U.S. Department of Transportation
Federal Highway Administration

OpenRoads Designer User Manual

Chapter 11

SITE MODELING

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Chapter 11 Site Modeling

This chapter details the Site Modeling process. Site Modeling refers to non-linear features that CANNOT be modeled with a Corridor (i.e., a parking lot).

Site Modeling is accomplished with Surface Templates and Linear Templates.

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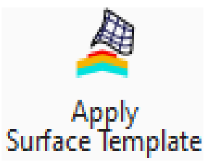
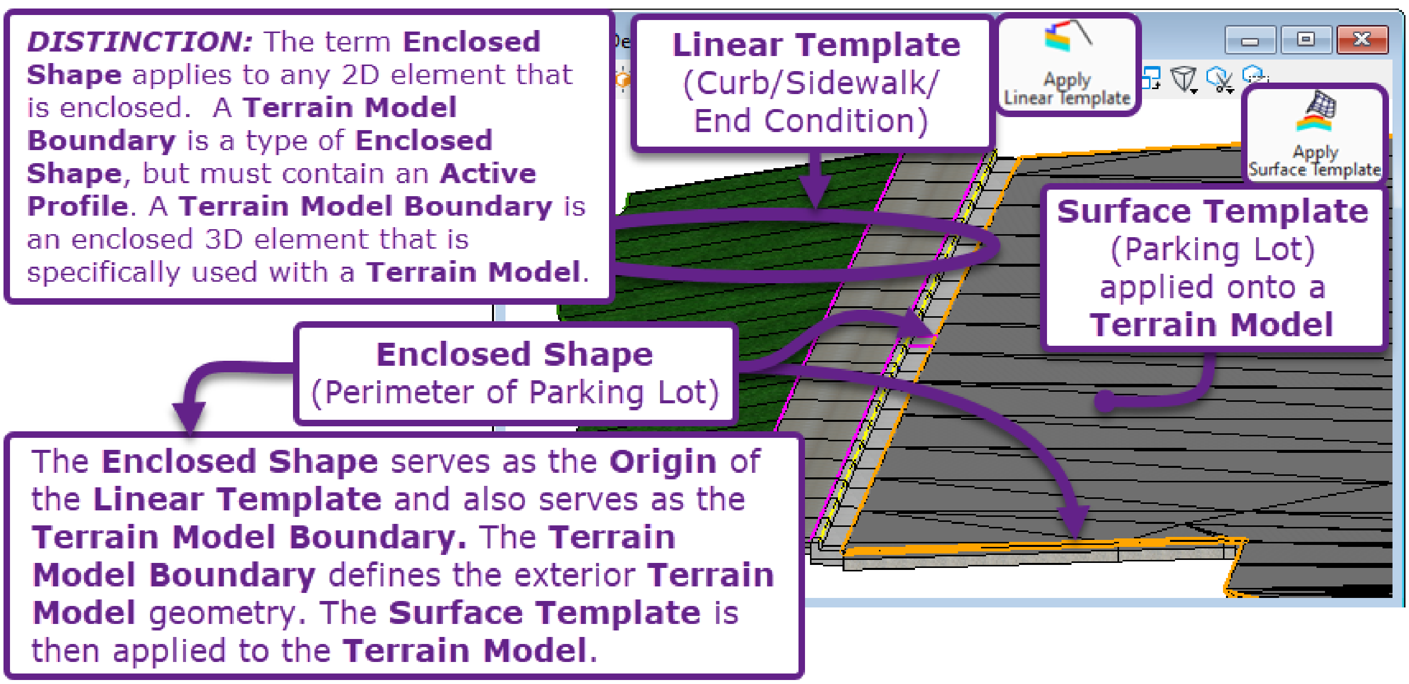
11A – INTRODUCTION TO SITE MODELING

Site Modeling consists of 3D Modeling of non-linear features, such as parking lots, intersections, detention basins, and building pads. Typically, these types of non-linear features CANNOT be modeled with a Corridor. Site Modeling features are typically modeled with a combination of *Surface Templates* and *Linear Templates*.**

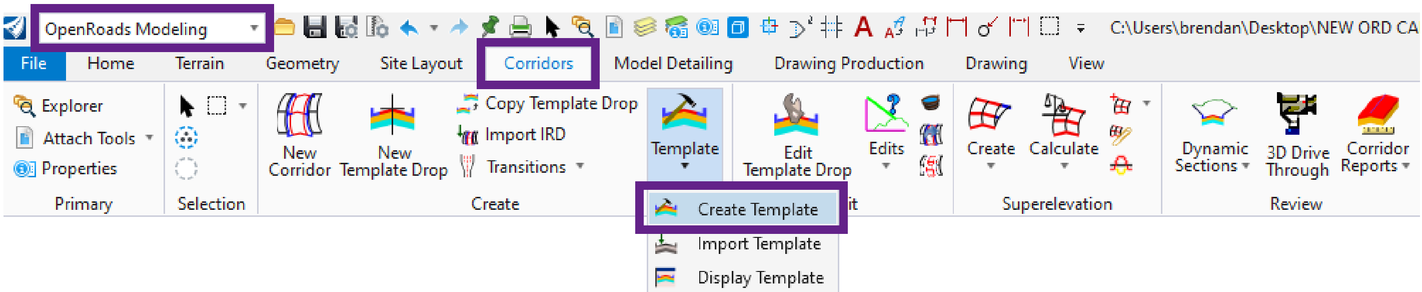
	**Linear Templates** are used to create minor modeling features that are linear in nature, such as the curb/sidewalk/end condition Template shown in the graphic below. Linear Templates operate almost identically to Corridors. However, Linear Templates are intended for minor or ancillary site features, while Corridors are generally meant for roads. For more information on the difference between Linear Templates and Corridors, see *9B.2.a Linear Templates vs Corridors*. In general, Linear Templates have fewer options for modification when compared to Corridors. Before creating a *Linear Template*, the User must create an Alignment, Profile, and Template (in the Template Editor).
	**Surface Templates** are used to create modeling features that are non-linear in nature. Examples include parking lots, building pads, irregular-shaped sidewalk layouts, or the bottom of a detention basin. In summary, Surface Templates are material component depths - such as a 4" asphalt component over a 6" aggregate component – that are applied to a proposed *Terrain Model*. Before creating a *Surface Template,* the User must create a proposed *Terrain Model*.



NOTE: The User can also use *Civil Cells* as an automated way to model simple approaches and other basic features. With *Civil Cells,* the User only has to create a few basic Alignment and Profiles. After which, the *Civil Cell* tool will automatically create *Surface Templates* and *Linear Templates* for a full 3D Model. For more information on *Civil Cells*, see *Chapter 12 – Civil Cells*. *Civil Cells* are typically used to automate the creation of simple approaches and intersections. However, a manual procedure for modeling a complicated approach with a culvert is shown in *11D – Driveway Approach with Culvert – Workflow*.

11A.1 Linear Template and Surface Templates in the Template Editor

Similar to Corridors, cross section Templates are used for both Linear Templates and Surface Templates. Templates are created and edited with the *Create Template* tool.



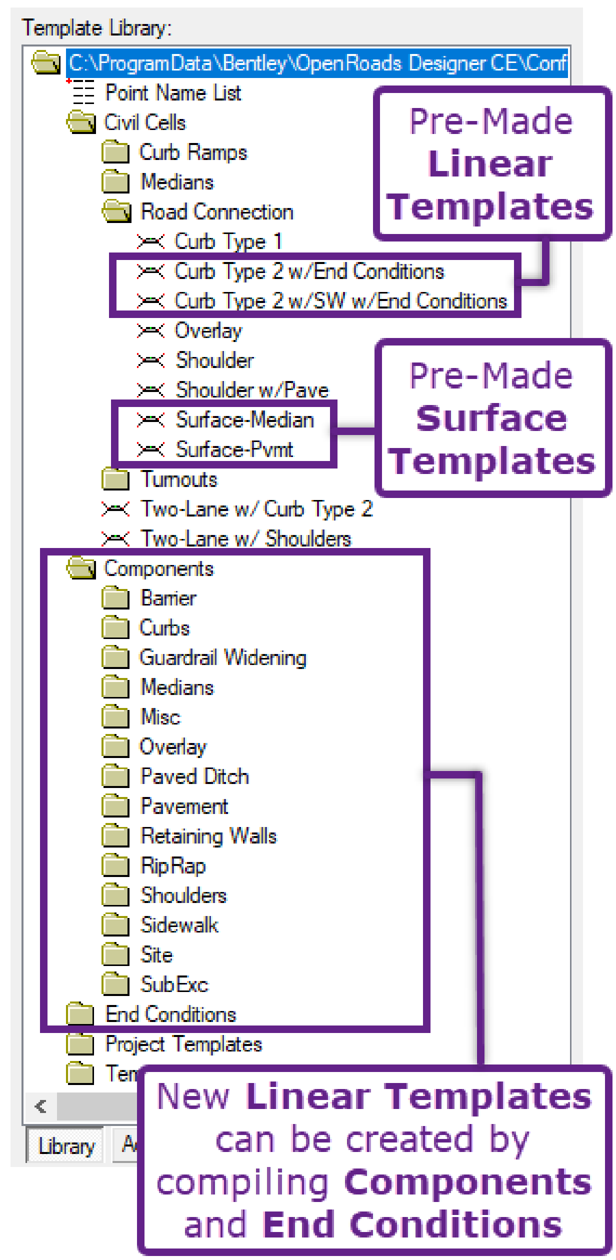
The *Template Editor* is discussed in detail in *Chapter 8 – Template Library*.

11A.1.a Linear and Surface Templates in the FLH Standard Template Library

The FLH Standard Template Library comes equipped with a few pre-made Templates that are useful in Site Modeling. Site Modeling Templates are found in the **Legacy Templates** folder.

IMPORTANT: *Linear Templates* can be used with ANY Template or Template Component found in the FLH Standard Template Library. For example, Road Templates can be used with Linear Templates, but this configuration is NOT recommended.

IMPORTANT: *Surface Templates* are a specific type of Template. In the FLH Template Library, *Surface Templates* are shuffled in with Linear/Corridor Templates. Surface Templates can be identified by their name. Surface Templates will always contain the prefix: "Surface-". For example, "Surface-Pvmt" is a *Surface Template* used to model a pavement section. Surface Templates in the Template Editor are discussed in detail in *8H – Surface Templates*.



11A.1.b Creating Linear and Surface Templates

In general, Linear and Surface Templates are created and modified with the same techniques used for Corridor Templates.

Linear Templates: The FLH Template Library only contains a few pre-made Linear Templates that are ready for use in Site Modeling applications. To create a custom Linear Template configuration, the User can compile pre-made *Components* and/or create *Components* from scratch. Examples applicable to the creation *Linear Template* can be found in *8G – Template Creation Workflows.*

Surface Templates: New Surface Templates configurations should be created by modifying a pre-made Surface Template found in the FLH Template Library. See *8G.3 Create a Surface Template Workflow.*

11A.2 Surface Templates and Terrain Models – Process Overview

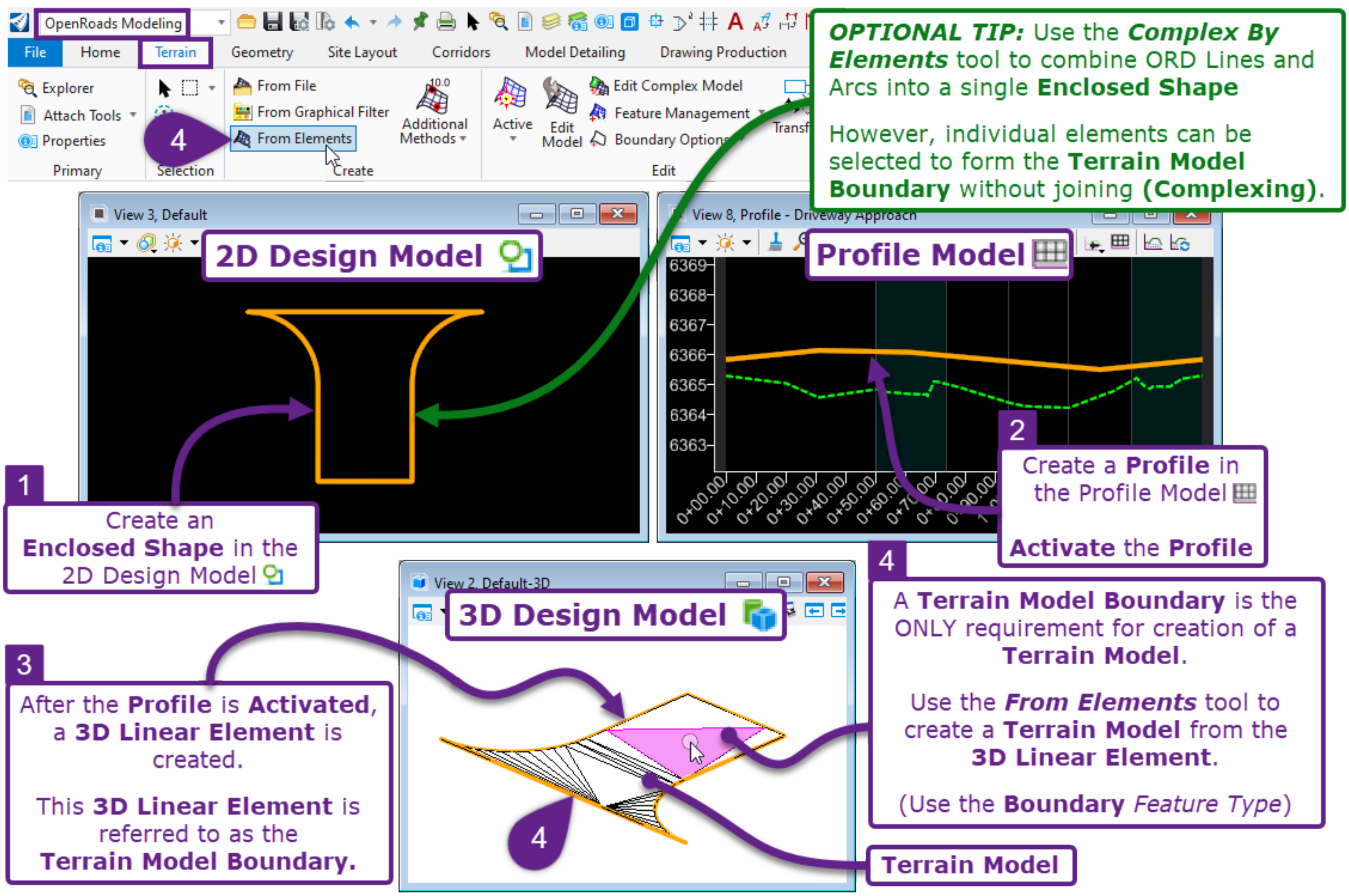
A **Surface Template** is applied to a **Terrain Model**. A Terrain Model can be created by from a 2D enclosed shape that contains an active Profile.

11A.2.a Create a Terrain Model from an Enclosed Shape

In the most simply configuration, a Terrain Model can be created by from a 2D enclosed shape that contains an active Profile. The 2D enclosed shape (with a Profile) creates a *3D Linear Element* in the *3D Design Model*. The 3D Linear Element is referred to as the Terrain Model Boundary element.

When the Terrain Model is created, the interior elevations are interpolated from the Boundary in a process called triangulation. See *11B.3 Triangulation of a Terrain Model*. The Terrain Model and triangulation becomes more complicated as Break Lines, Voids, Spot Elevations, and Imported Contours are added to the interior of the Terrain Model, which is shown in the graphic of *11B – Proposed Terrain Model Basics*.

The graphic below shows the overall concepts and sequence involved in creating a Terrain Model Boundary (3D Linear Element). The example below is intentionally simplified for better understanding of how an Approach Road Terrain Model may be created. ***IMPORTANT:*** The **preferred** procedure for creating an Approach Road involves drawing the Approach Centerline Alignment/Profile first. See *11D – Driveway Approach with Culvert – Workflow*.

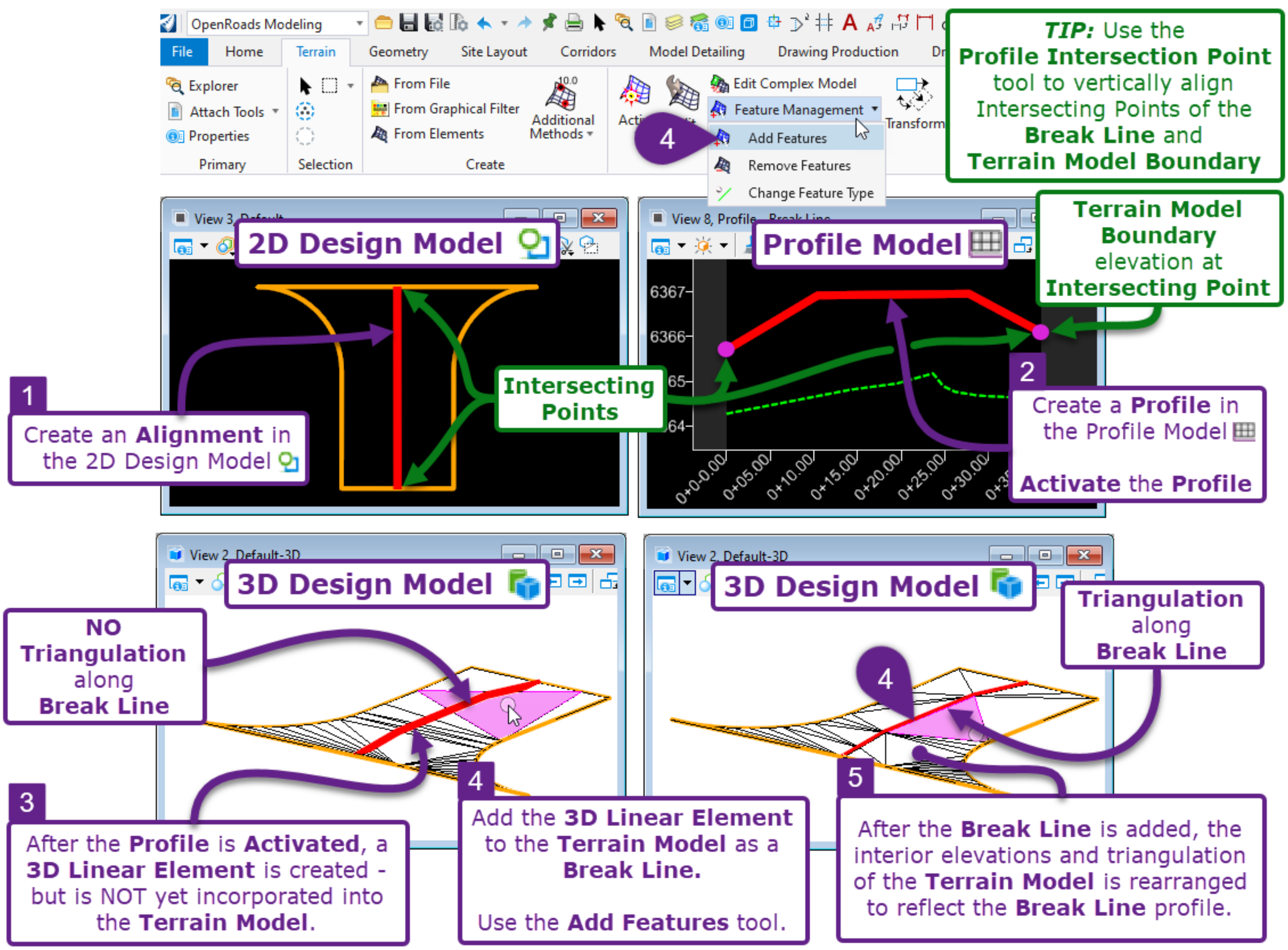


11A.2.b Adding Break Lines to a Terrain Model

As shown on the previous page, creating a Terrain Model ONLY requires a Boundary element. To manipulate the interior elevations of the Terrain Model, **Break Lines** must be created and added to the Terrain Model. Break Lines are commonly used to create ridges or swales within the interior of the Terrain Model.

A Break Line is created by drawing a linear element in the *2D Design Model* and assigning it a Profile.

As shown in the graphic below, a Break Line could be used to create a crown (ridge) in a driveway approach Terrain Model. The *Profile Intersection Point* tool is very useful for aligning the *Break Line* profile with other intersecting *3D Linear Elements* (i.e., the Terrain Model Boundary). See *7F.4.f Profile Intersection Point*.



TIP: In addition to Break Lines, there are a few other Feature Types that are commonly used to calibrate and fine grade a Terrain Model. See *11B.4 Source Features and the Add Feature tool*:

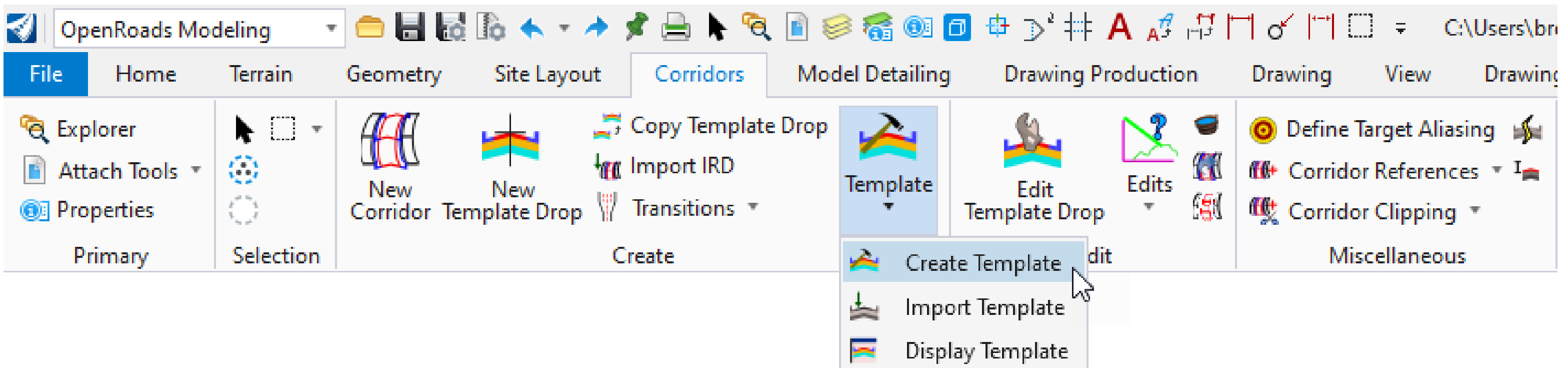
Voids: Voids are used to create a hole or gap in a Terrain Model.
Spot Elevations: Spot Elevations set the elevation for a Terrain for a Point location.

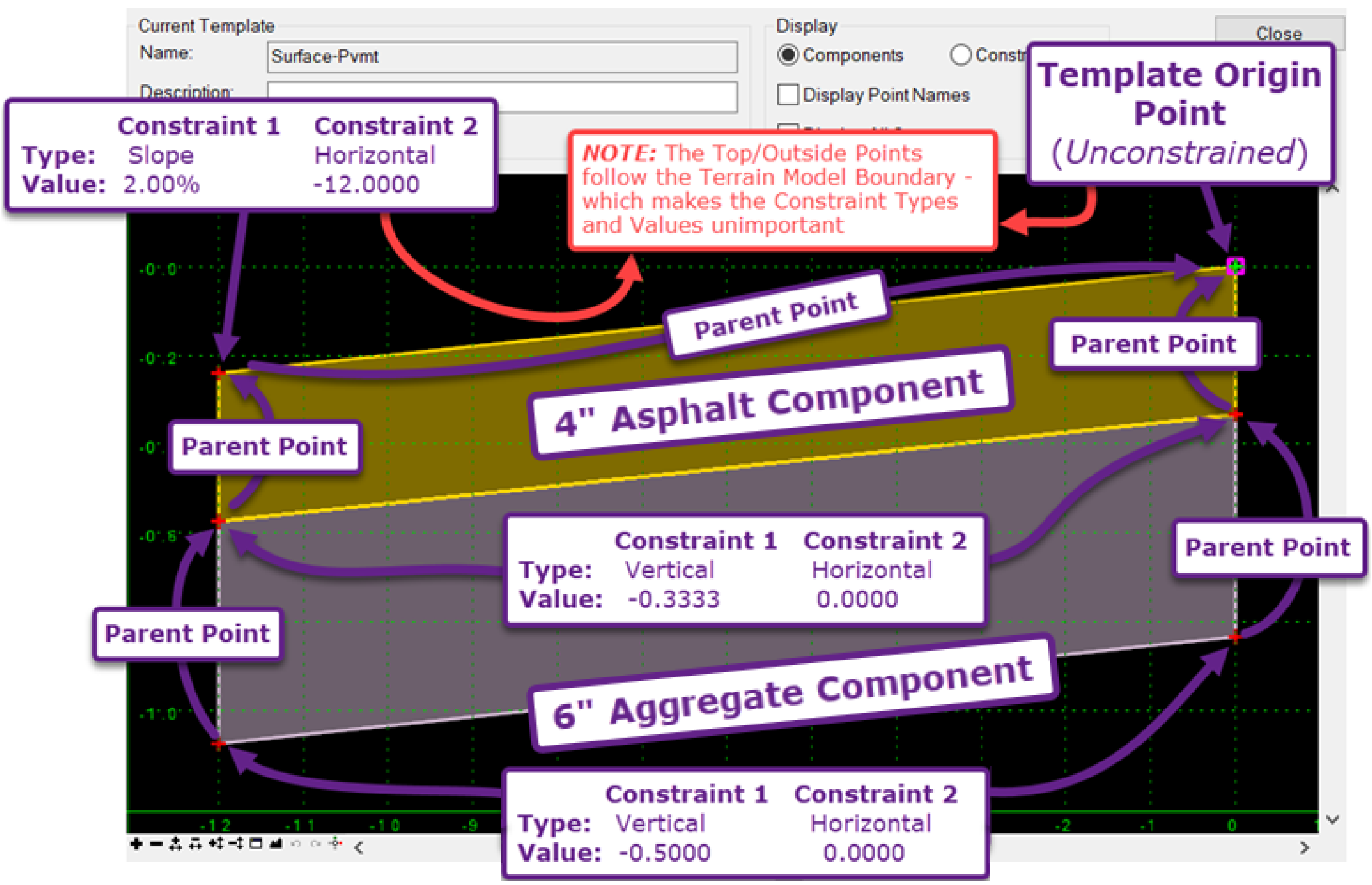
11A.2.c Create Surface Templates in the Template Editor

Within the Template Editor, a Surface Template must be configured to set the material and pavement depths.

The creation and editing of Surface Templates is discussed in *8G – Surface Templates*.

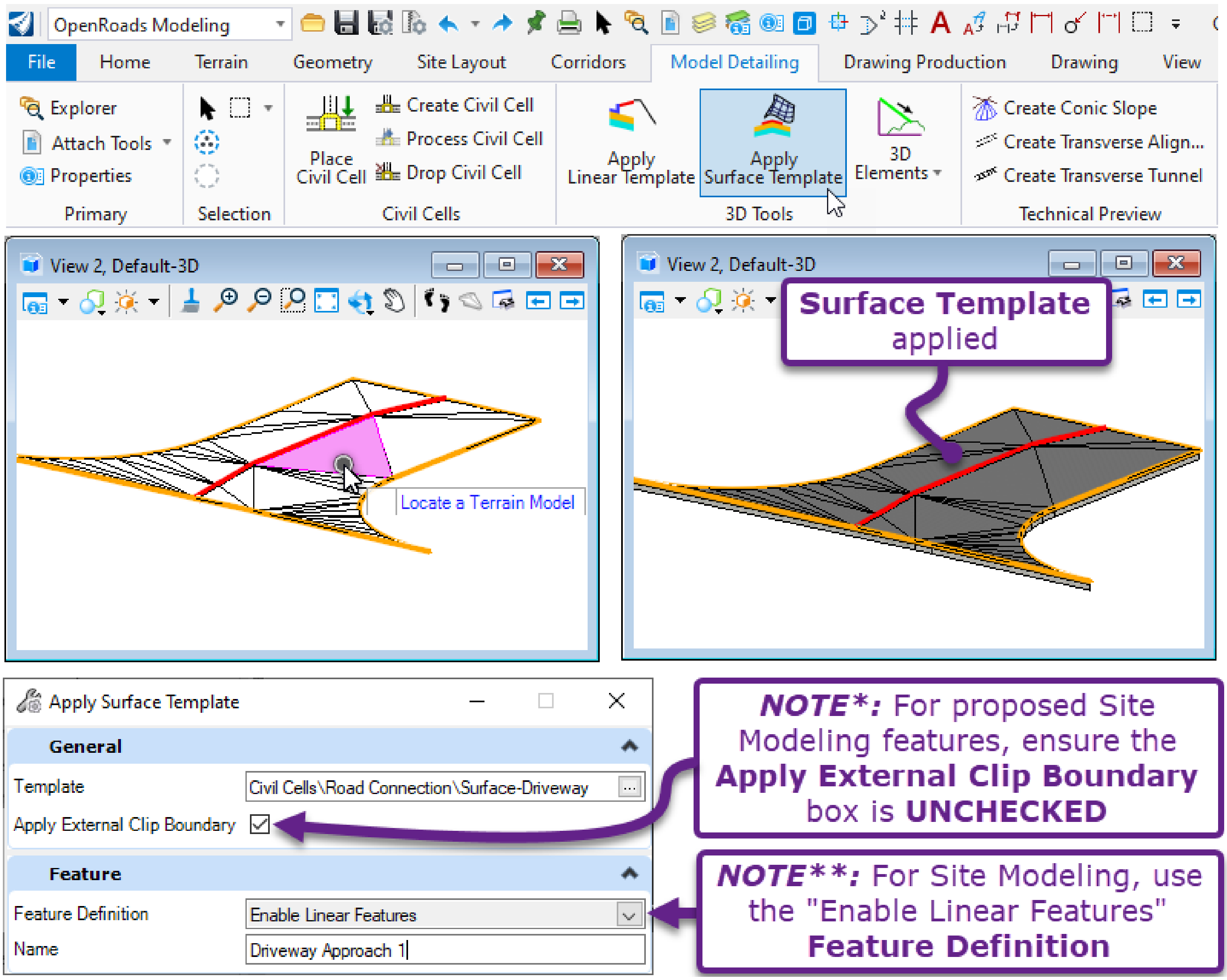
TIP: New Surface Templates configurations should be created by copying and then modifying a pre-made Surface Template found in the FLH Standard Library. See *8G.3 Create a Surface Template Workflow.*





11A.2.d Apply the Surface Template to the Terrain Model

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



NOTE*: UNCHECK the **Apply External Clip Boundary** box when the Surface Template is to be applied to the entire surface of the Terrain Model. If this box is CHECKED, then a "External Clip Boundary" element can be selected. This element must be placed within the limits of the Terrain Model. The resulting Surface Template is only applied to the Terrain Model within the vicinity of the "External" Clip Boundary" element.

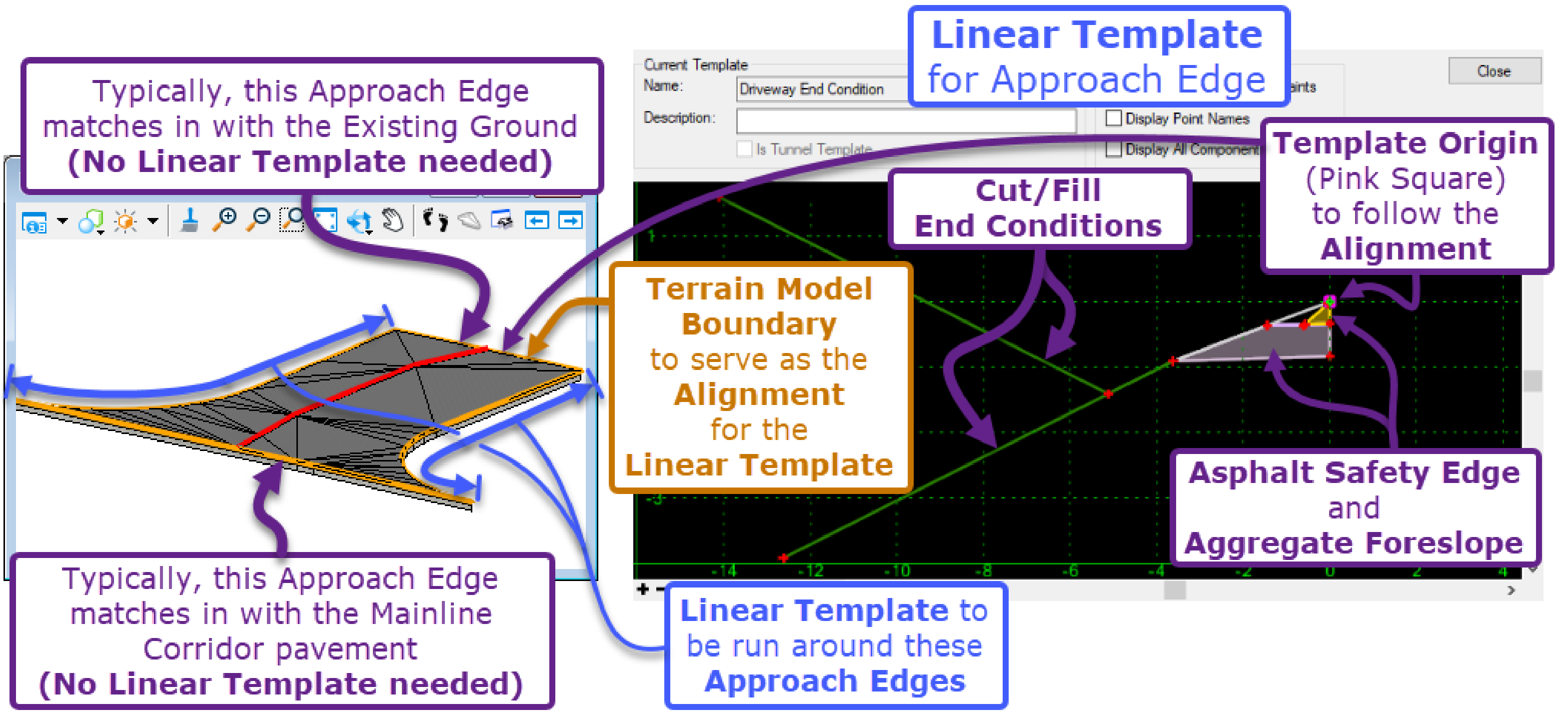
NOTE**: There are only two Feature Definitions available for Surface Templates: **Enable Linear Features** or **Disable Linear Features**. It is recommended that **Enable Linear Features** is used. When **Enable Linear Features** is used, *3D Linear Elements* are created at all Template Point locations (as established in the Template Editor). These *3D Linear Elements* are eventually used for reporting and staking data.

11A.3 Linear Template – Process Overview

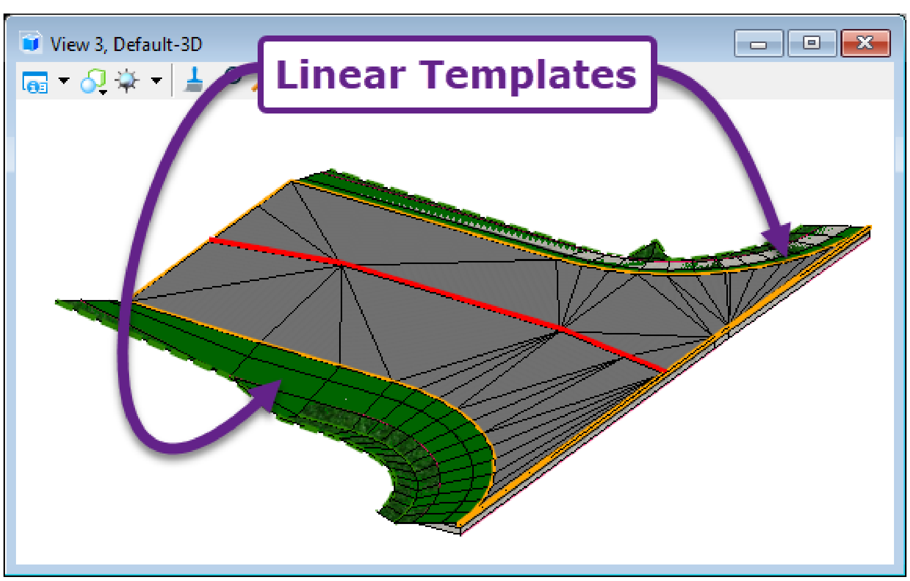
A Linear Template can be thought of as a mini-Corridor. Like a Corridor, a Linear Template is run along an **Alignment** element. The **Alignment** can be enclosed or non-enclosed (open). Also, the **Alignment** must contain an *Active Profile*.

A very common workflow in Site Modeling is to run a Linear Template along portions of a **Terrain Model Boundary**. This is a good technique because edits made to the Terrain Model Boundary element will affect both the Terrain Model and Linear Templates.

As shown in the graphic below, it is typically necessary to run a Linear Template along the side edges of an approach. In this case, two Linear Template models will be created. Each side edge will need its own Linear Template Model.



The detailed workflow for creating Linear Templates is shown in *9B.2 Create a New Linear Template*.

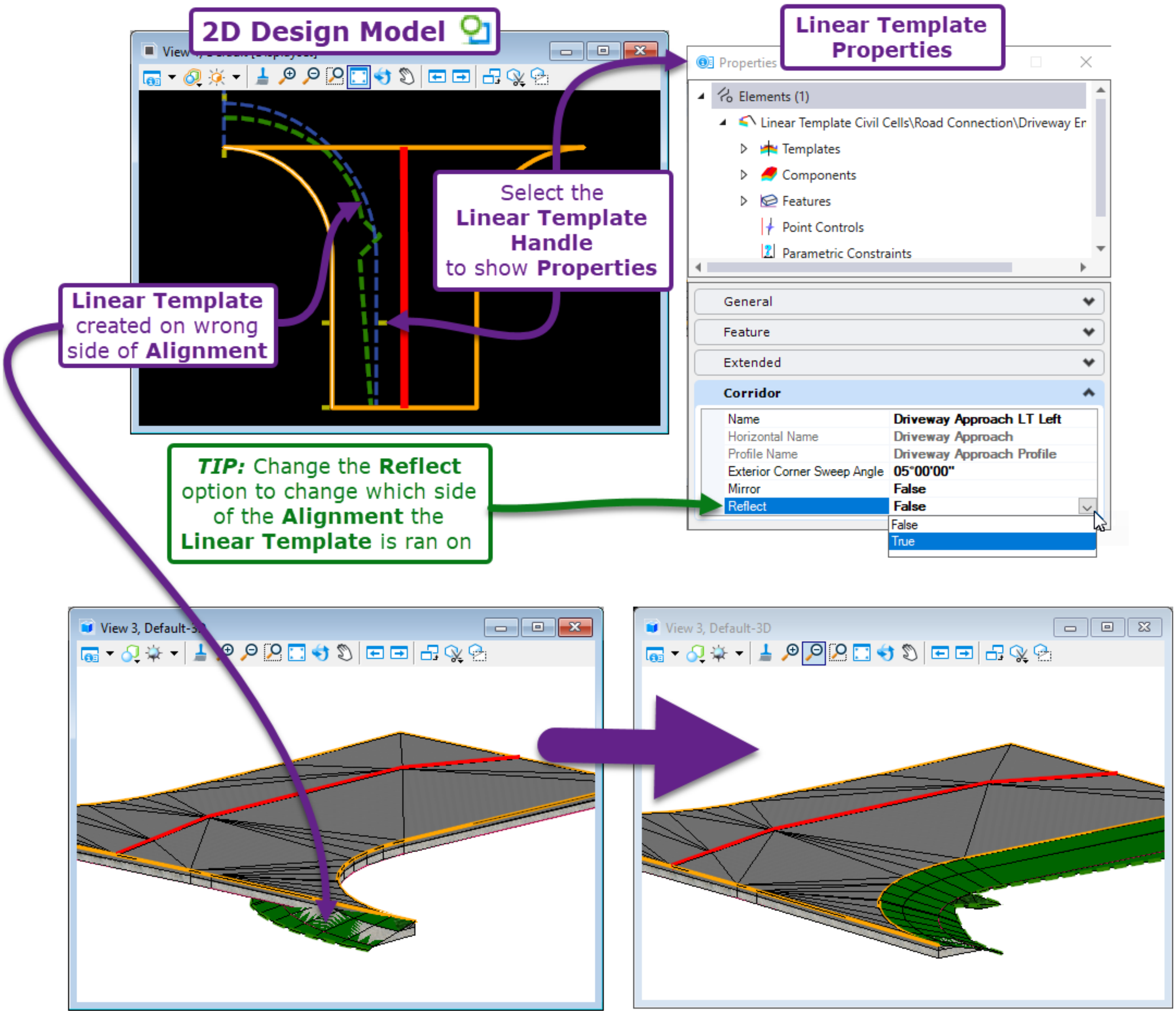


11A.3.a Linear Template TIP: Reflecting Over Alignment

TIP: A major benefit of Linear Templates is that they can be *Reflected* to either side of the Alignment. In other words, a single Template can be placed on either side of an Alignment, regardless of the orientation shown in the Template Editor.

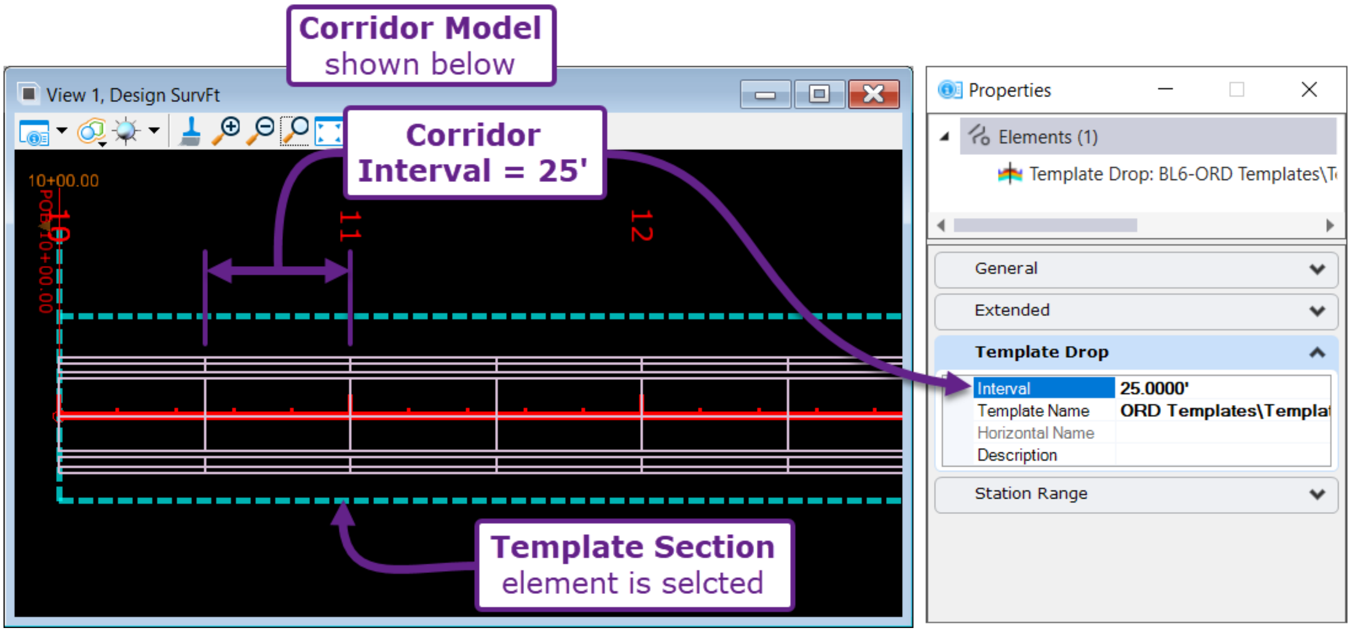
NOTE: The *Linear Template Handle* element is only selectable from the *2D Design Model*

The Reflect option is discussed in greater detail in *9B.2.c Reflect a Linear Template After Creation*.



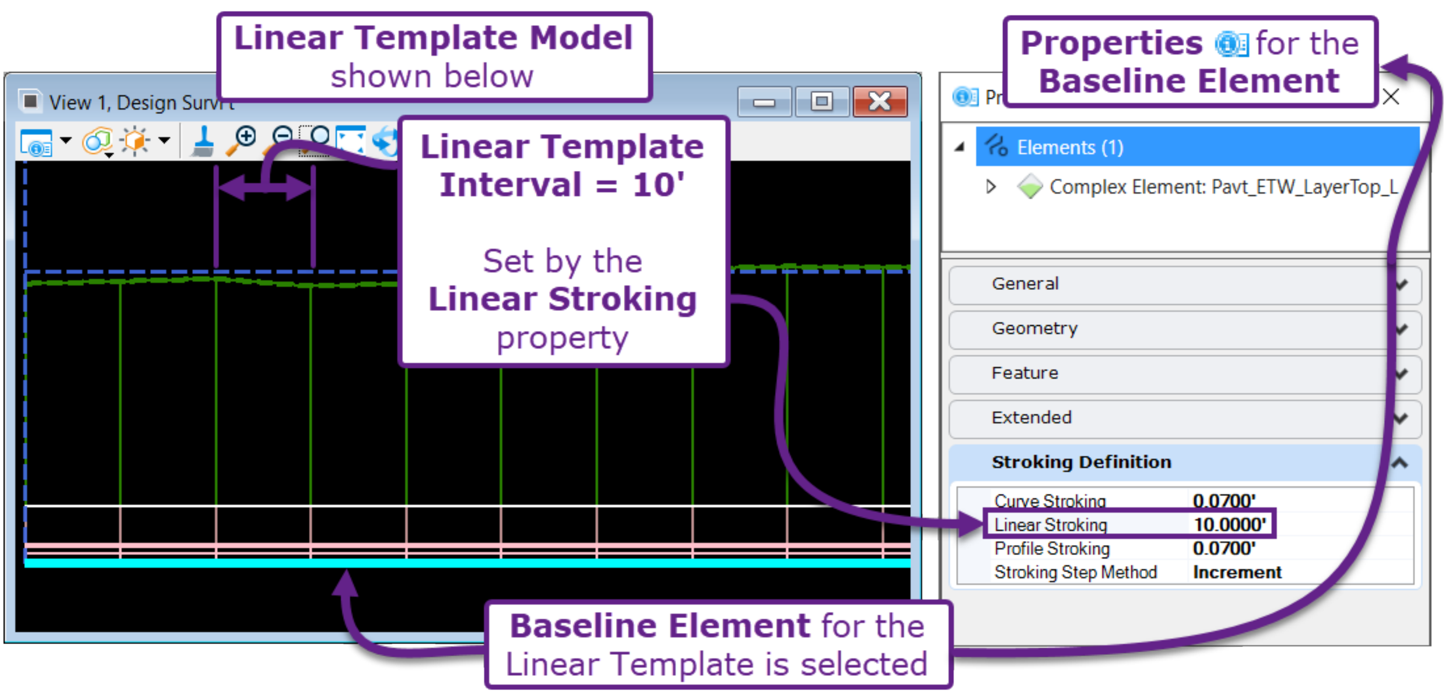
11A.3.b Linear Template TIP: Modify the Linear Template Interval Frequency

As shown below, the Template Interval spacing for a **Corridor** is set in the Properties box when a Template Section element is selected.



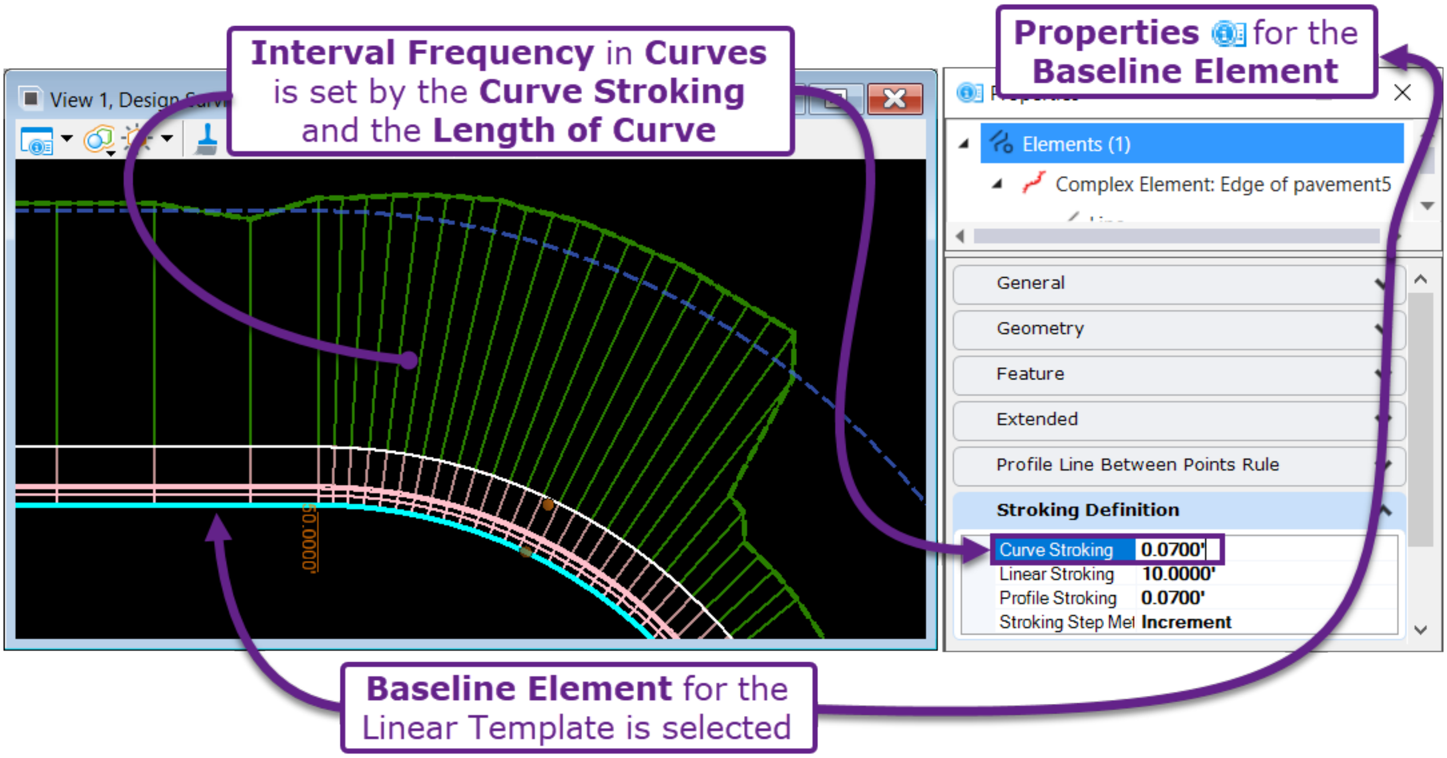
For a **Linear Template**, the Interval property is NOT available in the Properties box. The Interval spacing is set by the **Baseline element**. In the Properties box of the Baseline Element, the **Stroking Definitions** properties control the Interval spacing.

NOTE: The Baseline element is the element used to create the Linear Template.



As shown above, in a straight (Tangent) section, the Interval spacing for the Linear Template is set by the **Linear Stroking** property. By default, this property is set to 10'.

In curve sections, the Interval spacing depends on the **Curve Stroking** property.



By default, the Curve Stroking Value is set to 0.07'. **Increase** this property value to **reduce** the Interval frequency in curves. Decrease this value to increase the Interval Frequency.

NOTE: The Curve Stroking property does NOT directly set the Interval distance in curves. The actual Interval distance depends on the curve length of the Baseline element and the Curve Stroking property.

11A.4 Strategies for Site Modeling

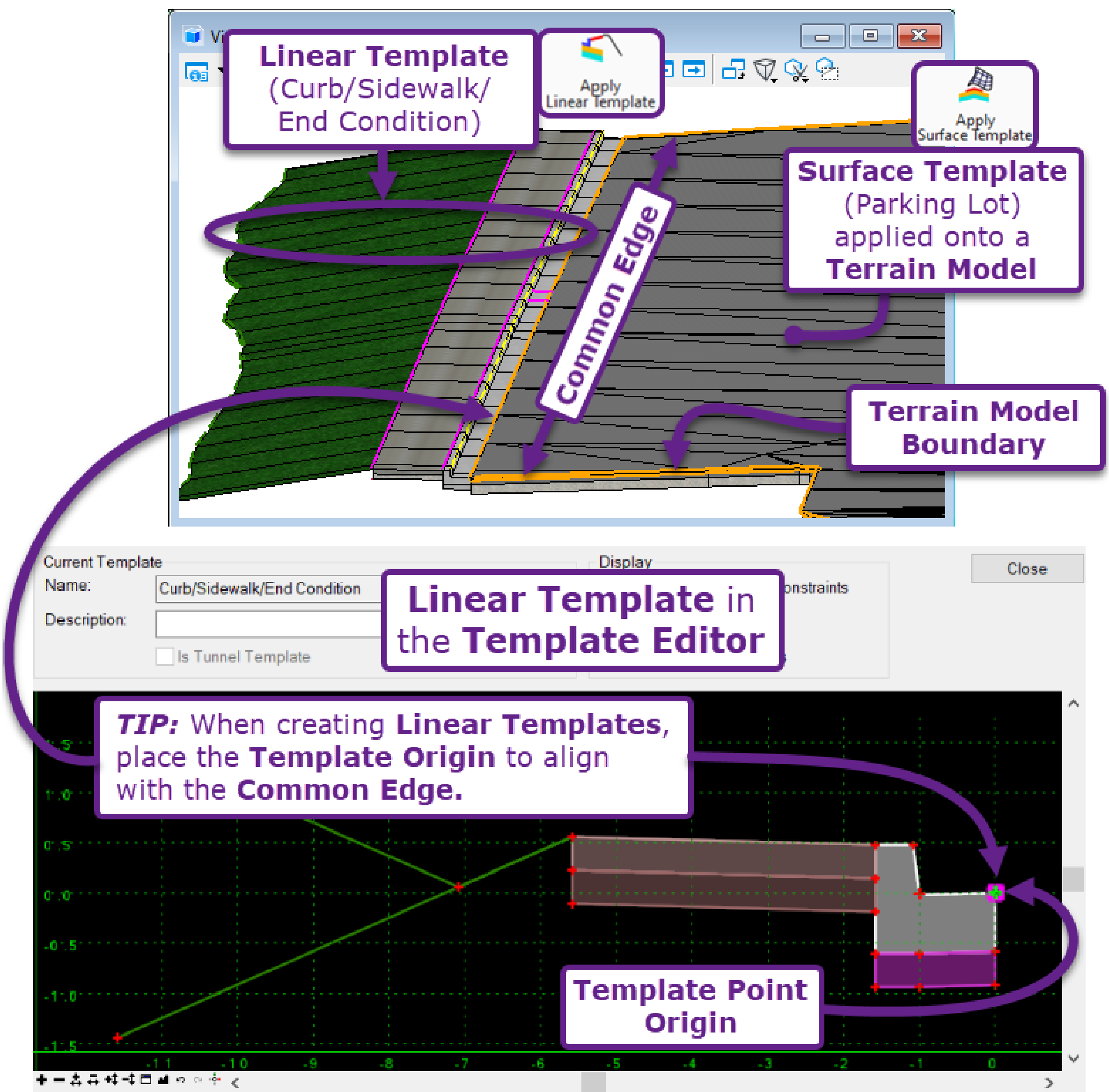
The following section provides important insights and tips that should be kept in mind when planning out and creating Site Modeling features.

11A.4.a Common Edges Among Adjacent Site Modeling Features

When creating Site Modeling features, carefully consider which defining geometric line will serve as the Linear Template Alignment or Terrain Model Boundary. A major factor in this decision is how multiple adjacent Site Modeling features will abut.

Typically, adjacent Site Modeling features share a common edge. If possible, use a common edge from an adjacent model to serve as the Alignment and/or Terrain Model Boundary. This is a good technique because it coordinates the horizontal and vertical position of the abutting Site Modeling features. When edits are made to the horizontal and/or vertical position of the common edge, all Site Modeling features attached to the common edge will re-position in kind.

In the example shown below, the **Terrain Model Boundary** would be created first. Next, the **Linear Template** can be created. The **Linear Template** is run off the **Terrain Model Boundary**, which creates a link between the two Site Modeling entities.

