Chapter 8
QUANTITY COMPUTATION

INTRODUCTION

This chapter provides guidelines for computing contract item quantities needed to construct a roadway project. These guidelines are intended to help standardize the quantity calculations. These calculations can be found in the *Quantity Workbook* which is used during construction as a reference for the Contract Administrator.

The *Standard Specifications for Road and Bridge Construction* is the primary reference for information regarding Item Descriptions, Method of Measurement, Basis of Payment, etc. Additional information may be located in the *Standard Plans for Road and Bridge Construction*, Special Attentions, Special Provisions, Special Details, Supplemental Specifications, and the Master Item List including various application rates, constants, appropriate item numbers, item nomenclature and intent of the work to be performed under that item. *Volume 2 of the Highway Design Manual* contains additional information including sample Construction Plans and Summary Tables. Coordinate with Bureau of Bridge Design when bridges are part of the project to determine match lines to the bridge items.

The Master Item List (Standard) is a good source to ensure that the correct Item Number, Description, and Units are used for a given Item. All Items on this list are Standard Items, except Items which are labelled with an asterisk " * " in front of the Item Description. These Items are not Standard Specification book items and require Special Provisions to be included in the Project's Proposal.

Computation of Item Quantities: Computations and estimation of quantities are used to estimate a project's cost and justify progress payments to the Contractor for work completed. Items and quantities shown on the PS&E Estimate must be the result of sound engineering judgment. Calculate each contract item in the *Quantity Workbook* on a worksheet similar to the Highway Design Calculation Sheet (Appendix 8-1). Most quantities are computed using spreadsheets, each worksheet should be initialed by the person calculating the quantity and then verified and initialed by a checker. Both individuals are responsible for the accuracy of the quantity. Keep the calculations simple, organized, clear, and neat. Show your work and any assumptions on the worksheet. It is helpful to show formulas, define variables, and always include the units. This will avoid confusion, minimize calculation errors, and make calculations easier to understand for the checker and the Construction Contract Administrator.

Proprietary Items: Be aware of unique items that do not have competitors – i.e. only produced by one manufacturer. There are several guardrail and drainage items, among others, that would require extra effort to use them. See Chapter 3 for more info. and consult a supervisor or the Specifications Engineer if you think you need the item.

Final Pay Items: Certain items are designated as Final Pay Items, denoted with an (F) at the end of the item description in the Master Item List.

Final Pay (F) items are only used when sufficient information exists such that quantities can be calculated to a high degree of accuracy. For Final Pay Items the intent is to permit Construction to pay the item total shown in the summaries without duplicating calculation efforts in the field (See Section 109 – *Standard Specification for Road and Bridge Construction)*.

If the item being calculated is considered a "final pay" item, but the information available does not allow the item to be calculated precisely, the designer will coordinate with the Specification Engineer for an appropriate non-final pay item number.

Slope Correction Factor: Another important topic is the Slope Correction Factor. Some work (drainage, landscaping, erosion control, etc.) is performed on a steep slope. Typically these quantities are calculated by measuring the lengths and widths on the plans to compute areas. Measurements that are calculated in the horizontal plane must be corrected for the slope angle that exists in the field. For example, an area measured in the horizontal plane is actually 29% smaller than the same area measured on a 1:1 slope. The standard Slope Correction Factors for various slopes are as follows in Table 8A.

TABLE 8A

4:1 (1.03)	3:1 (1.05)	2:1 (1.12)	1.5:1 (1.20)
1.25:1 (1.28)	1:1 (1.41)		

Curvature Adjustments: Distances between stations along the construction baseline (alignment) in a sharp curve location should not be treated the same way as those at tangent locations. In sharp curvature situations the distances between stations along the alignment are significantly shorter at the toe of slope on the inside of the curve, and longer at toe of slope on the outside of the curve. If the volume of cut is primarily on one side of the baseline and fill primarily on the other, the quantities for cut and fill along this alignment may be inaccurate and may need to be adjusted. Consult your supervisor for direction.

Quantity Rounding: Quantities are rounded after final item sub-totals are derived, the exception being Final Pay Items (see Final Pay section above) which are not rounded due to the calculation accuracy. Generally Final Pay quantities are calculated to one more significant digit than is stated in the 'Method of Measurement' of the *Standard Specifications for Road and Bridge Construction* for that item.

For example, the Method of Measurement for (F) Final Pay Item 304.2. - Gravel (F), states the item will be measured by the cubic yard, therefore calculate individual cubic yard of Gravel to the nearest 0.1 cy and round up to the nearest whole number after the final sub-total is determined. Some Final Pay Items are left unrounded.

Non-Final Pay Items: The decision to round quantities is at the discretion of the designer and supervisor but should comply with the intent as stated below.
Historically, rules for rounding have varied from rounding certain items very high, 5-10%, to rounding all items very low, 0%. The intent is to have an accurate quantity with very low rounding so that money is not left over in the Contract. However, some projects quantities are calculated with some uncertainty, such as resurfacing or culvert replacement projects that are not surveyed. For example, existing pavement width on a resurfacing project may vary and quantities were taken from tracing an aerial image with low resolution. On a pavement overlay

variable wheel rutting may affect quantity accuracy. Also for example, the area needed to have stone protection around a culvert may vary.
On the other spectrum, a roadway reconstruction project would propose and quantify the roadway to be a certain defined width, allowing for certainty in quantification, for example.

Use the following as a guideline when rounding non-final pay quantities:

Surveyed (high certainty) items – 0% - 2% above the subtotal.
Un-surveyed (lower certainty) items – 1% – 4% above the subtotal

Pavement width and rutting may be the high spectrum (2-4%) of rounding when un-certainty is involved, while a linear item such as pavement marking could be on the lower spectrum (1-2%)

Examples:
Interstate resurfacing overlay (not surveyed), Item 403.11001, calculated to 11,349 tons = rounds to 11,700 tons.
State highway reconstruction (surveyed), Item 403.11001, calculated to 3,112 tons = rounds to 3,150 tons.

Spreadsheet Quantity calculation allows a % based rounding to be done with ease. Please show % next to the rounding on the calculation sheet.

NOTE: For additional rounding result examples see the Summary table sheets in the sample Construction Plans section of the *Highway Design Manual Volume 2*.

CADD Microstation Quantity Drawings: As part of the general CADD project setup, a quantity drawing (12345qty.dgn) is created with a task menu to assist in quantifying items. Similar quantity drawings should be created for cross sections (i.e. 1234 XS_MC1m_qty.dgn) cut off individual alignments. The original plan and cross section drawings are referenced into the individual quantity drawings where the fill areas will be created and measured for use in quantity calculations. The Contractor and Construction personnel do not have access to these drawings; therefore it is important to define project areas on the quantity worksheets in a manner that construction can reasonably identify work locations, and roughly duplicate or confirm item quantities in the specified field locations.

The following provides guidance specific to the development of certain item quantities, as well as general rules as put forth in the specifications. Always begin by referencing the specific item in the *Standard Specifications for Road and Bridge Construction* for information regarding Item Descriptions, Method of Measurement, Basis of Payment, etc.

SECTION 201 - CLEARING AND GRUBBING

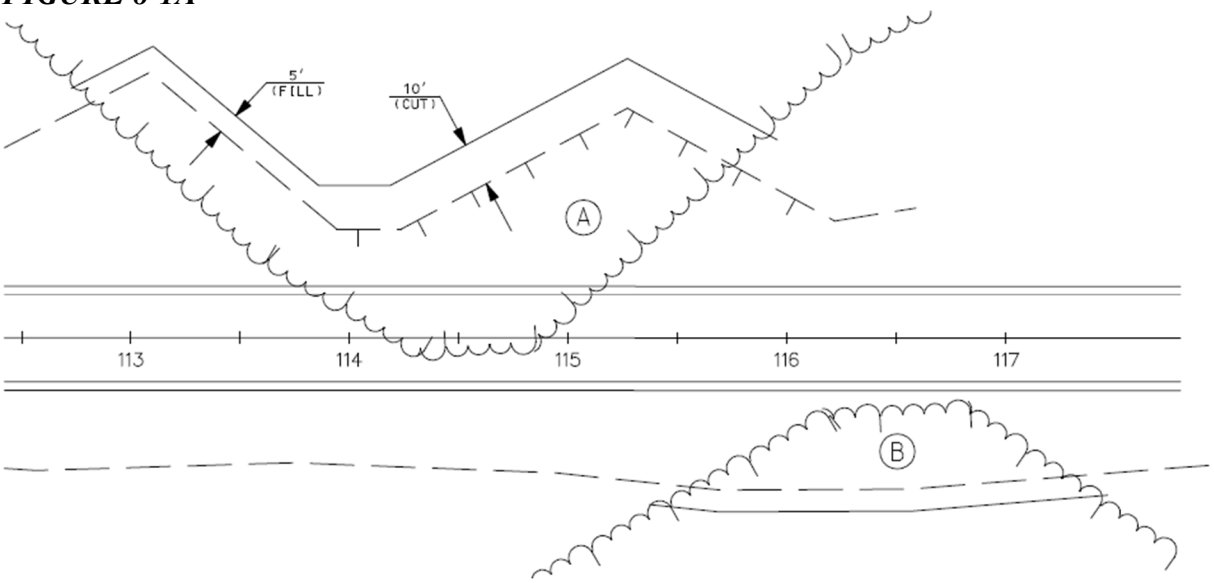
Item 201.1 - Clearing and Grubbing (F)

This work consists of cutting, removing, and disposing of trees and stumps, logs, brush, debris and vegetation within the limits shown on the plans or as ordered. Areas of growth including grass, weeds, crops, and trees measuring 12 inches or less in circumference (i.e. 4" diameter at a point 4 feet above the ground) will be classified as brush, and as such, their clearing will be considered subsidiary to this item. Unless otherwise shown on the plans, clearing and grubbing shall extend 10 feet beyond areas of excavation (cut) and 5 feet beyond areas of embankment (fill) slopes. (Note that clearing is generally not extended into wetlands)

Additional clearing & grubbing may be required for sight distance at intersections or along the inside of horizontal curves.

Measure the area to the nearest 0.01 acre using CAD/D software. Assign a letter identifier to each designated clearing area as shown below in Figure 8-1A.

FIGURE 8-1A



Location

(A) STA 112+65 – 15+73 LT
Measured in CAD/D 1186.44 sf x $\frac{1 \text{ acre}}{43560 \text{sf}}$ = 0.027 acres round to 0.03 acres

(B) STA 115+50 – 117+25 RT
Measured in CAD/D 711.74 sf x $\frac{1 \text{ acre}}{43560 \text{sf}}$ = 0.016 acres round to 0.02 acres

Note: If the total Clearing and Grubbing for the contract is smaller than 0.25 acres, the work shall be considered subsidiary with no item included in the contract. When subsidiary, area designations are still shown in a plan view and in a Clearing and Grubbing table on the summary sheets, clearly labeled as subsidiary.

Calculations for each designated area will be identified by a label and summarized separately on the quantity calculation sheets and summary table. Other areas where clearing and grubbing may be required include: wetland, mitigation areas, diversions, erosion control areas (swales, sedimentation basins), special access drives, easements (slope, drain, sight distance, and construction).

Item 201.21, 201.22, 201.4 - Removing Trees & Stumps

Tabulate trees and stumps to be removed as shown on the cross sections and general plans. Trees are deemed "Large" (Item 201.22) when greater than 24 inches in diameter (75" circumference or over), or "Small" (Item 201.21) when between 4 inches and 24 inch diameter (or 12" – 74" circumference).

Stump removal (Item 201.4) shall be calculated based on stumps, measuring more than 12" in diameter, existing before the start of contract work; stumps created as a result of tree removal by the Contractor are removed subsidiary to the tree removal item. All stumps within the limits of the roadbed shall be completely removed to a depth of 3 feet below subgrade.

See Volume 2 of the Highway Design Manual for the layout of the Tree Summary.

Item 201.6 - Clearing for Fence Lines (F)

Estimate a 3 feet wide clearing strip for fence lines by a station-to-station reference and compute to the nearest 0.01 acre. Do not assign a letter designation or show the clearing limits on the plans for the fence line clearing areas. A Right-of-Way slope easement may be required to clear and grub along a fence line since it is common practice to place the fence on the ROW line. Show a column on the Fencing Summary table and pay under Item 201.6 - Clearing for Fence Lines.

Item 201.7xx Selective Clearing and Thinning (F)

This Item is used when trees are being removed with the stumps being cut flush to the ground with minimum disturbance of the ground. It is primarily used when locations are identified by the Highway Maintenance District to expose the road to sunlight, reducing the winter maintenance efforts and expense. It may also be used where sight lines are obstructed and /or trees are within the clear zone but various types of constraints prevent doing significant ground disturbance. The work is typically noted within the Prosecution of Work.

Item 201.881 Invasive Species Control, Type I & Item 201.882 Invasive Species Control, Type II

Existing non-native invasive plant species may be delineated by the Bureau of Environment. Impacts to these areas need to be measured and quantified by the SY to be paid under these items. Make sure to include construction access impacts as well as excavation type of impacts.

SECTION 202 - REMOVAL OF STRUCTURES & OBSTRUCTIONS

Building demolitions are coordinated through the Property Management section of the Bureau of Right-of-Way (Refer also to Chapter 10 Right-of-Way).

Item 202.1xx – Demolishing Buildings Subject to Prior Removal

Under this Item the Department reserves the right to arrange for the removal or demolition by others (not the Contractor) prior to a specified date. If the buildings have not been completely

removed by others prior to that date, the work to be done shall be as directed by the Prosecution of Work and/or Standard Specifications. A date stipulating release of the building to the Contractor needs to be identified in the Prosecution of Work, as well as a discussion of the anticipated work to remain after the removal by others.

Item 202.1xx and 202.2xx – Demolishing Buildings

Under this Item, building removal is performed by the Contractor as part of the project. When only one single structure has been identified for removal, it is paid as one unit under Item 202.2. However, if there is more than one unit specified in the contract, separate item numbers will be developed for each separate and complete unit, as shown in the table below. Note the first two structures are on the same parcel, so they will be removed as one unit; and therefore are paid under the same Item. Refer to the summary sheets in Highway Design Manual Volume 2 Construction Plans section for a sample layout of the Demolishing Buildings summary table. Buildings slated for demolition need to be clearly identified on the general plans with additional supporting information in the Proposal.

All available information regarding the buildings to be demolished is provided by ROW in an *Informational Data - Building Interior Survey* document which is included in the contract Prosecution of Work to assist the contractor in bidding on building demolitions. See Appendix 8-2 for a building demo checklist.

202.30x – Building Asbestos Abatement

When a project involves demolition, the ROW Bureau will arrange for asbestos testing. If asbestos is present, a special provision will be developed through coordination with the Specifications Engineer. Work consists of the removal and proper disposal of asbestos containing materials identified within a building(s) intended for demolition.

Investigation for and identification of asbestos containing materials is conducted at each individual location through an "asbestos identification survey", which is completed by the Bureau of Right-of-Way. These materials need to be abated prior to the building being demolished. In conjunction with the "asbestos identification survey", the Bureau of Right-of-Way is responsible for providing Part II of the Special Provision for this Item which describes the material, asbestos type and percentage, location of the building, and quantity of asbestos. Item numbers for this work should be consistent with the corresponding building demolition item numbers.

Table 8B is an example of a typical summary for Building Demolition Items.

TABLE 8B Building Demolition

ITEM NO.	ITEM DESCRIPTION	PARCEL NO.	OWNER & ADDRESS	STRUCTURE	UNIT	QTY
202.101	Demolishing Buildings	8	John E. Smith 25 Main Street	Garage & House	U	1

202.102	Demolishing Buildings	13	Joseph J. Brown 37 Main Street	House	U	1
202.201	Demolishing Buildings Subject to Prior Removal	21	Michael A. Jones 45 Main Street	House	U	1
202.301	Building Asbestos Abatement	8	John E. Smith 25 Main Street	Garage & House	U	1
202.302	Building Asbestos Abatement	13	Joseph J. Brown 37 Main Street	House	U	1
202.303	Building Asbestos Abatement	21	Michael A. Jones 45 Main Street	House	U	1

Item 202.3X – Fill Abandoned Pipe (or Structure)

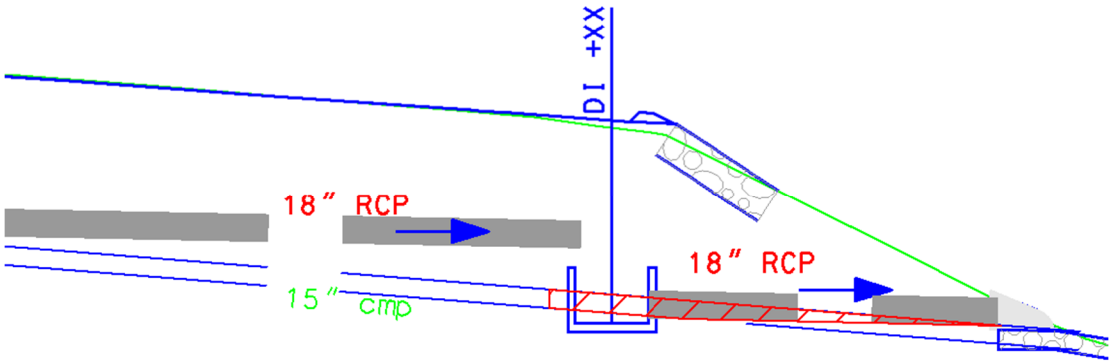
Work consists of filling abandoned pipes or drainage structures with flowable fill as designated on the plans or ordered. Fill abandoned pipe will be measured to the nearest 0.1 cubic yard of flowable fill based on delivery slips of material placed.

Item 202.4x and 202.5 – Removal of Existing Pipes, Catch Basins, Drop Inlets and Manholes

If an existing pipe or drainage structure falls within the excavation limits associated with placement of a new structure, removal of the existing structure is subsidiary to placement of the new items. If existing pipes or structures reside or extend beyond the limits of new installations, removal of those pipes and drainage structures is paid as a separate operation per *Standard Specifications* Section 202. When portions of existing structures are located outside or below the excavation limits, they are paid for under Item 202.4x, 202.5, etc. Refer to Section 603 & 604 computations for additional excavation limit information. Identify removal locations for this Item by station/offset for CB's, DI's and MH's, and station/offset-to-station/offset for pipes.

In Figure 8-1B, removal of DI XX and the portion of the 15" cmp within the proposed drainage excavation work limits (hatched area) is subsidiary, while the remaining portion of 15" cmp outside the drainage excavation work limits is paid under Item 202.4.

FIGURE 8-1B



Item 202.51 - Removal of Granite Curb Inlets

If CB's and DI's are being removed, any granite curb inlet removal is subsidiary to the removal of the structure (See Spec. 202.4.3). Otherwise, removals are paid under Item 202.51. Granite

curb inlet removals are listed in the curbing table summary. Tabulate removal locations by station/offsets.

Item 202.6 - Curb Removal for Salvage

There is a distinction between Curb Removal for Salvage, Reset Curb, and New Curb. The Designer should always reuse/reset existing curb if it is found to be in good condition. Curbing is considered surplus when it is removed, stockpiled, and not reused on the project. If there are specific locations where existing curb will be removed and not reused, tabulate the locations by station/offset, along with the associated quantity. If curb is removed for reset and extra curb will be left over, the balance will be paid as Item 202.6. Vertical and slope curb shall be tabulated separately for informational purposes. For more information, see Section 609 computations. Contact the District Maintenance Engineer to determine if any un-used curb should be salvaged to them.

Table 8C shows the Quantity Calculations for Item 202.6.

TABLE 8C Curb Removal

Item 202.6 - Curb Removal for Salvage		
LOCATION	**SLOPE CURB**	**VERTICAL CURB**
STA/Offset	**LF**	**LF**
STA 1+10.0 RT to 1+45.0 RT 14.8'	-	35
STA 1+10.0 LT to 1+70.0 LT 14.5'	60	-
STA 1+70.0 LT to 2+21.3 LT 18.0'	-	51
ITEM TOTAL =	60	86
ITEM SUB-TOTAL =	**146**	

Item 202.7 - Removal of Guardrail

Removal of guardrail shall be paid for under Item 202.7 regardless of whether new guardrail is to replace existing. If end units are also being removed they shall be covered under this item with their length added to the total removal. If a run is removing, and not replacing guardrail, the run shall be designated with a guardrail note and quantified in the summary.

FHWA will fund the upgrading of guardrail end terminals within a project's limits, but will not replace crashworthy ones that were hit; this would fall under routine maintenance. They will fund the removal and replacement of obsolete guardrail terminal units, but these terminal units must be replaced with new crashworthy ones.

For cable guardrail, the anchor rod on a cable guardrail anchor unit is cut 1 ft below ground, allowing the anchor block to be left in place. If the anchor is removed, the removal is included in the payment for Item 203.1 - Common Excavation.

Contact the District Maintenance Engineer to determine if any existing guardrail materials are to be salvaged to District (rail, cable, anchor units, steel posts or hardware). Salvaged materials are listed in the Materials Salvaged to the State summary table and in the Prosecution of Work. Identify guardrail removal locations by a station-to-station reference.

SECTION 203 - EXCAVATION AND EMBANKMENT

Excavation (Item 203.1, 203.2, 203.3, 203.4) and Embankment (Item 203.6) are commonly high cost items on a roadway project. The payment quantity for these items is derived by performing calculations on an Earthwork Summary calculation sheet. An abbreviated version of this document is included in the plans as the Earthwork Summary table, and will be discussed later in this section.

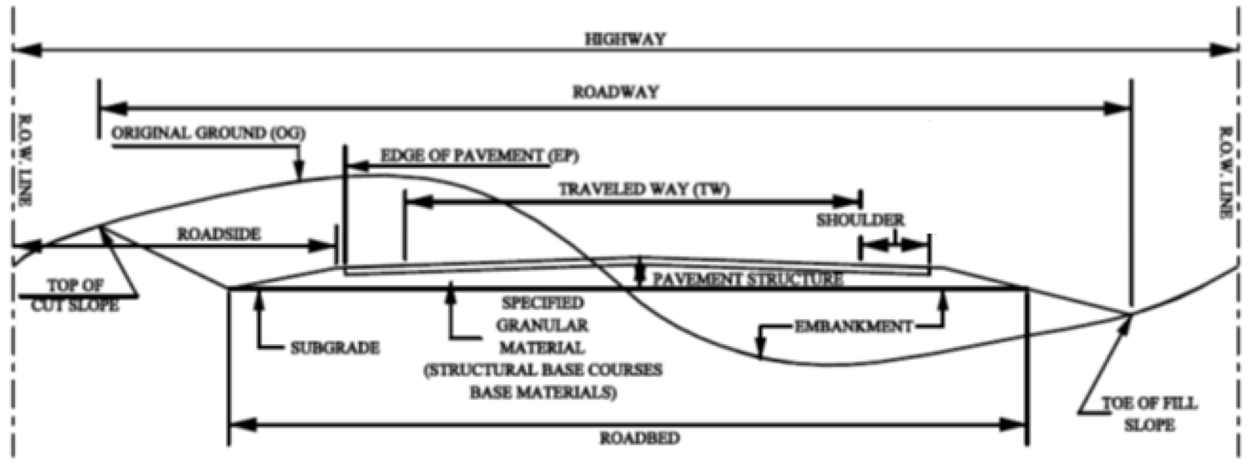
The common method to compute these volumes is the Average-End-Area Method. Newer methods involve generating volumes between 3-dimensional surfaces, but this is currently only recommended for preliminary quantities, or in the case of roundabouts, where other methods may not apply.

Average-End-Area Method: This method utilizes areas obtained from cross sections cut along a stationed alignment.

The average-end-area method involves determining the size of the area of interest on successive cross sections, with a volume obtained by multiplying the length between the sections by the average of the areas on each end. Start calculations for the Earthwork Summary by first determining the amount of material to be excavated (known as "Cut") on each cross section.

Figure 8-2 shows a roadway cross-section. Note that the original ground must be excavated on the left to construct the ditch line and base courses (i.e., one or more layers of specified select materials - sand, gravel, or stone - required to support the bituminous surface course).

FIGURE 8-2
Cross Section Elements



Using CADD software, closed shapes are created around the perimeter of the area to be removed, and a measure tool utilized to quantify the area. Note that rock, unclassified, and muck items are quantified separately from common excavation. Whatever method is used, it is important to document how the calculation was arrived at and where the information is located, so it is clearly understood and easily replicated when checked.

The total cut area between the original ground and bottom of proposed base, measured in Square Feet (SF), is entered on the Earthwork Quantities calculation sheet (Figure 8-3). This is subsequently used to calculate the volume of Cut between each station.

Show the total area of excavation to be performed within the limits of each cross section sheet on the line labeled "Area SF". The Construction Engineer will use this sheet to verify payment to the Contractor for earthwork completed at various stages of the construction phase.

FIGURE 8-3 Earthwork Calculation Sheet – Cut

New Hampshire DOT Department of Transportation

HIGHWAY DESIGN
CALCULATION SHEET

PROJECT ALTON
PROJECT NO. 14121D ROUTE NH 28
CALCULATED BY LMS DATE 06/06/13
CHECKED BY CJG DATE 06/12/13
SUBJECT QUANTITIES SHEET 2 OF 4

Item 203.1 - Common Excavation - In Section (CY)

	Station	Area (SF)	Average Area (SF)	Segment Volume (CY)	Cross - Section Sheet Totals (CY)
NH 28	5226+00	172			
			165	305	
	5226+50	157			931
			154	284	
	5227+00	150			
			175	324	
	5227+50	200			609
			183	338	
	5228+00	165			
			177	327	
	5228+50	188			
			188	348	
	5229+00	188			
			184	340	
	5229+50	179			1353
			198	366	
	5230+00	216			
			196	362	
	5230+50	175			
			210	389	
	5231+00	245			1117
			193	357	
	5231+50	141			
			144	266	
	5232+00	146			
			151	280	
	5232+50	156			
			159	294	
	5233+00	162			1197
			156	289	
	5233+50	150			
			156	289	
	5234+00	162			
			175	323	
	5234+50	187			
			173	320	
	5235+00	159			1221
			156	289	
	5235+50	153			
			152	281	
	5236+00	150			
			148	273	
	5236+50	145			843
			178	329	
	5237+00	210			
		PAGE SUB - TOTAL =		6973	

Note: The heavy horizontal lines are drawn at physical breaks between the CADD cross section sheets so the Cross Section Sheet Total table (located in the bottom right corner of each cross section sheet – see

HDM Vol. 2 Construction Plans cross section sample) can be completed. Spreadsheet software is often used to automate calculations – be sure to check cell formulas for accuracy.

