OpenRoads Designer User Manual

U.S. Department of Transportation
Federal Highway Administration

Chapter 20

QUANTITIES

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Chapter 20 Quantities

This chapter explains how to calculate quantities and generate reports from 3D Models.

TABLE OF CONTENTS

20A – INTRODUCTION TO QUANTITIES

This chapter covers the calculation of quantities from 3D Models created with Corridors, Linear Templates, Surface Templates, and Civil Cells.

20A.1 Best Practices: Creating Corridors, Approaches, and Parking Lots

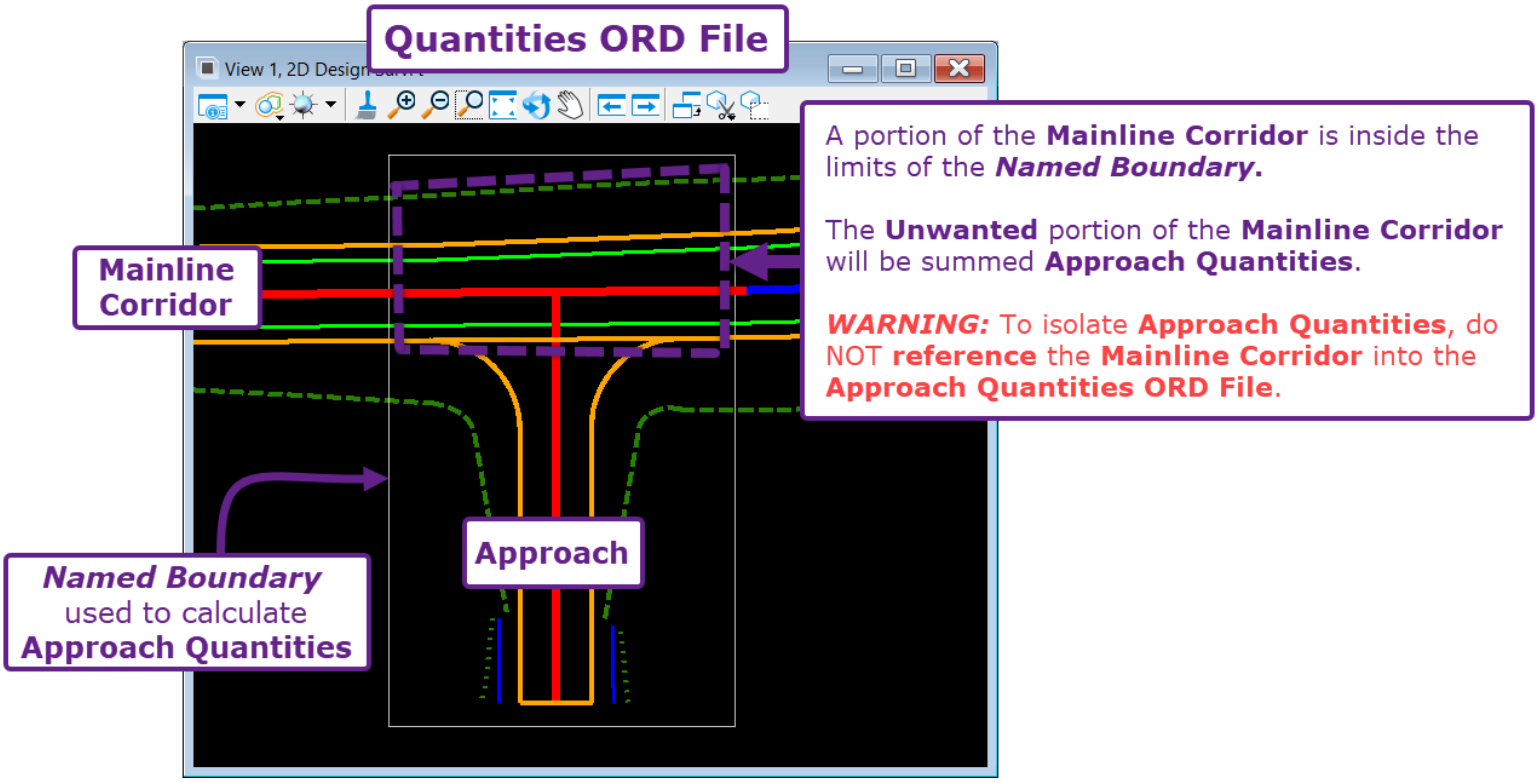
Easy and straightforward quantity calculations begin with proper setup of the mainline Corridor, Approaches, and other modeling entities. It is highly recommended that these BEST PRACTICES are considered at the beginning of project and before Corridor modeling.

BEST PRACTICE – ORD DESIGN FILE SETUP: Do NOT create Approach or Parking Lot models in the same ORD File as the Corridor. Place Approach or Parking models in their own dedicated ORD File (i.e., "…_cor_appr.dgn" for approaches). When calculating quantities, it is very difficult or impossible to separate mainline Corridor and Approach quantities when they are placed in the same file.

WARNING: When calculating Approach model quantities, create a dedicated **Approach Quantities ORD File** and do NOT reference the Mainline Corridor into that File.

> ***EXPLANATION:*** Typically, quantities for a Corridor are calculated with the *Component Quantities* tool – which isolates the Corridor Quantities. The combined Surface Templates and Linear Templates used to model an Approach are calculated in bulk with a *Named Boundary* element.
>
> ***IMPORTANT:*** The Corridors, Surface Templates, and Linear Templates used to model Approach Roads can NOT be isolated if a portion of the Mainline Corridor is within the *Named Boundary*.

As shown below, the *Named Boundary* would include unwanted Corridor quantities, if the mainline Corridor and Approaches are referenced into the same Quantities ORD File.



BEST PRACTICE – CORRIDOR AND APPROACH MODELING TECHNIQUES: Whenever possible, AVOID using Corridor Clipping in the mainline Corridor – particularly in the vicinity of an Approach. Alternate strategies for addressing overlap between the mainline Corridor and Approach modeling entities is discussed in *11A.5 Overlap Between Mainline Corridor and Site Modeling Features*.

> ***TIP:*** The preferred method for accommodating Approaches in the mainline Corridor is to use a Road Template that utilizes Display Rules to trigger OFF shoulder and end condition components in the vicinity of the Approach. See *11A.5.c Use a Template containing Display Rules to Address Overlap*.

BEST PRACTICE – FEATURE DEFINITIONS IN TEMPLATES: To decipher quantities reports, the User must know the Feature Definition that each Template Point and Component is assigned to. In the report, material quantities are listed by Feature Definitions. All Template Components assigned to a particular Corridor will be summed together in the report. **To separate material types in the report, each unique material in the Template must be assigned to a unique Feature Definition.**

Feature Definitions are assigned to Template Points and Components in the Template Editor. See *8C.2 Point Feature Definition and Name Properties* and *8D.1 Component Symbology Properties*.

> **EXAMPLE SCENARIO:** In this scenario, a single Corridor utilizes two Templates. Both Templates use asphalt, but the required asphalt mix type differs between the two Templates. This can be problematic because it is FLH convention to place Components that represent asphalt on the "XS_TC_Pavement Layer 1" Feature Definition. If the different asphalt mix Components are assigned to the same Feature Definition (i.e., "XS_TC_Pavement_Layer 1"), then these two different materials will NOT be differentiated in the report – even though they belong to different Templates. **To separate material types in the report, each unique material must be assigned to a unique Feature Definition.**

Consistent and logical Feature Definition assignments (for both Template Points and Template Components) must be considered in Template creation to easily and appropriately separate materials and easily decipher the resulting quantities report.

WARNING: Quantity Calculations from the ORD Software should NEVER be completely trusted. When possible, use hand-calculations and engineering judgment to assure the validity of automatically calculated quantities.

> For example, for a concrete sidewalk quantity in a parking lot design; manually draw an enclosed shape around the perimeter of the sidewalk. Compare the area of the enclosed shape with the automatically calculated values derived from the Sidewalk Template Model.
>
> ***BEST PRACTICE:*** For asphalt, use hand-calculations to validify the automatically calculated quantities from the Road Template. To approximate the volume of asphalt: multiply the **width** and **length** of the road against the **depth** of the asphalt. Compare this hand-calculation with the report quantity. It is acceptable and advised to use the report quantity ONLY after its validity has been established.

WARNING: Confirm that Cut/Fill (earthwork) quantities are within the expected order of magnitude. A common mistake is forgetting to delete previously-created Cut/Fill mesh elements when re-calculating quantities. This results in Cut/Fill quantities that are approximately **doubled**. See *20B.3 WARNING: Re-creating Cut and Fill Meshes*.

20A.2 Calculation Methods: Prismatic vs Average Area End Method

There are two general methods for calculating quantities: **Prismatic** or **Average Area End Method**.

Prismatic Method: When using prismatic calculations, the entire length/area/volume of the 3D elements are analyzed. With this method, the resulting quantity calculations will exactly reflect the accuracy of the 3D Model.

Average Area End Method: The *Average Area End Method* is used to calculate earthwork quantities at specified cross-section locations. With this method, the accuracy of the results depend on how frequently cross-sections are analyzed. This method is most appropriate for linear projects that utilize Corridors. This method is NOT appropriate for irregular site designs – such as parking lot projects.

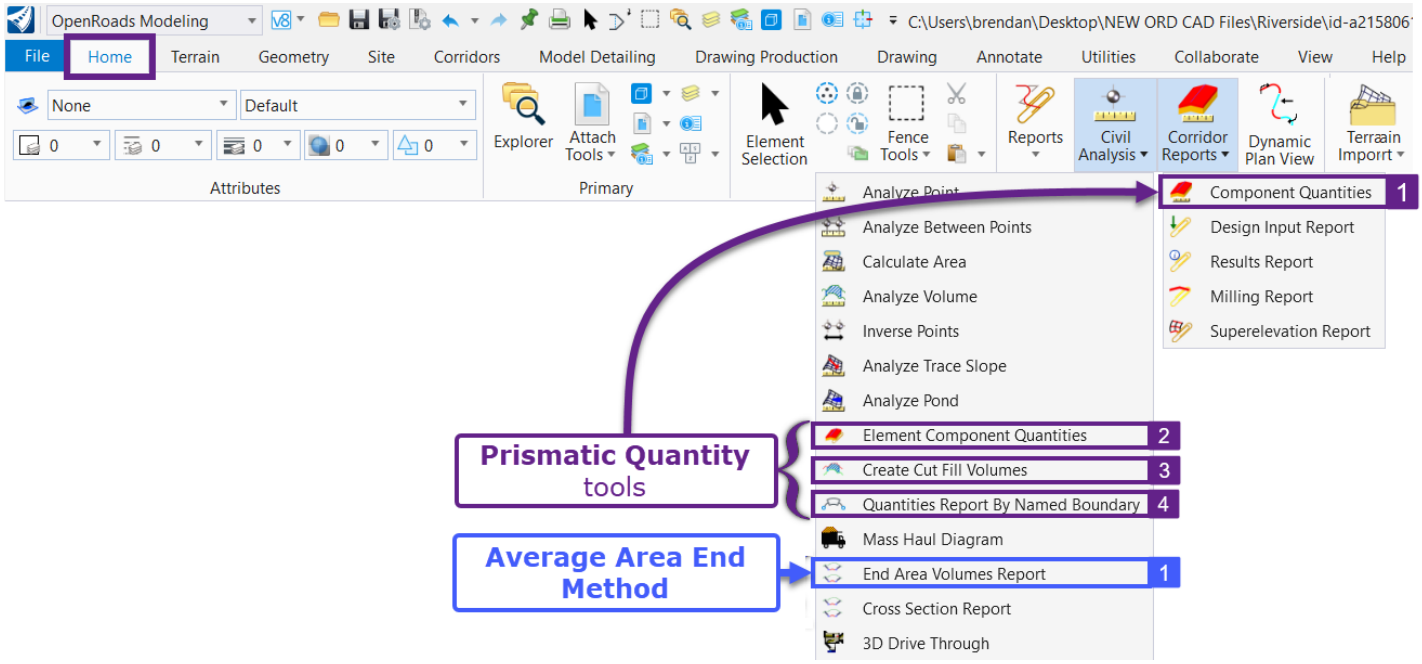
WARNING: With this method, the 3D Model is IGNORED in between the specified cross-section locations. If an important feature is located in between adjacent cross sections, then the corresponding quantities will not be reflected in **Average Area End Method** quantity calculations.

BEST PRACTICE: In general, Prismatic Quantity tools should be used because the results better reflect the 3D Model. Average Area End Method calculations should only be used if a Average Area End Method earthwork report is required for the specific project.

20A.3 Tools used in Quantity Calculations

Tools used for quantity calculations and reporting are found in the following location:

OpenRoads Modeling workflow → **Home** tab → **Model Analysis and Reporting** panel



NOTE: The *Component Quantities* tool 1 and *Element Component Quantities* tool 2 are very similar. They both operate by simply selecting a Corridor, Linear Template, or Surface Template. However, each tool has limitations. See the table on the next page for the advantages and disadvantages of each tool.

Prismatic Quantity tools		
	Tool:	**Description:**
1	**Component Quantities**	Generates volume and surface area quantities for a single Corridor or Linear Template. This tool is generally used to quickly calculate the quantities for the mainline Corridor. **PRO:** This tool generates Cut and Fill volume quantities without using the *Create Cut Fill Volumes* tool. **CON:** Only a single Corridor or Linear Template can be selected per report. Surface Templates are NOT compatible with this tool. Unsuitable Materials CANNOT be calculated with this tool Operation of this tool is shown in *20C.1 Component Quantities tool for Corridors*.
2	**Element Component Quantities**	Generates surface area and volume quantities for one or more Corridors, Linear Templates, and Surface Template. **PRO:** Multiple Corridors, Linear Templates, and Surface Templates can be selected and totaled in a single report. Surface Templates are compatible with this tool. **CON:** This tool does NOT generate Cut and Fill quantities. Cut and Fill Meshes for Surface Templates must be generated with the *Create Cut Fill Volumes* tool and calculated with the *Quantities Report By Named Boundary*.
3	**Create Cut Fill Volumes**	This tool generates Cut and Fill Meshes between sub-grade and the Existing Ground Terrain Model. This tool needs to be used prior to the *Quantities Report By Named Boundary* tool and *End Area Volume Report* tool. This tool is discussed in *20B – Create Cut Fill Volume Tool and Earthwork Calculations*. ***WARNING:*** Cut and Fill Meshes are STATIC – which means they will NOT adjust if the design changes. If the design changes, then previously-created Cut/Fill mesh elements must be deleted and re-created. See *20B.3 WARNING: Re-creating Cut and Fill Meshes*.
4	**Quantities Report By Named Boundary**	Creates a report that calculates the lengths, volumes, and surface areas of all 3D modeling elements located in the limits of a PLAN *Named Boundary*. However, this tool does NOT require a PLAN *Named Boundary* to be created. If the "None" option is selected, then the resulting report will reflect all quantities in the ORD File. ***IMPORTANT:*** This tool needs to be used for models that utilize Surface Templates - such as Parking Lots and Approaches. A detailed workflow for this tool is shown in *20C – Quantities Report Workflow for Roadway with Approaches*.

Average Area End Method tools		
	Tool:	**Description:**
1	**End Area Volume Report**	Creates a report that calculates Cut and Fill areas and volumes at specified cross section station locations. This tool requires the User to create CROSS SECTION *Named Boundaries* to specify the stationing interval for cross section calculations. A detailed workflow for this tool is shown in *20D - Earthwork By Cross Sections*.

20A.4 Example Usages for Quantity Workflows

There are four workflows for quantities calculations. Each workflow has advantages, disadvantages, and limitations. The table below explains which workflows can be used for specific design situations and project types.

IMPORTANT: To generate quantities for **Surface Templates**, the *Quantities Report By Named Boundary* workflow MUST be used.

Quantity Workflows			
Workflow:	**Recommended Use:**	**Compatibility:**	**Disadvantages:**
Component Quantities *20C.1 Component Quantities tool for Corridors*	*Corridors* Very quick workflow for calculating materials and earthwork for single Corridor or Linear Template. Typically, used to calculate quantities for the **Mainline Corridor**.	• Corridors • Linear Templates	If the Corridor uses Clipping (not recommended), then the clipped portions are included in the output report – which produces quantities overlap with the clipping feature. Only a single Corridor OR Linear Template can be shown in the output report. Unsuitable Materials are NOT accounted for.
Quantities Report by Named Boundary *20C – Quantities Report Workflow for Roadway with Approaches* All Corridor, Linear Template, and Surface Template quantities within a Named Boundary are calculated.	Non-Mainline Corridor quantity calculations: • Approach Roads • Driveways/Aprons • Intersections • Parking Lots • 3D Linear Elements (i.e., guardrail) • Site Design • Unsuitable Material Calculations	**All and any combination of 3D Modeling elements within the specified Named Boundary:** • Corridors • Linear Templates • Surface Templates • 3D Linear Elements	Reports can be difficult to decipher; especially when inconsistent Feature Definitions are used amongst Corridors, Linear Templates, and Surface Templates. For guidance in deciphering the resulting report, see *20A.6 Deciphering and Understanding the Quantities Report*. Cut/Fill Meshes must be created with the Create Cut Fill Volumes tool. Cut/Fill Meshes are STATIC – which means they do not adjust when the design changes. If previously-created Cut/Fill Meshes are NOT deleted, then quantity overlap occurs.
Element Component Quantities *20A.5.c. Element Component Quantities tool.*	Material quantities ONLY. Will NOT generate earthwork quantities.	• Corridors • Linear Templates • Surface Templates	Does NOT include cut/fill (earthwork) quantities.
End Area Volume Report *20D – Earthwork by Cross Section*	Not recommended unless required for specific project. Do NOT use for Parking Lots.	• Corridors • Linear Templates • Surface Templates	Due to the nature of By Section calculations, the resulting output is generally less accurate than Prismatic calculations. Specifically, this workflow should NOT be used for Site Designs and Parking Lots.

20A.5 Quantity Workflow Overviews

The following flow charts briefly describe how to use each Quantity Calculation tool.

20A.5.a Component Quantities tool

The *Component Quantities* tool works by simply selecting a Corridor or Linear Template. A detailed workflow is shown in *20C.1 Setup the Corridor Quantity File and use the Component Quantities tool*.

Create a new Corridor Quantity File.

↓

Reference in the following ORD Files:

- **Existing Terrain Model File**
- **Corridor Modeling File**

↓

Use the *Component Quantities* tool.

Ribbon Location:
[OpenRoads Modeling → Home → Model Analysis and Reporting]

Select the Corridor Handle or Linear Template Handle.

↓

Save the Quantities Report.

20A.5.b Quantities Report By Named Boundary tool

The *Quantities Report By Named Boundary* tool will sum ALL Corridors, Linear Templates, and Surface Templates quantities within the limits of PLAN *Named Boundary*. **ALTERNATIVELY,** if PLAN *Named Boundary* elements are NOT created, then all elements in the ORD File will be analyzed.

A detailed workflow is shown in *20C – Quantities Report Workflow for Roadway with Approaches*. Also, tips and guidelines for deciphering the resulting quantity report is discussed in *20A.6 Deciphering and Understanding the Quantity Report*.

Create a new Quantity File.

↓

Reference in the following ORD Files:

- **Existing Terrain Model File**
- **Design Files that contain desired Corridor, Linear Template, and Surface Template models**

↓

OPTIONAL: Create PLAN *Named Boundary* elements to specify specific calculation areas.

If *Named Boundary* elements are NOT created, then all elements referenced into the ORD File are analyzed.

↓

Create Cut/Fill Meshes with the *Create Cut Fill Volumes* tool.

↓

Use the *Quantities Report By Named Boundary* tool to generate the quantity report.

↓

Save the Quantities Report.

20A.5.c Element Component Quantities tool

The *Element Component Quantities* tool is the EXACT same as the *Component Quantities* tool, with three exceptions:

- This tool CANNOT calculate Cut/Fill (Earthwork) quantities – which can be done with the *Component Quantities* tool.
- Multiple Corridors, Linear Templates, and Surface Templates can be selected and totaled in a single report – which could be useful for quickly calculating pavement section quantities. The *Component Quantities* tool can only select ONE Corridor or Linear Template at a time.
- This tool can calculate Component Quantities for **Surface Templates**. The *Component Quantities* tool is NOT compatible with **Surface Templates**.

The procedure for operating this tool is the exact same as the *Element Component Quantities* tool. See *20C.1 Component Quantities tool for Corridors*.

Create a new Quantity File.

Reference in the following ORD Files:

- **Existing Terrain Model File**
- **Design Files that contain desired Corridors, Linear Templates, and Surface Templates models**

Use the Element Component Quantities tool.

Ribbon Location:
[OpenRoads Modeling → Home → Model Analysis and Reporting]

Select a single or combination of Corridors, Linear Templates, and Surface Templates.

Save the Quantities Report.

20A.5.d End Area Volumes Report tool

The *End Area Volumes Report* will generate an Earthwork Report at each CROSS SECTION *Named Boundary* station. In the resulting report, only Cut/Fill areas and volumes are shown.

A detailed workflow is shown in *20D – Earthwork By Cross Section (Average Area End Method)*.

Create a new Quantity File.

Reference in the following ORD Files:

- **Existing Terrain Model File**
- **Alignment File**
- **Design Files that contain desired Corridors, Linear Templates, and Surface Templates**

Create CROSS SECTION *Named Boundaries* at desired station locations.

Create Cut/Fill Meshes with the *Create Cut Fill Volumes* tool.

Use the End Areas Volume Report tool to generate the Earthwork Report.

Save the Quantities Report.

20A.6 Deciphering and Understanding the Quantity Report

When using the *Quantities Report By Named boundary* tool, the resulting quantity report analyzes and includes ALL 3D elements that are referenced into the *3D Design Model* - which can make the quantity report appear cluttered. The following concepts must be considered when deciphering quantity reports:

CONCEPT 1 – Verify Quantity Calculations with Hand Calculations:

WARNING: Quantity Calculations from the ORD Software should NEVER be completely trusted. When possible, use hand-calculations and engineering judgment to assure the validity of automatically calculate quantities.

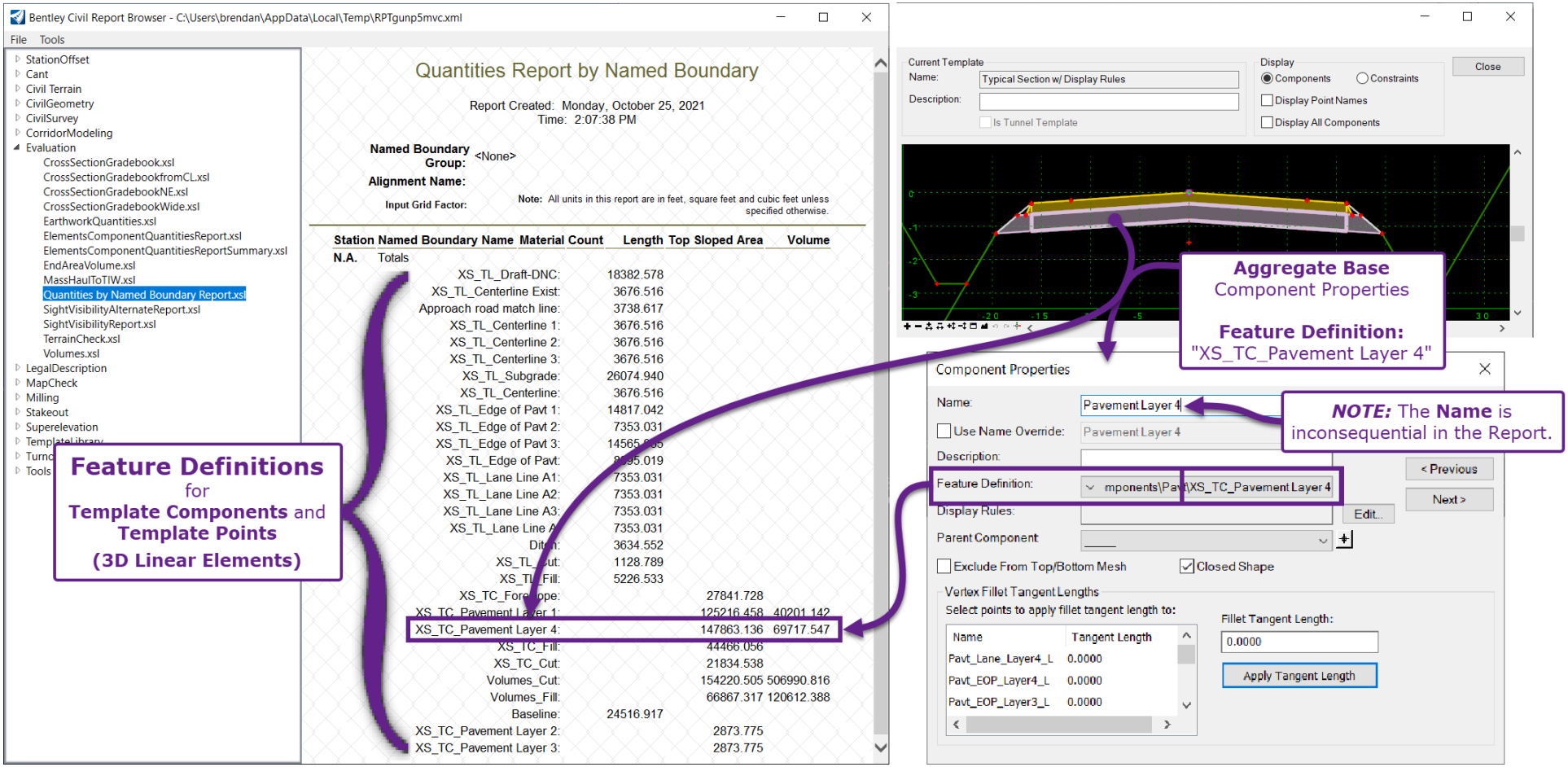
> For example, for a concrete sidewalk quantity in a parking lot design; manually draw an enclosed shape around the perimeter of the sidewalk. Compare the area of the enclosed shape with the automatically calculated values derived from the Sidewalk Template Model.

BEST PRACTICE: For asphalt, use hand-calculations to validify the automatically calculated quantities from the Road Template. To approximate the volume of asphalt: multiply the **width** and **length** of the road against the **depth** of the asphalt. Compare this hand-calculation with the report quantity. It is acceptable and advised to use the report quantity ONLY after its validity has been established.

WARNING: Confirm that Cut/Fill (earthwork) quantities are within the expected order of magnitude. A common mistake is forgetting to delete previously-created Cut/Fill Meshes when re-calculating quantities. This results in Cut/Fill quantities that are approximately **doubled**. See *20B.3 WARNING: Re-creating Cut and Fill Meshes*.

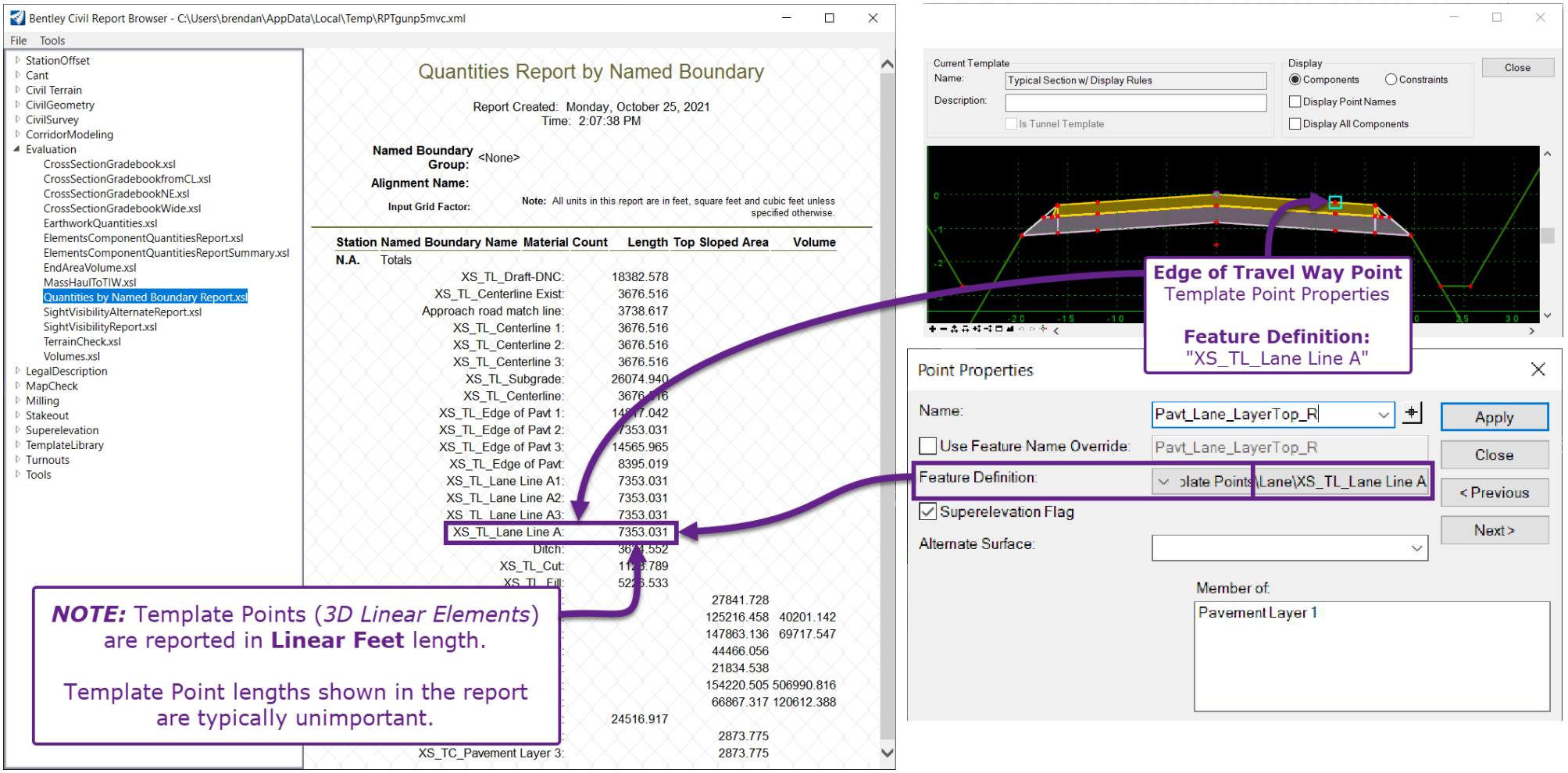
CONCEPT 2 – Feature Definition: The quantity report is listed by Feature Definition. All 3D elements assigned to a specific Feature Definition are summed together and placed on the same line in the report. **To separate material types in the report, each unique material must be assigned to a unique Feature Definition.**

TIP: Feature Definitions are assigned to Template Points and Components in the Template Editor. See *8C – Template Points* and *8D.1 Component Symbology Properties*.

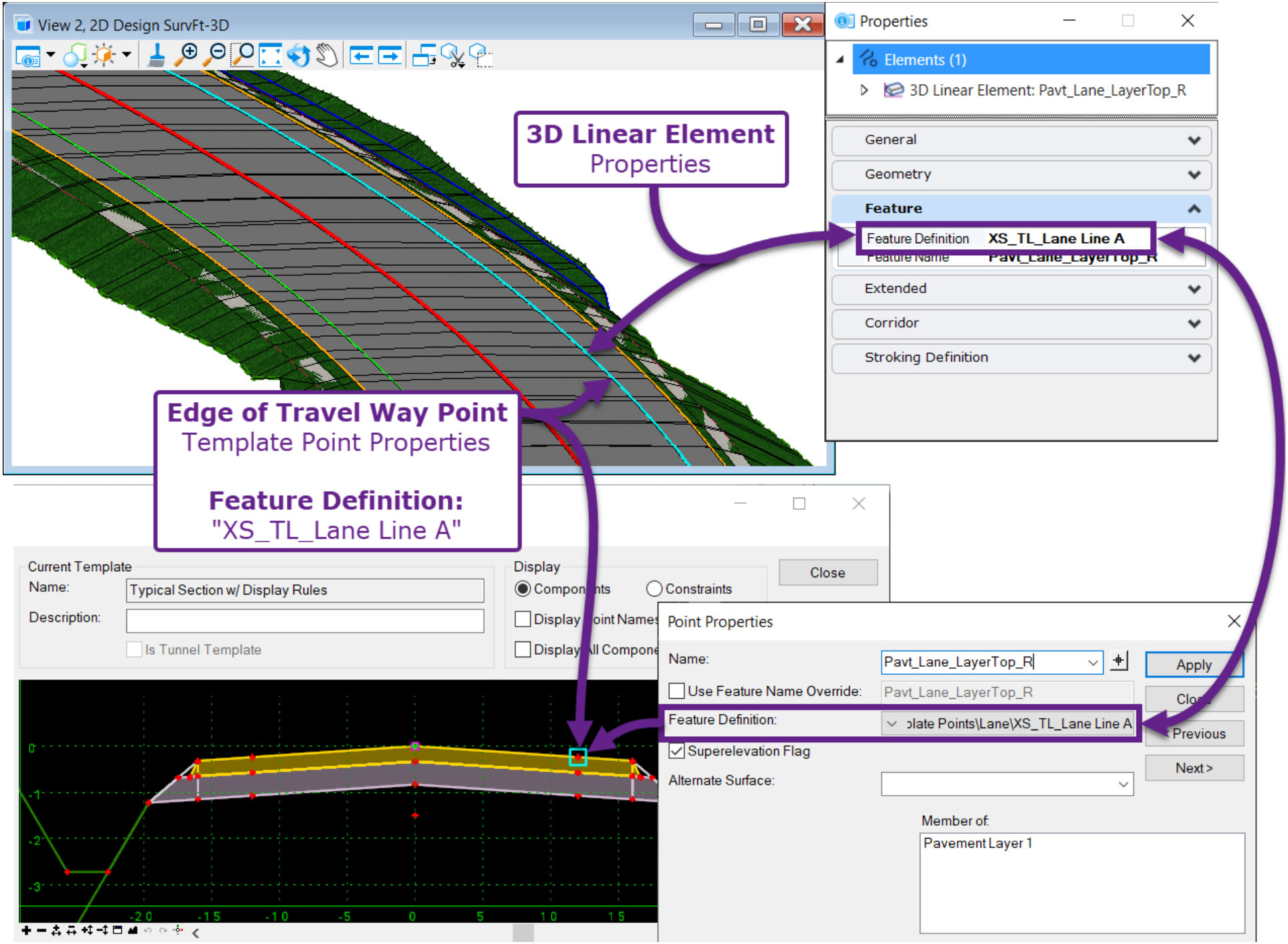


CONCEPT 3 – Template Points in the Report: All 3D elements in the current ORD File will be analyzed and included in the quantity report – which means there will be extraneous and unimportant information to sift through. Specifically, Feature Definitions that correspond with Template Points (*3D Linear Elements*) are often ignored because they are not relevant to bid items in the project.

Background Information: In the creation of Corridors, Template Points are extruded as *3D Linear Elements* (which is graphically depicted on the next page). As stated, all 3D elements found in the ORD File are be included in the report when the *Quantities Report By Named Boundary* tool is used. See **CONCEPT 4** for additional guidance in identifying 3D element types within the report.



See the next page for a graphical depiction of the **Edge of Travel Way Point** in the *3D Design Model* .

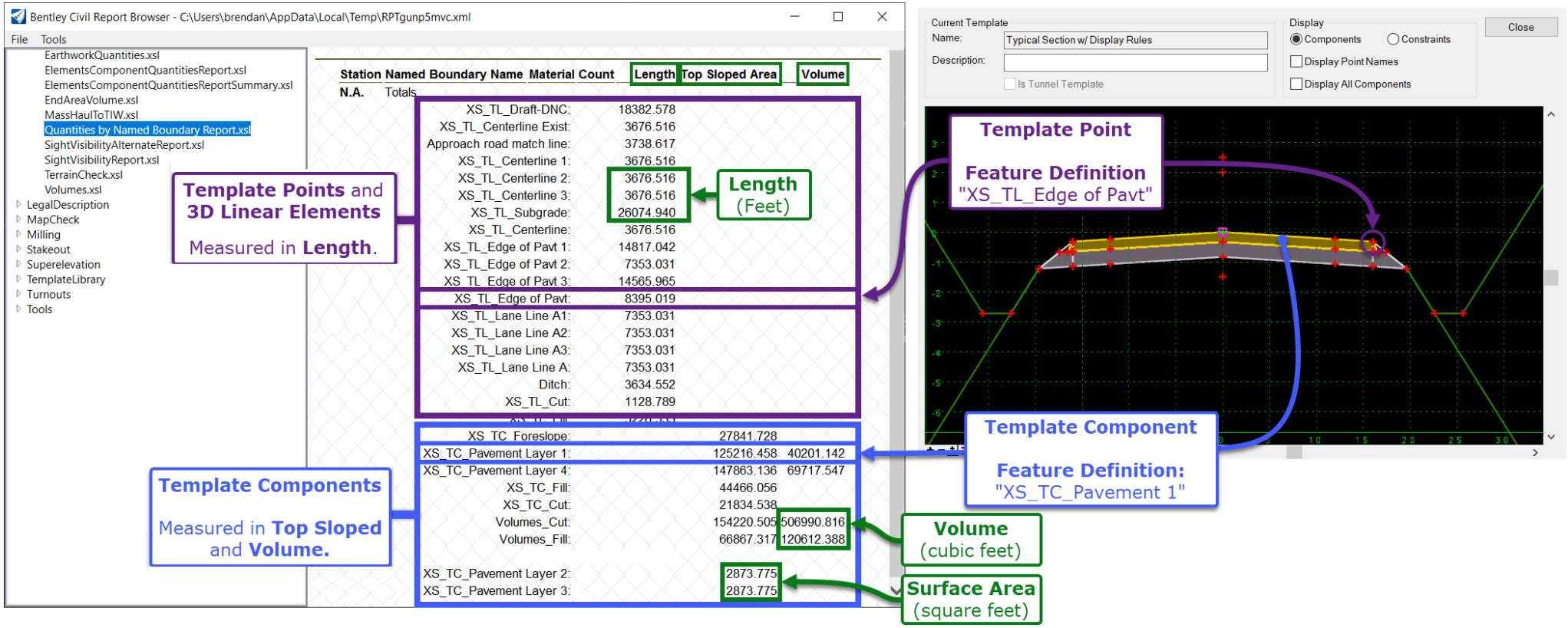

View 2, 2D Design SurvFt-3D
3D Linear Element
Properties
Edge of Travel Way Point
Template Point Properties
Feature Definition:
"XS_TL_Lane Line A"
Properties
Elements (1)
3D Linear Element: Pavt_Lane_LayerTop_R
General
Geometry
Feature
Feature Definition
XS_TL_Lane Line A
Extended
Corridor
Stroking Definition
Current Template
Name:
Typical Section w/ Display Rules
Description:
Is Tunnel Template
Display
Constraints
Close
Point Properties
Name:
Pavt_Lane_LayerTop_R
Use Feature Name Override:
Pavt_Lane_LayerTop_R
Feature Definition:
Superelevation Flag
Alternate Surface:
Apply
Previous
Next >
Member of:
Pavement Layer 1

CONCEPT 4 – Identify Template Points and Components by Reported Units of Measurements: To identify and distinguish between *Template Points* and *Template Components* in the report, examine the Units of Measurement.

