Road 2

CADD Support

Training

OpenRoads Designer Road 2

Advanced Terrain Modeling

1.1 Group Exercise-1: Create Terrain by Alternate Surface

1) Open **Perry\J9P3093\Corridors_J9P3093.dgn**

2) Review project setup. **AC** is mainline Corridor; **TG** is sideroad Corridor and two linear templates are in the radius return area at the intersection of **AC** & **TG**.

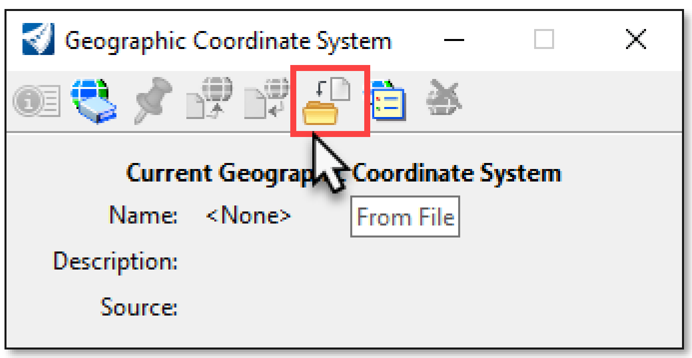
3) Review Template Drop on mainline **AC** Corridor.

    a. Use the Active Template Tab and review the **Alternate Surfaces** for the Template.

4) Create a new file named **Terrain_Proposed_J9P3093.dgn** using the following Seed file: **MoDOT_Roadway_Seed_3D.dgn**

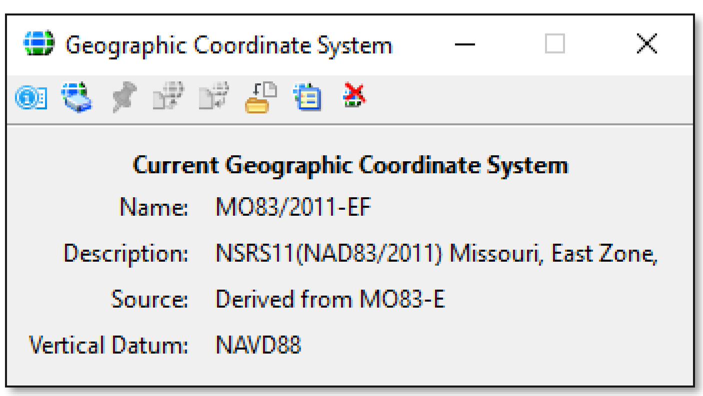
5) Open the **Coordinate System** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Utilities** Tab ➔ **Geographic** Section.

6) Select "**From File**" icon.



7) Select the **Terrain_Existing_J9P3093.dgn** file in the data.

8) Verify the settings.



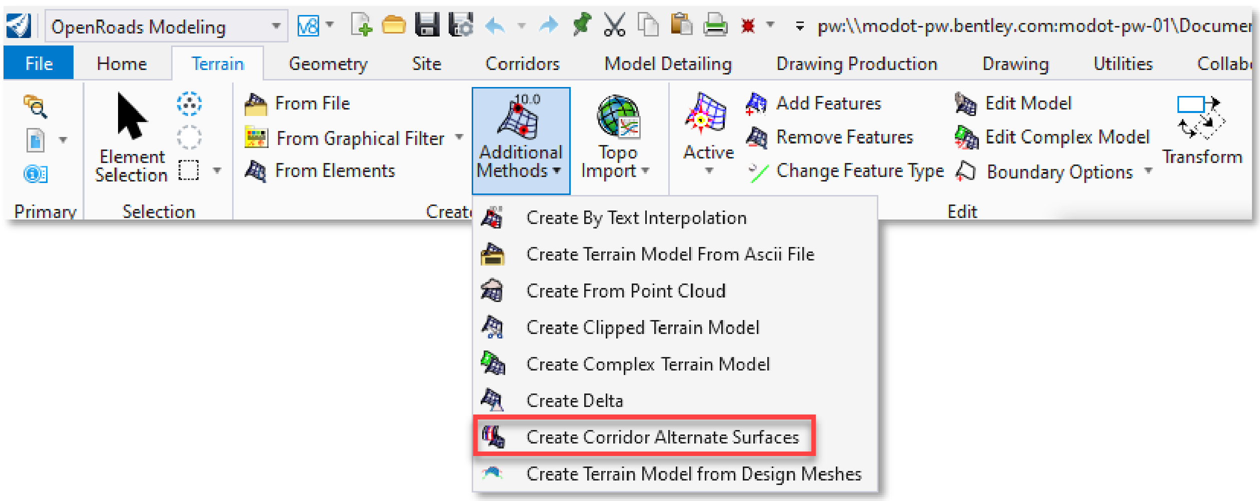
9) Reference in the following files:

Corridors_J9P3093.dgn (Default 2D View)
Terrain_Existing_J9P3093.dgn

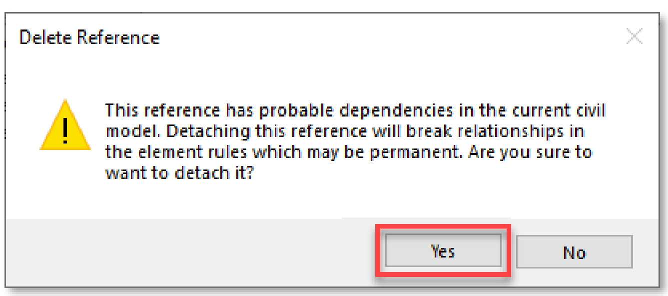
Important - Set the terrain active after referencing it in.

Note: Creating a Terrain Model with an Alternate Surface(s) will work with any **Corridor** or **Linear Template Feature Definition**.

10) Choose the **Create Corridor Alternate Surfaces** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Terrain** Tab ➔ **Create** Section ➔ **Additional Methods** Tools and then select the "**AC**" Corridor and wait.



11) After creating the Alternate Surface Terran Models, **detach all reference files**, select "**Yes**" below to break the rules back to the reference files.



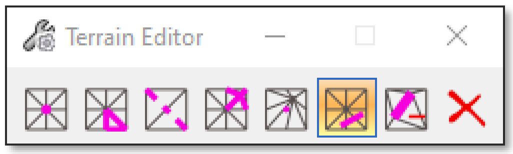
12) There are three Alternate Surface Terrain Models created, rotate the view to see the terrain models **RTEAC.Proposed Finished Grade, RTEAC.Subgrade,** and **RTEAC.Bottom of Pavement.**

13) Use the **Explorer** ➔ **OpenRoads Model** Group ➔ **Terrain Models** to delete the **AC.Subgrade** and **RTEAC.Bottom of Pavement** terrain models.

14) Set the **RTEAC.Proposed Finished Grade** Terrain Model to have a Feature Definition of **Design Triangles.**

15) Rotate the view to **top** and select **fit** view.

16) Select **Terrain > Edit> Edit Model** tool.
    a. Edit the Terrain model.

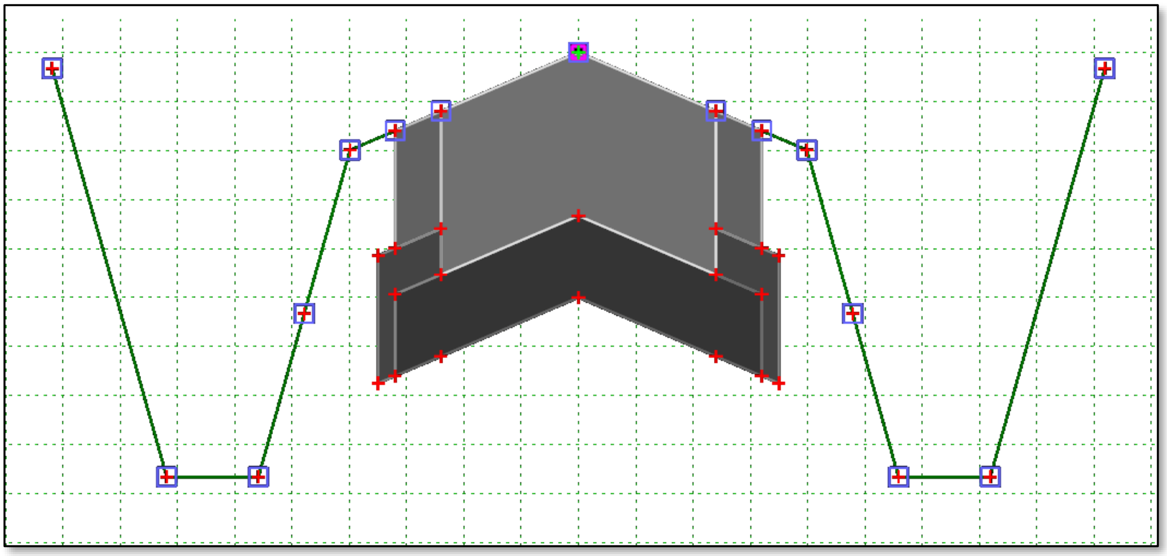


Additional Notes:

- Alternate Surface(s) can only process one corridor at a time.
- The **Create Corridor Alternate Surfaces** tool works with Referenced Corridors, in other words you don't need to be in the Corridors file for the tool to work.
- Alternate Surfaces **do** have rules back to the original Corridor and template.
- With Alternate Surfaces, to get the End Conditions included in the terrain model, typically the existing ground must be **referenced** and **active**.
- The **Terrain Edit** Tools can modify the newly created Terrain Models from the Alternate Surfaces Tool only after the rules have been dropped back to the Corridor.
- When you remove the Rules from the Terrain Model you break the link back to the Corridor.
- The **Corridor Feature Definition** can modify the number of triangles created based on the multiplication interval being applied.

1.2 Group Exercise-2: Create Terrain by Graphical Filter

The following steps will show the User how to create a Terrain Model of the Proposed Surface using the **Design - Proposed Finished Grade with Boundary** Graphic Filter. The Graphic Filter uses points along the entire proposed finished grade surface which includes but is not limited to side-slope conditions, top of pavement, top of shoulder, curb, etc. A Terrain Boundary will also be incorporated that includes the points that make up the Limits of Construction (LOC points).



1) Open **Perry\J9P3093\Corridors_J9P3093.dgn**

2) Verify the **Corridor Feature Definition** is set to a **Final-x 1** for the **RTEAC** and **TG** Corridors, as well as the **Radius Return Linear Templates**.

3) Open the **Terrain_Proposed_J9P3093.dgn**.
   a) If not already done so, **Delete** and **Detach** everything in the file.
   b) **Compress File** by Selecting **File ➔ Tools ➔ Compress File**

4) Reference in **Corridors_J9P3093.dgn (Default 2D View).**
   a) If needed rotate the view to "**Top**" and fit the view.

5) Within the **OpenRoads Modeling** Workflow, select **Terrain Model ➔ Create ➔ From Graphical Filter** tool and choose the following:
   a) Graphical Filter Group: **Design - Proposed Finished Grade with Boundary**
   b) Select the **Preview** Button
      a. Linear Elements in the surface of the model should highlight.
   c) Edge Method: **None**
   d) Feature Definition: **Design Triangles**
   e) Name: **Proposed Terrain from Graphic Filter**

Note: When the tool is activated the Corridors 3D View is automatically referenced into the drawing.

6) Notice in the Project Explorer that the Filter Group and Individual Filters were copied over into the active file.

   Explorer ➔ OpenRoads Standards ➔ Terrain_Proposed_J9P3093.dgn ➔ Terrain Filters

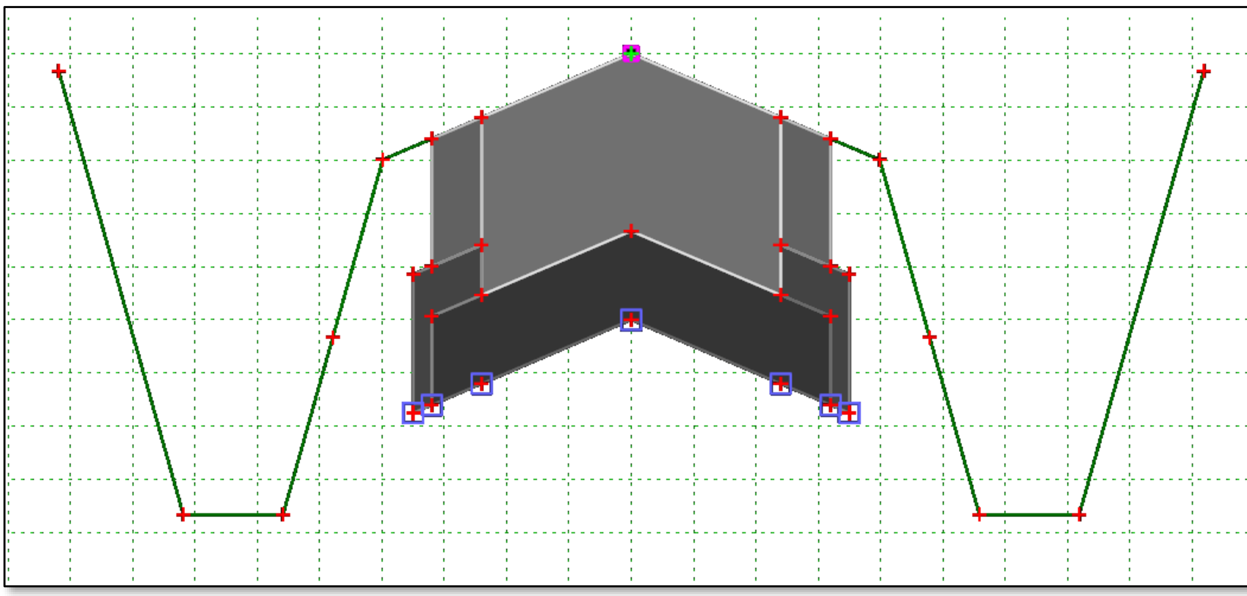
7) Detach both references (2D and 3D) to the **Corridors_J9P3093.dgn.**

Additional Notes:

- Terrain Models created from **Graphic Filters** **do not** have rules back to the original Corridor and template.
- **Graphic Filters** can process all Corridors and Linear Templates at the same time.
- The **Graphic Filters** tool works with Referenced Corridors, in other words you don’t need to be in the Corridors file for the tool to work.
- The **Terrain Edit** tools can modify the newly created Terrain Models created from the **Graphic Filters** tool.
- The **Corridor Feature Definition** can modify the number of triangles created based on the multiplication interval being applied.
- Compressing a file will purge deleted elements and clears the undo buffer.

1.3 Individual Exercise-3: Create Terrain by Graphical Filter

The following steps will show the User how to create a Terrain Model of the Proposed Surface using the **Design – Bottom of Base with Boundary** Graphic Filter. The Graphic Filter uses points along the entire proposed finished grade surface which includes but is not limited to side-slope conditions, top of pavement, top of shoulder, curb, etc. A Terrain Boundary will also be incorporated that includes the points that make up the Limits of Construction (LOC points).



1) Open **Perry\J9P3093\Corridors_J9P3093.dgn**

2) Verify the **Corridor Feature Definition** is set to a **Final-x 1** for the **RTEAC** and **TG** Corridors, as well as the **Radius Return Linear Templates**.

3) Open the **Terrain_Proposed_J9P3093.dgn**.
   a) If not already done so, **Delete** and **Detach** everything in the file.
   b) **Compress File** by Selecting **File ➔ Tools ➔ Compress File**

4) Reference in **Corridors_J9P3093.dgn (Default 2D View).**
   a. If needed rotate the view to "**Top**" and fit the view.

5) Within the **OpenRoads Modeling** Workflow, select **Terrain Model ➔ Create ➔ From Graphical Filter** tool and choose the following:
   b. Graphical Filter Group: **Design - Bottom of Base - Daylighted with Boundary**
      i. Select the **Preview** Button
      ii. Linear elements in the surface of the model **should highlight**.
   c. Edge Method: **None**
   d. Feature Definition: **Design Triangles**
   e. Name: **Proposed Terrain from Graphic Filter**

Note: When the tool is activated the Corridors 3D View is automatically referenced into the drawing.

6) Notice in the Project Explorer that the Filter Group and Individual Filters were copied over into the active file.

   Explorer ➔ OpenRoads Standards ➔ Terrain_Proposed_J9P3093.dgn ➔ Terrain Filters

7) Detach both references (2D and 3D) to the **Corridors_J9P3093.dgn**

Additional Notes:

- Terrain Models created from **Graphic Filters <u>do not</u>** have rules back to the original Corridor and template.
- **Graphic Filters** can process all Corridors and Linear Templates at the same time.
- The **Graphic Filters** tool works with Referenced Corridors, in other words you don't need to be in the Corridors file for the tool to work.
- The **Terrain Edit** tools can modify the newly created Terrain Models created from the **Graphic Filters** tool.
- The **Corridor Feature Definition** can modify the number of triangles created based on the multiplication interval being applied.
- Compressing a file will purge deleted elements and clears the undo buffer.

1.4 Group Exercise-4: Create Terrain from Elements (Linear Features)

1) Open **Perry\J9P3093\Corridors_J9P3093.dgn**

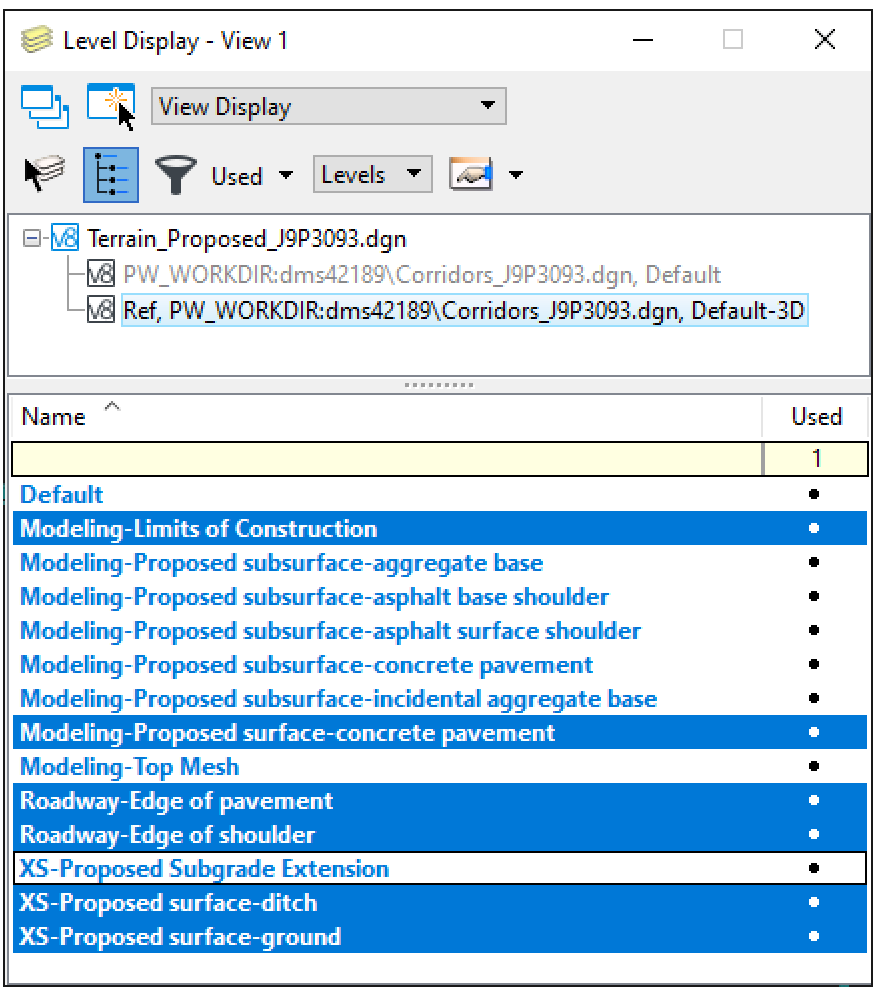
2) Verify the **Corridor Feature Definition** is set to a **4-Final-x 1 – Linear Features Only** for the **RTEAC** and **TG** Corridors, as well as the **Radius Return Linear Templates**.

3) Select the "**F6**" key to open the 3D view of the Model.

4) Open the **Terrain_Proposed_J9P3093.dgn**.
   a) If not already done so, **Delete** and **Detach** everything in the file.
   b) **Compress File** by Selecting **File ➔ Tools ➔ Compress File**

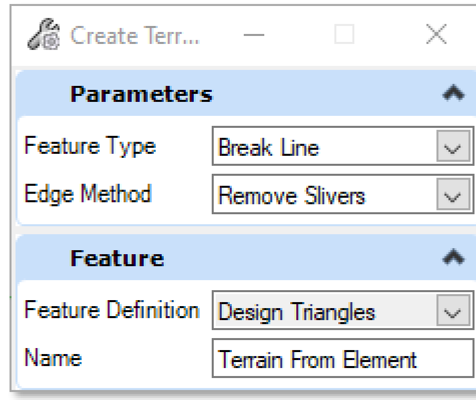
5) Reference in **Corridors_J9P3093.dgn (Default 3D View).**
   a) In the Reference Dialog turn off the display of the Corridors 2D view
   b) If needed rotate the view to "**Top**" and fit the view.

6) Use the **Level Manager** and only display the "**Surface**" Levels.



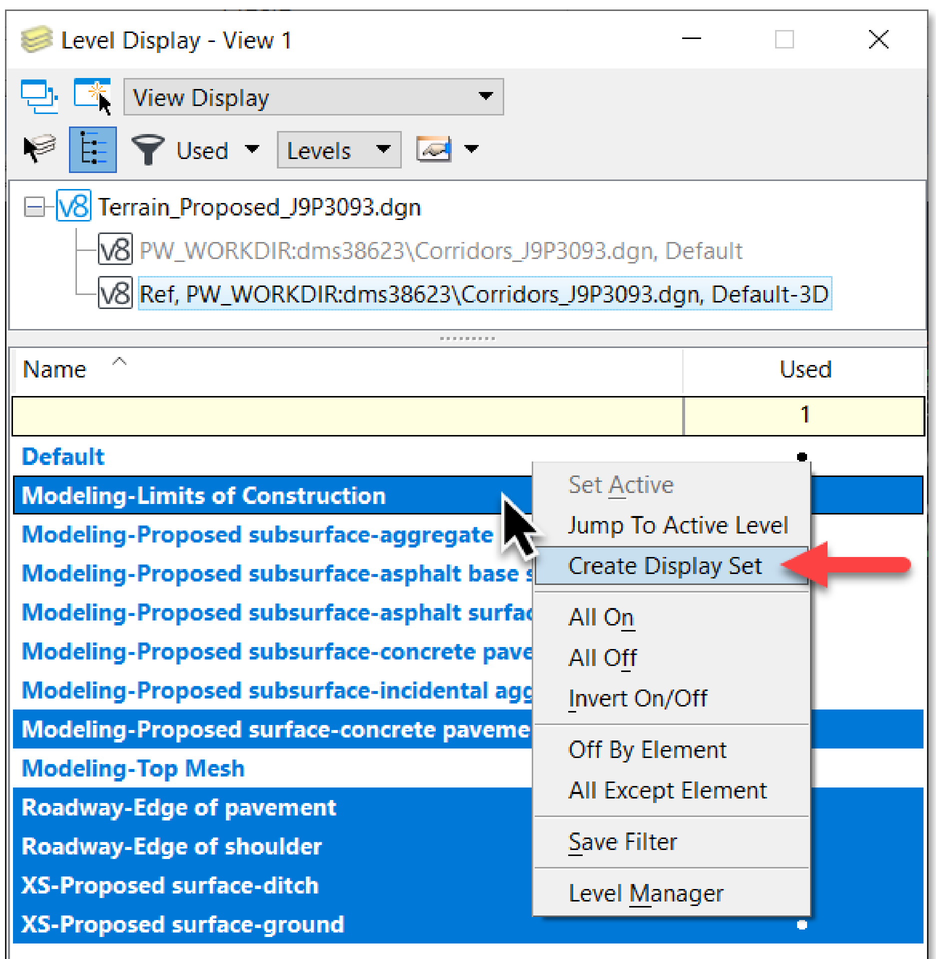
7) Using the **Element Section** Tool place all **38 visible items** in a Selection Set.

8) Within the **OpenRoads Modeling** Workflow, select **Terrain Model** Tab ➔ **Create** Section ➔ **From Elements** tool and choose the following:



9) To reduce the long Exterior Triangles that don't represent the proposed linear features, we will change the **Limits of Construction** elements to a **Boundary** Feature Type.

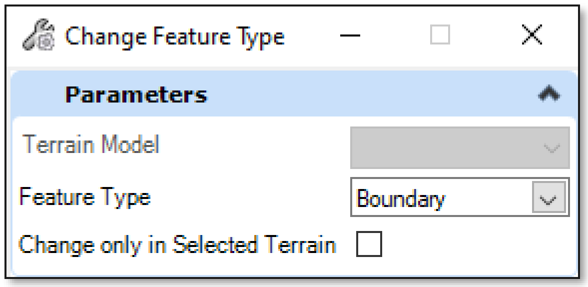
To help with the selection of **Limits of Construction** elements, we will utilize the **Level Display** dialog and the **Display Set** tool. First put the **Modeling-Limits of Construction** elements into a **Selection Set** (**NO** levels need to be turned off beforehand, for the **Display Set** to work).



10) Using the **Element Section** Tool place all **10 visible items** in a Selection Set.

11) Once Selection Set is created, **right-click** and hold in a blank area and select **View Control ➔ Displayset Clear**. The **10** elements should still be in a selection set.

12) Within the **OpenRoads Modeling** Workflow, select **Terrain Model** Tab ➔ **Edit** Section ➔ **Change Feature Type** tool and choose the following:



Additional Notes:

- The **Create Terrain from Elements** tool works with Referenced Corridors, in other words you don't need to be in the Corridors file for the tool to work.
- **Create Terrain from Elements** Surfaces **do not** have rules back to the original Corridor and template elements.
- The **Corridor Feature Definition** can modify the number of triangles created based on the multiplication interval being applied.
- Compressing a file will purge deleted elements and clears the undo buffer.

1.5 Group Exercise-5: Create Terrain from Design Meshes

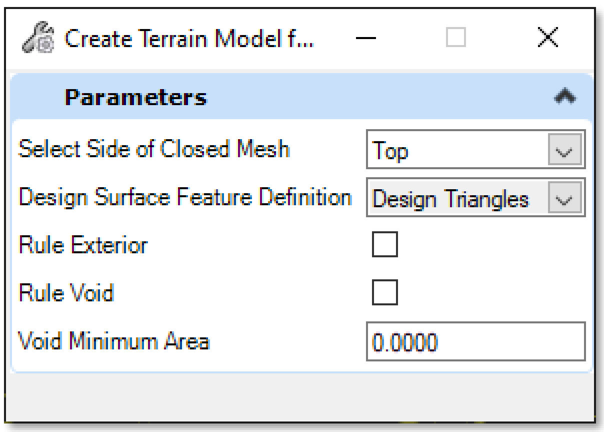
1) Open **Perry\J9P3093\Corridors_J9P3093.dgn**

2) In the 2D Default view, change the Design Stage to **2-Final x 1 Top Mesh Only** for all Linear Templates and Corridors.

3) Open **Perry\J9P3093\Terrain_Proposed_J9P3093.dgn**
   a. If not already done so, **Delete** and **Detach** everything in the file.

4) Reference in **Corridors_J9P3093.dgn (Default 2D View).**
   a. In the Reference Dialog turn off the display of the **Corridors 2D** view
   b. If needed rotate the view to "**Top**" and fit the view.

5) Within the **OpenRoads Modeling** Workflow, select **Terrain Model** Tab ➔ **Create** Section ➔ **Addition Methods** Tools ➔ **Create Terrain from Design Meshes** tool and choose the following:



5) Detach both reference files and rotate the view.

6) Using the **Terrain Model** heads-up tools select the terrain model **Export** tool and select Land XML.

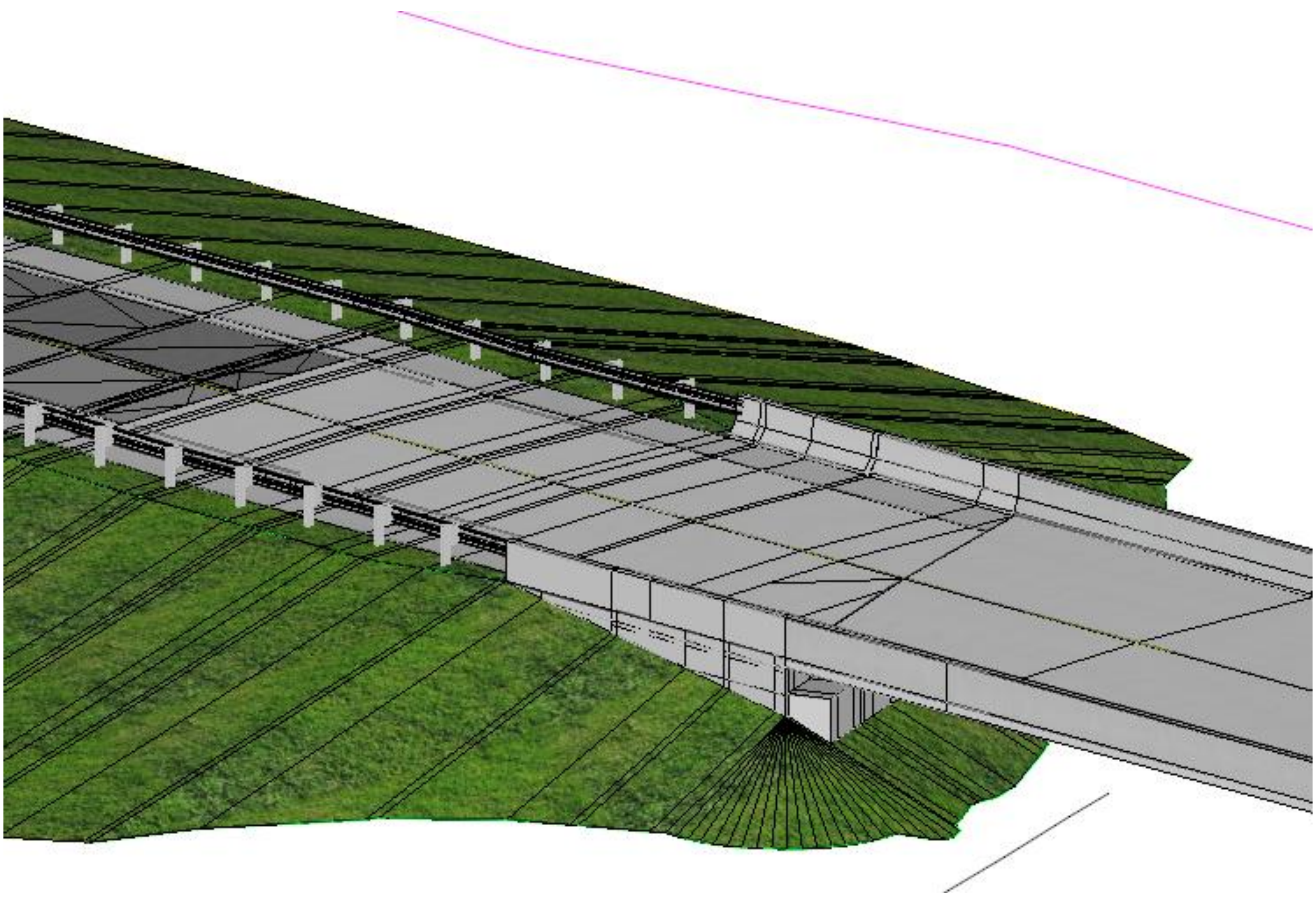
Select Terrain:	Design Triangles
Export Format:	Land XML (.xml)
Project Name:	J9P3093
Project Description:	AC Corridor Proposed Terrain
Export Options:	Export Triangles Only

Additional Notes:

- The **Create Terrain from Design Meshes** tool works with Referenced Corridors, in other words you don't need to be in the Corridors file for the tool to work.
- **Create Terrain from Design Meshes** Surfaces **do not** have rules back to the original Corridor and template elements.
- The **Corridor Feature Definition** can modify the number of triangles created based on the multiplication interval being applied.

OpenRoads Designer Road 2

Bridge End-Bent Layout



1.1 Group Exercise: Bridge End-Bent Layout

1) Open the **Pike\J2P3081\Exported_Graphics_J2P3081.dgn.**
   a) **Review** the Existing Survey Graphics.
   b) Using the Level Display **turn off all levels except** for the following levels:
      a. **Survey-Edge of Pavement**

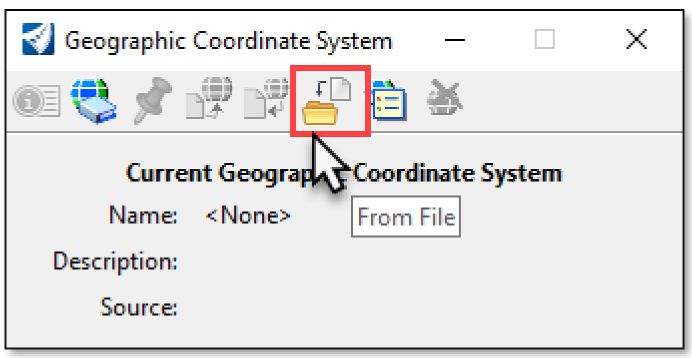
2) Add a **Feature Definition** of **EOP Existing** to the **Survey-Edge of Pavement** elements (4 elements)

3) Create a new file named **Civil_Geometry_J2P3081.dgn** using the **MoDOT_Roadway_Seed_2D.dgn** as the seed file.

4) Open the Coordinate System tool by selecting the OpenRoads Modeling Workflow ➔ Utilities Tab ➔ Geographic Section.

5) Select "**From File**" icon.

   a. Choose the **Existing_Terrain_J2P3081.dgn**



6) Set Annotation Scale to **50**

7) Import Alignment and Profile called "**Mainline**" and "**Proposed**" from the **mainline.xml**

8) **Rename** the alignment to **Route 14**

9) **Annotate** the **Route 14** alignment.

10) **Reference** in the following:
    a. **Exported_Graphics_J2P3081.dgn**
    b. **Existing_Terrain_J2P3081**

11) **Activate** the Existing Ground Terrain

12) Hover over the **Route 14** alignment and verify that there is an active profile.

13) Open **Plan_J2P3081.dgn** File.
    a) Attach **Civil_Geometry_J2P3081.dgn**
    b) **Review** plan geometry.

14) Create a new file named **Corridors_J2P3081.dgn** using the **MoDOT_Roadway_Seed_2D.dgn** as the seed file.

15) **Assign the GCS** (Geographic Coordinate System) from file.

16) Set Annotation Scale to **50**

17) **Reference** in the following files:
    a) **Civil_Geometry_J2P3081.dgn**
    b) **Existing_Terrain_J2P3081.dgn**
    c) **Exported_Graphics_J2P3081.dgn**
    d) **Plan_J2P3081.dgn**

18) **Activate** Existing Ground Terrain.

19) Next select the "**F6**" key to open the multi-model view. In the **3D View** turn **Off** the **Display** of the **Exported_Graphics_J2P3081.dgn**

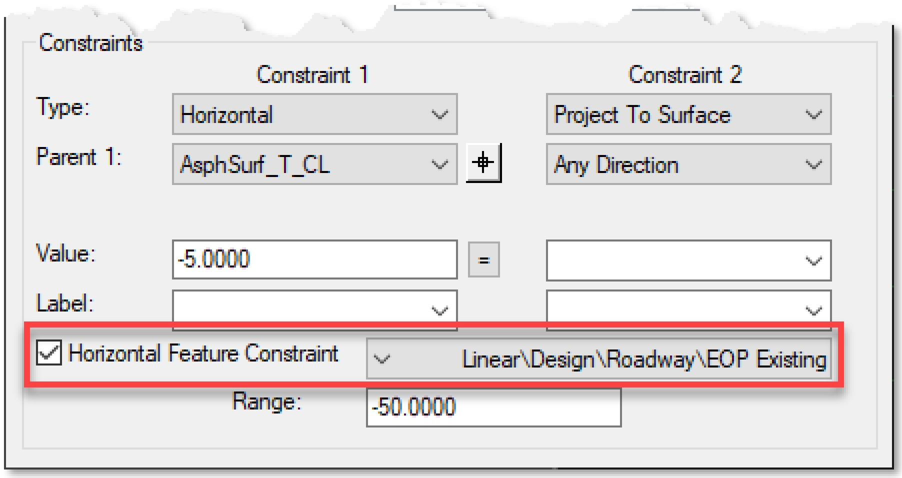
20) **Turn off** the Levels **Common-Notes** in the **Plan_J2P3081.dgn** referenced file

21) **Verify** all the Levels in the **Exported Graphics_J2P3081.dgn** are turned off except for the **Survey-Edge of pavement**.

22) **Open** the Project Template Library **J2P3081.itl**.
    a) **Review** the *Bridge* template
    b) **Review** the *Roadway* templates
    c) **Close** Template Library.

23) **Create a Corridor** for **Route 14** using the Create Corridor tool
    a) Name the corridor "**Route14"**
    b) Apply Roadway template "**J2P3081 2 Lane w/ Agg Base Option 1 Mill and Fill Concrete Widening"** from station **68+00** to **71+68.64 R1** with Drop Interval of **25ft**.
    c) If not open already select the "**F6**" key to open 3D view of model.

24) Review the **LT_Seek_Surface** point in the template drop to verify that the Horizontal Feature Constraint is defined as ***EOP Existing*** for the Feature Definition. Do the same for the **RT_Seek_Surface** point.



25) Review the **LT_Conc_T_EOP** point in the template drop to verify that the Horizontal Feature Constraint is defined as ***EOP New*** for the Feature Definition. Do the same for the **RT_Conc_T_EOP** point.

26) Close the **Editing Roadway Designer Template Drop** dialog.

27) **Add** the two ***EOP New*** and two ***EOP Existing*** lines as **Corridor References.**

28) Add the following **Parametric Constraint** to remove Pavement Widening on Left side ending at Station **70+52.89.**

Start:	68+00.00
Stop:	70+52.89
Constraint Label:	LT_Pvmt_Surf_Conc_Width
Start Value:	0.00
Stop Value:	0.00

29) To help with placement of a **Horizontal Temporary Dimension Line** in the next step, add in a **Key Station** at **71+68.63** (make sure the **Dynamic Cross Section Model** is **not** open while executing this step, it will cause incorrect slope values).

30) Open Dynamic XS model, and display XS at Station **71+68.63 R1**

a) Verify that the pavement slopes on left and right side by adding horizontal dimensioning to the left and right side of pavement.

b) **Left = 0.52%** **Right = -0.79%**

Note: If after using the **Horizontal Dimention Tool**, if you notice a "**Dimension**" meassage on the end your **Cursor**, that won't go away, selecting the tool again will remove that message.

31) **Apply Roadway/Bridge Approach template**.

a) Review **Concrete Approach Pavement with Barrier** Template (focus on Display Rule for Type "B" Barrier)
b) Apply **Concrete Approach Pavement with Barrier** from station **71+68.65 R1** to **72+37.00 R1**
c) Use a drop spacing of 1ft

32) **Add** the following **two Parametric Constraints** to transition the Overlay Pavement Slopes onto the Concrete Approach Pavement Slopes:

Parametric Constraint #1

Start:	71+68.65
Stop:	71+78.65
Constraint Label:	LT_Pvmt_Surf_Conc_Slope
Start Value:	0.52%
Stop Value:	2.0%

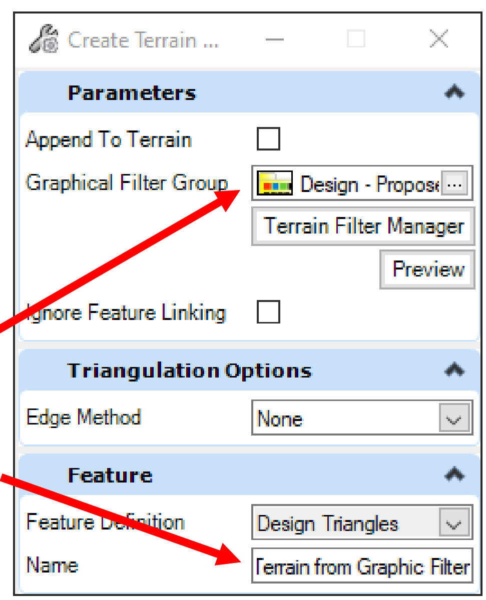
Parametric Constraint #2

Start:	71+68.65
Stop:	71+78.65
Constraint Label:	RT_Pvmt_Surf_Conc_Slope
Start Value:	-0.79%
Stop Value:	-2.0%

- Note if gap in slope between the two templates is not resolved, check to make sure the existing ground terrain is active.

33) **Create a terrain model from the 3D Model**. This terrain Model will be used to create a profile around the Bridge End Bent.

a) Create new file called **Graphic_Filter_J2P3081.dgn** using a **3D** Seed.
b) **Assign the GCS** (Geographic Coordinate System) from file.
c) Reference in the **Corridors_J2P3081.dgn** and its **Default-3D** view.
d) Select the **Create Terrain Model From Graphical Filter.**
e) Use a Filter Group called **Design – Proposed Finish Grade with Boundary**.
f) Use Feature Definition of **Design Triangles**.
g) Name the new Terrain model "**J2P3081 Terrain from Graphic Filter**"
h) **Detach All** References and **Dynamically Rotate** the View to view the new terrain.



Create Horizontal and Vertical Civil Alignment End Bent Corridor:

34) Open **Civil_Geometry_J2P3081.dgn**

   a) Reference in **Plan_J2P3081.dgn (Default 2D Model)**
   b) Use Horizontal Geometry **Complex by PI** Tool and trace end bent **counterclockwise**.
      a. Use radius of 0.00’
      b. Use Feature Definition > **Bridge_Approach_Slab_503-10.00**
         i. (Located under: **Linear\Design\Safety and Structures**)
      c. Use Feature Name “**End_Bent_1**”
   c) Reference in **Graphic_Filter_J2P3081.dgn**
      a. If triangles are turned on, go into the properties of the Terrain Model and override the symbology and turn **triangles off**.
   d) Select **End Bent 1’s** Alignment and open its **Profile Model**.

35) Use Vertical Geometry Tool **Quick Profile from Surface** to create a profile from Graphic Filter Surface.

   a) Set profile **Active**.
   b) To be safe Remove Rules to the newly created profile before performing the next step.
   c) In **Default 2D** view Detach the **Graphic_Filter_J2P3081.dgn**

36) Open **Corridors_J2P3081.dgn** file

37) Add the **Traffic Control Barrier Lines** near the End Bent as **Corridor References**.

Note: You will notice that after adding the Corridor References the **Type B Barriers** are still not displaying. Investigate and solve the reason why.

38) Add the following two Parametric Constraints to transition in the Guardrail Widening Width over a distance of **10ft** near the Bridge Approach slab:

Parametric Constraint #1

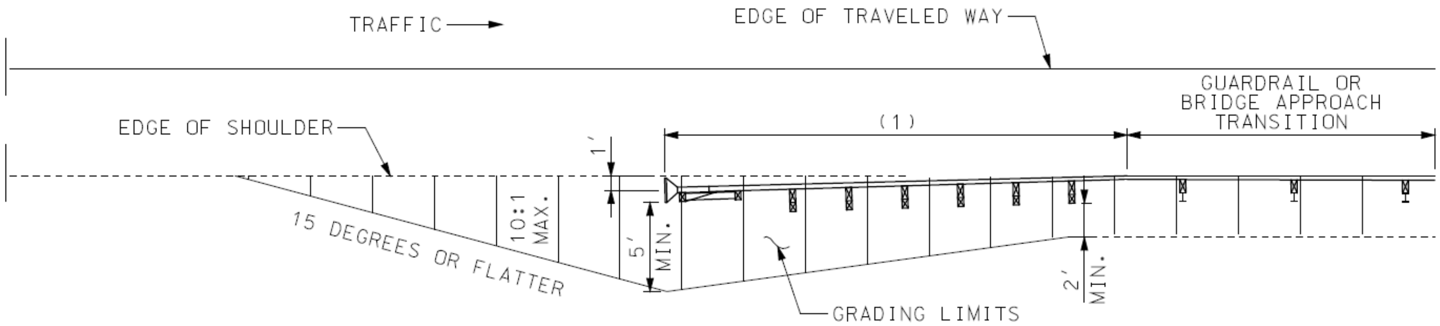
Start:	71+87.89
Stop:	71+97.89
Constraint Label:	LT_Guardrail_Widening_Width
Start Value:	-3.9375’
Stop Value:	-1.50'

Parametric Constraint #2

Start:	72+00.52
Stop:	72+10.52
Constraint Label:	RT_Guardrail_Widening_Width
Start Value:	3.9375’
Stop Value:	1.50'

Note: The rest of the **Guardrail Widening** behind the **Type B Barrier** will be removed in another step later in this exercise.

39) Review below the Guardrail Widening Width requirements on the right side of **Route14** to meet our requirements in the **Standard Plans 606.80**.

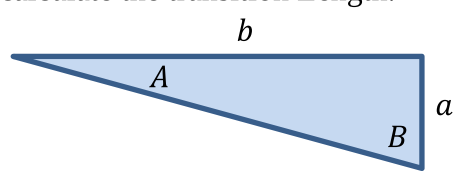


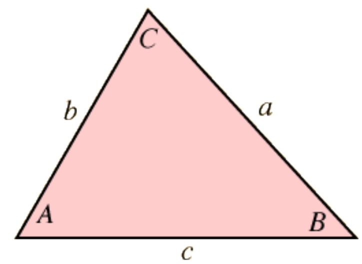
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Using the ***Law of Sines*** calculate the transition Length.

$$\frac{a}{\sin\ A} = \frac{b}{\sin\ B}$$

$$\frac{7\text{ft}}{\sin\ (15°)} = \frac{b}{\sin\ (90°-15°)}$$





$b = \left(\frac{\sin 75°}{\sin 15°}\right)\ (7ft)$ = 26.12ft, **use 30ft for Guardrail Widening Transition Distance**.

40) Modify the Guardrail Widening Width requirements on the **<u>both sides</u>** of the Mainline using the following Parametric Constraints to meet MoDOT's requirements in the **Standard Plans 606.80**.

Parametric Constraint #1

Start:	Start of Alignment
Stop:	68+70
Constraint Label:	Guardrail_Widening_Width
Start Value:	0.00 ft
Stop Value:	0.00 ft

Parametric Constraint #2

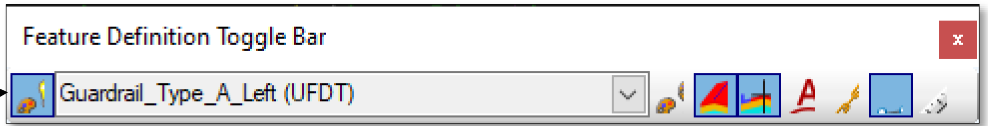
Start:	68+70
Stop:	69+00
Constraint Label:	Guardrail_Widening_Width
Start Value:	0.00 ft
Stop Value:	7.00 ft (-7.00 ft for left side)

Parametric Constraint #3

Start:	69+00
Stop:	69+30
Constraint Label:	Guardrail_Widening_Width
Start Value:	7.00 ft (-7.00 ft for left side)
Stop Value:	3.9375 ft (-3.9375 ft for left side)

41) In the **Corridors_J2P3081.dgn** 2D Default View, if it is on, turn off the **3D reference** from the **Corridors 3D Model**.

