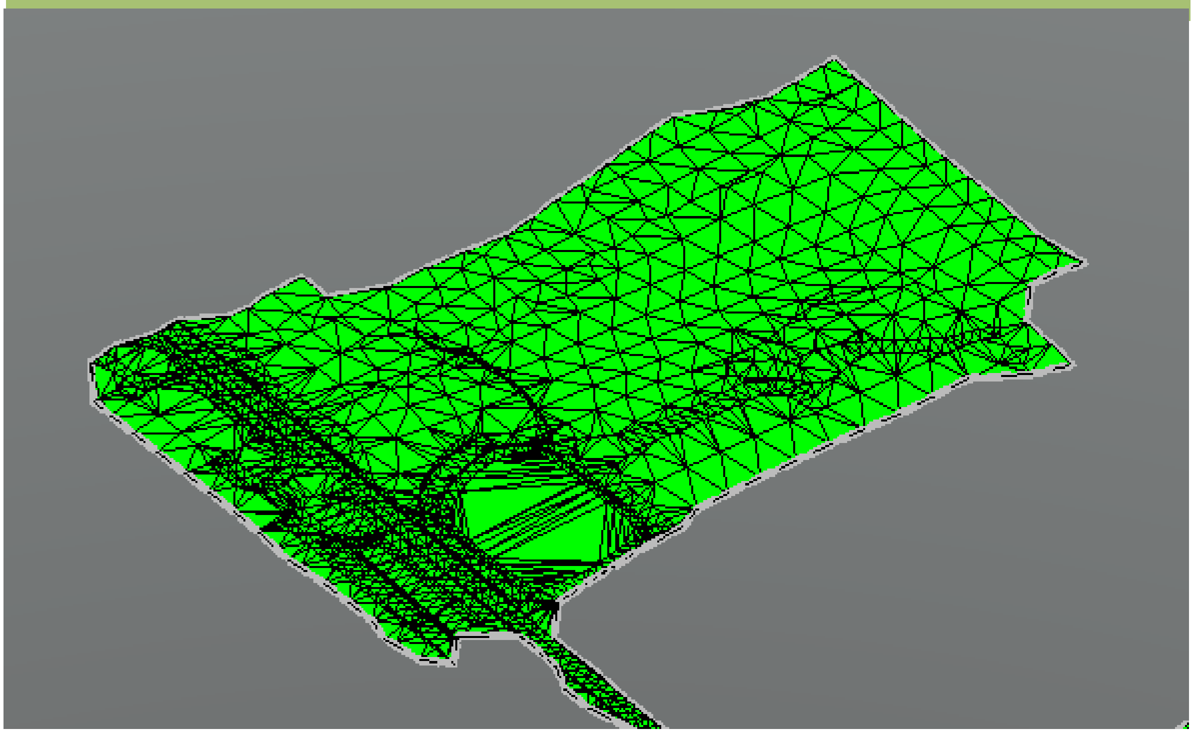
SURVEY

OpenRoads Designer

(Formerly GEOPAK Survey)

CONNECT Edition



TDOT

Roadway Design Division

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TN TDOT Department of Transportation

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Preface

Purpose & Need

The **SURVEY** OpenRoads Designer (ORD) Manual is the second document in a series of **six** training manuals released by the Tennessee Department of Transportation (TDOT) that is available through a digital, interactive **flipbook** format. Bentley's ORD software is being adopted and implemented statewide by TDOT as the new **3D modeling** design software, which will ultimately replace both MicroStation V8i and Geopak (SELECT Series 2). This manual provides an introduction to the **Survey** workflow, which includes terrain, civil geometry, drainage and utility, and plan development tools.

Disclaimer

The ***SURVEY*** Manual is developed based on OpenRoads Designer CONNECT Edition 2020 Release 3, Version **10.09.00.91**. The TDOT ORD workspace (**10.09.00.91_06.04.2021**) complies with the latest CADD standards and should be used in conjunction with this manual. It can be downloaded on the TDOT CADD Support website under **TDOT ORD Info**. If you have any technical issues or recommendations for this manual, please contact TDOT CADD Support at TDOT.ORD@tn.gov.

Training Videos

The ***SURVEY*** Manual has accompanying training videos which are intended to be utilitzed as you go through the exercises. Video icons have been inserted throughout the flipbook, providing direct access to the applicable video. At a minimum, there is at least one video per chapter. In general, the videos contain instructional guidance and additional tips and tricks, as well as an informational bar at the bottom of the screen to help stay on track.

Revisions

The ***SURVEY*** Manual will be revised over time as a result of future ORD software releases and procedural & workspace updates. All revisions will be documented by WSP/TDOT and included on the **Revision History** page at the end of the manual. TDOT CADD support will announce updated manual versions when they become available via emailed Instructional Bulletins. The updates will also be posted on the ORD TDOT webpage.

ORD Training Manuals

The ***SURVEY*** Manual is one of **six** ORD training manuals available. Each manual has its own icon and color associated with it, which are maintained throughout the applicable manual and videos to help the user with wayfinding.

Chapter 1. Course Overview

Course Description and Objectives:

This course introduces users to the **survey** functionality of the OpenRoads Designer (ORD) CONNECT software, which is Bentley's current drafting and civil design platform that is being adopted for use by TDOT.

At the conclusion of this course, participants will be able to:

1. Import, analyze and edit field book data.
2. Create existing terrain models utilizing different methods and data sources.
3. Import, create and edit civil geometry (horizontal and vertical).
4. Create different reports for civil geometry.
5. Project linear and crossing utilities onto profiles.
6. Add annotation for plan view geometry.
7. Create a profile named boundary and add annotation.
8. Create bridge sketches and flood plain sections utilizing different methods.
9. Create stream alignments and profiles.
10. Place existing box culverts (crossing) in profile view.
11. Delineate drainage areas.
12. Place low wire crossings, control points and benchmarks in profile view.

The topics covered in this class are:

1. Survey Feature Definitions and Settings
2. Terrain Tools
3. Civil Geometry Tools (including Utilities)
4. Plan Development Tools
5. Survey Drainage Elements
6. Additional Survey Elements

Target Audience:

This course is designed for Survey staff.

Pre-Requisites:

- Familiarity with TDOT's survey policies, procedures, and standards.
- A working knowledge of Windows 10.
- Fundamentals (ORD) Manual.

Chapter 2. Survey Feature Definitions and Settings

The engine behind survey field code linkage and automatic display in ORD is contained within the dgnlib and survey settings. This sets the foundation for all survey elements that are brought in from the field data so that they are in accordance with the **TDOT Survey Standards**.

2.1 Objectives

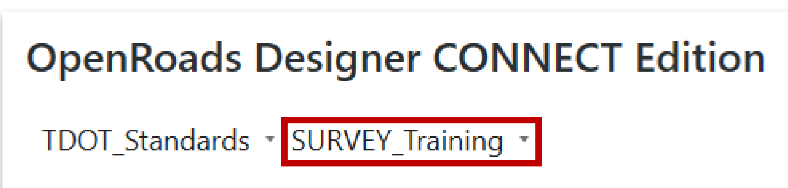
At the conclusion of this chapter, participants will be able to:

1. Locate and navigate the ORD Explorer.
2. Locate the survey feature definitions and settings.

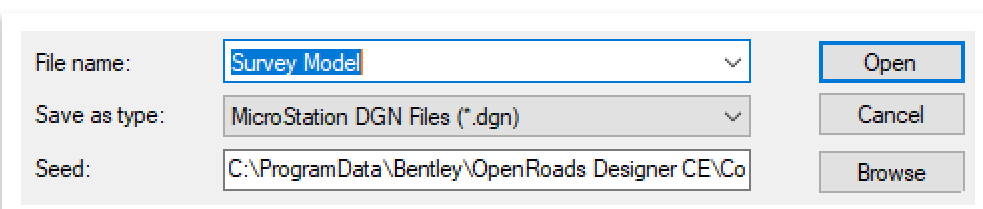
2.2 Exercise: File Creation

In this exercise, we will create a file utilizing the **SURVEY_Training** workset, which will then be used to explore the survey feature definitions and settings described in this chapter, as well as for the upcoming exercises. **Note:** On an actual project, remember to use the TDOT ORD naming convention when creating **all** survey files. The file names used in this manual serve as general guidance for training purposes only.

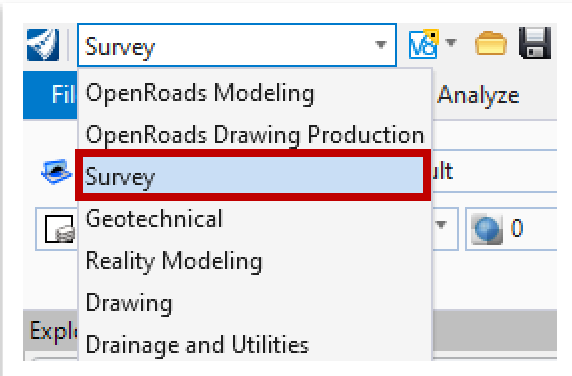
1. Before we begin, move the provided **class files** to the following location within File Explorer: **C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\Survey_Training\dgn**. These files will be utilized later in the manual.
2. Open ORD from your desktop. The **TDOT_Standards** workspace should still be active after taking the Fundamentals (ORD) training. Go ahead and select the **SURVEY_Training** workset, which will be used for the duration of this manual.



3. Create a new file and name it **Survey Model**. Select the **TDOTSeed3D.dgn** and click **Save**. **Note:** By default, the software should save the file in the workset dgn subfolder: **C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\SURVEY_Training\dgn**.



4. Make sure that the **Survey** workflow is selected in the upper left corner of the ORD interface. This workflow will be used for most of the manual. However, there will be certain tools utilized later that require other workflows.



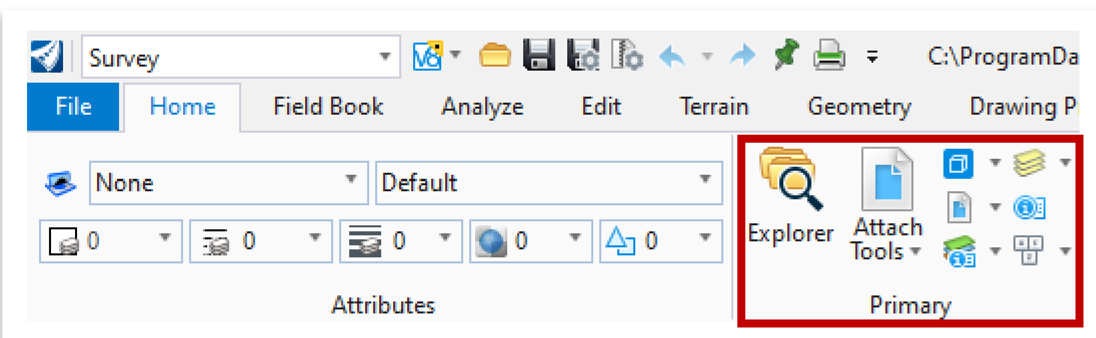
Take Note!

This file will be used to show the software interface and explore the concepts presented in Sections 2.3 and 2.4. It will also be used in Chapter 3.

2.3 Lecture: Reviewing the ORD Explorer

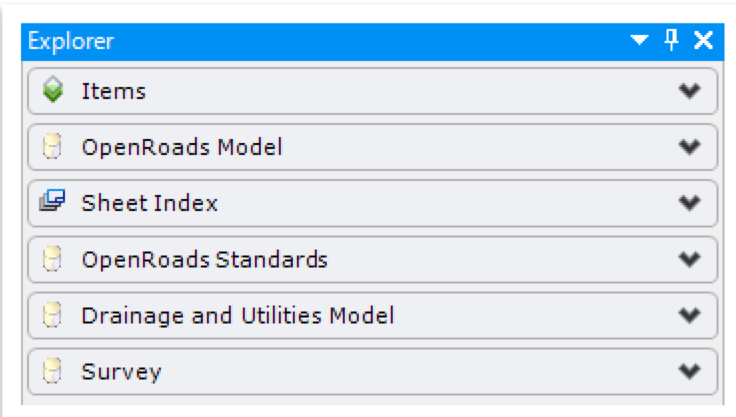
Within the **Survey** workflow, the **Primary** tools are located under the **Home** tab by default. (Figure 1).

FIGURE 1. SURVEY WORKFLOW – PRIMARY TOOLS



The **Explorer** (Figure 2) should still be docked but can be opened within the **Primary** tools, if necessary. Refer to the Fundamentals (ORD) Manual for more insight on the **Explorer**. The **Survey** tab will be referenced predominantly in this manual and will be covered in Chapter 3. Feature Definitions are contained within a library and are part of the overall workspace managed by TDOT CADD support. They cannot be edited, but we will view them for the purpose of understanding the organization of survey features.

FIGURE 2. EXPLORER TABS



Take Note!

*It is important to understand the function of **Feature Definitions**. Section 2.4 is provided as a reference to explain their properties and how they are used by the software.*

2.4 Lecture: Feature Definitions

Feature Definitions essentially tell the software what each model object represents (e.g. edge of pavement that is asphalt versus concrete, or digital terrain model). Each Feature Definition has an associated **Feature Symbology** used to create the civil model both in 2D and 3D. Feature Definitions have been set up per the **TDOT CADD Standards** for appropriately setting symbology and survey mapping of all current TDOT survey codes.

There are **13** types of Feature Definitions. Each type is used to control different elements of a civil design model. Table 1 on the next page displays a summary of all the Feature Definitions and their descriptions. TDOT has multiple feature definition libraries for survey, roadway, drainage and utilities. This manual will only cover those applicable to **Survey** and **Aerial Surveys**.

TABLE 1. SUMMARY OF ORD FEATURE DEFINITIONS AND DESCRIPTIONS

Feature Definition Type	Description
Alignment Features	A special type of linear feature used for horizontal and vertical alignments that can be assigned an annotation group. They can also have a template assigned to them to allow the program to automatically create 2D plan view geometry directly from the template.
Terrain Features	Used to allow the user to draw the digital terrain model properties, such as contours and triangles.
Corridor Features	Used to set the settings, which control model density based on stages of the project, such as conceptual, preliminary and final design. They are used to help with computer performance when using large data sets.
Superelevation Features	Used to define the symbology of superelevation objects, such as the setting for superelevation lane lines.
Linear Template Features	Like corridor features but used to set up the settings of linear templates.
Surface Template Features	Used by terrain models to draw or not draw the 3D break lines the surface templates used in the civil cells.
Linear Features	Used to define linear objects, such as edges of pavement, sidewalk, guardrail, etc.
Point Features	Used to define point elements, such as right-of-way markers, signs, survey points, etc.
Mesh Features	Used to define the outer surface of 3D solids created by ORD, such as top or bottom of pavement mesh.
Trace Slope Features	Used in tracing a path on a terrain model or mesh surface.
Aquaplaning Features	Also known as hydroplaning, these features control the symbology of both linear (water depth) and surface (delta terrain model) entities.
Sight Visibility	Used in the analysis of sight distance along a corridor.
Survey Features	Used by the survey settings to map physical features picked up in the field by survey staff.

2.4.1 Feature Definition Properties

All Feature Definitions must be given these three properties: **Name**, **Description** and a **Name Seed**. The name seed is the default name for that piece of geometry. If there are multiple elements with the same Feature Definition, the name seed is incremented by **1** with every new element placed.

2.4.2 Feature Symbologies

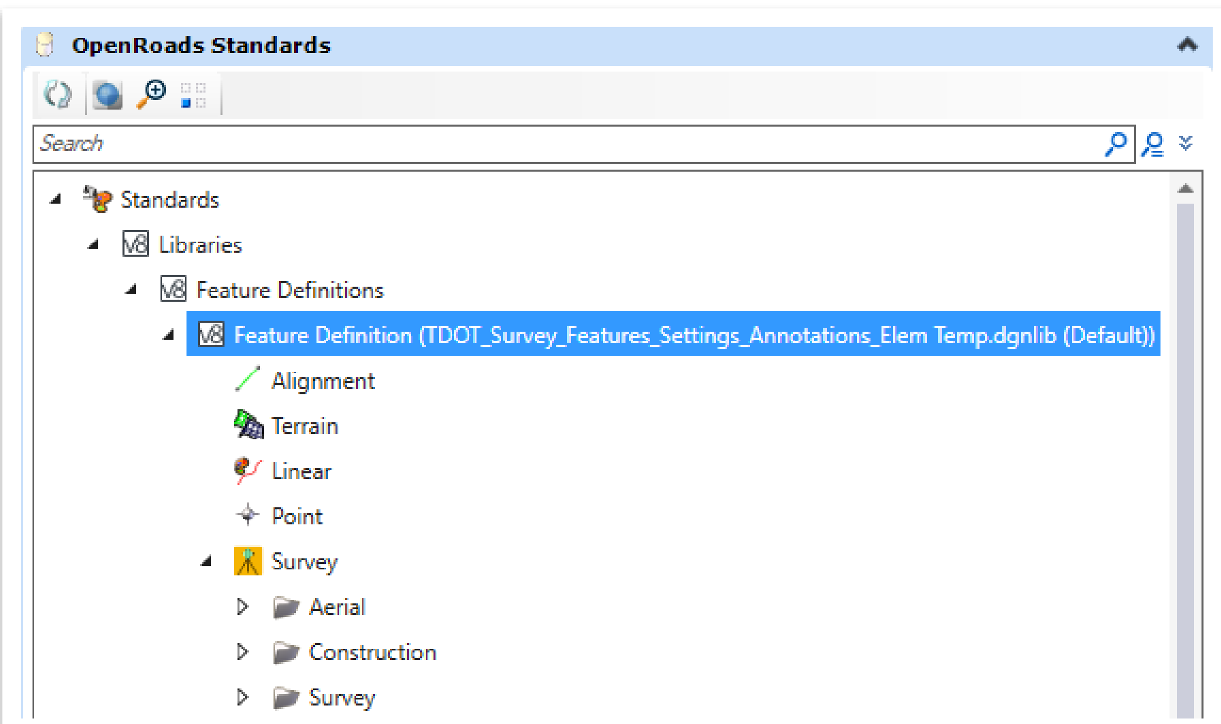
The settings for Feature Symbologies let the software know what element templates to assign to each Feature Definition. These settings determine how each element looks and what level to place the geometry.

2.4.3 Survey Feature Definitions

Survey Feature Definitions are located within the **TDOT_Survey_Features_Settings _Annotations_Elem_Temp.dgnlib** file.

Within the **Explorer**, you can expand the **OpenRoads Standards** tab and browse to the following location: **Standards >> Libraries >> Feature Definitions >> TDOT_Survey_ Features_Settings_Annotations_Elem_Temp.dgnlib >> Survey** (Figure 3).

FIGURE 3. EXPLORER – OPENROADS STANDARDS – SURVEY FEATURES



While these Feature Definitions may not be edited, they can be reviewed within the **Explorer**, as shown below in Figure 4 thru Figure 9.

Take Note!

A complete list of TDOT's Feature Definitions will be available in the TDOT CADD Standards Manual once the workspace is completed.

FIGURE 4. TDOT SURVEY FEATURE DEFINITION ORGANIZATION

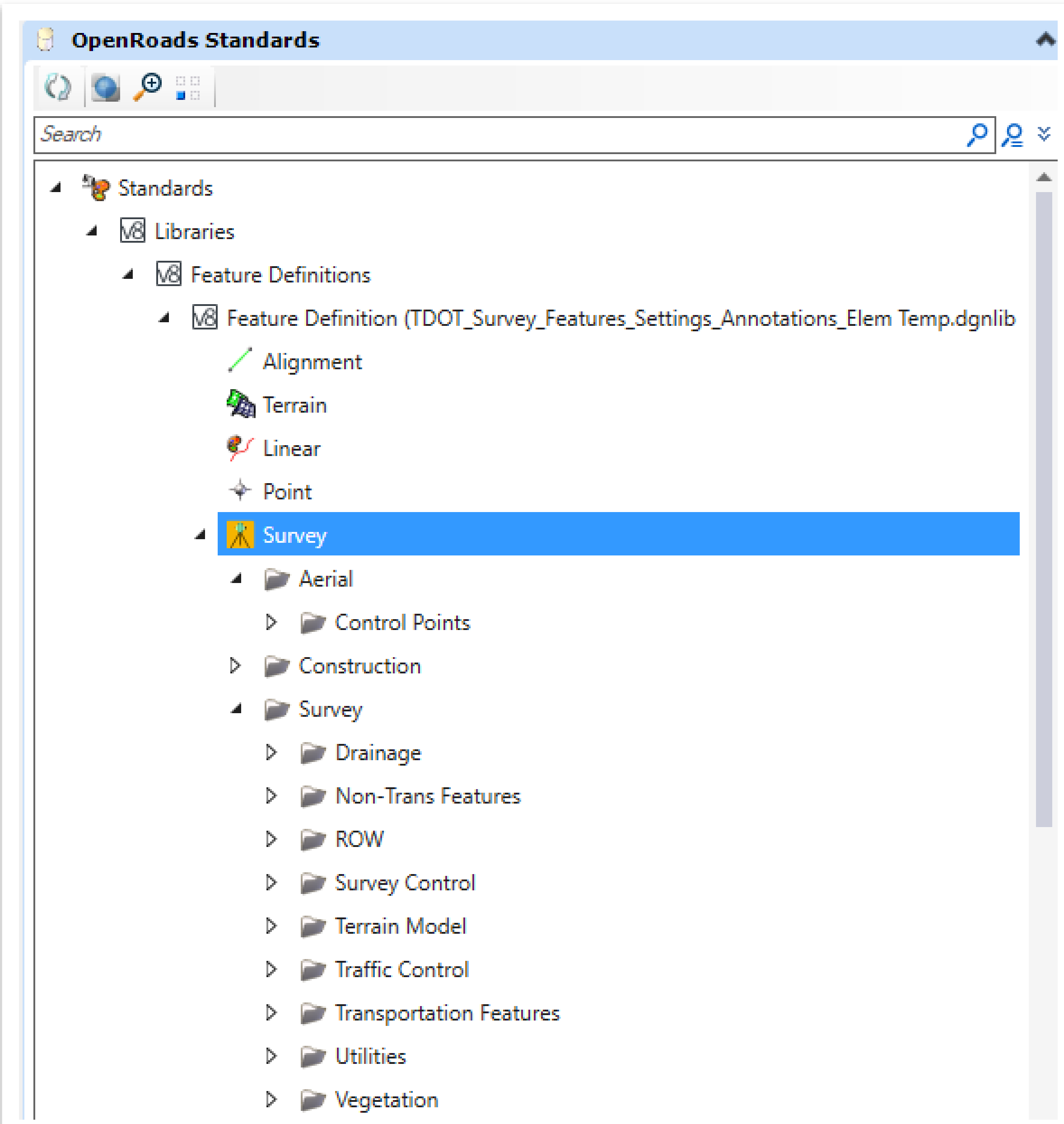


FIGURE 5. TDOT SURVEY FEATURE DEFINITIONS: DRAINAGE

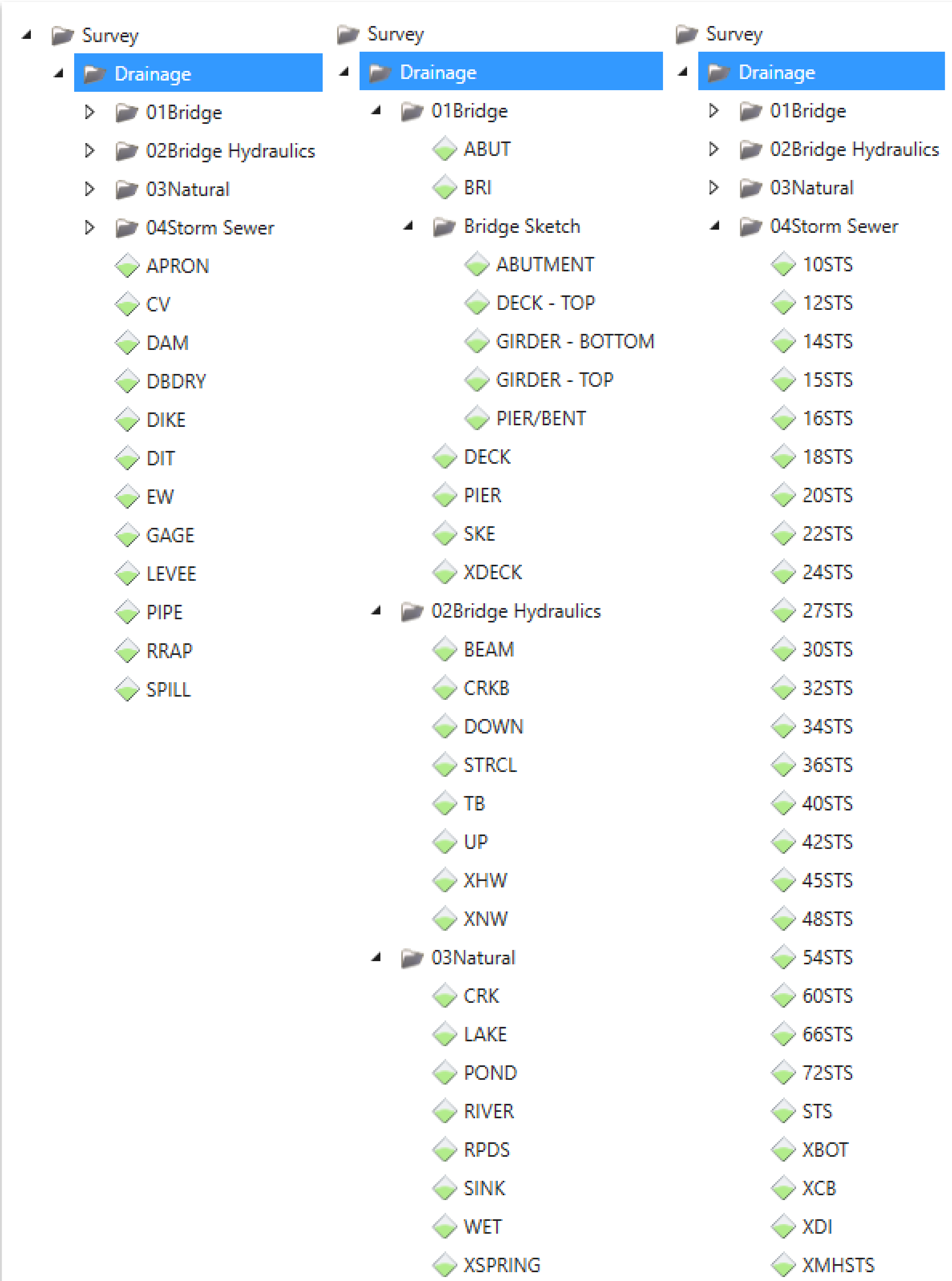


FIGURE 6. TDOT SURVEY FEATURE DEFINITIONS: NON-TRANS, ROW, SURVEY CONTROL, TERRAIN MODEL AND VEGETATION

- Non-Trans Features
  - AFLD
  - BC
  - CEM
  - CG
  - DASH
  - DOT
  - FN
  - GATE
  - GRAVE
  - LD
  - MISC
  - PAD
  - PIT
  - ROCKW
  - RWP
  - RWPWF
  - SEP
  - SIGNP
  - SOLID
  - SWP
  - TANK
  - TOWER
  - XBLDR
  - XFE
  - XFLAG
  - XFP
  - XMB
  - XMISC
  - XSATLIT
  - XSEP
  - XWELL
- ROW
  - CITY
  - COUNTY
  - ESMT
  - ESMTD
  - PARCEL
  - PL
  - PLWF
  - ROW
  - ROWWF
  - STATE
  - XIP
  - XMON
  - XPL
  - XROW
  - XROWA
  - XROWB
- Survey Control
  - XBM
  - XCK
  - XCP
  - XSPUR
  - XTRAV
- Terrain Model
  - BL
  - OL
  - XP
- Vegetation
  - HEDGE
  - TREE
  - XBUSH
  - XTREE
  - XTREEL
  - XTREEM
  - XTREES

There are 3 new survey codes available for trees:

- ***XTREES*** *(0"-6")*
- ***XTREEM*** *(6"-12")*
- ***XTREEL*** *(12"+)*

They were created to give surveyors the option to let the software automatically determine relative sizes. This will avoid having to scale each cell up or down.

FIGURE 7. TDOT SURVEY FEATURE DEFINITIONS: TRAFFIC CONTROL AND TRANSPORTATION FEATURES

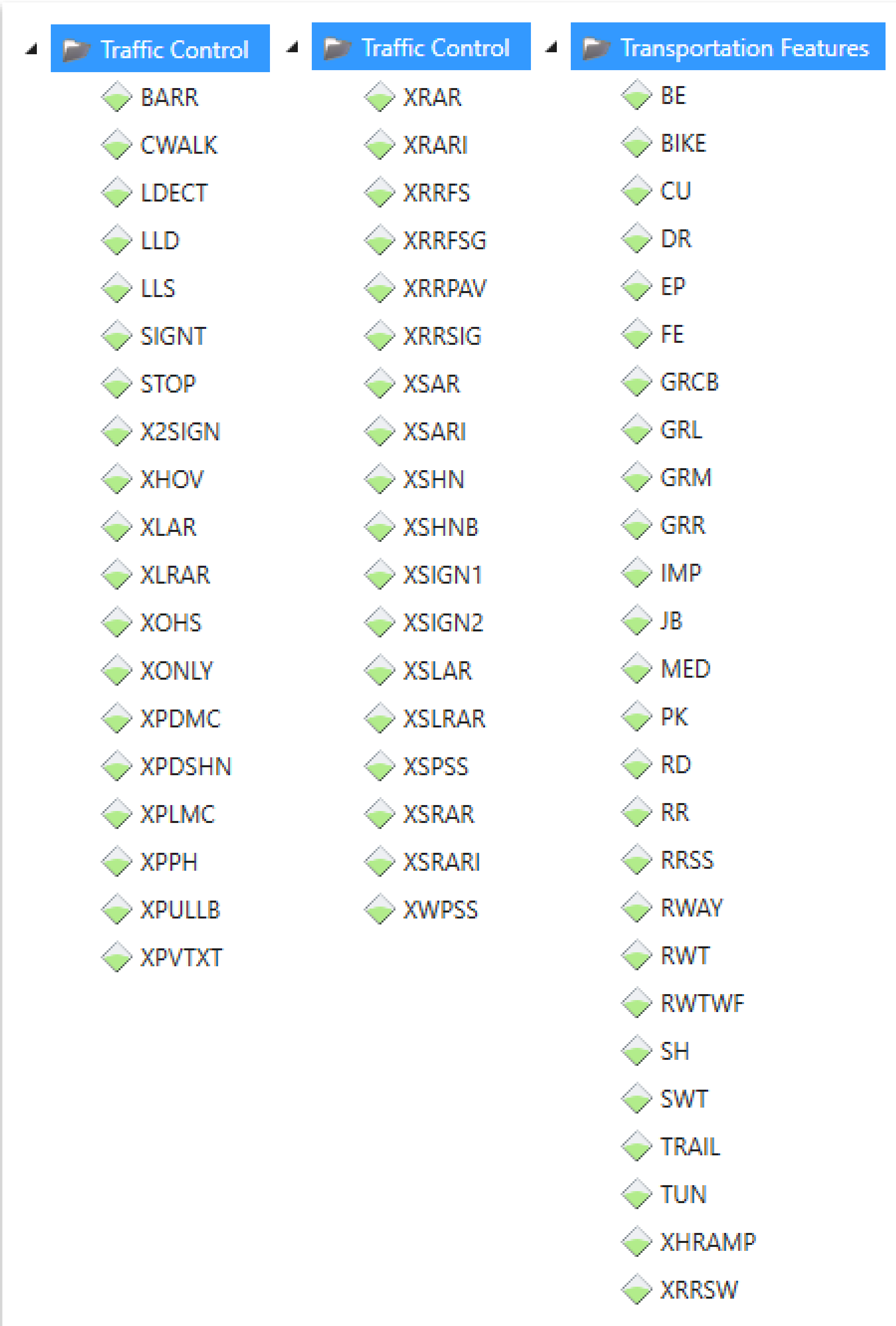


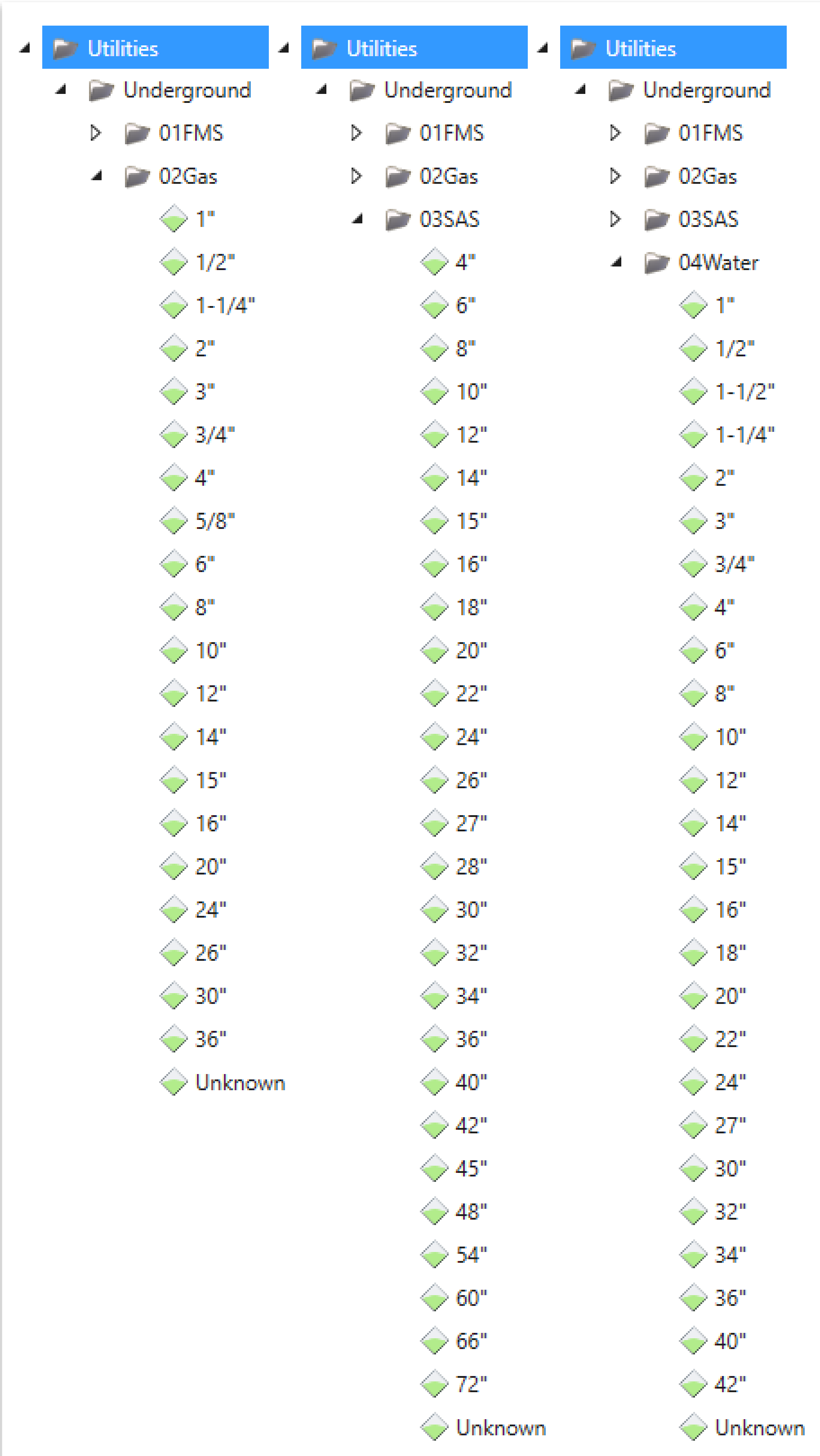
FIGURE 8. TDOT SURVEY FEATURE DEFINITIONS: UTILITIES (PART I)

- Utilities
  - Overhead
    - OHW
    - PTOW
    - XCPED
    - XFH
    - XGAA
    - XGM
    - XGV
    - XGVA
    - XGW
    - XHMPLF
    - XHMPLH
    - XLCC
    - XLP1
    - XLP2
    - XLP3
    - XLP4
    - XLW
    - XOFTLP
    - XSM
    - XSV
    - XTBOOTH
    - XTBOX
    - XTGP
    - XTOWER
    - XTPED
    - XUP
    - XUPL

- Utilities
  - Underground
    - 01FMS
    - 02Gas
    - 03SAS
    - 04Water
    - UGC
    - UGF
    - UGP
    - UGPT
    - UGT
    - UM
    - XMH
    - XMHC
    - XMHF
    - XMHG
    - XMHP
    - XMHSAS
    - XMHT
    - XMHW
    - XPB
    - XUM
    - XWM
    - XWV

- Utilities
  - Underground
    - 01FMS
      - 2"
      - 4"
      - 6"
      - 8"
      - 10"
      - 12"
      - 14"
      - 16"
      - 18"
      - 20"
      - 22"
      - 24"
      - 26"
      - 28"
      - 30"
      - Unknown

FIGURE 9. TDOT SURVEY FEATURE DEFINITIONS: UTILITIES (PART II)



2.4.4 Survey Settings

Survey Settings are also located within the **TDOT_Survey_Features_Settings_ Annotations_Elem_Temp.dgnlib** file. These settings are used by the software to properly map survey field files (TXT files). These settings also help automate the process for importing survey text files correctly.

Within the **Explorer**, you can expand the **OpenRoads Standards** tab and browse to the following location: **Standards >> Libraries >> Survey Settings >> TDOT_Survey_ Features_Settings_Annotation_ElemTemp.dgnlib >> TDOT Survey Settings** (Figure 10). The **Properties** are shown in Figure 11 on the next page.

Take Note!

This section is provided as reference material. TDOT CADD Support will maintain this file.

FIGURE 10. TDOT SURVEY SETTINGS

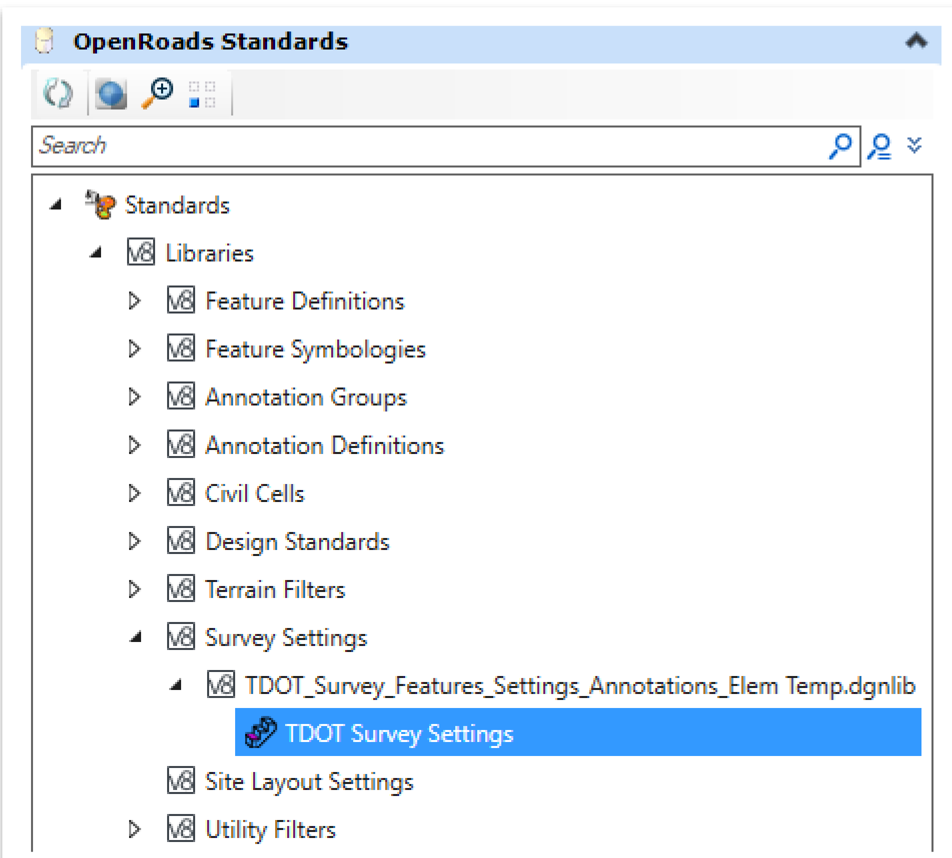
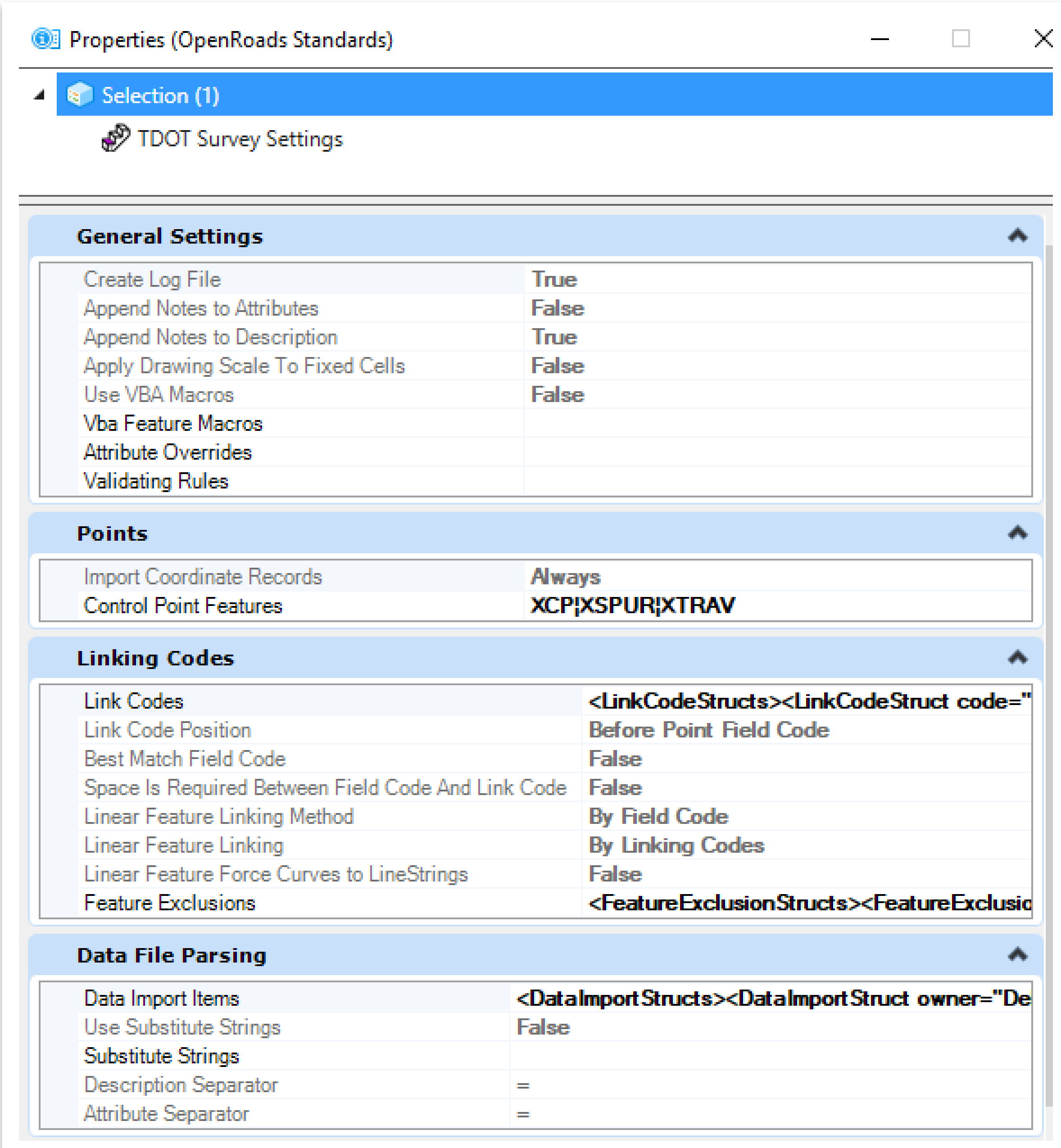


FIGURE 11. TDOT SURVEY SETTINGS: PROPERTIES



2.4.4.1 Linking Codes

Linking Codes indicate the beginning and ending of linear features, or specific attributes to points such as PC, PT, etc. The software is configured based on the **TDOT Standard Linking Codes**. Table 2 provides the current linking codes used by TDOT.

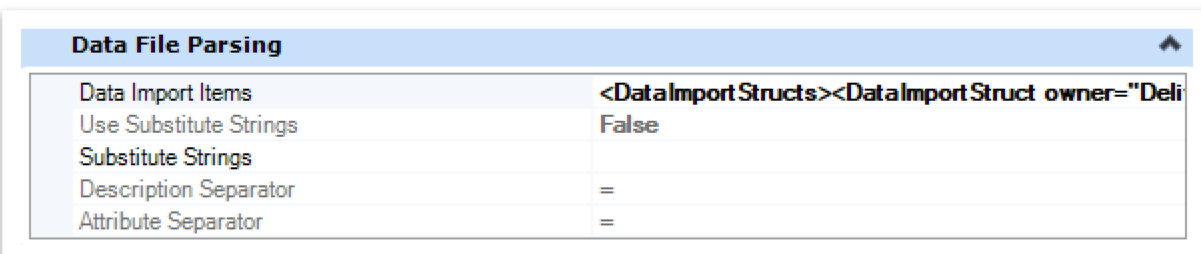
TABLE 2. TDOT LINKING CODE SETTINGS

Linking Code	Alpha
Start	+
End	-
Close	*

2.4.4.2 Data File Parsing

Data File Parsing settings tell the software what options are available to map survey data sets (Figure 12).

FIGURE 12. TDOT SURVEY SETTINGS: DATA FILE PARSING



The software is configured to use **ASCII** text files via the **Text Import Wizard** tool, which is covered later in the manual. However, other types of files supported by the software include:

- Leica DBX File (*.xcf)
- Leica Digital Levels File (*.gsi)
- Leica MDF File (*.mdf)
- Trimble Link Engine (*.job)
- Trimble DC SDR (*.dc)
- Field Genius (*.dbf)
- LandXML (*.xml)
- Topcon MaXML (*.mxl)
- Tripod Data Systems TDS (*.rw5)
- Efbp OBS (*.obs)
- Efbp XYZ (*.xyz)

Chapter 3. Terrain Tools

The survey process within ORD starts with the creation of the field book after the field data is collected. There are various tools within the Survey workflow that allow for editing of the surveyed data after the initial automatic mapping. Once the field book has been reviewed, the Civil Terrain Model can then be created and edited, as necessary. The Field Book, Analyze, Edit and Terrain tabs will be covered in this Chapter.

3.1 Objectives

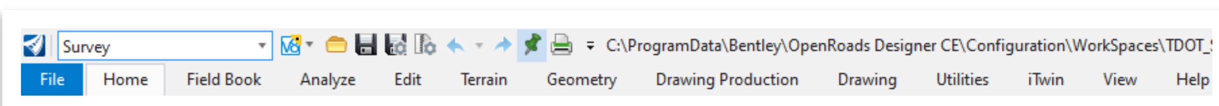
At the conclusion of this chapter, participants will be able to:

1. Learn the overall survey workflow.
2. Create a field book.
3. Import, analyze and edit field book data.
4. Create existing terrain models utilizing different methods and data sources.
5. Analyze, edit and review the Properties of different Civil Terrain Models.

3.2 Lecture: Survey Workflow

The **Survey** workflow houses all tools needed for importing and editing survey data sets and terrain models (Figure 13). This workflow also contains traditional MicroStation tools for placing lines, cells, text, etc.

FIGURE 13. SURVEY WORKFLOW TABS

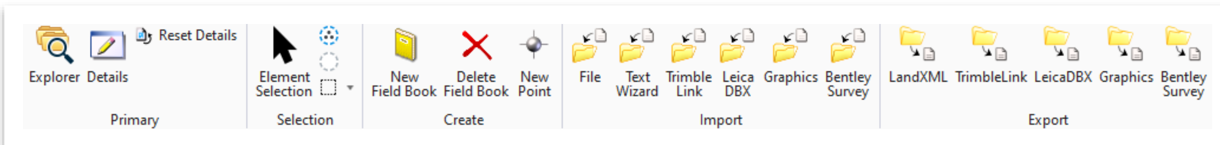


- **<u>ORD Survey</u>**: For **<u>new</u>** ORD projects, there are **four** survey deliverables listed below that are needed for design. Reference Appendix A for the detailed workflow.
  - Field Survey Data
  - Terrain Model
  - Preliminary Geometry
  - Utility Model
- **<u>SS2 Survey</u>**: For **<u>converted</u>** ORD projects, design can utilize the SS2 survey files. There is no added benefit or need to re-featurize the 2D graphics in ORD. The existing TIN can be imported and the dgn file can be opened as-is in ORD and then attached as a reference to the applicable sheets. There is a separate SS2 configuration zip file that design will utilize so that the visual element looks correct.

3.3 Lecture: Field Book Tools

The **Field Book** tab houses all tools used to create a new field book (Figure 14). A **Field Book** is a compilation of all feature codes (or features) being mapped, including points, lines and any terrains generated from the data set.

FIGURE 14. FIELD BOOK TAB



The user can create and delete field books and add points from this menu. Other options in this menu include **importing** and **exporting** survey data.

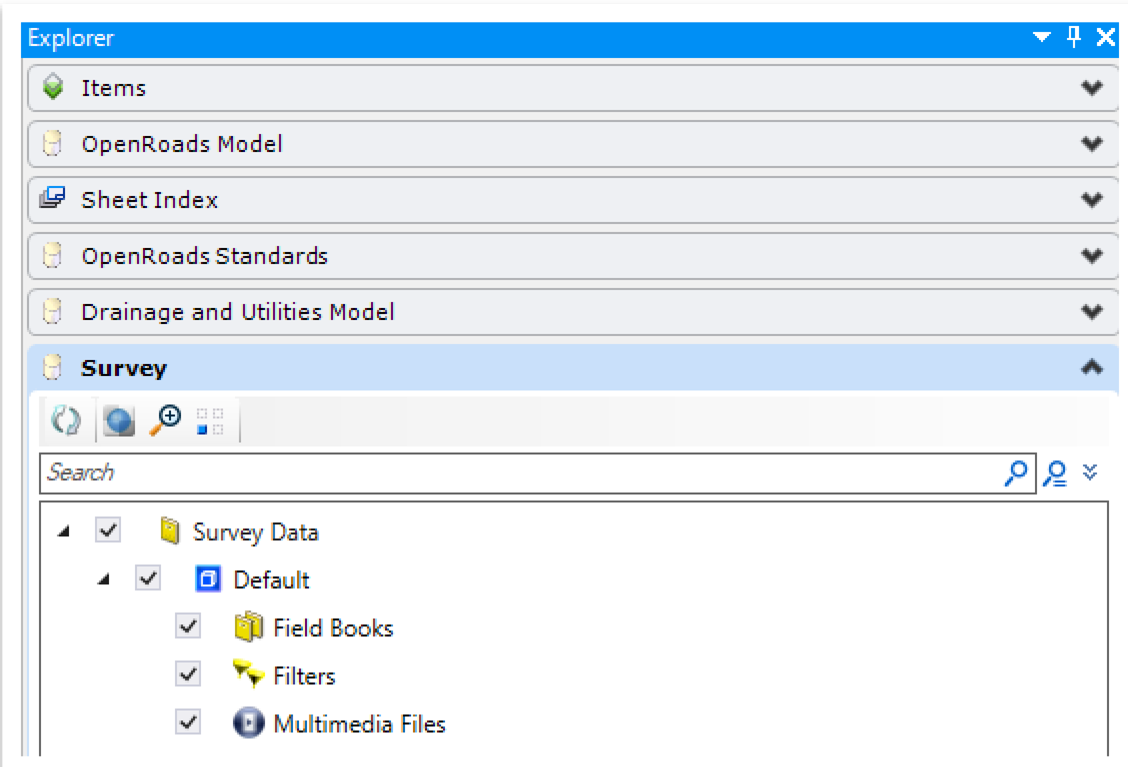
For importing TDOT survey data, the user will primarily utilize either the **File Import** method or drag and drop the text files into the field book from File Explorer. The **File Import** option is used for importing previously created survey text files within ORD. There is also a **Text Import Wizard** option which allows for surface data to be imported in a variety of **ASCII** formats, but would not typically be needed unless additional customization is necessary (e.g. record format, delimiter settings, column headers, etc).

It is highly recommended that the text files are carefully reviewed prior to importing into ORD. Below are some recommendations to consider when reviewing a text file:

- Were the proper field codes used?
- Were the proper linking codes used?
- Were the proper delimiters used?
- Were the proper descriptions used?
- If known, were the proper utility sizes included?

The **Explorer** tools should be used for managing and reviewing all survey data. The Survey Data **Field Books** are accessed via the **Explorer** (Figure 15). In ORD, all survey files are embedded in the DGN file including field book data sets and multimedia files (e.g. photos and videos).

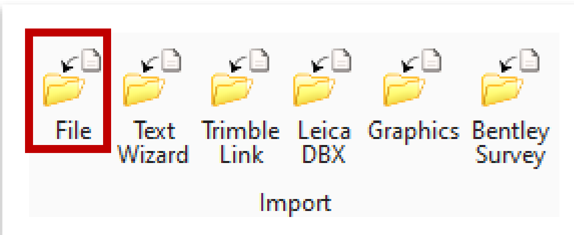
FIGURE 15. EXPLORER: SURVEY DATA TREE



When creating a field book, the user has several options. By default, the new field book will be called **Field Book 1** for each scenario but can be renamed after creation.

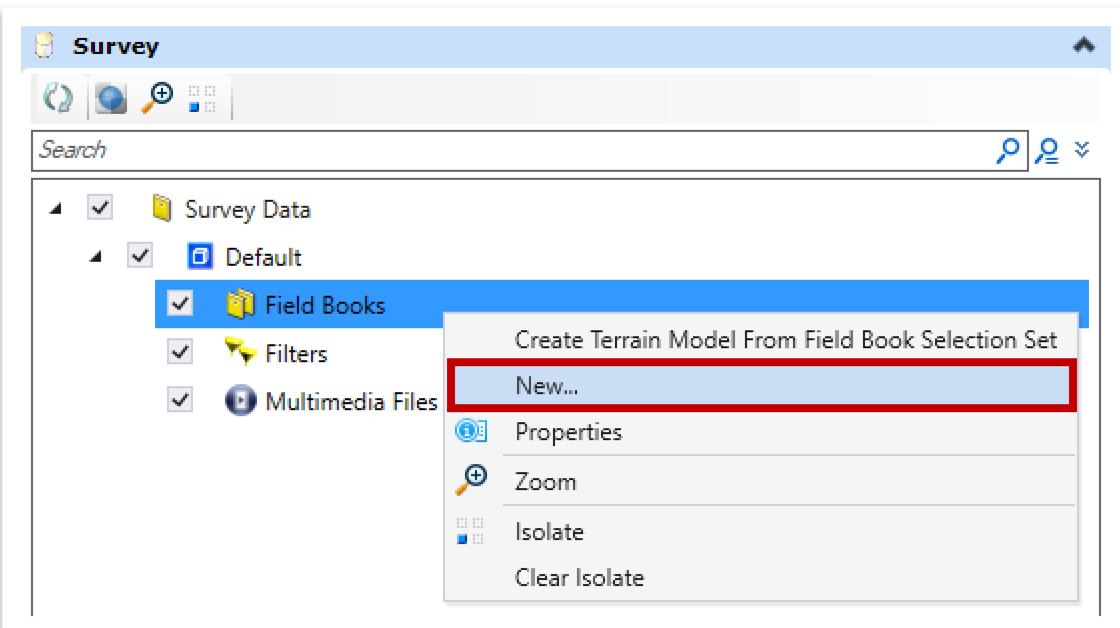
1. Open the **File** tool in the ribbon (**Survey >> Field Book >> Import**) (Figure 16) and then select the text file(s) to add. This process will automatically create the field book.

FIGURE 16. FILE IMPORT TOOL



2. Right click on **Field Books** within the **Explorer** and select **New** (Figure 17). You would then need to either right click on the new field book and select **Import >> File** or drag and drop the text file(s) into the new field book.

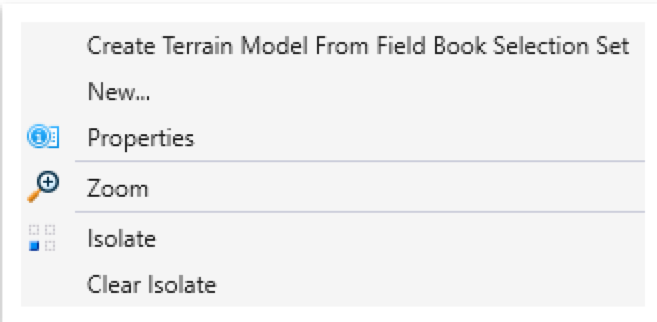
FIGURE 17. FIELD BOOKS: RIGHT CLICK NEW OPTION



3. Drag and drop the text file(s) on the main **Field Books** header in the **Explorer**, which will automatically create the field book. This option will be demonstrated in the next exercise.

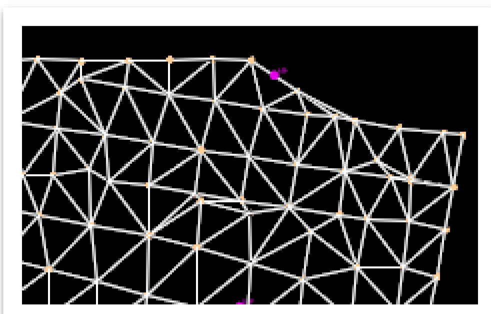
Field Book right click options (Figure 18)

FIGURE 18. FIELD BOOKS: RIGHT CLICK OPTIONS



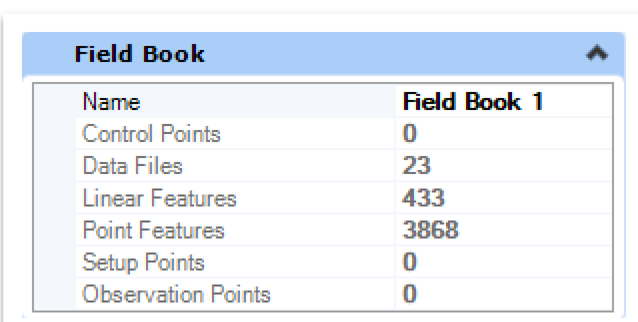
- **Create Terrain Model From Field Book Selection Set:** If a data set was imported to create a field book but a terrain was not created during the import session, this option could be used to create the terrain after-the-fact (Figure 19).

FIGURE 19. SAMPLE TERRAIN CREATION



- **New:** Creates a new field book under the field books folder structure. It is up to the user to organize his or her own field book structure. TDOT users should continue to organize their field books per their region's preference. One field book may contain data from multiple text files.
- **Properties:** Contains information associated with the imported data file (Figure 20). The only field that can be updated is the field book **Name**.

FIGURE 20. FIELD BOOK: PROPERTIES



Field Book

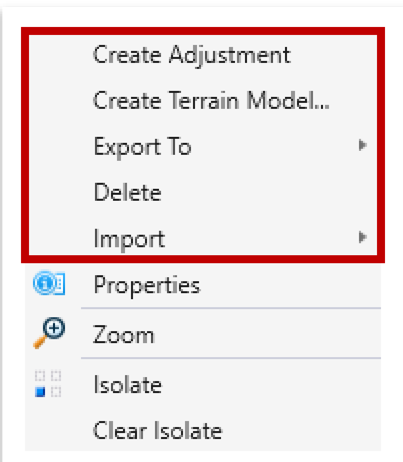
Name	Field Book 1
Control Points	0
Data Files	23
Linear Features	433
Point Features	3868
Setup Points	0
Observation Points	0

- **<u>Zoom</u>:** Allows the selection of an element from the field book list or an entire field book (in the case of multiple field books), and the software zooms in on the graphics associated with those files. **Note:** This option does not work in Release 3. A defect has been logged by Bentley.
- **<u>Isolate</u>:** Displays only the field codes that are selected when the command is called out. For example, if the field code SIGNP is selected in the field book tree, the software will highlight all SIGNP graphics mapped in the file without needing to turn levels on and off. **Note:** This option does not work in Release 3. A defect has been logged by Bentley.
- **<u>Clear Isolate</u>:** Clears the isolate selection set.

<u>Post-created Field Book right click options</u>

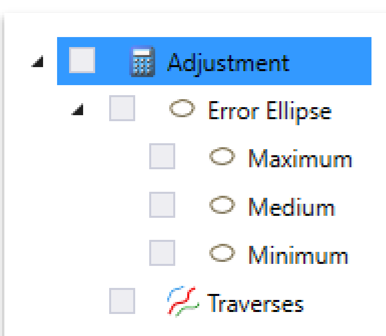
Once a field book has been imported, the following options are also available (Figure 21).

FIGURE 21. FIELD BOOK: RIGHT CLICK OPTIONS



- **<u>Create Adjustment</u>:** Allows the addition of an overall adjustment (e.g. traverse) for that specific field book (Figure 22). **Note:** This is not applicable to the TDOT Survey workflow within ORD.

FIGURE 22. ADJUSTMENT OPTIONS



- **<u>Create Terrain Model</u>:** Creates a terrain model for that specific field book.
- **<u>Export To</u>:** Used to export a field book to several file formats, and to DGN graphics (Figure 23). The **LandXML Format** option may be used to deliver to contractors wanting to use automated machine control grading (AMG). Export tools can also be accessed via the **Field Book** tab in the ribbon (Figure 24).

FIGURE 23. FIELD BOOK: EXPORT TO OPTIONS

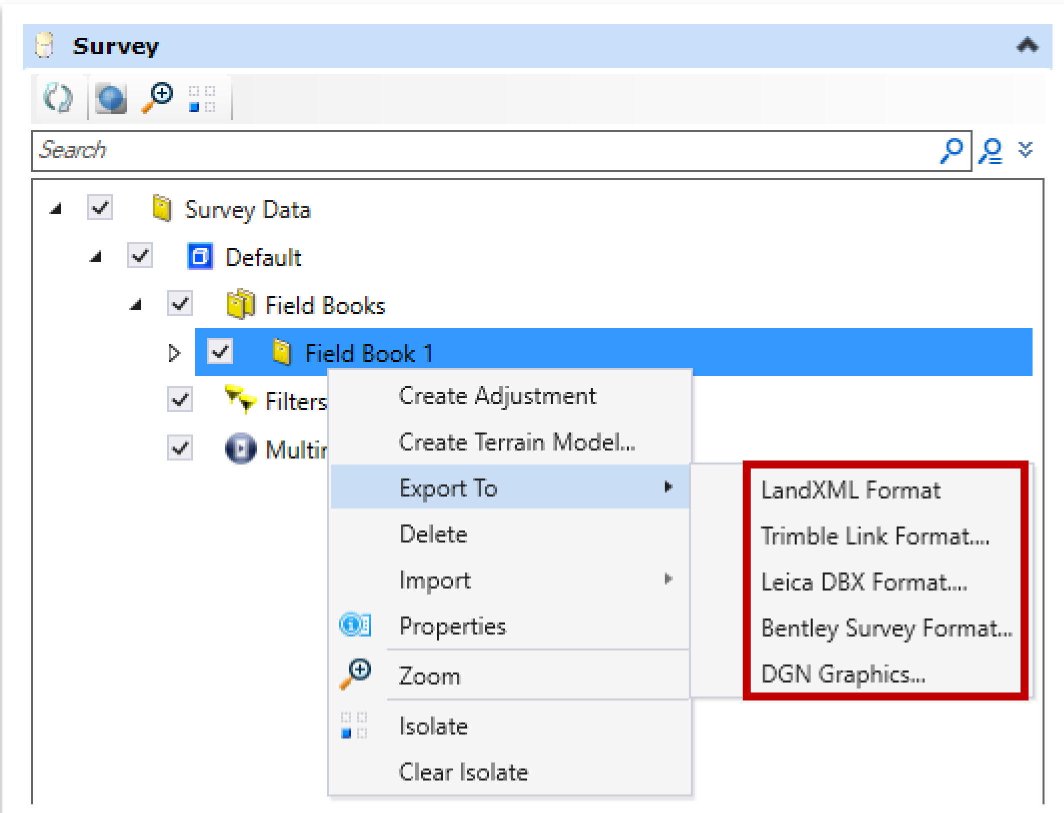
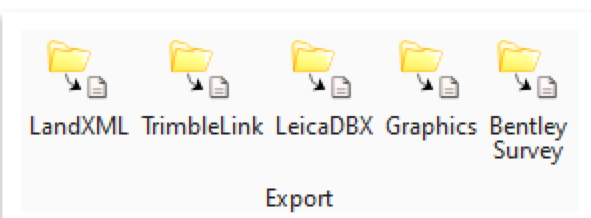


FIGURE 24. FIELD BOOK TAB: EXPORT OPTIONS

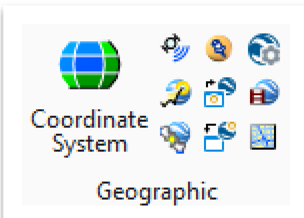


- **<u>Delete</u>:** Deletes the field book and all associated mapped data.
- **<u>Import</u>:** Allows for importing additional information into the field book from other sources.
- **<u>Properties</u>, <u>Zoom</u>, <u>Isolate</u>, <u>Clear Isolate</u>:** Continue to appear in this menu too.

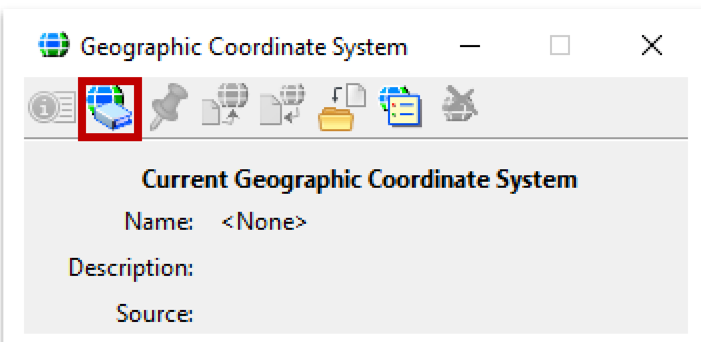
3.3.1 Exercise: Importing Field Survey Data

In this exercise, we will import a series of field survey data (text files) to create a Field Book and examine the Properties. We will continue to utilize the same **Survey Model.dgn** file.

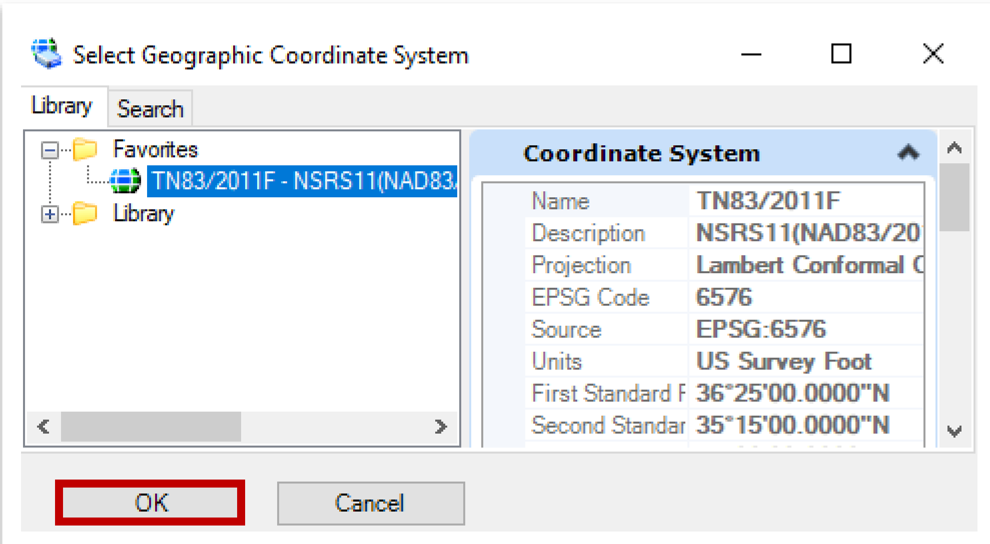
1. We first need to set the **Geographic Coordinate System** (GCS) for the file. As a reminder, this procedure was discussed in Exercise 13.3 in the Fundamentals (ORD) Manual. Also, you should already have the correct coordinate system saved as a Favorite. Although we utilized the tool under the Drawing workflow previously, it is also located in the **Survey** workflow by default (**Survey >> Utilities >> Geographic**). Go ahead and open the **Coordinate System** tool. **Note:** You could also utilize the **Search Ribbon** in the upper right corner of the screen and key-in coordinate system.



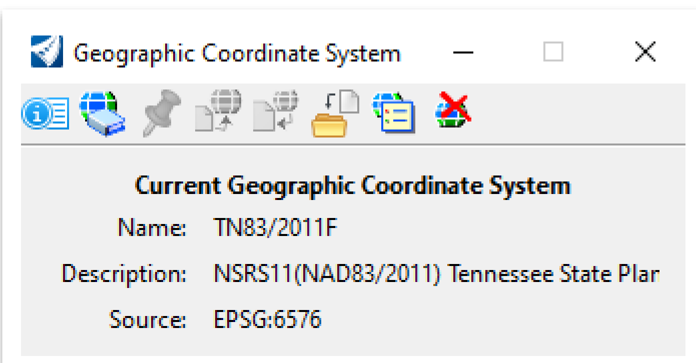
2. Click the **From Library** option (second icon from the left). Notice that by default there is not a coordinate system associated with the file.



3. You should already have the correct coordinate system saved as a Favorite (**TN83/2011F – NSRS11 (NAD83/ 2011) Tennessee State Plane Zone, US Foot**) based on the Fundamentals (ORD) Manual. If not, you can browse to it here: **Library >> Projected (northing, easting, …) >> North America >> United States of America >> Tennessee**. Once selected, click **OK**.



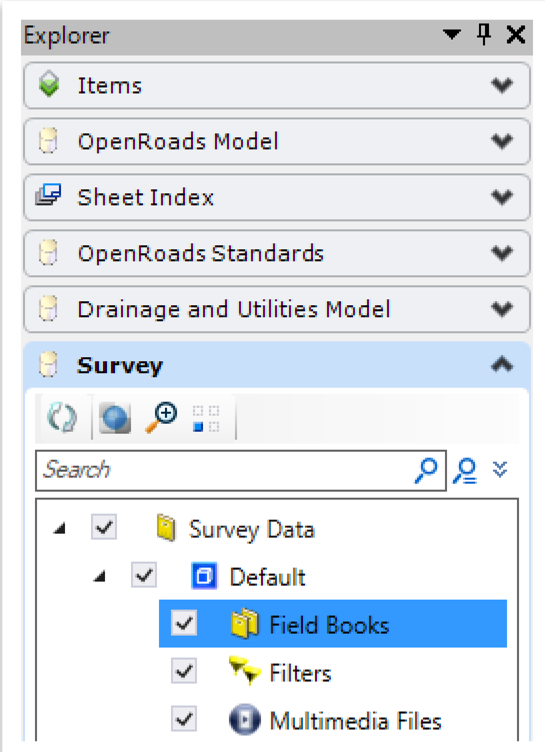
4. Once the **GCS** is set, you should see the following image.



Take Note!

