Better by DESIGN
MDOT
Design Division

Workflow – Earthwork Calculations using End Area Volumes

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General

This document provides guidance for calculating earthwork using the end area volume method on MDOT projects using the MDOT02 Workspace. This document can be used for any MDOT design project where a complete 3D model has been developed for both existing and proposed conditions. End area volumes can be used to calculate all earthwork items including calculating the amount of topsoil stripping and subtracting existing pavement from the end area volumes.

Utilizing this workflow is required to use the Earthwork Spreadsheet to calculate sheet quantities from end area volumes. This spreadsheet can be found in the following location: Earthwork Spreadsheet

A working knowledge of CADD, OpenRoads and design modeling are necessary to complete the steps described in this document.

Data Requirements

Existing Conditions 3D Model

The existing conditions 3D model must include all elements that are to be included in the earthwork calculations. Examples of items to be included are existing pavement, and existing topsoil to be removed.

The recommended method to create an existing 3D model is described in the MDOT workflow for Modeling Existing Conditions

It is recommended that a new DGN file be created for each existing roadway or ramp model. End area volumes will be calculated for any component that shows up in the cross sections (i.e. any component that is currently displayed in the 3D view). It is much easier to display the necessary information when the existing models are separated by roadway.

Existing Conditions for 3R Projects

Pavement that is being removed must be modeled as a separate surface template from pavement that is remaining in place for 3R projects. Geopak will treat each surface template as a single component when cutting the cross sections. The user will need to differentiate between pavement being removed and pavement remaining in place as this will impact the earthwork calculations.

On 3R projects, it is important to give existing surfaces descriptive names so that users can determine whether the material is being removed or staying in place.

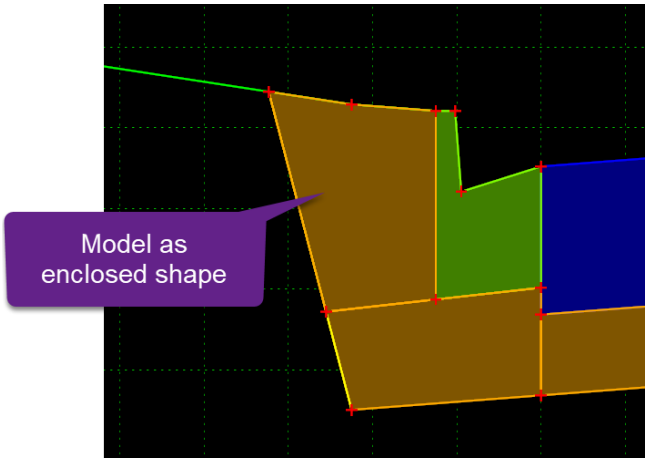
Modeling Existing Topsoil

Geopak will include all components that are displayed in the cross sections when calculating earthwork using the End Area Volume Method. Topsoil components should not extend past the slope stake line.

Proposed 3D Model

Proposed 3D models should be developed to a level that designer feels comfortable with the end area volumes. Geopak will not honor any changes made by hand to cross sections after they are cut. The end area volumes will only be as accurate as the existing and proposed 3D models.

Geopak will not locate embankment areas that are enclosed by proposed model elements. These areas will need to be modeled with enclosed shapes in order to be reported. The image below shows an area behind curb and gutter where this would be necessary.



