# OpenRoads Survey: Horizontal Geometry

Alignment Design Files

For ODOT projects, each geometric alignment is typically stored in its own Geometry Basemap (BK) design file. These files are stored in the **400-Engineering\Roadway\Basemaps** folder.

This multi-file approach, also referred to as a "federated" approach, allows multiple users on a project to create and edit horizontal and vertical geometry simultaneously.

Alignment design files are created using the **OHDOT Create Design Files** application. The application is accessed from the **Ohio DOT** WorkFlow by selecting the **OHDOT Create Design Files** icon.
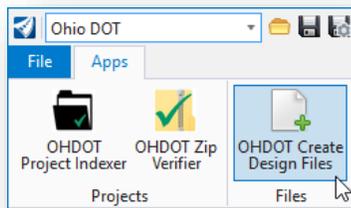
The create design files application has been enhanced to utilize multiple filter fields to find the basemap or sheet files you are looking to create.

For the Geometry Basemap (BK) design file we can utilize a **Roadway** and a **Basemap Filter** to narrow down our file types within the application.
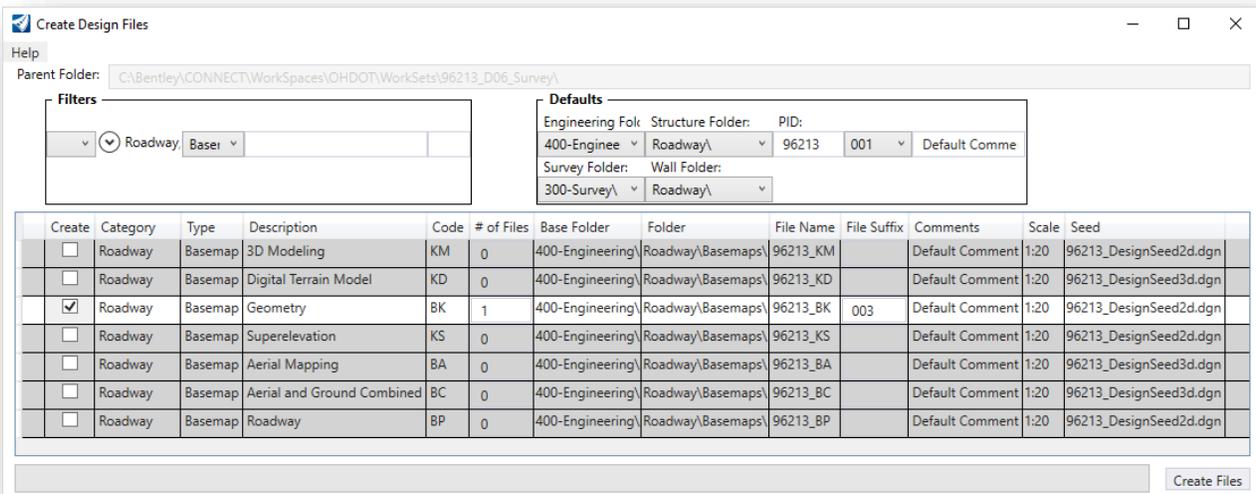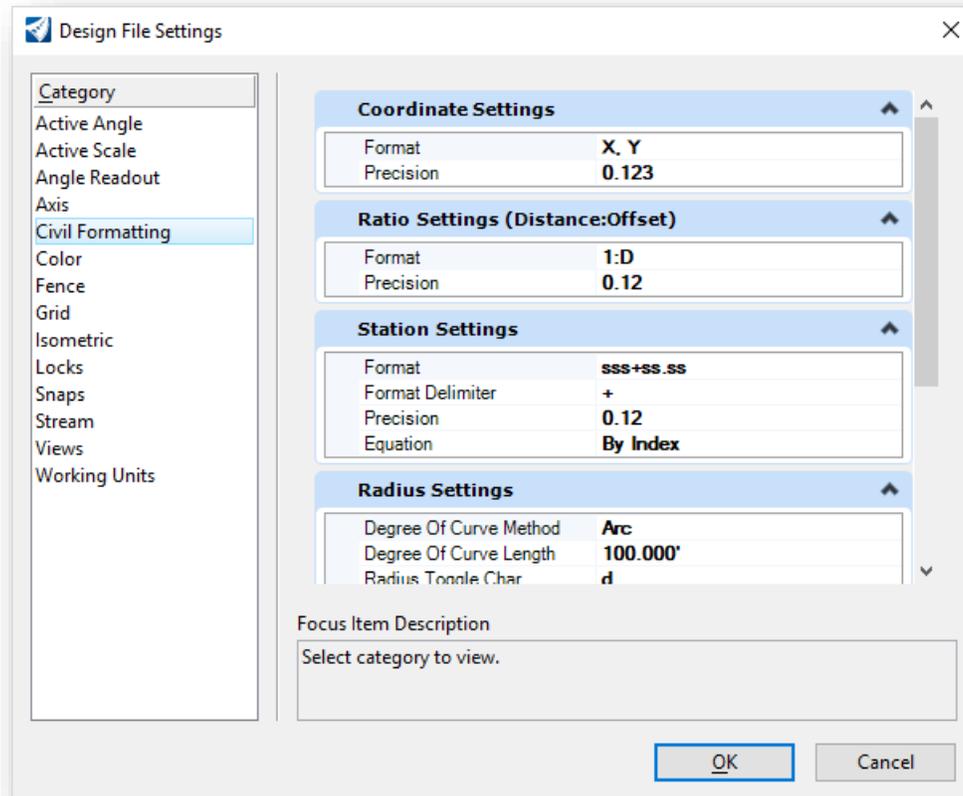
Civil Formatting

Before getting started with the OpenRoads geometry tools, it is a good idea to review the design file settings to ensure they are set correctly for ODOT projects. Take the following steps to review the **Civil Formatting** settings:

- Select the **Files** tab to access the backstage area.

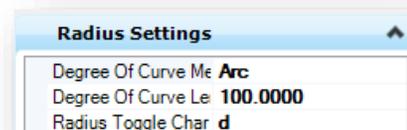- Select **Settings > File > Design File Settings** to access the dialog shown below

Choose the **Civil Formatting** option to review the current settings. Settings specific to ODOT are detailed below. These setting are set in the ODOT seed files. See the online help for additional information.

Station Settings
Make sure the **Equation** option is set to **By Index** for compatibility with the GEOPAK GPK file.
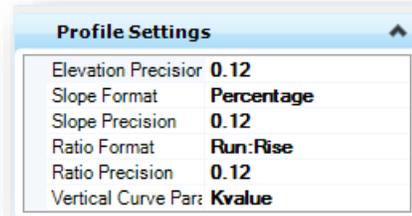
Radius Settings
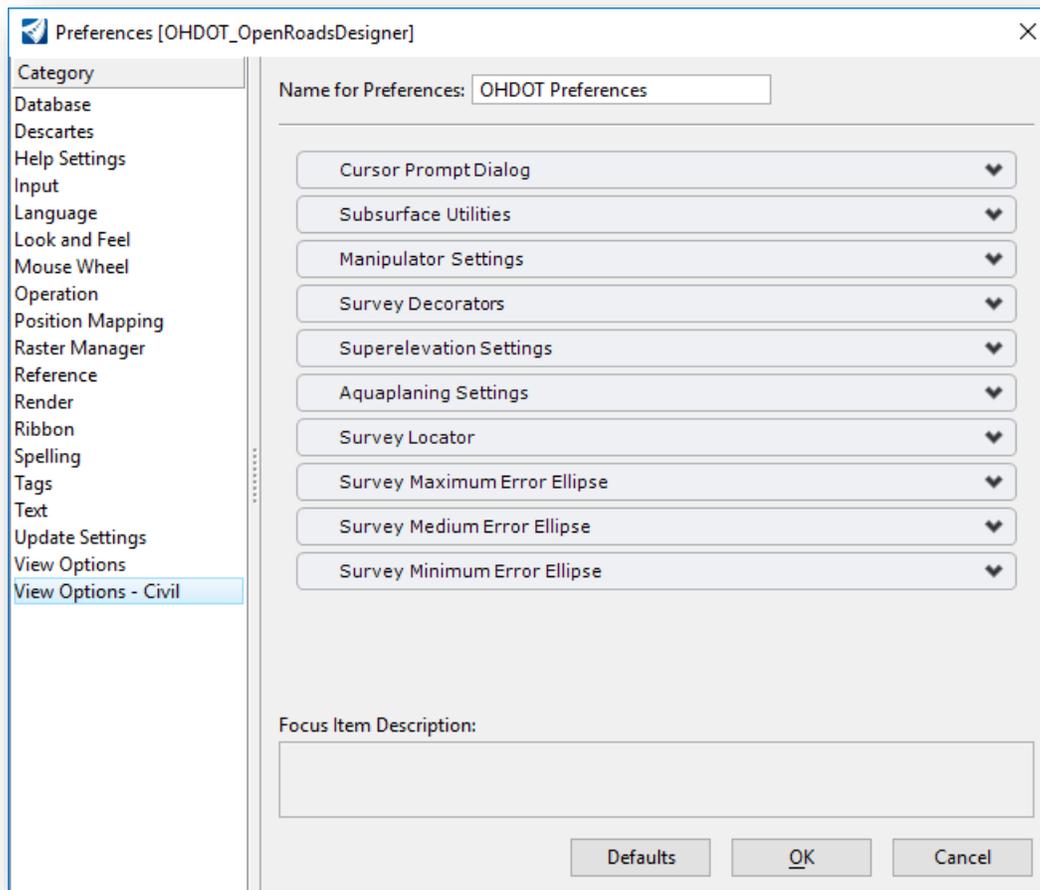The **Radius Settings** should be set as shown at right

Profile Settings
The **Profile Settings** should be set as shown at right

Profile Settings	^
Elevation Precision	**0.12**
Slope Format	**Percentage**
Slope Precision	**0.12**
Ratio Format	**Run:Rise**
Ratio Precision	**0.12**
Vertical Curve Para	**Kvalue**

User Preferences

The ORD User Preferences include several options for the civil products. These parameters are accessed by selecting **File > Settings > User > Preferences** as shown below. These options have been configured as necessary in the OHDOT workspace. See the Bentley online help for information not covered in this document.
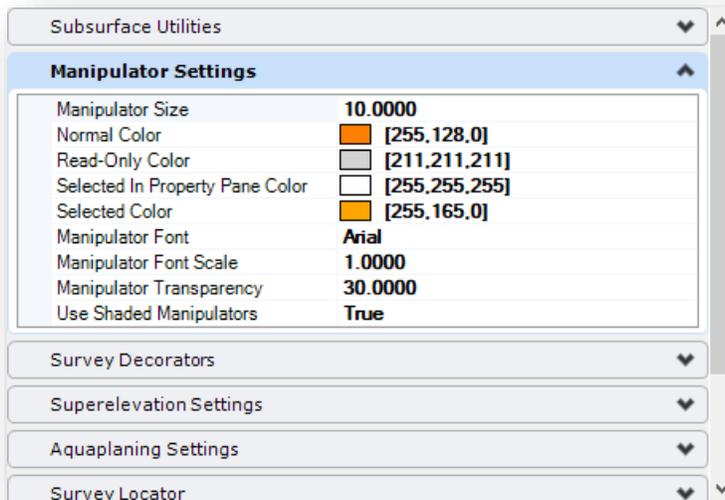
Preferences [OHDOT_OpenRoadsDesigner]

Category
Database
Descartes
Help Settings
Input
Language
Look and Feel
Mouse Wheel
Operation
Position Mapping
Raster Manager
Reference
Render
Ribbon
Spelling
Tags
Text
Update Settings
View Options
View Options - Civil

Name for Preferences: OHDOT Preferences

Cursor Prompt Dialog
Subsurface Utilities
Manipulator Settings
Survey Decorators
Superelevation Settings
Aquaplaning Settings
Survey Locator
Survey Maximum Error Ellipse
Survey Medium Error Ellipse
Survey Minimum Error Ellipse

Focus Item Description:

Defaults   OK   Cancel

View Options Civil - Manipulator Settings

When OpenRoads geometry elements are placed in the design file, the elements are "ruled" graphics that behave according the geometric rules that define how the element was placed. These rules can be edited based on the element type. The line below was drawn using the **Line Between Points** command and contains three rules: The start point, the direction, and the length.

The rules are revealed when the element is selected using the **Element Selection** tool as shown at left. The rules can be selected and edited as described on the followin pages.