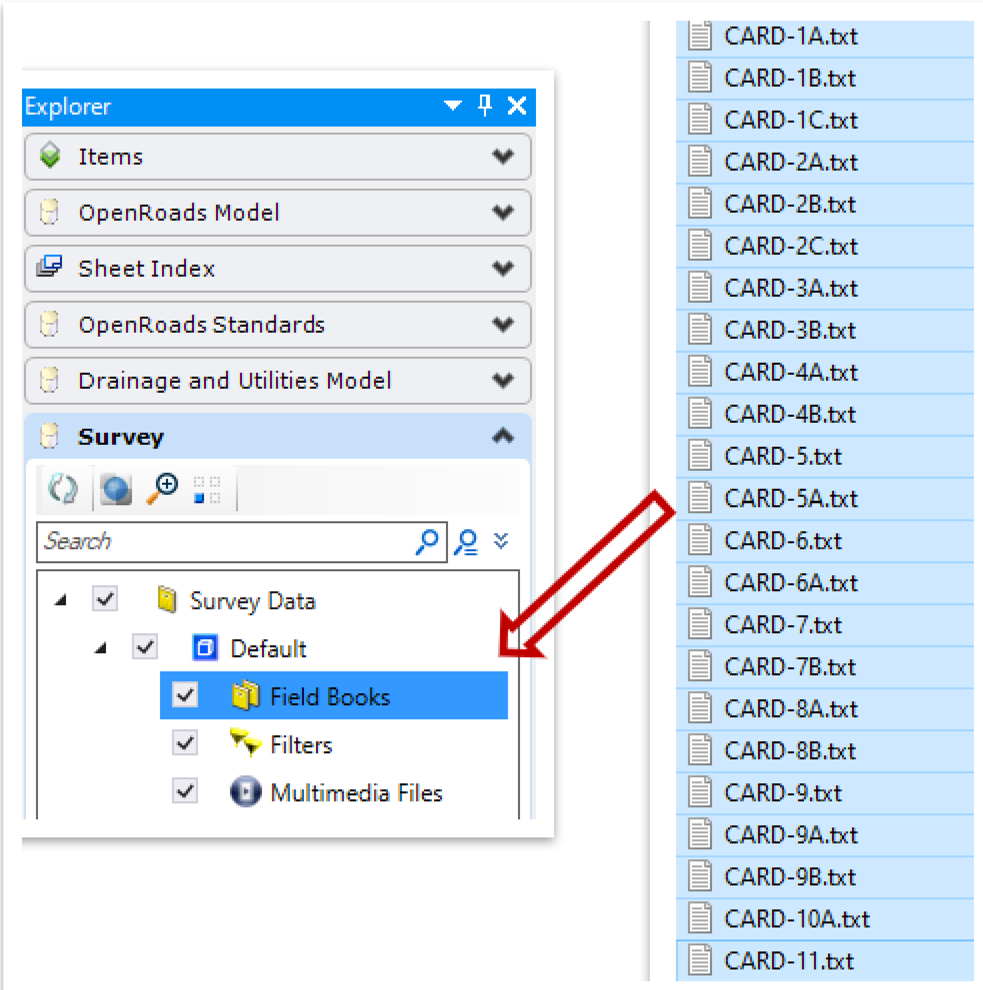
*Each time a new additional file is created in this manual and beyond, make sure and first set the coordinate system (**TN83/2011F – NSRS11 (NAD83/ 2011) Tennessee State Plane Zone, US Foot**).*

5. Now, within the **Explorer**, navigate to **Field Books** folder (**Survey >> Survey Data >> Default**).

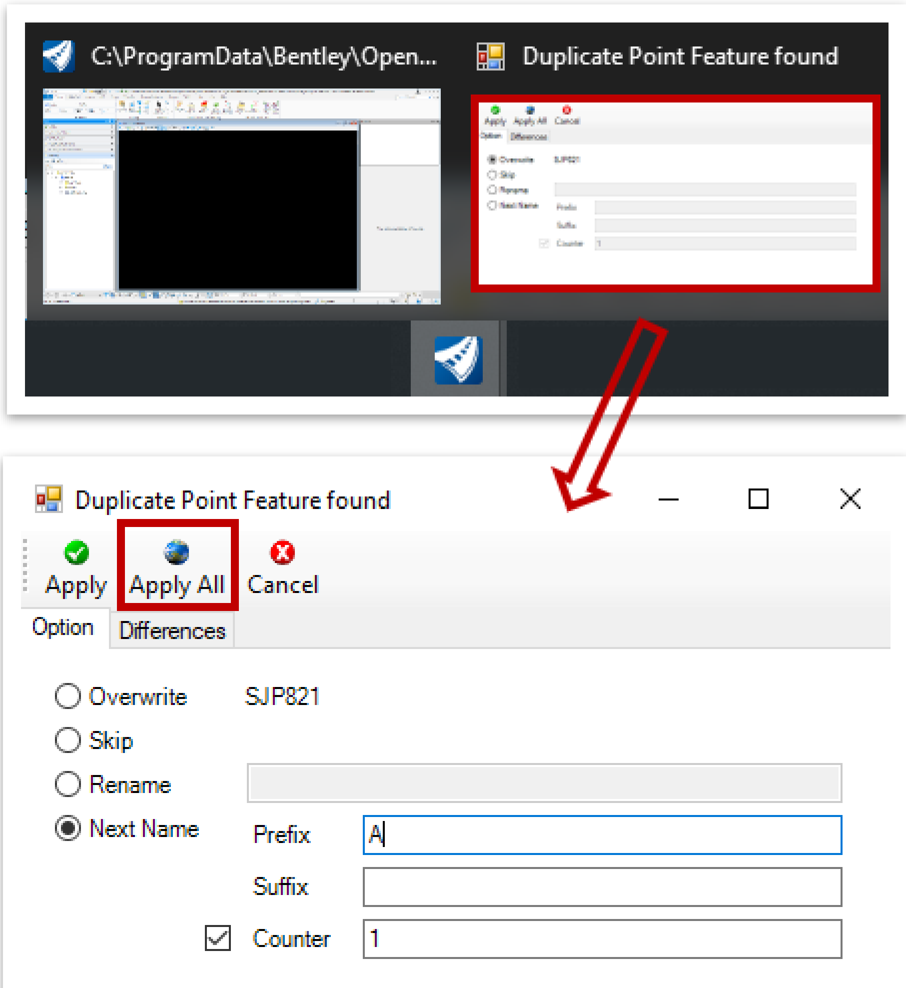


6. Open **File Explorer** and browse to the class files within the **SURVEY_Training** workset located here: **C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\Worksets\SURVEY_Training\dgn**.

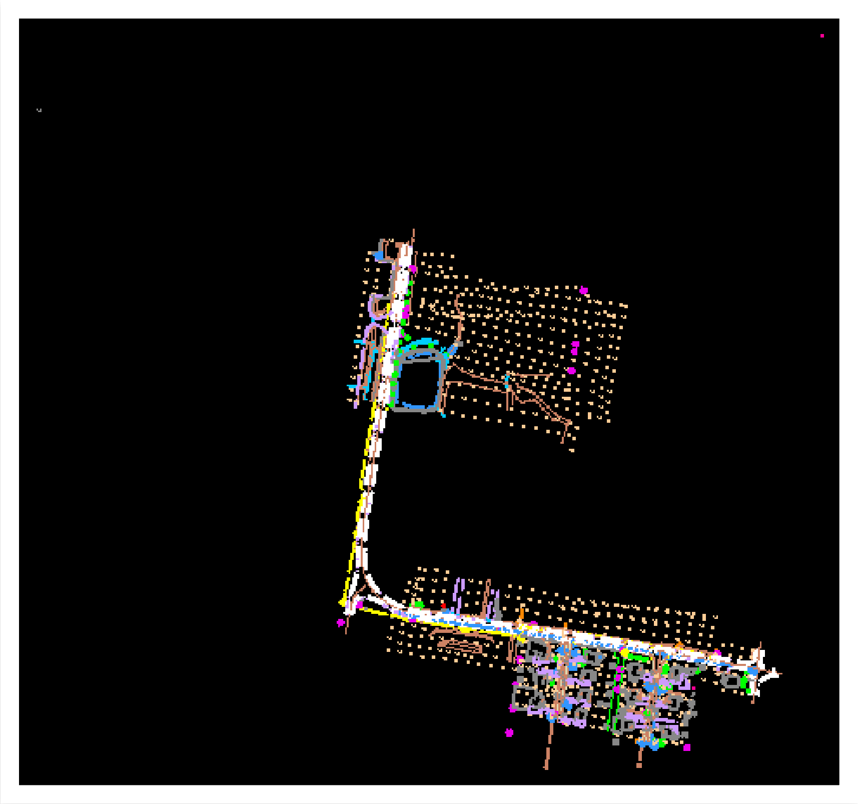
7. Select the ASCII text files **CARD-1A.txt** through **CARD-11.txt**, then drag and drop into the **Field Books** folder within the **Explorer**.



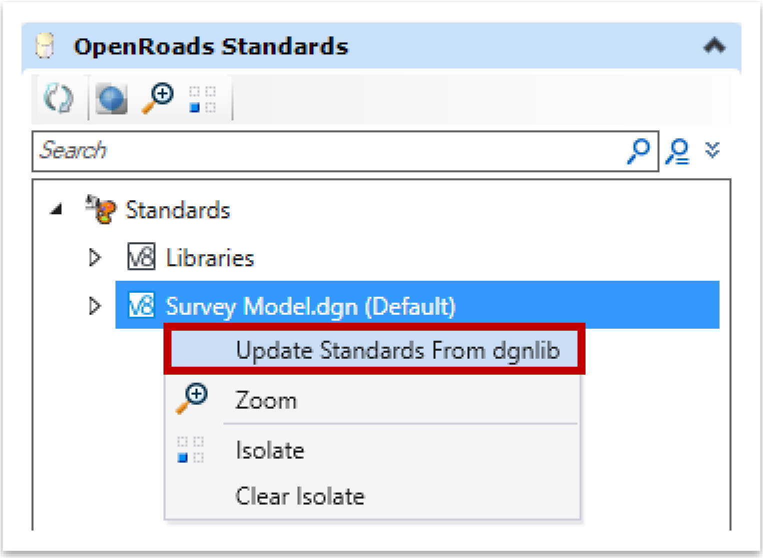
8. Duplicate names of features should be found in the sample data. Select **Next Name** and add a **Prefix A**. Then click **Apply All** and give it a second to process. **Note:** The window below may appear in the background as a second window. If so, you can "open" it by clicking on the ORD icon in the taskbar on your desktop.



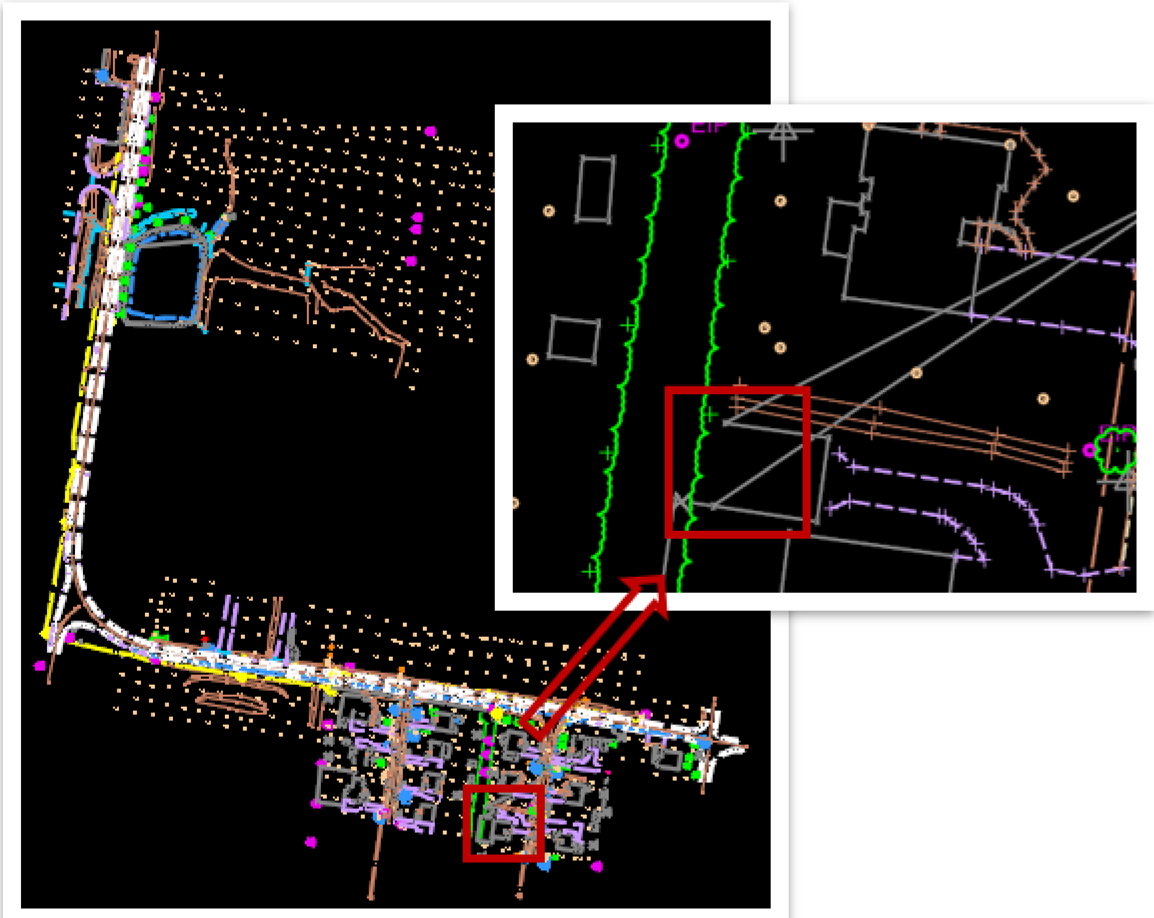
9. Click **Fit View** and review the file. You should see the image below.



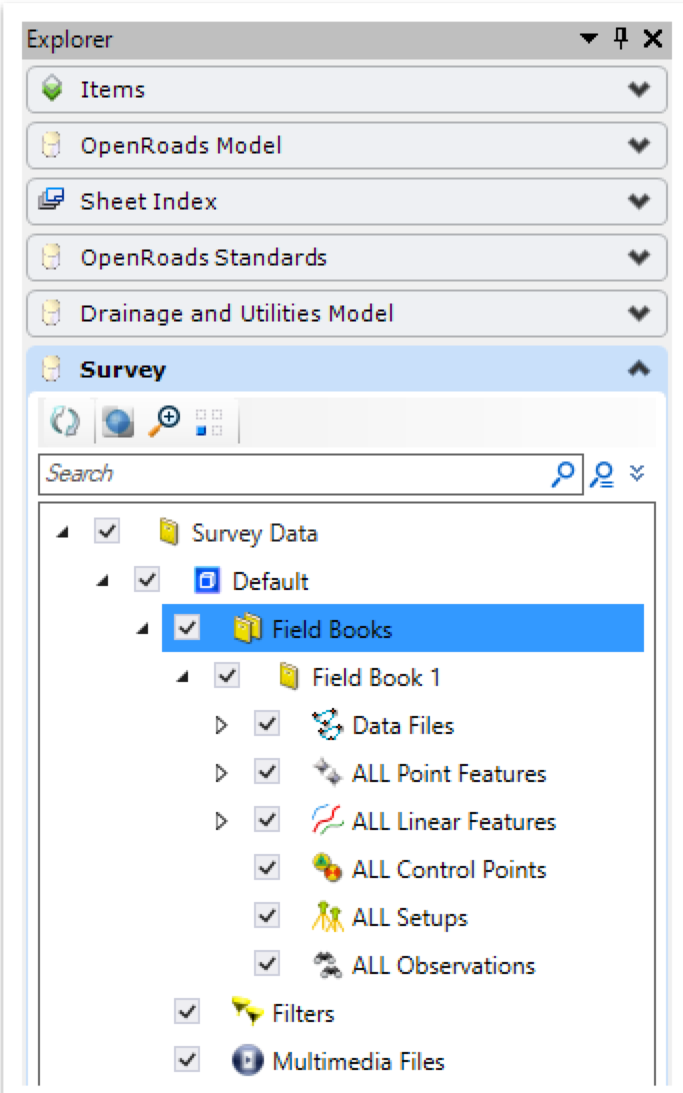
10. The first thing we need to do after import is update the **dgnlib standards** so that all survey **locators** are the correct scale. There is a quirk in the software, so it is good practice to perform this step after any survey text file import. Expand the **OpenRoads Standards** tab within **Explorer**. Right click on the active file (**Survey Model.dgn**) and select **Update Standards From dgnlib**. Give the software a minute to process.



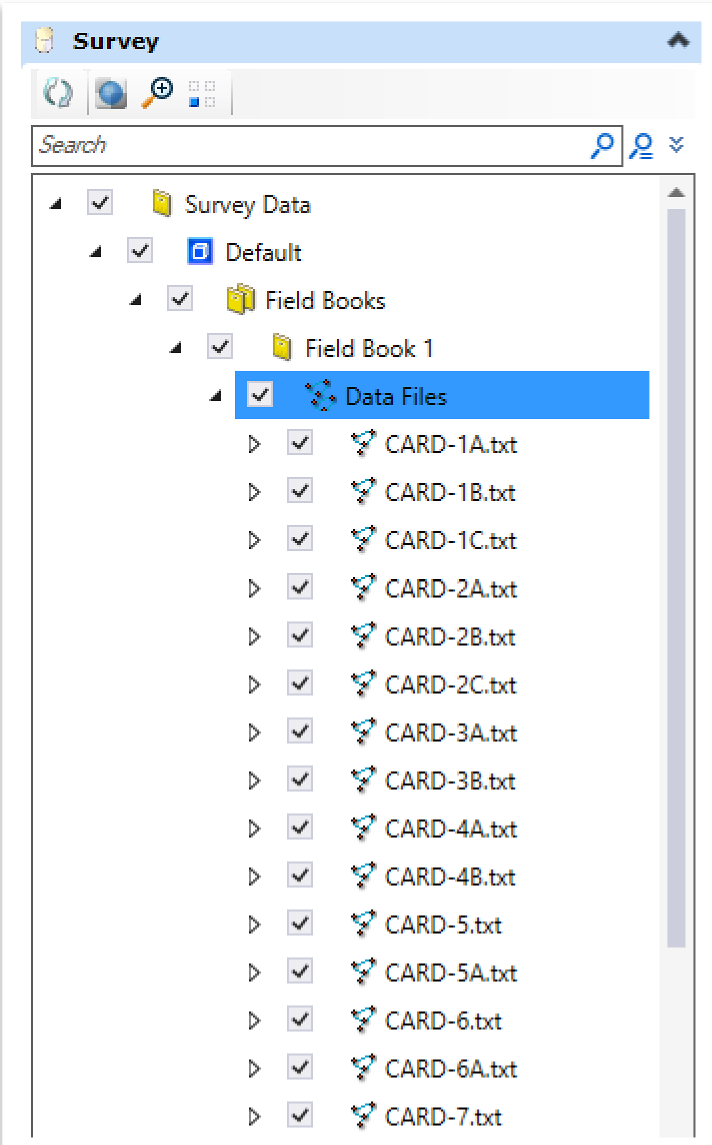
11. Next, zoom into the southeast area of the survey (highlighted below) and notice that it appears something was not mapped correctly. We will investigate further in the next exercise. For now, continue to the next step.



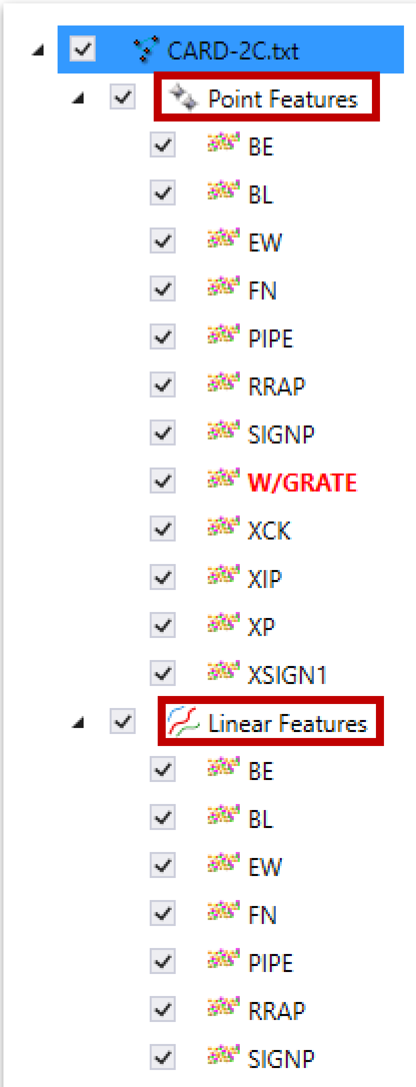
12. Expand the **Survey** tab within the **Explorer** once again and under **Field Books**, you should now see a **Field Book 1** folder which contains all the data that was just imported in. This includes **Data Files**, **ALL Point Features** and **ALL Linear Features**. Each category can then be expanded.



13. Expand **Data Files** to see the imported data files. A portion of the text files are shown below, but all the files should have been imported. **Note:** The software doesn't always show the files in alphebetical order, but they should all be there.



14. Now, expand the **CARD-2C** text file. Then expand **Point Features** and **Linear Features**, as shown below. **Note: Control Points**, **Setups** and **Observations** do not have any data. This is because raw data files from the survey data collection software were not used as the source of the data import.



Take Note!

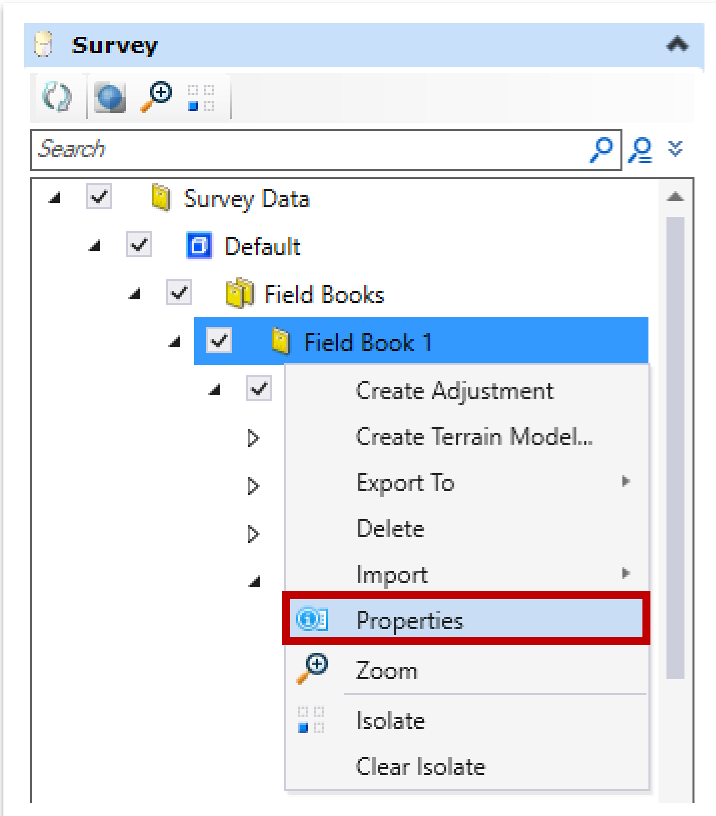
Every survey code listed in the ***CARD-2A.txt*** *file is listed as either a Point or Linear Feature.*

The codes will show in ***black*** *text if everything imported correctly and the software mapped it in the drawing.*

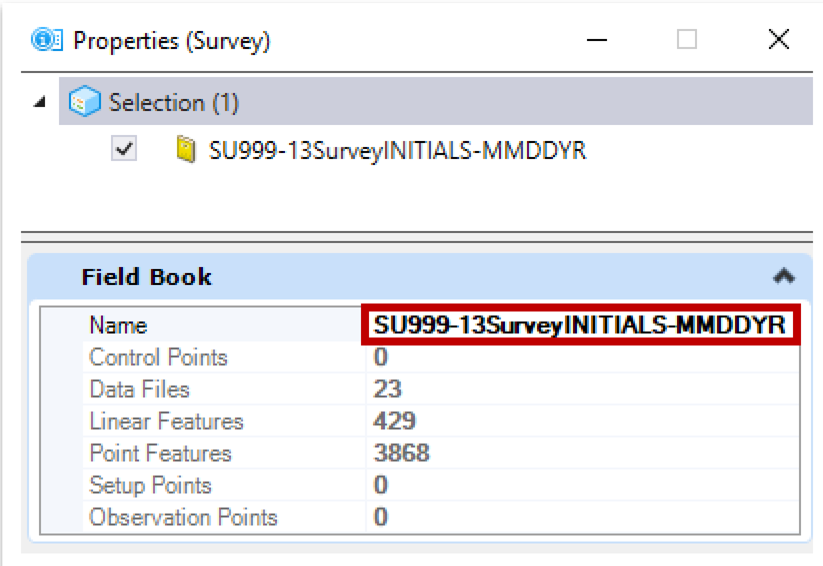
The codes will show in ***red*** *text if the survey code data was imported into the field book, but it was not mapped in the drawing.*

We will address the ***red*** *text problem in a different exercise.*

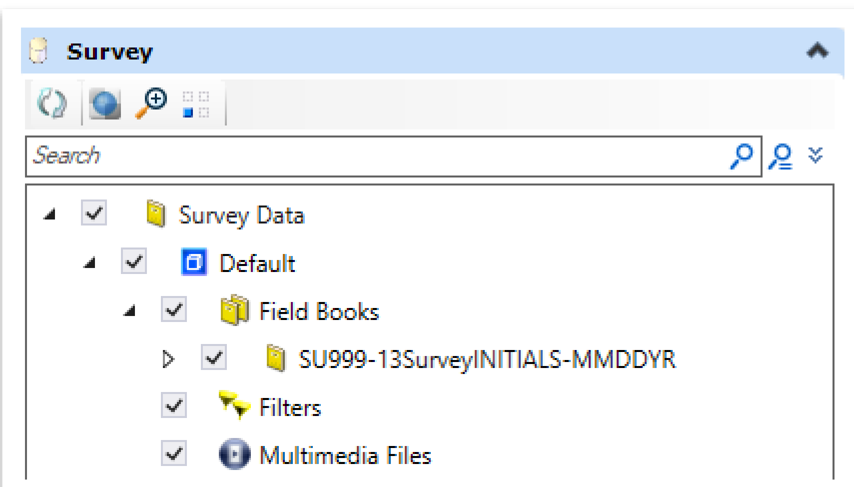
15. Next, select **Field Book 1** and let's examine the **Properties**. If you do not already have **Properties** docked, you can right click on **Field Book 1** and select **Properties**.



16. Left click in the **Name** field and rename the Field Book to **SU999-13Survey INITIALS-MMDDYR**, using your initials and the current date**. Note:** This is the only way to rename the Field Book at this time.



17. Notice that the name has now been updated in the **Explorer** as well.



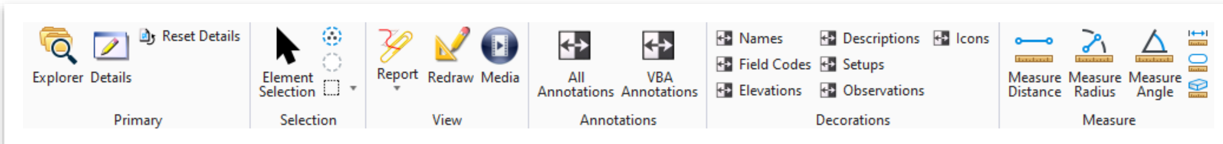
Take Note!

*Now, we will go back to the lecture and discuss the **Analyze** tools before getting into the next exercise.*

3.4 Lecture: Analyze Tools

The **Analyze** tab houses all tools needed for reviewing the data sets after being imported into a field book (Figure 25).

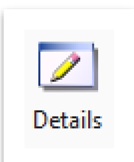
FIGURE 25. ANALYZE TAB



3.4.1 Primary Tools

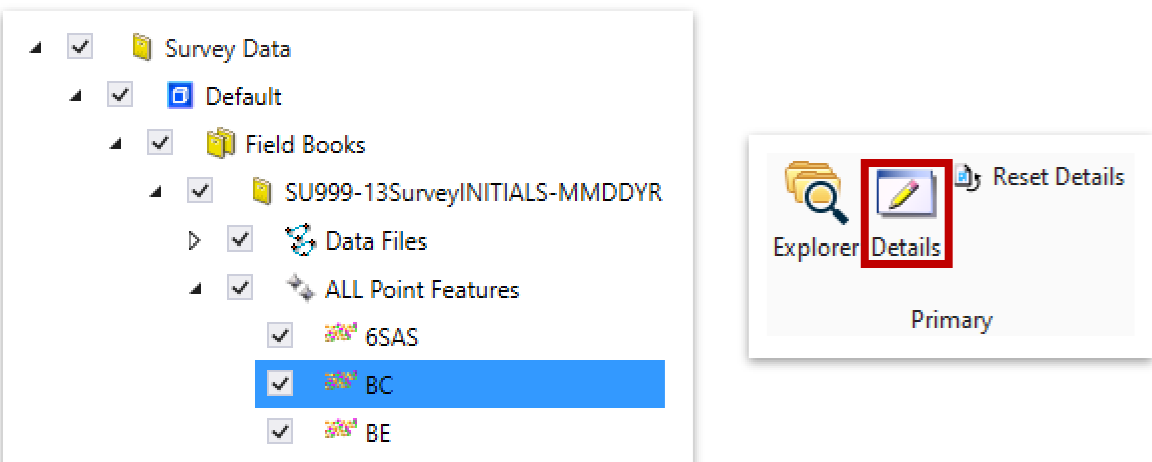
The **Primary** tools include basic tools such as the **Explorer**, **Details** and **Reset Details**. The Explorer was introduced in the Fundamentals (ORD) Manual. The Details tool is one of the most important within the **Survey** workflow and will be explained further below.

Details Tool



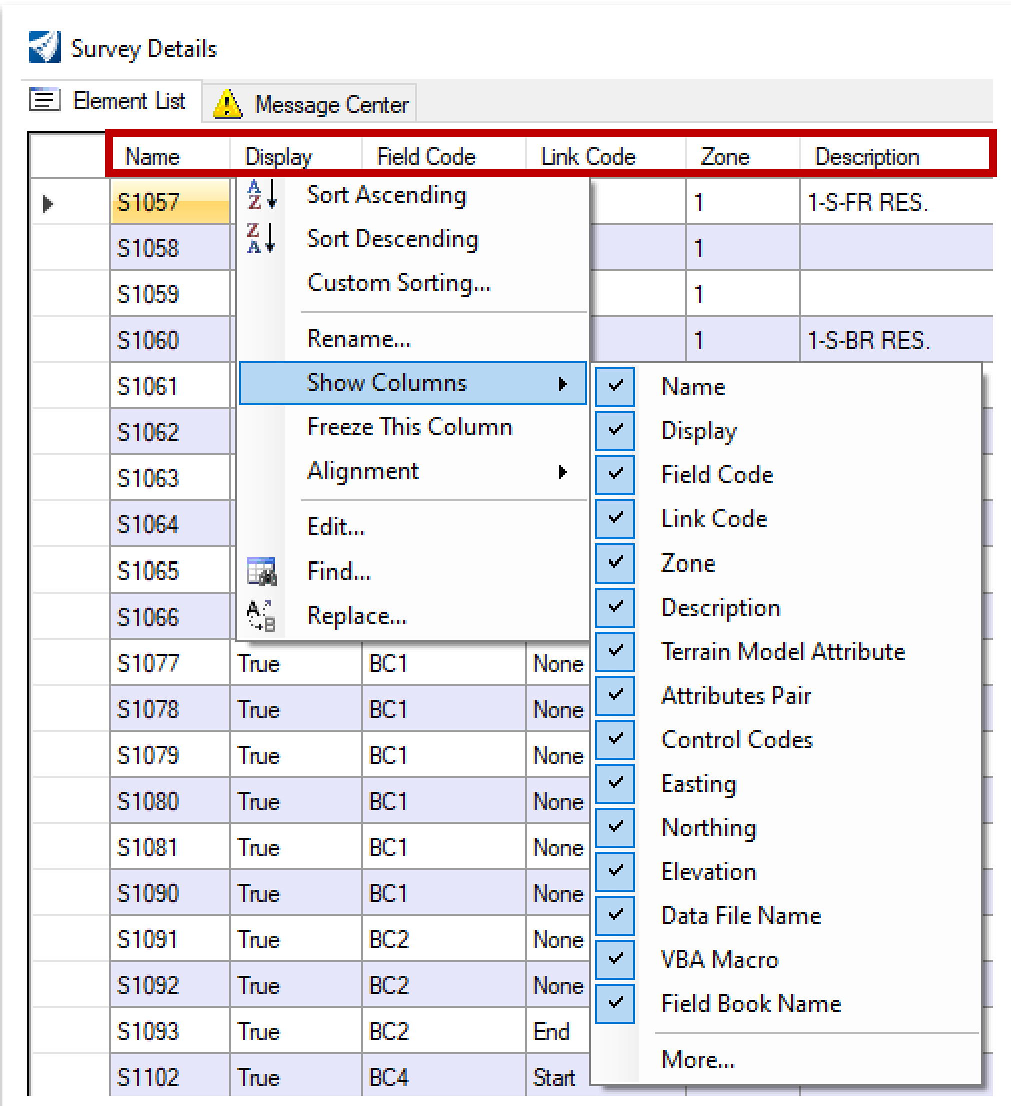
This tool allows the user to view survey feature codes with all the details of the documented field data, such as point numbers, feature code, link codes, descriptions and more. The Details tool may also be used to update or fix any errors, such as correcting the linking code or the feature code. Survey codes that are both a spot and a breakline will show up in the point and linear feature lists. To see the applicable points tied a specific feature code, you would select the code in the **Field Book** (e.g. **BC**) and then open the **Details** tool (Figure 26).

FIGURE 26. FIELD BOOK: SELECTING A SURVEY FEATURE + DETAILS TOOL



The **Survey Details** window has multiple columns and rows, mimicking a spreadsheet. The software will list all the points with the **BC** survey code, which Bentley refers to as **Field Code**. To un-display a column, right click anywhere within the column headers and select **Show Columns >> Uncheck the desired column** (Figure 27).

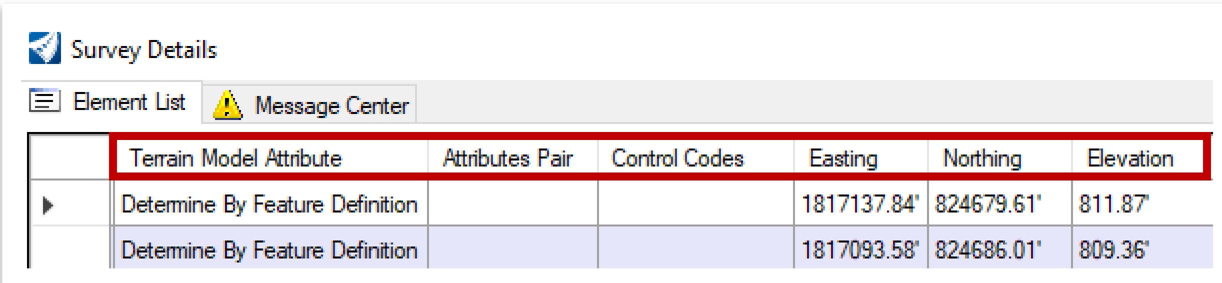
FIGURE 27. SURVEY DETAILS WINDOW: NAME – DESCRIPTION



- **Name**: The point assigned during the field data collection (e.g. S1057).
- **Display**: A setting that tells the software to display the point in the DGN file.
- **Field Code**: The survey code assigned during the field data collection (e.g. BC).
- **Link Code**: The linking code assigned during the field data collection to note the start and end of a line.
- **Description**: The descriptor assigned to the code during the field data collection (e.g. 1-S-FR RES.)

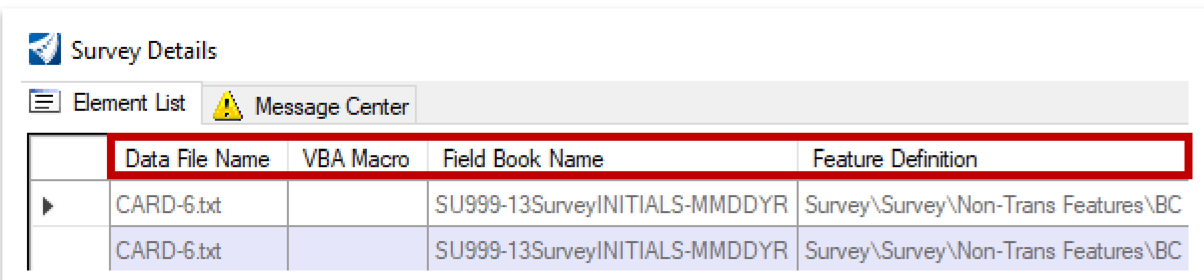
The remainder of the columns within the **Survey Details** window are shown below (Figure 28 - Figure 30).

FIGURE 28. SURVEY DETAILS WINDOW: TERRAIN MODEL ATTRIBUTE – ELEVATION



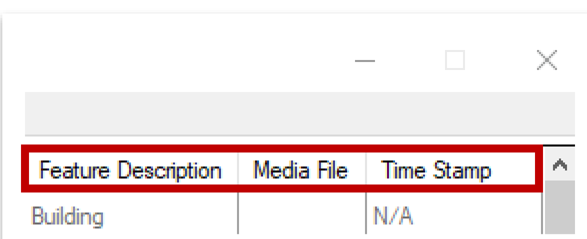
- **Terrain Model Attribute**: Setting that determines whether the point is to be included in the terrain model, which is mostly dependent on the feature definition.
- **Easting, Northing and Elevation**: Coordinates and elevation associated with the survey feature.

FIGURE 29. SURVEY DETAILS WINDOW: DATA FILE NAME – FEATURE DEFINITION



- **Data File Name**: The text file name from which the survey feature was imported.
- **Field Book Name**: The field book name in which the survey feature was imported.
- **Feature Definition**: The feature definition associated with the survey feature.

FIGURE 30. SURVEY DETAILS WINDOW: FEATURE DESCRIPTION – TIME STAMP

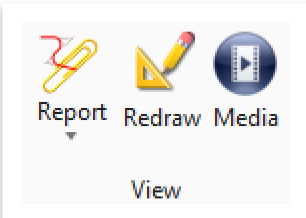


- **Feature Description**: The description associated with the feature definition name.
- **Media File**: The media file name associated with the survey feature (if applicable).
- **Time Stamp**: Associated with the raw data file. For TDOT, this column will be N/A because raw files from the data collector are not being used during the import.

3.4.2 View Tools

Once survey data has been imported, the user can utilize the **View** tools to analyze and correct errors or issues with the imported data (Figure 31). These tools allow the user to redraw survey geometry, view reports and view media files associated with the field books

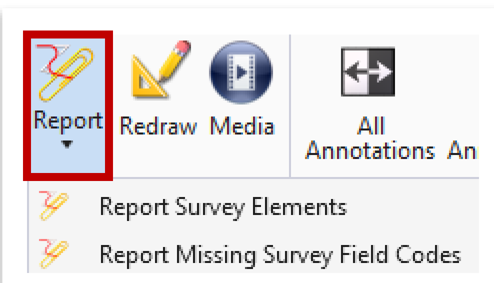
FIGURE 31. VIEW TOOLS



3.4.2.1 Report Tools

There are two options within the survey reporting tool: **Report Survey Elements** and **Report Missing Survey Field Codes** (Figure 32). We will utilize the latter report in the next exercise.

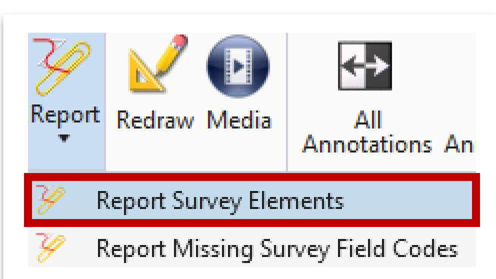
FIGURE 32. SURVEY REPORT OPTIONS



- **<u>Report Survey Elements</u>**

  This report option returns a printout of the feature name, description, coordinates (northing/easting), elevation, feature definition, link code, and other attribute information (Figure 33).

  FIGURE 33. REPORT SURVEY ELEMENTS



The report requires the user to select either a survey point or linear element in the dgn file, which will then open the report automatically. An example **survey linear feature report** is shown below for a **RD** element (Figure 34).

FIGURE 34. SURVEY LINEAR FEATURE REPORT

Survey Linear Feature Report

Report Created: Friday, February 26, 2021
Time: 4:39:33 PM

Project: Survey
Units: Imperial

Chain Name	Description	Feature Definition	Display	Zone	Attributes Pair	Data File Name	Field Book	Media File	Length	Time Stamp
RD		RD	True	1		CARD-1B.txt	SU999-13SurveyINITIALS-MMDDYR		1497.964	N/A
Point:	SJP2	**Feature:**	RD	**N**	826318.328	**E**	1816362.027	**Z**	799.846	
	Course from:	SJP2		**to:**	SJP4	S8.918° W				
		Dist: 49.772		**Slope Dist:** 49.773	**Elev Diff:**	-0.173		**Grade:** -0.003		

- **<u>Report Missing Survey Codes</u>**

  This report option returns a printout of all the field codes that were imported but were not drawn (Figure 35). This is a great tool to utilize post-import to find out which field codes need to be corrected in the dataset for proper mapping.

FIGURE 35. SURVEY MISSING FIELD CODES REPORT

Survey Missing Field Codes Report

Report Created: Friday, February 26, 2021
Time: 4:52:27 PM

Project: Survey
Units: Imperial

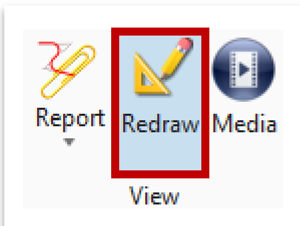
Missing Field Codes
SIGN
UGF
XPC
XPIPE

3.4.2.2 Redraw Tool

The **Redraw** tool forces the software to redraw all survey data (Figure 36). It is unlikely this option will be used as all the graphics are associated with the field book data set.

Take Note! *Deleting graphics from the drawing will also delete the item from the field book.*

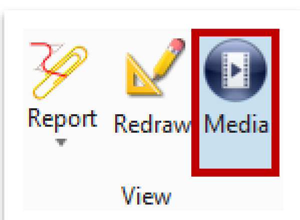
FIGURE 36. REDRAW TOOL



3.4.2.3 Media Tool

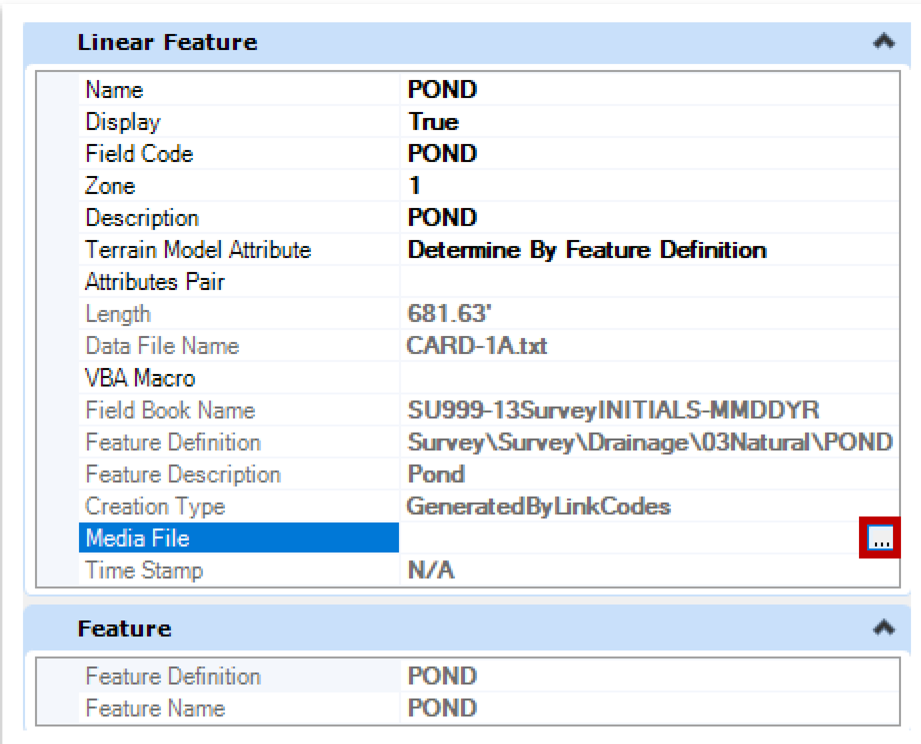
The **Media** tool can be used to locate points or other survey features that have media files attached (Figure 37). If the element does not have a media file attached, the user will receive a **No Media Found** alert.

FIGURE 37. MEDIA TOOL



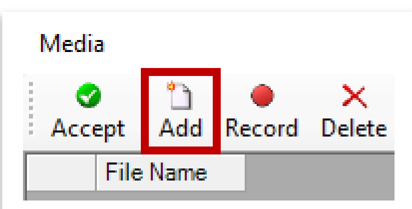
To attach media files to a specific point or linear feature, you would select the applicable element in the dgn file and then open its **Properties**. You can open the properties either via the heads-up display or in the ribbon. Within the properties, you would browse to the media file by clicking on the ellipses next to the **Media File** field (Figure 38).

FIGURE 38. ATTACH MEDIA FILE



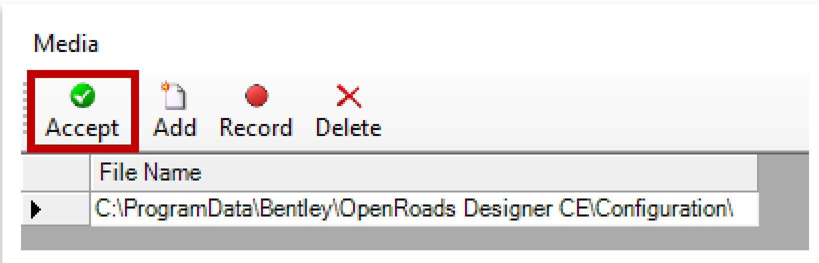
Within the **Media** dialog box, you would select the **Add** button and navigate to the selection of your file (Figure 39).

FIGURE 39. MEDIA DIALOG BOX: ADD



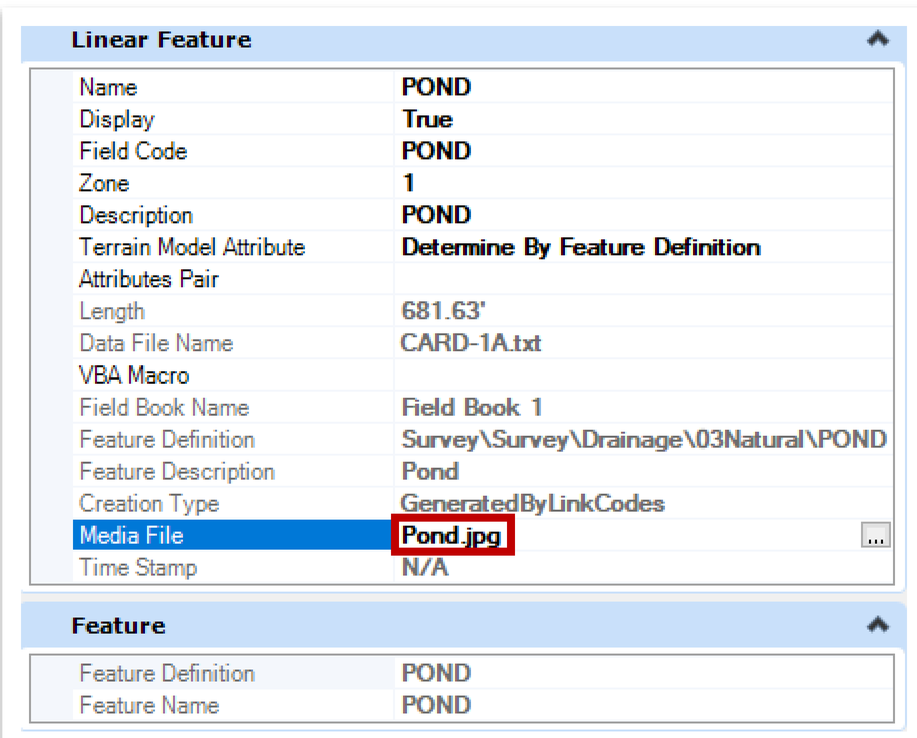
By default, the software will open to the **Survey_Training** workset dgn subfolder but you can browse to the applicable location to select the file. Once you select the media file, it will add it to the list indicating the File Name path location. Clicking **Accept** will complete the attachment (Figure 40).

FIGURE 40. MEDIA DIALOG BOX: ACCEPT



The media file is then attached, as shown in the field below (Figure 41).

FIGURE 41. MEDIA FILE FIELD



3.4.3 Annotation Tools

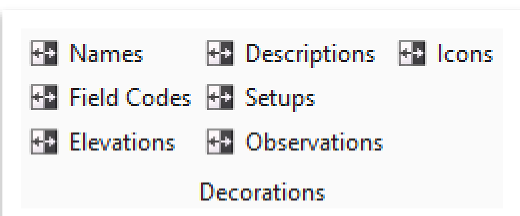
The software allows the user to toggle on and off permanent annotations through the **Annotation** tools (Figure 42). The TDOT ORD workspace has been set up to automatically annotate certain features with standard labels. A user can choose to display the annotation as needed. This tool **does not** delete the permanent labels. No VBA annotations have been setup in the TDOT ORD workspace.

FIGURE 42. ANNOTATIONS TOOLS

3.4.4 Decorators

Decorators are temporary visualized labels for survey features (Figure 43). These are not permanent labels and can be customized under User Preferences. The labels that are available as decorators include **Names** of points and features, **Field Codes**, **Elevations** and **Observations** to name a few. These labels are a nice alternative to permanent labels as it allows the surveyor to review the data without crowding the file with too many permanent labels.

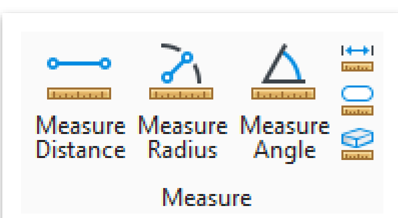
FIGURE 43. DECORATIONS OPTIONS



3.4.5 Measure Tools

The **Measure** tools are used to measure distances, radii, angles, length of line, areas and volumes (Figure 44). Please refer to the Fundamentals (ORD) Manual for details.

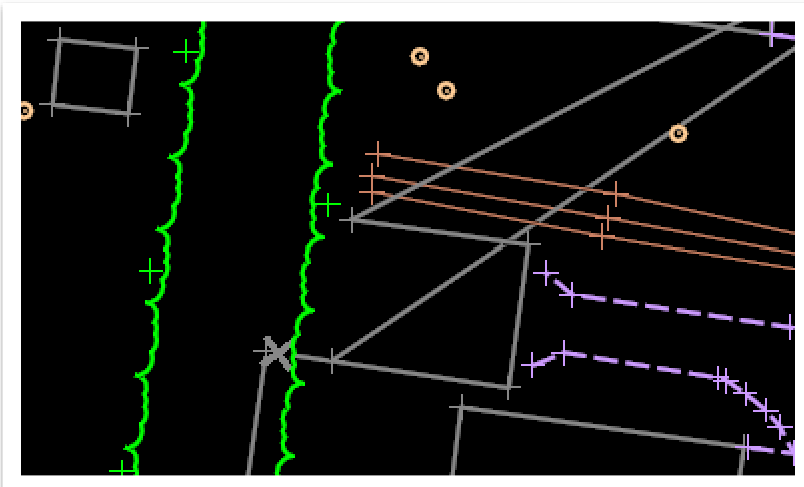
FIGURE 44. MEASURE TOOLS



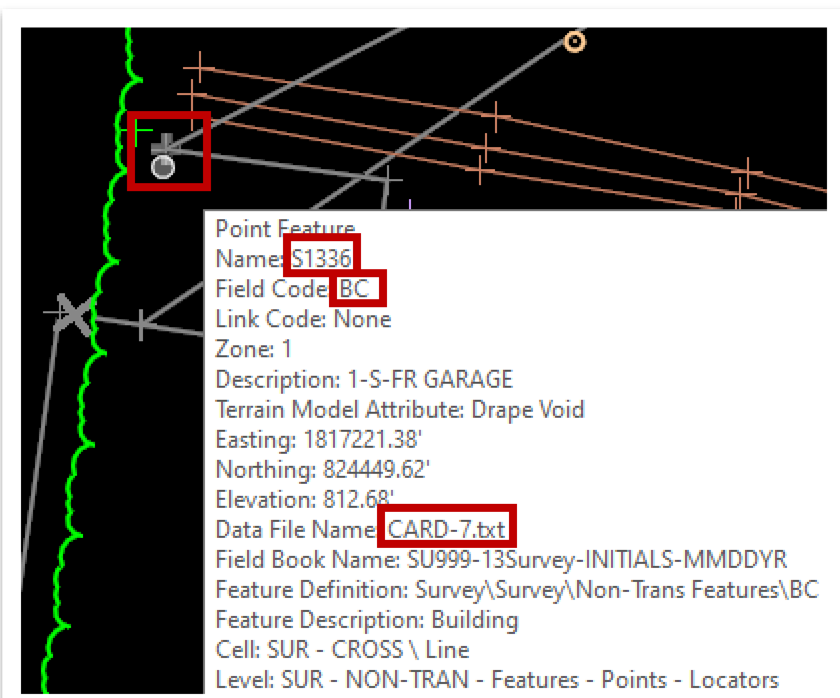
3.4.6 Exercise: Analyze Field Book Data

In this exercise, we will analyze the field book data that we previously imported and fix several issues utilizing the Details tool. This also includes addressing two of the missing field codes. We will continue to utilize the same **Survey Model.dgn** file.

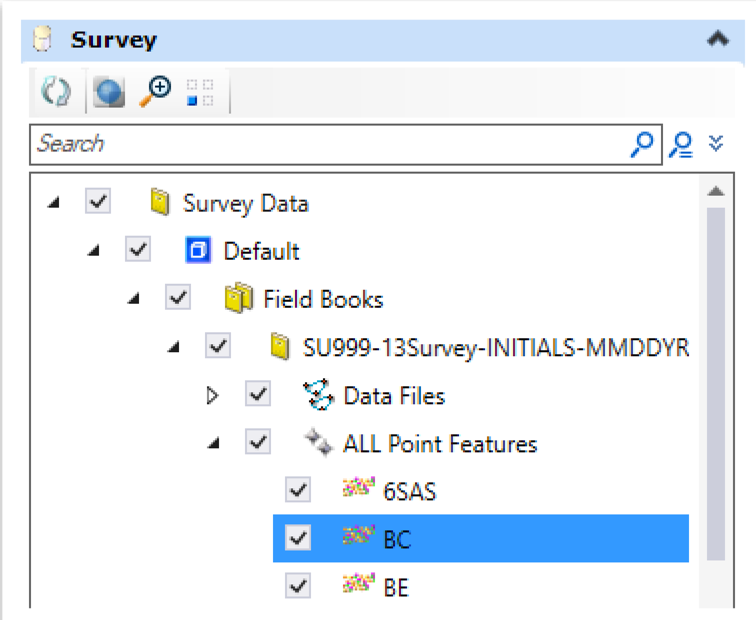
1. Zoom back into the southeast area that we previously highlighted in Exercise 3.3.1, Step 11 showing the error.



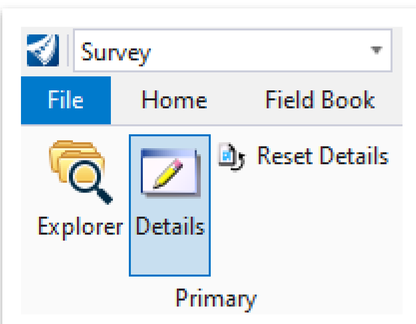
2. Left click the gray locator (highlighted below) and notice from the information reported, this is a **BC** point code (**S1336**) that came from the **CARD-7.txt** file. The geometry was generated by link codes, so most likely the starting link code for the shape was not present in the text file.



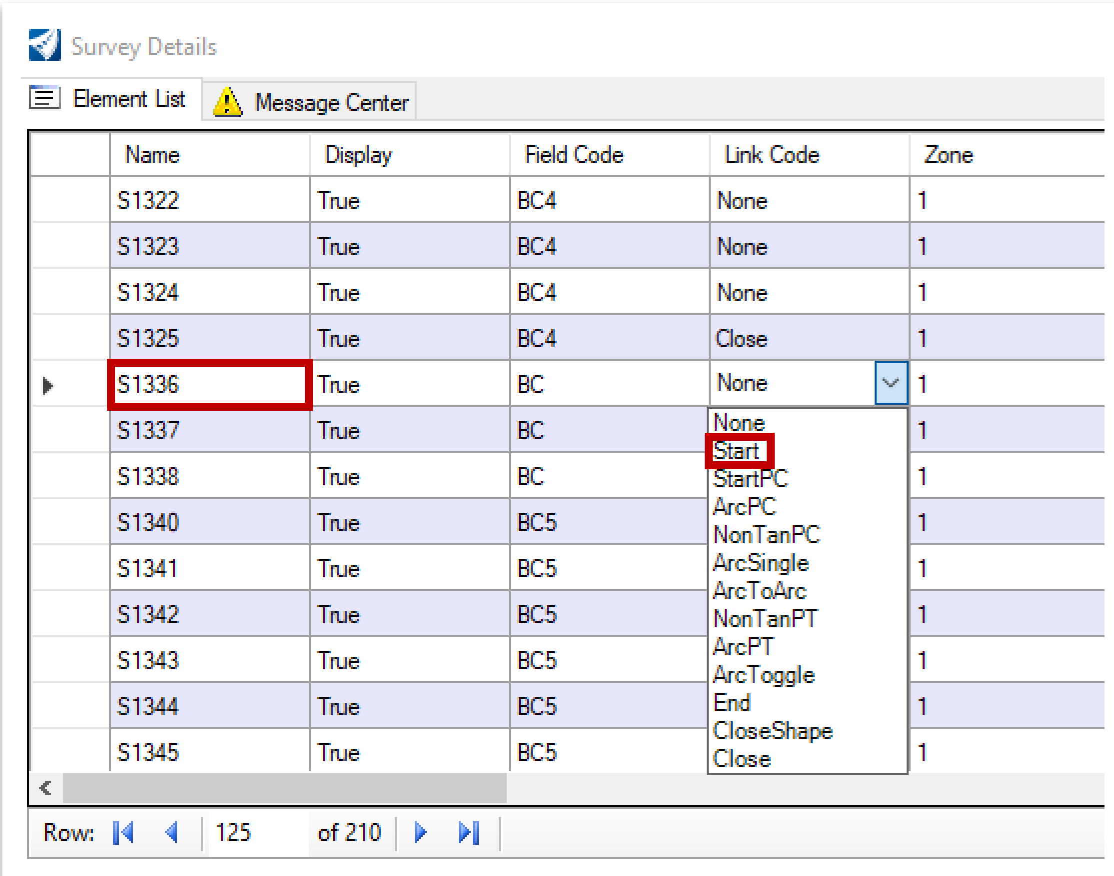
3. Within the **Explorer**, we will now fix this error. Expand **All Point Features** under your field book and select the **BC** code.



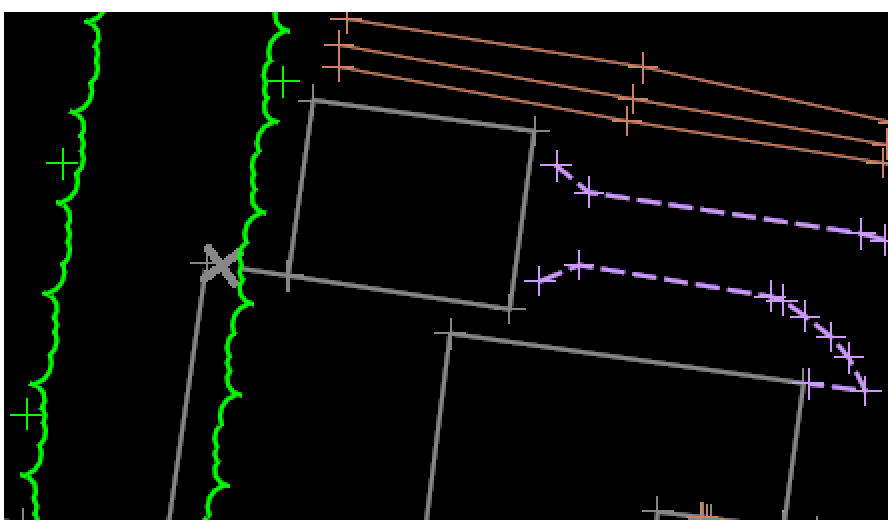
4. Next, open the **Details** tool (**Survey >> Analyze >> Primary**).



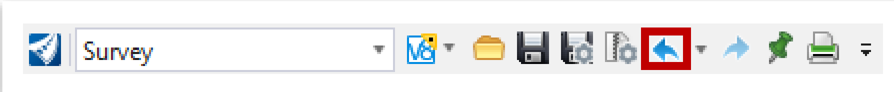
5. Within the **Survey Details** window, scroll down to point **S1336**. Under the **Link Code** column, notice that it is set to **None**. Change the option to **Start** and then close the window.



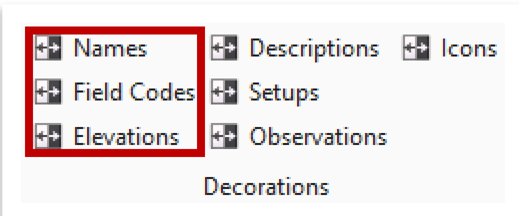
6. Notice that the drawing resolved itself, as shown below.



7. **Alternatively**, you can also make the same edit graphically. Let's click **Undo** <u>one time</u> (or CTRL+Z on your keyboard) to undo the last command.



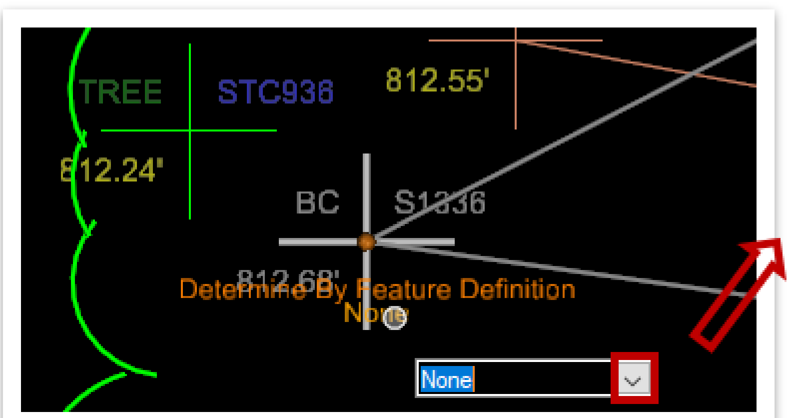
8. Then, turn on the **Names**, **Field Codes** and **Elevations Decorations** (**Survey >> Analyze >> Decorations**). It might appear nothing happened but if you zoom in, you will notice that the decorations appear.

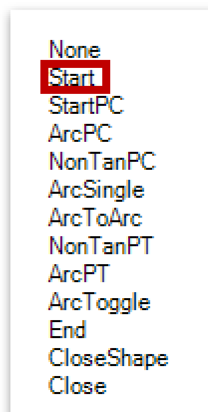


Take Note!

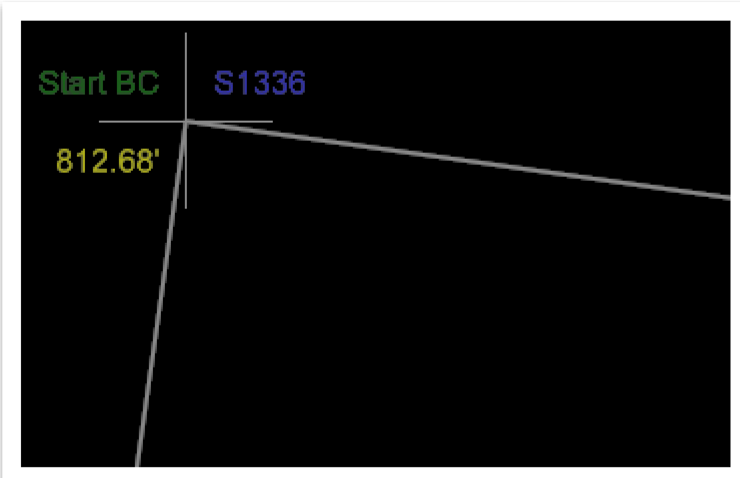
Decorations are not permanent text. They are simply tools to help the surveyor analyze the data mapped in the drawing. Permanent annotation will be explained in the Plan Development Chapter.

9. Zoom in and select **BC** point **S1336**. Left click on the **orange** text "**None**" (**linking code**) and change to **Start**.

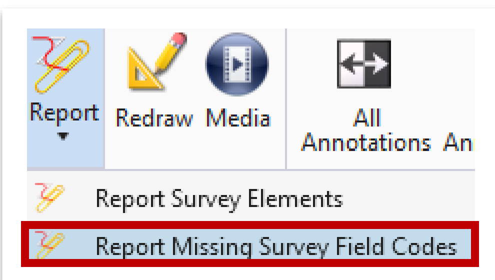




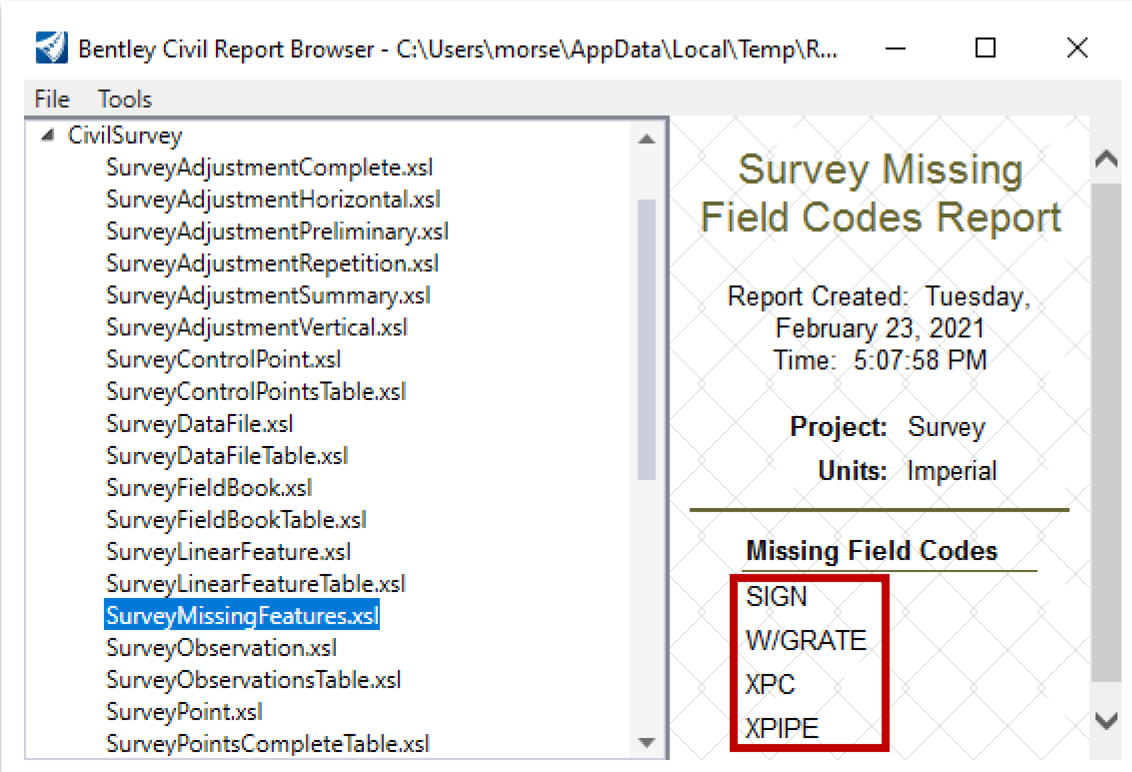
10. Notice that the drawing resolved itself once again, as shown below. While the previous link code editing options were applied to a singular survey point, you can also make mass changes to imported survey data with the **Details** tool. We will go through that process in the next exercise.



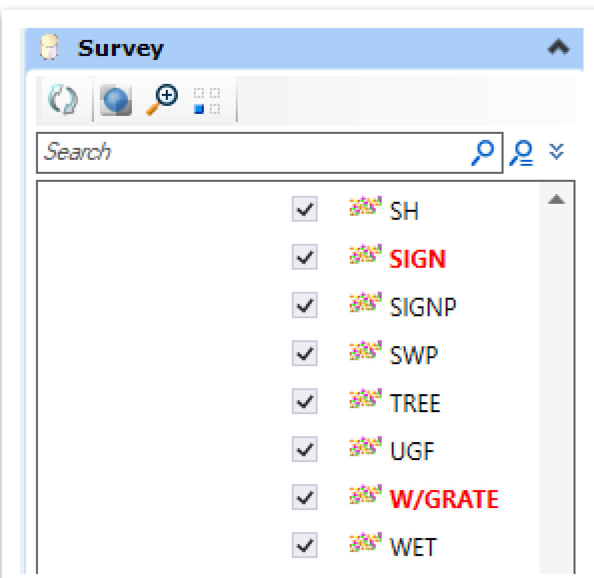
11. For now, let's continue and check for missing codes. Open the **Report Missing Survey Field Codes** report (**Survey >> Analyze >> View >> Report**).

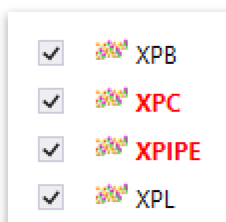


12. The following report should appear. The report shows that the Field Codes **SIGN**, **W/GRATE**, **XPC** and **XPIPE** are missing.

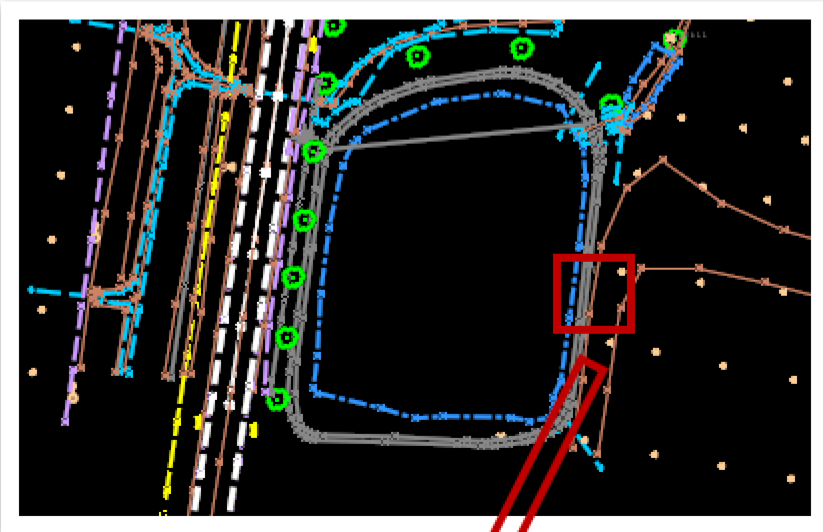


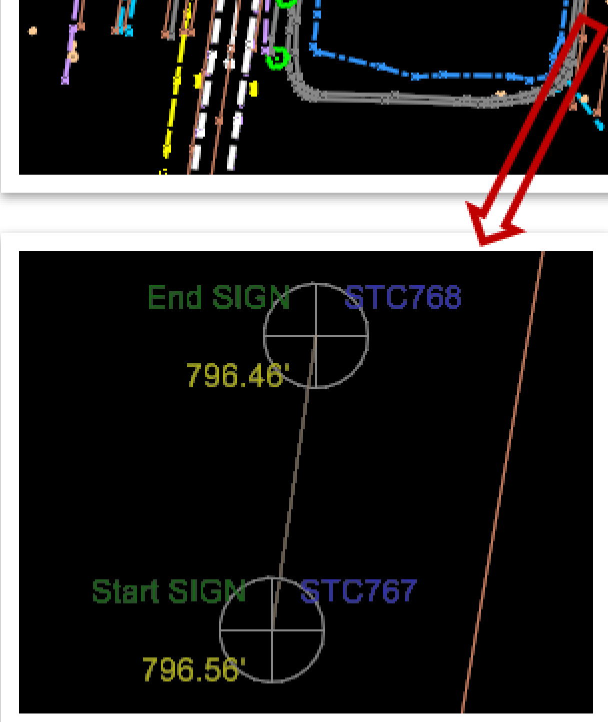
13. Within the **Explorer**, expand **All Point Features** under your field book and notice that the four field codes listed appear in **red**. The coordinates were imported, but the software did not know how to map it.



