be considered when determining mobilization costs, as the contractor may demobilize for the winter and remobilize in the spring. Rural verses urban projects, projects with multiple work sites, projects with a substantial level of preparatory removal items, projects with large quantities of excavation, and projects extending over two seasons where the contractor would be expected to shut down operations and move out will typically require a higher mobilization percentage.

To adequately estimate mobilization costs on a project utilizing historical-based data, the overall project must be very comparable in size, location, and work involved. For this reason, organizations that rely on historical bid-based estimating methods often use a parametric figure to estimate mobilization costs. This figure is normally a percentage of the overall construction item total and in the range of 6 to 18 percent. Some examples of this follow:

- *Typical mobilization estimates for a roadway project may be 8 percent based on past history for a state.*

- *Typical mobilization estimates for a structures project may be 10 percent based on past history for a state.*

- *Typical mobilization estimates for small projects that are not complicated may be 12 percent based on past history for a state.*

Traffic Control and Maintenance of Traffic

No matter how much time and effort a DOT spends in evaluating how a project will likely be constructed, contractors will have different ideas on how to execute the work to their advantage. Innovation by contractors can realize cost savings for DOTs but can quickly make all their efforts in developing a usable traffic control plan obsolete. This fact is why many states now use the lump-sum method of payment, or other alternative methods, for traffic control/maintenance in lieu of developing full-scale traffic control plans. The use of a lump-sum item for traffic control can have a significant reduction in preliminary engineering effort and also a reduction in construction inspection efforts. Even so, considerable effort on the part of the DOT needs to occur to approximate the types and quantities of traffic control devices, the number of times an item has to be moved, and the duration for which the items will be needed.

If the DOT feels that certain limitations are of significant importance, then those limitations need to be identified and stated in the special provisions/specifications for the project. Items such as when lane restrictions can be imposed, duration that a detour can be in place, and maximum length of a work zone will all have a bearing on the minimum number and type of devices that are necessary to prosecute the work. Significant items that the DOT will require such as minimum amounts of portable precast concrete barrier rail and number of changeable message signs, arrow boards, and truck-mounted impact attenuators should all be identified. This informs the contractor that these items have to be used in the construction of the project and

that they need to be included in the bid. The inclusion of these items may reduce risk to the contractor, which can be reflected in a lower lump-sum price. It will at least reduce the potential for claims once the project is under construction.

The establishment and identification of these significant items and consideration of the anticipated phasing/staging of the work along with imposed limitations, as well as approximate types and numbers of other anticipated traffic control devices, will all aid the estimator in establishing a reasonable lump-sum cost. By breaking out the larger portions of the cost in a lump-sum item, the estimator can rely on historical bid data for those items and the given limitations to come up with a reasonable lump-sum cost.

External Factors to Consider:

Below is a list of some potential External Factors to consider throughout the cost estimating process as documented in WSDOT's *Cost Estimating Manual for WSDOT Projects (December 2020).*

Inflation

The estimate represents the probable cost at the time of estimate. Any time an estimate is created or updated; the unit prices must reflect the cost at the time the estimate is done. It may require the estimator to go back to the unit price database and get the latest information. The estimator must always adjust the unit price for inflation considering the interval of time from when the price was used and the estimating time.

Expected Competition/Contractor Availability

Projects that are advertised for bids late in the season or after contractors have scheduled their work for the year, can expect higher bid prices. This is due to the lack of competition or contractor availability. Projects that are bid during a period when a large number of contractors are available may be bid more competitively. Competition could be a major factor of the cost of the construction. When the estimator expects just one bidder, then the project cost may be much higher than otherwise. On the other hand, if there are many bids, the project cost may be significantly lower than the estimate.

