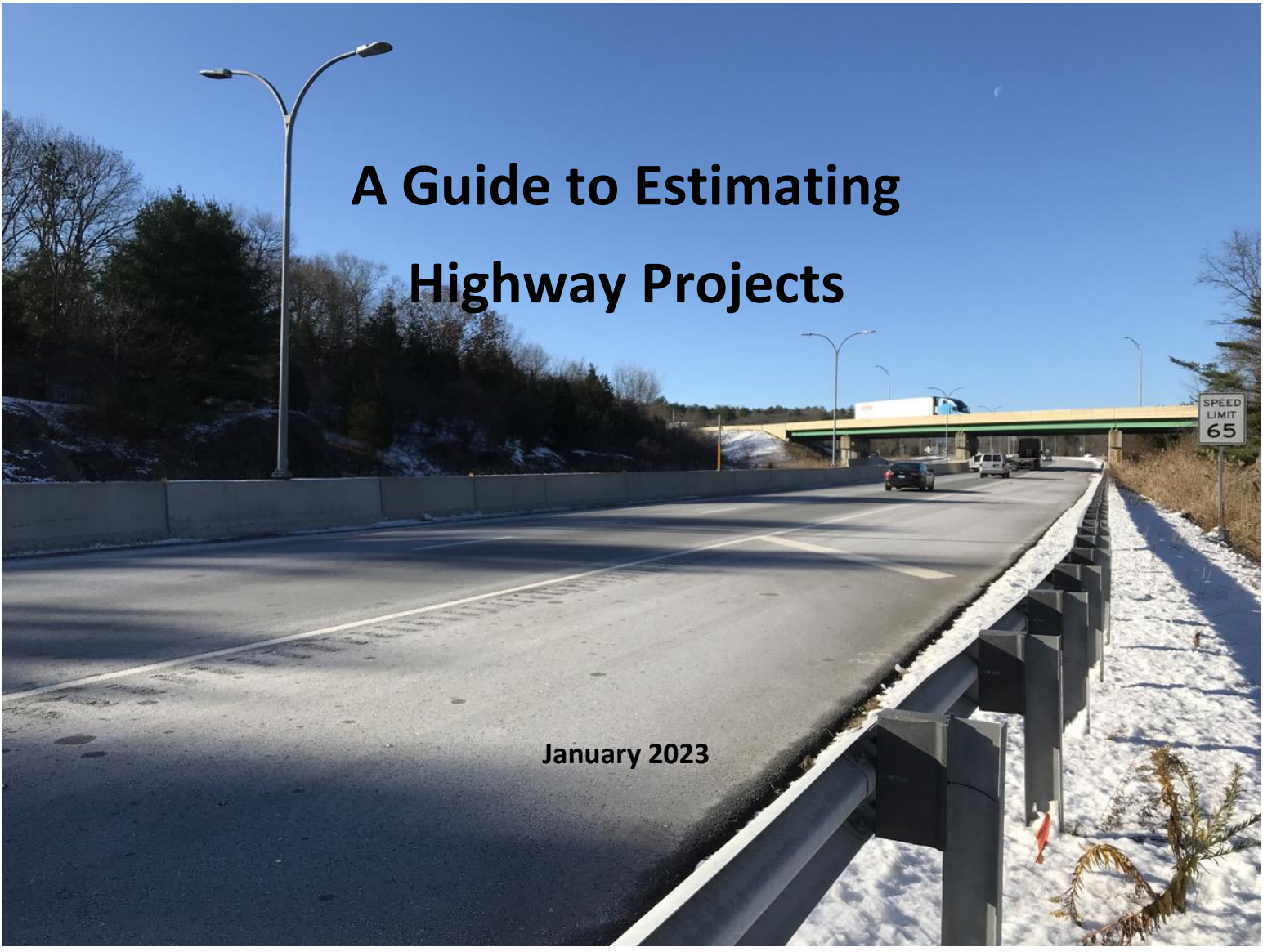
THE COMMONWEALTH OF MASSACHUSETTS

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION

HIGHWAY DIVISION



A Guide to Estimating Highway Projects

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massDOT
Massachusetts Department of Transportation

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APPENDIX

1. Purpose of this Guide

This guide has been developed to promote consistent, accurate and transparent cost estimates on MassDOT Highway Division projects.

Consistent cost estimate techniques ensure that competing projects or alternatives can be viewed objectively.

Accurate project costs are necessary to maintain a fiscally constrained capital plan and provide a basis for project financing. MassDOT maintains a five-year Capital Investment Plan (CIP) and participates in the development of the 5-year State Transportation Improvement Program (STIP). Both plans are fiscally constrained. A federal aid project cannot be advertised for construction unless the estimated Total Federal Participating Construction Cost is in conformance with the amounts and funding categories programmed on the STIP. Scope changes and cost increases often result in the need to amend the STIP. This amendment process takes one to three months to execute. Cost increases may also result in the need to move the project experiencing the increase or other project(s) to a future STIP year.

A transparent project estimating framework imbues confidence in Massachusetts transportation investments and the capital plan at large.

This guide establishes a framework for MassDOT project estimating by incorporating best practices, outlines areas of risk and uncertainty, and identifies measures from which to gauge the accuracy of project cost estimates. Although the target audience for this guide is the MassDOT Project Manager, it is expected that this guide will also find an audience with project proponents, planners, designers, managers and stakeholders. Many of the activities included in this guide are specific to MassDOT Project Managers. As a result, this guide does include reference to internal SOPs that are only available to MassDOT staff.

2. Definitions

Term	Definition
Allowance Items	Budgeted items included in the construction contract that are anticipated to be required above and beyond the Bid Items.
Basis of Payment	The portion of the bid specification that describes how the contractor will be paid for the work performed.
Bid Items	A product or service to be provided by the contractor to deliver the project scope of work. Items are either standard, and defined by the MassDOT standard specifications, or special provision items which are uniquely defined with the project specifications.
Capital Investment Plan (CIP)	The CIP is a five-year plan that is based on spending per state fiscal year (July 1 to June 30).
Contingency	Estimated cost to cover risk or uncertainty
Contract Advertising and Planning Estimator (CAPE)	A MassDOT application used to calculate construction contract value
Construction Engineering	Estimated cost of MassDOT Construction Management including Payroll, Inspectional Services, QA, and QC Testing
Construction Project Estimator (CPE)	A MassDOT application that allows designers to create Preliminary Estimates based on current bid data.
Estimated Price Proposal	For Design-Build projects this amount is the sum of the construction costs plus the costs for the Design-Builder's consultant(s) to provide final design and design services during construction.
Estimated Total Construction Cost	The Estimated Total Contract Cost plus reimbursable utilities and construction engineering.
Estimated Total Contract Cost	Office Estimate plus other budgeted costs (traffic, police, railroad flaggers, trainees, partnering, non-participating, and others), plus contingencies. This does not include reimbursable utilities or construction engineering.
Estimated Total Federal Participating Construction Cost (TFPCC)	The portion of the Estimated Total Construction Cost (minus Municipal and 100% State items) in which the Federal Highway Administration (FHWA) will participate depending on Federal Aid project type. This is the amount that should be programmed on the STIP.
Federal Aid Programming and Reimbursement Office (FAPRO)	FAPRO is responsible for reviewing and advertising the Final PS&E and requesting federal funding from the Federal Highway Administration. FAPRO also ensures that adequate funds are available for Non-Federal Aid (NFA) projects.
Method of Measurement	The portion of the bid item specification that describes how the work will be measured.
State Transportation Improvement Plan (STIP)	The STIP is a five-year, budgetary document that includes a fiscally constrained listing of transportation projects. It is based on obligations per federal fiscal year (October 1 to September 30).
Stewardship and Oversight Agreement	An agreement between FHWA and the state highway agency that outlines the roles and responsibilities of each party.

Term	Definition
Total Estimated Project Cost	Estimated Total Construction Cost plus estimated design, Right-of-Way, and environmental mitigation costs.
Office Estimate	The sum of all contract bid items.
Weighted Average Bid Price Application	A module of the CPE that provides access to mean and median bid price data from all responsive bids.

3. Estimate Structure

This guide is focused on accurate estimates of construction cost. In addition to construction cost, a project budget also includes the cost of design, project management, Right-of-Way acquisition and construction supervision/quality control.

MassDOT uses an enterprise project management system called ProjectInfo to support the advancement of projects from approval through advertisements. The project construction cost is updated at each design milestone, and when used in conjunction with the construction contract time determination (CCTD) and advertisement schedule, allows the department to forecast costs and maintain a fiscally constrained STIP and CIP.

ProjectInfo includes a separate construction cost module, Contract Advertisement Planning Estimator (CAPE), which was developed to track construction cost in a consistent framework responsive to departmental, state and federal financial guidelines. The major components of this framework are as follows:

3.1. Office Estimate

The Office Estimate consists of a list of bid items necessary for the physical construction of the project. MassDOT maintains a list of standard bid items within the Standard Specifications. Nonstandard items may also be needed to accomplish unique aspects of the project scope.

The responsibility of the design engineer is to identify what items are need, at what quantity, and determine an appropriate unit cost estimate for each item in the specific project. The bidder will provide their own unit cost for each item in their bid proposal.

On Design-Build Projects, the Office Estimate is synonymous with the Price Proposal. See Chapter 8.

3.2. Design Contingency

Design Contingency is a value included in a project estimate which is intended to account for the anticipated cost increases as design progresses. The design contingency amount should be highest at planning stages and be reduced to zero at final design once all project elements have been identified and estimated. This amount is applied when entering the estimate in the CAPE and is based on design maturity.

Considering MassDOT will add the design contingency when justified, designers should not include a contingency amount in their Office Estimate. The Designer should however advise the Project Manager on the requirement and magnitude of a contingency based on perceived risk at each submission. The Project Manager is responsible entering this amount in the CAPE.

3.3. Allowance Items

3.3.1. Traffic Police

Section 10 of Chapter 86 of the Acts of 2008 and the regulations promulgated in 700 CMR 6.00, indicate that police details are required for certain construction activities performed on divided and undivided public roads with a legal speed limit greater than or equal to 45 miles per hour. The designer shall use

the MassDOT Standard Traffic Control Plans and the Work Zone Safety Guidelines plates as the Construction Zone Safety Plan to determine if conditions warrant the need for traffic control devices, road flaggers, or police details to maintain a safe construction zone. The estimated value for traffic police is included in the Total Contract Cost as an Allowance Item. For federal aid projects, FHWA will only participate in the cost associated with 70% of the estimated hours.

Road flaggers are provided by the contractor. Therefore, these costs are a bid item that is included in the Office Estimate.

3.3.2. Trainees

Provisions for Trainees are required for federal aid projects with an Office Estimate of $3 Million or more. These provisions are intended to provide on the job training for minority group workers, women and disadvantaged persons. These provisions require that the contractor provide on-the-job training aimed at developing full journeymen in the type of trade or job classification involved. The estimated amounts for Trainees were developed in cooperation with FHWA and are based on the value of the Office Estimate. Guidance regarding the amount to include can be found in the Project Management Standard Operation Procedures (SOPs). The units used for the estimate are dollars. The Project Manager is responsible for entering this amount in the CAPE.

3.3.3. Extra Depth Class A Trench Excavation

If the designer determines that excavations for masonry culverts (having a clear square span of less than 8 ft), inlets and walls will extend greater than 8 feet, an estimated quantity shall be determined for this allowance item. The unit price shall be 1.5 times the unit price for Class A Trench.

3.3.4. Cofferdam Class B Rock Excavation

If the designer determines that the Class B Rock Excavation is likely to be required within a cofferdam, an estimated quantity for this allowance item shall be calculated. The unit price shall be 3 times the price identified for Class B Rock Excavation.