The display of the manipulators and text can be adjusted as part of the **User Prefernces** by select the Manupulator Settings group as shown below. These parameters allow the user to control the settings and symbology of the civil geometry manipulators and associated text.
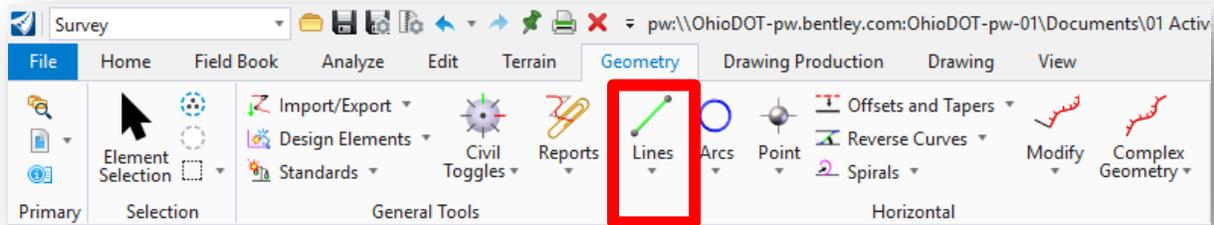
Civil Geometry Manpulation and Modification

Civil Geometry elements drawn using the OpenRoads tools are "ruled" graphics that behave according to the geometric rules that define how the element was placed.

For example, a simple line drawn using the **Line Between Points** command has two rules: Length and Direction.

The rules can be reviewed in the *Properties* dialog. An example for a line element is shown below.
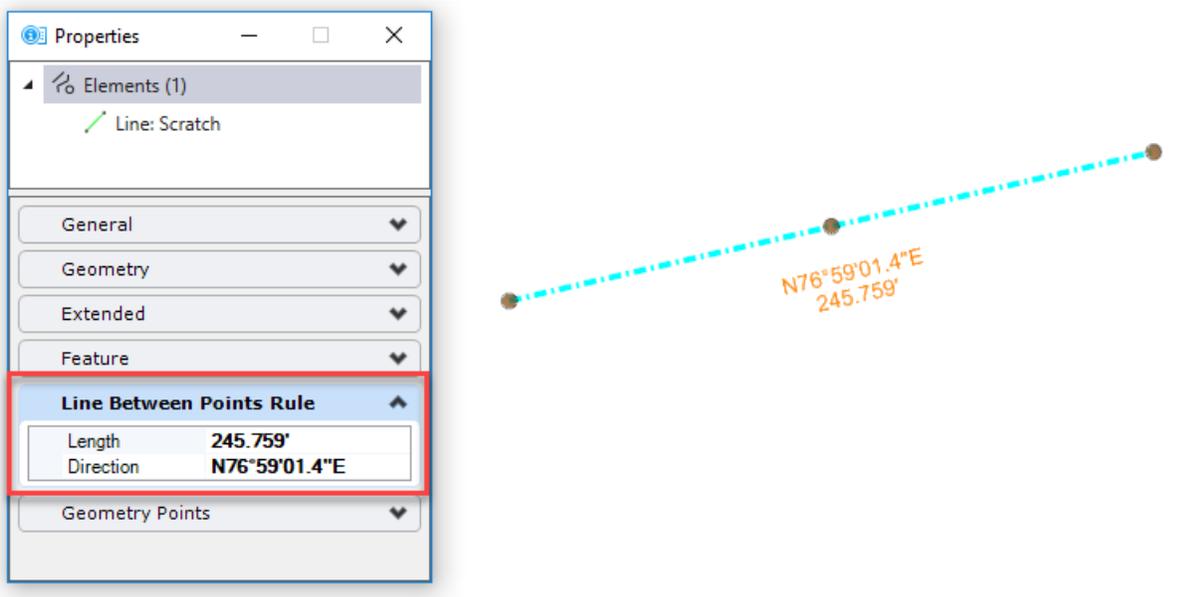
MicroStation's **Manipulate** commands (Copy, Move, Scale, Rotate, etc.) cannot be used on ruled geometry. The rule must be removed to use these commands. To remove a rule, select the line and choose the Rules menu as shown below.
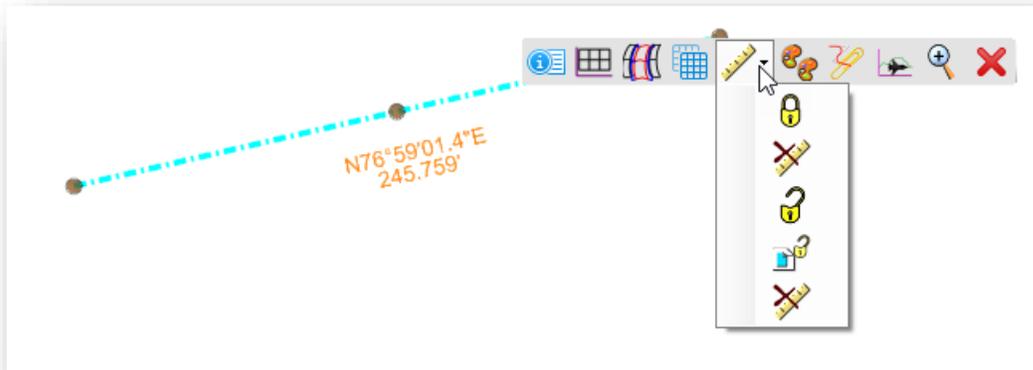
The following options are provided:

> **Lock** – Deactivate Rule
> **Remove Rule**
> **Unlock** – Activate Referencing Rules
> **Lock** – Deactivate Referencing Rules
> **Remove Rule**

Element Manipulators

OpenRoads Geometry elements have **Manipulators** that are displayed in MicroStation when an element is selected. These manipulators can be used to edit the selected element graphically or by entering a value.
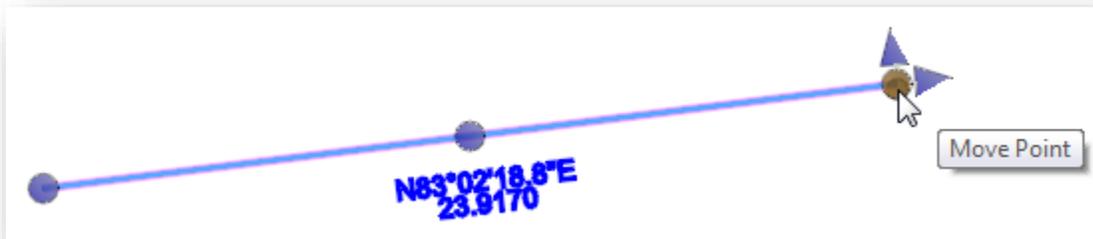
For example, a simple two-point line has several manipulators as shown below.

Clicking on the direction or the length manipulator will open an editor to change the display as shown below.

Clicking on one of the key point manipulators will display direction arrows to edit the line, as shown on the example below.


Tip: The size and color of the Manipulator Text can be adjusted in the **User Preferences**. From the MicroStation menu, select **Workspace > Preferences** and then choose the **View-Options - Civil** item on the left side of the dialog. The **Manipulator Size** or the **Manipulator Font Scale** parameters can be used to adjust the text size.

Design Intent

As geometric elements are drawn in MicroStation using the OpenRoads Horizontal Geometry tools, the software retains information about not only *what* element was drawn, but *how* it was drawn. This is referred to as the **Design Intent**.

In the example below, the horizontal line was drawn first. The second line was drawn using the MicroStation Perpendicular snap to draw the line at a perpendicular form the horizontal line to a specific ending point.
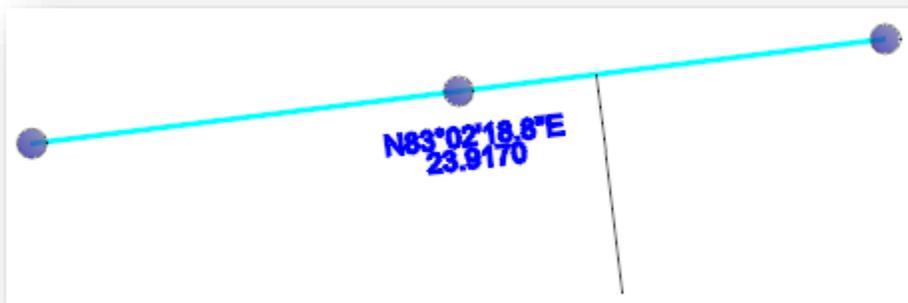
If the horizontal line is modified by changing the direction of the line, the design intent for the perpendicular line is preserved. The Perpendicular rule, and the ending location are preserved. The result is shown below.
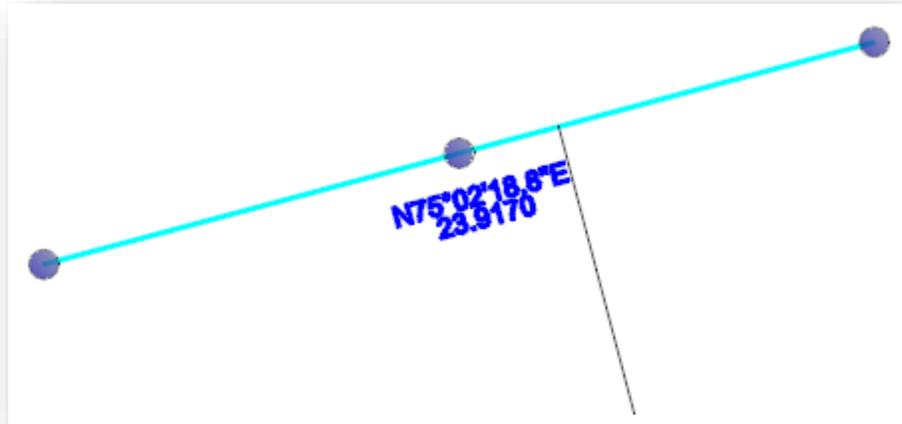
Alignment Feature Definitions

Alignment elements are assigned a **Feature Definition**, which controls the symbology of the element (level, color, line style, and line weight) as well as the annotation properties of the element. The OHDOT Standards include feature definitions for alignments, which can be reviewed from the *Project Explorer* dialog, as shown below.
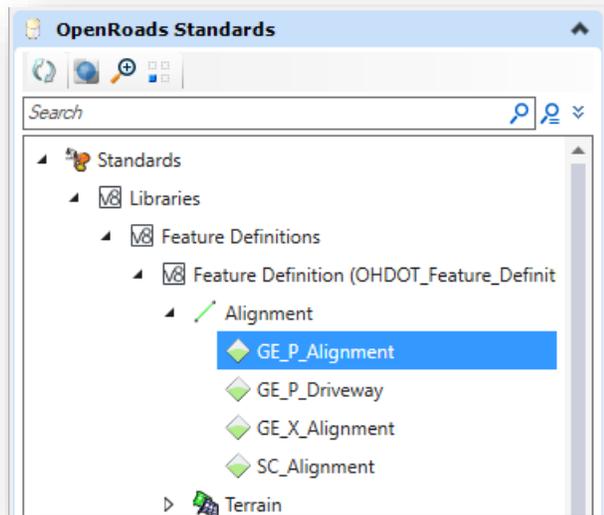

Note that the alignment feature definition controls the symbology and annotation settings for both the horizontal geometry and the proposed vertical alignment.

Alignment Annotation

When geometric alignments are placed in the file, the annotation is not automatically generated by the software. The user must identify the alignments that are to be annotated either individually, by selecting the specific alignments, or by annotating all of the alignments contained in the active model, or all models in the active file.

