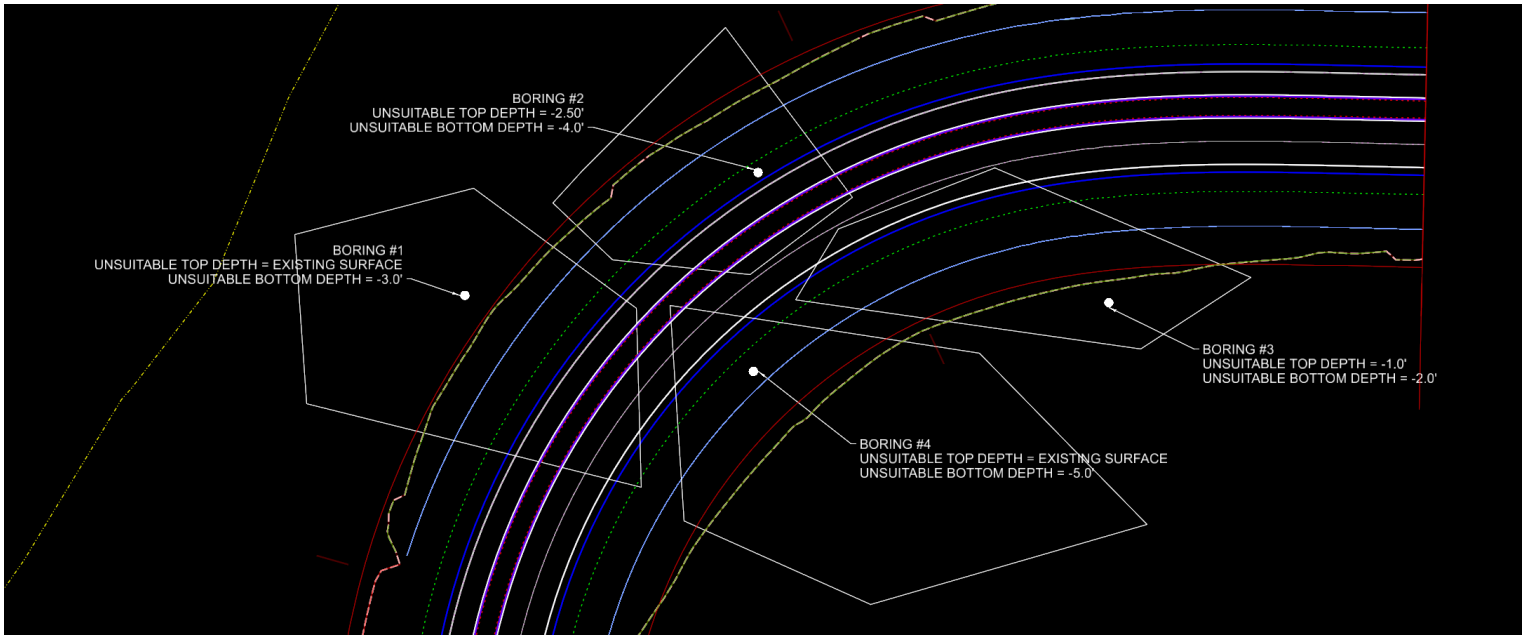
DRAFT

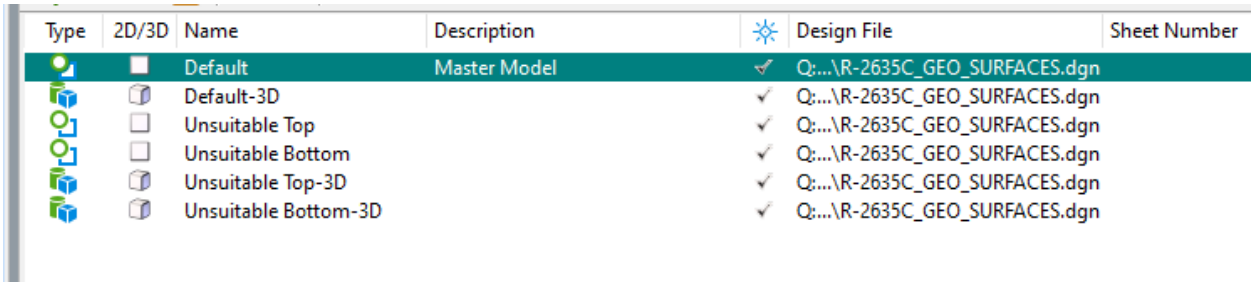
Geotech Volumes Patterns on Cross Sections

For this Example only one layer is evaluated – Unsuitable Excavation

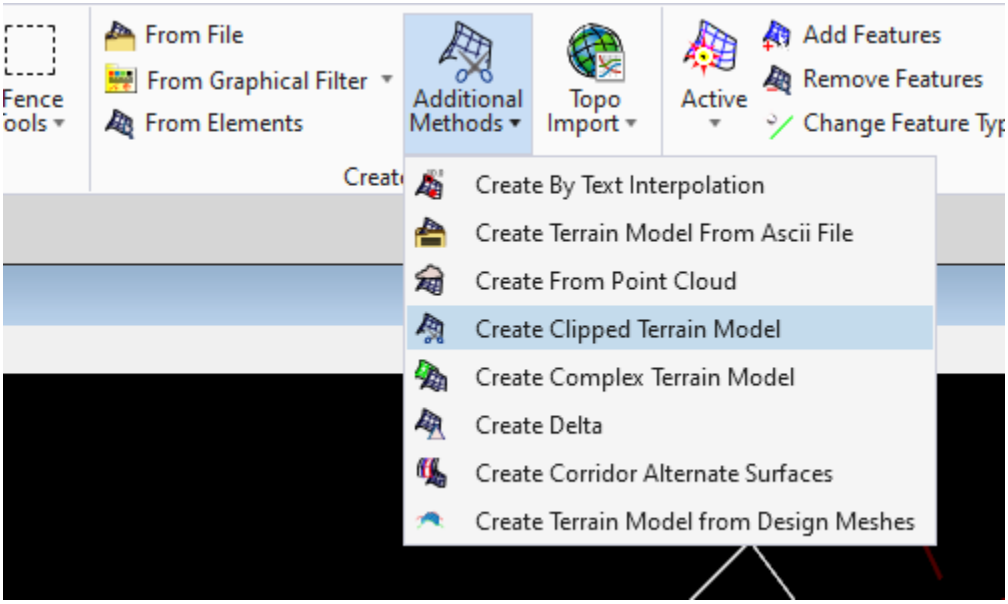
1. Delineate the Unsuitable layer
    a. Create Boundaries for the Top and Bottom of the desired layer
    b. Example File is R-2635C_GEO_SURFACES
    c. Bore holes are added as a reference and the top and bottom depth of each layer is noted.
    d. Draw a closed shape representing the boundaries of the constant depth around each borehole
        i. These shapes do not have to touch
        ii. Intermediate shapes at various depths could be added
        iii. The shapes can be (should be) outside of the roadway corridor
        iv. In the screen shot below the Borings, Boundaries and Closed Shapes are shown



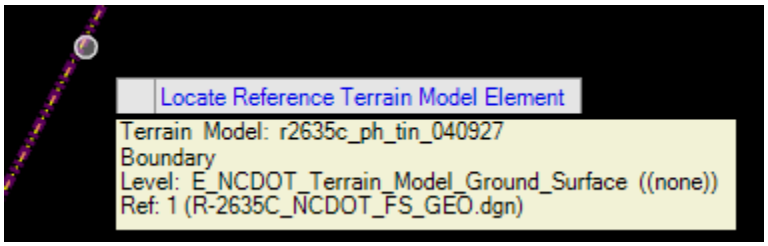
2. Create Terrains for the Top and/or Bottom as required
    a. Recommedn creating a 2D model in the design file for each top and bottom layer, multiple layers could eb stored in one file. The 3D Models are automatically created when the terrains are created.



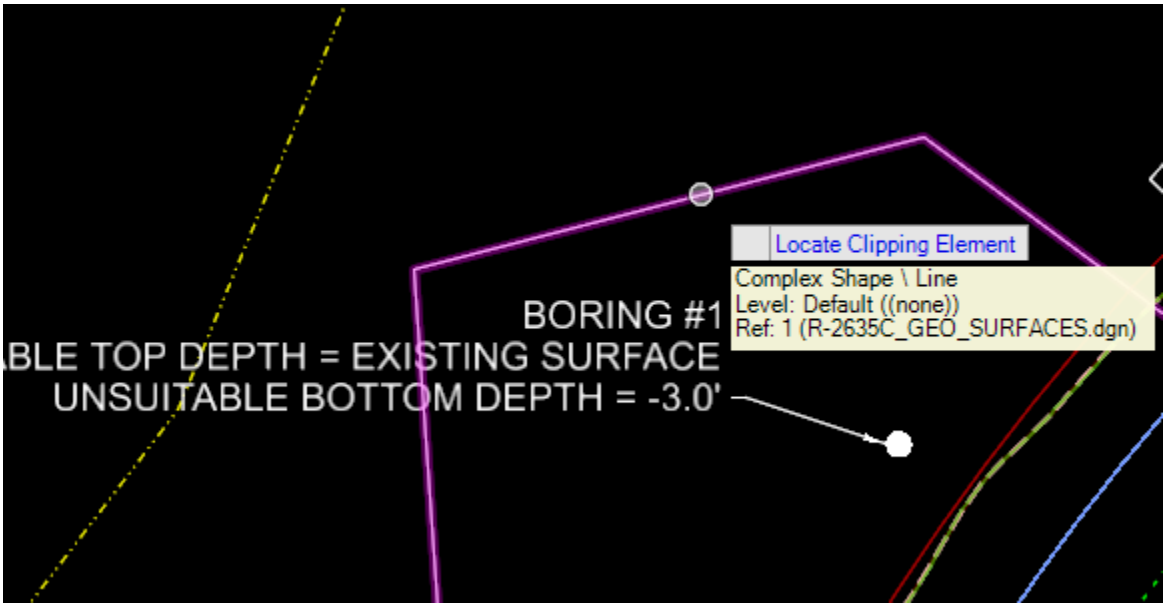
    b. Select the Create Clipped Terrain model tool



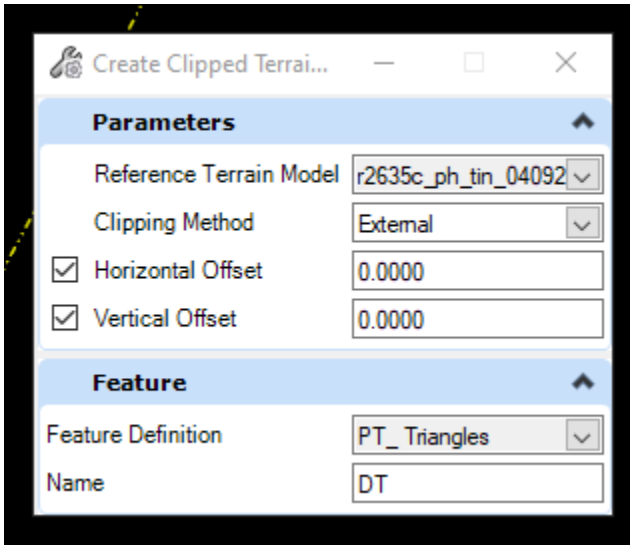
c. Locate the reference element, this is the existing terrain



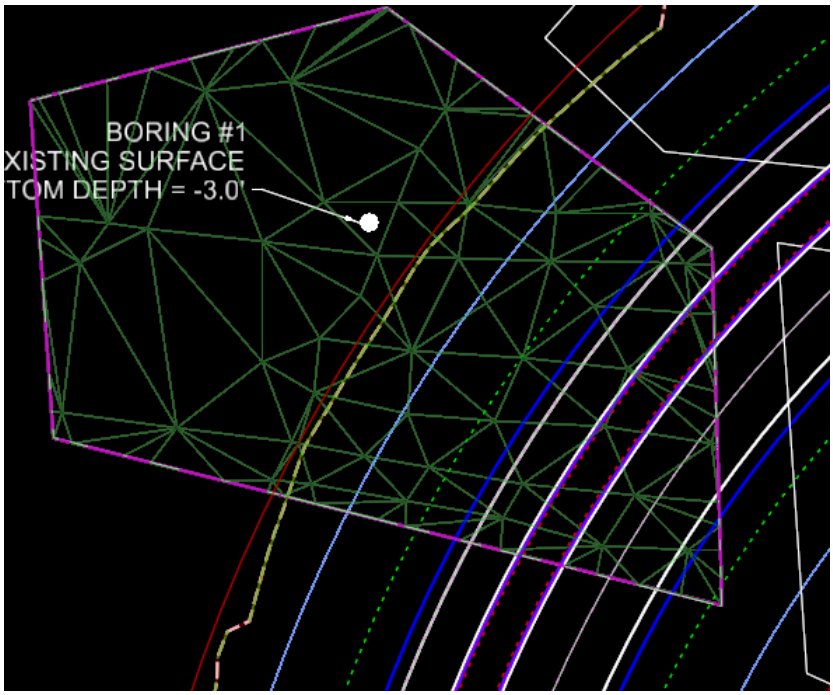
d. Locate the clipping element, this is the boundary around the bore hole



