Using and Editing Terrain Models

This course is for the **2021 Release 1** *version of:*

OpenSite Designer CONNECT Edition

OpenRoads Designer CONNECT Edition

OpenRail Designer CONNECT Edition

About this Practice Workbook...

- This workbook is designed for use in Live instructor-led training and for OnDemand self study. OnDemand videos for this course are available on the *LEARNserver* and through *CONNECT Advisor*.
- This PDF file includes bookmarks providing an overview of the document. Click on a bookmark to quickly jump to any section in the file.
- Both Imperial and Metric files are included in the dataset. Throughout this practice workbook Imperial values are specified first and the metric values second with the metric values enclosed in square brackets.
  For example: **12.0'** *[3.4m]*.
- This course workbook uses the *Training and Examples* WorkSpace and the *Training-Imperial* or *Training-Metric* WorkSet delivered with the software.
- The terms "Left-click", "Click", "Select" and "Data" are used interchangeably to represent pressing the left mouse button. The terms "Right-click" and "Reset" are also used interchangeably to represent pressing the right mouse button. If your mouse buttons are assigned differently, such as for left-handed use, you will need to adjust accordingly.

Have a Question? Need Help?

If you have questions while taking this course, search in *CONNECT Advisor* for related courses and topics. You can also submit questions to the Civil Design Forum on Bentley Communities where peers and Bentley subject matter experts are available to help.

Bentley Institute

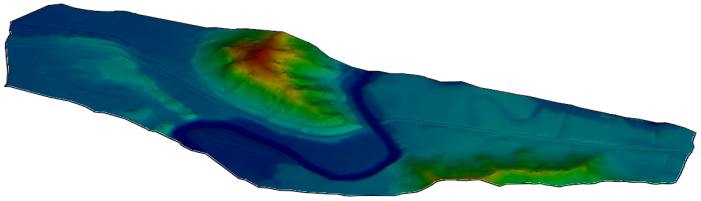
Edition **06-01**

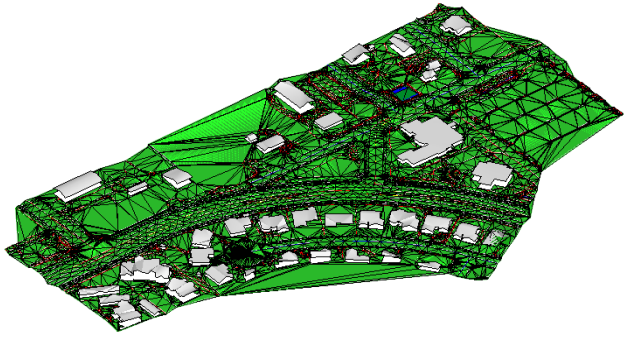
Course Level: **Fundamental**

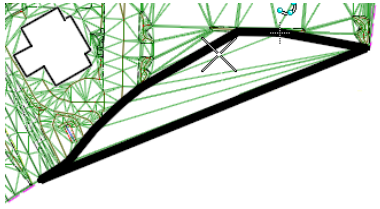
Course Overview

In this course you will ...

- Review terrain features and display, and learn to create thematic height displays
- Create a terrain from graphical elements
- Create a terrain from graphical elements using filters
- Learn about terrain model rules and how they affect editing
- Learn how to add and modify features in a terrain model
- Learn how to report on and resolve crossing break lines and conflicting points
- Learn how to remove edge triangles using the edge method property and the edit terrain tools
- Learn how to complex two terrain models into one terrain model
- Learn how to create a ‘final’ terrain model by adding and modifying a boundary feature







Exercise 1: Terrain Model Review and Display

Description

In this exercise we will review what is a terrain model and then learn how to use the override symbology option to control the display of a referenced terrain model to view different source and computed features including the boundary, triangles, contours, and thematic height illustrations.

Skills Taught

- Terrain Model Review
- Define Override Symbology and select Element Templates
- Display Terrain Model Boundary, Contours and Triangles
- Display Terrain Model Thematic Height

Terrain Model Review

What is a Terrain Model?

A terrain model is a set of triangles mathematically computed from point data collected from the surface being modeled. They are typically used to model highly irregular surfaces, like the surface of the earth. A terrain model is created from 3D features such as points, break lines, and contours. Terrain models are also referred to as digital terrain models (DTMs), triangulated irregular networks (TINs), or triangulated surfaces.

A terrain model is stored as a 3D mesh element in an OpenRoads/OpenRail Designer 3D design (.dgn) file, similar to what used to be stored in a GEOPAK TIN, InRoads DTM, or MX FIL file. When you select a terrain model in the design file, the Element Selection tool recognizes it as a Terrain Model, and the Properties and Explorer Windows will show it as a Terrain Model Element. The display of a terrain model in the product is controlled by using a Feature Definition and Element Template.

Being an element stored in a 3D design file, terrain models are easily shared and used by anyone using any DGN based application like AECOsim Building Designer, OpenPlant Modeler, or MicroStation CONNECT Edition.

Terrain Model Features

Terrain Models contain two types of features.

- **Source Features** are created from the source data imported to create the terrain model and include Break lines, Boundary, Imported Contours, Islands, Holes, Voids, and Feature Spots.
- **Calculated Features** are derived or calculated from the source features and include Contours, Triangles, Spots, Flow Arrows, Low Points, and High Points.

Terrain Models contain two types of ‘spot’ points, Feature Spots and Spots.

- **Feature Spots** are a *Source Feature* and contain the x,y,z information from imported point data.
- **Spots** are a *Calculated Feature* and contain the x,y,z information at all of the triangle vertices in the terrain model.

In an existing terrain model, it is possible and often likely that the Feature Spots and Spots will be the same. In a complex terrain model where an existing terrain model and a proposed design terrain model have been combined, you will see differences in the points.

Terrain Display with Feature Definitions, Feature Symbology and Element Templates

An important concept to understand ...

When a Terrain Model is used with the product, it is linked to a Feature Definition which provides additional intelligence such as the terrain models role in volume calculations (design, existing, etc.) and links to a Feature Symbology. The Feature Symbology then links to three Element Templates that define how the terrain model appears in plan, profile and 3D views. The Element Template defines the default display for the terrain model, but can be overridden when needed.

"What something is and what something looks like are separate things."

- *Feature Definition* defines "**what**" an item is.
- *Feature Symbology* defines "**how**" the item is displayed.
- *Element Templates* and *Annotation Groups* define the **detailed display settings**.

Element Template Manager

Remember that a **Feature Definition** defines "*what*" an item is, and a **Feature Symbology**, along with its Element Templates and Annotation Groups, define "*how*" an item is displayed.

The *Element Template Manager* is where you set all the parameters for an **Element Template**. These parameters include which features are displayed and the symbology used to display each feature type. Some features have additional settings such as contours which have settings for smoothing, major and minor intervals, and labeling.

Element Templates are stored in DGN Libraries making it easy to setup standard display configurations that can be deployed and managed across large groups of users.

When an Element Template is used, it is copied to the active design file model so that the model appears and behaves correctly even when the original DGN Library that contains the standard is not available.

The Element Templates dialog is accessed from the templates selection drop-down menu by clicking "Manage Templates...".

Open File and Attach Reference

The terrain model used in this exercise is in a file named *Existing Ground Terrain.dgn*. The terrain model will be attached as a reference to the active design file model.

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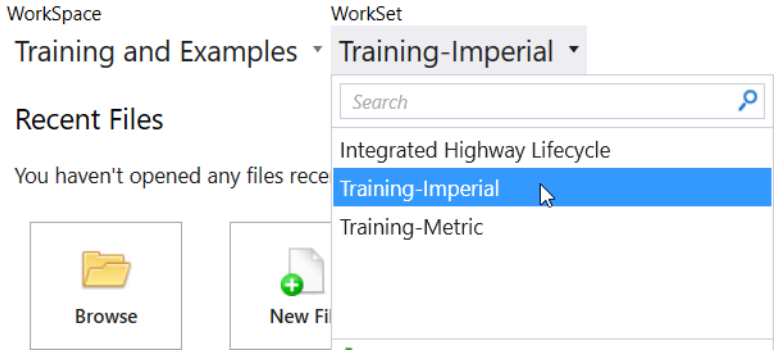
1. Start the software.
2. Set the WorkSpace and WorkSet.

   The WorkSpace and WorkSet define standards that are used by the software. The WorkSpace and WorkSet used for this training are installed during the software installation.

   Typically, the WorkSpace contains organizational standards and the WorkSet contains project standards.

   a. Select **Training and Examples** from the *WorkSpace* drop-down menu.

   b. Select **Training-Imperial** *[Training-Metric]* from the *WorkSet* drop-down menu.



3. Open an existing design file and attach the existing ground terrain model as a reference file.

   a. Select **Browse**

   b. Browse to *C:\Bentley Training\Using and Editing Terrain Models* or other folder where you unzipped the dataset files

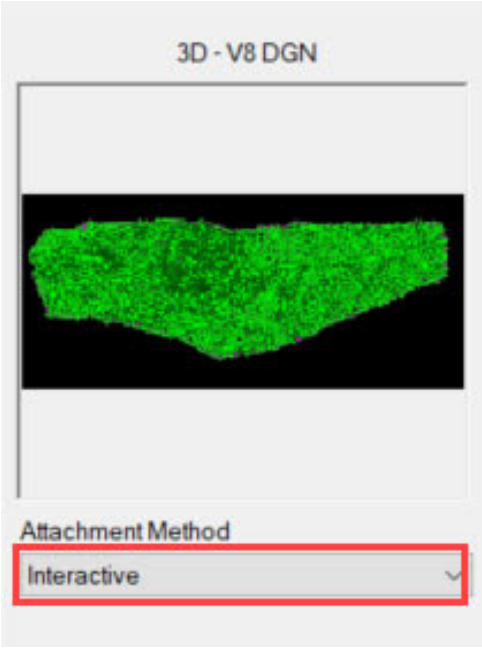
   c. Select the 2D design file **Display Terrain Model.dgn** *[Metric_Display Terrain Model.dgn]*.

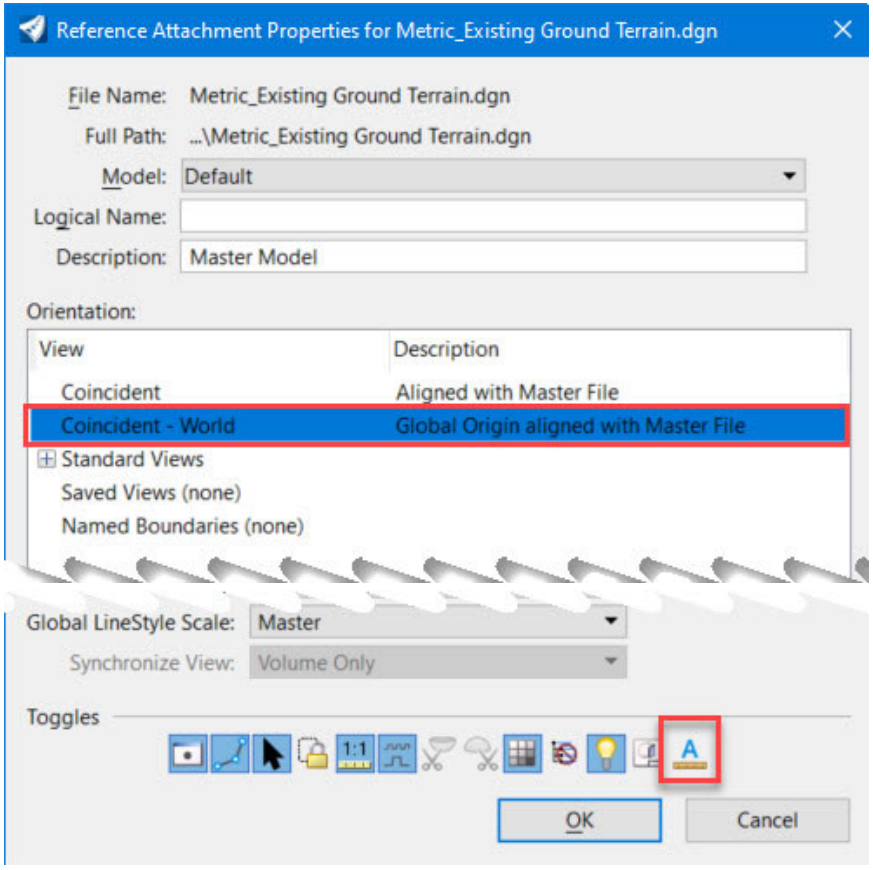
      This is an empty design file.

      Note: If you get a message stating “Incompatible Civil Data”, this is because the training files are “aligned” to OpenSite Designer. Clicking *Yes* will align the file to the software you are using (OpenRoads Designer or OpenRail Designer). This will have zero impact for the training courses. However, note that in production, upgrading the file will make the file read-only in OpenSite Designer. Full information is available at *Bentley Communities - Product Realignment*.

d. Attach the file **Existing Ground Terrain.dgn** *[Metric_Existing Ground Terrain.dgn]* as a reference by selecting **Home > Primary > Attach Tools > References > Tools > Attach**.

- Select the *file* **Existing Ground Terrain.dgn**
- Set the *Attachment Method* to **Interactive**
- Select **Open**
- Set the *Orientation* to **Coincident - World**

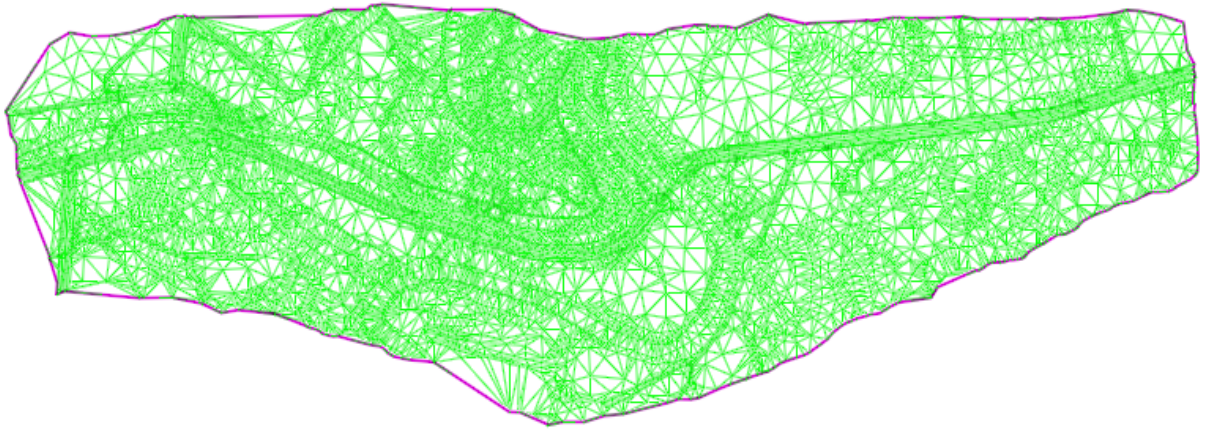




- Select **OK**

e. **Close** the *References* dialog box.

4. **Fit** the view so that the terrain model is visible.

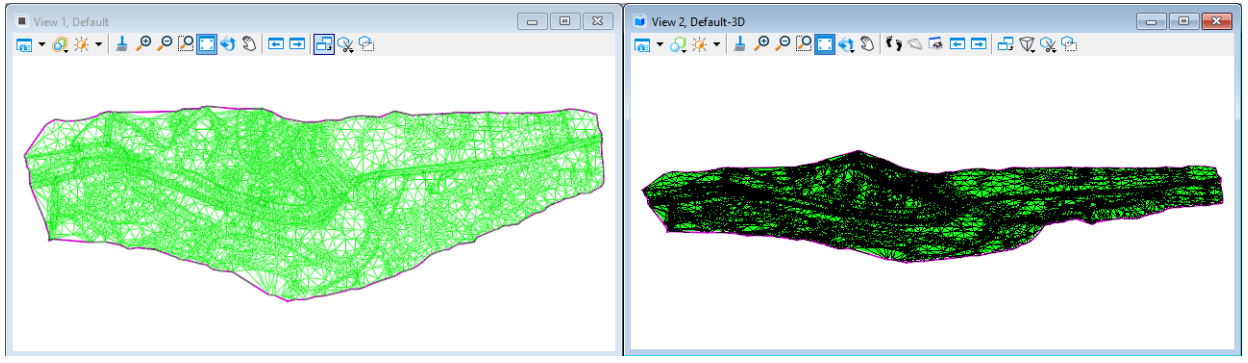


5. Set the attached terrain model as *Active* by using the **Element Selection** tool to select the terrain model boundary, *hover* until the *Context Sensitive Toolbar* displays, then select **Set As Active Terrain Model**.

   Setting the terrain model active automatically creates a 3D model and attaches it to the 2D design file as a reference.

Use the View Control tool to open Plan and 3D views.

6. *Right-click* and *hold* in **View 1**, then select *View Control > 2 Views Plan/3D* to open the two views.
7. Then **Fit View** in both views.



Display Terrain Model

In this section you will learn how to set the Override Symbology option for the referenced terrain model and use feature definitions to change the terrain display.