3.3.5. Railroad (RR) Flaggers

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required.

MGL C.120, S 41 of the Acts of 2009 requires that MassDOT furnish flaggers for all Chapter 634 bridges over MBTA railroad tracks. A 634 bridge is a highway bridge over a railroad that meets the National Bridge Inspection Standards (NBIS) definition of a bridge whose ownership was transferred to MassDOT under Chapter 634 of the Acts of 1971. The only projects for which MassDOT will not pay for railroad flagging are Chapter 634 bridges over non-MBTA Right of Way. All other projects requiring railroad flagging must include the Railroad Flagger item. A decision flowchart for the use of Railroad Flaggers is found in the Project Management SOPs.

Railroad Flaggers are an allowance item and the unit of measure is Days. This item must be included in the Estimated Total Contract Cost and is not to be paid for using a Force Account. The Project Manager is responsible for entering this amount in the CAPE.

3.3.6. Incentive/Disincentive

MassDOT's policy on the use of Incentive/Disincentive (I/D) provisions is described in Engineering Directive E-21-003. This Engineering Directive is applicable to all Design-Bid-Build and Design-Build projects with an Office Estimate greater than $10 million and categorized as one of the project types identified in the Engineering Directive. This directive includes a checklist that facilitates the decision making process regarding which projects are appropriate for I/D provisions. Should it be determined that I/D provisions are appropriate for a project, these potential costs must be included in the project cost at the earliest design stage possible. This amount is identified by the designer. The Project Manager is responsible for entering this amount on the CAPE.

Incentives/Disincentives are an allowance item and the unit of measure is dollars. This item must be included in the Estimated Total Contract Cost. The Project Manager is responsible for entering this amount in the CAPE.

3.3.7. Engineering Services

The two most common reasons for using the Engineering Services allowance item are for engineering services related to MBTA and/or other railroad work and engineering services associated with certain maintenance contracts.

Regarding MBTA/Railroad services related work, the Project Manager shall work with the State Utilities Engineer to coordinate the MBTA/Railroad work necessary to support MassDOT's construction contract. Examples of these services include the scope of work associated PTC cable relocation splicing, relocation of railroad equipment or other scope identified as necessary and appropriate by the railroad and MassDOT. If it is determined that an allowance item is the most appropriate means to compensate the MBTA/Railroad for these services is through an allowance item, it is the project manager's responsibility to work with the State Utilities Engineer to determine the approximate value of this work and ensure the item is included in the estimate.

For maintenance contracts, the allowance item provides a mechanism for the Resident Engineer to compensate the contractor for designs or other consulting services that are deemed necessary for the completion of the work. The estimated amount for this item shall be based on a review of historical utilization of this item under previous similar contracts and a consideration of what type of engineering services may be required. The compensation is based on the quantity of workhours multiplied by an assumed average hourly rate, multiplied by an assumed overhead rate (maximum of 155%) and include a 10% fee.

3.3.8. Specialty Services

This allowance item provides a mechanism for the Resident Engineer to compensate the contractor for work outside the scope of the bid items contained in the contract. The estimated amount for this item shall be based on a review of historical utilization of this item under previous similar contracts and a consideration of what type of specialty services may be required. This work is paid for based on time and materials plus 10%.

3.3.9. Materials

This allowance item provides a mechanism for the Resident Engineer to compensate the contractor for materials that are not included in the contract, however deemed necessary complete the work during the construction phase. The estimated amount for this item shall be based on a review of historical utilization of this item under previous contracts and a consideration of what type of materials may be required. The amount shall be based on the actual net cost for materials plus 10%.

3.3.10. Equipment Rental

This allowance item provides a mechanism for the Resident Engineer to compensate the contractor for work that cannot be completed with other items in the contract. The estimated amount for this item shall be based on a review of historical utilization of this item under previous similar contracts and a consideration of what type of equipment may be required. The amount shall be based on the Rental Blue Book and include the cost of the operator plus 10%.

3.4. Construction Engineering

The estimated amount for Construction Engineering is intended to cover MassDOT's salary costs, inspectional services, QA, and QC testing. The estimated amount is based on the value of the construction contract and is calculated automatically by the CAPE.

3.5. Construction Contingency

Construction Contingency is a budget built into every project to provide a funding mechanism for cost increases that may occur during the implementation of the construction contract. These costs may include quantity overruns, extra work orders and price adjustments (required by Chapter 303 of the Acts of 2008 to account for market changes in the prices for liquid asphalt, Portland cement, diesel fuel, gasoline, structural steel and reinforcing steel). MassDOT's Construction Section utilizes these contingency funds first to cover cost increases. Once the contingency is exhausted, additional funding is requested. The estimated amount is based on the value of the Office Estimate, the type of funding and is calculated automatically by the CAPE.

3.6. Utility Force Accounts

Engineering Directive E-11-008 defines MassDOT's utility reimbursement policy. When the construction of a project requires the relocation of privately-owned utilities, a portion of the costs associated with the relocation are reimbursable. If the utility owner completes their relocation work within the approved schedule, as determined by MassDOT, MassDOT will reimburse the owner for 50% (or other partial amount) of the actual costs incurred for the relocation, including costs for temporary (if necessary) and permanent relocations.

MassDOT shall reimburse the owners of municipally owned utilities 100% of the actual costs incurred for the necessary relocation of their facilities. The Project Manager is responsible entering this amount in the CAPE.

3.7. Escalation

Escalation is used to forecast the future value of a project based on changes in the cost of labor, materials and services over time. To account for escalation, the Federal Highway Administration requires that a Year of Expenditure (YOE) formula of 4% per year, starting in the second year, be applied during the development of the development of the Statewide Transportation Improvement Program (STIP) for federal aid projects. The YOE is applied automatically in the Office of Transportation's ESTIP application. MassDOT also applies escalation in the Capital Investment Plan for all projects.

Designers and Project Managers should not include escalation in Office Estimates, and should always estimate project value in today's dollars.

Figure 1 shows the evolution of a cost estimate from the planning phase to final design.

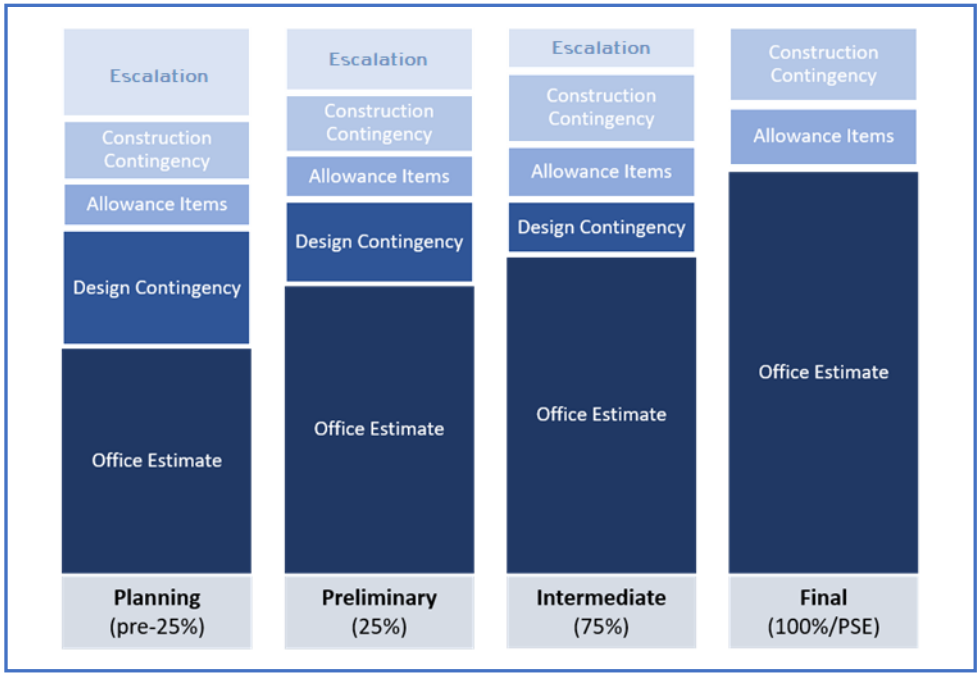

Figure 1: Evolution of a Cost Estimate

4. Other Project Costs

This section will describe project costs that are not included in the estimated Total Contract Cost or the Estimated Total Federal Participating Construction Cost. It is important to monitor these costs in order for MassDOT to understand the total cost to the Commonwealth for completion of the project and to establish budgets and contracts to pay these costs. The Project Manager will first need to determine which of the costs noted in this section are applicable to a given project. This guide provides a recommended means for determining each of these costs at the earliest stages of the project development process. Once these services are contracted with a vendor, the actual amounts shall be used.

4.1. Project Accounting and Reporting System (PARS) Numbers

A PARS Number is a unique code that is used to establish budgets for and track project expenses. Budgets and expenses are categorized into three project categories: Design, Right of Way, and Construction. PARS numbers are managed through the FAPRO Masterworks application (AKA Masterworks) (https://fapro.masterworkslive.com/Modules/USRMGMT/login.aspx). The Design costs estimated in sections 4.2 through 4.8 below can only be contracted and invoiced if budgets are established via a PARS Number request in Masterworks. Similarly, staff can only charge their time to a project in Self Service Time and Attendance if a budget is established via a PARS Number to account for the MassDOT Project Development Costs (Section 4.9). In Masterworks, Design Costs are called Materials and Other expenses and Project Development Costs are called MassDOT Labor (aka Pay Phase) PARS Numbers.

4.2. Design Costs

4.2.1. Preparation of Plans Specifications and Estimate

This value represents the estimated cost of consultant engineering services in instances where the Highway Division has a contract with a consultant engineering firm for the purposes of preparing Plans, Specifications and Estimates.

Consulting engineering costs associated with a municipally administered project (e.g., the municipality has entered into a contract with a consulting engineering firm) shall not be included here.

For in-house designed projects, the costs of MassDOT workhours shall be accounted for under MassDOT Project Development Costs.

When MassDOT intends to contract with a consulting engineering firm for the preparation of plans, specifications and estimate, it is recommended that 6 to 10% of the Total Construction Cost be allocated for Design-Bid-Build projects. Larger percentages should be considered for projects that have a small Total Construction Cost, but still require a significant level of design (e.g., intersection reconstruction projects, rail trails, etc.). Conversely, certain high value projects that require limited environmental permitting and limited plan preparation should use a lower percentage (e.g., resurfacing projects). These costs shall typically include survey and borings and construction phase services.

For Design-Build projects it is recommended that 3 to 4% of the Total Construction Cost be allocated for preliminary design, environmental permitting and preparation of the BTC and RFP documents. An additional 3 to 4% should also be included for construction phase services that are provided by the preliminary designer.

4.2.2. Field Survey

These services are related to the collection of electronic field survey data and the completion of AutoCAD Base Plans. Firms performing this work must be pre-qualified in MassDOT Architectural and Engineering Board's "S2- Total Station AutoCAD Base Plan Services" category.

For consultant designed projects, the costs associated with field survey and the preparation of the base map for the project are often included the consultant's contract. However, MassDOT's Survey Section may utilize the services of a survey firm under contract to the Survey Section. For municipally designed projects the municipality will be responsible for the field survey. For MassDOT, in-house designed projects, the survey will be obtained through MassDOT's Survey Section. The Project Manager shall consult with the Survey Section regarding the most appropriate means of obtaining the field survey and also discuss approximate costs.

4.2.3. Subsurface Investigations

Subsurface investigations may include geophysical explorations and traditional borings. These services may be required for projects involving bridges, walls and mast arms.

For consultant designed projects these services are typically included in the consultant's contract. However, in rare instances the subsurface explorations may be performed through MassDOT's Geotechnical Section.

