OpenRoads Designer User Manual

U.S. Department of Transportation
Federal Highway Administration

Chapter 7

HORIZONTAL AND VERTICAL ALIGNMENT

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Chapter 7 Horizontal and Vertical Alignment

This chapter covers the creation and manipulation of horizontal and vertical alignments using ORD Elements.

ORD Elements should be used to draft alignments and elements used in 3D civil modeling. In contrast, MicroStation Elements are used for basic 2D drafting tasks.

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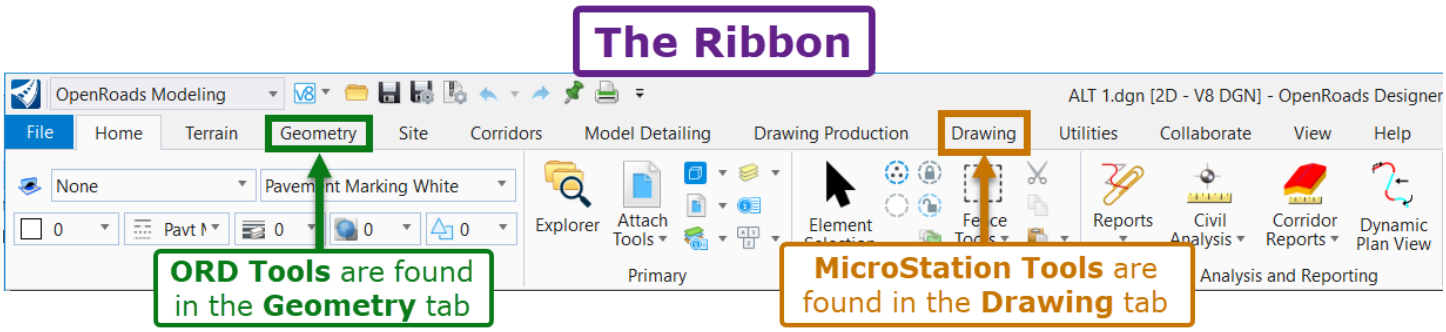
7A – INTRODUCTION TO GEOMETRY

7A.1 ORD Tools vs MicroStation Tools

There are two types of tools for creating geometrical elements: **ORD Tools** and **MicroStation Tools**.



ORD Tools and MicroStation Tools in concept because they are both used to draft shapes and geometry. However, ORD Tools and MicroStation Tools have different functionality and are intended for different tasks.

ORD Tools: These tools create **ORD Elements**. ORD Elements contain *Feature Definitions* and *Names*. Also, ORD Elements attempt to capture *Design Intent* through use of Persist Snaps and Civil Rules.

> ***IMPORTANT:*** Before using ORD Tools to create an Alignment or Profile, familiarize yourself with the concept of **Persist Snaps**. When editing ORD Elements, the Persist Snaps formed in creation element may rearrange the element in unpredictable manner. For more information on Persist Snaps, see *7C.2 Persist Snaps*.

ORD Tools are used to create civil features, such as Alignments, Profiles, Terrain Models, and Corridors. If an element is being drawn for civil modeling purposes, then an ORD Tool should be used. Tools for creating geometry with ORD Tools are found in the **Geometry** tab.

MicroStation Tools: These tools create **MicroStation Elements**. MicroStation Elements are simple and have less functionality than ORD Elements. MicroStation Tools should be used to draft basic 2D linework. Tools for creating geometry with MicroStation tool are found in the **Drawing** tab.

CONCLUSION: Geometrical elements can be drawn with either **ORD Tools** or **MicroStation Tools**. When drafting Alignments and Profiles, **ORD Tools** should be used.

> ***TIP:*** To determine whether a previously-created element is an ORD Element or a MicroStation Element, select it and view its Properties. ORD Elements will have the **Feature Drop-Down** shown in the Properties. MicroStation elements do NOT contain the Feature drop-down. For the location of the Feature drop-down, see *1F.1 Properties Box Overview*.

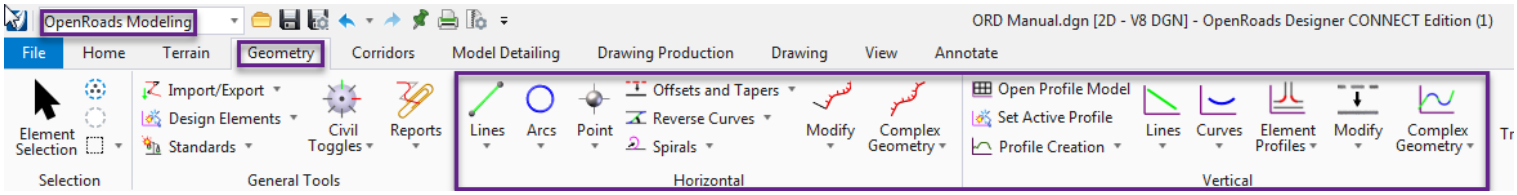
7A.2 ORD Elements and MicroStation Elements Ribbon Locations

The graphics below shows the Ribbon locations for ORD Elements and MicroStation Elements.

NOTE: The Ribbon Location shown correspond to the default configuration. The Ribbon layout and tool locations can be customized and rearranged, which is shown in *4B – Customize the Ribbon and Quick Access Toolbar*.

7A.2.a ORD Elements

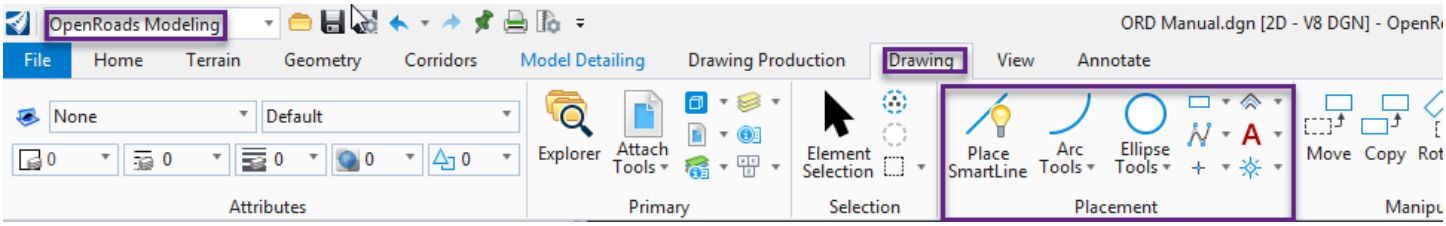
All *ORD Elements* are found in the **OpenRoads Modeling** workflow → **Geometry** tab → **Horizontal** and **Vertical** panel



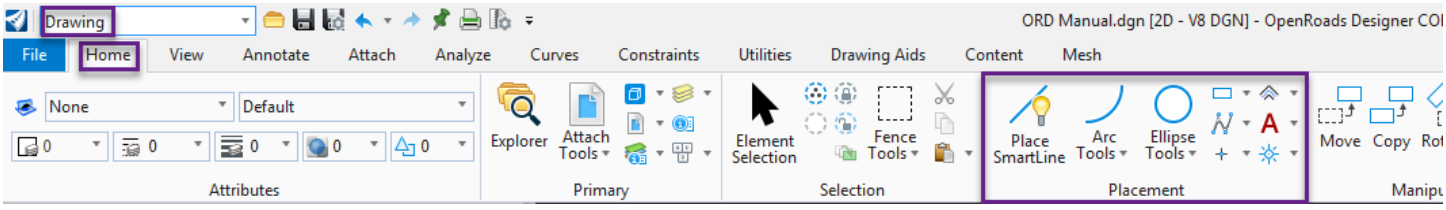
7A.2.b MicroStation Elements

MicroStation Elements are found in two main locations:

1. **OpenRoads Modeling** workflow → **Drawing** tab → **Placement** panel

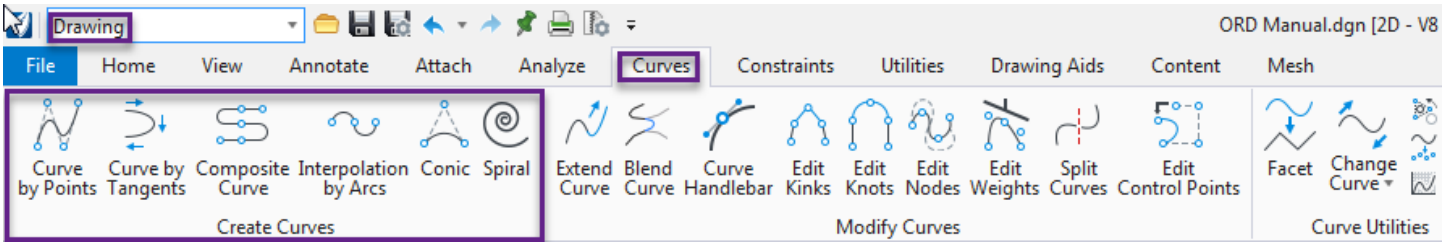


2. **Drawing** workflow → **Home** tab → **Placement** panel



Additionally, more advanced curve drawing tools are available in the following location:

Drawing workflow → **Curves** tab → **Create Curves** panel



7A.2.c ORD Elements: Horizontal vs Vertical

7A.2.c.i ORD Elements

There are two categories of ORD Elements – *Horizontal* and *Vertical* – which are defined by which the Models they can be placed in.

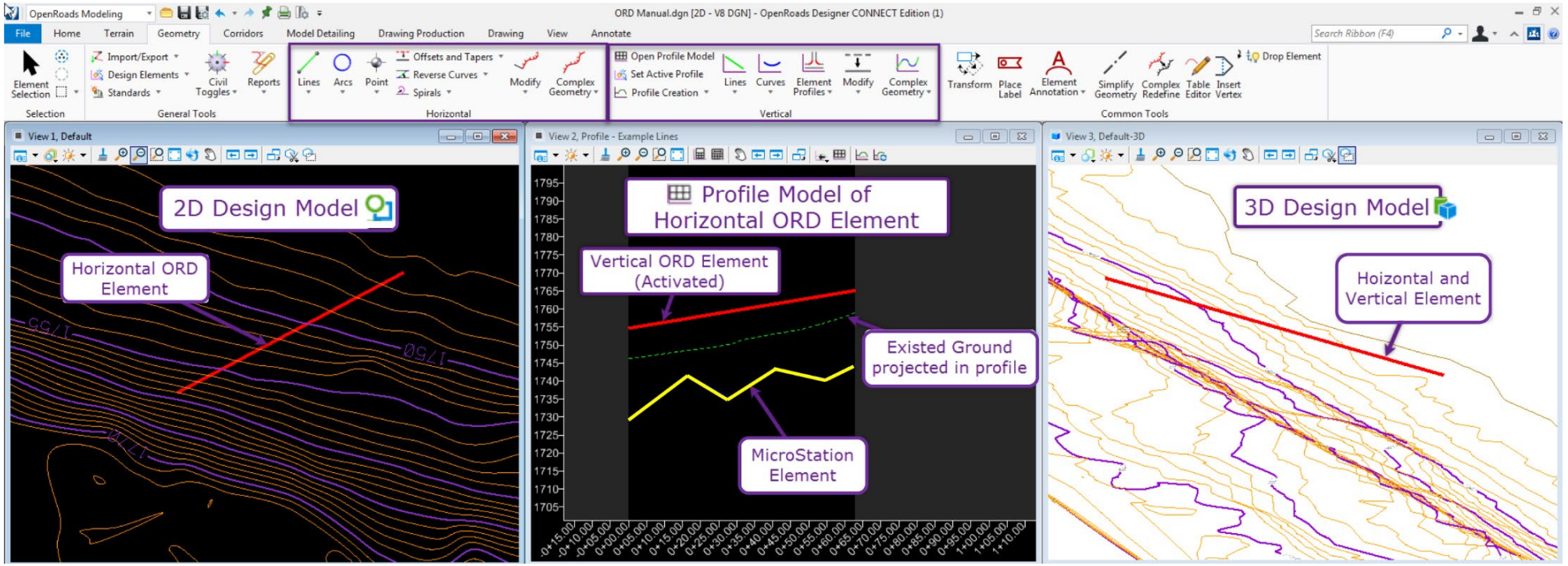
Horizontal ORD Elements can ONLY be placed in the *2D Design Model*. After a Horizontal ORD Element has been placed, the User can access the *Profile Model* for that specific element. Every Horizontal ORD Element has a corresponding Profile Model.

Vertical ORD Elements can ONLY be placed in a *Profile Model*. After placement, a Vertical ORD Element can be *activated*. When *activated*, the vertical geometry becomes associated with the horizontal geometry. ONLY after *activation* will an element be definied in all 3-dimensions. After *activatation*, a 3D Linear Element is created in the *3D Design Model*. The 3D Linear Element is a combination of the horizontal and vertical geometry.

7A.2.c.ii MicroStation Elements

MicroStation Elements (i.e., *Smart Lines*) can be placed in all three design models: the *2D Design Model*, *Profile Models*, and the *3D Design Model*). It is possible to place a MicroStation Element in the *2D Design Model* and then access its *Profile Model*. Similarly, a MicroStation can be drawn in a *Profile Model* and *activated* to create a 3D Linear Element.

BEST PRACTICE: In the Profile Model, use MicroStation Elements to draft ancillary linework that does not need to be *Activated.* Use *Vertical ORD Elements* to draft Profiles that are to be *Activated*.



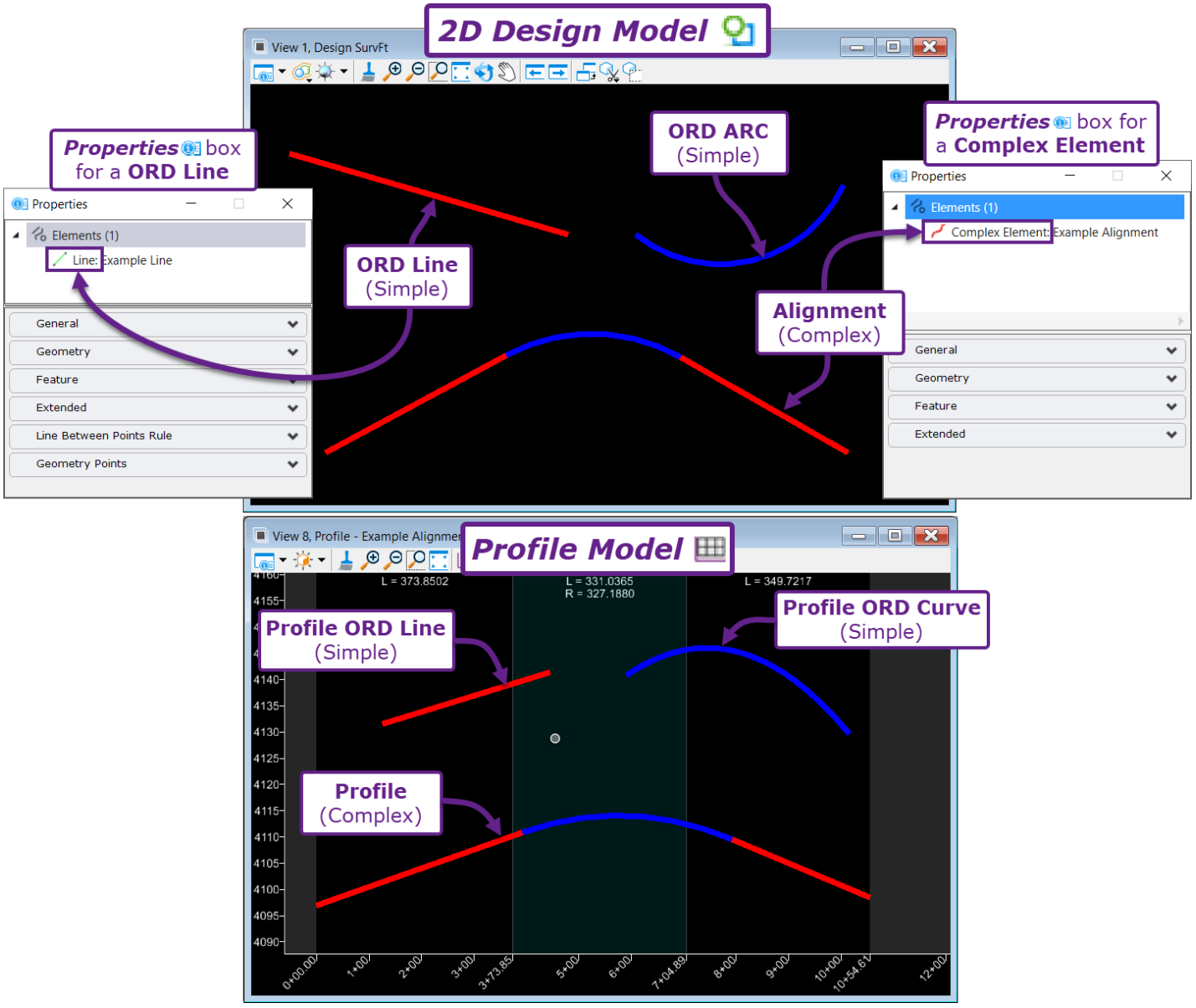
7A.2.d Simple and Complex ORD Elements

An ORD Element can be classified as a *Simple* or *Complex*.

Simple ORD Element - A single geometric ORD Element entity, such as a Line, Arc (Horizontal), Curve (Vertical), or Spiral. When drawing alignments and profiles, typically Simple ORD Elements are drawn out. After initial layout, the *Complex By Element* tool is used to join all Simple ORD Elements into a **Complex ORD Element**. A Simple ORD Element can be identified by selecting it and viewing its Properties. The element type (i.e., Line, Arc, Curve) and a representative icon will be shown at the top of the Properties box.

Complex ORD Element – The term "Complex" refers to a continuous ORD Element that is comprised of adjoining Lines, Arcs, Curves, and/or spirals. Use the *Complex By Element* tool to create a Complex ORD Elements from adjoining Simple ORD Elements. A Complex ORD Element can be identified by selecting it and viewing its Properties. The term "Complex Element" will be shown at the top of the Properties.

> ***Terminology Distinction:*** When MicroStation Elements are joined together, the resulting linear element is referred to as a Complex Chain. For more information on Complex Chains, see *6H.2 Create Complex Chain tool*.



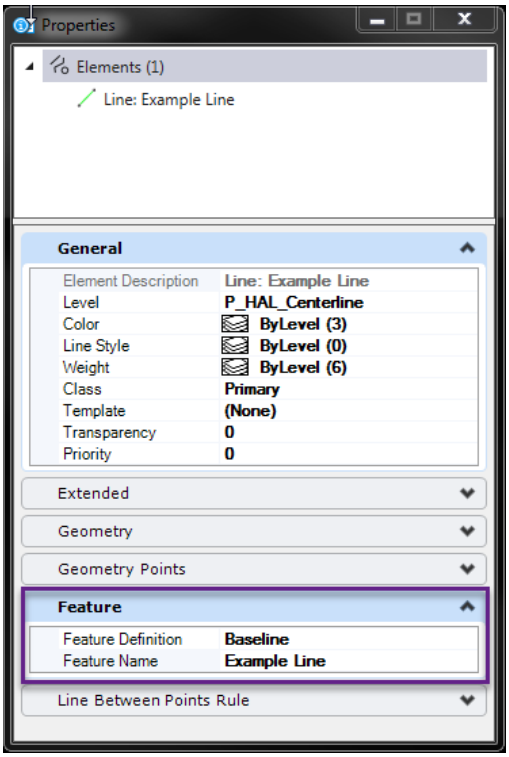
7A.2.e Feature Definitions and Feature Names

In the Properties box, ORD Elements and MicroStation Elements both contain the same General properties – such as Level, Color, Line Style, and Weight. Unique to ORD Elements are **Feature Definitions** and **Feature Names**.

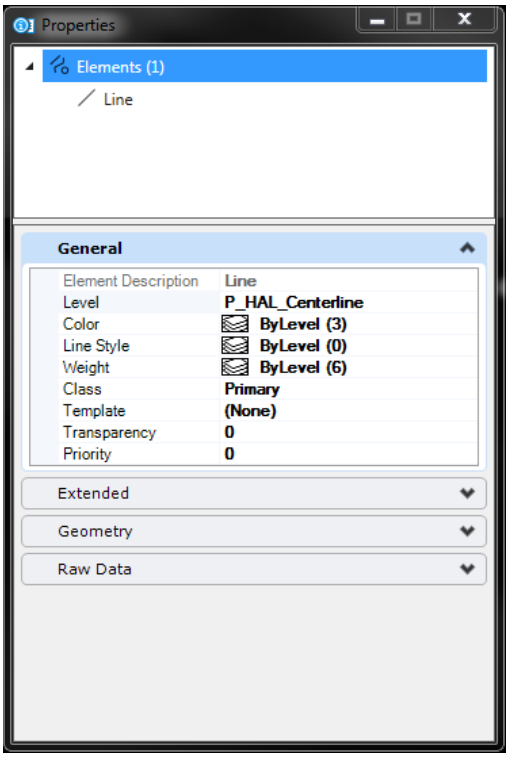
Feature Definitions – Feature Definitions represent, organize, and display the *Feature* that's being drafted. Features represent real-world entities, both existing and proposed. Examples of Feature entities are the proposed road centerline (Baseline), existing curb and gutter, culvert, and existing ground surface. FLH Workspace contains a library of predefined Feature Definitions to represent most Features used in roadway design. For more information on Feature Definitions, see *Chapter 17 – Feature Definitions*.

BEST PRACTICE: If an appropriate *Feature Definition* is NOT found in the FLH Feature Definition library, create one using the process shown in *17D – Create a New Feature Definition*.

Feature Definitions control the Level and Symbology Properties. If the Level for an ORD Element is manually changed, then it is considered an override. If edits are made to the ORD Element, the overridden Level will return to the default Level assigned to the Feature Definition.



Properties for an ORD Element



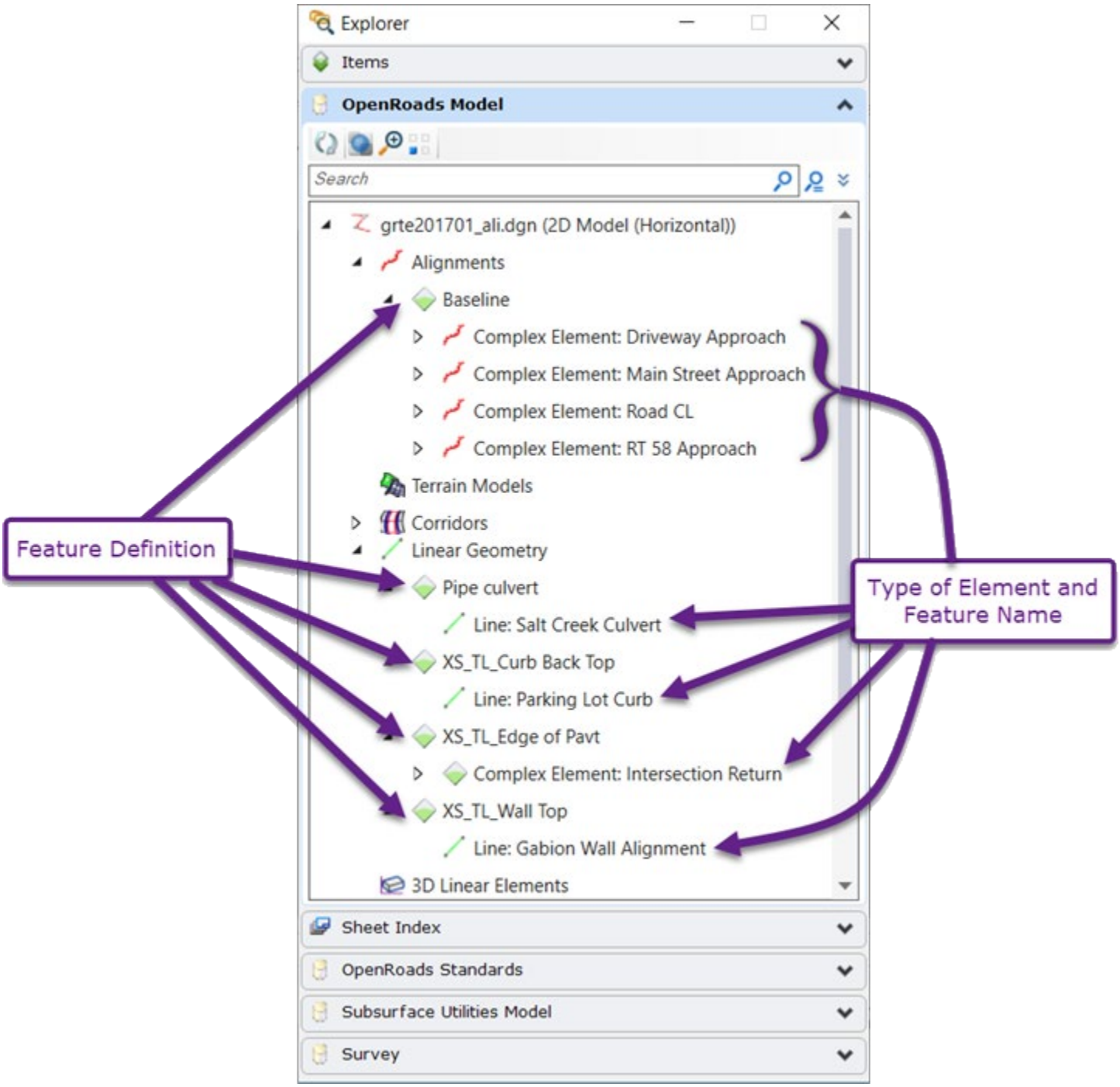
Properties for a MicroStation Element

Feature Names – ORD Elements can be named by the User. If a Feature Name is not given to an ORD Element upon creation, the software will automatically name the ORD Element based on the set Feature Definition.

BEST PRACTICE: Use FLH Feature Naming Conventions for ORD Elements that represent important Features, such as the centerline of road. When drawing Simple ORD Elements to be joined into a Complex Element it is not necessary or practical to give each ORD Element a name. For more information on the FLH Feature Naming Convention, see *3F – Naming Convention For Proposed ORD Features*.

ORD Elements in the Explorer – ORD Elements are organized and sorted according to Feature Definition type in the Explorer. As an alternative to selecting an ORD Element graphically, select it through the Explorer. ORD Elements are located in the **OpenRoads Model** drop-down within the Explorer.

BEST PRACTICE: Always assign ORD Elements a logical name. It is very difficult to distinguish between elements when the a name is NOT assigned to ORD Elements..



7A.3 Using ORD Elements or MicroStation Elements – Best Practices

ORD Elements and MicroStation Elements are both used for drafting, but it is important to know the most appropriate tool for the task. The table below describes design, drafting, and modeling situations and whether to use ORD Elements or MicroStation Elements for that situation.

When to Use ORD Elements and MicroStation Elements			
Feature:	**Example of Feature:**	**Preferred Element Type:**	**Explanation:**
Draw the Baseline Alignment for use in Corridor or Linear Template modeling	Centerline of Road Alignment, Approach Road Alignment, Culvert Alignment, Retaining Wall Alignment	**ORD Element**	- MicroStation Elements CANNOT be named. Alignments should be named per the FLH Naming Convention. - Civil Manipulators provide convenient way to edit alignments. MicroStation Elements are difficult to manipulate. - ORD Elements are compatible with the Table Editor tool. - Alignment Annotation (stationing) compatibility. MicroStation Elements can be labeled (stationed) with the *Annotate Element* tool. However, if the MicroStation Element is manipulated, the stationing elements may become dissociated. If dissociation occurs, the Annotation Elements must be deleted and recreated.
Site-Layout features for 3D Modeling	Edge of Parking Lot, Building Foundation, Guardrail and Jersey Barriers, Curb and Gutter, Swales	**ORD Element**	- Site-Layout elements should be named per FLH Convention. - ORD Elements retain relationship to Terrain Models. MicroStation Elements may become static after a Terrain Model is created - Table Editor tool compatibility.
Offset Features Created from an Alignment or Corridor Generated Element	Striping, Guardrail and Right of Way, Fencing, utilities, and erosion control features that parallel the road.	**ORD Element**	The *Move Parallel* tool (MicroStation tool) is NOT compatible with ORD Elements to create an offset element. The *Offset and Taper* tools (ORD Tools) must be used.
Point Control for Corridor or Linear Template modeling	Change the width, slope, or vertical offset of a Template Point used in a Corridor.	**ORD Element**	Point Control is not compatible with MicroStation Elements.
Active Profile in Profile Model 	Centerline of Road Profile, Retaining Wall Baseline Profile, Culvert Profile	**ORD Element**	- Table Editor tool compatibility - Profile should be named per FLH Conventions

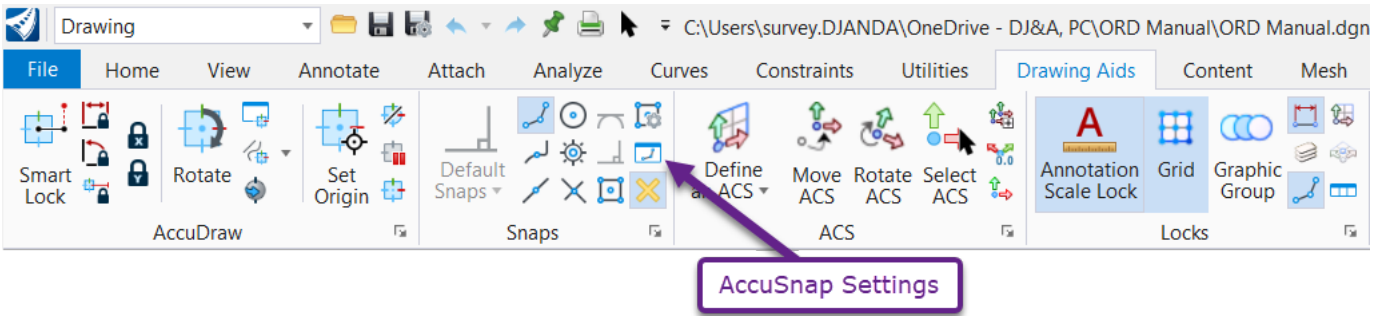
When to Use ORD Elements and MicroStation Elements			
Feature:	**Example of Feature:**	**Preferred Element Type:**	**Explanation:**
Linework and Details	Typical Roadway Sections graphics, custom details, line graphs, utility and erosion control features.	**MicroStation Element**	These Features are not related to 3D modeling and therefore do not require ORD Elements. ORD Elements add processing requirements to the ORD File which may cause slowing or crashes.
Linework in Profile Model .	Culvert and bridge sections to be shown in Profile of Road P&P sheets. Riprap and bridge abutments shown in Bridge Profile.	**MicroStation Element**	
Elements in Drawing Models and Sheet Models .	Custom annotation components and various linework	**MicroStation Element**	ORD Elements can NOT be drawn in Drawing Models and Sheet Models .

7B – SETTINGS

This section explains settings to consider before and after creation and while editing ORD Elements.

Settings that effect ORD Elements are found in four locations:

1. **AccuSnap –** Enables ORD Elements to be snapped to or from a Reference Element. AccuSnaps work in conjunction with **Persist Snaps**, which are discussed in *7C.2 Persist Snaps*.

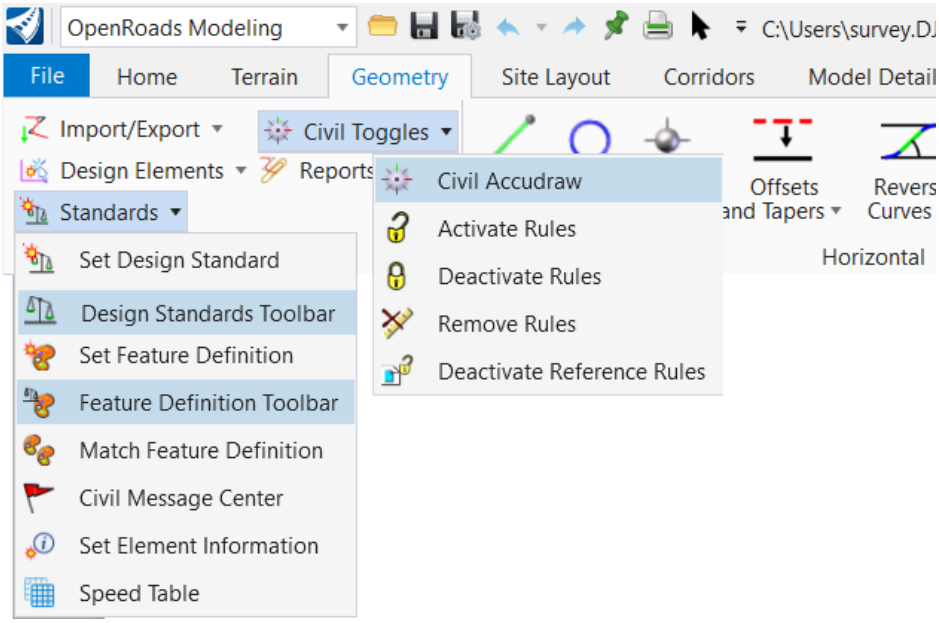


2. **Civil AccuDraw –** When enabled during ORD Element creation, provides a Floating Coordinate System that also provides additional Cursor Dialogue options that specifically relate to civil-design parameters – such as station or elevation.

3. **Feature Definition Toolbar –** This toolbar houses a majority of the settings unique to ORD Elements. The two main purposes of this tool bar are to manage settings related to *Feature Definitions* and *Persist Snaps*.

   NOTE: The *Persist Snap* toggle is ONLY located in the Feature Definition Toolbar Settings.

4. **Design Standards Toolbar–** Allows the User to set *Design Standards* for ORD Elements. ORD Elements that represent road alignments can be checked against AASHTO standards to ensure AASHTO compliance. *Design Standards* allow the User to input a design speed to check minimum radius, K-values, and other design requirements.



BEST PRACTICE: All 4 toolbars should be docked or readily available. When creating or editing ORD Elements, settings should be monitored to avoid unintended results, such as the unintended creation of Persist Snaps.

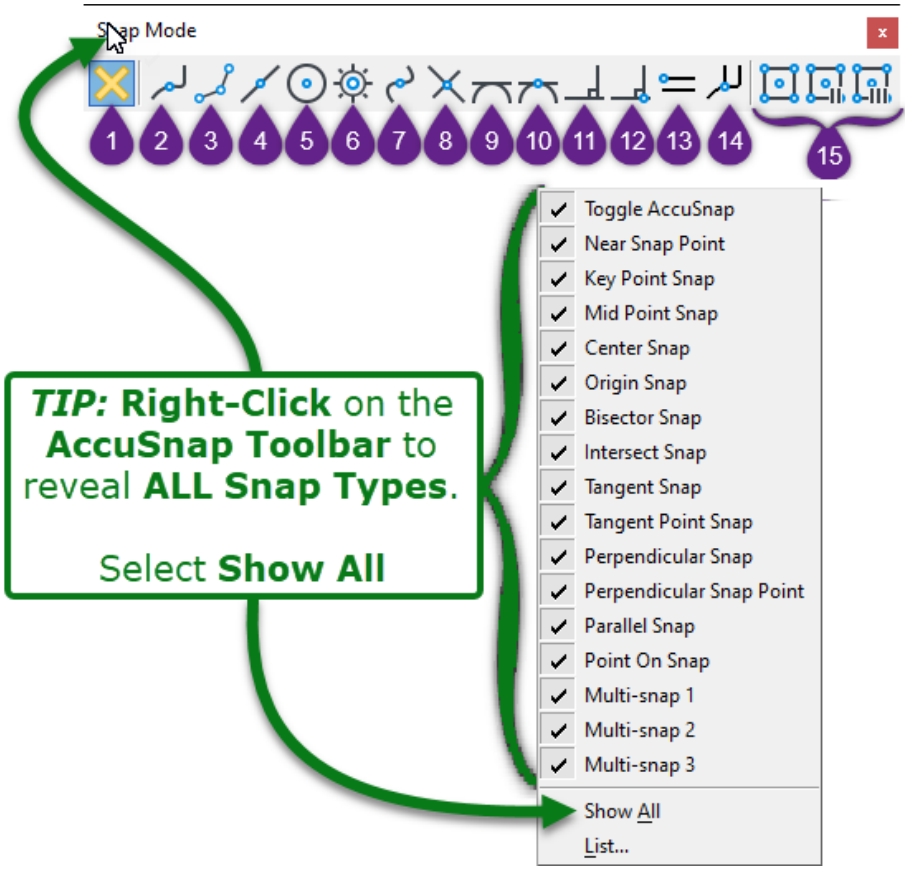
7B.1 AccuSnap Settings

AccuSnaps are used to snap the element being drawn/manipulated to or from a *Reference Element*.

IMPORTANT: *AccuSnaps* work in direct correlation with *Persist Snaps*. See *7C.1 Persist Snaps*.

> ***TIP:*** By default, there are some useful AccuSnap Types are hidden. To reveal ALL AccuSnap Types, right-click on the AccuSnap Toolbar and select "Show All".

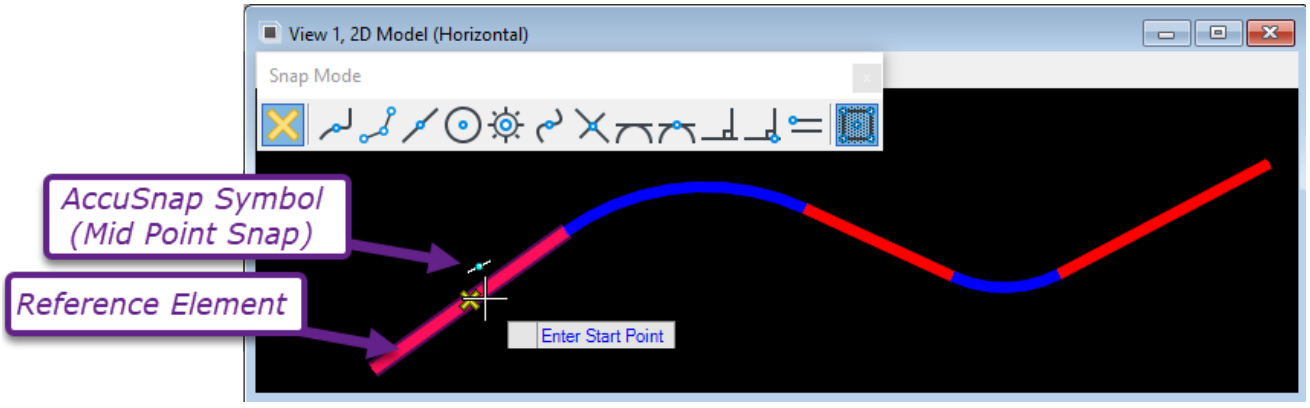
Double-click on a Snap to "permanently" enable it. Single-click on a different Snap type to "temporarily" enable it for the next operation. After the operation is performed, the Snap type will revert back to the "permanently" enabled Snap type.



AccuSnap Symbol & Type			Description
1		AccuSnap Toggle	Enables AccuSnaps functionality. ***Note:*** AccuSnaps must be enabled for *Persist Snaps* to function.
2		Near Snap Point	Snaps to a point along a *Reference Element* that is nearest to the Cursor position.
3		Key Point Snap	Snaps to the End Points or Key Points of a *Reference Element*. By default, Key Points are set to divide an element in half. However, the Key Point divisor can be changed to divide an element into thirds, fourths, etc.
4		Mid-Point Snap	Snaps to the midpoint of a *Reference Element.*
5		Center Snap	Snaps to *Reference Elements* that have a center, such as a circle, arc or text box.

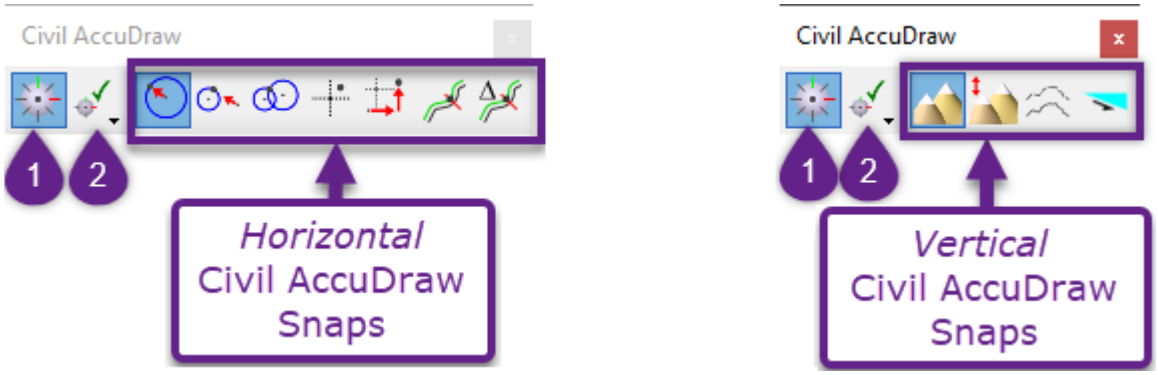
6		Origin Snap	Snaps to *Reference Element* that have an origin point, such as a *Cell* or text element.
7		Bisector Snap	Similar to Mid Point Snap, but will snap to the mid-point of a *Complex Chain* or *Complex Element* – instead of the midpoint of the closest segment.
8		Intersect Snap	Snaps to the intersection point of two *Reference Elements*.
9		Tangent Snap	Snaps to the tangent point of a circular *Reference Element.*
10		Tangent Point Snap	This snap must be enabled before the start point of the element being drawn is placed. This snap is used to draw an element that begins at the start/end point of a circular *Reference Element*. The angle of the element being drawn is locked to maintain tangency with the circular *Reference Element*.
11		Perpendicular Snap	Snaps to or from a *Reference Element* to create a perpendicular element.
12		Perpendicular Snap Point	This snap works similarly to the **Tangent Point Snap**. Instead of drawing an element tangentially from a circular *Reference Element*, the Perpendicular Snap Point draws an element perpendicularly from the start/end point of a circular *Reference Element*.
13		Parallel Snap	After placing the start point of an element, enable this snap and hover the mouse-cursor over a *Reference Element* to draw parallel to it.
14		Point on Snap	After placing the start point of an element, enable this snap to place the end point directly on top of a *Reference Element*.
15		Multi-Snap I-III	This Snap type is a combination of other Snap types. The Snap type that will be used depends on the mouse-cursor location and location on the *Reference Element*. There are three Multi-Snap types available. To program which Snap types are used for the Multi-Snap, right-click on and select "List".

NOTE: Before applying an AccuSnap, the Reference Element must be highlighted and the AccuSnap Symbol must be displayed near the cursor. When these conditions are satisfied, Left-Click (accept) to apply the AccuSnap.



7B.2 Civil AccuDraw Settings

Civil AccuDraw is analogous to MicroStation AccuDraw but provides additional Dialogue Inputs that specifically relate to civil design – such as reference stationing and elevation.

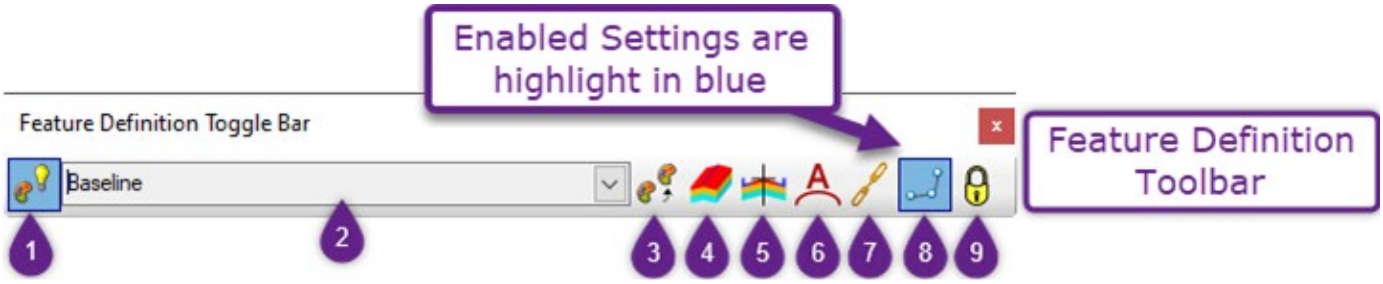


7B.3 Feature Definition Toolbar

The *Feature Definition Toolbar* has two primary purposes:

1. Settings and active Feature Definition for the next ORD Element to be created.
2. Enable/Disable Persist Snaps 8.

BEST PRACTICE: it is recommended to have the *Feature Definition Toolbar* visible in the software window – specifically - so the User can monitor *Persist Snap* settings. ***Persist Snaps* are automatically enabled every-time the software is opened.**



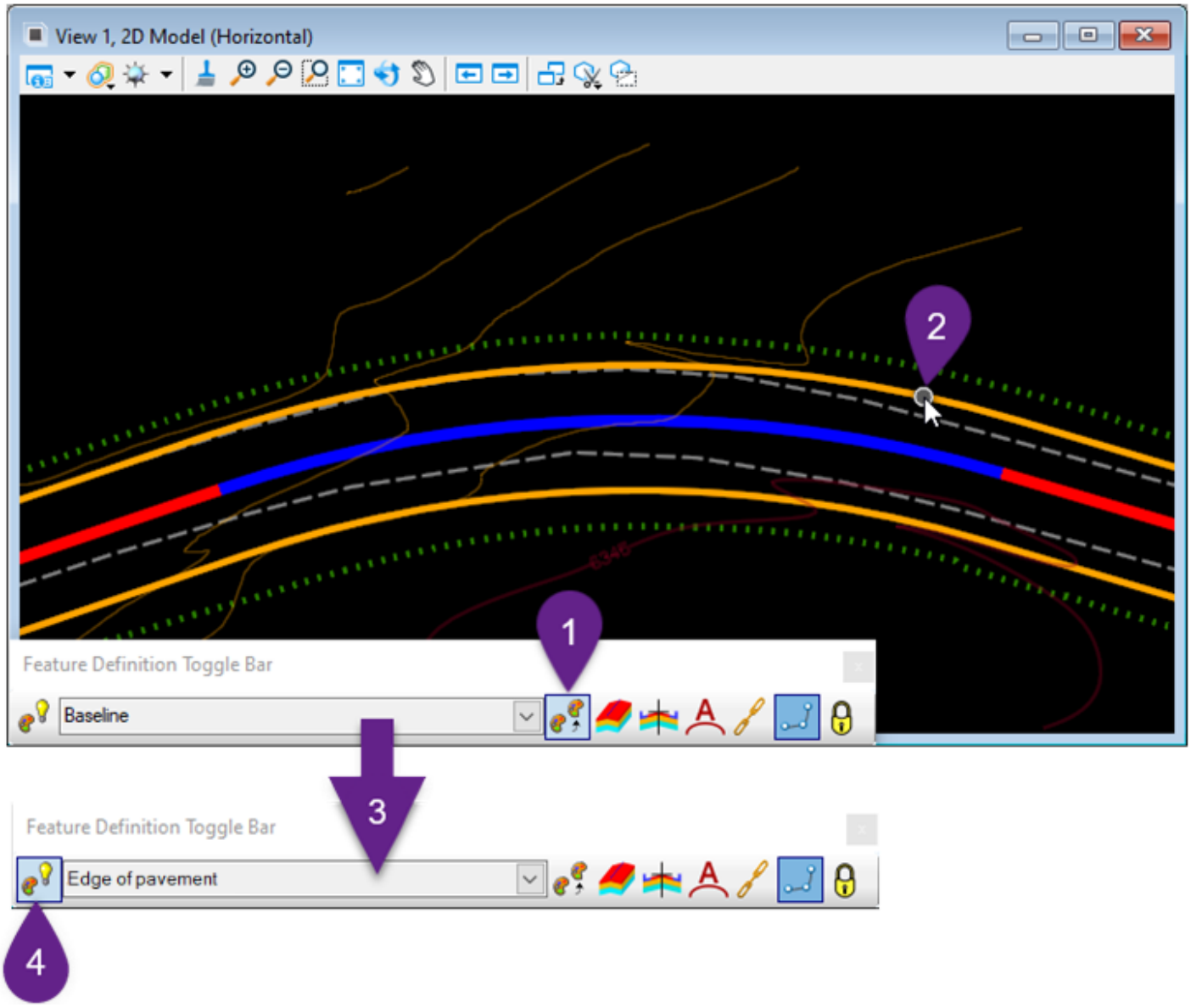
Setting			Description
1		Active Feature Definition toggle	When enabled, the Feature Definition shown in the dropdown 2 will be Active. Newly-created ORD Elements will take on the *Active Feature Definition*. The Active Feature Definition can be selected from dropdown or by matching the Feature Definition of a previously-created element with the 3 **Match Feature Definition** tool . See *7B.3 Set Active Feature Definition with Match Feature Definition*. Feature Definition can be changed after an ORD Element is created in the Properties Box or with the *Set Feature Definition* tool.
4		Create 3D Automatically	When enabled, Horizontal ORD Elements drawn over the active Terrain Model will automatically be assigned a Profile. In other words, this tool will create an ORD Element that is defined in all 3 dimension and immediately viewable in 3D Design Models. The automatically generated profile is draped onto the active Terrain Model. ***BEST PRACTICE:*** Keep this setting disabled due to the User's lack of control in profile creation.

5		Use Feature Definition Template	When enabled, a Corridor is automatically created when a Horizontal ORD Element is placed. The Create 3D Automatically toggle must be enabled for this tool to function. The Template used for automatic Corridor creation is assigned to the Feature Definition selected for the Horizontal ORD Line. ***NOTE:*** The FLH Feature Definition library does NOT contain Template assignments for Horizontal ORD Elements. ***BEST PRACTICE:*** Keep this setting disabled. Automatic Corridor creation is discouraged because a custom Template should be created for each Corridor.
6		Auto Annotate	When enabled, a Horizontal ORD Elements are automatically annotated (i.e., stationed) immediately after placement. ***BEST PRACTICE:*** Keep this setting disabled to prevent clutter from unnecessary annotations. Horizontal ORD Elements can be manually annotated with the *Annotate Element* tool. See *15D - Civil Annotations (Stationing & Profile)*.
7		Chain Commands	This option is used to create a string of ORD Elements. When enabled, each new ORD Element is placed to the end point of the previous ORD Element.
8		Persist Snaps	When enabled, Persist Snaps are applied when creating or editing an ORD Element. **When creating ORD Elements, the concept of Persist Snaps should be fully understood**. See *7C.2 Persist Snaps*. ***BEST PRACTICE:*** Keep this setting off during normal software use. Only enable when Persist Snaps are specifically intended by the User. **Persist Snaps are automatically enabled when the software is opened.**
9		Rule Deactivation	When enabled, new ORD Elements will be created with locked Civil Rules. Similarly, edits performed to previously-created ORD Elements will Lock their Civil Rules.

7B.3.a Set Active Feature Definition with Match Feature Definition tool

The *Match Feature Definition* tool is used to set the active Feature Definition by selecting a previously-created ORD Element. The active Feature Definition is shown in the Feature Definition Toolbar. The next ORD Element to be created will automatically be assigned to the active Feature Definition, assuming the *Set Active Feature Definition* toggle is enabled.

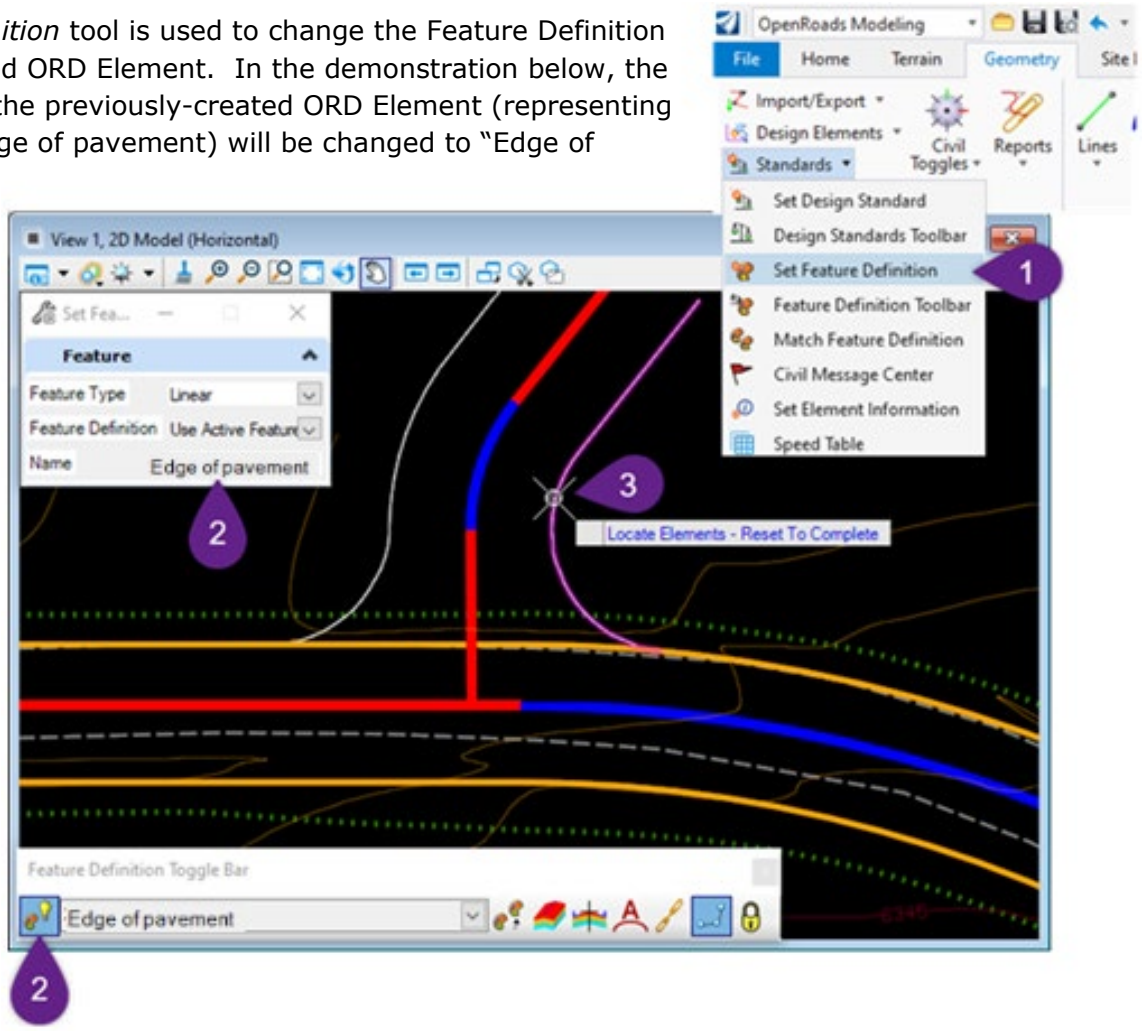
The demonstration shown below changes the *active* Feature Definition to "Edge of Pavement" – which represent an edge of pavement line.



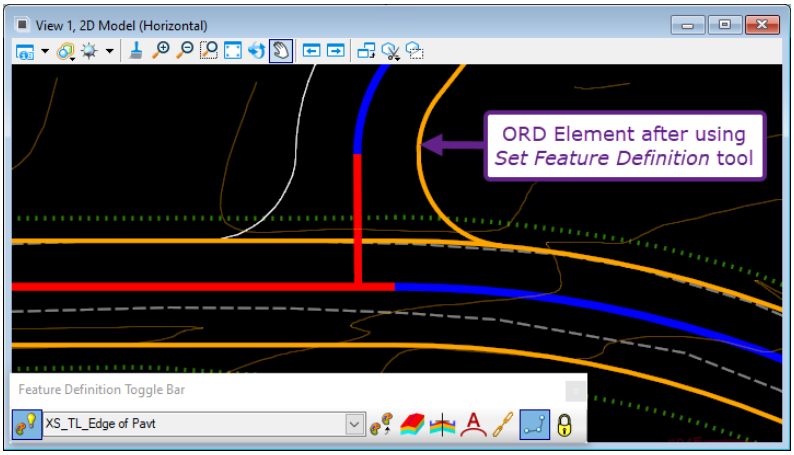
1	Left-Click on the *Match Feature Definition* icon from the *Feature Definition Toolbar*.
2	*Prompt: Locate Element* – Left-Click on the ORD Element containing desired Feature Definition
3	Notice the ORD Element Feature Definition is now shown in the dropdown.
4	*Left-Click* on the *Set Active Feature Definition* icon.

7B.3.b Change Feature Definition with Set Feature Definition Tool

The *Set Feature Definition* tool is used to change the Feature Definition of a previously-created ORD Element. In the demonstration below, the Feature Definition of the previously-created ORD Element (representing the approach road edge of pavement) will be changed to "Edge of Pavement".

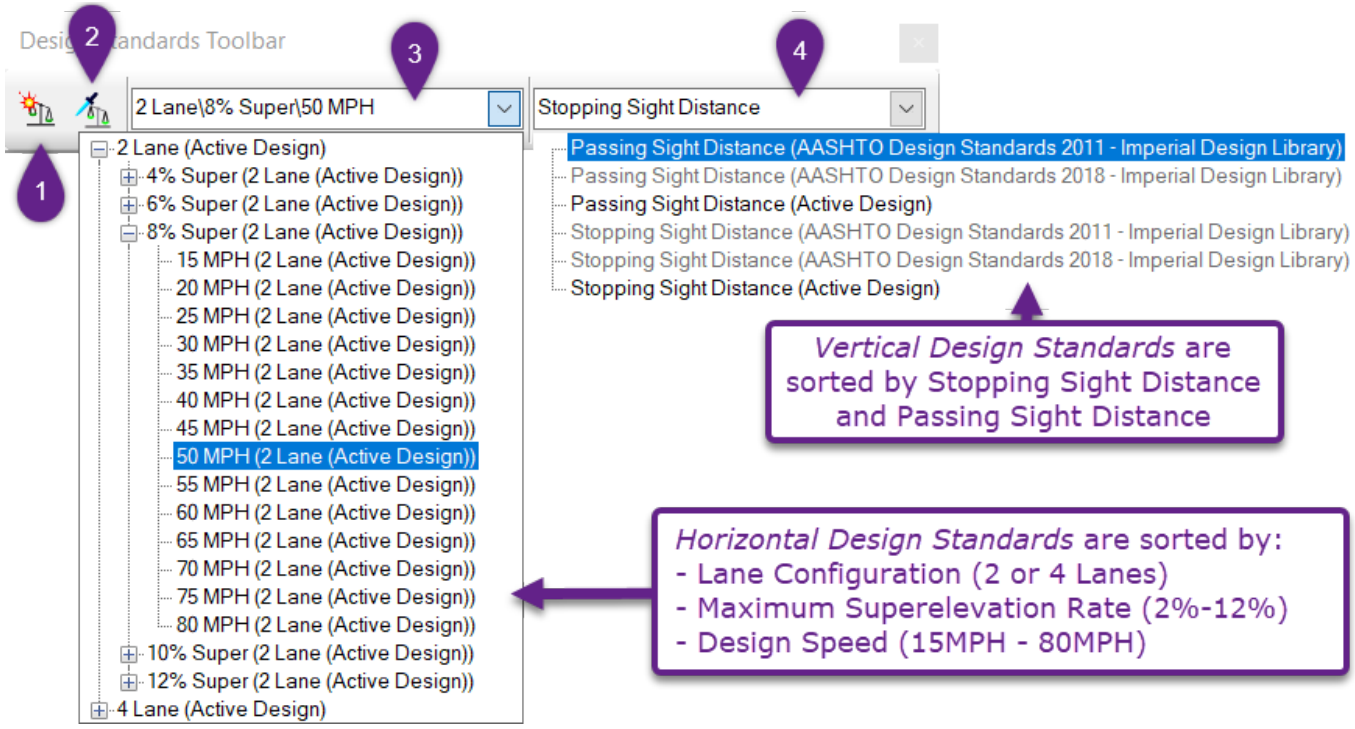


1	From the Ribbon, select the *Set Feature Definition* tool: [***OpenRoads Modeling*** → ***Geometry*** → ***General Tools***].
2	*Prompt: Locate Element – Reset To Complete* – Ensure the desired Feature Definition is active (which is shown on the previous page). If desired, type in a Name for the ORD Element.
3	Left-Click on the previously-created ORD Element to changes it's Feature Definition.



7B.4 Design Standards Setting

The *Design Standards* tool can be used to check horizontal and vertical alignments for compliance with AASHTO Design Standards.



		Setting	Description
1		Set Design Standard	Used to apply Design Standards checks to a previously-created element. After creating an ORD Element, use this button to apply Design Standards to it.
2		Toggle Active Design Standard	If enabled, the active Design Standards are automatically applied to new ORD Elements.
3		Active Horizontal Design Standard	Used to set Lane Configuration, Maximum Superelevation, and Design Speed for a Horizontal ORD Element.
4		Active Vertical Design Standard	Used to set the sight distance condition (Stopping Sight Distance or Passing Sight Distance) for automatic Design Standard checks to the Profile (Vertical Alignment). ***NOTE:*** An Active Horizontal Design Standard has to be set before a Vertical Design Standard can be specified.

NOTE: Design Standards have to be set manually for both Horizontal and Vertical ORD Elements. In other words, Design Standards will not carry over to the Active Profile in the Profile Model after Design Standards are applied to the Horizontal ORD Element.

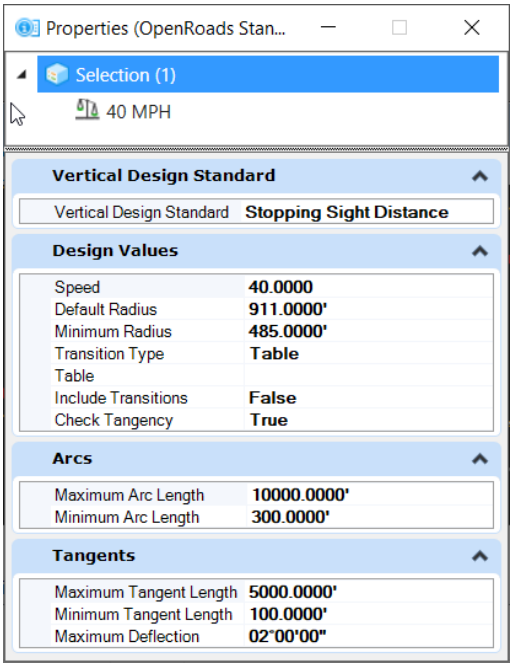
7B.4.a Design Standard Criteria

Horizontal Design Standards check the following criteria:

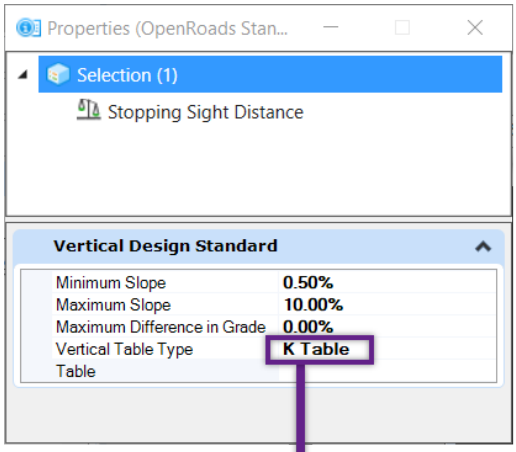
- Minimum Radius Value
- Tangency (between Arcs/Spirals/Lines)
- Transition
- Maximum Arc Length
- Minimum Arc Length
- Maximum Tangent Length
- Minimum Tangent Length
- Maximum Deflection (between two-line segments)

Vertical Design Standards check the following criteria:

- Minimum Slope
- Maximum Slope
- Minimum K-Value (Sag and Crest)



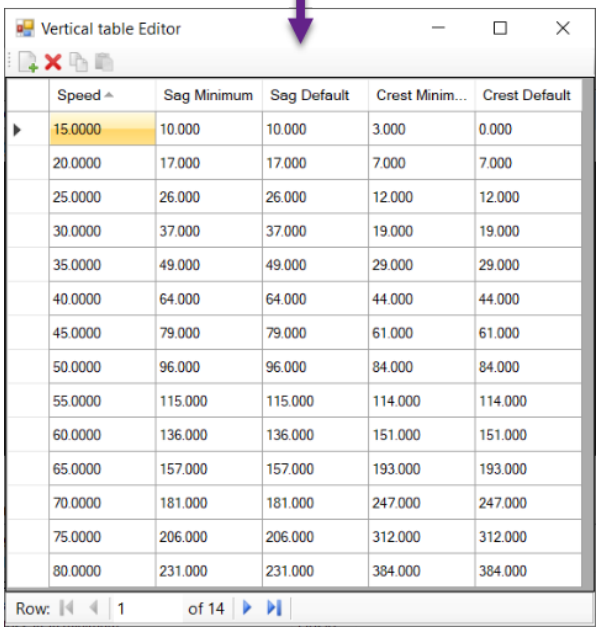
ORD Elements that do NOT meeet Design Standards criteria are shown with a or graphically ontop of the ORD Element or in the Civil Error Message Center.



denotates an Error
denotates a Warning

NOTE: The software will NOT autocorrect Errors or Warnings from Design Standards.

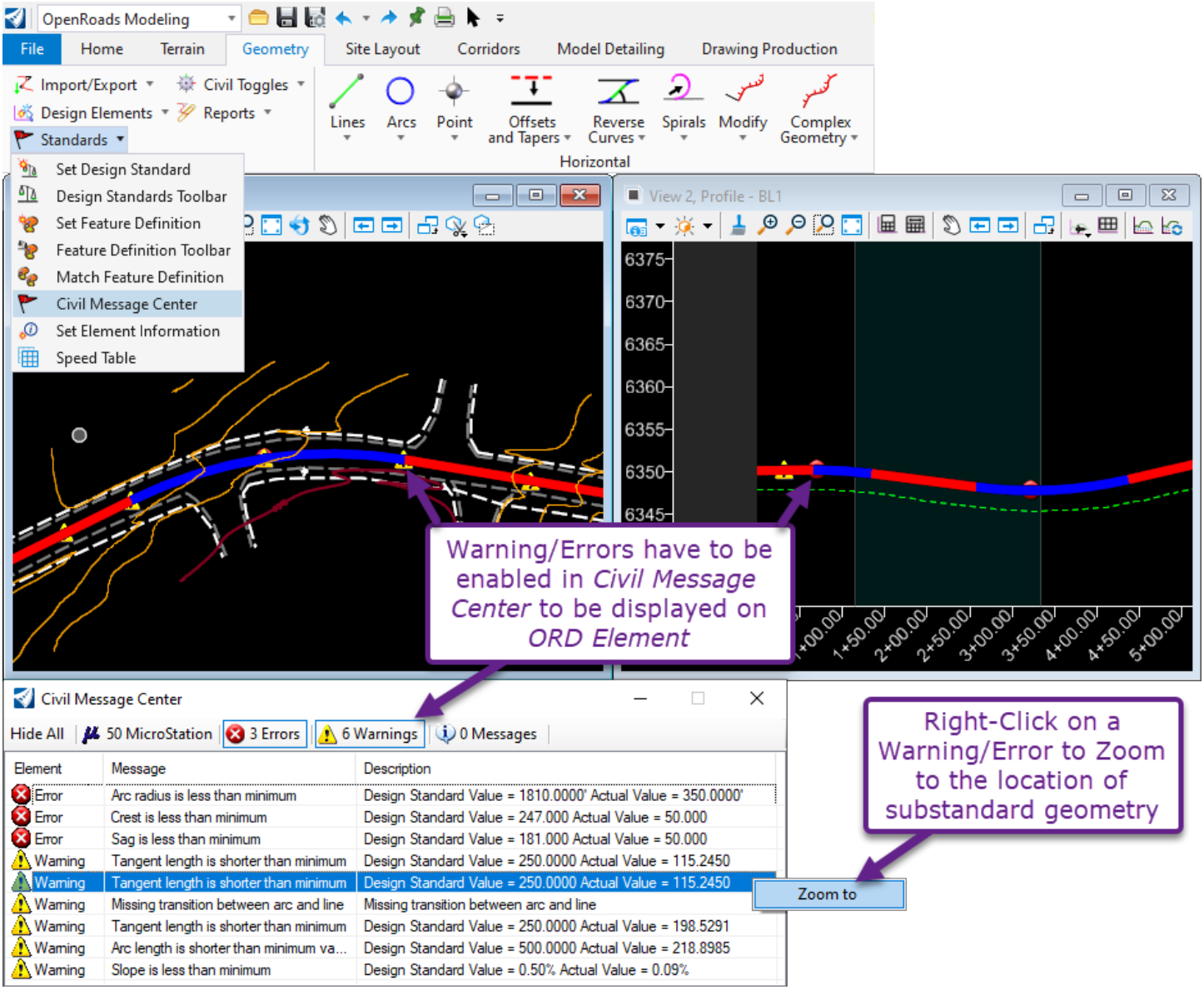
WARNING: The software's ability to check Design Standards is very convenient – but should only be used as an aid. **It is the responsibility of the USER to ensure geometry is compliant with the applicable standards.**



7B.4.b Civil Message Center

ORD Element not meeting applied Design Standards are listed in the *Civil Message Center*..

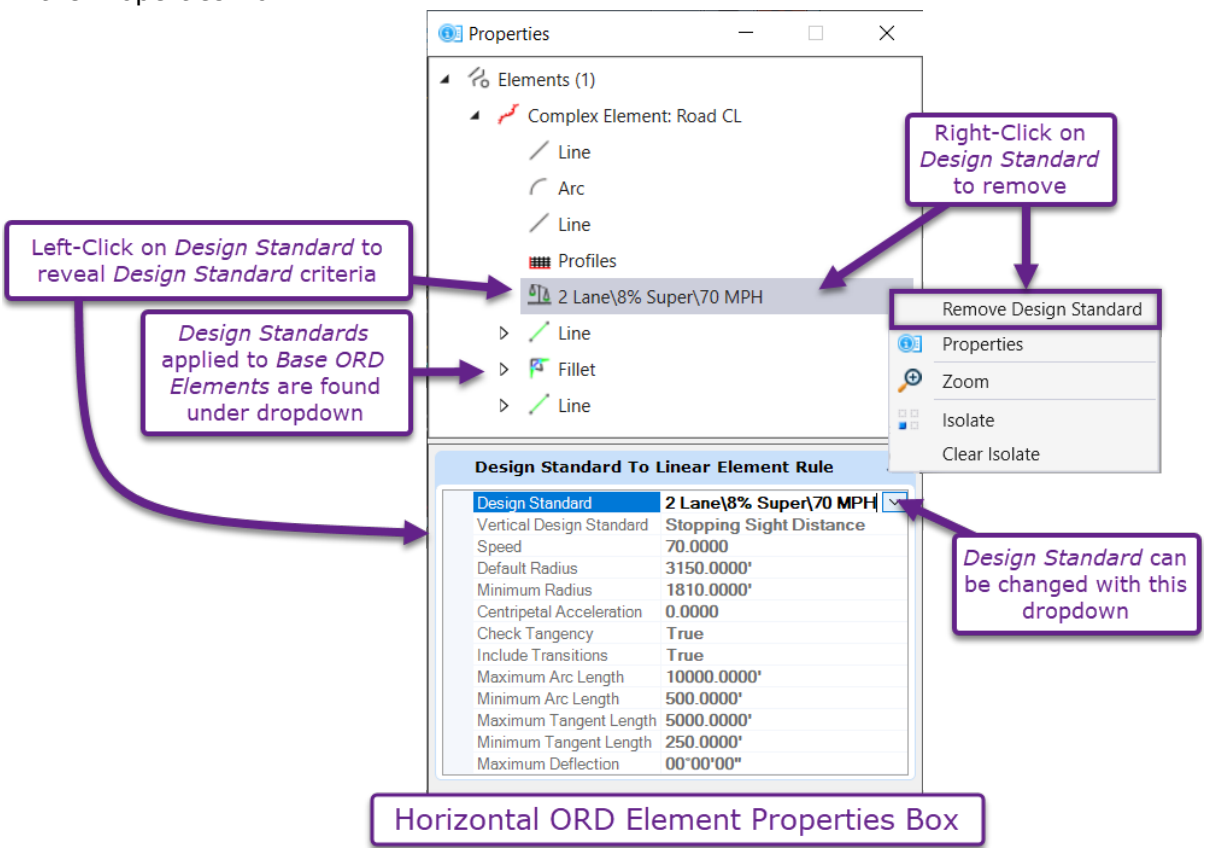
The Civil Message Center provides information on the Error/Warning. The same information can be found in the Properties Box by selecting the Error/Warning symbol on the ORD Element.



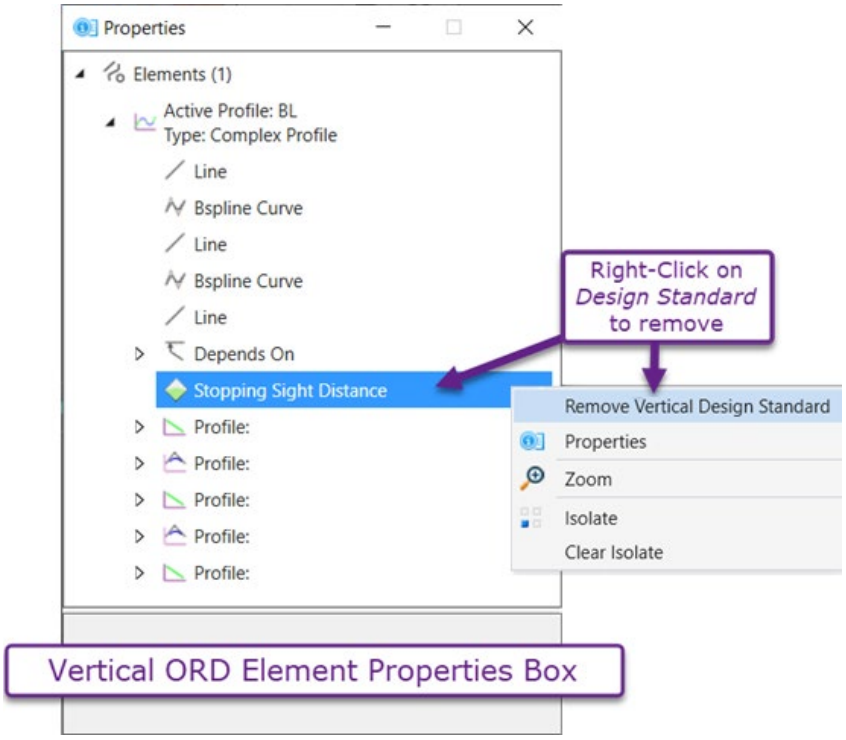
NOTE: The "Design Standard Value" represent the minimum allowable value to meet the Design Standard. The "Actual Value" represents the current value for the ORD Element. If the ORD Element is edited to exceed the "Design Standard Value", then the Error or Warning will be removed.

7B.4.c Identify, Change, and Remove Design Standards

Design Standards previously applied to a **Horizontal** ORD Element can be identified, removed, and changed in the Properties Box.



Design Standards previously applied to a **Vertical** ORD Element can be identified and removed in the Properties Box.



NOTE: Vertical Design Standards cannot be changed directly. Vertical design Standards must be Removed and reapplied.

7C – DESIGN INTENT

Unlike MicroStation Elements, ORD Elements will capture the *Design Intent* used in the creation of the ORD Element. *Design Intent* is formulated by the Persist Snaps and Civil Rules used to the create the ORD Element.

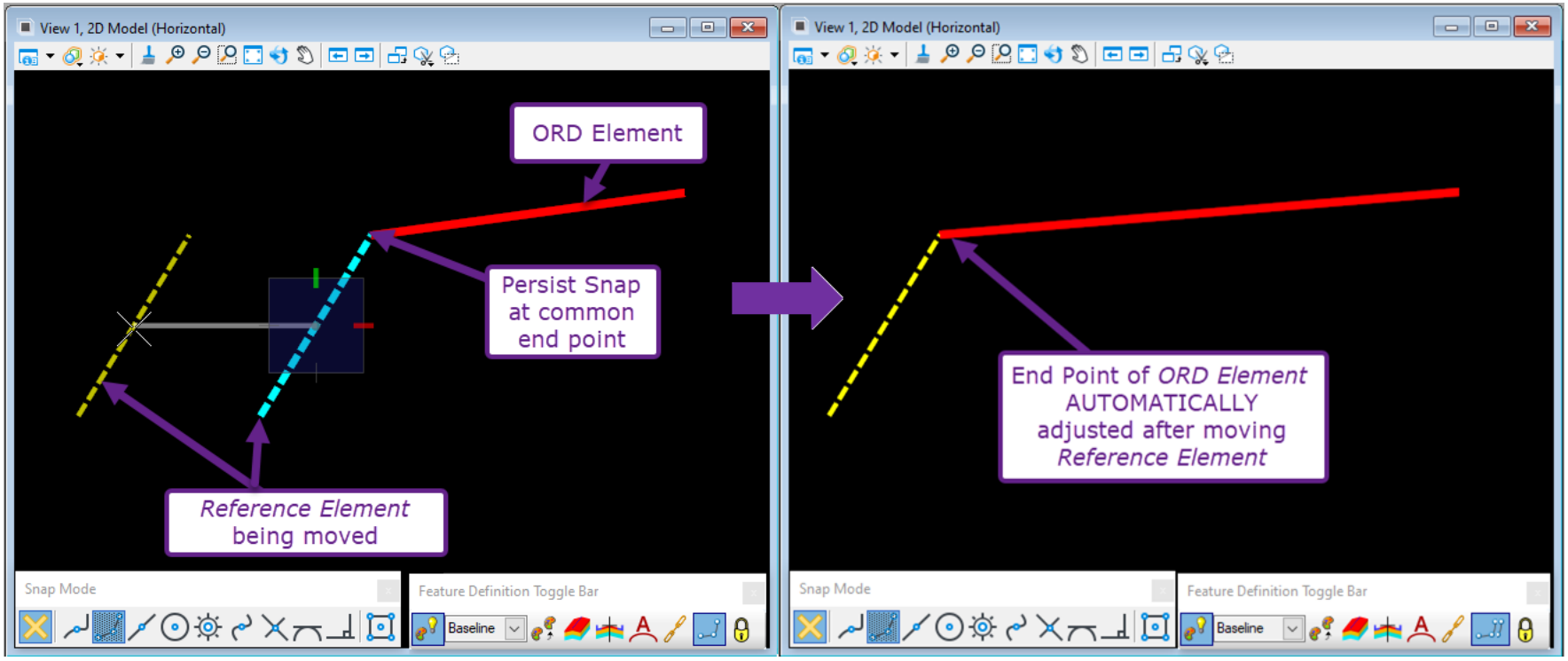
An ORD Element created with *Design Intent* may automatically reposition itself if related elements are manipulated.

WARNING: It is paramount that the User understands how the software will assign Design Intent to newly-created ORD Elements. Similarly, the User should be able to identify Design Intent assigned to previously created ORD Elements. Failure to understand Design Intent can result in unintentional repositioning of adjacent/related ORD Elements.

The following sections explain the dynamic *Design Intent* relationships that are automatically formed when an ORD Element is created.

7C.1 Persist Snaps

When creating new ORD Elements or performing *grip-edits* to a previously-created ORD Element, it is common to use AccuSnaps to snap to/from a Reference Element. If AccuSnap and Persist Snap settings are enabled when an ORD Element is created or grip-edited, then the software remembers the specific instance of AccuSnap use as *Design Intent*. The Persist Snap will assign the ORD Element a dependency to the Reference Element that was snapped to. If the Reference Element is moved or edited, then the position of the ORD Element is AUTOMATICALLY adjusted to honor the original use of AccuSnap is honored.



WARNING: Previously-created Persist Snap relationships should be considered before editing an ORD Element. Any ORD Elements that are persist snapped to the element being manipulated will be automatically repositioned. Previously created Persist Snap relationships can be identified and removed in the Properties box.

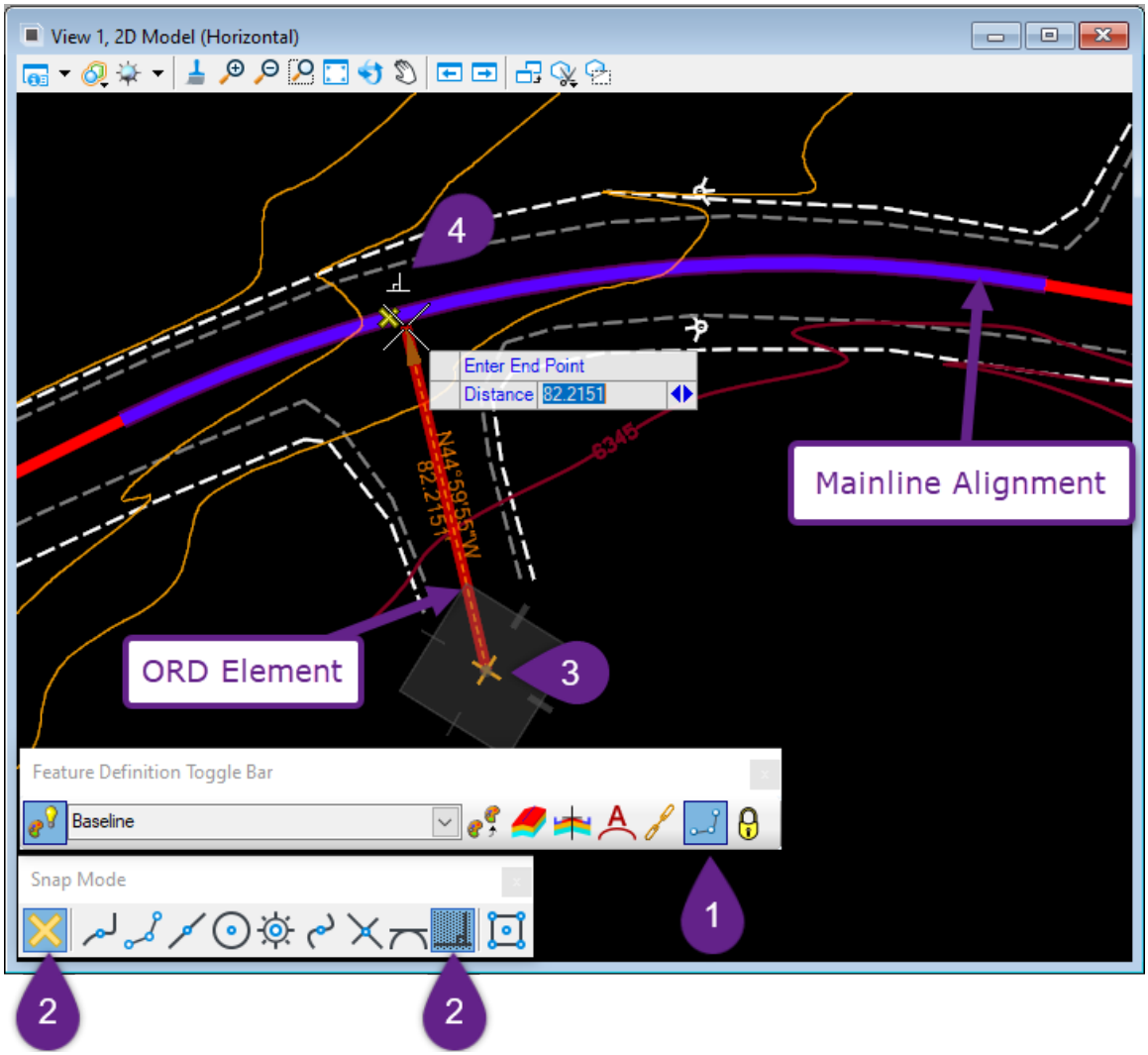
Persist Snaps can be convenient if used correctly or problematic if used unintentionally due to automatic repositioning. If Persist Snaps are to be used, the user should anticipate how the Reference Element may be edited in the future - so that the ORD Element will automatically shift in a predictable and intended manner.

BEST PRACTICE: Only enable Persist Snaps Settings when the use of Persist Snaps is SPECIFICALLY intended. *Disable Persist Snaps Settings* during normal ORD software use. By default, *Persist Snaps Settings* are enabled upon opening of ORD Software, so the user must manually disable *Persist Snaps* every time the program is opened.

IMPORTANT – If ***Persist Snaps*** and ***AccuSnaps Settings*** are enabled, ORD Elements snapped to a Reference Element (either through new creation or grip-edits) will form ***Persist Snaps***.

7C.1.a Demonstration of Persist Snap Creation and Automatic Repositioning

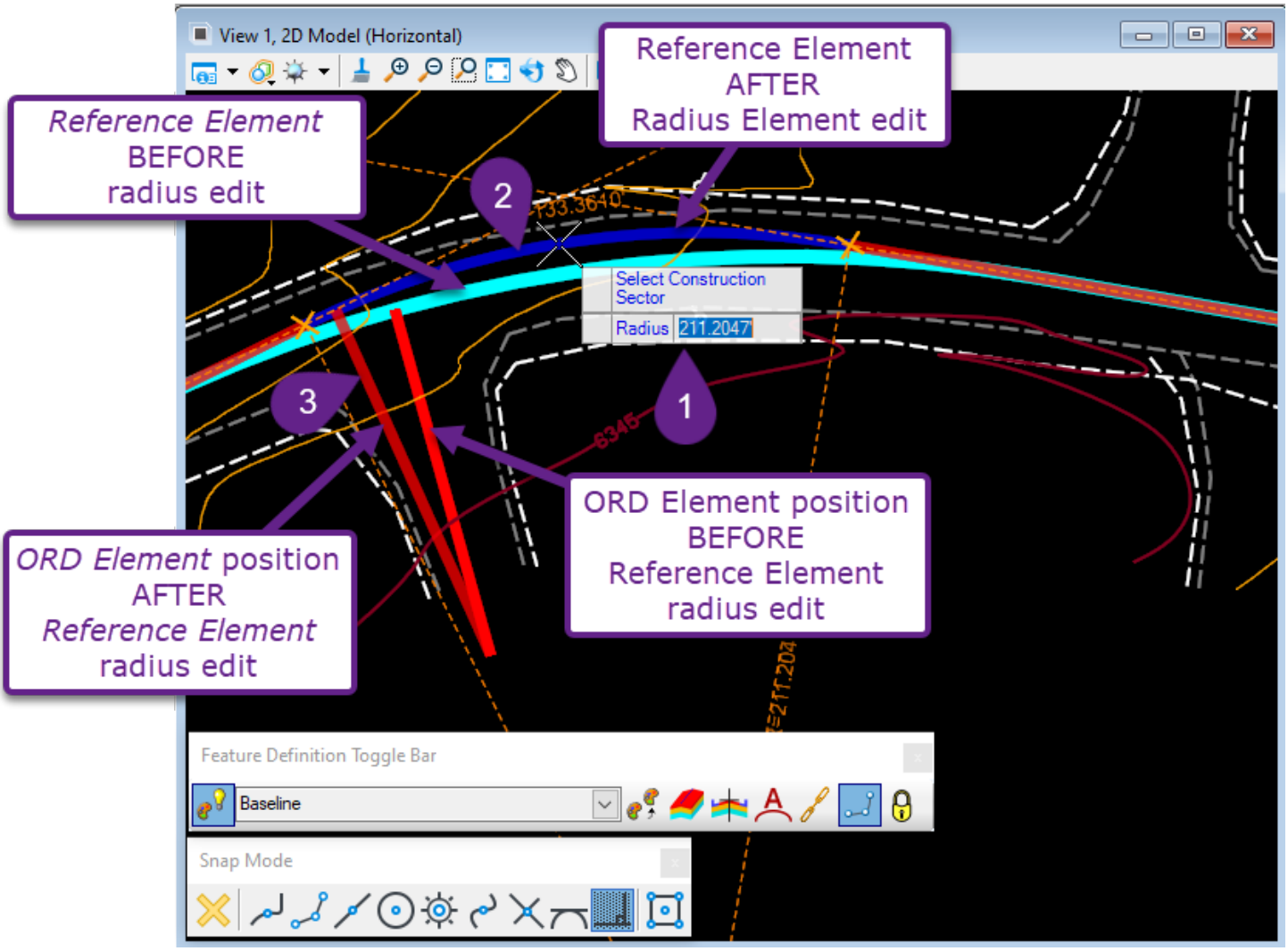
In this example, the *Design Intent* is to draw an Approach Road alignment (ORD Element) PERPENDICULARLY to the Mainline Road alignment (Reference Element) using *Persist Snaps*.



1	Enable *Persist Snaps* in the Feature Definition Toggle Bar.
2	If not already enabled, toggle-on *AccuSnaps* and choose the desired snap. In this case, the *Perpendicular Snap* is enabled
3	Using the *Line Between Points* tool to create a Horizontal ORD Element, place the Start Point of the Approach Road (ORD Element)
4	Hover over the Reference Element – paying close attention to the AccuSnap Type that appears near the cursor . When the desired AccuSnap Symbol is displayed near the cursor, left-click to accept the snap and finish the ORD Element creation

TIP: Monitor the *Cursor Snap Display* when using *AccuSnaps* and *Persist Snaps*. Only accept the placement position when the desired *AccuDraw Snap* symbol is displayed.

After the creation of the Perpendicular Persist Snap, the radius of the Mainline Road Alignment (Reference Element) is edited. After the Mainline Road Alignment (Reference Element) is edited, the end point of the Approach Road Alignment (ORD Element) automatically shifts to become perpendicular to the edited radius of the Reference Element.



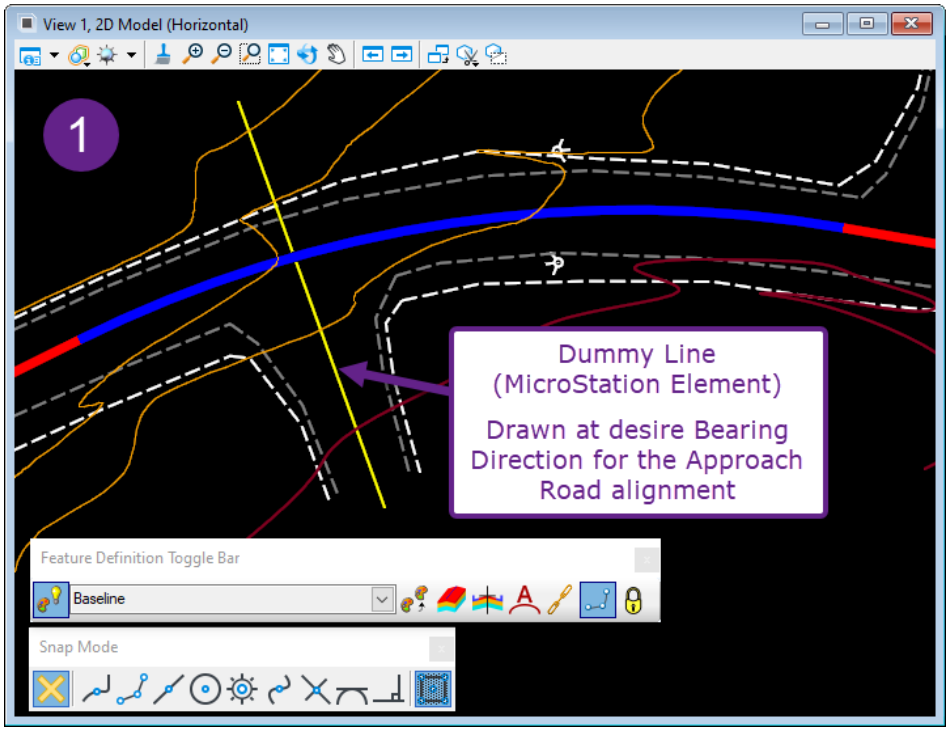
1	Select the Reference Element and change the radius of the curve.
2	The new position of the Reference Element will be shown here.
3	The new position of the ORD Element will be shown here.

