Design Bureau

21B-270

Developing 3D Models for Design Projects

Design Manual
Chapter 21
Automation Tool Instructions

Originally Issued: 10-13-14
Revised: 06-25-19

To facilitate the development of the data files needed for machine control grading, the following protocol needs to be followed when developing Surfaces for mainline, side roads, ramps, loops, and on-site detours for a project. Refer to Section 20B-71 for required files and file naming conventions for Final Turn-In.

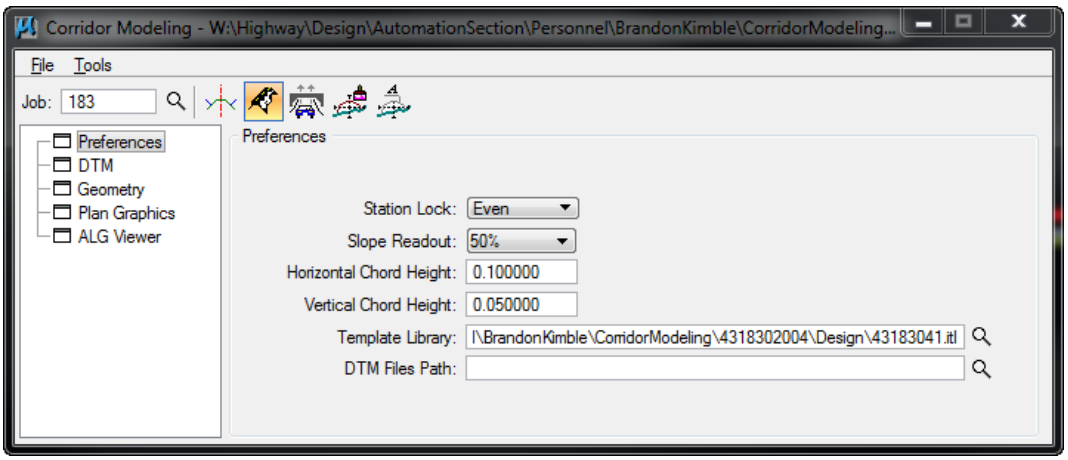
Corridor Modeler Chord Preferences

Chord heights are used to control the number of points along a curve that are added to the surface creation process in Roadway Designer.

Horizontal Chord Height = 0.1

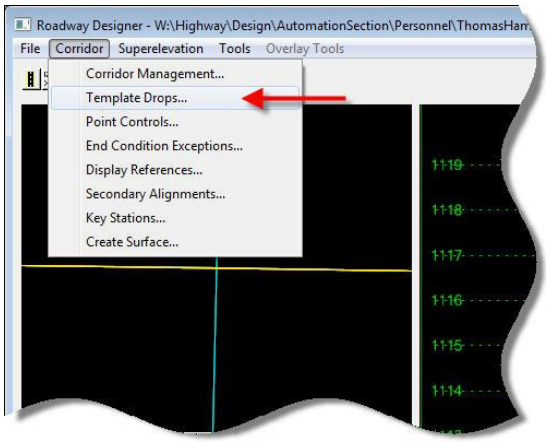
Vertical Chord height = 0.05

Station Lock: EVEN



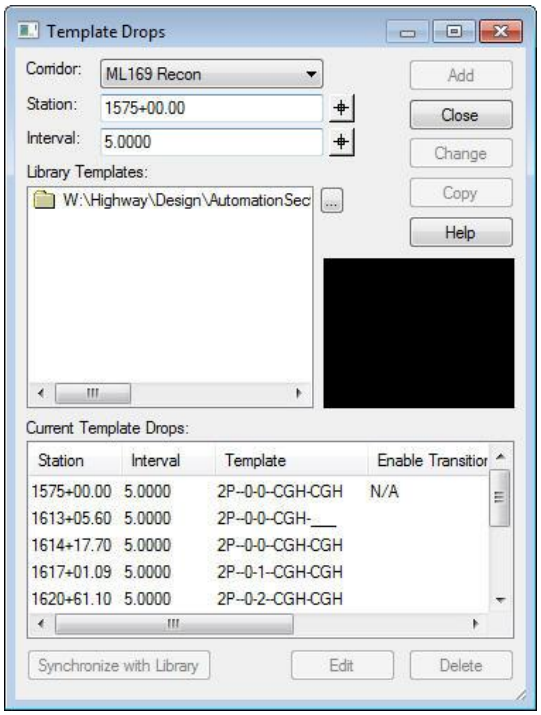
Interval Spacing in Corridor Modeler

The proper interval spacing for a corridor should be set in the template drops interface. To access the Template Drops dialog go to **Roadway Designer>Corridor>Template Drops**



1. **Interval Spacing**
   A 5 foot spacing between template drops is required for projects that will be built with machine control techniques. The template drop on 5 foot intervals shall be at even +05 stations.

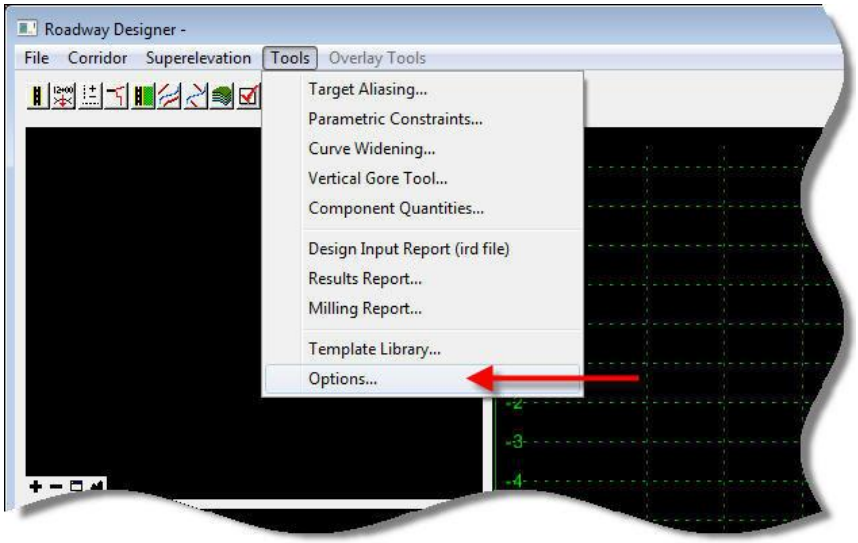
   Note: The 5 foot spacing will not be used for calculating earthwork quantities, and soils layer lines will only be placed at currently established earthwork spacing. This will help later when calculating earthwork quantities and cutting cross sections in that the spacing will be able to accommodate earthwork spacing.



2. **Additional Surface Processing Locations**
   In addition to the 5 foot spaced template drops, the following locations require additional processing due to the unique changes in the proposed design:

   - Changes in Typical Sections.
   - Beginning and End of Transitions.
   - Ditch Grades.
     An effort should be made to place ditch grade points on +10 stations.
   - Foreslope Transitions.
   - Backslope Transitions.
   - Horizontal Curve Geometry Points:
     a. Curves without Spirals: PC and PT (Refer to Section 2A-1).
     b. Curves with Spirals: TS, SC, CS, and ST (Refer to Section 2C-1).
     c. PI Points with No Curves.
   - Vertical Curve Geometry Points:
     a. VPC and VPT (Refer to Section 2B-1).
     b. Maximum or Minimum Points (if not VPC or VPT).
   - Super Elevation Points (A, B, C, and D). See Standard Road Plans PV-300 series.
   - Guardrail Berms Transition Points. See Standard Road Plan EW-301.
   - Median Shaping for Cable Barrier. See Standard Road Plan EW-302.