Political Factors

Political influences can and often do play a factor in the scope, schedule, and cost of many projects. Normally these political influences are never anticipated and realized long after the Base Estimate has been prepared and published. Often, designs need to be adjusted to overcome unanticipated political challenges. This is the type of situation the estimator(s) or project manager, has no control over, and is challenging to incorporate as a risk into the estimating process. However, it clearly demonstrates the importance of the maximum amount of due diligence while the estimate is being prepared and the crucial need for thorough documentation of the Basis of Estimate.

Permit Conditions

Throughout the stages of planning, scoping, and design, various projections of permit conditions for construction can be obtained from District or Central Office Environmental staff. Engaging these groups early helps to identify specific permits or conditions that can drive up construction costs and identify opportunities to avoid costly environmental conflicts.

At the same time, the estimate must address:

1. *The actual out-of-pocket costs for developing and constructing transportation projects.*

2. *The labor, material usage, equipment usage, and travel expenses of staff or consultants doing environmental analysis and documentation during project development.*

3. *The purchase of RW, materials, and installation labor, and additional purchases for major environmental mitigation features such as wetlands restoration and noise walls during construction.*

Be aware that considerable costs may be required due to stormwater collection and treatment; wetland protection and mitigation; hazardous materials testing; containment and treatment; and removal and disposal of underground fuel tanks, creosote timbers, and contaminated soils.

Macroeconomic Variables

Contractor competition, inflation, other macroeconomic variables (i.e., unemployment rates, mortgage rates, labor rates).

Appendix F

Updating Unit Costs for Market Conditions Memorandum

Appendix F – Updating Unit Costs for Market Conditions Memorandum

FROM: Kerry A. Bates, P.E, State Construction Engineer
          Susan Keen, P.E., Location and Design Division Administrator
          Kendal Walus, P.E., Structure and Bridge Division Administrator
          S. Mitchell Ball, P.E., Cost Estimation Office Director

TO: District Engineers
          District Preliminary Engineering Managers
          District Construction Engineers
          District L&D Engineers
          District S&B Engineers

CC: Mohammad Mirshahi, P.E. Deputy Chief Engineer
          Bart Thrasher, P.E., Chief Engineer

DATE: 10/19/2020 (Updated May 20, 2021)

RE: Updating Unit Costs for Market Conditions

As the Department evaluates and implements process and staffing improvements as identified in the E&Y Estimating study, there continues to be a need to augment the review of the Department's Design estimates prior to Project Advertisement to capture market trends.

The Construction Division has begun posting the 3-month averages for all Item Codes that we have received bids for over the last 3 months, by District. This document should be used as a tool to identify any changes in market conditions that have led to higher unit costs that will affect the overall estimate. The 3-month average will be updated on the first of every month and the Construction Division will maintain the previous three versions of the 3-month average in perpetuity.

Prior to any project advertisement submission to the Construction Division, the Responsible Charge Engineer should compare estimated unit prices against this document. Upon comparison, the Engineer should update unit prices when market condition is trending higher. While the unit costs utilized in each respective district's estimate are discretionary based on project specific details, consideration should be given to updating any unit price that has a difference greater than or equal to 20% of each unit price in consultation with the Discipline Expert, District Project Engineer, District Construction Engineer, and District Structure and Bridge Engineer, as applicable. Please note that unit prices should never be lowered to match the 3-month average cost document. To be reflected in the final design estimate, all updates to the unit costs must occur prior to changing the estimate's control group to Construction Division.

Appendix G

Estimating Tips and Aids

Appendix G – Estimating Tips and Aids

G-1 – Major Earthwork Estimating Approach

Estimating is a science and an art; this appendix will highlight some of the art of the process to help improve the outcome of the science. This appendix will also look at some fundamental items and considerations of major earthwork estimating process. This document will primarily focus on earthwork activities in cut and fill sections for roadway earthwork volumes.

