Earthwork Design Guide



Engineering Division Production Support

Website: <u>https://www.tn.gov/tdot/engineering-division/engineering-production-support.html</u> Email: TDOT.EngineeringProductionSupport@tn.gov

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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 2-1000.

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 and 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 2-1008.00.</u>
- Cross Section Sheets: For every cross section, a cut, fill, and rock area value will be listed in square feet.

								_
	ESTIN	IATED GRA	DING QUA	NTITIES				
DESCRIPTION		UNADJUSTED V	UNADJUSTED VOLUMES (CY)		BALANCE SUMMARY			
		EXC.	EMB.	EXC.	SHRINK = 15 % SWELL =		15 %	
MAINLINE		219500	243000	190870				
SIDE ROADS		12500	5490	10870				
PVT. DRIVES, BUSINES	SS AND FIELD ENTRANCES				1			
INDEPENDENT DITCHE	S				EXC.		EMB.	
TEMPORARY CONSTRU	UCTION EXITS				253490	VS.	-253490	
OTHER								
PAVEMENT					1			
TOPSOIL (EMB.)		5000		4348	AVAILABLE	=	0	
TOPSOIL (EXC.)		13000		11305				
TOPSOIL (TO REPLACE	STRIPPED TOPSOIL)		5000					
ROCK (C.Y.)		TOTALS (C.Y.)			WASTE MATER	IAL =	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.