42) **Set** the Feature Definition to: **Alignment/Guardrail_Type_A _LT or RT (UFDT)**



Make sure the following are active:

Use Active Feature Definition
Create 3D Automatically

Use **F**eature **D**efinition **T**emplate

43) Using the **Horizontal Geometry - Variable Offset Taper** along with **Civil AccuDraw** tool, place on <u>**BOTH**</u> Left and Right sides of the roadway the 1ft offset taper section of the guardrail.

Variable Offset Taper Settings

Locate Element:	**Proposed Edge of Shoulder**
Start Offset:	1.00
End Offset:	0.00
Start Station:	69+00
End Station:	69+30
Feature Definition:	Guardrail_Type_A_**LT/RT** (UFDT)

Notes:

- If in the 3D View the guardrail looks like a block, go into the View Attributes and turn off the **Construcion** View.
- If a very tall guardrail post draw, select the "**F4**" Key.

44) Using the **Horizontal Geometry** – **Single Offset Partial** along with Civil AccuDraw tool, place on the **LEFT** side of the roadway the following section of the guardrail.

Single Offset Partial Settings Left

Locate Element:	**Proposed Edge of Shoulder**
Offset:	0.00
Start Station:	69+30
End Station:	71+80.11
Feature Definition:	Guardrail_Type_A_ **Left** (UFDT)

Variable Offset Taper Settings Left

Locate Element:	**Proposed Edge of Shoulder**
Start Offset:	0.00
End Offset:	-0.50
Start Station:	71+80.11
End Station:	71+98.49
Feature Definition:	Guardrail_Type_A_ **Left** (UFDT)

NOTE: You'll notice that the Guardrail meanders in and out, (especially on the left side) because it is tied to the edge of shoulder line. To remove the meander tie the outside shoulder line to the baseline at a 16 feet offset, in other words within the **LT_Conc_T_O_EOS** point make the parent point of the Horizontal Constraint be the **AsphSurf_T_CL** point and set the distance to -16 feet.

45) Using the **Horizontal Geometry – Single Offset Partial** along with Civil AccuDraw tool, place on the **Right** side of the roadway the following section of the guardrail.

Single Offset Partial Settings Right

Locate Element:	**Proposed Edge of Shoulder**
Offset:	0.00
Start Station:	69+30
End Station:	71+98.75
Feature Definition:	Guardrail_Type_A_**Right** (UFDT)

Variable Offset Taper Settings Right

Locate Element:	**Proposed Edge of Shoulder**
Start Offset:	0.00
End Offset:	0.50
Start Station:	71+98.75
End Station:	72+11.02
Feature Definition:	Guardrail_Type_A_**Right** (UFDT)

Note: In the **3D View** the best visualization setting is **Illistration: Modeling** and adjust the Brightness. To get back to the default views hit the **F6** key.

46) **Create/Apply** a **Linear Template Drop** for **End Bent #1**. To see the End Bent Geometry in the 2D View you may need to turn **ON** the **Roadway-Edge of Pavement level** within the **Level Display** for the Reference File **Civil_Geometry_J2P308.dgn**

Locate Element:	The **End_Bent_1** Horizontal Linear Feature
Start Station:	Lock to Start
End Station:	Lock to End
Exterior Sweep Angle:	5 degrees
Mirror:	No
Reflect:	No
Template:	2:1 Earth Slopes with Upper Concrete Structure
Feature Definition:	1-Final x 1
Description:	End Bent 1

47) Add **Corridor Clip** to the Mainline Corridor
   a. Clip out the End Bent **Linear Template.**

48) Using Parametric Constraints adjust the **End Bent #1** Linear Template Drop:

Parametric Constraint #1
(Bench Width)

Start:	Lock to Start
Stop:	0+25.00
Constraint Label:	Bench_Width
Start Value:	0.00 ft
Stop Value:	0.00 ft

Parametric Constraint #2
(Bench Width)

Start:	0+61.90
Stop:	Lock to End
Constraint Label:	Bench_Width
Start Value:	0.00 ft
Stop Value:	0.00 ft

Parametric Constraint #3
(Wall Depth)

Start:	Lock to Start
Stop:	0+25.00
Constraint Label:	Wall_Depth
Start Value:	0.00 ft
Stop Value:	-4.00 ft

Parametric Constraint #4
(Wall Depth)

Start:	0+61.90
Stop:	Lock to End
Constraint Label:	Wall_Depth
Start Value:	-4.00 ft
Stop Value:	0.00 ft

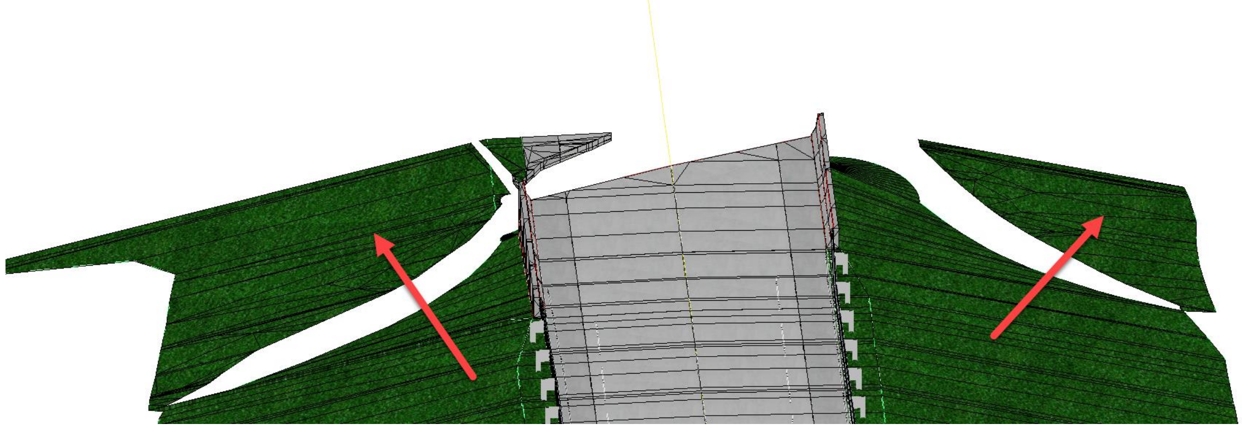
Parametric Constraint #5
(Fill Slope)

Start:	Lock to Start
Stop:	0+25.00
Constraint Label:	Fill Slope
Start Value:	-25%
Stop Value:	-50%

Parametric Constraint #6
(Fill Slope)

Start:	0+61.90
Stop:	Lock to End
Constraint Label:	Fill Slope
Start Value:	-50%
Stop Value:	-25%

49) After applyinig the Parametic Constraints in the previous step you should notice slopes from the Mainline still solving and not being fully clipped out (see below).



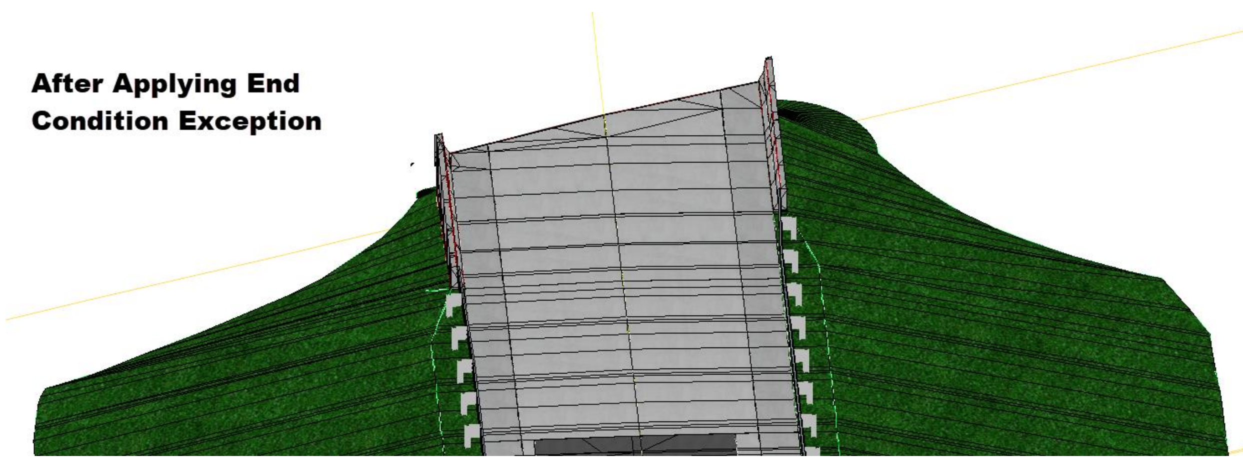
To remove the two slopes we are going to apply a **End Condition Exception** to the Mainline Corridor for each side of the roadway.

End Condition Exception #1
(Right Side)

Name:	Remove Right End Condition
Apply ECE TO:	Backbone Only (Right)
Start:	72+10.53
Stop:	72+50

End Condition Exception #2
(Left Side)

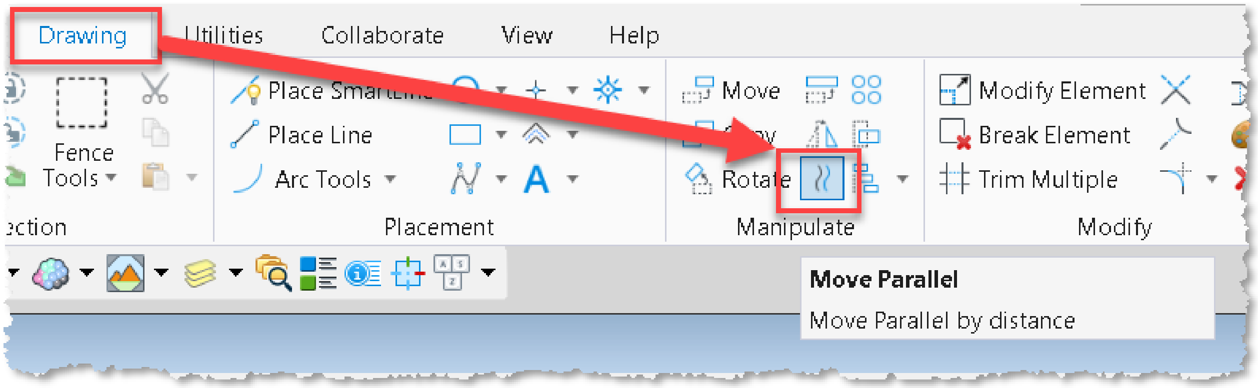
Name:	Remove Left End Condition
Apply ECE TO:	Backbone Only (Left)
Start:	71+97.89
Stop:	72+50



50) To help close the gap near the start of the Barrier on the left side of the roadway, add a **Key Station** at **71+97.88**

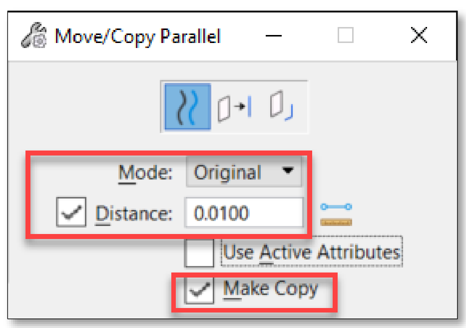
51) To Clip out the remaining piece of the Mainline Corridor, we are going to create a **Clipping Block**. We will place the Clipping Block in the **Plan_J2P3081.dgn** file.

a. Use the MicroStation **Move Parallel** tool and offset end bent line.

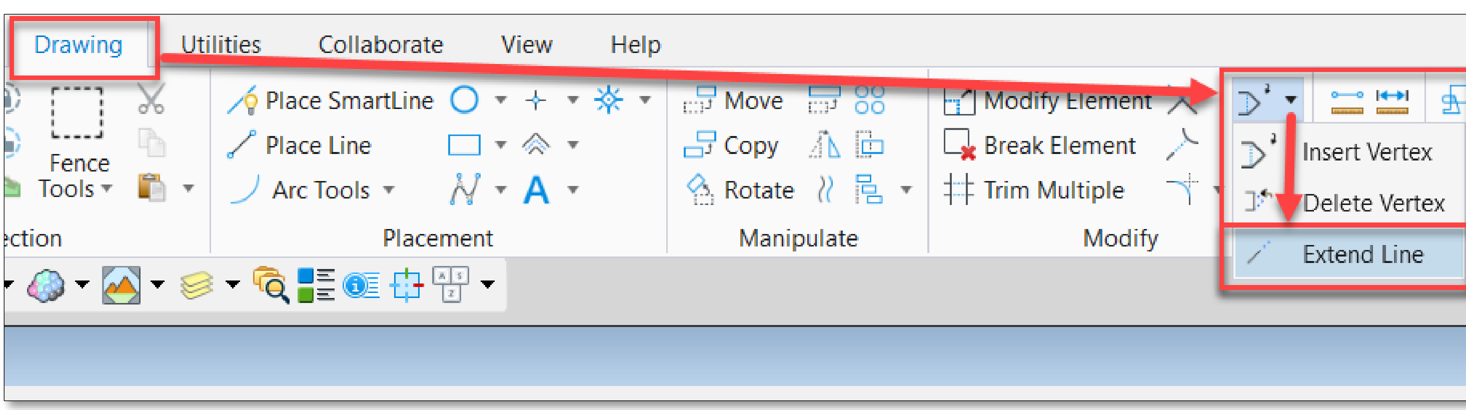


b. **Offset** the bentline **0.01 up-station** and **down-station** using the **copy** option within the **MicroStation Move/Copy Parallel tool**.

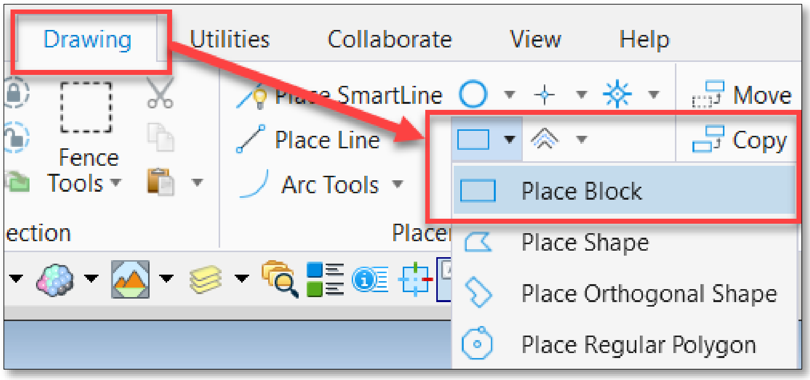
c. We are offsetting the line **twice** because we are going to make **two Clipping Blocks**, one for the clipping out part of the **Mainline Corridor** and another for clipping out part of the future **Bridge Corridor**.

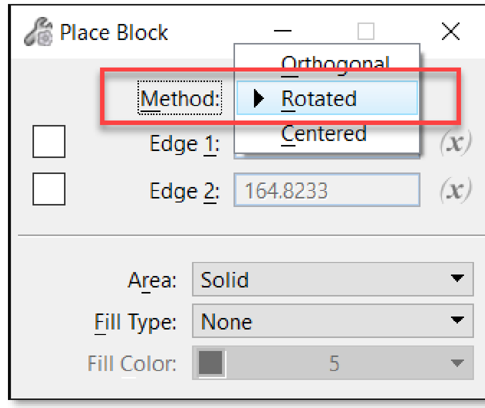


d. **Extend** the offset lines well past *Corridor Limits* using the **Extend Line tool**.



e. Select the **Place Block** tool and set the method to **Rotated**.





f. Create **two** blocks. One up-station and one down-station using the copied offset lines by using a keypoint snap to each end of the extended line. You will want them to overlap.

52) **Open Corridors_J2P3081.dgn**

   a. Add Clipping Reference to **Route14** (Mainline) Corridor using the newly created block.

53) Create a new 2D file for the Bridge Corridor named **Corridors_Bridge_J2P3081.dgn**.

   a. **Set the GCS** using the **Existing_Terrain_J2P3081.dgn**
   b. Reference in the following:
      i. **Civil_Geometry_J2P3081.dgn**
      ii. **Existing_Terrain_J2P3081.dgn**
      iii. **Plan_J2P3081.dgn**
   c. Select **F6** to open the **2D** and **3D** window

54) Create a **Corridor** named **Bridge** using the Mainline Alignment.

55) Add the **Bridge Template** using the following settings:

Corridor Name:	Bridge
Template:	Bridge
Start Station:	72+20
End Station:	73+50
Drop Interval:	25.00’

56) Add a **Clipping Reference** to the Bridge Corridor using the down station block with an elevation of 400’

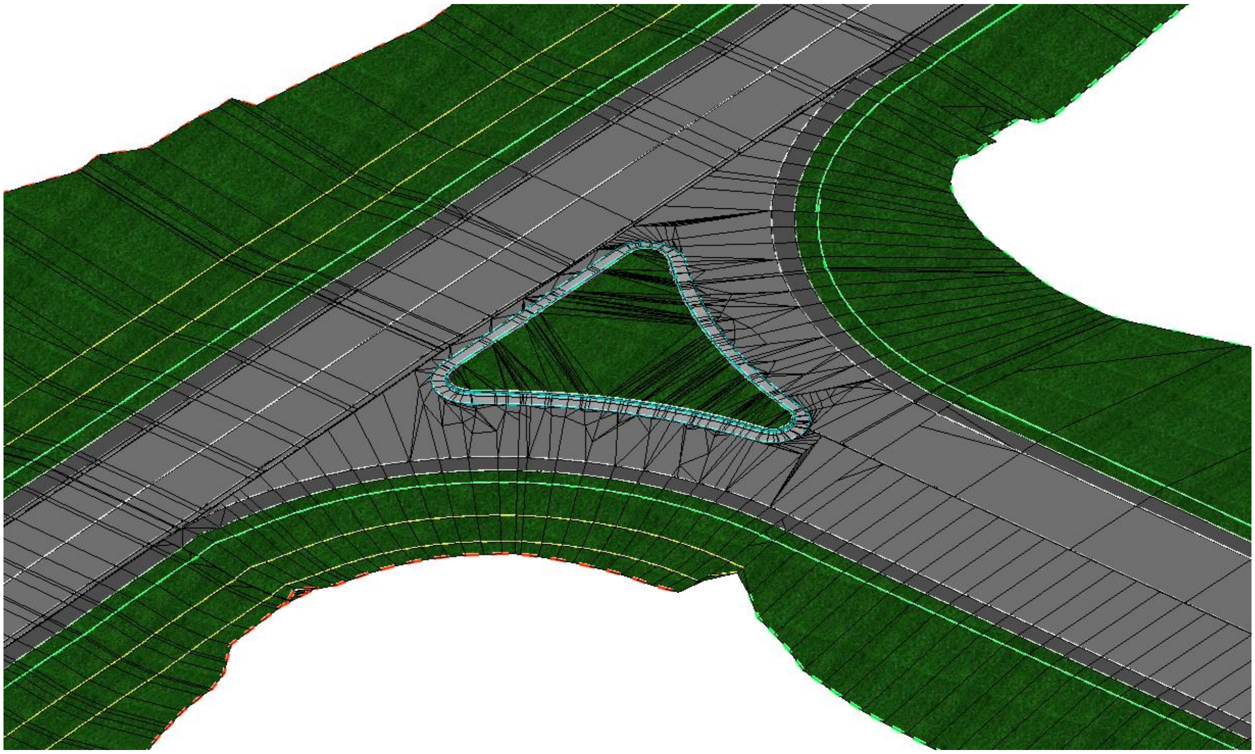
57) Open **Corridors_J2P3081.dgn**

   a. In the **3D View** refrence in the **3D Model** of the **Corridors_Bridge_J2P3081.dgn**
   b. Review Project

END OF EXERCISE

OpenRoads Designer Road 2

Intersection Design



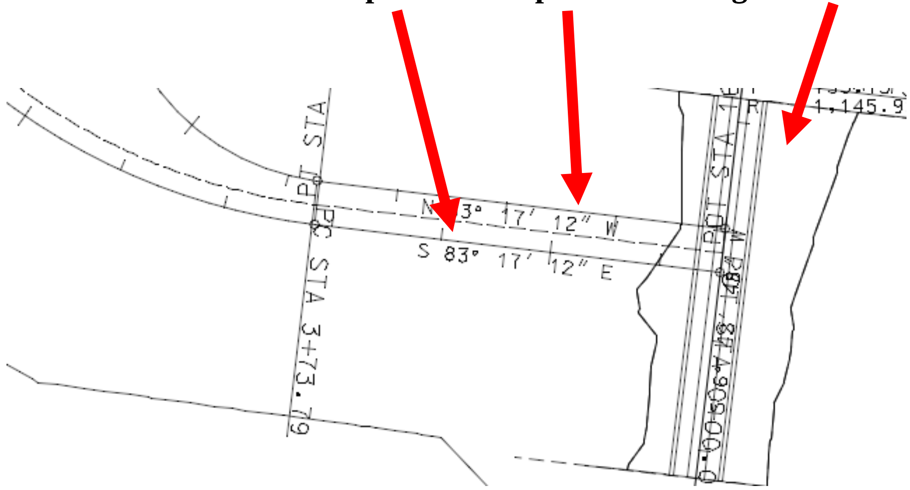
2.1 Objectives

The objective of this chapter is to give the user an overview of the Civil Design Tools and the design workflow using these tools. The user will learn how to access the tools, set preferences, navigate through the create template and Civil Tool dialog boxes. Designing an intersection can be a complex and iterative process. There are an abundance of criteria to consider such as min/max slopes, stopping sight distance, drainage and R/W constraints – just to name a few.

There are many techniques utilizing Horizontal, Vertical and Corridor Civil Tools that can be used to model intersections. This chapter will cover the workflow used to model a Tee-intersection. In addition, this method may be used to model an intersection where the mainline roadway is within the limits of a horizontal curve. This method will ultimately work for most intersection types.

2.2 Intersection Design Exercise

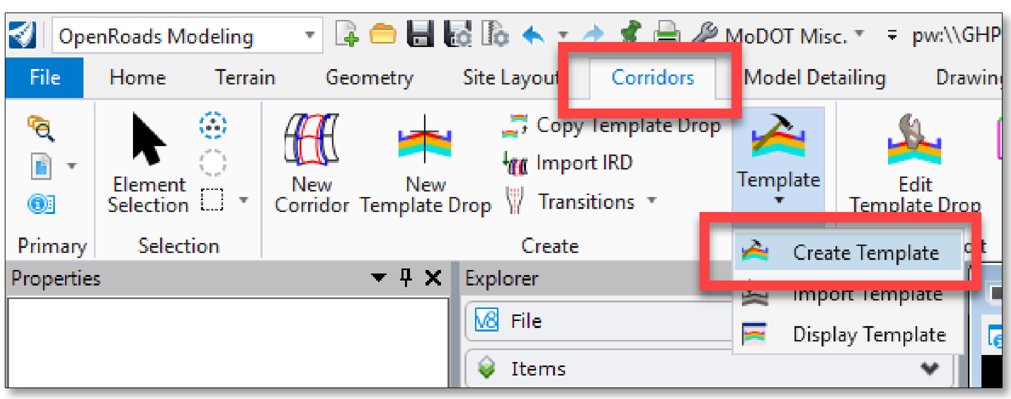
1. Within the **Cole\J5P0100** folder, open the file: **Plan_Overview_J5P0100.dgn**
2. Zoom in to the location where **Ramp 2** and **Ramp 4** intersect **Big Horn Drive**.



Note: Ramp 2 station at **Big Horn** is **16+55.31** and **Ramp 4** at **Big Horn** is **0+00**. The Ramps run in opposite directions.

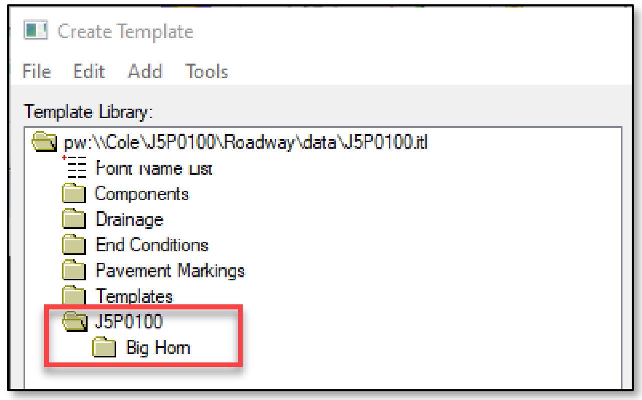
Creating the Project Template Library

3. Within the **OpenRoads Modeling** Workflow, select **Create Template** by selecting the **Corridors** Tab ➔ **Create** Section ➔ **Template** Tools.



Path to MoDOT itl ➔ Documents\CADD_Standards\ORD Standards\Connect_Config\WorkSpaces\MoDOT\Standards\Template Library\

4. Select **File > Save As** from the **Create Template** dialog menu. Save the **MoDOT** template library as **J5P0100.itl** in the folder.
5. Within the **itl** create a folder named **J5P0100** to store templates for the Project Corridors.
6. Within to the **J5P0100** folder and create a new folder called **Big Horn**.

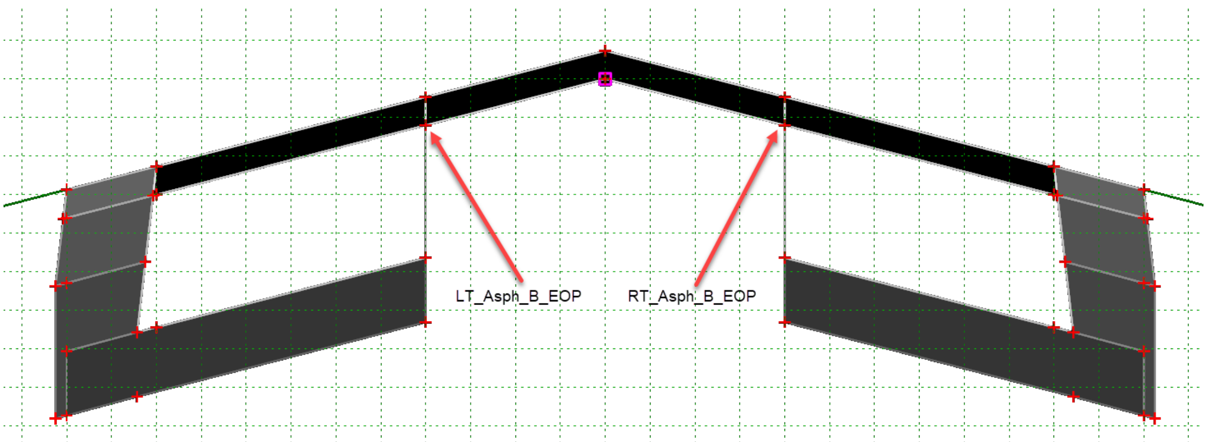


7. Copy within the **Big Horn** Folder the following Template:

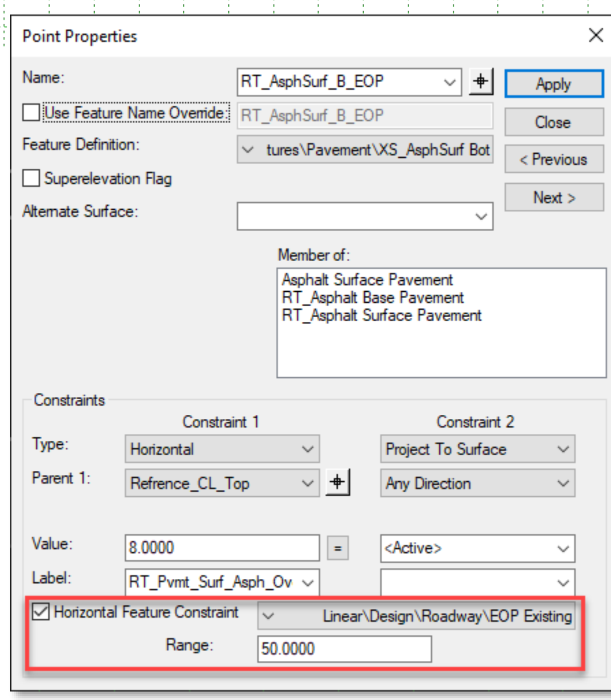
   Templates ➔ Overlay ➔ Overlay w/ Asphalt Pavement Widening and A2 Shoulder - Option #3 ➔ **Match Existing Slope Surface Course**.

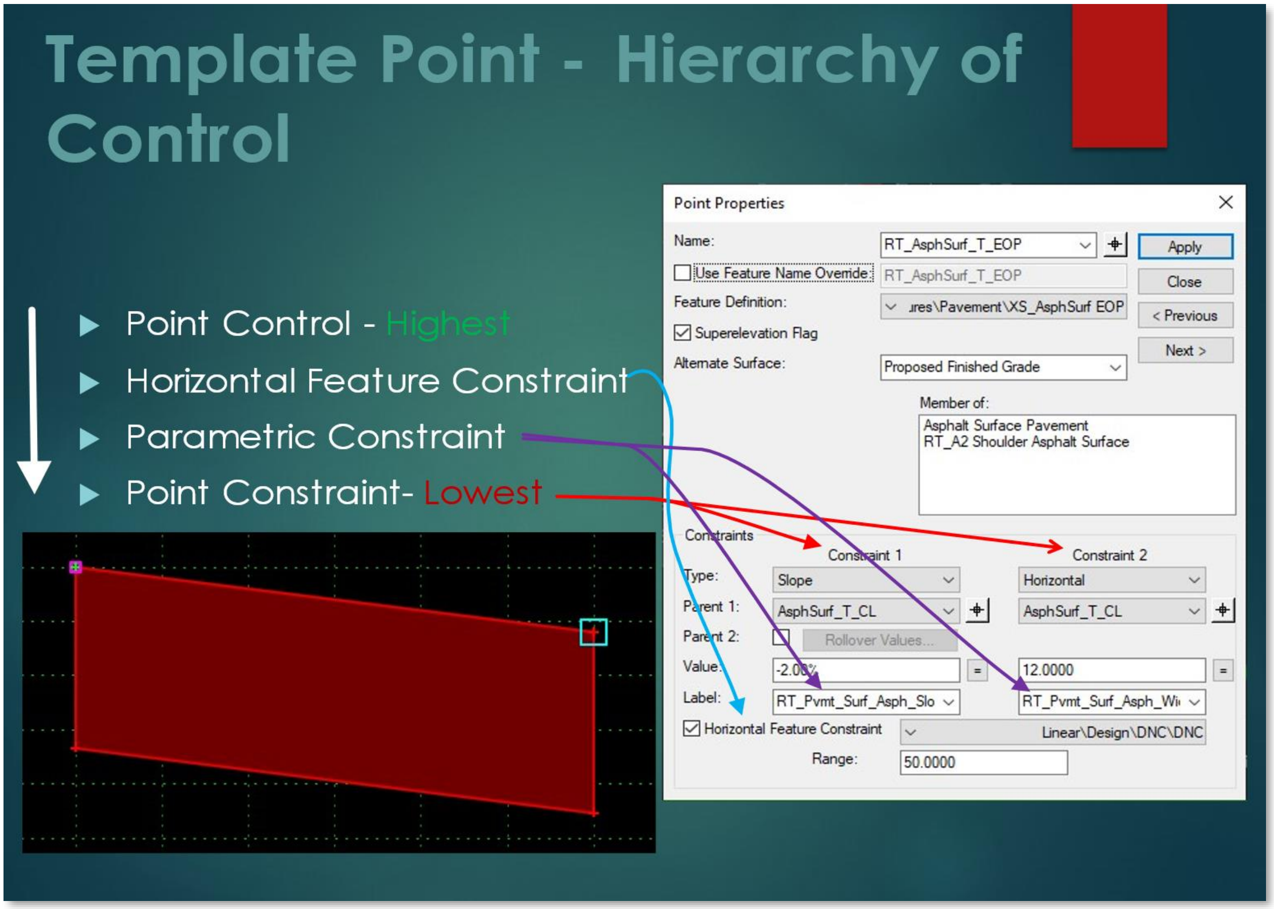
8. Rename Template to **Big Horn - Match Existing Slope Surface Course**

9. To get the Widening to start at the Existing Edge of pavement edit the **Big Horn - Match Existing Slope Surface Course** Template and select the **RT_AsphSurf_B_EOP** and the **LT_AsphSurf_B_EOP** points and modify the **Horizontal Feature Constraint** to be **Linear\Design\Roadway\EOP_Existing**



For the previous step **edit** the following area in the Point Property dialog:





10. **Close** the **J5P0100.itl** Template Library and **Save** on exit.

Creating the Big Horn Corridor

11. Create the Corridor dgn file for all the alignments going into the Intersection of **Big Horn**, **Ramp 2**, and **Ramp 4**.

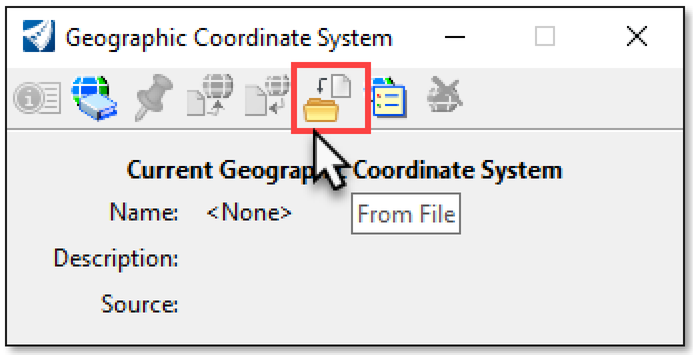
12. Create a new dgn file named **Corridors_J5P0100.dgn** using the:

    MoDOT_Roadway_Seed_2D.dgn seed file.

    Note: This new file will hold all the Corridors for this intersection.

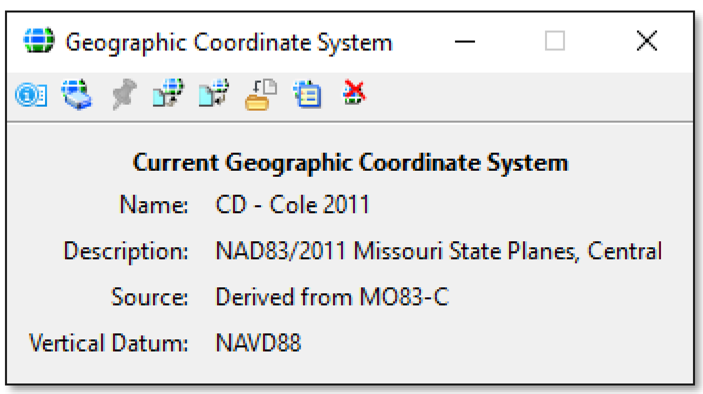
13. Open the **Coordinate System** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Utilities** Tab ➔ **Geographic** Section.

14. Select "**From File**" icon.



15. Select the **Terrain_Existing_J5P0100.dgn** file in the **data** folder.

16. Verify the settings.



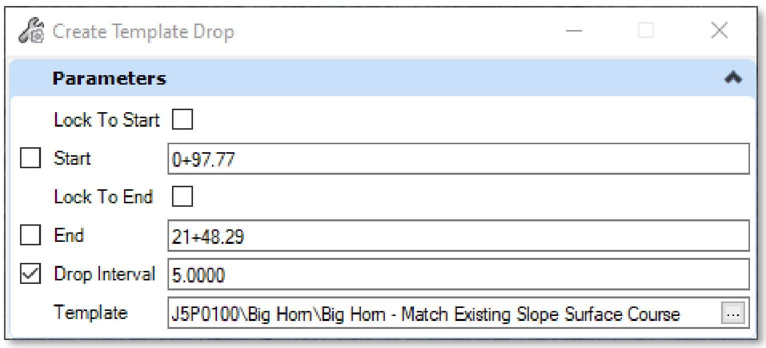
17. Reference in the following files within the **Default 2D Model**:

    Civil_Geometry_J5P0100.dgn
    Terrain_Existing_J5P0100.dgn

18. Fit View, change the Annotation Scale to **1"=50', and** set the Existing Terrain as **Active**.

19. Create a **Corridor** for **Big Horn Drive**

   a. Open the **New Corridor** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Corridors** Tab ➔ **Create** Section
   
   b. Select the **Big Horn** Alignment
   c. **Right Click** for the Active Profile (Big Horn Existing).
   d. **Corridor Name: Big Horn**
   e. Template: **J5P0100** ➔ **Big Horn** ➔ **Big Horn - Match Existing Slope Surface Course**
   f. Start Station **0+97.77** (Start of Alignment)
   g. End Station **21+48.29** (End of Alignment)
   h. Drop Interval **5'**



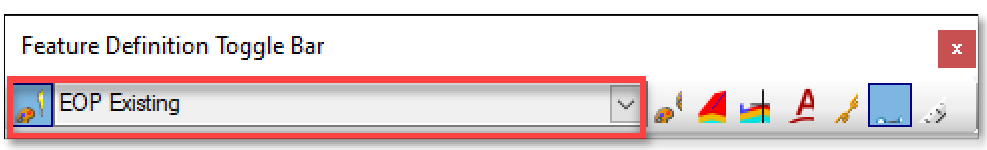
20. Select **F6** to view the 3D model of the Corridor.

21. To allow the template to see the **Big Horn Existing Edge of Pavement** (EOP) lines we need to set a "**Design**" Feature Definition on those lines. Currently the Big Horn **EOP Existing** lines have a "**Survey**" Feature Definition applied to them, which does not currently work with ORD Corridor Modeling.

    To resolve this, let's open the **Exported_Graphics_J5P0100.dgn** and update the **EOP Existing** Feature Definitions.

22. Using the **Level Display**, turn off all levels except for **Survey-Edge of Pavement.**

23. Set the **Feature Definition Toggle Bar** with the following settings:

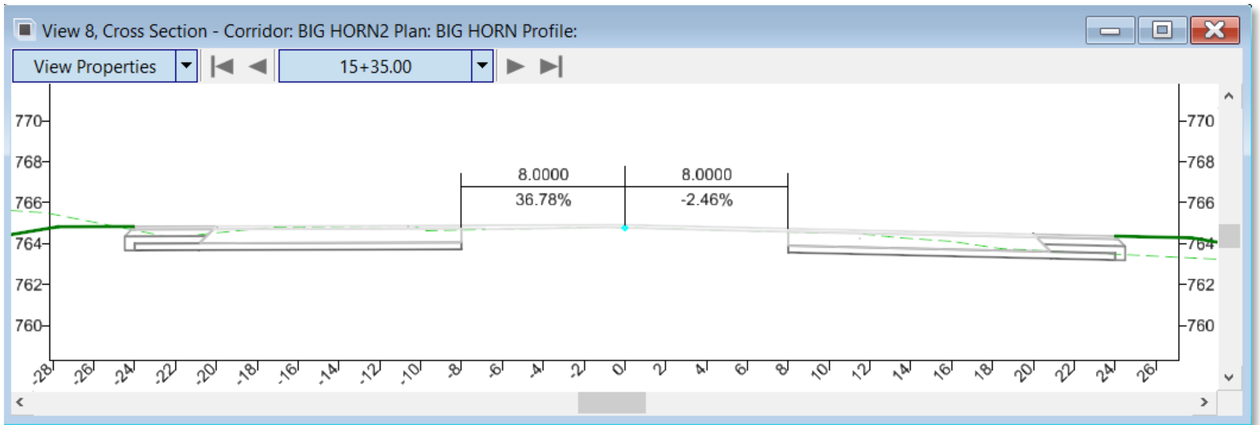


Linear ➔ Design ➔ Roadway ➔ EOP Existing

Also make sure the **Use Active Feature Definition** is toggle ON.

Open the **Set Feature Definitions** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Geometry** Tab ➔ **General Tools** Section ➔ **Standards** Pull-Down. Then select and "**Set**" the two Existing EOP lines.

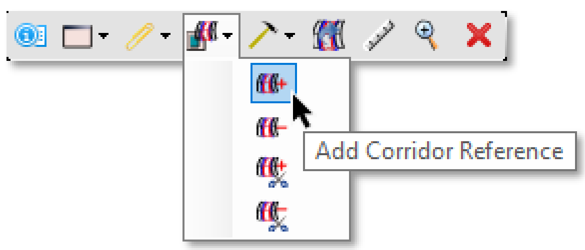
24. Reopen the **Corridors_J5P0100.dgn** file and then open a **Dynamic XS** view for the **Big Horn Corridor**. Also add a **Horizontal Temporary Dimension Line** in the **Overlay Area** of the template.



25. Reference in the following files within the **Default 2D Model**:

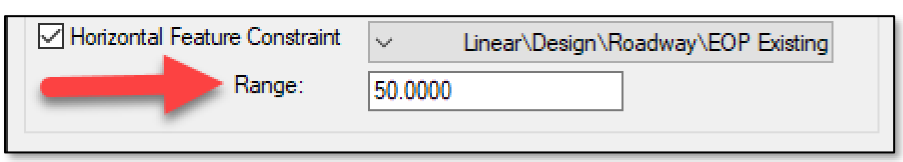
Exported_Graphics_J5P0100.dgn

26. For the Corridor to see the **Existing Edge of Pavement** line, the line needs to be added as a Corridor Reference. To add a Corridor Reference, select the corridor's heads up tools and select the **4th** set of tools from the left and select **Add Corridor Reference**.



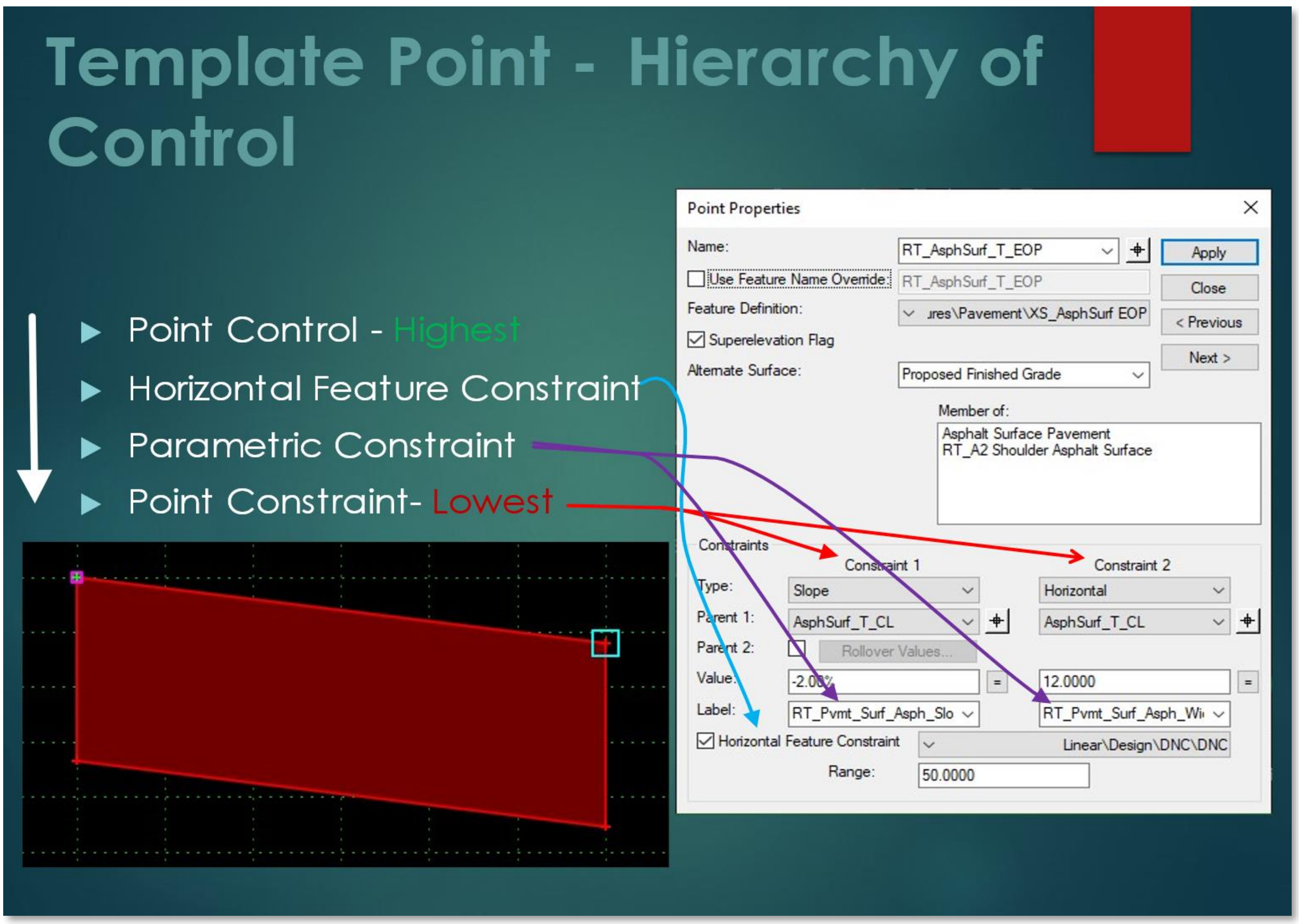
The start of the Edge of Widening offset should have changed from the default 8' offset defined in the template to the actual distance to the Existing Edge of Pavement line.

Note: Horizontal Feature Constraint Range Explained:

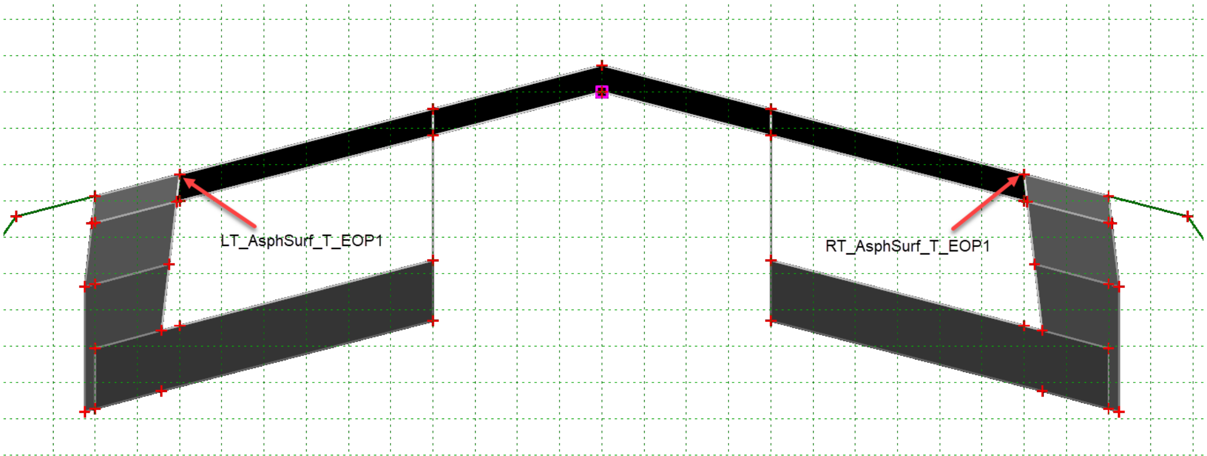


- Range uses the offsets as defined in the template. For example, if your point is defined at 38 offset in the template, and the range is -18, the point will look from 38 to 20 offset from the corridor baseline for the feature definition.
- Positive (+) values entered, will cause the template to look only to the Right of the Template point.