Once all the excavation from the cross sections has been computed, compute the amount of fill material needed to construct any embankments (Item 203.6) needed along the roadway (known as "Fill"). Calculate the Fill volume by using the same method used to quantify the Cut, i.e., Average-End-Area. The Fill is the material in the area above the old ground up to the subgrade (Figure 8-2). Again, remember to note the total amount of Fill on each cross section Sheet Total table line labeled "Fill".

The Cut and Fill information will be transferred to the Earthwork Summary Sheet including any Rock or Muck excavation if involved. This is where the final earthwork quantities will be computed (Item 203.1, 203.2, 203.4, etc.).

Figure 8-4 shows an example of the typical Earthwork Summary Sheet, also available in a spreadsheet. (There may not be an entry for every line shown in the example. Similarly, the example may not show a line that is needed for the particular project. The example should not be taken literally, as shown. It can be modified to account for specific project needs by hiding/unhiding lines on the electronic spreadsheet.) The purpose of the following figure is to provide a sample calculation sheet which will simplify calculation of earthwork quantities.

FIGURE 8-4 Earthwork Summary *(Available in spreadsheet format)*

Project: _____ Fed. No. _____ State No. _____

		Preliminary	Final
1.	**Common Excavation in Sections, Including Boulders and Pavement**		
2.	**Common Excavation Not In Sections (Bituminous Pavement)**		
2a.	**Bituminous Pavement in Fill Sections**		
3.	**Common Excavation for Wetland Creation, Including Boulders**		
4.	**Drive and Approach Excavation, Including Boulders**		
	**********		
5.	**Common Excavation in Sections, Excl. Bldrs. & Conc. Pvmt.** [1-(22+23)]		
6.	**Common Excavation for Wetland Creation** *(3 - 24)*		
7.	**Muck Excavation in Sections** (Not Item 203.4)		
8.	**Topsoil Removed Beneath Fill Sections, Outside ROW**		
8a.	**Topsoil Removed Beneath Fill Sections, Within ROW (Item 203.11)**		
8b.	**Topsoil Removed in Cut Sections, Within ROW (Item 203.11)**		
9.	**Unsuitable Material Removed Beneath Fill Sections**		
10.	**Drive Excavation** (Line 4- Line 26)		
11.	**Total Common Excavation** *(Sum of (2+2a) + 5 through 10, not including 8a & 8b & then subtract 8b)*		
	COMMON EXCAVATION FOR ESTIMATE ITEM 203.1		
11a	**Total Common Excavation – LRS** *(Line 8a + 8b)*		
	COMMON EXCAVATION – LRS FOR ESTIMATE ITEM 203.11		
12.	**Muck Excavation (See Item 203.4)**		
	MUCK EXCAVATION FOR ESTIMATE ITEM 203.4		
13.	**Wetland Soils Removed For Mitigation (Cuts and Fills) (See Item 203.49)**		

	WETLAND SOILS FOR MITIGATION FOR ESTIMATE ITEM 203.49		
14.	**Rehandling Surcharge Material**		
	REHANDLING SURCHARGE MAT'L FOR ESTIMATE ITEM 203.7		
15.	**Unclassified Channel Excavation, Roadway (See Item 207.3)**		
16.	**Unclassified Channel Excavation, Bridge (See Item 207.3)**		
17.	**Common Bridge Excavation (Item 504.1)** *(From Bridge Quantities)*		
18.	**Common Channel Excav., Roadway (See Item 207.1)** *(From Drainage Quants.)*		
19.	**Common Channel Excav., Bridge (See Item 207.1) (***From Bridge Quants.)*		

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20.	**Rock Excavation in Sections (Solid)**		
21.	**Rock Excavation for Wetland Creation (Solid)**		
22.	**Boulders in Sections** *(1 x ___%)*		
23.	**Concrete Pavement in Sections**		
24.	**Boulders in Common Excavation for Wetland Creation** *(3 x __%)*		
25.	**Drive and Approach Excavation (Solid Rock)**		
26.	**Drive and Approach Excavation (Boulders)** *(4 x_____ %)*		
27.	**Rock Overbreakage**		
28.	**Rock Not Covered by Sections** *(Surface Bldrs, Headers, Foundations, etc.)*		
29.	**Total Rock Excavation (Item 203.2)** *(Sum of 20 through 28)*		
	ROCK EXCAVATION FOR ESTIMATE ITEM 203.2		
30.	**Rock Structure Excavation (See Item 206.2)**		
31.	**Rock Bridge Excavation (See Item 504.2, 504.21 or 504.24)** *(From Bridge Quants.)*		
32.	**Rock Channel Excavation, Roadway (See Item 207.2)** *(From Drainage Quantities)*		
33.	**Rock Channel Excavation, Bridge (See Item 207.2)** *(From Drainage Quants.)*		

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34.	**Sections Fill**		
35.	**Topsoil Replacement** *(8+8a)*		
36.	**Unsuitable Material Replacement** *(9)*		
37.	**Muck Replacement** *(7 or 12)*		
38.	**Drive and Approach Fill**		
39.	**Wetland Soil Replacement** *(13)*		
40.	**Fill for Rock Cut Earth Berms**		
41.	**Replace Embankment Settlement with Fill Material**		
41a.	**Replace Bituminous Pavement in sections (2a)**		
42.	**Embankment-In-Place (Item 203.6)** *(Sum of 34 through 41a)*		
	EMBANKMENT-IN-PLACE FOR ESTIMATE ITEM 203.6		

Computed By: ___________ ***Date:***_____ ***Revised By:*** ___________ ***Date:*** ____________

Checked By: ___________ ***Date:***_____ ***Checked By:*** ___________ ***Date:*** ____________

****NOTE: Do not show italicized matter on Earthwork Summary for the Plans***

EARTHWORK SUMMARY SHEET

Instructions for compiling the Earthwork Summary Sheet (shown in Figure 8-4) follow. Directions may include information that is not relevant to every project, and may also not include information that is needed. Use engineering judgment to determine what should be shown on the Earthwork Summary for a specific plan set. Add or delete (hide) lines as needed. The purpose of the summary is to assist bidders in determining whether the project involves hauling material onto, or away from, the site.

1. ***Common Excavation in Sections, Including Boulders and Pavement*** - Compute this quantity on the Earthwork Quantities Sheets using the "Average-End-Area" method of volumetric computation. This quantity represents the sum of the volumes measured on the cross section sheets that are entered on the sheet in the line labeled "Common Excavation". This is not the quantity that is paid as Item 203.1 - Common Excavation. This work includes any boulders or concrete pavement that would be in the measured cross sectional area that are not paid under Item 203.1. There is no provision for slope rounding.

2. ***Common Excavation Not In Sections (Bituminous Pavement)*** - This quantity represents excavation to remove existing bituminous pavement not shown (or falling beyond the limits of) the cross sections.

   2a. ***Bituminous Pavement in Fill Sections*** **-** This line is used to quantify existing bituminous pavement shown in the cross sections that is unacceptable for use as a fill material.

3. ***Common Excavation for Wetland Creation, Including Boulders*** - This work seldom falls completely within the roadway cross-sections. This quantity separates wetland construction from roadway construction, and may be computed by the Average-End-Area method if cross sectional information for the site is available. A grading plan could be used instead of cross sections, as long as an acceptable method of three-dimensional measurement is used.

4. ***Drive and Approach Excavation, Including Boulders*** - Simplify this calculation as much as possible, due to its small percentage in the total Common Excavation. Assume cross sections along the drive or approach centerline and use the Average-End-Area method to calculate the quantity, or use an acceptable method of three-dimensional measurement if using a grading plan. Do not include this quantity in the volume shown on the cross section sheets in the line labeled "Common Excavation".

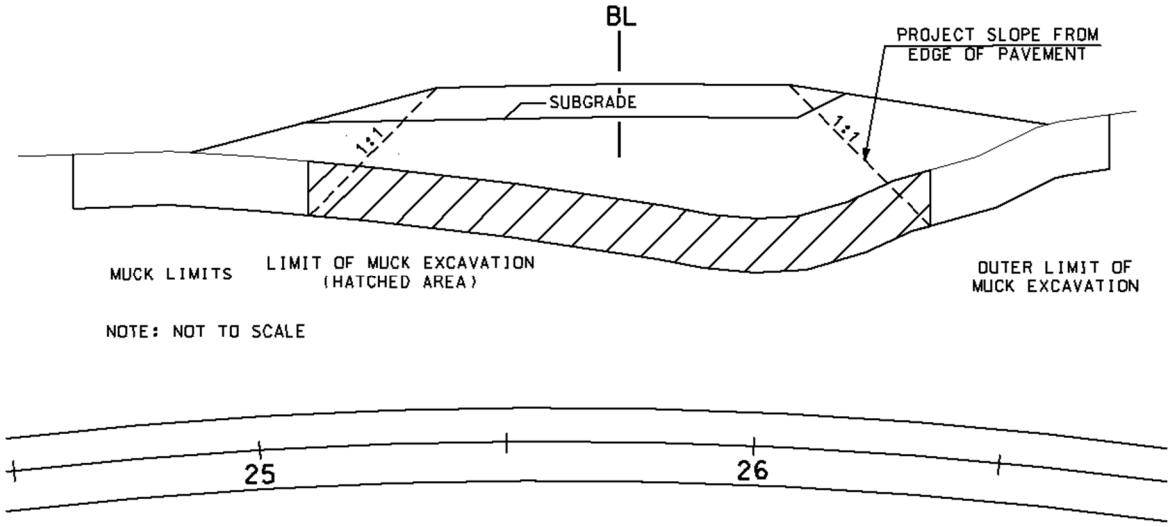
5. ***Common Excavation in Sections, Excluding Boulders and Concrete Pavement*** - This calculation excludes material that is not paid as Common Excavation that may be in the measured cross sectional area (e.g., boulders, concrete pavement). The resultant quantity is part of the total quantity paid as Item 203.1.

6. ***Common Excavation for Wetland Creation*** - This calculation excludes material that is not paid as Common Excavation in the excavation for the wetland that may be in the measured cross sectional area (e.g., boulders, concrete pavement, etc.). The resultant quantity is part of the total quantity paid as Item 203.1.

7. ***Muck Excavation in Sections (Not Item 203.4)*** - The decision to pay for the removal of this material as either Item 203.1 - Common Excavation or Item 203.4 - Muck Excavation may be influenced by the construction activities involved. Generally, if the volume encountered

is more than 3000 cy or the average depth is more than 2 ft, it can be paid as Item 203.4 - Muck Excavation. Refer to the geotech. report and coordinate with the District Construction Engineer to determine the preferred payment item. If this line is used, do not use line 12.

FIGURE 8-5 Muck Excavation

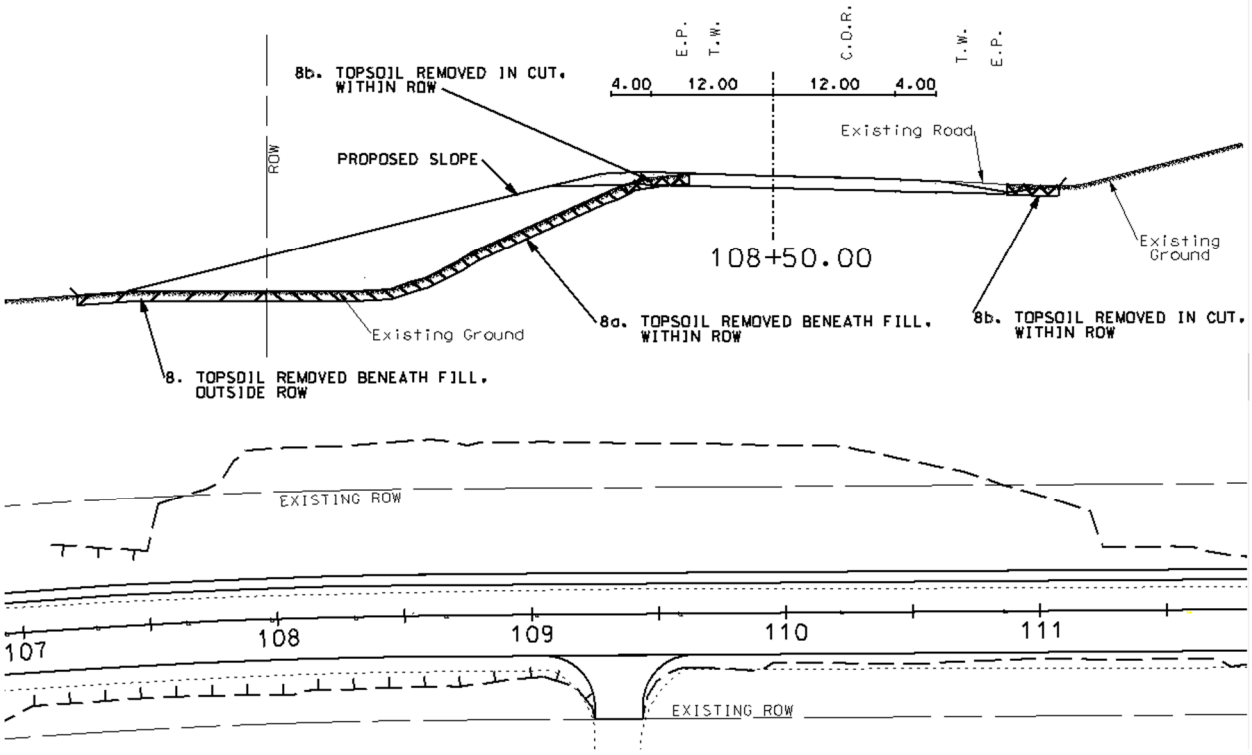


8. ***Topsoil Removed Beneath Fill Sections, Outside ROW*** - Compute by multiplying the area (plan view) within fill slopes outside the ROW by the depth of Topsoil recommended in the Geotechnical Report. If there is no Geotechnical Report for a project, you can assume 4"-6", or make the Embankment Item a non-final pay, after review and approval by the District Construction Engineer. Include only those areas proposed to be filled as indicated on the cross sections, not necessarily the limits of the fill slope lines (see Figure 8-6). Review with Construction and M & R prior to computing to make sure topsoil needs to be removed as part of the project.

8a. ***Topsoil Removed Beneath Fill Sections, Within ROW*** – Compute as in #8, for areas within the State ROW, except with a minimum depth of 6". This volume will count toward Item 203.11.

8b. ***Topsoil Removed in Cut Sections, Within ROW*** – Make similar estimations for depth as in 8a. Measure areas of cut within the ROW and multiply times depth for volumes toward Item 203.11.

FIGURE 8-6 Topsoil Excavation & LRS



9. ***Unsuitable Material Removed Beneath Fill Sections*** - This line is used to quantify excavated material that is unacceptable as a base for fill material (i.e., stump dumps, silt deposits, marine clays, organic fill, etc.). When this material is over excavated in pipe trenches, Granular Backfill replacement will be required. The Geotechnical Report will describe the location of this material, its depth, and recommended excavation limits. Compute this quantity by multiplying the area of the material by the depth noted in the Geotechnical Report.

10. ***Drive and Approach Excavation*** - This calculation excludes material, i.e., boulders, concrete pavement, etc., that may be in the measured drive or approach area that is not paid as Common Excavation. This quantity should not be part of the volume entered on the cross section sheets in the line labeled "Common Excavation".

11. ***Total Common Excavation*** - This is the total volume of excavation that is paid under Item 203.1 - Common Excavation.

11a. ***Total Common Excavation – LRS*** – This is the total volume of excavation that is paid under Item 203.11 – Common Excavation – LRS.

12. ***Muck Excavation (Item 203.4)*** - Using this line results in the payment of this excavation under Item 203.4 - Muck Excavation. Generally, if the volume encountered is more than 3000 cy or the average depth is greater than 2 ft, it should be paid as Item 203.4 - Muck Excavation. If this line is used, do not use line 7.

13. ***Wetland Soils Removed for Mitigation in Cuts and Fills (Item 203.49)*** - This line is used when a source of Wetland Soils suitable for mitigation is noted in the Geotechnical Report or by specific Environmental determination and will be used in a mitigation site. This quantity includes Wetland Soils removed from cut and fill sections.

14. ***Rehandling Surcharge Material*** - Rehandling surcharge material consists of removing and redepositing the surplus surcharge material that has been used to displace or consolidate certain material below the specified sections of fill. The quantity is computed as the volume of material placed above subgrade minus any estimated settlement. The estimated settlement amount is normally provided in the Geotechnical Report as part of the recommendation to surcharge the material. Actual settlement measurements may be taken during construction using Settlement Platforms (Item 210.1) and possibly Settlement Platform Monitoring (Item 210.2) if monitored by the contractor.

15. ***Unclassified Channel Excavation, Roadway (See Item 207.3)*** - This item is used if classification of the material is not known, i.e., common, rock, muck. Compute for channels that have a bottom width of 10 feet or more. (This item may also be used for excavation of detention ponds and vegetated treatment swales. This quantity will appear on the Drainage Summary. See Figure 8-7 and the sample calculation in Table 8E.)

FIGURE 8-7 Unclassified Channel Excavation

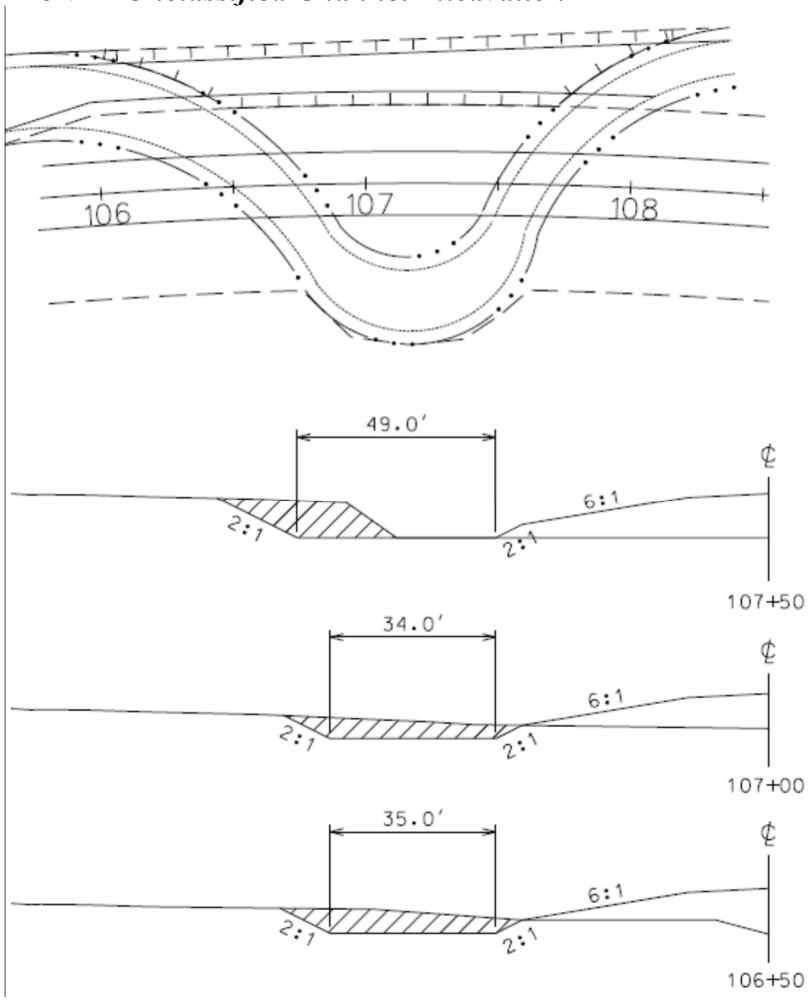


TABLE 8E

Unclassified Channel Excavation

Station	Area (SF)	Average	Segment

		Area (SF)	Volume (CY)
106+00	0.00		
		1.62	3.0
106+50	3.24		
		3.21	5.9
107+00	3.18		
		2.71	5.0
107+50	2.25		
		1.13	2.1
108+00	0.00		
	SUB - TOTAL =		**16.0**

16. ***Unclassified Channel Excavation, Bridge (Item 207.3)*** - If Unclassified Channel Excavation is paid for in the Bridge items, the quantity is repeated here for informational purposes.

17. ***Common Bridge Excavation (Item 504.1)*** - If Common Bridge Excavation is paid for in the Bridge items, it is repeated here for informational purposes.

18. ***Common Channel Excavation, Roadway (Item 207.1)*** - Compute for channels that have a bottom width of 10 feet or more and where classification of the material is known to be common. (This item may also be used for excavation of detention ponds and vegetated treatment swales). This item will appear on the Drainage Summary and calculated similar to the example shown in Line 15.

19. ***Common Channel Excavation, Bridge (Item 207.1)*** - If Common Channel Excavation is paid for in the Bridge items, the quantity is repeated here for informational purposes.

20. ***Rock Excavation in Sections (Solid)*** - This quantity is the sum of all the solid rock areas measured on the cross sections.

    Presplitting & Overbreakage: Rock excavation usually includes pre-splitting where the designed slope is 1:2 (H:V) or steeper and the rock is 10 feet or more in depth above the subgrade, measured along the slope (*Standard Specification Section 203.3.2.9.1)*. Where pre-splitting is not required, a certain amount of rock overbreakage in the slopes will be measured (*Standard Specification 203.4.8*) and included on the Summary. Compute, but do not show on the cross sections, 2 feet beyond the rock face above the subgrade for over-breakage as a pay item. Embankment-In-Place will be used to replace overbreakage. No over-breakage is allowed or paid for if pre-splitting is required.

    The Bureau of Materials and Research Geotechnical Section will provide the pre-splitting hole spacing. The designer will compute the pay quantities for linear feet of hole, as follows:

    - Measure the depth from top of rock along the designed rock slope to subgrade at 25 ft intervals and average the depth between the 25 feet intervals.
    - Multiply the number of holes in the 25 feet section by the average depth. Repeat the process for the length of the face to be pre-split.

If the rock cut is more than 35 feet deep, a mid-slope shelf may be needed, but should be omitted if possible. Extra drilled holes without explosives are added by using a percentage recommended by the Bureau of Materials and Research.

21. ***Rock Excavation for Wetland Creation (Solid)*** - This work usually falls outside of (or beyond) the roadway cross-sections. This line separates wetland construction from roadway construction. If cross-sectional information is available then the quantity is computed by the average-end-area method. If a grading plan is used, the quantity can be computed by any acceptable method of three-dimensional measurement. Coordinate the limits of this excavation with the wetland Designer. This quantity should also include rock excavation for large stormwater detention basins not shown on the cross sections.

22. ***Boulders in Sections*** - Compute this quantity by multiplying the volume of excavation in Line 1 by the "percentage of boulders in common excavation" recommended in the Geotechnical Report.

23. ***Concrete Pavement in Sections*** - This quantity represents the quantity of Concrete Pavement (slab 6" thick or greater) present in the excavation. Refer to the old project's typical sections for the dimensions to compute this quantity.

24. ***Boulders in Common Excavation for Wetland Creation*** - Compute this quantity by multiplying the quantity in Line 3 by the "percentage of boulders in common excavation" recommended in the Geotechnical Report.

25. ***Drive and Approach Excavation (Solid Rock)*** - Simplify this calculation as much as possible, due to its small percentage in the total Rock Excavation. Assume cross sections along the drive or approach centerline and use the Average-End-Area method to calculate the quantity, or use an acceptable method of three-dimensional measurement if using a grading plan. Do not include this quantity in the volume entered on the cross section sheets in the line labeled "Rock Excavation".

26. ***Drive and Approach Excavation (Boulders)*** - Compute this quantity by multiplying the quantity in Line 4 by the "percentage of boulders in common excavation" recommended in the Geotechnical Report.

27. ***Rock Overbreakage*** - If Pre-splitting is paid for, no measurement for overbreakage will be allowed. When overbreakage is measured and allowed, it will be measured 2 feet horizontally beyond the required slope lines per *Standard Specification Section 203.4.8*. No allowance for overbreakage will be made below the subgrade elevation.

28. ***Rock not Covered by Sections*** - This quantity includes surface boulders (that cannot be removed without blasting or ripping) and the removal of existing stone or masonry structures not accounted for in the cross sectional information (e.g. headwalls measuring 2 cy or more).

29. ***Total Rock Excavation (Item 203.2)*** - This is the total volume of excavation that is paid as Item 203.2 - Rock Excavation.

30. ***Rock Structure Excavation (Item 206.2)*** - This quantity is solid rock excavation for structure installation (i.e. ditches, catch basins, culverts, headwalls (measuring between 1-2 cy),

retaining walls, drainage swales). Make sure to cross-reference this quantity with the Total from the Drainage Summary.

31. ***Rock Bridge Excavation (Item 504.2, 504.21 or 504.24)*** - This excavation is performed for the construction of bridge piers and abutments. The quantity should be provided by the Bridge Designer and is shown here for informational purposes.

32. ***Rock Channel Excavation, Roadway (Item 207.2)*** - Compute for channels that have a bottom width of 10 feet or more where classification of the material is known to be rock. (This item may also be used for excavation of detention ponds and vegetated treatment swales.) This item will appear on the Drainage Summary and calculated similar to the example shown in Line 15.

33. ***Rock Channel Excavation, Bridge (Item 207.2)*** - This quantity is provided by the bridge Designer when the classification of the material is known to be rock, and is repeated here for informational purposes. Do not adjust for slope rounding.

34. ***Sections Fill*** - Compute this quantity using the "Average-End-Area" method of volumetric computation. This quantity represents the sum of the fill volumes measured on the cross section sheets in the line labeled "Fill".