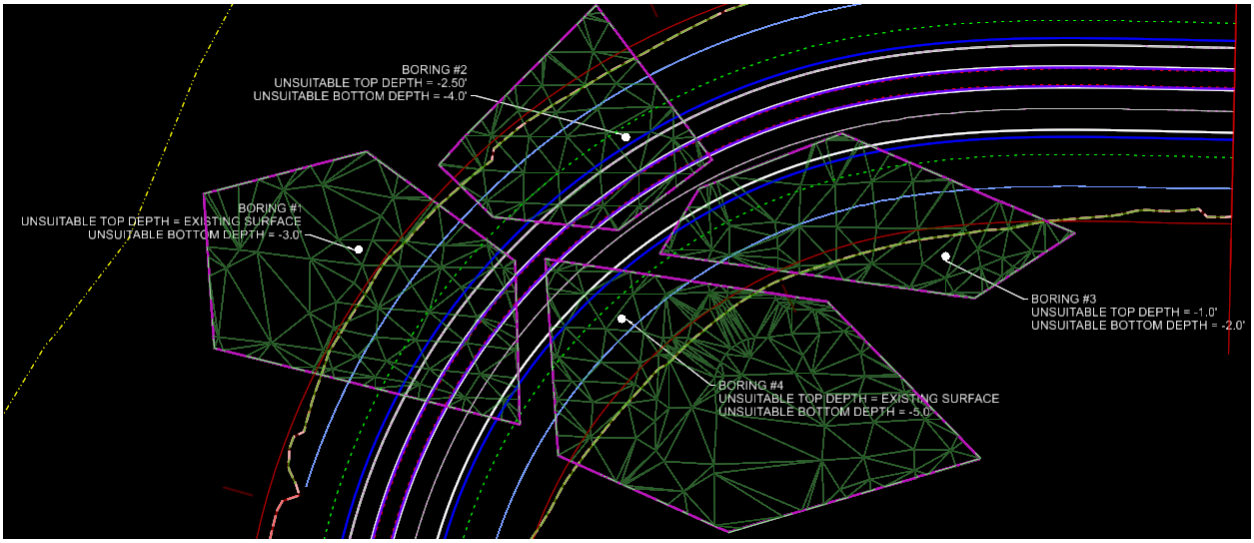
e. Set the dialog as shown
    i. Clipping method = External
    ii. Horizontal Offset = 0.00
    iii. Vertical Offset = 0.00
        1. This boundary uses the existing ground as the top elevation



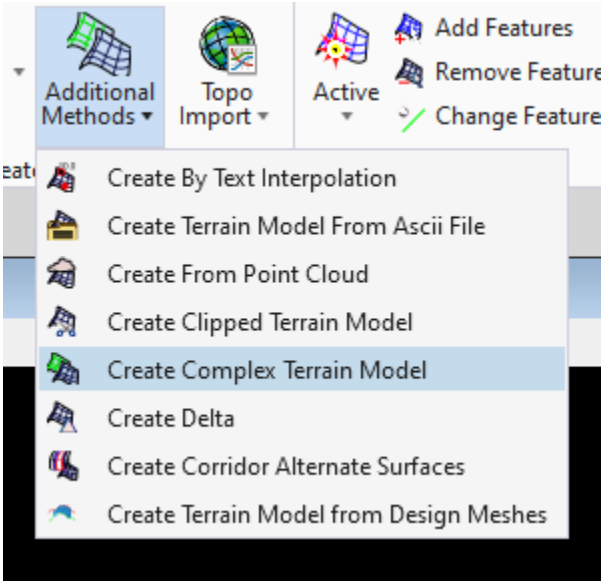
f. This clips the existing ground at an offset of 0.00’ vertical



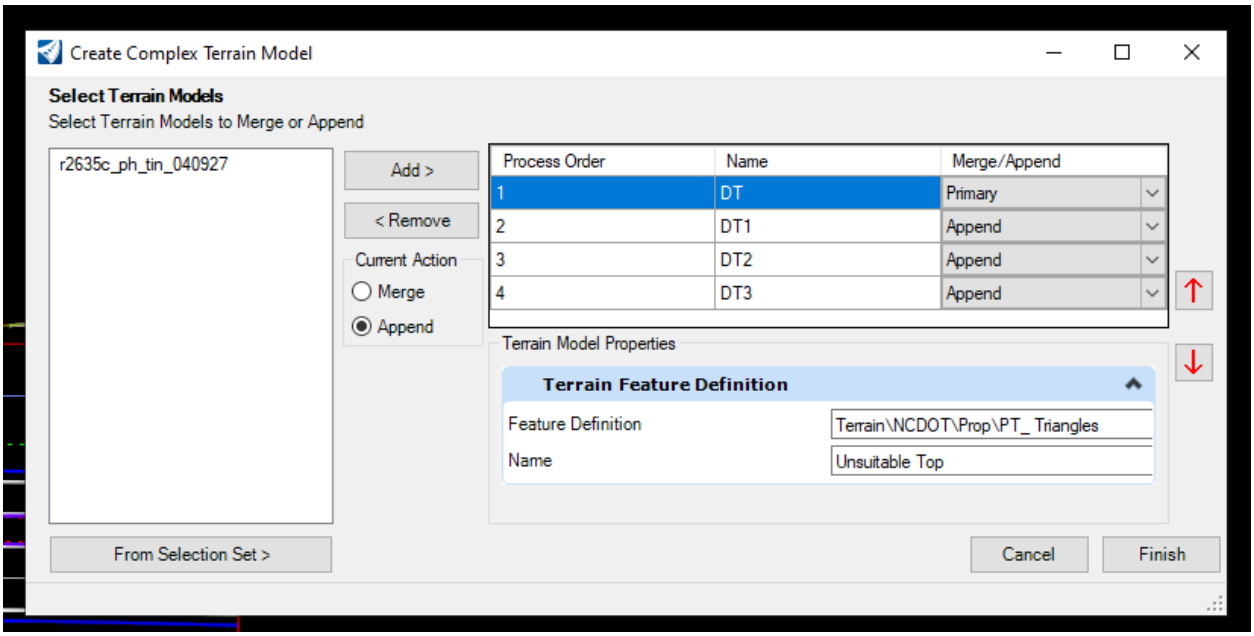
g. Repeat this process for the remaining areas
    i. Borehole 2 = -2.50’
    ii. Borehole 3 = -1.00’
    iii. Borehole 4 = 0.00’
    iv. This will create 4 separate terrains at various offsets vertical from the existing ground



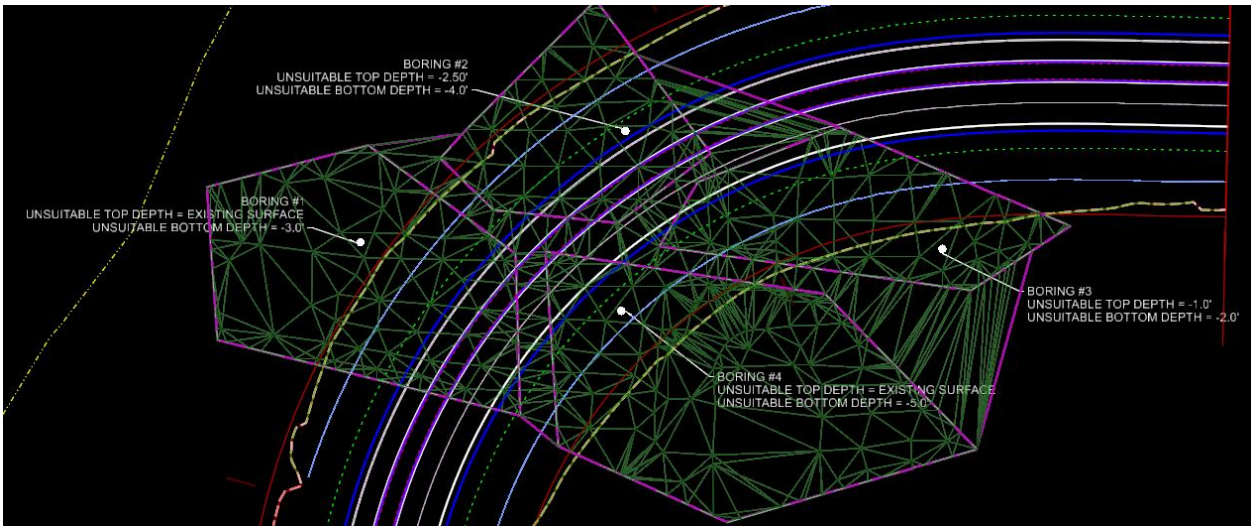
h. Create a Complex Terrain to create a single top surface
    i. Select the create complex terrain model tool



i. In the dialog
    i. Add the terrains setting 1 to primary and the rest to append, use append because the terrains do not overlap
    ii. Select and appropriate name and Feature Definition
    iii. Select Finish

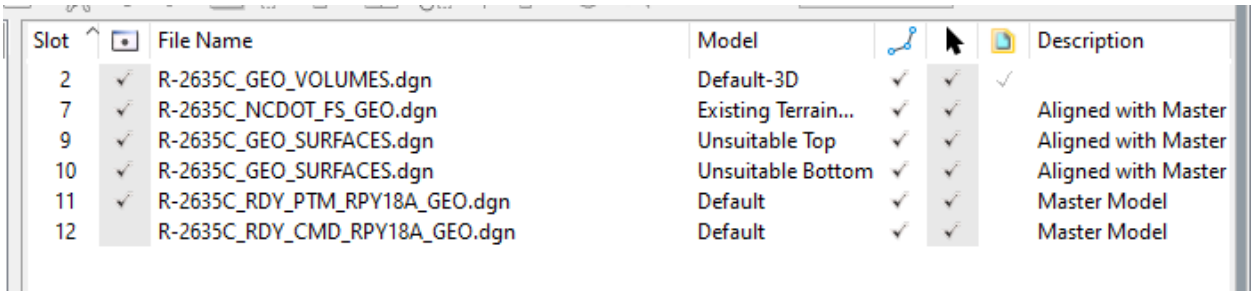


j. This creates a new terrain that joins the 4 smaller areas into a single surface.



k. Repeat this process in the Unsuitable Bottom Model using the same areas and the bottom layer depth.

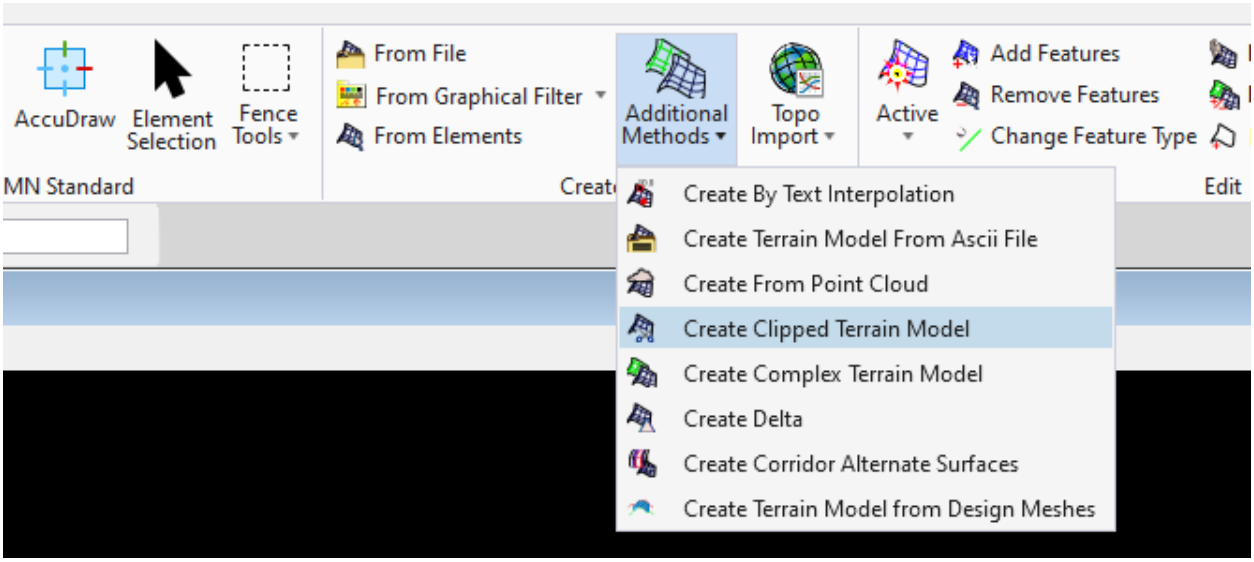
3. Create clipped terrains
    a. These clipped terrains will be used to create the Closed Mesh. This can be done with boundary elements as well which may be a simpler process but using clipped terrains seems to provide more reliable results.
    b. Attach the following reference files
        i. The Existing Terrain and set Active to get the Default 3D Model
        ii. The Surface file with the top and bottom model attached
        iii. The proposed roadway terrain
            1. This file is deliverable from NCDOT Roadway. It should be created from the proposed roadway model, this could be multiple files or a single file for smaller projects.
            2. Note that roadway templates need to be evaluated for Point Feature Definitions to facilitate creating a proposed grading surface. For example if the undercut only extends to the shoulder point it may be desirable to have a set of points that only do subgrade grading to the shoulder point.