Creating the Earthwork Cross Section File

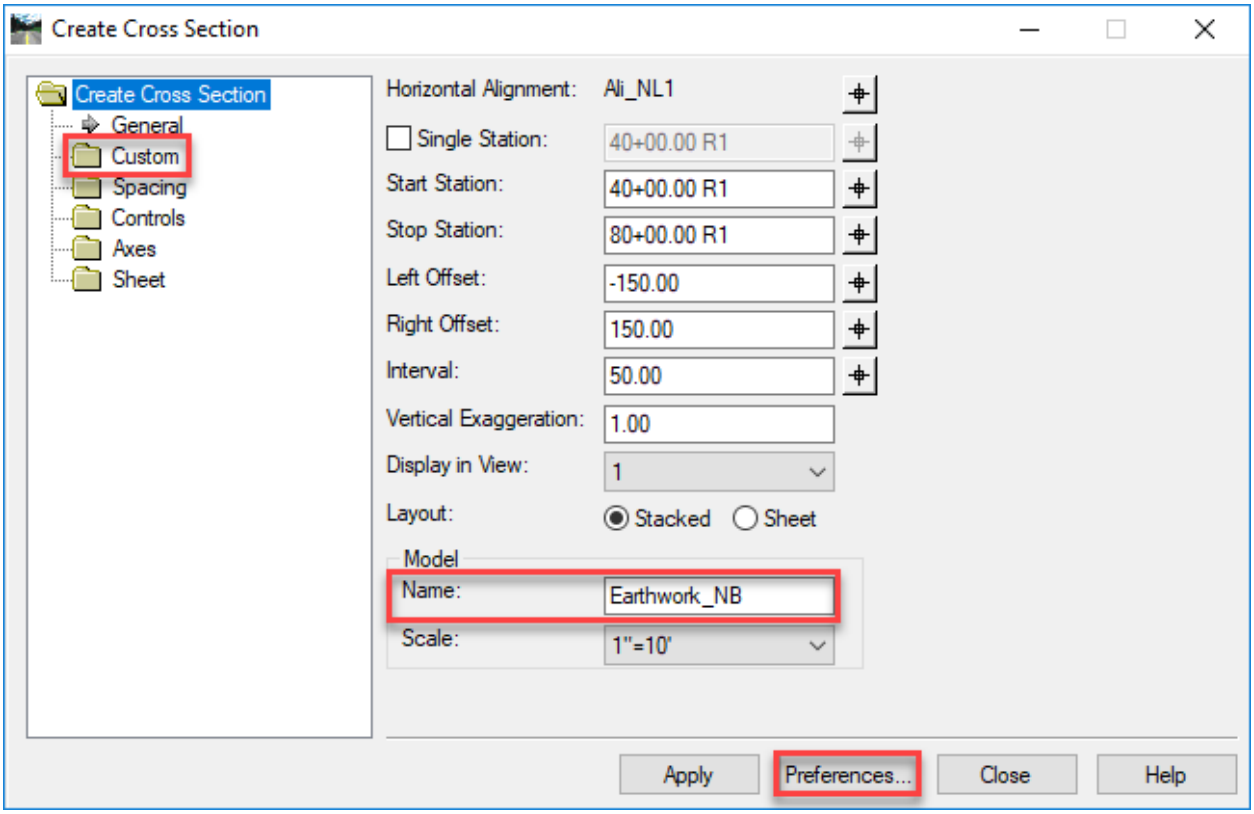
1. Create a new 2D DGN using a Bentley Power GEOPAK OpenRoads edition product (SS4) and the MDOT 02 Workspace. Name the file "Z-XXXXXX-Earthwork" replacing XXXXXX with the Job No. per the standard MDOT naming convention.
2. Reference the existing terrain DGN file and set the existing terrain as active
3. Reference each DGN file containing a 3D model to be included in the earthwork calculations (all existing and proposed models)
4. In the Default-3D model, turn off any levels that are not needed for earthwork calculations along the corridor.
5. Save Settings
    a. The components that will display in the cross sections are the components that were displayed in the Default-3D model view as of the last time the settings were saved

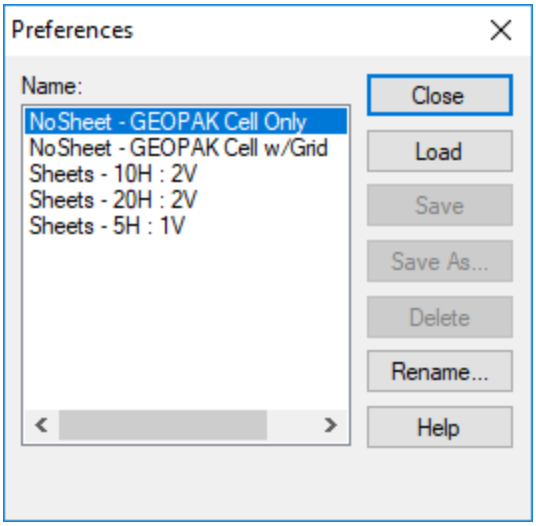
Note that multiple cross section sets can be cut in the same file. It is helpful to create saved views in the 3D view for each cross section set to facilitate re-creating sets later in the design process.