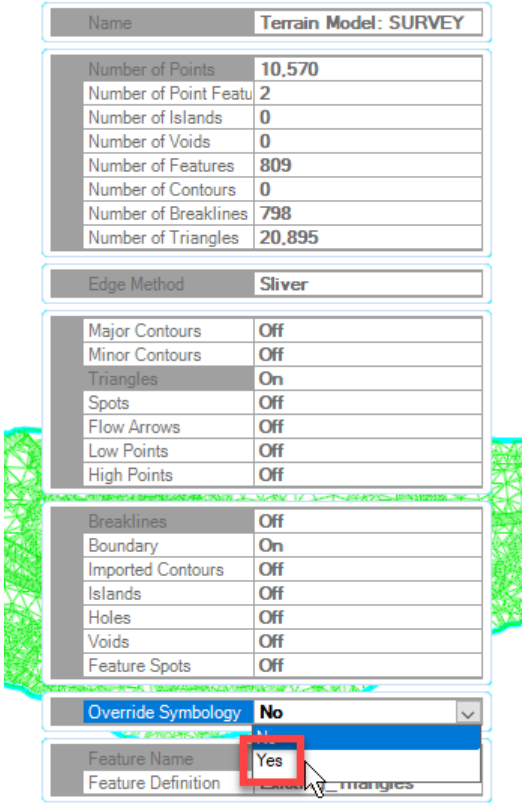
1. Enable Override Symbology on the Terrain Model

   a. Select the **Properties** tool from the **Home > Primary** section.

   b. Select the **Element Selection** tool and then in *View 1*, select the *Terrain Model*.

      The Properties window displays information about the selected terrain model.

      Note: You may also use the context sensitive toolbar to access the Properties as shown at the right.

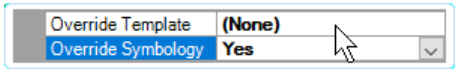


2. Observe that the following parameters are grayed out and unavailable:

   - *Template* parameter in the General section
   - *Edge Method* in the Edge Method Section
   - *All parameters* in the Calculated Features Display section
   - *All parameters* in the Source Features Display section
   - *Feature Definition* parameter in the Feature section

   These parameters are grayed out because the terrain model is referenced into the current file and as is common with references that are read only. However, terrain models have a special parameter to override symbology (display) even though the reference is read only. The override allows the terrain model to display different in the reference without changing the source.

3. In the *Reference* section, set *Override Symbology* to **Yes**.
4. Observe the changes to the Properties and note that the following parameters are now accessible and can be used to modify the display of the terrain:
   - *All parameters* in the Calculated Features Display section
   - *All parameters* in the Source Features Display section
   - *Override Template* in the Reference section



5. Set the *Override Template* to **Terrain\Existing_Boundary** and note that the display in View 1 changes to show only the boundary.

   Remember that Override Symbology is view dependent. Only the active view changes when you set the Override Symbology to Yes. You can repeat these steps for all views where the terrain model is displayed and where you want to change the display parameters.
6. Set the *Override Template* to **Terrain\Existing_Contours** and note that the display changes to show only the contours.
7. Use the **On/Off** toggles in the *Calculated Features Display* and *Source Features Display* sections to individually turn feature displays on and off.

   Remember that you can double click on the feature name or on the On/Off option to toggle the setting.

Prepare the view for the steps in the next section.

8. **Click** in *View 2, Default-3D* to set that view active
9. Select the terrain model and use Properties to
   - Set *Override Symbology* to **Yes**
   - Set *Overrride Template* to **Terrain\Existing_Triangles**
10. **Click** in the view to clear the selection of the terrain model.
11. **Close** the *Properties Window*.

Exercise 2: Create Terrain from Graphical Elements

Description

In this exercise you will learn how to import graphic elements into a terrain model using a selection set and the Create Terrain from Elements tool.

Skills Taught

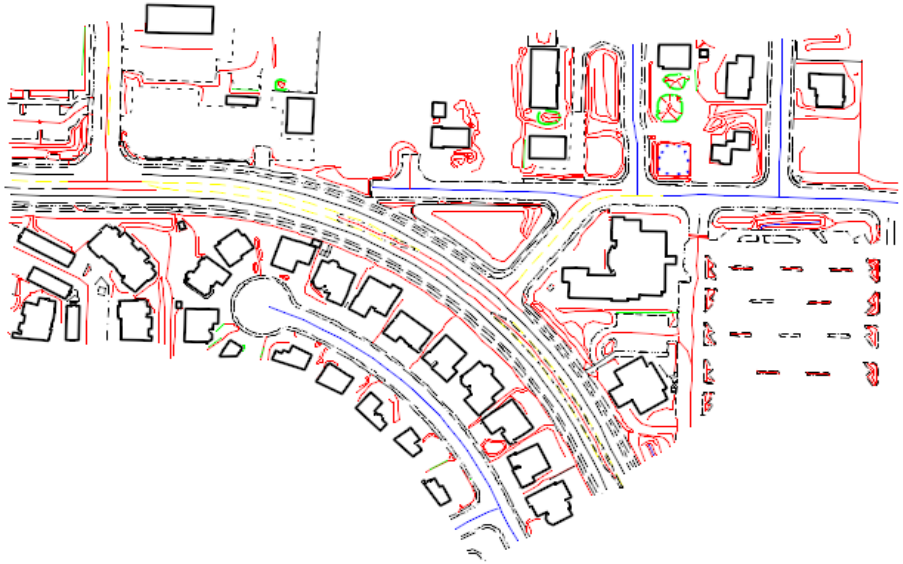
- Create a terrain model from graphic elements

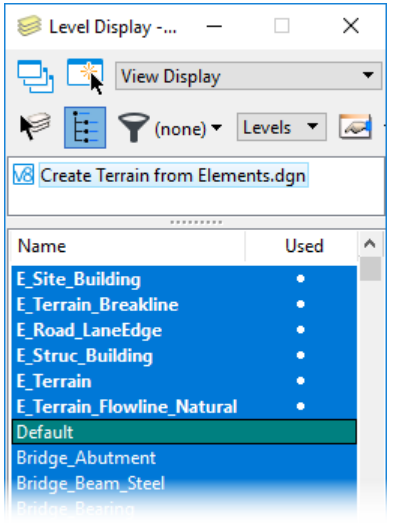
Create Terrain from Elements

1. From the Quick Access tool bar, select **Open** to open the **Create Terrain from Elements.dgn** *[Metric_Create Terrain from Elements.dgn]* file.

   Note: If you get a message stating “Incompatible Civil Data”, this is because the training files are “aligned” to OpenSite Designer. Clicking *Yes* will align the file to the software you are using (OpenRoads Designer or OpenRail Designer). This will have zero impact for the training courses. However, note that in production, upgrading the file will make the file read-only in OpenSite Designer. Full information is available at *Bentley Communities - Product Realignment*.

   This file contains graphics representing buildings, roads and terrain features. The graphics are identified by which level in the design file they were placed.

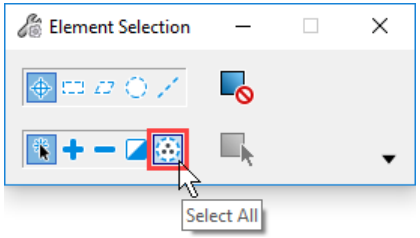




2. **Close** the *Properties Window* if it is open.

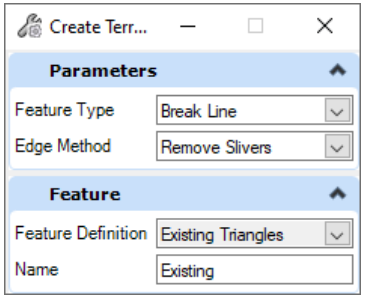
3. In View 1, use the **Element Selection** tool to select all 1222 elements in the file.

   Hint: Click **Select All** icon in the tool settings window.



4. Create the Terrain Model.

   a. Select **Terrain > Create > From Elements**.



   b. Set the following values in the dialog box.

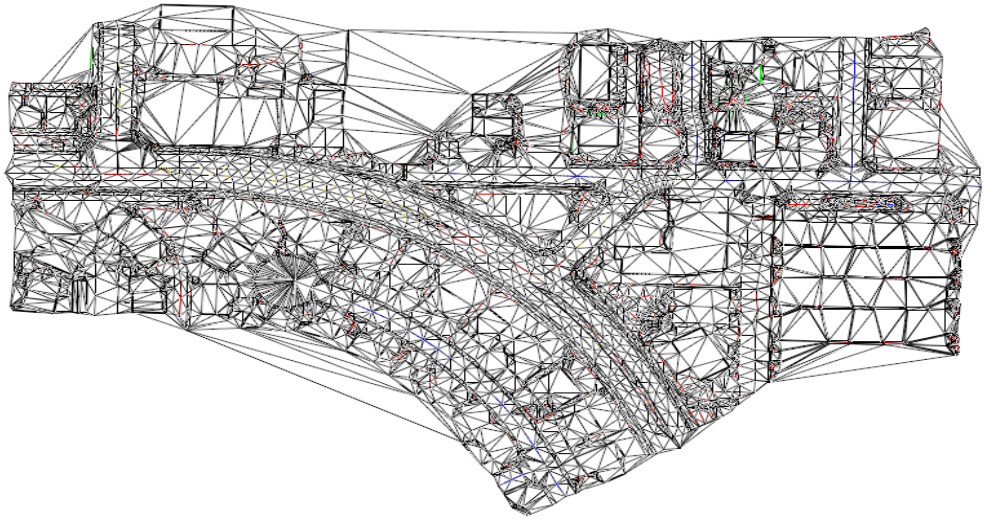
      - *Feature Type*: **Break Line**
      - *Edge Method*: **Remove Slivers**
      - *Feature Definition:* **Existing_Triangles**
      - *Name:* **Existing**

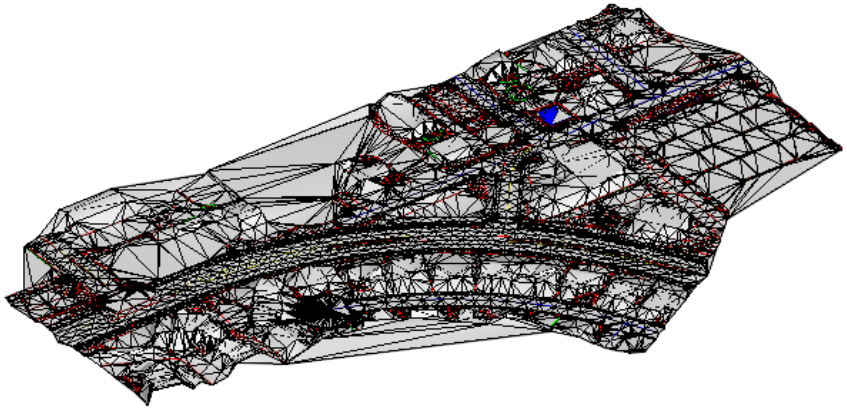
   c. Follow the heads up prompts and **left-click** for each of the following:

      - *DataPoint to Add 1222 selected elements*
      - *Feature Type: Break Line*
      - *Edge Method: Remove Slivers*

   d. The graphic elements are processed.

The new terrain model is created and the terrain model triangles are displayed. While this is a valid terrain model, it might not be everything as desired.





One issue is that the terrain model is triangulating through the buildings which should more accurately be represented as void areas. In this workflow, all of the graphic elements were loaded at once and defined as break lines. An alternative workflow would be to bring in the break lines and the building voids in separate steps. That workflow would be something like this.

- Create a selection set with all of the elements except the buildings and create a terrain model from those elements defining them as break lines.
- Create a selection set with just the buildings and create a second terrain model from those elements defining them as voids.
- Use the Complex Terrain Model tool (we will learn about that later) to combine the two terrain models.

While this process works, it is a bit tedious. If you do this regularly, or have more than two types of data to load, this method would be very inefficient. When there are multiple feature types to load, using the **Graphic Filters** tools is the *Best Practice* method.

Exercise 3: Create Terrain from Graphical Elements using a Filter

Description

In this exercise learn how to create filters and filter groups in the local design file and then create a terrain model with multiple feature types using the graphical filter.

Skills Taught

- Creating graphical filters and filter groups
- Creating a terrain model using a graphical filter
- Understanding the linkage between graphical source data and the terrain models
- Terrain model rules
- Editing linked source data

Terrain Filters

There are two parts to the Terrain Filter Manager, Filters and Filter Groups.

Filters define the feature type (break line, spot, void, etc.) and the filter selection criteria. Elements that meet all of the filter selection criteria pass the filter and are created in the terrain model with the designated feature type. The filter selection criteria includes color, level, element type, line style, line weights, cell names, feature definitions, transparency, element templates, and elevations. A minimum of one selection criteria must be defined.

Filter Groups are a combination of individual Filters that will be processed in a single operation. For example, a Filter Group might contain three filters. One for break lines, one for spot points, and one for void areas. Complex filter groups could contain dozens of filters.

The *Training and Examples* workspace delivered with the software includes several filters and filter groups that can be used.

Create a Graphical Filter and Filter Group

In this exercise learn how to create filters and filter groups in the local design file. It is best practice to create filters and filter groups in DGN Libraries that are shared throughout an organization as standards, but they can also be created in a local file if the filter is specific to a project and will have little value as a standard.

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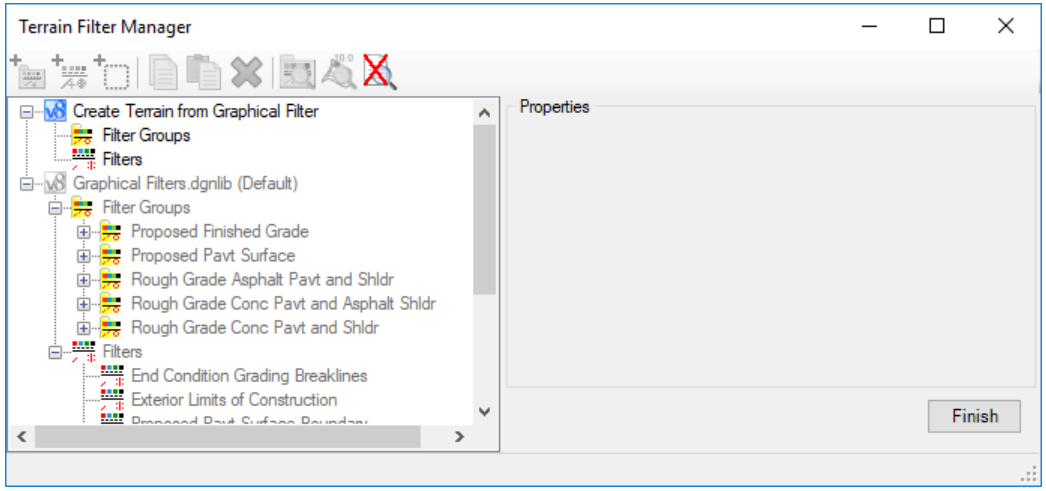
1. Open the 3D file **Create Terrain from Graphical Filter.dgn** *[Metric_Create Terrain from Graphical Filter.dgn]*.

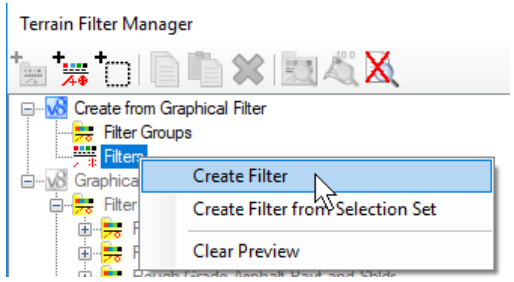
   This file contains the same graphics that were used in the previous exercise.

2. Select the **Terrain > Create > From Graphical Filter > Graphical File Manager** tool to display the *Terrain Filter Manger* dialog box.



3. Use the **scroll** bar in the middle of the dialog to scroll to the *top* of the list view.
4. Create a **Filter** to load the building graphics as drape void features.
   a. As necessary, expand **Create Terrain from Graphical Filter** *[Metric_Create Terrain from Graphical Filter]* in the tree view so the *Filter Groups* and *Filters* sections are visible as shown in the above image.

b. **Right-click** on *Filters* and select **Create Filter**.



- Set *Name* to **Buildings.** If the Name field is grayed out, right click on the filter in the tree view and select **Rename**.
- Set *Description* to **Buildings**
- Set *Feature Type* to **Drape Void**

Note: The Drape Void feature type will create void features (no triangles inside the feature) but the elevations for the feature are not read from the graphic elements. Instead each vertex is draped onto the active terrain model and the elevation taken from that model.

c. **Enable** the *Link to Terrain Features* option.

Terrain elements created with this option enabled are automatically updated if the original graphic element is modified.

d. Click **Edit Filter**.