For municipally designed projects the municipality will be responsible for the subsurface investigations. For MassDOT, in-house designed projects, the subsurface explorations will be obtained in coordination with MassDOT's Geotechnical Explorations.

The Project Manager shall consult with the Geotechnical Section regarding the most appropriate means of performing subsurface investigations and also discuss approximate costs (typically 1 to 3% of construction costs).

All Projects anticipated to involve subsurface utility relocations shall include scope and workhour provisions for the completion of Subsurface Utility Engineering (SUE) Level B during the project design phase, per Engineering Directive E-21-005. The work shall only be performed by firms prequalified by MassDOT's A&E Board. The costs for these services are accounted for under Preparation of Plans Specifications and Estimates (Section 4.2.1)

4.3. Public Meetings

4.3.1. Stenographer

The services to be performed by the Stenographer consist of attending public hearings and information meetings and furnishing the stenographic and transcription services that are

required to provide comprehensive coverage of the proceedings. MassDOT administers contracts with vendors specifically for this purpose. MassDOT typically provides these services for all projects (consultant design, municipal design and in-house design) under one of these contracts.

Stenographers typically cost approximately $500 per event.

4.3.2. Newspaper Advertisements

The Project Manager is responsible for consulting the Project Management SOPs and municipal representatives and/or District personnel to identify at least two newspapers local to the Project where the Notice of a Public Hearing/Meeting (the Notice) can be advertised.

Newspaper advertisements typically average approximately $1,100.

4.3.3. Written Notice Translations

The Project Manager is responsible for consulting the Project Management SOPs to procure written notice translations if additional language access services are required.

Written Notice Translations typically cost $70.

4.3.4. Live Language Translation

If additional language access services are required, live language translation will need to be secured. The Project Manager shall follow the public hearing and meeting SOPs to procure a live language translator.

Live Language Translations typically cost $800 per event.

4.3.5. Communication Access Realtime Translation (CART)

CART Service provides instantaneous translation of what is being said into visual print display so that it can be read (instead of heard). CART Service is one means of communication access for deaf or hard of hearing individuals who read English fluently. The Project Manager shall follow the public hearing and meeting SOPs to procure a live language translator.

CART services typically cost $500 per event.

4.3.6. American Sign Language (ASL) Services

ASL Interpreters provide live interpretations for meeting participants that may be Deaf or Hard of Hearing. The Massachusetts Office for the Deaf and Hard of Hearing maintain contracts with Interpreters.

ASL services typically cost about $500 per event.

4.4. Peer Review

In certain instances, MassDOT may either supplement or replace the review performed MassDOT staff with a review performed by an independent consultant engineering firm. This peer review typically involves a review of all components of the design submittal and is not specifically focused on the estimate. In accordance with the peer review SOPs, a peer review of the PS&E is recommended on projects with an estimated value greater than $15 Million.

4.5. Independent Cost Estimate

For projects with an Office Estimate of $15 Million or greater, MassDOT may secure the services of an independent firm to prepare an Independent Cost Estimate (ICE). Unlike a peer review which involves a review of the work prepared by the designer of record, an ICE involves building the estimate in its entirety based on a review of the plans and special provisions by a firm that was not involved in the development of the design.

Often this process begins with a meeting where the designer of record provides project information to the firm performing the ICE. After the ICE is completed, a reconciliation is conducted. At this reconciliation meeting the two firms exchange information regarding the basis and methodology used to prepare the estimate. The goal is for MassDOT to arrive at an estimated construction cost for the project.

An independent Cost Estimate typically costs in range of $50,000 to $75,000.

4.6. Value Engineering

Value Engineering (VE) involves the performance of systematic reviews and analyses of projects during the project development and design phases by multidisciplined teams of persons not involved in each project. These reviews and analyses yield recommendations for providing the needed project functions safely, reliably, efficiently and at the lowest overall cost; improving the value and quality of the project; and reducing the time to complete the project. Firms performing this work must be pre-qualified in MassDOT Architectural and Engineering Board's “V. Value Engineering”.

FHWA’s Stewardship and Oversight Agreement with MassDOT, indicates that projects on the Federal-aid system with an estimated total cost of $50 million or more ($40 million or more for a bridge project), require at least one VE analysis to satisfy federal requirements (see 23 CFR 627). When it is determined that a VE Study is required, MassDOT will contract with an independent firm to establish a Value Engineering Team. The team will review the project design and the associated cost. The Team will then determine if there are variations to the proposed design that would result in a more cost effective way of providing the same value to public.

A VE Study is not required on Design-Build Projects as the confidential Alternative Technical Concept process is viewed as a form of value engineering. However, there may be circumstances, such as significant scope or cost growth during preliminary design, which warrant conducting a VE Study.

A Value Engineering Study typically costs in the range of $50,000 to $100,000.

4.7. Owner's Representative (OR)

Massachusetts General Law - Chapter 39M1/2 requires that an OR be assigned to a project with an estimated cost exceeding $50 Million. ORs are specialized firms with Commonwealth registered professional engineers and a minimum of five years experience in construction of major projects and construction supervision. The focus of their work is to ensure that design and construction phase estimates, schedules and outcomes are reasonable and that any deviations or issues highlighted to management. The ORs are responsible for preparing monthly status reports and annual reports that are filed with the Inspector General, Secretary of Transportation, House and Senate Chairs of the Joint Committee on Transportation and the State Auditor.

MassDOT's Office of Performance and Asset Management maintains contracts with a number of ORs.

For projects greater than $50 Million a value of 1% of the Office Estimate shall be used.

4.8. Stipend

For Design-Build projects, the Stipend is an amount paid to the unsuccessful shortlisted entities to mitigate the costs associated with preparing the proposals. The amount determined shall multiplied by 2 (assumes three shortlisted entities). The Stipend will be calculated by multiplying the Office Estimate by 0.20 %.

4.9. MassDOT Project Development Costs

Overseeing the project development process from concept to project advertisement requires a significant investment of workhours by MassDOT staff. Nearly all projects require involvement by multiple discipline experts (highway, bridge, environmental, geotechnical, hydraulics, etc.) The costs included under MassDOT Project Development Costs include MassDOT staff workhours associated with the management, administration and design review for a project.

The MassDOT Project Development costs estimated in this section are the DOT Labor budgets that need to be established in the PARS Number requests.

In addition, workhours associated with in-house designed projects must also be accounted for under this category.

Note that MassDOT oversight costs associated with the construction phase are accounted for under Construction Engineering which is included in the Total Federal Participating Construction Cost.

For all Design-Bid-Build projects, regardless of design responsibility, it is recommended that 3 to 6% of the Total Construction Contract Cost be estimated for this purpose. These costs shall not include staff time during the construction phase as these costs are covered by Construction Engineering.

For Design-Build projects it is recommended that 2% of the Total Construction Contract Cost be estimated for this purpose. These costs shall not include staff time during the construction phase as these costs are covered by Construction Engineering.

4.10. Environmental Mitigation

In certain instances, MassDOT may enter into Agreements with regulatory agencies to account for costs associated with mitigating the environmental impacts of a project. Under these Agreements, payments are made from MassDOT to the regulatory agency.

The Project Manager shall consult with Environmental Services regarding the potential need to establish a budget for Environmental Mitigation and also discuss approximate costs.

4.11. Right of Way (ROW) Costs

For projects that will require the alteration of a State Highway Layout, the costs associated with these acquisitions must be accounted for.

ROW acquisition costs borne by the municipality for the alteration of municipal layout lines shall not be accounted for.

For projects that clearly will not require the acquisition of property and those that only require alterations to municipally owned layouts, a value of zero shall be used. For projects that will require the alteration of a State Highway Layout, a best estimate shall be made. It is understood that estimating these costs at the conceptual level of design is challenging. The Right of Way Bureau shall be consulted in instances where it is known that a significant alteration to the State Highway Layout is required. Otherwise, a value of 1% of the Office Estimate is recommended

5. Factors Influencing Cost Estimates

When developing any kind of cost estimates, there are multiple factors that must be considered in order to determine the most accurate value. The categories listed below are some of the key contributors that will make a project unique from others. If parametric values or weighted average bid prices are used for unit pricing, it is important to reference projects that share similar characteristics as listed below.

5.1. Geographic considerations

- Take into account urban vs. rural locations, number of roads/highways to provide access for construction equipment and material deliveries
- Terrain may require items for regulatory or safety reasons
- Site access coordination may be required to access areas such as railroads, waterways, or environmentally sensitive zones
- Geotechnical Conditions
- Site/Ground Conditions

5.2. Operations

- Include costs for night work or day work
- Separate operations meaning that you have your work spread across various locations
- Inefficient operations; includes handwork or work that is more difficult to produce

5.3. Item Availability

- Supply/demand
- Seasonal items

5.4. Scheduling

- Delays due to weather, design changes and labor availability
- Accelerations to the construction schedule identified during the design phase, may lead to labor premiums when working a non-standard schedule
- Miscellaneous contributions to schedule changes such as site conditions, moratoriums issued by municipalities, in-water work windows, and other factors that limit the contractor from working a standard work week

5.5. Lump Sum Pay Items

- Lump sum pay items are used to reduce cost overruns to minimize cost growth of projects and to share the risk of additional material quantities with contractors. The scope and plans for work to be included in a lump sum item must be well defined. The determination regarding

how best to define a lump sum item must consider how effectively the measurement and payment of the work can be administered by MassDOT.

5.6. Force Account/Third Party Utilities

- Early coordination is required with Third Party Utility companies to allow for them to provide an estimate and to plan for relocations.
- Consider that any schedule impacts a utility relocation may have to a project as a delay in time will lead to extended overhead costs and escalated material/labor prices.

5.7. Advertisement Date/Contractor Availability

- Need to consider how the timing of the advertising date affects contractor availability. A project that is advertised during the middle of the construction season may not be as competitive because the bidders are already at capacity for the season.
- Specialty work will limit the number of bidders resulting in higher bid pricing.

6. Production Based Construction Cost Estimates

6.1. Summary

The Production Based Estimating approach is often referred to as 'bottom-up' cost estimating. This construction cost estimating methodology is more effective than traditional unit price estimating because estimates are developed based on the way that the project will be constructed rather than merely applying unit prices to quantity take-offs.

Bottom-up estimates are typically performed at the 75% design stage, 100% design stage and at PS&E stage for lump sum items. Bottom-up cost estimates are not required for standard items with other units of measure, but recommended for bid items with extended cost greater than $100,000. A bottom-up cost estimate is a cost estimate that is based on a detailed breakdown of labor, materials, equipment and production rates. A bottom-up cost estimate for lump sum items will be performed if the Project:

- has an estimated construction cost of at least $15 million;
- has an estimated construction cost of at least $6 million and is complex (e.g., includes complex traffic sequencing, construction over a waterway, utility relocation, Right of Way issues, or railroad coordination), as determined by MassDOT;
- includes accelerated construction techniques;
- or on an as needed basis as determined by MassDOT

Bottom-Up Cost Estimating:

- Involves developing costs for the crews, equipment, and production rates that a contractor would use in constructing the project, and developing the estimate based on this information.
- Helps to identify and resolve constructability issues to optimize the contractor bid price (risk reduction) and construction performance.
- Helps to prepare a comprehensive schedule (significant time related dependencies can be translated into a project construction schedule from the detailed cost estimate.)

This early linking of design to project cost estimating fosters effective cost and schedule control throughout the life of the project and helps to avoid claims and delays.