Cutting Cross Sections

1. Cut cross sections by using the Create Cross Section tool

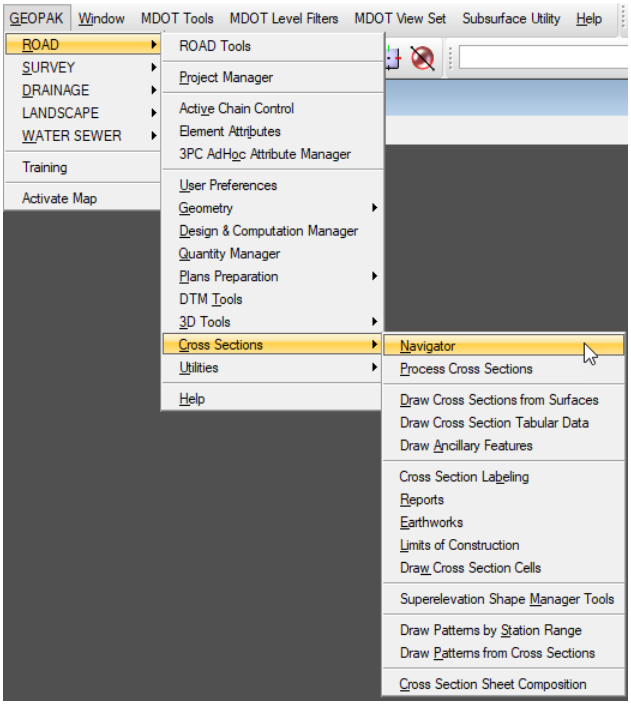
2. Choose the alignment for the desired cross sections
3. Load the preferences “NoSheet – GEOPAK Cell Only”
4. Give the cross section set a descriptive name – This will also be the name of the DGN model that is created for the cross sections
5. Utilize the Custom Cross Sections section to define your cross section interval and to cut cross sections at key locations. Examples of key locations include driveways or taper locations.
    a. Note that these custom cross sections can be saved for later use if cross sections need to be cut again for the same corridor
6. Select Apply to cut the cross sections


Create Cross Section
Create Cross Section
General
Custom
Spacing
Controls
Axes
Sheet
Horizontal Alignment:
Ali_NL1
Single Station:
40+00.00 R1
Start Station:
40+00.00 R1
Stop Station:
80+00.00 R1
Left Offset:
-150.00
Right Offset:
150.00
Interval:
50.00
Vertical Exaggeration:
1.00
Display in View:
1
Layout:
Stacked
Sheet
Model
Name:
Earthwork_NB
Scale:
1"=10'
Apply
Preferences...
Close
Help


Preferences
Name:
NoSheet - GEOPAK Cell Only
NoSheet - GEOPAK Cell w/Grid
Sheets - 10H : 2V
Sheets - 20H : 2V
Sheets - 5H : 1V
Close
Load
Save
Save As...
Delete
Rename...
Help