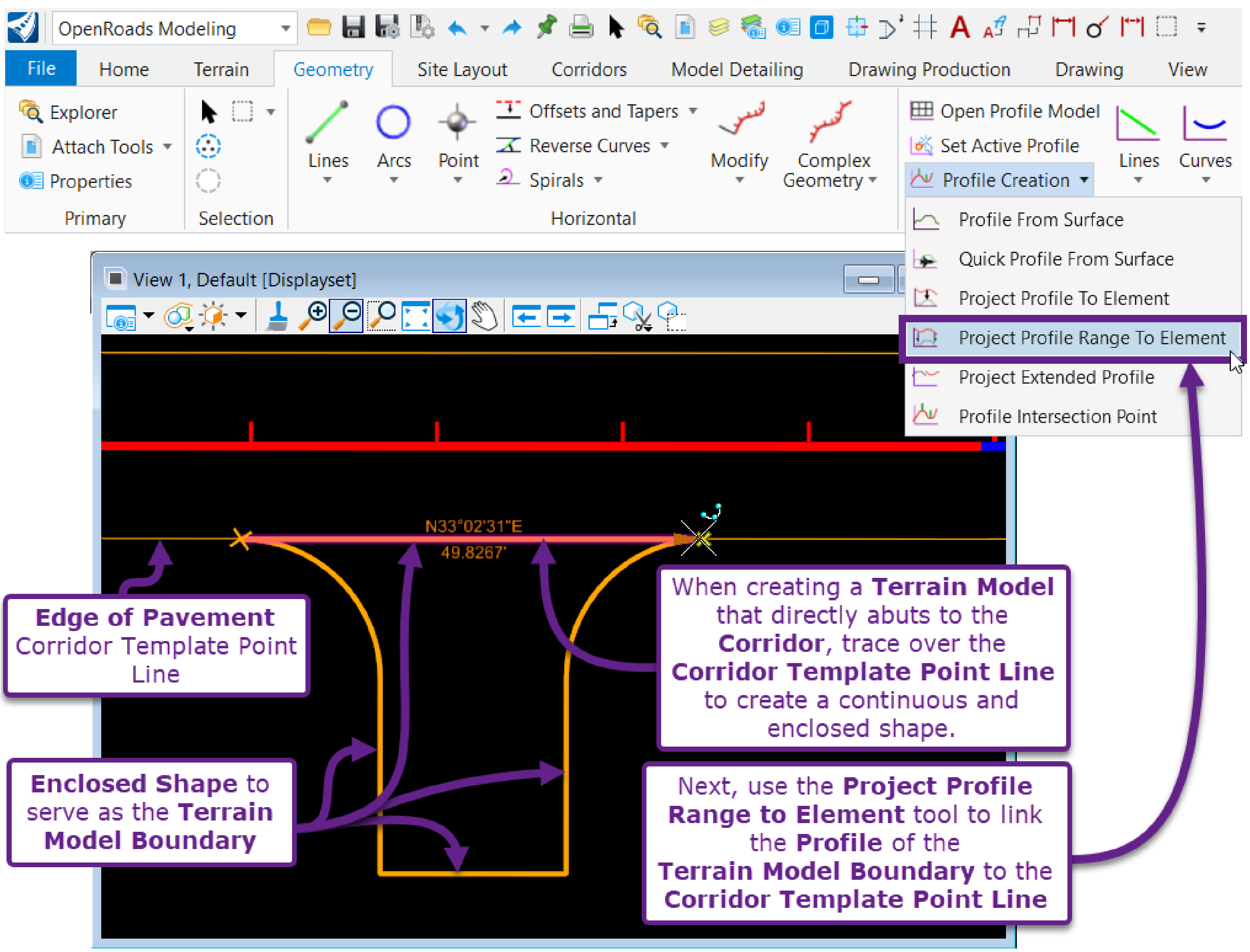


11A.4.b Site Modeling Features Interaction with the Mainline Corridor

It is very common for Site Modeling features to share a common edge with a Linear Element generated by the Corridor. For example, driveway approaches will share a common edge with the mainline Edge of Pavement element generated by the Corridor.

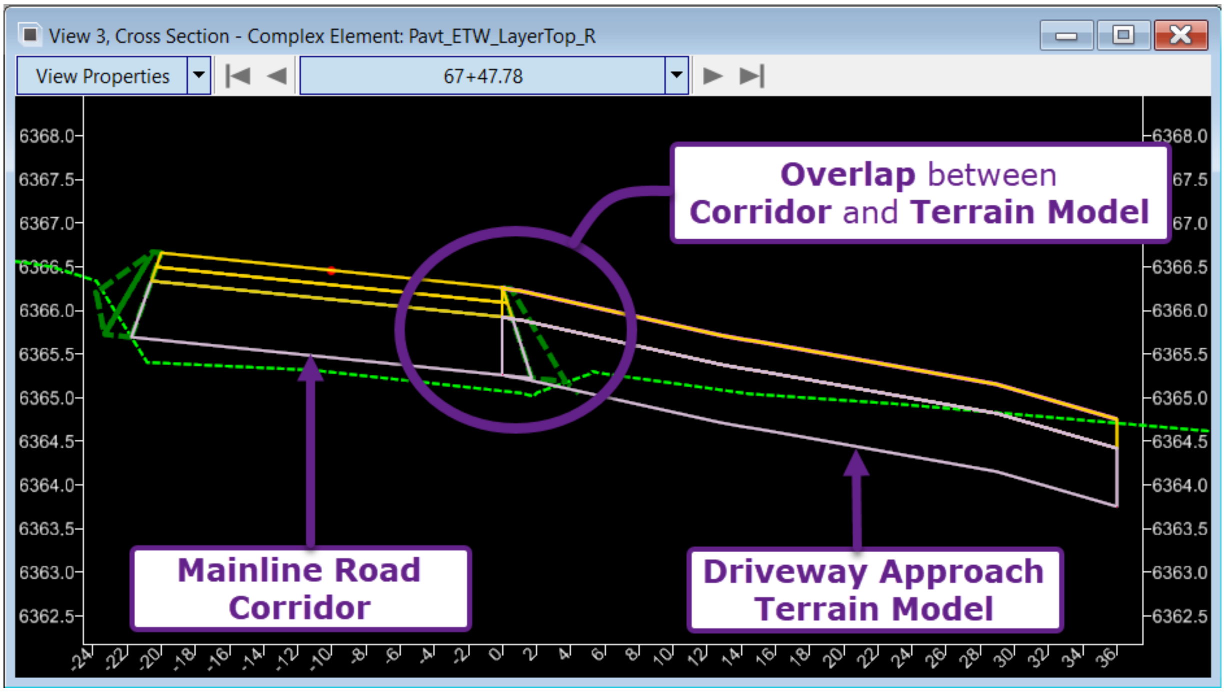
When using Terrain Models to model the pavement surface of a driveway approach, the Edge of Pavement element CANNOT be directly included in the Terrain Model. Instead, the User will have to "trace" over the exact segment that represents the common edge line of the approach and Corridor. The Profile of the common edge line is coordinated with the elevation of the Edge of Pavement Template element with the *Project Profile Range to Element* tool. This procedure is demonstrated in *11C.2.a Draw the Horizontal Elements for the Terrain Model Boundary*.

The reason why the Corridor line CANNOT be directly included in the Terrain Model is because the resulting shape is NOT continuous and enclosed when combined with the other elements that form the Terrain Model Boundary.



11A.5 Overlap Between Mainline Corridor and Site Modeling Features

When modeling an approach, driveway, or intersection, it is common for overlap to occur between the Corridor and approach Terrain Model. Typically, the Corridor safety edge and shoulder wedge components will protrude into the approach Terrain Model. This section discusses many methods for eliminating this overlap.



WARNING: The *Add Corridor Clipping Reference* tool can be used to eliminate this overlap. See *9G.10 Corridor Clipping References*. However, use of this tool is STRONGLY DISCOURAGED. Excessive clipping of the Corridor may significantly increase Corridor processing times; or in some cases, **corrupt the Corridor ORD File**.

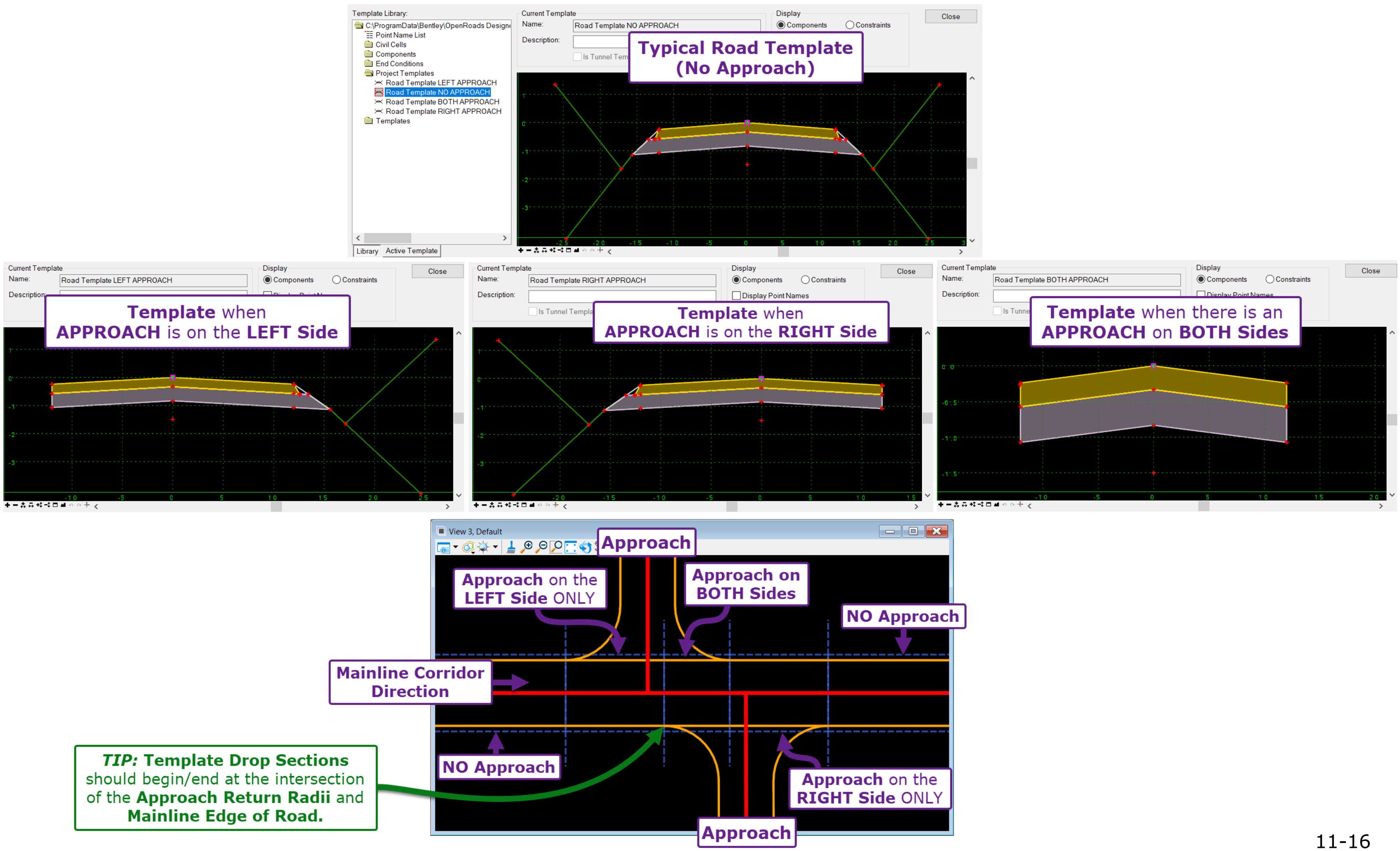
The table below shows alternative methods for eliminating Corridor Model overlap. These methods are discussed in greater detail in the next few pages.

Methods for Eliminating Corridor Model Overlap	
Method:	**Description:**
Create a new Template Section in the Overlap Area	This method involves creating a new Template Drop Section for each segment of the Corridor that overlaps with the adjacent approach model. This method is simple to perform but can be disorganized if Corridor geometry changes.
Use the End Condition Exception tool in the Overlapping Area	This method uses the End Condition Exception tool with the **Backbone Only** method to eliminate the Corridor End Condition in the overlapping segment. The disadvantage of this method is that the Safety Pavement Edge and Shoulder Foreslope components are not eliminated, which results in a very minor (possibly negligent) overlap of asphalt and aggregate quantities between the overlapping models.
Create or Use a Template that contains Display Rules to Address Overlap	**PREFERRED METHOD:** This method may seem complex at first but is the most dynamic if Corridor geometry changes. This method also requires the least amount of processing for the Corridor. The User will either create or use a standard Template from the FLH Template Library that contains Display Rules. The Display Rules triggers OFF the Safety Pavement Edge and Shoulder Foreslope Components in the vicinity of the approach model.

11A.5.a Create a New Template Section for the Overlapping Area

When addressing model overlap of the Mainline Corridor and Approaches, this method may require the creation of three variations of the typical Corridor Template.

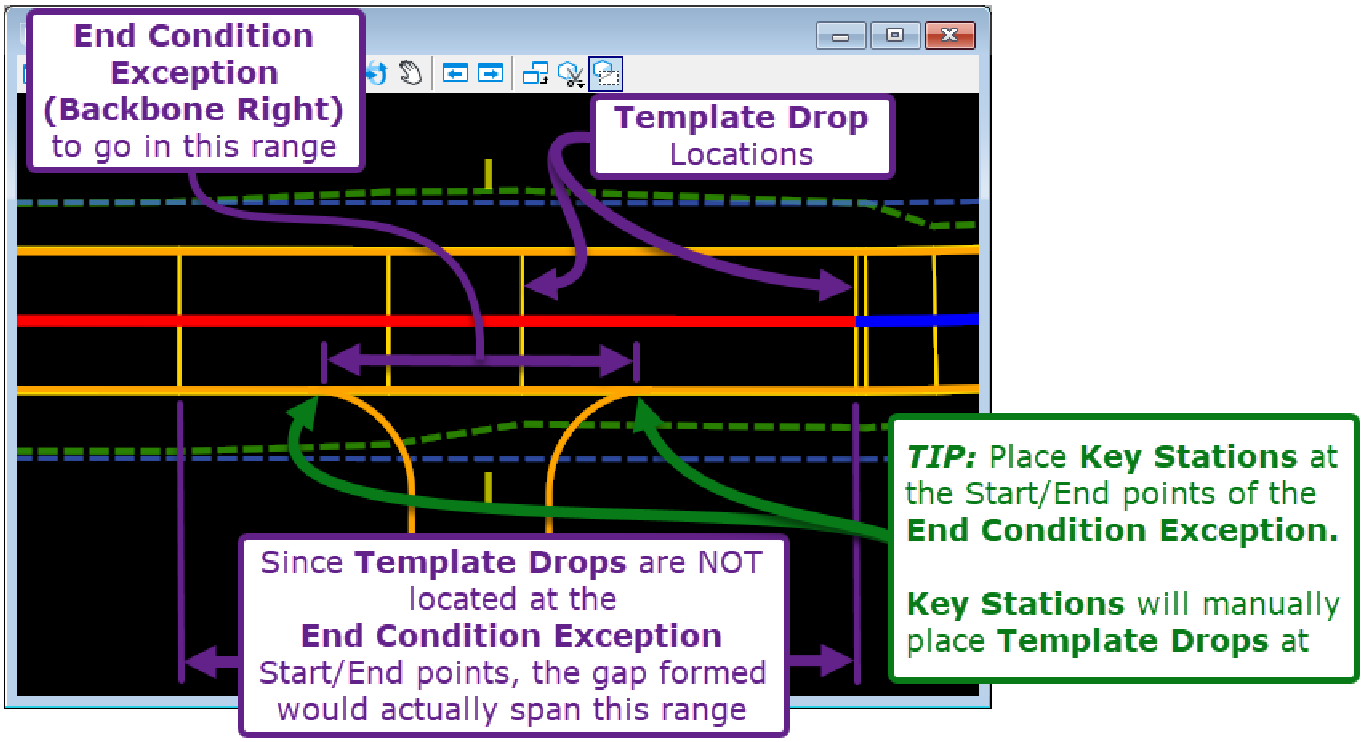
As shown in the graphic below, this method can be disorganized when there are Approaches on both sides of the Road Corridor. Similarly, if Corridor geometry changes, then the User may have to manually adjust/update each Template variation.

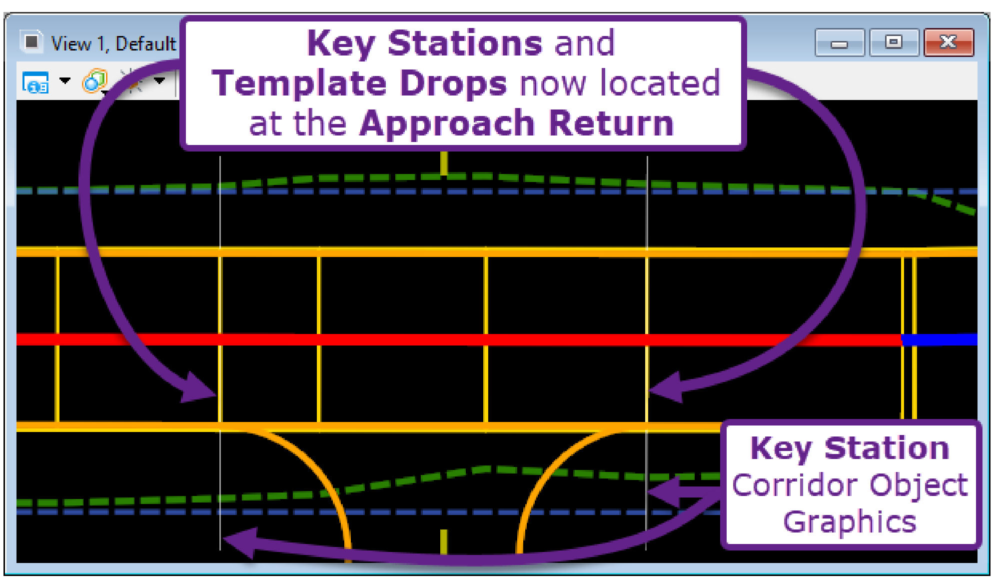


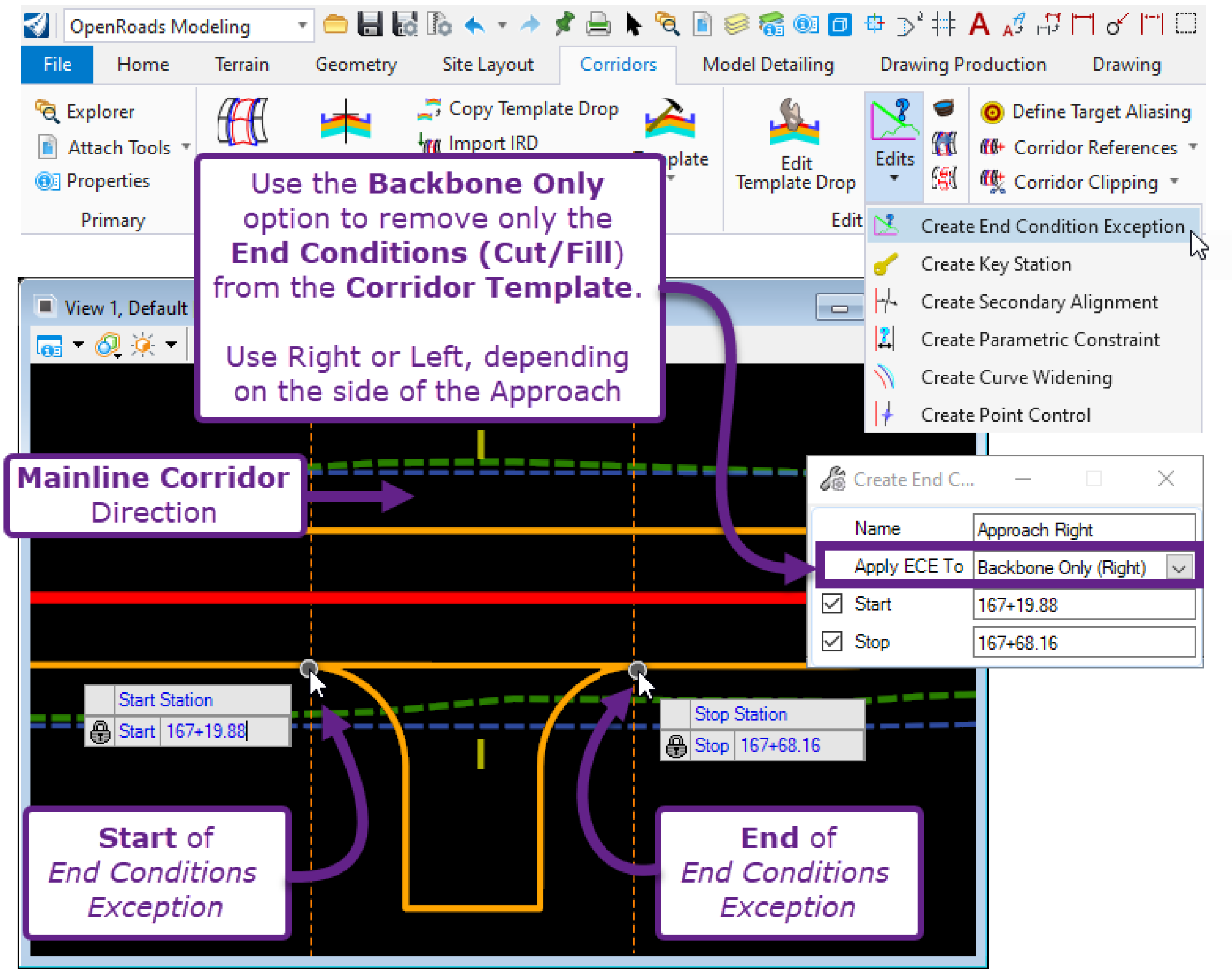
11A.5.b Use the End Condition Exception Tool in the Overlapping Area

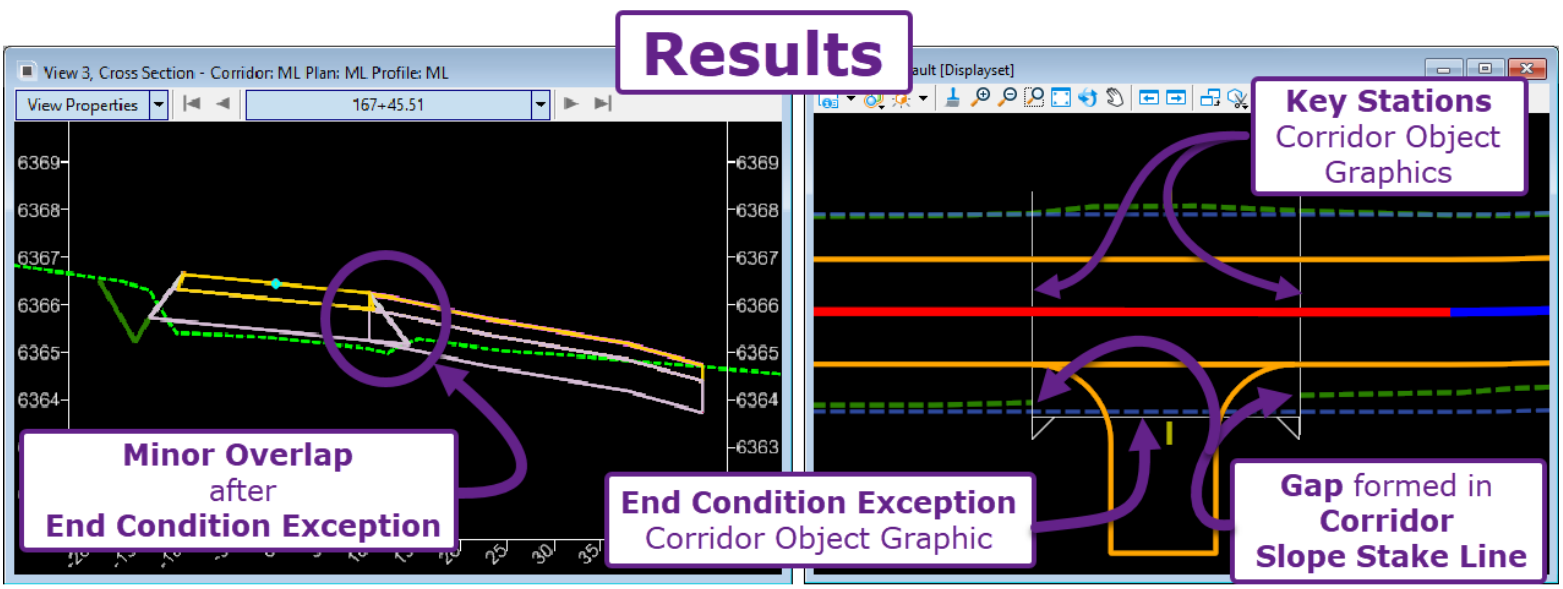
This method is simple and convenient. However, the disadvantage to this method is that there is still minor model overlap. With this method, the Safety Pavement Edge and Shoulder Foreslope are NOT eliminated. Theoretically, this results in a slight excess of asphalt and aggregate in quantity calculations. However, the excess asphalt and aggregate quantities is of a very small order magnitude and may considered to be unappreciable on most road projects. For a detailed explanation of the *End Condition Exception* tool, see *9G.6 End Condition Exception*.

TIP: Before creating the *End Condition Exception* (Mode = *Backbone Only*), place *Key Stations* on the Mainline Corridor (see *9G.3 Key Station*) at the approach return locations shown below. If *Key Stations* are NOT added, then the *End Condition Exception* would actually span from the exterior *Template Drop* locations.





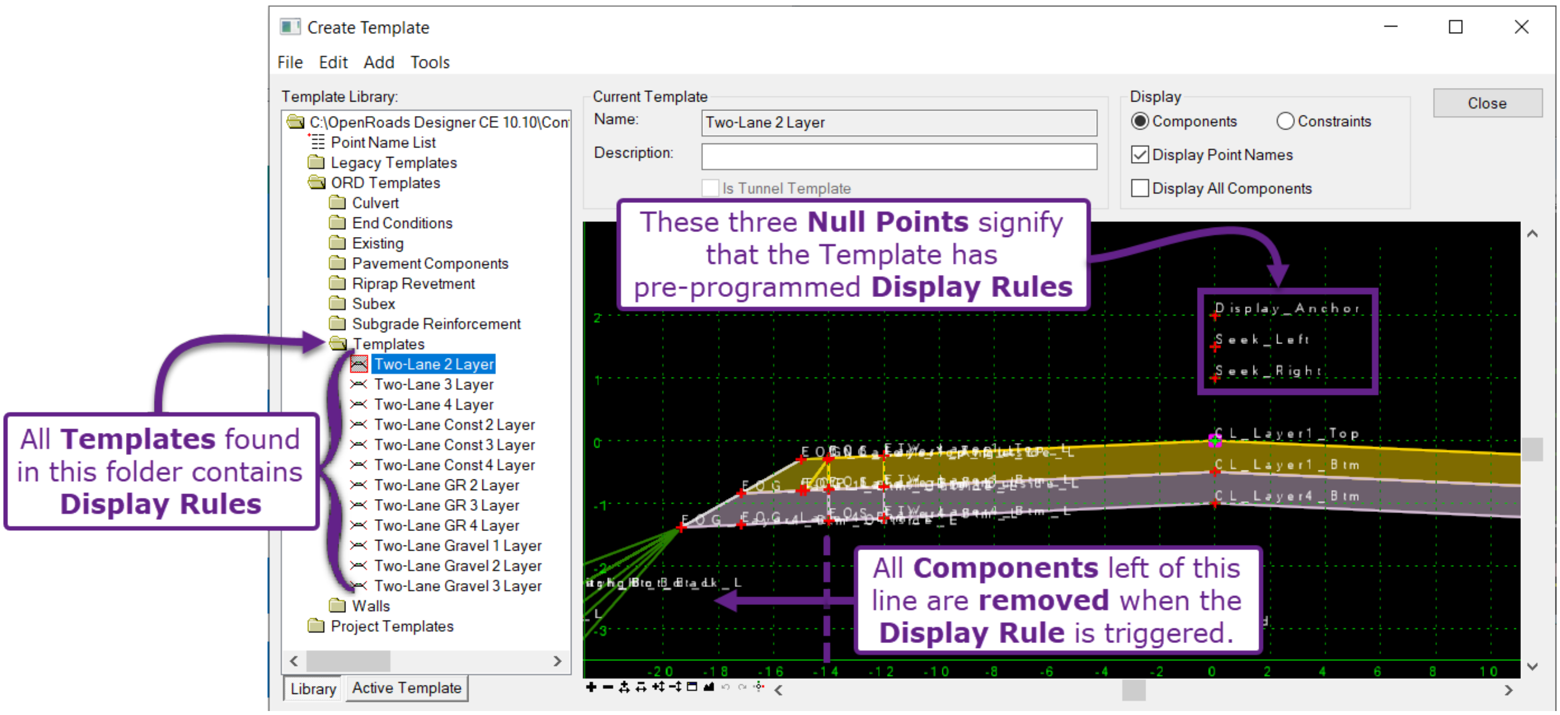

OpenRoads Modeling
File
Home
Terrain
Geometry
Site Layout
Corridors
Model Detailing
Drawing Production
Drawing
Explorer
Attach Tools
Properties
Primary
Copy Template Drop
Import IRD
Edit Template Drop
Edits
Edit
Define Target Aliasing
Corridor References
Corridor Clipping
Create End Condition Exception
Create Key Station
Create Secondary Alignment
Create Parametric Constraint
Create Curve Widening
Create Point Control
Use the **Backbone Only** option to remove only the **End Conditions (Cut/Fill)** from the **Corridor Template.**
Use Right or Left, depending on the side of the Approach
View 1, Default
Mainline Corridor Direction
Create End C...
Name
Approach Right
Apply ECE To
Backbone Only (Right)
Start
167+19.88
Stop
167+68.16
Start Station
Start 167+19.88
Stop Station
Stop 167+68.16
Start of *End Conditions Exception*
End of *End Conditions Exception*


Results
View 3, Cross Section - Corridor: ML Plan: ML Profile: ML
View Properties
167+45.51
6369
6368
6367
6366
6365
6364
6363
Minor Overlap after **End Condition Exception**
End Condition Exception Corridor Object Graphic
ault [Displayset]
Key Stations Corridor Object Graphics
Gap formed in **Corridor Slope Stake Line**

11A.5.c Use a Template containing Display Rules to Address Overlap

This method requires Display Rules to be programmed into the Corridor Template.

As of FLH WorkSpace update 10.10.21.00V, standard road Templates in the FLH Template Library have Display Rules pre-programmed. To determine if a road Template has Display Rules, look for three Null Points placed above the road centerline point.



NOTE: To manually create a Template that contains Display Rules, see *8G.4 Mainline Road Template with Display Rules for Managing Approach Roads and Driveways*.

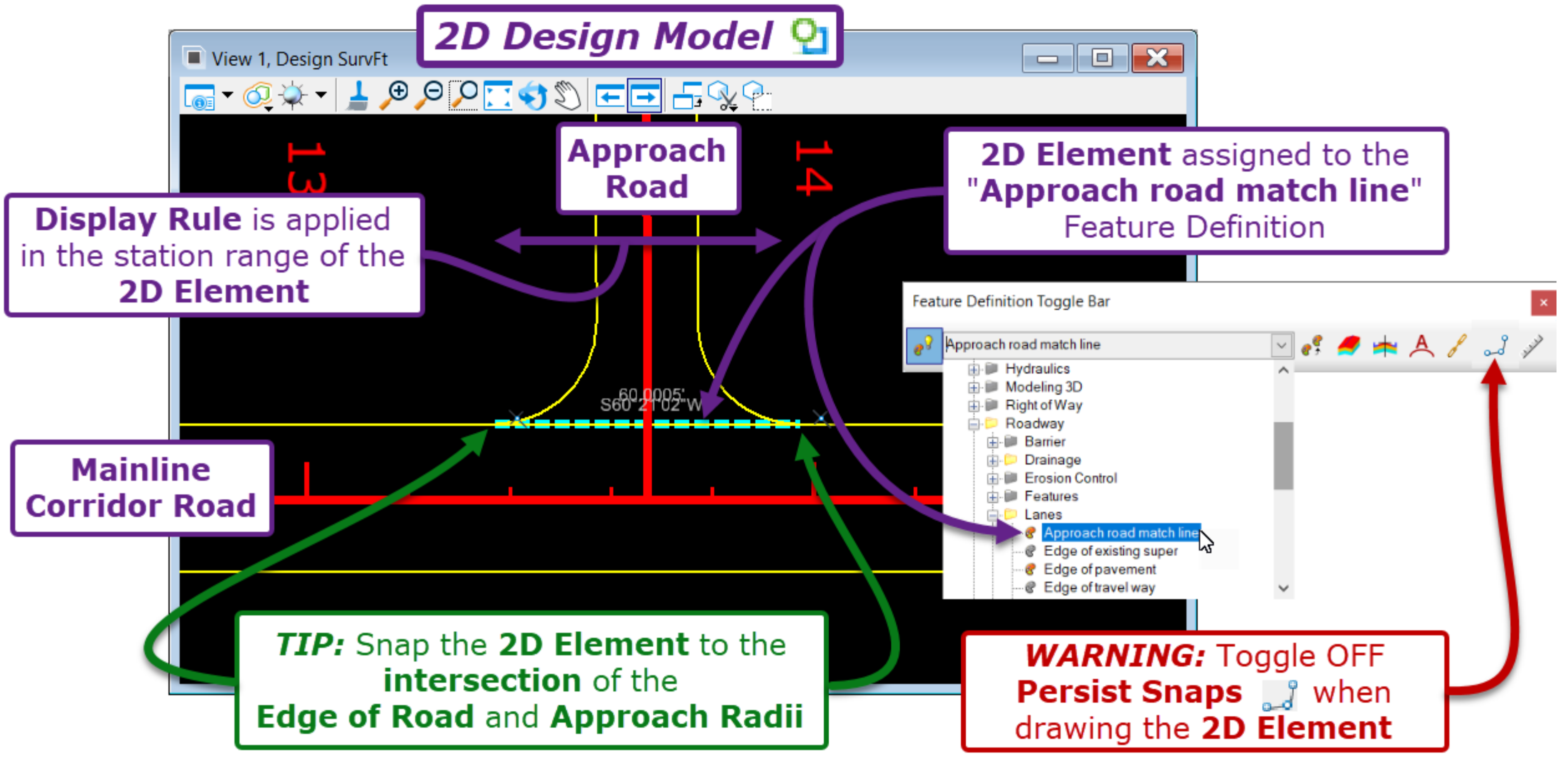
The Display Rules automatically eliminate the Asphalt Safety Edge and Shoulder Foreslope components in the vicinity of the approach, intersection, or driveway model.

The next few pages discuss how to trigger the Display Rules, assuming that the Corridor Template is properly pre-programmed. For more information, the "behind the scenes" operation of the Null Point and Display Rules relationship is discussed in *8D.2.a Display Rules in the FLH Standard Road Templates for Approaches*.

The Display Rules are triggered by manually drawing a 2Delement in the *2D Design Model*. The Display Rules are ONLY triggered in the station range of the 2D element. The 2D element should be match the station limits of the approach.

The 2D element should be drawn with an ORD Line. The Feature Definition assigned to the ORD Line must be set to "Approach road match line".

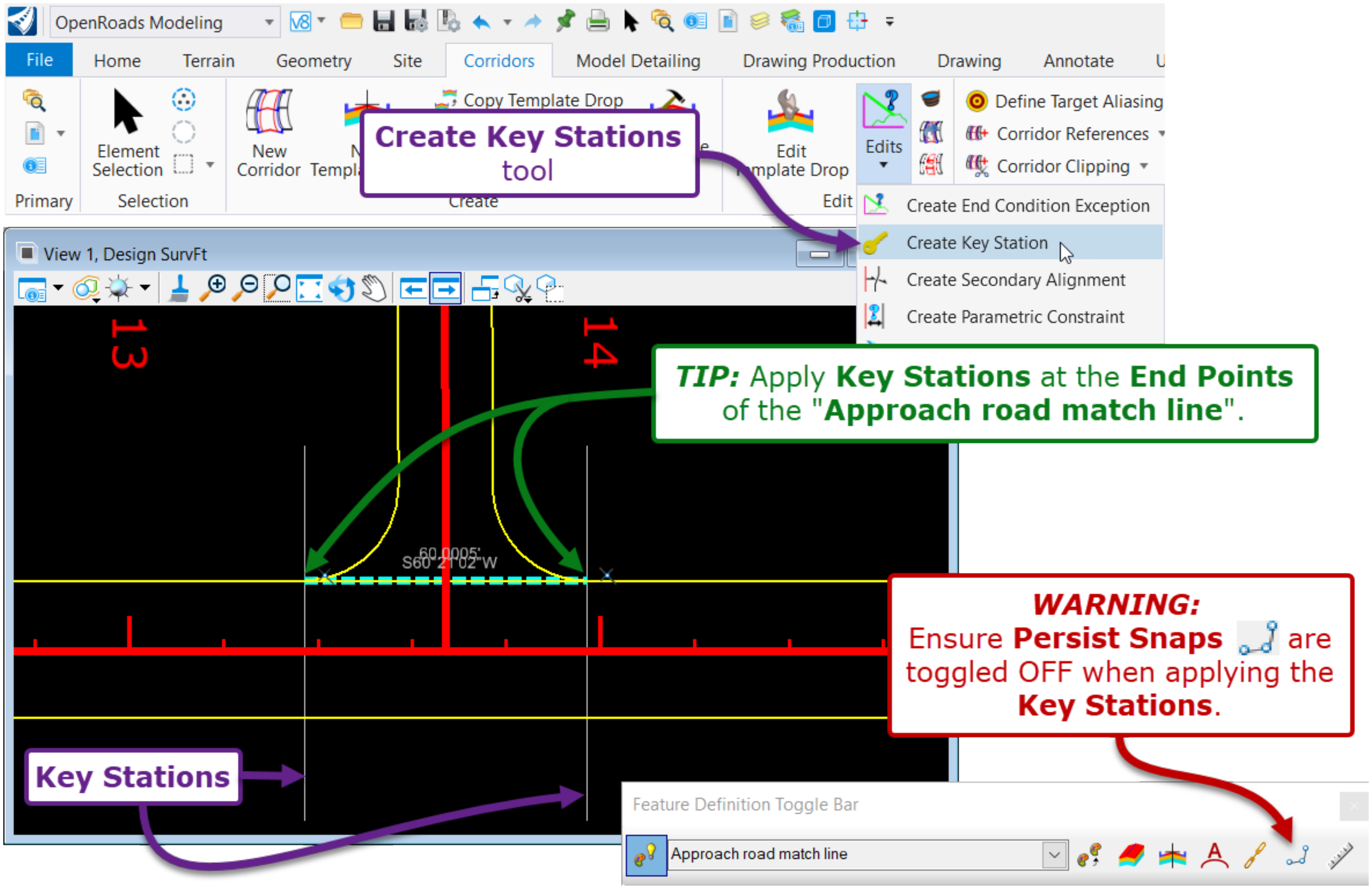
After drawing the 2D element, it must be added to the Corridor as a reference with the *Add Corridor Reference* tool. See *9G.10 Add Corridor Reference*. After the 2D element is added as a Corridor Reference, the Display Rules will be triggered.



WARNING: **When drawing the 2D Element toggle OFF the Persist Snap setting.** If Persist Snaps are used, then the 2D Element will be REJECTED when the *Add Corridor Reference* tool is used. The Persist Snap toggle is in the Feature Definition Toolbar. See *7B.3 Feature Definition Toolbar*.

TIP: Apply Key Stations to the Corridor at the end points of the "Approach road match line" element. The Key Stations ensure the Corridor is processed for the exact full distance of the "Approach road match line" element. Key Stations are discussed in *9G.3 Key Stations*.

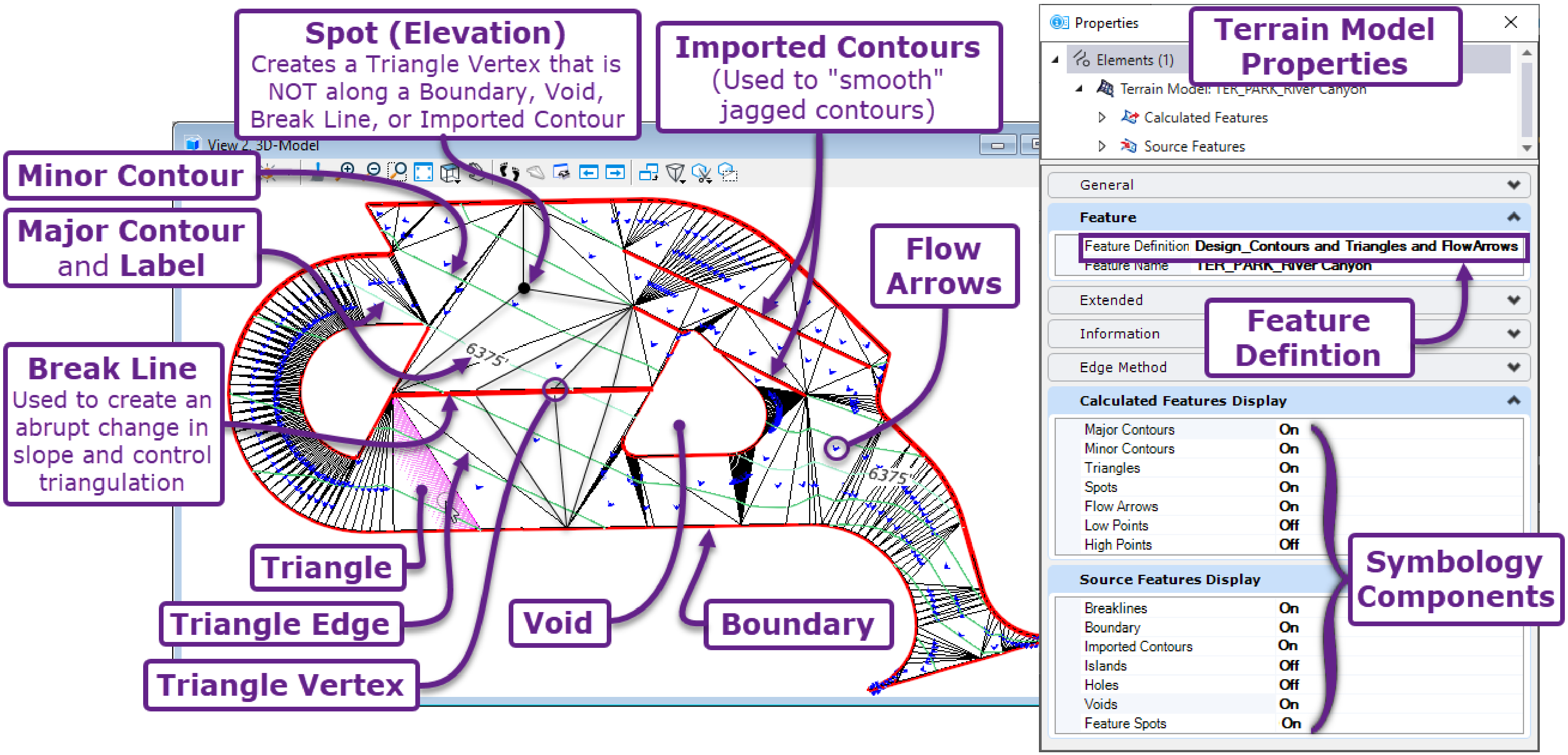
WARNING: The **Persist Snap** toggle must be OFF when placing the Key Stations. If NOT the Key Stations will NOT be created because a circular reference would be formed with the "Approach road match line" Corridor Reference.



This section is intended to provide insight for the display and manipulation of Terrain Models. The creation of Terrain Models for Corridors is discussed in *9I - Creating Terrain Models from the Corridor* and *Chapter 22 – Proposed Terrain Model Creation*.

A Terrain Model is a 3D element, which means it "lives" in the *3D Design Model*. For example, a Terrain Model can only be deleted by selecting it in the *3D Design Model*. Terrain Models and Contours are displayed in the *2D Design Model* through **referencing**.

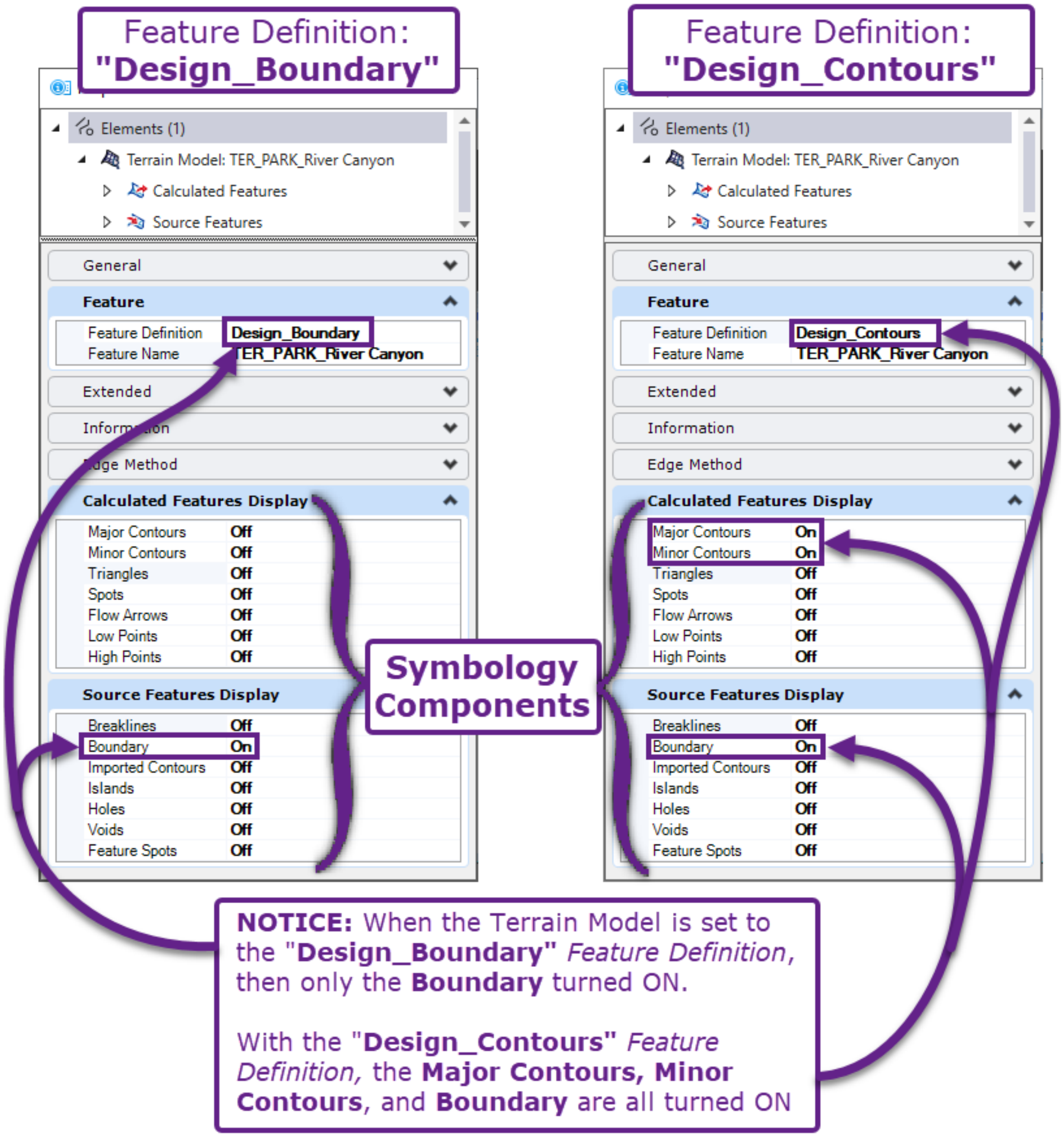
A Terrain Model is comprised of Symbology Components, which are shown in the Properties box when the Terrain Model is selected. Symbology Components are graphics used to analyze, manipulate, and display components of a Terrain Model. The majority of Symbology Components types available for Terrain Models are shown in the graphic below. Each Symbology Component type is assigned to a unique Level. See *11B.5 Level Management for Terrain Models.*



11B.1 Symbology Components and Feature Definitions

A Terrain Model entity is comprised of several types of Symbology Components. Symbology Components are graphical elements that are generated and displayed from a Terrain Model. For example, Major Contours, Minor Contours, and Flow Arrows are three distinct types of Symbology Components that are used to display Terrain Model information and graphics.

The display settings for Symbology Components are shown in the Properties box for a Terrain Model:



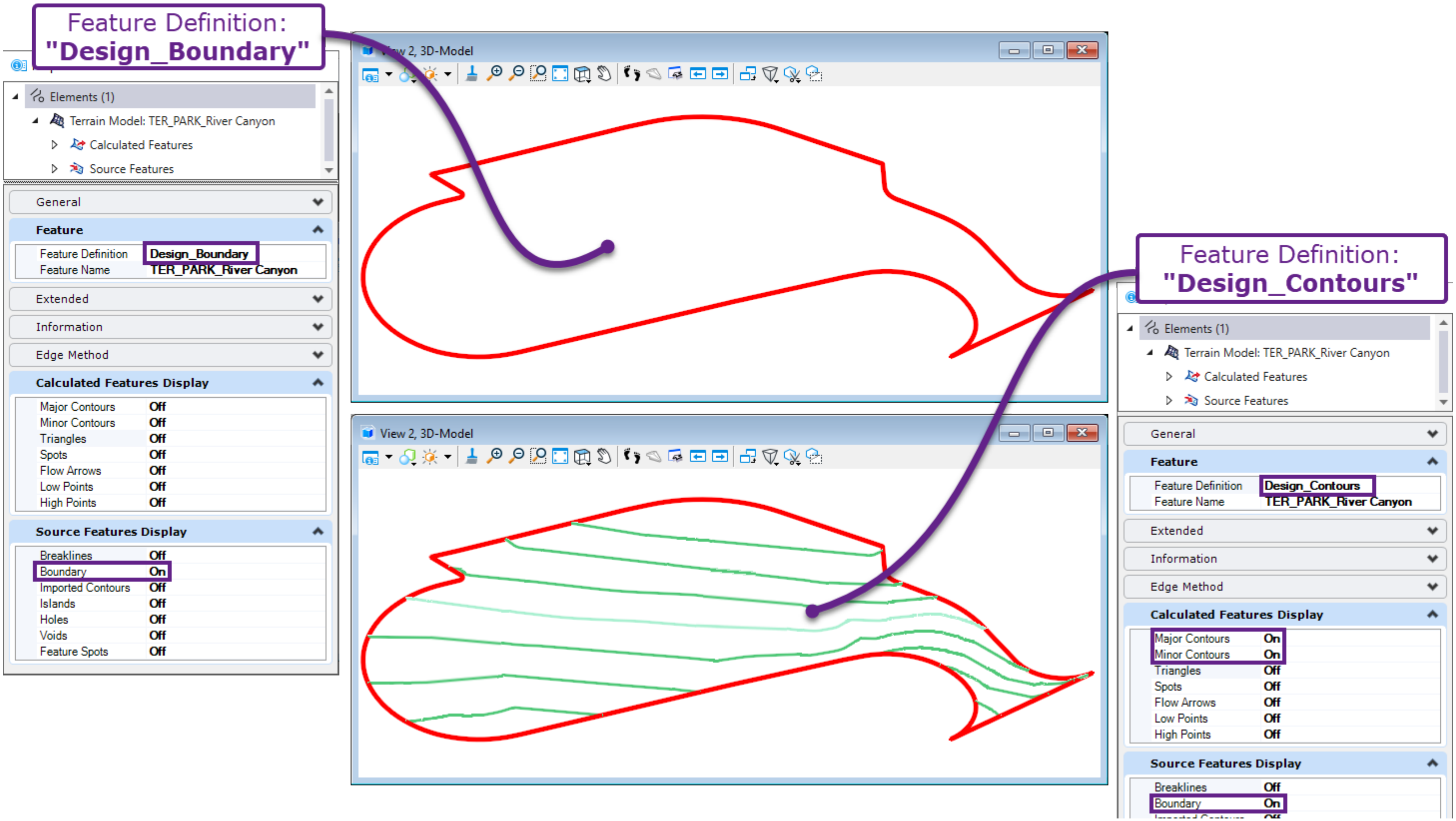
IMPORTANT: The preferred method of altering the display of a Terrain Model is by changing the Feature Definition (found in the Properties box). For example, when manipulating and troubleshooting a Terrain Model; it is convenient to assign the Terrain Model to the "Design_Contours and Triangles and FlowArrows" Feature Definition. This Feature Definition shows the triangulation of the Terrain Model, which is usefully for manipulating and troubleshooting. When finished manipulating a Terrain Model, re-assign it to the "Design_Contours" Feature Definition to view only the Contours and Boundary elements.

NOTE: The User could manually toggle ON/OFF Symbology Components, which is referred to as a *Symbology Override*. However, this method is discouraged because the display override will revert to the default display when the Terrain Model is edited.

The graphic below shows how changing the Feature Definition of a Terrain model will affect the display.

BEST PRACTICE: To manipulate display graphics, re-assign the Terrain Model to an appropriate Feature Definition. Avoid toggling ON/OFF settings in the Properties box.

WARNING: Terrain Models that represent proposed features should ALWAYS be set to a "Design_..." Feature Definition.



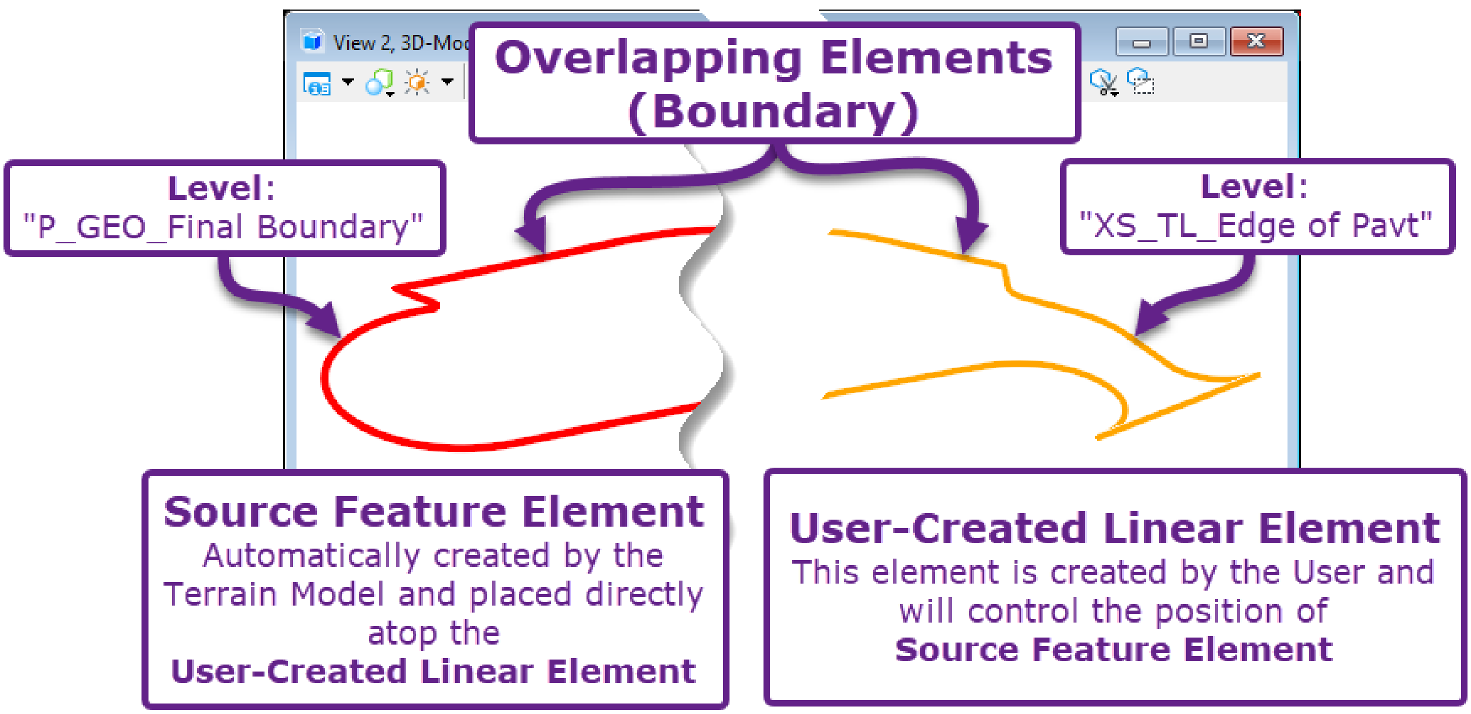
11B.2 Symbology Components: Calculated Features vs Source Features

In the Properties box, Symbology Components are classified as *Calculated Features* or *Source Features*.

Calculated Features: Calculated Features are automatically generated (calculated) by the Terrain Model. Calculated Features include Major/Minor Contours. Also, Triangles and Flow Arrows are considered Calculated Features and are useful for designing and grading a Terrain Model.

Source Features: Source Features correspond with the User-Created Linear Elements that are used to define the grading of a Terrain Model. When a User-Created Linear Element is added to a Terrain Model (i.e., a Boundary or Break Line), then a corresponding *Source Feature* element is automatically created and placed atop the User-Created Linear Element.

> ***IMPORTANT:*** User-Created Linear Elements are added to the Terrain Model with the *Add Features* tool (See *11B.4 Source Features and the Add Feature tool*). When a User-Created Linear Element is added to a Terrain Model, an identical Source Feature Element is placed atop the User-Created element.



WARNING:
Source Feature Elements CANNOT be directly edited. Instead, the **User-Created Linear Element** must be edited to manipulate the Terrain Model.

11B.3 Triangulation of a Terrain Model

This section provides an introduction and overview of Terrain Model triangulation. Understanding triangulation is important for troubleshooting and accurately grading a Terrain Model.