6.2. Important Pricing Considerations

All Bottom-Up estimates for lump Sum items shall contain appropriate markups for indirect costs including home office overhead, profit and insurance (special coverage such as pollution, marine, and other unique job requirements) and bonds. All estimates should exclude escalation from the Items as MassDOT will apply this programmatically. Time and care must also be taken to develop overhead costs, general conditions costs, and profit rates in a sound, logical manner, rather than by applying blanket percentages and should be done in a manner that does not duplicate mark-ups already applied to the historical unit prices used in the estimate (if applicable). Prices at the detail level for material, equipment, and labor must reflect local/industry pricing to the maximum extent possible.

Labor pricing shall be current and shall incorporate:

- Appropriate Prevailing Wage rates and fixed fringes for the local area;
- Variable fringe/burden calculations based on assumption of hours per working year or years of retention (e.g., holidays and vacation for some Union trades);
- Workers' Compensation rates;
- Appropriate payroll taxes and insurances (Federal and State Income tax, Social Security, Medicare, Mass. Health, etc.); and
- Assumed contractor healthcare and vacation benefits.

Pricing of overtime and shift work shall reflect appropriate local labor wage premiums and appropriate calculation of payroll taxes and burdens. This will be evaluated as part of the 75% (or 100%) submission, following the completion of a detailed Contract Time Determination study (i.e., detailed construction schedule) that utilizes information from the construction cost estimate.

The designer's estimator should be mindful to avoid applying duplicative mark-ups to the components of the cost estimate that are unit priced (not lump sum) – as the WABA data base already includes mark-ups. Guidance on the use of WABA can be found (here). The estimator should carefully consider the date range selected. It is important to select a date range that will result in a meaningful sample size. However, the estimator must also be aware that if there have been recent fluctuations in the economy, or other changes in the market that affect unit pricing, a shorter date range or other adjustments may be necessary.

All construction 'Bottom Up' cost estimates provided by the designer are not to include design phase contingency of any type embedded into the payment items. MassDOT will formulate escalation and design phase contingency to account for: the lack of scoping detail; changes to the scope that will inevitably occur as design progresses; known and unknown project risk factors; and market fluctuations that will occur over the life of the project. However, the Designer is asked to identify what aspects of the quantity development are considered to be quantity contingency (because the scope has not fully evolved yet).

6.3. Construction Cost Estimate Narrative

For all projects requiring a Bottom-Up Construction Cost Estimate, the designer is required to submit a detailed narrative providing all of the relevant basis and assumptions used to produce the pricing for all applicable lump sum items.

The estimate narrative should list the following:

- List the specific project documents and source documents forming the basis of estimated scopes and assumptions (include dates for each of the identified sources).
- Identify all scopes, quantities, and costs provided by sources other than the estimating team (e.g., 'pass-through' allowances provided by the MassDOT (including MBTA), the Designer, or third party).

- Reconcile major scope changes from prior estimates, as identified by the design team.
- Reconcile summary level cost variances from prior estimate, in tabular or narrative form.
- Reference, and explain, detailed estimate 'backup' so that third party readers can correlate summary level information with the backup.
- Outline unresolved scope or cost issues.
- Verify that the Project Utilities Coordination form (PUC) has been provided and utilized.
- Describe concerns, approach, and documents used to formulate the estimate for all sub-surface work.
- Describe any constructability concerns that were identified during the preparation of the estimate that MassDOT's Construction Section should be made aware of and identify what actions are being taken by the Designer to resolve them.
- Describe estimate departures from project documents, and why they are included (e.g., constructability).
- Describe estimate assumptions regarding site access restraints.
- Describe estimate assumptions regarding sequence of work and labor shifts.
- Describe the specific estimating methodologies employed (e.g., parametric; detailed; quoted; historical, or other sources).
- Describe the basis of material cost development, labor cost development, equipment cost development, markups development.
- Describe the basis and levels of project markups, overhead, profit, and soft costs applied, with justification.
- Describe contingencies applied and how they were developed (if any).
- Describe escalation markup applied to bottom line (if any).
- Outline major project risks that may significantly impact project costs.
- Where formal, or informal, risk analysis has been employed, outline how it has been used in development of the cost estimate.

6.4. Estimator Working with Design Team

The professional cost estimator is engaged to help ensure that project design is likely to meet construction budget expectations. Whereas each design professional in the team may work on a subset of the project scope, the estimators must become familiar with all content in all documents and will need to frequently be involved in the evolution of the design. Developing estimates with the mindset of contractor preparing a bid estimate will allow the estimator to produce valuable feedback to the

Designer and MassDOT (through the Designer PM) regarding final document clarity, accuracy, biddability, and constructability.

The level of detail of the assumptions will vary from project to project, but the estimator shall discuss and validate all assumptions with the project design team.

6.5. Bottom-Up Estimating Quality Assurance Considerations

The designer is required to provide quality assurance for the development of their submission documents. The following are some recommendations for those aspects of the estimate that should be specifically addressed as part of the designer's quality process. This list may vary depending upon the project complexity.

- Check to ensure that all scope elements are included in the estimate.
- Check to ensure the estimate is in the required format (review of correspondence and other documentation provided by the estimator which identifies the required format that the estimate is to be presented in, e.g., CSI (buildings), bid item numbers, Uniformat (buildings), etc.)
- Review the summary level pricing represented by the overall estimate, if feasible. For example, check the overall square foot price of the estimate and compare it with pricing of similar bridge projects using the most pertinent pricing source available, e.g., historic project pricing, or estimating manuals.
- Review the estimator's take-off files to ensure the accuracy of quantities derived by the estimator. At a minimum, check quantities of major scope items comprising the majority of the cost of the project. Ensure that quantity take-off documentation is included in the estimate file prepared by the estimator and utilized the current documents.
- Ensure that backup documentation is included in the estimate file prepared by the estimator for all items of material. Backup documentation may include vendor quotes, historic pricing from other recent estimates, photocopies of pages from estimating manuals, copies of recent invoices, or other pertinent substantiation.
- Ensure that backup documentation is included in the estimate file prepared by the estimator for all equipment. Backup documentation may include vendor quotes, historic pricing from other recent estimates, photocopies of pages from estimating manuals, copies of recent invoices or lease agreements, or other pertinent substantiation.
- Ensure that backup documentation is included in the estimate file prepared by the estimator for all labor. Backup documentation should include prevailing wage agreements in the vicinity of the project and other pertinent information. If appropriate, check to see that the backup includes a workup of the elements comprising the fully burdened wage rate.
- Check to ensure that overhead and profit have been included in the estimate. Verify that the overhead and profit rates used are appropriate for the project. Ensure that the estimate file prepared by the estimator contains a discussion/workup of overhead and profit rates used.

- The quality review process shall document all questionable cost elements identified during the review by red-lining the estimate, or other suitable means. The reviewer shall then discuss the review, including all questionable cost elements, with the estimator. The estimator shall make adjustments to the estimate based on the comments provided by the reviewer, and shall provide a copy of the adjusted estimate to the reviewer. The reviewer shall validate that all adjustments discussed with the estimator have been incorporated into the estimate.

6.6. Example Bottom-Up Estimate

Figure 2 shows an example of the details provided in the production based cost estimate for the direct cost elements (i.e., those costs that are directly attributable to a particular operation – excluding indirect costs that are often shared between many operations, such as the field office costs). This example is shown in HCSS Software. Timberline and Excel Spreadsheets are also commonly used to satisfy the production based estimating approach.

Activity / Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Material	Constr Matl/Exp	Equip Ment	Sub-Contract	Total
BID ITEM = 700	CLIENT# = 945.204										
Description =	APPROACH LAND: 8-EA, DIA-5.0'				Unit = LF	Takeoff Quan:		150.000	Engr Quan:		150.000
2	MATERIALS		150.00	LF	125.000		19,406				19,406
8CR25T	Hydraulic Crane, 25 To	1.00	177.27	HR	101.720				18,663		18,663
8MDRTM	Drill Rig Track-Mounte	1.00	177.27	HR	330.000				60,547		60,547
8SUCHOSE	20' Suction Hose, 2"	1.00	177.27	HR	0.270				50		50
8WDH6	50' Discharge Hose 6"	1.00	177.27	HR	1.660				305		305
8WP6	Cent. Water Pump 6"	1.00	177.27	HR	40.000				7,339		7,339
LABFM	Labor Foreman	1.00	177.27	MH	54.010	14,156					14,156
LABOR	Laborer	3.00	531.82	MH	51.600	40,377					40,377
OPCR	Crane Operator	2.00	354.55	MH	50.100	26,261					26,261
OPEO	Equipment Operator (Light)	1.00	177.27	MH	50.100	13,130					13,130
OPOIL	Oiler	2.00	354.55	MH	50.100	26,261					26,261
PDD	Pile Driver	2.00	354.55	MH	65.320	34,098					34,098
$260,592.18	13.0000 MH/LF		1,950.01	MH	[721.62]	154,283	19,406		86,903		260,592
0.8462 Units/Hr	6.7693 Un/Shift		0.0769	Unit/MH		1,028.56	129.38		579.35		1,737.28
======> Item Totals:	700 - APPROACH LAND: 8-EA, DIA-5.0'										
$260,592.18	13.0000 MH/LF		1,950.01	MH	[721.62]	154,283	19,406		86,903		**260,592**
1,737.281	150 LF					1,028.56	129.38		579.35		1,737.28

HCSS SOFTWARE

Figure 2: Example Direct Cost Estimate Format

Estimate components expected:

- Bid Item or cost group
- Quantity (Unit to be measured and installed)
- Description of item being priced
- Coding for labor and equipment

- Crew size/composition
- Material costs / unit – with breakdown of all materials (described) required for the operation (not shown above for simplicity) – shown as temporary or permanent
- Production rate – MH/Unit, Unit/MH, Unit/Shift, Unit/Hr. Sub-Totals – for all labor material and equipment
- Working Hours / Overtime Rules

7. Design-Bid-Build Estimate Process

7.1. Process

Chapter 3 described the structure to be used when organizing all the costs associated with a MassDOT construction project. This chapter will replicate that structure for each of the major milestones in the project development process.

The certainty of a project cost estimate is linked to the maturity of the underlying concept or design. Generally, a project begins as a concept and is refined over a series of design iterations to constitute a design package to support competitive bidding of the work. The major project development milestones are discussed below from the standpoint of cost.

Project Initiation (PI)

Considering that design work has not started, and an alternatives analysis has not been completed, it is understood that the estimate will be very high level. Estimates at this stage are often based on costs associated with similar projects.

Planning (Pre-25%)

Engineering Directive E-21-002 describes the Pre-25% Design Scoping Procedures. Although more is known about the project at this stage than was known at the PRC stage, the design is only at approximately the 10% level and the public involvement process has likely been limited. As a result, the estimate at this stage is still at a conceptual level.

Preliminary (25%)

Preliminary cost estimates are based on specific project limits, a general scope of work and a defined roadway cross section. Preliminary design is intended to demonstrate a basic engineered solution to the purpose and need of the project. The plans are developed sufficiently to communicate to MassDOT the application of the design criteria and also communicate to the public the potential environmental and ROW impacts.

Intermediate (75%)

Intermediate design should fully detail and estimate all facets of the project and provide construction sequencing, construction duration and utility impacts as part of the submission.

Final Design (100%/PS&E)

Final Design presents completed plans, specifications and an estimate for bidding of the project.

7.2. Structure of this Chapter

This chapter will provide guidance for each element of the estimate structure associated with each project development milestone. This guidance evolves as the level of detail associated with the project development milestones advances. Although the structure of this chapter results in some repetition, it allows the reader to refer to one location of the guide to understand the methodology for all aspects of the estimate.