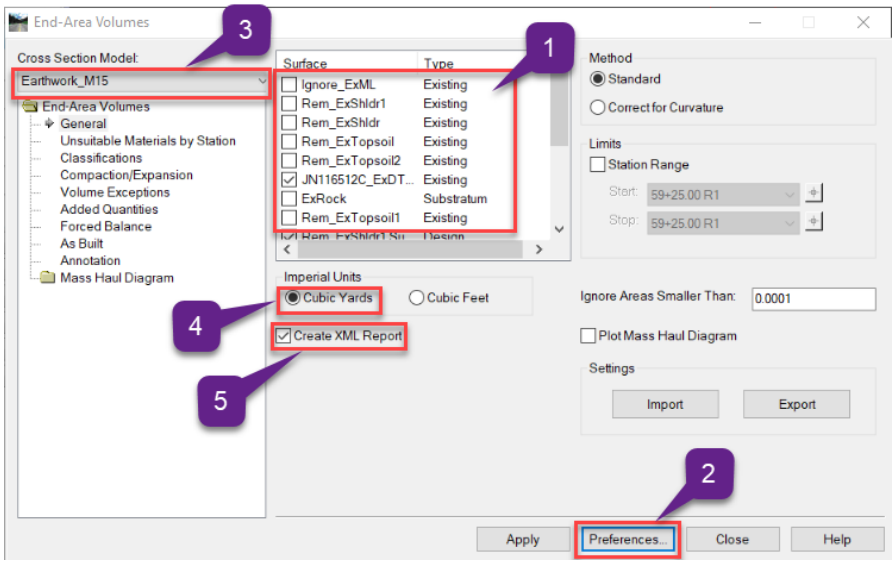
Preparing Cross Sections for Earthwork

1. Review your cross sections to ensure the required components are displayed
    a. The Cross Section Navigator is helpful in this process
2. Compute End Area Volumes using the End Area Volumes tool



