

CHAPTER 19

EARTHWORK

PLOTTING OF CROSS-SECTION SHEETS 19-1

For most projects, cross-sections are plotted on a horizontal and vertical scale of 1"= 10'. On mountainous projects with extremely high cuts and fills 1" = 20' might be more practical. In all cases horizontal and vertical scales should be the same. Half-size plots are sent out with plans having over 30 cross-section sheets. Full-size plots are sent out on projects with 30 or less cross-section sheets. If the Division request full-size plots for stake out and construction purposes, these should be provided.

USE OF CADD FOR EARTHWORK 19-2

Most cross sections will be created from a DTM (Digital Terrain Model) originating from Location and Surveys Unit or the Photogrammetry Unit. Geopak can be utilized to plot existing cross-sections, and complete proposed templates and earthwork. (Refer to Geopak Reference Manuals for procedures.)

EARTHWORK BALANCE SHEET 19-3

An earthwork balance sheet is required in the project file. Furnish a copy to the Geotechnical Engineering Unit on projects with available subsurface plans. Adhere to the following guidelines when preparing the Earthwork Balance Sheet:

A. BREAKDOWN QUANTITIES AS FOLLOWS:

1. Summary points at every 3,000' \pm .
2. Summary points end/begin at each bridge (stream or grade separation).
3. Summary points end/begin near each major at-grade multi-lane intersection or at-grade railroad crossing.
4. Separate Y line, ramp, loop and other major construction items from mainline earthwork, but include in the respective summary.
5. On widening projects, respective summaries are provided for right and left side if the material cannot be hauled across traffic.
6. On existing divided facilities to be widened, respective summaries are provided for right side, left side and median widening if the material cannot be hauled across traffic.
7. Projects with complex construction phasing plans may require phasing of the summary points. Coordinate phasing with the Division and The Traffic Control Unit.

- B. Include recommendations from the Geotechnical Engineering Unit and/or the Soils and Foundation Section as follows:
1. Shrinkage Factor – (See Figure 1)
 2. Loss Due to Clearing and Grubbing - This volume is estimated for loss in cuts of up to one (1) foot in depth. Any loss in fills is included in the shrinkage factor.
 3. Undercut Excavation - A recommendation for excavating benches at grade points and removing unsuitable material below subgrade. This normally should be wasted, but in certain conditions can be used in embankments.
 4. Top Soil on Borrow Pits - On projects requiring borrow material, an additional 5% of the total borrow should be computed for replacing the top soil on the borrow pit.
 5. Rock – “Hard Rock” is only shown on the Earthwork Balance Sheet. All rock on the project should be used in embankments before using suitable excavation and should be computed on a one-to-one basis unless recommendations specify otherwise.

The earthwork balance sheet, shown in Part II, 19-3, F-2, (with numbered columns) is for use with the descriptions below.

- C. The information for a basic Earthwork Balance Sheet should be listed as follows:
1. List, in column one, the survey line reference and beginning station for each summary point.
 2. Record, in column two, the ending station for each summary point.
 3. Show, in column three, the volume of all material excavated between summary point stations (except material covered by other excavation pay items such as undercut excavation and drainage ditch excavation).
 4. Column four contains volumes of "hard" rock that is excavated as a part of unclassified excavation.
 5. Record, in column five, volumes of material excavated beneath the roadway subgrade.
 6. Show, in column six, volumes of any unclassified excavation that is not suitable for roadway embankments.

7. Column seven contains Unclassified Excavation (less "hard" rock) volumes that are suitable for constructing roadway embankments.
8. List the total embankment (include backfill for undercut) in column eight. This figure is the volume of all the different materials used (do not include shrinkage or swell factors).
9. Show, in column nine, the volume of embankment that is to be constructed from "hard" rock. Use the "hard" rock portion of unclassified excavation, before the earth, to construct embankments within each summary point.
10. Show, in column ten, the volume of embankment that is to be constructed from earth.
11. Column eleven reflects the actual volume of material needed to construct the embankment. A shrinkage factor must be applied to the earth portion and then the "hard" rock is added if applicable. Shrinkage and swell factors do not apply to "hard" rock unless specified by the Geotechnical Engineering Unit.
12. Column twelve shows the amount of borrow material needed to construct embankments after the suitable excavation (rock and earth) has been utilized within the summary points.
13. Any "hard" rock excavation not utilized in embankments must have the volume listed in column thirteen.
14. Record, in column fourteen, the volume of any suitable excavation (undercut or unclassified) not utilized in embankments. Exclude "hard" rock.
15. In column fifteen, record the volume of excavation (unclassified or undercut) that does not have the necessary properties to be used in embankments.
16. Column sixteen shows the summation of volumes recorded in columns thirteen, fourteen, and fifteen.