Annotation commands are selected from the **OpenRoads Modeling** WorkFlow, or in the **Survey** Workflow, in the **Drawing Production** tab, as shown below.
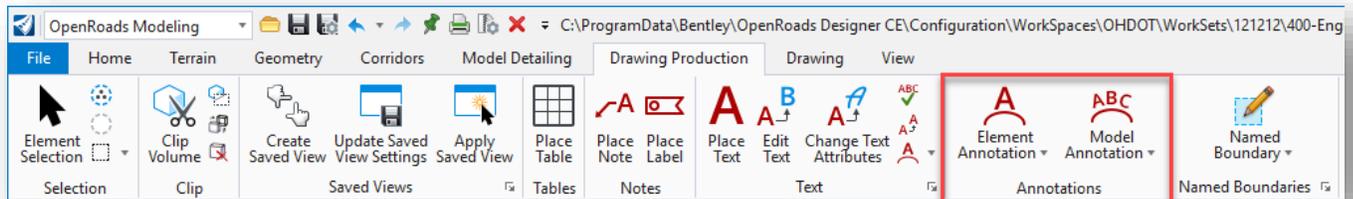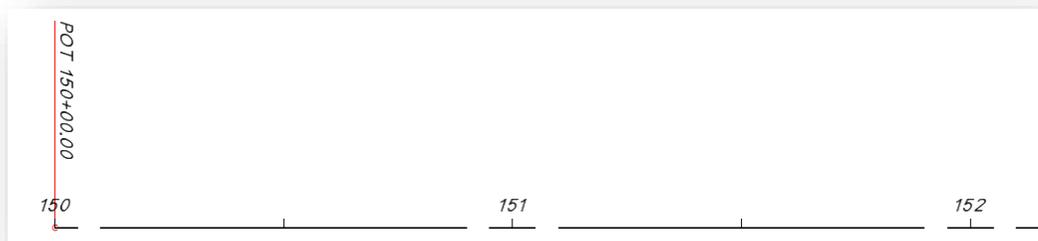

Element Annotation

Individual elements are annotated by selecting the **Element Annotation** command from the **Drawing Production** tab. Two commands are available as shown below.
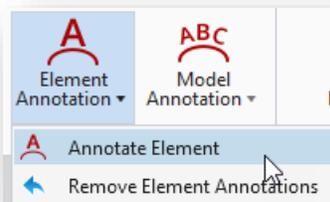
Annotate Element

The **Annotate Element** command is used to annotate one of more selected elements. The command prompts to select the OpenRoads element to be annotated. Multiple elements can be selected. Reset (right-click) to complete the selection process and initiate the annotation placement.

An example of annotation at the beginning of an alignment is shown below.

Remove Element Annotations

The **Remove Element** Annotations command is used to remove the annotation from selected elements. When prompted, select the elements to remove the annotation. Reset (right-click) to end the selection process and initiate the removal process.
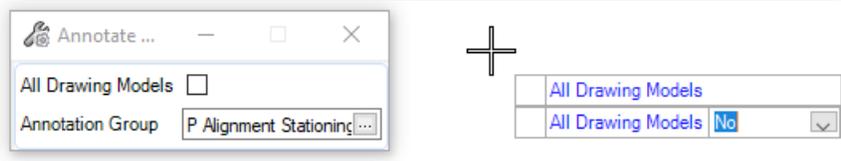
Model Annotation

The **Model Annotation** command us used to annotate all of the elements in the active model, or all models, by selecting a specfic Annotation Group. Two options are available as shown below.
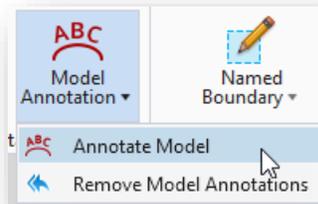
Annotate Model

Select this command to annotate all the elements in a model, or in all models, by selecting a specific Annotation Group.

When the command is selected, the user is prompted as shown below. Issue a data point (left mouse-click) to initiate the process.

Remove Model Annotations

Select this command to remove all annotations from the active model or all models in the active file.

Alignment Annotation Levels

Stationing is defined by the Feature Definition assigned to the alignment element. Annotation is frequently drawn at different intervals depending on the type of sheet that is displaying the alignment information (20-scale plan vs. a 500-scale schematic sheet). There is no way to assign an element template to an alignment in one file with one set of annotation values appropriate for the 20-scale plan, and a different element template in another file with a different set of annotation values appropriate for a 500-scale schematic plan. To facilitate different station and tic intervals, it is necessary to define the text for multiple scales in the Feature Definition that is assigned to the element.

Three groups of levels and element templates are provided to facilitate alignment annotations with 100', 500', and 100' spacing for the major station labels.

In the example below, stations and curve data for a sprial elemet are visible. The levels for the stations at 100' interval are turned on, while the levels for the 500' and 1000' stationing interval are turned off. The **Annotation Scale** value is set to 1:20.
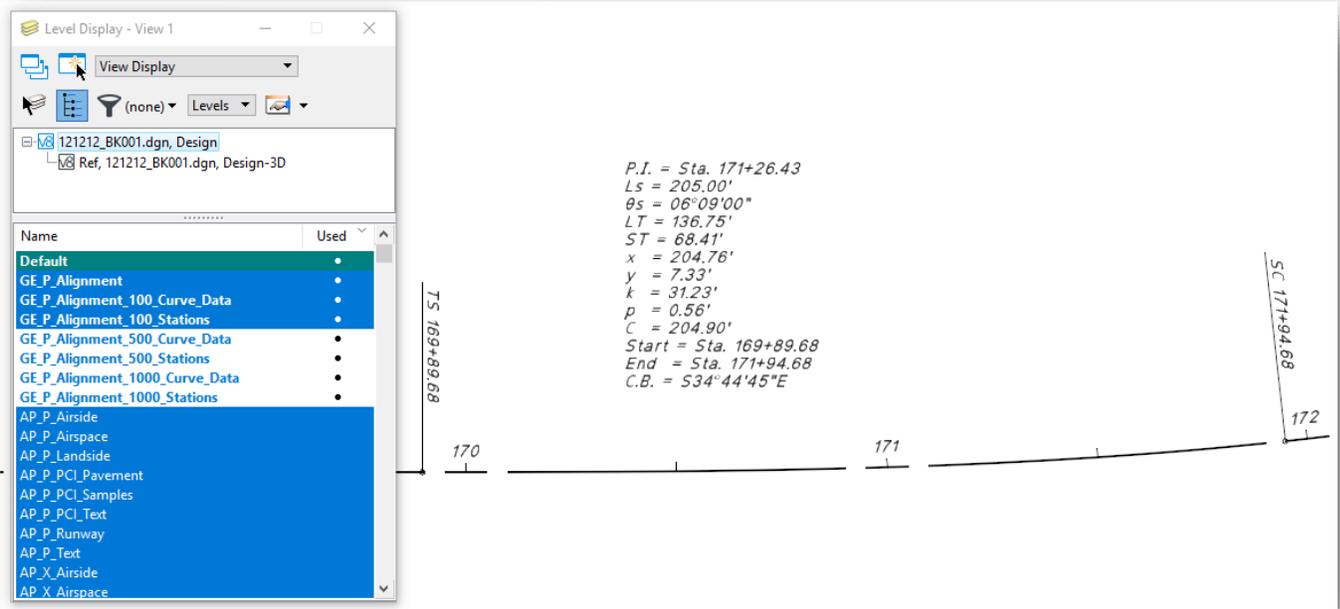
In the example below, the **Annotation Scale** value is set to 1:100 with the levels for 500' station intervals toggled on.
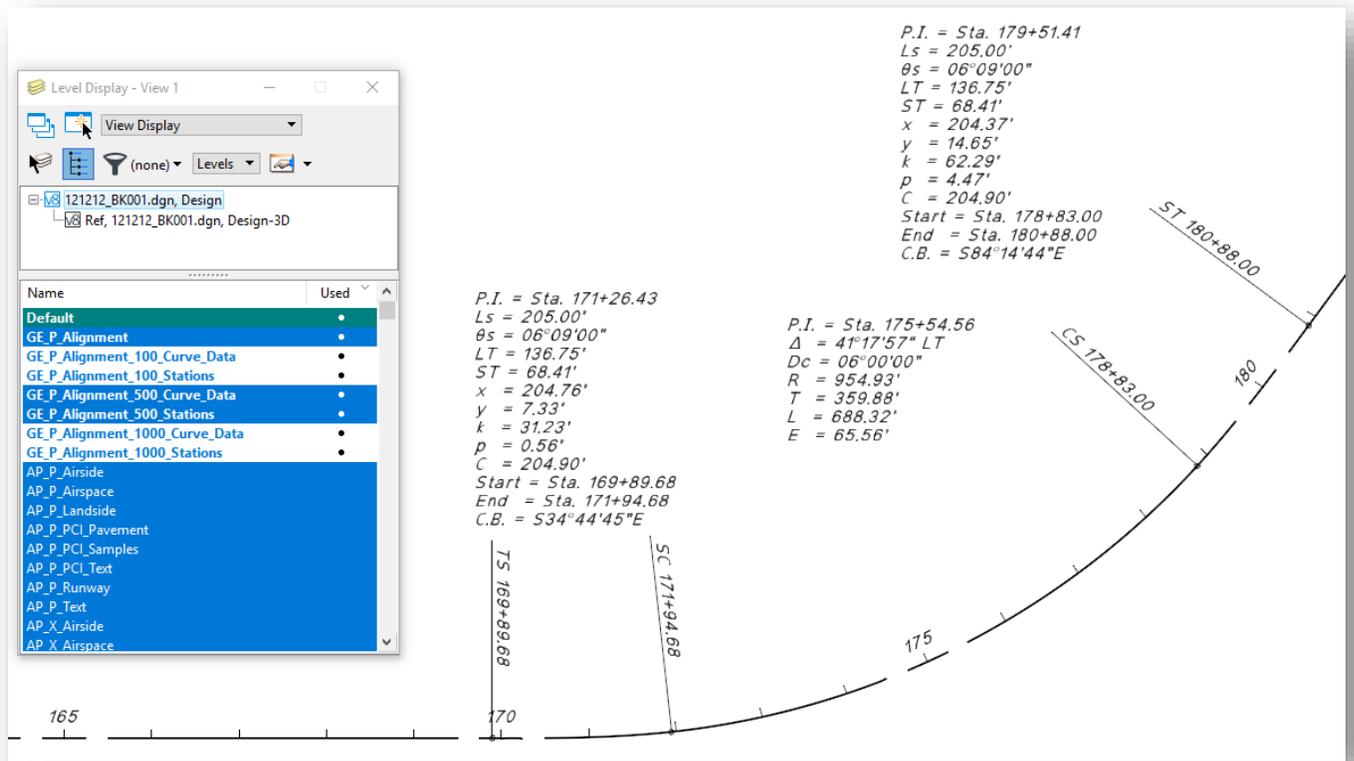
Note: The levels are named according to the station label intervals (100', 500', and 1000'), not the annotation scale value. For example, the **GE_P_100_Stations** and **GE_P_100_Curve_Data** levels are appropriate for multiple annotation scale values (1:10, 1:20, 1:50).

Also note that the spiral and curve data cannot be configured as a combined curve set with OpenRoads Designer Update 3. This is planned for a future update and will be adjusted in the OHDOT standards after it has been implemented.

Exercise 1: Creating Design Files

For this exercise we will create 4 Alignment (BK) files, one for each of the four centerlines.

ODOT projects that have been created outside of the ProjectWise environment using the OHDOT template contain the file **400-Engineering\Startup.dgn**. This file is used as the launching point for opening ORD to create new DGN files for the WorkSet. The Startup.dgn file can be ignored once the initial design files for the project are created.

Inside the ProjectWise environment, the Startup DGN file is not used. One of the seed files is used as the initial launching point to create new design files for the WorkSet.

Take the following steps to open **106471_DesignSeed2d.dgn** and create a new FB design file for the project.
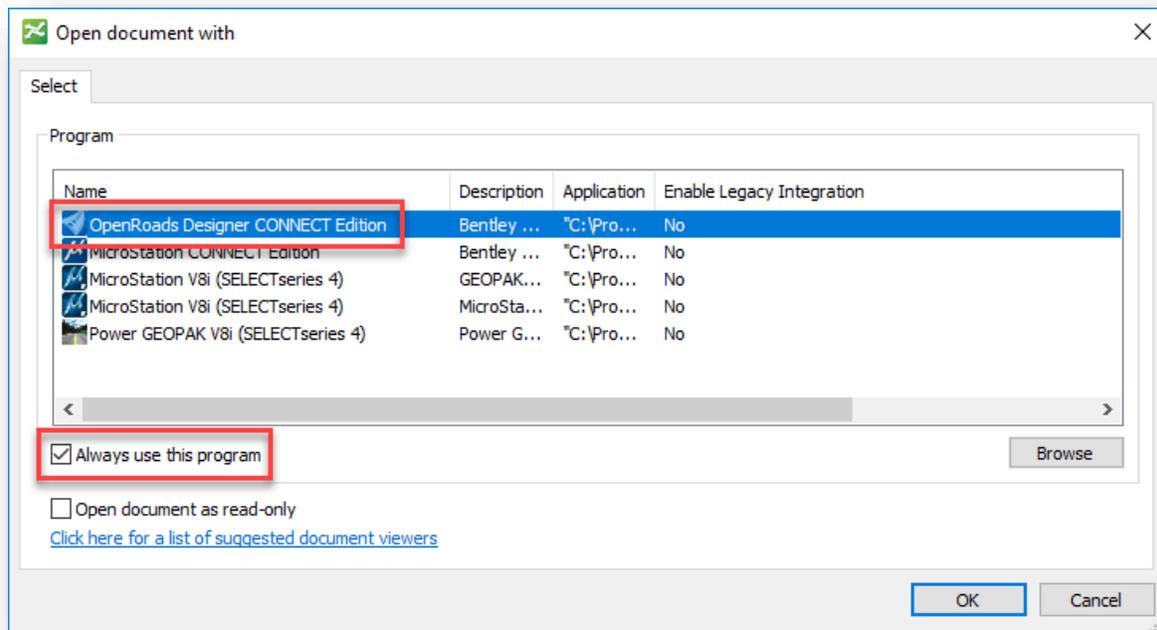
- Open **ProjectWise Explorer**