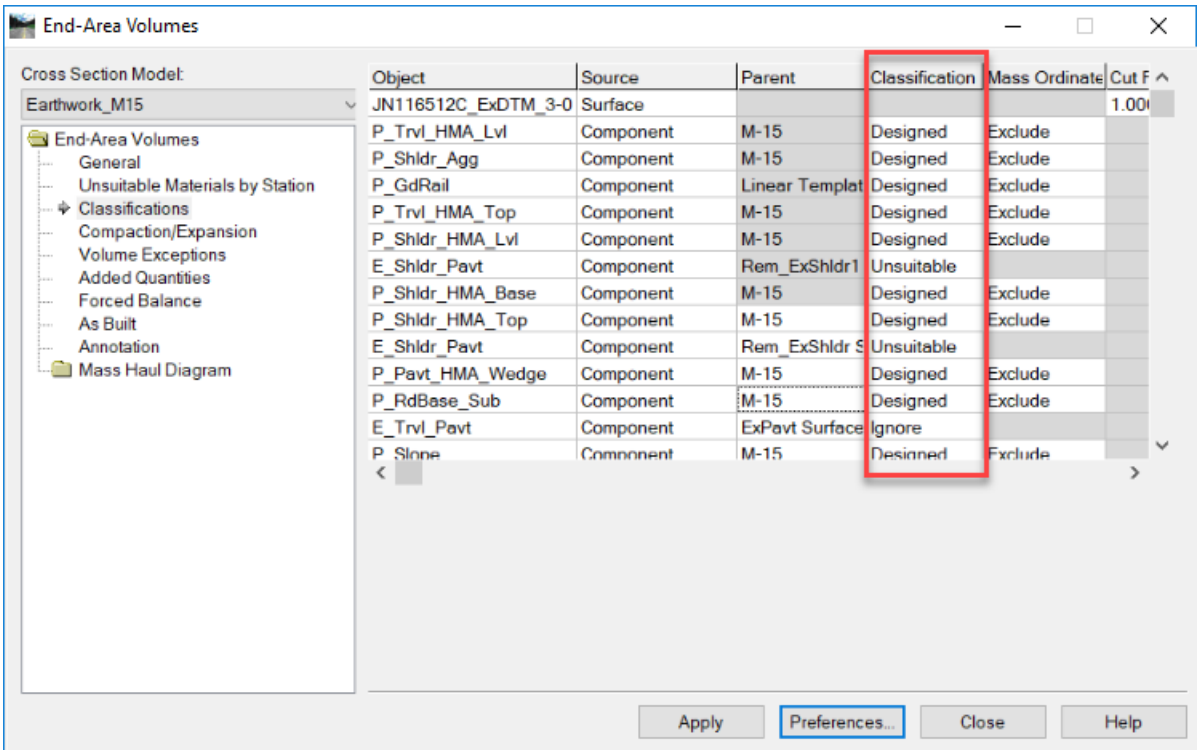
General Tab

1. Uncheck all surfaces of type Existing except for the existing survey terrain
2. Load Earthwork Preferences
3. Ensure the correct cross section model is selected
4. Ensure the Imperial Units are set to Cubic Yards
5. Ensure the Create XML Report is toggled on



Classifications Tab

1. Set existing materials that are being removed to the classification type of Unsuitable
2. Set existing materials that are remaining in place to the classification type of Ignore
    a. If there are proposed materials over top of existing materials that are remaining in place, these proposed materials must also be set to ignore
    b. The name of the surface or corridor is shown in the "Parent" column. If descriptive names are used, this column can be used to easily find materials that should be classified as unsuitable or ignore
3. After classifications are set, Select Apply to generate an XML report of the end area volumes



Below is a description of each classification and how it will be treated in the end area shapes

Ignore – Geopak will treat the component as if it does not exist. The component will not be reported.

Unclassified – The end area of the component will be reported, but it will be ignored in the cut and fill shapes.

Unsuitable – Existing materials that must be removed. Two quantities will be reported. One for unsuitable materials that are above or within the proposed components (Not Replaced), and one quantity for unsuitable materials that are below the proposed components (Replaced). Volume of unsuitable material is not included in normal cut / normal fill.

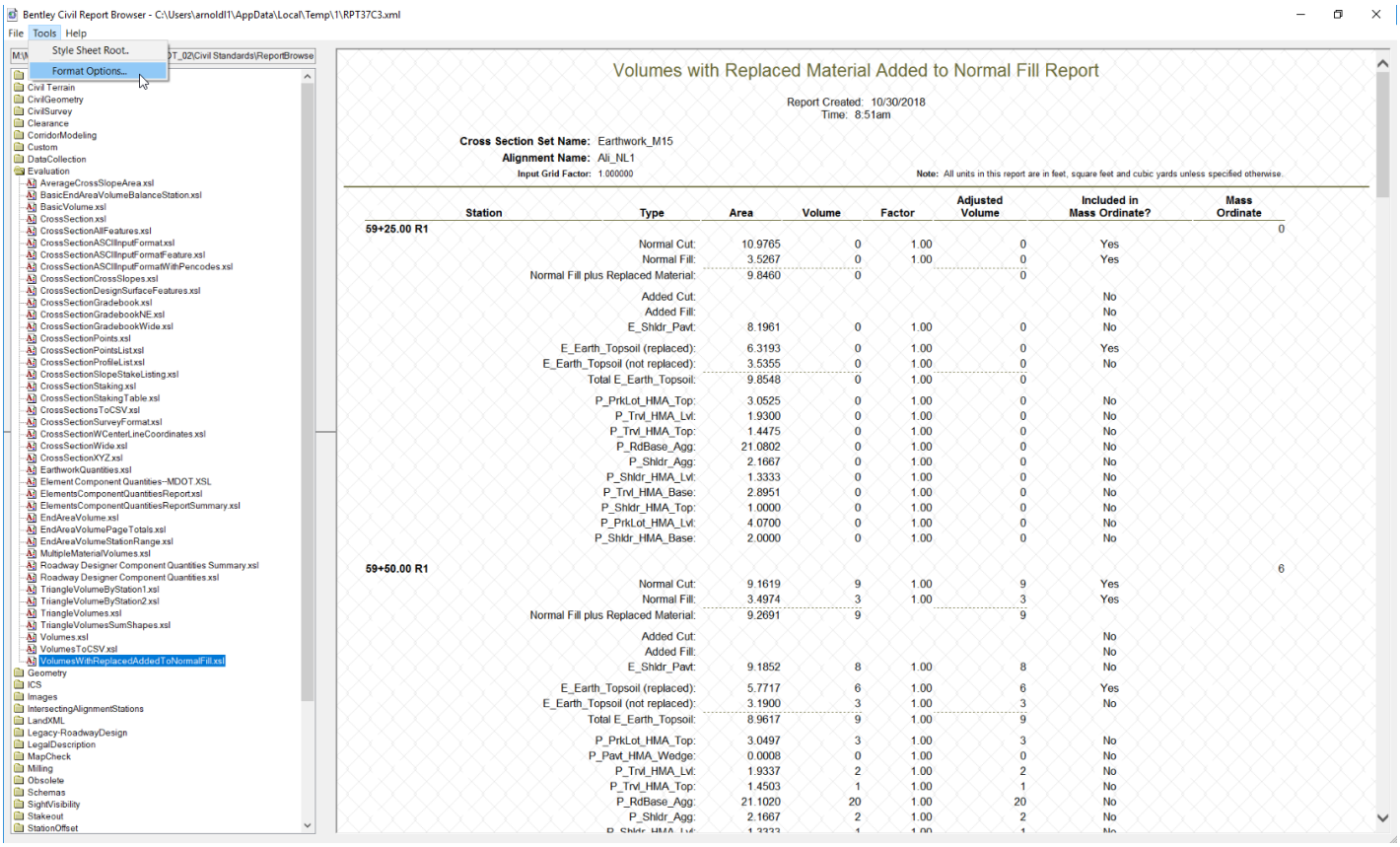
Rock – Should only be used to classify surfaces. This classification reports the end area of proposed elements that are below the rock surface. Rock end areas will be excluded from the normal cut and fill shapes.