DBB Project Review Committee

7.3. Project Initiation (PI)

Estimated Total Construction Cost

7.3.1. Office Estimate

Considering how little is known about the project at this stage, a parametric approach to estimating is appropriate. Appendix A provides values based on project type that may be used to establish an estimated construction cost. It is important to consider that these are average values. Adjustments to these values may be appropriate based on an understanding of the unique circumstances associated with a given project. These values are current as of 2022 and should escalated by 4% each year for estimates completed after 2022. See Section 10. STIP Compliance and the CAPE, for Construction Project Estimator process.

7.3.2. Design Contingency

The amount for Design Contingency is based on the Office Estimate as noted below:

Project Type	% of Office Estimate for Design Contingency
Roadway Reconstruction	30%
Bridge Construction	20%
Resurfacing and Maintenance	0%

The District or Program Manager responsible for initiating the project is also responsible for entering the design contingency in the project initiation stages. At this stage, Design Contingency should be included in the Office Estimate amount until such time as the formulas are added to the CAPE drop down lists. If any of the items are required at PI, the Districts and Program Managers will need to put them into MaPIT so they can be carried forward.

7.3.3. Allowance Items

7.3.3.1. Traffic Police (999.001 and 999.002)

The percentages listed below are based on historical information and represent an average for the project type identified in the chart. The designer may adjust these values based on their understanding of the specific circumstances associated with the project. Note the FHWA will only participate in 70% of the hours estimated for Traffic police. Therefore, the hours for Traffic Police must be allocated to a FA Item number and a NFA Item number. The roadway flaggers are not an allowance item. Roadway flaggers are included in the Office Estimate and paid under Item 850.41 Roadway Flagger.

Project Type	% of Office Estimate for Traffic Police	% of Office Estimate for Roadway Flaggers
Bikeways and Paths	1.50%	1.00%
Bridge Closed - Detour Provided	1.00%	0.025%
Bridge Kept Open - Staged	2.00%	0.10%
Bridge Open - Temporary Signal	2.00%	0.10%

Project Type	% of Office Estimate for Traffic Police	% of Office Estimate for Roadway Flaggers
Interstate Highways	5.50%	0.00%
Roadway Reconstruction	3.50%	0.20%
Town Centers	4.50%	0.10%
Bridge - Various Locations	7.00%	0.00%
Highway - Various locations	7.50%	0.00%

7.3.3.2. Trainees (999.080)

The amount for Trainees is based on the Office Estimate and is determined using the table below:

Office Estimate	Amount
$0 to $2,999,999	$0
$3M to $3,999,999	$800
$4M to $4,999,999	$1,600
$5M to $6,999,999	$2,400
$7M to $9,999,999	$3,200
$10M+	$4,000

7.3.3.3. Railroad (RR) Flaggers (999.200)

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required. For Chapter 634 bridges owned by the MBTA, flagging is paid for under Item 999.200. For all non-MBTA Chapter 634 bridges the railroad is responsible for providing these services without compensation.

The designer shall estimate the cost of flaggers based on assumed durations for potentially fouling the tracks and hourly rates for flaggers. MassDOT's State Utilities Engineer may be consulted for assistance.

7.3.3.4. Incentive (999.785)/Disincentive (999.786)

At the PI stage sufficient information is typically not available to evaluate the appropriateness of I/D or lane rental provisions. Therefore, at the PI stage it is acceptable to use a value of zero.

7.3.4. Construction Engineering

The estimated amount for Construction Engineering is based on a percentage that is applied to the Office Estimate plus the 999 items and is calculated by the CAPE.

Project Type	% for Construction Engineering
Office Est. plus 999 Items Less Than $1 Mil.	15%

Project Type	% for Construction Engineering
Office Est. plus 999 Items Between $1 Mil. and $5 Mil.	10%
Office Est. plus 999 Items Greater than $5 Mil.	5%

7.3.5. Construction Contingency

The estimated amount for Construction Contingency is based on the Office Estimate and is calculated by the CAPE.

Project Type	% of Office Estimate for Construction Contingency
NFA Open Ended	0%
Municipal Non-Participating	0%
Federal Aid	10%
NFA Site Specific	15%

DBB Project Review Committee

7.3.6. Utility Force Accounts

Considering how little is known about the impacts of a project on existing utilities at the PI stage, it is acceptable to use the table below for estimating purposes. The costs contained in the table below have already taken into account the reimbursement percentages in accordance with the MassDOT Utility Reimbursement Policy (Engineering Directive E-11-008). These recommended percentages are for guidance only. When applying these costs, the designer and Project Manager must continue to use engineering judgement gained from their detailed knowledge of the specific project involved before determining the estimated cost. For example, if the proposed project is known to not contain any existing utilities, the project estimate does not need to include an amount. Conversely, if the project is known to have a very high volume of complex utility relocations, a higher percentage could be applied.

Project Group	% of Office Estimate for Utility Agreement Costs
Roadway (Reconstruction, Widening, Resurfacing, etc.) (Less than $20 Million)	8%
Roadway Projects Over $20 Million	5%
Bridge (Less than $20 Million)	8%
Bridge (More Than $20 Million)	4%

7.4. Planning (Pre-25%)

Estimated Total Construction Cost

7.4.1. Office Estimate

DBB 25%

At the Pre-25% stage a parametric approach to estimating may be acceptable in certain instances. However, a more detailed project specific approach should be considered whenever feasible. Although a detailed item by item estimate is not necessary at this stage, a well-organized, project specific conceptual estimate will provide a more accurate estimated value than the parametric approach. A framework for estimating projects at the conceptual level is contained in the following link https://www.mass.gov/doc/state-aid-reimbursable-programs-estimating-tool/download.

The designer should consider the use of a 5% or 10% design in AutoCAD for the purposes of developing this estimate. The design typically is developed to a level that has an AutoCAD civil 3D corridor and design surface built, albeit a basic design. It may not contain more advanced design such as roadside grading for barriers, superelevation transitions, stormwater BMPs, etc. However, the design linework and surfaces can be used to prepare quantities for earthwork, pavements, retaining walls, etc. Items such as drainage, environmental, landscaping, and utility relocations may be estimated as a percentage of the project, or if possible, developed to the 10% level. Proposed traffic design should be estimated if large items such as signals, overhead signs, or ITS are included. Temporary traffic signals and temporary traffic control, including temporary pavement should be estimated if staging has been developed, otherwise a percentage can be used.

7.4.2. Design Contingency

The amount for Design Contingency is based on the Office Estimate as noted below:

Project Type	% of Office Estimate for Design Contingency
Roadway Reconstruction	25%
Bridge Construction	15%
Resurfacing and Maintenance	0%

7.4.3. Allowance Items

7.4.3.1. Traffic Police (999.001 and 999.002)

The percentages listed below are based on historical information and represent an average for the project type identified in the chart. The designer may adjust these values based on their understanding of the specific circumstances associated with the project. Note the FHWA will only participate in 70% of the hours estimated for Traffic Police. Therefore, the hours for Traffic Police must be allocated to a FA Item number and a NFA Item number. The roadway flaggers are not an allowance item. Roadway flaggers are included in the Office Estimate and paid under Item 850.41 Roadway Flagger.

Project Type	% of Office Estimate for Traffic Police	% of Office Estimate for Roadway Flaggers
Bikeways and Paths	1.50%	1.00%
Bridge Closed - Detour Provided	1.00%	0.025%
Bridge Kept Open - Staged	2.00%	0.10%
Bridge Open - Temporary Signal	2.00%	0.10%
Interstate Highways	5.50%	0.00%
Roadway Reconstruction	3.50%	0.20%
Town Centers	4.50%	0.10%
Bridge - Various Locations	7.00%	0.00%
Highway - Various locations	7.50%	0.00%

7.4.3.2. Trainees (999.080)

The amount for Trainees is based on the Office Estimate and is determined based on the table below:

Office Estimate	Amount
$0 to $2,999,999	$0
$3M to $3,999,999	$800
$4M to $4,999,999	$1,600
$5M to $6,999,999	$2,400
$7M to $9,999,999	$3,200
$10M+	$4,000

7.4.3.3. Railroad (RR) Flaggers (999.200)

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required. For Chapter 634 bridges owned by the MBTA, flagging is paid for under Item 999.200. For all non-MBTA Chapter 634 bridges the railroad is responsible for providing these services without compensation. In all other instances the designer shall estimate the cost of flaggers based on assumed durations for potentially fouling the tracks and hourly rates for flaggers. MassDOT's State Utilities Engineer may be consulted for assistance.

7.4.3.4. Incentive (999.785)/Disincentive (999.786)

At the Pre-25% stage sufficient information may not be available to evaluate the appropriateness of I/D or lane rental provisions. However, if the Project Manager is aware that the nature of the project is such that the impacts to the traveling public are so great that reducing the construction duration is an important consideration, and the project meets the criteria described in Engineering Directive E-21-003, the Project Manager may include an amount equal to 5% of the Office Estimate.

7.4.4. Construction Engineering

The estimated amount for Construction Engineering is based on a percentage that is applied to the Office Estimate plus the 999 Items and is calculated by the CAPE.

Project Type	% for Construction Engineering
Office Est. plus 999 Items Less Than $1 Mil.	15%
Office Est. plus 999 Items Between $1 Mil. and $5 Mil.	10%
Office Est. plus 999 Items Greater than $5 Mil.	5%

7.4.5. Construction Contingency

The estimated amount for Construction Contingency is based on the Office Estimate and is calculated by the CAPE.

Project Type	% of Office Estimate for Construction Contingency
NFA Open Ended	0%
Municipal Non-Participating	10%
Federal Aid	10%
NFA Site Specific	15%

7.4.6. Utility Force Accounts

Considering how little is known about the impacts of a project on existing utilities at the Pre-25% stage, it is acceptable to use the table below for estimating purposes. The costs contained in the table below have already taken into account the reimbursement percentages in accordance with the MassDOT Utility Reimbursement Policy (Engineering Directive E-11-008). These recommended percentages are for guidance only. When applying these costs, the designer and Project Manager must continue to use engineering judgement gained from their detailed knowledge of the specific project involved before determining the estimated cost. For example, if the proposed project is known to not contain any existing utilities, the project estimate does not need to include an amount. Conversely, if the project is known to have a very high volume of complex utility relocations, a higher percentage could be applied.

Project Group	% of Office Estimate for Utility Agreement Costs
Roadway (Reconstruction, Widening, Resurfacing, etc.)	8%
Roadway Projects Over $20 Million	5%
Bridge (Less than $20 Million)	8%
Bridge (More Than $20 Million)	4%

7.5. Preliminary (25%)

Estimated Total Construction Cost

7.5.1. Office Estimate

At the 25% design a detailed item by item estimate is not required. However, a well-organized, preliminary estimate is required. A framework for estimating projects at the conceptual level is contained in the following link https://www.mass.gov/doc/state-aid-reimbursable-programs-estimating-tool/download. Designers may also use CADD models to determine surface areas and cut and fill volumes, then organize the estimated quantities based on Division II of the Standard Specifications for Highways and Bridges. Depending on the methodology used to determine the value for certain elements of the work, the designer may use WABA to develop unit prices. Although an individual item by item estimate may not be employed for every element of the work, it is important that the total reflect the entirety of work to be included in the contractor's bid.

See Section 10. STIP Compliance and the CAPE, for Construction Project Estimator process.

DBB 25%

7.5.2. Design Contingency

The amount for Design Contingency is based on the Office Estimate as noted below:

Project Type	% of Office Estimate for Design Contingency
Roadway Reconstruction	25%
Bridge Construction	15%
Resurfacing and Maintenance	0%

7.5.3. Allowance Items

7.5.3.1. Traffic Police (999.001 and 999.002)

At the 25% stage it is acceptable to use the table below. However, if the details of the traffic management plan are sufficiently advanced, an estimate of the actual hours for Traffic Police and roadway flaggers shall be prepared as described later in this section.

