# Earthwork Design Guide



TDOT Department of Transportation Roadway Design Division

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# Introduction

An accurate and easily interpreted earthwork report is helpful to correctly estimate the cost of a project, both in terms of money and in terms of time and work. To accurately assess the earthwork for a project, a designer needs to have cut cross-sections, calculated topsoil needs and determined the rock content of the soil, if possible.

Part 1 of this document pulls together information from many sources and provides links for reference. The Designer should be able to find answers to most questions here.

Part 2 will go over how a designer will determine the earthwork quantities for a project and how to fill out the Earthwork Grading Quantities Table.

Part 3 provides a step-by step guide for calculating topsoil quantities.

# Part 1 - Earthwork Quick Guide

#### Design Guidelines

Details on Earthwork design can be found in the Roadway Design Guidelines, Chapter 2-700.

#### **Specifications Manual**

Earthwork is discussed in Part 2 of the TDOT Specifications Manual

#### Standard Drawings

Not applicable.

#### TDOT CADD Programs

Details of how to use MicroStation to calculate and record earthwork values can be found in Chapter 15 of the <u>GEOPAK Road Design class manual</u>. Chapter 16 describes cross-sections, including how to incorporate the earthwork data.

Details of how to use the Open Roads Designer to calculate an record earthwork values can be found in Chapter 8 of the <u>ORD Roadway Design I Manual</u>

#### Roadway Design Plans

This list below describes where earthwork values can be found in a standard roadway plan set.

- Estimated Roadway Quantities Sheet: The totals of each earthwork type that was calculated will be shown here in cubic yards.
- Tabulated Quantities Sheet: On this sheet, an estimated grading quantities block, such as the one in Figure 1, will be shown. This table can be found in the Estimated Roadway Quantities excel file that will be used for your project. The example below is a balanced example, this one and an unbalanced example is shown in more details in <u>Roadway</u> <u>Design Guidelines, Chapter 2-706.00.</u>
- Cross Section Sheets: For every cross section, a cut, fill, and rock area value will be listed in square feet.

ESTIMATED GRADING QUANTITIES												
DES	DESCRIPTION		VOLUMES (CY)	ADJUSTED VOLUMES (CY)			MMARY					
		EXC.	EMB.	EXC.	SHRINK = 1	5 % \$	SWELL =	15 %				
MAINLINE		219500	243000	190870								
SIDE ROADS		12500	5490	10870								
PVT. DRIVES, BUSINE	SS AND FIELD ENTRANCES	i										
INDEPENDENT DITCHE	S				EXC.		EMB.					
TEMPORARY CONSTR	UCTION EXITS				253490	VS.	-253490					
OTHER												
PAVEMENT												
TOPSOIL (EMB.)		5000		4348	AVAILABLE	=	0					
TOPSOIL (EXC.)		13000		11305								
TOPSOIL (TO REPLACE	E STRIPPED TOPSOIL)		5000									
ROCK (C.Y.)		TOTALS (C.Y.	)	•	WASTE MATERIA	L =	0					
EXC. EMB.	EXC. (UNCL.) EMB. (UNCL	.) EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)								
45000	250000 253490	232000	201740	253490								

Figure 1. Estimated Grading Quantities block, balanced example.

#### Grading Reports

Grading reports are included in Construction Plan sets. These reports are used by construction contractors to estimate the amount of time, labor and equipment that will be needed. It is useful to separate the mainline estimates from those of side roads, driveways, ditches and culverts. An example of a grading report can be seen in Figure 2 below.

To create a grading report, start with the Grading Report Template file. Edit the header to include the correct information for your project, then paste the Estimated Grading Quantities block in the place the template indicates (removing the instructions). For each major feature of your project (mainline, sideroad, etc), paste the results of the earthwork log file generated by GEOPAK, or any calculations done manually. For readability, separate each log file with a copy of the text box provided in the template, and edit the description.