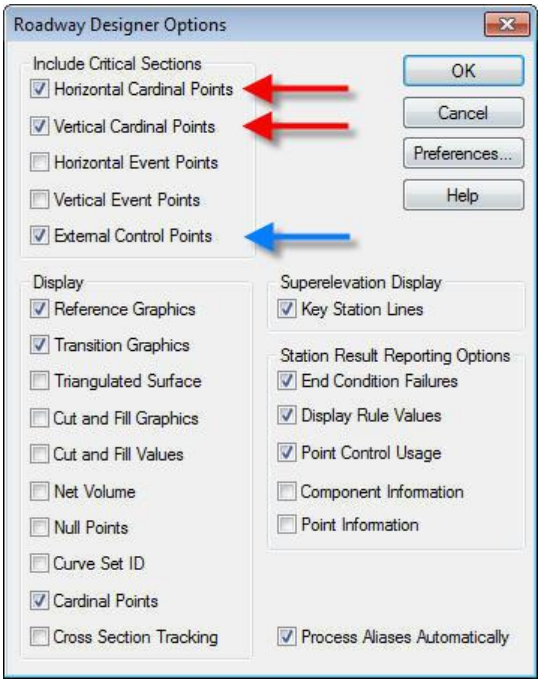
To create the additional processing locations described on the previous page, open by *Selecting* **Tools>Options** in the **Roadway Designer** dialog shown on the right. The dialog for **Roadway Designer Options** will then open. *Toggle* on the checkboxes for Horizontal and Vertical Cardinal Points (red arrows), as well as External Control Points (blue arrow).



Horizontal Cardinal Points – Control points for horizontal alignments: PC, PT, PI, SC, TS, SCS, etc.

Vertical Cardinal Points – Control points for vertical alignments: VPC, VPT, VPI, etc.

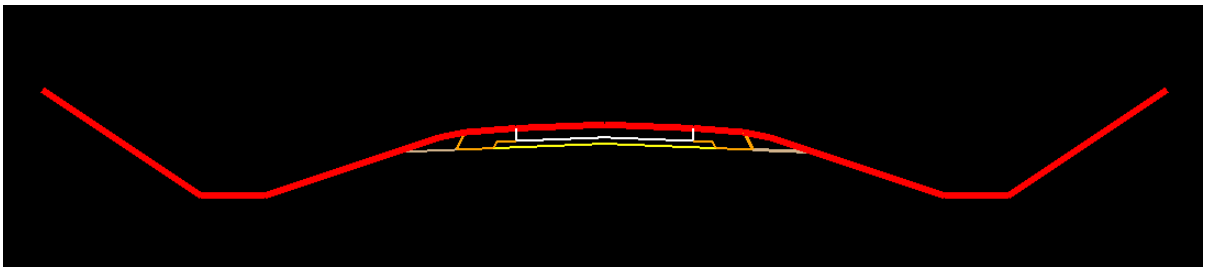
External Control Points – External control points are points which are controlled by plan graphics, alignments, parametric constraints, and features. If any of these control points are being used, make sure the check box for External Control Points is on.



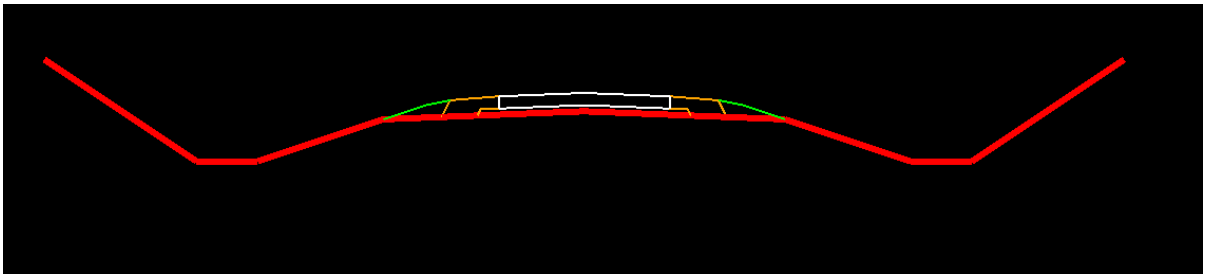
Generation of 3D Surfaces

Once the Corridors are complete, the following steps are to be completed to develop the surface files. Surface files include an XML file and a .3d file which contains all the 3D longitudinal grade breaks represented in a 3D Microstation file. These files will be provided to the grading contractor for application in the machine control grading process. A proposed Top surface and Subgrade Surface will be provided.

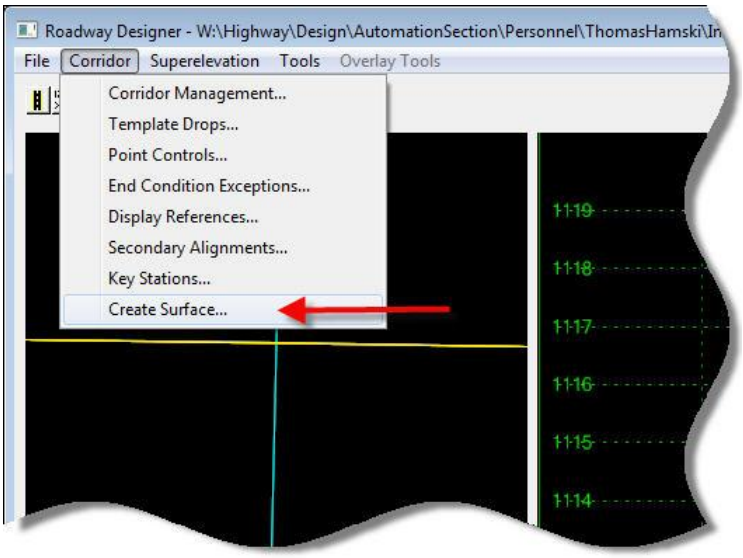
Proposed Top Surface



Subgrade Surface



To create surfaces, *Open* **Roadway Designer>Corridor>Create Surface** as shown on the right.



The following options should be enabled when creating final surfaces to be used for automated machine guidance (AMG):

Empty Design Surface – empties the existing design surface. Check this on.

Create Alternate Surface – depending on the job required, alternate surfaces may need to be created for top of pavement and subgrade. Ensure that Create Alternate Surface is checked on if multiple surfaces are needed.