- Identify enough boundary survey to establish a good DTM so that the pre-TIN file will have sufficient data.
- Identify the construction equipment anticipated for the cut.
  - Will the material be hauled with off road trucks?
    - If off road equipment is utilized, include cost for construction of a haul road to the disposal site.
  - Will the material be hauled with over the road trucks?
    - The estimate will possibly require flagging, cleaning of roadway, etc.
    - Can impact production rates if in high traffic area.
  - Be sure to evaluate the length of haul which impacts daily production rates.
    - This will need to be considered for all types of hauling and placing equipment.
    - Note: Grades on haul roads should not exceed 13% due to loss of material and impact on trucks.
    - Note: haul roads should have an adequate width to allow equipment to pass if feasible.
    - E&S controls for the haul roads will need to be estimated and maintained.
  - Estimate the equipment that will need to account for at the disposal or fill site.
  - Can pans be utilized?
    - Identify to what elevation.
    - Identify whether they will require haul roads.
  - Estimate the cost for road crossings.
    - This is usually #1 stone placed higher than the existing roadway to eliminate edge damage to the state road.
    - The estimate will need to include flagging operation costs.
  - Will need to plan for fuel adjustment and the equipment is large it may be rented.
- Identify the production rate.
  - If the production rate is high the cost will be low.
- Evaluate the height of cut and depth of fill sections. This will help establish additional needs.
  - Chart the boring logs on the cross section of the cut area – See attached examples.

- Look at the RQD and type of material to determine how much material will require blasting operations.

- Identify the quantity for easy removal with excavator and hydraulic hammers.

- How much topsoil can be salvaged and re-used to reduce your cost of topsoil price?

- Will there be enough rock produced to allow for on-site crushing operations?

- How much organic material or other material will need to be disposed of?

- How wet is the material and will the contractor have to estimate drying the material or use additives to dry the soil before using in fills?

  - Where is the top of the water table?

- Is the cut height greater than 30'? If so;

  - Estimate costs for an access road.

  - Ensure adequate easements and RW are sufficient.

  - Start with a flatter slope and work to steepen as geotechnical work is complete.

  - Evaluate additional drainage and E&S controls.

  - Consider the long-term maintenance of drainage and other items.

  - Identify other incidental items associated with high cut section.

- Evaluate the fill placement/waste material options in the cost of material.

  - Will the fill area require access roads to be constructed and cost accounted for in the estimate?

  - Will pavements or VDOT assets be damaged? Are the costs accounted for in the estimate?

  - Will false embankments or other construction be required for adequate placement of material?

  - How much material will be disposed of by phase and allow for shrink and swell when determining fill or waste placement of material.

- Check for phase balance of the project.

  - Make sure that you have each phase of material needed and accessibility identified.

  - How much waste will there be between phases?

    - Allow for payment of double handling of material.

  - Do the E&S control quantities and planning align with earthwork operations for each phase as well as the phase changes?

  - If material for a fill is inaccessible till a later time, consider:

    - Use of commercial material

    - Use of borrow pit

  - Excavate and stockpile material before it is not accessible and estimate the cost for double handling.

- Evaluate the items above before making the final selection.
- Capture cost of any local permitting and E&S/VPDES permits that may be required for borrow or disposal area.
- Estimate construction entrances for cut/fill/disposal areas.
- Evaluate the need for additional traffic control and flagging operations if offsite facilities are used.
  - This may not be needed but will be incidental to other items.
- Include costs for E&S controls for the disposal area as part of excavation costs.
- Include costs for payment to property owners to receive disposal of material or purchase of land to dispose of material.
- Will the RW and easements need to extend out to protect the stability of the embankment area?
- Remember the contractor will figure their price to complete the earthwork and then divide by the contract quantity to arrive at their price. So, think of the operation and pricing from their perspective.
- Tools for use
  - Bluebeam or other PDF analysis software to calculate section quantity for use of end area method.
  - Use CADD model to calculate volumes by .tin to .tin comparison. See CADD manual CH 14.
  - Use CADD features in 3D model to evaluate phase balance. See Bentley product help guide.
  - Utilize AgTek or similar software to validate your calculations.
  - Understand the process and establish controls to help the estimator(s) deliver repeatable performance.