	177		GRADIN	IU NEPI	UNI			- 4
DMPUTED BY: AMY LOREN							SHEET 1 OI	
HECKED BY: DAWN PRUET	T				6	STATE NO.	:83027-3221-	94
N: 124717.00					FEDERAL PRO	DJECT NO:	BR-STP-174(2	27)
OUTE NO. OR STREET: SR 1	74					CO	UNTY: SUMN	ER
	ES		GRADIN	g qua				
DESCRIPTION			DVOLUMES		ADJUSTED VOLUMES(CY)		NCE SUMMARY	
MAINLINE		EXC.	_	MB.	EXC.	SHRINK=	20 % SWELL =	20 9
SIDE ROADS		4235		578	3529	-		
SIDE ROADS		2341	0	54	1951	EXC.	EMB.	
PVT. DRIVES, BUSINESS AND FIEL	DENTRANCES					16883	VS7232	
PAVEMENT		542			452	]		
TOPSOIL (EMB.)						AVAIL	ABLE= 9651	
TOPSOIL (EXC.)			_			4		
TOPSOIL (TO REPLACE STRIPPED						WASTE MATE	ERIAL= 11581	
		LS(C.Y.)				-		
ROCK EXC. (UNCL.) EN 543 7118	1B. (UNCL.) 1 7232		N) EXC.(A 54		EXC. (ADJ.) 16883			
Material Name End Areas		d Adjusted	Mult /	Mass		Accum		
	Unadjusted	d Adjusted	Mult / Volumes	Mass Fac		Accum Unadj Vol		
Material Name End Areas	Unadjusted	d Adjusted Volumes	Mult / Volumes	Mass Fac	Accum	Accum Unadj Vol	Adj Vol	
Material Name End Areas tation	Unadjusted (sq. ft.)	d Adjusted Volumes	Mult / Volumes (cu.yd	Mass Fac	Accum tor Ordinate	Accum Unadj Vol	Adj Vol	
Material Name End Areas tation 100+43.56 EARTH	Unadjusted (sq. ft.)	Adjusted Volumes (cu. yd.)	Mult / Volumes (cu.yd	Mass Fac .)	Accum tor Ordinate	Accum Unadj Vol (cu. yd.)	Adj Vol (cu. yd.)	
Material Name End Areas tation 100+43.56 EARTH Excavation	Unadjusted (sq. ft.) 	Adjusted Volumes (cu. yd.)	Mult / Volumes (cu.yd	Mass Fac .) 0.85	Accum tor Ordinate	Accum Unadj Vol (cu. yd.) 	Adj Vol (cu. yd.) 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation	Unadjustec (sq. ft.)  20 0 22	d Adjusted Volumes (cu. yd.) 0 0	Mult r Volumes (cu. yd 0 0	Mass Fac .) 0.85 1.00 0.85	Accum tor Ordinate ( 	Accum Unadj Vol (cu. yd.) 0 0 5	Adj Vol (cu. yd.) 0 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH	Unadjustec (sq. ft.) - 20 0	0 Volumes (cu. yd.) 0 0	Mult r Volumes (cu. yd 0 0	Mass Fac .) 0.85 1.00	Accum tor Ordinate ( 	Accum Unadj Vol (cu. yd.) 0 0	Adj Vol (cu. yd.) 0 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill	Unadjustec (sq. ft.)  20 0 22	d Adjusted Volumes (cu. yd.) 0 0	Mult r Volumes (cu. yd 0 0	Mass Fac .) 0.85 1.00 0.85	Accum tor Ordinate ( 	Accum Unadj Vol (cu. yd.) 0 0 5	Adj Vol (cu. yd.) 0 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH	Unadjusted (sq. ft.) 	i Adjusted Volumes (cu. yd.) 0 0 5 0	Mult r Volumes (cu. yd 0 0 4 0	Mass Fac .) 0.85 1.00 0.85 1.00	Accum tor Ordinate 	Accum Unadj Vol (cu. yd.) 0 0 5 0	Adj Vol (cu. yd.) 0 0 4 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill	Unadjusted (sq. ft.) 	d Adjusted Volumes (cu. yd.) 0 0	Mult / Volumes (cu. yd 0 0 4 0 29	Mass Fac .) 0.85 1.00 0.85	Accum tor Ordinate 	Accum Unadj Vol (cu. yd.) 0 0 5	Adj Vol (cu. yd.) 0 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH Excavation Fill	Unadjusted (sq. ft.) 20 0 22 0 51	d Adjusted Volumes (cu. yd.) 0 5 0 34	Mult / Volumes (cu. yd 0 0 4 0 29	Mass Fac .) 0.85 1.00 0.85 1.00 0.85	Accum tor Ordinate 0 4	Accum Unadj Vol (cu. yd.) 0 0 5 0 39	Adj Vol (cu. yd.) 0 0 4 0 33	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH Excavation Fill 101+00.00 EARTH	Unadjustec (sq. ft.) 20 0 22 0 51 0	d Adjusted Volumes (cu. yd.) 0 0 5 0 5 0 34 0	Mult r Volumes (cu. yd 0 0 4 0 29 0	Mass Fac .) 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33	Accum Unadj Vol (cu. yd.) 0 0 5 0 5 0 39 0	Adj Vol (cu. yd.) 0 4 0 33 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH Excavation Fill 101+00.00 EARTH	Unadjustec (sq. ft.) 20 0 22 0 51 0 117	i Adjusted Volumes (cu. yd.) 0 0 0 5 0 34 0 78	Mult r Volumes (cu. yd 0 0 4 0 29 0 66	Mass Fac .) 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33	Accum Unadj Vol (cu. yd.) 0 0 5 0 39 0 117	Adj Vol (cu. yd.) 0 0 4 0 33 0 99	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH Excavation Fill 101+00.00 EARTH	Unadjustec (sq. ft.) 20 0 22 0 51 0	d Adjusted Volumes (cu. yd.) 0 0 5 0 5 0 34 0	Mult r Volumes (cu. yd 0 0 4 0 29 0 66	Mass Fac .) 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33	Accum Unadj Vol (cu. yd.) 0 0 5 0 5 0 39 0	Adj Vol (cu. yd.) 0 4 0 33 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH Excavation Fill 101+00.00 EARTH Excavation Fill	Unadjustec (sq. ft.) 20 0 22 0 51 0 117	i Adjusted Volumes (cu. yd.) 0 0 0 5 0 34 0 78	Mult r Volumes (cu. yd 0 0 4 0 29 0 66	Mass Fac .) 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33	Accum Unadj Vol (cu. yd.) 0 0 5 0 39 0 117	Adj Vol (cu. yd.) 0 0 4 0 33 0 99	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH 101+00.00 EARTH Excavation Fill 101+25.00 EARTH	Unadjustec (sq. ft.) 20 0 22 0 51 0 117 0	i Adjusted Volumes (cu. yd.) 0 0 0 5 0 34 0 78	Mult r Volumes (cu. yd 0 0 4 0 29 0 66 0	Mass Fac .) 0.85 1.00 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33 99	Accum Unadj Vol (cu. yd.) 0 0 5 0 39 0 117 0	Adj Vol (cu. yd.) 0 0 4 0 33 0 99 0	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH Excavation Fill 101+00.00 EARTH Excavation Fill	Unadjustec (sq. ft.) 20 0 22 0 51 0 117 0	d Adjusted Volumes (cu. yd.) 0 0 0 5 0 34 0 78 0	Mult r Volumes (cu. yd 0 0 4 0 29 0 66 0 119	Mass Fac .) 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33 99	Accum Unadj Vol (cu. yd.) 0 0 5 0 39 0 117	Adj Vol (cu. yd.) 0 0 4 0 33 0 99	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH Excavation Fill 101+00.00 EARTH Excavation Fill 101+25.00 EARTH Excavation Fill	Unadjustec (sq. ft.) 20 0 22 0 51 0 117 0 185	4 Adjusted Volumes (cu. yd.) 0 0 5 0 34 0 78 0 140	Mult r Volumes (cu. yd 0 0 4 0 29 0 66 0 119	Mass Fac .) 0.85 1.00 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33 99	Accum Unadj Vol (cu. yd.) 0 0 5 0 39 0 1117 0 257	Adj Vol (cu. yd.) 0 0 4 0 33 0 99 0 218	
Material Name End Areas tation 100+43.56 EARTH Excavation Fill 100+50.00 EARTH Excavation Fill 100+75.00 EARTH Excavation Fill 101+00.00 EARTH Excavation Fill 101+25.00 EARTH	Unadjustec (sq. ft.) 20 0 22 0 51 0 117 0 185 0	4 Adjusted Volumes (cu. yd.) 0 0 5 0 34 0 78 0 140	Mult r Volumes (cu. yd 0 0 4 0 29 0 66 0 119	Mass Fac .) 0.85 1.00 0.85 1.00 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33 99	Accum Unadj Vol (cu. yd.) 0 0 5 0 39 0 1117 0 257	Adj Vol (cu. yd.) 0 0 4 0 33 0 99 0 218	

Figure 2 Example of Grading Report.

## Other Helpful Material

FHWA Earthwork Design

# Part 2 – Earthwork Grading Quantities Block Guide

# 2.01 Introduction

First, the designer should receive a Soils and Geology Report from the Geotechnical Engineering Division after the project has been submitted for Initial Studies. If the project changes during the R.O.W. stage, a Soils and Geology Report Addendum will be issued which is what is shown below and what will be used in this guide.



# 2.02 Estimated Grading Quantities Block Set-Up

First, obtain the Estimated Grading Quantities Block and Topsoil Quantities Table from the Estimated Roadway Quantities File located on the <u>Roadway Design Documents</u> webpage. An example of the Estimated Grading Quantities Block is shown below.