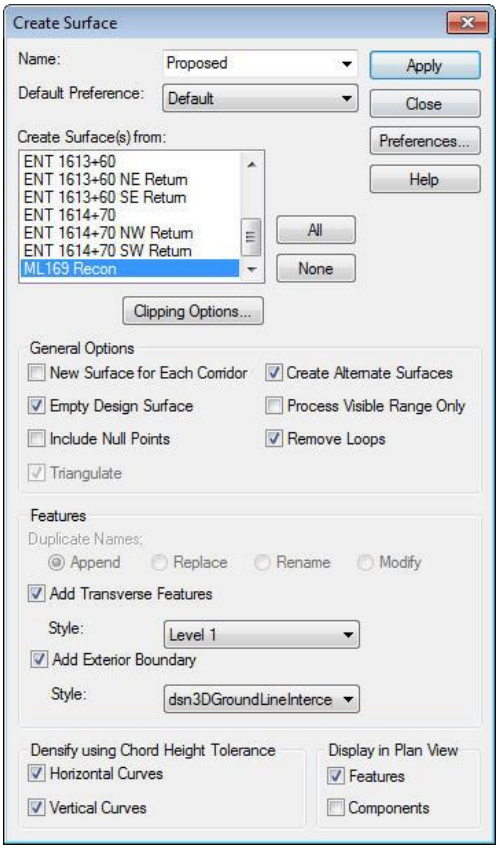
Add Transverse Features – this option adds transverse features for the corridors processed and attempts to tighten the surface geometry when in large fill sections. Place this on feature on **Level 1**.

Add Exterior Boundary – creates a boundary around the proposed surface being created and will trim excess triangulation. Place this feature on level **dsn3DGroundlineIntercept**.

Horizontal Curves – when developing a final surface, ensure the horizontal chord height tolerance is checked on.

Vertical Curves – when developing a final surface, ensure the Vertical chord height tolerance is checked on.

Features – creates longitudinal features in a 3D file based of the template point names surface feature style. These features will represent all the grade breaks for the machine control grader to follow.



After the settings have been checked, ensure that a 3D file is active. *Select* **Apply** in the **Create Surface** dialog, which will create a “Name.tin”, and place the 3D longitudinal features in the active file open.

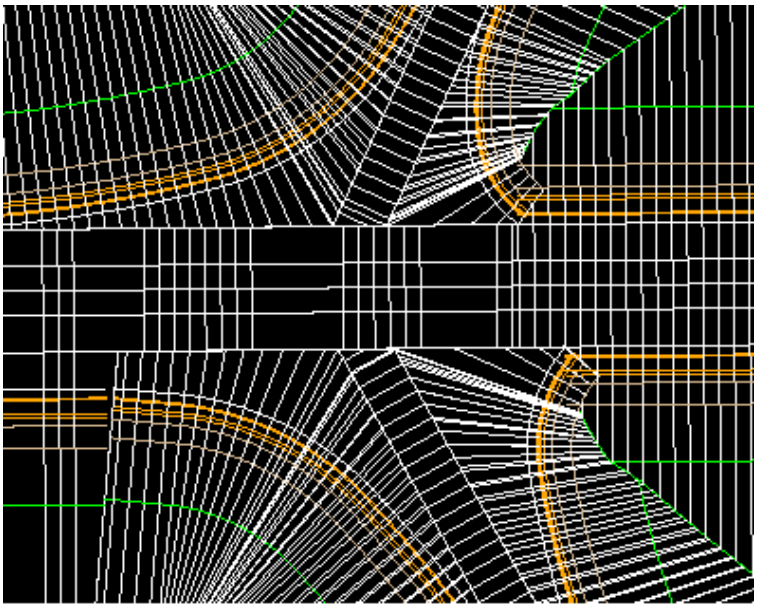
For video instructions on creating surfaces refer to:
http://www.iowadot.gov/design/videos/Ustn_CM_CreateSurface

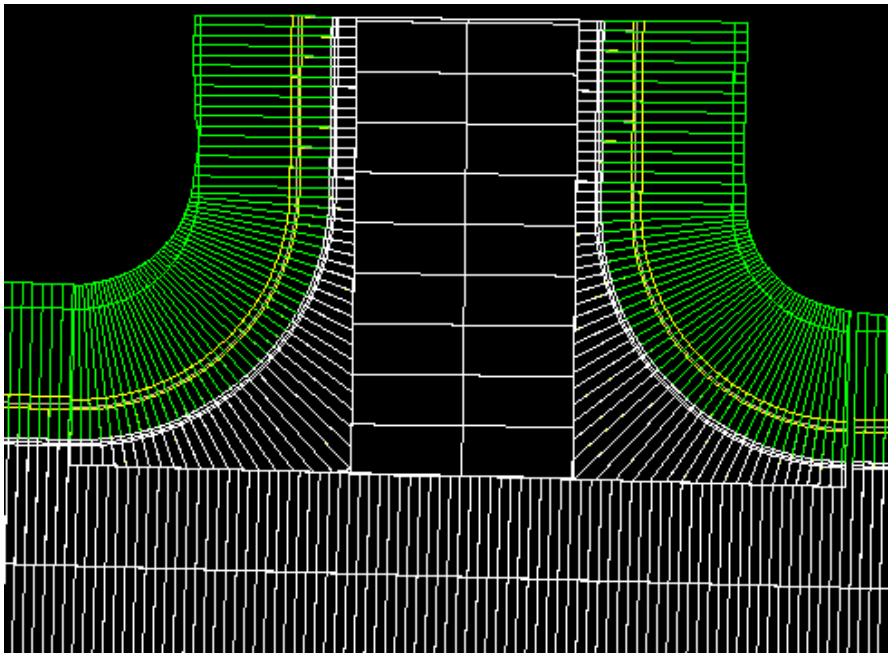
3D File Content

Only 3D breaklines created through Corridor Modeler should be in the 3D Microstation files used for AMG. No components are necessary since they are not used for AMG purposes. All features from the roadway typical created through Corridor Modeler that represent 3D breaklines should be present. All feature levels will begin with the level names dsn3D”Breaklinefeature”. This would include Pavement, Shoulders, Subgrade, Walls, and any Grading which includes foreslope, backslope, and ditching breaklines.

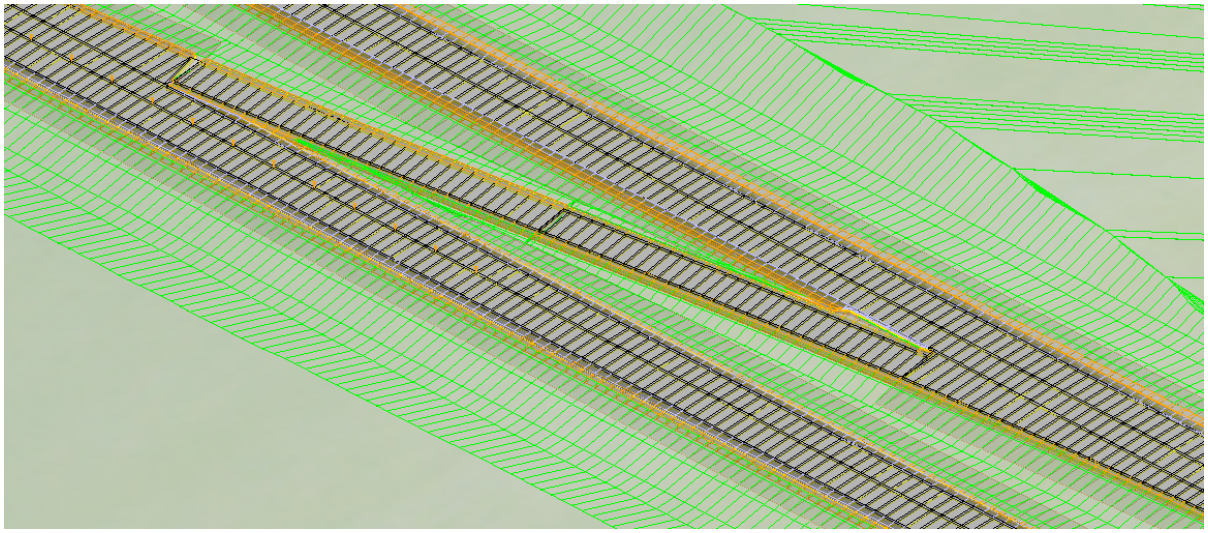
Minimum Areas to be Modeled for AMG

Intersections – Spacing through the returns may need to be reduced some.