- Negative (-) values entered, will cause the template to look only to the Left of the Template point.
- A Zero (0) value entered, will cause the template to look both left and right of the Template point.
- The start location of the Range is always the original offset location of the Point in the Template. Even if the point is shifted to a different offset in the model, for example a point being shifted using Parametric Constraint, the start location of the Range is always the original offset location of the Point in the Template.
- A **Horizontal Feature Constraint Range** can be overwritten with a **Point Control** using a **Control Type** called **Feature Definition**, the program will determine the offset of the point that is assigned the Point Control and apply the range value to the offset of that point as it exists in the template.
- If there are two or more Features within the **Horizontal Feature Constraint Range**, the closest one to original offset location of the Point in the Template will be selected.

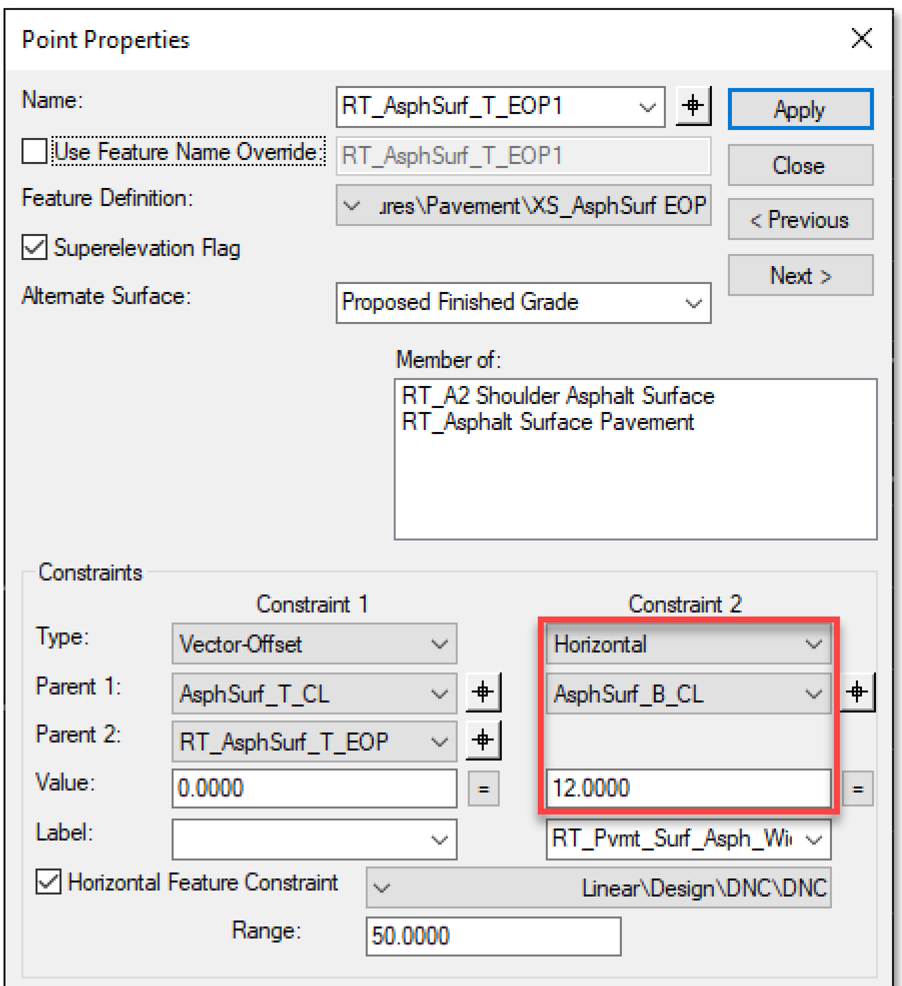


27. Next, we are going define amount of widening. The max amount of Widening will be 12' left and right of the centerline of Big Horn.



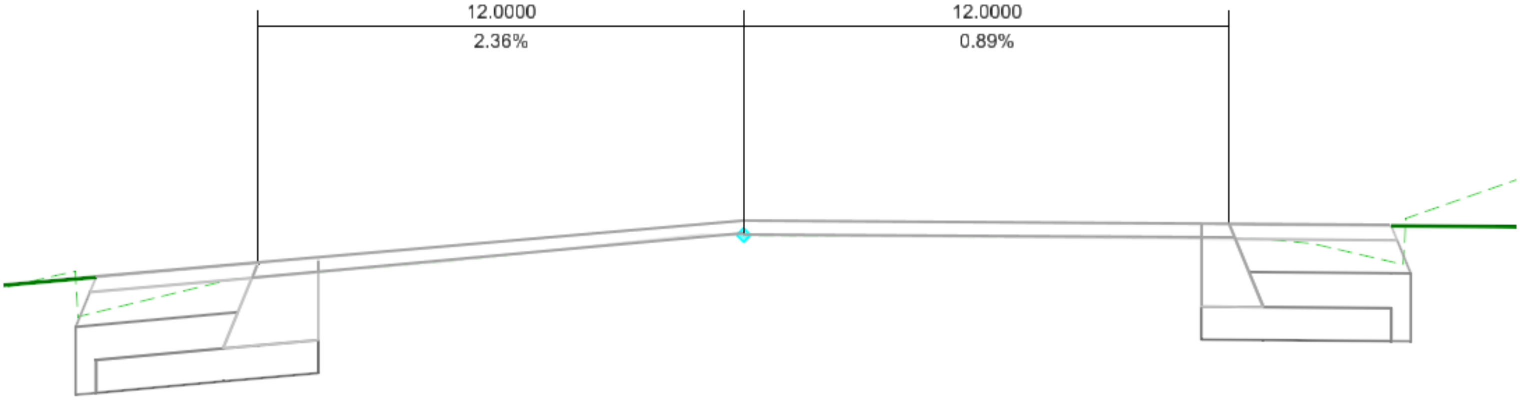
To get the Widening to stop at an offset of 12' from the baseline we will need to modify the **Big Horn - Match Existing Slope Surface Course** Template. To do this select the **RT_AsphSurf_T_EOP1** and the **LT_AsphSurf_T_EOP1** points and modify the **Horizontal Constraint** to have a parent point **AsphSurf_B_CL** with an **Offset = 12 ft**

For the previous step **edit** the following area in the Point Property dialog:



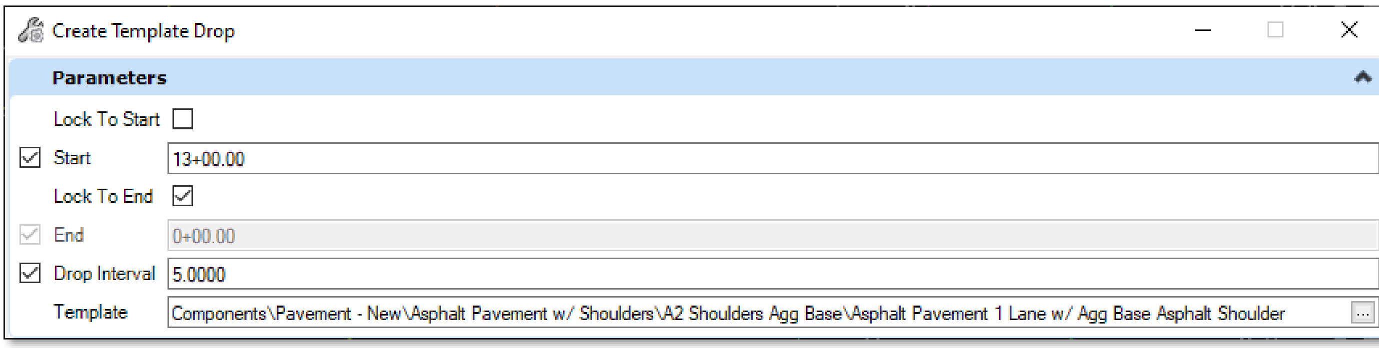
28. **Close** the **J5P0100.itl** Template Library and **Save** on exit.

29. Reopen a **Dynamic XS** view for the **Big Horn Corridor**. Verify the 12' Widening Limit by using a **Horizontal Temporary Dimension Line.**

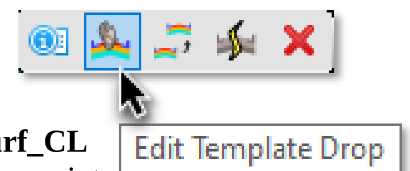


Creating the Ramp Corridors

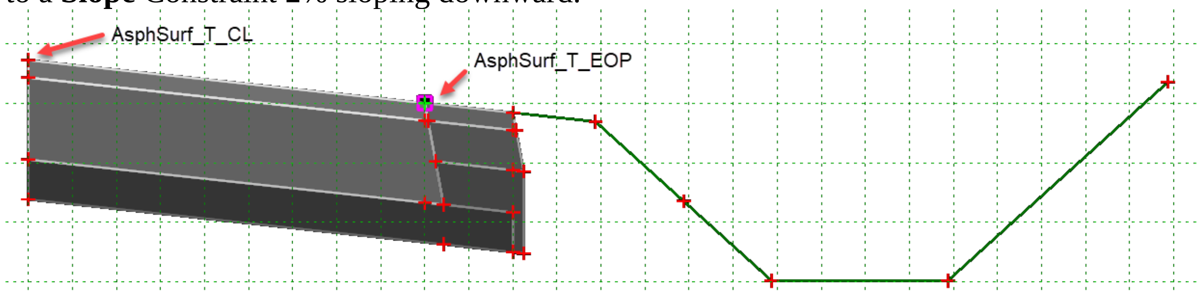
30. Create a Corridor for **Ramp2**
    a. Open the **New Corridor** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Corridors** Tab ➔ **Create** Section
    b. Select the **Ramp 2** Alignment
    c. Right Click for the **Active Profile** (Ramp 2 Proposed).
    d. Corridor Name: **Ramp 2**
    e. Corridor **Feature Definition**: **0-Preliminary x 5**
    f. Template: Components ➔ Pavement - New ➔ Asphalt Pavement w/Shoulders ➔ A2 Shoulders Agg Base ➔ **Asphalt Pavement 1 Lane w/Agg Base Asphalt Shoulder**.
    g. Start Station **13+00,** End Station **Lock to End,** and Drop Interval **5'**



31. Modify the **Template Drop** in the dgn:

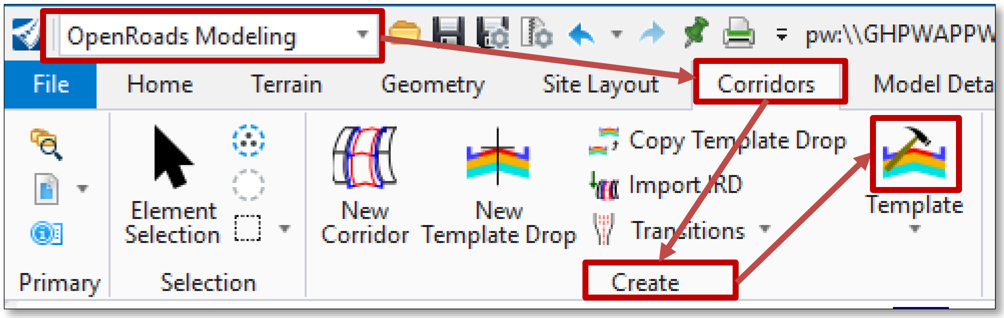


    a. Make the Template Origin point **AsphSurf_T_EOP**
    b. **Remove** the point constraints from **AsphSurf_T_EOP**.
    c. Change the **AsphSurf_T_EOP** Feature Definition to **XS_AsphSurf_CL**
    d. Add Horizontal and Slope Constraints to the **AsphSurf_T_CL** from point **AsphSurf_T_EOP,** horizontally **-18' @ -2%** slope.
    e. Change the **AsphSurf_T_CL** Feature Definition to **XS_AsphSurf_EOP**
    f. Add **Guardrail Widening** to the outside Edge of Shoulder:
        End Conditions ➔ Combined ➔ Guardrail Widening
    g. Add a **6:1 Fill or 6:1 Foreslope and Back Ditch** End Condition to the right side of the Guardrail Widening:
        End Conditions ➔ Combined ➔ **6:1 Fill or 6:1 Foreslope and Back Ditch**
    h. Change the **AsphSurf_T_O_EOS** point properties from a **Vector-Offset** constraint to a **Slope** Constraint 2% sloping downward.



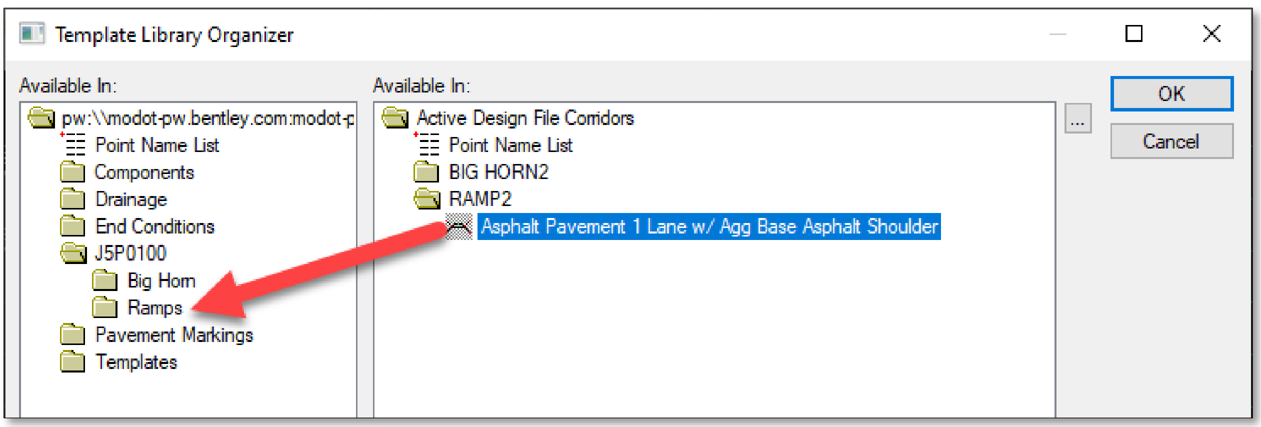
    i. Click **OK** to save the Template

32. From the **OpenRoads Modeling** Workflow, select **Create Template** by selecting the **Corridors** Tab ➔ **Create** Section ➔ **Template** Tools.



33. Navigate to the **J5P0100** folder and create a new folder called **Ramps**.

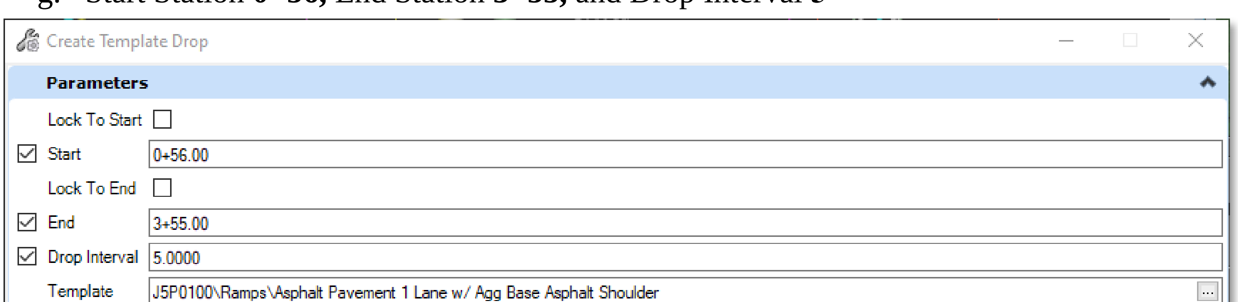
   a. From the Create Template dialog select **Tools** ➔ **Template Library Organizer**
   b. Copy the **Asphalt Pavement 1 Lane w/Agg Base Asphalt Shoulder** to the **J5P0100** ➔ **Ramps** Folder



   c. **Close**, **Save,** and **Check In** the Template Library when prompted

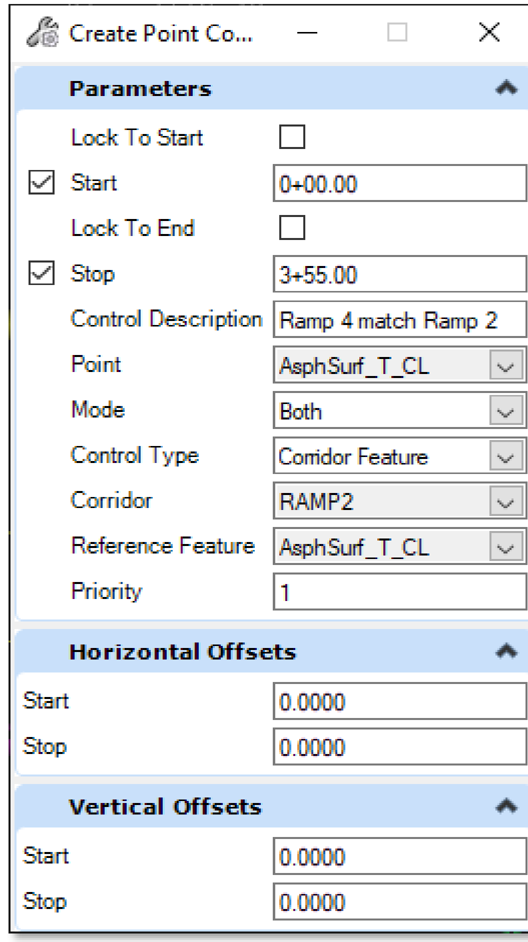
34. Create a Corridor for **Ramp4**

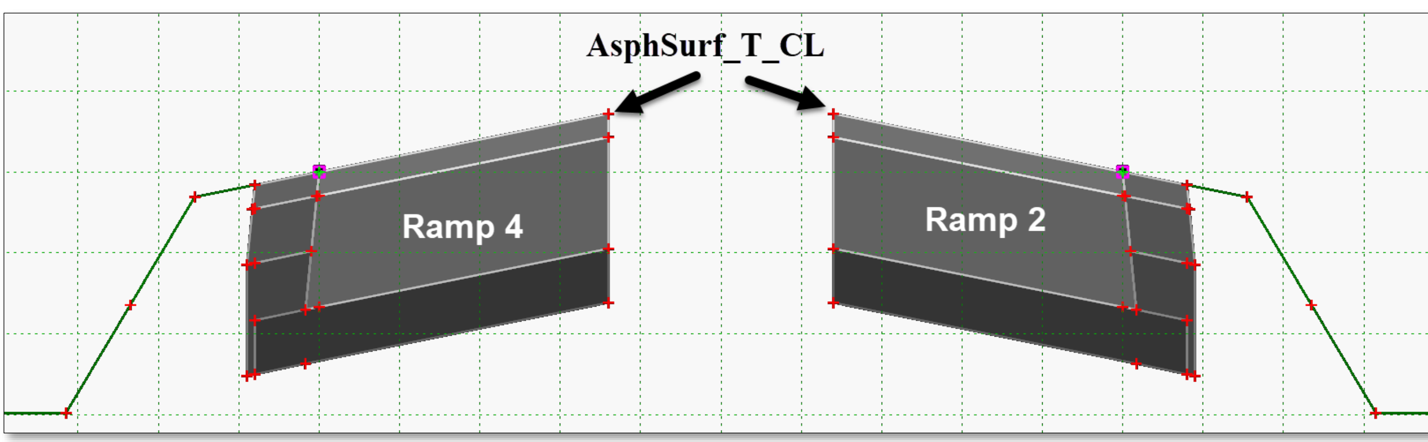
   a. Open the **New Corridor** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Corridors** Tab ➔ **Create** Section
   b. Select the **Ramp 4** Alignment
   c. Right Click for the **Active Profile** (Ramp 4 Proposed).
   d. Corridor Name: **Ramp 4**
   e. Corridor **Feature Definition**: **0-Preliminary x 5**
   f. Template: J5P0100 ➔ Ramps ➔ **Asphalt Pavement 1 Lane w/Agg Base Asphalt Shoulder**.
   g. Start Station **0+56,** End Station **3+55,** and Drop Interval **5'**



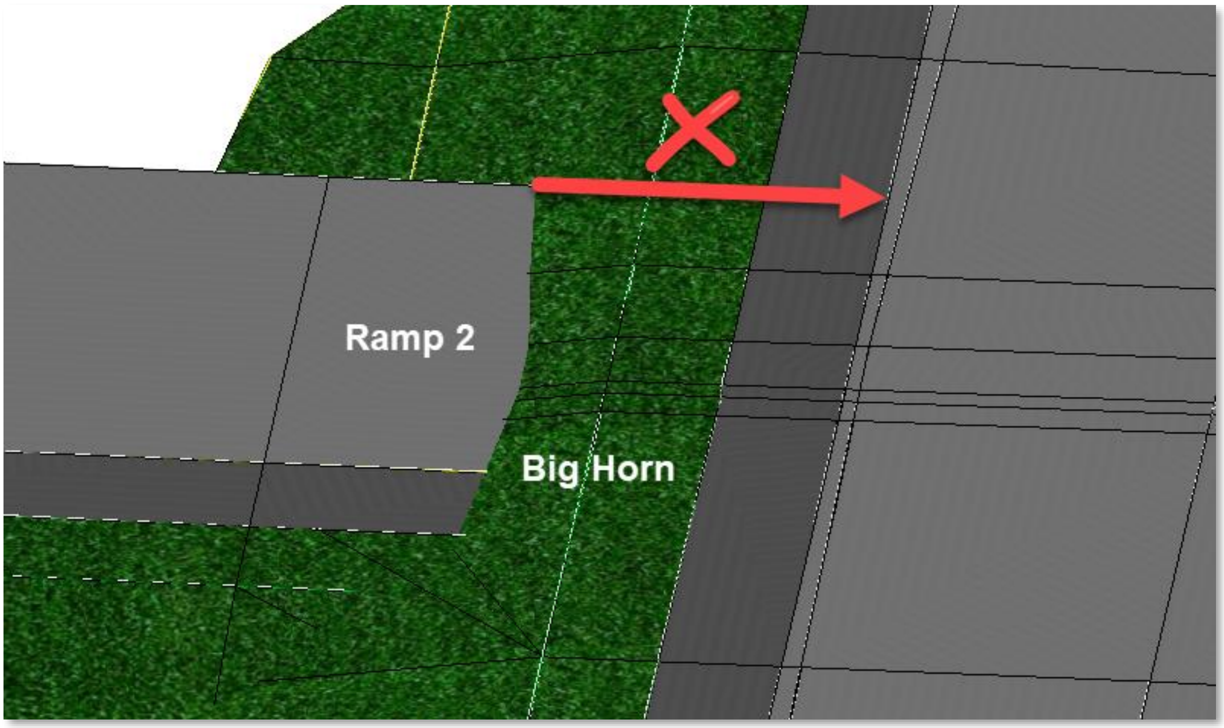
35. Add a **Point Control** to Ramp4 corridor for both **Vertical** and **Horizontal** to meet Ramp2 corridor. *(Note: Make sure all references are displayed in the view)*

    a. Open the **Point Control** Tool from the **Ramp 4** heads up display
    b. Set the Start Station **0+00**
    c. Set the End Station **3+55**
    d. Control Description**: Ramp4 Match Ramp2**
    e. Point: **AsphSurf_T_CL**
    f. Mode: **Both**
    g. Control Type: **Corridor Feature**
    h. Corridor: **Ramp2**
    i. Reference Feature: **3D Linear Element AsphSurf_T_CL**
    j. Priority: **1**
    k. Horizontal and Vertical Offsets: **0**





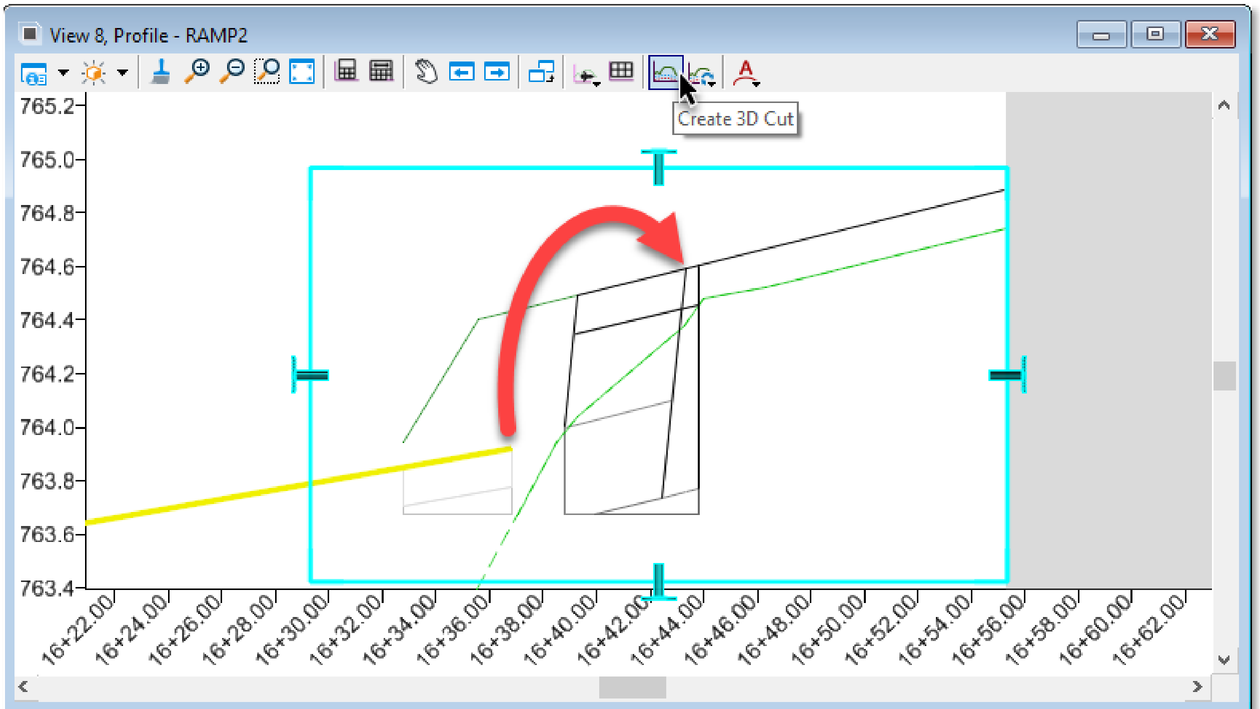
NOTE: There appears to be a problem with the **Ramp 2 Profile**. The **Ramp 2 Profile** is supposed to be designed so that the **Crown Point** in-between the **Ramp 2 and Ramp 4 Corridors** matches the elevation of the **Big Horn EOP/EOP** line. You can see in the 3D view that the **Ramp 2 Corridor** is diving too far below into the Big Horn Corridor.



36. **Open** the **Civil_Geometry_J5P0100.dgn** file
37. **Reference** in the **2D Model** of the **Corridors_J5P0100.dgn**.
38. Make the terrain **active**

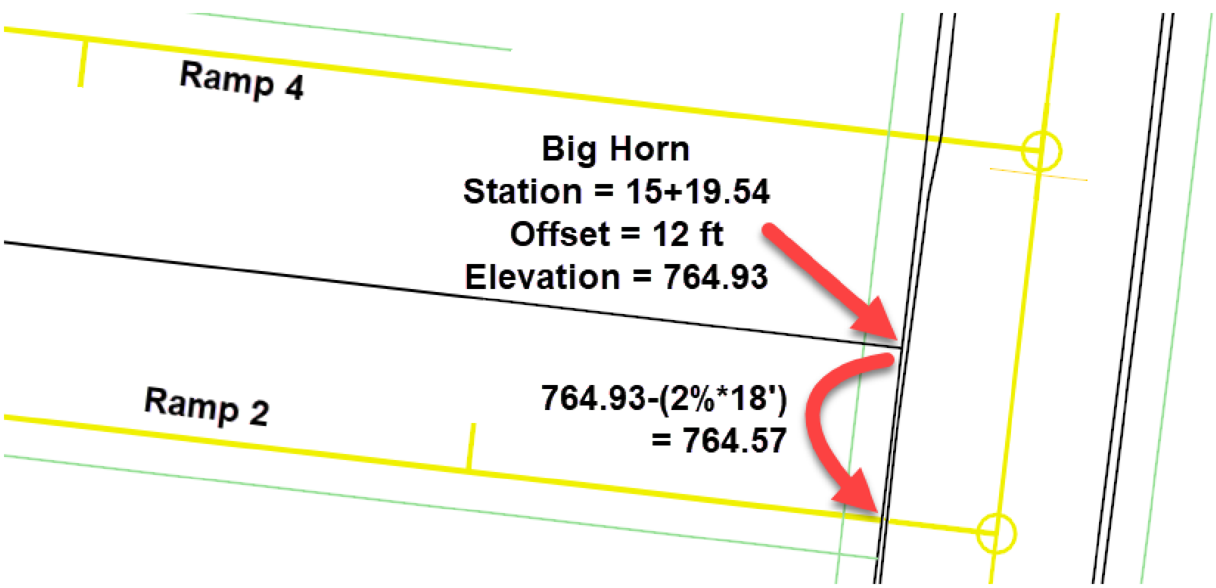
39. Open the **Profile Model** for **Ramp 2** and zoom in to an area near the end of the profile.

Utilizing the **Create 3D Cut** tool (the third icon from the right), and the **Corners** option, place a box around the end of the profile. You can see that the profile is not ending anywhere near the EOP/EOS point of the Big Horn Template.



Adjust the **Station** and **Elevation** of the end of the Profile to the following:

Station = 16+43.31
Elevation = 764.57 (See calculations below.)



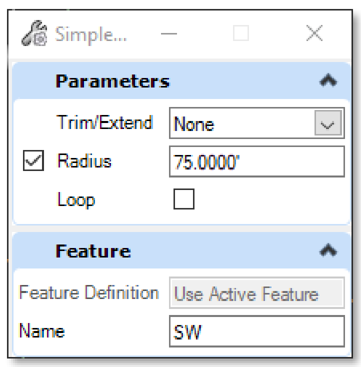
40. Open the **Corridors_J5P0100.dgn** file to see the adjustments to the Ramp 2 Corridor modeling up to the **EOP/EOS** point of Big Horn.

Creating the Radius Return Linear Templates

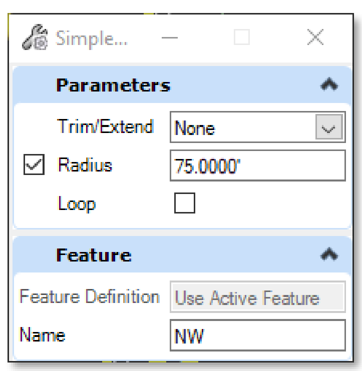
41. Reopen the **Civil_Geometry_J5P0100.dgn** file.

42. Using the **Feature Definition Toggle Bar** set the Feature Definition to **MoDOT_Baseline_Proposed** (located under Alignment) and toggle on **Use Active Feature Definition**.

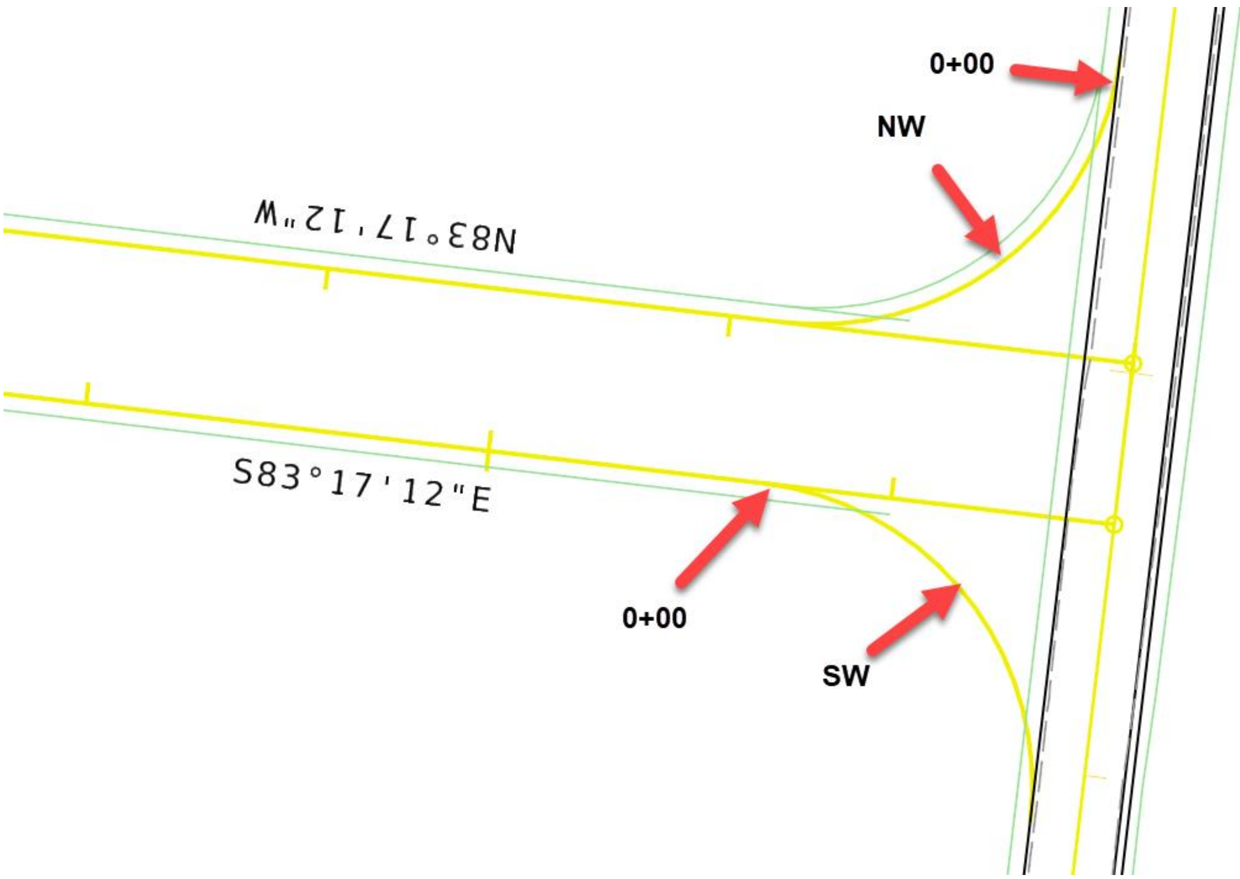
43. For the **SW Radius Return**, select the "**Simple Arc**" tool by selecting the **OpenRoads Modeling** Workflow, then **Geometry** Tab ➔ **Horizontal** Section ➔ **Arc** Tools ➔ Arc Between Elements.
    a. First select the **EOP** line (Baseline) of **Ramp2** and then the **EOP** line of **Big Horn Drive** to place the Arc.
    b. Use a radius of **75**.
    c. Trim: **None**
    d. Name: **SW**



44. For the **NW Radius Return**, use the same **Simple Arc** tool with a radius of 75.
    a. First select the **EOP** of **Big Horn Drive** then the **EOP** (Baseline) for **Ramp4**. (Important to go in this order so the same template can be used later)
    b. Use a radius of **75**.
    c. Trim: **None**
    d. Name: **NW**



45. Define the **Start Station (0+00)** for each radius return as indicated below using the "**Start Station**" tool. To do this select the **OpenRoads Modeling** Workflow, then **Geometry** Tab ➔ **Horizontal** Section ➔ **Modify** Tools ➔ **Start Station**



46. In the next few steps, we are going to define a profile for the Radius Returns based on the **longitudinal** slopes of the edge of pavements coming into each Radius Return.

    First, we are going to use the **Project Extended Profile** tool to view the longitudinal EOP slope coming into and out of the Radius Returns. Then we will us the **Quick Profile Transition** tool to define the transition profile between the two extended profiles.

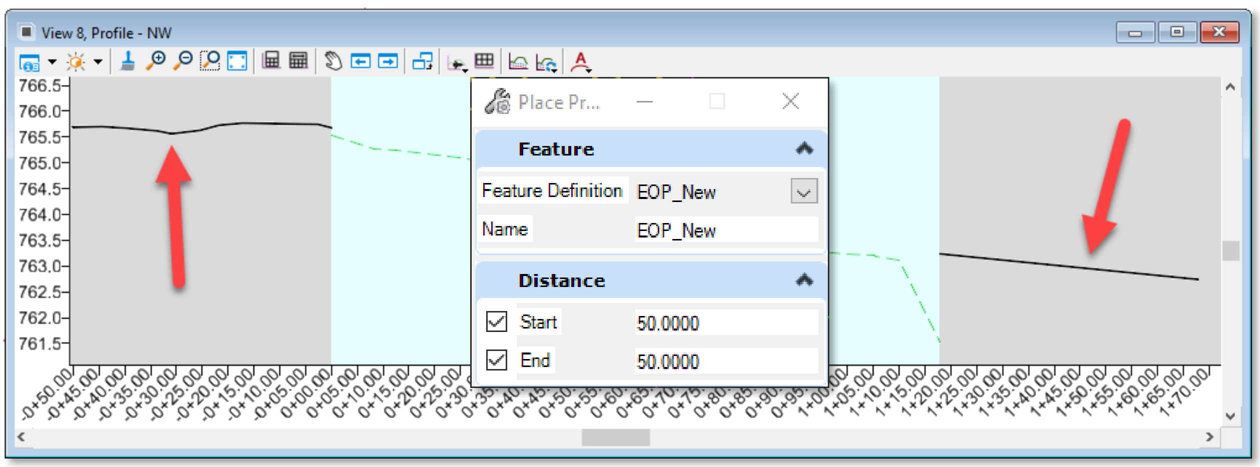
    The **Project Extended Profile** tool is located under the **OpenRoads Modeling** Workflow, **Geometry** Tab ➔ **Vertical** Section ➔ **Profile Creation** Tools.

    The **Quick Profile Transition** tool is located under the **OpenRoads Modeling** Workflow, **Geometry** Tab ➔ **Vertical** Section ➔ **Element Profiles** Tools.

    <u>NW Radius Return:</u>

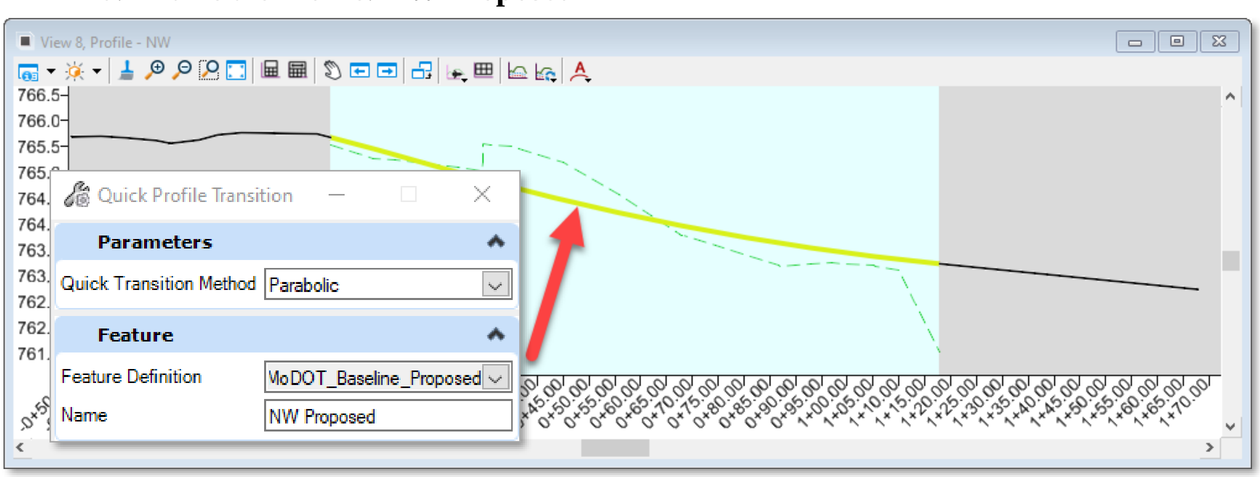
    a. Open the **Profile Model** for the **NW Radius Return.**

    b. Using the **Project Extended Profile** tool place both longitudinal new Edge of Pavement profile slopes coming into the Radius Returns. Use a **Feature Definition** of **EOP New** (located under Linear ➔ Design ➔ Roadway).



    c. Apply a vertical profile to the NW radius return using the **Quick Profile Transition** tool. Using the **Parabolic** method with a Feature Definition of **MoDOT_Baseline_Proposed** (located under **Alignment**).

    d. Name the Profile: **NW Proposed**



Note: The **Quick Profile Transition** tool will automatically make the newly created profile Active.

47. Drop the **Rules** of the newly created **NW Proposed Profile**.

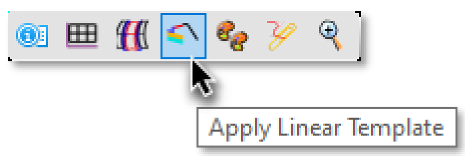
48. (**Individual Step**) Using the same steps in storing a profile for the **NW Radius Return**, store a profile for the **SW Radius Return** (start on Step 46).

49. Do not do the following step until both the SW and NW profiles have been stored.

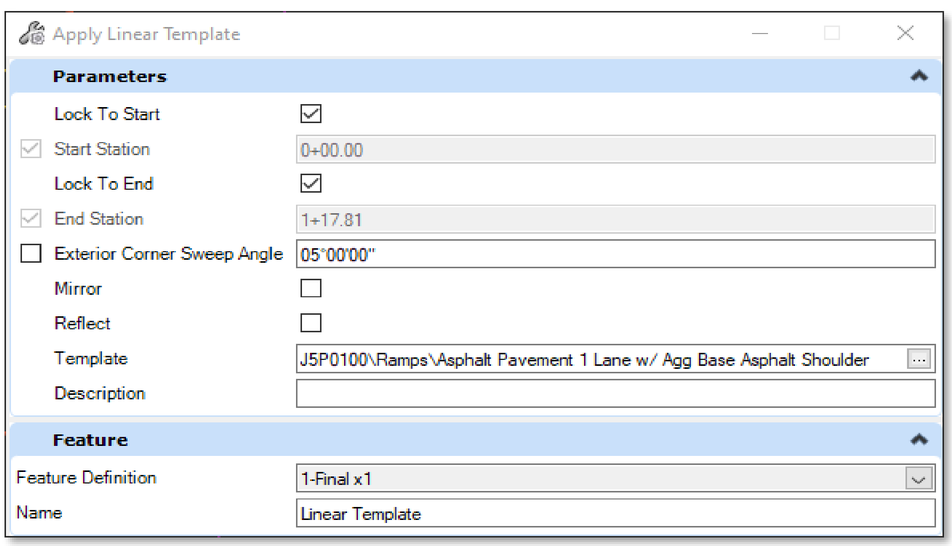
    Detach the **Corridors_J5P0100.dgn** file from the **Civil_Geometry_J5P0100.dgn** file. When prompted, break the rules between the two files. The **Extended Profiles** (white lines) should disappear from both the **NW** and **SW** Profile models leaving the Proposed Profiles (yellow lines).

50. Open the **Corridors_J5P0100.dgn** file.

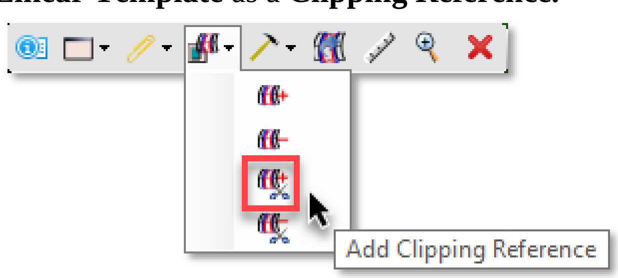
51. Select the **NW Radius Return's** alignment and open the heads-up tools and then select **Apply Linear Template**.



52. Set the **Apply Linear Template** dialog up as follows:



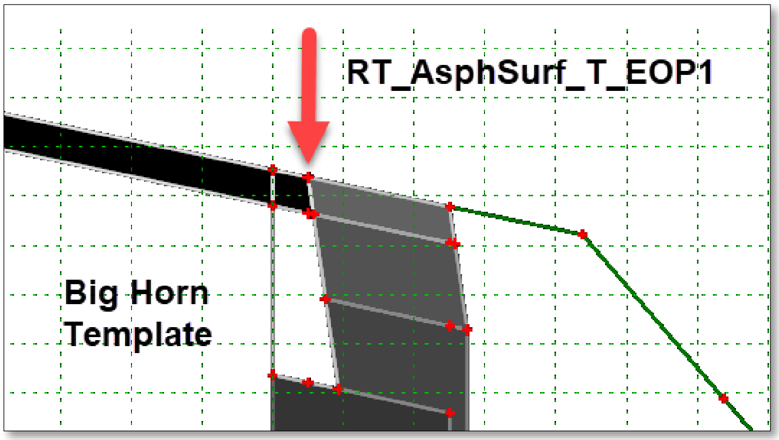
53. Individually select the **Big Horn** and **Ramp 4** corridors and select their heads-up tools and add the **NW Linear Template** as a **Clipping Reference.**

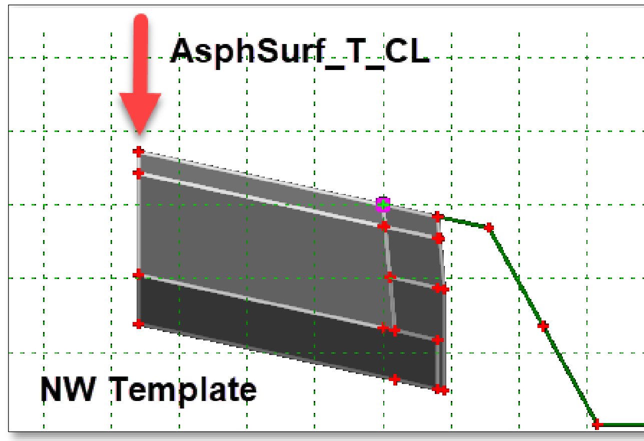


Radius Return Linear Templates draw to Big Horn Edge of Pavement

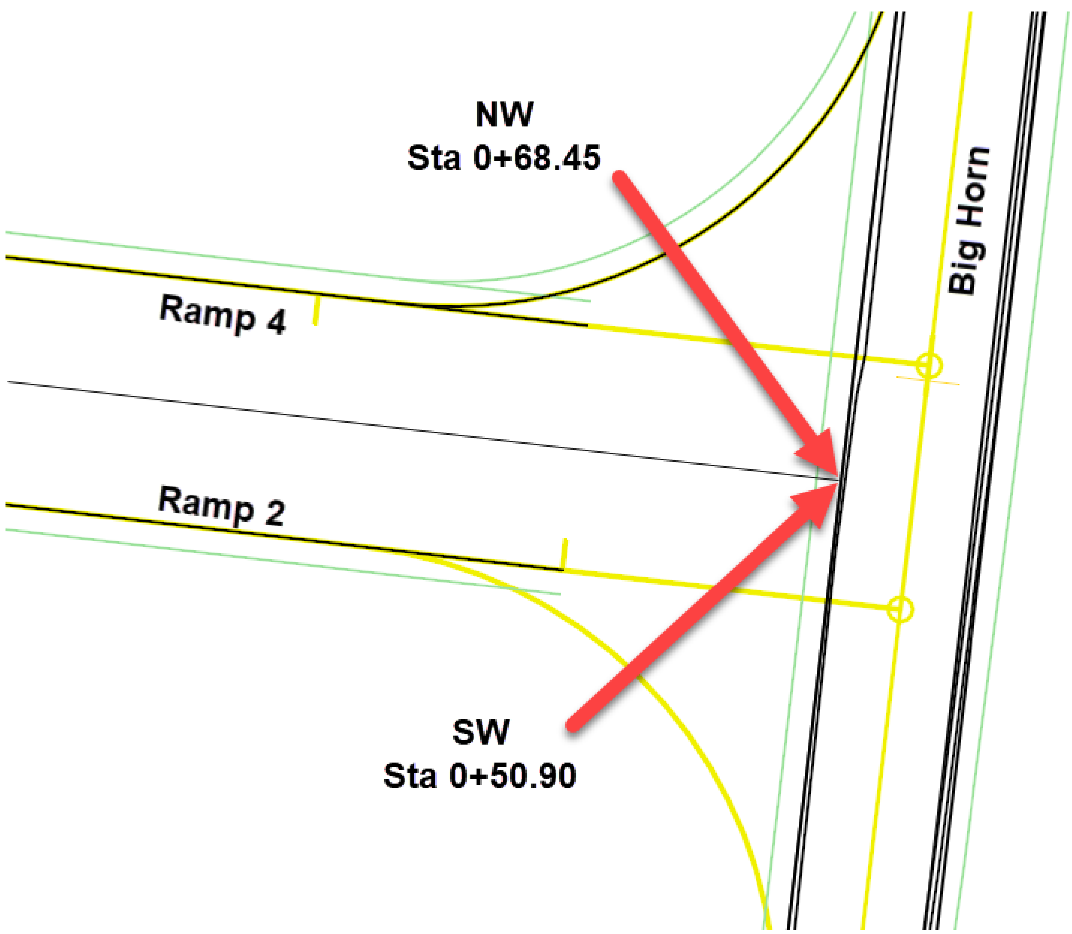
Next, we are going to make the Left EOP in the **NW** template (**AsphSurf_T_CL**) draw up to the Right Outside Edge of Pavement in the **Big Horn** template (**RT_AsphSurf_T_EOP1**).