	ESTIM	ATED GRAD	ING QUAN	ITITIES					
DESC	RIPTION		OLUMES (CY)	JMES (CY) ADJUSTED BALANCE S VOLUMES (CY)		NCE SI	SUMMARY		
		EXC.	EMB.	EXC.	SHRINK = 0 % SWELL		SWELL =	0 %	
MAINLINE		0	0						
SIDE ROADS		0	0						
PVT. DRIVES, BUSINESS A	ND FIELD ENTRANCES	0	0		EXC.		EMB.		
INDEPENDENT DITCHES		0	0						
TEMPORARY CONSTRUCT	ION EXITS	0	0		0	VS.	0		
OTHER (BRIDGE EXCAVAT	ION, PAVEMENT, ETC)	0	0						
TOPSOIL (EMB.)		0			AVAILABLE	=	0		
TOPSOIL (EXC.)		0							
	TOPSOIL TOTALS (SEE	E TOPSOIL TAB)			WASTE MATERI	AL =	0		
ROCK (C.Y.)		TOTALS (C.Y.)							
EXC. EMB.	EXC. (UNCL.) EMB. (UNCL.)	) EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)					
0 0	0 0	0	0	0					

#### 2.02.01 Shrink and Swell

The shrink and swell factors are an important thing to pull from the Soils and Geology Report. For this project, both the **shrink and swell factors** are 20%.

	ESTIM	ATED GRAD	ING QUAN	ITITIES				
DESC	RIPTION	I UNAD JUSTED VOLUMES (CY)		ADJUSTED VOLUMES (CY)				
		EXC.	EMB.	EXC.	SHRINK = 20 % SWELL =		SWELL =	20 %
MAINLINE		0	0					
SIDE ROADS		0	0					
PVT. DRIVES, BUSINESS A	ND FIELD ENTRANCES	0	0		EXC.		EMB.	
INDEPENDENT DITCHES		0	0					
TEMPORARY CONSTRUCT	ION EXITS	0	0		0	VS.	0	
OTHER (BRIDGE EXCAVAT	ION, PAVEMENT, ETC)	0	0					
TOPSOIL (EMB.)		0			AVAILABLE	=	0	
TOPSOIL (EXC.)		0	-					
	TOPSOIL TOTALS (SEE	TOPSOIL TAB)			WASTE MATERIAL	=	0	
ROCK (C.Y.)		TOTALS (C.Y.)						
EXC. EMB.	EXC. (UNCL.) EMB. (UNCL.)	) EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)				
0 0	0 0	0	0	0				

#### 2.02.02 Graded Solid Rock

The report recommended that graded solid rock (GSR) and geotextile fabric are to be used in the fill sections along the project. These two items were given in the report and shown below. These quantities should be added to the Estimated Roadway Quantities sheet.

		ESTIMATED SOIL QUANITITIES							
	ITEM NO.	UNIT	QUANITY						
(1)	203-02.01	BORROW EXCAVATION (GRADED SOLID ROCK)	TON	229					
Ĭ	740-10.04	GEOTEXTILE FABRIC (TYPE IV)	SY	379					
FOOTNOTES: THIS ITEM TO BE USED BETWEEN STATION 101+70 TO 103+28 RIGHT OF CENTERLINE AND STATION 104+68 TO 105+08 LEFT OF CENTERLINE OTHERWISE AS DIRECTED BY									
		ER FOR THE STABILIZATION OF SUBGRADE.	L AG DIREC						

For this project, from the Soils and Geology Report, it would require 229 tons of GSR or 130 C.Y. This quantity should be added to the **ROCK EMB.** cell in the Estimated Grading Quantities block.

	ESTIMATED GRADING QUANTITIES												
DESC	RIPTION	UNADJUSTED \	OLUMES (CY)	ADJUSTED VOLUMES (CY)	I BALANCE SLIMMAR'								
		EXC.	EMB.	EXC.	SHRINK = 20 % SWELL =		20 %						
MAINLINE		0	0										
SIDE ROADS		0	0										
PVT. DRIVES, BUSINESS AN	D FIELD ENTRANCES	0	0		EXC.		EMB.						
INDEPENDENT DITCHES		0	0										
TEMPORARY CONSTRUCTI	ON EXITS	0	0		0	VS.	130						
OTHER (BRIDGE EXCAVATION	ON, PAVEMENT, ETC)	0	0										
TOPSOIL (EMB.)		0			AVAILABLE	=	130						
TOPSOIL (EXC.)		0											
	TOPSOIL TOTALS (SEE	TOPSOIL TAB)			WASTE MATERIA	L =	156						
ROCK (C.Y.)		TOTALS (C.Y.)			BORROW ROCK	: =	156						
EXC. EMB.	EXC. (UNCL.) EMB. (UNCL.)	EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)									
0 130	0 -130	0	0	0									

# 2.03 Mainline Cut/Fill Calculations

The next quantities to determine will be the project's mainline cut and fill volumes. To calculate these, follow the steps in Chapter 8 of the <u>ORD Road I Manual</u> or in Exercise 15 of the <u>GEOPAK Road Course Guide</u>. The following is the result from running the earthwork in GEOPAK. The unadjusted volumes (C.Y.) can be added to the Estimated Grading Quantities block. This would be <u>230 C.Y</u>. for **MAINLINE EXC**. and <u>250 C.Y</u>. for **MAINLINE EMB**.

Material M	Material Name		Adjusted Volumes (cu. yd.)	Mult Factor
EARTH				
	Excavation	230	230	1.00
	F <b>i</b> 11	250	250	1.00

		ESTIN	IATED GRAD	ING QUAN	ITITIES					
	DESCR		UNADJUSTED \	OLUMES (CY)	ADJUSTED VOLUMES (CY)	BALANCE SUMMA				
			EXC.	EMB.	EXC.	SHRINK = 20		SWELL =	20	%
MAINLINE			230	250	184					┓
SIDE ROADS			0	0						
PVT. DRIVES, E	BUSINESS ANI	D FIELD ENTRANCES	0	0		EXC.		EMB.		
INDEPENDENT	DITCHES		0	0						
TEMPORARY C	ONSTRUCTIC	N EXITS	0	0		184	VS.	-120		
OTHER (BRIDG	E EXCAVATIC	N, PAVEMENT, ETC)	0	0						
TOPSOIL (EMB.	.)		0			AVAILABLE	=	64		
TOPSOIL (EXC.	)		0							
		TOPSOIL TOTALS (SE	E TOPSOIL TAB)			WASTE MATERIAI	- =	77		
ROCK	(C.Y.)		TOTALS (C.Y.)			BORROW ROCK	=	156		
EXC.	EMB.	EXC. (UNCL.) EMB. (UNCL	) EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)					
0	130	230 120	230	230	184					

# 2.04 Additional Cut/Fill Project Amounts

#### 2.04.01 Side Roads

The side road earthwork quantities can be calculated using a similar method as the mainline quantities in the manuals mentioned above. For this project, it was determined that the **SIDE ROADS EXC.** quantity is 309 C.Y. and the **SIDE ROADS EMB** quantity is 67 C.Y., as shown below.