35. ***Topsoil Replacement*** - This quantity is used to fill the excavation performed to save the Topsoil removed beneath the fill sections and is the quantity shown in Line 8 & 8a.

36. ***Unsuitable Material Replacement*** - This quantity is used to fill the excavation that was performed to remove unsuitable material beneath fill sections and is the quantity shown in Line 9.

37. ***Muck Replacement*** - This quantity is used to fill excavation performed to remove Muck and is the quantity shown in either Line 7 or Line 12.

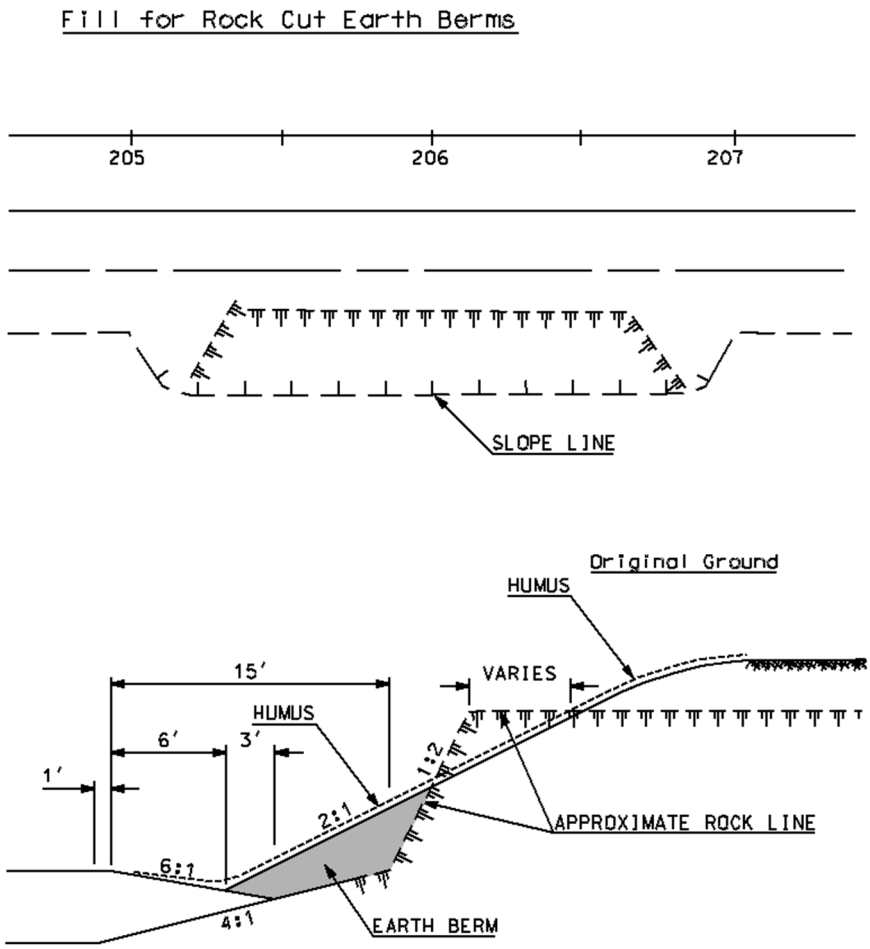
38. ***Drive and Approach Fill*** - Simplify this calculation as much as possible, due to its small percentage in the total Embankment-In-Place. Assume cross sections along the drive or approach centerline and use the Average-End-Area method to calculate the quantity, or use an acceptable method of three-dimensional measurement if using a grading plan. Do not include this quantity in the volume that is entered on the cross section sheets in the line labeled "Fill".

39. ***Wetland Soil Replacement*** - This quantity is used to fill the excavation that was performed to save identified Wetland Soils, and is the "Fill" part of the quantity shown in Line 13.

40. ***Fill for Rock Cut Earth Berms*** **-** This quantity is the volume of fill material needed to construct the earth berm at the bottom of a rock cut as shown on the typical sections included in the plans. An example is shown in Figure 8-8. Compute this volume by applying the constant shown on the typical. In the example the berm is constructed from STA 205+20 to STA 205+80.

    Volume = 60 ft x 184 cf /100 ft = 110.4 cf or 4.1 CY

FIGURE 8-8



41. ***Replace Embankment Settlement with Fill Material*** - This quantity is used only when the settlement is not replaced by an aggregate base course, e.g., Item 304.1 - Sand. The approximate settlement is recommended in the Geotechnical Report.

    41a. ***Replace Bituminous Pavement in Sections (2a)*** – This quantity is used to fill the excavation that was performed to remove the bituminous pavement in fill sections and is the quantity shown in Line 2a.

42. ***Embankment-In-Place (Item 203.6)*** - This volume is the quantity that is paid as Item 203.6 – Embankment-In-Place.

Item 203.1 - Common Excavation

Common Excavation will consist of all excavation not included as rock excavation, structure excavation, or otherwise classified. The item consists of several types of excavation including that identified from the cross sections, excavation for wetland creation, drive and approach excavation, areas outside of cross section coverage (such as driveway pavement removal), and removal of topsoil.

The accepted quantities of excavation will be paid for at the contract price per cubic yard.

Item 203.11 – Common Excavation – LRS

This item will consist of all excavation that meets the definition of Limited Re-use Soil. Currently this is defined as topsoil that is to be removed (disturbed by construction) from within the existing ROW. Topsoil when unknown will be estimated at a minimum of 6 inches deep. Previously, topsoil removed beneath fill was the only existing topsoil removal calculated. Now topsoil must be separated between within ROW and outside ROW, and topsoil within cut sections also needs to be estimated.

Item 203.2 - Rock Excavation

Rock Excavation will consist of the removal of all solid rock that cannot be removed without blasting or ripping, as well as boulders and parts of masonry/concrete structures when found to measure 2 cy or more. Designers should note the difference between *Item 203.2 – Rock Excavation*, and *Item 206.2 - Rock Structure Excavation* by referring to the Description section and specifics of the individual items in the *NHDOT Standard Specifications for Road and Bridge Construction*.

The cost of all blasting related vibration control and monitoring, pre-blast condition survey, post blast surveys, blasting precautions, and other protective measure necessary to prevent damages are subsidiary to this item. Refer to *Standard Specifications section 203.5.11.*

Note: If Rock Excavation is greater than 5,000 cy, groundwater and/or well monitoring may be required depending upon the proximity of drinking water wells to the work, and may include Items 203.93- Hydrologist, 203.94 – Baseline Water Sampling, 203.95 – Extended Water Sampling, or 1008.6 – Drinking Water Resource Protection. If groundwater monitoring is required the Bureau of Materials and Research Geotechnical Section will need to evaluate the potential for impacts to supply wells.

Item 203.3 - Unclassified Excavation

Use this item for excavation performed in compliance with *Standard Specification* Section 203 when the nature of the material is unknown. Unless the nature of the material is found to be unsuitable, it can be used within roadway embankments.

Plans and/or details showing unclassified excavation need to define the location and limits of the work, if known, such that accurate quantities can be developed. Quantity computations should include a dimensioned sketch. "Unclassified Excavation" will be paid for based upon measurement of excavation limits of this type, in a cubic yard quantity.

Item 203.53 – Low Permeability Fill (F)

This work typically consists of furnishing and placing a low permeability material as shown on the plans and details, or as ordered. The intent is to form a soil layer that is as impervious as possible to minimize infiltration of storm water runoff into the ground. Some examples of soils that are acceptable for low permeability fill are: clay, glacial till, and well-graded soils with high silt contents.

Plans and details showing low permeability fill will define the location and limits of the work such that accurate quantities can be developed. Quantity computations should include a dimensioned sketch. If the computation involves measuring an area from a cross section sheet, set up calculations the same way Earthwork Quantities are shown (Items 203.1, 203.6, etc.).

Low permeability fill is a final pay item and will not be measured, but shall be paid for by the cubic yard final pay quantity as shown in the plans.

Item 203.6 - Embankment - In - Place (F)

Embankment-in-Place shall consist of furnishing, placing, and compacting the total volume of embankment material required to construct fill below subgrade and within the roadway template lines.

The quantity for this item is a final pay quantity and will not be measured. Embankment shall be paid for at the cubic yard as derived from calculations on the Earthwork Summary Sheet and as shown in the plans and cross sections. The basis of the quantity is normally the amount of fill material needed to create embankments and computed using the average-area-end method described earlier in this chapter.

Item 206.1 - Common Structure Excavation & Item 206.2 - Rock Structure Excavation

This item consists of the excavation and backfill, or disposal when necessary, of all materials required to be removed to complete the work as shown on the plans or as ordered. Excavation for the following shall be included under this item: ditches that are not part of the 'standard' roadway template (berm ditches, inlet ditches and outlet ditches), drainage pipes, manholes, catch basins, drop inlets, headwalls, overhead sign bases, water and sewer pipes, pipe sleeves, conduits, and channels with less than a 10 ft bottom width. Also, see the *Standard Specifications Section 206*, and Appendices 8-3 and 8-4 for a description of when to use this item and to what extent/limits this item is paid for.

Designate each location on the quantity worksheet by station to station, or drainage note number, as appropriate, draw or reference a detailed sketch, and show dimensions as part of the calculation. Quantities associated with drainage will be shown on the Drainage Summary table with the respective drainage note.

Common Structure Excavation will be paid for based upon measurement of excavation limits of this type, in a cubic yard quantity. Surplus (if material is suitable) may also be used as a source of earthwork material if the trench excavation for the structures is backfilled with hauled-in material and if their total volume is substantial. Use engineering judgment if compiling Surplus Common Structure Excavation and coordinate with The Bureau of Construction.

Roadway ditches that are not adjoining the standard roadway typical are to be paid under Item 206.1 – Common Structure Excavation and are computed by Average-End-Area method similar to roadway excavation quantities. See *Standard Specifications* Section 206.4 for excavation limits. An example of Structure Excavation can be found under the computations for Items 603 & 604.

Note the differences between *Item 206.1 – Common Structure Excavation, Item 206.2 – Rock Structure Excavation* and *Item 203.2 – Rock Excavation*. Masonry or concrete header removals and boulders measuring individually between 0cy – 1cy will be paid under Item 206.1 – Common Structure Excavation; those measuring 1cy – 2cy will be paid under Item 206.2 – Rock Structure Excavation; while those measuring greater than 2 cy will be paid under Item 203.2 – Rock Excavation.

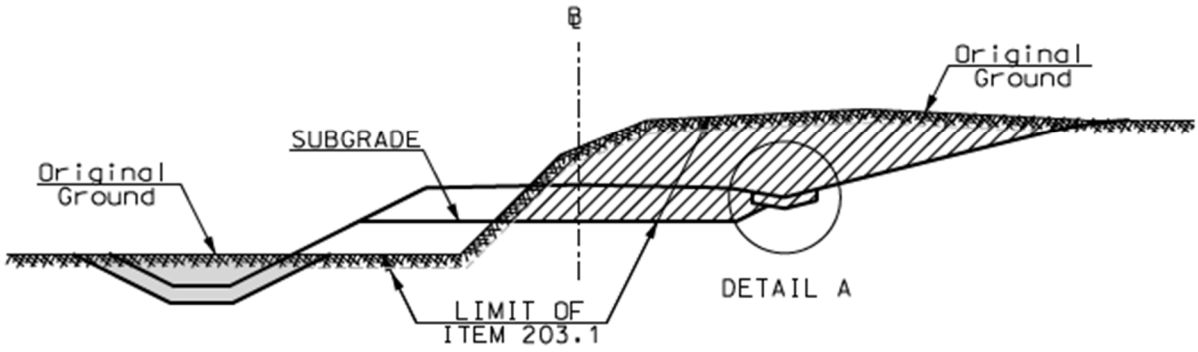
Figure 8-9 shows an example of when to pay for roadway ditch excavation. Additional information describing excavation pay limits can be found in the *Standard Specifications Section 206*.

FIGURE 8-9

ROADWAY AND DITCH EXCAVATION PAY LIMITS

FOR FURTHER INFORMATION, SEE STANDARDS SPECIFICATIONS SECTION 206. AND 203.1

I. NEW CONSTRUCTION

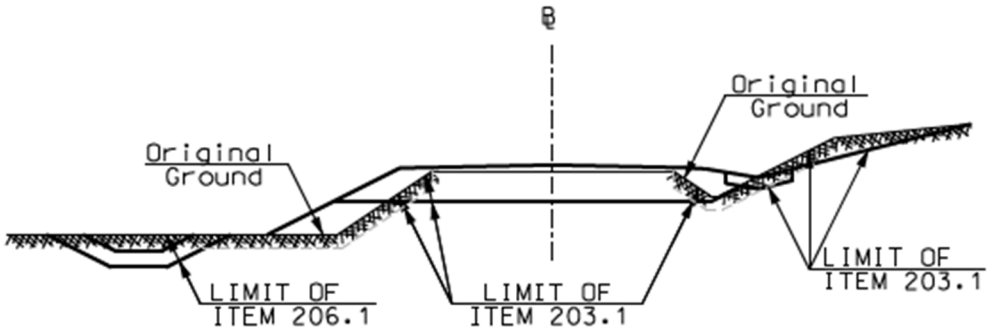


SHADED AREA WILL BE PAID AS ITEM 206.1 (THE DITCH IS NOT ADJACENT TO THE ROADWAY EXCAVATION; IT IS A SEPARATE EXCAVATION.

DETAIL A

HATCHED AREA WILL BE PAID AS ITEM 203.1 (THE DITCH IS PART OF THE EXCAVATION FOR THE ROADWAY TYPICAL)

II. RECONSTRUCTION



Item 206.19 - Common Structure Excavation Exploratory

Include this item in a contract with an estimated quantity, consistent with the size of the project or work expected, when it is anticipated that locations or depths of underground utilities are not accurately known and it is necessary to verify the locations prior to placement of drainage. Refer also to *Standard Specifications Section 206.5.4;* it is generally better to include a small quantity than none at all.

"Common Structure Excavation, Exploratory" will be paid for based upon measurement to the field excavation limits of this type, in a cubic yard quantity.

SECTION 207 - CHANNEL EXCAVATION

This item consists of excavation and disposal of all material encountered in the construction of channels having a bottom width of 10 feet or more, except inlet and outlet ditches for multiple pipe culverts.

Rock channel excavation specifically will be used where solid rock exists within what is otherwise considered Common Channel Excavation and can only be removed by blasting or ripping. It shall also include boulder and parts of masonry/concrete structures when found to measure more than 1 cubic yard, within those same channel limits.

Show or reference a dimensioned sketch or detail of the channel profile and cross sections to illustrate computations. This quantity is usually computed by the Average-End-Area method.

SECTION 209 - GRANULAR BACKFILL

Granular Backfill is used for several purposes, e.g., bedding for drainage pipes in rock and unsuitable material, bedding for pipes larger than 48 inches in diameter (See *Standard Specifications Section 603.3.2*), retaining walls, etc. It shall not be used under Headers unless in ledge or in unsuitable material.

At times it may be necessary to specify Granular Backfill (Sand), Granular Backfill (Gravel), or Granular Backfill (Bridge) (see *Standard Specifications Section 209.2.1*). For an example of this computation, see the Division 500 computations.

SECTION 210 – GEOTECHNICAL INSTRUMENTATION

The geotechnical report may recommend various types of monitoring instrumentation for installation during the construction phase of a project where geotechnical concerns are present, such as embankments over compressible soils. Coordinate with the Bureau of Materials and Research Geotechnical Section for locations and quantities of items covered in this section.

SECTION 211 - VIBRATION MONITORING

Vibration caused by blasting operations are required to be monitored and are subsidiary to the rock excavation items paid under Sections 203, 206, and 504 of the Standard Specifications, so they should not be included in this item. This item is specifically for non-blasting induced ground vibrations which can be generated by construction activities such as pile driving, vibratory compaction, pavement breaking, movement of heavy equipment, hoe ramming, dynamic compaction, excavating and earth moving. Vibration monitoring services (Item 211.11)

should be used when circumstances exist in the vicinity of a project site where non-blasting construction vibrations exceeding certain thresholds are expected to be produced at adjacent structures (historic and/or sensitive), facilities with electronic equipment, and certain manufacturing processes. A maximum distance of 150 feet should be used to determine what structures or sensitive equipment are "in the vicinity" of vibration producing construction activities; although this distance can be extended for very sensitive structures or manufacturing processes.

The assessment of need is on a case-by-case basis and needs to be coordinated and evaluated between all the relevant parties including Highway Design, Construction, Right of Way, Environment, Materials and Research's Geotechnical Section, and Design Services to determine the need and extent, as its inclusion should be carefully considered and based on engineering judgment. The quantity should be determined in consultation with the Geotechnical Section in the Bureau of Materials and Research.

SECTION 214 - FINE GRADING

Item 214. – Fine Grading

This work consists of the construction survey and final grading necessary for the subgrade, the surface of each course of material, the roadway outside the surface course (shoulders, slopes, and ditches), and other locations, as directed by the Engineer, to conform to the lines shown on the plans.

Although this work includes final grading beyond the limits of the pavement (See *Standard Specifications* Section 214.3) the calculation is based on a measured proposed pavement surface. Therefore, calculate the total area of the new pavement. Break down quantities into main line, drives, side streets, and approaches. Estimate the cost by multiplying the appropriate square yard area by the recommended cost per square yard; unit costs vary depending on the project type and size, use a higher price for urban jobs or phased construction projects. Reference recent bid prices for projects of similar size and scope to confirm an appropriate cost is being proposed, and confer with the Bureau of Construction.

Consult with your supervisor or District Construction Engineer on whether to include fine grading on projects involving full depth Item 306.21x - Reclaimed Stabilized Base Removed and Rehandled, when substantial re-grading is involved to re-establish design superelevations, roadway crowns, and profiles.

Item 214.3 – Fine Grading Earth Berms in Rock Cuts

If there are rock cuts within the project, the project designer will need to account for the additional grading required for the earth berms, as well as include this specific item for the grading.

When no quantity for 214.X items is included in the contract, the work will be subsidiary. List this item on the Incidental Summary table.

Item 214.42 – Fine Grading – Mound and Pool Microtopography

Use this item where micropools for detention ponds are constructed. Fine grading for slow drainage paths within flat areas such as these requires hand work beyond that of normal fine grading.

SECTION 217 – PREFABRICATED VERTICAL DRAINS

The geotechnical report may recommend various items, such as prefabricated vertical drains and a sand drainage blanket, for treatment of embankment construction over compressible soil areas. Coordinate with the Bureau of Materials and Research Geotechnical Section for locations and quantities of items covered in this section.

SECTION 223 – SLOPE STABILIZATION BY SOIL NAILING

The geotechnical report may recommend various items, such as driven or drilled soil nails, and dowels, for stabilizing an existing or newly constructed soil slope during construction. Coordinate with the Bureau of Materials and Research Geotechnical Section for locations and quantities of items covered in this section.

SECTION 225 – ROCK BOLTS

The geotechnical report may recommend various items, such as rock bolts, dowels or netting, for stabilizing an existing or newly constructed rock slope during construction. Coordinate with the Bureau of Materials and Research Geotechnical Section for locations and quantities of items covered in this section.

SECTION 304 - AGGREGATE BASE COURSES

This section addresses the use of sand, gravel, and/or crushed stone, primarily for use as roadbed base select course materials, but also for any roadway element requiring structural materials. Crushed gravel shall also be used as bedding for sidewalks and driveways where deemed appropriate.

Specifically, Items 304.1 - Sand (F), 304.2 - Gravel (F), Item 304.3 - Crushed Gravel (F), and Items 304.4 - Crushed Stone (Fine Gradation) (F) and 304.5 - Crushed Stone (Coarse Gradation) (F), respectively are used in the preparation of the roadbed. The work associated with these items consists of furnishing and placing base courses on a previously prepared subgrade or course, as shown on the plans or as ordered.

The quantities for most of the items within this section are *typically* Final Pay (F) and, as such, will not be measured in the field by the Contract Administrators. These items shall be paid for by the cubic yard as derived from calculations within the quantity book developed by the designer(s). Coordinate with the Specifications Engineer should a non-final pay item number be required.

Keep in mind that pavement recommendations may come with sand as the first base course, but if the roadway is narrow (12-4) and traffic needs to be maintained during construction, a switch to gravel may need to be made.

There are several methods for calculation of base course material quantities. The Designer will use good judgment to determine which method will produce an acceptable level of accuracy in a reasonable amount of time.

- "Applied Constant Method": This NHDOT method involves the use of a volumetric constant per 100 feet of roadway base course materials either depicted on the applicable "Typical Section" contained in *Highway Design Manual Volume 2* or the typical shown in the Contract plan. To calculate quantities, simply apply the appropriate constants to the lengths of roadway they represent. Where roadway width varies, show a sketch with the quantity calculations.

  The limitation with this method is that the volumetric constants shown on the "typicals" are for normal crown conditions only. The "Applied Constant Method" of computation may not be the best choice for computing base course quantities depending on the number of horizontal curves and curve length; additional constants may be computed for bank areas, however the effort may exceed that of using another method.

  The "Applied Constant Method" produces best results when used in an urban typical, since the volume of base course materials on the high side of a superelevated curve does not vary greatly through transition sections. This method may also be appropriate for use on projects containing few horizontal curves, limited superelevation, and no major intersections.

- "Average-End-Area" or "Back and Ahead Method": To use this method the project must have cross-sectional information available so that areas can be calculated at every station. Areas between the "back and ahead" cross section station are averaged, and then multiplied by the distance between the two stations to calculate the average volume existing between them. This can be applied using computer or hand drawn cross sections.

Remember that neither the "Applied Constant" or "Average-End-Area" method account for the quantity of material within the radius area at an intersection. To compute this volume, measure the area in the radius and multiply it by the depth of material noted on the typical.

- 3D Computer Modeling: This requires full survey or 3D information at an appropriate accuracy for roadway design. The Department is in the process of fully implementing 3D computer modeling capability on select projects, to complete 3D models to a 'final design stage' that would allow automated machine guidance and GPS capable construction equipment, to directly utilize the information in their equipment. This level of modeling allows designers to quantify base course materials directly from the model will produce more accurate results than the previously mentioned approaches.

  3D models need to fully incorporate and reflect the final product including slope and drain design, superelevation transitions, intersection radial adjustments, travelway tapers, guardrail widenings, driveway design, bridge work locations, etc. If the project has a tight project schedule, it may be quicker to do the calculations using another method.

  Utilization of computer generated quantities should be supplemented by one of the other methods to assist in quantifying progress payments by the Contract Administrator, and as a method to allow designers to check for reasonable accuracy of their model.

Do not deduct the volume occupied by a curb (See *Standard Specifications* Section 609.5.2).

Table 8F shows an example quantity computation for the Sand Base Layer. The area is computed by measuring the cross sectional area at the designated station, taking the average between stations and multiplying by the length between stations to find the volume (CY).

TABLE 8F

ITEM 304.1 - SAND (F)			
Station	**Area (SF)**	**Average Area (SF)**	**Segment Volume (CY)**
53+70	44.94		
		44.63	49.59
54+00	44.32		
		47.37	87.72
54+50	50.42		
		49.78	92.19
55+00	49.14		
		49.14	90.99
55+50	49.13		
		48.28	89.40
56+00	47.42		
		47.42	87.81
56+50	47.42		
		47.59	88.13
57+00	47.76		
		PAGE TOTAL	**586**

Compute volumes similarly for Item 304.2 - Gravel and Item 304.3 - Crushed Gravel.
An example calculation for Item 304.35 - Crushed Gravel for Drives can be found in the Section 403 computations. Crushed Gravel for Drives, or crushed stone if used in the roadway, should be used for drives unless a new drive is being built and the Gravel for Drives could be used as a course.

If the Geotechnical Report recommends additional sand layers, show separate computations for these areas.

Item 304.32 Crushed Gravel for Shoulder Leveling

Crushed Gravel for Shoulder Leveling is typically used on overlay or guardrail projects to address the elevation difference at the interface between the new edge of paved surface and the unpaved shoulder. This is typically not required on new full box construction as the typical addresses this with select materials.

Adjust required depths of fill to accommodate existing drop offs along the edge of pavement in addition to the depth of overlay. Include a dimensioned sketch in the quantity calculations to assist the Contract Administrator in verifying your assumptions. Be sure to subtract out any volumes for driveways or sides roads within the shoulder leveling locations. For conversion from cubic yards to tons: multiply the volume in cy by 1.5 tons/cy: 100 cy x 1.5 tons/cy = 150 tons

The accepted quantity of crushed gravel for shoulder leveling will be paid for at the contract unit price per ton delivered and used on the project.

Item 304.35 - Crushed Gravel for Drives

Cross sections should reflect either commercial or residential drive depths. See Section 403 for example calculation of this item.

SECTION 306 - RECLAIMED STABILIZED BASE (F)

This work consists of scarifying (break up, loosen, or roughen the surface), if necessary, and pulverizing the existing pavement together with a base course material. It may require removal and re-handling, and/or the addition of other materials to meet gradation specifications.

Recommendations for reclaim are typically contained in the pavement report generated by Materials and Research. Pavement coring and subsurface material information is critical in determining if reclaiming is an appropriate option. Recommended reclaim depths may include a portion of the existing underlying select materials or addition of stone to meet gradation requirements.

Reclaiming generates additional volume as a result of pavement pulverizing and mixing with underlying structural materials or addition of stone. Designers should be aware of this ‘fluff’ factor, coordinate with Materials and Research on the anticipated profile increase and discuss any necessary adjustments to minimize subsequent ROW and slope impacts. Develop profiles accordingly and obtain Materials and Research approval on profile adjustments, or excess material removal or utilization as shoulder leveling.

Computations for this item will be broken down into specific areas. Payment is determined by using computed areas, dimensioned sketches, or by using a station-to-station reference.

Example:

Main Line	Sta. 30+50 to 32+85, Rt. (24 ft wide)	
	235 ft x 24 ft	= 5,640 sf

Girard Drive (area from CADD) = 11,025 sf

Item 306 - Reclaimed Area = (5,640 sf +11,025 sf) x 1 sy /9 sf = 1,852 sy

Quantities for this item are Final Pay (F), to the depth(s) specified, and will not be measured in the field by the Contract Administrators, but shall be the quantity within the limits shown in the contract plans. These items shall be paid for by the square yard.