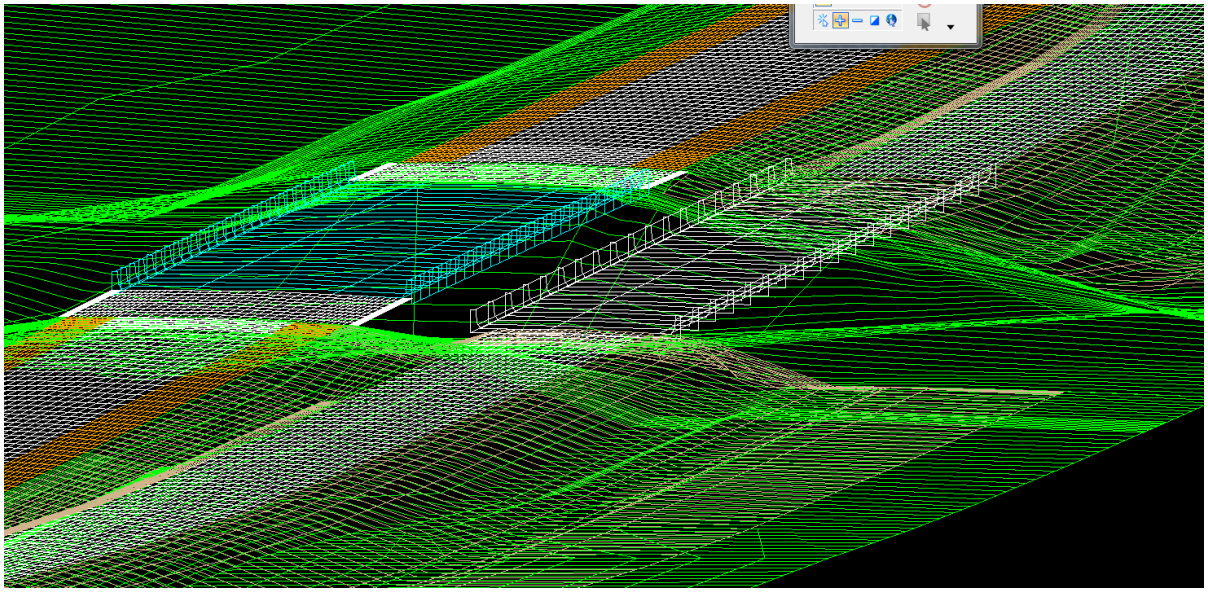




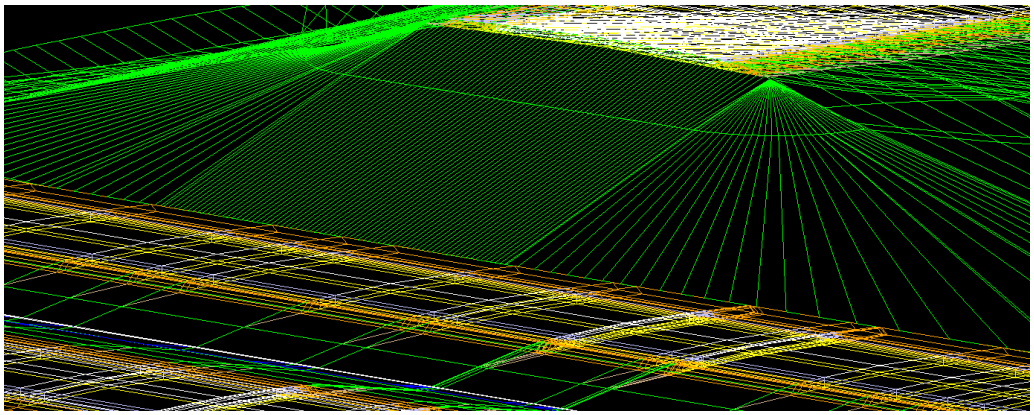
Cross Overs



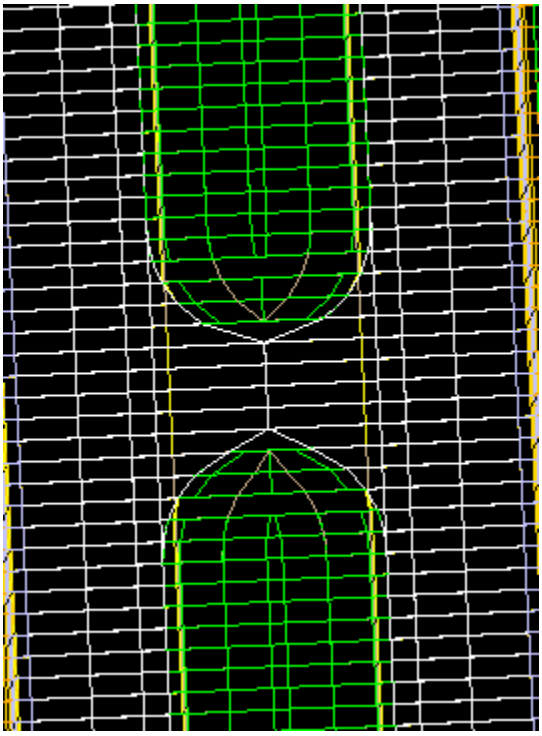
Detours and Staging



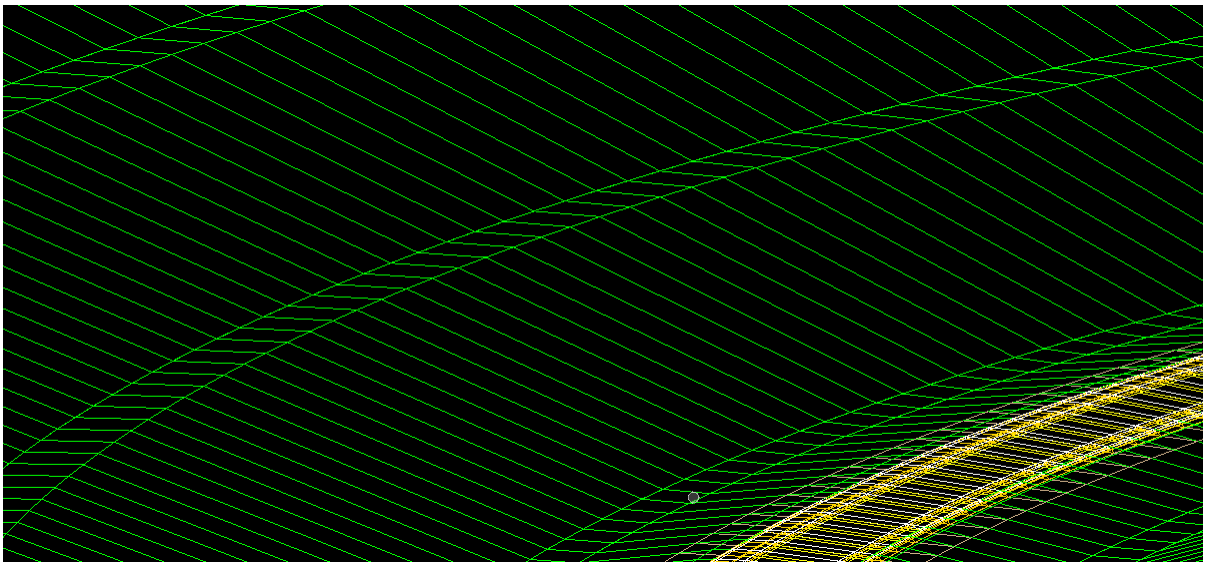
Bridge Berms



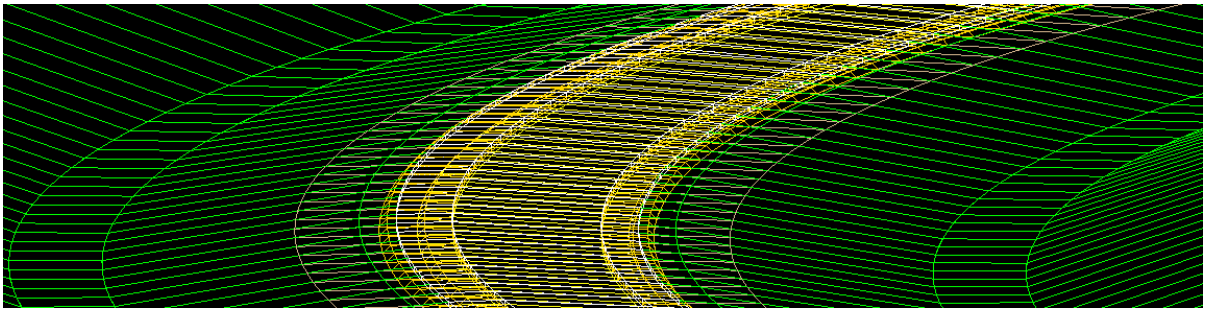
Median Turnarounds