	ESTIMATED GRADING QUANTITIES											
DESCRIPTION		UNADJUSTED VOLUMES (CY)		ADJUSTED VOLUMES (CY)	BALAN	CE SU	E SUMMARY					
		EXC.	EMB.	EXC.	SHRINK = 20	) %	SWELL =	20	%			
MAINLINE		230	250	184								
SIDE ROADS		309	67	248								
PVT. DRIVES, BUSINESS AND FIELD ENT	RANCES	0	0		EXC.		EMB.					
INDEPENDENT DITCHES		0	0									
TEMPORARY CONSTRUCTION EXITS		0	0		432	VS.	-187					
OTHER (BRIDGE EXCAVATION, PAVEME	NT, ETC)	0	0									
TOPSOIL (EMB.)		0			AVAILABLE	=	245					
TOPSOIL (EXC.)		0										
TOPSC	IL TOTALS (SEE <sup>-</sup>	TOPSOIL TAB)			WASTE MATERIA	L =	294					
ROCK (C.Y.)		TOTALS (C.Y.)			BORROW ROCK	=	156					
EXC. EMB. EXC. (UNC	.) EMB. (UNCL.)	EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)								
0 130 539	187	539	539	432					┛			

If a project has pavement, independent ditch, private drive, business, or field entrances earthwork, those quantities can also be calculated and then added to the Estimated Grading Quantities block. Steps on how to calculate each of these can be found in either the <u>ORD Road</u> <u>I Manual</u> or the <u>GEOPAK Road Course Guide</u>. For driveways, see the <u>Driveway Quick</u> <u>Guide</u> for guidance on driveway earthwork calculations.

## 2.04.02 Temporary Construction Exits

This project requires two temporary construction exits in the project limits. From the <u>Drainage</u> <u>Manual Chapter 10</u>, each exit requires earthwork to take place. Section 10.08.1.3 discusses the pay items that are required for temporary construction exits. Each exit requires a minimum of 7.15 C.Y. of excavation. Since this project has two and using the minimum required excavation, double 7.15 C.Y. to make 14.3 C.Y. This number can be rounded up to 15 C.Y. and added to the Estimated Grading Quantities Block under Temporary Construction Exits. Each project may require more excavation for the temporary construction exits.

			<b>ESTIM</b>	ATED GRAD	ING QUAN	ITITIES				
	DESCR	IPTION		UNADJUSTED \	/OLUMES (CY)	ADJUSTED VOLUMES (CY)	BALANCE SUMMARY			
				EXC.	EMB.	EXC.	SHRINK = 20 % SWELL		SWELL =	20 %
MAINLINE				230	250	184				
SIDE ROADS				309	67	248				
PVT. DRIVES, BUSIN	VESS AND	FIELD ENTRAI	NCES	0	0		EXC.		EMB.	
INDEPENDENT DITC	CHES			0	0					
TEMPORARY CONS	TRUCTIO	N EXITS		15	0	12	444	VS.	-187	
OTHER (BRIDGE EX	CAVATIO	N, PAVEMENT,	ETC)	0	0					
TOPSOIL (EMB.)				0			AVAILABLE	=	257	
TOPSOIL (EXC.)				0						
		TOPSOIL T	OTALS (SEE	TOPSOIL TAB)			WASTE MATERIAL	=	309	
ROCK (C.Y.)	)			TOTALS (C.Y.)			BORROW ROCK	=	156	
EXC.	EMB.	EXC. (UNCL.) E	EMB. (UNCL.)	EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)				
0	130	554	187	554	554	444				

#### 2.04.03 Bridge Excavation

This project includes a proposed bridge, which means that bridge excavation is required. The process on how to calculate how much bridge excavation is needed, follow Part 4 of the <u>Structures Calculation Guide</u>. The following shows the excavation volumes required for the proposed bridge. Add the <u>122 C.Y</u>. to the **OTHER (BRIDGE EXCAVATION, ETC.)** tab on the Estimated Grading Quantities block.

-	R A N D ial Name	Ui Ve	nadjusted olumes	T O T A Adjusted Volumes (cu. yd.)	Mult
EARTH	Excav Fi:	vation	122 0	122 0	1.00 1.00

	ESTIMA	ATED GRAD	ING QUAN	ITITIES					
DESC	RIPTION	UNADJUSTED V	OLUMES (CY)	ADJUSTED VOLUMES (CY)	BALAN	CE SU	MMARY		
		EXC.	EMB.	EXC.	SHRINK = 20	%	SWELL =	20	%
MAINLINE		230	250	184					
SIDE ROADS		309	67	248					
PVT. DRIVES, BUSINESS AN	D FIELD ENTRANCES	0	0		EXC.		EMB.		
INDEPENDENT DITCHES		0	0						
TEMPORARY CONSTRUCTION	ON EXITS	15	0	12	541	VS.	-187		
OTHER (BRIDGE EXCAVATION	ON, PAVEMENT, ETC)	122	0	98					
TOPSOIL (EMB.)		0			AVAILABLE	=	354		
TOPSOIL (EXC.)		0							
	TOPSOIL TOTALS (SEE	TOPSOIL TAB)			WASTE MATERIAL	. =	425		
ROCK (C.Y.)		TOTALS (C.Y.)			BORROW ROCK	=	156		
EXC. EMB.	EXC. (UNCL.) EMB. (UNCL.)	EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)					
0 130	676 187	676	676	541					

#### 2.04.04 Topsoil

Topsoil is another earthwork quantity that needs to be added to this estimated grading quantities block. Topsoil can either be furnished to the project or used from the existing soil on

the project site. Geotech will assist with the determination of whether or not your on-site soil is approved. Additionally, the project needs to have adequate on-site storage area for the topsoil. The steps to calculate the required topsoil can be found in Part 3 – Computing Topsoil Quantities. For this project, it was determined that there will be 32 C.Y. of fill topsoil required to replace the stripped topsoil. This quantity can then be added to the Topsoil Quantities Table under the subcategory Existing Topsoil is Not Suitable for Reuse. Chapter 7 of the RDG contains all relevant item numbers and payment options used for Topsoil.