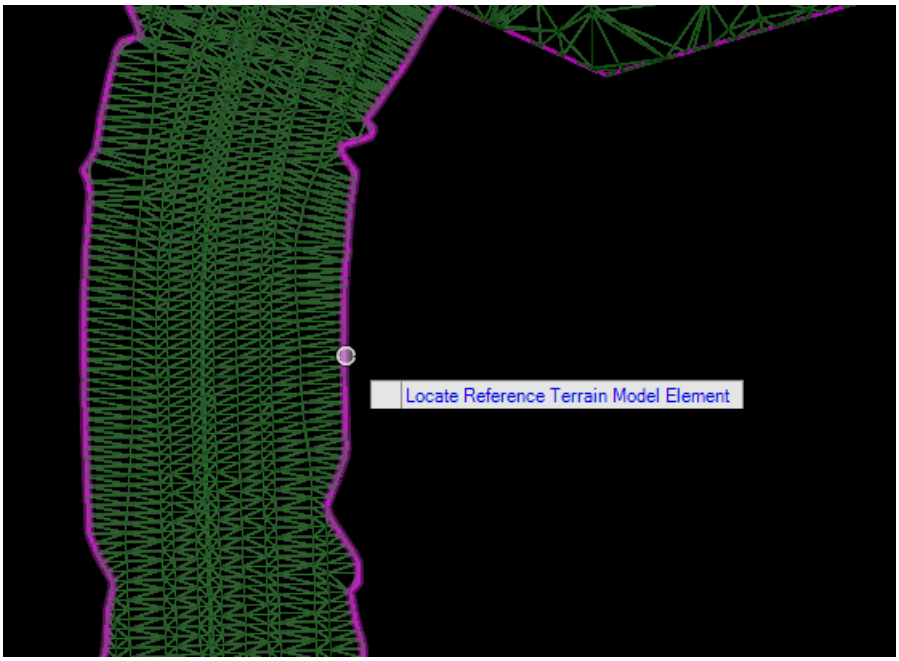
Slot	File Name	Model	Description
2	R-2635C_GEO_VOLUMES.dgn	Default-3D	
7	R-2635C_NCDOT_FS_GEO.dgn	Existing Terrain...	Aligned with Master
9	R-2635C_GEO_SURFACES.dgn	Unsuitable Top	Aligned with Master
10	R-2635C_GEO_SURFACES.dgn	Unsuitable Bottom	Aligned with Master
11	R-2635C_RDY_PTM_RPY18A_GEO.dgn	Default	Master Model
12	R-2635C_RDY_CMD_RPY18A_GEO.dgn	Default	Master Model

c. Create a clipped terrain from the Proposed Roadway Terrain

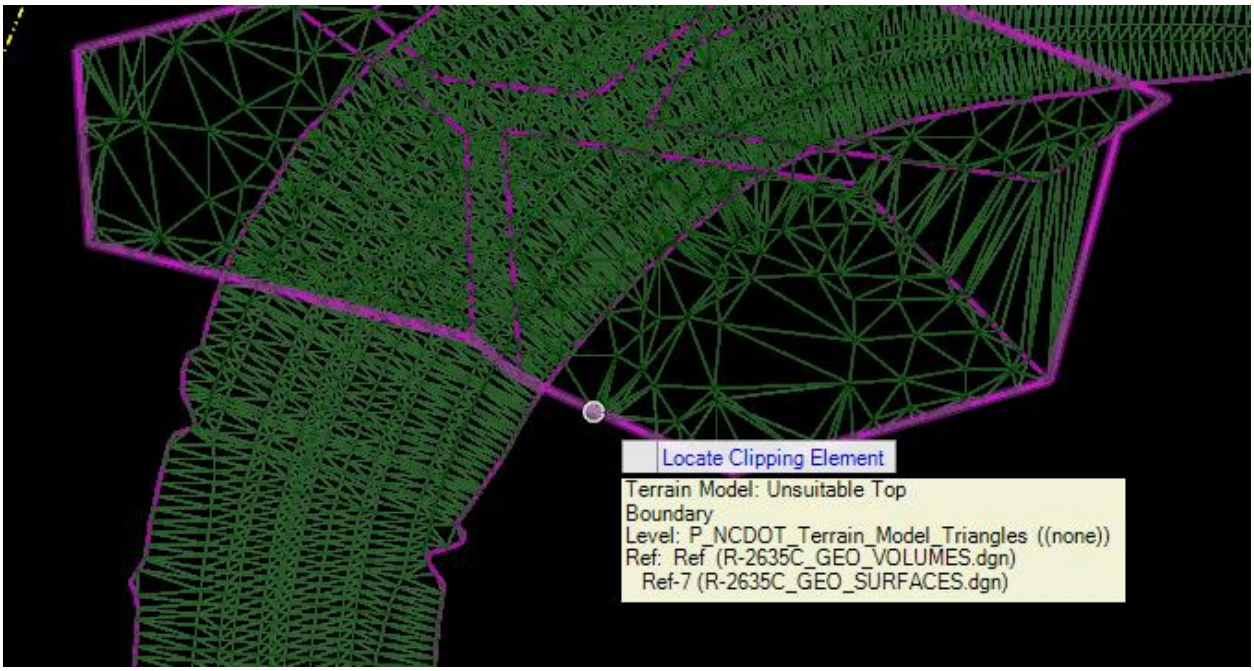
i. Select the Create Clipped Terrain tool



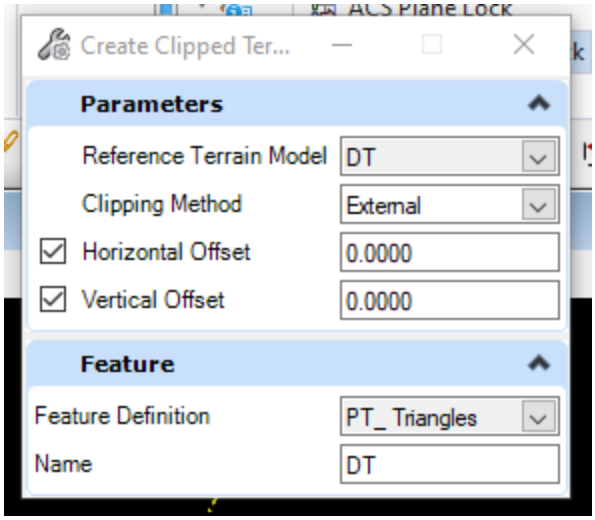
ii. Select the Proposed Roadway terrain as the reference



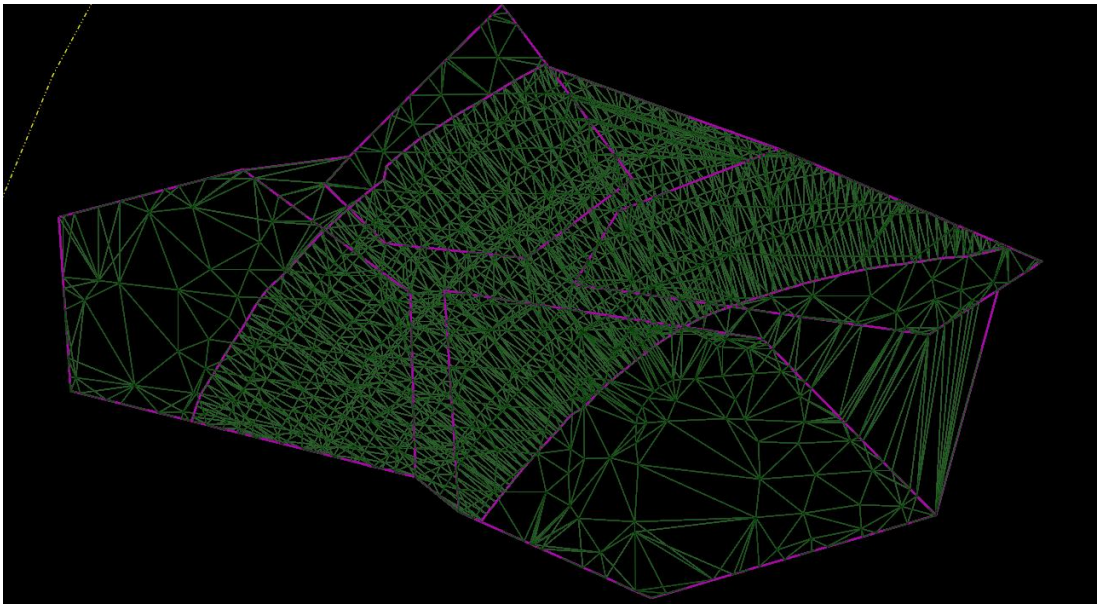
iii. Select either the top or bottom surface as the clipping element



iv. Clipping method should be set to external and the Horizontal and vertical offsets should be 0’

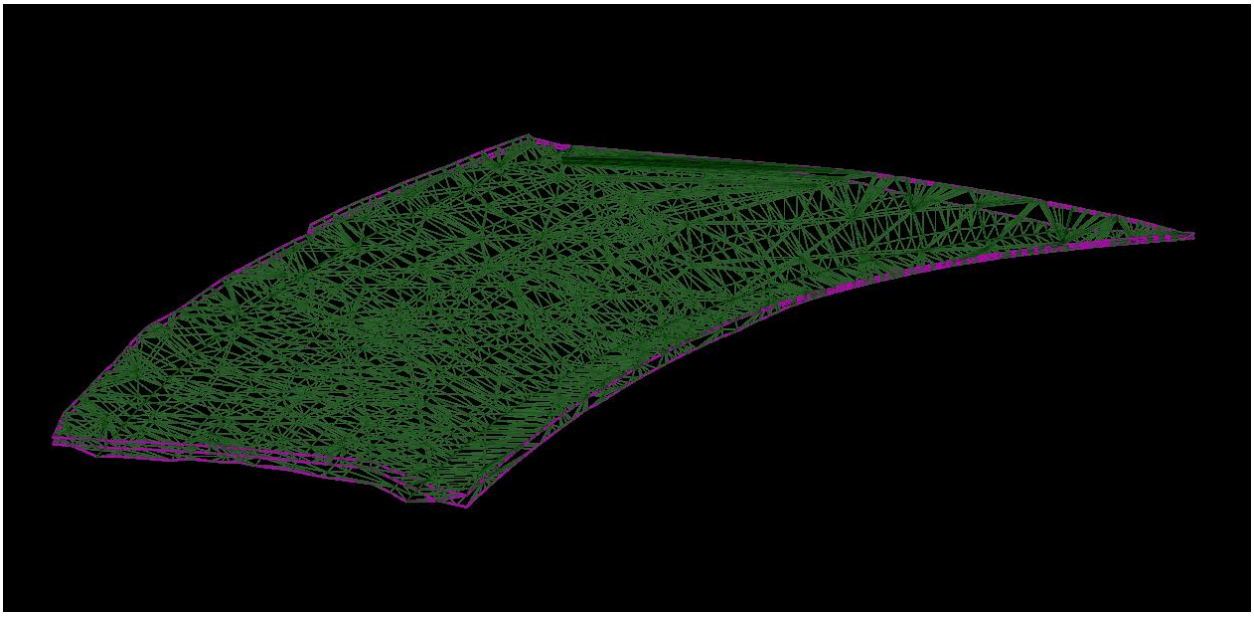


v. By turning off the proposed terrain reference you can see a smaller section has been created where the proposed terrain overlapped with the geotech surfaces

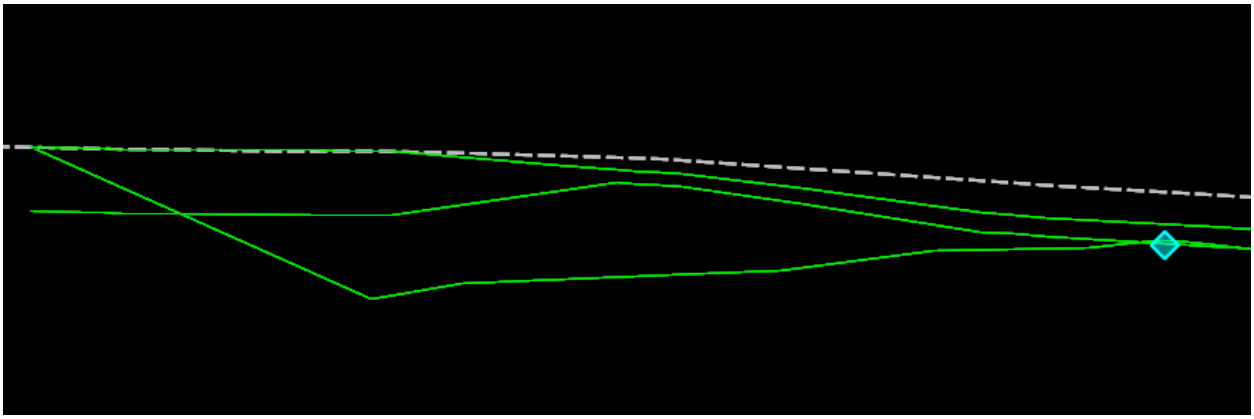


vi. Feature definition and volume option need to be reviewed to ensure these are not included in earthwork calculations. It’s also possible to delete these after making the volume. The original surfaces are still in reference files and can be used again for project updates during design.