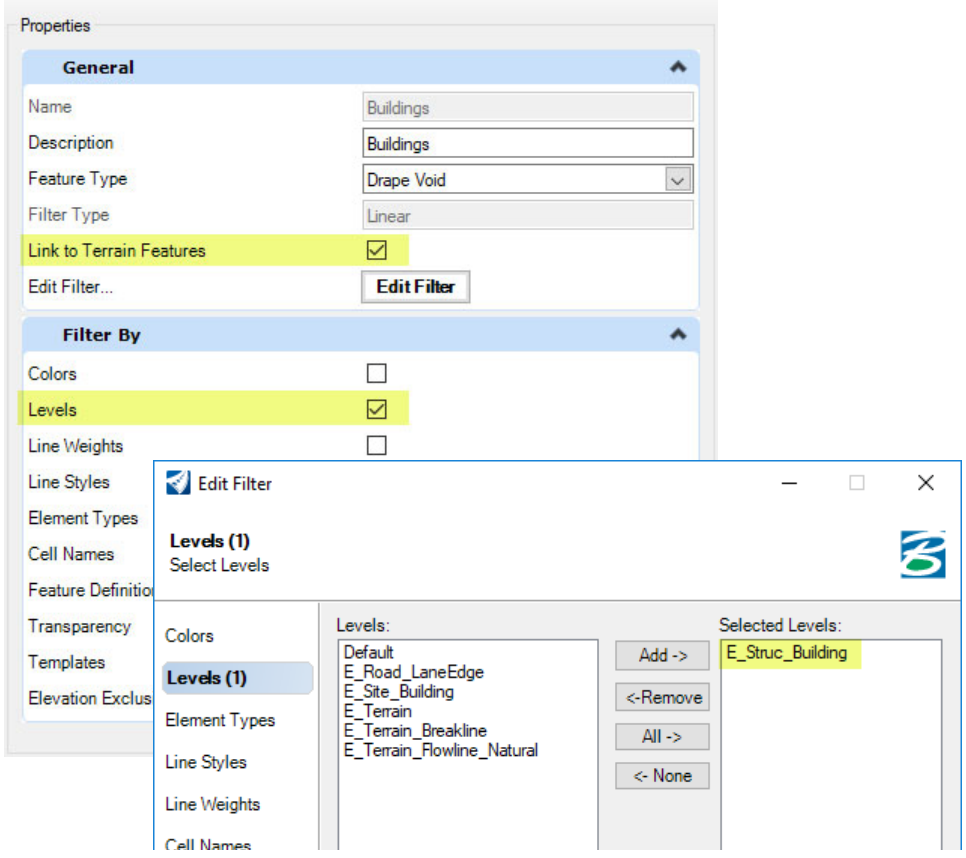
The Edit Filter window appears.

e. Select the **Levels** category.

f. Select the *E_Struc_Building* level and click **Add->**.

Hint: Double-click on the E_Struc_Building level name to quickly add it to the Selected Levels list.

g. Click **Finish** on the *Edit Filter* dialog.



h. Verify that the **Levels** option is *enabled* in the **Filter By** section on the *Terrain Filter Manager* dialog.

5. Create a **Filter** to load all of the other graphics as break line features.

   a. **Right-click** on *Filters* and select **Create Filter**.

      - Set *Name* to **Break Lines.** If the Name field is grayed out, right click on the filter in the tree view and select **Rename**.
      - Set *Description* to **Break Lines**
      - Set *Feature Type* to **Break Lines**
      - **Enable** the *Link to Terrain Features* option.

   b. Click **Edit Filter**.

   c. Select the **Levels** category.

   d. Click **All->**.

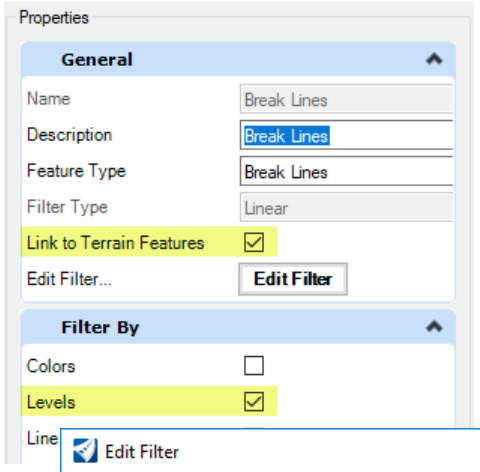
      All of the levels are moved to the Selected Levels column. However we do not want all of these levels selected.

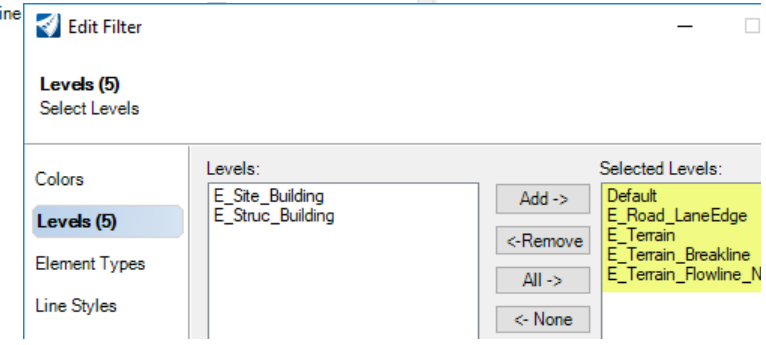
   e. Select the *E_Site_Building* level and click **<-Remove**.

   f. Select the *E_Struc_Building* level and click **<-Remove**.

   g. Click **Finish** on the *Edit Filter* dialog.

   h. Verify that the **Levels** option is *enabled* in the **Filter By** section on the *Terrain Filter Manager* dialog.





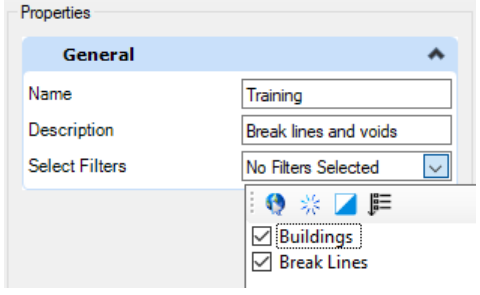
6. Create a **Filter Group** that includes the Building and the Break Line filters.

   a. **Right-click** on *Filter Groups* and select **Create Filter Group**.

      - Set *Name* to **Training**
      - Set *Description* to **Break lines and voids**

   b. Select the **Buildings** and **Break Lines** filters from the *Select Filters* option.

7. Click **Finish** to close the *Terrain Filter Manager* dialog.



Create a Terrain Model using a Graphical Filter

In this exercise learn how to use a graphical filter to create a terrain model.

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1. Create a **Terrain Model** using the graphical filter.

   a. Select the **Terrain > Create > From Graphical Filter** tool.

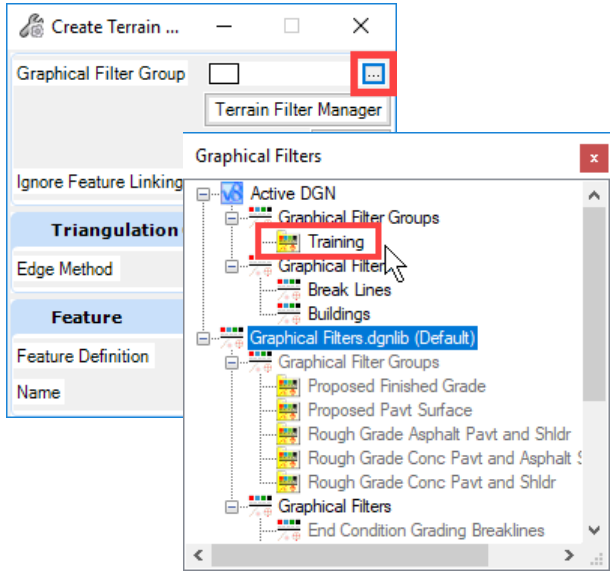
   b. In the *Create Terrain From Graphical Filter* window, select the **ellipsis** ... in the *Graphical Filter Group* option.

   c. In the *Graphical Filters* dialog box, **scroll up** to the top of the list.

   d. Select the **Training** *Graphical Filter Group* from the Active DGN.

   e. **Enable** the *Ignore Feature Linking* option.

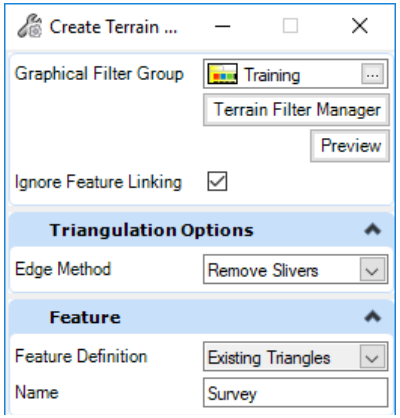
      When this option is enabled an unruled terrain model is created without a link to the source graphic elements. Changes to the source graphics do not affect the terrain model.



   When this option is disabled and if the *Link to Terrain Features* option is enabled in the filter, a ruled terrain model is created. Changes to the source graphics cause the terrain model to immediately update. Using this option on large datasets takes a significantly longer time to build the terrain model.

f. Set the following parameters in the dialog box:

- Set *Edge Method* to **Remove Slivers**.
- Set *Feature Definition* to **Terrain > Existing > Existing Triangles**.
- Set *Name* to **Survey**.

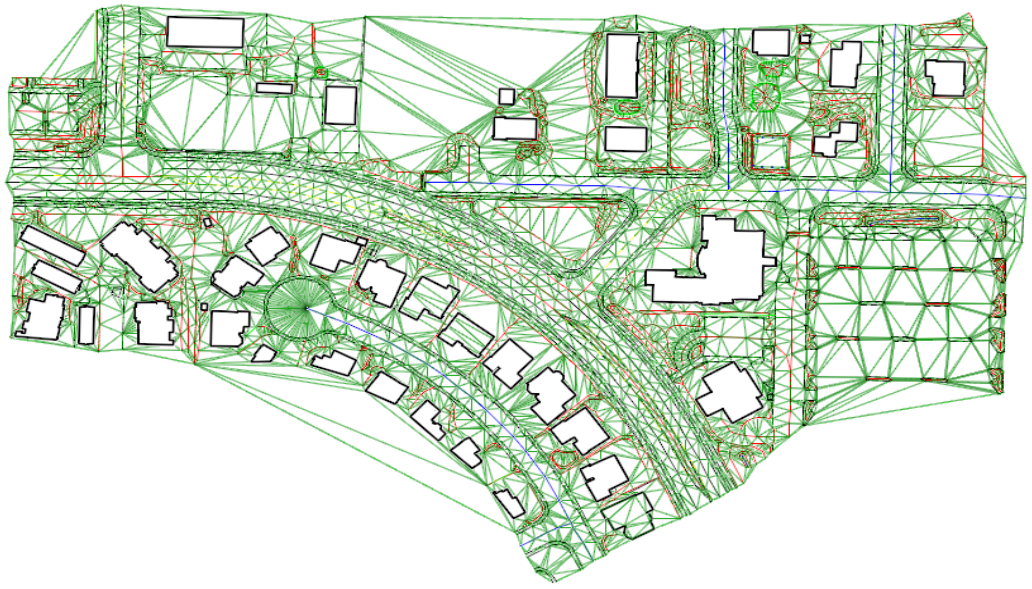


g. **Left-click** in the graphic view to confirm the edge method, accept solution and create the terrain model.

- *Append to Terrain:* **No**

h. **Right-click** or **Esc** to exit the *Create Terrain Model From Graphical Filter* tool.

Notice that the buildings are now voids in the terrain model. All of the graphic elements were loaded into the terrain model but the buildings were loaded as voids and the other elements as break lines.



Terrain Model Rules

Terrain Models created using the OpenRoads Designer tools have an additional level of intelligence called *rules* that preserve a link between the source data and the terrain model so that it can be updated when revisions are made to the source data. This has very powerful implications for how terrain models are updated and edited. For example, terrain models created from design elements are automatically updated as changes are made when geometry and templates change. Unlike the past when DTMs and TINs were a result of a design process, terrain models are a dynamic representation of the current source data.

Sometimes it is desirable to lock or remove the rules to temporarily or permanently deactivate them. For example, there are tools to make minor edits to terrain models that may be necessary if the source data no longer exists or is impractical to edit. Also, large terrain models and terrain models shared with non-OpenRoads users may benefit from removing the rules. The Activate, Deactivate, and Remove Rules tools are used to change how terrain model rules are applied.

Deactivate Rule

- Temporarily deactivate rules.
- When deactivated, terrain models will not automatically update when the source data changes.
- The Edit Terrain Model tools require the terrain model to be deactivated.

Activate Rule

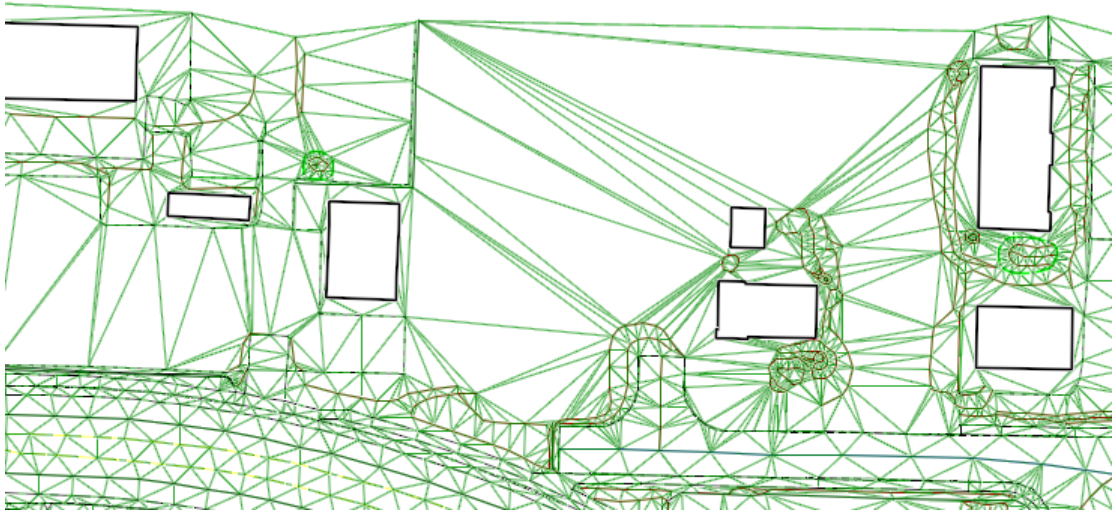
- Activates rules. This is the default state of a terrain model when it is created.
- Edits to source data are updated in the terrain model either automatically or using the Update from Source tool.
- If previous edits were made with the Edit Terrain Model tools they will be lost if the terrain model is set to activate rules **and** the rules are reapplied (model re-triangulated). The edits are saved if the terrain model is just set to activate rules.

Remove Rule

- Permanently removes rules. Once removed, rules cannot be reactivated, the link to the source is broken permanently.
- Improves the performance of a terrain model and is recommended for all large terrain models.
- Recommended when sharing a terrain model with non-OpenRoads/OpenRail Designer users such as MicroStation, plant, or building.

Note: Terrain Models created from Survey field books have a slightly different locking process. Instead of locking the terrain you need to deactivate the survey processing rules. To do this, go to the Survey tab in the Project Explorer. Right-click on the survey project and select Deactivate Survey Processing Rules.

1. **Zoom** into the center of the terrain model so your view is similar to the following illustration.



2. Use the **Move** tool (*Drawing > Manipulate*) to move one of the buildings to a new location.

   Notice that the terrain model **does not** change.

   When the filters were created the *Link to Terrain Features* option was enabled which established a link between the graphics and the terrain model. However, this option works in conjunction with the *Ignore Feature Linking* option on the Create Terrain From Graphical Filter tool. Since Ignore Feature Linking is enabled, the link defined in the filter is active but the terrain model is NOT automatically updated.

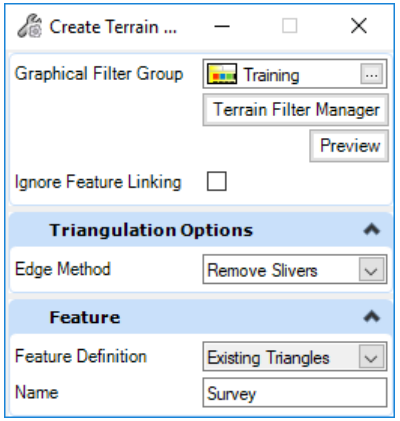
   Hint: Working with the *Ignore Feature Linking* enabled is recommended when numerous edits to the graphics are being made and when working with large terrain models. The *Ignore Feature Linking* option can be disabled when working with a smaller terrain model to see immediate updates to the terrain model.

3. Select **Undo** again to move the building back to its original location.

4. **Select** the *terrain* and from the context sensitive menu select **Delete** to delete the terrain model.

   Note that the terrain model can also be deleted using the Undo tool, but the better practice is to use the Delete tool.

5. Create the Terrain Model again using the graphical filter but with the Ignore Feature Linking option disabled.



   a. Select the **Create Terrain Model From Graphical Filter** tool.

      - *Graphic Filter Group*: **Training**
      - *Ignore Feature Linking*: **Disabled**
      - *Edge Method*: **Remove Slivers**
      - *Feature Definition*: **Existing Triangles**
      - *Name*: **Survey**

   b. **Click** in the graphic view to confirm edge method, accept solution and create the terrain model.

      - *Append to Terrain:* **No**

   c. **Right-click** to exit the *Create Terrain Model From Graphical Filter* tool.

6. Use the **Move** tool to move one of the buildings to a new location.

   The terrain model updates automatically because it is linked to the source graphics.

7. Select **Undo** as necessary to remove the triangulation changes and to move the building back to its original location.

Exercise 4: Updating, Analyzing and Editing Features

Description

In this exercise you will learn how to identify and fix various types of terrain model problems including adding features to the terrain model, changing a feature type, fixing crossing break lines, and resolving conflicting points.

Skills Taught

- Add new features to a terrain model
- Change feature types in terrain models
- Locate and correct crossing break lines in terrain models
- Review and resolve conflicting points

Adding and Modifying Features

The source data for the terrain model may be incomplete or inaccurate and require features to be added, removed, or redefined in the terrain model.

1. **Fit** the view.

   Notice that there are three buildings where the terrain model is still triangulating through the buildings.

2. **Zoom** into the two buildings that are side by side.