To do this we will use a **Point Control**.

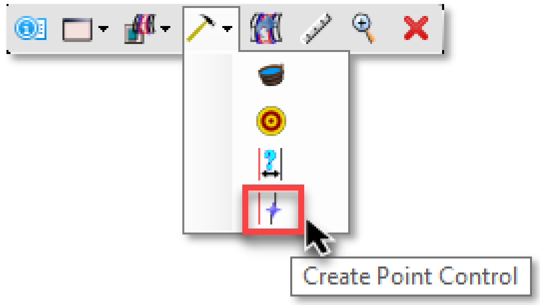




But first, another piece of information we will need for our Point Control is the **Start** and **Stop** Location for drawing to the **Big Horn Edge of Pavement**. With the **NW** Linear Template, we will start at **Sta. 0+00** and end at **Sta. 0+68.45**

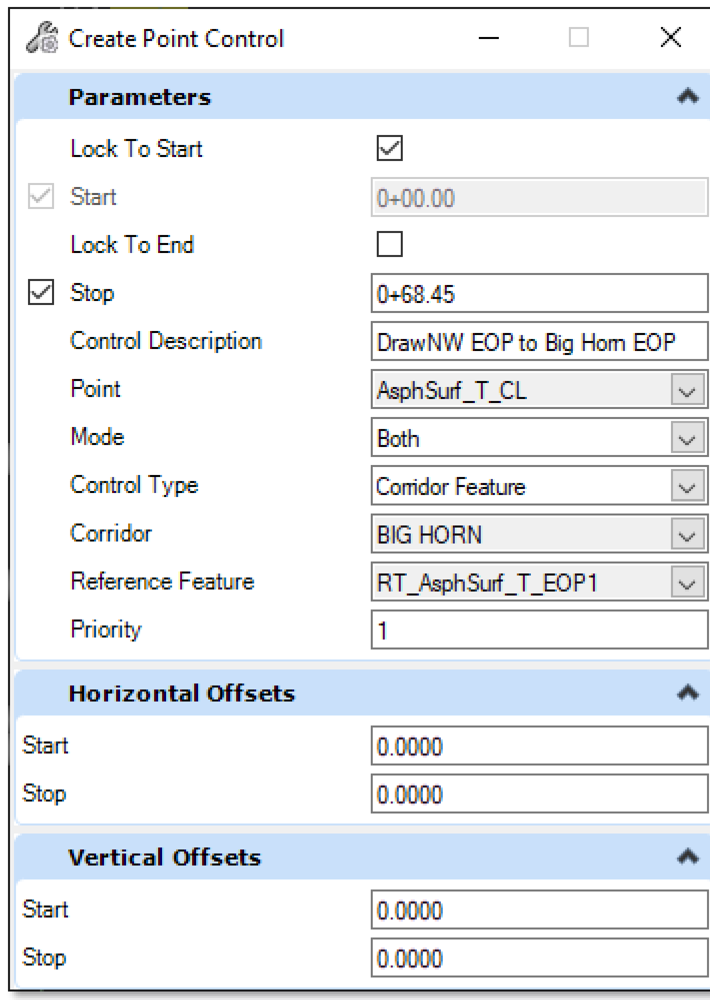


54. Using the heads-up prompts on the **NW Linear Template** grips, select the **Corridor Creation Tools ➔ Point Controls**



Fill out Point Control dialog as shown below:

Start Station:	**Lock to Start**
Stop Station:	**0+68.45**
Control Description:	**Draw NW EOP to Big Horn EOP**
Point:	**AsphSurf_T_CL**
Mode:	**Both**
Control Type:	**Corridor Feature**
Corridor:	**Big Horn**
Reference Feature:	**RT_AsphSurf_T_EOP1**
Priority:	**1**
Start Horz. Offset:	**0**
Stop Horz. Offset:	**0**
Start Vertical Offset:	**0**
Stop Vertical Offset:	**0**

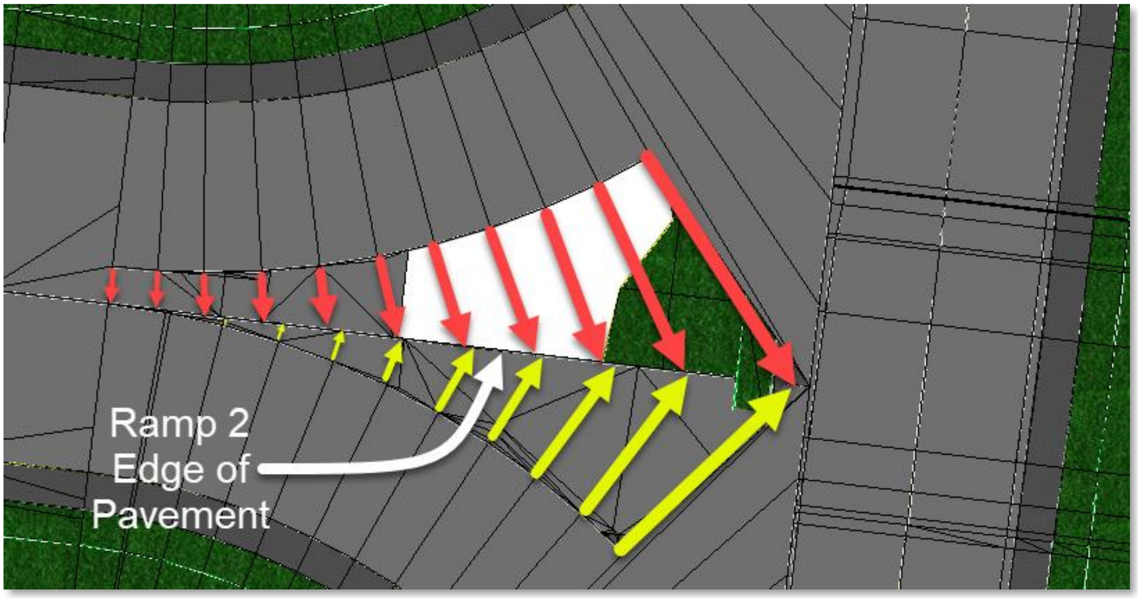


55. (**Individual Step**) Using the same steps in storing the **NW Linear Template**, that drew the **NW EOP** up to the **Big Horn EOP**. Create a **Linear Template** and then a **Point Control** for the **SW Radius Return** that does the same thing. (These steps started back on step 51).

Note: You will use the same Template that was used in the **NW Linear Template.**

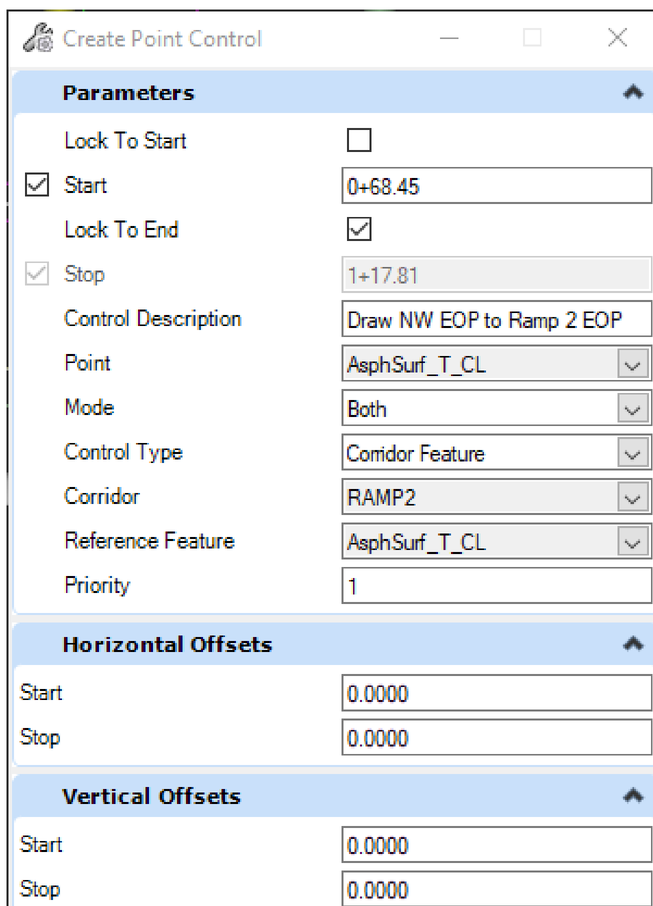
Radius Return Linear Templates draw to Ramp 2 Edge of Pavement

In the second part of modeling our **NW** and **SW Linear Templates** we are going to use another **Point Control** to draw the EOP up to the **Ramp 2 EOP** line.



56. Using the heads-Up prompts on the **NW Linear Template** grips, select the **Corridor Creation** tools ➔ **Point Controls.** Fill out dialog as indicated below:

Start Station:	**0+68.45**
Stop Station:	**Lock to End**
Control Description:	**Draw NW EOP to Ramp 2 EOP**
Point:	**AsphSurf_T_CL**
Mode:	**Both**
Control Type:	**Corridor Feature**
Corridor:	**Ramp 2**
Reference Feature:	**AsphSurf_T_CL**
Priority:	**1**
Start Horz. Offset:	**0**
Stop Horz. Offset:	**0**
Start Vertical Offset:	**0**
Stop Vertical Offset:	**0**



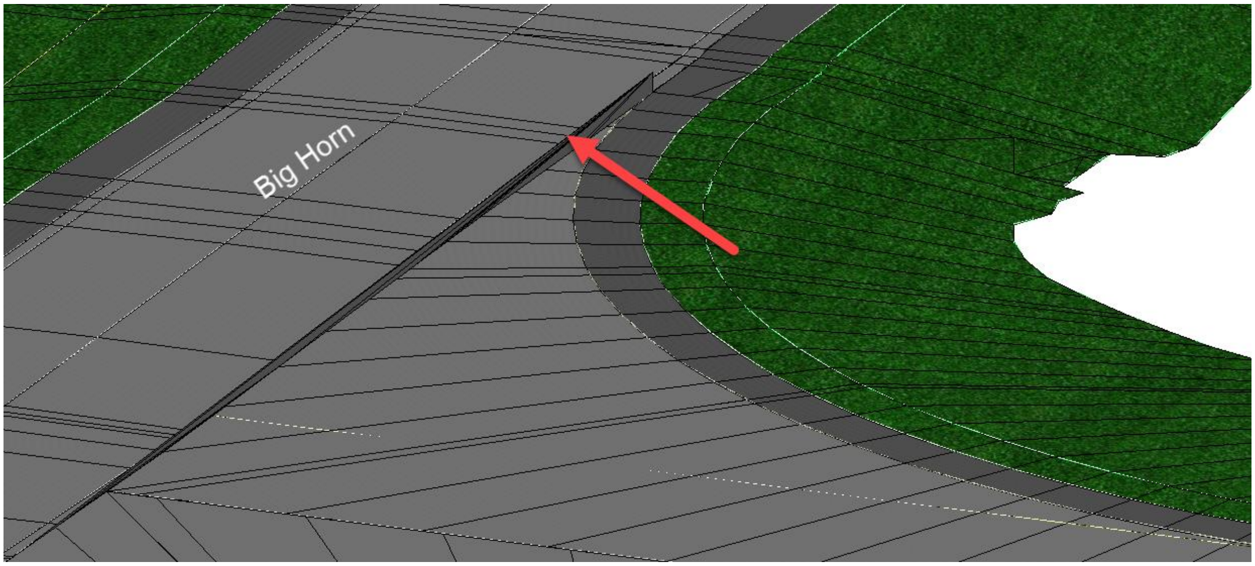
57. (**Individual Step**) Using the same steps in storing the **NW Linear Template**, that drew the **NW EOP** up to the **Ramp 2 EOP**. Create a **Point Control** for the **SW Radius Return** that does the same thing.

Hint:

Start Station:	**Lock to Start**
Stop Station:	**0+50.90**
Control Description:	**Draw SW EOP to Ramp 2 EOP**
Point:	**AsphSurf_T_CL**
Mode:	**Both**
Control Type:	**Corridor Feature**
Corridor:	**Ramp 2**
Reference Feature:	**AsphSurf_T_CL**
Priority:	**1**
Start Horz. Offset:	**0**
Stop Horz. Offset:	**0**
Start Vertical Offset:	**0**
Stop Vertical Offset:	**0**

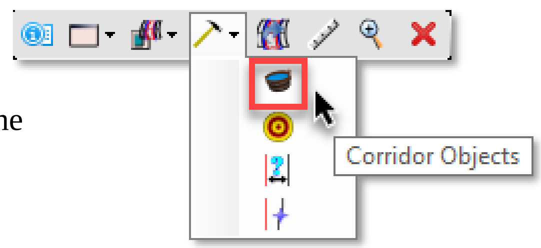
Modeling Bonus Steps:

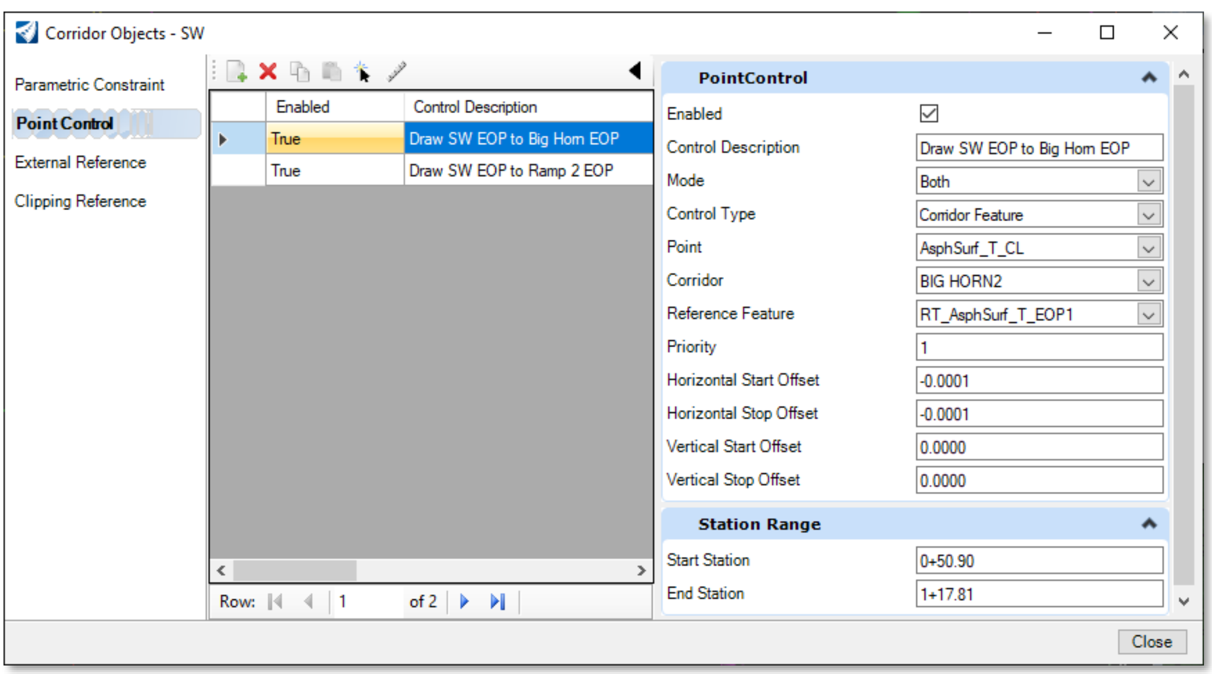
58. If your model has a vertical slice sticking up at the Big Horn EOP (see below)…



You may need to add a slight offset to the **SW Linear Template Point Control.** To do this select the **Corridor Objects** icon from the **SW Linear Template** heads-up tools.

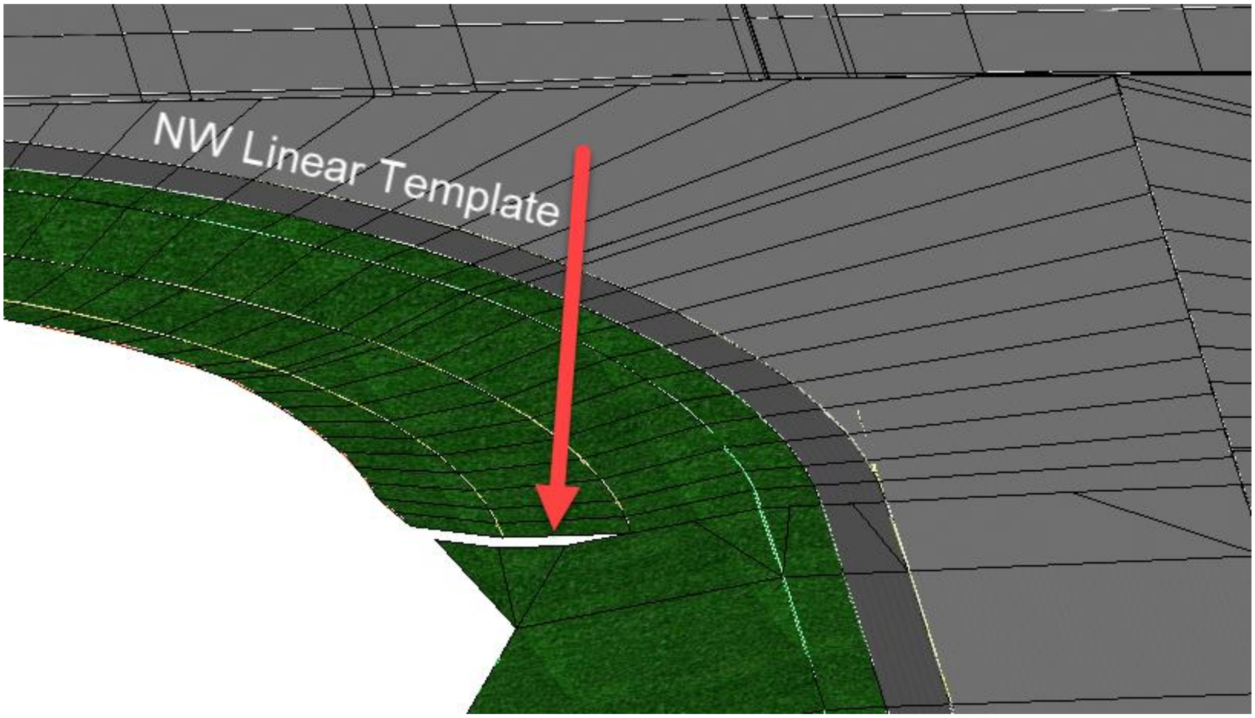
After selecting **Point Control** in the Corridor Objects dialog edit the **Big Horn EOP** Point Control. Add a **-0.0001 Horizontal Offset** to both the **Start** and **Stop Offset** (See Below).





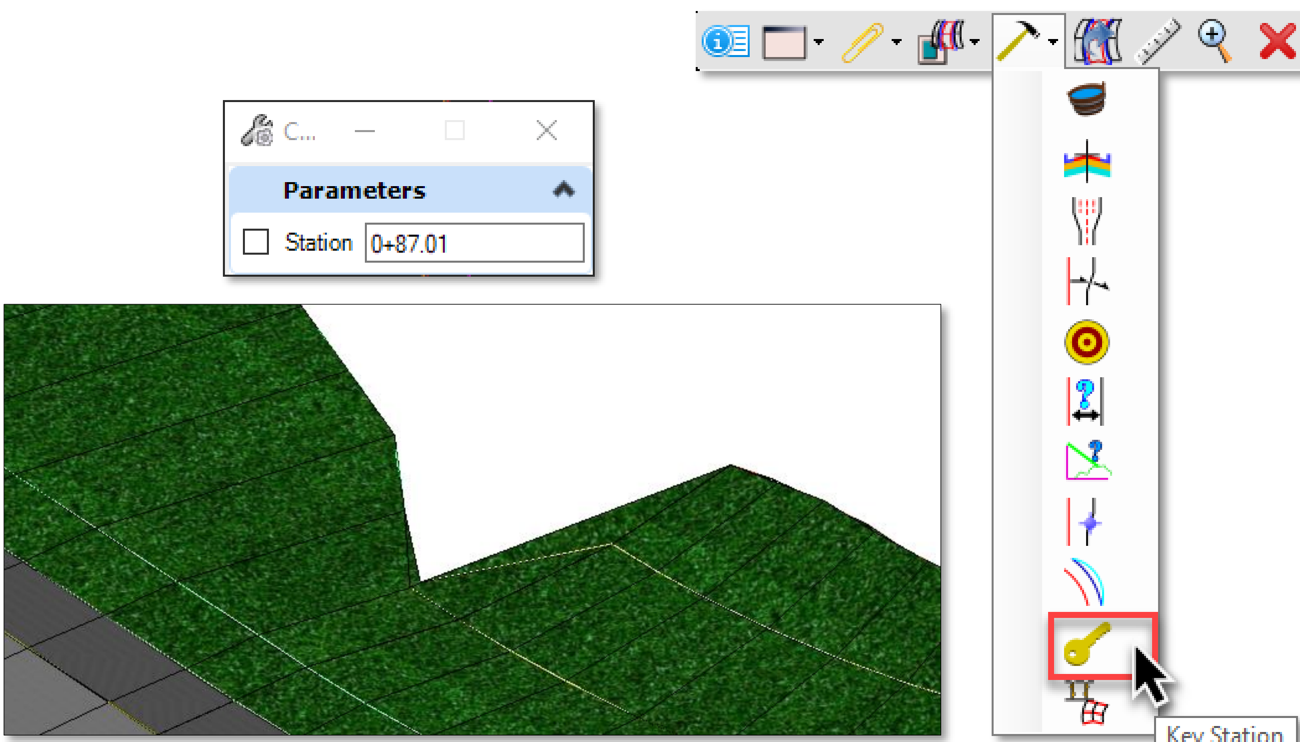
Modeling Bonus Steps (Continued):

59. If your model has a mismatched ditch between the **NW Linear Template** and the **Ramp 4 Corridor** (see below)…

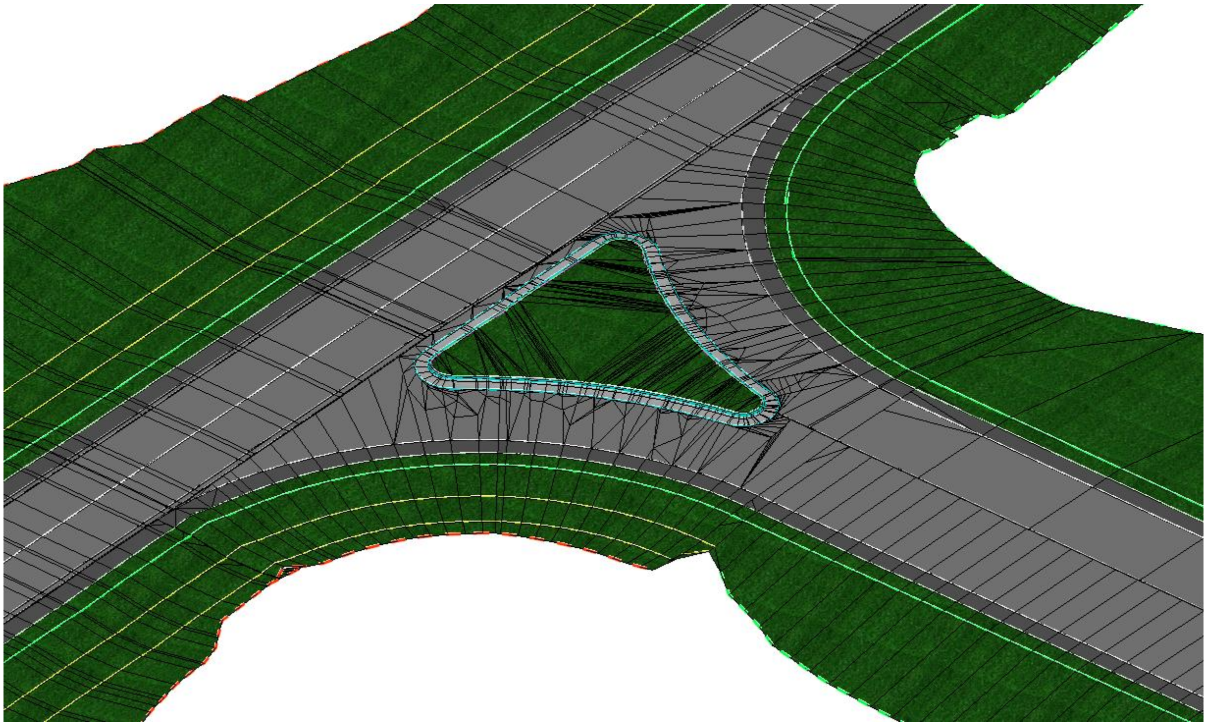


You may need to change the **Corridor Feature Definition** for the **Ramp 4 Corridor** from **0-Preliminary x5** to **1-Final x1.**

Also, from the **Ramp 4 Corridor** add in a **Key Station** at **0+87.01.**



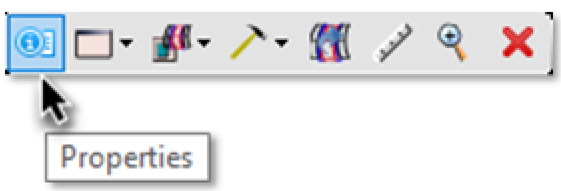
Creating a Right Turn Only Grassy Island

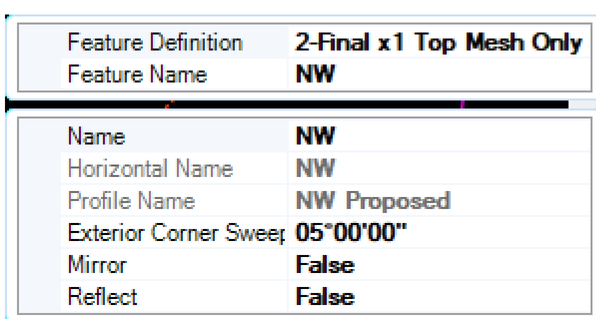


60. Open the **Cole/J5P0100/Roadway/data/Corridors_J5P0100.dgn** (If not in it already).

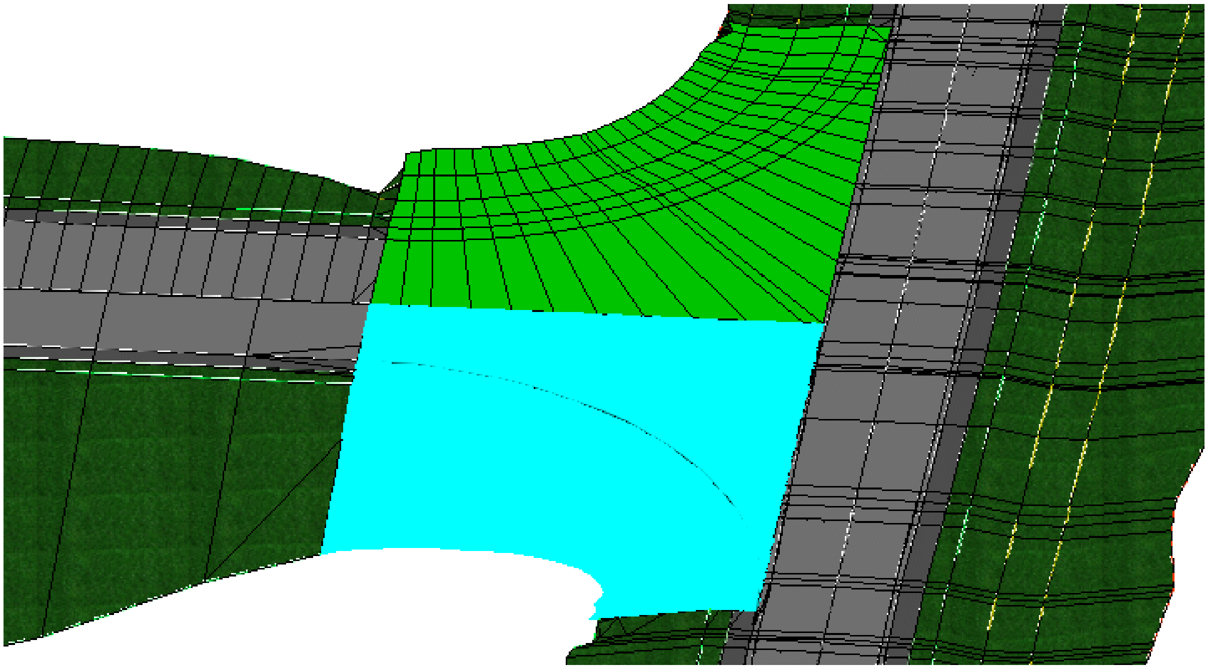
61. From the Corridors file, we will create a Terrain Surface from the **NW** and **SW Linear Templates** to use as a reference surface to create a profile for the island. **Press F6** to make sure the 3D window is open.

    Before we create the terrain, first switch the **NW** and **SW** Linear Template Feature Definition to **2-Final x 1 Top Mesh Only.** To do this you go into the **Properties** of the Linear Template.



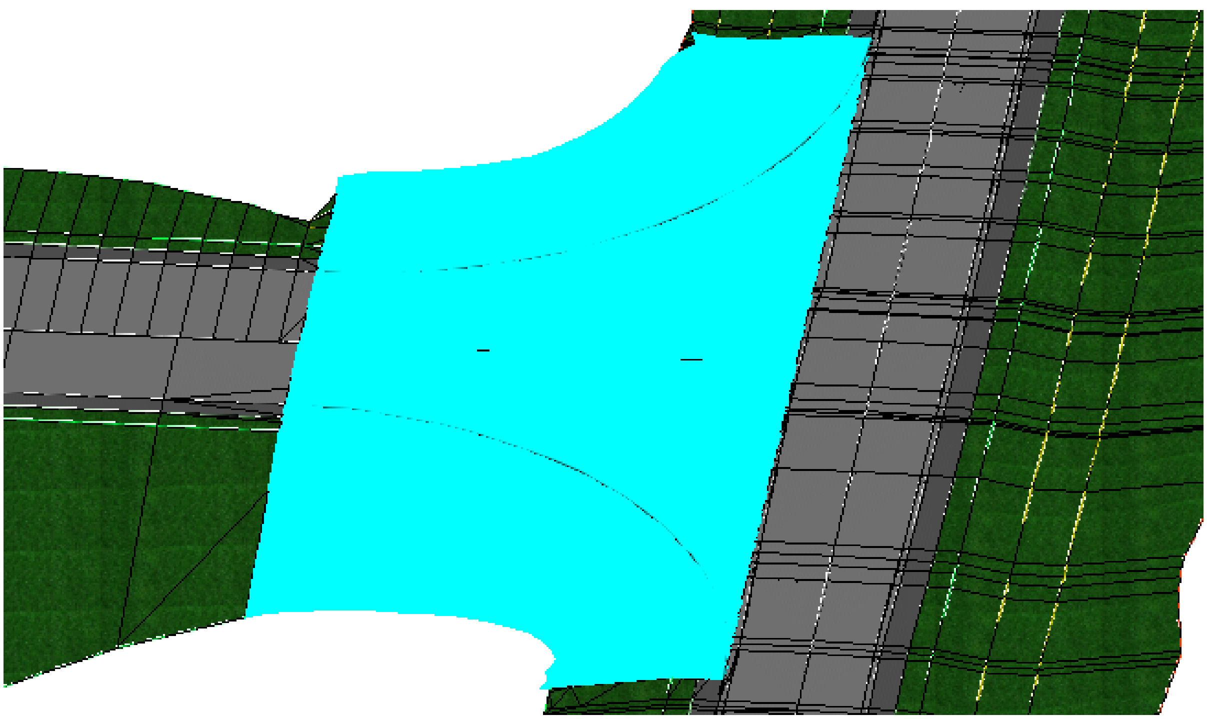


62. Within the **3D Model** and a **Top View** first select the **SW** Radius Return Linear Template.



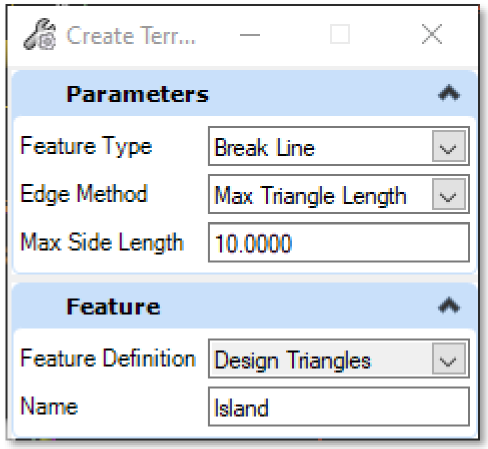
The corridor road surface highlights.

63. Next, select the NW Radius Return Linear Template.



64. To create the Terrain, select the **From Elements** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Terrain** Tab ➔ **Create** Section.

    Fill out the dialog as follows:



    Left-Click to accept two previously selected elements.

    Left-Click to accept the option of **Breakline** for the type.

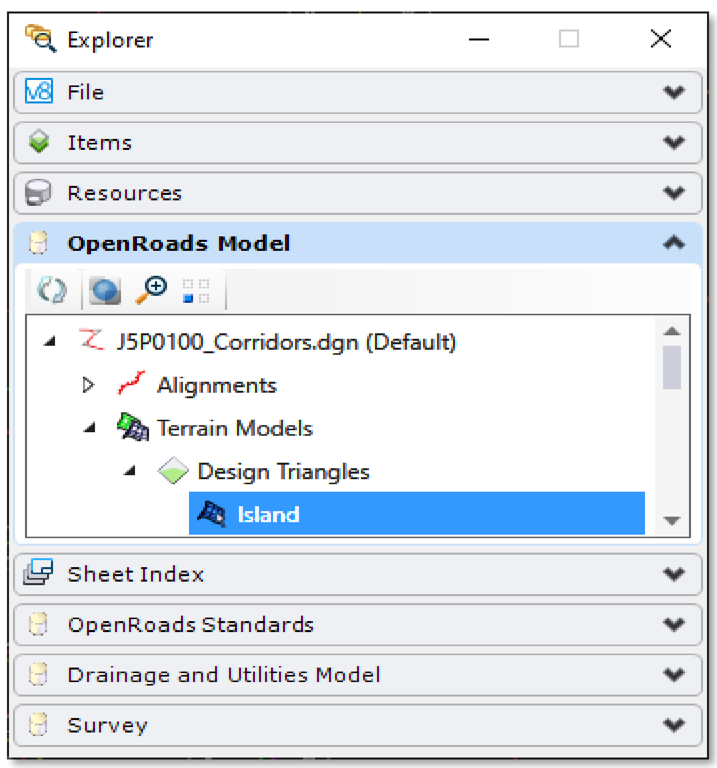
    For Edge Method: **Max Triangle Length** of **10**

65. Press **F4** to clear out the tool.

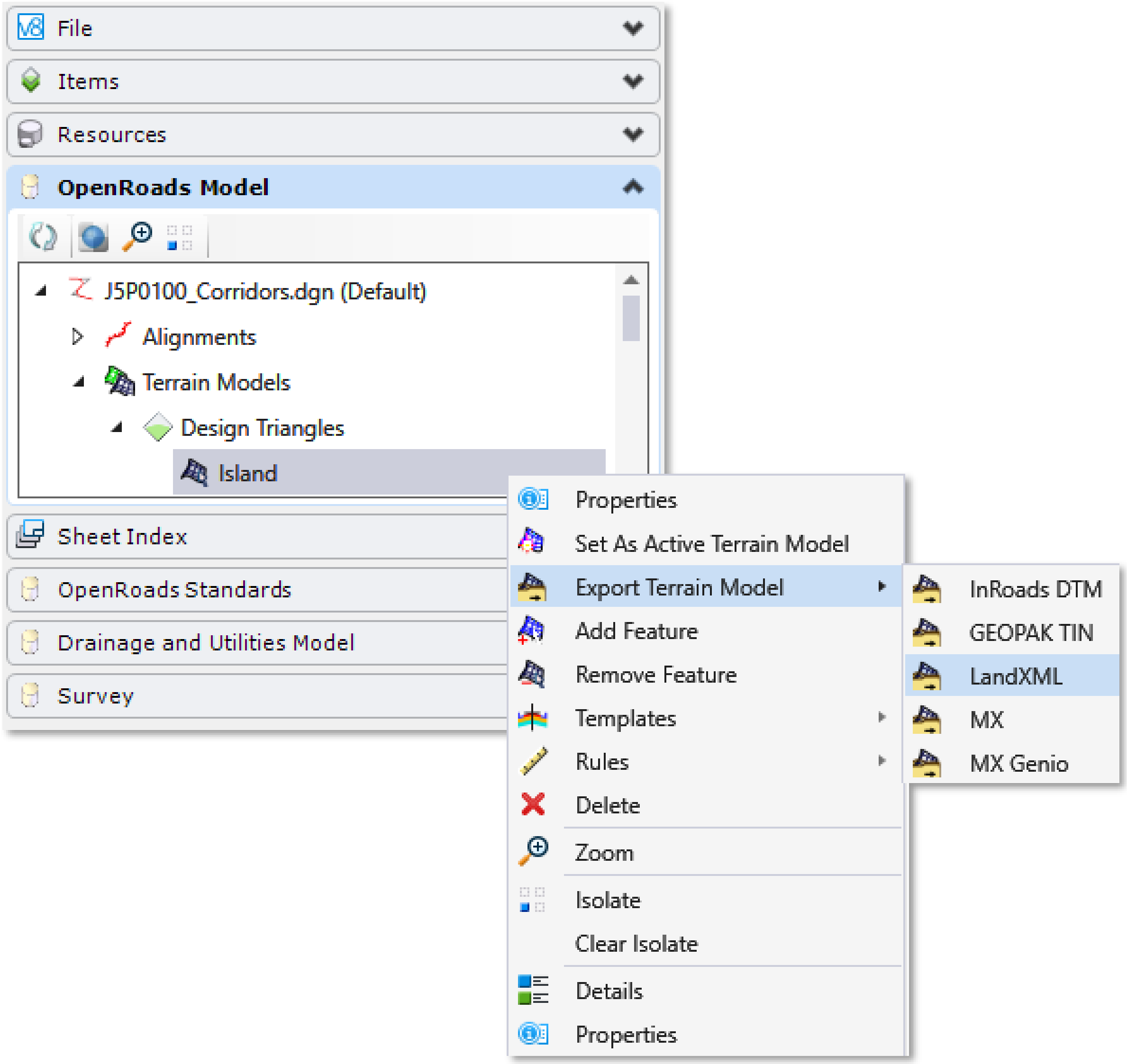
66. Next, we are going to **export** the terrain to a new file via an **XML** file. To export the file to XML we are going to utilize the **Explorer** Tool.

    To open Explorer, select the **OpenRoads Modeling** Workflow ➔ **Home** Tab ➔ **Primary** Section.

67. Within **Explorer** select the **OpenRoads Model** section:

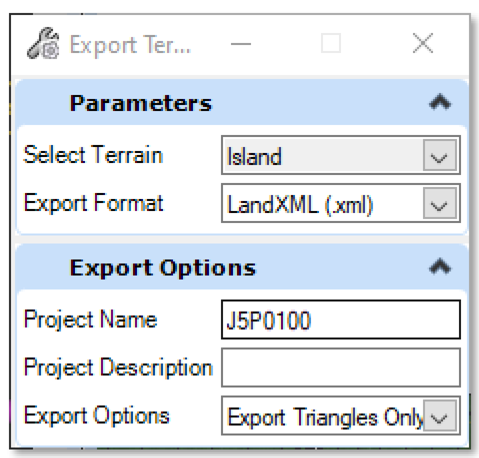


68. Right click on the Island Terrain model and select **Export Terrain Model → LandXML**



69. Fill out the Export Terrain to LandXML dialog as follows:

Select Terrain:	Island
Export Format:	LandXML (.xml)
Project Name:	(Optional) use J5P0100
Project Description:	(Optional)
Export Options:	Export Triangles Only



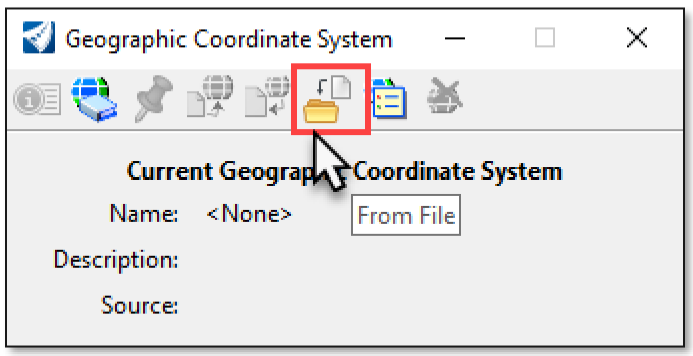
70. Once exported, delete the **Island** Terrain in the **Corridors_J5P0100.dgn** file. Also switch the **Linear Template Feature** back to **1-Final x 1**.

71. Next, we are going create a new dgn file to store our **Island** Terrain.

    Create a new dgn file named **Terrain_Proposed_J5P0100.dgn** using the **MoDOT_Roadway_Seed_3D.dgn** seed file.

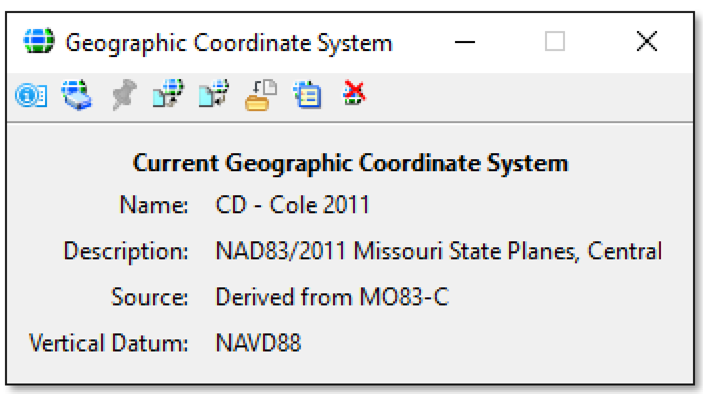
72. Open the **Coordinate System** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Utilities** Tab ➔ **Geographic** Section.

73. Select "**From File**" icon.

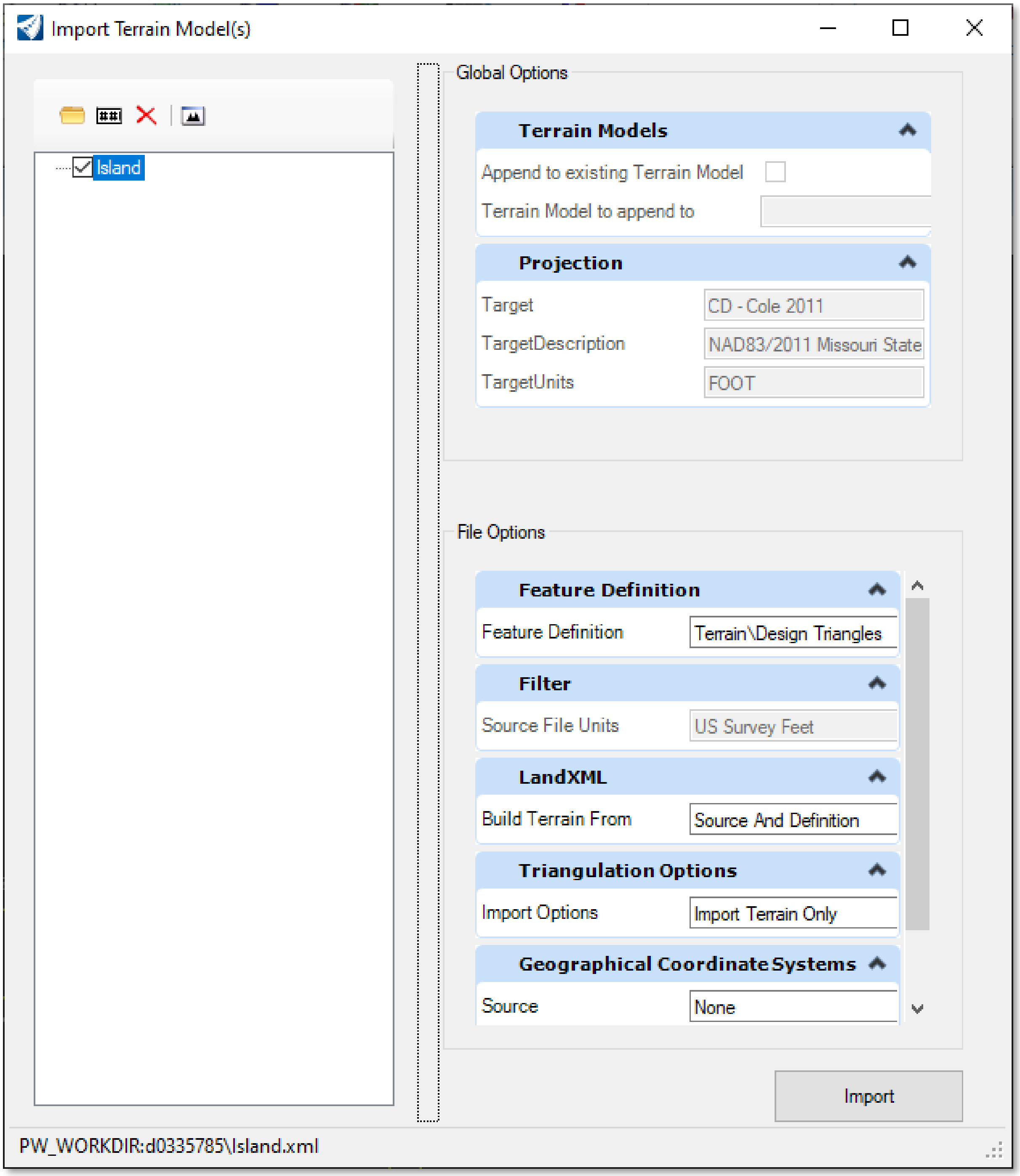


74. Select the **Terrain_Existing_J5P0100.dgn** file in the **data** folder.

75. Verify the settings.



76. In this step we are going to import the Terrain Model. To open the **Create from File** tool select the **OpenRoads Modeling** Workflow ➔ **Terrain** Tab ➔ **Create** Section. Fill out the dialog as follows and select **Import**:



LandXML Import Options

- **Definition -** Utilizes the stored triangulated faces to define the Terrain
- **Source -** Utilizes survey features such as breaklines, voids and points, then triangulates.
- **Source and Definition** (default) Utilizes both in creating the terrain.