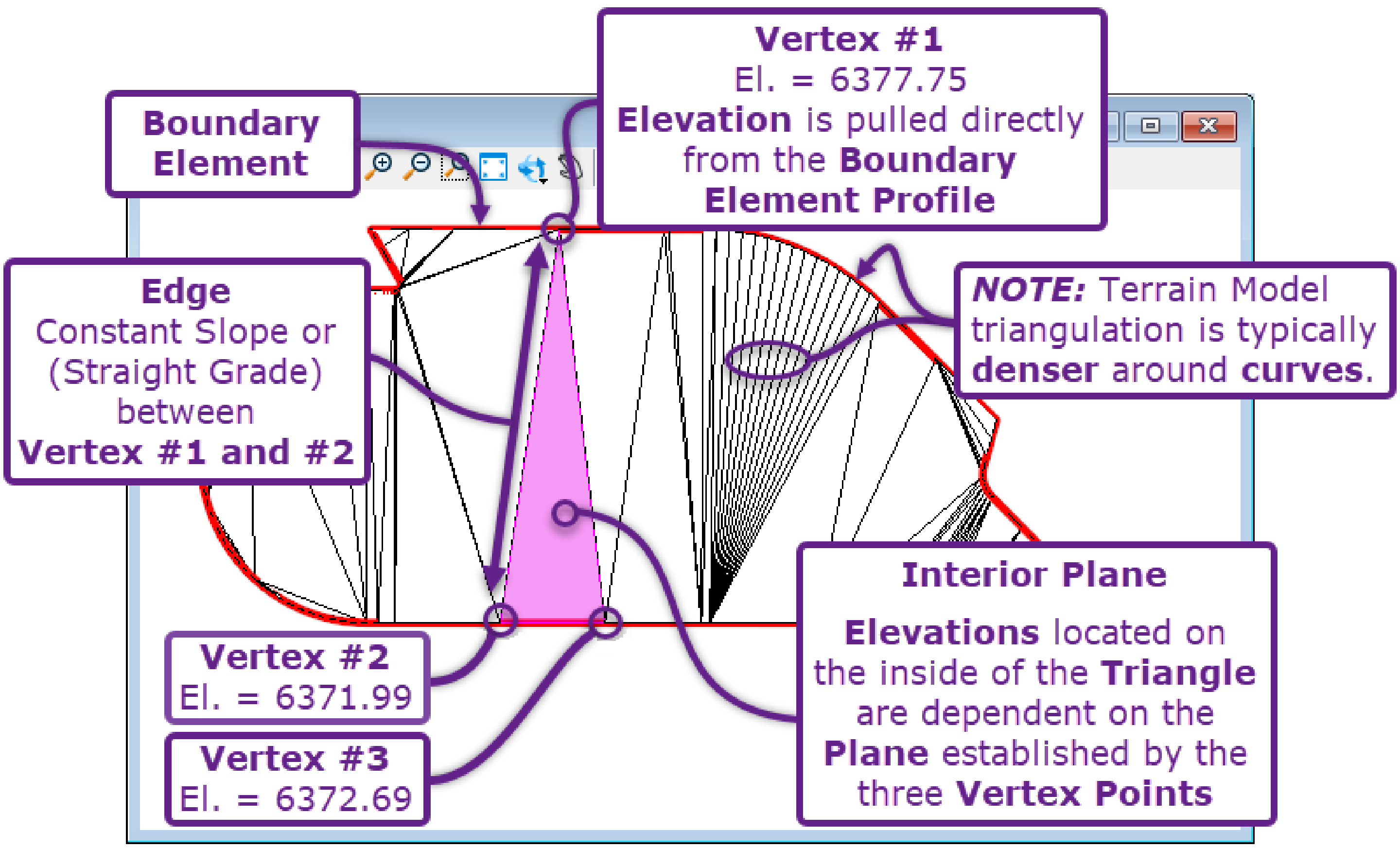
As shown below, a Terrain Model is a mesh of triangles. Each triangle is a 3-dimensional plane. The more triangles a Terrain Model contains, the denser and more accurate the Terrain Model will be.

Terrain Model triangles have three defining parts: the **Vertex**, the **Edge**, and the **Interior Plane**.

Vertex: The Vertex of a triangle represents a **User-established elevation**. Elevations are established from *Source Features*, such as Break Lines, Voids, Spot Elevations, and the Boundary Element. ***IMPORTANT:*** Vertex are ONLY placed on and along *Source Features*. In the example below, the Terrain Model is defined by a single *Source Features* - which is the Boundary element. Notice that all Vertices are placed along the Boundary. The Vertex elevations are pulled from the Profile of the Boundary element. If an interior Break Line was added to the Terrain Model as a *Source Features*, then Vertices would be placed along the interior Break Line. ***IMPORTANT:*** Vertices are ALWAYS placed at **Horizontal** and **Vertical** (profile) geometry points (i.e., deflection points, PI's, PC's, PT's, VPI's, VPT's, VPC's). Additionally, the **Stroking Definition** properties of the *Source Feature*s determine the frequency which vertices are placed. See *11A.3.b Linear Template TIP: Modify the Linear Template Interval Frequency*.

Edge: Elevations along the Edge of a triangle are interpolated from the two adjacent Vertices. In other words, the elevations along the Edges are straight-graded from the adjacent Vertices.

Interior Plane: The area inside a triangle should be thought of as a 3-dimensional plane. Geometrically speaking, a 3D plane is defined by THREE non-collinear points (three points not on a common line or ray). In Terrain Model triangulations, the three non-collinear points correspond with the three Vertices that delineate the triangle.



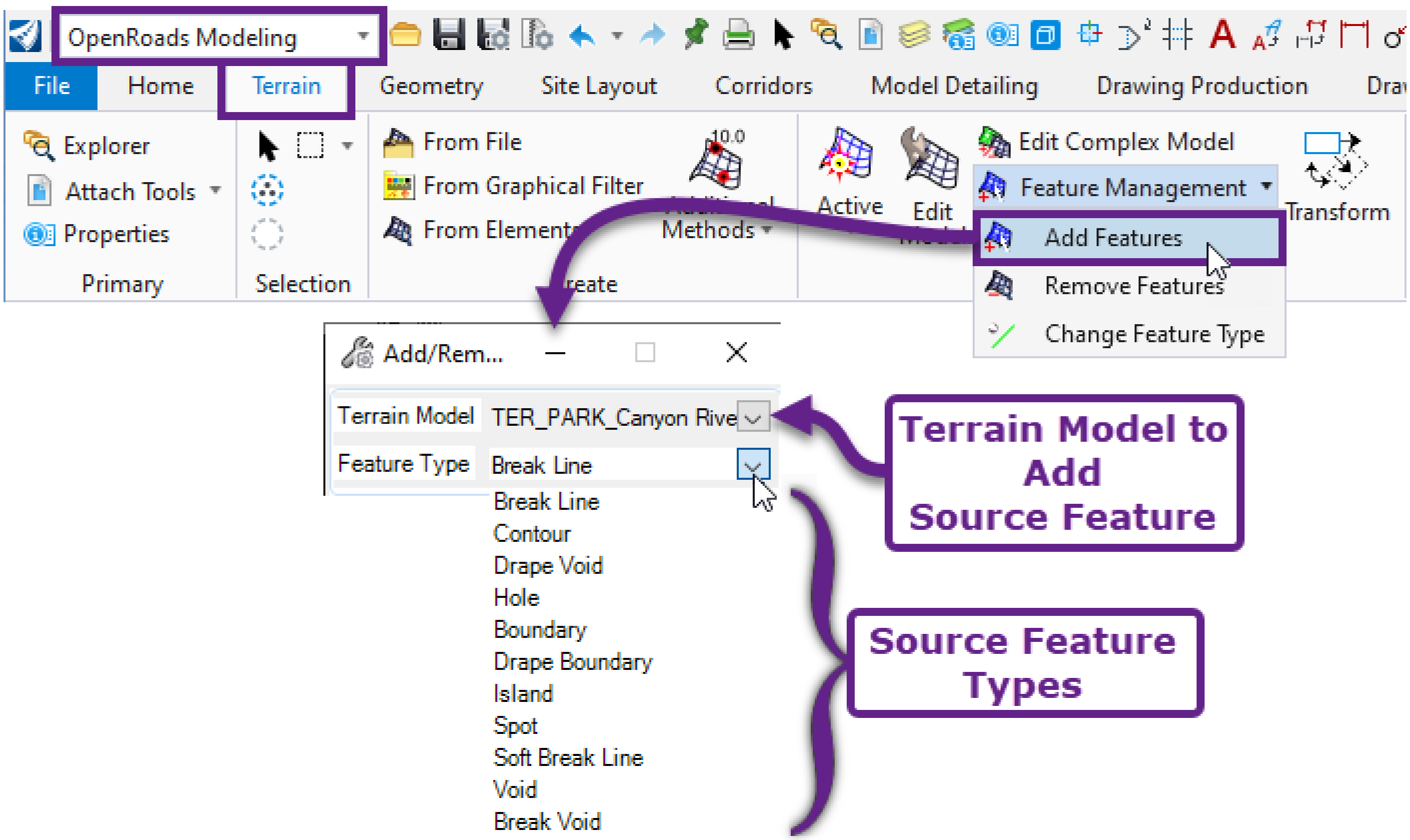
11B.4 Source Features and the Add Feature tool

Source Features are used to grade the interior elevations of a Terrain Model. When a *Source Feature* is added to a Terrain Model, the triangulation is altered. Triangle Vertices will be placed at geometrically important points along the *Source Features* (i.e., Deflection Points, PC and PVI points)

Source Features begin as User-Created Elements, most commonly *3D Linear Elements* (which could very well be a 2D Element with an Active Profile). However, *ORD Points* (see *7D.4 Points*) can be added to a Terrain Model to create *Source Feature* in the form of a *Spot* (elevation). A *Spot* (elevation) could be used to create a high or low point in a Terrain Model, which is shown in *11C.7.b Place a Low Spot in the Terrain Model with and ORD Point*.

***Source Features* are added to a Terrain Model with the *Add Feature* tool.** The table below lists all the *Source Feature* types that are compatible with the *Add Feature* tool.

For a visual representation of the most common *Source Features*, see *11B – Proposed Terrain Model Basics*.



Source Feature Types	
Options:	**Description:**
Break Line	A Break Line must be created from a 3D Linear Element (or a 2D Element containing an Active Profile). Break Lines are placed in the interior of a Terrain Model to capture an abrupt change in slope. For example, a Break Line could be used to create a ridge or swale on the inside the parking lot Terrain Model. If Break Lines are NOT used for a Terrain Model, then the inner slopes and elevations are interpolated from the elevation Profile of the Boundary element. In other words, if Break Lines are NOT used, then the interior of the Terrain Model is "straight graded" from the exterior Boundary elevations. An example of a Break Line being added to a Terrain Model is shown in *11C.4.b Create a Break Line to serve as a Ridge or Swale*.
Contour	A Contour must be created from a 3D Linear Element. The 3D Linear Element must be at a constant elevation (i.e., the Elevation along entirety of the 3D Linear Element is a single value.) Contours are typically added to a proposed Terrain Model to manually smooth out a contour that is shown to jagged or not exactly in the intended position. However, the User can use this Feature to manually draw and define all proposed contours for the interior of a Terrain Model. An example of a Contour being added to a Terrain Model is shown in *11C.4.c Smooth Jagged Contours with Imported Contours*.
Drape Void	A Drape Void must be created from an **enclosed 2D** Linear Element. A Drape Void will create a gap (or void) in the Terrain Model. In essence, the enclosed 2D Linear element is *draped* or projected onto the Terrain Model and a *void* is created. The Terrain Model elevation along the perimeter of the void is the unaffected by the addition of the Drape Void. An example of a Drape Void being added to a Terrain Model is shown in *11C.4.a Landscaped Islands (Voids in the Terrain Model).*
Hole	A Hole must be created from an **enclosed 3D** Linear Element. A Hole operates nearly identically to a Void – as they both create a gap in a Terrain Model. The difference between Holes and Voids is only apparent when two different - but overlapping Terrain Models are merged with the *Create Complex Terrain Model* tool. If the first Terrain Model contains Holes – then the overlapping terrain information from the second Terrain Model will fill in the Holes (which means the gaps are filled). Conversely, if the first Terrain Model was built with Voids, then the second Terrain Model will not fill in the Voids (which means the gaps are NOT filled when the Terrain Models merge). It is recommended that Break Voids or Drape Voids are used to create gaps in a Terrain Model.
Boundary	A Boundary must be created from an **enclosed 3D** Linear Element. The Boundary is used to clip a Terrain Model. Similar to a Break Line, the elevation of the Boundary will be incorporated into the Terrain Model. If a Drape Boundary is used, then the Drape Boundary elevation will NOT be incorporated into the Terrain Model. The creation of Boundaries is discussed in *11C.2 Create the Terrain Model Boundary Geometry*.

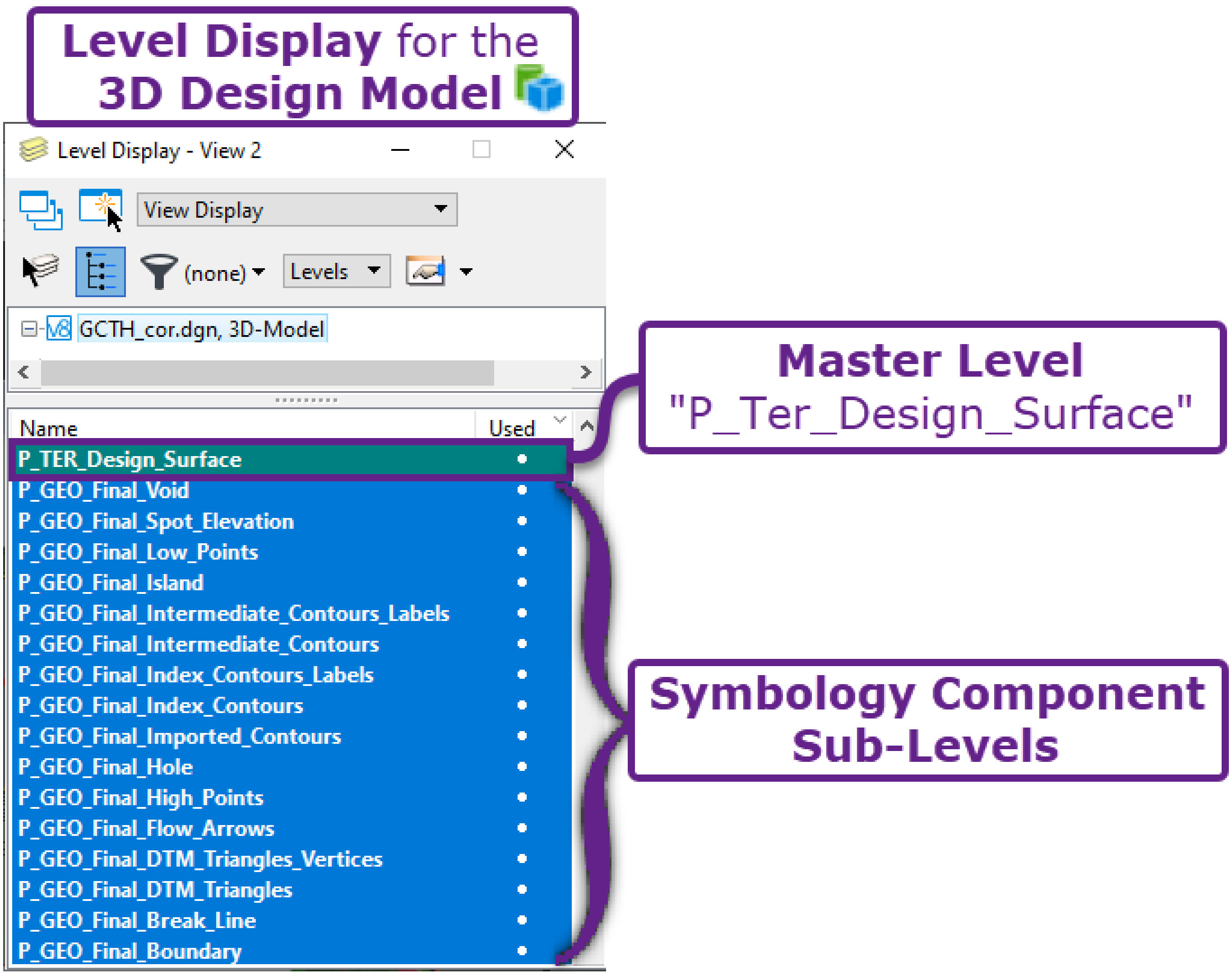
Source Feature Types	
Options:	**Description:**
Drape Boundary	This Feature is confirmed as broken – but is still useable through workarounds. This Feature is used to add a new Boundary to a Terrain Model. Similar to a Drape Void, the Terrain Model elevation is unaffected along the perimeter of the new Drape Boundary. This tool is broken because even though the elevation of the Terrain Model is unaffected, this tool only operates by selecting a 3D Linear Element. This can be worked around by drawing the Drape Boundary as a 2D Linear Element in the *2D Design Model* . Next, create a "dummy" Profile (i.e., set the profile at a constant elevation of 0) for the Drape Boundary. *Activate* the Profile, which will create a 3D Linear Element in the *3D Design Model* . ***IMPORTANT WORKAROUND:*** For this Feature to function, the User must **pre-select** the 3D Linear Element (from the *3D Design Model*) before using the *Add Features* tool. If the Drape Boundary element is not **pre-selected**, then the following error message is shown: "Drape Boundary will Intersect itself".
Island	An Island must be created from an **enclosed 3D** Linear Element. An Island should only be used for Terrain Models that contain a Hole or Void. The Island Feature is used to create an isolated (island) piece of the Terrain Model that is encapsulated within the Void or Hole.
Spot (Elevation)	A Spot (or Spot Elevation) must be created from a Point element. The Point element must contain an elevation value. The creation of *Points* is discussed in *7D.4 Points*. The Spot Feature is used to a single Spot Elevation to the Terrain Model. An example of a *Spot* being added to a Terrain Model is shown in *11C.7.b Place a Low Spot in the Terrain Model with an ORD Point.*
Soft Break Line	A Soft Break Line must be created from a 3D Linear Element. A Soft Break Line operates identically to Break Line under normally circumstances. The difference between a Break Line and a Soft Break Line is only apparent when these two Feature Types intersect. When these two features cross paths, the Soft Break Line will not affect the Terrain Model in the immediate vicinity of the intersection. Essentially, a Break Line has priority over a Soft Break Line.
Void	A Void must be created from an **enclosed 3D** Linear Element. A Void is a method for creating a gap in a Terrain Model. It is recommended to avoid using Voids because the Terrain Model will NOT triangulate at the Profile geometry points (VPI, VPC, VPT, etc..) of the Void element. Instead, Break Voids (3D) or Drape Voids (2D) should be used to create gaps in a Terrain Model.
Break Void	A Break Void must be created from an **enclosed 3D** Linear Element. A Break Void is the preferred way to create a gap in a Terrain Model. A Break Void will triangulate at all Profile geometry points contained in the Break Void element.

11B.5 Level Management for Terrain Models

The Level management scheme for Terrain Models must be understood for correct display of Terrain Model graphics and Symbology Components in the Plan Sheets.

Master Level: Proposed Terrain Models have a single *Master Level*, which is named "P_Ter_Design_Surface". Toggling ON/OFF this level will turn ON/OFF all Terrain Model graphics.

Symbology Components Sub-Levels: Each type Symbology Component (i.e., Contours, Labels, Flow Arrows) is assigned to a unique sub-level. For example, the minor contours for are assigned to the "P_GEO_Final_Intermediate_Contour" Level. This Level can be toggled ON/OFF to turn on/off the display of minor contours.



The following table describes and lists all the Levels used in a proposed Terrain Model:

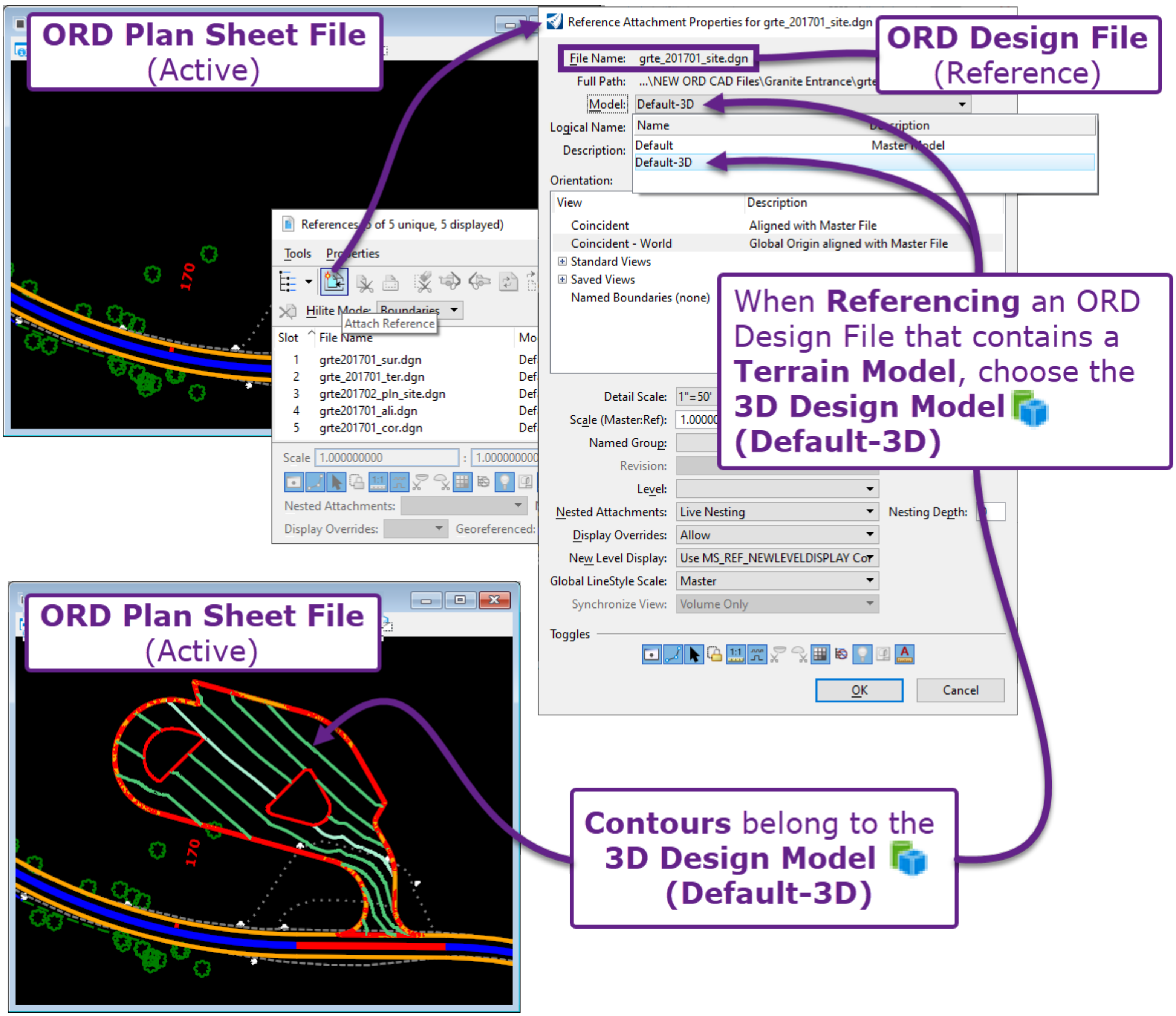
Symbology Components Levels and Descriptions			
Symbology Type:		**Level:**	**Description:**
Master Level		"P_Ter_Design_Surface"	Controls global display of the Terrain Model and all Symbology Component Sub-Levels
Calculated Feature Display	**Major Contours**	"P_GEO_Final_**Index_Contours**"	Displays Major Contours.
	Minor Contours	"P_GEO_Final_**Intermediate_Contours**"	Displays Minor Contours.
	Triangles	"P_GEO_Final_**Triangles**"	Displays the Triangles of a Terrain Model (also referred to as Triangulation)
	Spots	"P_GEO_Final_**Triangles_Verticies**"	Displays an X-mark and Elevation for the Vertex of each Triangle
	Flow Arrows	"P_GEO_Final_**Flow_Arrows**"	Denotes the drainage flow direction for the Terrain Model at a particular location.
	Low Points	"P_GEO_Final_**Low_Points**"	Displays an X-mark and Elevation for localized Low Points in the Terrain Model
	High Points	"P_GEO_Final_**High_Points**"	Displays an X-mark and Elevation for localized High Points in the Terrain Model
Source Feature Display	**Breaklines**	"P_GEO_Final_**Break_Line**"	Highlights and displays where Break Lines have been applied to the Terrain Model by the User.
	Boundary	"P_GEO_Final_**Boundary**"	Highlights and displays the Boundary of the Terrain Model.
	Imported Contours	"P_GEO_Final_**Imported Contours**"	Highlights and displays the Imported Contours that were applied to the Terrain Model by the User.
	Islands	"P_GEO_Final_**Island**"	Highlights and displays the Islands that were applied to the Terrain Model by the User.
	Holes	"P_GEO_Final_**Hole**"	Highlights and displays the Holes that were applied to the Terrain Model by the User.
	Voids	"P_GEO_Final_**Void**"	Highlights and displays the Voids that were applied to the Terrain Model by the User.
	Feature Spots	"P_GEO_Final_**Spot_Elevation**"	Highlights and displays the Spot Elevations (Points) that were applied to the Terrain Model by the User.

11B.6 Reference a Terrain Model (Contours) into an ORD Plan Sheet File

This section discusses the procedure for showing Major/Minor Contours (from a Terrain Model) as reference in an ORD Plan Sheet File.

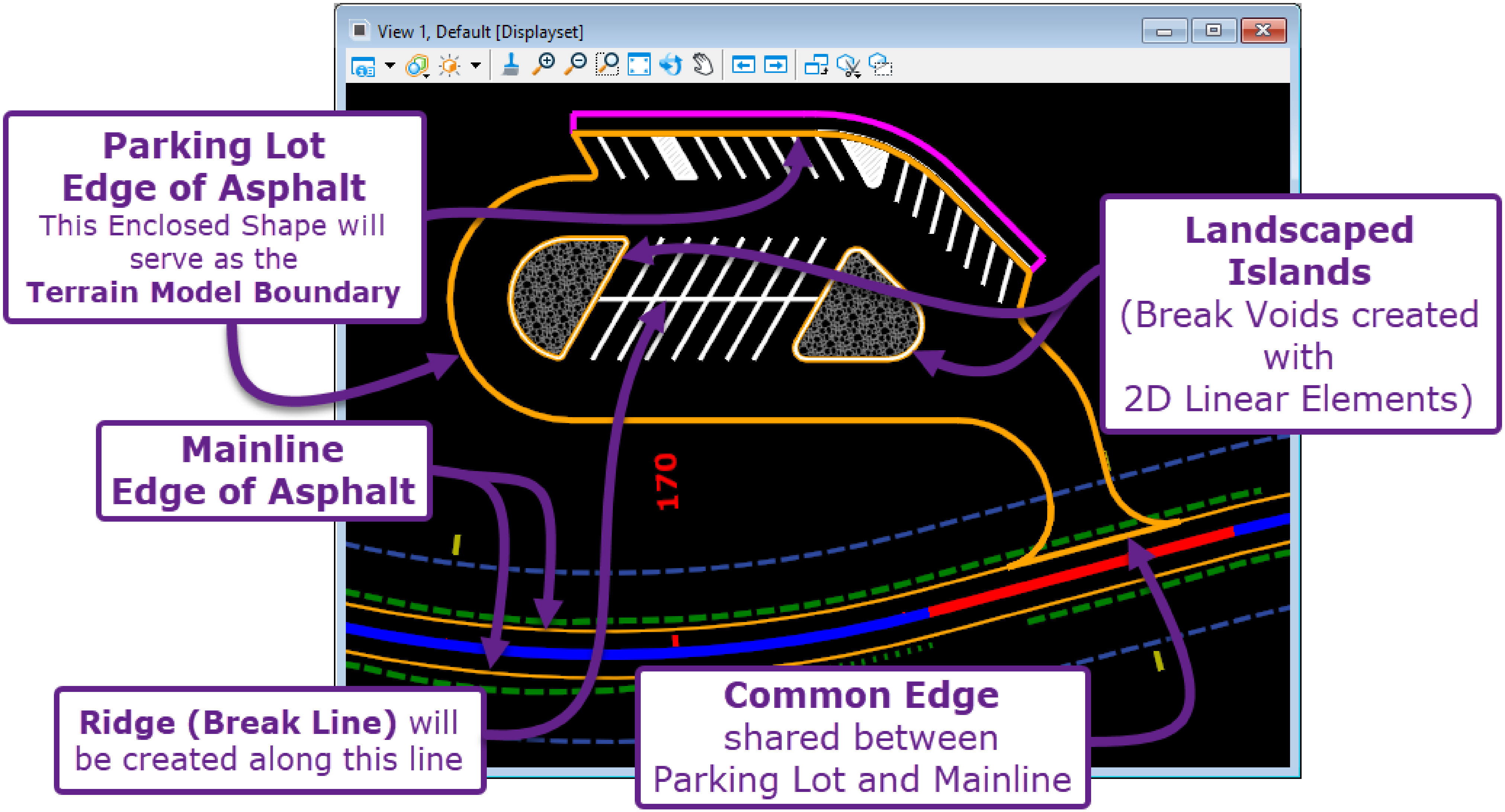
Terrain Models and Symbology Components (i.e., Major/Minor Contours) are 3D Elements that are created and belong to the *3D Design Model*. To show Terrain Model features in Plan Sheets, the User must reference the *3D Design Model* into the ORD Plan Sheet File.

To see Contours and Terrain Model features, choose the *3D Design Model* from the *Model* drop-down when making the Reference.



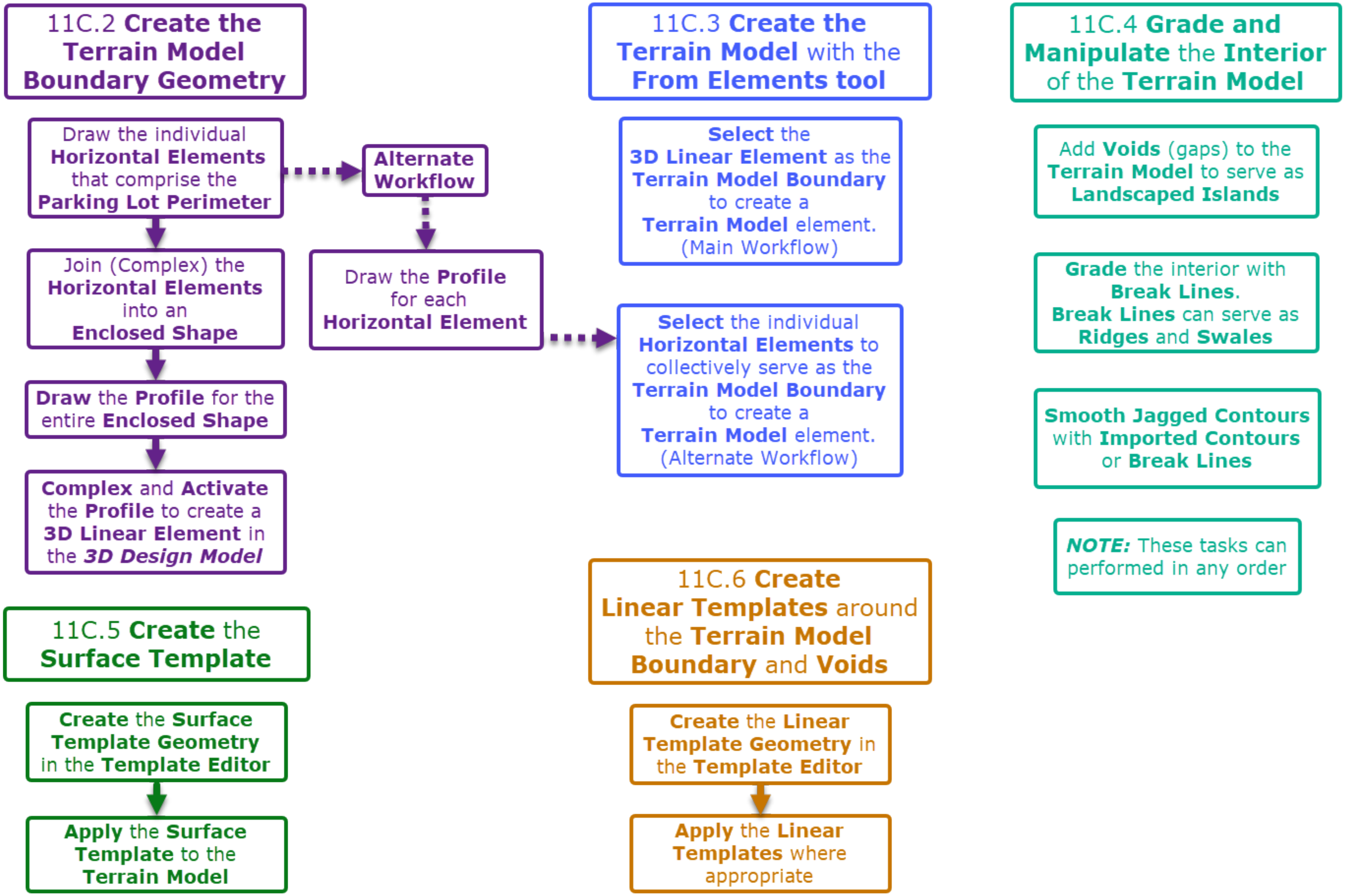
11C – PARKING LOT – ADVANCED SITE MODELING WORKFLOW

This section demonstrates techniques and processes for creating a parking lot Terrain Model. In this example, a Terrain Model will be created to represent the finished grade of the asphalt parking lot. Advanced techniques will be used to create landscape islands (Break Voids) and a ridge (Breakline) in the Terrain Model. Next, a Surface Template will be applied to the Terrain Model to represent the pavement section of the parking lot.



11C.1 Flow Chart for Creating Parking Lot Terrain Models

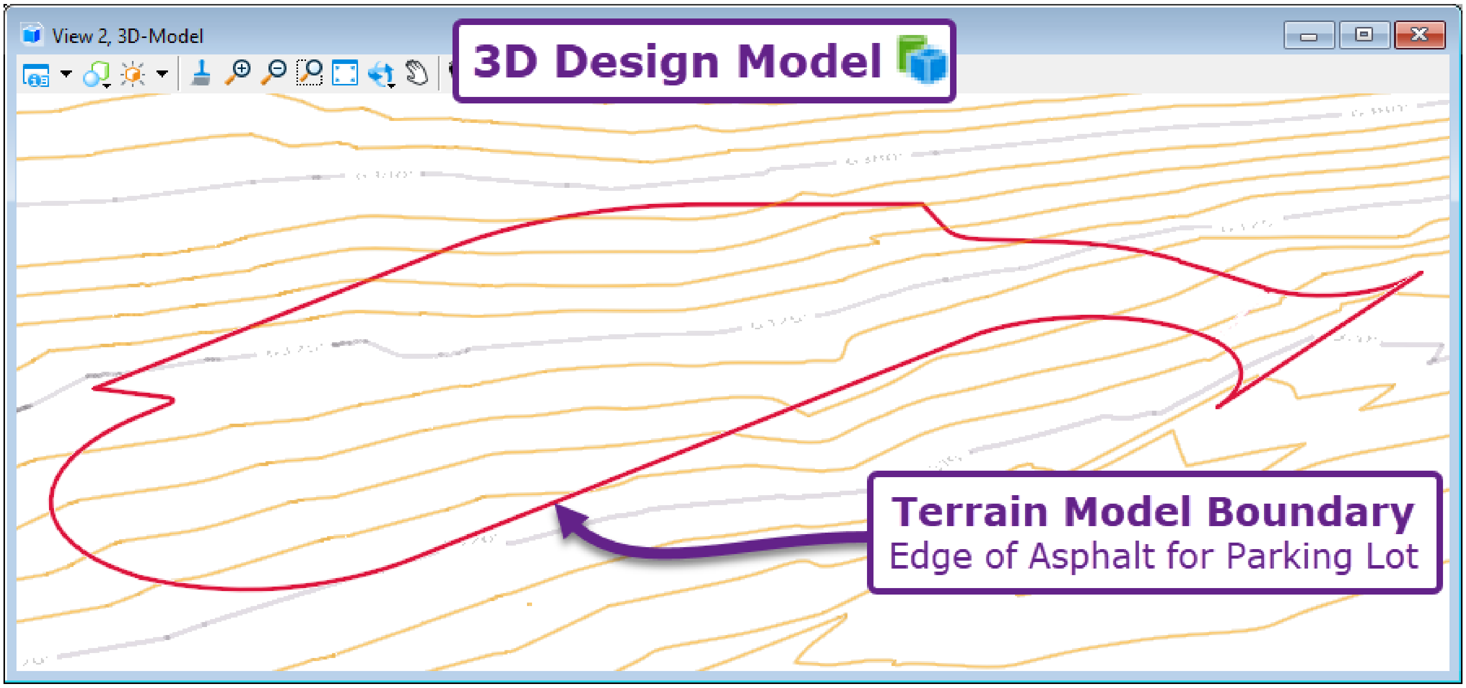
The flow-chart below outlines the major process in the creation of a Terrain Model that represents a Parking Lot.



11C.2 Create the Terrain Model Boundary Geometry

In this step, the User will draw the individual elements that comprise the Terrain Model Boundary. In this case, the Terrain Model Boundary is representative of the asphalt perimeter of the parking lot.

What is a Terrain Model Boundary? – In the simplest terms, a Terrain Model Boundary is an enclosed 3D element. However, a Terrain Model Boundary can also be comprised of several individual 3D Elements – assuming that together, the individual elements form a continuous and enclosed 3D shape.



What Design Model to draw the Terrain Model Boundary in? – The end result must be an enclosed 3D element shown in the *3D Design Model*. However, the User will draw the footprint of the Terrain Model Boundary in the *2D Design Model* and define the elevation profile of the Terrain Model Boundary in the *Profile Model*.

11C.2.a Draw the Horizontal Elements for the Terrain Model Boundary

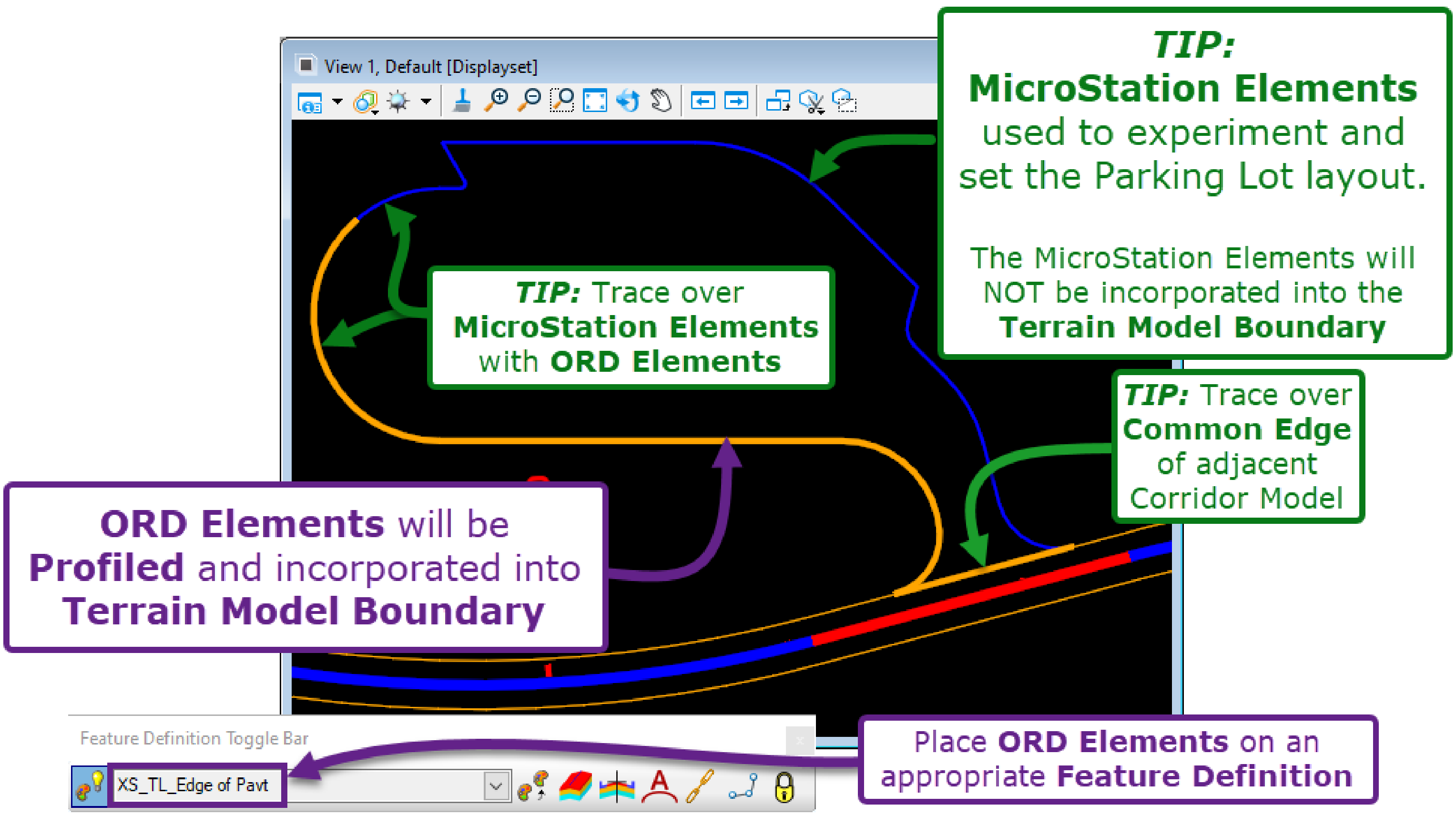
In this step, the horizontal layout of the Terrain Model Boundary will be drawn in the *2D Design Model*. The horizontal components of the Terrain Model Boundary are typically created with Horizontal ORD tools. MicroStation tools – such as *SmartLines* – can also be incorporated into the Terrain Model Boundary.

TIP: One common and suggested method for the drawing of abmorally shaped parking lots is to experiment with the Parking Lot layout using **MicroStation tools** – such as *Place SmartLines, Place Line, Construct Circular Fillet,* and *Place Arc*. After MicroStation Elements have been placed, the User can trace over with Horizontal ORD Tools. However, this method is not strictly necessary. An abnormally shaped parking lot can be drawn with Horizontal ORD Tools. However, Horizontal ORD Tools can be clunky and often become disjointed (gaps between segments) when manipulated in later stages of the design.

BEST PRACTICE: After drawing the outline of a Parking Lot or other site modeling feature – whether accomplished with Horizontal ORD Tools or MicroStation tools – use the *Complex By Elements* tool to join the individual components into a single Enclosed Shape. ***IMPORTANT:*** After using the *Complex By Elements* tool, use the *Simplify Geometry* tool on the Enclosed Shape. See *7C.3.b Simplify Geometry Tip*. *Simplifying* the geometry allows the Enclosed Shape to behave in a very perticable manner when PIs and other geometrical components are manipulated.

For more information on drawing with Horioznital ORD Tools, see *Chapter 7 – Geometry*. For more information on drawing with MicroStation tools, see *Chapter 6 – Drawing Tools*.

TIP: When planning for the horizontal layout – look for common edges that will be shared between the Terrain Model and other 3D Modeling features. In this example, the Parking Lot Terrain Model shares a common edge with the Edge of Road for the Mainline Corridor. This common edge occurs at the approach of the Parking Lot. Use *Key Point*, *Nearest*, and *Intersection Snaps* to snap to the common edge.

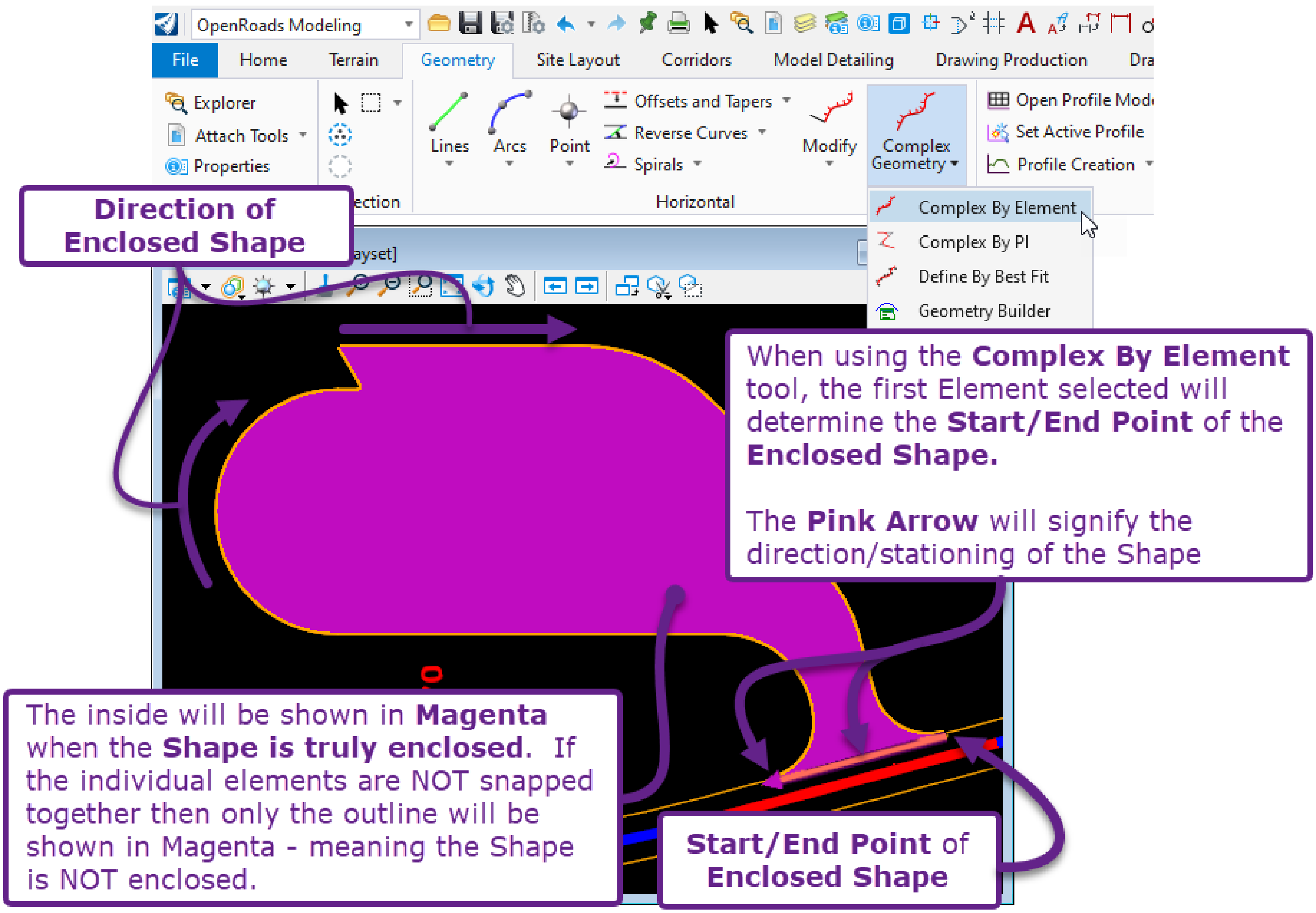


11C.2.b Join the Horizontal Elements into a Single Enclosed Shape

In this step, the individual Horizontal Elements are joined into a single, Enclosed Shape using the *Complex By Elements* tool .

For more information on the *Complex By Element* tool, see in *7D.2.a Complex By Element tool*.

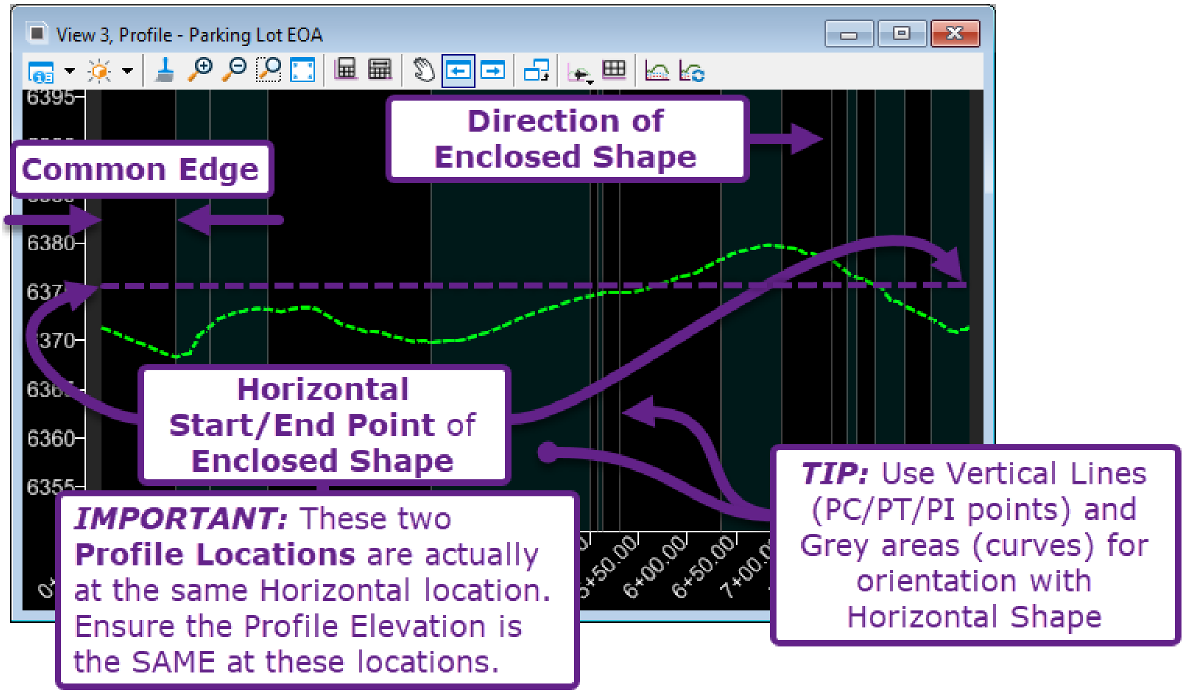
TIP: When using the *Complex By Element* tool, choose a logical Start/End Point and direction for the Enclosed Shape. The Start/End Point will serve as a "landmark" when creating the Profile in the next step. When drawing Profile elements, the User should be oriented and aware of the upstation direction of the Enclosed Shape.



11C.2.c Create the Profile for the Enclosed Shape

This step is performed within the *Profile Model* of the Enclosed Shape (Terrain Model Boundary). For more information on Vertical ORD Elements (Profile Elements), see *7F – Create Vertical ORD Elements*.

TIP: As explained in the graphic below, the start and end points for the Enclosed Shape should be placed at the same elevation. For an Enclosed Shape, the start and end points are positioned in the same horizontal location.

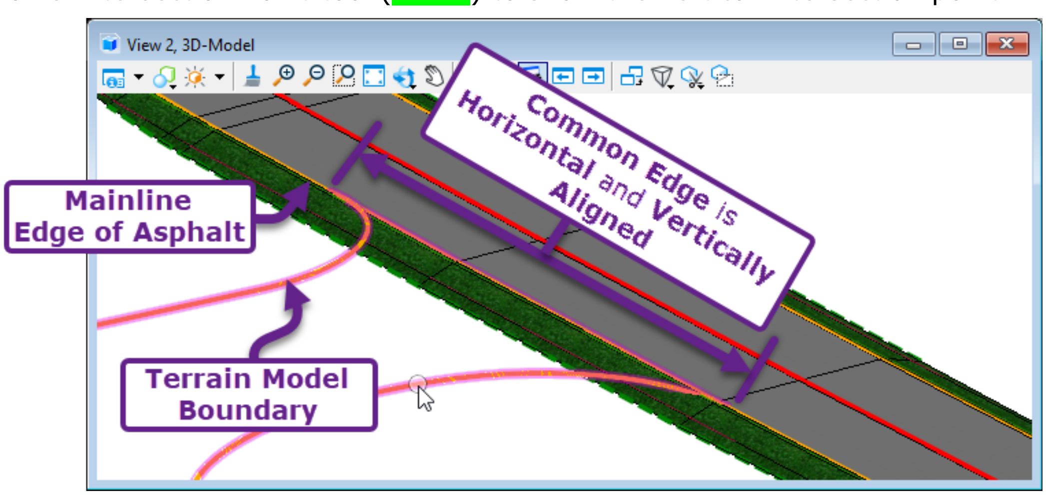


11C.2.c.i Project Profile Information for Features that Intersect or Share an Edge

In Site Modeling design, it is crucial that the Terrain Model Boundary is vertically aligned along the common edge of the adjacent feature. The *Project Profile Range To Element* and *Profile Intersection Point* tools can be used to Vertically align Site-Modeling features that share a common edge or intersect.

When the Terrain Model Boundary shares a common edge with an adjacent modeling feature, use the *Project Profile Range To Element* tool (*7F.4.d*). This tool can transfer the Profile data from the adjacent modeling feature directly into the *Profile Model* of the Terrain Model Boundary.

TIP: If the Terrain Model Boundary intersects an adjacent modeling feature at a single point location, then use the *Profile Intersection Point* tool (*7F.4.f*) to show the vertical intersection point.

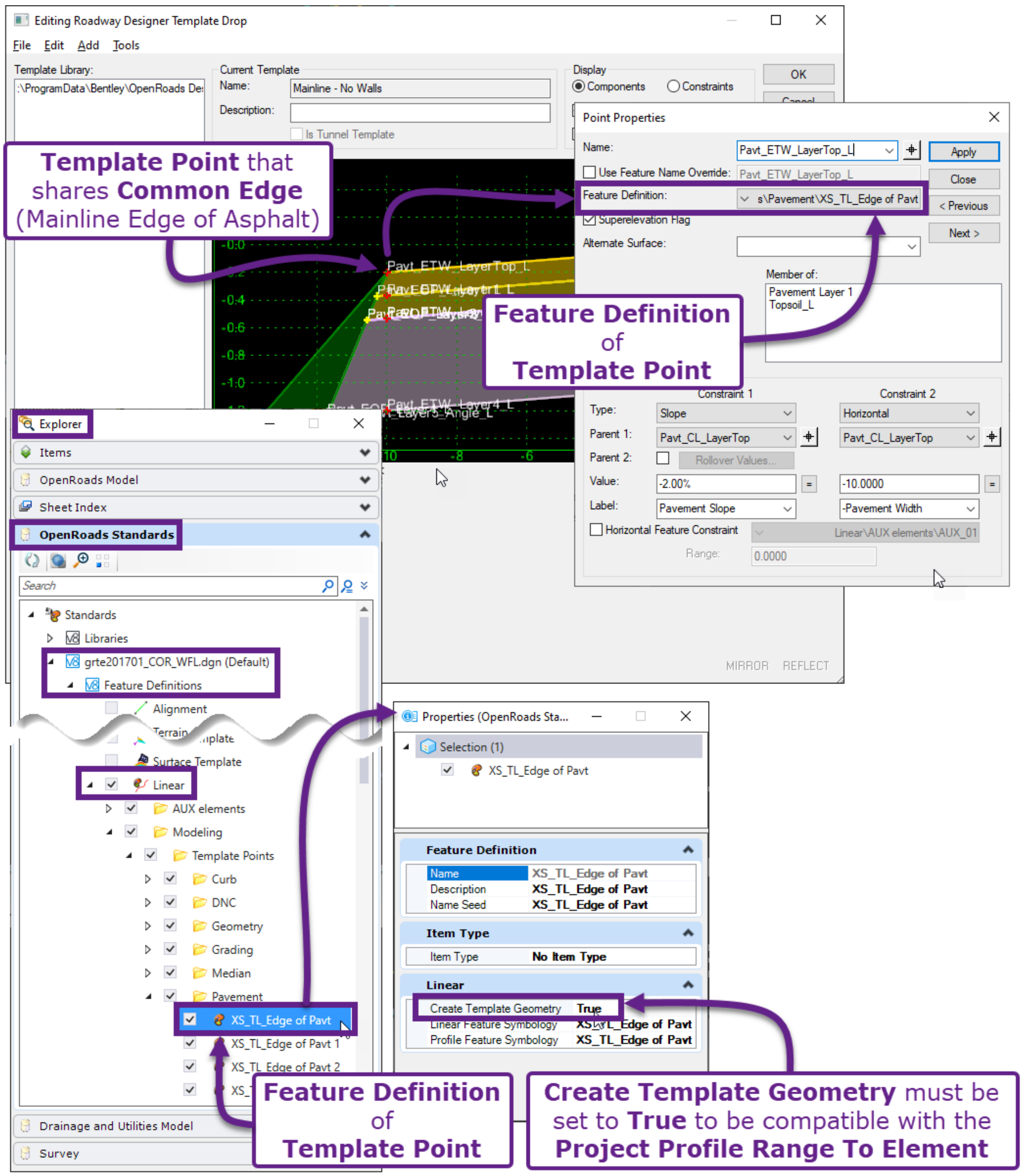


11C.2.c.ii Projecting Profile Information WARNING

The "Profile Projection" tools (i.e. *Project Profile Range To Element* tool and *Profile Intersection Point* tool) are ONLY compatible with Corridor *Complex Elements* that are created in the *2D Design Model*. This means that the Corridor **Template Point** must be placed on a **Feature Definition** that has the **Create Template Geometry** property set to **True**. See *9C.4.a.i Modify a Feature Definition to Create 2D Complex Element.*

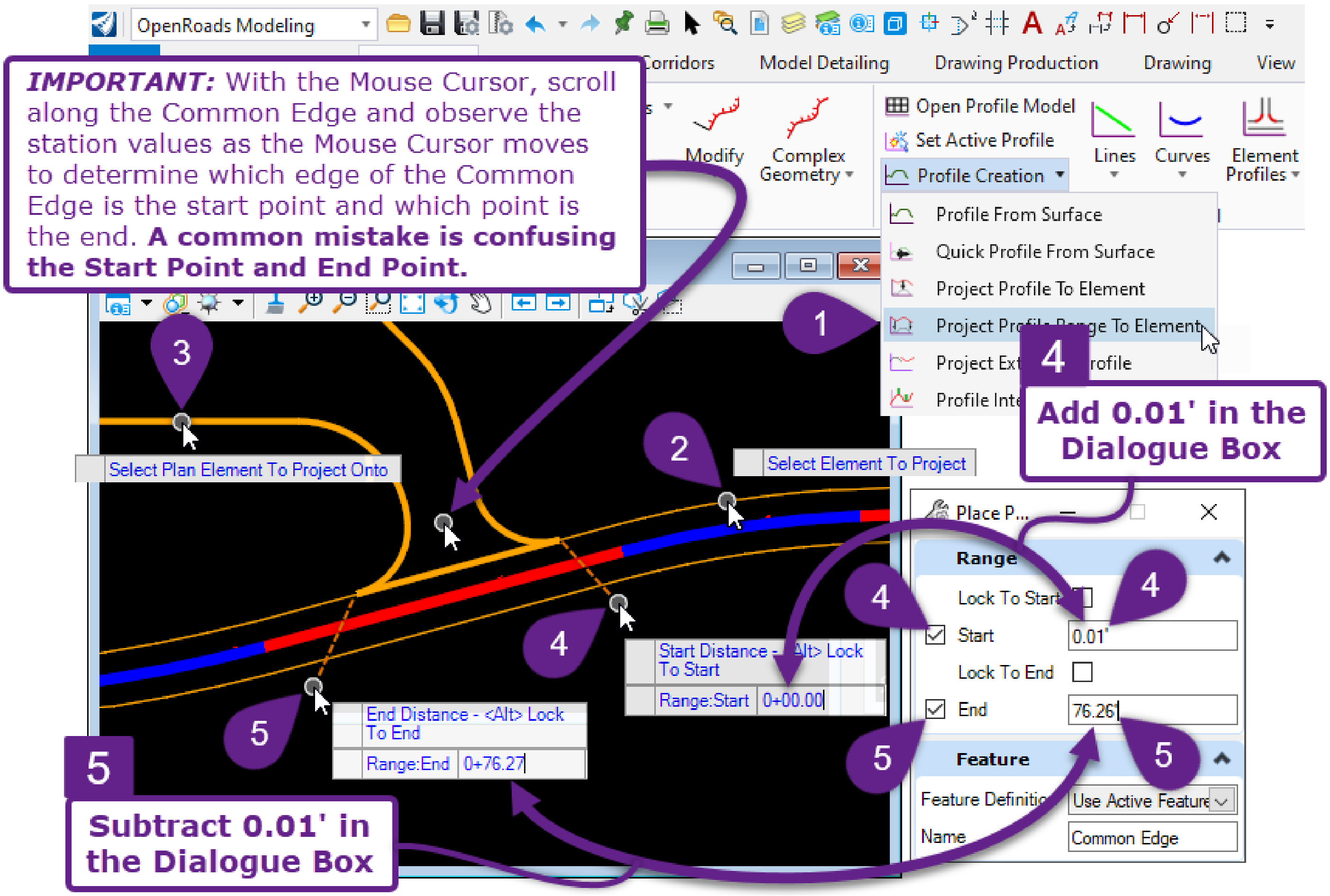
The "Profile Projection" tools are not compatible with Corridor 3D Linear Elements (i.e., Corridor linework that is created in the *3D Design Model*). For more information on Corridor Complex Elements vs 3D Linear Elements, see *9C.3 2D Complex Elements vs 3D Linear Elements*.