				GRADIN	G REP	ORT			
OMPUTED BY	: AMY LOREN	TZ						SHEET 1	OF 1
HECKED BY: D	AWN PRUETT						STATE NO.	:83027-32	21-94
N: 124717.00)					FEDERAL PR	OJECT NO:	BR-STP-17	4(27)
	STREET SR 1	7/1					0.1.001		VINER
DOTE NO. OK	JINEET, JN 1	/+						00011.301	VIINLIN
		ES		GRADING	g qua	NTITIES			
	DESCRIPTION		UNADJUSTE	D VOLUME \$	(CY)	ADJUSTED VOLUMES(CY)	BAL	ANCE SUMMA	RY
MAINUNE			EXC.	EN	/B.	EXC.	SHRINK=	20 % SWELL	.= 20 %
SIDE ROADS			42.30	60	54	1951	EXC		MB.
			2071			1301		-	
PVT. DRIVES, BU	JSINESS AND FIELD	ENTRANCES					16883	VS7	232
PAVEMENT			542	_		452			
TOPSOIL (EMB.)							AVAI	UNBLE= 9	001
TOPSOIL (TO RE	PLACE STRIPPED	TOPSOIL)					WASTEMAT	ERIAL= 11	1581
		TOT	ALS(C.Y.)	·					-
ROCK EX	C. (UNCL.) EM	B. (UNCL)	EXC (COMMO	N) EXC. (A	VAIL)	EXC. (ADJ.)			
Material Name	End Areas	Unadjuste	******* SR 1 d Adjusted	174 **********		Accum	Accum	**	
Material Name tation	End Areas	Unadjuster (sq. ft.)	********* SR 1 d Adjusted Volumes (cu. yd.)	Mult Mult Mult Mult Mult Mult Mult	lass Fac	Accum tor Ordinate	Accum Unadj Vol (cu. yd.)	** Adj Vol (cu. yd.))
Material Name tation 100+43.56 EAN	End Areas	Unadjuste (sq. ft.)	********* SR 1 d Adjusted Volumes (cu. yd.)	Mult Mult Mult Mult Mult Mult Mult	(ass Fac .)	Accum tor Ordinate	Accum Unadj Vol (cu. yd.)	** Adj Vol (cu. yd.))
Material Name tation 100+43.56 EAU	End Areas RTH Excavation	Unadjuster (sq. ft.) 20	With the second	Mult M Volumes (cu. yd.	(lass Fac .) 0.85	Accum tor Ordinate	Accum Unadj Vol (cu. yd.) 0	Adj Vol (cu. yd.))
Material Name tation 100+43.56 EAU	End Areas RTH Excavation Fill	Unadjuster (sq. ft.) 20 0	d Adjusted Volumes (cu. yd.) 0 0	Mult M Volumes (cu. yd. 0	(ass Fac .) 0.85 1.00	Accum tor Ordinate	Accum Unadj Vol (cu. yd.) 0 0	Adj Vol (cu. yd.) 0 0)
Material Name tation 100+43.56 EAU 100+50.00 EAU	End Areas RTH Excavation Fill RTH	Unadjuste (sq. ft.) 20 0	d Adjusted Volumes (cu. yd.) 0 0	Mult Mult Mult Mult Mult Mult Mult Mult	4ass Fac .) 0.85 1.00	Accum tor Ordinate	Accum Unadj Vol (cu. yd.) 0 0	Adj Vol (cu. yd.) 0 0)
Material Name tation 100+43.56 EA 100+50.00 EA	End Areas RTH Excavation Fill RTH Excavation	Unadjuster (sq. ft.) 20 0 22	With the second	Mult Mult Mult Mult Mult Mult Mult Mult	(ass 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 tation 100+43.56 EA 100+50.00 EA	End Areas RTH Excavation Fill RTH Excavation Fill	Unadjuster (sq. ft.) 20 0 22 0	Grand SR 1 d 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 0 4	Accum Unadj Vol (cu. yd.) 0 0 5 0	** (cu. yd.) 0 0 4 0)
Material Name tation 100+43.56 EAU 100+50.00 EAU 100+75.00 EAU	End Areas RTH Excavation Fill RTH Excavation Fill RTH	Unadjuster (sq. ft.) 20 0 22 0	SR 1 d Adjusted Volumes (cu. yd.) 0 0 5 0	Mult N Volumes (cu. yd. 0 0 4 0	Mass Fac) 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4	Accum Unadj Vol (cu. yd.) 0 0 5 0	Adj Vol (cu. yd.) 0 0 4 0)
Material Name tation 100+43.56 EAI 100+50.00 EAI 100+75.00 EAI	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation	Unadjuster (sq. ft.) 20 0 22 0 51	SR 1 d Adjusted Volumes (cu. yd.) 0 0 0 5 0 34	Mult N Volumes (cu. yd. 0 0 4 0 29	4ass 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 tation 100+43.56 EAI 100+50.00 EAI 100+75.00 EAI	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill	Unadjuster (sq. ft.) 20 0 22 0 51 0	********* SR 1 d Adjusted Volumes (cu. yd.) 0 0 0 5 0 34 0	174 ******** Mult r Volumes (cu. yd. 0 0 4 0 29 0	4ass 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 0 5 0 39 0	Adj Vol (cu. yd.) 0 0 4 0 33 0)