				TOPS	OIL			
			IF EXISTING	G TOPSOIL IS S	SUITABLE FO	OR REUSE		
PROPOSED SLOPE AREA S.F.	EXISTING TOPSOIL (EXC.)	EXISTING TOPSOIL (EMB.)	EXISTING TOPSOIL (TOTAL) C.Y.	REQUIRED TOPSOIL C.Y.	PLACING TOPSOIL 203-04 C.Y.	FURNISHED TOPSOIL 203-07 C.Y.	EXCESS TOPSOIL C.Y.	WASTE TOTAL (C.Y.)
1728	0	0	0	32	0	32	0	425
		li	EXISTING T	OPSOIL IS NO	T SUITABLE	FOR REUSE		
PROPOSED SLOPE AREA S.F.	EXISTING TOPSOIL (EXC.)	EXISTING TOPSOIL (EMB.)	EXISTING TOPSOIL (TOTAL) C.Y.	REQUIRED TOPSOIL C.Y.	PLACING TOPSOIL 203-04 C.Y.	FURNISHED TOPSOIL 203-07 C.Y.	EXCESS TOPSOIL C.Y.	WASTE TOTAL (C.Y.)
1728	N/A	N/A	N/A	32	N/A	32	N/A	N/A

# 2.05 Item Numbers

With all the quantities calculated above filled in, the final Estimated Grading Quantities block item numbers can be filled out. Below is the Estimated Grading Quantities block with the quantities that need to be added to the estimated Roadway Quantities Block highlighted.

		ESTIMA	TED GRAD	ING QUAN	ITITIES					
DESCR	IPTION		UNADJUSTED V	OLUMES (CY)	ADJUSTED VOLUMES (CY)	BALAN	ICE SU	JMMARY		
			EXC.	EMB.	EXC.	SHRINK = 2	20 %	SWELL =	20	%
MAINLINE			230	250	184					
SIDE ROADS			309	67	248					
PVT. DRIVES, BUSINESS AND	FIELD ENTRA	NCES	0	0		EXC.		EMB.		
INDEPENDENT DITCHES			0	0						
TEMPORARY CONSTRUCTIO	N EXITS		15	0	12	541	VS.	-187		
OTHER (BRIDGE EXCAVATIO	N, PAVEMENT,	ETC)	122	0	98					
TOPSOIL (EMB.)			0			AVAILABLE	=	354		
TOPSOIL (EXC.)			0							
	TOPSOIL	TOTALS (SEE	TOPSOIL TAB)			WASTE MATERIA	۹L =	425		
ROCK (C.Y.)			TOTALS (C.Y.)			BORROW ROC	< =	156		
EXC. EMB.	EXC. (UNCL.)	EMB. (UNCL.)	EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)					
0 130	676	187	676	676	541					

						DR REUSE		
PROPOSED SLOPE AREA S.F.	EXISTING TOPSOIL (EXC.)	EXISTING TOPSOIL (EMB.)	EXISTING TOPSOIL (TOTAL) C.Y.	REQUIRED TOPSOIL C.Y.	PLACING TOPSOIL 203-04 C.Y.	FURNISHED TOPSOIL 203-07 C.Y.	EXCESS TOPSOIL C.Y.	WASTE TOTAL (C.Y.)
1728	0	0	0	32	0	32	0	425
		I	EXISTING T	OPSOIL IS NO	T SUITABLE	FOR REUSE		
PROPOSED SLOPE AREA S.F.	EXISTING TOPSOIL (EXC.)	EXISTING TOPSOIL (EMB.)	EXISTING TOPSOIL (TOTAL) C.Y.	REQUIRED TOPSOIL C.Y.	PLACING TOPSOIL 203-04 C.Y.	FURNISHED TOPSOIL 203-07 C.Y.	EXCESS TOPSOIL C.Y.	WASTE TOTAL (C.Y.)
1728	N/A	N/A	N/A	32	N/A	32	N/A	N/A

Below, is the Estimated Grading Quantities block with the earthwork quantities for this project filled out.

	ESTIMATED ROADWAY QUANTITIES		
ITEM NO.	DESCRIPTION	UNIT	QUANTITY EXAMPLE
203-01	ROAD & DRAINAGE EXCAVATION (UNCLASSIFIED)	C.Y.	676
203-02.01	BORROW EXCAVATION (GRADED SOLID ROCK)	TON	229
203-07	FURNISHING & SPREADING TOPSOIL	C.Y.	32

NOTE: 156 C.Y. of graded solid rock is the same quantity as 229 tons of graded solid rock.

For additional Item Numbers that may be needed for the completion of the Estimated Quantities block, see <u>Chapter 7 Item Numbers</u>.

# **Part 3 – Computing Topsoil Quantities**

The following is a step-by-step tutorial on using MicroStation to calculate topsoil quantities

#### 1. Drop Complex Elements

Before running the cross sections, the first step is to go into your Survey DGN file and drop the status on the edge of pavement lines. The program will not run for complex elements.

	-	
🖻 Tasks —	×	💱 Drop Ele — 🗆 🗙
훋 Tasks	-	Complex
		□ <u>Di</u> mensions To Geometry ▼ □ <u>Line Strings/Shapes</u>
<u>9 juur;</u>	_	Multi-lines ✓ Shared Cells To Geometry ▼
Roundabouts	*	
Z Civil Geometry	*	Application Elements
R Data Acquisition	**	and the second se

## 2. Run Existing Ground Cross Sections on Project

This example is SR 95 from Station 287+00 to Station 289+50 (6 sections):



## 3. Plot existing pavement on cross sections

GEOPAK Project Manager>Proposed Cross Sections

Create Run "EXPVMT"

#### Shape Clusters:

Select template "P\_XEOP"

