Central Federal Lands Highway Division

ENGINEER'S ESTIMATE MANUAL

DRAFT UPDATES

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CHAPTER 1

GENERAL

1.1 INTRODUCTION

The objective of this Manual is to provide a guide to the Central Federal Lands standard procedure for preparation, review, and updating of the engineer's estimate.

The engineer's estimate is a critical part of the project development process since it:

- Serves as a basis for probable construction cost;
- Supports decision-making on project scope; and
- Serves as a guide to evaluate bidders' proposals.

1.2 APPROACHES TO ESTIMATING

Unit prices for the engineer's estimate should reflect the actual cost to the contractor of doing business, including a reasonable profit. There are two common methods to determine this cost: historical costs (bid-based estimating) and actual costs (cost-based estimating). With either method, strive to predict the expected overall low bid, and develop unit prices that will at least equal, or slightly exceed this amount.

Develop unit prices for each defined pay item using either historical bid data that is factored for the project conditions, or cost-based pricing (using costs for equipment, labor, material, overhead, profit and production rates applicable for the project condition).

As a general rule, use historical bid-based estimating for minor items of work (e.g. culverts, cattleguards, and silt fence) and cost-based estimating for major items of work (e.g. roadway excavation, aggregate base, and pavement). In determining the major and minor items of work, generally follow the "80/20 rule": the major cost items are the 20% of the items that contribute 80% of the estimated costs. However, for some projects, such as 3R, ERFO, OMAD, or various unusual projects, some of the minor items could contribute large percentages of the project costs (e.g. traffic control, wall structures, drainage structures, reconditioning).

1.3 STANDARD PRACTICE AND PROCEDURE

Developing the Engineer's Estimate is a collaborative effort performed by the cross functional team.

Prepare an engineer's estimate for every project at each design milestone. Use a consistent and comprehensive methodology to prepare a quality estimate. Document in the project file the estimate basis, assumptions, calculations, contingencies, and uncertainties. Engage the cross functional team for guidance and input. Review the unit prices at each milestone to confirm that the prices fully reflect the project scope and market conditions. Develop the estimate in current-year dollars. Escalate the estimate to the proposed contract award date. Retain the

confidentiality of the unit price analysis and construction cost estimate at all times to maintain the integrity of the bidding and procurement process.

1.3.1 Estimate Types Required at Each Milestone

At each level of project development, the estimate has a specific purpose, methodology for development, and expected level of accuracy. The estimate level of accuracy is related to construction cost uncertainty. The contingencies included in the estimate are intended to account for construction cost uncertainties. Some of the typical causes of construction cost uncertainty are lack of scope definition, lack of information inside the roadway prism (e.g. no survey data available yet, incomplete technical recommendations), and lack of information outside the roadway prism (e.g. ROW, environmental, and inflation concerns). As the project development process advances, more information becomes available, so the expected contingency decreases and expected estimate level of accuracy increases. See Table 1 for a summary.

1.3.1.1 Project Scoping

Develop a construction cost estimate that is based on estimated quantities and unit costs for the major high-cost categories of work and a percentage of total construction costs for minor categories of work. Use cost per mile estimating methods to gauge that the estimated scoping costs are reasonable.

Add contingencies shown in Table 1 based on undefined work items and anticipated additional design elements.

1.3.1.2 Preliminary Design (15 and 30 percent)

Develop cost estimate using cost-based estimating for major items of work and historical bid-based estimating for minor items of work.

Refine the unit costs to reflect current level of design. Verify that the quantities used in the estimate reflect current design.

Add contingencies shown in Table 1 based on undefined work items and anticipated additional design elements.

1.3.1.3 Intermediate Design (50 and 70 percent)

Develop cost estimate using cost-based estimating for major items of work and historical bid-based estimating for minor items of work.

Contact material suppliers to update material costs. Refine the unit costs to reflect current level of design. Verify that the quantities used in the estimate reflect current design.

Add contingencies shown in Table 1 based on undefined work items and anticipated additional design elements.

1.3.1.4 Final Design (95 and 100 percent)

Develop cost estimate using cost-based estimating for major items of work and historical bid-based estimating for minor items of work.

Contact material suppliers to update material costs. Review production, equipment and labor rates to incorporate latest information and trends. Refine the cost-based items to reflect final design. Verify that the quantities used in the estimate reflect final design and review any significant changes from earlier estimates.

Review and update major cost items to reflect final bid quantities. Eliminate all contingencies and uncertainty factors added to earlier estimates.

Table 1: Cost Estimating Matrix

Project Development Level	Class Description	Purpose of Estimate	Methodology	Approximate Contingency Range *
Project Scoping	Class C	• Set the baseline cost • Verify the Program amount	• Historical-bid based • Cost per mile	25% to 35%
Preliminary Design (15% and 30%)	Class B	• Supports decision-making • Control of project scope and schedule	• Historical-bid based • Cost-based	20% to 30%
Intermediate Design (50%)	Class B	• Supports decision-making • Control of project scope and schedule	• Historical-bid based • Cost-based	10% to 20%
Intermediate Design (70%)	Class A	• Supports decision-making • Control of project scope and schedule	• Historical-bid based • Cost-based	10% to 20%
Final Design (95% and 100%)	Class A	• Obligate construction funds • Evaluate contractor's bids	• Historical-bid based • Cost-based	None

* The contingency is a percentage of the estimated project cost.

1.3.2 Cross-Functional Team (CFT) Roles and Responsibilities

Project Management

- The Project Manager is ultimately responsible for the accuracy and review of the estimate.
- Review estimate and provide comments to the Designer.
- Review escalated cost estimate for conformance to program amount.
- Review major cost items to determine if the appropriate detail is included to justify estimated costs.
- Participate in the development of unit prices by collaborating with the CFT.
- Review CFT input for the appropriate level of detail to reflect the project-specific conditions.
- Provide input, including production rate, labor, and equipment recommendations, for the development of cost-based unit prices.
- Review with designer project specific constraints, unusual economic conditions and other cost factors.