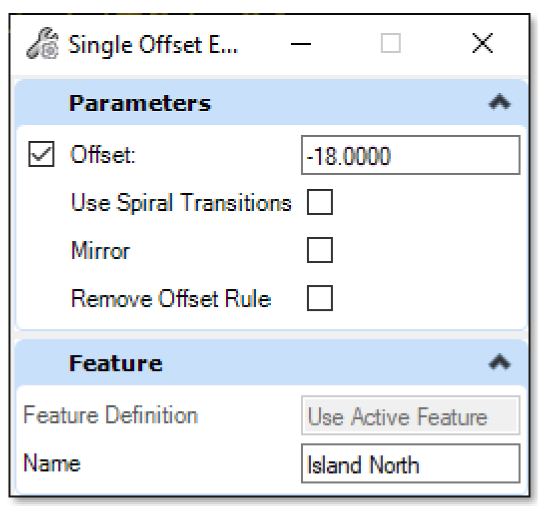
Notes: These import options are unique to LandXML files. **Best Practice** on which **LandXML Build Terrain From** Option to use:

- The method used will usually depend on the file and the situation.
- If you do not want to re-triangulate (i.e. you want to duplicate the triangles from the terrain that generated the LandXML file), then use the **Definition** method.
- Otherwise, the default (and recommended method) is to use **Source and Definition**. This does re-triangulate, but uses both triangles **and** source data to produce a "best" triangulation.

2017 Bentley OpenRoads Designer Best Practice – Terrain Modeling

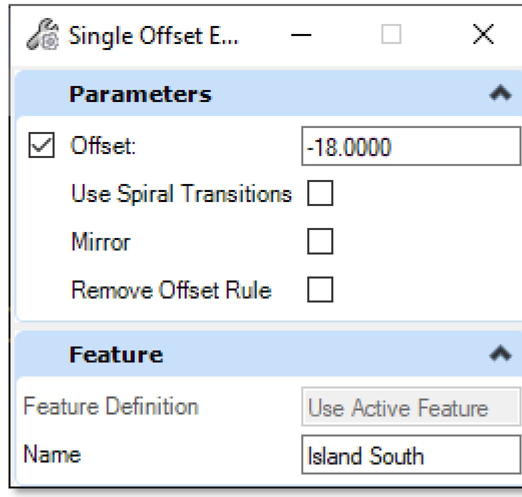
77. Open the **Cole/J5P0100/Roadway/data/Civil_Geometry_J5P0100.dgn**
78. Using the **Feature Definition Toggle Bar** set the Feature Definition to **Island (New)** (located under **Linear ➔ Design ➔ Roadway**) and toggle on **Use Active Feature Definition**.
79. To help create the limits of the Island we are going to use the **Single Offset Entire Element** tool. To do this select the **OpenRoads Modeling** Workflow ➔ **Geometry** Tab ➔ **Horizontal** Section ➔ **Offset and Tapers** tools. Select the **NW Radius Return** to off set the line toward the intersection.

Offset:	-18
Use Spiral Transitions:	No
Mirror:	No
Remove Offset Rule:	No
Feature Definition:	Island (New)
Name:	Island North



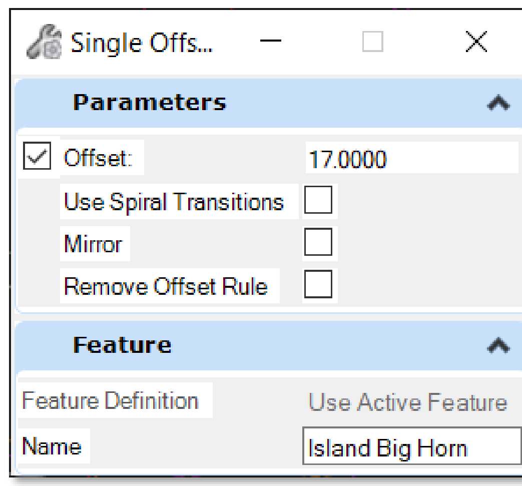
80. Repeat the **Single Offset Entire Element** tool for the **SW Radius Return**. Offset the line toward the intersection.

Offset:	-18
Use Spiral Transitions:	No
Mirror:	No
Remove Offset Rule:	No
Feature Definition:	Island (New)
Name:	Island South



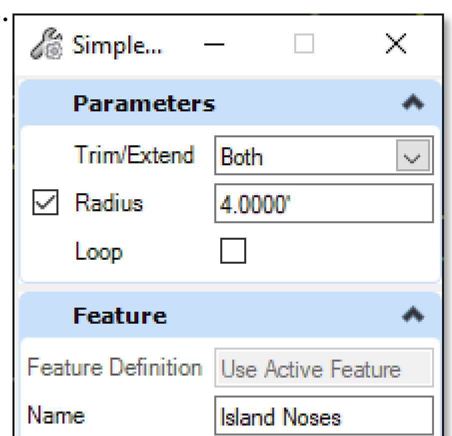
81. Repeat the **Single Offset Entire Element** tool, one more time, for the **Big Horn** baseline. Offset the line toward the **West** (away from the Big Horn centerline).

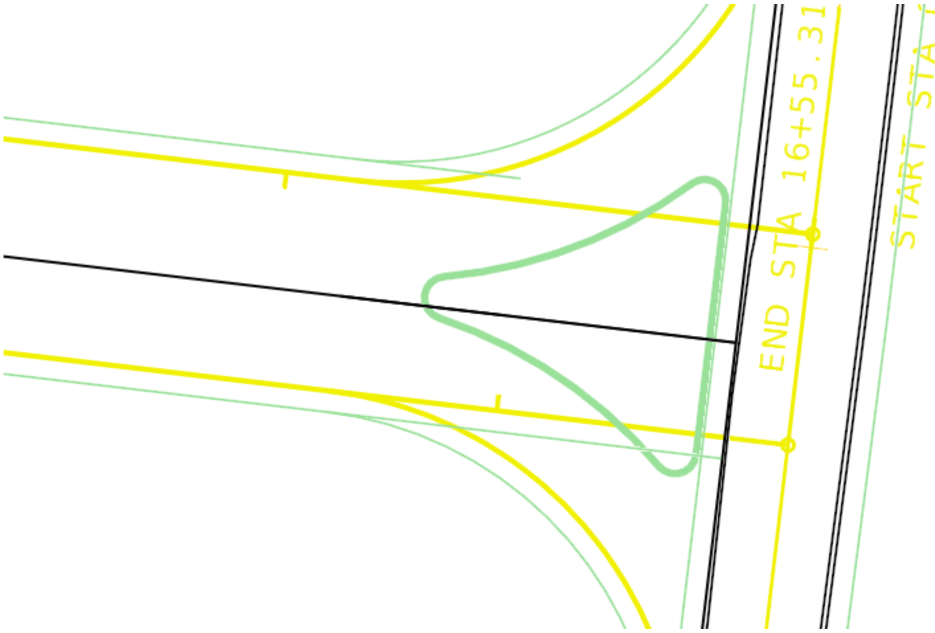
Offset:	17
Use Spiral Transitions:	No
Mirror:	No
Remove Offset Rule:	No
Feature Definition:	Island (New)
Name:	Island Big Horn



82. To help round the corners of the Island we are going to use the **Simple Arc** tool. To do this select the **OpenRoads Modeling** Workflow ➔ **Geometry** Tab ➔ **Horizontal** Section ➔ **Arcs** ➔ **Arc Between Elements** tools.

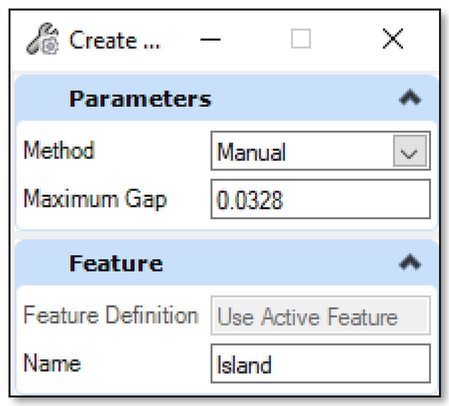
Trim Extend:	Both
Radius:	4 feet
Loop:	No
Feature Definition:	Island (New)
Name:	Island Noses





83. Next, we are going to **Create** a **Complex Element** around the island to make it one piece. To do this use the **Complex by Elements** tool located under the **OpenRoads Modeling** Workflow ➔ **Geometry** Tab ➔ **Horizontal** Section ➔ **Complex Geometry** tools.

Method:	Manual
Max Gap:	Use Default (0.0328)
Feature Definition:	Island (New)
Name:	Island



a. Click each line/arc that makes up the island. Make sure each arrow points in the clockwise direction. (Manual option makes sure the elements all go in the correct direction).

b. Accept the last element in a blank area with a **Left Click**.

84. Reference within the **Default 2D Model** the following file:

Terrain_ Proposed_J5P0100.dgn

85. Open the **Island's Profile Model** in **Window 8.**

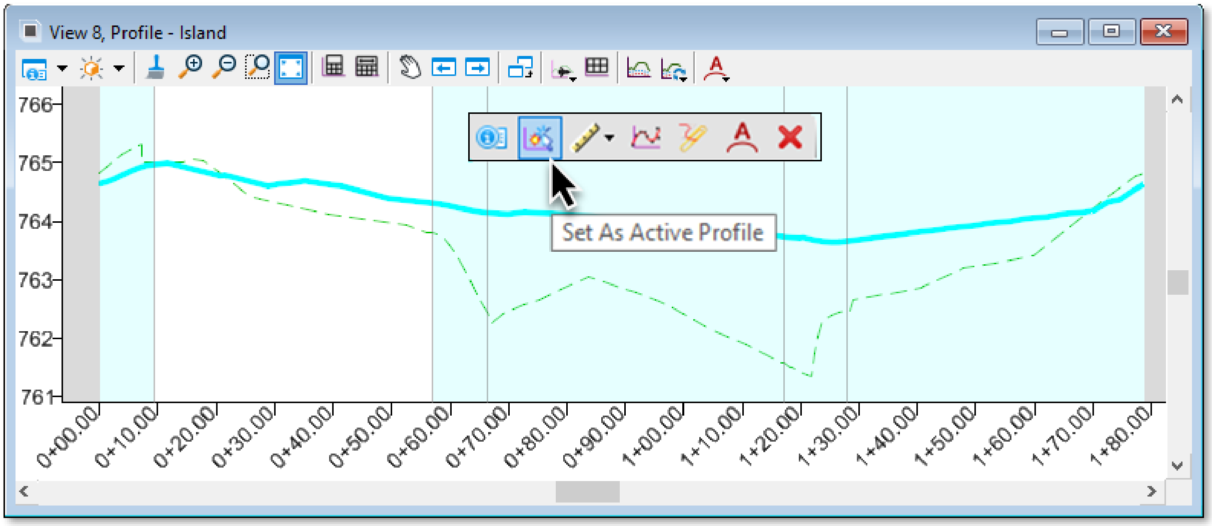
86. Next, we are going to create a **Profile** from the **Island** Terrain Model created earlier. To do this use the **Quick Profile from Surface** tool located under the **OpenRoads Modeling** Workflow ➔ **Geometry** Tab ➔ **Vertical** Section ➔ **Profile Creation** tools.

    a. For ***Locate Reference Element***, Left Click on the **Island** Complex Element.

    b. For ***Locate Reference Surface***, choose the **Island** Terrain Model.

    The profile is automatically created.

87. Left Click on the new **Island** profile (**solid light green line**), then name it **Island Proposed** and set it **Active**.



88. Open the Cole/J5P0100/Roadway/data/**Corridors_J5P0100.dgn**

89. Make sure you can see the new **Island** geometry, if you don't see the Island, use the **Level Display** to visualize the Island elements, **Level** ➔ **Roadway Safety**.

90. To help the Island draw to the **Proposed "Island" Surface** created back on **Step 71**, reference within the **Default 2D Model** the following file:

    Terrain_Proposed_J5P0100.dgn

91. Open the **Create Template** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Corridors** Tab ➔ **Create** Section ➔ **Template** tools.

92. From the Corridor tools click on the **Create Template** tool

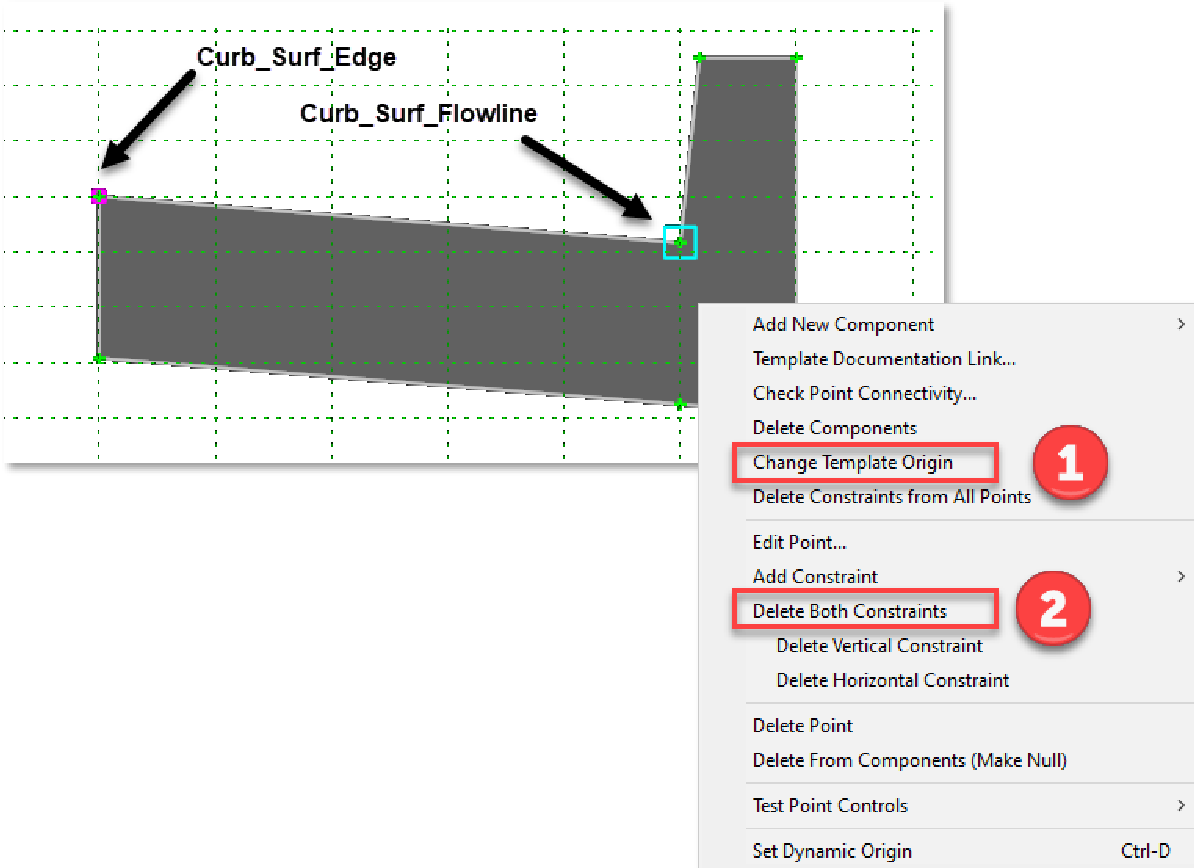
    Make sure the **J5P0100.itl** is open, if not, click **File** ➔ **Open** and select:

    Cole/J5P0100/Roadway/data/**J5P0100.itl**

93. From the **Components** ➔ **Curb and/or Gutter** folder, copy the **Curb and Gutter Type B** to the J5P0100 ➔ **Ramps** folder.

94. **Double-click** on the newly copied **Curb and Gutter Type B** to open it in the editor window.

95. Change the template origin to be the **Curb_Surf_Flowline** point and remove the constraints on the gutter point. Simply Right-Click on the **Curb_Surf_Flowline** point and choose the **Change Template Origin**.

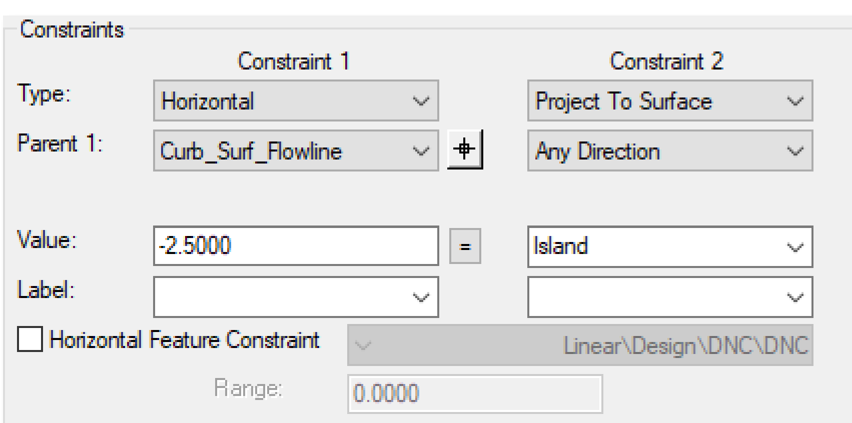


96. Zoom to the left of the template and locate the **Curb_Surf_Edge** point. **Double-click** on this point.

Set the Point Constraints to the following:

Constraint 1:	**Horizontal**
Parent 1:	**Curb_Surf_Flowline**
Value**:**	**-2.5000**

Constraint 2:	**Project to Surface**
Parent 1:	**Any Direction**
Surface:	**Island**



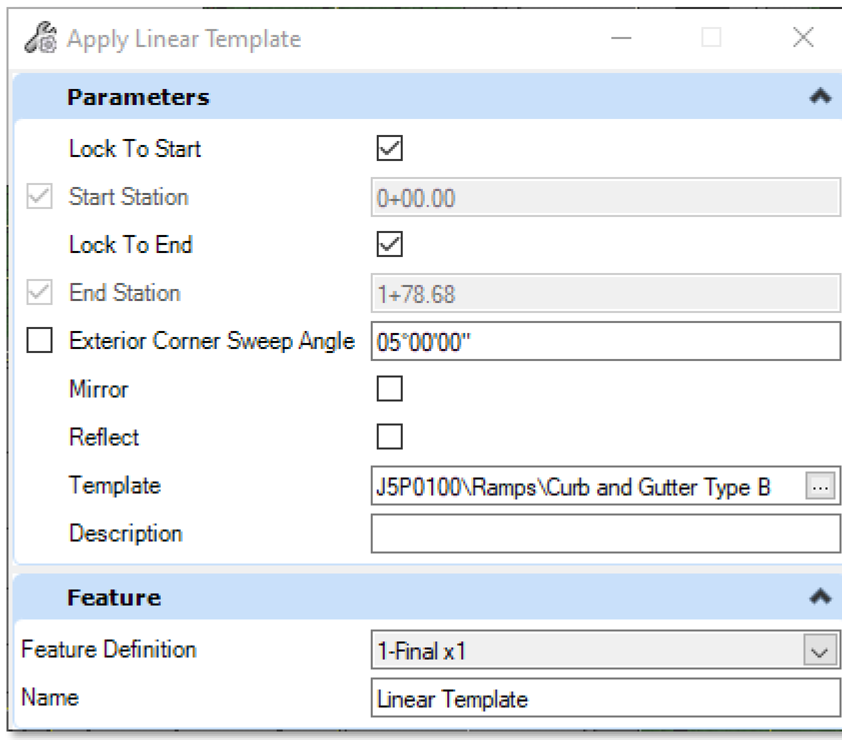
97. Run the **Test** when finished to see the Edge rise and fall with the surface.

98. **Close,** then **Save** changes to the **J5P0100.itl,** and then **Check-In**.

99. Select the **Island** geometry and bring up it's heads up tools and select **Apply Linear Template**.

100. Fill out the **Apply Linear Template** dialog as follows:

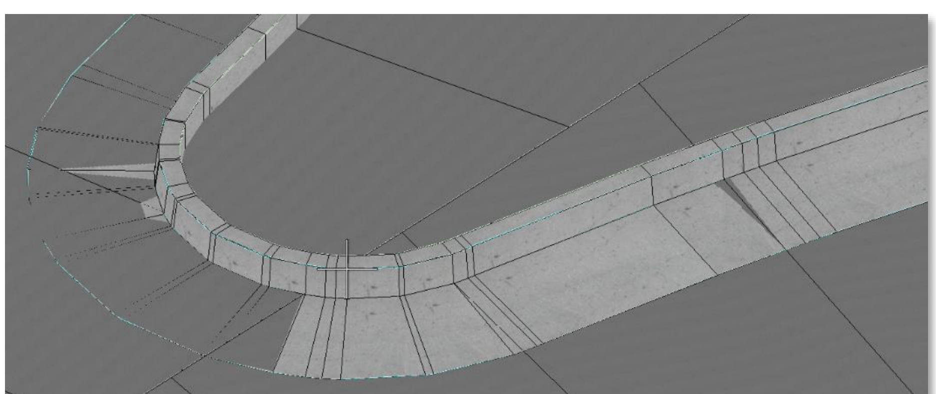
Lock to Start:	Check
Lock to End:	Check
Exterior Corner Sweep Angle:	5
Mirror:	No
Reflect:	No
Template:	Curb and Gutter Type B
Description:	Optional
Feature Definition:	1-Final x 1
Name	Island



101. Press **F4** to clear out the tool.

102. Press **F6** if the **Default-3D** window is not showing.

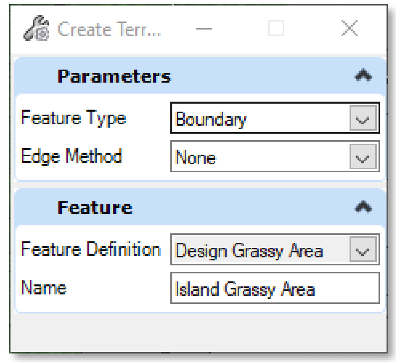
At this point, the 3D model should show the new island.



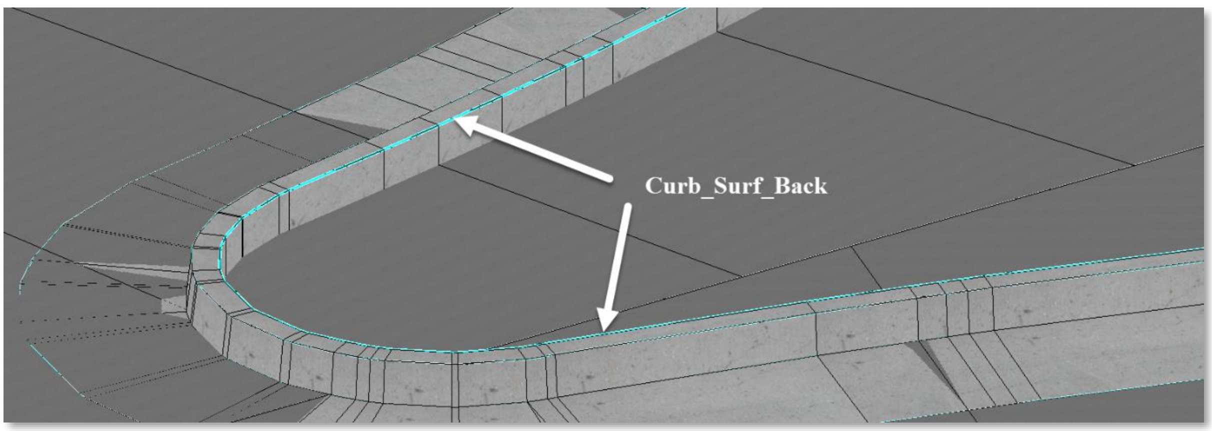
Next, we will add a grass top to the island.

103. Make the 3D view active, open the tool from Terrain Model tools, **Create from Elements**

Featue Type:	Boundary
Edge Method:	None
Feature Definition:	Design Grassy Area
Name	Island Grassy Area

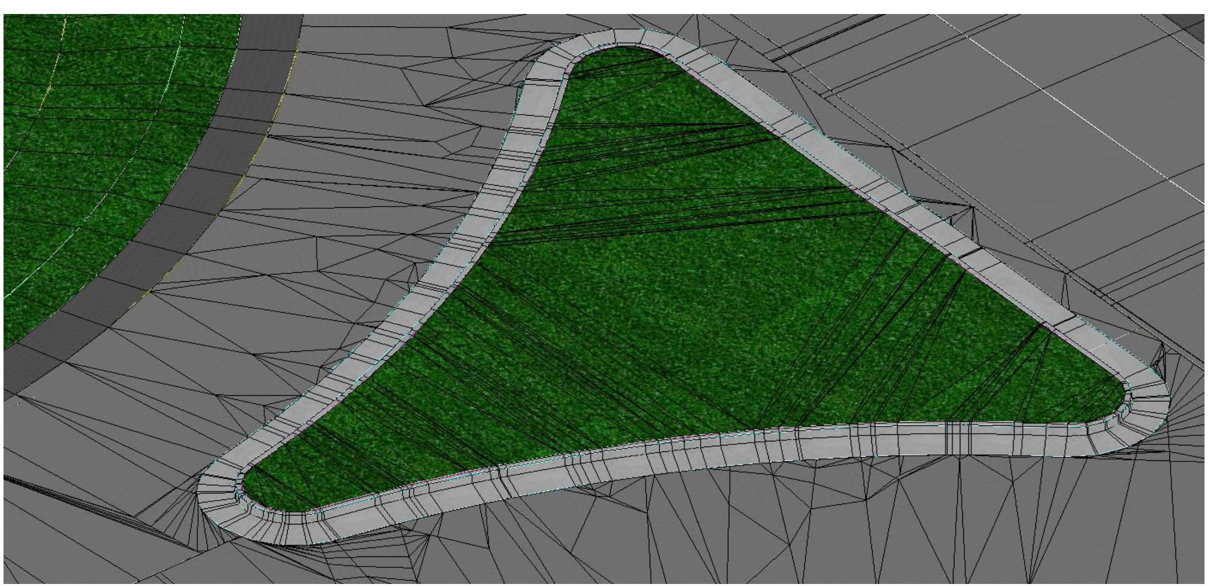


For *Locate Element to Add*, **Left-Click** the 3D line along the top inside edge of the curb (**Curb_Surf_Back**).



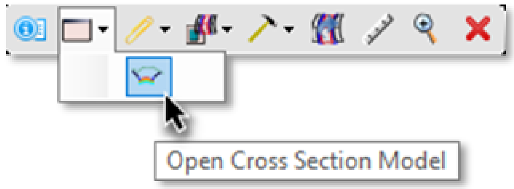
104. For *Locate Next Element*, **zoom out** to see a blank area, **Right-Click** in the <u>blank area of the **Default 2D View**</u>.

105. **Left-Click** to the prompts to accept all the values already entered in the dialog.

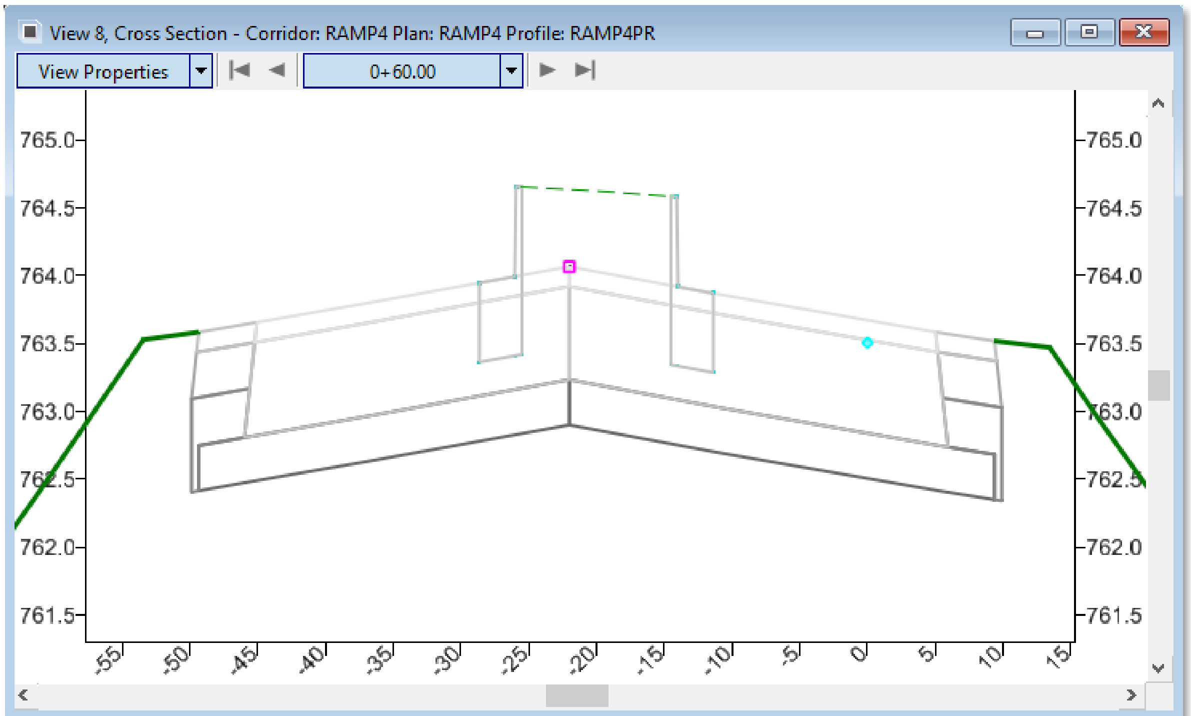


After the island is placed, let's look at the dynamic cross sections for the **Ramp-4** Corridor.

106. Left-Click on the **Ramp-4** Corridor Grip and bring up the heads-up tools.

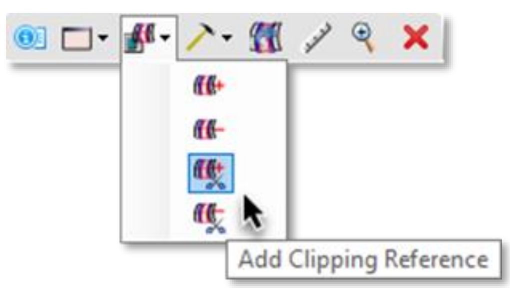


107. Open **Window 8** and left click in the window to display the Dynamic XS View.

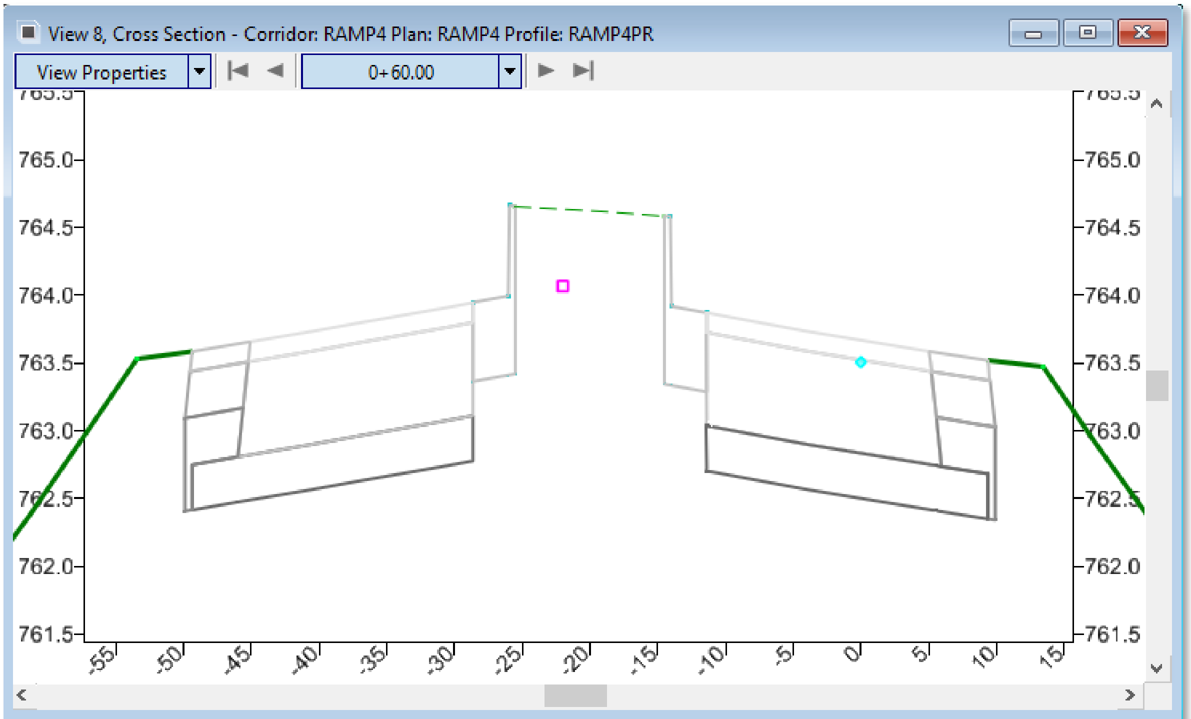


108. To clip the pavement area out below the Island let do the following:

Select the **SW** and **NW** Radius Return **Liner Templates** and Add a **Clipping Reference** and select the **Island Linear Template** as the Reference.



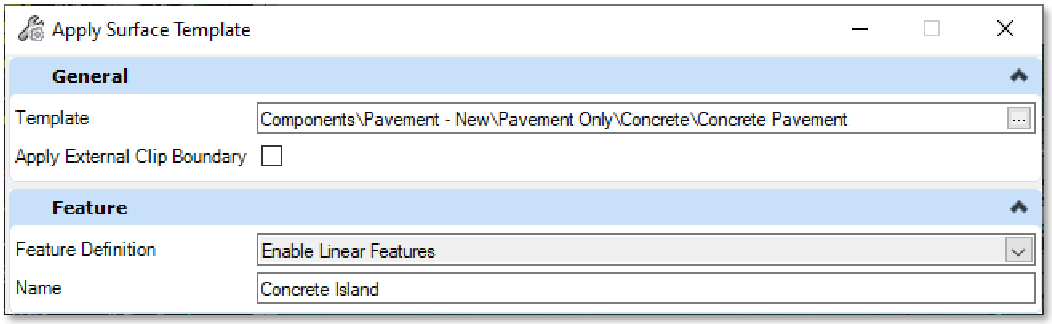
Below is what the **Ramp 4 Dynamic XS View** should look like after the **Clipping References** have been applied:



Remove Grassy Island for Concrete Island

109. First, we need to turn off the Triangles of the Grassy Area. If we don't the grassy area will still bleed through the newly placed pavement. The Grassy Island Terrain Model resides withing the 3D view, withing that view turn off the Triangles of the Island Grassy Area,

110. Using the **Apply Surface Template** tool located under the **OpenRoads Modeling** Workflow ➔ **Model Detailing** Tab ➔ **3D Tools** Section ➔ **Surface Template** tools.



a) For the Template select the following from the MoDOT section of the Template Library (itl):

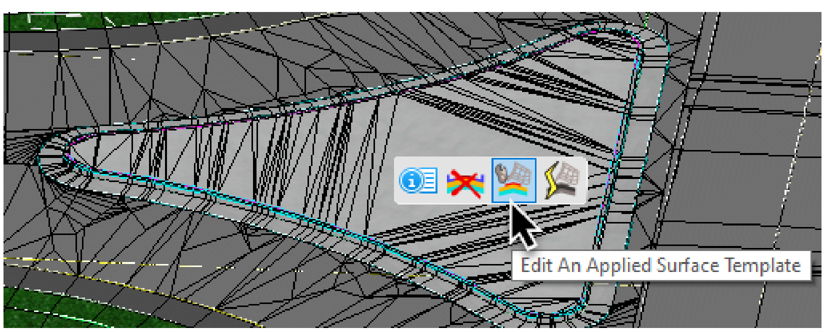
Components\Pavement - New\Pavement Only\Concrete**Concrete Pavement w/ Rock Fill Base**.

b) Do not **Apply an External Clip Boundary**
c) Select **Enable Linear Features**
d) Name the Surface Feature **Concrete Island**

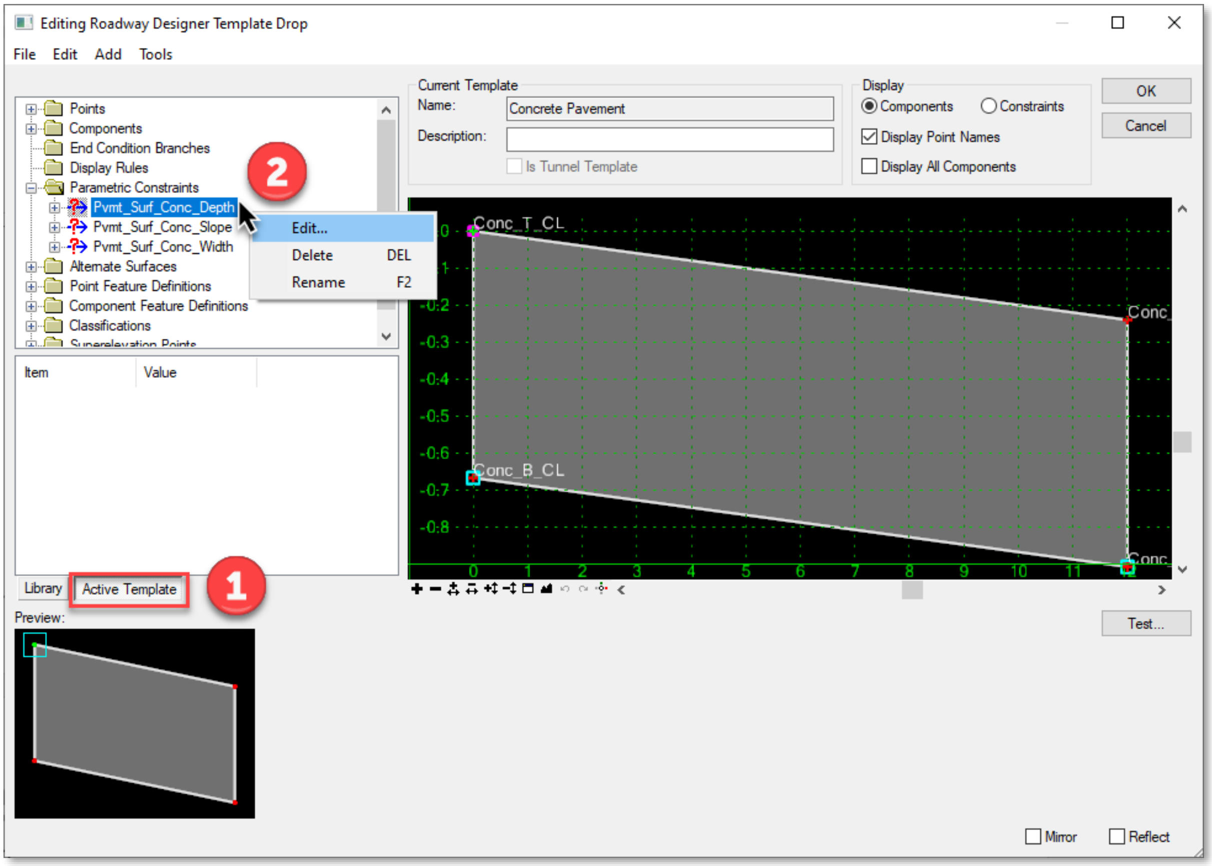
Notes:
Apply External Clip Boundary will limit the area the Surface Template within a User selected closed area/element.

Enable/Disable Linear Features will tell the program to either plot all the **Mesh** Layers of the Template (Enable), or just the Surface **Mesh** Layer (Disable).

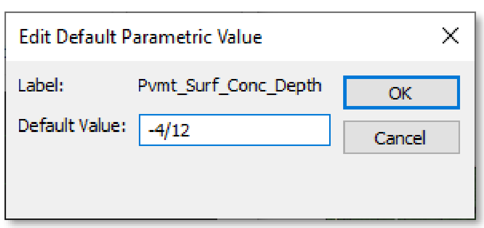
111. **Edit** the newly applied **Surface Template.**



112. When the Template window opens select the **Active Template** Tab. Then open the **Parametric Constraints** folder and **right-click** on the **Pavt_Surf_Conc_Depth** and select **Edit**.

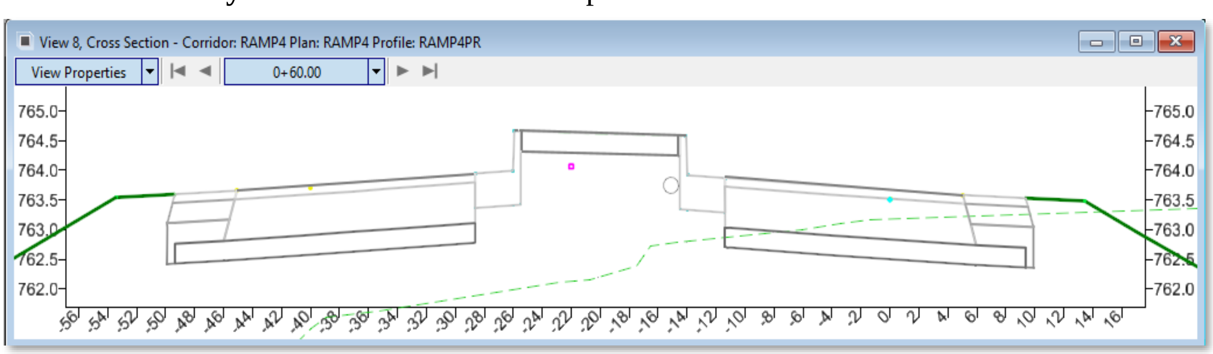


113. Change the Default value to -4 inches by typing in **-4/12** and then select **OK.**



114. Select **OK** to the **Editing Roadway Designer Template Drop** dialog.

115. **Review** the **Dynamic XS Model** for the updated Concrete Island.



Sight Visibility Tools

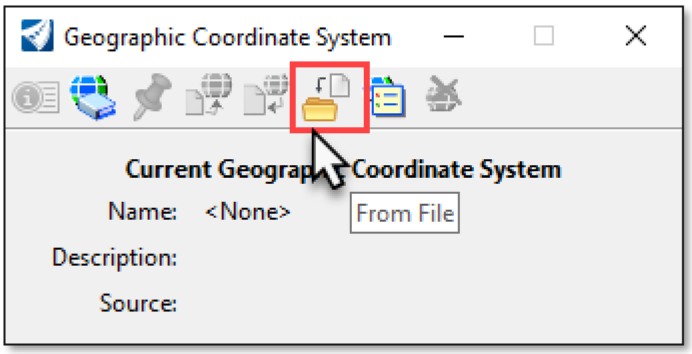
116. Create a new dgn file named **Site_Visability_J5P0100.dgn** using the:

MoDOT_Roadway_Seed_2D.dgn seed file.

Note: This new file will hold all the Site Lines for this Project.

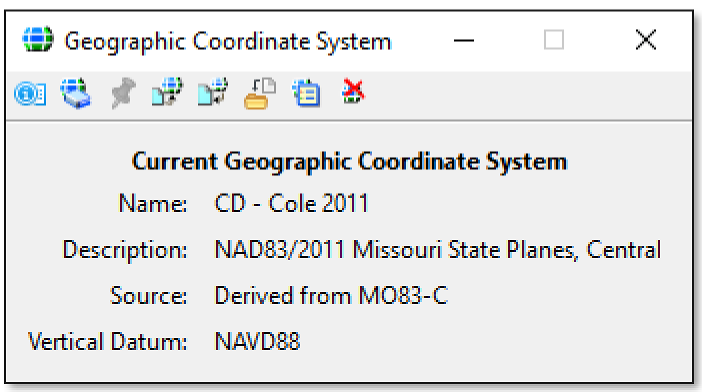
117. Open the **Coordinate System** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Utilities** Tab ➔ **Geographic** Section.

118. Select "**From File**" icon.



119. Select the **Terrain_Existing_J5P0100.dgn** file in the **data** folder.

120. Verify the settings.



121. Reference in the following files within the **Default 2D Model**:

Civil_Geometry_J5P0100.dgn
Corridors_J5P0100.dgn
Terrain_Existing_J5P0100.dgn

122. Fit View, change the Annotation Scale to **1"=50', and** set the Existing Terrain as **Active**.

123. Open **View Attributes** and turn-on **Line Weight**. This will help with visualizing the Site Lines that are drawn in the 2D Default View.

124. Select **F6** key to open the Multi-Model Views.

Sight Visibility Tools

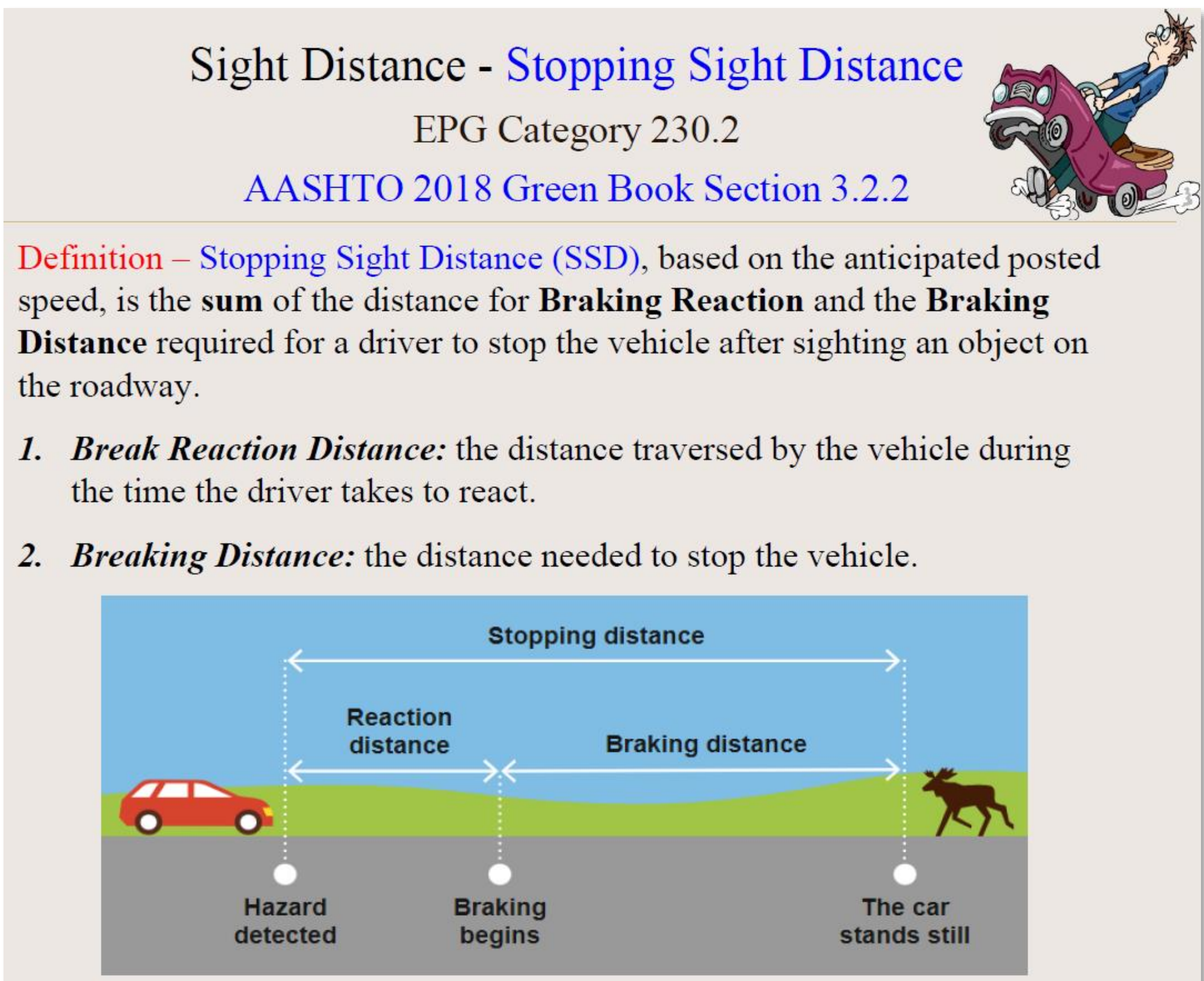
Recently **OpenRoads Designer** added a **Sight Visibility** tools that analyzes a corridor and/or terrain to display what can be seen and not seen along a given line of sight.