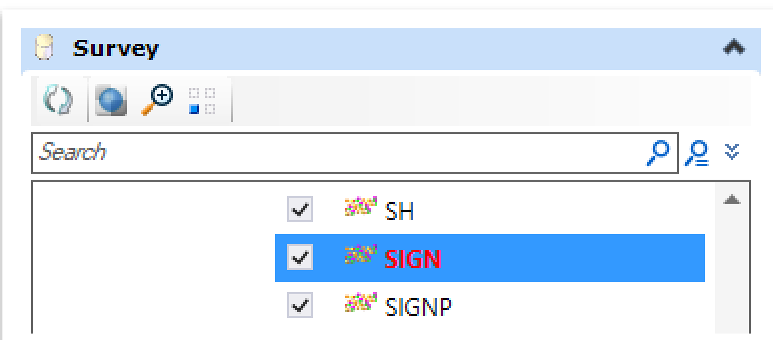


14. First, let's fix the **SIGN** code. Zoom in to the area highlighted below on the right side of the pond.

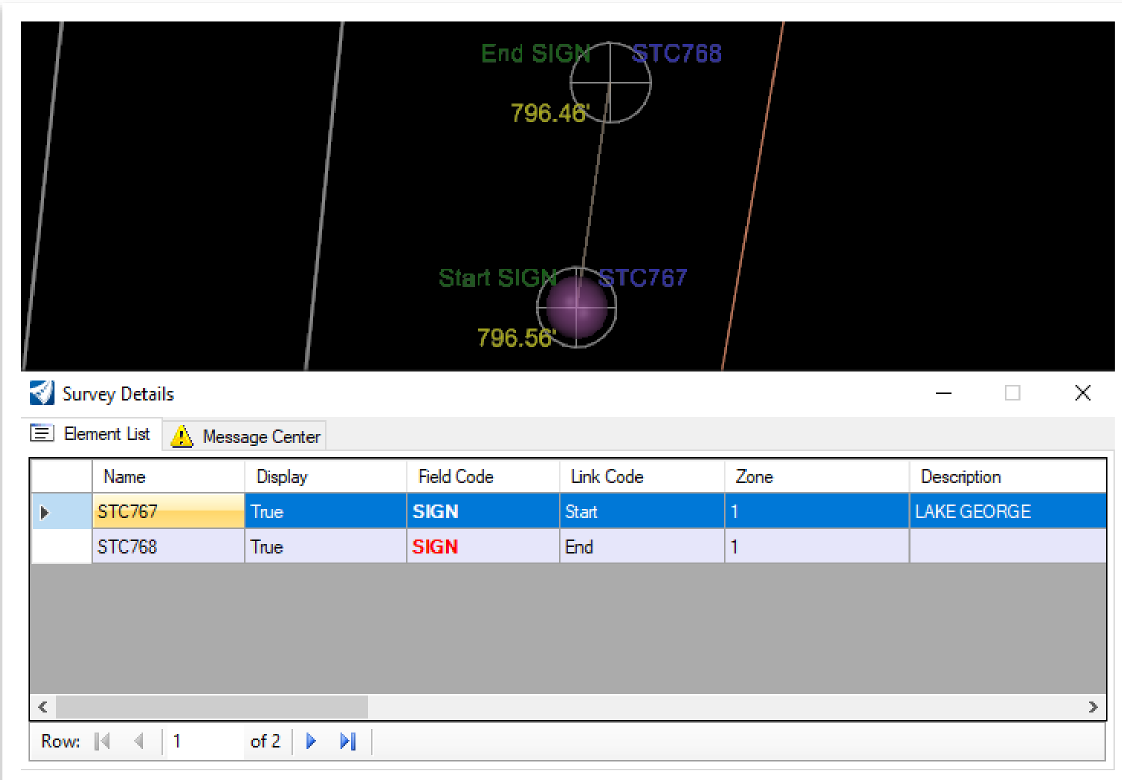




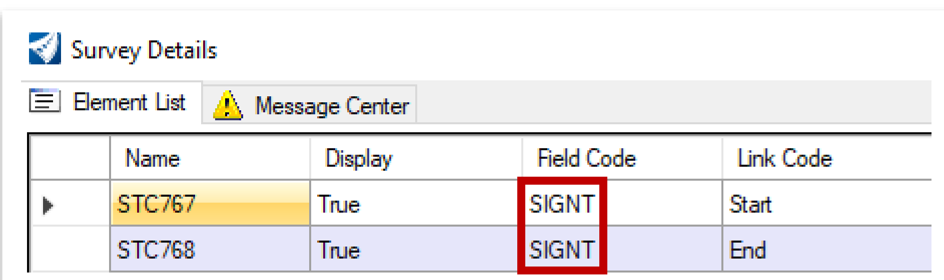
15. Within the **Explorer**, scroll down and click on the **SIGN** field code under **ALL Point Features**.



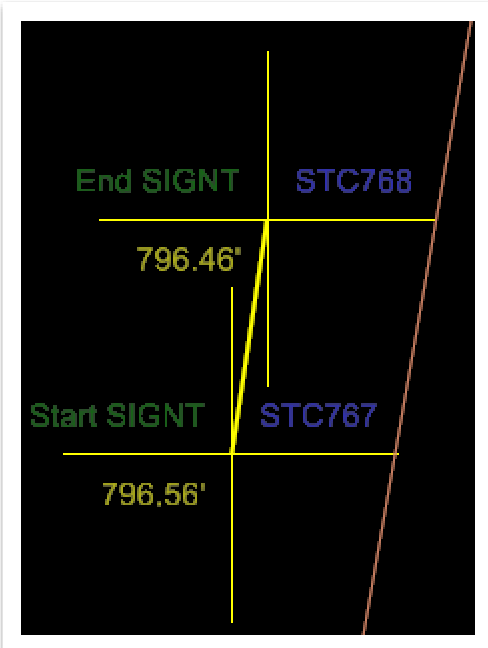
16. With the **SIGN** field code selected, open the **Details** tool (**Survey >> Analyze >> Primary**). When you click on the first line item (**STC767**), you will see a dark shadow highlighting the point.



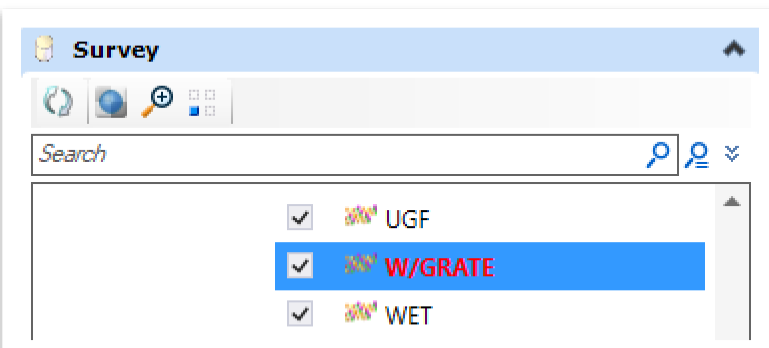
17. It appears that the wrong **Field Code** was entered before the import. The correct code was supposed to be **SIGNT**. To fix the error, click within the **Field Code** field for both points (**STC767** and **STC768**) and key-in the correct code. **Note:** The points will disappear from the **Survey Details** window after you have updated the code. To view, click the **SIGNT** feature code within the **Explorer**, as shown below.



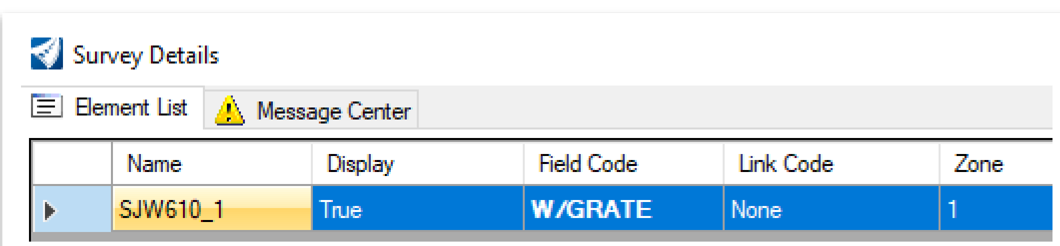
18. Notice that the two points have resolved themselves after the **field code** update.



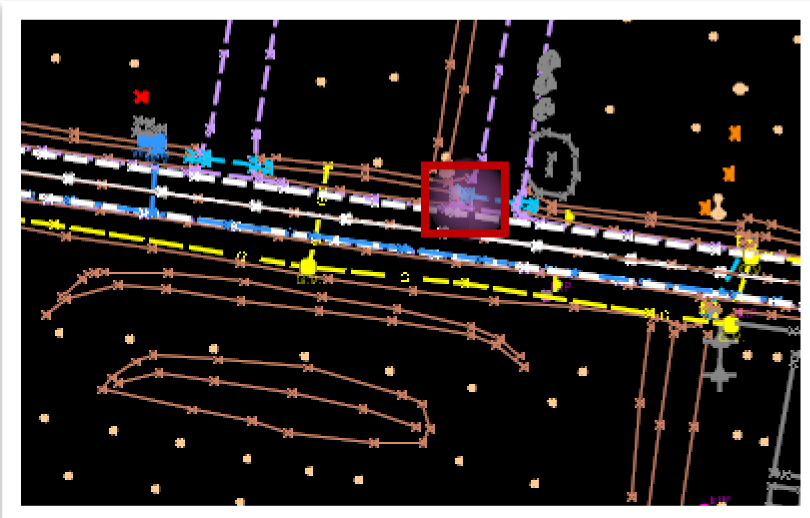
19. Next, let's fix the **W/GRATE** code. It appears that the **=** sign between the **Field Code** and the **Description** is missing. Within the **Explorer**, scroll down and click on the **W/GRATE** field code under **ALL Point Features**.



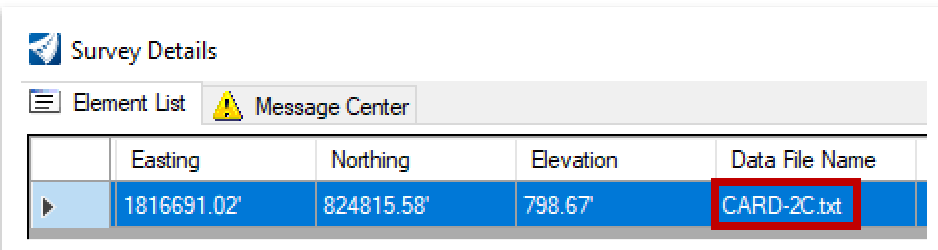
20. Within the **Survey Details** window, notice that point **SJW610_1** now shows. **Note:** If no point shows, close the window, click on a different feature code under **ALL Point Features** and then click on **W/GRATE** again and re-open the **Details** tool.



21. Once again, notice the dark shadow representing the point. Zoom in to **SJW610_1**, as highlighted below.

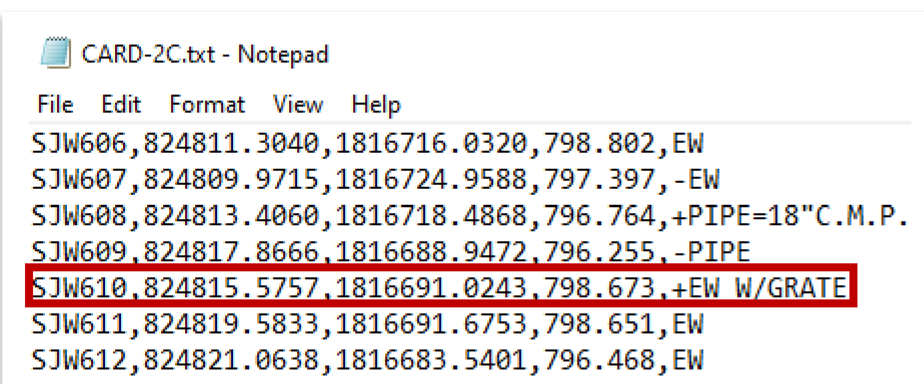


22. Within the **Survey Details** window, scroll over to the **Data File Name** column and notice that the erroneous field code is tied to the **CARD-2C.txt** file.



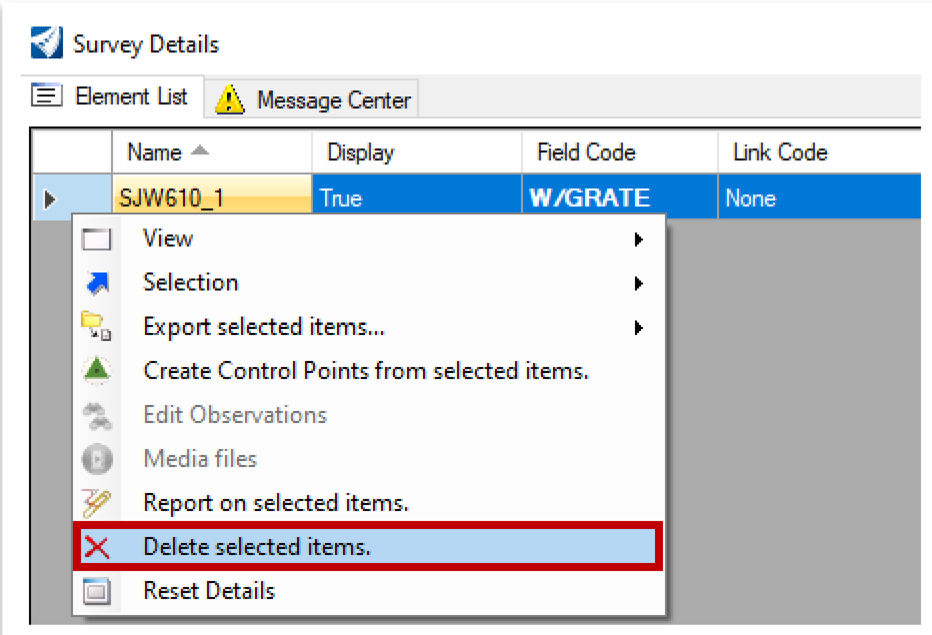
	Easting	Northing	Elevation	Data File Name
▶	1816691.02'	824815.58'	798.67'	CARD-2C.txt

23. Next, open **File Explorer** and navigate to the workset directory: **C:\Program Data\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\Survey_Training\dgn**. Open the **CARD-2C.txt** file in Notepad. Scroll down to **SJW610** and notice that there is an **=** sign missing between the **Field Code** (**+EW**) and the **Description** (**W/GRATE**).

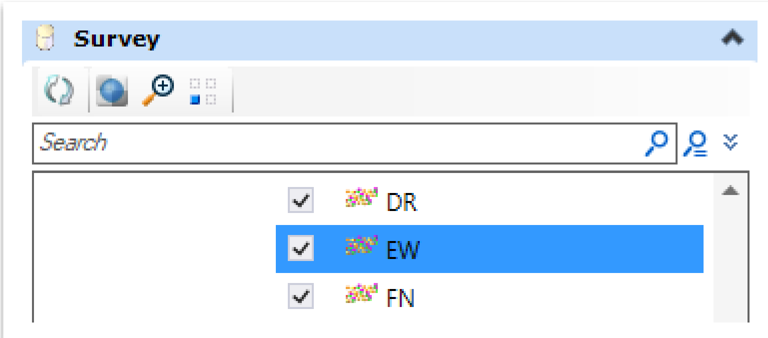



```
SJW606,824811.3040,1816716.0320,798.802,EW
SJW607,824809.9715,1816724.9588,797.397,-EW
SJW608,824813.4060,1816718.4868,796.764,+PIPE=18"C.M.P.
SJW609,824817.8666,1816688.9472,796.255,-PIPE
SJW610,824815.5757,1816691.0243,798.673,+EW W/GRATE
SJW611,824819.5833,1816691.6753,798.651,EW
SJW612,824821.0638,1816683.5401,796.468,EW
```

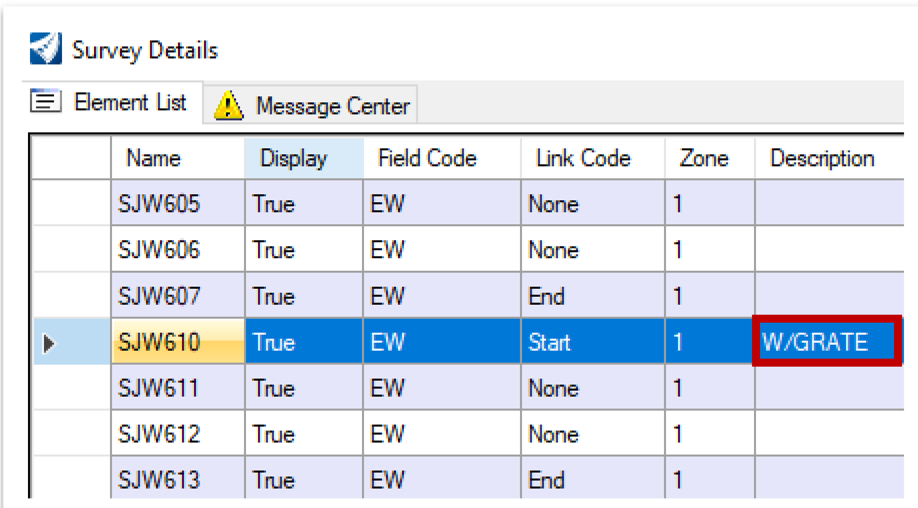
24. Point **SJW610_1** was logged as a duplicate point in ORD upon import due to the missing **=** sign, hence the **_1**. The software assumed that it was to import the point under both the **EW** feature code and the non-existent **W/GRATE** feature code. Adding the **=** sign in the **CARD-2c.txt** file would fix everything, but would require the text file to be reimported into ORD. Instead, we will delete the duplicate point (**SJW610_1**) and add the correct **description** to point **SJW610**. Go ahead and right click in the first blank column and select **Delete selected items**.



25. Next, select **EW** within the **Explorer** under **ALL Point Features**.



26. Scroll down to point **SJW610** and left click within the **Description** field and key-in **W/GRATE** to complete the update.



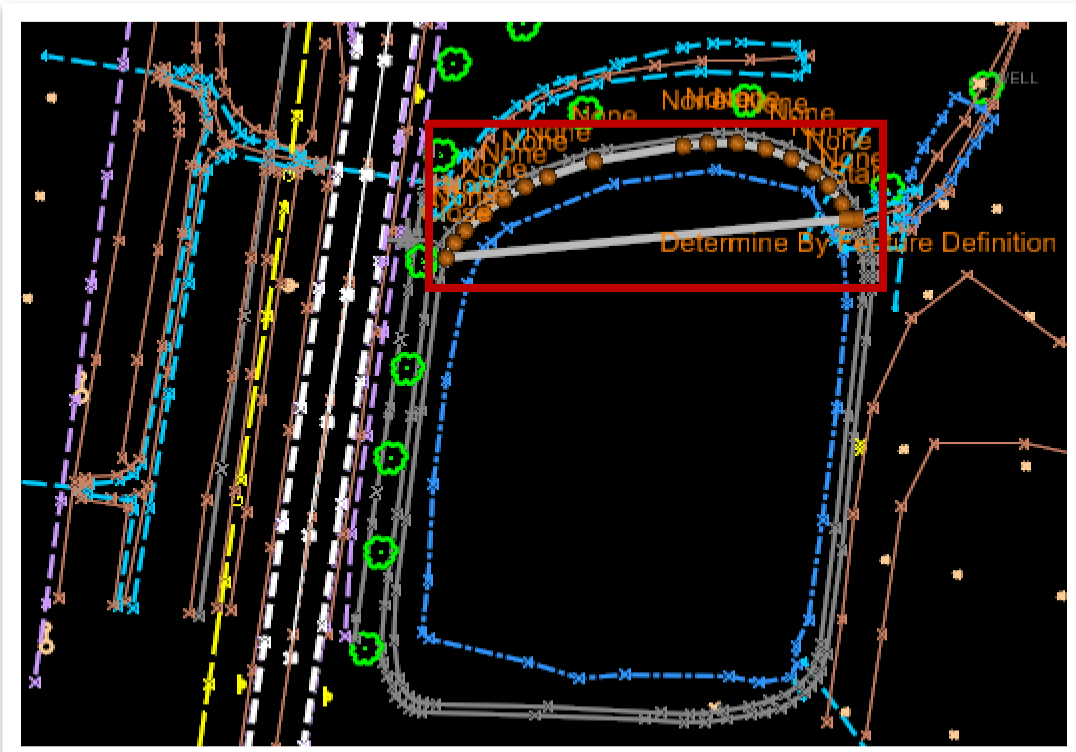
Name	Display	Field Code	Link Code	Zone	Description
SJW605	True	EW	None	1	
SJW606	True	EW	None	1	
SJW607	True	EW	End	1	
SJW610	True	EW	Start	1	W/GRATE
SJW611	True	EW	None	1	
SJW612	True	EW	None	1	
SJW613	True	EW	End	1	

27. The other two missing codes (**XPC** and **XPIPE**) would need to be assessed and addressed accordingly in the **Survey Details** window.

3.4.7 Exercise: Mass Feature Updates

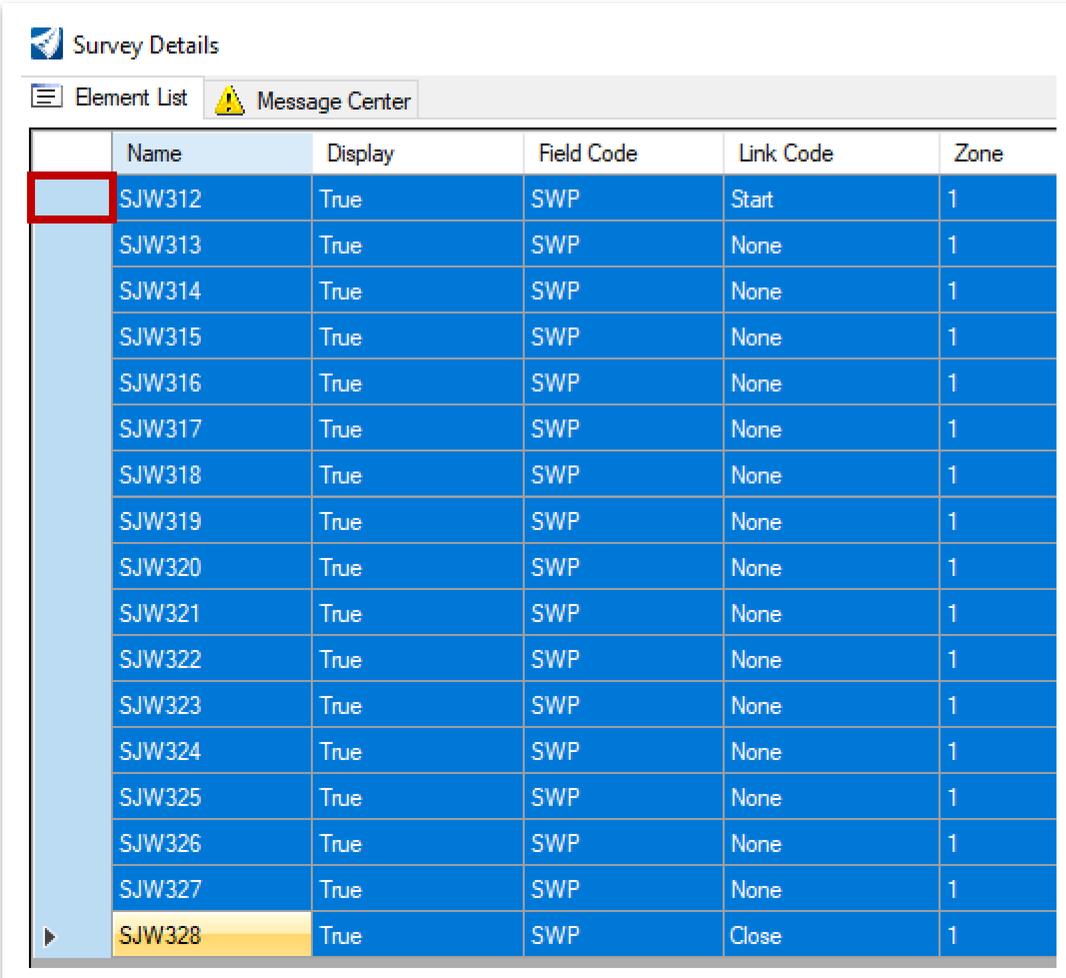
In this exercise, we will apply several mass updates to point features within the Survey Details window after selecting the applicable features in various ways. We will continue to utilize the same **Survey Model.dgn** file.

1. Once the imported data has been reviewed and updated (if necessary), the terrain model can then be created. However, upon further review, it was noticed that the Field Code **SWP** should not be included as a feature to create the terrain model. Zoom in and select the **SWP** feature, as highlighted below, to start the editing process. Go ahead and turn off the decorations.



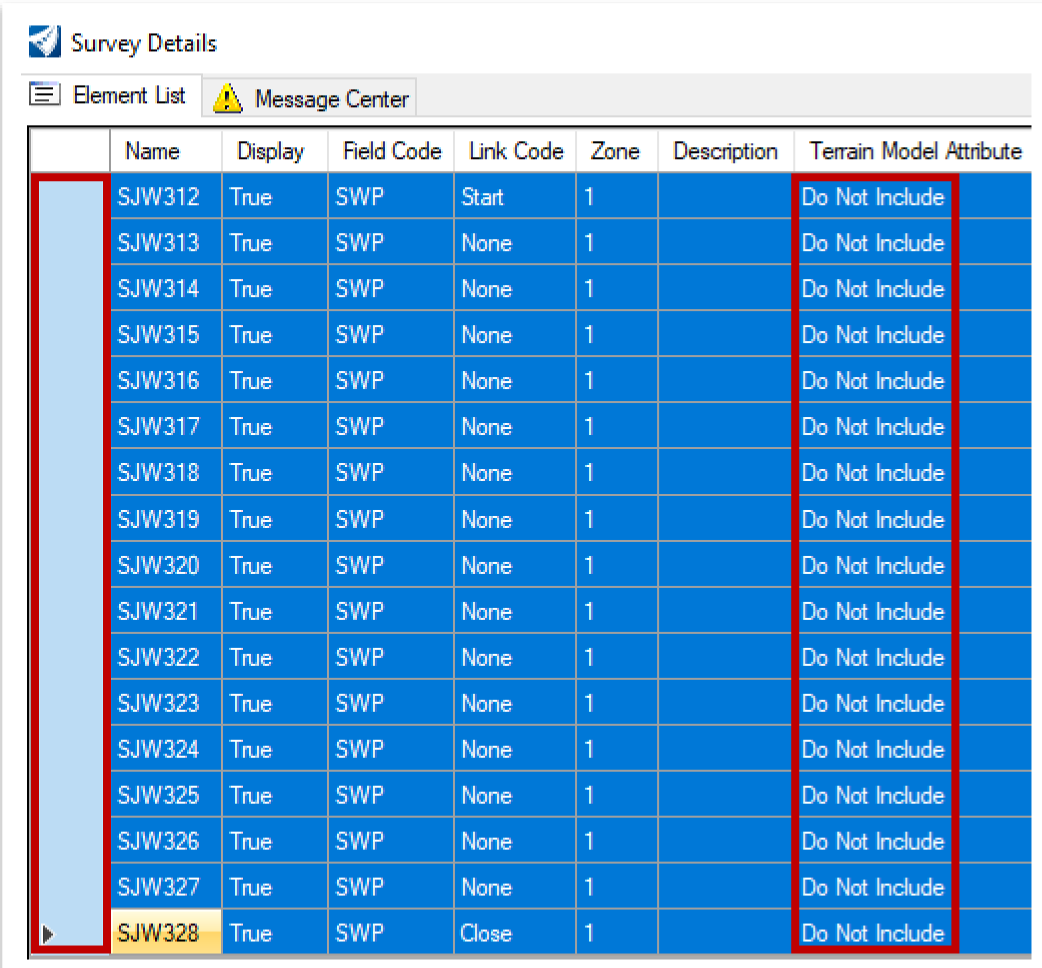
2. While selected, click the **Edit Point Features** tool within the heads-up display. **Note:** You could also open the **Details** tool (**Survey >> Field Book >> Primary**).

3. Select **all** rows (**SJW312** – **SJW328**). **Note:** Select the first row, hold down shift, and select the last row. You must click in the first column to the left of the **Name** field (highlighted in red) to select an entire row. You could also click the upper left corner above the red square to **select all**.



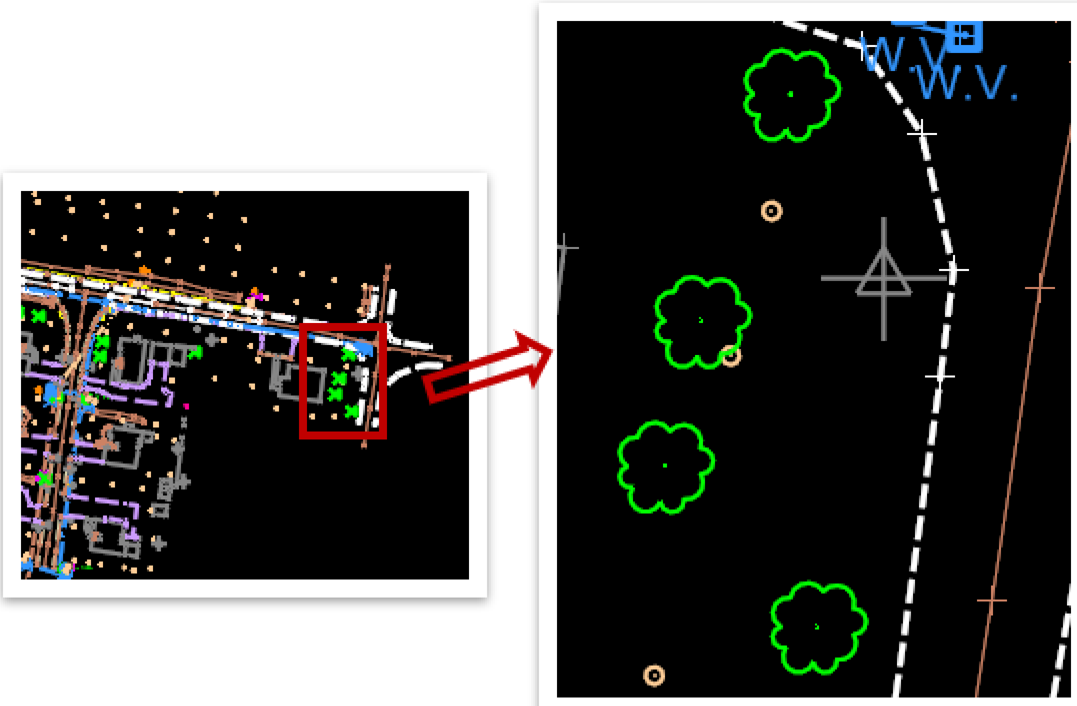
Name	Display	Field Code	Link Code	Zone
SJW312	True	SWP	Start	1
SJW313	True	SWP	None	1
SJW314	True	SWP	None	1
SJW315	True	SWP	None	1
SJW316	True	SWP	None	1
SJW317	True	SWP	None	1
SJW318	True	SWP	None	1
SJW319	True	SWP	None	1
SJW320	True	SWP	None	1
SJW321	True	SWP	None	1
SJW322	True	SWP	None	1
SJW323	True	SWP	None	1
SJW324	True	SWP	None	1
SJW325	True	SWP	None	1
SJW326	True	SWP	None	1
SJW327	True	SWP	None	1
SJW328	True	SWP	Close	1

4. Now, let’s change the **Terrain Model Attribute** for these selected points. Right click anywhere within the first blank column and select **Edit selected items. >> Terrain Model Attribute >> Do Not Include**. Notice that the attribute updates for all points at once. You could also highlight just the **Terrain Model Attribute** column and then right click and select **Edit**. Within the **Edit Property Value** dialog box, you would set the applicable option there. **Note:** If the terrain was already created, it will automatically re-triangulate.

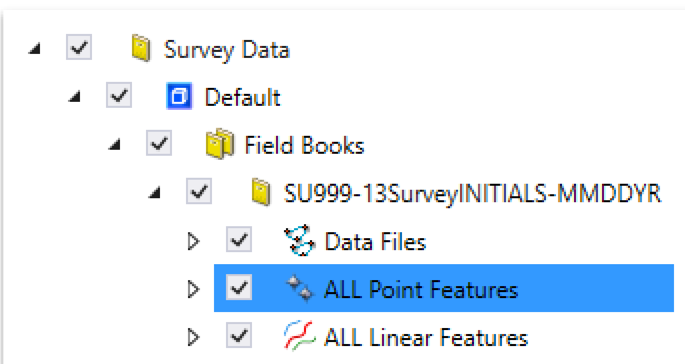


	Name	Display	Field Code	Link Code	Zone	Description	Terrain Model Attribute
	SJW312	True	SWP	Start	1		Do Not Include
	SJW313	True	SWP	None	1		Do Not Include
	SJW314	True	SWP	None	1		Do Not Include
	SJW315	True	SWP	None	1		Do Not Include
	SJW316	True	SWP	None	1		Do Not Include
	SJW317	True	SWP	None	1		Do Not Include
	SJW318	True	SWP	None	1		Do Not Include
	SJW319	True	SWP	None	1		Do Not Include
	SJW320	True	SWP	None	1		Do Not Include
	SJW321	True	SWP	None	1		Do Not Include
	SJW322	True	SWP	None	1		Do Not Include
	SJW323	True	SWP	None	1		Do Not Include
	SJW324	True	SWP	None	1		Do Not Include
	SJW325	True	SWP	None	1		Do Not Include
	SJW326	True	SWP	None	1		Do Not Include
	SJW327	True	SWP	None	1		Do Not Include
	SJW328	True	SWP	Close	1		Do Not Include

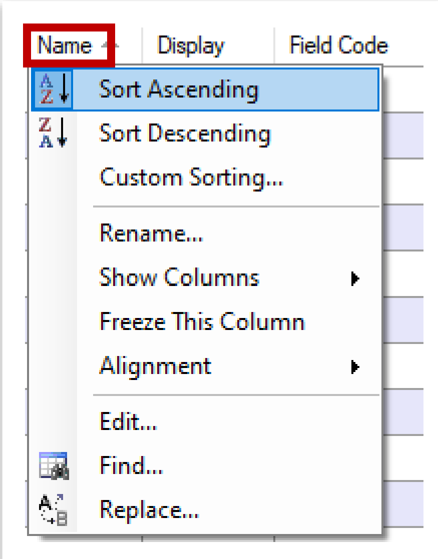
5. Next, let's apply a **Field Code** update across several points (trees) within the **Survey Details** window. We will assume that we know the specific points that need updating. Zoom into the far eastern part of the project and notice the **four** trees.



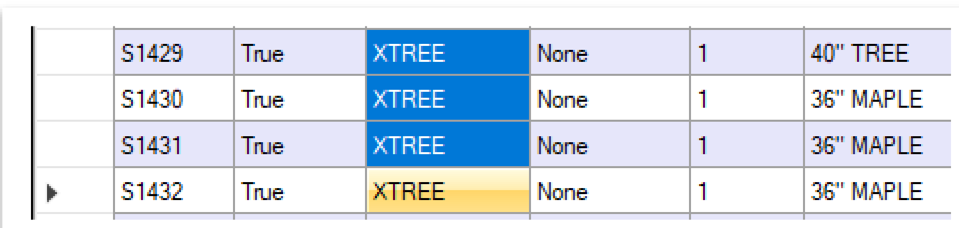
6. With the **Survey Details** window still open, select **ALL Point Features** within the **Explorer** and notice that all points are now listed.



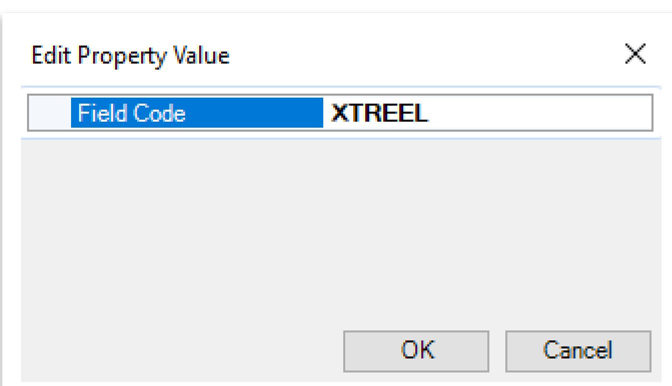
7. Within the **Survey Details** window, right click in the **Name** header and select **Sort Ascending**.



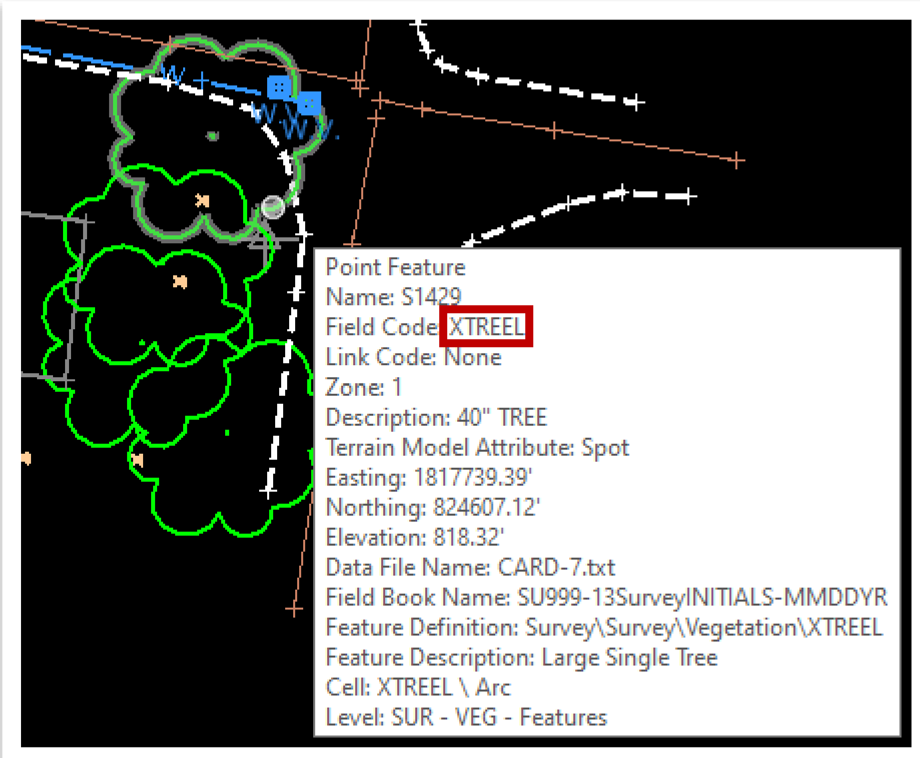
8. Scroll down until you get to points **S1429 – S1432**. It has been determined that the **Field Code** should actually be **XTREEL** (large sized trees 12”+). Highlight the **Field Code** for these four points. This can be done by either left clicking the first one, holding the SHIFT key down and left clicking the fourth one <u>or</u> left click and hold the first one and drag your cursor to the selection extent necessary.



9. Right click within the highlighted area and select **Edit**. Key-in an “**L**” at the end of **XTREE** and click **OK**.

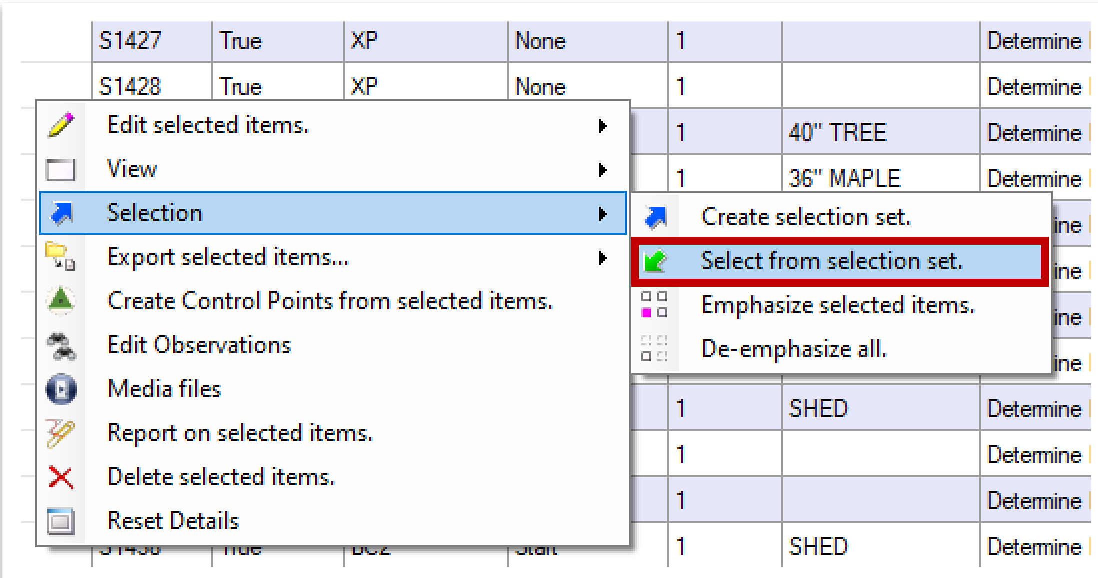


10. Notice that the four trees updated in plan view. You'll also notice that the updated field code is now reflected in the **Survey Details** window and in the **Properties**.

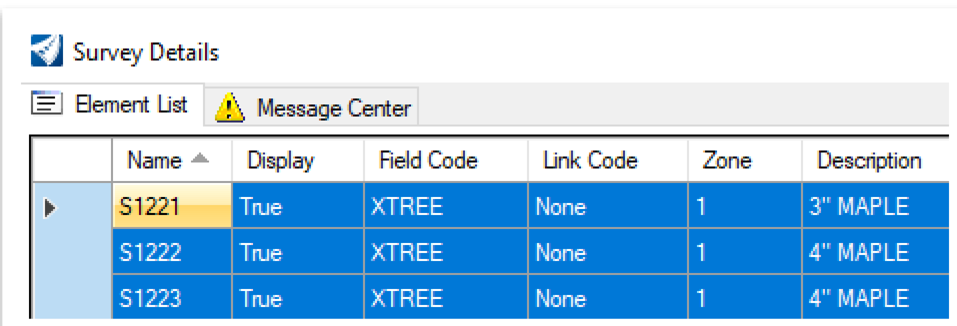


11. Lastly, let's apply a **Field Code** update across several points but utilizing a **selection set** this time. This option would be more applicable if you wanted to visually select points rather than select based on point name. Scroll over to the left until you get to the set of **three** trees, as shown below, and select all three using the **Element Selection** tool (**Survey >> Analyze >> Selection**). You can select the first one and then hold down the **CTRL** key while selecting the others. **Note:** It is recommended to select points that needed the **same** field code update and then repeat the following process if you had other selection sets that needed different field code updates.

12. Within the **Survey Details** window, **ALL Point Features** should still be showing. Right click anywhere within the first blank column and select **Selection >> Select from selection set**.

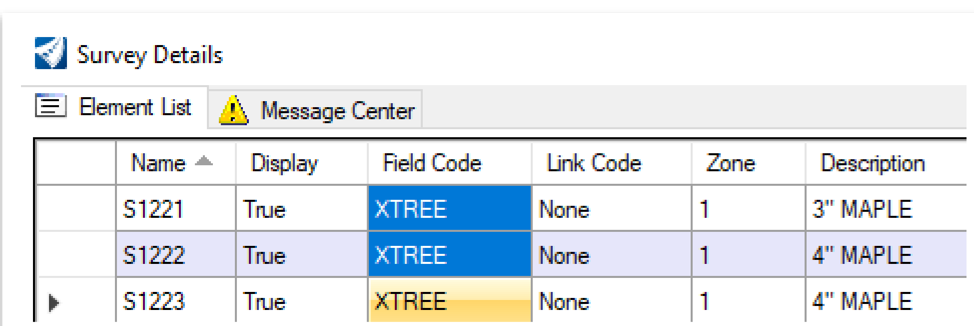


13. Notice that now only the selected point features appear (**S1221** – **S1223**), which will allow us to make edits just to those points.



Name	Display	Field Code	Link Code	Zone	Description
S1221	True	XTREE	None	1	3" MAPLE
S1222	True	XTREE	None	1	4" MAPLE
S1223	True	XTREE	None	1	4" MAPLE

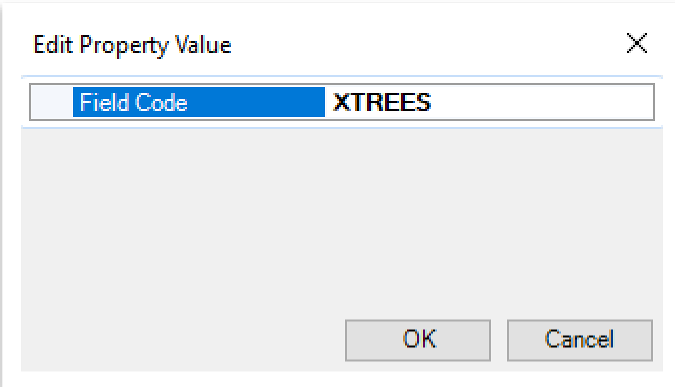
14. Go ahead and deselect the three lines and then highlight just the **Field Code** fields.



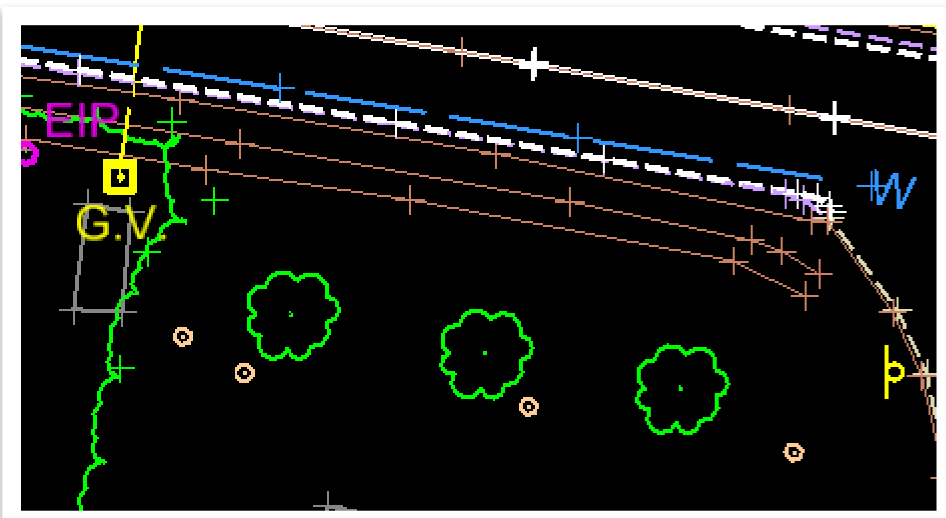
Name	Display	Field Code	Link Code	Zone	Description
S1221	True	XTREE	None	1	3" MAPLE
S1222	True	XTREE	None	1	4" MAPLE
S1223	True	XTREE	None	1	4" MAPLE

Right

15. Once again, right click within the highlighted area and select **Edit**. Key-in an "**S**" at the end of **XTREE** and click **OK**. **Note:** This feature code was selected since the tree sizes fall in the **0-6"** range, per the **description** column in the previous step.



16. Although the field code was updated, you'll notice that the trees look the same. That is because the **XTREES** cell is the same size as the original **XTREE** cell. Left click anywhere within the dgn file to deselect and close the **Survey Details** window.



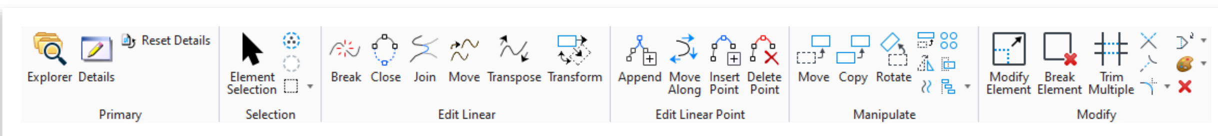
17. You could also use this process to make updates if field codes were omitted prior to importing. For any other field codes that need to be adjusted, you would follow these procedures depending on the scenario and apply the adjustment to the applicable column.

3.5 Lecture: Edit Tools

The **Edit** tab houses all tools needed to make necessary edits to the survey data (Figure 45). Because the feature definitions are tied to the graphics and the field book, once the graphics are edited, the program updates the Field Book data automatically and vice-versa.

While these tools are accessible via the ribbon, most likely they will be opened via the heads-up display within ORD. Each type of geometric element has its unique heads-up display menu.

FIGURE 45. EDIT TAB



3.5.1 Heads-Up Display

Heads-Up Display is a new feature seen in ORD. Each element has a set of tools, and the heads-up display gives the user easy access to those tools directly on the screen. All heads-up displays are opened directly from the geometry in the drawing.

Take Note!

There is no icon or pull-down menu to open Heads-Up Displays. *To open the heads-up display, the user must select a piece of geometry by data clicking on it and hovering for a few seconds. The heads-up display will pop up dynamically and will disappear if the cursor is not hovering on the selected element or on the tools.*

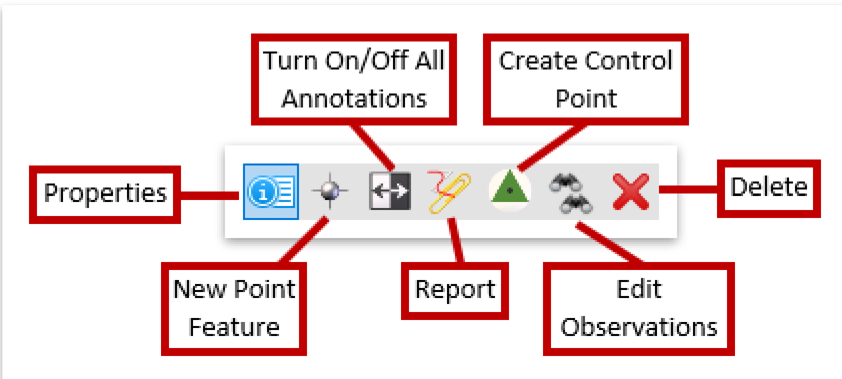
Common Heads-Up Display Tools (all elements)

- **Properties:** Contains all information associated with a civil element (e.g. terrains, points and linear features).
- **Delete:** Deletes the civil element (e.g. terrain, point and linear survey features, and civil geometry).

3.5.2 Heads-Up Display – Point Features

The heads-up display options for survey **points** are shown below (Figure 46). The user can access all the edit tools as well as a few others depending on the feature type (e.g. point or linear). To visualize the heads-up display for points, select (left click) the element and then hover the cursor over the element until it appears.

FIGURE 46. HEADS-UP DISPLAY: POINT FEATURES

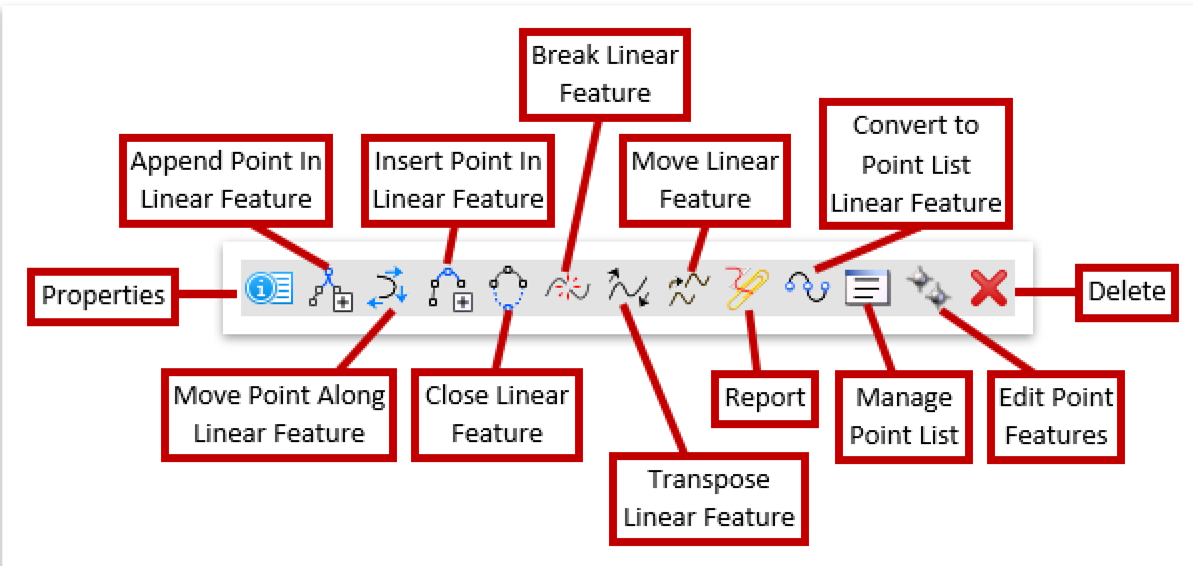


- **New Point Feature:** Allows the addition of a point after the data has been imported.
- **Turn On/Off All Annotations:** Many Feature Definitions (and feature codes) are set up to automatically be labeled using the ORD labeling tools. This tool allows the labels to be temporarily un-displayed to review the file without clutter.
- **Report:** Opens the reporting options. This command is available in the point and linear features heads-up displays.
- **Create Control Point:** Allows conversion of an imported point to a control point.

3.5.3 Heads-Up Display – Linear Features

The heads-up display options for survey **lines** are shown below (Figure 47). The user can access all the edit tools as well as a few others depending on the feature type (e.g. point or linear). To visualize the heads-up display for lines, select (left click) the element and then hover the cursor over the element until it appears. The **Manage Point List** tool is not seen within the ribbon, by default, so it is assumed that this tool is only accessible via the heads-up display.

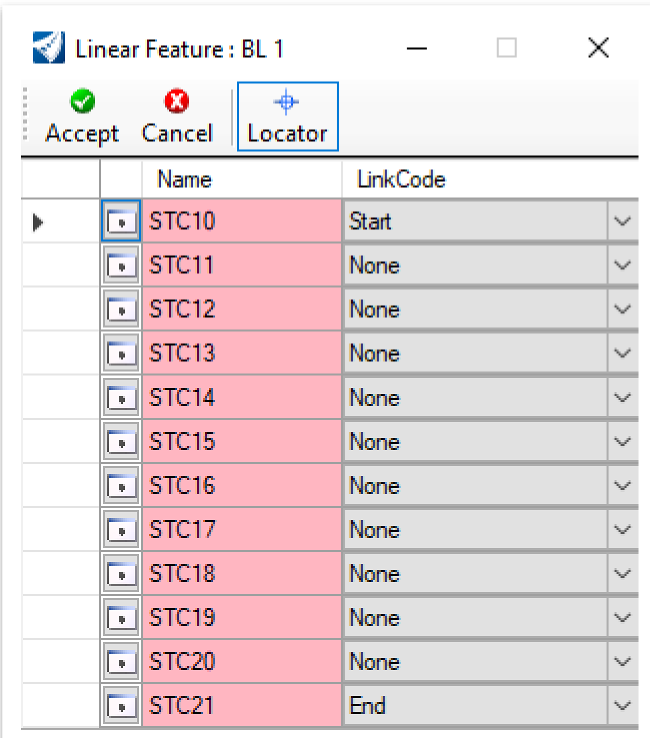
FIGURE 47. HEADS-UP DISPLAY: LINEAR FEATURES



- **Append Point In Linear Feature**: Appends a civil point to an existing linear feature.
- **Move Point Along Linear Feature**: Moves a point feature along an existing linear feature.
- **Insert Point In Linear Feature**: Inserts a civil point in an existing linear feature.
- **Close Linear Feature**: Connects the first point of the linear feature with the last one.
- **Break Linear Feature**: Breaks one linear feature into two distinct linear features.
- **Transpose Linear Feature**: Reverses all data points within the selected survey linear feature or horizontal alignment.
- **Move Linear Feature**: Moves a linear feature to a desired location.
- **Report**: Opens the reporting options. This command is available in the point and linear features heads-up displays.

- **<u>Convert to Point List Linear Feature</u>:** Allows conversion of an imported linear feature by using a survey feature code (also called dynamic linear feature) into a point list. Point lists are less intelligent linear features, but it may be helpful when editing and manipulating points that make up the original survey linear feature.
- **<u>Manage Point List</u>:** Uses the linear feature list dialog to manage the points that make up the linear feature (Figure 48). This command is used to edit linking codes, and to insert, replace, delete and reorder points in the point list.

FIGURE 48: MANAGE POINT LIST DIALOG BOX



- **<u>Edit Point Features</u>:** This tool was covered in the previous exercise.

3.5.4 Exercise: Edit the Survey

In this exercise, we will first convert the dynamic linear features for utilities (water line) into **point-list linear features** and then create one element prior to converting the linear features into **Civil 3D Plan Elements**. Also, we will explore the **Break**, **Close**, **Move** and **Transpose** tools and edit different elements of the survey. For this exercise, we will open a new file but for a regular project you would continue to make any edits in the original survey file.

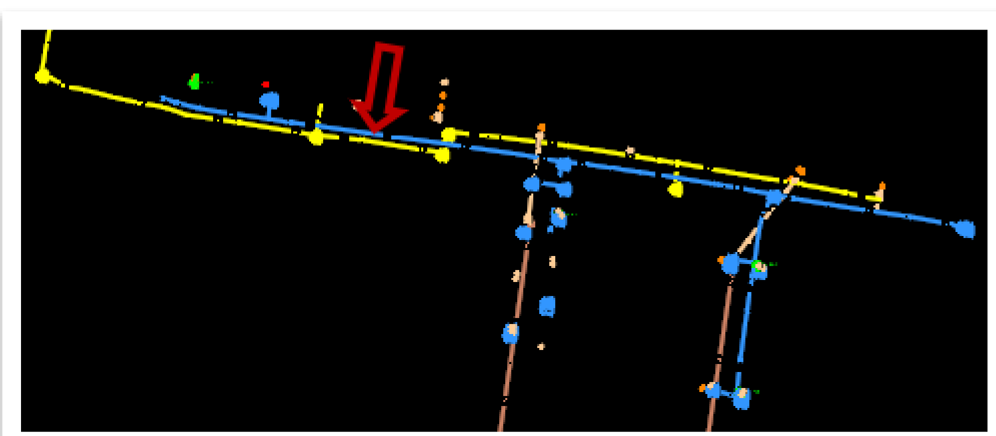
1. Open the **Survey Model – Edited.dgn** file within the **SURVEY_Training** workset dgn subfolder.

Take Note!

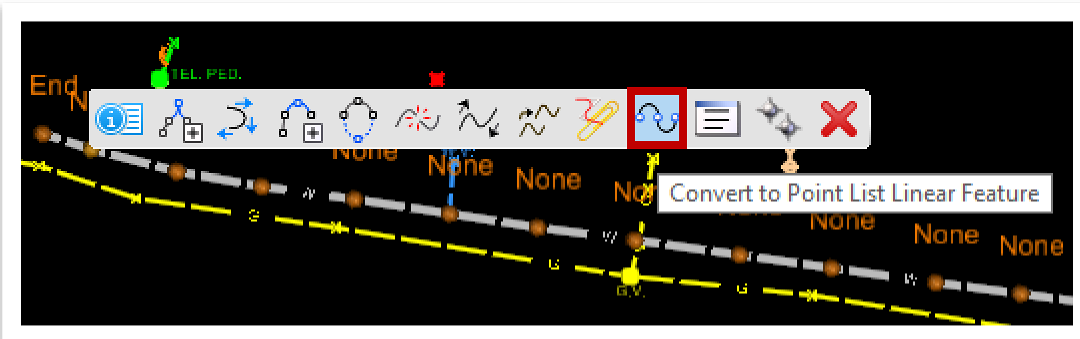
*ORD survey features are considered **dynamic linear features**, which are created directly from points with the same field code picked up in the field. ORD assumes that because these features were collected in the field using the same field code, they should not be edited once imported into the DGN. Therefore, ORD requires the user to convert these field code dynamic linear features into what is known as a **point-list linear feature**. Once that has been completed, the user can edit these point list linear features using all the edit tools in the ribbon. ORD also allows the user to convert these point-list linear features into **unintelligent graphic features**.*

*Once a feature has been dropped all the way to a graphic feature, it **CANNOT BE UNDONE**. It is imperative that the user doesn't accidently drop the dynamic linear feature into a graphic feature.*

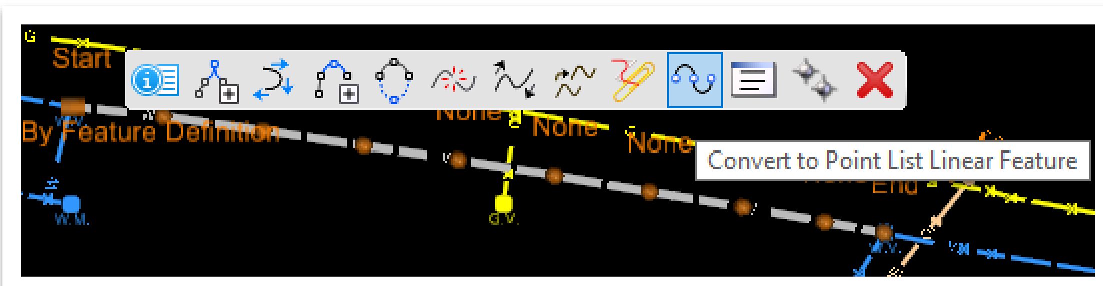
2. While ORD can project point-list features onto existing ground profiles, the software cannot create an existing ground profile unless the feature is a civil 3D element. Zoom in to the **Water** line, as shown below so we can convert the dynamic linear utility features into **point-list linear features**. **Note:** Only the utility levels are turned on.

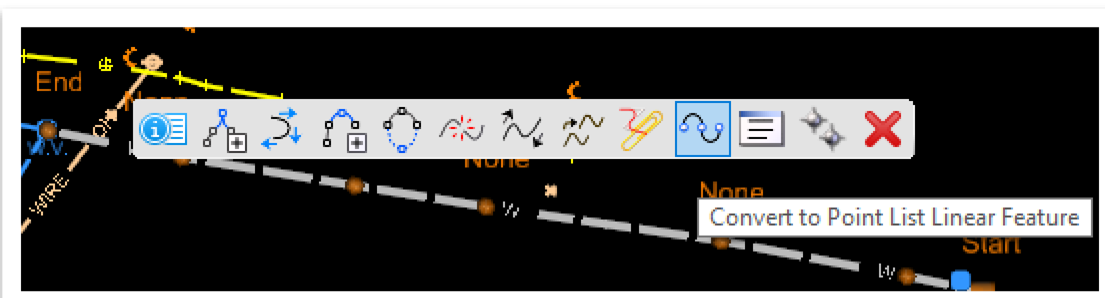


3. Next, left click to select the **first segment** of the **water line** and open the heads-up **display** menu. Click the fourth icon from the right **Convert to Point List Linear Feature**. **Note:** Only select it one time.

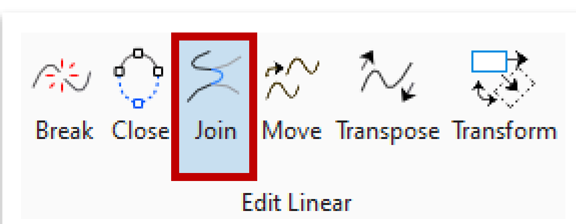


4. Go ahead and convert the next two segments of the **water line**. **Note:** This must be done for each segment individually.

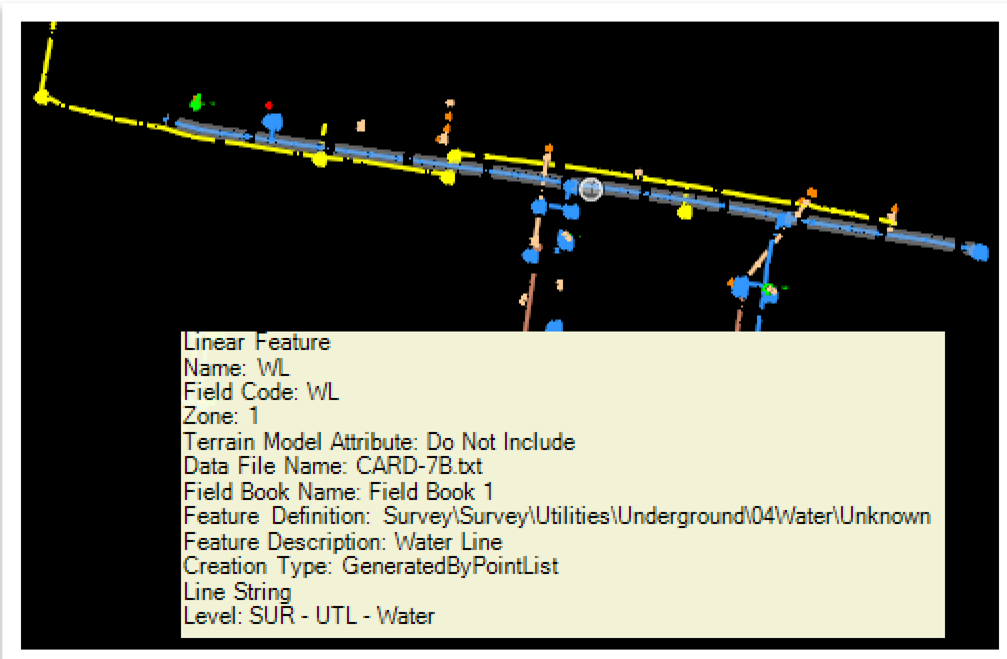




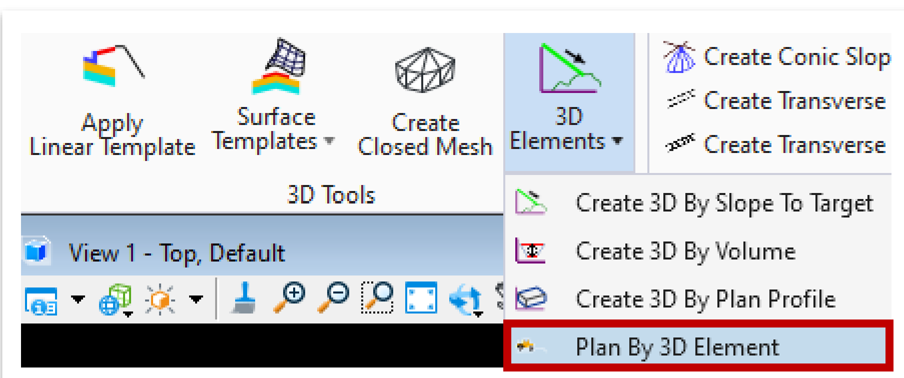
5. Now, we will join all three water line segments, so we can later plot the water profile as one long profile instead of short individual segments. Open the **Join** tool (**Survey >> Edit >> Edit Linear**). **Note:** The **Join** tool only works on point list linear features, which is why we had to do the previous steps first.



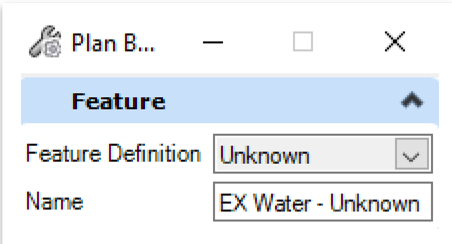
6. Notice the cursor prompt: **Locate Linear Feature**. Select the water line segment furthest to the right and then select the middle segment to join those two lines. Repeat this process to join the combined line with the water line segment furthest to the left. Once complete, open the **Selection** tool to deselect and then hover your cursor over the **water** line and notice that it is **one** overall line, made up of the 3 segments. **Note:** This tool can only join two linear features at a time.



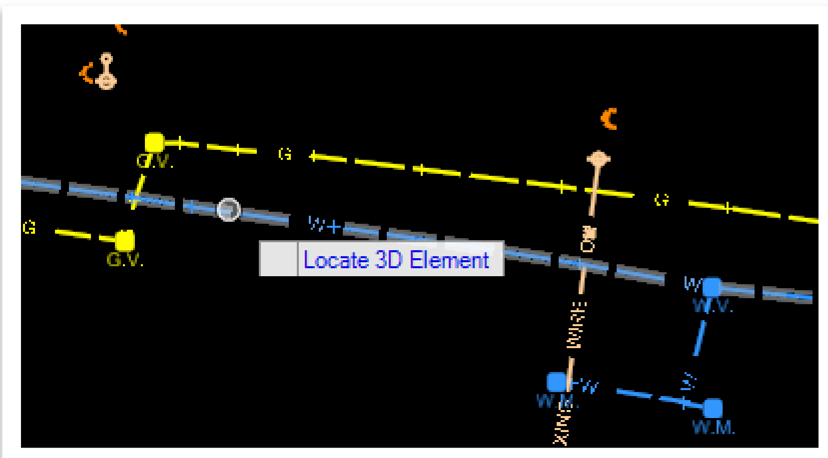
7. Next, we need to convert the water line into a **Civil 3D Plan Element**. Switch to the **OpenRoads Modeling** workflow and open the **Plan By 3D Element** tool (**OpenRoads Modeling >> Model Detailing >> 3D Tools >> 3D Elements**). **Note:** This will need to be done for any utility that you wish to show in profile view where no utility model is necessary (gas, water, etc.).



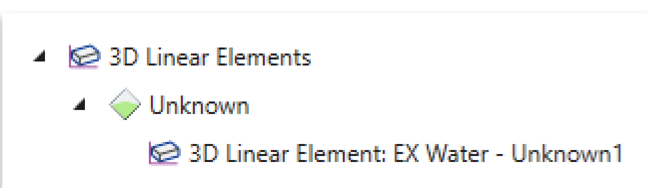
8. Within the **Plan By 3D Element** dialog box, select the **Unknown** feature definition (**Linear >> Utilities >> Existing >> Underground >> Water**) since the size was not included in the survey. You can leave the default **Name** as-is for now. **Note:** The software will increment each feature stored by 1.



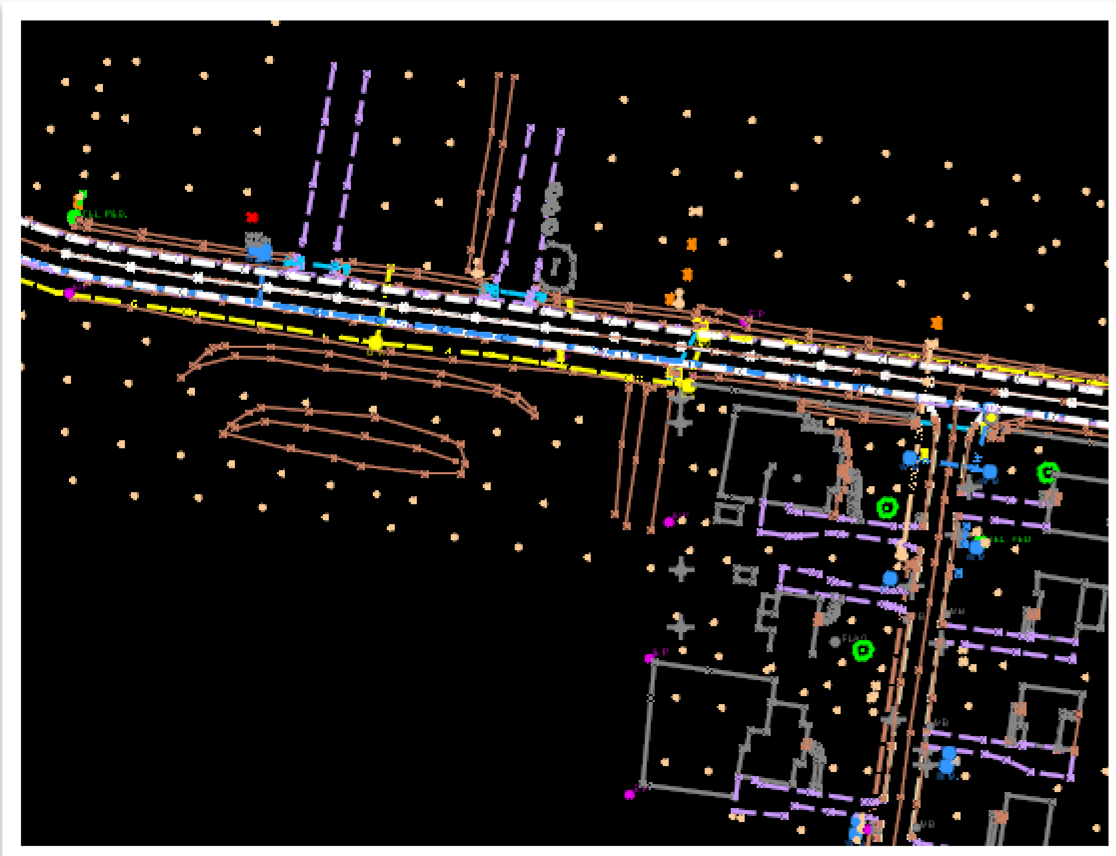
9. Notice the cursor prompt: **Locate 3D Element**. Left click on the **water** line.