The percentages listed below are based on historical information and represent an average for the project type identified in the chart. The designer may adjust these values based on their understanding of the specific circumstances associated with the project. The FHWA will only participate in 70% of the hours estimated for Traffic Police. Therefore, the hours for Traffic Police must be allocated to a FA Item number and a NFA Item number. The roadway flaggers are not an allowance item. Roadway flaggers are included in the Office Estimate and paid under Item 850.41 Roadway Flagger.

Project Type	% of Office Estimate for Traffic Police	% of Office Estimate for Roadway Flaggers
Bikeways and Paths	1.50%	1.00%
Bridge Closed - Detour Provided	1.00%	0.025%
Bridge Kept Open - Staged	2.00%	0.10%
Bridge Open - Temporary Signal	2.00%	0.10%
Interstate Highways	5.50%	0.00%
Roadway Reconstruction	3.50%	0.20%
Town Centers	4.50%	0.10%
Bridge - Various Locations	7.00%	0.00%
Highway - Various locations	7.50%	0.00%

If sufficient information is available, the designer shall calculate the actual hours of Traffic Police and roadway flaggers based on the traffic management plan prepared for the project. The designer is responsible for investigating which police department(s) have jurisdiction of roadway(s) included in the project. For MassDOT jurisdiction roadways the hourly rate shall be based on the rates for State Police. For municipal jurisdiction roadways, municipal police department rates shall be used. The designer is responsible for contacting the appropriate police department to obtain the rates.

7.5.3.2. Trainees (999.080)

The amount for Trainees is based on the Office Estimate as noted below:

Office Estimate	Amount
$0 to $2,999,999	$0
$3M to $3,999,999	$800
$4M to $4,999,999	$1,600
$5M to $6,999,999	$2,400
$7M to $9,999,999	$3,200
$10M+	$4,000

7.5.3.3. Railroad (RR) Flaggers (999.200)

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required. For Chapter 634 bridges owned by the MBTA, flagging is paid for under Item 999.200. For all non-MBTA Chapter 634 bridges the railroad is responsible for providing these services without compensation. In all other instances the designer shall estimate the cost of flaggers based on assumed durations for potentially fouling the tracks and hourly rates for flaggers. MassDOT's State Utilities Engineer may be consulted for assistance.

DBB 25%

7.5.3.4. Incentive (999.785)/Disincentive (999.786)

At the 25% design stage, Engineering Directive E-21-003, indicates that the Project Manager is responsible for evaluating the project utilizing the Incentive/Disincentive and Lane Rental Checklist, Part I. Provided the project is a Design-Bid-Build or Design-Build project with an Office Estimate greater than $10 million and the type of work is consistent with those identified in the Engineering Directive. Projects that involve accelerated construction techniques, or an overriding public interest shall also be subject to this Engineering Directive, regardless of the amount of the Office Estimate.

If the Boston Construction Section concurs that Incentive/Disincentive or Lane Rental provisions are appropriate the Project Manager is also responsible for ensuring that the Contract Advertising and Planning Estimator (CAPE) includes the proposed amount under ITEM 999.785 INCENTIVE. The CAPE shall also reflect an amount of $0.00 under ITEM 999.786 DISINCENTIVE.

7.5.4. Construction Engineering

The estimated amount for Construction Engineering is based on a percentage that is applied to the Office Estimate plus 999 Items and is calculated by the CAPE.

Project Type	% for Construction Engineering
Office Est. plus 999 Items Less Than $1 Mil.	15%
Office Est. plus 999 Items Between $1 Mil. and $5 Mil.	10%
Office Est. plus 999 Items Greater than $5 Mil.	5%

7.5.5. Construction Contingency

The estimated amount for Construction Contingency is based on the Office Estimate and is calculated by the CAPE.

Project Type	% of Office Estimate for Construction Contingency
NFA Open Ended	0%
Municipal Non-Participating	10%
Federal Aid	10%
NFA Site Specific	15%

7.5.6. Utility Force Accounts

At the 25% stage, it is acceptable to use the table below for estimating purposes. The costs contained in the table below have already taken into account the reimbursement percentages in accordance with the MassDOT Utility Reimbursement Policy (Engineering Directive E-11-008). These recommended percentages are for guidance only. When applying these costs, the designer and Project Manager must continue to use engineering judgement gained from their detailed knowledge of the specific project involved before determining the estimated cost. For

example, if the proposed project is known to not contain any existing utilities, the project estimate does not need to include an amount. Conversely, if the project is known to have a very high volume of complex utility relocations, a higher percentage could be applied.

Project Group	% of Office Estimate for Utility Agreement Costs
Roadway (Reconstruction, Widening, Resurfacing, etc.)	8%
Roadway Projects Over $20 Million	5%
Bridge (Less than $20 Million)	8%
Bridge (More Than $20 Million)	4%

DBB 75%

7.6. Intermediate (75%) Estimated Total Construction Cost

7.6.1. Office Estimate

At this stage of design, a detailed item by item cost estimate is required. Estimates shall be prepared using the Construction Project Estimator (CPE) and Weighted Bid Price Application (WABA). On certain projects, production based cost estimates for lump sum items may be required as described in Chapter 6.

7.6.2. Design Contingency

Design Contingency

Project Type	% of Office Estimate for Design Contingency
Roadway Reconstruction	12.5%
Bridge Construction	7.5%
Resurfacing and Maintenance	0%

7.6.3. Allowance Items

7.6.3.1. Traffic Police (999.001 and 999.002)

At the 75% stage sufficient information is available to calculate the actual hours of Traffic Police and roadway flaggers based on the traffic management plan prepared for the project. The designer is responsible for investigating which police department(s) have jurisdiction of roadway(s) included in the project. For MassDOT jurisdiction roadways the hourly rate shall be based on the rates for State Police. For municipal jurisdiction roadways municipal police department rates shall be used. The designer is responsible for contacting the appropriate police department to obtain the rates.

The FHWA will only participate in 70% of the hours estimated for Traffic Police. Therefore, the hours for Traffic Police must be allocated to a FA Item number and a NFA Item number. The roadway flaggers are not an allowance item. Roadway flaggers are included in the Office Estimate and paid under Item 850.41 Roadway Flagger.

7.6.3.2. Trainees (999.080)

The amount for Trainees is based on the Office Estimate as noted below:

Office Estimate	Amount
$0 to $2,999,999	$0
$3M to $3,999,999	$800
$4M to $4,999,999	$1,600
$5M to $6,999,999	$2,400
$7M to $9,999,999	$3,200
$10M+	$4,000

7.6.3.3. Railroad (RR) Flaggers (999.200)

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required. For Chapter 634 bridges owned by the MBTA, flagging is paid for under Item 999.200. For all non-MBTA Chapter 634 bridges the railroad is responsible for providing these services without compensation. In all other instances the designer shall estimate the cost of flaggers based on assumed durations for potentially fouling the tracks and hourly rates for flaggers. MassDOT's State Utilities Engineer may be consulted for assistance.

7.6.3.4. Incentive/Disincentive (999.785)

At the 75% design stage, Engineering Directive E-21-003, indicates that the Project Manager is responsible for updating the Incentive/Disincentive and Lane Rental Checklist, Part I, and preparing the Part II Checklist. This Engineering Directive also describes the process to receive approval to utilize Incentive/Disincentive or Lane Rental provisions and the mechanism to determine the recommended values. If the actual incentive values are available at this stage, these values shall be used. In the absence of a calculated amount, 5% of the Office Estimate shall be used. If it is determined that Incentive/Disincentive or Lane Rental provisions are not appropriate for the project, Item 999.785 shall not be included in the estimate.

7.6.4. Construction Engineering

The estimated amount for Construction Engineering is based on a percentage that is applied to the Office Estimate plus the 999 Items and calculated by the CAPE.

Project Type	% for Construction Engineering
Office Est. plus 999 Items Less Than $1 Mil.	15%
Office Est. plus 999 Items Between $1 Mil. and $5 Mil.	10%
Office Est. plus 999 Items Greater than $5 Mil.	5%

7.6.5. Construction Contingency

The estimated amount for Construction Contingency is based on the Office Estimate and is calculated by the CAPE.

Project Type	% of Office Estimate for Construction Contingency
NFA Open Ended	0%
Municipal Non-Participating	0%
Federal Aid	10%
NFA Site Specific	15%

7.6.6. Utility Force Accounts

At the 75% stage the scope of the utility relocations for the project are known. If estimates have been received from the affected utility companies these values shall be used. Otherwise, the Project Manager shall work with the State Utilities Engineer to determine an estimated value.

7.7. Final Design (100%/PS&E)

Estimated Total Construction Cost

7.7.1. Office Estimate

A detailed item by item cost estimate is required. Estimates shall be prepared using the Construction Project Estimator (CPE) and Weighted Bid Price Application (WABA). In certain instances, production based cost estimates for lump sum items may be required as described in Chapter 6.

7.7.2. Design Contingency

At this stage of design, a design contingency is not required for any project. All of the unknowns from the early design stages should resolved. Any unforeseen conditions encountered during construction are accounted for with the Construction Contingency.

7.7.3. Allowance Items

7.7.3.1. Traffic Police (999.001 and 999.002)

The designer shall calculate the actual hours of Traffic Police and roadway flaggers based the traffic management plan prepared for the project. The designer is responsible for investigating which police department(s) have jurisdiction of roadway(s) included in the project. For MassDOT jurisdiction roadways the hourly rate shall be based on the rates for State Police. For municipal jurisdiction roadways municipal police department rates shall be used. The designer is responsible for contacting the appropriate police department to obtain the rates.

The FHWA will only participate in 70% of the hours estimated for Traffic Police. Therefore, the hours for Traffic Police must be allocated to a FA Item number and a NFA Item number. The roadway flaggers are not an allowance item. Roadway flaggers are included in the Office Estimate and paid under Item 850.41 Roadway Flagger.

7.7.3.2. Trainees (999.080)

The amount for Trainees is based on the Office Estimate as noted below:

Office Estimate	Amount
$0 to $2,999,999	$0
$3M to $3,999,999	$800
$4M to $4,999,999	$1,600
$5M to $6,999,999	$2,400
$7M to $9,999,999	$3,200
$10M+	$4,000

DBB 100%

DBB 100%

7.7.3.3. Railroad (RR) Flaggers (999.200)

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required. For Chapter 634 bridges owned by the MBTA, flagging is paid for under Item 999.200. For all non-MBTA Chapter 634 bridges the railroad is responsible for providing these services without compensation. In all other instances the designer shall estimate the cost of flaggers based on assumed durations for potentially fouling the tracks and hourly rates for flaggers. MassDOT's State Utilities Engineer may be consulted for assistance. At the 100%/PS&E stage the actual estimate of costs from the railroad may be available. In these instances that actual costs shall be used.

7.7.3.4. Incentive (999.785)/Disincentive (999.786)

At the 100%/PS&E stage, the actual calculated values for the Incentive/Disincentive or Lane Rental provisions are available and shall be used. If it is determined that Incentive/Disincentive or Lane Rental provisions are not appropriate for the project Item 999.785 shall not be included in the estimate.

7.7.4. Construction Engineering

The estimated amount for Construction Engineering is based on a percentage that is applied to the Office Estimate plus 999 Items and is calculated by the CAPE.

Project Type	% for Construction Engineering
Office Est. plus 999 Items Less Than $1 Mil.	15%
Office Est. plus 999 Items Between $1 Mil. and $5 Mil.	10%
Office Est. plus 999 Items Greater than $5 Mil.	5%

7.7.5. Construction Contingency

The estimated amount for Construction Contingency is based on the Office estimate and iscalculated by the CAPE.