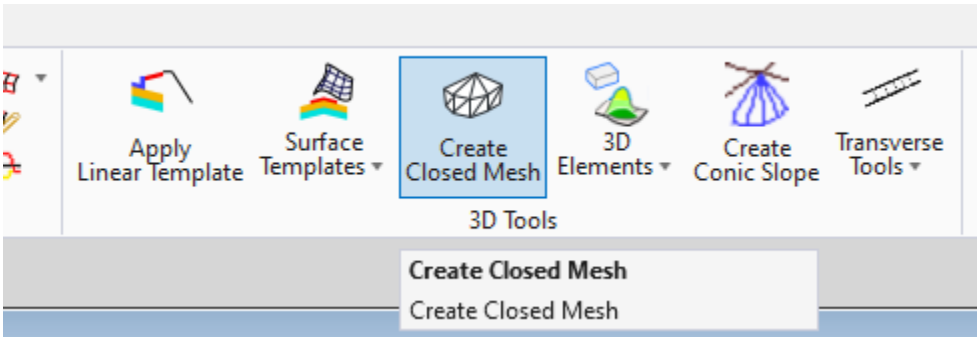
4. Repeat this process to clip the Geotechnical Top and Bottom Surface to match the proposed roadway limits
    a. You have to use the tool twice
    b. The top and bottom surface are the refence terrains
    c. The clipped roadway terrain is the clipping element for each
    d. Clipping method is external and the Offsets are 0’
    e. By turning off the surfaces references you will see 3 terrains that have the same horizontal limits
    f. The goal is create terrains that only overlap in the area of the proposed roadway and the geotechnical layer being evaluated



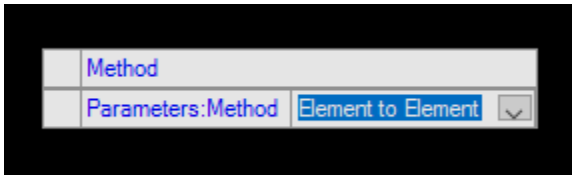
5. Review the dynamic sections
    a. Attach the proposed roadway corridor and start the dynamic sections
    b. Here we can see the
        i. Existing Ground
        ii. Top of the unsuitable layer
        iii. Bottom of the Unsuitable Layer
        iv. The Proposed Roadway grading surface



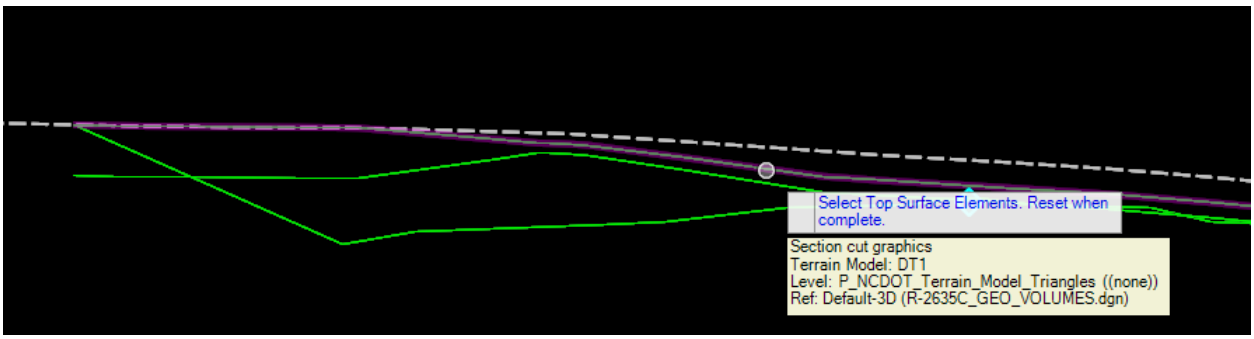
6. Create the 3D Volume
    a. Under the 3D Tools Section select the Create Closed Mesh tool



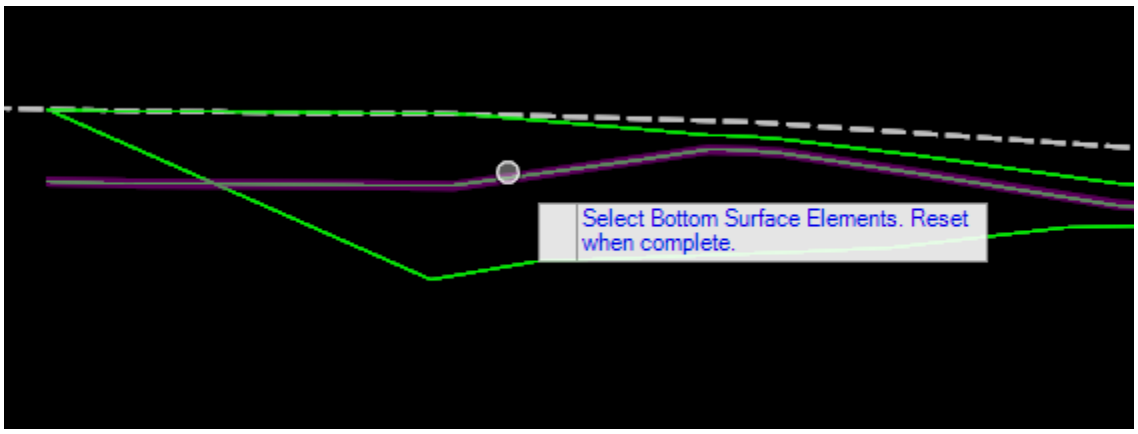
    b. Select the Element to Element method

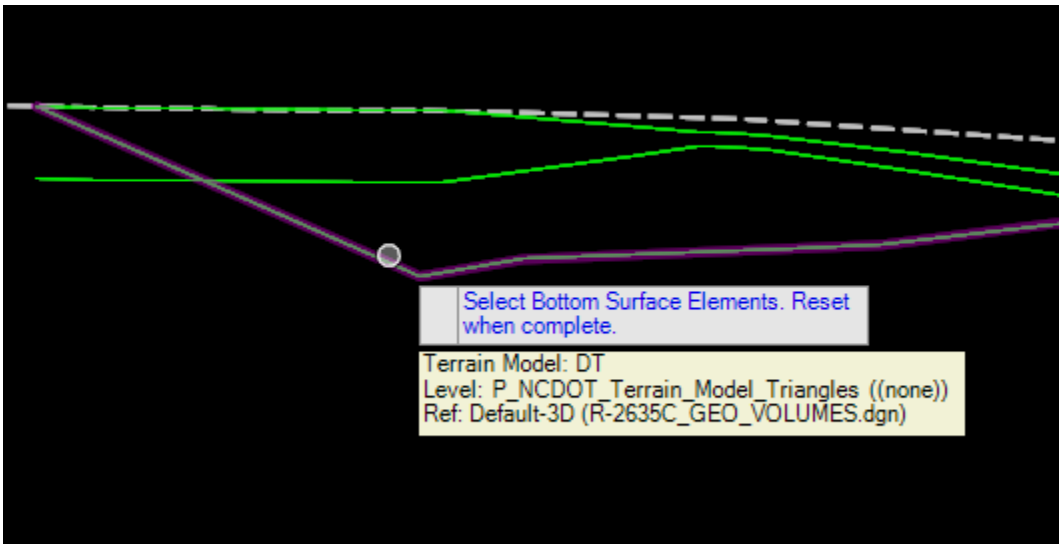


    c. For the top element select the top layer of the unsuitable material, this can be done in the Default 3D view or in the Dynamic Section view. And reset to complete



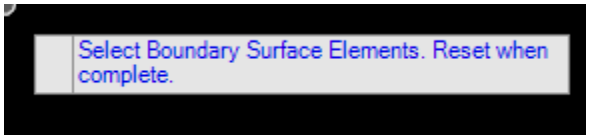
d. For the bottom surface select the bottom of the unsuitable layer and the proposed roadway grading terrain and then reset



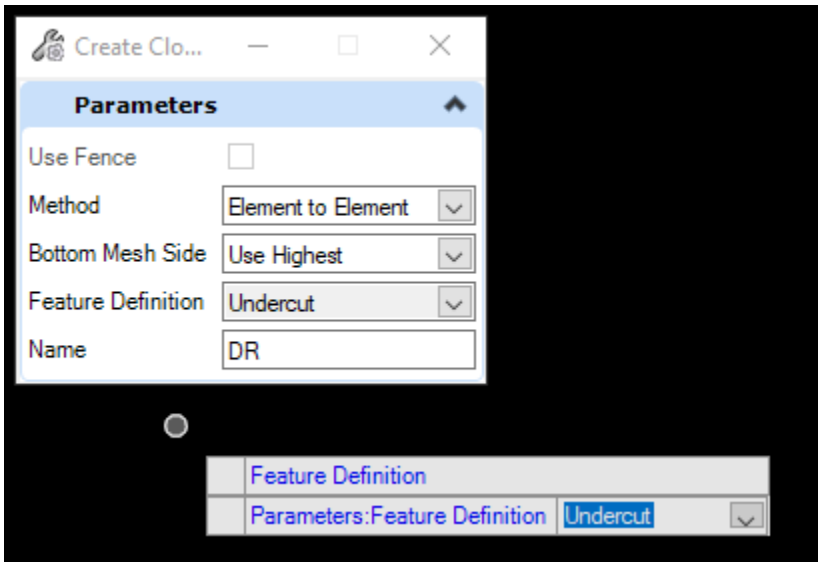


e. Because 2 terrains were selected an additional option will appear. Select Use highest. This will set the highest layer as the bottom of the 3D Mesh

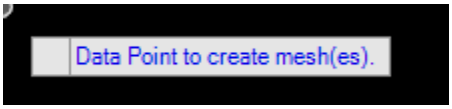
f. The next prompt is select boundary elements. Right click to reset past this selection. The use of clipped terrains does not require a boundary element. This should be re-evaulated, the use of a boundary element may be a better workflow.



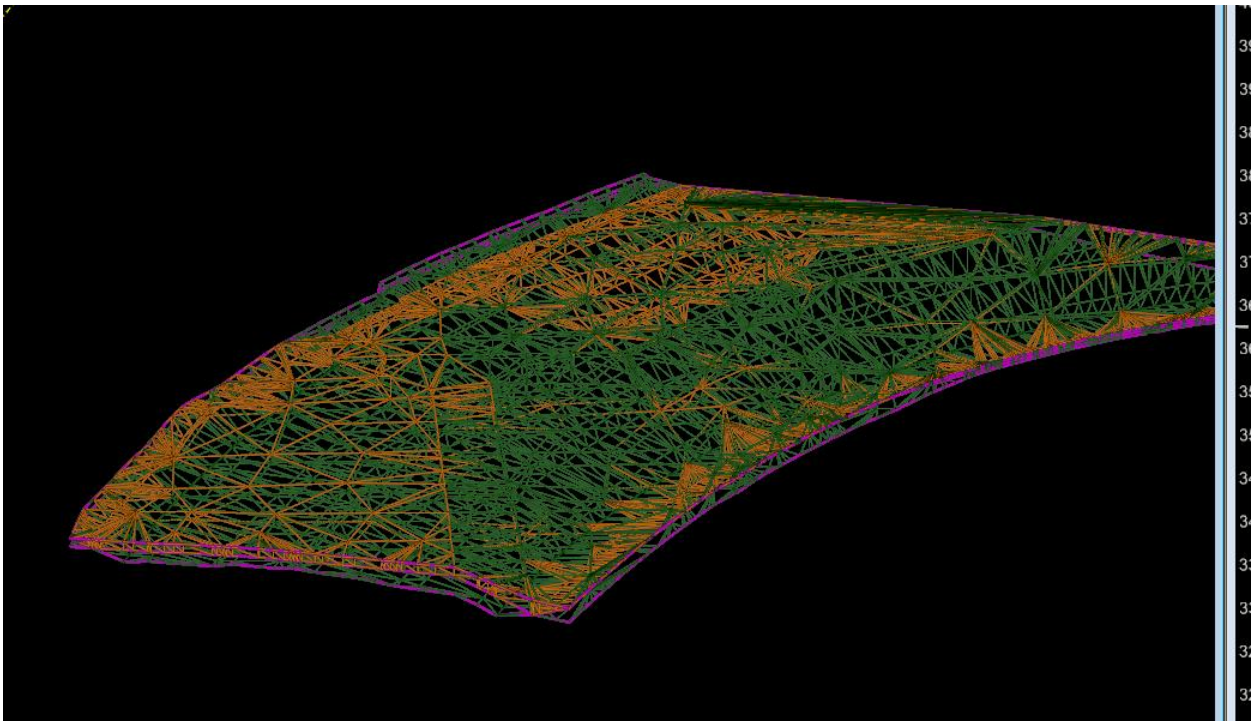
g. Select and appropriate feature definition. In this case Undercut has been created for the example.