   In this situation the building features are not included in the terrain model. How can we tell? Notice that there are no triangle vertices at the corners of the buildings.

   Why were these buildings not brought into the terrain model with the other graphics? These two buildings are on a level named *E_Site_Building*. This level was not included in either of the two filters created in the previous exercise so the graphics on this level were never loaded.

3. Add the Building graphics into the Terrain model

a. Select the **Terrain > Edit > Add Features** tool from the Terrain ribbon menu.

b. Follow the heads up prompts...

- *Locate Terrain Model To Add Elements:* **Left-click** on the **terrain**
- *Locate Element To Add:* **Left-click** on one of the **buildings**
- *Locate Next Element To Add - Reset When Done:* **Left-click** on the other **building**
- *Locate Next Element To Add - Reset When Done:* **Right-click** (reset)
- *Feature Type*: **Drape Void**

The terrain model updates to include the two buildings as void features.

4. **Zoom** to the other problem building on the southern portion of the terrain model.

Looking closely it appears this building is in the terrain model because the triangle vertices exist at the building corners. The problem is that the feature was incorrectly created as a break line when it should have been a void. This was caused by the graphics being on the wrong level.

5. Change the Feature Type of the building from Break Line to Void.

a. Select the **Terrain > Edit > Change Feature Type** tool.

b. Follow the heads up prompts...

- *Locate Terrain Linear Feature*: **Select the building graphic**
- *Locate Next Feature To Change - Reset When Done*: **Right-click** (reset)
- *Feature Type*: **Drape Void**

The terrain model updates with the building as a draped void feature.

Locate and Correct Crossing Break Lines

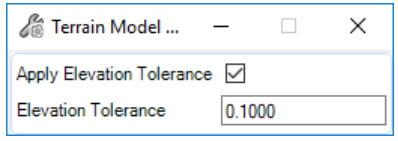
The Report Crossing Features tool locates intersecting line features in the terrain model, such as break lines or contours. At the intersection, the elevations of the two features are computed and compared. The elevation for both features and the difference in elevation is provided in the report. An elevation tolerance value can be set to filter or limit the number of conflicts reported.

---

1. Select the **Terrain > Analysis > Reporting > Report Crossing Features** tool.

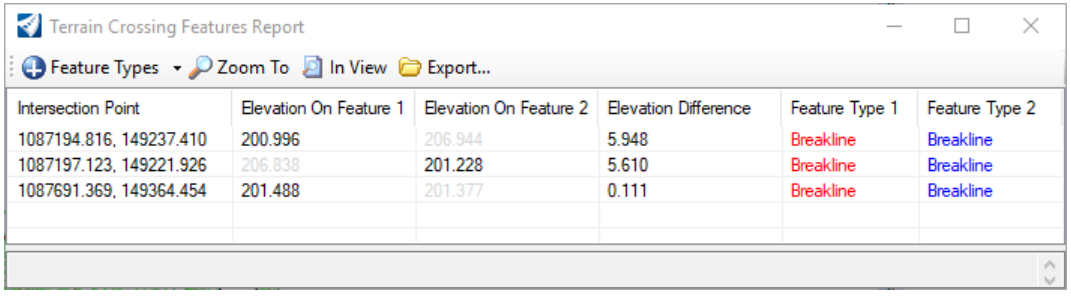
   This tool reports where two features cross. It will report on two separate features crossing as well as a single feature crossing itself.

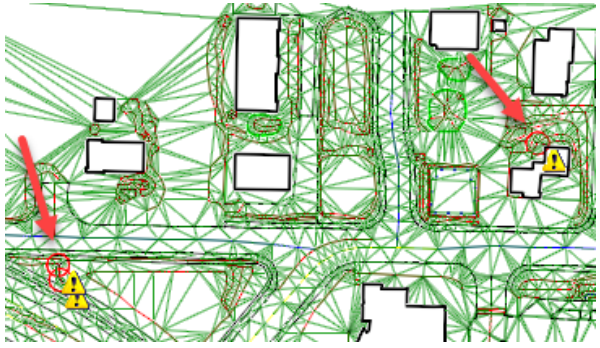
   a. Follow the heads up prompts, or enter the following values in the dialog box:



   - *Select Terrain Model element*: **Select the terrain model**
   - *Apply Elevation Tolerance*: **Yes**
   - *Set Elevation Tolerance*: **0.10** *[0.03]*

   The report lists all the crossing feature issues, and a warning graphic is displayed in the design file at each identified feature crossing.





   b. **Click** on the *first item* in the report and then select **Zoom To**. Your view window will zoom in tightly on the location of the crossing. Zoom out some so that you can see more of the two features that are crossing.

   c. **Close** the *Terrain Crossing Features Report* dialog box and select **Fit View**.

   We will fix these crossing features in the following steps.

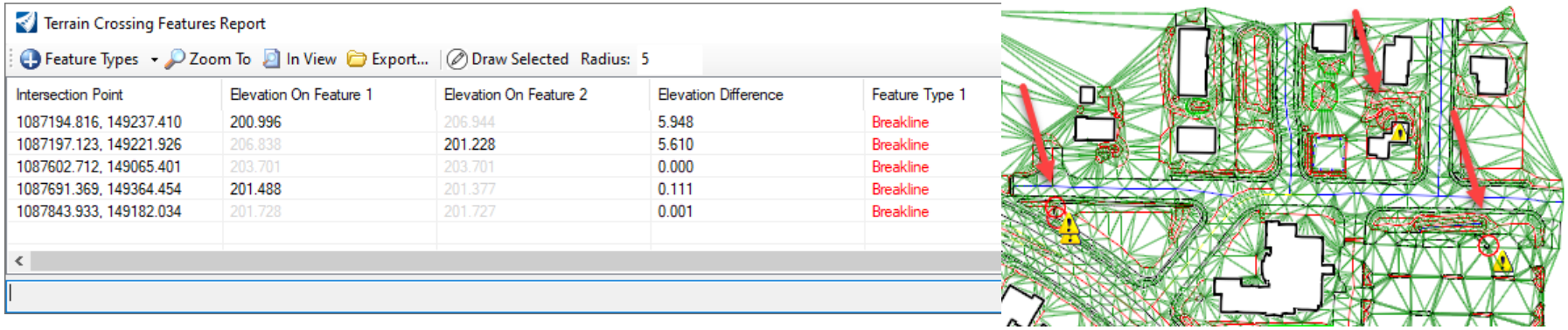
Next, report on crossing features *without* applying the elevation tolerance.

2. Select the **Terrain > Analysis > Reporting > Report Crossing Features** tool.

   a. Follow the heads up prompts...

   - *Select Terrain Model element*: **Select the terrain model**
   - *Apply Elevation Tolerance*: **No**

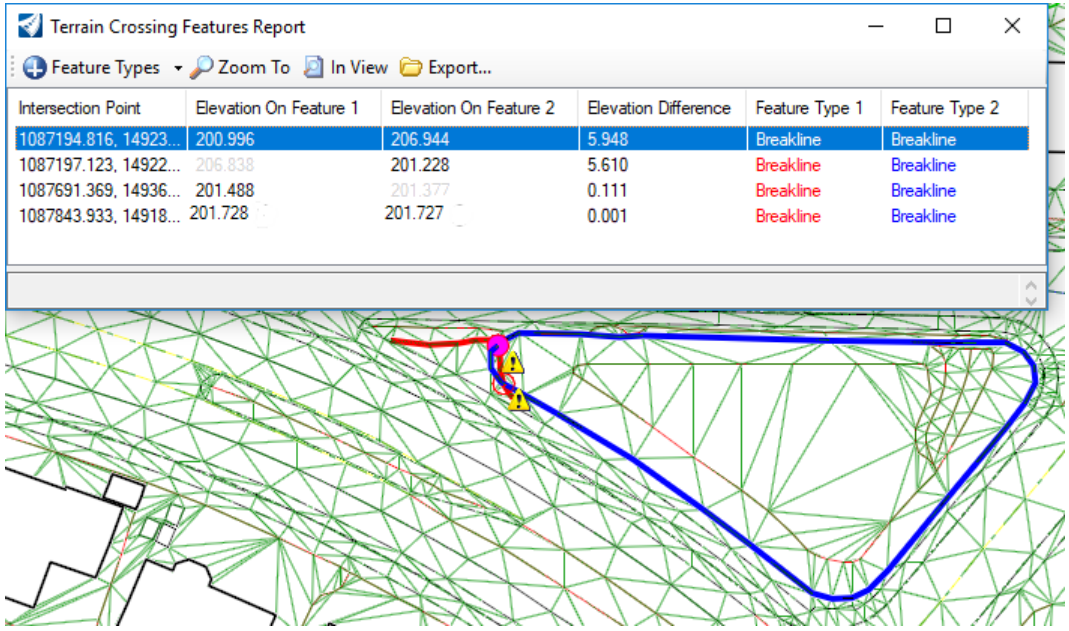
   The report now shows all the crossing features, regardless of the elevation difference, and the associated warning symbols in the design file. (**Note**: The *metric* files may show different results.)



   Why are there more results this time? Previously the apply tolerance value was set, so only elevation differences larger than the specified tolerance were reported. With the apply elevation tolerance toggled off, all feature crossings are reported, regardless of the elevation difference.

Review and correct the crossing features.

3. **Left-click** on the items listed in the report window to highlight the following crossing features.

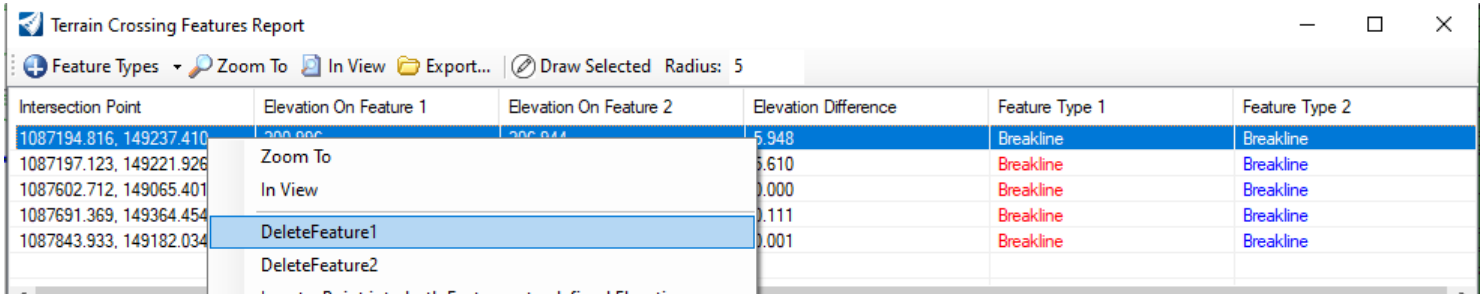


4. Adjust your view using **Window Area** or **Zoom** so that you can clearly see the crossing of the features.

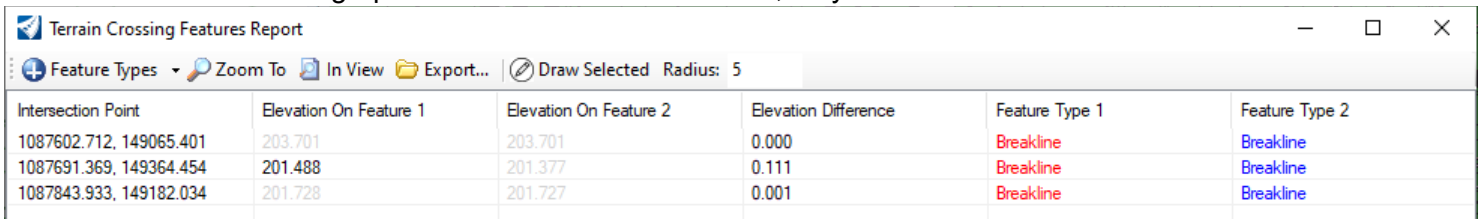
   In this situation it appears the red feature is a general elevation break line and the blue feature represents the boundary of a traffic island. The Terrain Crossing Features Report window shows that there is over a **5'** *[1.7 m]* elevation difference between the two features. Using our best judgment we determine the red feature is incorrect and should be deleted.

   Notice in the Terrain Crossing Features Report window that the red feature is 'Feature Type 1' and the blue feature is 'Feature Type 2'.

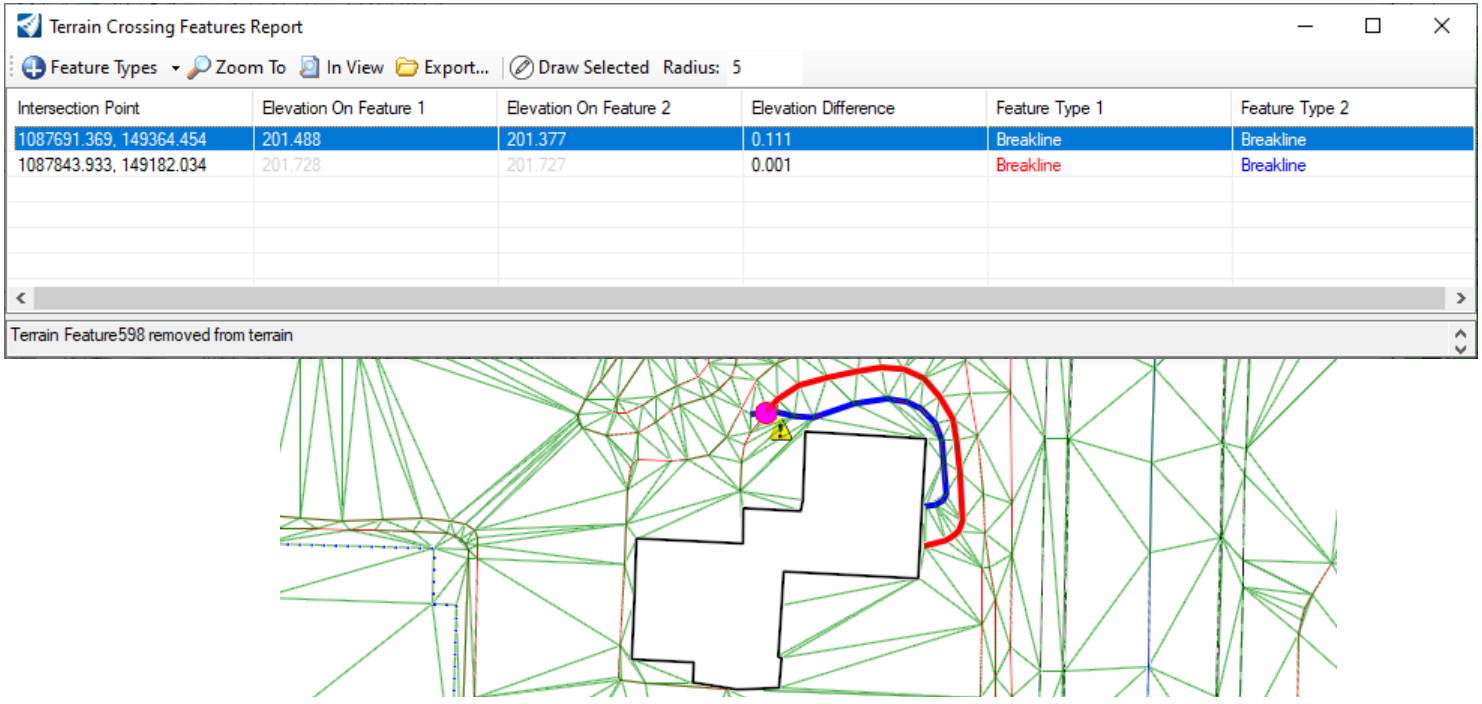
5. **Right-click** on the first row *Intersection Point* in the report window that highlights the *traffic island in blue* and select **DeleteFeature1**.



Note that the first two points in the list are removed because the one feature that was deleted crossed the traffic island feature in two locations. Also note that the source graphical element was not deleted, only the feature in the terrain model was deleted.



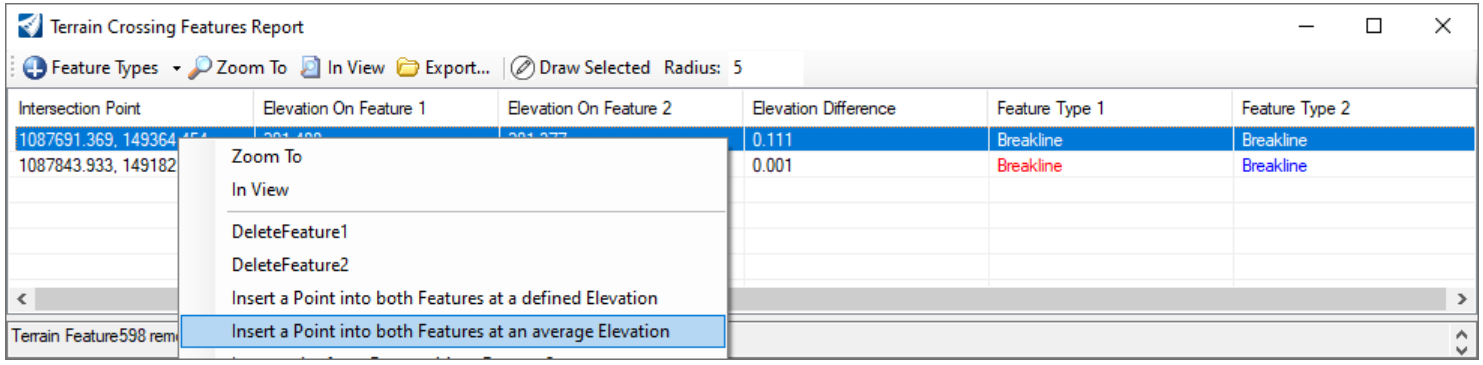
6. **Left-click** on the results in the report window to highlight the following crossing features.