Template Points (*3D Linear Elements*) are measured in Length units. By default, Template Points (*3D Linear Elements*) are reported **Feet**.

Template Components are reported by Surface Area (square feet) and/or Volume (cubic feet). Template Components can be *Planar* or *Volumetric* – which is discussed on the next page.

IMPORTANT: Typically, volumetric plan set bid items are specified in **CUBIC YARDS**. Volume Components in the report are in **CUBIC FEET**. Convert reported quantities to **CUBIC YARDS** for bid item purposes.



CONCEPT 5 – Planar Components versus Volumetric Components: As discussed in *8A.2 Basic Parts of a Template*, Template Components can be *Volumetric* (enclosed shape) or *Planar* (open shape or line vector).

Planar Components: Planar components are reported in Surface Area units (square feet) – which is denotated as "Top Sloped Area" in the report.

In a typical Road Template, common Planar components include:

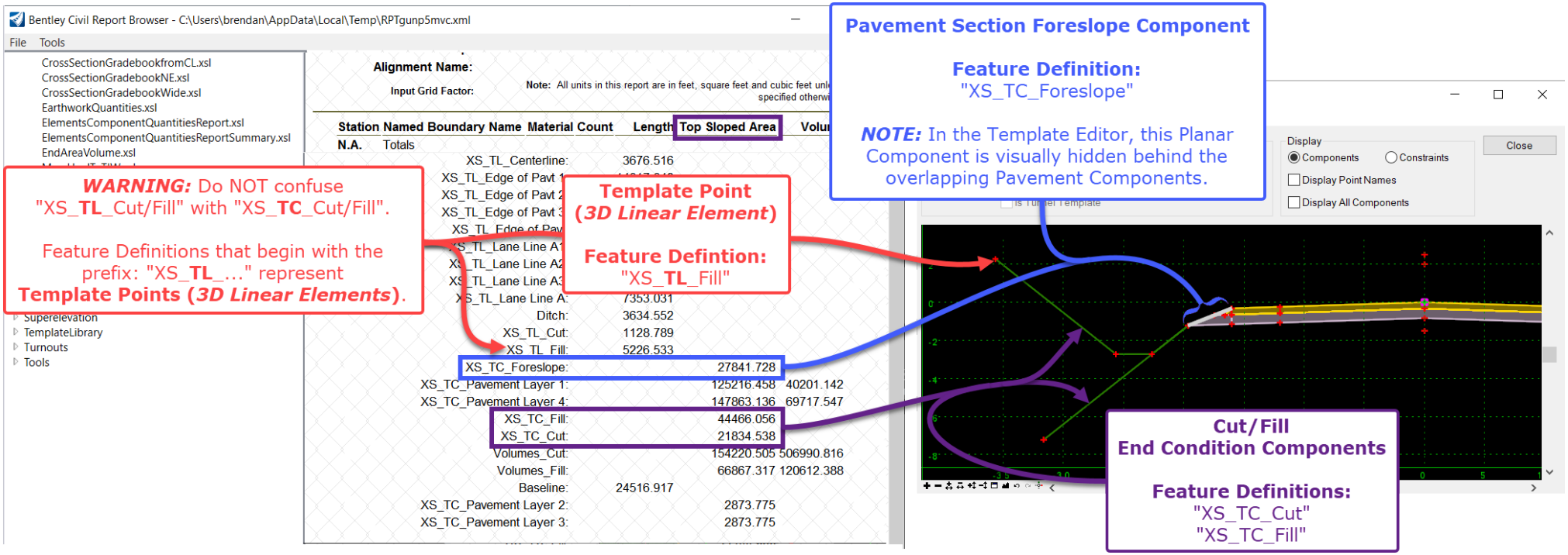
- Cut/Fill End Condition Components (found on the "XS_TC_Cut" or "XS_TC_Fill" Feature Definitions)

  Real-World Application: The surface area of the Cut/Fill End Condition Components typically corresponds with Turf Establishment quantities. For example, the Cut/Fill End Condition reported surface area value may represent the embankment slope area which requires Turf Establishment.

- Pavement Section Foreslope Components (found on the "XS_TC_Foreslope" Feature Definition)

  Real-World Application: The Pavement Section Foreslope surface area value may NOT be relevant for all FLH Projects. However, if the project requires the Pavement Section Foreslope to undergo Turf Establishment, then this surface area value could be utilized.

IMPORTANT: Planar components report the true, 3D sloped area value of the component. For example, if Turf Establishment area was manually measured in the *2D Design Model*, then the resulting value would be underestimated, because the embankment slope is NOT accounted from a top-down measurement.

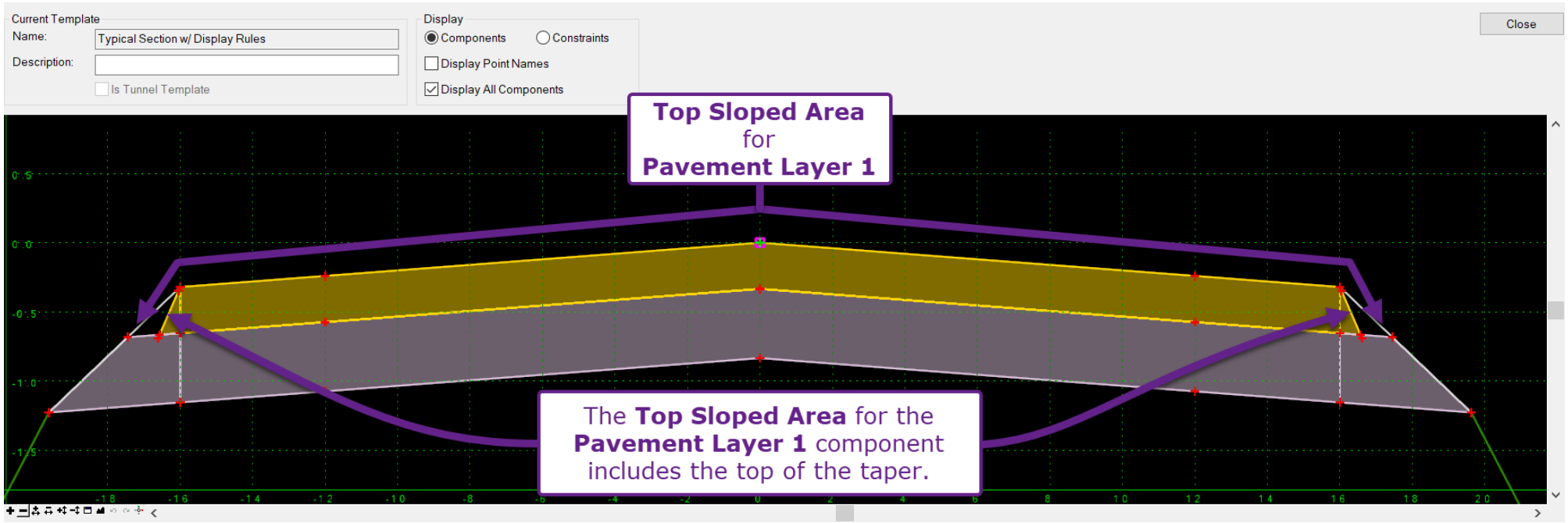


Volumetric Components: Volumetric Components are reported in both Volume (cubic feet) and Top Sloped Area units (square feet). Commonly, Volumetric Components represent materials that form the pavement section, such as Asphalt ("Pavement Layer 1") and Aggregate Base ("Pavement Layer 4").

Top Sloped Area: For Volumetric Components, only the TOP surface area of the Component is measured and reported.

WARNING: The "Top Sloped Area" measurement is occasionally unreliable for Volumetric Components. When possible, use hand-calculations to quantify surface areas – instead of relying on this reported value.

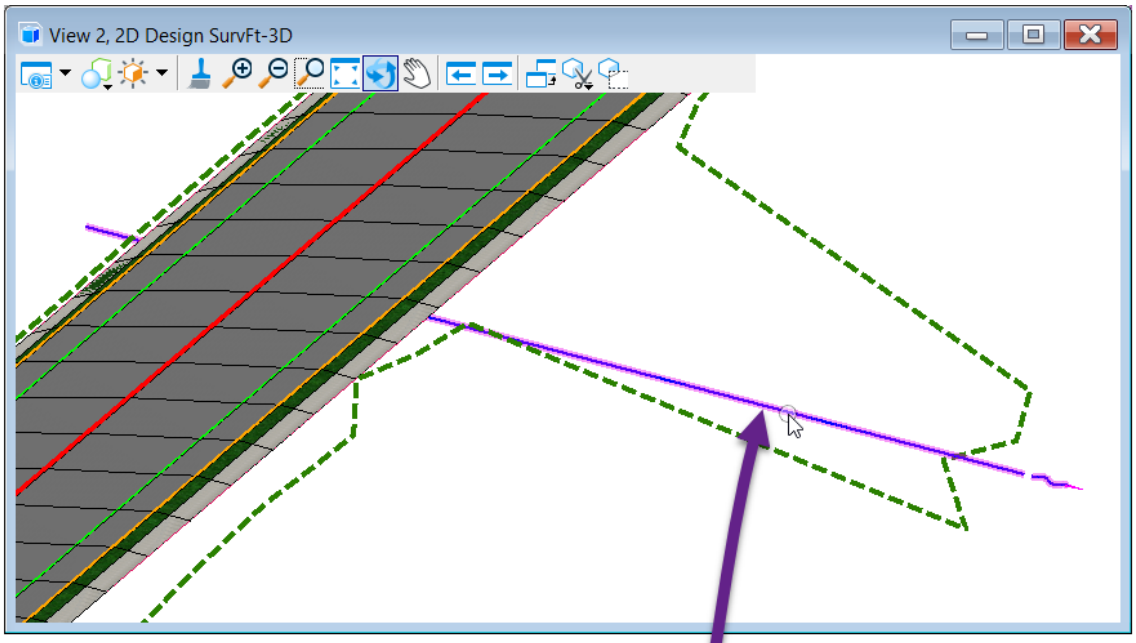
BEST PRACTICE: For example, when a sidewalk is modeled with Templates, it is advised that the sidewalk area is manually measured for plan set quantities. See **CONCEPT 1 – Verify Quantity Calculations with Hand Calculations**.



CONCEPT 6 – Non-Corridor Elements in the Report: As stated in **CONCEPT 3**, all 3D elements found (or referenced) into the ORD File are included in the report. This means *3D Elements* that were not generated by a Corridor, Linear Template, or Surface Template are included in the report.

Two common examples are the Corridor Alignment (typically assigned to the "Baseline" Feature Definition) and Culverts (assigned to the "Pipe culvert" Feature Definition).

BACKGROUND INFORMATION: In both cases, Horizontal ORD elements are drawn in the *2D Design Model*. Next, Vertical ORD Elements are drawn in the *Profile Model*. When the Vertical Profile is *activated* in the *Profile Model*, a *3D Linear Element* is created in the *3D Design Model*. The resulting *3D Linear Element* is analyzed and included in the quantity report.



Bentley Civil Report Browser - C:\Users\brendan\AppData\Local\Temp\RPTjhzbu4ey.xml

File Tools

- StationOffset
- ElementsComponentQuantitiesReportSummary.xs
- EndAreaVolume.xsl
- MassHaulToTIW.xsl
- Quantities by Named Boundary Report.xsl
- SightVisibilityAlternateReport.xsl
- SightVisibilityReport.xsl
- TerrainCheck.xsl
- Volumes.xsl
- LegalDescription
- MapCheck
- Milling

This **Culvert *3D Linear Element*** is NOT generated by a **Corridor**.

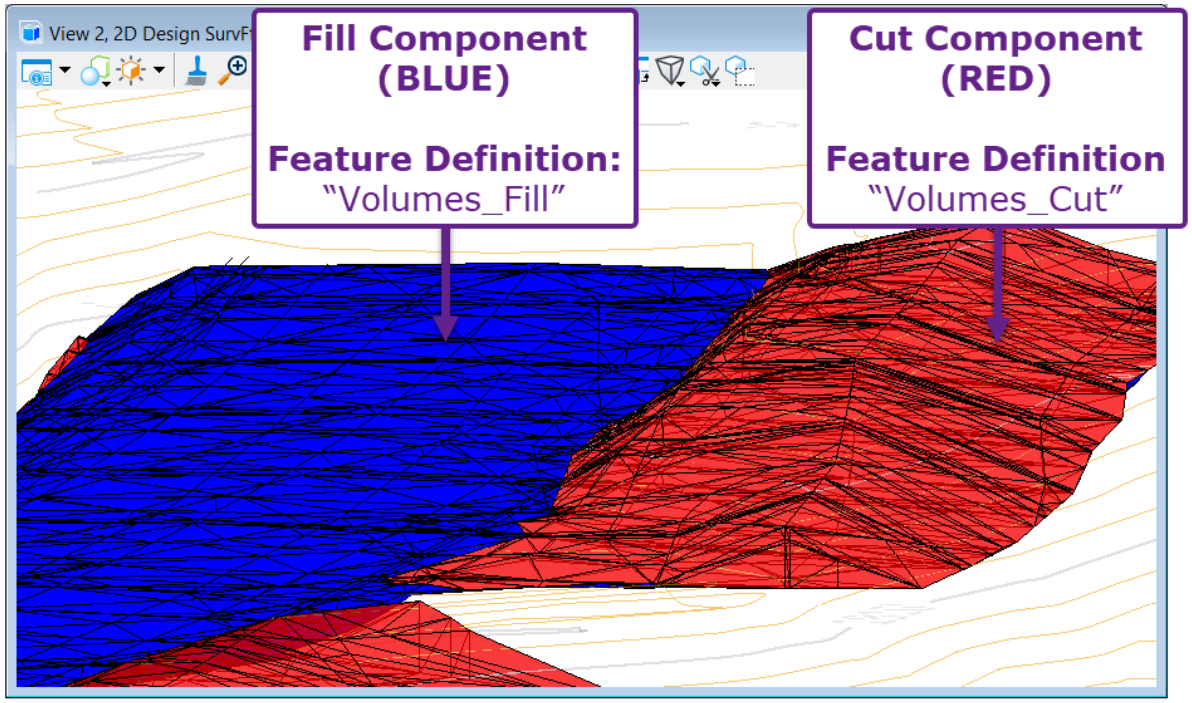
However, it is included in the report because it is found in the ***3D Design Model*** and is assigned a **Feature Definition** ("Pipe culvert").

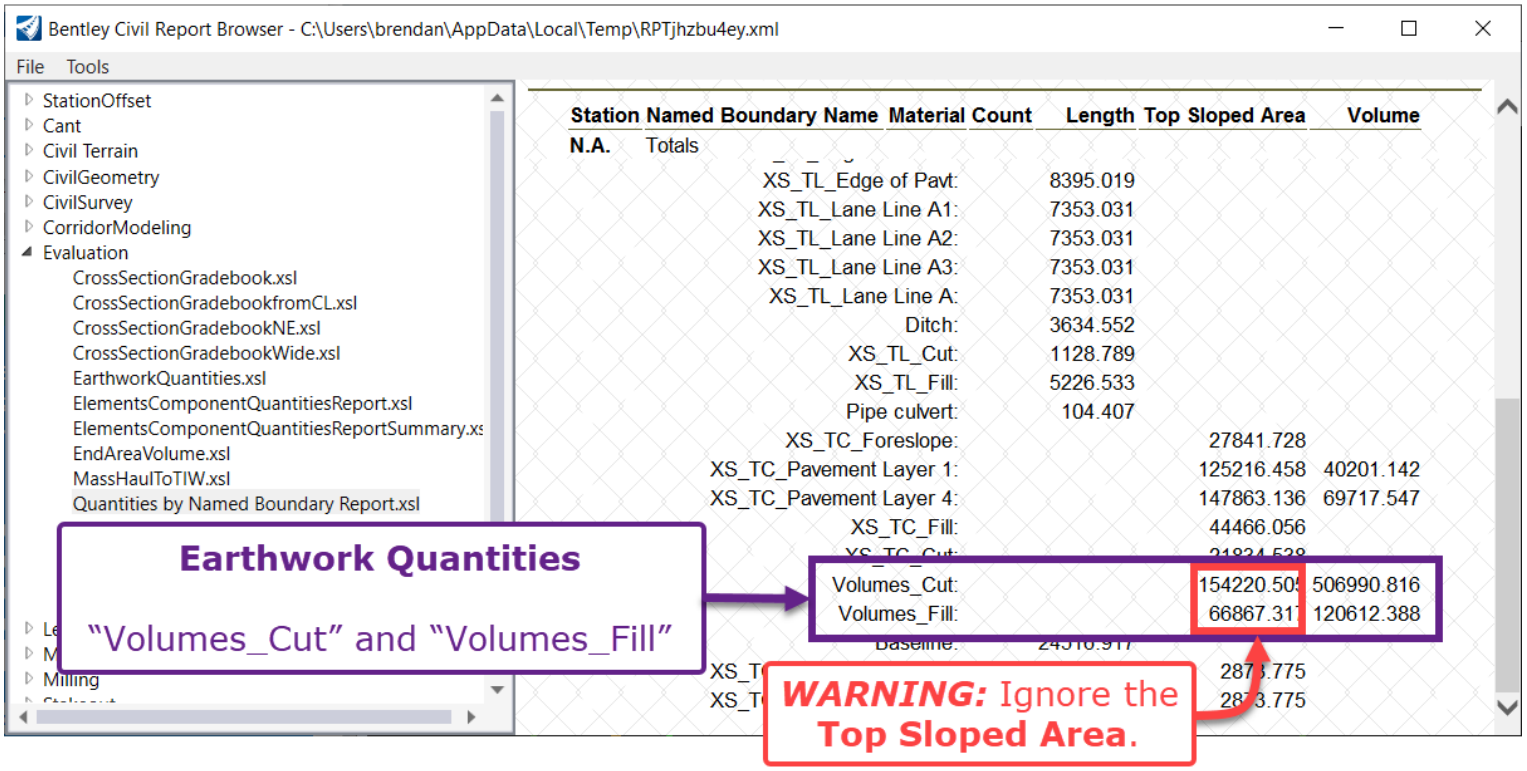
Named Boundary Name	Material	Count	Length	Top Sloped Area	Volume
XS_TL_Edge of Pavt:			8395.019		
XS_TL_Lane Line A1:			7353.031		
XS_TL_Lane Line A2:			7353.031		
XS_TL_Lane Line A3:			7353.031		
XS_TL_Lane Line A:			7353.031		
Ditch:			3634.552		
XS_TL_Cut:			1128.789		
XS_TL_Fill:			5226.533		
Pipe culvert:			104.407		
XS_TC_Foreslope:				27841.728	
XS_TC_Pavement Layer 1:				125216.458	40201.142
XS_TC_Pavement Layer 4:				147863.136	69717.547
XS_TC_Fill:				44466.056	
XS_TC_Cut:				21834.538	
Volumes_Cut:				154220.505	506990.816
Volumes_Fill:				66867.317	120612.388
Baseline:			24516.917		
XS_TC_Pavement Layer 2:				2873.775	
XS_TC_Pavement Layer 3:				2873.775	

CONCEPT 7 – Earthwork Components: To display Cut/Fill Earthwork volumes in the quantities report, the *Create Cut Fill Volumes* tool must be used to generate Cut and Fill Meshes. Cut and Fill Meshes are discussed in *20B - Create Cut Fill Volume tool and Earthwork Calculations*.

Cut and Fill Volumes are assigned to the "Volumes_Cut" and "Volumes_Fill" Feature Definitions.

WARNING: Confirm that Cut/Fill (earthwork) quantities are within the expected order of magnitude. A common mistake is forgetting to delete previously-created Cut/Fill Mesh elements when re-calculating quantities. This results in Cut/Fill quantities that are approximately doubled. See *20B.3 WARNING: Re-creating Cut and Fill Components*.





20B – CREATE CUT FILL VOLUME TOOL AND EARTHWORK CALCULATIONS

The primary purpose of the *Create Cut Fill Volume* tool is to generate Cut and Fill Meshes. Cut and Fill Meshes are necessary to calculate earthwork volumes for the following reporting tools:

- *Quantities Report By Named Boundary*
- *End Area Volume Report*

TIP: The *Component Quantities* tool is the ONLY earthwork calculation tool that does NOT require Cut and Fill Meshes to be created. The limitation of *Component Quantities* tool is that only a single Corridor or Linear Template can be selected and analyzed at a time. Models that utilize Surface Templates and Terrain Models require Cut and Fill Volumes to be created and the *Quantities By Named Boundary* tool to be used.

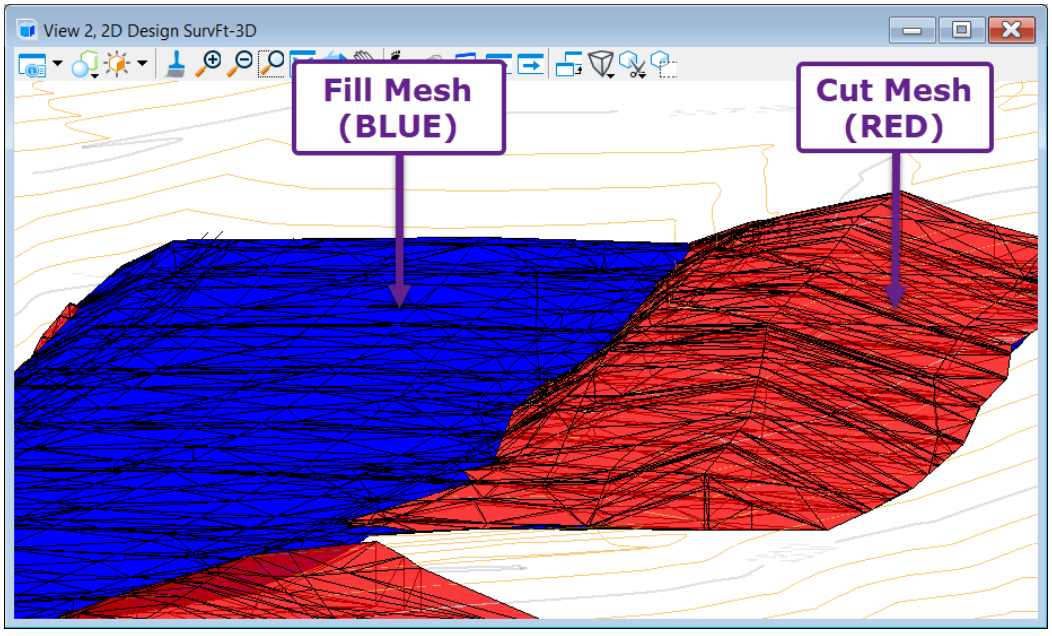
WARNING: The *Create Cut Fill Volume* tool does NOT allow the User to specifically select which Corridor, Linear Template, or Surface Templates to create Cut and Fill Meshes for. This tool creates Cut and Fill Meshes for **ALL** Corridors, Linear Templates, and Surface Templates created or **referenced** into the current ORD File. In the Quantities ORD File, reference only ORD Files that contain the desired modeling features.

20B.1 Cut and Fill Meshes

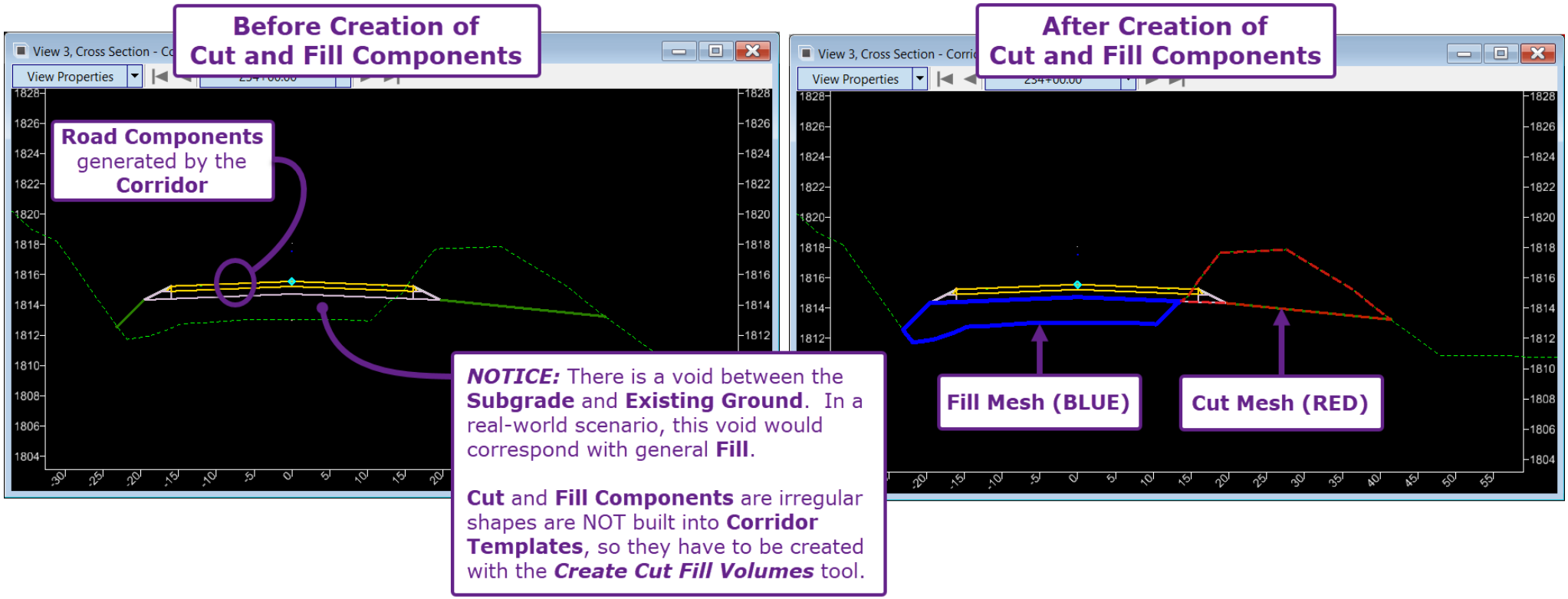
As discussed in *20A.6 Deciphering and Understanding the Quantities Report*, the *Quantities Report By Named Boundary* tool functions by calculating the volume of all Template Components and Meshes found in the *3D Design Model* . Cut and Fill Meshes correspond with earthwork volumes. However, Cut and Fill Meshes are NOT automatically created in the modeling of Corridors, Linear Templates, and Surface Templates. Instead, the Cut and Fill Meshes must be manually created with the *Create Cut Fill Volume* tool.

After Cut and Fill Meshes have been created, earthwork can be calculated and reported with the *Quantities Report By Named Boundary* tool (*20C - Quantity Report Workflow for Roadway with Approaches*) or *End Area Volume Report* tool (*20D – Earthwork By Cross Sections (Average Area End Method)*).

TIP: Advanced information relating to how the software creates Cut/Fill Mesh is discussed in *20G – Advanced Information: Component Feature Definition and Volume Options*.



As shown below, Road Components directly correlate with the Template used to create the Corridor, Linear Template, or Surface Templates. Due to their irregular shape Cut and Fill Meshes are NOT built directly into Templates – which is why they have to be manually created.



NOTICE: There is a void between the **Subgrade** and **Existing Ground**. In a real-world scenario, this void would correspond with general **Fill**.

Cut and **Fill Components** are irregular shapes are NOT built into **Corridor Templates**, so they have to be created with the ***Create Cut Fill Volumes*** tool.

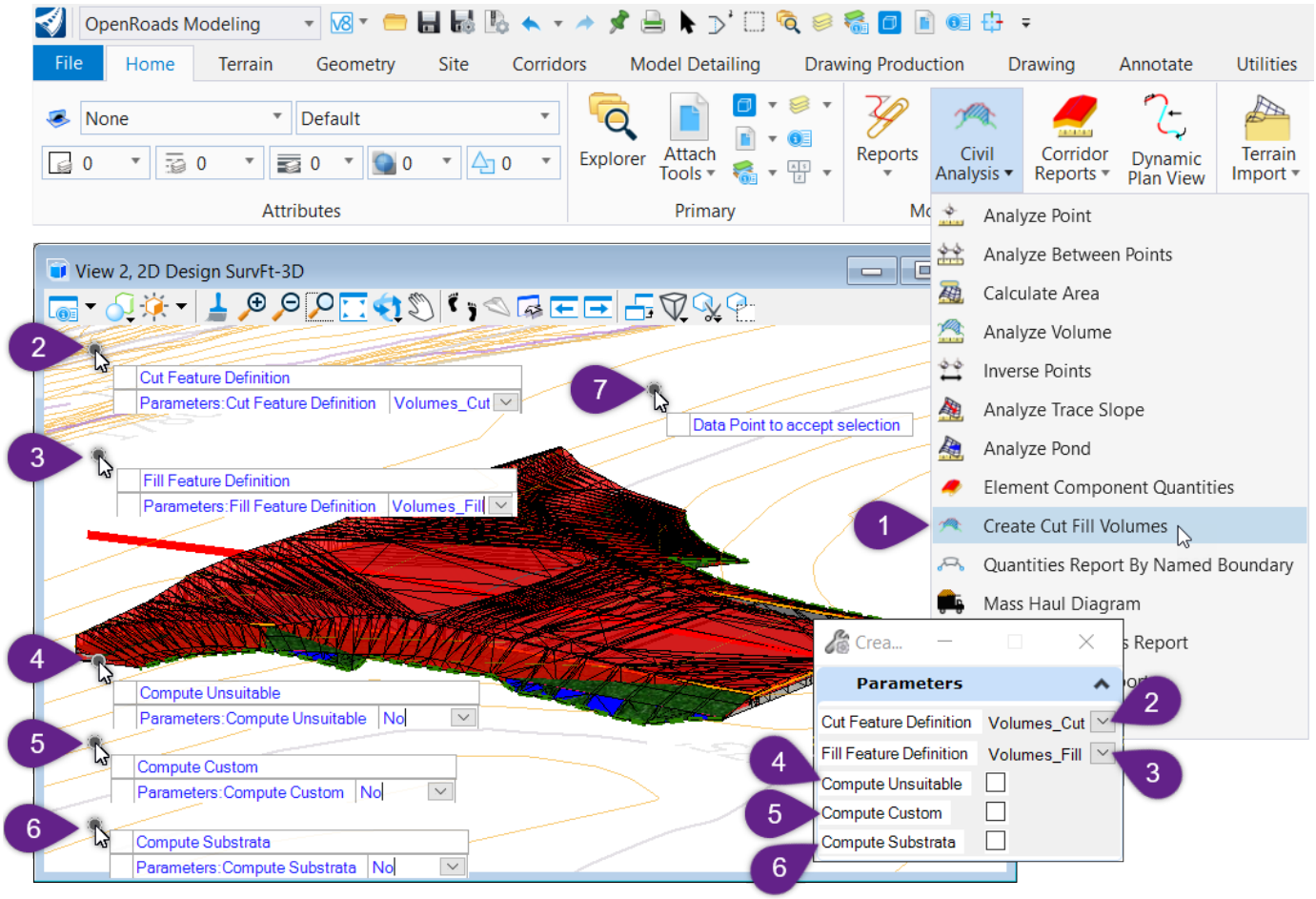
20B.2 Create Cut Fill Volumes tool - Workflow

This workflow demonstrates how to create Cut and Fill Meshes using the *Create Cut Fill Volume* tool. This tool can also be used to calculate earthwork with respect to the removal of Unsuitable Materials – which is shown in *20E – Unsuitable Material Modeling and Calculations*.

BEST PRACTICE: Never use this tool in the Corridor Modeling File (_cor.dgn) or other Design Files. Cut and Fill Meshes should ONLY be created in dedicated Quantity Files.

WARNING: Cut and Fill Meshes are STATIC – which means they will NOT adjust if the design changes. If the design changes, then previously-created Cut/Fill mesh elements must be deleted and re-created. See *20B.3 WARNING: Re-creating Cut and Fill Meshes*.

WARNING: This tool does NOT allow the User to specifically select which Corridor, Linear Template, or Surface Templates to create Cut and Fill Meshes for. All Corridors, Linear Templates, and Surface Templates created or referenced into the current ORD File will be sought out for Cut and Fill meshes creation. In the Quantities ORD File, reference in ONLY the desired modeling entities.



Cut and Fill Feature Definition: In steps 2 and 3, the User is prompted to specify the Cut Feature Definition and Fill Feature Definition. Do NOT change these Feature Definitions. Accept and use the default Cut and Fill Feature Definitions.

The resulting Cut and Fill mesh elements (found in the *3D Design Model*) will be assigned to these Feature Definitions. Later, when quantity reports are generated, Cut and Fill volumes will be shown next to these assigned Feature Definitions.

1	From the Ribbon, select the *Create Cut Fill Volumes* tool: [***OpenRoads Modeling*** → ***Home*** → ***Model Analysis and Reporting***].
2	*Prompt: Cut Feature Definition* – Accept and use the default Cut Feature Definition – which should be "Volumes_Cut". Left-Click in the *View* to accept and proceed to the next prompt.
3	*Prompt: Fill Feature Definition* – Accept and use the default Fill Feature Definition – which should be "Volumes_Fill". Left-Click in the *View* to accept and proceed to the next prompt.
4	*Prompt: Compute Unsuitable* – Typically, "NO" is selected. If "YES" is selected, then Components and Meshes that utilize the "Unsuitable" Volume Option* will be considered in the creation of Cut/Fill Meshes. See *20G.2 Unsuitable Volume Option*. A detailed workflow for modeling and calculating Unsuitable materials is shown in *20E - Unsuitable Material Modeling and Calculations*.
5	*Prompt: Compute Custom* – Typically, "NO" is selected. If "YES" is selected, then Components that utilize the "Custom" Volume Option***** will be considered in the creation of Cut/Fill Meshes. See *20G.3 Custom Volume Option*.
6	*Prompt: Compute Substrata* – Typically, "NO" is selected. If "YES" is selected, then Meshes that utilize the "Substrata" Volume Option***** will be considered in the creation of Cut/Fill Meshes. See *20G.4 Substrata Volume Option*.
7	*Prompt: Data Point to accept selection* – Left-Click anywhere in the *View* to create the Cut and Fill Meshes in the *3D Design Model* .

NOTE*: The *Volume Option* is found in the Feature Definition Properties – which is accessed in the Project Explorer. Volume Options are discussed in *20G – Advanced Information: Component Feature Definition and Volume Options*.