10. It will seem like nothing happened. However, within the **Explorer**, if you open the **OpenRoads Model** tab and go to **Survey Model – Edited.dgn >> 3D Linear Elements**, you will notice that the 3D water line was created. **Note:** We will discuss existing utility projections (non-modeled and modeled) onto profiles in Chapter 4 and then create a profile named boundary and add annotation in Chapter 5.

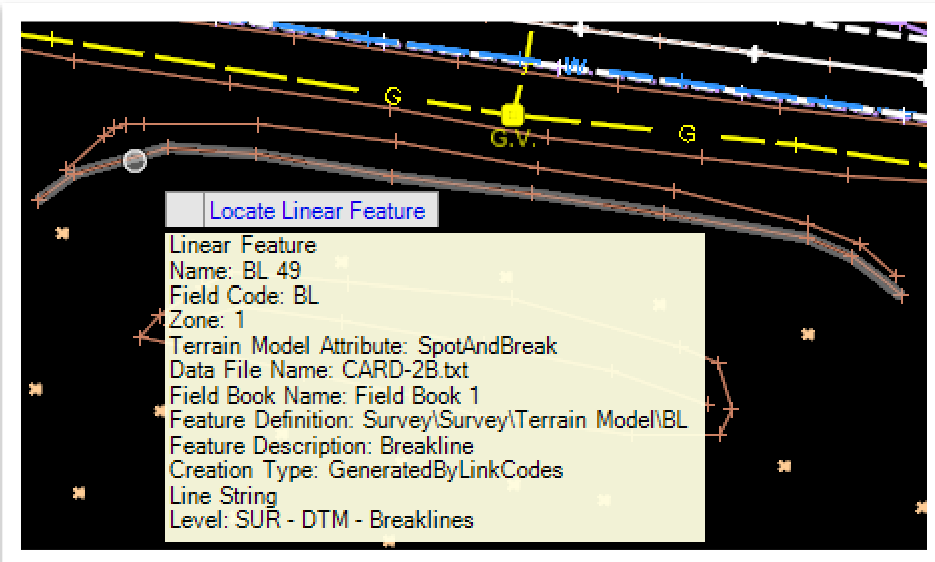


11. Next, we will demonstrate the **Break**, **Close**, **Move** and **Transpose** tools. Switch back to the **Survey** workflow. All these tools work the same way. Turn on all levels in the **Level Display** and zoom in to the extent shown below.

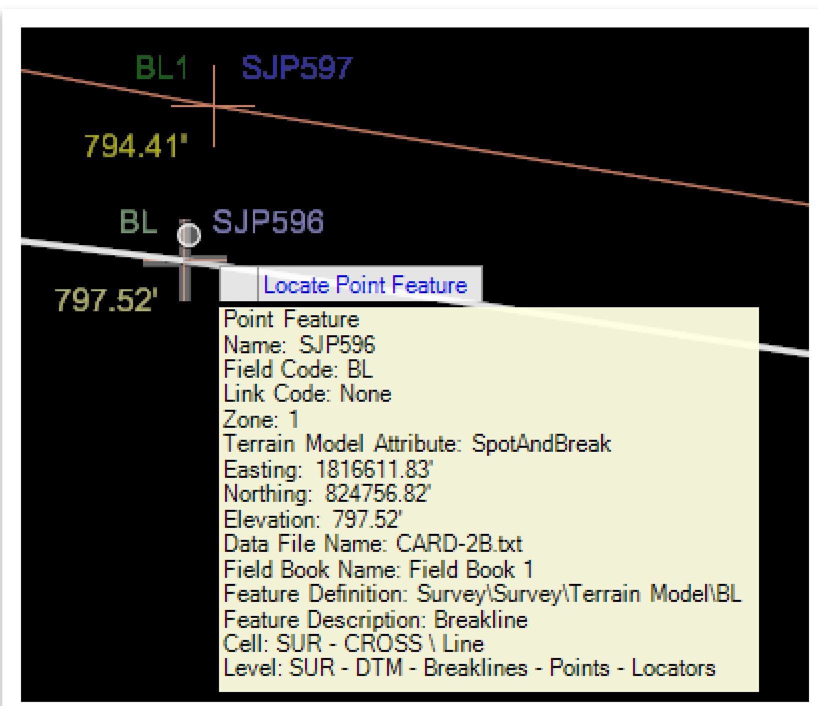


12. Open the **Break** tool (**Survey >> Edit >> Edit Linear**).

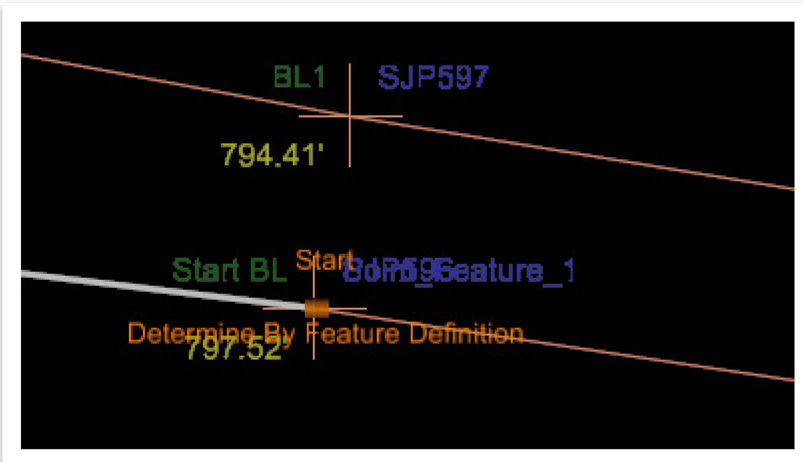
13. Notice the cursor prompt: **Locate Linear Feature**. Select the breakline, as shown below. You could also select **BL 49** from the drop-down menu within the **Break Line** dialog box.



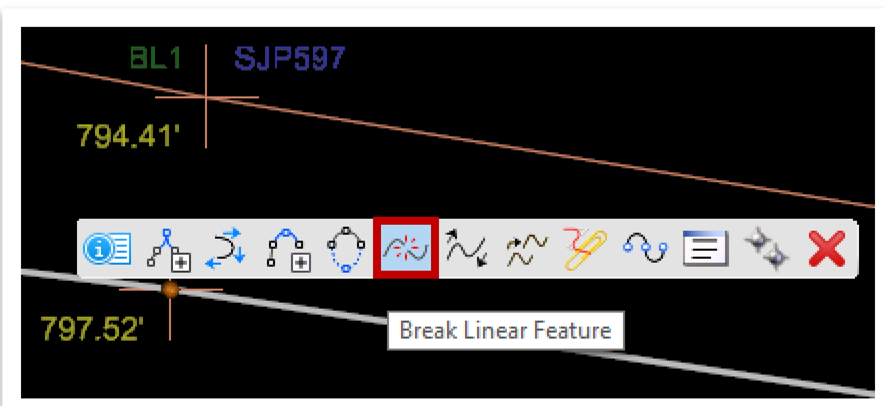
14. Notice the next cursor prompt: **Locate Point Feature**. Select the **point** where you wish to break the line. For this exercise, select point **SJP596**. Once again, you could also select **SJP596** from the drop-down menu within the **Breakline** dialog box. **Note:** The **decorations** (Names, Field Codes, Elevations) have been turned back on so that the correct point could be identified visually.



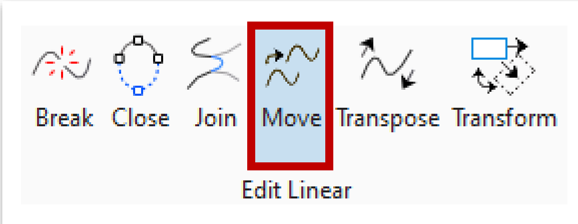
15. If you have the decorations turned on, you will see the point **Name** (blue text) update with a new name on top of the original name. If you activate the **Element Selection** tool (**Survey >> Edit >> Selection**) and select the breakline now, you will notice that the line has been broken into two pieces.



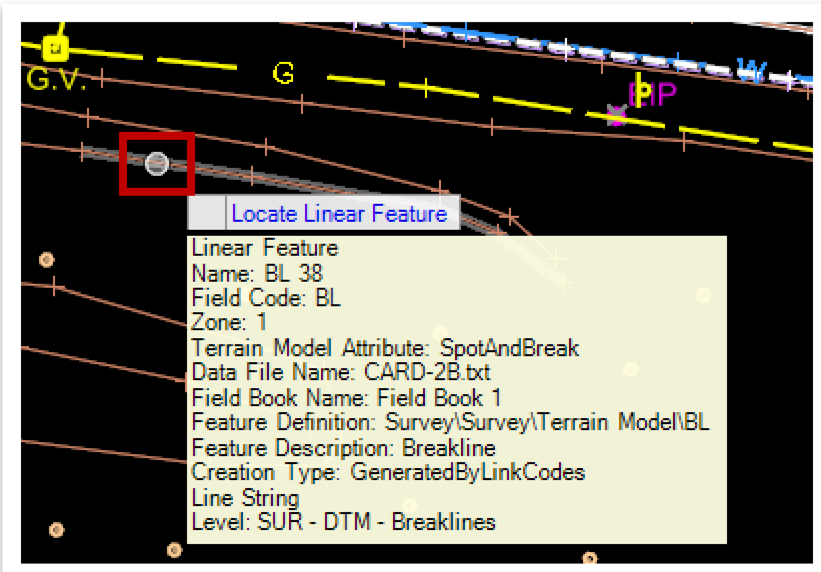
16. Another way to access the **Break Linear Feature** tool is to select the breakline and access the tool within the heads-up display (6th icon from the left). Then, you would only need to locate the point feature. Go ahead and use the **Element Selection** tool and left click anywhere within the drawing to deselect the elements.



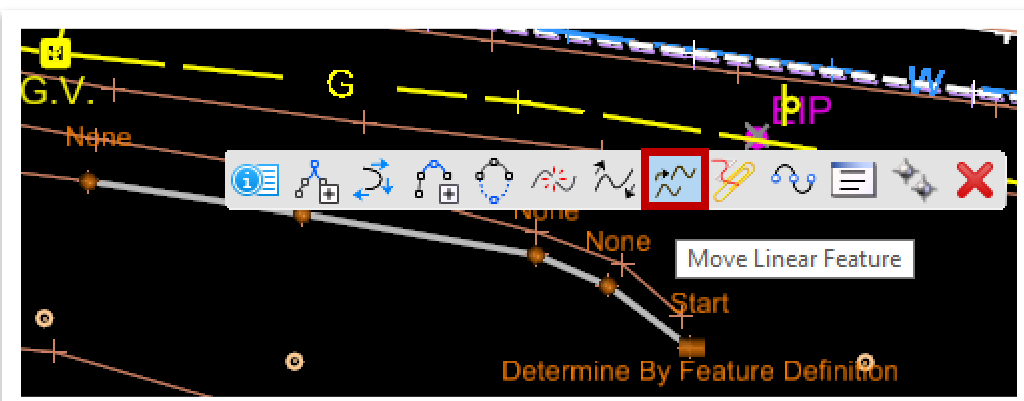
17. Next, let's open the **Move** tool (**Survey >> Edit >> Edit Linear**), which works similarly to the **Break** tool. Go ahead and turn off the **decorations** for now.



18. Notice the cursor prompt: **Locate Linear Feature**. For this exercise, select **BL 38** and temporarily move the line to see how it works, and then hit **CTRL+Z** to undo.

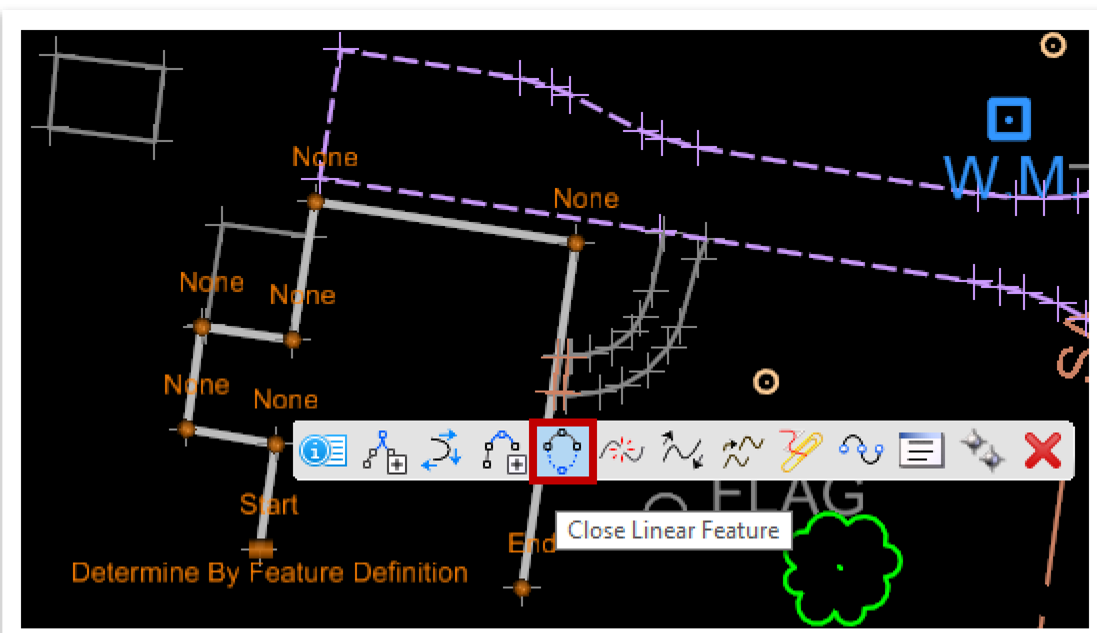


19. Like the previous tool, you could also select the breakline and access the tool in the heads-up display (6th icon from the right).

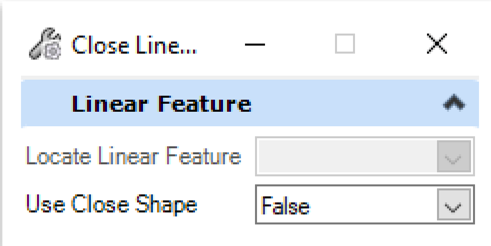


20. Next, zoom in to the highlighted area below so we can close the building shape.

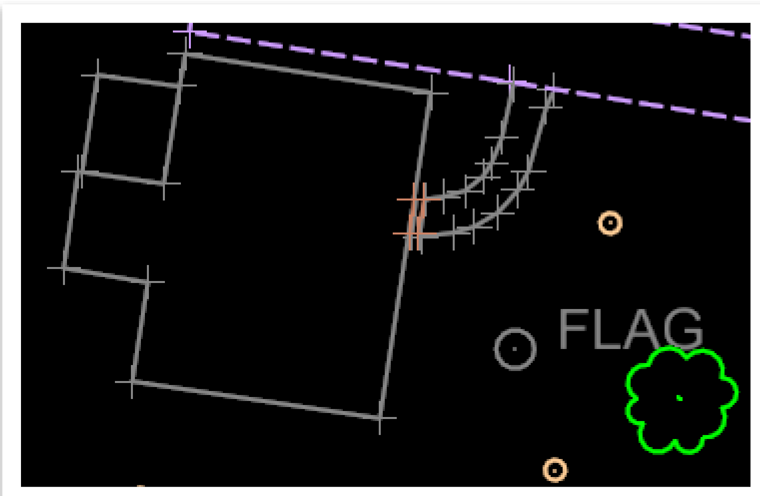
21. Select the building and then open the heads-up **display** menu. Click the fifth icon from the left **Close Linear Feature**.



22. Make sure the **Use Close Shape** field is set to **False** within the **Close Linear Feature** dialog box and then left click to accept closure.



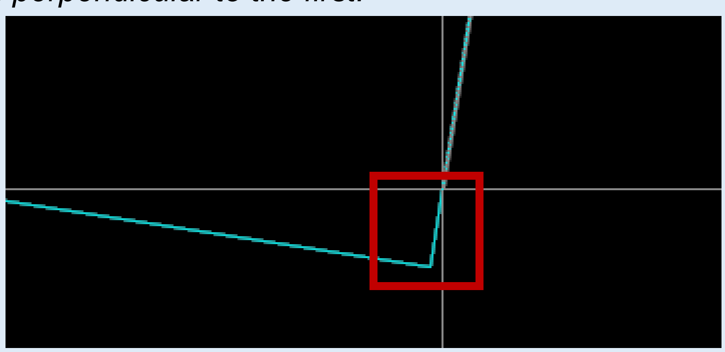
23. You should now see the enclosed building, as shown below.



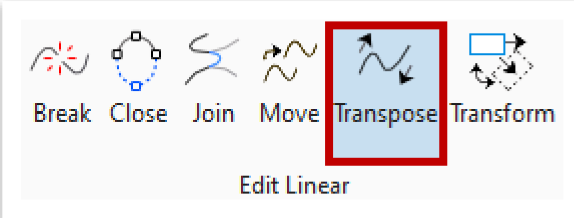
Take Note!

*The **Use Close Shape** (<u>False</u>) option will connect the two points tangentially, regardless if the points are along the same axis.*

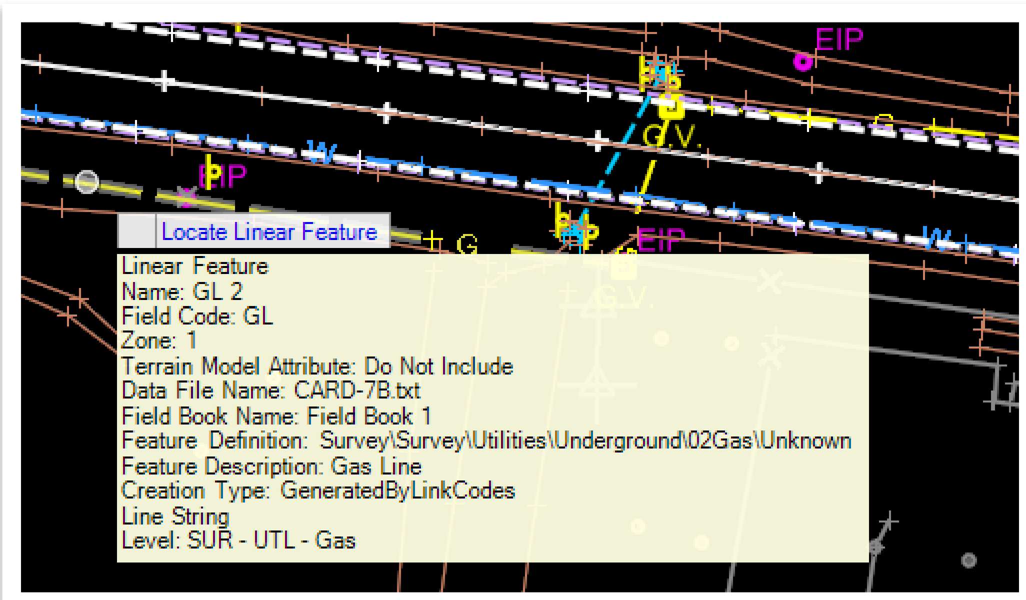
*The **Use Close Shape** (<u>True</u>) option will connect the two points by extending the lines until they intersect and project a point to create a line that is perpendicular to the first.*



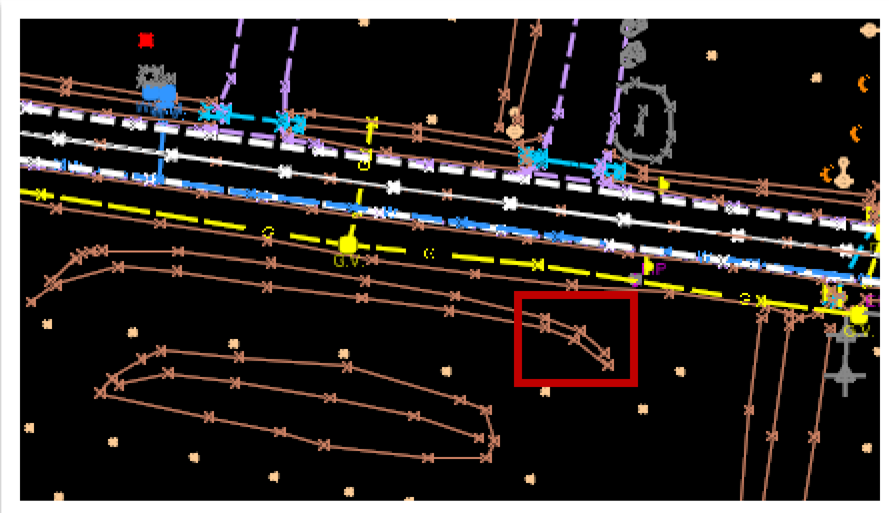
24. The last Edit Linear tool we will open is the **Transpose** tool (**Survey >> Edit >> Edit Linear**).



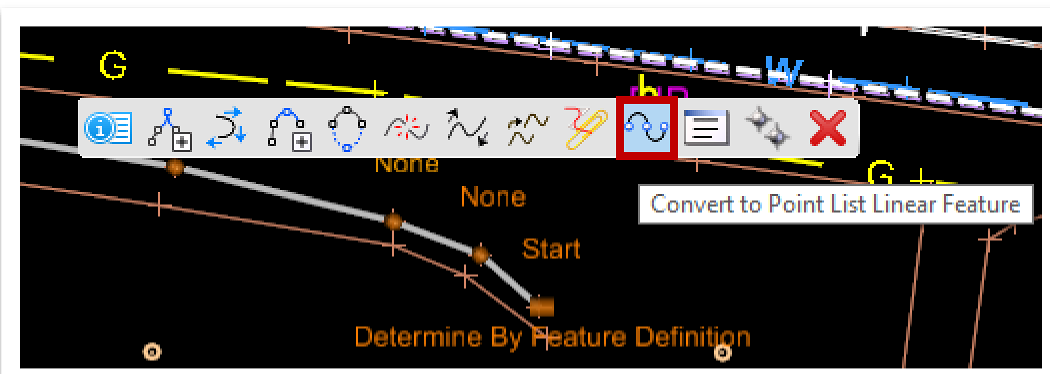
25. Notice the cursor prompt: **Locate Linear Feature**. Select the **Gas** line on the south side of the road, as shown below, and then left click to accept. This essentially reverses the order (direction) of the chain.



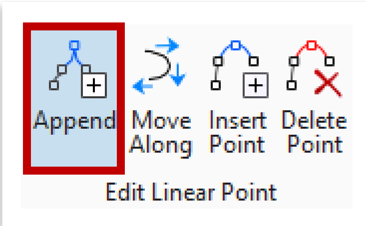
26. We will now jump to the **Edit Linear Point** tools, which work very similar to the previous tools. Zoom into the area highlighted below.



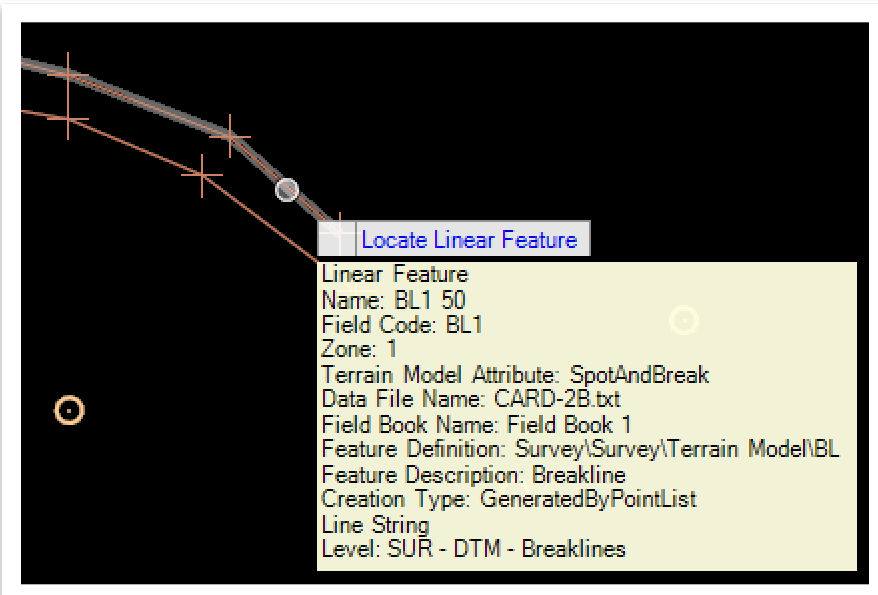
27. Before we utilize the **Append** tool, we need to convert the breakline which we will be appending to a point list linear feature. If this step is not done, the line that is appended to will disappear after processing. A ticket has been logged with Bentley and there is a known defect. Select breakline **BL1 50**, as shown below, and open the **Convert to Point List Linear Feature** tool within the heads-up display (4th icon from the right). **Note:** Only select it one time.



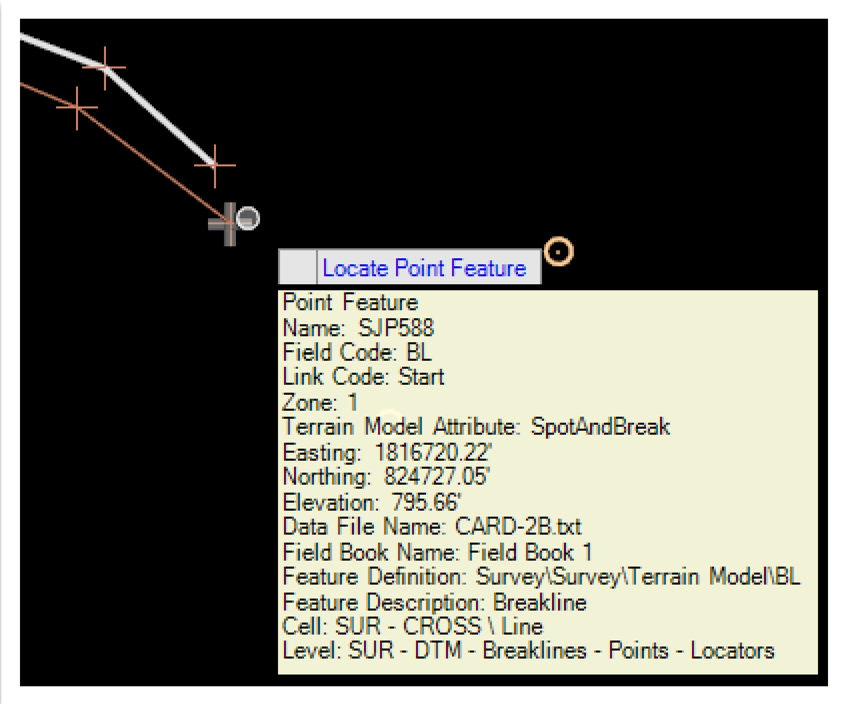
28. Now, go ahead and open the **Append** tool (**Survey >> Edit >> Edit Linear Point**).



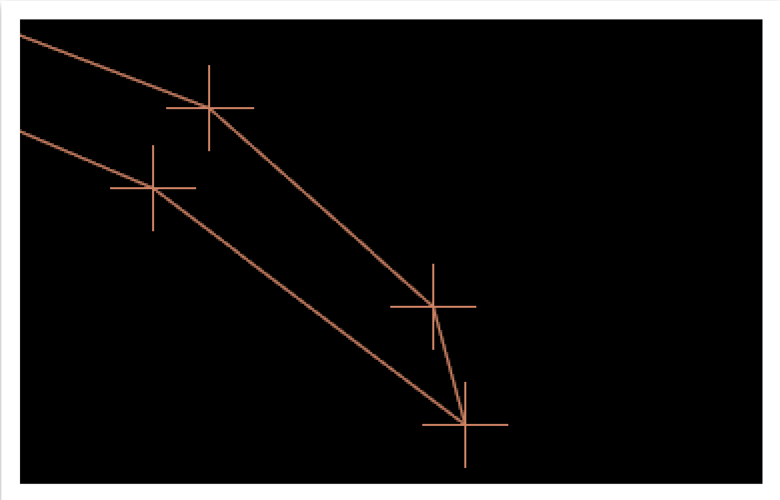
29. Notice the cursor prompt: **Locate Linear Feature**. Select breakline **BL1 50**.



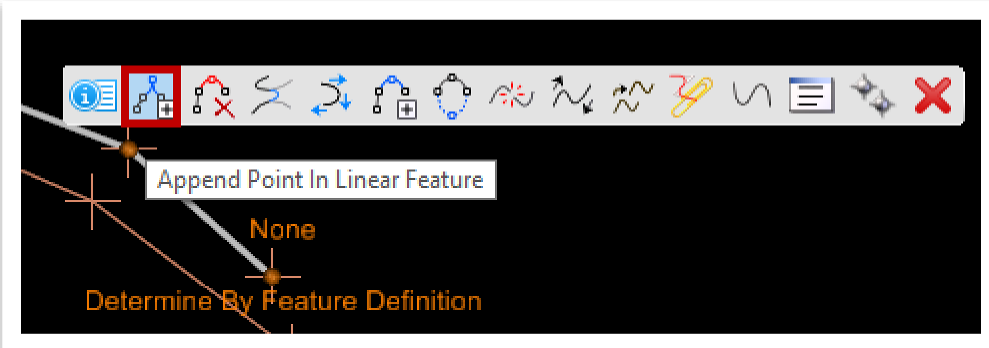
30. Notice the next cursor prompt: **Locate Point Feature**. Select point **SJP588** to append. **Note:** You can turn on the **Names** decorations for reference, if necessary.



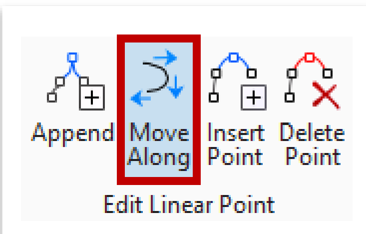
31. Left click to accept the append and notice the updates below.



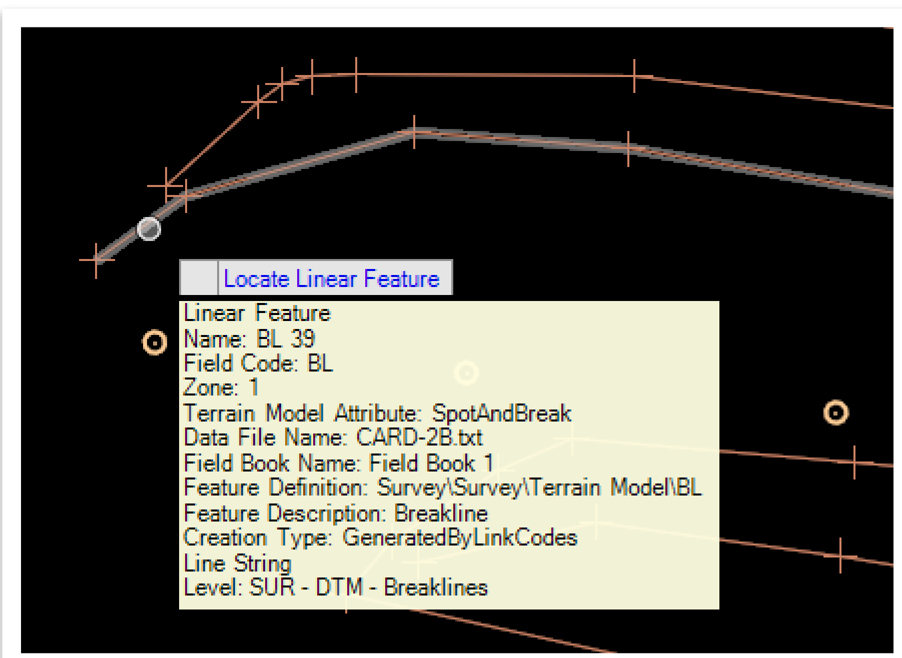
32. Alternatively, you could also select the breakline and access the tool in the heads-up display (2nd icon from the left).



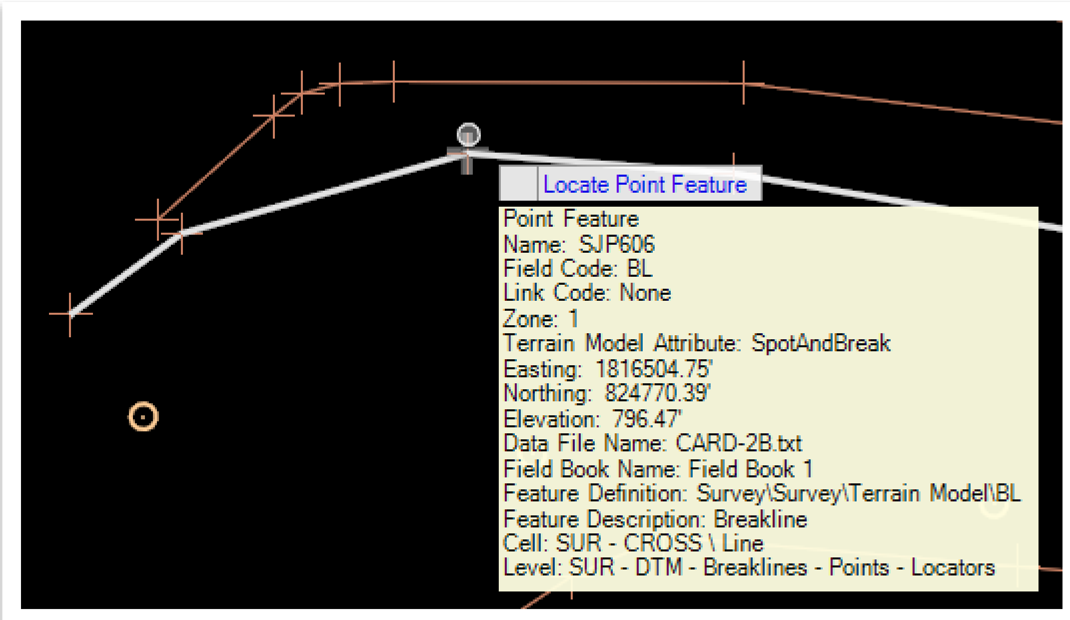
33. Zoom left to the other end of the same breaklines and open the **Move Along** tool (**Survey >> Edit >> Edit Linear Point**).



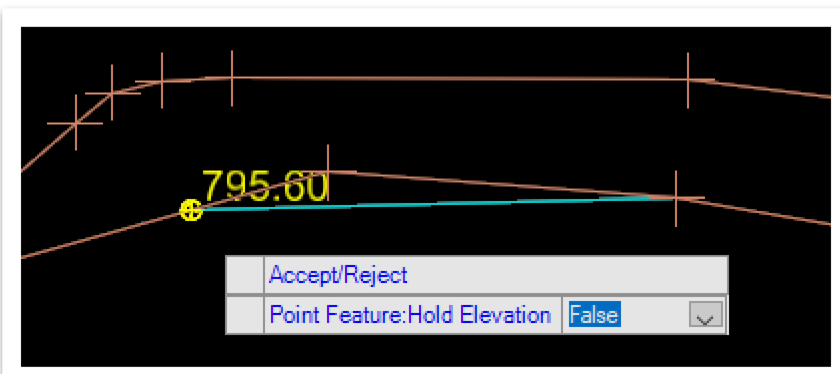
34. Notice the cursor prompt: **Locate Linear Feature**. Select breakline **BL 39**.

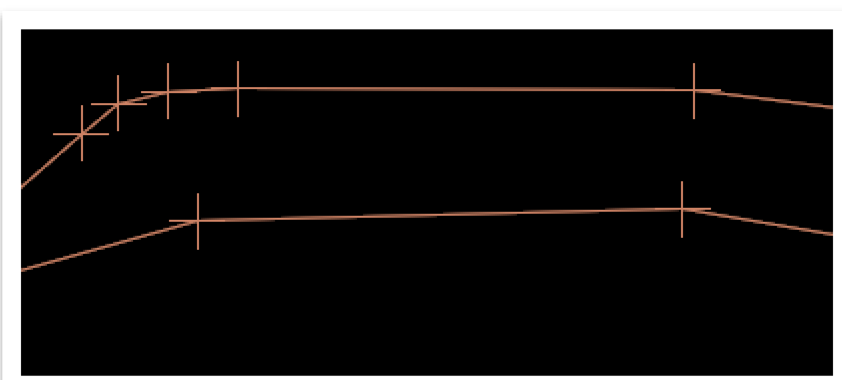


35. Notice the next cursor prompt: **Locate Point Feature**. Select point **SJP606**.

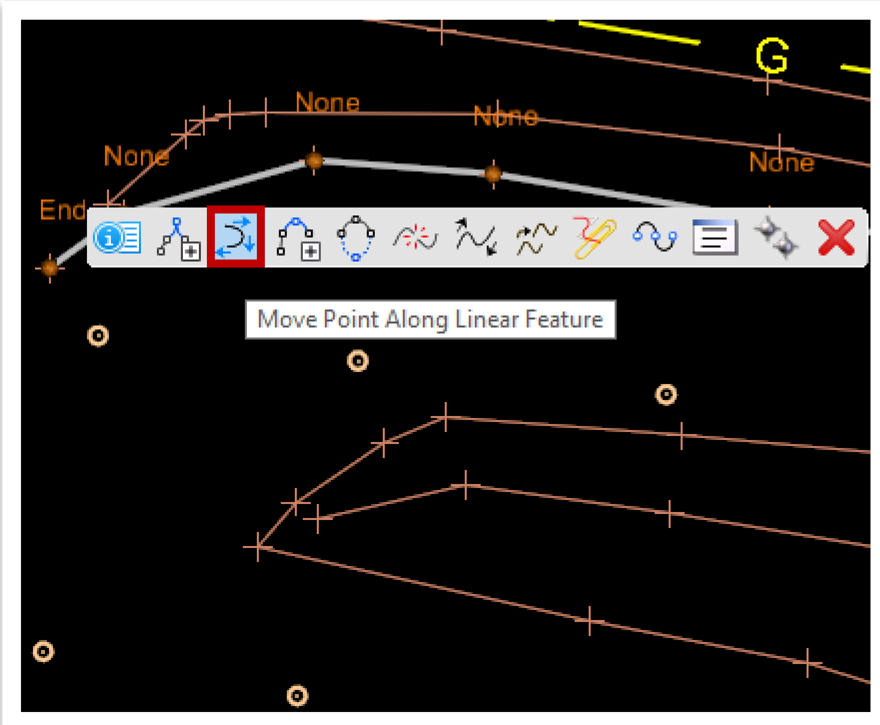


36. Move the point anywhere to the right or left of the locator and left click to accept. Leave the **Hold Elevation** set to **False** for this exercise.

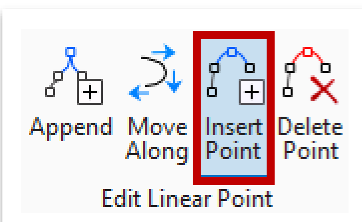




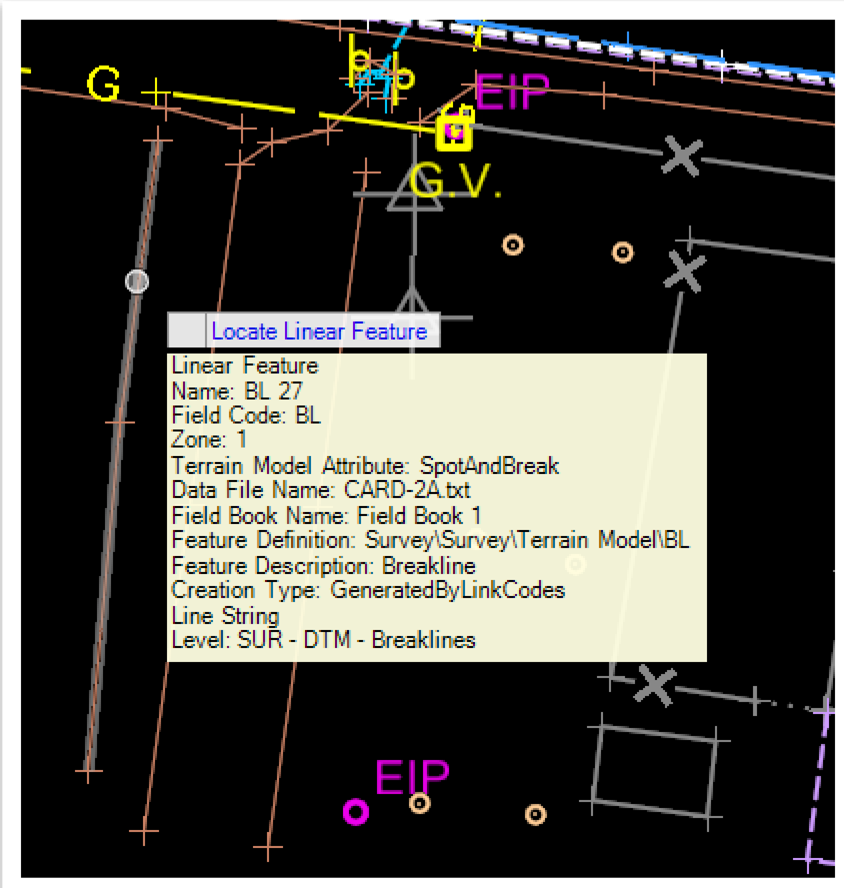
37. Alternatively, you could also select the breakline and access the tool in the heads-up display (3rd icon from the left).



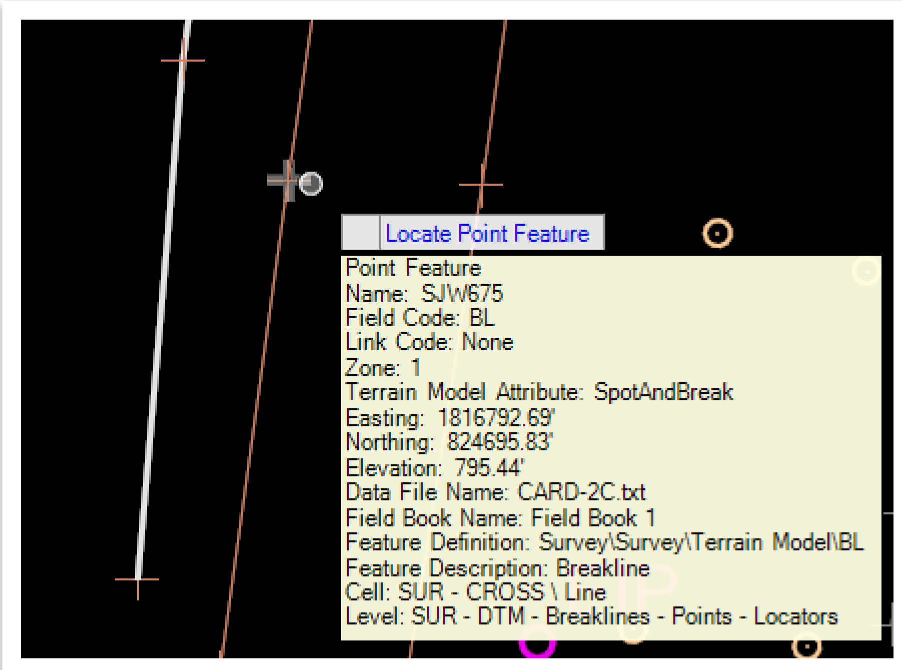
38. Next, open the **Insert Point** tool (**Survey >> Edit >> Edit Linear Point**).



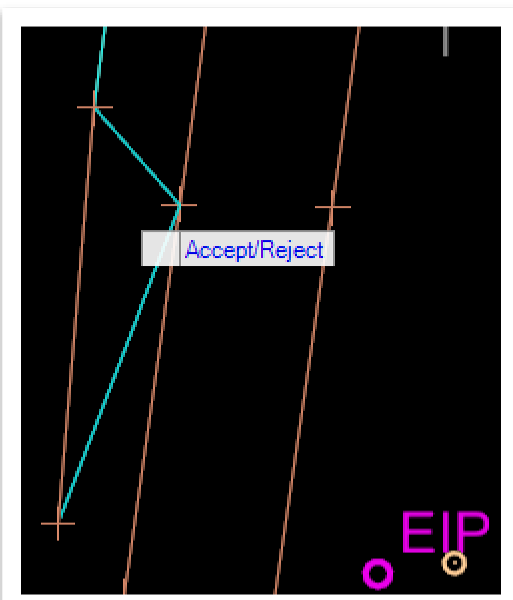
39. Notice the cursor prompt: **Locate Linear Feature**. Zoom to the right and select breakline **BL 27**.

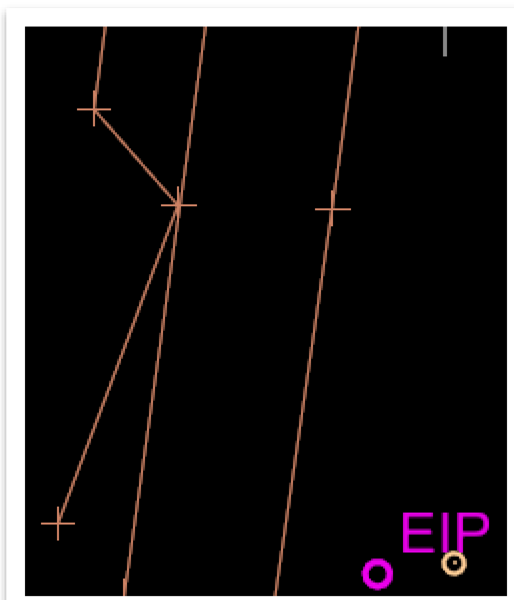


40. Notice the next cursor prompt: **Locate Point Feature**. Select point **SJW675** to add to the **breakline** and then **data-point** to accept the command.

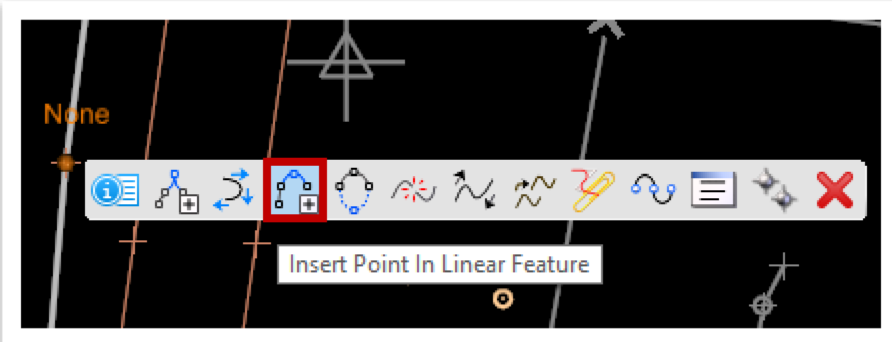


41. Move your cursor to see the different line placements and then left click to accept the option, as shown below.

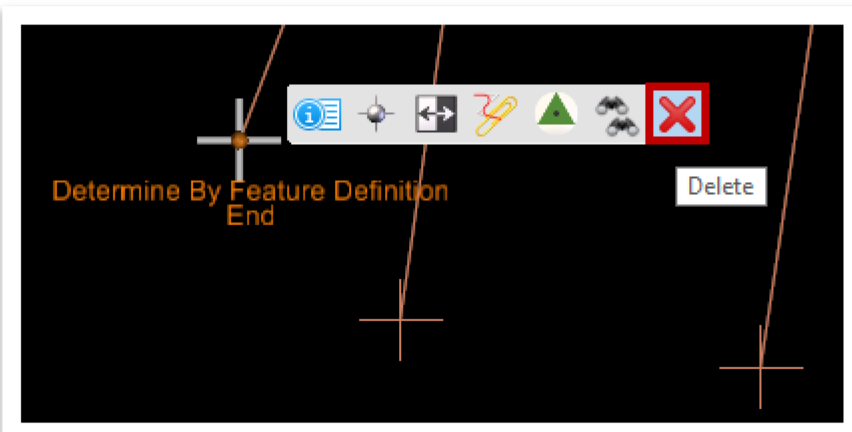




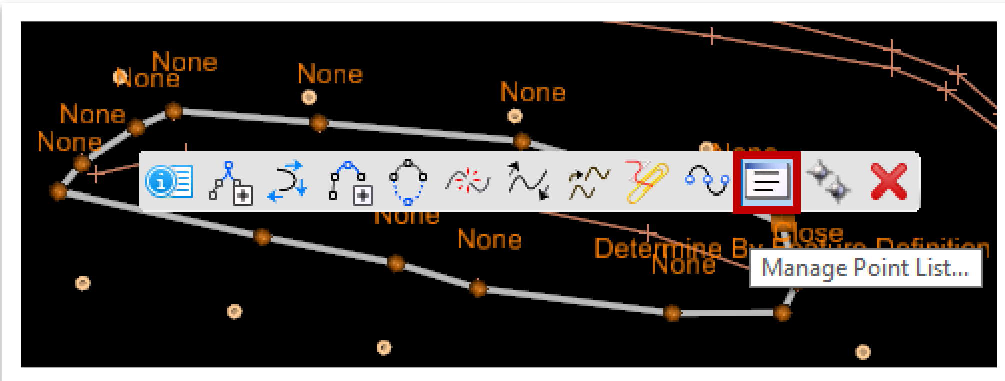
42. Alternatively, you could also select the breakline and access the tool in the heads-up display (4th icon from the left).

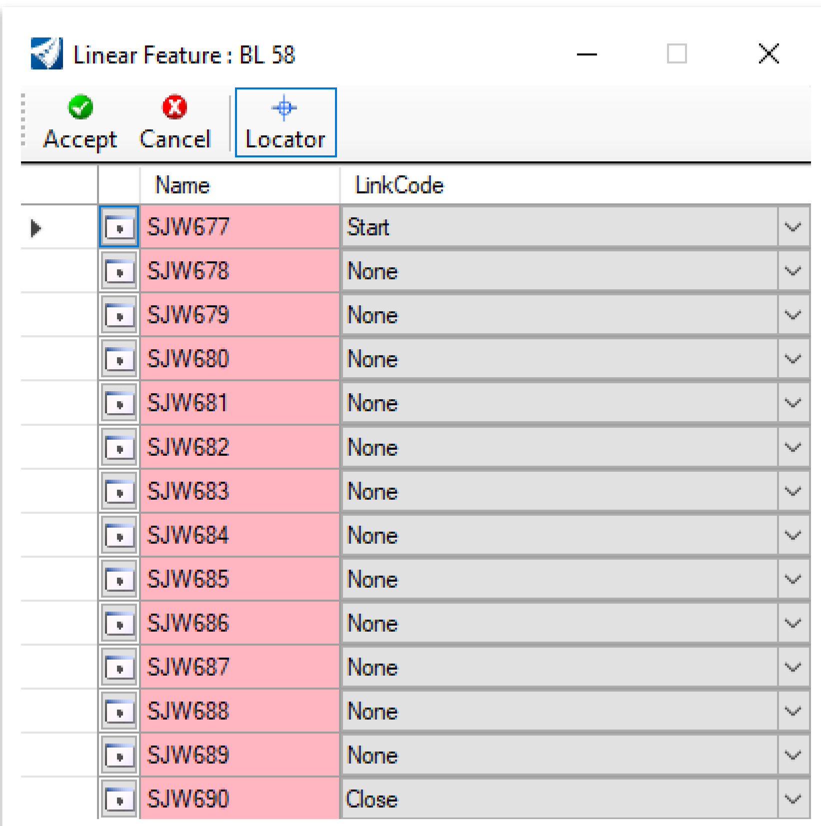


43. To **delete a point**, simply select the point you want to delete and then access the **Delete** tool in the heads-up display. For this exercise, we will not delete any points. **Note:** The **Delete Point** tool within the **Edit Linear Point** tools in the ribbon does not work properly. You will get an error unless you have previously converted the line it is associated with to a **Point List Linear Feature**.



44. Lastly, let's look at the **Manage Point List** tool. Select breakline **BL 58** and then select the 3rd icon from the right in the heads-up display. Within the **Manage Point List** window, you can see the list of points that make up the linear feature. **Link Codes** can also be updated within this window.





Take Note!

*Keep in mind that using the **Edit Tools** will also alter the terrain model, if already created. It is highly recommended to make all edits before creating a terrain model. We will explore terrain models in the next section.*

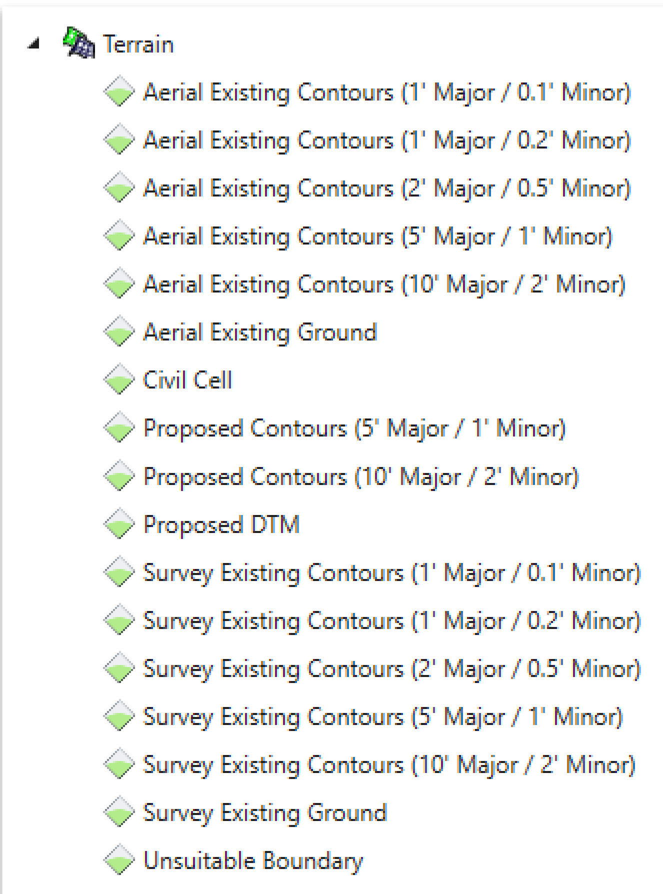
3.6 Lecture: Terrain Models

A **Terrain Model** is a set of 3D triangles mathematically computed from point data collected on the surface that is being modeled. Terrain Models are used to define regular and irregular surfaces (e.g. proposed finished grade, subsurface layers). In ORD, Terrain Models are recognized as **civil elements** within the drawing and represent the TIN. The Civil or Digital Terrain Model (DTM) is no longer a external file and can be referenced (e.g. attached) like any other design file. The DTM resides within the DGN file along with all its properties.

3.6.1 Terrain Feature Definitions

DTMs must be assigned a Terrain Feature Definition using TDOT standards to display the feature symbologies (e.g. contours, triangles, etc.). All terrain models coming from Field Surveys should be set to **Survey Existing Ground**. Aside from Civil Cell, the TDOT workspace has **16** Feature Definitions from which to choose. Each of the Feature Definitions shown in Figure 49 have been set up with specific settings for contours and triangles, to name a few.

FIGURE 49. TDOT TERRAIN FEATURE DEFINITIONS



The **Survey Existing Ground** Feature Definition has been setup to show the **boundary** and **triangles** by default, to allow for triangular editing tools to work properly. However, the user may turn on/off any other property once the terrain has been created (e.g. major/minor contours).

Existing ground profiles and cross sections are children of the terrain model in ORD. That being said, the software plots/displays the original ground for profiles and cross sections using the terrain feature symbology.

The key properties of a terrain feature include **Name**, **Feature Definition Name** and **Display Features**.

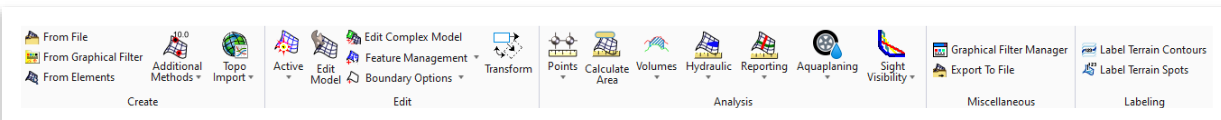
Take Note!

Display Features, such as contour spots, breaklines, boundary, contours, triangle, islands, holes and voids are controlled directly from the feature definition assigned to the terrain. They can be turned on and off as necessary and are not separate graphics.

3.6.2 Terrain Tools

The **Terrain** tab houses all the tools necessary to create, import and/or edit digital terrain models (DTM) (Figure 50). A DTM is a new ORD element. It is contained within the DGN file and it is part of the Field Book data when created directly from the imported field data. In this manual, we will focus on the **Create** tools and some of the **Edit** tools.

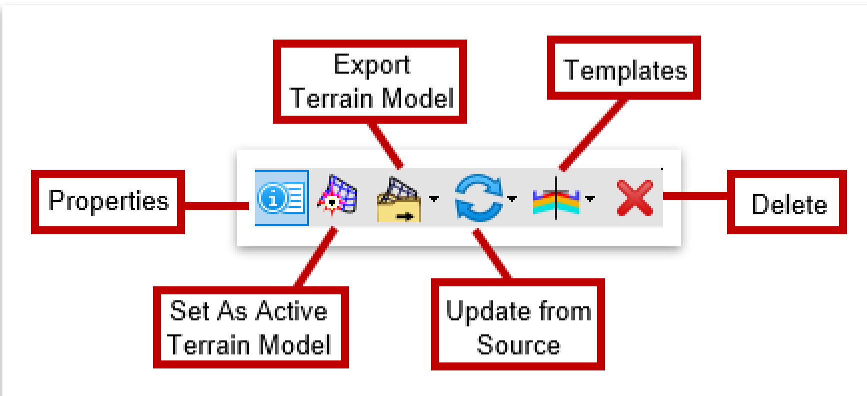
FIGURE 50. TERRAIN TOOLS



3.6.3 Heads-Up Display – Terrains

The heads-up display options for **terrains** are shown below (Figure 51). The user can access all the edit tools by selecting the terrain boundary in the file. To visualize the heads-up display for points, select (left click) the element and then hover the cursor over the element until it appears. This tool will be utilized in the upcoming exercises.

FIGURE 51. HEADS-UP DISPLAY: TERRAINS

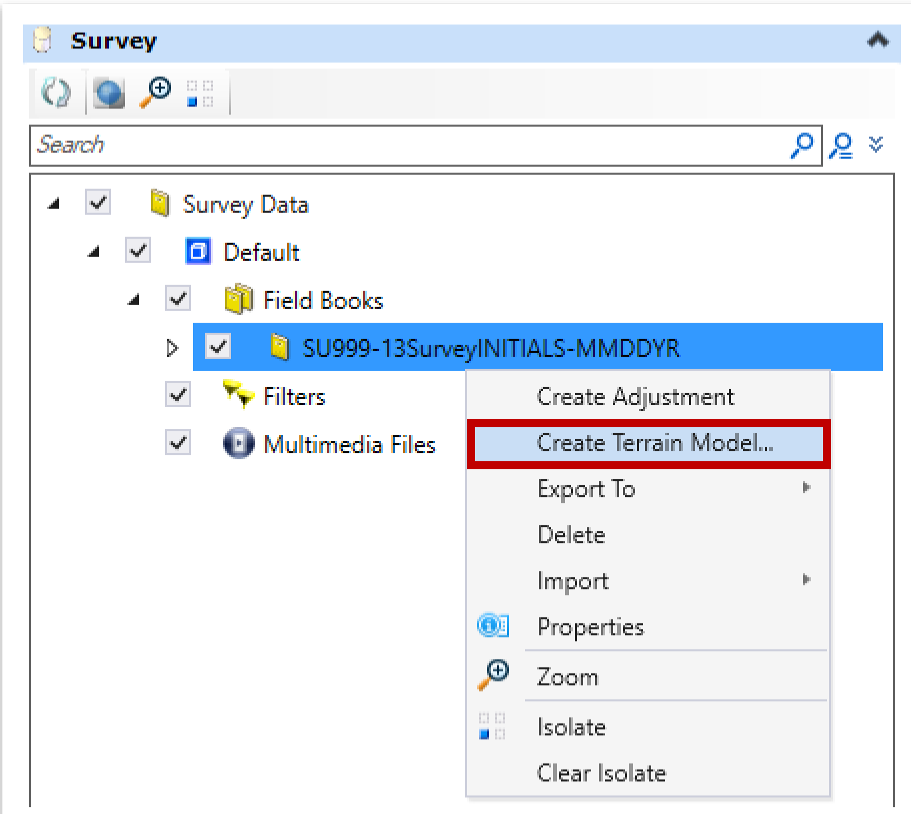


- **Set As Active Terrain Model:** Used to set the terrain to active. The active terrain is used by other tools, such as existing profiles and corridor templates.
- **Export Terrain Model:** Used to export the ORD terrain element. There are several options available, but the most ideal option would be a **LandXML** for construction applications.
- **Update from Source:** Used to update a terrain from the original source. This is used when a terrain is being referenced in a DGN file and needs refreshing.
- **Templates:** Used to select a linear or corridor template to apply to an element within the file. This tool is mainly used in design to create quick 3D models of specific objects.

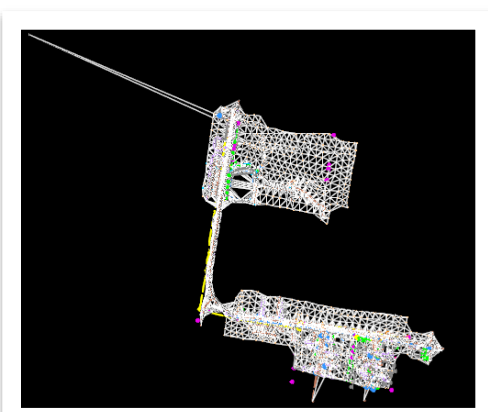
3.6.4 Exercise: Terrain Model Creation – Survey Text Files

In this exercise, we will create a terrain model from the previously imported survey text files and then look at different terrain properties before exporting to a TIN file. This method will be the most commonly used to create the initial terrain model. Since we did quite a bit of editing in the previous file, we will open back up the **Survey Model.dgn** file.

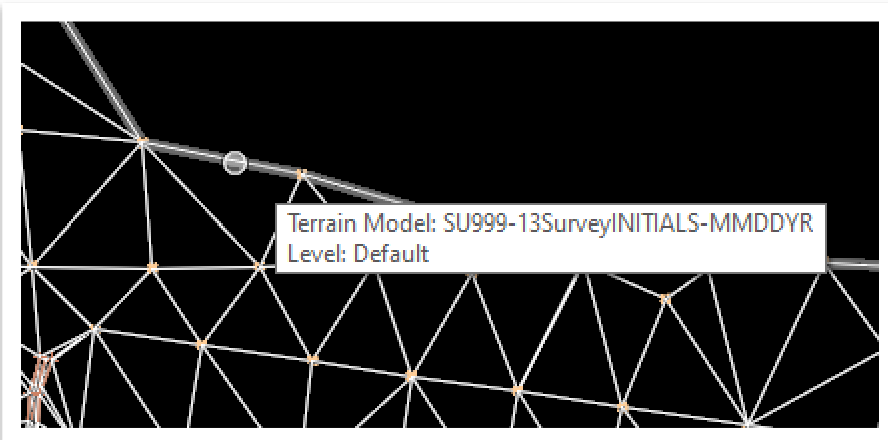
1. Within the **Explorer**, expand the **Survey** tab (if not already). Right click on your **SU999-13SurveyINITIALS-MMDDYR** field book and select **Create Terrain Model**.



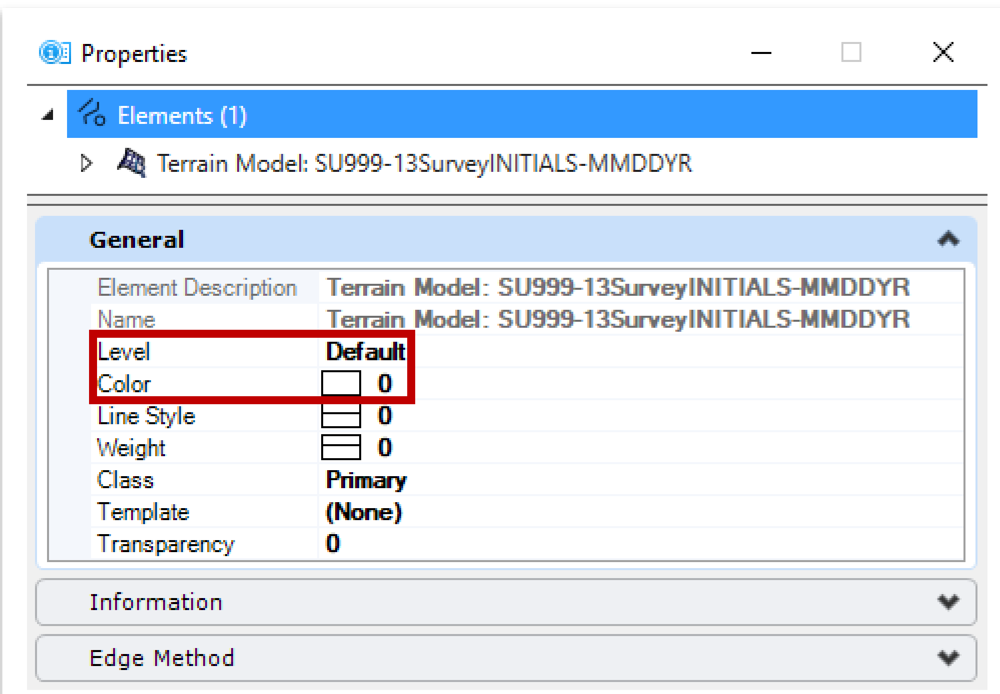
2. Notice the white triangulated terrain that is created.



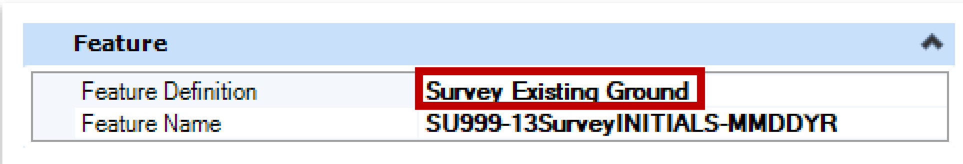
3. Select the border of the triangulated terrain and then open the **Properties** (**Survey >> Terrain >> Primary**). **Note:** You could also open the Properties within the heads-up display.



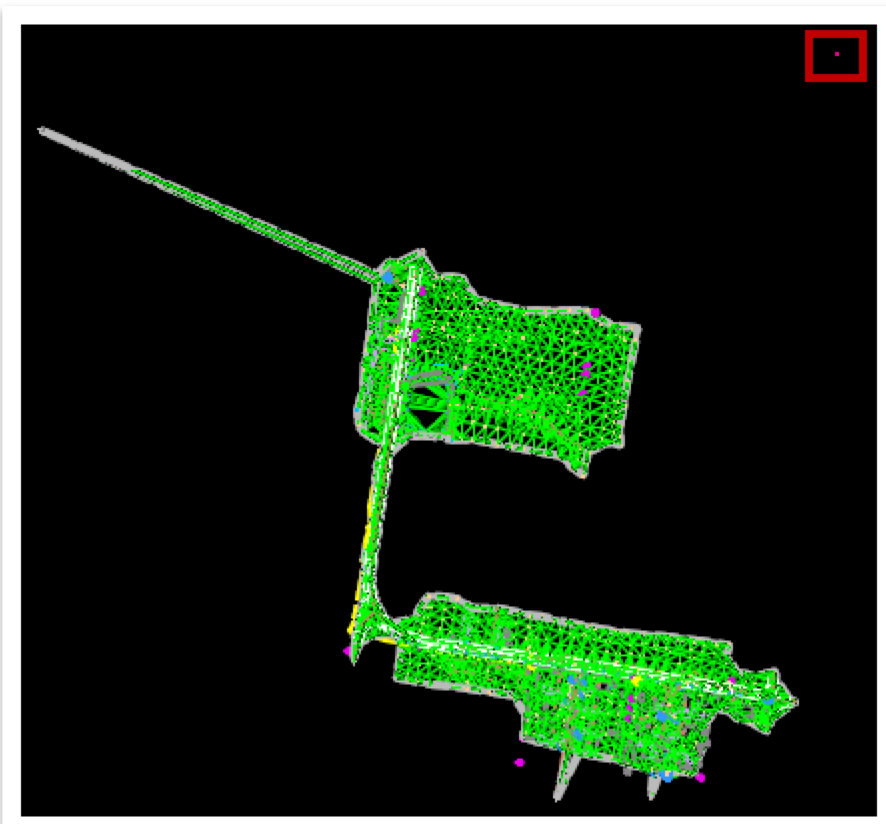
4. Within the **Properties**, expand the **General** tab. These settings show the name and description of the terrain model, as well as all the level symbology. Notice that the level is set to **Default** and the color is set to **zero**. Obviously, these are not the TDOT standards. We will resolve this issue by setting the terrain **feature definition** in the next step.



5. Within the **Properties**, expand the **Feature** tab. Left click within the **Feature Definition** field and notice a drop-down arrow appears. Click the arrow and then expand **Terrain** and select **Survey Existing Ground**.

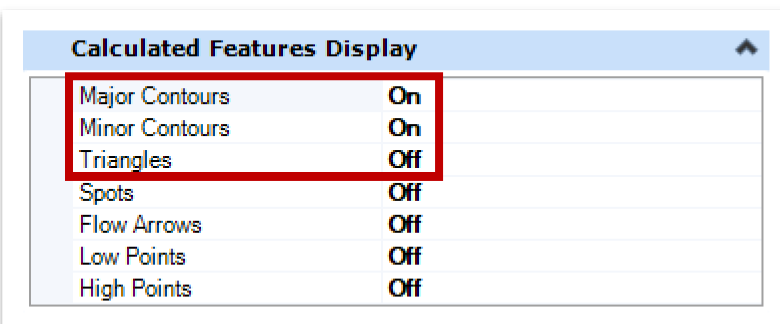


6. Notice that the terrain updated to the correct symbology. There is at least one **point** that shouldn't have been included in the terrain model (**STC863** in the upper right), which we will address in the next step.



7. To exclude the point from the terrain model, first zoom in to point **STC863**. Select the point and then left click within the **Determine By Feature Definition** orange text. Within the drop-down menu, change the terrain attribute to **Do Not Include**. If the orange text doesn't update initially, left click anywhere within the drawing window to deselect the point and then select it again to notice the update. **Note:** The **Names** decoration was turned on for the screenshot.

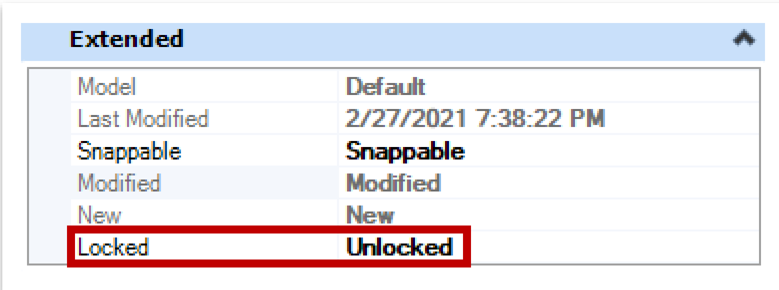
8. Next, let's turn off the triangles and turn on the **contours**. Select the terrain boundary and then expand the **Calculated Features Display** tab within the **Properties**. Toggle the **Major** and **Minor Contours** fields to **On** and the **Triangles** field to **Off**. **Note:** You can either change the toggle using the drop-down option within the applicable field <u>or</u> simply double click in the field to switch between.



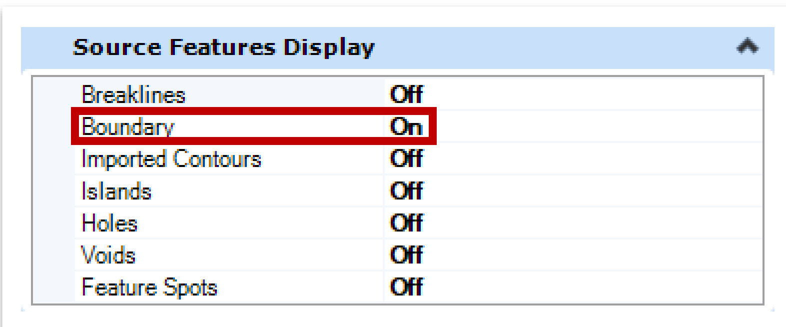
Take Note!