- Browse to the folder shown below, using your home District and your user name.
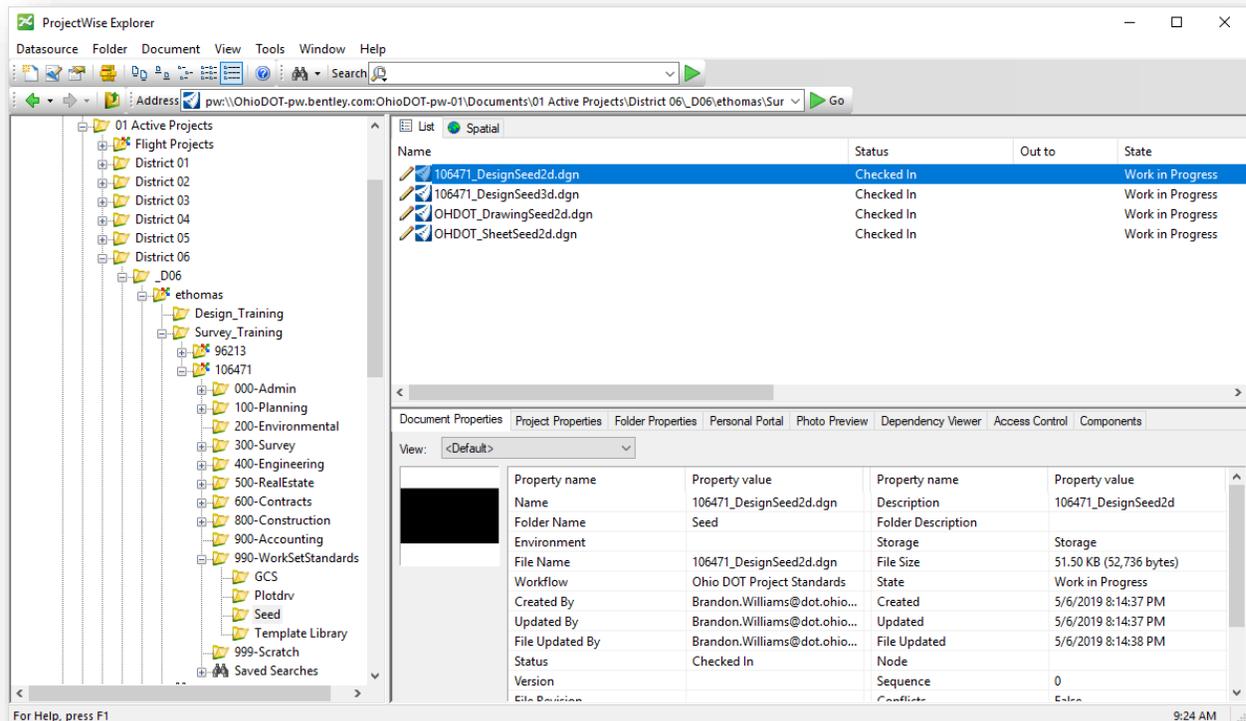
- Right-Click on the file **106471_DesignSeed2d.dgn** and choose the **Open With…** option to open the file with OpenRoads Designer CONNECT Edition. Toggle the **Always use the program** option **ON**

- Select **OK** to open the file.

- Select the **Ohio DOT** workflow from the top left of the ORD interface.

- From the **Apps** tab, select the **OHDOT Create Design Files** icon
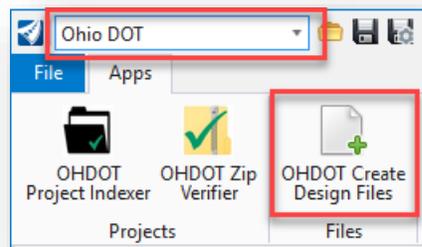
The application dialog will appear as shown below:
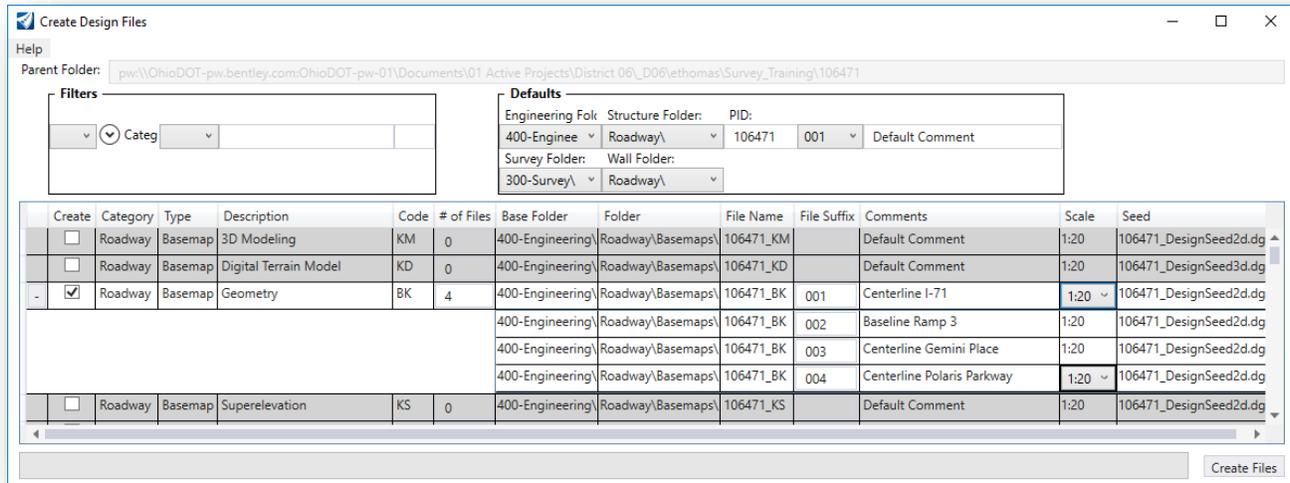
- Select the Roadway Geometry Basemap (BK) file using the checkbox and change the number of files to create to **4.**
  - ○ Fill in the comments section accordingly for each centerline and fieldbook
    - ▪ 106471_BK001.dgn → Centerline I-71
    - ▪ 106471_BK002.dgn → Baseline Ramp 3
    - ▪ 106471_BK003.dgn → Centerline Gemini Place
    - ▪ 106471_BK004.dgn → Centerline Polaris Parkway

- Click the **Create Files** button in the lower right-hand corner. Four design files are created.

- When complete, exit OpenRoads Designer and check the file back into ProjectWise.

Exercise 2: Creating the Centerline of 71

When generating horizontal geometry there are sever methods that can be utilized. This exercise will use the OpenRoads Geometry commands to generate a portion of the IR-71 centerline.

- Open the 106471_BK001.dgn (for the creation of the centerline of 71) through the ProjectWise Explorer client. (BK files are in the 400 Engineering\Roadway\Basemaps folder)

- Reference in the 106471_FB001.dgn using the attach tools command from the **Home→ Primary** tool set. This file contains the monumentation as surveyed.
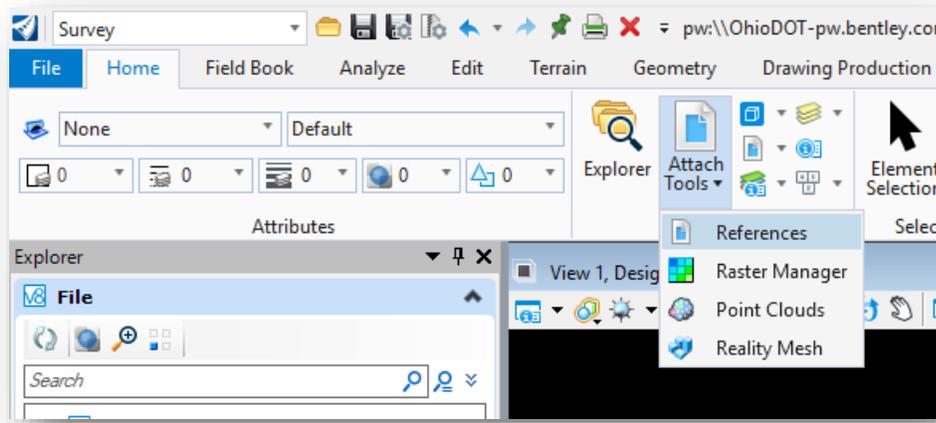
- Select the **Line Between Points** command as shown below.
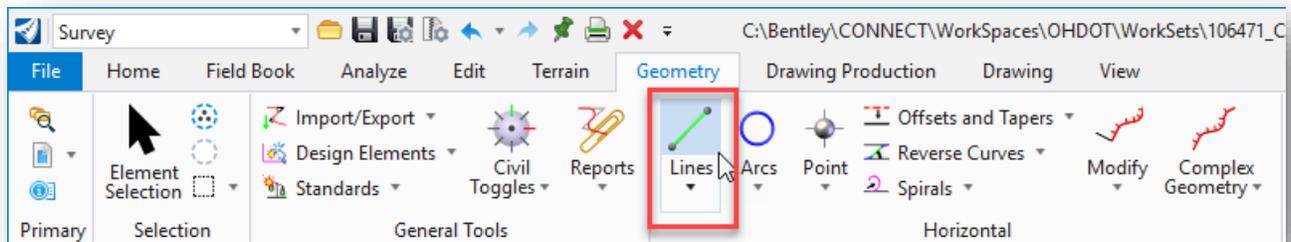
Use this command to place the first tangent line of IR-71 from the southern-most monument point, number SV1 as shown on below.

To place the **Line Between Points**, define the starting point using the MicroStation **Key-point Snap** to snap to the center of the surveyed point **SV1**. Use the following values:

Distance:	**9449.64**
Direction:	**N3:31:16E**
Feature Definition:	**Alignment > GE_X_Alignment**
Name:	**CLX_71**
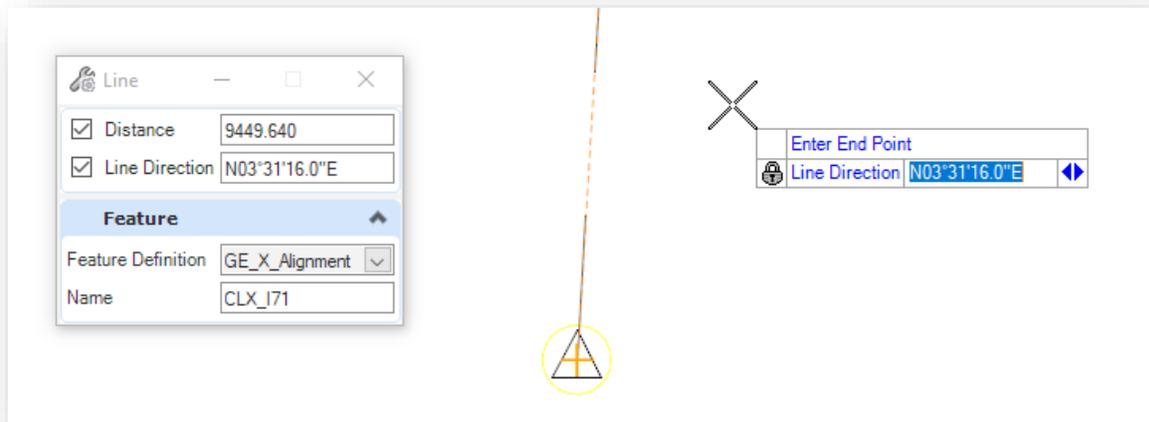
This defines the first tangent line for the centerline of IR-71.