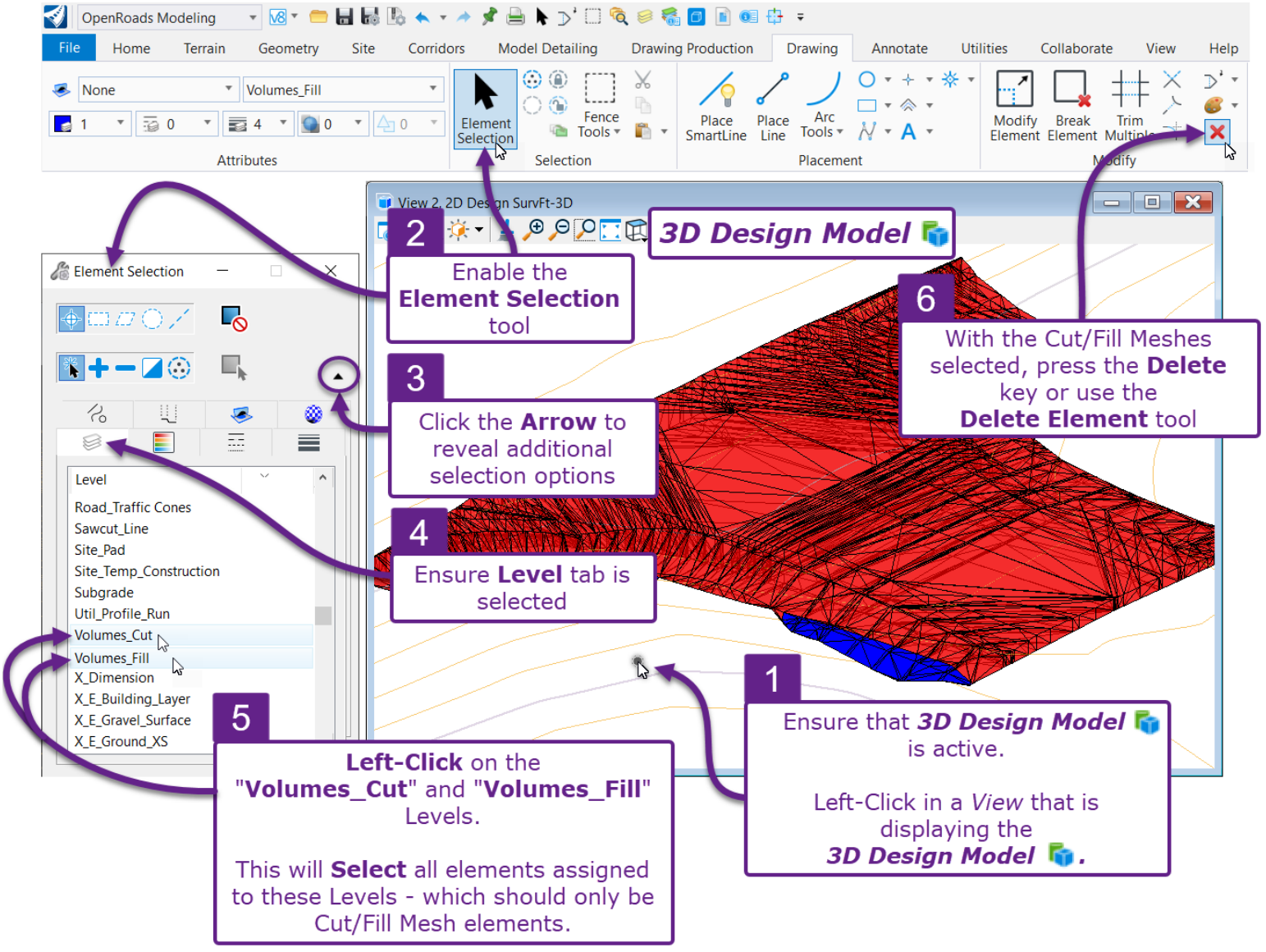
20B.3 WARNING: Re-creating Cut and Fill Meshes

Cut and Fill Mesh elements are static – meaning they will NOT automatically adjust if the design is changed.

If the design changes and Cut/Fill quantities need to be re-calculated, then the Cut and Fill Meshes should be deleted before the *Create Cut Fill Volumes* tool is used again.

> ***BACKGROUND INFORMATION:*** If this tool is used for second time – without deleting the initially-created Cut and Fill Meshes, then there will be two sets of Cut/Fill Meshes in the ORD File.
>
> ***WARNING:*** In the resulting report, the earthwork quantities will be **greatly overestimated** because the two sets of earthwork Meshes are both included and totaled together.

Cut and Fill Meshes can ONLY be selected and deleted from within the *3D Design Model* .



20C – QUANTITY REPORT WORKFLOW FOR ROADWAY WITH APPROACHES

In this workflow, a quantity report is created for the mainline Corridor using the *Component Quantities* tool. Next, a second quantity report is created for the Approaches using the *Quantities By Named Boundary* tool.

> ***TIP:*** The procedure shown here could also be used to calculate Parking Lot or Approach Road quantities.

PREREQUISITE WARNING: This workflow requires that the mainline Corridor and Approaches were created in separate ORD Design Files. If the Corridor and Approaches were created in the same ORD File, then it is very difficult to produce reports that separate mainline Road and Approaches quantities.

PREREQUISITE WARNING: In this workflow, the mainline Corridor quantities are calculated with the *Component Quantities* tool – which produces inaccurate results when the Corridor is clipped. For Corridors that were clipped, the *Quantities By Named Boundary* tool must be used. In lieu of Corridor Clipping in approach/intersection modeling, use an alternative method discussed in *11A.5 Overlap Between Mainline Corridor and Site Modeling Features*.

Two ORD Quantity Files need to be created: a **Corridor Quantity File** and an **Approach Quantity File**.

Corridor Quantity File*: This file is exclusively used to calculate quantities for the Corridor.

Name: *Project specific prefix*_**qty_cor**.dgn (WFL File Naming Convention)

ORD Files to Reference*:**

- Corridor Modeling File (_cor.dgn)
- Survey File (_sur.dgn) or Existing Terrain Model File (_ter.dgn) – which ever File contains the Existing Ground Terrain Model.

Workflow to Calculate Corridor Quantities: *Component Quantities* tool.

Approach Quantity File: This file is exclusively used to calculate quantities for Approaches.

Name: *Project specific prefix*_**qty_appr**.dgn (WFL File Naming Convention)

ORD Files to Reference*:**

- Approach, Driveway, and Intersection Modeling File (_cor_appr.dgn)***
- Survey File (_sur.dgn) or Existing Terrain Model File (_ter.dgn) – which ever File contains the Existing Ground Terrain Model.

Workflow to Calculate Approach Quantities: *Quantities By Named Boundary* tool.

NOTE*: It is NOT necessary to create a Corridor Quantity File to isolate Corridor quantities with the *Component Quantities* tool. This tool could be used directly in the Corridor Modeling File (_cor.dgn). However, the Corridor Quantity File allows isolation of the Corridor if Corridor quantities need to be separated by particular stationing limits – which is attained with the *Quantities By Named Boundary* tool.

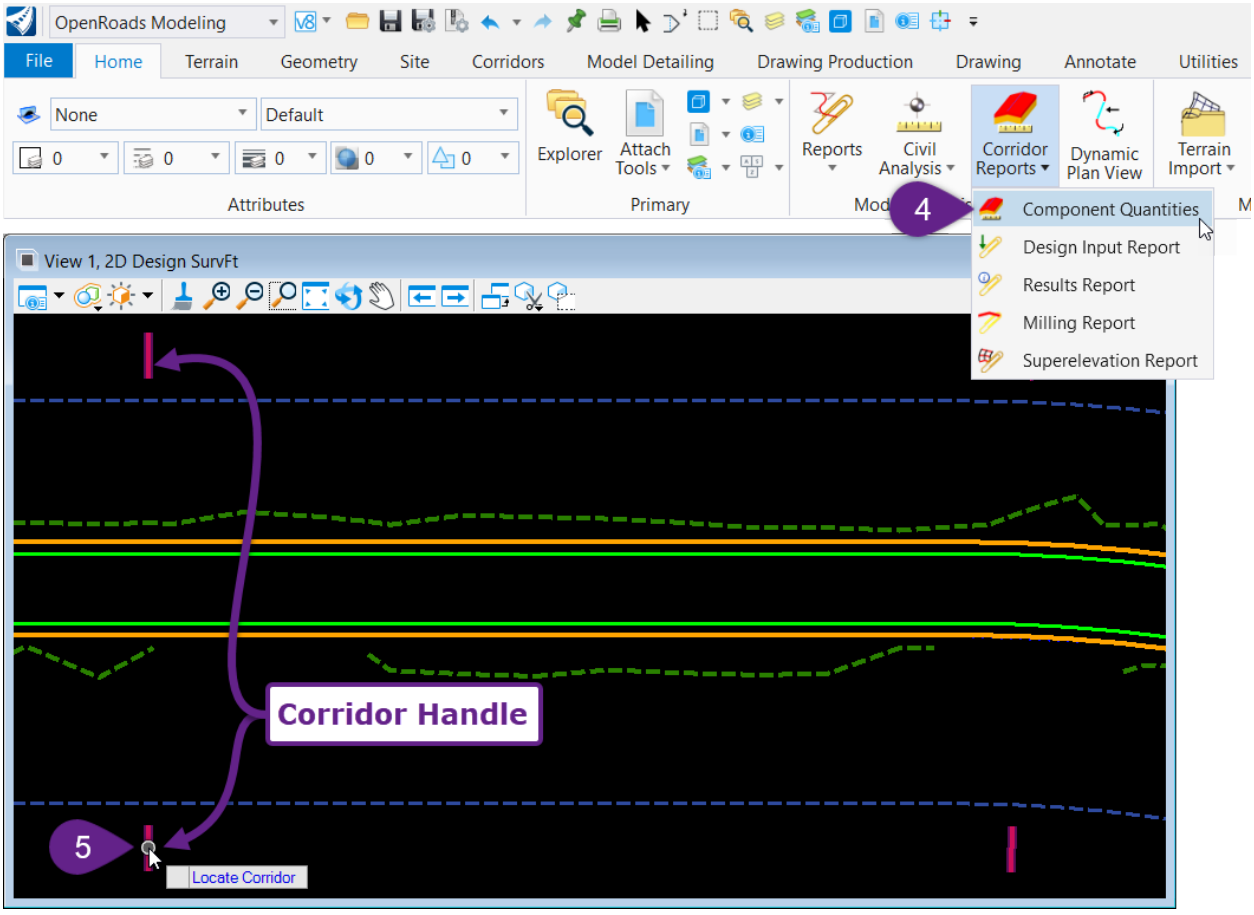
WARNING**: A common mistake is referencing unnecessary Design Files into a Quantity File. For example, it is unnecessary to reference the Alignment File (_ali.dgn) or Superelevation File (_sup.dgn) for accurate quantity calculations. Besides the Existing Ground Terrain Model File, reference ONLY Design Files that contain Corridors, Linear Templates, and/or Surface Templates.

WARNING**: Do NOT use Nested Reference in Quantity ORD Files.

20C.1 Component Quantities tool for Corridors

20C.1.a Setup the Corridor Quantity File and use the Component Quantities tool

1	**Create the Corridor Quantity File.** See *3B – Create a New ORD File*. The new Corridor Quantity File should be named in accordance with ORD File Naming Conventions listed in Chapter 3. See *3C – ORD File Naming Conventions*. Naming Convention for Corridor Quantity File by FLH Office: **WFLHD:** project specific prefix**_qty_cor**.dgn **EFLHD:** **0X**_project number**_XXX**.dgn **CFLHD:** **XXX**(alignment descriptor)project descriptor.dgn
2	In the *2D Design Model* of the new Approach Quantity File , **Reference** in the following files: • Survey File (_sur.dgn) or Existing Terrain Model File (_ter.dgn) – which ever File contains the Existing Ground Terrain Model. • Corridor Modeling File (_cor.dgn)
3	Set the Existing Ground Surface as *Active*. See *3D.3 Activate the Existing Ground Terrain Model*.
4	From the Ribbon, select the *Component Quantities* tool: [***OpenRoads Modeling*** → ***Home*** → ***Model Reporting and Analysis***].
5	*Prompt: Locate Corridor* – Left-Click on the Corridor Handle.

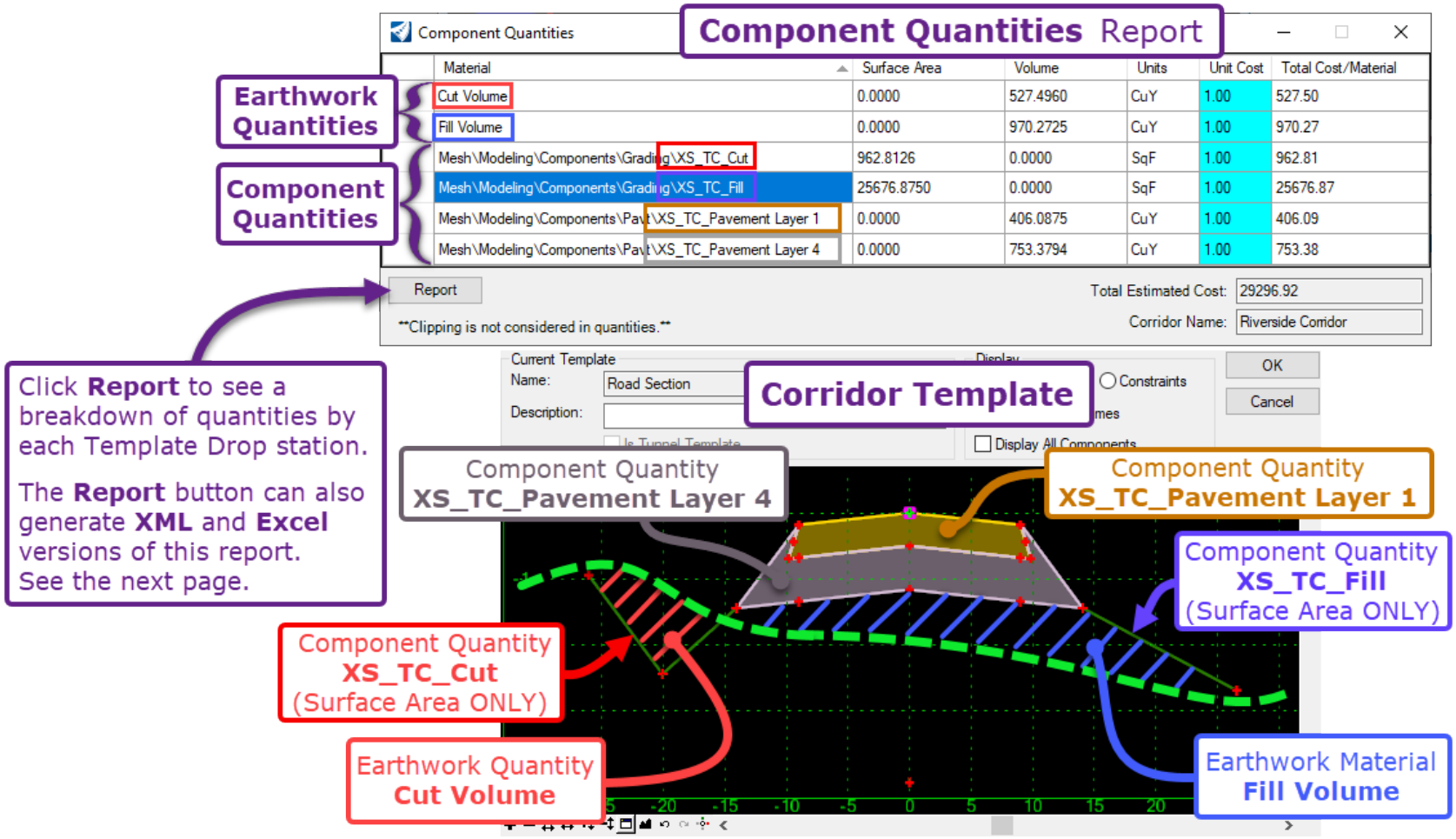


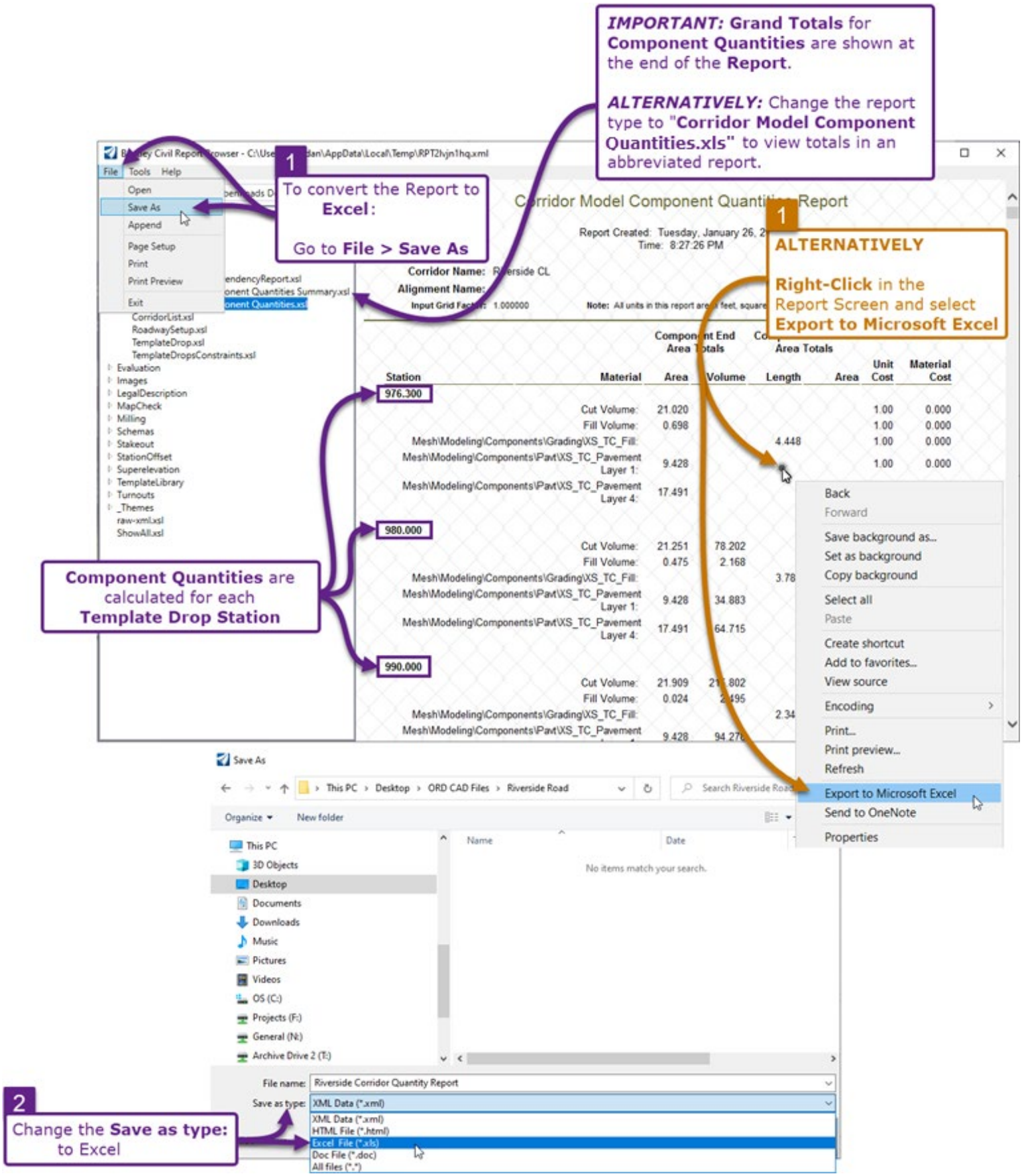
20C.1.b Decipher and Save the Component Quantities Report

An example **Component Quantities Report** is shown below. There are two types of quantities that are calculated:

1. **Earthwork Quantities –** include *Cut* and *Fill Volumes*. Earthwork Quantities are calculated as the volumetric difference between the Corridor Bottom Mesh and Existing Ground Terrain Model. See *9I.1 Top and Bottom Meshes*.
2. **Component Quantities –** are calculated from Template Components found in the Templates. Component Quantities can be planar (Surface Area) or Volumetric.

NOTE: *Cut Volume* and *Fill Volume* (Earthwork Quantities) are NOT interchangeable with *Cut* and *Fill* (Component Quantities). The *Cut/Fill* quantities correspond with the End Condition Components – which are *Planar Components* (See *8A.2.a Template Points and Components*). The *Cut/Fill* quantity values shown below represents the End Condition Component *Surface Area*.




IMPORTANT: Grand Totals for Component Quantities are shown at the end of the Report.
ALTERNATIVELY: Change the report type to "Corridor Model Component Quantities.xls" to view totals in an abbreviated report.
1
To convert the Report to Excel:
Go to File > Save As
File
Tools
Help
Open
Save As
Append
Page Setup
Print
Print Preview
Exit
Corridor Model Component Quantities Report
Report Created: Tuesday, January 26, 2
Time: 8:27:26 PM
Corridor Name: Riverside CL
Alignment Name:
Input Grid Factor: 1.000000
Note: All units in this report are in feet, square
1
ALTERNATIVELY
Right-Click in the Report Screen and select Export to Microsoft Excel
Station
Material
Component End Area Totals
Area
Volume
Component Area Totals
Length
Area
Unit Cost
Material Cost
976.300
Cut Volume: 21.020
Fill Volume: 0.698
Mesh\Modeling\Components\Grading\XS_TC_Fill: 4.448
Mesh\Modeling\Components\Pavt\XS_TC_Pavement Layer 1: 9.428
Mesh\Modeling\Components\Pavt\XS_TC_Pavement Layer 4: 17.491
980.000
Cut Volume: 21.251 78.202
Fill Volume: 0.475 2.168
Mesh\Modeling\Components\Grading\XS_TC_Fill: 3.78
Mesh\Modeling\Components\Pavt\XS_TC_Pavement Layer 1: 9.428 34.883
Mesh\Modeling\Components\Pavt\XS_TC_Pavement Layer 4: 17.491 64.715
990.000
Cut Volume: 21.909
Fill Volume: 0.024
Mesh\Modeling\Components\Grading\XS_TC_Fill: 2.34
Mesh\Modeling\Components\Pavt\XS_TC_Pavement 9.428
Component Quantities are calculated for each Template Drop Station
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
Save As
This PC › Desktop › ORD CAD Files › Riverside Road
Search Riverside Road
Organize
New folder
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
OS (C:)
Projects (F:)
General (N:)
Archive Drive 2 (T:)
Name
Date
No items match your search.
File name: Riverside Corridor Quantity Report
Save as type: XML Data (*.xml)
XML Data (*.xml)
HTML File (*.html)
Excel File (*.xls)
Doc File (*.doc)
All files (*.*)
2
Change the Save as type: to Excel

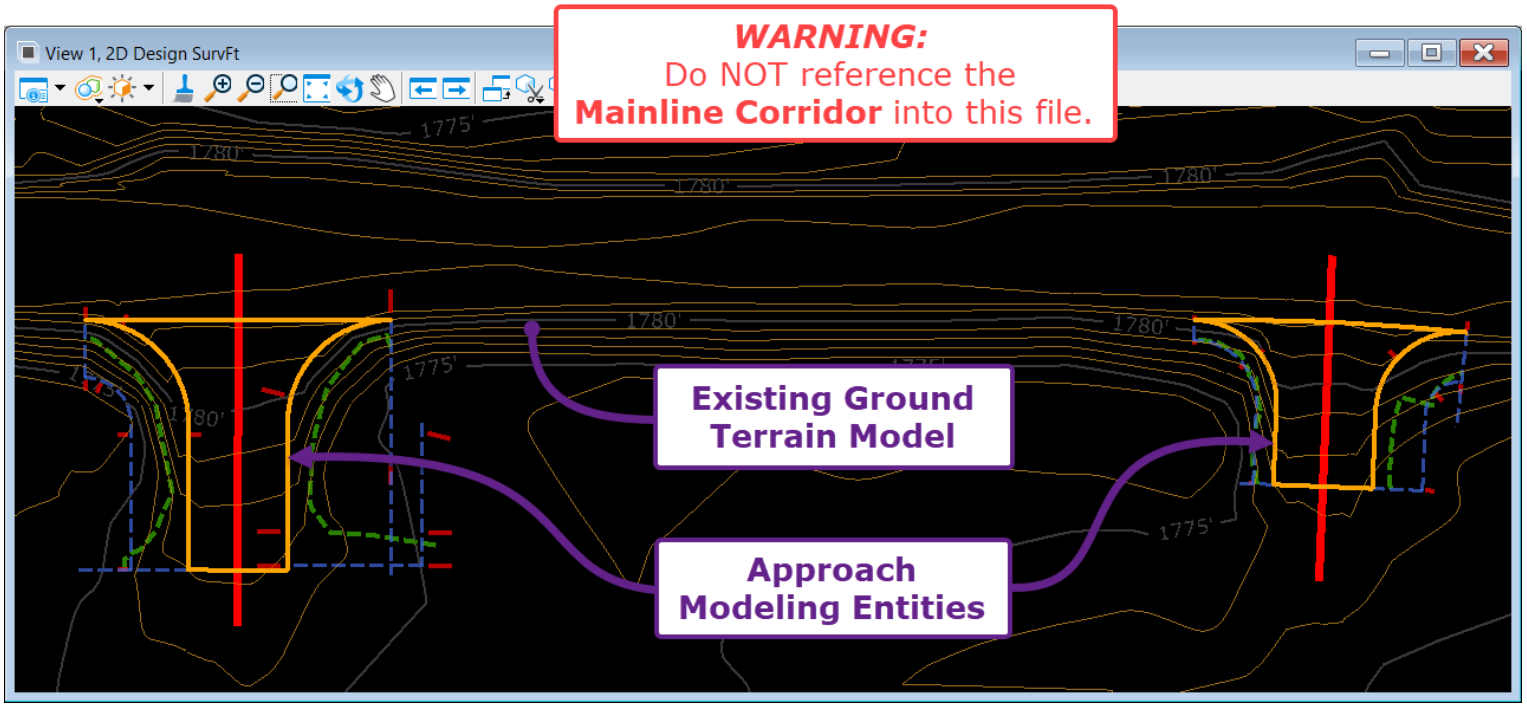
20C.2 Quantity Report By Named Boundary for Approaches

20C.2.a Setup the Approach Quantity File

1	**Create the Approach Quantity File.** See *3B – Create a New ORD File*. The new Approach Quantity File should be named in accordance with ORD File Naming Conventions listed in Chapter 3. See *3C – ORD File Naming Conventions.* Naming Convention for Corridor Quantity File by FLH Office: ***WFLHD*:** *project specific prefix*_**qty_appr**.dgn ***EFLHD*:** **0X**_*project number*_**XXX**.dgn ***CFLHD*:** **XXX**(*alignment descriptor*)*project descriptor*.dgn
2	***In the *2D Design Model* of the new Approach Quantity File, **Reference** in the following files: • Survey File (_sur.dgn) or Existing Terrain Model File (_ter.dgn) – which ever File contains the Existing Ground Terrain Model. • Approach Modeling File (_cor_appr.dgn)
3	Set the Existing Ground Surface as *Active*. See *3D.3 Activate the Existing Ground Terrain Model*.

WARNING:*** To separate Corridor and Approach quantities, do NOT reference the Corridor Modeling File (_cor.dgn) into the Approach Quantity File. If the Corridor Modeling File is referenced in, then the *Quantities By Named Boundary* report would include Corridor quantities.

As shown in the graphic below, the Approach Quantity File should ONLY contain approach modeling entities and the Existing Ground Terrain Model.

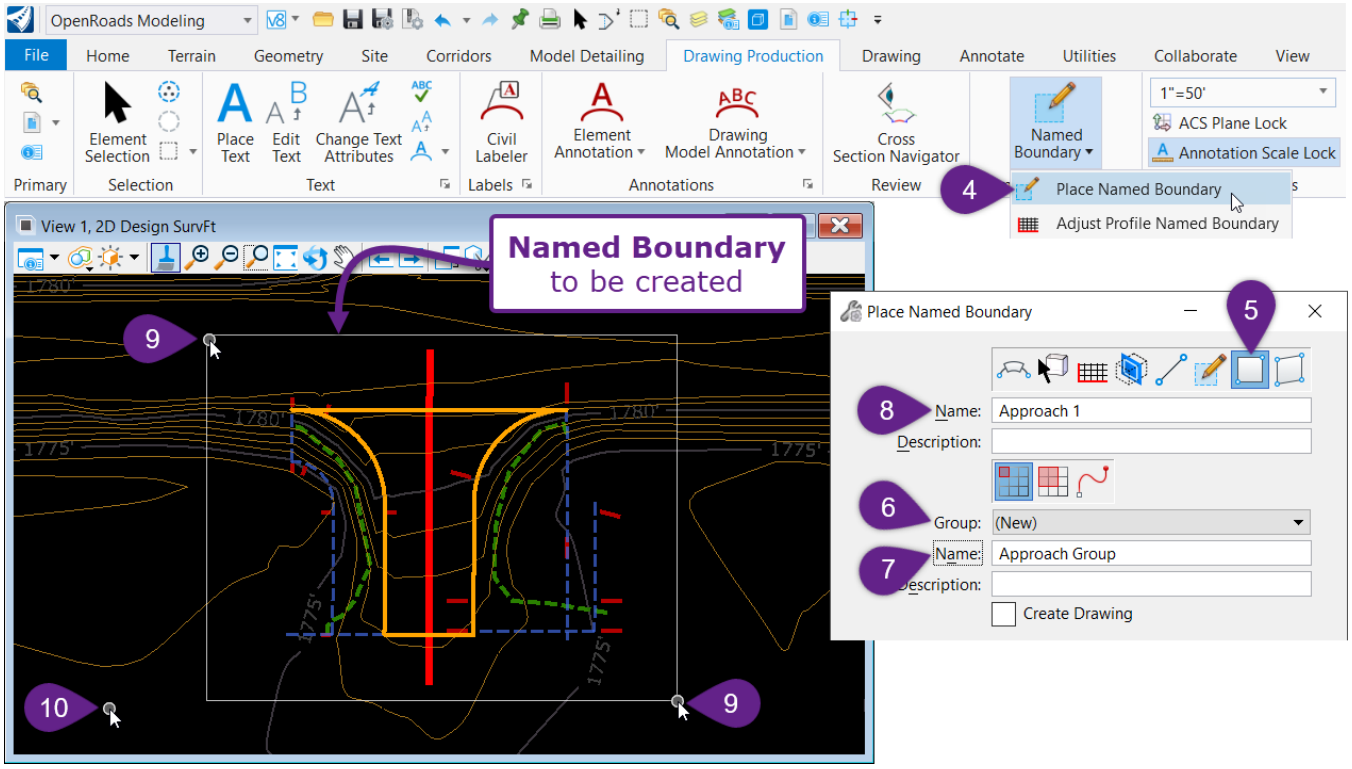


20C.2.b Create Named Boundaries for each Approach

To isolate the quantities for each approach, a PLAN *Named Boundary* is created around each approach. In this configuration, a quantities report can be generated for each approach. *Named Boundary* creation is discussed in *14A.3.a Place Named Boundary tool – Overview*.

> ***IMPORTANT:*** If the intent is to create a single quantities report that sums up quantities for ALL approaches, then it is NOT necessary to create *Named Boundaries*. If this is the intent, skip to *20C.2.c Create the Cut and Fill Meshes for the Approaches*.

NOTE: In this workflow, the **By 2 Points** mode is used to create the *Named Boundaries*. However, for irregular shaped *Named Boundaries* the **By Polygon** mode could be used. Similarly, using the **Civil Plan By Element** mode, an enclosed SmartLine can be converted into a *Named Boundary* for custom shapes.



4	From the Ribbon, select the *Place Named Boundary* tool: [***OpenRoads Modeling*** → ***Drawing Production*** → ***Named Boundaries***].
5	In the *Place Named Boundary* dialogue box, set the mode to **By 2 Points** .
6	Set the **Group** to *(New)* from the drop-down.
7	Assign the **Group** a **Name**. In this case, "Approach Group" is typed into **Name** box.
8	Assign the *Named Boundary* to be created a **Name**. In this case, "Approach 1" is typed into the **Name** box.
9	In the *2D Design Model* , define the *Named Boundary* shape by clicking in two locations that full encompasses the Approach modeling entities.
10	Left-Click in the *View* to accept the placement of the *Named Boundary*.

Repeat this process and create a *Named Boundary* for each Approach.

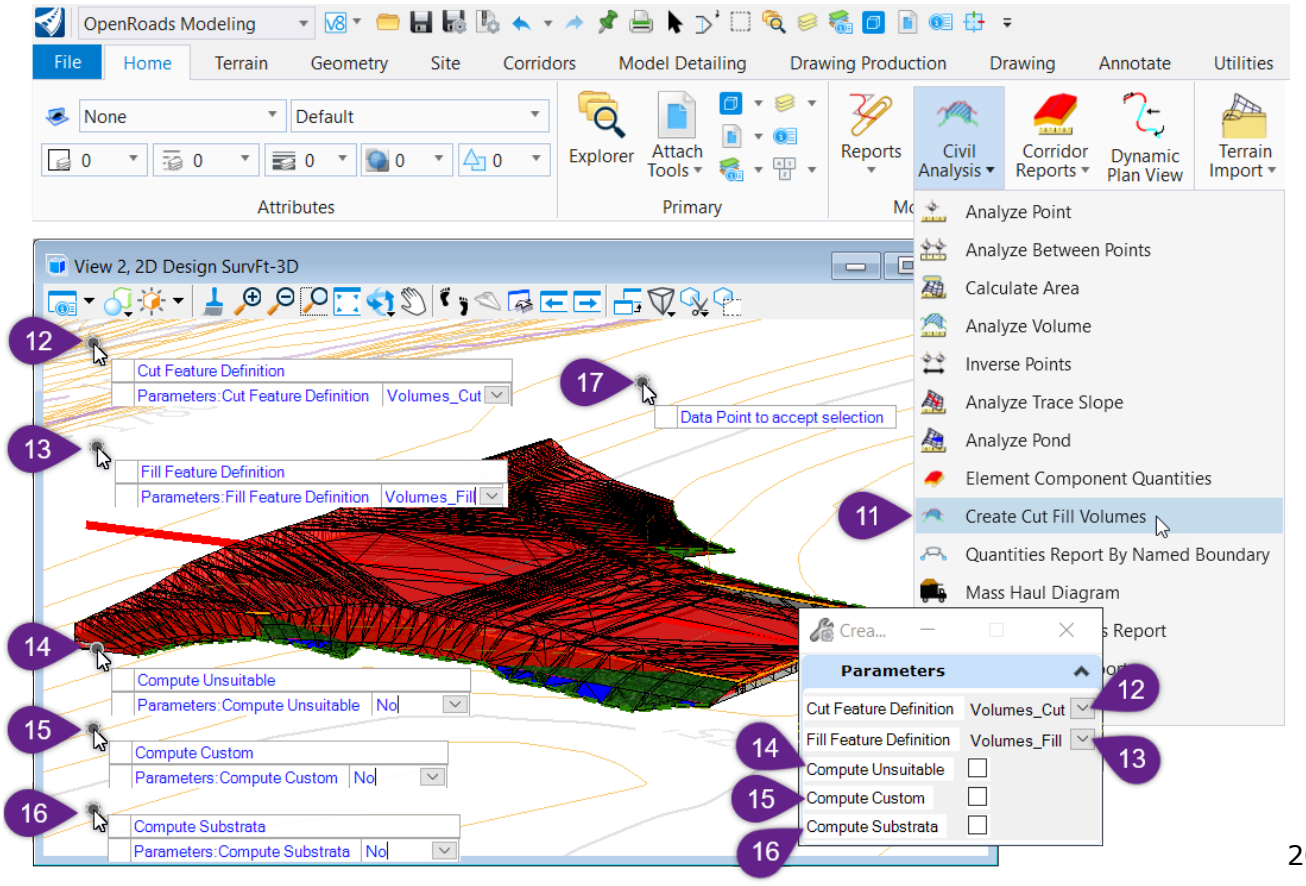
20C.2.c Create the Cut and Fill Meshes for the Approaches

To display cut and fill (earthwork) volumes in the Approach quantity report, then the *Create Cut Fill Volumes* tool must be used. This tool creates Cut and Fill Meshes in the *3D Design Model*. For more information on Cut and Fill Meshes, see *20B - Create Cut Fill Volume tool and Earthwork Calculations*.

WARNING: Cut and Fill Meshes are static – meaning they will NOT automatically adjust if the design is changed. If the design changes, Cut and Fill Meshes should be deleted and re-created.

WARNING: If this tool is used for second time – without deleting the initially-created Cut and Fill Meshes, then there will be two sets of Cut/Fill Meshes in the ORD File. In the resulting report, the earthwork quantities will be **greatly overestimated** because the two sets of earthwork Meshes are both included and totaled together. See *20B.3 WARNING: Re-creating Cut and Fill Meshes*.