Material Name tation 100+43.56 EA 100+50.00 EA 100+75.00 EA	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH	Unadjuster (sq. ft.) 20 0 22 0 51 0	********* SR 1 d Adjusted Volumes (cu. yd.) 0 0 0 5 0 5 0 34 0	174 ******** Mult r Volumes (cu. yd. 0 0 4 0 29 0	Aass 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 0 5 0 39 0	Adj Vol (cu. yd.) 0 0 4 0 33 0)
Material Name tation 100+43.56 EA 100+50.00 EA 100+75.00 EA 101+00.00 EA	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation	Unadjuster (sq. ft.) 20 0 22 0 51 0 117	Adjusted Volumes (cu. yd.) 0 0 0 5 0 34 0 78	Volumes (cu. yd. 0 0 4 0 29 0 66	Aass Fac.) 0.85 1.00 0.85 1.00 0.85 1.00 0.85	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 tation 100+43.56 EAU 100+50.00 EAU 100+75.00 EAU 101+00.00 EAU	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill	Unadjuster (sq. ft.) 20 0 22 0 51 0 117 0	********* SR 1 d Adjusted Volumes (cu. yd.) - - - - - - - - - - - - - - - - - - -	Mult r Volumes (cu. yd. 0 0 0 4 0 29 0 66 0	4ass Fac) 0.85 1.00 0.85 1.00 0.85 1.00 0.85	Accum tor Ordinate 0 4 33 99	Accum Unadj Vol (cu. yd.) 0 5 0 39 0 1117 0	** Adj Vol (cu. yd.) 0 0 4 0 33 0 99 0)
Material Name tation 100+43.56 EAU 100+50.00 EAU 100+75.00 EAU 101+00.00 EAU	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill	Unadjuster (sq. ft.) 20 0 22 0 51 0 117 0	SR 1 d Adjusted Volumes (cu. yd.) 0 0 5 0 5 0 34 0 78 0	174 ********* Mult r Volumes (cu. yd. 0 0 4 0 29 0 66 0	4ass 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 5 0 39 0 1117 0	** Adj Vol (cu. yd.) 0 0 4 0 33 0 99 0)
Material Name tation 100+43.56 EAI 100+50.00 EAI 100+75.00 EAI 101+00.00 EAI 101+25.00 EAI	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill	Unadjuster (sq. ft.) 20 0 22 0 51 0 117 0 185	********* SR 1 d Adjusted Volumes (cu. yd.) 0 0 0 5 0 5 0 34 0 78 0 78 0	174 ********* Volumes (cu. yd. 0 0 0 4 0 29 0 66 0 119	4ass Fac) 0.85 1.00 0.85 1.00 0.85 1.00 0.85 1.00 0.85	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 tation 100+43.56 EAI 100+50.00 EAI 100+75.00 EAI 101+00.00 EAI 101+25.00 EAI	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill	Unadjuster (sq. ft.) 20 0 22 0 51 0 117 0 185 0	SR 1 d Adjusted Volumes (cu. yd.) 0 0 5 0 5 0 34 0 78 0 140 0	174 ************************************	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 99 218	Accum Unadj Vol (cu. yd.) 0 5 0 39 0 1117 0 257 0	** Adj Vol (cu. yd.) 0 0 4 0 33 0 99 0 218 0)
Material Name tation 100+43.56 EAI 100+50.00 EAI 100+75.00 EAI 101+00.00 EAI 101+25.00 EAI	End Areas RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation Fill RTH Excavation RTH	Unadjuster (sq. ft.) 20 0 22 0 51 0 117 0 185 0	SR 1 d Adjusted Volumes (cu. yd.) 0 0 5 0 5 0 34 0 78 0 140 0	174 ************************************	44355 Fac)) 0.85 1.00 0.85 1.00 0.85 1.00 0.85 1.00	Accum tor Ordinate 0 4 33 99 218	Accum Unadj Vol (cu. yd.) 0 5 0 39 0 1117 0 257 0	** Adj Vol (cu. yd.) 0 4 0 33 0 99 0 218 0)
Material Name tation 100+43.56 EAI 100+50.00 EAI 100+75.00 EAI 101+25.00 EAI 101+50.00 EAI	End Areas RTH Excavation Fill	Unadjuster (sq. ft.) 20 0 22 0 51 0 117 0 185 0 251	********* SR 1 d Adjusted Volumes (cu. yd.) 0 0 0 5 0 34 0 78 0 140 0 202	174 ********* Volumes (cu. yd. 0 0 4 0 4 0 29 0 66 0 119 0 112	44355 Fac) 0.855 1.00 0.855 1.00 0.855 1.00 0.855 1.00 0.855 1.00 0.855	Accum tor Ordinate 0 4 33 99 218	Accum Unadj Vol (cu. yd.) 0 0 5 0 39 0 117 0 257 0 459	** Adj Vol (cu. yd.) 0 0 4 0 33 0 99 0 218 0 218 0 390)