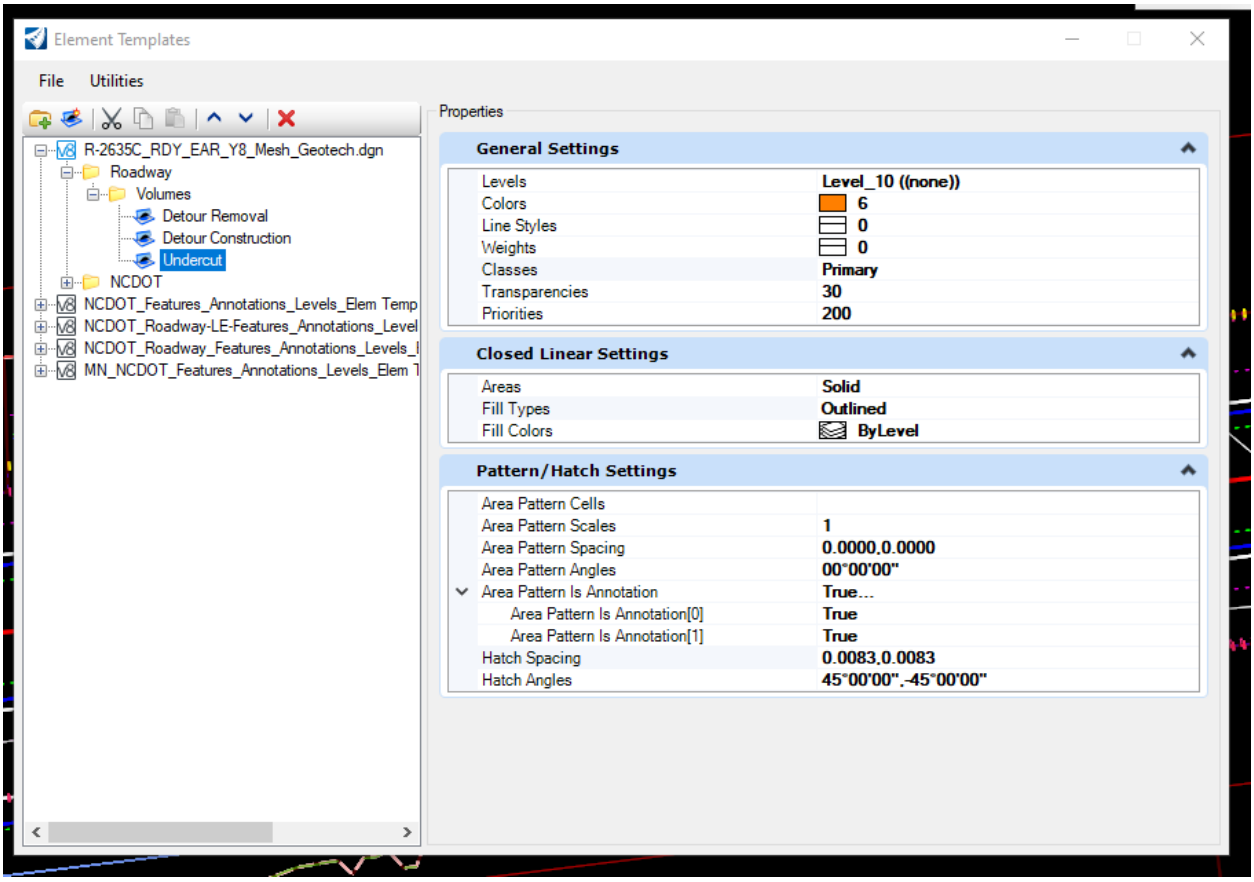
h. Left click to data point and create the mesh



i. An orange mesh should be shown in the default 3D model.

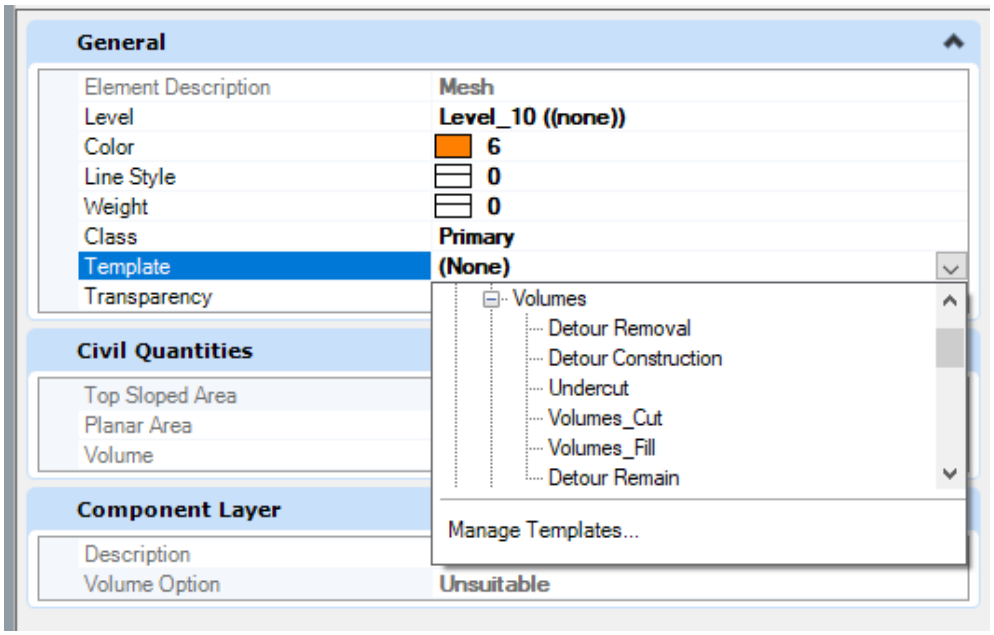


7. The feature definition requires some special configuration
    a. The feature definitions should point to a feature symbology that references an element template setup for hatching or patterning

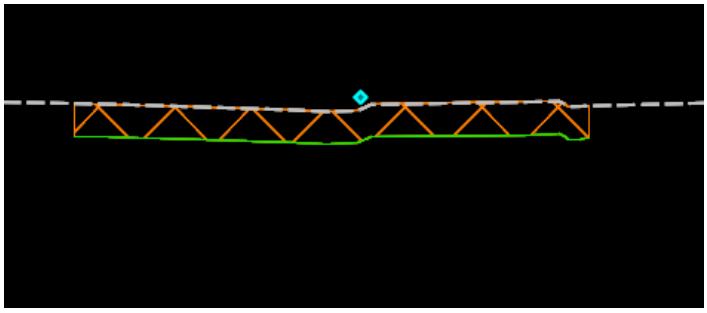


8. Attach the element template to the 3D Volume – Note that this is not shown for the sample files. This hatching will not show when picking multiple surfaces for either the top or bottom of the Closed mesh. This seems like a software issue that needs to be corrected on Bentleys side. See the following steps below for a workaround to this issue. The workaround is not difficult but it shouldn't be necessary.

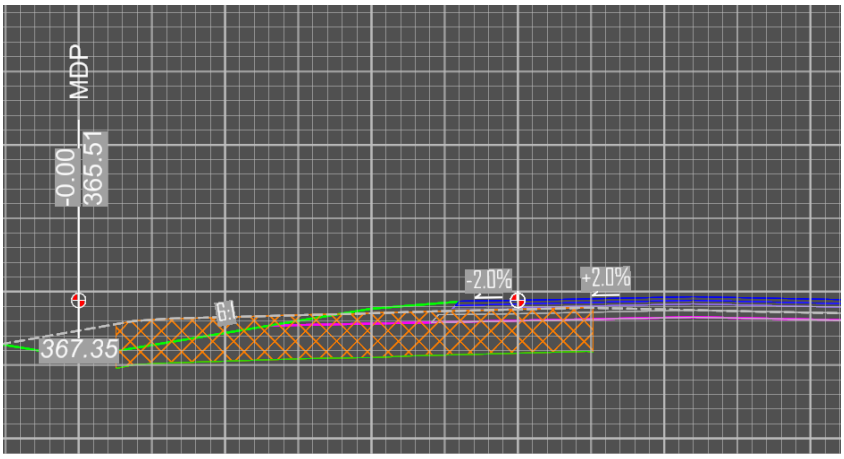
    a. This seems like another issue that could be setup in the software to work automatically. For some reason it won't associate the template with the 3D Volume when creating it but you can pick it in the Properties dialog after the fact. In the 3D view select the 3D Mesh. In the properties dialog find the Template drop down in the General Section and select Undercut.

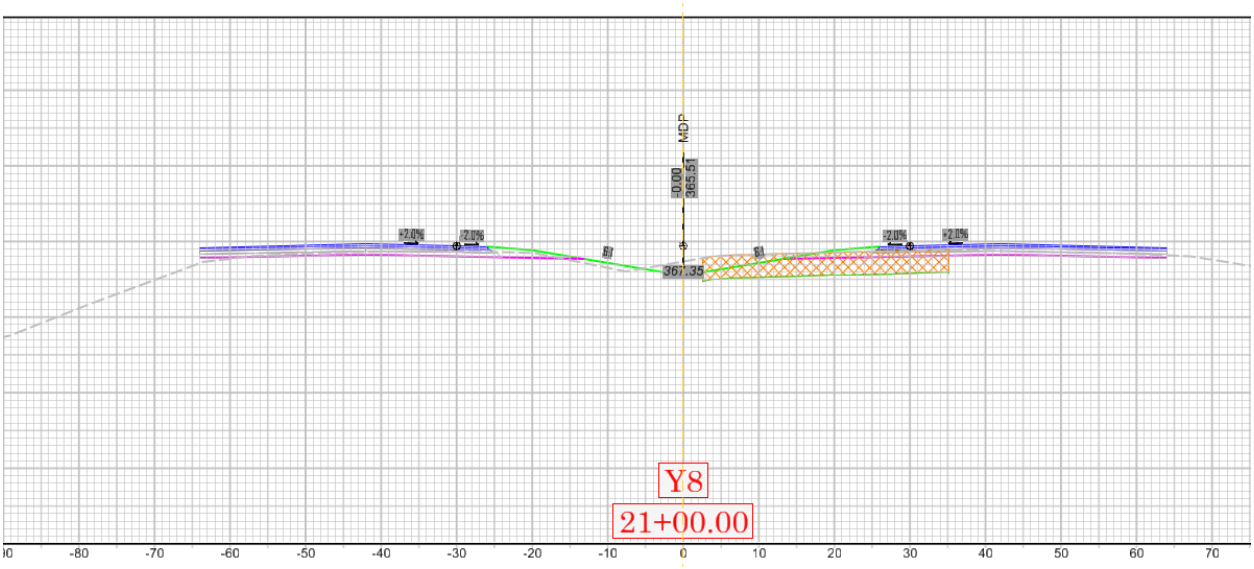


b. This now shows up as hatched in the dynamic sections. This is from a closed mesh that had a single top and bottom surface