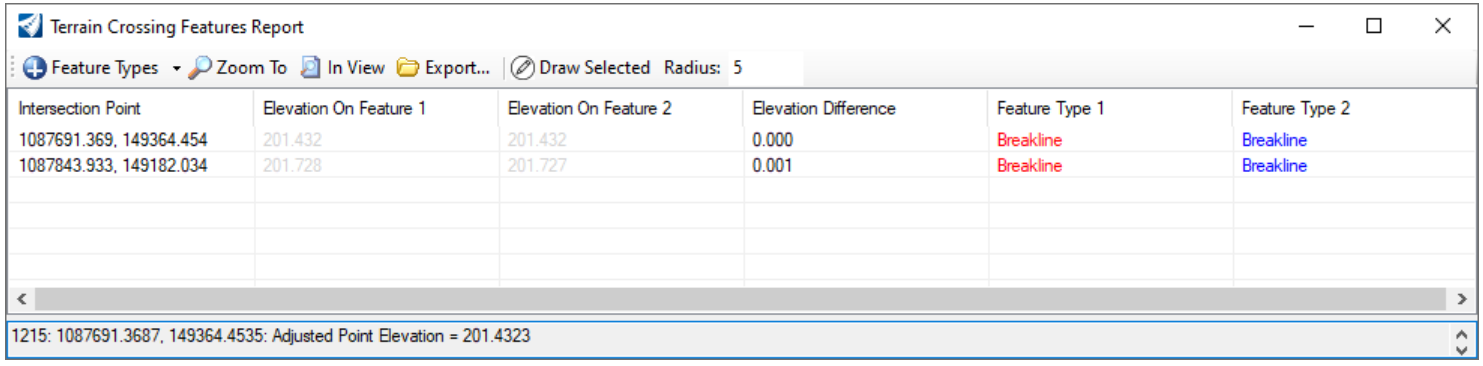
7. Adjust your view using **Window Area** or **Zoom** so that you can clearly see the crossing of the features.

   In this situation two break line features are crossing. The report shows the elevation difference is 0.111' *[0.034 m]*. The two survey strings are close but are not exactly the same elevation where they cross due to the interpolation along the break lines. An acceptable solution in this situation is to keep both break lines and establish a new point where they cross at the average elevation of the two lines.

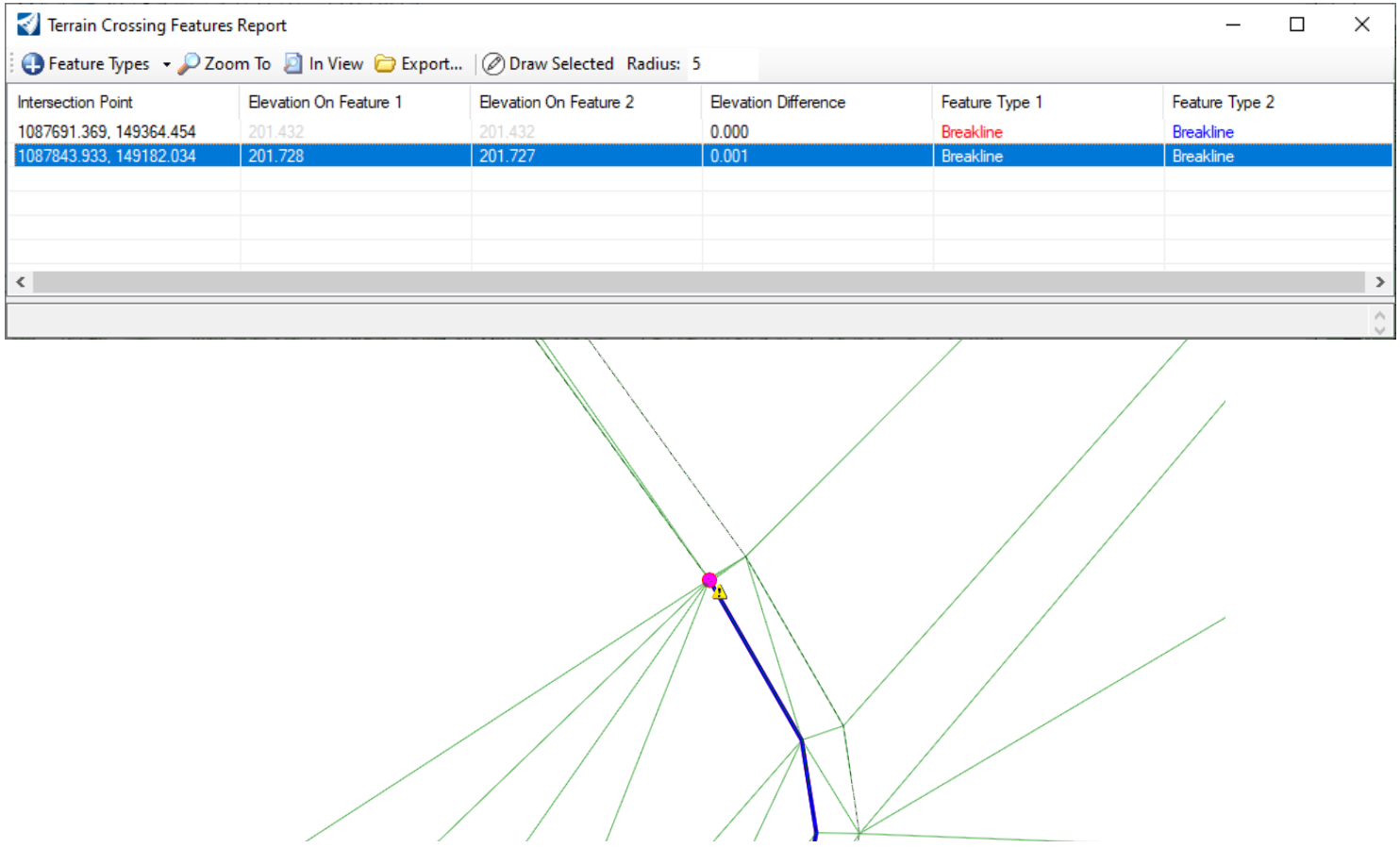
8. **Right-click** on the first row *Intersection Point* in the report window that highlights the *features as shown above*, and select **Insert a Point into both Features at an average Elevation**.



Note that after inserting a point at an average elevation, the intersection point remains in the list at that location, but the elevation difference is now zero and is acceptable.



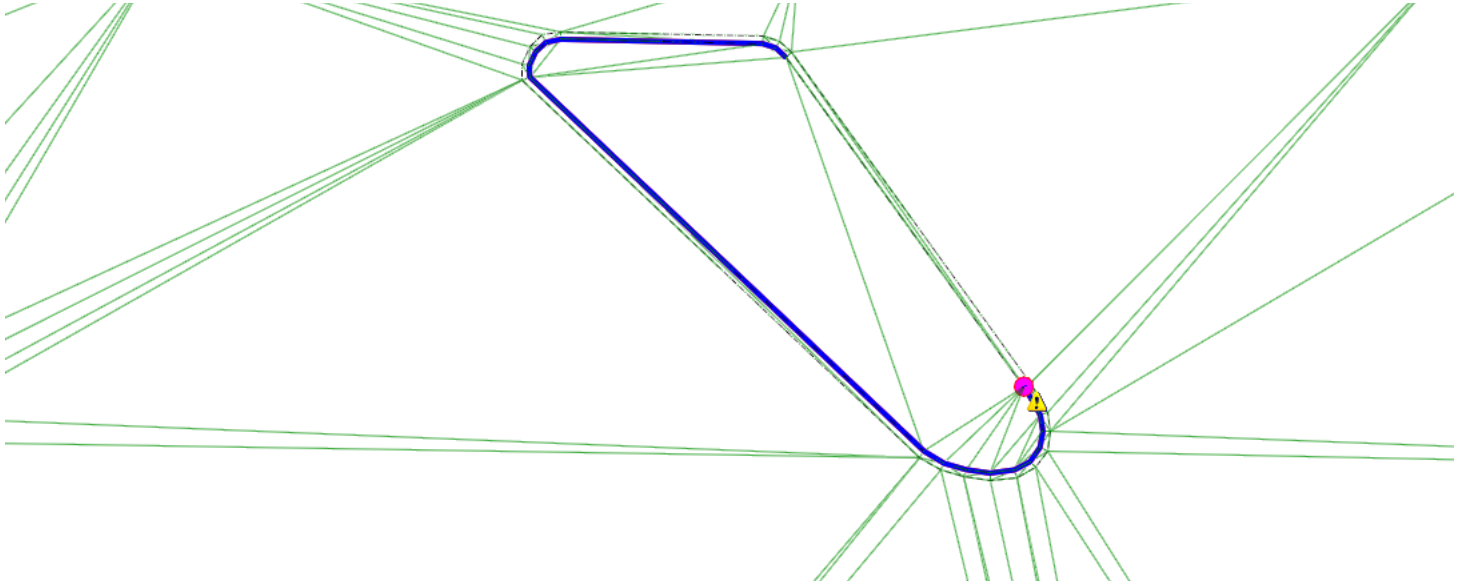
9. **Right-click** on the second row *Intersection Point* in the report window and select **Zoom To**.



10. **Zoom out** until you can see the ends of the lines that overlap one another.

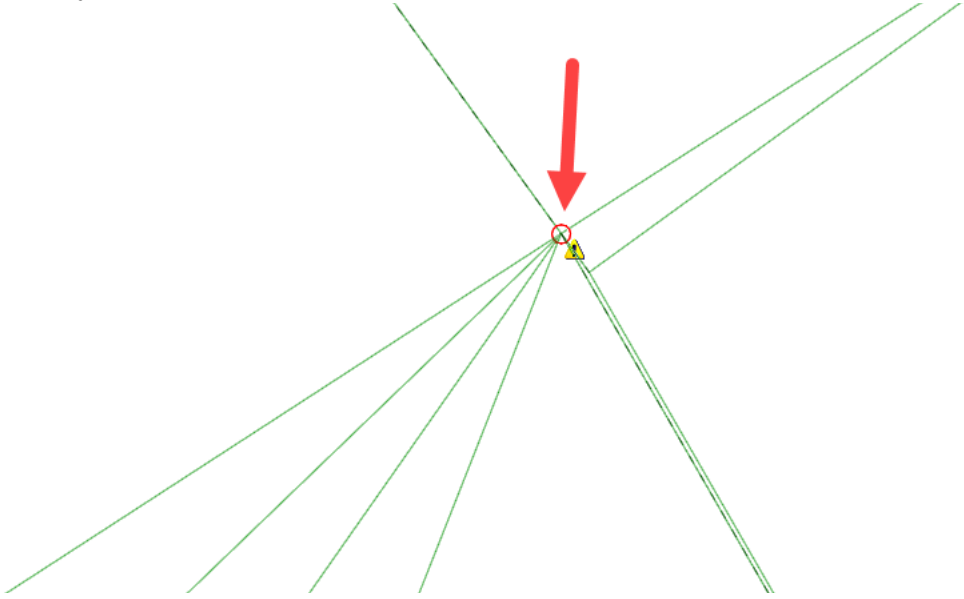
    The issue here is that the beginning and ending points of a closed shape representing a traffic island do not connect and they overlap.

    The reason for these differences is that this is a single feature that is crossing itself. The algorithm used to present the options to correct crossing features does not work on a single feature crossing itself. The solution is to use MicroStation tools to modify the graphics to move one end point to be coincident with the other end point.



11. Select the **Drawing > Modify > Modify Element** tool.
12. **Snap** to one end point and move to the other end point. Be sure to *snap* to the ends of the lines to ensure an accurate move.

    The Terrain Model is immediately updated.



Note: If the terrain model does not automatically update, most likely the *Ignore Feature Linking* option was enabled when the terrain model was created and the terrain is not automatically updating to changes in the source graphics.

13. **Close** the *Terrain Crossing Features Report* dialog box.

14. Select **Fit View**.

Review and Resolve Conflicting Points

Any location in a terrain model (as defined by an X, Y coordinate) can have one and only one elevation. However, the source data used to create the terrain model may have duplicate points (as defined by an X, Y location with the same or differing elevations). During triangulation, if two or more points with the same X,Y coordinates are encountered, the first point (with its elevation) is utilized, while the second or subsequent points which may have different elevations are ignored. The Report Conflicting Points tool utilizes the underlying source data for this report.

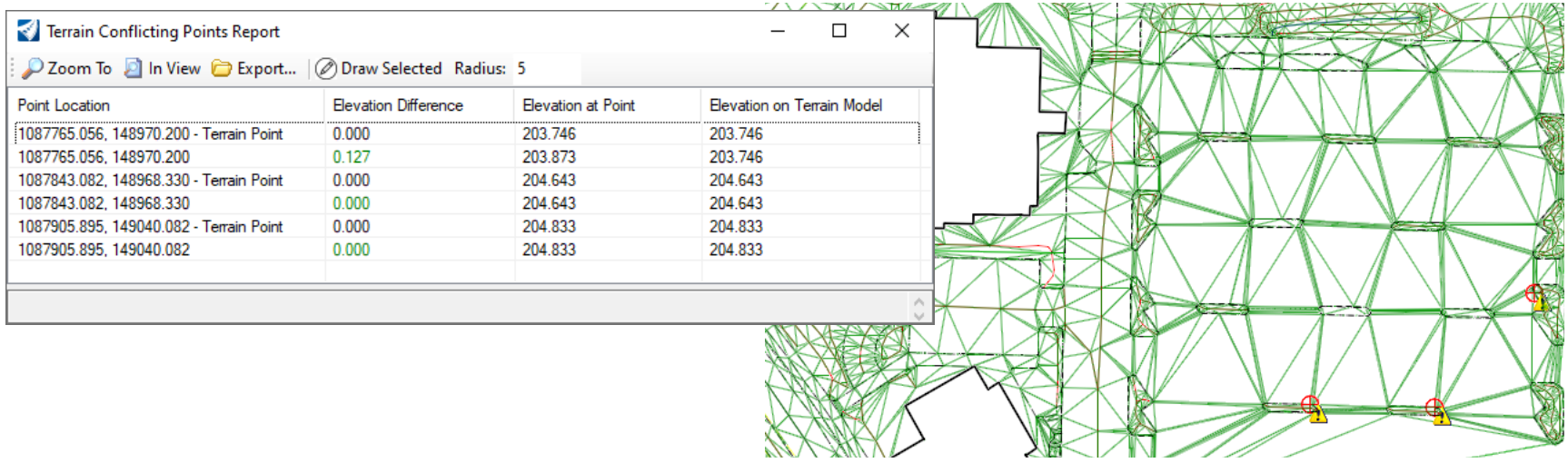
1. Select the **Terrain > Analysis > Reporting > Report Conflicting Points** tool.

   This tool reports the location of duplicate points at a single X, Y coordinate that have one or more different elevations.

   a. Follow the heads up prompts...

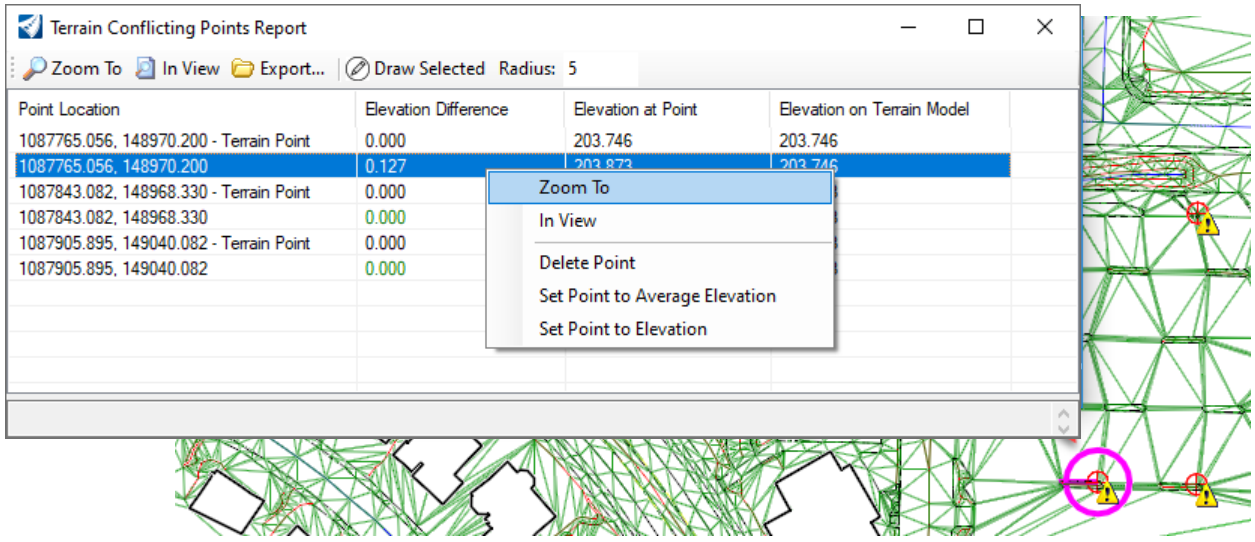
   - *Select Terrain Model Element:* **Left-click** on the **terrain** model
   - *Apply Elevation Tolerance*: **No**

   The report shows the conflicting points, the elevation difference, which points were used in the terrain model, and the associated warning symbols are displayed in the design file. (**Note**: The *metric* files may show different results.)