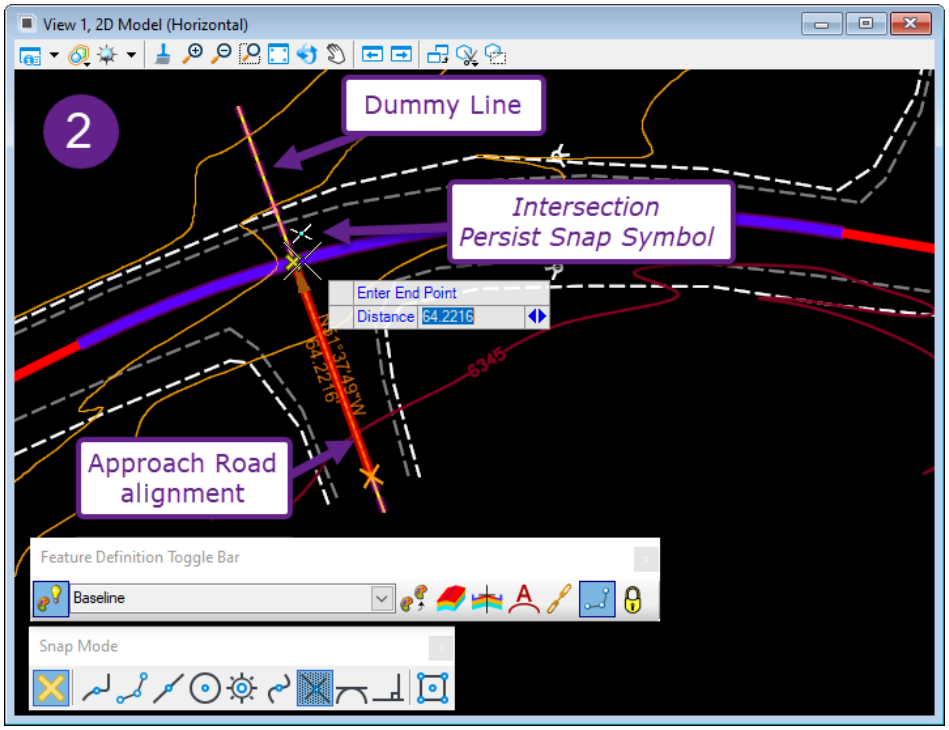
Was Design Intent maintained? – In this real-world example, the Approach Road alignment is shifted to stay perpendicular to the Mainline curve and the resulting alignment is no longer centered inside the Edge of Existing Road linework. If the actual *Design Intent* is to keep the Approach Road alignment centered in the existing approach road AND end at the Mainline Road alignment - then usage of the Perpendicular Persist Snap is incorrect.

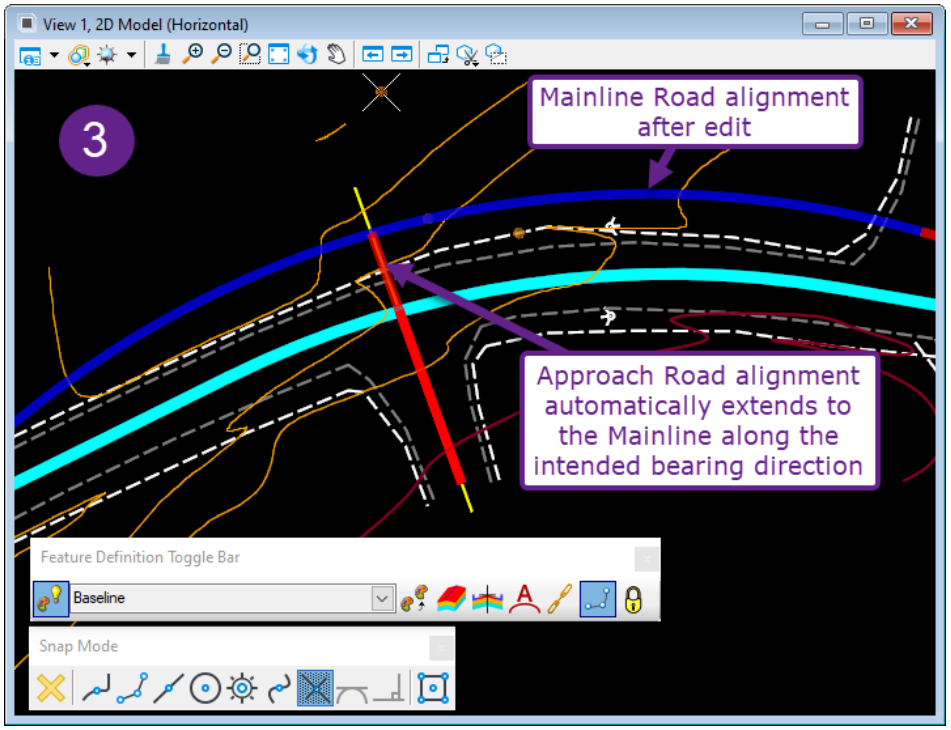
Alternate *Design Intent* workflow – As an example, let's assume the Design Intent is to keep the Approach Road alignment centered in the Edge of Existing Road linework, but also remain snapped to the Mainline Road Alignment if edits are made. This can be done by drawing a dummy MicroStation Element 1 at the intended bearing direction of the Approach Road. When the Approach Road Alignment is created, the Intersection Persist Snap is used at the intersection of the Dummy Line and Mainline Road Alignment 2.

If an edit is made to the Mainline Road Alignment – then the Approach Road Alignment automatically extends or contracts along the dummy line bearing direction 3.

WARNING: Check the *Profile Model* of both alignments after edits are made. Vertical ORD Elements can also have Design Intent (Persist Snaps and Civil Rules). Modifying the Horizontal ORD Element may automatically reposition Vertical ORD Elements due to dynamic Design Intent relationships.





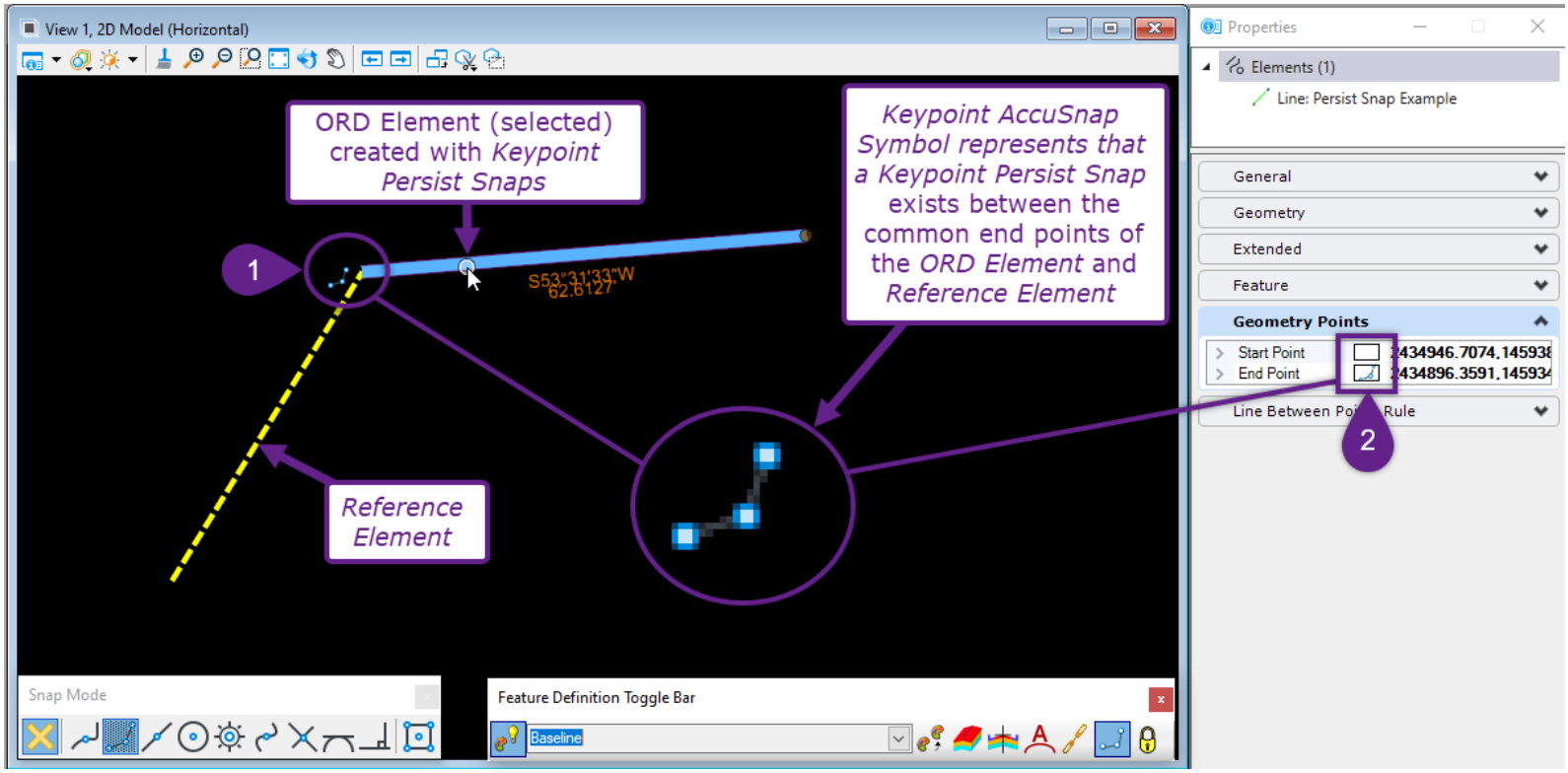


7C.1.b Identify Persist Snaps on a Previously-Created ORD Element

There are two locations which signify if Persist Snaps were used on a previously-created element:

Location 1: On the ORD Element, in the vicinity on the *Persist Snap* – Select the ORD Element to examine for *Persist Snaps.* if a *Persist Snap* exists, the *AccuSnap Symbol* type will be shown in the vicinity of the original snap

Location 2: In the *Properties Box* – In the Geometry Points subsection of the Properties Box, the *AccuSnap Symbol* type will be shown in the white box.

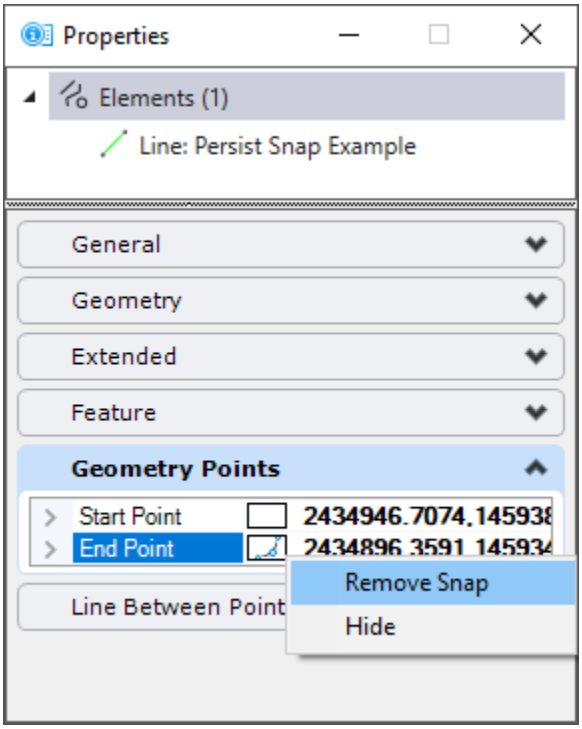


7C.1.c Remove Previously-Created Persist Snaps

There are two methods to remove *Persist Snaps* from a previously-created ORD Element:

Perform a Grip-Edit on the ORD Element – If a Grip-Edit made to an ***ORD Element*** result in a contradiction to the *Persist Snap* – then the *Persist Snap* will be automatically removed. An example would be performing a Grip-Edit to the End Point of the ORD Element shown at Location 1 above with *Persist Snaps* toggled OFF.

Remove *Persist Snap* in the *Properties Box* – Right-Click on the white box shown in Location 2 above. Select the *Remove Snap* option to remove the *Persist Snap*.



WARNING: *Persist Snaps* identifiers are NOT shown by selecting a *Complex ORD Element*. The *Base ORD Elements* within the *Complex Element* have to be selected to reveal previously-created *Persist Snaps*.

7C.2 Civil Rules

Civil Rules are unique to ORD Elements. Civil Rules are created and stored as *Design Intent* when an ORD Element is created or edited. Each ORD Tool contains a unique set Civil Rules.

After creation of an ORD Element, a set of Civil Manipulators (orange manipulation text) are shown when the ORD Element is selected. The ORD Tool to create the element will dictate what types of Civil Manipulators are available. For example, the *Line From Element* tool and *Line Between Points* tool are both used to create a Horizontal ORD Line element. However, Horizontal ORD Line element will have a different set of Civil Manipulators, depending on the tool used to created it.

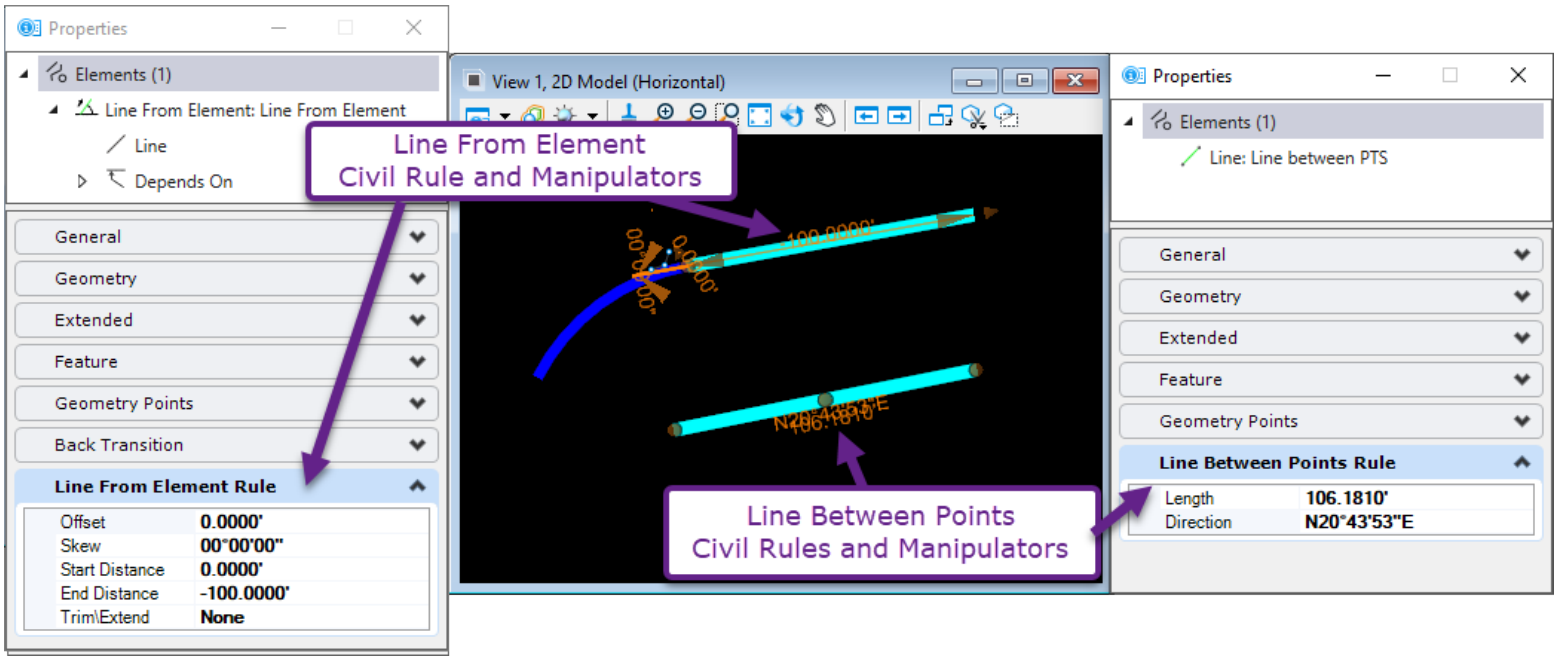
When creating or editing an ORD Element the following criteria will determine how *Civil Rules* are established:

- Specific tool used in ORD Element creation.
- Relationship to Reference Elements *(Civil Rule Dependency)*,
- Dialogue Options that are locked when creating the ORD Element
- *Civil Rule Manipulators* used when editing a previously-created ORD Element are remembered and stored as *Design Intent*.

When Reference Elements are edited, the ORD Element will automatically move in a manner to stay true to the established *Civil Rules*.

Simple Example: When a Horizontal ORD Element is created parallel to a Reference Element with the *Single Offset Entire Element* tool. The software interprets the *Design Intent* as if the Horizontal ORD Element is ALWAYS be parallel to the Reference Element *(Civil Rule Dependency)*. If the Reference Element is rotated, then the ORD Element will also rotate to keep the *Civil Rule* and *Design Intent* intact.

WARNING EXAMPLE: ORD Elements will have unique *Civil Rules* depending on the tool used in creation. For example, an ORD Line created with the *Simple Line From Element* tool will have unique Civil Manipulators and Properties options that are directly related to the Civil Rules created form this specific tool. The graphic below compares the Civil Rules and Manipulators for an ORD Line created with different tools.

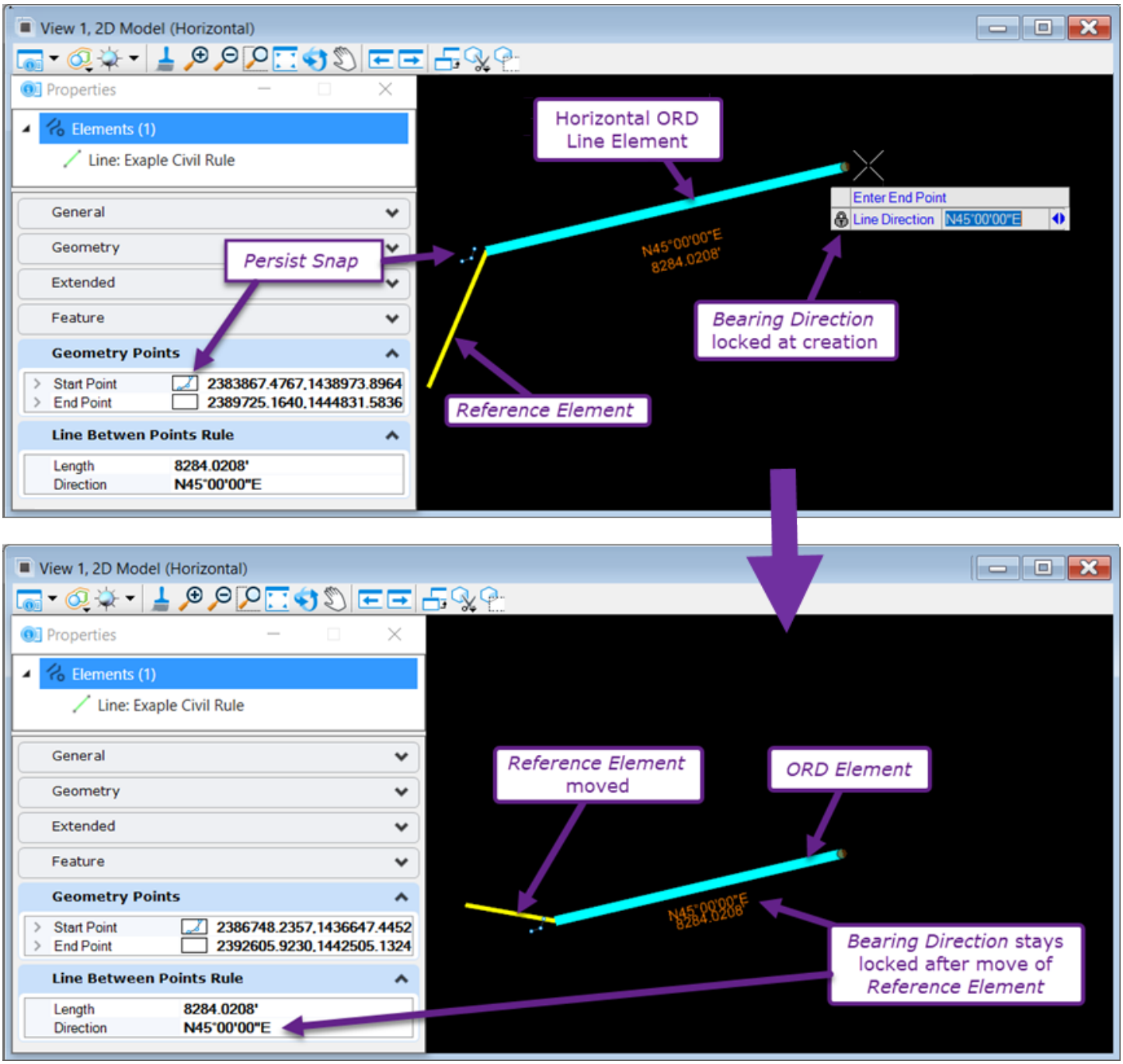


7C.2.a Civil Rules Example – Dialogue and Civil Rules Manipulator Inputs

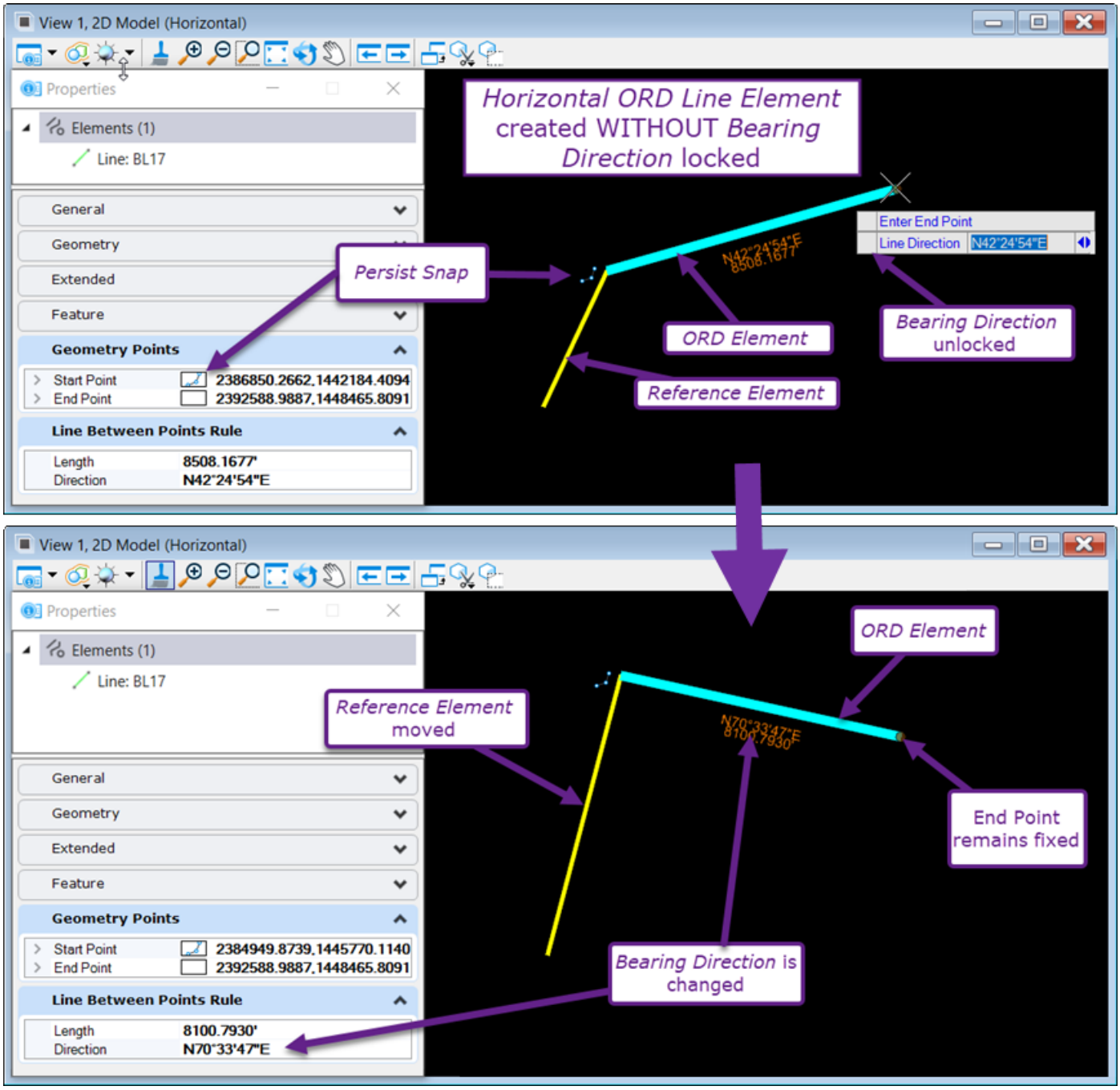
In this example, a Horizontal ORD Line Element is created with two *Design Intent* conditions:

1. The Start Point of the Horizontal ORD Line Element is *Persist Snapped* to the vertex of a Reference Element.
2. The Bearing Direction of the ORD Element is locked through *Dialogue Options*.

When the Reference Element is moved, the End Point is moved to keep the original User input Bearing Direction fixed.



To further demonstrate *Design Intent* – this example is the same as above, EXCEPT the Bearing Direction of the Horizontal ORD Line is NOT locked during creation. When the Reference Element is moved, the Bearing Direction is changed, and the End Point remains in a fixed position.



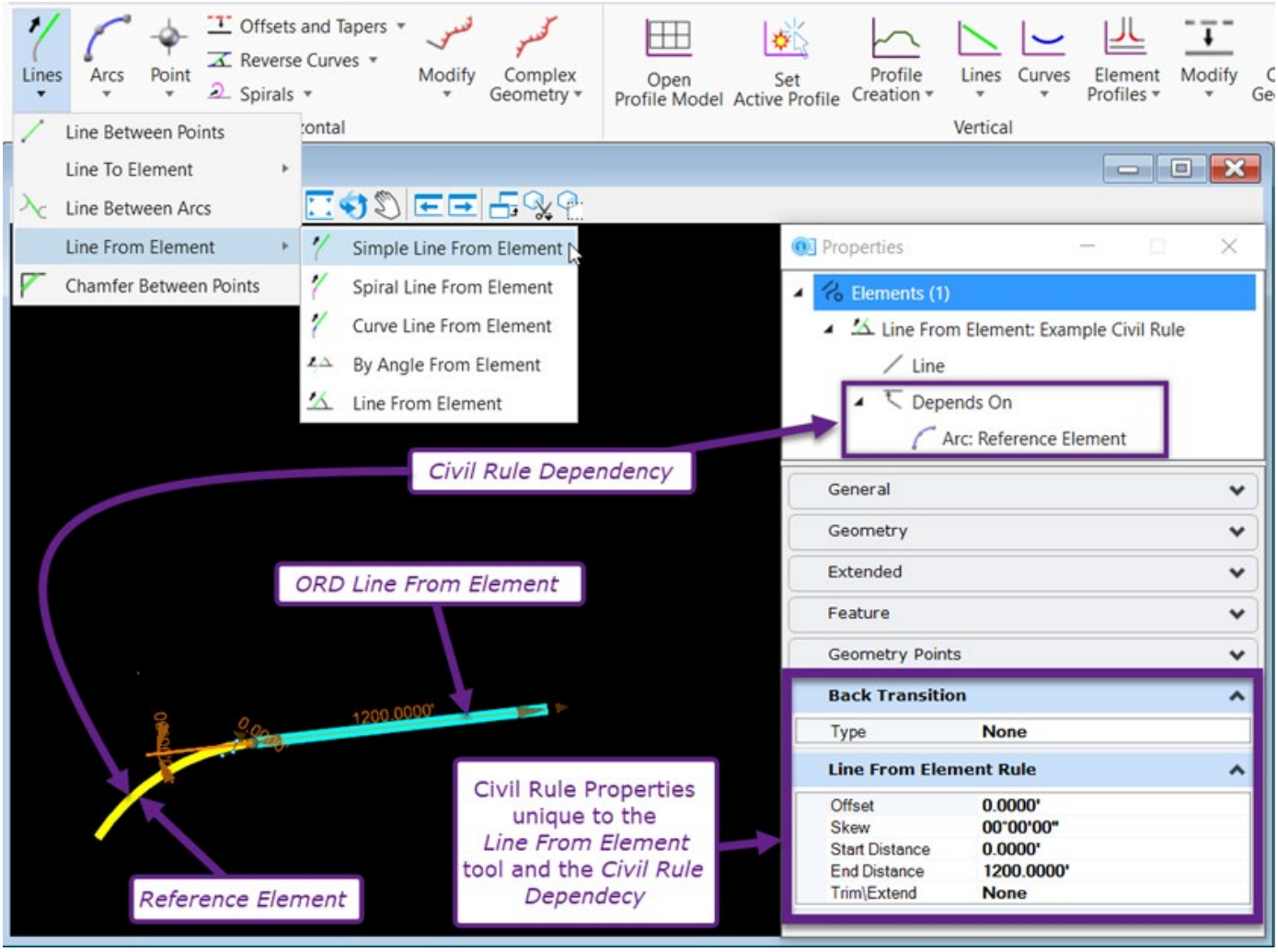
To reiterate – In the creation of an ORD Element, locked Dialogue Options are interpreted by the software as *Design Intent* and assigned to the ORD Element as *Civil Rules*.

***Relevant*:** *Design Intent* is formed in a similar manner when an *ORD Element* is edited with *Civil Rules Manipulators*. The keyed-in value becomes locked and stored as *Design Intent*.

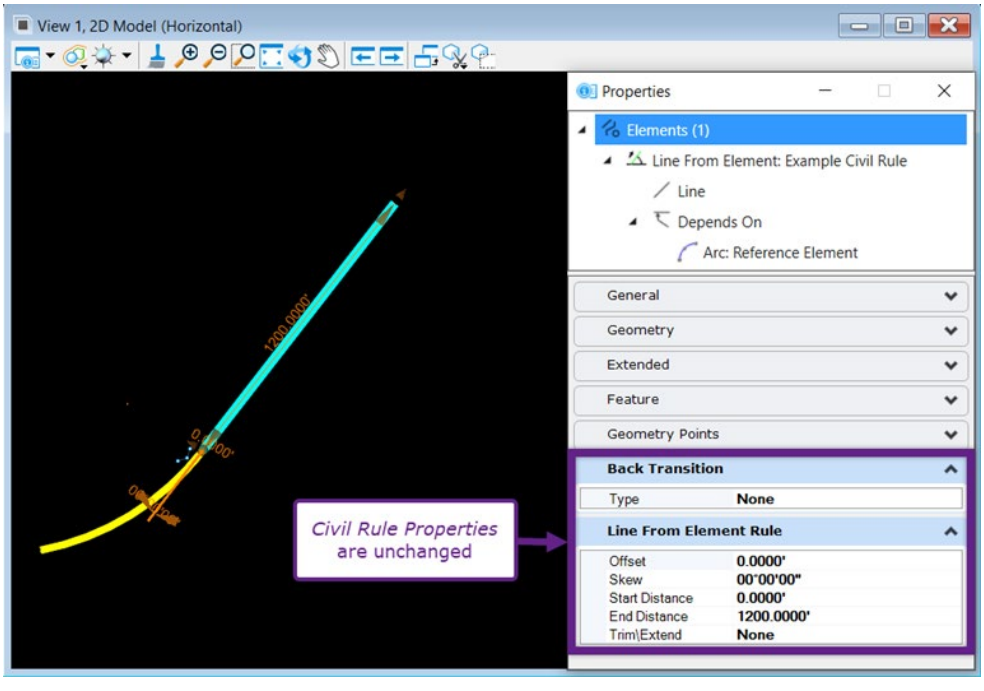
Note about *Design Intent* from *Dialogue* and *Civil Rule Manipulators* Inputs – A deficiency of the software is that there is no identifier of *Design Input* when it is formed through locked Dialogue Options and *Civil Rules Manipulators Inputs*. It is the responsibility of the User to account for automatic *Design Intent* changes made as a result of Dialogue Options and/or *Civil Rules Manipulators Inputs*.

7C.2.b Civil Rules Example – Civil Rule Dependencies

In this example, the *Line from Element* tool is used to demonstrate *Civil Rules Dependency* formed between a Reference Curve and an ORD Line From Element.



If the Reference Element was to be moved, then the *ORD Line From Element* will follow such that all unique *Civil Rule Properties* parameters remain satisfied.



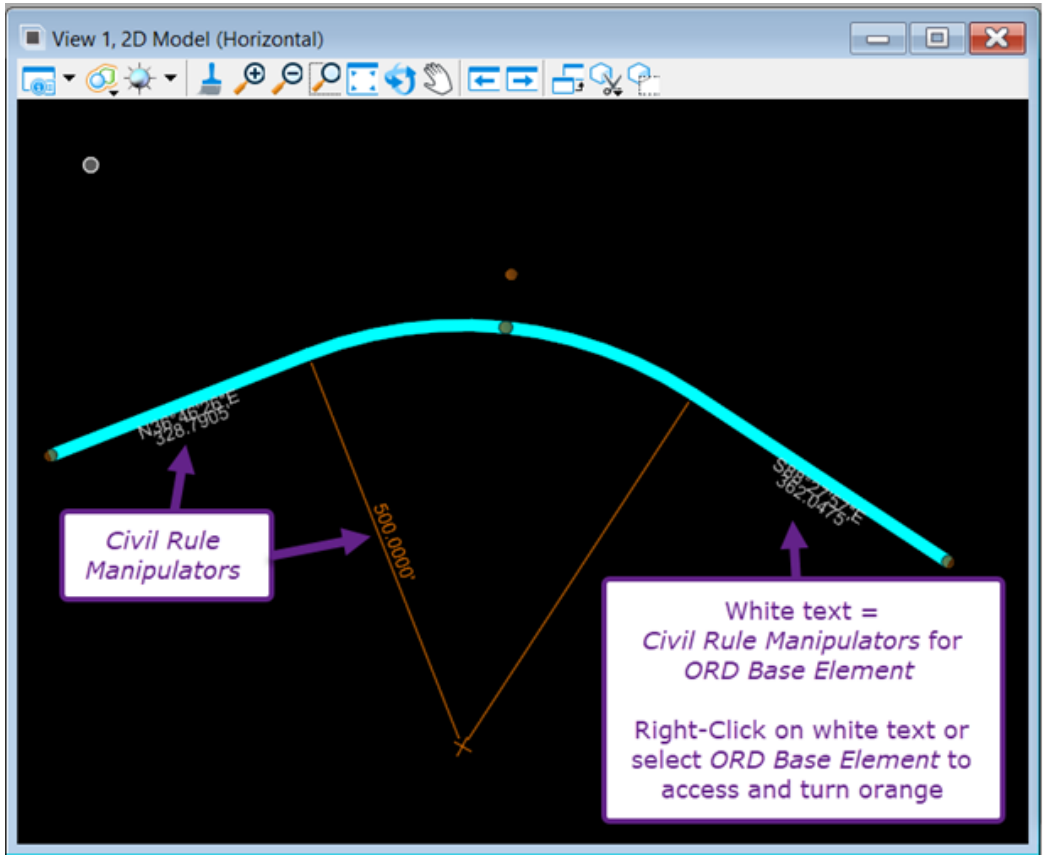
7C.2.c Manipulate Civil Rules

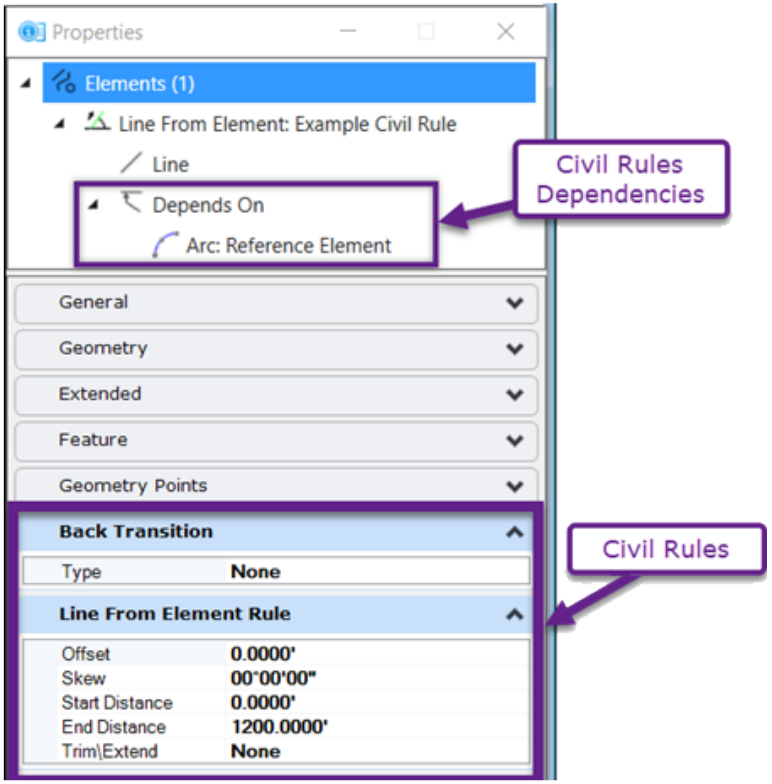
7C.2.c.i Identify Civil Rules (Access white Civil Rule Manipulator Text)

ALL ORD Elements contain *Civil Rules*. *Civil Rules* can be identified in two locations:

1. Selecting an ORD Element will reveal all *Civil Rules Manipulators* in orange (readily editable) OR white text (not readily editable) around the element.
    a. When an ORD Element is selected, Orange text appears and the *Civil Rule* parameter value can be directly edited.
    b. White text may appear when an ORD Element is Locked. See *Locking and Unlocking Civil Rules*. A more likely scenario is white text appearing when a Complex Element selected. **When a Complex Element is selected, the white text shown actually belongs to the underlying *Base ORD Element*.** At first attempt, it may appear that the white text is not editable because it cannot be directly selected. Instead, the *Base ORD Element* has to be selected to turn the white text into orange and allow User access to the *Civil Rule Manipulator*. See *Civil Rule Manipulator Edits*.

2. Selecting an ORD Element will reveal all *Civil Rules* and *Dependencies* in the Properties Box. *Civil Rules* parameter values can be changed in this location.



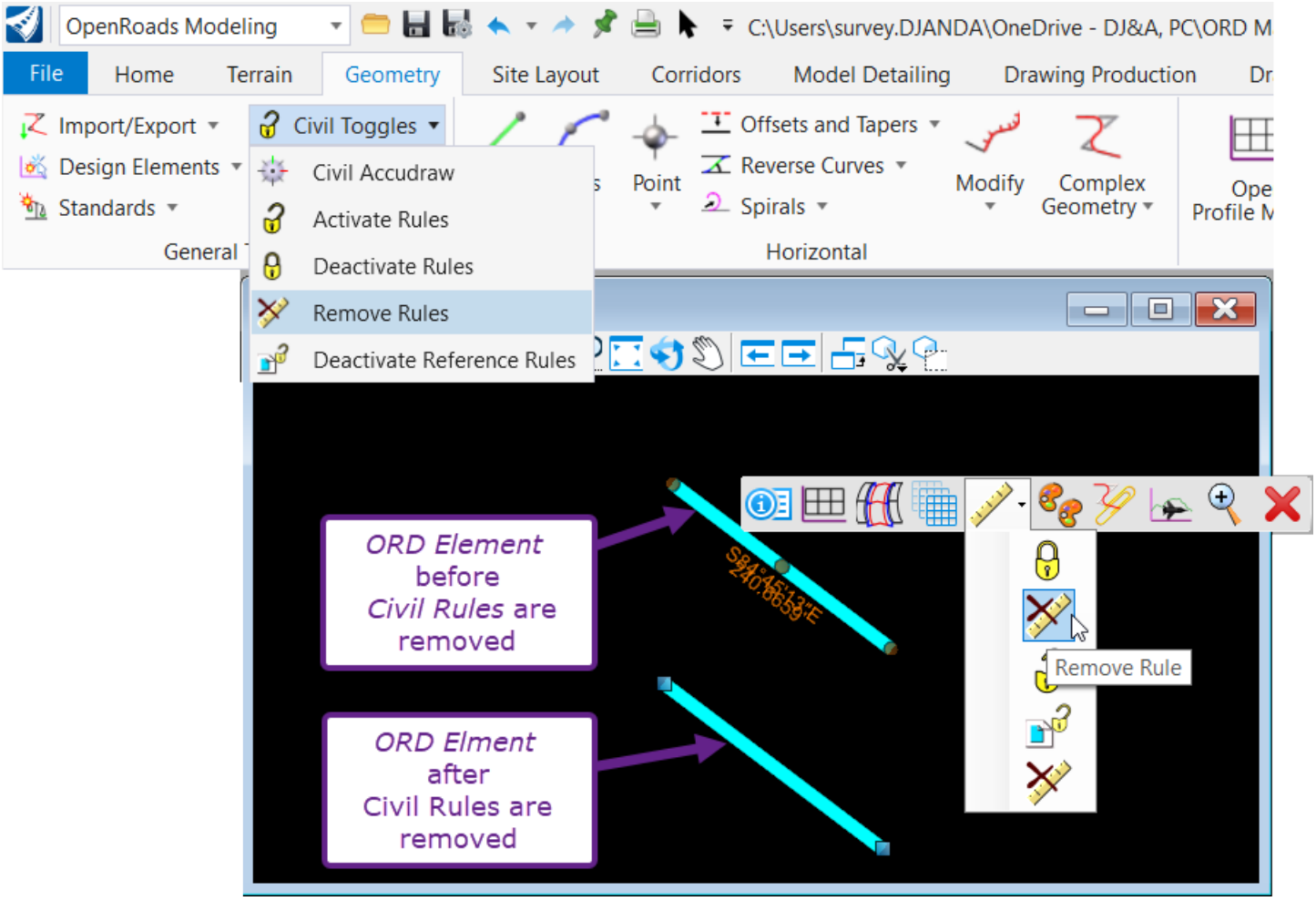


7C.2.c.ii Removing *Civil Rules* (Convert an ORD Element into a MicroStation Element)

When *Civil Rules* are removed from an ORD Element – it is converted into a MicroStation Element – however – the converted MicroStation Element retains *Feature Properties*.

Civil Rules are removed with the *Remove Civil Rules* tool. The *Remove Civil Rules* tool can be found in two locations

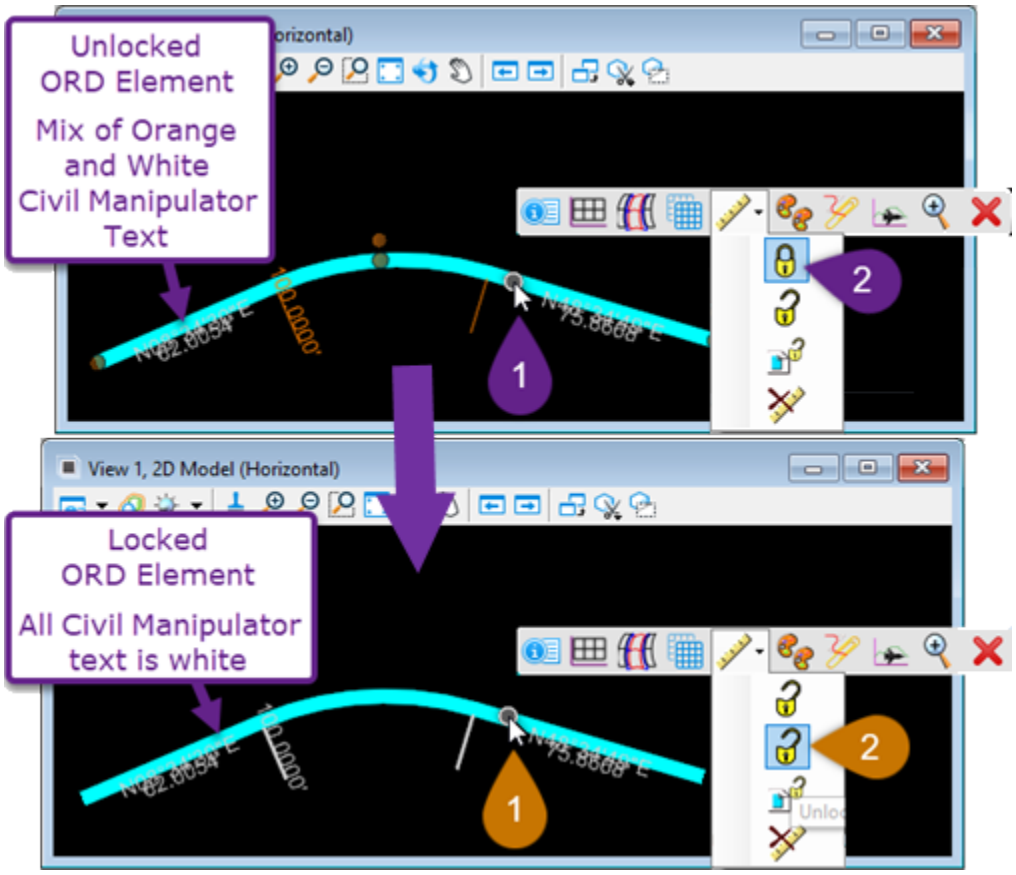
1. In the *Pop-Up Icon Menu* of the ORD Element
2. General Tools panel under the Geometry Tab



7C.2.c.iii Locking and Unlocking Civil Rules

With the *Lock – Deactivate Rule* tool, *Civil Rules* for an ORD Element can be locked – which make the ORD Element unable to be edited and essentially static.

TIP: A similar tool, *Lock – Deactivate Referencing Rule*, not only locks an ORD Element, but additionally locks all elements dependent on that ORD Element.



To Lock an ORD Element:

1	Left-Click on the ORD Element and hover over with the Mouse Cursor to display the Pop-Up Icon Menu.
2	Left-Click on the *Lock – Deactivate Rule* icon under the *Rules* icon dropdown

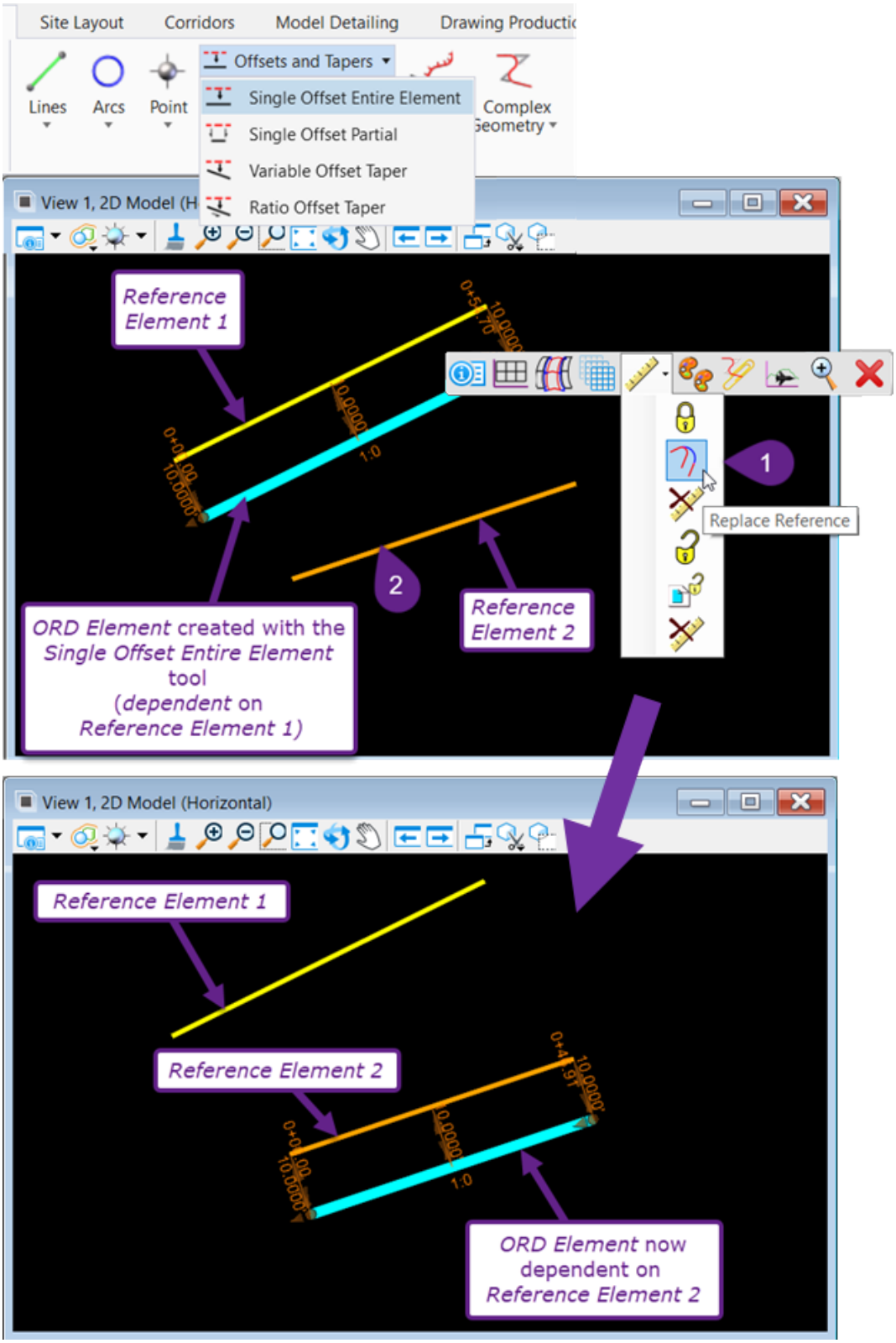
To Unlock an ORD Element:

1	Left-Click on the ORD Element and hover over with the Mouse Cursor to display the Pop-Up Icon Menu.
2	Left-Click on the *Unlock – Activate Rule* icon under the *Rules* icon dropdown

7C.2.c.iv Replacing Civil Dependencies

An *ORD Element* that is *dependent* on a Reference Element can have the *dependency* switched to a different Reference Element with the *Replace Reference* tool.

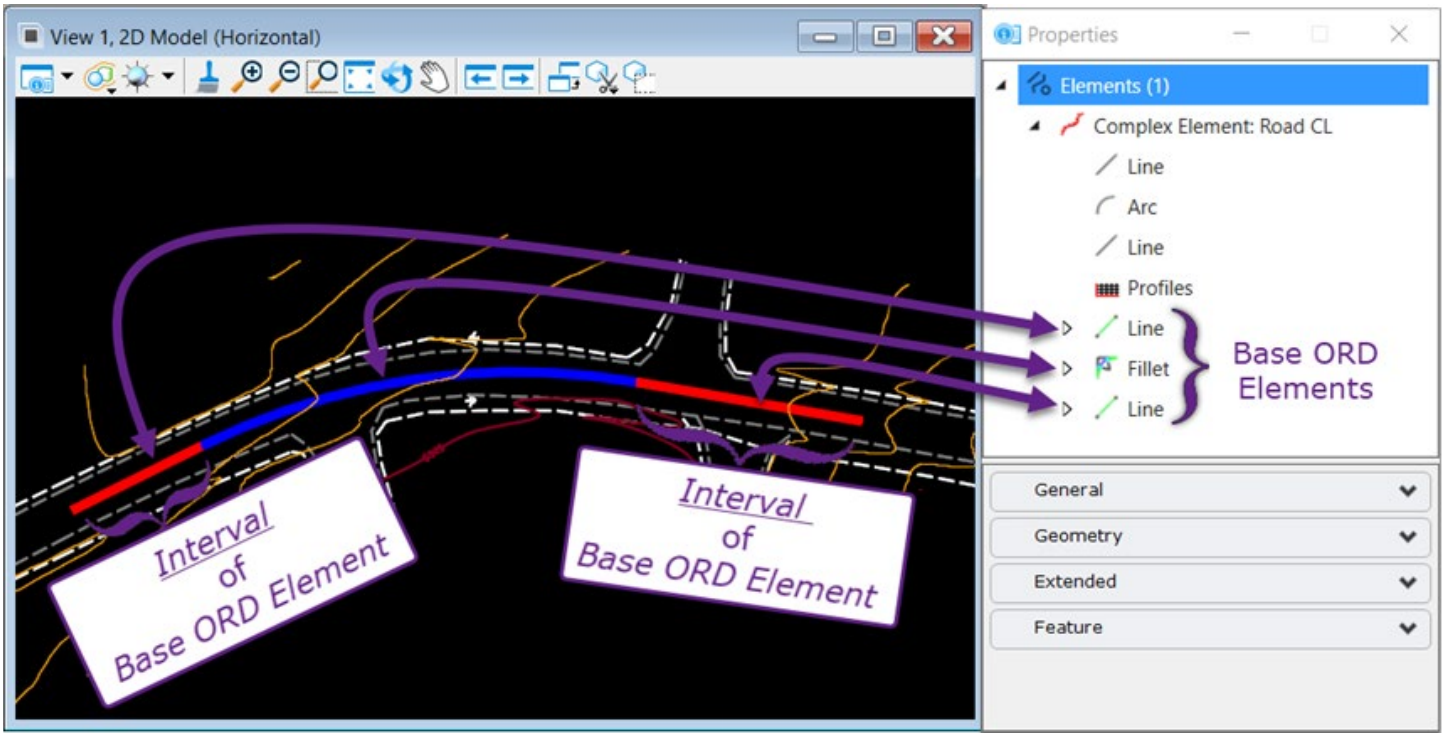
NOTE: *Civil Rule* parameter values – such as offset value - remain unchanged after the replacement.



1	Left-Click on the ORD Element and hover over with the Mouse Cursor to display the Pop-Up Icon Menu.
2	Left-Click on the *Replace Reference* icon under the *Rules* icon dropdown
3	*Prompt: Locate Replacement Element* – Left-Click on *Reference Element 2*. The ORD Element will now be *Dependent* on *Reference Element 2* instead of *Reference Element 1*

7C.3 Base ORD Elements and Intervals

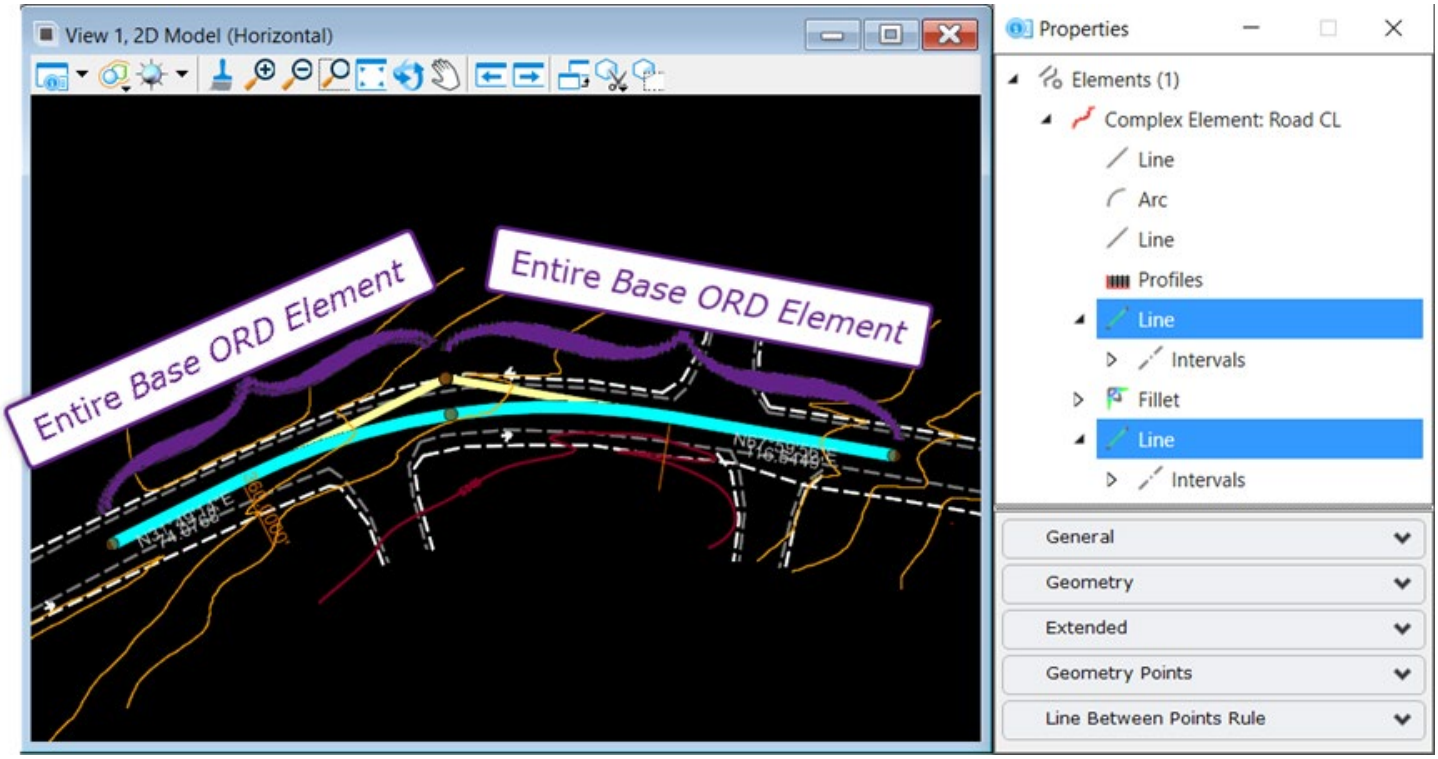
A Complex Element (i.e., an Alignment) is comprised of underlying *Base ORD Elements*. Base ORD Elements are the Lines, Arcs, and/or Spirals components that were joined to create a Complex Element. In the Properties box, Base ORD Elements are listed underneath the selected Complex Element:



In the Properties box, if a Base ORD Element is expanded, then an **Interval** is shown.

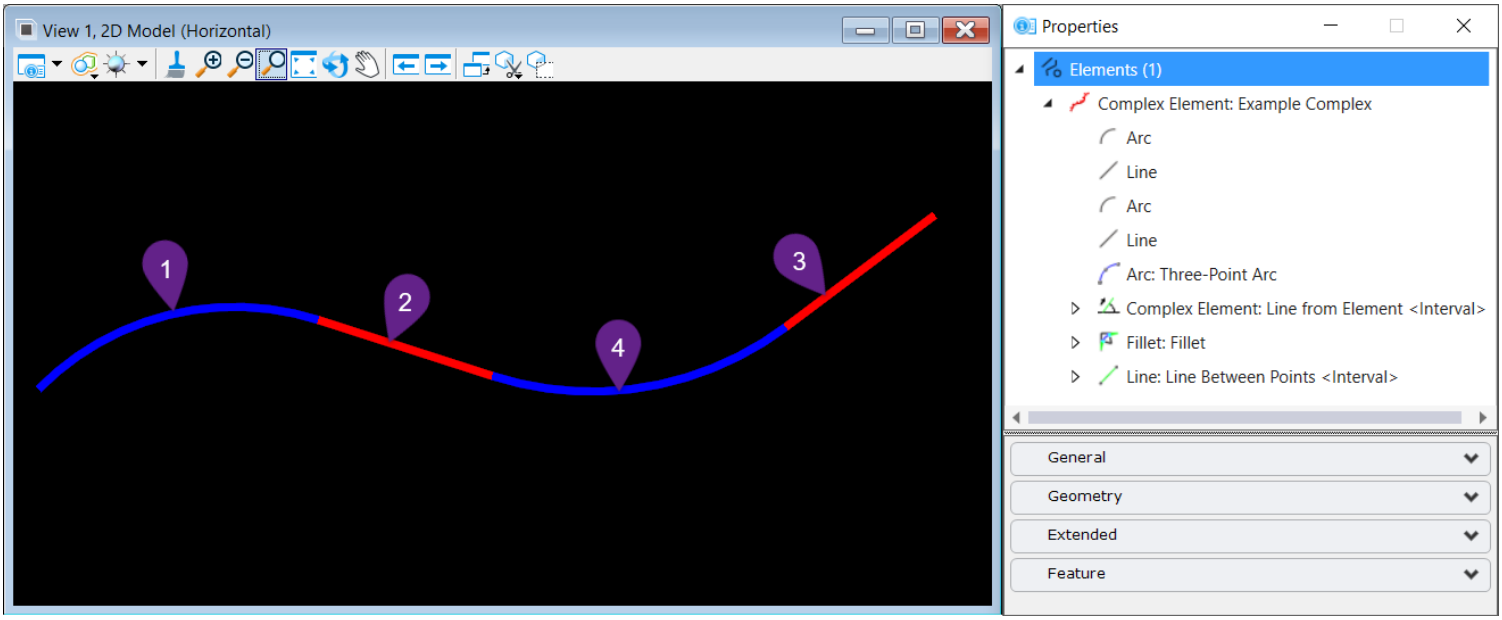
An *Interval* is the remainder of a *Base ORD Element* after trimming/extending, filleting, or chamfering operations are performed. For example, if an Arc is created between two Lines, then the two lines are trimmed to meet the arc. The trimmed portion of the Lines do NOT get deleted. Instead, the UNTRIMMED portion is converted into an Interval.

The Base ORD Element represents the original, untrimmed element. The Interval represents the remaining element after trimming.



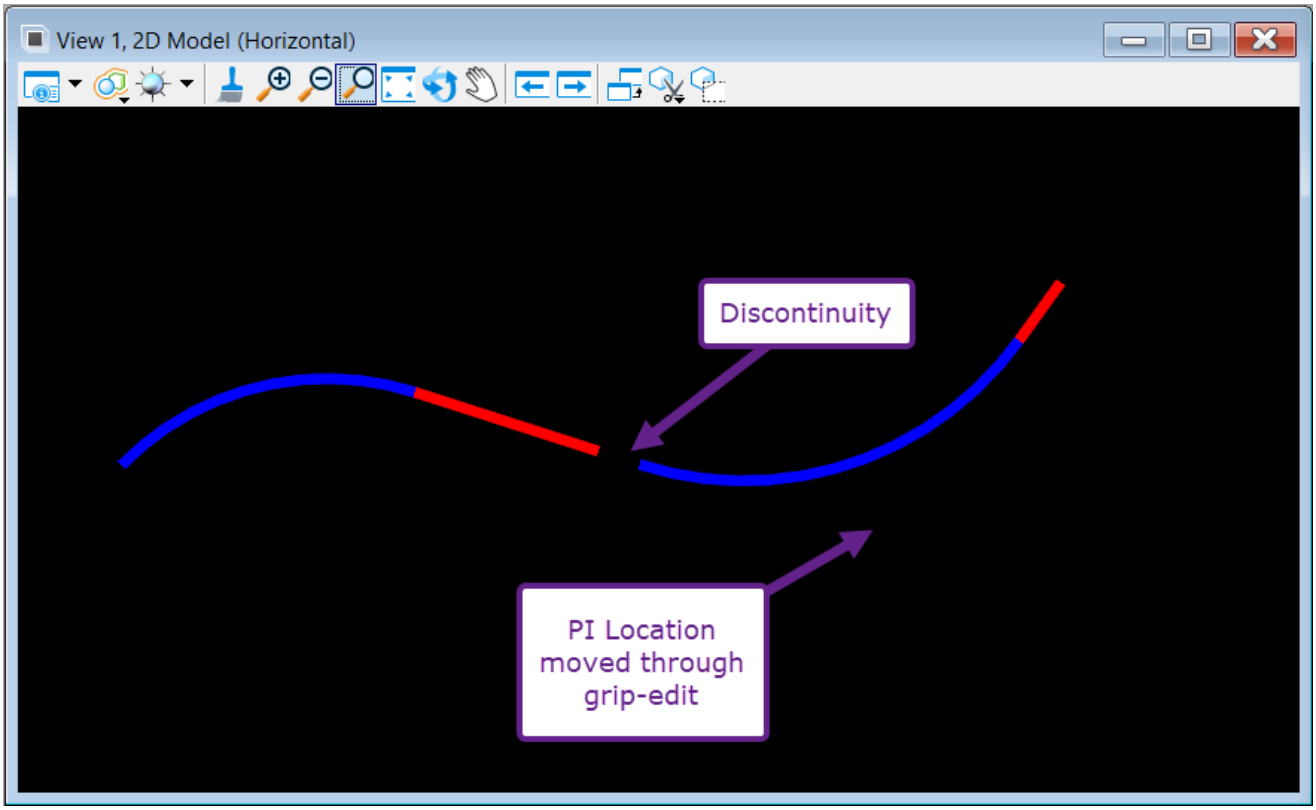
7C.3.a Base ORD Element Management Warning and Tip

Base ORD Elements and their underlying *Design Intent (*in the form of *Civil Rules* and *Persist Snaps)* need to be accounted for BEFORE editing a Complex Element. Edits made to a Complex Element that do not agree with the *Base Element's* underlying *Design Intent* could result in discontinuity or non-tangent *Base ORD Elements*.



In this demonstration, the Base ORD Elements of the Complex Element were created in the following order with the tools listed:

Order	Tool Used	Civil Rule formed
1	*Arc Between Points – Start/Pass-through/End* method	Radius = 90'
2	*Line From Element – Simple Line From Element*	Line is ALWAYS tangent from the end point of the *Arc Between Points*
3	*Line Between Points*	None
4	*Arc Between Elements* (Fillet)	Radius = 100' between Lines



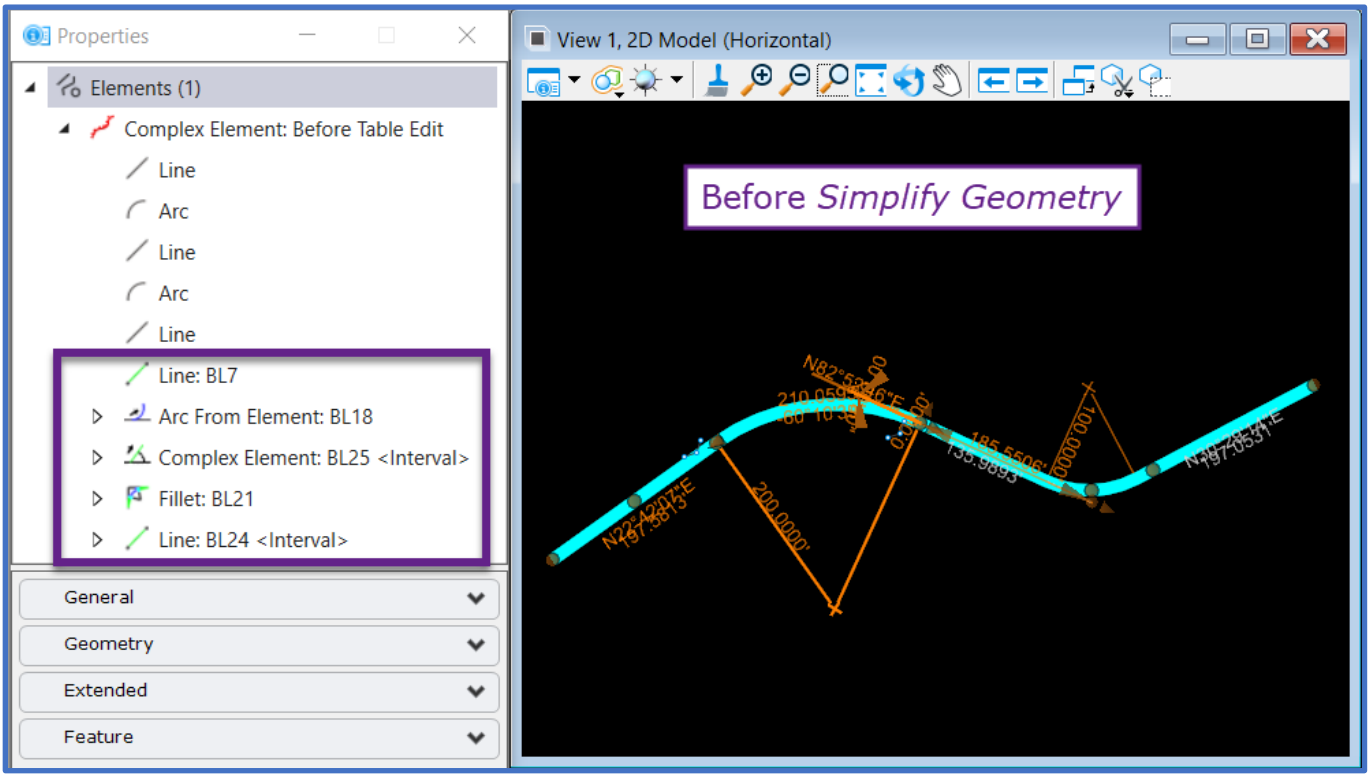
The PI location of the Lines is moved and a discontinuity appears in the Complex Element. The PI was moved off of the tangent that the Simple Line From Element was made from. Therefore, this PI move is in direct disagreement with the *Civil Rule* for Simple Line From Element. The Complex Element keeps the *Civil Rule* intact and accepts the PI move – which is geometrical infeasible and results in a discontinuity.

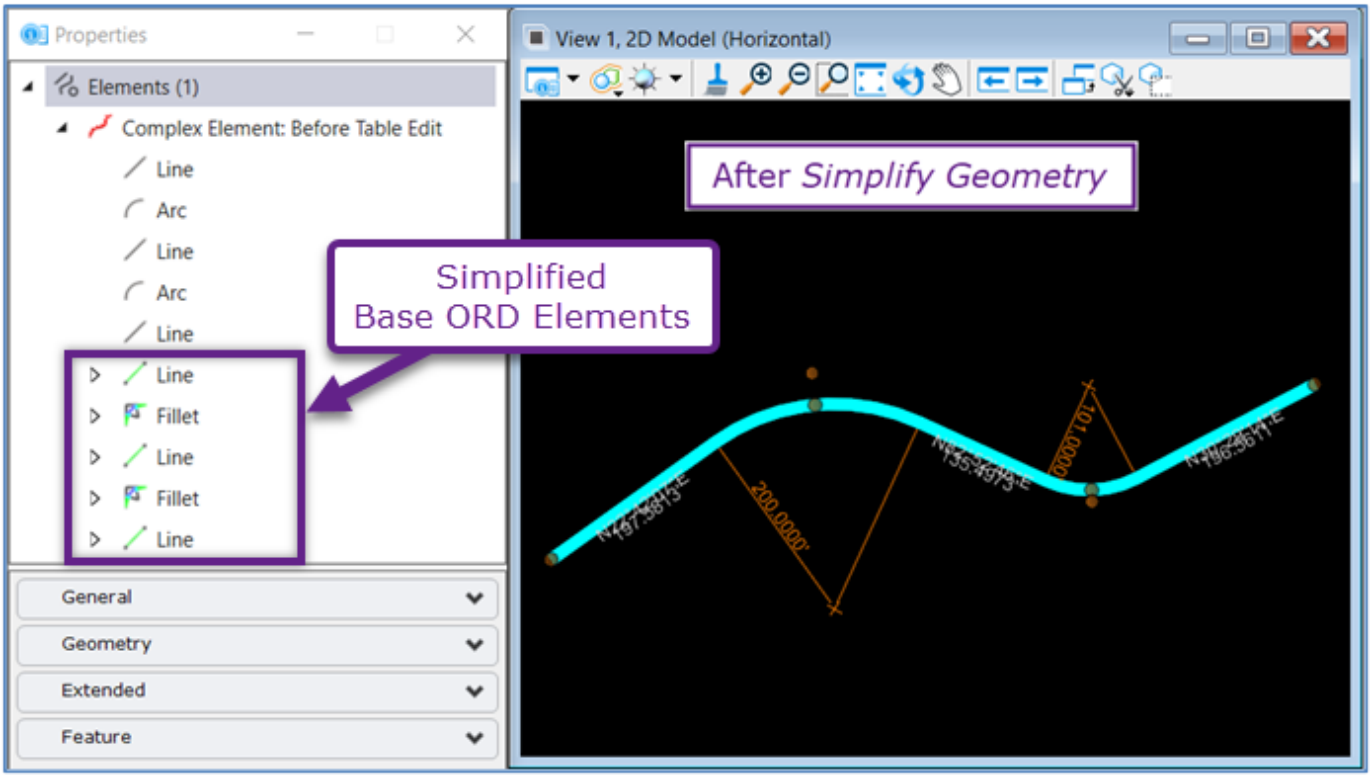
If the User is aware of the *Civil Rule* for the Simple Line From Element – then it could be inferred that the PI should only be moved along the back tangent.

7C.3.b Simplify Geometry Tip

The Simplify Geometry tool can help eliminate issues from undesirable *Civil Rules* and *Base ORD Elements* to make Complex Elements behave in a predictable manner. After using the *Simplify Element* tool, the Complex Element will contain simplified *Base ORD Elements* with logical *Civil Rules* constraints.

NOTE: Using the *Table Editor* tool on a Complex Element will also *Simplify* the *Base ORD Elements*.

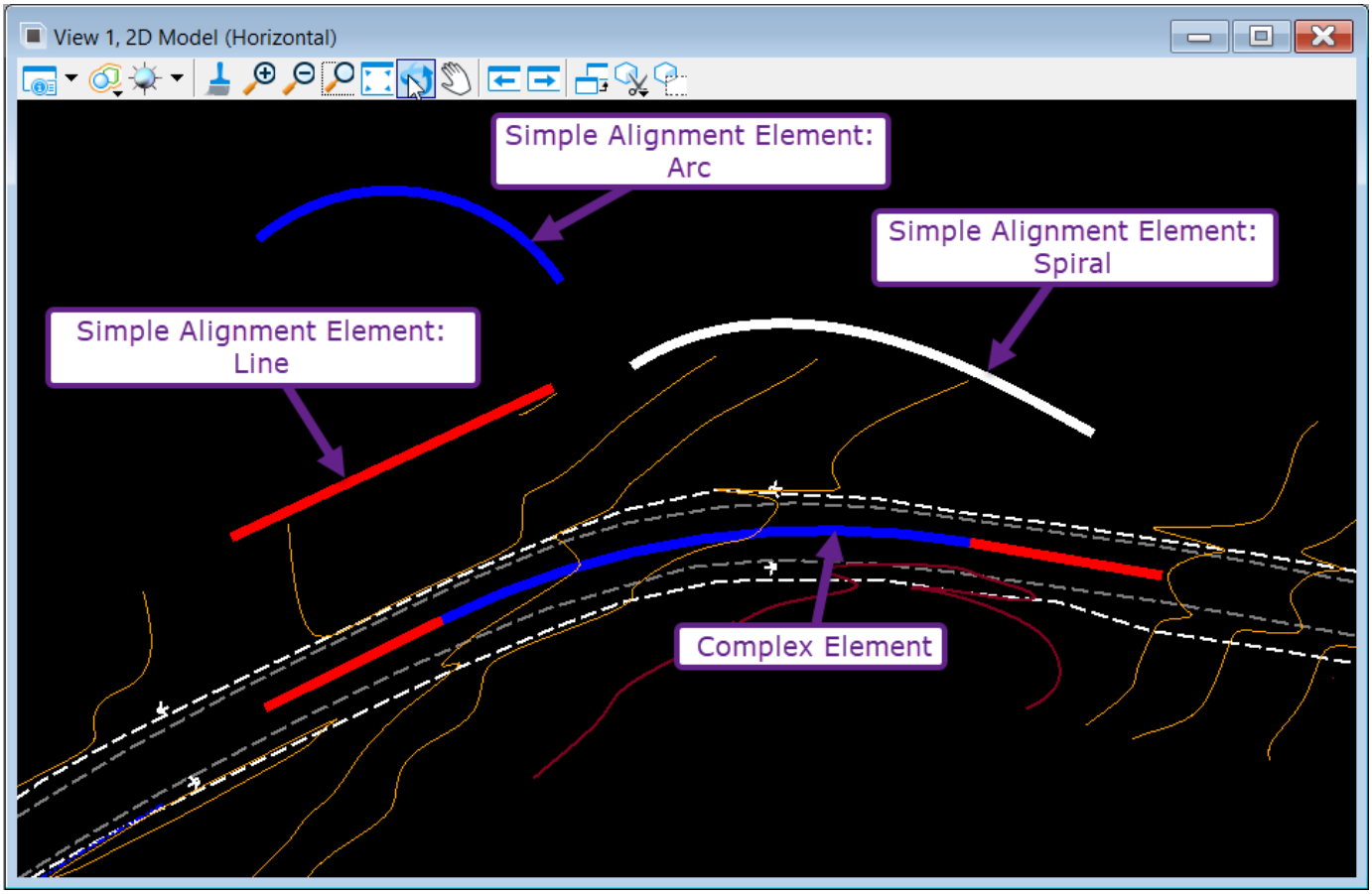




7D – CREATE HORIZONTAL ORD ELEMENTS

Horizontal ORD Elements are used to represent a roadway centerline or alignments associated with civil features such as culvert centerline or face of retaining wall. This section will cover the creation of horizontal alignments that represent civil features requiring stationing and/or have an associated vertical profile design. In general, Horizontal ORD Elements are used in 3D Modeling applications – for example - Road Corridor and Site-Layout modeling.

There are two types of Horizontal ORD Elements: *Simple Alignment Elements* and *Complex Elements*:

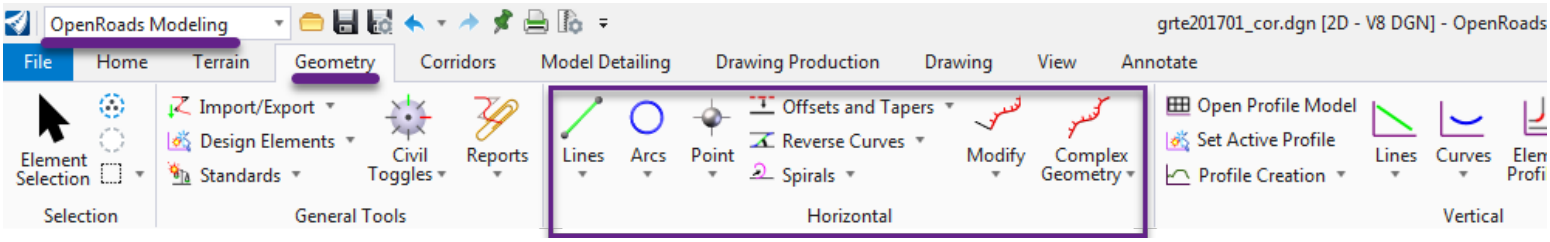


TIP: Simple Alignment Elements can be joined together to create a Complex Element with the *Complex By Elements* tool. See *Complex Elements* for additional Horizontal Alignment creation methods.

WARNING: Horizontal ORD Elements creation tools can only be used in a *2D Design Model*.

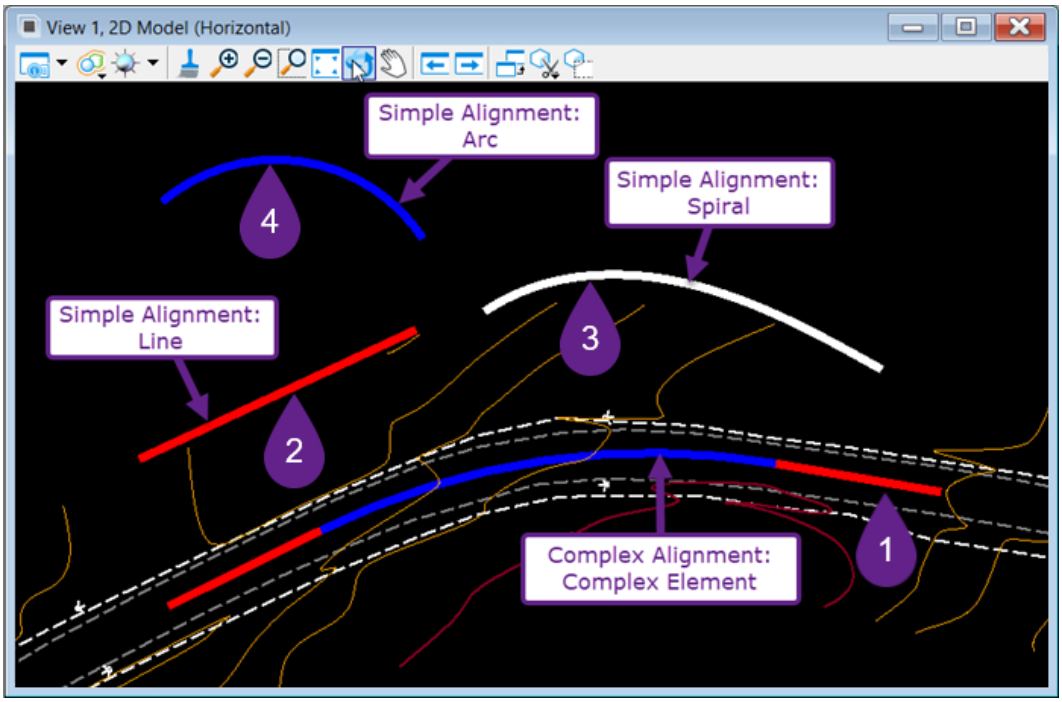
General Tool Locations

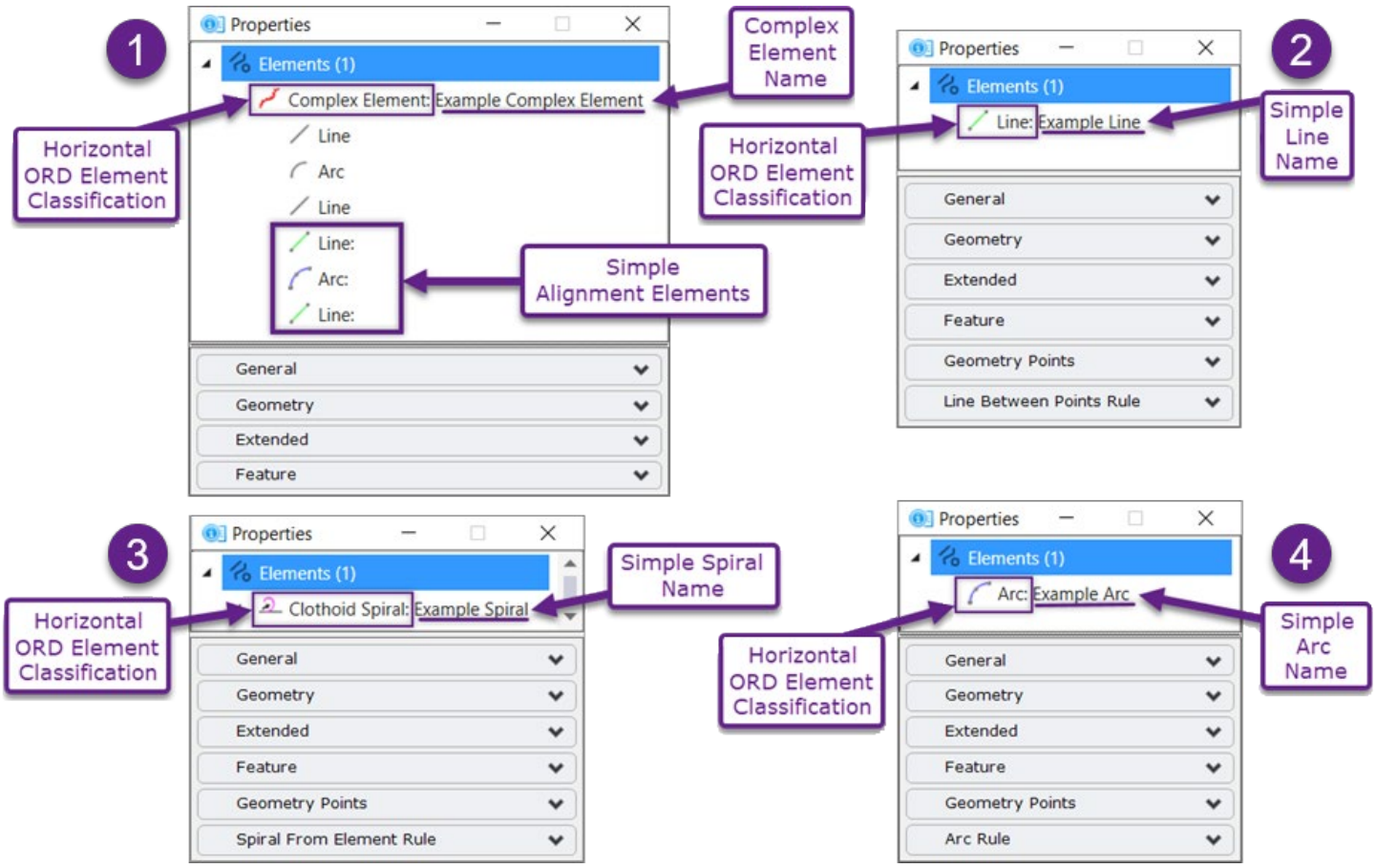
All tools needed to create Horizontal ORD Elements are found in the *Horizontal* panel of the *Geometry* ribbon of the *OpenRoads Modeling* workflow.



7D.1 Simple Alignment Elements

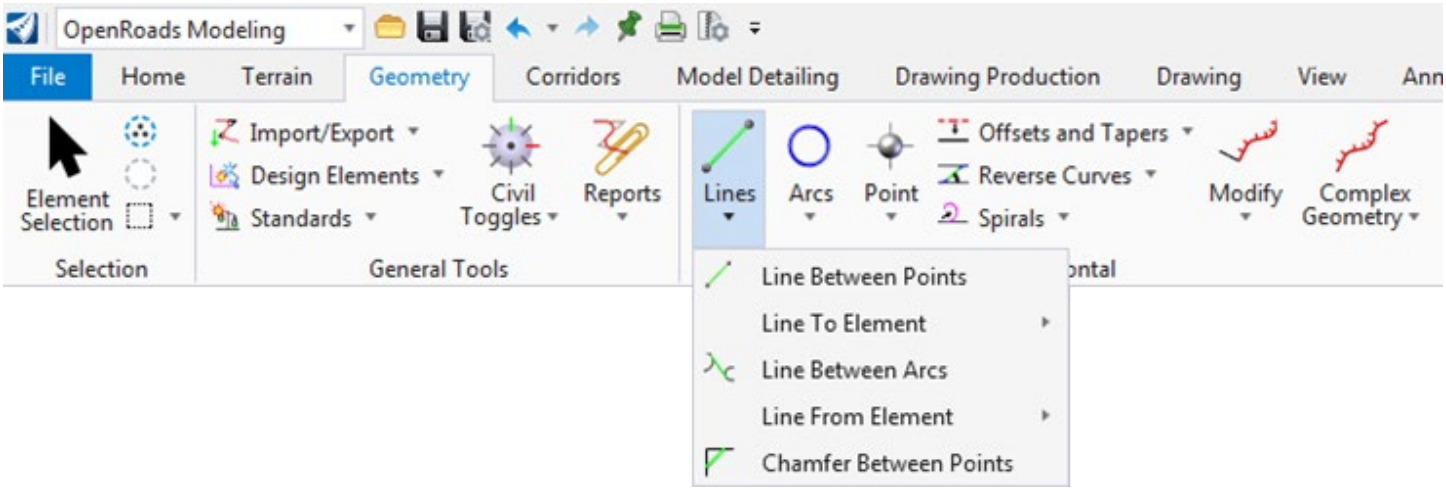
This section will cover the creation of *Simple Alignment Elements:* Lines, Arcs, Spirals, & Reverse Curves. Simple Alignment Elements can stand alone to represent a simple feature such as a culvert OR several Simple Alignment Elements can be combined with the Complex By Elements tool to create a *Complex Element.*





7D.1.a Lines

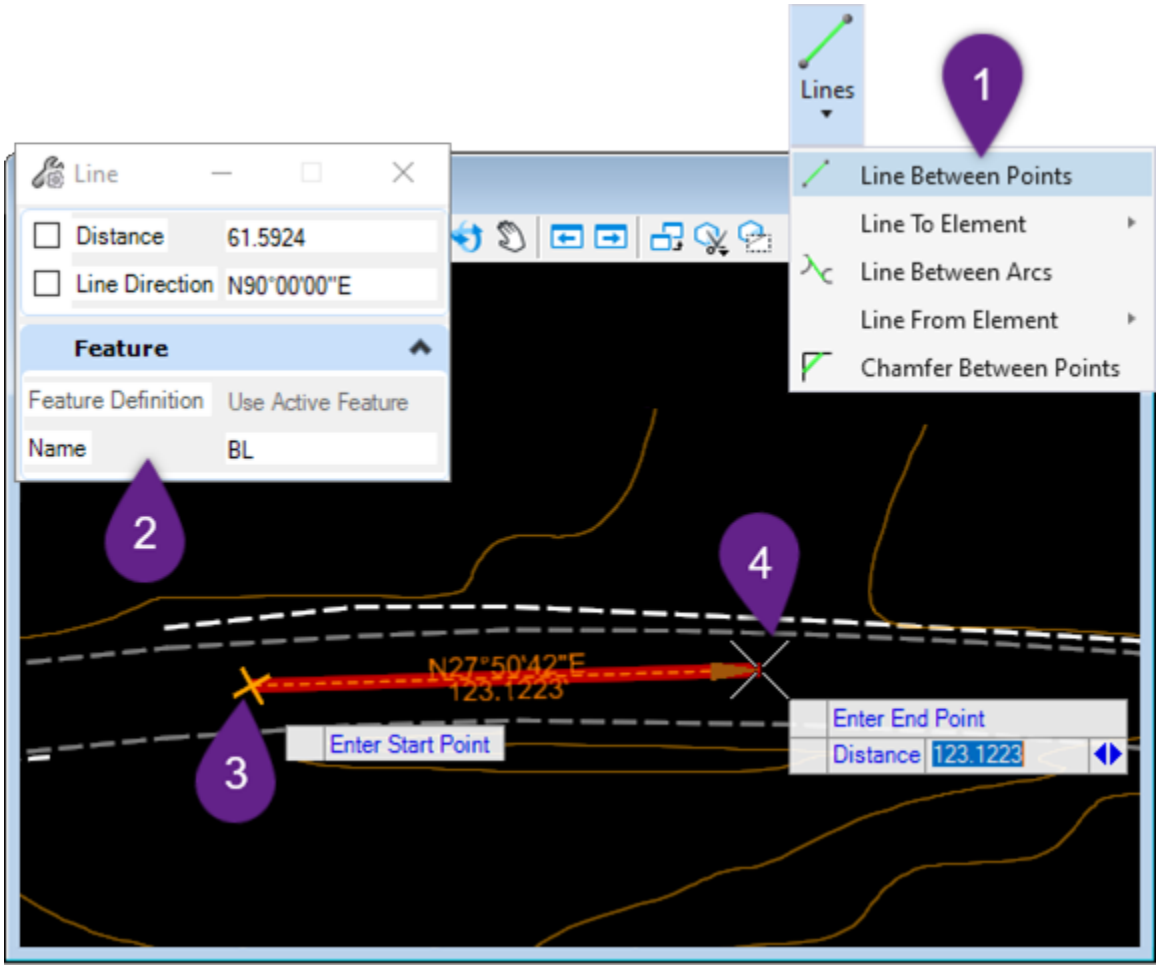
This section will cover how to create *Lines* to be used as a *Simple Alignments* OR used in the Complex by Element workflow to create a *Complex Element*. All *Line* creation tools can be found in the Lines dropdown of the Horizontal panel.