9. Cut Cross Sections like normal – this is from a closed mesh that had a single top and bottom surface





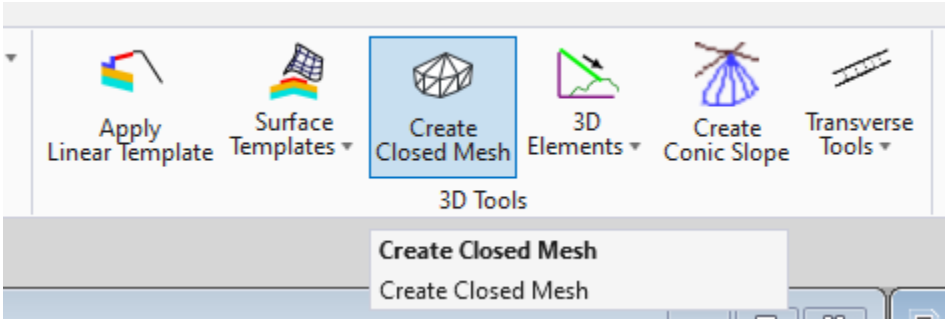
10. WORKAROUND FOR CLOSED MESH PATTERNING ISSUE

a. The following steps are a workaround for the closed mesh patterning issue. Note that the volume is correct either way this is just a way to display the hatching automatically on the cross sections. This is only required when the closed mesh is created by selecting 2 shapes for the bottom and using the highest one. If only one terrain is required for the bottom surface, for example on the proposed roadway surface is required, then the previous method for creating the closed mesh can be used.

b. To get around the problem caused by selecting multiple terrains when creating a closed mesh we need to have a single top surface and a single bottom surface. There is no way to merge terrains into a single surface and only use the higher or lower points.

c. The closed mesh tool will work with other closed meshes and not just terrains. By using this capability we can create a closed mesh that will be the bottom surface and avoid the previous issues with the hatching.

d. Select the Create Closed Mesh tool



e. Set the dialog for

i. Element to Depth

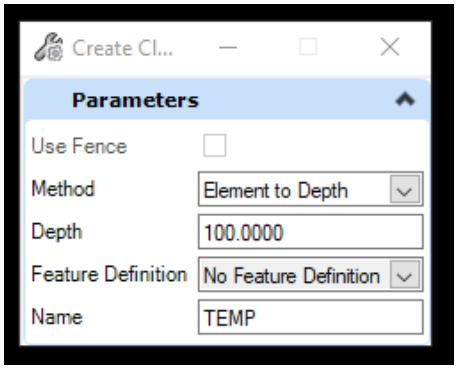
ii. Depth = 100 (this is a + numer)

iii. Feature definition = None

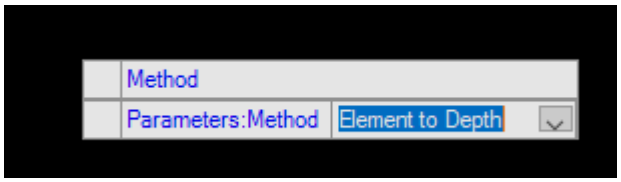
1. This is a temporary shape but a feature definition may be helpful

iv. Name = TEMP

1. This could be anything this shape will only be used temporarily

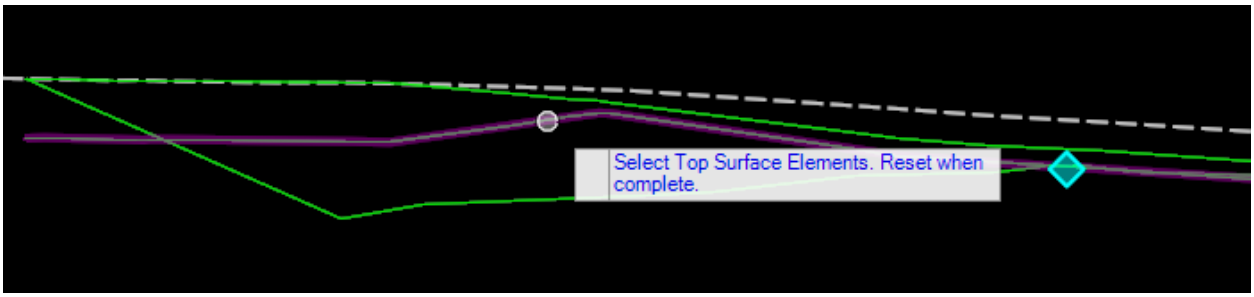


f. Left click to accept Element to Depth

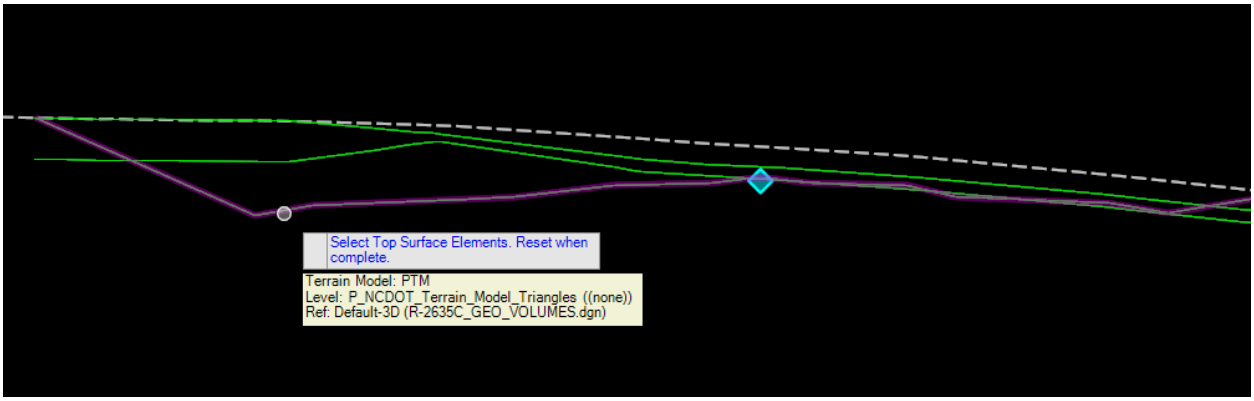


g. Left click to select the top surface elements. This can be done from the dynamic section window as well as the Default 3D model.

i. Select the Terrain that represents the bottom of the unsuitable layer



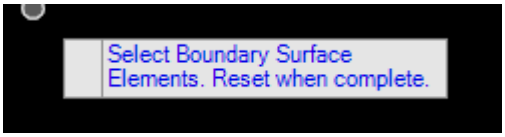
ii. Select the layer that represents the proposed roadway grading surface.



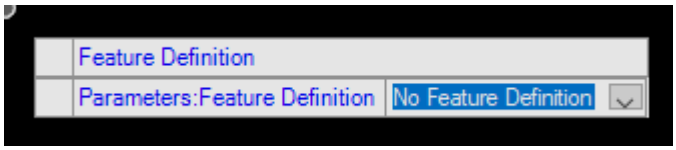
iii. Right click to confirm the selections and then left click to accept Use Highest.

h. Left click to accept a depth of (+) 100'. This number should always be positive for a depth and it should be large enough to be easily selected in later steps.

i. Right click to reset past the selection of a boundary element.

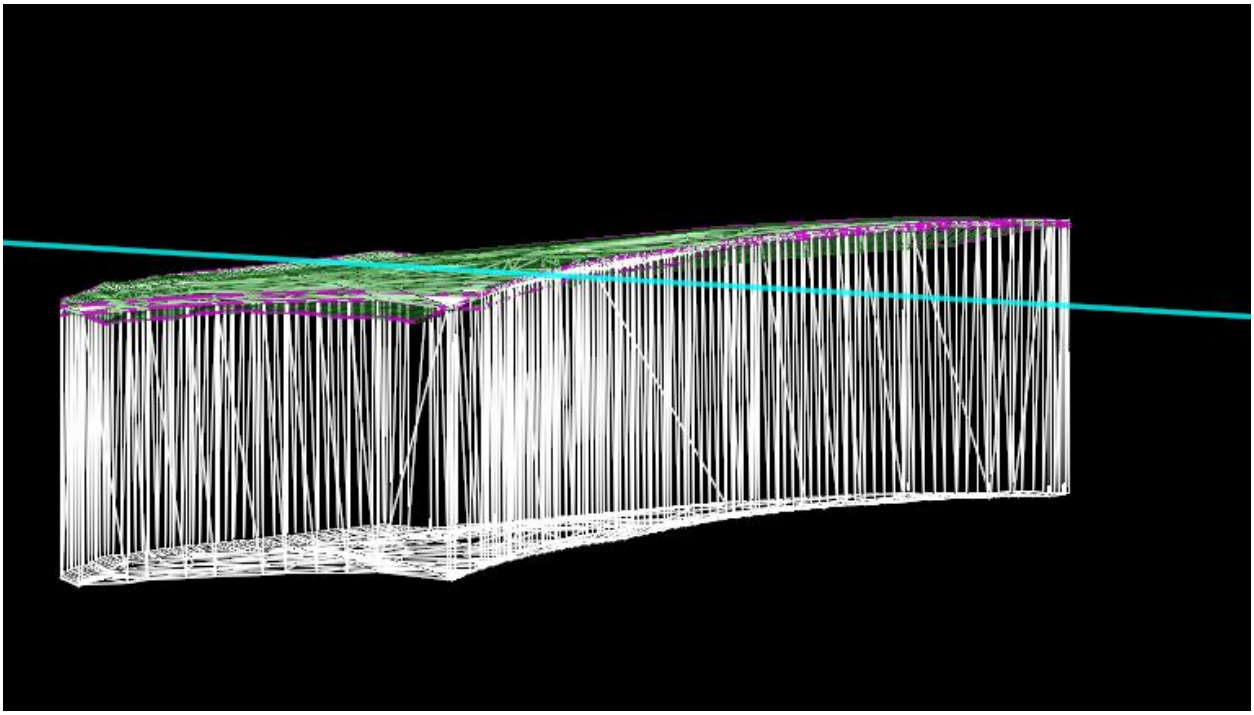


j. Left click to accept feature definition

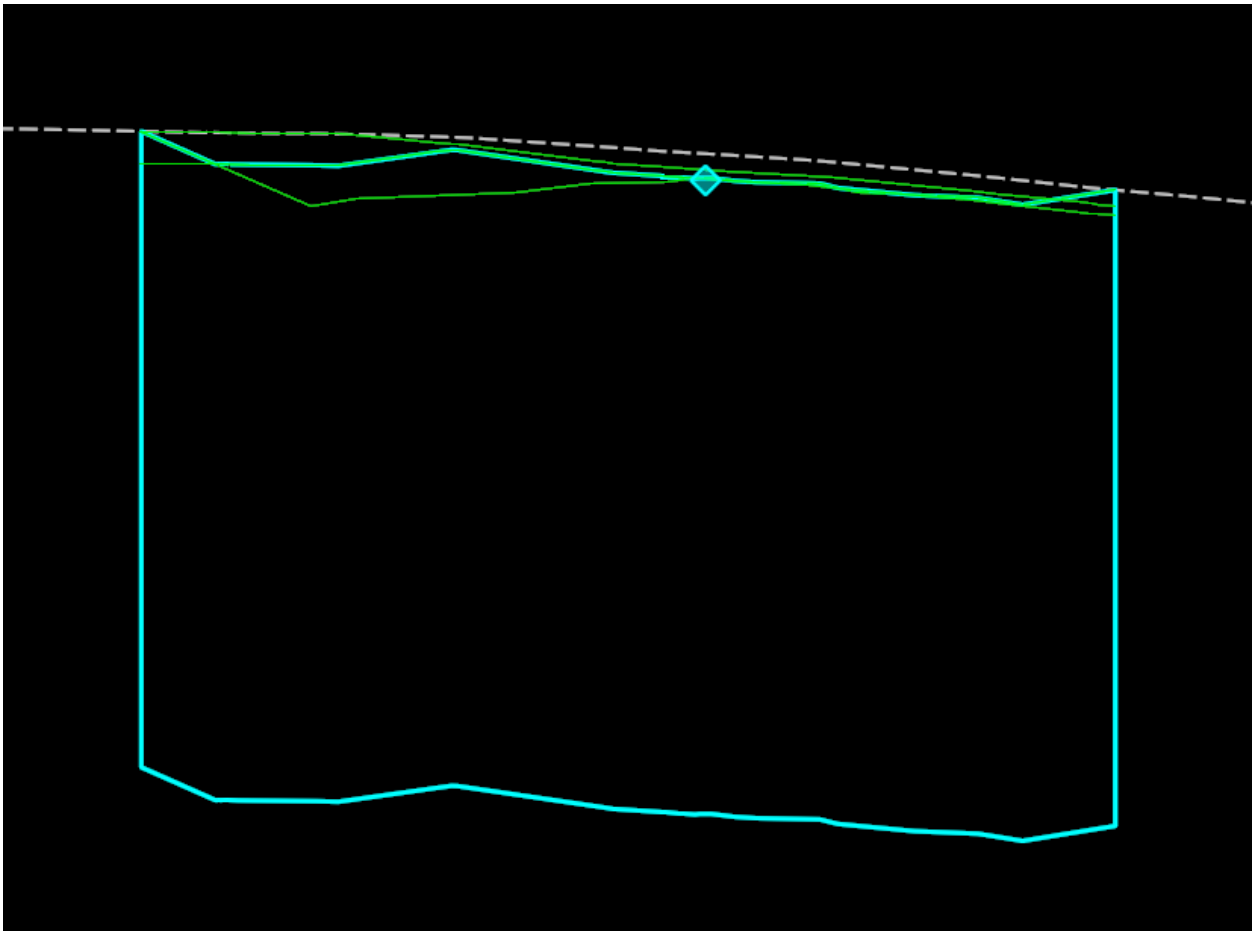


k. Left click to create the mesh

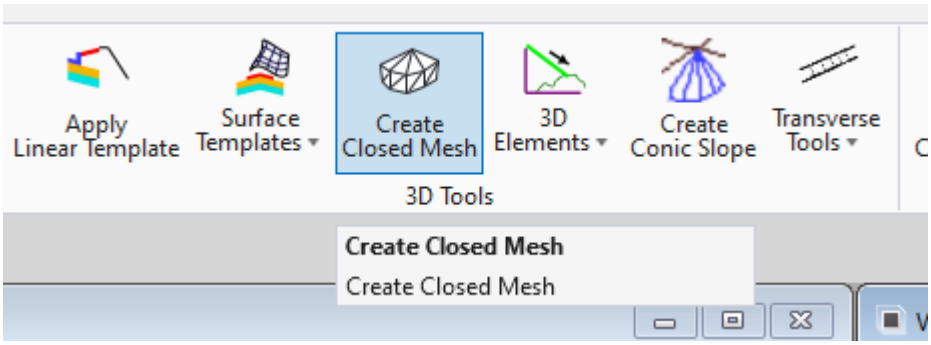
l. The Default 3D Model should show a closed mesh that extends down from the terrains