The graphic below shows the **Feature Definition** of the Corridor **Template Point** that serves as the Common Edge (found in the Template Point Properties). The **Feature Definition Property Settings** can be viewed in the **Explorer**.



11C.2.c.iii Project Profile Range to Element tool for Common Edges

WARNING: This tool will often "misfire" and is apt to draw the Projected Profile in the wrong location. This often happens when the User selects the Station Range in a graphical manner. To address this issue, manually type and lock in the Station Range with a slightly different value. This technique is shown in Steps 5 and 6.



1	Select the Project Profile Range To Element tool from the Ribbon. Ribbon Location: **OpenRoads Modeling** workflow → **Geometry** tab → **Vertical** panel.
2	Prompt: Select Element To Project – In this case, the **Mainline Edge of Asphalt** is the element that will be projected.
3	Prompt: Select Plan Element To Project Onto – In this case, the **Terrain Model Boundary** is the element that will receive the projection.
4	Prompt: Start Distance - <Alt> Lock To Start – Place the Mouse Cursor near the start point, but do NOT accept the value shown in the Floating Dialogue Box. Instead, enter the Start Point value into the Dialogue Box and **add 0.01'** to the Start Point Value. Lock the value and Left-Click in the view to advance to the next prompt. **Notice** in the graphic above, the **Start Point** value in the Floating Dialogue box is **0+00.0** – but a value of **0.01'** was entered into the Dialogue Box.
5	Prompt: End Distance - <Alt> Lock To End - Place the Mouse Cursor near the end point to determine the station. Similar to Step 4, enter the End Point value into the Dialogue Box but **subtract 0.01'** to the End Point value. Left-Click in the view to finish the command. **Notice** in the graphic above, the **End Point** value in the Floating Dialogue box **is 0+76.27** – but a value of **76.26'** was entered into the Dialogue Box.

11C.2.c.iv Draw the Remainder of the Profile Elements for the Enclosed Shape

In this step, the remainder of the Profile is drawn around the *Projected Profile* (created in the previous step). When drawing Profile for Site Modeling features the following concepts should be considered:

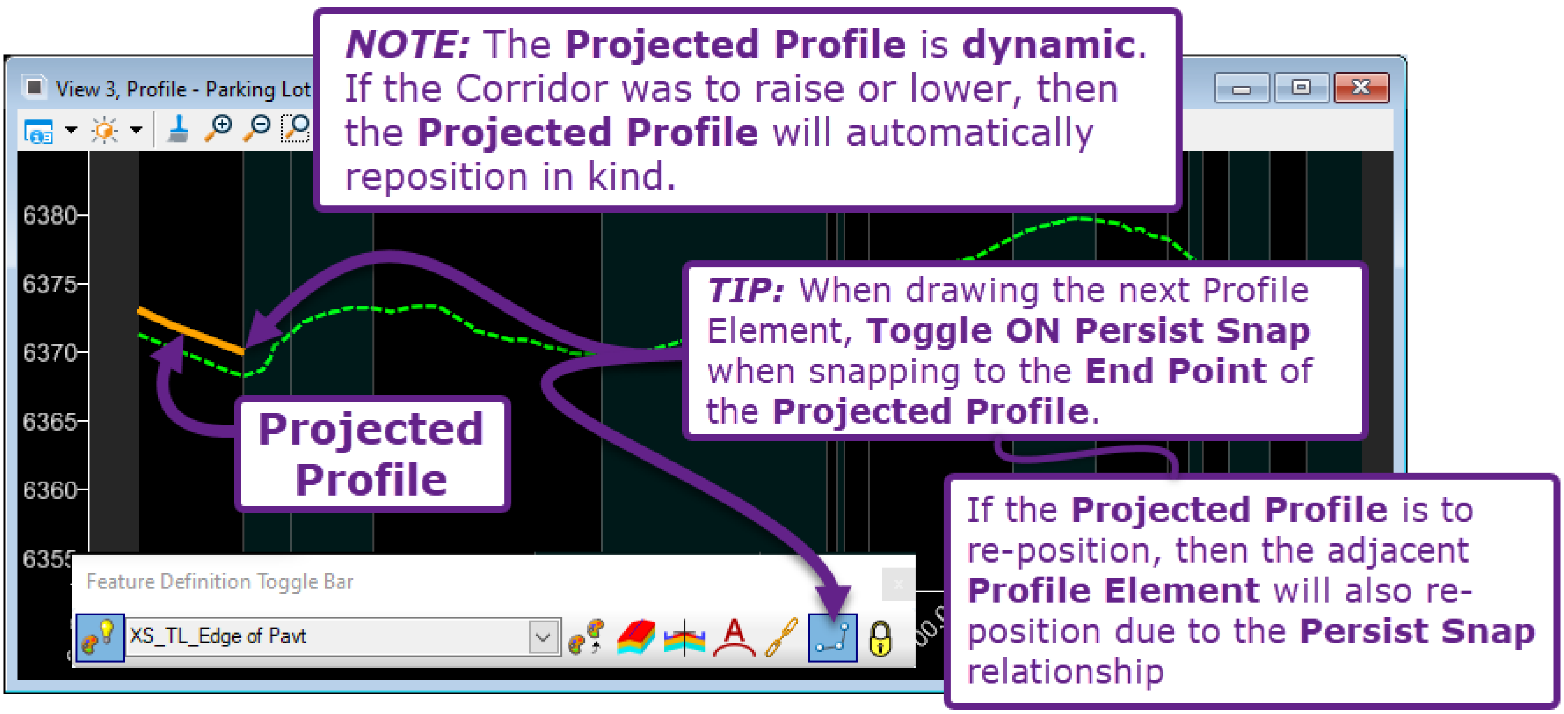
- For Enclosed Shapes, the Start Point and the End Point in the Profile Model are at the same Horizontal Location. Therefore, the Start Point and End Point must be placed at the same Elevation. The Start Point and End Point elevation can be coordinated using *Civil AccuDraw* and *Persist Snaps*, which is shown on the next page.

- For Site Modeling features, it is often **unnecessary to draw vertical curves** between tangent segments. For Terrain Model Boundaries, it is advised to keep the Profile relatively simple by mainly drawing with Line-Line segments. For Terrain Model Boundaries, vertical curves can be problematic when adjacent line segments and Project Profiles are edited.

- The Start Point of each individual Profile Element should be *Snapped* to the End Point of the Previous element. The entire Profile must be continuous.

- *Persist Snaps* should be toggled ON when creating Line-Line segments. *Persist Snaps* should be placed on the Start/End Point of each Line-Line segment to keep the Profile from "breaking" or "disjointing" when a PVI (deflection point) is edited.

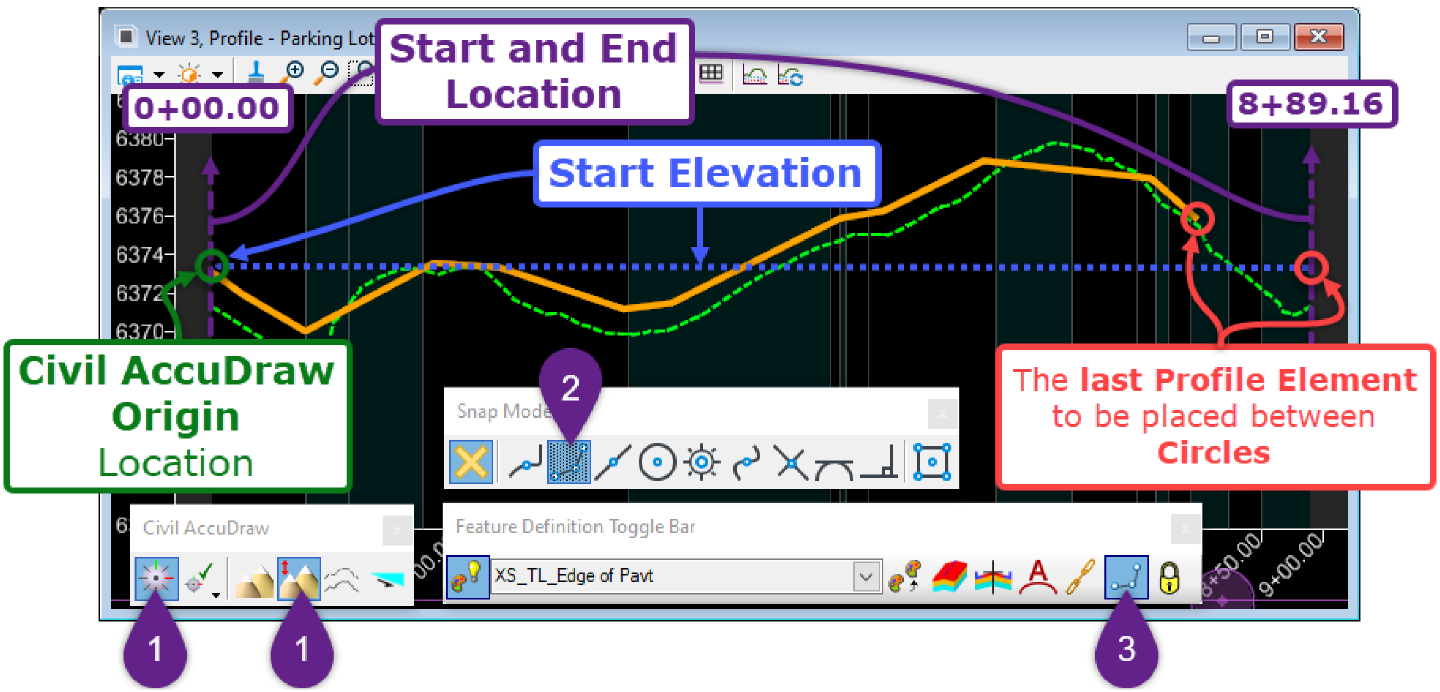
- *Persist Snaps* can be very useful when creating Profiles for Site Modeling features – especially when connecting to *Projected Profiles* – which is explained in the graphic below.



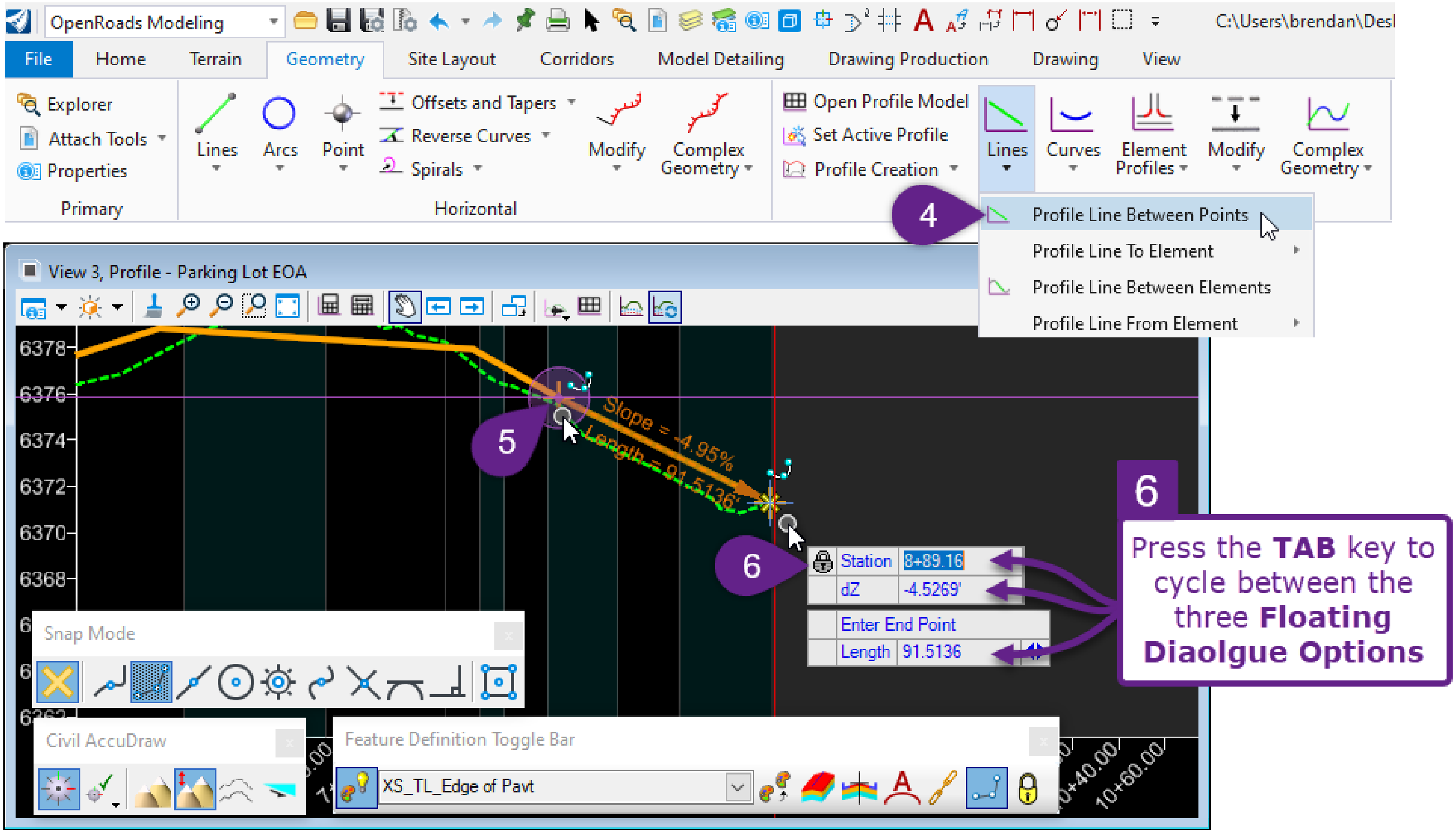
11C.2.c.v Lock the End Point to the Elevation of the Start Point with Civil AccuDraw

In this workflow, *Civil AccuDraw* and *Persist Snaps* are used to dynamically lock the elevation of the Profile End Point to the elevation of the Start Point. For Enclosed Shapes, the Start and End Points are at the same Horizontal Location, so they need to be placed at the same Elevation. This workflow ensures that End Point remains dynamically locked to the Start Point, even when the Start Point changes elevation.

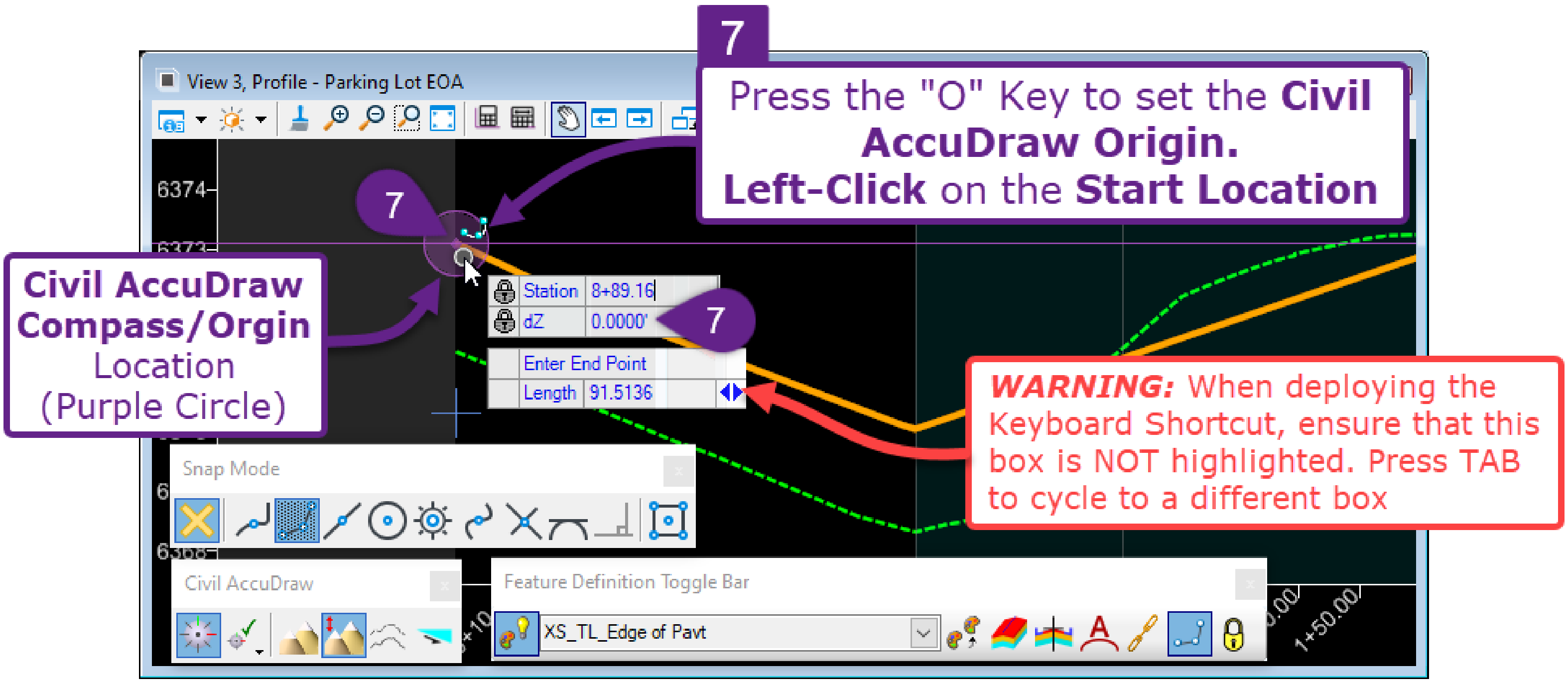
WARNING: In this workflow, the User must manually set the *Civil AccuDraw* ***Origin***. The only way to manually set the *Civil AccuDraw* ***Origin*** is with a Keyboard Shortcut. By default, the *Civil AccuDraw* ***Origin*** is set by pressing the "O" key and then Left-Clicking at the desired ***Origin*** location. However, if the User has customized Keyboard Shortcuts, then the "O" key may be set to a different tool or command. See *Chapter 4 – User Preferences and Software Interface Setup* for more information on setting Keyboard Shortcuts.



1	Toggle ON the **Civil AccuDraw** tool. Ribbon Location: **OpenRoads Modeling** workflow → **Geometry** tab → **General Tools** panel. In the Civil AccuDraw toolbar, toggle ON the **dZ** (delta Z) mode.
2	Toggle ON the **Key Point** Snap Mode. For more information on *Snaps*, see *7B.1 AccuSnap Settings.*
3	Ensure that **Persist Snaps** are toggled ON. **Persist Snaps must be toggled ON for this entire procedure.** For more information on Persist Snaps, see *7C.1 Persist Snaps.*



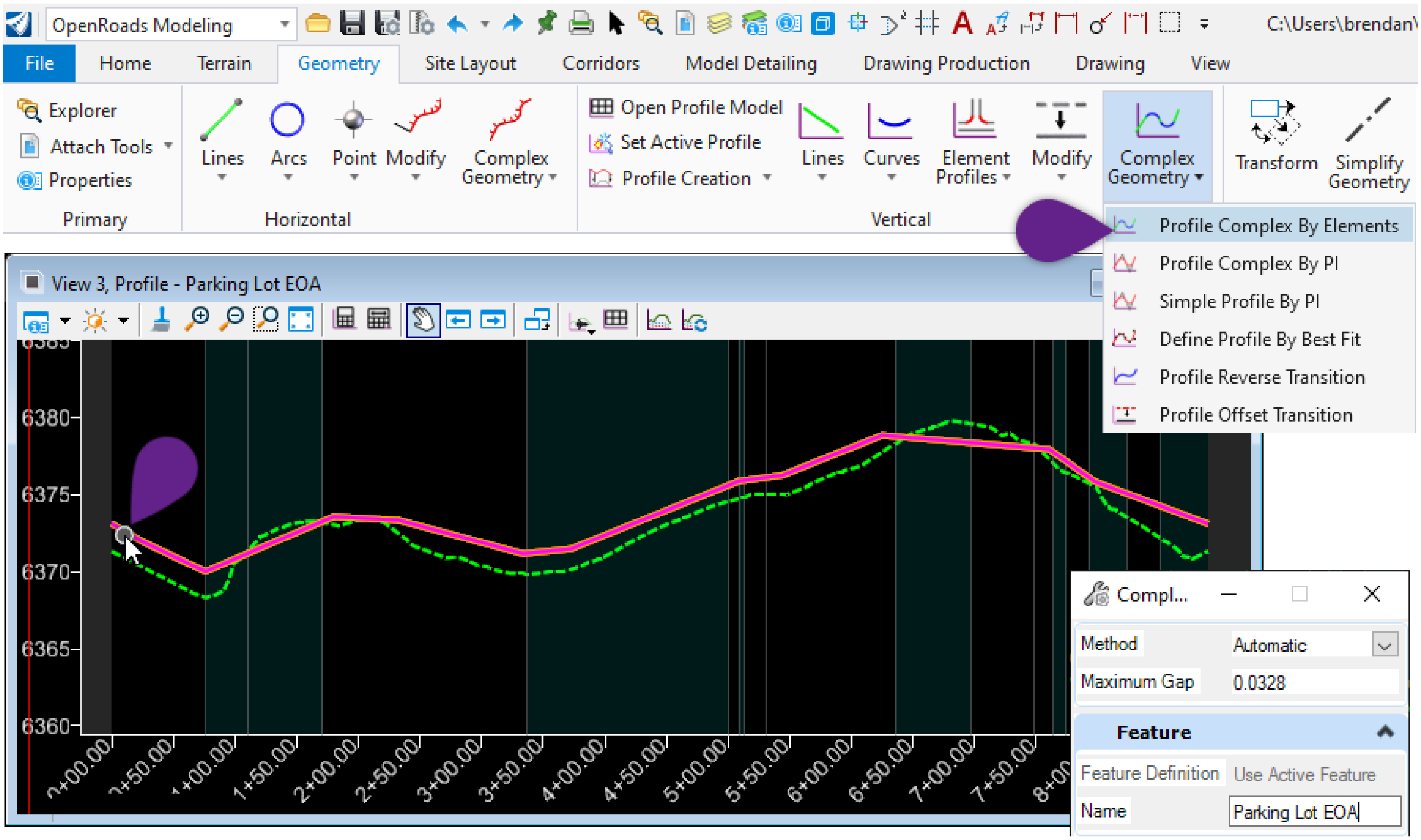
4	Select the *Profile Line Between Points* tool (*7D.1.a.i*). Ribbon Location: **OpenRoads Modeling** workflow → **Geometry** tab → **Vertical** panel.
5	*Snap* the Start Point of the new Line to the End Point of the adjacent Profile Element. Do NOT place the End Point until the following Civil AccuDraw steps have been performed
6	**Civil AccuDraw** – Lock the **Station** for the End Location. Press the TAB key to cycle between the different Floating Dialogue Box options. Press the TAB key until **Station** is highlighted. The End Location is easily determined and locked by hovering the Mouse Cursor at the very last Existing Ground vertex with the *Key Point* snap toggled ON. When the End Location station value is shown (in this case 8+89.16) correctly in the Floating Dialogue Box, press the ENTER key to lock.



	Civil AccuDraw – Set and lock the **dZ (delta Z)** value for the End Location. The **dZ (delta Z)** value is relative to the **Civil AccuDraw Origin**. In this case, the **dZ (delta Z)** between the Start Location and End Location should be 0.00. For this configuration, the **Civil AccuDraw Origin**, must be placed on the Start Location and the **dZ (delta Z)** is locked at 0.00.
7	To set the **Civil AccuDraw Origin**, press the "O" Key and the following *Prompt* will be presented: *Select a reference point or Reset to keep the currently selected one.* Left-Click on the Start Location. If this was performed correctly, the **Civil AccuDraw Compass (Origin)** will be shown at the Start Location. In the Floating Dialogue Box, lock the **dZ (delta Z)** value at 0.00. Press the TAB Key until the **dZ (delta Z)** value is highlighted. Key-in 0.00 and press enter to lock this value.
8	If the **Station** and **dZ (delta Z)** are locked 🔒 and the **Civil AccuDraw Compass (Origin)** is shown in the correct location, then Left-Click anywhere in the *View* to place the Profile Line.

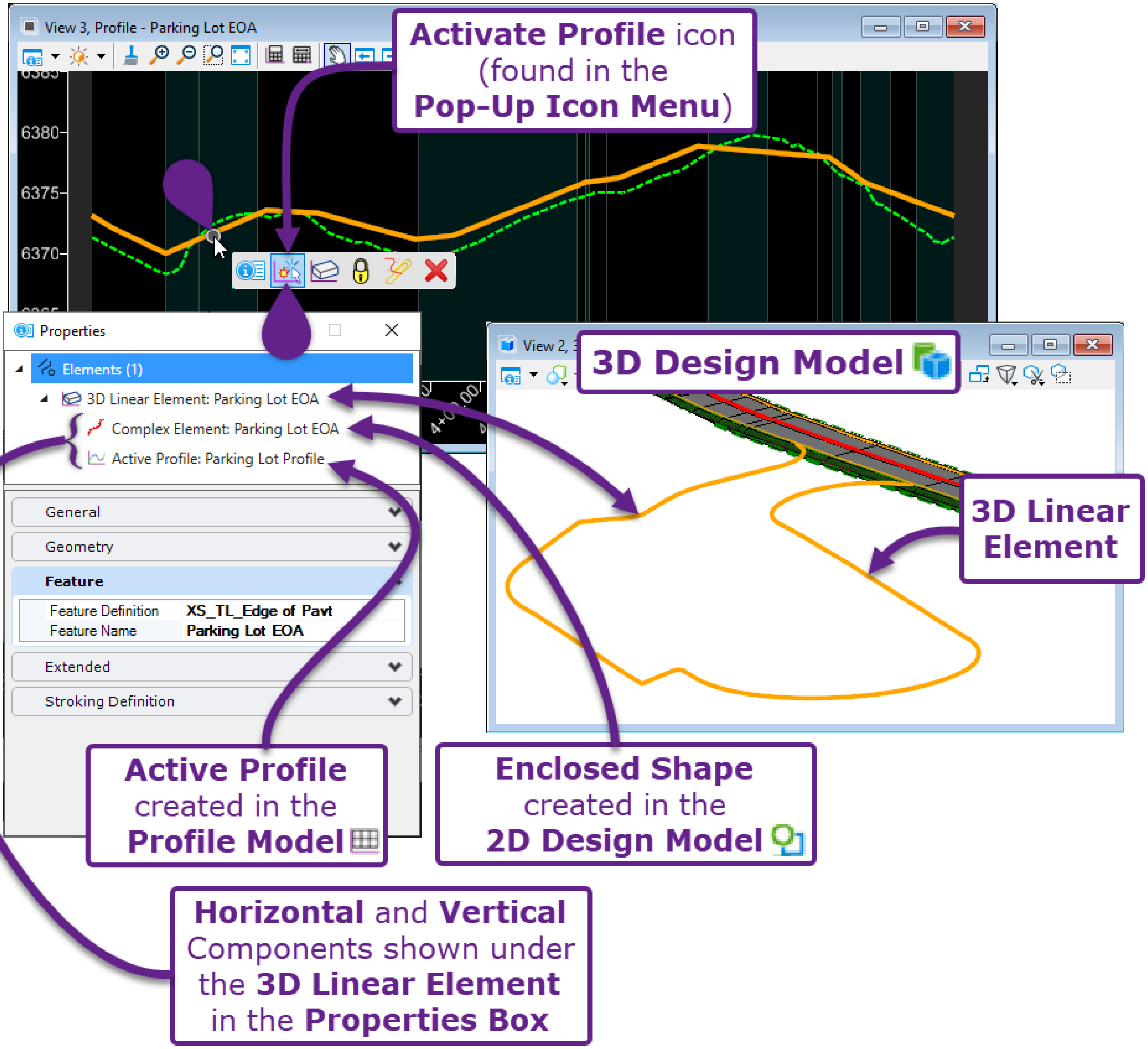
11C.2.c.vi Join Profile Elements into a Complex Profile Element

After the all the individual Profile Elements have been drawn, they can be joined into a single *Complex Profile* element. For more information on this procedure, see *7F.3.a Profile Complex By Elements*.



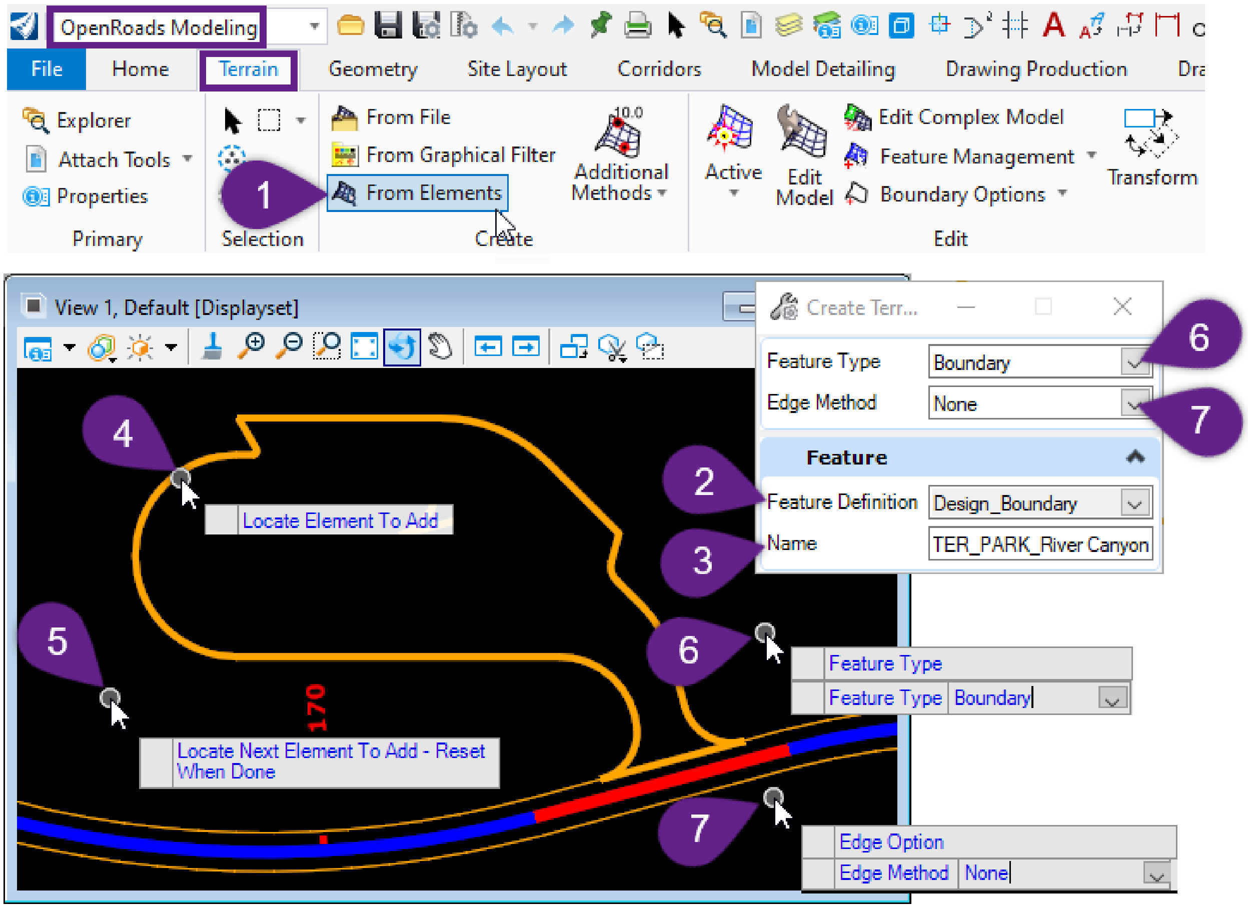
11C.2.c.vii Activate the Complex Profile Element

After the individual Profile Elements have been joined into a single *Complex Profile* element, the User must *Activate* the *Complex Profile*. After *Activation*, the Terrain Model Boundary is defined in all 3-dimensions. The Terrain Model Boundary will be shown in the *3D Design Model* as a 3D Linear Element.



11C.3 Create the Terrain Model with the From Elements Tool

After the Terrain Model Boundary (3D Linear Element) is created, then the actual Terrain Model can be created with the *From Elements* tool.



1	Select the *From Elements* tool from the Ribbon. Ribbon Location: **OpenRoads Modeling** workflow → **Terrain** tab → **Create** panel.
2	From the drop-down, select an appropriate *Design* **Feature Definition** for the Terrain Model. Terrain Model **Feature Definitions** are also discussed in *11B.1 Symbology Components and Feature Definitions.* ***IMPORTANT:*** The proposed Terrain Model must be placed on a Feature Definition found from the **Design** sub-folder. In this case, the Feature Definition is set to "Design_Boundary" – which means ONLY the outline (Boundary) of the Terrain Model will be displayed. To view the triangles and contours for the Terrain Model, select the "Design_Contours_Triangles" Feature Definition.
3	Assign an appropriate Name to the proposed Terrain Model. For Terrain Model naming conventions, see *3F – Naming Convention For Proposed ORD Features*. ***TIP:*** It is strongly recommended that proposed Terrain Models are given logical and distinct Names. When numerous Terrain Models are created in the same ORD File, the Naming convention is crucial for distinguishing between Terrain Models.

4	*Prompt: Locate Element to Add* – Left-Click on the Terrain Model Boundary. The User has the option to click on the Enclosed Shape (Complex Element) component found in the *2D Design Model* or the *3D Linear Element* entity found in the *3D Design Model* (which is shown on the previous sheet).
5	*Prompt: Locate Next Element To Add – Reset When Done* – In this case, there are no additional elements needed to define the Terrain Model Boundary. Right-Click (reset) in the *View* to advance to the next *Prompt*. ***TIP:*** Instead of a single, complex Boundary element, a Terrain Model Boundary could be defined with multiple elements – assuming the multiple elements form a continuous and enclosed shape.
6	*Prompt: Feature Type* – Select the ***Boundary*** option (use the UP and DOWN ARROW keys to cycle through the *Feature Type* options or select from the Dialogue Box drop-down). ***IMPORTANT:*** Typically, the ***Boundary*** option is used for the initial creation of a proposed Site Modeling Terrain Model. The other options are only relevant to the modification and refinement of a Terrain Model with the *Add Features* tool. The *Add Features* tool is shown throughout this chapter and discussed on the next page. The other *Feature Type* parameters are discussed in greater detail in *11B.4 Source Features and the Add Feature tool*.
7	*Prompt: Edge Options* – This option is inconsequential when the *Boundary* option is selected. Typically, the *None* option is used.

11C.4 Grade and Manipulate the Interior of the Terrain Model

After the Terrain Model has been created from the Boundary element, the interior portion of the Terrain Model can be graded. Similarly, islands and ridges can be created and added to the Terrain Model.

To define and grade the interior of the Terrain Model; first, the User must draw and Profile the interior features as *3D Linear Elements*. Next, the *3D Linear Elements* are added to the Terrain Model (as Source Features) with the *Add Feature* tool.

The different types of Source Features that can be added to a Terrain Model are discussed in *11B.4 Source Features and the Add Feature tool*.

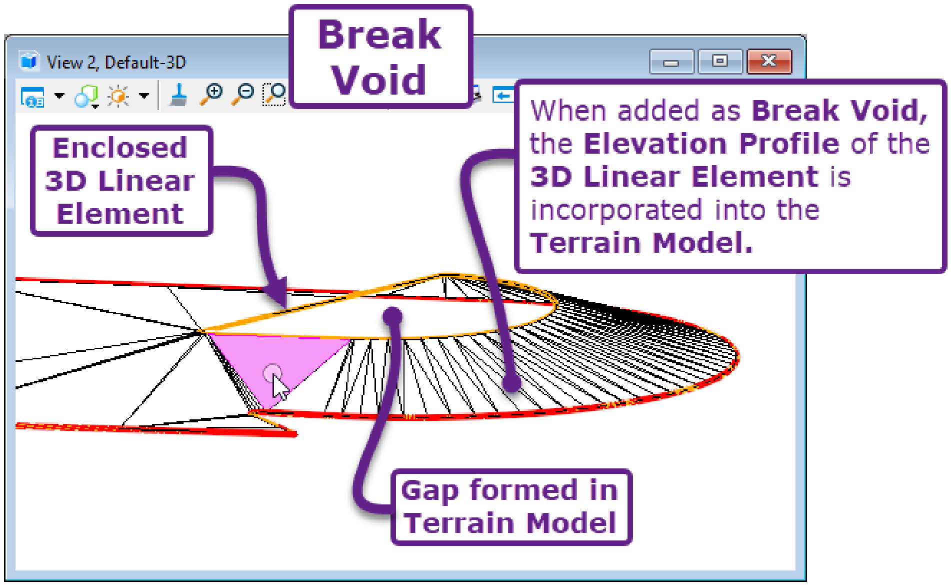
11C.4.a Landscaped Islands (Voids in the Terrain Model)

This section outlines the procedure for adding gaps into a Terrain Model – which could serve as a Landscaped Island in a real-world scenario. The interior *Voids* will be modeled with Terrain Models and Surface Templates – as shown in *11C.7 Model the Interior Voids (Landscape Islands).*

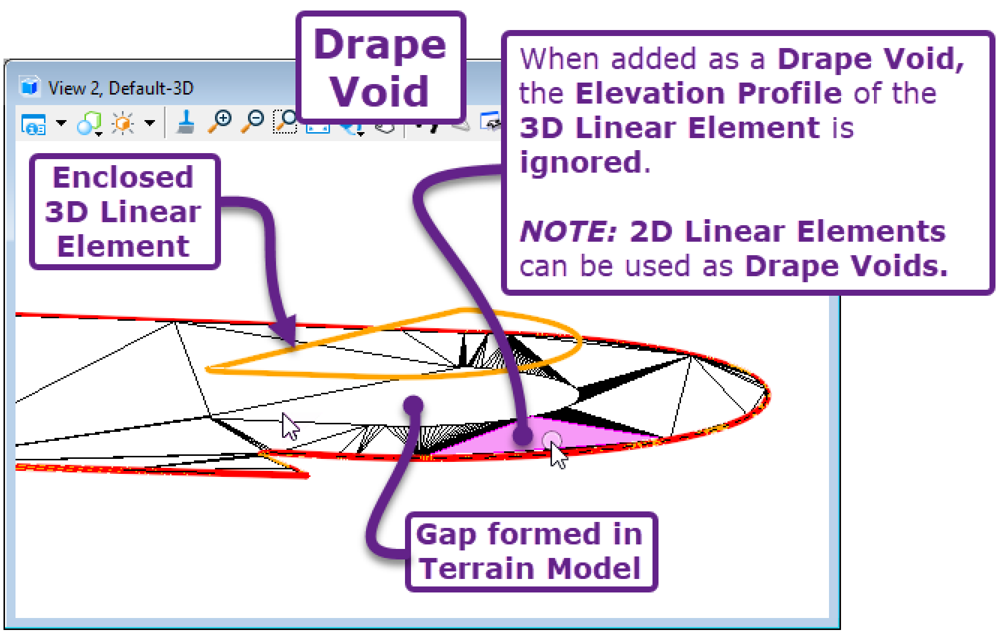
11C.4.a.i Break Voids vs Drape Voids

Creating a gap in the interior of a Terrain Model is typically accomplished with *Break Voids* or *Drape Voids*. Both *Break Voids* and *Drape Voids* create a gap in the Terrain Model. However, *Break Voids* must be created with a 3D Linear Element. Conversely, *Drape Voids* can be created with a *2D Linear Element*.

Break Void: A *Break Void* must be an **enclosed** *3D Linear Element*, which could be an Enclosed Shape (2D Element) that contains an Active Profile. Because *Voids* have a vertical component, the elevation profile of the *Break Void* element is incorporated into the Terrain Model.



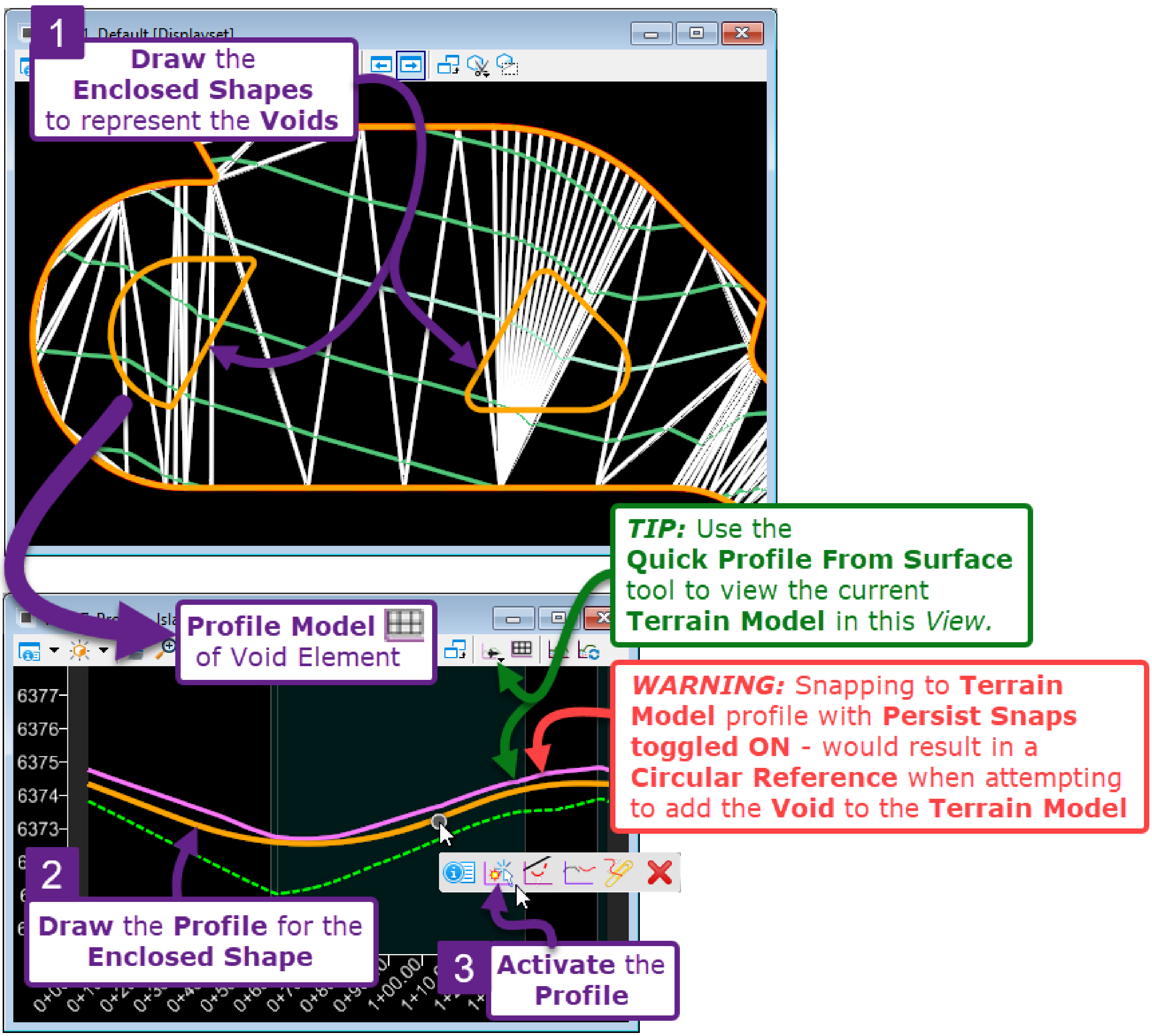
Drape Void: A *Drape Void* is an **enclosed** *2D Linear Element*, which is also referred to as an Enclosed Shape in this manual. A *Drape Void* is used to create a gap, without affecting the interior elevations of a Terrain Model. For example, if the intent is to keep the Landscaped Islands flush with the parking lot surface, then a Drape Void should be used.



11C.4.a.ii Create the 3D Linear Element for the Void

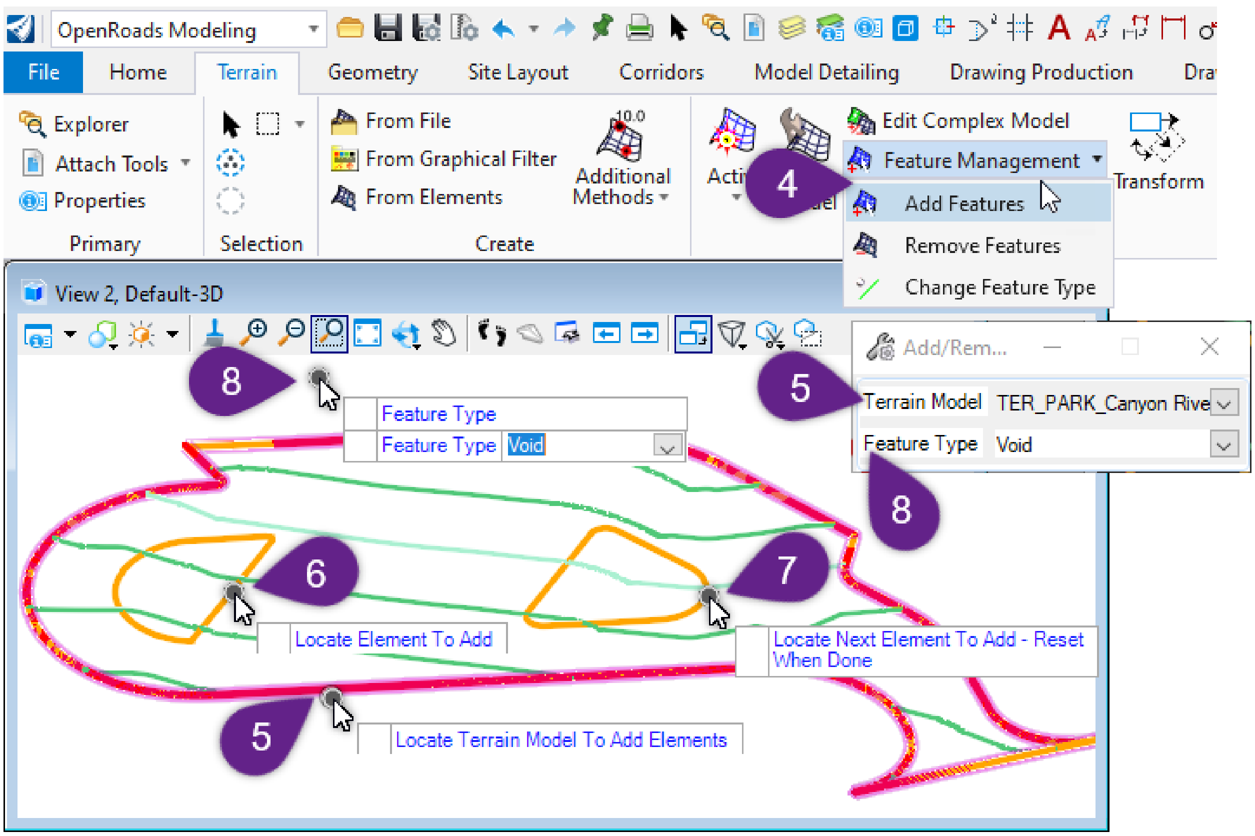
Creating geometry for a *Void* is accomplished in the same manner as a Terrain Model Boundary (see *11C.2 Create the Terrain Model Boundary Geometry*). The general steps for the process are as follows:

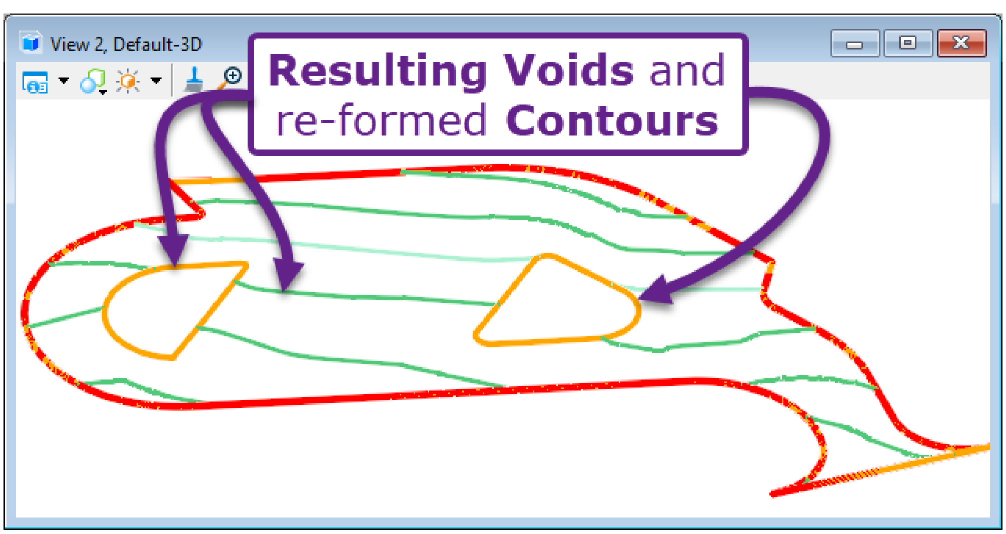
1	In the *2D Design Model*, draw an **Enclosed Shape** to represent the horizontal layout of the *Void*.
2	In the *Profile Model* belonging to the **Enclosed Shape**, draw a **Profile** for the elevation of the *Void*.
3	**Activate the Profile** to fully define in all three dimensions. After this step a corresponding *3D Linear Element* is created in the *3D Design Model*.



11C.4.a.iii Add the *3D Linear Element* to the Terrain Model to create the *Void*.

4	From the Ribbon, select the *Add Features* tool: [***OpenRoads Modeling*** → ***Terrain*** → ***Edit*** → ***Feature Management***].
5	*Prompt: Locate Terrain Model To Add Elements* – Left-Click on the Parking Lot Terrain Model
6	*Prompt: Locate Elements To Add* – Left-Click on the *3D Linear Element* to use as the *Void*
7	*Prompt: Locate Next Element to Add – Reset When Done* – Additional *3D Linear Element* can be added in this step. Otherwise, Right-Click (*Reset*) to proceed.
8	*Prompt: Feature Type* – Using the UP and DOWN keys, cycle to the *Void* option. Left-Click in the *View* to finish the command.





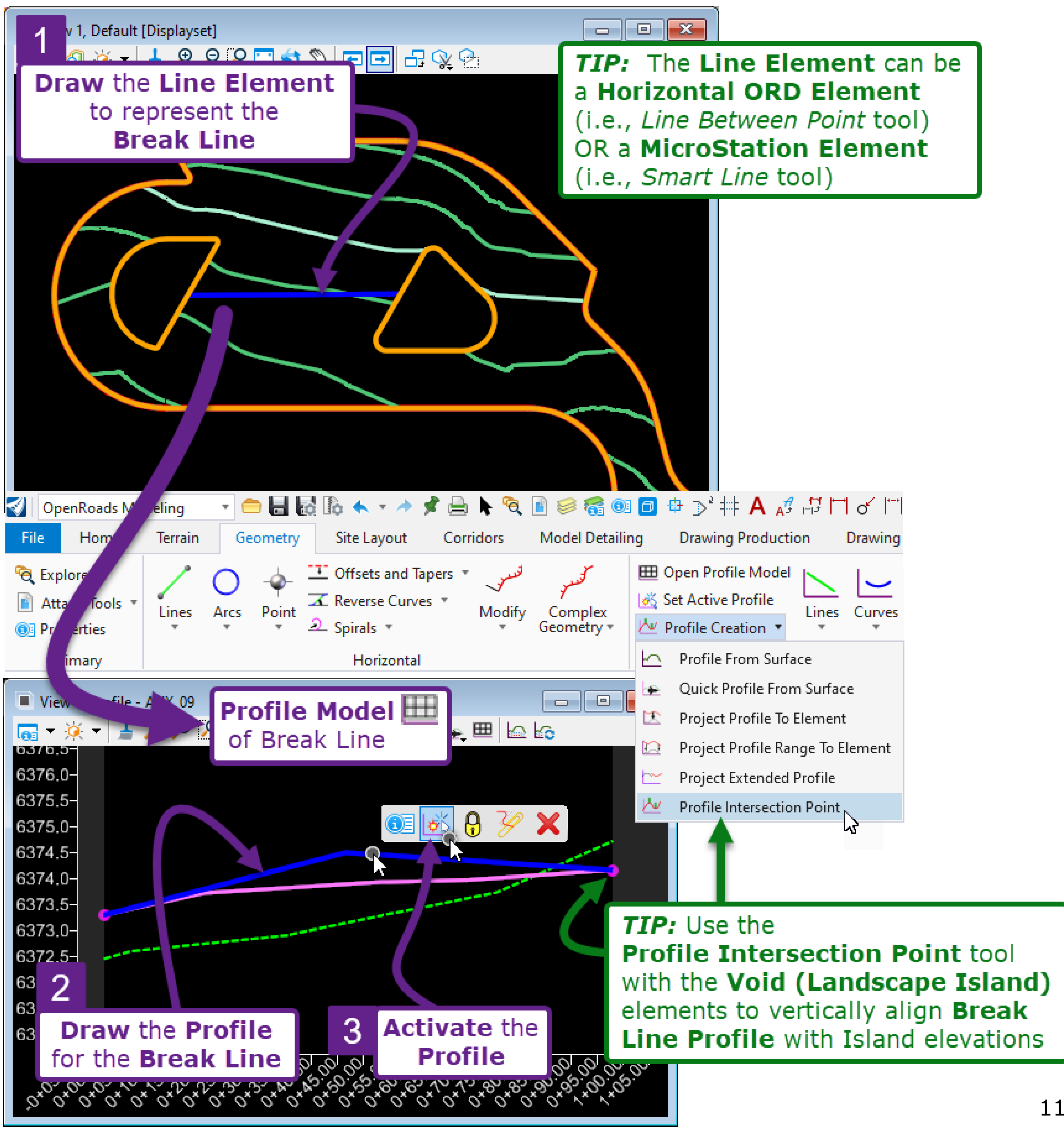
11C.4.b Create a Break Line to serve as a Ridge or Swale

Creating a *Break Line* is accomplished in a similar manner as a Terrain Model Boundary, with one important exception: a *Break Line* does NOT need to be enclosed.