   Note that in this case, the report displays “point pairs”... two points at the same X,Y or N,E with different elevations.

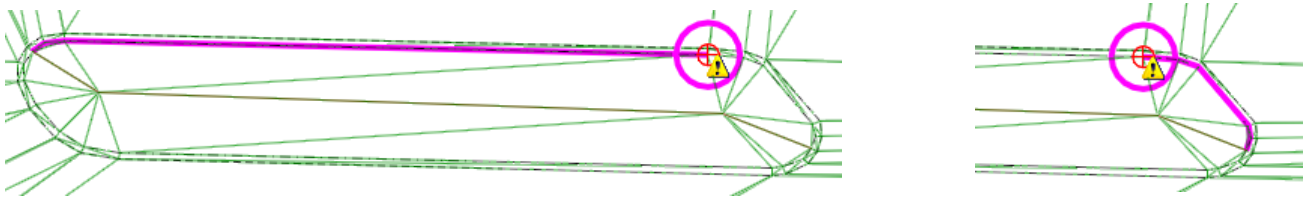
2. **Right-click** on the *Point Location* in the report window that shows an **Elevation Difference** of *0.127 [0.039]* and select **Zoom To**.



3. **Zoom out** until the location causing the issue is clearly visible.

   The feature in the image on the left below should be highlighted (*Point Location with 0.127 [0.039] elevation difference*).

   Clicking on the “point pair” (*the Point Location with the same XY/NE values*) will highlight the feature and point as shown in the right image below.



   In this situation two break line features along a traffic island meet at an elevation difference of 0.127’ *[0.039 m]*.

   An acceptable solution in this situation is to establish a new point at an average elevation of the two points.

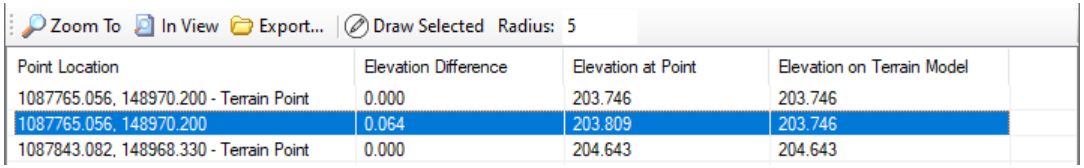
   Evaluating the elevations of the two points, the average elevation will be **203.8091’** *[62.1210 m]*.

Note the coordinate values of the “point pair” that will be modified to resolve the conflict.

Point Location	Elevation Difference
1087765.056, 148970.200 - Terrain Point	0.000
1087765.056, 148970.200	0.127

4. **Left-click** on the *Point Location* in the list so that the feature and point shown in the above *left image* (0.127 *[0.039]*) is highlighted.
5. **Right-click** on the *Point Location* and select **Set Point to Elevation** and at the *Enter Elevation* prompt, key-in **203.8091** *[62.1210].*

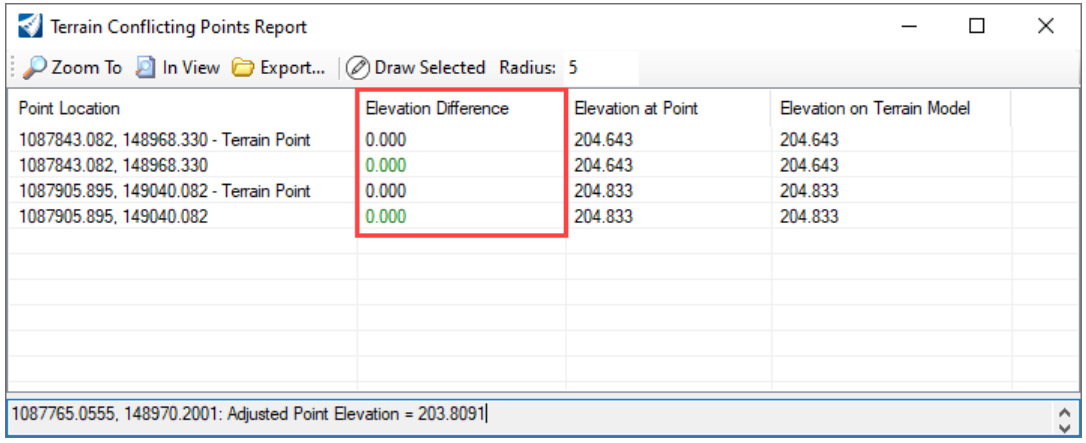
   The report window updates as shown below.



6. **Left-click** on the *Point Location* in the list of the “point pair” that shows *Elevation Difference of 0.000* so that the feature and point shown in the above *right image* is highlighted.
7. **Right-click** on the *Point Location* and select **Set Point to Elevation** and at the *Enter Elevation* prompt, key-in **203.8091** *[62.1210]*.

   Note that after setting the average elevation for **both** points, the two entries for that point location are removed from the report.

   The remaining warnings in the Conflicting Points Report all have an elevation difference of zero and require no modifications.



8. **Close** the *Terrain Conflicting Points Report* dialog box.

Exercise 5: Remove Edge Triangles and Complex Terrain Models

Description

In this exercise you will learn multiple methods for controlling and removing edge triangles, how to complex multiple terrain models together and add a boundary feature to control edge triangles.

Skills Taught

- Change the triangulation edge method
- Deactivate and activate terrain rules
- Use the Delete Edge Triangle and Delete Triangle by Line tools
- Create Complex Terrain models
- Add Boundary feature
- Modify boundary feature

Remove Edge Triangles using the Edge Method

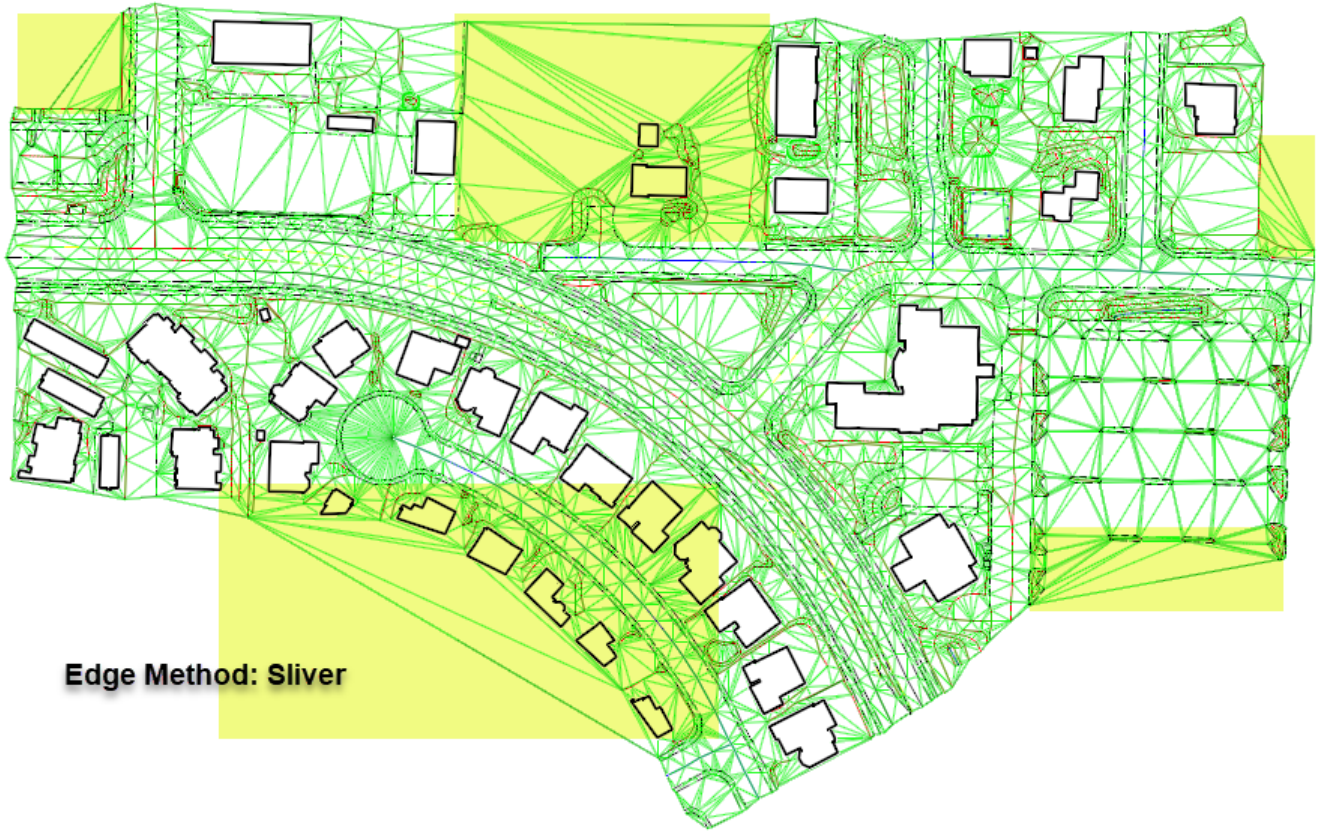
In this section learn how to remove unwanted terrain triangles along the outer edges of the terrain model using the Edge Method property.

---

1. Continue in the **Create Terrain from Graphical Filter.dgn** *[Metric_Create Terrain from Graphical Filter.dgn]* file.

2. **Fit** the view.

   The terrain model currently uses the *Sliver Edge Method* to reduce unwanted edge triangles. However, there are still unwanted triangles in several areas as shown in the following illustration.

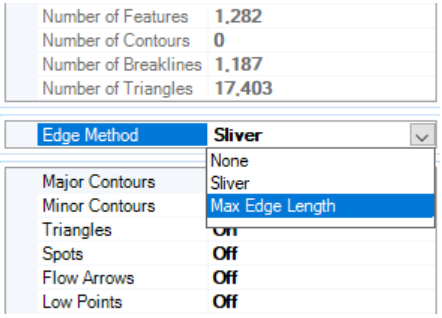


3. Use the **Element Selection** tool and select the *terrain model*.

4. Hover over the terrain model and select the **Properties** tool from the context sensitive toolbar.

5. Set the *Edge Method* to **Max. Edge Length**.

6. Set the *Length* to **100** *[30]* and **click** in the view.



Notice the reduction in the unwanted triangles around the edge of the terrain model.

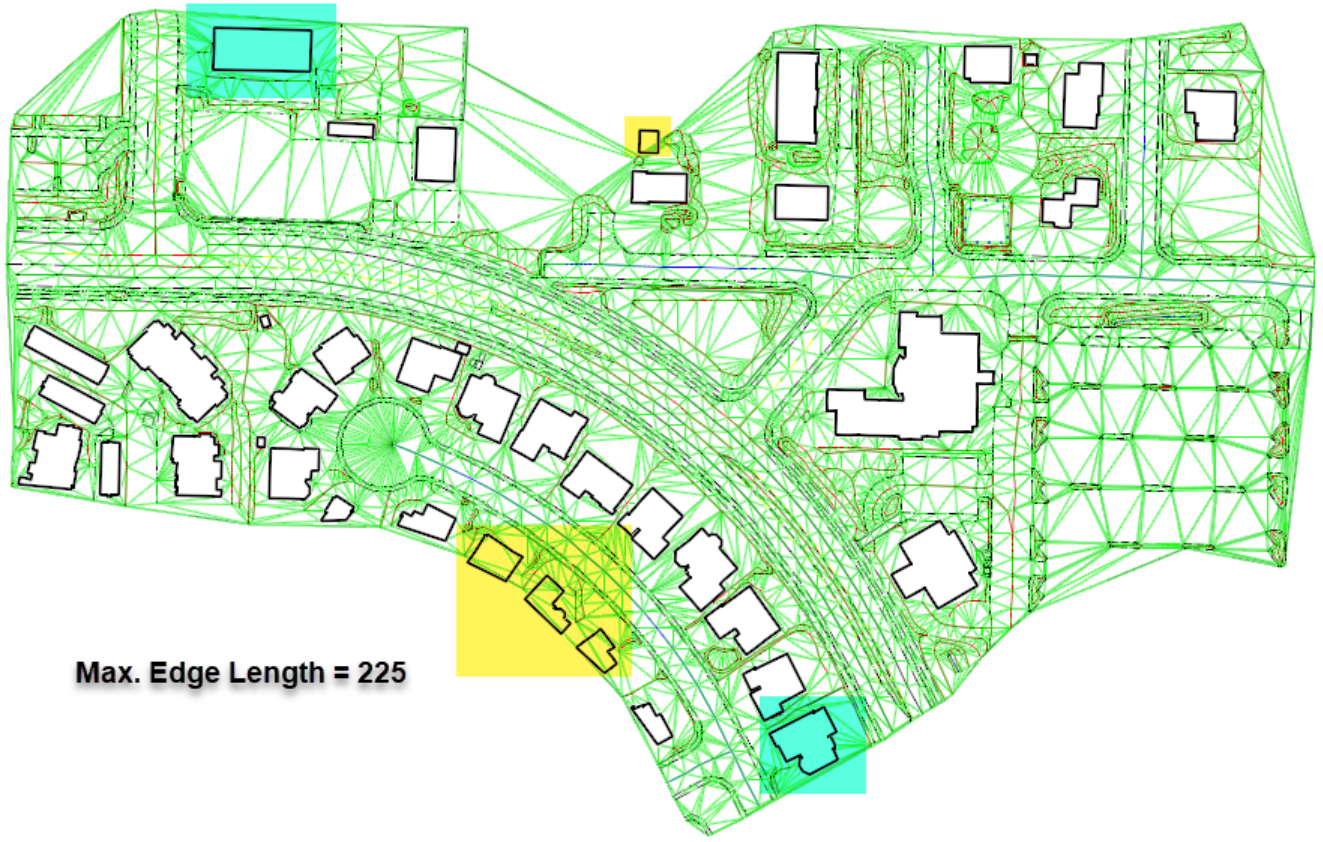
Also notice that in several areas around the edge of the model that buildings no longer have terrain data around them and they are no longer draped to the terrain.

The buildings were added to the terrain as *Drape Void* features. With the drape void feature type, the void coordinates are not included in the triangulation. The void coordinates and lines are inserted and draped on the terrain model surface *post* triangulation.

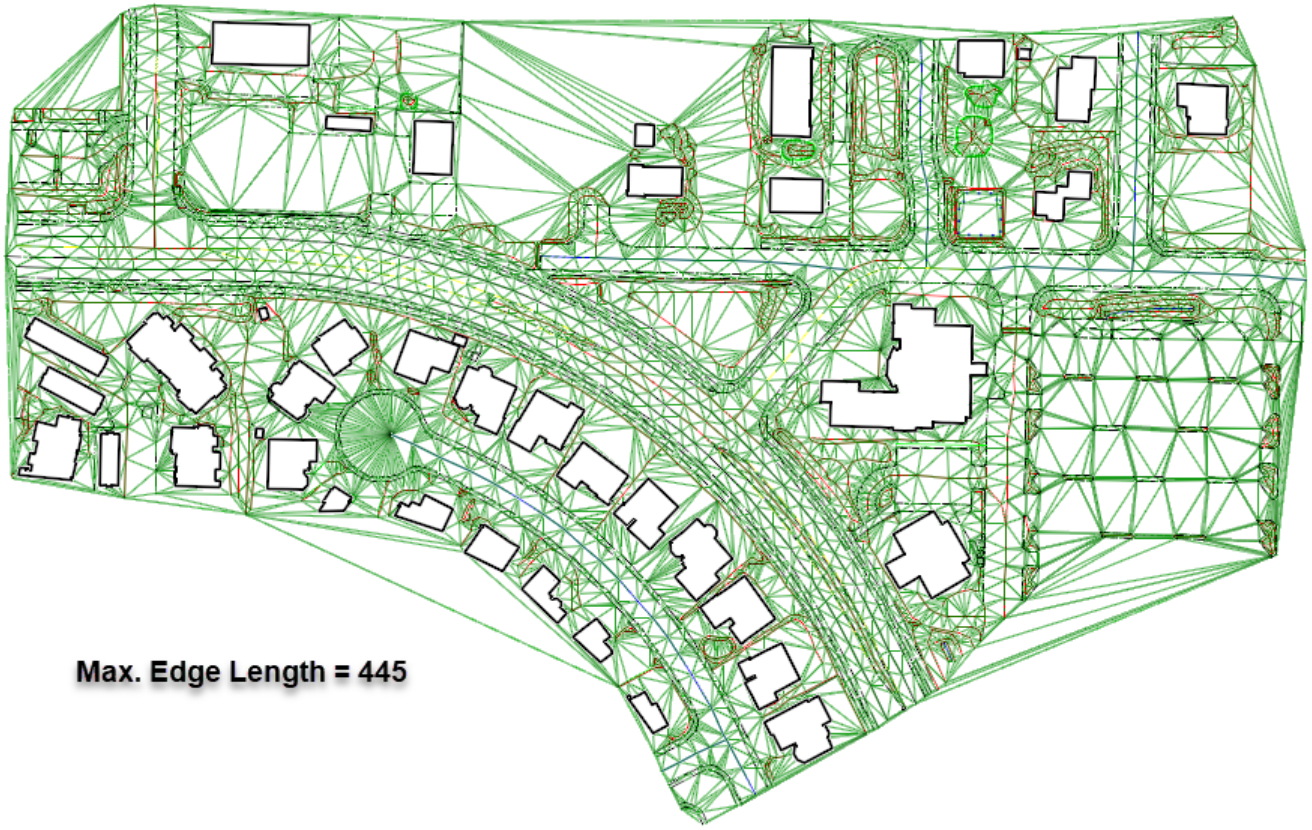
7. Use the **Element Selection** tool and select the *terrain model*.
8. Hover over the terrain model and select the **Properties** tool from the context sensitive toolbar.
9. For the **Edge Method**, change the *Length* to **225** *[70]* and **click** in the view.