The following sketches correspond to these earthwork estimating considerations.

CROSS SECTION
SCALE 1 IN = 50 FT

REVISED	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	VA.		460	3050-09-0134	1

PROJECT MANAGER
SURVEYED BY
DESIGN SUPERVISED BY
DESIGNED BY

APPROXIMATE RDZ LINE

Waste material - excavator, D9, Cat 992, and hauled by A2 hauler.

UPPER BANNER SANDSTONE

9,136.66 sf

Fill material - Excavator and A2 hauler. Hydraulic hammer excavator as needed.

2,454.32 sf

BANNER SHALE

Rock excavation - 4" rock drill, excacator, 9 D Dozer, Catt 992, and CAT 777

1650

LOWER BANNER SANDSTONE

37,159.39 sf

LOWER BANNER SANDSTONE

LOWER BANNER SHALE

1600 LOWER BANNER SHALE

BIG FORK SHALE

BIG FORK SHALE

Route 460

1550

Station 87+50.00   To Station 87+50.00

Natural drainage way - price rock core ditch and E&S

350   300   250   200   150   50   0   50   100   150   200   250   300   350

1500

	PLAN NO.	PROJECT	FILE NO.	SHEET NO.
		3050-09-0134		

VDOT
Virginia Department of Transportation

PROJECT #: 0460-013-773,C501,B628,B629,B630
LOCATION: Breaks, Virginia
STRUCTURE: US 460 - CUT

STATION: 87+50 — OFFSET: 47 R
LATITUDE: 37.304128° N — LONGITUDE: 82.281449° W
SURFACE ELEVATION: 1,705.06 ft — COORD. DATUM: NAD 83

FIELD DATA

LAB DATA

Date(s) Drilled: 10/27/09 - 10/27/09
Drilling Method(s): 4.25" H.S.A. / NQ Coring
SPT Method: Automatic Hammer
Other Test(s):
Driller: Tim Jenkins, Horn & Associates, Inc.
Logger: Vandana Muddu, MACTEC

GROUND WATER
▽ FIRST ENCOUNTERED AT 17.0 ft DEPTH
▼ STABILIZED AT 135.0 ft (1,570.06ft ELEV.)

FIELD DESCRIPTION OF STRATA

0.0 / 1,705.06
Brown, fine to coarse silty SAND, contains organics and black oxides, loose, moist **SM**

2.0 / 1,703.06
Brown, SILT, contains sand, organics and black oxides, hard to very hard, moist **ML**

7.0 / 1,698.06
Brown and orange-brown, highly weathered sandy SHALE, with sand, very dense, dry **HWR**

9.0 / 1,696.06
Coring Started at 9.0' BGS on 10/27/09.
Highly weathered to decomposed, soft to moderately hard, thinly bedded, intensely to highly fractured, gray, fine to medium grained shaly SANDSTONE (SRQD - 0%)

Inclusions: Shale Laminations.
Micaceous. **SST**

Dip & strike of rock is basic flat and little to no risk for loss of bit or tools.

24.4 / 1,680.66
Moderately to slightly weathered, soft to moderately hard, thinly bedded, highly to moderately fractured, gray and dark gray, interbedded fine to medium grained shaly SANDSTONE (SRQD - 81%)

Inclusions: Intensely Fractured from 40.0' to 40.5'.
Intensely fractured zone from 40.0' to 40.5'
SST-SHL

Could consider crushing and producing rock for fill and sub-base.