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.

ESTIMATED GRADING QUANTITIES									
DESCRIPTION		UNADJUSTED V	UNADJUSTED VOLUMES (CY)		BALANCE SUMMARY				
		EXC.	EMB.	EXC.	SHRINK =	0 %	SWELL =	0 %	
MAINLINE		0	0						
SIDE ROADS		0	0						
PVT. DRIVES, BUSINESS AN	D FIELD ENTRANCES	0	0		EXC.		EMB.		
INDEPENDENT DITCHES		0	0						
TEMPORARY CONSTRUCTION	ON EXITS	0	0		0	VS.	0		
OTHER (BRIDGE EXCAVATIO	DN, PAVEMENT, ETC)	0	0						
TOPSOIL (EMB.)		0			AVAILABLE	=	0		
TOPSOIL (EXC.)		0							
	TOPSOIL TOTALS (SEE TOPSOIL TAB)				WASTE MATER	IAL =	0		
ROCK (C.Y.)) TOTALS (C.Y.)								
EXC. EMB.	EXC. (UNCL.) EMB. (UNCL.)	ICL.) 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%.

	ESTIMATED GRADING QUANTITIES										
DESCRIPTION		UNADJUSTED V	UNADJUSTED VOLUMES (CY)		BALANCE SUMMARY						
		EXC.	EMB.	EXC.	SHRINK = 20 % SWELL =		20 %				
MAINLINE		0	0								
SIDE ROADS		0	0								
PVT. DRIVES, BUSINESS AND FIE	_D ENTRANCES	0	0		EXC.		EMB.				
INDEPENDENT DITCHES		0	0								
TEMPORARY CONSTRUCTION EX	ITS	0	0		0	VS.	0				
OTHER (BRIDGE EXCAVATION, PA	AVEMENT, ETC)	0	0								
TOPSOIL (EMB.)		0			AVAILABLE	=	0				
TOPSOIL (EXC.)		0									
	TOPSOIL TOTALS (SEE TOPSOIL TAB)				WASTE MATER	IAL =	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.	DESCRIPTION	UNIT	QUANITY				
(1)	203-02.01	BORROW EXCAVATION (GRADED SOLID ROCK)	TON	229				
$\check{1}$	740-10.04	SY	379					
C	(1) 740-10.04 GEOTEXTILE FABRIC (TYPE IV) SY 379 FOOTNOTES: (1) 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 ENGINEER FOR THE STABILIZATION OF SUBGRADE							