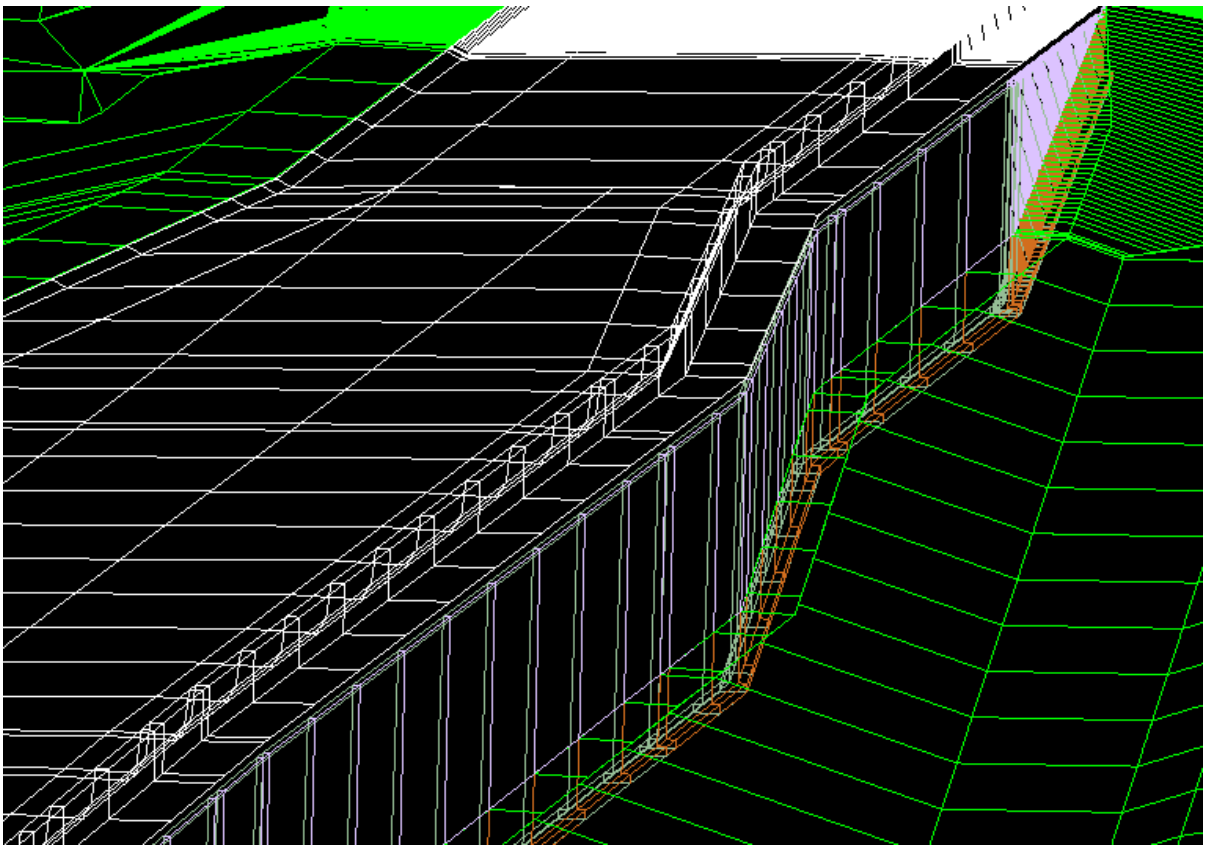
Benching



Ditching

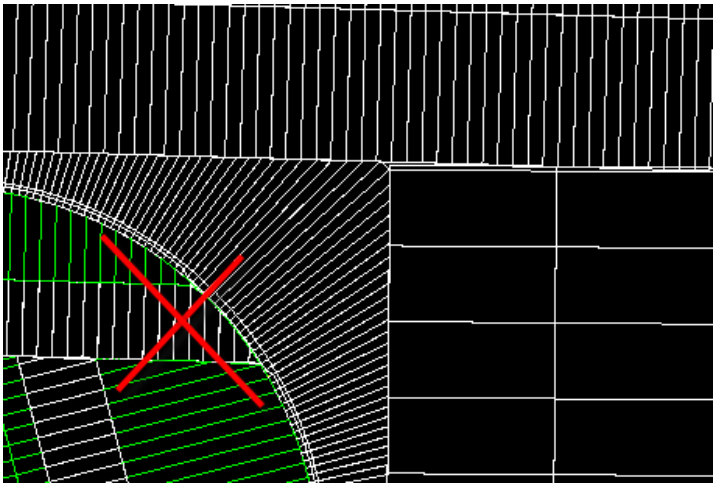


Retaining Walls

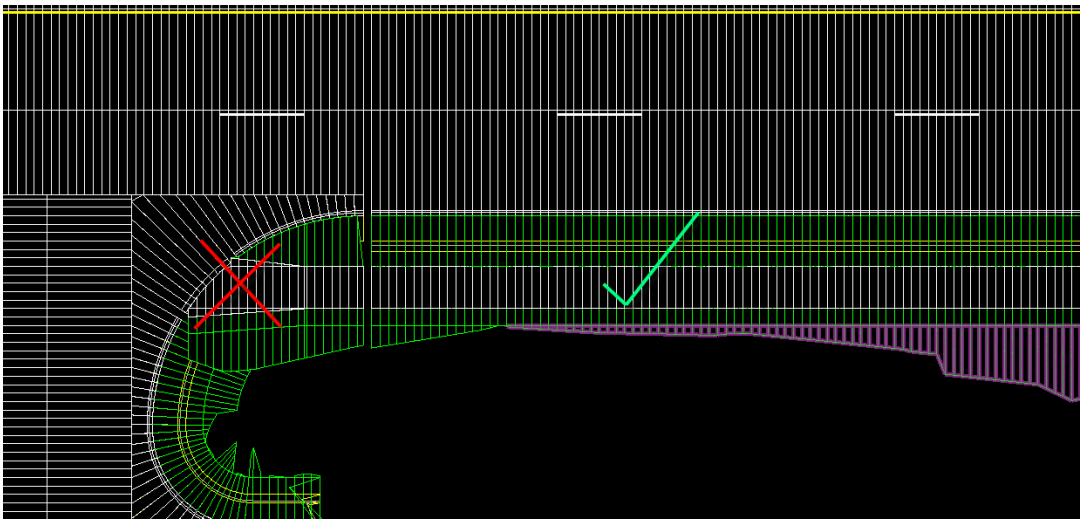


Areas Modeling is NOT Needed for AMG

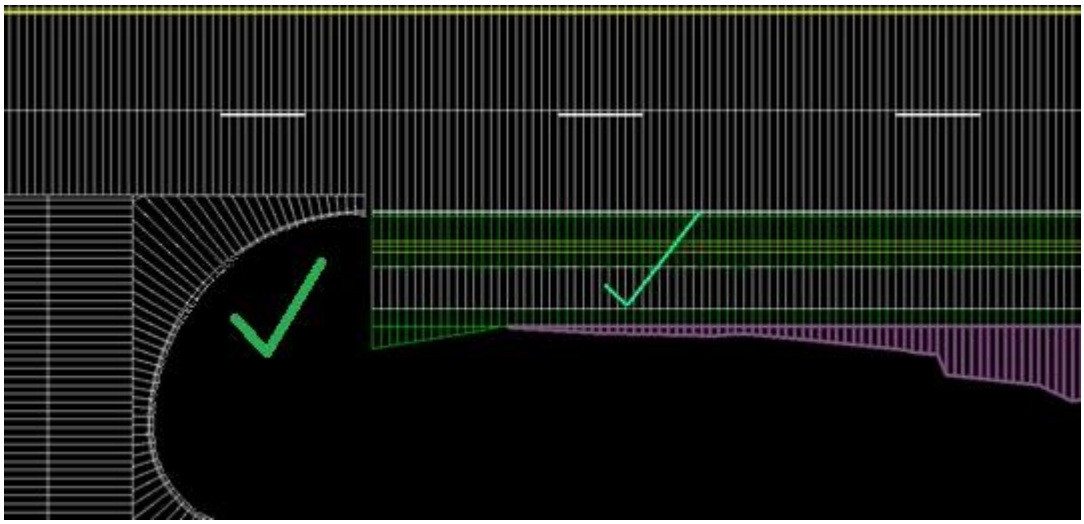
ADA Sidewalks