DIVISION 400 - PAVEMENTS

SECTION 403 - HOT BITUMINOUS PAVEMENT

Item 403.XXXXX - Hot Bituminous Pavement

Contact the Bureau of Materials and Research for information on what type of pavement treatments and mix types shall be used on a given project. For most projects this will be

provided in a Pavement Report developed by Materials and Research, and for smaller scale projects this information may be provided through email correspondence.

In quantifying this item, break down computations into areas of roadway, drives and approaches, parking areas, side streets, etc. Show quantities for base, binder, and wearing course pavements to provide Construction personnel with quantities to check pavement yields as placement occurs. All pavement shall be quantified as daytime pavement. If required, nighttime pavement operations shall be subsidiary to the daytime item. Show a dimensioned sketch to clarify the basis of computations, i.e., tapers, dimensions, radii, etc. Application rates are shown on the typical sections.

Calculate the extra width required for an asphalt curb by a station-to-station reference (see STD CR-2, Plate 2). In granite curb areas, the limit of machine method pavement calculations will be 12" *in front* of the curb for all binder and base courses of pavement. Compute hand method pavement (Item 403.12) in curbed areas to complete the paving operation of base and binder courses in front of the curb (See *Standard Specification* Section 609.5.3). Match existing pavement depth or assume an 8" depth for quantity purposes.

On projects with milling operations, District should be notified to see if they want the excess project millings salvaged for their use. Conventional pavement mixes contain 30% salvaged material. If a project's millings are a tonnage that is greater than the amount of RAP (Reclaimed Asphalt Pavement) needed in the new mix, then there will be excess available for District's use.

Example:

Tons From Millings = 8,000 Tons
Total Tons of Project Pavement = 20,000 Tons
30% of Project Pavement to Contractor for RAP = 20,000 Tons x 0.3 = 6,000 Tons
Millings available for Salvage = 8,000 Tons – 6,000 Tons = 2,000 Tons

ARGG (asphalt rubber gap graded) and bonded wearing course are two examples of mixes that do not have RAP used in their mix.

Item 403.11 – Hot Bituminous Pavement, Machine Method

A paving machine is typically 10' wide with 2' to 4 ½' extensions able to be mounted on either side. The width of a pavement pass generally is determined by the travelway widths. If shoulder widths are 4 feet or less, they will be assumed to be paved in the same pass with the adjacent lane. If shoulders measure greater than 4 feet wide, they will be assumed to be paved in a separate pass. The maximum width that Construction likes to use is 18 feet. Application rates are shown on the typical sections.

Plant mix pavements placed and produced under the Quality Control/Quality Assurance (QC/QA) specifications are designed to increase the quality of the finished product. This system provides incentive to the Contractor for constructing a good product, and applies a penalty to those who do substandard work.

The Bureau of Materials and Research will include in their pavement recommendations if QC/QA pavements are to be used. QC/QA pavement work depends on the scope of work rather than absolute tonnage included on a project. For example, if the road is reconstructed ½ of the

road at a time, one lift at a time, then that lift would need to be approximately 750 tons to have QC/QA applied.

There are two tiers of QC/QA pavements each with a corresponding item number, and a specific purpose, as specified in Section 401.1.5 Performance Requirements (QC/QA) of the *Standard Specifications for Road and Bridge Construction*

Item 403.XXXX1 - Hot Bituminous Pavement, _____ (QC/QA -Tier 1)

Quality/Pay Factors to be assessed under Tier 1, per the table contained in Section 401.1.5.1 of the *Standard Specifications for Road and Bridge Construction* are:

- Asphalt Content and Gradation
- Cross Slope
- Density
- Ride Quality
- Thickness

Items 403.XXXX2 - Hot Bituminous Pavement, _____ (QC/QA - Tier 2)

Quality/Pay Factors to be Assessed under Tier 2 are:

- Asphalt Content and Gradation
- Density

The accepted quantities for permanent or temporary pavements will be paid for at the contract price per ton, for the bituminous mixture, complete in place. When only a single course pavement is to be placed, it will be paid under either machine or hand method as prescribed.

Separate calculations should be made for all specific paving items, as well as leveling courses.

Item 403.12 – Hot Bituminous Pavement, Hand Method

Hand method pavement is used for driveways and driveway apron construction, where it is not feasible to use machine method, or unless otherwise noted. Other instances where hand method may be used include: paving around existing CBs, DIs, MHs (except with inlay/overlay projects where machine method is used), and for permanent drainage trench patches. In curbed areas hand method is used to begin the paving operation in front of the curb, existing or proposed depth of pavement, less wearing), 1 foot wide (see *Standard Specifications* Section 609.5.3).

Below is an example computation for the pavement quantities, including computations for drive excavation and fill. (Typical residential and commercial drives have 3 inches of pavement).

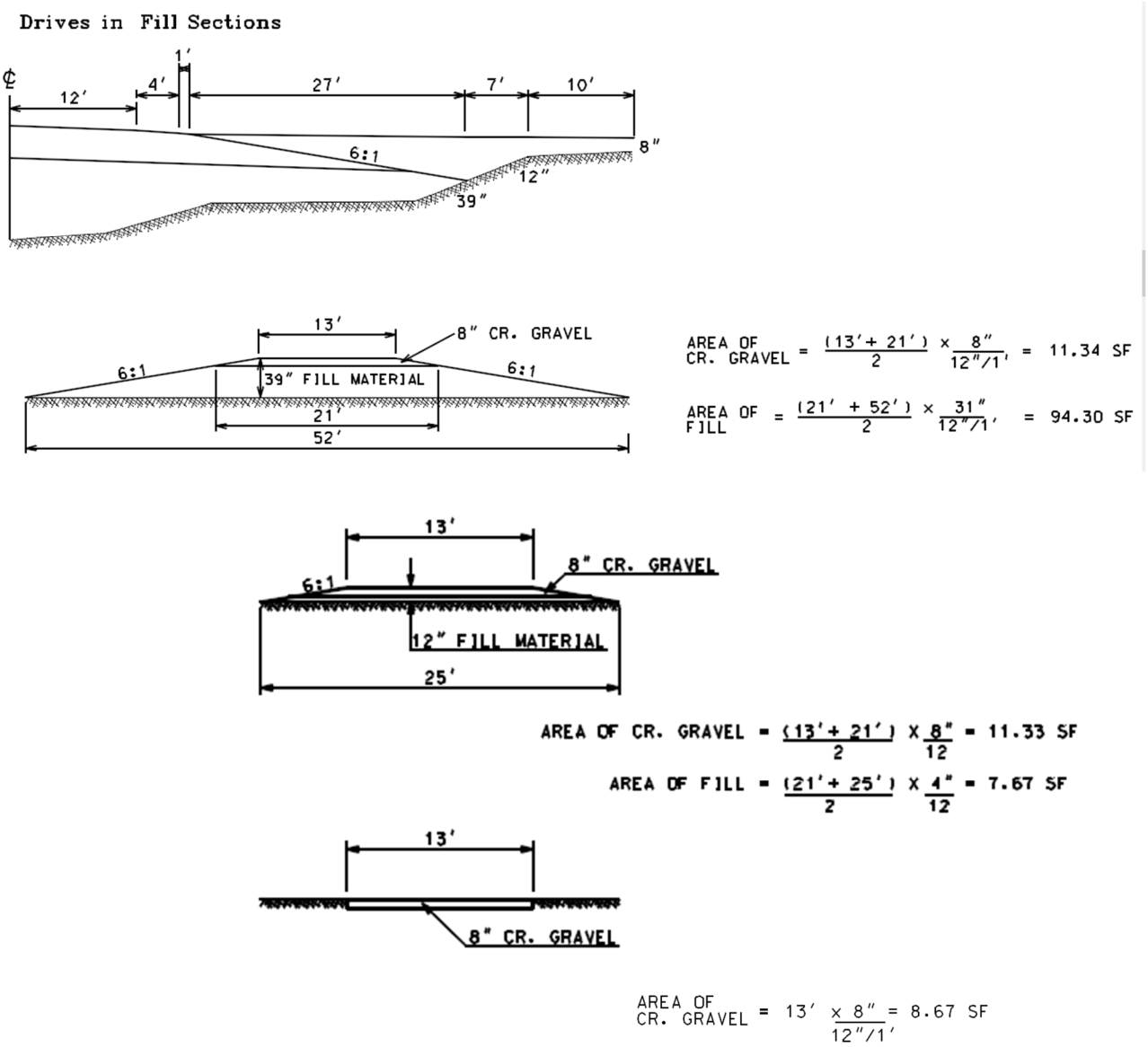
Example: Sta. 4+25, Rt. Const. Paved Drive (FIGURE 8-10)

Embankment in Place

$$\text{Volume} = \left[\frac{(0 \text{ sf} + 94.3 \text{ sf})}{2} \times 27 \text{ ft}\right] + \left[\frac{(94.3 \text{ sf} + 7.67 \text{ sf})}{2} \times 7 \text{ ft}\right] + \left[\frac{(7.67 \text{ sf} + 0 \text{ sf})}{2} \times 10 \text{ ft}\right]$$

Volume = 1876 cf / [27 cf /cy]
69.5 cy (round to 70 cy)

FIGURE 8-10



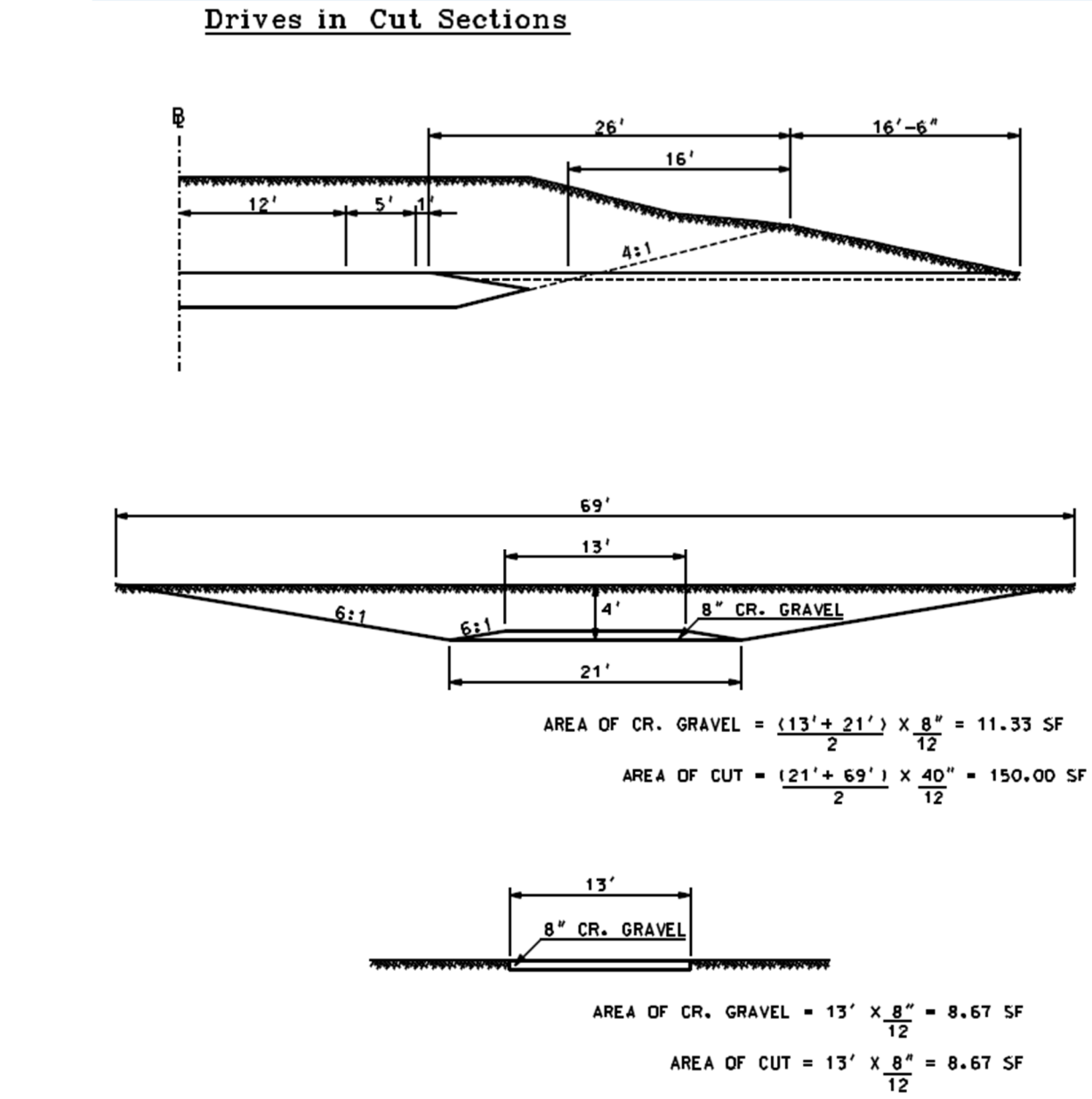
Crushed Gravel: Use Crushed Gravel for Drives, Item 304.35 for both gravel and paved drives (residential, 8 inches deep; commercial, 12 inches deep)

Hot Bituminous Pavement (Hand Method): Measure area on the plan view (CADD) to get the surface area of the drive. Wearing course for commercial and residential drives, 3 inches deep.

Wearing = 42.76 ft long x 13.1 ft wide x (sy/9sf) x [(0.057 t/sy)/1 in] x 3 in = 10.6 tons

Example: Sta. 3+15, Rt. Construct Paved Drive (See Figure 8 - 11)

FIGURE 8-11



Common Excavation: Part of Item 203.1, See Earthwork Summary Sheet

Hot Bituminous Pavement (Hand Method): Compute the drive area on the plan for drive surface, use 3 inch depth.

= 42.8 ft long x 13.1 ft wide x (sy /9sf) x [(0.057 t/sy)/1 in] x 3 in = 10.7 tons

Separate pavement quantities into base, binder and wearing courses, as shown in Table 8G.

TABLE 8G

ITEM 403.11 - HOT BITUMINOUS PAVEMENT, MACHINE METHOD

PAVEMENT CONSTANTS:
AREAS AS MEASURED IN CAD/D IN THE 14540MQTY.DGN

FOR 1.5 " WEARING COURSE =	0.085	T/SY
FOR 2.5" BINDER COURSE =	0.143	T/SY
FOR 3" BASE COURSE =	0.171	T/SY

NH ROUTE 123	**AREA (SF)**	**DEPTH (IN)**	**HBP (TON)**
Wearing Course			
STA 380+50 to 388+00	18181	1.5"	171.7
STA 400+00 to 403+50	8400	1.5"	79.3
Binder Course			
STA 380+50 to 388+00	18181	2.5"	288.9
STA 400+00 to 403+50	8400	2.5"	133.5
Base Course			
STA 380+50 to 388+00	18181	3"	345.4
STA 400+00 to 403+50	8400	3"	159.6

Item 403.4 Material Transfer Vehicle (MTV)

The MTV is used to transfer the bituminous mix from the hauling unit to the paver. The purpose of the MTV is to reduce the number of intermediate transverse joints, commonly known as "end of load" segregation. Per Standard Specifications, MTV's are required for mainline construction and straight ramps when the section is a minimum of 600 tons per paver mobilization. . MTVs are not used for leveling courses and maintenance type overlays (paver shim) over roadways that are in poor condition.

It is important to note that the MTV is a heavy piece of machinery and consideration to old structures, bridges, culverts, etc. which the MTV will be traversing should be taken into consideration when utilizing this item for use on a project.

Item 403.6 Pavement Joint Adhesive

Pavement Joint Adhesive is used to bond/seal between two adjacent passes made by the paver. It is to be used for the longitudinal joints associated with all pavement courses, base, binder, and wearing. It shall be applied to all longitudinal pavement joints for all pavement courses having a min. lift thickness of 1 inch. Joints are located at logical locations, generally at travel lane edges and the roadway's center line. If shoulder widths are 4 feet or less, they will be assumed to be paved in the same pass with the adjacent lane. If the shoulder measures greater than 4 feet wide, it shall be paved in a separate pass.

Pavement Joint Adhesive shall also be quantified along the granite bridge approach curb (all four corners) for each pavement course. Additional, pavement joint adhesive shall be quantified along the bridge curb, expansion joints, and all longitudinal joints (including bridge phase

construction joints) for the wearing course on the bridge. The adhesive for the bridge base course is paid for as bridge Item 403.61.

The item is measured Station to Station, by the linear foot.

Item 403.98 – Hot Bituminous Leveling, Machine Method & 411.1 – Hot Bituminous Concrete Leveling Course

There are two possible items that could be specified for leveling or shimming:

- *Item 403.98* is specified in cases where leveling is greater than (>) 1 inch depth
- *Item 411.1* is specified when the shimming depth is less than or equal to (≤) 1 inch depth

Leveling courses are used primarily to eliminate wheel ruts and shim existing pavements to achieve appropriate roadway grades and/or cross slopes in preparation for subsequent overlay courses. However, it may also be used to shim shoulders or fill rumble strips to accommodate temporary travel.
The Pavement Report will address leveling and shimming recommendations. It is worth noting that the Item 403.98 leveling course is a variable aggregate size mix that readily accommodates shim depth adjustment by the CA in the field, while Item 411.1 is a sand mix that is not stable as is prone to rutting at depths greater than the 1" thickness.

Typically by default, leveling is a non QC/QA item. Calculate areas by a station-to-station reference. Make note of length, width, and depths used to arrive at the appropriate quantity.

Item 403.99 – Temporary Bituminous Pavement

Temporary pavement is typically used for diversions, temporary widenings, and other areas needed for traffic control during construction such as temporary trench patches at drainage installations or removals except where the trench patch is to be overlaid as the final pavement treatment, or reclaimed through. Tabulate computations for temporary pavement using a station-to-station reference, and traffic control phase when applicable. Separate quantities for binder and wearing courses. Temporary pavement is also used on the bridge for phase construction. Coordinate with the Bridge Designer for determining the quantity.

Removal of temporary pavement is subsidiary.

SECTION 410 - BITUMINOUS SURFACE TREATMENT

This work consists of preparing and applying bituminous material to a gravel or stone course, and also includes tack coat applied to an existing bituminous or concrete surface. Application rates are as recommended by the Bureau of Materials and Research, per Section 410 of the *Standard Specifications*.

Item 410.22 – Tack Coat

Use the median of the rates found in the specification, per type of bond. Oxidized pavement is existing (aged) pavement, this is considered "smooth" pavement in the specification.
A bonded wearing course item already contains the tack coat within the process, so this item would not be included.

SECTION 411 - PLANT MIX SURFACE TREATMENT

This work consists of one or more courses of bituminous mixture constructed on existing pavements to achieve appropriate roadway grades and/or cross slopes. Plant Mix Surface Treatment (PMST) and leveling, under this item, are normally used for resurfacing projects over existing pavements where less than 1" of new material is desired. List the areas by a station-to-station reference. Make note of average length, width and assumed depth of wheel ruts, shoulder work, etc. to arrive at the appropriate quantity. Refer to the *Standard Specifications*.

The accepted quantities for leveling course pavements and PMST will be paid for at the contract price per ton, for the bituminous mixture, complete in place.

SECTION 413 – HOT-POURED CRACK SEALANT

Designate areas to be treated by station to station description, mile marker designation or roadway name.

This Item is measured by the number of pounds of sealant used, complete in place.

If estimating a quantity, describe the area and the condition of existing pavement to justify the total length of cracks to be filled. Typical application rates range from 0.32 lb/lf to 0.47 lb/lf assuming the sealant unit weight is 10.5 lb/gal. Variation in the application rate comes from routing or non-routing of the crack, overbanding or non-overbanding of the crack, varying router widths, the width and depth of cracks, and unit weight of the sealant. Contact the Bureau of Materials and Research to confirm the application rate for a given project.

SECTION 417 - COLD PLANING OF BITUMINOUS SURFACES

This work consists of the removal of existing bituminous pavement, by planing or milling type equipment, to the depth and grade shown on the plans or ordered. Break down areas as done under 403 Items. (roadways, shoulders, drives, and approaches, etc.).

Cold planing bituminous surfaces shall be measured by the square yard. The nominal depth of material removed will be as indicated on the plans.

Areas of cold planing are broken down the same way that hot bituminous pavement areas are. Compute each occurrence by plan area or scaled/computed dimensions. For example:

Construct Approach Detail (Beginning and End of Project)

Sta. 79+00.0 to 79+50 (Beg. of Project)

Area = [50 ft long x 32 ft wide] / (9 sf/sy) = 178 sy

Item 417.41X – Rumble Strips, X" Wide

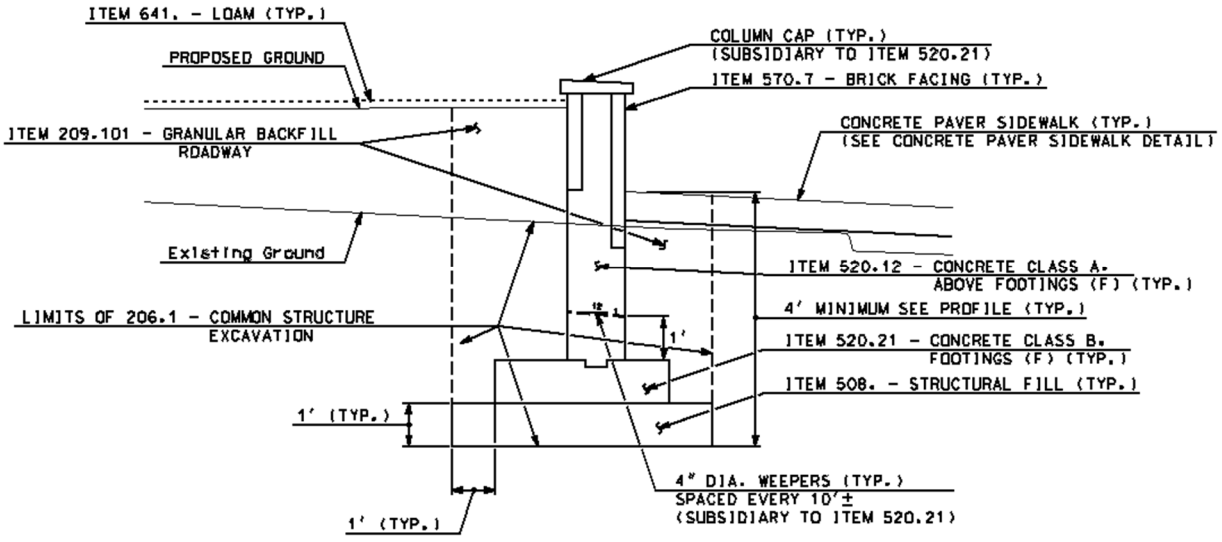
All interstates and divided highways will have rumble strips. They will be considered on other roads. See online Standard Plans, DL-3 through DL-8 for application. This item is summed per linear feet.

Item 417.53 – Remove and Inlay Existing Rumble Strips

When overlaying a *roadway containing rumble strips with a single lift of pavement, removal and inlay is needed so that the rumbles don't show back through the pavement.* This item is summed per linear feet.

DIVISION 500 - STRUCTURES

FIGURE 8-12



There are several items that the Designer will need to calculate when designing a structure: Concrete, Reinforcing Steel (Roadway), Granular Backfill, Common Structure Excavation, Structural Fill, Stone Fill, Safety Fence and Handrails, etc. The following is an example of the calculations for the concrete retaining wall design shown in Figure 8 - 12. Note retaining walls

can be different types but all will require the same basic quantities, for more information on other types see Chapter 7 of the Highway Design Manual. The Bureau of Materials and Research will provide the recommendation for the type of wall to use for the specific project.

Item 206.1 - Common Structure Excavation

The limits of Common Structure Excavation are described in Figure 8-12. Common Structure Excavation is used to pay for the excavation associated with the retaining wall. The area shown is measured in CAD/D. To calculate, the average end area method is used. See Table 8H.

TABLE 8H

Common Structure Excavation

Station	Area (SF)	Average Area (SF)	Segment Volume (CY)
35+35	60.67		
		60.67	11.2
35+40	60.67		
		56.65	21.0
35+50	52.63		
		41.94	15.5
35+60	31.24		
		PAGE TOTAL	**47.7**

*Item 209.101 - Granular Backfill Roadway (CY):*In Figure 8-12, notice that there are two areas that show Granular Backfill. There is the area in front of the wall under the sidewalk, and an area behind the wall. The area shown is measured in CAD/D and summed per station. To calculate, the average-end-area method is used. See Table 8I.

TABLE 8I

Granular Backfill

Station	Area (SF)	Average Area (SF)	Segment Volume (CY)
35+35	42.40		
		42.40	7.9
35+40	42.40		
		38.49	14.3
35+50	34.58		
		31.66	11.7
35+60	28.73		
		PAGE TOTAL	**33.8**

Item 508. - Structural Fill

Structural fill is used to stabilize the retaining wall footing. The structural fill has a constant width of 6 ft from Sta. 35+35 to 35+60

Volume from 35+35 to 35+60:

= 25 ft long x 6 ft wide x 1 ft deep = 150 cf

= 150 cf x 1cy /27 cf = 5.6 cy

Volume Sub-Total = 5.6 cy

Item 520.21 - Concrete Class B Footings

Wall Section

Station	Description of area	height	length	thickness	Volume (cy)
35+40 - 35+50	Footing to brick shelf	2.79	10	1.333	1.38
	Brick shelf to top of wall	3.12	10	1	1.16
35+50 – 35+55.3	Footing to brick shelf	2.2	5.3	1.333	0.58
	Brick shelf to top of wall	3.71	5.3	1	0.73
35+55.3 – 35+60	Footing to brick shelf	2.2	4.7	1.333	0.51
	Brick shelf to top of wall	3.16	4.7	1	0.55

Wall Total = 4.91cy

Footing

Sta. 35+40 35+60	4 ft	20 ft	1 ft	2.96

Footing total = 2.96 cy

Sub-Total = 7.9 cy

Item 544.1 Reinforcing Steel (Roadway)

Wall Section

Sta.	Height Reinforcement	Vertical Reinforcement	Wall length	Longitudinal Reinforcement	Length (ft)
35+40 to 35+50	3.783	(20 bars) 75.7 ft	10	(5 bars) 50.4 ft	75.7 ft 50.4 ft
35+50 to 35+55.3	5.658	(11 bars) 60 ft	5.3	(8 bars) 40.0 ft	60.0 ft 40.0 ft
35+55.3 to 35+60	5.108	(9 bars) 48.0 ft	4.7	(7 bars) 32.0 ft	48.0 ft 32.0 ft

Wall Total = 306.1 ft

Footing

sta. 35+40 – 35+60 Length of footing 20 ft
#3 bar 12” o.c. Length = 2.58 ft
Number of bars 20 So 20 * 2.58 ft = 51.6 ft
Longitudinal 3 # bars 18” o.c. So 20 * 3 = 60 ft

Footing Total = 111.6 ft

Total length = 306.1 ft + 111.6 ft = 417.7 ft
Weight = 417.7 ft * 0.376 Lb. per linear foot
(See Standard Specifications for Road and Bridge Construction, section 544, table 1E)
Weight = 157.0 lbs

Item 606.6311 - Safety Rail with Guard, Steel (ft)

Normally, there will be a handrail or safety rail installed at the top of a retaining wall if it is in a location accessible to pedestrians.