7D.1.a.i Lines Between Points

This tool creates a *Line* between two User-defined points.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Lines Between Points* tool from the *Lines* dropdown
2	In the *Dialogue Box,* select an appropriate *Feature Definition* and give the Line a *Feature Name* if desired.
3	*Prompt: Enter Start Point* – Left-Click at the desired Start Point in the *View*
4	*Prompt: Enter End Point* – Left-Click at the desired End Point OR specify End Point with *Dialogue Options* and Left-Click in the *View* to complete the command.

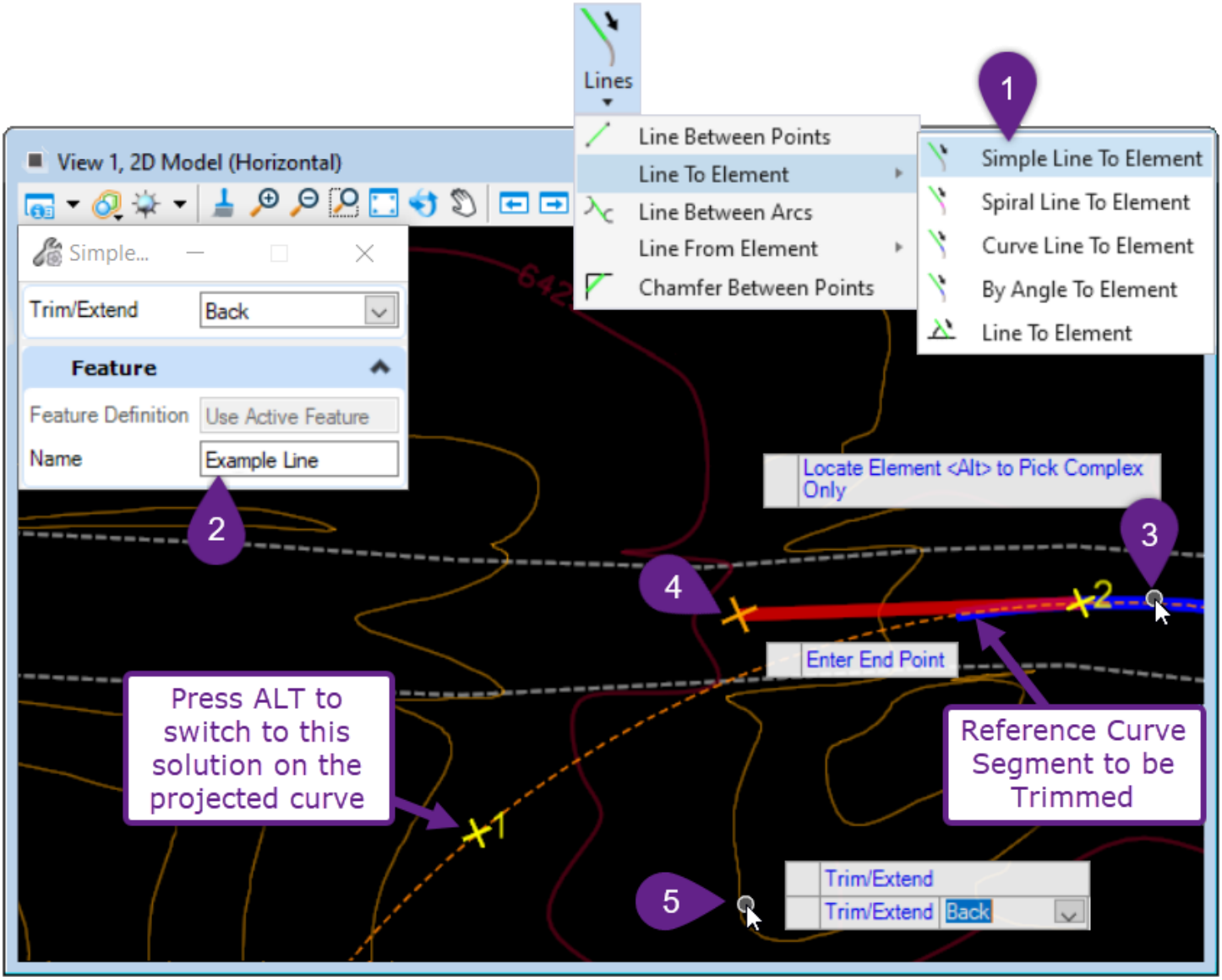
Dialogue Options	
Options:	**Description:**
Distance	Locks the length of the Line
Line Direction	Locks the Bearing Direction of the Line.

7D.1.a.ii Lines To Element

7D.1.a.ii(a) Simple Line To Element

This tool will draw a *Line* from a User-defined point tangentially to a *Reference Arc*.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Simple Line To Element* tool from the *Lines* dropdown
2	In the *Dialogue Box,* select an appropriate *Feature Definition* and give the *Line* a *Feature Name* if desired.
3	Prompt: *Locate Element <ALT> to Pick Complex Only* – Left-Click on the *Reference Curve*.
4	*Prompt: Enter End Point* – In the *View*, Left-Click at the desired End Point for the Line. Press the ALT key to switch between the two possible solutions.
5	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Line. Left-Click in the *View* to complete the command.

7D.1.a.ii(b) Spiral Line To Element

This tool operates identically to the Simple Line to Element tool, but has the added option of creating a Spiral transition between the ORD Line and Reference Arc.

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

7D.1.a.ii(c) Curve Line To Element

This tool operates identically to the Simple Line to Element tool, but has the added option of creating a Curve transition between the ORD Line and Reference Arc – resulting in a Compound Curve or 2 Center Curve.

See *Curve Methods and Dialogue Options* for an explanation of Curve Dialogue Options.

7D.1.a.ii(d) By Angle To Element

This tool operates identically to the Simple Line to Element tool, but has an added *Skew* angle option to create a non-tangent connection between the ORD Line and Reference Arc. The *Skew* option is relative to the Line/Arc connection point. For example, a *Skew* angle of 00°00'00" will create a Line tangent to the Reference Arc. A *Skew* angle of 90°00'00" will create a Line perpendicular to the Reference Arc.

7D.1.a.ii(e) Line To Element

This tool combines all functionality and Dialogue Options found in the other Line To Element tools. This tool allows the User to input a *Skew* and/or Transition between the ORD Line and Reference Arc. Differing from other Line To Element tools, this tool allows the user to input a horizontal offset from the ORD Line and Reference Arc.

7D.1.a.iii Line Between Elements

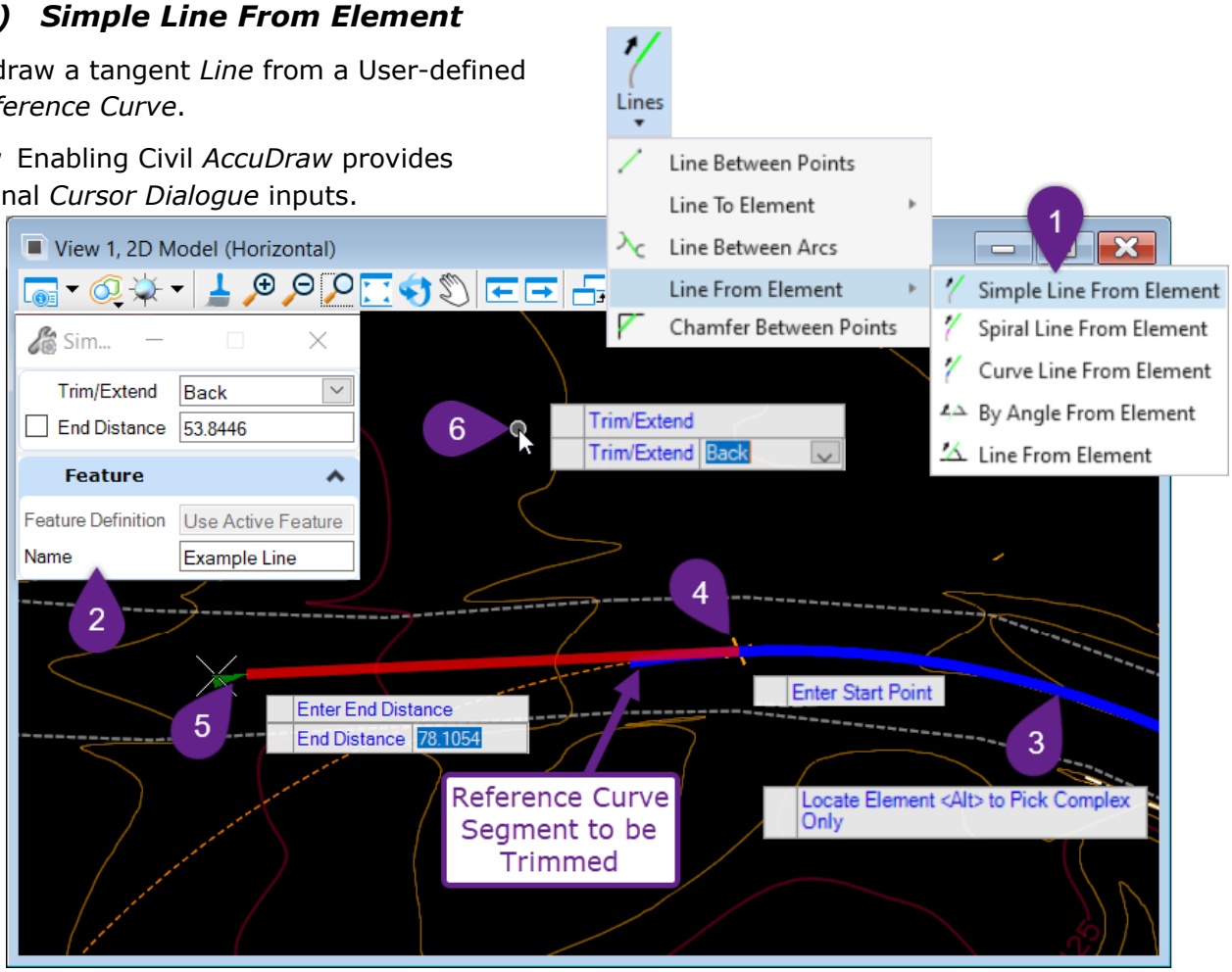
This tool creates an ORD Line - tangentially between two Reference Arcs.

7D.1.a.iv Line From Element

7D.1.a.iv(a) Simple Line From Element

This tool will draw a tangent *Line* from a User-defined point on a *Reference Curve*.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Simple Line From Element* tool from the *Lines* dropdown
2	In the *Dialogue Box,* select an appropriate *Feature Definition* and give the *Line* a *Feature Name* if desired.
3	*Prompt: Locate Element <ALT> to Pick Complex Only* – Left-Click on the *Reference Curve*.
4	*Prompt: Enter Start Point* –Left-Click at the desired Start Point along the *Reference Curve*. Press the ALT key to switch between the two possible solutions
5	*Prompt: Enter End Point* – In the *View,* Left-Click at the desired End Point.
6	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Line. Left-Click in the *View* to complete the command.

Dialogue Box and Key-Ins	
Input	**Description:**
End Distance	Locks the length of the Line
Trim/Extend	Trim/Extend the Reference Curve to meet the Start Point of the Line.

7D.1.a.iv(b) Spiral Line From Element

This tool operates identically to the Simple Line From Element tool, but has the added option of creating a Spiral transition between the ORD Line and Reference Arc.

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

7D.1.a.iv(c) Curve Line From Element

This tool operates identically to the Simple Line From Element tool, but has the added option of creating a Curve transition between the ORD Line and Reference Arc – resulting in a Compound Curve or 2 Center Curve.

See *Curve Methods and Dialogue Options* for an explanation of Curve Dialogue Options.

7D.1.a.iv(d) By Angle From Element

This tool operates identically to the Simple Line From Element tool, but has an added *Skew* angle option to create a non-tangent connection between the ORD Line and Reference Arc. The *Skew* option is relative to the Line/Arc connection point. For example, a *Skew* angle of 00°00’00” will create a Line tangent to the Reference Arc. A *Skew* angle of 90°00’00” will create a Line perpendicular to the Reference Arc.

7D.1.a.iv(e) Line From Element

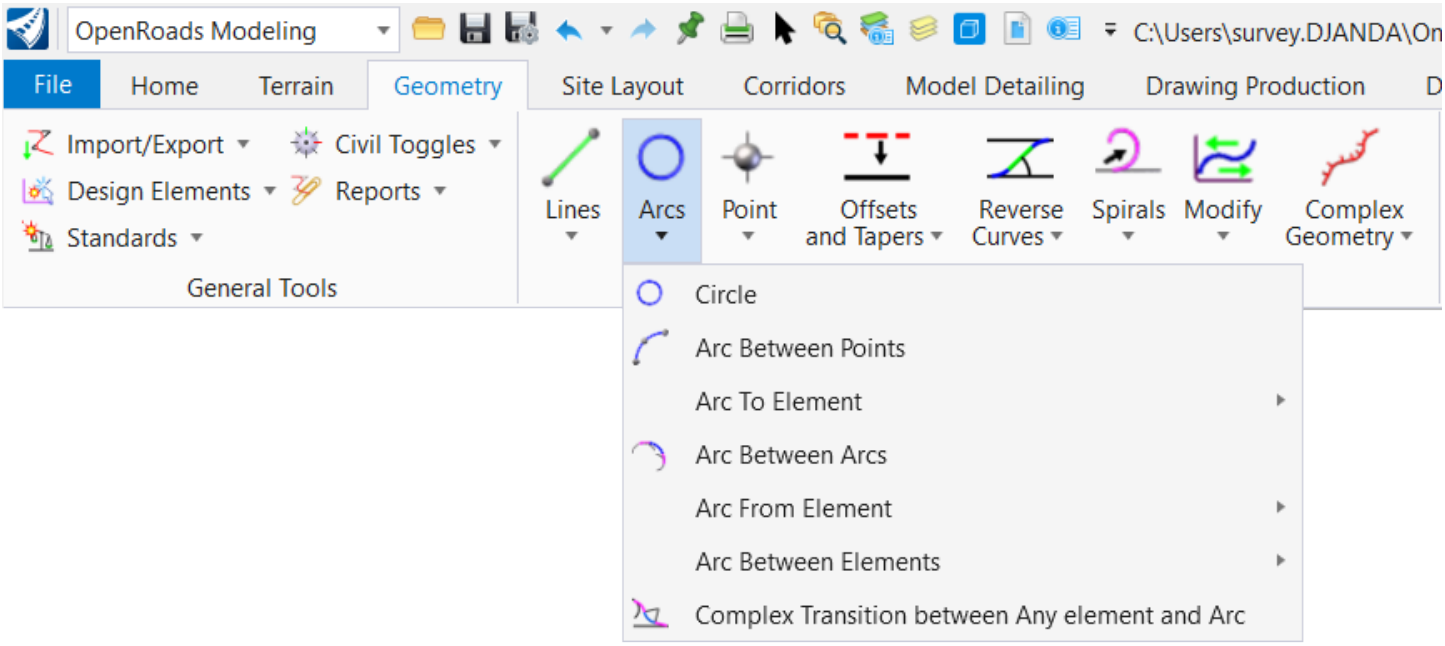
This tool combines all functionality and Dialogue Options found in the other Line From Element tools. This tool allows the User to input a *Skew* and/or Transition between the ORD Line and Reference Arc. Differing from other Line From Element tools, this tool allows the user to input a horizontal offset from the ORD Line and Reference Arc.

7D.1.a.v Chamfer Between Elements

In its most basic usage, this tool creates a chamfer ORD Line between two Reference Lines – which creates a Reference Line – Line – Reference Line configuration. The tool also allows the User to create a Back/Ahead Radius between the chamfer ORD Line and Reference Lines - which creates a Reference Line – Arc – Line – Arc – Reference Line configuration.

7D.1.b Arcs

This section will cover how to create *Arcs* to be used as a *Simple Alignment* OR used in the Complex by Element workflow to create a *Complex Alignment*. All *Arcs* creation tools can be found in the Arcs dropdown.



7D.1.b.i Circle

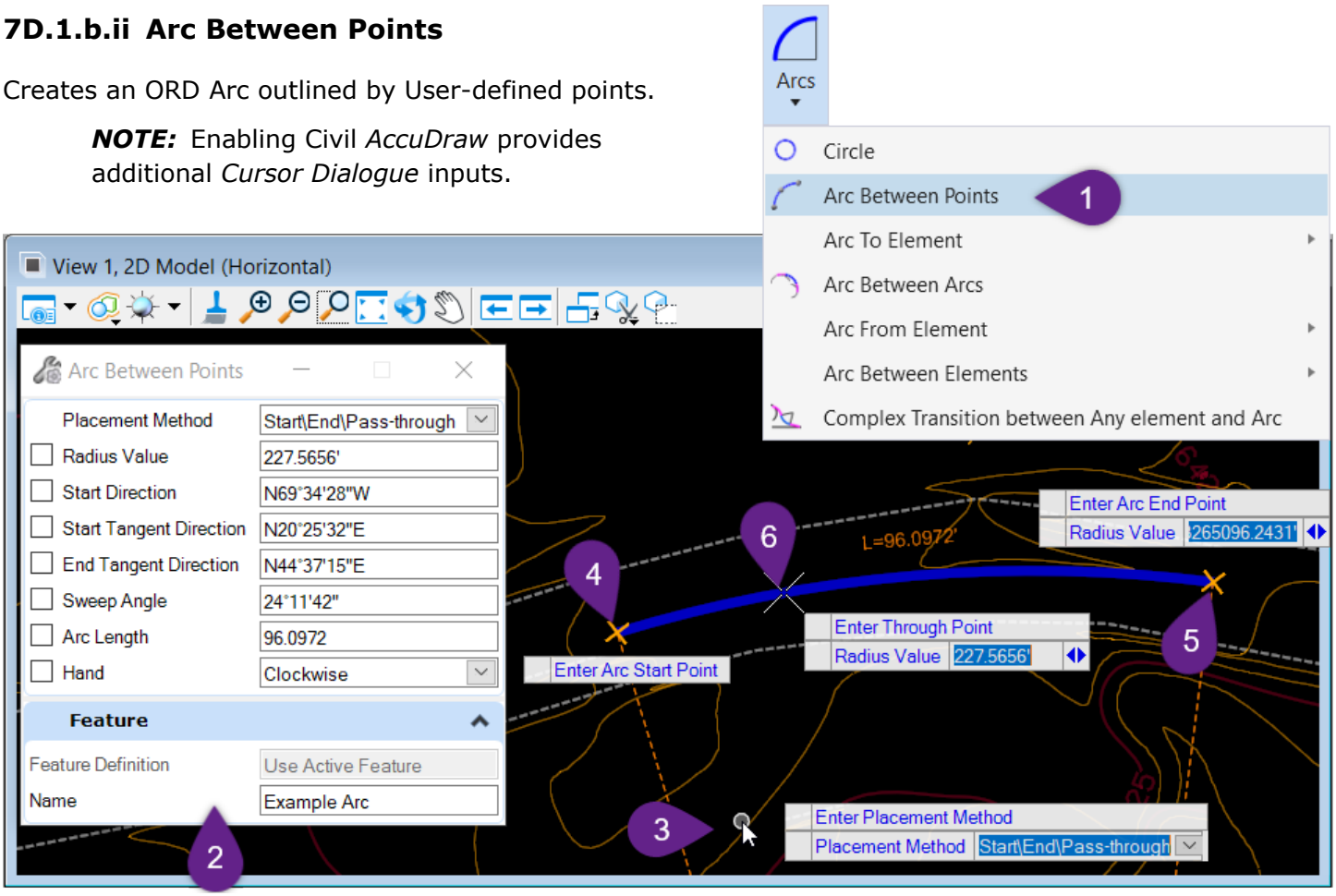
This tool creates a standalone ORD Arc in the form of a circle. This could be used to represent a circular foundation or footing.

NOTE: Even though this ORD Element is an enclosed circle in geometric shape – it is classified by the Software as an ORD Arc.

7D.1.b.ii Arc Between Points

Creates an ORD Arc outlined by User-defined points.

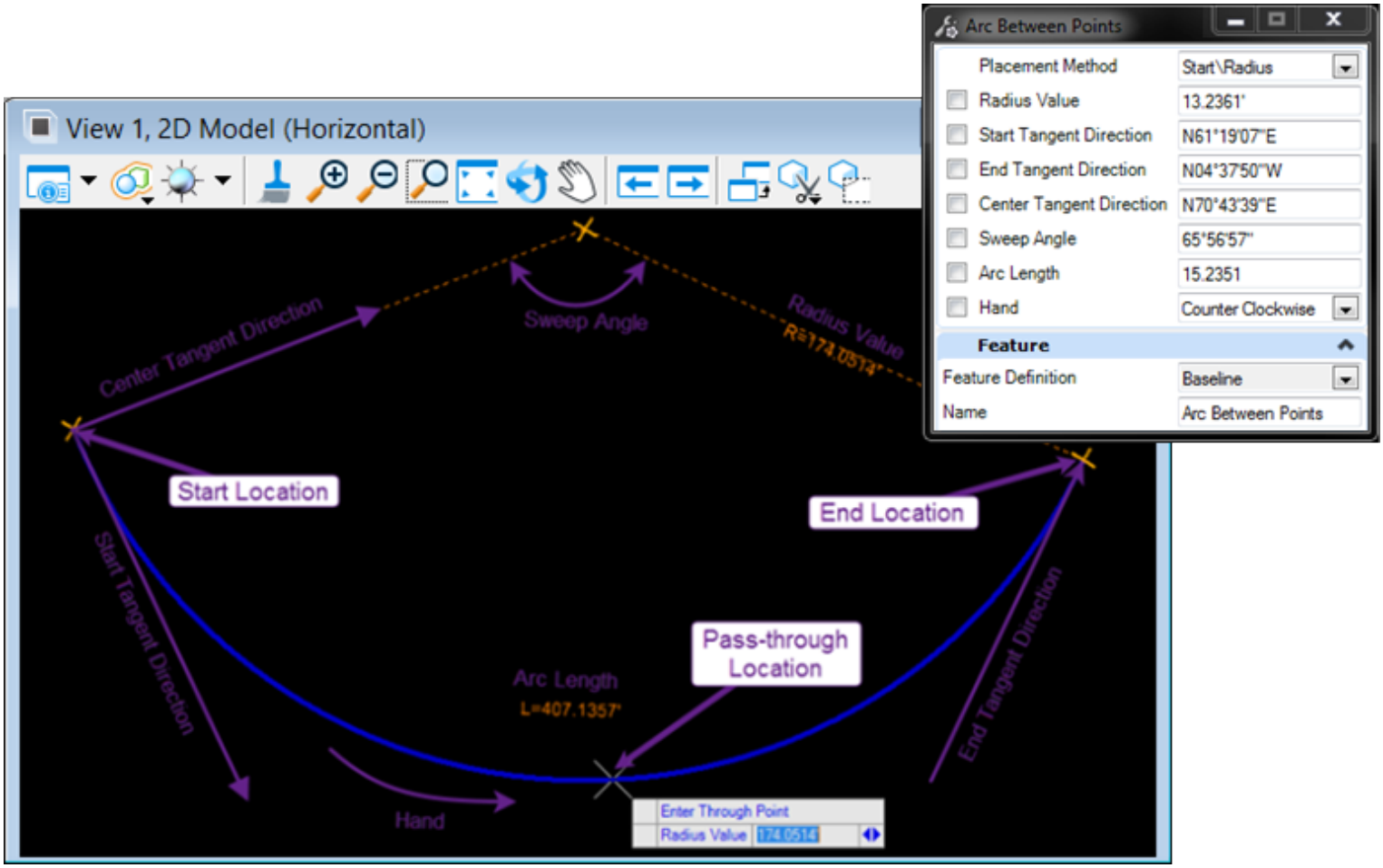
> ***NOTE:*** Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Arc Between Points* tool from the *Arcs* dropdown
2	In the *Dialogue Box,* select a *Feature Definition* and give the *Arc* a *Feature Name* if desired.
3	*Prompt: Enter Placement Method* – Select the desired Placement Method from the Dialogue Options. Left-Click in the View to accept Placement Method and advance to the next prompt. In this demonstration – the Start\End\Pass-through method is shown. See *Placement Methods Dialogue Options* on next page.
4	*Prompt*: *Enter Arc Start Point* – In the *View,* Left-Click at the desired Start Point location.
5	*Prompt*: *End Arc End Point* – In the *View,* Left-Click at the desired End Point Location
6	*Prompt: Enter Through Point* – In the *View,* Left-Click at the desired Pass-through location to complete the command.

Placement Methods	
Method	**Description:**
Start/Radius	The first data click defines the Start location of the Arc. The second data click defines centroid location. The third data click defines the End location.
Center/Radius	The first data click defines the centroid location of the Arc. The second data click defines the Start location and Radius of the Arc. The third data click defines the End location
Start/End/Pass-through	The first data click defines the Start location of the Arc. The second data click defines the End location. The third data click defines a point along the Arc and will define the radius.
Start/Pass-through/End	The first data click defines the Start location of the Arc. The second data click defines a point along the Arc. The third data click will define the End location and Radius
Start Direction/End	The first data click defines the Start location. The second data click defines the End location. The third data click will define the Back Tangent bearing direction in conjunction with the first data click. The third data click will also define the Radius
Start/End Direction	The first data click defines the Start location. The second data click defines the End location. The third data click will define the Ahead Tangent bearing direction in conjunction with the second data click. The third data click will also define the Radius

Arc Between Points tool Dialogue Option

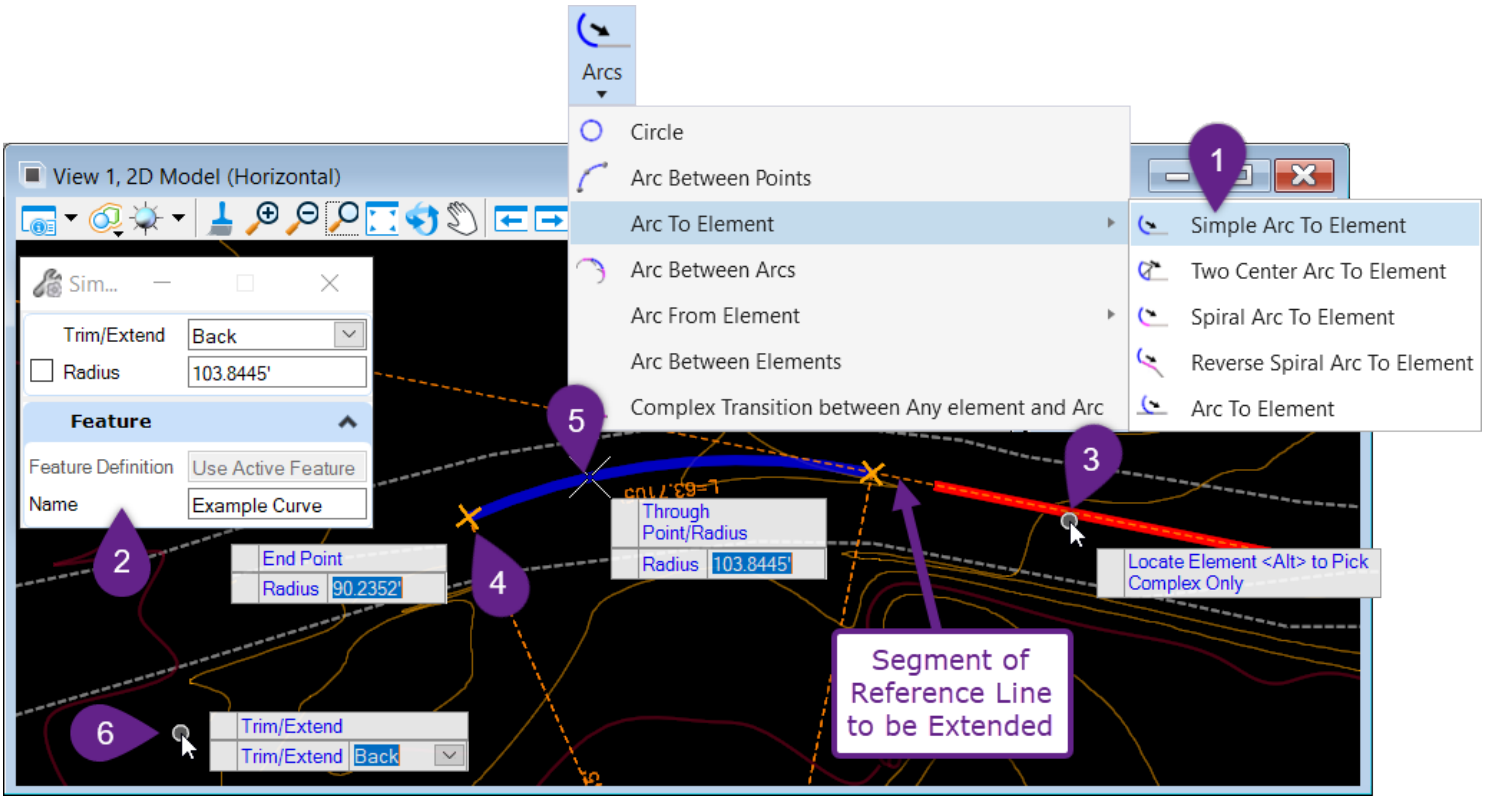


7D.1.b.iii Arc to Element

7D.1.b.iii(a) Simple Arc to Element

This tool will draw an ORD Arc from a User-defined Start point tangentially to a *Reference Element.*

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Simple Arc To Element* tool from the *Arcs* dropdown
2	In the *Dialogue Box,* select a *Feature Definition* and give the *Arc* a *Feature Name* if desired.
3	*Prompt: Locate Element <Alt> to Pick Complex Only* – Left-Click on the *Reference Element*.
4	*Prompt: End Point* – Left-Click at the desired location for the End Point
5	*Prompt: Through Point/Radius* – Left-Click at the desired through point location OR enter the desired radius through *Dialogue Options* and Left-Click in the *View* to complete the command.
6	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Line. Left-Click in the *View* to complete the command.

Dialogue Options	
Options:	**Description:**
Radius	Locks the radius of the Arc
Trim/Extend	Trim/Extend the Reference Elements to meet the at the resulting Arc.

7D.1.b.iii(b) Two Center Arc To Element

This tool operates identically to the Simple Arc To Element tool, but has the added option of creating a Curve transition between the ORD Arc and Reference Line – resulting in a Compound Curve or 2 Center Curve.

See *Curve Methods and Dialogue Options* for an explanation of Curve Dialogue Options.

7D.1.b.iii(c) Spiral Arc To Element

This tool operates identically to the Simple Arc To Element tool, but has the added option of creating a Spiral transition between the ORD Arc and Reference Line.

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

7D.1.b.iii(d) Reverse Spiral To Element

This tool is intended to be used with a Reference Arc to create the following geometry configurations:

Reference Arc – Spiral – Line – Spiral – Arc OR Reference Arc – Spiral – Spiral – Arc

See *Spiral Methods and Dialogue* Options for an explanation of Spiral Dialogue Options.

WARNING: Avoid Spiral – Spiral geometry configuration (without a Line between).

See ***REVERSE CURVE WARNING***.

7D.1.b.iii(e) Arc to Element

This tool combines all functionality and Dialogue Options found in the other Arc To Element tools. Differing from other Arc To Element tools, this tool allows the user to input a horizontal offset from the ORD Arc and Reference Line.

7D.1.b.iv Arc Between Arcs

Creates an *Arc* between two Reference Arcs – to create a double compound curve. Transitions can be placed between the Arc and Reference Arcs.

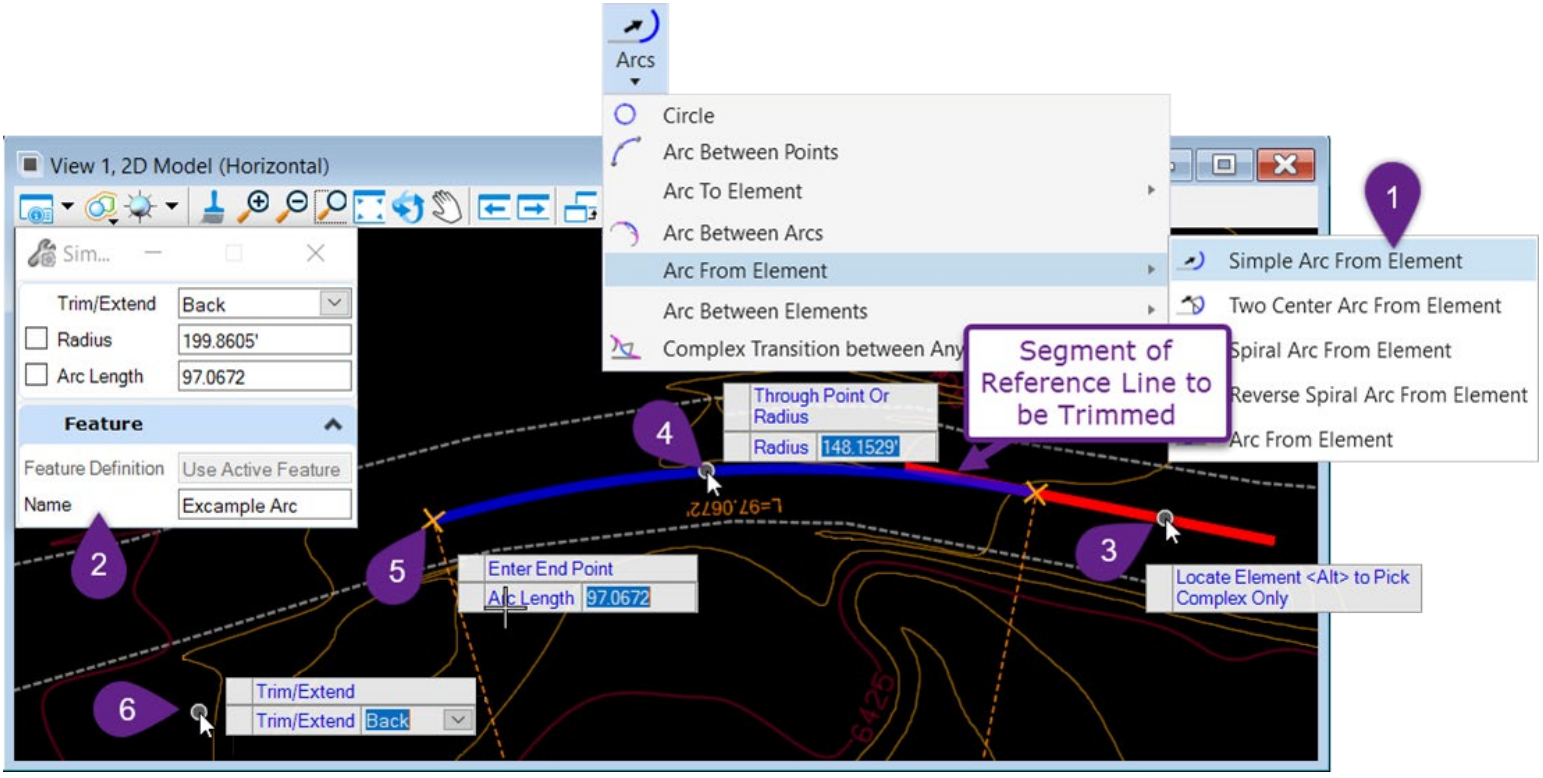
See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

7D.1.b.v Arc From Element

7D.1.b.v(a) Simple Arc From Element

This tool will create an Arc from a Start Point along a *Reference Element* to a User-defined End Point.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Simple Arc To Element* tool from the *Arcs* dropdown
2	In the *Dialogue Box,* select a *Feature Definition* and give the *Arc* a *Feature Name* if desired.
3	*Prompt: Locate Element <Alt> to Pick Complex Only* – Left-Click on the Reference Element.
4	*Prompt: Through Point or Radius* – Left-Click at the desired through point location (point on the arc) OR enter the desired radius through Dialogue Options and Left-Click in the *View* to complete the command.
5	*Prompt: End Point* – Left-Click at the desired location for the End Point to complete the command
6	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Line. Left-Click in the *View* to complete the command.

Dialogue Options	
Options:	**Description:**
Radius	Locks the radius of the Arc. This option can only be used in Step 4.
Arc Length	Locks the Arc Length of the Arc. This option can only be triggered in Step 5.
Trim/Extend	Trim/Extend the Reference Elements to meet the at the resulting Arc.

7D.1.b.v(b) Two Center Arc From Element

This tool creates an Arc with a Curve transition from a Reference Line to create a compound curve.

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

7D.1.b.v(c) Spiral Arc From Element

This tool operates identically to the Simple Arc From Element tool, but has the added option of creating a Spiral transition between the ORD Arc and Reference Line.

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

7D.1.b.v(d) Reverse Spiral Arc From Element

This tool is intended to be used with a Reference Arc to create the following geometry configurations:

Reference Arc – Spiral – Line – Spiral – Arc OR Reference Arc – Spiral – Spiral – Arc

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

WARNING: Avoid Spiral – Spiral geometry configuration (without a Line between).

See ***REVERSE CURVE WARNING***.

7D.1.b.v(e) Arc From Element

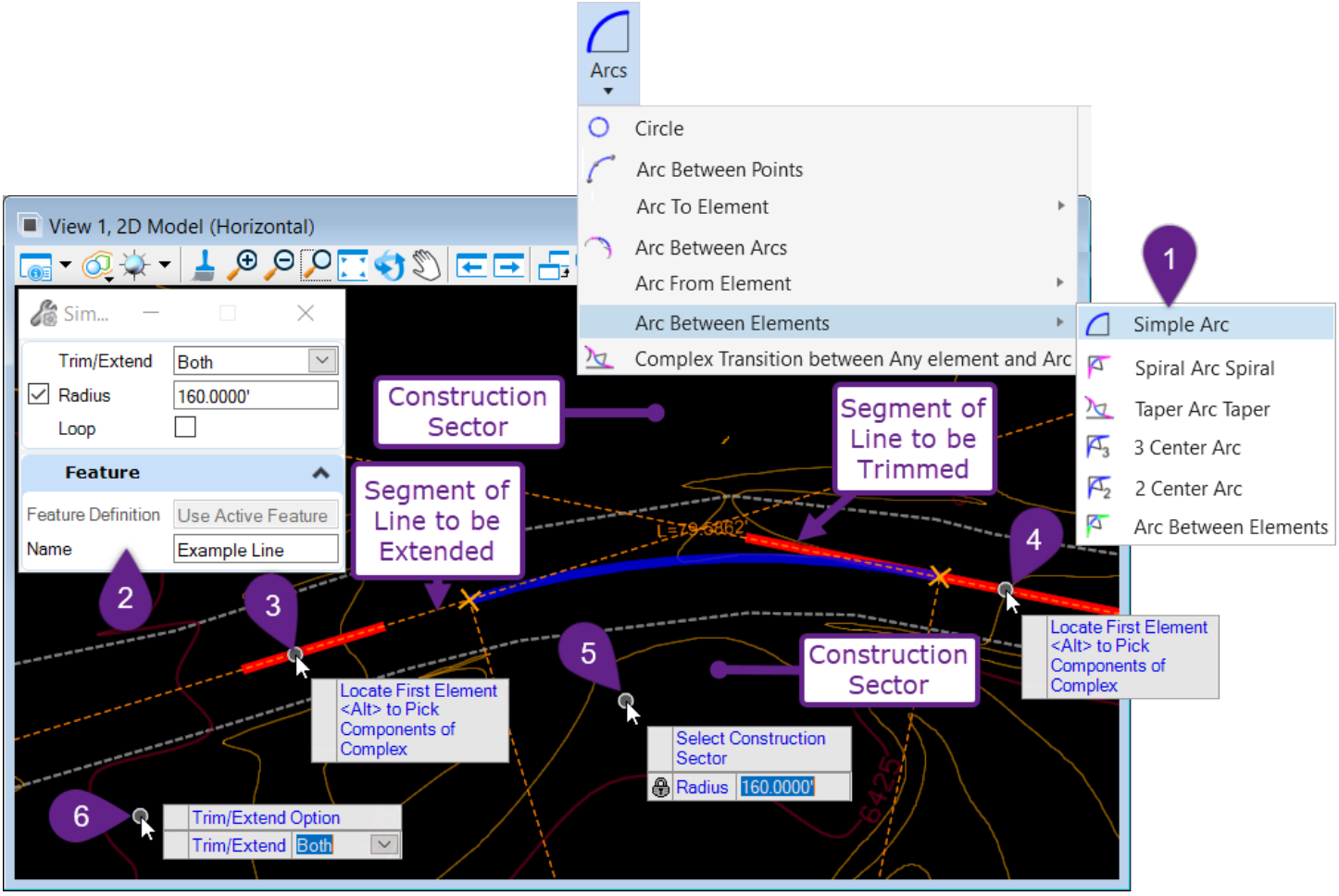
This tool combines all functionality and Dialogue Options found in the other Arc From Elements tools.

7D.1.b.vi Arc Between Elements

7D.1.b.vi(a) Simple Arc

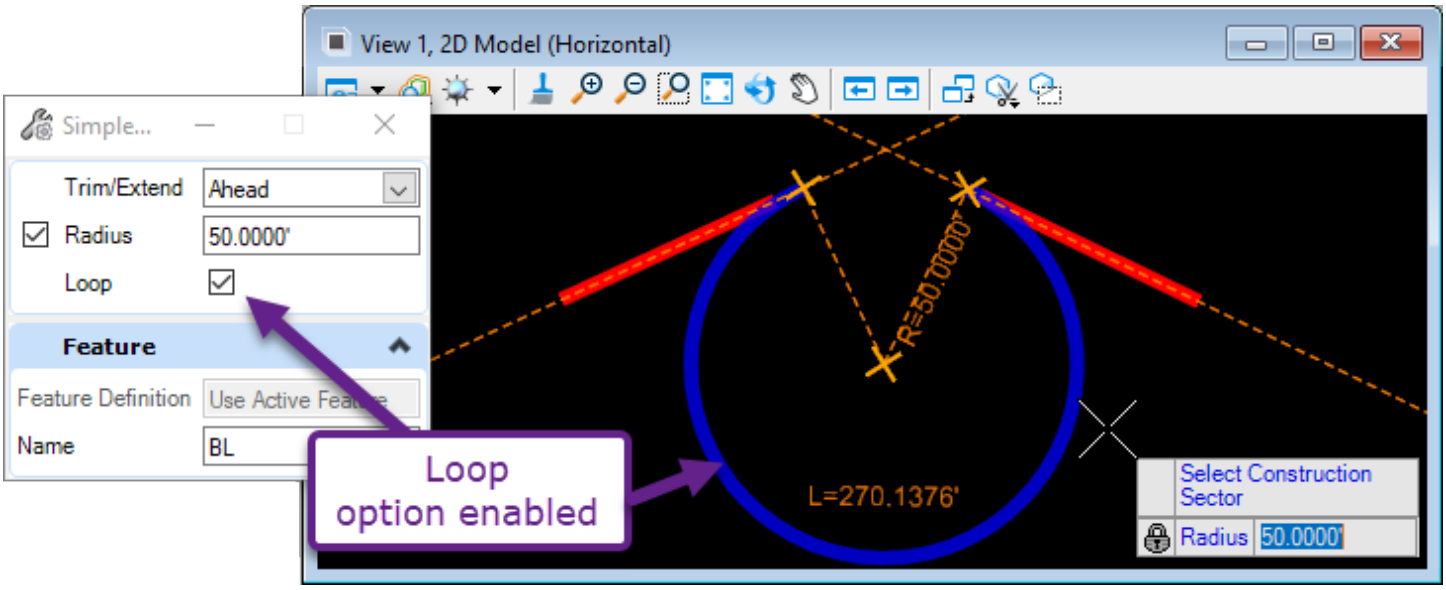
Creates an *Arc* to between two *Reference Elements*. This tools most common use is to create a *Fillet* between two *Lines*.

> ***Tip*:** This tool can be used to create Reverse Curves and Compound Curves by selecting a *Reference Arc* and *Line*. However, see the ***Reverse Curve Warning***



1	Left-Click the *Simple Arc* tool from the *Arcs* dropdown
2	In the *Dialogue Box,* select an appropriate *Feature Definition* and give the *Arc* a *Feature Name* if desired.
3	*Prompt*: *Locate First Element* – Left-Click on the first *Reference Element*.
4	*Prompt*: *Locate Second Element* – Left-Click on the second *Reference Element*.
5	*Prompt: Select Construction Sector* – Key-in the desired radius value with *Dialogue Options*. In the *View,* move the cursor to the intended construction sector. Left-Click when the curve is shown in the appropriate location.
6	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Elements. Left-Click in the *View* to complete the command.

Dialogue Options	
Options:	**Description:**
Radius	Locks the radius of the Arc.
Loop	If checked, the Arc is looped and directed in the opposite direction – such that the Arc is shown in the opposite construction sector. See graphic on next page.
Trim/Extend	Trim/Extend the Reference Elements to meet the at the resulting Arc.



7D.1.b.vi(b) Spiral Arc Spiral

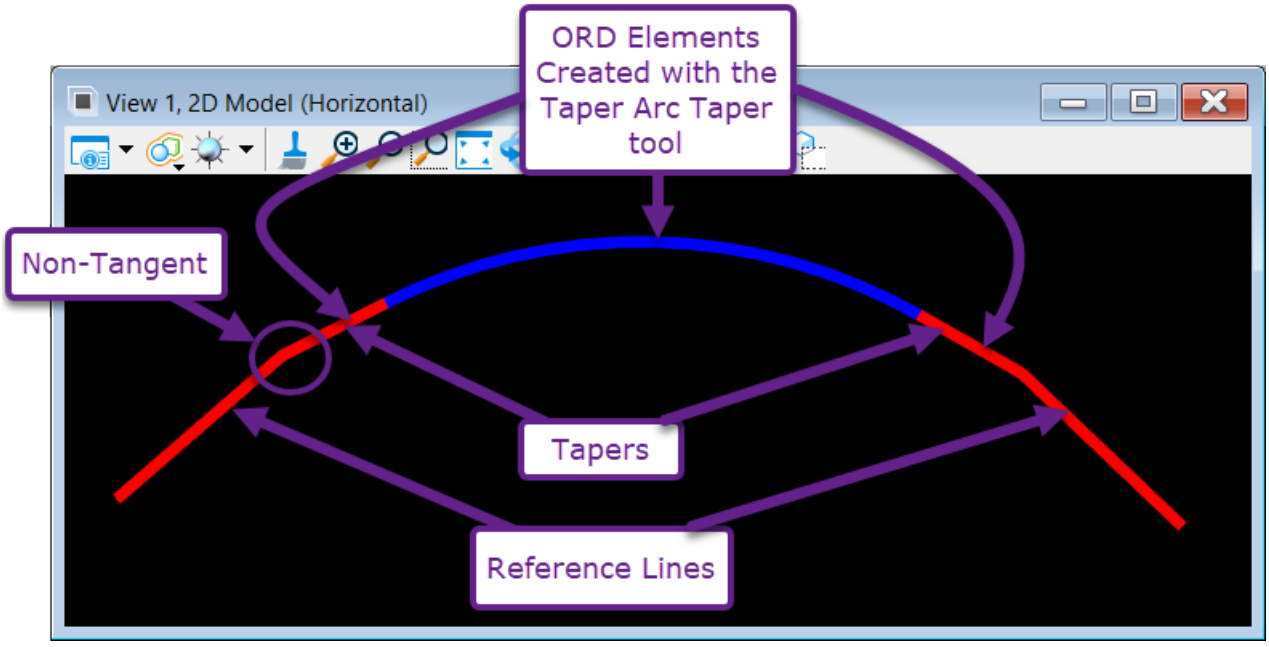
This tool operates identically to the Simple Arc tool, but has the added option of creating a Back/Ahead Spiral transition between the ORD Arc and two Reference Lines.

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

7D.1.b.vi(c) Taper Arc Taper

This tool operates identically to the Simple Arc tool, but has the added option of creating a Back/Ahead Taper transition between the ORD Arc and two Reference Lines.

In this context, a Taper is an ORD Line between the Reference Line and ORD Arc. The taper ORD Line and Reference Line are intended to be non-tangent.



7D.1.b.vi(d) 3 Center Arc

This tool operates identically to the Simple Arc tool, but has the added option of creating a Back and Ahead Curve transition between the ORD Arc and two Reference Lines – creating a double compound curve or 3 center arc.

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

7D.1.b.vi(e) 2 Center Arc

This tool operates identically to the Simple Arc tool, but has the added option of creating a Back Curve transition between the ORD Arc and two Reference Lines – creating a compound curve or 2 center arc.

See *Spiral Methods and Dialogue Options* for an explanation of Spiral Dialogue Options.

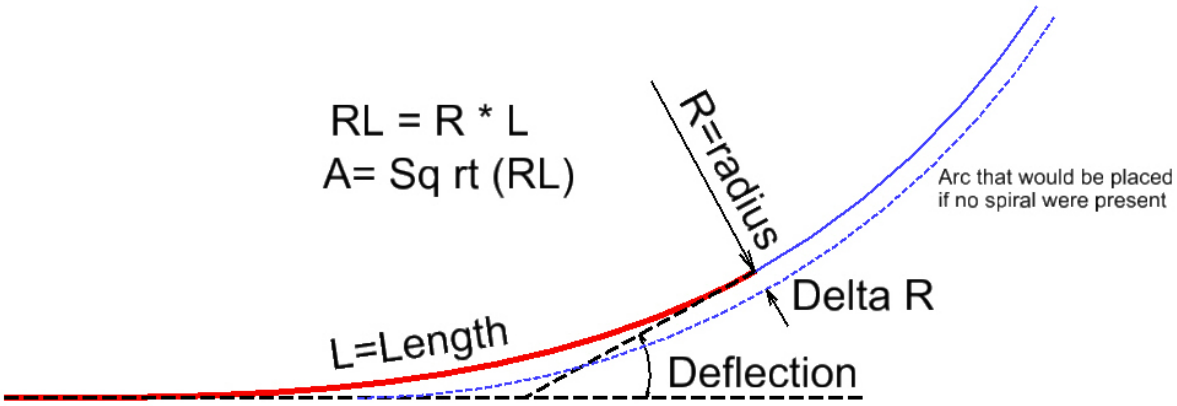
7D.1.b.vi(f) Arc Between Elements

This tool combines all functionality and Dialogue Options found in the other Arc Between Elements tools.

7D.1.b.vii Transition Method Dialogue Options

7D.1.b.vii(a) Spiral Methods and Dialogue Options

Method	Description:
Length	Allows the User to input the total length of a spiral. ***RECOMMENDED TRANSITION METHOD*** – AASHTO spiral criteria recommendations are provided in Length.
A-Value	Also referred to as the Spiral Parameter. Allows the User to input the A-Value of the Spiral. The Spiral A-Value is equal to the square root of the Spiral length multiplied by the Arc radius.
Deflection	Allows the User to input the Spiral's angular Deflection between the adjoining Line and the End Point of the Spiral.
Delta R or Offset	Allows the User to input the Spiral's Offset distance between projected Arc and end point of the Spiral.
RL-Value	Allows the User to input the Spiral's RL-Value. The RL values is equal to the Radius of the Arc multiplied by Length of Spiral.



7D.1.b.vii(b) Curve Methods and Dialogue Options

This Method creates a Transition Arc between an Arc and Line. In other words, this will create a 2-Center Curve.

Method	Description:
Length	Allows the User to input the Radius & Length of the Transition Arc.
Deflection	Allows the User to input the Radius & Deflection angle of the Transition Arc.
Offset	Allows the User to input the Radius & Offset distance of the Transition Arc.

7D.1.b.vii(c) Arc Ratio Methods and Dialogue Options

Similar to the Curve Method. This Method creates a Transition Arc between an Arc and Line. The Transition Arc radius is determined as a ratio of the primary Arc.

Method	Description:
Arc Ratio	Allows the User to input the radius ratio between the Primary Arc and Transition Arc to automatically determine the Transition Arc radius value

7D.1.c Spirals

The tools found under the Spirals dropdown create a standalone Clothoid Spiral. Generally, these tools should be AVOIDED because simpler and more functional spiral workflows are available with the Arc tools. Similarly, spirals can be easily inserted between previously-created Lines and Arcs with the Table Editor tool.

SUGGESTED ALTERNATE SPIRAL WORKFLOWS:

Create Spiral-Arc-Spiral geometry between two previously-created Lines with the Arc Between Elements tool.

Create Spiral-Arc geometry from a previously-created Line with the Arc From Element tool.

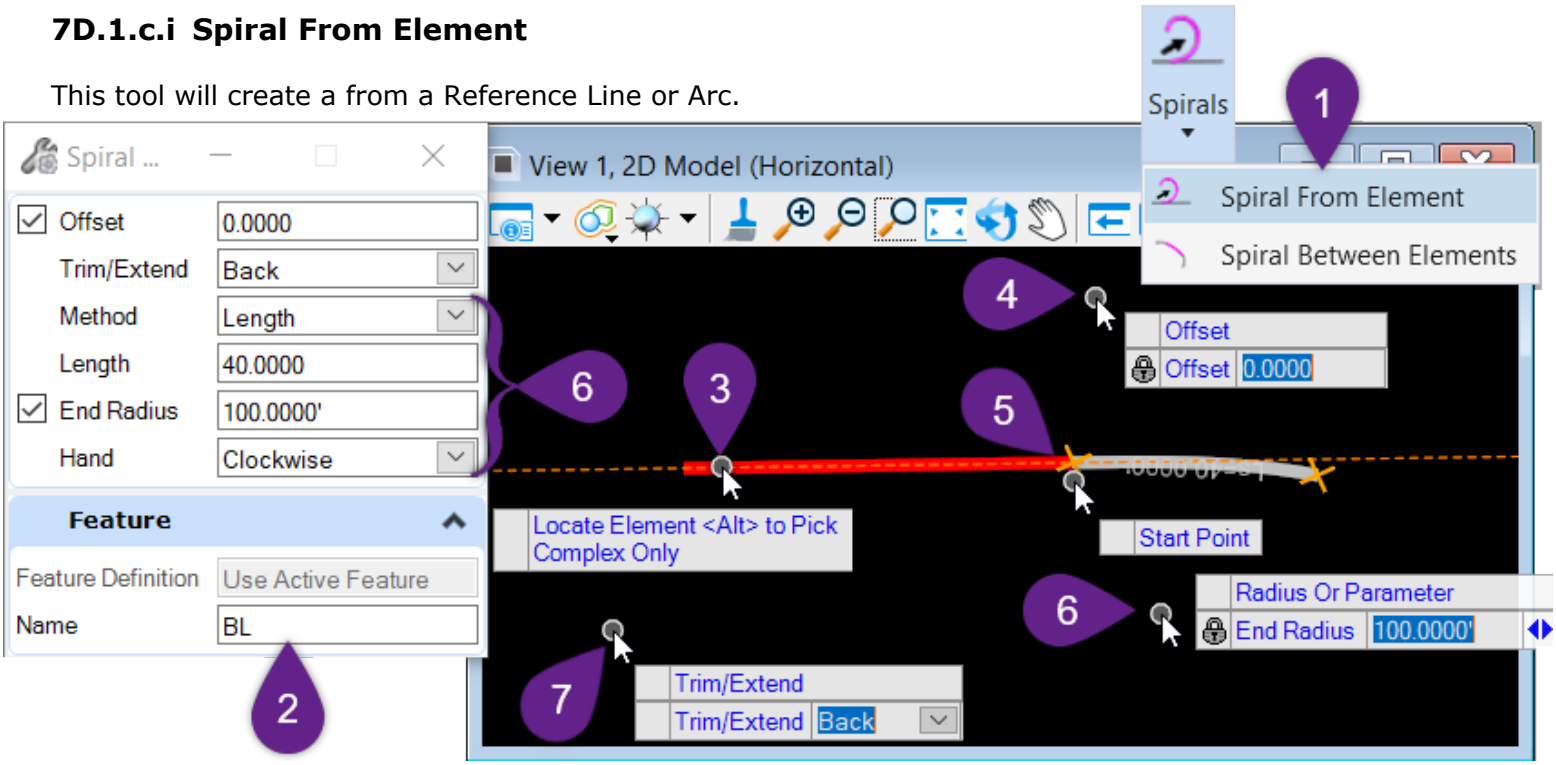
Create Arc-Spiral geometry to a previously-created Line with the Arc To Element tool.

Insert a Spiral between previously-created Lines and Arcs with the Table Editor tool.

> ***TIP:*** Toggle ON Design Standards to pull the Default Spiral Length from the Active Design Standard.
>
> ***TIP:*** See *Transition Method Dialogue Options* for an explanation of Spiral Methods.

7D.1.c.i Spiral From Element

This tool will create a from a Reference Line or Arc.



1	Left-Click the *Spiral From Element* tool from the *Spiral* dropdown.
2	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
3	*Prompt: Locate Element* – Left-Click on the Reference Element to draw the Spiral from.
4	*Prompt: Enter Offset* – Key-in the desired Start Offset relative to the Reference Element and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt.
5	*Prompt: Start Point* – Left-Click at the desired Start Point for the Spiral along the Refence Element.
6	*Prompt: Radius or Parameter* – Using the Dialogue Box or Cursor Dialogue, key-in and lock the desired Spiral Method, Length, and End Radius. In the *View,* Left-Click in the desired quadrant to advance to the next prompt.
7	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Elements. Left-Click in the *View* to complete the command.

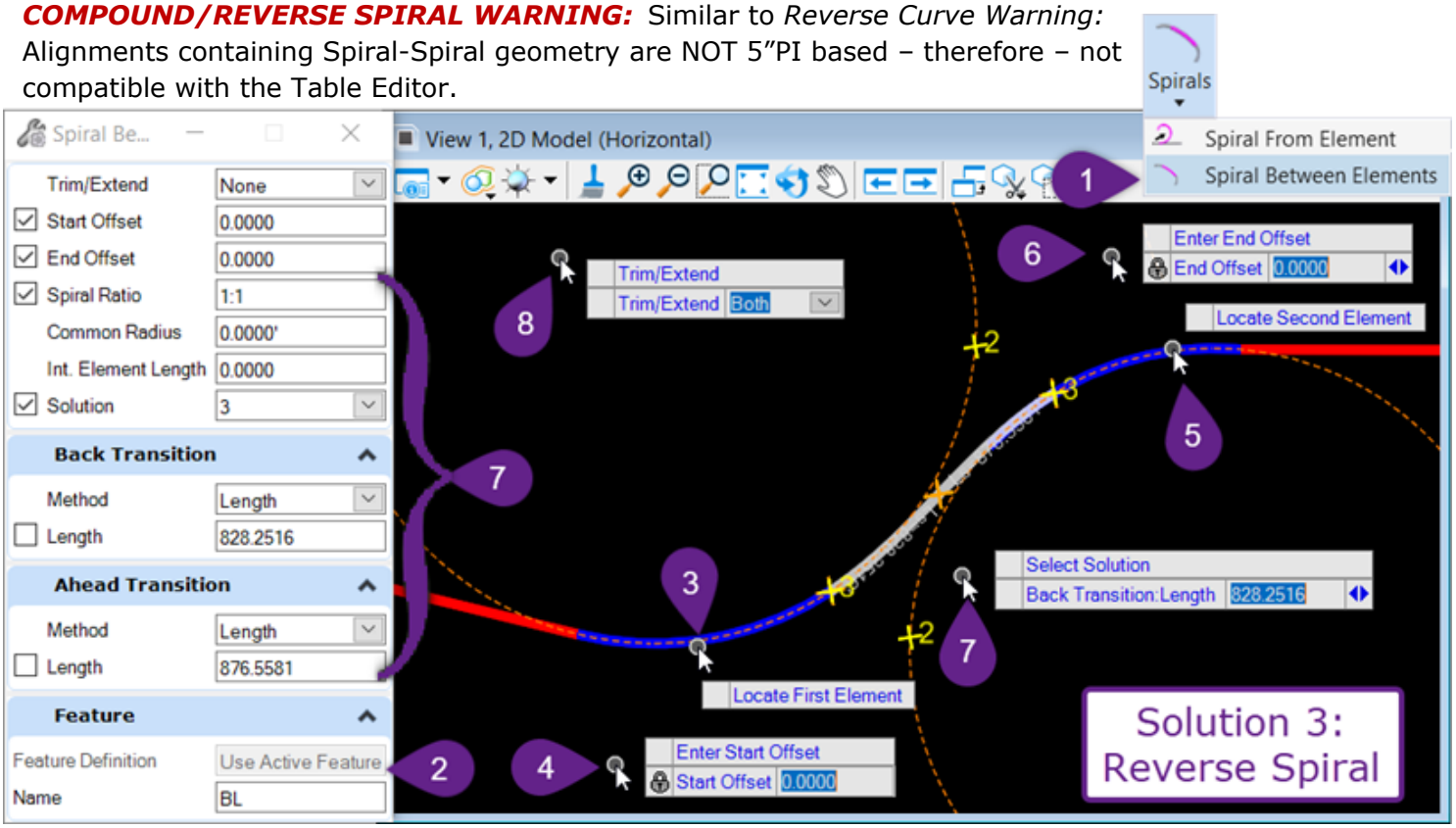
Dialogue Options	
Option:	**Description:**
Offset	Locks the Spiral start point offset distance from the Reference Element.
Trim/Extend	Trim/Extend the Reference Element to meet the start point of the Spiral
Method	Locks the Method used to create the spiral. See *Transition Method Dialogue Options*.
Length	Locks the Length of the Spiral.
End Radius	Lock the Radius of the Spiral at the end point. ***NOTE:*** This option will not be shown when the Reference Element is an Arc.
Hand	Locks the direction of the Spiral.

7D.1.c.ii Spiral Between Elements

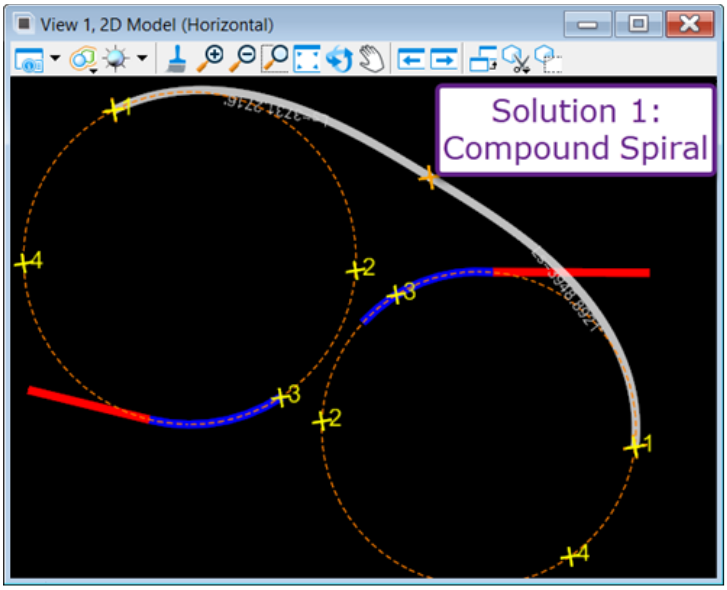
This tool can create 3 different types of Spiral transitions between Reference Elements.

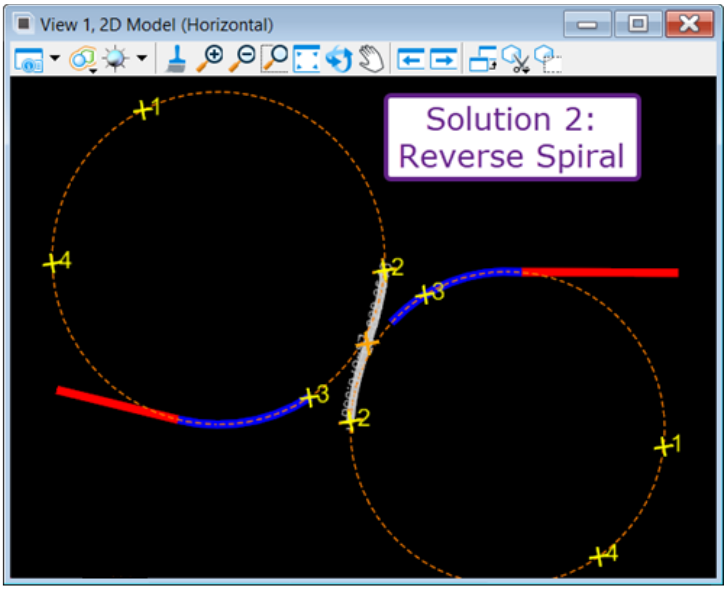
- Single Spiral transition between a Reference Line and Arc.
- Compound Spiral transition between two Reference Arcs.
- sReverse Spiral transition between two Reference Arcs.

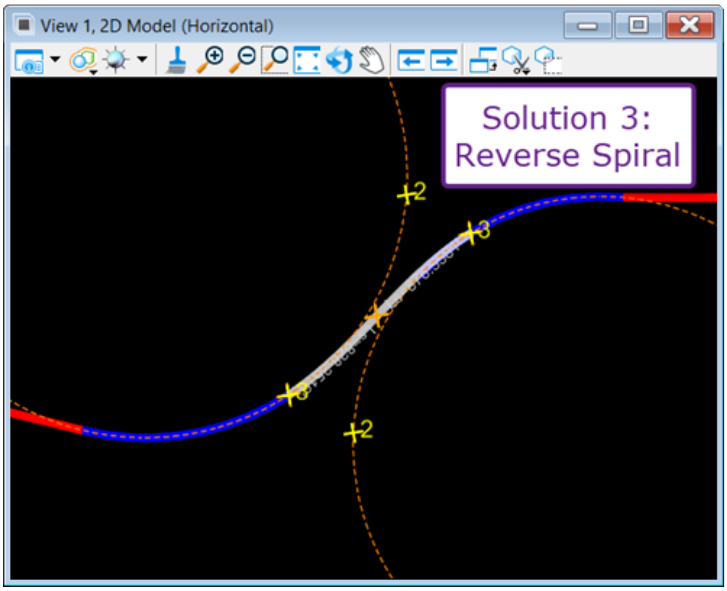
COMPOUND/REVERSE SPIRAL WARNING: Similar to *Reverse Curve Warning:* Alignments containing Spiral-Spiral geometry are NOT 5"PI based – therefore – not compatible with the Table Editor.

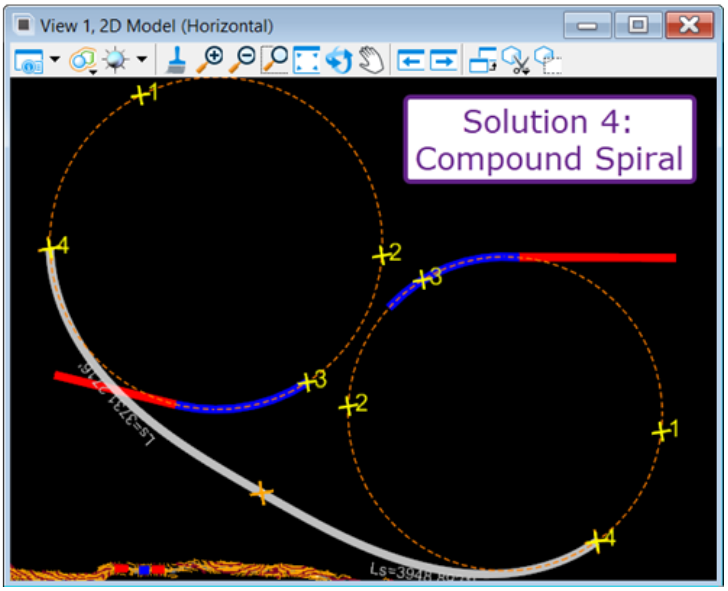


1	Left-Click the *Spiral Between Elements* tool from the *Spiral* dropdown.
2	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
3	*Prompt: Locate First Element* – Left-Click on the first Reference Element to draw a Spiral between.
4	*Prompt: Enter Start Offset* – Key-in the desired Start Offset relative to the first Reference Element and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt.
5	*Prompt: Locate Second Element* – Left-Click on the second Reference Element to draw a Spiral between
6	*Prompt: Enter End Offset* – Key-in the desired End Offset relative to the second Reference Element and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt.
7	*Prompt: Select Solution* – FIRST – Press the ALT Key to cycle between the available Solutions OR select the desired Solution from the dropdown in the Dialogue Box Option. Available Compound and Reverse Spiral Solutions are shown on the next page. SECOND - Using the Dialogue Box or Cursor Dialogue, key-in and lock the desired Dialogue Options. Left-Click in the *View* to advance to the next prompt.
8	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Elements. Left-Click in the *View* to complete the command.







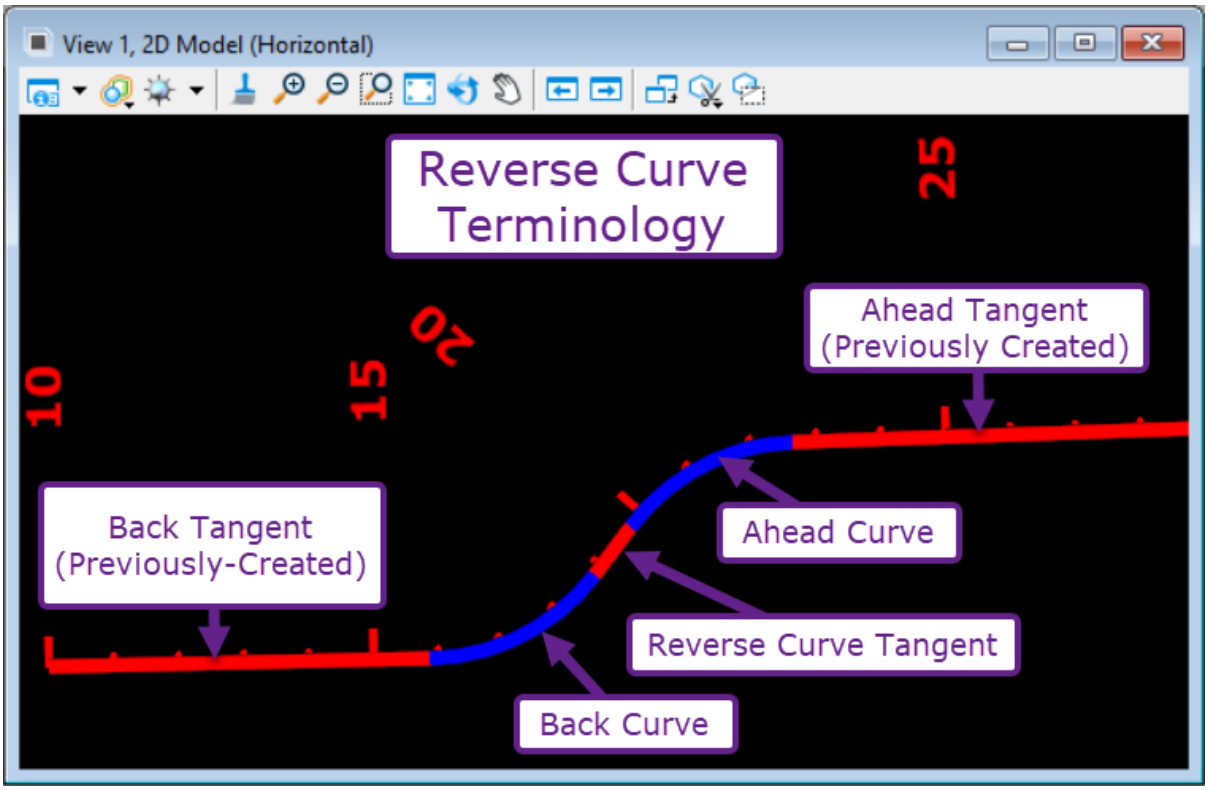


Dialogue Options	
Option:	**Description:**
Trim/Extend	Trim/Extend the Reference Element to meet the start point of the Spiral
Start Offset	Locks the Spiral start point offset distance from the First Reference Element.
End Offset	Locks the Spiral end point offset distance from the Second Reference Element.
Spiral Ratio	For Compound and Reverse Spirals, Locks the ratio between the Back and Ahead Spiral Length.
Int. Element Length	For Compound and Reverse Spirals. A Line with length equal to the inputted value will be created between the two Spirals. If value is 0, NO Line will be created.
Solution	Locks the Spiral Solution from the available configurations.
Back/Ahead Transition Method	Locks the Method used to create the spiral. See *Transition Method Dialogue Options*.
Back/Ahead Transition Length	Locks the Length of the Spiral.

7D.1.d Reverse Curves

In highway design, a Reverse Curve is two horizontal curves in close proximity and facing opposite directions. A Reverse Curve may contain a tangent line between the curves – OR – the curves may abut WITHOUT a line in between. The later combination should be avoided per the ***REVERSE CURVE WARNING*** below. Refer to the graphic below for Reverse Curve terminology to be used in this manual.

REVERSE CURVE WARNING: Reverse Curve tools allow the Reverse Curve Tangent length to be set to 0 – which means no Line will be placed between the Back and Ahead Curves. AVOID THIS WORKFLOW because the resulting curve-curve configuration is incompatible with the Table Editor and Simplify Geometry tools. Attempting to use these tools on a Complex Element containing curve-curve segments will result in an error reading "Complex Geometry is not PI based".



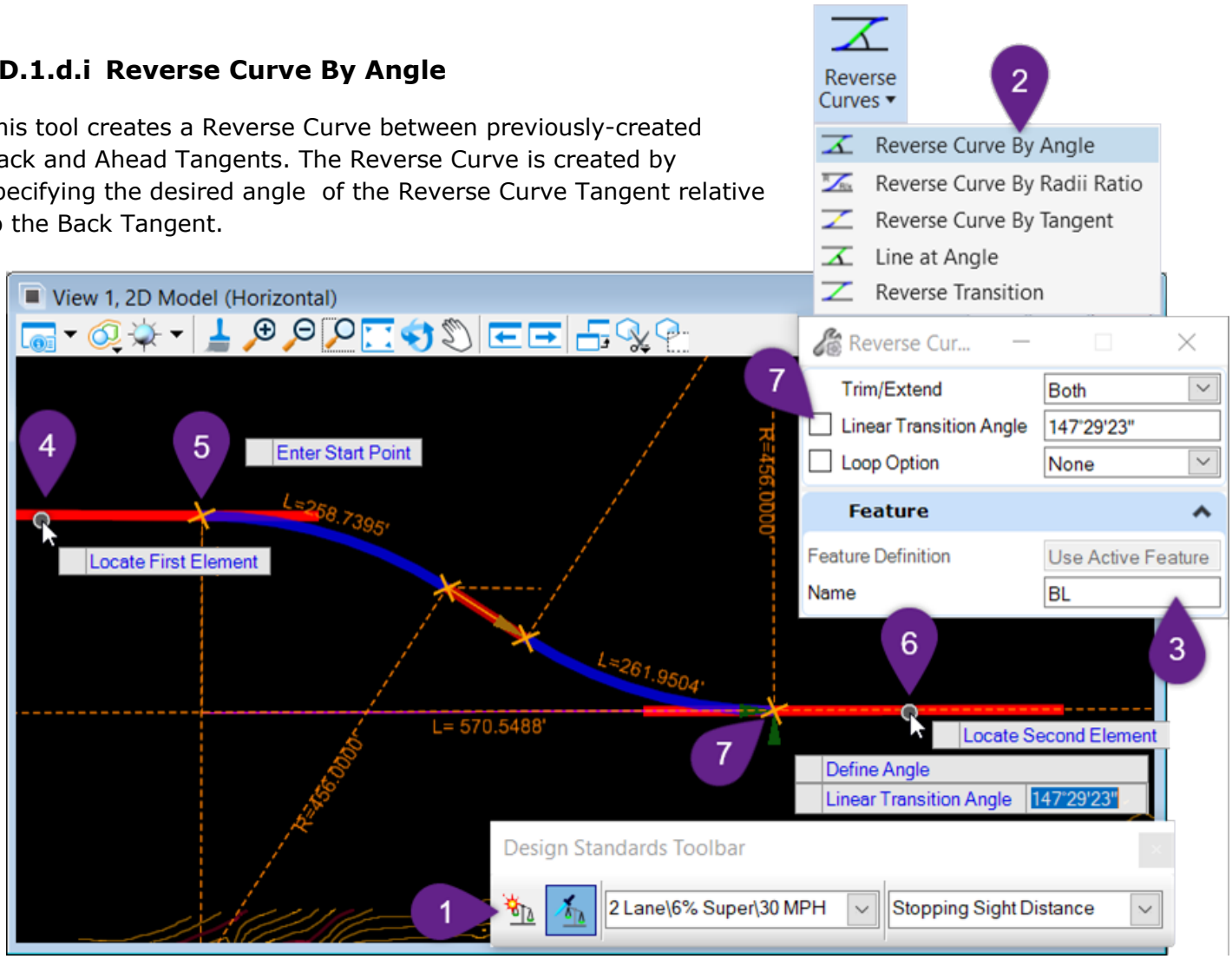
WARNING: All Reverse Curve tools – except the Reverse Transition tool - require Active Design Standards are toggled ON to create the Back and Ahead Reverse Curves. The radii values will be equal and dependent on the Default Radius of the Active Design Standard. If Active Design Standards are NOT toggled on – only a Reverse Curve Tangent Line will be created.

TIP: The Reverse Transition tool is the most powerful tool because it allows the User to individually input Back and Ahead Radii values. The Reverse

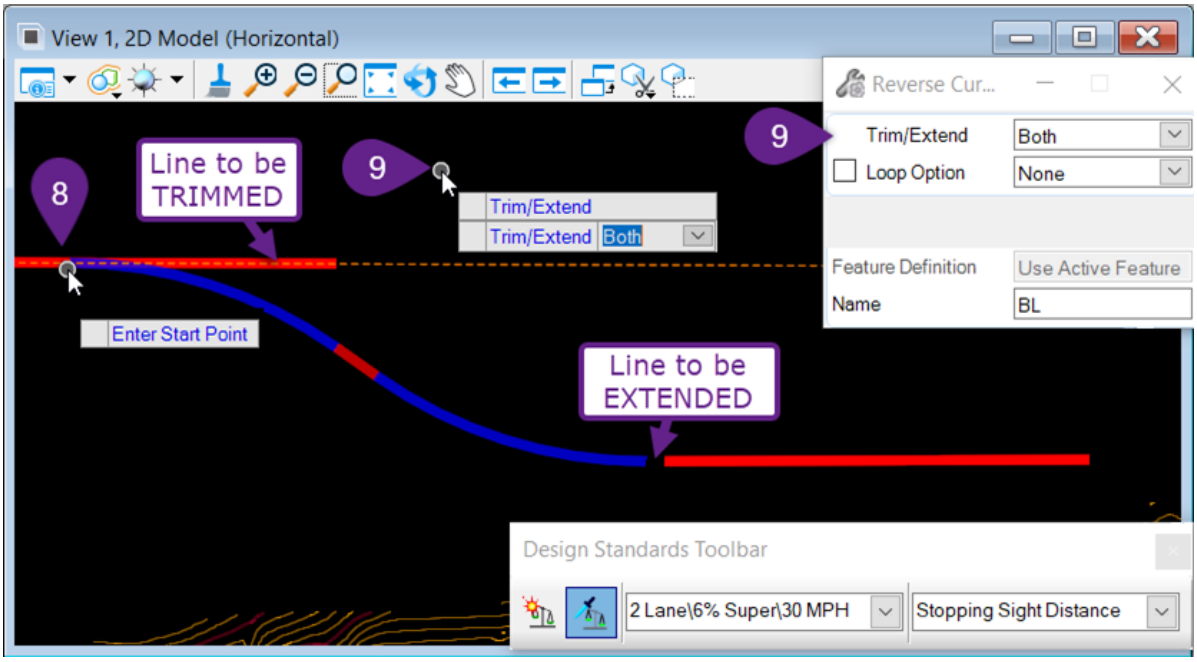
TIP: For all Reverse Curve tools: If the Reverse Curve Tangent is displayed in the wrong quadrant - Transpose (reverse) the direction of the Back Tangent and attempt the command again.

7D.1.d.i Reverse Curve By Angle

This tool creates a Reverse Curve between previously-created Back and Ahead Tangents. The Reverse Curve is created by specifying the desired angle of the Reverse Curve Tangent relative to the Back Tangent.

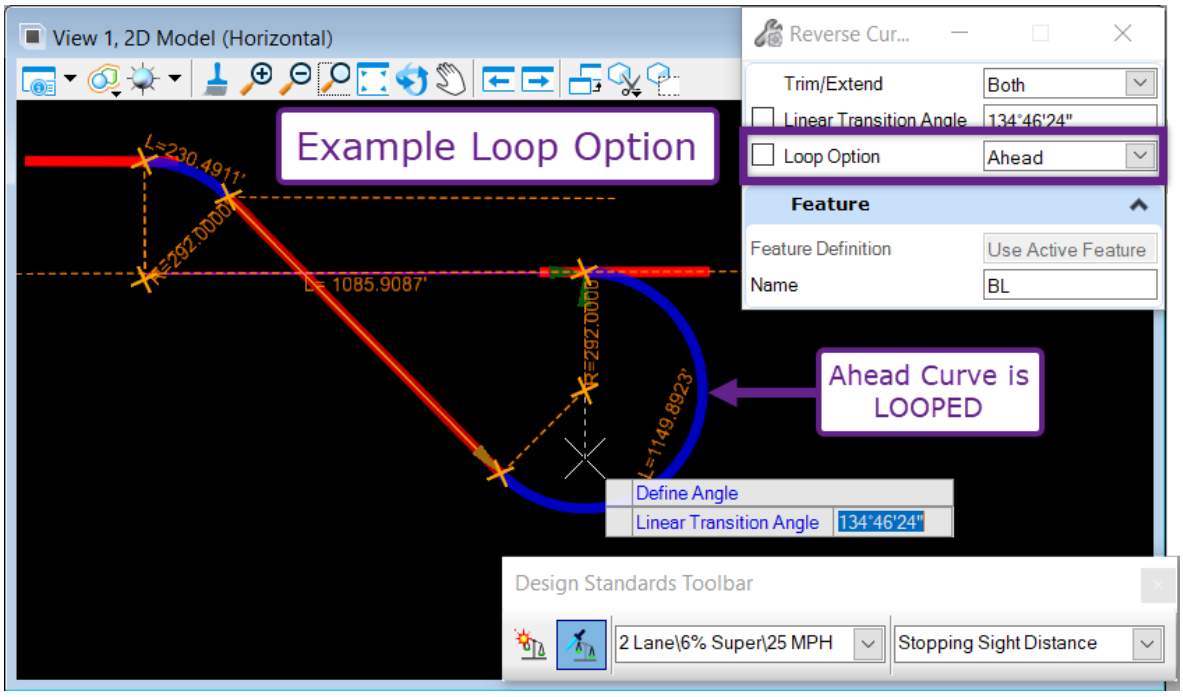


1	Toggle ON Design Standards Toolbar before operating tool.
2	Left-Click the *Reverse Curve By Angle* tool from the *Reverse Curves* dropdown.
3	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
4	*Prompt: Locate First Element* – Left-Click on the Back Tangent.
5	*Prompt: Enter Start Point* – Left-Click at the Start Point location on the Back Tangent. ***NOTE:*** This point is ONLY used to define the Reverse Curve Tangent angle. In STEP 8, the USER can slide the entire reverse curve assembly to set the start point of the Back Curve.
6	*Prompt: Locate Second Element* – Left-Click on the Ahead Tangent.
7	*Prompt: Define Angle* – Left-Click at a point location along the Ahead Tangent (or projected Ahead Tangent). The *Start Point* location (STEP 5) and this point location will define a Reverse Curve Tangent angle (Linear Transition Angle) relative to the Back Tangent. OR Key-In the desired Reveres Curve Tangent angle (Linear Transition Angle) to the Cursor Dialogue or Dialogue Box



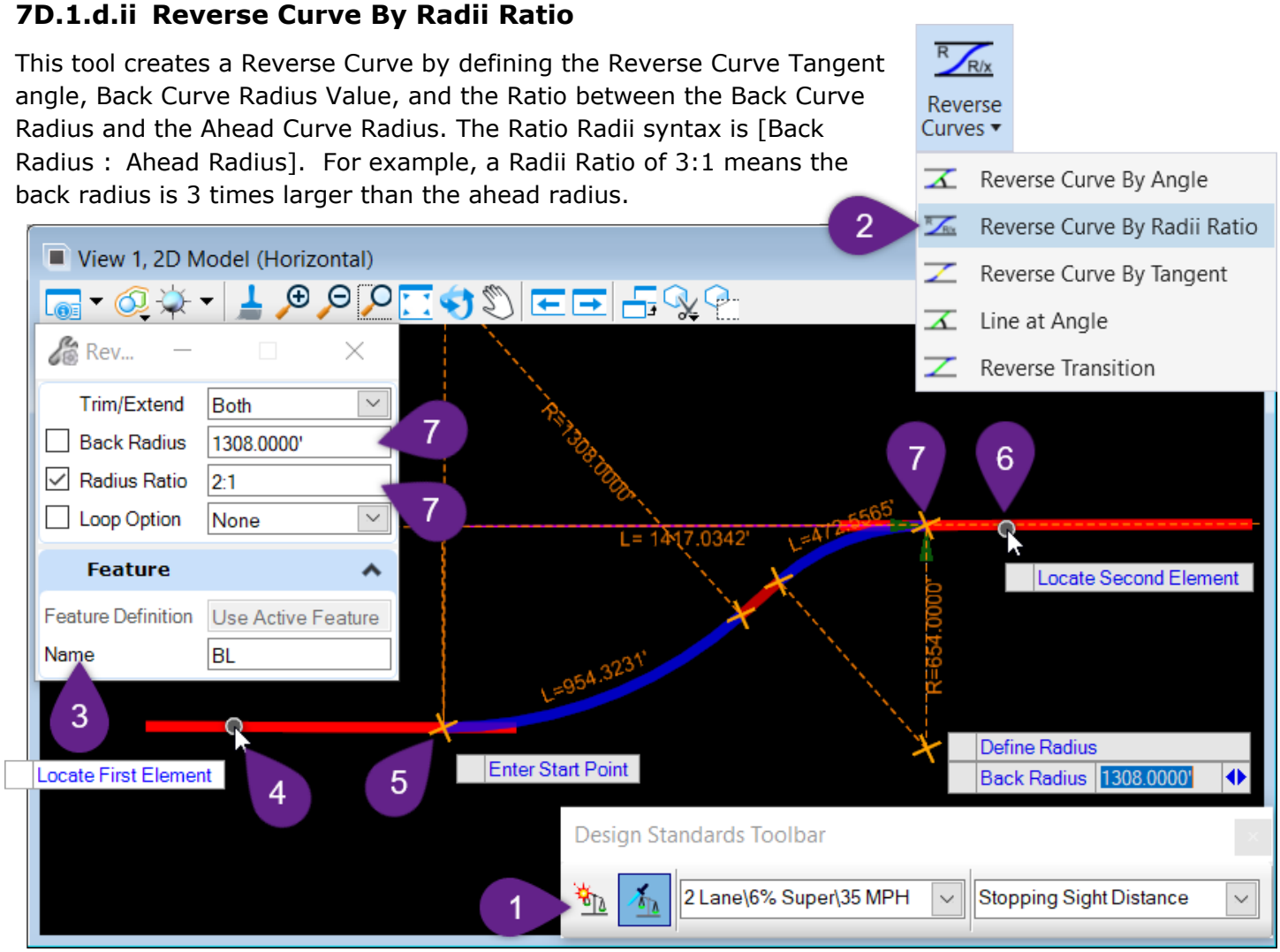
8	*Prompt: Enter Start Point* – Left-Click at the desired Start Point (PC Point) for the Back Curve. ***NOTE:*** The End Point (PT Point) of the Ahead Curve will remain at the same position shown in STEP 8. The Reverse Curve Tangent Angle will be altered to accommodate new Start Point.
9	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Elements. Left-Click in the *View* to complete the command.

Dialogue Options	
Input	**Description:**
Trim/Extend	Trim/Extend the Back and Ahead Tangents to meet the Reverse Curve.
Linear Transition Angle	Reverse Curve Tangent bearing angle defined relative to the Back Tangent and beginning at the *Start Point* located in STEP 5.
Loop Option	The Back, Ahead, or Both Curves are looped around and terminate in the opposite direction. See the example below.