It uses the **Stopping** and **Passing Sight Distance** listed in **AASHTO Green Book 2018 and MUTCD 2009**.

The Sight Visibility Tools can use a **pre-defined** Settings file to define the lengths of visibility. For MoDOT Users that setting file is called:

MoDOT-Sight Visibility Tables and Equations.xml

The Sight Visibility Tool uses a **Height of Eye** Position of **3.50 feet** and a **Height of Object** of **2.0 feet**, as defined in the setting file.



Sight Distance - Stopping Sight Distance

EPG Category 230.2

AASHTO 2018 Green Book Section 3.2.2

AASHTO Table 3-1. Stopping Sight Distance **on Level Roadways**

U.S. Customary				
Design Speed (mph)	Brake Reaction Distance (ft)	Braking Distance on Level (ft)	Stopping Sight Distance	
			Calculated (ft)	Design (ft)
15	55.1	21.6	76.7	80
20	73.5	38.4	111.9	115
25	91.9	60.0	151.9	155
30	110.3	86.4	196.7	200
35	128.6	117.6	246.2	250
40	147.0	153.6	300.6	305
45	165.4	194.4	359.8	360
50	183.8	240.0	423.8	425
55	202.1	290.3	492.4	495
60	220.5	345.5	566.0	570
65	238.9	405.5	644.4	645
70	257.3	470.3	727.6	730
75	275.6	539.9	815.5	820
80	294.0	614.3	908.3	910
85	313.5	693.5	1007.0	1010

AASHTO Table 3-2. Stopping Sight Distance **on Grades**

U.S. Customary						
Design Speed (mph)	Stopping Sight Distance (ft)					
	Downgrades			Upgrades		
	3%	6%	9%	3%	6%	9%
15	80	82	85	75	74	73
20	116	120	126	109	107	104
25	158	165	173	147	143	140
30	205	215	227	200	184	179
35	257	271	287	237	229	222
40	315	333	354	289	278	269
45	378	400	427	344	331	320
50	446	474	507	405	388	375
55	52[illegible]	553	593	469	450	433
60	598	[illegible]38	686	538	515	495
65	682	72[illegible]	785	612	584	561
70	771	825	891	690	658	631
75	866	927	1[illegible]03	772	736	704
80	965	1035	112[illegible]	859	817	782
85	1070	1149	1246	949	902	862

MoDOT-Sight Visibility Tables and Equations.xml file.

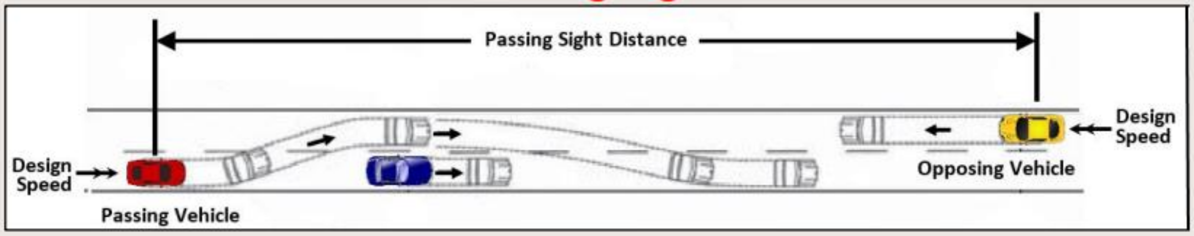
```
<?xml version="1.0" encoding="utf-8"?>
<OpenRoadsSightVisibility xmlns="OpenRoads">
    <Methods>
        <!--                    2018 AASHTO Standard Variables and Constants                    -->
        <!-- double reactionTime  //Brake reaction time. Defaults to 2.5 seconds if not defined in this settings file      -->
        <!-- double gradeThreshold // Grades(ft/ft) less than gradeThreshold will use SSD equation 3-2              -->
        <!--                       // Grades(ft/ft) greater than or equal to the gradeThreshold will use SSD equation 3-3  -->
        <!-- double gravityConst = 32.2; // feet/sec^2                                                               -->
        <!-- int roundingMultiple // Computed Required Sight distances will be rounded to this multiple.  0 indicates no rounding.-->
        <SightDistanceMethod name ="2011 AASHTO Stopping Site Distance - Zero Offset" methodType ="AASHTO_2011_SSD" >
            <EyePosition interval="50.0" offset="0.0" height="3.5"/>
            <ObjectPosition moveTargetToAchieveVisibility="false" interval="10.0" offset="0.0" height="2.0"/>
            <StandardVariables reactionTime="2.5" gravityConstant="32.2" gradeThreshold ="0.03" roundingMultiple="1"/>
        </SightDistanceMethod>
        <SightDistanceMethod name ="2011 AASHTO Stopping Site Distance - Eye 9 foot Offset" methodType ="AASHTO_2011_SSD" >
            <EyePosition interval="50.0" offset="9" height="3.5"/>
            <ObjectPosition moveTargetToAchieveVisibility="false" interval="10.0" offset="0.0" height="2.0"/>
            <StandardVariables reactionTime="2.5" gravityConstant="32.2" gradeThreshold ="0.03" roundingMultiple="1"/>
        </SightDistanceMethod>

        <!--                              2018 AASHTO Tables                              -->
        <SightDistanceMethod name ="AASHTO 2018 Stopping on Level Roadways" methodType="Table" >
            <EyePosition interval="50.0" offset="0.0" height="3.50"/>
            <ObjectPosition moveTargetToAchieveVisibility="true" interval="10.0" offset="0.0" height="2.0"/>
            <SpeedTableEntry speed ="15" sightDistance="80" relaxedDistance="80"/>
            <SpeedTableEntry speed ="20" sightDistance="115" relaxedDistance="115"/>
            <SpeedTableEntry speed ="25" sightDistance="155" relaxedDistance="155"/>
            <SpeedTableEntry speed ="30" sightDistance="200" relaxedDistance="200"/>
            <SpeedTableEntry speed ="35" sightDistance="250" relaxedDistance="[illegible]"/>
            <SpeedTableEntry speed ="40" sightDistance="305" relaxedDistance="305"/>
            <SpeedTableEntry speed ="45" sightDistance="360" relaxedDistance="360"/>
            <SpeedTableEntry speed ="50" sightDistance="425" relaxedDistance="425"/>
            <SpeedTableEntry speed ="55" sightDistance="495" relaxedDistance="495"/>
            <SpeedTableEntry speed ="60" sightDistance="570" relaxedDistance="570"/>
            <SpeedTableEntry speed ="65" sightDistance="645" relaxedDistance="645"/>
            <SpeedTableEntry speed ="70" sightDistance="730" relaxedDistance="730"/>
```

Sight Distance - Passing Sight Distance

AASHTO 2018 Green Book Page 3-11 & NCHRP Report 605

Minimum Passing Sight Distance



Sight Distance - Passing Sight Distance

MUTCD 2009

AASHTO 2018 Green Book Section 3.2.4.1

Minimum Passing Sight Distance

AASHTO 2018 Green Book states *"Minimum passing sight distances for use in design are based on the minimum sight distances presented in the MUTCD as warrants for no-passing zones on two-lane highways."*

Table 3B-1. Minimum Passing Sight Distances for No-Passing Zone Markings

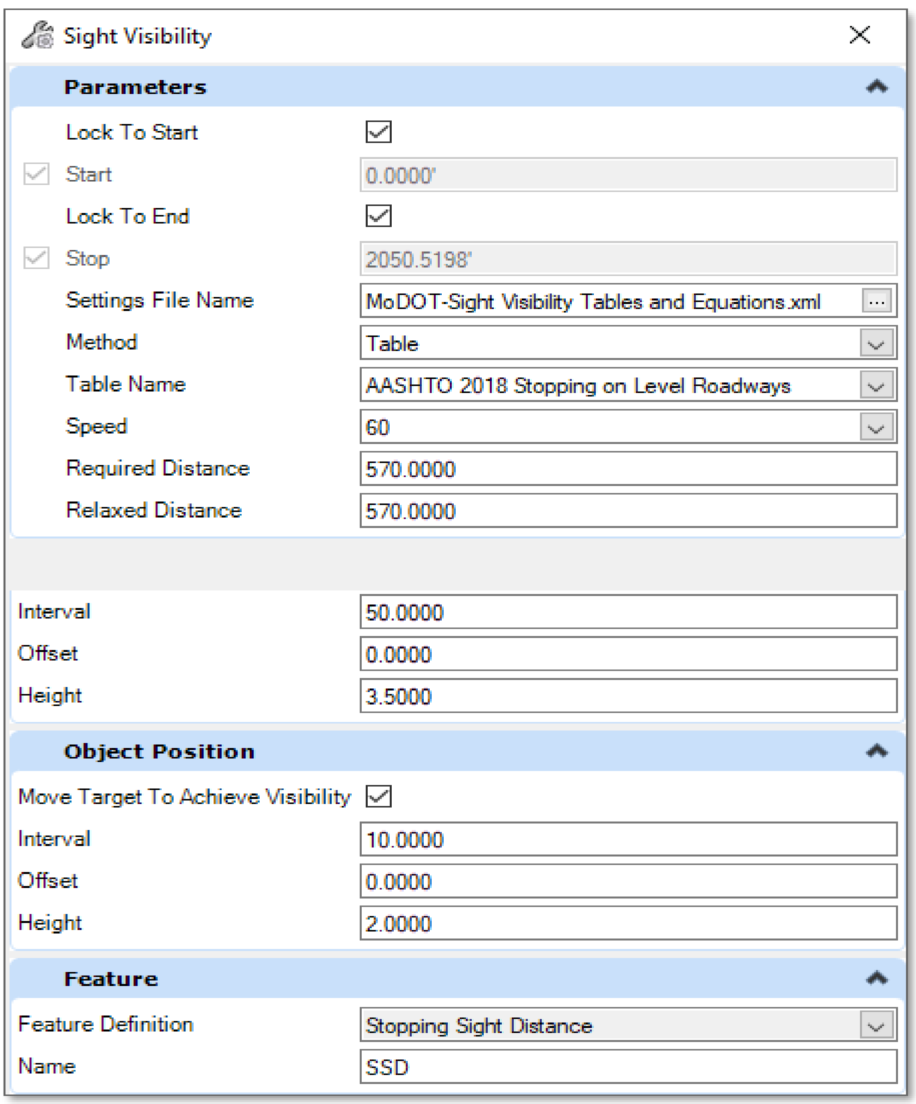
85th-Percentile or Posted or Statutory Speed Limit	Minimum Passing Sight Distance
25 mph	450 feet
30 mph	500 feet
35 mph	550 feet
40 mph	600 feet
45 mph	700 feet
50 mph	800 feet
55 mph	900 feet
60 mph	1,000 feet
65 mph	1,100 feet
70 mph	1,200 feet

Note: For the **Non-Table Methods**, when the **AASHTO Stopping Sight Distance method** is selected, the program uses the Equations 3-2, and 3-3 from the 2011 and 2018 AASHTO Green book. In the 2018 edition these are in section "3.2.2 Stopping Sight Distance".

125. Within the **3D** view of **Site_Visibility_J5P0100.dgn** file, rotate to a top view. Next, select the **Sight Visibility** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Terrain** Tab ➔ **Analysis** Section ➔ **Sight Visibility** Tools**.**

126. Define the dialog as follows and apply to the **Big Horn Corridor** and **Existing Ground Terrain**.

Settings File Name:	MoDOT-Site Visibility Tables and Equations
Method:	Table
Table Name:	AASHTO 2018 Stopping on Level Roadways
Speed:	60
Required Distance:	570
Relaxed Distance:	570
Locate Corridor:	Bighorn
Locate Eye Control Alignment:	Reset for Main Alignment
Locate Object Control Alignment:	Reset for Main Alignment
Start Station:	Lock to Start
End Station:	Lock to End
Located Existing Ground:	J5P0100 Terrain Existing



127. Compare your results with Table Below:

Sight Visibility Results - Section: SSD2

☑ Achieved ☑ Relaxed ☑ Not Achieved ☐ Show Selected

Eye Position	Object Position	Eye Level	Actual Level	Object Level	Design Speed	Instantaneous Grade	Average Grade	Sight Distance Required	Sight Distance Relaxed	Sight Distance Achieved	Sight Distance Along Sight Line Achieved	Sight Line Status
1+97.77	7+67.77	745.0494	755.9403	755.9403	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.2536	Achieved
2+47.77	8+17.77	743.8854	756.6248	756.6248	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.5033	Achieved
2+97.77	8+67.77	743.1561	757.4337	757.4337	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.7933	Achieved
3+47.77	8+57.77	742.7835	757.2718	757.2718	60.0000	0.00%	0.00%	570.0000	570.0000	510.0000	509.9525	Not Achieved
3+97.77	7+97.77	743.0555	756.3325	756.3325	60.0000	0.00%	0.00%	570.0000	570.0000	400.0000	399.9981	Not Achieved
4+47.77	7+77.77	744.2481	756.0710	756.0710	60.0000	0.00%	0.00%	570.0000	570.0000	330.0000	330.0000	Not Achieved
4+97.77	8+57.77	747.0482	757.2718	757.2718	60.0000	0.00%	0.00%	570.0000	570.0000	360.0000	360.0000	Not Achieved
5+47.77	11+17.77	750.2274	762.2336	762.2336	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.9987	Achieved
5+97.77	11+67.77	752.7164	763.8850	763.8850	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.9574	Achieved
6+47.77	12+17.77	754.7762	765.5712	765.5712	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.8074	Achieved
6+97.77	12+67.77	756.0912	766.8441	766.8441	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.5020	Achieved
7+47.77	13+17.77	757.1289	767.7696	767.7696	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.0198	Achieved
7+97.77	13+67.77	757.8325	768.0095	768.0095	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	568.3680	Achieved
8+47.77	14+17.77	758.6099	767.9933	767.9933	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	567.8020	Achieved
8+97.77	14+67.77	759.4169	767.6060	767.6060	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	567.4702	Achieved
9+47.77	14+67.77	760.2828	767.6060	767.6060	60.0000	0.00%	0.00%	570.0000	570.0000	520.0000	517.7282	Not Achieved
9+97.77	14+67.77	761.1150	767.6060	767.6060	60.0000	0.00%	0.00%	570.0000	570.0000	470.0000	468.0413	Not Achieved
10+47.77	14+77.77	762.1642	767.5097	767.5097	60.0000	0.00%	0.00%	570.0000	570.0000	430.0000	428.3806	Not Achieved
10+97.77	14+97.77	763.3412	767.3448	767.3448	60.0000	0.00%	0.00%	570.0000	570.0000	400.0000	398.8284	Not Achieved
11+47.77	15+57.77	764.7916	766.6731	766.6731	60.0000	0.00%	0.00%	570.0000	570.0000	410.0000	409.2498	Not Achieved
11+97.77	17+67.77	766.4056	766.4065	766.4065	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.5667	Achieved
12+47.77	18+17.77	767.9006	766.9980	766.9980	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.8435	Achieved
12+97.77	18+67.77	768.9387	767.8928	767.8928	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.9685	Achieved
13+47.77	19+17.77	769.4572	768.9947	768.9947	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.9884	Achieved
13+97.77	19+67.77	769.5249	770.4621	770.4621	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.9827	Achieved
14+47.77	20+17.77	769.2987	772.2503	772.2503	60.0000	0.00%	0.00%	570.0000	570.0000	570.0000	569.9786	Achieved

Note: **Move Target to Achieve Visibility is defined as follows:** The Object position's XY location is calculated like the Eye Position. However, for object position, the location is down range from the Eye Position along the Control Reference alignment a distance equal to the Required Distance.

When Move Target is **On** a sight line for each Object Position Interval is analyzed until the Required distance is either achieved for that Eye Position or an intersection with a design or an existing terrain or mesh is found. In the case where an intersection is found and the Required Sight Distance has not been achieved, the analysis displays the last successful sight line for that eye position.

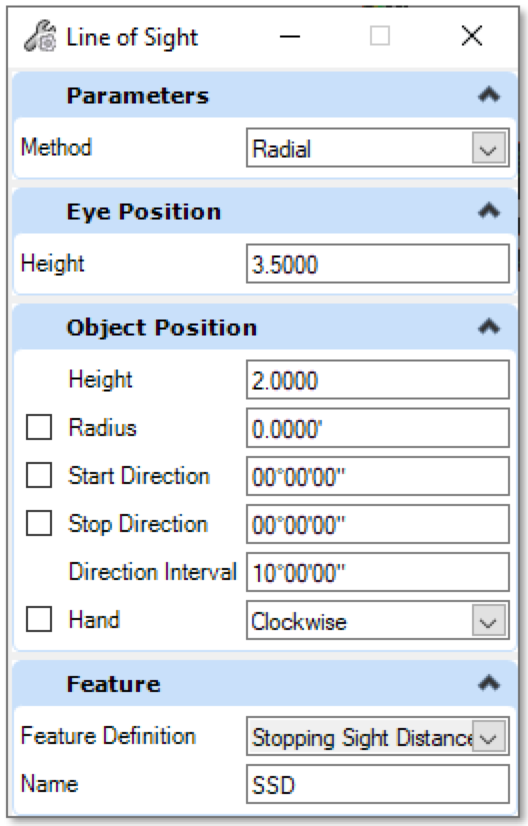
128. In the 3D view, select and then delete the **Sight Lines** that were drawn in the previous step.

129. Again, make sure 3D view is set to a TOP view.

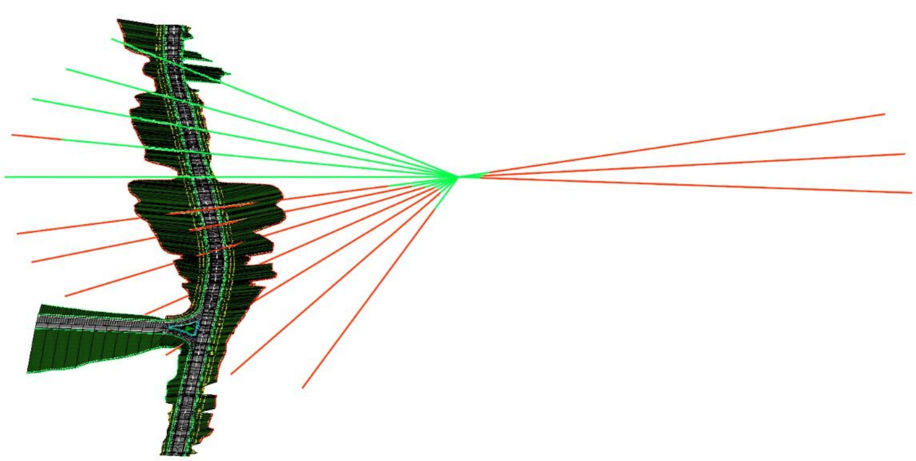
130. Next, select the **Line of Sight** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Terrain** Tab ➔ **Analysis** Section ➔ **Sight Visibility** Tools.

131. Fill in the **Sight Lines** prompts/dialog when directed, working within in the **2D** view:

Settings File Name:	MoDOT-Site Visibility Tables and Equations
Method:	Radial
Locate Corridor or Design Surface:	Select the Bighorn Corridor
Locate the Existing Surface:	J5P0100 Existing Ground
Eye position:	Click somewhere within the Existing Ground Terrain
Object position:	Click somewhere within the Existing Ground Terrain
Stop Direction	Try to make a 360-degree solution.



Note: You will need to datapoint both the **Height of Eye** and the **Height of Object** positions in the 3D view. When you Data Point to Accept Design the Sight Triangle will be placed in the **3D View**.



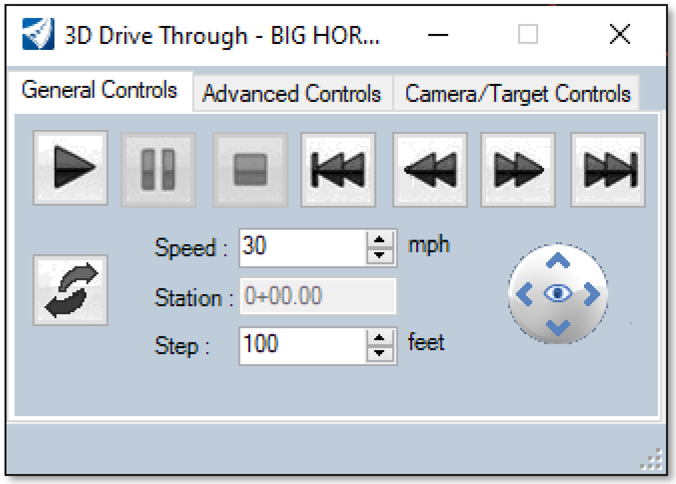
132. In the **Corridors_J5P0100.dgn** 3D view, select and then delete the **Sight Lines** that were drawn in the previous step.

3D Drive Through

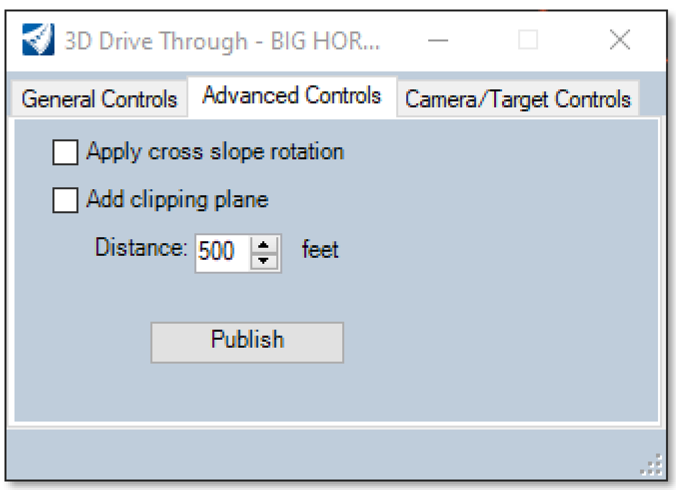
133. Within the **Corridors_J5P0100.dgn** file select the **3D Drive Through** tool by selecting the **OpenRoads Modeling** Workflow ➔ **Corridors** Tab ➔ **Review** Section**.**

134. Select the 3D view, and then select the centerline of Big Horn Drive.

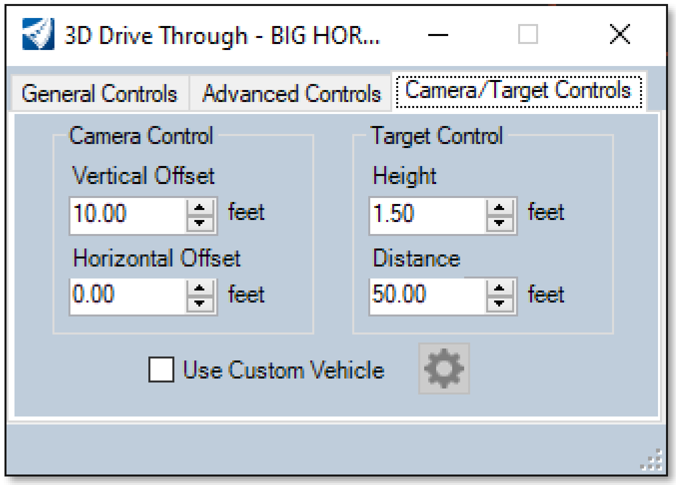
135. Under **General Controls** Tab set the following settings:



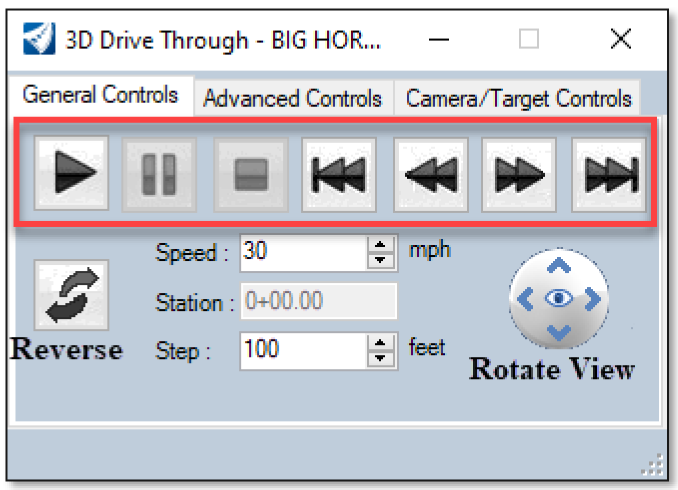
136. Within the **Advance Control** Tab set the following settings:

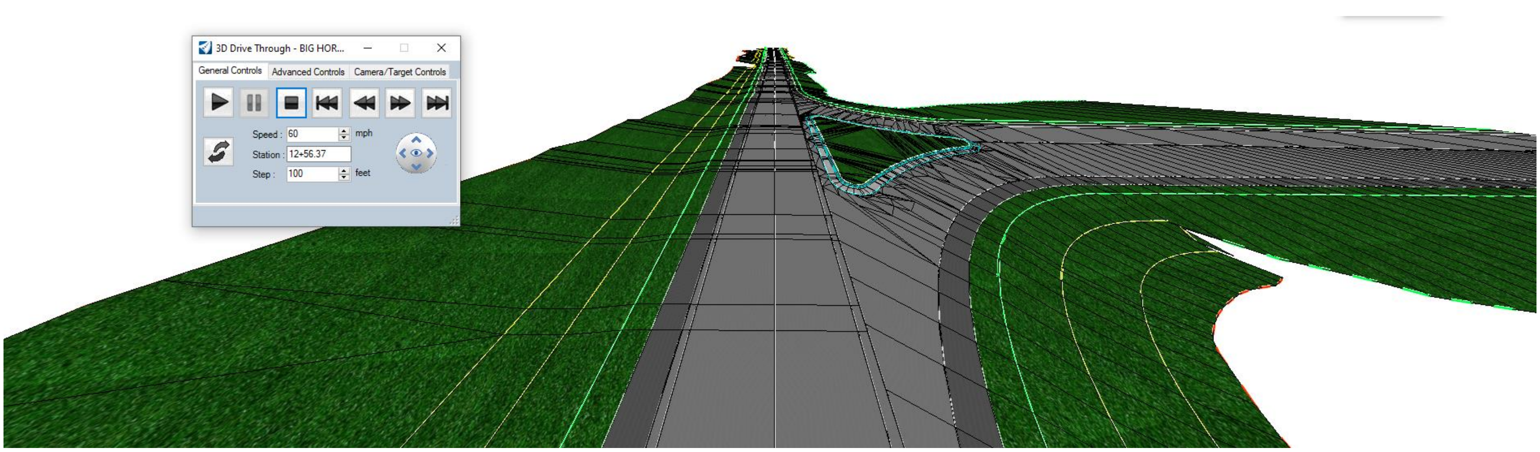


137. Within **Camera/Target Controls** Tab set the following settings:

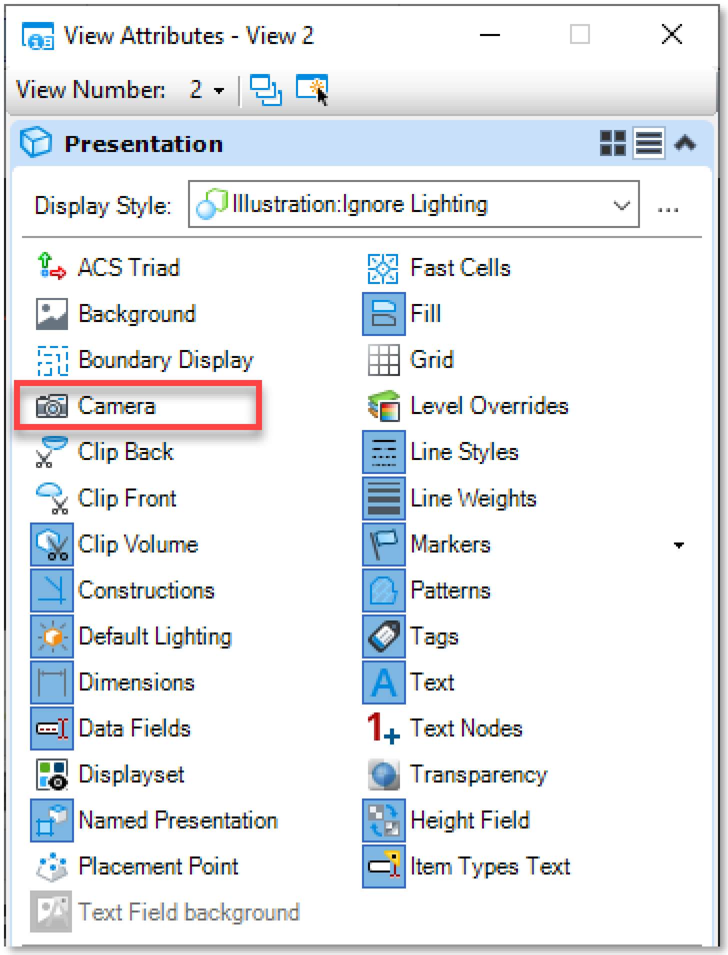


138. Lastly, go back to the **General Controls** Tab and select the **Play** icon. Utilize the **Reverse** and **Rotate View** controls.



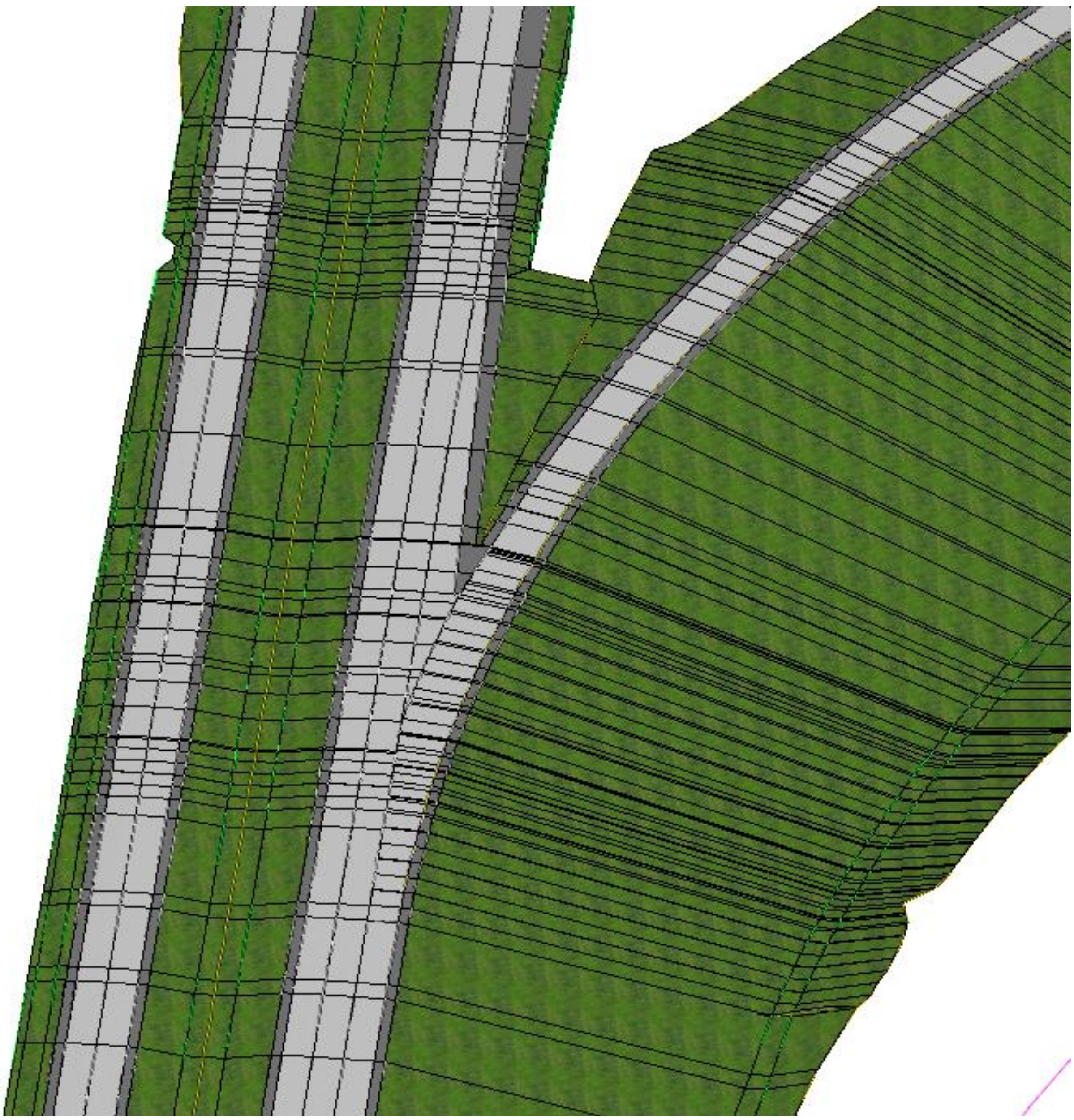


139. After using the 3D Drive Tool, you will notice a fish-eyed view within your 3D View, to turn that view effect off go into the **View Attributes** and deselect the "**Camera**" setting:



OpenRoads Designer Road 2

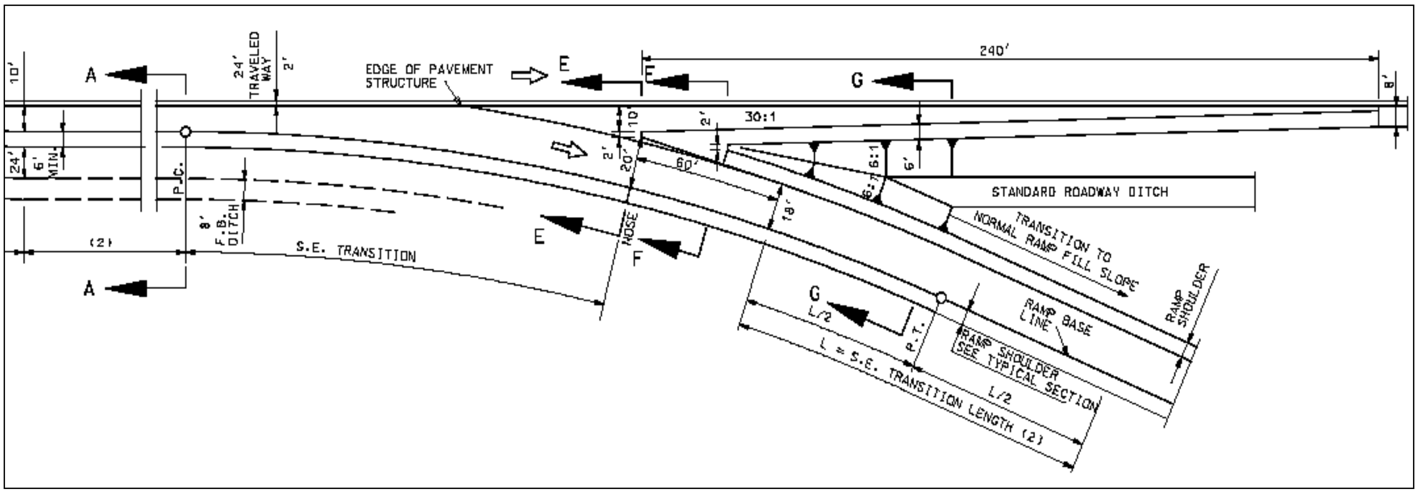
Ramp Transition& Special Ditch



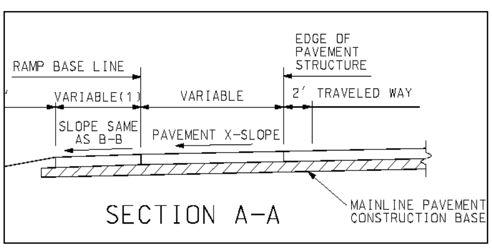
19.1 Group Exercise: Ramp Transition Layout

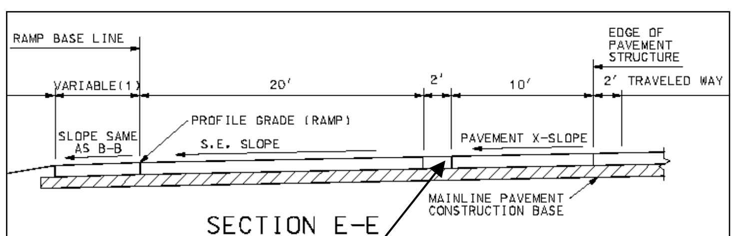
Objective and Background Information

The objective of this exercise is to demonstrate how the Power GeoPak Civil Tools can be used to create a profile for a ramp transition. This is the area between the sections A-A and E-E in the following figure from Missouri Standard Plans for Highway Construction (203.41). The profile will be applied along the ramp chain.



As the figure indicates, the ramp is in Superelevation transition from the pavement cross slope at Section A-A to the Superelevation required for the beginning curve of the ramp at Section E-E. These two sections as shown in the standard plans are provided below.





The break in the slope between the mainline and the ramp can occur

Before proceeding with the steps to create the profile, a decision needs to be made regarding the location of the break line between the mainline and ramp cross slopes. According to the Design Standards group, the exact location of this break line at Section E-E is not set. It can be located anywhere within the two-foot width of the ramp nose. For the purposes of this exercise, it will be located on the ramp side of the nose and held at a constant offset of 20' relative to the ramp chain from the ramp nose back to the point where this offset intersects with the mainline edge of pavement. As a designer, you can determine its location for your project.

Also needed is the Superelevation rate at the ramp nose, which is based on the design speed of the ramp and the radius of the curve. The radius of the first curve in Ramp 2 is 1,041 feet.

The relevant portion of the Superelevation table from Missouri Standard Plan 203.20F is shown below. Based on e_{max} = 8%, the ramp’s design speed of 40 M.P.H. and a rounded down radius of 1030’, the Superelevation for the start of the ramp is 5.8%.

MINIMUM RADII FOR DESIGN SUPERELEVATI
DESIGN SPEEDS, AND e_{max} = 8%

e%	DESIGN SPEED (MPH) 30			35			40			45			50			5
	RADIUS	L ∗1	L ∗2	RADIUS	L ∗1	L ∗2	RADIUS	L ∗1	L ∗2	RADIUS	L ∗1	L ∗2	RADIUS	L ∗1	L ∗2	RADIUS
NC	3,240	0	0	4,260	0	0	5,410	0	0	6,710	0	0	8,150	0	0	9,720
RC	2,370	36	55	3,120	39	58	3,970	41	62	4,930	44	67	5,990	48	72	7,150
2.2	2,130	40	60	2,800	43	64	3,570	46	58	4,440	49	73	5,400	53	79	6,450
2.4	1,930	44	65	2,540	46	70	3,240	50	74	4,030	53	80	4,910	58	86	5,870
2.6	1,760	47	71	2,320	50	75	2,960	54	81	3,690	58	87	4,490	62	94	5,370
2.8	1,610	51	76	2,130	54	81	2,720	58	87	3,390	62	93	4,130	67	101	4,950
3.0	1,480	55	82	1,960	58	87	2,510	62	93	3,130	67	100	3,820	72	108	4,580
3.2	1,370	58	87	1,820	62	93	2,330	66	99	2,900	71	107	3,550	77	115	4,250
3.4	1,270	62	93	1,690	66	99	2,170	70	106	2,700	76	113	3,300	82	122	3,970
3.6	1,180	65	98	1,570	70	105	2,020	74	112	2,520	80	120	3,090	86	130	3,710
3.8	1,100	69	104	1,470	74	110	1,890	79	118	2,360	84	127	2,890	91	137	3,480
4.0	1,030	73	109	1,370	77	116	1,770	83	124	2,220	89	133	2,720	96	144	3,270
4.2	955	76	115	1,280	81	122	1,660	87	130	2,080	93	140	2,560	101	151	3,080
4.4	893	80	120	1,200	85	128	1,560	91	137	1,960	98	147	2,410	106	158	2,910
4.6	834	84	125	1,130	89	134	1,470	95	143	1,850	102	153	2,280	110	166	2,750
4.8	779	87	131	1,060	93	139	1,390	99	149	1,750	107	160	2,160	115	173	2,610
5.0	727	91	136	991	97	145	1,310	103	155	1,650	111	167	2,040	120	180	2,470
5.2	676	95	142	929	101	151	1,230	108	161	1,560	116	173	1,930	125	187	2,350
5.4	627	98	147	870	105	157	1,160	112	168	1,480	120	180	1,830	130	194	2,230
5.6	582	102	153	813	108	163	1,090	116	174	1,390	124	187	1,740	134	202	2,120
5.8	542	105	158	761	112	168	1,030	120	180	1,320	129	193	1,650	139	209	2,010
6.0	506	109	164	7113	116	174	965	124	186	1,250	133	200	1,560	144	216	1,920
6.2	472	113	169	669	120	180	909	128	192	1,180	138	207	1,480	149	223	1,820
6.4	442	116	175	628	124	186	857	132	199	1,110	142	213	1,400	154	230	1,730

1) Open **Osage\J5P0555\Plan_Overview_J5P0555.dgn**
   a) Review project scope.

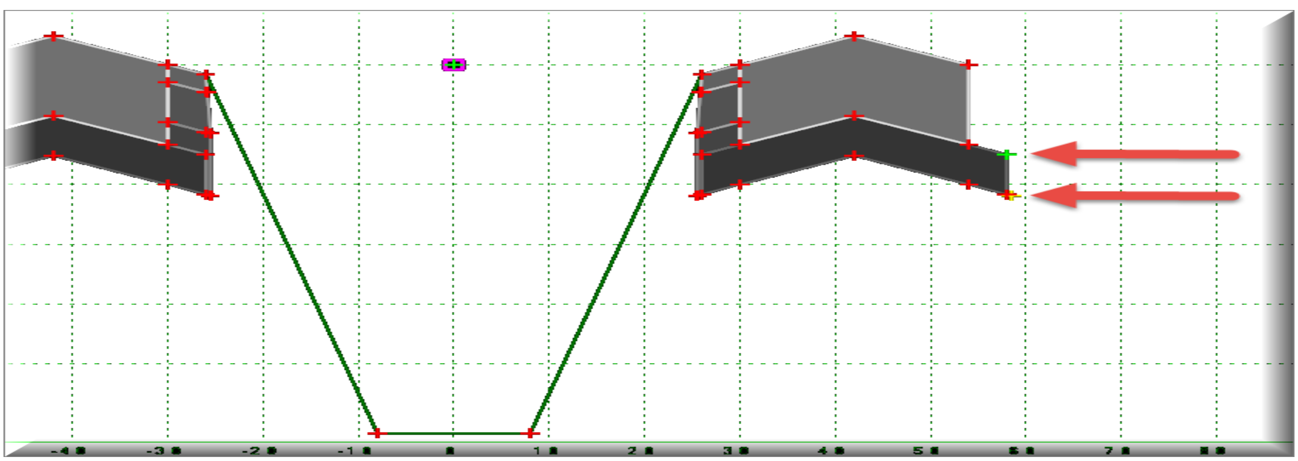
2) Open **Plan_J5P0555.dgn** File.
   a) Attach **Civil_Geometry_J5P0555.dgn**
   b) Review plan geometry.

Create template for Route 50 Corridor

3) Create template for Route 50 Corridor
   a) **Corridor Tab → Template Tools → Create Template**
   b) Open the **MoDOT Template Library (MoDOT.itl)**

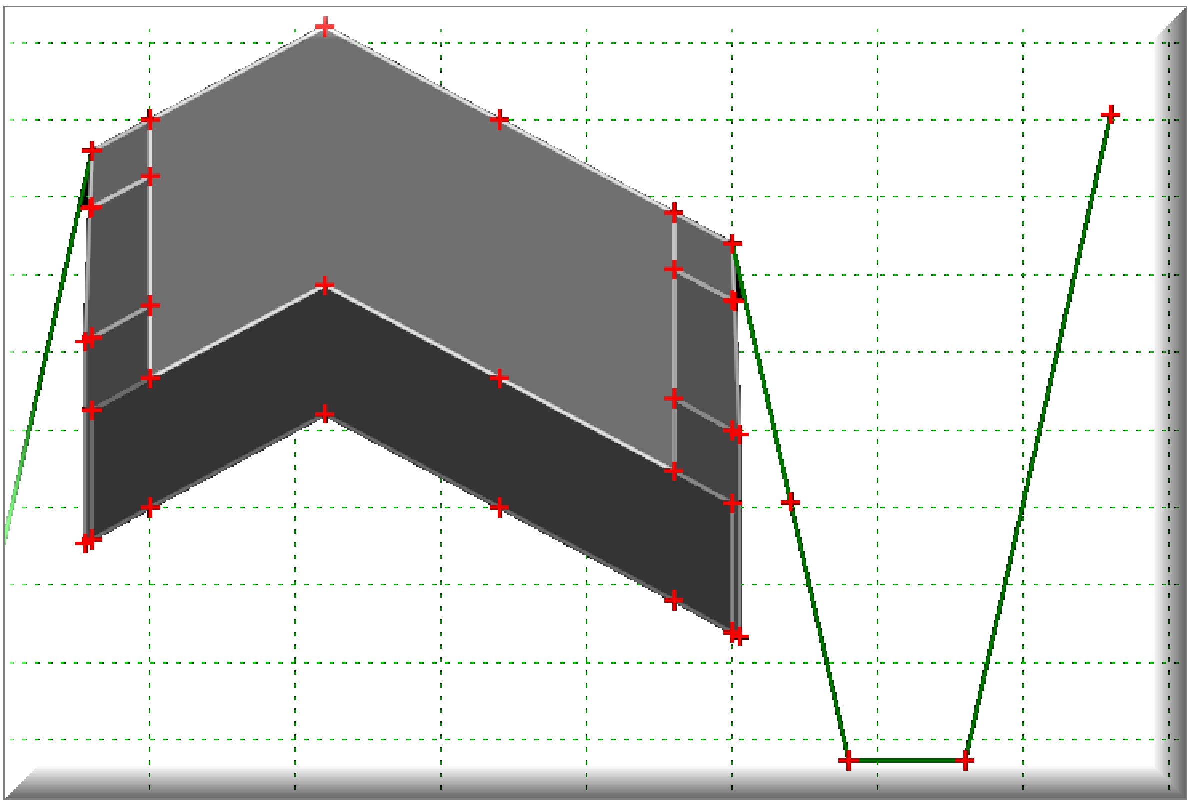
      The path to the MoDOT itl is as follows: Documents\CADD_Standards\ORD Standards\Connect_Config\WorkSpaces\MoDOT\Standards\Template Library\

   c) Save the **MoDOT.itl** to the Project's data folder naming it **J5P0555.itl**
   d) Create a folder under the root directory named **J5P0555**.
   e) Under the J5P0555 folder create a **Route 50** folder.
   f) Copy the following template into the **Route 50** folder:
      - Templates → Concrete Pavement w/ Shoulders → A2 Shoulders Agg Base → **Concrete Pavement 4 Lane Divided w/ Agg Base Option 3**
   g) Use the **Delete Components** option and remove the **<u>right outside</u>** Shoulder & Sublayers, Guardrail Widening, and End Conditions. Do not delete Aggregate Base (See picture below).
   h) Delete three outside Aggregate Base points (See arrows below)



Note: The next few steps will add an **auxiliary lane** on the right side of the template. The auxiliary lane is being added to provide the User a way to transition over a distance the **Pavement Normal Slope** of (**2%**) to the slope at the beginning of **Ramp 2** (**3.87%**).