Field/Soil/Rock column annotations
- Waste
- Fill material. Moist but no Drying needed
- Start rock excavation

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	JOINTS / DIP°	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT #200 (%)
2		5 5 4	55	0 / 1.5 / 2.5						9.0	
4	1700	8 15 15	67	4 / 5				34	7	9.9	97.4
6		25 50/5"	74	5.9						9.9	
8		16 34 38	78	7.5 / 9			5			10.2	
10	1695										
12					78	0					
14				15							
16	1690										
18											
20	1685				95	6					
22											
24	1680			25			5				
26							0				
28											
30	1675				100	81					
32							0 0 10				
34				35			0 0 0				
36	1670						0 10				
38							5				
40	1665				100	77	0 60				
42							45				
44	1660			45			5 0				
46							0				
48							10				
50											

REMARKS: RIG TYPE: Diedrich D-120.

SPT_LOG8:US 460 BORING LOGS - FINAL.GPJ:8.1.017:082009:4/15/10

VDOT
Virginia Department of Transportation

STATION: 87+50   OFFSET: 47 R
LATITUDE: 37.304128° N   LONGITUDE: 82.281449° W
SURFACE ELEVATION: 1,705.06 ft   COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 10/27/09 - 10/27/09
Drilling Method(s): 4.25" H.S.A. / NQ Coring
SPT Method: Automatic Hammer
Other Test(s):
Driller: Tim Jenkins, Horn & Associates, Inc.
Logger: Vandana Muddu, MACTEC

LAB DATA

GROUND WATER
▽ FIRST ENCOUNTERED AT 17.0 ft DEPTH
▼ STABILIZED AT 135.0 ft (1,570.06ft ELEV.)

FIELD DESCRIPTION OF STRATA

DEPTH (ft)	ELEVATION (ft)	SOIL — STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK — CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS (DIP °)	STRATA LEGEND	FIELD DESCRIPTION OF STRATA
52						100 / 96		10	30 / 10 / 5		52.3 / 1,652.76
54	1650				55				10 / 5		Slightly to moderately weathered, moderately hard, thinly to thickly bedded, highly to slightly fractured, light gray, fine to medium grained SANDSTONE (SRQD -80%)
56									15 / 10		
58											Inclusions: Iron Staining.
60	1645					100 / 80					Shale Laminations.
62									20		Micaceous. **SST**
64	1640				65						
66									10		
68											
70	1635					100 / 95			70 / 70 / 20		
72								20			
74	1630				75				10		
76											
78											
80	1625					100 / 98					
82											
84	1620				85						
86											
88								10	10 / 10 / 60		
90	1615					98 / 86			70 / 70		
92											
94	1610				95						
96											
98									70 / 10		
100									10		

LAB DATA			
LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT #200 (%)

REMARKS: RIG TYPE: Diedrich D-120.

SPT_LOGB:US 460 BORING LOGS - FINAL.GPJ:8.1.017:082009:4/15/10

VDOT
Virginia Department of Transportation

STATION: 87+50   OFFSET: 47 R
LATITUDE: 37.304128° N   LONGITUDE: 82.281449° W
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LAB DATA

GROUND WATER

▽ FIRST ENCOUNTERED AT 17.0 ft DEPTH
▼ STABILIZED AT 135.0 ft (1,570.06ft ELEV.)

DEPTH (ft)	ELEVATION (ft)	SOIL — STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS DIP°	STRATA LEGEND
102						100	90		90 / 10	
104–106	1600				105					
108–110	1595					100	100			
112–116	1590				115					
118–120	1585					100	100			
122–126	1580				125					
128–130	1575					100	100			
132–134					135					

FIELD DESCRIPTION OF STRATA

LL	PI	MOISTURE CONTENT (%)	FINES CONTENT #200 (%)

99.7 / 1,605.36
Slightly weathered, hard to very hard, thickly to massively bedded, slightly to very widely fractured, dark gray, sandy SHALE (SRQD - 99%)

Inclusions: Sandstone Laminations.
         Intensely Fractured with Rounded Pebbles
         up to 0.75" in Diameter from 99.8' to 100.1'.
         Unweathered from 101.4' to 135.0'.
         Intensely fractured zone from 99.8' to 100.1'.