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									
DESCRIPTION		UNADJUSTED V	UNADJUSTED VOLUMES (CY) AD				JMMARY			
		EXC.	EMB.	EXC.	SHRINK = 2	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 CONSTRUCTIO	DN EXITS	0	0		0	VS.	130			
OTHER (BRIDGE EXCAVATIO	DN, PAVEMENT, ETC)	0	0							
TOPSOIL (EMB.)		0			AVAILABLE	=	130			
TOPSOIL (EXC.)		0								
	TOPSOIL TOTALS (SEE TOPSOIL TAB)				WASTE MATERIA	AL =	156			
ROCK (C.Y.)	TOTALS (C.Y.)			BORROW ROC	к =	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	Name	Unadjusted Volumes (cu. yd.)	Adjusted Volumes (cu. yd.)	Mult Factor
EARTH				
	Excavation	230	230	1.00
	Fill	250	250	1.00

	ESTIMATED GRADING QUANTITIES									
DESCRIPTION		UNADJUSTED \	UNADJUSTED VOLUMES (CY)		Y) BALANCE		JMMARY			
		EXC.	EMB.	EXC.	SHRINK = 2) %	SWELL =	20 %		
MAINLINE			230	250	184					
SIDE ROADS			0	0						
PVT. DRIVES, BI	USINESS AND) FIELD ENTRANCES	0	0		EXC.		EMB.		
INDEPENDENT [DITCHES		0	0						
TEMPORARY CO	DNSTRUCTIO	N EXITS	0	0		184	VS.	-120		
OTHER (BRIDGE	EXCAVATIO	N, PAVEMENT, ETC)	0	0						
TOPSOIL (EMB.))		0			AVAILABLE	=	64		
TOPSOIL (EXC.)			0							
		TOPSOIL TOTALS (SE	E TOPSOIL TAB)			WASTE MATERIA	L =	77		
ROCK (С.Ү.)		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 V	UNADJUSTED VOLUMES (CY)				JMMARY		
		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 CONSTRUCTIO	ON EXITS	0	0		432	VS.	-187		
OTHER (BRIDGE EXCAVATIO	N, PAVEMENT, ETC)	0	0						
TOPSOIL (EMB.)		0			AVAILABLE	=	245		
TOPSOIL (EXC.)		0							
	TOPSOIL TOTALS (SEE	TOPSOIL TAB)			WASTE MATERIAL	=	294		
ROCK (C.Y.)	TOTALS (C.Y.)			BORROW ROCK	=	156			
EXC. EMB.	EXC. (UNCL.) 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.

	ESTIMA	TED GRAD	ING QUAN	ITITIES				
DESCRIPTION		UNADJUSTED VOLUMES (CY)		ADJUSTED VOLUMES (CY)	Y) BALANCE SUMM		JMMARY	
		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	444	VS.	-187	
OTHER (BRIDGE EXCAVATI	DN, PAVEMENT, ETC)	0	0					
TOPSOIL (EMB.)		0			AVAILABLE	=	257	
TOPSOIL (EXC.)		0						
	TOPSOIL TOTALS (SEE	TOPSOIL TAB)			WASTE MATERIAL	=	309	
ROCK (C.Y.)		TOTALS (C.Y.)			BORROW ROCK	=	156	
EXC. EMB.	EXC. (UNCL.) 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.

GRA	ND SU	MMARY	ΤΟΤΑ	LS
Material M	Name	Unadjusted Volumes (cu. yd.)	Adjusted Volumes (cu. yd.)	Mult Factor
EARTH				
	Excavation	122	122	1.00
	Fill	0	0	1.00

	ESTIMA	ATED GRAD	ING QUAN	ITITIES				
DESC	DESCRIPTION		UNADJUSTED VOLUMES (CY)		BALANCE SUMMARY			
		EXC.	EMB.	EXC.	SHRINK = 2	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	N EXITS	15	0	12	541	VS.	-187	
OTHER (BRIDGE EXCAVATIO	DN, PAVEMENT, ETC)	122	0	98				
TOPSOIL (EMB.)		0			AVAILABLE	=	354	
TOPSOIL (EXC.)		0						
	TOPSOIL TOTALS (SEE	TOPSOIL TAB)			WASTE MATERIA	AL =	425	
ROCK (C.Y.)		TOTALS (C.Y.)			BORROW ROCI	< =	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 8 of the RDG contains all relevant item numbers and payment options used for Topsoil.

				TOPS	OIL				
	IF EXISTING TOPSOIL IS 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	0	0	0	32	0	32	0	425	
	IF EXISTING TOPSOIL IS NOT 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.