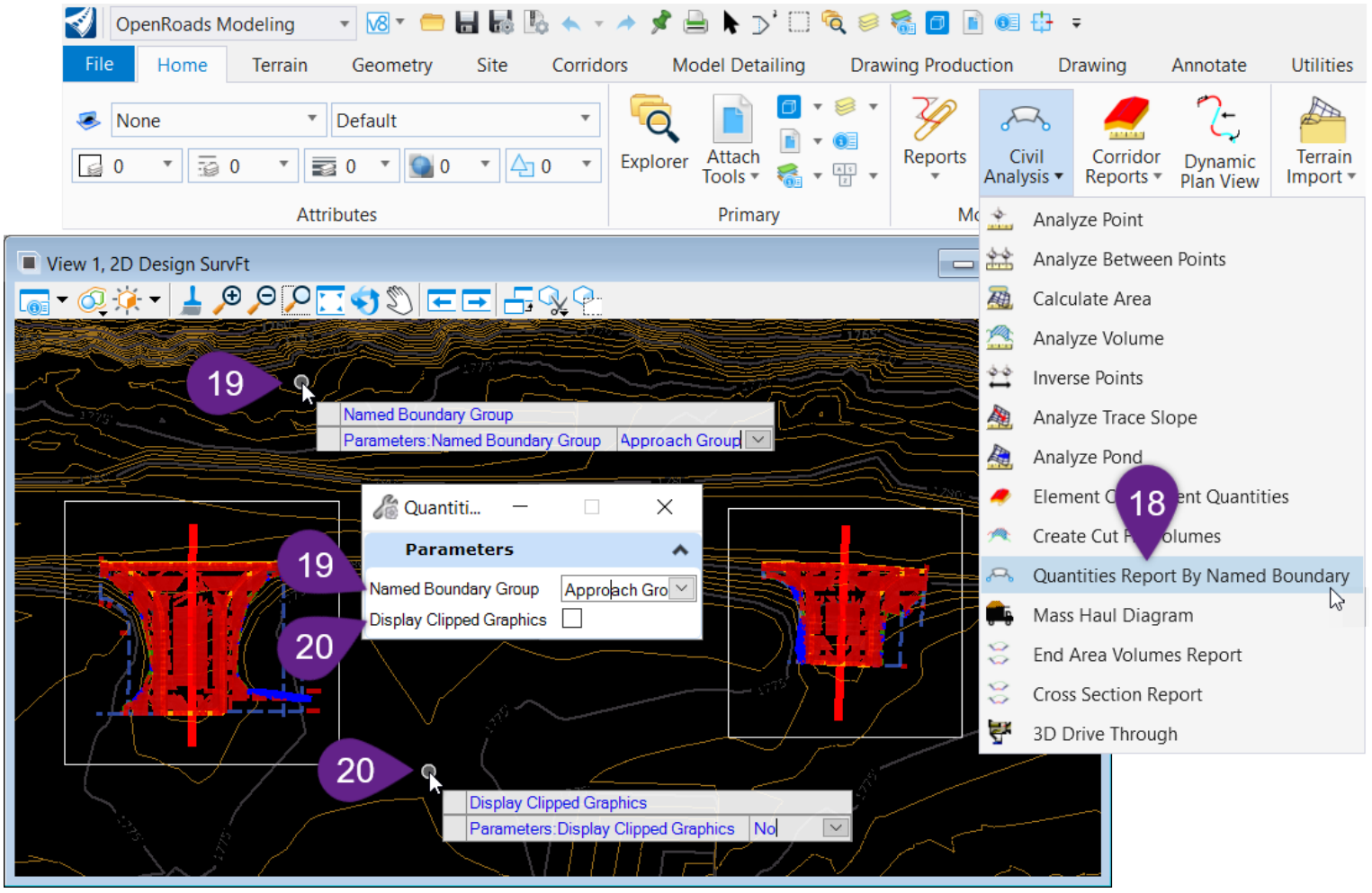
11	From the Ribbon, select the *Create Cut Fill Volumes* tool: [***OpenRoads Modeling*** → ***Home*** → ***Model Analysis and Reporting***].
12	*Prompt: Cut Feature Definition* – Accept and use the default Cut Feature Definition – which should be "Volumes_Cut". Left-Click in the *View* to accept and proceed to the next prompt.
13	*Prompt: Fill Feature Definition* – Accept and use the default Fill Feature Definition – which should be "Volumes_Fill". Left-Click in the *View* to accept and proceed to the next prompt.
14	*Prompt Compute Unsuitable* – In this case, "NO" is selected.
15	*Prompt Compute Custom* – In this case, "NO" is selected.
16	*Prompt Compute Substrata* – In this case, "NO" is selected.
17	*Prompt: Data Point to accept selection* – Left-Click anywhere in the *View* to create the Cut and Fill Meshes in the *3D Design Model*.



20C.2.d Generate the Report with Quantities Report By Named Boundary tool

In this step, the *Quantities Report By Named Boundary* tool is used to generate the quantities report.

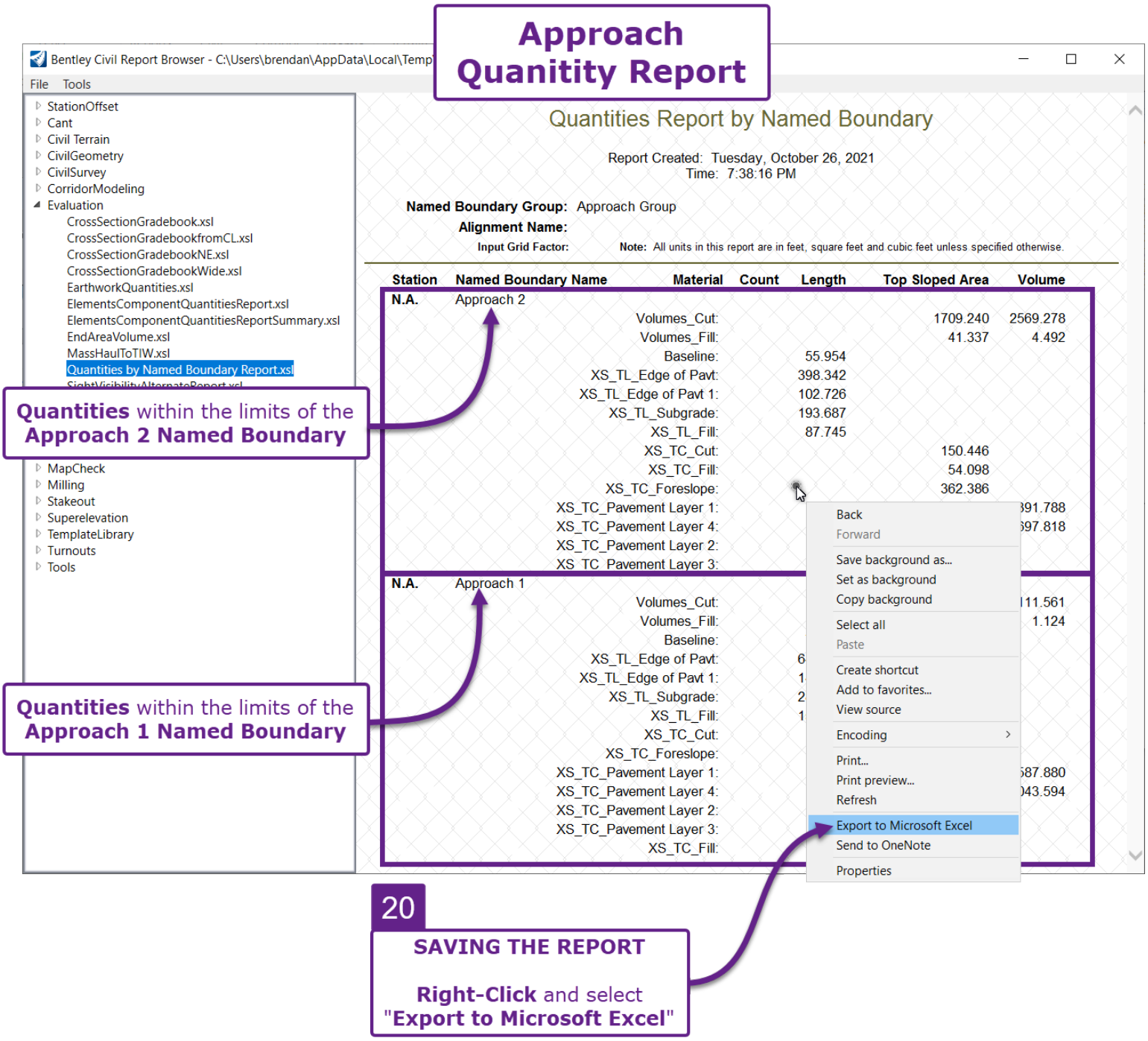
18	From the Ribbon, select the *Quantities Report By Named Boundary* tool: [***OpenRoads Modeling*** → ***Home*** → ***Model Analysis and Reporting***].
19	*Prompt: Named Boundary Group* – Select the **Group** create in step 7. ***IMPORTANT:*** If the "<None>" option is selected, then the *Named Boundaries* are ignored. All quantities in the ORD File will be totaled and shown in the Report. Quantities will NOT be separated by *Named Boundaries*.
20	*Prompt: Display Clipped Graphics* – select "No". Ensure this option is NOT used. ***WARNING:*** If this option is used ("Yes" is selected), then a duplicate set of Components and 3D Linear Elements are created and placed in the *3D Design Model*. This is **PROBLEMATIC** if the *Quantities Report By Named Boundary* tool is used for a subsequent time. The duplicate set of Components and 3D Linear Elements are included in the report – which results in quantities being **OVERESTIMATED** and **DOUBLED**. ***BACKGROUND INFORMATION:*** This option is intended as a method to verify quantities shown in the report. The User can verify if the correct quantities are calculated by visually examining the duplicated 3D elements. However, do NOT use this option if a subsequent report is to be created in the current ORD File.



20C.2.e Decipher and Save the Approach Quantities Report

For guidance in deciphering the contents of quantities report produced by the *Quantity Report By Named Boundary* tool, see *20.A.6 Deciphering and Understanding the Quantities Report*.

To save the Earthwork Report, right-click in the report window and select "Export to Microsoft Excel".



20D – EARTHWORK BY CROSS SECTIONS (AVERAGE AREA END METHOD)

In this workflow, the *End Areas Volume Report* tool is used to generate an Earthwork report.

As a precursor procedure, CROSS SECTION *Named Boundaries* have to be created. Average Area End Method calculations are performed at each CROSS SECTION *Named Boundary* station location. CROSS SECTION *Named Boundaries* are discussed in *Chapter 16 – Cross Section*.

DESIGN ITERATIONS WARNING: CROSS SECTION *Named Boundaries* are static and will NOT automatically adjust if the Alignment is edited. If the Alignment is edited, then CROSS SECTION *Named Boundary* elements will have to be re-created for earthwork calculation purposes.

20D.1 Create the Earthwork Quantity File

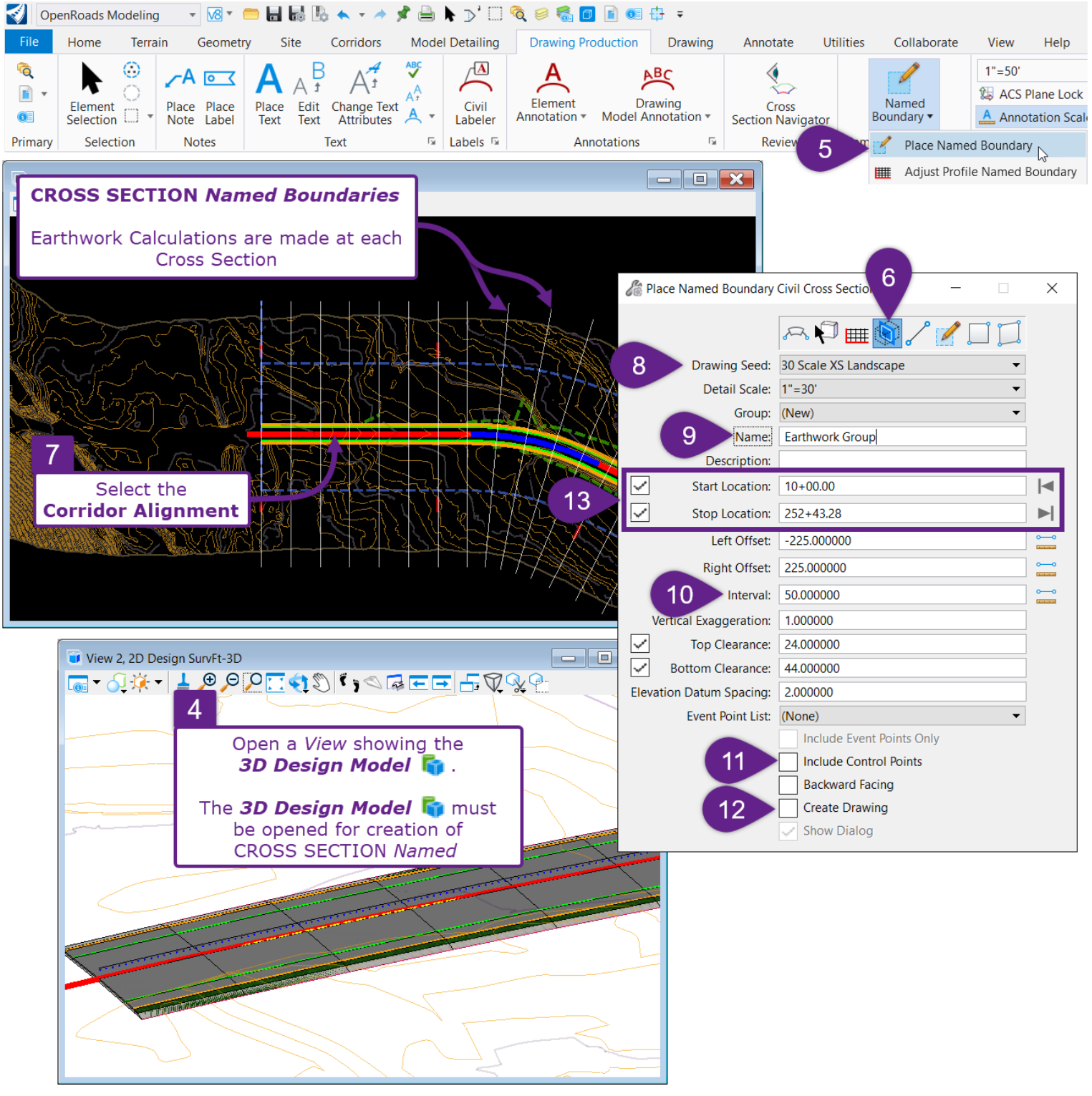
TIP: Typically, Average Area End Method earthwork reports are coordinated with the Cross Section plans deliverable. It is conventional to perform Average Area End Method calculations at each station location shown in the Cross Section plans. As an alternative to creating a new ORD Quantity File, perform a Copy or Save As of the ORD Cross Section File (_xs.dgn) and rename it to *prefix_qty_ew.dgn* (WFL Naming Convention). If this alternate procedure is used, then proceed to *20D.3 Create Cut/Fill Meshes with the Create Cut Fill Volumes tool*.

1	**Create the Earthwork Quantity File.** See *3B – Create a New ORD File*. The new Earthwork Quantity File should be named in accordance with ORD File Naming Conventions listed in Chapter 3. See *3C – ORD File Naming Conventions.* Naming Convention for Corridor Quantity File by FLH Office: ***WFLHD*:** *project specific prefix*_**qty_ew**.dgn ***EFLHD*:** **0X**_*project number*_**XXX**.dgn ***CFLHD*:** **XXX**(*alignment descriptor*)*project descriptor*.dgn
2	In the *2D Design Model*  , **Reference** in the following files: • Survey File (_sur.dgn) or Existing Terrain Model File (_ter.dgn) – which ever File contains the Existing Ground Terrain Model. • Alignment File (_ali.dgn) • Corridor Modeling File (_cor.dgn) • **OPTIONAL:** Reference in all ORD Design Files that need be included in earthwork calculations. It may be necessary to reference in the Approach Modeling File (_cor_appr.dgn) or a Parking Lot Design File (_cor_park.dgn).
3	Set the Existing Ground Surface as *Active*. See *3D.3 Activate the Existing Ground Terrain Model*.

20D.2 Create the CROSS SECTION Named Boundaries

For explanations of all settings found in the *Place Named Boundary* dialogue box, see *16B.2.a Initial Setup of the Named Boundary Dialogue Box*. In the steps below, only the parameters important to earthwork calculations are discussed.

IMPORTANT: To create CROSS SECTION *Named Boundaries*, a *View* displaying the *3D Design Model*, must be opened. The *3D Design Model* is automatically created after the Existing Ground Surface is set as *Active*.

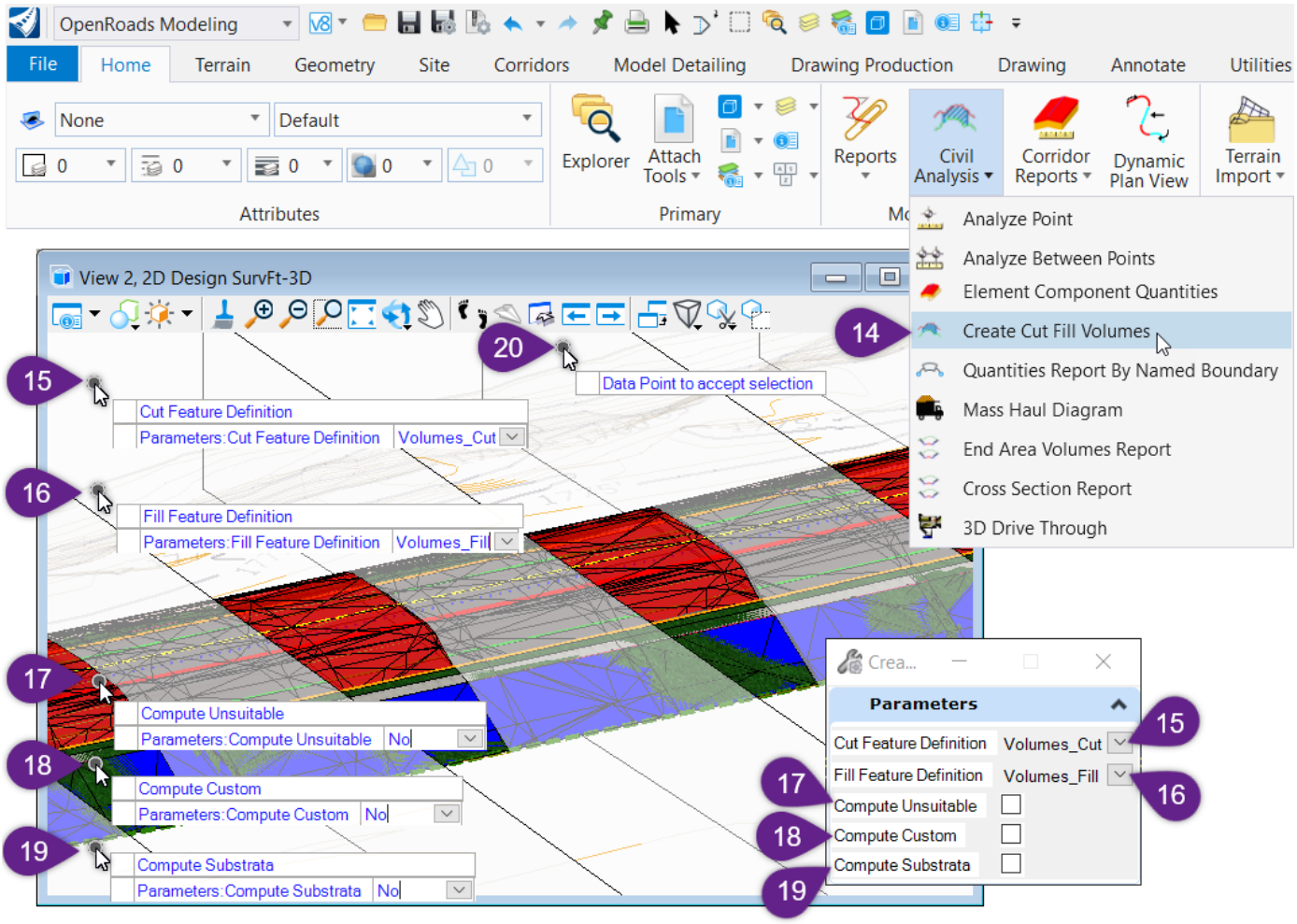


4	Open a second *View* displaying the *3D Design Model*. Most *Named Boundary* procedures are performed in the *2D Design Model*. ***WARNING:*** If CROSS SECTION *Named Boundaries* are attempted to be created without the *3D Design Model*, then an error message will be displayed.
5	From the Ribbon, select the *Place Named Boundary* tool: [***OpenRoads Modeling*** → ***Drawing Production*** → ***Named Boundaries***].
6	In the *Place Named Boundary* Dialogue Box, select the ***Civil Cross Section*** mode by clicking on the icon.
7	*Prompt: Place Named Boundary Civil Cross Section > Identify Path Element* – Left-Click on the Corridor Alignment.
8	**Drawing Seed:** CROSS SECTION *Named Boundaries* created for earthwork calculations are NOT presented in plans. Therefore, choose a large *Drawing Seed* to ensure the Corridor and/or Approaches fit within the limits of the resulting *Named Boundaries*. To determine the Total Length for each *Drawing Seed*, see *16B.2.a.i Cross Section Drawing Seed Table and Total Lengths*. In this case, the "30 Scale XS Landscape" *Drawing Seed* is used to ensure all 3D Modeling elements fit in the *Named Boundaries*.
9	**Group Name:** Assign the *Group* to be created a logical name. In this case, "Earthwork Group" is typed into the *Group Name* box.
10	**Interval:** The *Interval* sets the cross section spacing that will be used for Average Area End Method calculations. The *Interval* will depend on project requirements for earthwork calculations. In this case, the *Interval* is set at every 50 feet.
11	**Include Control Points:** If this box is CHECKED then a Cross Section is placed and earthwork calculations are made at each horizontal Alignment geometry point (i.e., PC/PT of curves). Conventionally, this box should be CHECKED.
12	**Create Drawing:** Ensure this box is UNCHECKED. It is NOT necessary to create *Drawing Models* and *Sheet Models* for earthwork calculations.
13	**Set the Start Location and Stop Location:** In the dialogue box, type in the *Start Location* and *End Location*. **Alternative:** In the *2D Design Model*, follow the *Prompts* in the lower-left corner and specify the *Start Location* and *End Location* with the mouse-cursor.

20D.3 Create Cut/Fill Meshes with the Create Cut Fill Volumes tool

The *Create Cut Fill Volumes* tool must be used to calculate earthwork volumes. If Cut and Fill Meshes are NOT created, then the resulting earthwork report will be blank. For more information on this tool and Cut and Fill Meshes, refer to *20B - Create Cut Fill Volumes tool and Earthwork Meshes*.

A detailed workflow for this tool is shown in *20B.2 Create Cut Fill Volumes tool – Workflow*.



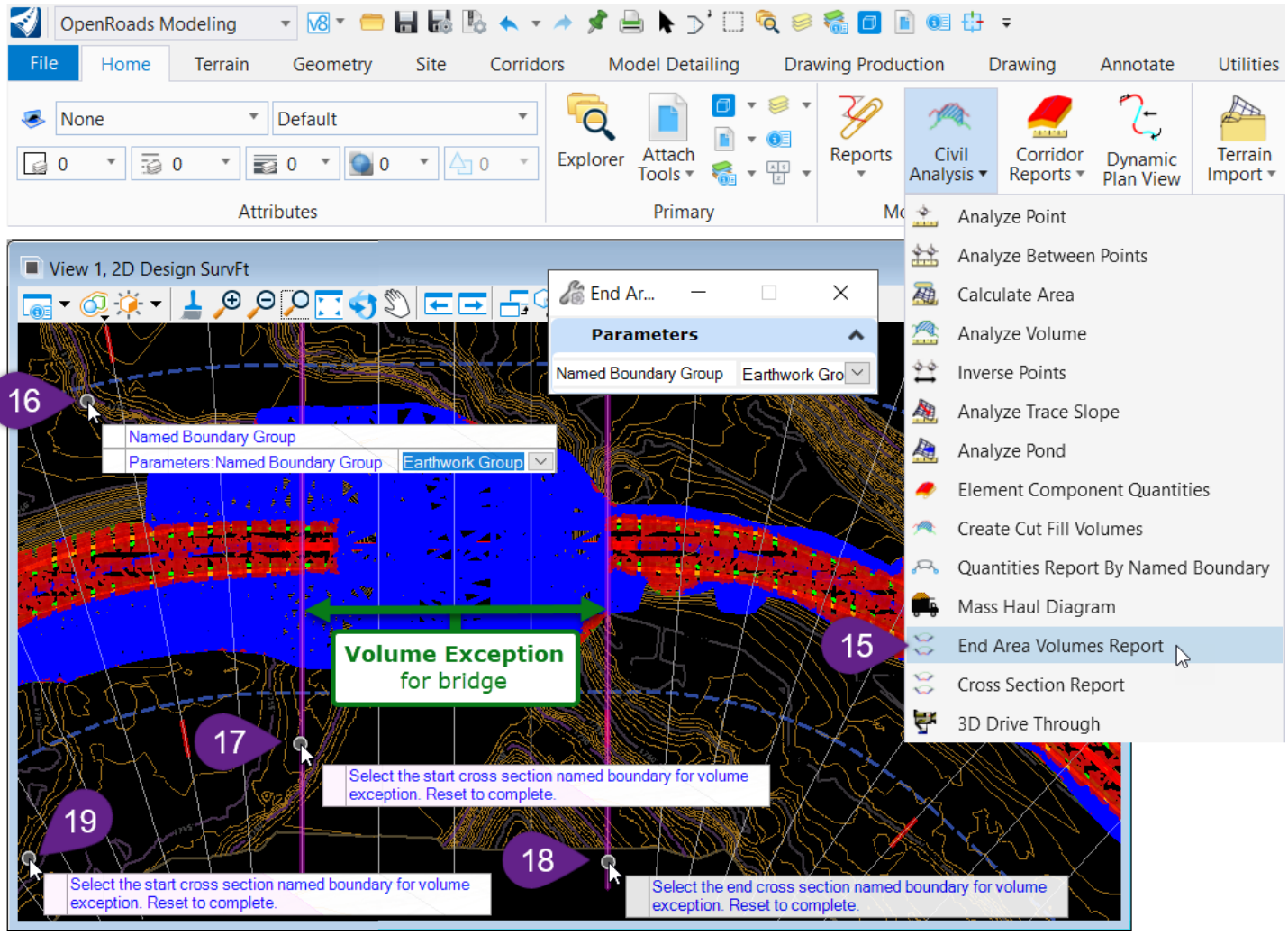
14	From the Ribbon, select the *Create Cut Fill Volumes* tool: [***OpenRoads Modeling*** → ***Home*** → ***Model Analysis and Reporting***].
15	*Prompt: Cut Feature Definition* – Accept and use the default Cut Feature Definition – which should be "Volumes_Cut". Left-Click in the *View* to accept and proceed to the next prompt.
16	*Prompt: Fill Feature Definition* – Accept and use the default Fill Feature Definition – which should be "Volumes_Fill". Left-Click in the *View* to accept and proceed to the next prompt.
17	*Prompt Compute Unsuitable* – In this case, "NO" is selected.
18	*Prompt Compute Custom* – In this case, "NO" is selected.
19	*Prompt Compute Substrata* – In this case, "NO" is selected.
20	*Prompt: Data Point to accept selection* – Left-Click anywhere in the *View* to create the Cut and Fill Meshes in the *3D Design Model* .

20D.4 Generate the Report with the End Area Volumes Report tool

After CROSS SECTION *Named Boundary* elements and Cut/Fill Meshes have been created, then the earthwork report can be generated with the *End Areas Volumes Report*.

TIP: As shown in steps 17 and 18, it is possible to exclude a range of Cross Sections – which is referred to as a "volume exception" by the software. The range of Cross Sections designated as a "volume exception" will NOT be included and calculated in the earthwork report.

In this case, a "volume exception" is used to exclude the *Named Boundaries* in the vicinity of a bridge.



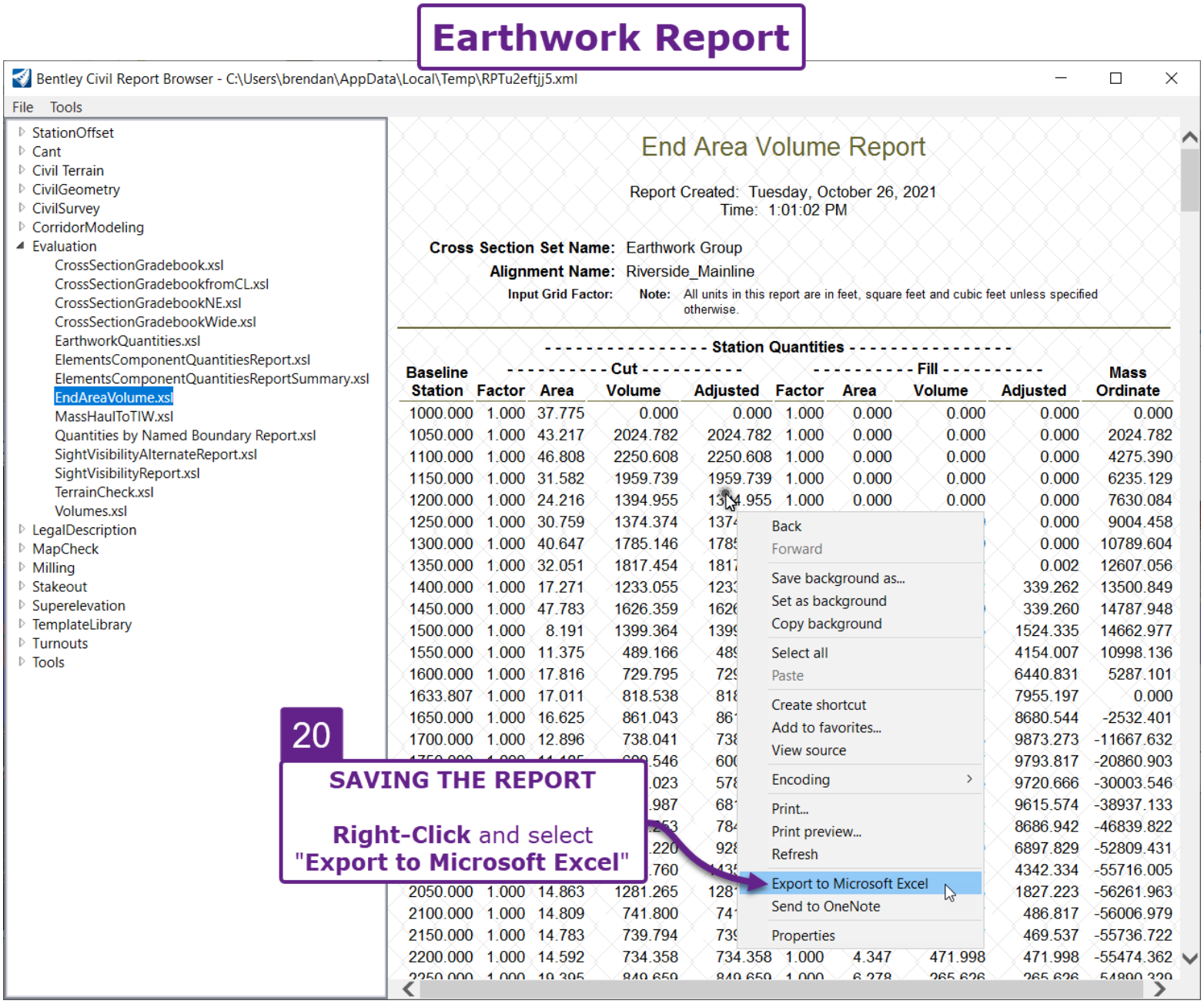
15	From the Ribbon, select the *End Area Volumes Report* tool: [***OpenRoads Modeling*** → ***Home*** → ***Model Analysis and Reporting***].
16	*Prompt: Named Boundary Group* – select the **Group** that was created in step 9.
17	*Prompt: Select the start cross section named boundary for volume exception. Reset to complete.* **OPTION 1:** If the desire is to perform earthwork calculations at every cross section location, then Right-Click in the *View* and the earthwork report will be created. **OPTION 2:** To create a gap or "volume exception" in the report, then Left-Click on the first *Named Boundary* to be included in the "volume exception"

18	**OPTION 2:** *Prompt: Select the end cross section named boundary for volume exception. Reset to complete –* Left-Click on the last *Named Boundary* to define the "volume exception".
19	**OPTION 2:** *Prompt: Select the start cross section named boundary for volume exception. Reset to complete*. If no other "volume exceptions" are to be specified, then Right-Click in the *View* to create the report.

20D.5 Saving the Earthwork Report

To save the Earthwork Report, right-click in the report window and select "Export to Microsoft Excel".

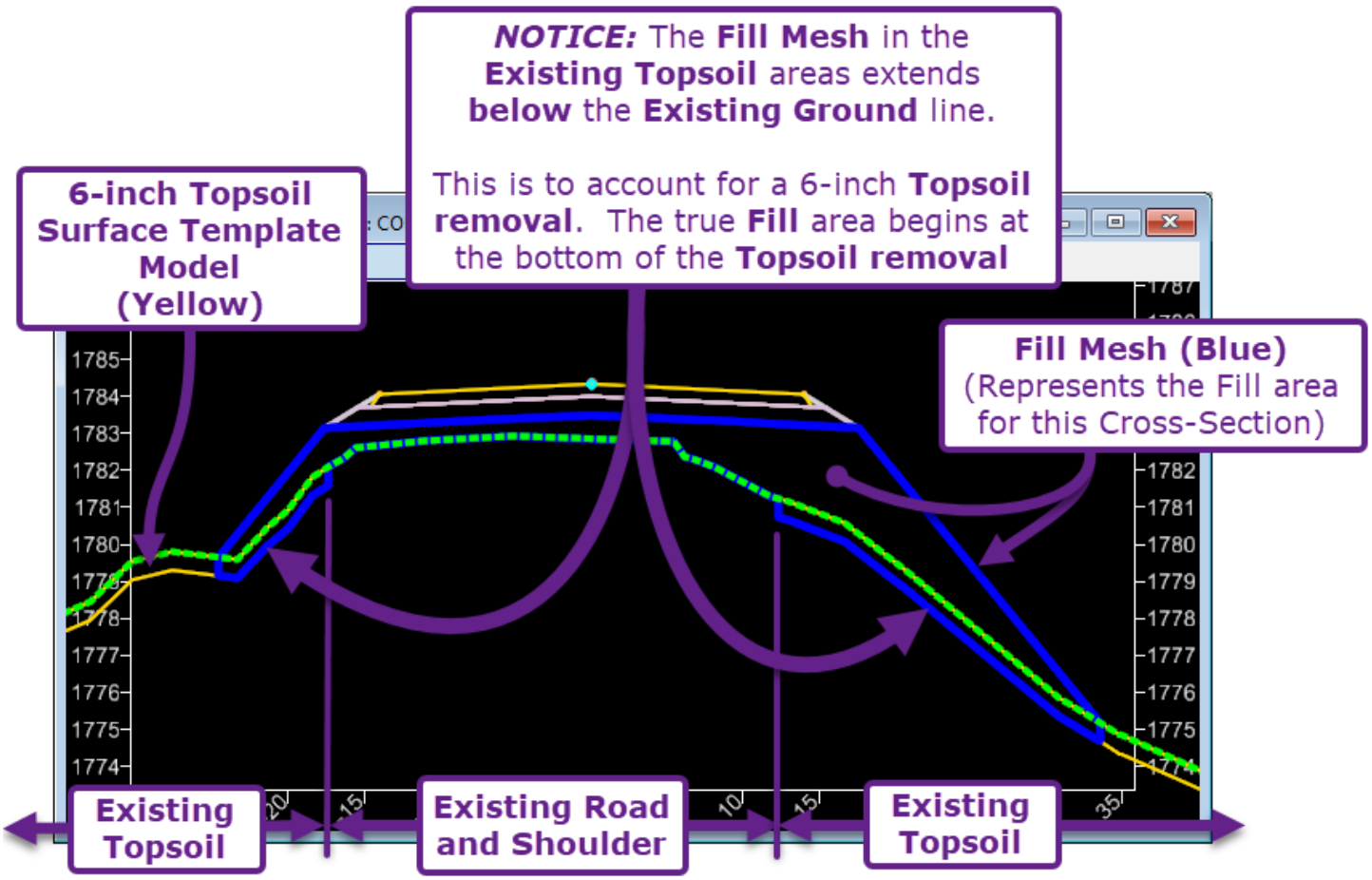
TIP: The Earthwork grand totals are listed at the end of the report.



20E – UNSUITABLE MATERIAL MODELING AND CALCULATIONS

In real-world construction, unsuitable materials, such as existing pavement and topsoil are often encountered. Before building a new roadway or parking lot, the unsuitable material must be removed from the ground. After removing unsuitable materials, the ground surface may be lower than the surveyed Existing Ground Terrain Model, which is used for the design and earthwork (cut/fill) quantity calculations of the new road or parking lot.

This workflow demonstrates how to account for the removal of Unsuitable Materials in the creation of Cut/Fill (earthwork) Meshes. Before using the *Create Cut Fill Volume* tool, the area where Unsuitable Materials are located and the depth of the Unsuitable Material must be modeled using Surface Templates. In the graphic below, the Unsuitable Material is a 6" depth of topsoil that is located past the Existing Road Shoulder.



NOTICE: When the Cut/Fill Meshes are created, they will extend below the Existing Ground Terrain Model surface and begin at the bottom of the Unsuitable Material Surface Template, which simulates the removal of the Unsuitable Material and provides a more accurate account of Cut/Fill (earthwork) quantities in calculation.

20E.1 Process Overview for Modeling Unsuitable Materials

The general processes for modeling Unsuitable Materials are discussed below.