*The contours are a feature of the terrain and are not physically drawn in the dgn file. In ORD, they should be turned on/off utilizing the toggle within the terrain **Properties**.*

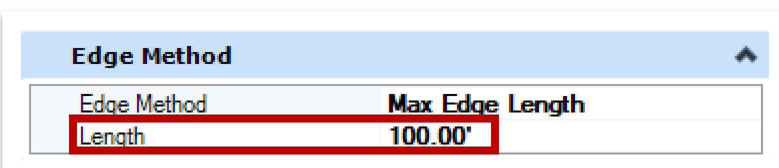
9. It should be noted within the **Extended** tab that the terrain is **Unlocked** by default. It is recommended to **Lock** it to avoid any changes to the original data. However, for this exercise, we will leave the terrain unlocked while exploring other properties.



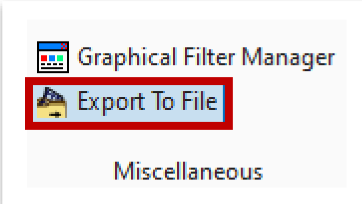
10. Now, expand the **Source Features Display** tab. The most important feature to turn on is the terrain **Boundary**. By default, notice that it is **On**, which is based on the feature definition we selected previously. Other feature definitions have other defaults that you may want to see displayed automatically.



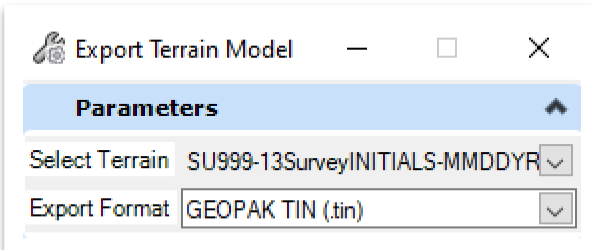
11. Lastly, expand the **Edge Method** tab and make sure the **Length** is set to **100.00'**. The **Edge Method** field allows you to determine the triangulation option for the DTM. The **Max Edge Length** option allows you to set the maximum length for triangulating around the edge of a DTM. The other two options are **None** and **Sliver**. The **None** option keeps all external triangles and the **Sliver** option dissolves long thin external triangles based on a formula that is hard coded within the software.



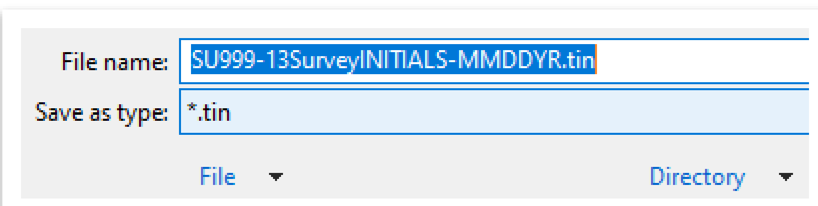
12. Now that we have reviewed the properties, we need to export the terrain and create a **TIN** file. Open the **Export To File** tool (**Survey >> Terrain >> Miscellaneous**).



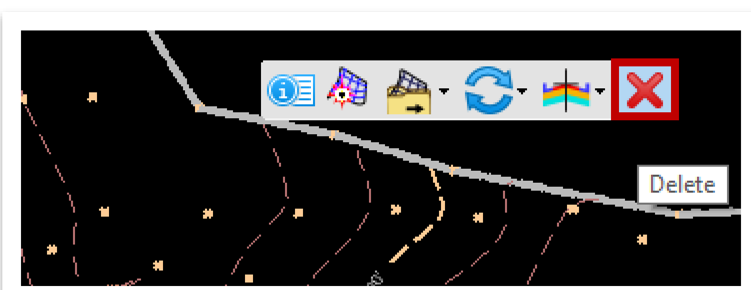
13. Within the **Export Terrain Model** dialog box, select the following settings.
    a. **Select Terrain:** SU999-13SurveyINITIALS-MMDDYR
    b. **Export Format:** GEOPAK TIN (.tin)



14. Left click to accept the settings. You will be prompted to save the TIN file. By default, the software should open to your workset dgn subfolder location and pre-populate the file name with your field book name. We will leave the name as-is for this exercise. Go ahead and click **Save**.



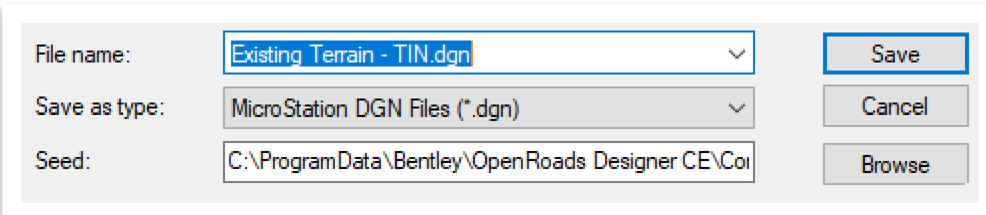
15. Now, for an actual project, you would then left click to select the terrain boundary and click **Delete** in the heads-up display so that it is removed from the **Survey Model.dgn** file. As a reminder, the existing terrain will now be submitted as a separate dgn file utilizing the **import** process, which is shown in the next exercise with a pre-created TIN file.



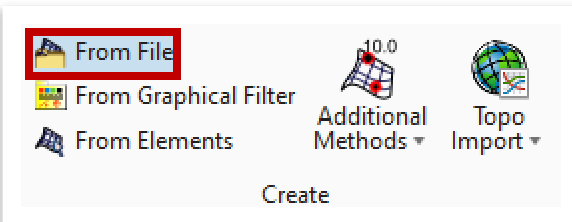
3.6.5 Exercise: Terrain Model Creation – TIN File

In this exercise, we will create a terrain model from a TIN file and then look at different terrain properties. In additional to TIN files, other file formats that can be utilized are XYZ (text files), LandXML, Lidar (LAS), Digital Elevation Models (DEM) and others. <u>This method is the second part to creating the existing terrain dgn file</u>.

1. Create a new file and name it **Existing Terrain – TIN**. Select the **TDOTSeed3D. dgn** and click **Save**.



2. Open the **From File** tool (**Survey >> Terrain >> Create**).

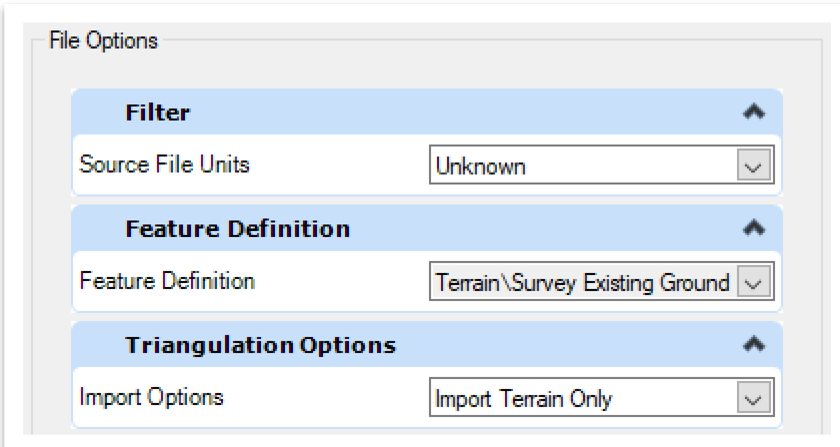


3. Select the **SU999-13 DTM.TIN** file within the **SURVEY_Training** workset dgn subfolder and click **Done**. Within the **Import Terrain Model(s)** dialog box, skip down to **File Options**.

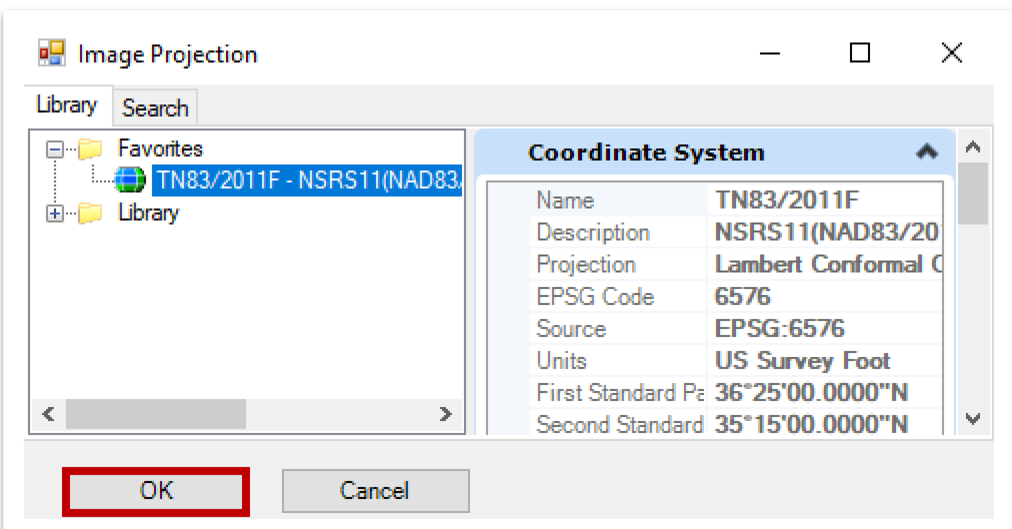
Take Note!

*If you are appending to an existing model, you will need to check the box and select a Terrain Feature Definition. However, **Projection should never be used because those projections are already completed in the survey software in which the data was collected**. Geographic Coordinate Systems (GCS) are needed to exchange files between ORD and GIS applications, and to inform downstream users that the files have a GCS.*

4. Under **File Options**, select the following settings.
   a. **Source File Units:** Leave as-is. This field will take care of itself and disappear once the geographic coordinate system is selected in the next step.
   b. **Feature Definition:** Terrain\Survey Existing Ground
   c. **Import Options:** Import Terrain Only



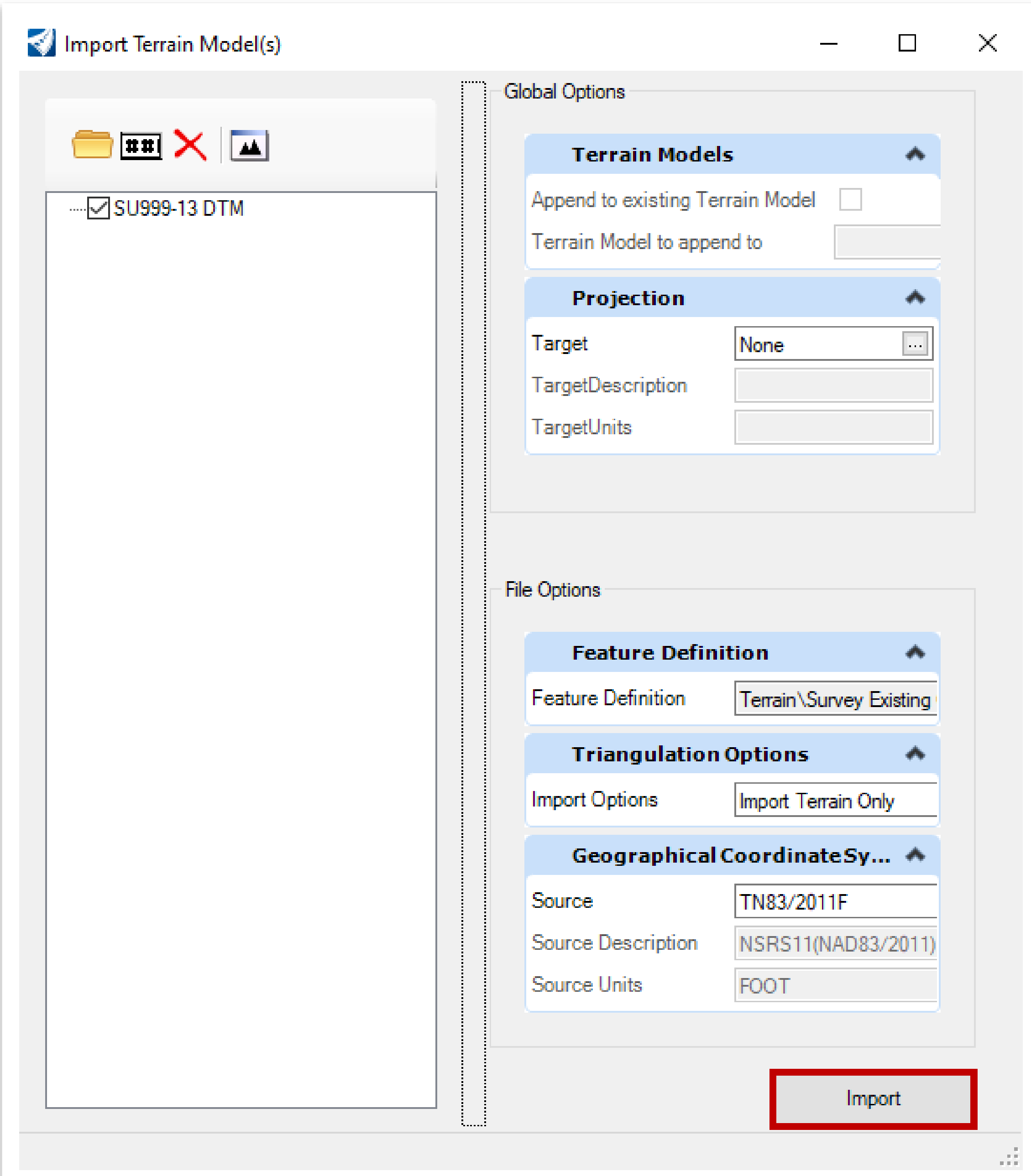
5. Under **Geographical Coordinate Systems**, click the ellipses next to the **Source** field. You should already have the correct coordinate system saved as a Favorite (**TN83/2011F – NSRS11 (NAD83/ 2011) Tennessee State Plane Zone, US Foot**) from earlier in the manual. If not, you can browse to it here: **Library >> Projected (northing, easting, …) >> North America >> United States of America >> Tennessee**. Once selected, click **OK**.



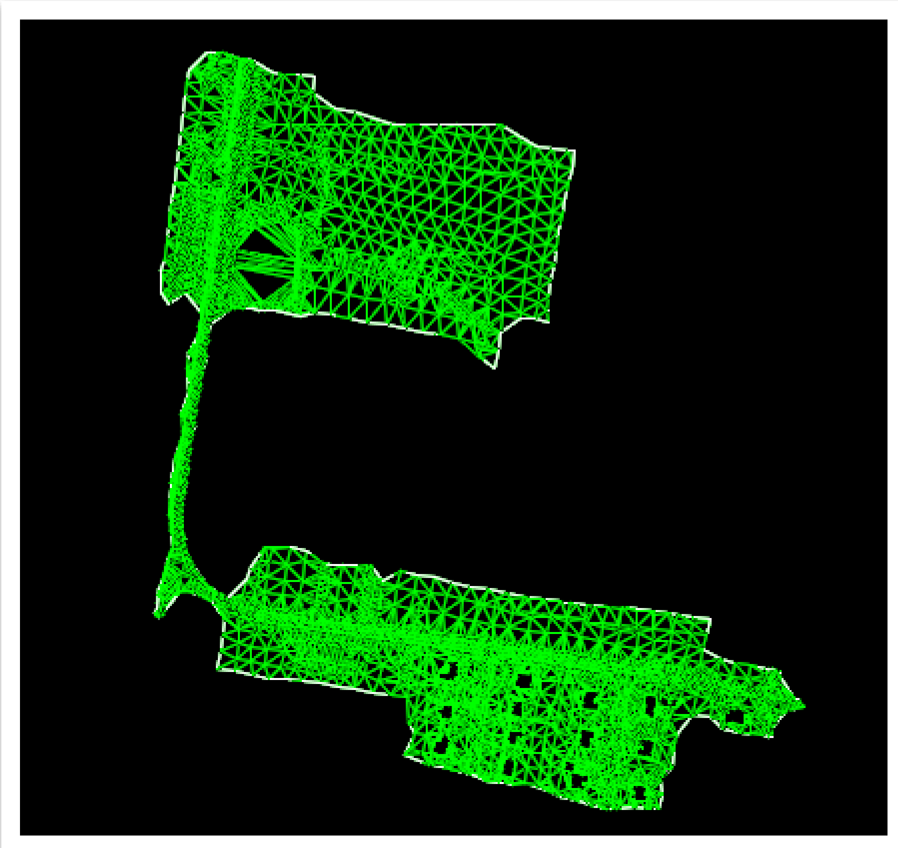
Take Note!

It is not recommended to set a projection target for your TIN models or other DTM's. To set up the Geographic Coordinate System, a GIS application such as ArcGIS or Google Earth can be used for the data exchange.

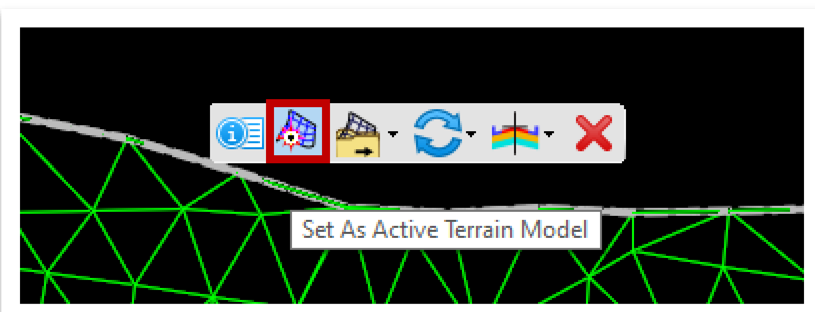
6. Next, click **Import** and then close the **Import Terrain Model(s)** dialog box once processed.



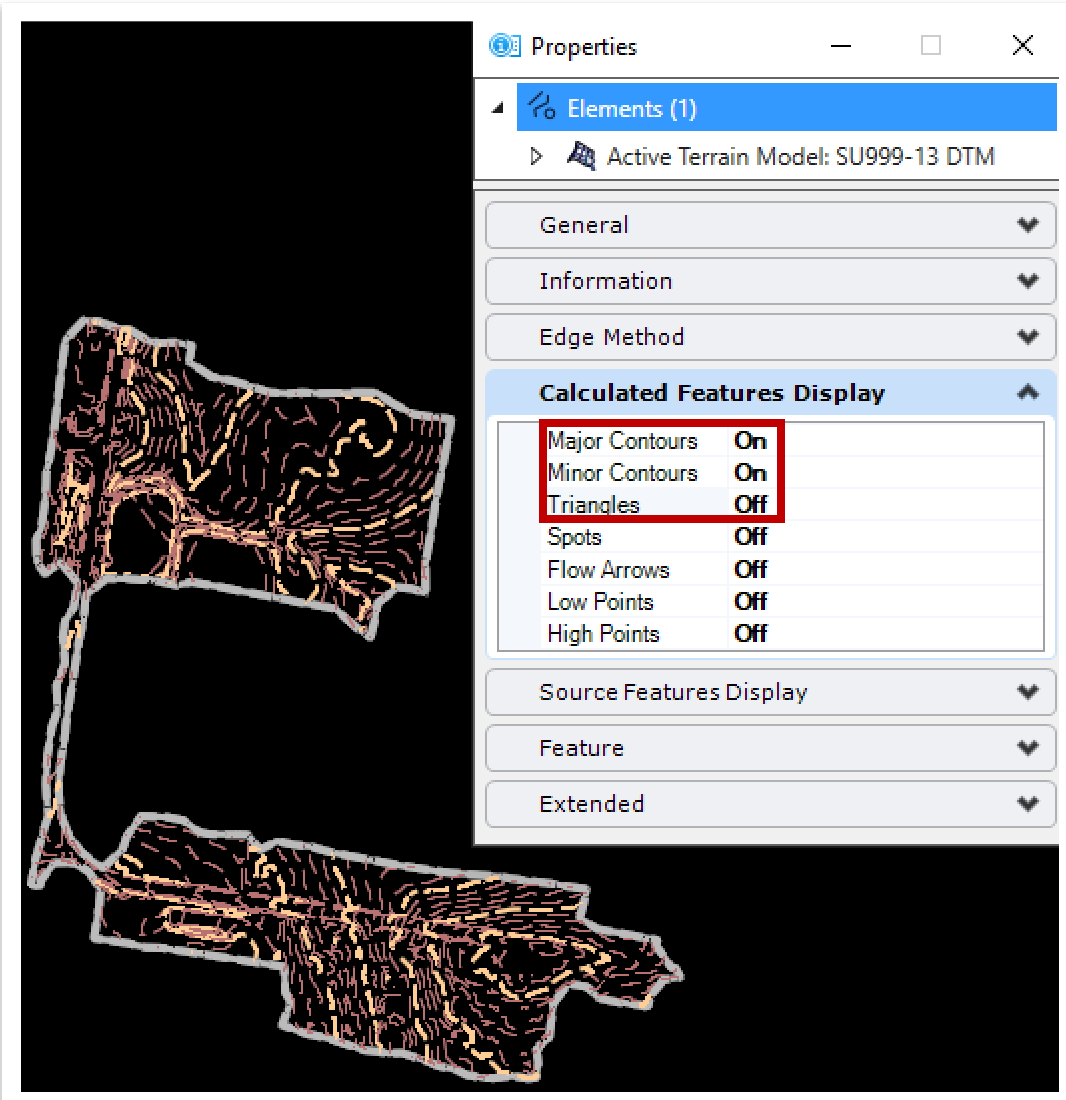
7. Click **Fit View** and review the model. It should look like the image below.



8. Select the **terrain** boundary and bring up the heads-up display. Click the second icon to **Set As Active Terrain Model**.



9. Now, with the terrain boundary still selected, open the **Properties** (**Survey >> Terrain >> Primary** or **Heads-Up Display >> 1st icon**). Expand the **Calculated Features Display** tab and toggle the **Major** and **Minor Contours** fields to **On** and the **Triangles** field to **Off**.



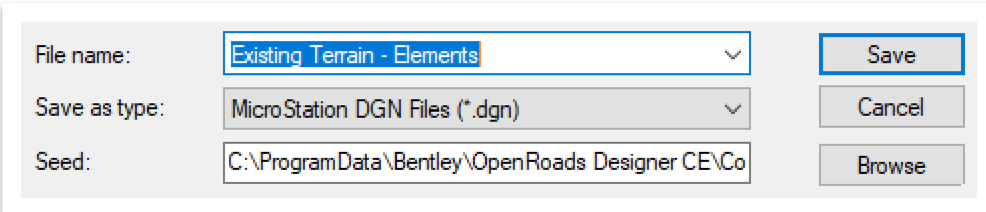
Take Note!

Create From Graphical Filter is the next Terrain tool. However, this function is more applicable for roadway designers. Graphical filters are groups of graphic model elements and allow the user to create proposed design DTM's (e.g. Design Grading Surface, Design Roadway Surface).

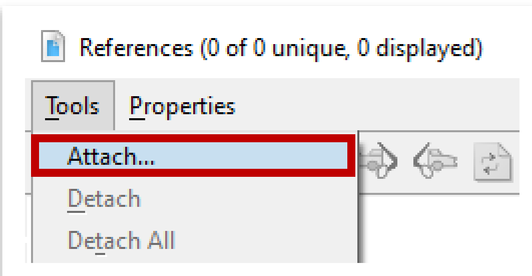
3.6.6 Exercise: Terrain Model Creation – Elements (Aerial Survey)

In this exercise, we will create a terrain model from 3D aerial graphics (points and breaklines) and then look at different terrain properties.

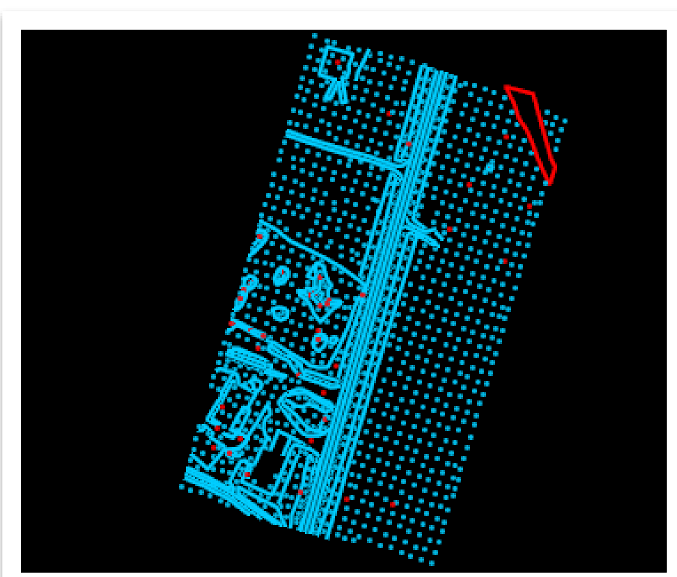
1. Create a new file and name it **Existing Terrain – Elements**. Select the **TDOTSeed 3D.dgn** and click **Save**.



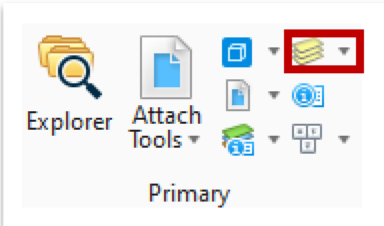
2. Open the **References** window (**Survey >> Terrain >> Primary**) and go to **Tools >> Attach**.



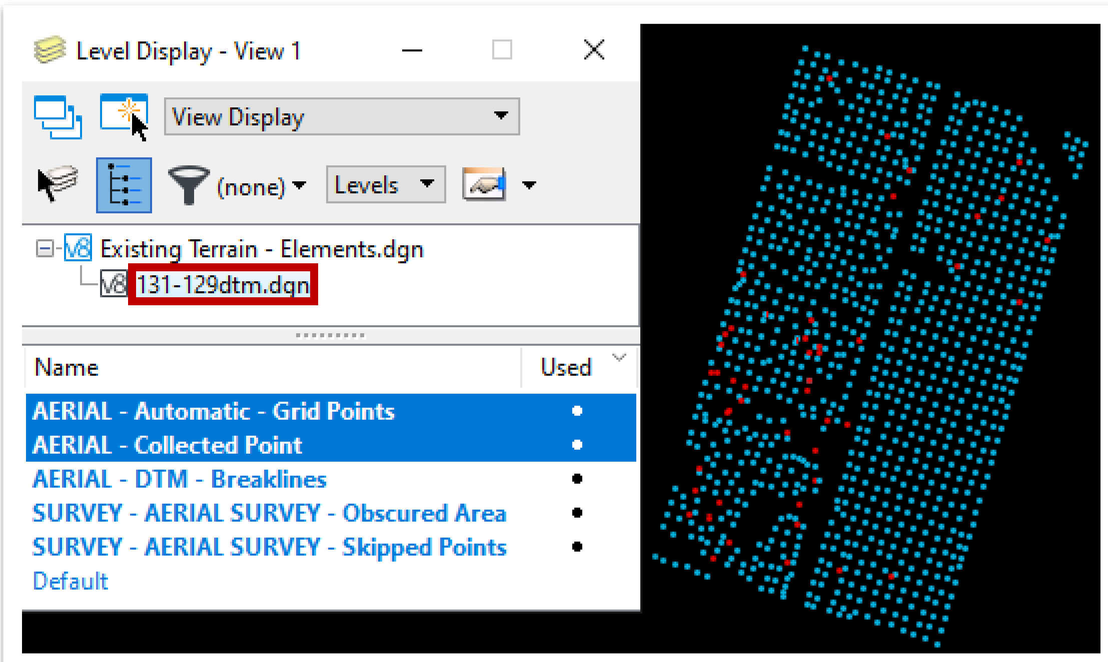
3. Select the **131-129dtm.dgn** file and set the **Attachment Method** to **Coincident World**. Click **Open** and then **Fit View** and notice the image below. Go ahead and close the **References** window. **Note:** If you kept **Attachment Method** set to **Interactive** in the **Attach Reference** window, you can select the correct orientation in the next window that appears and then click **OK**.



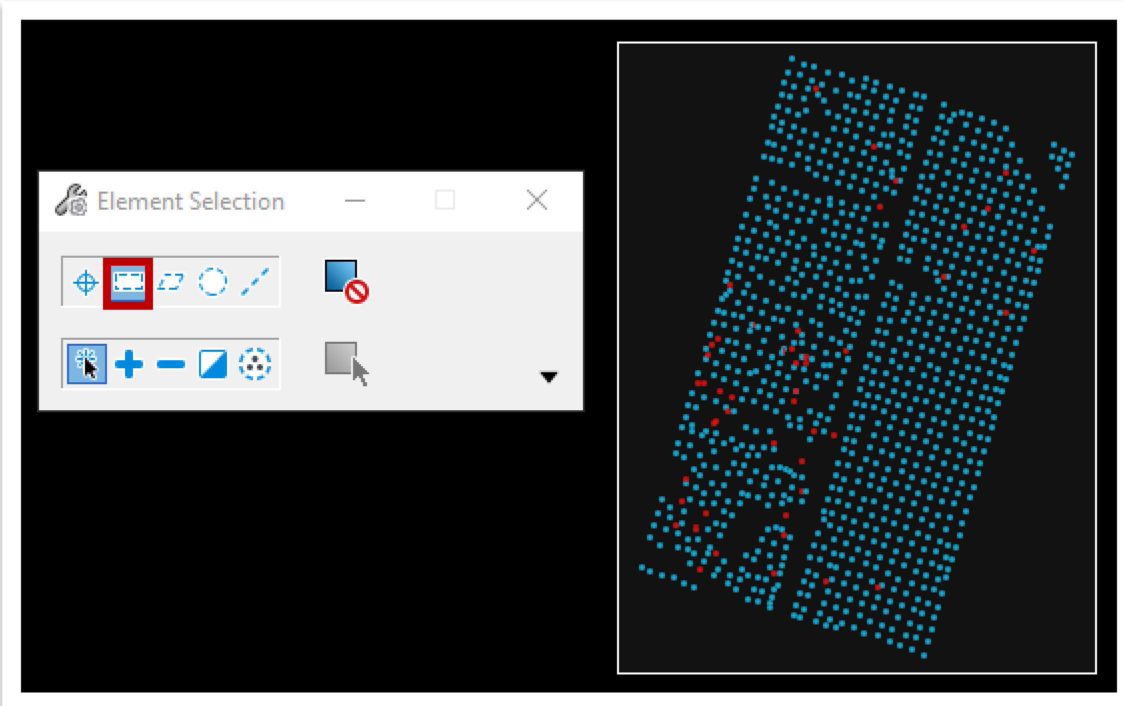
4. Next, open the **Level Display** (**Survey >> Home >> Primary**).



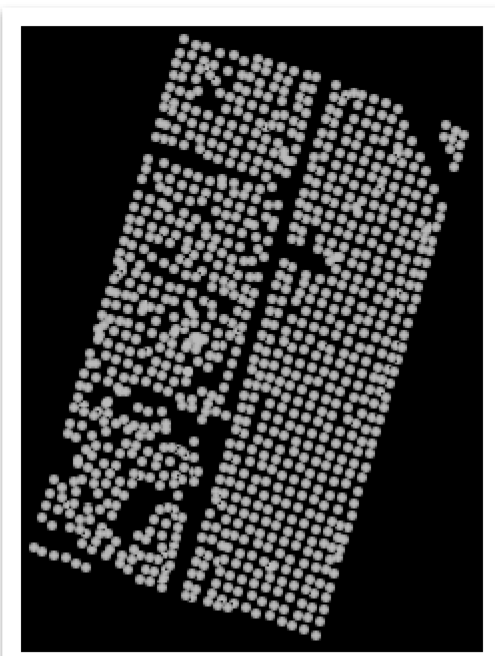
5. Select the **131-129dtm.dgn** reference file in the **Level Display** and **turn off** all levels except **AERIAL - Automatic - Grid Points** and **AERIAL - Collected Point**.



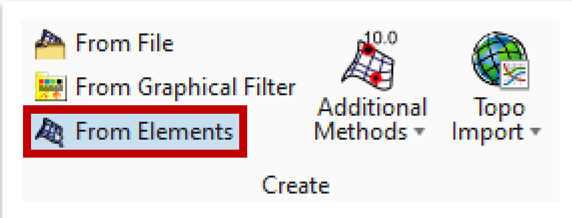
6. Now, open the **Element Selection** tool (**Survey >> Terrain >> Selection**) and select the **Block** method. Draw a rectangle around **all** points.



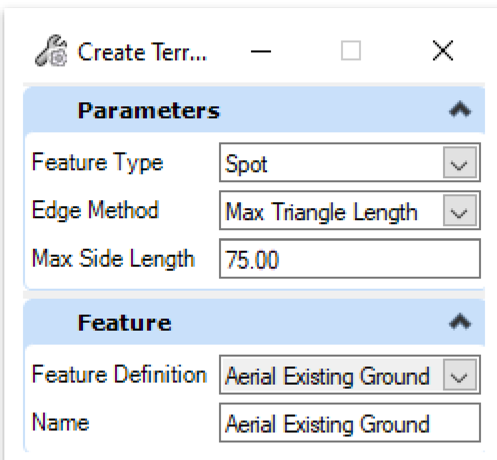
7. Your **selection set** should look like the image below. **Note:** Your highlight color might be set to a different color.



8. To create the terrain from the selected elements, open the **From Elements** tool (**Survey >> Terrain >> Create**).

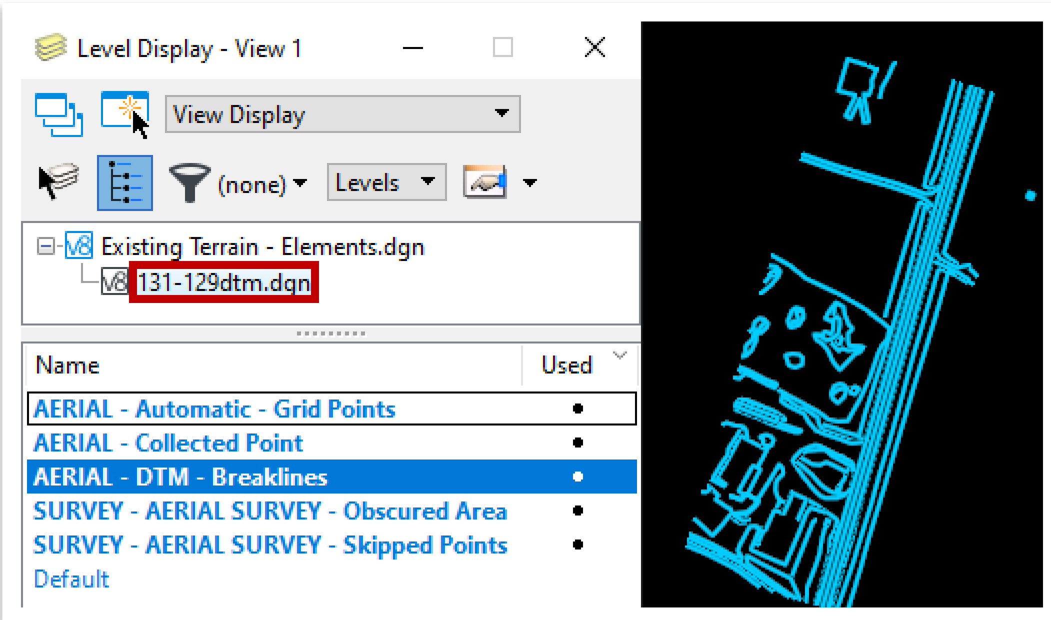


9. Within the **Create Terrain Model By Elements** dialog box, select the following settings.
   a. **Feature Type:** Spot
   b. **Edge Method:** Max Triangle Length
   c. **Max Side Length:** 75.00
   d. **Feature Definition:** Terrain >> Aerial Existing Ground
   e. **Name:** Aerial Existing Ground

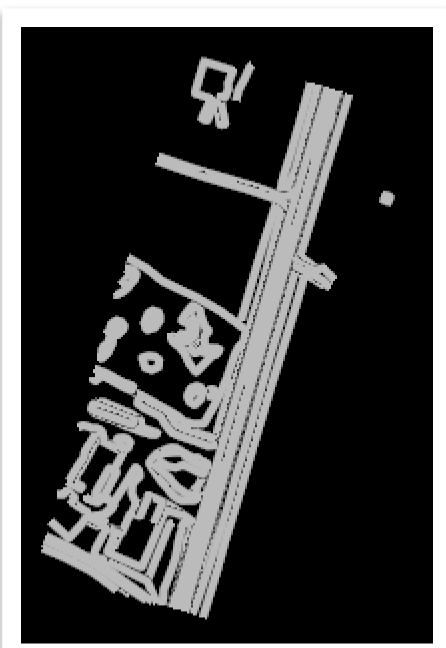


10. Left click once to add **all** selected elements and then left click through the remaining prompts to accept the terrain creation. Right click to clear the tool. You should notice that a terrain boundary has been created automatically.

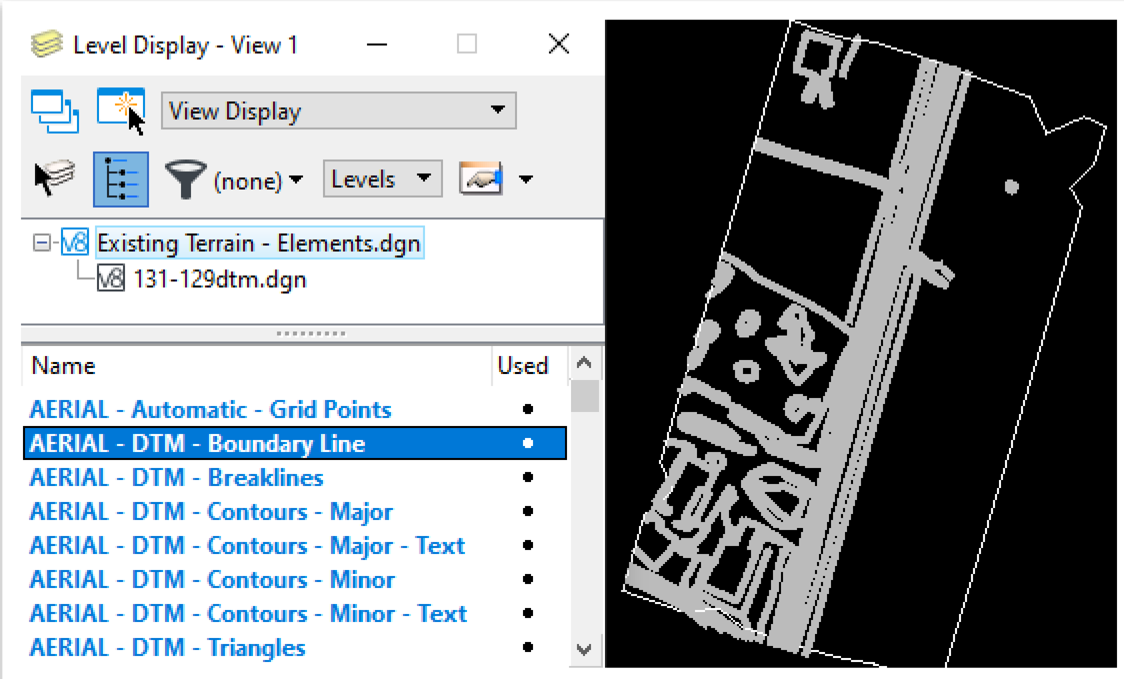
11. Now, we will repeat the process and add the **breaklines**. Within the **Level Display**, turn off all levels in the active file and then select the **131-129dtm.dgn** reference file. This time **turn off** all levels except **AERIAL - DTM – Breaklines**.



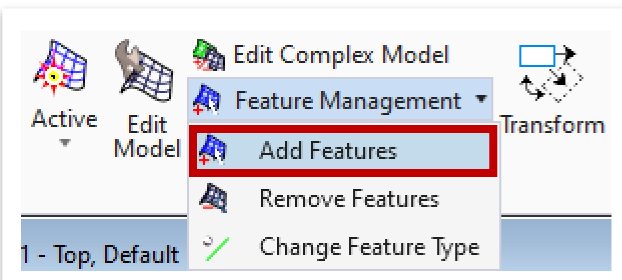
12. Next, open the **Element Selection** tool (**Survey >> Terrain >> Selection**) and select the **Block** method once again. Draw a rectangle around **all** breaklines. Your **selection set** should look like the image below.



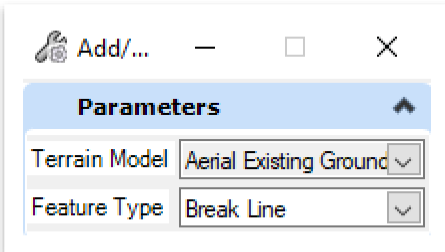
13. With the breaklines still selected, go back to the **Level Display** and turn on the **AERIAL - DTM - Boundary Line** level in the active file.



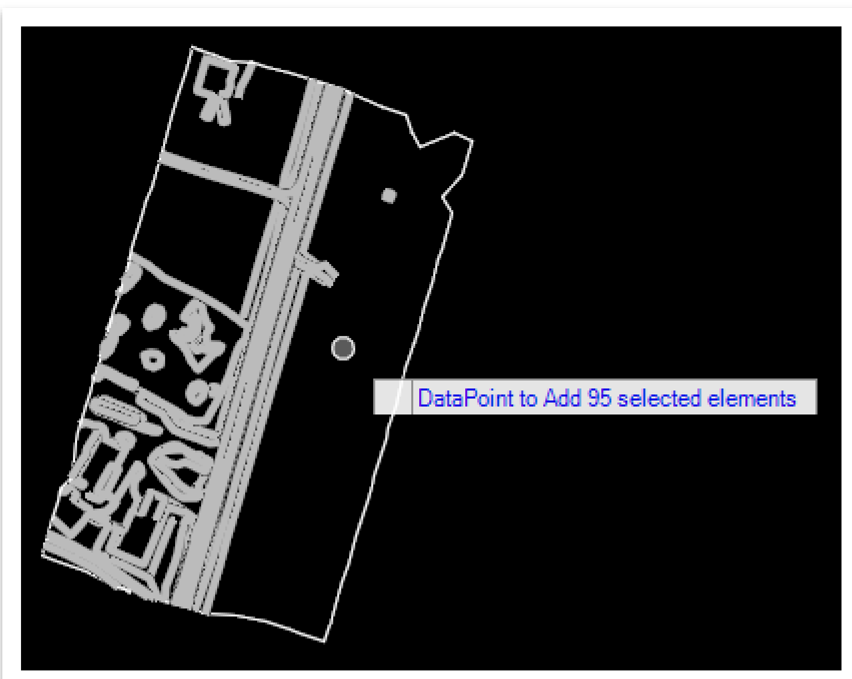
14. Open the **Add Features** tool (**Survey >> Terrain >> Edit >> Feature Management**).



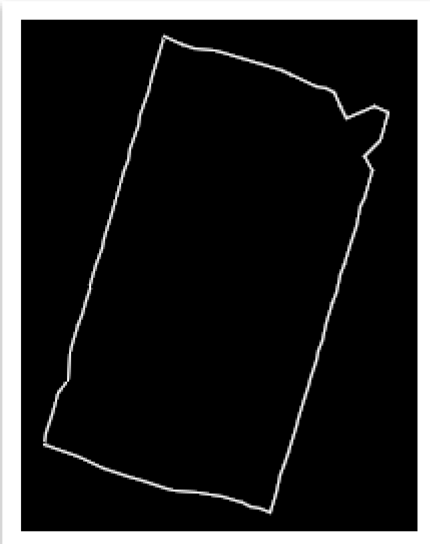
15. Notice the cursor prompt: **Locate Terrain Model To Add Elements**. You could select the terrain boundary line in plan view, but we will select the settings within the **Add/Remove Terrain Model Features** dialog box.
    a. **Terrain Model:** Aerial Existing Ground (if it was not set to Active Terrain)
    b. **Feature Type:** Break Line (if not already populated)



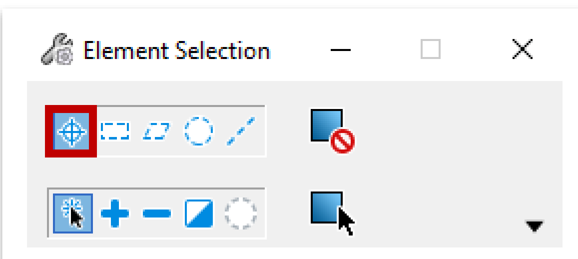
16. Notice the new cursor prompt: **DataPoint to Add 95 selected elements**. Left click to add the selected elements and then left click to accept the remaining prompts. Right click to clear the tool.



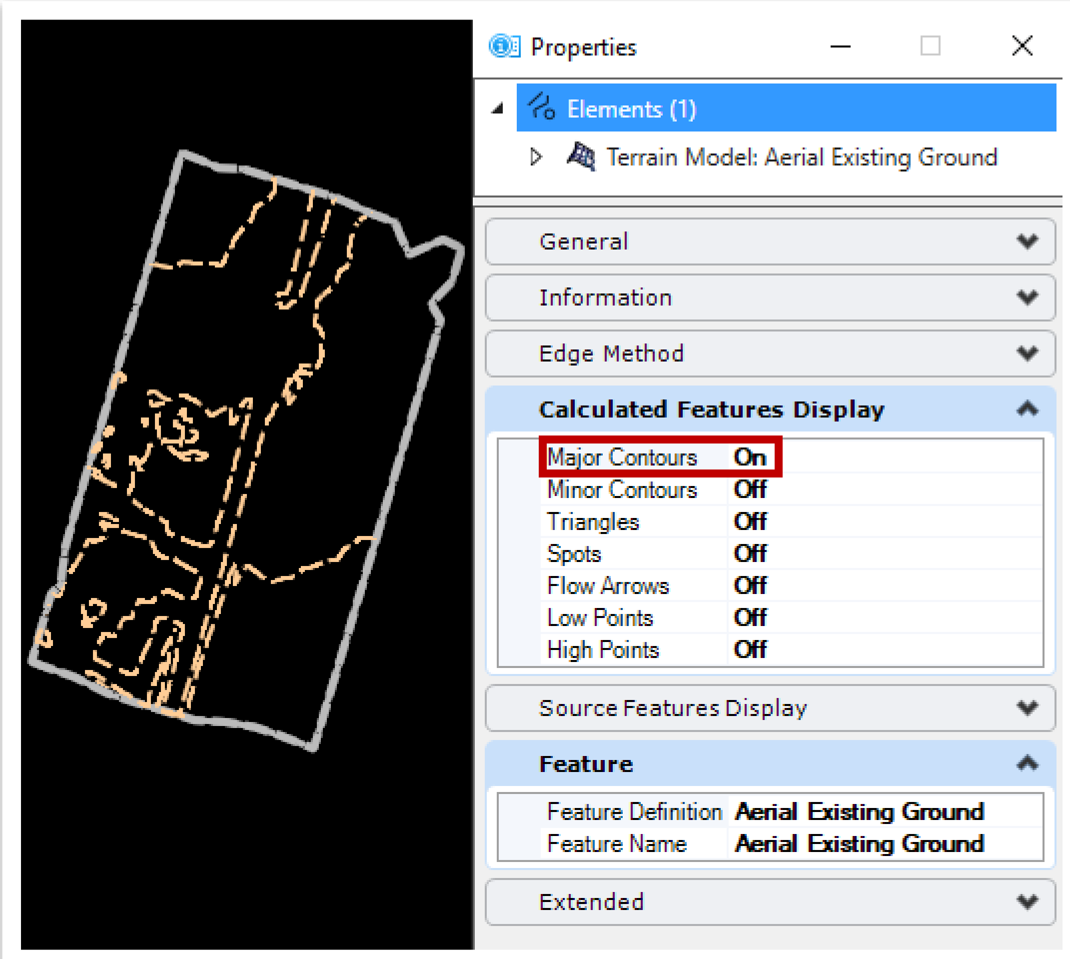
17. Now that the points and breaklines have been added, **turn off** all levels within the **131-129dtm.dgn** reference file and **turn on** all levels in the **active** file.



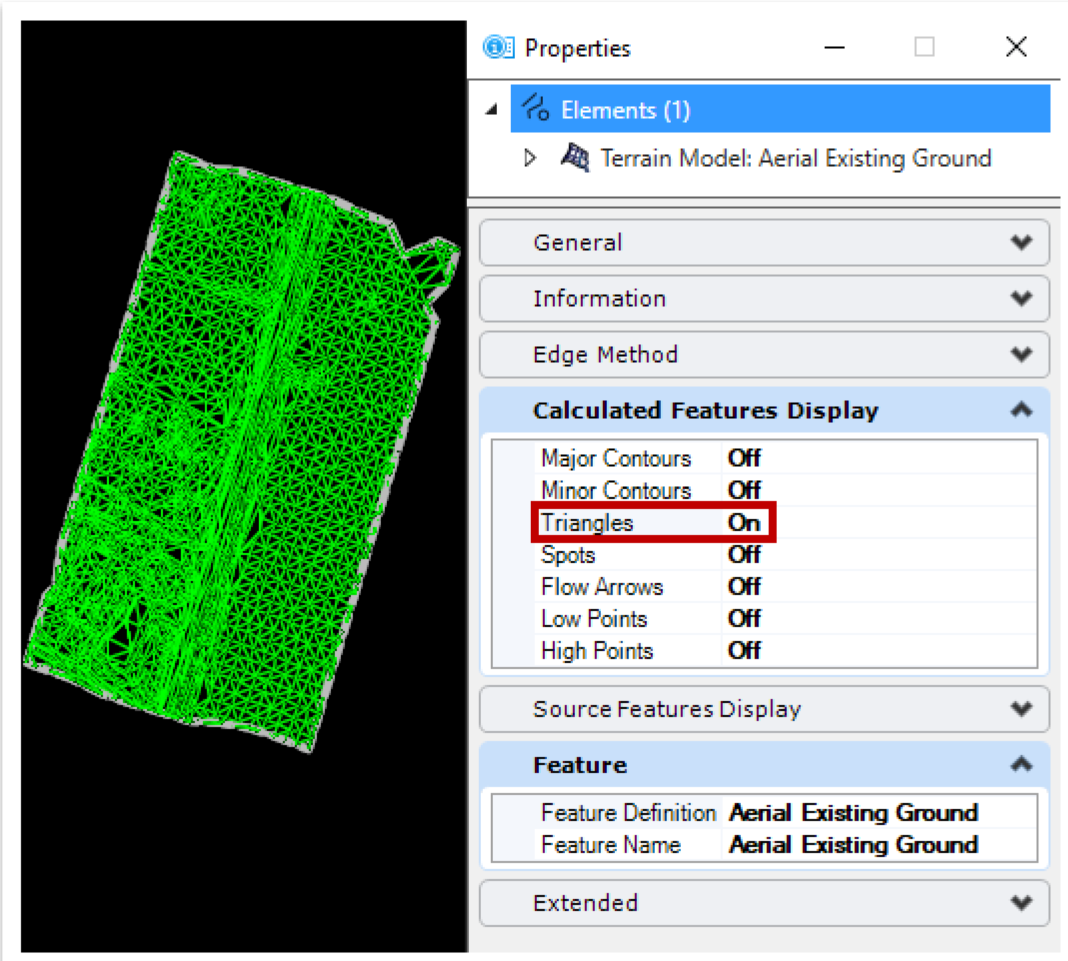
18. Next, open the **Element Selection** tool (**Survey >> Terrain >> Selection**) and select the **Individual** method.



19. Select the terrain boundary line and view the **Properties**. Expand the **Calculated Features Display** tab and turn on the **Major Contours**.



20. Lastly, turn off the **Major Contours** and turn on the **Triangles**.



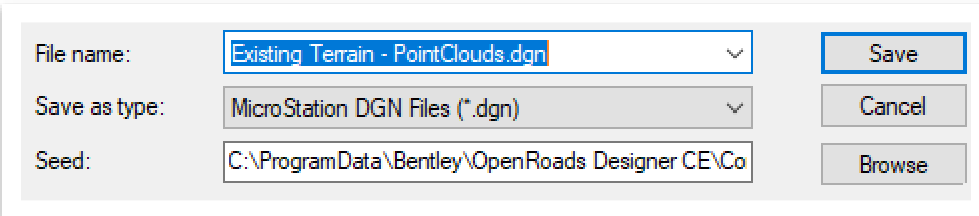
Take Note!

Terrain models are a civil element and feature definitions control the way they look and behave. The Properties dialog box will be the place to change Feature Definitions, Feature Name (terrain name) and Edge Method and where to turn Calculated Features (e.g. triangles and contours) on and off.

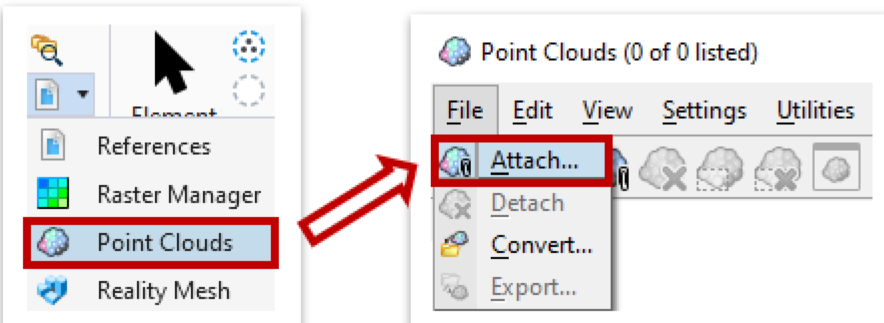
3.6.7 Exercise: Terrain Model Creation – Additional Methods

In this exercise, we will import a point cloud file into ORD and show how to create a terrain model with the Reality Modeling tools. It is recommended, however, that terrains are created in the point cloud software and classified, and then exported to import into ORD.

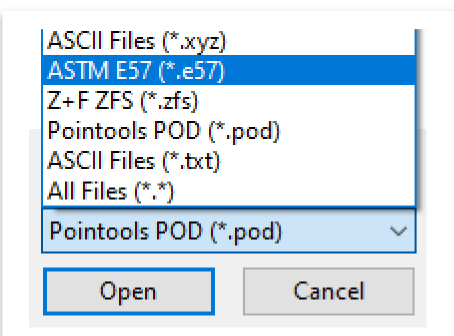
1. Create a new file and name it **Existing Terrain – PointClouds**. Select the **TDOT Seed3D.dgn** and click **Save**.



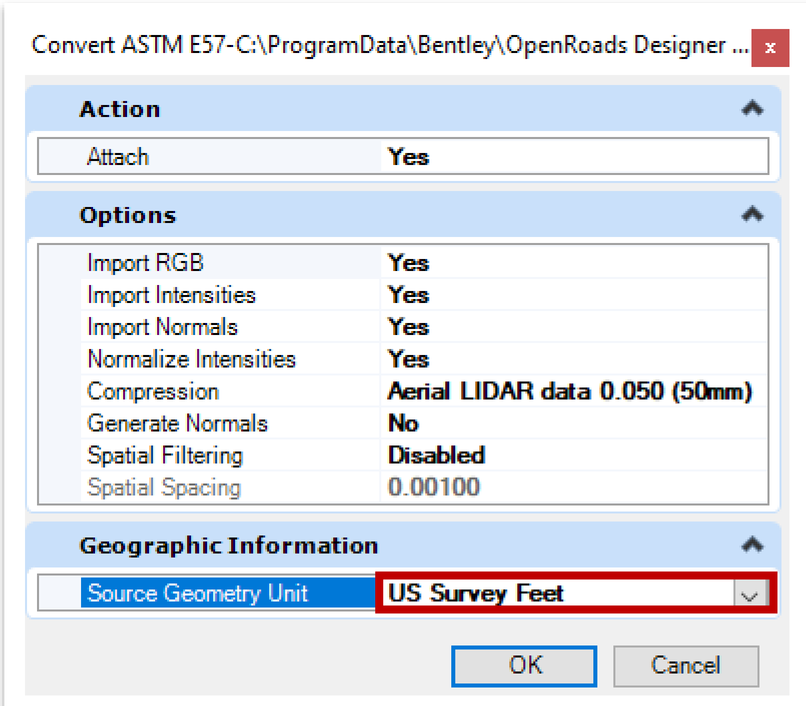
2. Open the **Point Clouds** window (**Survey >> Terrain >> Primary >> Attach Tools**) and go to **File >> Attach**.



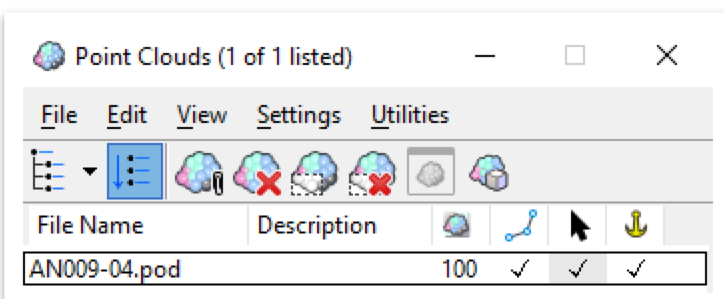
3. Change the file filter from **Pointools POD (*.pod)** to **ASTM E57 (*.e57)**.



4. Select the **AN009-04.e57** file and click **Open**. The following dialog will appear. We will assume that the **Source Geometry Unit** is **US Survey Feet**, so go ahead and update that field. Leave all other default values as-is and click **OK**.



5. A **Specify new pod file** window will appear. By default, the software will open to the **SURVEY_Training** workset dgn subfolder and pre-populate the file name with **AN009-04.pod**. Leave the file name as-is and click **Save**.
6. The software will now convert the **e57** file into an ORD **POD** file, so give it a few minutes to process. Once complete, notice that the file now appears in the **Point Clouds** window.



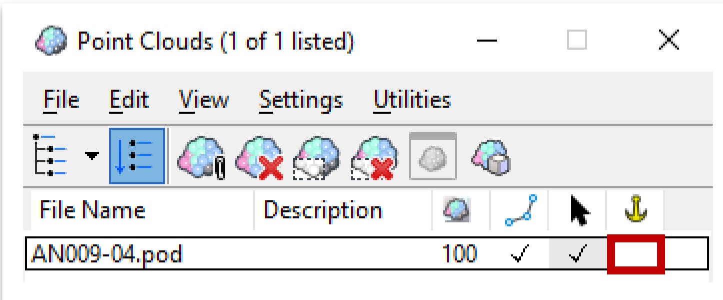
7. Click **Fit View** and notice the black and white extents of the point cloud.

Take Note!

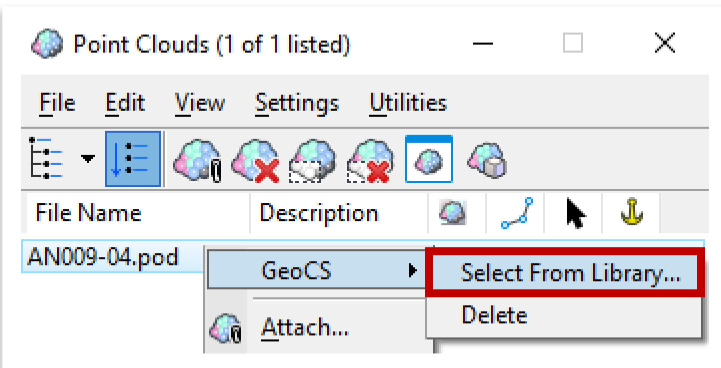
*Remember that **Lidar** files are very large, and the software may take some time to import. Also, consider processing the point clouds in the scanning software to add breaklines and reduce points to create a DTM for design. However, having the point cloud is useful for designers to analyze existing terrain conditions, so you will need to create a POD file using the import options shown in this exercise. It is not uncommon for the software to crash during the import. If that happens, simply re-open the file as needed.*

8. It is important that the point cloud be geospatially correct. Although its accuracy level is not obvious without any referenced data, we will assume that an adjustment is needed for this exercise. We will confirm the point cloud coordinate system and then scale it by the inverse of the datum adjustment factor. For this exercise, we will assume the same coordinate system that we have been using and then a **1.00009** datum adjustment factor. **Note:** It is recommended to apply a scale factor up front if the pod file will be used in final design.

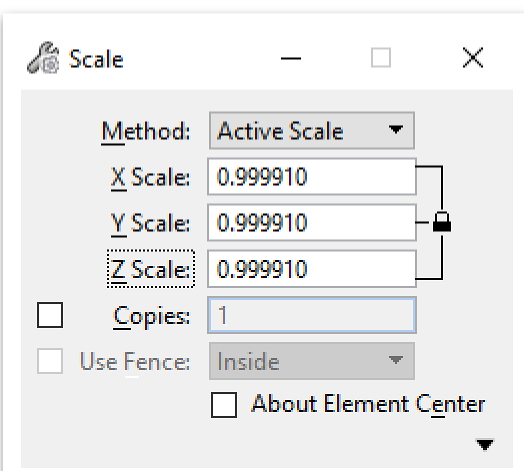
9. Within the **Point Clouds** window, toggle off the **anchor** column (highlighted below). This will allow us to make location edits to the point cloud.

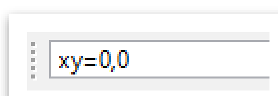


10. Right click on the pod file and select **GeoCS >> Select From Library**.

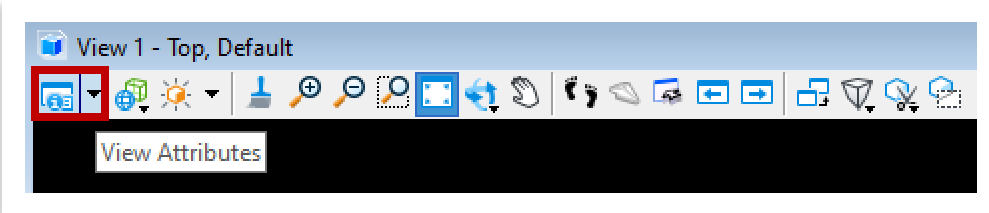


11. Confirm that the following coordinate system is selected: **TN83/2011F – NSRS11 (NAD83/ 2011) Tennessee State Plane Zone, US Foot**. **Note:** If you had set the coordinate system of the dgn file, this should already be selected.
12. Next, right click once again on the pod file and select **Scale**. Enter **0.999910** (inverse of 1.00009). Then, key-in **xy=0,0** in the **Key In** tool so that the point cloud will scale about the origin. Hit **Enter** to accept the scaling.

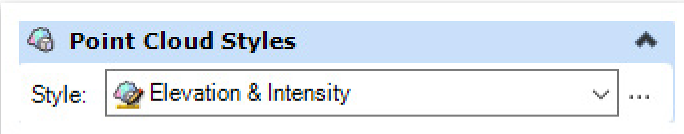


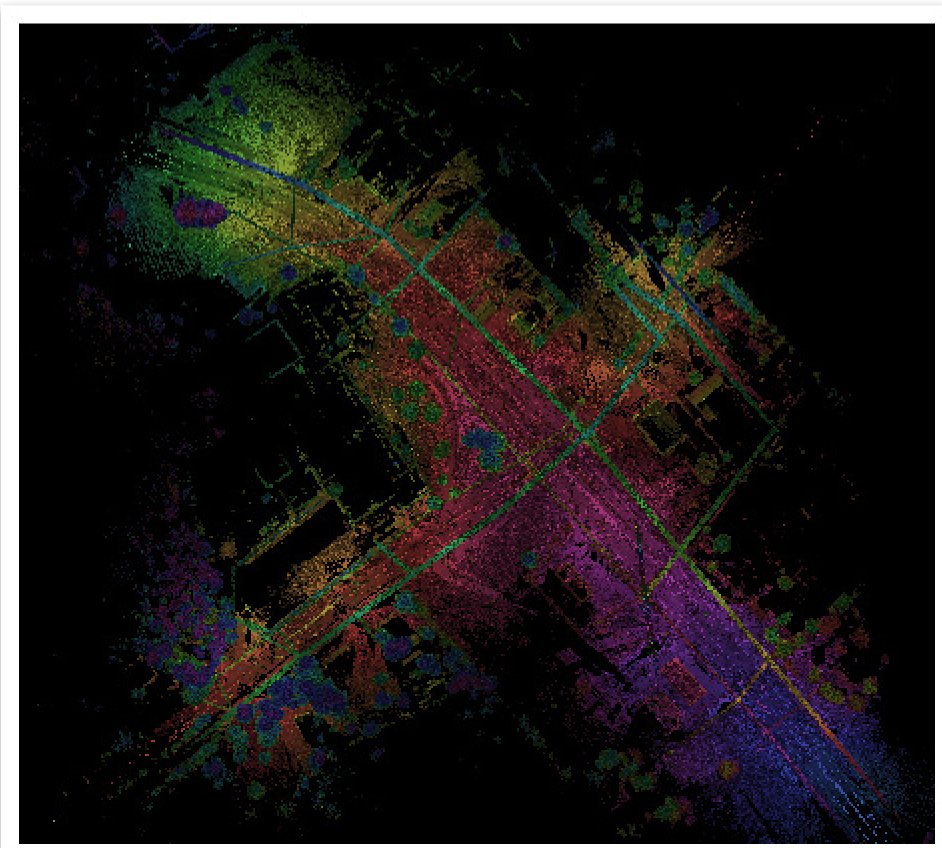


13. Now, open **View Attributes** in the upper left corner of **View 1 - Top, Default**.



14. Change the **Point Cloud Style** from None to **Elevation & Intensity** to see colors.



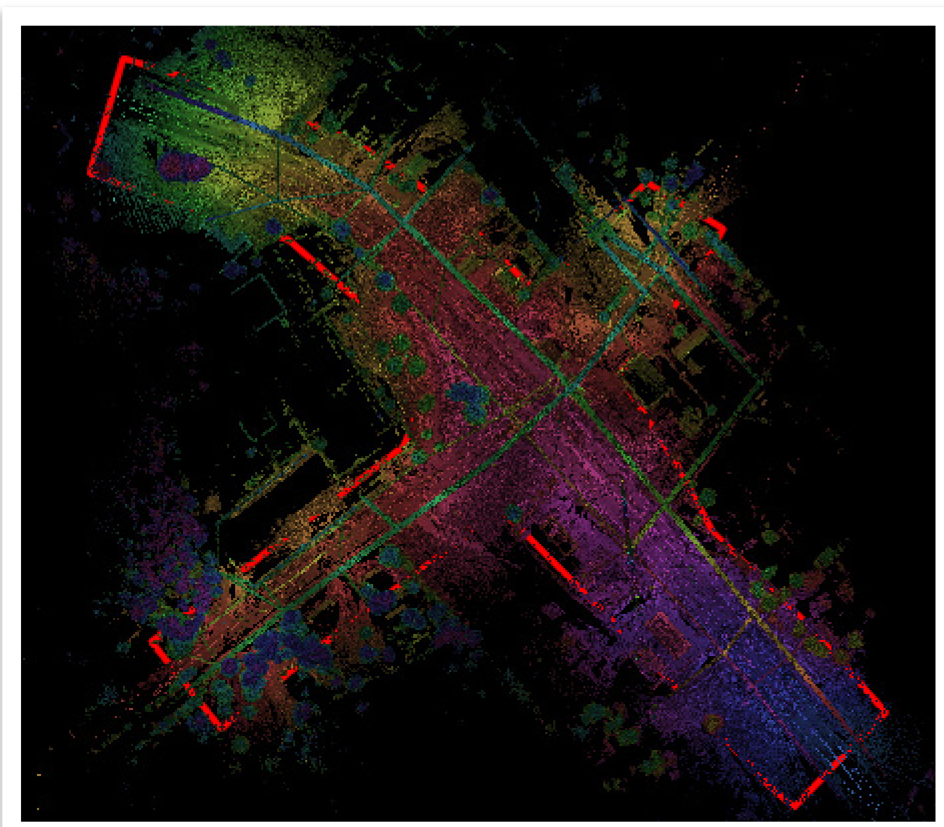


Take Note!

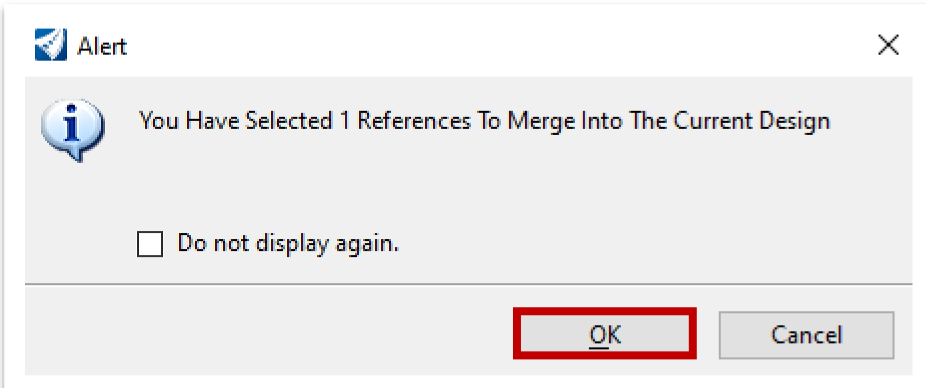
*Before we can create a **Terrain** model, we will need to clip the point cloud to the area from which we want to extract the ground. Since this is a terrestrial laser scan data set, we need to do a bit of manipulation to make sure that we do not include areas where the laser scanner could not reach the ground and thus have sparse point density.*

The process requires several steps, which include drawing the point cloud boundary, using Point Cloud tools to clip the area outside of the desired boundary, and using Reality Modeling workflow tools.

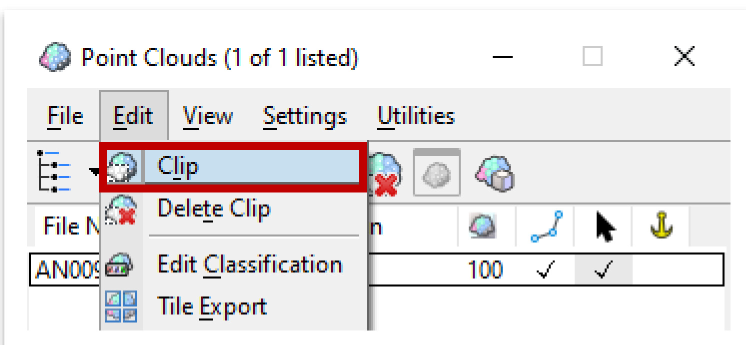
15. Next, open the **References** window (**Survey >> Terrain >> Primary >> Attach Tools**) and attach the **Point_Cloud_Boundary.dgn** file. Make sure to and set the **Attachment Method** to **Coincident World** and then click **Open**. This file contains a previously drawn red boundary. For an actual project, you would need to draw the boundary in this file based on your specific data set. **Note:** The boundary should be drawn to avoid areas where the laser scanner could not reach the ground.



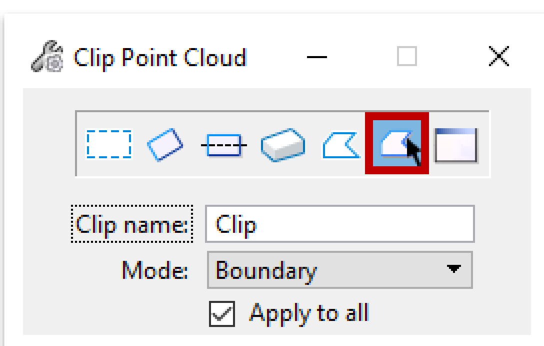
16. The boundary <u>must</u> be in the active file, so now we need to **merge** the reference file into the master file. Within the **References** window, right click on the **Point_Cloud_Boundary.dgn** reference file and select **Merge Into Master**. Notice that a **Merge References** window appears. Go ahead and leave both boxes unchecked for this exercise. Left click anywhere within the drawing and you should get an **Alert**. Click **OK** to accept and notice the file will disappear from the **References** window. Go ahead and close the References window once you are done.



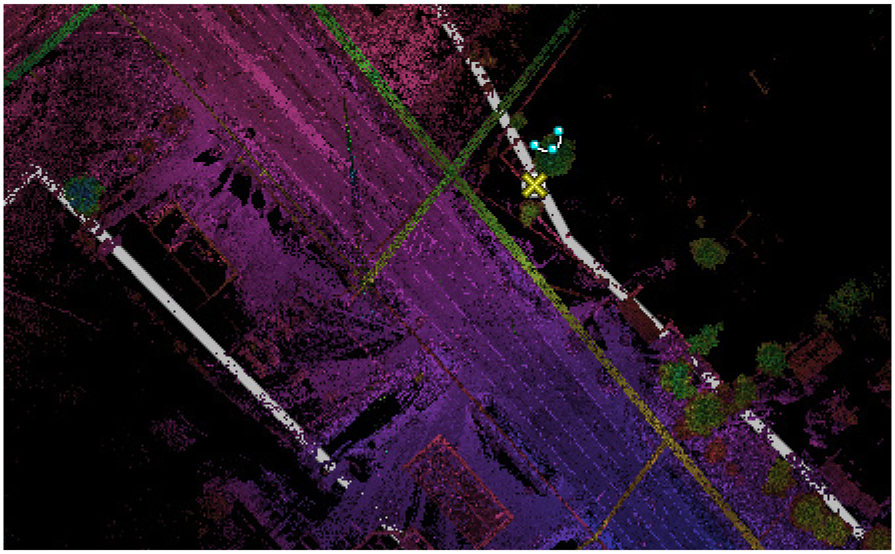
17. Now, open the **Point Clouds** window once again (**Survey >> Terrain >> Primary >> Attach Tools**) and select the **AN009-04.pod**. Go to **Edit >> Clip** (or 4th icon from the right).