Project Type	% of Office Estimate for Construction Contingency
NFA Open Ended	0%
Municipal Non-Participating	10%
Federal Aid	10%
NFA Site Specific	15%

7.7.6. Utility Force Accounts

At the 100%/PSE stage the scope of the utility relocations for the project are known. If estimates have been received from the affected utility companies these values shall be used.

Otherwise, the Project Manager shall work with the State Utilities Engineer to determine an estimated value.

8. Design-Build Estimate Process

The previous chapter described the structure and process to be followed when developing an estimate for traditional Design-Bid-Build procurements. This chapter will provide guidance for developing the cost estimate for a project employing Design-Build delivery.

Similar to the previous process, a Design-Build project will follow similar guidance up through the Planning phase. The approach changes during the Preliminary Design Phase where the estimating deliverables for the Base Technical Concept (BTC) and Request for Proposal (RFP) require more detail.

Project Initiation (PI)
Similar to a Design-Bid-Build project, at the PI stage, design work has not started and an alternatives analysis has not been completed. It is understood that the estimate will be very high level. Estimates at this stage are often based on costs associated with similar projects.

Planning (Pre-25%)
Engineering Directive E-21-002 describes the Pre-25% Design Scoping Procedures. The level of design at this stage is consistent with a Design-Bid-Build project. Although more is known about the project at this stage than was known at the PI stage, the design is only at approximately the 10% level and the public involvement process has likely been limited. As a result, the estimate at this stage is still at a conceptual level.

Preliminary (Base Technical Concept (BTC)/Request for Proposals)
The Base Technical Concept will form the basis for the Technical and Price proposal to be submitted by the Proposers. The level of design developed for the BTC may vary depending upon the type of work involved. Although often compared to the 25% Highway and Bridge Sketch Plans submittal, the BTC documents may provide less detail in order to promote innovation and creativity by allowing for flexibility in the final design details. In other instances, more detail may be necessary in order to ensure certain aspects of the project are sufficiently defined in order to meet MassDOT's expectations.

8.1. Project Initiation (PI)

Estimated Total Construction Cost

8.1.1. Estimated Price Proposal

8.1.1.1. Construction Cost

Considering how little is known about the project at this stage, a parametric approach to estimating is appropriate. Appendix XX provides values based on project type that may be used to establish an estimated construction cost. It is important to consider that these are average values. Adjustments to these values may be appropriate based on an understanding of the unique circumstances associated with a given project. These values are current as of 2022, future Projects should be escalated by 4% to the midpoint of construction.

8.1.1.2. Final Design and Design Services During Construction

The Proposers Price proposal will include the costs associated with the consultant engineering services necessary to prepare the final design and provide services during construction. For final design a value of 7 to 10% of the construction cost shall be used depending on the complexity. For design services during construction, an estimated value of 1 to 2% of the Construction Cost shall be used.

8.1.1.3. Design Contingency

The amount for Design Contingency is based on the Estimated Price Proposal Estimate as noted below:

Project Type	% of Estimated Price Proposal Estimate for Design Contingency
Roadway Reconstruction	30%
Bridge Construction	20%
Resurfacing and Maintenance	0%

8.1.2. Allowance Items

8.1.2.1. Traffic Police (999.001 and 999.002)

The percentages listed below are based on historical information and represent an average for the project type identified in the chart. The designer may adjust these values based on their understanding of the specific circumstances associated with the project. Note the FHWA will only participate in 70% of the hours estimated for Traffic Police. Therefore, the hours for Traffic Police must be allocated to a FA Item number and a NFA Item number. The roadway flaggers are not an allowance item. Roadway Flaggers are included in the Estimated Price Proposal and paid under Item 850.41 Roadway Flagger.

Project Type	% of Estimated Price Proposal Estimate for Traffic Police	% of Estimated Price Proposal Estimate for Roadway Flaggers
Bikeways and Paths	1.50%	1.00%
Bridge Closed – Detour Provided	1.00%	0.025%
Bridge Kept Open – Staged	2.00%	0.10%
Bridge Open – Temporary Signal	2.00%	0.10%
Interstate Highways	5.50%	0.00%
Roadway Reconstruction	3.50%	0.20%
Town Centers	4.50%	0.10%
Bridge – Various Locations	7.00%	0.00%
Highway – Various locations	7.50%	0.00%

8.1.2.2. Trainees (999.080)

The amount for Trainees is based on the Estimated Price Proposal and is determined using the table below:

Estimated Price Proposal	Amount
$5M to $6,999,999	$2,400
$7M to $9,999,999	$3,200
$10M+	$4,000

8.1.2.3. Railroad (RR) Flaggers (999.200)

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required. For Chapter 634 bridges owned by the MBTA, flagging is paid for under Item 999.200. For all non-MBTA Chapter 634 bridges the railroad is responsible for providing these services without compensation. In all other instances the designer shall estimate the cost of flaggers based on assumed durations for potentially fouling the tracks and hourly rates for flaggers. MassDOT's State Utilities Engineer may be consulted for assistance.

8.1.2.4. Incentive (999.785)/Disincentive (999.786)

At the PI stage sufficient information may not be available to evaluate the appropriateness of I/D or lane rental provisions. However, if the Project Manager is aware that the nature of the project is such that the impacts to the traveling public are so great that reducing the construction duration is an important consideration, and the project meets the criteria described in Engineering Directive E-21-003, then the Project Manager may include an amount equal to 5% of the Estimated Price Proposal.

8.1.3. Construction Engineering

The estimated amount for Construction Engineering shall be 5% of the Estimated Price Proposal (based on an Office Estimate of $5 Million or greater) and is calculated automatically by the CAPE.

8.1.4. Construction Contingency

The estimated amount for Construction Contingency is based on the Office estimate and is calculated automatically by the CAPE.

Project Type	% of Office Estimate for Construction Contingency
NFA Open Ended	0%
Municipal Non-Participating	10%
Federal Aid	10%
NFA Site Specific	15%

8.1.5. Utility Force Accounts

Considering how little is known about the impacts of a project on existing utilities at the PI stage, it is acceptable to use the table below for estimating purposes. The costs contained in the table below have already taken into account the reimbursement percentages in accordance with the MassDOT Utility Reimbursement Policy (Engineering Directive E-11-008). These recommended percentages are for guidance only. When applying these costs, the designer and Project Manager must continue to use engineering judgement gained from their detailed knowledge of the specific project involved before determining the estimated cost. For example, if the proposed project is known to not contain any existing utilities, the project estimate does not need to include an amount. Conversely, if the project is known to have a very high volume of complex utility relocations, a higher percentage could be applied.

Project Group	**% of Estimated** Price Proposal **for Utility Agreement Costs**
Roadway (Reconstruction, Widening, Resurfacing, etc.) (Less than $20 Million)	8%
Roadway Projects Over $20 Million	5%
Bridge (Less than $20 Million)	8%
Bridge (More Than $20 Million	4%

8.2. Planning (Pre-25%)

Estimated Total Construction Cost

8.2.1. Price Proposal Estimate

8.2.1.1. Construction Cost

At the Pre-25% stage a parametric approach to estimating may be acceptable in certain instances. However, a more detailed project specific approach should be considered whenever feasible. Although a detailed item by item estimate is not necessary at this stage, a well-organized, project specific conceptual estimate will provide a more accurate estimated value than the parametric approach. A framework for estimating projects at the conceptual level is contained in the following link https://www.mass.gov/doc/state-aid-reimbursable-programs-estimating-tool/download.

The designer should consider the use of a 5% or 10% design in AutoCAD for the purposes of developing this estimate. The design typically is developed to a level that has an AutoCAD civil 3D corridor and design surface built, albeit a basic design. It may not contain more advanced design such as roadside grading for barriers, superelevation transitions, stormwater BMPs, etc. However, the design linework and surfaces can be used to prepare quantities for earthwork, pavements, retaining walls, etc. Items such as drainage, environmental, landscaping, and utility relocations may be estimated as a percentage of the project, or if possible, developed to the 10% level. Proposed traffic design should be estimated if large items such as signals, overhead signs, or ITS are included. Temporary traffic signals and temporary traffic control, including temporary pavement should be estimated if staging has been developed, otherwise a percentage can be used.

8.2.1.2. Final Design and Design Services During Construction

The Proposer's Price proposal will include the costs associated with the consultant engineering services necessary to prepare the final design and provide services during construction. For final design a value of 7 to 10% of the construction cost shall be used depending on the complexity. For design services during construction, an estimated value of 1 to 2% of the Construction Contract Cost shall be used.

8.2.1.3. Design Contingency

The amount for Design Contingency is based on the Office Estimate as noted below:

Project Type	% of Estimate Price Proposal for Design Contingency
Roadway Reconstruction	25%
Bridge Construction	15%
Resurfacing and Maintenance	0%

8.2.2. Allowance Items

8.2.2.1. Traffic Police (999.001 and 999.002)

The percentages listed below are based on historical information and represent an average for the project type identified in the chart. The designer may adjust these values based on their understanding of the specific circumstances associated with the project. Note the FHWA will only participate in 70% of the hours estimated for Traffic Police. Therefore, the hours for Traffic Police must be allocated to a FA Item number and a NFA Item number. The roadway flaggers are not an allowance item. Roadway Flaggers are included in the Office Estimate and paid under Item 850.41 Roadway Flagger.

Project Type	% of Estimated Price Proposal for Traffic Police	% of Estimated Price Proposal for Roadway Flaggers
Bikeways and Paths	1.50%	1.00%
Bridge Closed – Detour Provided	1.00%	0.025%
Bridge Kept Open – Staged	2.00%	0.10%
Bridge Open – Temporary Signal	2.00%	0.10%
Interstate Highways	5.50%	0.00%
Roadway Reconstruction	3.50%	0.20%
Town Centers	4.50%	0.10%
Bridge – Various Locations	7.00%	0.00%
Highway – Various locations	7.50%	0.00%

8.2.2.2. Trainees (999.080)

The amount for Trainees is based on the Office Estimate and is determined using the table below:

Estimated Price Proposal	Amount
$5M to $6,999,999	$2,400
$7M to $9,999,999	$3,200
$10M+	$4,000

8.2.2.3. Railroad (RR) Flaggers (999.200)

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required. For Chapter 634 bridges owned by the MBTA, flagging is paid for under Item 999.200. For all non-MBTA Chapter 634 bridges the railroad is responsible for providing these services without compensation. In all other instances the designer shall estimate the cost of flaggers based on assumed durations for

potentially fouling the tracks and hourly rates for flaggers. MassDOT's State Utilities Engineer may be consulted for assistance.

8.2.2.4. Incentive (999.785)/Disincentive (999.786)

At the Pre-25% design stage, the Project Manager is responsible for evaluating the project utilizing the Incentive/Disincentive and Lane Rental Checklist, Part I. Provided the project is a Design-Build Estimated Price Proposal greater than $10 million and the type of work is consistent with those identified in the engineering directive. This includes projects that involve accelerated construction techniques, or an overriding public interest shall also be subject to this Engineering Directive, regardless of the amount of the Office Estimate.

If the Boston Construction Section concurs that Incentive/Disincentive or Lane Rental provisions are appropriate, the Project Manager is also responsible for ensuring that the Contract Advertising and Planning Estimator (CAPE) includes an amount equal to 5% of the project Office Estimate under ITEM 999.785 INCENTIVE. The CAPE shall also reflect an amount of $0.00 under ITEM 999.786 DISINCENTIVE.

8.2.3. Construction Engineering

The estimated amount for Construction Engineering shall be 5% of the Estimated Price Proposal (based on an Estimated Price Proposal of $5 Million or greater) and is calculated automatically by the CAPE.