DESCRIPTION UNADJUSTED VOLUMES (CY) ADJUSTED VOLUMES (CY) ADJUSTED VOLUMES (CY) BALANCE SUMMARY SHRINK = 20 % SWELL = 20 % MAINLINE 230 250 184 SIDE ROADS 309 67 248 EXC. EMB. EXC. SIDE ROADS 0 0 0 EXC. EMB. EXC. EMB. EXC. EMB. EXC. EMB. EXC. EMB. EXC. EMB. EXC. EXC.			ESTIMA	ATED GRAD	ING QUAN	TITIES				
EXC. EMB. EXC. SHRINK = 20 % SWELL = 20 % MAINLINE 230 250 184 309 67 248 7 <td< td=""><td>DESCRI</td><td colspan="2">DESCRIPTION</td><td colspan="2">UNADJUSTED VOLUMES (CY)</td><td>ADJUSTED VOLUMES (CY)</td><td colspan="2">BALANCE SUMMARY</td><td></td></td<>	DESCRI	DESCRIPTION		UNADJUSTED VOLUMES (CY)		ADJUSTED VOLUMES (CY)	BALANCE SUMMARY			
MAINLINE 230 250 184 SIDE ROADS 309 67 248 PVT. DRIVES, BUSINESS AND FIELD ENTRANCES 0 0 EXC. EMB. INDEPENDENT DITCHES 0 0 541 VS. -187 OTHER (BRIDGE EXCAVATION, PAVEMENT, ETC) 122 0 98 541 VS. -187 OTHER (BRIDGE EXCAVATION, PAVEMENT, ETC) 122 0 98 AVAILABLE = 354 TOPSOIL (EMB.) 0 0 VASTE MATERIAL = 425 ROCK (C.Y.) TOPSOIL TOTALS (SEE TOPSOIL TAB) VASTE MATERIAL = 425 BORROW ROCK EXC. (UNCL.) EMB. (UNCL.) EXC (COMMON) EXC. (AVAIL.) EXC. (ADJ.) BORROW ROCK = 156 VALUE 676 676 541 VS. 156				EXC.	EMB.	EXC.	SHRINK =	20 %	SWELL =	20 %
SIDE ROADS 309 67 248 PVT. DRIVES, BUSINESS AND FIELD ENTRANCES 0 0 EXC. EMB. INDEPENDENT DITCHES 0 0 12 541 VS. -187 OTHER (BRIDGE EXCAVATION, PAVEMENT, ETC) 122 0 98 541 VS. -187 TOPSOIL (EMB.) 0 0 0 0 0 12 541 VS. -187 TOPSOIL (EMB.) 0 0 0 98 0 0 12 541 VS. -187 TOPSOIL (EXC.) 0 0 0 0 98 0 12 541 VS. -187 TOPSOIL (EXC.) 0 0 0 0 130 676 156 16	MAINLINE			230	250	184				
PVT. DRIVES, BUSINESS AND FIELD ENTRANCES 0 0 EXC. EMB. INDEPENDENT DITCHES 0 0 12 541 VS. -187 TEMPORARY CONSTRUCTION EXITS 15 0 12 541 VS. -187 OTHER (BRIDGE EXCAVATION, PAVEMENT, ETC) 122 0 98 AVAILABLE = 354 TOPSOIL (EMB.) 0 0 0 0 0 0 0 0 TOPSOIL (EXC.) 0 <	SIDE ROADS			309	67	248				
INDEPENDENT DITCHES 0 0 TEMPORARY CONSTRUCTION EXITS 15 0 12 OTHER (BRIDGE EXCAVATION, PAVEMENT, ETC) 122 0 98 TOPSOIL (EMB.) 0 -187 TOPSOIL (EXC.) 0 -187 MAYAILABLE = TOPSOIL TOTALS (SEE TOPSOIL TAB) TOTALS (C.Y.) ROCK (C.Y.) TOTALS (C.Y.) EXC. (UNCL.) EMB. (UNCL.) EXC (COMMON) EXC. (AVAIL.) EXC. (ADJ.) 0 130 676 187 676 676 541	PVT. DRIVES, BUSINESS AND	FIELD ENTRA	NCES	0	0		EXC.		EMB.	
TEMPORARY CONSTRUCTION EXITS 15 0 12 OTHER (BRIDGE EXCAVATION, PAVEMENT, ETC) 122 0 98 TOPSOIL (EMB.) 0 4VAILABLE = TOPSOIL (EMB.) 0 0 0 TOPSOIL (EXC.) 0 0 0 TOPSOIL TOTALS (SEE TOPSOIL TAB) WASTE MATERIAL = ROCK (C.Y.) EXC. (UNCL.) EMB. (UNCL.) EXC (COMMON) EXC. (AVAIL.) EXC. (ADJ.) 0 130 676 187 676 676 541	INDEPENDENT DITCHES			0	0					
OTHER (BRIDGE EXCAVATION, PAVEMENT, ETC) 122 0 98 TOPSOIL (EMB.) 0 AVAILABLE = 354 TOPSOIL (EXC.) 0 Vaste material = 425 BOCK (c.Y.) TOTALS (SEE TOPSOIL TAB) Vaste material = 425 ROCK (c.Y.) TOTALS (C.Y.) BORROW ROCK = 156 EXC. EMB. EXC. (UNCL.) EXC (COMMON) EXC. (AVAIL.) EXC. (ADJ.) 0 130 676 187 676 676 541	TEMPORARY CONSTRUCTION	N EXITS		15	0	12	541	VS	-187	
TOPSOIL (EMB.) 0 AVAILABLE = 354 TOPSOIL (EXC.) 0 WASTE MATERIAL = 425 ROCK (C.Y.) TOPSOIL TOTALS (SEE TOPSOIL TAB) WASTE MATERIAL = 425 ROCK (C.Y.) TOTALS (C.Y.) BORROW ROCK = 156 C. EMB. EXC. (UNCL.) EMB. (UNCL.) EXC (COMMON) EXC. (AVAIL.) EXC. (ADJ.) 0 130 676 676 541	OTHER (BRIDGE EXCAVATION	N, PAVEMENT,	ETC)	122	0	98				
TOPSOIL (EXC.) 0 WASTE MATERIAL 425 ROCK (c.Y.) TOTALS (SEE TOPSOIL TAB) WASTE MATERIAL 425 ROCK (c.Y.) TOTALS (C.Y.) BORROW ROCK = 425 EXC. EMB. UNICL.) EXC (COMMON) EXC. (AVAIL.) EXC. (ADJ.) 0 130 676 187 676 676 541 541	TOPSOIL (EMB.)			0			AVAILABLE	=	354	
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	TOPSOIL (EXC.)			0						
ROCK (C.Y.) TOTALS (C.Y.) BORROW ROCK = 156 EXC. EMB. EXC. (UNCL.) EXC (COMMON) EXC. (AVAIL.) EXC. (ADJ.) 0 130 676 187 676 676 541		TOPSOIL 1	TOTALS (SEE	TOPSOIL TAB)			WASTE MATER	IAL =	425	
EXC. EMB. EXC. (UNCL.) EMB. (UNCL.) EXC (COMMON) EXC. (AVAIL.) EXC. (ADJ.) 0 130 676 187 676 676 541	ROCK (C.Y.)			TOTALS (C.Y.)			BORROW ROO	ск =	156	
0 130 676 187 676 676 541	EXC. EMB.	EXC. (UNCL.)	EMB. (UNCL.)	EXC (COMMON)	EXC. (AVAIL.)	EXC. (ADJ.)				_
	0 130	676	187	676	676	541				