Design

- The Designer is the primary leader in estimate development.
- Develop, revise, and update Engineer's Estimates.
- Collaborate with the Project Manager, Construction, and Technical Services to develop unit prices.
- Incorporate cost data provided by CFT members.
- Maintain cost estimate documentation.
- Perform appropriate quality control and quality assurance activities.

Construction

- Collaborate with the CFT in the development of unit prices.
- Provide input, including production rate, labor, and equipment recommendations, for the development of cost-based unit prices.
- Review all estimates and provide comments to the Designer.
- Discuss with the designer any project-specific constraints, unusual economic conditions and other cost factors.
- Perform appropriate quality control and quality assurance activities.

Technical Services

- Collaborate with the CFT in the development of unit prices.
- Discuss with the Designer any project-specific constraints, unusual economic conditions, and other factors that may affect cost
- Develop current cost data for unique bid items, as appropriate.
- Understand the cost and construction implications of technical recommendations.
- Contact material suppliers to obtain current cost data.
- Review estimates and provide comments to the Designer.
- Perform appropriate quality control and quality assurance activities.

Below are examples of specific tasks the members of the CFT would complete:

- The Pavements Engineer develops a few surfacing alternatives for a 3R project. The Pavements Engineer uses bid histories, information gathered from local suppliers, and engineering judgment to determine costs for comparison purposes. The Designer, Construction Operations Engineer, and Project Manager provide input about local conditions and previous experience with the proposed surfacing alternatives. The CFT discusses alternatives and revises the estimate to reflect the results of the collaboration.

- The Geotechnical Engineer recommends using a mechanically stabilized earth (MSE) wall. The Designer performs a unit price analysis of the MSE wall using bid histories. The Designer collaborates with the Geotechnical Engineer to revise the unit price based on technical requirements specific to the project. The Project Manager provides insight and guidance on the unit price for the MSE wall. The CFT discusses the MSE wall unit cost and revises the estimate to reflect the results of the collaboration.

1.3.3 Project Support Team (PST) Roles and Responsibilities

Project Management

- The Project Manager is responsible for endorsing the estimate developed by the A/E.
- Review the estimate and provide comments/guidance to the A/E.
- Evaluate the estimate against Task Order and project requirements.
- Review escalated cost estimate for conformance to program amount.
- Review major cost items to determine if the appropriate detail is included to justify estimated costs.
- Engage the PST on an as-needed basis to assist with estimate review.
- Review PST input for the appropriate level of detail to reflect the project-specific conditions.
- Assure communication of actions and recommendations between the A/E consultant and the PST.

PST (Design, Pavements, Materials, Construction, Bridge, Geotech, Hydraulics, Safety)

- Provide input and recommendations as requested by the Project Manager.

1.3.4 Software

1.3.4.1 Engineer's Estimate System (EES)

The EES is a Federal Lands developed construction estimating software program that is currently in use at CFL for project development, advertisement, and award. Microsoft Excel is typically used in conjunction with the EES. It is expected that the EES will be phased out over the next few years.

1.3.4.2 Engineer's Estimating, Bidding, Award, and Construction System (EEBACS)

The EEBACS is a construction estimating software program developed by Federal Lands that is scheduled for release in the future. There is a separate manual with instructions on how to use the new estimating software currently under development.

1.3.5 Documentation

Documentation is a key element in good estimating practice. The estimate file is a well organized, easy to follow history from the first estimate at scoping through the preparation of the final estimate. Include the following in the estimate documentation:

- Assumptions
- Contingency amount selected and descriptions of the uncertainty in the design
- Quantity and unit price calculations
- Changes from the previous estimate
- Recommendations on unit costs provided by the CFT

For examples of how to document the estimate, see the CFL samples located at http://www.cflhd.gov/resources/design/eeprog/documents/EE_examples.pdf

CHAPTER 2

PAY ITEM SELECTION

2.1 GUIDANCE FOR PAY ITEM SELECTION

Select appropriate pay items to use for each project. Have a clear method of payment (direct or indirect) for all items of work on the project.

Select pay items to facilitate contract administration for the construction staff. For example, avoid using pay items that are difficult to measure in the field.

Consider minimizing the number of pay items. Using fewer pay items may allow for streamlined plans preparation (less items for the designer to account for in the plan package) and improved contract administration (less time spent by field staff tracking small, individual quantities).

Collaborate with the CFT and consider site-specific constraints during pay item selection. Use the specific information below as guidance for selecting pay items.

Section 151 – Mobilization

Project Type	*Size*	*Typical Pay Item*
All projects	All	• 15101-0000 Mobilization LPSM *Use the LPSM item for all projects. Include mobilization for contract options.*

Section 152 – Construction Survey and Staking

Project Type	*Size*	*Typical Pay Items*	*Additional Options for Pay Items*
Projects with limited scope, such as OMAD, ERFO, and pavement preservation projects	All	• For some of these projects, survey and staking is not paid for directly	• 15201-0000 Construction survey and staking LPSM *In the SCRs, add a list of items of work included in the LPSM item (do not need specific estimated quantities)*
3R	Smaller (<$5 million)	• 15201-0000 Construction survey and staking LPSM *In the SCRs, add a list of items of work included in the LPSM item (do not need specific estimated quantities)*	

Project Type	*Size*	*Typical Pay Items*	*Additional Options for Pay Items*
3R	Larger (>$5 million)	• 15210-3000 Centerline, verification and staking STA	• 15215-3000 Survey and staking, template control STA *Typically used on superelevation correction areas or other areas of minor grade correction on 3R projects*
4R	All	• 15206-0000 Slope, reference, and clearing and grubbing stake STA • 15215-3000 Survey and staking, drainage structure EA • 15216-2000 Grade finishing stakes STA	• Other items as appropriate, such as bridge, parking area, or approach road staking items

Section 153 – Contractor Quality Control

Project Type	*Size*	*Typical Pay Items*
All projects	All	• 15301-0000 Contractor quality control LPSM *Use the LPSM item for all projects. Also include a pay item for Section 154.*

Section 154 – Contractor Sampling and Testing

Project Type	*Size*	*Typical Pay Items*
All projects	All	• 15401-0000 Contractor testing LPSM *Use the LPSM item for all projects. Also include a pay item for Section 153*.