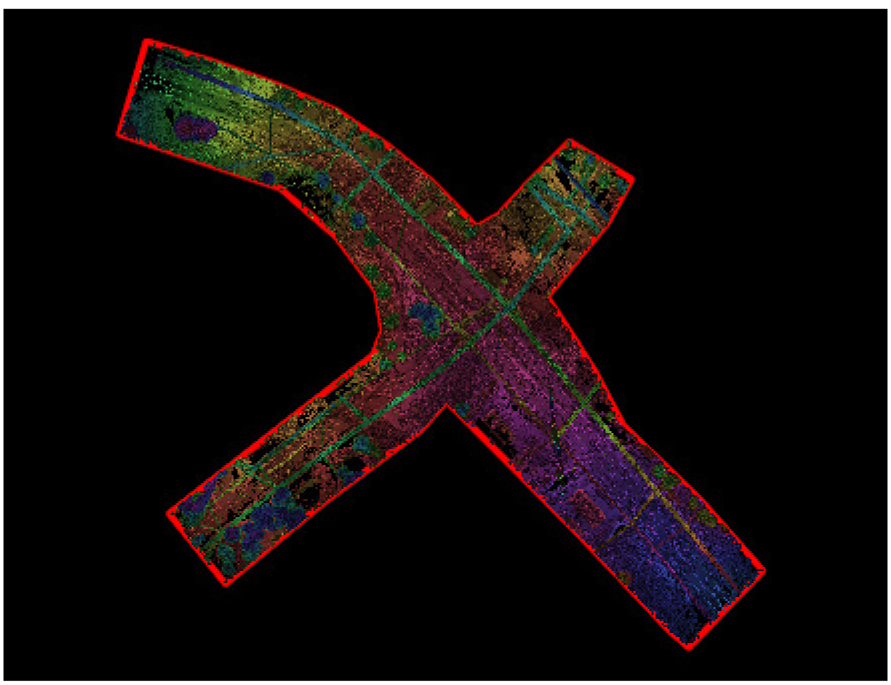
18. Within the **Clip Point Cloud** dialog box, select the **Element** clipping method (2nd icon from the right).



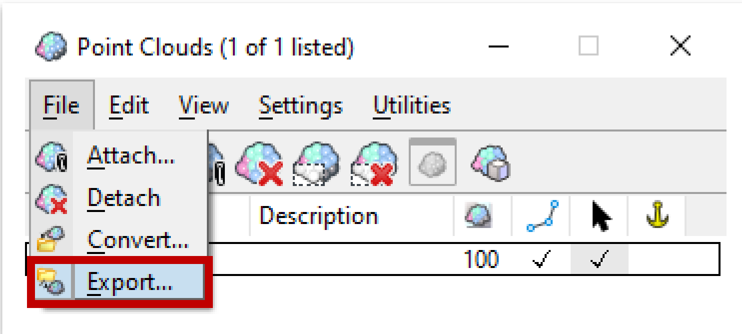
19. Zoom in and select the **red boundary**.



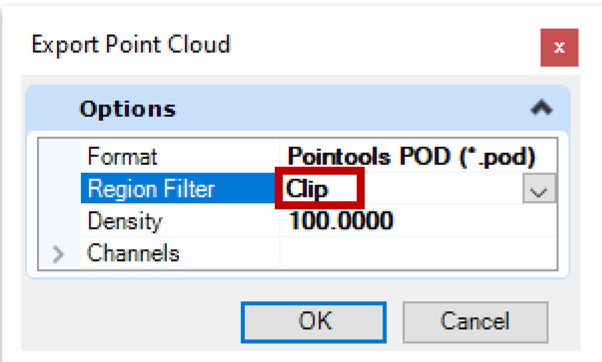
20. Left click once more to accept the clip and then click **Fit View** and notice that the point cloud is now clipped to the boundary.



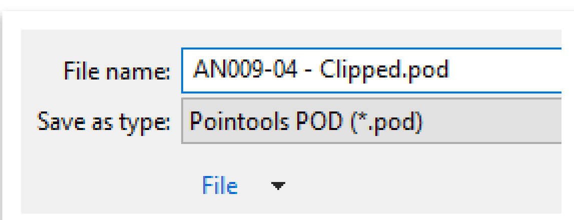
21. Next, we will need to export the clipped point cloud for further processing. Within the **Point Clouds** window, select the **AN009-04.pod** file and go to **File >> Export**.



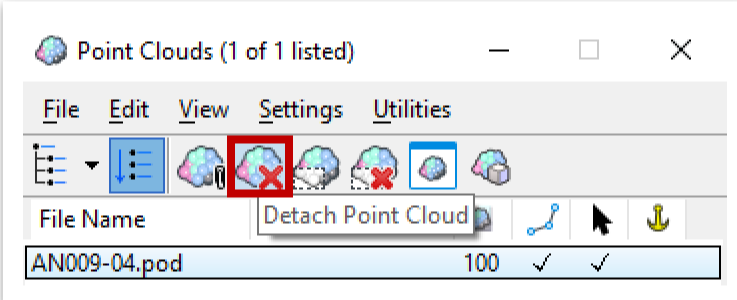
22. An **Export Point Cloud** dialog box should appear. Change the **Region Filter** from All to **Clip** and then click **OK**.

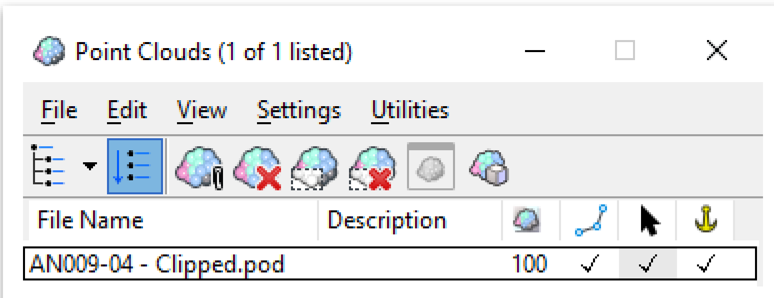


23. You will be prompted to save the clipped POD file in the **SURVEY_Training** workset dgn subfolder. Name the new file **AN009-04 - Clipped.pod** and then click **Save**.

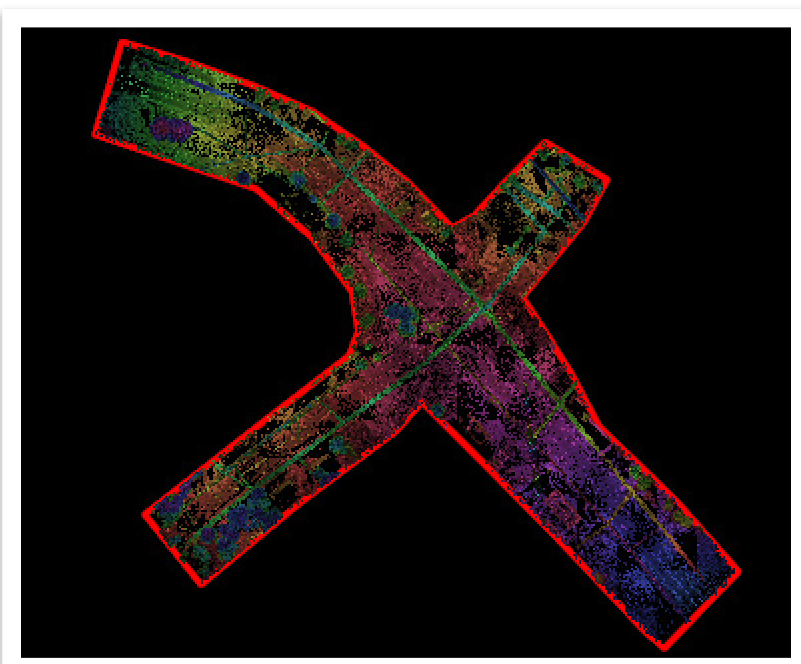


24. Once exported, **detach** the current point cloud (**AN009-04.pod**) and **attach** the new clipped point cloud (**AN009-04 - Clipped.pod**).





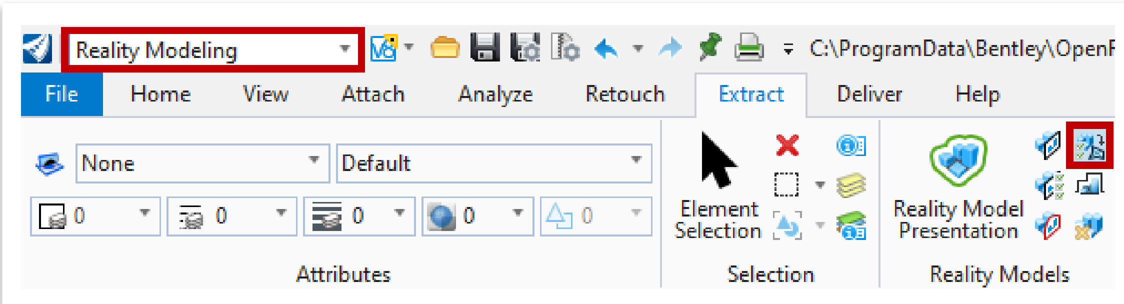
25. You should see the clipped point cloud, as shown below.



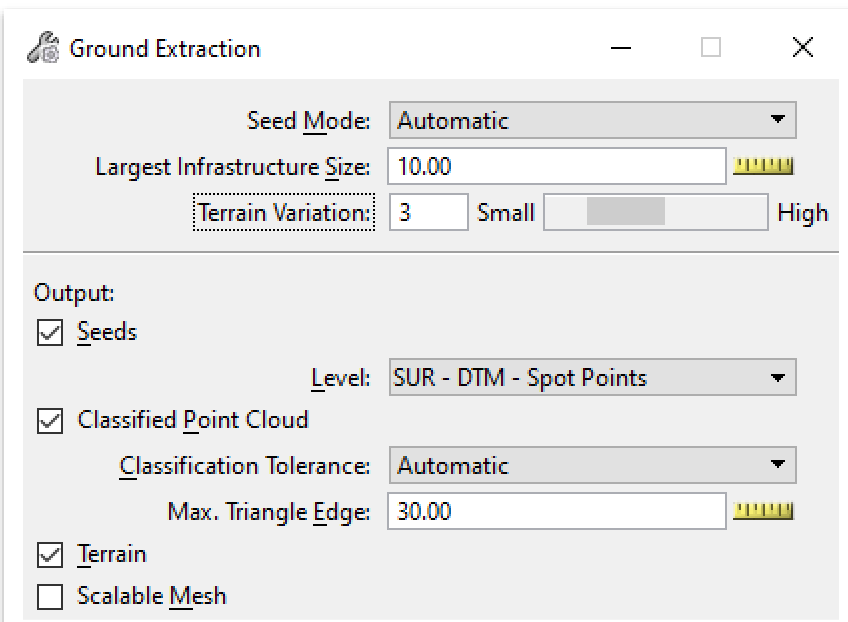
Take Note!

*Before creating the terrain model, we will need to extract **seed points**. Seed points represent terrain elevations that can be used for creating scalable terrain models.*

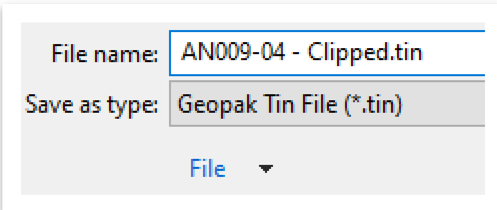
26. Now, we need to switch to the **Reality Modeling** workflow in the upper left of the screen and open the **Ground Extraction** tool (**Reality Modeling >> Extract >> Reality Models**). This tool will allow the automatic creation of a **tin** and **stm** file. **Note:** You could also open this tool within the **Point Clouds** window under **Edit**.

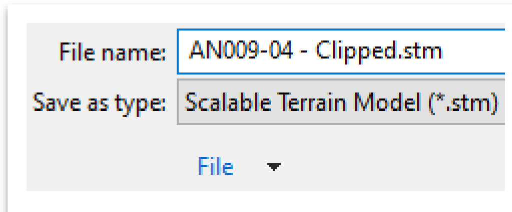


27. Within the **Ground Extraction** dialog box, select the following settings.
    a. **Seed Mode:** Automatic
    b. **Largest Infrastructure Size:** 10.00
    c. **Terrain Variation:** 3
    d. **Seeds:** Checkmark
    e. **Level:** SUR - DTM - Spot Points
    f. **Classified Point Cloud:** Checkmark
    g. **Classification Tolerance:** Automatic
    h. **Max Triangle Edge:** 30.00
    i. **Terrain:** Checkmark
    j. **Scalable Mesh:** Unchecked



28. Left click anywhere within the mesh to select it and then left click again to accept. The software will create **two** files: a **Geopak Tin** and a **Scalable Terrain Model** (**.stm**). You will be prompted to save both files. By default, the file will be saved within the **SURVEY_Training** workset dgn subfolder. Name the two files **AN009-04 - Clipped.tin** and **AN009-04 - Clipped.stm** respectively.

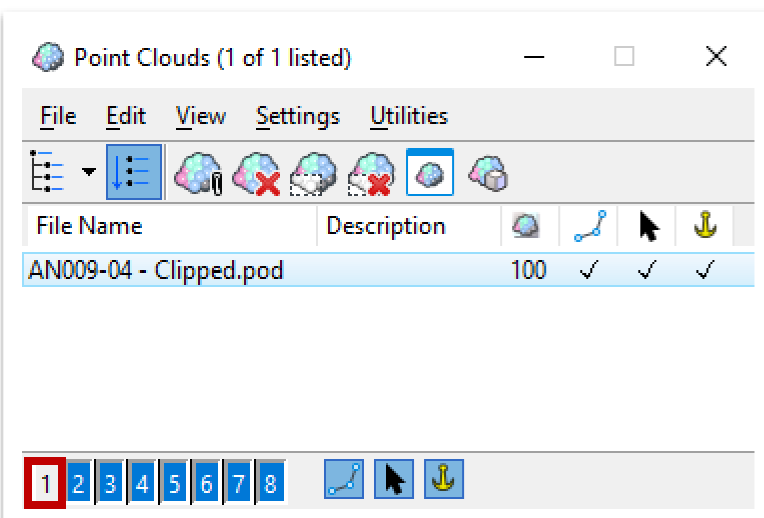




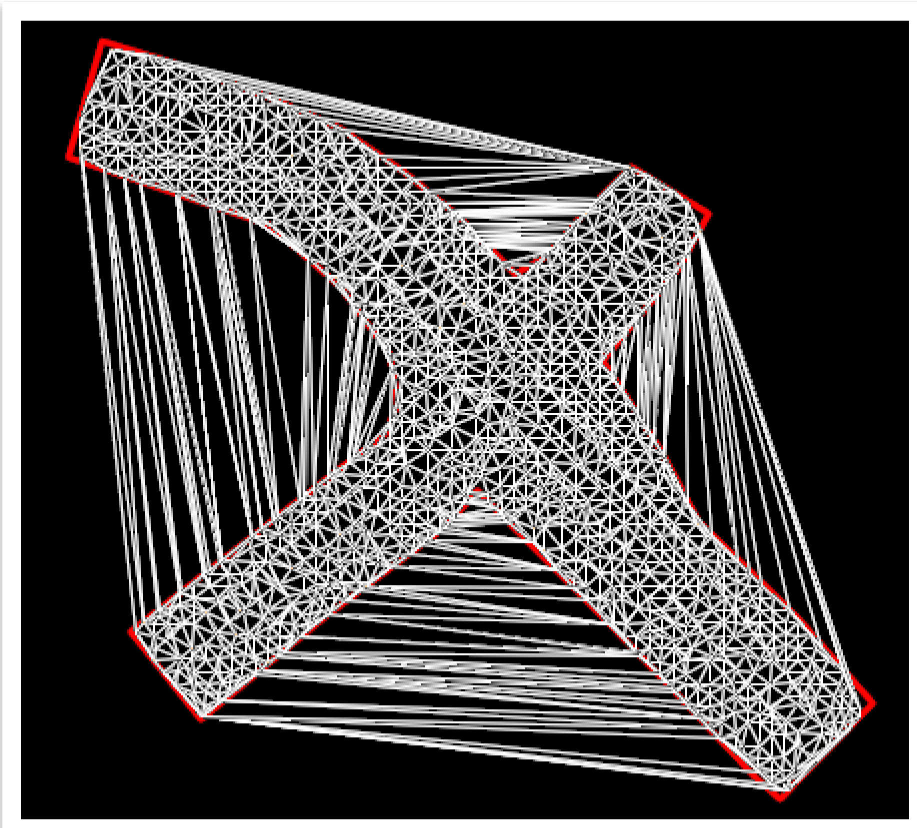
Take Note!

*A **Scalable Terrain Model** is a new concept in ORD. Because of extremely dense data sets (e.g. point clouds, reality meshes), scalability enables faster processing and visualization. **STM** files can be exported to a TIN file within ORD.*

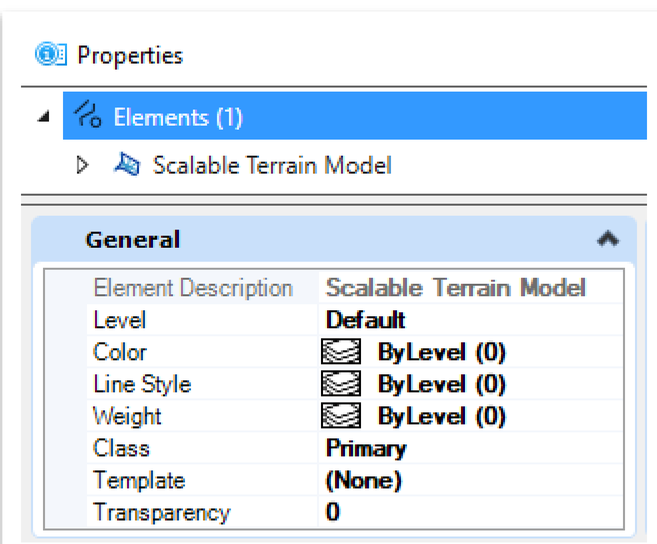
29. Within the **Point Clouds** window, turn **off** the pod file in **View 1** by clicking the **1** in the lower left corner (highlighted below). This will make it easier to review the new terrain. **Note:** It is recommended to provide the cleanest possible pod file for use by design, free of erroneous data. To create a reduced-size pod file with just the extracted ground points, you would go to **File >> Export** and make sure the **Classification Filter** was set to **1 Class** (**Ground**) and the **Point Filter** set to **Classification**. For this exercise, however, we will move to the next step.



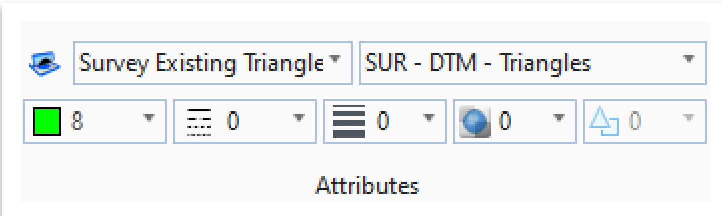
30. Once the terrain is created, you should see the image below. Go ahead and switch back to the **Survey** workflow in the upper left of the screen.



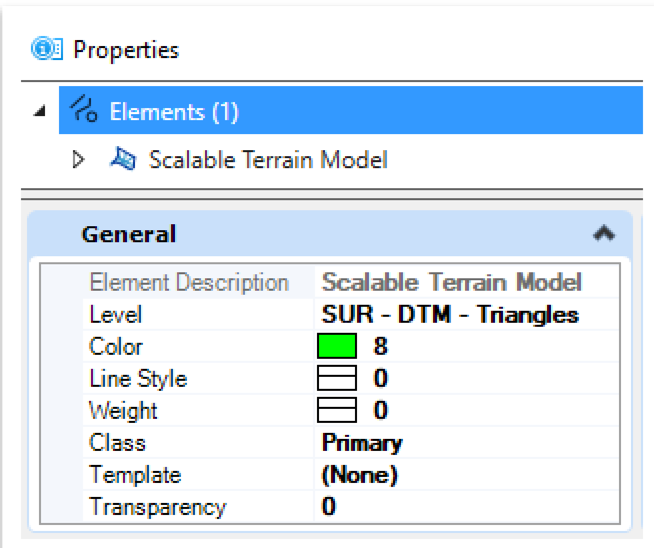
31. Next, select the terrain boundary or anywhere within the mesh (not the red boundary) and open the Scalable Terrain Model **Properties** (**Survey >> Terrain >> Primary**). Notice under the **General** tab that the symbology is not set to TDOT standards. We will need to change the properties.



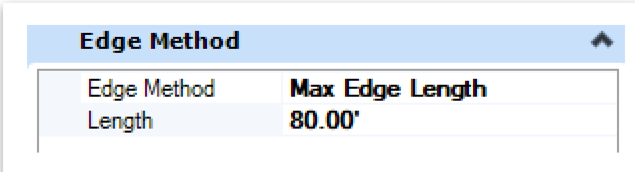
32. Under the **Home** tab, select the **Survey Existing Triangles** element template (**Design >> Roadway - 3D Modeling >> Terrain >> Existing - Survey**). Alternatively, you could key-in the element template name in the **Search Templates** field. This will allow the label to display with the correct attributes.

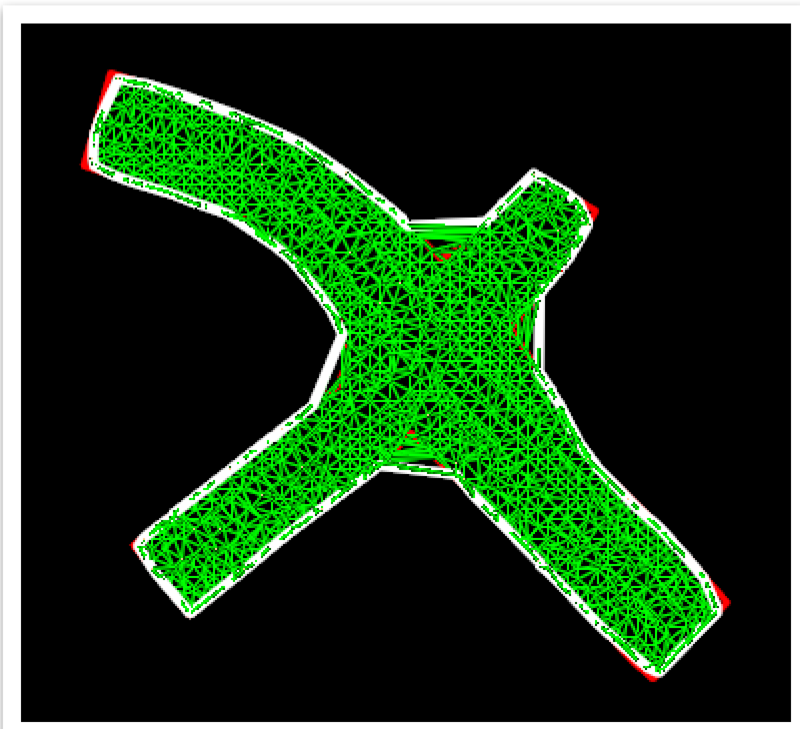


33. Notice that the **General** settings automatically updated within the **Scalable Terrain Model Properties**.

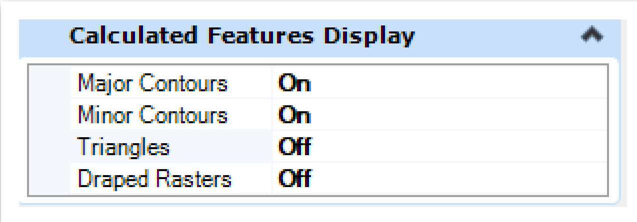


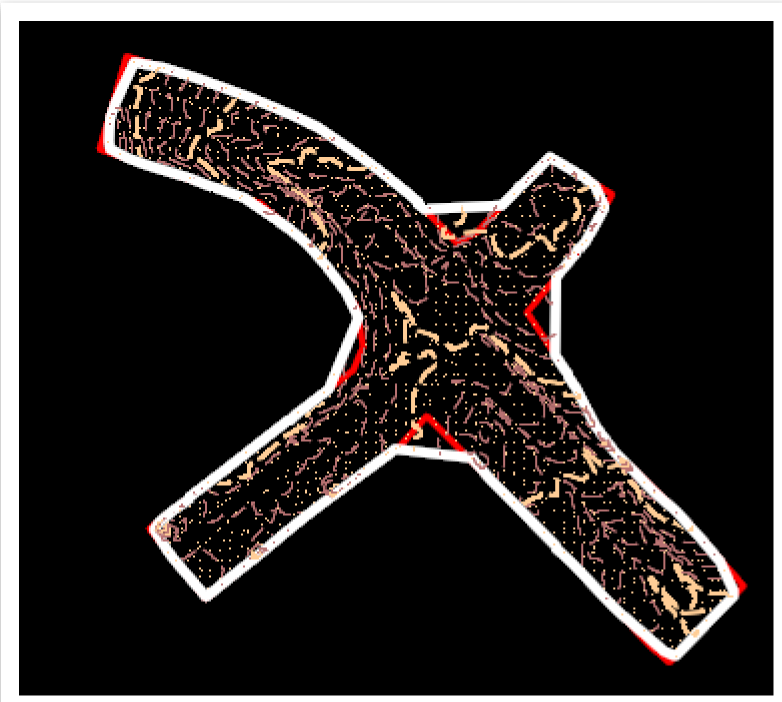
34. Within the **Properties**, select the following settings under the **Edge Method** tab and notice the update.
    a. **Edge Method:** Max Edge Length
    b. **Length:** 80.00’





35. Lastly, toggle the **Major** and **Minor Contours** fields to **On** and the **Triangles** field to **Off**. Keep the **Draped Rasters** field toggled **Off**.





Take Note!

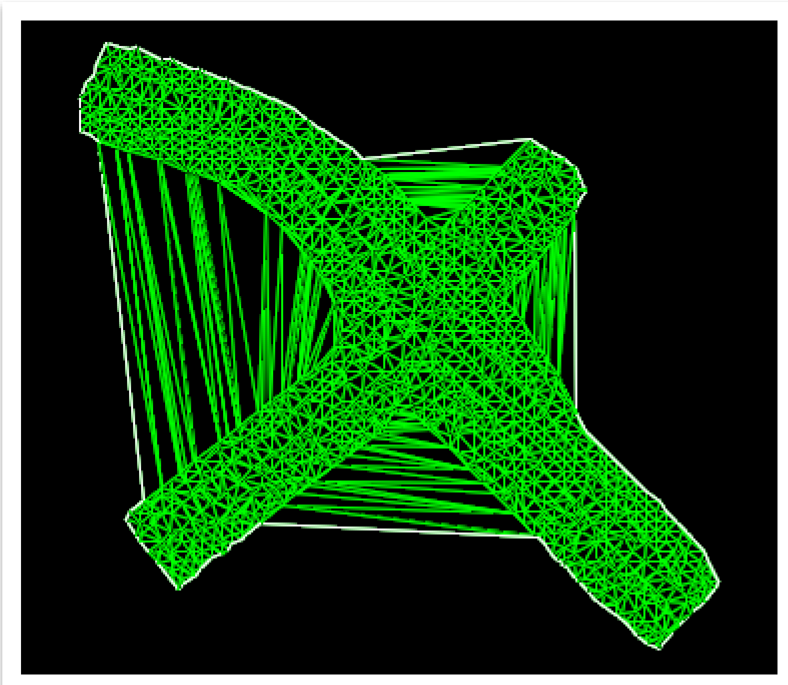
Because a raw point cloud is extremely dense and complex, point cloud classification and creation of digital terrain models should be done by a laser scanning technician in the native scanning software.

In this exercise, we demonstrated using the ORD ***Ground Extraction*** *tool by extracting seed points from a raw point cloud to create a scalable terrain model and a TIN. If this method is used, the terrain should be thoroughly inspected prior to delivery.*

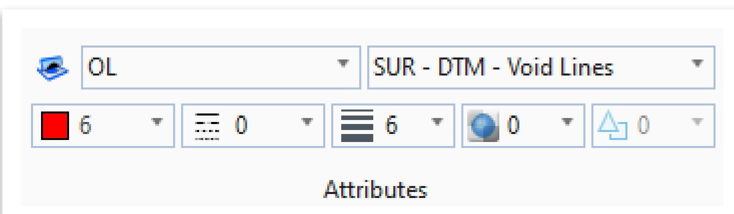
3.6.8 Exercise: Terrain Model Creation – Clipped Terrain Model

In this exercise, we will utilize a pre-existing terrain and clip a rectangle from it to create an updated DTM.

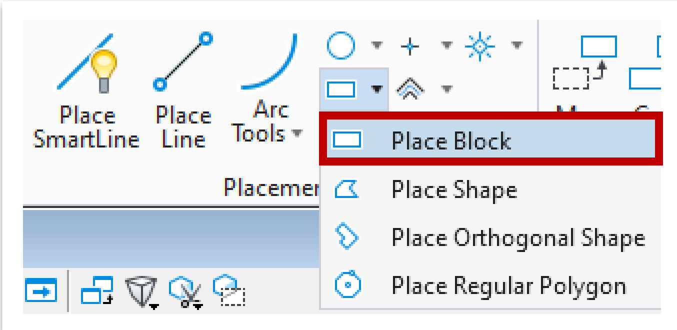
1. Open the **Existing Terrain – Clipped.dgn** file within the **SURVEY_Training** workset dgn subfolder and notice the triangulated terrain.



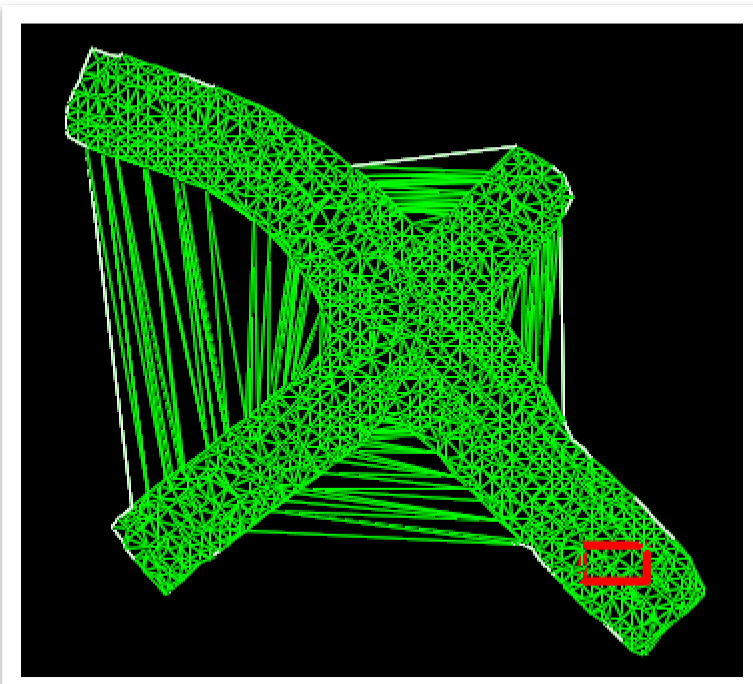
2. Select the **OL** element template (**Survey >> Terrain Model >> Lines**) and then change the line weight to **6**.



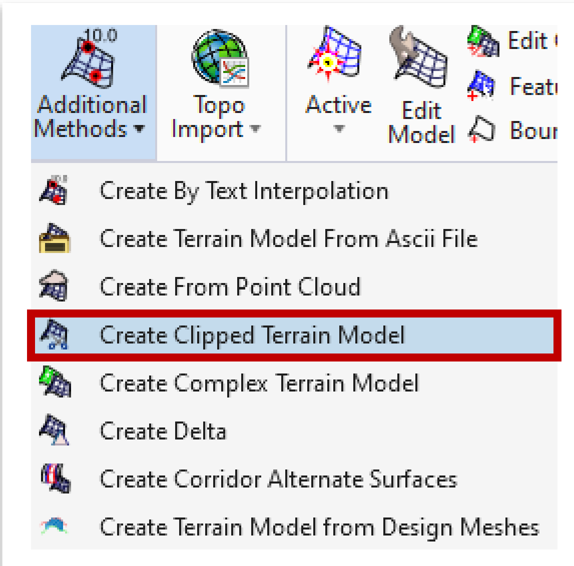
3. Next, open the **Place Block** tool (**Survey >> Drawing >> Placement >> Polygon Tools**).



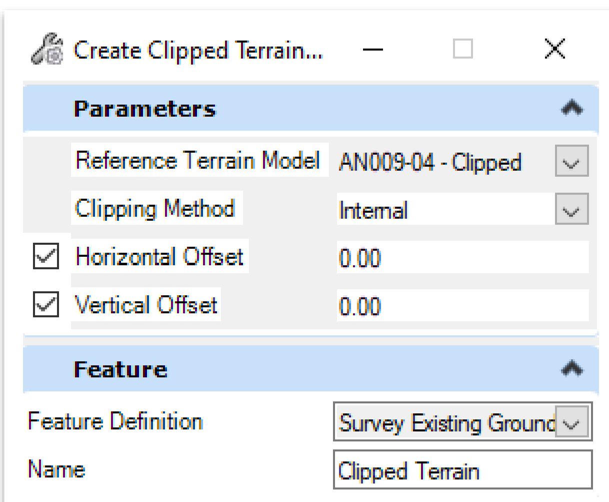
4. Zoom in to the lower right corner of the terrain and draw a rectangle, as shown below.



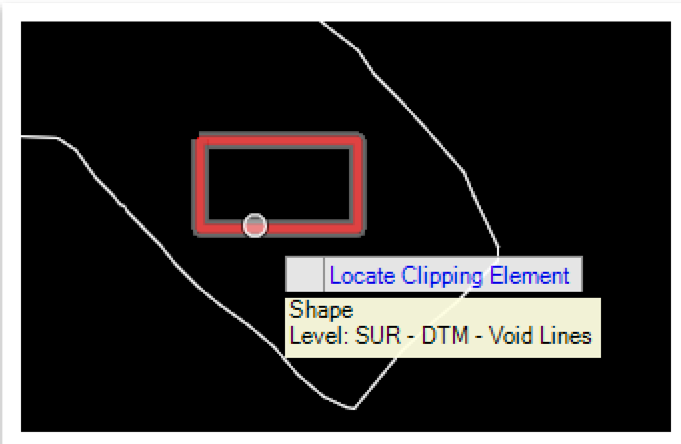
5. Select the terrain boundary and then open the **Properties**. Go ahead and turn off the **triangles** and then open the **Create Clipped Terrain Model** tool (**Survey >> Terrain >> Create >> Additional Methods**).



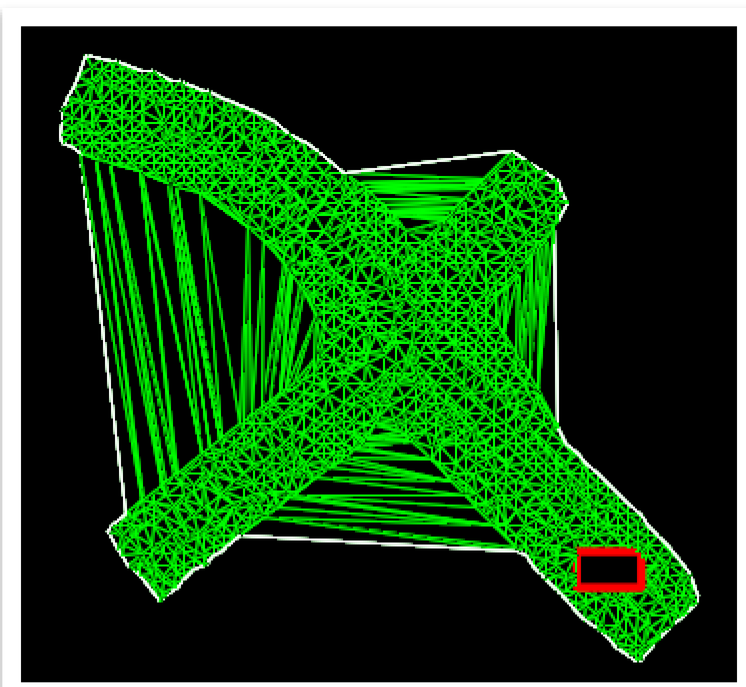
6. Within the **Create Clipped Terrain Model** dialog box, select the following settings.
    a. **Reference Terrain Model:** AN009-04 - Clipped
    b. **Clipping Method:** Internal
    c. **Horizontal/Vertical Offsets:** Checkmark and set to 0.00
    d. **Feature Definition:** Terrain >> Survey Existing Ground
    e. **Name:** Clipped Terrain



7. Notice the cursor prompt: **Select Clipping Element**. Select the rectangle that you drew earlier in the exercise. Since there is only one clipping element, right click when prompted for the next element.



8. Left click to accept the remaining prompts and then click **Fit View**. Notice that the clipped triangulation has been removed from the terrain.



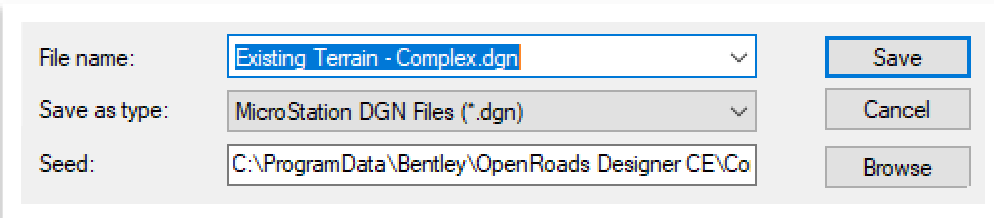
Take Note!

Clipping the terrain can be useful when you need to ***exclude*** *buildings and other features that you may not want to include in the terrain. You can also clip externally to remove triangles outside of a desired boundary.*

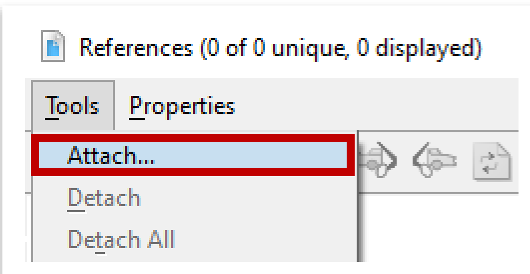
3.6.9 Exercise: Terrain Model Creation – Complex

In this exercise, we will create a new complex terrain by merging two pre-existing terrains.

1. Create a new file and name it **Existing Terrain – Complex**. Select the **TDOTSeed 3D.dgn** and click **Save**.

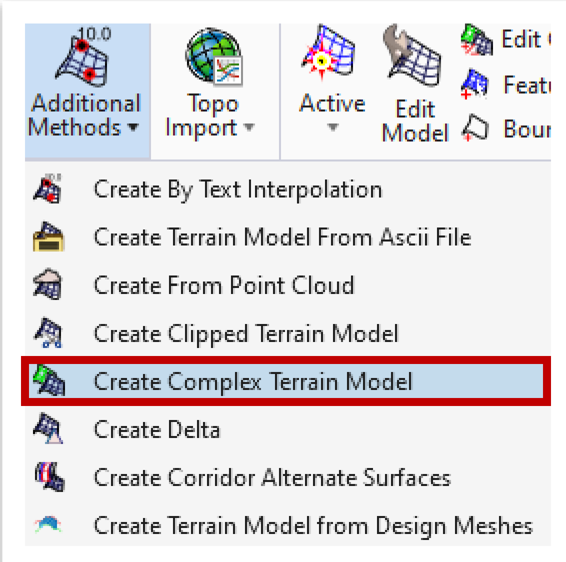


2. Open the **References** window (**Survey >> Terrain >> Primary**) and go to **Tools >> Attach**.

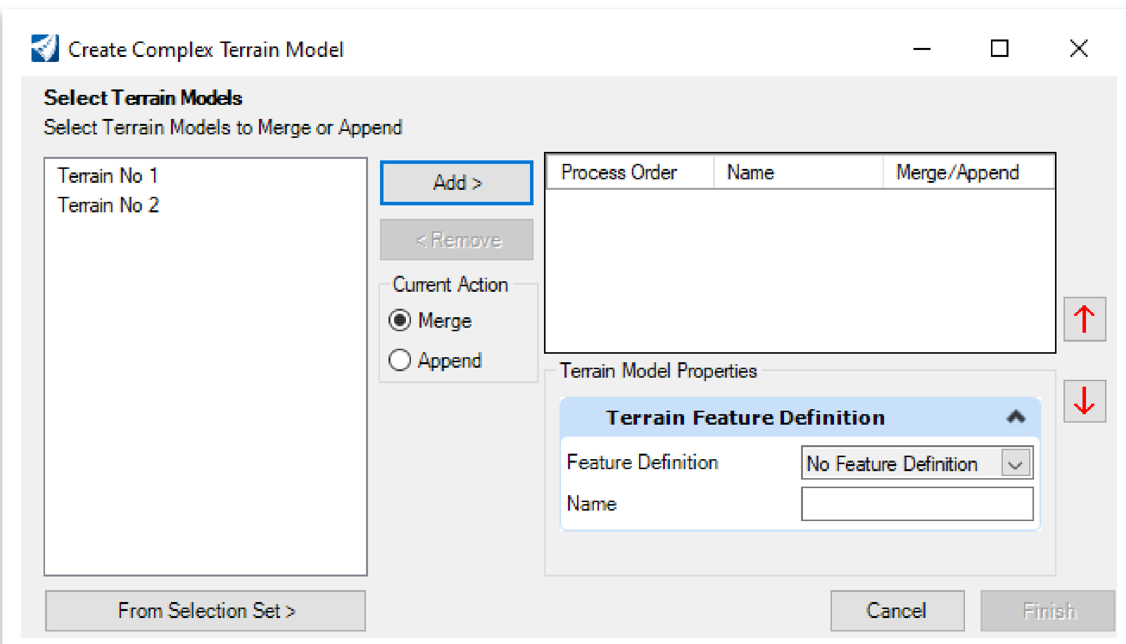


3. Select the **Terrains.dgn** file and set the **Attachment Method** to **Coincident World**. Click **Open** and then **Fit View** and notice the image below. Go ahead and close the **References** window.

4. Next, open the **Create Complex Terrain Model** tool (**Survey >> Terrain >> Additional Methods**).



5. Notice that the **Create Complex Terrain Model** dialog box appears showing **Terrain No 1** and **Terrain No 2** on the left side.



Take Note!

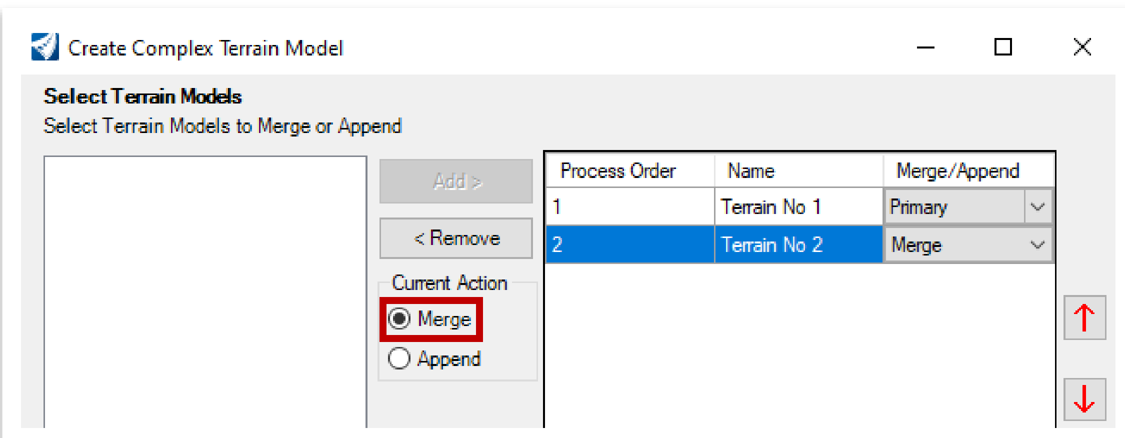
*There are two options to choose from: **Merge** or **Append**. Both options combine the data from the terrains but use different processes to yield different results.*

***Merge** combines the data only in the areas they do not overlap, and it requires there to be at least one point that overlaps between the two. If there is data in both models in an overlapping area, the data from the **primary** model is discarded, and only the data from the **merging** model is used. Therefore, <u>it is critical to set the order correctly</u>.*

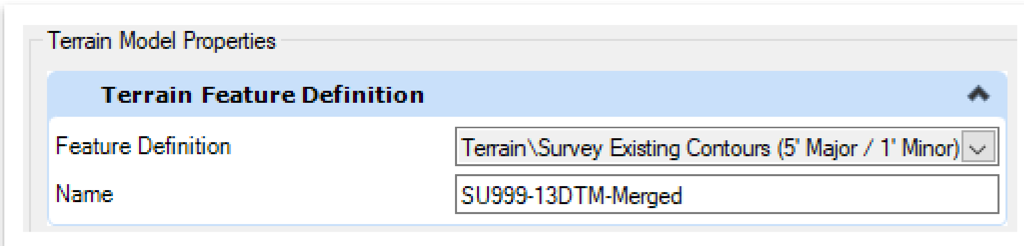
***Append** triangulates the combined data from the terrains using all data from both models whether they overlap or are adjacent to each other.*

*TDOT Survey recommends using the **Merge** option.*

6. For the purpose of this exercise, we will choose the **Merge** option. Select each terrain name (**Terrain No 1** and **Terrain No 2**) and **Add** the list of terrain models on the left. List **Terrain No 1** as **Process Order 1** and set it as the **Primary** terrain. List **Terrain No 2** as **Process Order 2** and set it as the **Merge** terrain. The arrows on the right side of the dialog box allow you to adjust the order of the terrains.

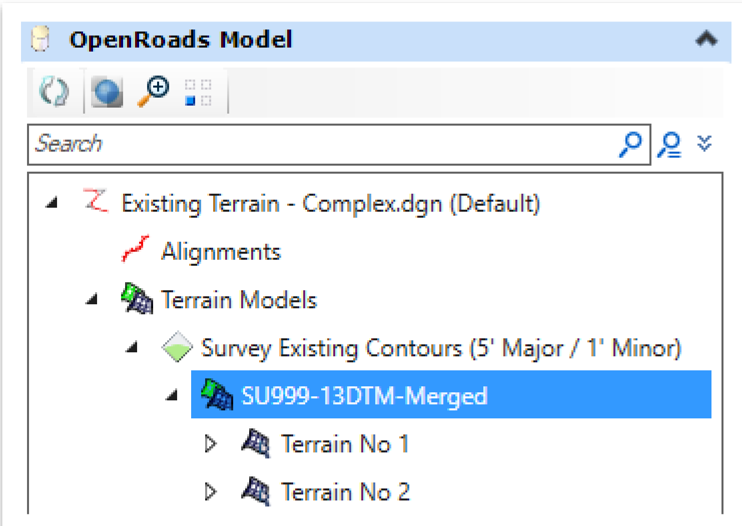


7. Under **Terrain Model Properties**, select the following settings and then click **Finish**.
    a. **Feature Definition:** Terrain\Survey Existing Contours (5' Major / 1' Minor)
    b. **Name:** SU999-13DTM-Merged



8. When the process is completed, turn off the referenced **Terrain.dgn** file and you should see the complex terrain shown below.

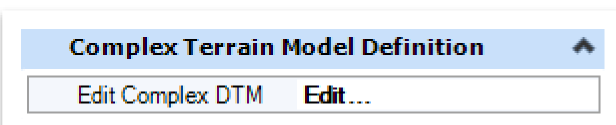
9. Next, expand the **OpenRoads Model** tab within the **Explorer**. Go to **Existing Terrain – Complex.dgn (Default) >> Terrain Models >> Survey Existing Contours (5' Major / 1' Minor) >> SU999-13DTM-Merged**. Notice that both terrains are listed under the merged terrain that you just created.



Take Note!

*A **Complex Terrain** is made from each of the individual terrains, therefore **do not detach** the referenced terrains. They are now part of the civil model and if you detach them, all the civil relationships will be broken.*

10. Select the complex terrain boundary in plan view and then open the **Properties**. Notice that there is an additional **Complex Terrain Model Definition** tab. If you left click within the Edit Complex DTM field and then click on the ellipses, it will take you back to the Create Complex Terrain Model dialog box that we saw in Steps 5-7.

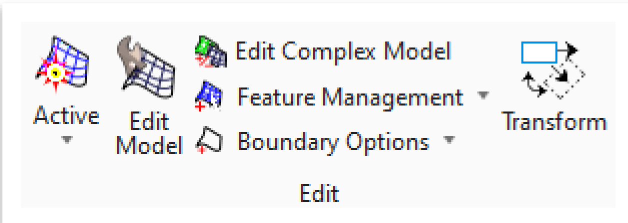


11. There are other tools under **Additional Methods**, but they are not applicable for TDOT Survey so are not covered in this manual.

3.7 Lecture: Editing Terrain Tools

The **Edit Terrain** model tools can only be used with terrains imported using the create **From File** option (TIN, LandXML, point clouds, digital elevation models, etc.) (Figure 52).

FIGURE 52. EDIT TERRAIN TOOLS



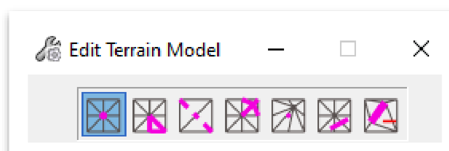
Take Note!

*Terrains created from survey field books **are not** editable unless the processing rules are **deactivated**. Either the survey data is editable (e.g. field codes, 3D geometry) or the terrain is editable, but not both.*

Once survey processing rules are deactivated, the terrain model will become editable. However, if the survey processing rules are activated again, all terrain edits will revert to the original survey data processed terrains.

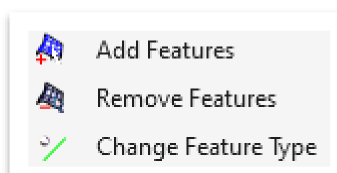
<ins>**Set/Clear Active**</ins>**:** The most common editing terrain tool is the Set/Clear Active. This tool will allow the user to set or clear the DTM as the active terrain. An active terrain is required to cut existing profiles and create corridor designs.

<ins>**Edit Model**</ins>**:** Opens the **Edit Terrain Model** tools, which allow the user to delete vertex or edge triangle, swap line, insert or move vertex, delete triangle by line and delete by feature.

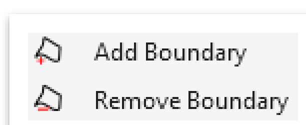


<ins>**Edit Complex Model**</ins>**:** Allows the user to edit a complex model by merging and appending individual terrains and adding or removing individual DTM components.

<ins>**Feature Management Tool**</ins>**:** Allows the user to add, remove or change feature types (e.g. breaklines or points). For example, if the user created a terrain using spot features with the create **From Elements** tool, the feature management tool can be opened to add breakline features to the terrain.



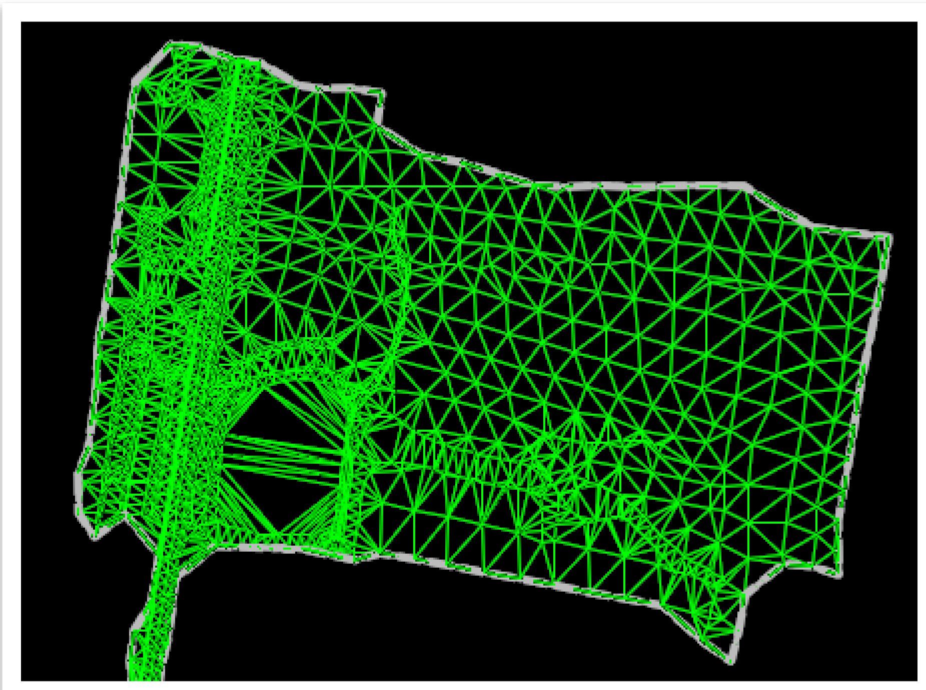
<ins>**Boundary Options Tool**</ins>**:** Allows the user to either add or remove a terrain boundary.



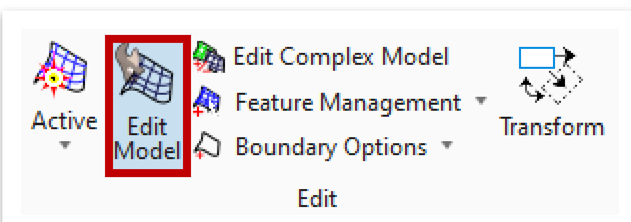
3.7.1 Exercise: Edit the Terrain

In this exercise, we will edit a previously created terrain by deleting a vertex. We will open back up the **Existing Terrain – TIN.dgn** file.

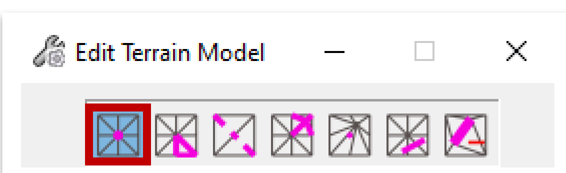
1. Select the terrain boundary and open the **Properties**. Toggle the **Major** and **Minor Contours** fields to **Off** and the **Triangles** field to **On** and then zoom in to the area shown below.



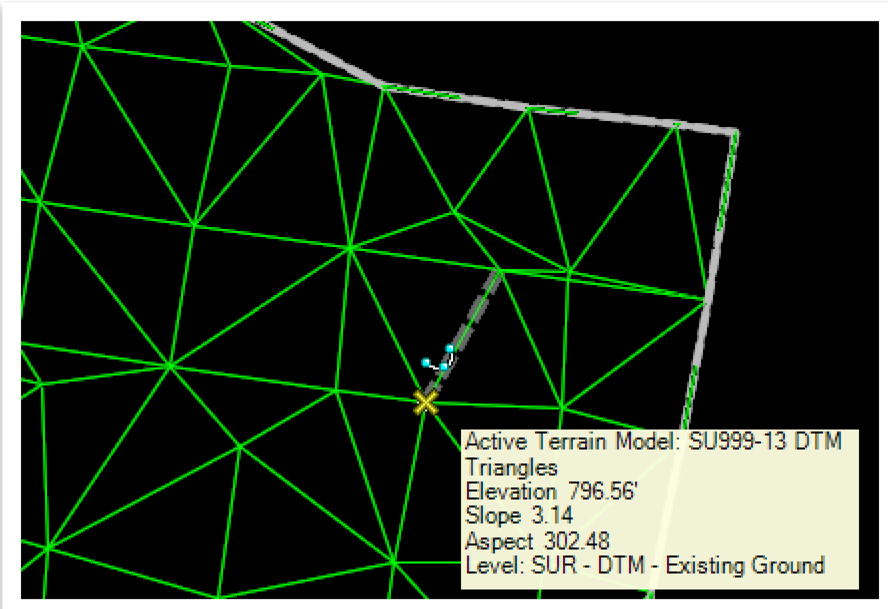
2. Open the **Edit Model** tools (**Survey >> Terrain >> Edit**) and notice a toolbar appears.



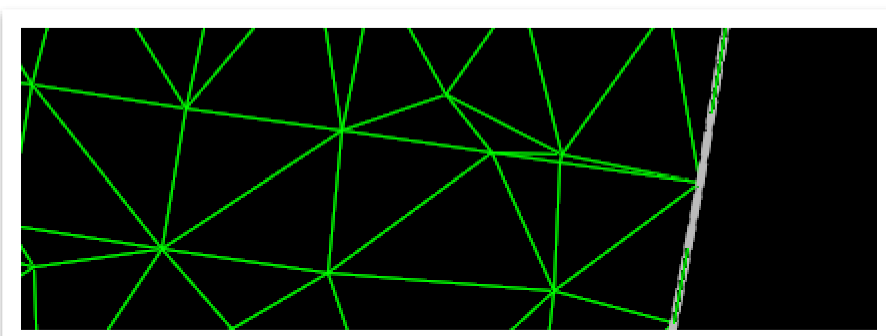
3. Within the **Edit Terrain Model** tools, select the first icon (**Delete Vertex**).



4. Notice the prompt in the lower left corner: **Select Terrain Model**. Select the terrain boundary or anywhere within the mesh.
5. Notice the next prompt in the lower left corner: **Accept Vertex/Reset to Select Terrain**. This prompt is asking to select what vertex you want to delete. Zoom in to the upper right of the terrain and left click on <u>any</u> vertex. **Note:** You don't have to select the same vertex as shown in the image below.



6. Notice that the triangulation automatically updates after deleting the vertex. Hit **ESC** to clear the tool.



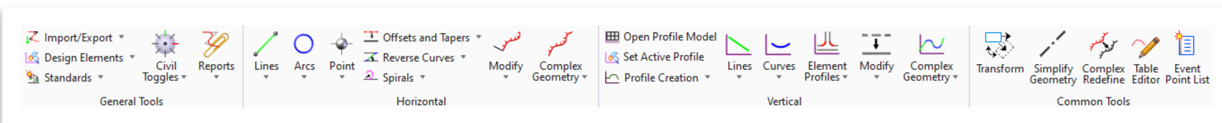
Take Note!

*All other **Edit Terrain Model** tools will work the same way, so we will move on to the next chapter. Most likely, these tools will not be used very often as the terrains are generated from the field books. Feel free to try the other terrain editing tools following Steps 3-6.*

Chapter 4. Civil Geometry Tools

The Civil Geometry tools are located under the **Geometry** tab in the Survey workflow (Figure 53). These are the necessary tools to create, import, place and/or manipulate alignments, profiles and other smart geometry. All geometry placed with these tools are intelligent and can be assigned a Feature Definition.

FIGURE 53. GEOMETRY TAB



4.1 Objectives

At the conclusion of this chapter, participants will be able to:

1. Import, create and edit civil geometry.
2. Create different reports for civil geometry.
3. Plot property information utilizing Geometry Builder.
4. Project linear utilities onto profiles (non-utility and utility models).
5. Project crossing utilities onto profiles.

4.2 Lecture: Civil Geometry

All civil geometry (e.g. points, lines, curves, alignments) are stored as **ORD elements** in the DGN file. Therefore, <u>there are no external files</u>. Civil geometry is dynamic, interactive and rules-based, which means all components are associated and preserve the original design intent. For example, a typical alignment is composed from several points and a couple of curves. If one of the points is moved, the alignment automatically adjusts to reflect the change. If the curve radius is changed, the alignment changes accordingly.

4.2.1 Feature Definitions

All civil geometry should be assigned a **Feature Definition**. Feature Definitions are the standards that let the software know the feature that the civil geometry represents (alignment, profile, edge of pavement, etc.). The Feature Definition also sets all the TDOT standard symbology and is directly linked to automatic annotation (e.g. stationing of an alignment). The user can simply assign the Feature Definition when creating the geometry, and ORD will apply the correct attributes (level, color, line style (or cell in the case of a point) and line weight).

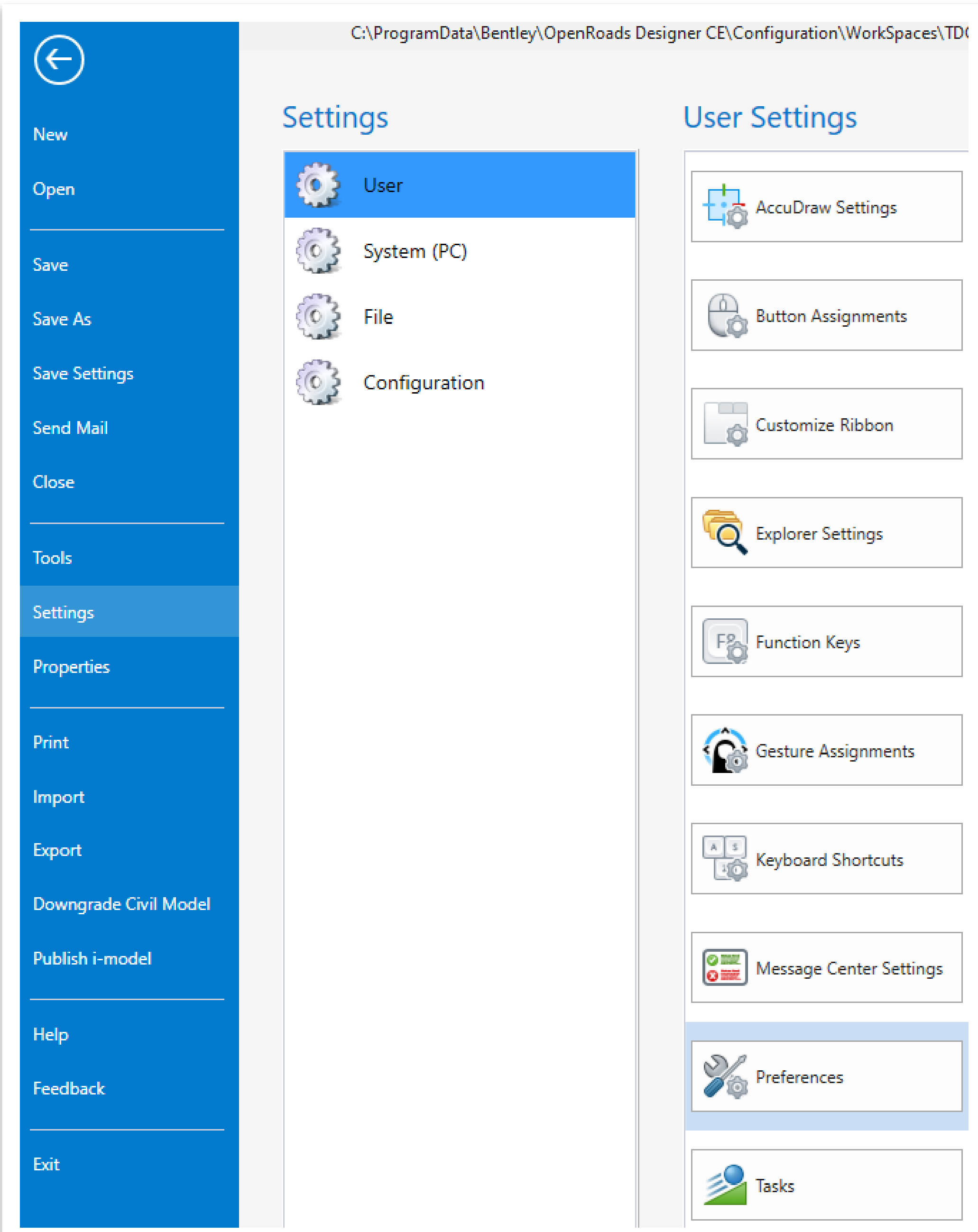
Take Note!

*Civil geometry can either be in the form of **point** or **linear** features. A feature is anything that can be seen or located and is a physical part of the design representing a real-world entity.*

4.2.2 User Settings Preferences

The **User Settings Preferences** (**File >> Settings >> User >> Preferences**) allow the user to change the way the software behaves and looks (Figure 54). Within the User Settings Preferences are **View Options** and **View Options - Civil**. They contain several different view preferences such as the color of selected or highlighted elements, manipulators, or superelevation fills. For more details, please refer to the Fundamentals (ORD) Manual.

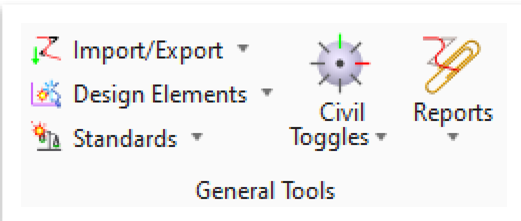
FIGURE 54. USER SETTINGS



4.3 Lecture: General Tools

The **General Tools** contain many tools that are used in combination with other tools in the ribbon and provide options for more accurate and precise models (Figure 55). We will only discuss the tools that are applicable to TDOT Survey.

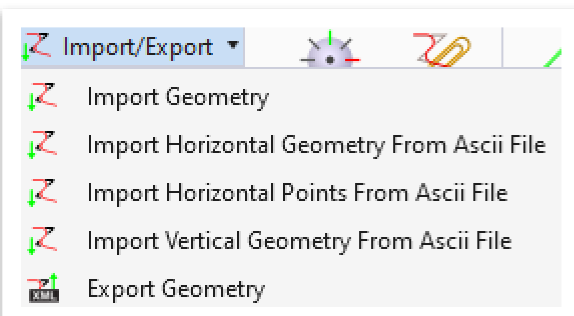
FIGURE 55. GENERAL TOOLS



4.3.1 Import/Export

The **Import/Export** tools allow the user to import alignments and profiles from various sources and then export out of ORD (Figure 56). We will demonstrate the **Import Geometry** option in the next exercise.

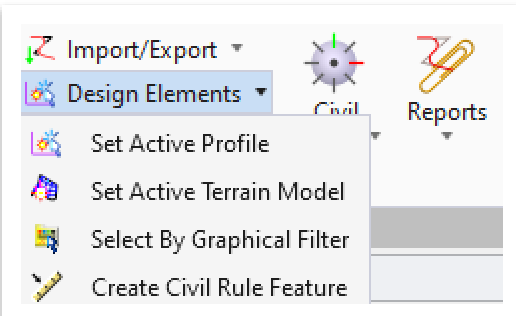
FIGURE 56. IMPORT/EXPORT TOOLS



4.3.2 Design Elements

The **Design Elements** tools allow the user to set profiles and terrain models active, select by graphical filter and create civil rules (Figure 57). The **Select By Graphical Filter** tool allows the user to select elements by specific Graphical Filters, which are used in design when creating proposed models. The **Create Civil Rule Feature** tool gives the user the flexibility to assign civil geometry rules to elements that were created with basic Microstation tools, such as **Place Line**.

FIGURE 57. DESIGN ELEMENTS TOOLS



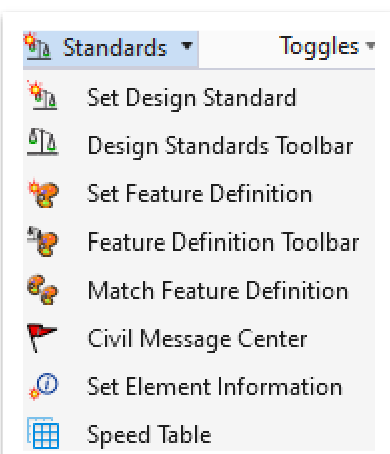
Take Note!

*Geometry created with non-civil tools **will not** have any intelligence and **will not** be recognized by any of the tools covered in this chapter, unless assigned a feature definition and civil geometry rules.*

4.3.3 Standards

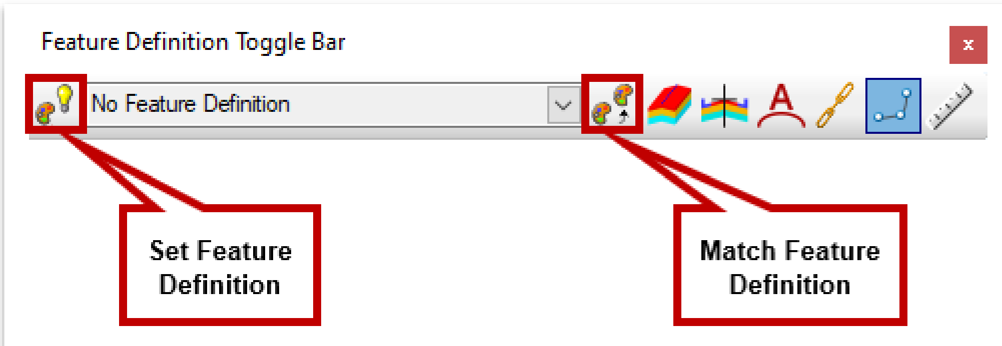
The **Standards** tools allow the user to set Feature Definitions and Design Standards and open the corresponding toolbars (Figure 58). The different options will be explained further on the next pages.

FIGURE 58. STANDARDS TOOLS



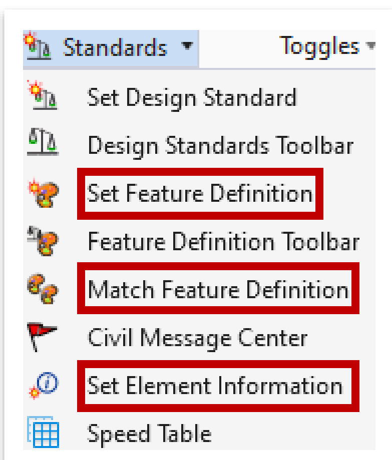
- **<u>Feature Definition Toolbar</u>:** Houses several key tools used to set and match feature definitions in addition to accessing other tools (Figure 59).

FIGURE 59. FEATURE DEFINITION TOOLBAR



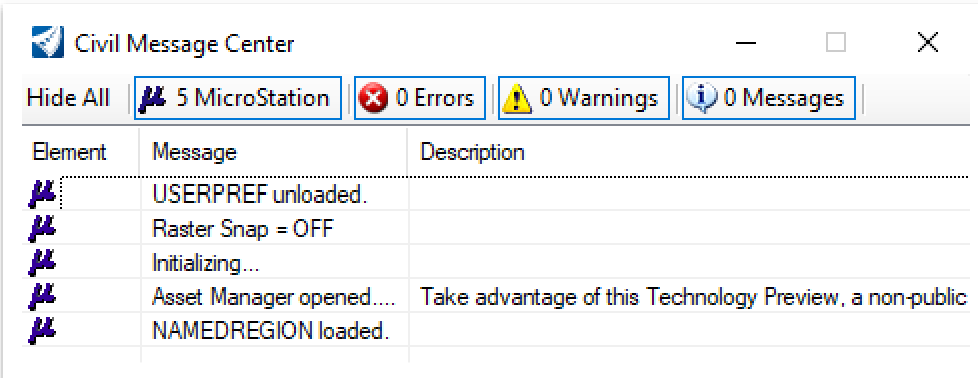
- **<u>Set Feature Definition</u>**, **<u>Match Feature Definition</u>** and **<u>Set Element Information</u>:** These tools are specifically designed for ORD Civil Model Elements (Figure 60). The **Set Feature Definition** assigns a feature definition to a civil geometry element or changes an already assigned feature definition. The **Match Feature Definition** allows the user to match one element's feature definition attributes to another in the drawing. The **Set Element Information** allows the user to add a personal note to an element in the drawing.

FIGURE 60. SET/MATCH FEATURE DEFINITION + SET ELEMENT INFORMATION



- **Civil Message Center:** Opens a window with a list of ORD messages related to recent actions performed by the user (Figure 61). This can be useful for viewing errors in construction or design standards that have been violated.

FIGURE 61. CIVIL MESSAGE CENTER

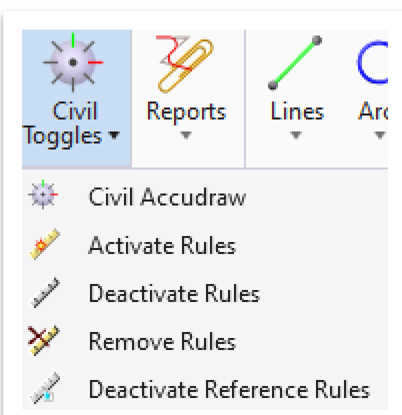


- **Set Design Standard**, **Design Standards Toolbar** and **Speed Table:** These tools are relevant to roadway design and use AASHTO Geometric Design Standards to alert designers when they are not meeting minimum geometric standards on alignments and profiles. These tools are not applicable to the TDOT Survey process, so will not be covered in this manual.