				TOPS	OIL			
	IF EXISTING TOPSOIL IS 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	0	0	0	32	0	32	0	425
	IF EXISTING TOPSOIL IS NOT 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 8 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	-	
		□ <u>Di</u> mensions To Geometry ▼ □ <u>Line Strings/Shapes</u>
_ <u></u>	_	Shared Cells To Geometry
Roundabouts	*	<u> </u>
Z Civil Geometry	*	<u>Application Elements</u>
Data Acquisition	**	Contraction of the Contraction o

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	ЕОР ЕОР
	· · 4	
		~~~*
PLC	T EXIS	STING PAVEMENT
	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_XBOW	PLOT EXIST	Apply to Whole Chain 🔻
RADII	INTERSECT	Begin Sta.: DP End Sta.: DP
RADIIU	INTERSECT 🗡	
<	>	Un Uhain: SK95 Select
		Apply

📕 Proposed Cross Section	ns - EXPVMT	Ī	_	- 🗆 X
File				
XS DGN File Pattern Existing Ground Shapes Shape Clusters Define DGN Variables Define Variables Plot Parameters Drainage Side Slope Conditions	Chain SR95 Chain: SR	Tie/PGL 0.00000 95 Apply Profile Modify	Profile 0 SR95 ✓ "№ Profile: S at: Tie ✓ ( Delete	Typical Thick 3R95 • 0.000000 Up Down
LT Define Mo	odify	Delete	Up	Down
Name PlotExistPavement.x	Description Plot Existin	n ng Pavement on	XSections.	
Add	Delete		Up	Down

#### Define Variables:

Change the Survey DGN name to the file for your project

📕 Proposed Cr	ross Section	ns - EXP	VMT	_		$\times$
<u>F</u> ile						
XS DGN File Pattem Existing Ground Shapes Shape Clusters Define DGN Var	iables	Var Surv xs so exist	iable rey DGN cale pavement depth		Value RO095 10 1	5
Plot Parameters Drainage	8	Ву	file: All	•	Q	
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	×	<
F	"TOPSOIL DEPTH" 	
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	_	- 🗆 🗙
XS DGN File Pattern Existing Ground Shapes Shape Clusters Define DGN Variables Define Variables Plot Parameters Drainage Side Slope Conditions	Chain SR95 Chain: S Add	Tie/PG 0.00000 R95 Apply Profile Modify 00 R 1 and cha S	L Profile 0 SR95 ▼ "№ Profile:   at: Tie ▼ [ Delete R95 sta < =289-	Typical Thick SR95 ▼ 0.000000 Up Down +50.00 R 1
Define M	odify	Delete	Up	Down
Criteria Files Name Plot Topsoilat Depth x	Descript Plot Top	tion osoil at Specified I	Depth	
Add	Delete		Up	Down

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

Variable	Value
Topsoil depth (inches)	3
XS DGN	ROSR95Mainline
3	
By file: All	<ul> <li>Q</li> </ul>
DGN	
R95MainlineXSections.dgn	Q
	By file: All DGN SR95MainlineXSections.dgn

Next - select "Run"

28	7-60,00 A
	2372
485685666666666666666666666666666666666	
	L L L L L L L L L L L L L L L L L L 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 2-1006.00</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       ✓         □       Lv Numbers:       ✓       ✓         ✓       Colors:       0       ✓         ✓       Styles:       0       ✓         ✓       Weights:       0       ✓         Types:       ✓       ✓							
	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	✓ Write S ASCII File: Decimal Pla	✓ Write Sheet Quantities File         ASCII File:       SR95Earth_Topsoil.txt         Decimal Places       0 ▼         Total Quantity Length       10 ▼							
Add/Subtract Volume Centroid Adjustment Skip Areas Ignore Areas Sheet Quantity	Column So 1 E 2 E 3 To	oil Type arth arth opsoil	Earthwork Operation Common Exc Fill Subsoil Exc	Quantity Typ End Area End Area End Area	De	+/- + + +			
	3 <b>v</b> Top	psoil	Subsoil Exc	End Area	lify	•	•		

When all settings are made, then select File>Run

Output file SR95Earth_Topsoil.txt:

SR95Earth_1	Topsoil - N	lotepad					
File Edit For	mat Vie	w Help					
Station				Volumes	Volumes	Factor	r Ordinate
			(sq. ft.)	(cu. yd.)	(cu. yd.)	)	
287+00.00	) EARTH						
	Co	ommon Exc	319.2	0	0	1.00	
	Sub	grade Exc	0.0	0	0	1.00	
	Sul	bsoil Exc	0.0	0	0	1.00	
		Fill	132.6	0	0	1.00	0
	TOPSO:	IL					
	Co	ommon Exc	55.0	0	0	1.00	
	Sub	grade Exc	0.0	0	0	1.00	
	Sul	bsoil Exc	34.9	0	0	1.00	
		Fill	0.0	0	0	1.00	0
	Ma	ass ordinat	te for TOPSO	IL = 0			
287+50.00	) EARTH						
	Co	ommon Exc	244.9	522	522	1.00	
	Sub	grade Exc	0.0	0	0	1.00	
	Sul	bsoil Exc	0.0	0	0	1.00	
		Fill	82.8	199	199	1.00	323
	TOPSO	IL					
	Co	ommon Exc	61.4	108	108	1.00	
	Sub	grade Exc	0.0	0	0	1.00	
	Sul	bsoil Exc	26.6	57	57	1.00	
		Fill	0.0	0	0	1.00	323
	Ma	ass ordinat	te for TOPSO	IL = 165			
288+00.00	EARTH						
	Co	ommon Exc	125.6	343	343	1.00	
	Sub	grade Exc	0.0	0	0	1.00	
	Sul	bsoil Exc	0.0	0	0	1.00	
		Fill	139.4	206	206	1.00	460
	TOPSO	IL					
	Co	ommon Exc	42.2	96	96	1.00	
	Sub	grade Exc	0.0	0	0	1.00	
	Sul	bsoil Exc	39.9	62	62	1.00	