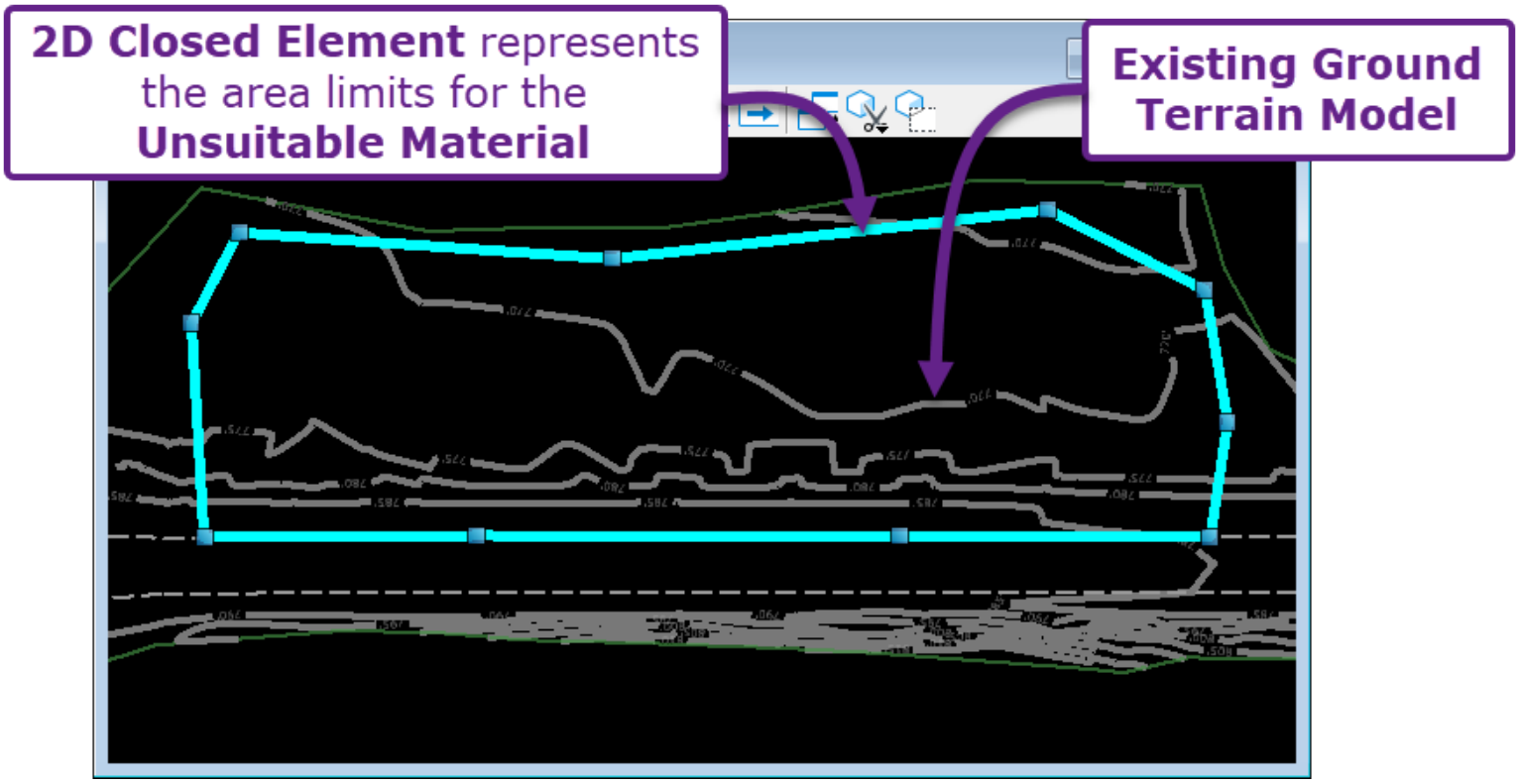
Process 1 – Create a new ORD File for Modeling the Unsuitable Material:

Do NOT model Unsuitable Materials in a Corridor ORD File or other Design ORD File. Create a new ORD File that is solely used for modeling the Unsuitable Material. Use a **2D Seed File** when creating the new ORD File.

In the new ORD File, **reference in the Survey ORD File** or whichever ORD File contains the Existing Ground Terrain Model. The Existing Ground Terrain Model will be directly used to create the Surface Template discussed in the remaining processes. It is NOT necessary to reference in the Corridor ORD File into this new ORD File.

Process 2 – Draw a 2D Closed Element to represent the area of the Unsuitable Material:

A 2D Closed Element must be drawn to represent the limits (footprint area) of the Unsuitable Material. The 2D. The 2D Closed Element must be located within the boundary of the Existing Ground Terrain Model. As discussed in the next process, the Surface Template is applied to the Existing Ground Terrain Model, but ONLY within the limits of the 2D Closed Element.

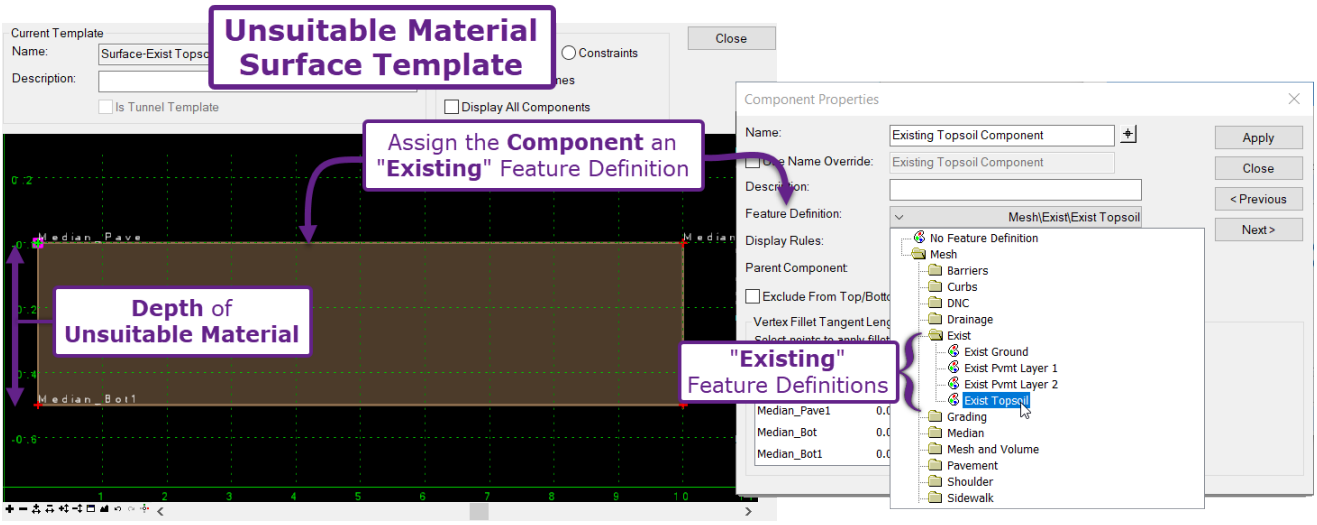


NOTE: The Unsuitable Material Surface Template does NOT interact with the Corridor or other proposed modeling elements until earthwork calculations are performed. The footprint area of the Unsuitable Material Surface Template does NOT need to be coordinated with the footprint area of the Corridor. The area of the Surface Template can extend past the footprint of the Corridor and correct earthwork calculations are still achieved.

Process 3 - Create the Unsuitable Material Template in the Template Editor:

Unsuitable Materials are modeled with Surface Templates. The Surface Template represents the depth of the unsuitable material. Create the Unsuitable Material Template in the Template Editor. Creation of Surface Templates in the Template Editor is shown in *8H.3 Create a Surface Template Workflow*.

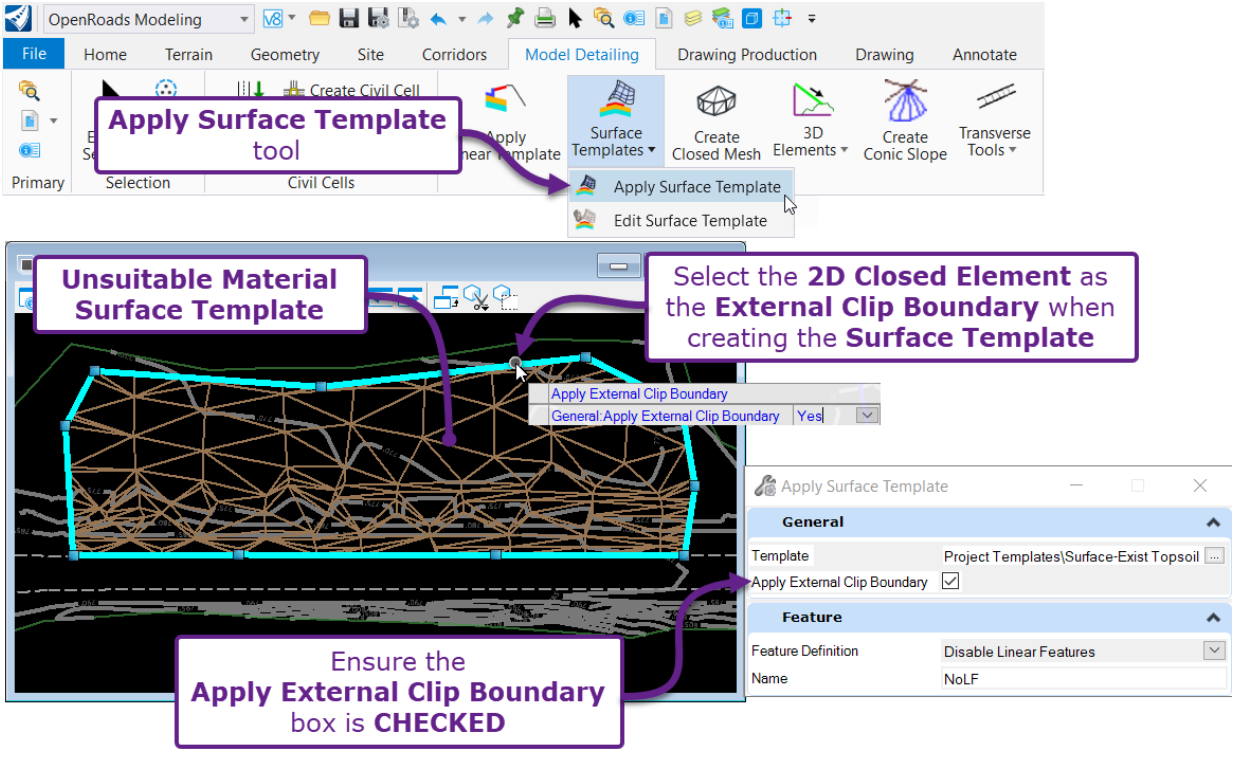
IMPORTANT: The Surface Template component must be assigned to an "Existing" Feature Definition. If NOT then the Unsuitable Surface Template will NOT be accounted for in earthwork quantity calculations.



Process 4 – Apply the Surface Template to the Existing Ground Terrain Model:

After the 2D Closed Element is created, the *Apply Surface Template* tool can be used to model the Unsuitable Material. When using this tool, the 2D Closed Element and the Existing Ground Terrain Model are both selected. The Existing Ground surface is specified as the Terrain Model and the 2D Closed Element is specified as the **External Clip Boundary**.

With the External Clip Boundary specified, the Surface Template is ONLY applied to the Existing Ground within the 2D Closed Element.



Process 5 – Create a new Quantities ORD File and Calculate Earthwork Quantities:

Create a new Quantities ORD File using a **2D Seed File**. Reference in the following ORD Files:

- The **Survey ORD File** or whichever ORD File contains the original Existing Ground Terrain Model.
- The **Unsuitable Materials ORD File**, which was created in **Process 1**.
- The **Corridor ORD File** and other **Design ORD Files** that contain proposed design models.

Use the *Create Cut Fill Volume* tool to create the Cut/Fill Meshes. When using this tool, ensure the **Compute Unsuitable** option is set to **Yes**. The resulting Cut/Fill Meshes will extend below the Existing Ground surface to account for the removal of the Unsuitable Materials. See *20B.2 Create Cut Fill Volumes tool – Workflow*.

> ***BEST PRACTICE:*** After using the *Create Cut Fill Volumes* tool, examine the resulting Cut and Fill Meshes in a cross-section view. Ensure that the Cut and Fill Meshes are created with the respect to the Unsuitable Materials removal. To view cross-sections, use the *Dynamic Cross Section Viewer* (*9F.1 Accessing the Dynamic Cross Section Viewer*)

Use the *Quantity Report By Named Boundary* tool to calculate the earthwork quantities and generate a report. See *20C.2 Quantity Report By Named Boundary for Approaches*.

In the quantities report, the "Volumes_Cut" and "Volumes_Fill" feature definitions represent the earthwork quantities and reflect the removal of Unsuitable Materials. For more information deciphering this report, see *20E.3.b Unsuitable Materials in the Quantities Report*.

> ***WARNING:*** In the quantities report, the Feature Definition used to create the Unsuitable Material Surface Template will be shown (i.e., "Exist Topsoil"). **This volume should be IGNORED and NOT used for plan quantities.**
>
> The Unsuitable Material Surface Template feature definition corresponds with the total volume of the Surface Template. This quantity may NOT correlate with the volume of Unsuitable Material that needs to be removed. If the Surface Templates extend past the Corridor footprint area, then this quantity will be greater than the Unsuitable Material volume that actually needs to be removed to construct the road.
>
> ***TIP:*** To determine the actual Unsuitable Material removal volume, the 2D Closed Element that is used to create the Surface Templates must NOT extend past the Corridor footprint area. If the 2D Closed Element and Corridor footprint area are coordinated, then the Unsuitable Material feature definition volume may be used.

20E.2 Model the Unsuitable Material with Surface Templates - Workflow

20E.2.a Create a New ORD File for the Unsuitable Material Models

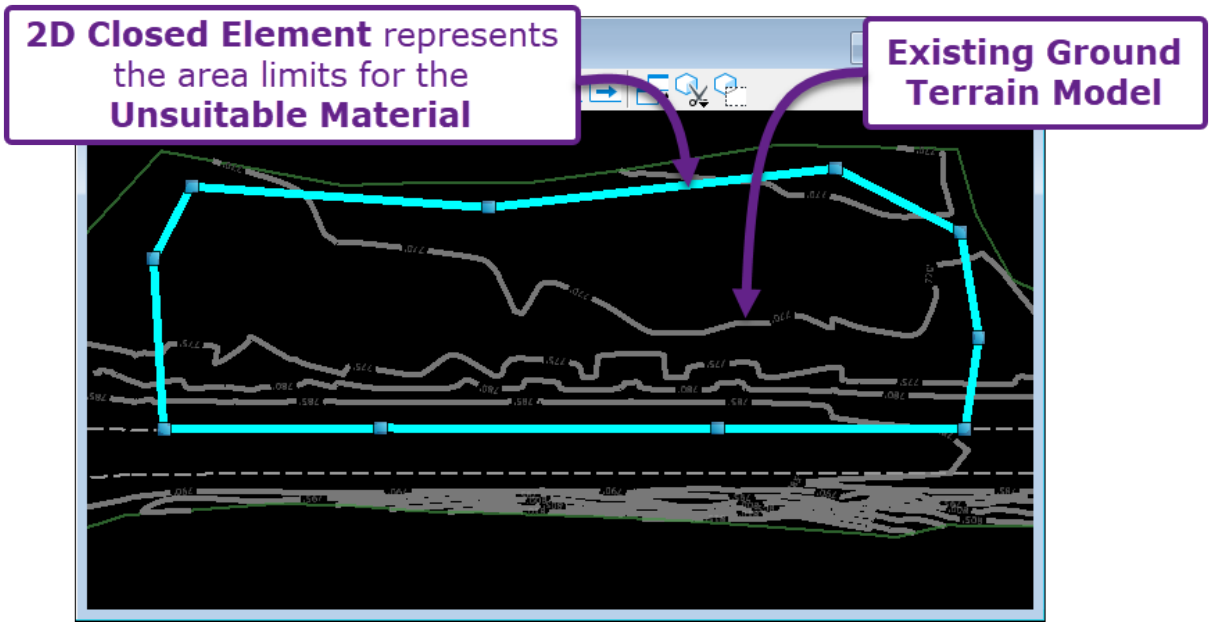
It is advised that Unsuitable Material are modeled are created in a dedicated Unsuitable ORD File.

References Needed in the Unsuitable ORD File: In the new Unsuitable ORD File, reference in the Existing Survey ORD File. For this process, **Existing Ground Terrain Model** must be referenced in and *Activated*. Also, the **Existing Shoulder** survey linework, which represents the front edge of the Topsoil Removal Area, must be copied into the Unsuitable ORD File.

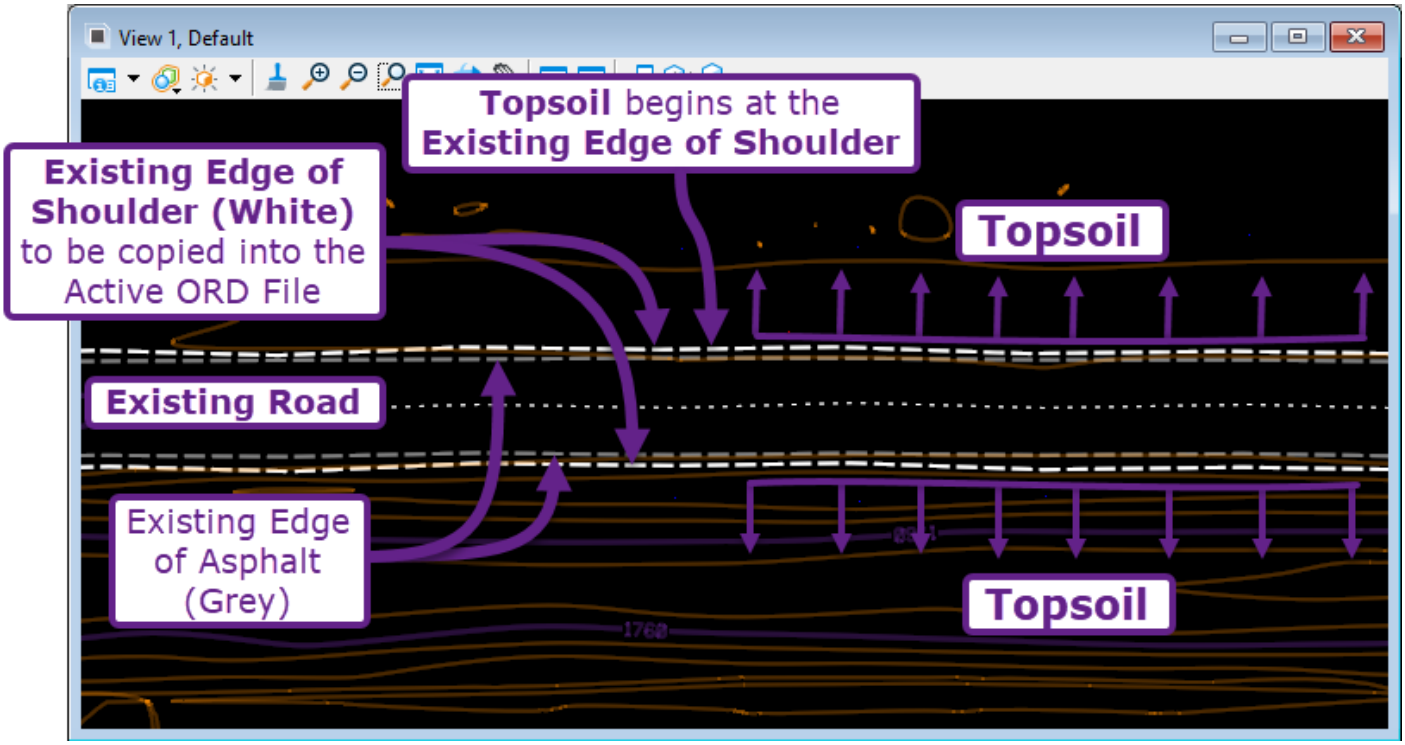
1	**Create a new ORD File** to contain the Unsuitable Material Models. See *3B – Create a New ORD File*. The new Unsuitable Material Model ORD File should be named in accordance with ORD File Naming Conventions listed in Chapter 3. See *3C – ORD File Naming Conventions*. Naming Convention for Unsuitable Material Model ORD Files by FLH Office: **WFLHD:** project specific prefix**_unsuitable**.dgn **EFLHD:** **0X**_project number**_XXX**.dgn **CFLHD:** **XXX**(alignment descriptor)project descriptor.dgn
2	Set the coordinate system for the new ORD Sheet File. See *3D.1 Set the Coordinate System*.
3	In the *2D Design Model* of the new ORD Sheet File, **Reference** in the necessary **Survey ORD Files**.

20E.2.b Create a Closed Element to represent the Unsuitable Materials Area

In this process, the User must create a 2D CLOSED Shape element to delineate the area of the Unsuitable Material, which is in this case is topsoil. The 2D CLOSED Shape element could be a closed SmartLine.



However, in this workflow, linework found in the Survey ORD File is copied into the Active ORD File and incorporated into the CLOSED Shape element with the *Create Complex Shape* tool. Specifically in this example, topsoil exists outside of the existing road Shoulder line. The Shoulder line will be copied from the Survey ORD File and used as a defining edge of the topsoil area.



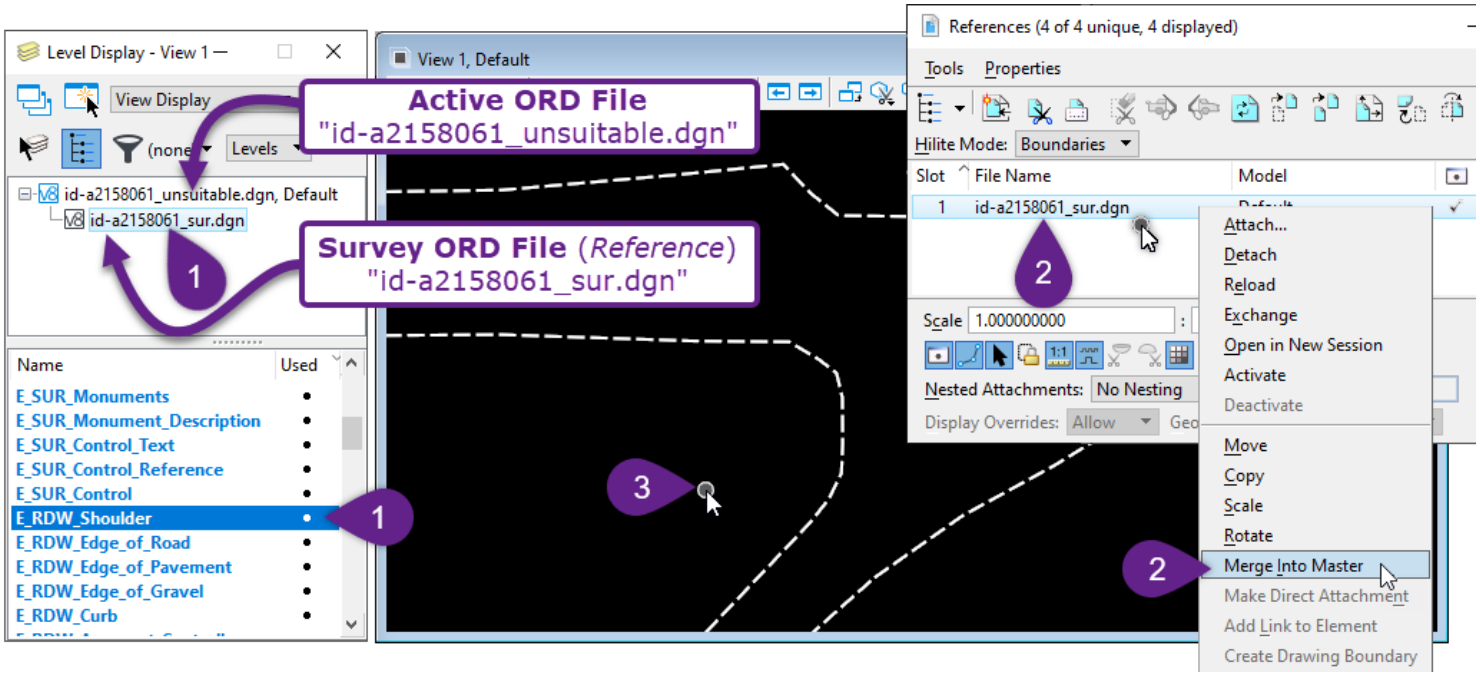
20E.2.b.i Copy or Merge Survey Linework into the Active ORD File

In this example, the Existing Edge of Shoulder – which is in the Survey ORD File – needs to be brought into the Unsuitable Material ORD File (Active). There are two methods for bringing in Survey elements into the Active ORD File:

Use the Copy tool: With this method, the *Copy* tool is used with linework found in reference ORD File (Survey). When referenced Linework is *Copied*, the resulting copies are placed in the Active ORD File. This method could be tedious because the User must manually select each Survey element to be copied in.

Merge Into Master: With this method, the *Merge Into Master* is used. When this tool is used, all displayed reference linework (Level = ON) is brought into the Active ORD File. Before this tool is used, toggle OFF the Levels of all elements that do NOT need to be brought into the Active ORD File. Only elements that are displayed in the *View* are brought into the Active ORD File. This method is convenient because Survey linework is brought in without manually referenced elements. The *Merge into Master* tool is discussed in *1E.7.a Merge Into Master tool (Import Reference into Current ORD File)*.

In this workflow, the **Merge Into Master** tool is used to bring in all Survey elements assigned to the "E_RDW_Shoulder" Level. The "E_RDW_Shoulder" Level contains all linework that represents the Existing Edge of Shoulder – which will be used to delineate the Topsoil areas.



1	In the *Level Display* manager, toggle OFF all Levels of the Survey ORD File – except for the linework Levels to bring into the Active ORD File ("E_RDW_Shoulder").
2	In the *References* manager, Right-Click on the Survey ORD File reference. Select the *Merge Into Master* tool.
3	*Prompt: Select View For Merge…* - Left-Click in the *View* to complete the command.

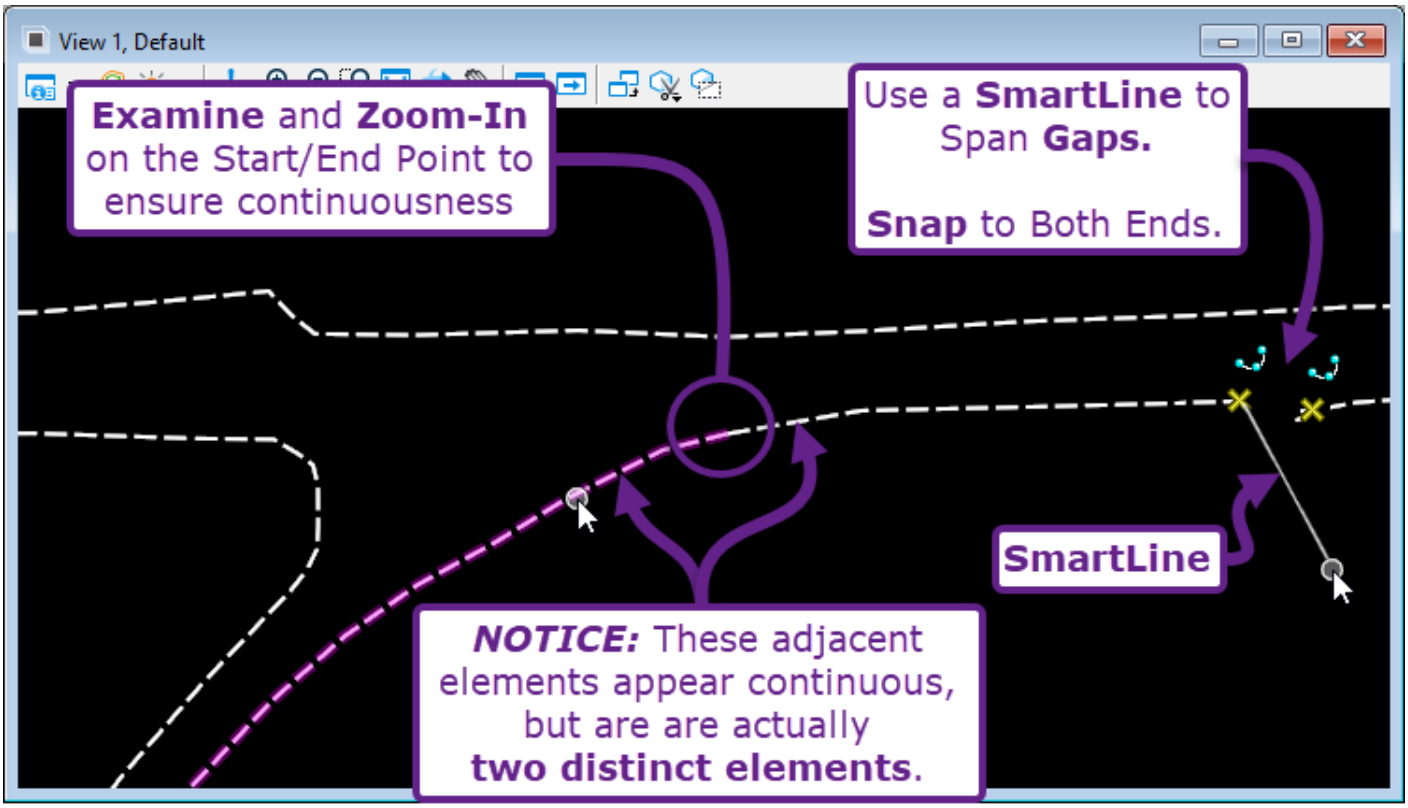
IMPORTANT: After the *Merge Into Master* tool is used, the Survey ORD File reference is removed. If the Existing Ground Terrain Model is in this file, then it will have to be re-referenced for later steps.

20E.2.b.ii Examine Survey Linework for Discontinuities, Gaps, and Breaks

WARNING: Survey Linework – such as the Existing Edge of Shoulder line – may appear as a single continuous element but is often segmented. Adjacent segments may NOT share a common start/end point, which can be problematic when using the *Create Complex Shape* tool to combine elements into a single CLOSED Shape.

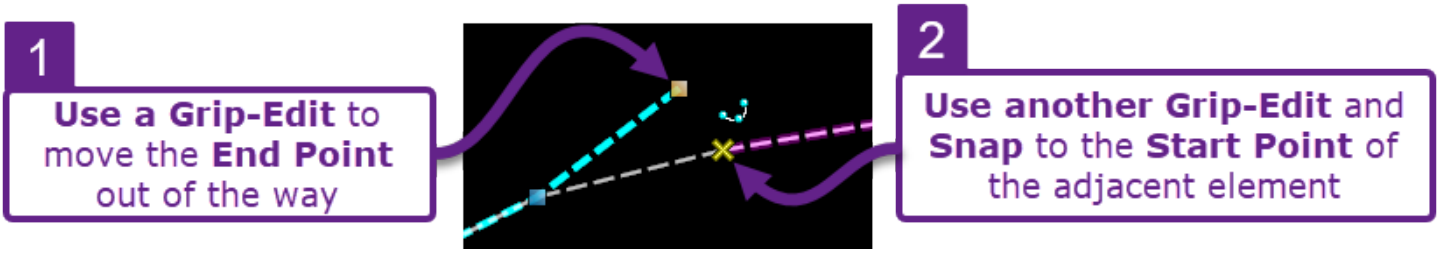
The User must examine the Start/End Point of each Survey Linework element and ensure that it coincides with the neighboring element. If Survey Linework does not exactly align, use a grip-edit to snap the two ends together.

Similarly, there may be gaps between Survey Linework elements. Use a SmartLine element to span gaps between Survey Linework elements.



WARNING: Adjusting Survey Linework to be continuous is important when joining elements together with the *Create Complex Shape* tool. The *Create Complex Shape* tool allows for a "Maximum Gap" between elements to be joined. However, this Maximum Gap is often unreliable. For best results with the *Create Complex Shape* tool, all elements should be Snapped to each other.

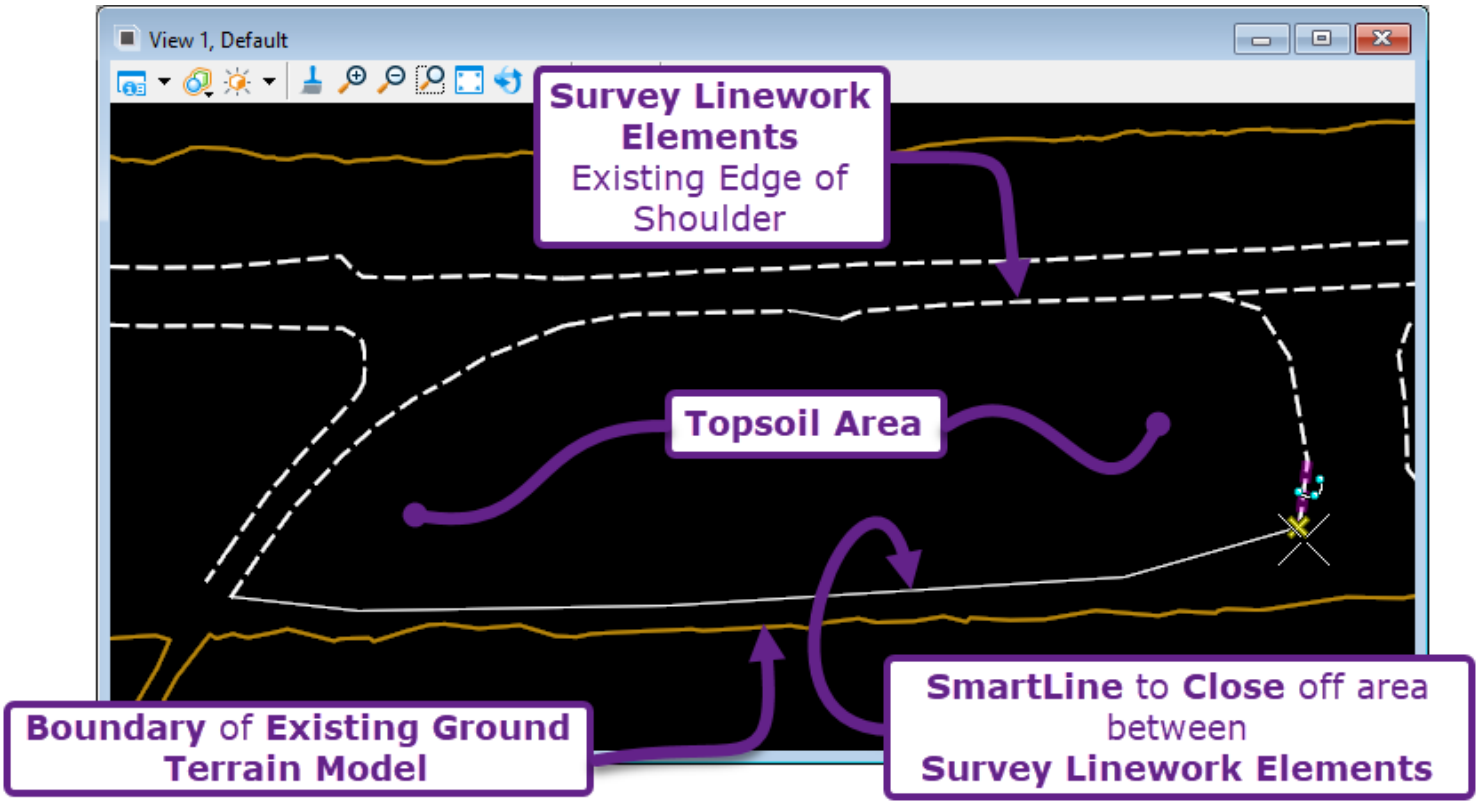
BEST PRACTICE: For each Survey linework element, manually Snap the element End Point to the Start Point of the adjacent element – as shown below:



20E.2.b.iii Manually Draw the Outside Edges for the 2D Closed Shape

In this process, the remaining elements for the CLOSED Shape are manually drawn by the User. When drawing the Outside Edges, be sure to provide enough area to fit the proposed Corridor and Site Modeling features within the CLOSED Shape. However, the Outside Edges should NOT expand past the boundary of the Existing Ground Terrain Model.

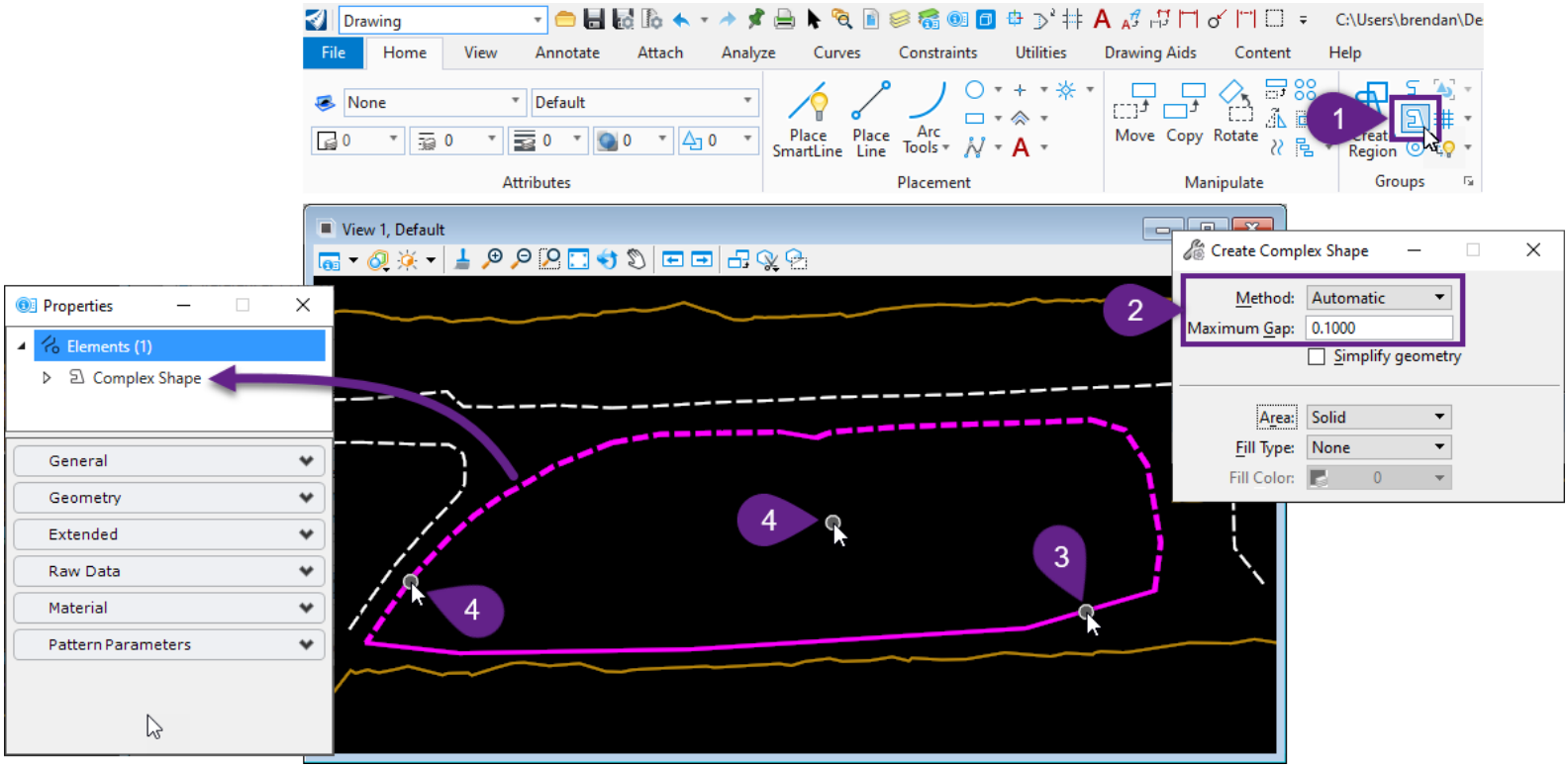
IMPORTANT: Only the Unsuitable Materials directly underneath the Corridor and Site Modeling features are factored into **Earthwork (Cut/Fill)** calculations.