11C.4.b.i Draw the Break Line Horizontal and Vertical Geometry

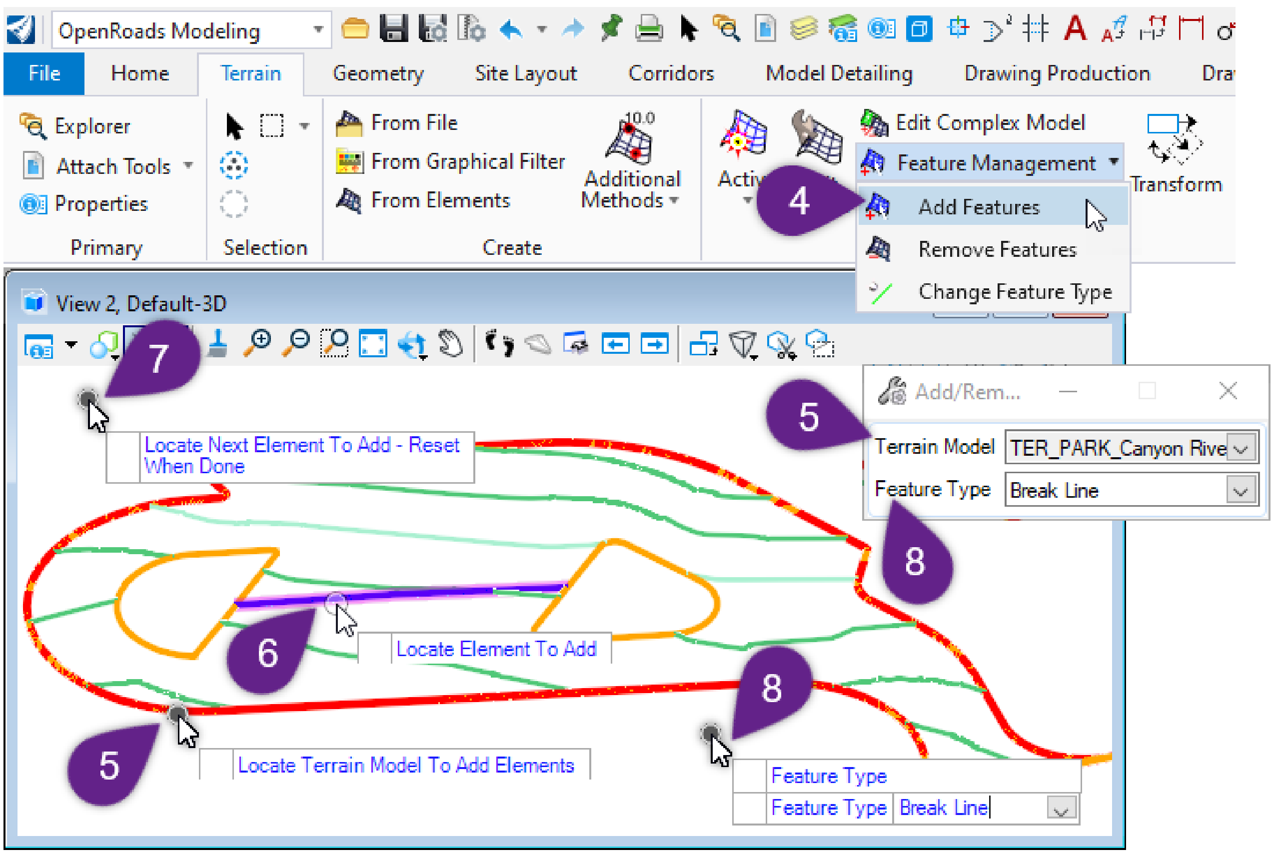
The general process for creating a Break Line geometry is as follows:

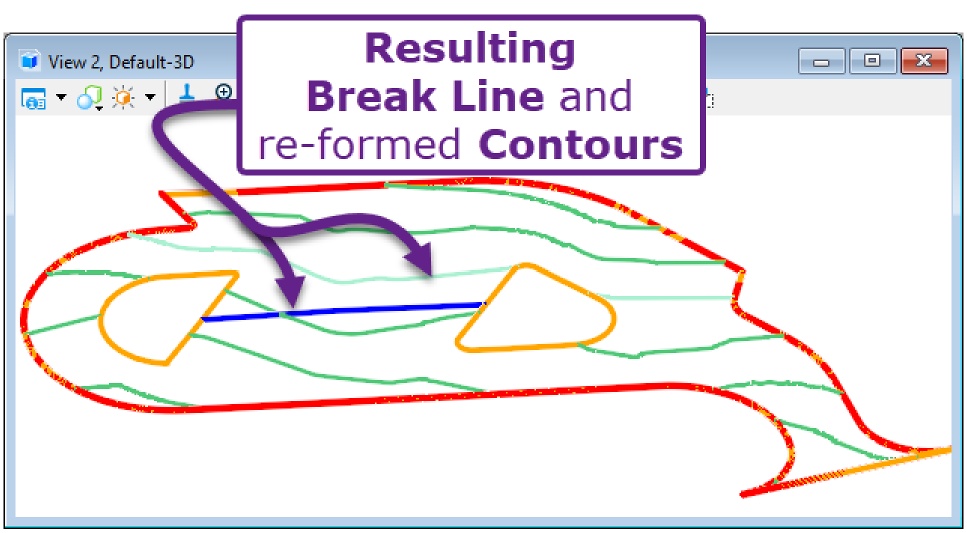
1	In the *2D Design Model*, draw a break line **Alignment** element to represent the horizontal layout of the swale or ridge.
2	In the *Profile Model* belonging to the break line **Alignment**, draw a **Profile**.
3	**Activate the Profile** to fully define in all three dimensions. After this step, a corresponding *3D Linear Element* is created in the *3D Design Model*.



11C.4.b.ii Add the *3D Linear Element* to the Terrain Model as a *Break Line*

4	From the Ribbon, select the *Add Features* tool: [***OpenRoads Modeling*** → ***Terrain*** → ***Edit*** → ***Feature Management***].
5	*Prompt: Locate Terrain Model To Add Elements* – Left-Click on the Parking Lot Terrain Model
6	*Prompt: Locate Elements To Add* – Left-Click on the *3D Linear Element* to use as the *Break Line*
7	*Prompt: Locate Next Element to Add – Reset When Done* – Additional *3D Linear Element* can be added in this step. Otherwise, Right-Click (*Reset*) to proceed.
8	*Prompt: Feature Type* – Using the UP and DOWN keys, cycle to the *Break Line* option. Left-Click in the *View* to finish the command.





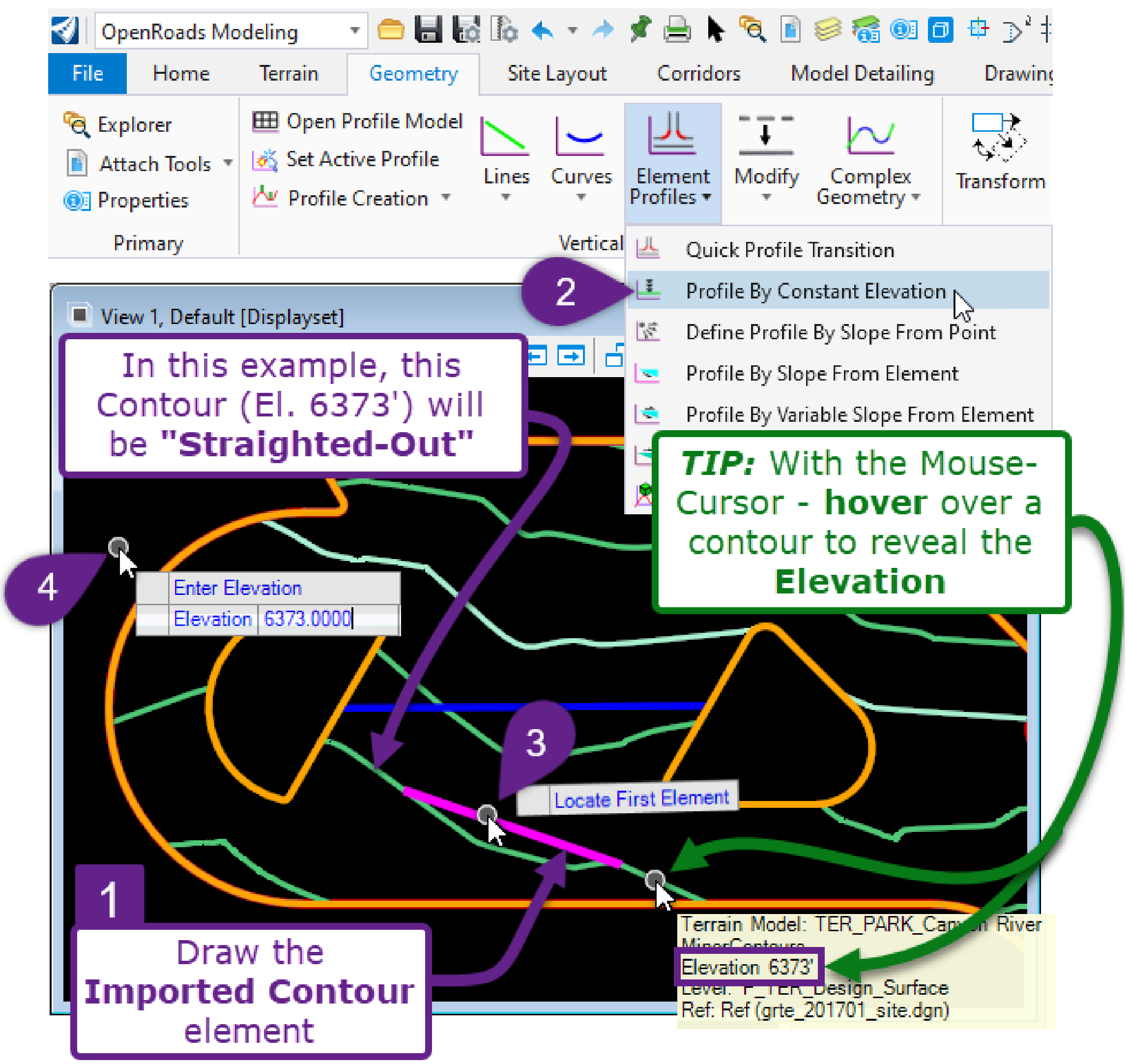
11C.4.c Smooth Jagged Contours with Imported Contours

It is very common for contours to appear jagged. Using *Imported Contours*, the User can manually smooth Terrain Model contours for a more appealing display.

11C.4.c.i Draw the *Imported Contour* Element (in the 2D Design Model)

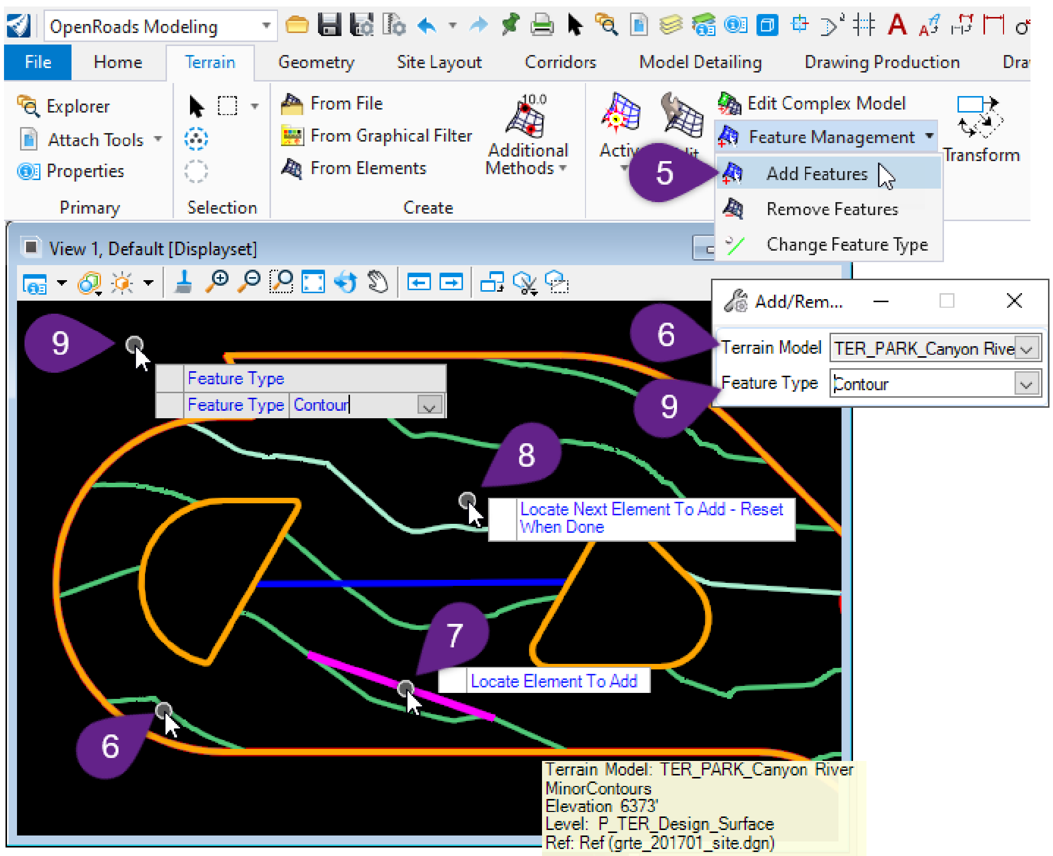
The general process for using *Imported Contours* is as follows:

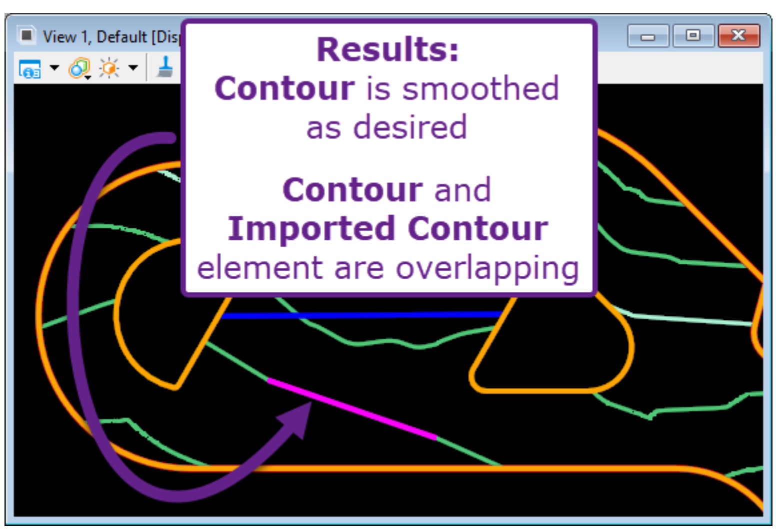
1	In the *2D Design Model*, draw the desired path for the *Imported Contour*.
2	Use the Profile By Constant Elevation tool to profile the Imported Contour at the correct elevation. See *7F.5.b Profile By Constant Elevation*. From the Ribbon, select the *Place Named Boundary* tool: **[OpenRoads Modeling → Geometry → Vertical]**
3	Prompt: Locate First Element – Left-Click on the Imported Contour element
4	*Prompt: Enter Elevation* – Key-in the desired elevation for the *Imported Contour*. In this case, the elevation of the contour to smooth is 6373’.



11C.4.c.ii Add the Imported Contour to the Terrain Model

5	From the Ribbon, select the *Add Features* tool: [***OpenRoads Modeling*** → ***Terrain*** → ***Edit*** → ***Feature Management***].
6	*Prompt: Locate Terrain Model To Add Elements* – Left-Click on the Parking Lot Terrain Model
7	*Prompt: Locate Elements To Add* – Left-Click on the *Imported Contour* element.
8	*Prompt: Locate Next Element to Add – Reset When Done* – Additional *Contours* can be added in this step. Otherwise, Right-Click (*Reset*) to proceed.
9	*Prompt: Feature Type* – Using the UP and DOWN keys, cycle to the *Contour* option. Left-Click in the *View* to finish the command.





11C.5 Create the Surface Template

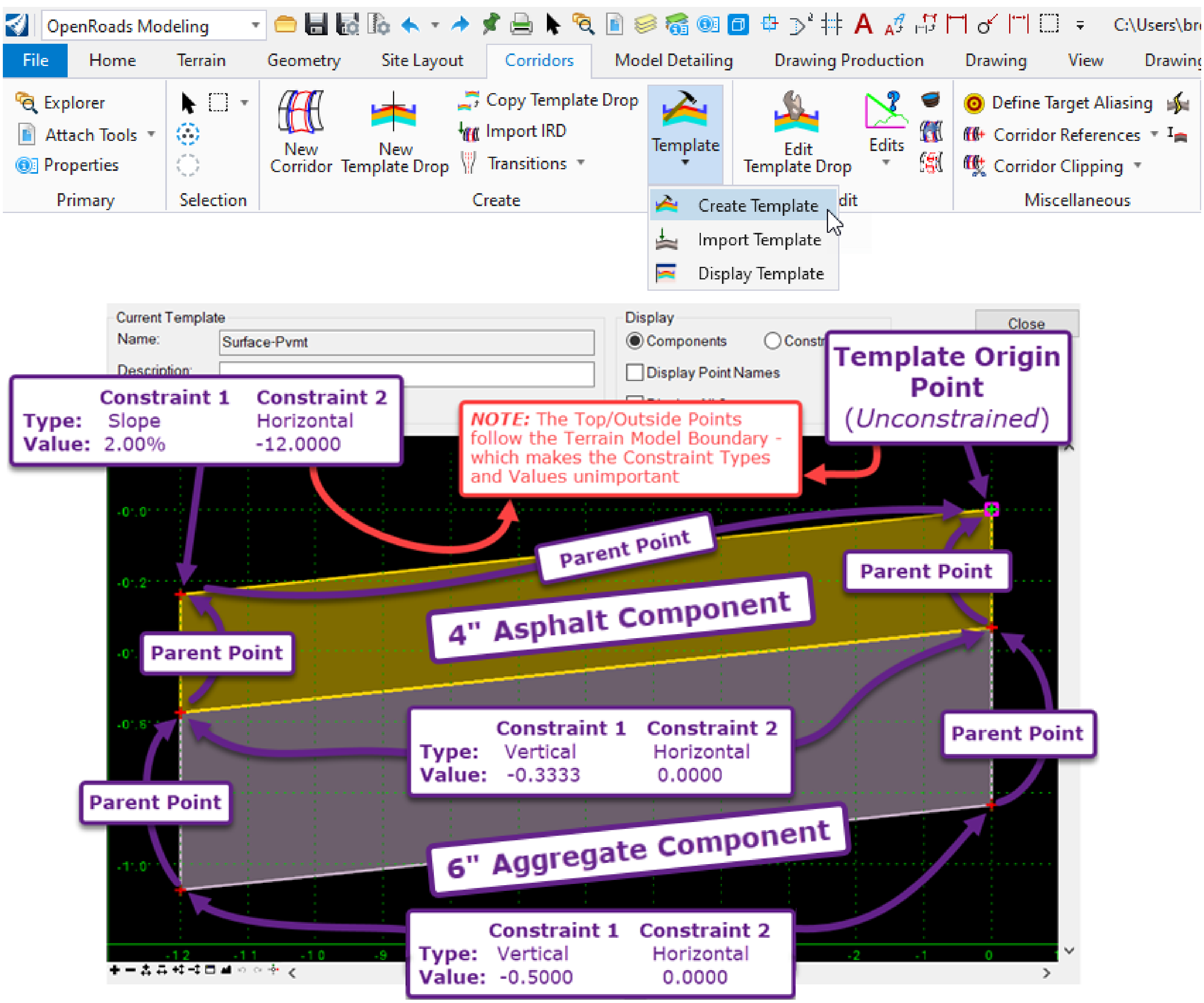
After the Terrain Model has been created and graded (using *Source Features* – such as *Break Lines*, *Voids*, *Imported Contours*, and *Spots*), then the Surface Template can be applied.

11C.5.a Create the Surface Template Geometry in the Template Editor

Before applying to the Terrain Model, the Surface Template must be created and configured in the *Template Editor*. In the *Template Editor*, the material component depths (i.e., pavement section depths) must be set. In this case, a 4" asphalt section over 6" of aggregates is the desired section.

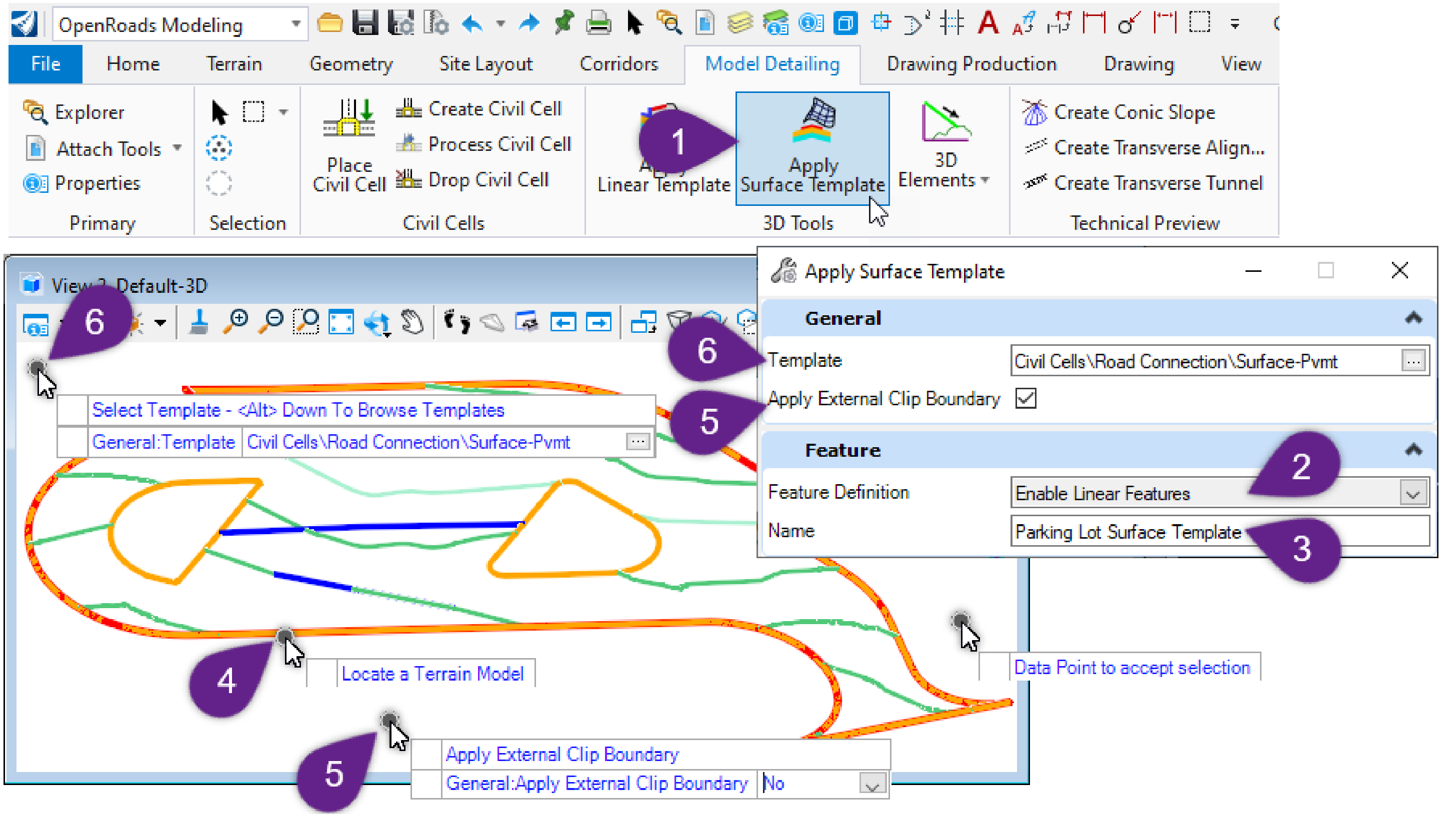
The creation and editing of Surface Templates is discussed in detail in *8G – Surface Templates*.

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 *8G.3 Create a Surface Template Workflow.*

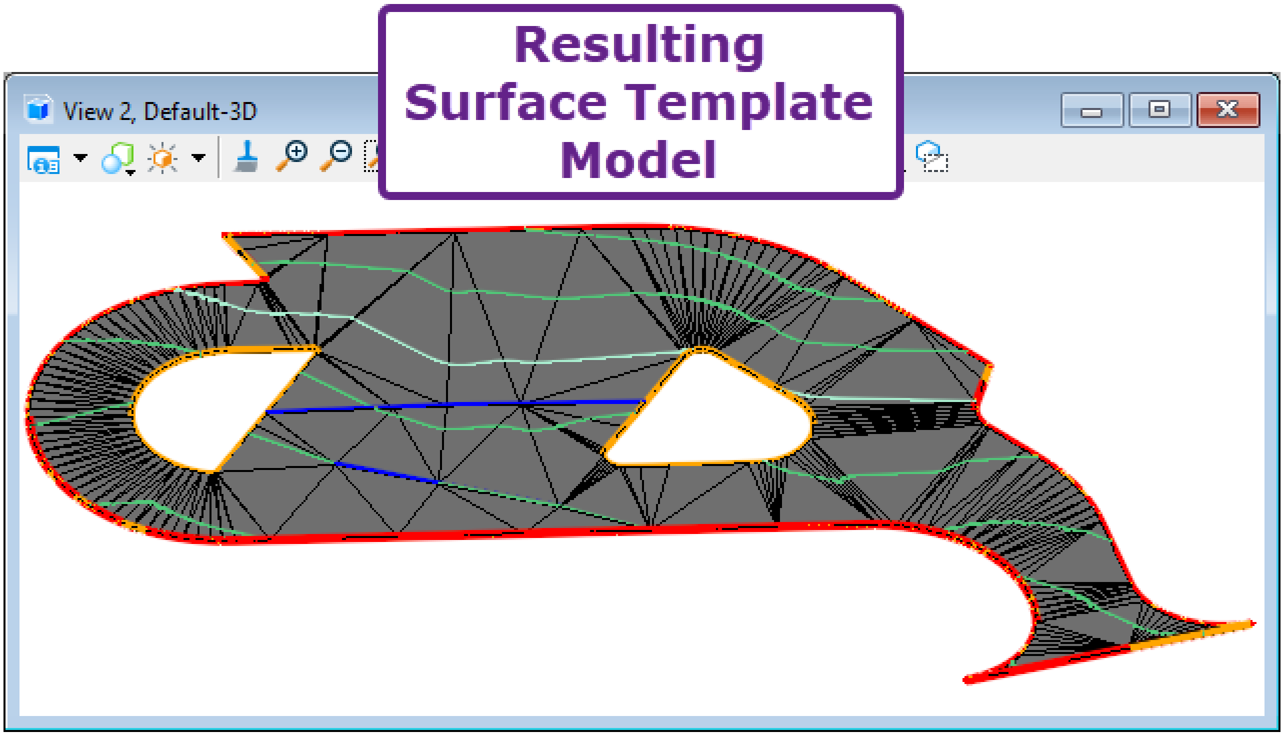


11C.5.b Apply the Surface Template to the Terrain Model

The Surface Template is created with the *Apply Surface Template* tool.



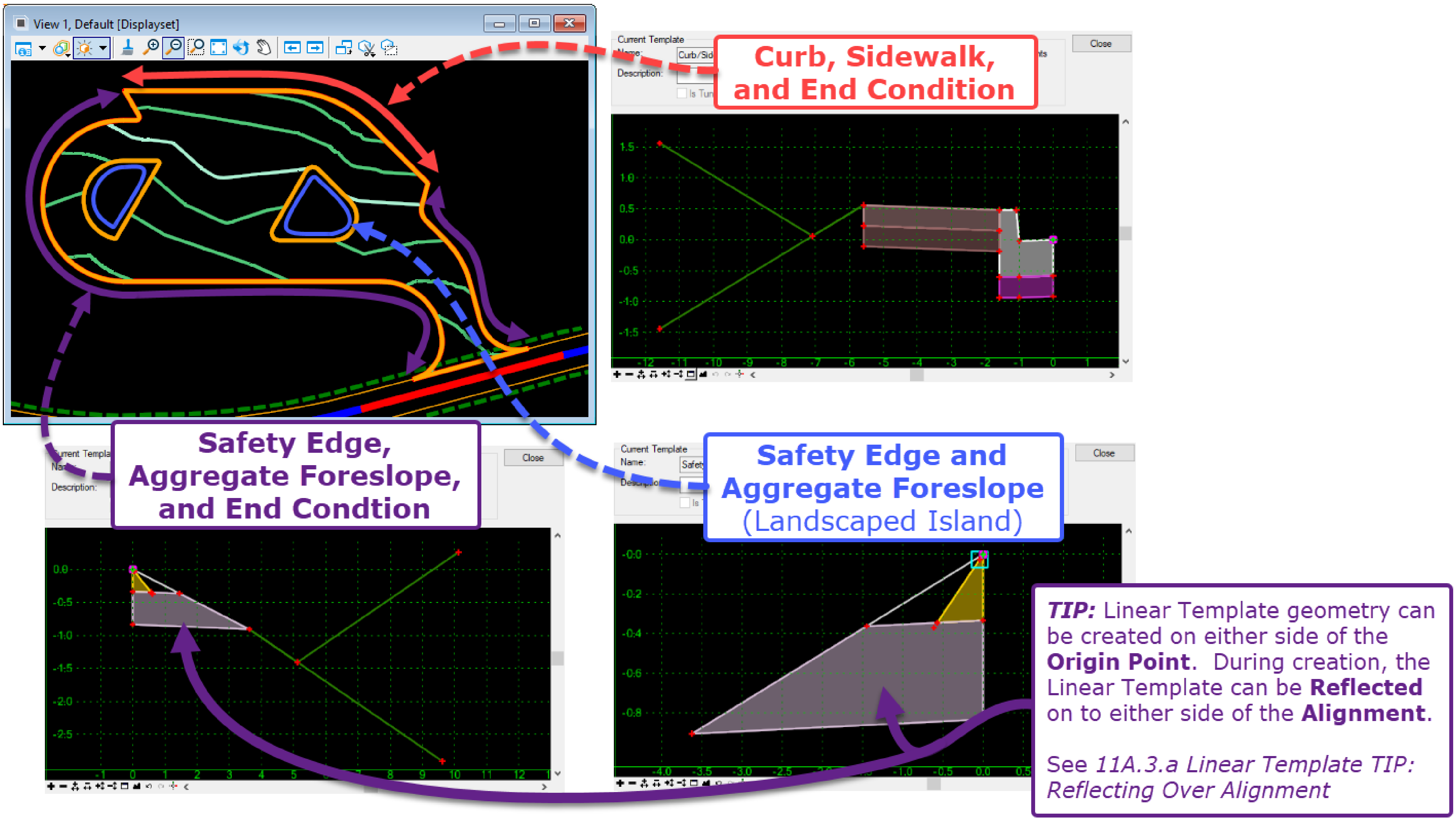
1	From the Ribbon, select the *Place Named Boundary* tool: [***OpenRoads Modeling*** → ***Model Detailing*** → ***3D Tools***].
2	In the Dialogue Box, select a **Feature Definition**. Typically, the "Disable Linear Features" options is used. ***NOTE:*** There are only two **Feature Definitions** available for Surface Templates: **Enable Linear Features** or **Disable Linear Features**. It is recommended that **Enable Linear Features** is used. When **Enable Linear Features** is used, *3D Linear Elements* are created at all Template Point locations (as established in the Template Editor). These *3D Linear Elements* are eventually used for reporting and staking data.
3	In the Dialogue Box, enter a **Name** for the Surface Template.
4	*Prompt: Locate Terrain Model* – Left-Click on the Parking Lot Terrain Model
5	*Prompt: Apply External Clip Boundary* – Select **No**. Left-Click in the *View* to advance. ***NOTE:*** The **Apply External Clip Boundary** is NOT necessary when creating proposed Site features. This option is useful when modeling existing unsuitable materials – as shown in *20E – Unsuitable Material Modeling and Calculations*.
6	*Prompt: Select Template - <Alt> Down To Browse Templates* – Press the ALT and DOWN Arrow to access the Template Selection List. Select the appropriate Surface Template.


Resulting Surface Template Model
View 2, Default-3D

11C.6 Create Linear Templates Around the Terrain Model Boundary and Voids

In this section, Linear Templates are applied around the Boundary of the Terrain Model. Also, Linear Templates are run around the interior of the *Voids* (Landscape Island) to model the Safety Edge and Aggregate Foreslope along the *Void* interior edge components.

In this example, three distinct Linear Templates configurations are used at different locations:



TIP: Linear Template geometry can be created on either side of the **Origin Point**. During creation, the Linear Template can be **Reflected** on to either side of the **Alignment**.

See *11A.3.a Linear Template TIP: Reflecting Over Alignment*

11C.6.a Create the Linear Template in the Template Editor

Before creating a Linear Template model, the Linear Template geometry must be defined in the Template Editor. In this step, the

Linear Templates are created and edited in the same manner as Corridor Templates. See *Chapter 8 – Template Library*.

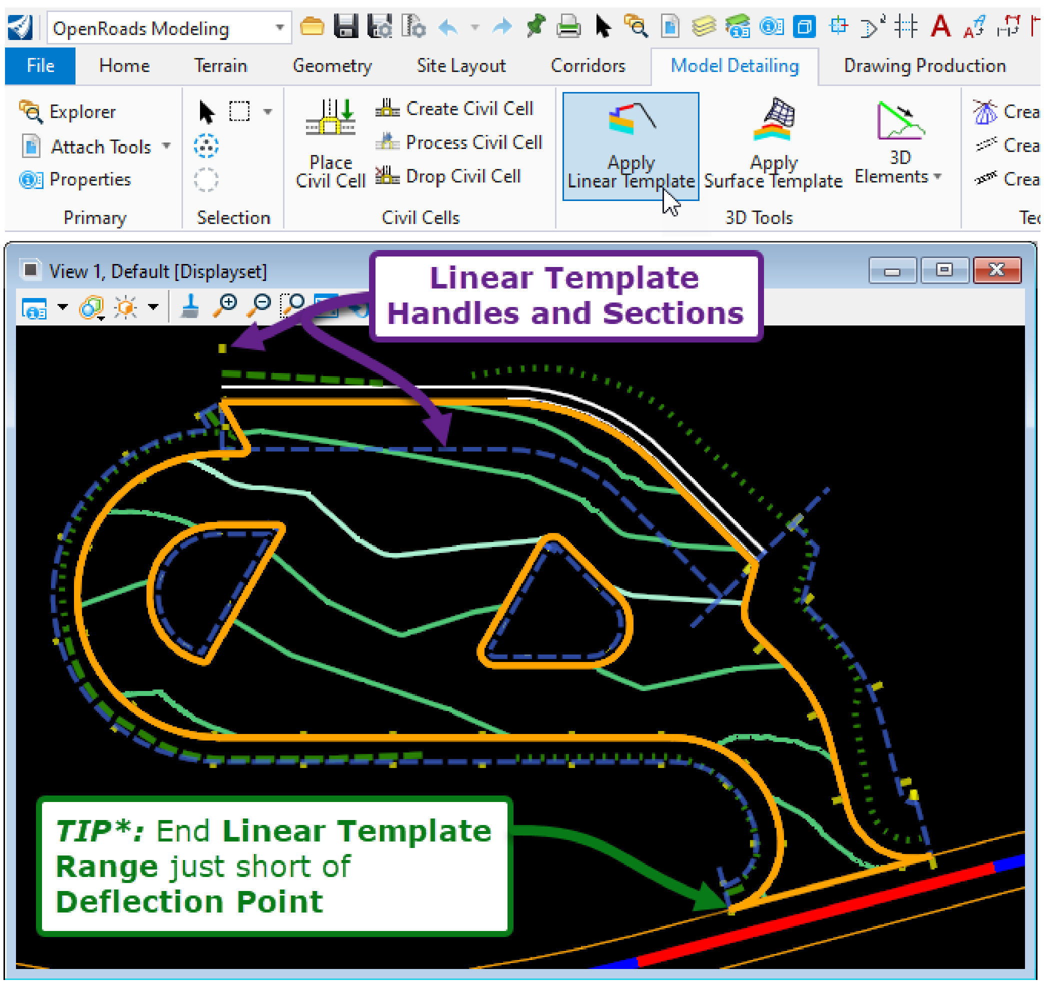
11C.6.b Create the Linear Template Models

After defining the Linear Template geometry in the Template Editor, the actual Linear Template Models can be created around the Terrain Model Boundary and interior Voids.

The detailed workflow for creating Linear Template Models is shown in *9B.2.b Create a New Linear Template Workflow*.

WARNING: Always assign Linear Templates an appropriate **Name**. It is common for an ORD File to contain numerous Linear Templates. **Names are necessary** for organizing Linear Templates in the Explorer menu.

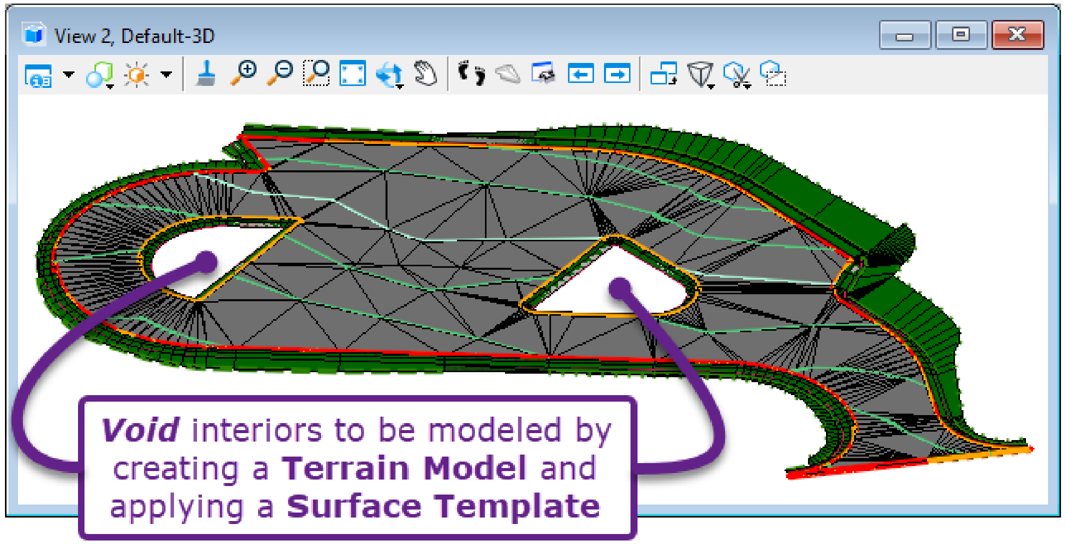
TIP*: Linear Template models often behave awkwardly around sharp deflection points (no curve between two lines) – especially when a deflection point occurs at the Start or End of the Linear Template. To address this issue, begin/end Linear Templates a very short distance (0.01' or so) before Start/End locations.



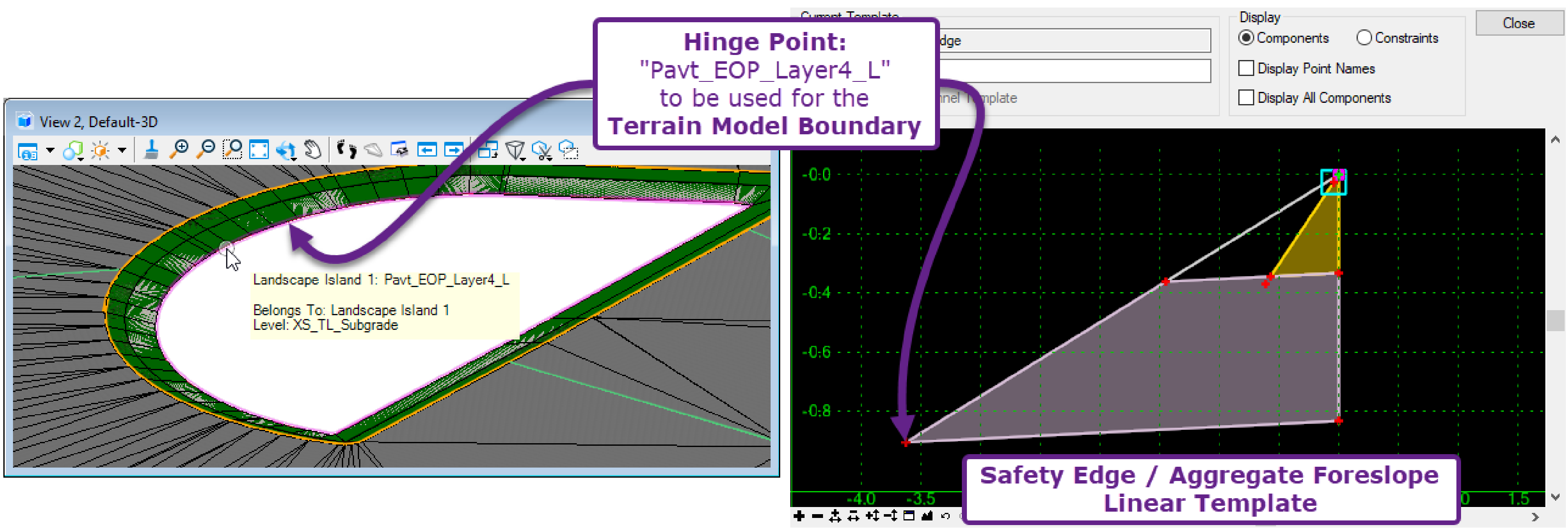
NOTE: By default, Linear Templates are assigned to the "Design" Feature Definition, which is not setup to show contours. Change the Linear Template Feature Definition to "Final w/ Contours" to show contours.

11C.7 Model the Interior Voids (Landscape Islands)

Up to this step in the workflow, the Parking Lot is almost completely modeled – with the exception of the interior *Voids*. In this step, a Terrain Model is created for each individual *Void*.



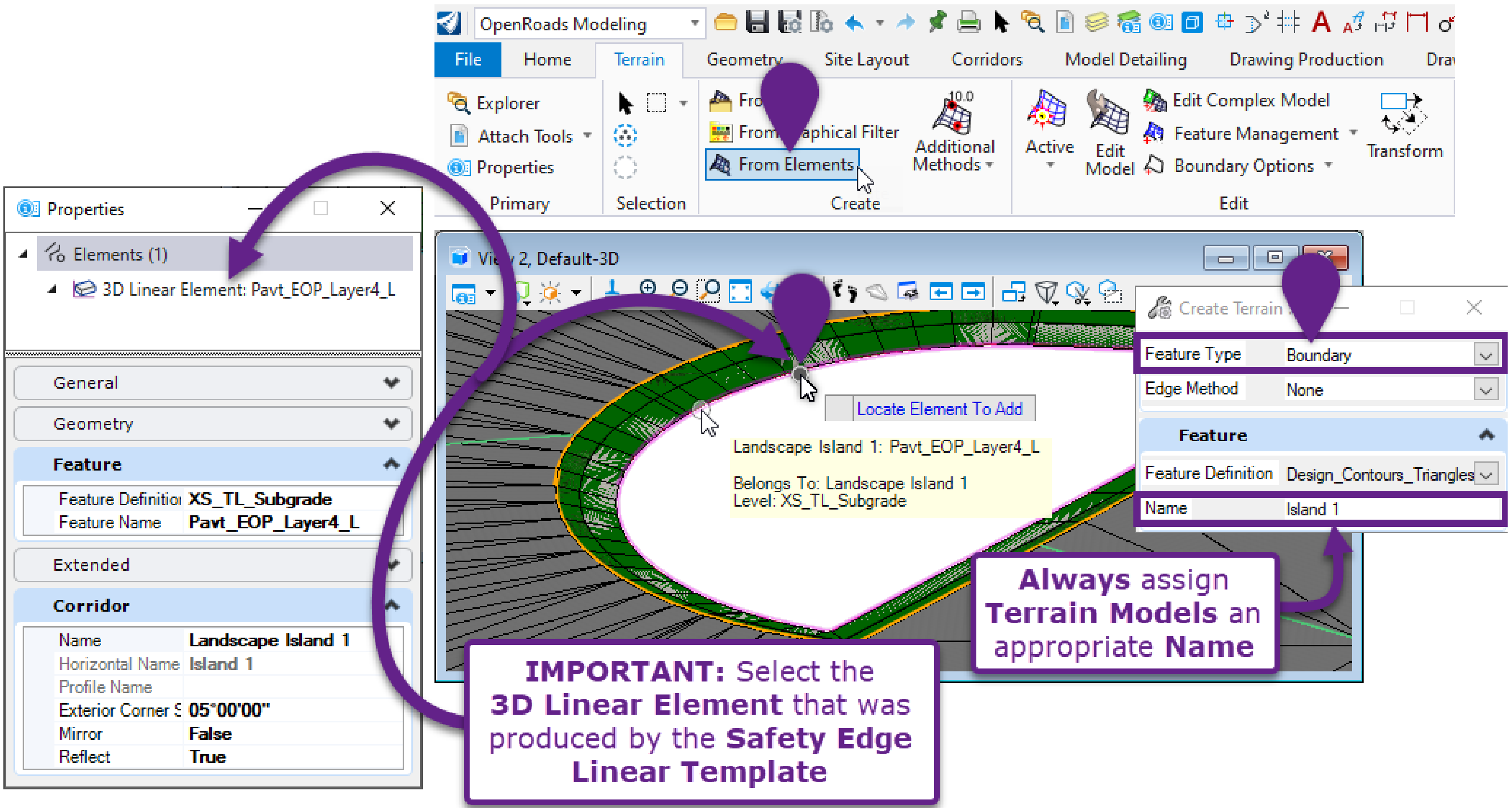
The Terrain Model for the *Void* is created from the Hinge Point belonging to the Safety Edge/Aggregate Foreslope Linear Template. This Template Point Line (which is technically a *3D Linear Element*) will serve as the Terrain Model Boundary.

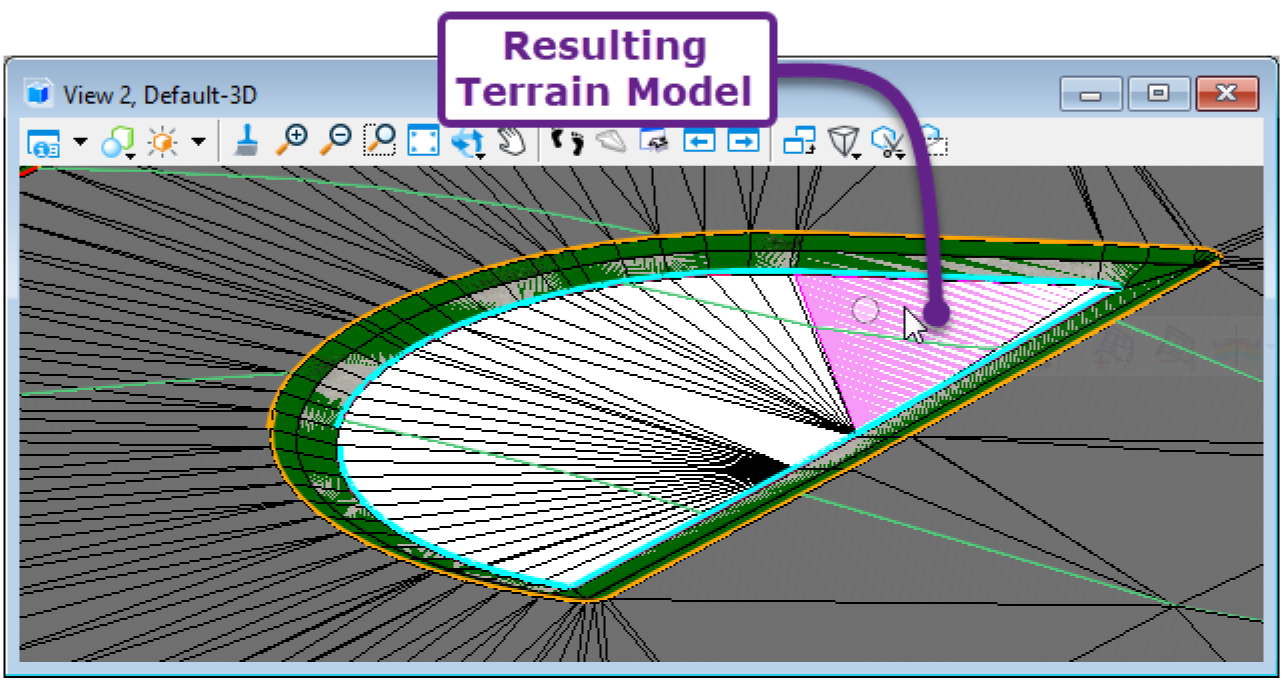


11C.7.a Create the Terrain Model from the Linear Template Point Line

The Terrain Model for the interior *Void* is created with the *From Elements* tool, by selecting the Hinge Point Template Point Line as the *Boundary*.

For a more detailed workflow of creating a proposed Terrain Model from a Boundary, see *11C.3 Create the Terrain Model with the From Elements Tool*.

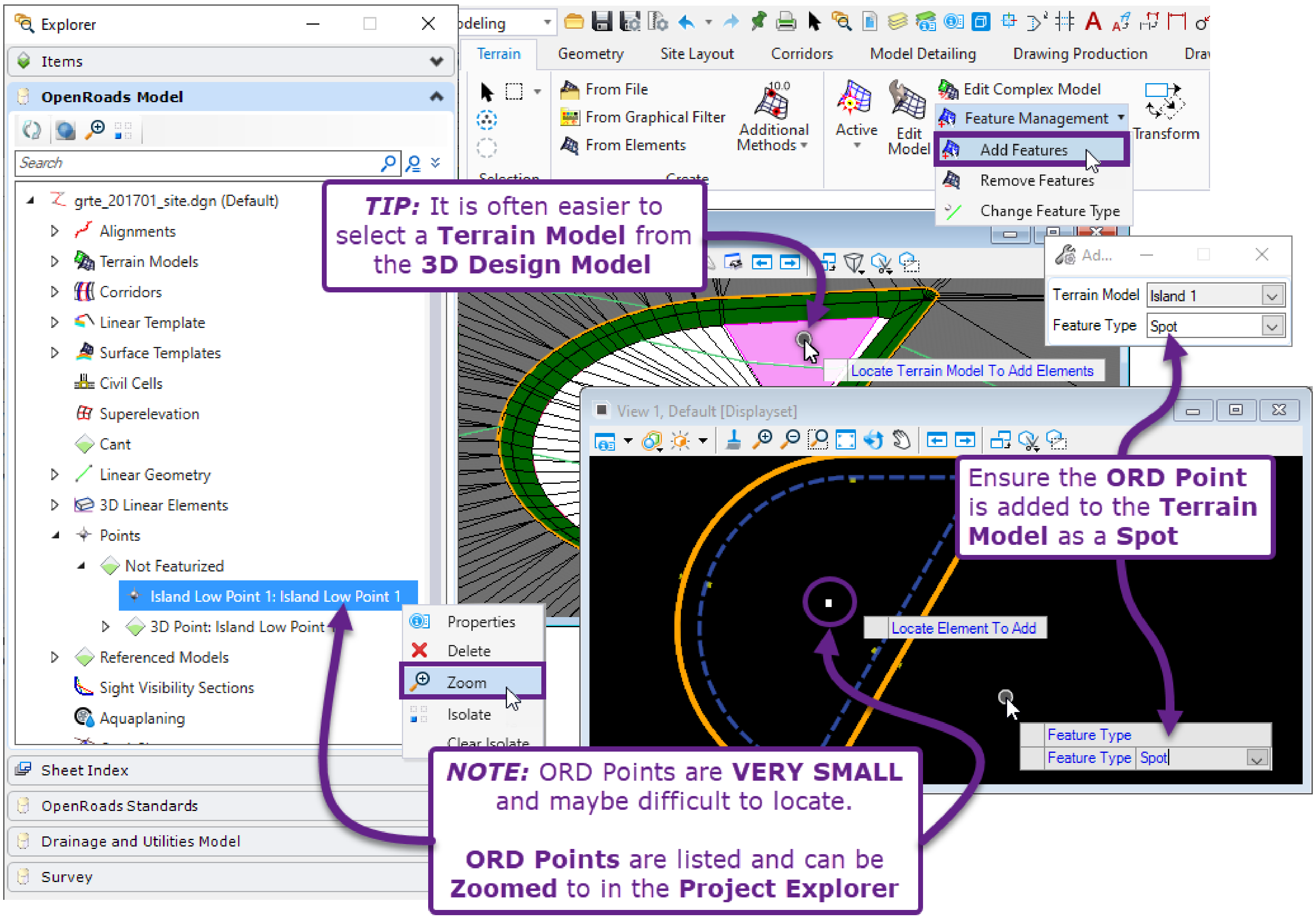


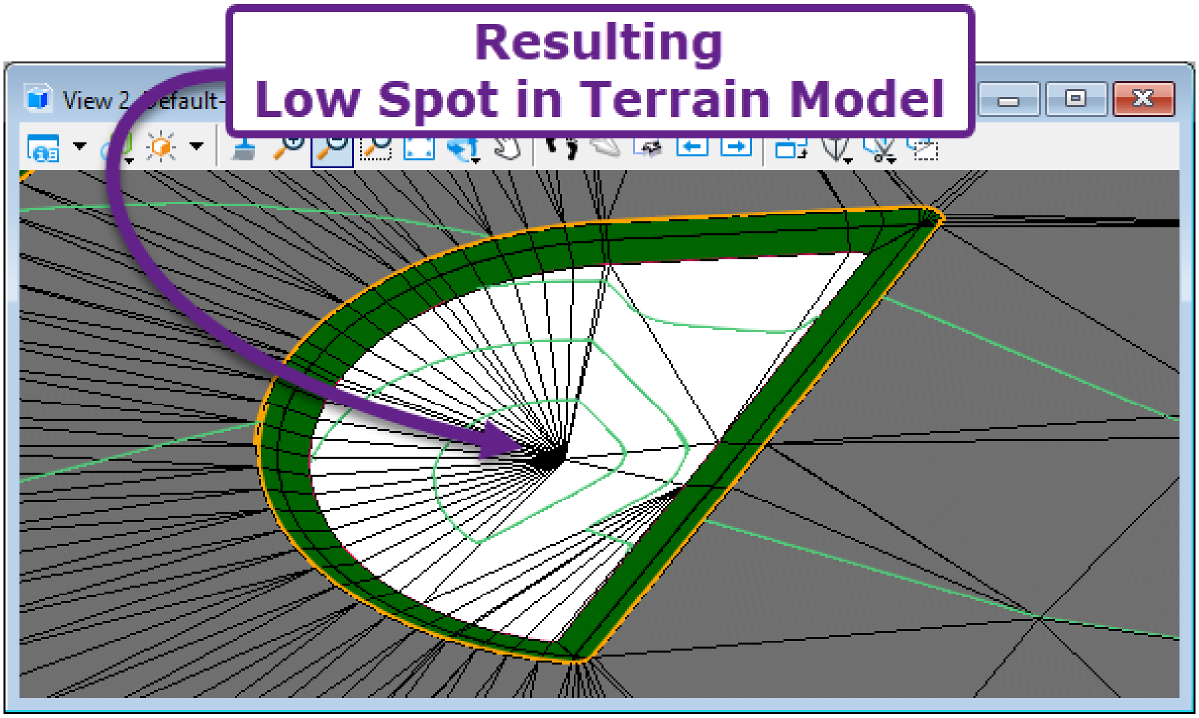


11C.7.b Place a Low Spot in the Terrain Model with an ORD Point

In this step, the interior of the Terrain Model is graded to include a low spot in the center. The low spot is formed by creating an *ORD Point* at the desired elevation. When creating the *ORD Point*, use the *Value* mode to input the elevation of the Point to be created. Next, the *ORD Point* is incorporated into the Terrain Model with the *Add Feature* tool

For more information on ORD Points, see *7D.4.b Point Tool*. Place the ORD Point in the *2D Design Model*.