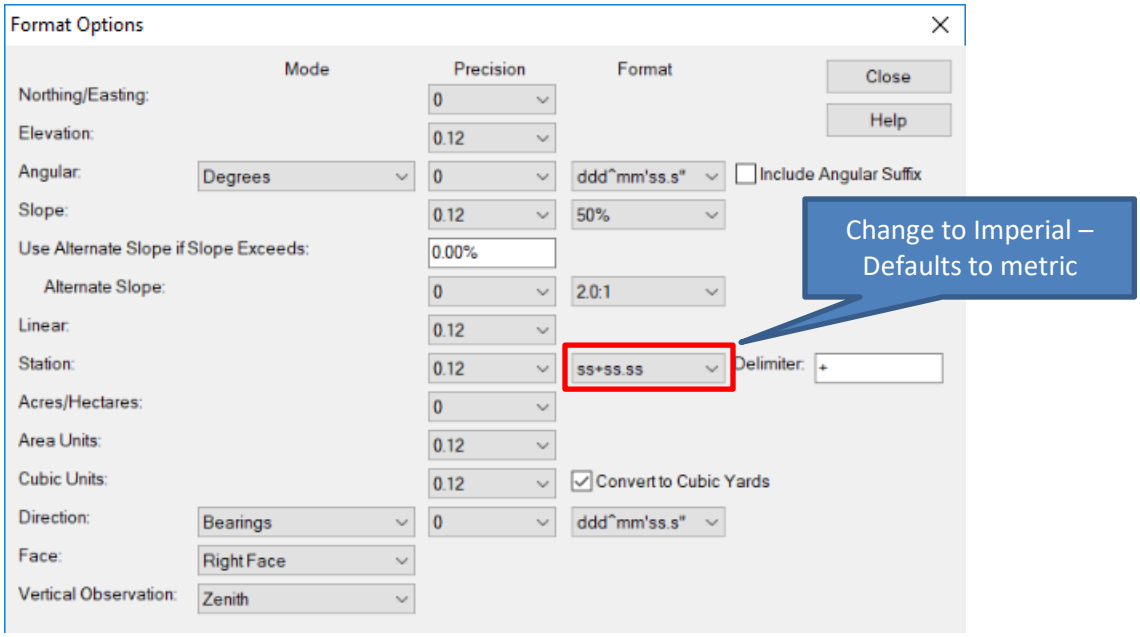
Designed – Proposed component. Reports the end area of components.