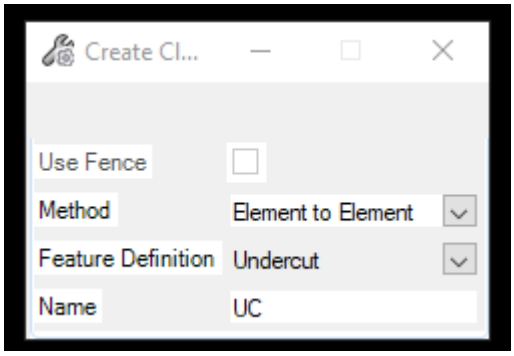
m. The Dynamic Section view will show the outline of a closed shape that traces the highest elevations based on the Bottom of the Unsuitable Layer and the Roadway Grading surface. This is the final Bottom of the Unsuitable Layer because for this example we are not excavating anything below the proposed roadway grading.



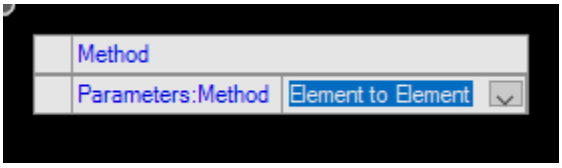
n. Create the closed Mesh representing the actual Unsuitable Excavation. Start the Closed Mesh tool.



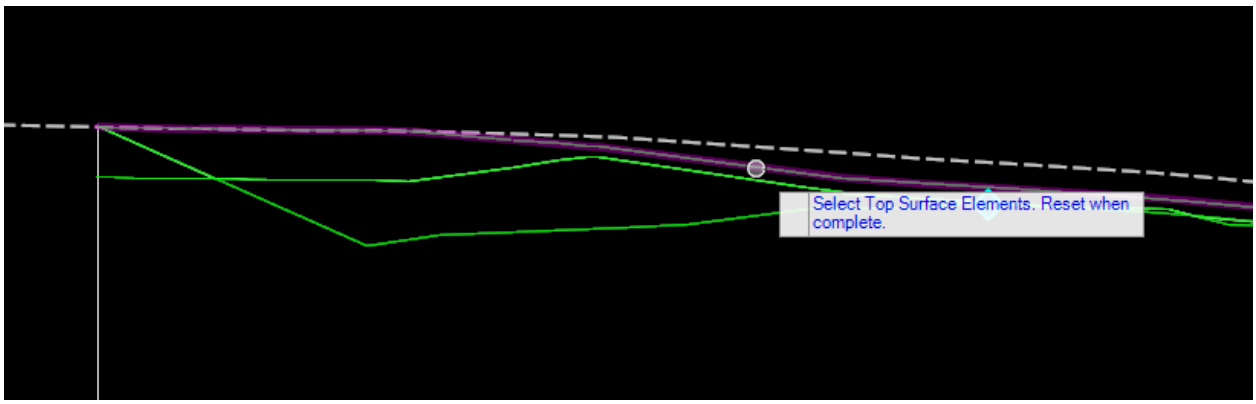
o. his time the tool should be set to Element to Element and the feature definition to Undercut.



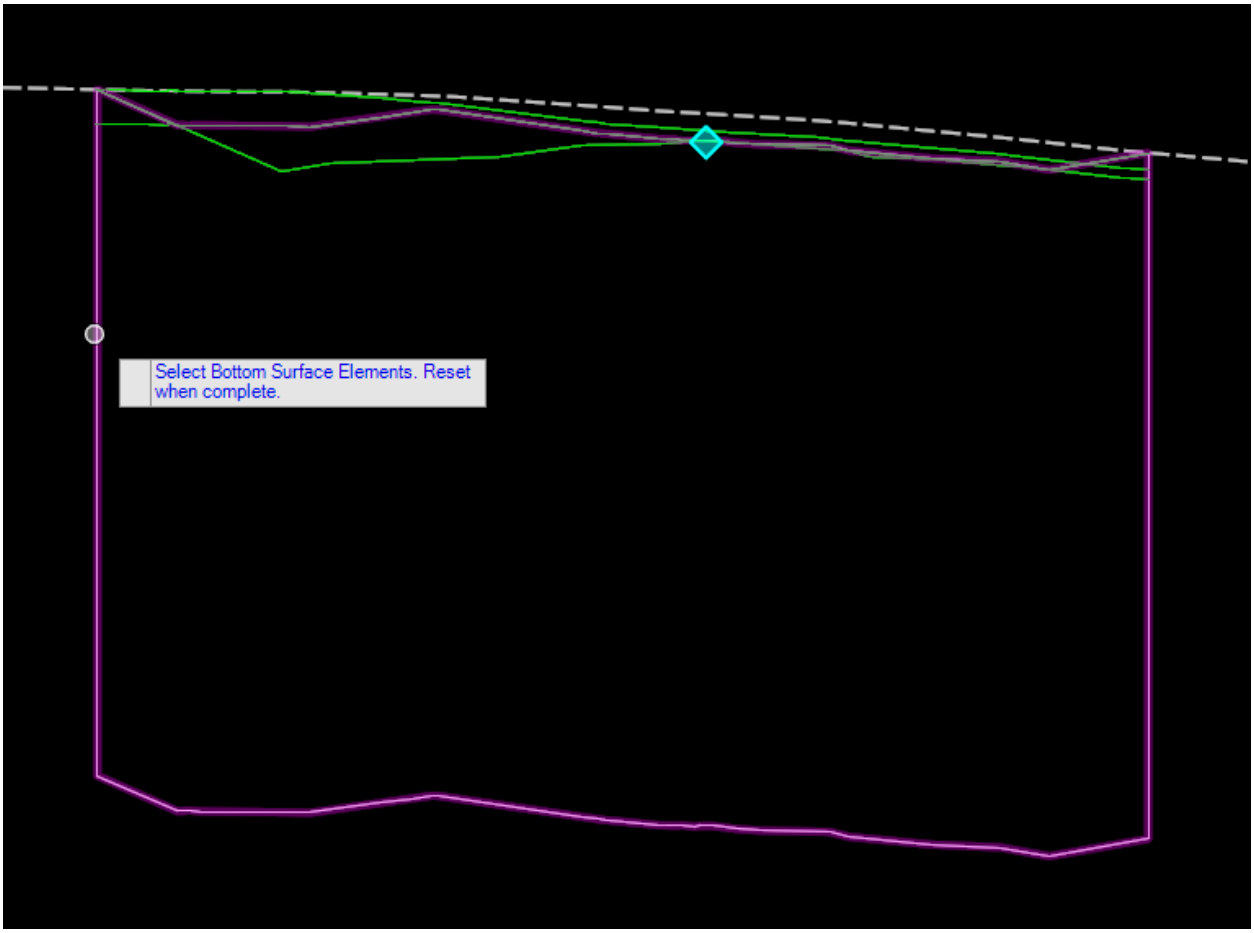
p. Left click to accept element to element.



q. Select the top of the unsuitable layer as the top element and reset to confirm selection



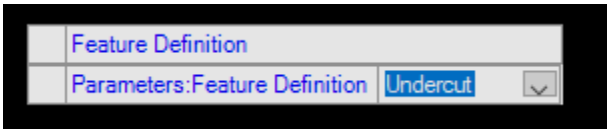
r. For the bottom surface select the Closed Mesh that was created in the previous step and right click to accept.



s. The program can use the top or bottom of this closed mesh to crate the new shape, so even though we only selected a single shape it is going to have a slection for Use Highest or Use Lowest. Select Use Highest to use this top of this shape, which represents the bottom of the unsuitable excavation.

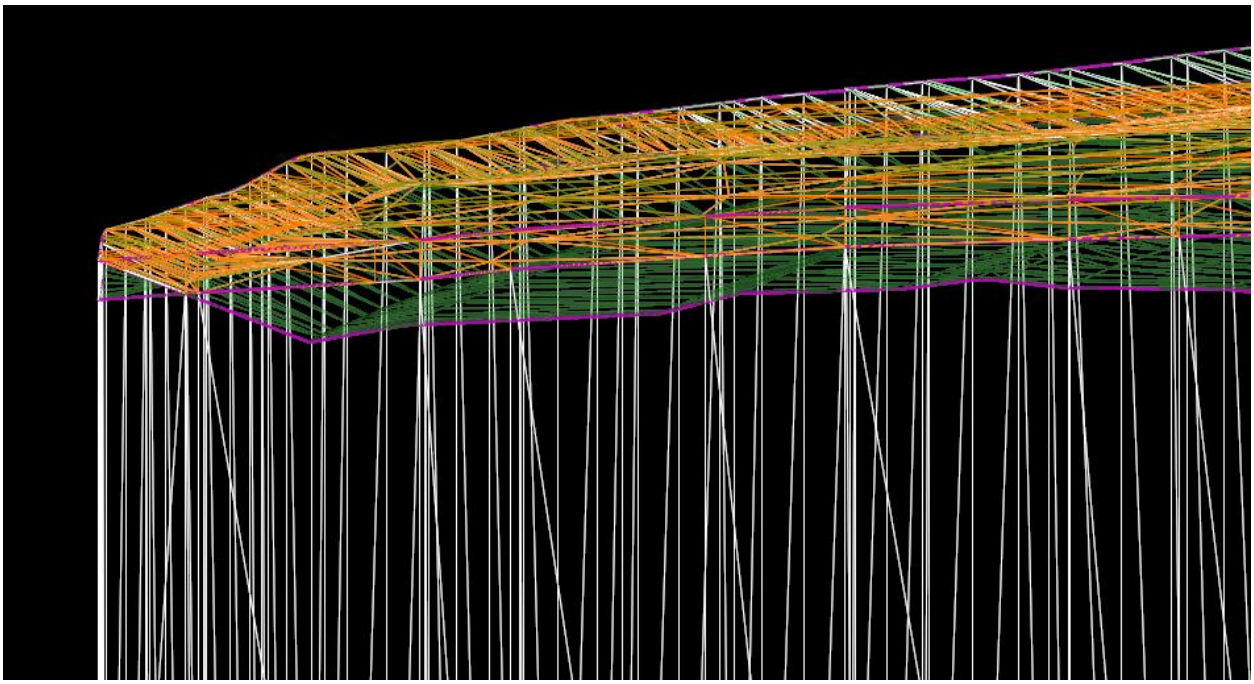
t. Right click to reset past the boundary selection