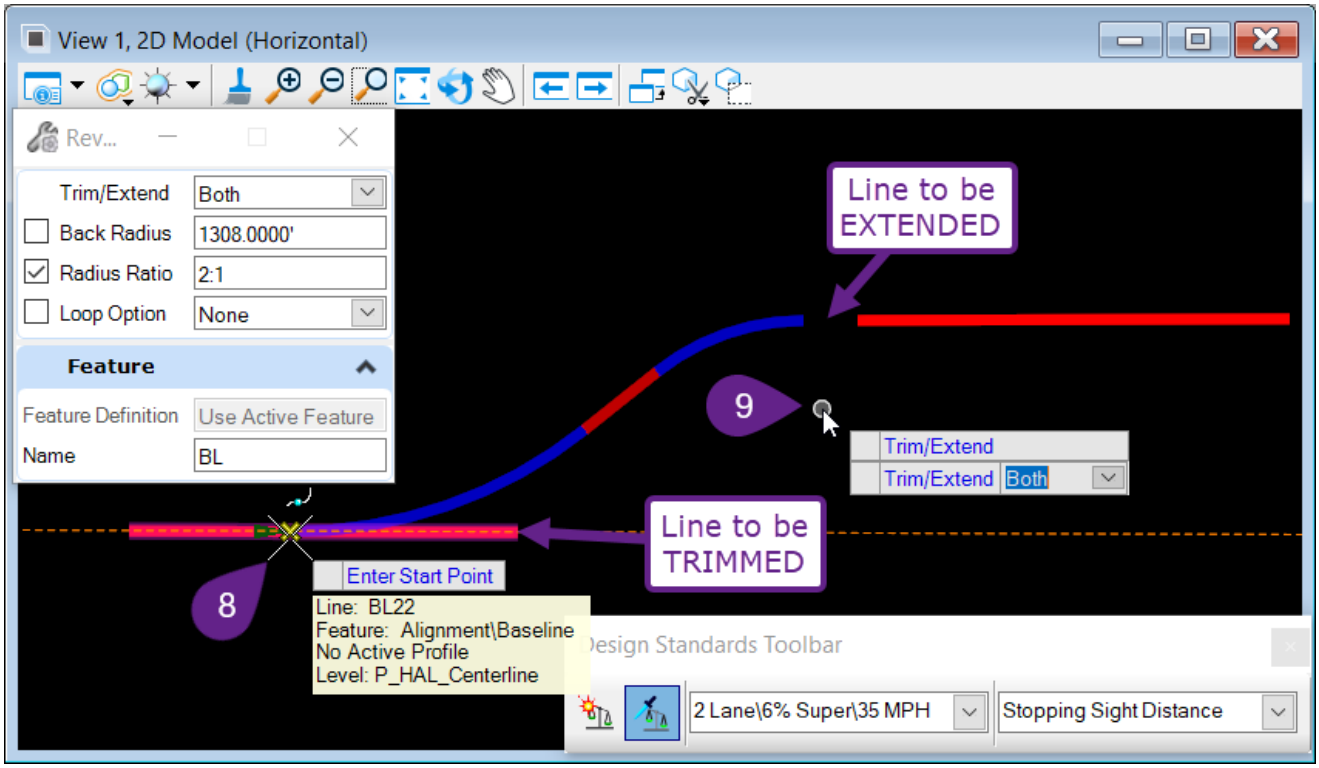


7D.1.d.ii Reverse Curve By Radii Ratio

This tool creates a Reverse Curve by defining the Reverse Curve Tangent angle, Back Curve Radius Value, and the Ratio between the Back Curve Radius and the Ahead Curve Radius. The Ratio Radii syntax is [Back Radius : Ahead Radius]. For example, a Radii Ratio of 3:1 means the back radius is 3 times larger than the ahead radius.



1	Toggle ON Design Standards Toolbar before operating tool.
2	Left-Click the *Reverse Curve By Radii Ratio* tool from the *Reverse Curves* dropdown.
3	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
4	*Prompt: Locate First Element* – Left-Click on the Back Tangent.
5	*Prompt: Enter Start Point* – Left-Click at the Start Point location on the Back Tangent. ***NOTE:*** This point is ONLY used to define the Reverse Curve Tangent angle. In STEP 8, the User can slide the entire reverse curve assembly along the Back Tangent – which will change the Start Point.
6	*Prompt: Locate Second Element* – Left-Click on the Ahead Tangent.
7	*Prompt: Define Radius* – Key-in Back Radius value to create a Reverse Curve with equal radii ratio (1:1). OR In the Dialogue Box, uncheck the Back Radius box. The Radius Ratio input will then appear. Input the desired ratio. In the *View,* Left-Click along the Ahead Tangent to define the Reverse Curve Tangent Angle to advance to the next prompt.



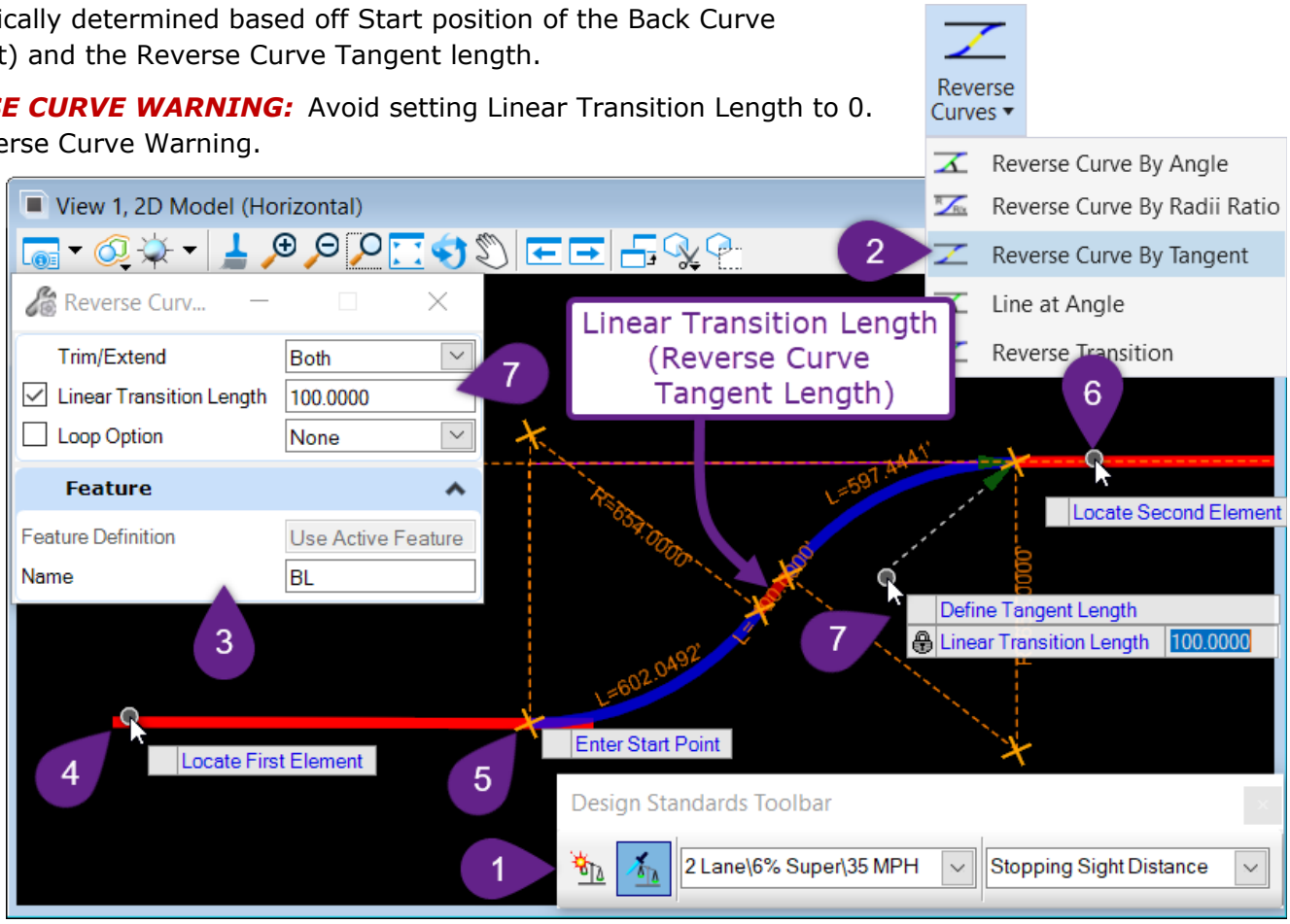
8	*Prompt: Enter Start Point* – Left-Click at the desired Start Point (PC Point) for the Back Curve. ***NOTE:*** The End Point (PT Point) of the Ahead Curve will remain at the same position shown in STEP 8. The Reverse Curve Tangent Angle will be altered to accommodate new Start Point.
9	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Elements. Left-Click in the *View* to complete the command.

Dialogue Options	
Input	**Description:**
Trim/Extend	Trim/Extend the Back and Ahead Tangents to meet the Reverse Curve.
Back Radius	Locks the Back Radius value. ***WARNING:*** If this box is checked, the Radius Ratio dialogue option will disappear and the Ahead Radius will equal the Back Radius
Radius Ratio	Locks the Radii Ratio between the Back and Ahead curves. The Radii Ratio syntax is [Back Radius : Ahead Radius]. ***NOTE:*** Design Standards must be Active for this dialogue to function. The radius ratio of 1 is equal to Default Radius value pulled from the Active Design Standards. For Example, a 2:1 radii ratio means the Back Radius is 2 times the value of the Default Radius.
Loop Option	The Back, Ahead, or Both Curves are looped around and terminate in the opposite direction. See the example below.

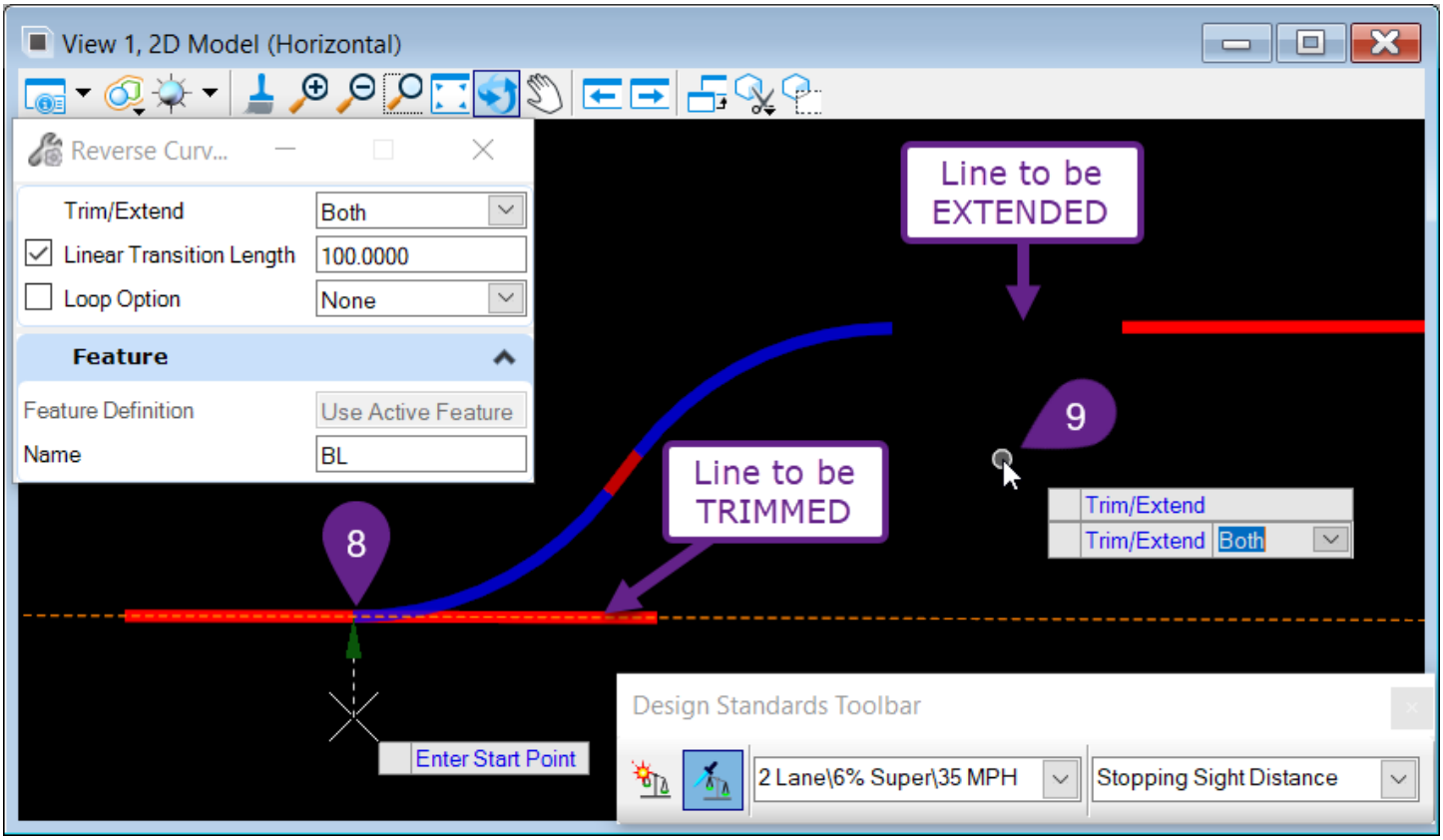
7D.1.d.iii Reverse Curve By Tangent

This tool creates a Reverse Curve by inputting the desired Reverse Curve Tangent length. The Back and Ahead Radii will be equal. The Reverse Curve Tangent angle and Ahead Curve end point (PT Point) is automatically determined based off Start position of the Back Curve (PC Point) and the Reverse Curve Tangent length.

REVERSE CURVE WARNING: Avoid setting Linear Transition Length to 0. See Reverse Curve Warning.



1	Toggle ON Design Standards Toolbar before operating tool.
2	Left-Click the *Reverse Curve By Tangent* tool from the *Reverse Curves* dropdown.
3	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
4	*Prompt: Locate First Element* – Left-Click on the Back Tangent.
5	*Prompt: Enter Start Point* – Left-Click at the Start Point location on the Back Tangent. ***NOTE:*** In STEP 8, the USER can slide the entire reverse curve assembly along the Back Tangent – which will change the Start Point.
6	*Prompt: Locate Second Element* – Left-Click on the Ahead Tangent.
7	*Prompt: Define Tangent Length* – In the Cursor Dialogue or Dialogue Box, key-in the desired Linear Transition Length (Reverse Curve Tangent length). Left-Click in the *View* to advance to the next prompt. OR In the *View,* position the cursor such that Reverse Curve is shown as desired and Left-Click to accept.

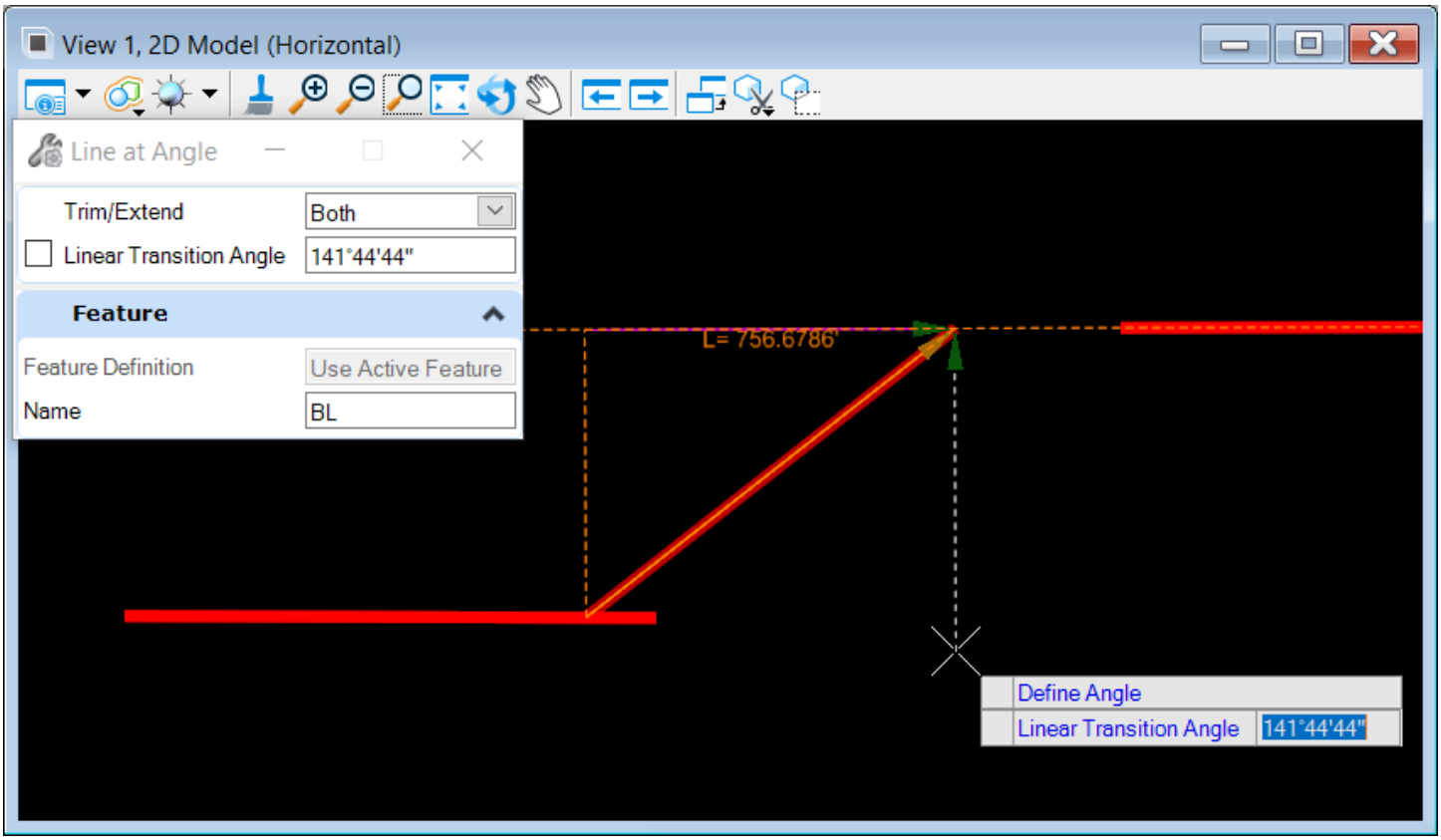


8	*Prompt: Enter Start Point* – Left-Click at the desired Start Point (PC Point) for the Back Curve. The entire Reverse Curve assembly will shift to accommodate new start point.
9	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Elements. Left-Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Trim/Extend	Trim/Extend the Back and Ahead Tangents to meet the Reverse Curve.
Linear Transition Length	Locks the Reverse Curve Tangent Length between curves. ***REVERSE CURVE WARNING:*** Avoid using a Linear Transition Length of 0. See Reverse Curve Warning.
Loop Option	The Back, Ahead, or Both Curves are looped around and terminate in the opposite direction. See the example below.

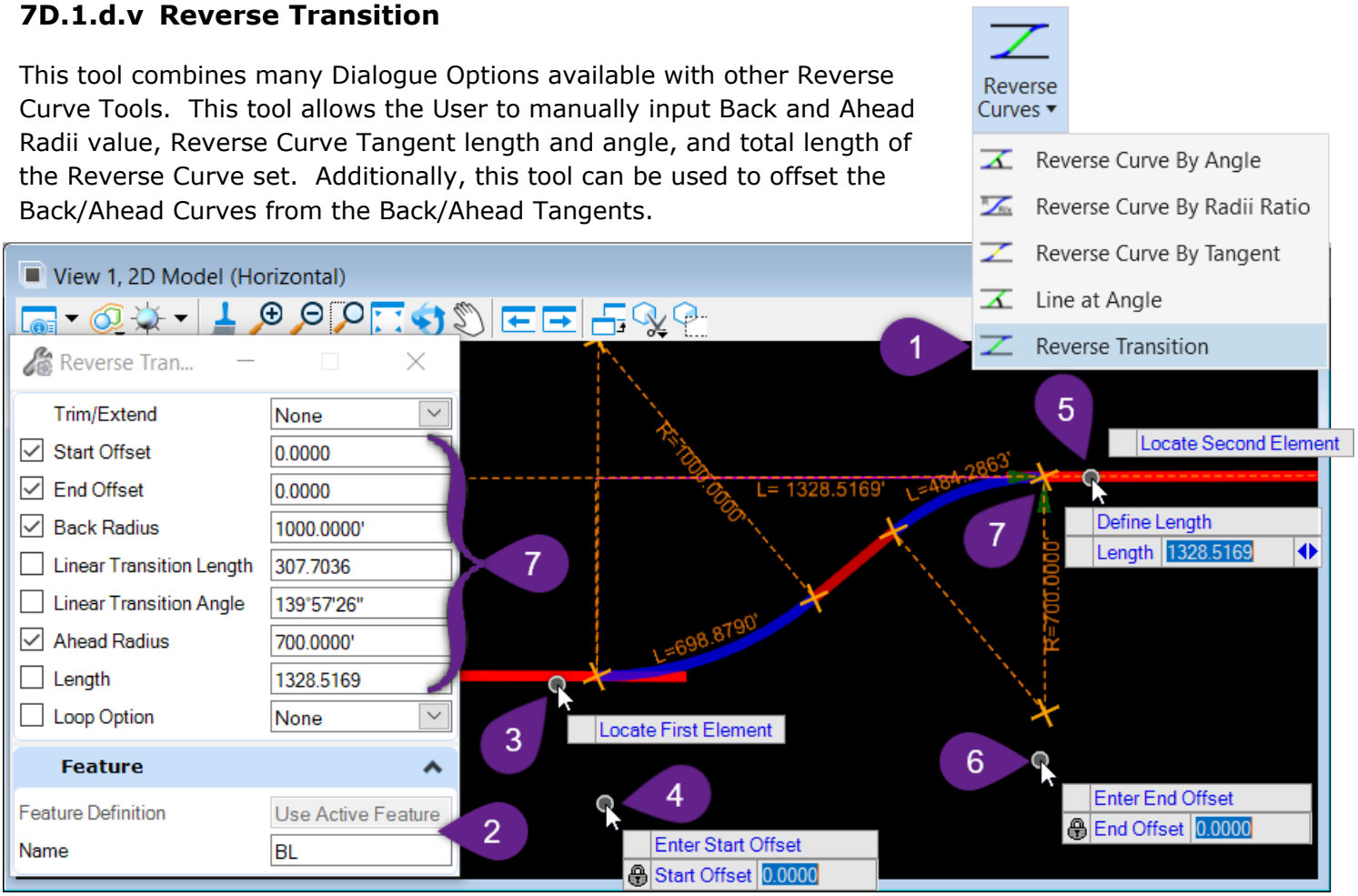
7D.1.d.iv Line at Angle

This tool functions and is operated identically to the Reverse Curve By Angle tool but is intended to create ONLY a Reverse Curve Tangent between the Back and Ahead Tangents. Back/Ahead Curves are NOT created with this tool.

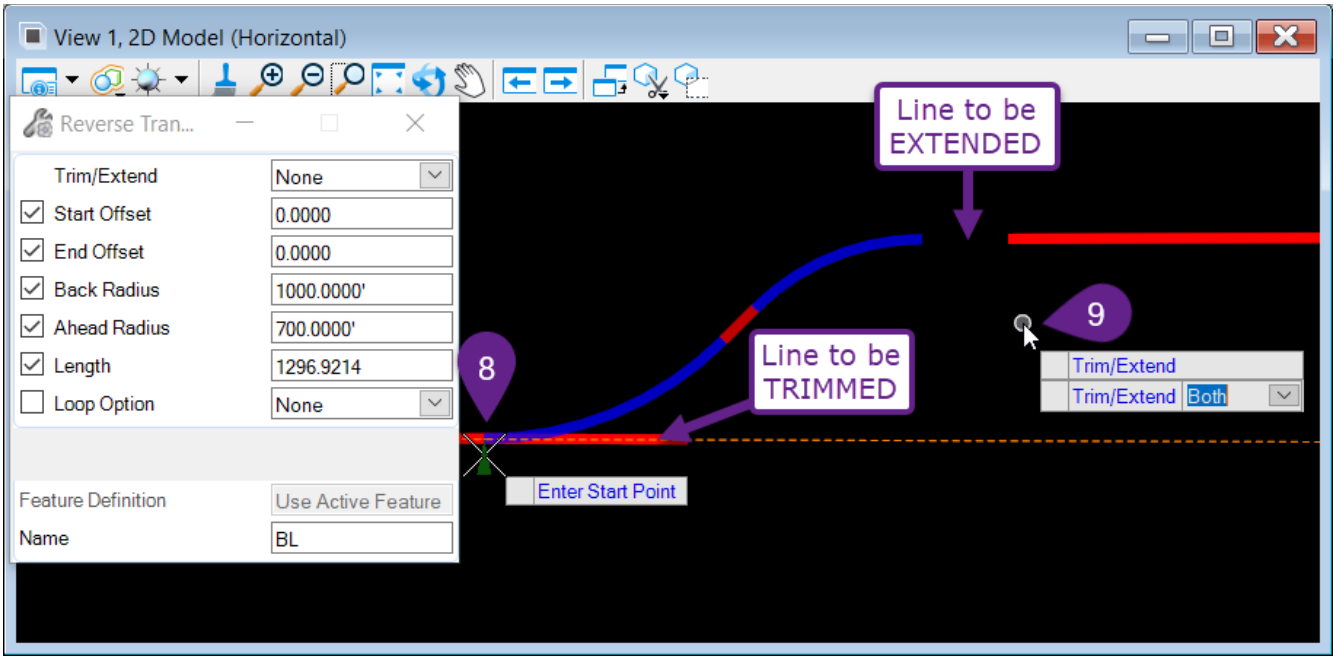


7D.1.d.v Reverse Transition

This tool combines many Dialogue Options available with other Reverse Curve Tools. This tool allows the User to manually input Back and Ahead Radii value, Reverse Curve Tangent length and angle, and total length of the Reverse Curve set. Additionally, this tool can be used to offset the Back/Ahead Curves from the Back/Ahead Tangents.



1	Left-Click the *Reverse Curve By Tangent* tool from the *Reverse Curves* dropdown.
2	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
3	*Prompt: Locate First Element* – Left-Click on the Back Tangent.
4	*Prompt: Enter Start Offset* – Key-in the desired Start Offset relative to the Back Tangent and press the Enter key to lock. ALSO, Left-Click at the desire Start Point location on the Back Tangent. ***NOTE:*** This STEP has two function – determining the Start Offset AND the Start Point.
5	*Prompt: Locate Second Element* – Left-Click on the Ahead Tangent.
6	*Prompt: Enter End Offset* – Key in the desired End Offset relative to the Ahead Tangent and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt.
7	*Prompt: Define Length* – In this STEP, key-in and lock all desired Dialogue Options in the Cursor Dialogue or Dialogue Box. Left-Click in the *View* to accept and advance to the next prompt. ***NOTE:*** Press the Left and Right Arrow keys to cycle between Dialogue Options with the Cursor Dialogue.



8	*Prompt: Enter Start Point* – Left-Click at the desired Start Point (PC Point) for the Back Curve. The entire Reverse Curve assembly will shift to accommodate new start point. ***NOTE:*** If Linear Transition Length is NOT locked, the End Point will stay fixed as shown in STEP 7, and the Linear Transition Length and Angle will adjust to accommodate new Start Point.
9	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Elements. Left-Click in the *View* to complete the command.

NOTE ABOUT DIALOGUE OPTIONS: Individual Dialogue Options will disappear when they are constrained by other locked Dialogue Options. For Example, the User will NOT see the Linear Transition Length and Angle options when Back Radius, Ahead Radius, and Length are locked.

Dialogue Options	
Option:	**Description:**
Trim/Extend	Trim/Extend the Back and Ahead Tangents to meet the Reverse Curve.
Start Offset	Locks the Offset Distance of the Start Point relative to the Back Tangent.
End Offset	Locks the Offset Distance of the End Point relative to the Ahead Tangent.
Back Radius	Locks the Back Curve Radius value.
Ahead Radius	Locks the Ahead Curve Radius value.
Linear Transition Length	Locks the Reverse Curve Tangent Length between curves. ***REVERSE CURVE WARNING:*** Avoid using a Linear Transition Length of 0. See Reverse Curve Warning.
Linear Transition Angle	Locks the Reverse Curve Tangent bearing angle defined relative to the Back Tangent.
Length	Locks the total length of the Reverse Curve assembly. Length is measured along the Back tangent from Start Point (PC Point) of Back Curve to End Point (PT Point) of Ahead Curve.
Loop Option	The Back, Ahead, or Both Curves are looped around and terminate in the opposite direction. See the example below.

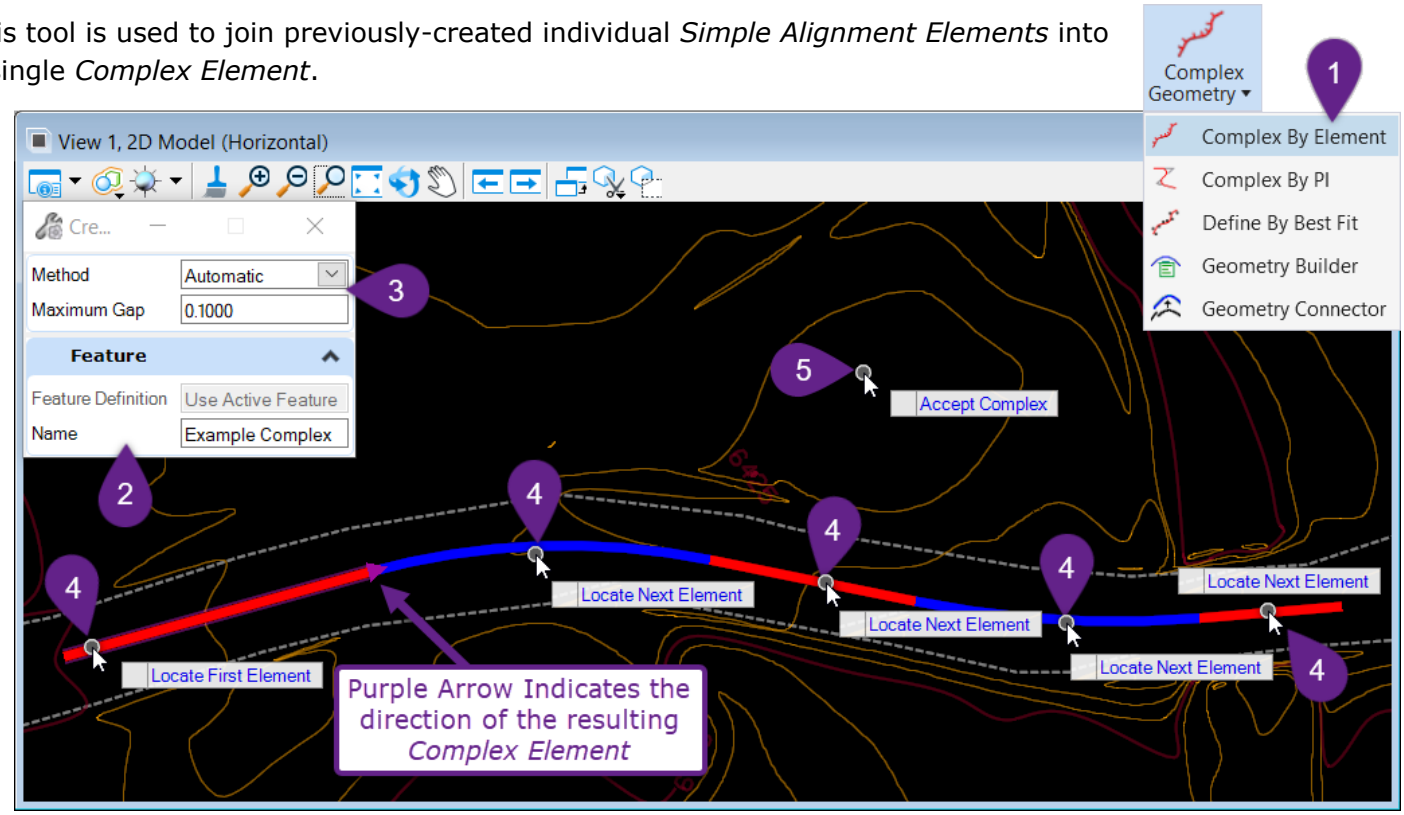
7D.2 Complex Elements

Creating a Complex Element (Horizontal Alignment) is accomplished with four distinct workflows:

Horizontal Alignment Creation Workflows			
Workflow:	**Description:**	**Advantages:**	**Limitations:**
Complex by Elements	This method creates a single *Complex Element* by joining together a continuous string of previously-created *Simple Alignment Elements.*	Graphically find a "Best Fit" for an alignment by individually laying out Lines and Arc components.	Underlying *Base ORD Elements* will retain *Design Intent* relationships after being joined into a *Complex Element*. Edits made to the *Complex Element* can result disjointed/broken due to conflicting *Design Intent* in *Base ORD Elements*.
Complex by PI	This method creates a *Complex Element* by graphically determining Points of Intersection (PI). The software automatically draws in Lines between user defined PIs - which are tangentially connected by Arcs and Spirals.	*Complex Elements* created with this method take to edits in a predictable manner. Underlying *Base ORD Elements* are created with *Simplified Civil Rules.* Edits made through this workflow are less likely to disjoint/break when compared to *Complex By Elements* method.	Even if the combined user defined PI locations and curve parameters are not geometrically tangible, the software will still draw the alignment, without prompted the user with an error message. The result can be a disjointed/broken alignment.
Define By Best Fit	This method creates a *Complex Element* AUTOMTATICALLY by finding a "Best Fit" from previously-created elements - such as a surveyed existing road centerline.	Can be efficient way to automate relatively simply alignments. Can be used to create spiral transitions automatically.	This workflow may have to be attempted several times with varying input parameters in order to get an acceptable "Best-Fit". This workflow can produce undesirable results such as non-tangent or broken elements.
Geometry Builder	This method creates a *Complex Element* by tabularly inputting data relating to bearing direction and distance, PI coordinates, arc lengths and radii.	Files that contain alignment data in tabular form – such as XML or CSV - can be uploaded into *Geometry Builder* to create a *Complex Element*	It is difficult to find a "Best Fit' for an alignment with coordinates and bearing directions alone. The user must be careful that the DGN coordinate system and the inputted geospatial information are in agreeance. If not, then the alignment may not be geo-referenceable.

7D.2.a Complex By Elements tool

This tool is used to join previously-created individual *Simple Alignment Elements* into a single *Complex Element*.



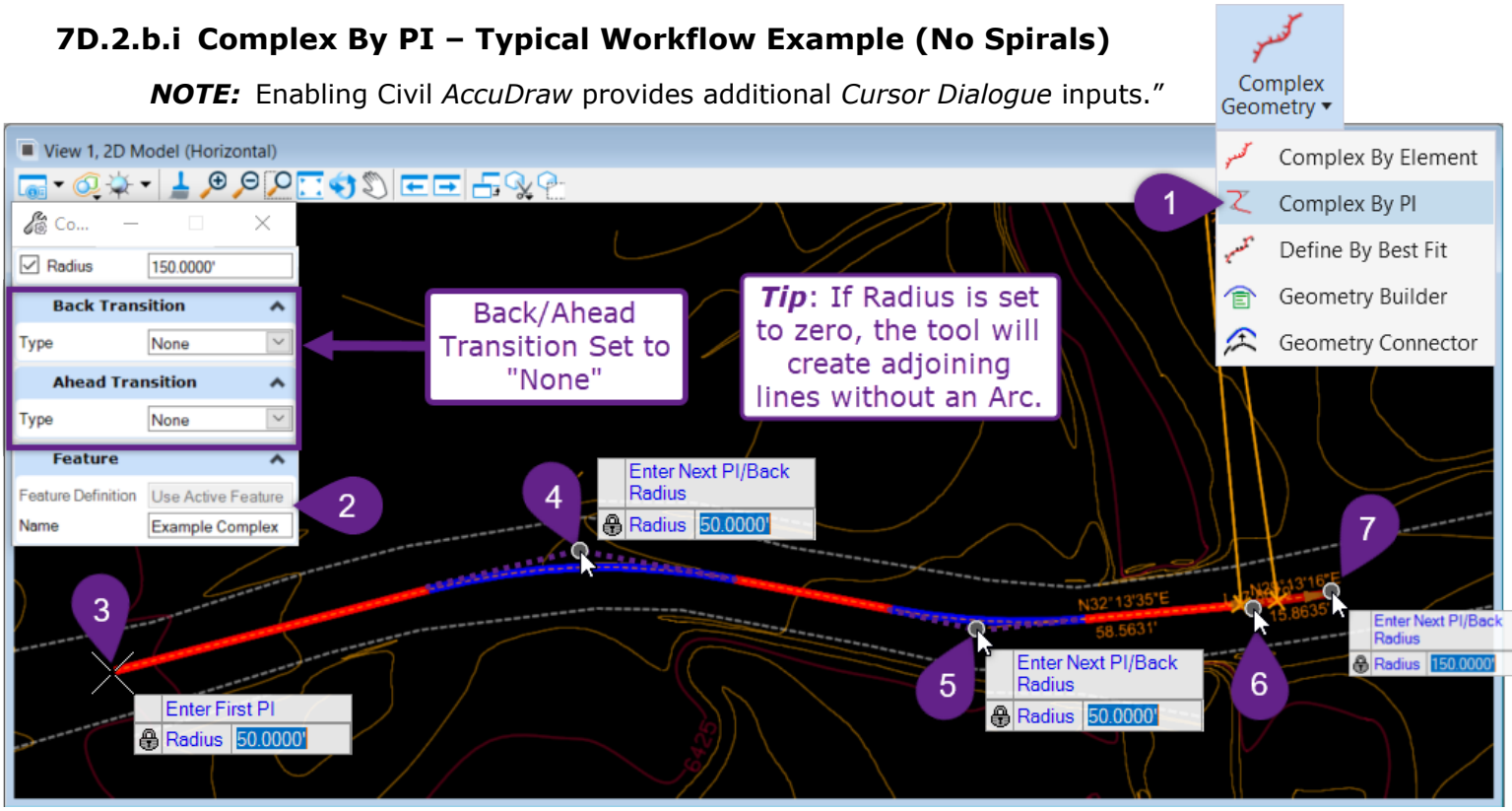
1	Left-Click the *Complex By Elements* tool from the *Complex Geometry* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	In the *Dialogue Box,* select the *Method* to be used to create the *Complex Element* **Manual** – Individual *Simple Alignment Elements* are selected manually and in sequentially order. **Automatic –** The first *Simple Alignment Element* is selected and all connecting *Simple Alignment Elements* (or elements within the specified *Maximum Gap*) are then automatically selected. ***BEST PRACTICE:*** Use *Trim/Extend* operations when creating *Simple Alignment Elements* to ensure there is no gap between *Elements*. ***RECCOMMENDATION:*** Use a *Maximum Gap* value of 0.1000 for first attempt with the **Automatic** method. If this *Maximum Gap* value does not work, re-check that there is no gap between *Simple Alignment Elements* OR marginally increase *Maximum Gap* value.
4	*Prompt: Locate First Element* – Near the intended Starting Point of alignment, Left-Click on the first *Simple Alignment Element* to be joined into a *Complex Element.* A purple arrow will display the direction of the resulting alignment. ***WARNING:*** Verify the purple arrow is pointing in the direction of stationing. Reversing a *Complex Element* later in the design process can be problematic. If the *Automatic Method* is chosen – advance to the next step. If the *Manual Method* is chosen – Left-Click on the remain *Simple Profile Elements* in sequential order.
5	*Prompt: Accept Complex* - Ensure all *Elements* to be included in the *Complex Profile Element* are highlighted. Left-Click in the *View* to complete the command.

7D.2.b Complex By PI

The 'Complex by PI tool' is used for creating horizontal alignments or *Complex Elements* without the need to draft *Simple Alignment Elements* prior. The tool creates a *Complex Element* by graphically clicking on the Points of Intersection (PI). The software will automatically draw in *Lines* between user defined PIs - which are tangentially connected by Arcs. Advanced use of this tool allows for the placement of *Spiral* and curve-to-curve (compound) transitions.

7D.2.b.i Complex By PI – Typical Workflow Example (No Spirals)

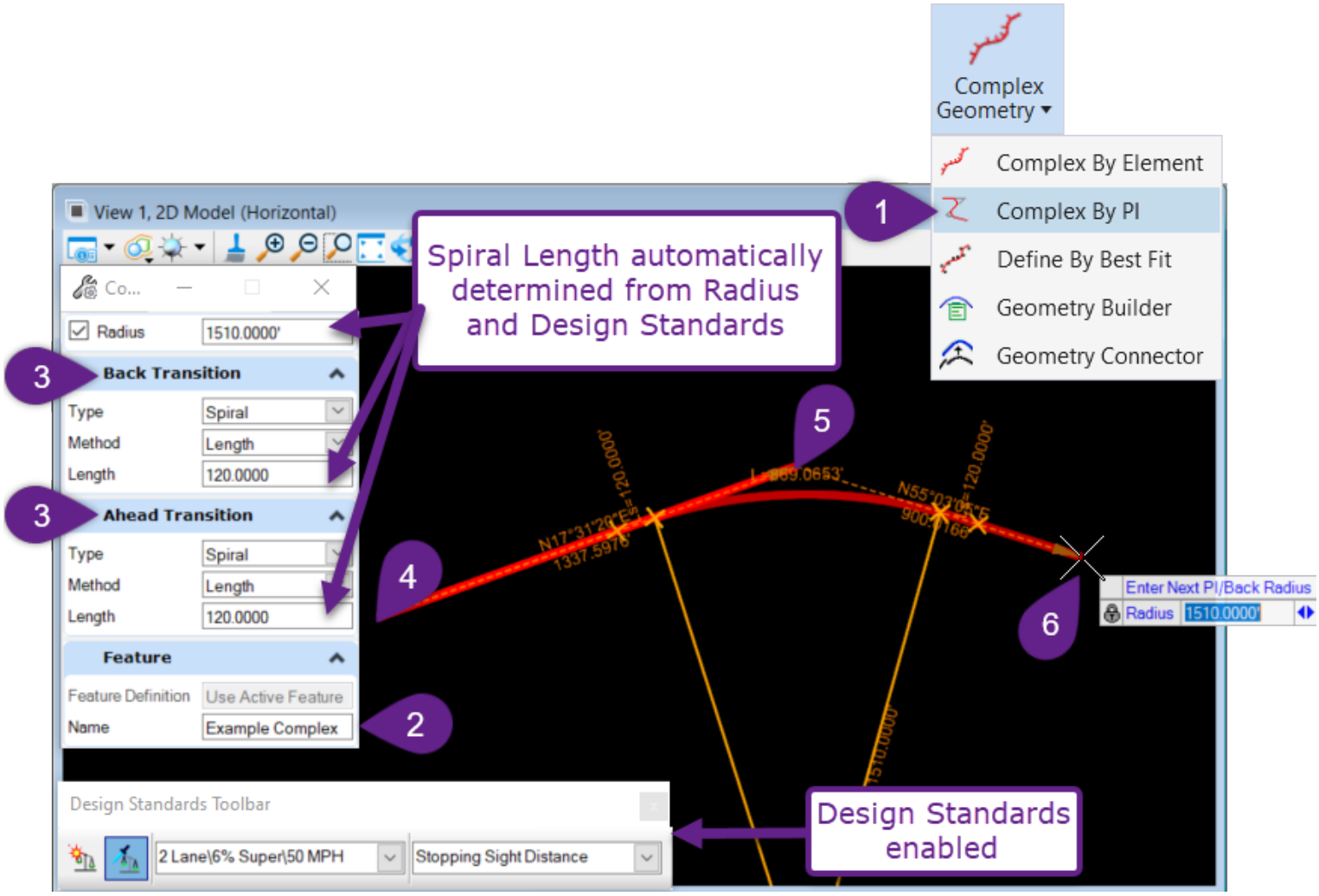
NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs."



1	Left-Click the *Complex By PI* tool from the *Complex Geometry* dropdown.
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name*.
3	*Prompt: Enter First PI* – In the *View,* Left-Click at the desired Starting Point location.
4	*Prompt: Enter Next PI/Back Radius* – Left-Click at the first PI location.
5	*Prompt: Enter Next PI/Back Radius* – Left-Click at the second PI location. ***NOTE:*** At this point in the tool workflow, the Radius of the FIRST arc can be locked with *Dialogue Options*. If the Radius is set to zero, two lines will be joined without an Arc.
6	*Prompt: Enter Next PI/Back Radius* – Left-Click at the End Point location. ***NOTE:*** At this point in the tool workflow, the Radius of the SECOND Arc can be locked with *Dialogue Options*.
7	*Prompt: Enter Next PI/Back Radius* – Right-Click in the *View* to complete the command.

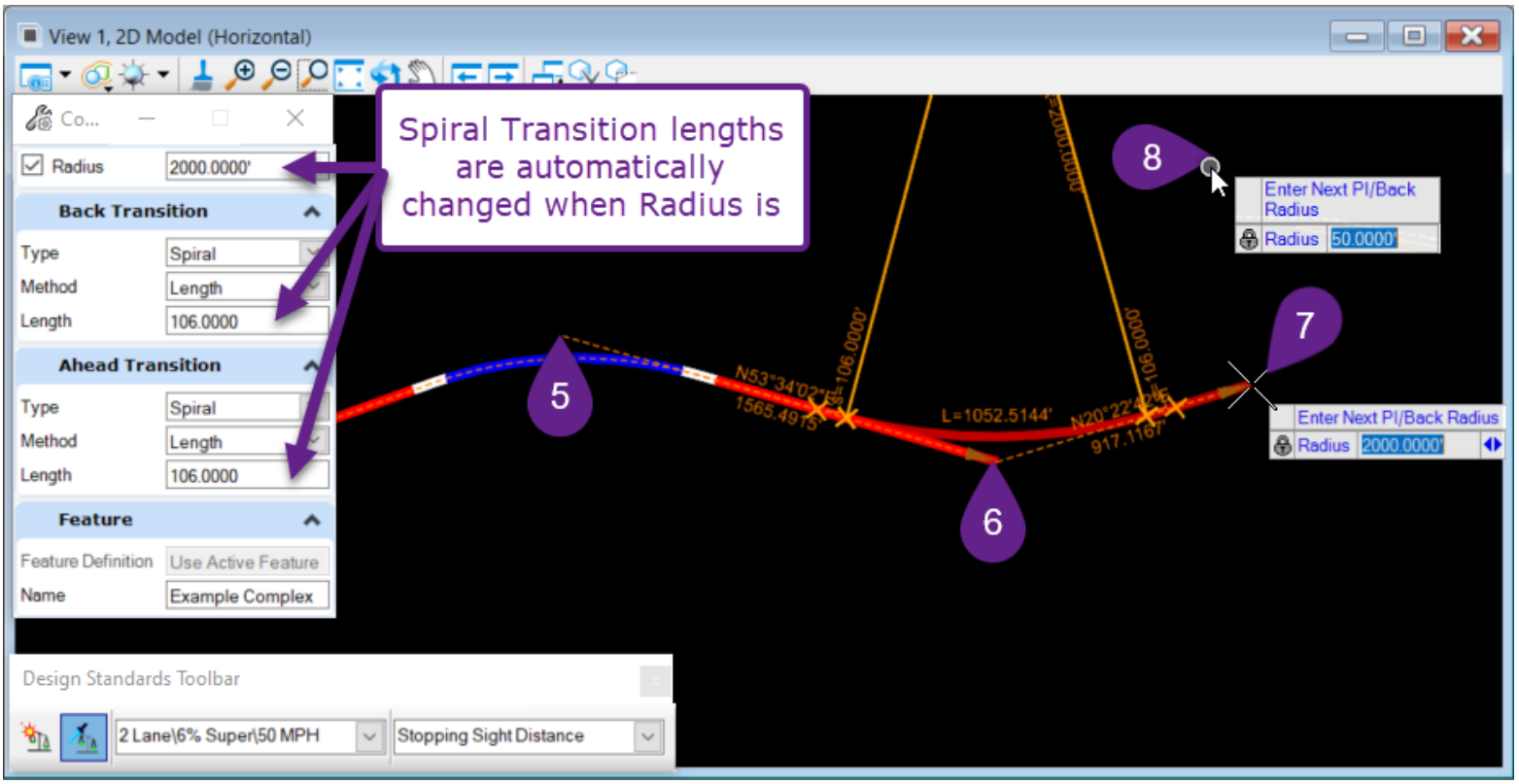
7D.2.b.ii Complex By PI – Spiral Transition Example

This tool can be used to create a *Complex Element* containing Spiral-Curve & Curve-Curve transition. In this demonstration, the *Complex Element* is created with *Design Standards* enabled – which automatically determine Spiral transition lengths depending on the User-inputted Radius, design- speed, and maximum super elevation. Spiral transition lengths are pulled from the AASHTO Greenbook.



1	Left-Click the *Complex By PI* tool from the *Complex Geometry* dropdown.
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	In the *Dialogue Box,* set *Back* and *Ahead Transition Type* to None and *Method* to Length.
4	*Prompt: Enter First PI* – In the *View,* Left-Click at the desired Starting Point location.
5	*Prompt: Enter Next PI/Back Radius* – Left-Click at the First PI location.
6	*Prompt: Enter Next PI/Back Radius* – Set the desired Radius value (1510') for the FIRST Arc. Notice how the *Length* for the *Back* and *Ahead Transition* is automatically set. Left-Click at Second PI location.

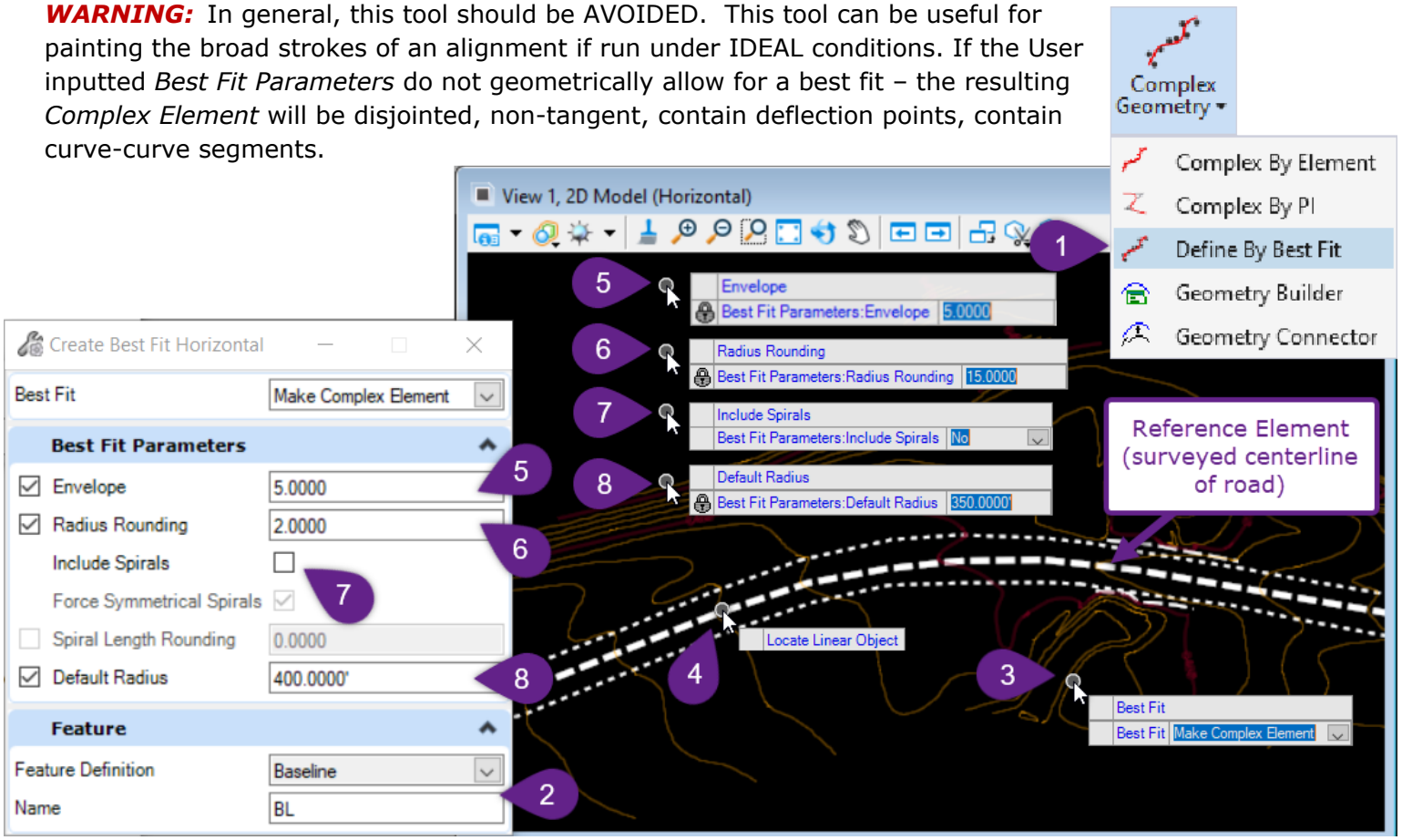
7	*Prompt: Enter Next PI/Back Radius* – Set the desired Radius value (2000') for the SECOND Arc. Notice how the *Transition Lengths* are again automatically changed. Left-Click at the End-Point location.
8	*Prompt: Enter Next PI/Back Radius* – Right-Click in the *View* to complete the command.



7D.2.c Define By Best Fit

This tool will automatically create a *Simple* or *Complex Alignment Element* based off a best fit from a Reference Element – such as a surveyed existing centerline of road.

WARNING: In general, this tool should be AVOIDED. This tool can be useful for painting the broad strokes of an alignment if run under IDEAL conditions. If the User inputted *Best Fit Parameters* do not geometrically allow for a best fit – the resulting *Complex Element* will be disjointed, non-tangent, contain deflection points, contain curve-curve segments.

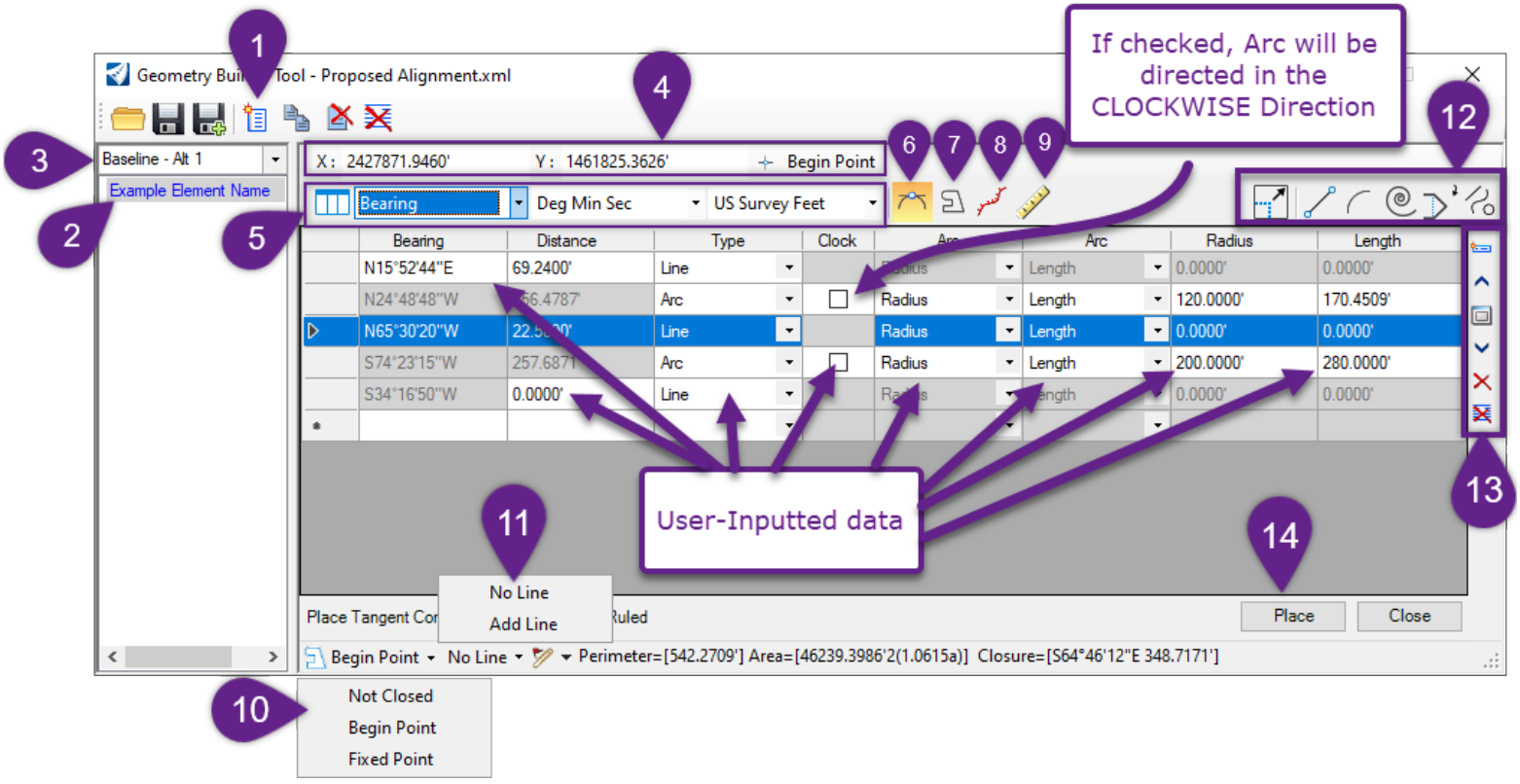


1	Left-Click the *Define By Best Fit* tool from the *Complex Geometry* dropdown.
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	*Prompt: Best Fit* – Specify the best fit method with *Dialogue Options*. Left-Click in the *View* to accept and advance to the next *Prompt*
4	*Prompt: Locate Linear Object* – Left-Click on the *Reference Element*
5	*Prompt: Envelope* – Key-in desired envelope value and Left-Click in the *View*
6	*Prompt: Radius Rounding* – Key-in desired radius rounding value and Left-Click in the *View*
7	*Prompt: Include Spirals* – Check the box in the Properties box or select with Cursor Dialogue to have spirals inserted into the Complex Element. Left-Click in the *View*
8	*Prompt: Default Radius* – Key-in the desired default radius. Left-Click in the *View.*

Dialogue Options	
Options:	**Description:**
Best Fit	Make Complex Element: The resulting alignment is a single Line.
	Make Single Element: The resulting alignment is Complex Element made of Lines and Curves.
Envelope	The outer allowable boundary for the automatically created Complex Element. The software will insert as many PPIs as necessary to create a best fit Complex Element within the Envelope.
Radius Rounding	Best fit Arc radii will be rounded to the nearest value.
Include Spirals	If checked, the Complex Element will include spiral transitions between Lines and Arcs.
Spiral Length Rounding	The Spiral Length will be rounded to the nearest value.
Default Radius	Preferred radius to be used when finding a best fit.

7D.2.d Geometry Builder

This tool creates has the capability of creating a MicroStation OR ORD Element by tabularly inputting data relating to line bearing direction/distance and arc lengths/radii.



Symbol		Description	
1	Add New Geometry	Creates a new Element. New Element will be shown at 2 ocation	
2	Element Name	Feature Name for the Element	
3	Feature Definition dropdown	Set the Feature Definition of the Element	
4	Begin Point input	Coordinate inputs for the Start Point of the Element	
5	Input Type option	Allows the user to input the Angular input type and units used to define the Element	
6	Force Tangent Restriction	If this is toggled, Lines and Arcs of the Element will be forced into tangency. The software will lock constrained input cells and automatic make adjustments and to ensure tangency between Lines and Arcs.	
7	Create Complex Element	If this is toggled, the tool will place a single Complex Element. If NOT toggled, will place Simple Elements for each line or arc in the table.	
8	Create Graphic Element	If this is toggled, the tool will place a MicroStation Element. If not toggled, will place an ORD Element.	
9	Create Ruled Civil Elements	If this is toggled, the ORD Element will have Civil Rules Manipulators and Grip-Edit Handles. If not toggled, the ORD Element will be static.	
10	Close Element Dropdown	Not Closed	The Element will not be automatically closed
		Begin Point	The Element will be closed. A Line is automatically drawn from the start point to the end point of the Element
		Fixed Point	If this is selected, the User can enter End Point Coordinates. A line is automatically drawn from the last element in the table end point to the User-inputted End Point Coordinates.
11	Closing Element Option	No Line	A line is drawn from the start point to the end point
		Add Line	No line is drawn.
12	Insert Element Graphically	When these buttons are pressed, the component type selected will be inserted into the element – at a position along the element dependent on the highlighted line in the table.	
13	Insert Element Tabularly	These tools are used to insert a blank line in to the table. The User can then input data for the component.	
14	Place Element	When satisfied with the element preview, press this to create the Element	

7D.2.e Geometry Connector

This tool is used to create complex spiral curve sets configurations - that are not easily solved by graphical layout. This tool is used by specifying the connecting line, arc, and spiral segments and control which segments are fixed and which can be adjusted to solve the layout.

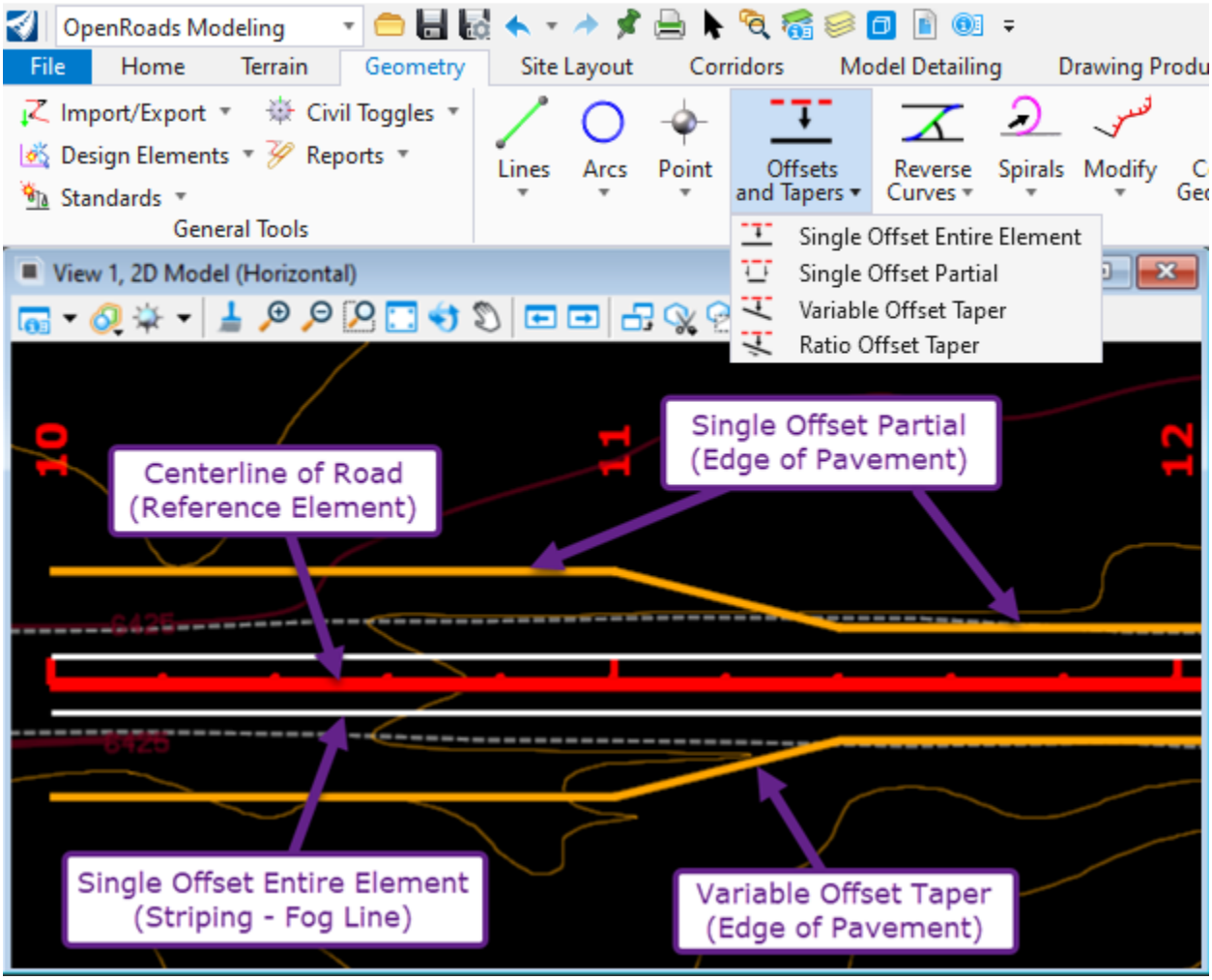
7D.3 Offsets and Tapers

Offset are used on a reference ORD Elements to create a parallel copy of the Reference Element. For ORD Elements, the Offset tools take the place of the Move Parallel tool – which is only compatible with MicroStation Elements.

Tapers are a form of the Offset tool but the resulting ORD Element is NOT parallel to the reference element. The Taper tool can quickly and precisely draw changes in the pavement width. Tapers are commonly used with Point Control to model changes in pavement width with a Corridor.

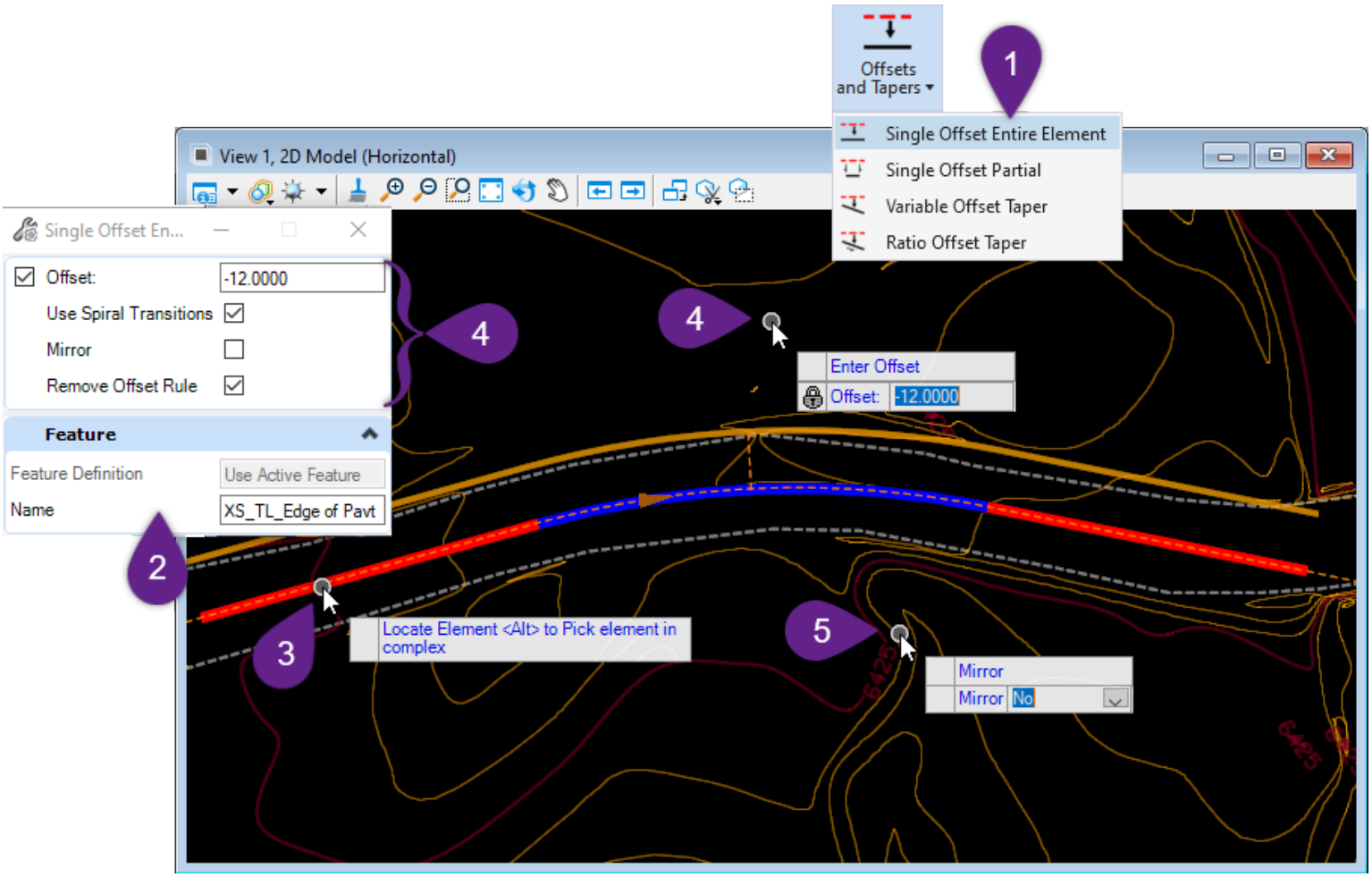
Offset and Tapers are usefully to draw features that are set relative to the centerline of road – such as edge of pavement, and striping elements.

TIP: The Reference Element can be offset with a value of 0 to essentially create a copy of the Reference Element. If the Reference Element is edited, the Offset ORD Element with a value of zero will automatically reposition with the Reference Element. This can be useful for creating ORD Elements to represent centerline pavement markings – such as a solid double yellow lines or dashed yellow lines.



7D.3.a Single Offset Entire Element

This tool will create an ORD Element that is parallel and offset from a reference element. The resulting ORD Element will be offset the ENTIRE length of the reference element.

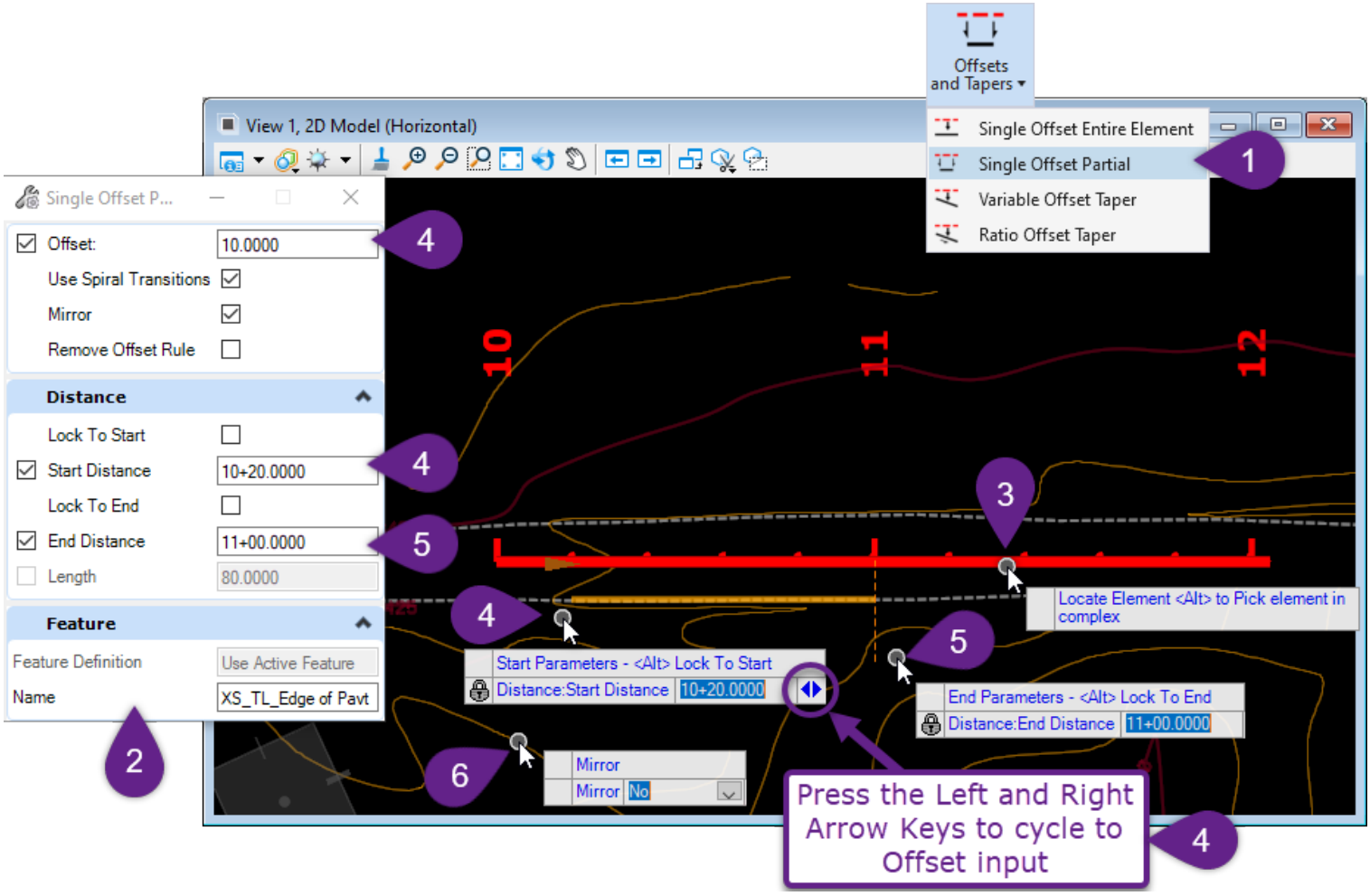


1	Left-Click the *Single Offset Entire Element* tool from the *Offset and Tapers* dropdown.
2	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
3	*Prompt: Locate Element <Alt> to Pick element in complex* – Left-Click on the Reference Element to be offset. Press the ALT key to only offset an individual segment within a Complex Element – such an arc or line.
4	*Prompt: Enter Offset* – Key-In the desired offset value in Dialogue Box OR in the Cursor Dialogue and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt. ***NOTE:*** At this point in the workflow, any parameters in the Dialogue Box can be manipulated.
5	*Prompt: Mirror* – Use the Up and Down arrow keys to cycle through the Mirror Options Yes – Offset ORD Elements will be created on BOTH sides of the Reference Element No – Offset ORD Elements will only be created on the side of the Reference Element that the cursor is placed. Left-Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Offset	If this box is checked, the ORD Element offset value will be locked with the value shown. If the box is unchecked, the offset will be unlocked – the final offset location depends on the mouse cursor location in the *View*.
Use Spiral Transitions	Spiral transitions and corresponding Civil Rules remain intact in offset ORD Element. If this box is unchecked, spiral transitions on Offset ORD Element will not be editable. ***BEST PRACTICE:*** Always keep this box checked.
Mirror	If this box is checked, offset ORD Elements are created on both sides of the Reference Element
Remove Offset Rule	If this box is checked, the offset ORD Element will NOT automatically reposition when the Reference Element is manipulated. If this box is unchecked, Civil Rules and Manipulators will be created between the Offset ORD Element and the Reference Element.

7D.3.b Single Offset Partial

This tool operates identically to Single Offset Entire Element, except only a portion of the reference element will be offset.

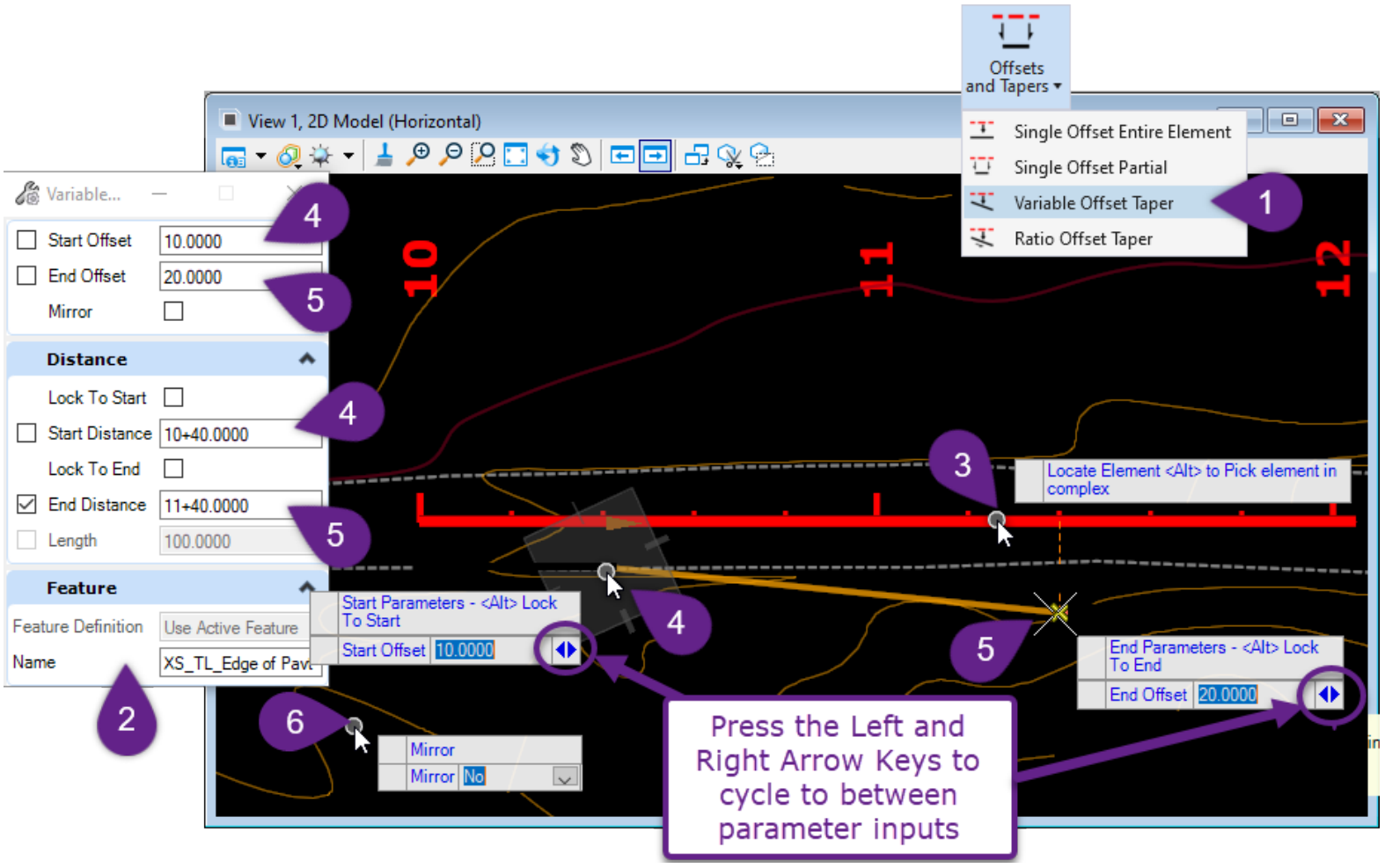


1	Left-Click the *Single Offset Entire Partial* tool from the *Offset and Tapers* dropdown.
2	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
3	*Prompt: Locate Element <Alt> to Pick element in complex* – Left-Click on the Reference Element to be offset.
4	***NOTE:*** At this step in the workflow, the User is prompted to enter the Offset value AND the Start Parameters. Use the Left and Right Arrow keys to cycle between the inputs. *Prompt: Enter Offset* - Key-In the desired offset value in Dialogue Box OR in the Cursor Dialogue and press the Enter key to lock. AND *Prompt: Start Parameters <Alt> Lock To Start* – Key-In the desired starting station (relative to the Reference Element) to begin the Offset ORD Element and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt. ***NOTE:*** At this point in the workflow, parameters in the Dialogue Box can be manipulated.
5	***NOTE:*** At this step in the workflow, the User is prompted to enter the End Station OR Length of the Offset ORD Element. Use the Left and Right Arrow keys to cycle between the inputs. *Prompt: End Parameters <Alt> Lock To End* – Key-In the desired ending station (relative to the Reference Element) to end the Offset ORD Element and press the Enter key to lock. OR *Prompt: Length* – Key in the desired length and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt. ***NOTE:*** At this point in the workflow, any parameter in the Dialogue Box can be manipulated.
6	*Prompt: Mirror* – Use the Up and Down arrow keys to cycle through the Mirror Options Yes – Offset ORD Elements will be created on BOTH sides of the Reference Element No – Offset ORD Elements will only be created on the side of the Reference Element that the cursor is placed. Left-Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Offset	If this box is checked, the ORD Element offset value will be locked with the value shown adjacently. If the box is unchecked, the offset will be unlocked – the final offset location depends on the mouse cursor location in the *View*.
Use Spiral Transitions	Spiral transitions and corresponding Civil Rules remain intact in offset ORD Element. IF this box is unchecked, spiral transitions will not be editable.
Mirror	If this box is checked, offset ORD Elements are created on both sides of the Reference Element
Remove Offset Rule	If this box is checked, the offset ORD Element will NOT automatically reposition when the Reference Element is manipulated. If this box is unchecked, Civil Rules and Manipulators will be created between the Offset ORD Element and the Reference Element.
Lock to Start	If this box is checked, the offset ORD Element will begin at the start point of the Reference Element
Start Distance	Allows the user to key-in the Reference Element start station for the offset ORD Element to begin. The Lock to Start box must be unchecked for this parameter to function.
Lock to End	If this box is checked, the offset ORD Element will end at the end point of the Reference Element
End Distance	Allows the user to key-in the Reference Element end station for the offset ORD Element to end. The Lock to End box must be unchecked for this parameter to function.
Length	Once the start point for the offset ORD Element is established, the desired length for the offset ORD Element can be keyed-in. The Lock to End and End Distance boxes must be unchecked for this parameter to function.

7D.3.c Variable Offset Taper

This tool will create a Taper between two points with different offset values and positions relative to a Reference Element.



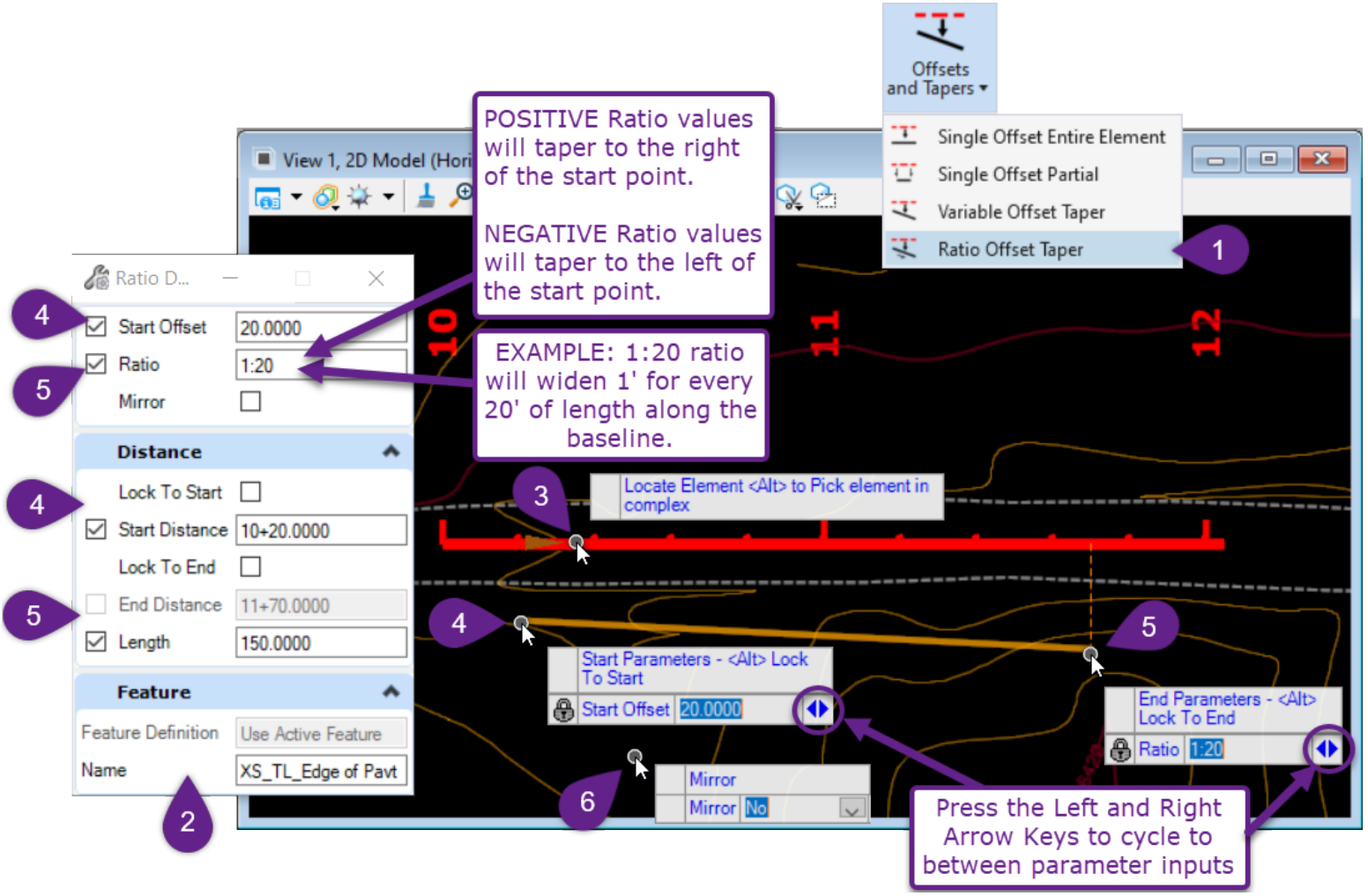
1	Left-Click the *Variable Offset Taper* tool from the *Offset and Tapers* dropdown.
2	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
3	*Prompt: Locate Element <Alt> to Pick element in complex* – Left-Click on the Reference Element to be offset and tapered.
4	***NOTE:*** At this step in the workflow, the User is prompted to enter the Start Offset value AND the Start Station. Use the Left and Right Arrow keys to cycle between the two inputs. *Prompt: Start Offset* - Key-In the desired offset value in Dialogue Box OR in the Cursor Dialogue and press the Enter key to lock. AND *Prompt: Start Parameters <Alt> Lock To Start* – Set the desired starting station (relative to the Reference Element) to begin the Offset ORD Element and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt.

5	***NOTE:*** At this step in the workflow, the User is prompted to enter the End Offset value AND End Station OR Length. Use the Left and Right Arrow keys to cycle between the three inputs. *Prompt: End Offset* - Key-In the desired offset value in Dialogue Box OR in the Cursor Dialogue and press the Enter key to lock. AND *Prompt: End Parameters <Alt> Lock To End* – Key-In the desired ending station (relative to the Reference Element) to end the Offset ORD Element and press the Enter key to lock. OR *Prompt: Length* – Key in the desired length and press the Enter key to lock. Left-Click in the *View* to advance to the next prompt.
6	*Prompt: Mirror* – Use the Up and Down arrow keys to cycle through the Mirror Options Yes – Offset ORD Elements will be created on BOTH sides of the Reference Element No – Offset ORD Elements will only be created on the side of the Reference Element that the cursor is placed. Left-Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Start Offset	If this box is checked, the start offset value will be locked with the value shown adjacently. If the box is unchecked, the offset will be unlocked and the start offset location will be placed at the location of the mouse cursor.
End Offset	If this box is checked, the end offset value will be locked with the value shown adjacently. If the box is unchecked, the offset will be unlocked and the end offset location will be placed at the location of the mouse cursor.
Mirror	If this box is checked, offset ORD Elements are created on both sides of the Reference Element
Lock to Start	If this box is checked, the offset ORD Element will begin at the start point of the Reference Element
Start Distance	Allows the user to key-in the Reference Element start station for the offset ORD Element to begin. The Lock to Start box must be unchecked for this parameter to function.
Lock to End	If this box is checked, the offset ORD Element will end at the end point of the Reference Element
End Distance	Allows the user to key-in the Reference Element end station for the offset ORD Element to end. The Lock to End box must be unchecked for this parameter to function.
Length	Once the start point for the offset ORD Element is established, the desired length for the offset ORD Element can be keyed-in. The Lock to End and End Distance boxes must be unchecked for this parameter to function.

7D.3.d Ratio Offset Taper

This tool creates a taper defined by a User-determined taper ratio. This tool is convenient because it is common for highway design standards to prescribe pavement shoulder width or striping transitions in a taper ratio form.



1	Left-Click the *Ratio Offset Taper* tool from the *Offset and Tapers* dropdown.
2	If a *Feature Definition* is not already Active, select an appropriate *Feature Definition* and give the Offset ORD Element a *Name*, in the Dialogue Box.
3	*Prompt: Locate Element <Alt> to Pick element in complex* – Left-Click on the Reference Element to be offset and tapered.
4	***NOTE:*** At this step in the workflow, the User is prompted to enter the Start Offset value AND the Start Station. Use the Left and Right Arrow keys to cycle between the two inputs. *Prompt: Start Offset* - Key-In the desired offset value in Dialogue Box OR in the Cursor Dialogue and press Enter to lock. AND *Prompt: Start Parameters <Alt> Lock To Start* – Set the desired starting station (relative to the Reference Element) to begin the Offset ORD Element and press Enter to lock. Left-Click in the *View* to advance to the next prompt.

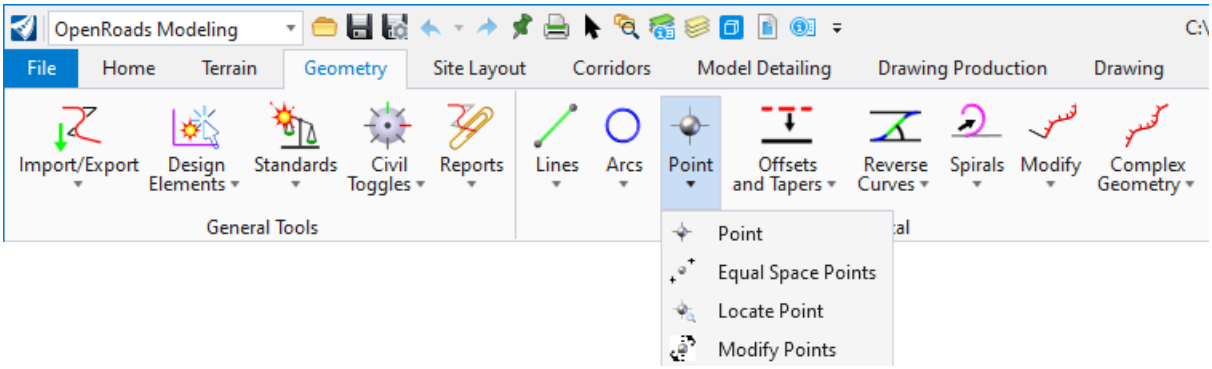
5	***NOTE:*** At this step in the workflow, the User is prompted to enter the Ratio, End Station, and Length. Use the Left and Right Arrow keys to cycle between the two inputs. *Prompt: End Offset* - Key-In the desired offset value in Dialogue Box OR in the Cursor Dialogue and press Enter to lock. AND *Prompt: End Parameters <Alt> Lock To End* – Key-In the desired ending station (relative to the Reference Element) to end the Offset ORD Element and press Enter to lock. Left-Click in the *View* to advance to the next prompt.
6	*Prompt: Mirror* – Use the Up and Down arrow keys to cycle through the Mirror Options Yes – Offset ORD Elements will be created on BOTH sides of the Reference Element No – Offset ORD Elements will only be created on the side of the Reference Element that the cursor is placed. Left-Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Start Offset	If this box is checked, the start offset value will be locked with the value shown adjacently. If the box is unchecked, the offset will be unlocked and the start offset location will be placed at the location of the mouse cursor.
Ratio	Allows the User to key-in the offset ORD Element taper ratio relative to the Reference Element.
Mirror	If this box is checked, offset ORD Elements are created on both sides of the Reference Element.
Lock to Start	If this box is checked, the offset ORD Element will begin at the start point of the Reference Element
Start Distance	Allows the User to key-in the Reference Element start station for the offset ORD Element to begin. The Lock to Start box must be unchecked for this parameter to function.
Lock to End	If this box is checked, the offset ORD Element will end at the end point of the Reference Element
End Distance	Allows the User to key-in the Reference Element end station for the offset ORD Element to end. The Lock to End box must be unchecked for this parameter to function.
Length	Once the start point for the offset ORD Element is established, the desired length for the offset ORD Element can be keyed-in. The Lock to End and End Distance boxes must be unchecked for this parameter to function.