- Select the **Simple Arc From Element** command to place the horizontal curve at the end of the tangent line.
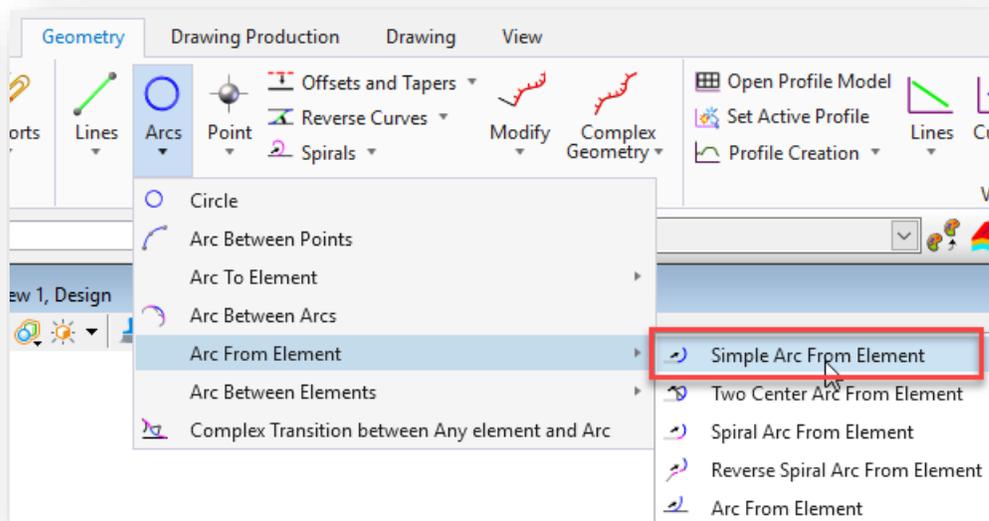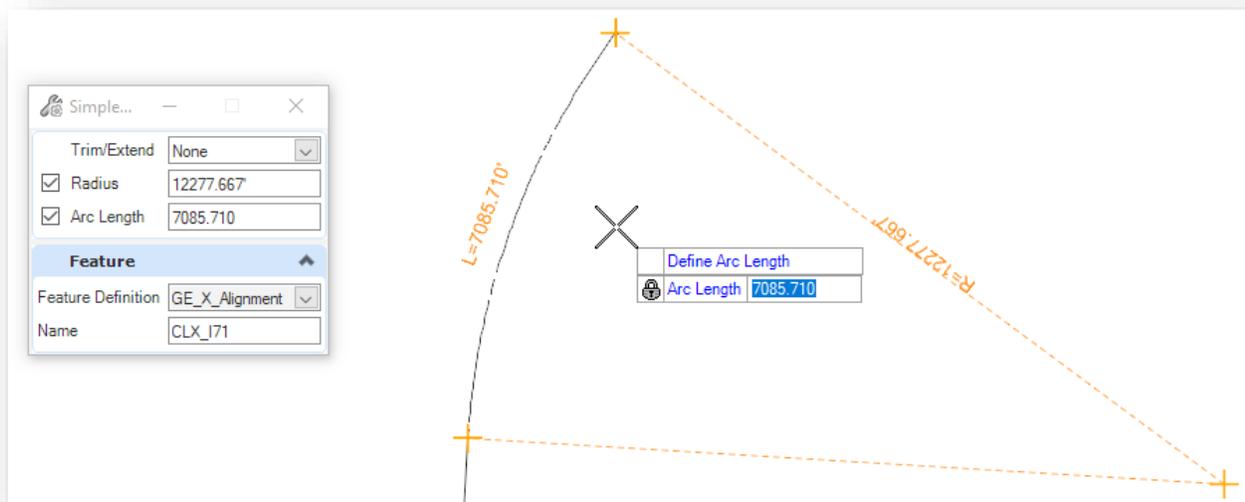
Place a 0°28' arc by using the following parameters:

Trim/Extend:	**None**
Radius:	**d0:28**
Arc Length:	**7085.71'**
Feature Definition:	**Alignments > GE_X_Alignment**
Name:	**CLX_I71**

Notice that the **Radius** value can be keyed in using a lower case "**d**" to designate the value in degrees as shown above. The value is converted to the radius as shown below.

At this point, two separate pieces of geometry have been created. These elements can now be combined into a single alignment using the **Complex Geometry** command.

- Select the **Complex Geometry** command as shown below.
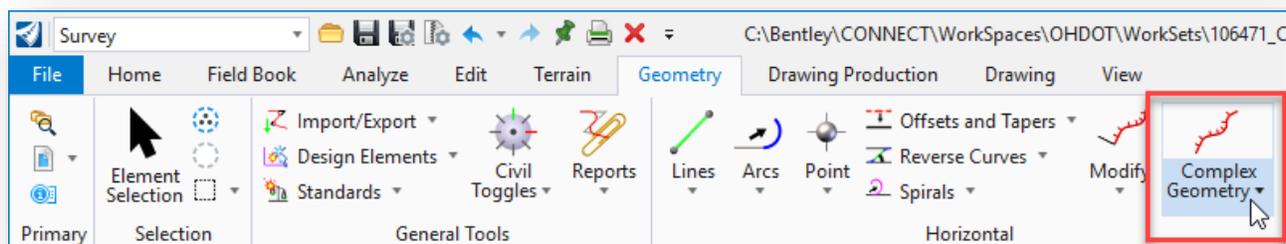
Create the complex element using the settings below.

Method:	**Automatic**
Maximum Gap:	**0.033**
Feature Definition:	**Alignments > GE_X_Alignment**
Name:	**CLX_I71**

When prompted to select the first element, be sure to identify the element by selecting the element as shown below to store the complex element in the appropriate direction.
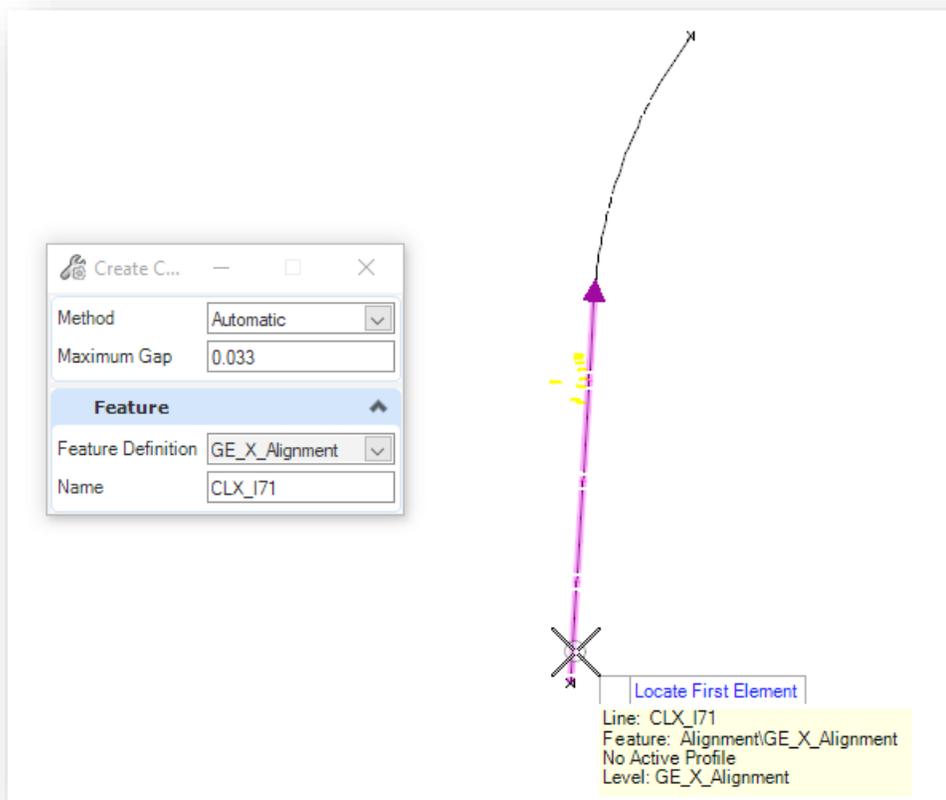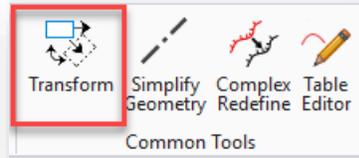

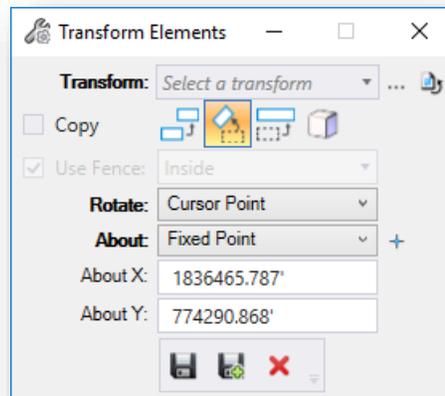The elements are joined together as a single complex element.

Transform

Now that the geometry is placed the centerline will need to be rotated into place using the **Transform** tool under the **Common Tools** grouping (from the **Survey** Workflow→ **Geometry** tab)


- Once selected the ***Transform Elements*** tool dialog will open

The **Transform Elements** command can be used for translating, rotating and scaling elements. For this example, we will rotate the centerline of IR 71.

- Enable the **Rotate** command and unselect the other transform options as shown above
  - Use **Cursor Point** and **About: Fixed Point** options
- To the right of the **About: Fixed Point** select the **Select point to scale or rotate about** icon
- Snap to the "fixed" end of CLX_IR71 at point SV1. The coordinates are populated in the dialog as shown above
- Select the CLX_IR71 element which will be transformed by snapping to the end of the alignment (at the northern end)
- Snap to the center of SV2 and left click to accept the rotation as shown below
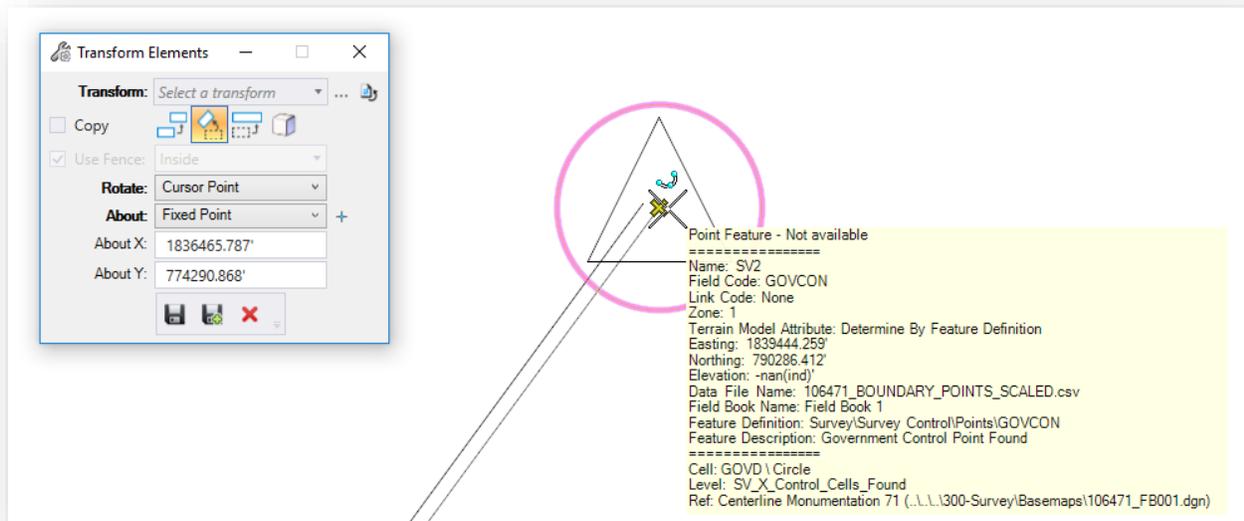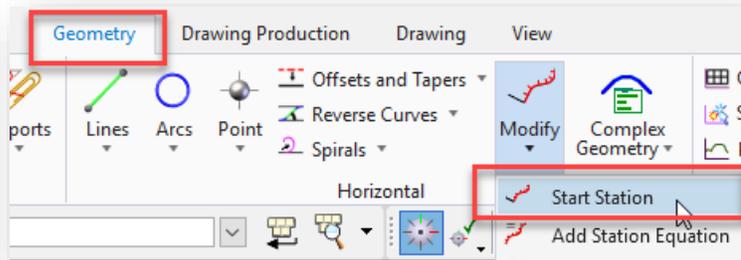
The centerline line element is rotated to meet the control point.

Stationing

Now that the centerline is now in its proper location, the stationing can be to be applied

- Under the **Survey** workflow → **Geometry** tab → **Horizontal** group select under the modify command **Start Station**

  - Following the heads-up prompt locate the element to station (CLX_IR71)
  - Enter the start distance as 0.00'
  - Enter the begin stationing for CLX_IR71 as **191+71.05** and left click to accept

Notice the stationing is not visible upon completion but is ruled to the geometry. To check, select the element and look at the beginning to see the station. This is one place the stationing can be adjusted as well.