Section 157 – Soil Erosion Control

Project Type	*Size*	*Typical Pay Items*
Projects with limited scope, such as OMAD, ERFO, and pavement preservation projects	All	• For some of these projects, soil erosion control is not paid for directly • 15701-0000 Soil erosion control LPSM *In the SCRs, add a list of items of work included in the LPSM item (do not need specific estimated quantities)*
3R	Smaller (<$5 million)	• 15701-0000 Soil erosion control LPSM *In the SCRs, add a list of items of work included in the LPSM item (do not need specific estimated quantities)*
3R	Larger (>$5 million)	• Use the appropriate pay items for each of the erosion and sediment control devices used on the projects. Common pay items include: o 15705-0100 Soil erosion control, silt fence LNFT o 15705-1500, Soil erosion control, sediment wattle LNFT o 15706-0200 Soil erosion control, check dam EA o 15706-1000 Soil erosion control, inlet protection EA

Project Type	*Size*	*Typical Pay Items*
4R	All	• Use the appropriate pay items for each of the erosion and sediment control devices used on the projects. Common pay items include: o 15705-0100 Soil erosion control, silt fence LNFT o 15705-1500, Soil erosion control, sediment wattle LNFT o 15706-0200 Soil erosion control, check dam EA o 15706-1000 Soil erosion control, inlet protection EA

Section 158 – Watering for Dust Control

Project Type	*Size*	*Typical Pay Items*	*Additional Options for Pay Items*
All projects	All	• 15802-0000 Watering for dust control LPSM	• 15801-0000 Watering for dust control MGAL *Considerations for where the pay item by the MGAL may be advantageous include:* o *Project soil types (high amounts of asbestos in the soils or soils are mainly fine grained)* o *Residents within the project limits* o *High political profile* o *Project is within an area with high visitation* o *Air quality regulations are unusually strict.*

Section 203 – Removal of Structures and Obstructions

Project Type	***Size***	***Typical Pay Items***
All projects	All	• 20304-1000 Removal of Structures and Obstructions LPSM *Typically use the LPSM pay item for removal of various structures and obstructions that are easily identified in the field, such as delineators, fences, curbs, signs, bollards, etc. In the Special Contract Requirements (SCRs) Section 203, show a list of the items included in the LPSM pay item (do not show the quantities in the SCRs).* • Removals may also be broken out into various pay items. Consider paying removals by the each, length, area, or volume for removal items that are underground or are anticipated to be high-cost or high-risk items. Example items include: o 20301-1900 Removal of pipe culvert EA o 20304-2000 Removal of bridge LPSM o 20304-7000 Removal of utility conduits LPSM

Section 204 – Excavation and Embankment

Project Type	*Size*	*Typical Pay Items*
All projects	All	Projects with waste material: • 20401-0000 Roadway excavation CUYD • 20441-0000 Waste CUYD Projects with borrow: • 20420-0000 Embankment construction CUYD *Refer to the Earthwork Representation Guidelines for more information.*

Section 208 - Structure Excavation and Backfill

Project Type	*Size*	*Typical Pay Items*
Projects with shoring and bracing	All	• Typically include the cost of temporary shoring in the cost of a major element of work (in most cases, MSE walls). For most projects, no Section 208 pay item for temporary shoring will be included. • On some bridge projects, pay for shoring and bracing as recommended by the Structural Engineer

Section 301 – Untreated Aggregate Course

Project Type	*Size*	*Typical Pay Items*
Projects with less than 5,000 tons of aggregate base	Smaller	Payment is typically covered by Section 308 - see below
Projects with more than 5,000 tons of aggregate base	Larger	• 30101-0000 Aggregate base TON o *Use statistical acceptance for projects with more than 5,000 tons of aggregate base.* o *The Contractor may select the grade of aggregate base to use, so avoid using the pay items that have the grade specified*

Section 303 – Road Reconditioning

Project Type	*Size*	*Typical Pay Items*	*Additional Options for Pay Items*
Projects with Section 303 pay items	All	Pay for pulverizing pay items by the STA. Example pay items include: • 30305-2000 Pulverizing, 4-inch depth STA • 30305-3000 Pulverizing, 6-inch depth STA	For parking areas, pay for pulverizing by the area. Example pay items include: • 30306-2000 Pulverizing, 4-inch depth SQYD • 30306-3000 Pulverizing, 6-inch depth SQYD

Section 308 – Minor Crushed Aggregate

Project Type	***Size***	***Typical Pay Items***
Projects with less than 5,000 tons of aggregate base	Smaller	• 30802-1000 Roadway aggregate, method 2 TON o *Use certification acceptance for projects with less than 5,000 tons of aggregate base.*
Projects with more than 5,000 tons of aggregate base	Larger	• See Section 301 above

Section 401 – Superpave Asphalt Concrete Pavement, **Section 402** – Hot Asphalt Concrete Pavement by Hveem or Marshall Mix Design Method, **Section 403** – Hot Asphalt Concrete Pavement, and **Section 404** – Minor Hot Asphalt Concrete

Description	***Typical Pay Items***
Notes: o The 4,000 ton project size shown in this table reflects the minimum requirement for statistical analysis. This tonnage is determined using a maximum pay factor of 1.03 (6 samples at 700 tons each). o "*Statistical Analysis"* is easier to contractually administer than "*Conformance Testing"* when materials are out of specification. o All project conditions need to be evaluated to determine the appropriate HACP material. The CFT must discuss and agree on the appropriate pay item.	
Small non-mainline paving areas (small pullouts, paved ditches, small approach roads, trails) where the government wants little control	• 40401-0000 Minor Hot Asphalt Concrete Pavement TON o *Uses certification acceptance* o *Used on non-mainline areas*