After the listing of the summary points is completed, a "TOTAL" is needed. Total each respective column, three through sixteen. Make earthwork adjustments after the "TOTAL" as follows:

1. "Loss due to clearing and grubbing" volumes, recommended by the Geotechnical Engineering Unit, are to be deducted from columns three and seven. This figure also needs to be deducted from columns fourteen and sixteen on waste projects or added to column twelve on borrow projects.
2. "Hard" rock waste, used to replace borrow, is to be added in column nine. It must be deducted from columns ten, twelve, thirteen and sixteen.

3. Another line of adjustment is needed to "Adjust for rock waste." The volume of rock used to replace borrow should have the shrinkage factor applied (example: a project with 20% shrinkage should have this volume multiplied by 0.20). This adjustment must be deducted from columns eleven and twelve because the shrinkage factor was applied to the material within the summary points, but hard rock is not subject to the shrinkage factor.
4. Any earth waste to replace borrow should be deducted from columns twelve, fourteen, and sixteen.
5. Borrow projects with graded shoulder sections require a line of adjustment with volumes for shoulder material shown in columns eight and ten. These volumes, increased by the shrinkage factor, should show in columns eleven and twelve. Curb and gutter or shoulder trench sections do not need to be included. Projects, with enough usable waste material to build the graded shoulder section, should have a separate pay item of "Shoulder Borrow" which reflects this volume. Do not cover shoulder borrow within the earthwork balance sheet. This should be shown at the bottom of the sheet (below the grand total of earthwork balance sheet items). Do not use the "Shoulder Borrow" pay item on projects with the "Borrow Excavation" pay item.
6. Additional undercut (undercut not shown on plans such as grade point undercut, contingency undercut, etc.) should have an earthwork adjustment line if other undercut is shown within the summary points. This volume is to show in columns five, eight, ten, fifteen and sixteen. List this volume in column fourteen (instead of fifteen) if undercut is suitable. Show this volume, increased by the shrinkage factor, in columns eleven and twelve. Projects with no undercut shown within the summary points can have this volume listed, as estimated undercut, at the bottom of the sheet (below the grand total of earthwork balance sheet items). Using this method should result in the undercut quantity shown on the earthwork summary and the quantity on the summary of quantities being identical.

Other adjustments (select borrow, rock swell, flyash, etc.) may be warranted on select projects. The method of including this information on the earthwork balance sheet can vary due to recommendation format.

Total each respective column, three through sixteen, after the above adjustments are complete. This will be the "Grand Totals" on waste projects and "Project Totals" on borrow projects. Borrow projects need an additional 5% added to the figure shown in column twelve of the "Project Totals" line. This is an "Estimated 5% for Replacing Topsoil on Borrow Pits" which must be included in the "Grand Total" of borrow projects.

"Say" quantities should be shown beneath the "Grand Totals" for any volumes shown in columns that require a pay item.

The following note should be included on each Earthwork Balance Sheet: Note: "Earthwork quantities are calculated by the Roadway Design Unit. These quantities are based in part on subsurface data provided by the Geotechnical Engineering Unit."

The "Earthwork Summary" shown in the Roadway Plans shall be restricted to information shown in columns one, two, three, five, eleven, twelve and sixteen of the Earthwork Balance Sheet (Part II, 19-3, F-2). Do not show the shrinkage factor in the embankment +% column (eleven) of the Earthwork Summary in the plans.

An example of the earthwork balance sheet for a "Borrow" project shows in Part II, 19-3, F-3. See Part II, 19-3, F-4 for an example showing a "Waste" project.

The Plan Review Section of the Project Services Unit will assist you at your request.

NOTE ON CROSS SECTIONS

(EXCLUDING LUMP SUM GRADING AND LUMP SUM BIDPROJECTS)

The following note shall be shown on the first cross-section or cross section summary sheet:

Note: "Quantities are approximate only. The Resident Engineer will re-cross-section the work accurately when the project is staked out. These cross-section notes will be used in computing the final quantities for which the contractor will be paid."

NOTE FOR LUMP SUM GRADING

The following note shall be shown on the first cross-section sheet, the Earthwork Summary, and the Pavement Removal Summary on Lump Sum Grading projects:

Note: Approximate quantities only. Unclassified Excavation, Borrow Excavation, Shoulder Borrow, Fine Grading, Clearing and Grubbing, Breaking of Existing Pavement, and Removal of Existing Pavement will be paid for at the contract lump sum price for "Grading."

For additional information, see Chapter 11 of the Policy and Procedure Manual.