STA 305+40 to STA 305+60 = Length = 20.0 ft

SECTION 503 – COFFERDAMS AND WATER DIVERSION STRUCTURES

Cofferdams are sometimes needed for temporary excavation support for the installation of structure foundations, deep manholes, pipes or culverts, and they are usually constructed of interlocking sheet piling or an excavation bracing system. Water diversion structures are used to protect work areas from surface water flows during construction, and they can consist of sand bags, earth dikes, sheeting, or specially designed units (e.g. Portadam). Both cofferdams and water diversion structures are typically estimated as a unit item for each location used.

The cost of these Unit items is difficult to estimate. Check recent bid prices for similar Items and discuss potential materials and methods with Construction.

Item 503.10X – Water Diversion Structures

These items are generally required when perennial flow is expected, or when construction is not able to take place during dry times of the year. Water Diversions are typically designed by the Contractor, so materials and methods can vary. Diversions typically include a dam upstream of the work area and a pump or temporary pipe to route flow through or around the work area. Diversions may also be achieved by excavating temporary channels.

Costs for these Items may include design, erosion control provisions, purchase/rental/transporting of materials and equipment, installation, maintaining pumps and/or temporary pipes during construction, and removal. The amount of flow to be diverted, duration of the diversion, and length / complexity of the diversion path all have a significant effect on the cost.

Example Calculation, water diversion:

Const. Dam with Sandbags (variable per site) ~ $3,500
Const. temporary pipe for redirection of water ~ 150 LF, @ $75/lf = $11,250

Pump water through pipe for 2 weeks, 1 cfs stream flow (~448 gal/min) ~$300 / day rental
Include cost of fuel and rental of a backup pump, total cost ~$700 / day
14 days x $700 / day = $9,800

Remove sandbags ~ $1,500

Total = $27,050 Round to $30,000

Item 503.20X – Cofferdams

These items are used as structural excavation support and are needed to prevent groundwater from entering excavations and when the limits of unconfined excavation would cause undesirable impacts.
Cofferdams are typically designed by the Contractor, so materials and methods can vary. In some cases, the Plans will specify the size and type of cofferdam to be used and may require that portions of the cofferdam remain in place. In most cases, cofferdam materials remain the property of the Contractor and are removed after construction is complete.

Costs for these Items may include design, working drawings, purchase/rental/transporting of materials, installation, maintaining the cofferdam during construction, dewatering, and removal.

Example Calculation for a steel sheet pile cofferdam:

Designed cofferdam - Length = 230 ft Height 21 ft
Area = 4830 sf
Using PDA27 (Type of sheet wall profile): Weight of steel = 27 psf
Total Weight = 130,410 lbs
Cost = $0.70 /lb = $91,287
Add estimated cost for bracing = $10,000
Total = $101,287

SECTION 506 – SHEET PILING

Steel or wood sheet piling may be needed for a temporary retaining structure, to perform a foundation or muck excavation, to perform phased construction of a roadway embankment, or for protection of environmentally sensitive areas. Sheet piling quantity is usually estimated by the pound, except for Environmental Sheeting (Item 506.4), which is estimated by the square yard. Sheet piling may be permanent or temporary. If permanent sheet piling is included in the project see the Bridge Design Manual Chapter 6 - Section 6.5.8 for any design requirements or limitations of sheet piling. See the Standard Specifications and/or project specific Special Provisions for the length of sheet piling that will be measured. Quantity calculation for steel sheet piling would be similar to cofferdam example above. Timber sheet piling is measured and paid by the thousand board foot measure (MBM).

SECTION 520 - CONCRETE

This work consists of furnishing and placing Portland cement concrete of the classes specified including fly-ash, silica fume, or ground granulated furnace slag as shown on the plans. Unless otherwise shown on the plans, the specific class of concrete shall be used in the following applications:

a) Footing concrete shall be Class B

b) Concrete above footings shall be Class A

c) Abutment backwall concrete and Concrete bridge decks shall be Class AA

d) Concrete foundations seals shall be Class T

e) Flowable Fill shall be Class F

f) Precast concrete shall be Class AAA

Concrete class AAA, AA, A, B, T and F will be measured by the cubic yard in place unless otherwise indicated. No deductions will be made for the volume of concrete displaced by steel reinforcement. Concrete Class B (on rock) will be measured to the form lines placed at the limits shown on the plans.
Locate and dimension a sketch of the structure to provide backup for the computations. If concrete is used when constructing drainage, i.e., headwalls, energy dissipater, etc., show the computations under a section entitled "Drainage." All computations should show the different classes of concrete, i.e., Footings, Above Footing, etc. Refer to the sample computation in the retaining wall example Figure 8-12.

Item 521.1 – Shotcrete Liner (F)

This item is used to line the invert of existing man-accessible culverts, typically in metal culverts.
Shotcrete area is calculated by multiplying finished surface (inside diameter) times length. Subsidiary materials may include shear studs, reinforcing steel, wire mesh, and waterproofing. Quantities for subsidiary materials should be calculated and included in the Quantity Summaries.

Item 520.32 – Grouting Voids in Backfill Material

This Item is used to fill sub-surface voids outside of pipes or other buried structures when a separate grouting operation is required. Typical applications include filling voids prior to pipe rehabilitation using methods that do not require filling an annular space, filling voids above the midpoint of the pipe wall, and filling potentially large voids below sinkholes or areas of settlement.

Some voids can be filled as part of the annular space grouting operation. See guidelines for Item 602.11 – Fill material for Annular Space and the Special Provision 602 Pipe Lining for additional information.

This Item should not be used to fill sinkholes that are accessible from the surface and capable of being repaired with conventional excavation and backfill methods.

Field review and culvert inspection should provide an indication of whether voids are present, and if so, to what extent. The quantity calculation should be based on estimated length x width x depth of voids. Use 20% rounding to account for air entrainment in the mix.

SECTION 544 - REINFORCING STEEL

This work consists of furnishing and placing reinforcing steel as shown on the plans. Reinforcing steel (roadway) will be measured by the pound of reinforcing steel placed as shown on the plans or as ordered. The accepted quantity of reinforcing steel (roadway) will be paid for at the Contract unit price per pound complete in place. No allowance will be made for clips, wire or other material used for fastening reinforcement in place and no allowance will be made for *additional* splices or permitted substitutions.

Keep the quantity of roadway reinforcing steel separate from the bridge quantities. Reinforcing steel is typically encountered when constructing energy dissipaters, concrete headwalls, retaining walls, steps, sign bases, etc. Bridge Design will usually provide reinforcing steel configuration and quantities with their retaining wall designs, and also review the layout of reinforcing and its quantity for energy dissipater designs. The quantity of reinforcing steel for standard headwalls is found on the Standard Plans. Refer also to the sample computation in the retaining wall example Figure 8-12.

SECTION 570 - STONE MASONRY

This work consists of furnishing all materials and constructing masonry of approved stones laid with or without cement mortar, as shown on the plans or ordered.

Stone masonry, of the class specified, except coping and resetting masonry wall, are final pay quantity items and will be paid for at the Contract unit price per cubic yard complete in place.

For Mortar Rubble Masonry (MRM) headwalls that differ from those shown in the Standard Plans, dimension a drawing of the structure to provide backup for computations. The quantity of MRM for unmodified headwalls is in the Standard Plans. Caution: Only use MRM headwalls where necessary for aesthetics. Otherwise use concrete headwalls. This is due to both cost and long term durability attributed to the lack of skilled workers who perform this type of work. Be sure that the Maintenance District is aware the project will be constructing MRM headwalls as some Districts feel the MRM headers are a maintenance problem. Show a tabulation of the quantity from each drainage note to provide a total quantity for the project estimate. Cross reference the quantity of MRM for a retaining wall with the quantity shown on the drainage summary. Below is a sample computation for a Mortar rubble masonry (MRM) retaining wall. This can be calculated using the average-end-area method, as shown in Table 8K.

TABLE 8K

Wall Calculation

Station	Area (SF)	Average Area (SF)	Segment Volume (CY)
124+00	4.55		
		5.43	10.0
124+50	6.30		
		7.55	14.0
125+00	8.80		
		10.90	20.2
125+50	13.00		
		12.80	23.7
126+00	12.60		
		PAGE TOTAL	**67.9**

SECTION 583 - RIPRAP

This work consists of furnishing and placing riprap stone of the size specified for erosion protection of bridge structures in waterways, for active waterway channel slopes and bottoms, and for intermittent waterway channels where the Engineer determines riprap protection is

required to resist expected high water flows velocities. Riprap generally provides a smoother and more uniform surface appearance than stone fill (Section 585 items) because it is required to be placed stone by stone. If riprap is included in the project see the Bridge Design Manual Chapter 2 - Section 2.7.7 for details about determining quantities.

SECTION 585 - STONE FILL

This work consists of furnishing and placing a dense stone fill for stability of embankment fill and soil cut slopes steeper than 2 horizontal to 1 vertical, although slopes at a flatter grade with water seepage or subject to submergence, such as in water quality treatment basins, could require stone fill. Stone fill is also used for erosion protection at pipe outlets, in drainage channels and for other drainage structures where expected water flows and velocities may require it. Stone fill has four different classes (A, B, C, and D), all dependent upon the allowable stone size. For each class there are typical minimum stone depths specified, Class A = 3 feet, Class B = 2 feet, Class C = 1 foot, Class D = 6 inches. Depending on the application it may be necessary to increase the thickness beyond these minimums.

The Geotechnical Report may offer recommendations for locations where stone fill should be used, its size and thickness. The recommendations may also include a typical treatment cross section sketch, especially if the stone fill needs to be extended at the base of the slope (called a keyway) for stability and support.

Typical Applications

- For fill and cut slopes 1.5H:1V that are not adjacent to a water course and which meet global stability requirements, Typically use 2 feet of Class B Stone.
- A slope adjacent to a water course would be evaluated on a project specific basis whether to use Class A, Class B, or a Rip Rap Item and also the stone thicknesses. Riprap is typically required for scour / erosion protection of bridge structures in waterways, for active waterway channel slopes and bottoms, and for intermittent waterway channels where the Engineer determines riprap protection is required to resist expected high water flow velocities.
- For soil cuts at 2H:1V in wet conditions, Typically use 1.5 to 2 feet of Class C stone.

Stones and spalls for stone fill shall be deposited and graded to eliminate voids and obtain a dense mass throughout the course (subsidiary to Item 585.).

Stone fill will be measured by the cubic yard.

Locate areas of stone fill by station-to-station reference for slope protection or as part of inlet and/or outlet protection at a drainage structure. Drainage notes should include the length, width, and depth of the stone fill treatment. Note the class of stone that is used. Each class may require a different type of geotextile fabric, which is explained in the 593 Items calculation.

On long runs of slope protection, stone quantities are typically computed using the average-end-area method. Locate and dimension a sketch of the area requiring the stone fill. Tabulate the slope lengths at 50 feet intervals using the layout shown in the example (See Figures 8-13A & B).

Where work is confined to a small area, show a dimensioned sketch. Note: If the excavation for placement of the stone is part of the excavation of the roadway typical, it will be paid under Item 203.1. If it is not part of the roadway typical it will be paid for under Item 206.1, see Figure 8-9.

FIGURE 8-13A

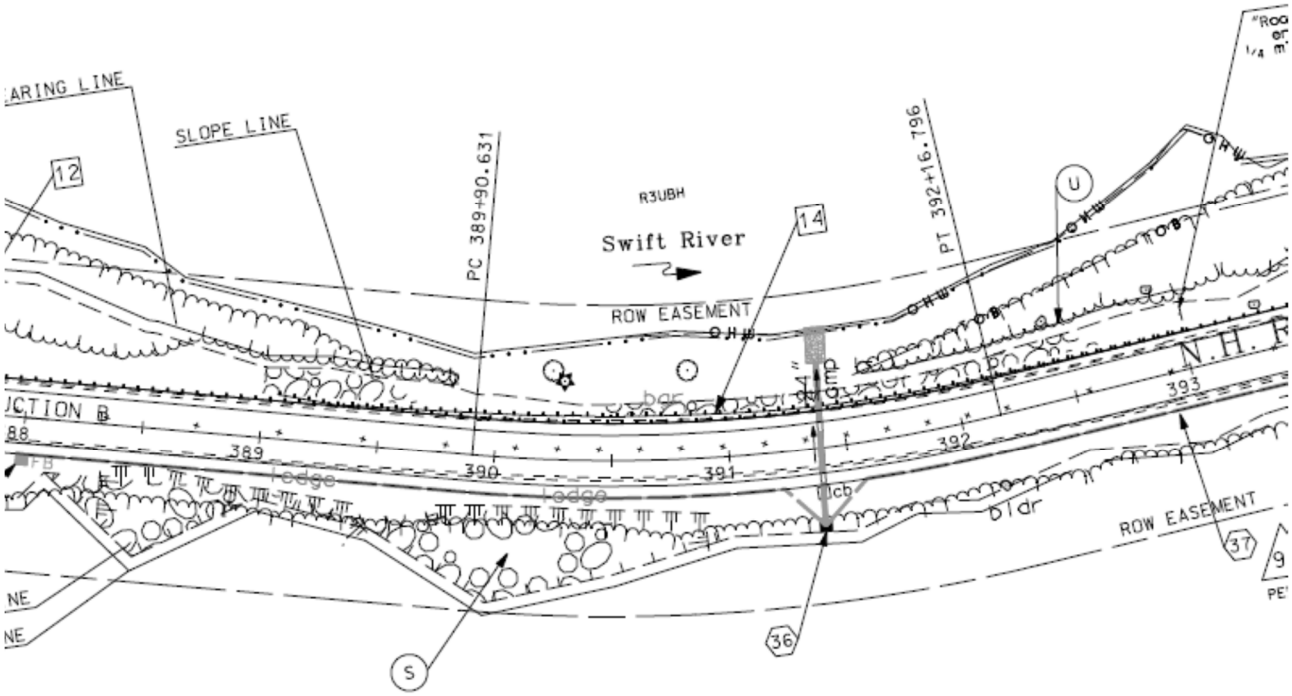


FIGURE 8-13B

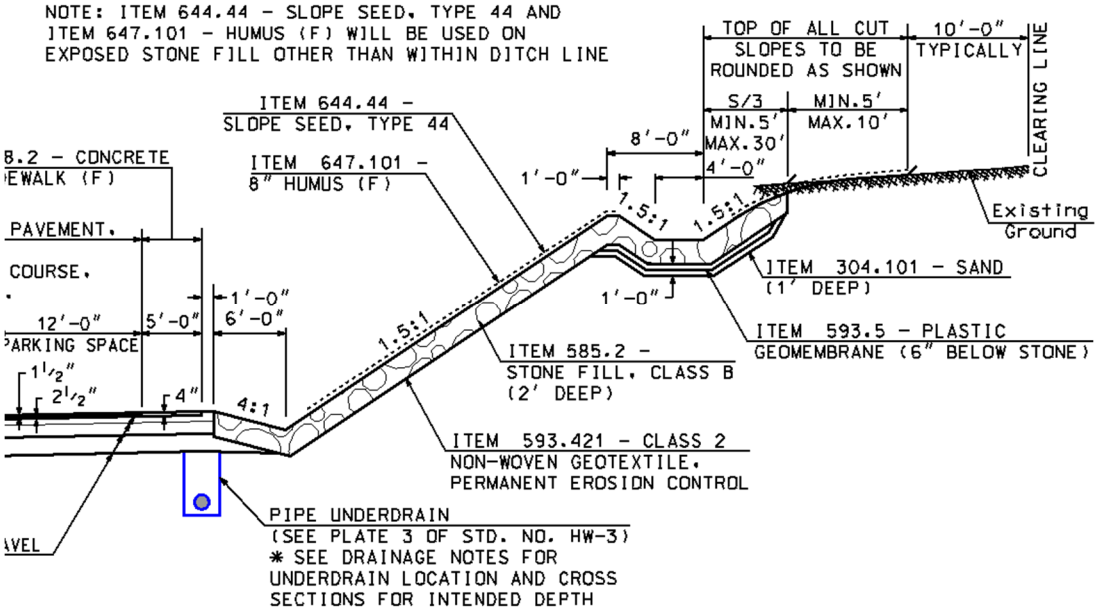


TABLE 8L

Stone Fill

Station	Area (SF)	Average Area (SF)	Segment Volume (CY)
388+20	67.72		
		70.12	77.9
388+50	72.52		
		40.18	74.4
389+00	7.84		
		10.56	19.5
389+50	13.27		
		49.95	92.5
390+00	86.63		
		69.74	129.1
390+50	52.85		
		26.43	48.9
391+00	0.00		
		SUB-TOTAL	**442.4**

SECTION 593 - GEOTEXTILE

This work consists of furnishing and installing geotextile fabric as shown on the plans or as ordered, including any labor and materials needed to anchor, splice or repair the geotextile.

Geotextile will be measured by the square yard (sy) as determined by the actual surface measurements of the covered area. Additional material used for overlaps and repairs will not be measured. The cost of all labor or materials used to anchor, splice, or repair the geotextile is considered subsidiary to the geotextile installation. Removal of temporary geotextile will be considered subsidiary to the geotextile.

Recommendations for the type, application for use and strength class of geotextile will be included in the Geotechnical Report or standard drawings. In the absence of a Geotechnical report, check with the Bureau of Materials and Research - Geotechnical Section. Their specifications are all included in the Standard Specifications. Applications for use include subsurface drainage, separation, stabilization, and permanent erosion control.

Geotextile type and strength class are dependent upon the application:

- Subsurface Drainage; use Medium Strength (Class 2) non-woven or woven Geotextiles.
- Separation; use Medium Strength (Class 2) non-woven or woven Geotextiles.
- Stabilization; use Medium or High Strength (Class 1 or 2) woven Geotextiles.
- Permanent Erosion Control:
  - Class A Stone; use High Strength (Class 1) non-woven Geotextiles.
  - Class B Stone; use Medium Strength (Class 2) non-woven Geotextiles.
  - Class C Stone; use Low Strength (Class 3) non-woven Geotextiles.
- When more than one type of Stone Fill is needed on a project, the highest strength Geotextile needed is used for all Stone Fill locations. This helps to control cost of the item and to eliminate confusion in the field.

- Use Extra High Strength Geotextile only when recommended (Class 0)

Locate by stations and compute each site separately. Separate into two categories for the Landscaping Summary, one as Slope Protection and the other as Landscaping.

In the computation below, the longitudinal length of geotextile is the distance it extends between stations. The width of geotextile is measured (laterally) along the length of the slope as measured from the cross sections. If geotextile is part of a drainage note, reference the drainage note and list the quantity here for tabulation. Do not include the overlap of successive rolls in the length of geotextile. If you use a plan view instead of a cross-section to compute the areas, be sure to include a slope correction factor in your computations. Note: No longer computing the "end wrap" for the geotextiles.

Example: From Figures 13 A & B

TABLE 8M

Construct Non-Woven Geotextile

Station	Length (LF)	Slope Width (LF)	Average Width (LF)	Area (SF)	Area (SY)
388+20		0.0			
	30		16.2	484.5	53.8
388+50		32.3			
	50		17.2	857.5	95.3
389+00		2.0			
	50		5.0	250.0	27.8
389+50		8.0			
	50		24.0	1,200.0	133.3
390+00		40.0			
	50		30.0	1,500.0	166.7
390+50		20.0			
	50		10.0	500.0	55.6
391+00		0.0			
				SUB-TOTAL	**532**

SECTION 595 – GEOGRID

The geotechnical report may recommend a reinforced slope be constructed as part of a project, which allows a slope to be constructed to as steep as 1 horizontal to 1 vertical. Coordinate with the Bureau of Materials and Research Geotechnical Section for the slope reinforcing configuration and quantities of items covered in this section. Geogrids are typically paid by the square yard, and items for the slope fill material and slope face treatment will also be needed.

DIVISION 600 - INCIDENTAL CONSTRUCTION

SECTION 602 – PIPE LINING

Item 602.011 Fill Material for Annular Space.

This Item is used for filling the annular space between the host pipe and certain types of liners. Calculate the difference between the host pipe inside area and liner pipe outside area and multiply by the pipe length. See Appendix 8-5 for specific manufacturer's liner diameters.

Example:

drain note	Host pipe Dia (in) (inner)	Host pipe area (sf) (inner)	Lining pipe Dia (in) (outer)	Inner pipe area (sf)	difference (grout area)	pipe length	grout cy
1	60	19.63	54	15.90	3.73	268	37.01

If necessary, add additional quantity to account for material loss into voids outside the pipe. Field review and culvert inspection should provide an indication of whether voids are present, and if so, to what extent. This calculation should be based on estimated length x width x depth of voids. Use 20% rounding to account for air entrainment in the mix.

602.1XXXX – 602.9XXXX Pipe Liners

These items are handled by special provision. There are various methods of pipe rehabilitation and new methods and materials are continuing to be developed. See the Special Provision 602 Pipe Lining for methods and materials and key to determining the Item number. Not all methods and materials are appropriate for all pipe types, sizes, and sites. Costs and benefits of several alternatives should be investigated before selecting a treatment. Other pipe rehabilitation

methods include shotcrete invert lining (Item 521.1), concrete pipe joint repair (formerly Item 1008.36) and pipe repair (formerly Item 1008.38)

Pipe liners will be measured by the linear foot complete in place. See the Special Provision 602 Pipe Liners for subsidiary items. For surveyed pipes, the quantity for each liner should be rounded up to the nearest foot. No additional rounding should be necessary.

For liner types that do not require filling an annular space, voids outside the pipe may need to be filled by pressure grouting. See guidelines for Item 520.32– Grouting Voids in Backfill Material.

Consider needs for access and staging areas and control of surface water and groundwater. Separate Pay Items commonly associated with pipe rehabilitation are 503.10X Water Diversion, 503.20X Cofferdam, and 670.049X Construct and Remove Temporary Access Road. Discuss access, staging, pay Items and subsidiary work with the District Construction Engineer.

SECTION 603 - CULVERTS & STORM DRAINS

This work consists of furnishing and installing, or removing and relaying pipes, pipe end sections, and pipe sleeves at the locations shown or ordered, including the necessary joints fittings and connections as required. See the Standard Specifications Section 603.3.2 for pay limits of the bedding materials and excavation items associated with the applicable pipe installation.

Item 603.0001 Video Inspection

The specification for this Item states for pipes 36” diameter and less. A special note is needed to call for use of this item when carrying pipe underdrain is installed. In this event, call out for pipes 12”-36” diameter, 603. and 605. items. This item is in linear feet and can be summed up from drainage items within the drainage summary clearly.

Item 603.3XXXX End Sections and Applications:

Concrete end sections:

- Pipes that are not greater than 72 inches in diameter
- Areas that are within Public view
- Urban areas
- Areas with abnormally low pH
- inlet ends of concrete pipes

Steel End sections:

- All steel pipes
- At Concrete pipe outlets where a concrete end section or headwall is not used. When used on concrete pipes, the end section shall be sized one size greater than the pipe size.

Aluminized Steel End Sections:

- Aluminized Steel End Sections: In wet areas where concrete would sink and metal would rust quickly.

Plastic end sections:

- NHDOT no longer uses them, due to damage from maintenance mowing operations.