To display the stationing and annotations the element must be annotated. There are 2 methods for achieving this:

Annotate Element
This function is used to annotate the selected element or elements

Annotate Model
This function will annotate every element in the model that has a feature definition assigned with an annotation definition defined
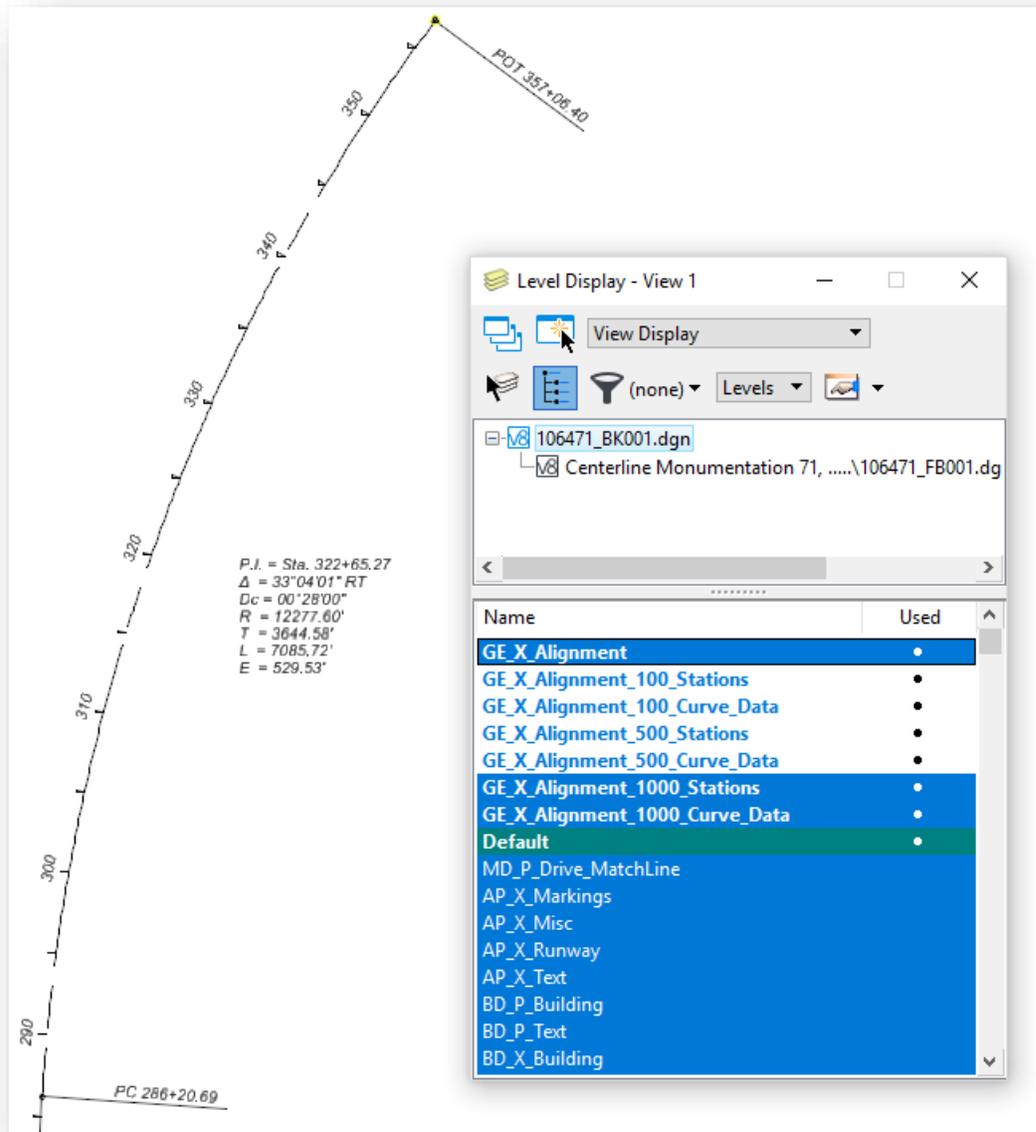
This exercise will introduce element annotation.

- The tool can be found under the **Survey** workflow→ **Drawing Production** tab → in the annotations group. The dropdown will allow for annotations to be removed (same functionality as the annotations command).

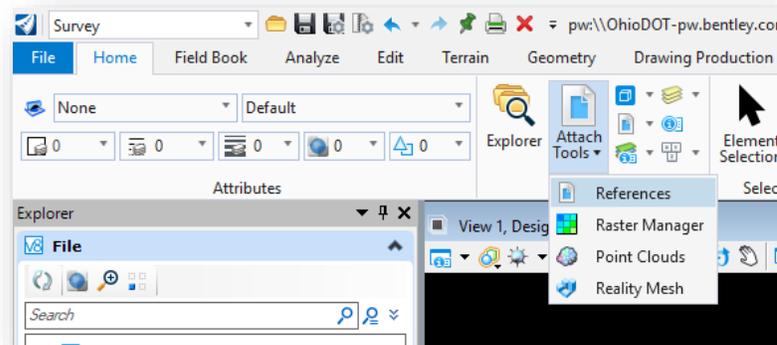- Using the heads-up prompt data point to select the element that needs annotated (CLX_IR71).

*Note different annotations are plotted during this function. Please select the proper spacing for the project using the **Level Display** dialog (**Survey** workflow → **Home** tab → **Primary** group).

In the example below, the **Annotation Scale** value is set to 1:500.

- Close 106471_BK001.dgn.

Exercise 3: Creating the Centerline for Ramp 3

Ramp three consists of two curves and a spiral as shown below.

Take the following steps to define the geometry for Ramp 3:

- Open the 106471_BK002.dgn (for the creation of Ramp 3) through the ProjectWise Explorer client. (BK files are in the **400-Engineering\Roadway\Basemaps** folder)

- Reference in the **106471_BK001.dgn** using the attach tools command from the **Home→ Primary** tool set (also located in other workflows).

Before entering the baseline for Ramp 3, we will store a point at the station and offset location where the ramp begins relative to the centerline of IR 71.
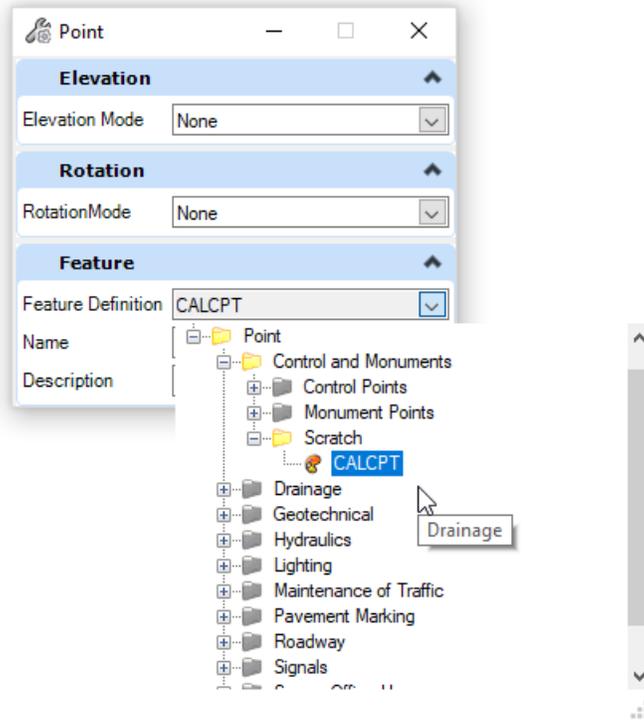
- Open the **Civil Accudraw** dialog if it is not already open by selecting the command from the **Survey WorkFlow → Geometry** tab

- Toggle on the **Station-Offset** ordinate
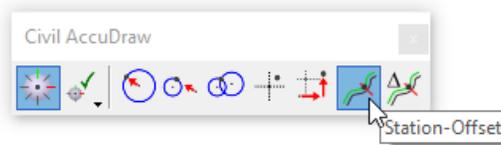
After **Civil AccuDraw** is turned on the next step is to select the **Point** tool in the **Geometry** tab.
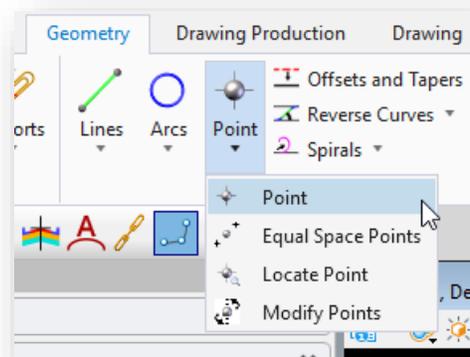
Once the point tool has been selected this icon and dialog box will appear.

- The **Feature Definition** defines the symbology for the point. For this exercise choose the **CALCPT** feature definition as shown above.

- Use **Civil AccuDraw** to identify the station and offset location for the CALCPT.
    - Press the **Tab** button to change the keyboard focus to the **Offset** field
    - With focus in the **Offset** field, type in the "origin" shortcut with the letter "**o**". This must be done in the offset tab since stations can have letters in the name.
    - You are prompted to select the centerline to use as the station and offset reference. Select the **CLX_IR71** element.
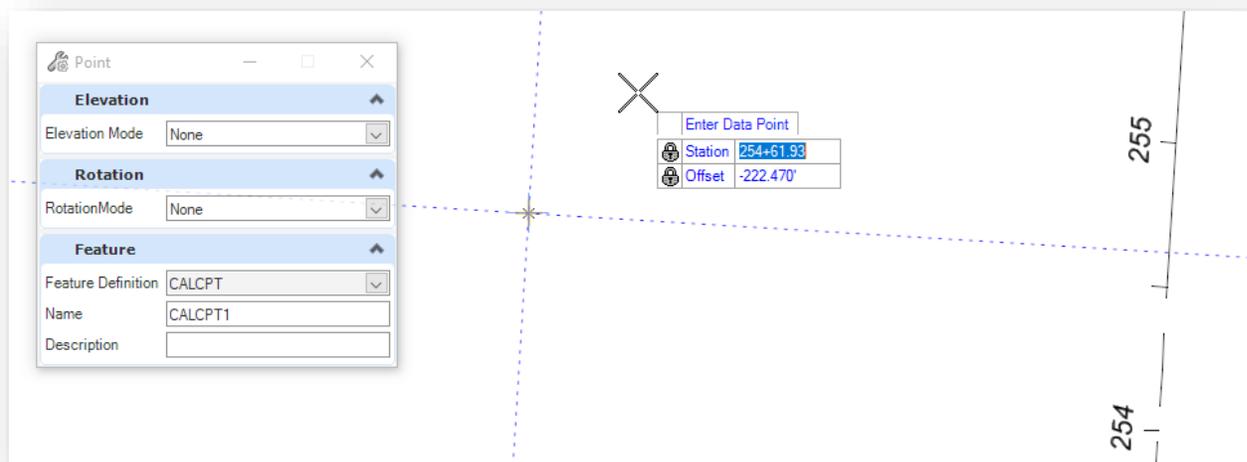
- Enter the following values:
  - **Station**: 254+61.93
  - **Offset**: -222.47 for offset.

  *Note The offset is negative since it is to the left of the CL-71. A point will be placed at that location.

Ramp 3 starts on a curve. In order to enter the curve using the **Simple Arc From Element** tool, a reference line must first be placed at the correct bearing for the arc.