20E.2.b.iv Join Elements into a Single Closed Shape

In this process, the Survey linework elements and SmartLine Outside Edges are formed into CLOSED Shapes with the *Create Complex Shape* tool.

The *Create Complex Shape* tool is discussed in greater detail in *6H.3 Create Complex Shape tool*.

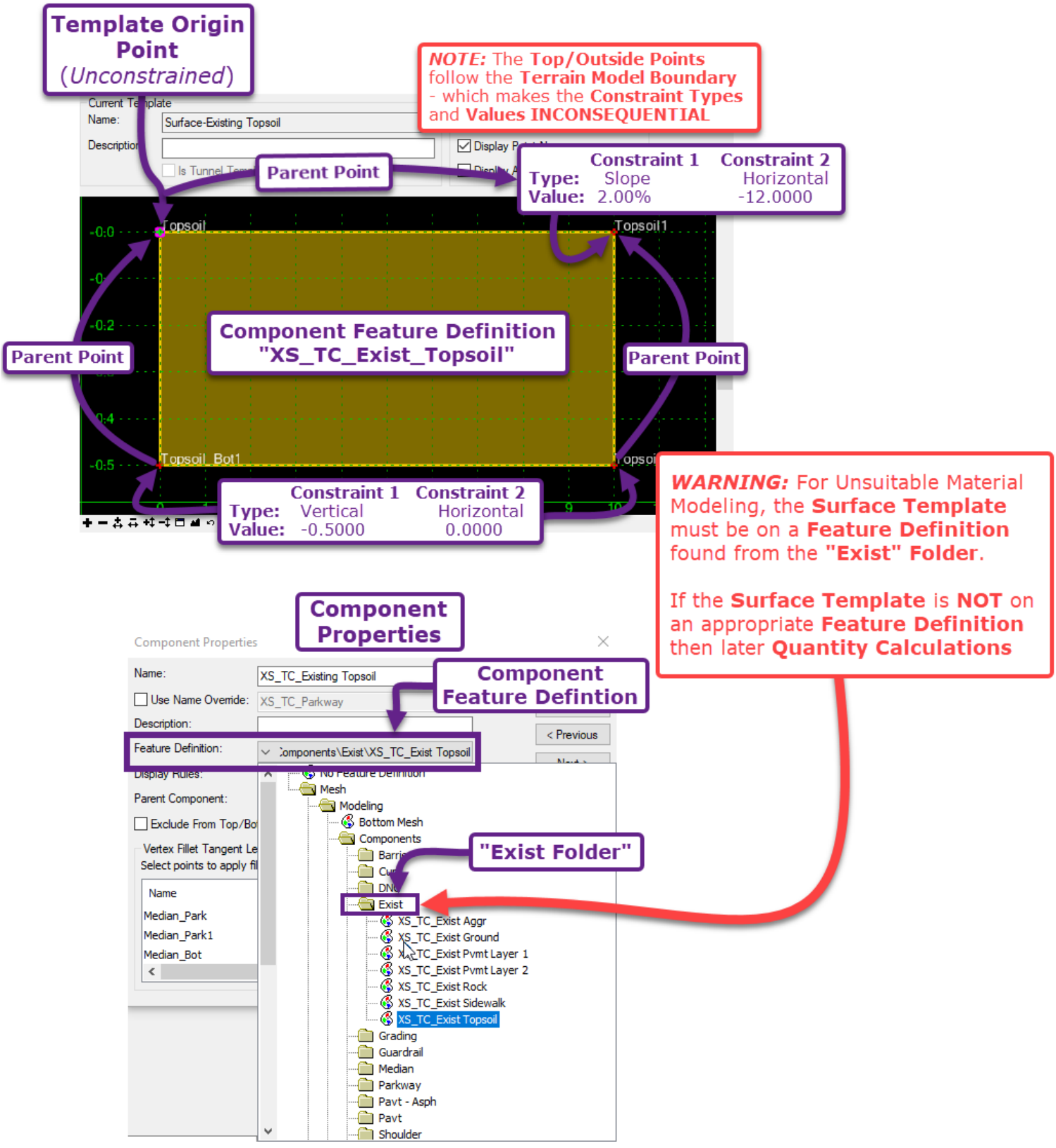


1	From the Ribbon, select the *Create Complex Shape* tool: [***Drawing*** → ***Home*** → ***Groups***].
2	Before following the *Prompts* and selecting elements, configure the Dialogue Box: **Method: Automatic** **Maximum Gap: 0.1000** ***NOTE:*** If the *Create Complex Shape* is NOT working for the **Automatic Method**, then try changing the **Method** to **Manual**. This method is tedious for larger areas but will produce a CLOSED Shape.
3	*Prompt: Automatic Create Complex Element Shape > Identify Element* – Select the first element to be included in the *Complex Shape*.
4	*Prompt: Automatic Create Complex Element Shape > Accept/Reject (select next input)* – With the **Automatic Method**, it may be necessary to manually select the next element to be included in the CLOSED Shape. If the Shape is NOT showing as closed, select the next element in line to be included If the Shape is showing a closed, left-click anywhere in the *View* to create the CLOSED Shape.

20E.2.c Create the Surface Template in the Template Editor

In this process, the Surface Template used to model the Unsuitable Material is created. The creation and editing of Surface Templates is discussed in detail in *8H – Surface Templates*.

TIP: New Surface Templates configurations should be created by copying and then modifying a pre-made Surface Template found in the FLH Standard Library. See *8H.3 Create a Surface Template Workflow.*

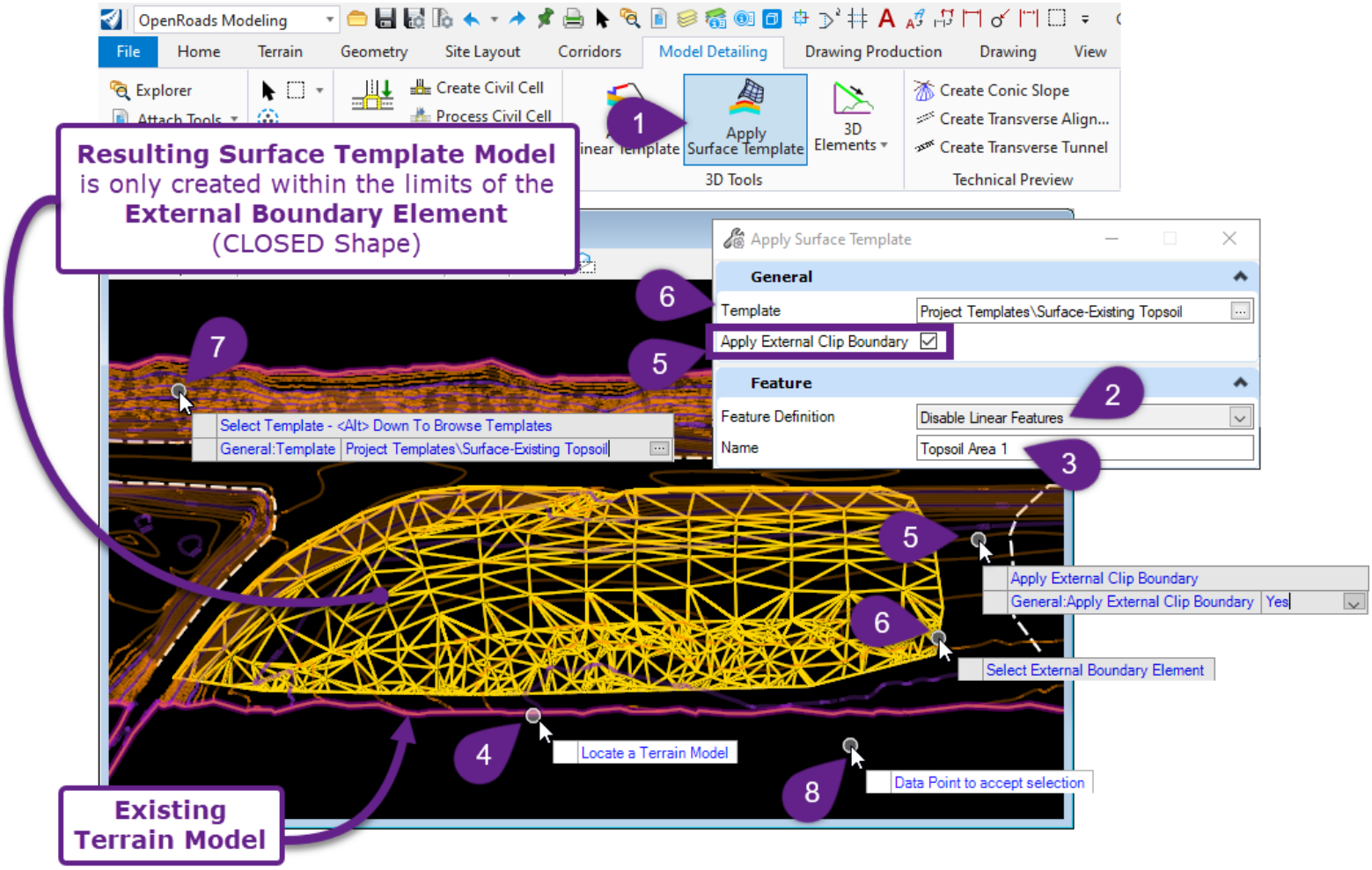


20E.2.d Apply the Surface Template with an External Clip Boundary

After creating the Unsuitable Material Surface Template in the *Template Editor*, it can be applied to the **Existing Ground Terrain Model** with the *Apply Surface Template* tool.

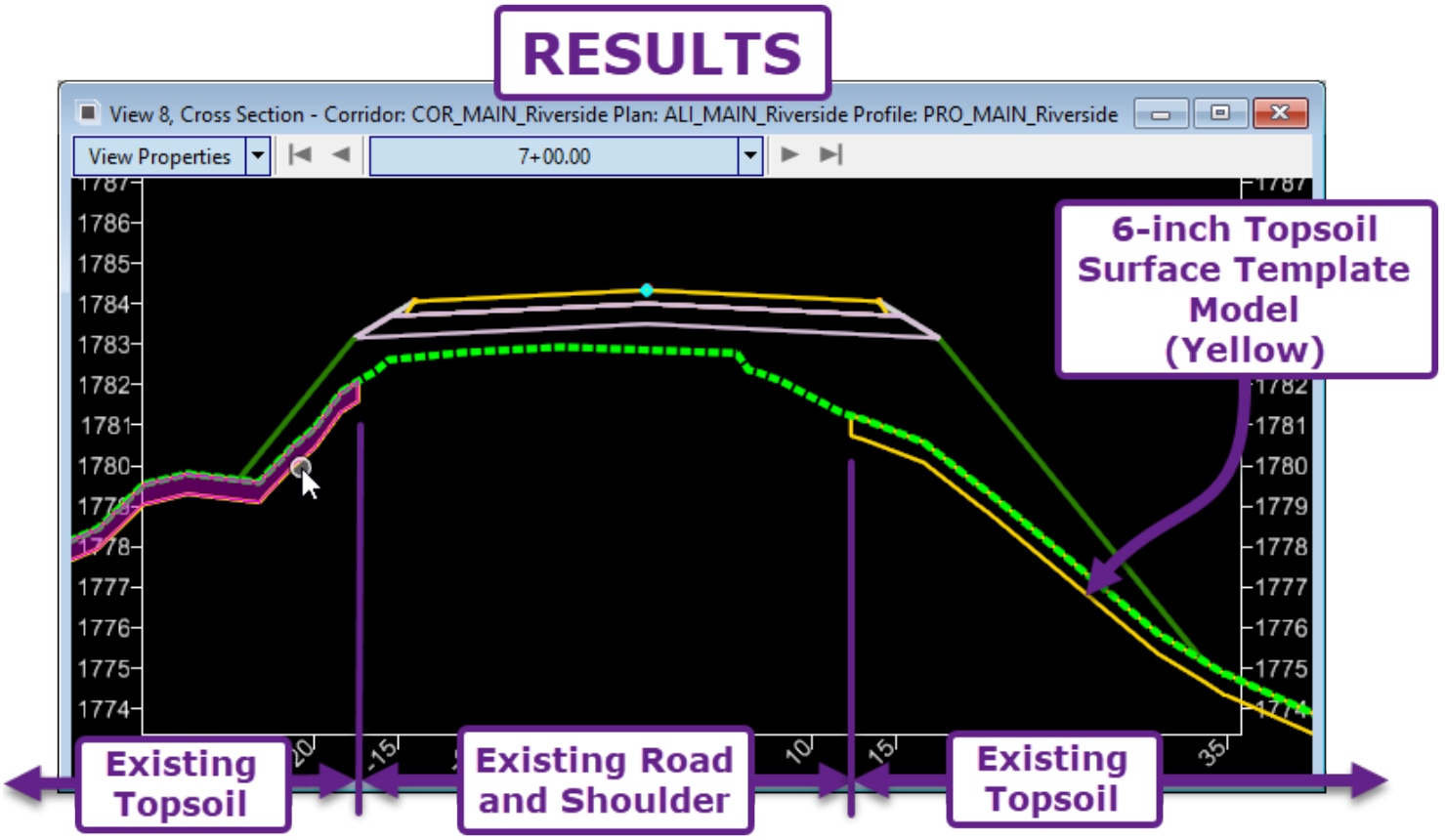
For Unsuitable Material models, the **Apply External Clip Boundary** should be CHECKED and the CLOSED Shapes (created in previous steps) are used as the *External Clip Boundaries*.

> ***WARNING:*** Ensure the **Existing Ground Terrain Model** has been *Activated* before creating the Surface Template Model.



1	From the Ribbon, select the *Apply Surface Template* tool: [***OpenRoads Modeling*** → ***Model Detailing*** → ***3D Tools***].
2	In the Dialogue Box, select a **Feature Definition**. Typically, the "Disable Linear Features" options is used.
3	In the Dialogue Box, enter a **Name** for the Unsuitable Material Surface Template.
4	*Prompt: Locate Terrain Model* – Left-Click on the **Existing Ground** Terrain Model**.**
5	*Prompt: Apply External Clip Boundary* – Select **Yes** – or CHECK the box in the Dialogue Box.

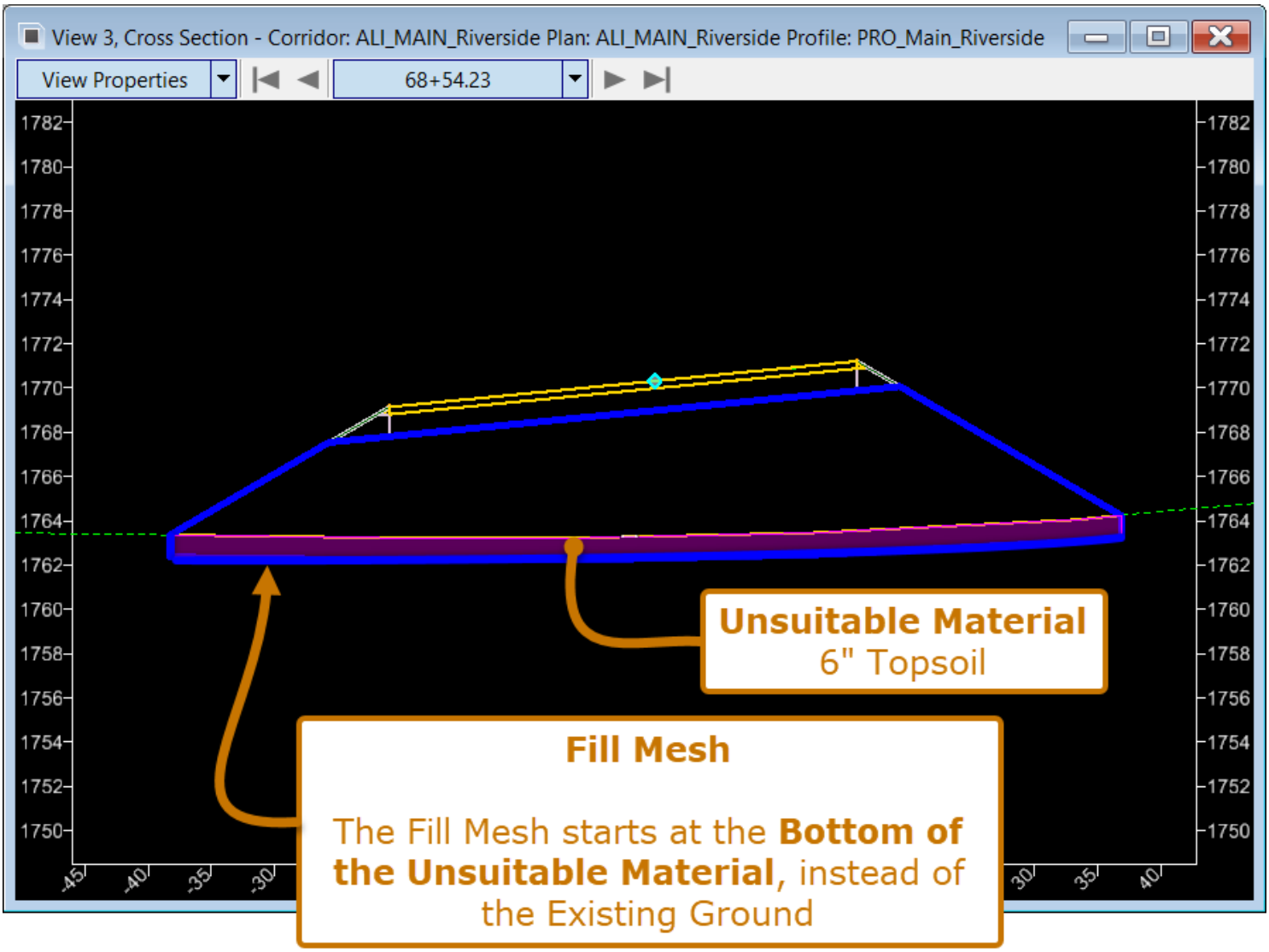
6	*Prompt: Select External Boundary Element* – Select the CLOSED Shape created in *20E.2.b Create a Closed Element to Represent the Unsuitable Material Area*. ***IMPORTANT:*** The Closed Shape is the External Boundary Element.
7	*Prompt: Select Template - <Alt> Down To Browse Templates* – Press the ALT and DOWN Arrow to access the Template Selection List. Select the Unsuitable Material Surface Template created on the previous page.
8	*Prompt: Data Point to accept selection* – Left-Click (Data Point) anywhere in the *View* complete creation of the Unsuitable Material Surface Template model.



20E.3 Unsuitable Material Calculations

After modeling the Unsuitable Materials with Surface Templates, quantity calculations can be performed.

If the previous processes in this workflow were followed, then the resulting Quantities Report will reflect the removal of Unsuitable Materials in the **Cut and Fill volume quantities**.



20E.3.a Unsuitable Material Calculation Workflow

The calculation and reporting process for Unsuitable Materials is the same as the *Quantities Report By Named Boundary* workflow shown in *20C.2 Quantity Report By Named Boundary for Approaches* – with a notable exception:

> ***IMPORTANT:*** Set *Compute Unsuitable* to "YES" when using the *Create Cut Fill Volumes* tool. See *20B.2 Create Cut Fill Volumes tool – Workflow*.

Create a new Quantity File

↓

Reference in the following ORD Files:

- **Existing Terrain Model File**
- **Design Files that contain desired Corridor, Linear Template, and Surface Template models**
- **Unsuitable Material Modeling File** (created in *20E.2.a Create a New ORD File for the Unsuitable Materials*)

↓

OPTIONAL: Create PLAN *Named Boundary* elements to specify specific calculation areas.

If *Named Boundary* elements are NOT created, then all elements referenced into the ORD File are analyzed.

↓

Create Cut/Fill Meshes with the *Create Cut Fill Volumes* too

IMPORTANT: Set the "Compute Unsuitable" option to YES

↓

Use the *Quantities Report By Named Boundary* tool to generate the Quantity Report

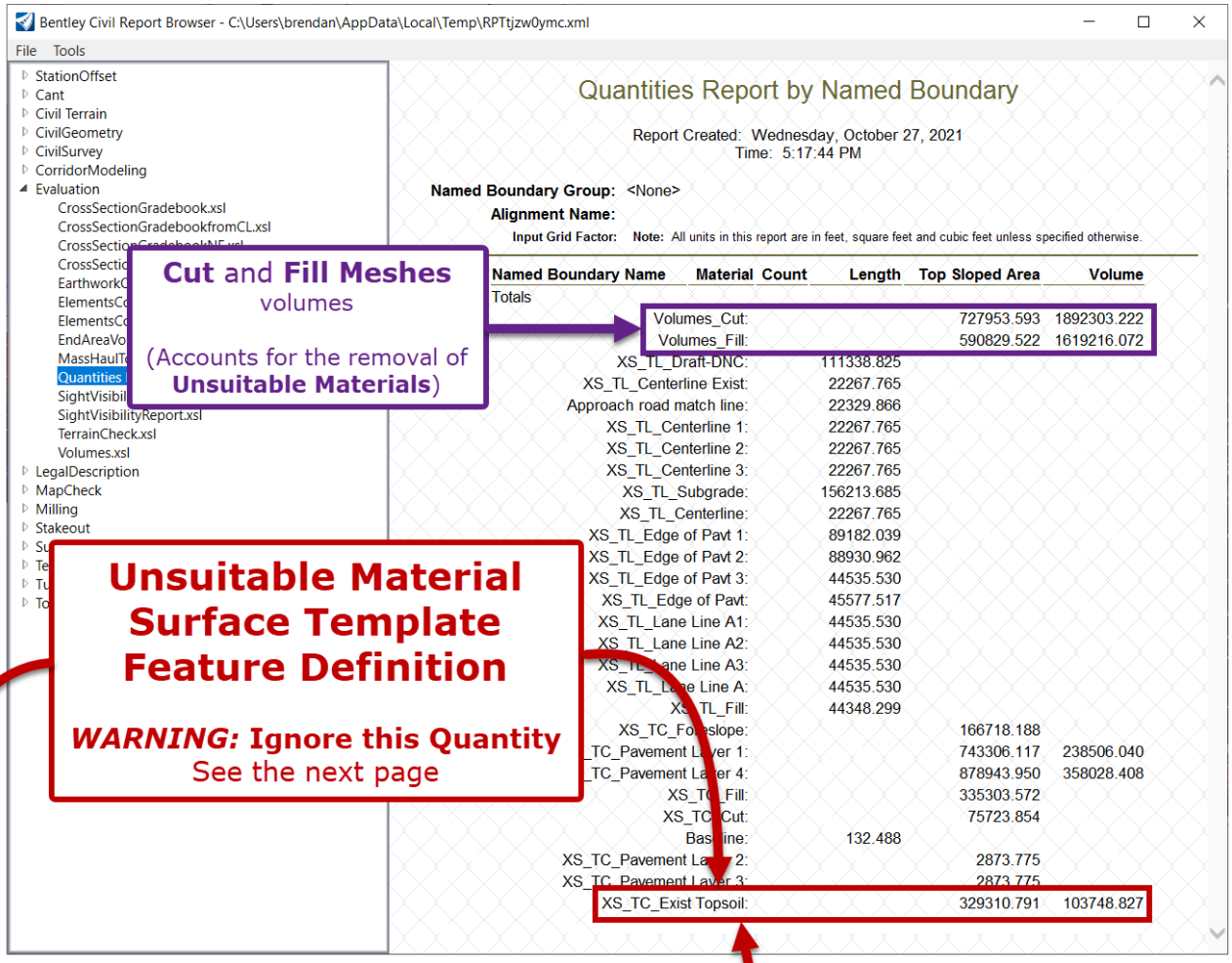
↓

Save the Quantities Report

BEST PRACTICE: After using the *Create Cut Fill Volumes* tool, examine the resulting Cut and Fill Meshes in a cross-section view. Ensure that the Cut and Fill Meshes are created with the respect to the Unsuitable Materials removal. To view cross-sections, use the *Dynamic Cross Section Viewer*. See *9F.1 Accessing the Dynamic Cross Section Viewer*.

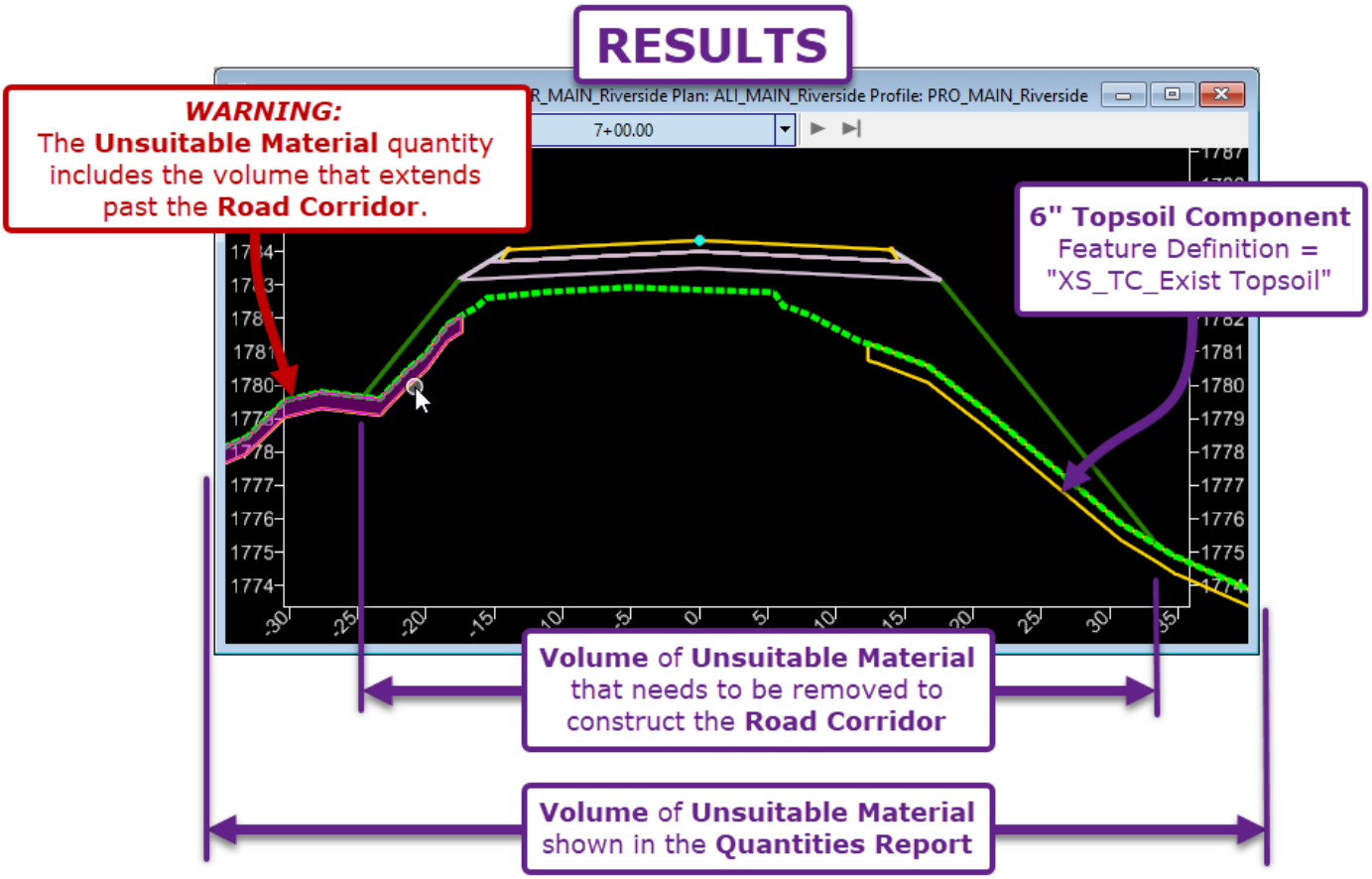
20E.3.b Unsuitable Materials in the Quantity Report

In the Quantity Report shown below, the "Volumes_Cut" and "Volumes_Fill" feature definitions represent earthwork volumes. The "Volumes_Cut/Fill" values should reflect the removal of Unsuitable Materials.



WARNING: In the quantities report, the Feature Definition used to create the Unsuitable Material Surface Template will be shown (i.e., "XS_TC_Exist Topsoil"). **This volume should be IGNORED and NOT used for plan quantities** (i.e., existing topsoil removal quantity).

The Unsuitable Material quantity ("XS_TC_Exist Topsoil") corresponds with the total volume of the Surface Template.



This quantity may NOT correlate with the volume of Unsuitable Material that needs to be removed to construct the road. If the Surface Templates extend past the Corridor footprint area, then this quantity will be greater than the Unsuitable Material volume that needs to be removed to construct the road.

In most cases, it will be necessary to estimate the volume of Unsuitable Material to be removed through hand calculations. For example, use hand calculations to determine the volume of existing topsoil that must be removed.

TIP: To determine the actual Unsuitable Material removal volume, the 2D Closed Element that is used to create the Surface Templates must NOT extend past the Corridor footprint area. If the 2D Closed Element and Corridor footprint area are coordinated, then the Unsuitable Material feature definition volume may be used.

20F – MISCELLANEOUS QUANTITY WORKFLOWS

20F.1 Culvert Excavation – Workflow

This workflow demonstrates how to model Culvert Excavation in a way that it can be calculated separately from Road Embankment Earthwork.

Advanced configuration of the Culvert Template and Component Feature Definitions is required to separate Culvert Excavation volumes from the Cut/Fill Meshes that quantify Road Embankment Earthwork.

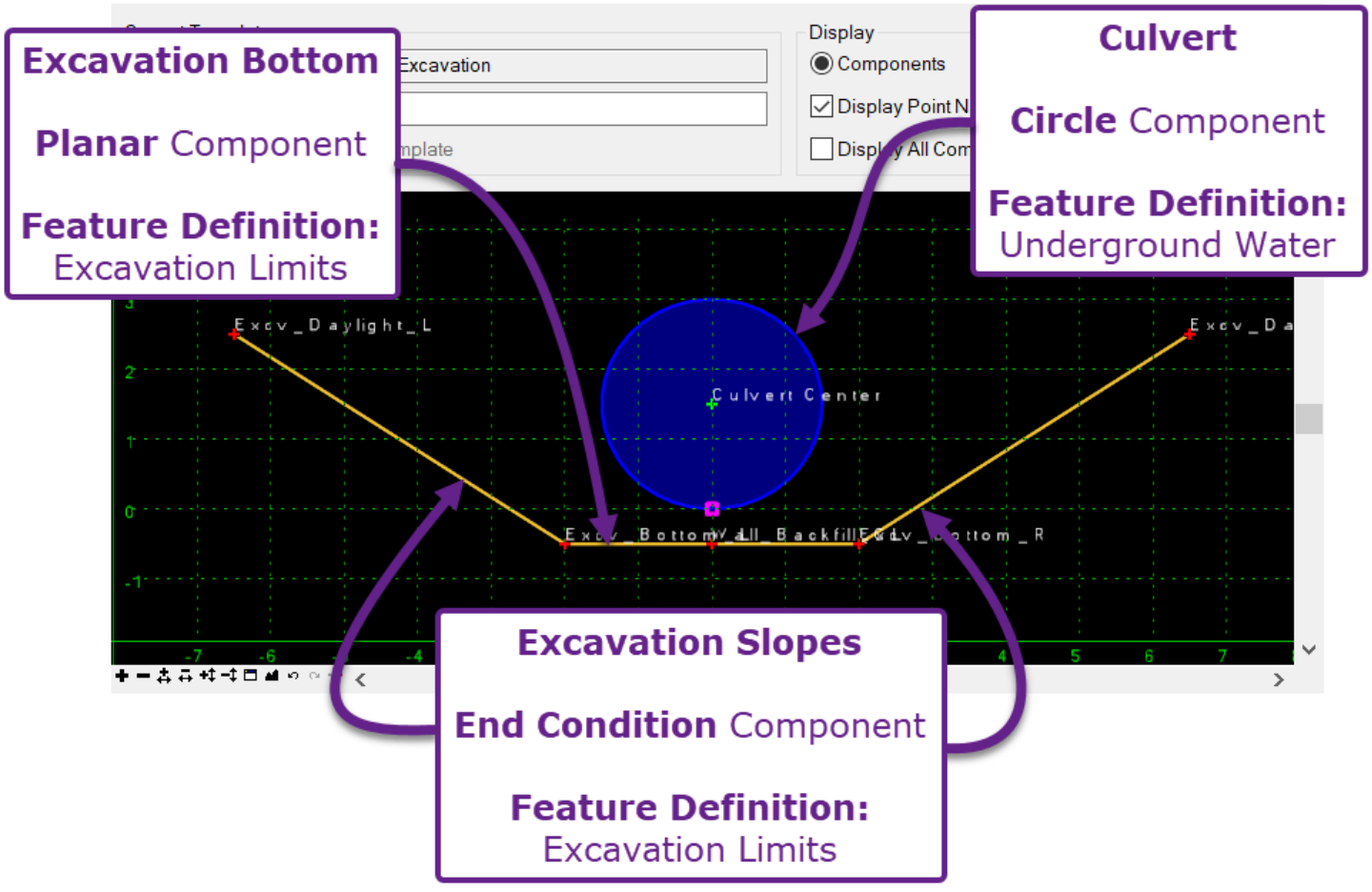
Before performing this workflow, review the Volume Option concepts found in *20G - Advanced Information: Component Feature Definition*.

20F.1.a Culvert Template Configuration

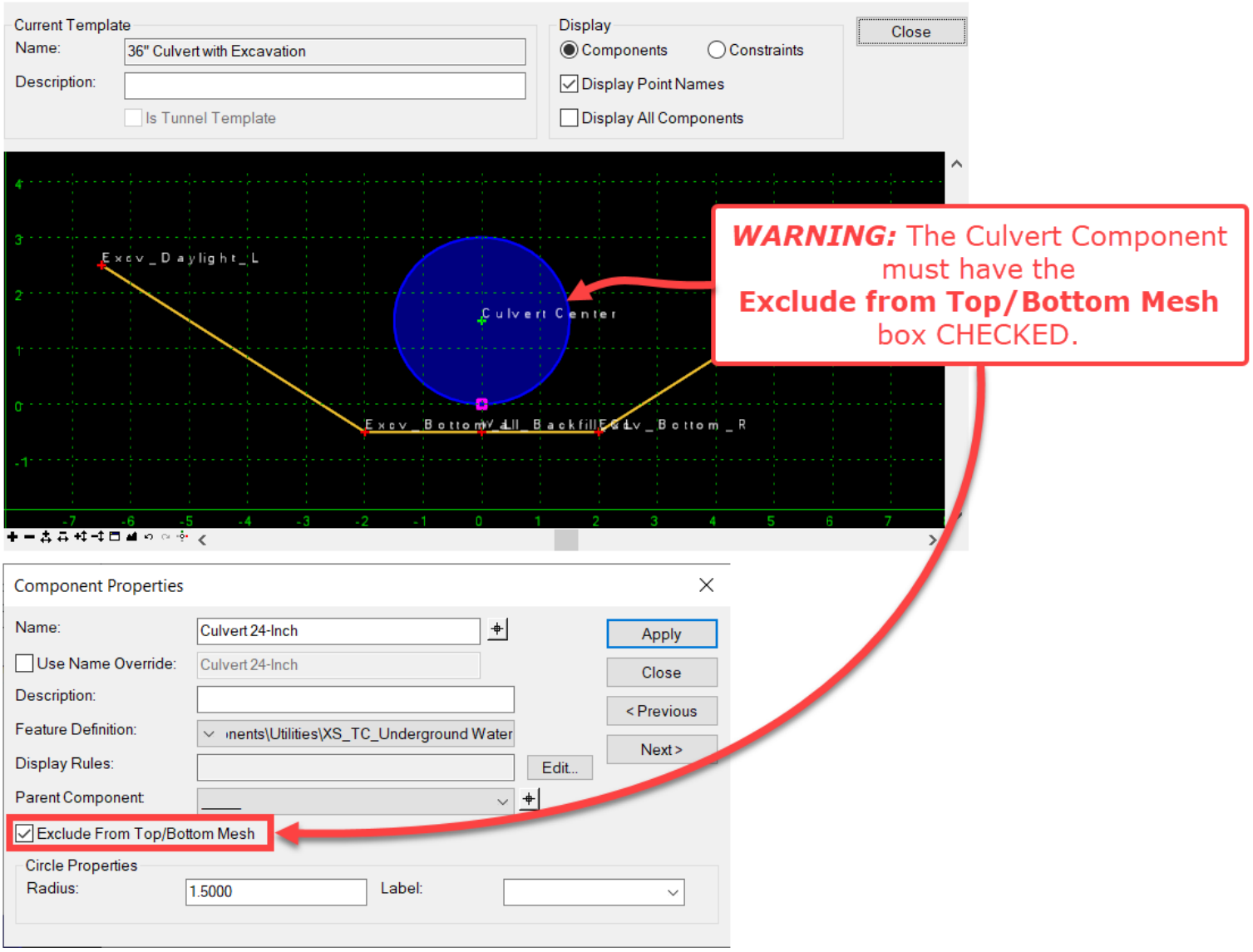
Build the Culvert Template as shown below.