SSHL

Auger Refusal at 9.0' BGS on 10/27/09.
Coring Terminated at 135.0' BGS on 10/27/09.
Boring Terminated at 135.0' BGS on 10/27/09.

REMARKS: RIG TYPE: Diedrich D-120.

PAGE 3 OF 3
09BH-071

SPT_LOGB:US 460 BORING LOGS - FINAL.GPJ:8.1.017:082009:4/15/10

Drafted By _N.JB_
Date _08-25-2010_
Reviewed By _RDR_
Date _08-26-2010_

REVISED	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	VA.			3050-09-0134	

Disposal Site

Scale 1" = 150'

−150   −75   0   150

Boring Location Plan

PLAN NO.	PROJECT	FILE NO.	Figure No.
	3050-09-0134		2.1

Drafted By NJB
Date 08-25-2010
Reviewed By RDR
Date 08-26-2010

REVISED	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	VA.			3050-09-0134	

Haul Road for Disposal

Access Road

Cut #1

Scale 1" = 150'

-150   -75   0   150
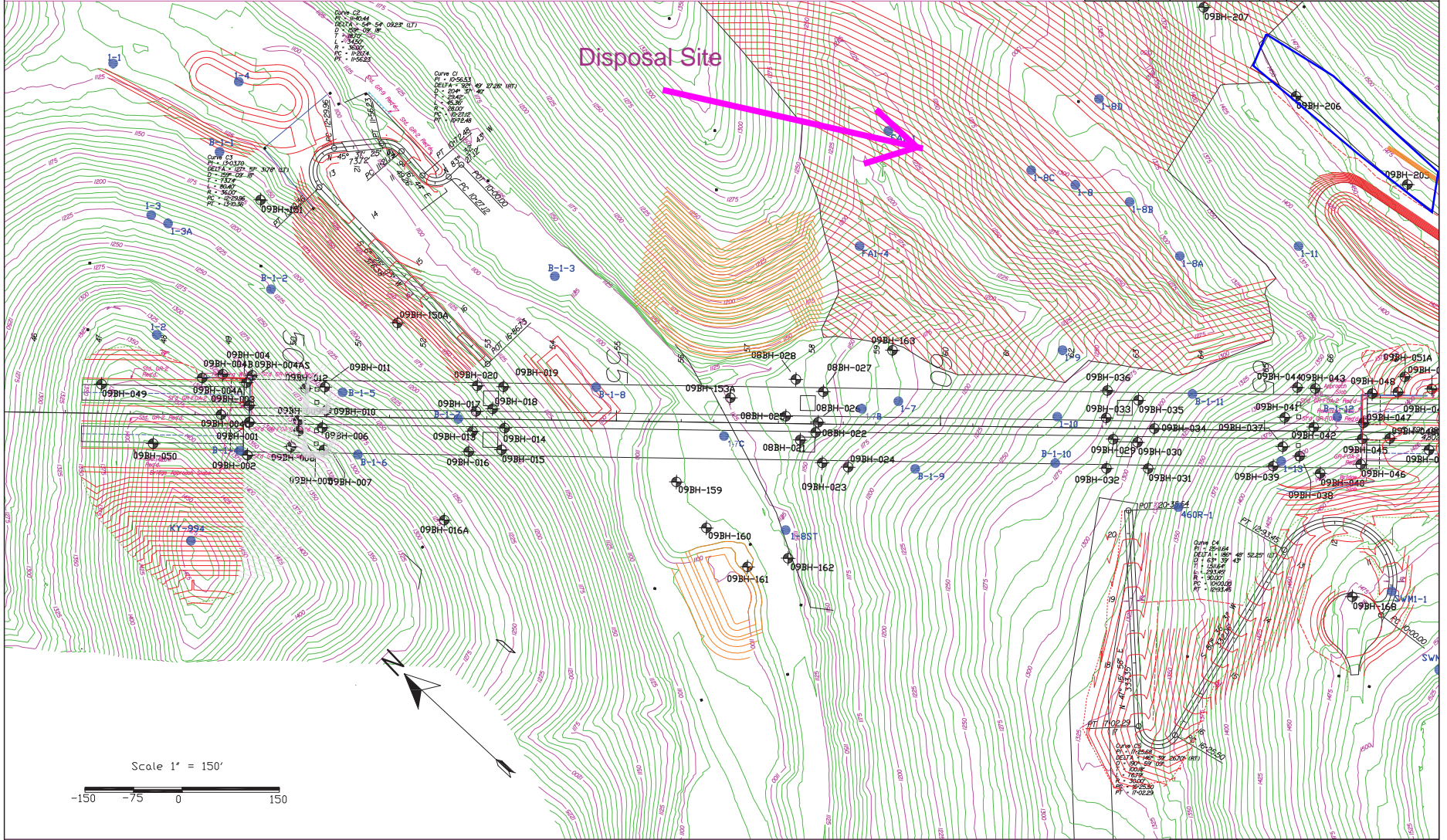
Boring Location Plan