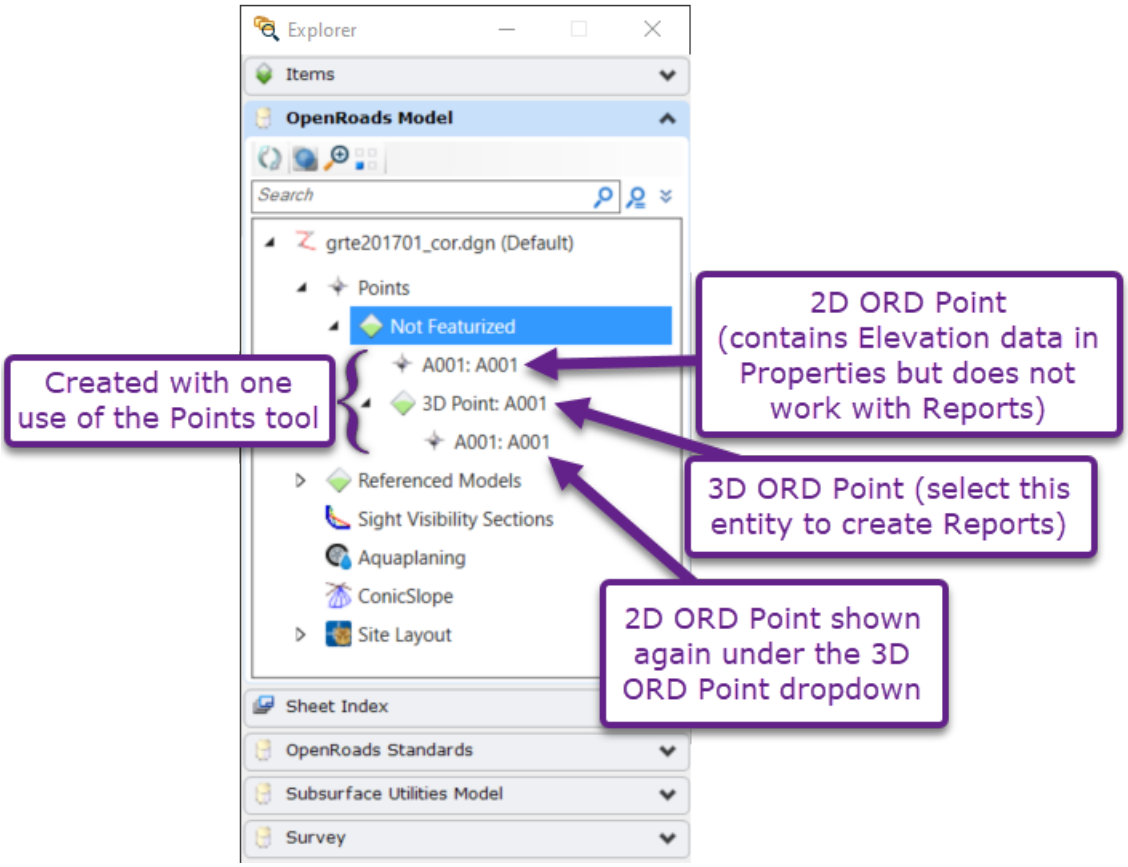
7D.4 Points

ORD Points are used to find and organize coordinate and elevation information for a point location in the *2D Design Model*. ORD Points can pull an elevation from a *Terrain Models* (such as existing or proposed design surfaces), corridor/linear template, or a Horizontal Line with an Active Profile. Generally, ORD Points are used to create design Layout Point Tables. ***BEST PRACTICE*:** Use the *Analyze Point* and *Analyze Between Points* tools to quickly determine elevation and slope information that is NOT needed for Layout Point Tables or for future reference.

TIP: When using ORD Points with Corridor and Linear templates, the elevation information is pulled by selecting the *Top Mesh*.



NOTE: The creation of a single ORD Point with an elevation component results in the creation of two entities in the *Project Explorer*. The 3D Point: entity needs to be selected when creating Layout Point Report Tables that have an elevation component.



7D.4.a Create Layout Tables with ORD Points

ORD Points are generally used to create design Layout Points. After creating all Layout Points, the *Point Feature Offset Elevation Report* is used to gather point data. Point data is exported and manipulated in Microsoft Excel to show be shown in Plan Sheets.

Station Offset Northing Easting Elevation Feature Report

Report Created: Monday, July 20, 2020
Time: 9:53:07 PM

ORD Points Report created from the ORD Software

Project: Default
Description:
Baseline (Active) Alignment: MAINLINE — Reference Alignment
File Name: C:\Users\survey.DJANDA\OneDrive - DJ&A, PC\wy-grte201701_Granite\grte201701_layouts.dgn
Last Revised: 7/20/2020 21:51:41
Input Grid Factor:

Note: All units in this report are in feet unless specified otherwise.

ORD Point Feature Name

Point	Station	Offset	Northing	Easting	Elevation	Feature
I001	1718.238	60.380	1457433.111	2433928.032	6347.583	
I003	1718.238	64.380	1457429.711	2433930.139	6347.555	
I002	1734.435	90.574	1457415.974	2433957.702	6347.354	
I005	1743.468	89.828	1457421.365	2433964.989	6347.350	
I004	1743.470	80.599	1457429.211	2433960.130	6347.389	

Point numbers may not be in chronological order. Use Microsoft Excel 'Sort' function to rearrange.

Station value is displayed in raw format (no + sign)

Offset value will be NEGATIVE if the point is located to the right of the reference alignment (RT). POSITIVE Offset value if the point is located to the Left of the reference alignment (LT).

Use Microsoft Excel to manipulate raw Station, Offset, and LT/RT values to be shown in plan-sheet Layout Tables

Reference Alignment and Notes to be filled in manually

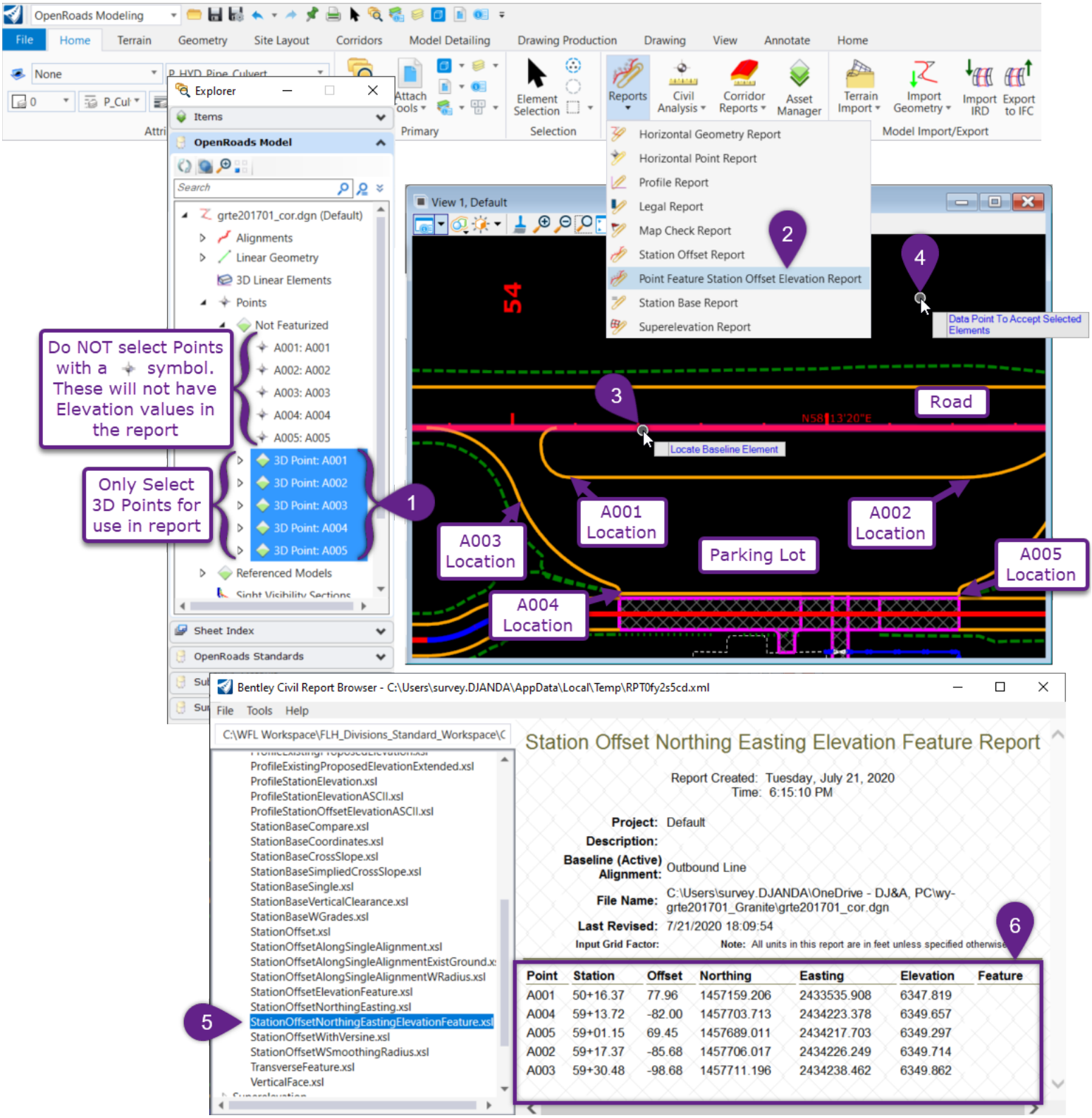
EXAMPLE LAYOUT INFORMATION

POINT	*NORTHING*	*EASTING*	*STATION*	*OFFSET*	*LT/RT*	*ELEVATION*	*ALIGNMENT*	*NOTES*
I001	*1457433.11*	*2433928.03*	*17+18.24*	*60.38*	*LT*	*6347.58*	*MAINLINE*	*Edge of Pavement*
I002	*1457415.97*	*2433957.70*	*17+34.44*	*90.57*	*RT*	*6347.35*	*MAINLINE*	*Top Back of Curb*
I003			*8.24*	*64.38*	*LT*	*6347.56*	*MAINLINE*	*Radius Point*
I004			*3.47*	*80.60*	*RT*	*6347.39*	*MAINLINE*	*Back of Sidewalk*
I005			*3.47*	*89.83*	*LT*	*6347.35*	*MAINLINE*	*Edge of Pavement*

Plan Sheet Layout Table - created by the User in Microsoft Excel

7D.4.a.i Layout Point Table Workflow

This workflow demonstrates how to create a Layout Point Table to be used in a plan sheet using the *Point Feature Station Offset Elevation Report* tool. **This workflow assumes all ORD Points have already been created.**



1	In the *Project Explorer*, select the ORD Points to be included in the Layout Table. Multiple Points can be selected in the *Project Explorer*, by holding down Ctrl key when left-clicking on the ORD Points
2	Left-Click on the *Point Feature Station Offset Elevation Report* tool.
3	*Prompt: Locate Baseline Element* – Left-Click on the desired Alignment. The report will display Station and Offset values relatives to the selected alignment.
4	*Prompt: Data Point to Accept Selected Elements* – Left-Click in the *View* to create the report.
5	In the table options on the right side of the report, Left-Click on the *StationOffsetNorthingEastingElevationFeature* report style.
6	The data displayed in this report can be highlight with the mouse cursor and then copy and pasted into Microsoft Excel for manipulation.

7D.4.b Point tool

This tool creates an ORD Point at a User-defined location in the *2D Design Model*. The elevation value for the ORD Point can be inputted manually – OR - automatically pulled from a terrain model, corridor mesh, or horizontal alignment with an active profile.

Listed below are the different elevation and rotation options for creating an ORD Point using the *Point* tool:

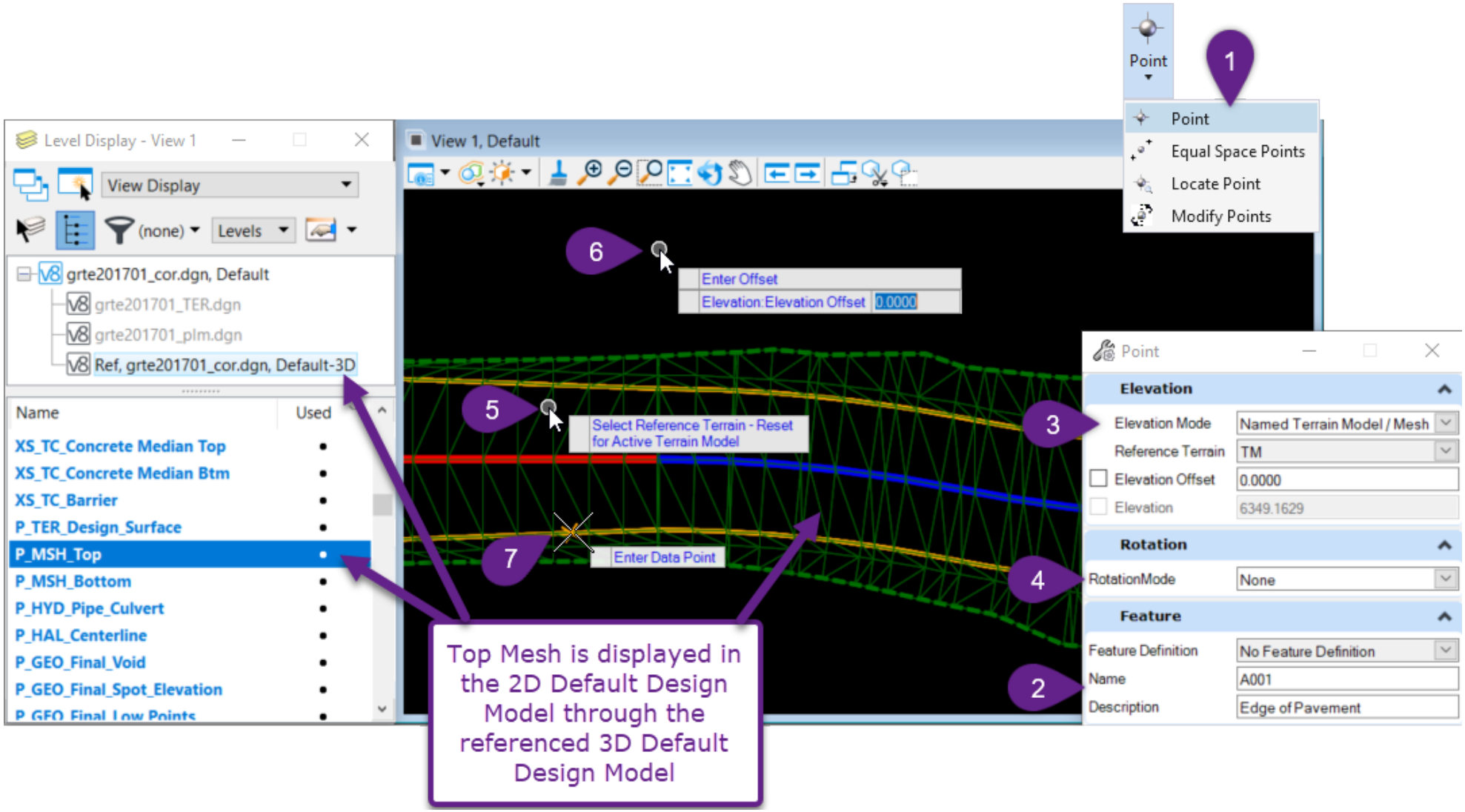
Elevation Mode – Dialogue Option		
Input	**Description:**	
None	No elevation value is assigned to the ORD Point.	
Value	Elevation value is inputted manually by the User.	
Named Terrain Model / Mesh	Elevation value is automatically assigned from a terrain model or mesh (usually existing ground, a design surface, or a corridor/linear template mesh)	**Elevation Offset** An ORD Point cab be vertically offset from the actual elevation of the reference terrain model, mesh, or alignment. For example, an ORD Point with an Elevation Offset Value is set to -0.5’ will have an elevation of 0.5’ below grade.
From Alignment	This option is used to create an ORD Point that’s placed along (snapped) a horizontal alignment. The Active Profile elevation at the horizontal point location is automatically assigned to the ORD Point. ***WARNING:*** this mode is NOT compatible with MicroStation Elements – such as SmartLines.	

Rotation Mode – Dialogue Option	
Input	**Description:**
None	The User is not prompted with a point rotation option. Points will be automatically oriented in the true north direction (N00°00'00"E)
Absolute Value	ORD Points are orientated in the inputted bearing direction.
Relative to Alignment	The point is orientated relative to a reference alignment. If the *Rotation* box is NOT checked, the point will be oriented in the direction of the alignment. If the *Rotation* box is checked, the user can input the point orientation relative to the alignment. I.E. if the Rotation is set to N90°00’00”E, the point will be oriented perpendicular to the alignment, facing the right side.

7D.4.b.i Point tool workflow with using Corridor finished grade (Top Mesh)

This workflow demonstrates how to create a point containing the finished grade elevation of a *Corridor* or *Linear Template*.

WARNING: The *Top Mesh* must be displayed to pull the finished grade elevation from a *Corridor* or *Linear Template.*



1	Left-Click the *Point* tool from the *Point* dropdown
2	In the *Dialogue Box,* give the point a *Name* and a *Description* if desired. ***NOTE:*** In a typical Plan Sheet Layout Table, the *Name* serves as the unique Point Number for a Layout Point. The *Description* can be used for the Note column of a Layout Table – such as Top Back of Curb. ***TIP:*** When using this tool in succession – for example, to create a Layout Point Table – the *Name* will be automatically numerically incremented. The first *Name* is entered by the User manually – for example, "A001". After the first ORD Point is placed, the *Feature Name* will automatically increment to "A002". The User should take care to place ORD Points in a logical and intended sequence to reduce the risk of manually renumbering ORD Point *Names*.
3	In the *Dialogue Box and Elevation Mode* dropdown, select the *Named Terrain Model / Mesh* option. ***NOTE:*** Only Terrain Models will be displayed in the *Reference Terrain* dropdown. Corridor and Linear Template Meshes must be selected graphically.
4	In the *Dialogue Box and Rotation Mode* dropdown, select the *None* option.
5	*Prompt: Select Reference Terrain – Reset for Active Terrain Model*. Left-Click on the *Top Mesh* – which is referenced into *2D Default Design View* ***OR*** Left-Click on the *Top Mesh* in a separate *View* showing the *3D Default Design*
6	*Prompt: Enter Offset* – Key-in a value of 0 and press Enter to lock. Left-Click in the *View* to advance to the next prompt.
7	*Prompt: Enter Data Point* – In the *2D Default Design View* Left-Click at the desired location for the ORD Point to complete the command.

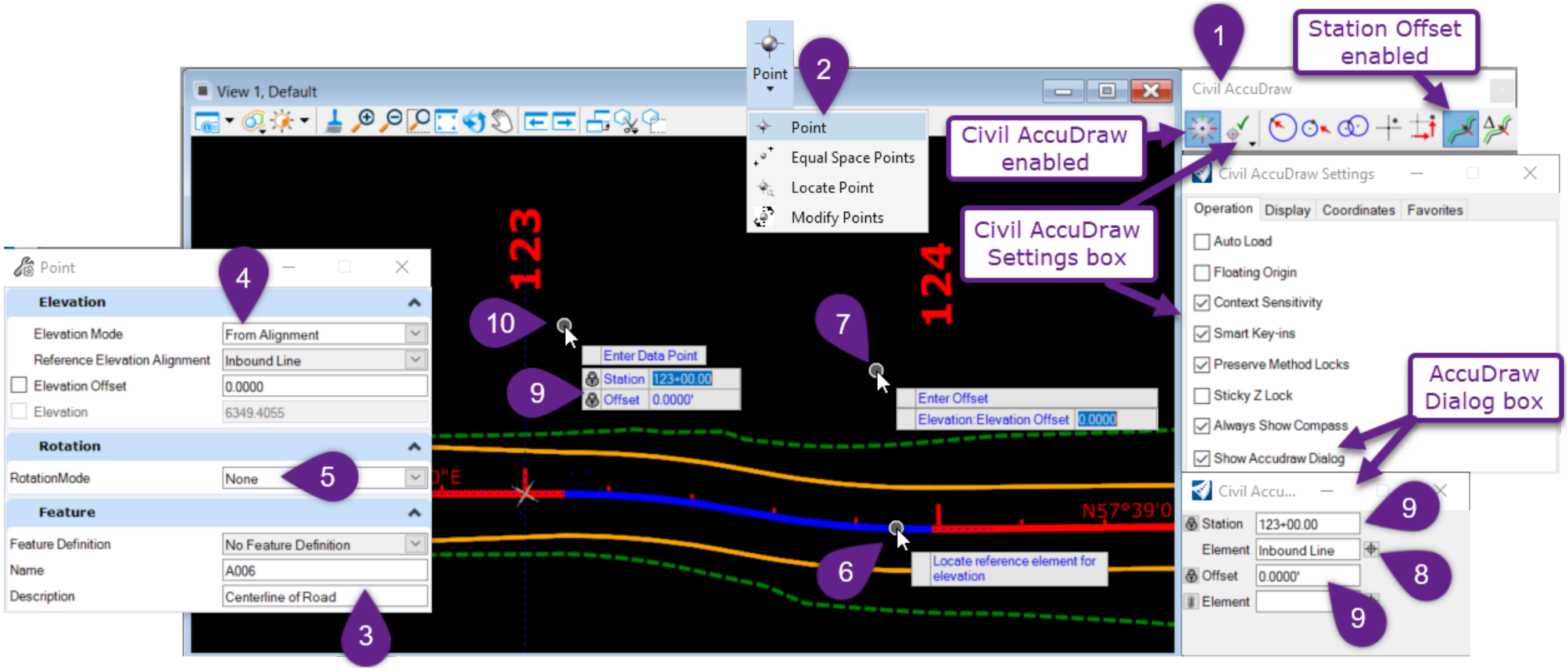
2 **EXAMPLE LAYOUT INFORMATION** 2

POINT	NORTHING	EASTING	STATION	OFFSET	LT/RT	ELEVATION	ALIGNMENT	NOTES
I001	1457433.11	2433928.03	17+18.24	60.38	LT	6347.58	MAINLINE	Edge of Pavement
I002	1457415.97	2433957.70	17+34.44	90.57	RT	6347.35	MAINLINE	Top Back of Curb
I003	1457429.71	2433930.14	17+18.24	64.38	LT	6347.56	MAINLINE	Radius Point
I004	1457429.21	2433960.13	17+43.47	80.60	RT	6347.39	MAINLINE	Back of Sidewalk
I005	1457421.37	2433964.99	17+43.47	89.83	LT	6347.35	MAINLINE	Edge of Pavement

7D.4.b.ii Point tool workflow with an Alignment

This workflow demonstrates how to create a point containing the *Active Profile* elevation of an alignment. *Civil AccuDraw Inputs* are used to place the point at an even station (123+00.00).

WARNING: Before this workflow is performed, enable Civil AccuDraw and the Station-Offset mode.



1	Enable Civil Accudraw and the Station-Offset mode.
2	Left-Click the *Point* tool from the *Point* dropdown
3	In the *Dialogue Box,* give the point a *Name* and a *Description* if desired.
4	In the *Dialogue Box and Elevation Mode* dropdown, select the *From Alignment* option.
5	In the *Dialogue Box and Rotation Mode* dropdown, select the *None* option.
6	*Prompt: Locate reference element for elevation* – Left-Click on the d
7	*Prompt: Enter Offset* – Key-in a value of 0 and press Enter to lock. Left-Click in the *View* to advance to the next prompt.
8	Press the 'O' Key*** and Left-Click on the alignment to set the reference element for Civil AccuDraw operations. OR Set the Civil AccuDraw Reference Element in the AccuDraw Dialog box. Press the  button and Left-Click on the alignment. The Feature Name of the alignment will be displayed (*Inbound Line)* when the reference element is set. ***The default ORD Software *Keyboard Shortcuts* has the 'O' key set up for the *Civil AccuDraw Set Origin* tool.
9	In the AccuDraw Dialog box or in the Civil AccuDraw Cursor Dialog – enter the station and horizontal offset parameter values to place the ORD Point at. Press the Enter key after each input to lock the parameter value.
10	*Prompt: Enter data point* – Left-Click in the *View* to complete the command.

7D.4.c Equal Space Point tool

This tool places multiple ORD Points at evenly-spaced Intervals. The ORD Points can be placed along a reference element or between two User-defined point locations. ***WARNING:*** This tool can NOT pull ORD Point elevation data from a terrain model, mesh, or active profile. This tool only allows the User to set a constant elevation value for all ORD Points. ***TIP:*** After ORD Points are created with this method, the elevations can be changed to match a terrain model, mesh, or active profile with the *Modify Point*.

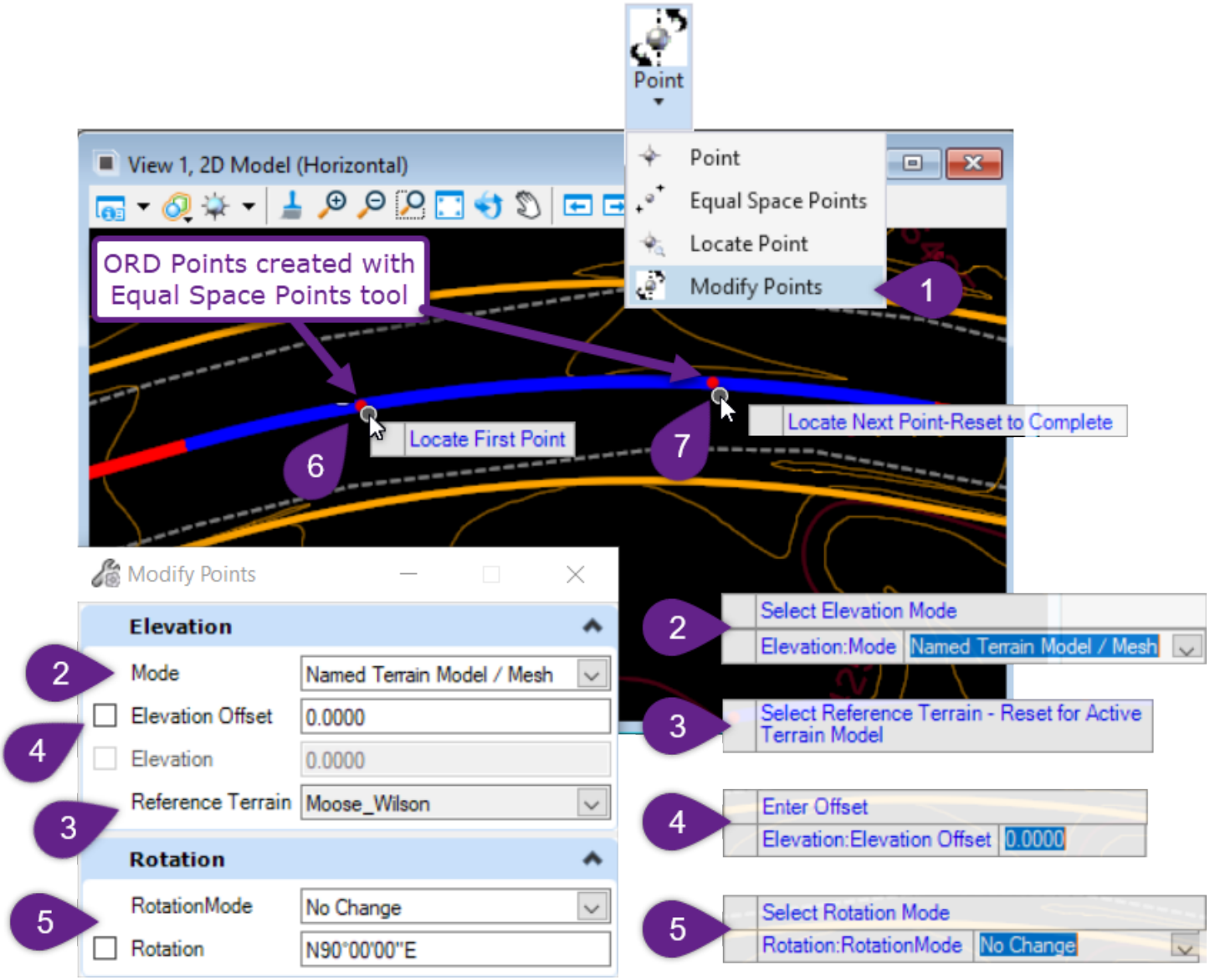
Dialogue Box Options		
Paramater:	**Description:**	
Want 3d Point	If this box is checked, the Elevation value directly below is applied to all ORD Points	
Placement Method	**Between Points**	ORD Points are placed between two User-defined point locations.
	Along Element	ORD Points are placed along or offset from a Reference Element. The Reference element can be a Simple or Complex Element.
Spacing	**Number of Points**	Places ORD Points at an equidistance interval distance along the reference element or between points.
	Interval	Places ORD Points at a specified Interval distance along the reference element. The first point is placed at the start point of the reference element.
	Even	Places ORD Points at a specified Interval distance along the reference element AND at even stations along the reference element (i.e. 10+00, 11+00)
	Max Interval	The user is prompted to input a maximum allowable interval distance between points. The software will automatically calculate a slightly smaller interval distance to place evenly spaced ORD Points placed along the reference element.
Offset	If this box is checked, the ORD Points are horizontally offset from the *Reference Element*. A negative offset value will place points to the left of the alignment.	
End Points	If this box is checked, an ORD Point will ALWAYS be placed at the end point of the Reference Element – even when inputted interval distance doesn't mathematically call for point placement at the end of the reference element. In this case, the interval distance between the end point ORD Point and subsequent ORD Point will be different than interval distance between all other ORD Points created with this tool.	
By Segment	When using this tool on a Complex Element. The spacing input parameters are applied to each individual segment of the complex element. For example, with the complex element shown above - if this box is checked, and the *Number of Points* values is set for 5. A total of 15 ORD Points will be created (5 on each segment). If this box is unchecked, a total of 5 ORD Points will be created, evenly spaced along the entire complex element.	
Rotation	ORD Points are orientated in the inputted bearing direction.	

7D.4.d Locate Point tool

Dialogue Options		
Input	**Description:**	
Method	Angle Resection	In the *View,* the User Left-Clicks at three locations. The User is then prompted to enter the angle between location 1 and 2 (**Angle 1**) and the angle between location 2 and 3 (**Angle 2**). An ORD Point is placed at the center of the angles and locations.
	Points of Intersection	In the *View,* the User Left-Clicks at three locations to define two tangents. The first location represents the start point of the tangent 1, the second location represents the end point of tangent 1 and the start point of tangent 2 (the point of intersection), the third location represents the end point of tangent 2. The User is then prompted to input a **Radius** value to place a fillet (arc) the two tangents. ORD Points are placed at the PC,PT, and center (origin) of the arc.
	Points on Curve	In the *View,* the User Left-Clicks at three locations to define an arc. An ORD Point is placed at the center (origin) of the arc.

7D.4.e Modify Point tool

This tool changes the elevation (referenced source or value) and rotation of a previously-created ORD Point. In the workflow shown below, the previously-created ORD Points were created with the Equal Space Points tool and contain the same constant elevation value. The workflow demonstrates how to change the elevation to pull from the existing ground Terrain Model.



1	Left-Click the *Modify Point* tool from the *Point* dropdown.
2	*Prompt: Select Elevation Mode* – Select the *Named Terrain Model / Mesh* mode in the *Dialogue Box* or *Cursor Dialogue*. Left-Click in the *View* to advance to the next prompt. See Elevation Model Dialogue options for explanation of all Elevation Modes.
3	*Prompt: Select Reference Terrain – Reset for Active Terrain Model* – Left-Click on the existing ground Terrain Model OR Right-Click if the desired Terrain Model is *Active*.
4	*Prompt: Enter Offset* – Key-In a value of 0 and Left-Click in the *View* to advance to the next prompt.
5	*Prompt: Select Rotation Mode* – In the *Dialogue Box* or *Cursor Dialogue*, select No Change. Left-Click in the *View* to advance to the next prompt.
6	*Prompt: Locate First Point* – Left-Click on the first ORD Point.
7	*Prompt: Locate Next Point-Reset to Complete* – Left-Click on the second ORD Point or Right-Click in the *View* to complete.

7E – EDITS TO HORIZONTAL GEOMETRY

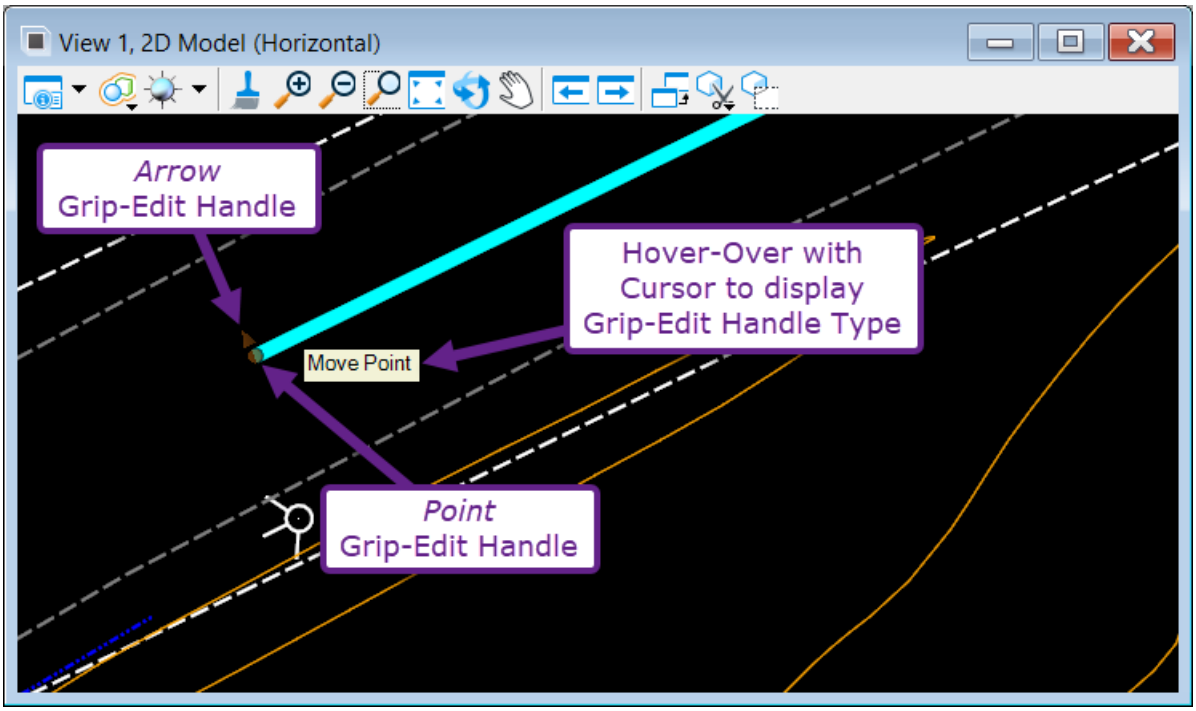
Edits to *Horizontal ORD Elements* are accomplished with three distinct workflows:

WARNING: Edits made to *Horizontal ORD Elements* can affect position of *Vertical ORD Elements*. ***BEST PRACTICE:*** Check the *Profile Model* after edits are made to a *Horizontal ORD Element.*

Horizontal ORD Element Editing Workflow			
Workflow:	**Description:**	**Advantages:**	**Limitations:**
Grip-Edits, Civil Rules Manipulators,* and *Properties Box Edits	Performed by graphically selecting a Horizontal ORD Element. Accomplished with *Grip-Edits*, or changing geometry parameter values displayed in *Civil Rules Manipulators* or *Properties Box*	Graphically find a "Best Fit" for an alignment with grip-edits.	Edits can result in unfeasible geometry without warning from the software. Edits that conflict with underlying *Base ORD Elements, Civil Rules,* and original *Design Intent* can result in unpredictable behavior. Edits can result in loss of tangency between alignment components.
***Table Editor* tool**	Allows ORD Elements to be edited tabularly. Parameters that can be edited tabularly are: - Back/ Ahead Tangent Length - Back/Ahead Bearing Direction - Back/Ahead Spiral Length - Northing/Easting Coordinates - Arc Radius - Arc Length	Most stable form of editing – edits that would result in unfeasible geometry will be displayed in red and can be recognized before edits are applied. **Best method to Insert and Delete a PI/Arc.** Very easy to insert, delete, and edit *Spiral* transitions. **After *Table Edits* are applied, *Complex Elements* will be *Simplified***	It is difficult to find a "Best Fit' for an alignment with coordinates and bearing directions alone. After *Table Edits* are applied, the *Complex Element* will be *Simplified*. After *Table Edits* are applied, lines that are not joined by an arc will be automatically deleted. *Table Edits* can only be performed on *Complex Elements*. This tool will not work on *Simple Elements.*
***Horizontal Modify* tools**	All tools found in *Modify* dropdown in the *Horizontal* panel Types of edits include: -Start Station value edits -Station Equation creation/edits -Reversing alignment direction -Copying *ORD Elements* -Extending *Complex Elements* -Inserting curve edits	These tools are generally unique in functionality and perform edits that can NOT be achieved through alternative means.	***BEST PRACTICE:*** Insert arcs/PIs with the *Table Editor* tool – opposed to the *Insert Fillet* tool found in the *Modify* dropdown.

7E.1 Grip-Edits

Grip-Edits are performed by selecting *Grip-Edit Handles* and dragging geometry points around in the *View*. There are two types of *Grip-Edit Handles* that can appear when a *Horizontal ORD Element* is selected:

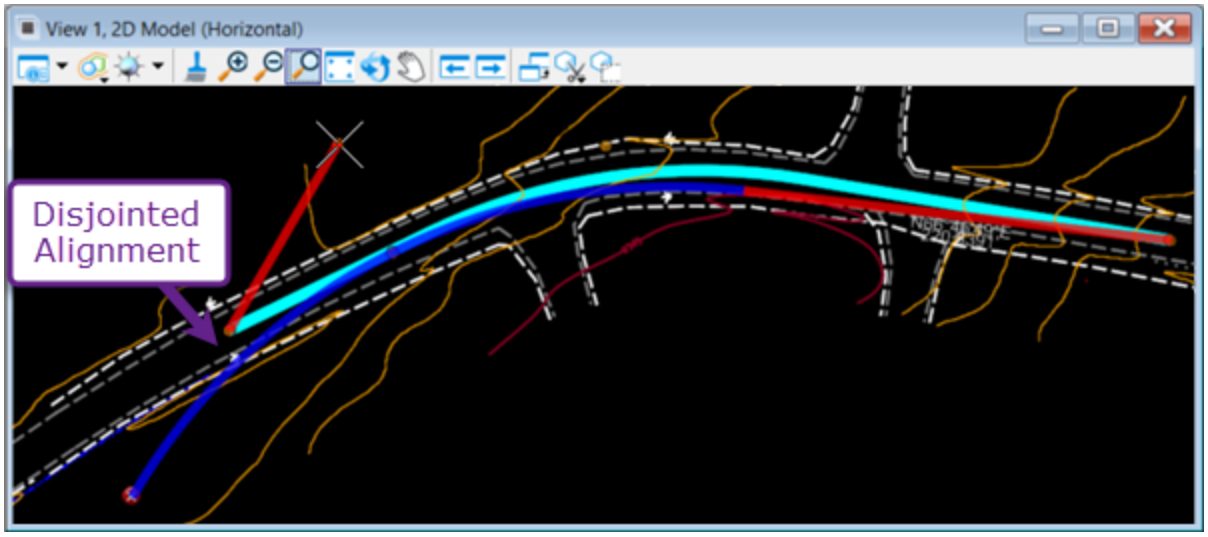


Point Handles can be moved and placed at any location in the *View*. *Point Handles* are generally found on the start and end points of lines and PI locations and radius of arcs. *Point Handles* will always be found at User-defined geometry points during *ORD Element* creation.

For example, an arc created with the *Arc Between Points* tool using the *Start/through/End-Point* method - will contain *Point Handles* at the Start, End, and arbitrary Through-Point.

Arrow Handles are moved on a fixed linear path. *Arrow Handles* are generally used to trim/extend lines and arcs, move lines parallel, and rotate lines.

Base ORD Element Grip-Edit Handles are a "hidden" set of *Grip-Edit Handles* - revealed by *Selecting* a *Base ORD Element*. These *Grip-Edit Handles* can be used to trim/extend the beginning and end tangent of a *Complex Element* and to slide a PI point along a tangent.

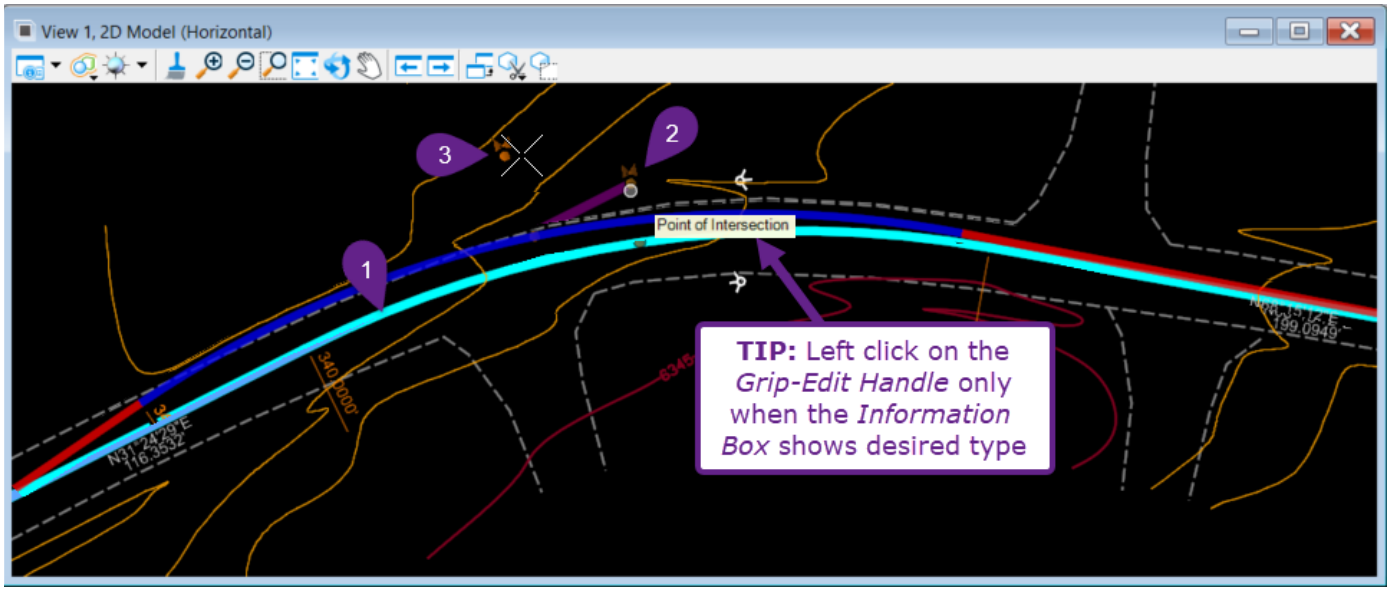


WARNING: Grip-Edits can result in a disjointed alignment if a *Grip-Edit Handle Point or Arrow* conflicts with geometry parameter values (such as radius) or *Civil Rules* of adjacent Elements.

7E.1.a Grip-Edits – PI Move Example

It is common in civil road alignment edits to move a PI location. This can be accomplished by moving the PI to a new arbitrary location OR by sliding the PI along the back or ahead tangent.

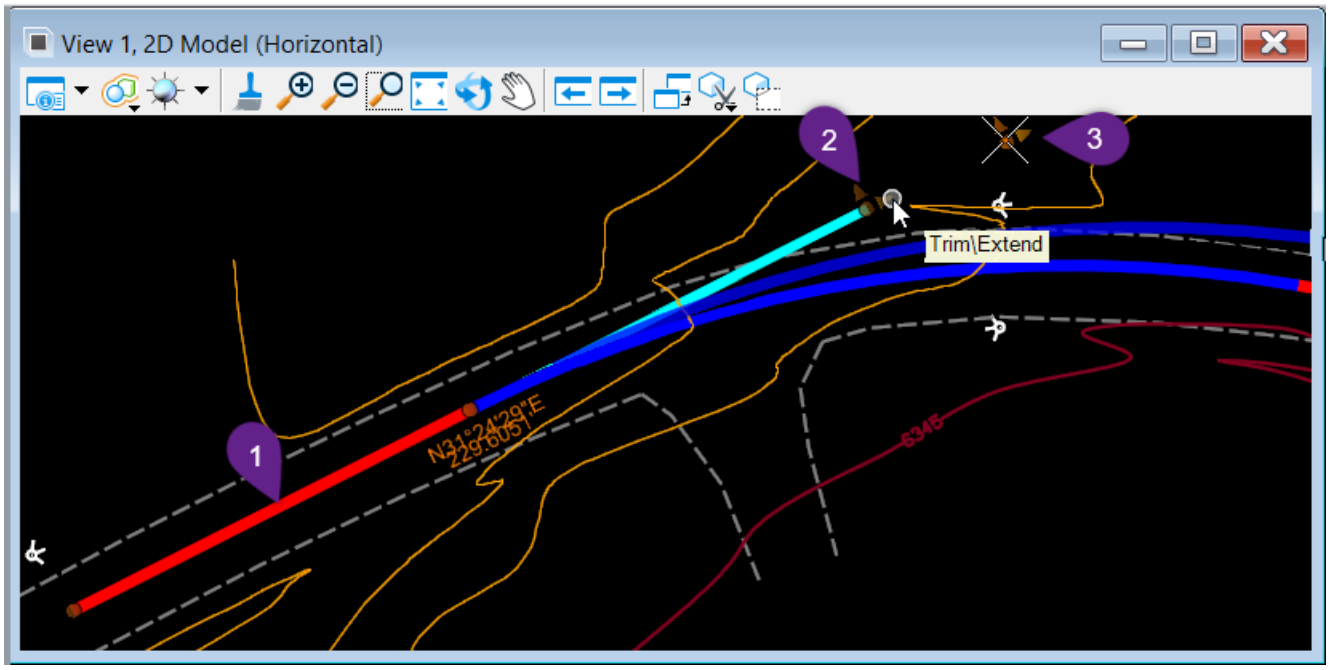
7E.1.a.i Move PI to a new arbitrary location



1	*Select* the *Complex Element*.
2	Left-Click on the *Point of Intersection Point Handle.*
3	Move the *Point Handle* to the desired location. Left-Click to accept new location and complete the command.

7E.1.a.ii Move PI along tangent using *Arrow Handles*

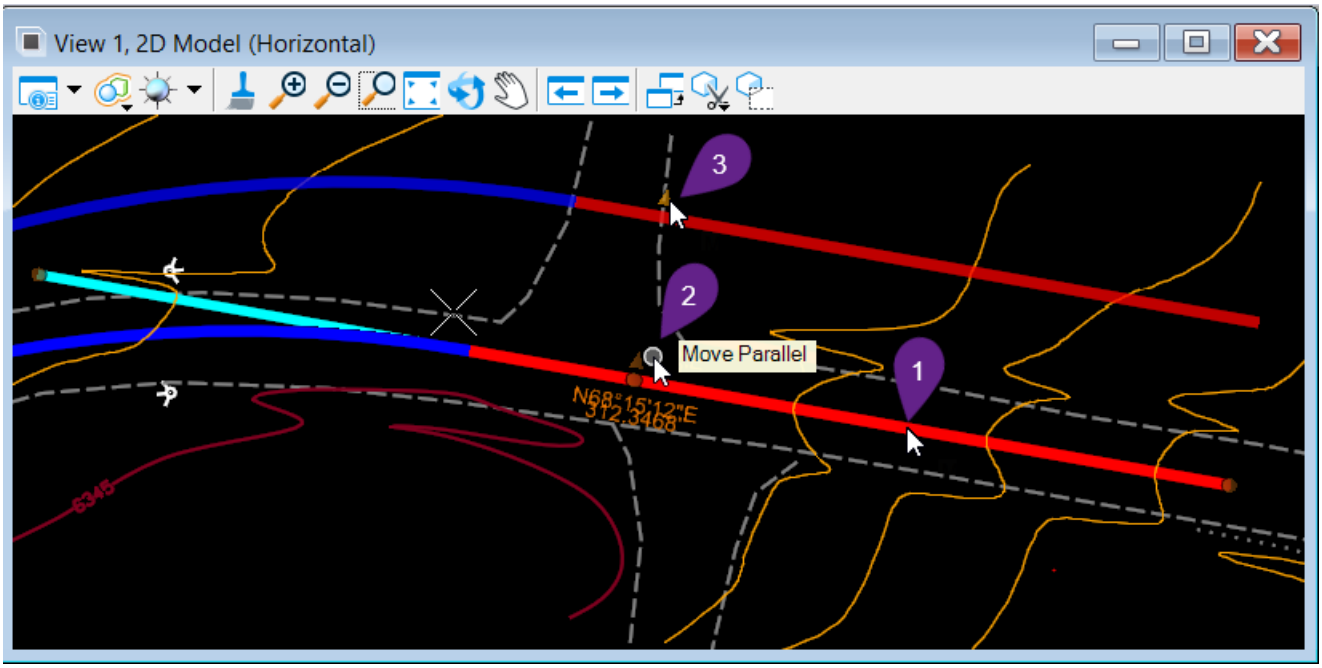
To move a PI along a tangent – the *Base ORD Line Element* has to be *Selected* to reveal the *Trim/Extend Arrow Handle*



1	*Select* the *Base ORD Line Element* by Left-Clicking on the tangent to be edited, then Right-Clicking again on the tangent.
2	Left-Click on the *Trim/Extend Arrow Handle.*
3	Move the *Arrow Handle* to the desired location. Left-Click to accept new location and complete the command.

7E.1.b Move Tangent Line Parallel

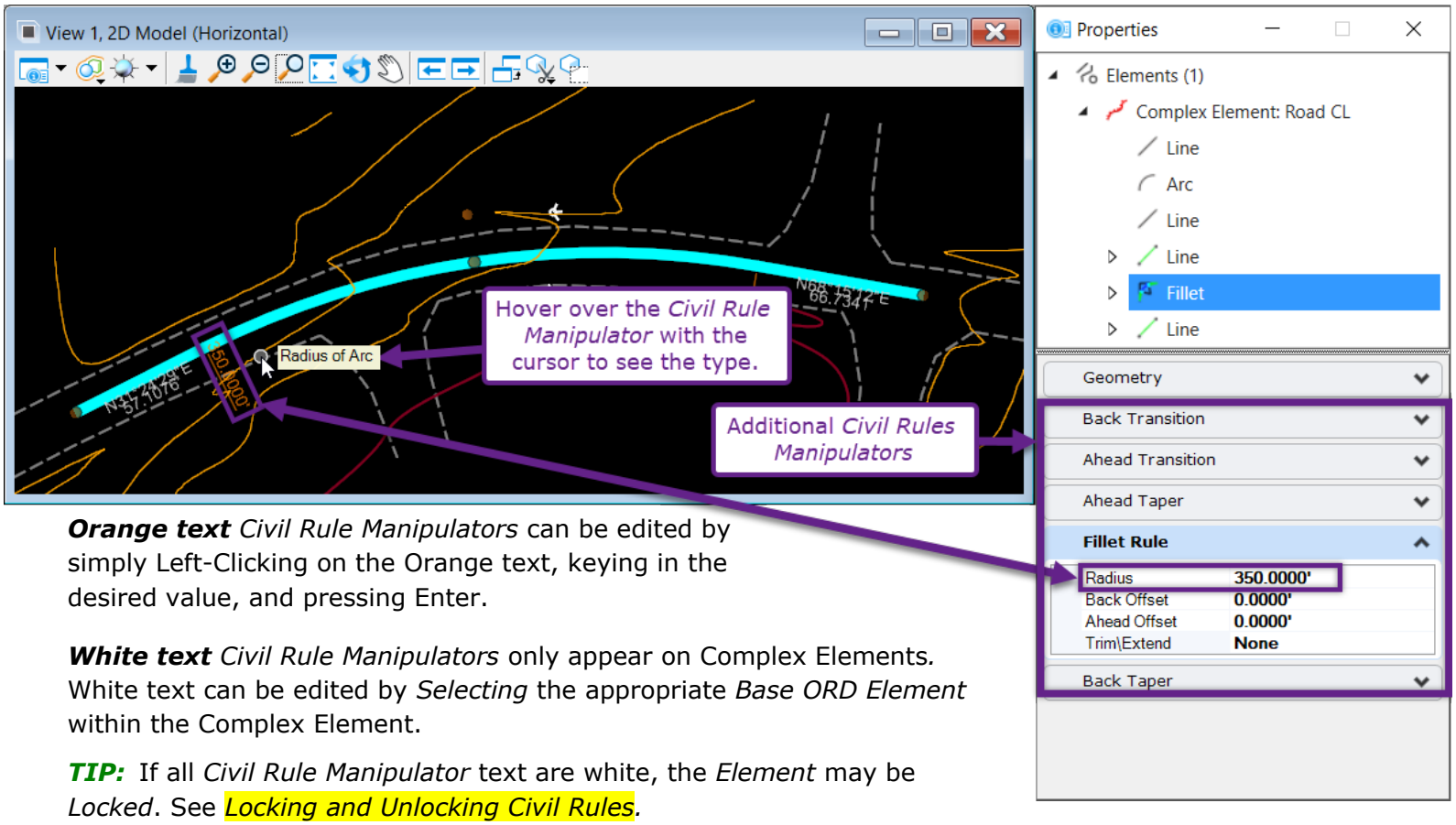
To move a Tangent Line Parallel – the *Base ORD Line Element* has to be selected to reveal the *Move Parallel Arrow Handle*



1	*Select* the *Base ORD Line Element* by Left-Clicking on the tangent to be edited, then Right-Clicking again on the tangent.
2	Left-Click on the *Move Parallel Arrow Handle.*
3	Move the *Arrow Handle* to the desired location. Left-Click to accept new location and complete the command.

7E.2 Civil Rule Manipulator and Properties Box Edits

Civil Rule Manipulators are displayed as orange and white text that appear when an *ORD Element* is selected. *Civil Rule Manipulators* found in the graphics are also found in the *Properties Box*. Additionally, the *Properties Box* may contain some additional *Manipulators* not shown in graphics.

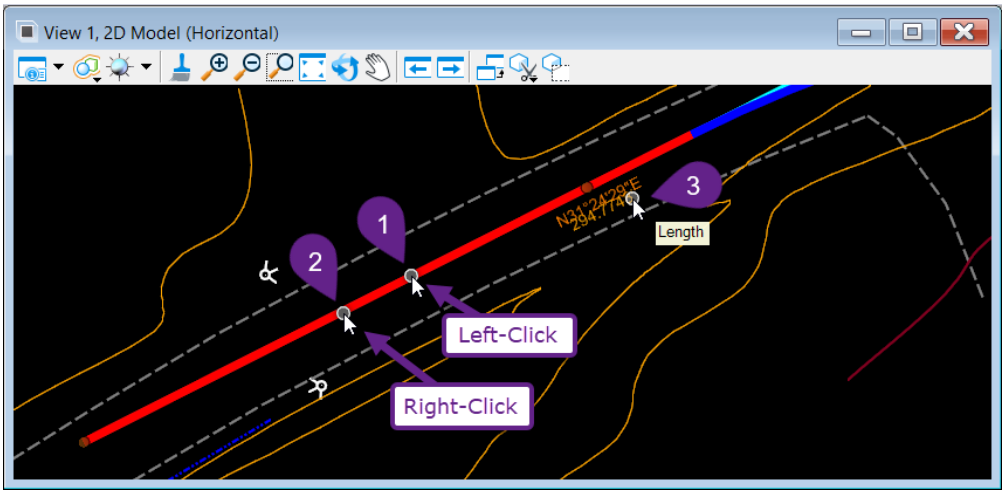


Orange text *Civil Rule Manipulators* can be edited by simply Left-Clicking on the Orange text, keying in the desired value, and pressing Enter.

White text *Civil Rule Manipulators* only appear on Complex Elements. White text can be edited by *Selecting* the appropriate *Base ORD Element* within the Complex Element.

TIP: If all *Civil Rule Manipulator* text are white, the *Element* may be *Locked*. See *Locking and Unlocking Civil Rules*.

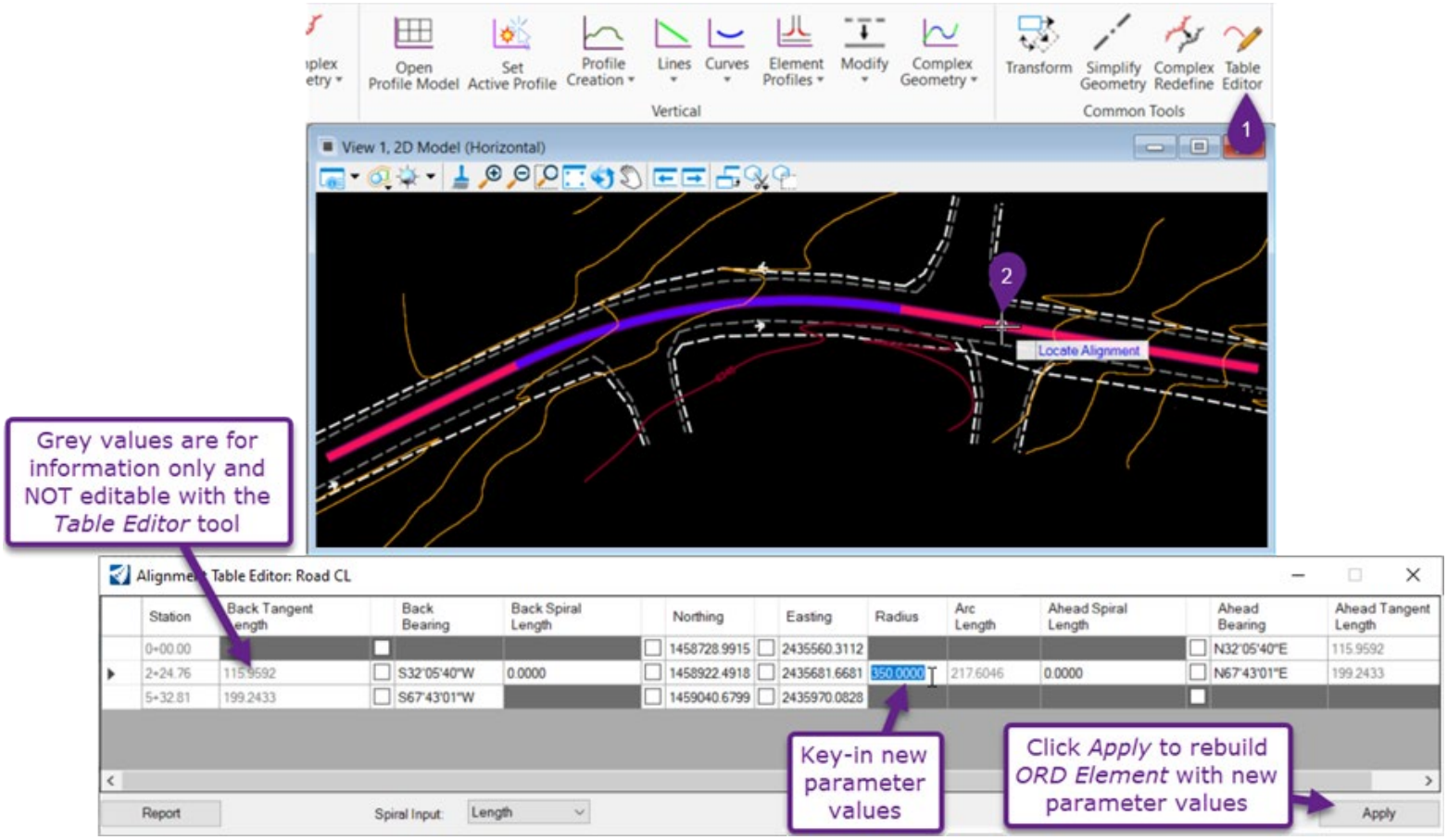
To *Select* a *Base ORD Element* to edit *Civil Rule Manipulators* (white text):



1	Left-Click on the *Complex Element* – at the location of the *Base ORD Element.*
2	Right-Click on the *Complex Element* – at the location of the *Base ORD Element.*
3	Now the *Base ORD Element* is selected. *Civil Rule Manipulators* will be orange and editable.

7E.3 Table Editor

The *Table Editor* tool is used to tabularly edit *Complex Elements*. To access the *Table Editor* tool:

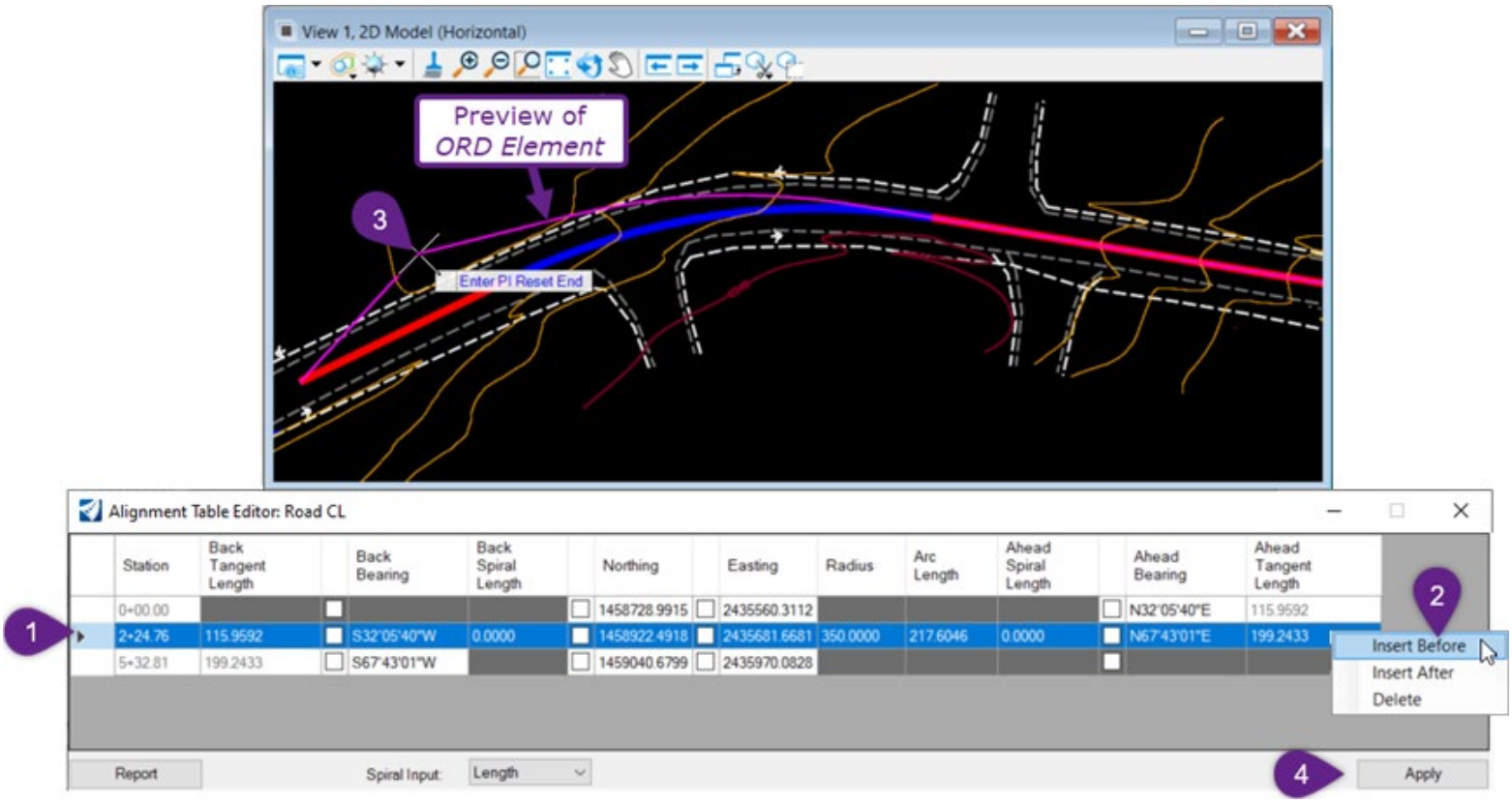


1	Left-Click on the *Table Editor* tool
2	*Prompt: Locate Alignment* – Left-Click on the *Complex Element* to display the *Table Editor*.

The first and last row in the *Table Editor* represent the Start and End Point of the *ORD Element*. The interior rows represent PI Locations.

WARNING: After *Table Edits* are *Applied* – the *Complex Element* will be *Simplified* – which means *Base ORD Elements* will be reconfigured with the most basic *Civil Rules*. See *Simplify Geometry Tip* and *Simplify Geometry* tool.

7E.3.a Table Editor – Inserting and Deleting PI's into a *Complex Element*



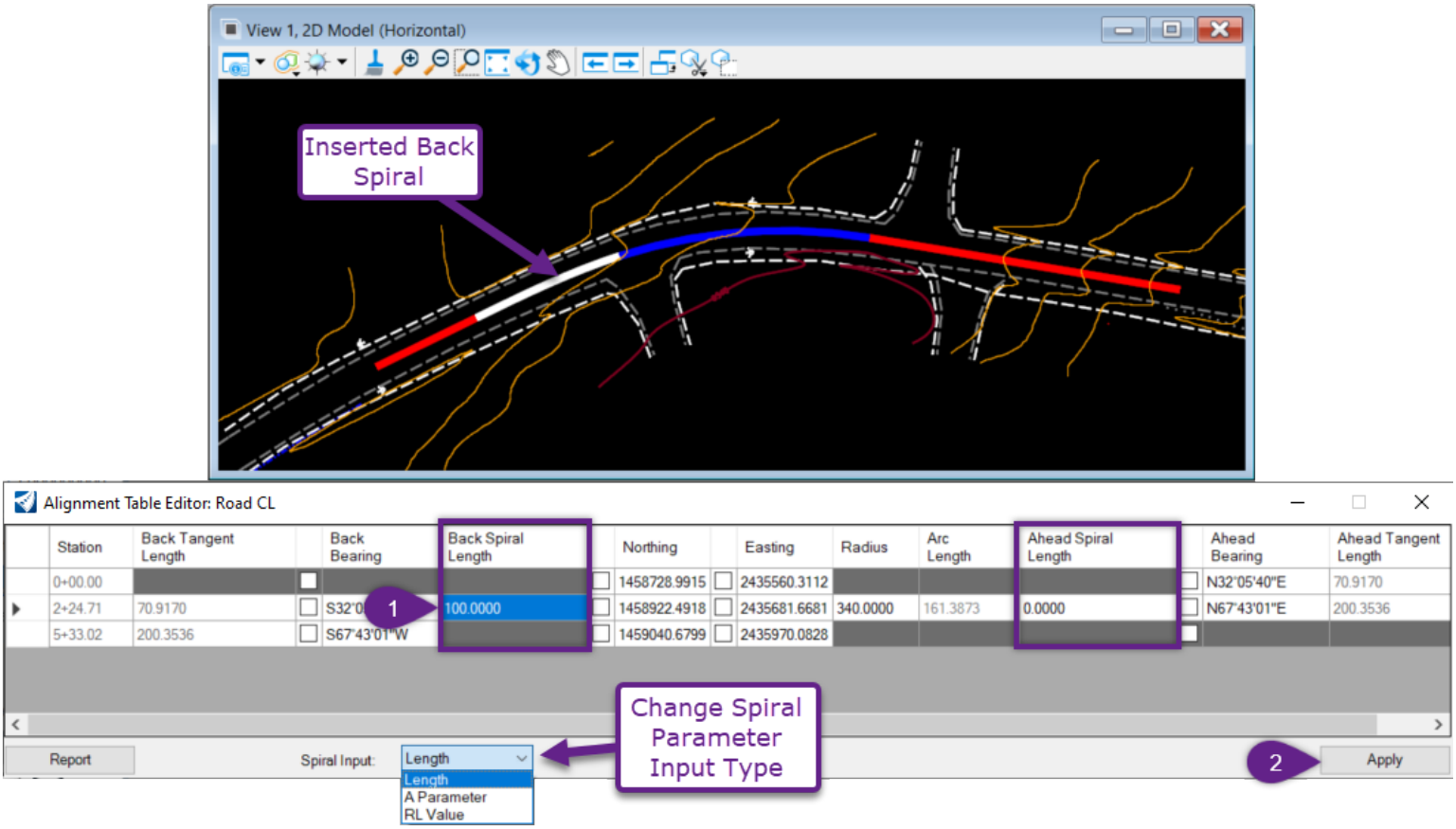
1	In the *Table Editor*, select a row adjacent to where the inserted PI is to be placed by Left-Clicking on the blank cell in the first column.
2	With the desired row selected, Right-Click anywhere in the table. Depending on the selected row in relation to the desired new PI Location, choose the appropriate option: *Insert Before* or *Insert After*.
3	*Prompt: Enter PI Reset to End* - In the *View,* position the cursor in the desired location for the new PI Location. Left-Click to accept the location. (Right-Click to exit the command)
4	Left-Click *Apply* to finish command and rebuild the *Complex Element*

Deleting a PI is accomplished with the *Table Editor* in a similar manner:

1	In the *Table Editor*, select the row of the PI to be deleted by Left-Clicking on the blank cell in the first column
2	With the desired row selected, Right-Click anywhere in the table and select *Delete*.
4	Left-Click *Apply* to finish command and rebuild the *Complex Element*

7E.3.b Table Editor – Inserting, Removing, and Editing Spiral Transition

Spiral Transitions can be inserted, removed or edited by changing the values in the *Ahead/Back Spiral Length* cells.

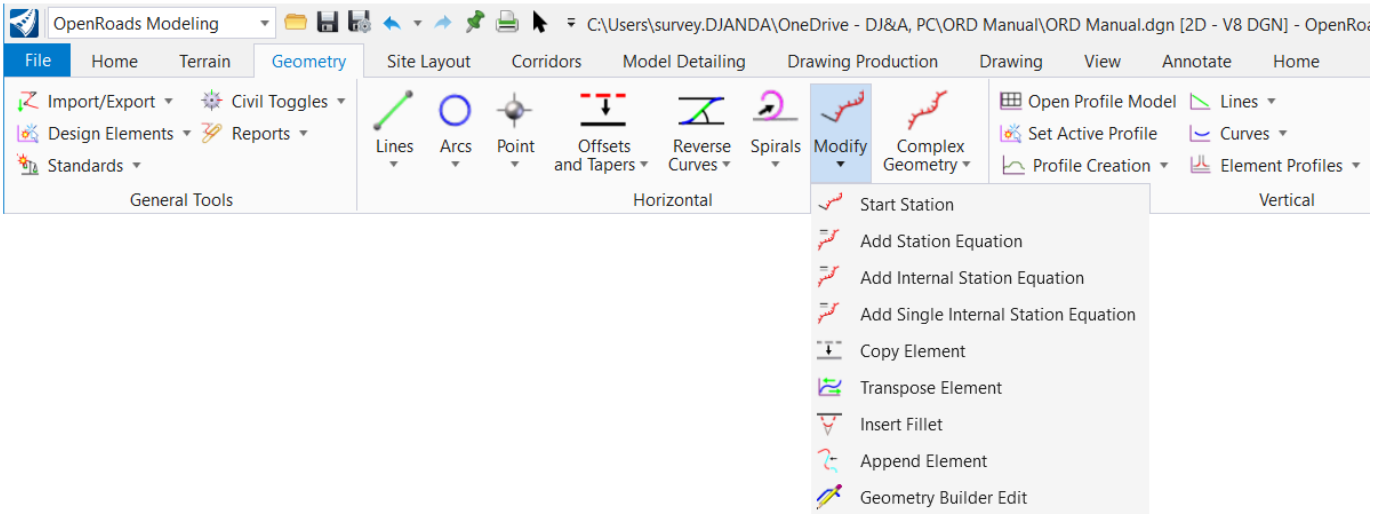


1	Change the value of the *Back/Ahead Spiral Length.*If the value is changed to zero, the spiral will be removed. If the value is changed from zero to a positive value, a spiral will be inserted.
2	Left-Click *Apply* to finish command and rebuild the *Complex Element*

In the *Table Editor*, the default Spiral Input Parameter is Length. The Spiral Input Parameter can be changed to RL Value or A Parameter.

7E.4 Modify tools

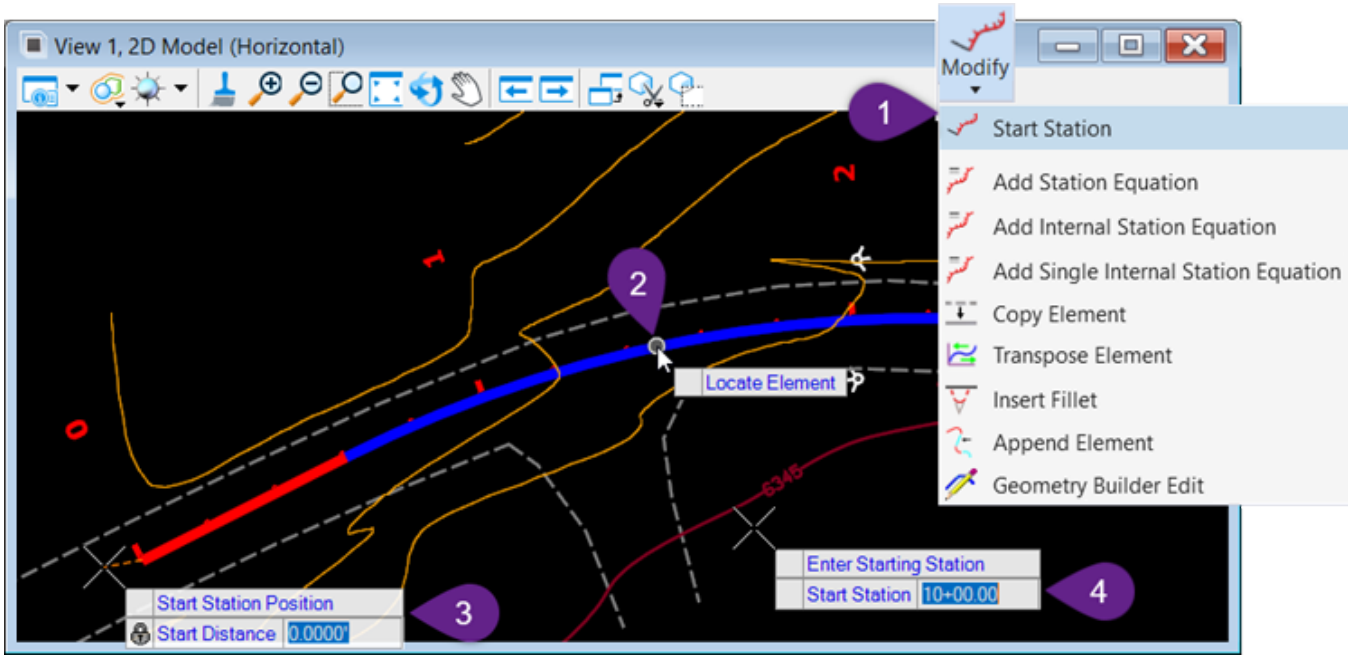
All tools to be discussed in this section are found in the *Modify* dropdown of the *Horizontal* Panel



7E.4.a Start Station

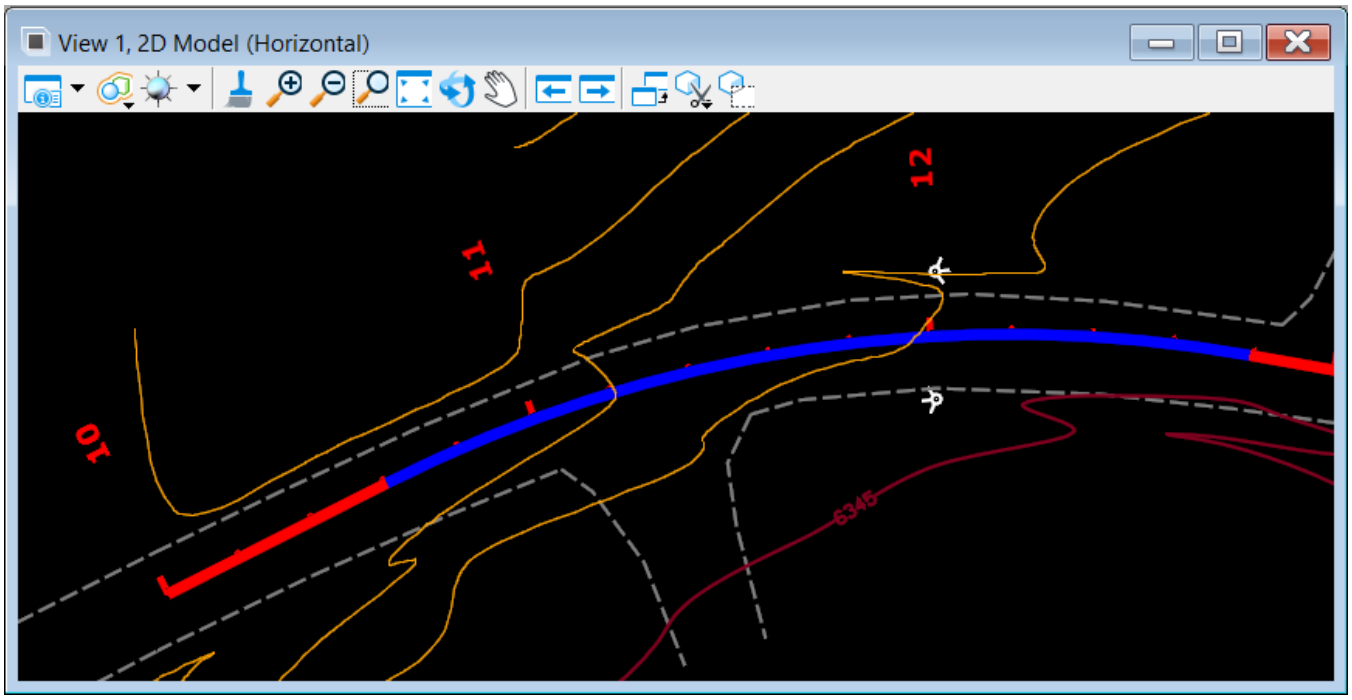
By default, all Complex Elements will have a station value of 0+00.00 at the start point. With the *Start Station* tool, this value can be changed to – for example – 10+00.00.

NOTE: The Alignment shown below has already been Annotated to show Station Annotations. This tool will change the internal stationing values, but not create Annotations.



1	Left-Click the *Start Station* tool from the *Modify* dropdown
2	*Prompt: Locate Element* – Left-Click on the *Complex Element* to be stationed to advance to the next prompt.

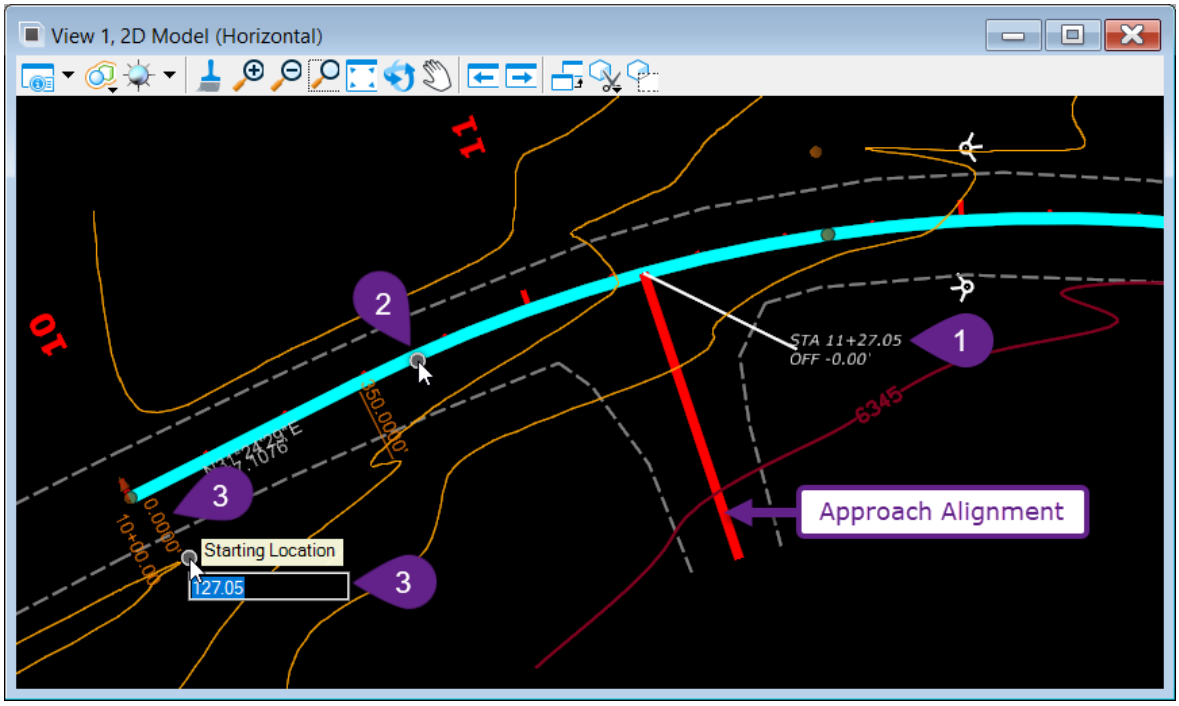
3	*Prompt: Start Station Position* – Key-in the start station position OR place the cursor at the desired position in the *View.* Left-Click to advance to the next prompt. The *Start Position* is where the User-defined station begins along the *Complex Element*. *Start Position* values are relative to the Start Point of the *Complex Element* – with the start point equaling zero. In this example, it is desired that the Alignment begin with a stationing value of 10+00.00.
4	*Prompt: Enter Starting Station* – Key-in the desired Starting Station value. Left-Click to finish the command.



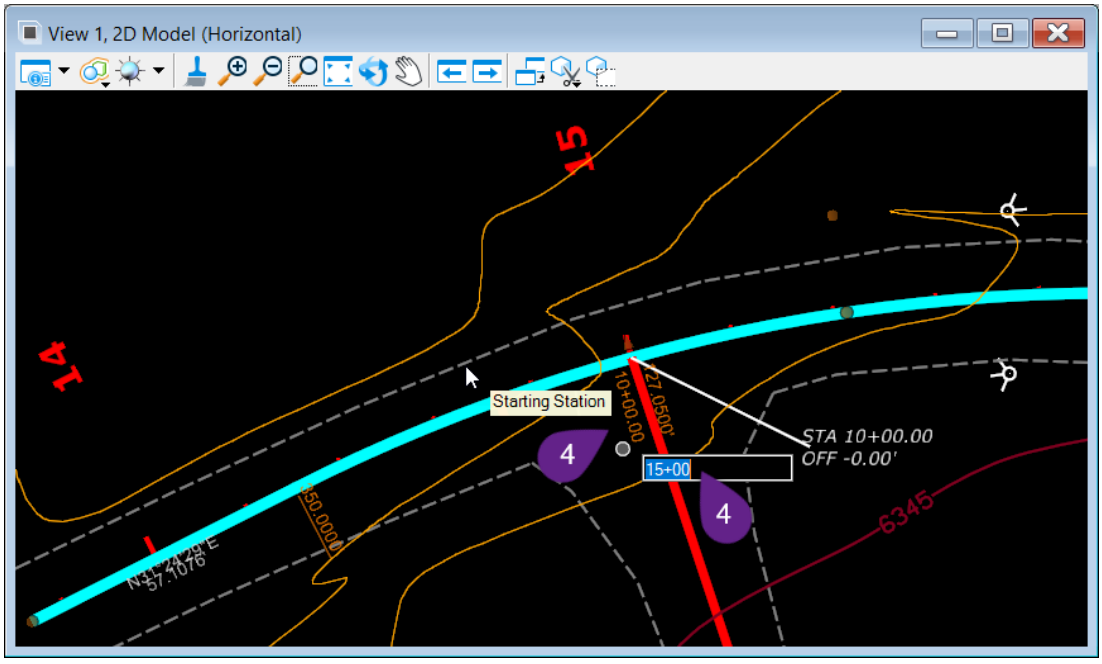
7E.4.b Edit Start Station Value

If the *Start Station* tool has already been used on a Complex Element – it can NOT be used a second time (However, stationing can be removed in the *Properties Box*). Instead, the Start Station value can be changed with a *Civil Rule Manipulator Edit*.

In this demonstration, the stationing will be edited such that the Mainline Alignment station equals 15+00.00 at the intersection of the Approach Alignment.



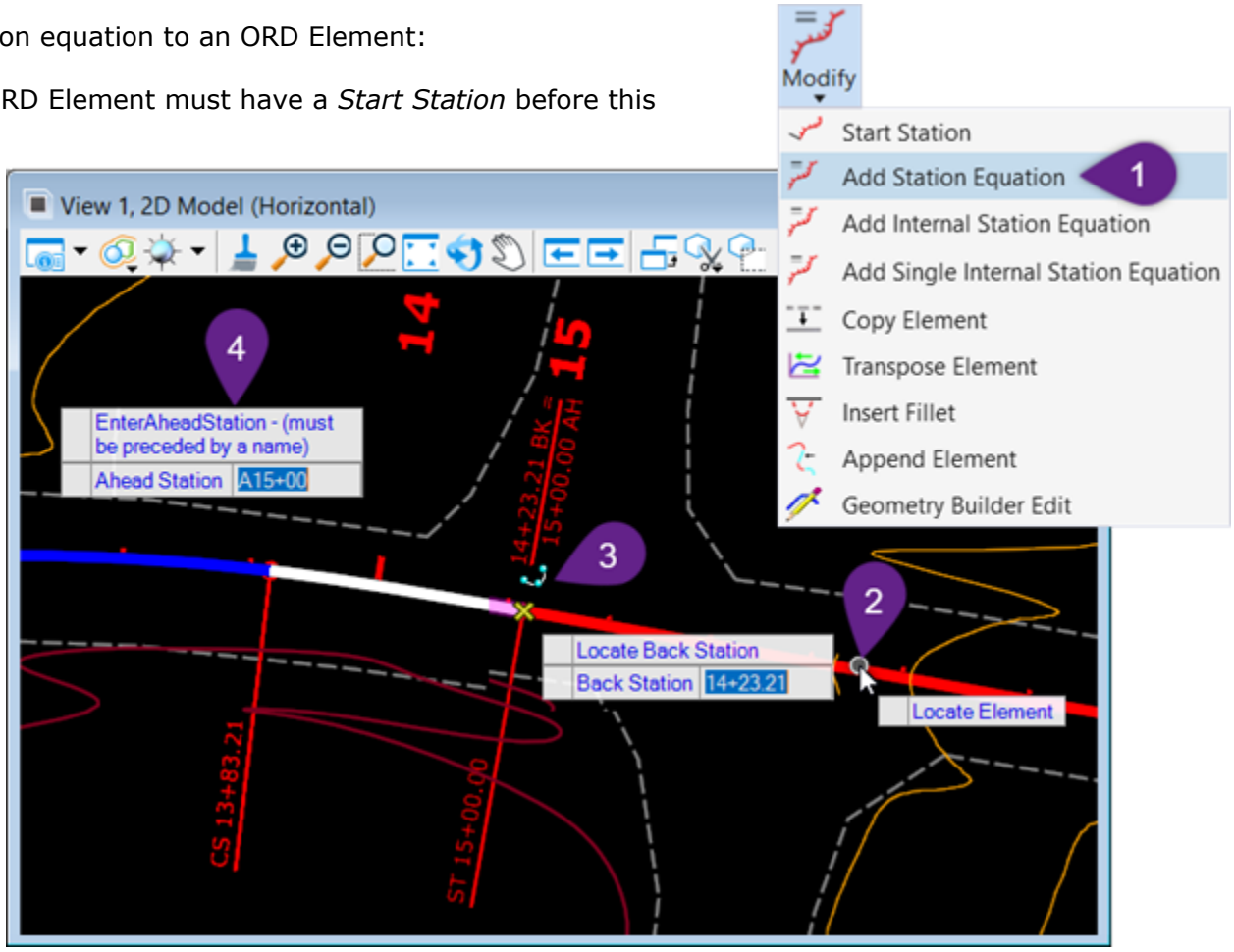
1	Place a *Station-Offset* label at the intersection of the Mainline and Approach Alignments
2	Left-Click the Mainline Alignment
3	Left-Click on the *Starting Location Civil Rule Manipulator* and key-in the actual length along the Mainline alignment to move the *Starting Location* to. Press Enter to accept new *Starting Location*. Since the current start station is 10+00.00 and the desired location is at 11+27.05. The actual length from the start point of the alignment is 11+27.05 – 10+00.00 = 127.05
4	Left-Click on the *Start Station Civil Rule Manipulator* and key-in desired station (15+00.00). Press Enter to accept new *Start Station*.



7E.4.c Add Station Equation

To add a station equation to an ORD Element:

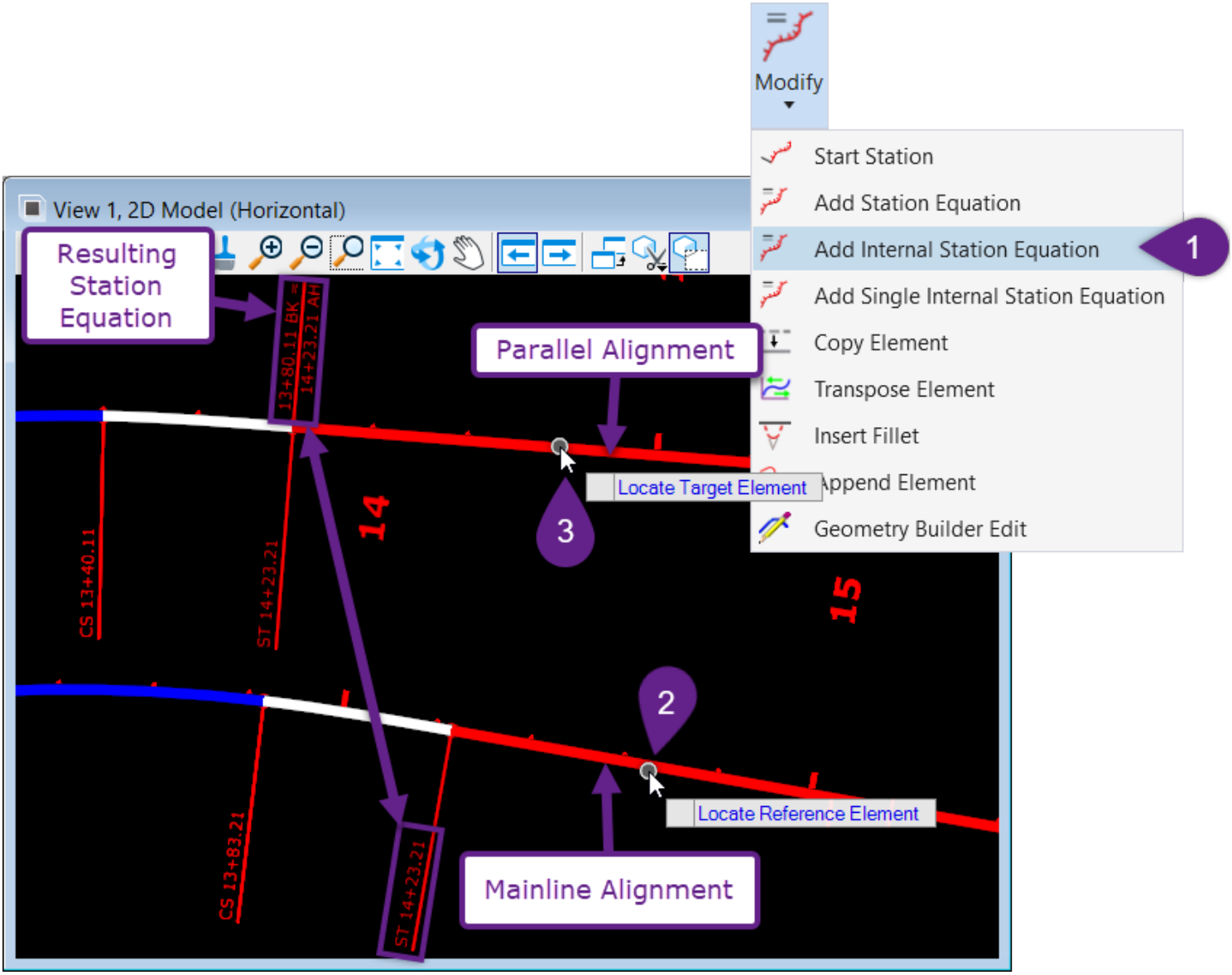
NOTE: The ORD Element must have a *Start Station* before this tool is used.