SECTION 604 - CATCH BASINS, DROP INLETS, AND MANHOLES

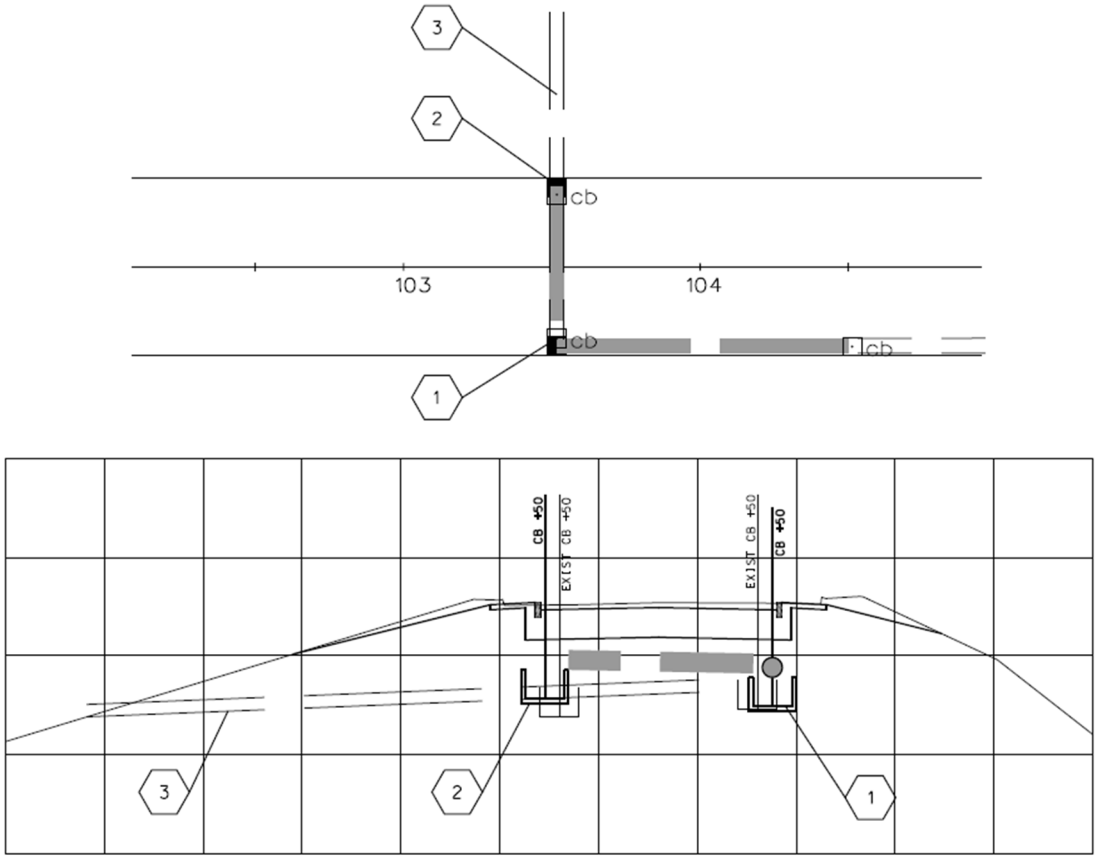
This work consists of construction or reconstructing catch basins, drop inlets, and manholes and furnishing and placing grates or manhole covers, as shown on the plans or as ordered. Common structure excavation to the depth specified, bedding if required and backfill shall be included in this work.

Be sure to properly size the diameter of the drainage structure. Keep in mind to use a core hole size of 7" (min.) (for 6" underdrain) with a minimum spacing of 6" between core holes for the underdrain and the carrying pipe. A 12" spacing between core holes for the carrying pipes should be used. See Drainage Manual for other pipe size core holes.

For the development of drainage quantities, refer to the specific installation, as identified by the individual drainage note (See Appendix13-21, Drainage Note Format). Compute most of the items payable under the noted work and include in a section of the Quantities Workbook. Some linear and each items will already be quantified on the drainage summary as complete as a quantity and do not need this duplicated effort. A number of items will be cross-referenced to this section (Item 209.1, 570.4, 520, etc.).

Consider the Example represented in Figure 8-14:

FIGURE



1 STA 104+50, RT 15' TO STA 103+50, RT 15'
CONST 96 ft x 15 in RCP Class III
CONST CB-B @ 103+50, RT 15'
INV IN = 128.25
INV OUT = 128.00
GRATE EL. = 134.70
CONST INV IN @ 104+50 CB = 127.50 (SUBSID.)

2 STA. 103+50, RT 15' TO 103+50, LT 15'
REMOVE 3 ft x 12 in cmp (SUBSID.)
REMOVE Exist. CB (SUBSID.) @ +50, LT 15'
CONST 26 ft x 15 in RCP Class III
CONST CB-B @ +50.0 LT, 15'
INV OUT = 128.50
GRATE EL.= 134.70

3 STA 103+50, LT 62' TO STA 103+50, LT 15'
REMOVE Exist. 44 ft x 12 in cmp

In this example, a new 15 in RCP is being installed above an existing 12 in cmp. According to the Drainage Note, the Contractor is required to remove the 12 in cmp. The removal will be paid for under Item 202.41 – Removal of Existing Pipe, 0 in – 24 in, because the existing pipe is below the proposed pipe. An additional operation is necessary to remove the existing pipe (i.e.,

it is not necessary to remove the existing pipe in order to construct the new one above it). (However, it is usually prudent to do so)

There are situations where removal is subsidiary to other operations. If the new pipe was below the existing pipe, the excavation for the new pipe would require the Contractor to remove the existing pipe. In this situation the removal would be subsidiary to the construction of the new pipe. (See *Standard Specifications* Section 206 for trench width limits for C.B.'s, D.I.'s, M.H.'s and pipes.) If the pipe or drainage structure to be removed is within the limits described in Section 206, the removal is subsidiary.

Using these guidelines as a starting point, the Designer must use judgment on a case by case basis when deciding if drainage removal is paid for or if it is subsidiary. There are also situations where part of a pipe or drainage structure is within (paid) excavation limits and another part is not.

See Figure 8-14, Drainage Note 2, in this example, 3 feet of the 12 inch cmp is considered subsidiary removal. This is because only 3 feet of the structure is within the excavation limits of the new drainage structure. The remaining 44 feet is paid for as Item 202.41 since it is beyond the point of excavation associated with the new drainage.

In Drainage Note 1, the quantities are:

Item 603.00215 = 96 ft
Item 604.12 = 1.3 unit (10 ft deep)
Remove exist CB at 103+20.0 LT 15 (SUBSID.) (within new CB)

In Drainage Note 2, the quantities are:

Item 603.00215 = 26 ft
Item 604.12 = 1.2 unit (9.5 ft)
Remove 3 ft x 12 in cmp (SUBSID.) (within new CB)
Remove exist CB-B, 103+20 LT 15 (SUBSID.) (within new CB)

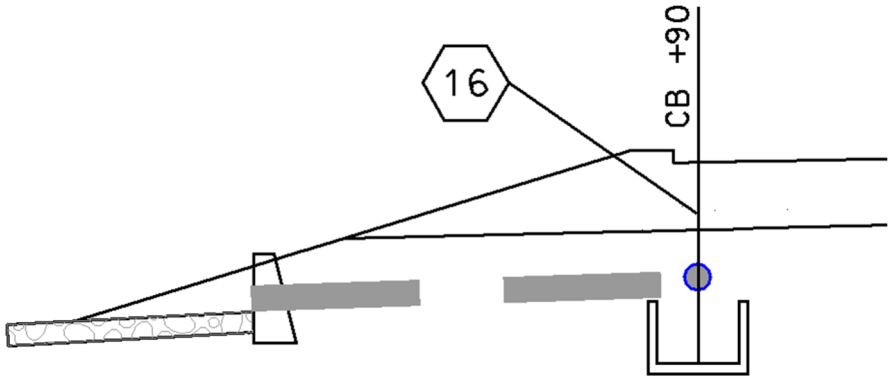
In Drainage Note 3, the quantities are:

Item 202.41 = 44 ft (Outside limits of excavation for the pavement structure and not within the trench for pipe)

There may be other items (i.e. concrete, common structure excavation, stone fill) that are required in a drainage note. Each of these items should be accounted for within the drainage quantities shown in the Quantities Workbook.

Consider the Example Represented in Figure 8-14a:

FIGURE 8-14a



16 STA 182+90 LT 14.8 TO STA 183+26 LT 31.2
CONSTRUCT 36.1 ft x 15 in RCP, CLASS III
CONSTRUCT CB-B STA 182+90 LT 14.8
INV. IN = 266.17
INV. OUT = 265.92
GRATE EL. = 273.14
CONSTRUCT PC-4 HEADWALL STA 182+90 LT 27.6
INV @ HDR = 263.86
CONSTRUCT OUTLET DITCH (4 ft x 13 ft)
CONSTRUCT STONE FILL, CLASS C AT OUTLET (4 ft x 13 ft x 1 ft)
INSTALL LOW STRENGTH NON-WOVEN GEOTEXTILE
(SEE DRAINAGE DETAILS)

Typical quantity computations would be as follows:

Item 604.12 - Catch Basin Type B

Top Grate Elev.
- Depth of Grate (From Standards, Std. No. DR-1, Pl. No. 2 (8in CB, 6in MH Grate & Frame)
- Sump Elev. (Inv. Out – sump depth (3')

273.14 ft
- 0.67 ft
- (265.92 ft – 3 ft)
= 9.55 ft / (8ft/unit) = **1.2 units**

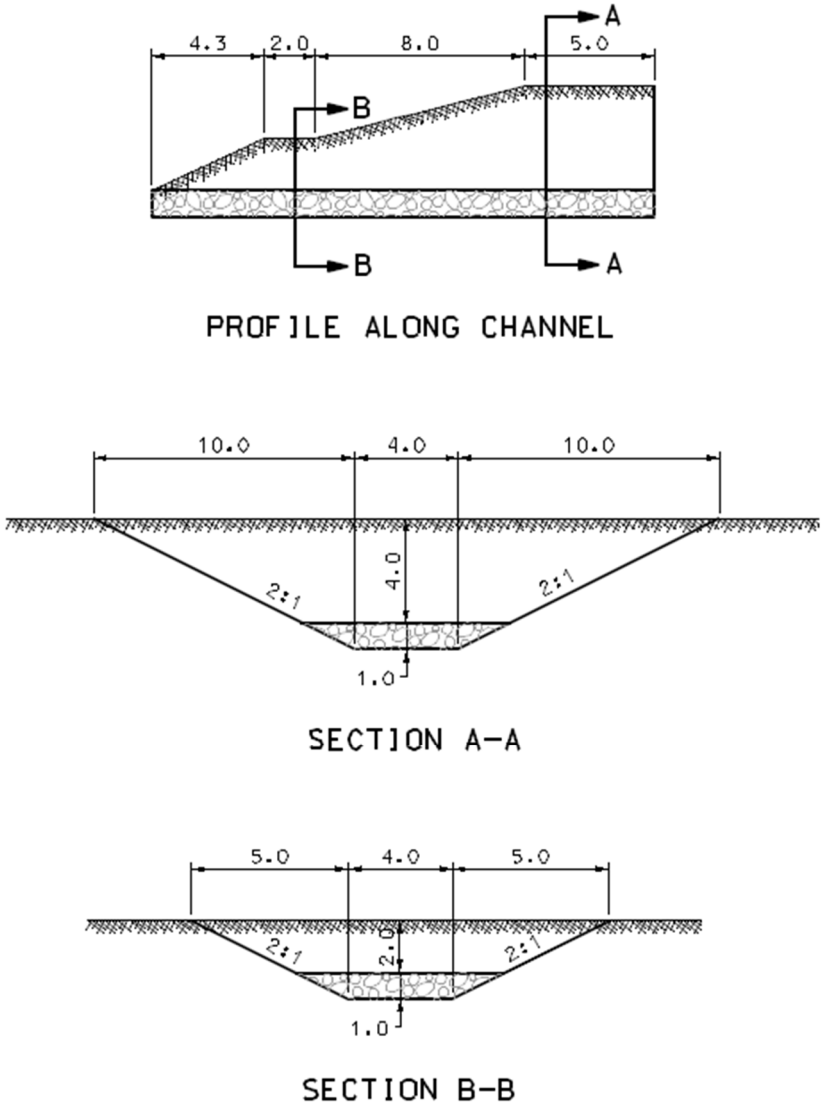
Item 603.00215 – 15" R.C. Pipe, 2000D

Normally, pipe lengths are calculated measuring the distance between the center of drainage structures and subtracting the radius of each structure from the measured length. In this example, there is only one structure, therefore, subtract 2 ft from the measured length. (If this pipe were a slope pipe on a steep grade such as a 2:1, use the Slope Correction Factor to calculate the correct length.)

Length = 38.1 ft – 2 ft = 36.1 ft

When you are installing proposed pipe beneath an existing roadway where you are trenching for the pipe and not completing full box reconstruction, the first 9 feet of the backfill up to where the subgrade for the existing typical is subsidiary. Payment is made for the selects required to finish backfilling the trench.

FIGURE 8-15



Item 585.3 - Stone Fill, Class C

The outlet in this example has a flat bottom (See Figure 8-15).

Volume = ((4.3+2+8+5) x 1 x ((4+8)/2))/27 = 4.3 CY

Item 206.1 - Common Structure Excavation

For Ditch (See Figure 8-15):

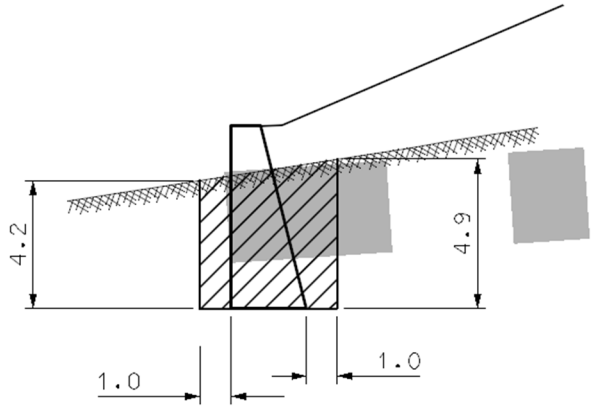
Volume = (4.3 x ((3+0)/2) x ((4+14)/2)) + (2 x 3 x ((4+14)/2)) + (8 x ((3+5)/2) x ((24+4+14+4)/4)) + (5 x 5 x ((24+4)/2) = 58.05 + 54 + 368 + 350 = 830.05 CF
830 CF/27 = 30.75 CY

For Headwall (See Figure 8-16): 36" RCP

From *Standard Plans* Standard No. HW-2, Plate No.1, P.C. -3

Volume of Excavation = ((4.2+4.9)/2) x 13 x (2.5+1+1?))/27 = 5.47 cy

FIGURE 8-16



Item 520.1 – Concrete Class A

For Headwall (See Figure 8-16)

From *Standard Plans* Standard No. HW-2 Plate No. 1, P.C-3

Volume = 4.43cy

Item 544.1 – Reinforcing Steel (Roadway)

For Headwall Reinforcement (See Figure 8-16)

From *Standard Plans* Standard No. HW-2 Plate No. 1, P.C-3

Lbs. = 35

Item 593.211 – Geotextile; Separation CL. 1, Non-Woven

Note: No longer account for "side wrap" around the fill material. Only calculate area placed.

Area = 13ft long x (4 ft wide + 2 ft sides) = 78 sf

Item 604.0007 – Polyliners

Proposed C.B.s, D.I.s and DI-DX's in a paved roadway will receive polyliners. Existing CB's and DI's in pavement that do not have liners should also get liners. C.B.s and D.I.s in the ditchline do NOT receive polyliners.

Item 604.1X – Catch Basins

Make sure you check the basin for the needed diameter size to structurally take pipes entering it. The drainage design manual has general guidance on pipes entering, but basins with pipes entering and existing at skewed angles should be checked as a general rule.

If the distance between the top of the structure and 3 inches above the top of the pipe is less than 2 feet deep, then a slab top is required for the structure. Slab tops are typically 12 in thick. No special item number is needed when using a slab top C.B., but it is to be called out in the drainage note.

SECTION 606 - GUARDRAIL

This work consists of furnishing guardrail, anchorages, terminal units, concrete barriers, transition rails, transition barriers, temporary impact attenuators, and pipe handrails of the type specified at the location shown on the plans or as ordered. Resetting of existing guardrail and the resetting of rail, blocks and guardrail, shall be included in this work.

Guardrail (new, temporary or reset), type E2, and E- modified terminals units, and concrete barrier will be paid for by the linear foot. Other terminal units, rail transition units, concrete barrier transitions, temporary impact attenuators, and bridge approach units will be paid for by the unit installed.

Guardrail removal is paid for, even when installing new rail. If anchors are left in place, then they shall be cut off one foot below the finished ground.

Wood guardrail, box beam guardrail and double - faced beam guardrail will be measured from end to end of rail by linear foot. Measurement includes entire length to the end of the terminal sections unless otherwise shown on the plans.

Locate the barrier by a station-to-station reference. In the event of no survey, layout proposed rail in reference to existing guardrail ends. Show, or make reference to, the warrant calculations used to determine the length of need. Adjust the length of the barrier to correspond to a standard manufactured length (e.g. 12.5 ft for guardrail, 20.0 ft for precast concrete median barrier). Tabulate backup computations as they will appear on the Summary Sheet. Summarize as shown in Volume 2 of the Highway Design Manual.

Temporary Locations:

A tabulation of locations for temporary guardrail or portable concrete barrier should be set up to simplify the computation for each item. During various phases of the Traffic Control Plan (TCP) there will be specific quantities of barrier used on a temporary basis to separate work areas from traffic. Show the length of each barrier required for each phase of the TCP. Table 8P shows a typical calculation summary for temporary barrier to be used during phased construction.

Table 8N:

PHASE	STATION			TEMP GUARDRAIL (LF)	PORTABLE CONCRETE (LF)	END TREATMENTS
1-A	100+50	To	200+85		1,035	
1-B	160+00	To	190+60		360	2 impact attenuators
1-C	220+50	To	320+85		1,035	(see spec book for the test level)
2	170+00	To	260+90		990	
3-A	300+00	To	360+15		615	
3-B	180+50	To	210+85		335	
4	280+40	To	300 +60	225**		2 end units (appropriate for the
						location and design speed)

**This length does not include the length of the (temporary) end treatments, which are paid under a separate item.

In the table above, there are 3 areas of the project under construction in Phase I requiring a total of 2430.0 ft of portable concrete barrier. Phase II requires 990.0 ft and Phase III, 950.0 ft. The TCP requires the portable concrete barrier in Phase I to be completely removed before Phase II or Phase III is started on this project. Since by Standard Specification 606.4.4.2 once the portable concert barrier is delivered to the project, relocation of it on the project will not be measured for payment; the quantity total for Item 606.417 would be the longest run, 2430.0 ft.

During the winter months guardrail is the preferred temporary barrier since it simplifies snow removal operations.

Item 606.41XX – Portable Concrete Barrier for Traffic Control and
Item 606.9XXX - Temporary Traffic Control Barrier

Temporary guardrail, temporary concrete barrier, temporary traffic control barrier, and temporary impact attenuator items consist of furnishing, installing, maintaining, relocating and removing rail or barrier as specified. Terminal units shall be installed as appropriate for the type and location of the barrier ends consistent with the design speed adjacent to the barrier. This may include impact attenuators. Impact Attenuation Device (Sand Barrel Crash Cushion) shall not be allowed for use during the winter maintenance period unless otherwise specifically approved by the Engineer.

Specifying Item 606.9XXX in a Contract is a common method for establishing the minimum criteria for temporary barrier while still allowing the Contractor to use available materials. This Item allows the Contractor the option of using either guardrail or portable concrete barrier (or approved equal) on a temporary basis. The length of temporary traffic control barrier specified under the item *includes the end treatment* and is therefore not paid separately. If portable concrete barrier is used, this may include an impact attenuator, paid for under a separate item.

There are two different approved types of Temporary Traffic Control Impact Attenuators: Redirective, where the vehicle impacts the unit from the side and glances off the unit to then reenter traffic in a controlled manner and Non-Redirective, which will allow gating from a side

impact, capture the vehicle upon impact, or will slow the vehicle down (absorb the energy) in an end on impact. The intent of all Non-Redirective units is to not allow the vehicle to reenter traffic. Most of the time Non-Redirective units are used, but it should be determined on a case by case basis when to apply each.

SECTION 607 – FENCES

This work consists of the constructing, removing, and resetting railings, fences, and gates as shown of the plans or as ordered.

All fence, new or reset, will be measured by the linear foot. Post assemblies will be measured by the number of units installed, and gates will be measured as complete units of the size and type specified.

Tabulate the locations of a fence by a station-to-station reference for each roadway including the number and location of post assemblies (i.e. corner, gate, etc.), keeping in mind that the end of fences and abrupt changes in terrain require post assemblies. The maximum length of fence without post assemblies shall be 600 ft for woven wire and 500 ft for chain link. Separate fenced areas within project into Main Line, Ramp A, Ramp B, etc. See the *Standard Specifications* and the *Standard Plans* for additional information regarding fences and post assemblies. See Chapter 10 of the Highway Design Manual for fencing of ROW.

Main Line (Woven wire)		
Sta. 123+50 to 130+50	700 ft	2 post assemblies (at least 1 every 600 ft; so 0 & 350 ft)
Sta. 130+50 to 130+62	1 gate	2 post assemblies (post assemblies included in gate item)
Sta. 130+62 to 132+90	228 ft	1 post assembly (end)
Sub-Total =	928 ft	5 post assemblies total (but only 3 reflected in the post assembly quantity since the 2 are included with the gate)
Ramp A (Chain link)		
Sta. 206+50 to 221+50	1,500 ft	4 post assemblies (at least 1 every 500 ft; 0, 500, 1,000, and 1,500 feet)
Sub-Total =	1,500 ft	4 post assemblies

SECTION 608 - SIDEWALKS

This work consists of constructing sidewalks of either hot bituminous pavement or portland cement concrete, reinforced when specified.
Sidewalks are final pay quantity items and will be paid for at the contract unit price per square yard. Base course material will be measured by the cubic yard determined by the area of the sidewalk.

The design engineer shall tabulate the location of sidewalks and islands by a station-to-station reference. Deduct the width of the curb from the total width to compute the surface area of the sidewalk. Generally sidewalks are constructed with either 2 inches of hot bituminous pavement or 4 inches of concrete. Concrete traffic islands (shown on the Sidewalk Summary) are typically

built with 6 inches of concrete. High-speed facility ramp gores are constructed with 8 inches concrete and are also paid under Section 608.

Bituminous pavement shall be placed in two 1 inch lifts, one each of binder and wearing, for all paved sidewalks. Bedding material used under sidewalks shall match the top layer of the roadway materials. Typical applications include Item 304.3 – Crushed Gravel or Item 304.5 – Crushed Stone (fine), placed at a depth of 6 inches for the width of the sidewalk.
See Volume 2 of the Highway Design Manual for more information, however, some towns and cities have their own standards for sidewalk, and since sidewalks are usually maintained by the town or city, the Department will usually follow the standards of the municipality.

Identify Each Location

Item 608.12 – 2" Bituminous Sidewalk (F) (6 ft wide) (Subtract out 5 in curb width)

Station 25+25 to 28+50 RT (325 ft long x 5.58 ft width) = 1,813.5 sf

Item 304.3 – Crushed Gravel (Bedding for sidewalk) at 6" thick

Station 25+25 to 28+50 RT (1,813.5 sf x 6)" = 906.75 cf

Concrete islands area also located by a station-to-station reference and can be computed by plan area for irregular shaped island, or computed by length x width. For example:

Item 608.26 – 6" Concrete Sidewalk (F) STA 308+50 LT to STA 313+85 LT

$$352{,}843.2 \text{ sf} \times \frac{1 \text{ sy}}{9 \text{ sf}} = 272.3 \text{ sy}$$

Item 304.3 – Crushed Gravel (under concrete island)

272.3 sy x 4 in thick = 89.86 cy

When there is a sidewalk on a bridge, it is included as part of the bridge deck concrete item. The limits typically are the expansion joints.

SECTION 609 – CURBS

This work consists of constructing or resetting curbs, as shown on the plans or as ordered, and is measured by the linear foot.

List the curb computations as depicted in the example below. Measure the lengths of curb with a station-to-station reference. Curbing shall be listed as station/offset on the Summary Table. On curves, compute the length to the nearest 0.1 foot.
Minimum allowable curb reveal is 2 inches. See table below for curb type usage per radius. Also refer to standard plan CR-1 & CR-2.

Curb Type	Item #	Item Description	Radius Range
Vertical Curb	609.01	Straight Granite Curb	≤ 21 ft
	609.02	Curved Granite Curb	> 21 ft
Sloped Curb	609.23	Curved Granite Slope Curb	< 2 ft
	609.22	Straight Granite Slope Curb with Radial Joints	2 to 15 ft

	609.21	Straight Granite Slope Curb	> 15 ft

Reuse of any existing granite curbing on the project shall be calculated first. Identify straight granite curb and slope curb separately for reuse, as they are different in size. A field inspection of the existing granite curb shall be completed to determine how much is reusable. Consider the construction phasing when calculating reset granite curb as construction phasing may not allow removal of existing granite curb that is planned to be reset.

After determining what existing curb can be reused, calculate the length as Item 609.5 – Reset Granite Curb. When all of the reset curb is used, continue with new curb. In areas with a radius 20 feet or less new curb is required and reset curb shall not be used. Any reusable existing curb not used on the project will be removed and be paid under Item 202.6 – Curb Removal for Storage. See the Item 202.6 computation section for an example.

When resetting curb, be sure to also include Item 209.1 – Granular Backfill to back up the area around the curbing. See Standard Plan CR-1 for more information. See Volume 2 of the Highway Design Manual for a typical curbing summary table.

SECTION 614 - ELECTRICAL CONDUIT

This work consists of furnishing installing and testing conduit of the size and type specified, including sweeps, bends, joints, hangers, pull boxes, special fittings, plastic warning tape, and other appurtenances, as shown on the plans or as ordered. This section includes ITS conduit as well.

Conduit will be measured by the linear foot of the specified type, size, and number of ducts required. Schedule 40 shall only be used under grass areas, and schedule 80 will be used under roadways and sidewalks. When a conduit is connected to a foundation for a signal pole, control cabinet pole, or light pole, measurement will be made only to 3 ft from the center of the base measured horizontally. Pullboxes will be measured by each.

Tabulate conduit runs by a station-to-station reference, from pull box (or power source at the beginning of a run) to pull box. Normally, *molded* pull boxes are used for lighting in grassed or sidewalk areas and *concrete* pull boxes for lighting in paved areas and for traffic signals. Verify the type and size of pull boxes that should be used with Design Services for lighting designs and the Bureau of Traffic for signal designs.

The utility company involved supplies power for traffic control signals and/or lighting. 3” Steel Conduit will also be included in the contract for conduit sweeps between utility poles and conduit installations.

Typically a note on the General Notes sheet is included as follows:

> “Both ends of conduit runs carrying lighting conductor cable shall utilize 3” galvanized steel 90° sweeps (vertical to horizontal) approved for electrical cables and a 10 foot maximum length galvanized steel horizontal section connected by threaded couplings. 3” PVC conduit may be used for the intermediate section. All conduit runs that are entirely steel conduit shall be grounded.”