IMPORTANT: All Component Feature Definitions in the Culvert Template must be set to the "None" Volume Option. See *20G.5 None Volume Option*. If any Component Feature Definitions are set to the "Design" Volume Option, then the Culvert Template will interfere with the creation of Cut/Fill Meshes for the Road Embankment Earthwork.

IMPORTANT: The Circle Culvert Component must have the "Exclude from Top/Bottom Mesh" box CHECKED in the Component Properties. See the next page.



Culvert Component Properties: The Circle Culvert Component must have the "Exclude from Top/Bottom Mesh" box CHECKED in the Component Properties. If this box is NOT checked, the Culvert Component will interfere with the *Create Closed Mesh* tool – which is used in *20F.1.d Calculate Culvert Excavation Volume*.

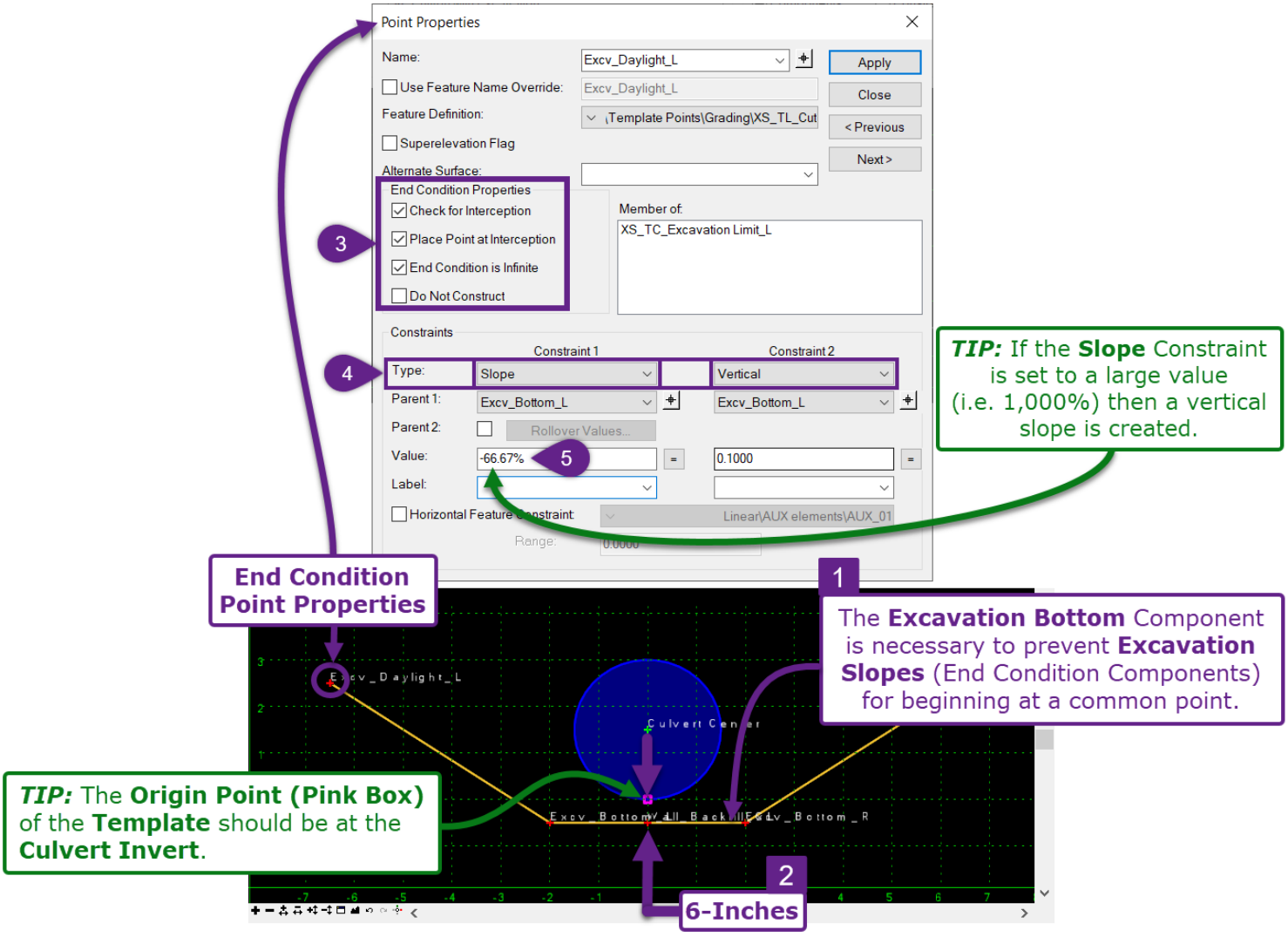


Excavation Slopes and Excavation Bottom Configuration: Consider the following Template configuration and Point Constraints when creating the Excavation Components.

1	The Excavation Slopes (End Condition Components) CANNOT begin from a common Template Point. If End Condition Components begin at a common Point, then only ONE End Condition is solved for in the Linear Template. The Excavation Bottom (Planar Component) is necessary to separate the End Condition Components.
2	The Excavation Bottom should account for culvert bedding. In this case, 6" of bedding is needed beneath the culvert so the Excavation is set 0.5 feet below the Culvert invert.

Use the following configuration in the Point Properties of the **Excavation Slopes End Condition Points**.

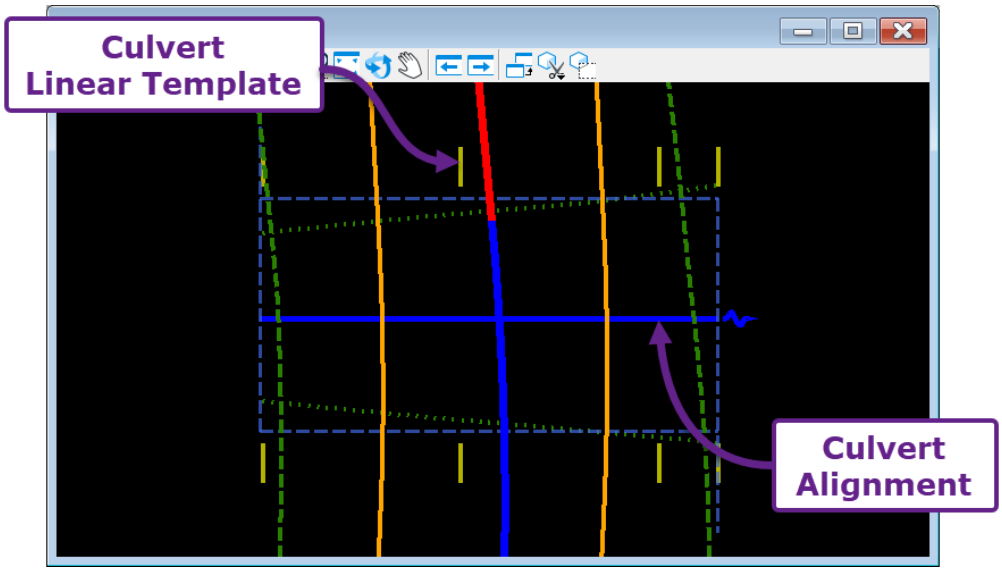
3	Ensure the *Check for Interception*, *Place Point at Interception*, and *End Condition Is Infinite* boxes are CHECKED.
4	Use the **Slope** and **Vertical** Constraints for the End Condition Points.
5	Set the **Slope** Constraint to match the required Excavation Slope in construction. In the example below, the **Slope** constraint is set to 1V:1.5H (66.66%). If the Excavation Slope is vertical in construction, then set the **Slope** Constraint to a very large value (i.e., 1,000%) to mimic a vertical Excavation Slope.



20F.1.b Create the Culvert Linear Template

The Culvert Linear Templates can be created in the Corridor ORD File. However, ***BEST PRACTICE*** is to create Culvert Linear Templates in a dedicated Culvert Design ORD File.

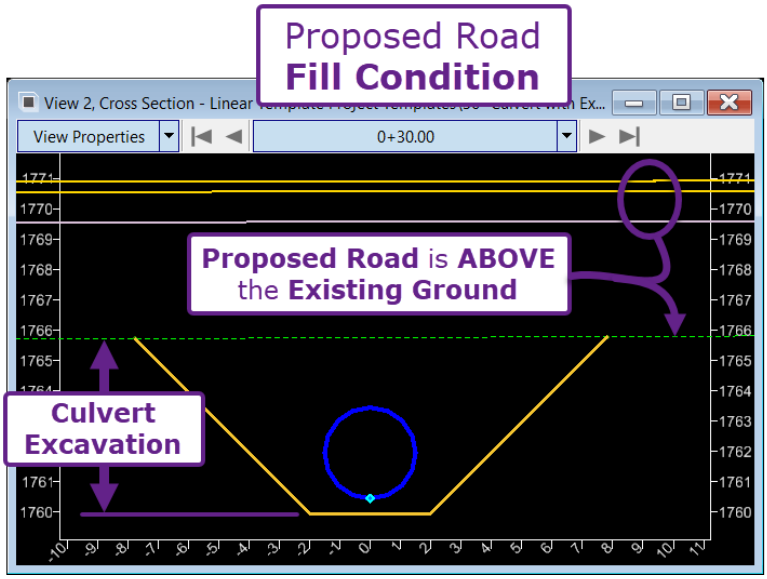
The creation of Linear Templates is discussed in *9B.2 Create a New Linear Template*.

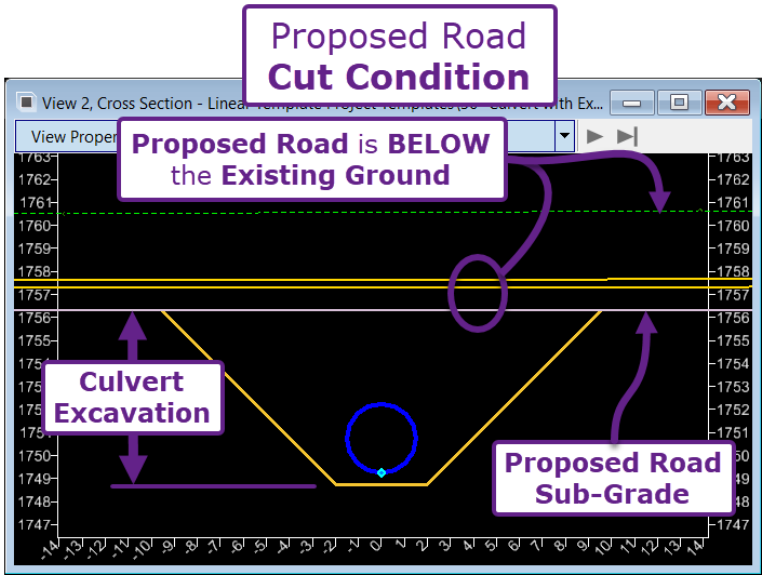


After creating the Culvert Linear Template, scroll through the Cross Sections for the Culvert Linear Template. Pay close attention to the **Proposed Road Sub-Grade** in relation to the **Existing Ground**.

If the **Proposed Road Sub-Grade** is **ABOVE** the **Existing Ground**, then the Proposed Road is in a **Fill Condition**. In this case, the **Culvert Excavation Volume** should be measured between the **Existing Ground** and the **Culvert Excavation** datum. See *20F.1.d.i Proposed Road Fill Condition*.

If the **Proposed Road Sub-Grade** is **BELOW** the **Existing Ground**, then the Proposed Road is in a **Cut Condition**. In this case, the **Culvert Excavation Volume** should be measured between the **Proposed Road Sub-Grade** and the **Culvert Excavation** datum. See *20F.1.d.ii Proposed Road Cut Condition*.





20F.1.c Set the Volume Options for Culvert Feature Definitions

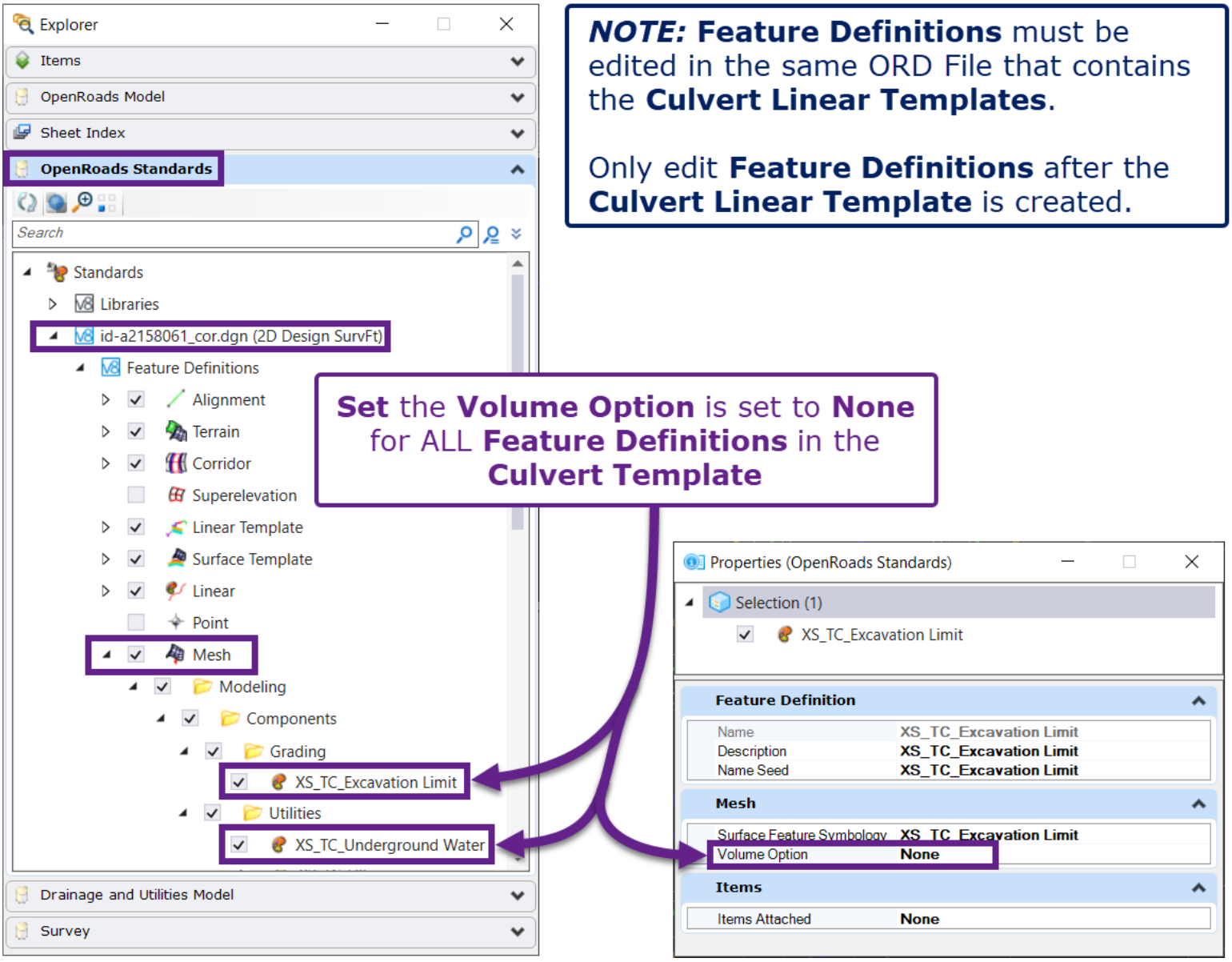
The Components in the Culvert Template use the following Feature Definitions:

XS_TC_Excavation Limit: Excavation Slopes and Excavation Bottom Components.

XS_TC_Underground Water: Culvert Component.

Component Feature Definitions properties are accessed through the Project Explorer:

Project Explorer → ***OpenRoads Standards*** → ***Current DGN Name (Default)*** → ***Mesh***



20F.1.d Calculate Culvert Excavation Volume

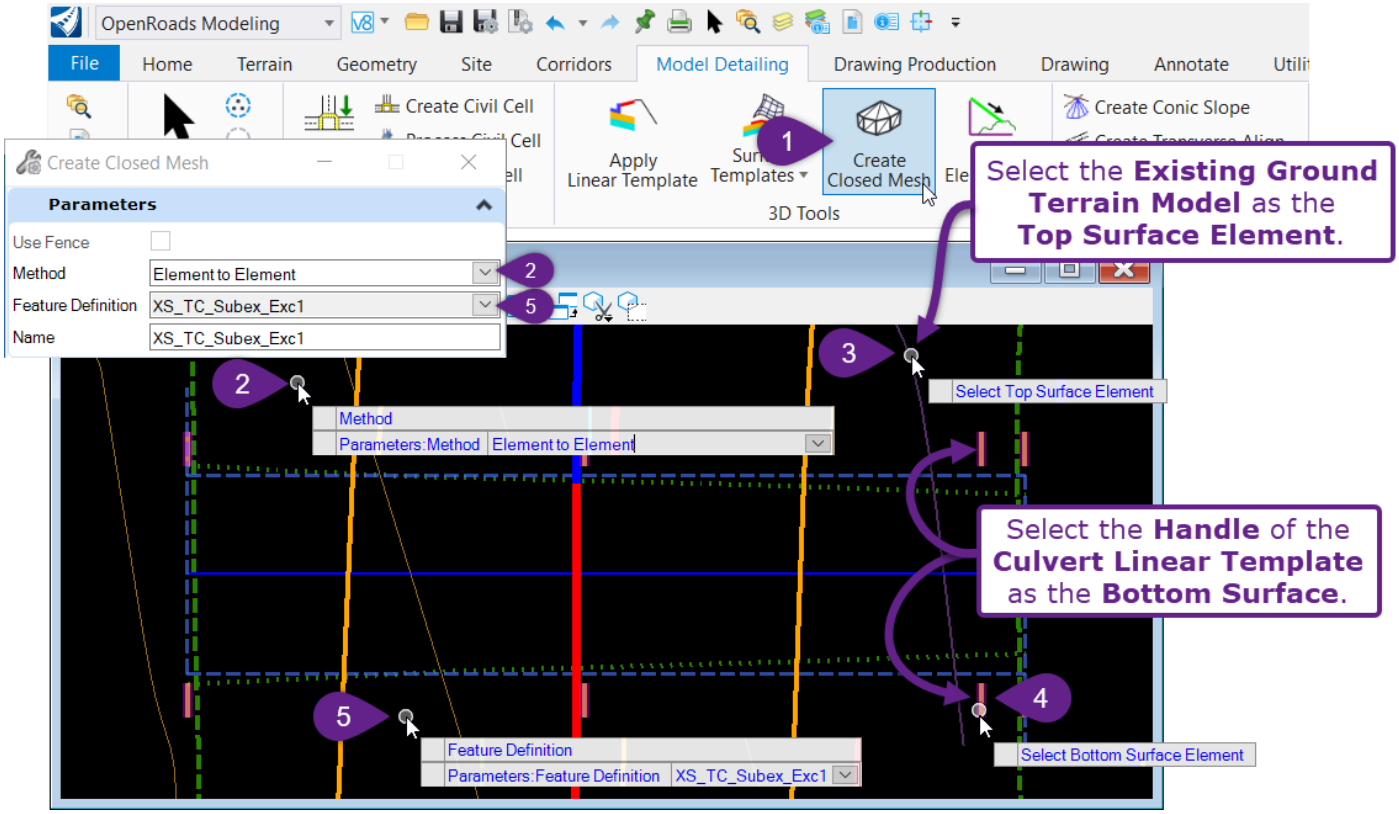
Culvert Excavation can be calculated in the Corridor Quantities File. However, ***BEST PRACTICE*** is to create a dedicated Culvert Quantity ORD File for the calculation of Culvert Excavation Volumes.

20F.1.d.i Proposed Road Fill Condition

In the Proposed Road Fill Condition, the Culvert Excavation Volume is measured from the Culvert Excavation Slopes/Bottom to the Existing Ground.

Using the *Create Closed Mesh* tool with the *Element to Element* Method, a Mesh element is created between the Culvert Linear Template and the Existing Ground Model. The resulting Mesh Element represents the Culvert Excavation volume. See the next page.

WARNING: Place the resulting Mesh element on a Feature Definition with a "None" Volume Option. If the "Design" Volume Option is set, then the resulting Mesh element will interfere with Cut/Fill Meshes when the *Create Cut Fill Volumes* tool is used to calculate Road Embankment Earthwork.

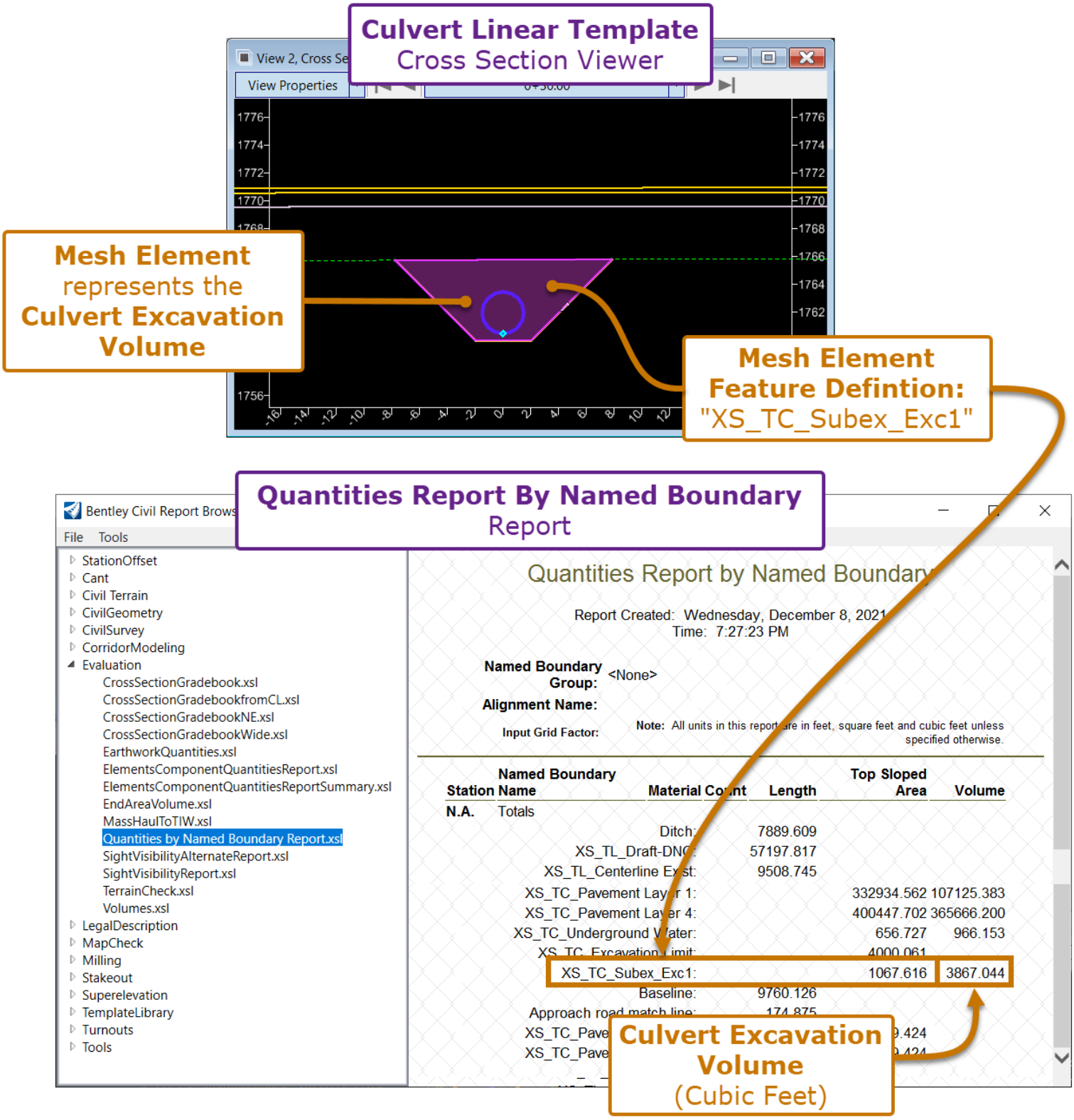


1	From the Ribbon, select the *Create Closed Mesh* tool: [***OpenRoads Modeling*** → ***Model Detailing*** → ***3D Tools***].
2	*Prompt: Method* – Select the **Element to Element** Method.
3	*Prompt: Select Top Surface Element* – Select the **Existing Ground Terrain Model**.
4	*Prompt: Select bottom Surface Element* – Select the **Handle** of the **Culvert Linear Template**.
5	*Prompt: Feature Definition* – Select a Feature Definition. In this case, the "XS_TC_Sub_Excv1" Feature Definition is used. See the ***WARNING*** above.

The resulting Mesh element is shown in the Cross Section Viewer for the Culvert Linear Template.

Use the *Quantities Report By Named Boundary* tool to generate the quantities report. The Excavation Volume is shown next to the **Feature Definition** selected on the previous page.

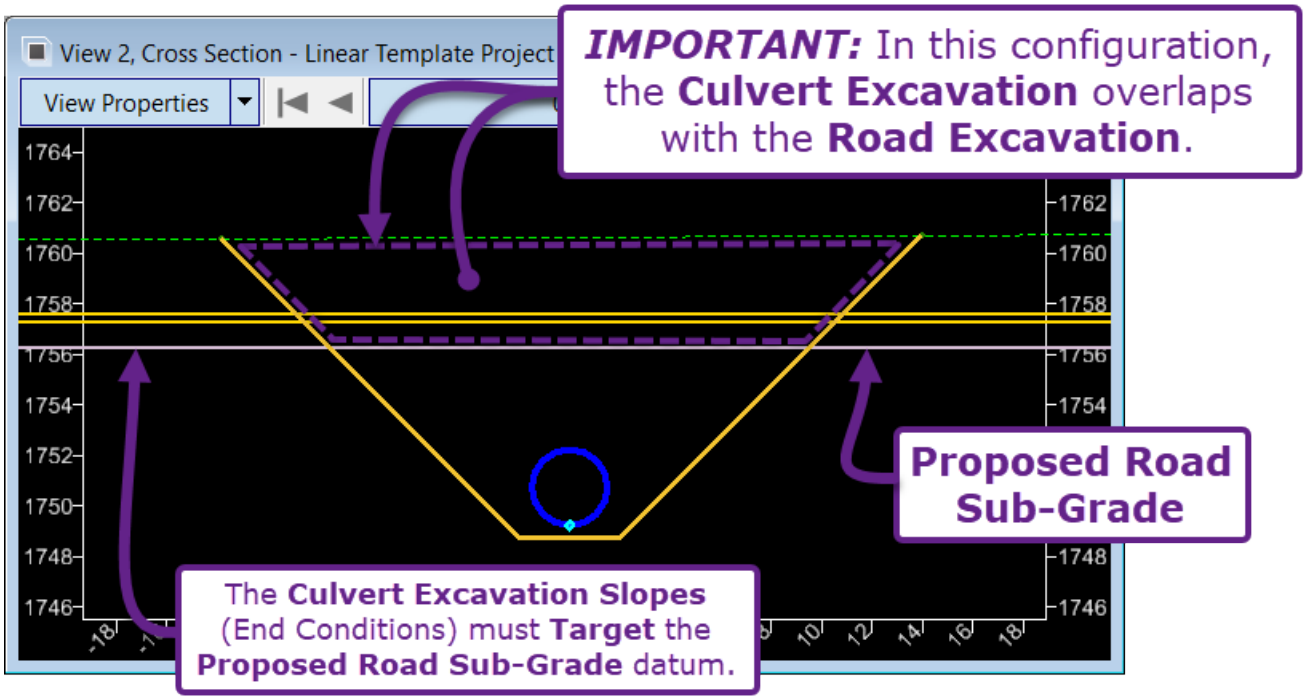
A detailed workflow for the *Quantities Report By Named Boundary* tool is shown in *20C.2 Quantities Report By Named Boundary for Approaches*.



20F.1.d.ii Proposed Road Cut Condition

In the Proposed Road Cut Condition, the Culvert Excavation Volume is measured from the Culvert Excavation Slopes/Bottom to the Proposed Road Sub-Grade.

By default, the **Culvert Excavation Slopes** (End Condition Component) target the Existing Ground Terrain Model (Active Surface), as shown below. The configuration shown below is problematic because the **Culvert Excavation** would overlap with **Road Embankment Excavation**.

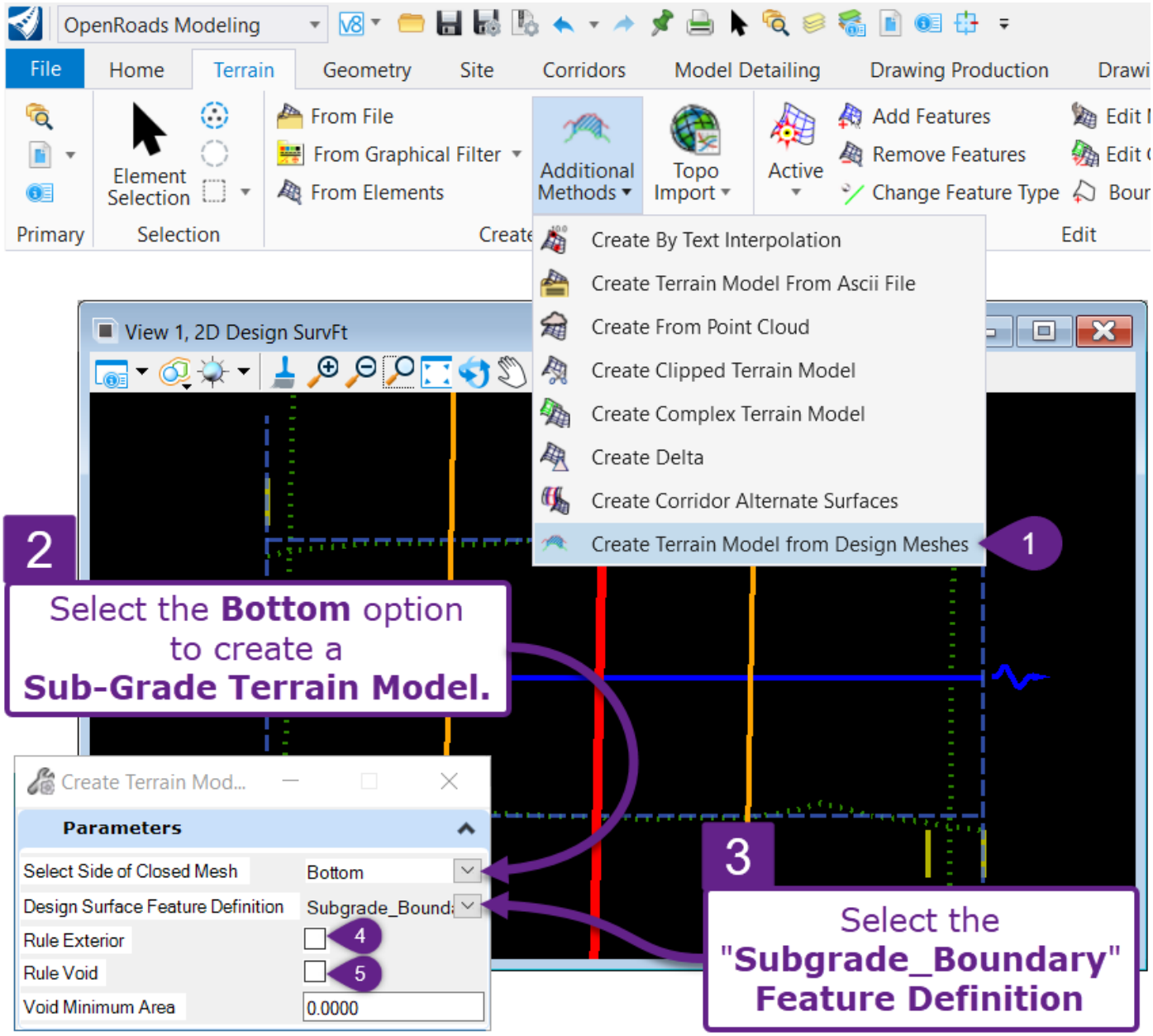


For correct calculation, the **Culvert Excavation Slopes** (End Condition Component) must target the **Proposed Road Sub-Grade**. This is accomplished by:

- Creating a **Proposed Road Sub-Grade Terrain Model** with the *Create Terrain Model From Design Meshes* tool.
- Use the *Target Aliasing* tool on the Culvert Linear Template. Set the **Proposed Road Sub-Grade Terrain Model** as the target.

Create the Proposed Road Sub-Grade Terrain Model

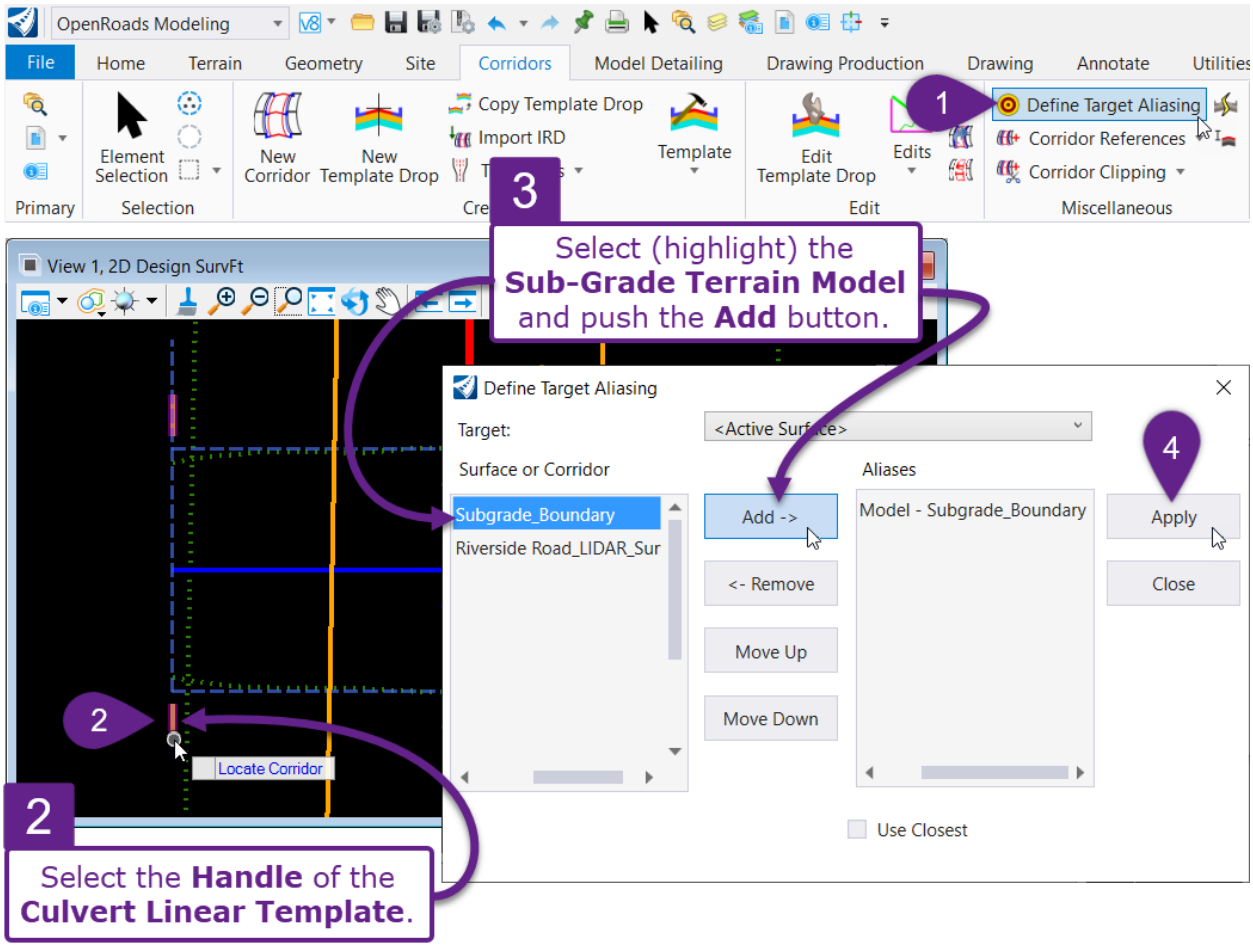
The Create Terrain Model From Design Mesh tool is used to create the **Proposed Road Sub-Grade Terrain Model**. This tool is discussed in *9I.2 Create Finished Grade and Subgrade Terrain Models from Corridor*.



1	From the Ribbon, select the *Create Terrain Model from Design Meshes* tool: [***OpenRoads Modeling*** → ***Terrain*** → ***Create*** → ***Additional Methods***].
2	*Prompt: Select Side of Closed Mesh* – Select the **Bottom** option.
3	*Prompt: Design Surface Feature Definition* – Select a Terrain Model Feature Definition for the **Proposed Road Sub-Grade Terrain Model**. In this case, the "Subgrade_Boundary" Feature Definition is used.
4	*Prompt: Rules Exterior* – Select **NO**.
5	*Prompt: Rules Void* – Select **NO**.

Set the Target Aliasing for the Culvert Linear Template

Using the *Target Aliasing* tool, set the Culvert Linear Template target to the **Proposed Road Sub-Grade Terrain Model**. The *Target Aliasing* tool is discussed in *9G.8 Target Aliasing*.