- Use the **Line Between Points** command to place a line at the **CALCPT** location using the values shown below.
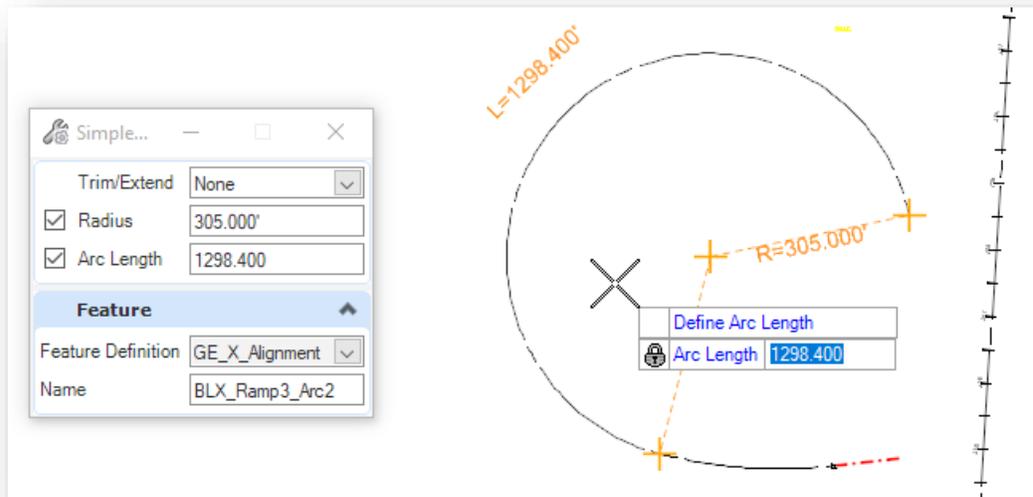
  Tip: Use the **Origin** snap to ensure that you are placing the line by snapping to the center of the calculated point.
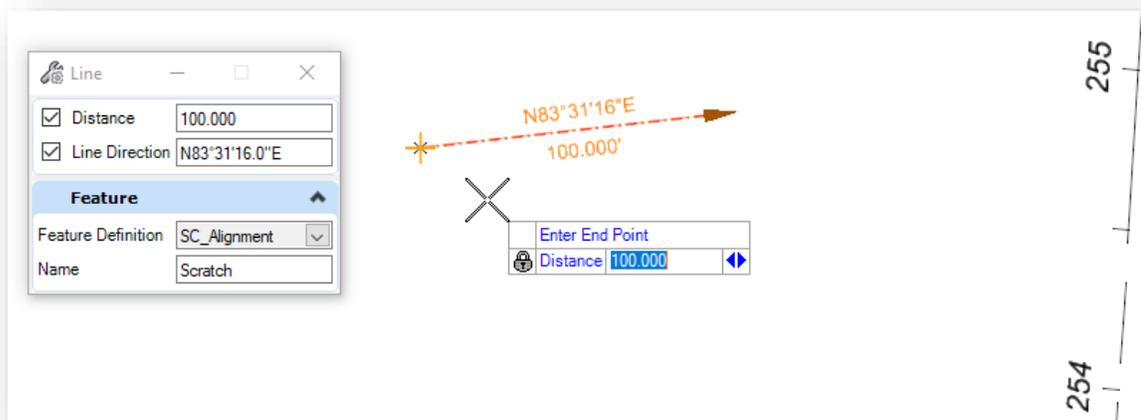
- Select the **Survey > Geometry > Arcs > Arc From Element > Simple Arc From Element** command to place an arc as shown below:
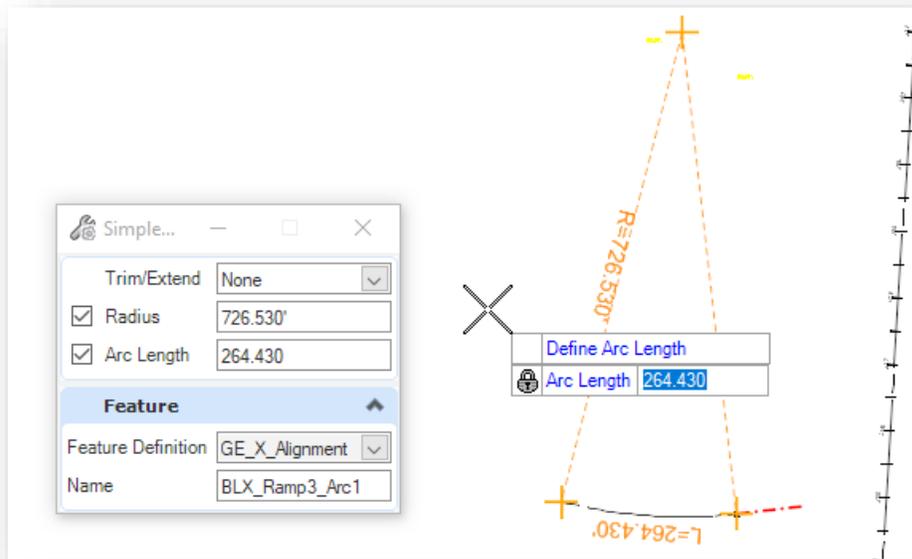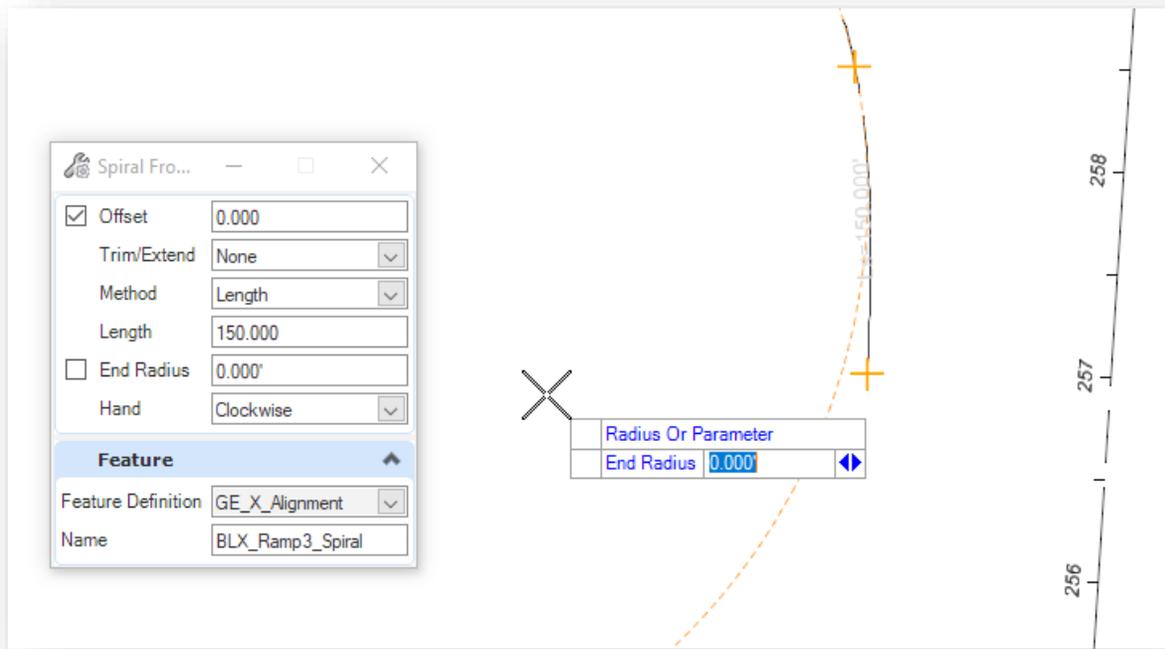
- Select the **Survey > Geometry > Arcs > Arc From Element > Simple Arc From Element** command to place the second arc as shown below:

- Select the **Survey > Geometry Spirals > Spiral From Element** command to place the spiral as shown below:


- After entering the elements for the ramp, delete the scratch line that was used to define the entrance bearing for the first curve.

- Select the **Survey > Geometry > Complex Geometry** command to create a complex element for the ramp. The ramp will be stored in the opposite direction than it was initially defined as shown below.
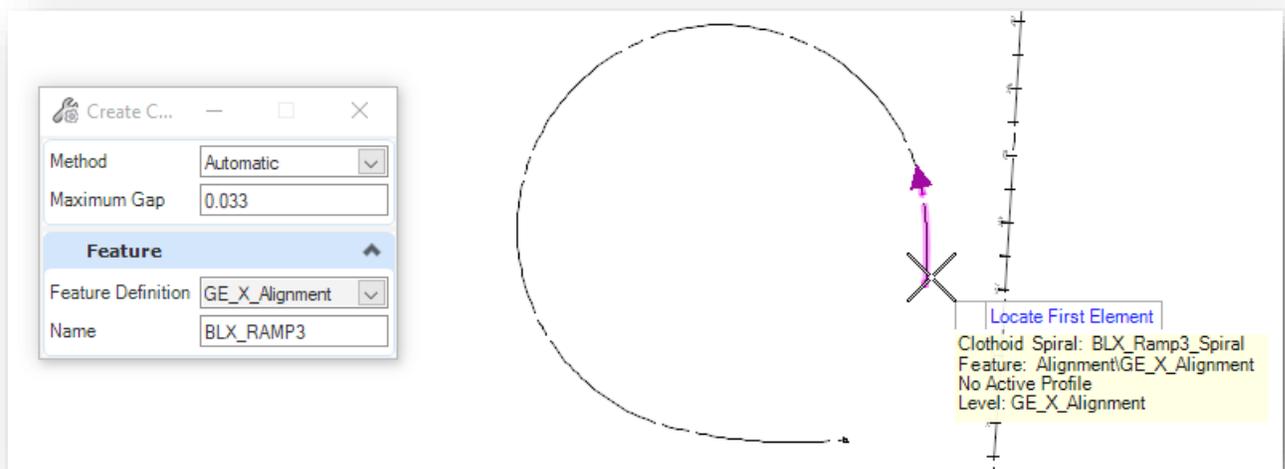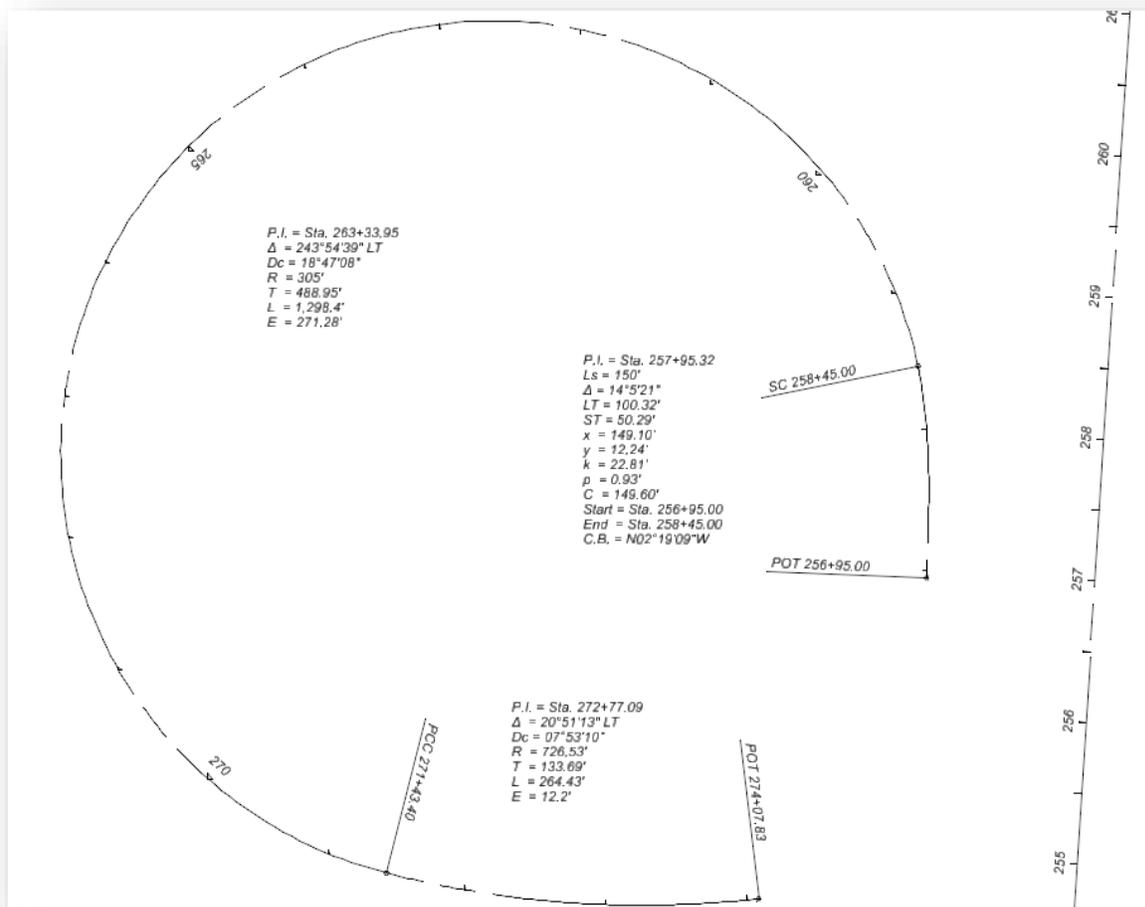
- Define the stationing be selecting the Survey > Geometry > Modify > Start Station command as shown below:
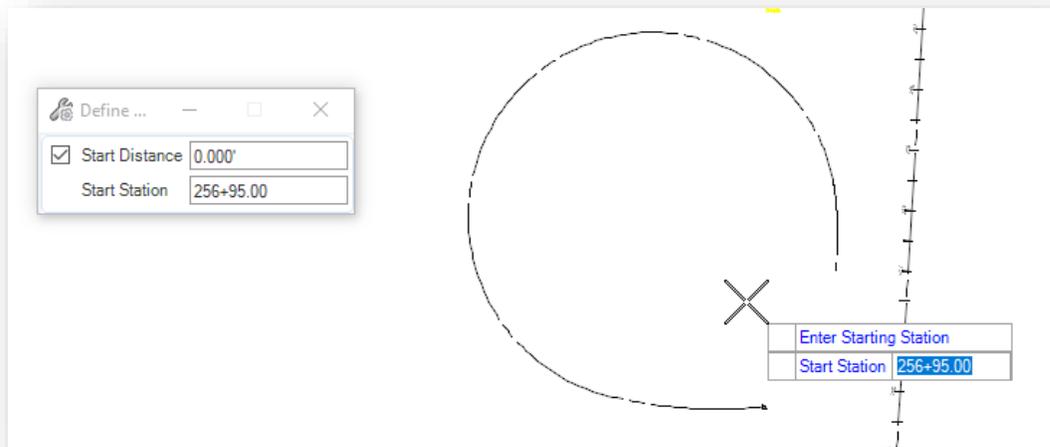
- Annotate the alignment using the **Survey > Drawing Production > Annotations > Element Annotation** command. The stationing and curve data are annotated like the example below.