Any sidewalk that follows the geometry of the adjacent roadway and doesn't require special shaping/profiles will be modeled.

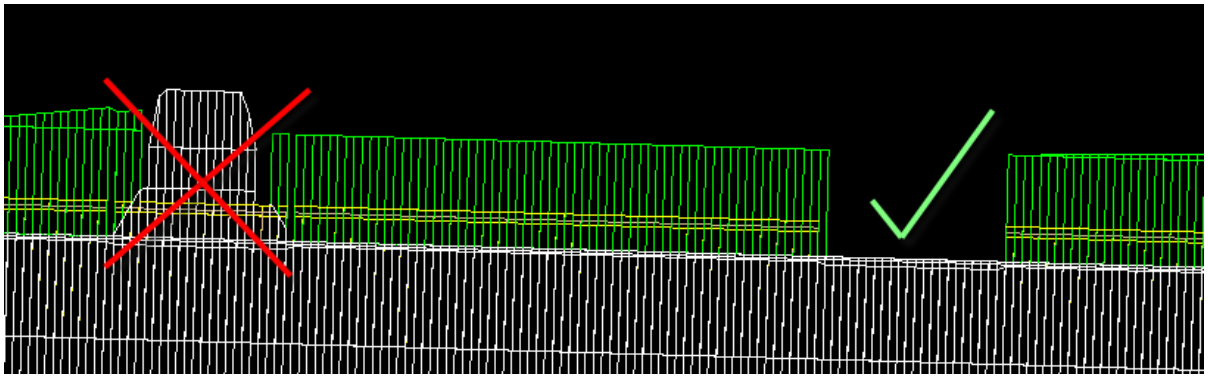


Modeling efforts for the area marked with the red X in the image above should be omitted behind the back of the curb.