📕 Typical Sections		X
	"EXISTING PA	VEMENT DEPTH"
	ЕОР	EOP
	<sup>u</sup> t	
		~~~*
PLC	T EXIS	STING PAVEMENT
Cell PVTDR	Description ^	Job Number: 101 Template
P_PROW	PLOT PROP	Template Designed to Work with: 1 Shape Cluster
P_ROCK P_TOPS	PLOT ROCK PLOT TOPS	Apply to Left Roadway 🔻 Description
P_UMTL	PLOT UNSU	Range
P_XEOP P_XROW	PLOT EXIST	Apply to Whole Chain 🔻
RADII	INTERSECT	Begin Sta.: DP End Sta.: DP
RADIIU	INTERSECT Y	On Chain: SR95 Select
<	>	On Chain: SR95 Select
		Apply

📕 Proposed Cross Section	ns - EXPVMT		_	
<u>F</u> ile				
XS DGN File Pattern Existing Ground Shapes Shape Clusters Define DGN Variables Define Variables Plot Parameters Drainage Side Slope Conditions	Chain SR95 Chain: SR95	Tie/PGL 0.000000 5 • • Apply Profile a Modify	¦ "\$ <sup>®</sup> Profile: S t: Tie ▼ 0	Typical Thick R95 V 000000 Up Down
Define Mo Criteria Files Name PlotExistPavement x	Description Plot Existing	Delete	Up KSections.	Down
Add	Delete	U	þ	Down

#### Define Variables:

Change the Survey DGN name to the file for your project

📕 Proposed Cr	ross Section	ns - EXP	/MT	_		$\times$
<u>F</u> ile						
XS DGN File Pattern Existing Ground Shapes Shape Clusters Define DGN Var		Surv xs so	able ey DGN cale pavement depth		Value RO095 10 1	5
Define Variables Plot Parameters Drainage	-	By	file: All	<b>•</b> (	ર	
Variable Name:	Survey DG	iN				
Value:	RO095-01	Survey.d	gn			۹
	Add			Modify		

All other settings can stay the same as for other cross section runs

Then run cross sections:



## 4. Plot Existing Topsoil Layer

Open GEOPAK Project Manager. Go to Proposed Cross Sections. Create a new run "topsoil", or copy the Proposed cross section run, and use the same settings with the exception of "Shape Clusters". Delete the previous clusters, add new cluster using the template P\_TOPS

📕 Typical Sections	×	<
	"TOPSOIL DEPTH" TOPSOIL DEPTH" LOT TOPSOIL AT SPECIFIED DEPTH NOTE: IF EXISTING PAVEMENT IS PLOTTED ON THE CROSS SECTIONS, TOPSOIL LINE IS DIVERTED UPWARDTO THE TO GROUND AND WILL PICK UP AGAIN ON THE OTHER SIDE OF THE EXISTING PAVEMENT.	
Cell P_TOPS P_UMTL P_XEOP P_XROW RADII RADIIU RECRW REUCRW REUCRW ROUNDABOUT	Description       Job Number: 101         PLOT TOPS       Template         PLOT UNSU       Template Designed to Work with: 1 Shape Cluster         PLOT EXIST       Apply to Left Roadway ▼         PLOT PRES       INTERSECT         INTERSECT       Range         RESURF CR       Apply to Station Range ▼         Begin Sta.:       287+00.00 R 1       DP End Sta.:         200 On Chain:       SR95         Select       Apply	

Proposed Cross Sectio	ns - topso	il	-	- 🗆 X
XS DGN File Pattern Existing Ground Shapes Shape Clusters Define DGN Variables Define Variables Plot Parameters Drainage Side Slope Conditions	Chain: SR95	Apply Profile	0 SR95 ▼ "№ Profile: at: Tie ▼ Delete	0.000000 Up Down
	odify	Delete	Up	Down
Criteria Files Name PlotTopsoilatDepth.x	Descrip Plot Top	tion osoil at Specified I	Depth	
Add	Delete		Up	Down

In "Define Variables" edit the "XS DGN" file:

	1			
XS DGN File		Variable	Value	_
Pattern Existing Ground		Topsoil depth (inches)	3	
		XS DGN	ROSR95Mainli	ine
Shapes				
Shape Clusters				
Define DGN Va	and the second se			
Define Variables				
Plot Parameters				
Drainage		By file: All	• Q	
	XS DGN			1
Variable Name:	V2 DOW			-

Next - select "Run"

28	7-F0-07 A
	2312
***************************************	5937 2457
	L

The topsoil layer is plotted on the cross sections at a default depth of 3 inches. This is to allow for 100% Shrinkage. See Roadway Design Guidelines <u>Chapter 2-706.00</u> Topsoil Requirements for Earthwork Balances for more information regarding the shrinkage guidelines for topsoil. Notice it excludes the existing pavement but plots along the entire ground line of the cross sections.

The available topsoil is the ground line (dashed) between the excavation limit lines, excluding the existing pavement area.

#### 5. Run Proposed Cross Sections



## 6. Run Earthwork

Create run "Topsoil"

Make settings as shown in <u>GEOPAK Road Manual</u> Exercise 15. In Soil Types, add settings for Topsoil and Excavation Limit as shown-

Topsoil Settings:

📕 Earthwork - topsoil	- 🗆 X
<u>F</u> ile	
XS DGN File Soil Types Earthwork Shapes Output Format Add/Subtract Volume Centroid Adjustment Skip Areas Ignore Areas Sheet Quantity	Soil Type Items Existing Ground Existing Unsuitable Proposed Finish Grade Excavation Limit Search Criteria
Class Existing Unsuitable   Soil Type: Topsoil  Multiplication Factors  Roadway Excavation: 1.000  Subsoil Excavation: 1.000  Fill: 1.000  Add	Lv Names: SURVEY - GROUND - E   Lv Numbers: ************************************

Level Name - SURVEY-GROUND- Bottom of Topsoil Layer

#### Excavation Limit:

📕 Earthwork - topsoil	– 🗆 X
<u>F</u> ile	
XS DGN File Soil Types Earthwork Shapes Output Format Add/Subtract Volume Centroid Adjustment Skip Areas Ignore Areas	Soil Type Items Existing Ground Existing Unsuitable Proposed Finish Grade Excavation Limit