Projects where testing for conformance is preferred over statistical acceptance (local mix used or variability in placement of mix is anticipated)	• 40301-0000 Hot Asphalt Concrete Pavement TON o *Use of local mix (state DOT) required; job specific mix not desired* o *Uses conformance testing* o *Good choice when bid quantity is insufficient for statistical analysis (less than 4,000 tons of mix on project). May use for larger quantities if appropriate.* o *Good choice when a lot of anticipated starts and stops during HACP production or non-mainline paving is anticipated*
Projects where state DOTs typically don't use superpave (such as NV & select CA projects) or local materials are known to not produce superpave mix	• 40201-0000 Hot Asphalt Concrete Pavement, Hveem, or Marshall TON o *Uses statistical acceptance* o *More than 4,000 tons of mix on project* o *Nevada and select California projects (on routes where we have used a Hveem mix) may be appropriate for use of a 402 mix. This 400 section allows the use of either Marshall or Hveem, however, only Hveem should be specified. All other states in CFLHD's region are superpave states.*
Most projects where there is more than 4,000 tons of asphalt	• 401 Superpave Pavement TON o *Uses statistical acceptance* o *In general, projects with more than about 4,000 tons of asphalt will use the Section 401 pay items.*

Section 622 – Rental Equipment

Project Type	***Size***	***Typical Pay Items***
Projects with limited scope, such as OMAD and pavement preservation projects	All	Include equipment hours in the contract to facilitate contract administration for the Project Engineer. Typical items may include: • 62201-0050 Dump truck, 5 cubic yard minimum capacity HOUR • 62201-0450 Backhoe loader, 4 cubic foot minimum rated capacity bucket, 18-inch width HOUR
ERFO	All	The scope of ERFO projects can vary significantly, so use judgment when selecting appropriate equipment pay items. Some common pay items include: • 62201-0150 Dump truck, 7 cubic yard minimum capacity HOUR • 62201-0900 Wheel loader, 2 cubic yard minimum capacity HOUR • 62201-3350 Hydraulic excavator, 1 cubic yard minimum capacity HOUR
3R and 4R	All	Include equipment hours in the contract to facilitate contract administration for the Project Engineer. Typical items may include: • 62201-0200 Dump truck, 8 cubic yard minimum capacity HOUR • 62201-0550 Backhoe loader, 6 cubic foot minimum rated capacity bucket, 24-inch width HOUR • 62201-0950 Wheel loader, 3 cubic yard minimum capacity HOUR • 62201-1300 Bulldozer, 350HP minimum flywheel capacity HOUR • 62201-2850 Motor grader, 12 foot minimum blade HOUR • 62201-3350 Hydraulic excavator, 1 cubic yard minimum capacity HOUR • 62202-1000 Materials Transfer Vehicle LPSM - *The MTV pay item may be included on some larger projects (>50,000 tons of asphalt) or projects with a long haul from the hot plant to the project site. Verify the use of this pay item with the CFT.*

Section 623 - General Labor

Project Type	*Size*	*Typical Pay Items*
All projects	All	• 62301-1000 General labor HOUR • 62302-1000 Special Labor, hired technical services HOUR • 62302-1100 Special Labor, hired survey services HOUR

Section 635 – Temporary Traffic Control

Project Type	***Size***	***Typical Pay Items***	***Additional Options for Pay Items***
All	All	Use the appropriate pay items for each of the traffic control devices used on the project. Common pay items include: • 63502-0700 Temporary traffic control, cone EA • 63502-1300 Temporary traffic control, drum EA • 63503-0300 Temporary traffic control, barricade type 3 LNFT • 63503-1000 Temporary traffic control, plastic fence LNFT • 63504-1000 Temporary traffic control, construction sign SQFT • 63505-1000 Temporary traffic control, pavement markings MILE • 63506-0500 Temporary traffic control, flagger HOUR • 63506-0600 Temporary traffic control, pilot car HOUR	Projects with significant issues with traffic or safety: • 63510-0200 Temporary traffic control, traffic and safety supervisor WEEK Projects where the roadway will be closed, simple traffic control, or very low ADT: • 63501-0000 Temporary traffic control LPSM *In the SCRs, add a list of items of work included in the LPSM item (do not need specific estimated quantities)*

CHAPTER 3

ROUNDING QUANTITIES

3.1 GUIDANCE ON ROUNDING QUANTITIES FROM PLAN QUANTITY TO BID QUANTITY

Typically, many calculated quantities are rounded up from the plan quantity to bid quantity to allow for contingency and to facilitate contract administration for the field staff. Use Table 3 as guidance for rounding from plan to bid quantities.

Table 3: Rounding from Plan to Bid Quantities

FP-03 Section	Typical Rounding
152 – Construction Survey and Staking	Plan and bid quantities are usually the same.
157 – Soil Erosion Control	• Quantities by the lnft: Round plan quantities up about 5% to obtain an even 10, 50, or 100 lnft bid quantity • Quantities by the EA: Round plan quantities up about 5% to obtain an even 5 or 10 bid quantity • Quantities by the sqyd or acre: Round plan quantities up about 5% to obtain an even 10 or 50 sqyd or acre bid quantity
158 – Watering for Dust Control	Plan and bid quantities are usually the same.
201 – Clearing and Grubbing	Show plan quantities to the nearest 0.01 acre. Add about 3% to round up to the next 0.1 acre.
202 – Additional Clearing and Grubbing	Plan and bid quantities are usually the same.
203 – Removal of Structures and Obstructions	• For items paid by the each, such as removal of light pole or removal of headwall, plan and bid quantities are usually the same. • Some items, such as removal of fence or removal of guardrail, round plan quantities up about 5% to obtain an even 5 or 10 bid quantity
204 – Excavation and Embankment	• Excavation quantities: Add about 10% for quantities up to 50,000 cuyd to obtain an even 500 cuyd and add about 5% for quantities larger than 50,000 cuyd to obtain an even 1,000 cuyd • Embankment, borrow and topping quantities: Add about 5% to obtain an even 500 cuyd • Furrow ditch quantities: Add about 5% to obtain an even 100 lnft