1	Left-Click the *Add Station Equation* tool from the *Modify* dropdown
2	*Prompt: Locate Element* – Left-Click on the ORD Element
3	*Prompt: Locate Back Station* – Key-in back station value and Left-Click to in the *View* to accept OR graphically Left-Click at desired back station location OR in the *Dialogue Box*, key in the actual distance from the start of the alignment to place the station equation.
4	*Prompt: Enter Ahead Station (must be preceded by a name)* – Key-in a name for the station equation and then the ahead station value. An example would be 'A15+00'. Left-Click in the *View* to accept and complete the command. ***NOTE:*** In this example the *Name* picked is simply 'A' and the desired *Ahead Station* is 15+00. The *Name* is just supposed to be an identifier for the Station Equation and can be any text (doesn't have to be a single character). For example, the *Name* can be 'CurveTwo'. The *Name* can NOT include numbers.

7E.4.d Add Internal Station Equation

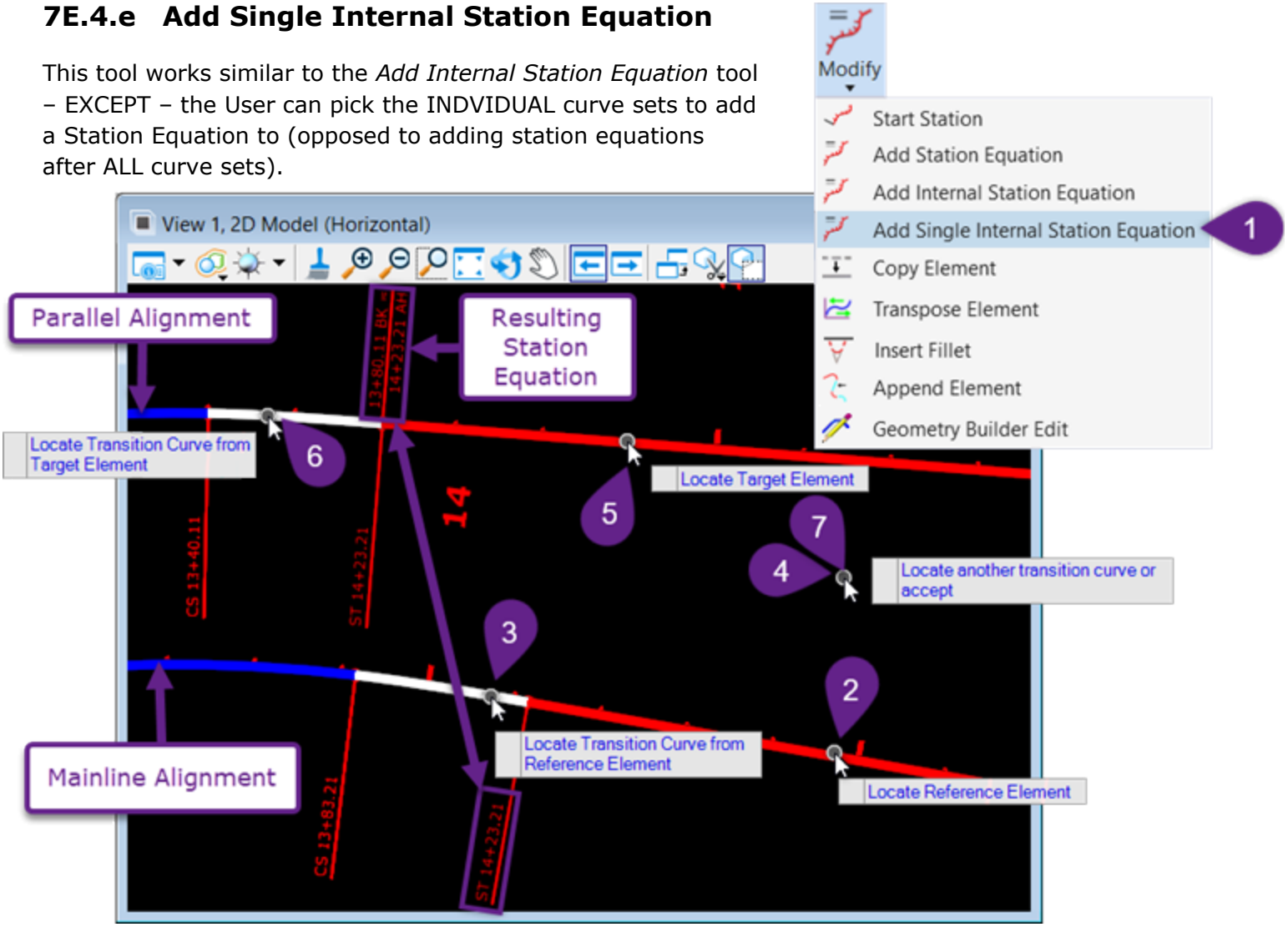
This tool is used to sync stationing between a previously stationed Mainline Alignment and a Parallel Alignment. Stationing will be synced at the start of the two alignments and station equations will be added to the Parallel Alignment after all curve sets.



1	Left-Click the *Add Internal Station Equation* tool from the *Modify* dropdown
2	*Prompt: Locate Reference Element* – Left-Click on the Mainline Alignment
3	*Prompt: Locate Target Element* – Left-Click on Parallel Alignment to complete the command

7E.4.e Add Single Internal Station Equation

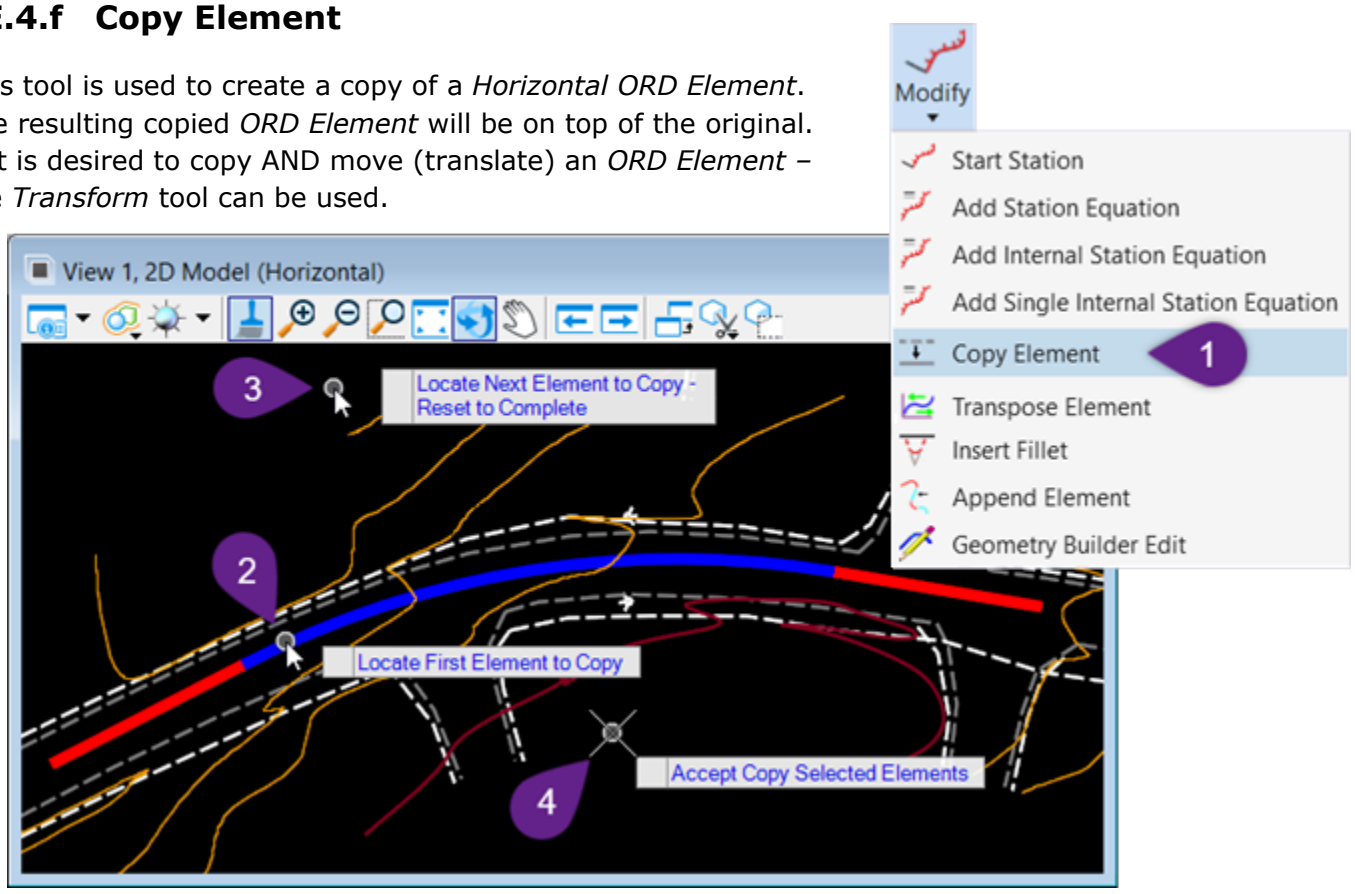
This tool works similar to the *Add Internal Station Equation* tool – EXCEPT – the User can pick the INDVIDUAL curve sets to add a Station Equation to (opposed to adding station equations after ALL curve sets).



1	Left-Click the *Add Single Internal Station Equation* tool from the *Modify* dropdown
2	*Prompt: Locate Reference Element* – Left-Click on the Mainline Alignment.
3	*Prompt: Locate Transition Curve from Reference Element* – Left-Click on the desired spiral or transition curve to be used for reference in station equation creation.
4	*Prompt: Locate another transition curve or accept.* If its desired to add station equations to more than one curve set – Left-Click on the additional spirals or transition curves. If no other curve sets need station equations – Left-Click anywhere in the *View* to advance.
5	*Prompt: Locate Target Element* – Left-Click on Parallel Alignment
6	*Prompt: Locate Transition Curve from Target Element* – Left-Click on the desired spiral or transition curve to create a station equation for.
7	*Prompt: Locate another transition curve or accept.* If it's desired to add station equations to more than one curve set – Left-Click on the additional spirals or transition curves. If no other curve sets need station equations – Left-Click anywhere in the *View* to advance.

7E.4.f Copy Element

This tool is used to create a copy of a *Horizontal ORD Element*. The resulting copied *ORD Element* will be on top of the original. If it is desired to copy AND move (translate) an *ORD Element* – the *Transform* tool can be used.



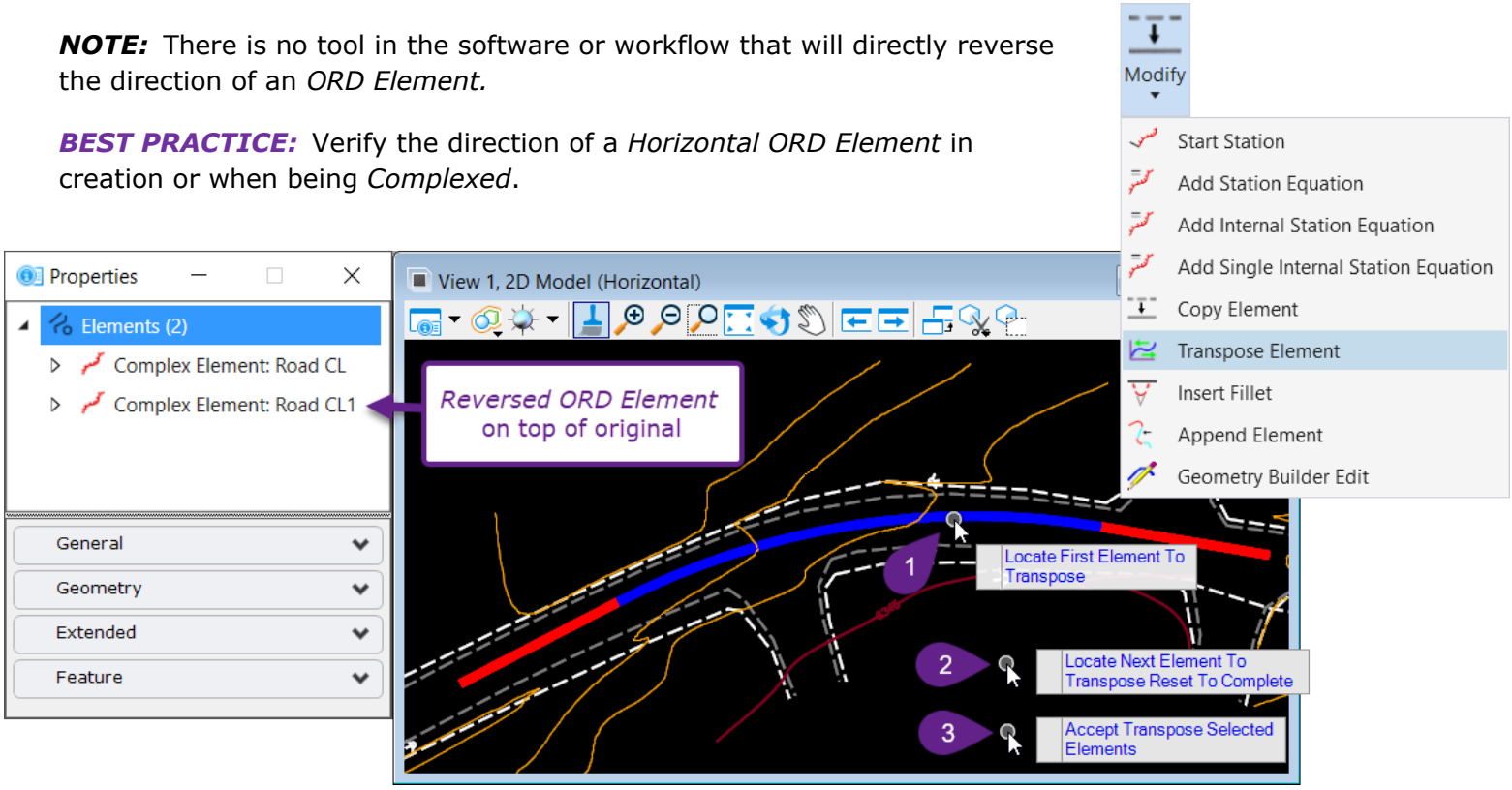
1	Left-Click the *Copy Element* tool from the *Modify* dropdown
2	*Prompt: Locate First Element to Copy* – Left-Click on the *ORD Element* to be copied.
3	*Prompt: Locate Next Element to Copy – Reset Complete* – Left-Click on additional *ORD Elements* to be copied OR Right-Click in the *View* advance to the next *prompt.*
4	*Prompt: Accept Copy Selected Elements* – Left-Click in the *View* to complete the command.

7E.4.g Transpose Element

This tool is used to create a COPY of a *Horizontal ORD Element* with reversed direction/stationing. In the *Profile Model* of the reversed *Horizonal ORD Element*, the *Vertical ORD Elements* will also be reversed. However, *Corridors* from the original (unreversed) *Horizontal ORD Element* will NOT be copied and reversed. The user must remake *Corridors* for the reversed *Horizontal ORD Element*.

NOTE: There is no tool in the software or workflow that will directly reverse the direction of an *ORD Element.*

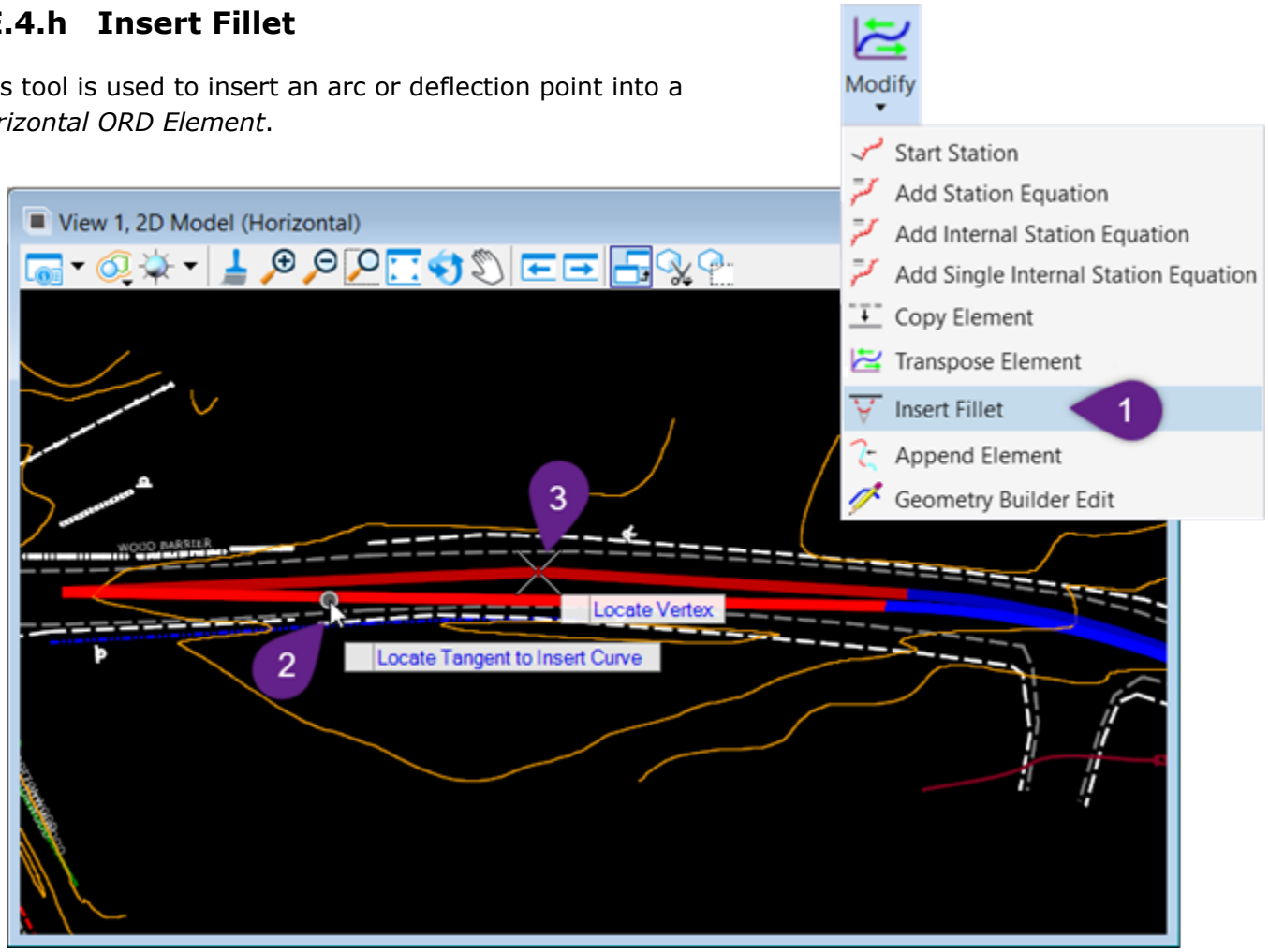
BEST PRACTICE: Verify the direction of a *Horizontal ORD Element* in creation or when being *Complexed*.



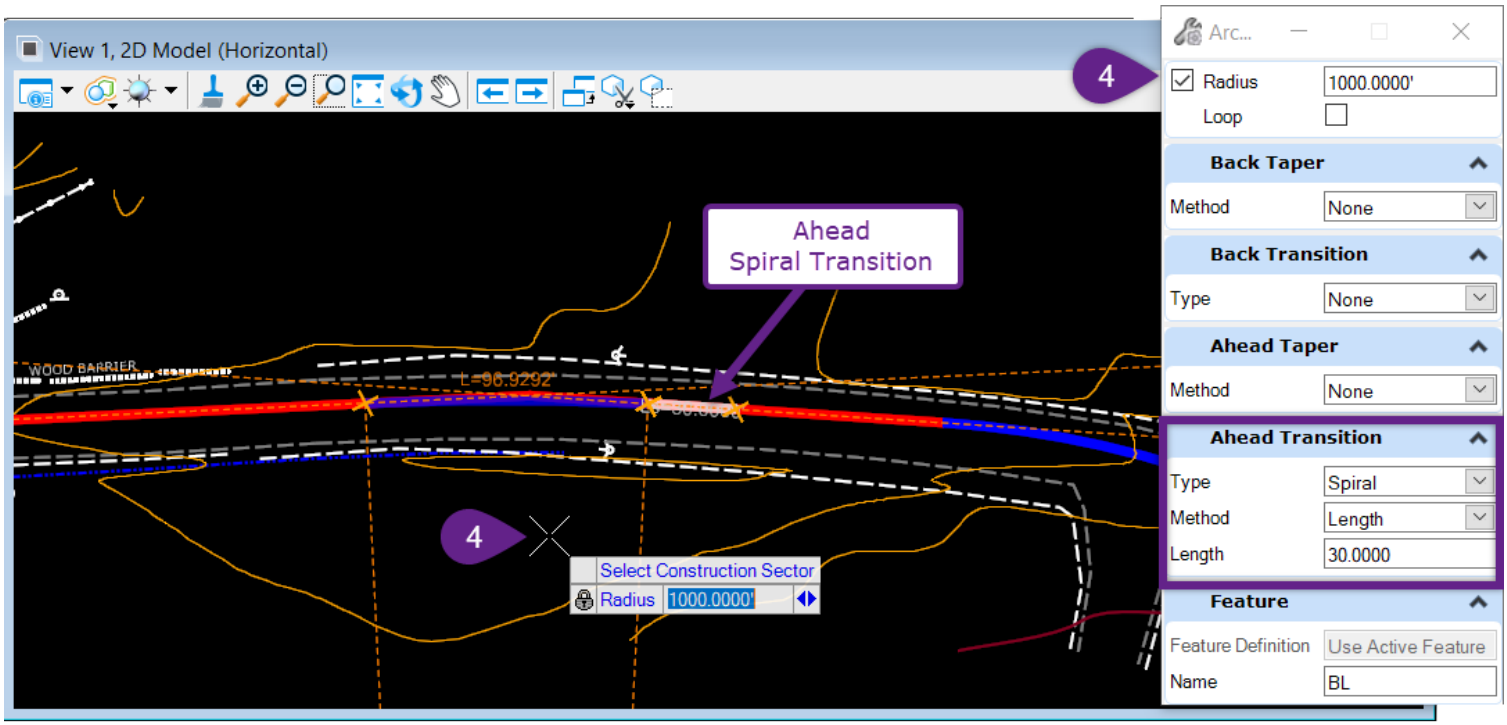
1	Left-Click the *Transpose Element* tool from the *Modify* dropdown
2	*Prompt: Locate First Element to Transpose* – Left-Click on the ORD Element to be reversed.
3	*Prompt: Locate Next Element to Transpose – Reset Complete* – Left-Click on additional ORD Elements to be transposed OR Right-Click in the *View* to advance to the next *prompt.*
4	*Prompt: Accept Transpose Selected Elements* – Left-Click in the *View* to complete the command.

7E.4.h Insert Fillet

This tool is used to insert an arc or deflection point into a *Horizontal ORD Element*.



1	Left-Click the *Insert Fillet* tool from the *Modify* dropdown
2	*Prompt: Locate Tangent to Insert Curve* – Left-Click on a tangent or Line component to insert the PI into.
3	*Prompt: Locate Vertex* – In the *View,* Left-Click at the desired location for the inserted PI.

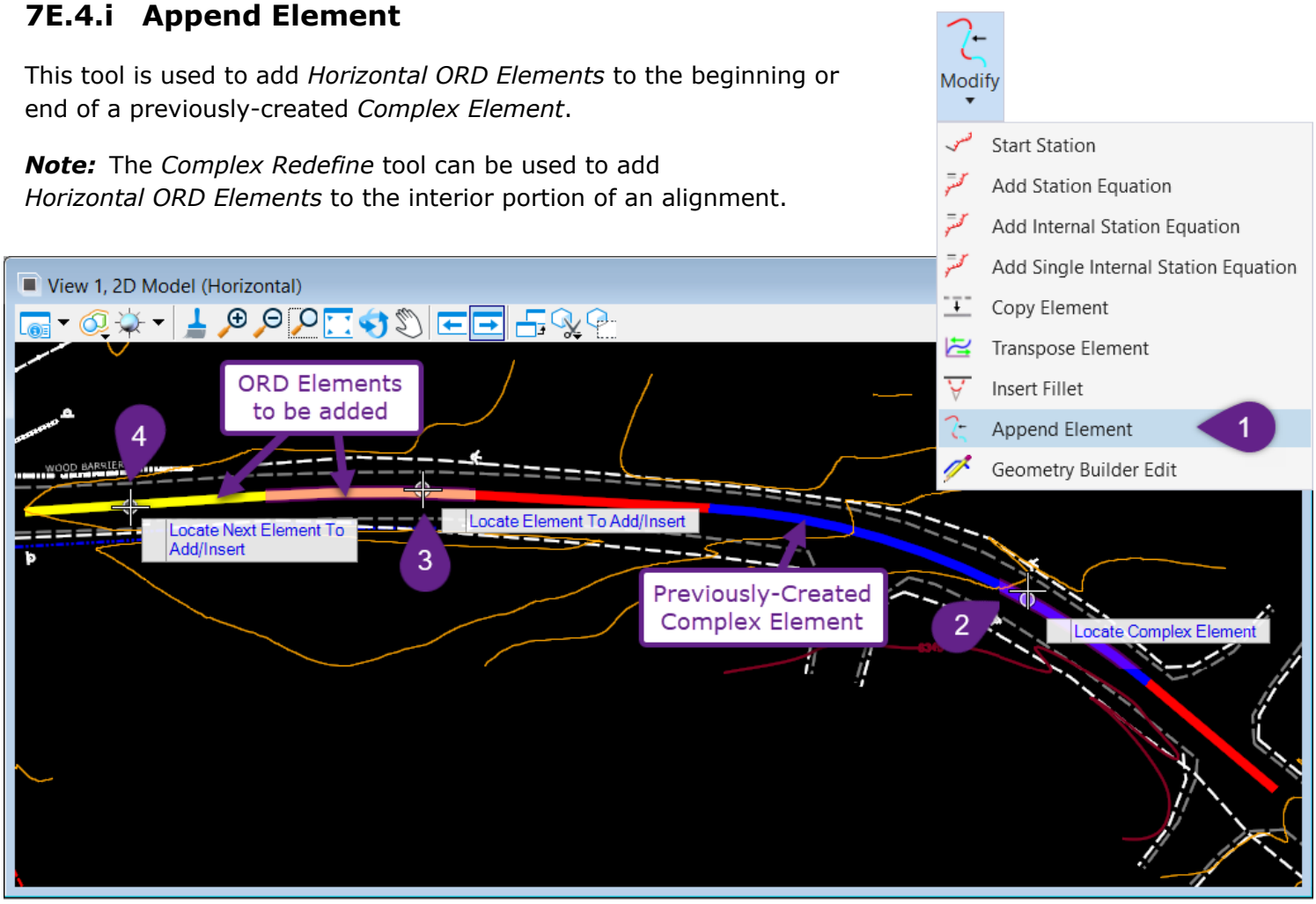


4	*Prompt: Enter Through Point* - In the *View,* Left-Click at the desired through point location for the inserted curve to complete the command OR Key-in a curve radius into the *Dialogue Box*. Back and Ahead Spirals can be added to the curve by adding Transition parameters in the *Dialogue Box*. In the *View,* Left-Click to the side of the *ORD Element* where the curve will be inserted.

7E.4.i Append Element

This tool is used to add *Horizontal ORD Elements* to the beginning or end of a previously-created *Complex Element*.

Note: The *Complex Redefine* tool can be used to add *Horizontal ORD Elements* to the interior portion of an alignment.



1	Left-Click the *Append Element* tool from the *Modify* dropdown
2	*Prompt: Locate Complex Element* – Left-Click on the previously-created *Complex Element*.
3	*Prompt: Locate Element to Add/Insert* – Left-Click on the first *ORD Element* to be added to the beginning or end of the *Complex Element*
4	*Prompt: Locate Next Element to Add/Insert* – Left-Click on the next *ORD Element* to be added OR Right-Click in the *View* to complete the command.

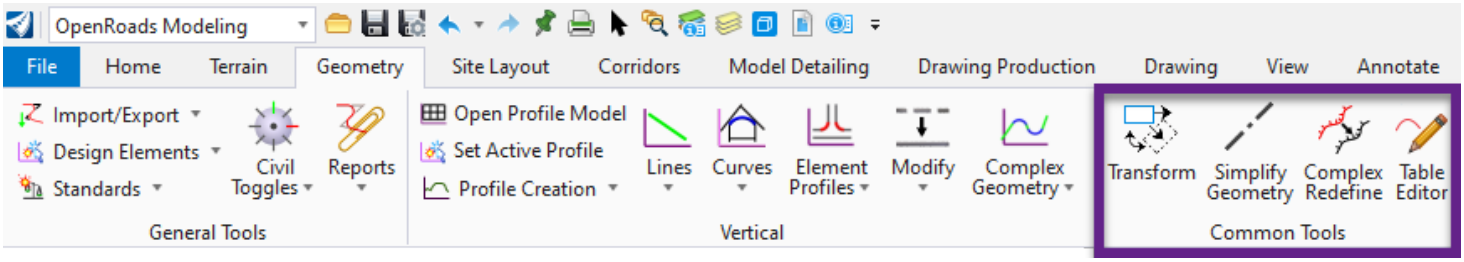
7E.4.j Geometry Builder Edit

This tool is used to edit Horizontal ORD Elements in table form.

BEST PRACTICE: Use this tool with Complex Elements that were created with the *Geometry Builder* tool. Use the *Table Editor* tool to make table edits for Complex Elements that were created with tools other than the *Geometry Builder* – such as *Complex By Elements* or *Complex By PI.*

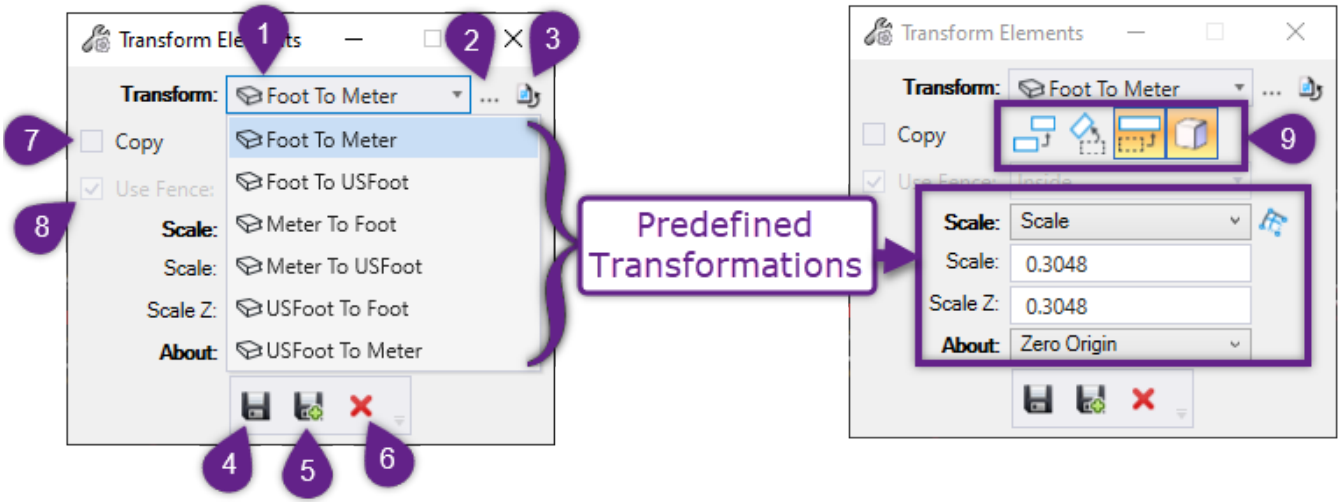
7E.5 Common Tools

Common Tools are used to make edits to both *Horizontal* and *Vertical ORD Elements.*



7E.5.a Transform

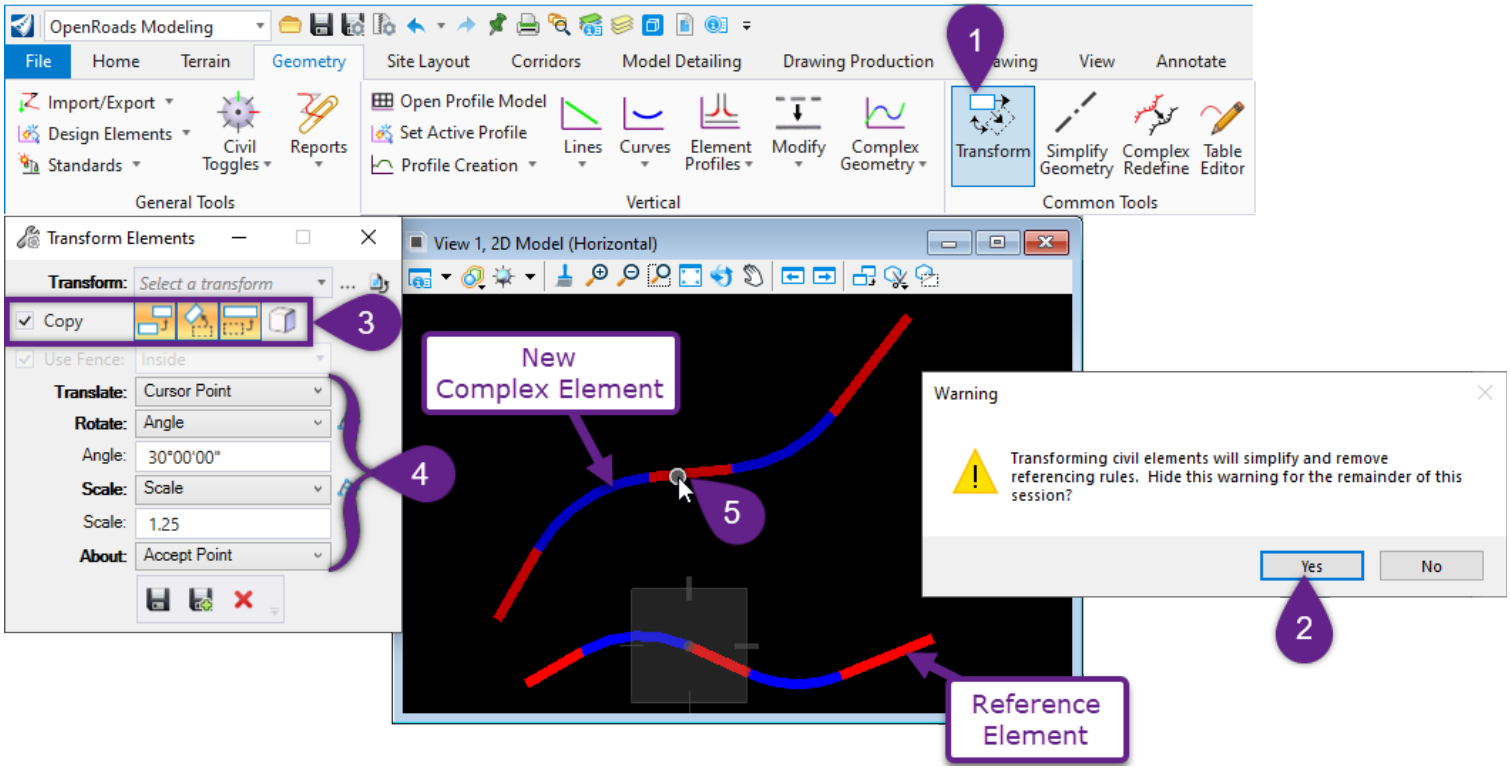
In its simplest use, this tool will move (translate), rotate, or scale an ORD Elements – with the option of creating a copy in the processes. This tool also contains predefined transformation functions which can be used to change the units of an ORD Element. For example, an ORD Element that was drafted in Feet can be converted to Meters with this tool.



1	Transform dropdown	Contains Predefined Transformations. When a Predefined Transformation is selected – appropriate Transformation Type and Values will be automatically set
2	Browse Transforms	Used to locate Custom Transformations that were previously created.
3	Reset Transforms	Used to reset Predefined Transformation Types and Values if altered by the User
4	Save Transforms	Creates a Custom Transformation from the Transformation Types and Values currently displayed.
5	Duplicate Transforms	Used to duplicate a Predefined Transformation to be used as a template to create a Custom Transformation.
6	Delete Transforms	Deletes a Custom or Predefined Transformation
7	Copy	If this box is checked, a copy of the original ORD Element will be retained after Transformation is performed.
8	Use Fence	If a *Fence* has been created, this option is used to Transform all Elements within the fence.
9	Transformation Types	Type of Transformation to be performed. Active Transformation Types are highlighted in orange. More than one transformation type can be active.
		Translate (Move) Elements
		Rotate Elements
		Scale Elements
		Scale Elevation (Z-Direction) – When enabled, gives the option to scale elevation components of Element

7E.5.a.i Transform Example Workflow

In this demonstration, a Reference Element will be copied, translated (moved), rotated and scaled - to create a new Complex Element.



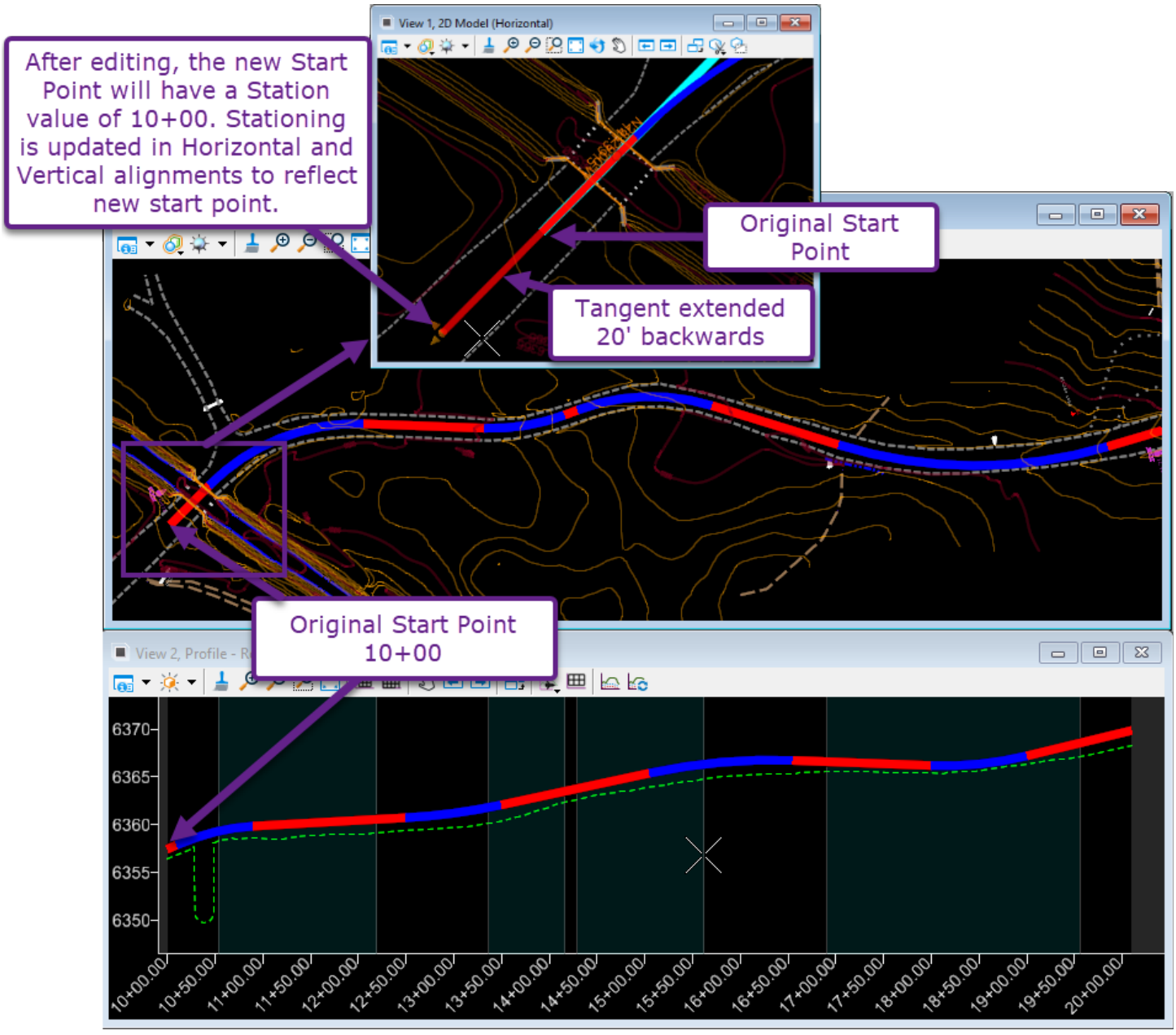
1	Left-Click on the *Transform* tool in the *Common Tools* panel.
2	The following *Warning* message will appear when using this tool for the first time in the session. Left-Click on *Yes*.
3	*Prompt: Identify Element* – Check the *Copy* box and select the *Transportation Type* icons to be used in the transform. ***NOTE:*** Transportation Types can be used individually or combined (as shown in this demonstration). For example: An ORD Element can be moved only by toggling on Translate (Move) Elements and unchecking the *Copy* box.
4	In the *Dialogue Box* input desired parameter values relating to the *Transportation Types* selected in the previous step. In this case, the Reference ORD Element will be copied and the New Complex Element will be scaled by 1.25 and rotated by 30°
5	Left-Click in the *View* to create the New Complex Element.

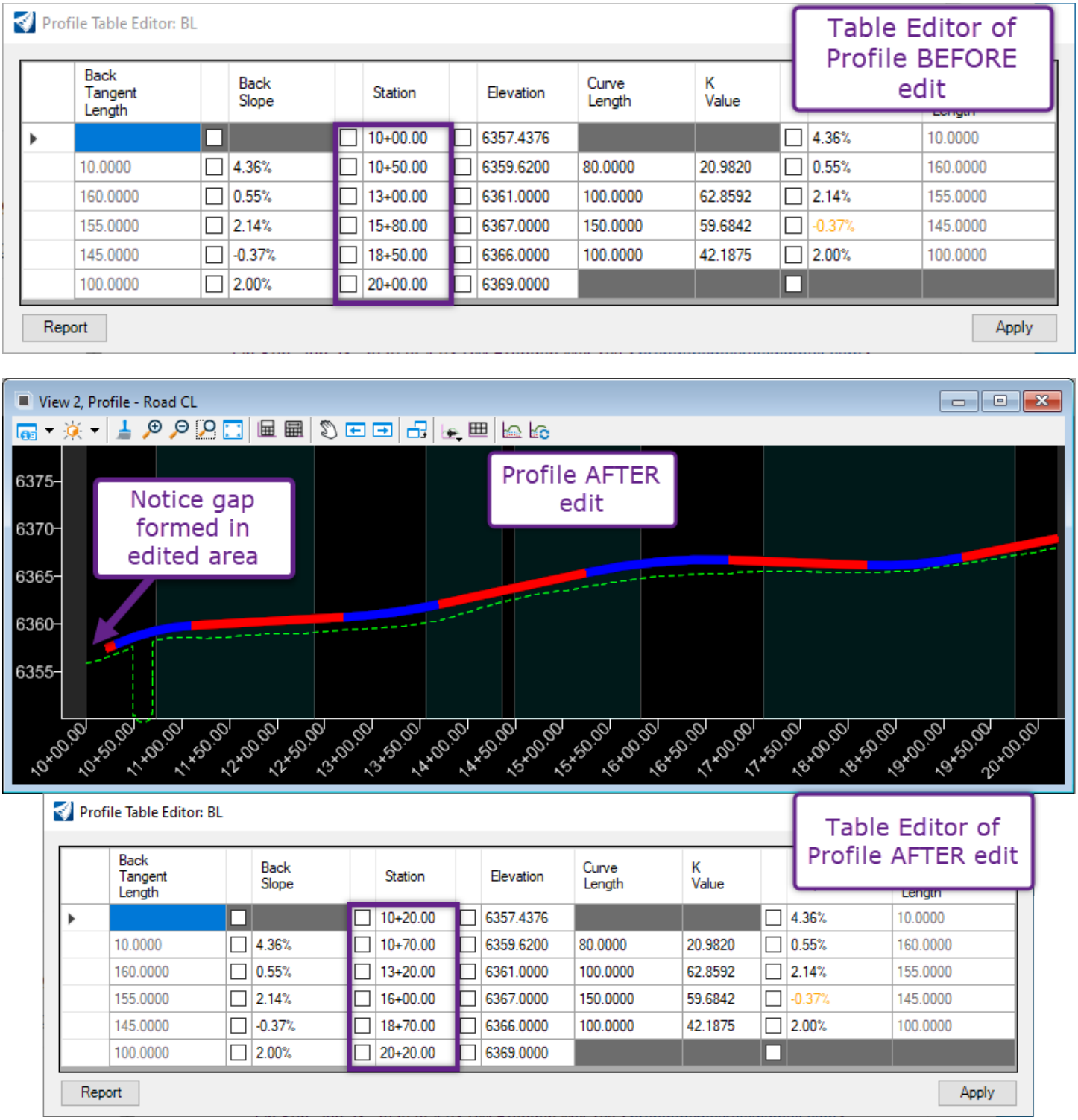
7E.6 Effect of Horizontal Edits on Profile Elements

Edits made to *Horizontal Alignments* will always have consequences to the *Vertical Profile Elements* in the *Profile Model.* The software will attempt to maintain the position of vertical elements relative to the existing ground and geometry points on horizontal curves.

BEST PRACTICE: After edits are made to a *Horizontal Alignment*, open the *Profile Model* to address *Vertical Profile Elements* that may have shifted.

7E.6.a Demonstration 1: Extend first tangent of the alignment



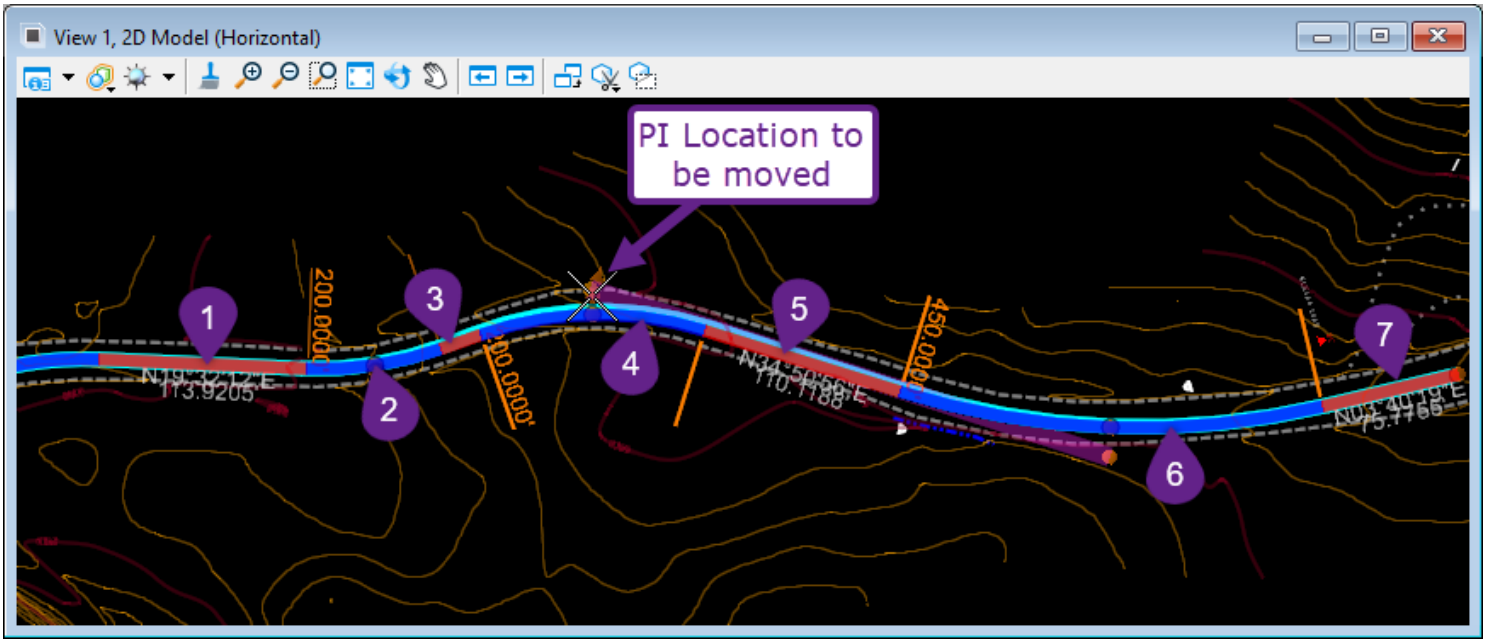


In this demonstration, the *Profile* behaved in an intuitive manner – the *Profile* was kept in the same position relative to the original start point. Only the PVI stationing changed to reflect the new start point and the update in station values due to the horizontal edit.

TIP: For this situation after the edit, the *Starting Location* of the stationing can be changed to the location of the alignment's original start point. By doing so, stationing values down line of the edit are preserved.

7E.6.b Demonstration 2: Move PI location in middle of the alignment

When a PI is moved in the middle of an alignment, then 7 elements are affected by the edit:

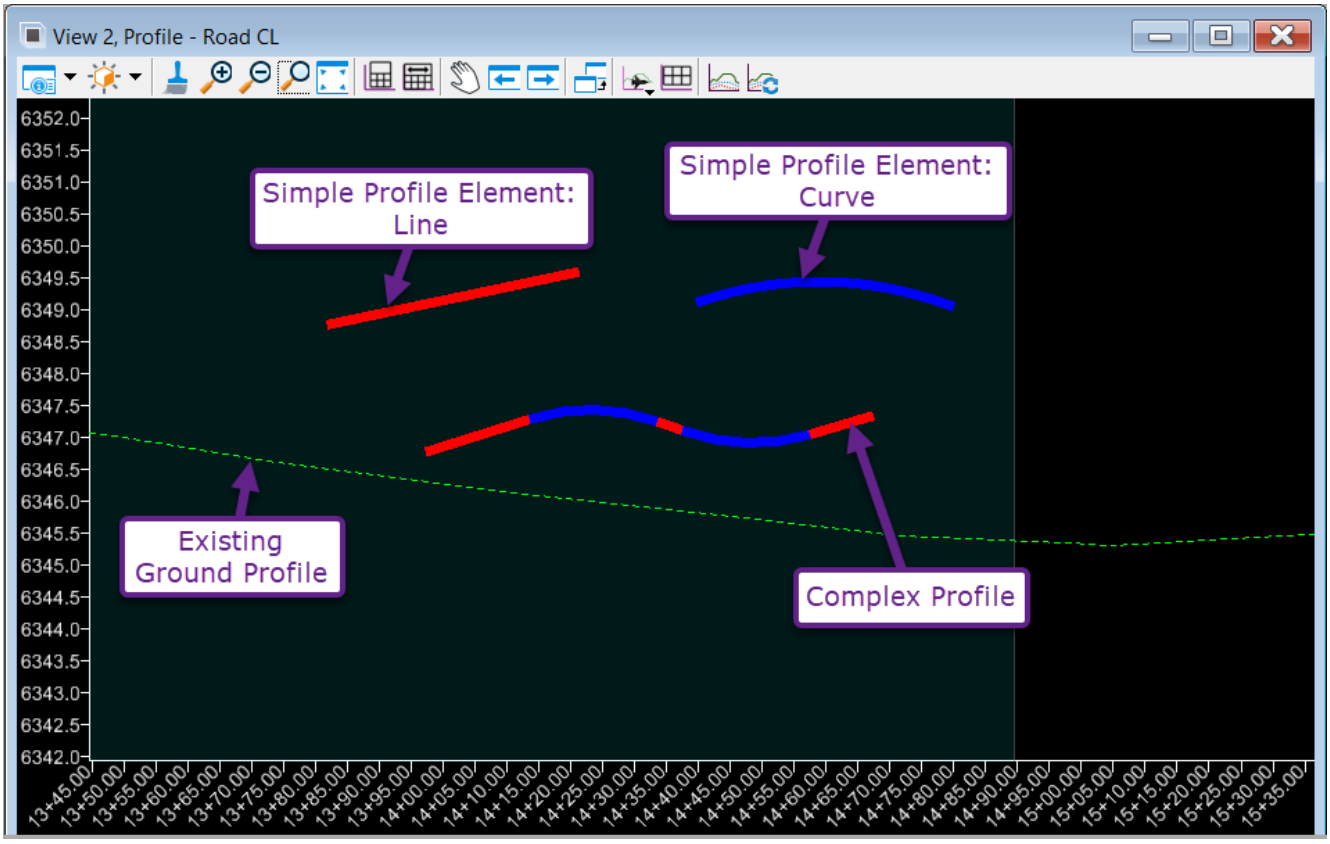


1	Back Tangent 1	Bearing Direction stays fixed Length is changed
2	Back Curve 2	PI Location, Radius, and Back Bearing Direction stays fixed Arc Length and Ahead Bearing Direction are changed
3	Back Tangent 3	Bearing direction and Length is changed
4	Curve 4	Radius is fixed PI Location, Arc Length, Ahead/Bearing Direction are changed
5	Ahead Tangent 5	Bearing direction and Length is changed
6	Ahead Curve 6	PI Location, Radius, and Ahead Bearing Direction stays fixed Arc Length and Back Bearing Direction are changed
7	Ahead Tangent 7	Bearing Direction stays fixed Length is changed

7F – CREATE VERTICAL ORD ELEMENTS

After creation of Horizontal ORD Elements, the User can create *Profiles* to represent civil features, such as the centerline of road or culvert profile. Vertical ORD Elements can be assigned and *Activated* to a Horizontal ORD Element to define an ORD Element in all 3-dimensions.

There are two categories of Vertical ORD Elements: *Simple Profile Elements* and *Complex Profile Elements*.

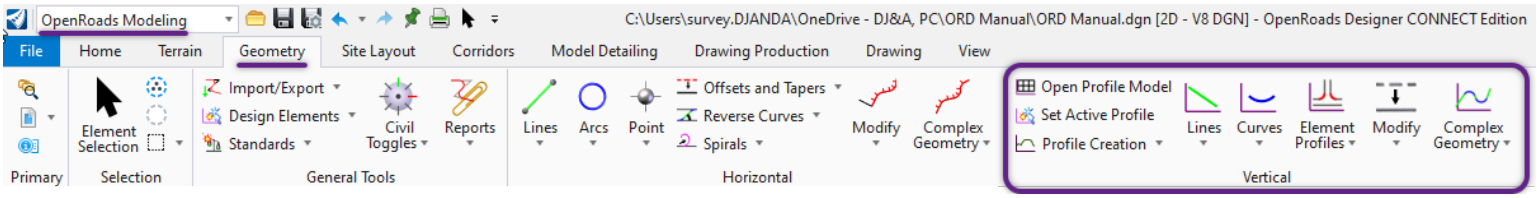


TIP: Simple Profile Elements can be joined together to create a Complex Profile Element with the *Complex By Profile Elements* tool. See *Complex Profiles* for additional Profile creation methods.

WARNING: Vertical ORD Elements creation tools can only be used in a *Profile Model*.

General Tool Locations

All tools needed to create Vertical ORD Elements are found in the *Vertical* panel of the *Geometry* ribbon of the *OpenRoads Modeling* workflow.



7F.1 Profile Model Basics

All Horizontal ORD and MicroStation Elements created in a 2D Design Model have a corresponding *Profile Model* that can be accessed by the User. A Profile Model can be thought of as a profile or elevation view of a Horizontal Element. The Profile Model appears as a grid with the X-axis representing increasing stationing along the Horizontal Element and the Y-axis representing elevation.

NOTE: The *Profile Model* grid will always appear with stationing increasing along the X-Axis and the *View* cannot be rotated. The Horizontal Alignment direction in the *2D Design Model* is arbitrary because the *View* can be rotated. The User should be aware of the direction of the Horizontal Alignment when drafting in the Profile Model. When the *Profile Model View* is active, blue arrows representing the alignment direction will appear along the Horizonal Element (in the *2D Design Mode*)

7F.1.a Accessing a Profile Model

The Profile Model for any Horizontal Element can be accessed in two locations with the *Open Profile Model* tool :

NOTE: *Profile Models* do not appear in the Model Menu. **Profile Models can ONLY be accessed with the *Open Profile Model* tool**

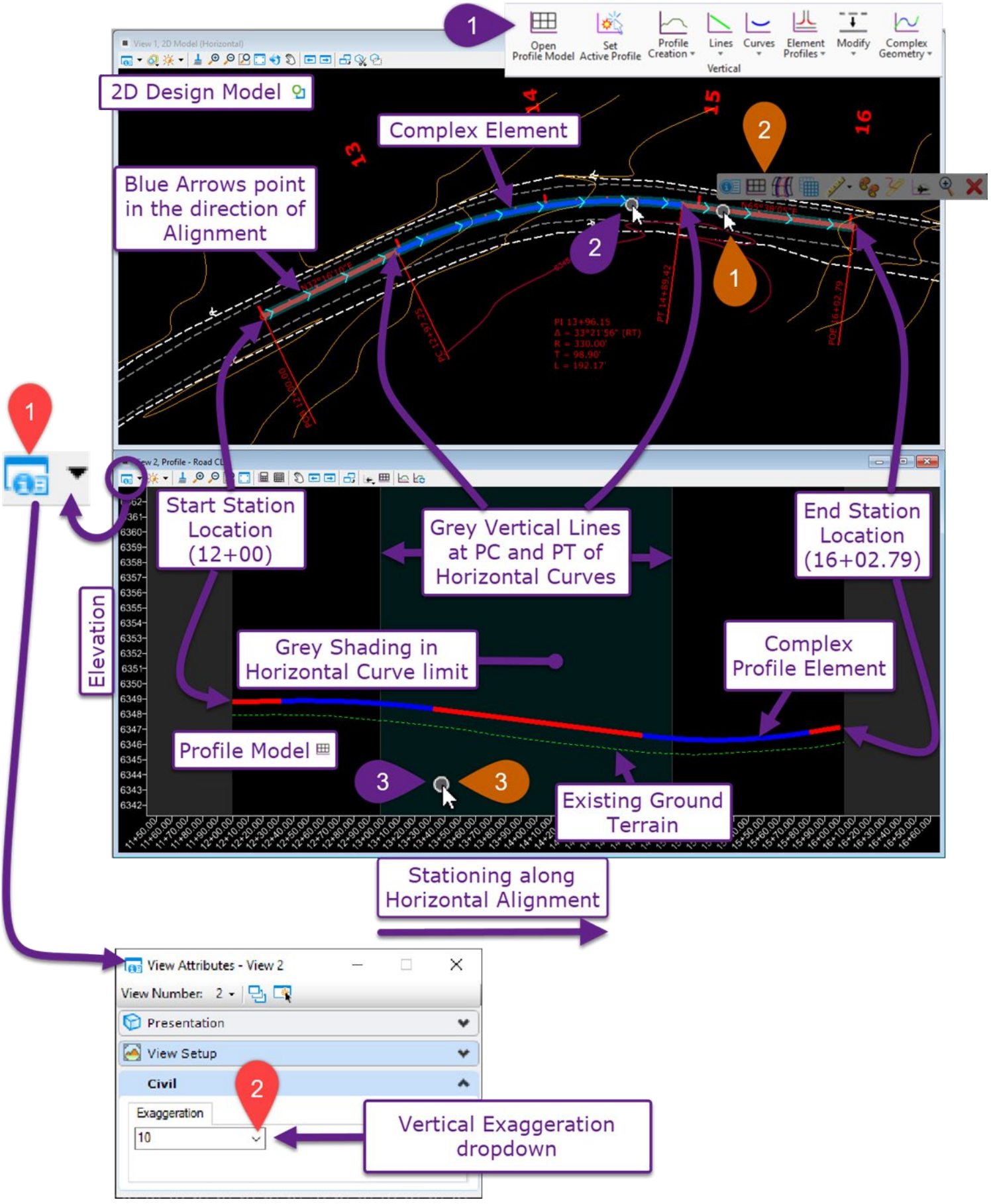
Access Profile Model with the Ribbon

1	Left-Click the *Open Profile Model* tool in the Vertical panel.
2	Left-Click on the Horizontal Element in the 2D Design Model.
3	Open a new *View* window and Left Click anywhere in the *View* OR Left-Click anywhere in the *2D Model View*.

Access Profile Model with the Pop-Up Icon Menu

1	In the 2D Design Model, Left-Click and hover over the Horizontal Element with the mouse cursor until the *Pop-Up Icon Menu* appears.
2	Left-Click on the *Open Profile Model* tool in the *Pop-Up Icon Menu*.
3	Open a new *View* window and Left Click anywhere in the *View* OR Left-Click anywhere in the *2D Model View*.

See next page for workflow graphic.


Open Profile Model
Set Active Profile
Profile Creation
Lines
Curves
Element Profiles
Modify
Complex Geometry
Vertical
2D Design Model
Complex Element
Blue Arrows point in the direction of Alignment
Start Station Location (12+00)
Grey Vertical Lines at PC and PT of Horizontal Curves
End Station Location (16+02.79)
Elevation
Grey Shading in Horizontal Curve limit
Complex Profile Element
Profile Model
Existing Ground Terrain
Stationing along Horizontal Alignment
View Attributes - View 2
View Number: 2
Presentation
View Setup
Civil
Exaggeration
10
Vertical Exaggeration dropdown

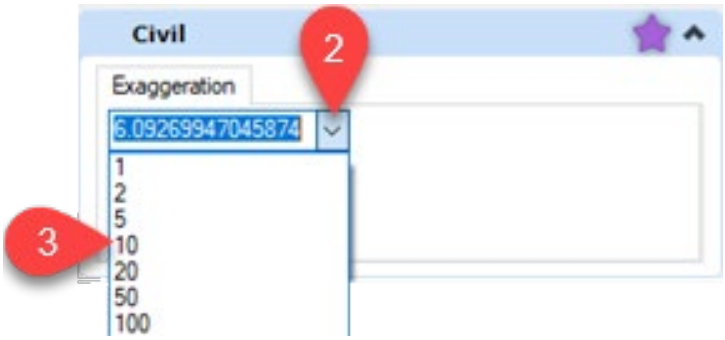
7F.1.b Changing the Vertical Exaggeration of a Profile Model

By default, a Profile Model will exaggerate the vertical scale of the grid by 10 times that of the horizontal scale (1H:10V). The 1H:10V vertical exaggeration is useful to the User because FLH Road Plan & Profile sheets typically shows Road Profiles at the same 1H:10V vertical exaggeration. When designing culverts or other civil features it is useful to view the *Profile Model* with less or no vertical exaggeration (i.e. 1H:1V).

The Vertical Exaggeration of a Profile Model can be changed in two possible ways:

Change Vertical Exaggeration in the View Attributes menu:

1	Left Click on the View Attributes icon to bring up the View Attributes menu. (This STEP is shown on previous page)
2	Under the *Civil* dropdown, Left-Click on the *Exaggeration* dropdown.
3	Select the desired Vertical Exaggeration (i.e., 1, 2, 5, 10, 20, 50, 100).



Change Vertical Exaggeration with Mouse Scroll-Wheel and Shift key:

Left-Click anywhere in the Profile Model *View.*
Press and hold the Shift key. While holding the Shift key, spin the Mouse Scroll-Wheel. Spinning upwards will increase the Vertical Exaggeration. Spinning downwards will decrease the Vertical Exaggeration.

NOTE: The *Mouse Scroll Wheel Method* produces unrounded values of Vertical Exaggeration (i.e. 1H:6.0926V). The *View Attributes Method* only contain the values listed in the dropdown. It is not possible to create a custom exaggeration, such as 1H:3V.

TIP: The value of Vertical Exaggeration obtained with the *Mouse Scroll-Wheel Method* can be checked in the View Attributes menu as shown above.

7F.1.c Activate Terrain Model - Show Terrain Model in a Profile Model

To give a Profile Model context, it is necessary to show the existing ground surface or other relevant Terrain Models. *Active* Terrain Models will be automatically displayed in a Profile Model – given the Horizontal Element is placed within the boundary of the Terrain Model.

Generally, the Existing Ground Terrain Model needs to be *Active* for design purposes. For a typical FLH project DGN setup, the Existing Ground Terrain Model will reside in the DGN with a suffix of _sur.dgn.

The _sur.dgn needs to be Referenced into the current .dgn file to for the Existing Ground Terrain Model to be *Activated*.

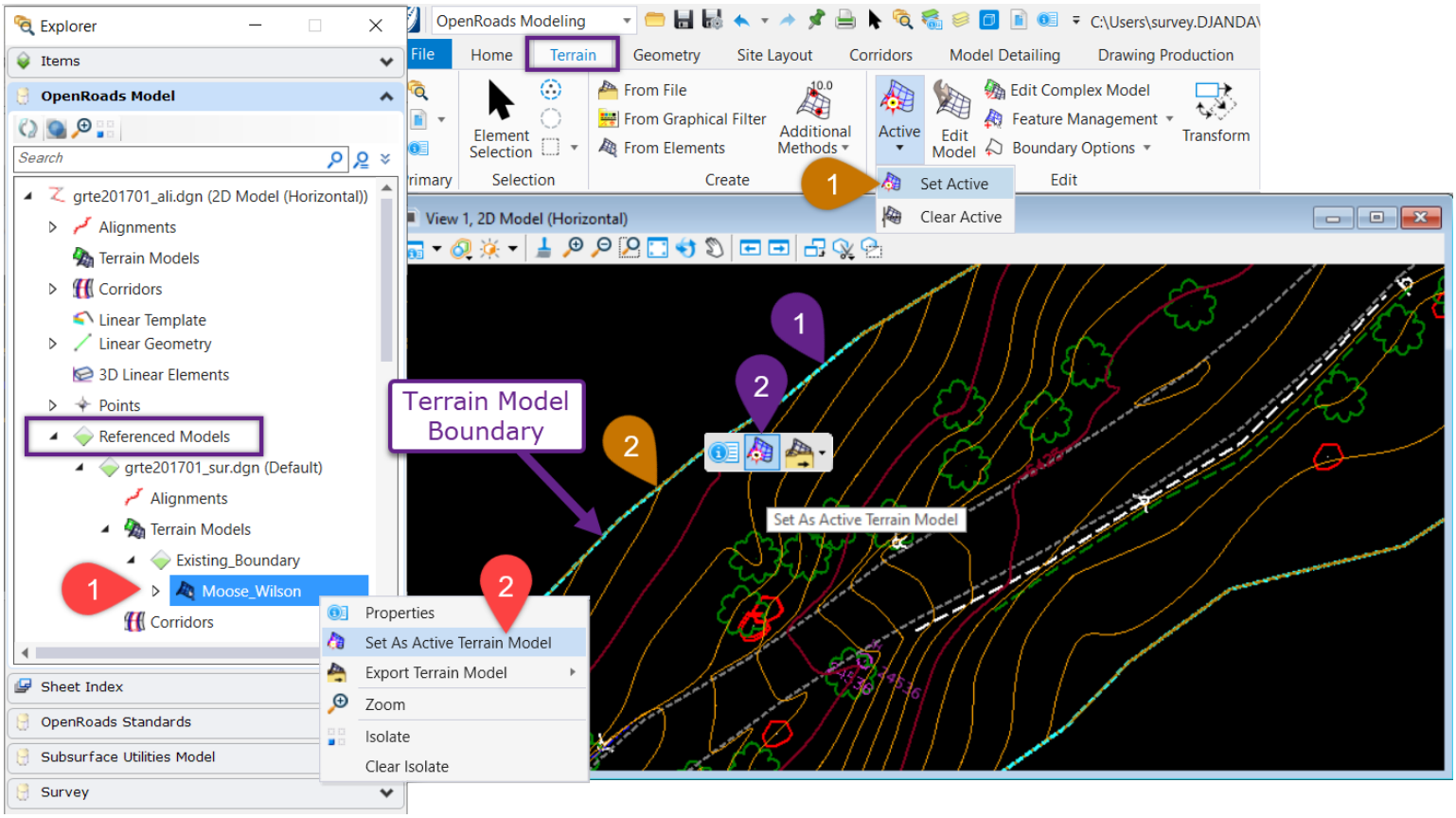
NOTE: Only one Terrain Model can be *Active* at any given time. Use the Add Surface To Profile tool

To *Activate a* Terrain Model with the Pop-Up Icon Menu:

1	Left-Click and hover over the Terrain Model with the mouse cursor until the *Pop-Up Icon Menu* appears.
2	Left-Click on the *Set As Active Terrain Model* tool  in the *Pop-Up Icon Menu*.

To *Activate* a Terrain Model with the Ribbon:

1	Left-Click on the *Set Active* tool under the *Active* dropdown.
2	*Prompt: Locate Terrain Model to set as Active* – Left-Click on the Terrain Model to complete the command.

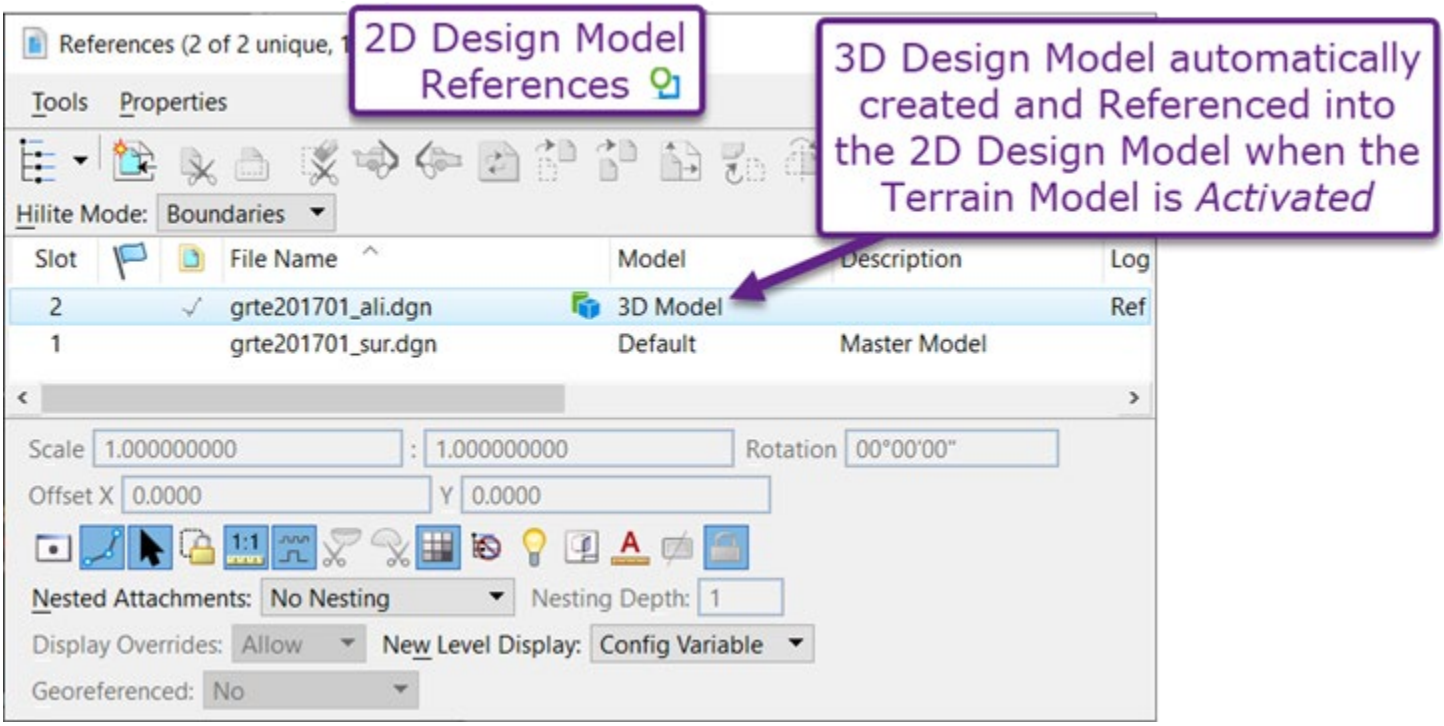


To *Activate* a Terrain Model with the Project Explorer:

1	Locate the Terrain Model in the Project Explorer.
2	Right-Click on the Terrain Model and select the *Set as Active Terrain Model* option.

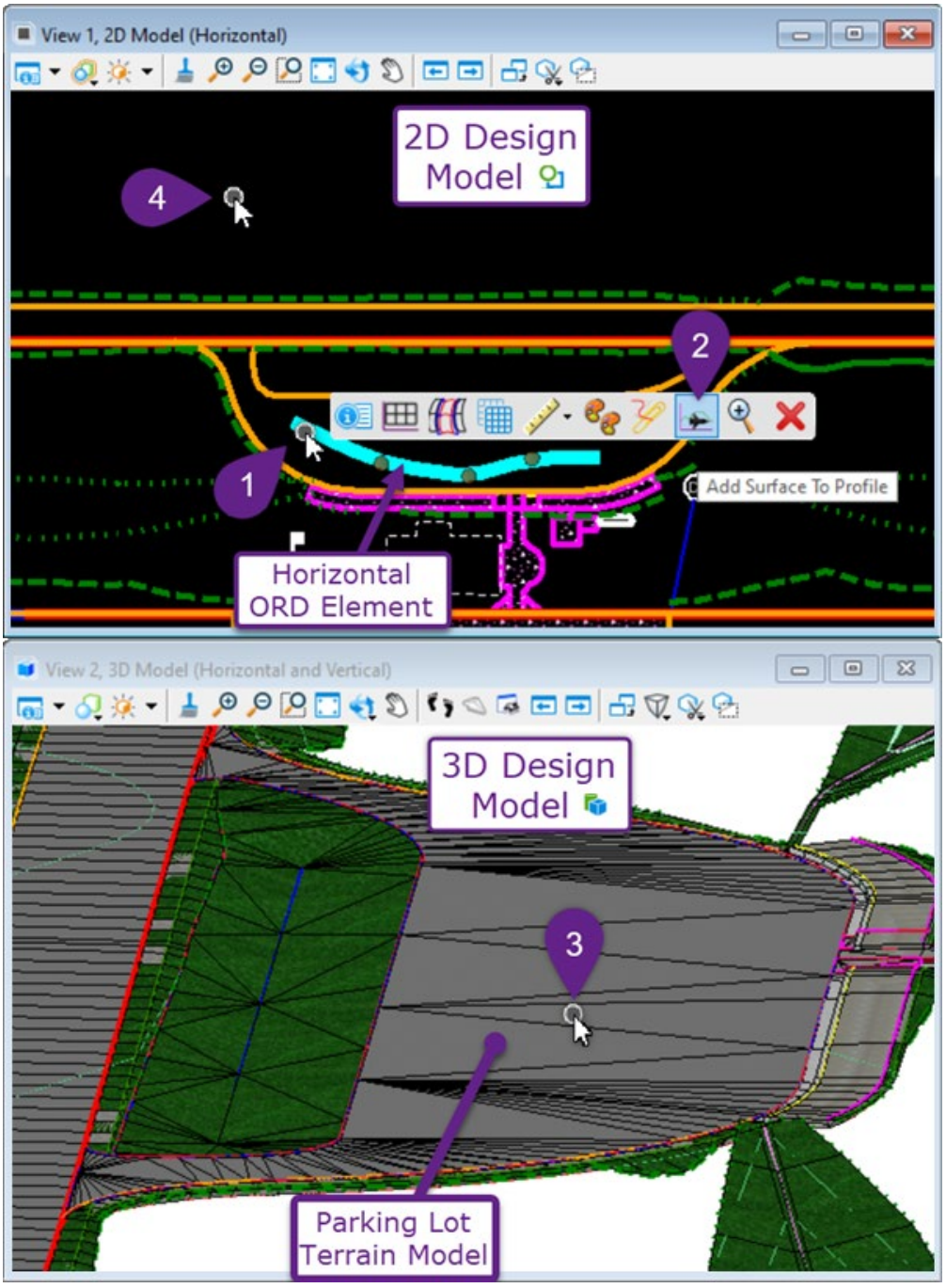
BEST PRACTICE: *Activate* the Existing Ground Terrain Model as a part of the Creating a New DGN Process.

NOTE: A new DGN file created with a *2D* Seed File will only contain a *2D Design Model*. When a Terrain Model is *Activated*, the software will automatically and additionally create a *3D Model*. The newly created *3D Model* will automatically be *Referenced* into the *2D Model*. In other words, 3D Elements are projected into a *2D Design Model* through a referenced *3D Design Model*. A *3D Design Model* will be automatically created whenever 3D Elements (such as a Terrain Model) are introduced and *Activated* in a DGN. Another example would be *Activating* a profile.

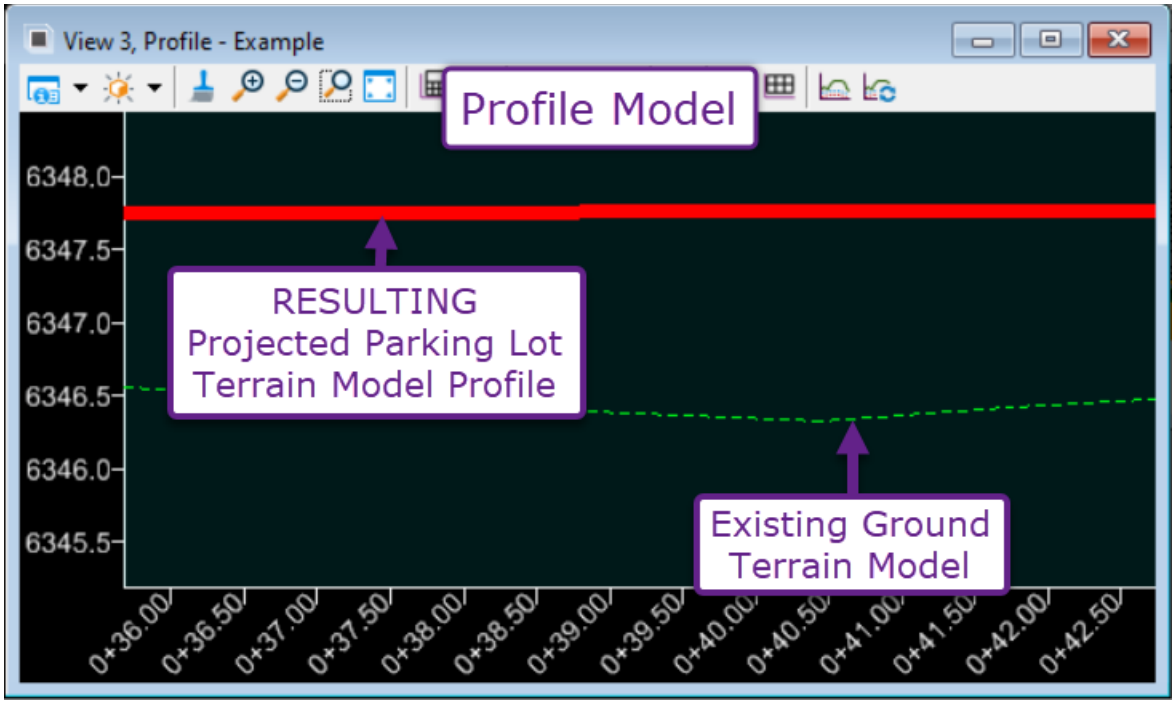


7F.1.d Show Multiple Terrain Models in a Profile Model

By default, the *Activated* Terrain Model will automatically be projected into the *Profile Model* of a Horizontal Element. Additional Terrain Models can be projected into the *Profile Model* of a Horizontal Element with the *Add Surface To Profile* tool:

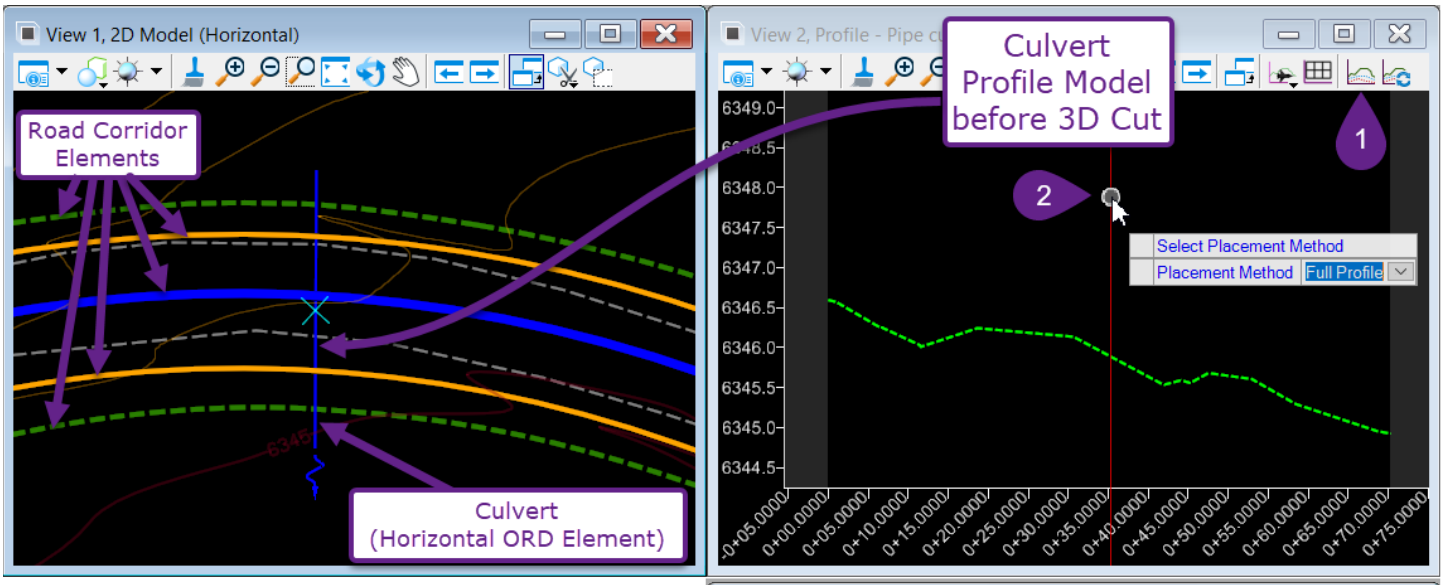


1	Left-Click and hover over the Horizontal Element with the mouse cursor until the *Pop-Up Icon Menu* appears.
2	Left-Click on the *Add Surface To Profile*  icon.
3	*Prompt: Locate Reference Surface* – Left-Click on the Terrain Model
4	*Prompt: Locate Reference Surface or Reset to End* – If desired, select another Terrain Model OR Right-Click in the *View* to complete the command.

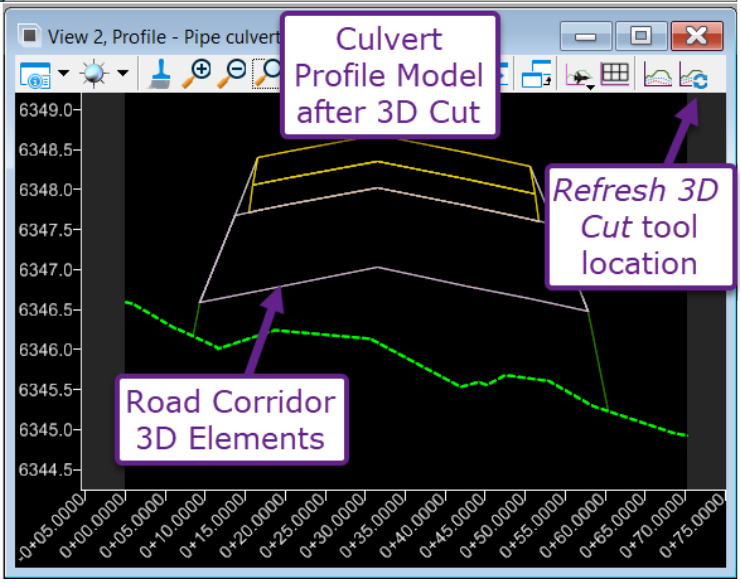

View 3, Profile - Example
Profile Model
6348.0
6347.5
6347.0
6346.5
6346.0
6345.5
RESULTING
Projected Parking Lot
Terrain Model Profile
Existing Ground
Terrain Model
0+36.00
0+36.50
0+37.00
0+37.50
0+38.00
0+38.50
0+39.00
0+39.50
0+40.00
0+40.50
0+41.00
0+41.50
0+42.00
0+42.50

7F.1.e Show Corridor and 3D Elements in a Profile Model with Create 3D Cut

By default, a newly-created Horizontal ORD Element will ONLY show the Active Terrain Model Profile (typically the existing ground) in the Profile Model. 3D Elements that cross the Horizontal ORD Element, such as a Corridor, can be shown in the Profile Model using the *Create 3D Cut* tool.



TIP: In the Model, Use the *Refresh 3D Cut* tool to update the 3D Cut if the Road Corridor is edited.

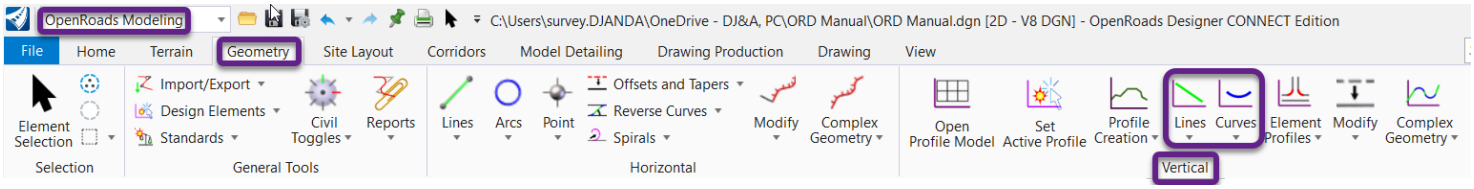


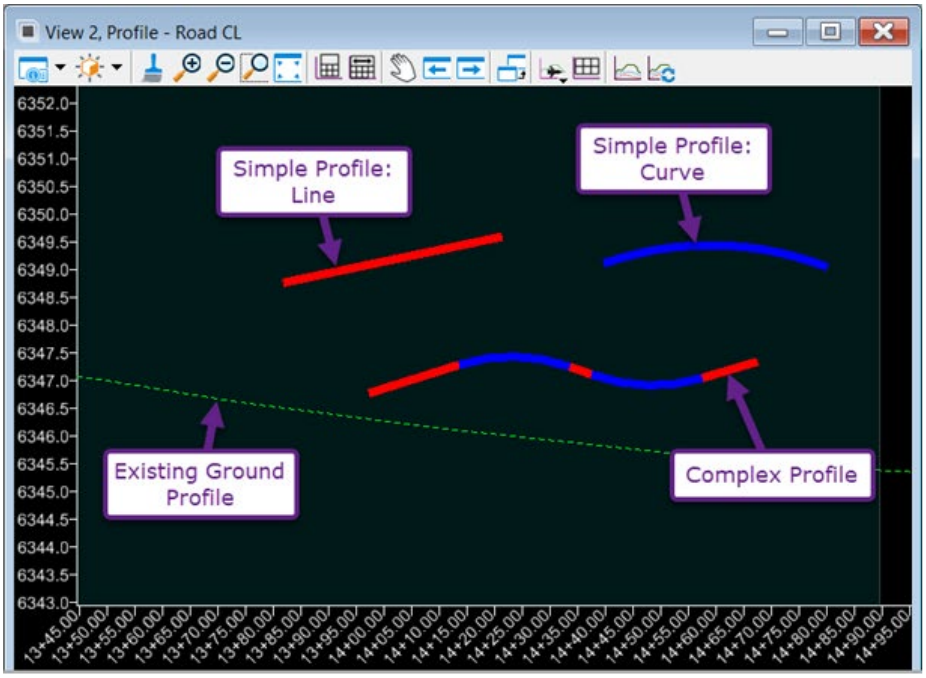
1	Left-Click on the *Create 3D Cut* icon in the *Profile Model* ribbon.
2	*Prompt: Select Placement Method* – Use the Up and Down Arrow keys to select the Placement Method. Left-Click in the Profile Model to complete the command.