Sheet Quantity Class Excavation Limit Soil Type: Earth Multiplication Factors Roadway Excavation: 1.000 Subsoil Excavation: 1.000 Fill: 1.000	✓       Lv Names:       DESIGN - EARTHWOR       Image: Colors:         ✓       Colors:       0       Image: Colors:         ✓       Colors:       0       Image: Colors:         ✓       Colors:       0       Image: Colors:         ✓       Styles:       0       Image: Colors:         ✓       Weights:       0       Image: Colors:         ✓       Weights:       0       Image: Colors:         ✓       Match       Display       Reset
Add	Delete Modify

Level Name - DESIGN-EARTHWORK- Excavation Limit Lines

#### Sheet Quantity

Add column for Topsoil and change the ASCII File Name to Project\_Topsoil.txt

📕 Earthwork - topsoil					_		$\times$		
<u>F</u> ile									
XS DGN File Soil Types Earthwork Shapes Output Format	<ul> <li>✓ Write Sheet Quantities File</li> <li>ASCII File: SR95Earth_Topsoil.txt</li> <li>Decimal Places 0 ▼ Total Quantity Length 10 ▼</li> </ul>								
Add/Subtract Volume Centroid Adjustment Skip Areas Ignore Areas Sheet Quantity	2 E	arth arth	Earthwork Operation Common Exc Fill Subsoil Exc	Quantity Typ End Area End Area End Area End Area	be	+/- + +			
	3 <b>•</b> Top	psoil Ad	Subsoil Exc      Delete	End Area	lify	• +	•		

When all settings are made, then select File>Run

Output file SR95Earth\_Topsoil.txt:

SR95Earth_Topsoil - Notepad					
File Edit Format View Help					
Station		Volumes	Volumes	Factor	Ordinate
	(sq. ft.)	(cu. yd.)	(cu. yd.)		
287+00.00 EARTH					
Common Exc	319.2	0	_	1.00	
Subgrade Exc	0.0	0	0	1.00	
Subsoil Exc	0.0	0	-	1.00	
Fill	132.6	0	0	1.00	0
TOPSOIL					
Common Exc	55.0	0	0	1.00	
Subgrade Exc	0.0	0	0	1.00	
Subsoil Exc	34.9	0		1.00	
Fill	0.0	0	0	1.00	0
Mass ordinate	e for TOPSO	1L = 0			
287+50.00 EARTH					
Common Exc	244.9	522	522	1.00	
Subgrade Exc	0.0	0	0	1.00	
Subsoil Exc	0.0	0	0	1.00	
Fill	82.8	199	199	1.00	323
TOPSOIL					
Common Exc	61.4	108	108	1.00	
Subgrade Exc	0.0	0	0	1.00	
Subsoil Exc	26.6	57	57	1.00	
Fill	0.0	0	0	1.00	323
Mass ordinate	e for TOPSO	IL = 165			
288+00.00 EARTH					
Common Exc		343	343	1.00	
Subgrade Exc	0.0	0	0	1.00	
Subsoil Exc	0.0	0	0	1.00	
Fill	139.4	206	206	1.00	460
TOPSOIL					
Common Exc	42.2	96	96	1.00	
Subgrade Exc	0.0	0	0	1.00	
Subsoil Exc	39.9	62	62	1.00	
Fill	0.0	0	0	1.00	460
Mass ordinate	e for TOPSO	IL = 323			

Continued:

SR95Earth_Topsoil - Notepad						
File Edit Format View Help						
288+50.00 EARTH						
Common Exc	55.7	168	168	1.00		
Subgrade Exc	0.0	0	100	1.00		
Subsoil Exc	0.0	õ	õ	1.00		
Fill	309.8	416	416	1.00	212	
TOPSOIL	50510	120	110	1.00		
Common Exc	22.8	60	60	1.00		
Subgrade Exc	0.0	0	0	1.00		
Subsoil Exc	52.6	86	86	1.00		
Fill	0.0	0	0	1.00	212	
Mass ordinate		-	Ŭ	1.00		
289+00.00 EARTH						
Common Exc	40.6	89	89	1.00		
Subgrade Exc	0.0	0	0	1.00		
Subsoil Exc	0.0	0	0	1.00		
Fill	429.7	685	685	1.00	-384	
TOPSOIL						
Common Exc	12.4	33	33	1.00		
Subgrade Exc	0.0	0	0	1.00		
Subsoil Exc	57.8	102	102	1.00		
Fill	0.0	0	0	1.00	-384	
Mass ordinate	for TOPSO	IL = 604				
289+50.00 EARTH						
Common Exc	35.6	71	71	1.00		
	0.0	0	0	1.00		
Subgrade Exc Subsoil Exc	0.0	0	0	1.00		
		-		1.00	1220	
Fill TOPSOIL	669.0	1017	1017	1.00	-1330	
Common Exc	9.5	20	20	1.00		
Subgrade Exc	0.0	20	20	1.00		
Subsoil Exc	66.3	115	115	1.00		
Fill	0.0	0	0	1.00	-1330	
Mass ordinate		-	v	1.00	-1550	
		,,,,				
290+00.00 EARTH						
Common Exc	0.0	33	33	1.00		
Subgrade Exc	0.0	0	0	1.00		
Subsoil Exc	0.0	0	0	1.00		
Fill	0.0	619	619	1.00	-1916	
TOPSOIL						
Common Exc	0.0	9	9	1.00		
Subgrade Exc	0.0	0	0	1.00		
Subsoil Exc	0.0	61	61	1.00		
Fill	0.0	0	0	1.00	-1916	
Mass ordinate	for TOPSO	IL = 809				
XS-NOELEM No cross-section el	ements fou	nd at				

#### Continued:

Luit	Format			News		Here 11				M. 14					
		Mater	rial	Name		Volum	justed mes yd.)	Volu	imes	Mult Factor					
	EARTH			Common	Eve		1226		1226	1.00					
				Subgrade			1220		1220						
				Subsoil			ø		0						
				Fill			3142		3142						
	TOPSOI	L													
				Common			326		326						
				Subgrade			0			1.00					
				Subsoil	Exc		483		483						
				Fill		ΙТ	0		-	1.00 ТОТА		-			
				2	ΡL		ant 30			Add/Sub Qu			Quant		
		Materi	ial M	lame						Unadjusted		Adjuste	-	Mult	
		in cer a		- Chine		Volum						Volume		Factor	
						(cu.	yd.)	(cu	ı. yd.)	(cu. yd.)		(cu. yd	.)		
	EARTH														
	LANTI			Common	Exc		1226	٦	1226		0		0	1.00	
				Subgrade			0		0		ø		-	1.00	
				Subsoil	Exc		-	-	0		0		0	1.00	
				Fill			3142		3142		0		0	1.00	
	TOPSOI	L													
				Common			326		326		0		0	1.00	
				Subgrade Subsoil			483		0 483		0		0	1.00 1.00	
				Fill	EXC		465		465		0 0		0	1.00	
		R	Δι	ANCE	p	0 1 1	_		MMA	RY	0		0	1.00	
		Mater					Cumulat			Increm	enta	al	Mult		
									sted	Unadjusted			Factor		
						Volum	ies	Volu	imes	Volumes	Vol	lumes			
						600	vd )	(cu	vd )	(cu. yd.)	(	v vd )			

Earth (Common Exc.) = 1226 C.Y.

Emb. = 3142 C.Y.

Exc. Topsoil Volume = 326 C.Y. + 483 C.Y. = 809 C.Y.

#### 7. Required Topsoil

Since topsoil will be required on all slopes, calculate the surface area of the proposed fill and cut slopes and multiply by the thickness of the required topsoil (6").