FP-03 Section	Typical Rounding
207 – Earthwork Geotextiles	• For small quantities of less than 3,000 sqyd, add about 10% to round to the nearest 100 sqyd • For quantities over 3,000 sqyd, add about 5% to round to the nearest 500 sqyd.
208 – Structure Excavation and Backfill	Round plan quantities up about 5% to obtain an even 10, 50, or 100 cuyd bid quantity
211 – Roadway Obliteration	Add about 10% to obtain an even 100, 500, or 1,000 sqyd bid quantity
213 – Subgrade Stabilization	• Round sqyd quantities up about 5% to the nearest 100 or 500 sqyd. • Round tons up about 5% to the nearest 10 tons.
251 – Riprap	Add about 10% to obtain an even 50, 100, or 500 cuyd.
252 – Special Rock Embankment and Rock Buttress	Add about 10% to obtain an even 10, 50, or 100 cuyd.
253 – Gabions and Revet Mattress	Round plan quantities up about 5% to the nearest 100 sqft or 10 cuyd.
255 – Mechanically-Stabilized Earth Walls	Round plan quantities up about 3% to the nearest 100 sqft
301 – Untreated Aggregate Course	Add about 5% to obtain an even 500 ton
303 – Road Reconditioning	Add about 5% to obtain an even 100 or 500 sqyd
304 – Aggregate Stabilization	Round plan quantities for chemical additives up about 5% to an even 10, 50, or 100 ton
305 – Aggregate-Topsoil Course	Round plan quantities up about 5% to an even 10, 100, or 500 units
306 – Dust Palliative	Add about 5% to obtain an even 10, 50, or 100 ton
308 – Minor Crushed Aggregate	Add about 5% to obtain an even 500 ton
309 – Emulsified Asphalt Treated Base Course	Round plan quantities up about 3% to the nearest 1,000 sqyd
401 – Superpave Asphalt Concrete Pavement	Add about 3% to obtain an even 500 or 1,000 ton
408 – Cold Recycled Asphalt Base Course	Round plan quantities up about 3% to the nearest 1,000 sqyd
409 – Asphalt Surface Treatment	Round plan quantities up about 3% to the nearest 1,000 sqyd

FP-03 Section	Typical Rounding
410 – Slurry Seal	Round plan quantities up about 3% to the nearest 1,000 sqyd
411 – Asphalt Prime Coat	• Prime coat: Round up about 5% to an even 10 tons or 5,000 gal • Blotter: Round up to an even 10 or 100 tons
412 – Asphalt Tack Coat	Round plan quantities up about 5% to an even 5 or 10 tons, or 5,000 gal
413 – Asphalt Pavement Milling	Round plan quantities up about 3% to an even 1,000 sqyd
501 – Rigid Pavement	Minimal rounding
551 – Driven Piles	Plan and bid quantities are usually the same.
601 – Minor Concrete Structures	Show plan quantities to the nearest 0.1 cuyd. Round plan quantities up to an even cuyd.
602 – Culverts and Drains	Round plan quantities up about 5% to the nearest 5 or 10 ft
604 – Manholes, Inlets, and Catch Basins	Plan and bid quantities are usually the same
605 – Underdrains, Sheet Drains, and Pavement Edge Drains	Round plan quantities up about 5%to the nearest 5 or 10 ft
609 – Curb and Gutter	Round plan quantities up about 2% for mainly parking lot work and 5% for mainly roadway ditch work. Round quantities to the nearest 50 or 100 ft
615 – Sidewalks, Drive Pads, and Paved Medians	Round plan quantities up to the nearest 50 or 100 sqyd
617 – Guardrail	Round plan quantities up about 3% to the nearest 25 ft
619 – Fences, Gates, and Cattleguards	Gates and Cattleguards: Plan and bid quantities are usually the same. Fences: Round plan quantities up about 5% to the nearest 50 or 100 ft
624 – Topsoil	Round plan quantities up about 5% to an even 50 or 100 sqyd or acre
625 – Turf Establishment	Round plan quantities up about 5% to an even 50 or 100 sqyd or acre
633 – Permanent Traffic Control	Minimal rounding
634 – Permanent Pavement Markings	Minimal rounding
635 – Temporary Traffic Control	Plan and bid quantities are usually the same

CHAPTER 4

METHODS OF ESTIMATING

4.1 HISTORICAL BID-BASED ESTIMATING

Use the historical bid price approach, tempered with engineering judgment, for estimating minor items of work on a project.

The following are typically considered minor items of work:

- Erosion control
- Guardrail
- Landscaping
- Culverts
- Underdrains
- Drop inlets and catch basins
- Manholes
- Curb and gutter
- Sidewalk
- Riprap
- Fencing and cattleguards
- Traffic control
- Signing
- Striping

Some items that cannot be estimated using the historical bid approach include:

- Lump sum items. Most lump sum items (except mobilization and contractor testing) are very different from one project to another. See Section 4.3.1 for guidance on estimating lump sum items.

- Unique or seldom used items. The lack of available historic data for these items often leads to inaccurate unit prices. See Section 4.3.2 for guidance on estimating unique items.

4.1.1 Sources of Historical Bid-based Estimating Data

Historical bid prices are available in the following locations:

- Recent CFL project bid tabulations are posted at http://www.cflhd.gov/contracting/construction/bidTabs/

- *Using EES*: Bid histories for both US Customary and Metric files are posted at http://www.cflhd.gov/resources/design/eeprog/cfl-ee.cfm. For internal designers, bid histories may be accessed through the following:

    - Click on the 'Browhist English03' or the 'Browhist Metric03' shortcuts that are on the desktops.

    - Click on 'Do UPA' while in the individual estimate item screen.

- *Using EEBACS*: Follow the instructions in the EEBACS Manual for accessing bid histories.

4.1.2 Historical Bid-based Estimating Considerations

Consider the bids received for like items on recent projects (within the past one to three years) built under similar conditions that fairly represent the contractor's cost plus a reasonable profit. Consider the average of the low bids received on previous projects in similar locations, factored for project conditions and cost indices, as a basis for the anticipated minimum overall cost for current projects.

Use the average of the unit prices from the lowest three bidders to verify that the low-bid unit price is reasonable and consistent, as appropriate. Modify the unit prices to fit the conditions on the project, and adjust for increases in the overall cost of construction over time using an inflation index. Inflate the historical unit bid prices from bid date to current year using the following methods:

- For EES: Use the following spreadsheet: http://www.cflhd.gov/resources/design/eeprog/documents/Construction_Inflation.xls

- For EEBACS: Follow the instruction in the EEBACS manual (all inflation to current year is within the EEBACS system based on published construction cost indices).