PLAN NO.	PROJECT	FILE NO.	Figure No.
	3050-09-0134		2.2

$TIME$STAMP$

Appendix H

References

Appendix H – References

- [Dashboard Business Rules](#)
- [SMART SCALE Cost Overrun Policy](#)
- [SGR Bridge Web Page](#)
- [PMO-22.0 Change Management](#)
- [Project Development Process](#)
- [IIM-LD-260/IIM-IID-11](#)
- [IIM-IID-1.5](#) (Inside VDOT, internal only)
- [SMART Portal](#)
- [Project Development Process](#)
- [Project Tasks and Scheduling Guide](#)
- [Section 33.2-368 of the Code of Virginia and the FHWA-VDOT Stewardship and Oversight Agreement](#)
- [Review of Cost Estimating Tools](#)
- [Construction Cost Estimate - Estimating Quantities](#)
- [VDOT ROW and Utility](#)
- [PM-104 Form](#)
- [VDOT Right of Way Cost Estimate Guide](#)
- [VDOT Right of Way Manual](#)
- [VDOT Utility Manual](#)
- [VDOT Rail Manual of Instructions](#) (Internal only)
- [Staying on Track with Rail Projects Webinar (February 2021)](#)
- [Environmental Scoping Worksheet](#) (Internal only)
- [Environmental Thresholds and Considerations](#)
- [Environmental Estimating Workbook](#)
- [FHWA Guidance on Major Projects](#)
- [AASHTO's Practical Guide to Cost Estimating (2013 First Edition)](#)
- [PMO-15](#)
- [PCES Manual](#)
- [FHWA's Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation](#)
- [Guidelines and Procedures for Estimating](#)
- [PMO-10.2](#)
- [IIM-CD-2020-02-01](#)
- [Alternative Project Delivery Division Design-Build Procurement Manual](#)

- [Design-Build Evaluation Guidelines](#).

- [IIM-APD-1.3](#)

- [IIM-APD-5](#)

- [Road Design Manual](#)

- [Cost Estimate Workbook Overview Training Module](#)

- [Cost Estimate Workbook](#)

- [PCES - Workbook](#)

- [Local Government Users](#)

- [AASHTOWare Project Preconstruction](#)

- [AASHTOWare Project Preconstruction Manual](#)

- [VDOT Estimating Training Modules](#)

- [Bristol Estimating Tool](#)

- [Culpeper Estimating Tool](#)

- [NOVA ICVT Estimating Tool](#) (Inside VDOT, internal only)

- [VDOT Bid Tabulations](#)

- [VDOT Construction Resource Information Including District and Statewide Bic Tab Averages](#)

Appendix I

Citations

Appendix I – Citations

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Virginia Department of Transportation