4.3.4 Civil Toggles

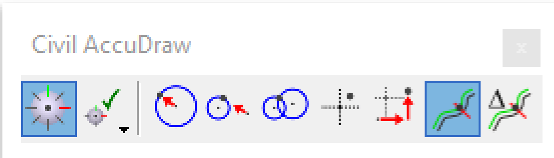
Geometry Civil Toggles can be helpful for quickly changing the way ORD behaves, allowing the user to spend less time adjusting settings (Figure 62).

FIGURE 62. CIVIL TOGGLES



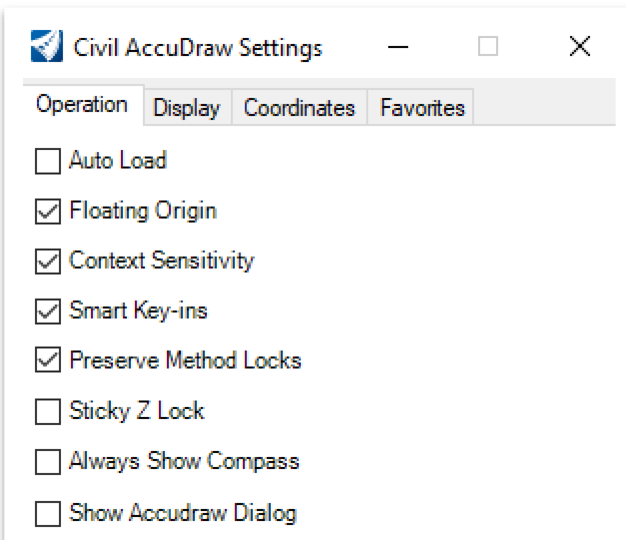
- **<u>Civil AccuDraw</u>:** Tools allowing the user to define elements by precise inputs (Figure 63).

FIGURE 63. CIVIL ACCUDRAW TOOLS

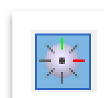


  - **Settings:** Allow the user to alter the look and feel of AccuDraw as well as the coordinate system (Figure 64). A list of shortcut key-ins can be accessed under the **Display** tab within the Civil AccuDraw Settings. To set Settings, go to the second icon in the Civil AccuDraw toolbar.

FIGURE 64. CIVIL ACCUDRAW SETTINGS

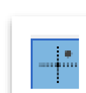


  - **Tools:** To activate/deactivate Civil AccuDraw, select the first icon. **The most commonly used tools are listed below:**

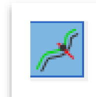


    - **Distance-Direction** – The first tool in the Civil AccuDraw pallet, which is used to place lines based on a specific distance and direction from a known point. This option may be used to locate the first point of a present ROW line, parcel or property line from a land corner or other known point. The user would draw a civil line starting the first point of the line at the reference point, then use Civil AccuDraw to enter the distance and direction to place the end point of the line.

    - **DX DY** – The fourth tool in the Civil AccuDraw pallet, which is used to store points or the beginning of a line by entering the X and Y coordinates.



- **Station-Offset** – The second to last tool in the Civil AccuDraw pallet, which is used to place labels needing the station and offset reference from an alignment (e.g. present ROW lines).

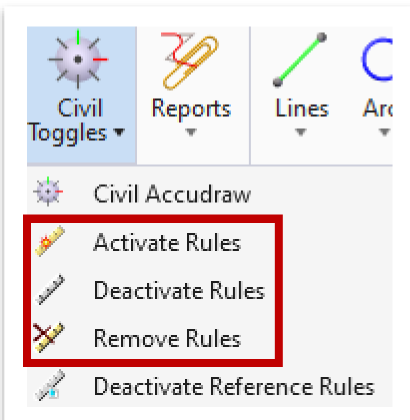


Take Note!

Civil AccuDraw tools are intended to be used in combination with placing horizontal or vertical civil geometry. ***Civil AccuDraw CANNOT be running at the same time as Regular AccuDraw****, so make sure to deactivate regular AccuDraw before enabling Civil AccuDraw.*

- **<u>Activate/Deactivate/Remove Rules</u>:** The user can activate or deactivate rules to toggle whether manipulators are available for editing on selected elements (Figure 65). Rules can also be completely removed.

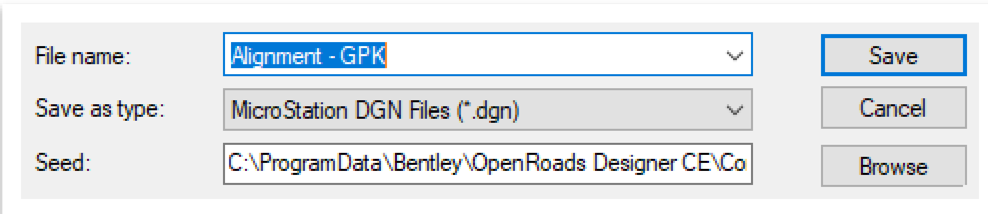
FIGURE 65. ACTIVATE/DEACTIVATE/REMOVE RULES



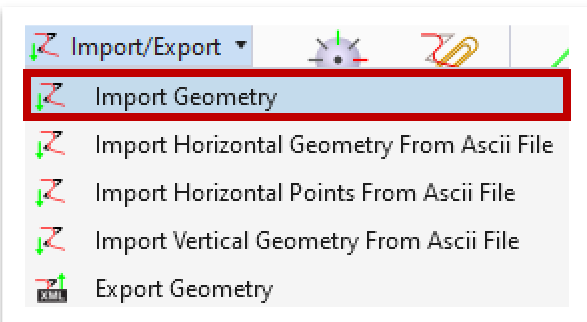
4.3.5 Exercise: Horizontal Geometry Creation – Import

In this exercise, we will import horizontal alignments from a gpk file and apply the applicable feature definition to create the preliminary centerline.

1. Create a new file and name it **Alignment – GPK**. Select the **TDOTSeed2D.dgn** and click **Save**.

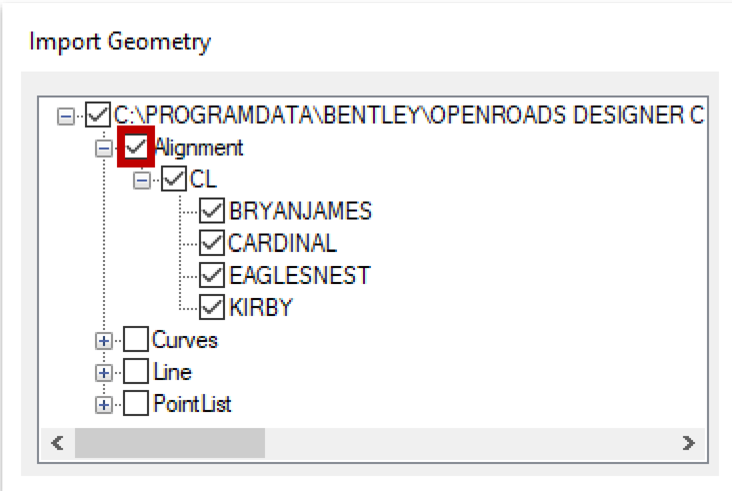


2. Open the **Import Geometry** tool (**Survey >> Geometry >> General Tools >> Import/Export**).

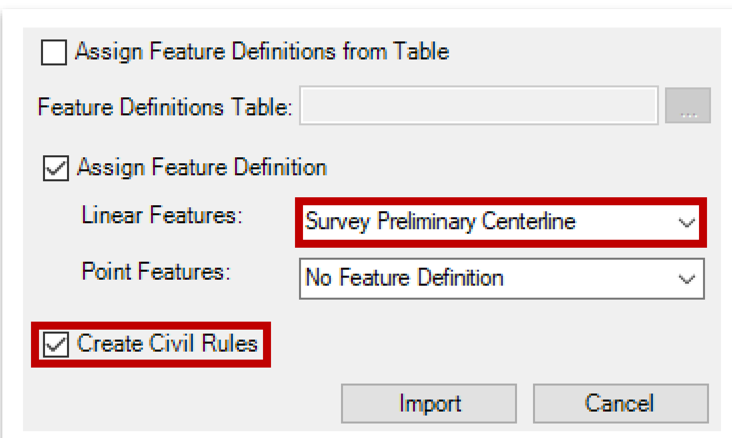


3. Select the **04_job32w.gpk** file within the **SURVEY_Training** workset dgn subfolder and click **Open**. **Note:** The software should open to this location by default.

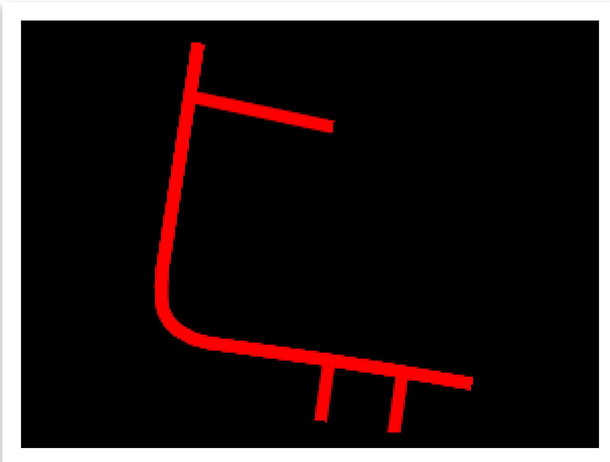
4. Within the **Import Geometry** dialog box, toggle on **Alignment** and then expand the structure, as shown below. By toggling on Alignment at the root level, the software will import **every** alignment tied to the gpk. **Note:** You could import specific alignments by toggling on or off the applicable chains under **CL**.



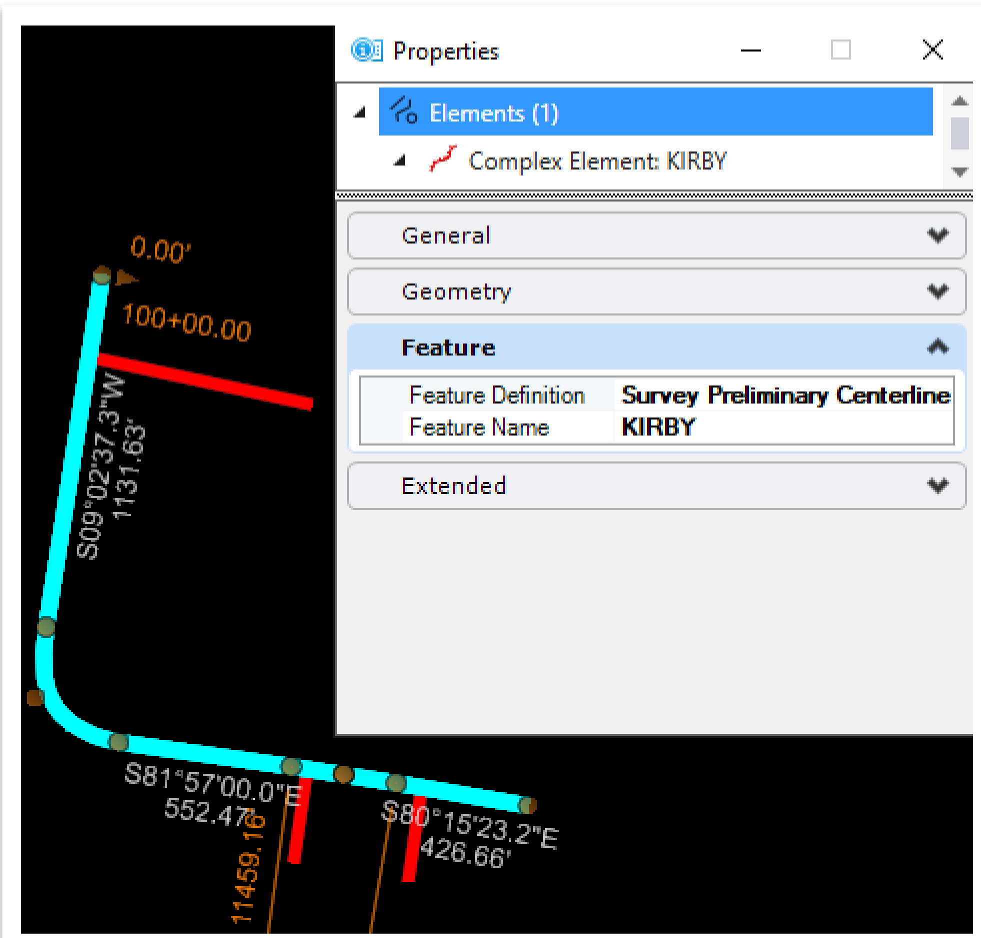
5. Select the following **Linear Feature Definition**: Alignment >> **Survey Preliminary Centerline**. Make sure that the **Create Civil Rules** box is toggled **on** and then click **Import**. **Note:** You could also apply a feature definition after importing using the **Set Feature Definition** tool (**Survey >> Geometry >> General Tools >> Standards**).



6. Click **Fit View** and notice that the geometry has now been imported.



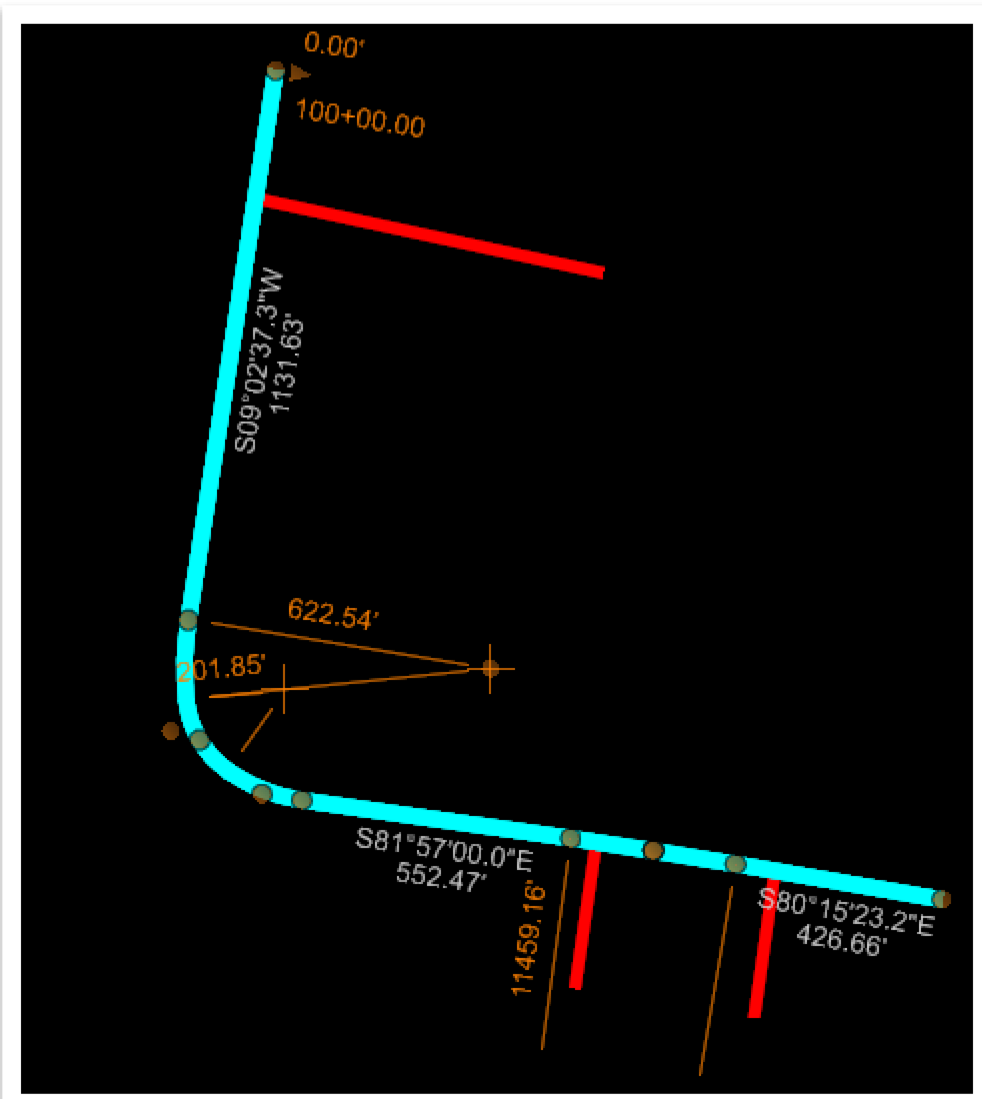
7. Select the mainline (**KIRBY**) alignment and then open the **Properties**. Under the **Feature** tab, notice that both the **Feature Definition** and **Feature Name** fields are populated. Go ahead and review the three side road alignments as well. **Note:** We will annotate the alignment in Chapter 5 when we talk about plan preparation tools.



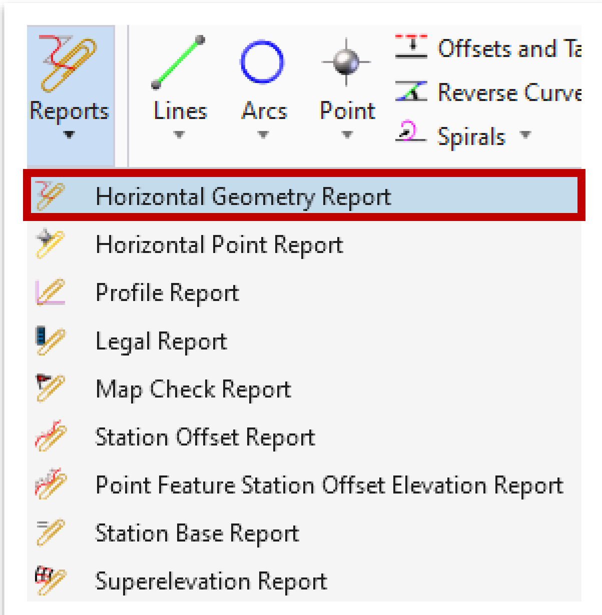
4.3.6 Exercise: Horizontal Geometry – Reports

In this exercise, we will create several different reports for the horizontal geometry and review the properties of each one. We will continue to utilize the same **Alignment – GPK.dgn** file.

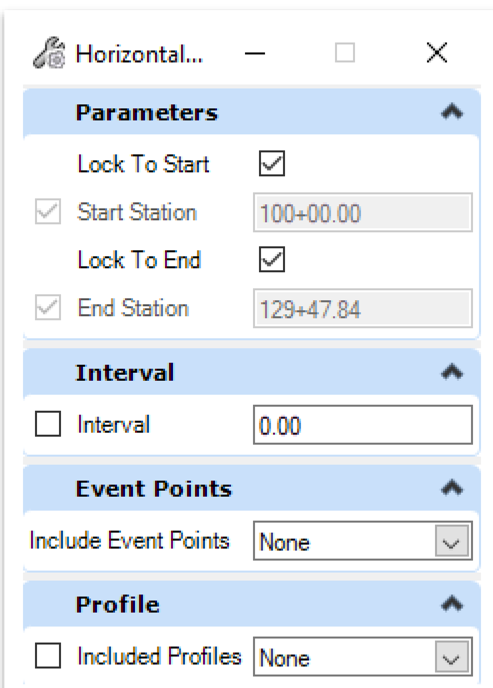
1. As noticed in the previous exercise, when selecting an alignment in ORD, you'll see its geometric data (e.g. starting station, bearing, length, etc). One way to make edits to the geometry would be to left click within the orange text and key-in your update. Go ahead and deselect the alignment and notice that the data disappears since it is dynamic.



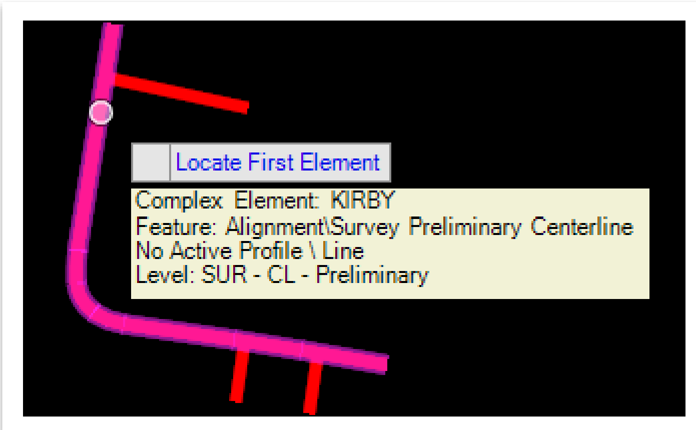
2. Now that you've seen the geometric data in dynamic form, lets create it in report form. Open the **Horizontal Geometry Report** tool (**Survey >> Geometry >> General Tools >> Reports**), which will create a report for the selected element.



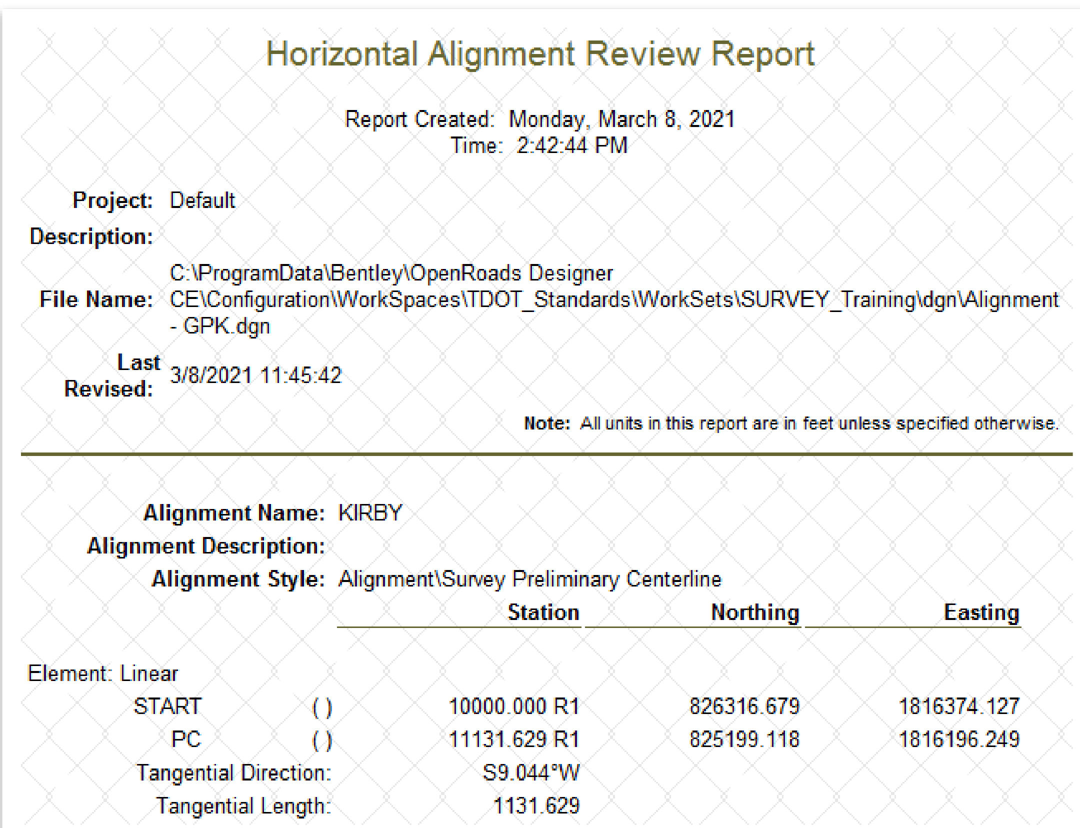
3. Within the **Horizontal Geometry Report** dialog box, select the following settings:
    a. **Lock To Start/End:** Toggle ON (**Note:** Ignore if your station fields look different. They will update automatically once the next steps are taken.
    b. **Interval:** 0.00 / **Include Event Points:** None / **Included Profiles:** None



4. Notice the cursor prompt: **Locate First Element**. Select the **KIRBY** alignment.



5. Notice the next cursor prompt: **Locate Next Element – Reset To Complete**. You could select additional alignments to add to the report, but for this exercise, go ahead and right click to complete.
6. Left click to accept the remaining prompts and the **Horizontal Alignment Review Report** should automatically open (within the **Bentley Civil Report Browser**). **Note:** If you hadn't toggled on **Lock To Start/End**, you could have selected specific points graphically when prompted <u>or</u> keyed-in a station range within the dialog box.


Horizontal Alignment Review Report

Report Created: Monday, March 8, 2021
Time: 2:42:44 PM

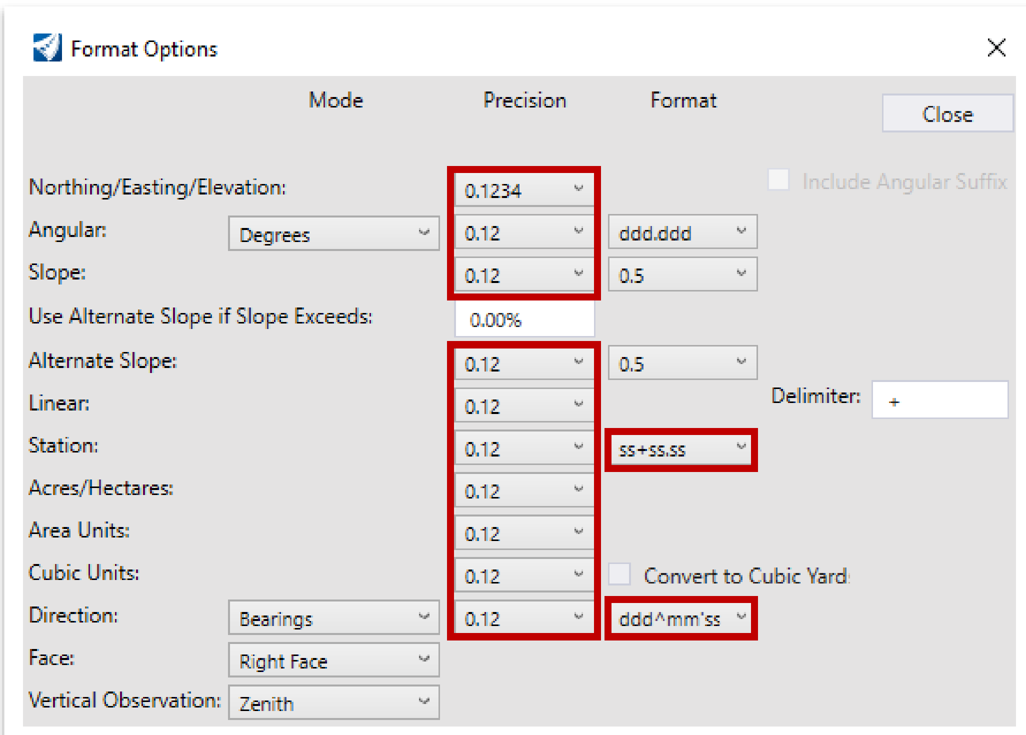
Project: Default
Description:
File Name: C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\SURVEY_Training\dgn\Alignment - GPK.dgn
Last Revised: 3/8/2021 11:45:42

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

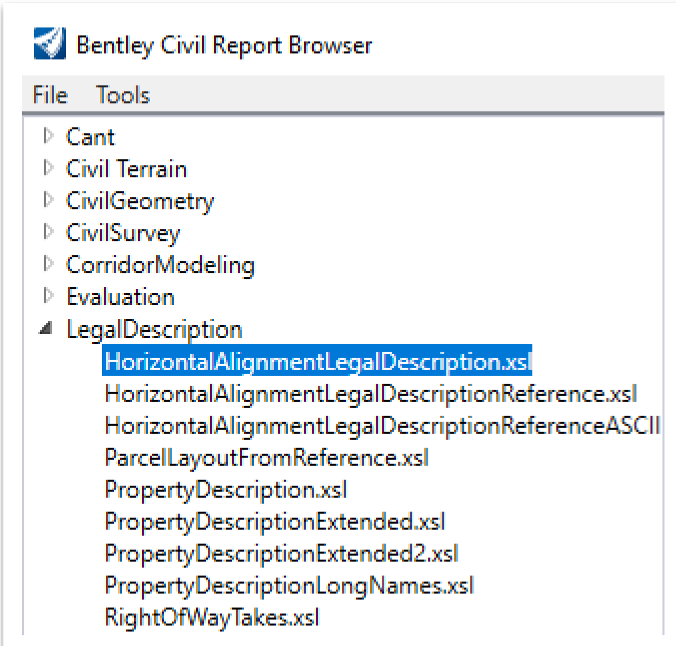
Alignment Name: KIRBY
Alignment Description:
Alignment Style: Alignment\Survey Preliminary Centerline

		Station	Northing	Easting
Element: Linear				
START	( )	10000.000 R1	826316.679	1816374.127
PC	( )	11131.629 R1	825199.118	1816196.249
Tangential Direction:		S9.044°W		
Tangential Length:		1131.629		

7. You may have noticed that some of the formatting is not what you are used to seeing. Within the report, we will change the precisions and the format for both **Station** and **Direction**. **Note:** Once you apply these updates, you will see them in the opened report and for any future reports that you create.
8. Within the **Bentley Civil Report Browser**, go to **Tools >> Format Options**. Change the following settings and then click **Close** and notice the updates.
    a. **Northing/Easting/Elevation Precision:** 0.1234
    b. **All other Precision:** 0.12
    c. **Station Format:** ss+ss.ss
    d. **Direction Format:** ddd^mm'ss.s"



9. Next, let's look at the **Horizontal Alignment Legal Description**. Within the **Bentley Civil Report Browser**, scroll down and expand the **LegalDescription** category on the left side. Left click on **HorizontalAlignmentLegalDescription .xsl**. **Note:** If you had closed out of the **Bentley Civil Report Browser**, you would need to initiate the **Legal Report** tool (**Survey >> Geometry >> General Tools >> Reports**) and follow the prompts.



10. Notice that the **Horizontal Alignment Legal Description** now appears for **KIRBY**.

Horizontal Alignment Legal Description

Report Created: Monday, March 8, 2021
Time: 5:07:46 PM

Project: Default

Description:

File Name: C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\SURVEY_Training\dgn\Alignment - GPK.dgn

Last Revised: 3/8/2021 11:45:42

Input Grid Factor:

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

Alignment Name: KIRBY

Alignment Description:

Commencing at ,
said point being the POINT OF BEGINNING;
thence S09°02'37.28"W, 1131.63 feet,
to a point on a curve ,
having a radius of 622.54 feet and a central angle of 14.95°,
thence along the arc of said curve a distance of 162.46 feet,
said arc subtended by a chord bearing S01°34'03.49"W, a distance of 162.00 feet.
to a point on a curve ,
having a radius of 201.85 feet and a central angle of 49.28°,
thence along the arc of said curve a distance of 173.61 feet,
said arc subtended by a chord bearing S30°32'52.29"E, a distance of 168.31 feet.
thence S55°11'14.26"E, 1.56 feet,
to a point on a curve ,
having a radius of 344.13 feet and a central angle of 26.76°,
thence along the arc of said curve a distance of 160.74 feet,
said arc subtended by a chord bearing S68°34'07.11"E, a distance of 159.28 feet.
thence S81°56'59.96"E, 552.47 feet,
to a point on a curve ,
having a radius of 11459.16 feet and a central angle of 1.69°,
thence along the arc of said curve a distance of 338.71 feet,
said arc subtended by a chord bearing S81°06'11.60"E, a distance of 338.69 feet.
thence S80°15'23.24"E, 426.66 feet.
and the POINT OF BEGINNING; Containing 26.34 acres, more or less.

11. Now, expand the **MapCheck** category on the left side and left click on **MapCheck.xsl**. A portion of the **Map Check Report** is shown below for **KIRBY**. This report shows precision information based on plotted data (e.g. lengths, directions, coordinates) in the drawing rather than the internal precision stored by the software. The plotted values are used during construction to determine closure errors based on plotted precision. Scroll down to see the full report. **Note:** Once again, if you had closed out of the **Bentley Civil Report Browser**, you would need to initiate the **Map Check Report** tool (**Survey >> Geometry >> General Tools >> Reports**) and follow the prompts.

Map Check Report

Report Created: Monday, March 8, 2021
Time: 5:08:38 PM

Project: Default
Description:
File Name: C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\SURVEY_Training\dgn\Alignment - GPK.dgn
Last Revised: 3/8/2021 11:45:42
Input Grid Factor:

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

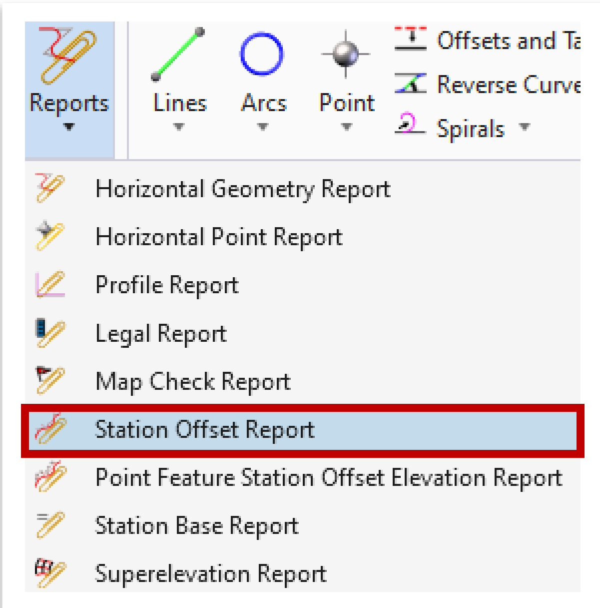
Alignment Name: KIRBY
Alignment Description:

Type	Point Name/ Direction	Northing/ Length	Easting	Elevation
START	()	826316.6791	1816374.1272	0.0000
	S09°02'37.28"W	1131.63		
PC	()	825199.1173	1816196.2491	0.0000
	N80°57'22.72"W	622.54		
CC	()	825101.2618	1816811.0502	0.0000
	S84°05'29.69"W	622.54		
PCC	()	825037.1783	1816191.8173	0.0000
	S84°05'29.69"W	201.85		

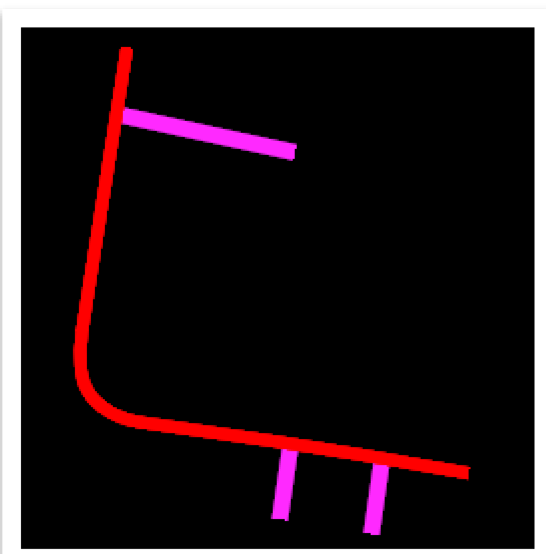
Take Note!

*All the available reports can be accessed within the **Bentley Civil Report Browser** for the selected element(s) after you initiate any <u>one</u> of the reports. You do not need to generate the applicable report via the **Reports** tools in the ribbon every time. If you want to report on a different element or want to select additional elements, then you would need to re-initiate one of the reports and go through the prompts.*

12. Next, lets run a **Station-Offset Report**. Before doing so, close the **Bentley Civil Report Browser** and deselect all elements, if necessary. Open the **Station Offset Report** tool (**Survey >> Geometry >> General Tools >> Reports**).



13. Notice the cursor prompt: **Locate Element**. Select the **KIRBY** alignment. Notice the next cursor prompt: **Locate First Offset Element**. Select each of the **three** side road alignments (**CARDINAL**, **BRYANJAMES**, **EAGLESNEST**) and then right click to complete. Once you select them, they will be highlighted, as shown below.



14. The **Station Offset Report** should automatically appear, which provides a list of stations and offsets for selected horizontal geometry elements. Offsets are always measured perpendicular from the base element to the offset element. The reported stationing is measured along the offset element. Offsets are given for the cardinal points on the base element (in this case **KIRBY**).

Station Offset Report

Report Created: Monday, March 8, 2021
Time: 5:11:16 PM

Project: Default

Description:

Baseline (Active) Alignment: KIRBY

File Name: C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\SURVEY_Training\dgn\Alignment - GPK.dgn

Last Revised: 3/8/2021 11:45:42

Input Grid Factor:

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

Baseline Alignment (KIRBY)				Offset Alignment (CARDINAL)			
Station	**Type**	**Distance to Offset Point**	**Radial Direction**	**Station**	**Type**	**Distance to Offset Point**	**Radial Direction**
102+64.31 R1	POT	-0.00	N80°57'22.72"W	74+00.00 R1	START	0.00	S12°06'44.55"W
103+02.98 R1	POT	-721.17	N80°57'22.72"W	81+22.21 R1	END	0.00	S12°06'44.55"W

Baseline Alignment (KIRBY)				Offset Alignment (BRYANJAMES)			
Station	**Type**	**Distance to Offset Point**	**Radial Direction**	**Station**	**Type**	**Distance to Offset Point**	**Radial Direction**
122+34.51 R1	POC	0.00	S08°18'36.80"W	37+00.00 R1	START	0.00	N81°45'40.29"W
122+34.89 R1	POC	300.00	S08°18'43.71"W	40+00.00 R1	END	0.00	N81°45'40.29"W

Baseline Alignment (KIRBY)				Offset Alignment (EAGLESNEST)			
Station	**Type**	**Distance to Offset Point**	**Radial Direction**	**Station**	**Type**	**Distance to Offset Point**	**Radial Direction**
126+02.60 R1	POT	0.00	S09°44'36.76"W	47+00.00 R1	START	0.00	N81°55'20.17"W
126+11.32 R1	POT	299.87	S09°44'36.76"W	50+00.00 R1	END	0.00	N81°55'20.17"W

15. Lastly, let's look at the **Station Base Report**. Within the **Bentley Civil Report Browser** (still under **StationOffset**), left click on **StationBaseCompare.xsl** and notice the report appears. **Note:** Once again, if you had closed out of the **Bentley Civil Report Browser**, you would need to initiate the **Station Base Report** tool (**Survey >> Geometry >> General Tools >> Reports**) and follow the prompts.

Station Base Report

Report Created: Monday, March 8, 2021
Time: 5:15:00 PM

Project: Default

Description:

Baseline (Active) Alignment: KIRBY

File Name: C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\SURVEY_Training\dgn\Alignment - GPK.dgn

Last Revised: 3/8/2021 11:45:42

Input Grid Factor:

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

- - - - - - - - Baseline Alignment - - - - - - - (KIRBY)				- - - - - - - - Offset Alignment - - - - - - - - (CARDINAL)			
Station	**Type**	**Distance to Offset Point**	**Radial Direction**	**Station**	**Type**	**Distance to Offset Point**	**Radial Direction**
102+64.31 R1	POT	0.00	N80°57'22.72"W	74+00.00 R1	START	-0.00	S12°06'44.55"W
103+02.98 R1	POT	0.00	N80°57'22.72"W	81+22.21 R1	END	-721.17	S12°06'44.55"W

- - - - - - - - Baseline Alignment - - - - - - - (KIRBY)				- - - - - - - - Offset Alignment - - - - - - - - (BRYANJAMES)			
Station	**Type**	**Distance to Offset Point**	**Radial Direction**	**Station**	**Type**	**Distance to Offset Point**	**Radial Direction**
122+34.51 R1	POC	0.00	S08°18'36.80"W	37+00.00 R1	START	0.00	N81°45'40.29"W
122+34.89 R1	POC	0.00	S08°18'43.71"W	40+00.00 R1	END	300.00	N81°45'40.29"W

- - - - - - - - Baseline Alignment - - - - - - - (KIRBY)				- - - - - - - - Offset Alignment - - - - - - - - (EAGLESNEST)			
Station	**Type**	**Distance to Offset Point**	**Radial Direction**	**Station**	**Type**	**Distance to Offset Point**	**Radial Direction**
126+02.60 R1	POT	0.00	S09°44'36.76"W	47+00.00 R1	START	0.00	N81°55'20.17"W
126+11.32 R1	POT	0.00	S09°44'36.76"W	50+00.00 R1	END	299.87	N81°55'20.17"W

Take Note!

*To get the **side road** reports, you would simply select the appropriate preliminary centerline(s) and go through the same process as above. Remember, you can select multiple alignments at the same time.*

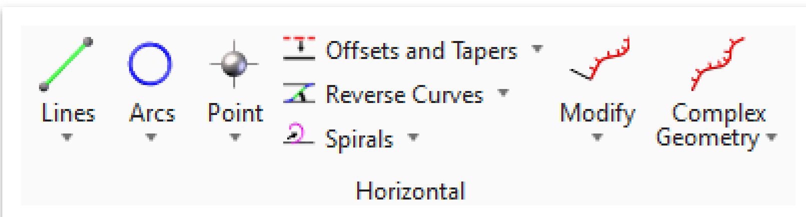
Other reports available for **Civil Geometry** within the **Reports** tools (**Survey >> Geometry >> General Tools**) include:

- **Horizontal Point Report:** Contains a list showing point name, feature, description, northing, easting and elevation.
- **Profile Report:** Contains a list showing the profile elements.
- **Point Feature Station Offset Elevation Report:** Contains point name, point feature, station, and offset from selected points to a baseline, civil horizontal geometry or survey element.
- **Superelevation Report:** Contains the superelevation data along the selected element(s).

4.4 Lecture: Horizontal Civil Geometry

The **Horizontal Civil Geometry** tools house all the commands to create, modify and manipulate horizontal geometry, such as points, lines, all types of curves and spirals (Figure 66). Also, these tools offer options to combine, copy, offset and taper already placed geometry, and edit specific properties of alignments.

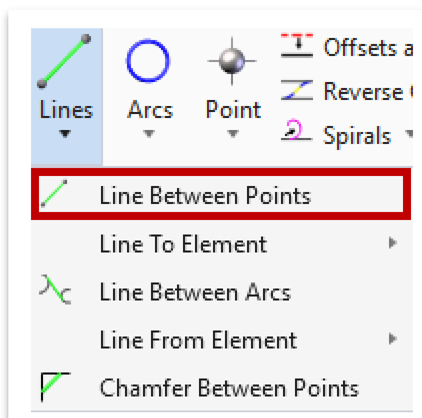
FIGURE 66. HORIZONTAL CIVIL GEOMETRY TOOLS



4.4.1 Lines Tools

The horizontal **Lines** tools are used to create horizontal linework (Figure 67). The most common method of placement is using the **Line Between Points** option. When a line is placed without the use of Snaps or Civil AccuDraw, the element has basic manipulators for moving the end points of the line, moving the entire line, or editing the distance and direction. If a line is placed with **Snaps** or **Civil AccuDraw**, the normal manipulators are replaced by Snap or AccuDraw manipulators. Snap manipulators will automatically update the line as the snapped element updates unless the snap is broken.

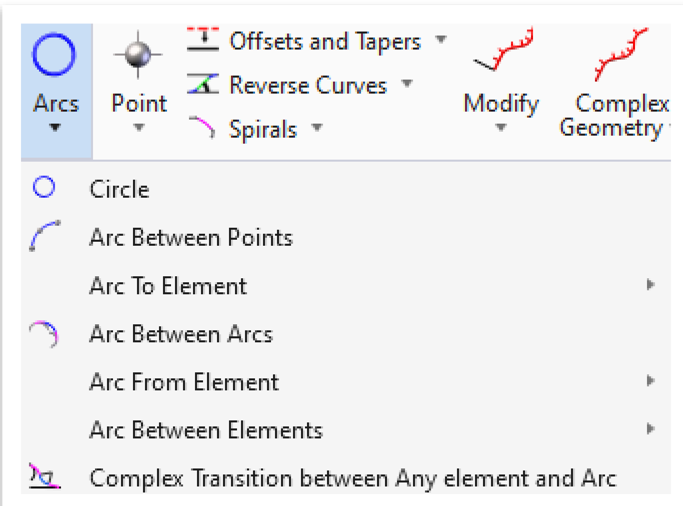
FIGURE 67. LINES TOOLS



4.4.2 Arcs Tools

The horizontal **Arcs** tools are used to create horizontal simple curves and allow the user to create arcs in the drawing defined by various parameter combinations (Figure 68). The most commonly used Arc tools are **Arc Between Points** and **Arc Between Elements** (Simple Arc).

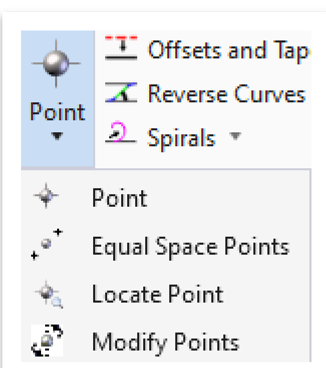
FIGURE 68. ARCS TOOLS



4.4.3 Point Tools

The **Point** tools allow for the construction of civil point elements (Figure 69). The user can place a single point or multiple points at equal spacing. We will look further into the Equal Space Points tool in Section 4.4.10.

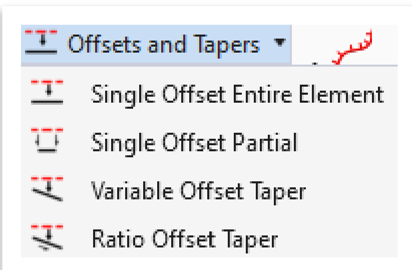
FIGURE 69. POINT TOOLS



4.4.4 Offsets and Tapers Tools

The **Offsets and Tapers** tools can be used to offset a copy of an element and create tapered offsets of elements (Figure 70). The user can offset a section of an element with the **Single Offset Partial** tool. The **Taper** offset tools allow the user to offset an element at a taper defined by a ratio or by two offset distances. Elements created by offset tools will have a rule linking them to the base element (e.g., if the base element is moved, the offset element will move with it). If the base element is modified in any way (lengthened, radius changed, etc.) the offset element will update to match while the offset rule is active.

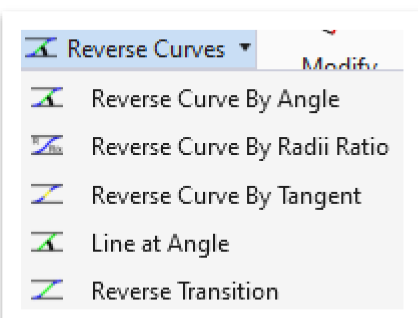
FIGURE 70. OFFSETS AND TAPERS TOOLS



4.4.5 Reverse Curves Tools

The **Reverse Curves** tools can be used to create reverse curves (Figure 71). The most commonly used option for placing a reverse curve is the **Reverse Curve by Tangent**. Two referenced tangent lines must be already placed in the drawing to use this option. There is an optional setting for placing a transition length in between the reverse curves.

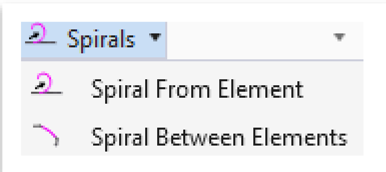
FIGURE 71. REVERSE CURVES TOOLS



4.4.6 Spirals Tools

Spirals can be created with the **Spiral From Element** tool, where an element defines tangency at one end of the spiral, or with the **Spiral Between Elements** tool, where a spiral is constructed between two elements that determine tangency (Figure 72).

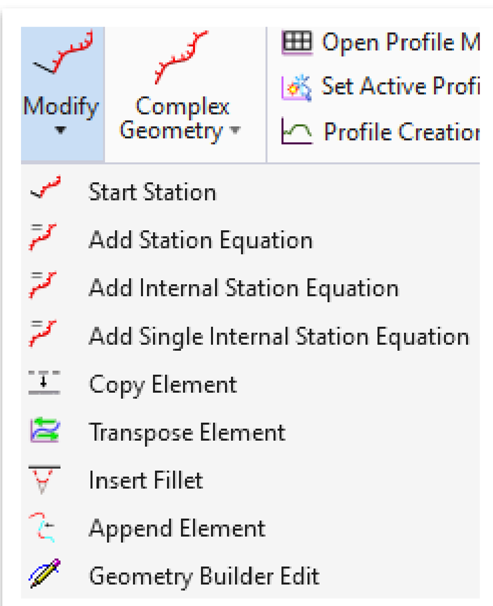
FIGURE 72. SPIRALS TOOLS



4.4.7 Modify Tools

The **Modify** tools allow the user to change basic aspects of a horizontal alignment, such as **stationing** (including inserting station equations), **copying**, **transposing** and **appending** elements (Figure 73).

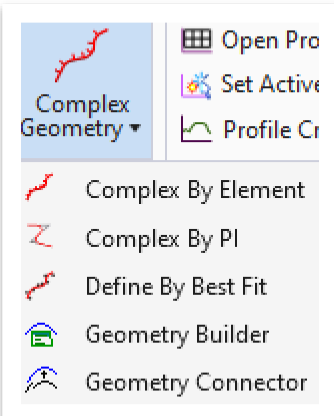
FIGURE 73. MODIFY TOOLS



4.4.8 Complex Geometry Tools

The **Complex Geometry** tools allow the user to create complex geometry elements through several methods (Figure 74).

FIGURE 74. COMPLEX GEOMETRY TOOLS

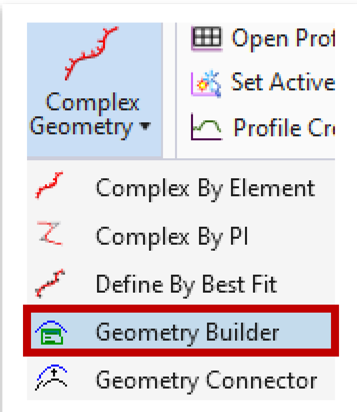


- **Complex By Element**: Allows the user to combine existing geometry elements into one complex element.
- **Complex By PI**: Allows the user to create a new complex element by defining points of intersection and radii.
- **Define By Best Fit**: Allows the user to construct an element that best fits a course defined by a selected linear object.
- **Geometry Builder**: Allows the user to enter all the design parameters (e.g. X, Y, bearings, distances, degree of curvature) into a table via a dialog box. This tool is used if the user has all the information to store each piece of geometry using a tabular form (ROW and Parcel definition).
- **Geometry Connector**: Allows the user to free or lock elements that you wish to keep within the geometry.

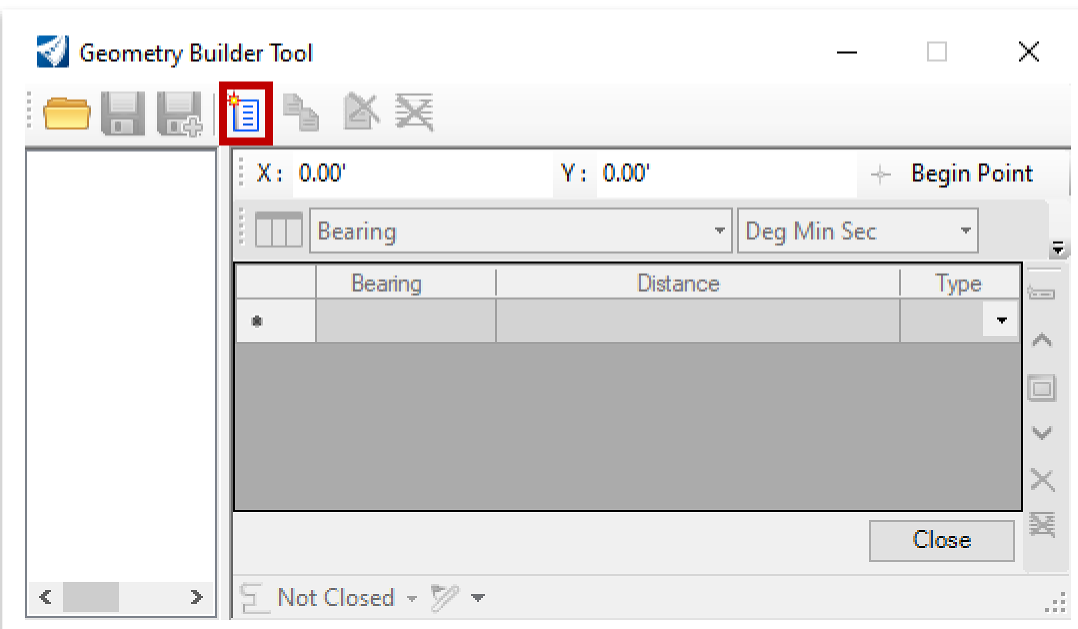
4.4.9 Exercise: Geometry Builder

In this exercise, we will utilize known metes and bounds descriptions from a deed, in which we will input into ORD. The Geometry Builder would best be used by TDOT Survey to plot property information from deeds into a development level so that the parcels could be fit together before establishing actual property lines. We will continue to utilize the same **Alignment – GPK.dgn** file.

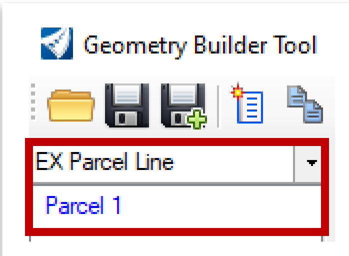
1. Open the **Geometry Builder** tool (**Survey >> Geometry >> Horizontal >> Complex Geometry**).



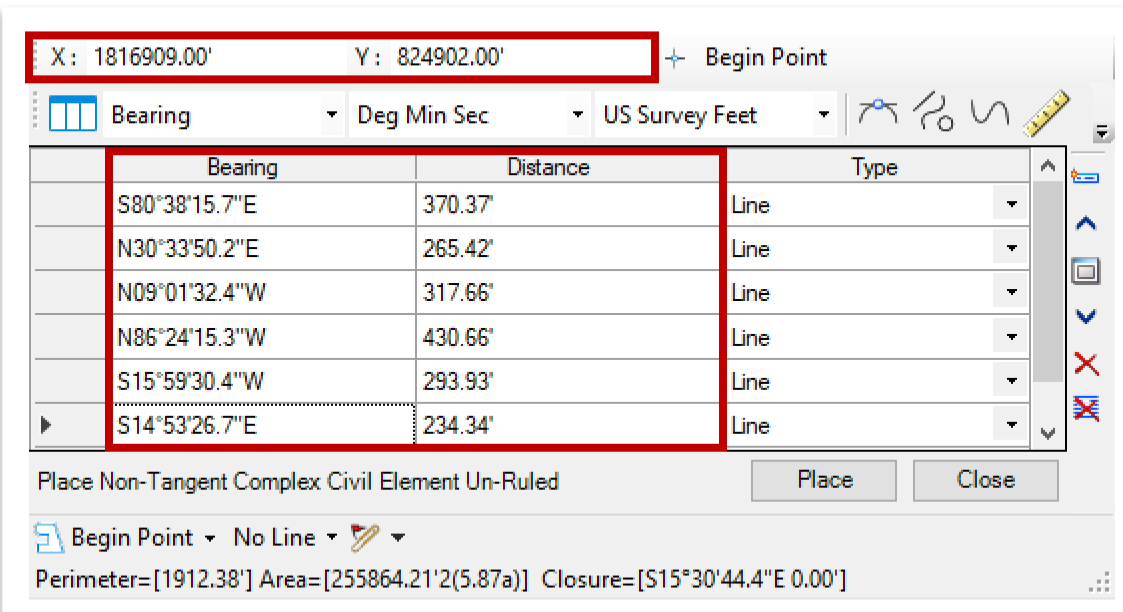
2. Within the **Geometry Builder Tool** dialog box, click on **Add new geometry** in the upper left corner.



3. Click on the drop-down arrow next to **No Feature Definition** and select the **EX Parcel Line** feature definition (**Linear >> Right Of Way**). Name this new geometry **Parcel 1** by left clicking within the **NewGeometry1** field. **Note:** You could add as many parcels as you'd like, but for this exercise we will only create one.

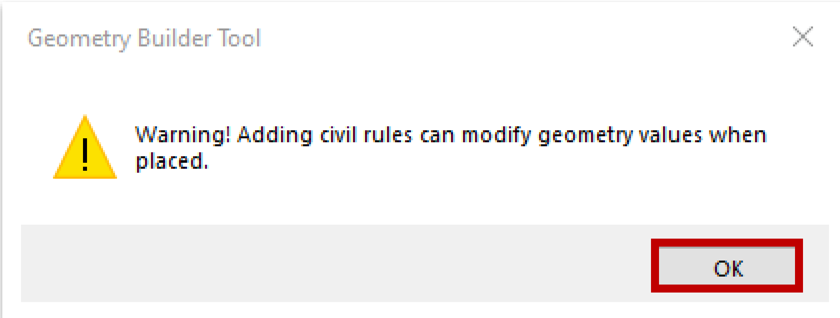


4. For this exercise, we will assume that we know the bearings and distances from the deed. **Key-in** the data below, including the starting **XY** coordinates. Remember to use the **^** key for degrees. To add additional lines for bearings/distances, you can either hit **Enter** after keying in the Distance or left click in the bottom blank row. As you enter each row, you will notice the parcel line temporarily being drawn in your file.

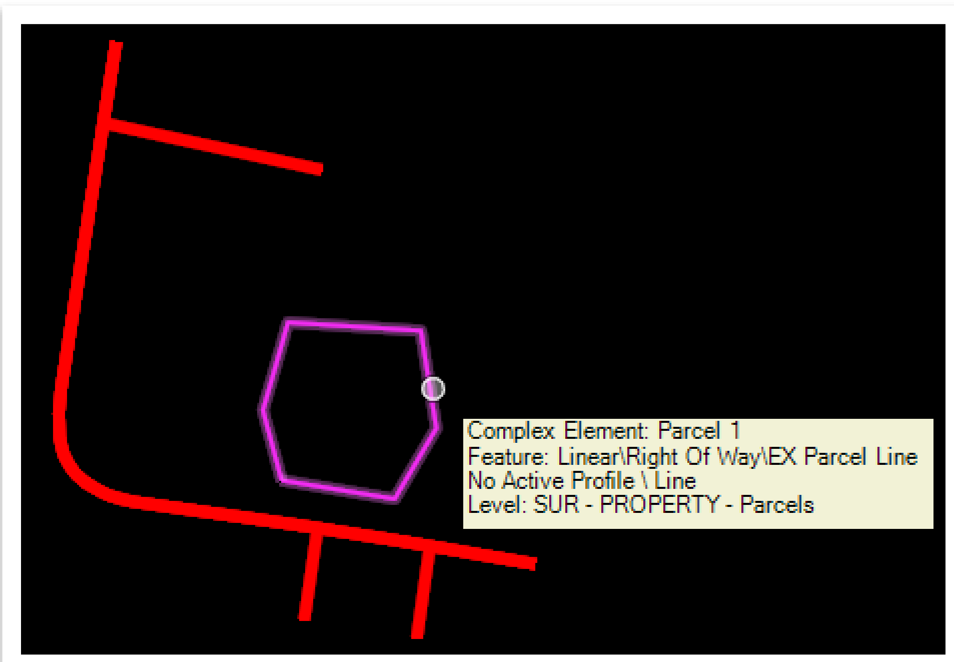


5. Once you have the data entered, toggle on **Create ruled civil elements** (highlighted in red).

6. You will get an alert message. Click **OK**.



7. Within the **Geometry Builder Tool** dialog box, click **Place** and your parcel should look like the image below. Notice that if you select the parcel, the correct TDOT feature and symbology is applied.

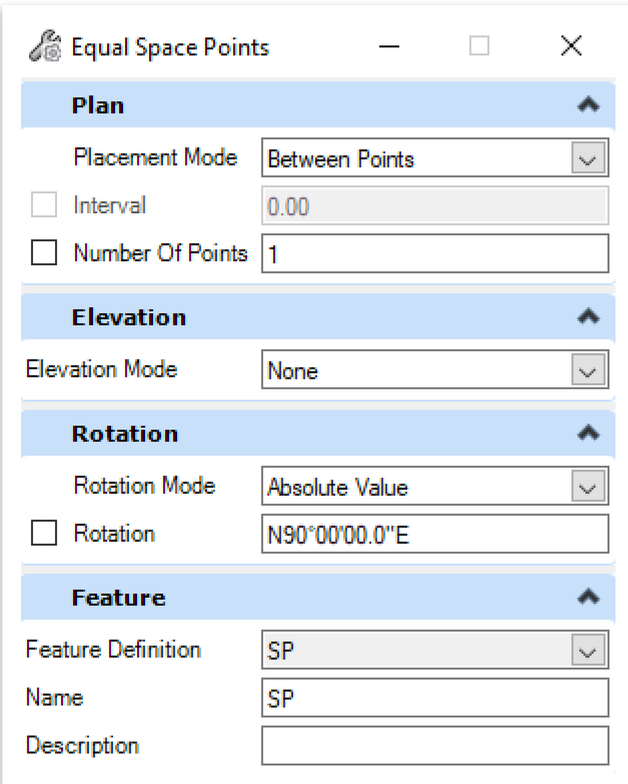


8. Go ahead and **Close** the **Geometry Builder Tool** dialog box. You will be asked if you want to save the file. Go ahead and save the xml file in your **SURVEY_ Training** workset dgn subfolder and name it **Parcel 1**. **Note:** If you already had a xml file, you could open it within the tool as well.

4.4.10 Best Fit Horizontal Geometry

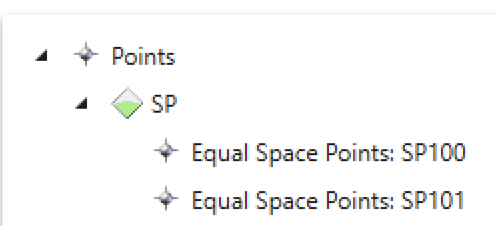
As discussed earlier in Section 4.4.3, the **Equal Space Points** tool (Figure 75) is located within the **Horizontal Point** tools (**Survey >> Geometry >> Horizontal >> Point**). This will be used to split the existing roadway pavement (RD) shots and to guide the creation of the **Survey Preliminary Centerline** via the **Best Fit** tool.

FIGURE 75. EQUAL SPACE POINTS DIALOG BOX



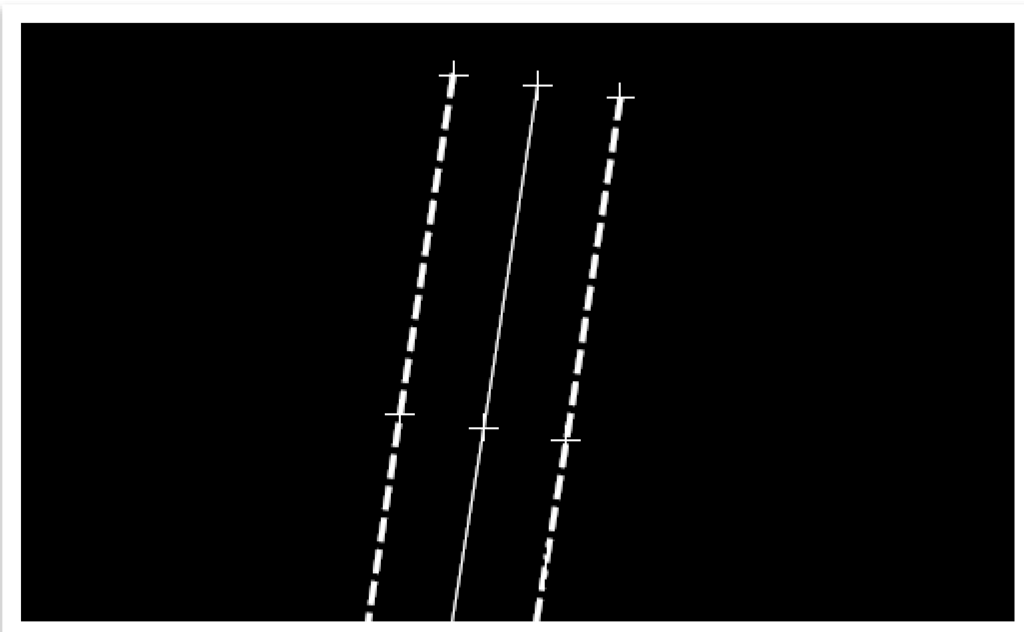
The **Feature Name** field (**SP**) will count in sequential order with each point placed within the file (Figure 76). However, it is only sequential starting at 1. There is an enhancement request filed with Bentley so that ORD will auto-increment based on the starting point number you enter (e.g. SP100, SP101, etc). You may fill in a Description for each point if you would like or just leave it blank.

FIGURE 76. EQUAL SPACE POINTS: FEATURE NAMING



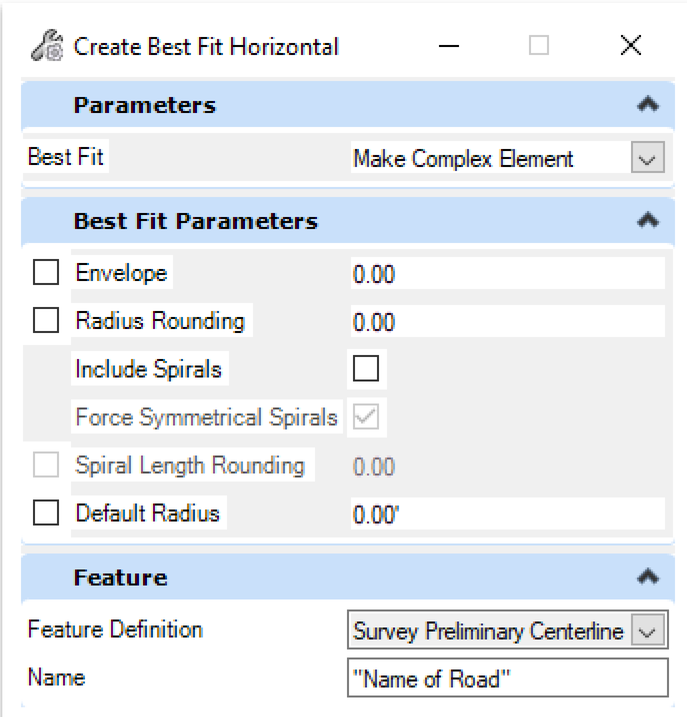
Once you have placed all Equal Space Points, you will have to **Place SmartLine** to connect all points (**Survey >> Drawing >> Placement**) (Figure 77). Previously, the points could be added in COGO in Geopak, but that functionality does not exist yet in ORD and has been requested as an enhancement with Bentley. You must have the linear element (SmartLine) to select when utilizing the **Define By Best Fit** tool (**Survey >> Geometry >> Horizontal >> Complex Geometry**). The symbology of the SmartLine is not critical during its creation.

FIGURE 77. EQUAL SPACE POINTS: PLAN VIEW



Once the **Define By Best Fit** tool is initiated, the additional parameters including the Feature Definition can be filled in to create the **Survey Preliminary Centerline** (Figure 78). The stationing will be added after the centerline is placed via the **Start Station** tool (**Survey >> Geometry >> Horizontal >> Modify**).

FIGURE 78. CREATE BEST FIT HORIZONTAL DIALOG BOX



In order to see the offset difference between the equal space points along the CL in relation to the Best Fit line, you can run a **Point Feature Station Offset Elevation** report (Figure 79). We will look further into this type of report in the next exercise.

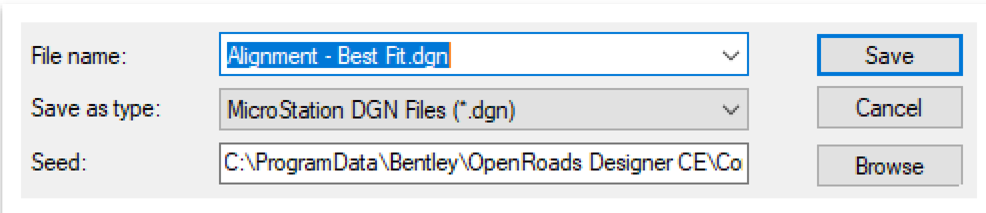
FIGURE 79. POINT FEATURE STATION OFFSET ELEVATION REPORT EXAMPLE

Point	Description	Station	Offset	Elevation	Feature
Survey Prelim CL Point	1	100+00.00 R1	-0.052		Point\Survey\Transportation
Survey Prelim CL Point 1	2	100+50.07 R1	-0.132		Point\Survey\Transportation
Survey Prelim CL Point 2	3	101+00.59 R1	-0.052		Point\Survey\Transportation
Survey Prelim CL Point 3	4	101+54.21 R1	-0.084		Point\Survey\Transportation

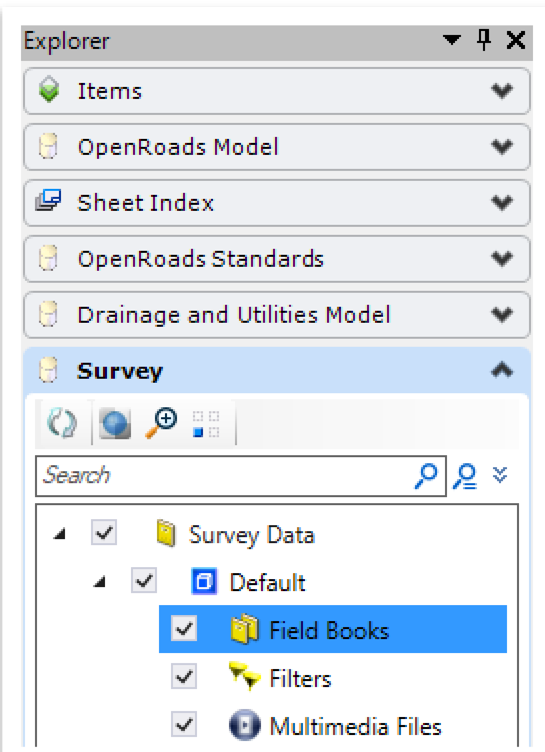
4.4.11 Exercise: Horizontal Geometry Creation – Best Fit

In this exercise, we will create a best fit preliminary centerline via the breaklines contained within the survey text file. We will also make some modifications to the centerline and create a station offset report.

1. Create a new file and name it **Alignment – Best Fit**. Select the **TDOTSeed2D.dgn** and click **Save**.

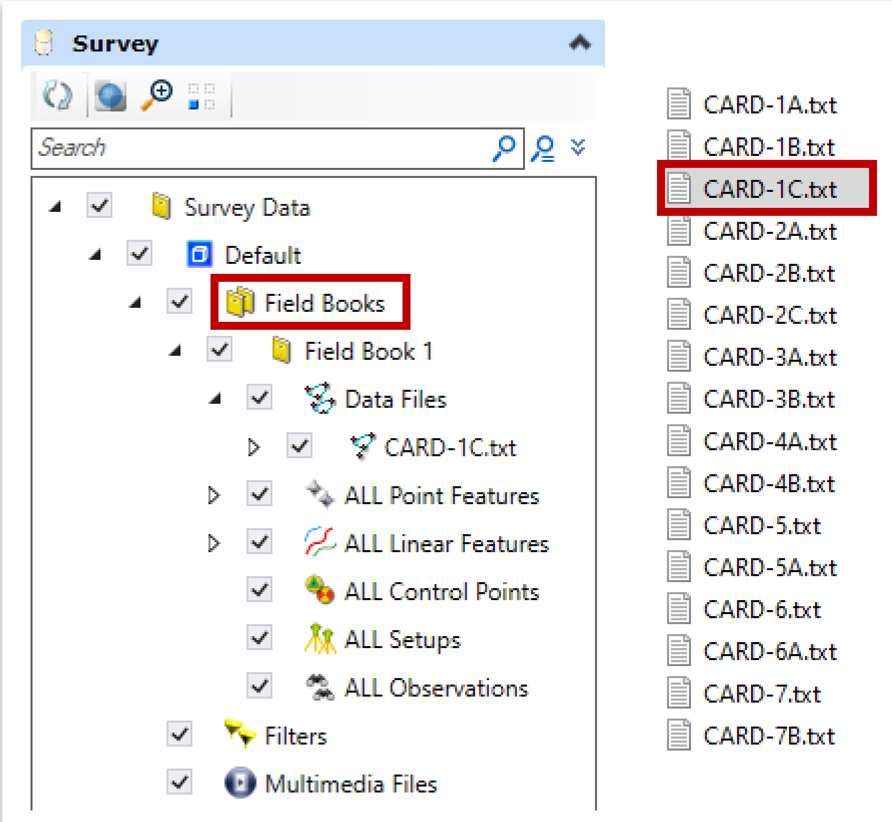


2. First, let's create the survey field book. For this exercise, we will only import the **CARD-1C.txt** file. Within the **Explorer**, navigate to **Field Books** folder (**Survey >> Survey Data >> Default**).