FIGURE 2

PROJECT _____ COUNTY _____ Volumes in Cubic _____ SHEET _____ OF _____ SHEETS
 DATE _____ COMPILED BY: _____

STATION	STATION	EXCAVATION						EMBANKMENT				BORROW			WASTE			
		TOTAL UNCLASS.	ROCK	UNDERCUT	UNSUIT. UNCLASS.	SUITABLE UNCLASS.	TOTAL	ROCK	EARTH	EMBANK. (+) %	TOTAL	ROCK	SUITABLE	UNSUIT.	ROCK	SUITABLE	UNSUIT.	TOTAL
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			

Note: Earthwork quantities are calculated by the Roadway Design Unit.
 These quantities are based in part on subsurface data provided by
 The Geotechnical Engineering Unit

PROJECT _____ COUNTY _____ Volumes in Cubic _____ COMPILED BY: _____ SHEET _____ OF _____ SHEETS
DATE _____

STATION	EXCAVATION				EMBANKMENT			BORROW			WASTE		
	TOTAL UNCLASS.	ROCK	UNDERCUT UNCLAS.	SUITABLE UNCLAS.	TOTAL	ROCK	EARTH	EMBANK. (+) 20%		ROCK	SUITABLE	UNCLAS.	TOTAL
L 120+00	60,000	5,000	3,000	7,000	75,000	5,000	70,000	89,000				10,000	10,000
Y1 10+00	10,000				8,000		8,000	9,600				400	400
SUBTOTAL	70,000	5,000	3,000	7,000	83,000	5,000	78,000	98,600				400	10,400
L 150+00	50,000	10,000			7,000	7,000	7,000	7,000				40,000	43,000
SUBTOTAL	50,000	10,000			7,000	7,000	7,000	7,000				40,000	43,000
L 180+00	40,000			8,000	80,000		80,000	96,000				8,000	8,000
Y2 20+00	20,000		7,000		25,000		25,000	30,000				7,000	7,000
SUBTOTAL	60,000		7,000	8,000	105,000		105,000	126,000				15,000	15,000
TOTAL	180,000	15,000	10,000	15,000	195,000	12,000	183,000	231,600				40,400	68,400
Loss due to clear. & grub.	-5,000												
Rock waste to repl. bor.				-5,000									
Adjust. for rock waste						3,000	-3,000					-3,000	-3,000
Earth waste to repl. bor.								-600					
Est. Shoulder Material					12,000		12,000	14,400					
Additional Undercut			5,000		5,000		5,000	6,000					
PROJECT TOTALS	175,000	15,000	15,000	145,000	212,000	15,000	197,000	251,400				30,000	30,000
Est. for repl. Topsoil on borrow pits												4,570	
GRAND TOTALS	175,000											95,970	
SAY	175,500											96,500	

Note: Earthwork quantities are calculated by the Roadway Design Unit. These quantities are based in part on subsurface data provided by The Geotechnical Engineering Unit

FIGURE 4

PROJECT _____ COUNTY _____ Volumes in Cubic _____ SHEET _____ OF _____ SHEETS
 DATE _____ COMPILED BY: _____

STATION	STATION	EXCAVATION					EMBANKMENT			BORROW	WASTE				
		TOTAL UNCLASS.	ROCK	UNDERCUT	UNCLAS. UNSUIT.	SUITABLE UNCLAS.	TOTAL	ROCK	EARTH		EMBANK. (+) 20 %	ROCK	SUITABLE	UNSUIT.	TOTAL
L 220+00	250+00	75,000	10,000	5,000	1,000	64,000	60,000	10,000	50,000	70,000			4,000	6,000	10,000
Y10 15+00	25+00	8,000				8,000	10,000		10,000	12,000					
	SUBTOTAL	83,000	10,000	5,000	1,000	72,000	70,000	10,000	60,000	82,000			4,000	6,000	10,000
L 250+00	280+00	14,000	2,000			12,000	20,000	2,000	18,000	23,600	9,600				
	SUBTOTAL	14,000	2,000			12,000	20,000	2,000	18,000	23,600	9,600				
L 280+00	310+00	80,000			12,000	68,000	40,000		40,000	48,000			20,000	12,000	32,000
Y11 27+00	39+00	20,000	1,000	7,000		19,000	3,000	1,000	2,000	3,400			16,600	7,000	23,600
	SUBTOTAL	100,000	1,000	7,000	12,000	87,000	43,000	1,000	42,000	51,400			36,600	19,000	55,600
TOTAL		197,000	13,000	12,000	13,000	171,000	133,000	13,000	120,000	157,000	13,600		40,600	25,000	65,600
Loss due to clear. & grub.		-5,000											-5,000		-5,000
Adjust undercut				5,000			5,000		5,000	6,000	6,000		5,000	5,000	5,000
Waste to repl. Borrow											-19,600		-19,600	-19,600	-19,600
GRAND TOTALS		192,000	13,000	17,000	13,000	166,000	138,000	13,000	125,000	163,000			16,000	30,000	46,000
SAY		192,500													

Note: Earthwork quantities are calculated by the Roadway Design Unit. These quantities are based in part on subsurface data provided by The Geotechnical Engineering Unit