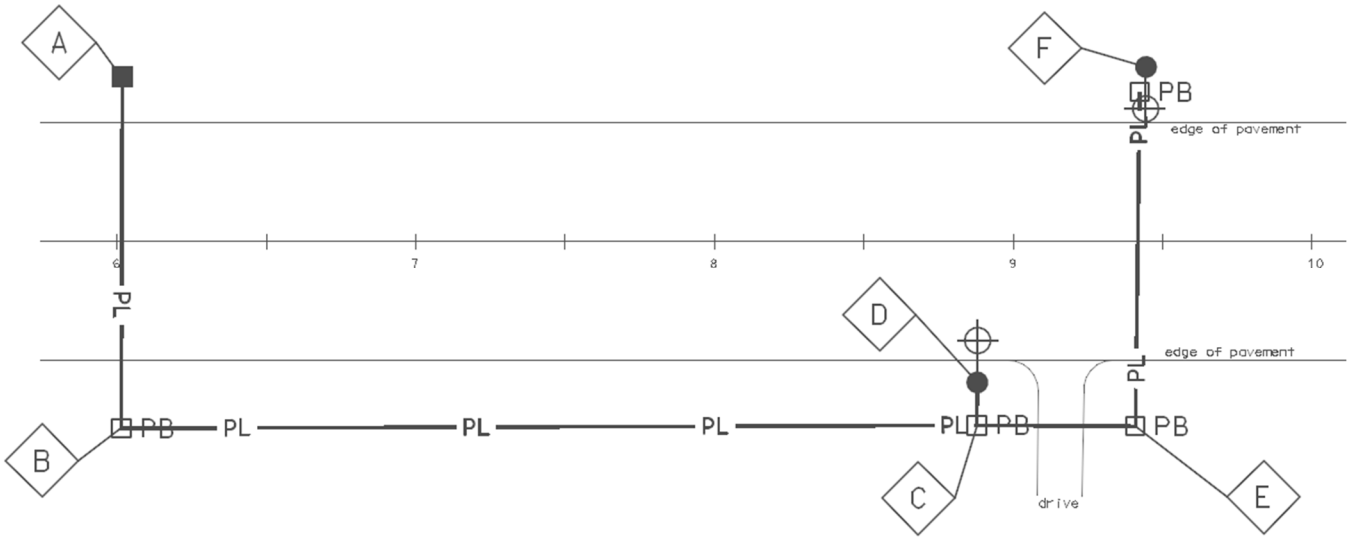
Design Services supplies the lighting design, which is the basis for all the lighting quantities. Each conduit sweep is computed as 3 ft in length at each entrance or exit at power sources and

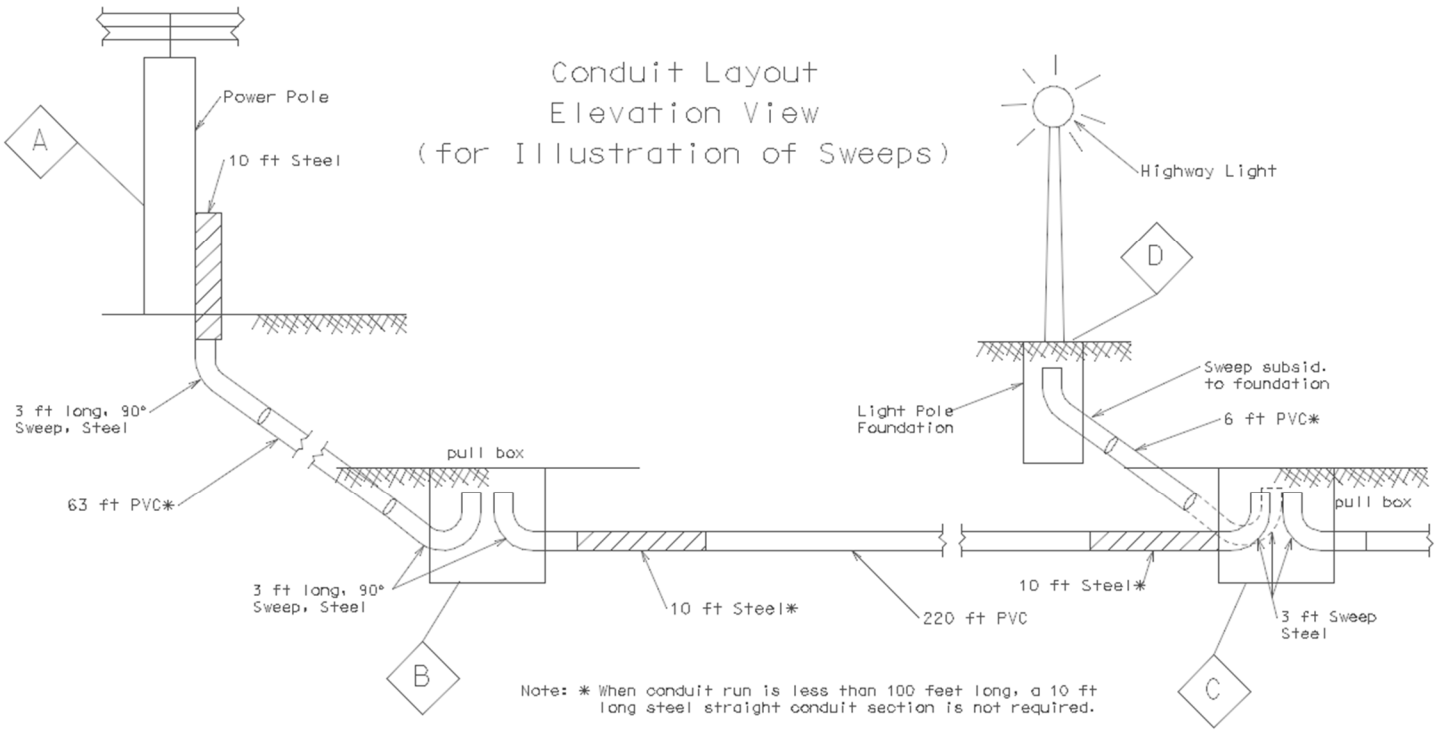
pull boxes (i.e., measure conduit installations from center to center of pull box adding 6 feet for steel sweeps).

Typically the conduit and pull box items for lighting installations are shown with the items for traffic signal installation on the Traffic Signal and Lighting Summary. However, if the lighting design is complex (as it may be for interstate interchanges) consider separating the lighting and traffic signal items into their own summaries.

For example:

Ref. No.	Ref. Line for Conduit	Location	625.22 Light Pole Base Type B (Each)	614.331 Steel Conduit	614.523 Molded Pull Box 17" X 30"	614.7314 3" PVC Conduit, Sch. 40 (lf)	614.7318 3" PVC Conduit, Sch. 80 (lf)
A		6+50, Lt. 33.0 ft (Power Source)		10			
	A-B			6			63
B		6+50, Rt. 30.0 ft			1		
	B-C			26		220	
C		8+90, Rt. 30.0 ft			1		
	C-D			3		6	
D		8+90, Rt. 36.0 ft	1				
	C-E			6			50
E		9+40, Rt. 30.0 ft			1		
	E-F			6			56
F		9+40, Lt. 26.0 ft	1		1		





SECTION 615 - TRAFFIC SIGNS

This work consists of furnishing, erecting, relocating, or removing traffic signs and signs supports, as shown on the plans or as ordered.

Overhead traffic sign structures will be measured as a unit. When more than one unit is specified in the contract plans a specific item number will be developed for each overhead sign (i.e. 615.10001, 615.10002, etc.).

There are several different types of signs. Sign layout, including dimensions, lettering, and post types required are provided by the Bureau of Traffic. The different types are as follows:

Type A: Extruded aluminum plank signs with retroreflective sheeting background and retroreflective demountable cut-out copy. This sign type is generally used when the sign height is greater than 5 feet or the width is greater than 12 feet and is typically mounted on 4" tubes, steel I-beams, or on an overhead sign structure. When mounted on tubes or I-beams, the mounting and supports are included in the sign cost. A typical example of a Type A sign is an exit sign or other guide sign.

Type B: Flat sheet aluminum with retroreflective sheeting background and retroreflective cut-out copy. This sign type has a maximum height of 5 feet, a maximum width of 12 feet and is typically mounted on 4" tubes or steel U-channel posts. If mounted on tubes or U-channel posts, the cost of the mounting and supports are included in the cost of sign. A typical example of a Type B sign is a smaller guide sign that does not meet Type A sign requirements.

Type C: Flat sheet aluminum sign with retroreflective sheeting background and non-embossed copy unless shown on the plans. In most cases a Type C sign is mounted on 4" tubes when on an Interstate and on U-channel posts

in all other cases. Mounts and supports are included in the sign cost. Typical examples of Type C signs are regulatory and warning signs along with other smaller guide signs.

Type AA, BB, or CC signs are as described above for type A, B or C signs respectively. However, AA, BB and CC signs are not supplied with mounts or supports.

Anytime a sign is relocated a new post is required, Type C Example:
Item 615.034, Type C. If you have multiple signs on the post, one of the relocated signs will be paid for as Item 615.034 – Relocating Traffic Sign, Type C (includes post). The others will be paid for as Item 615.064 – Relocating Traffic Sign, Type CC (does not include post).

Removal of existing signs is paid under Item 615.0X3 – Removing Traffic Sign, Type X.

To compute traffic sign quantities, categorize each type of sign and tabulate by specific item number in a Traffic Sign summary table.

If there are overhead signs on the project, a quantity table identifying the overhead sign structures will need to be developed referencing each location by station/offset to include all items associated with the overhead sign construction (i.e. common structure excavation, cofferdams (if required), structural fill, concrete, reinforcing steel, etc.). The Bureau of Bridge Design, or the consultant completing the design, shall provide estimated quantities for the overhead sign items. The Bureau of Traffic shall be contacted to provide costs for full or cantilevered sign structures.

When developing the estimate for construction, provide funding in the contract for shop inspection of overhead sign structures. Use $1500 to $2000 for a single structure and $1000 each for multiple structures. See the Estimate Guidelines in Chapter 13 for additional information.

SECTION 616 - TRAFFIC SIGNALS

This work consists of furnishing and installing traffic signals, pedestrian signals, or flashing beacons including poles, mast arms, foundations, and all necessary fittings, cables and components ordered.

Traffic signals and flashing beacons will be measured as a unit. Where more than one unit is specified in the contract, separate item numbers will appear for each separate and complete unit. The accepted quantity of traffic signals or flashing beacon will be paid for at the contract lump sum price complete in place.

Traffic signals are typically summarized under the Traffic Signal and Lighting Summary Table and are developed in conjunction with the traffic signal plans and special provision. Careful attention must be made to ensure that the signal plans, quantity table, and supplemental specification are all in agreement. In the quantity tables, note the location and type of mast arm foundation by station and offset. Also note the major components of the signal system such as the loop detectors, controller cabinet, and meter pedestals if used. A list of the recommended materials required to install the system is typically included as an amendment to this specification. The Bureau of Traffic needs to be closely coordinated with throughout the development of traffic signal plans, specifications, and quantities.

Typically 14" concrete pull boxes should be used in the signal design. However, if you have more than 6 - 3" conduits running into one pull box then use an 18" concrete pull box.

SECTION 618 - UNIFORMED OFFICERS AND FLAGGERS

This work consists of furnishing qualified uniformed officers, with or without vehicles, or flaggers, as required to direct traffic through or around the work area as ordered.

A spread sheet with information as to which construction operations warrant officers and flaggers is included as Appendix 8-6

Uniformed Officers (Item 618.6) and Uniformed Officers with Vehicles (Item 618.61) will not be a bid item within the contract, and is shown as a single-unit dollar amount in the estimate. A unit price will be inserted in the proposal for these items as developed by the Department. This amount shall not be altered by the Bidder on the proposal and must be included in the grand total of the bid. Payment of the amount set in the proposal will not be on a lump sum basis, but only the dollar value as authorized will be paid.

Flaggers (Item 618.7) will be measured by the actual hours anticipated for the contract, with a 4 hour/day minimum and will be paid for at the contract unit price per hour.

Use of flaggers and/or uniformed officers / uniformed officers with vehicles will be in accordance with the FLAGGER AND UNIFORMED OFFICER USE IN WORK ZONES GUIDELINES

The design engineer will determine how long (in weeks) it will take to construct the project. The calculation should include work hours per day, workdays per week and the number of flaggers and/or uninformed officers anticipated (with or without vehicle). Review the total number of hours for each item with the District Construction Engineer.

SECTION 619 - MAINTENANCE OF TRAFFIC

This work consists of providing and maintaining safe and passable traffic accommodations for public travel, preventing dust nuisance, and furnishing, erecting and maintaining necessary traffic signs, barricades, lights, signals, delineators, concrete barriers, pavement markings, and other traffic control warning devices and shall include pilot car operation and other means of guidance of traffic through the work zone.

Maintenance of Traffic is paid as a unit item. The purpose of this item is to provide safe and passable traffic accommodations for the traveling public within the project limits.

The Construction Signs and Warning Devices package (CSWD) is also paid for under this item. The CSWD as developed by the Bureau of Traffic includes only permanent signage. Permanent is defined as signs that are intended to be up for 24 hours for two or more consecutive days. The permanent (typically post mounted) signs included in the CSWD are shown in the Sign Summary Table of the contract plans. The CSWD is developed by the Bureau of Traffic and is reviewed/modified by the Bureau of Construction. Once the CSWD is finalized by the Bureau of Traffic, it is forwarded to the Bureau of Highway Design for review.

When estimating the cost for Item 619.1 – Maintenance of Traffic, keep in mind that the permanent construction sign cost is not a basis of cost toward the item. Recent Bid Projects of similar size and scope should be referenced for item pricing. Also keep in mind that unit items that are not measured for payment can be variable and difficult to estimate.

Item 619.25 - Portable Changeable Message Sign (U)

Portable Changeable Message Signs are paid by the unit. The basis for this quantity is the number of units needed for the length of the project and approaches into the workzone. Two (2) signs required for the project would be two (2) units.

Item 619.253 - Portable Changeable Message Sign (Unit/Week)

Portable Changeable Message Signs (Unit/Week) are paid by the unit week. The basis of this quantity is different than it is for Item 619.25. The quantity is calculated by taking the number of signs necessary and multiplying it by the number of weeks they are needed. Two (2) signs used for ten (10) weeks would be twenty (20) units. When used on interstate type facility, one sign per each side of the barrel affected needs to be used. Item 619.253 is typically used in place of 619.25 when the signs will only be required for a short span of time, such as notice of shut down of ramps for paving.

Item 619.27 – Trailer Mounted Speed Limit Sign (Unit) & Item 619.273 - Trailer Mounted Speed Limit Sign (Unit/Week)

These item's quantities are developed in the same manner as Portable Changeable Message Sign above. The Bureau of Construction should be coordinated with to ensure the proper quantities and items are being used.

SECTION 621 - DELINEATORS

This work consists of furnishing and installing retroreflective delineators with or without posts as shown on the plans.

Delineators or retroreflective delineator faces will be paid for at the contract unit prices per each of the type specified, complete in place.

The delineators shall be tabulated by the item showing locations in a station-to-station/offset reference with the required spacing and quantity. Delineators are now summarized in its own item Summary Table. The summary shall provide Construction with a subtotal of different color delineators within each item. See Volume 2 for an example. Delineator spacing along a roadway will be set by establishing the spacing through curves along the alignment, then setting the spacing along the tangent sections. The roadside delineator spacing is found on Standard No. DL-1 and Interchange Delineation on Standard No. DL-2 in the "Standard Plans for Road and Bridge Construction" and Special Detail Terminal Unit Delineation. The appropriate tables will need to be referenced for both the roadside and beam guardrail delineator layout based upon the horizontal alignments.

For example (mainline):

PC to PT	RADIUS	PLAN SPACING	ITEM 621.3

28+50 to 43+50 Lt. & Rt.	2,292 ft	1,500 ft x $\frac{1 \text{ Del.}}{250 \text{ ft}}$	6 x 2 sides = 12

Curve/Guardrail example: When the curve is within a guardrail section, beam guardrail delineators are required in addition to the roadside delineators and are paid for separately. Note that these beam guardrail delineators are not necessarily placed at the same locations as the roadside delineators as the placement and spacing of each are independent of one other. The guardrail length, including the length of the end unit shall be included in calculating the guardrail delineators.

RADIUS	DELINEATORS REQUIRED	ITEM 621.2
2,292 ft	1,500 ft x $\frac{1 \text{ Delineator}}{100 \text{ ft spacing}}$ = 15	15

Now calculate the first, second, and third delineator spacing before and after the curve, based on the previously mentioned detail sheets. Similar computation layouts should be used when calculating other delineator items. Delineators for temporary barrier including temporary guardrail are subsidiary to the item. Post-mounted delineators are not required along sidewalks, but are required within median islands. Reference Standard HR-2 Plate 2 for delineator spacing within median islands. Delineators for permanent barrier including guardrail and end units are paid separately.
In general, when summarizing, the color shall match the edgeline in the nearby pavement, although guardrail approaches shall have a double red and guardrail departures a single green. See Special Detail "Terminal Unit Delineation" on the web for more information.

SECTION 622 - MARKERS AND BOUNDS

This work consists of furnishing and erecting witness markers and bounds at the location shown on the plans.

Witness markers, concrete bounds, and stone bounds of the type specified will be measured by the number of each installed or reset complete in-place. All excavation required for this work is subsidiary except when excavation of solid rock is ordered by the Engineer.

Item 622.1 - Steel Witness Markers

Witness markers are used to locate ditch line drainage structures, ends of culverts, slope drains and underdrains. Witness markers are not placed at the ends of culverts that are 36" and larger in diameter.

For example:

Sta. 103+50 RT Und. Out.	1
Sta. 103+75 LT CB	1
Sta. 104+90 LT & RT (12" culvert)	2
Sub-Total =	**4**

Item 622.2,.4,.5 - Bounds

Bounds are set on Right-of-Way lines, at the beginning and end of the project, at the beginning and end of (horizontal) curves, at the beginning and end of spirals, at angle points. They shall be

spaced no further than 900 feet apart on tangents. Bounds shall not be placed on property lines or on existing right-of-way lines since they are only approximations of the right-of-way layout and not boundary surveys. The majority of the bounds that are set are concrete bounds. Stone bounds are used when bounding Non-State Right-of-Way for cities and towns. A typical bound Summary Table can be found in Volume 2 of the Highway Design Manual.

SECTION 625 - LIGHT POLE BASES

This item will consist of concrete light pole bases constructed at the locations and of the design shown on the plans or as ordered. Light poles with luminaires may also be included under this section. Light pole bases and light poles with luminaires will be measured by the number of units installed.

Design Services will design the lighting layout and provide quantities for the required lighting layout. This is typically completed after the utility pole relocations have been finalized so that the power source and potential light installations on utility poles is known. Close coordination with Design Services will be required to ensure that proper layouts are developed.

Tabulate light pole base locations by station and offset. Separate by roads, ramps, etc. This item is typically included in the Traffic Signal and Lighting Summary, as shown in Volume 2 of the Highway Design Manual.

SECTION 628 - SAWED PAVEMENTS

This work consists of sawing concrete pavement, bituminous pavement, or both as shown on the plans or as ordered.

Sawed pavement of the type specified will be measured by the linear foot.

Pavement cuts can be made with a pavement saw, or can be done with a cutting wheel on the back of a piece of heavy equipment such as a grader. All concrete pavement cuts, longitudinal bituminous pavement cuts which will not be overlaid later, transverse cuts and driveway cuts are done with a saw and paid under Section 628. See payment directive following. Saw cut is the method typically used and wheel cuts are rarely used.

Sawed Bituminous Pavement Guidelines:

Pay:

1. Sawed areas that will be permanently incorporated in the work, excluding drainage and utility trenches.
2. Shoulder widening projects (permanent longitudinal joint along existing edge of pavement).
3. Reset curb in existing pavement that is to remain.
4. Curb installation if pavement was placed wider than final pavement layout to accommodate traffic control phasing.
5. Phased construction, between new and old pavement.

Non – Pay:

1. Drainage and utility trenches (these shall be subsidiary to their respective items).
2. Areas around structures, such as CB's and MH's (i.e. saw cutting binder to raise structures).
3. Areas around curbing in new pavement.
4. Areas where the contractor paved wider than the plans dictate.
5. Contractor's chosen means and methods (example: milling out old pavement as opposed to saw cutting and excavating).

SECTION 632 - RETROREFLECTIVE PAVEMENT MARKINGS

This work consists of furnishing, placing, and removing white or yellow retroreflective paint pavement markings, preformed retroreflective tape pavement markings, and retroreflective thermoplastic pavement markings at the locations shown on the plans or as ordered. Additionally, it consists of furnishing and installing raised pavement markers including cutting the pavement to accommodate the markers as required by the manufacturer.

Retroreflective pavement marking lines of the type and width specified will be paid for by the linear foot, to the nearest foot of length applied. Double lines and combination solid/broken lines will be measured as separate lines according to the length of each individual marking applied. Symbols or words of the type specified will be measured by the square foot. The limits of pavement marking are 500 feet beyond the construction limits on both the project begin approach and the end approach.

Retroreflective pavement markings include pavement markings applied during construction phasing and applied as the final markings upon completion of the project. The designer should review not only the final Pavement Marking Layout supplied by the Bureau of Traffic, but also any Construction Traffic Control Phasing to determine a reasonable estimate for this quantity. Tabulate the locations and types of markings at each location.

Keep in mind that many construction projects last more than one construction season. The Bureau of Traffic pavement marking crews skip the projects from "ROAD WORK 500 FEET" to "END ROAD WORK" sign. The Bureau of Traffic requests that all projects that last more than one construction season include enough pavement markings to restripe the entire project at the conclusion of each season (this quantity should be entered in the pavement marking summary as "END OF SEASON STRIPING). Additionally, due to the new water-based pavement marking requirements and the bleeding through of new pavements, it is necessary that final striping, or temporary striping that intends to last through winter, receive two applications of paint. This needs to be accounted for in all quantity takeoffs as well.

Item 632.3xxx – Thermoplastic Pavement Markings

All symbols, words, and transverse markings (stop bars, cross walk lines, and railroad symbols) shall be thermoplastic. Bureau of Traffic may request certain intersections and high traffic areas to receive Thermoplastic on center, and lane lines to delay difficult yearly re-striping.

Final Layout Pavement Markings (From Pavement Marking Plans)

Main Line STA 10+00 to STA 13+65

Item 632.0104 – Retroreflective Paint Pave. Marking, 4" Line

4" SSL (W) (Edge, LT & RT)	365 ft x 2 lines	= 730.0 ft
4" SBL (Y) (Centerline)	365 ft x 3 ft / 40 ft	= 27.38 ft

Town Road STA 1+50 to STA 3+00

Item 632.0104 – Retroreflective Paint Pave. Marking, 4" Line

4" SSL (W) (Edge, LT & RT)	150 ft x 2 lines	= 300 ft
4" SBL (Y) (CL, Double)	150 ft x 2 lines	= 300 ft

Town Road, Stop Line

Item 632.3118 – Retroreflective, Thermoplastic Pave. Marking, 18" Line

18" SSL (W)	12' lane width x 1 line	= 12 ft

Construction Phasing Pavement Markings (Developed for Traffic Control Plans)

Main Line (Phase 2) STA 10+00 to STA 13+65

Item 632.0104 – Retroreflective Paint Pave. Marking, 4" Line

4" SSL (W) (Edge, LT & RT)	365 ft x 2 lines	= 730 ft
4" SBL (Y) (CL, Double)	365 ft x 2 lines	= 730 ft

Town Road, Stop Line

Item 632.0118 – Retroreflective Paint Pave. Marking, 18" Line

18" SSL (W)	12' lane width x 1 line	= 12 ft

Detour (Phase 1) STA 10+85 to STA 12+85

Item 632.0104 – Retroreflective Paint Pave. Marking, 4" Line

4" DSL (W) (Edge, LT & RT)	200 ft x 2 lines	= 400 ft
4" DSL (Y) (CL, Double)	200 ft x 2 lines	= 400 ft

Item 632.712xx Grooved Polyurea

These longer lasting pavement markings may be requested by the Bureau of Traffic. These higher costing items may be approved for use on a project by project basis.

The TCP may require the Designer to consider using other types of roadway delineation along with painted lines to highlight the traveled way. For example, locations where vehicular traffic is close to pedestrian traffic may require special delineation (i.e., raised pavement markers, tubular markers, etc.). Any additional delineation will be paid under its appropriate item number.

Item 632.9xx - Obliterate Pavement Marking

Compile the quantity of markings to be obliterated, using a chart similar to the one used for placing pavement markings. Describe locations where the pavement markings are no longer applicable. Tabulate by station, as necessary, to clarify computations. Include breakdown of TCP phasing to assist in the determination of the quantity. Obliterate pavement marking lines

will be measured by the linear foot and obliterate markings and symbols will be measured by the square foot.

Not all pavement markings need to be obliterated before paving over. When paint pavement markings exist on a binder pavement course, the Contractor can pave over the markings without needing to obliterate. These lines typically only need to be ground out if they are thermoplastic pavement lines. Some specialty types of pavement, bonded for example, require paint marking removal.

SECTION 641 - LOAM

This work consists of collecting and preparing loam material encountered in the work or obtained from other sources, and placing the material at the locations shown on the plans or as ordered, including necessary excavation for placing loam.

The loam shall be spread on the prepared subgrade surface to the depth of 4 in, unless otherwise specified, and will be measured by the cubic yard.

Loam is typically used in areas that are aesthetically sensitive and designated as "lawns" (e.g., in front of homes and businesses, around parks and playgrounds, and under sod). The majority of other landscaping areas will receive humus, except wetland areas which receive wetland humus.

List each area by a station-to-station reference. Compute from dimensioned layout or measure the plan area in CAD\D.