		Fill	0.0	0	0	1.00	460
	Ma	ass ordinat	te 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	0	1.00					
Subsoil Exc	0.0	0	0	1.00					
Fill	309.8	416	416	1.00	212				
TOPSOIL									
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	for TOPSO	IL = 469							
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					
Subgrade Exc	9.0	, i 0	, i 0	1 00					
Subsoil Exc	0.0	ø	â	1 00					
Fill	669.0	1017	1017	1 00	-1330				
TOPSOTI	005.0	1017	1017	1.00	-1550				
	95	20	20	1 00					
Subgrade Exc	9.9	20	20	1 00					
Subsoil Exc	66.3	115	115	1 00					
Fill	0.9	115	115	1 00	-1330				
Mass ordinate	for TOPSO	)TI = 739	Ŭ	1.00	-1550				
	101 101 50	.12 755							
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 ele	ements fou	ind at							

#### Continued:

/// S	R95Ea	rth_Topso	il - Note	pad												
File	Edit	Format	View	Help												
			Mater	rial	Name		Unad	justed	Adju	sted	Mult					
							Volu	mes	Volu	mes	Factor					
							(cu.	yd.)	(cu.	yd.)						
		EARTH														
					Common	Exc		1226		1226	1.00					
					Subgrade	Exc		0		0	1.00					
					Subsoil	Exc		0		0	1.00					
					Fill			3142		3142	1.00					
		TOPSOI	L													
					Common	Exc		326		326	1.00					
					Subgrade	Exc		0		0	1.00					
					Subsoil	Exc		483		483	1.00					
					Fill			0		0	1.00					
♠					S I	ΡL	IT	S U	MM	ARY	ТОТА	LS		_		
							XS Q	uant	XS	Quant	Add/Sub Qu	ant /	Add/Sub	Quant		
			Materi	Lal N	ame		Unad	justed	Adj	usted	Unadjusted		Adjuste	a	Mult	
							(cu	wd)	(cu	ume vd)	(cu vd)		(cu vd	)	Factor	
										. yu.,	(cu. yu.)			•••		
		EARTH							_							
					Common	Exc		1226		1226		0		0	1.00	
					Subgrade	Exc		Ø		0		0		0	1.00	
					Subsoil	Exc		-		0		0		0	1.00	
					Fill			3142		3142		0		0	1.00	
		TOPSOI	L													
					Common	Exc		326		326		0		0	1.00	
					Subgrade	Exc		402		0		0		0	1.00	
					Subsoil	EXC		483		483		0		0	1.00	
			D	A 1			ОТ	6	<b>.</b>	м м . О	D V	0		0	1.00	
•			Mater	AL	ANCE	Р	01	NII Cumulat	5 U	mmA	л ї Тастот	onto	1	Mu1+		
			nacer	TRT	valle		Unadi	justed	Adiu	stod	Unadjusted	enca. Adiu	⊥ ustod	Factor		
							Volu	justeu mes	Volu	mes	Volumes	Vol	usteu	ractor		
							(cu.	vd.)	(cu.	vd.)	(cu. vd.)	(сп	. 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		_		Х					
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:	<u></u>	Display						
Proposed Finish G	rade:	<u></u>	Display						
Candidate Seeding Eler	nents:		Display						
Max Allowable Slop	e: 1.0000 : 6.	0000	Rise:Ru	in 🔻					
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 Dis	stance	via Statior	ı					
Report Decimal: 2 💌	Additiona	al Dista	nce						
Pause on Each XS									
ASCII File: TopsoilRe	eqd.txt			٩					
	Apply								

Output file TopsoilReqd.txt:

SUBTOTALS EVERY SCALING FACTOR	50.0000 Ft BE	GINNING AT 1.0	STATION 28	7+00.00	OD INCR WITH LAB	EL	[ SF ]			
STATION	SLOPE DISTANCE LT RT (TOTAL)	AVERAGE LT	SLOPE DIST RT	۵ LT	AREA 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	20.70	44.02	4525	2000		1627	2558	4185	
288+00.00 R 1	29.46 37.72	30.70	44.03	1535	2202	3/3/	1535	2202	3736	
288+50.00 R 1	( 67.18) 27.06 24.60	28.26	31.16	1413	1558	2971	1413	1558	2971	
289+00.00 R 1	( 51.66) 13.48 28.17	20.27	26.39	1014	1320	2334	1014	1320	2333	
289+50.00 R 1	( 41.65) 16.18 40.43 ( 56.61)	14.83	34.30	741	1715	2456	741	1715	2456	
TOTAL SF=	LEFT 6330.0000	RIGHT 9353.0000	1	BOTH	0					
ACRES=	0.1453	0.2147	6	.3000						

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 2-1007.00</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) x 1.30 = <u>2969 C.Y.</u>

#### 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.

	ESTIMATED GRADING QUANTITIES												
DESCRIPTION				/OLUMES (CY)	ADJUSTED VOLUMES (CY)	BALANCE SUMMARY							
				EXC.	EMB.	EXC.	SHRINK = 30	0%	SWELL =	30 %			
MAINLINE				1226	3142	859							
SIDE ROADS				0	0								
PVT. DRIVES, BUSINES	FIELD ENTRA	NCES	0	0		EMB.		EXC.					
INDEPENDENT DITCHES				0	0								
TEMPORARY CONSTR	UCTIO	N EXITS		0	0		3142	VS.	-859				
OTHER (BRIDGE EXCA	VATIO	N, PAVEMENT,	ETC)	0	0								
TOPSOIL (EMB.)				326			AVAILABLE	=	2283				
TOPSOIL (EXC.)				483									
		TOPSOIL T	OTALS (SEE	TOPSOIL TAB)			BORROW MATER	AL =	2968				
ROCK (C.Y.)				TOTALS (C.Y.	]								
EXC. EME	З.	EXC. (UNCL.) E	EMB. (UNCL.)	EXC (COMMON	) EXC. (AVAIL.)	EXC. (ADJ.)	7						
0 0		2035	3142	2035	1226	859							

	TOPSOIL										
		I	IF EXISTING	TOPSOIL IS	SUITABLE F	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.	ADJUSTED WASTE TOTAL (C.Y.)			
15681	809	0	809	290	290	0	519	3487			
		IF	EXISTING T	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.