4.2 COST-BASED ESTIMATING

Use the cost-based approach, tempered with engineering judgment, for estimating the major items of work on a project.

The following are typically considered major items of work:

- Earthwork, including excavation, embankment, borrow, and waste
- Aggregate base
- Asphalt pavement

The major items of work contribute to about 80% of the project cost. Typical items are noted above, but depending on the project, other items may also be significant cost items. Document the basis for estimating these items.

4.2.1 Sources of Cost-based Estimating Data

Sources of information used to develop cost-based unit prices include the following:

- Production Rates. General production rates are provided in the CFL production rate spreadsheet located at: http://www.cflhd.gov/resources/design/toolsguidance/documents/CFLHD_production_rates.xls

  Adjust the general production rates to fit project-specific requirements. Consult with the Construction Operations Engineer and other members of the CFT as appropriate to verify the selected production rate.

- Equipment. Equipment costs include ownership expenses to cover items such as depreciation, repairs, taxes, fuel, and storage. Equipment costs may be estimated by using historical bid prices or from the latest edition of *Heavy Construction Cost Data* published by RS Means.

- Labor. Obtain estimated labor rates from the current Davis-Bacon prevailing wage rates at http://www.gpo.gov/davisbacon/allstates.html. Add fringes to the Davis-Bacon labor rate. Apply the appropriate payroll burden, overhead, and profit to the current labor rates.

- Material. Contact suppliers directly to obtain material quotes. Material prices should include royalties, crushing costs, and vendor profit. Hauling costs are estimated based on haul distance, truck capacity, load and unload time, driver wage and truck expense.

- Overhead and Profit. Estimate overhead at 10%. Estimate profit at 10%. Profit is applied to all costs, including labor, equipment, materials, and overhead.

4.2.2 Cost-based Estimating Methods

Use the cost-based unit price option in EEBACS following the instructions in the EEBACS Manual.

As appropriate, use the Cost-based Unit Price Spreadsheet located at http://www.cflhd.gov/resources/design/eeprog/documents/Cost_Base_Unit_Price.xlsx to develop cost-based unit prices.

4.3 OTHER ESTIMATING CONSIDERATIONS

4.3.1 Estimating Lump Sum Items

For commonly used lump sum items, such as mobilization and contractor testing, refer to Chapter 5. For less commonly used lump sum items, first quantify the work included in the lump sum item. Use historical bid data to come up with costs on the quantified work within the lump sum item and make any necessary project-specific adjustments to determine a lump sum estimated cost.

See Chapter 2 for additional guidance on lump sum pay item selection.

Using lump sum items typically transfers risk to the Contractor, and the Contractor will adjust bid prices upward to account for this risk.

4.3.2 Estimating Unique Items

Occasionally, items of work that have little or no historical data to aid in establishing unit prices are included in a project. For these unique items, look for similar items that may provide some guidance on cost. In addition, gather information from others who may be familiar with the item, including State Departments of Transportation, other government agencies, or suppliers. Add appropriate overhead and profit to the estimated cost.

If the item is comprised of various components (e.g. concrete, aggregate, steel), estimate the individual components and add the components together to estimate a total cost.

4.3.3 Subsidiary Items

Include the costs of any subsidiary items in the estimated cost of the related pay item. Subsidiary items are paid for indirectly; do not assume that because an item of work is subsidiary that it does not cost anything. Clearly note in the plans or SCRs any work that is considered subsidiary to a specific pay item.

4.3.4 General Considerations

Consider the following rules of thumb when making adjustments to unit bid prices:

Project size. Generally, the unit price for larger quantities of a given material will be less than for smaller quantities.

Geographic location. The project's location, whether in an urban or rural setting, should be considered in establishing bid prices. A project in an urban setting is generally faced with confined work spaces, greater volumes of traffic, and limited hours of operation. A project in a rural location generally requires materials, equipment and personnel brought in from elsewhere.

The location of a material source may have a large impact on cost. For a rural project with long material hauls and no commercial asphalt hot plants or concrete batch plants available, unit bid prices most likely would be higher than an urban project where these facilities are readily available.

Traffic conditions. Projects with complex sequences of work and high traffic volumes will have higher prices than uncomplicated projects with low traffic volumes. Short traffic delays (less than 30 minutes per passage through the project) or other project-specific requirements will increase costs.

Timing of Advertisement. Timing of advertisement and contract award may have a major influence on the bid prices. Contractors typically have a time of year that is busier than others. There is a benefit to advertise the project as soon as possible before the peak season to allow the Contractor to plan and schedule the work. Contractors are usually more readily available for work early in the spring. Later in the spring or during the summer, many contractors have on-going projects that keep them busy, so they tend to bid higher or not at all.

Construction season. The time of year that a project is to be let for contract and the estimated time required for completion may be significant in price selection. Factors, such as if the project will have to be suspended or delayed by inclement weather, will have an effect on bid prices. Compressed or accelerated construction schedules could potentially increase costs. These factors should be considered when establishing the construction schedule for each project.

Projects requiring long periods of construction (a year or longer) will quite likely reflect higher bid prices for items which must be purchased from suppliers. Especially

noteworthy are large quantity items or expensive items which will be constructed during the later stages of the project, since suppliers are usually unwilling to guarantee prices for extended periods of time. Contractors, for protection against any increase in prices, will usually hedge their bid on this type of item, resulting in higher prices than in projects with shorter completion times. Price adjustments or escalation clauses may be necessary to mitigate the effects of construction time. Estimated costs must include the anticipated adjustments during the period of the construction contract.

Accessibility. Accessibility to the work area and the existing terrain are important factors. For example, work that is normally easy to accomplish on level terrain or gentle slopes may be almost impossible on steep slopes. Mountainous terrain and steep grades reduce production rates which lead to increased costs.

Restrictive conditions. Restricting the working hours or method of work on a project can have a great effect on prices. If the specifications limit work to nighttime or short shifts, increase unit prices to reflect:

- The cost of premium wages for night work.
- Premium payments for partial shifts.
- General decreases in productivity and efficiency.