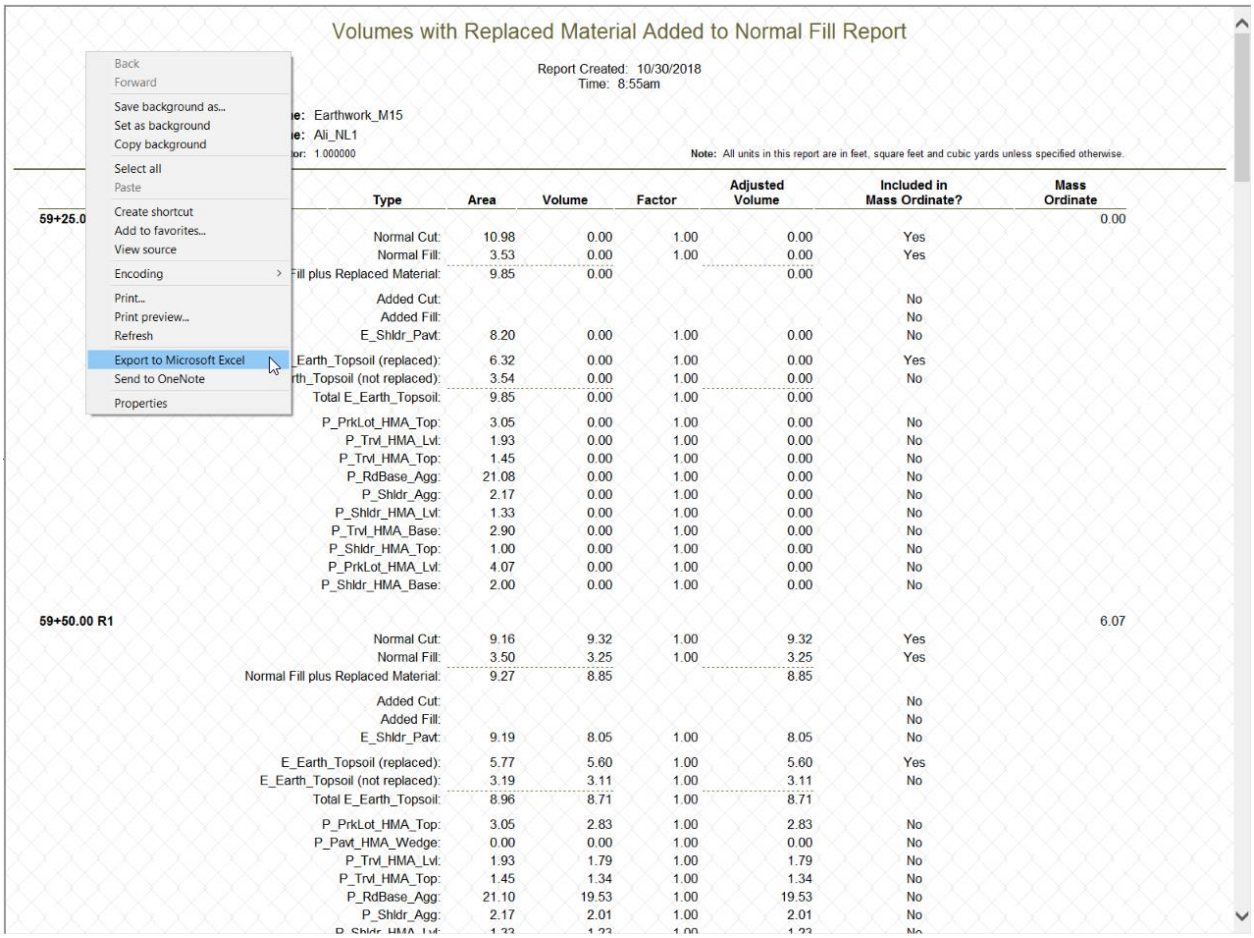
MDC –Two quantities are reported: The quantity of material above the existing surface, and below the existing surface. The end areas of MDC shapes are included in the normal cut and fill shapes. It is not recommended to use the MDC classification.