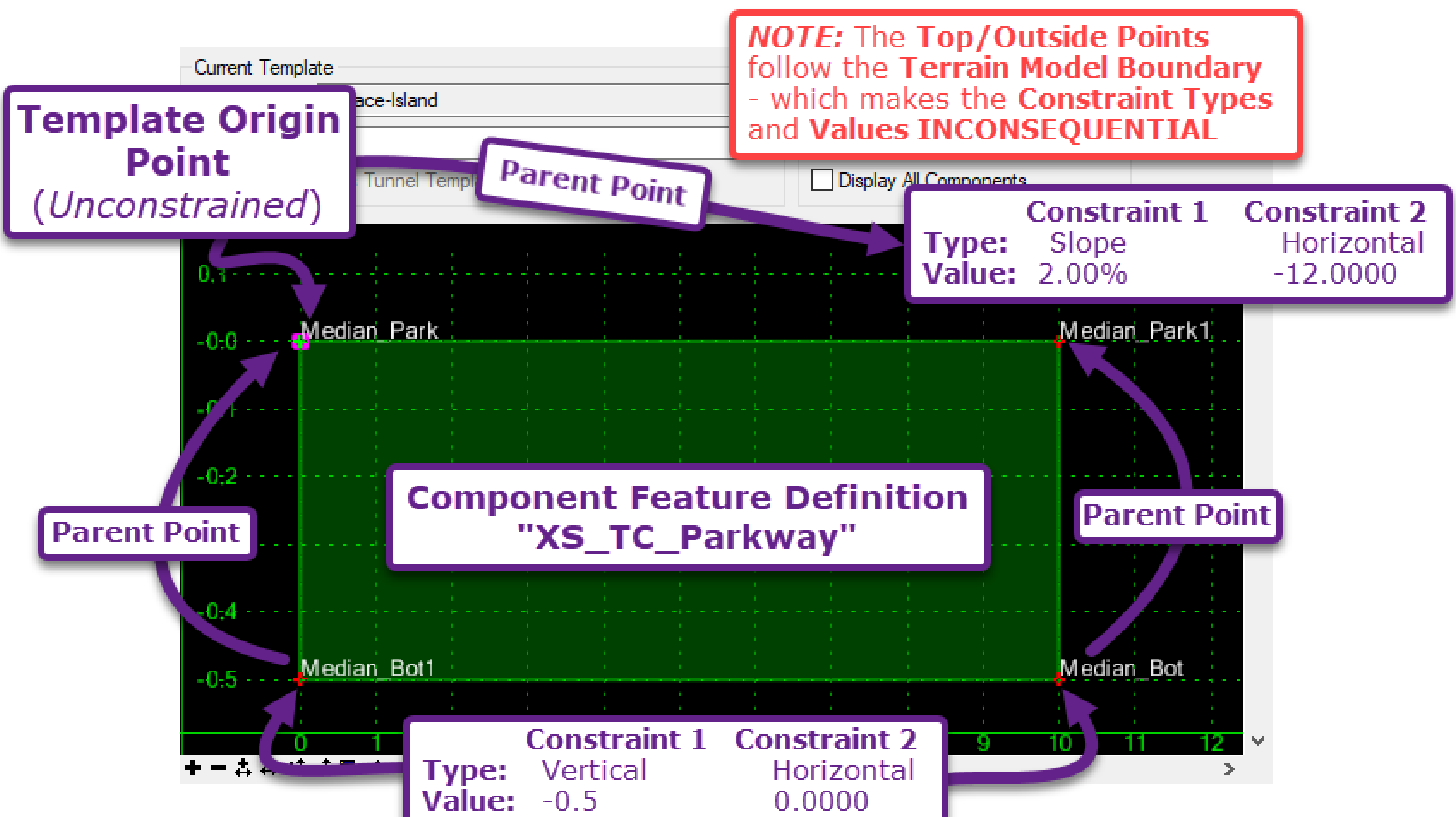


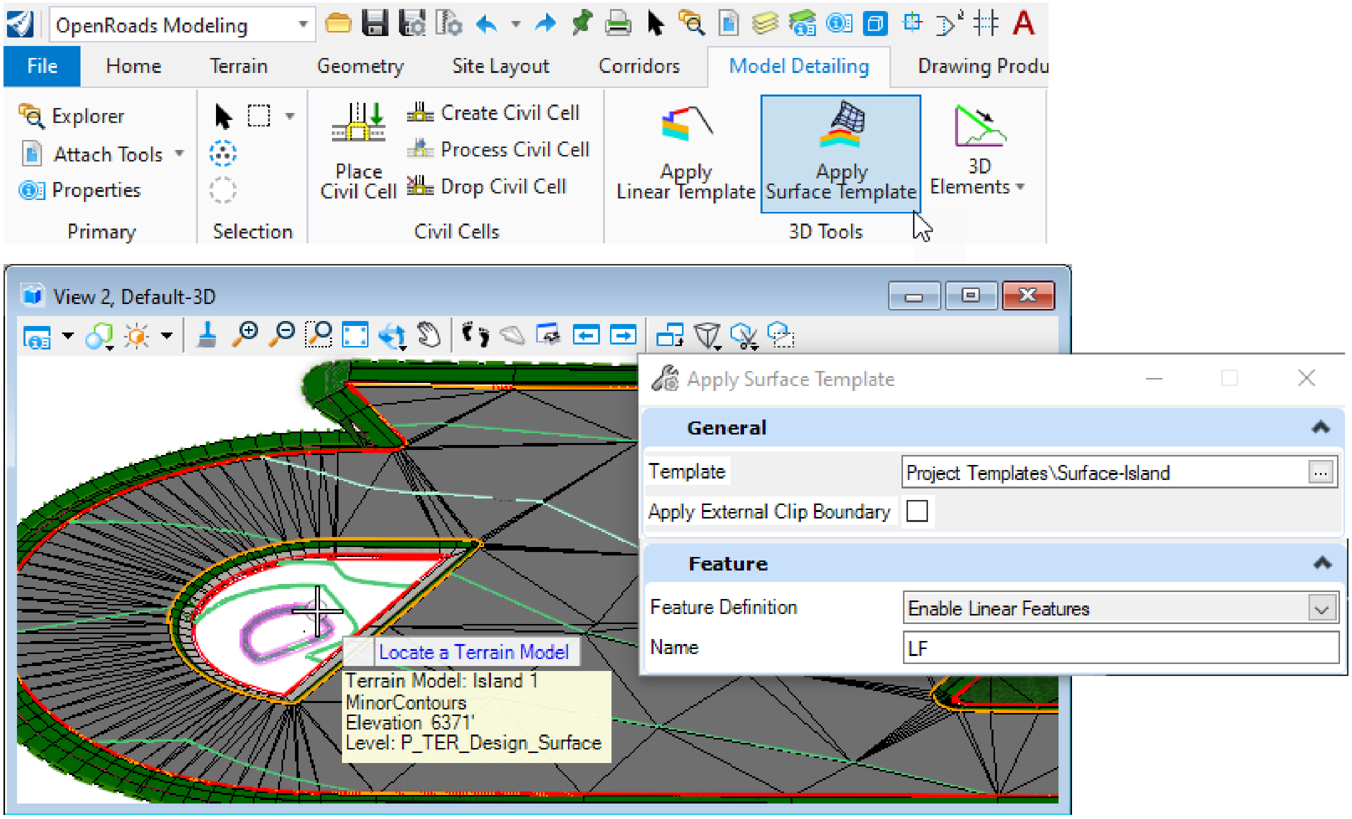


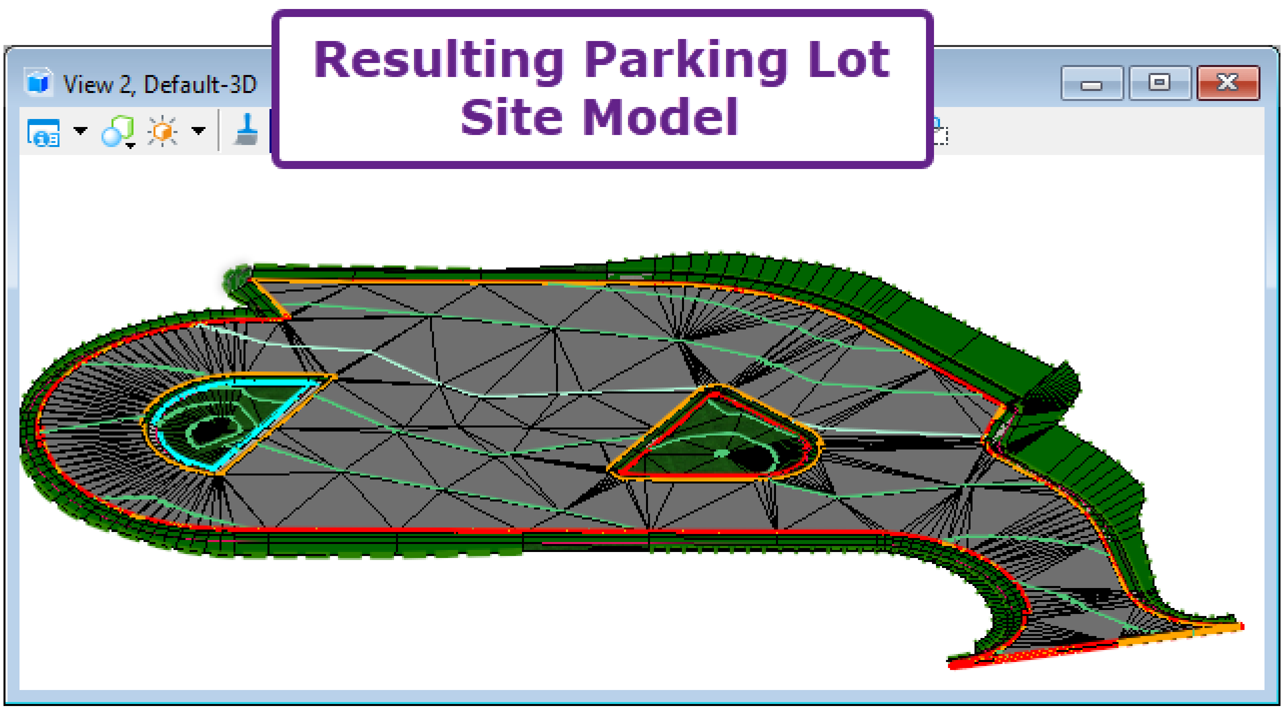
11C.7.c Apply a Surface Template to the Void Terrain Model

For the final step, a Surface Template is applied to the Terrain Model. For more information on this procedure, see *11C.5.b Apply the Surface Template to the Terrain Model*.

The Surface Template is a single material Component - consisting of 6-inches of Topsoil.







FINAL MODEL PREPARATION: The *Resulting Parking Lot Site Model* (shown above) is ready to be displayed in plans and *Sheet Models* . However, the User may need to perform additional tasks to prepare the site model for **construction staking**. For example, it may be desirable to join all individual Terrain Models and Linear Templates into a single, combined Finished Grade surface. The final preparation of Corridors and site models is discussed in *Chapter 22 – Proposed Terrain Model Creation*.

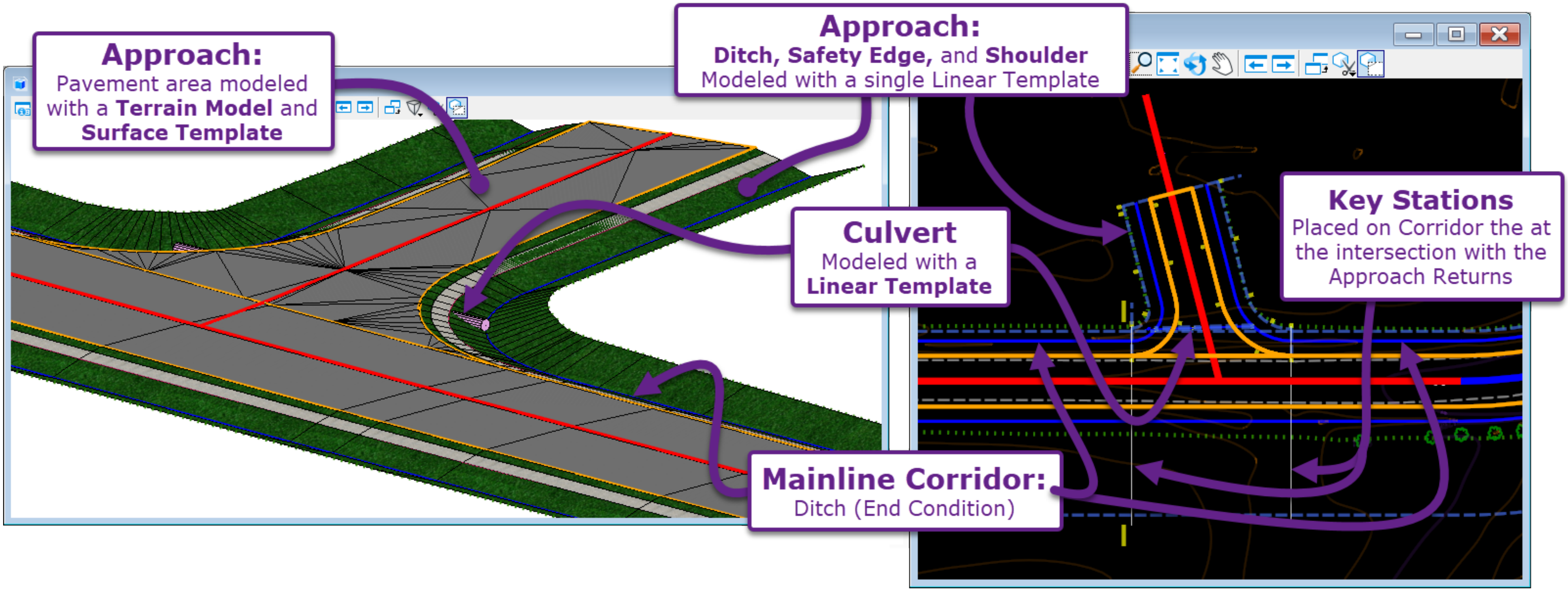
To calculate the cut/fill earthwork quantities for the model, see *Chapter 20 – Quantities*.

11D – DRIVEWAY APPROACH WITH CULVERT - WORKFLOW

In this workflow, a Driveway Approach with a culvert is modeled. The Approach contains a ditch line that converges with the Mainline Corridor ditch line. The Approach pavement area is modeled with a Terrain Model and a Surface Template – in the same processes shown in *11A.2 Surface Templates and Terrain Models – Process Overview*.

Located on the outside perimeter, the Approach Ditch, Safety Edge, and Shoulder components are modeled with a Linear Template. This is the same process shown in *11A.3 Linear Template – Process Overview*.

***IMPORTANT*:** Key Stations (Corridor Objects) must be placed on the Mainline Corridor – at the location where the Approach returns intersect with the Corridor edge of pavement. To align the Approach Ditch and End Conditions with the Mainline Corridor, the Corridor must be processed (with Key Station Template Drops) in these exact locations.

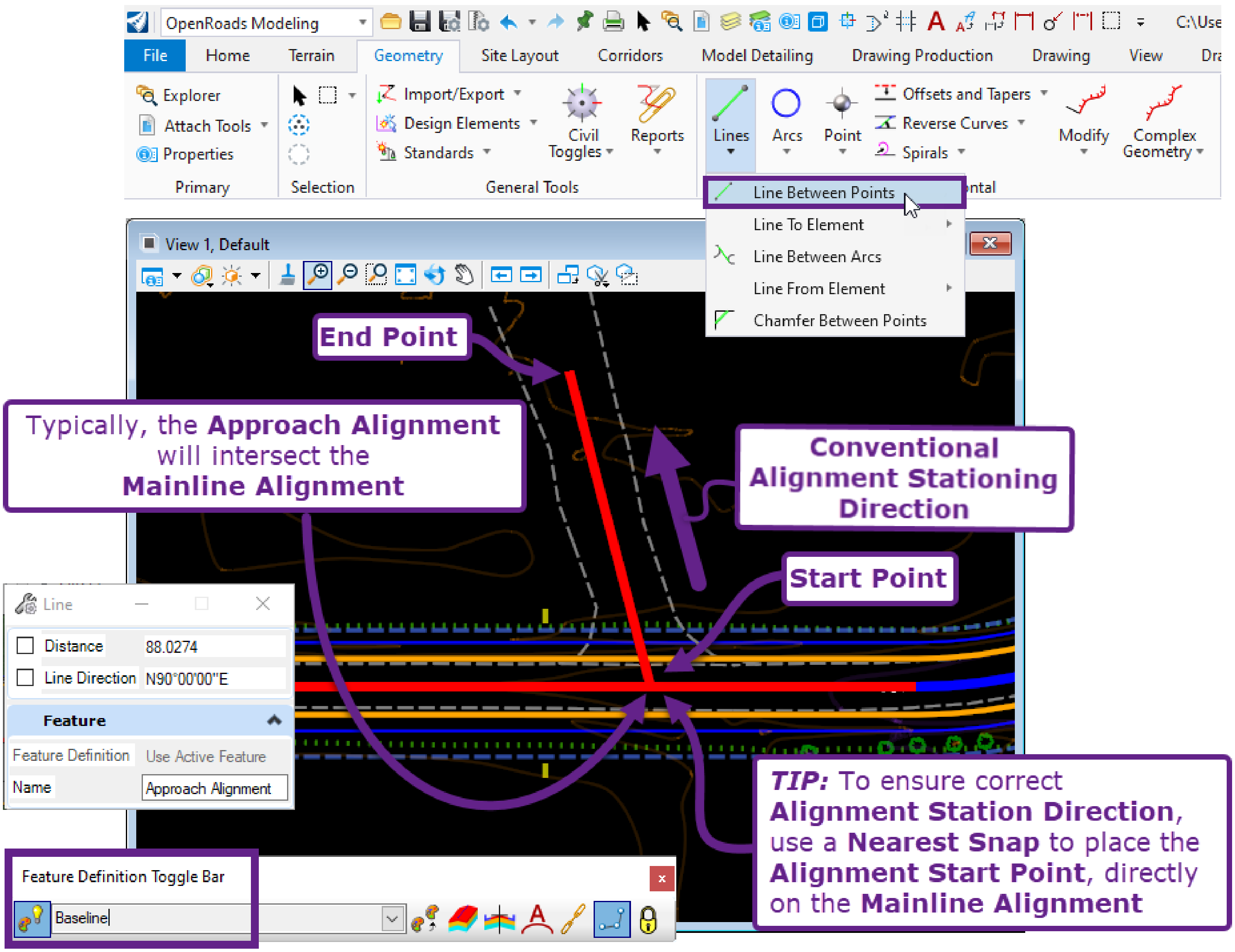


11D.1 Create the Approach Alignment and Profile

11D.1.a Draw the Approach Alignment

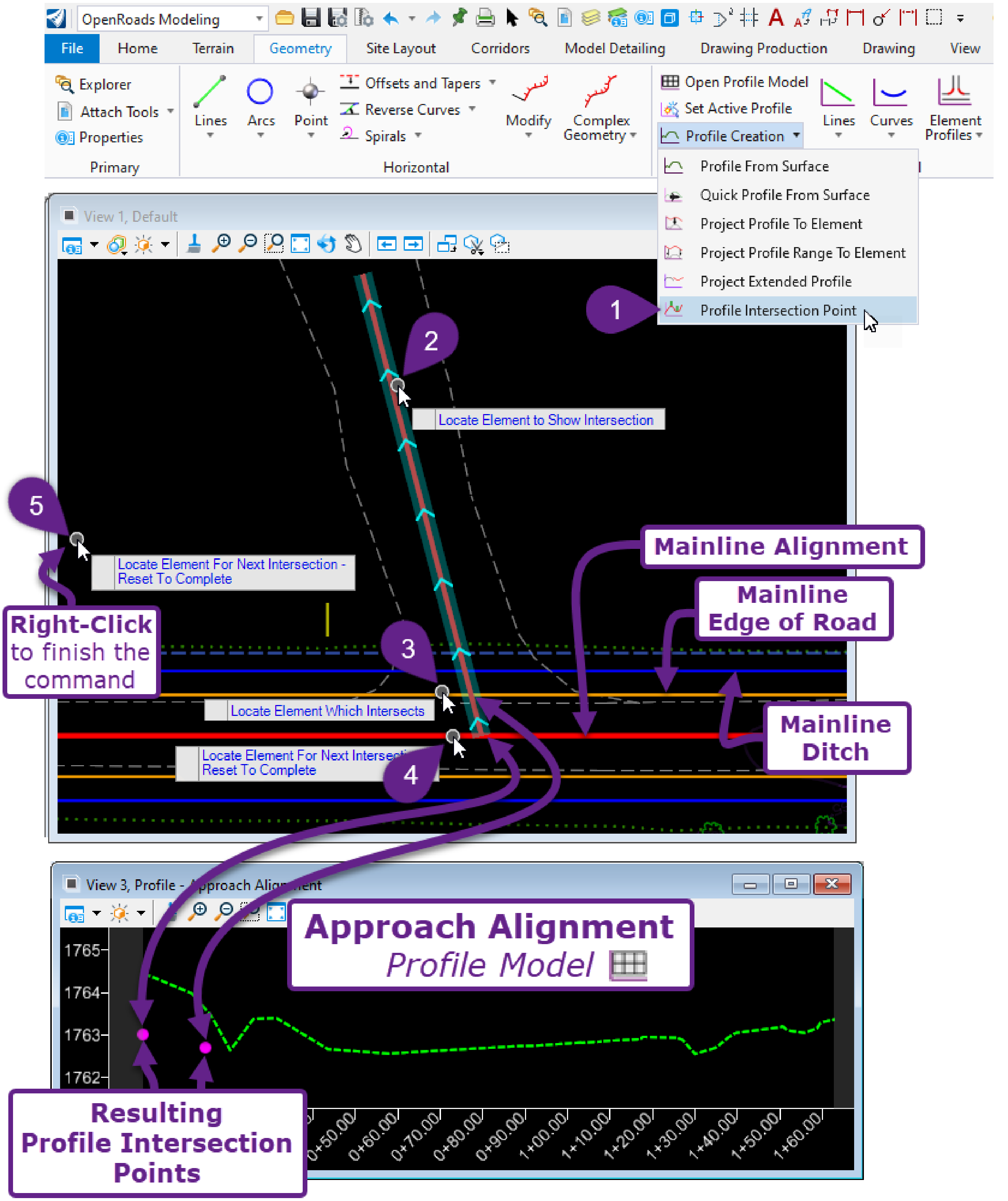
In this step, the Approach Alignment is drawn. The Approach Alignment is typically drawn with Horizontal ORD Elements – which are discussed in *7C – Create Horizontal ORD Elements*. Shown below, the simple Approach Alignment consists of single Line created with the *Line Between Points* tool.

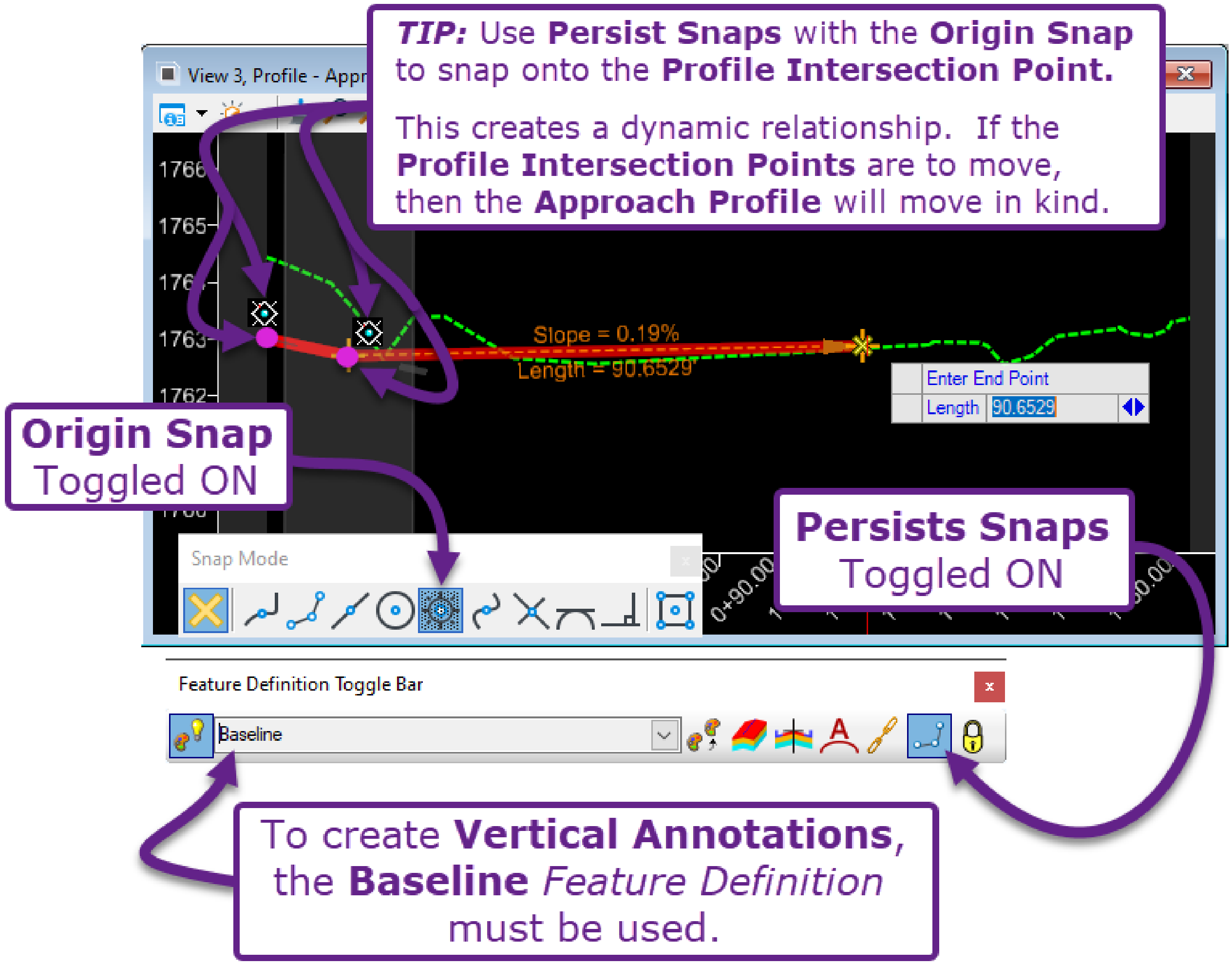
NOTE: To show stationing annotations, the Approach Alignment should be assigned to the "Baseline" Feature Definition.

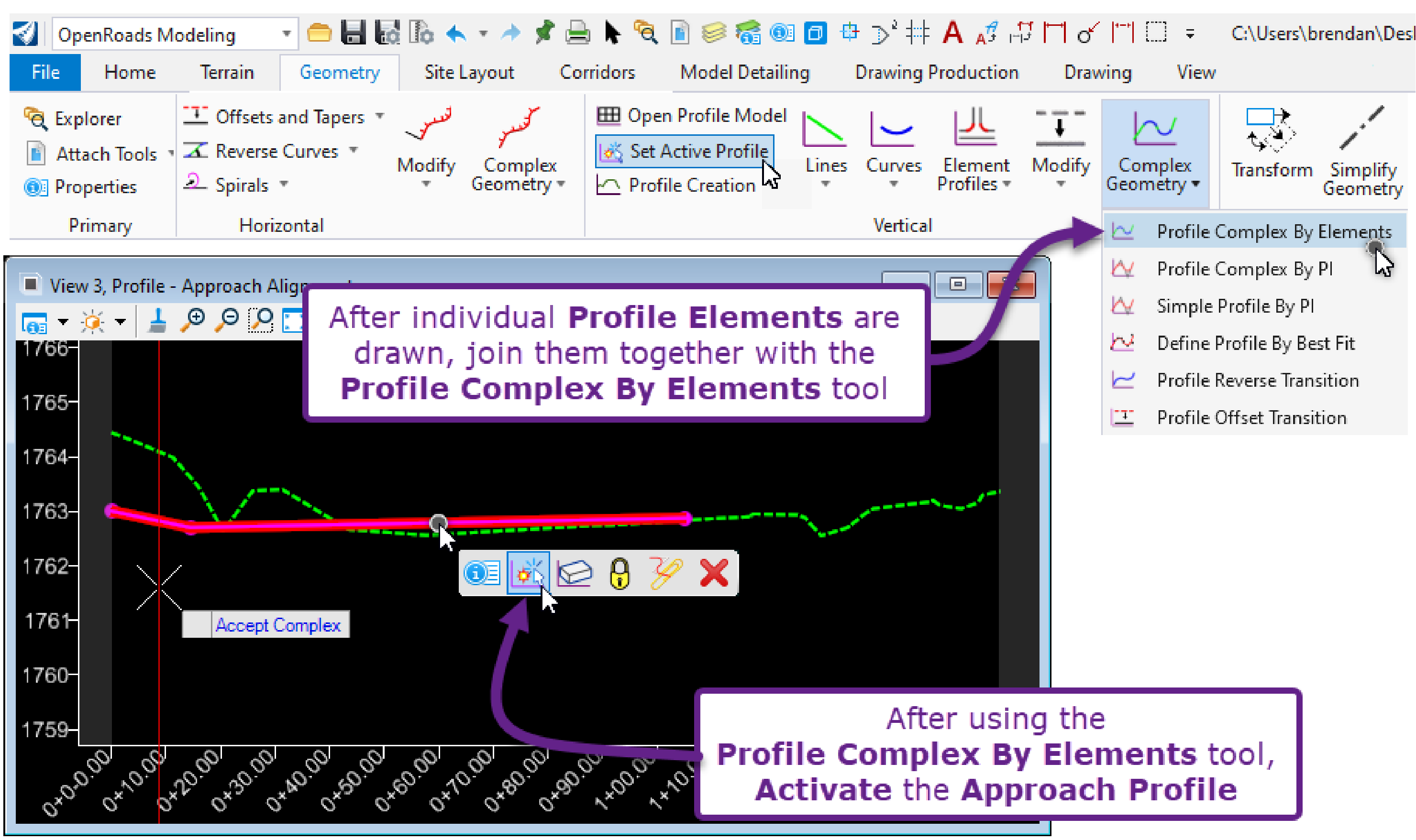


11D.1.b Draw the Approach Profile using the Profile Intersection Point tool

Using the *Profile Intersection Point* tool, the **Approach Profile** can be drawn to exactly match the elevations of the **Mainline Alignment** and the **Mainline Edge of Road** at the intersecting locations. The *Profile Intersection Point* tool is discussed in detail in *7F.4.f Profile Intersection Point*.



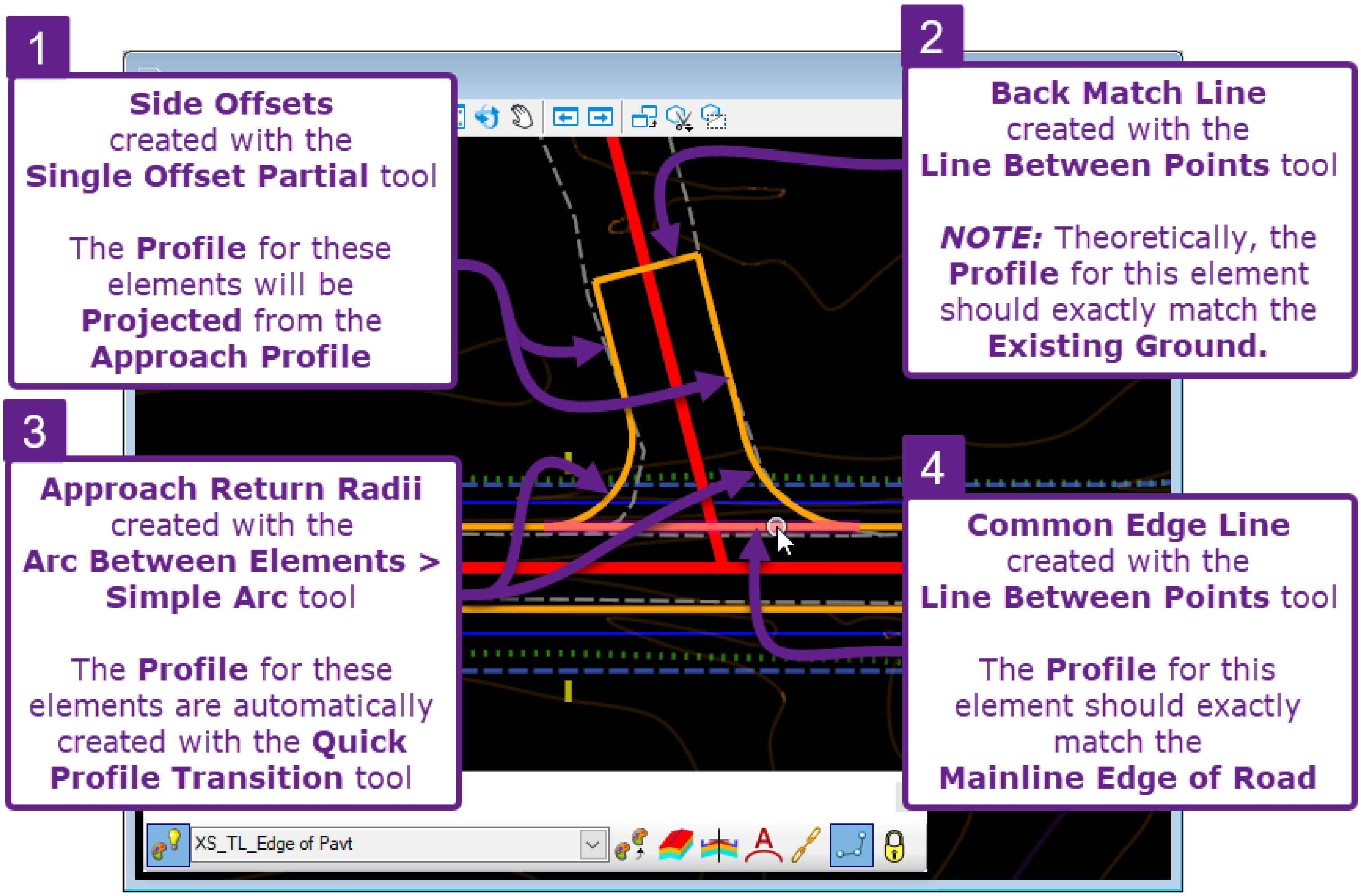

TIP: Use Persist Snaps with the Origin Snap to snap onto the Profile Intersection Point.
This creates a dynamic relationship. If the Profile Intersection Points are to move, then the Approach Profile will move in kind.
View 3, Profile - Appr
Slope = 0.19%
Length = 90.6529
Enter End Point
Length 90.6529
Origin Snap Toggled ON
Snap Mode
Persists Snaps Toggled ON
Feature Definition Toggle Bar
Baseline
To create Vertical Annotations, the Baseline Feature Definition must be used.


OpenRoads Modeling
File
Home
Terrain
Geometry
Site Layout
Corridors
Model Detailing
Drawing Production
Drawing
View
Explorer
Attach Tools
Properties
Primary
Offsets and Tapers
Reverse Curves
Spirals
Horizontal
Modify
Complex Geometry
Open Profile Model
Set Active Profile
Profile Creation
Lines
Curves
Element Profiles
Modify
Complex Geometry
Transform
Simplify Geometry
Vertical
Profile Complex By Elements
Profile Complex By PI
Simple Profile By PI
Define Profile By Best Fit
Profile Reverse Transition
Profile Offset Transition
View 3, Profile - Approach Align
After individual Profile Elements are drawn, join them together with the Profile Complex By Elements tool
Accept Complex
After using the Profile Complex By Elements tool, Activate the Approach Profile

11D.2 Draw the Terrain Model Boundary Geometry

In this step, the perimeter of the Approach is drawn, which will serve as the Terrain Model Boundary. There are many methods and sequences for the creation of the Approach perimeter. However, this sequence uses advanced techniques to dynamically relate the Approach Alignment and Profile to the Terrain Model geometry.

In this workflow, the overall sequence for creating the Terrain Model Boundary geometry is shown below:



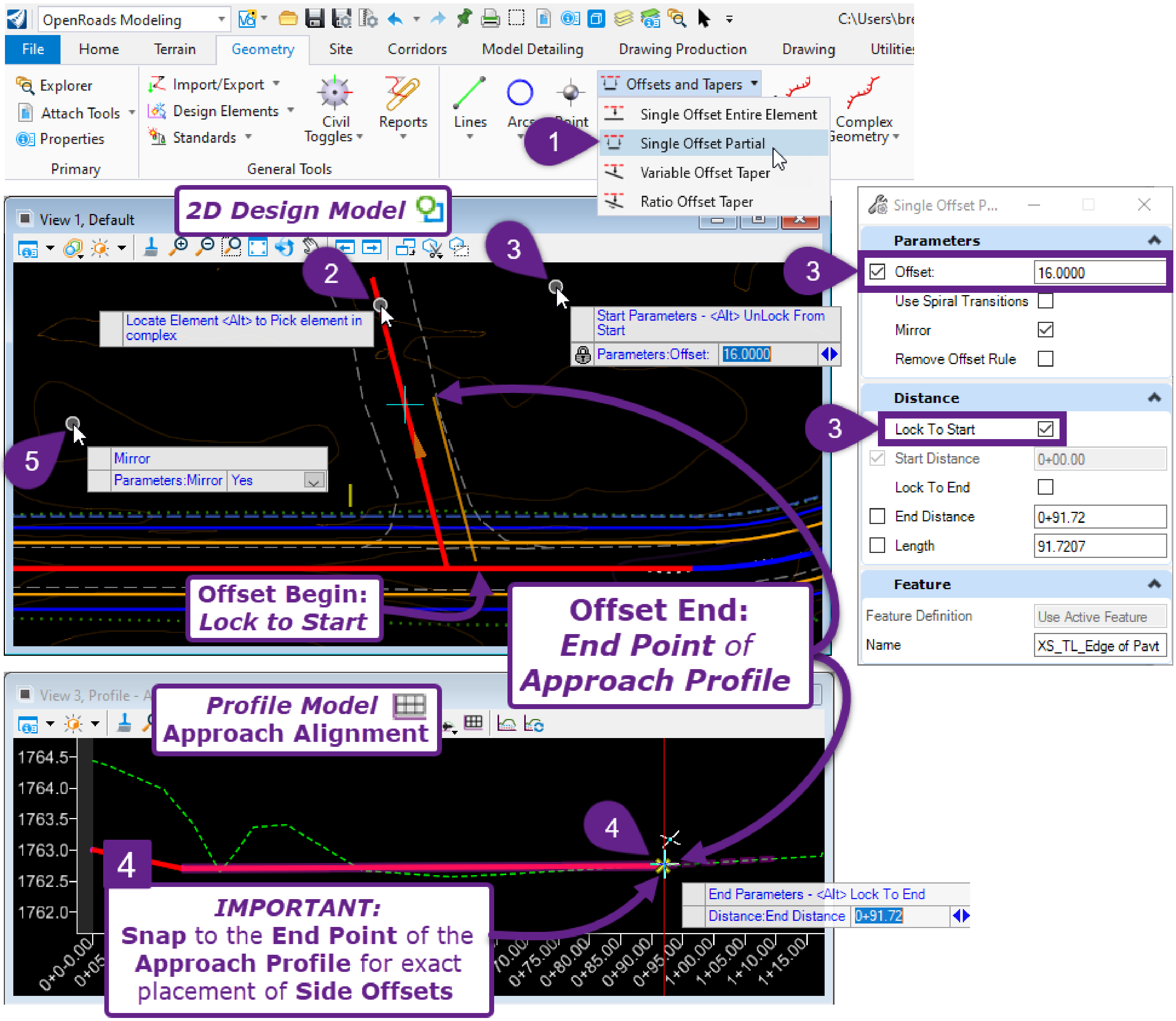
11D.2.a Create the Side Offsets from Approach Alignment and Profile

In this step, the **Side Offsets** are created by directly from the Approach Alignment/Profile. The **Side Offsets** are created with the *Single Offset Partial* tool, which is discussed in detail in *7D.3.b Single Offset Partial*.

For this step, the User should have two *Views* open:

View 1: A *View* should be open that is displaying the *2D Design Model*

View 2: A *View* should be open that is displaying the *Profile Model* for the Approach Alignment



1	From the Ribbon, select the *Single Offset Partial* tool: [***OpenRoads Modeling*** → ***Geometry*** → ***Horizontal***].
2	Select (left-click on) the **Approach Alignment** as the *Reference Element*.
3	Set the Start Offset parameters in the *Dialogue Box*: Key-in the desired *Offset* value. Check the *Lock To Start* box. Left-Click in the *View* to advance to the End Offset parameters.
4	Theoretically, the End Offset station should exactly align with the End Point of the Approach Profile. To ensure exact placement of the **Side Offset**, place the mouse-cursor in the *Profile Model* of the Approach Alignment. In the *Profile Model*, **Snap** (left-click) to the **End Point** of the **Approach Profile** for exact placement of the **Side Offsets**.
5	To draw the symmetrical **Side Offset** of the opposite side of the **Approach Alignment**, use the **Mirror Option**.

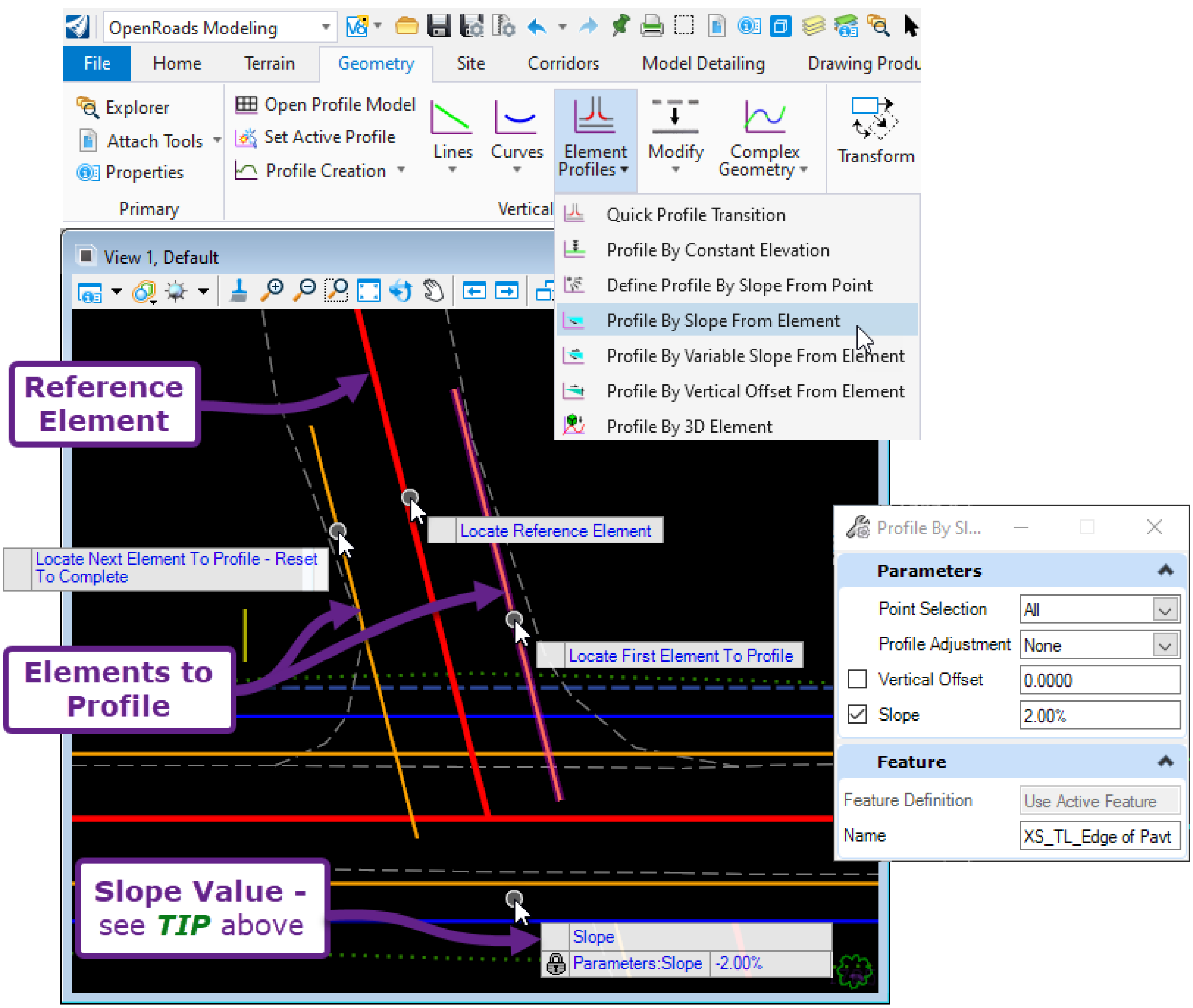
11D.2.b Create the Profile for the Side Offsets

The Profiles for the **Side Offsets** can be created manually or automatically. Manual creation of the **Side Offsets** is commonly performed after the remaining perimeter elements have been created and joined into an *Enclosed Alignment*.

Using the *Profile By Slope From Element* tool or the *Profile By Variable Slope From Element* tool (discussed in *7F.5.d* and *7F.4.e* respectively) the **Side Offset** Profiles can be created automatically by referencing the Approach Profile. For example, these tools can be used to project a crown on to the **Side Offsets** (i.e., 2% projection from the Approach Alignment/Profile to the Side Offsets).

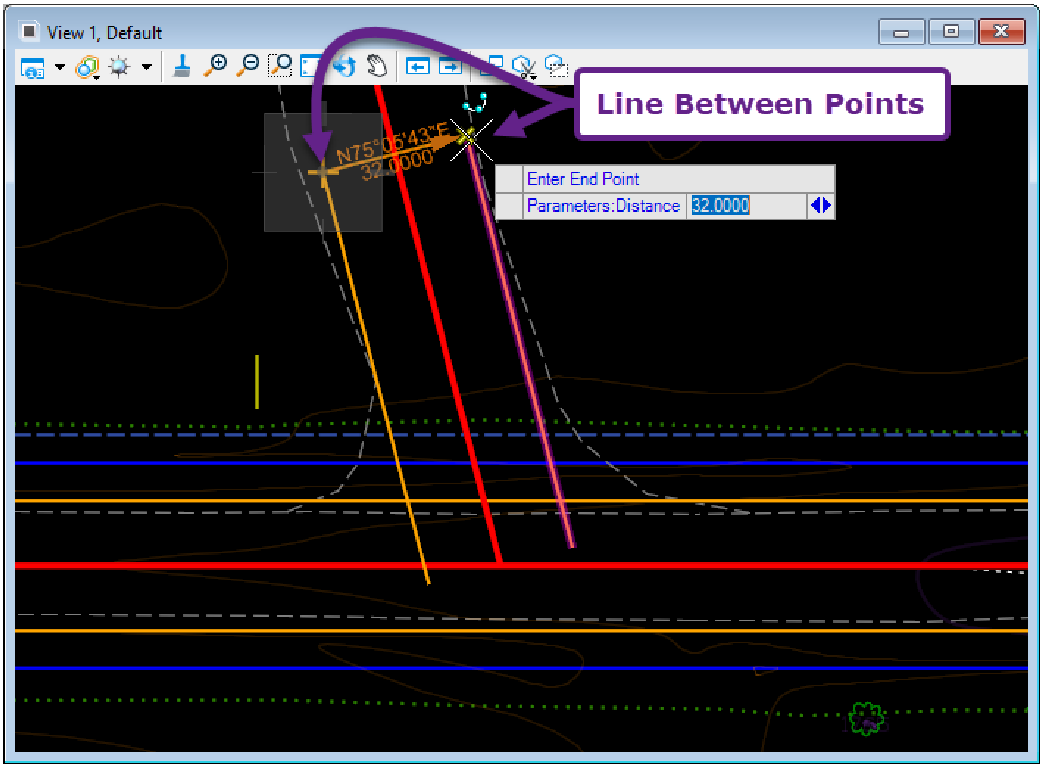
WARNING: If the existing is NOT crowned, then it may NOT be appropriate to put a crown into the proposed Approach Road model (i.e., by using the *Profile Projection* tools). An inappropriate use of a crown would create an abrupt transition between the proposed Approach model and existing ground along the **Back Match Line**. This ***WARNING*** is demonstrated in the graphic for **Method 2 –** which is shown in the next section: *11D.2.c Create the Back Match Line and Profile*.

TIP: To create a *Crown*, the **Approach Profile** should be projected to BOTH **Side Offsets** at a -2.00% value. To create a *Reverse Crown* one of the **Side Offsets** should be set to -2.00% and the opposing **Side Offset** should be set to +2.00%.



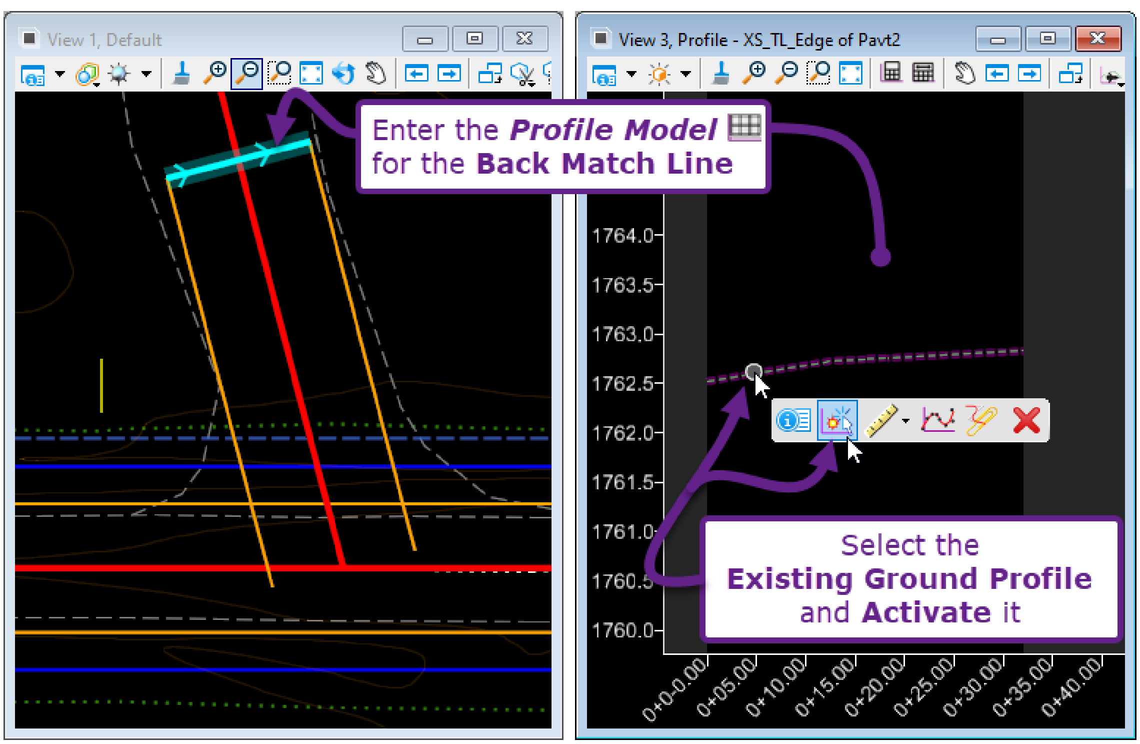
11D.2.c Create the Back Match Line and Profile

The **Back Match Line** is simply created by drawing a line between the end points of the two **Side Offsets**. Use the *Line Between Points* tool to perform this task. See *7D.1.a.i Lines Between Points*.



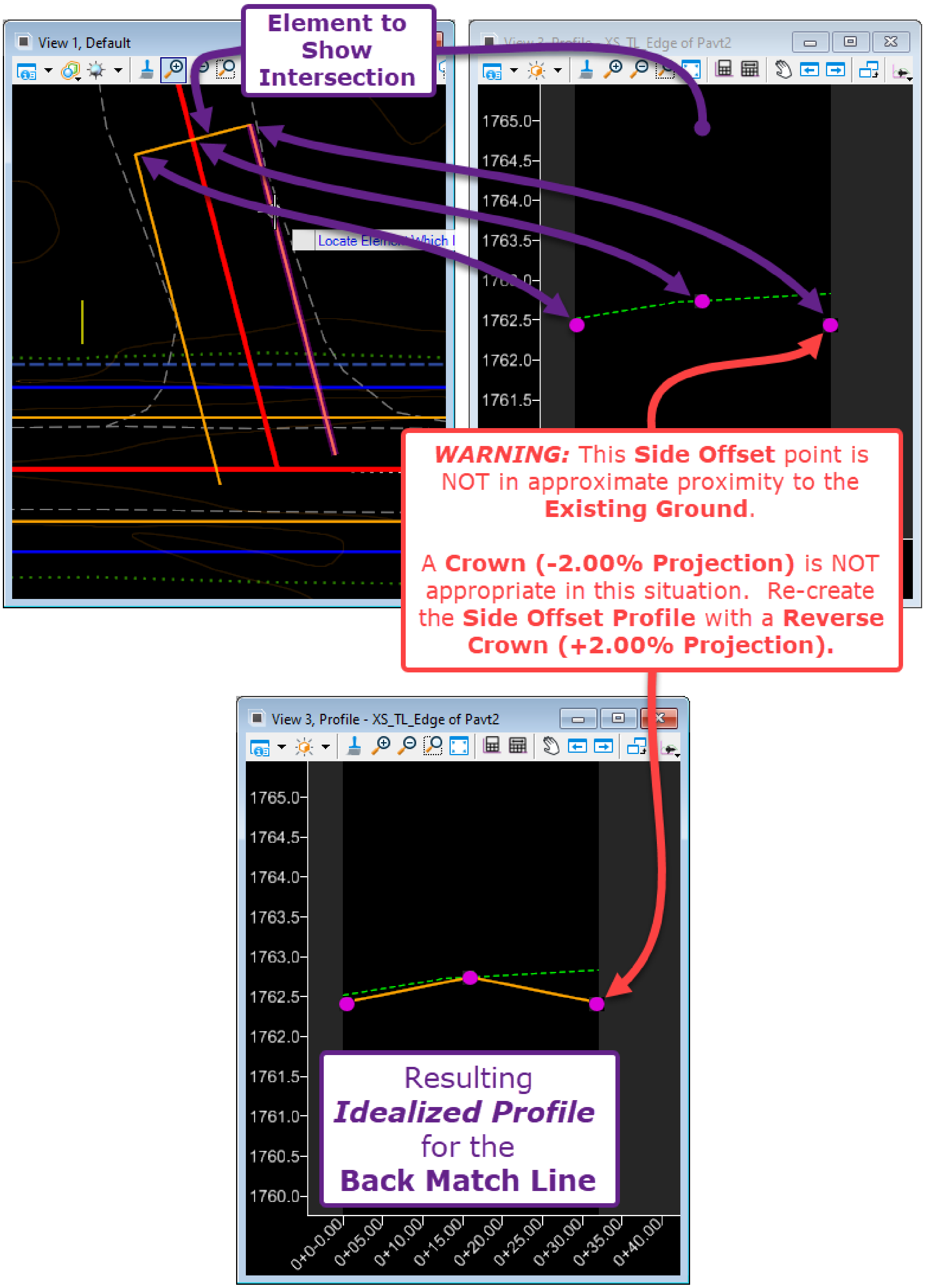
There are typically two methods for creating the Profile for the **Back Match Line.**

Method 1 – Use the Existing Ground for the Back Match Line Profile: Theoretically, this method reflects what occurs in real-world construction. In the example of an existing paved approach, the **Back Match Line** is where a sawcut is made. The proposed approach is paved directly up to the sawcut – matching the sawcut elevation profile exactly. The process for performing this method is shown below:



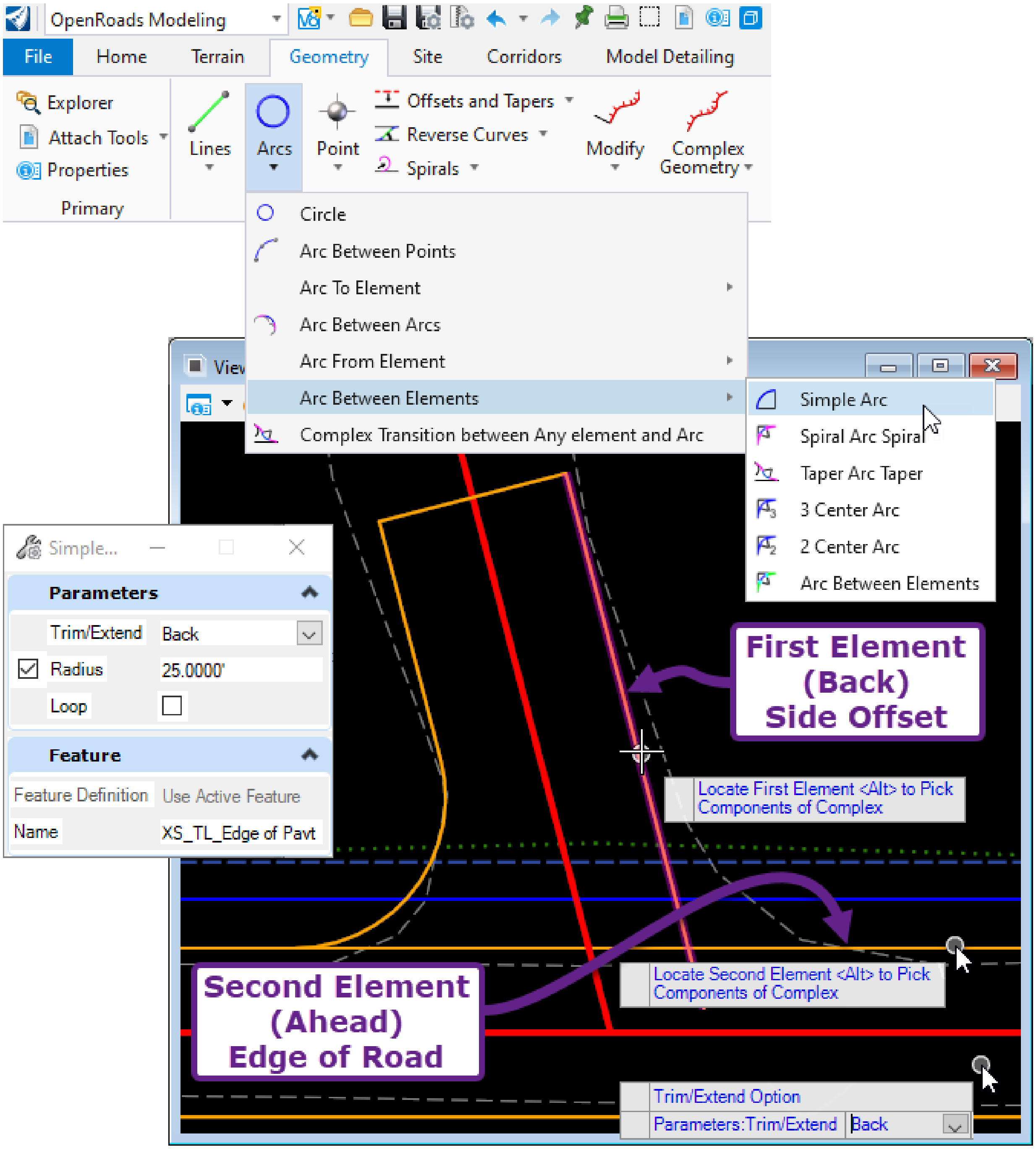
Method 2 – Use the Profile Intersection Point tool in conjunction with the Side Offsets and Approach Alignment: This method produces an idealized Profile for the **Back Match Line**. As shown below, this method involves making a Profile that may or may NOT match up with Existing Ground profile.

Use the *Profile Intersection Point* tool (see *7F.4.f Profile Intersection Point*) to project intersecting points into the *Profile Model* of the **Back Match Line**. Then, use two *Profile Line Between Points* to draw lines between the *Profile Intersection Points*. Join the two *Profile Lines* into a *Complex Profile Element* and *Activate* it. See *7F.2.a.i Profile Line Between Points* and *7F.3.a Profile Complex By Elements*.



11D.2.d Create the Approach Return Radii and Profile

The **Approach Return Radii** are created with the *Arc Between Elements > Simple Arc* tool. This tool is discussed in detail in *7D.1.b.vi Arc Between Elements*. The **Approach Return Radii** are simply a circular fillet between the **Side Offset** and **Mainline Edge of Road**.