Night work for asphalt concrete can be especially expensive where small quantities are involved because asphalt plants do not usually operate at night and may have to do special runs at a much higher operating cost per unit.

Conditions and limitations imposed by client agencies should be reviewed with the Project Manager for discussion with the client agency. Flexibility in requirements or incentives to complete the operations in a timely manner can influence the estimated costs.

Environmental commitments that restrict construction operations typically increase costs. Examples of environmental restrictions that have increased costs include:

- Seasonal restrictions due to nesting birds,
- Haul restrictions,
- Restrictions on the amount of clearing or disturbance allowed,
- Coordination with archaeologists and cross haul requirements.

Availability of materials. Materials that are readily available or commonly used are generally less expensive. Material shortages or stringent requirements can cause construction delays and increase costs.

Experimental or research items. Projects which include experimental or research items usually receive higher bids.

Specifications. The Special Contract Requirements (SCRs) may dictate materials or procedures more costly to the contractor than the conventional items.

Plan clarity. Plans which are neat, clear, and accurate will usually contribute to lower overall unit bid prices.

Bidder competition. A lack of competition or contractor availability often leads to higher bid prices. Generally, projects that are bid during a period of time when a large number of contractors are available are bid more competitively.

4.4 RULES FOR ROUNDING UNIT PRICES AND ESTIMATES

An estimate is an approximation of costs; it cannot be an exact calculation. If an estimate is shown calculated to the nearest penny, there is a false impression that the estimate is very precise. Round numbers as described below:

- Table 2 provides guidance for rounding the unit bid prices:

Table 2: Unit Price Rounding

Unit Price Range	Rounding
$ 0.01 - $ 19.99	$ 0.25
$ 20.00 - $ 99.99	$ 1.00
$100.00 - $ 499.99	$10.00
$ 500.00 - $ 999.99	$ 50.00
$ 1,000.00 - $ 2,499.99	$ 100.00
$ 2,500 - $ 9,999.99	$ 500.00
$ 10,000 - $ 49,999.99	$1,000.00
$ 50,000 +	$ 5,000.00

Example: $6.37 rounded to $6.50
$67.26 rounded to $68.00

- For the total estimated cost, round to the nearest appropriate significant digit (generally this is either three or four significant figures). Adjust the mobilization cost to show a rounded total estimated cost.

Example: $1,348,127.58 rounded to $1,350,000
$12,479,697.35 rounded to $12,480,000

4.5 INFLATION

Inflate the historical unit bid prices from bid date to current year using the following methods:

- For EES: Use the following spreadsheet:
http://www.cflhd.gov/resources/design/eeprog/documents/Construction_Inflation.xls

- For EEBACS: Follow the instruction in the EEBACS manual (all inflation to current year is within the EEBACS system based on published construction cost indices).

4.6 ESCALATION

After estimating the cost in current-year dollars, escalate the total estimated cost to the proposed contract award date. Escalate the total cost only; do not escalate each pay item separately. Use the following spreadsheet:
http://www.cflhd.gov/resources/design/eeprog/documents/CFLHD_EE_Cover_Sheet.xls.

Include this cover sheet with each Engineer's Estimate.

For Shelf projects, escalate the Engineer's Estimate according to the Policy on Managing Shelf Projects and Escalation of Engineer's Estimate:
http://www.cflhd.gov/resources/pm/documents/policies/shelf-project-managing-policy.pdf.

CHAPTER 5

COST ESTIMATING

5.1 SECTION 151 - MOBILIZATION

Use Table 4 as guidance for estimating mobilization.

Table 4: Estimating Mobilization

Project Type	Size	Percentage of the Construction Estimate
Projects with limited scope, such as OMAD and pavement preservation projects	All	4 – 9%
3R	Smaller (<$5 million)	13%
3R	Larger (>$5 million)	12%
4R	Smaller (<$5 million)	15%
4R	Larger (>$5 million)	13%

Adjust the estimated cost of mobilization so that the total engineer's estimate reflects an appropriate number of significant digits.

5.1 SECTION 153 – CONTRACTOR QUALITY CONTROL AND SECTION 154 - CONTRACTOR SAMPLING AND TESTING

Use Table 5 as guidance for estimating contractor quality control and testing.

Table 5: Estimating Contractor Quality Control and Contractor Testing

Project Type	Size	Percentage of the Construction Estimate
Projects with limited scope, such as OMAD and pavement preservation projects	All	3%
3R	Smaller (<$5 million)	4%
3R	Larger (>$5 million)	4%
4R	Smaller (<$5 million)	3%
4R	Larger (>$5 million)	5%

Stringent requirements or unusual structures or materials will add to the typical testing cost. The items that typically add to the testing costs include Section 301, 401, 402, 552, and 551-565 items.

5.2 SECTION 155 – SCHEDULES FOR CONSTRUCTION CONTRACTS

Estimate construction schedules as 1.5% of the construction estimate.

5.3 SECTION 158 – WATERING FOR DUST CONTROL

Use historical bid prices from projects in the same geographical area and adjust for any project-specific requirements. Consider the haul distance for the water and any royalties or premiums that must be paid by the contractor.

5.4 SECTION 201 – CLEARING AND GRUBBING

Consider the following:

- Vegetation density and size (e.g. dense forest of large trees vs. prairies with few trees)
- Terrain and accessibility (e.g. steeper terrain with inaccessible slopes vs. flat, open areas)
- Timber costs (e.g. any US Forest Service costs for tree removal)

5.5 SECTION 203 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS

If historical bid data is not available for the work proposed, use cost-based estimating methods to determine a unit price. Provide sufficient information about removal items so that they can be properly bid.

5.6 SECTION 204 – EXCAVATION AND EMBANKMENT

Collaborate with the Geotech CFT member to estimate these items.

To estimate earthwork early in project development (before mapping is available), review similar projects to get an idea on an approximate range of expected earthwork quantities. Collect rough estimates of widening widths and slope heights in the field. Use the field data to calculate rough estimates of earthwork quantities. Compare the calculated earthwork quantities with similar projects to verify that the rough estimate is reasonable.