u. Left click to accept Undercut Feature Definition

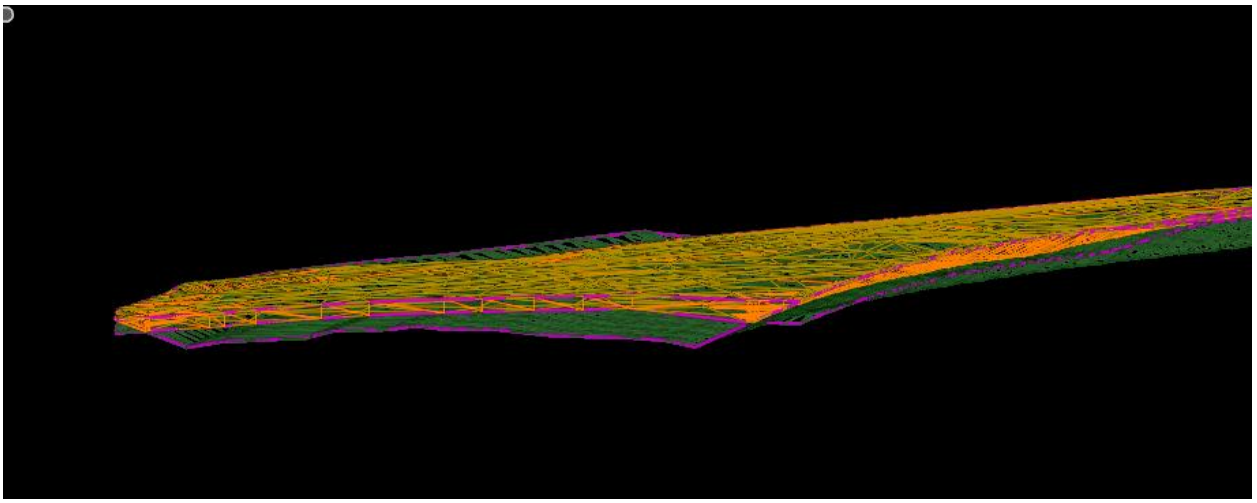


v. Left click to data point and create the mesh

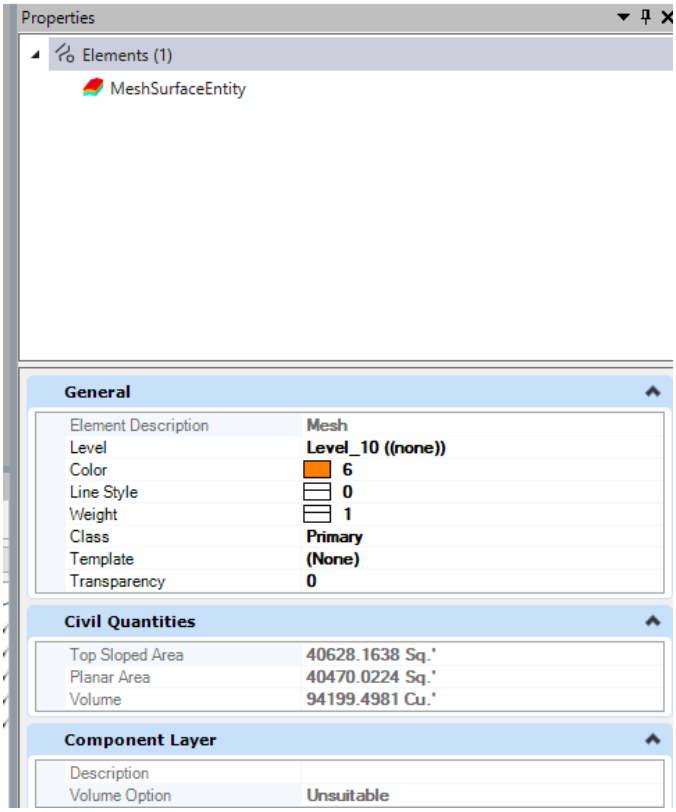
w. The default 3D model will now show an orange shape representing the Unsuitable Excavation Volume.



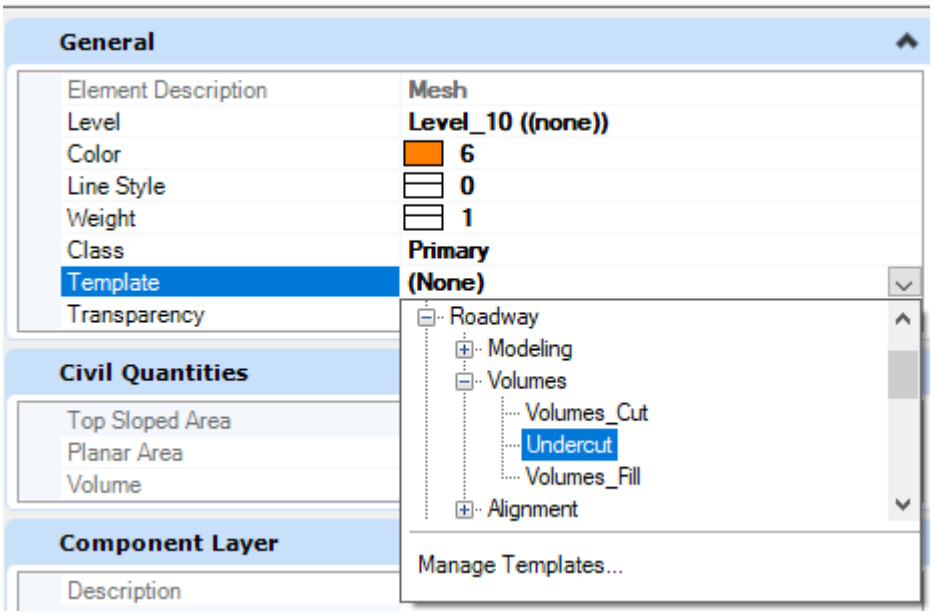
x. Delete the temporary shape, this is done to ensure there are no issues with earthwork or cross section displays and just the orange excavation shape will be left with the terrains. Note that it may be better to delete the terrains also so that earthwork will not be affected.



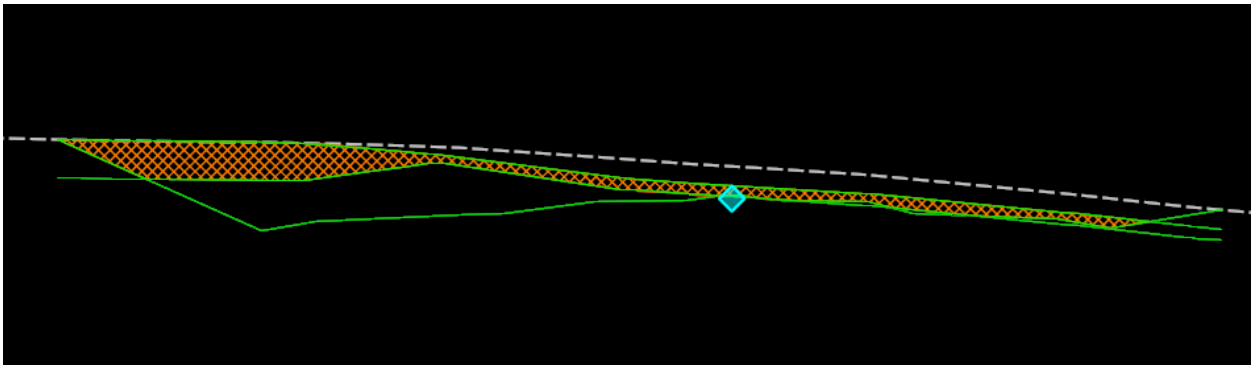
y. Select the closed mesh in the Default 3D view and go to the properties dialog.



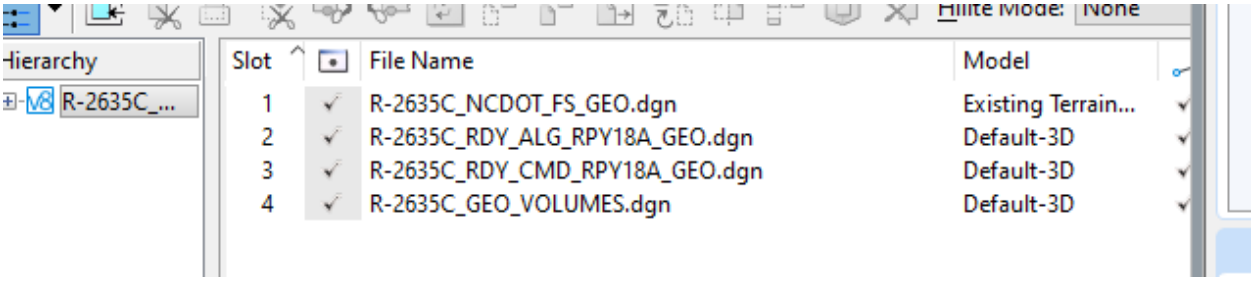
z. In the general section find the Template line and select Undercut from the drop down list. It will be under Roadway / Volumes



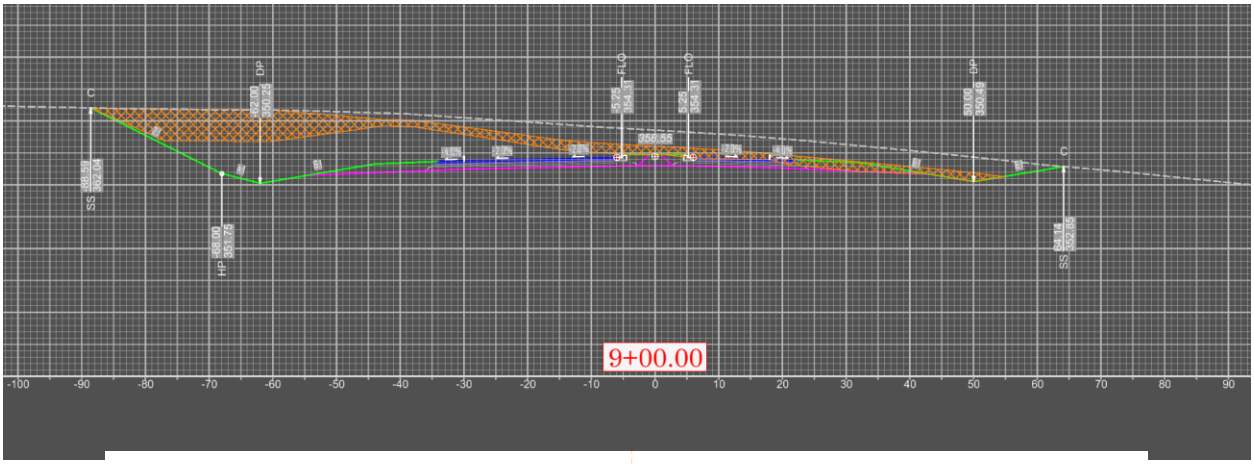
aa. This adds the Hatching to the Dynamic Section view. This could also be a pattern.

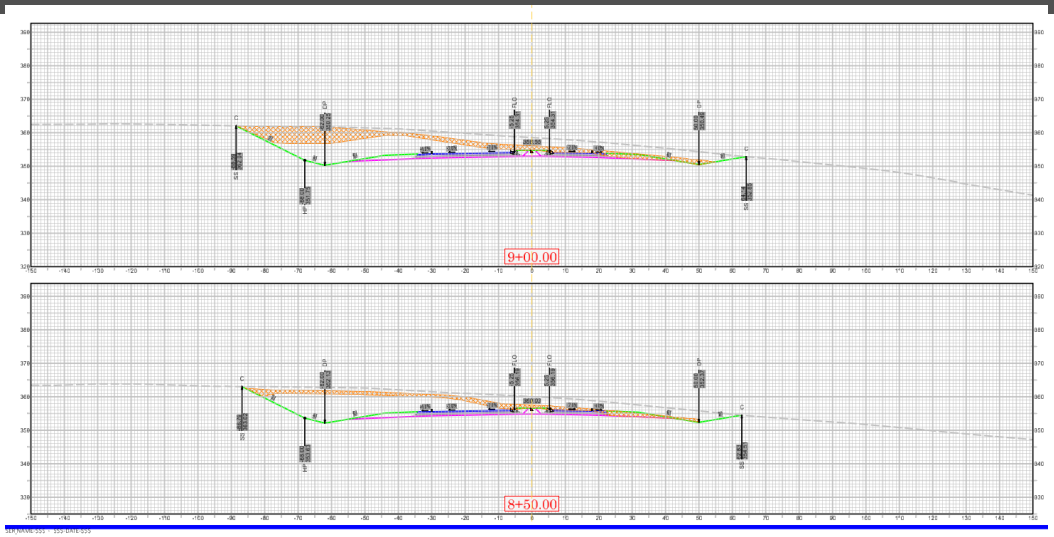


11. Finish the Cross Sections
    a. Open the cross section file
        i. R-2635C_RDY_XPL_RPY18A_GEO
    b. Attach the GEO_VOLUMES dgn file to the default model and it should automatically attach to the Default 3D model



    c. Turn off all the levels except for the hatching shape
    d. The cross hatching will now display in the Cross section drawing models and sheets





12. This volume is the same thing as the earthwork volume it can be measured directly in the cadd file.
13. If the Feature definition is set to a volume option of unsuitable the Unclassified Excavation would automatically be eliminated in this area and the volume would be reported out with the earthwork.
14. Geotech would deliver back to roadway the initial shapes and the files containing the top and bottom layers of the unsuitable materials.
    a. This would just be references in between the NCDOT folder structure or it might be better for Geotech to maintain copies of the files that were delivered with DRPS approval in the geotech folders.
    b. After hydro and any additional revisions are completed Roadway would redo the proposed grading terrain and the geotechnical closed meshes and reprint the cross sections and provide new earthwork runs. The final plans would have accurate Geotech volumes and shading.