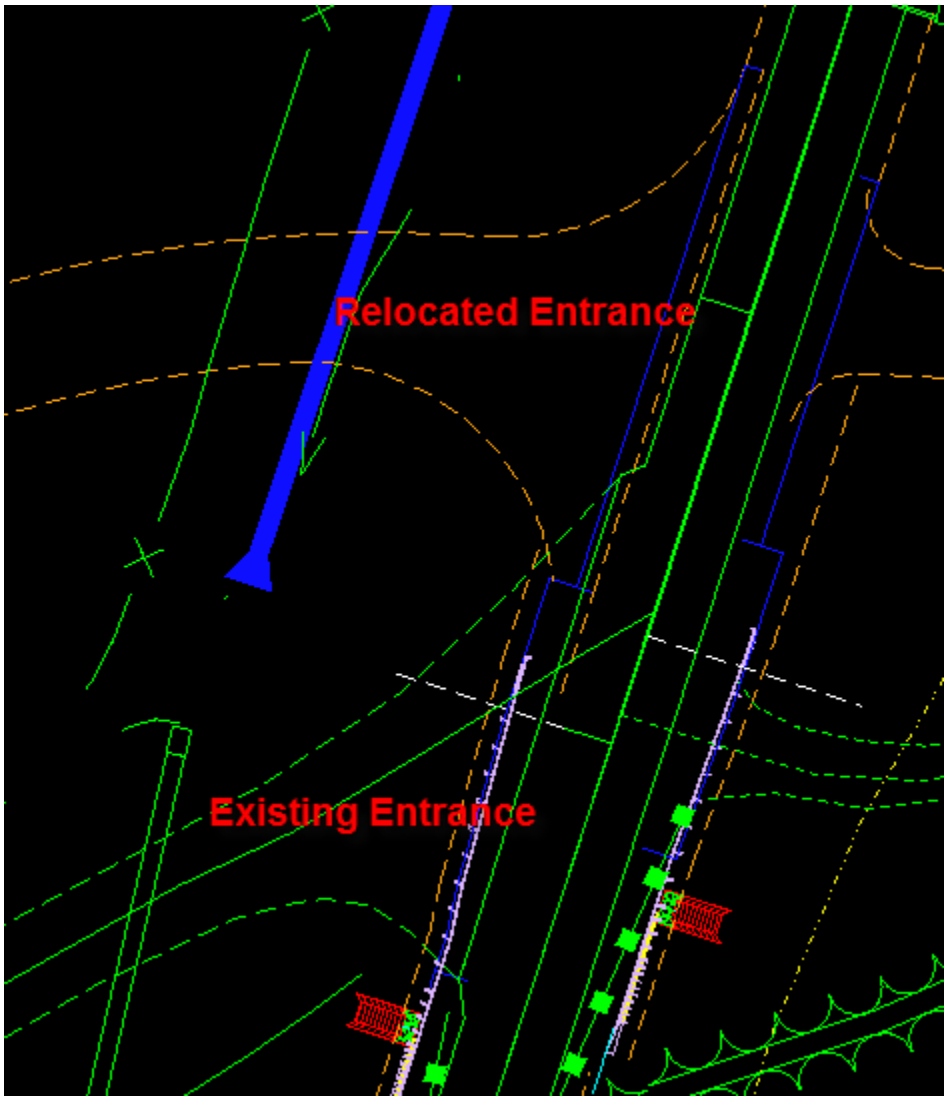


Urban Entrances

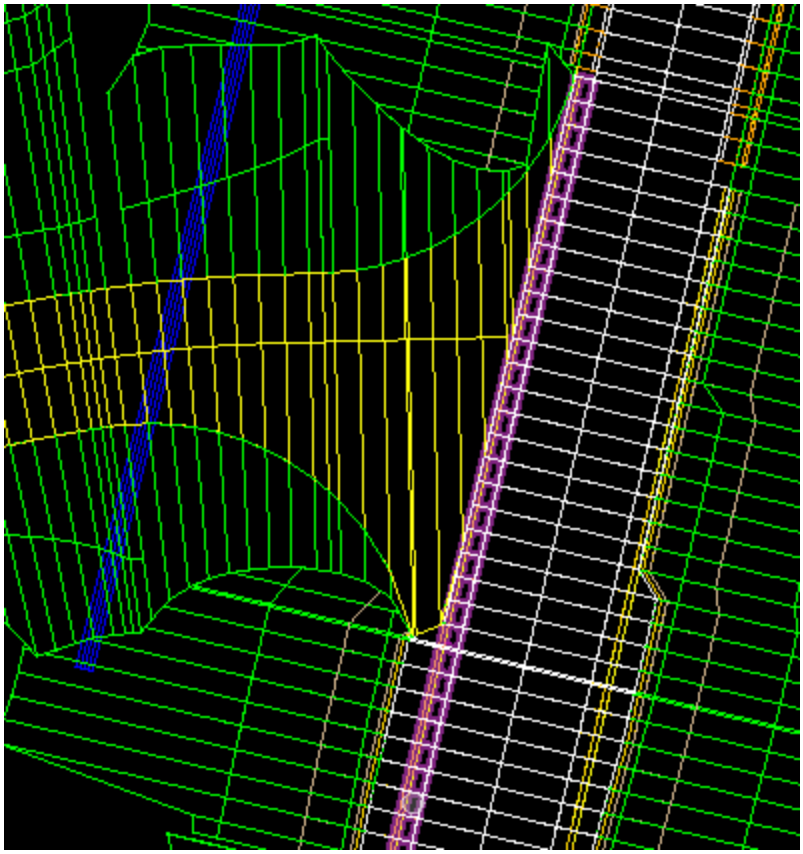
When urban entrances are encountered, omit the entrance and run the curb and gutter unit through the entrance area and leave out any ground, sidewalk, entrance grading.



When a significant shift or redesign is required with an entrance design, a 3D model and surface may be required. The example on the next page shows a rural entrance relocate that required a 3D model and surface.



Entrance Relocation.



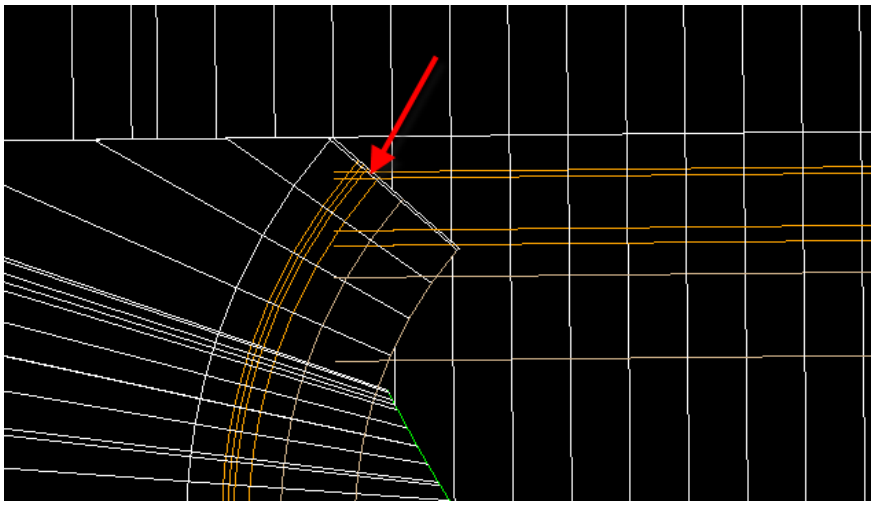
3D model of relocated entrance.