Route 66; STA 85+50 RT to STA 96+0 RT

$$1{,}050.00 \text{ ft long} \times 7 \text{ ft wide} \times 0.33 \text{ ft deep} \times \frac{1 \text{ cy}}{27 \text{ cf}} = 89.83 \text{ cy}$$

Plummer Road – Island (from CAD/D)

$$126.65 \text{ sf} \times 0.33 \text{ ft} \times \frac{1 \text{ cy}}{27 \text{ cf}} = 1.55 \text{ cy}$$

Sod Area; STA 8+00 RT to STA 39+50 RT (behind sidewalk adjacent to business)

$$150.00 \text{ ft long} \times 2.0 \text{ ft wide} \times 0.33 \text{ ft deep} \times \frac{1 \text{ cy}}{27 \text{ cf}} = 3.67 \text{ cy}$$

Sub-Total = 95.05 cy

Since loamed areas are traditionally limited to only sensitive areas as noted above, loam should be tabulated in its own separate summary table with specific station-to-station references.

SECTION 642 - LIMESTONE

This work consists of furnishing and applying limestone on areas shown on the plans or as ordered. Limestone will be measured by the ton.

Limestone is used to raise the pH of the soil. It is applied in loam and humus areas only when the "Turf Establishment" item is not being used and some special landscaping areas never receive limestone (e.g., wetland humus areas). Per *Standard Specifications*, the application rate is based upon the pH of the soil. If the pH is known, refer to the *Standard Specifications* to

determine the correct application rate. If the pH of the soil is unknown, an average of 2 tons/acre should be used.

For example:

Loam: $7{,}350 \text{ sf} \times \frac{1 \text{ acre}}{43{,}560 \text{ sf}} \times \frac{2.0 \text{ t}}{1 \text{ acre}} = 0.337 \text{ t}$

Humus: $15{,}000 \text{ sf} \times \frac{1 \text{ acre}}{43{,}560 \text{ sf}} \times \frac{2.0 \text{ t}}{1 \text{ acre}} = 0.689 \text{ t}$

Total = 1.026 t

SECTION 643 - FERTILIZER FOR GRASSES

This work consists of furnishing and applying an initial application of fertilizer on a new surface and one or more fertilizations after the growth has progressed sufficiently, as shown on the plans or as ordered.

Fertilizer will be measured by the pound. However, if the calculated quantity for fertilizer (for initial application or refertilization) is more than 500 lbs, pay this quantity by the ton.

Fertilizer is applied in loam and humus areas only when the "Turf Establishment" item is not being used and some special landscaping areas never receive fertilizer (e.g., wetland humus areas). Since the condition and the fertilizer needs of the soil is typically unknown to the Designer, use the application rate for a 10-10-10 fertilizer.

For example:

Loam (4 in): $7{,}350 \text{ sf} \times \frac{20.0 \text{ lb}}{1{,}000 \text{ sf}} = 147.0 \text{ lb}$

Humus (3 ½ in): $125 \text{ sf} \times \frac{20.0 \text{ lb}}{1{,}000 \text{ sf}} = 2.5 \text{ lb}$

Total = 149.5 lb

Refertilization is generally used on multi-construction season where the seeding is done in one construction season (for all or part of the project), but completion is not until a subsequent construction season.

SECTION 644 - GRASS SEED

This work consists of furnishing and sowing grass seed as shown on the plans or as ordered. Grass seed shall be measured by the pound.

When not using the "Turf Establishment" item all loam, humus, and wetland humus areas are seeded with grass seed. Each type of area gets a different type of seed, consult the *Standard Specifications* or Special Provisions for the proper seed mix. Apply the various types of seed at the rates specified. Compute each seed type separately. Also separate out by use (e.g., landscaping, slope protection, or both), as quantities are often summarized this way.

For Example:

Item 644.15 – Park Seed Type 15 (Used in loam areas)

$$\text{Loam } 600 \text{ sf} \times \frac{1 \text{ acre}}{43{,}560 \text{ sf}} \times \frac{120 \text{ lb}}{1 \text{ acre}} = 1.65 \text{ lb}$$

Item 644.44 – Slope Seed Type 44 (Used in humus areas)

$$\text{Humus } 10{,}000 \text{ sf} \times \frac{1 \text{ acre}}{43{,}560 \text{ sf}} \times \frac{80 \text{ lb}}{1 \text{ acre}} = 18.37 \text{ lb}$$

There are other special purpose seeds not referenced in the *Standard Specifications*. The Specifications Engineer can supply the special provisions for these items. Consult with the Specialty Section/Roadside Development of Highway Design for guidance in the application of these special seeds.

SECTION 645 - EROSION CONTROL

This work will consist of furnishing, placing, maintaining and removing both permanent and temporary erosion control devices at locations as shown on the contract plans, Item 645.7 – Storm Water Pollution Prevention Plan (SWPPP) or as ordered.

In addition to the *Standard Specifications* and information provided below, the Department has developed a handbook, *NHDOT Guidelines for Temporary Erosion and Sediment Control and Stormwater Management*, that can be referenced for further information on Erosion Control. NHDES developed the NH Stormwater Manual in 2008. Volume 3, "Erosion and Sediment Controls During Construction", is the most current manual on the subject.

Item 645.1XX – Mulch

Mulch is used to trap moisture and hold seed in place until the grass is established. Use the loam and humus areas to compute this quantity. Separate calculations will be used when special mulch is used for erosion control. Tackifiers are normally used to help keep the mulch in place. Some landscaping areas do not receive mulch (e.g., sod and wetland humus areas).

Mulch and temporary mulch will be measured by the square yard or by the acre. The acre item shall be used in larger areas, with the square yard item being reserved for the smaller areas. Mulch can be developed as a Final Pay (F) item when areas can be accurately calculated with little potential for need of refining during construction.

Item 645.3 Erosion Stone

Erosion stone should be used to provide for temporary control of erosion or pollution including stone check dams, inlet control, and stabilized construction entrances, or as ordered.

Erosion stone will be measured by the ton. A weight of 1.25 tons/cy should be used in the quantity development for this item.

The "NH Stormwater Manual, Volume 3, Erosion and Sediment Controls During Construction", is a good resource in identifying the proper locations for erosion stone.

Item 645.42 – Temporary Slope Matting Type B (Wildlife Friendly)

The products under this Item are used to help protect slopes of 3:1 or flatter where high runoff velocities would cause a problem with grass establishment. It shall be used in environmentally sensitive areas. Slope Matting is measured by the square yard and is calculated as described below.

The typical method of measurement is to calculate areas using CADD software and applying the appropriate Slope Correction Factor (if needed).

For example:

	Plan Area (sf)	Slope Correction Factor	Actual Area (sf)
16+00.0 to 18+75.0 Rt. (2:1 Slope)	2,750.0	1.12	3,080
17+25.5 to 19+30.5 Lt. (4:1 Slope)	1640.0	1.03	1,689.2
		Sub-Total =	**4769.2**

Item 645.44 – Temporary Slope Matting Type D (Wildlife Friendly)

The products under this Item are used to help protect slopes of 2:1 or flatter where high runoff velocities would cause a problem with grass establishment. It shall be used in environmentally sensitive areas. Slope matting is measured by the square yard and is calculated as described above.

Item 645.45 – Permanent Channel Matting Type A

The products under this Item are used on locations in need of protection, to permanently protect vegetated channels or ditches with a slope profile of 5% or less.

Channel Matting is measured by the square yard. The typical method of measurement is to calculate areas using CADD software.

Item 645.471 - Temporary Channel Matting Type A (Wildlife Friendly) and Item 645.472 – Temporary Channel Matting Type B

These temporary products are measured in a manner similar to the equivalent permanent items.

Item 645.512 – Compost Sock for Erosion and Sediment Control
& Item 645.531 – Silt Fence (Perimeter Control)

The silt fence and compost sock items include the placement, maintenance, and dismantling. The actual length used will be dependent upon the Contractor's construction operations, the Contractor's SWPPP, and the erosion control devices selected by the Contractor.

The design engineer however needs to identify all potential locations that warrant silt fence and compost sock placement. The "NH Stormwater Manual, Volume 3 Erosion and Sediment Controls During Construction" is a good resource in identifying the proper criteria and locations for silt fence.

Silt fence and compost socks serve similar purposes. Typically silt fence is placed at the bottom of slopes, whereas compost socks are used along flatter grades. Parallel installations of silt fence

and compost sock are required adjacent to environmentally sensitive areas, such as within 50' of wetlands.

List locations where silt fence and/or compost socks may be required by a station-to-station reference, supported by the conceptual plan developed by the Designer. Generally, place along all wetlands and fill slopes. A remarks column should be used to point out requirements for temporary detours or other uses for silt fence and/or compost socks required during phases of the Traffic Control Plan.

For example:

Main Line
36+50 to 43+85 Rt. 735.0 ft
36+50 to 42+50 Lt. 600.0 ft

Detour
37+00 to 39+85, Rt. 285.0 ft
Sub-Total = 1620.0 ft

Silt fence and compost socks will be measured by the linear foot, to the nearest ½ ft.

Item 645.611 - Bonded Fiber Matrix, Item 645.612 - Fiber Reinforced Matrix, and Item 645.613 – Stabilized Mulch Matrix

These hydraulically applied products are used to treat exposed soil areas to stabilize them and promote establishment of vegetation. They are paid by the pound, but estimated by pounds per acre per the application rate tables below based on whether it is a temporary or permanent condition use. The areas to be treated, including temporarily exposed areas during progress of the work, should be estimated and rounded up by a generous percentage (~50%) to account for unknowns.

Bonded Fiber Matrix (BFM) Application Rates

Condition	Max Continuous Slope Length (ft)	Temporary Cover by Mulch (no seed) Application Rate (lbs/acre)	Temporary Cover by Seeding Application Rate (lbs/acre)	Permanent Cover Application Rate (lbs/acre)
4:1 Slope	70	2,500	1,500	2,500
3:1 Slope	60	3,000	1,800	3,000
2:1 Slope	50	3,500	2,000	3,500
1:1 Slope	35	4,000	2,500	Not Applicable

Fiber Reinforced Matrix (FRM) Application Rates

Condition	Max Continuous Slope Length (ft)	Temporary Cover by Mulch (no seed) Application Rate (lbs/acre)	Temporary Cover by Seeding Application Rate (lbs/acre)	Permanent Cover Application Rate (lbs/acre)

4:1 Slope	**100**	**2,500**	**1,500**	**2,500**
3:1 Slope	**85**	**3,000**	**1,800**	**3,000**
2:1 Slope	**75**	**3,500**	**2,000**	**3,500**
1:1 Slope	**50**	**4,000**	**2,500**	**Not Applicable**

Stabilized Mulch Matrix (SMM) Application Rates

Condition	Max Continuous Slope Length (ft)	Temporary Cover by Mulch (no seed) Application Rate (lbs/acre)	Temporary Cover by Seeding Application Rate (lbs/acre)	Permanent Cover Application Rate (lbs/acre)
5:1 Slope	**70**	**1,800**	**1,200**	**1,800**
4:1 Slope	**60**	**2,000**	**1,500**	**2,000**
3:1 Slope	**50**	**2,500**	**1,800**	**2,500**
2:1 Slope	**25**	**3,000**	**2,000**	**Not Applicable**

Item 645.7 Stormwater Pollution Prevention Plan

A Stormwater Pollution Prevention Plan (SWPPP) is generally only required on a project if the area of impacts is greater than 1 acre. An example where they have been required with smaller impact areas is culvert replacements or rehabilitations.

It shall be developed using a combination of structural, non-structural, and vegetative Best Management Practices (BMP's) to adequately control erosion and sedimentation and manage stormwater. Typically this plan is developed by the Contractor and submitted for approval to the Department for review and approval in meeting the environmental permitting requirements. Although it is the Contractor's responsibility to develop the SWPPP, the Designer shall develop a conceptual plan to appropriately identify erosion and sediment needs and address stormwater issues such that appropriate quantities can be developed. This conceptual plan shall be kept in the quantity book for reference during construction. If a wetland permit is required, the conceptual Erosion Control Plan will be included in the Permit Application.

Construction sites are dynamic operations that change throughout the duration of the project. It is understood that the SWPPP as developed will be refined throughout construction to meet the current project needs.

The Stormwater Pollution Prevention Plan will be measured as a unit and includes preparation, submittals, modifications, and resubmittals.

Item 645.71 - Monitoring SWPPP and Erosion and Sediment Controls

This item is only required on a project if a SWPPP is required.

Monitoring includes on-site reviews, both weekly and within 24 hours after any storm event greater than 0.25" of rain in a 24-hour period.

Monitoring is required throughout the duration of a project. In quantifying this item, the engineer will need to determine the number of weeks that are needed to construct this project from beginning to completion (accounting for winter shutdown). This can be approximated from looking at previously advertised projects. Then determine the number of hours per week that monitoring will be necessary based on the requirements in the *Standard Specifications.* A reasonable assumption to start with is 4 hours/week, however size and scope of the project need to be factored in with this approximation.

Computations should show how the quantity was derived: hours/week, number of weeks, and project duration. Review this quantity with the District Construction Engineer. The total quantity is typically shown in the Incidental Items Summary Table.

SECTION 646 - TURF ESTABLISHMENT

Item 646.XXX - Turf Establishment

This work consists of preparing the soil and furnishing and applying seed of the type or types specified (fertilizer, limestone, and mulch) if required, on all areas designated for turf establishment as shown on the plans or ordered.

The 646 items are typically used for contracts versus the separate individual items except for certain specific situations. This is due to the fact that the same work gets done to the same degree without multiple measurements and computations.

Turf establishment will be computed to the square yard or acre, depending upon the area to be computed. Use of the acre should be used in larger areas, with the square yard being reserved for the smaller areas. This item can be developed as a Final Pay (F) item when areas can be accurately calculated with little potential for refining during construction.

SECTION 647 - HUMUS

This work consists of salvaging humus material encountered in the work or furnishing humus material from other sources, and placing the material at the locations shown in the plans or as ordered.

Humus will be measured by the cubic yard along the slope that it is placed.

All grassed areas (except those areas receiving loam or wetland soils) receive humus, typically 3-1/2" deep. The typical method of measurement is to estimate an average slope length between stations, and compute the quantity as the sum of areas between stations. Separate special intermixed or wetland humus areas as required.

SECTION 648 - SOD

This work consists of furnishing and placing live grass sod, including sod gutters, as shown on the plans or as ordered. This work shall also include any excavation necessary to place the sod. Sod areas will also need loam, limestone, and fertilizer (paid under their respective items).

Sod will be measured by the square yard.

Sod is used in developed areas to quickly and more comparatively match adjacent landscaped areas. Sometimes the areas to receive sod are stipulated by ROW agreement. Sod is more costly than loam/seed or turf establishment; therefore, carefully evaluate the area before specifying its use. Describe the sod areas with a station-to-station reference. Areas can be scaled or measured using CADD software and identified by station locations.

SECTION 650 – LANDSCAPING

Item 650.2 – Landscaping

This item addresses all types of plantings, including trees, shrubs, vines, and ground cover plants, irrespective of type. Grasses and sod, however, are paid for under the respective items. All plant material will be identified under this single item and will be paid for by the "unit". Close coordination with the Specialty Section/Roadside Development is required to ensure that the appropriate plantings are proposed.

The designer, likely someone from Specialty Section/Roadside Development or a consultant, will develop the appropriate planting plans, to include a list of required plantings and related information.

See volume 2 for an example of the summary table for 650.2.

SECTION 670 - SPECIAL ITEMS

Item 670.045XX – Construct and Remove Diversion

A temporary widening is typically used for providing additional roadway width for the purpose of shifting traffic away from a work area. The MUTCD defines a diversion as "a temporary rerouting of road users onto a temporary highway or alignment placed around the work area." A diversion is different from a "detour" in that a "detour" refers to use of other existing off-site roadways for the purpose of maintaining traffic.

Item 670.046X – Construct and Remove Temporary Widening

This work consists of constructing and removing a temporary widening at locations shown on the Traffic Control Plan(s). The typical section to define the earthwork, side slopes, shoulders, base courses and pavement requirements will be as shown on the plans or as ordered.

This Item will be paid as a "unit". When more than one unit is specified in the Contract, separate item numbers will appear for each separate and complete unit. Payment by the unit will eliminate the need to measure the quantity of materials used and the excavation required to construct and remove temporary widenings in the field during construction. This Item includes all earthwork, aggregate base courses, slope treatment, bituminous curb, sidewalks, the maintenance of traffic including installing, maintaining and removing construction signs and warning devices not covered in Item 619.1. Removal of items necessary to provide an approved

widening and not needed for the final roadway configuration, including earthwork, bituminous curb, etc. will be subsidiary to this Item.

The Designer shall compute excavation, fill, and aggregate base course, and re-excavation quantities. These items constitute the most significant elements of this item and are the basis of the cost of the unit item. Other items required to complete the work such as drainage, pavement, and guardrail are paid separately and are identified as temporary in their item description.

Item 670.049X – Construct and Remove Temporary Access Road

This work consists of constructing and removing a temporary access road at locations shown on the Plans or as ordered. This Item is typically used to provide construction access to difficult areas such as culvert inlets and outlets and to the top or toe of steep slopes. Coordinate with the District Construction Engineer to determine if Temporary Access Road Items(s) are necessary and if so, what information needs to be included in the Plans.

This Item will be paid as a "unit". When more than one unit is specified in the Contract, separate item numbers will appear for each separate and complete unit. See the Special Provision 670.049X for elements of the work that are subsidiary to this Item.

Quantities for the most significant elements should be calculated and included in the Quantity Summaries. These typically include clearing and aggregate base course over geotextile for crossing wetlands and areas of soft soil, and may include clearing and grubbing, earthwork, and road surfacing materials.

(See Volume 2 Construction Plans in the quantity summary area showing this item and the quantities provided for information purposes to the bidder.)

Item 670.066 - Mailbox Post Assemblies and Item 670.0661 - Multiple Mailboxes Support Assemblies

This work consists of installing relocated mailboxes or new mailboxes furnished by others on new mailbox support assemblies at locations shown on the plans, or as ordered.

Single and multiple mailboxes support assemblies will be measured as a single unit, paid by "each" location, as specified on the plans or as ordered. This unit shall include all materials and labor required to install the support assembly and mailboxes. Mailboxes mounted on acceptable mailbox support assemblies salvaged during construction shall be reinstalled subsidiary to Item 619.1 - Maintenance of Traffic.

List the mailbox locations by approximate station and offset.

Main Line	Item 670.066	Item 670.0661
64+35.0 Rt.	1	
66+65.3 Lt.		1
67+10.5 Rt.	1	
South Street		
26+60.0 Rt.		1
26+80.0 Lt.	1	

Total	**5**

Item 670.10X - Temporary Lighting

This work consists of furnishing, installing, maintaining, including power, and removing temporary lighting at locations shown on the plans or ordered. A unit includes all work, material, equipment, hardware, required power, and appurtenances as necessary to provide temporary lighting.

Design Services will design the temporary lighting layout and provide quantities for the required lighting layout. This is typically completed after the utility pole relocations have been finalized and preliminary temporary traffic signal design is prepared so that potential light installations on utility poles or temporary traffic signals is known. Close coordination with Design Services will be required to ensure that proper layouts are developed.

Occasionally temporary lighting is installed as part of and subsidiary to a temporary traffic signal installation.

Item 670.104 – Temporary Portable Lighting (U)

Temporary Portable Lighting is paid by the unit. The basis for this quantity is the number of units needed for the length of the project. Two (2) lights required for the project would be two (2) units.

Item 670.105 – Temporary Portable Lighting (Unit/Week)

Temporary Portable Lighting (Unit/Week) is paid by the unit week. The basis of this quantity is different than it is for Item 670.104. The quantity is calculated by taking the number of portable lights necessary during a phase and multiplying it by the number of weeks they are needed. Two (2) lights used for ten (10) weeks would be twenty (20) units. Item 670.105 is typically used in place of 670.104 when the lights will only be required for a short span of time, such as lighting portable concrete barrier for a few weeks on a multi-year contract.

SECTION 692 - MOBILIZATION

This Item consists of preparatory work and operations. This includes, but is not limited to those necessary to the movement of personnel, equipment, supplies, and incidentals to the work site. Also included is all other work and operations which must be performed and all costs which must be incurred prior to beginning work on the various project items.

This Item shall be used on all projects, unless otherwise directed. This Item will be measured as a unit with the dollar amount being based on a percentage of the contract item sub-total (including bridge items). Bid dollar amounts for Mobilization depending upon the size, scope, and location of the project. Generally, the higher the construction cost, the lower the percentage used in the calculation, which typically ranges from 3% to 8%.

General estimate practices are to compare project percentage from three recently awarded projects that are located in the general area of your current project. It is typical for a higher project percentage for projects up north due to the long travel times. High percentages also occur along major routes and the interstate due to access difficulties. Round the dollar amount up to the nearest $1,000.

SECTION 693 - TRAINING PROGRAMS

The primary objective of the Training Program is to provide equal employment opportunities for workers by providing training and upgrading with the goal of reaching journey worker status and retaining them in the highway construction industry.

On-the-Job Training is accounted for as a fixed dollar amount within the Contract. At the beginning of each Federal fiscal year (October), the Labor Compliance Section of the Bureau of Human Resources produces a list of the recommended number of trainees for Federal Aid construction projects that will advertise. If a project is scheduled to include this item in the Contract, the number of trainees required to meet On-the-Job training goals is on this list. (Usually on larger projects $5 million and above) Contact the Project Lead or Specifications Section for this list.

The dollar amount inserted in the Proposal under this Item represents $600 times the number of workers specified to be trained under the program. For example if you have 2 positions, it should be shown in the estimate as 1 unit at $1,200.

SECTION 698 - FIELD FACILITIES

This section accommodates for the use of a Contractor owned and Contractor maintained field office and physical testing laboratory if needed, during the construction of the project.

Item 698.1X - Field Office Type A, B, C, D

Highway Design will coordinate with the Bureau of Construction to determine which type of Field Office, if any, is appropriate for the project. A separate item is included if NHDOT supplies the field office (e.g., a building owned by the State that may be used during construction). This item quantity is estimated based on the contract time + 1month prior + 1 month after. For example, a 2 season project, April 2000 to October 2001 will have a trailer in place March 2000 through November 2001.

Item 698.2 - Physical Testing Laboratory

Highway Design will also coordinate with the Bureau of Construction to determine whether a Physical Testing Laboratory is needed. This item quantity is estimated based on the need for the lab. For example, if the lab is only going to be used for testing pavement and the paving will be placed in the second season of work, then the lab is only needed during the paving of that second season.

The field office and physical testing laboratory will be separate facilities, each with its individual item, with the exception of Field Office Type D. The Type D field office includes testing equipment for determining gradation of gravels as set forth in the *Standard Specifications* and will not have an accompanying item for the physical testing laboratory.

The cost of these items is on a Monthly basis and is estimated using the Weighted Average Unit Prices report or recently bid contracts of similar size and scope (both available online) and is applied over the duration of the construction contract.

SECTION 699 – MISCELLANEOUS TEMPORARY EROSION AND SEDIMENT CONTROL

Item 699. – Miscellaneous Temporary Erosion and Sediment Control

This Item includes work required to establish temporary measures to control erosion and prevent water pollution through the duration of the project. This work includes, but is not limited to, the use of pipes, berms, dams, sediment basins, fiber mats, filter fabrics, netting, gravel, slope drains, and other erosion control devices or methods.

The quantity of work required will depend upon many factors. The amount of exposed soil contributes greatly to potential erosion and sedimentation, as well as the Contractor's methods of construction and construction sequencing. A construction site is very dynamic and the needs of erosion and sediment control can vary greatly throughout the duration of construction. It is important that the Designer keep this in mind when developing a cost for this item. The final cost of this item is primarily dependent upon the extent of the pollution control needed, and is driven by experience. In addition, there may be some specialty items that, if not paid for under specific items, will be paid for under this Item (i.e. silt curtains, sand bags, etc.). The Designer needs to account for these types of best management practices accordingly when developing this item.

General estimate practices are to compare project percentage from three recently awarded projects that are similar in scope to your current project. Coordination with the Bureau of Construction is also recommended for guidance in setting a dollar amount for this item. When an approximate dollar amount has been determined it should be rounded up to the nearest $1,000.

1008.11 – Unanticipated Work:

Although "unanticipated" this Item must be specified in the Prosecution of Work (POW). In the POW there should be an explanation as to what this item is intended to be used for. This item is not permitted to be used in Federally funded projects without a legitimate and defendable reason.

1010.15 Fuel Adjustment:

The gas and diesel fuels have been combined so there will only be one line item in the contracts. Guidelines for inclusion in contract is based on the Contract total cost in the table below. A link to the current adjustment practice for 1010.15, 1010.2 & 1010.3 is given and it is suggested that this is checked for updates:

https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/specifications/documents/Fuel-AsphaltCementAdjustGuidelines2012.pdf

Total Contract Cost	Fuel Adjustment Dollar Amount
Less than $250,000	Eliminate Item from Contract
$250,000 to $500,000	$2,000
$500,000 to $1,000,000	$10,000
$1,000,000 to $3,000,000	$20,000
$3,000,000 to $5,000,000	$40,000
$5,000,000 to 10,000,000	$70,000
$10,000,000 to $25,000,000	$100,000
Over $25,000,000	$250,000

1010.2 Asphalt Adjustments:

The price adjustment for asphalt cement is related to the design quantity tonnage of asphalt mix in the project. The total asphalt mix tonnage is the sum of the design quantities for all 403, 404, and 411 Items in the project.

Total Asphalt Mix	Asphalt Adjustment Dollar Amount
Less than 1,000 tons	Eliminate Item from Contract
1,000 to5,000 tons	$10,000
5,000 to 15,000 tons	$25,000
15,000 to 25,000 tons	$50,000
Over 25,000 tons	$100,000

1010.3 Quality Control Quality Assurance (QC/QA) Asphalt:

This Item is to be utilized as a pay adjustment for QC/QA pavement. The pay adjustment is based on gradation, cross slope, thickness, asphalt binder content, in place air voids, and ride quality (made up of the sum of all sublots). Pay adjustments may be applied at the end of each month based on all available test results for each lot. Pavement Management should indicate whether the pavement item will be QC/QA. Items that have small pavement courses placed at a time (construction phase), 750 tons, and that don't total more than three lots that size, 2250 tons, will not have this item associated with it.

The quantity for this Item is a dollar amount, equaling 5% of the total dollar amount of the Hot Bituminous pavement machine method (QC/QA) item.

APPENDIX INDEX