   Notice the change in the triangles around the edge of the terrain model.

   Also notice that several of the buildings are again being draped to the terrain, but some are still not draped onto the terrain.



10. Select the terrain model again, click on **Properties** and change the **Edge Method** *Length* to **445** *[136]* and **click** in the view.



11. Review all of the buildings and verify that they are draped onto the terrain model. If you still find triangles going through a building, continue to increase the Max. Edge Method Length value until all buildings are draped onto the terrain.

    Increasing the max edge length in order for all the buildings to be draped onto the terrain brings back edge triangles that we may not want to be included in the final terrain model. The Edge Method, Sliver and Max. Edge Length options, is one of the tools for removing triangles around the boundary of a terrain, but as we have seen here, in some areas it may work well and in other areas not as well. There are additional tools available that can be used to remove undesired edge triangles.

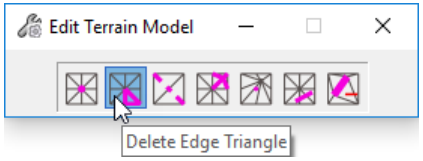
Remove Edge Triangles using the Edit Terrain Model Tools

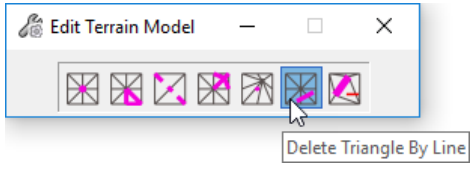
In this section, you will learn how to use the Edit Terrain Model tools to delete triangles along the edge of the terrain model. This editing should be done after all other terrain model edits have been completed.

1. Select **Terrain > Edit > Edit Model**. This will bring up the *Edit Terrain Model* dialog.

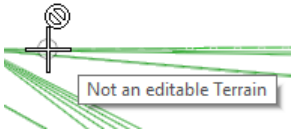
   There are several tools on this dialog that you may find helpful in modifying your terrain model. In this exercise we will use:

   - **Delete Edge Triangle** - deletes edge triangles one at a time as identified and updates the boundary
   - **Delete Triangle by Line** - deletes all edge triangles which intersect the line defined by two data points and updates the boundary





2. Select **Delete Edge Triangle** and follow the prompt to *select the terrain model*. When you try to select the terrain model, you get a message that says “Not an editable Terrain”. What does this mean?



When this terrain model was created using the graphical filters, the *Link to Terrain Features* option was enabled which established a link (*rules*) between the graphics and the terrain model. These *rules* preserve the connection between the source data and the terrain model so that the terrain model can be updated when revisions are made to the source data.

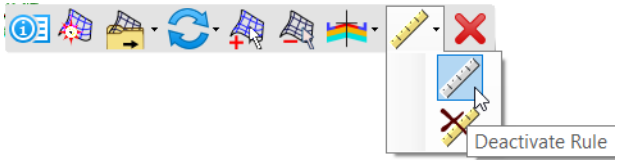
By default, when the terrain model is created the *rules* are **active** (unlocked).

Let's review how terrain models behave when the rules are activated and deactivated.

Activate Rule

- Activates rules. This is the default state of a terrain model when it is created.
- Edits to source data are updated in the terrain model either automatically or using the Update from Source tool.
- If previous edits were made with the Edit Terrain Model tools they will be lost if the terrain model is set to activate rules **and** the rules are reapplied (model re-triangulated). The edits are saved if the terrain model is just set to activate rules.

Deactivate Rule

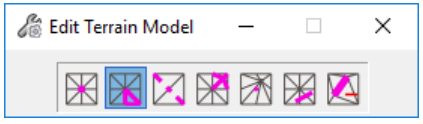


- Temporarily deactivate rules.
- When deactivated, terrain models will **not** automatically update when the source data changes.
- The Edit Terrain Model tools require the terrain model rules to be deactivated.

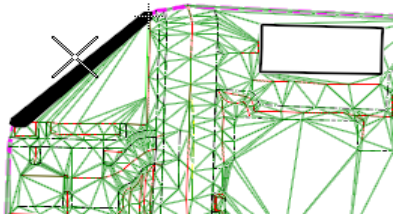
3. **Select** the *terrain model boundary*, hover and from the context sensitive toolbar select **Rules > Lock - Deactivate Rule**.

   This will deactivate the rules and allow the Edit Terrain Model tools to be used

4. Select **Terrain > Edit > Edit Model**. This will bring up the *Edit Terrain Model* dialog. .

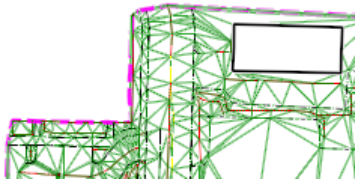


5. Select **Delete Edge Triangle** and follow the prompt to *Select Terrain Model* by left-clicking on the terrain model.

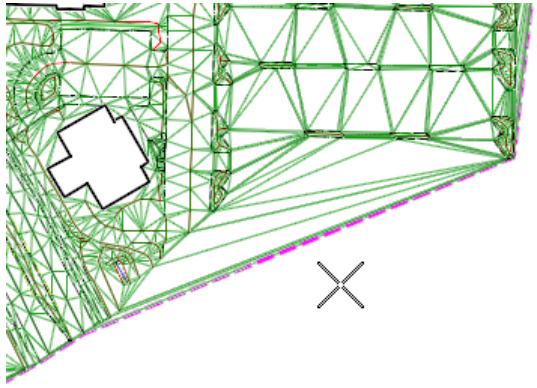
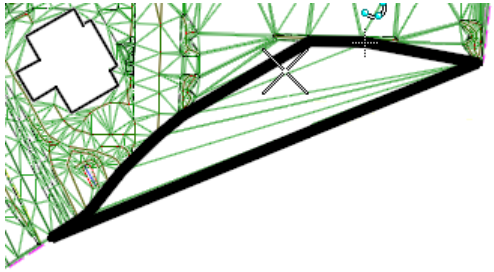
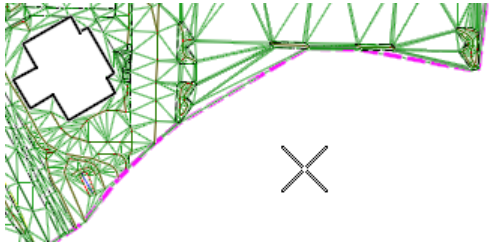


6. **Move the cursor** to the *edge of the terrain* in the upper-left or Northwest corner of the model. When the cursor is positioned on an edge triangle, the triangle will 'highlight' with thick lines.
7. **Left-click** to delete the highlighted triangle.
8. Continue to **left-click** and delete several more edge triangles on the NW corner.

   Note that only edge triangles can be deleted and that the boundary is automatically updated as the triangles are deleted. Interior triangles in the model cannot be deleted with this tool.



9. Select **Delete Triangle By Line** and follow the prompt to *Select Terrain Model* by **left-clicking** on the terrain model.
10. **Move the cursor** to the *edge of the terrain* in the lower-right or Southeast corner of the model.
    - Prompt *Point to Start Line/Reset to Select Terrain*: **left-click** just outside the boundary line
    - Prompt *Point to Accept Deletion/Reset for New Start*: **move** cursor over triangles and they will 'highlight' with a thick border, then **left-click** to delete
    - The boundary is automatically updated

    - **Reset** to exit the command

Complex Terrain Models

When multiple terrain models need to be combined, the recommended best practice is to reference the terrain models into a blank file and create the new complex terrain model there. This keeps the complex and the source terrain models organized in separate files making it easier to manage your data.

1. Open the file *Complex Terrain Model.dgn [Metric_Complex Terrain Model.dgn]*.

   This is a blank 3D design file.

2. **Attach** the following as reference files using the *Coincident World* attachment method:

   - **Create Terrain from Graphical Filter.dgn** *[Metric_Create Terrain from Graphical Filter.dgn]*
   - **East Survey Terrain Model.dgn** *[Metric_East Survey Terrain Model.dgn]*

3. **Fit** the view.

   Survey graphics and triangles are shown on the left for the terrain model we created in the previous exercise. On the right are the survey graphics and terrain boundary (green line) for the remainder of the project site. Remember that the terrain model display can be changed using override symbology and a different feature definition. These two models are edge to edge and do not overlap.

4. Create a complex terrain model.

a. Select the **Terrain > Create > Additional Methods > Create Complex Terrain Model** tool.

b. Select the *Survey* terrain model.

c. Click **Add**.

d. The Survey terrain model is added as the *Primary* terrain model.

e. Set the *Current Action* to **Append**.

f. The Append action defines that if the terrain models overlap the data from both terrain models is retained. The Merge action will discard data from the primary terrain model and only keep the data from the merge model.

g. Select the *East Survey* terrain model.

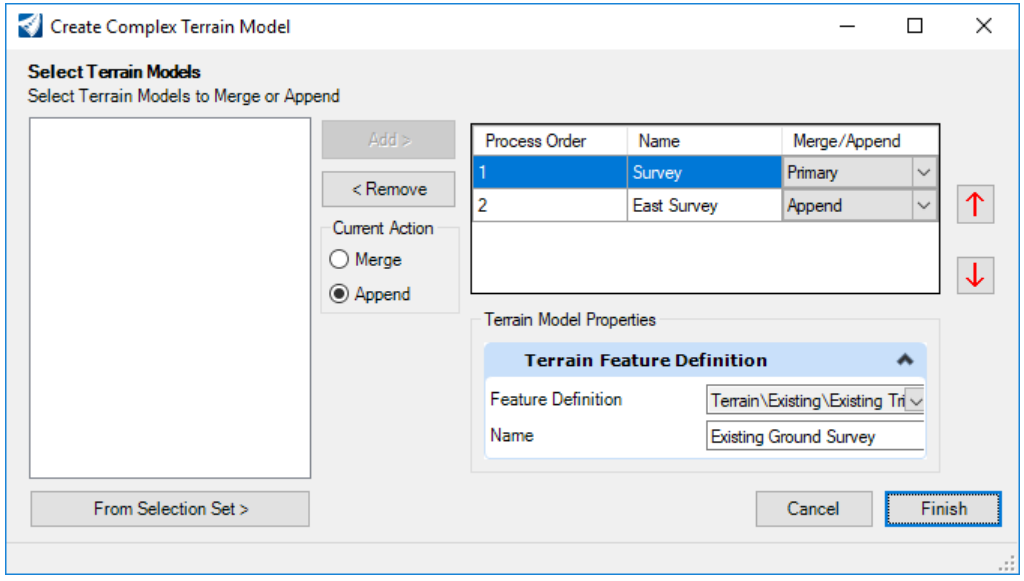
h. Click **Add**.

i. Set the *Feature Definition* to **Existing Triangles**.

j. Set the *Name* to **Existing Ground Survey**.

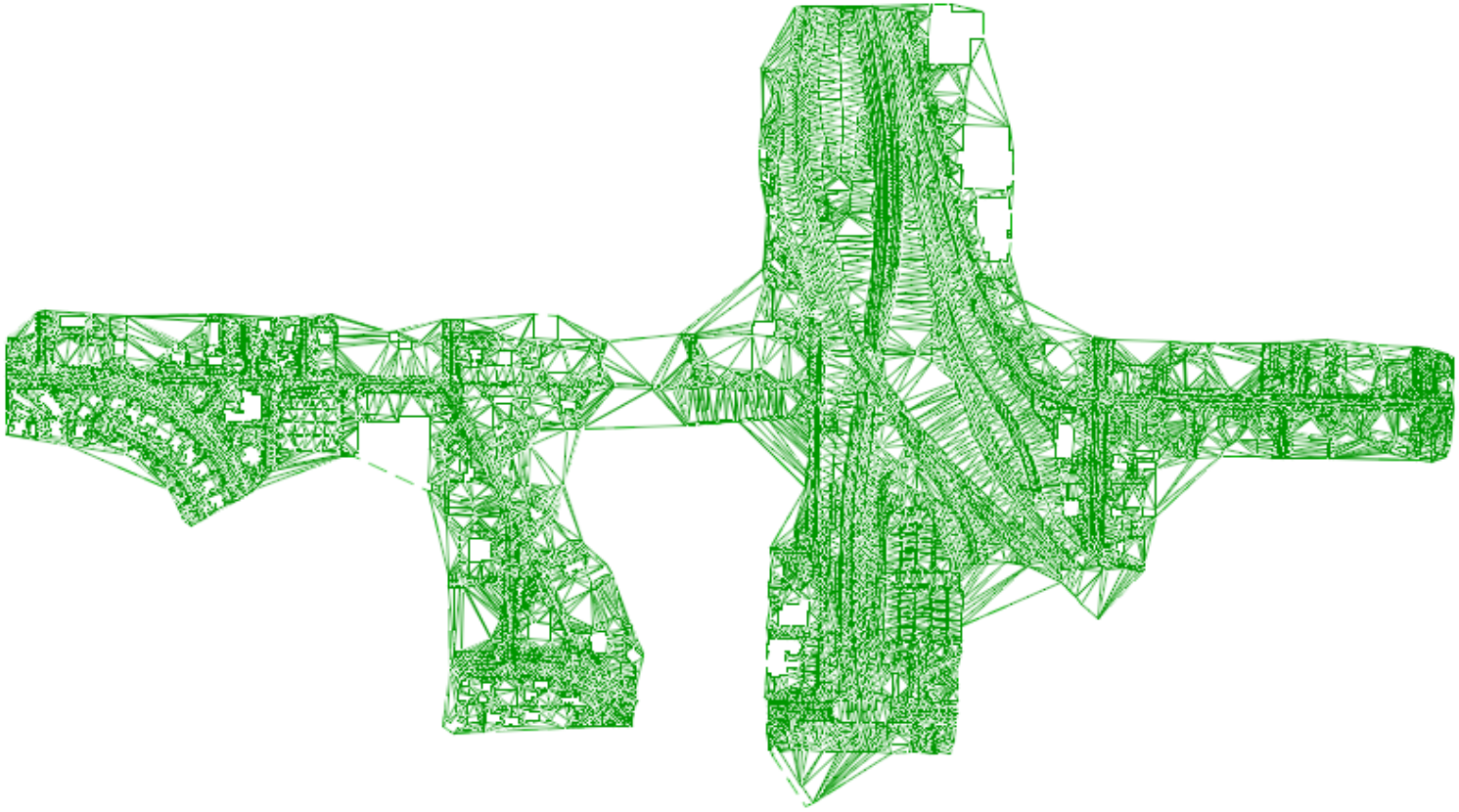
k. Click **Finish**.

A new terrain model named Existing Ground Survey is created that is the combination of the original *Survey* and *East Survey* terrain models.



5. Open the **Attach References** dialog and **turn off** the *two reference displays*. Do not detach the references, just turn their display off.

The result is the single new complex terrain model. The model is currently displaying the triangles based on the assigned feature definition Existing Triangles, but that display can be changed by changing the feature definition.



Note: The **Edge Method** set in the *primary* terrain model is applied to the combined terrain model. If your results differ from the image above, you can go back to the *Create Terrain from Graphical Filter.dgn [Metric_Create Terrain from Graphical Filter.dgn]* file and review what edge method was last applied to the Survey terrain model.

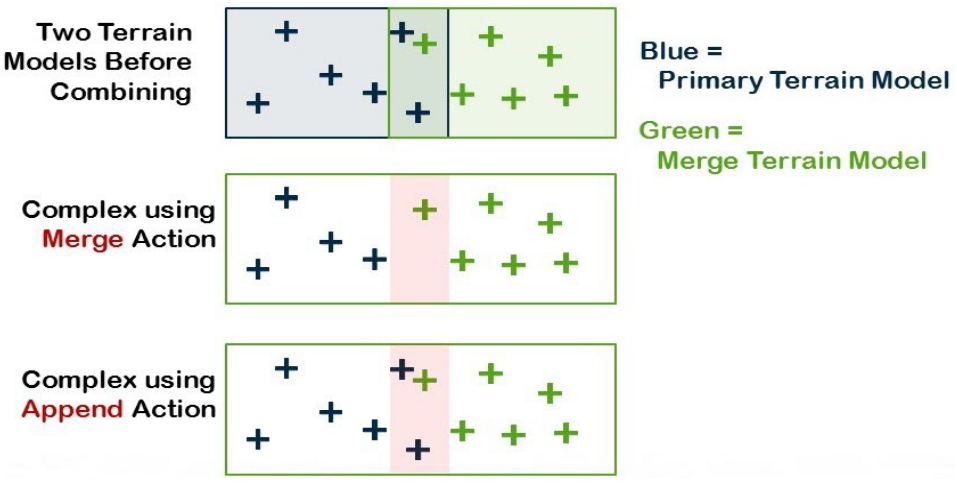
Also note: The edge triangles in the NW and SE corners of the Survey model that were previously deleted using the Edit Model tools have returned. During the processing of the Create Complex Terrain Model tool, the two terrain models are re-processed (triangulated) and this causes the terrain rules to be reapplied.