In the <u>GEOPAK Road Couse Guide</u>, reference Exercise 17 (Cross Section Reports) to calculate the surface area (seeding and sodding). In step 5 of Exercise 17, use the setting **Even at 50** for the Subtotal option. For the ASCII File name, use TopsoilReqd.txt.

\* 6" is used for quantities calculations to allow for 100% shrinkage down to the required 3" (See Roadway Design Guidelines Chapter 2-707.00 Roadway Design Guidelines)

📕 Seeding Report		_		×
Job: 101	Current Station:	298+	-50.00 R	1
Chain: SR95		-		
Begin Station: 287+00.0	00 R 1	287+	+00.00 R	1
End Station: 347+50.0	00 R 1	298+	-50.00 R	1
Search Criteria				
Existing Ground	Line:		Display	
Proposed Finish G	irade:	<u></u>	Display	
Candidate Seeding Eler	ments:	<u></u>	Display	
Max Allowable Slop	e: 1.0000 : 6	.0000	Rise:Ri	un 🔻
Subtotal Split Slope	: 0.0000 : 0	.0000		
Even   Sub Every:	.000000 First	Sub at:	+00.00	R 1
Scale Factor:	1.00000	Label:	SF	
ByPass Segments	Additional Di	stance	via Statio	n
Report Decimal: 2 💌	Addition	al Dista	nce	
Pause	on Each XS			
ASCII File: TopsoilR	eqd.txt			٩
	Apply			

Output file TopsoilReqd.txt:

SUBTOTALS EVERY SCALING FACTOR	50.0000 Ft BE =	50.0000 Ft BEGINNING AT STATION 287+00.00 R 1 METHOD INCR = 1.00000 WITH LABEL								
STATION	SLOPE DISTANCE LT RT (TOTAL)	AVERAGE LT	SLOPE DIST RT	A LT	R E A RT	SF BOTH	SUBTOTAL LT	AREA RT	SF BOTH	
287+00.00 R 1	33.15 51.98 ( 85.13)	32.54	51.16	1627	2558	4185	0	0	0	
287+50.00 R 1	31.93 50.33 ( 82.26)	30.70	44.03	1535	2202	3737	1627	2558	4185	
288+00.00 R 1	29.46 37.72 ( 67.18)	28.26	31.16	1413	1558	2971	1535	2202	3736	
288+50.00 R 1	27.06 24.60 ( 51.66)	20.20	26.39	1014	1320	2334	1413	1558	2971	
289+00.00 R 1	( 51.66) 13.48 28.17 ( 41.65)	14.83	34.30	741	1715	2456	1014	1320	2333	
289+50.00 R 1	( 41.65) 16.18 40.43 ( 56.61)	14.83	54.30	741	1/15	2456	741	1715	2456	
TOTAL SF=	LEFT 6330.0000	RIGHT 9353.0000	1	BOTH 5681.000	0					
ACRES=	0.1453	0.2147		.3600						

Multiply the proposed slope area by the required thickness:

15681 S.F. x 6 in x 1ft/12 in = <u>7841 C.F.</u>

7841 C.F. x 1 C.Y./27 C.F. = <u>290.4 C.Y.</u> (This is the required topsoil)

Refer to <u>Chapter 2-707.00</u> Topsoil Requirements for Earthwork Balances in Roadway Design Guidelines for the relationship of topsoil to total earthwork.

Earthwork Balances:

30% Shrinkage

Road & Drainage Exc (Uncl.) (Item 203-01) = Common Exc (calculated in Step 5) =

 $(1226 \text{ C.Y.}) \times (1 - 0.30) = 859 \text{ C.Y.}$ 

Borrow Exc (Uncl.) (Item 203-03) = Fill (calculated in Step 5) – Road & Drainage Exc =  $(3142^* - 858) \times 1.30 = 2969 \text{ C.Y.}$ 

#### 8. Grading Quantity Block

The figure below is the earthwork summary from the *Earthwork Design Guide*, Section 6 which includes the topsoil excavation volumes.

When the earthwork is ran in GEOPAK shapes are placed on the cross section corresponding to the excavation and embankment areas as shown in the figure below.



Earth common Exc. = White (CO=0)

Earth Fill = Gray (CO=1) + Purple (CO = 10)

Topsoil Common Exc. = Tan (CO=2)

Topsoil Subsoil Exc. = Purple (CO=10)

In the figure below is the Estimated Grading Quantities Block and Topsoil Quantities Table with numbers filled in as calculated in the earthwork report.

			ESTIMA	TED GRAD	DING QUA	NTITIES					
	DESCRIPTION		UNADJUSTED	VOLUMES (CY)	BALANCE SUMMARY						
				EXC.	EMB.	EXC.	SHRINK = 3	0%	SWELL =	30	%
MAINLINE				1226	3142	859					_
SIDE ROADS				0	0						
PVT. DRIVES,	BUSINESS AN	ID FIELD ENTR	ANCES	0	0		EMB.		EXC.		
INDEPENDEN	T DITCHES			0	0						
TEMPORARY	CONSTRUCT	ION EXITS		0	0		3142	VS.	-859		
OTHER (BRID	GE EXCAVATI	ON, PAVEMENT	, ETC)	0	0						
TOPSOIL (EM	B.)			326			AVAILABLE	=	2283		
TOPSOIL (EX	C.)			483							
		TOPSOIL	TOTALS (SEE	TOPSOIL TAB)			BORROW MATER	IAL =	2968		
ROCK (C.Y.)				TOTALS (C.Y	.)	7					
EXC.	EMB.	EXC. (UNCL.)	EMB. (UNCL.)	EXC (COMMON	) EXC. (AVAIL.)	EXC. (ADJ.)	7				
0	0	2035	3142	2035	1226	859					

	TOPSOIL IF EXISTING TOPSOIL IS SUITABLE FOR REUSE										
PROPOSED SLOPE AREA S.F.EXISTING 							WASTE TOTAL				
15681	809	0	809	290	290	0	519	3487			
		IFI	EXISTING TO	OPSOIL IS NO	T SUITABLE	FOR REUS	E				
PROPOSED SLOPE AREA S.F.	EXISTING TOPSOIL (EXC.)	EXISTING TOPSOIL (EMB.)	EXISTING TOPSOIL (TOTAL) C.Y.	REQUIRED TOPSOIL C.Y.	PLACING TOPSOIL 203-04 C.Y.	FURNISHED TOPSOIL 203-07 C.Y.	EXCESS TOPSOIL C.Y.	ADJUSTED WASTE TOTAL (C.Y.)			
	N/A	N/A	N/A	0	N/A	0	N/A	N/A			

#### Unadjusted Volumes:

Mainline Exc. = Earth Common Exc. = 1226 C.Y.

Mainline Emb. = Earth Fill - Topsoil Subsoil Exc. = 3142 C.Y. - 483 C.Y. = 2659 C.Y.

Existing Topsoil (Exc.) = Topsoil Common Exc. + Topsoil Subsoil Exc. = 483 C.Y. + 326 C.Y. = 809 C.Y.

#### Totals:

Exc. (UNCL.) = 1226 C.Y.

Emb. (UNCL.) = 2659 C.Y.

Exc. (Common) = 1226 C.Y. – Exc. (Rock) = 1226 C.Y.

Exc. (Avail.) = 1226 C.Y. x (1-0.30) = 859 C.Y.

If value of Rock is known, then the Exc. (Adj.) can be calculated as follows:

Exc. (Adj.) = 859 + Exc. (Rock) x (1 + 0.30)

NOTE: If there are Side Roads and Private Drives, etc. add the corresponding exc. and emb. values in the appropriate spaces.