When mapping becomes available, use cost-based estimating to develop unit prices for earthwork. Use the Cost-based Unit Price Spreadsheet located at http://www.cflhd.gov/resources/design/eeprog/documents/Cost_Base_Unit_Price.xlsx as a guide for estimating earthwork costs.

Consider the following conditions that may increase the earthwork costs:

- Rocky conditions that require ripping, blasting, or reduction in material size before it can be used as embankment.
- Difficult earthwork that requires pioneering a road for construction access.

- Traffic control restrictions and sequencing of work that require significant demobilization and moving of equipment.
- Subgrade and slope finishing that have slower production rates than bulk production earthwork. Examples of earthwork finishing activities with slower production rates include:
  - Using a motor grader to finish subgrade within staking tolerances
  - Finishing cut and fill slopes by 'tracking in' material with a dozer

5.7 SECTIONS 255, 257, 258, AND 259 – WALLS

Collaborate with the Geotechnical CFT member to estimate these items.

5.8 SECTIONS 301 AND 308 – AGGREGATE COURSES

Collaborate with the Materials and Pavements CFT member to estimate these items. Use the Cost-based Unit Price Spreadsheet located at http://www.cflhd.gov/resources/design/eeprog/documents/Cost_Base_Unit_Price.xlsx as a guide for estimating aggregate costs.

5.9 SECTION 303 – ROAD RECONDITIONING

Collaborate with the Materials and Pavements CFT member to estimate these items. Consider the subgrade material; expect higher costs for subgrade with significant areas of unsuitable material. Include equipment and labor costs for grade finishing.

5.10 SECTIONS 401 AND 402 – ASPHALT SURFACING

Collaborate with the Materials and Pavements CFT member to estimate these items. Consider the additional cost of materials and binder not available locally. Review current local price trends for asphalt.

Use the Cost-based Unit Price Spreadsheet located at http://www.cflhd.gov/resources/design/eeprog/documents/Cost_Base_Unit_Price.xlsx as a guide for estimating paving costs.

5.11 SECTION 552 – STRUCTURAL CONCRETE

Collaborate with the Bridge CFT member to estimate these items. Consider the haul distances for materials and any special forming requirements. Determine if there are any local cement shortages.

5.12 SECTION 553 – PRESTRESSED CONCRETE

Collaborate with the Bridge CFT member to estimate these items. Consider the haul distances for materials. Determine the availability of local girder types.

5.13 SECTION 602 – CULVERTS AND DRAINS

Consider the haul distances for materials (e.g. is reinforced concrete pipe readily available locally?). Consider the difficulty of installation (e.g. is the culvert in a deep fill or is the subgrade material difficult to work in (rock or highly erodible)?).

5.14 SECTION 609 – CURB AND GUTTER

Consider the haul distances for materials. Expect higher costs for curb that requires more difficult installation (i.e. on tight radii, unique shape and size, or hand forming required). Include the additional cost for any concrete coloring.

5.15 SECTION 617 – GUARDRAIL

Consider the subgrade material near the guardrail; expect higher costs if the guardrail will be installed in rocky subgrade.

Consider special connections to structures; expect higher costs if complicated connections are required at box culverts or other structures.

5.16 SECTION 635 – TEMPORARY TRAFFIC CONTROL

Review the assumptions made for the cost-based unit price items and verify that the hours estimated for both flaggers and pilot car match the assumptions. Assure that conditions and requirements included in the SCRs are addressed with adequate temporary traffic control items and quantities. Road closures, nighttime construction, length of construction zone, number of intersections and traffic volume during the construction period are critical elements of consideration for temporary traffic control. Check similar projects for final traffic control costs.

CHAPTER 6

OTHER RESOURCES

6.1 SOURCES OF INFORMATION

- *FHWA Office of Program Administration*
  http://www.fhwa.dot.gov/programadmin/contracts/ta508046.cfm

  This website details the FHWA Guidelines for Preparing Engineer's Estimate, Bid Reviews, and Evaluation.

- *Transportation Estimator's Association (TEA)*
  http://www.tea.cloverleaf.net/

  The TEA website has estimating information and links to other useful sites.

- *American Society of Professional Estimators (ASPE)*
  http://aspenational.com/

  The ASPE serves construction estimators by providing education, fellowship, and opportunity for professional development.

- *Associated General Contractors (AGC) of America*
  http://www.agc.org/cs/industry_topics/construction_economics

  The AGC website provides a number of reports that address historical, present, and future cost trends of highway and other types of construction.

- *Washington State Department of Transportation (WSDOT)*
  http://www.wsdot.wa.gov/biz/construction/constructioncosts.cfm

  The WSDOT website provides extensive information on construction cost trends of several States (Washington, California, Colorado, Oregon, South Dakota, and Utah). The site also contains information on the price trends of individual materials (fuel, concrete pavement, concrete structural, crushed surfacing, hot mix asphalt, road excavation, steel reinforcing bar, and structural steel), the status of competition for highway construction projects, and the steps that WSDOT has taken promote competition and mitigate the effects of cost escalation.

- *California Department of Transportation (Caltrans)*
  http://www.dot.ca.gov/hq/esc/oe/costinfo.html

  The Caltrans website has information about highway construction costs in California.

- *Caltrans Labor Surcharge and Equipment Rental Rates*
  http://www.dot.ca.gov/hq/construc/equipmnt.html

  This Caltrans website has current equipment cost data for California.

- *Caterpillar*
  http://www.cat.com

  This website has information about Caterpillar brand construction equipment.

- *John Deere*
  http://www.deere.com

  This website has information about John Deere brand construction equipment.

- *Komatsu*
  http://www.komatsuamerica.com/

  This website has information about Komatsu brand construction equipment.

- *Construction Equipment Ownership and Operating Expense Schedules*
  http://www.nww.usace.army.mil/html/OFFICES/Ed/C/ep_current.asp

  This website has equipment rates published by the U.S. Army Corps of Engineers (USACOE). There are separate volumes for different regions of the United States defined by the USACOE.