4) In the **Dynamic Settings**, verify the **Apply Affixes**, are set with X & Y Steps = **0.1**
5) Add the following components to the right side of the template:
    a) Components ➔ Pavement – New ➔ Concrete Pavement w/ Shoulders ➔ A2 Shoulders Agg Base ➔ **Concrete Pavement 1 Lane w/ Agg Base Option 3**
    b) End Conditions ➔ Combined ➔ **6:1 Fill or 6:1 Foreslope and Backslope Ditch**



6) Optional Step: Merge the common components.

7) Edit the **RT_Conc_T_EOP1** point.
    a) Toggle off the Horizontal Feature Constraint

8) Edit the **RT_Conc_T_EOP2** point.
    a) Toggle off the Superelevation Flag
    b) For the Slope Constraint Label enter in **Auxiliary_Lane_Pavement_Slope**
    c) Set the Horizontal Feature Constraint from the drop-down menu, select **Linear ➔ Design ➔ Roadway ➔ EOP_New**
    d) Set Horizontal Constraint distance to 0.001'

9) Edit the **RT_AsphSurf_T_O_EOS1** point.
    a) Set the Horizontal Feature Constraint from the drop-down menu, select **Linear ➔ Design ➔ Roadway ➔ EOS_New_Asphalt**

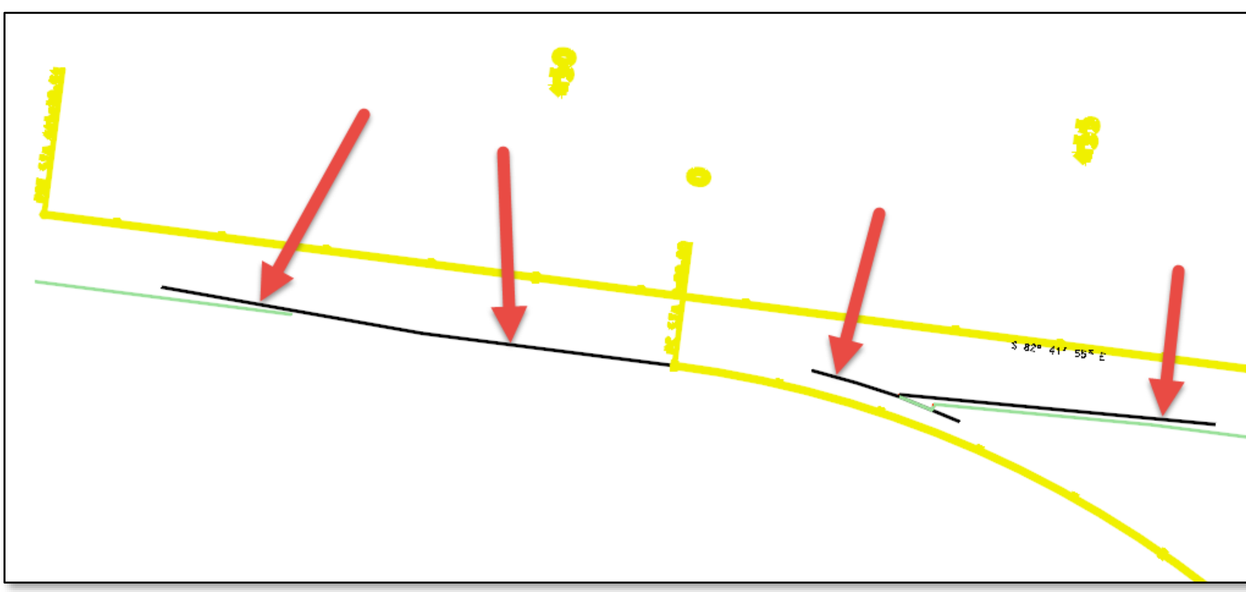
10) **Close,** and **Save** the **J5P0555.itl**

Create Route 50 Corridor

11) Create **Corridors_J5P0555.dgn** using the **MoDOT_Roadway_Seed_2D.dgn** as the seed file.
    a) Set the **Geographic Coordinate System** from the **Existing_Terrain_J5P0555.dgn**
    b) Reference in the following dgn files:
       Existing_ Terrain_J5P0555.dgn
       Plan_J5P0555.dgn
       Civil_Geometry_J5P0555.dgn
    c) Set **Annotation Scale** to **50**
    d) Activate Existing Ground Terrain.
    e) Select the "**Corridor** Tab ➔ **Create** Section ➔ **New Corridor**" tool.
    f) Select the **Route50** baseline (use the active profile) and name the corridor "**Route50"**
    g) Apply Roadway template
       - **J5P0555 ➔ Route 50 ➔ Concrete Pavement 4 Lane Divided w/ Agg Base Option 3**
       - From Station **445+30.94 R1 to Sta. 460+00 R1**
       - Drop Interval of **5ft**.
         - Note if the drop interval is too large the corridor might not see the Corridor Reference Elements.
    h) Select the "**F6**" key to open 3D view of model.

12) Make the **Default 2D** view the active view in the Corridors_J5P0555.dgn.
    a) Turn off the display of the Corridors 3D file using the reference dialog.

13) In the **Route 50 Corridor** add the four individual **EOP_New** lines from the **Plan_J5P0555.dgn** file as **Corridor References**.

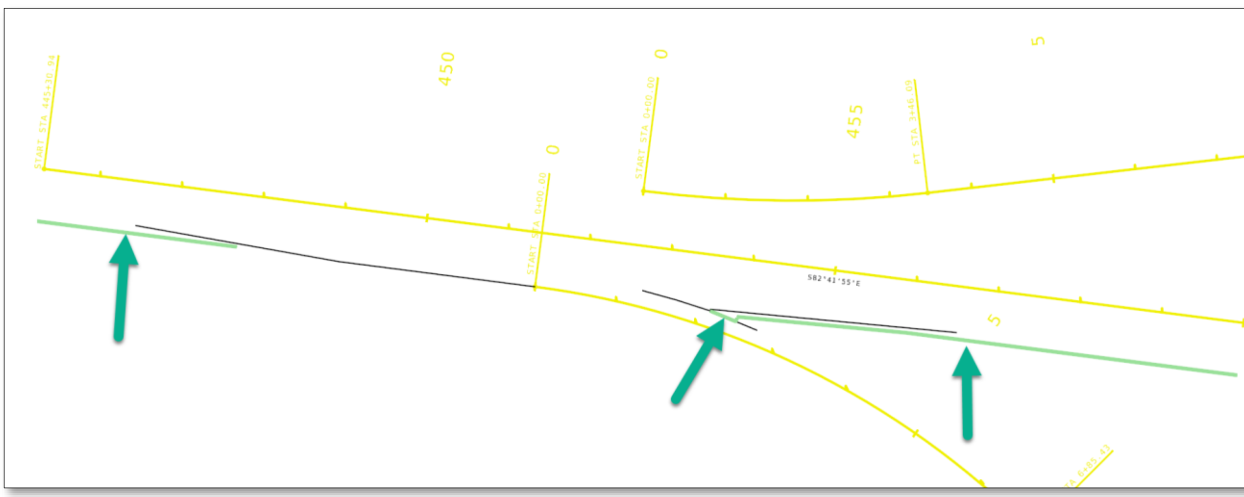


14) Add the following two Key Stations to the Route 50 Corridor
   a) **451+40.67 R1** (Just past beginning of Ramp 2)
   b) **453+55.67 R1** (Just before location of Shoulder Gore nose)

   Notes:
   - If a template drop does not cross an individual corridor reference element, the Corridor will not draw to that corridor reference element.
   - Use the **Corridor Object Tool** to verify the Key Stations were placed at the correct location.
   - You can also use the **undo/redo** buttons to help see the changes to your model.

15) The shoulder width in the Ramp area is going to be narrower than the mainline. In the Route 50 Corridor add the Complex **EOS_New_Asphalt** line from the **Plan_ J5P0555.dgn** file as Corridor References.

   Notes:
   - The shoulder is going to vary in width in certain areas of the project. The plan shoulder element (**EOS_New_Asphalt**) will control the width in these areas

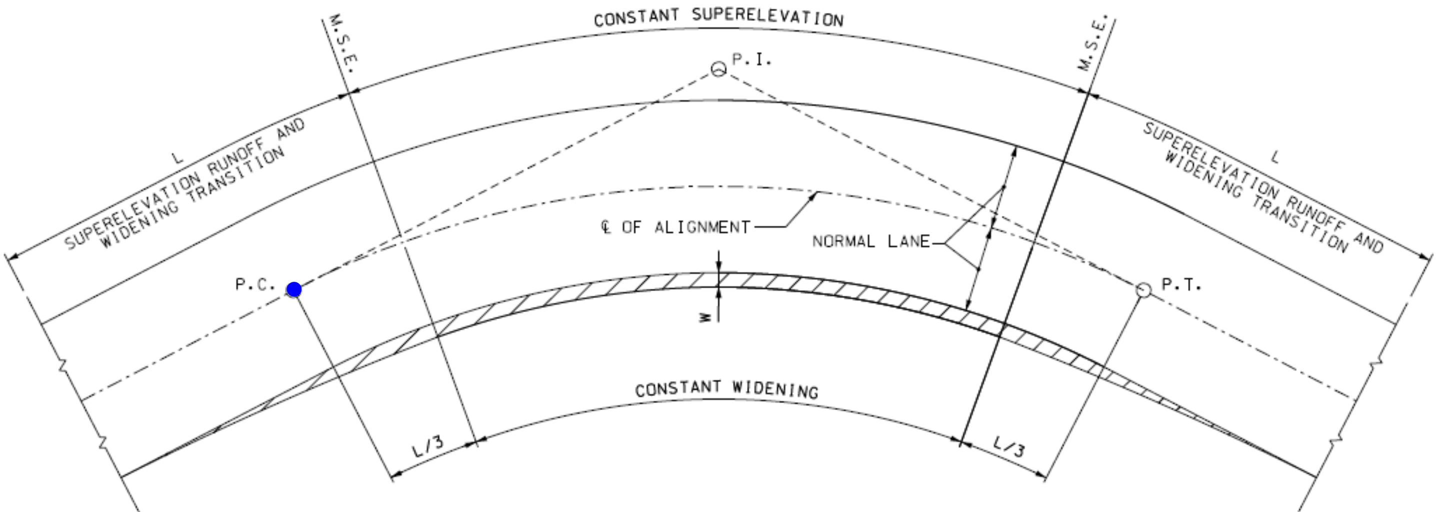


16) Add the following Key Station to the Route 50 Corridor.
   a) **453+88.86 R1** (Just before location of Median Grass Gore nose)

   Notes:
   - If a template drop does not cross an individual corridor reference element, the Corridor will not draw to that corridor reference element.
   - Use the **Corridor Object Tool** to verify the Key Station was placed at the correct location.
   - You can also use the **undo/redo** buttons to help see the changes to your model.

Calculation of Ramp 2 Vertical Complex Element (Profile)

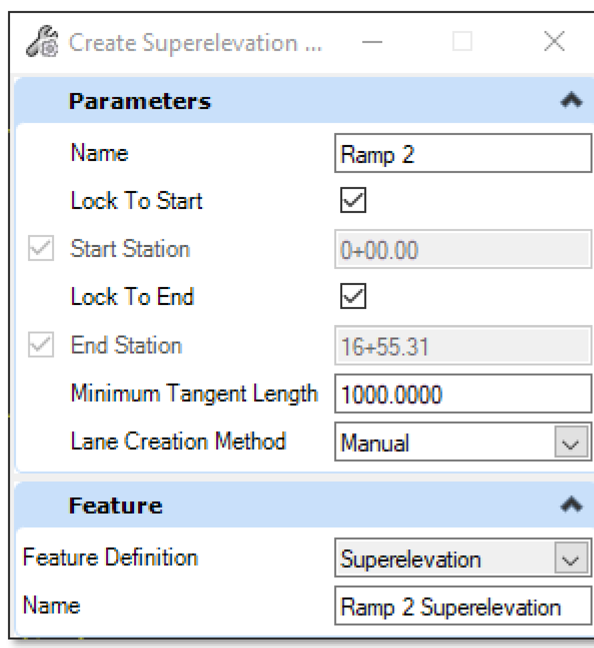
17) Create **Superelevation_ J5P0555.dgn** using the **MoDOT_Roadway_Seed_2D.dgn** as the seed file.
    a) Set the **Geographic Coordinate System** from the **Existing_Terrain_J5P0555.dgn**
    b) Reference in **Civil_Geometry_J5P0555.dgn**
    c) Set **Annotation Scale** to **50**
    d) Review the undivided non-spiraled Superelevation runoff diagram below.



SUPERELEVATION RUNOFF AND WIDENING TRANSITIONS WITHOUT SPIRALS

18) Select **Create Superelevation Section.**

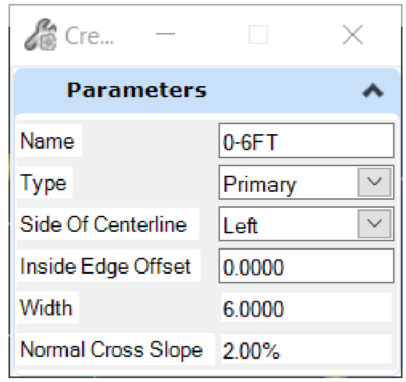
Feature Definition:	Superelevation
Feature Name:	Ramp 2 Superelevation
Section Name:	Ramp2
Alignment:	Ramp2
Start Station:	Lock to Start
Stop Station:	Lock to End
Minimum Transition Length:	1000
Lane Creation Method:	Manual



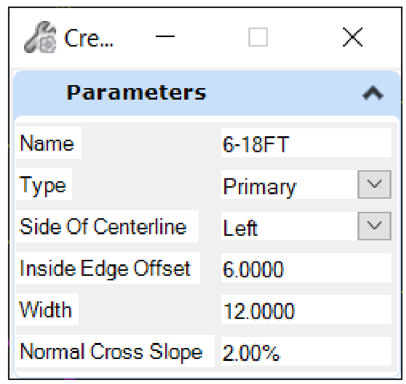
Note: If two Superelevation Sections are created, delete second Superelevation Section, and then extend the First section to the end of the Ramp 2 alignment.

19) Select **Create Superelevation Lanes** and create the following two Superelevation Lanes.

Lane Name:	**0-6FT**
Type:	**Primary**
Side of Centerline:	**Left**
Inside Edge Offset:	**0'**
Width:	**6'**
Normal Cross Slope:	**2.00%**

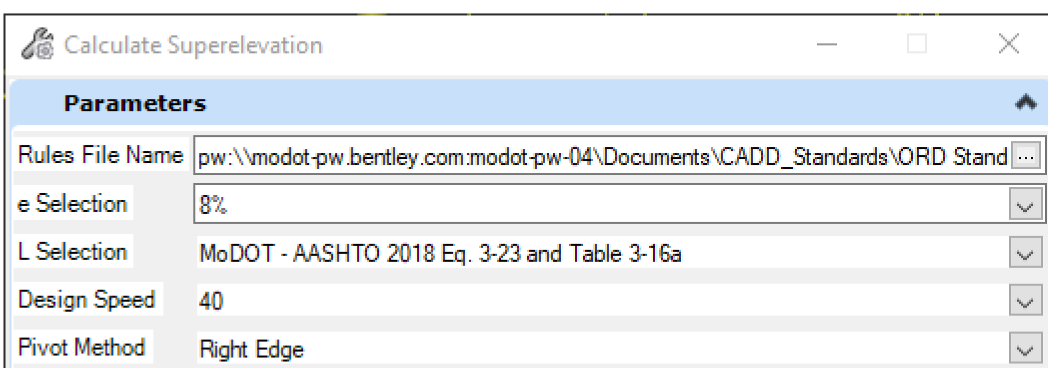


Lane Name:	**6-18FT**
Type:	**Primary**
Side of Centerline:	**Left**
Inside Edge Offset:	**6'**
Width:	**12'**
Normal Cross Slope:	**2.00%**

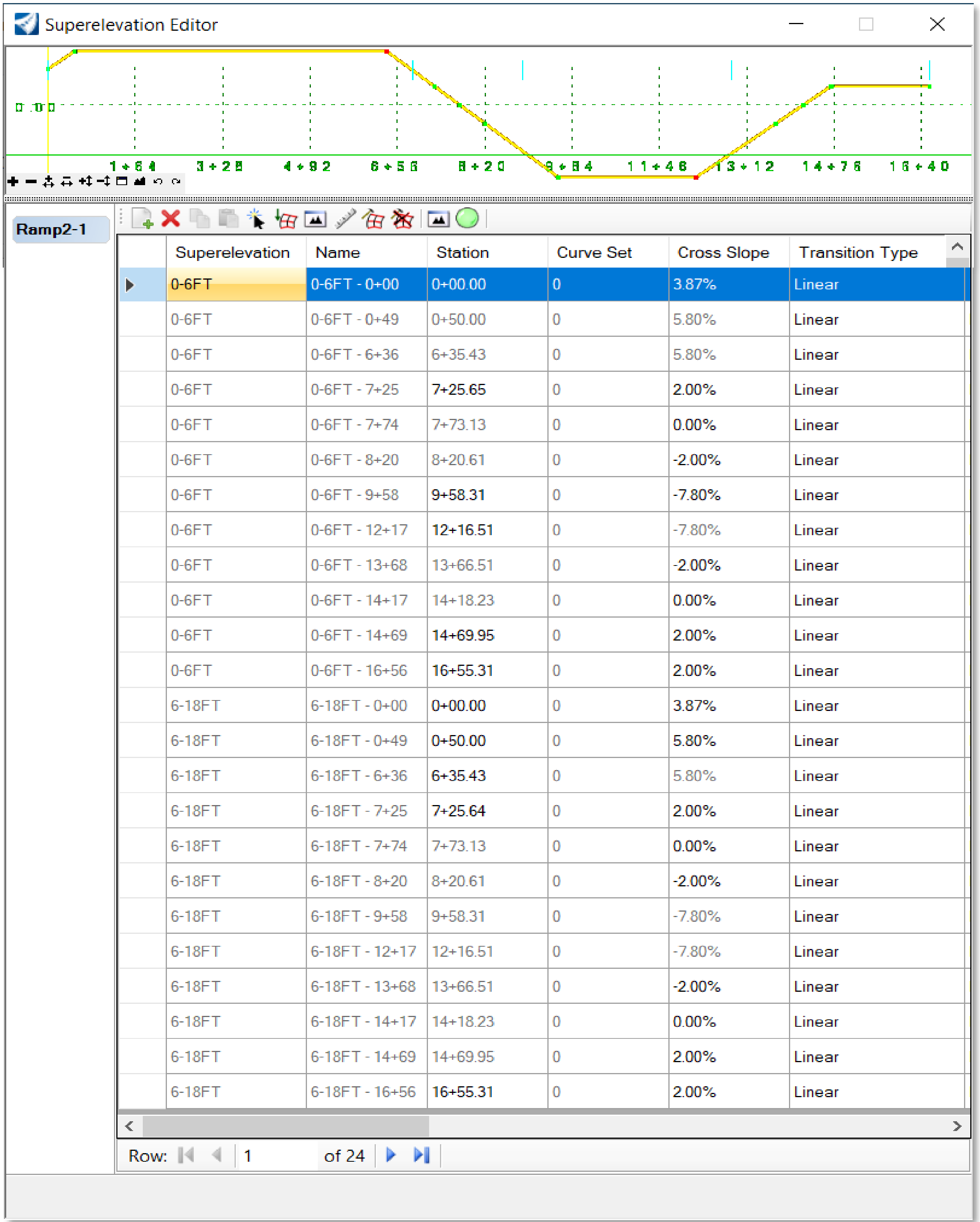


20) Select **Calculate Superelevation.**

Rules File Name:	MoDOT_Superelevation_Rules_File.xml
e Selection:	8%
L Selection:	MoDOT – AASHTO 2018 Eq. 3-23 and Table 3-16a
Design Speed:	40 mph
Pivot Method:	Right Edge
Open Editor	Yes



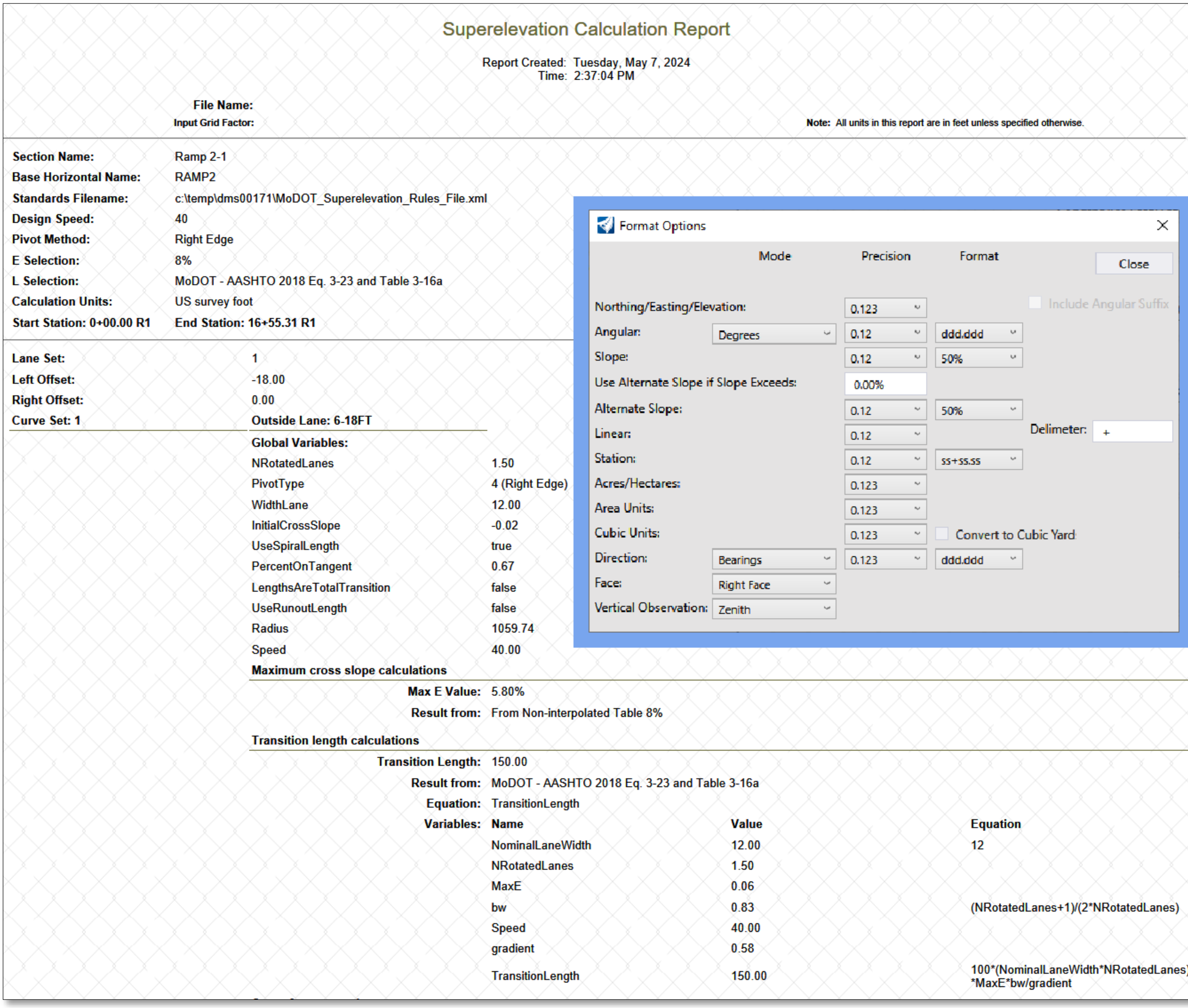
Below is a view of the Superelevation Editor for **Ramp 2.**



	Superelevation	Name	Station	Curve Set	Cross Slope	Transition Type
▶	0-6FT	0-6FT - 0+00	0+00.00	0	3.87%	Linear
	0-6FT	0-6FT - 0+49	0+50.00	0	5.80%	Linear
	0-6FT	0-6FT - 6+36	6+35.43	0	5.80%	Linear
	0-6FT	0-6FT - 7+25	7+25.65	0	2.00%	Linear
	0-6FT	0-6FT - 7+74	7+73.13	0	0.00%	Linear
	0-6FT	0-6FT - 8+20	8+20.61	0	-2.00%	Linear
	0-6FT	0-6FT - 9+58	9+58.31	0	-7.80%	Linear
	0-6FT	0-6FT - 12+17	12+16.51	0	-7.80%	Linear
	0-6FT	0-6FT - 13+68	13+66.51	0	-2.00%	Linear
	0-6FT	0-6FT - 14+17	14+18.23	0	0.00%	Linear
	0-6FT	0-6FT - 14+69	14+69.95	0	2.00%	Linear
	0-6FT	0-6FT - 16+56	16+55.31	0	2.00%	Linear
	6-18FT	6-18FT - 0+00	0+00.00	0	3.87%	Linear
	6-18FT	6-18FT - 0+49	0+50.00	0	5.80%	Linear
	6-18FT	6-18FT - 6+36	6+35.43	0	5.80%	Linear
	6-18FT	6-18FT - 7+25	7+25.64	0	2.00%	Linear
	6-18FT	6-18FT - 7+74	7+73.13	0	0.00%	Linear
	6-18FT	6-18FT - 8+20	8+20.61	0	-2.00%	Linear
	6-18FT	6-18FT - 9+58	9+58.31	0	-7.80%	Linear
	6-18FT	6-18FT - 12+17	12+16.51	0	-7.80%	Linear
	6-18FT	6-18FT - 13+68	13+66.51	0	-2.00%	Linear
	6-18FT	6-18FT - 14+17	14+18.23	0	0.00%	Linear
	6-18FT	6-18FT - 14+69	14+69.95	0	2.00%	Linear
	6-18FT	6-18FT - 16+56	16+55.31	0	2.00%	Linear

21) **Delete** the **6-18ft Lane**.

22) Verify your result by running a **Superelevation Calculation Report** and comparing with the results listed below:



Superelevation Calculation Report

Report Created: Tuesday, May 7, 2024
Time: 2:37:04 PM

File Name:
Input Grid Factor:

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

Section Name:	Ramp 2-1
Base Horizontal Name:	RAMP2
Standards Filename:	c:\temp\dms00171\MoDOT_Superelevation_Rules_File.xml
Design Speed:	40
Pivot Method:	Right Edge
E Selection:	8%
L Selection:	MoDOT - AASHTO 2018 Eq. 3-23 and Table 3-16a
Calculation Units:	US survey foot
Start Station: 0+00.00 R1	**End Station: 16+55.31 R1**

Lane Set:	1
Left Offset:	-18.00
Right Offset:	0.00
Curve Set: 1	**Outside Lane: 6-18FT**

Global Variables:

NRotatedLanes	1.50
PivotType	4 (Right Edge)
WidthLane	12.00
InitialCrossSlope	-0.02
UseSpiralLength	true
PercentOnTangent	0.67
LengthsAreTotalTransition	false
UseRunoutLength	false
Radius	1059.74
Speed	40.00

Maximum cross slope calculations

Max E Value: 5.80%
Result from: From Non-interpolated Table 8%

Transition length calculations

Transition Length: 150.00
Result from: MoDOT - AASHTO 2018 Eq. 3-23 and Table 3-16a
Equation: TransitionLength
Variables:

Name	**Value**	**Equation**
NominalLaneWidth	12.00	12
NRotatedLanes	1.50	
MaxE	0.06	
bw	0.83	(NRotatedLanes+1)/(2*NRotatedLanes)
Speed	40.00	
gradient	0.58	
TransitionLength	150.00	100*(NominalLaneWidth*NRotatedLanes)*MaxE*bw/gradient

Format Options

	Mode	Precision	Format
Northing/Easting/Elevation:		0.123	
Angular:	Degrees	0.12	ddd.ddd
Slope:		0.12	50%
Use Alternate Slope if Slope Exceeds:		0.00%	
Alternate Slope:		0.12	50%
Linear:		0.12	
Station:		0.12	ss+ss.ss
Acres/Hectares:		0.123	
Area Units:		0.123	
Cubic Units:		0.123	Convert to Cubic Yard
Direction:	Bearings	0.123	ddd.ddd
Face:	Right Face		
Vertical Observation:	Zenith		

Close

Include Angular Suffix

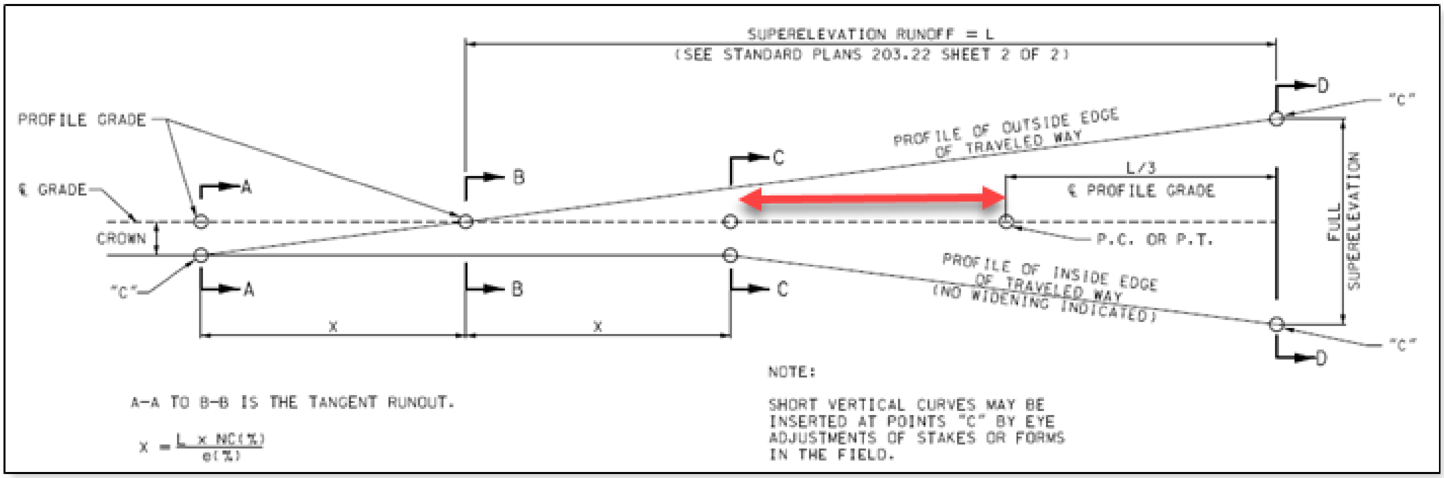
Delimeter: +

23) Next calculate the transition distance of the Mainline Pavement in the transition area before the **PC location** of the **Ramp2 Curve**.

x = (150) (2%)/ (5.8%) = 52'

Distance from C-C section to PC = L - (L/3) - x = (150') - (150'/3) – 52' = 48'

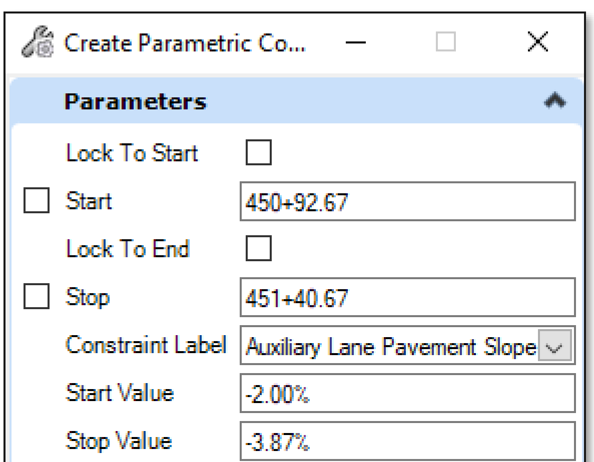
Note: This is the distance the Auxiliary Lane will have to transition from 2% (Mainline Slope) to a 3.87% (**Ramp 2 Slope**) at the **PC location** of the Ramp.



Open the **Corridors_J5P0555.dgn.**

24) For the next step select the **Corridor Views ➔ Open Cross Section Model** and verify the **Route 50 Mainline Ramp Pavement** is transitioning downward. Use the **Place Temporary Dimension Line** to verify the slopes of the mainline pavement.

25) Apply the following **Parametric Constraint.**
   a) **Route50** station value at start location of Ramp2 = Sta. 451+40.67
   b) Transition Start Station = Sta. 451+40.67 - 48' = **Sta. 450+92.67**



Start:	450+92.67 R1
Stop:	451+40.67 R1
Constraint Label:	Auxiliary_Lane_Pavement_Slope
Start Value:	-2.00%
Stop Value:	-3.87%

Create templates for Ramp 2 Corridor

26) Create template for Ramp2 Corridor
    a) In the Corridor Modeling Tab select the **Create Template** icon
    b) Open the **J5P0555.itl**
    c) Navigate to the **J5P0555** and **Create** a new folder called **Ramp 2**
    d) Right click on **Ramp 2** folder and select **New** > **Template**
    e) Name the Template **Ramp 2**
    f) In the **Dynamic Settings** dialog, verify the **Apply Affixes (LT_ , RT_)**, with X & Y Steps = **0.1**
    g) Use the following Components and End Conditions to create the **Ramp2** Template:

Template Components:

Left Side

Concrete Pavement 1 Lane w/ Agg Base Option 3

Right Side

A2 Shoulder Asphalt Option 3 w/ Agg Base

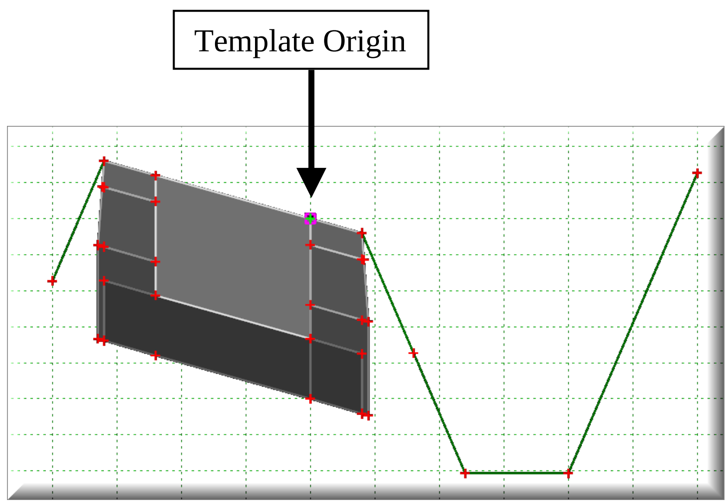
Template End Conditions:

Left Side

Fill Slope (6:1)

Right Side

6:1 Fill or 6:1 Forslope and Backslope Ditch



*Notes

a) **Concrete Pavement 1 Lane w/ Agg Base Option 3** is located in the following location:
Components\Pavement - New\Concrete Pavement w/ Shoulders\A2 Shoulders Agg Base\
b) **A2 Shoulder Asphalt Option 3 w/ Agg Base** is located in the following location:
Components\Shoulders\Asphalt Adjacent to Concrete Pavt w/o Curb\
c) **6:1 Fill or 6:1 Forslope and Backslope Ditch** is located in the following location:
End Conditions\Combined\
d) Adjust pavement slope to be 2% going up from baseline.
e) If not already done so, adjust the shoulders to follow the pavement slope using a Vector Offset constraint.
f) Check Priorities on End Conditions using the "**TEST**" button.

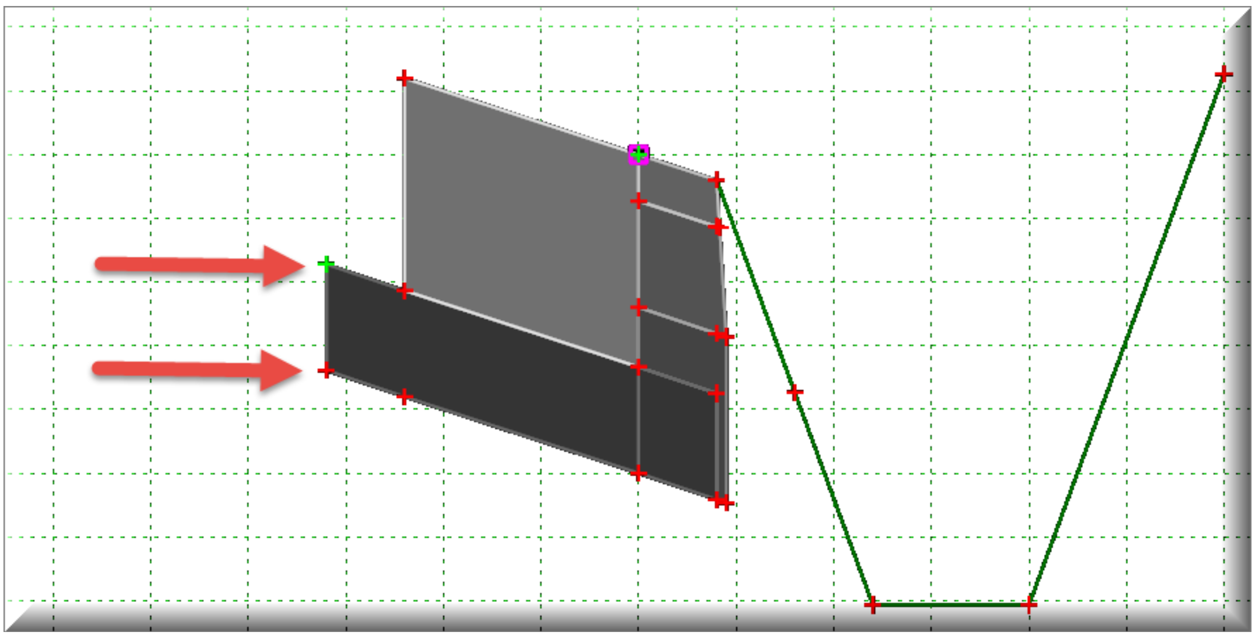
Next, we will need to create another **Ramp2** template for the area where the ramp and mainline butt up to each other.

27) Copy and paste the "**Ramp2"** Template located in the **Ramp2** folder.

28) Name new template "**Ramp2 - No LT Shoulder".**

29) Use the Delete Components option and remove the <u>**left outside**</u> Shoulder & Sub layers, and End Conditions. Do not delete Aggregate Base (See picture below).

30) Delete two Aggregate Base points (See arrows below)



31) Close and save.

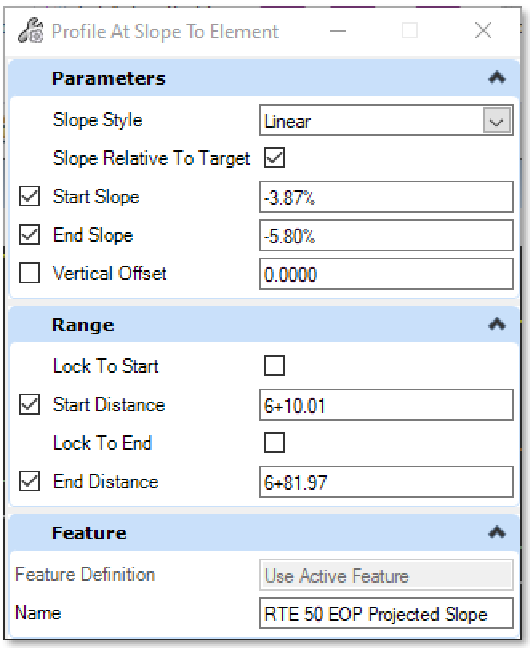
Create Ramp 2 Profile

32) Open the **J5P0555_Superelevation.dgn** file and review superelevation sections.
    a) Verify slope at PC location is **3.87%**
    b) Verify slope at Max Super is **5.80%**

33) Open the **J5P0555_Civil_Geometry.dgn** file.
    a) Within the Default 2D View reference in the **Corridors_J5P0555.dgn** file.

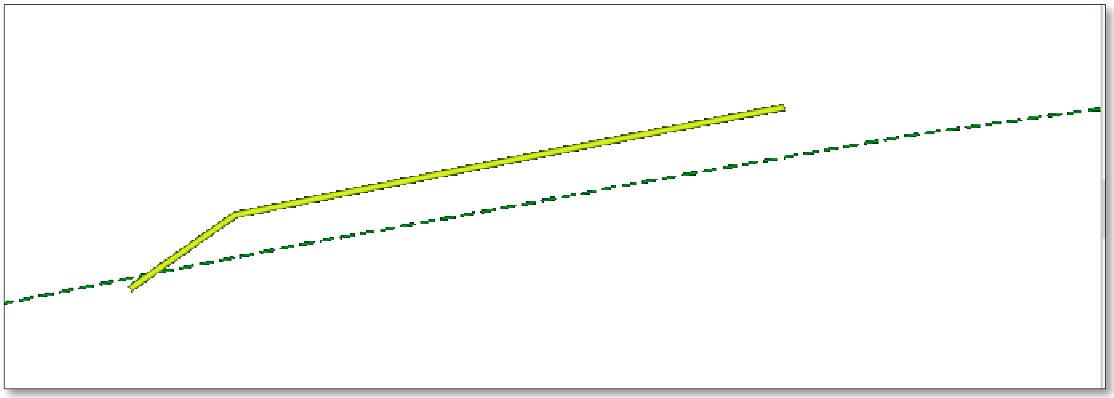
34) Open the **Profile Model** for the **Ramp2** Alignment.

35) From the **Route50** edge of pavement, project the superelevation slope down to the Ramp2 baseline. Select the **Geometry** Tab ➔ **Vertical Geometry** Section ➔ **Element Profiles** Tools ➔ **Profile by Variable Slope from Element**.



Feature Definition:	Geometry Scratch
Name:	RTE 50 EOP Projected Slope
Slope Relative to Target:	Check
Slope Style:	Linear
Plan Element:	Ramp2 Baseline
Reference Element:	EOP_New line between Ramp and Mainline
Start Distance:	6+10.01 (Ramp2 Sta. 0+00.00)
Start Value:	-3.87%
Stop Distance:	6+81.97 (Ramp2 D-D Section)
Stop Value:	-5.80%
Vertical Offset:	0.00’

Note: The profile created in the previous step should look like the profile below. Because the Reference Element (Mainline EOP) had 90-degree edge near the beginning of Ramp2, a kink is produced in the resulting profile. The 90-degree edge was created because the EOP_New plan line is being targeted with Corridor Reference.



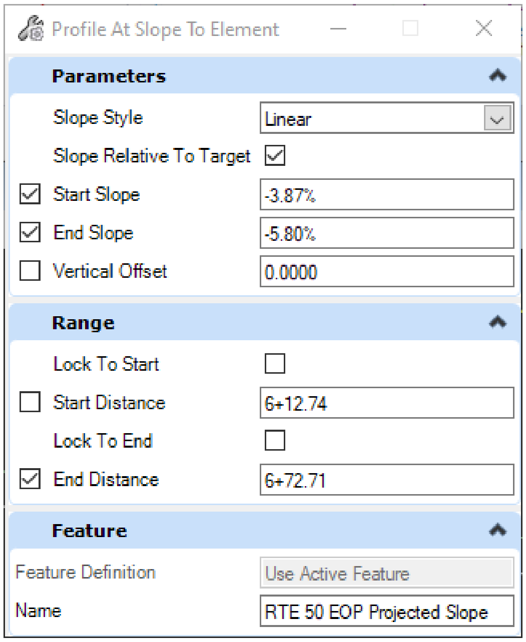
36) To create a profile without a kink, remove the **EOP_New** Corridor Reference nearest the PC of the Curve.
    a) Open the **Corridors_J5P0555.dgn** file
    b) From the Corridor heads up tools, select "**Remove Corridor Reference**"

37) Open the **J5P0555_Civil_Geometry.dgn** file.

38) Open the **Profile Model** for the **Ramp2** corridor.

39) Delete first projected profile.

40) From the **Route50** Edge of **Pavement**, project the superelevation slope down to the Ramp2 baseline. Select the **Geometry** Tab ➔ **Vertical Geometry** Section ➔ **Element Profiles** Tools ➔ **Profile by Variable Slope from Element.**



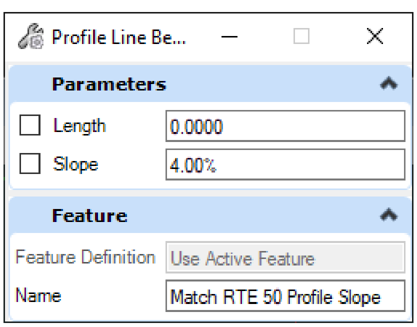
Feature Definition:	Geometry Scratch
Name:	RTE 50 EOP Projected Slope
Slope Relative to Target:	Check
Slope Style:	Linear
Plan Element:	Ramp2 Baseline
Reference Element:	EOP_New line between Ramp and Mainline
Start Distance:	6+12.74 (Ramp2 Sta. 0+00.00)
Start Value:	-3.87%
Stop Distance:	6+72.71 (Ramp2 D-D Section)
Stop Value:	-5.80%
Vertical Offset:	0.00’

Note: If you add EOP_New Corridor Reference back in the kink will show back up. The profile is dynamically linked to the EOP profile.

41) Open the **Route50** Profile model and verify the profile grade at **Sta. 451+40.61** is **4.00%**

42) Reopen the **Ramp2** Profile model.

43) Using the **Profile Line Between Points** tool, located under the **Geometry** Tab ➔ **Vertical Geometry** Section ➔ **Line** Tools, place a **4%** slope before the Projected Ramp2 profile.