8.2.4. Construction Contingency

The estimated amount for Construction Contingency is based on the Office estimate and is calculated automatically by the CAPE.

Project Type	% of Office Estimate for Construction Contingency
NFA Open Ended	0%
Municipal Non-Participating	10%
Federal Aid	10%
NFA Site Specific	15%

8.2.5. Utility Force Accounts

Considering how little is known about the impacts of a project on existing utilities at the Pre-25% stage, it is acceptable to use the table below for estimating purposes. The costs contained in the table below have already taken into account the reimbursement percentages in accordance with the MassDOT Utility Reimbursement Policy (Engineering Directive E-11-008). These recommended percentages are for guidance only. When applying these costs, the designer and Project Manager must continue to use engineering judgement gained from their detailed knowledge of the specific project involved before determining the estimated cost. For example, if the proposed project is known to not contain any existing utilities, the project

estimate does not need to include an amount. Conversely, if the project is known to have a very high volume of complex utility relocations, a higher percentage could be applied.

Project Group	% of Estimated Price Proposal for Utility Agreement Costs
Roadway (Reconstruction, Widening, Resurfacing, etc.)	8%
Roadway Projects Over $20 Million	5%
Bridge (Less than $20 Million)	8%
Bridge (More Than $20 Million	4%

8.3. Preliminary (Base Technical Concept (BTC)/Request for Proposals) Estimated Total Construction Cost

8.3.1. Estimated Price Proposal

8.3.1.1. Construction Costs

The Designer shall update the 25% design estimate, then incorporate standard bid items into a grouped lump sum items, except for items that fall into any of these categories: already lump sum items (i.e., structures), fixed cost items, items to be bid by unit (i.e., 180. items) items subject to variation in quantity independent of the design such as repairs, signage, and percent based items, such as mobilization, etc. The design shall not create more grouped lump sum items than is necessary to delineate work for payment purposes. A typical Design-Build estimate can be obtained from the Design-Build Section to use as a reference. Specialty items, such as fiber optic work, ITS, or project specific work should be placed into separate lump sum groups to provide a clear bid result explanation. Item names should be clear; it may be beneficial to use the specification sections as initial grouped lump sums.

Upon completion of all grouped lump sum items, costs of final design and bid contingency shall be spread across all items. It is expected that the Proposers will build some contingency into their Price Proposal to account for forward-pricing a preliminary design. The Project Manager is responsible for coordinating with the Design-Build section to determine an appropriate contingency factor. The designer shall take care to provide equal weight to design and bid contingency in all items.

8.3.1.2. Final Design and Design Services During Construction

The Proposers Price proposal will include the costs associated with the consultant engineering services necessary to prepare the final design and provide services during construction. For final design, a value of 7 to 10% shall be used depending on the complexity. For design services during construction, an estimated value of 1 to 2% of the Construction Cost shall be used.

8.3.1.3. Design Contingency

At this stage of design, a design contingency is not required. All of the unknowns from the early design stages should be resolved. Any unforeseen conditions encountered during construction are accounted for with the Construction Contingency.

8.3.2. Allowance Items

8.3.2.1. Traffic Police (999.001 and 999.002)

The designer shall calculate the actual hours of traffic police and roadway flaggers based on the traffic management plan prepared for the project. The designer is responsible for investigating which police department(s) have jurisdiction of roadway(s) included in the project. For MassDOT jurisdiction roadways the hourly rate shall be based on the rates for state police. For municipal jurisdiction roadways municipal police department

rates shall be used. The designer is responsible for contacting the appropriate police department to obtain the rates.

The FHWA will only participate in 70% of the hours estimated for Traffic Police. Therefore, the hours for Traffic Police must be allocated to a FA Item number and a NFA Item number. The roadway flaggers are not an allowance item. Roadway Flaggers are included in the Estimated Price Proposal and paid under Item 850.41 Roadway Flagger.

8.3.2.2. Trainees (999.080)

The amount for Trainees is based on the Estimated Price Proposal as noted below:

Office Estimate	Amount
$5M to $6,999,999	$2,400
$7M to $9,999,999	$3,200
$10M+	$4,000

8.3.2.3. Railroad (RR) Flaggers (999.200)

If any of the work required to be done by the Contractor may obstruct the tracks of a railroad or in any way endanger the operation of its trains, flaggers or other railroad employees are required. For Chapter 634 bridges owned by the MBTA, flagging is paid for under Item 999.200. For all non-MBTA Chapter 634 bridges the railroad is responsible for providing these services without compensation.

At the BTC/RFP stage the actual estimated of costs from the railroad should be available. In these instances that actual costs shall be used. In all other instances the designer shall estimate the cost of flaggers based on assumed durations for potentially fouling the tracks and hourly rates for flaggers. MassDOT's State Utilities Engineer may be consulted for assistance.

8.3.2.4. Incentive (999.785)/Disincentive (999.786)

At the BTC/RFP stage, the Project Manager is responsible for updating the Incentive/Disincentive and Lane Rental Checklist, Part I, and preparing the Part II Checklist. Engineering Directive E-21-003 describes the process to receive approval to utilize Incentive/Disincentive or Lane Rental provisions and the mechanism to determine the recommended values.

The actual calculated values for the Incentive/Disincentive or Lane Rental provisions shall be used at the BTC/RFP stage. If it is determined that Incentive/Disincentive or Lane Rental provisions are not appropriate for the project Item 999.785 shall not be included in the estimate.

8.3.3. Construction Engineering

The estimated amount for Construction Engineering shall be 5% of the Office Estimate (based on an Office Estimate of $5 Million or greater) and is calculated automatically by the CAPE.

8.3.4. Construction Contingency

The estimated amount for Construction Contingency is based on the Office estimate and is calculated automatically by the CAPE.

Project Type	% of Office Estimate for Construction Contingency
NFA Open Ended	0%
Municipal Non-Participating	10%
Federal Aid	10%
NFA Site Specific	15%

8.3.5. Utility Force Accounts

At the BTC/RFP stage the scope of the utility relocations for the project are known. If estimates have been received from the affected utility companies these values shall be used. Otherwise, the Project Manager shall work with the State Utilities Engineer to determine an estimated value.

9. Estimate Review

MassDOT's policies and procedures provide a number of opportunities for the review of the project cost estimate.

9.1. District/HQ Review

Chapter 2 of the Project Development and Design Guide describes the process for the submittal and review of design documents. Typically, the review performed by the District Office provides the most detailed and comprehensive review of the estimate. The intensity of this review increases with each submittal. In addition, comments regarding the estimate are also provided by discipline experts within MassDOT's Headquarters (i.e., Pavement Management, Bridges and Structures, Environmental, etc.).

9.2. Peer Review

In certain instances, MassDOT may either supplement or replace the review performed MassDOT staff with a review performed by an independent consultant engineering firm. This peer review typically involves a review of all components of the design submittal and is not specifically focused on the estimate. After the Peer Review is completed, a Project meeting should be conducted to identify additional scope which may affect the cost estimate. Project Managers shall refer to the Project Management SOPs for guidance regarding when a peer review should be performed.

9.3. Independent Cost Estimate (ICE)

For projects with an Office Estimate of $15 Million or greater, MassDOT may secure the services of an independent firm to prepare an ICE. Unlike a peer review which involves a review of the work prepared by the designer of record, an ICE involves building the estimate in its entirety based on a review of the plans and special provisions by a firm that was not involved in the development of the design. Often this process begins with a meeting where the designer of record provides project information to the firm performing the ICE. After the ICE is completed, a reconciliation is conducted. At this reconciliation meeting the two firms exchange information regarding the basis and methodology used to prepare the estimate. The goal is for MassDOT to arrive at an estimated construction cost for the project.

9.4. Value Engineering

FHWA's Stewardship and Oversight Agreement with MassDOT, indicates that projects on the Federal-aid system with an estimated total cost of $50 million or more ($40 million or more for a bridge project), require at least one Value Engineering analysis to satisfy federal requirements (see 23 CFR 627). When it is determined that a Value Engineering Study is required, MassDOT will contract with an independent firm to establish a Value Engineering Team. The team will review the project design and the associated cost. The Team will then determine if there are variations to the proposed design that could add value or result in a more cost effective way of providing the same value to public.

9.5. Finance Plans

All federal aid projects with an estimated total cost exceeding $100 million must have an Initial Finance Plan with Annual Updates. The FHWA has defined the total cost as all costs and the value of all resources necessary to perform the preliminary engineering (including the cost of NEPA and other environmental documentation), Right-of-Way, environmental mitigation, construction, project management, public

outreach, and costs of external third party work such as utility and railroad relocations. The Project Manager is responsible for coordinating with the Project Controls section to obtain a Finance Plan template for the design consultant to use.

For Design-Bid-Build projects, the Initial Finance Plan should be submitted after the selected alternative for the project has been identified in the NEPA decision document. Finance Plans must be approved by FHWA prior to the authorization of federal funds for construction. For projects other than Design-Bid-Build, the Project Manager should consult with the FHWA division office concerning the timing of the submittal of the Initial Finance Plan. Annual Updates must be submitted to FHWA to track the progress of the project over time by highlighting significant deviations from the Initial Finance Plan and subsequent Annual Updates.

The Finance Plans must be reviewed and approved by FHWA prior to the authorization of federal funds for construction.

STIP Compliance Analysis

All federal aid projects must be programmed in the Statewide Transportation Improvement Plan (STIP) and are constrained by the amount and type of funding programmed for them in the STIP. MassDOTs SOPs require STIP Compliance Analyses for every project programmed in the first or second year of the current STIP. These Analyses are also performed when Federal Aid Numbers are requested. Please see Chapter 10 STIP Compliance and the CAPE for additional information.

10. STIP Compliance and the CAPE

Project Development

Every project programmed in the STIP is constrained by the amount and type of funding programmed for it in the STIP. Each year, MassDOT must certify that the amount programmed for all projects does not exceed the money available to us for each year of the STIP and in each category. Moreover, if the estimate for a project is too high or too low, a STIP Amendment may be required before advertising is allowed. The amendment process can take 1-3 months depending on the geographic location of the project.

Project Managers can assist with this process at the project level by following the STIP Compliance Analysis procedure. This procedure is found in the Project Development Internal Standard Operating Procedures and is a precautionary review of the estimate before loading it into the CAPE. It is performed at each design submission for all projects programmed in the first and second years of the STIP.

Designers (in-house and consultants) can assist with STIP Compliance at the project level when developing an Office Estimate by recognizing:

1. what funding categories are programmed in the STIP for a project and using them, and;
2. the STIP amount is the Total Federal Participating Construction Cost (TFPCC) and includes construction engineering, contingencies, and any allocated items and utilities eligible for federal participation, and;
3. the STIP amount is programmed using a Year of Expenditure (YOE) formula which applies a four percent annual inflation factor to the TFPCC starting in the second year of each STIP. For example, a 2nd year project will be inflated by 4% and a 5th year project by 16%.

This means the Office Estimate loaded in the CPE should:

1. reflect all funding categories in the STIP, and;
2. be less than 10-20% of the STIP Amount, and
3. always be estimated without inflation or design contingencies unless otherwise directed.

Construction Contract Award

STIP compliance remains important even after the project is advertised. Once the bids are opened and the actual unit bid prices are applied to the contract quantities, the amount calculated by funding category may be different than planned. If there are compliance issues associated with the application of the unit bid prices, the Project Manager must consult with FAPRO. Federal funding categories often have specific eligibility requirements (of particular note: CMAQ and HSIP). It is important to adhere to the spirit of the STIP Budget. It may be necessary to adjust how certain contract quantities are allocated to the available funding categories (without changing the total contract quantity for the item).

January 2023

APPENDIX

Parametric Estimating Factors

Preliminary Design Estimates