Exercise 4: Importing the LandXML File for Gemini Place

As shown in exercise 4, it is best practice to export alignments to an XML file once finalized in ORD. This allows for the surveyor to retain a record of the alignment for posterity purposes. This also allows for the centerline to be imported into other programs or for use in future projects.

- To begin the exercise, open the file 106471_BK003.dgn (created previously)
- Reference the Centerline of 71
  - Under the **Home** tab→ **Primary** group → select the attach tools command
    - 400-Engineering\Roadway\Basemaps\106471_BK001.dgn
- Select the **Import Geometry** tool from the **Survey** workflow → **Home** tab → **Model Import/Export**
- Once selected the *Import Geometry* dialog will prompt the user to select the geometry to be imported.
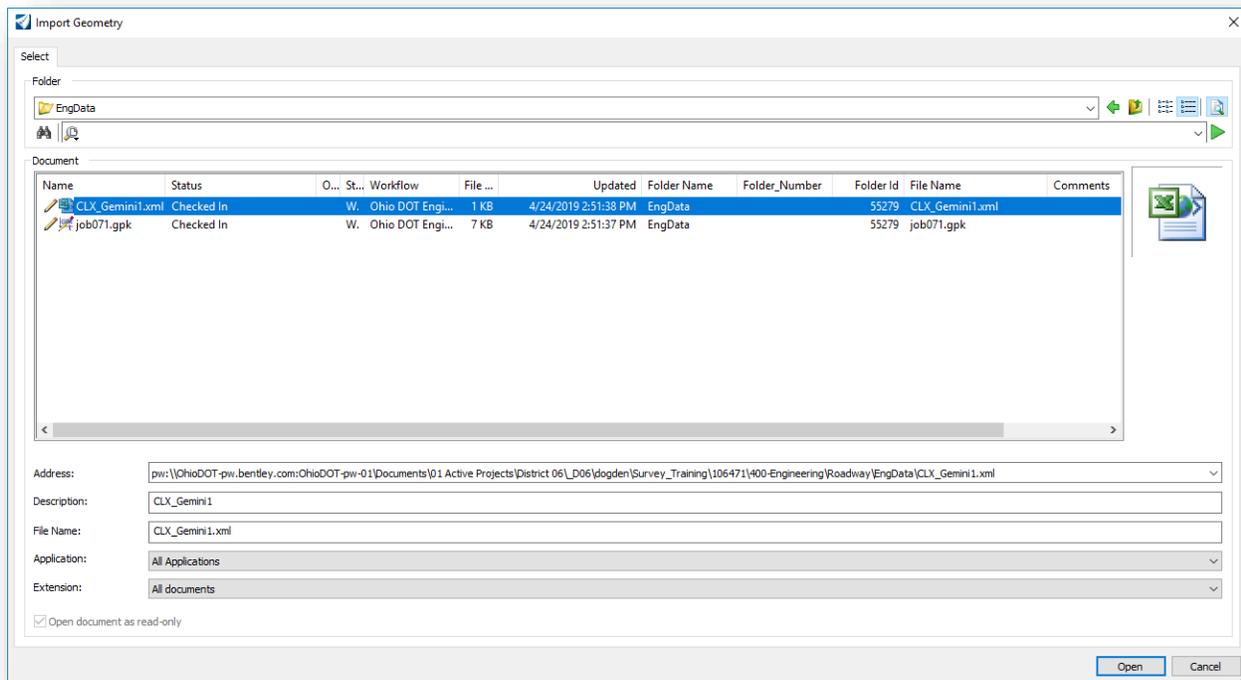
- Browse to the LandXML file located in the **300-Survey\SurveyData\FieldData\Reports** folder
- Select **Open**
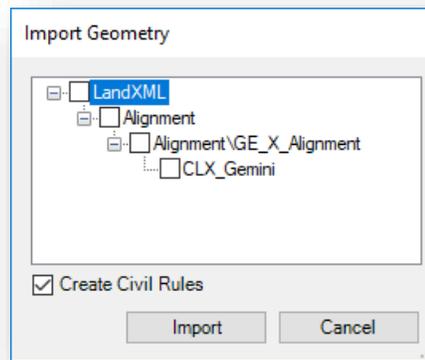
- The contents of the file will appear in a new dialog box
  - The XML file containing the geometry for Gemini Place does not contain a vertical profile or any additional alignments.
- Select the **CLX_Gemini** and click **Import**
  - Be sure the **Create Civil Rules** is checked on.
- The alignment can now be annotated
  - The tool can be found under the **Survey** workflow→ **Drawing Production** tab → in the annotations group. The dropdown will allow for annotations to be removed (same functionality as the annotations command).
    - Using the heads-up prompt, data point to select the element that needs annotated (CLX_Gemini).

      *Note different annotations are plotted during this function. Please select the proper spacing for the project using the **Level Display** dialog (**Survey** workflow → **Home** tab → **Primary** group).

Exercise 5: Importing Polaris Parkway from a GEOPAK GPK File

Openroads Designer also allows for the importing of legacy GPK alignment data. This will allow surveyors to update existing data to an open source format while keeping the civil rules associated with the file.

*Note: It is still best practice to export GPK alignments to a LandXML format once imported into ORD.

- For this exercise open the 106471_BK004.dgn created previously
- Reference the Centerline of 71
  - Under the **Home** tab→ **Primary** group → select the **Attach Tools** command
    - 400-Engineering\Roadway\Basemaps\106471_BK001.dgn
- Select the **Import Geometry** tool from the **Survey** workflow → **Home** tab → **Model Import/Export**
- Once selected the *Import Geometry* dialog will prompt the user to select the geometry to be imported.
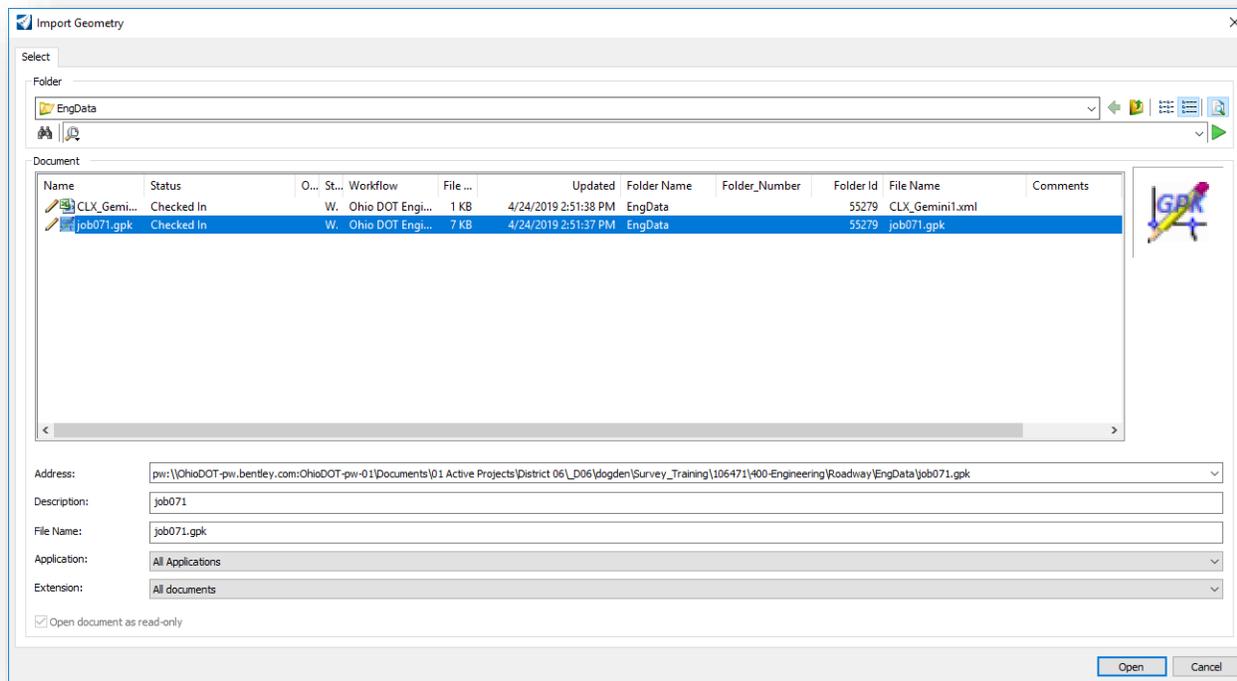
- Browse to the GPK file located in the 300-Survey\SurveyData\FieldData\Reports\ folder
- Select **Open**
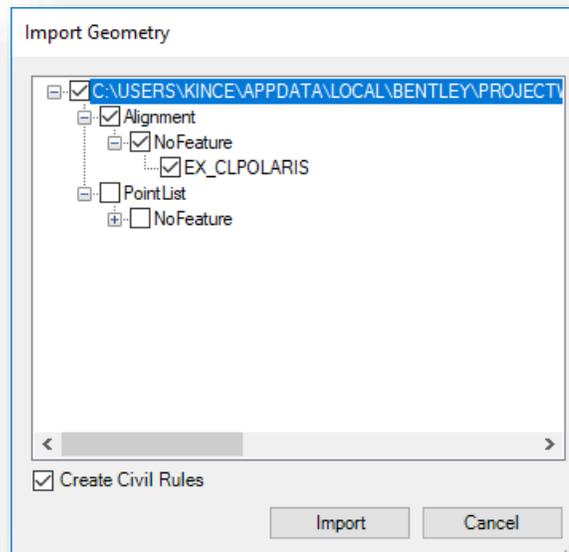
- The contents of the file will appear in a new dialog box
  - This GPK does not have a vertical profile but it does contain points. In order to load only the alignment data, browse the tree to select the alignment as shown above.
- Select the **EX_CLPOLARIS** and click **Import**
  - Be sure the **Create Civil Rules** is checked on.

*Notice the alignment does not contain a feature definition (one will need to be added)

- Adding a feature definition
  - Select the **Set Feature Definition** tool from the **Survey** workflow → **Geometry** tab → **General Tools** group → **Standards** dropdown.
  - The **Set Feature Definition** dialog will open
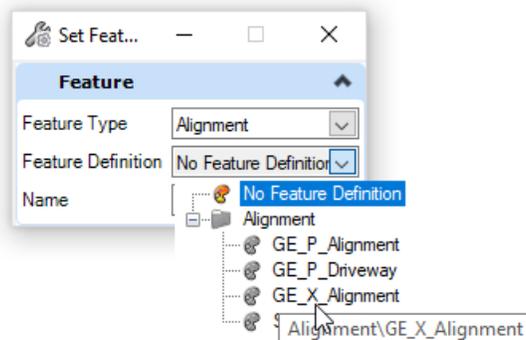
    - Select the feature definition from the dropdown (GE_X_Alignment)
    - Name the alignment accordingly (CLX_Polaris)

    o   Using the heads-up display, select the alignment element to assign the feature definition

        ■ Reset (Right click) to Complete

The Alignment can now be annotated

- The tool can be found under the **Survey** workflow→ **Drawing Production** tab → in the **Annotations** group. The dropdown will allow for annotations to be removed (same functionality as the annotations command).

  o   Using the heads-up prompt, data point to select the element that needs annotated (CLX_Polaris).

  *Note different annotations are plotted during this function. Please select the proper spacing for the project using the *Level Display* dialog (**Survey** workflow → **Home** tab → **Primary** group).

- Close and check in the DGN file to complete the exercise

OpenRoads Software Version

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Contacts

For any questions, suggestions, or problems with this document please contact the ODOT Office of CADD and Mapping Services by use of the following form on the ODOT website:

https://odot.formstack.com/forms/cadd_servicerequest