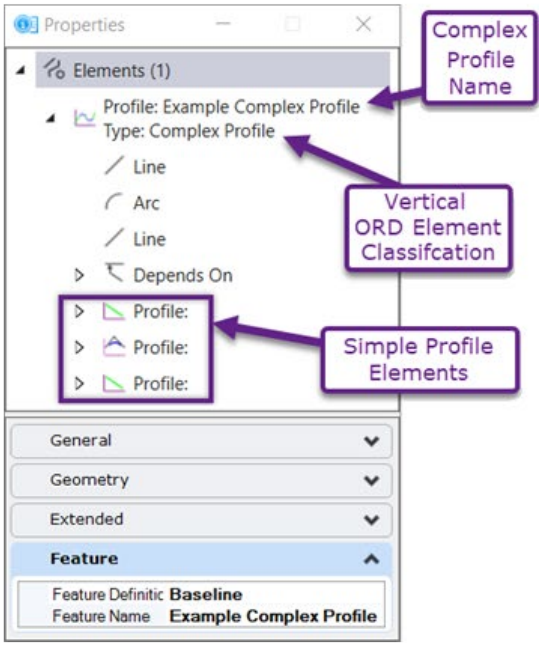
Placement Methods	
Method:	**Description:**
Corners	A window is placed in the Profile Model with the User specifying the corners. Only 3D Elements within the window length and height are shown.
Full Profile	Any 3D Element along the entire length of the Profile is shown

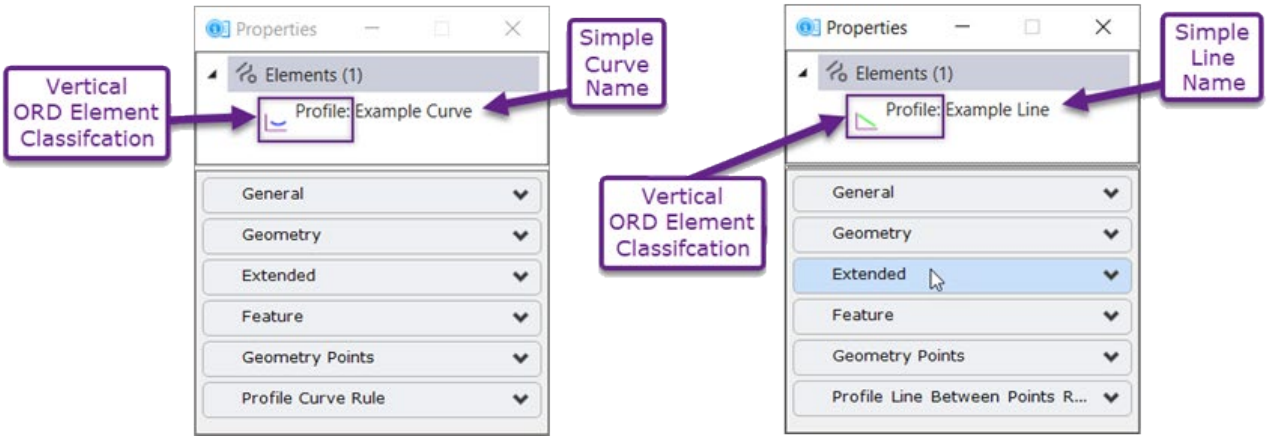
7F.2 Simple Profile Elements

Simple Vertical ORD Elements or *Simple Profile Elements* are singular geometric elements found under the *Lines* and *Curves* drop-down menus of the Vertical Panel of the *Geometry* ribbon. *Simple Profile Elements* are the same in concept as *Simple Alignment Elements*, but can only be used in the *Profile Model*. *Simple Profile Elements* can serve as a *Simple Profile* OR be joined (*Complexed*) with a string of other *Simple Profile Elements* (with the *Profile Complex By Elements* tool) to create a *Complex Profile*.



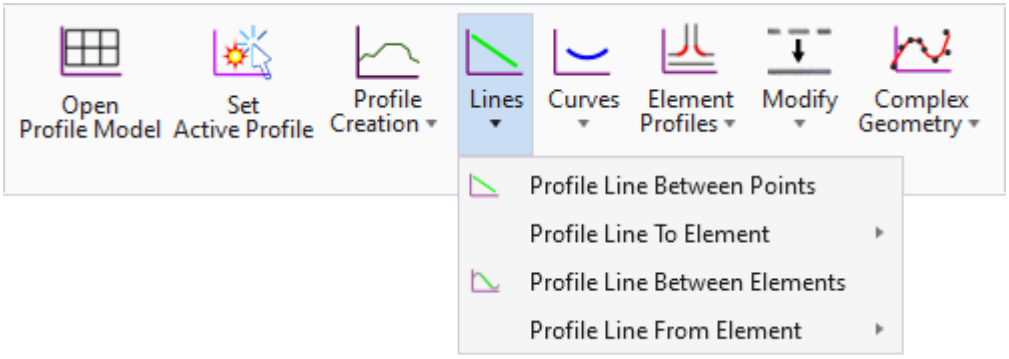






7F.2.a Lines

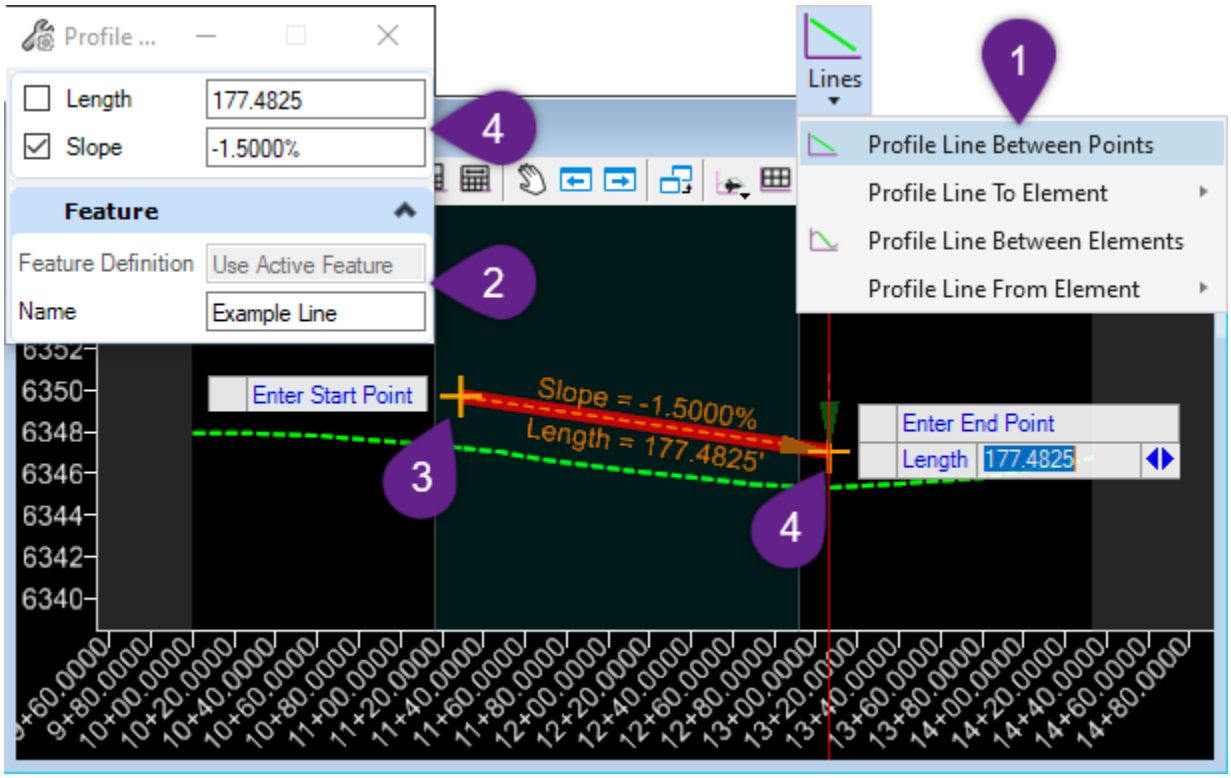
This section will cover how to create *Lines* to be used as a *Simple Profile* OR used in the Profile Complex by Element workflow to create a *Complex Profile*. All Line creation tools can be found in the Lines dropdown of the *Vertical* panel.



7F.2.a.i Profile Line Between Points

This tool creates a *Line* between two User defined points. This tool functions similar in concept as the Horizontal tool – *Line Between Points*.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Profile Line Between Points* tool from the *Lines* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Line* a *Feature Name* if desired.
3	*Prompt: Start Point* - In the *View,* position the cursor in the desired location for the Start Point. Left-Click to accept the location.
4	*Prompt: End Point* - In the *View,* position the cursor in the desired location for the End Point. Left-Click to accept the location and complete the command. OR Specify End Point location with *Dialogue Inputs*. Left-Click to accept the location and complete the command

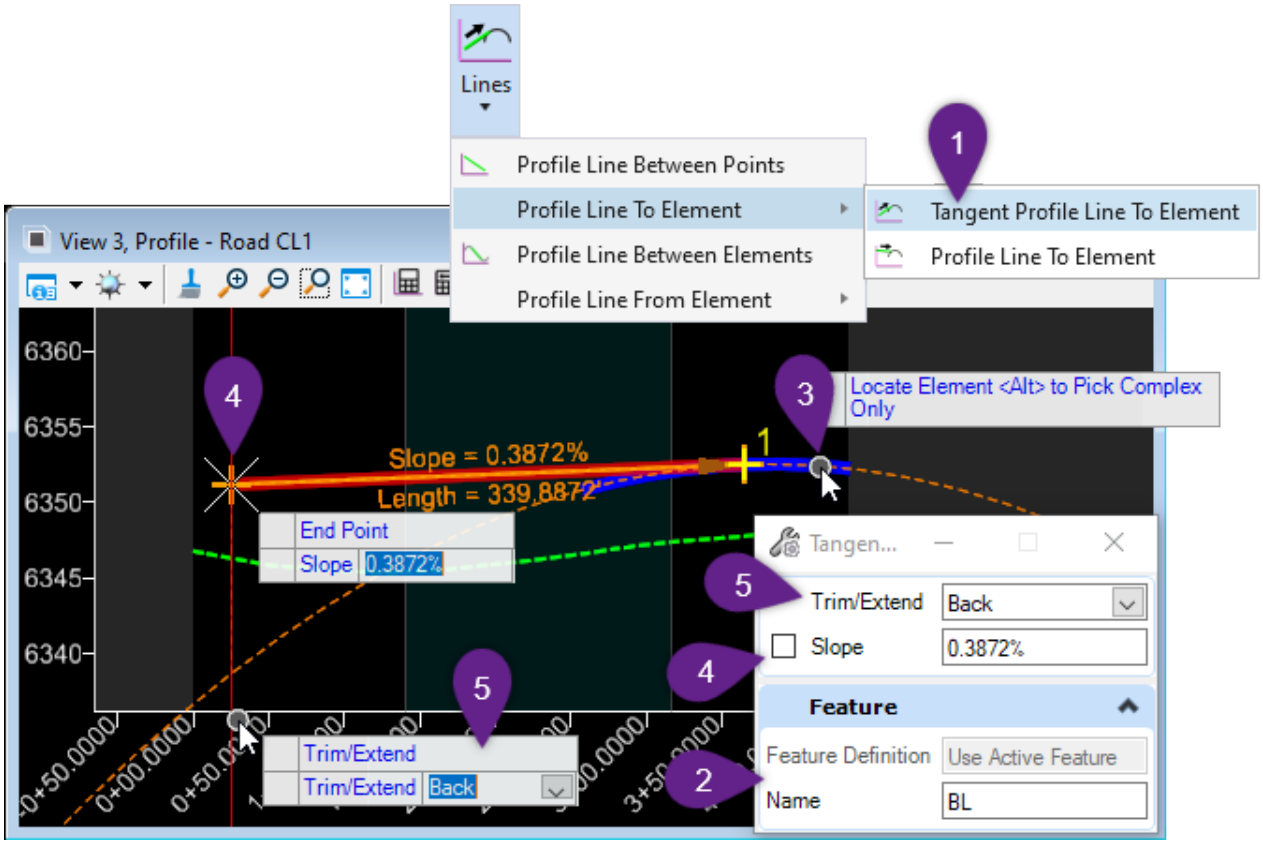
Dialogue Options	
Option:	**Description:**
Length	Locks the horizontal linear distance (along x-axis) from the Start Point to the End Point
Slope	Locks the slope between the Start Point and the End Point

7F.2.a.ii Profile Line To Element tools

7F.2.a.ii(a) Tangent Profile Line To Element

Creates a *Line* from a User-defined point – tangentially - to a point on a reference curve. This tool functions similar in concept as the Horizontal tool – Line To Element – Simple Line To Element.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Tangent Profile Line to Element* tool from the *Lines* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Line* a *Feature Name* if desired.
3	*Prompt: Locate Element <Alt> to Pick Complex Only* – Left-Click on the reference curve to draw a Profile Line tangentially to.
4	*Prompt: End Point (Tap ALT to Switch to Back solution)* – Move the mouse cursor around in the *View* to preview *Line*. If two solutions are possible to draw a line to the curve (or on the Projected Curve), press the ALT key to switch between the *Ahead Solution* and the *Back Solution*. Left Click at desired *Profile Line* end point to complete the command.
5	*Prompt: Trim/Extend Dialogue Key-In* – Use the Up and Down arrow keys to switch between various Trim/Extend methods. Left Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Trim/Extend	Trim/Extend the reference Curve to meet the start point of the *Profile Line*.
Slope	Locks the slope that the tangent *Profile Line* will meet the *Curve* with.

7F.2.a.ii(b) Profile Line To Element

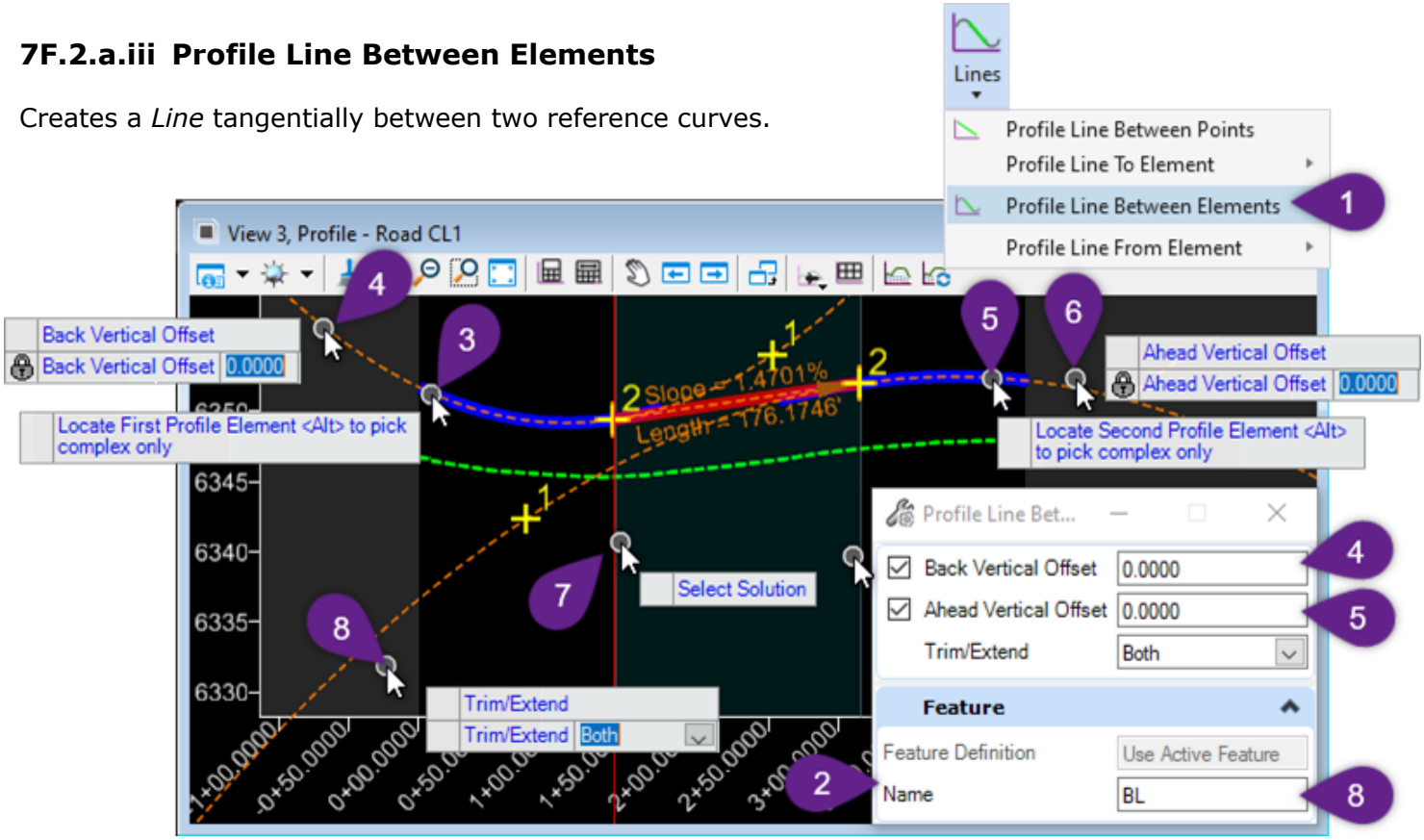
Creates a *Line* from a user defined point to a reference element. This tool differs from the *Tangent Profile Line To Element* tool in two key ways:

1. This tool will draw a *Line* to a reference Curve or Line, but the resulting line does not have be tangent. A *Delta Slope* can be specified to draw an non-tangent *Line* to a reference element. Because the resulting line does NOT have to be tangent to the reference element, this tool also works with Lines - unlike the *Tangent Profile Line to Element* tool.
2. A *Vertical Offset* can be specified. The resulting *Profile Line* will be drawn to the projected offset curve.

NOTE: Enabling Civil *AccuDraw* will provide additional *Cursor Dialogue* options.

7F.2.a.iii Profile Line Between Elements

Creates a *Line* tangentially between two reference curves.



1	Left-Click the *Profile Line Between Elements* tool from the *Lines* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Line* a *Feature Name* if desired.
3	*Prompt: Locate First Profile Element <Alt> to Pick Complex Only* – Left-Click on the first reference curve to draw a Profile Line tangentially from.
4	*Prompt: Back Vertical Offset* – If desired, the resulting Line can be drawn from a projected vertical offset of the reference curve. Key-In the desired vertical offset distance OR Key-In the value 0 if no vertical offset is desired. Press ENTER to lock the *Vertical Offset* value. Left Click in the *View* to advance to the next prompt

5	*Prompt: Locate Second Profile Element <Alt> to Pick Complex Only* – Left-Click on the second reference curve to draw a Profile Line tangentially to.
6	*Prompt: Ahead Vertical Offset* – Key-In the *Vertical Offset* value and press ENTER. Left Click in the *View* to advance to the next prompt.
7	*Prompt: End Point (Tap ALT to Switch to Back solution)* – Move the mouse cursor around in the *View* to preview *Line*. If two solutions are possible to draw a line to the curve (or on the Projected Curve), press the ALT key to switch between the *Ahead Solution* and the *Back Solution*. Left Click at desired *Profile Line* end point to complete the command.
8	*Prompt: Trim/Extend Dialogue Key-In* – Use the Up and Down arrow keys to switch between various Trim/Extend methods. Left Click in the *View* to complete the command. ***Note:*** Trim/Extend operations will not function on reference curves with a vertical offset.

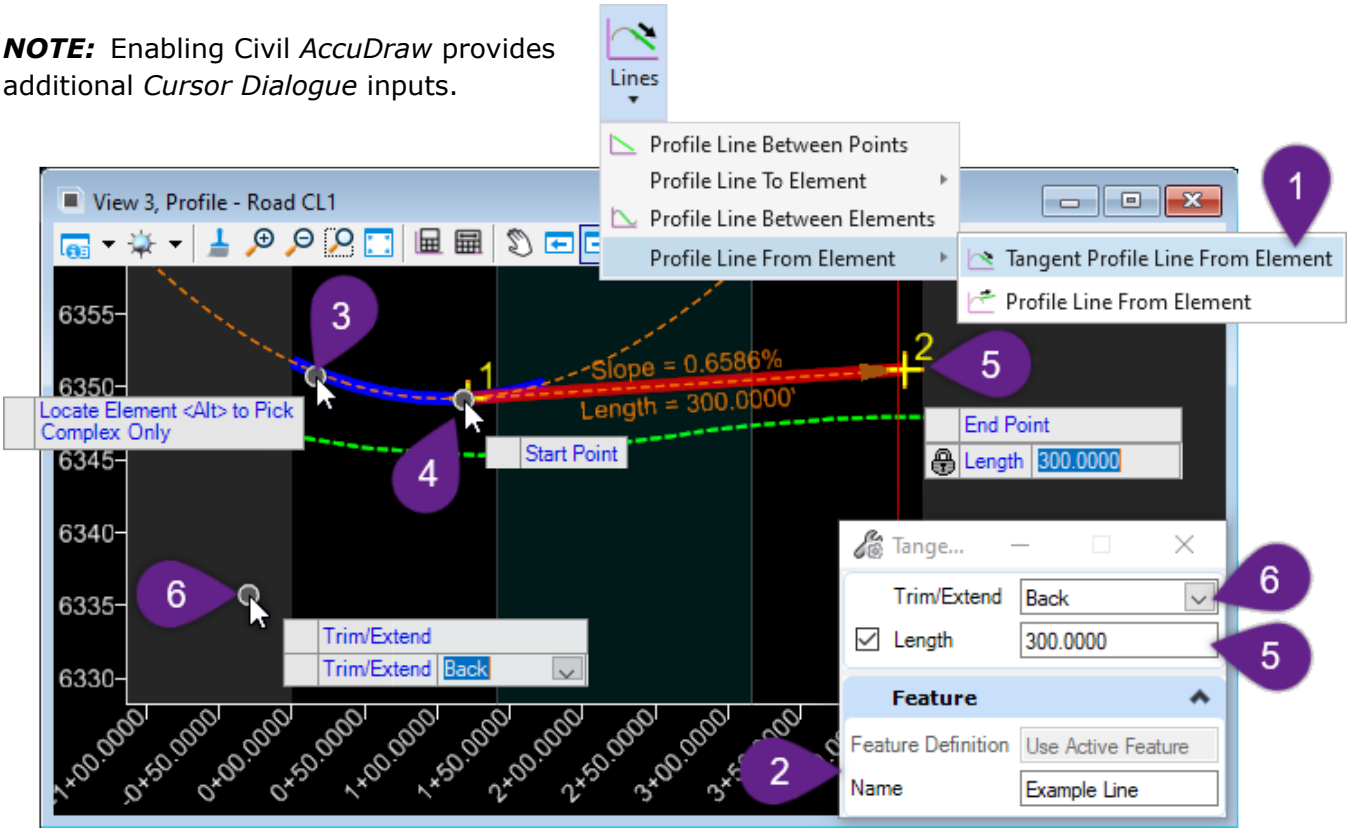
Dialogue Options	
Options:	**Description:**
Back Vertical Offset	Locks the *Back Vertical Offset* of the first reference curve
Ahead Vertical Offset	Locks the *Ahead Vertical Offset* of the second reference curve
Trim/Extend	Trim/Extend the reference Curve to meet with resulting *Profile Line*.

7F.2.a.iv Profile Line From Element tools

7F.2.a.iv(a) Tangent Profile Line From Element

Creates a *Line* from a start point on a reference curve tangentially to a User-defined end point. This tool functions similar in concept as the Horizontal tool – Line From Element – Simple Line From Element.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Profile Line From Element* tool from the *Lines* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Line* a *Feature Name* if desired.
3	*Prompt: Locate Element <ALT> to complex only* – Left Click on the reference Curve to draw a *Profile Line* tangentially from.
4	*Prompt: Start Point* - Left Click at a point on the reference Curve (or projected curve) to begin drawing tangent Profile Line from – to advance to the next *Prompt.*
5	*Prompt: End Point* - Left Click at the desired end point of the *Profile Line* to advance to the next *Prompt.* If two solutions are possible, press the ALT key to switch between the solutions.
6	*Prompt: Trim/Extend Dialogue Key-In* – Press the Up and Down arrow keys to switch between various Trim/Extend methods. Left Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Length	Locks the horizontal linear distance (along x-axis) from the Start Point on the reference curve to the end point of the *Profile Line.*
Trim/Extend	Trim/Extend the reference Curve to meet the start point of *Profile Line*.

7F.2.a.iv(b) Profile Line From Element

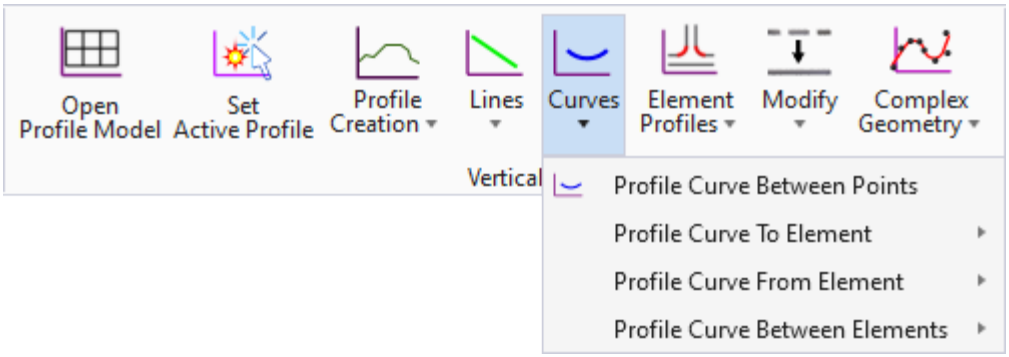
Creates a *Line* from a reference element to a user-defined end point. This tool differs from the *Tangent Profile Line From Element* tool in two key ways:

1. This tool will draw a *Line* from a reference Curve or Line – however - the resulting line does not have be tangent. A *Delta Slope* can be specified to the draw an un-tangent *Line* from a reference element. Because the resulting line does NOT have to be tangent to the reference element, this tool will also works with Lines - unlike the *Tangent Profile Line to Element* tool.
2. A *Vertical Offset* can be specified. The resulting *Line* will be drawn from the projected offset curve.

NOTE: Enabling Civil *AccuDraw* will provide additional *Cursor Dialogue* options.

7F.2.b Curves

This section will cover how to create *Lines* to be used as a *Simple Profile Element* OR used in the Profile Complex by Element workflow to create a *Complex Profile.* All Curve creation tools can be found in the Curve dropdown.



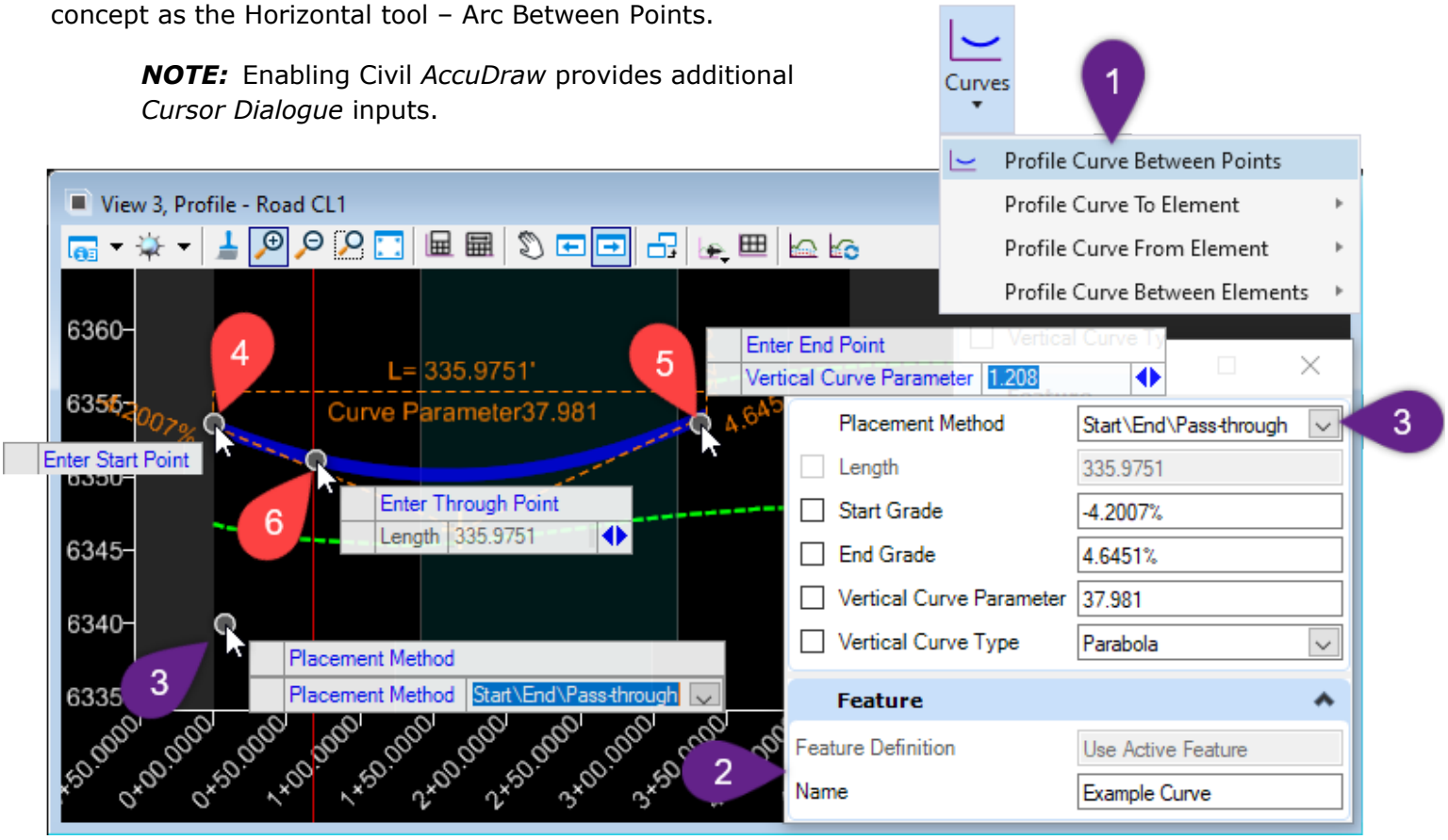
PARABOLA VS CIRCULAR CURVE NOTE: In the software, the User has the option to create either CIRCULAR and PARABOLIC vertical curves. In vertical highway design, it is conventional to idealize vertical curves as equal-tangent PARABOLIC curves. AASHTO Vertical Curve Equations are written in the form of aX^2+bX+c to represent an equal-tangent parabola.

BEST PRACTICE: Use PARABOLIC curves to create vertical geometry represents the proposed centerline of road profile.

7F.2.b.i Profile Curve Between Points

Creates a free-standing *Profile Curve* outlined from User-defined points. This tool functions similar in concept as the Horizontal tool – Arc Between Points.

> ***NOTE:*** Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



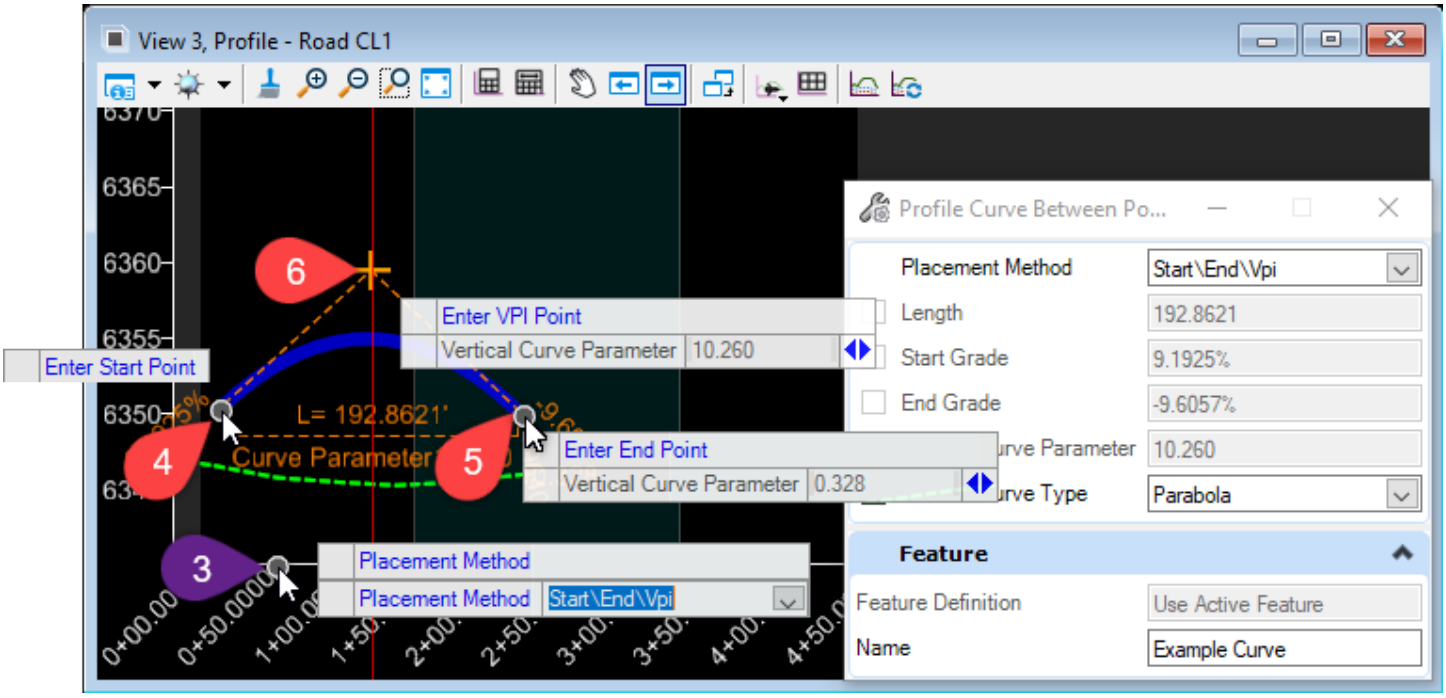
1	Left-Click the *Profile Curve Between Points* tool from the *Curves* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Curve* a *Feature Name* if desired.
3	*Prompt: Placement Method* – In the *Dialogue Key-In*, use the UP and DOWN arrow to cycle through the 3 methods to place a free-standing curve – OR select a *Placement Method* from the drop-down in the *Dialogue Box*. Left Click in *View* to advance to the next prompt

Placement Method: Start\End\Pass-through

4	*Prompt: Enter Start Point* – Left-Click at the desired start point for the Curve.
5	*Prompt: Enter End Point* – Left-Click at the desired end point for the Curve.
6	*Prompt: Enter Through Point (Tap <Ctrl> to switch to switch to Circular Curve)* – Left-Click at desired pass through point to complete the command. Press the CTRL key to switch to from a parabolic curve to a circular curve. See *Parabola vs Circular Curve NOTE.*

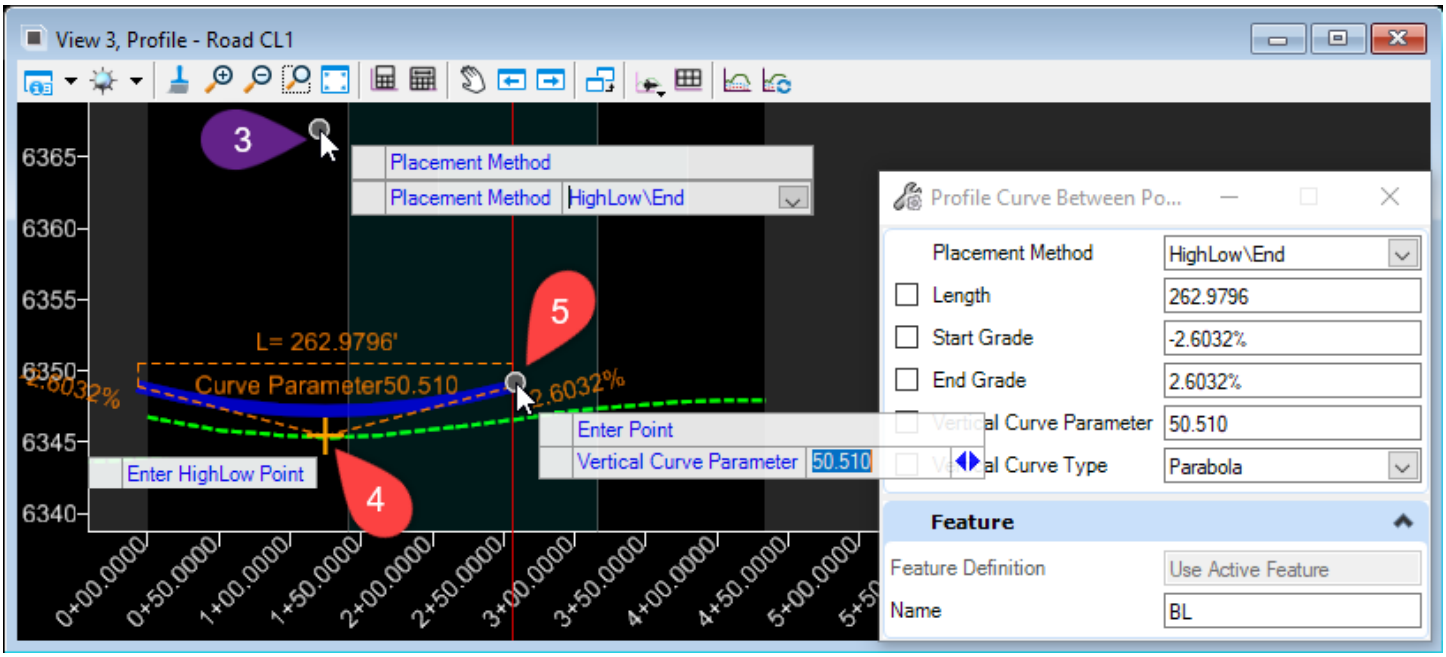
Placement Method: Start\End\VPI

NOTE: This Placement Method does not allow for Dialogue options; however, Civil AccuDraw Inputs can be effective for this Placement Method.



4	*Prompt: Enter Start Point* – Left Click at the desired start point for the *Curve*.
5	*Prompt: Enter End Point* – Left Click at the desired end point for the *Curve*.
6	*Prompt: Enter VPI Point* – Left Click at the desired VPI elevation point to complete the command. ***Note:*** VPIs are horizontally placed exactly halfway between Start and End Point.

Placement Method: HighLow\End



4	*Prompt: Enter HighLow Point* – Left-Click at either the desired high or low point of the *Profile Curve*.
5	*Prompt: Enter Point* – Left-Click at the desired End Point for the *Profile Curve*. If the End Point is above the preceding High/Low Point, then the tool will produce a Sag Curve. Conversely, an End Point placed below the preceding will produce a Crest Curve.

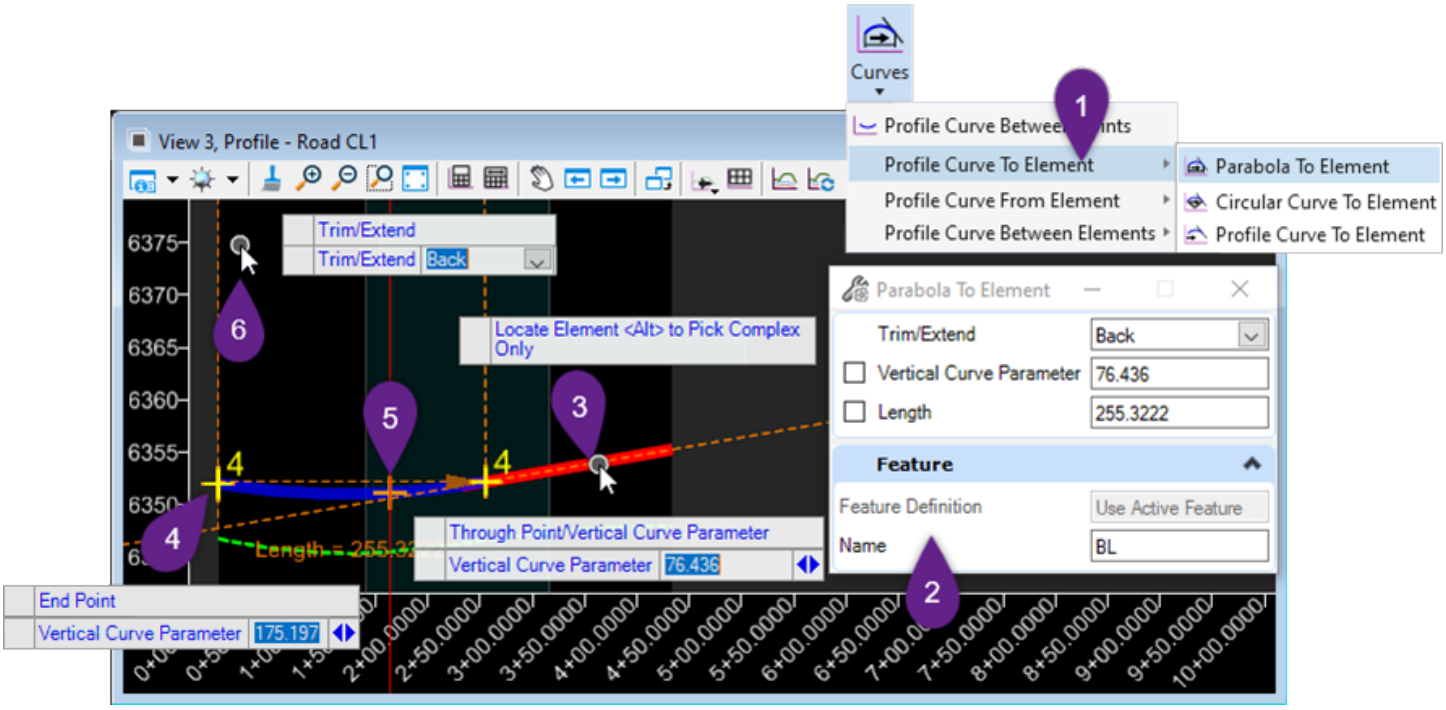
Dialogue Options	
Option:	**Description:**
Length	Locks the horizontal distance (along x-axis) from the Start Point to the End Point of the *Profile Curve.*
Start Grade	Locks the grade of the *Profile Curve* at the Start Point
End Grade	Locks the grade of the *Profile Curve* at the End Point
Vertical Curve Parameter	Locks the K-Value of the *Profile Curve.* Note: by default, Vertical Curve Parameter will be set to K-Value in the FWHA seed file – Design File Settings.
Vertical Curve Type	Option available in *Dialogue Box* only. Locks the Vertical Curve Type. Options include Parabolic Curve or Circular Curve.

7F.2.b.ii Profile Curve to Element tools

7F.2.b.ii(a) Parabola To Element

Creates a parabolic *Profile Curve* from a user-defined point tangentially to a reference element. This tool functions similar in concept as the Horizontal tool – *Arc To Element – Simple Arc To Element*.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Parabola To Element* tool from the *Curves* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Curve* a *Feature Name* if desired.
3	*Prompt: Locate Element <Alt> to Pick Complex Only* – Left Click on the Reference Element to draw a curve tangentially to. ***NOTE:*** the reference element can also be a curve to create adjoining vertical curves (compound curve)
4	*Prompt: End Point (Tap <Alt> to switch to solution 2)(Tap <Ctrl> to switch to Circular Curve)* – Left Click in the *View* at the desired End Point location to advance to the next prompt. If two solutions are possible, press the ALT key to switch between solutions. See *Parabola vs Circular Curve NOTE.*
5	*Prompt: Through Point/Vertical Curve Parameter (Tap <Alt> to switch to solution 2)(Tap <Ctrl> to switch to Circular Curve)* – Left Click at the desired at a point on the curve to advance to the next prompt. Alternatively, complete curve definition with *Dialogue Options*.
6	*Prompt: Trim/Extend Dialogue Key-In* – Press the Up and Down arrow keys to switch between various Trim/Extend methods. Left Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Vertical Curve Parameter	Locks the K-Value of the *Profile Curve.* If value is locked, the software will automatically find the geometrically feasible location of the Through Point and Start Point on reference element.
Length	Locks the horizontal distance (along x-axis) from the Start Point on the reference element to the end point of the *Profile Curve*
Trim/Extend	Trim/Extend the reference element to meet the start point of *Profile Curve*.

7F.2.b.ii(b) Circular Curve To Element

Creates a circular *Profile Curve* from a user-defined start point tangentially to a reference curve. This tool functions exactly the same as the *Parabola to Element* tool with two exceptions:

1. This tool will create a circular curve instead of an equal-tangent parabolic curve
2. The Dialogue Option – *Length* is not available for this tool

WARNING: Do NOT use Circular Curves in a centerline of road profile. See Parabola vs Circular Curve NOTE.

7F.2.b.ii(c) Profile Curve To Element

Creates a *Profile Curve* from a user-defined start point tangentially to a reference curve. This tool is a combination of the *Parabola To Element* and *Circular Curve To Element* – with additional Dialogue Options

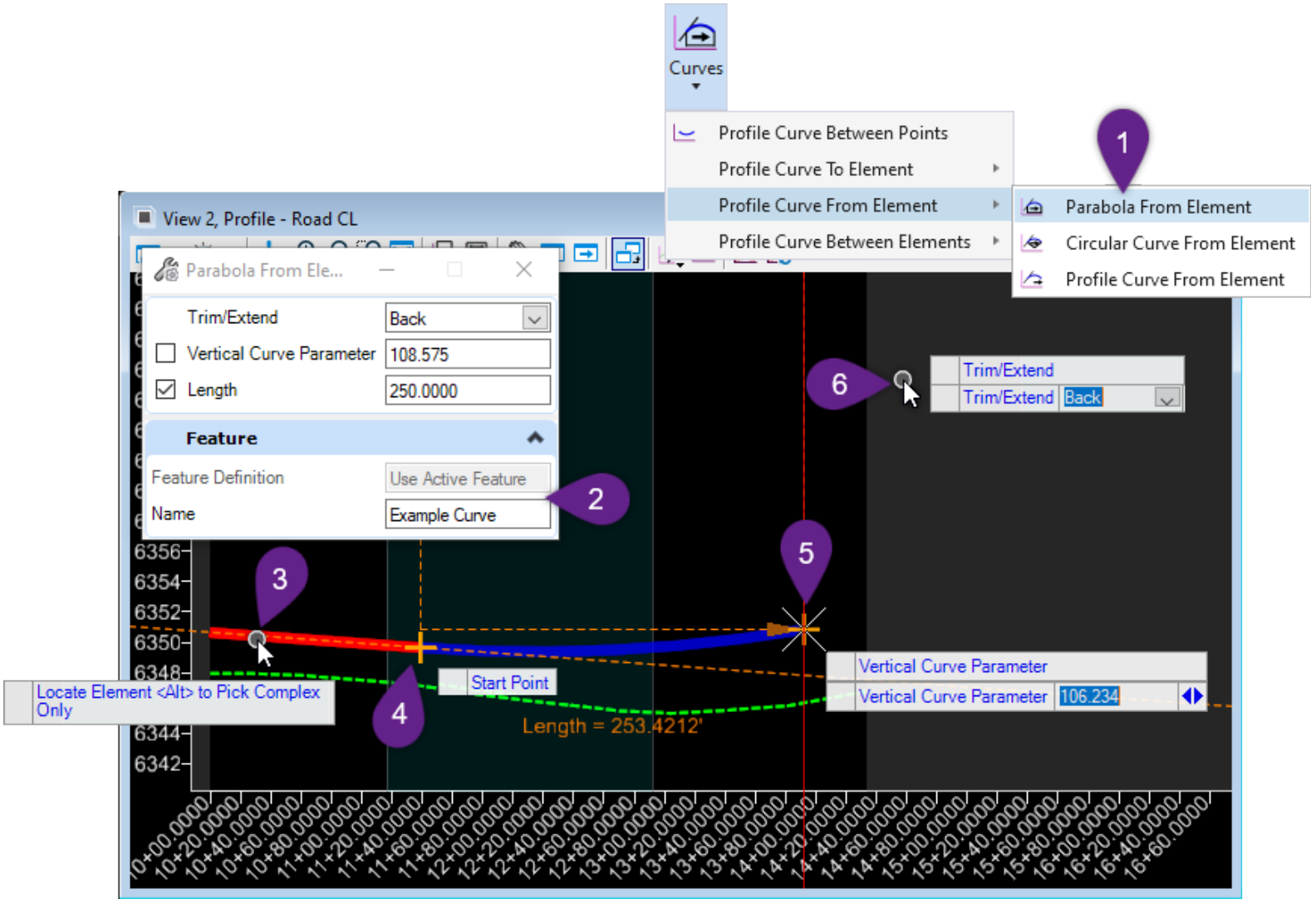
1. Creates both parabolic and circular curves
2. Allows the user to enter a *Vertical Offset* to the draw the *Profile Curve* to.
3. Allows the user to enter an *End Grade* to define the *Profile Curve.*

7F.2.b.iii Curve From Element tools

7F.2.b.iii(a) Parabola From Element

Creates a parabolic *Curve* from a Reference Line tangentially to a User-defined end point. This tool functions similar in concept as the Horizontal tool – Arc From Element – Simple Arc From Element.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Parabola From Element* tool from the *Curves* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Curve* a *Feature Name* if desired.
3	*Prompt: Locate Element <Alt> to Pick Complex Only* - Left Click on the Reference Element to draw a curve tangentially from. Note: the reference element can also be a curve to create adjoining vertical curves (compound curve)
4	*Prompt: Start Point* – Left Click at the desired Start Point location along the reference element.
5	*Prompt: End Point/Vertical Curve Parameter* – Left-Click at the desired End Point location OR key-in *Dialogue Options* to define *Curve* geometry.
6	*Prompt: Trim/Extend* – Use the Up and Down arrow keys to switch between various Trim/Extend methods for the Reference Line. Left-Click in the *View* to complete the command.

Dialogue Option	
Option:	**Description:**
Vertical Curve Parameter	Locks the K-Value of the *Profile Curve.* If value is locked, the software will automatically calculate the *Profile Curve* End Grade.
Length	Locks the horizontal distance (along x-axis) from the Start Point on the reference element to the end point of the *Profile Curve*
Trim/Extend	Trim/Extend the reference element to meet the start point of *Profile Curve*.

7F.2.b.iii(b) Circular Curve From Element

Creates a circular *Profile Curve* from a reference element tangentially to a user-defined end point. This tool functions exactly the same as the *Parabola From Element* tool with two exceptions:

1. This tool will create a circular curve instead of an equal-tangent parabolic curve
2. The Dialogue Option – *Length* is not available for this tool

WARNING: Do NOT use Circular Curves in a centerline of road profile. See Parabola vs Circular Curve NOTE.

7F.2.b.iii(c) Profile Curve From Element

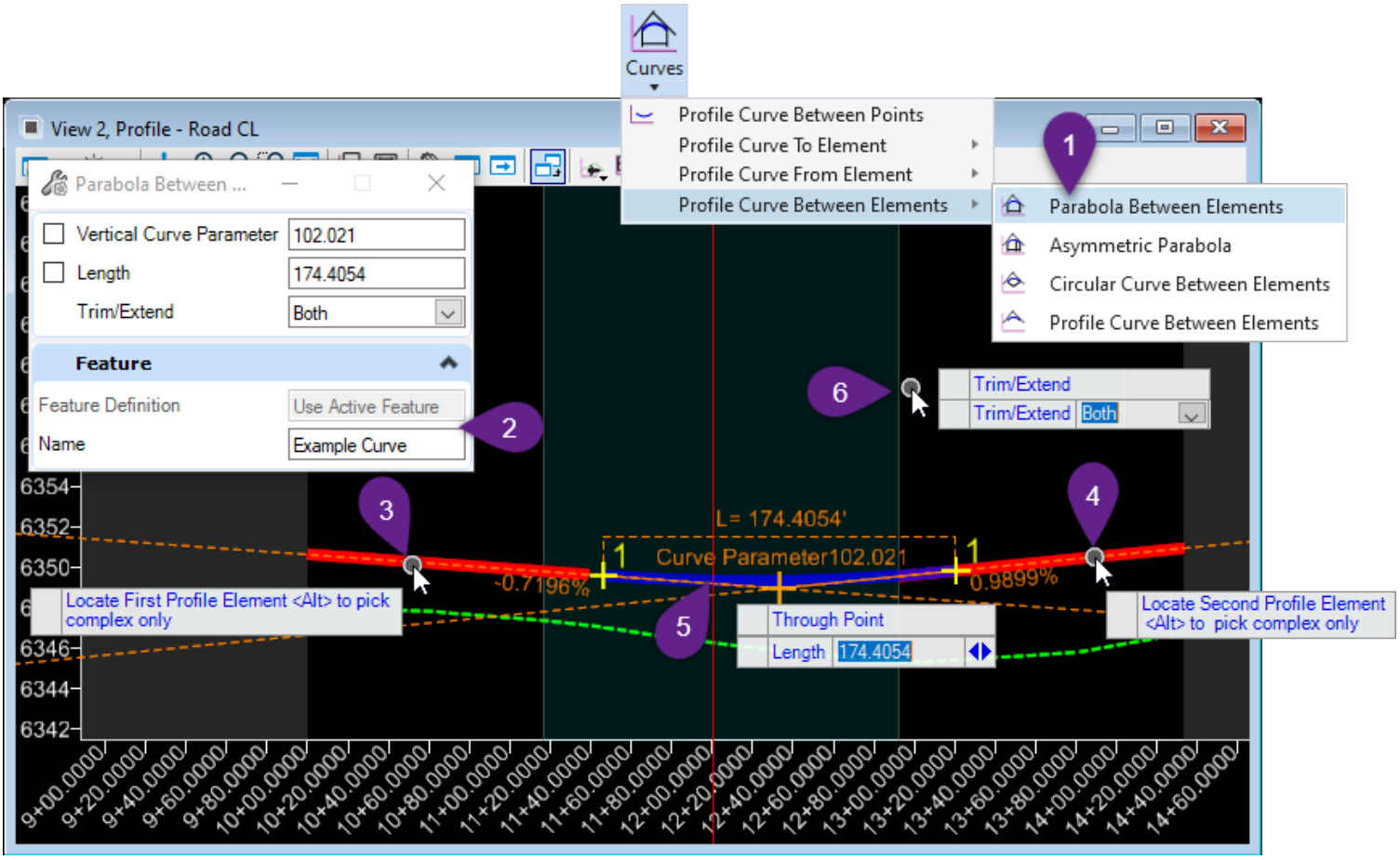
Creates a *Profile Curve* from a reference element tangentially to a user-defined end point. This tool is a combination of the *Parabola From Element* and *Circular Curve From Element* – with additional Dialogue Options:

1. Creates both parabolic and circular curves
2. Allows the user to enter a *Vertical Offset* to the draw the *Profile Curve* From.
3. Allows the user to enter an *End Grade* to define the *Profile Curve.*

7F.2.b.iv Profile Curve Between Elements tools

7F.2.b.iv(a) Parabola Between Elements

Creates a parabolic Curve between two Reference Lines. In other words, this tool will create a parabolic Fillet between two *Profile Line* elements.



1	Left-Click the *Parabola Between Elements* tool from the *Curves* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Curve* a *Feature Name* if desired.
3	*Prompt:* Locate First Profile Element <Alt> to pick complex only – Left Click on the first reference element.
4	*Prompt:* Locate Second Profile Element <Alt> to pick complex only – Left Click on the second reference element.
5	*Prompt: Through Point (Tap <Alt> to switch to crest/sag) (Tap <Ctrl> to switch to Asymmetric Parabola)* - Left Click at the desired through point for the curve to advance to the next prompt. Alternatively – Define the *Profile Curve* with Dialogue Options. ***NOTE:*** Press the ALT key to switch between available crest/sag solutions ***NOTE:*** Press CTRL key to switch from a parabola to an asymmetric parabola.
6	*Prompt: Trim/Extend Dialogue Key-In* – Use the Up and Down arrow keys to switch between various Trim/Extend methods. Left Click in the *View* to complete the command.

Dialogue Option	
Option:	**Description:**
Vertical Curve Parameter	Locks the K-Value of the *Profile Curve.* If value is locked, the software will automatically calculate the *Profile Curve* Length.
Length	Locks the horizontal distance (along x-axis) for the *Profile Curve* from the Start Point on the *Back* reference element to the end point on the *Ahead* reference element. If value is locked, the software will automatically calculate the Vertical Curve Parameter.
Trim/Extend	Trim/Extend the *Back* and *Ahead* elements to meet the start and end point of the *Profile Curve*.

7F.2.b.iv(b) Asymmetric Parabola

Creates an Asymmetric Parabolic Curve between two Reference Lines. An Asymmetric Parabolic Curve is 2-Center Vertical Curve or Vertical Compound Curve.

7F.2.b.iv(c) Circular Curve Between Elements

Creates a Circular Curve between two Reference Lines.

WARNING: Do NOT use Circular Curve in a centerline of road profile. See Parabola vs Circular Curve NOTE.

7F.2.b.iv(d) Profile Curve Between Elements

Creates any type of *Profile Curve* between two Reference Lines. This tool is a combination of all Curve Between Elements tool – which means it can create either a parabola, asymmetric, or circular curve. This tool has the added option of vertically offsetting the Start or End Point from the Reference Lines.

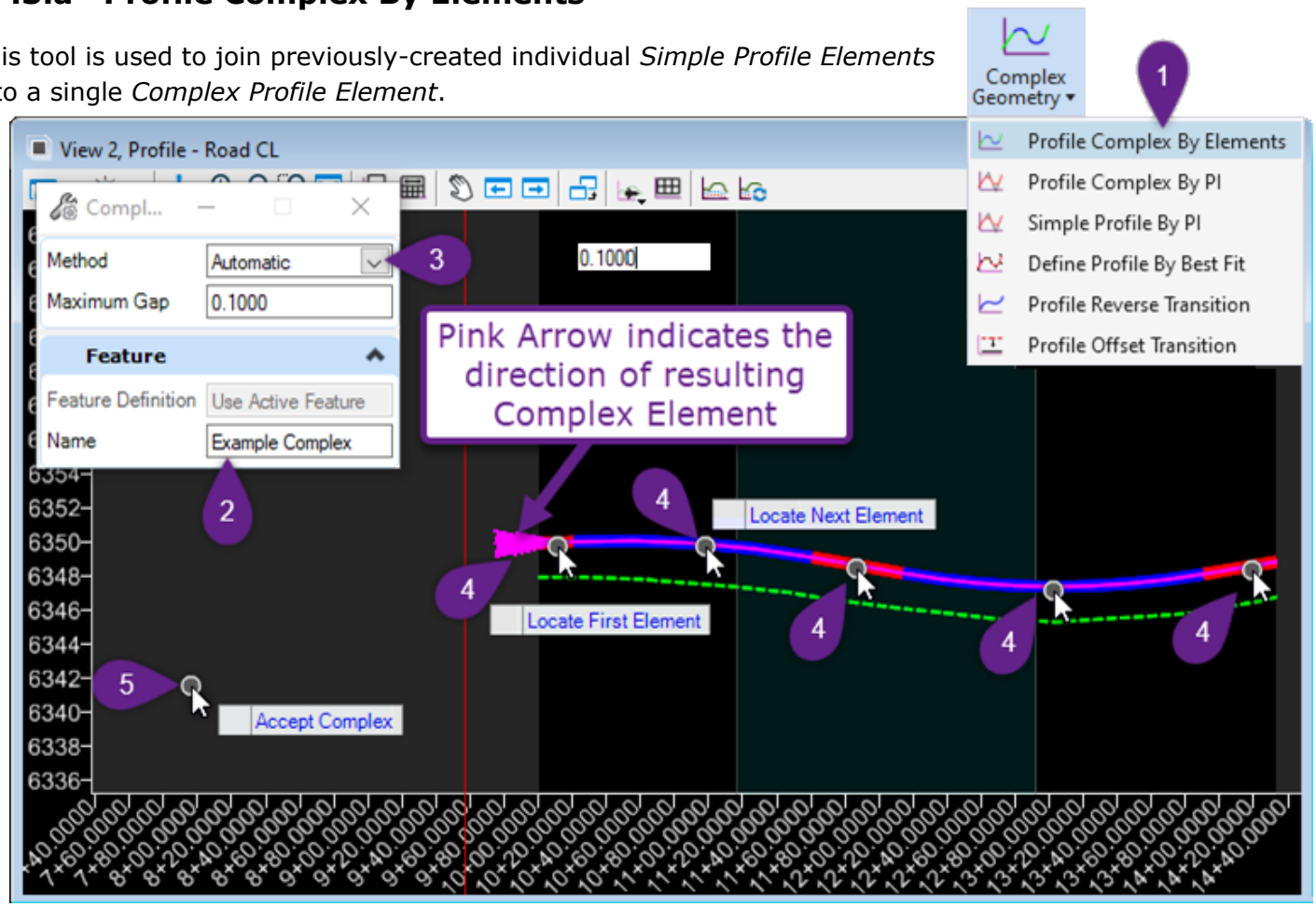
7F.3 Complex Profiles

Creating a *Complex Profile Element* is accomplished with four distinct workflows:

Vertical Alignment Creation Workflows			
Workflow:	**Description:**	**Advantages:**	**Limitations:**
Profile Complex By Elements	This method creates a single *Complex Profile Element* by joining together a continuous string of previously-created *Simple Profile Elements.*	Graphically find a "Best Fit" for a profile by individually laying out Lines and Curve components.	Underlying *Base ORD Elements* will retain *Design Intent* relationships after being joined into a *Complex Profile Element*. Edits made to the *Complex Profile Element* can result disjointed/broken due to conflicting *Design Intent* in *Base ORD Elements*.
Profile Complex By PI	This method creates a *Complex Profile Element* by graphically determining Points of Intersection (PI). The software automatically draws in Lines between user defined PIs - which are tangentially connected by Curves.	*Complex Profile Elements* created with this method take to edits in a predictable manner. Underlying *Base ORD Elements* are created with *Simplified Civil Rules.* Edits made through this workflow are less likely to disjoint/break when compared to *Profile Complex By Elements* method.	Even if the combined user defined PI locations and curve parameters are not geometrically tangible, the software will still draw the alignment, without prompted the user with an error message. The result can be a disjointed/broken alignment.
Simple Profile By PI	This workflow is very similar to the *Profile Complex By PI* described above. This tool creates a *Complex Profile* by clicking at the desired VPIs locations.	This workflow is intended for closed Horizontal Elements - representing site-layout features such as the perimeter of a parking lot. This tool ensures that the beginning and end of a *Complex Profile* have a common elevation – which is geometrically necessary for a closed feature. The resulting closed 3D Element can directly generate a *Terrain Model* to be used with a *Surface Template.*	This tool ONLY allows the user to input *Vertical Curve Parameters* in the creation process. This contrasts with the *Profile Complex By PI* workflow – which allows for the User to input Slope, Curve Length, and Vertical Curve Parameter.
Define Profile By Best Fit	This method creates a *Complex Profile Element* AUTOMTATICALLY by finding a "Best Fit" from previously-created elements - such as a surveyed existing ground under existing centerline of Road	This tool allows the User to specify Upper and Lower Envelope and *Vertical Curve Parameters* to automatically create a *Complex Profile*. The resulting profile will need to be edited for the reasons stated in the Disadvantages column, however, this workflow can be a quick and efficient way to begin the profile creation process based off of relatively simply reference elements.	If the tool cannot find a best fit with the User input, the result can be a messy vertical alignment without tangential geometry. Similarly, the automated process will use default inputs to generalize C*urves* which results in a vertical alignment with the same *Curve* lengths throughout.

7F.3.a Profile Complex By Elements

This tool is used to join previously-created individual *Simple Profile Elements* into a single *Complex Profile Element*.



1	Left-Click the *Profile Complex By Elements* tool from the *Complex Geometry* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	In the *Dialogue Box,* select the *Method* to be used to create the *Complex Element* **Manual** – Individual *Simple Profile Elements* are selected manually and in sequentially order. **Automatic –** The first *Simple Profile Element* is selected and all connecting *Profile Elements* (or elements within the specified *Maximum Gap*) are then automatically selected. ***BEST PRACTICE:*** When creating Simple Profile Elements, use *Trim/Extend* operations to ensure there is no gap between Profile Elements. ***RECCOMMENDATION:*** Use a *Maximum Gap* value of 0.1000 for first attempt with the **Automatic** method. If this *Maximum Gap* value does not work, re-check that there is no gap between *Simple Alignment Elements* OR marginally increase *Maximum Gap* value.
4	*Prompt: Locate First Element* – Left-Click on the first *Simple Profile Element* to be joined into a *Complex Element.* A pink arrow will display the direction of the resulting alignment. If the *Automatic Method* is chosen – advance to the next step. If the *Manual Method* is chosen – Left-Click on the remain *Simple Profile Elements* in sequential order.
5	*Prompt: Accept Complex* - Ensure all *Elements* to be included in the *Complex Profile Element* are highlighted. Left-Click in the *View* to complete the command.

Dialogue Box and Key-Ins	
Input	**Description:**
Method	**Manual** – Individual *Simple Profile Elements* are selected manually and in sequentially order. **Automatic –** The first *Simple Profile Element* is selected and all connecting *Profile Elements* (or elements within the specified *Maximum Gap*) are then automatically selected.
Maximum Gap	Allowable gap distance between the end points of adjacent *Simple Profile Elements* to be joined in the *Complex Element.*

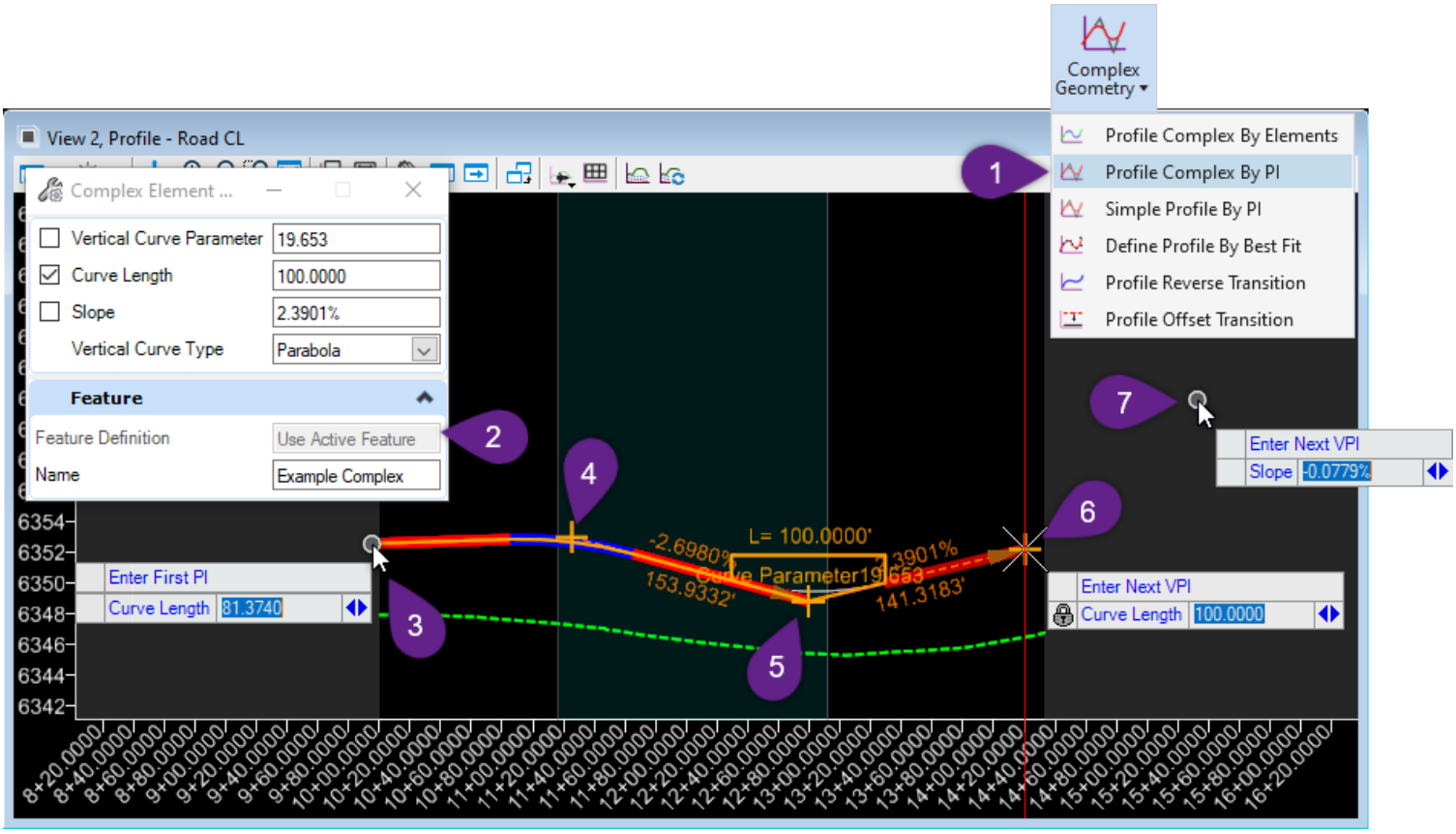
WARNING: After this tool is used – *Simple Profile Elements* are converted to underlying *Base ORD Elements* within the resulting *Complex Profile Element*. *Design Intent, Civil-Rules,* and *Persist-Snap* used in the creation of the individual *Simple Profile Elements* are preserved in the *Base ORD Elements*.

TIP: Use the *Simplify Geometry* tool or make an edit with the *Table Editor* to *Simplify* the underlying *Base ORD Elements* within the *Complex Profile Element*.

7F.3.b Profile Complex By PI

This tool creates a *Complex Profile Element* – without having to create *Simple Profile Elements* prior.

NOTE: Enabling Civil *AccuDraw* provides additional *Cursor Dialogue* inputs.



1	Left-Click the *Profile Complex By PI* tool from the *Complex Geometry* dropdown.

2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Profile Element* a *Feature Name.*
3	*Prompt: Enter First PI* – In the *View,* Left-Click at the desired Starting Point location.
4	*Prompt: Enter Next VPI* – Left-Click at the first VPI location. ***NOTE:*** At this point in the tool workflow, the *Slope* of the first line can be locked with *Dialogue Options*.
5	*Prompt: Enter Next VPI* – Left-Click at the second VPI location. ***NOTE:*** At this point in the tool workflow, the *Curve Length* or *Vertical Curve Parameter* for the FIRST vertical curve can be locked with *Dialogue Options.* The *Curve Length* can be locked at a value of zero to create VPI without a curve (Line to line).
6	*Prompt: Enter Next VPI* – Left-Click at the End Point location. ***NOTE:*** At this point in the tool workflow, the *Curve Length* or *Vertical Curve Parameter* for the SECOND vertical curve can be locked with *Dialogue Options.*
7	*Prompt: Enter Next VPI* – Right-Click in the *View* to complete the command.

Dialogue Options	
Option:	**Description:**
Vertical Curve Parameter	Locks the K-Value of the *Profile Curve.* If value is locked, the software will automatically calculate the *Profile Curve* Length.
Length	Locks the horizontal distance (along x-axis) for the *Profile Curve* from the Start Point on the *Back* reference element to the end point on the *Ahead* reference element. If value is locked, the software will automatically calculate the Vertical Curve Parameter.
Trim/Extend	Trim/Extend the *Back* and *Ahead* elements to meet the start and end point of the *Profile Curve*.

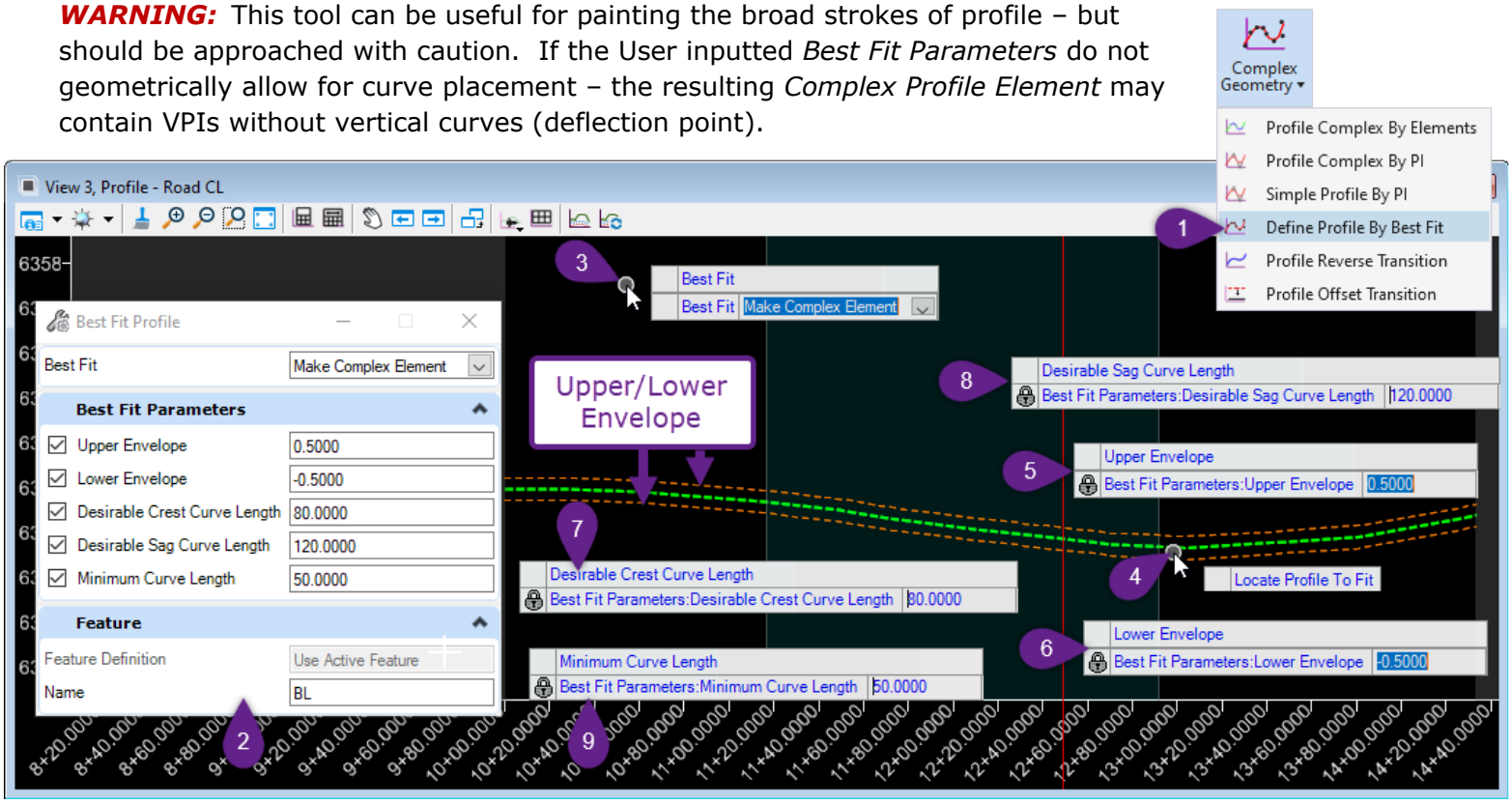
7F.3.c Simple Profile By PI

This tool is a more basic version of *Profile Complex By PI*. This tool is intended to create a *Complex Profile Element* for *CLOSED Horizontal ORD Elements*. *Closed Horizontal ORD Elements are* commonly used to represent site-design features – such as the edge of a parking lot. This tool automatically places the start and end point at the same elevation.

7F.3.d Define Profile By Best Fit

This tool will automatically create a *Simple* or *Complex Profile Element* based off a best fit from a *Reference Element* – such as an existing ground profile.

WARNING: This tool can be useful for painting the broad strokes of profile – but should be approached with caution. If the User inputted *Best Fit Parameters* do not geometrically allow for curve placement – the resulting *Complex Profile Element* may contain VPIs without vertical curves (deflection point).

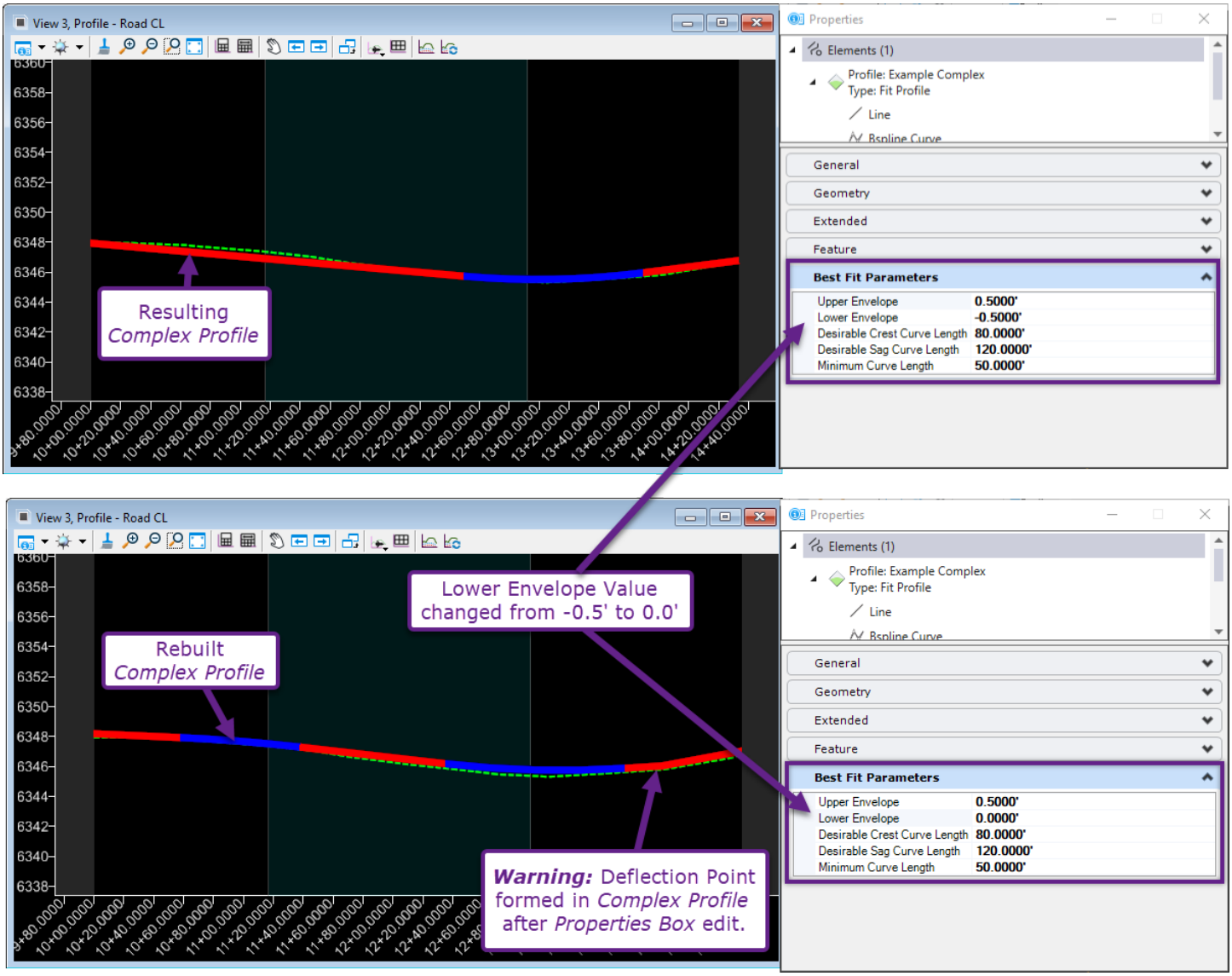


1	Left-Click the *Define Profile By Best Fit* tool from the *Complex Geometry* dropdown.
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	*Prompt: Best Fit* – Specify the best fit method with *Dialogue Options*. Left-Click in the *View* to accept and advance to the next *Prompt*
4	*Prompt: Locate Profile To Fit* – Left-Click on the *Reference Element*
5	*Prompt: Upper Envelope* – Key-in desired upper envelope value and Left-Click in the *View*
6	*Prompt: Lower Envelope* – Key-in desired lower envelope value and Left-Click in the *View*
7	*Prompt: Desirable Crest Curve Length* – Key-in value and Left-Click in the *View*
8	*Prompt: Desirable Sag Curve Length* – Key-in value and Left-Click in the *View*
9	*Prompt: Minimum Curve Length* – Key-in value and Left-Click in the *View*.

Dialogue Options		
Options:	**Description:**	
Best Fit	Make Complex Element	The resulting profile is a single Profile Line
	Make Single Element	The resulting profile is *Complex Profile Element*
Upper/Lower Envelope	The upper and lower vertical boundaries for the automatically created *Complex Profile Element*. The software will insert as many VPIs as necessary to create a best fit *Complex Profile* within the upper and lower envelope.	
Desirable Crest/Sag Curve Length	If geometrically feasible, the software will create crests and sag curves at the desired length. ***NOTE:*** the software will NOT create crests and sag curves larger than the desired length.	
Minimum Curve Length	Minimum length of curve that will be automatically generated.	

The *Best Fit Parameters* for the resulting Complex Profile Element can be changed in the Properties Box to essentially rebuild the Complex Profile Element.

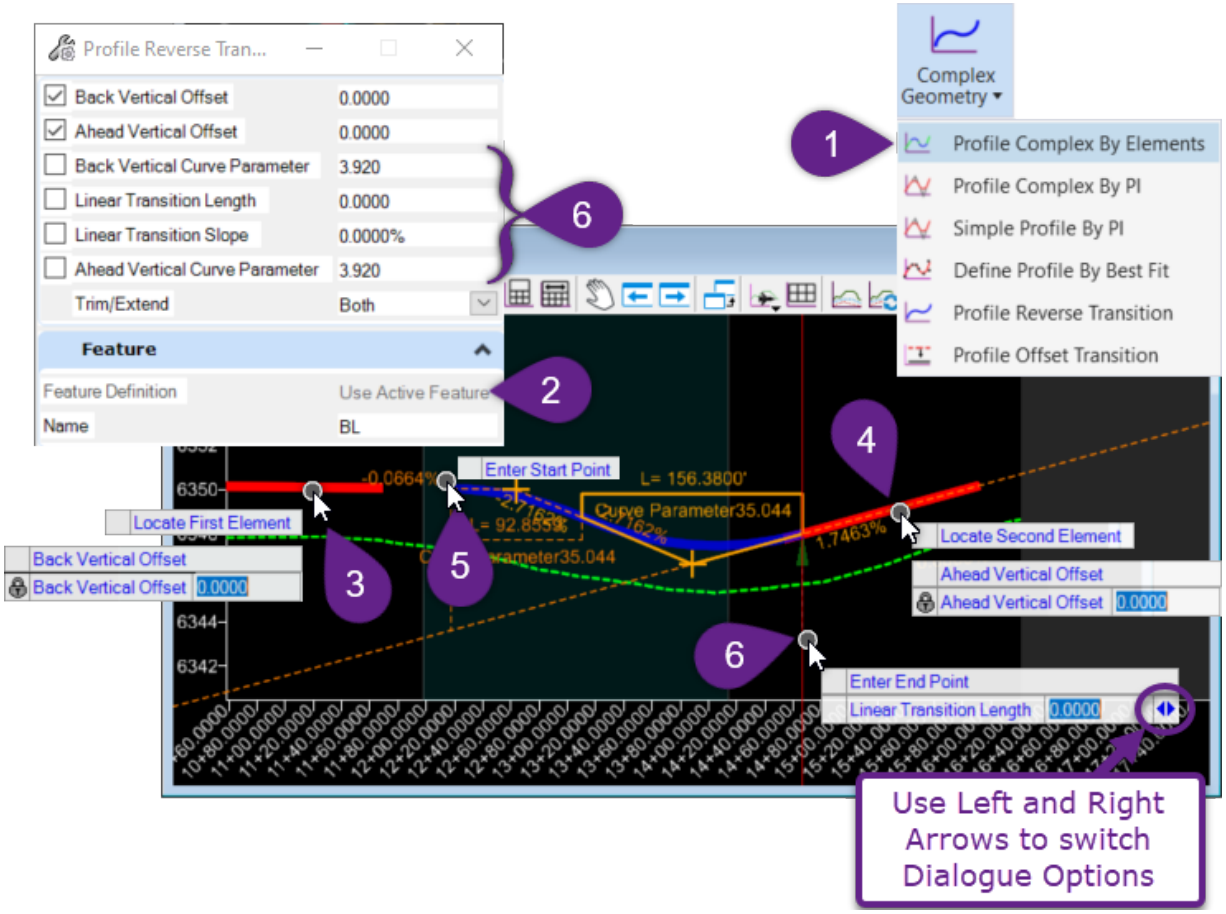
Complex Profile Element*s* made with this tool can NOT be edited through Grip-Edits and *Civil-Rule Manipulators* - unless the *Simplify Geometry* tool is used on the Complex Profile Element.



7F.3.e Profile Reverse Transition

This tool is used to create a Vertical Reverse Curve Profile Element between two Reference Lines.

NOTE: Unlike Horizontal Reverse Curves, it is possible to create Vertical Reverse Curves with a Line – Curve – Curve – Line configuration and still retain Table Editor compatibility.



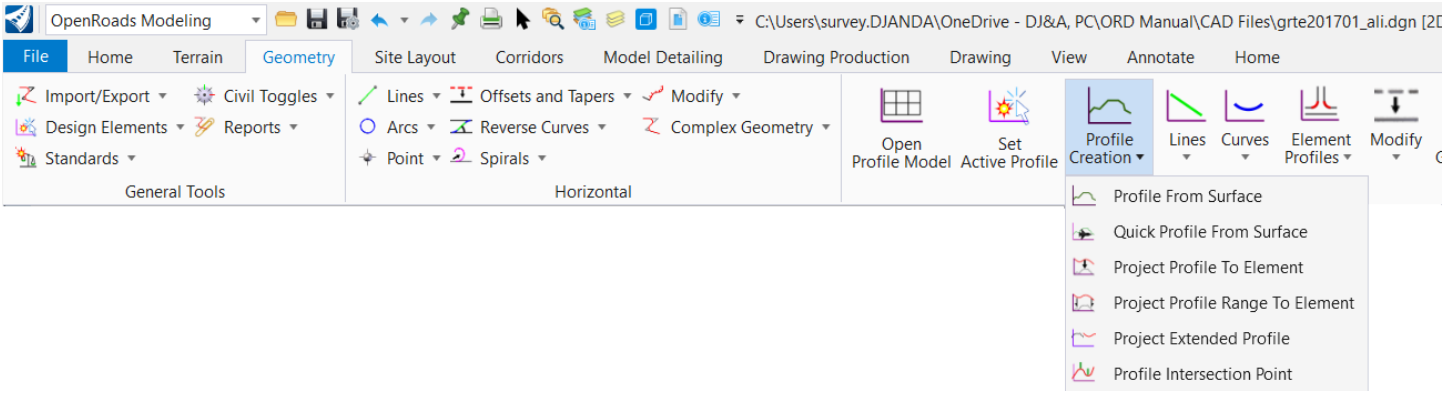
1	Left-Click the *Reverse Transition* tool from the *Complex Geometry* dropdown.
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	*Prompt: Locate First Element* – Left-Click on the first Reference Line *Prompt: Back Vertical Offset* – Key-in the desired back vertical offset value and press the Enter key to lock. Left-Click in *View* to advance to the next command.
4	*Prompt: Locate Second Element* – Left-Click on the second Reference Line *Prompt: Ahead Vertical Offset* – Key-in the desired ahead vertical offset value and press the Enter key to lock. Left-Click in *View* to advance to the next command.
5	*Prompt: Enter Start Point:* Left-Click at the desired start point for the vertical reverse curve along the Back Reference Line.
6	*Prompt: Enter End Point:* In the Dialogue Box or Cursor Dialogue, key-in the desired Dialogue Options values. Place the mouse cursor at the desired location along the Ahead Reference Line. When satisfied with Dialogue Options and End Point location, Left-Click to complete the command.

NOTE: Locking a Dialogue Option OR a combination of Dialogue Options can cause other Options to disappear because they would be constrained. For Example, locking the Back Vertical Curve Parameter and Linear Transition Length causes the Linear Transition Slope to disappear.

Dialogue Options	
Options:	**Description:**
Back/Ahead Vertical Offset	Allows the Start/End points to be vertically offset from the Back/Ahead Reference Lines
Back/Ahead Vertical Curve Parameter	Locks the Back/Ahead Vertical Curve K-Values.
Linear Transition Length	Locks the length of Line to be inserted between the Back and Ahead Curves. In no value is inputted – the Back and Ahead Curves will be created without a Line in between.
Linear Transition Slope	Locks the slope of the Line between Back and Ahead Curves. If no Line is between (Linear Transition Length set to 0), this will lock the slope angle which the Back and Ahead Curves meet at.
Trim/Extend	Trim/Extend the Back and Ahead Reference Lines to meet the Reverse Curve.

7F.4 Profile Creation

In general, Profile Creation tools are used to project the Active Profile of a Horizontal Reference Element or Terrain Model into the Profile Model of a Horizontal ORD Element.

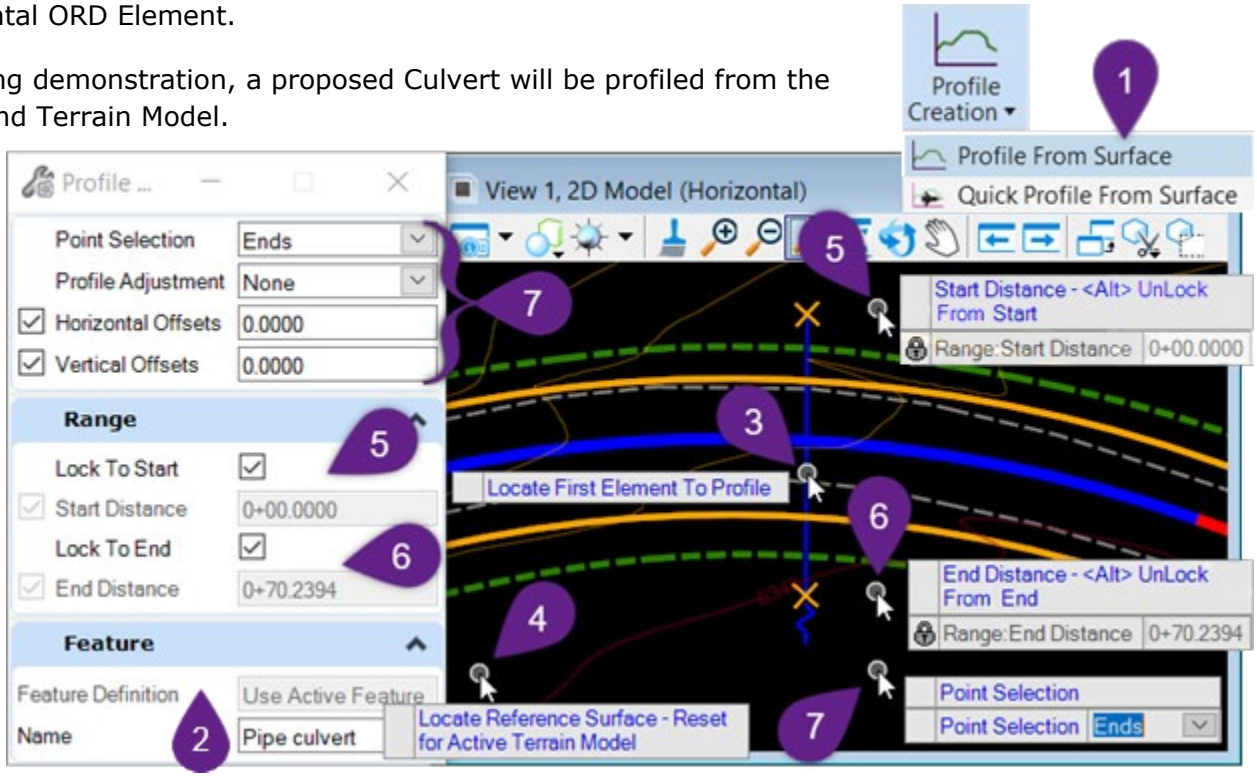


7F.4.a Profile From Surface

This tool projects a Terrain Model Profile onto a Horizontal ORD Element. The projected Terrain Model Profile can be manipulated and adjusted with Dialogue Option. Similarly, the Profile can be applied to only a certain range along the Horizontal ORD Element.