Reporting End Area Volumes

1. In the Bentley Civil Report Browser, Choose the VolumesWithReplacedAddedToNormalFill.xsl report
2. Ensure your report Options are set properly by selecting Tools → Format Options
3. Right click in the upper left corner of the report browser and choose Export to Excel.
4. Import the report into cell A1 of Microsoft Excel
5. Save the report as an excel spreadsheet. This report can now be utilized for use with the Earthwork Spreadsheet to calculate earthwork sheet quantities.







Volumes with Replaced Material Added to Normal Fill Report

Report Created: 10/30/2018
Time: 8:55am

e: Earthwork_M15
e: Ali_NL1
or: 1.000000

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

	Type	Area	Volume	Factor	Adjusted Volume	Included in Mass Ordinate?	Mass Ordinate
59+25.0							0.00
	Normal Cut:	10.98	0.00	1.00	0.00	Yes	
	Normal Fill:	3.53	0.00	1.00	0.00	Yes	
	Fill plus Replaced Material:	9.85	0.00		0.00		
	Added Cut:					No	
	Added Fill:					No	
	E_Shldr_Pavt:	8.20	0.00	1.00	0.00	No	
	_Earth_Topsoil (replaced):	6.32	0.00	1.00	0.00	Yes	
	rth_Topsoil (not replaced):	3.54	0.00	1.00	0.00	No	
	Total E_Earth_Topsoil:	9.85	0.00	1.00	0.00		
	P_PrkLot_HMA_Top:	3.05	0.00	1.00	0.00	No	
	P_Trvl_HMA_Lvl:	1.93	0.00	1.00	0.00	No	
	P_Trvl_HMA_Top:	1.45	0.00	1.00	0.00	No	
	P_RdBase_Agg:	21.08	0.00	1.00	0.00	No	
	P_Shldr_Agg:	2.17	0.00	1.00	0.00	No	
	P_Shldr_HMA_Lvl:	1.33	0.00	1.00	0.00	No	
	P_Trvl_HMA_Base:	2.90	0.00	1.00	0.00	No	
	P_Shldr_HMA_Top:	1.00	0.00	1.00	0.00	No	
	P_PrkLot_HMA_Lvl:	4.07	0.00	1.00	0.00	No	
	P_Shldr_HMA_Base:	2.00	0.00	1.00	0.00	No	
59+50.00 R1							6.07
	Normal Cut:	9.16	9.32	1.00	9.32	Yes	
	Normal Fill:	3.50	3.25	1.00	3.25	Yes	
	Normal Fill plus Replaced Material:	9.27	8.85		8.85		
	Added Cut:					No	
	Added Fill:					No	
	E_Shldr_Pavt:	9.19	8.05	1.00	8.05	No	
	E_Earth_Topsoil (replaced):	5.77	5.60	1.00	5.60	Yes	
	E_Earth_Topsoil (not replaced):	3.19	3.11	1.00	3.11	No	
	Total E_Earth_Topsoil:	8.96	8.71	1.00	8.71		
	P_PrkLot_HMA_Top:	3.05	2.83	1.00	2.83	No	
	P_Pavt_HMA_Wedge:	0.00	0.00	1.00	0.00	No	
	P_Trvl_HMA_Lvl:	1.93	1.79	1.00	1.79	No	
	P_Trvl_HMA_Top:	1.45	1.34	1.00	1.34	No	
	P_RdBase_Agg:	21.10	19.53	1.00	19.53	No	
	P_Shldr_Agg:	2.17	2.01	1.00	2.01	No	

Back
Forward
Save background as...
Set as background
Copy background
Select all
Paste
Create shortcut
Add to favorites...
View source
Encoding
Print...
Print preview...
Refresh
Export to Microsoft Excel
Send to OneNote
Properties