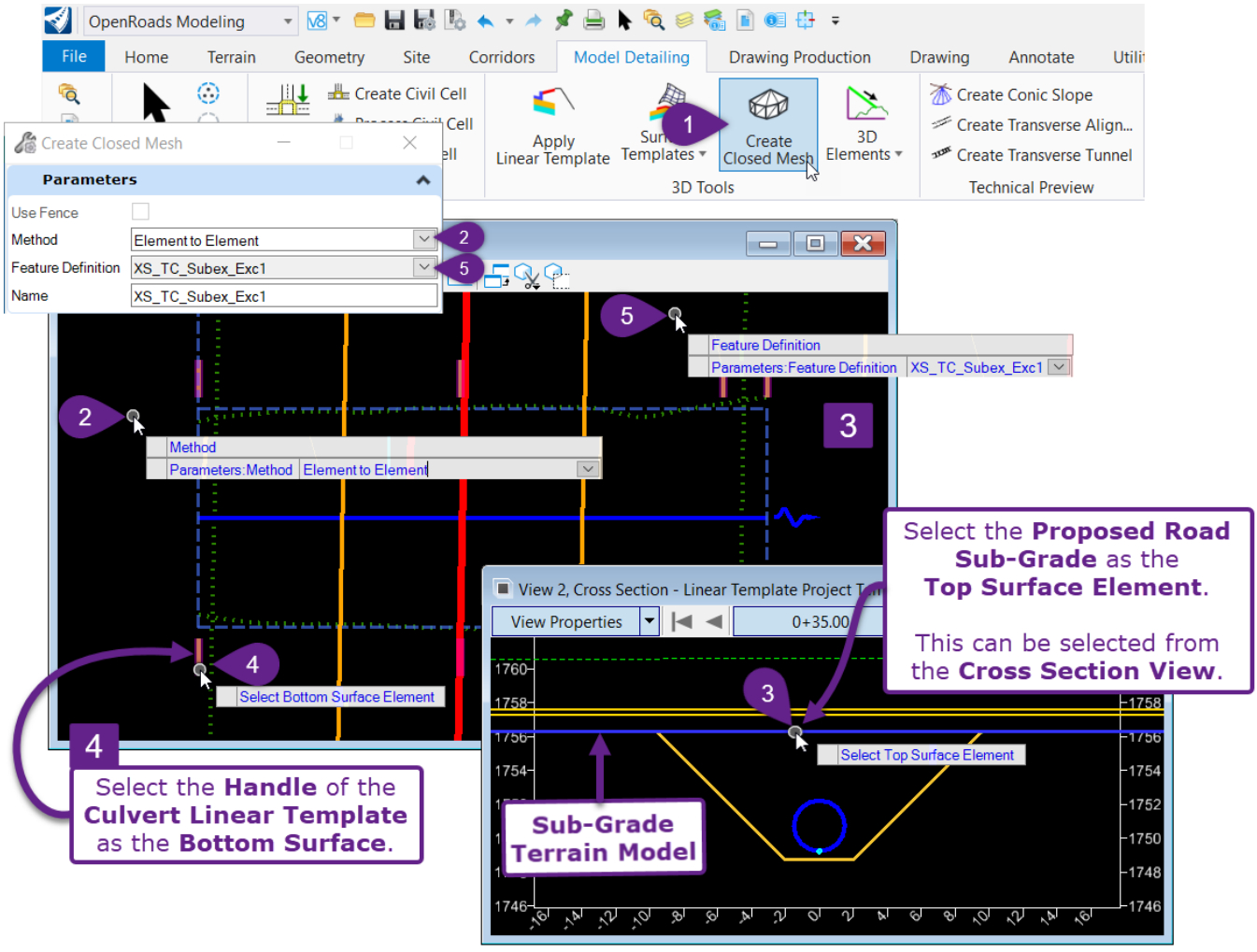
1	From the Ribbon, select the *Define Target Aliasing* tool: [***OpenRoads Modeling*** → ***Corridor*** → ***Miscellaneous***].
2	*Prompt: Locate Corridor* – Select the **Culvert Linear Template** Handle
3	In the *Define Target Aliasing* menu, select the **Proposed Road Sub-Grade Terrain Model** and push the **Add** button.
4	Push the **Apply** button.

After setting the *Target Aliasing*, scroll through the Cross Sections for the Culvert Linear Template. Ensure that the **Culvert Excavation Slopes** (End Condition Component) intercept and target the **Proposed Road Sub-Grade**

In the Proposed Road Cut Condition, the Culvert Excavation Volume is measured from the **Culvert Excavation Slopes/Bottom** to the **Proposed Road Sub-Grade Terrain Model**.

The *Create Closed Mesh* tool with the *Element to Element* Method is used to create a Mesh element that represents the Culvert Excavation. For the **Top Surface Element**, select the **Proposed Road Sub-Grade Terrain Model**. For the **Bottom Surface Element**, select the **Handle** of the **Culvert Linear Template.**

WARNING: Place the resulting Mesh element on a Feature Definition with a "None" Volume Option. If the "Design" Volume Option is set, then the resulting Mesh element will interfere with Cut/Fill Meshes when the *Create Cut Fill Volumes* tool is used to calculate Road Embankment Earthwork.

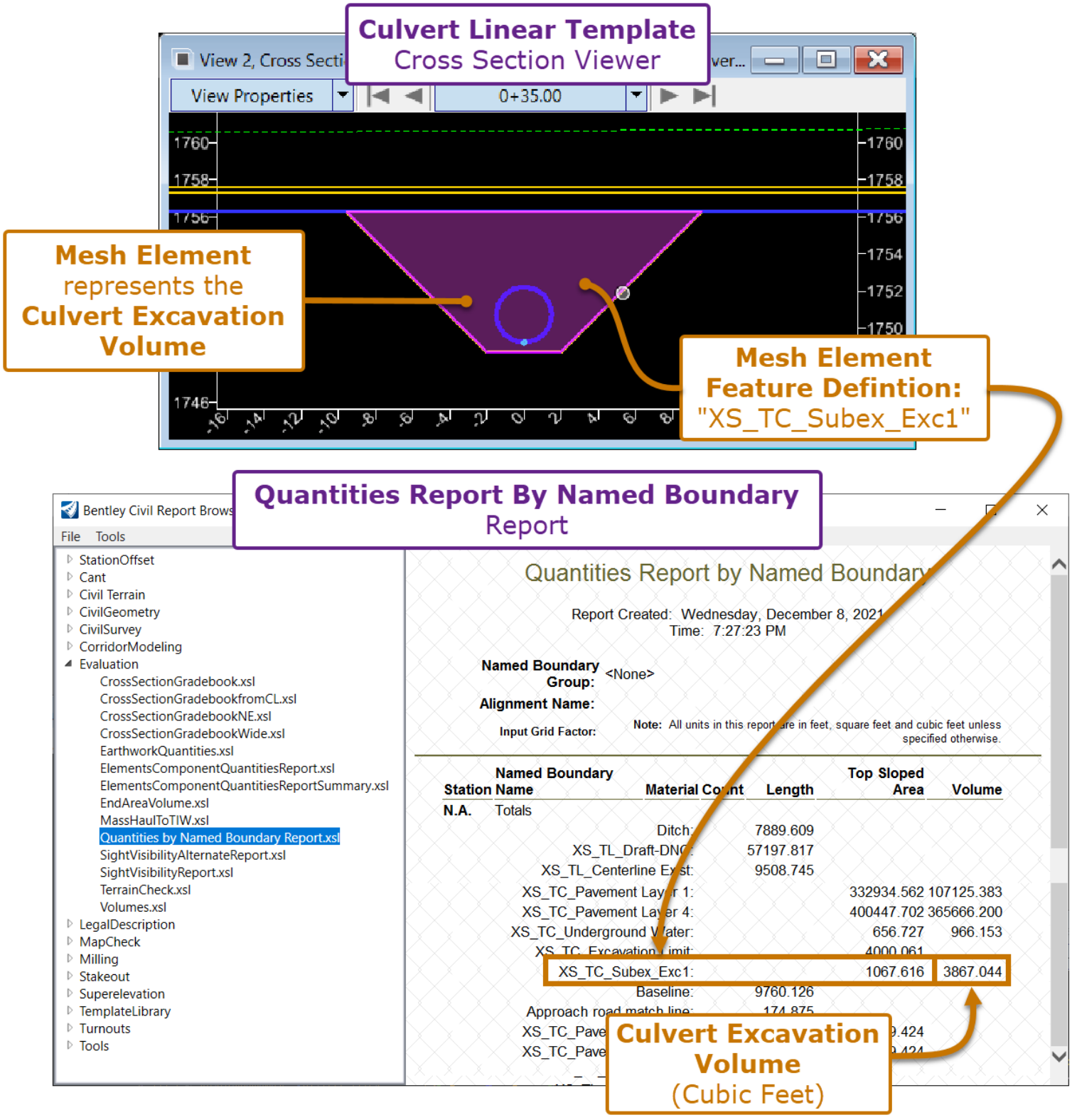


1	From the Ribbon, select the *Create Closed Mesh* tool: [***OpenRoads Modeling*** → ***Model Detailing*** → ***3D Tools***].
2	*Prompt: Method* – Select the **Element to Element** Method.
3	*Prompt: Select Top Surface Element* – Select the **Proposed Road Sub-Grade Terrain Model**. ***TIP:*** The **Proposed Road Sub-Grade Terrain Model** can be selected in the Cross Section View.
4	*Prompt: Select bottom Surface Element* – Select the **Handle** of the **Culvert Linear Template**.
5	*Prompt: Feature Definition* – Select a Feature Definition. In this case, the "XS_TC_Sub_Excv1" Feature Definition is used. See the ***WARNING*** above.

The resulting Mesh element is shown in the Cross Section Viewer for the Culvert Linear Template.

Use the *Quantities Report By Named Boundary* tool to generate the quantities report. The Excavation Volume is shown next to the **Feature Definition** selected on the previous page.

A detailed workflow for the *Quantities Report By Named Boundary* tool is shown in *20C.2 Quantity Report By Named Boundary for Approaches*.

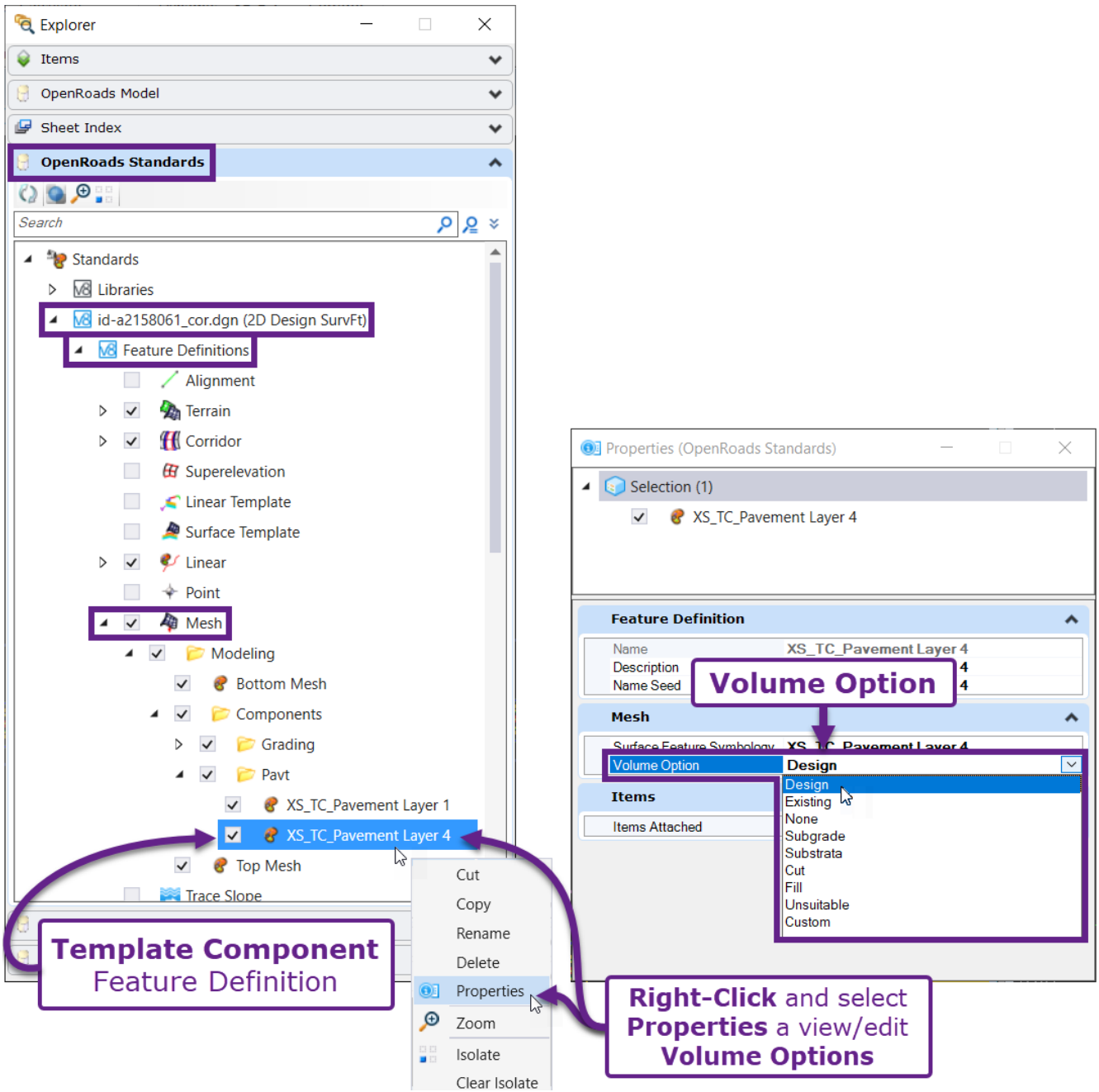


20G – ADVANCED INFORMATION: COMPONENT FEATURE DEFINITION AND VOLUME OPTIONS

This section explains the inner workings of the *Create Cut Fill Volumes* tool and how the *Volume Option* Feature Definition setting affects the resulting Cut/Fill Meshes.

In the Feature Definition settings, the *Volume Option* determines how Cut/Fill Meshes will interact with the Template Components.

Component Feature Definitions properties are accessed through the Project Explorer:
Project Explorer → ***OpenRoads Standards*** → ***Current DGN Name (Default)*** → ***Mesh***

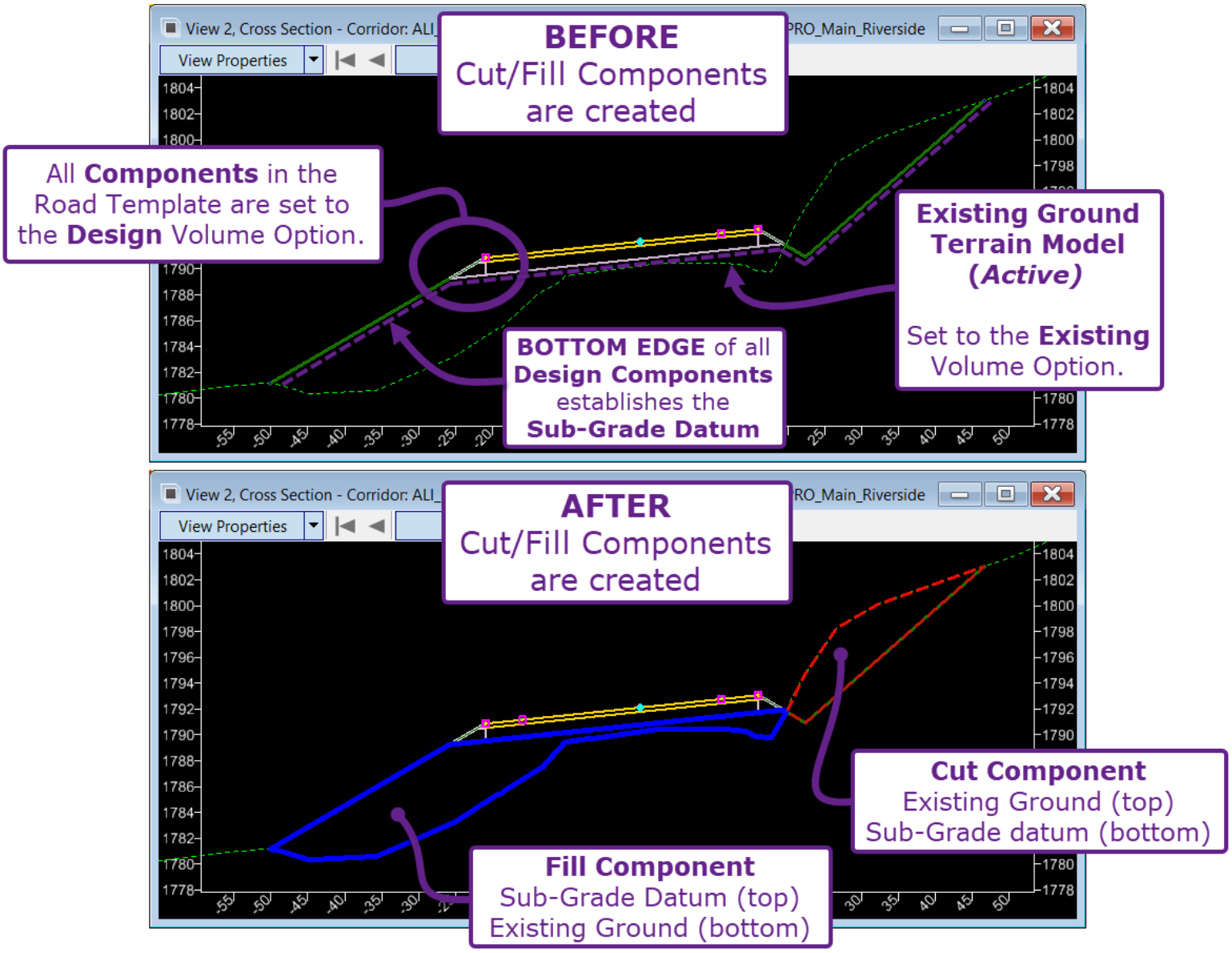


NOTE: The *Volume Option* must be edited in the Design ORD File that contains the Template Components. For example, the *Volume Options* for Corridor Template Components can ONLY be edited in the Corridor ORD File to take effect. Do NOT change the *Volume Option* in the Quantity ORD File.

20G.1 Design Volume Option

Proposed features are typically set to the "Design" *Volume Option*. In the graphic below, all Road Template Components (Cut/Fill End Conditions, Pavement Layer 1, Pavement Layer 4) are set to the "Design" *Volume Option*.

When the *Create Cut Fill Volumes* tool is used, the software seeks out the **BOTTOM EDGE** of all "Design" Components to create a **Sub-Grade Datum**. Cut and Fill Meshes are created between the **Sub-Grade Datum** and the **Existing Ground Terrain Model**.



NOTICE: In the graphic above, the Pavement 1 Layer (which typically represents asphalt) is assigned to the "Design" *Volume Option*. However, the Pavement 1 Layer Component is NOT positioned on the **BOTTOM EDGE** of the Road Template, so it is irrelevant to Cut/Fill Mesh creation.

20G.2 Unsuitable Volume Option

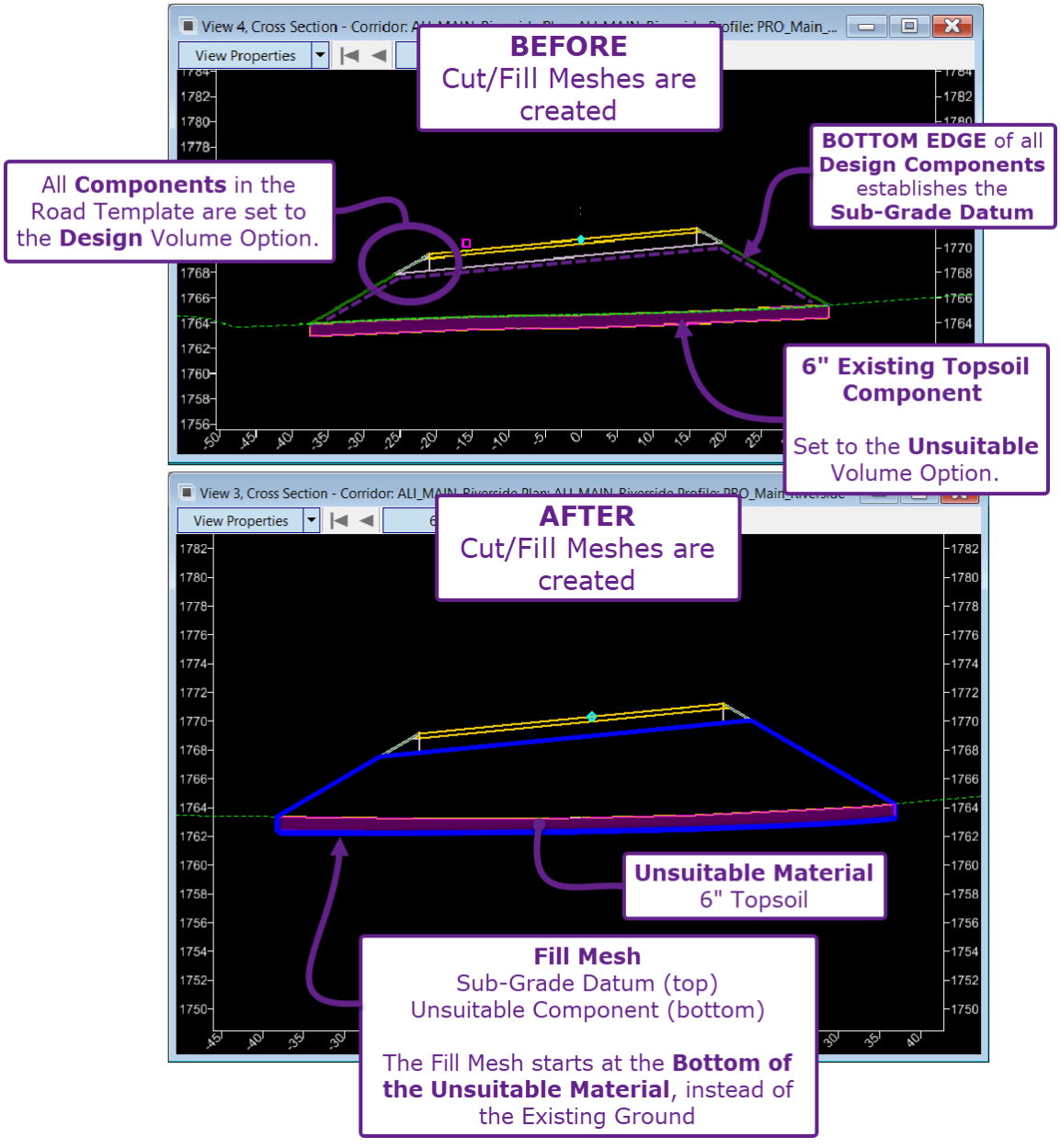
The "Unsuitable" *Volume Option* is applied to existing materials that are unsuitable for construction, such as topsoil, loam, and existing asphalt. Unsuitable Components and Meshes are applied to the Existing Ground Terrain Model with Surface Templates and the *Create Closed Mesh* tool.

WARNING: Road Templates and Proposed Modeling Features should NOT use Components with Unsuitable Feature Definitions.

When "Unsuitable" Components and the Existing Ground Terrain Model overlap, then the Existing Ground is ignored. The resulting Cut and Fill Meshes are created between the **BOTTOM EDGE** of the "Unsuitable" Components and the **Sub-Grade Datum**.

A detailed procedure for modeling and calculating unsuitable material quantities is shown in *20E – Unsuitable Material Modeling and Calculations*.

NOTE: Ensure that the *Compute Unsuitable* option is CHECKED when using the *Create Cut Fill Volumes* tool.



20G.3 Custom Volume Option

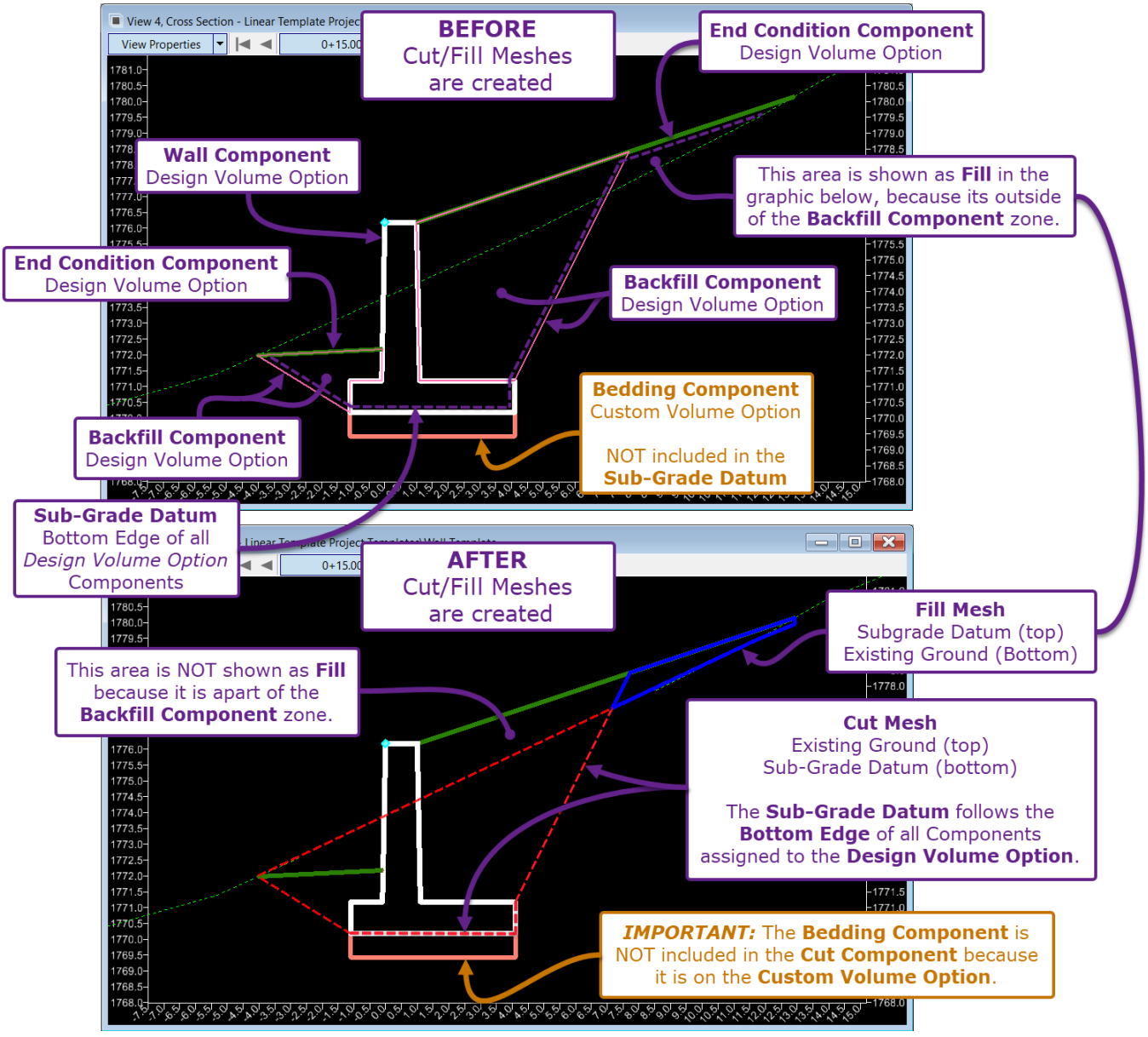
When the *Create Cut Fill Volumes* tool is used, "Custom" Volume Option Components are NOT considered in the formation of the **Sub-Grade Datum**.

As shown in the retaining wall example below, the **Bedding Component** of the wall is assigned to the "Custom" Volume Option. All other Components in the Template are assigned to the "Design" Volume Option. The **Sub-Grade Datum** excludes the **Bedding Component** when creating Cut/Fill Meshes.

In this scenario, the excavation for the **Bedding Component** needs to be separated from the excavation for all the Wall Components. The **Cut Component** represents the excavation volume for all Wall Components – but excludes excavation necessary for the **Bedding Component**.

> ***TIP:*** In the Quantities Report, the Feature Definition that corresponds with the **Bedding Component** will display the volume – which also corresponds with the additional excavation needed to place the **Bedding Component**.

NOTE: Ensure that the *Compute Unsuitable* option is CHECKED when using the *Create Cut Fill Volumes* tool.

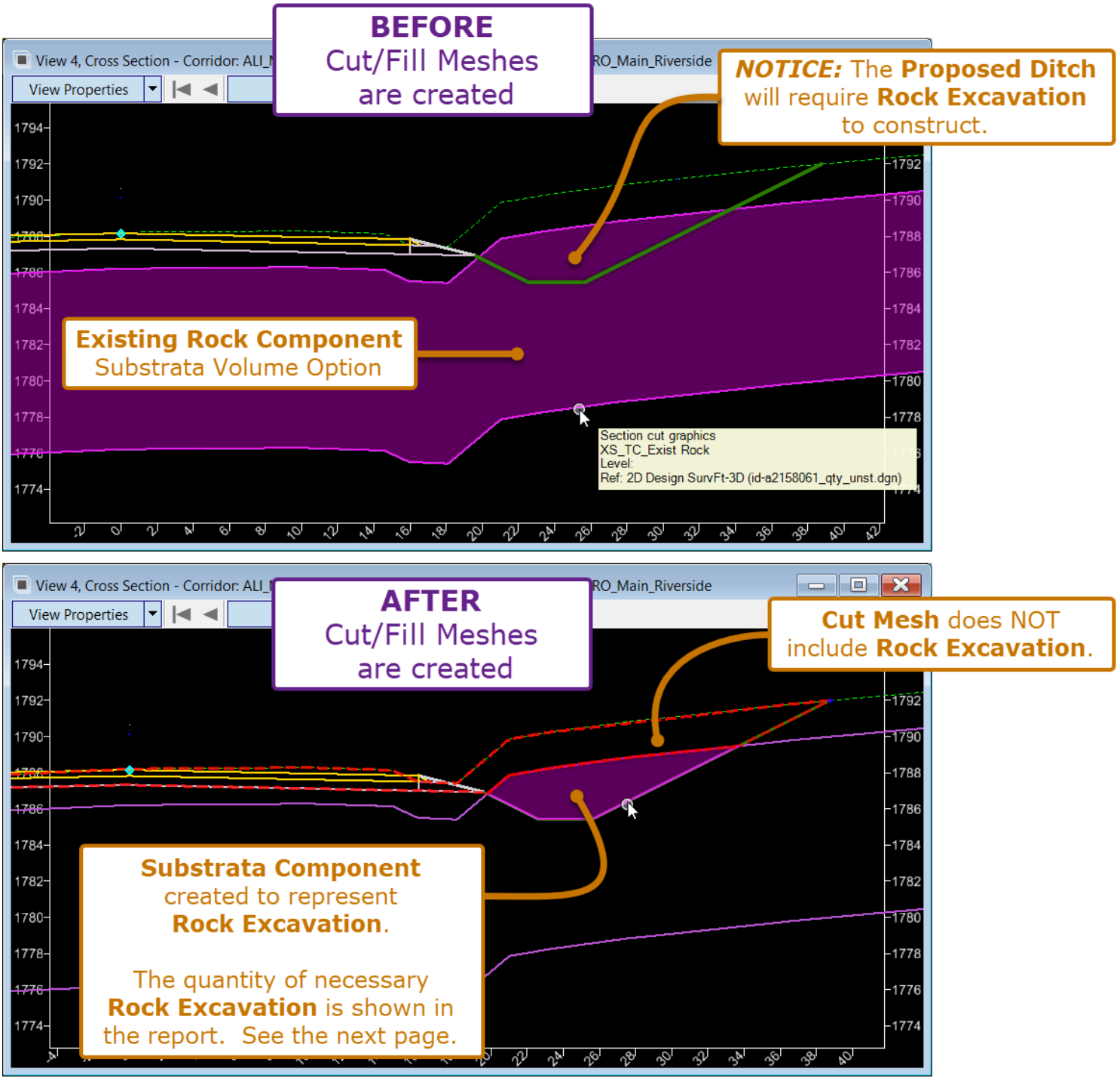


20G.4 Substrata Volume Option

The "Substrata" Volume Option is used to account for different geo-technical layers in the existing ground.

In this example, there is an **Existing Rock Component** that represent lime stone and is located 3-feet below the existing ground grade. The **Existing Rock Component** Feature Definition is set to the "Substrata" Volume Option. When the *Create Cut Fill Volumes* tool is used, **Rock Excavation** required to construct the proposed ditch is quantified and separated from conventional excavation (which his represented by the **Cut Mesh**).

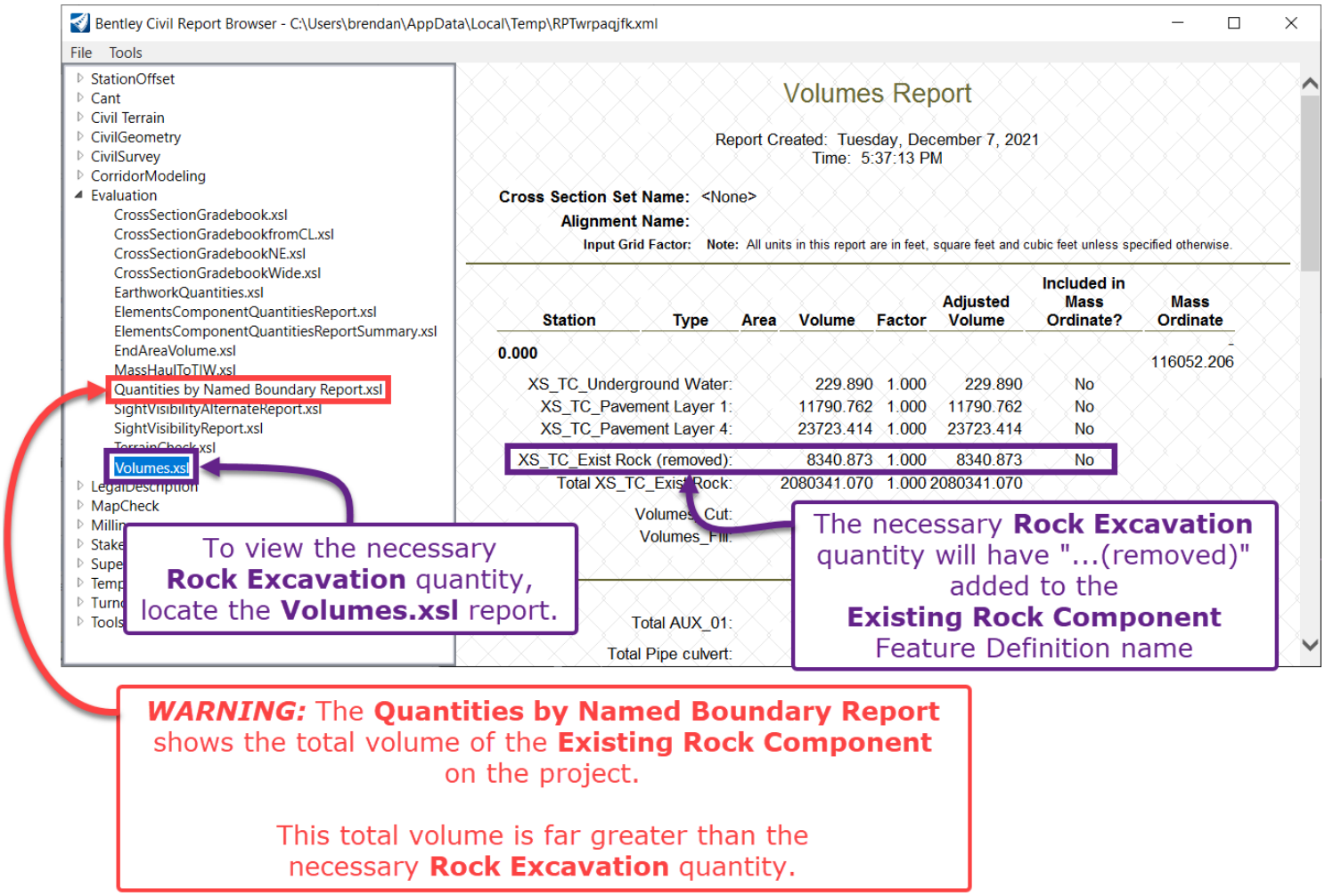
NOTE: Ensure that the *Compute Substrata* option is CHECKED when using the *Create Cut Fill Volumes* tool.



After using the *Quantites Report By Named Boundary* tool, locate the **Volumes.xsl** report.

WARNING: Do NOT consult the **Quantities By Named Boundary Report.xsl** – which is initially shown be default. The value shown in the default report represents the total volume of the Existing Rock Substrata Component.

The **Rock Excavation** required to construct the ditch will have "…(removed)" added to the Feature Defintion name.



20G.5 None Volume Option

Components assigned to the "None" Volume Option are completely ignored by the *Create Cut Fill Volumes* tool.

In the example shown below, a Culvert Component is examined. If the Culvert Component is assigned to the "Design" Volume Option, then the Culvert Excavation recognized in the Cut Component. This is undesirable because the Culvert Excavation quantity is mixed in with Road Embankment quantities. Also, a sliver of required Road Embankment is excluded due to the presence of the Culvert with a "Design" Volume Option.

If the Culvert Component is assigned to the "None" Volume Option, then the culvert does NOT interfere with calculation of Road Embankment quantities.

A detailed procedure for the calculation of Culvert Excavation quantities is shown in *20F.1 Culvert Excavation - Workflow*.