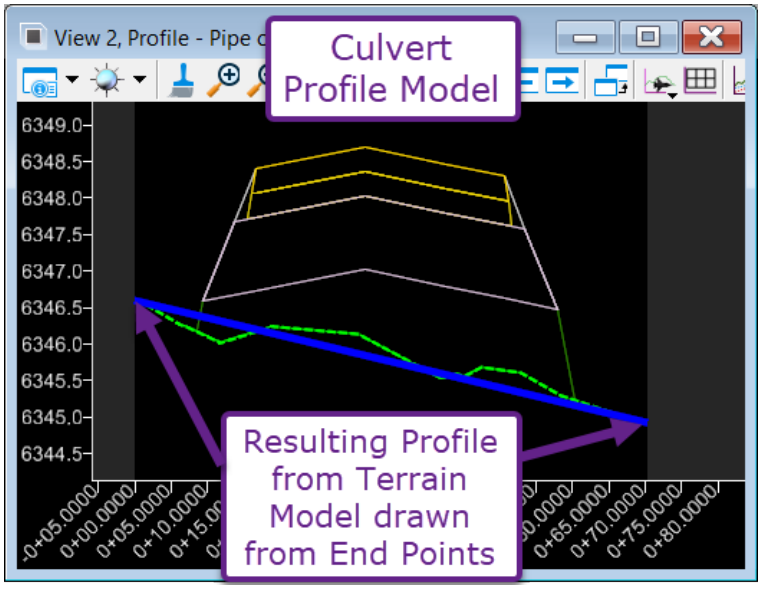
NOTE: Use the *Quick Profile From Surface* OR *Add Surface To Profile* tool to project an unadjusted Profile to the Horizontal ORD Element.

In the following demonstration, a proposed Culvert will be profiled from the Existing Ground Terrain Model.



1	Left-Click the *Profile Complex By Elements* tool from the *Profile Creation* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	*Prompt: Locate First Element To Profile* – In the 2D Design Model, Left-Click on the Horizontal ORD Element to be profiled. *Prompt: Locate Next Element To Profile – Reset To Complete* – Left-Click on another Horizontal ORD Element or Right-Click in the *View* to advance to the next command.
4	*Prompt: Locate Reference Surface – Reset for Active Terrain Model* – Left-Click on the Terrain Model to be projected OR Right-Click to use the Active Terrain Model. In this case, the Active Terrain Model is the Active Terrain and to be used for the Profile.
5	*Prompt: Start Distance* – In the Dialogue Box or Cursor Dialogue, key-in the desired start station to begin the Profile – OR - check the *Lock To Start* to begin the profile at the start point of the ORD Element. Left-Click in the *View* to advance to the next prompt.
6	*Prompt: End Distance* – In the Dialogue Box or Cursor Dialogue, key-in the desired ending station for the Profile – OR - check the *Lock To End* to begin the profile at the end point of the ORD Element. Left-Click in the *View* to advance to the next prompt.
7	*Prompt: Point Selection* – Select the desired *Point Selection* method in the Dialogue Box or Cursor Dialogue. Left-Click in the *View* to advance to the next prompt.

8	*Prompt: Profile Adjustment* - Select the desired *Profile Adjustment* method or select None.
9	*Prompt: Horizontal Offset* - Key-in the desired *Horizontal Offset* and Left-Click in the *View*.
10	*Prompt: Vertical Offset* - Key-in the desired Vertical Offset and Left-Click in the *View.*



Dialogue Options		
Option	**Description:**	
Point Selection	All	Elevation from the Terrain Model is applied along the entire length of the Horizontal ORD Element.
	Vertices	Elevation from the Terrain Model is only applied at the vertices of the Horizontal ORD Element. The resulting Profile consists of Lines drawn from the vertices elevation points.
	Ends	Elevation from the Terrain Model is only applied at the end points of the Horizontal ORD Element. The resulting Profile is a single Line drawn from the projected elevation points at the end points of the ORD Element.
	Centroid	Elevation from the Terrain Model is pulled from the centroid location of the Horizontal ORD Element and a constant profile (flat) is formed from that elevation
Profile Adjustment	Minimum	The resulting Profile is constant (flat), set at the lowest Terrain Model elevation along the Horizontal ORD Element.
	Maximum	The resulting Profile is constant (flat), set at the highest Terrain Model elevation along the Horizontal ORD Element.
Horizontal Offsets	Elevation is pulled from the Terrain Model at a location offset from the Horizontal ORD Element. For example, a Horizontal Offset of -10’ will pull elevations 10’ to the left of the Horizontal ORD Element.	
Vertical Offsets	The resulting Profile is vertically offset by the specified value.	
Start Distance	Station along the Horizontal ORD Element to begin the Profile.	
End Distance	Station along the Horizontal ORD Element to end the Profile.	

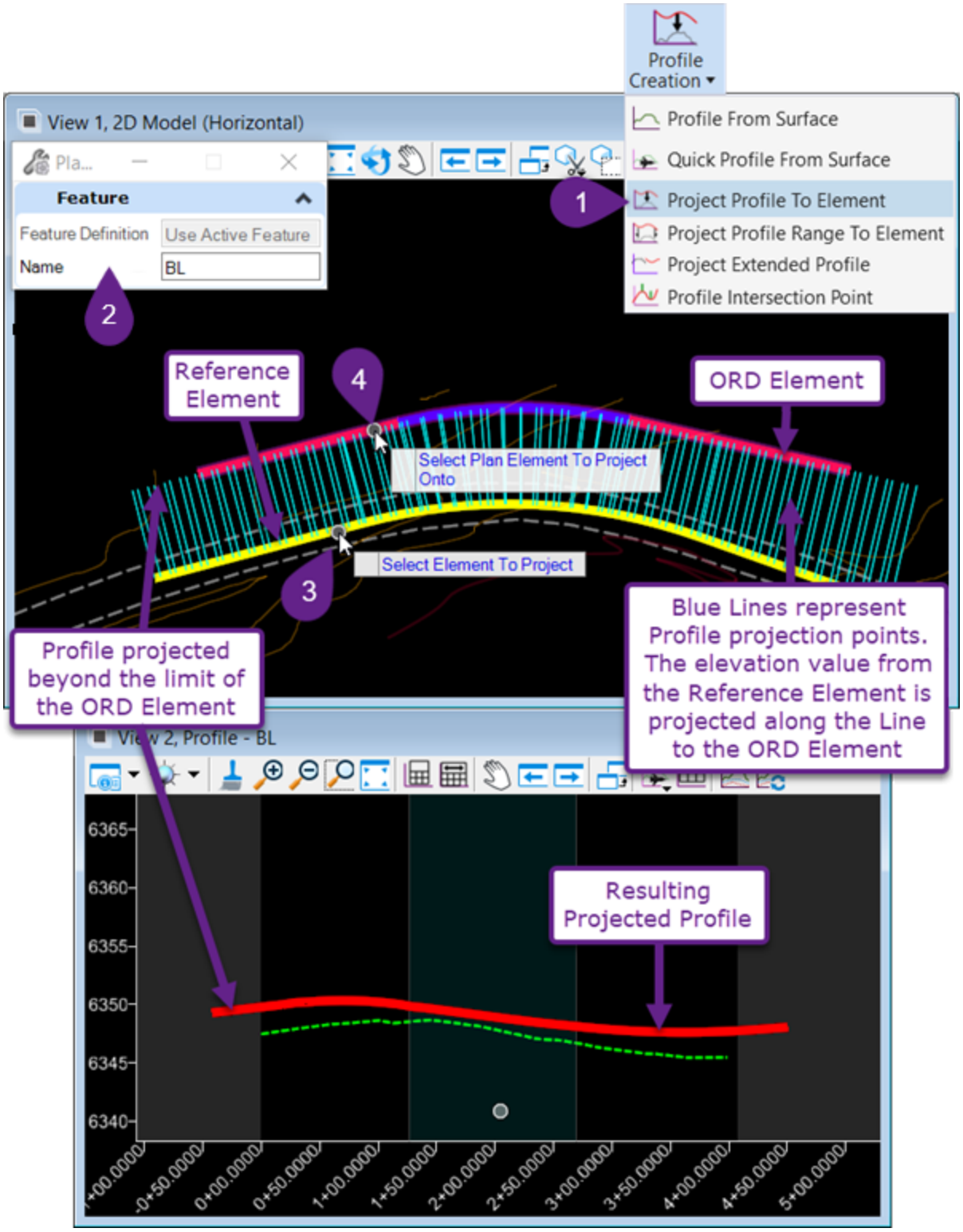
7F.4.b Quick Profile From Surface

This tool is a simplified form of the *Profile From Surface* tool. This is exact same tool as the *Add Surface to Profile* tool found in the Pop-Up Icon Menu. See the *Show Multiple Terrain Models in a Profile Model* workflow. This tool projects a Terrain Model into the Profile Model of a Horizontal ORD Element.

7F.4.c Project Profile To Element

This tool projects the Active Profile of a Reference Element into the Profile Model of an adjacent Horizontal ORD Element. It is NOT necessary for ORD Element and Reference Element to be overlapping, parallel, or the same length – however – they should be oriented in the same general direction.

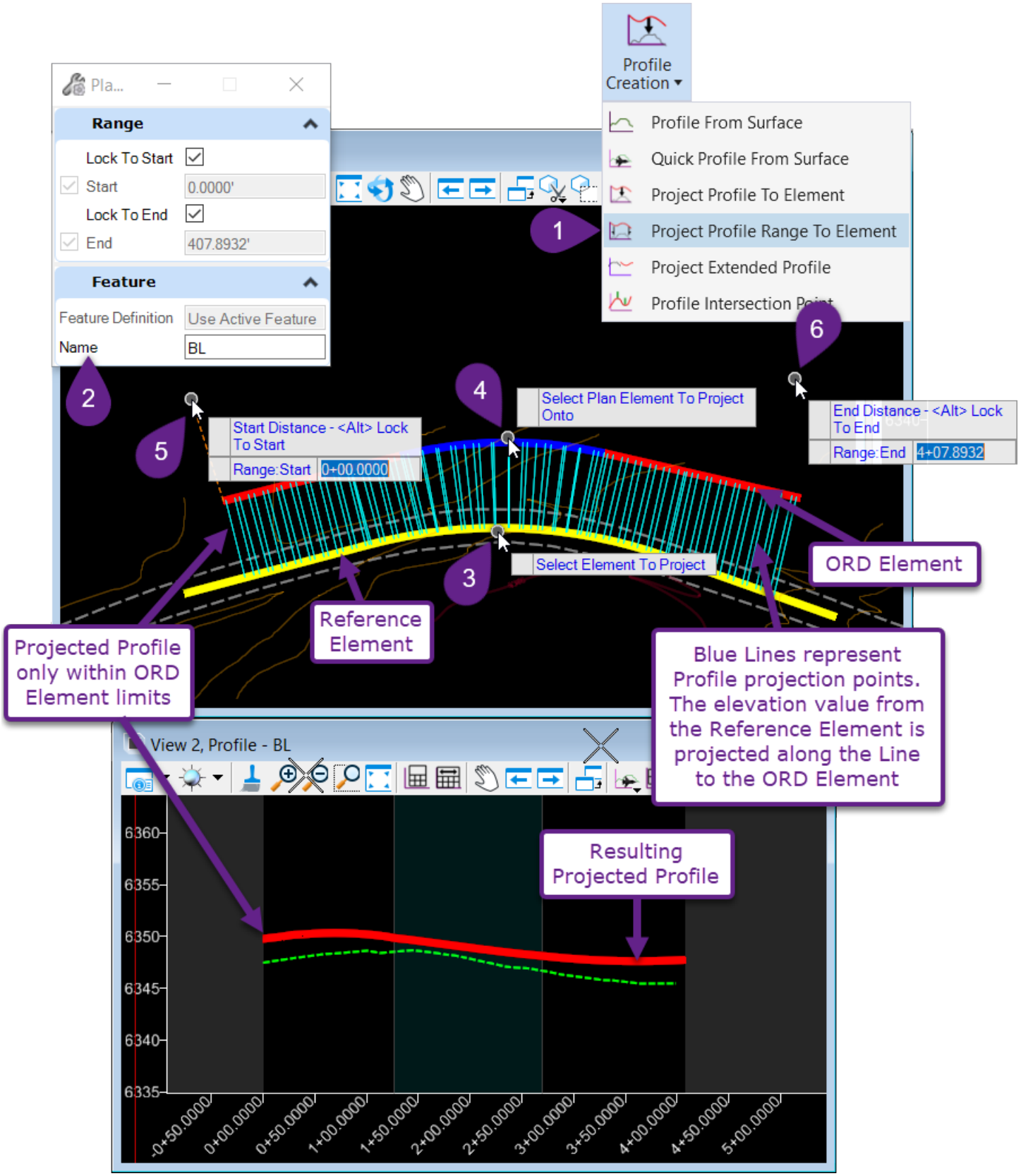
The entire Reference Element Active Profile will be projected into the Profile Model of the ORD Element – which can be undesirable if the Reference Element is much longer than ORD Element. The *Project Profile Range To Element* tool can be used to only project a portion of the Reference Element Active Profile.



1	Left-Click the *Project Profile To Element* tool from the *Profile Creation* dropdown.
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Curve* a *Feature Name* if desired.
3	*Prompt: Locate Element To Project* – Left-Click on the Reference Element.
4	*Prompt: Select Plan Element To Project Onto* – Left-Click on the ORD Element.

7F.4.d Project Profile Range To Element

This tool operates identically to the *Project Profile To Element* tool - with the added option of projecting only a portion of the Reference Profile into the Profile Model of the ORD Element.

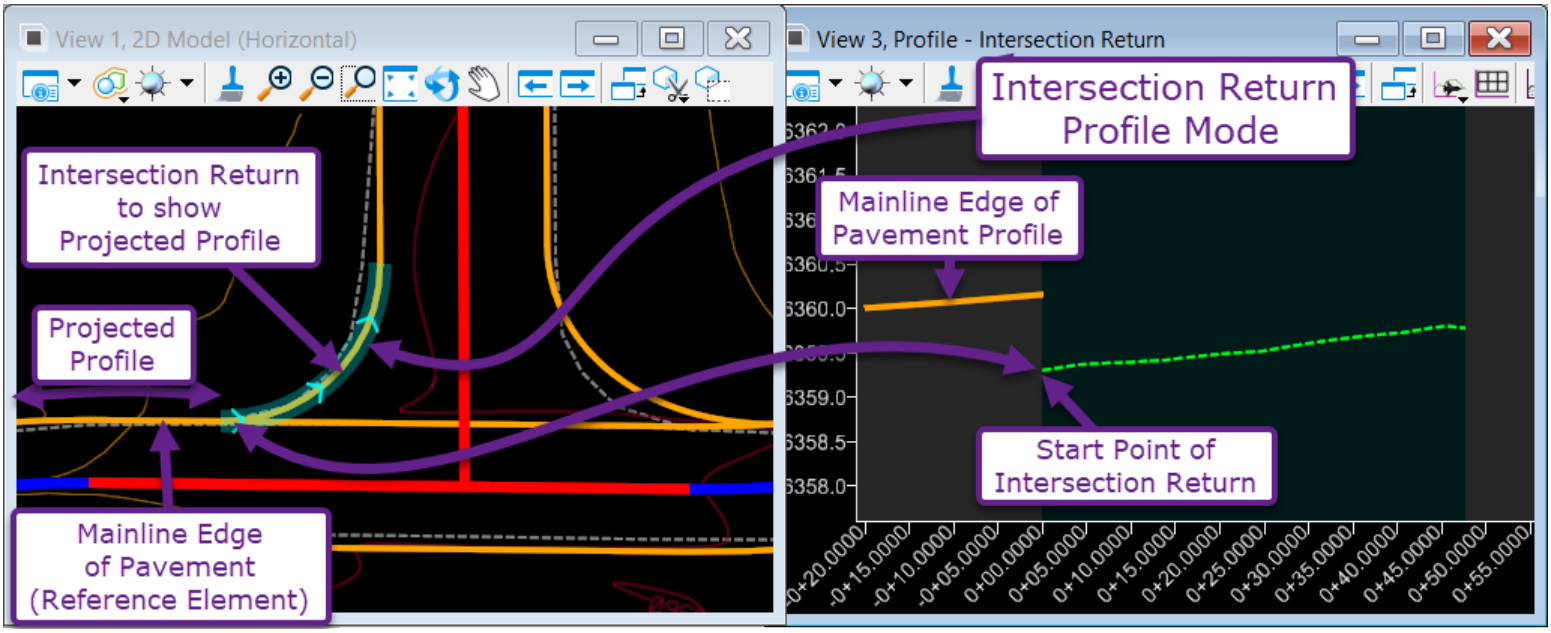


1	Left-Click the *Project Profile To Element* tool from the *Profile Creation* dropdown.
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Curve* a *Feature Name* if desired.
3	*Prompt: Locate Element To Project* – Left-Click on the Reference Element.
4	*Prompt: Select Plan Element To Project Onto* – Left-Click on the ORD Element.
5	*Prompt: Start Distance <Alt> Lock to Start* – In the Dialogue Box or Cursor Dialogue, key-in the desired start station for the projected Profile and left-click in the *View* to advance to the next prompt. OR Check the Lock To Start box in the Dialogue Box or press the ALT key to lock the projected Profile to the start point of the ORD Element.
6	*Prompt: End Distance <Alt> Lock to End* – In the Dialogue Box or Cursor Dialogue, key-in the desired end station for the projected Profile and Left-Click in the *View* to advance to the next prompt. OR Check the Lock To End box in the Dialogue Box or press the ALT key to lock the projected Profile to the end point of the ORD Element. Left-Click in the *View* to advance to the next prompt.

7F.4.e Project Extended Profile

This tool will show the Active Profile of Reference Elements connected to an ORD Element. In the Profile Model, the Projected Reference Profile will be shown beyond the limits of the ORD Element. The horizontal ORD Element must have a *Dependency* to the Reference Element for this tool to work.

This tool is useful for coordinating the Profile of an approach road intersection return with the Mainline Edge of Pavement (Reference Element) – as shown below:



The resulting Projected Reference Profile is dynamic – which means it will automatically reposition to follow edits made to the Reference Element. The User can create the Intersection Return Profile to also be dynamic by creating Base Vertical ORD Elements with *Dependencies* to the Reference Profile. By doing so, the User can ensure that Mainline Edge of Pavement and Intersection Return are coordinated even if edits are made.

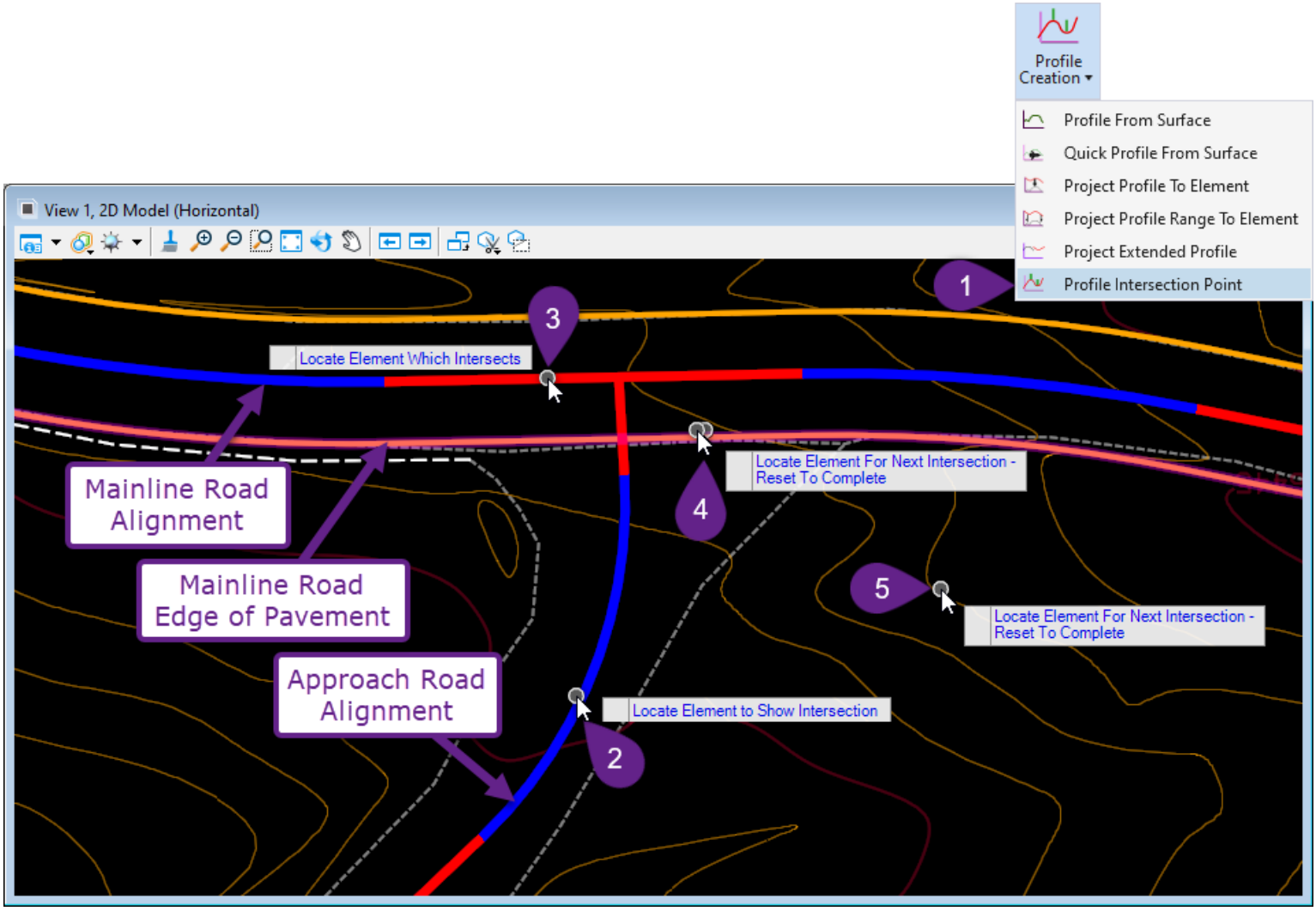
WARNING: For this tool to function, the ORD Element has to been created from or *Dependent* to the Reference Element. In the example above, the Intersection Return was created with the *Simply Arc Between Elements* tool and is *dependent* to the Mainline Edge of Pavement and the Edge of Approach Road line segment.

SIMILARILY: All Reference Elements that ORD Element is *Dependent* to must have an Active Profile. In the above example, the Edge of Approach Road line was given a temporary Active Profile for this tool to function - given the *Dependencies* of the Intersection Return.

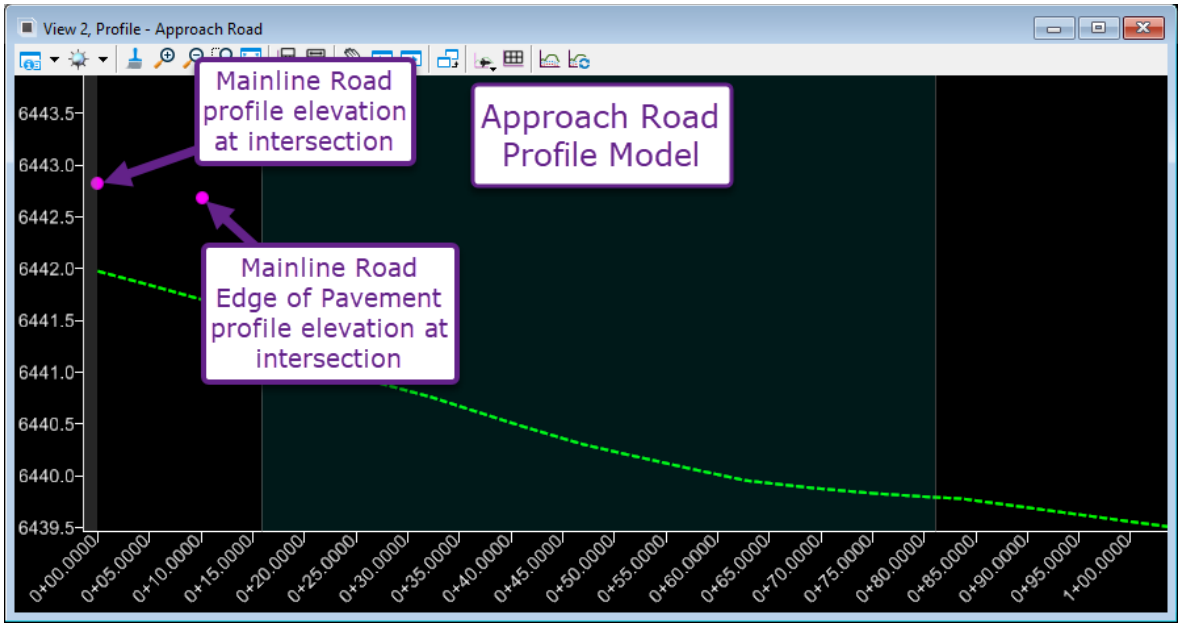
Dialogue Options		
Options:	**Description:**	
Distance	Start	Length of the Back Element profile to project in the ORD Element. Length is measured backwards from the ORD Element start point.
	End	Length of the Ahead Element profile to project in the ORD Element. Length is measured forwards from the ORD Element end point.

7F.4.f Profile Intersection Point

If two *Horizontal ORD Elements* intersect – this tool can be used to project the profile elevation intersection point into the *Profile Model*. This tool is very useful to ensure an Approach Road profile intersects the Mainline Road profile at the same elevation.

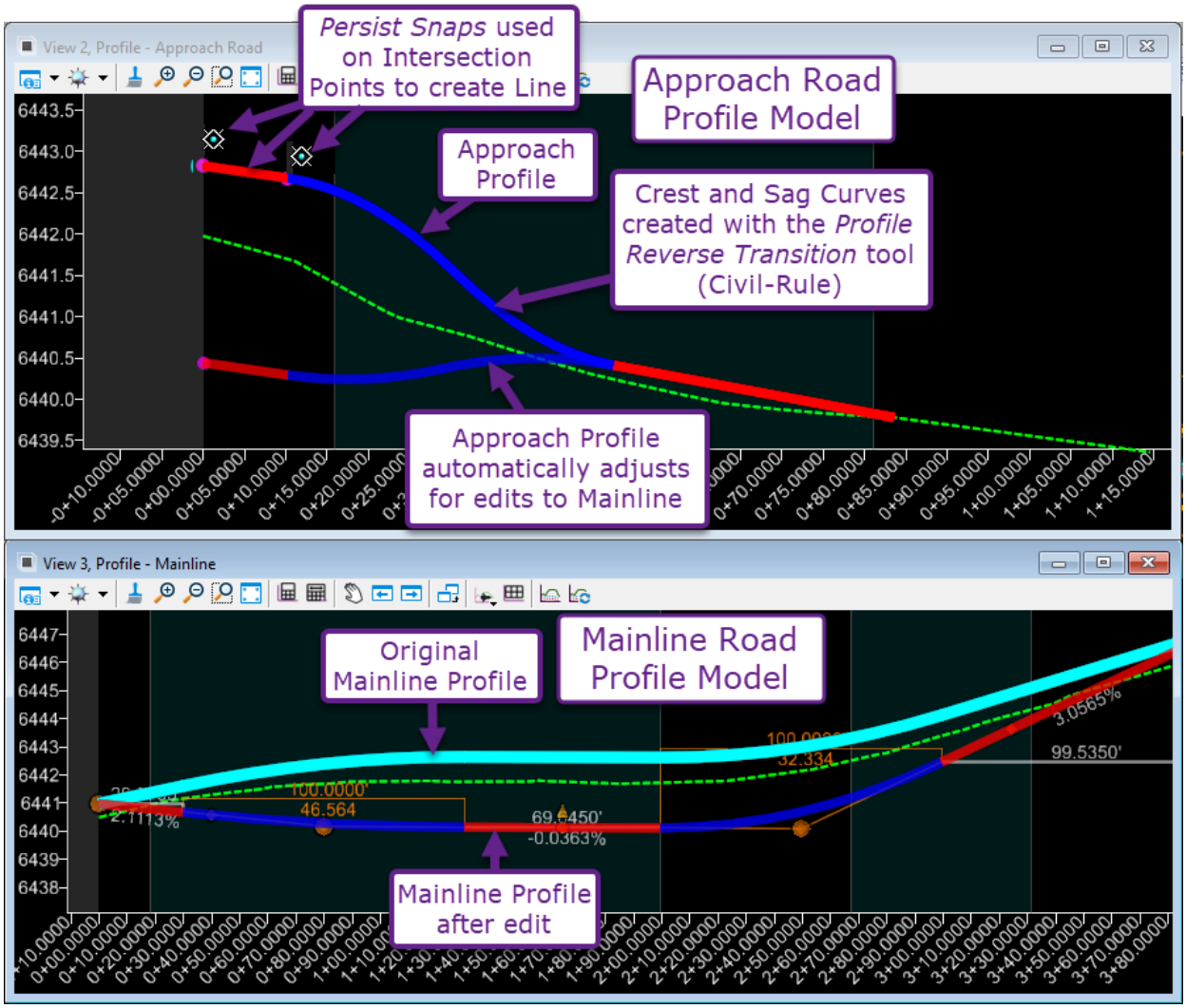


1	Left-Click the *Profile Intersection Point* tool from the *Profile Creation* dropdown.
2	*Prompt: Locate Element to Show Intersection* – Left-Click on the *Horizontal ORD Element* to display the profile elevation intersection point – in this example, the Approach Road Alignment.
3	*Prompt: Locate Element Which Intersects* – Left-Click on the *Reference Horizontal Element* – in this example, the Mainline Road Alignment. ***NOTE:*** The Reference Horizontal Element must have an Active Profile to function with this tool.
4	*Prompt: Locate Element For Next Intersection – Reset To Complete* – If desired, Left-Click on the next *Reference Horizontal Element* – in this example, the Mainline Road Edge of Pavement.
5	*Prompt: Locate Element For Next Intersection – Reset To Complete* – Right-Click in the *View to* complete the command.



In this example, the resulting Profile Elevation Intersection points is used to synchronize the Approach and Mainline profiles. The resulting Profile Elevation Intersection points are dynamic – meaning – if the Mainline Profile is edited – the Intersection points in the Approach Road Profile Model will automatically reposition to reflect the edit.

In the demonstration below, the Approach Road Profile is created with *Persist Snaps* at the Intersection points and a Vertical Reverse Curve between the two lines. This configuration makes the Profile dynamic and responsive to changes made to the Mainline Profile.



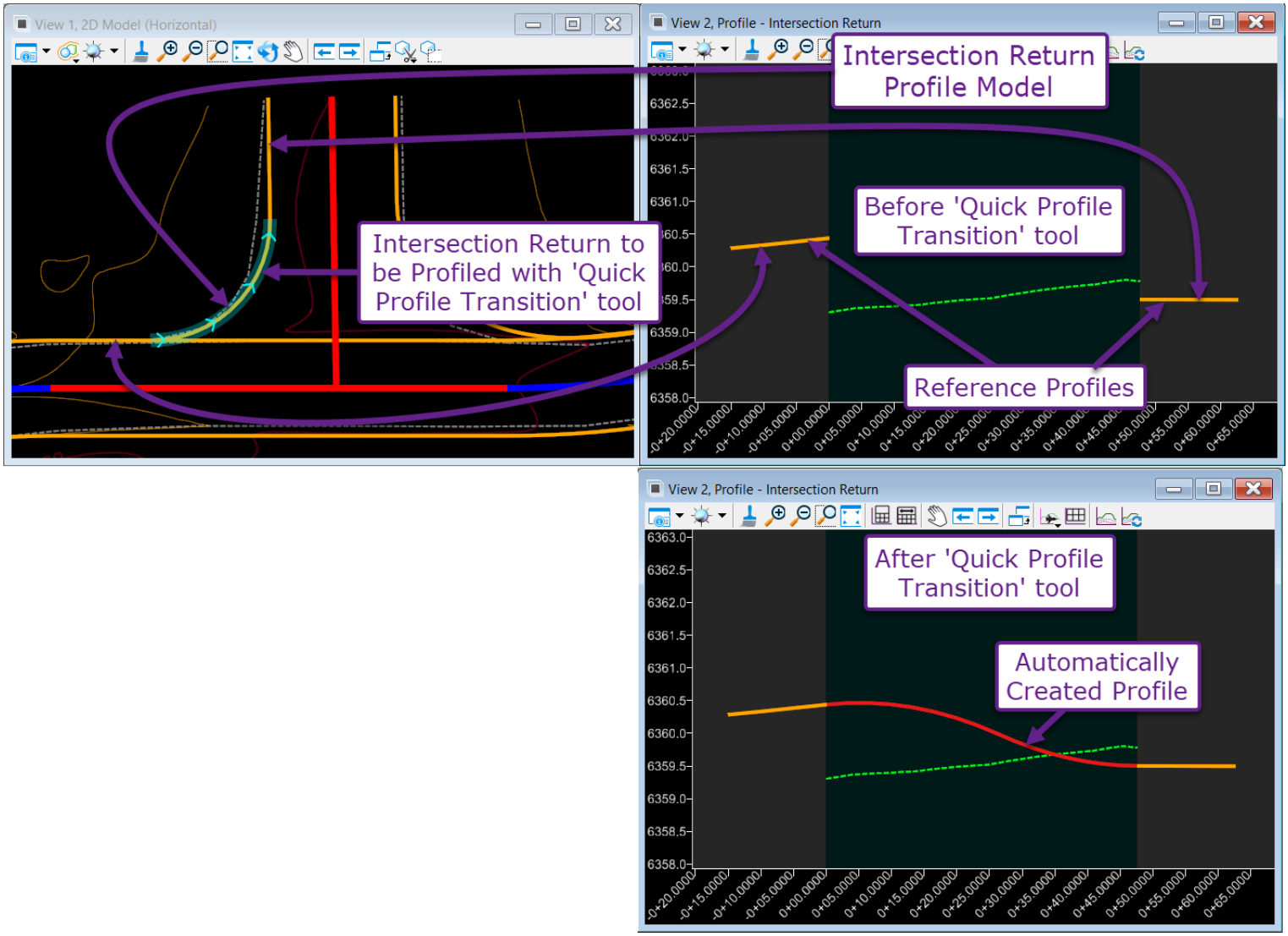
7F.5 Element Profiles

These tool work similarly to Profile Creation tools. In general, the Element Profile tools are used to project the Active Profile of a Horizontal Reference Element into the Profile Model of a Horizontal ORD Element.

7F.5.a Quick Profile Transition

This tool automatically creates a Profile for an ORD Element that is connected at both ends to Reference Elements with Active Profiles.

This tool is useful for creating Profiles for Intersection Returns, as shown in the example below:

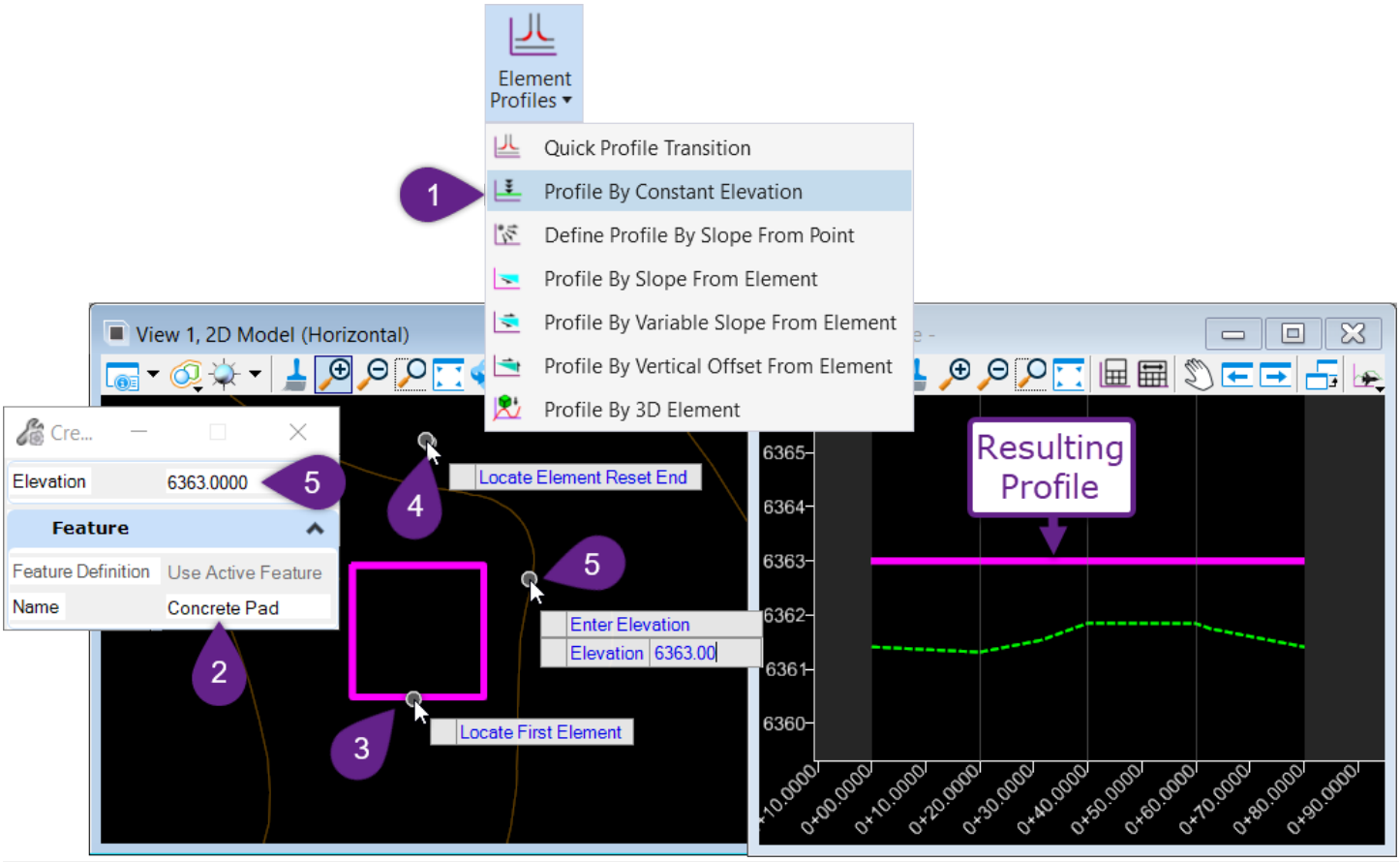


Dialogue Options		
Options:	**Description:**	
Quick Transition Method	Linear	The automatically created profile will be a single line connecting the Back and Ahead profiles.
	Parabolic	The automatically created profile will be non-linear and contain curves. The example above was created with the Parabolic method.

7F.5.b Profile By Constant Elevation

This tool automatically creates a Profile set at a constant elevation (flat) for an ORD Element. This tool is convenient because the constant elevation Profile is created without the extra step of opening the Profile Model. Similarly, multiple ORD Elements can be selected and set at the same constant elevation.

This tool can be useful for setting the profile for ORD Elements that represent flat Site-Layout features – such as a building pad.

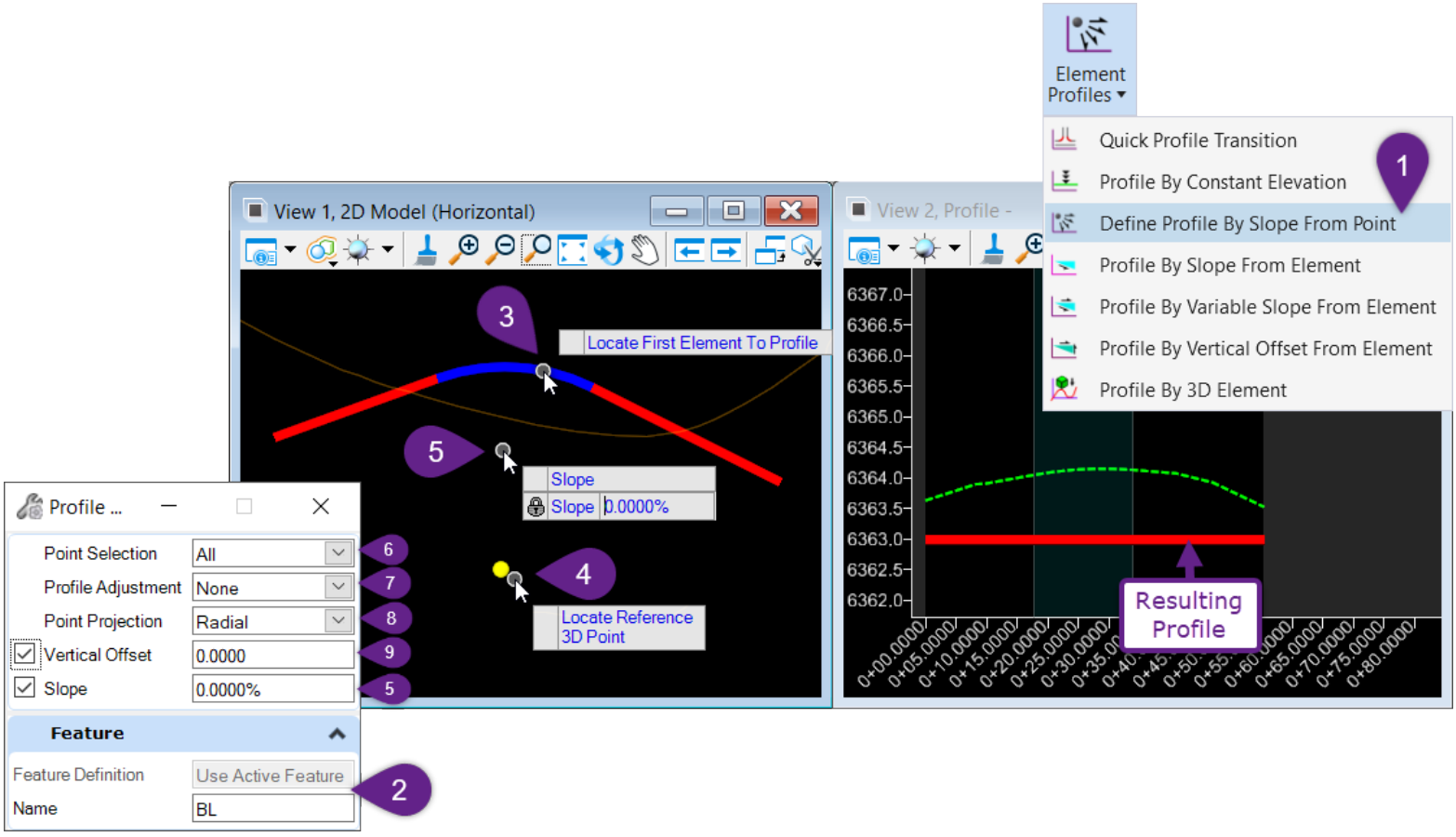


1	Left-Click the *Profile By Constant Elevation* tool from the *Element Profiles* dropdown.
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Curve* a *Feature Name* if desired.
3	*Prompt: Locate First Element* – Left-Click on the ORD Element to be profiled
4	*Prompt: Locate Element Reset End* – Left-Click on another ORD Element (both Elements selected in this STEP and the previous will be profiled at the same constant elevation) OR Right-Click in the *View* to advance to the next prompt.
5	*Prompt: Enter Elevation* – In the Dialogue Box or Cursor Dialogue, key-in the elevation to set the constant profile at. Left-Click in the *View* to complete the command.

7F.5.c Define Profile By Slope From Point

This tool automatically creates a Profile for an ORD Element based off of an elevation projection from a nearby Reference ORD Point. The Reference ORD Point is projected to the ORD Element at a User-specified slope.

WARNING: This tool has known bugs and does not function as described by the software.



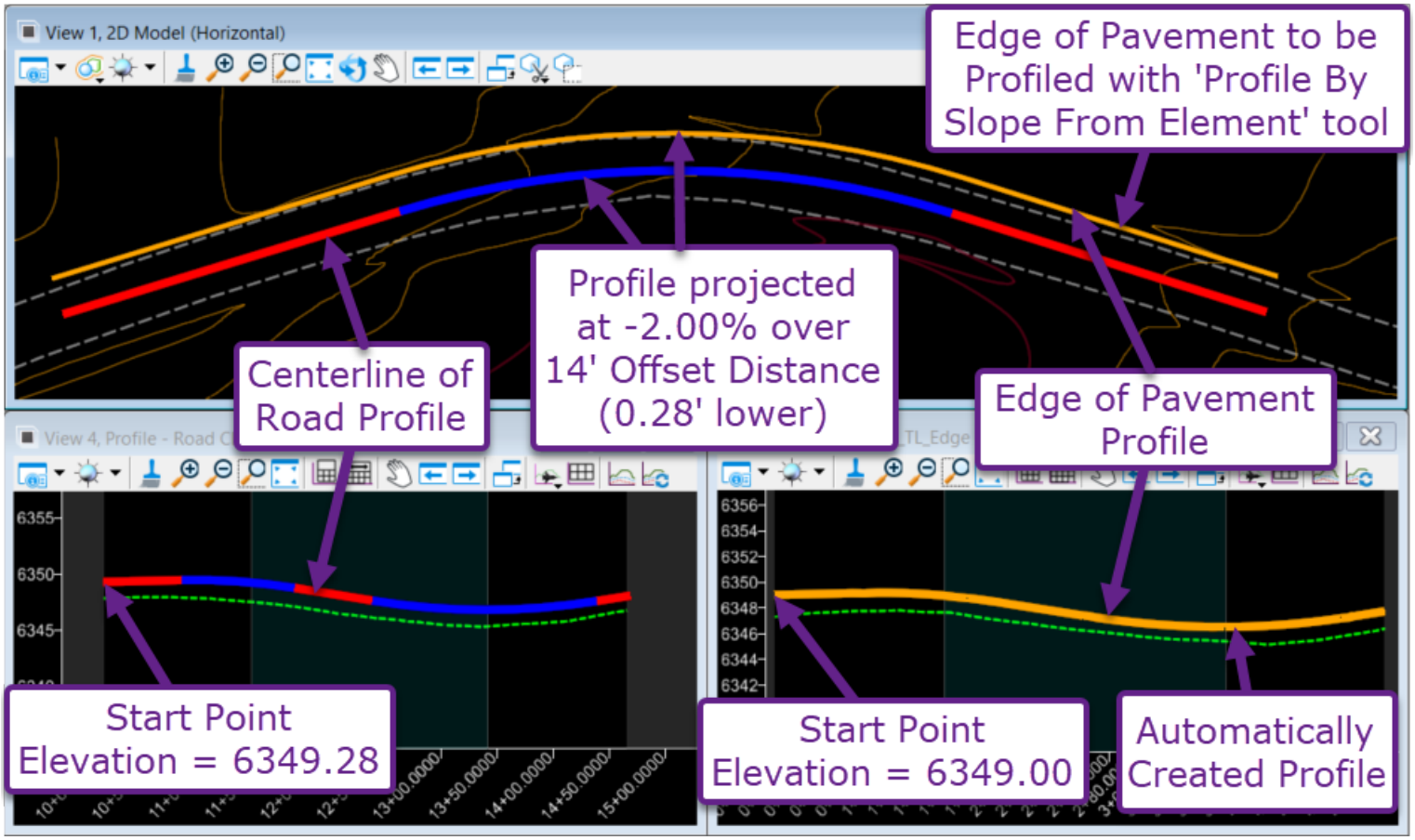
1	Left-Click the *Define Profile By Slope From Point* tool from the *Element Profiles* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	*Prompt: Locate First Element To Profile* – Left-Click on the Horizontal ORD Element.
4	*Prompt: Locate Reference 3D Point* – Left-Click on the Reference ORD Point. ***NOTE:*** The Reference ORD Point can NOT be selected through the 2D Design Model. The point has to be selected in the 3D Design Model – which can be Referenced into the 2 Design Model.
5	*Prompt: Slope* – Key-in the desired projection Slope and Left-Click in the *View*.
6	*Prompt: Point Selection* – Select the Point Selection method and Left-Click in the *View.*
7	*Prompt: Profile Adjustment* – Select the Profile Adjustment method and Left-Click in the *View*.
8	*Prompt: Point Projection* – Select the Point Projection method and Left-Click in the *View.*
9	*Prompt: Vertical Offset* – Key-in the desired Vertical Offset value and Left-Click in the *View.*

Dialogue Options		
Options:	**Description:**	
Point Selection	All	Elevation from the Reference ORD Point is projected along the entire length of the Horizontal ORD Element.
	Vertices	Elevation from the Reference ORD Point is only projected to the vertices of the Horizontal ORD Element. The resulting Profile consists of Lines drawn from the vertices elevation points.
	Ends	Elevation from the Reference ORD Point only projected to the end points of the Horizontal ORD Element. The resulting Profile is a single Line drawn from the two end point elevations.
	Centroid	Elevation from the Reference ORD Point is only projected to the centroid location of the Horizontal ORD Element. A constant profile (flat) is automatically created at the projected centroid elevation.
Profile Adjustment	Minimum	The resulting Profile is constant (flat), set at the lowest projection elevation along the Horizontal ORD Element.
	Maximum	The resulting Profile is constant (flat), set at the highest projection elevation along the Horizontal ORD Element.
Point Projection	Radially	The Reference ORD Point elevation is projected radially from the ORD Point to the ORD Element.
	Through	The Reference ORD Point elevation is projected to the nearest point along the ORD Element. The resulting elevation is then projected along the ORD Element.
Vertical Offsets	The resulting Profile is vertically offset by the specified value.	
Slope	The Reference ORD Point elevation is projected to the ORD Element at the specified slope value. ***NOTE:*** If this value is set to 0.00% - the resulting Profile will be constant (flat) and set at the Reference ORD Point elevation - assuming **Vertical Offset** value is set to 0.00'.	

7F.5.d Profile By Slope From Element

This tool functions the same as the *Project Profile To Element* tool – EXCEPT – the projected profile is adjusted vertically based off a User inputted slope value and the horizontal distance from the Reference Element to the ORD Element.

In the example below, the Centerline of Road Profile is projected onto the Edge of Pavement at a -2.00% slope over the horizontal offset distance of 14’. Essentially, the Centerline of Road Profile is copied into the Edge of Pavement Profile Model, but is lowered 0.28’ (2.00% x 14’ = 0.28’).



Dialogue Options		
Options:	**Description:**	
Point Selection	All	Elevations from the Reference Element are projected along the entire length of the Horizontal ORD Element – as shown in the example above.
	Vertices	Elevations from the Reference Element are only projected to the vertices of the Horizontal ORD Element. The resulting Profile consists of Lines drawn from the vertices elevation points.
	Ends	Elevations from the Reference Element are only projected to the end points of the Horizontal ORD Element. The resulting Profile is a single Line drawn from the two end point elevations.
	Centroid	Elevation from the Reference Element is only projected to the centroid location of the Horizontal ORD Element. A constant profile (flat) is automatically created at the projected centroid elevation.

Dialogue Options		
Options:	**Description:**	
Profile Adjustment	Minimum	The resulting Profile is constant (flat), set at the lowest projection elevation from the Reference Element Profile.
	Maximum	The resulting Profile is constant (flat), set at the highest projection elevation from the Reference Element Profile.
Vertical Offsets	The resulting Profile is vertically offset by the specified value.	
Slope	The Reference Element Profile is projected to the ORD Element at the specified slope value over the horizontal distance between Reference and ORD Element.	

7F.5.e Profile By Variable Slope From Element

This tool functions the similarly to the *Profile By Slope From Element* - with the added option of projecting only a portion of the Reference Profile into the Profile Model of the ORD Element. Also, additional options are available for the slope in which the Reference Profile is projected at.

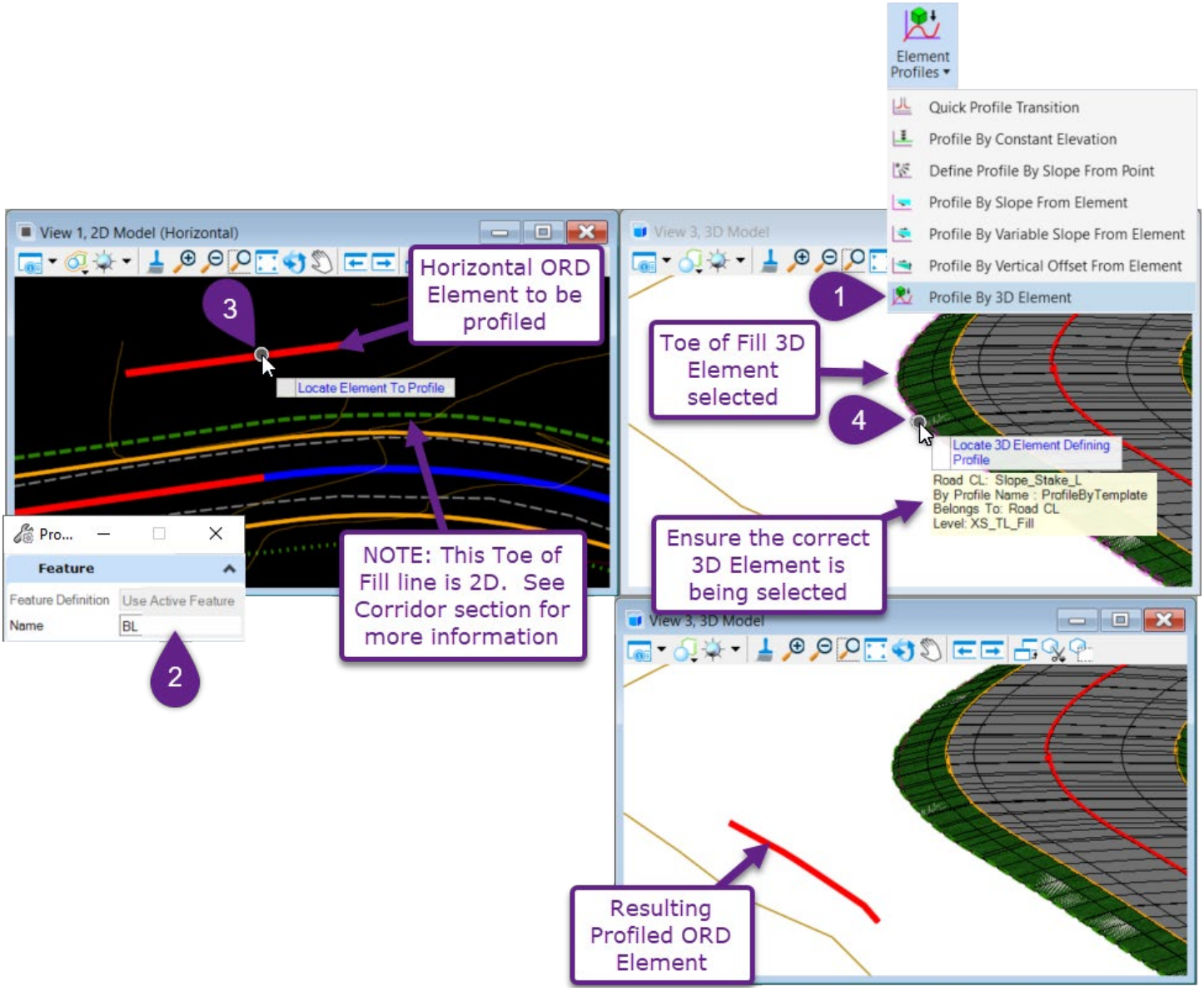
Dialogue Options		
Options:	**Description:**	
Slope Style	Constant	Elevations from the Reference Element Profile are projected at a fixed or constant slope.
	Linear	The user is prompted to input a start and end slope to project the Reference Element Profile. Projection slopes between the start and end are linearly interpolated form the start and end point values
	Reverse Biquadratic	The user is prompted to input a start and end slope to project the Reference Element Profile. Projection slopes between the start and end are interpolated with a quadratic distribution.
	Reverse Cubic	The user is prompted to input a start and end slope to project the Reference Element Profile. Projection slopes between the start and end are interpolated with a cubic distribution.
Slope	The Reference Element Profile is projected to the ORD Element at the specified slope value over the horizontal distance between Reference and ORD Element.	
Vertical Offsets	The resulting Profile is vertically offset by the specified value.	
Start Distance	Start station along the ORD Element to begin projection. Check the Lock to Start box to start at the beginning of the ORD Element.	
End Distance	End station along the ORD Element to begin projection. Check the Lock to End box to end at the ending of the ORD Element.	

7F.5.f Profile By Vertical Offset From Element

This tool functions exactly the same as the Profile By Variable Slope From Element tool. Both tools have the same Dialogue Options and order of operation prompts.

7F.5.g Profile By 3D Element

This tool functions the same as the *Project Profile To Element* tool – EXCEPT – the Reference Element is selected from the 3D Design Model. An example of this tool's use would creating a Profile from a Linear Corridor Element – such as the toe of fill line.



1	Left-Click the *Profile By 3D Element* tool from the *Element Profiles* dropdown
2	In the *Dialogue Box*, select a *Feature Definition* – if one is not already *Active*. Give the *Complex Element* a *Feature Name.*
3	*Prompt: Locate Element To Profile* – Left-Click on the Horizontal ORD Element.
4	*Prompt: Locate 3D Element Defining Profile* – Left-Click on the Reference 3D ORD Element.

7G – EDITS TO VERTICAL GEOMETRY

Edits to *Vertical ORD Elements* function similarly or identically to *Horizontal ORD Elements*.

Vertical ORD Element Editing Workflow			
Workflow:	**Description:**	**Advantages:**	**Limitations:**
Grip-Edits, Civil Rules Manipulators*, and *Properties Box Edits	Performed by graphically selecting a *Vertical ORD Element.* Accomplished with *grip-edits*, or changing geometry parameter values displayed in *Civil Rules Manipulators* or *Properties Box*	Graphically find a "Best Fit" for an alignment with *grip-edits*.	Edits can result in unfeasible geometry without warning from the software. Edits that conflict with underlying *Base ORD Elements, Civil Rules,* and original *Design Intent* can result in unpredictable behavior. Edits can result in loss of tangency between alignment components.
***Table Editor* tool**	Allows *ORD Elements* to be edited tabularly. Parameters that can be edited tabularly are: - PVI Station - PVI Elevation - Vertical Curve Length - Back/ Ahead Slope - Vertical Curve K-Value	Most stable form of editing – edits that would result in unfeasible geometry will be displayed in red and can be recognized before edits are applied. **Best method to Insert and Delete a PVI/Curve.** **After *Table Edits* are applied, *Complex Profile Elements* will be *Simplified*** After *Table Edits* are applied to a *Complex Profile Element*, underlying *Base ORD Elements* will automatically be brought into tangency	After *Table Edits* are applied, the *Complex Profile Element* will be *Simplified*. After *Table Edits* are applied, lines that are not joined by a curve will be automatically deleted. After *Table Edits* are applied, lines and curves will automatically be brought into tangency. *Table Edits* can only be performed on *Complex Profile Elements*. This tool will not work on *Simple Profile Elements.*
***Vertical Modify* tools**	All tools found in *Modify* dropdown in the *Vertical* panel Types of edits include: -Copying *ORD Elements* -Extending *Complex Elements* -Inserting curve edits		***BEST PRACTICE:*** insert curves/PVIs with the *Table Editor* tool – opposed to the *Profile Insert Curve* tool found in the *Modify* dropdown.

7G.1 Grip-Edits

Grip-Edits for *Vertical ORD Elements* function similarly to *Horizontal ORD Elements* with a notable exception - PVI location is moved by *Grip-Editing* the *End Point* of the back tangent OR the *Origin Point* of the ahead tangent.

Grip Edit *Point* Handles

Display	Location	Function
Origin Point	Start Point of *Lines*	Moves the Start Point a *Line* and the VPI of a *Curve*. ***NOTE:*** The End Point of the intersecting line will also be moved
End Point	End Point of *Lines*	Moves the End Point a *Line* and the VPI of a *Curve*. ***NOTE:*** The Start Point of the intersecting line will also be moved
Move	Mid Point of *Lines*	Move a *Line* to any location in the *Profile Model*. The length and slope of the *Line* are held fixed during translation.
Move Point	Mid Point of *Curves*	Changes the Length of the *Curve*. The PVI Location is held fixed.

***Grip Edit Arrow* Handles** are found at the following locations for *Lines*

Display	Location	Function
Trim\Extend	Start and End Point of *Lines*	Change the length of a *Line*. Slope is kept fixed. ***NOTE:*** The *Base ORD Line Element* has to be selected to reveal this *Grip Edit Arrow Handle*.
Move Vertically	Mid Point of *Lines*	Moves a *Line* up or down vertically

7G.2 Civil Rule Manipulator Edits

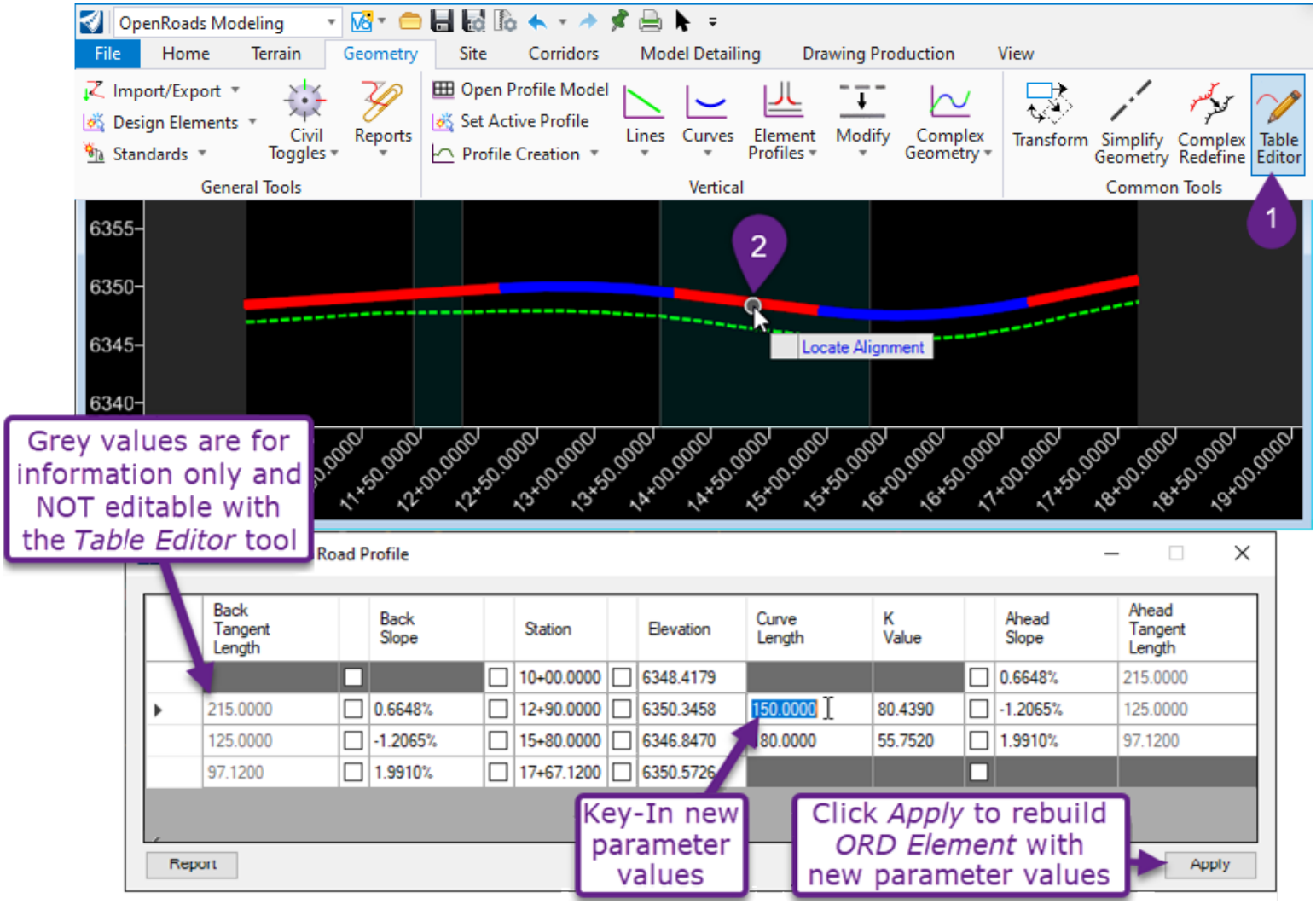
Civil Rule Manipulators for Vertical ORD Elements operate identically to Horizontal ORD Elements. See *Civil Rule Manipulator and Properties Box Edits* in the *Edits to Horizontal Geometry* section.

TIP: Hover over *Civil Rule Manipulator* with cursor to identify the parameter to be edited.

TIP: By default, the *Civil Rule Manipulator* identified as *Vertical Curve Parameter* is set to Vertical Curve K-Value. It is possible – but not recommended – to switch *Vertical Curve Parameter* setting to R-Value.

7G.3 Table Editor tool

The *Table Editor* tool is used to tabularly edit *Complex Profile Elements*. To access and make edits with the *Table Editor* tool:



1	Left-Click on the *Table Editor* tool
2	*Prompt: Locate Alignment* – Left-Click on the Complex Profile to display in the *Table Editor*.
3	In the *Table Editor,* Key-In new parameter values for the desired VPI. The preview of the new Profile is shown in purple.
4	In the *Table Editor,* Left-Click on the *Apply* button.

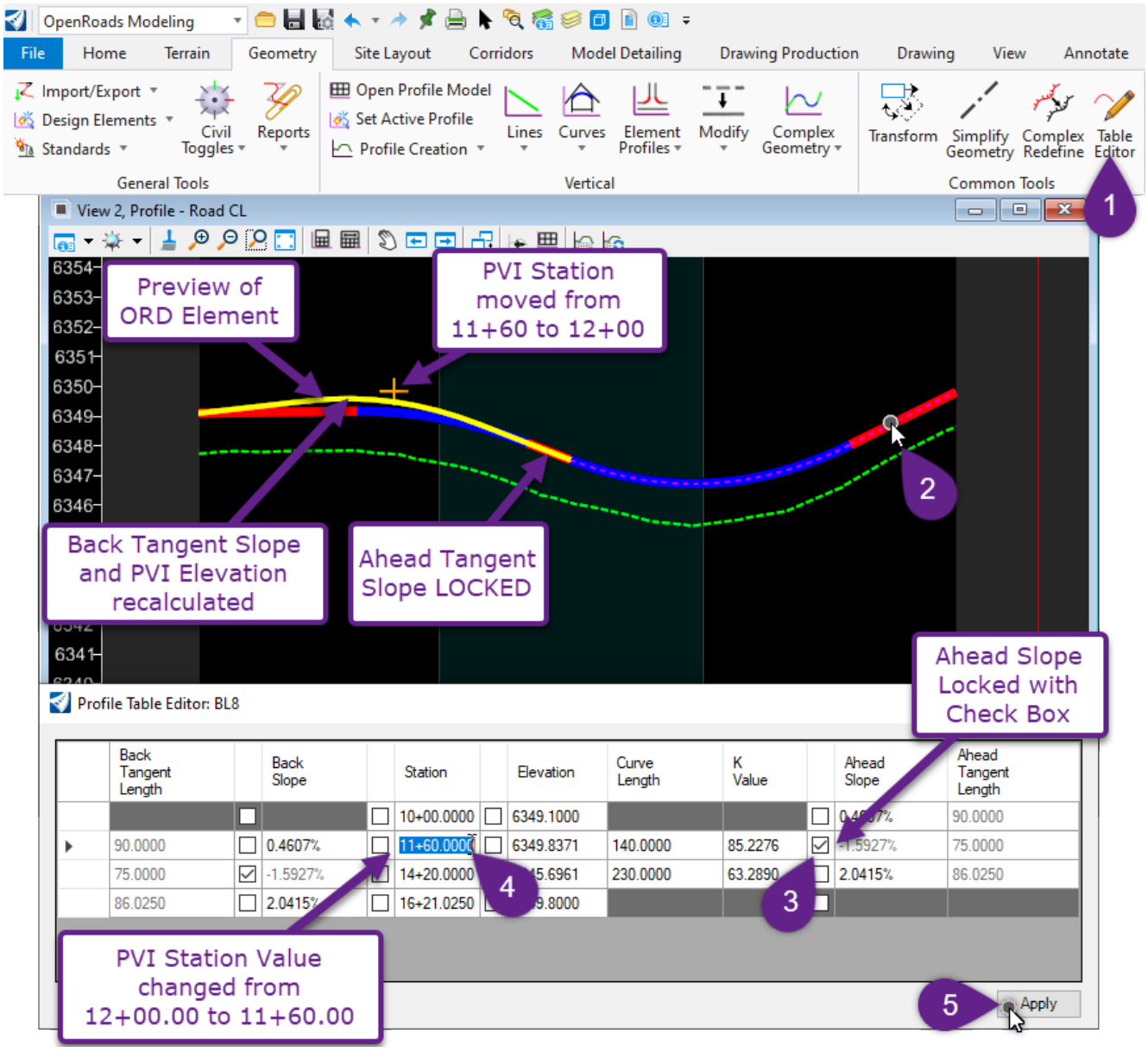
The first and last row in the *Table Editor* represent the Start and End Point of the Complex Profile. The interior rows represent PVI Locations.

WARNING: After *Table Edits* are *Applied* – the *Base ORD Elements* of the Complex Profile will be *Simplified*. See *Simplify Geometry Tip* and Simplify Geometry Tool.

7G.3.a Checkbox Tips

The *Table Editor* contains checkboxes which can be used to lock individual geometry segments/parameters. Edits performed to adjacent PVIs will not affect the checked parameters.

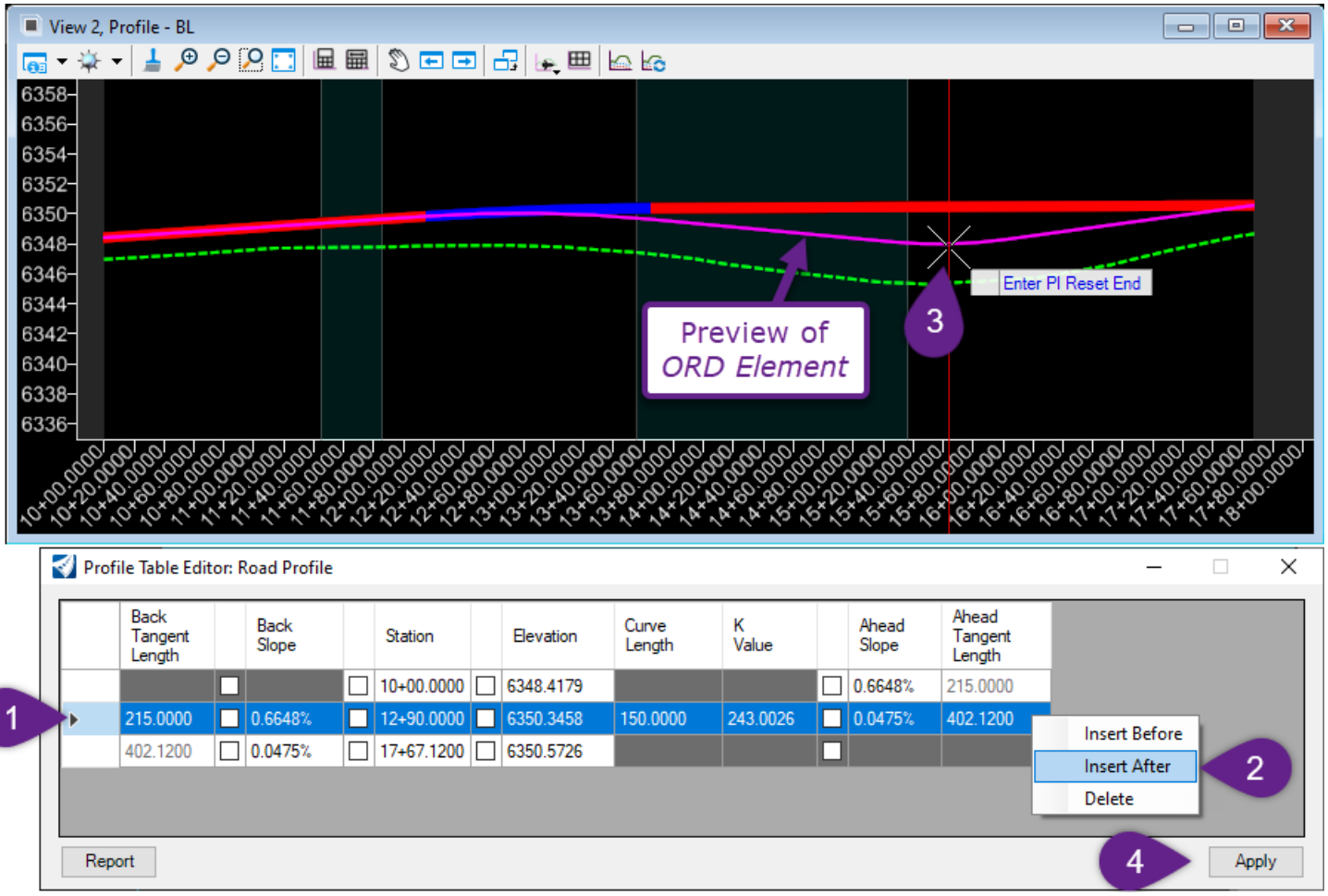
In the example shown below, the AHEAD SLOPE is locked, and the PVI Station is moved. The Back Tangent Slope and Elevation is recalculated to accommodate the PVI Station move, whilst the Ahead Slope remains fixed.



1	Left-Click the *Table Editor* tool from the *Common Tools* panel
2	*Prompt: Locate Alignment* – Left-Click on the Complex Profile to display in the *Table Editor*.
3	Left-Click on the *Ahead Slope* checkbox for the PVI to be repositioned.
4	Key-in the new PVI Station value.
5	Left-Click on the *Apply* button.

7G.3.b Inserting and Deleting PVI's into a *Complex Element*

Insert a PVI as follows:



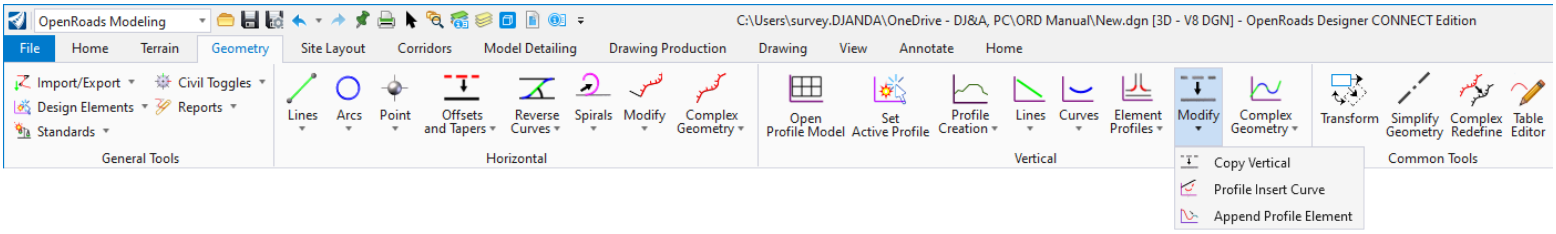
1	In the *Table Editor*, select a row adjacent to where the inserted PVI is to be placed by Left-Clicking on the blank cell in the first column.
2	With the desired row selected, Right-Click anywhere in the table. Depending on the selected row in relation to the desired new PVI Location, choose the appropriate option: *Insert Before* or *Insert After*.
3	*Prompt: Enter PI Reset to End* - In the *Profile Model,* position the cursor in the desired location for the new PVI Location. Left-Click to accept the location. (Right-Click to exit the command)
4	Left-Click *Apply* to finish command and rebuild the *Complex Profile Element*

Deleting a PVI is accomplished with the *Table Editor* in a similar manner:

1	In the *Table Editor*, select the row of the PI to be deleted by Left-Clicking on the blank cell in the first column
2	With the desired row selected, Right-Click anywhere in the table and select *Delete*.
4	Left-Click *Apply* to finish command and rebuild the *Complex Profile Element*

7G.4 Vertical *Modify* tools

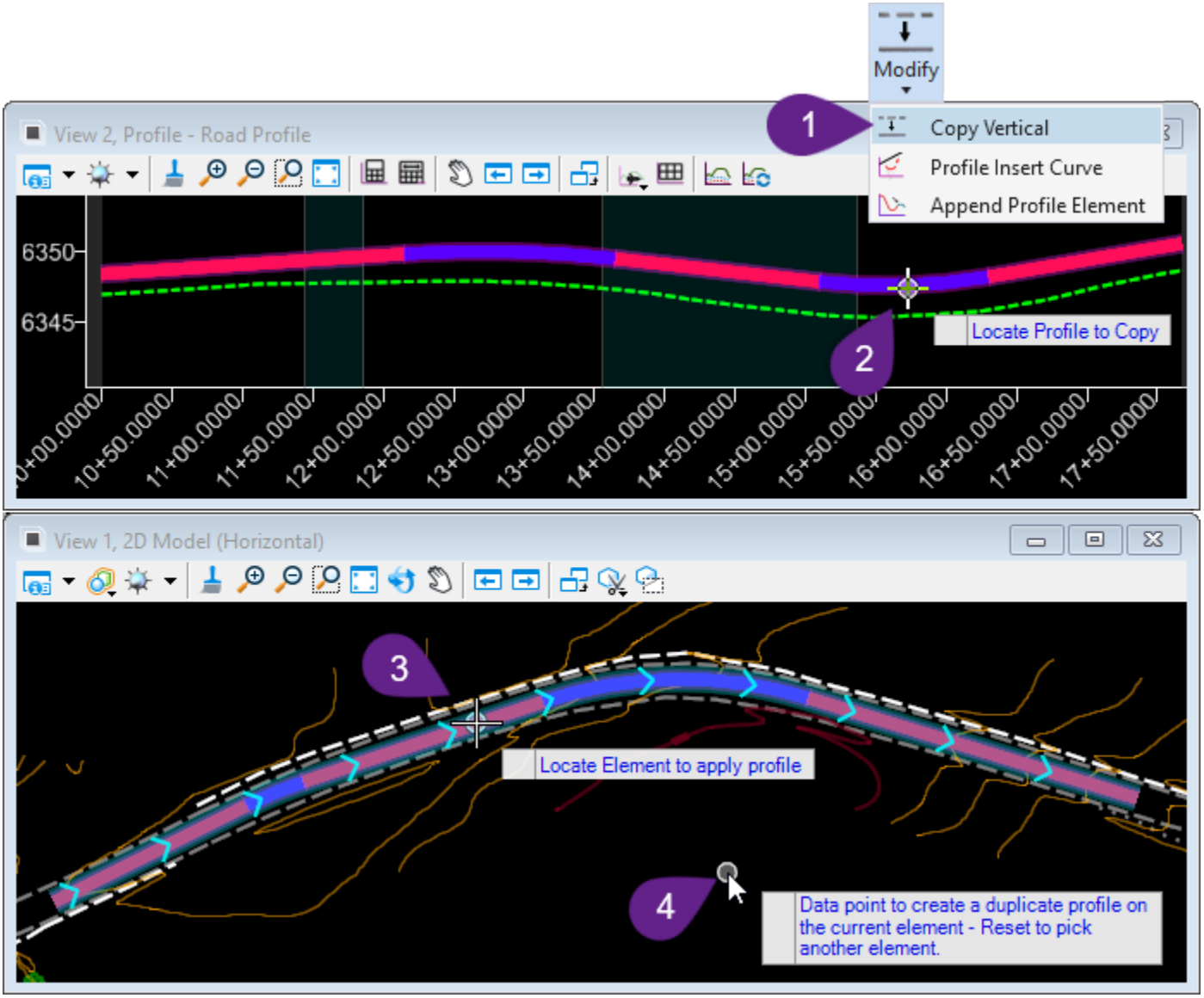
All tools to be discussed in this section are found in the *Modify* dropdown of the *Vertical* Panel



7G.4.a Copy Element tool

This tool is used to create a copy of a *Vertical ORD Element*. The *Vertical ORD Element* can be copied to the original *Profile Model* OR to the *Profile Model* of an overlapping *ORD Element*.

> ***TIP:*** If it is desired to copy AND move (translate) a *Vertical ORD Element* – the *Transform* tool can be used.



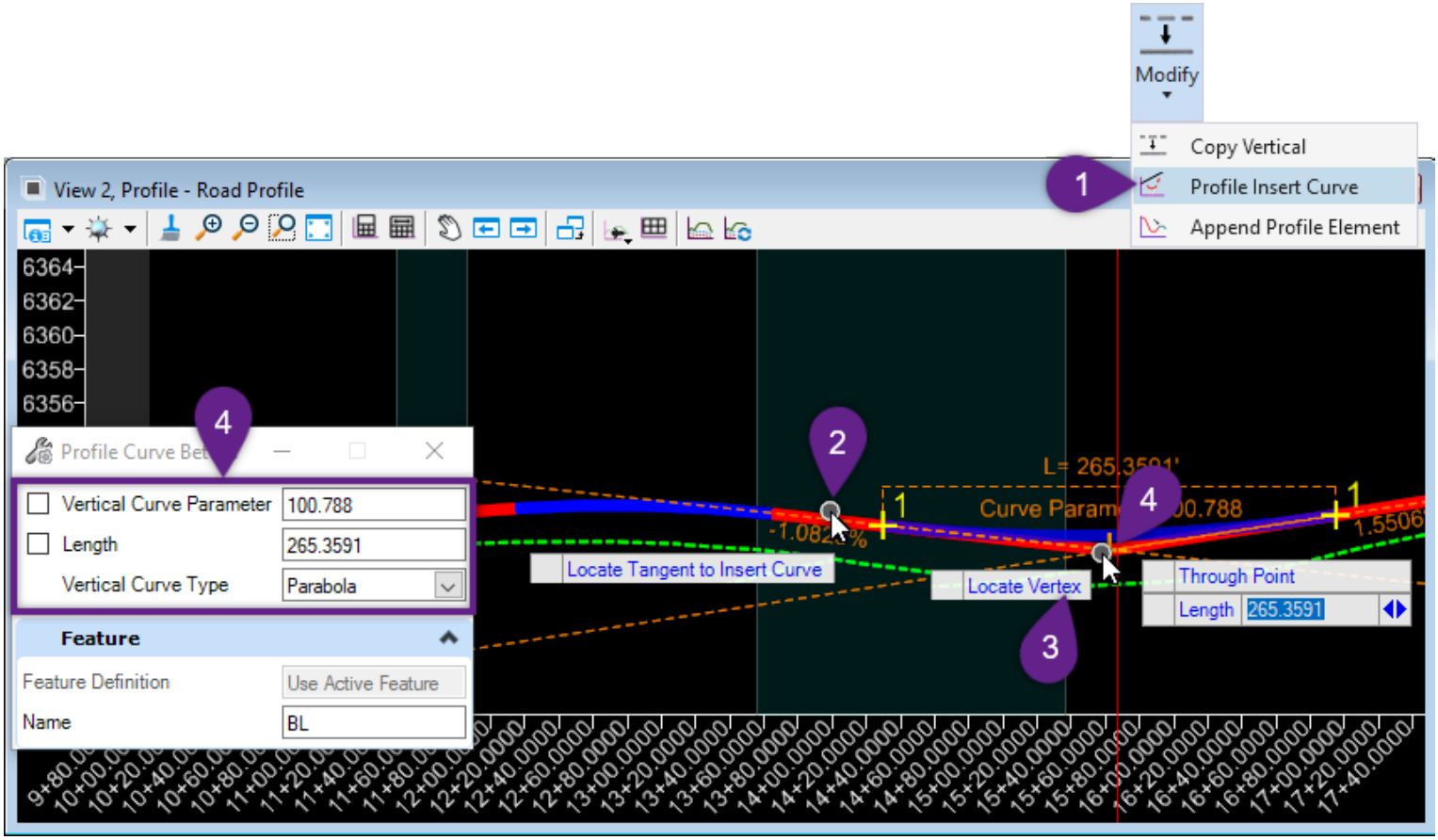
1	Left-Click the *Copy Element* tool from the *Modify* dropdown
2	*Prompt: Locate Profile to Copy* – Left-Click on the *Vertical ORD Element* to be copied.
3	*Prompt: Locate Element to apply profile* – Left-Click on the *Horizontal ORD Element* where the *Vertical ORD Element* is to be copied to. ***NOTE:*** This tool can be used to copy *Vertical ORD Elements* into the *Profile Model* of an overlapping *Horizontal ORD Element*.
4	*Prompt: Data point to create a duplicate profile on the current element – Reset to pick another element* – Left-Click to create a copy of the *Vertical ORD Element* in the same *Profile Model*. Right-Click to pick an overlapping *Horizontal ORD Element* to copy the *Vertical ORD Element* to.

7G.4.b Profile Insert Curve tool

This tool is used to insert a curve or deflection point into a *Vertical ORD Element*.

WARNING: This tool does not work with on Lines created with the *Profile Line To Element* OR *Profile Line From Element* tool sets. **This includes Complex Profiles with *Base ORD Elements* made with the aforementioned tool sets.** Inserting a curve would violate the "To" or "From" Element *Civil Rule* issued to the Line during initial creation.

BEST PRACTICE: Use the *Table Editor* tool to insert a PVI or curve into Complex Profile. The *Table Editor* tool will work in all situations because the *Civil Rules* in the underlying *Base Elements* are *Simplified* in the *Table Editing* process.

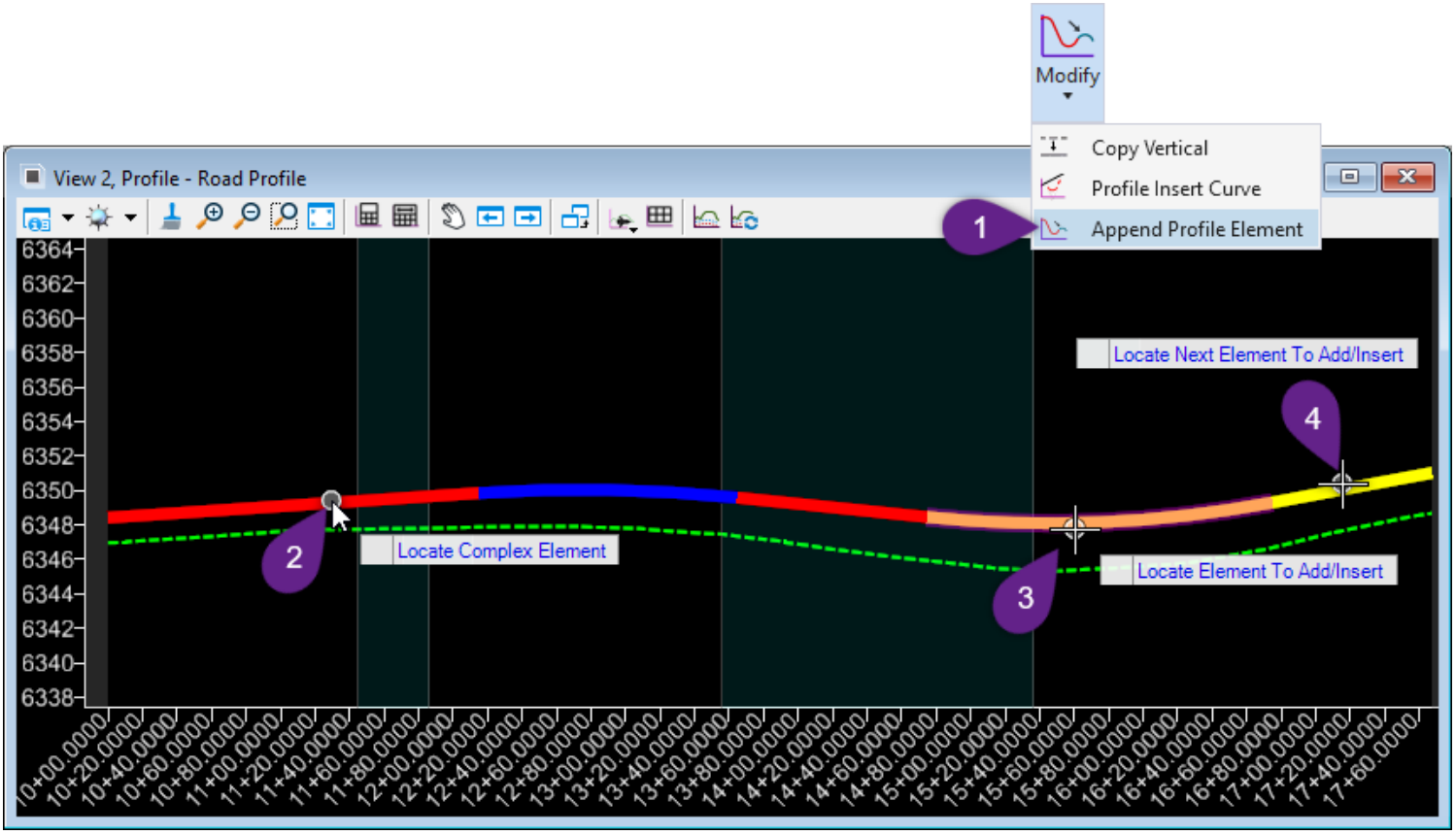


1	Left-Click the *Insert Curve* tool from the *Modify* dropdown
2	*Prompt: Locate Tangent to Insert Curve* – Left-Click on a tangent or Line to insert PVI and Curve into.
3	*Prompt: Locate Vertex* – In the *Profile Model,* Left-Click at the desired location for the inserted PVI.
4	*Prompt: Enter Through Point* - In the *Profile Model,* Left-Click at the desired through point location for the inserted curve to complete the command OR Key-in a Vertical Curve Length, Parameter, and/or Type into the *Dialogue Box*. Left-Click in the *Profile Model* to complete the command.

7G.4.c Append Profile Element tool

This tool is used to add *Vertical ORD Elements* to the beginning or end of a previously-created *Complex Profile Element*.

> ***NOTE:*** The *Complex Redefine* tool can be used to add *Vertical ORD Elements* to the interior portion of a profile.



1	Left-Click the *Append Profile Element* tool from the *Modify* dropdown
2	*Prompt: Locate Complex Element* – Left-Click on the previously-created *Complex Profile Element*.
3	*Prompt: Locate Element to Add/Insert* – Left-Click on the first *Vertical ORD Element* to be added to the beginning or end of the *Complex Profile Element*
4	*Prompt: Locate Next Element to Add/Insert* – Left-Click on the next *Vertical ORD Element* to be added OR Right-Click in the *Profile Model* to complete the command.

7G.5 Common Tools

Common Tools are used to make edits to Vertical ORD Elements in the exact same way as Horizontal ORD Elements. See Common Tools in the Edits to Horizontal Geometry section.