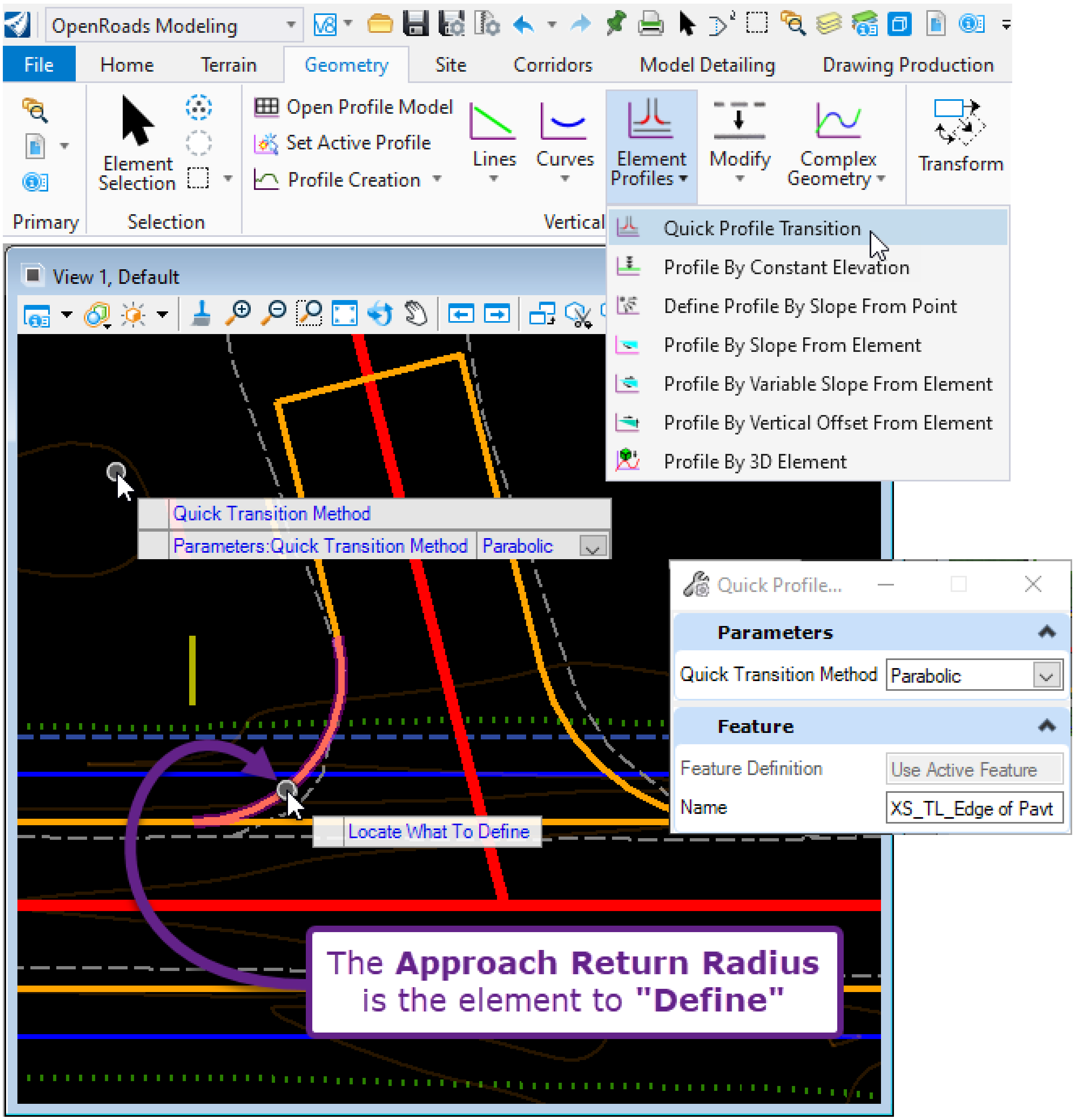


IMPORTANT: The **Side Offset** must be **Trimmed.** The **Mainline Edge of Road** (Corridor element) should NOT be trimmed.

If the **Side Offset** was selected **First**, then use the **Back** Trim Option.

The Profile for the **Approach Return Radii** can be automatically created with the *Quick Profile Transition* tool. This tool is specifically intended for **Approach Return Radii** that were created with the *Arc Between Elements > Simple Arc* tool (as shown on the previous page). This tool is discussed in detail in *7F.5.a Quick Profile Transition*.

For this tool to work, both elements used to create the **Approach Return Radii** – in this case, the **Side Offset** and the **Mainline Edge of Road –** must contain an *Active Profile*. The Profile for the **Mainline Edge of Road** is a function of the Mainline Corridor, Alignment, and Profile. This tool CANNOT be used before an *Active Profile* is created for the **Side Offset** element.

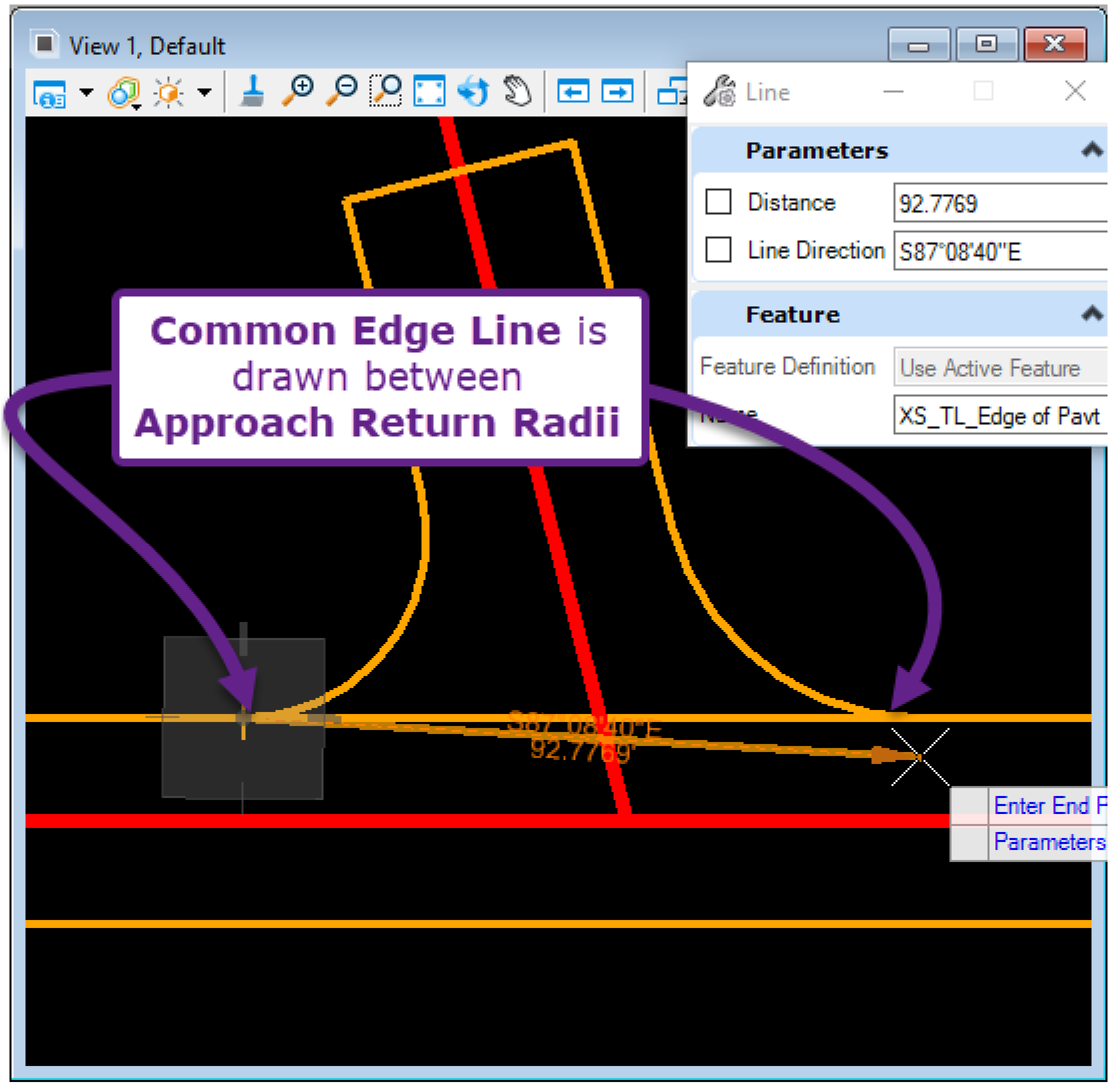


11D.2.e Create the Common Edge Line and Profile

The **Common Edge Line** is drawn between the two **Approach Return Radii**. The **Common Edge Line** should trace the **Mainline Edge of Road** both horizontally and vertically.

In this case, the **Common Edge Line** is created with the *Line Between Points* tool. See *7D.1.a.i Lines Between Points*.

The Profile for the **Common Edge Line** is created with the *Project Profile Range to Element* tool. This technique is shown in *11A.4.a Common Edges Among Adjacent Site Modeling Features*.



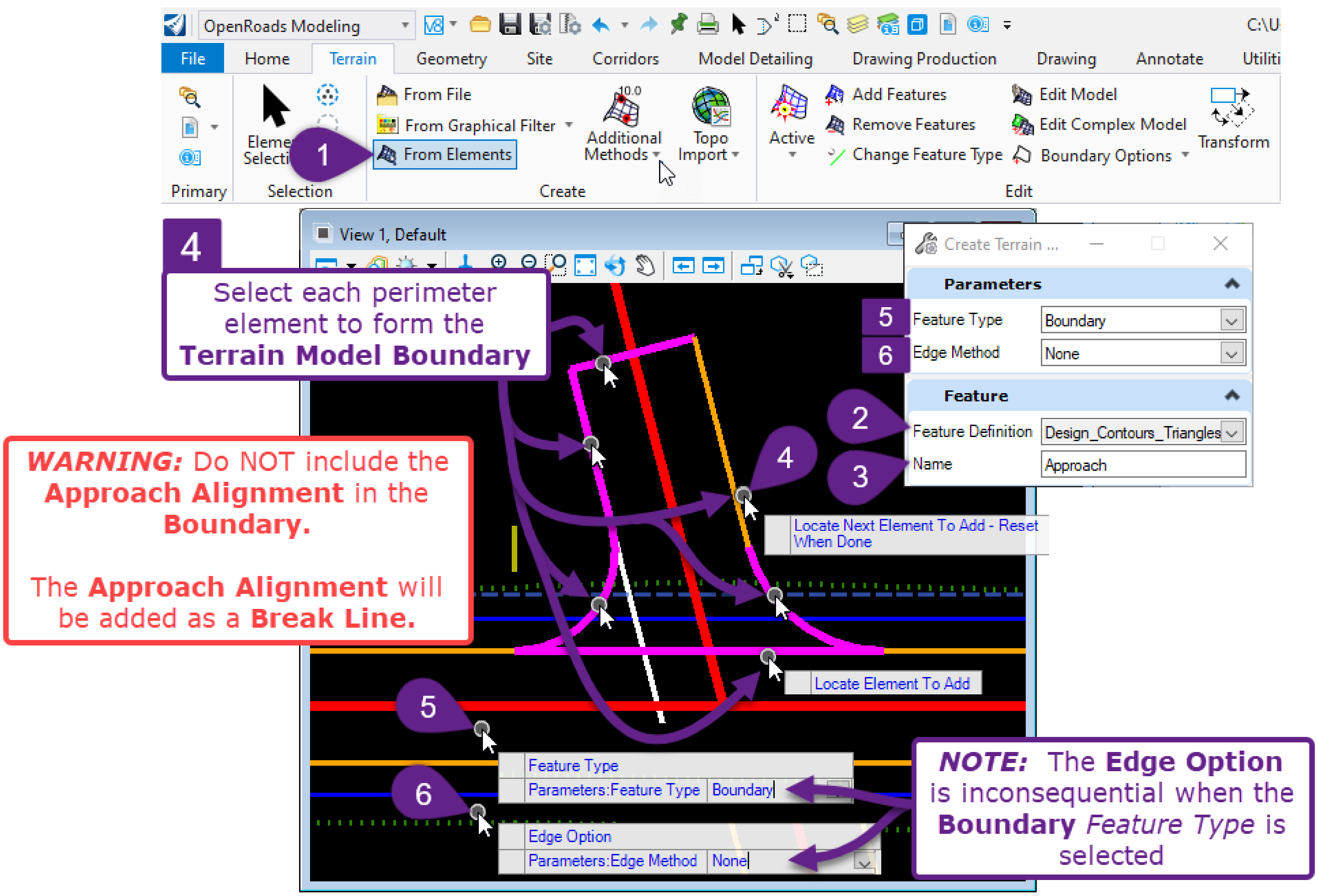
11D.3 Create the Terrain Model and Surface Template

11D.3.a Create the Terrain Model

In this step, the *From Elements* tool is used to create the Terrain Model from all elements that make up the perimeter of the approach.

NOTE: The User can optionally join all **Terrain Model Boundary** geometry elements into a single **Enclosed Shape** with the *Complex By Elements* tool. However, this NOT strictly necessary and can actually be detrimental. If Profiles were drawn for each individual element (as shown in previous steps), then these distinct Profiles become static and inaccessible when joined (*Complexed*). In other words, Profiles drawn individually, CANNOT be modified after the **Terrain Model Boundary** geometry elements are joined (*Complexed*). ***BEST PRACTICE:*** Only join **Terrain Model Boundary** geometry elements if the intent is to draw all Profile elements from the *View* of single **Enclosed Shape** *Profile Model*.

NOTE: Place the Terrain Model on a Feature Definition from the *Design* folder. For correct quantity calculations, proposed Terrain Models must be on a *Design* Feature Definition. It is recommended that the Terrain Model is initially placed on the "Design_Contours_Triangles" Feature Definition for initial configuration and manipulation. See *11B.1 Symbology Components and Feature Definitions*.

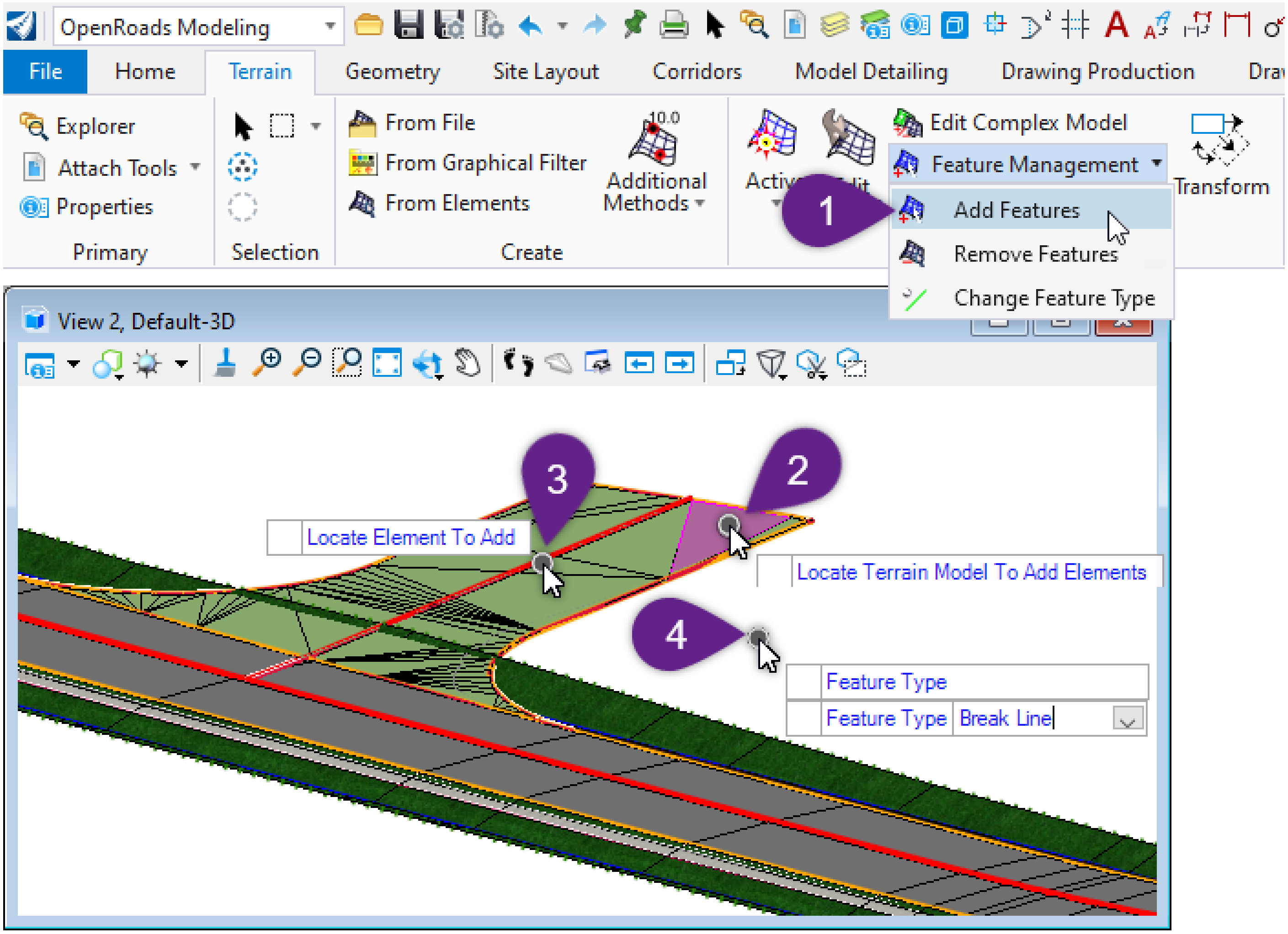


1	From the Ribbon, select the *From Elements* tool: [***OpenRoads Modeling*** → ***Terrain*** → ***Create***].
2	From the drop-down, select an appropriate *Design* **Feature Definition** for the Terrain Model. Terrain Model **Feature Definitions** are also discussed in *11B.1 Symbology Components and Feature Definitions.*
3	Assign an appropriate Name to the proposed Terrain Model. For Terrain Model naming conventions, see *3F – Naming Convention For Proposed ORD Features*. ***TIP:*** It is strongly recommended that proposed Terrain Models are given logical and distinct Names. When numerous Terrain Models are created in the same ORD File, the Naming convention is crucial for distinguishing between Terrain Models.
4	*Prompt: Locate Elements to Add* – Left-Click on each element that will constitute the **Terrain Model Boundary**. ***WARNING:*** Do NOT select the **Approach Alignment**. The **Approach Alignment** will be added to the Terrain Model as a *Break Line* in the next step.
5	*Prompt: Feature Type* – Select the *Boundary* option.
6	*Prompt: Edge Options* – This option is inconsequential when the *Boundary* option is selected. Typically the *None* option is used.

11D.3.b Add the Approach Alignment to the Terrain Model as a Break Line

In this step, the **Approach Alignment** is added to the **Terrain Model**. Using the *Add Features* tool, the **Approach Alignment** is added as a *Break Line*.

This process is also discussed in greater detail in *11A.2.b Adding Break Lines to a Terrain Model* and *11C.4.b Create a Break Line to serve as a Ridge or Swale*.

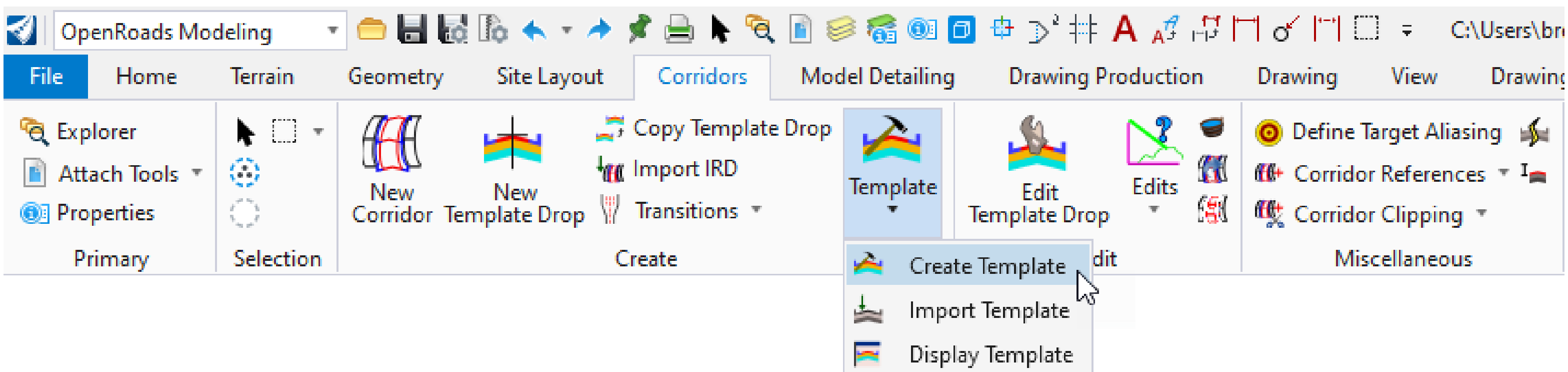


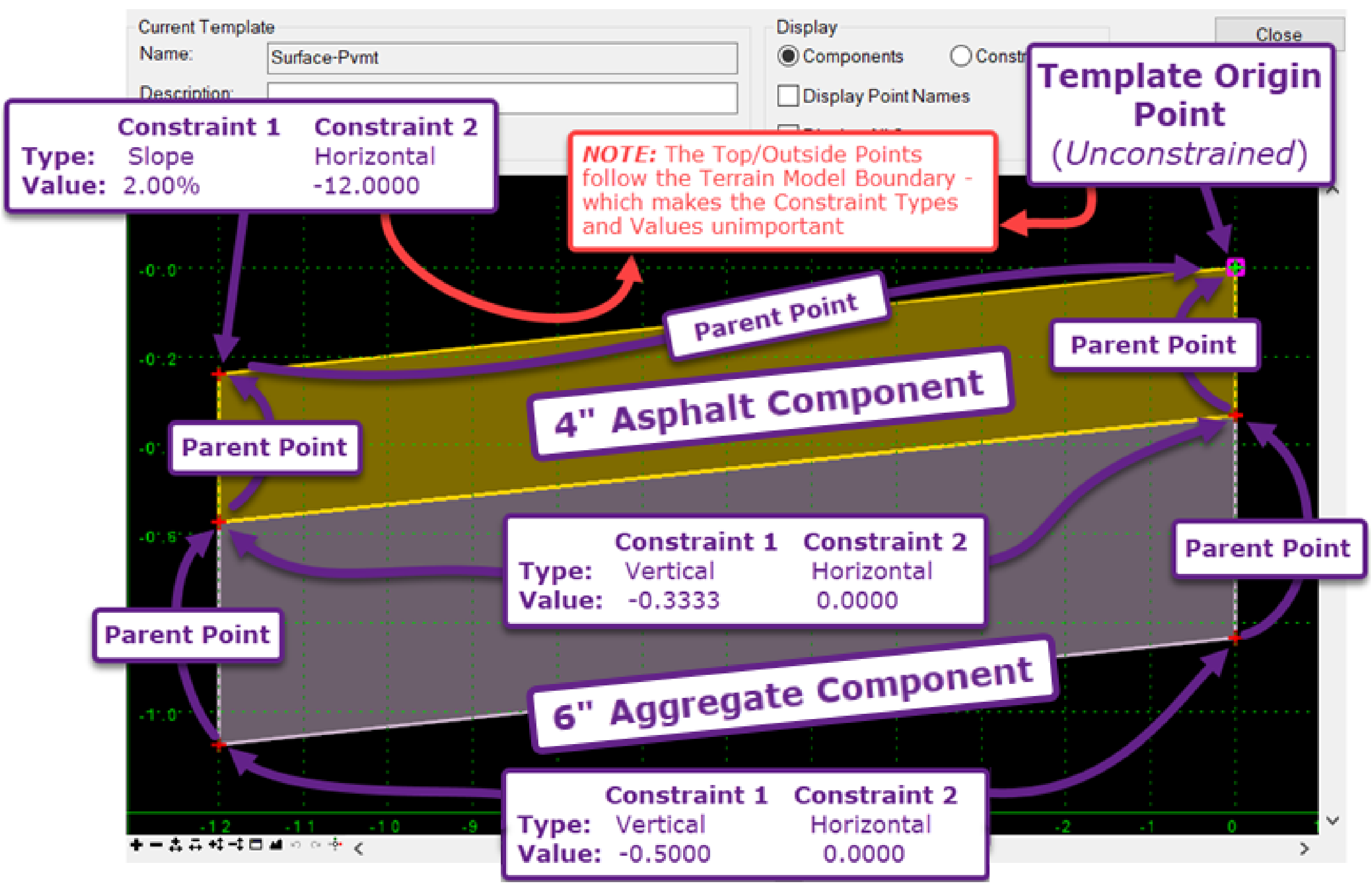
11D.3.c Create and Apply the Surface Template to the Terrain Model

With the **Approach Terrain Model** fully defined, a pavement section *Surface Template* can be created in the Template Editor and then applied to the Terrain Model with the *Apply Surface Template* tool. This procedure is covered in more detail in:

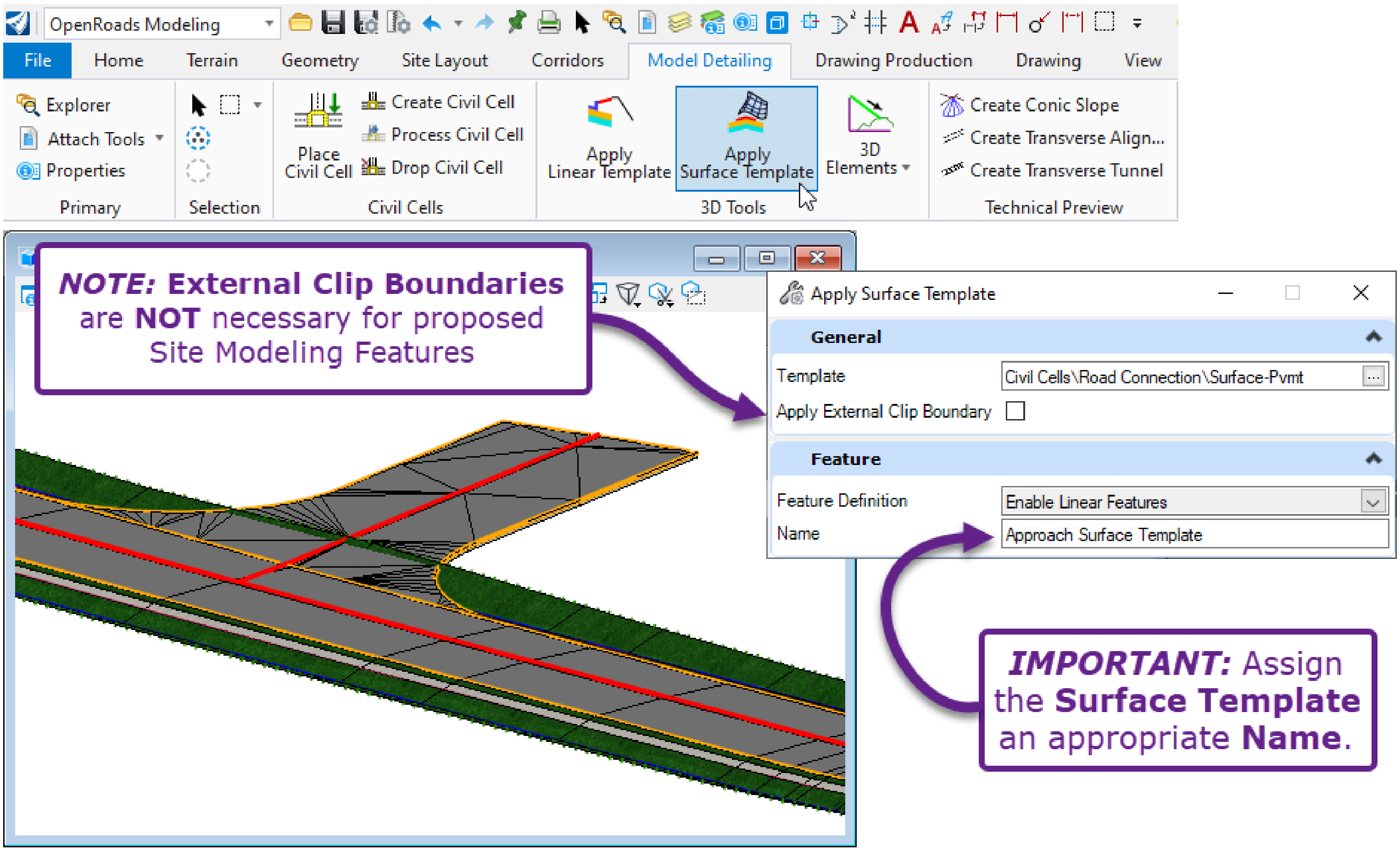
- *11A.2.c Create Surface Templates in the Template Editor*
- *11A.2.d Apply the Surface Template to the Terrain Model*

Create the Surface Template in the Template Editor:





Apply the Surface Template to the Terrain Model:



11D.4 Create the Linear Template around the Terrain Model Boundary

In this step, Linear Templates for the Approach edge Boundary are created. The Linear Template *Components* include an Asphalt Safety Edge, Aggregate Shoulder, and Cut/Fill End Conditions.

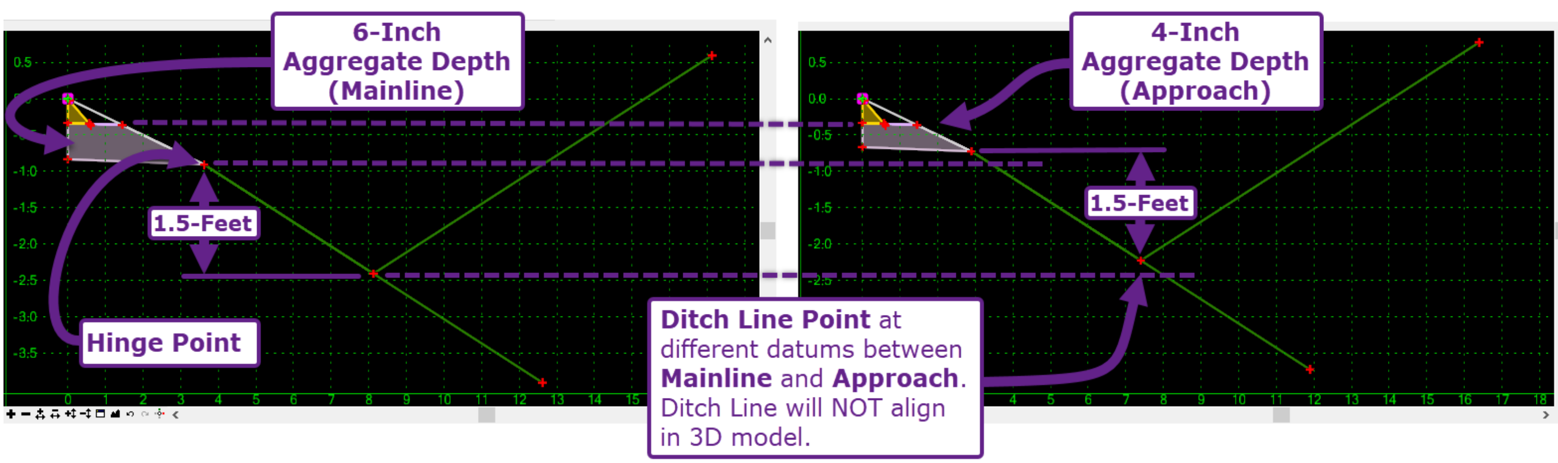
11D.4.a Align Ditch Lines for Mainline and Approach

The most problematic part of creating Approach models is precisely aligning the **Ditch line** between the Mainline Corridor and the Approach Linear Template. Some common factors that may affect continuous ditch alignment between the Mainline and Approach ditch include:

- **Matching Template Components between the Mainline and Approach –** The configuration of the Asphalt Safety Edge, Aggregate Shoulder, and Ditch End Condition components should be exactly the same between the Mainline and Approach. The User can ensure an exact match between the Corridor and Linear Template by creating the Linear Template directly from the Corridor Template. This can be accomplished by **copying the Corridor Template** and **deleting** all **Components** that are NOT to be used in the Linear Template. This process ensures that the Corridor and Linear Template contain matching slopes and depths for all Components. This process is shown in *11D.4.b Create the Linear Template in the Template Editor*.

- **Differing Pavement Section between Mainline and Approach** – To reduce costs, some projects use a reduced pavement section for Approaches. This design scenario results in differing Template Components between the Mainline and Approach. In this scenario, the Hinge Point may be located at different elevation datums. This is problematic because the Ditch Line Template Point is usually placed relative (child) to the Hinge Point.

  In the graphic below, both the Mainline and Approach use a 1.5-foot depth ditch – relative to the Hinge Point. However, the Mainline uses a 6-inch depth of aggregate, while the Approach uses a 4-inch depth of aggregate. As a result, the Hinge Point is located on a different vertical datum for the two conditions. This means the Ditch Line Point would not align at the match point of the Mainline Corridor and Approach Linear Template models.

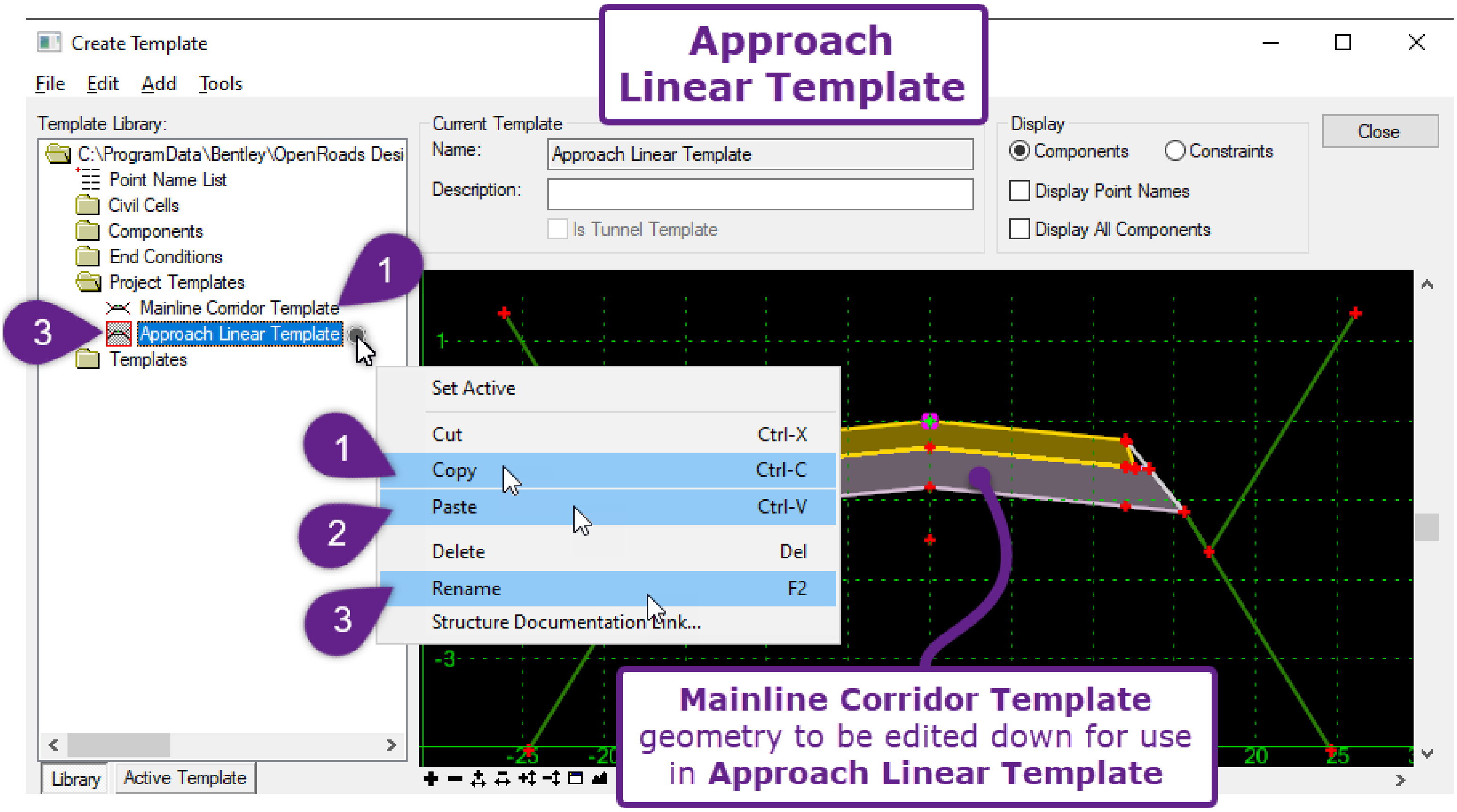


Superelevation – If the Mainline Corridor is located in a superelevation section (along a horizontal curve) or in a superelevation transition, then the project Approach Linear Template may NOT align due to similar circumstances shown in the graphic above. Under superelevation conditions, the Hinge Point for the Mainline Corridor will be located on a different vertical datum than the Approach Linear Template. To address this issue, a custom Linear Template has to be built to match Mainline Corridor superelevation conditions.

11D.4.b Create the Linear Template in the Template Editor

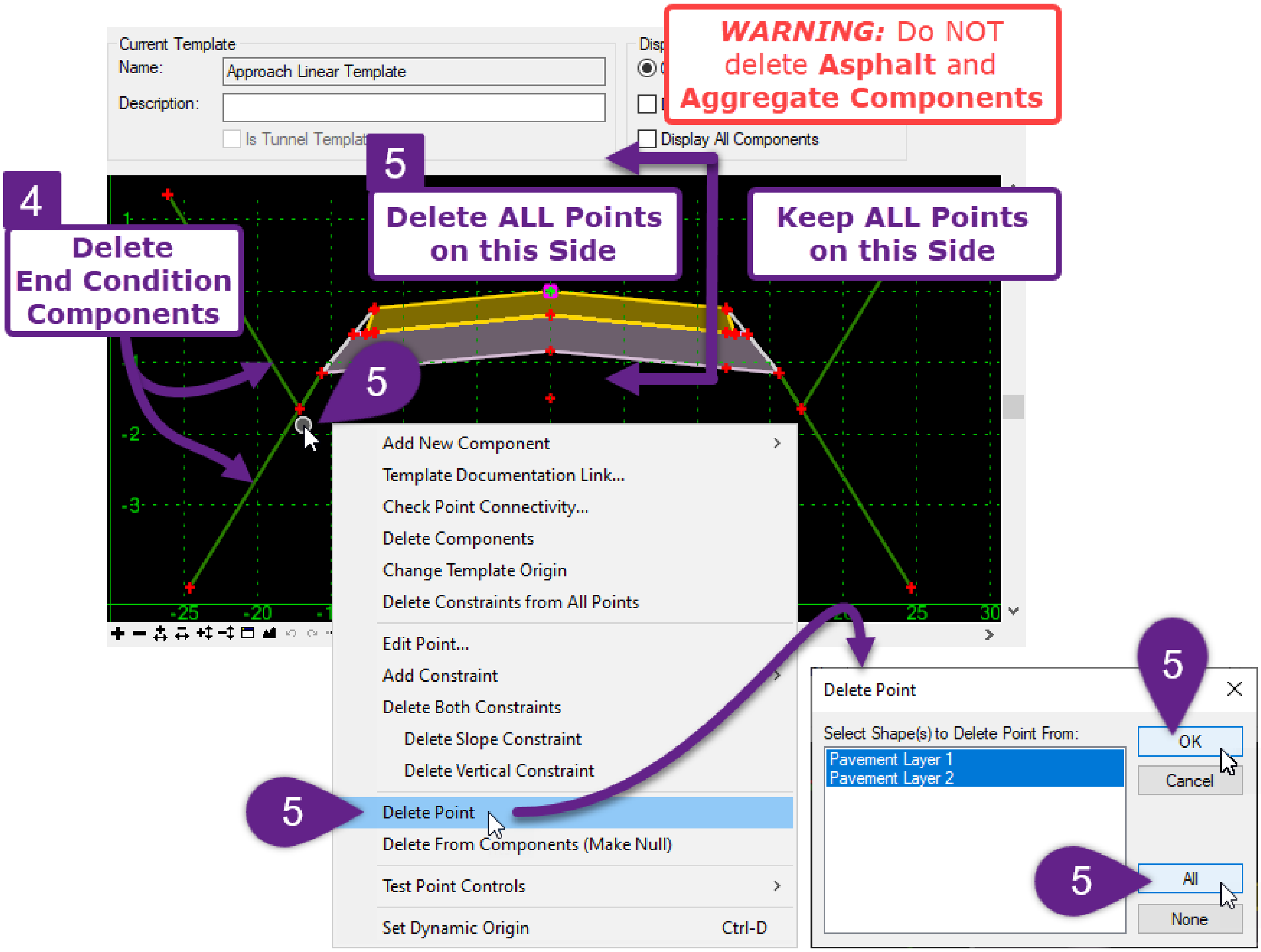
In this step, the User will create the Linear Template for the Approach by copying out and editing the Mainline Corridor Template. Opposed to creating a Linear Template from scratch, copying out the Mainline Corridor Template ensures that Approach Linear Template contains the exact same configuration for the Safety Edge, Aggregate Shoulder, and Ditch End Condition components.

The following steps are performed from the *Template Editor*.



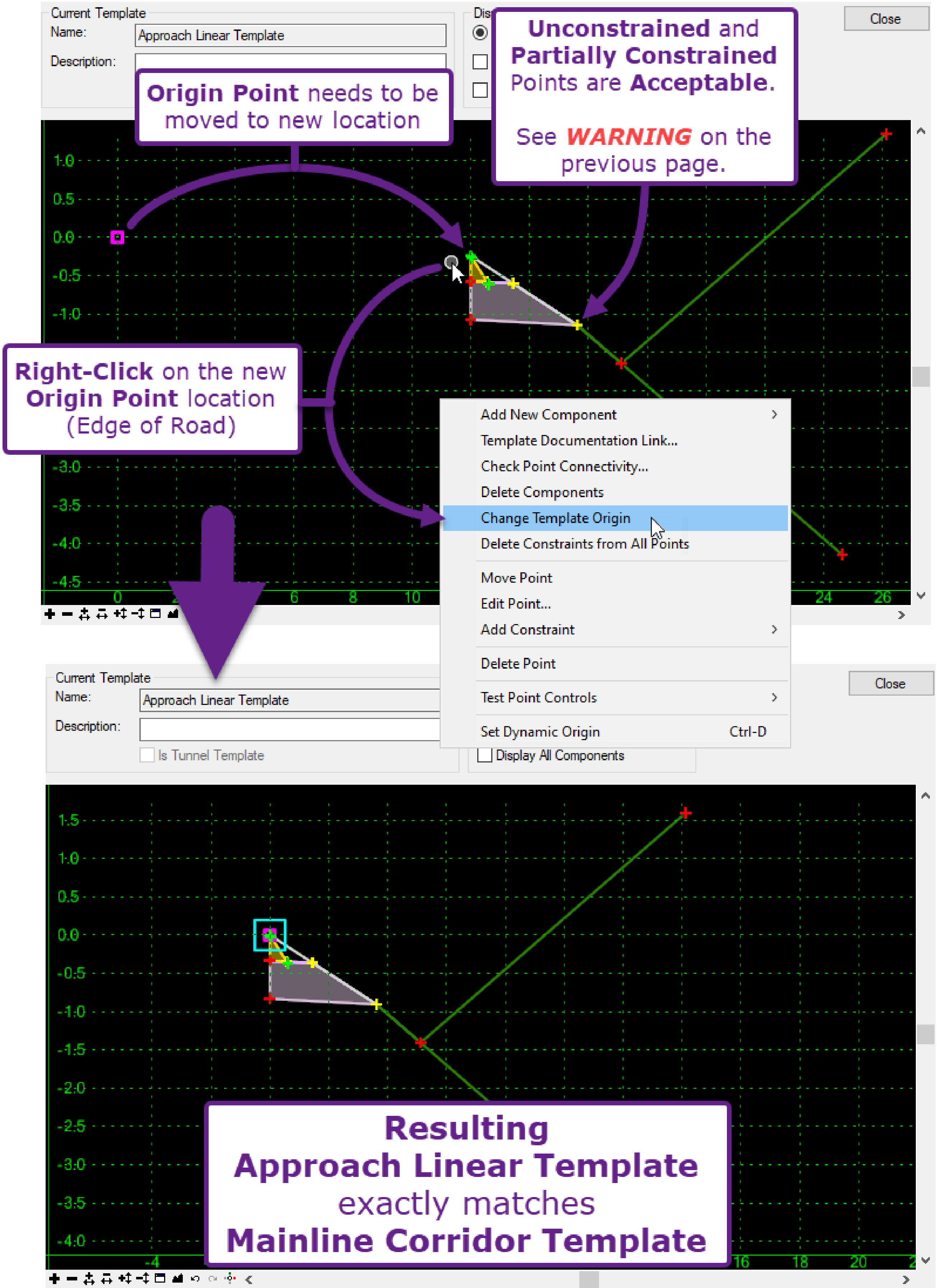
1	*Copy* the Mainline Corridor Template.
2	*Paste* the Mainline Corridor Template.
3	*Rename* the copied version of the Mainline Corridor Template. Double-click on the *Renamed* Template to *Activate* it.

In Step 5, all Points that are unneeded for the Approach Linear Template are deleted. This process can be tedious but ensures an exact match for the ditch lines used in the Approach and Mainline.



4	**Delete all Components Unnecessary for the Approach Linear Template**. The deletion of components is discussed in *8E.11 Delete Template Components*.
5	**Delete all Points that are Unnecessary for the Approach Linear Template.** Right-Click on each Point to be deleted. Select Delete Point. For Points that belong to multiple Components, the User will be prompted to *Select Shape(s) to Delete Pont From:*. Push the *All* button to select all Components and then push the *OK* button.

WARNING: As unnecessary Points get deleted, some of the Points needed for the **Approach Linear Template** side will become **Unconstrained** (Green ✚) or **Partially Constrained** (Yellow ✚). This is acceptable because even though the Points are **Unconstrained** and **Partially Constrained**, they are graphically located in the correct position. If Points are **Unconstrained** and/or **Partially Constrained**, they are placed in their graphical position when the Linear Template is created. Do NOT re-assign **Unconstrained** and **Partially Constrained** Points because of the risk of moving them out of alignment with the Corridor Template. For the final procedure in the Approach Linear Template creation, re-assign the **Origin Point** to the new location – which coincides with the Approach Terrain Model Boundary.

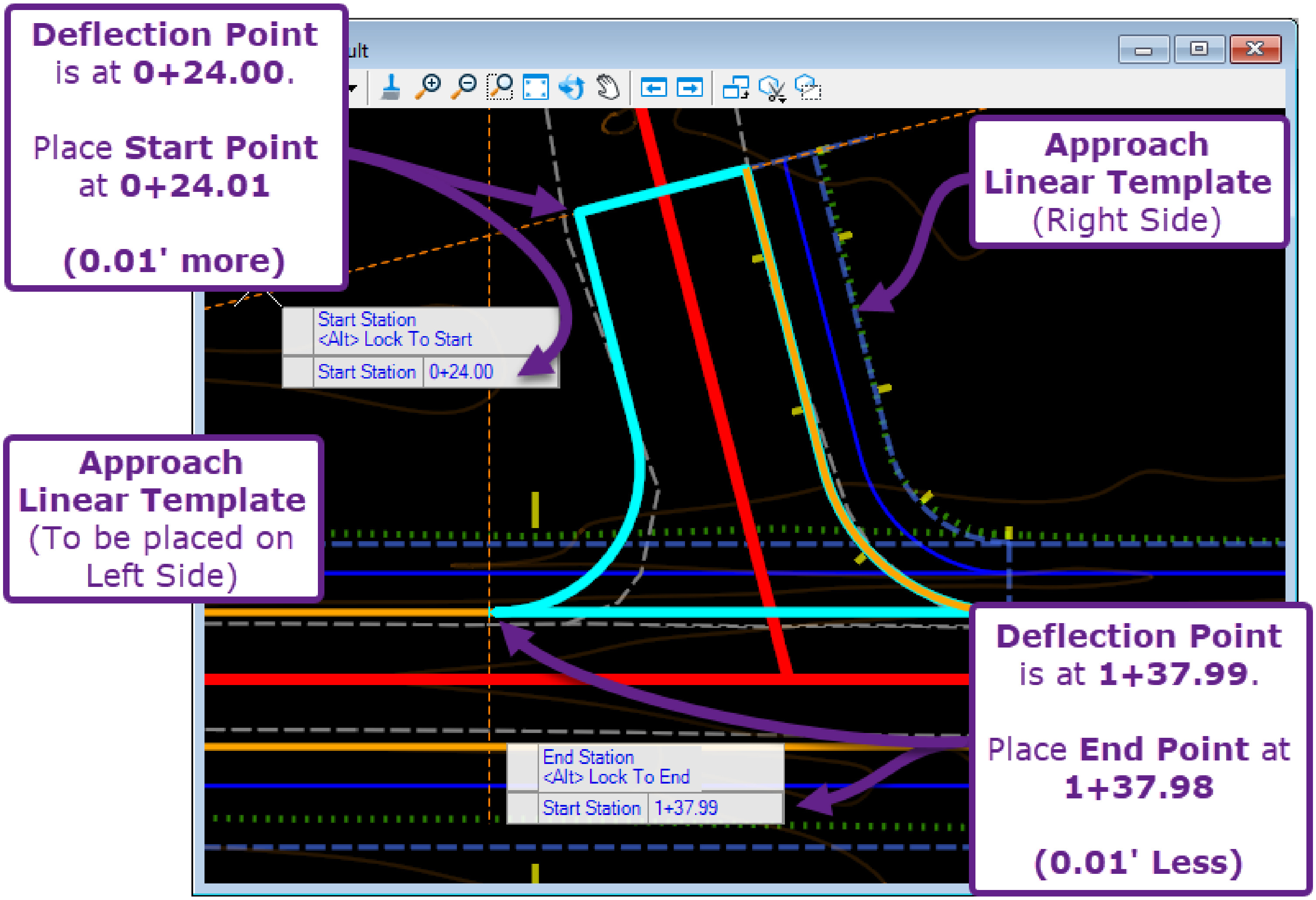

Current Template
Name:
Approach Linear Template
Description:
Origin Point needs to be moved to new location
Unconstrained and Partially Constrained Points are Acceptable.
See WARNING on the previous page.
Close
Right-Click on the new Origin Point location (Edge of Road)
Add New Component
Template Documentation Link...
Check Point Connectivity...
Delete Components
Change Template Origin
Delete Constraints from All Points
Move Point
Edit Point...
Add Constraint
Delete Point
Test Point Controls
Set Dynamic Origin
Ctrl-D
Is Tunnel Template
Display All Components
Resulting Approach Linear Template exactly matches Mainline Corridor Template

11D.4.c Apply the Linear Template

With the Linear Template cross-section geometry created, the Approach Linear Template can be applied along the Terrain Model Boundary. This procedure is discussed in detail in *9B.2.b Create a New Linear Template Workflow*.

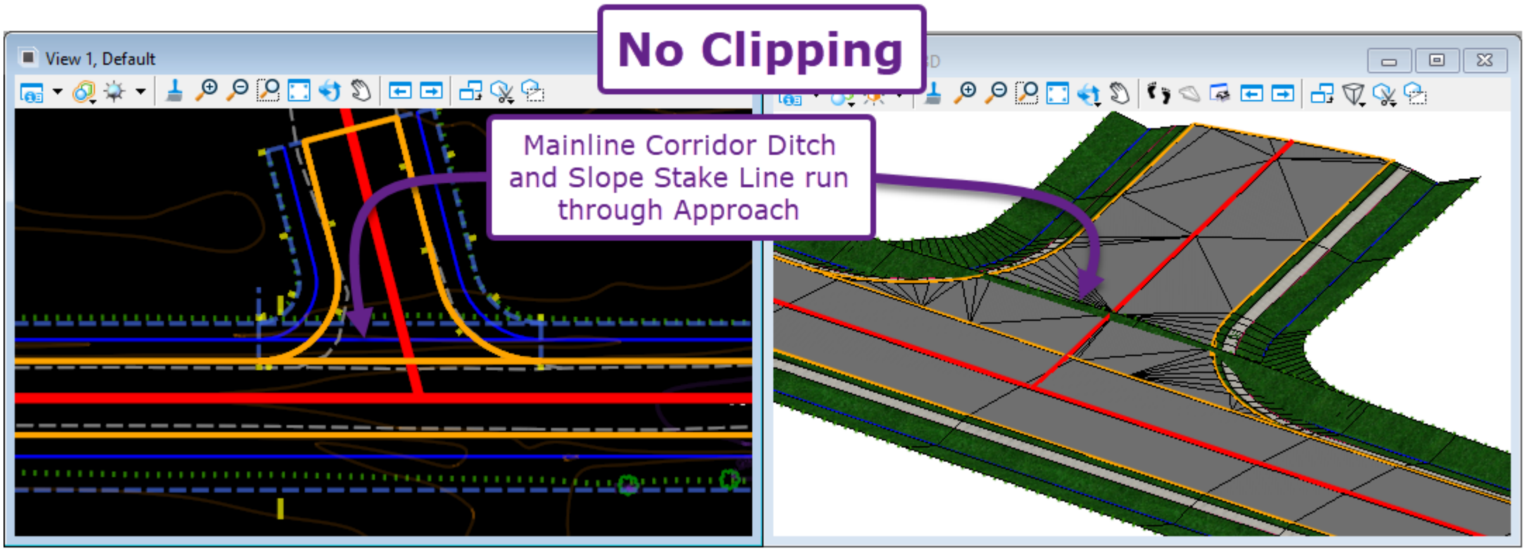
TIP: When setting the **Start Station** and **End Station**, place both values just inside of the deflection points shown below. Linear Templates often behave erratically when the **Start Station** and/or **End Station** is placed directly atop of deflection points. It is recommended that the **Start Station** and **End Station** is placed a value of 0.01' before/after a deflection point to prevent the Linear Template from pointing in an unintended direction. This configuration does NOT affect quantities and the 0.01' gap is imperceptible when viewing the 3D Model.

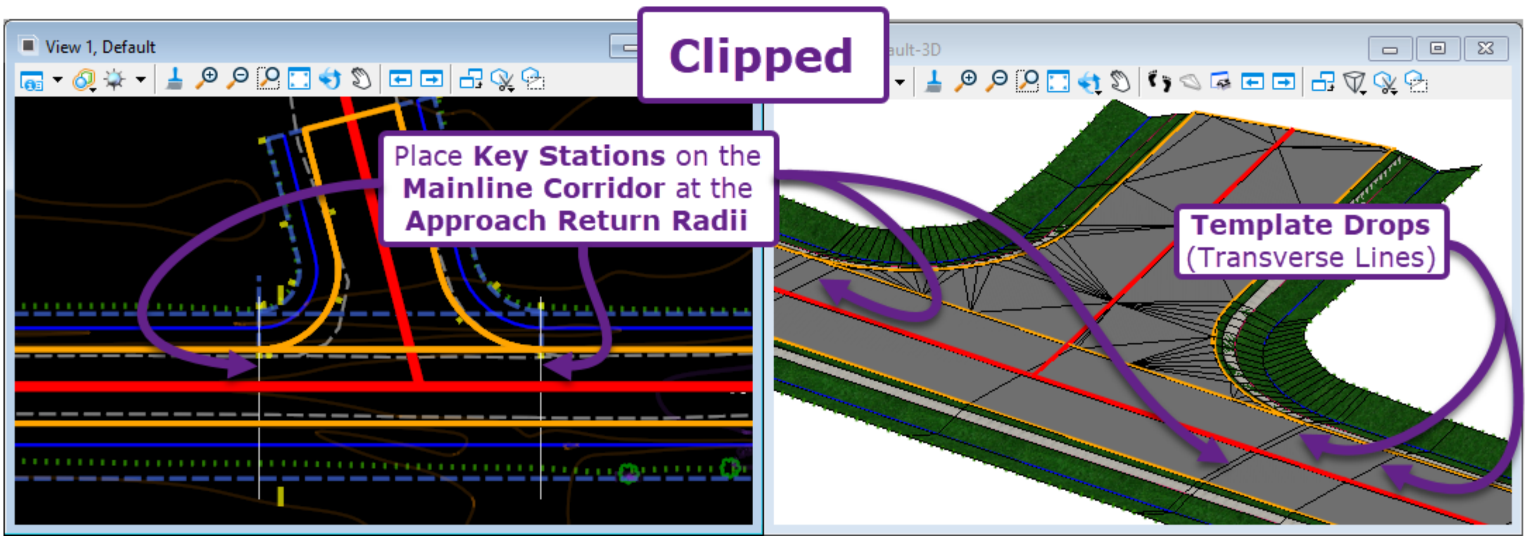
NOTE: The *Apply Linear Template* tool must be used twice. A distinct Linear Template model is created for each side of the Approach.



11D.5 Clip the Mainline Corridor and Create Key Stations at the Approach

To clip the Mainline Corridor in the range of the Approach, use any of the three procedures shown in *11A.5 Overlap Between Mainline Corridor and Site Modeling Features*:





11D.6 Create the Culvert Linear Template

This step shows techniques for creating a Culvert Linear Template model to be placed under the Approach.

WARNING: The design of approach culverts can be very complicated if ditch depths are shallow.

For example, an 18-inch culvert typically requires 12-inches of minimum cover – which means 30-inches of clearance is needed from the culvert invert (which is placed on the ditch line) to the road surface.

For the sake of this example, assume the Mainline pavement section is 4-inches of asphalt and 6-inches of aggregate (10-inch total pavement section) and contains a 12-inch ditch depth (as measured from ditch line to the bottom of the aggregate layer). This results in 22-inches of clearance from ditch line to the road surface. As stated in the previous paragraph, an 18-inch culvert requires 30-inches of clearance – so this configuration does NOT satisfy minimum cover requirements.