3D Model Accuracy

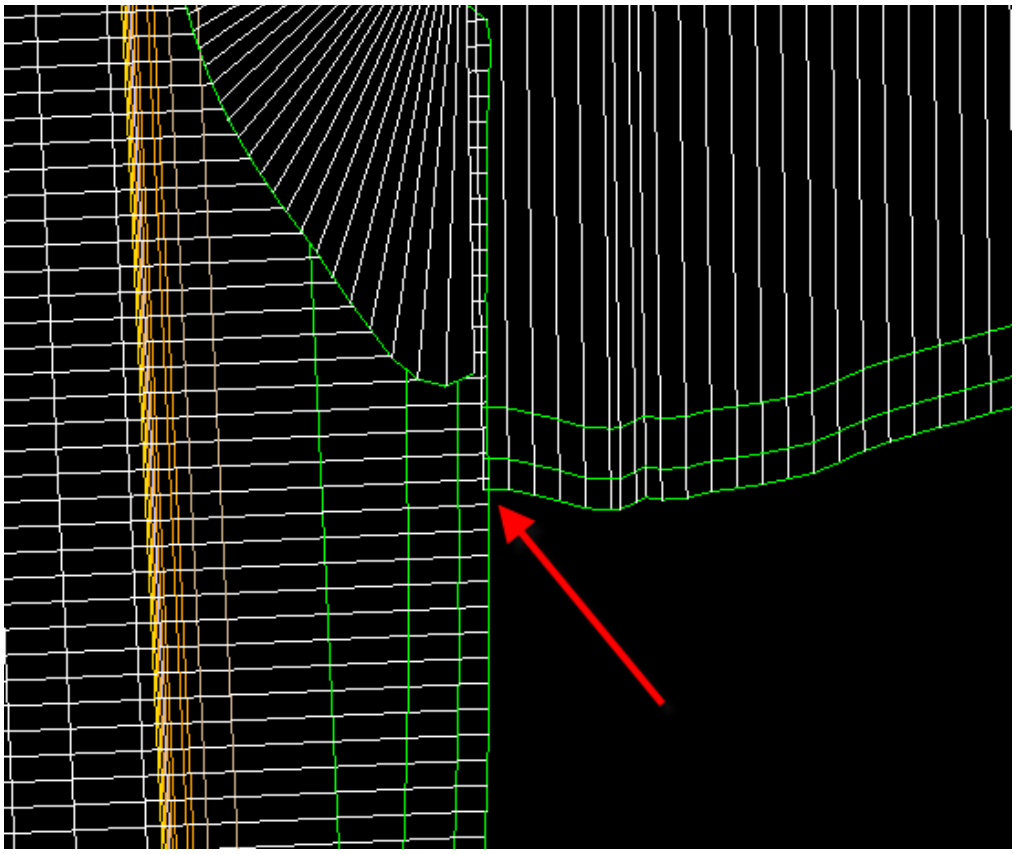
The 3D model and surface files should be developed to the best of the software's ability. The most time should be committed to making sure the pavement matches the correct superelevation and roadway geometry, especially when developing intersections, ramp tie-ins, and return geometry. On the pages that follow are examples and areas that may contribute little value in spending a significant amount of time modeling.

Shown below is an area where, after the model was created, some breaklines appeared, but did not get clipped out as expected. At this point hand editing the breaklines would be required.

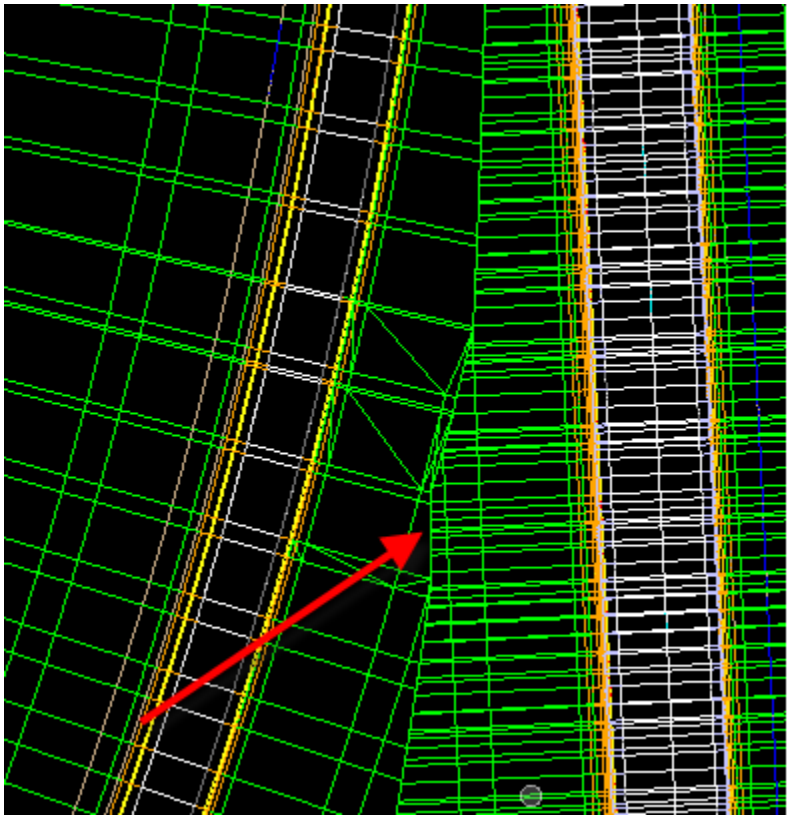
Below shows return geometry that was developed with an acute angle. Notice the breaklines for the shoulder (Orange Lines) don't quite match up. The value vs. time spent here is not beneficial.

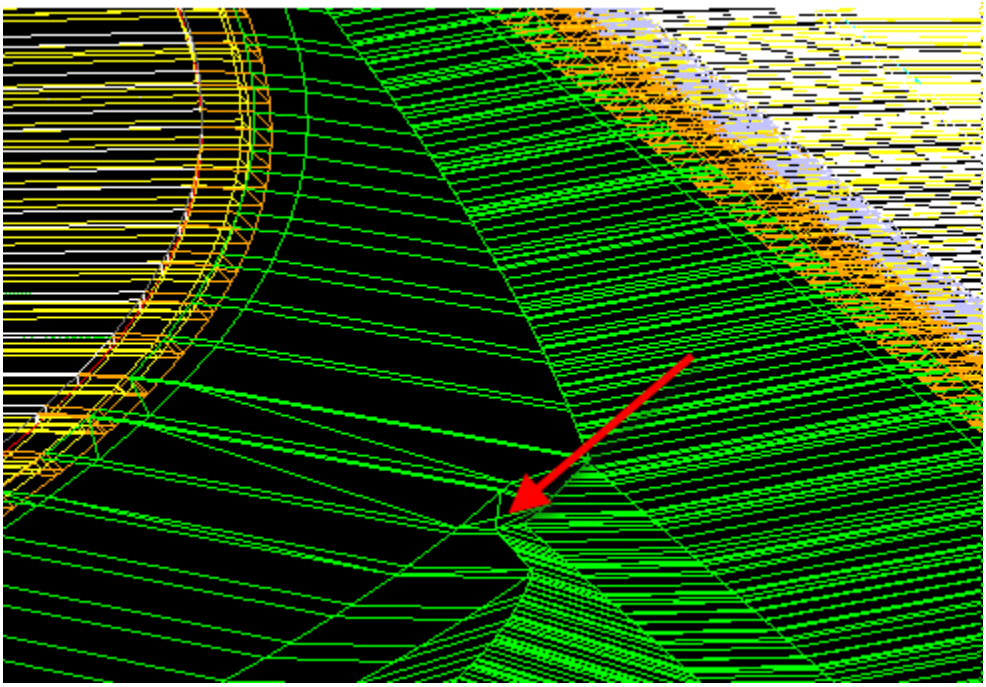


Here is an example where two ditches are joining together at a perpendicular angle. Time could be spent here to round the breaklines, but as long as the ditches meet and are approximately the same elevation where they meet, this would be acceptable.



The two examples below demonstrate an infield ramp gore area showing the two ditches from each roadway coming together. Notice how they don't quite look perfect, but are close. As long as they represent the drainage accurately, this would be acceptable.





Chronology of Changes to Design Manual Section:

021B-270 Developing 3D Models for Design Projects

6/25/2019	Revised Updated hyperlinks. Updated header logo and text.
10/13/2014	NEW New