Merge and Append Options

Terrain models can be combined into Complex Terrain models. The complex terrain model is not only a combination of terrain models but a combination that remembers the order in which terrain models are combined and how they are combined. Terrain models can be combined by merging or appending them together.

- **Merge** – The data from the primary terrain model is discarded and replaced with the data from the merge terrain model in the area where the two overlap. The two terrain models must overlap with at least one point.
- **Append** – The combined data from both terrain models is retained in the areas where the terrain models overlap. The two terrain models can overlap or be adjacent to one another.

When the terrain models are combined, the Edge Method of the primary terrain model is applied to the new combined terrain model.



Note: The Edit Complex Terrain Model tool is used to make changes to complex terrain models such as changing the order of the terrain models or the merge/append action.

Add Boundary and Modify

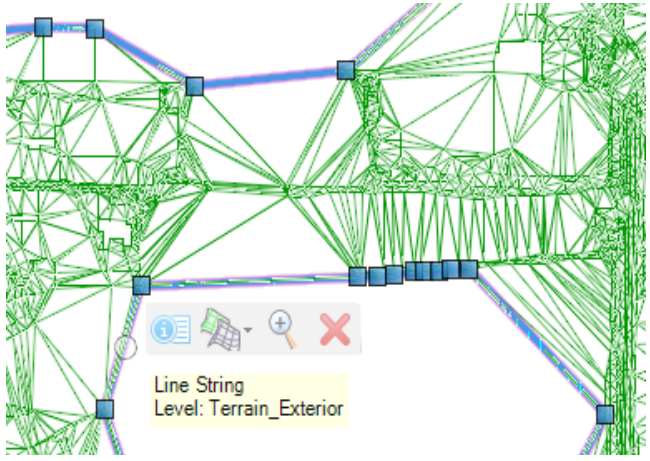
In this section, you will learn how to add a boundary to the terrain model and then modify the boundary feature. The Add Boundary tool extracts the implied or stored boundary from a terrain and adds it to the terrain as the edge method, overriding all other edge methods. The tool options provide the ability to create a 3D graphic of the boundary, add a non-graphical feature to the terrain, or add an editable graphical boundary that is ruled to the terrain.

---

1. Select **Terrain > Edit > Boundary Options > Add Boundary** and set the following parameters in the dialog box:
   - *Method*: **Add Ruled Boundary**
   - *Feature Definition*: **Linear > Terrain Feature> Terrain_Exterior**
   - *Name*: **Boundary**
2. At the *Locate a Terrain Model* prompt, **click** on the terrain model to identify it and then **click** again to accept the settings and process the command.

   What happened?

   - The boundary was added to the model as an editable boundary that is ruled to the terrain
   - The edge method was set to From Boundary
   - The terrain model was processed (triangulated)



3. **Select** the edge of the terrain to highlight the *new boundary graphic* and **hover**.
   - The line string is on level Terrain_Exterior (from the feature definition setting)
   - The feature context sensitive toolbar is available
   - Handles are available on the line string for modifications

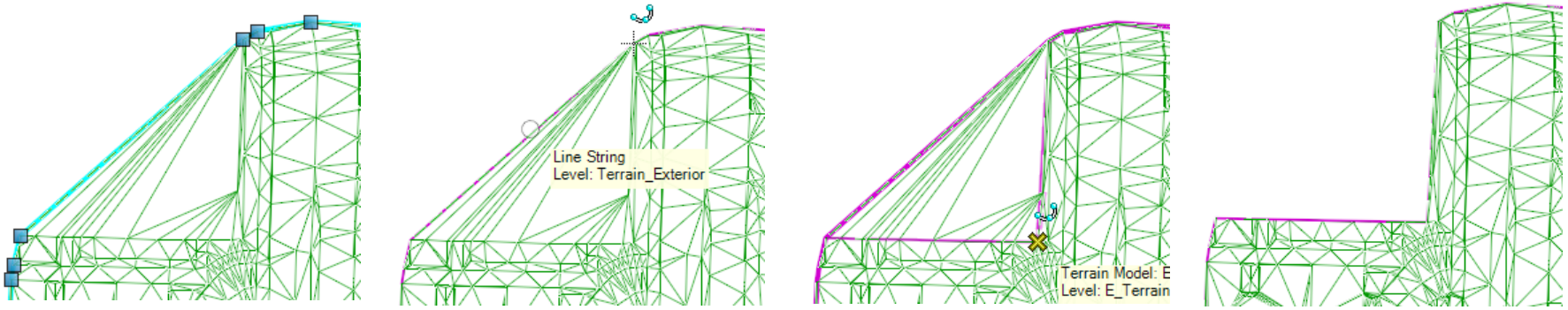
Note: **After a boundary has been added to a terrain model, the Terrain > Edit Model tools cannot be used to edit the model.**

4. **Zoom Out/In** to move your view to the *Northwest corner* of the complexed terrain model.

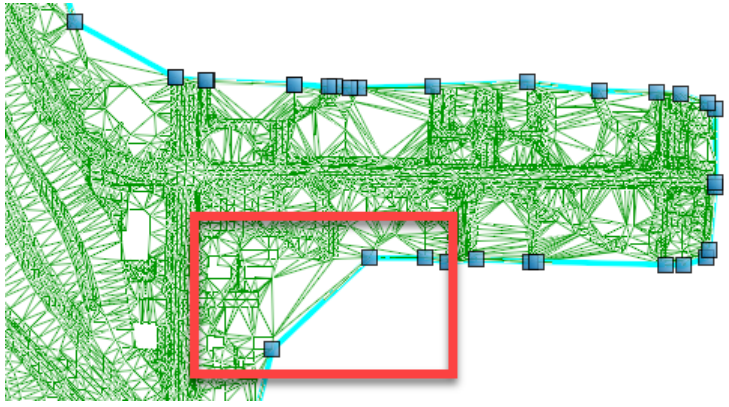
   The boundary graphic may or may not be selected, it will not matter.

5. Select **Drawing > Modify > Insert Vertex** and **click** on the *boundary graphic* then move the cursor and **click** to identify the *location for the new vertex*.

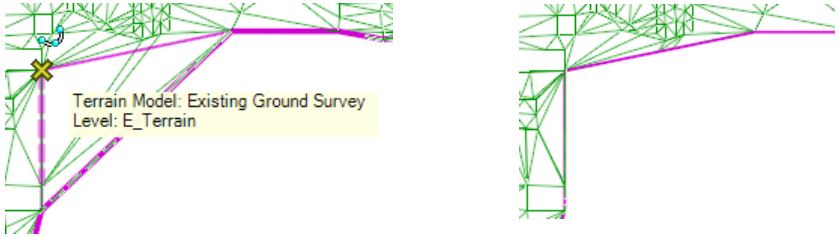
   The boundary graphic and triangles are updated to reflect the change in the boundary.



6. **Zoom Out/In** to move your view to the *Southeast corner* of the complexed terrain model.



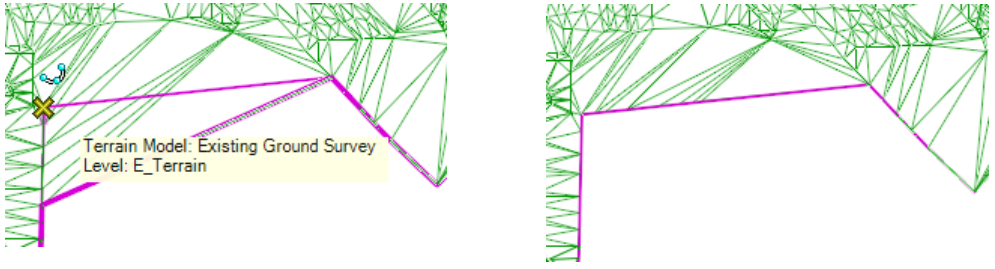
7. Select **Drawing > Modify > Insert Vertex** and **click** on the *boundary graphic* then move the cursor and **click** to identify the *location for the new vertex*.



8. **Zoom Out/In** to move your view to the *Southeastern corner* of the complexed terrain model.

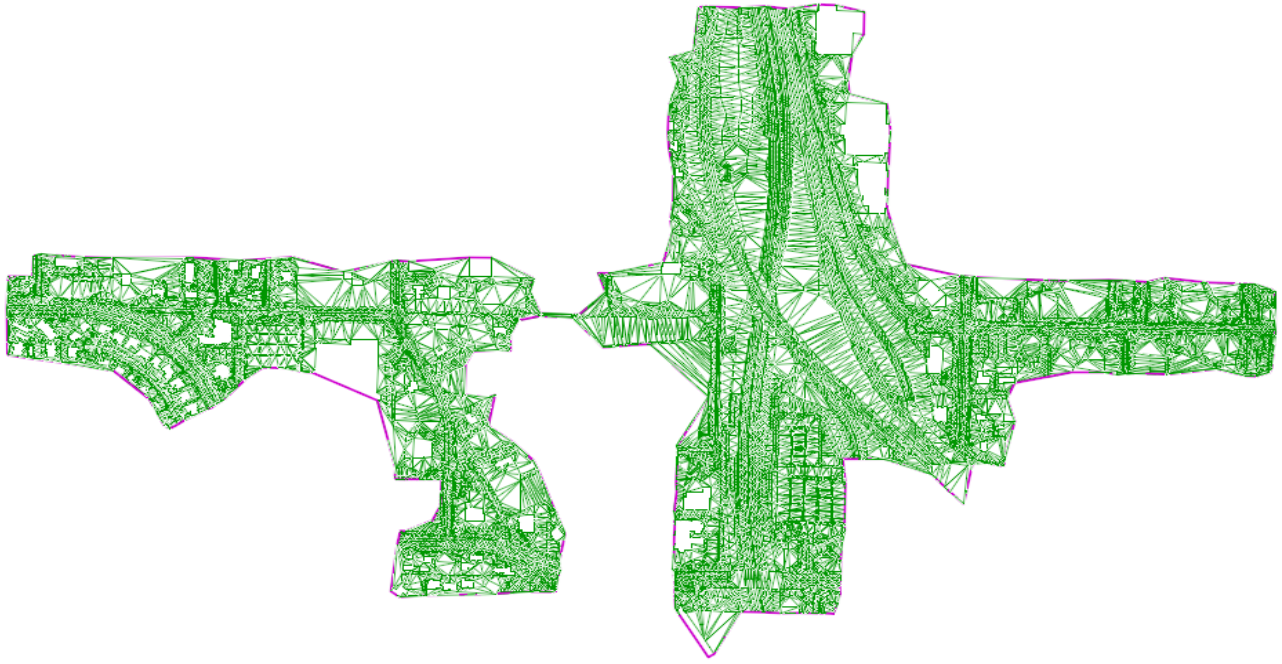
9. **Select** the edge of the terrain to highlight the *boundary graphic* so that the handles are visible.

10. Select **Drawing > Modify > Modify Element** and **click** on the lower left *boundary handle* and move the cursor and **click** to identify the *location for the new vertex*.



11. Continue to move around the model boundary and use the **Modify** tools - *Modify Element*, *Insert Vertex*, and *Delete Vertex* - to modify the boundary graphic to remove undesired edge triangles.

    The final terrain model may look similar to the following.



Note: A boundary feature added to a terrain model will control the creation of triangles regardless of future feature edits or reprocessing of the terrain model.

Add Boundary Methods

- **Extract Graphic** - creates a graphical 3D line string that can be edited. It is just a simple graphic and is not linked to the terrain in any way.
- **Add Boundary** - extracts the current boundary for the triangulation and creates a non-graphical boundary feature within the terrain model and it overrules all other trimming methods (Sliver, Max Edge Length).
- **Add Ruled Boundary** - extracts the current boundary for the triangulation and creates an editable graphical boundary that is ruled to the terrain. It overrules all other trimming methods (Sliver, Max Edge Length).

Skills Assessment

The questions below will test your retention of the skills covered in this course.

---

1. From the list of Terrain Model features, which ones are considered Source Features? (select all that apply).
   a. Triangles
   b. Boundary
   c. Break lines
   d. Low Points
2. From the list of Terrain Model features, which ones are considered Calculated Features? (select all that apply).
   a. Contours
   b. Triangles
   c. Boundary
   d. Break lines
   e. Low Points
3. What terrain model feature type is required to be displayed in order to create a Thematic Display?
   a. Voids
   b. Contours
   c. Breaklines
   d. Triangles

4. When a terrain model is referenced into another design file, what must be turned on so that you can change how the terrain is displayed?

   a. Override Symbology

   b. Feature Definition

   c. Element Template

   d. Triangles

5. A user should manually create a 3D model in their 2D project file.

   a. True

   b. False (Use the Set As Active Terrain Model command and let the software automatically create the 3D model).

6. Using a selection set to import graphics requires multiple imports in order to identify various data types such as break lines, voids, and contours.

   a. True

   b. False

7. A Terrain Filter Group provides the ability to define a feature type (break line, spot, void, etc.) and selection criteria (level, color, element type, line style, etc.) for importing graphical elements to create a terrain model.

   a. True

   b. False (A Terrain Filter defines the feature type and selection criteria. A Terrain Filter Group defines one or more Terrain Filters to be processed in a single operation).

8. The Link to Terrain Features option creates a rule that links the graphic element (source data) to the terrain model so that the terrain model will be updated when revisions are made to the source data.

   a. True

   b. False

9. Once rules are created in terrain models they cannot be changed.

   a. True

   b. False (Terrain rules can be activated, deactivated and removed).

10. The Add Features and Change Feature Type tools can be used to add a feature to an existing terrain model or change a feature type (i.e. from break line to void).
    a. True
    b. False
11. Terrain model edge triangles can be removed by several methods. Select all that are valid.
    a. Edge Method set to Max Length
    b. Add boundary
    c. Edge Method set to Slivers
    d. Delete Element
    e. Delete Edge Triangle
12. The Create Complex Terrain Model tool is used to combine multiple terrain models into a single model with options to merge or append the data.
    a. True
    b. False

Skills Assessment - Answers

The answers to the skills assessment questions are highlighted below.

---

1. From the list of Terrain Model features, which ones are considered Source Features? (select all that apply).
   a. Triangles
   b. **Boundary**
   c. **Break lines**
   d. Low Points
2. From the list of Terrain Model features, which ones are considered Calculated Features? (select all that apply).
   a. Contours
   b. **Triangles**
   c. Boundary
   d. Break lines
   e. **Low Points**
3. What terrain model feature type is required to be displayed in order to create a Thematic Display?
   a. Voids
   b. Contours
   c. Breaklines
   d. **Triangles**

4. When a terrain model is referenced into another design file, what must be turned on so that you can change how the terrain is displayed?

   a. **Override Symbology**

   b. Feature Definition

   c. Element Template

   d. Triangles

5. A user should manually create a 3D model in their 2D project file.

   a. True

   b. **False (Use the Set As Active Terrain Model command and let the software automatically create the 3D model).**

6. Using a selection set to import graphics requires multiple imports in order to identify various data types such as break lines, voids, and contours.

   a. **True**

   b. False

7. A Terrain Filter Group provides the ability to define a feature type (break line, spot, void, etc.) and selection criteria (level, color, element type, line style, etc.) for importing graphical elements to create a terrain model.

   a. True

   b. **False (A Terrain Filter defines the feature type and selection criteria. A Terrain Filter Group defines one or more Terrain Filters to be processed in a single operation).**

8. The Link to Terrain Features option creates a rule that links the graphic element (source data) to the terrain model so that the terrain model will be updated when revisions are made to the source data.

   a. **True**

   b. False

9. Once rules are created in terrain models they cannot be changed.

   a. True

   b. **False (Terrain rules can be activated, deactivated and removed).**

10. The Add Features and Change Feature Type tools can be used to add a feature to an existing terrain model or change a feature type (i.e. from break line to void).

    a. **True**

    b. False

11. Terrain model edge triangles can be removed by several methods. Select all that are valid.

    a. **Edge Method set to Max Length**

    b. **Add boundary**

    c. **Edge Method set to Slivers**

    d. Delete Element

    e. **Delete Edge Triangle**

12. The Create Complex Terrain Model tool is used to combine multiple terrain models into a single model with options to merge or append the data.

    a. **True**

    b. False

Summary

In this course you have learned what a terrain model is and how to display, create, and edit terrain models.

Terrain models are a set of triangles stored in a 3D mesh element in a 3D design file. They contain different feature types and use Feature Definitions, Feature Symbology, Element Templates and Annotation Groups to control their display. Most often a terrain model is referenced into another design file and the Override Symbology option is enabled to allow control of the terrain model display. The thematic height display provides a color shaded display based on elevation, aspect angle (direction), slope and hill shade.

There are many methods available to create terrain models. In this course terrain models were created directly from graphical elements and from graphical elements using graphical filters and filter groups. Terrain model rules and the linking of the source data to the terrain model was explored and how the rules and linkage affects the terrain model when the source graphics are edited.

After a terrain model is initially created, there is often a need to make additions and revisions to the terrain model. Features were added to the terrain model and the feature type was changed on a current feature. Crossing break lines were located and corrected. Conflicting points were located, reviewed and resolved. Edge triangles were controlled with the Sliver and Max Edge Length methods and additional edge triangles were deleted using the Edit Model tools.

A complex terrain model was created from two terrain models and the append and merge options discussed. A boundary feature was added to the terrain model to control the extents of the triangulation.