In this case, alternative design efforts would have to be explored – such as:

- **Increase Ditch Depth for entire Mainline Corridor**
- **Special Ditches to deepen the ditch around the Approach** (This method could result in a ditch low spot at the approach if adequate slope is NOT obtainable at the culvert outlet. In relatively flat terrain, this method may require long Special Ditches to provide positive slope with adjacent ditch areas.)
- **Raise the Approach Road Grade and move the Culvert location away from the Mainline**

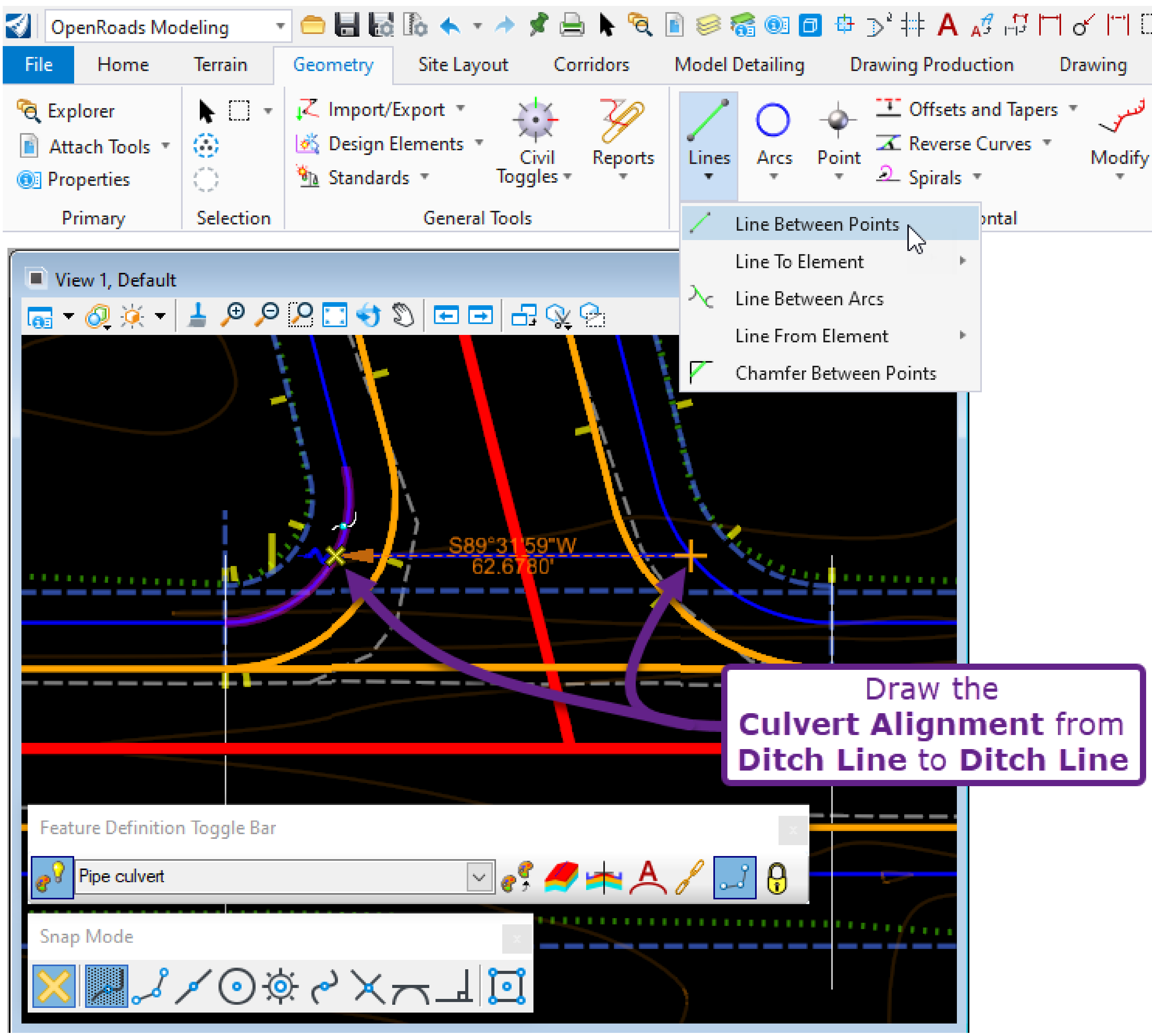
11D.6.a Draw the Culvert Alignment

For Approaches, the Culvert Alignment should span from Ditch low-point on the inlet side to the Ditch high-point on the outlet side. The location of Ditch low and high points is dependent on a number of factors; specifically, the lay of the existing terrain and Corridor/Approach design grades.

TIP: Draw the Culvert Alignment with a Horizontal ORD Line (*Line Between Points* tool).

NOTE: Assign the Culvert Alignment on the "*Pipe Culvert*" Feature Definition.
[Linear → Hydraulics → Pipe Culvert]

TIP: Use *Persist Snaps* with the *Nearest Snap* to dynamically lock to the Ditch line.



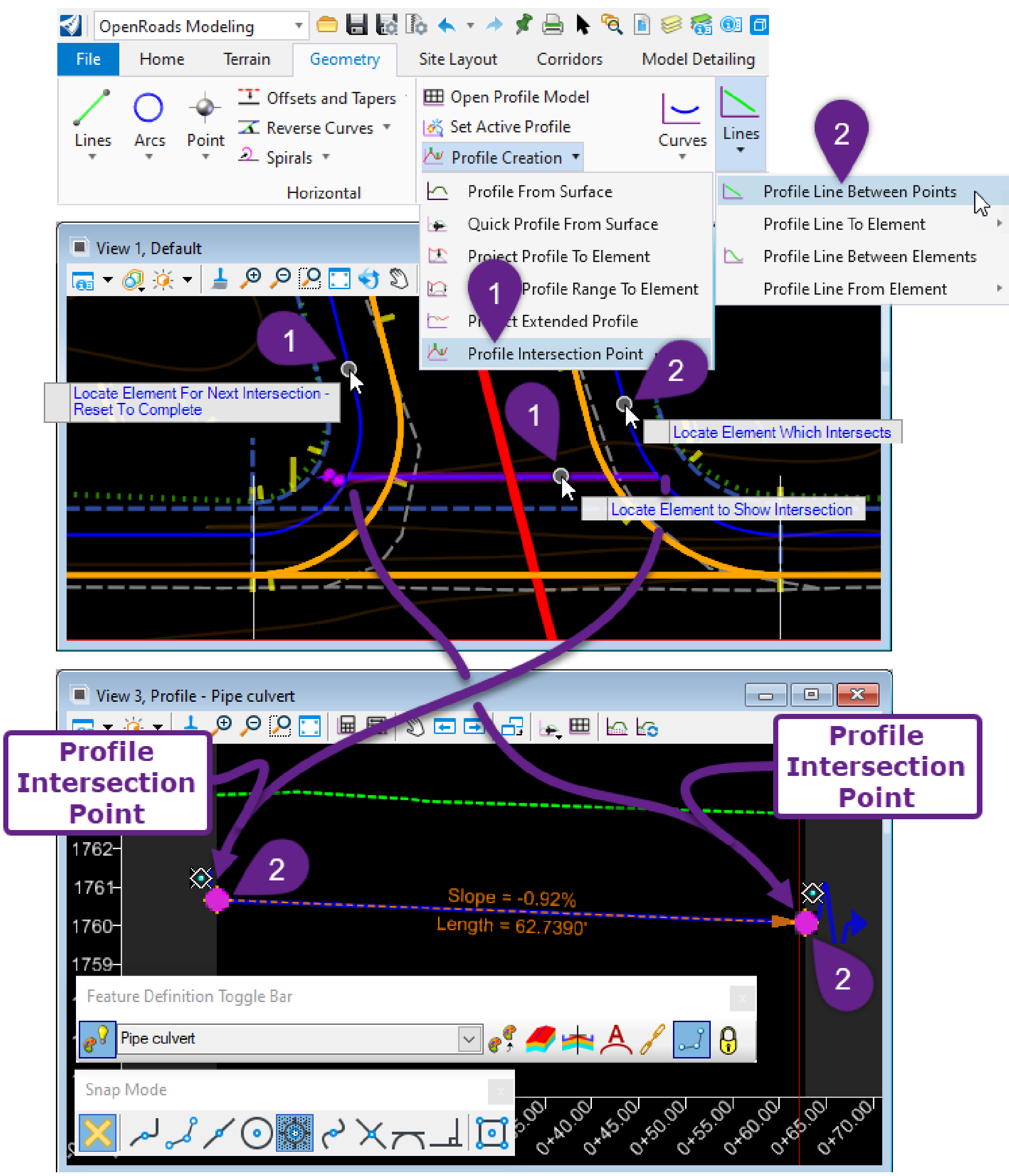
11D.6.b Draw the Culvert Profile with the Profile Intersection Point tool

In this step, the Profile for the Approach Culvert is created. The Culvert Profile can be easily placed at the correct Ditch Line elevation by using the *Profile Intersection Point* tool with the Culvert Alignment and Ditch Lines. After this procedure, **Activate the Culvert Profile**.

1	In the *2D Design Model*, Use the *Profile Intersection Point* with the Culvert Alignment (*Element to Show Intersection*) and the Approach Linear Template Ditch Lines (*Elements which Intersects*)
2	In the *Profile Model* of the Culvert Alignment, use a *Profile Line Between Points* to draw the Culvert Profile. Snap to the *Profile Intersection Point* (pink dot) for accurate placement the Culvert Profile Inverts (Start and End Points)

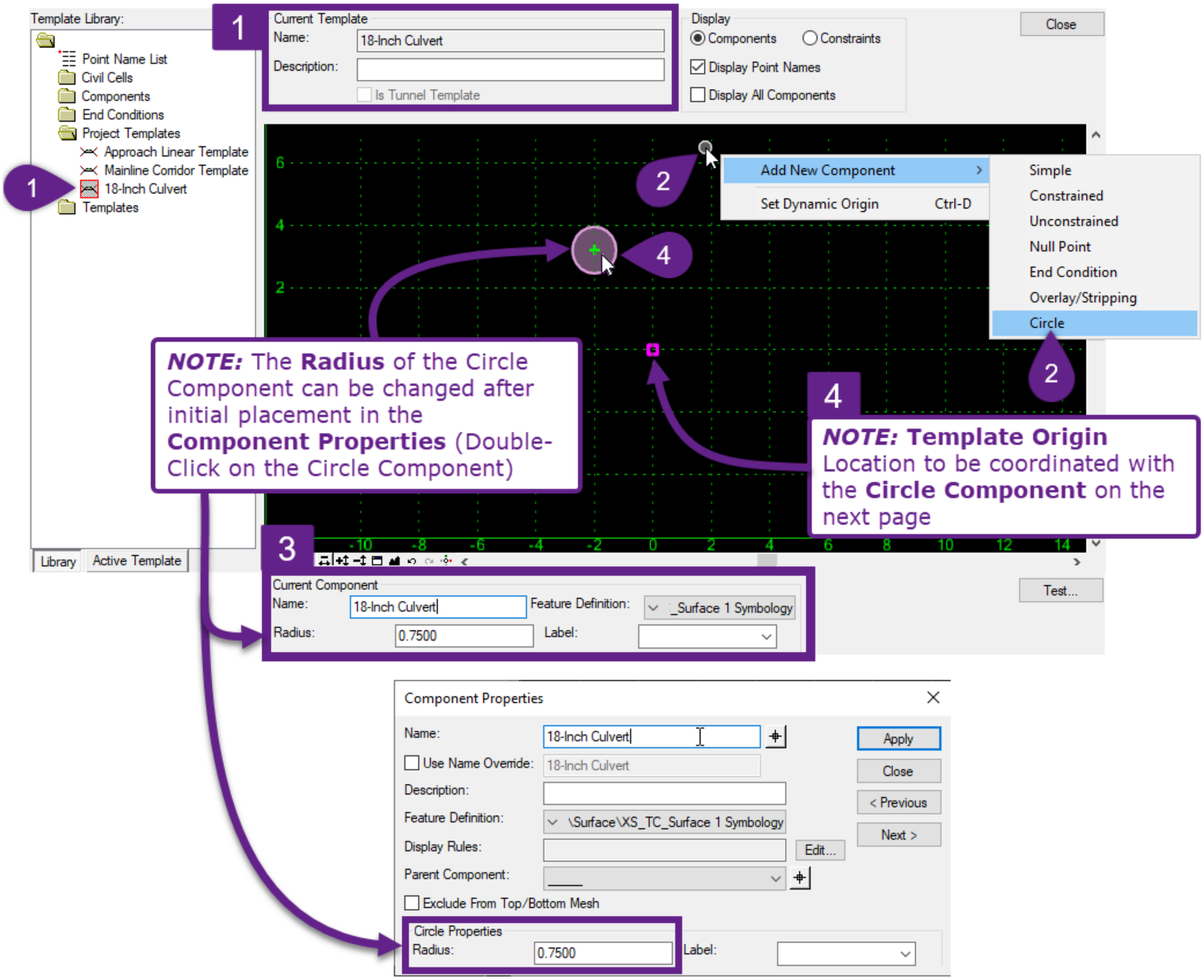
NOTE: Assign the Culvert Profile on the "*Pipe Culvert*" Feature Definition.
[Linear → Hydraulics → Pipe Culvert]

TIP: Use *Persist Snaps* with the *Origin* to dynamically lock to the *Profile Intersection Points*. If the Ditch Line is to move, then the *Profile Intersection Points* will adjust – which in turn will dynamically re-arrange the Culvert Profile.

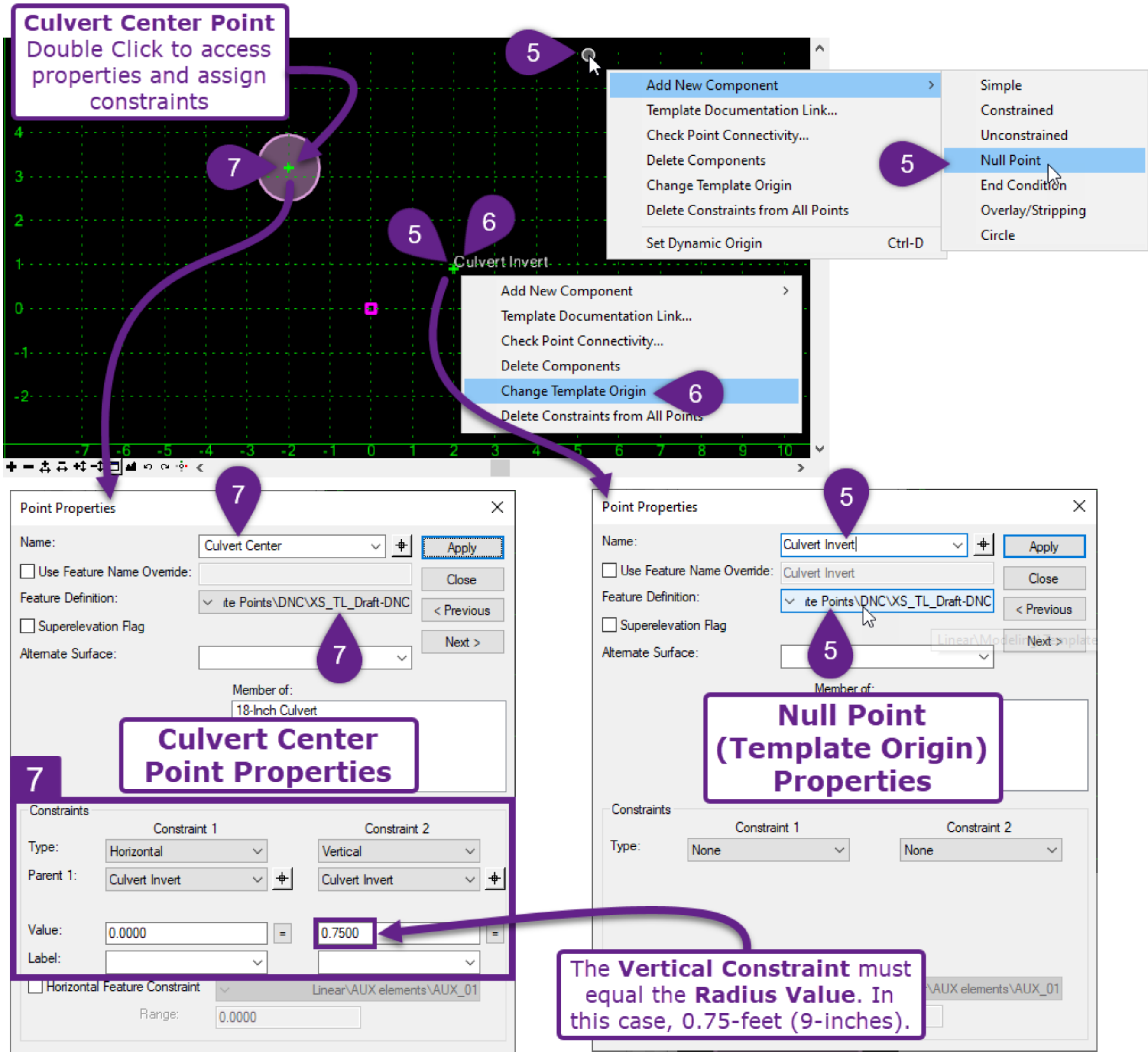


11D.6.c Create the Culvert Template

A Culvert Template can be created with a Circle Component and a single Null Point. This step is performed in the *Template Editor*. ***NOTE:*** As of FLH WorkSpace update 10.10.21.00V, a Culvert Template is included in the FLH Template Library. This Culvert Template can be modified and used instead of creating a new Culvert Template.

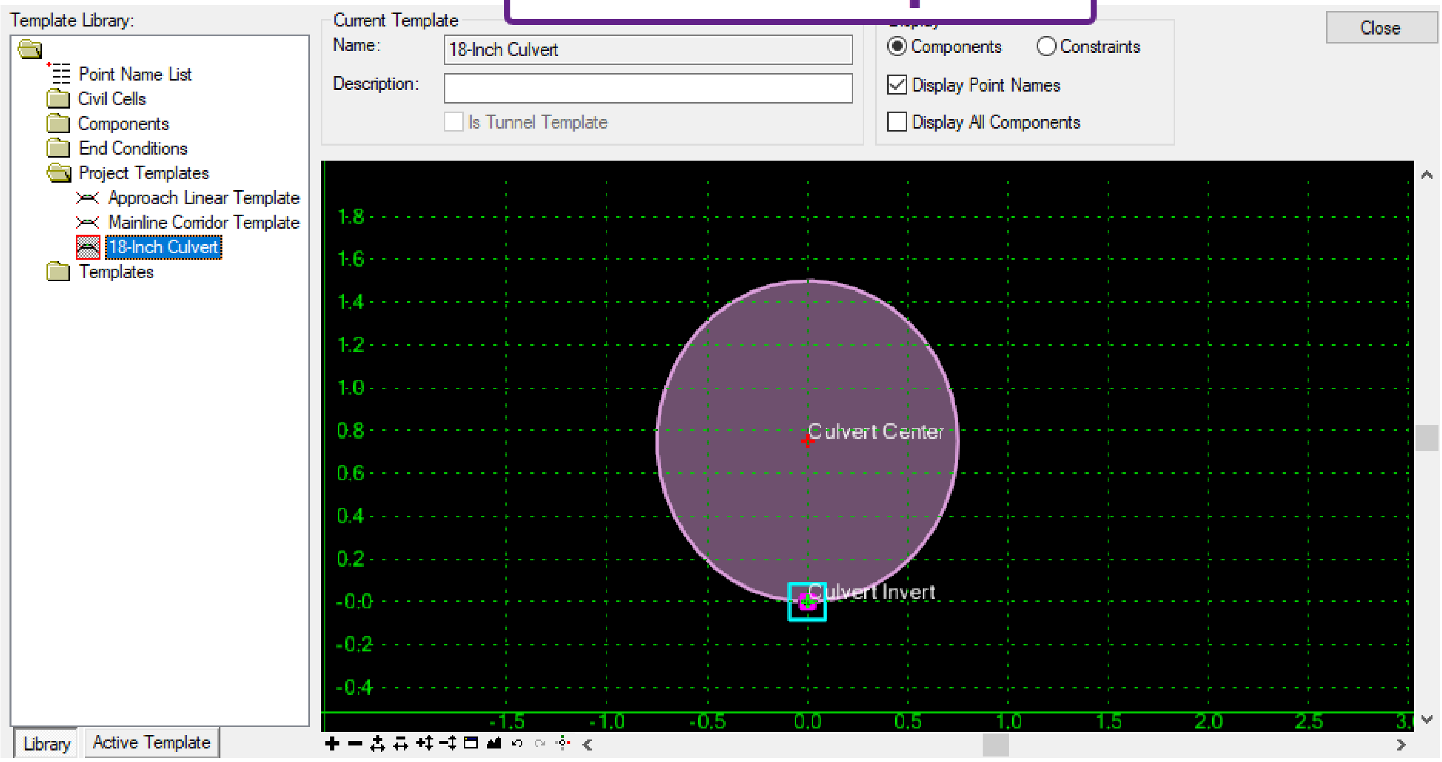


1	Create a new, blank Culvert Template. Assign the new Culvert Template a Name. In this case, the Culvert Template is called "18-Inch Culvert". See *8C.3 Create a New Template or Edit a Pre-Made Template*.
2	Right-Click in the Template Editor grid area and create a new Circle Component.
3	Before placing the new Circle Component, assign it a Name, Feature Definition, and Radius. ***NOTE:*** The Circle Component asks for a Radius – **NOT Diameter**. In this case, the Circle Component will represent an 18-Inch Diameter Culvert, so the radius is 0.75-feet (9-inches).
4	Left-Click in the Template Editor grid area to place the Circle Component. In this step, the exact placement is unimportant. The placement will be rectified on the next page.



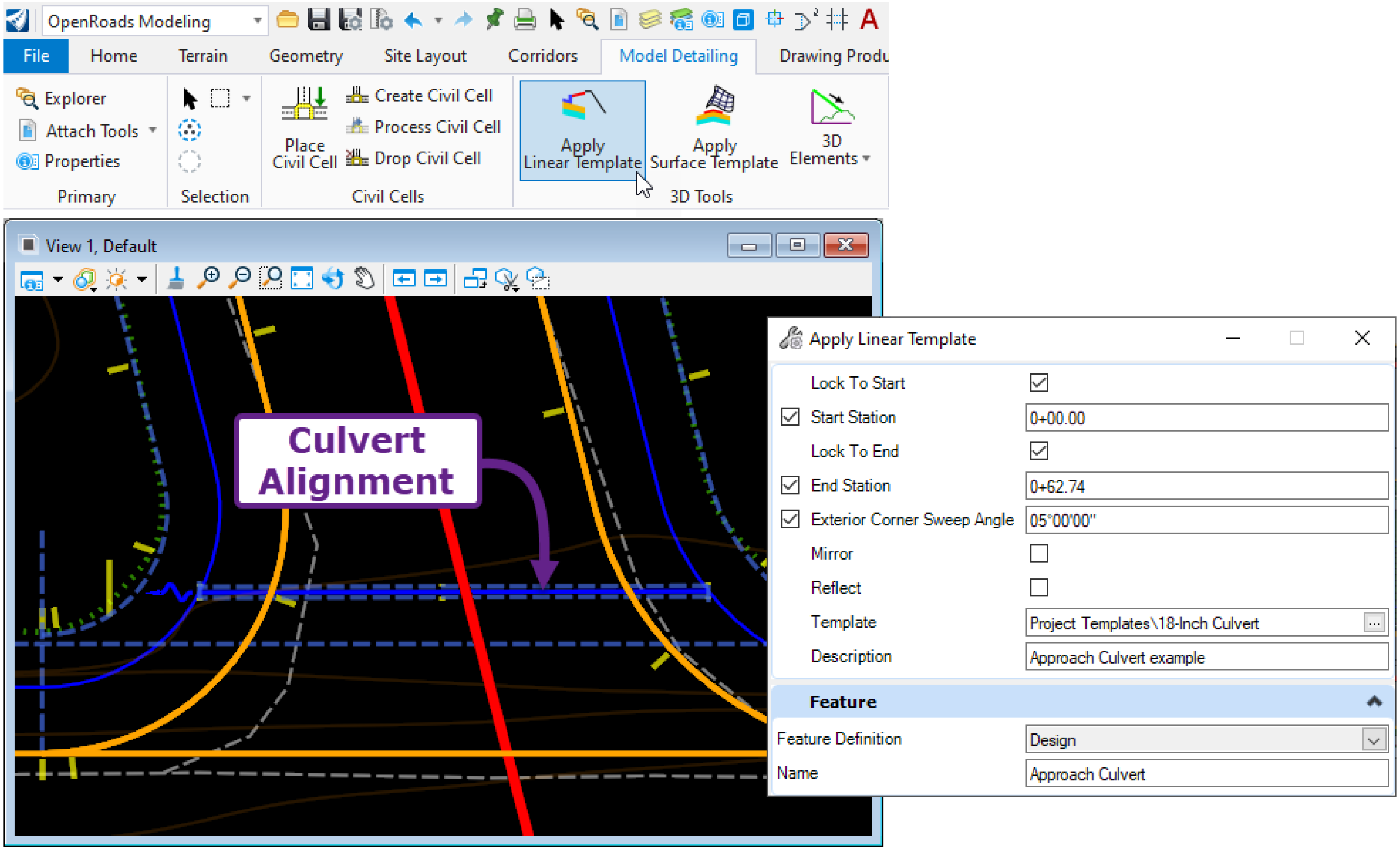
5	Create a Null Point. Place the new Null Point anywhere in the Template Editor grid area. This Null Point should be **Unconstrained** and will serve as the **Template Origin**. In the Null Point Properties, assign the Null Point a Name (in this case “Culvert Invert”) Assign the Null Point a Feature Definition. In this case, the Culvert Invert is assigned to the “XS_TL_Draft-DNC” Feature Definition, because it does NOT need to be displayed in Plan Sheets. The “XS_TL_Draft-DNC” Feature Definition does NOT plot.
6	Make the Null Point the Template Origin. Right-Click on the Null Point and select *Change Template Origin*.
7	Assign Constraints, a Name, and a Feature Definition to the Culvert Center Point. Double Click on the Culvert Center Point to access its properties. The Culvert Center Point should be horizontally aligned with the Null Point (Horizontal Value = 0.0000). The Vertical Constraint of the Culvert Center should equal the Radius value of the culvert. In this case, 0.75-feet (9-inches) [For an 18-Inch Diameter Culvert].

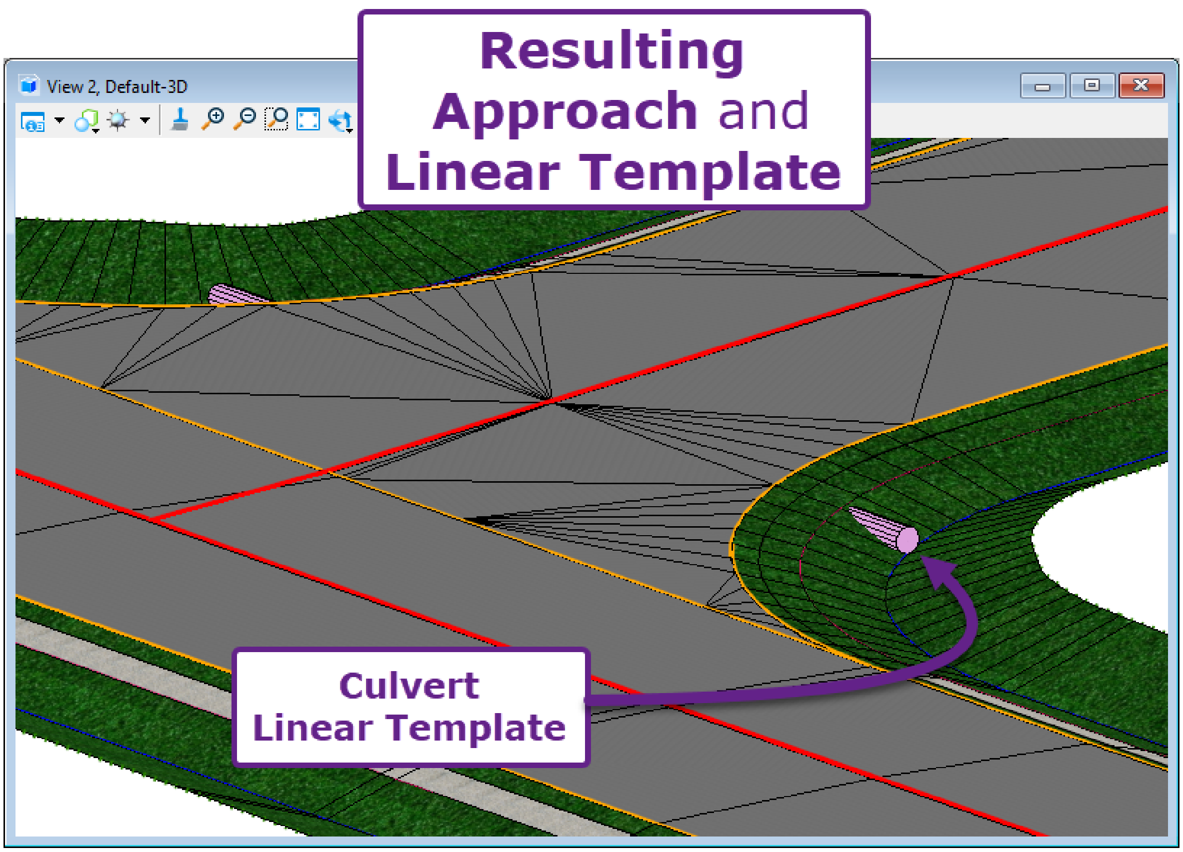
Resulting Culvert Template



11D.6.d Apply the Linear Template

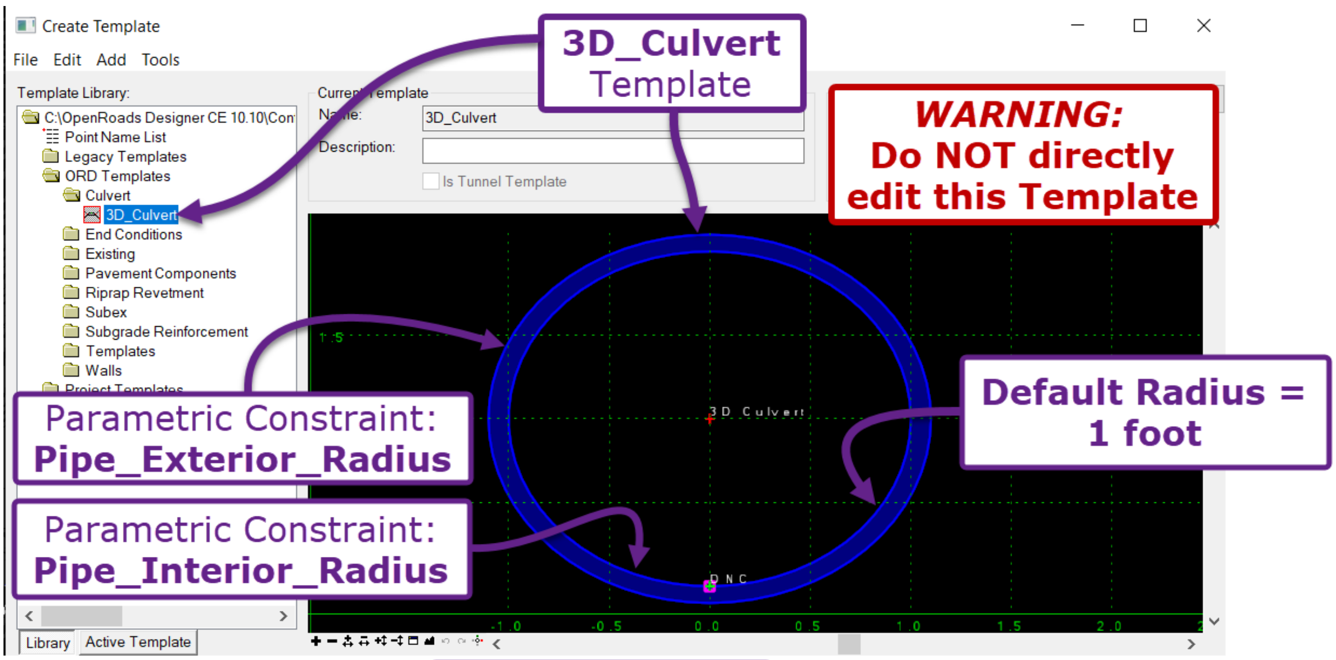
The final step in this process is to apply the Culvert Template to the Culvert Alignment as a Linear Template. This procedure is discussed in detail in *9B.2.b Create a New Linear Template Workflow*.

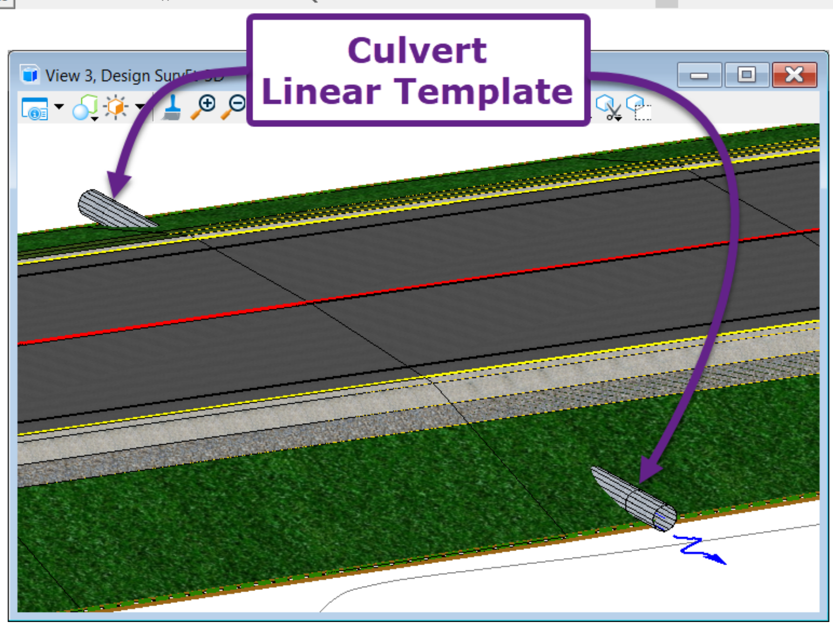




11E.1 Model a Circular Culvert with a Linear Template

In this workflow, a circular culvert is modeled with the "3D_Culvert" Template found in the FLH Template Library. The circular culvert is modeled with the *Apply Linear Template* tool and requires Parametric Constraints to set the Interior and Exterior Radius.



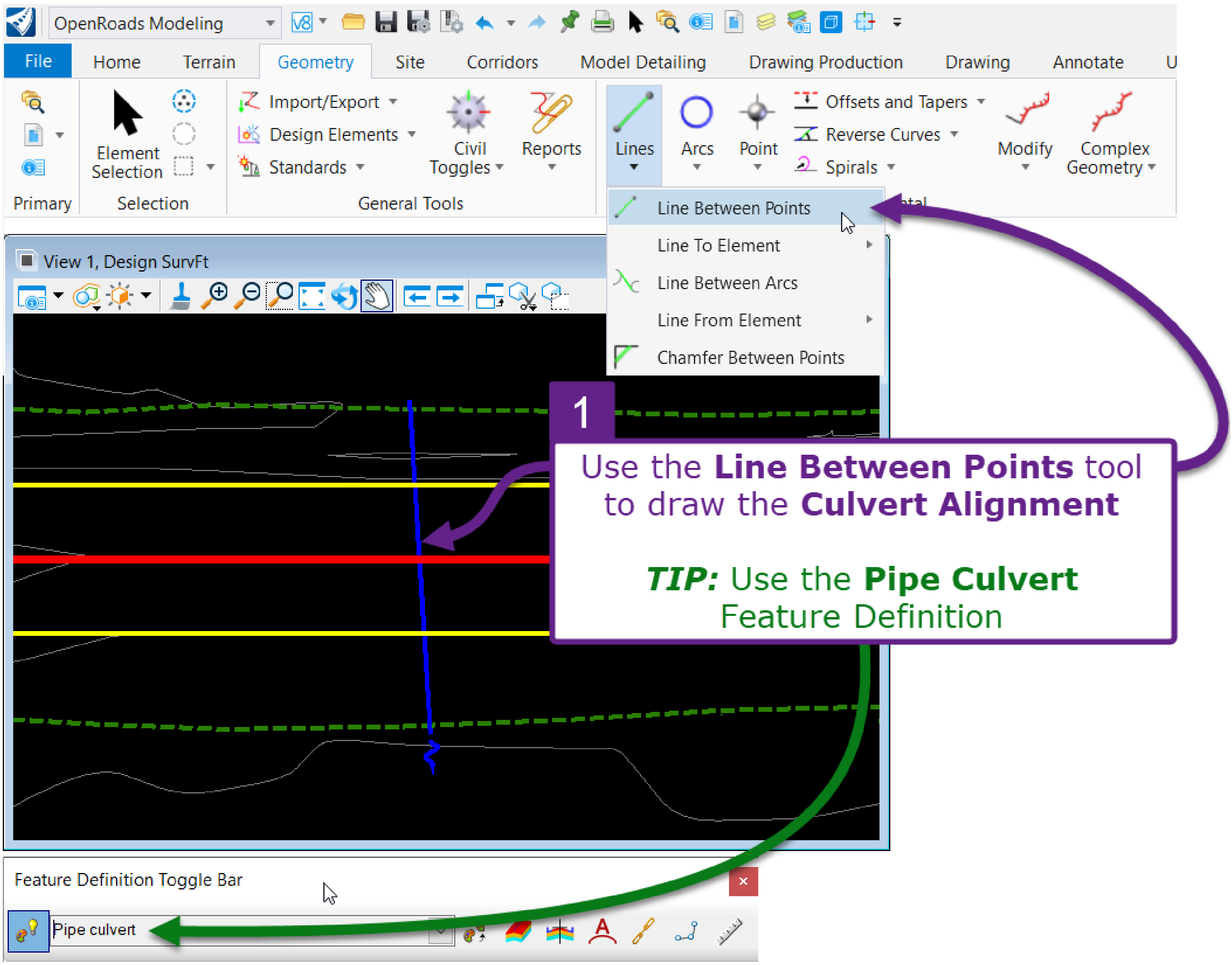


WARNING: Do NOT edit the radius of the "3D_Culvert" Template in the Template Editor. The radius of the culvert is set with the **Parametric Constraint** tool after the Linear Template is created.

By default, the "3D_Culvert" Template is set to a 1' radius (2' diameter). If modeling a 24" culvert, then the Parametric Constraint procedure shown in **Process 3** is unnecessary.

NOTE: Modeling a culvert with a Linear Template is primarily for 3D visualization purposes ONLY. A Culvert Linear Template is generally NOT appropriate for culvert cross section sheets because a bevel or miter CANNOT be modeled on the ends of a Culvert Linear Template. Similarly, the "3D Culvert" Template is NOT setup for calculation of culvert excavation quantities. However, creating a Culvert Template for calculation of excavation quantities is explained in *20F.1 Culvert Excavation – Workflow*.

Process 1 – Draw the Culvert Alignment and Profile: Use ORD Geometry Tools to create the Culvert Alignment and Profile. Use the *Line Between Points* tool draw the horizontal Alignment. Assign the culvert alignment to the "Pipe culvert" Feature Definition.



TIP: Add **Key Stations** to the Corridor around the culvert alignment. Key Stations ensure the Corridor is processed around the culvert. If Key Stations are NOT used, then the Corridor cut/fill lines may be placed at the wrong location and elevation for critical design points on the culvert alignment.

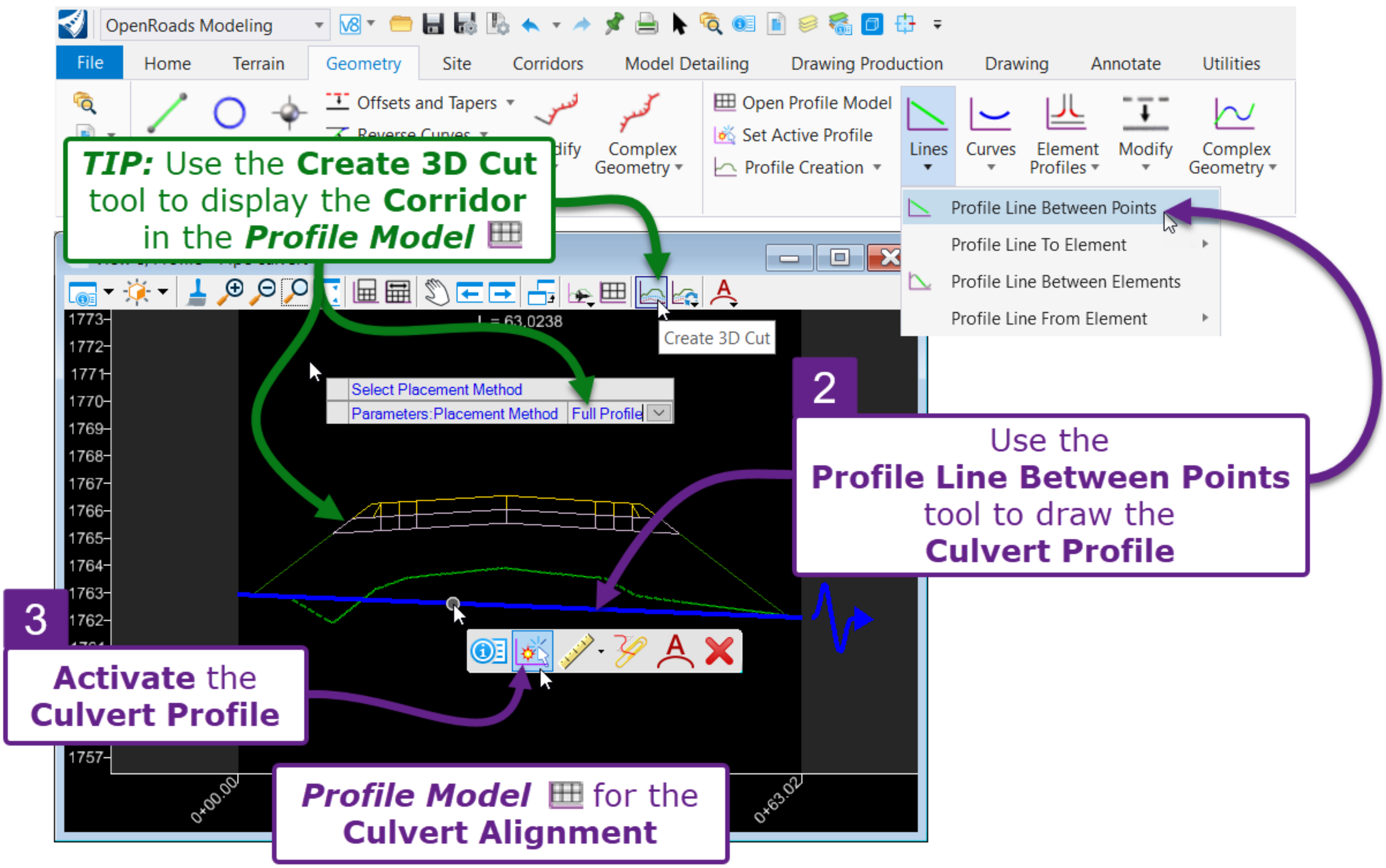
If the culvert is skewed, it is recommended that a Key Station is added at the start point, end point, and intersection point between the culvert and road alignment.

For more information on Key Stations, see *9G.3 Key Stations*.

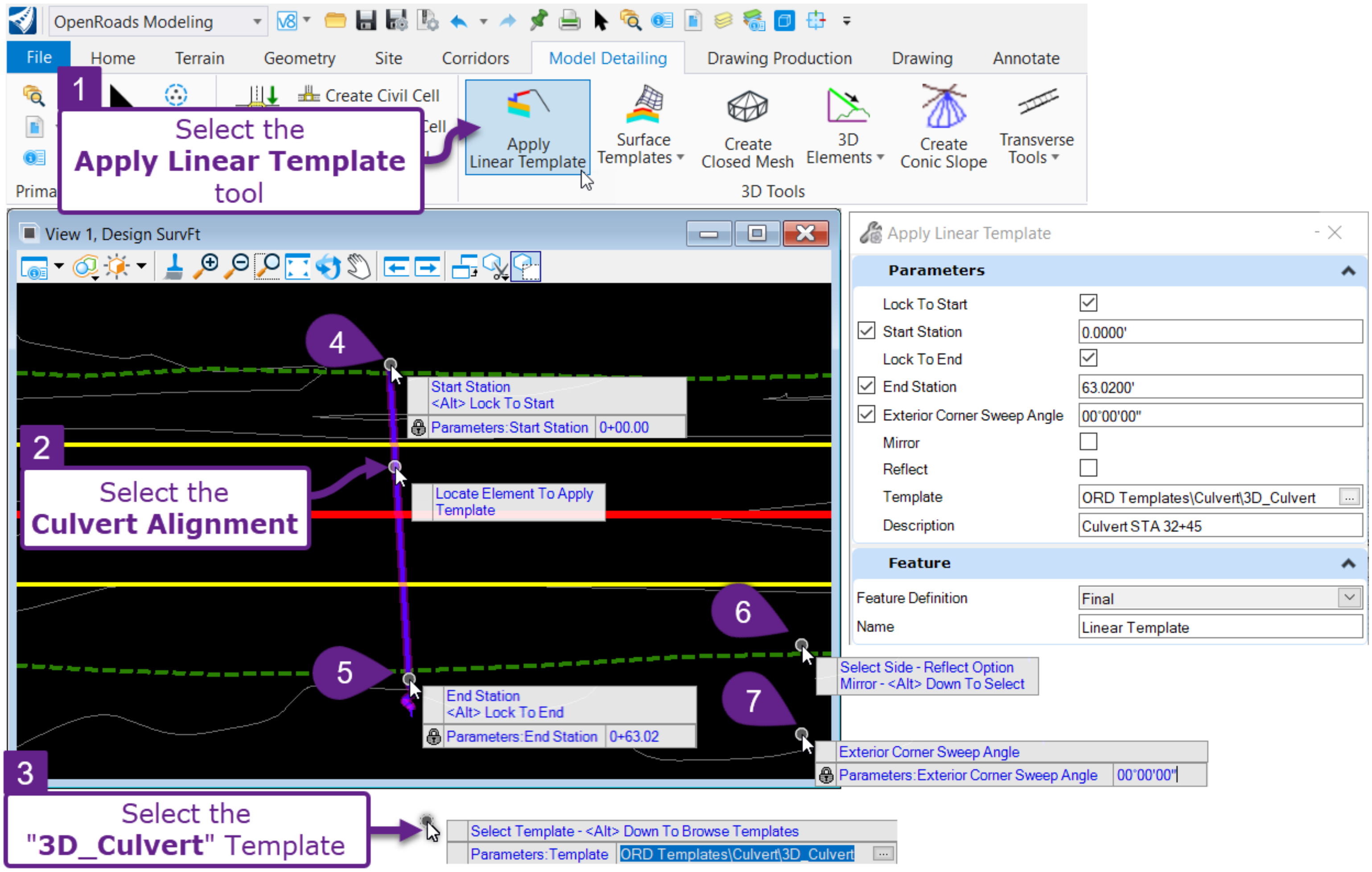
Use the *Profile Line Between Points* tool to draw the vertical Profile. The Profile line should correspond with the culvert invert elevation. Activate the Profile after drawing it. Assign the Profile to the "Pipe culvert" Feature Definition.

TIP: The *Create 3D Cut* tool will display all 3D and Corridor elements that intersect the Alignment. Use the "Full Profile" placement method when using this tool. If the horizontal Alignment geometry is modified, then the *Refresh 3D Cut* tool must be used to update the 3D element graphics. For more information about the *Create 3D Cut* tool, see *7F.1.e Show Corridor and 3D Elements in a Profile Model with Create 3D Cut*.

DESIGN TIP: Offset the Culvert profile to create the top of culvert line (crown). Ensure **minimum cover requirements** are met by measuring between the top of culvert and the 3D Corridor elements.



Process 2 – Create the Linear Template using the "3D_Culvert" Template: Use the *Apply Linear Template* tool to model the culvert. The *Apply Linear Template* is discussed in more detail in *9B.2 Create a New Linear Template* and *11A.3 Linear Template – Process Overview*.



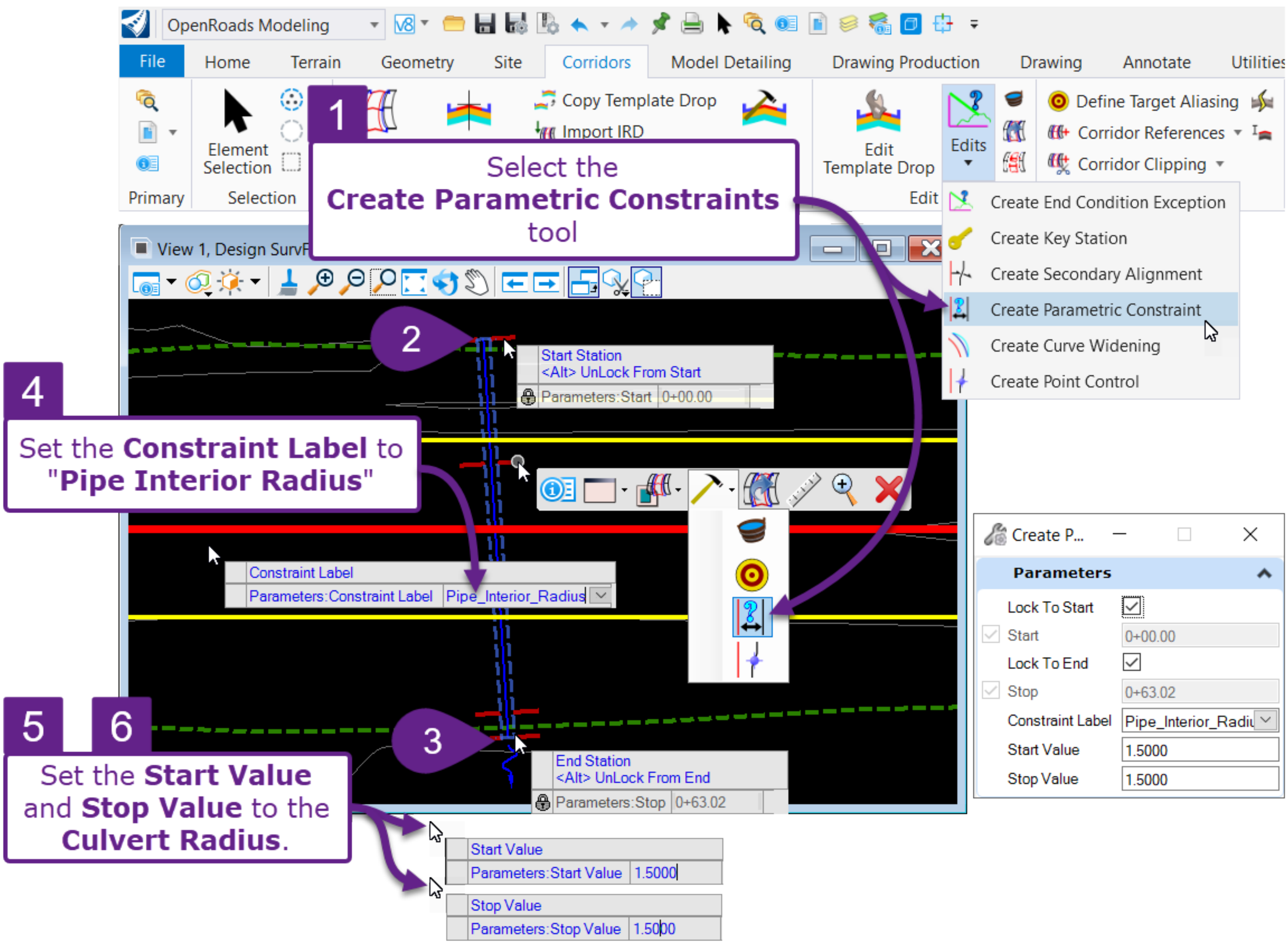
1	From the Ribbon, select the *Apply Linear Template* tool: [***OpenRoads Modeling*** → ***Model Detailing*** → ***3D Tools***].
2	*Prompt: Locate Element to Apply Template*. Select the **Culvert Alignment**.
3	*Prompt: Select Template - <ALT> Down to Browse Templates*. Press the ALT key and DOWN ARROW key simultaneously to select the "**3D_Culvert**" Template form the Template Library.
4	*Prompt: Start Station. <ALT> Lock to Start*. Select the beginning of the Culvert Alignment.
5	*Prompt: End Station. <ALT> Lock to End*. Select the end of the Culvert Alignment.
6	*Prompt: Select Side – Reflect Option Mirror - <Alt> Down To Select*. The Reflect Option Mirror option is inconsequential because the "3D_Culvert" Template is symmetrical.
7	*Prompt: Exterior Corner Sweep Angle* – This value is inconsequential because the Culvert Alignment does NOT contain deflection points.

Process 3 – Set the Culvert Radius with the Parametric Constraint Tool: To set the Culvert radius, the Parametric Constraint must be used twice. The "3D_Culvert" Template has separate Parametric Constraints for the **inside** culvert radius and the **outside** culvert radius. For more information on the *Parametric Constraints* tool, see *9G.4 Parametric Constraints*.

WARNING: Do NOT use the culvert **diameter** when creating the Parametric Constraints. The Parametric Constraints require a **radius** value.

BEST PRACTICE: Set the interior culvert radius a standard size. For example, set the interior radius to 1.5′ (18″) for a 36″ diameter culvert. Set the exterior culvert radius slightly larger than the interior radius. For example, set the exterior radius to 1.51′ for an interior radius of 1.5′. Alternatively, look up the true exterior radius value from a culvert manufacturer's catalogue.

NOTE: By default, the "3D_Culvert" Template is set to a 1′ radius (2′ diameter). If modeling a 24″ culvert, then creating Parametric Constraints is unnecessary.

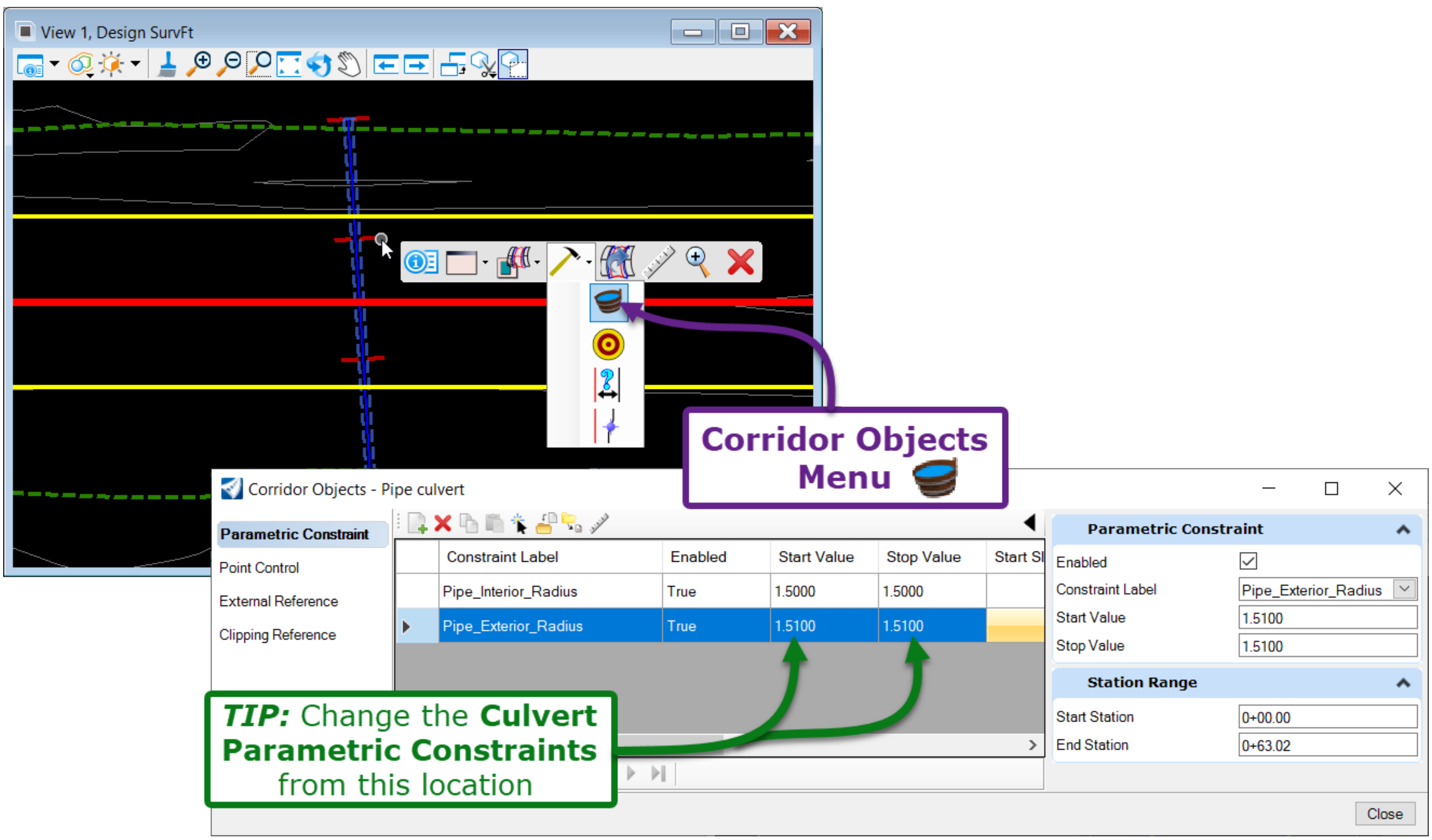


1	Select the Linear Template Handle to summon the *Pop-Up Icon Menu*. Select the *Create Parametric Constraint* icon. → . **ALTERNATIVELY:** From the Ribbon, select the Create Parametric Constraints tool: [***OpenRoads Modeling*** → ***Corridors*** → ***Edit*** → ***Edit* drop-down**].

2	*Prompt: Start Station. <ALT> Lock to Start*. Select the beginning of the Culvert Alignment.
3	*Prompt: End Station. <ALT> Lock to End.* Select the end of the Culvert Alignment.
4	*Prompt: Constraint Label* – Set the Constraint Label to "**Pipe_Interior_Radius**".
5	*Prompt: Start Value* = 1.5. In this case, both the Start Value and Stop Value should be set to the match the **interior** culvert radius. In this case, a 36-inch diameter culvert is modeled. Therefore, a 1.5-feet radius is set for the Start/Stop value. See the ***BEST PRACTICE*** on the previous page.
6	*Prompt: Stop Value* = 1.5. The Stop Value should match the Start Value.

Repeat steps 1-6 to set the Parametric Constraint for the **Exterior Radius**. In step 4, select the "**Pipe_Exterior_Radius**" parametric constraint. In steps 5 and 6, set the Start Value and Stop Value slightly larger than the interior radius Start/Stop Values (i.e., 1.51). See the ***BEST PRACTICE*** on the previous page.

TIP: After the Parametric Constraints are created, open the **Corridor Objects Menu** for the Culvert Linear Template to modify the parametric constraint values. Accessing the Corridor Objects Menu is shown in *9D.1.a Access the Corridor Objects Menu*.



11F – SITE LAYOUT TOOLS

[Placeholder for future development]