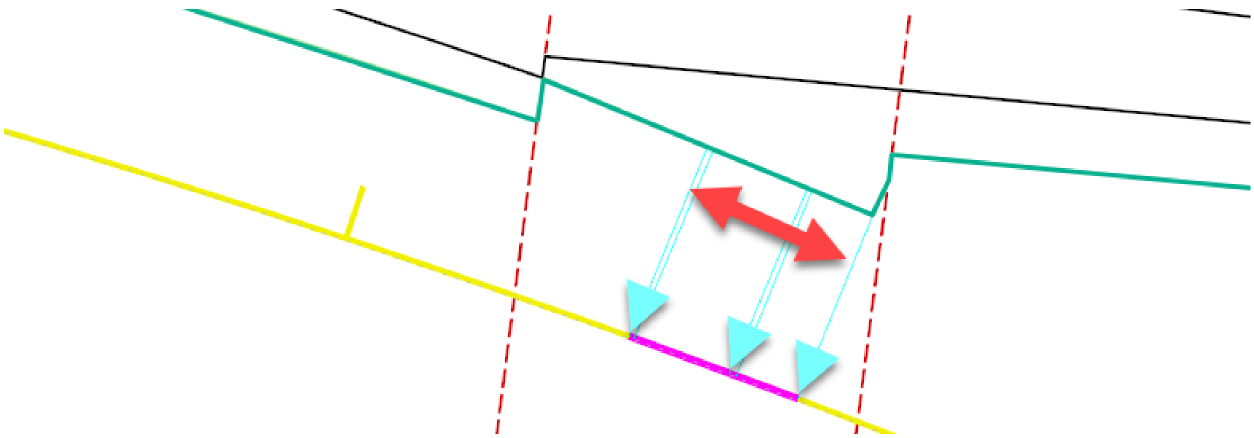


Feature Definition:	EOP_New
Name:	Match RTE 50 Profile Slope
Slope:	4%

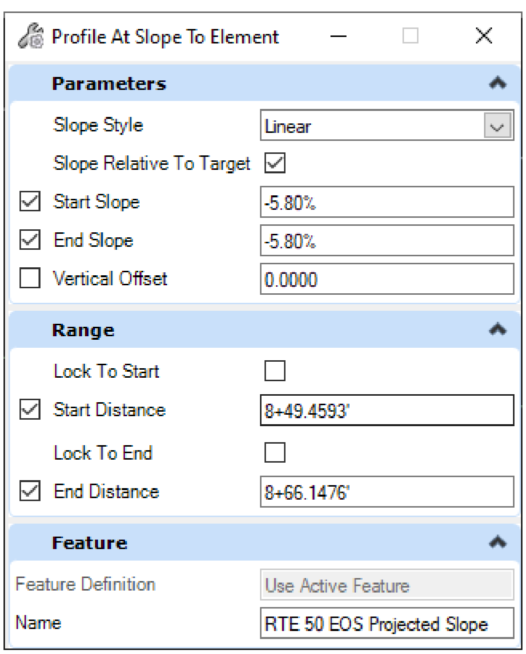
44) Once again project the superelevation slope down to the Ramp2 baseline, but this time from the **Route50** **<u>Edge of Shoulder</u>**.

Select the **Geometry** Tab ➔ **Vertical Geometry** Section ➔ **Element Profiles** Tools ➔ **Profile by Variable Slope from Element.**

Project down from the midpoint of the shoulder line to right edge (See below).

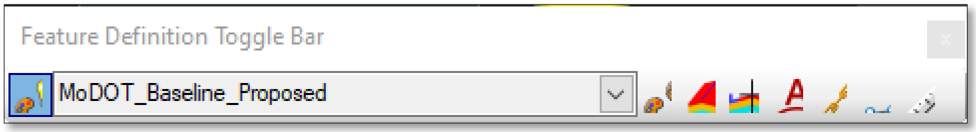


To understand how **Start** and **Stop** distances of this step relates to the station limits and plan geometry, review the notes in the **Plan_J5P0555.dgn** file.



Feature Definition:	Geometry Scratch
Name:	RTE 50 EOS Projected Slope
Slope Relative to Target:	Check
Slope Style:	Linear
Plan Element:	Ramp2 Baseline
Reference Element:	EOS_New line between Ramp and Mainline
Start Distance:	8+49.46 (Ramp2 Sta. 2+28.79)
Start Value:	-5.80%
Stop Distance:	8+66.1476 (Ramp2 Sta. 2+45.18)
Stop Value:	-5.80%
Vertical Offset:	0.00’

45) Within the Feature Definition Toggle Bar set the Feature Definition to MoDOT_Baseline_Proposed. Also, toggle on "**Use Active Feature Definition**".



46) Using the **Parabola from Element** tool, located under the **Geometry** Tab ➔ **Vertical Geometry** Section ➔ **Curve** Tools ➔ **Profile Curve from Element** Sub-Tools, place a vertical curve from the start of the Projected profile to the end.

a) After starting the tool, the "**Locate Element**" will be the **4% Profile Line**.
b) After placing the start point at the beginning of the Projected Profile, define the endpoint of the vertical curve by Accu-Snapping to the right endpoint of the second Projected Profile.
c) When asked to Trim, select the "**None"** option.

Note: You can use Civil AccuDraw to help start the profile at **Sta. 0+00.00**

47) The last VPI for the **Ramp2** profile will be where the ramp chain **crosses the Big Horn crossroad gutter line**. This point is **offset 18.5'** from the crossroad centerline. The elevation of the crossroad at this point and corresponding ramp station have already been determined below. Based on this, **the last VPI at the end of the profile should use the following VPI station and elevation**.

Station	Elevation
16+36.81	763.92

Using the **Tangent Profile Line to Element** tool, located under the **Geometry** Tab ➔ **Vertical Geometry** Section ➔ **Lines** Tools ➔ **Profile Line to Element** Sub-Tools, select the previously placed profile line, and using AccuDraw and its "Z" Mode place the endpoint at **Sta. 16+36.81** at an **Elevation of 763.92**. When asked to **Trim**, select the "**Back"** option.

48) Delete both the **4% Profile** line located before the **PC Point** and the two **Projected Profiles**.

49) Join the two profile elements using the Vertical Geometry **Profile Complex By Elements**, naming the profile **Ramp 2 Proposed (**If the tool does not let you Complex the profile elements make sure you make sure you delete all the elements in the previous step).

50) Set the **Ramp2 Proposed** profile as **active**.

51) Run the **Vertical Alignment Report** on the **Ramp 2 Proposed** profile.

Vertical Alignment Review Report

Report Created: Sunday, December 3, 2023
Time: 11:26:19 PM

Project: Default
Description:
File Name: c:\temp\dms35432\Civil_Geometry_J5P0555.dgn
Last Revised: 12/3/2023 23:25:14

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

Horizontal Alignment: RAMP2
Horizontal Description:
Horizontal Style: Alignment\MoDOT_Baseline_Proposed

Vertical Alignment: Ramp 2 Proposed
Vertical Description:
Vertical Style: Alignment\MoDOT_Baseline_Proposed

	Station	Elevation
Element: Symmetrical Parabola		
VPC	0+00.00 R1	728.845
VPI	3+70.59 R1	743.669
VPT	7+41.18 R1	749.596
Length:	741.18	
Entrance Grade:	4.00%	
Exit Grade:	1.60%	
r = 100 * (g2 - g1) / L:	-0.32	
K = l / (g2 - g1):	308.74	
Middle Ordinate:	-2.22	
Element: Linear		
VPT	7+41.18 R1	749.596
END	16+36.81 R1	763.920
Tangent Grade:	1.60%	
Tangent Length:	895.63	

52) Open the **Corridors_J5P0555.dgn** file.

53) Reapply the **EOP_New** element located just before the beginning of **Ramp 2** as a **Corridor Reference** for the **Route50** corridor.

Create Ramp2 Corridor

54) Create a new corridor by selecting **Corridors** Tab ➔ **New Corridor.**

55) Select the **Ramp2** baseline and name the corridor "**Ramp2**".

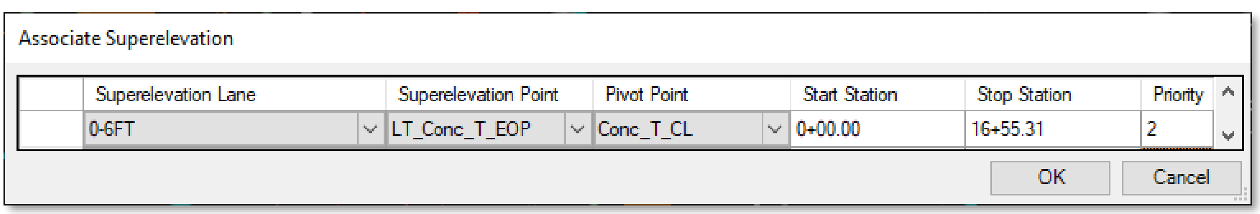
56) Apply Roadway template.
    a) **J5P0555\Ramp2\Ramp2 - No LT Shoulder**
    b) From Station **0+00.00 R1** to **Sta. 2+45.18 R1**
    c) Drop Interval of **1ft**.

57) Apply Roadway template.
    a) **J5P0555\Ramp2\Ramp2**
    b) From Station **2+45.19 R1** to **Sta. 15+00 R1**
    c) Drop Interval of **10ft**.

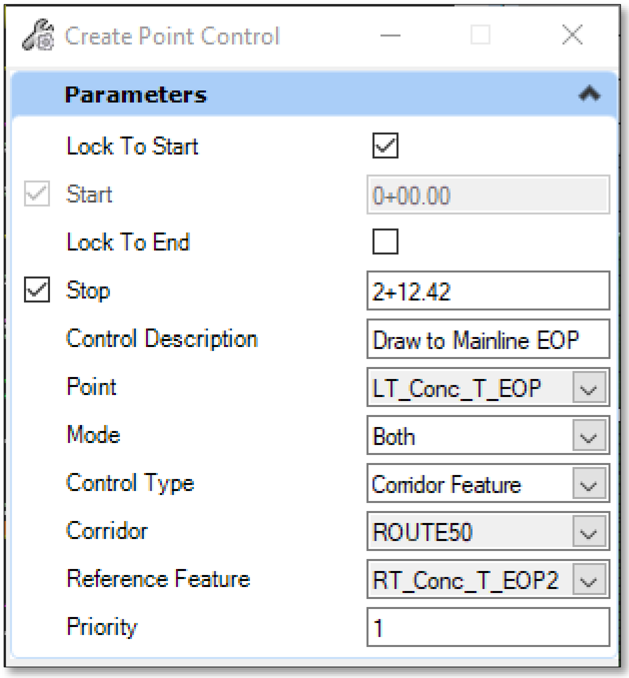
58) From the **Route 50 Corridor** clip out the **Ramp2 Corridor**.

59) If needed select the "**F6**" key to open 3D view of model.

60) Within the Default 2D View, reference in the **J5P0555_Superelevation.dgn** file.
    a) Assign Superelevation to the **Ramp2** Corridor.
    b) The slope of the pavement before the shoulder nose will be controlled by the **Route 50 Edge of Pavement** using a **Point Control**.
    c) The slope of the pavement after the **shoulder nose** will be controlled by the **Superelevation shape**. Therefore, adjust the **Priority** of the Superelevation Point Control to be **greater than 1**.
    d) In the Reference Dialog turn off the Display of the Superelevation.dgn.

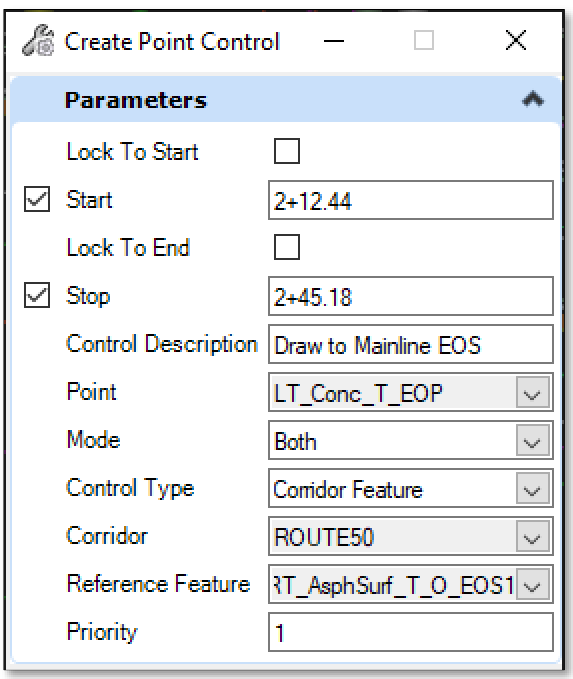


61) To make the **Ramp2** pavement draw up to the **EOP** of the **mainline** set the following Point Control:



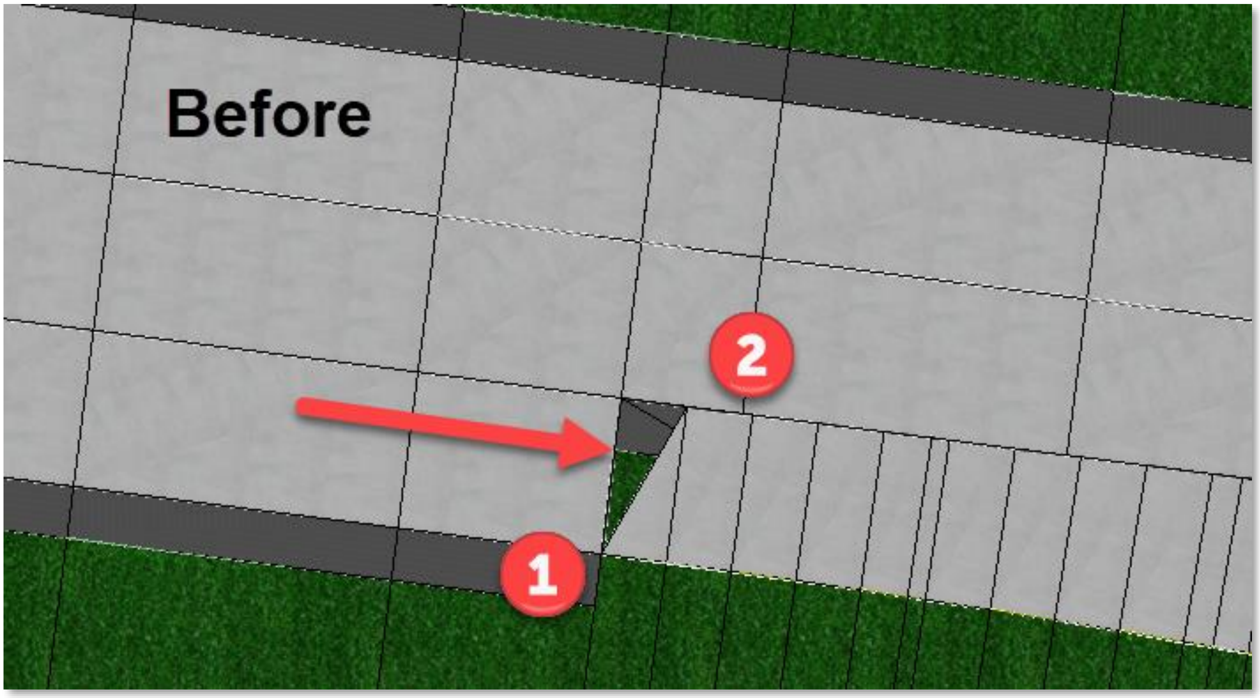
Start Station:	0+00
Stop Station:	2+12.42 (just shy of the shoulder nose)
Description:	Draw to Mainline EOP
Point:	LT_Conc_T_EOP
Mode:	Both
Control Type:	Corridor Feature
Corridor:	Route50
Reference Feature:	RT_Conc_T_EOP2
Priority:	1
Horz. & Vert. Offset:	0

62) To make the **Ramp2** pavement draw up to the **EOS** of the mainline (in the area of the shoulder median), set the following Point Control:



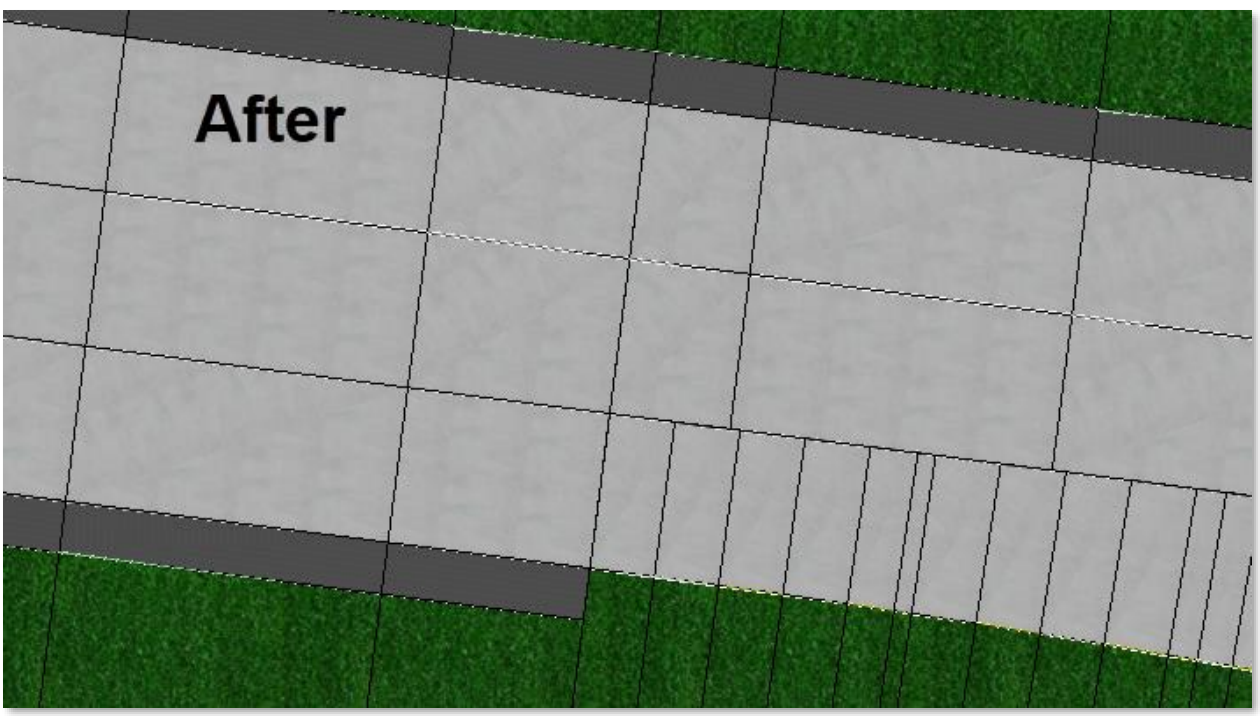
Start Station:	2+12.44
Stop Station:	2+45.18
Description:	Draw to Mainline EOS
Point:	LT_Conc_T_EOP
Mode:	Both
Control Type:	Corridor Feature
Corridor:	Route50
Reference Feature:	RT_AsphSurf_T_O_EOS1
Priority:	1
Horz. & Vert. Offset:	0

63) You will notice that after the point Controls were applied that the Ramp Pavement at the start of the alignment now does not draw correctly. To fix this will apply a **Key Station**.



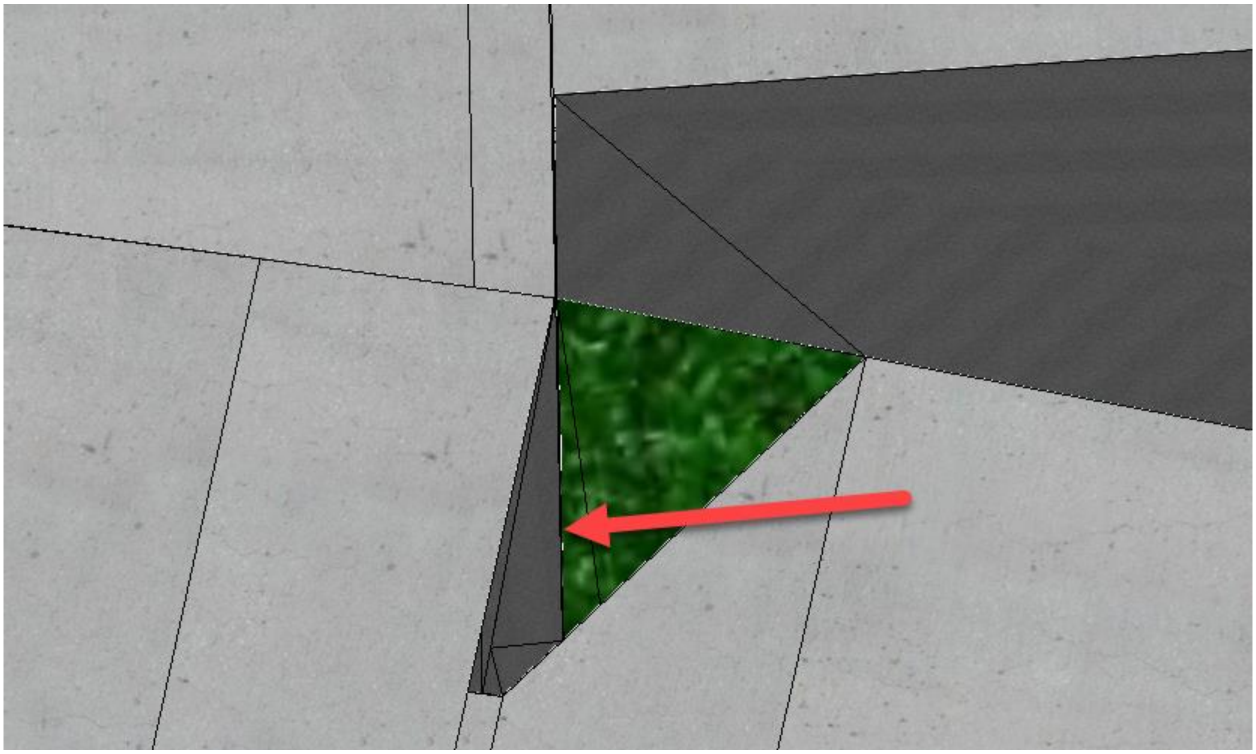
The first two Template Drops for Ramp 2 are both solving for the Route 50 EOP. The first Template Drop is solving for the widened Axillary Lane EOP, and the Second Template Drop is solving for the normal Route 50 EOP.

To fix this we will introduce a **Key Station** just after the Start of the Ramp 2 start location at **Station 0+00.01** and adjust the **Template Drop Start Station** to **0+00.004**.



64) To make the Ramp 2 pavement model correctly, the **Route 50** shoulder indicated by the red arrow needs to be removed.

Because there is shoulder width in the area indicated by the red arrow, the **pavement of Ramp 2** is not allowed to draw to the **Route 50 Edge of Shoulder** near the Shoulder Median Nose.



65) In the **Route 50** Template modify the **RT_AsphSurf_T_O_EOS1** point and **rename** the **Horizontal Constraint Label** from **Shldr_Asph_A2_Width** to **RT_Outside_Shldr_Asph_A2_Width**.

Notes:

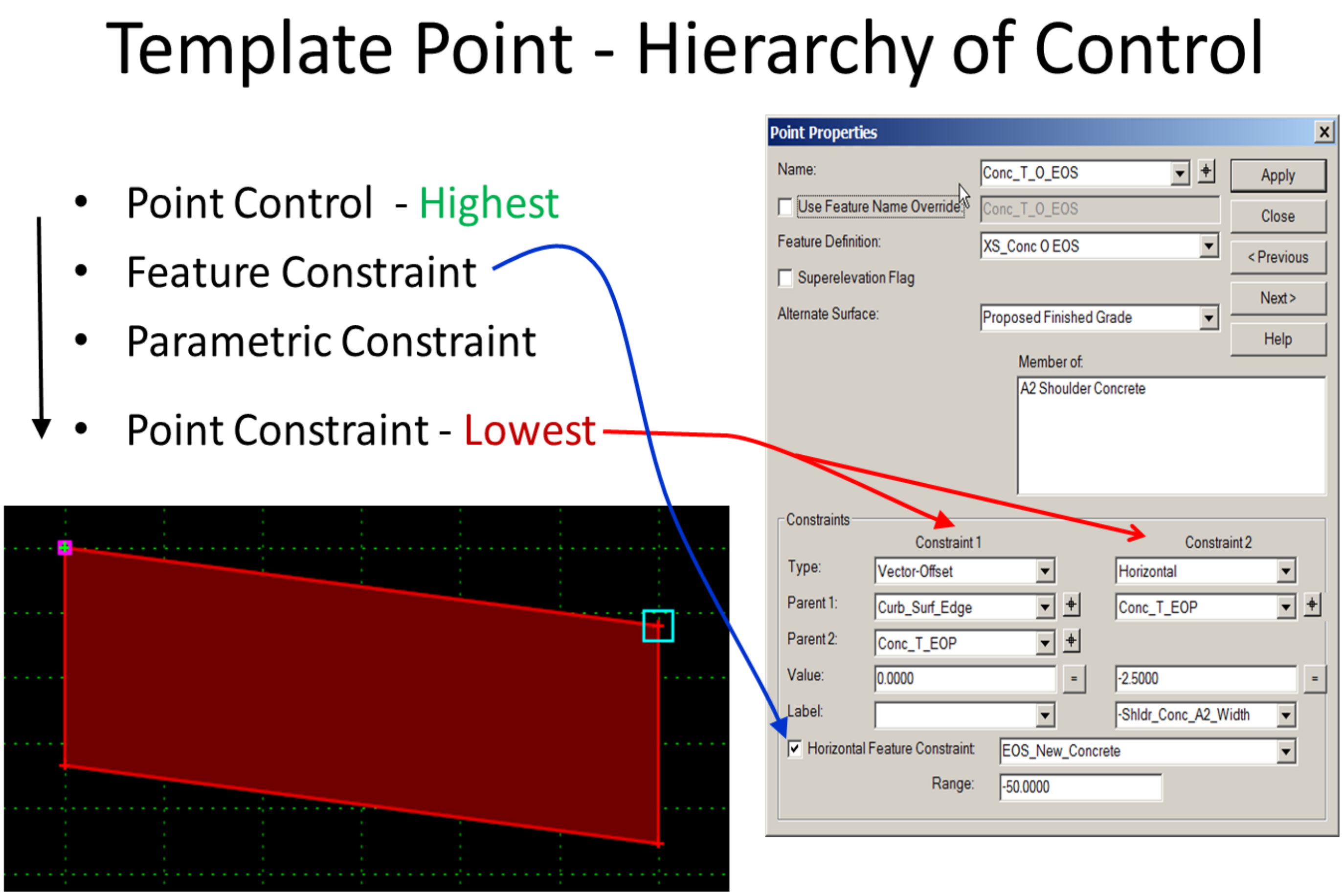
- In the next step we will use a Parametric Constraint to set the Route 50 Shoulder Width to zero in the area above.

- The benefit to using a Parametric Constraint is because it's a lower level of control than the Feature Constraint. Therefore, the User should define a general station range to apply the Parametric Constraint around the shoulder gore area and let the Plan Element of the Feature Constraint exactly define the limits of the shoulder gore nose.

- See next page for Template Point Hierarchy of Control.

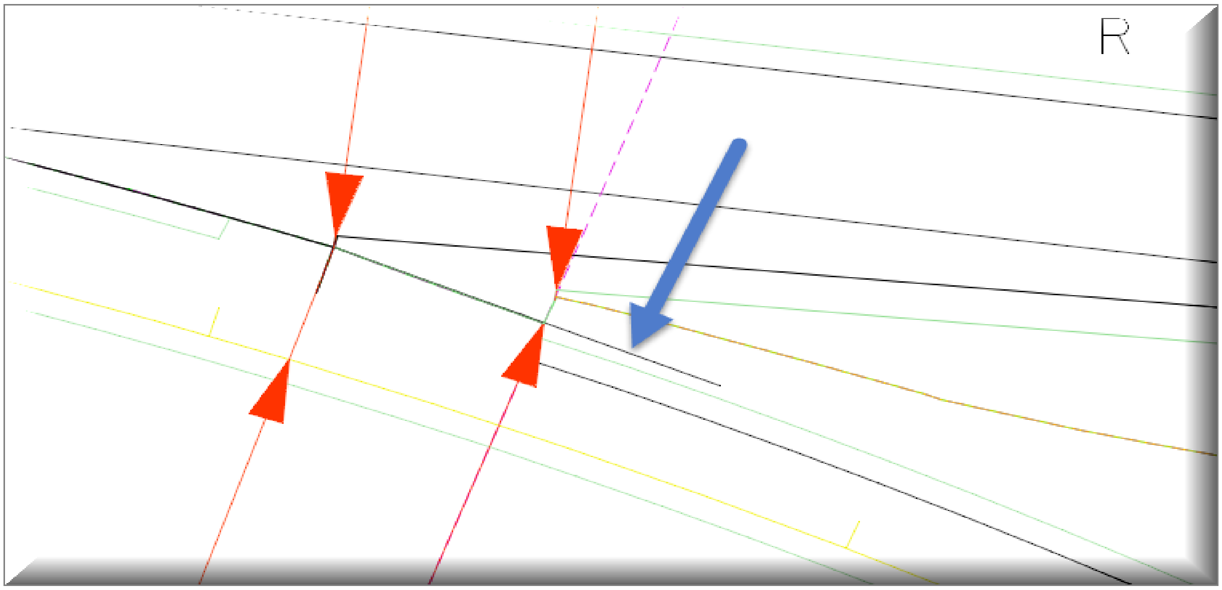
66) Apply the following **Parametric Constraint** to the **Route 50 Corridor** to set the Shoulder Width to zero around the Shoulder Nose.

Start:	453+40.00 R1 +/-
Stop:	453+70.00 R1 +/-
Constraint Label:	RT_Outside_Shldr_Asph_A2_Width
Start Value:	0.00
Stop Value:	0.00



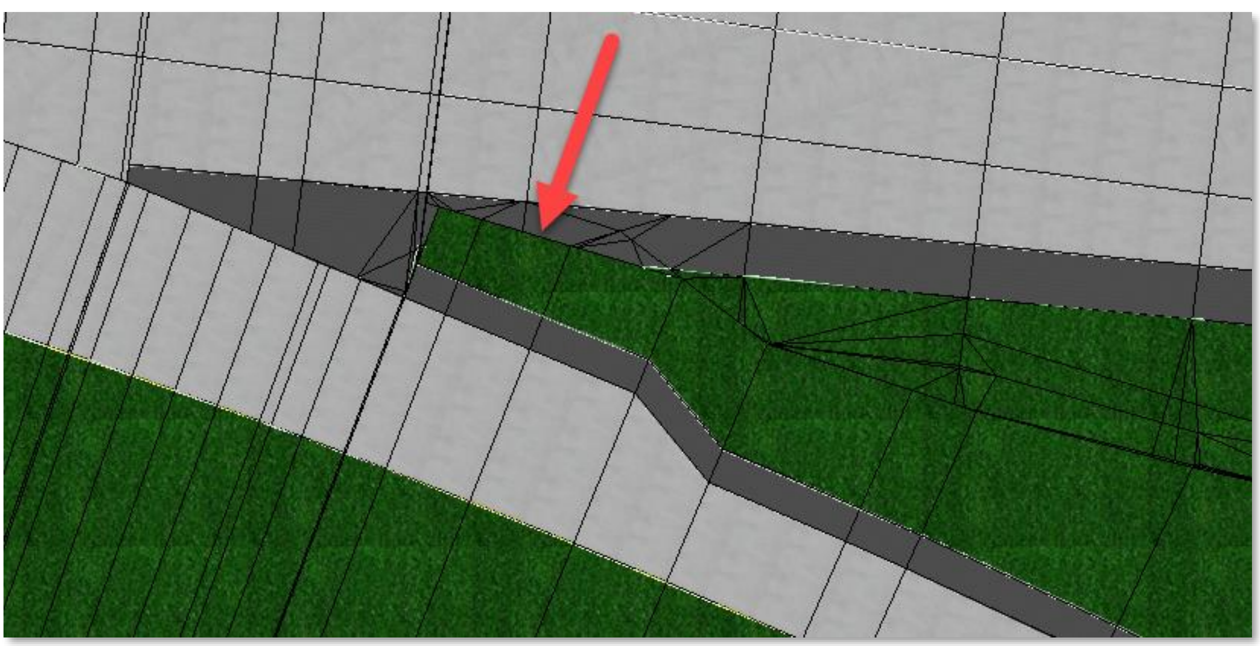
67) Add the **EOP_New** line that transitions from an **18’** offset to a **20’** offset as corridor references in the **Ramp2 Corridor**. The EOP line is near the grass gore point (see Blue Arrow below).

- Next, you will need to change the **LT_Conc_T_EOP** point’s **Horizontal Feature Constraint** in **both** the **Ramp 2** Template Drops from Linear ➔ Design ➔ Roadway ➔ ***DNC*** to Linear ➔ Design ➔ Roadway ➔ ***EOP_New***



68) Edit the J5P0555\Ramp2**Ramp2** template and modify the **Horizontal Constraint** for the **LT_Conc_T_EOP** point to a width of 18’.

69) To help with the situation below, within the **Ramp 2** Corridor, **Target Alias** the Route 50 Corridor. Also **add the terrain** as the secondary target.



Create Special Ditch - Drawing the Ditch Foreslope to a Alignment and Profile

70) In the **Civil_Geometry_J5P0555.dgn** create following Ditch Alignment and Profile.

a) Use the Horizontal Geometry Tool **Complex By PI** to place a line with a **Feature Definition** of Linear ➔ Design ➔ Drainage ➔ **Special_Ditch_Right** at the following locations:

- Note: use **Civil AccuDraw** to place line accurately along the **Route50** and **Ramp 2** Alignment.
- Use a radius of **200'**
- Name the ditch alignment: **Special Ditch**

Station	Offset	Chain
445+30.94	120	Route50
448+70.00	120	Route50
449+50.00	150	Route50
1+00	90	Ramp2
5+00	70	Ramp2
10+00	100	Ramp2

b) Open the **Special Ditch Profile** View. Use the Vertical **Profile Line Between Points** Tool to place a profile with the following VPIs:

- Note: use **Civil AccuDraw** to place profile accurately along the **Special Ditch** Alignment.
- Name this profile: **Special Ditch Proposed**
- Make the profile **Activate**

Station	Elevation
0+00	688.00
15+75.75	704.00

71) In the next few steps, we are going to apply a Point Control that will control how the **Ditch Foreslope Bottom** point (RT_Dtch_Frslp_1_B) behaves. Currently within the Ramp2 Corridor, all the right End Conditions are only solving for a Fill Slope.

Note: For the **RT_Dtch_Frslp_1_B** to be controlled with a Point Control the Right Ditch End Condition must be solving somewhere in the corridor.

In other words, with a Point Control, to select and control the **RT_Dtch_Frslp_1_B** point, a right cut/ditch must be drawing somewhere in the corridor. If a ditch is not drawing, the ditch foreslope point will not be listed as an available point to control in the **Point Control** dialog.

Open the **Corridors_J5P0555.dgn** and within the **first** **Ramp 2 Corridor Template Drop** change the **Ditch** Foreslope **Slope** constraint to a **-50%** slope.

72) In the **Corridors_J5P0555.dgn** file create the following Point Controls to have the ditch bottom foreslope point draw the special ditch.

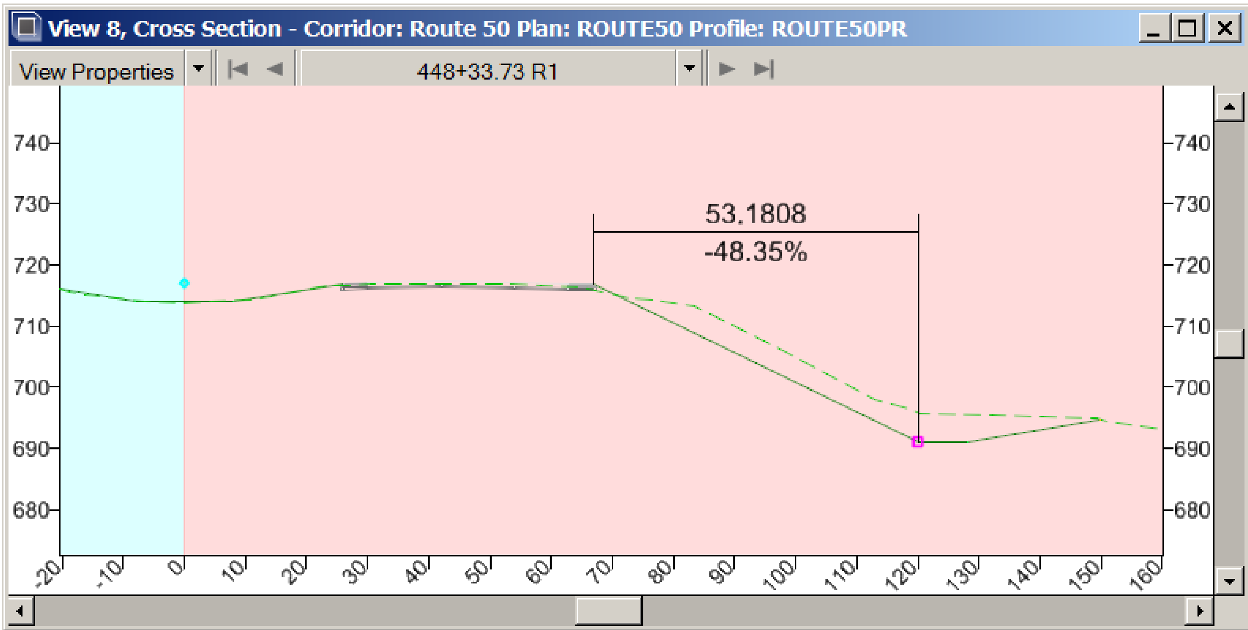
Route 50 Corridor:

Start Station:	Beginning of Alignment
Stop Station:	451+40.67 R1 (Start of Ramp 2)
Control Description:	Draw to Special Ditch Alignment and Profile
Point:	RT_Dtch_Frslp_1_B
Mode:	Both
Control Type:	Linear Geometry
Plan Element:	Special Ditch
Profile Element:	Special Ditch Proposed
Use as Secondary Alignment:	Yes
Priority:	1
Horz. & Vert. Offset:	0

Ramp 2 Corridor:

Start Station:	Beginning of Alignment
Stop Station:	15+00 R1
Control Description:	Draw to Special Ditch Alignment and Profile
Point:	RT_Dtch_Frslp_1_B
Mode:	Both
Control Type:	Linear Geometry
Plan Element:	Special Ditch
Profile Element:	Special Ditch Proposed
Use as Secondary Alignment:	Yes
Priority:	1
Horz. & Vert. Offset:	0

73) Open the **Route 50 Dynamic Cross Section** Model View. Place **Temporary Dimension Lines** along the Ditch Foreslope. You should notice that the slope is changing from section to section because the Bottom Ditch Foreslope point must hit the Special Ditch Alignment and Profile. In the next few steps, the parameters will change such that the slope remains constant, and the ditch will follow the ditch elevation.



Notes: When placing a **Temporary Dimension Line** and you're having troubles selecting a location on the template, you might try the following:

a) Delete the Dynamic XS View, by **Right Clicking** and **Holding** in the Cross Section view, select **View Controls → Delete Dynamic XS View**.

b) If you used the "**Locate Station via Datapoint**" option, make sure the Dynamic Cross Section you're viewing is on a template drop location and not in between two drops.

Create Special Ditch - Drawing to a Ditch Profile while holding Constant the Ditch Foreslope

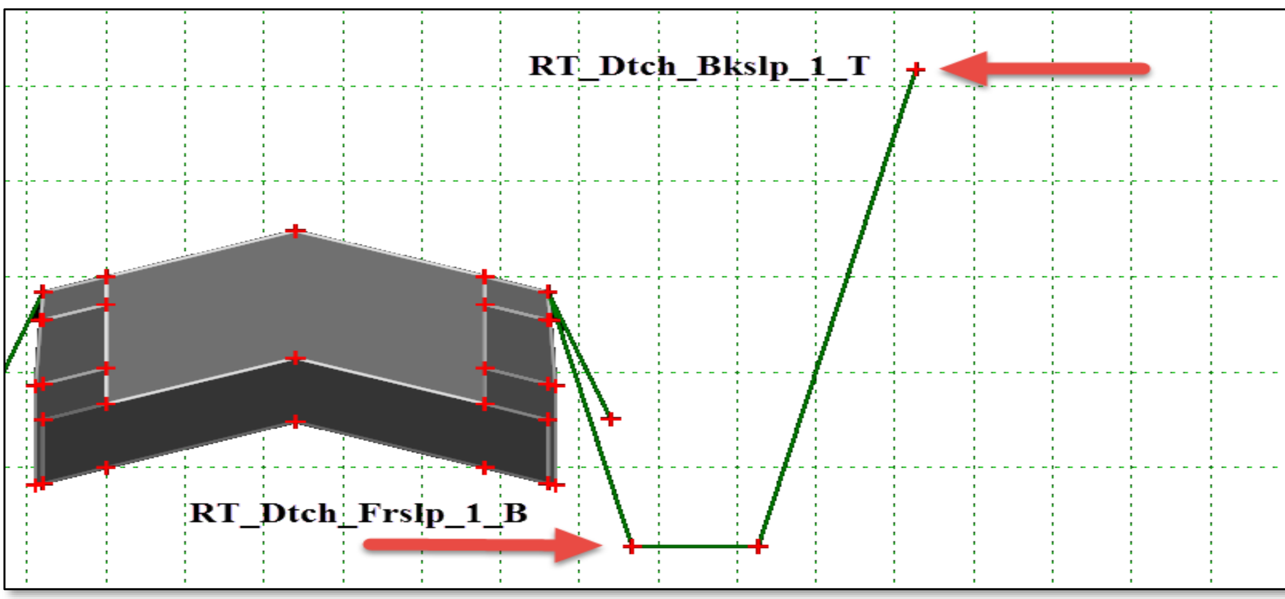
Point Controls work by replacing the constraint that most closely matches the point control. **Example**: If a point has a **Horizontal** and **Slope** Constraint, a **Vertical** Control will replace the **Slope** Constraint, but if the point has a **Vertical** Constraint and a **Slope** Constraint, the **Vertical** Control would replace the **Vertical** Constraint. If the constraints are the same (**Slope-Slope** for instance), the **Second** constraint will be replaced.

Tips and Tricks for Roadway Designer - Bentley 2009 Roads and Bridges

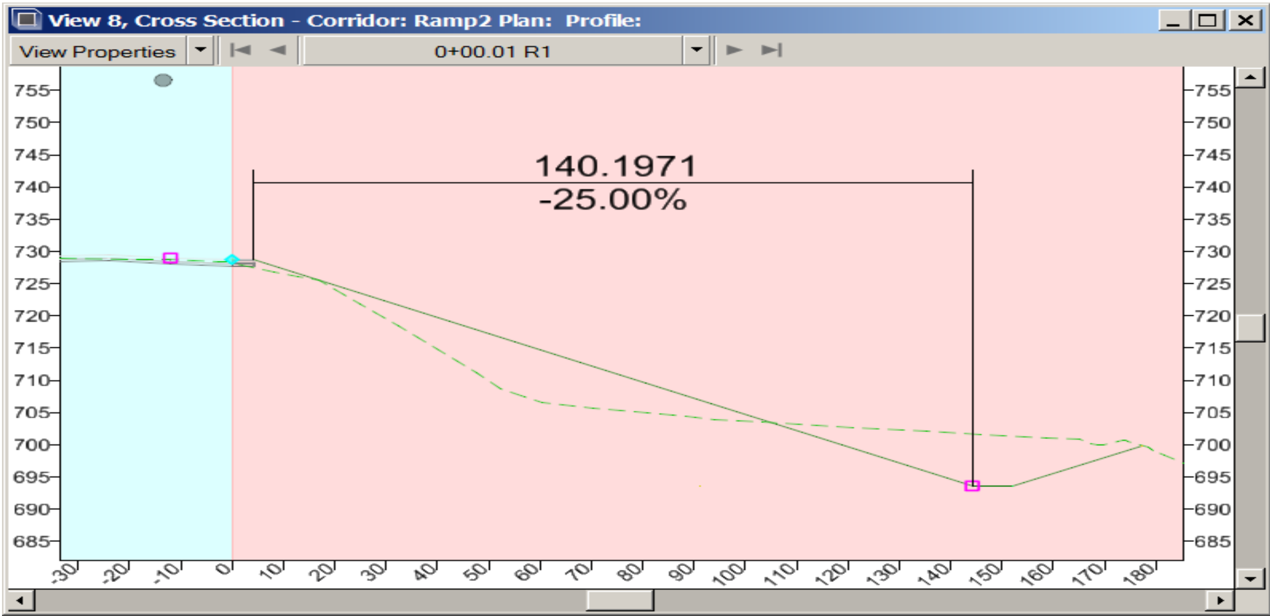
74) To draw to Ditch profile some points in the Ditch Component need to be redefined in **all three template drops** on the **south** side of the project.

a) Edit the **RT_Dtch_Frslp_1_B** point.
- Adjust the slope to **-25.00%**
- Change the **Horizontal Constraint** to a **Vertical Constraint**.

b) Edit the **RT_Dtch_Bkslp_1_T** point.
- Adjust the slope to **25.00%**



75) In the **Route 50** and **Ramp 2** Corridors, edit the Special Ditch Point Controls by changing the **Point Control Mode** from **Both** to **Vertical**.



Note: There is one section off the **Route 50 Corridor** that does not solve for a Ditch after applying the adjusted Point Controls. To make that section solve as a ditch, the User could move the **Special Ditch Profile** down one foot at the start the profile.

Note: **Point Control Recommendations** from **Kevin McDonald** at Bentley

- I advise all Users not to use point controls on the last point of an end condition. End conditions need the freedom to seek their targets successfully, and typically, extending the end condition out to meet the target is typically last, even after point controls are applied.
- Instead of using point controls on the last point of end conditions, a higher priority end condition can be created that seeks the linear geometry. So, for example, in the station range from **138+97.04** to **139+78.05** right, we should not use point controls on the points “Fill_Slope_1_B_R” and “Fill_Slope_2_B_R”, we should instead create **Priority 1** End Conditions that seek the **Linear Geometry** elements (or add an end condition exception that does it). If they find their target, they will construct a point along the linear, if they fail, they will move to the next priority end condition that will seek the Terrain.
- The question sometimes gets raised… “Why does it work sometimes?” As in this case, it seems to work OK on some stations, but it is now failing. The answer I give is because there are lot of factors that affect the order end conditions and point controls are processed, so it can work sometimes, but not dependably. Using **End Conditions** to seek targets is the dependable method.

<u>In Summary:</u>

It’s good practice to never to use a **Point Control** on the last point of an **End Condition**. The main reason is that the end condition needs the freedom on the last point to successfully find its target. Point controls can possibly move the last point such that it doesn’t find the target which can cause the entire end condition to fail. (There are cases where it will work out OK, but it is just safer never to do it.)

If you have some geometry that will **fully control** the last point of an **end condition**, just seek that geometry with an End Condition. For example, if I have a geometry representing the **Horizontal** and **Vertical** location of where I want a slope to tie, I can model it with an end condition that seeks the **horizontal**, then attach another end condition that seeks the **vertical**. If you mark the first point as **Do Not Construct**, it will draw the slope from the start point to the tie point.

Kevin McDonald
Bentley Systems, Inc.