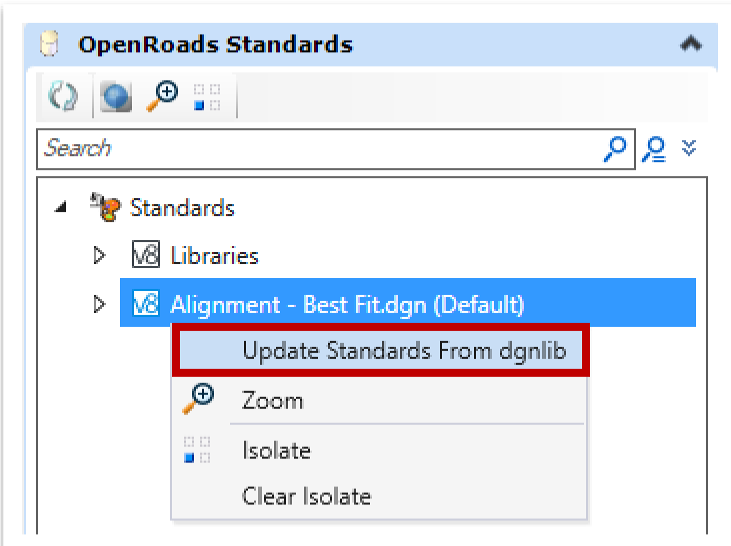
3. Open **File Explorer** and browse to the class files within the **SURVEY_Training** workset located here: **C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\Worksets\SURVEY_Training\dgn**.

4. Select the ASCII text file **CARD-1C.txt**, then drag and drop into the **Field Books** folder within the **Explorer**.

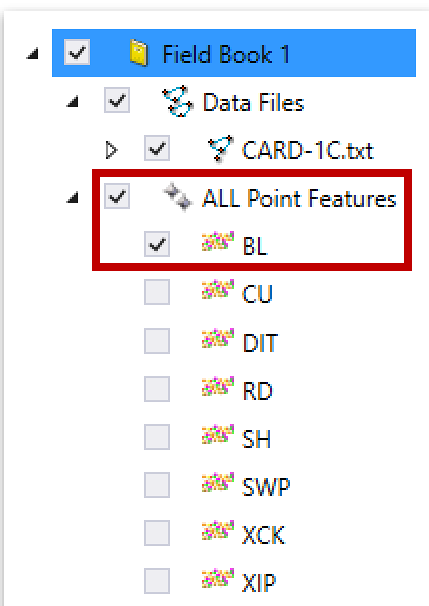


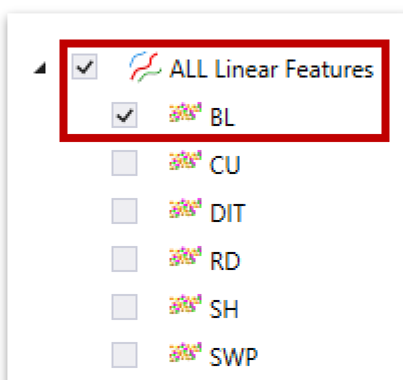
5. Click **Fit View** and review the file. You should see the image below.

6. As a reminder, the first thing we need to do after import is update the **dgnlib standards** so that <u>all</u> survey **locators** are the correct scale. Expand the **OpenRoads Standards** tab within **Explorer**. Right click on the active file (**Alignment – Best Fit.dgn**) and select **Update Standards From dgnlib**. Give the software a minute to process.



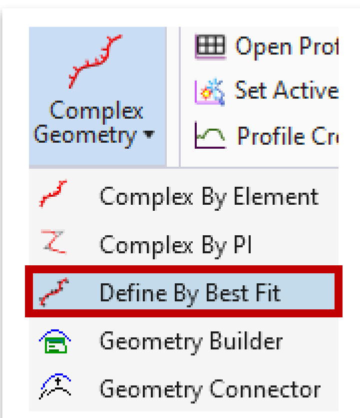
7. Next, go back to the **Survey** tab within the **Explorer** and expand **All Point Features** and **All Linear Features**. Toggle **off** all features other than **BL** for each category. This will display only the **BL** features which will be used to create a **Best Fit** alignment.



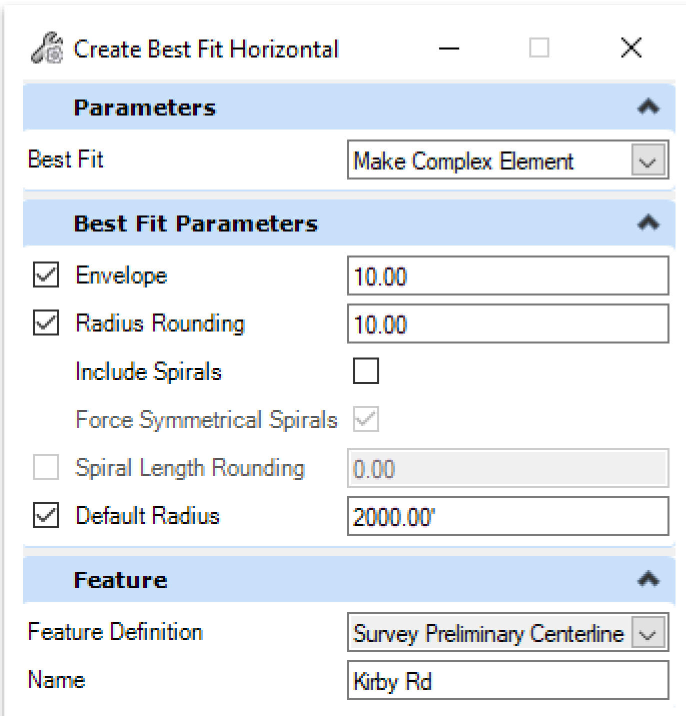


8. Notice that only the **breaklines** (points and linear features) are shown. Click **Fit View** again, if necessary.

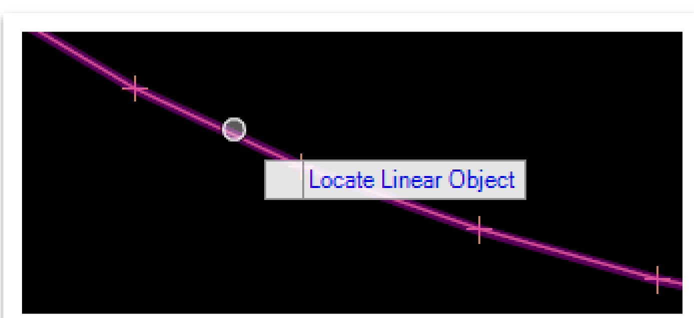
9. Now, we will create a survey preliminary centerline (complex geometry) via the **Define By Best Fit** tool. Go ahead and open the **Define By Best Fit** tool (**Survey >> Geometry >> Horizontal >> Complex Geometry**).



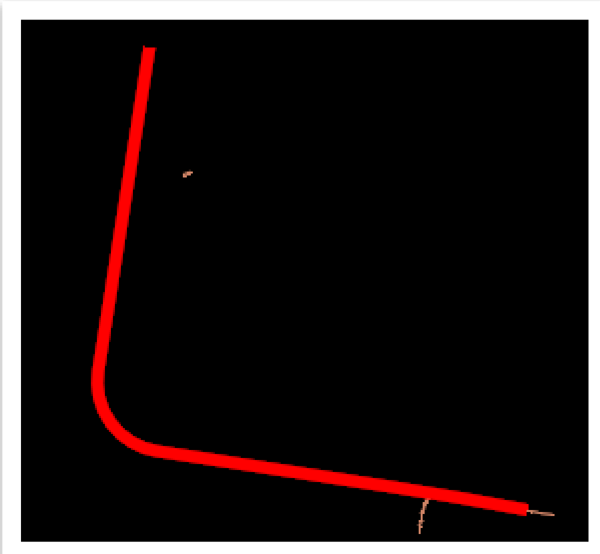
10. Within the **Create Best Fit Horizontal** dialog box, select the following settings.
    a. **Best Fit:** Make Complex Element
    b. **Envelope:** 10.00
    c. **Radius Rounding:** 10.00
    d. **Include Spirals:** None
    e. **Default Radius:** 2000.00
    f. **Feature Definition:** Alignment >> Survey Preliminary Centerline
    g. **Name:** Kirby Rd



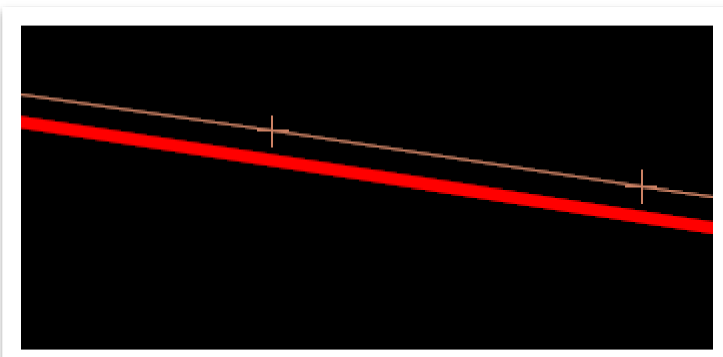
11. You will be prompted to first accept the **Best Fit: Make Complex Element** prompt. Left click to accept and then notice the next cursor prompt: **Locate Linear Object**. Select the **BL** survey chain and then left click through the remaining prompts to accept.



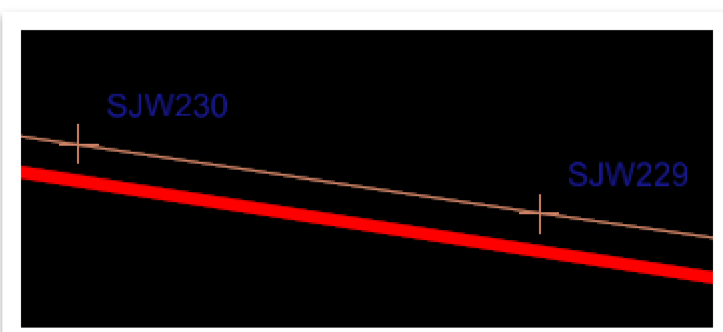
12. Once completed, you should notice a red survey preliminary centerline. Go ahead and right click to close the **Best Fit** tool.



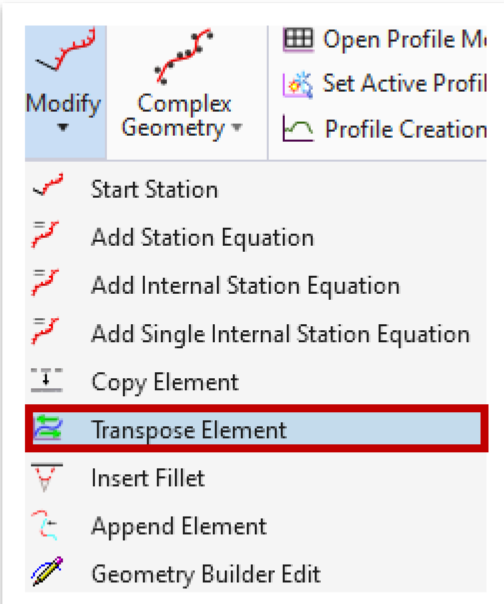
13. Zoom in and notice that there are two separate lines. This is to be expected since the **Best Fit** line does not perfectly overlay the breakline.



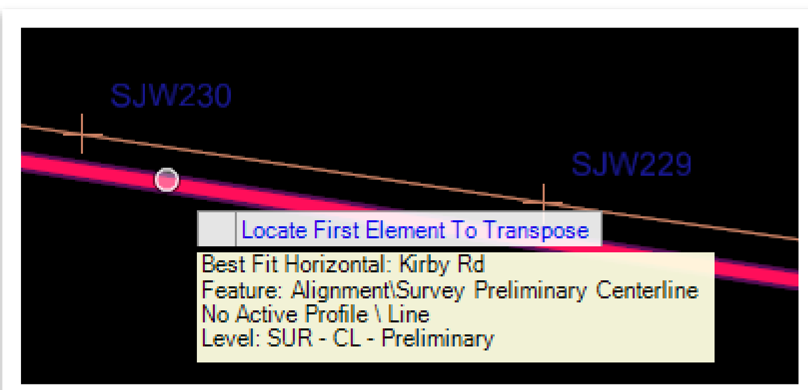
14. Next, turn on the **Names** decorations (**Survey >> Analyze >> Decorations**) so we can see the surveyed point names. You will notice that the point names go chronologically from right to left in terms of numbering.



15. The alignment was created without stationing. If we added stationing right now, it would be backwards and upside down. We need to first **Transpose** the best fit line, which essentially reverses the direction of the centerline. Open the **Transpose Element** tool (**Survey >> Geometry >> Horizontal >> Modify**).

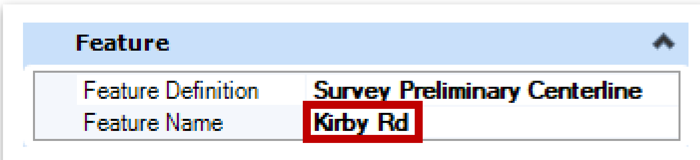


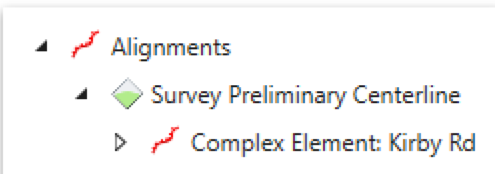
16. Notice the first cursor prompt: **Locate First Element To Transpose**. Select the **Kirby Rd** centerline that was just created. Make sure to zoom in so that you don't select the breakline by accident.



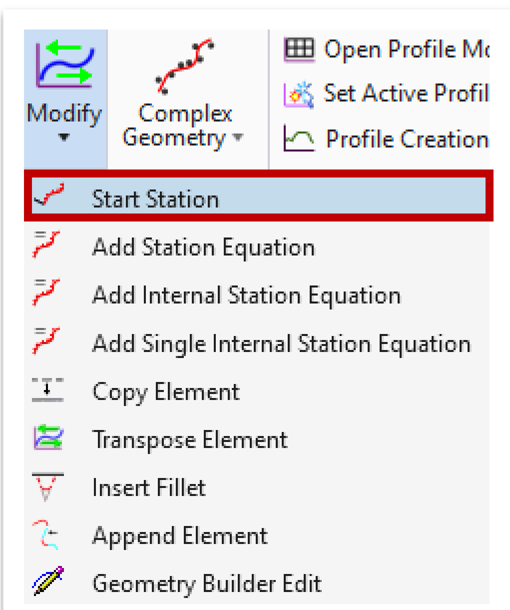
17. Right click to reset since we are only concerned with the one centerline. Notice the last prompt: **Accept Transpose Selected Elements**. Left click to accept. It will look like nothing happened, but you will see shortly that when we apply the stationing, it will be in the correct direction.

18. Before setting the start station, let's examine the alignments that are now in the file. Within the **Explorer**, under the **OpenRoads Model** tab expand **Alignment – Best Fit.dgn (Default) >> Alignments >> Survey Preliminary Centerline**. Notice there are **two** centerlines. The **Best Fit Horizontal** centerline was created initially and then the transposed centerline resulted in the **Complex Element** (**Kirby Rd1**). Go ahead and delete the **Best Fit Horizontal: Kirby Rd** centerline by right clicking on the name and selecting **Delete**. Then, select the new complex element in the drawing and open its **Properties**. Under the **Feature** tab, remove the "**1**" from the feature name (first image). Afterwards, you should only see the **Complex Element** in the **Explorer** with the updated name, as shown in the second image. **Note:** You may need to close out and reopen ORD to see the name update.

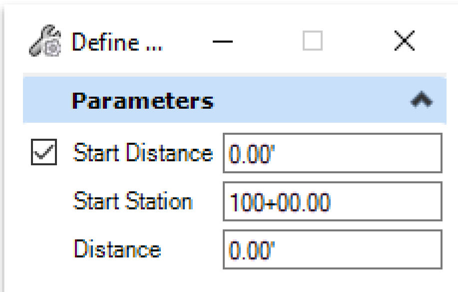




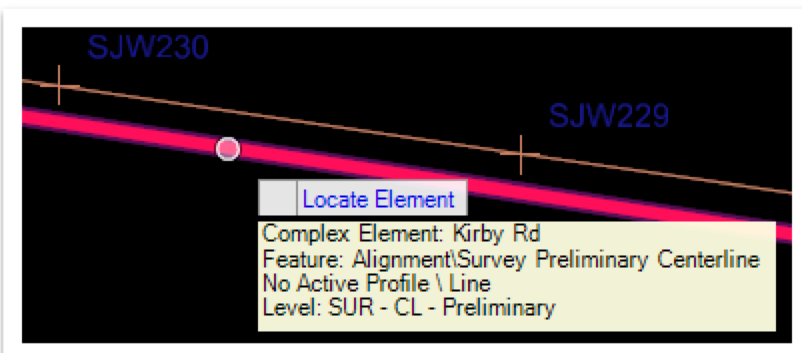
19. Next, let's apply a specific **Start Station** to the centerline. Open the **Start Station** tool (**Survey >> Geometry >> Horizontal >> Modify**).



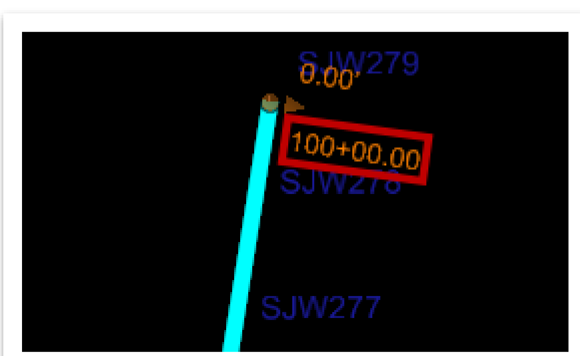
20. Within the **Define Starting Station** dialog box, select the following settings. This will set the stationing to start right at the beginning of the chain.
    a. **Start Distance:** 0.00'
    b. **Start Station:** 100+00.00
    c. **Distance:** 0.00'



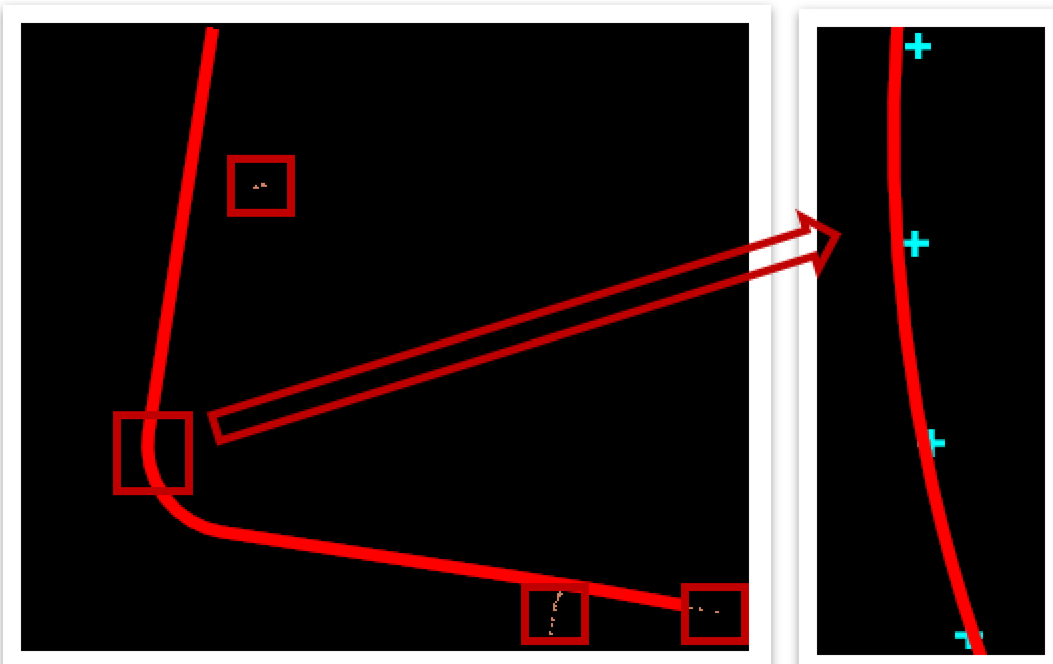
21. Notice the cursor prompt: **Locate Element**. Select the **Kirby Rd** centerline and then left click through the remaining prompts to accept.



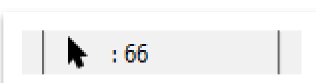
22. Once again it will look like nothing happened. Using the **Element Selection** tool, select the **Kirby Rd** centerline and notice now that there is an orange starting station of **100+00.00** on the northern end. The orange text is selectable and can be edited if you wish to change the starting station. You can also change the properties of the best fit line by selecting the centerline and opening the **Properties** window.



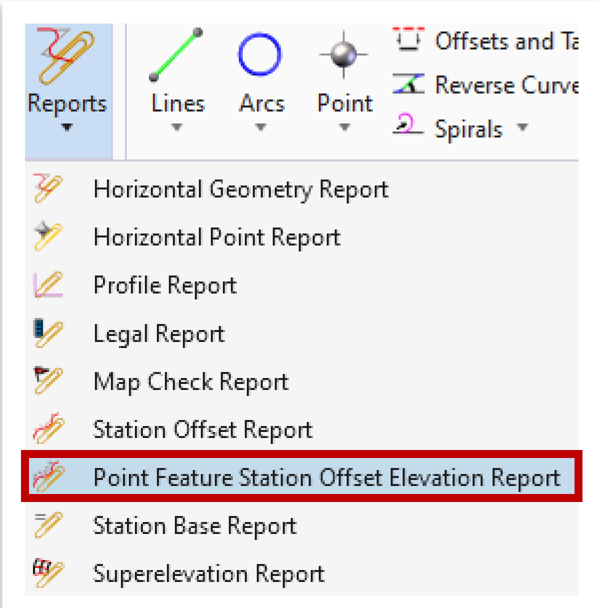
23. Now, let's create a **Point Feature Station Offset Elevation Report** along the best fit centerline. First, turn off the **Names** decorations (**Survey >> Analyze >> Decorations**) and the **SUR - DTM - Breaklines** level. We need to select the survey points that we want included in the station and offset report. Using the **Element Selection** tool, select all the **BL** point features along the centerline, <u>excluding the outlying points</u> (highlighted below). **Note:** It is quicker to first select all elements in the drawing and then hold down the **CTRL** key and deselect the elements you don't need.



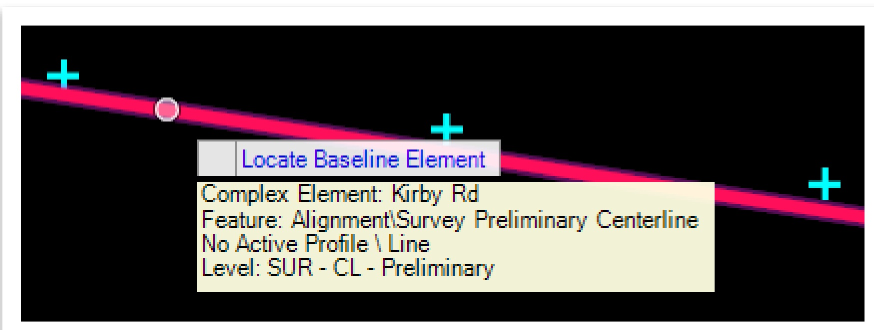
24. You should have **66** points selected. While the points are selected, the software will provide the total count at the bottom of the drawing window.



25. Next, open the **Point Feature Station Offset Elevation Report** tool (**Survey >> Geometry >> General Tools >> Reports**).



26. Notice the cursor prompt: **Locate Baseline Element**. Select the **Kirby Rd** centerline.



27. Notice the next cursor prompt: **Data Point To Accept Selected Elements**. Left click to accept and the report should open automatically.

Station Offset Elevation Feature Report

Report Created: Wednesday, March 10, 2021
Time: 7:20:03 PM

Project: Default

Description:

Baseline (Active) Alignment: Kirby Rd

File Name: C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\SURVEY_ - Best Fit.dgn

Last Revised: 3/10/2021 19:19:32

Input Grid Factor:

Note: All units in this report are in feet

Point	Description	Station	Offset	Elevation	Feature
SJW279		100+00.00	0.15	800.3050	BL
SJW278		100+47.76	-0.27	800.1680	BL
SJW277		100+98.27	-0.37	799.9100	BL
SJW276		101+48.62	-0.35	799.7970	BL
SJW275		102+00.62	-0.28	799.5680	BL
SJW274		102+50.86	-0.22	799.3740	BL
SJW273		102+98.66	0.01	799.3220	BL
SJW272		103+44.84	0.28	799.0240	BL
SJW271		103+94.51	0.42	798.8540	BL
SJW270		104+47.46	0.28	798.3960	BL

28. Once reviewed, go ahead and close the report. Delete the **field book** within the **Explorer** so that only the alignment is in the active file.

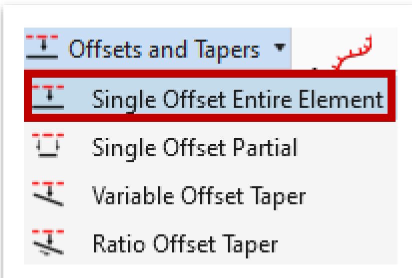
Take Note!

Once the complex geometry has been placed, you may modify it graphically by either grabbing the handles and moving the points or by using the dynamic fields to change the bearings and distances. Once again, we will add annotation in Chapter 5.

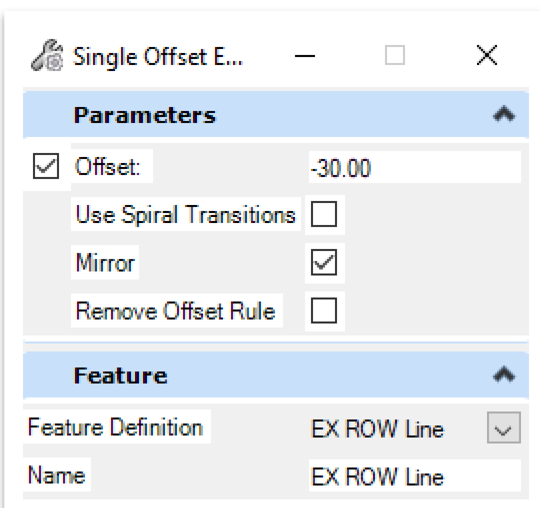
4.4.12 Exercise: Horizontal Offsets – ROW Lines

In this exercise, we will add existing ROW lines in the survey file utilizing the horizontal offset tools. We will open back up the **Survey Model – Edited.dgn** file.

1. Attach the **Alignment – Best Fit.dgn** file as a reference. For simplicity, turn off all levels in the active survey file. For this exercise, let's assume the existing R.O.W. is at a **30'** offset on each side of the centerline. Open the **Single Offset Entire Element** tool (**Survey >> Geometry >> Horizontal >> Offsets and Tapers**) so that we can create the existing ROW lines.

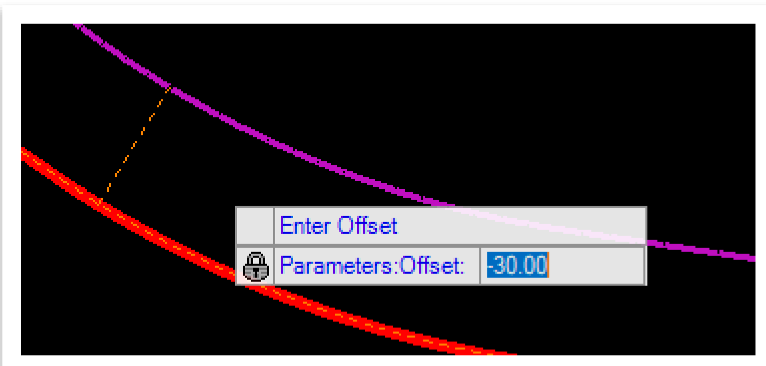


2. Within the **Single Offset Entire Element** dialog box, select the following settings.
   a. **Offset:** -30.00
   b. **Use Spiral Transitions / Remove Offset Rule:** Unchecked
   c. **Mirror:** Checked
   d. **Feature Definition:** EX ROW Line (**Linear >> Right Of Way**)
   e. **Name:** EX ROW Line

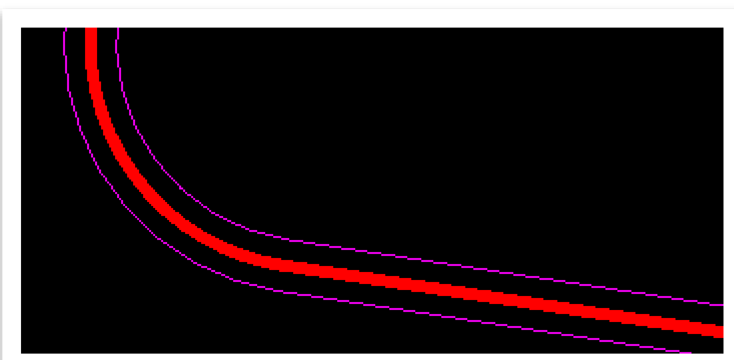


3. Notice the cursor prompt: **Locate Element <Alt> to Pick element in complex**. Select the **Kirby Rd** centerline.

4. Move your cursor to the northern side of the centerline. Left click to accept the placement of the existing ROW line and then left click again to select **Yes to Mirror** so that it is also placed on the southern side.



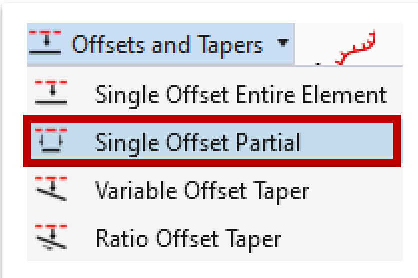
5. Turn on the **SUR - PROPERTY - ROW Lines** level and you should now see **two** existing ROW lines along the entire centerline.



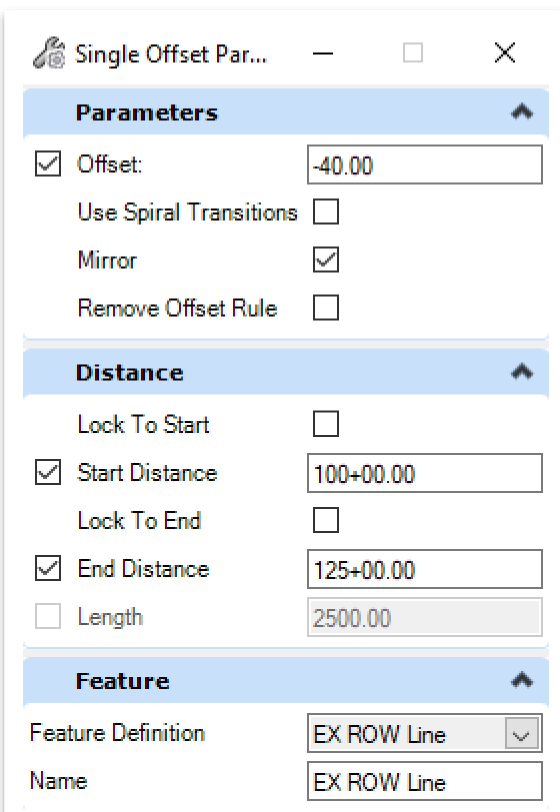
Take Note!

*The **Offsets and Tapers** tools must be used to associate the existing ROW lines to the centerline.*

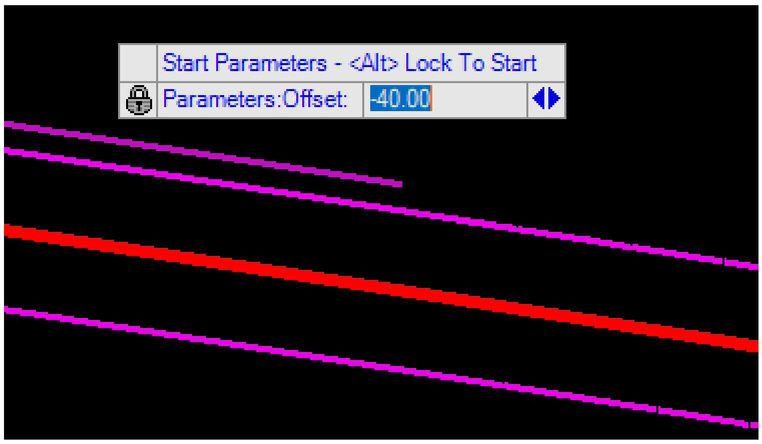
6. Now, let's place an existing ROW line within a specific station range along the centerline. Open the **Single Offset Partial** tool (**Survey >> Geometry >> Horizontal >> Offsets and Tapers**).



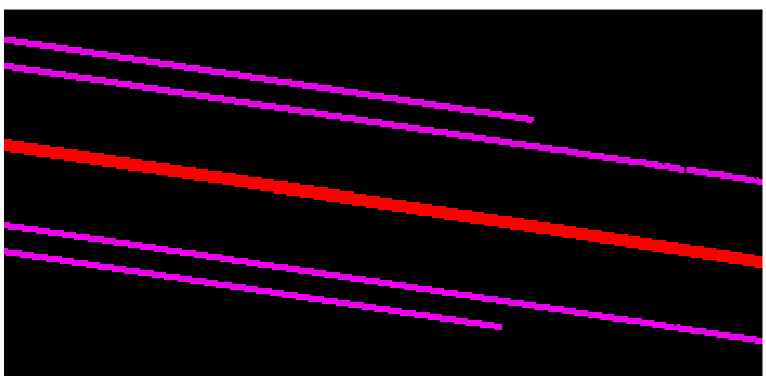
7. Notice the cursor prompt: **Locate Element <Alt> to Pick element in complex**. Select the **Kirby Rd** centerline. Within the **Single Offset Partial** dialog box, select the following settings. **Note:** You must select the centerline before setting stations.
    a. **Offset:** -40.00
    b. **Use Spiral Transitions / Remove Offset Rule:** Unchecked
    c. **Mirror:** Checked
    d. **Start Distance:** 100+00.00 (Checked)
    e. **End Distance:** 125+00.00 (Checked)
    f. **Feature Definition / Name:** EX ROW Line (**Linear >> Right Of Way**)



8. Once again, move your cursor to the northern side of the centerline. Left click to accept the placement of the existing ROW line and then again to accept the extent. Left click once more to select **Yes to Mirror** so that it is also placed on the southern side.



9. You should now see **two** additional existing ROW lines along the centerline that are shorter than the previous two that we placed.



Take Note!

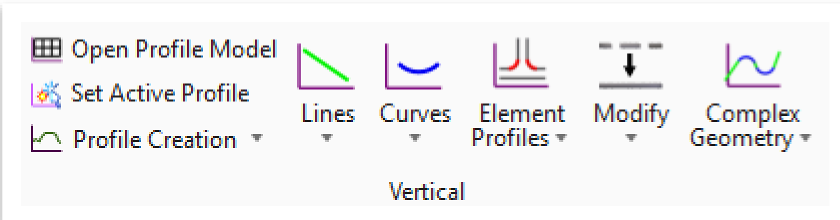
If the survey preliminary centerline gets updated in the alignment file after ***associated*** *elements have been placed in the survey file (e.g. existing ROW lines), the elements will automatically update maintaining the same offset(s). You will visually see the update(s) the next time that you open the survey file.*

While this process utilized the offset tools to create geometry, other civil geometry tools can also be used in the office (e.g. place line, place arcs, place points, Civil AccuDraw). The key is making sure the correct feature definition is selected when creating the geometry.

4.5 Lecture: Vertical Civil Geometry

The **Vertical Civil Geometry** tools contain all the tools necessary to create profiles (Figure 80). An active existing terrain model must be available to create a profile from a surface. An active alignment must be available to create a proposed profile.

FIGURE 80. VERTICAL TOOLS

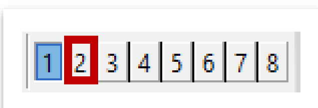


4.5.1 Open Profile Model

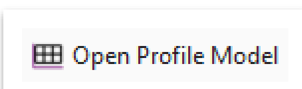
In ORD, vertical civil geometry is viewed using the **Profile Model** within the file in which the alignment or plan view element is placed. Each horizontal geometry element can have its own profile view assigned to it.

<u>The process to open a profile model is as follows</u>:

1. Open a new drawing window (for profile views, it is recommended to use **View 2**, although not mandatory).



2. Open the **Profile Model** tool (**Survey >> Geometry >> Vertical**).



3. Select (data-point) alignment or plan view element (e.g. edge of pavement or ditch line) as the reference geometry for the profile.
4. Data-point inside of the view selected in step #1.

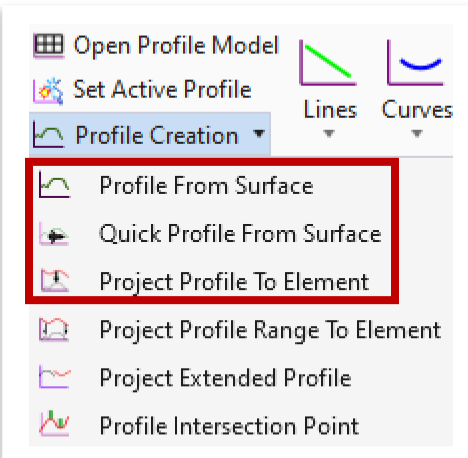
Take Note!

A profile model must be open to work with vertical geometry tools. This, however, is not a separate model space as the name implies but rather a view within the design model space. Also, an alignment must be stored in the current DGN file.

4.5.2 Profile Creation Tools

The **Profile Creation** tools allow the user to create a profile from the existing terrain (Figure 81). The three most common tools that surveyors will use for creating profiles are described below.

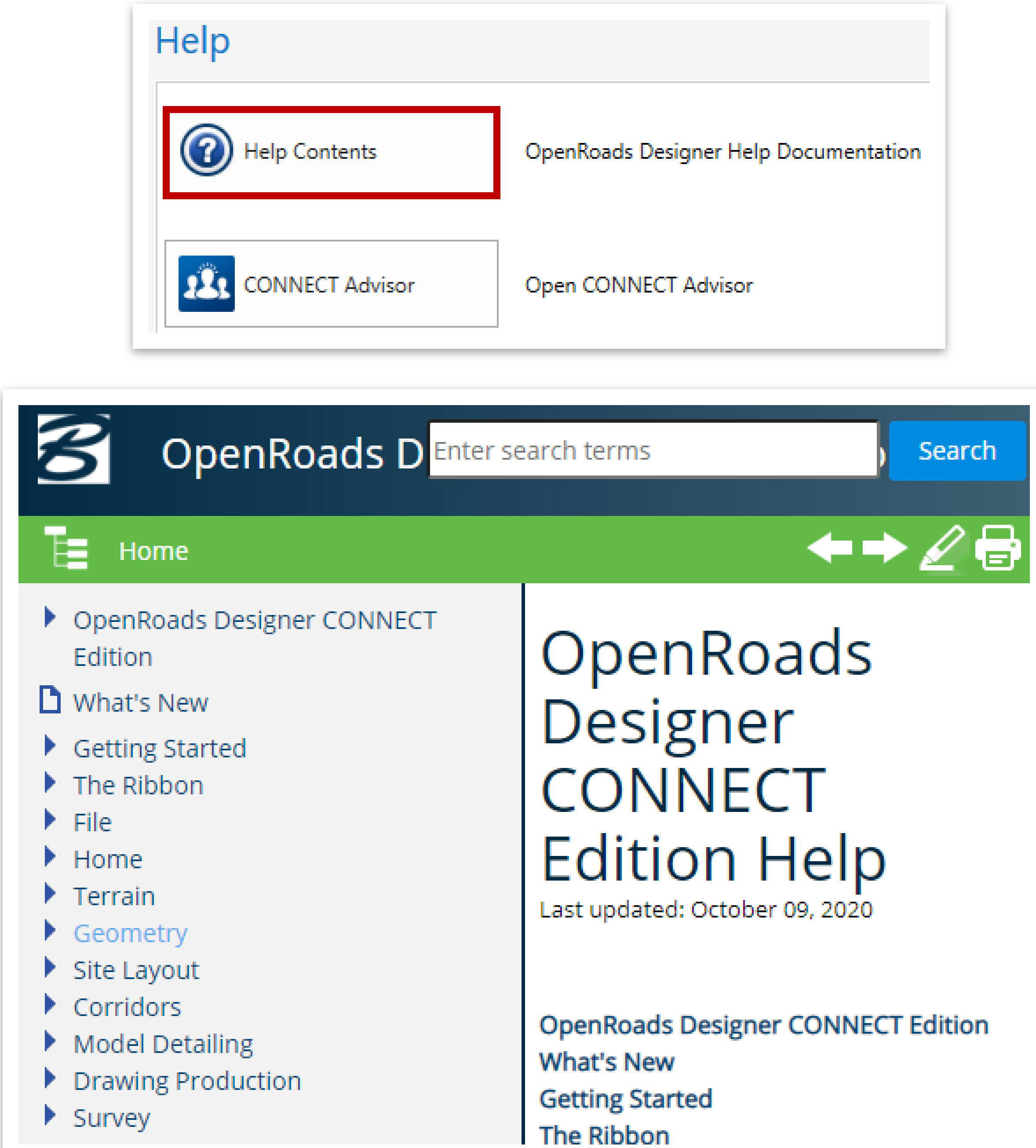
FIGURE 81. PROFILE CREATION TOOLS



- **Profile from Surface:** Generates a profile whose elevations are determined by draping onto a surface. For example, this option would be used for creating an existing ground profile for an alignment or civil feature.
- **Quick Profile from Surface:** A companion tool that provides the same results as the Profile from Surface tool but simplifies the input by assuming that the entire element is draped and that the offsets are zero. This would be used to create a profile of a civil element by matching the slope and elevation of adjoining elements.
- **Project Profile to Element:** Used for showing one element's profile in the profile view of another plan view element. For example, viewing a gas utility line in relation to the survey preliminary centerline.

The other options under the **Profile Creation** tools are typically not used in survey, so they will not be covered in this class. However, if the user is interested in learning more about these tools, please refer to the Bentley ORD Help Documentation, which can be accessed via **File >> Help >> Help Contents**. This option will bring up a web browser window (Figure 82).

FIGURE 82. ORD HELP DOCUMENTATION



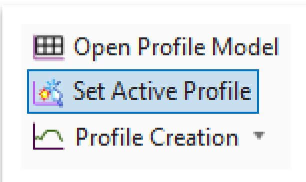
Take Note!

The profile will update automatically if any changes are made to the horizontal alignment, such as radial updates or alignment shortening / extending.

4.5.3 Set Active Profile

The **Set Active Profile** tool allows the user to set the active profile which will control the 3D model (Figure 83). A 3D spline is created for the 3D model representing the combination of the selected plan element and profile element.

FIGURE 83. SET ACTIVE PROFILE TOOL



Take Note!

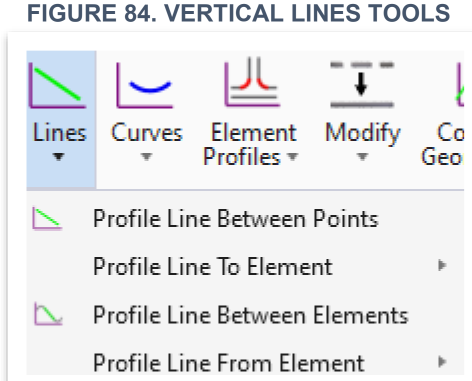
The rest of the Vertical Geometry tools are primarily used by design. A short description of those tools is included in this section for reference. However, because these tools do not apply to Surveyors, they will not be covered in this class.

4.5.4 Lines Tools

The vertical **Lines** tools are used to create profile tangents by using several options (Figure 84).

- **Profile Line between Points:** The most commonly used tool which generates a profile line between two user-defined points.
- **Profile Line to Element:** Generates a profile line at a delta slope from a specific location to a reference element.
- **Profile Line from Element:** Generates a profile line at a delta slope from a reference element to a designated location.
- **Profile Line between Elements:** Generates a profile between two previously placed curves.

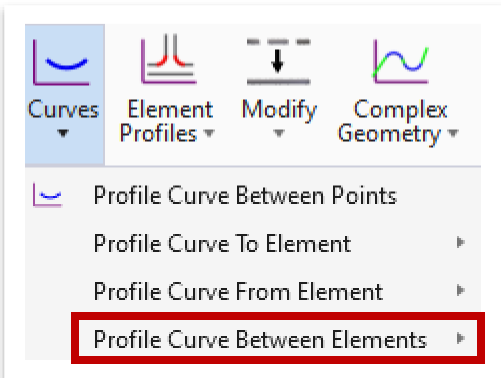
FIGURE 84. VERTICAL LINES TOOLS



4.5.5 Curves Tools

The vertical **Curves** tools are used to create profile curves by using several options (Figure 85). The most commonly used option is the **Profile Curve Between Elements**, which constructs a vertical curve between two lines or elements.

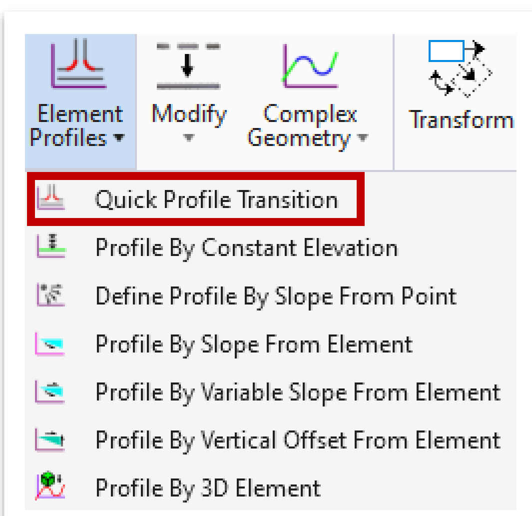
FIGURE 85. VERTICAL CURVES TOOLS



4.5.6 Element Profiles Tools

The **Element Profiles** tools are used to add profiles to elements by defining transitions, slopes or offsets (Figure 86). However, the most commonly used command is the **Quick Profile Transition**, which defines the profile of an element by matching the slope and elevation of adjoining elements.

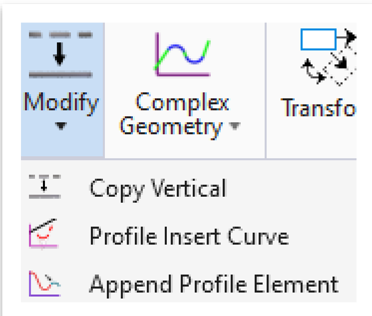
FIGURE 86. ELEMENT PROFILES TOOLS



4.5.7 Modify Tools

The **Modify** tools are used to copy or modify vertical profiles (Figure 87). The user can insert curves on tangent sections or add elements to existing complex profiles.

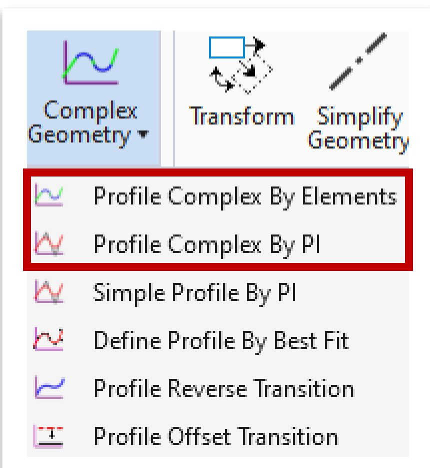
FIGURE 87. MODIFY TOOLS



4.5.8 Complex Geometry Tools

The **Complex Geometry** tools are used to create complex geometry elements through several methods (Figure 88).

FIGURE 88. COMPLEX GEOMETRY TOOLS

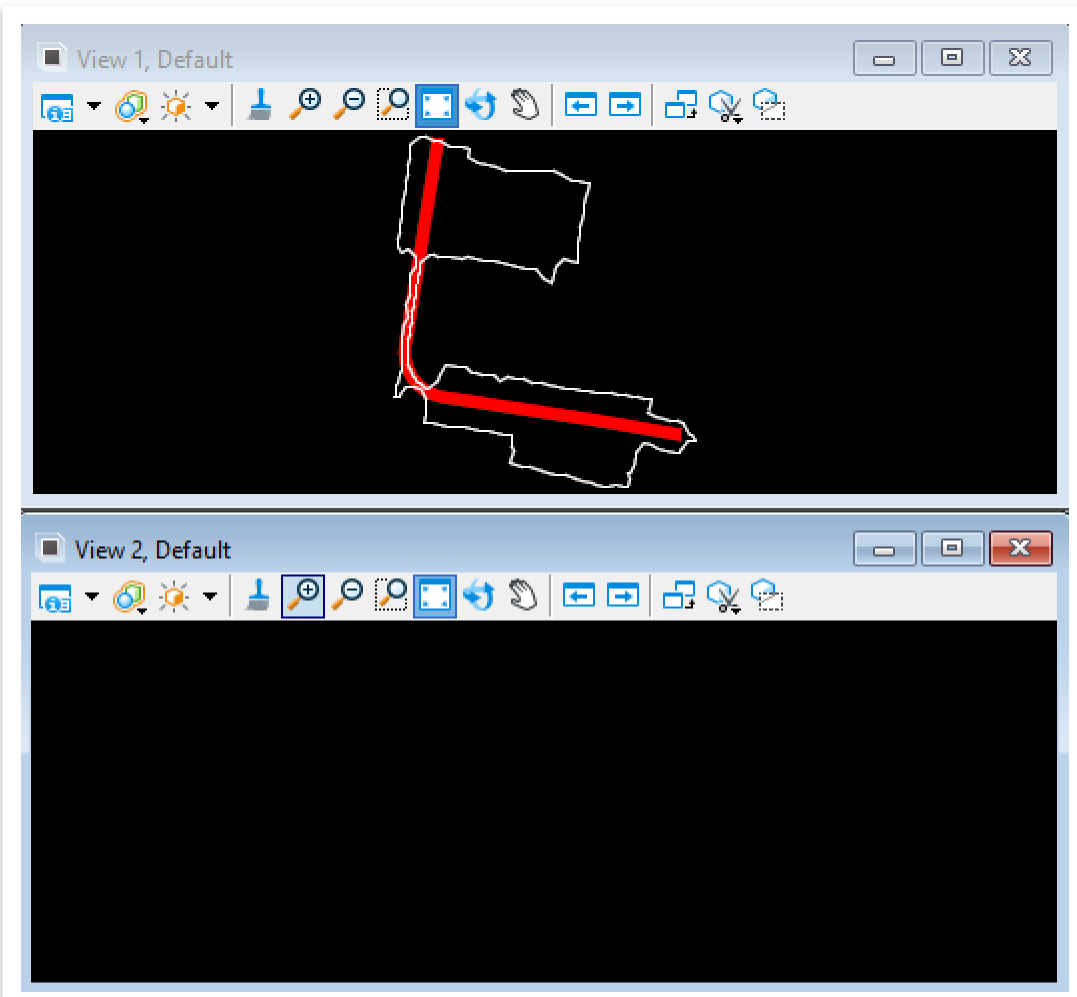


- **Profile Complex By Elements**: Used for combining existing geometry elements into one complex element.
- **Profile Complex By PI**: Used for creating a new complex element by defining points of intersection and radii.

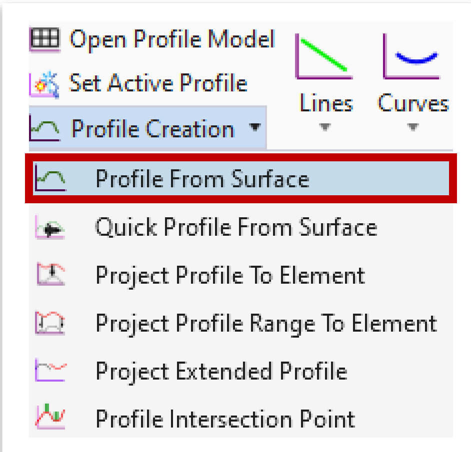
4.5.9 Exercise: Vertical Geometry Creation

In this exercise, we will be opening the profile model, creating and viewing the preliminary centerline profile. We will open back up the **Alignment – Best Fit.dgn** file.

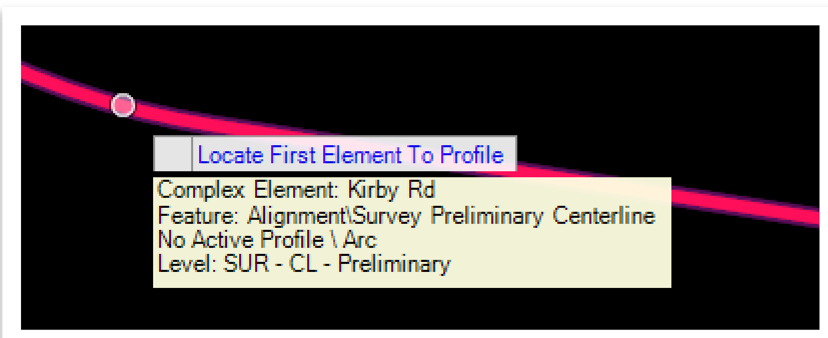
1. Attach the following reference files using the **Coincident World** attachment method and click **Fit View**.
    - Existing Terrain – TIN.dgn
    - Survey Model – Edited.dgn (turn off)
2. To turn the triangles off, select the terrain boundary and open the **Properties**. Under the **Reference** tab, set the **Override Symbology** field to **Yes** and then toggle off the triangles under **Calculated Features Display**. Go ahead and open **View 2** as well, which is where we will place the preliminary centerline profile.



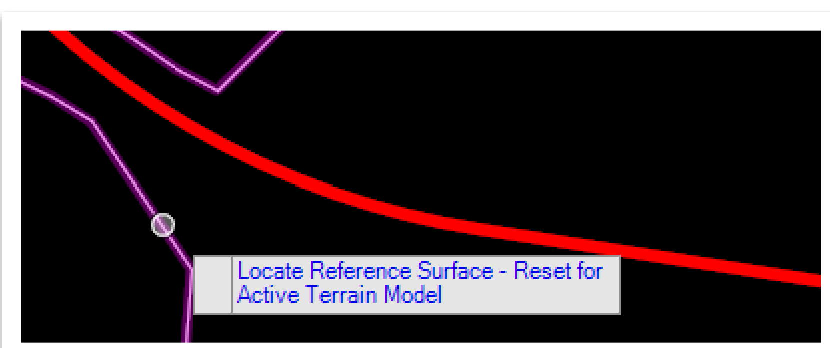
3. Zoom in so you can see the red preliminary centerline. Open the **Profile From Surface** tool (**Survey >> Geometry >> Vertical >> Profile Creation**).



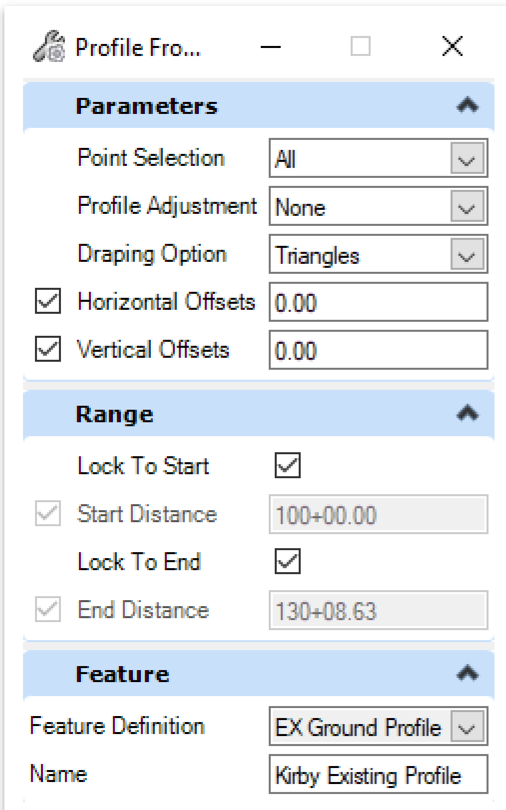
4. Notice the cursor prompt: **Locate First Element To Profile**. Select the preliminary centerline (Kirby Rd). Since we are only profiling one centerline, right click to complete.



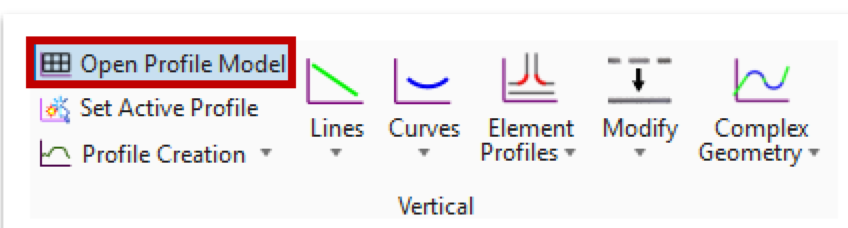
5. Notice the next cursor prompt: **Locate Reference Surface**. Select the terrain boundary and then right click to complete. **Note:** If your terrain was already set to active, then you would simply right click to accept.



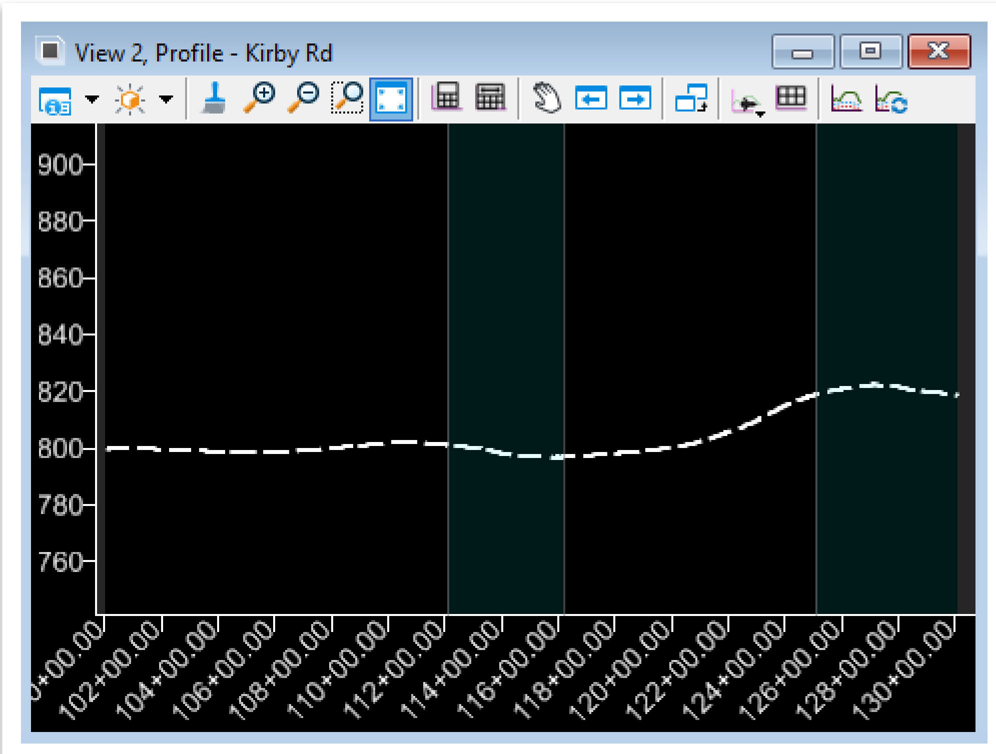
6. Now, within the **Profile From Surface** dialog box, select the following settings and then left click through each prompt to accept.
   a. **Point Selection:** All
   b. **Profile Adjustment:** None
   c. **Draping Option:** Triangles
   d. **Horizontal/Vertical Offsets:** 0.00
   e. **Lock To Start / End:** Checkmark
   f. **Feature Definition:** EX Ground Profile (**Linear >> Profiles >> Roadway >> Existing**)
   g. **Name:** Kirby Existing Profile



7. Next, open the **Open Profile Model** tool (**Survey >> Geometry >> Vertical**).



8. Notice the cursor prompt: **Locate Plan Element**. The software is asking for the centerline. Select the **Kirby Rd** centerline in plan view (View 1). Notice the next cursor prompt: **Select or Open View**. Left click anywhere within **View 2** and you should see the existing ground profile with the correct symbology. **Note:** Once the profile is created, it will always be in the file. You may have to re-visualize it if you close **View 2** at any time.



9. Alternatively, you could have used the **Quick Profile From Surface** tool (**Survey >> Geometry >> Vertical >> Profile Creation**).
   a. Select **Reference Element** (Kirby Rd centerline).
   b. Select **Reference Terrain** (terrain boundary).
   c. Right click to complete the creation.

Take Note!

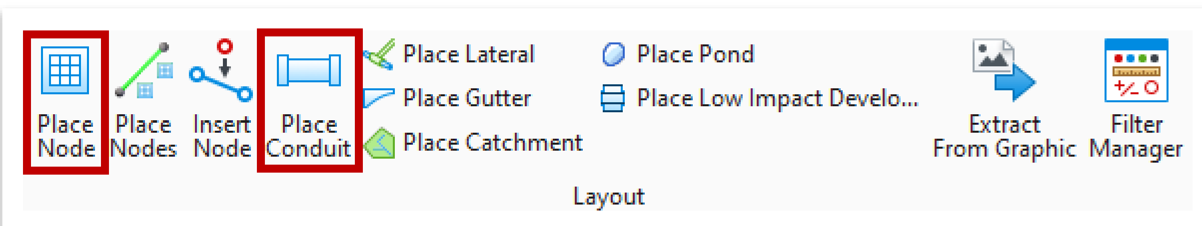
*The **Profile From Surface** option in Step 3 gives you more options, such as setting adjustment profiles, horizontal and vertical offsets and start / end ranges. Most likely, surveyors will be using the **Quick Profile From Surface** option. These two options only work with alignment geometry, which means **the reference element must be set with an alignment**.*

4.6 Lecture: Vertical Civil Geometry – Utilities

The automatic projection method of existing utilities onto profiles will depend on the type of utility and scenario. This will also determine whether a utility model is needed or not. For those linear utilities that do not require a depth to be shown on the profile (single line representation), a utility model is **not** needed. For those linear utilities that do require a depth to be shown on the profile (top and bottom of pipe) or if the utility is crossing the centerline, a utility model **is** needed. **Note:** Linear refers to along the centerline.

When creating a utility model, the **Extract From Graphic** tool will be the TDOT standard, which will be shown in Exercises 4.6.2 and 4.6.3. However, the alternative option would be to use the **Nodes** and **Conduits** method under the **Drainage and Utilities** workflow if your utility extractions look erroneous (Figure 89). This would entail cross-referencing the surveyed properties for a given utility (e.g. pipe size, elevations) and then keying in the applicable data within these tools so that the conduit would be visualized correctly on the profile. We will utilize this method in Chapter 7 (Exercises 7.2.2, 7.3.2 and 7.4.2) when placing low wire crossings, control points and benchmarks in the profile.

FIGURE 89. NODE AND CONDUIT TOOLS



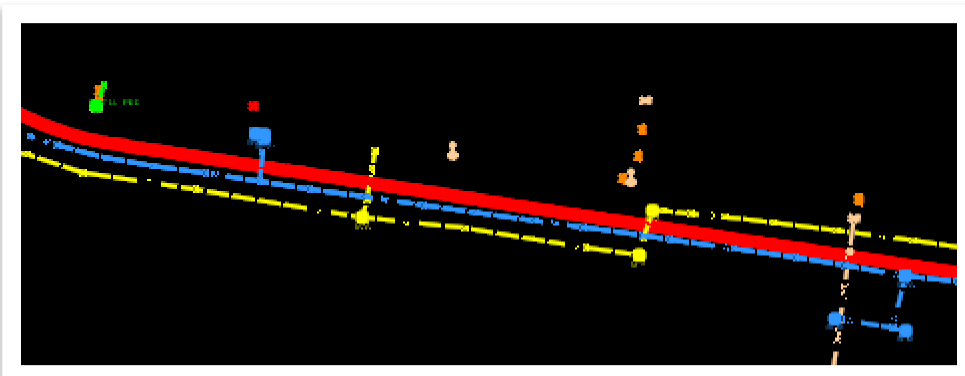
Take Note!

*There have been multiple service tickets filed with Bentley regarding the **Extract From Graphic** tool. Bentley has put a large emphasis on enhancing this tool, which will be reflected in the next software release, thus making it more reliable.*

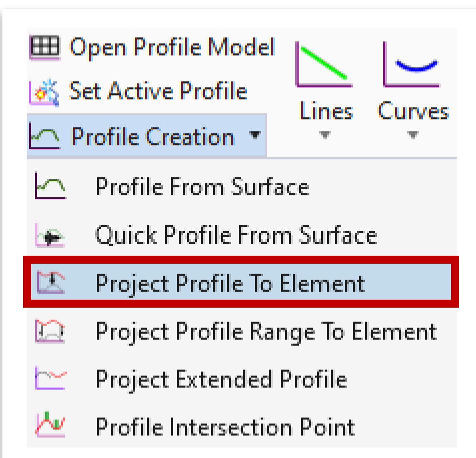
4.6.1 Exercise: Utility Profile Projection – Non-Utility Model

In this exercise, we will project an existing linear water line onto the roadway profile. This process would also be applied for **Gas**, **Electric** and **Fiber** lines, which do not require a utility model for the projection. Existing linear **Storm** and **Sanitary** profile creation will be discussed in the next exercise. We will continue to utilize the same **Alignment – Best Fit.dgn** file.

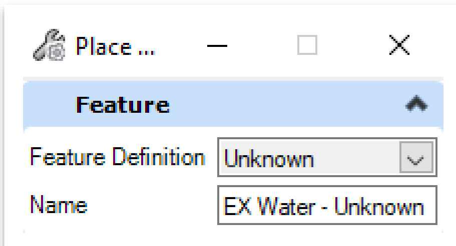
1. Within the active file, turn off all levels other than **SUR - CL - Preliminary**. Turn off the **Existing Terrain – TIN.dgn** reference file. Turn on the **Survey Model – Edited .dgn** reference file and turn off all levels other than the utility levels (**SUR - UTL**).



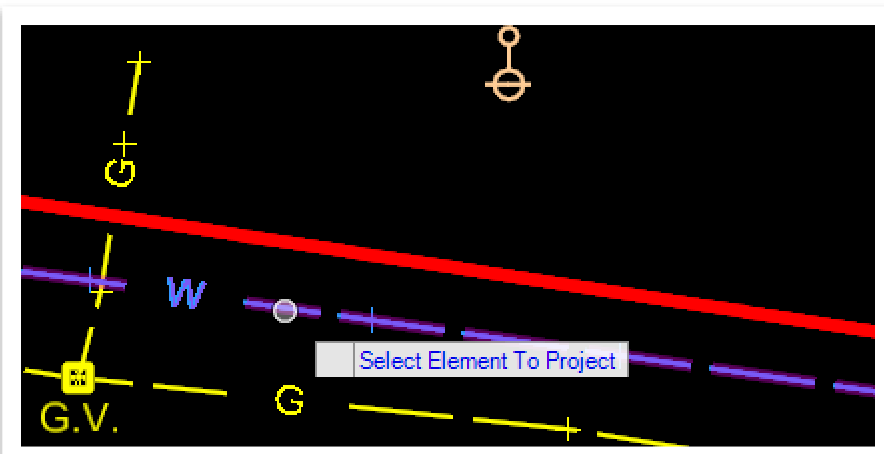
2. Open the **Project Profile To Element** tool (**Survey >> Geometry >> Vertical >> Profile Creation**).



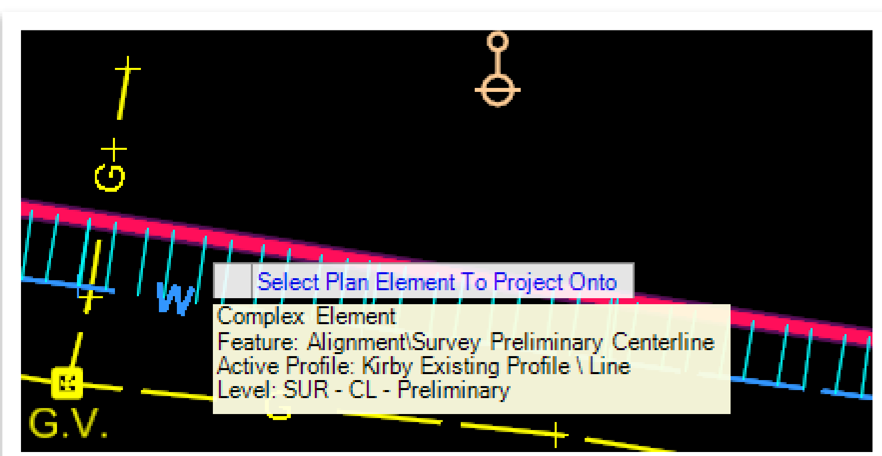
3. Within the **Place Projected Profile** dialog box, select the following settings. Since no pipe size was included in the survey, we will assume an unknown size. If you knew the size, you would pick the applicable size in the feature definition.
    a. **Feature Definition:** Unknown (**Linear >> Utilities >> Existing >> Underground >> Water**)
    b. **Name:** EX Water - Unknown



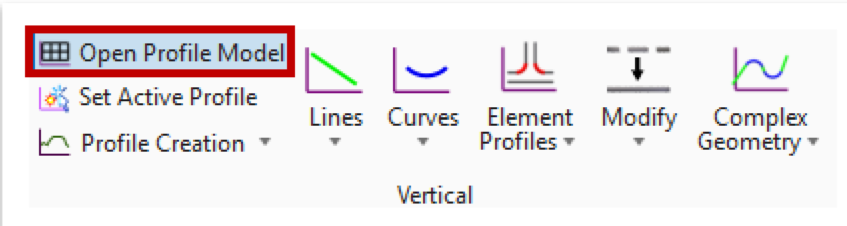
4. Notice the cursor prompt: **Select Element To Project**. Select the water line.



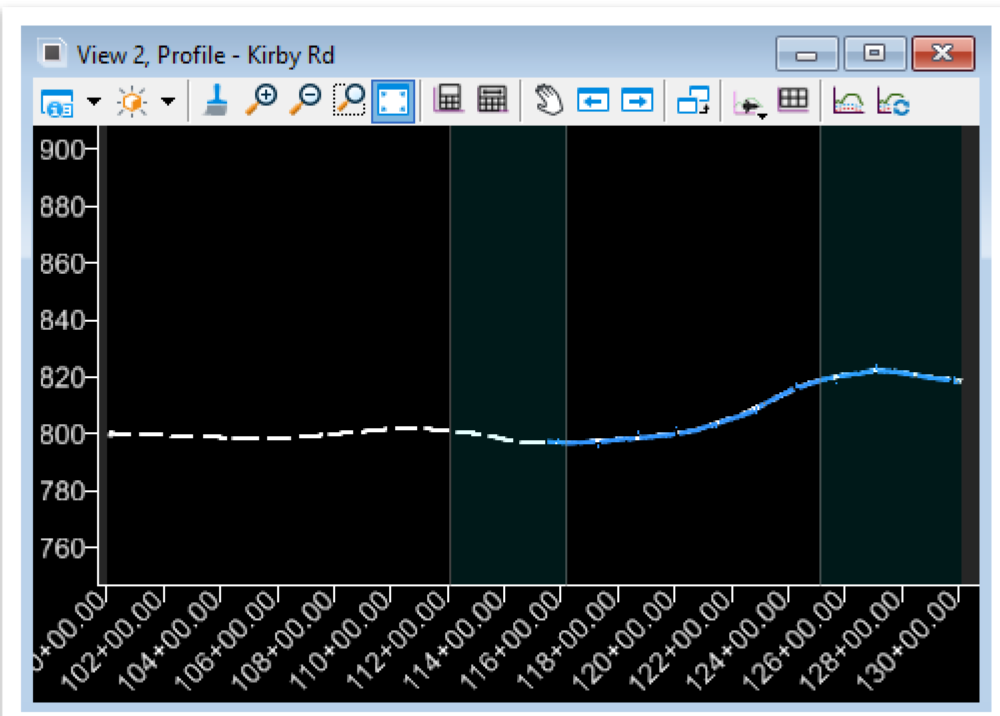
5. Notice the next cursor prompt: **Select Plan Element To Project Onto**. Select the Kirby Rd centerline. **Note:** You should see turquoise lines temporarily between the water line and the centerline until you physically left click on the centerline.



6. If you had closed the profile model (**View 2**), go ahead and re-visualize it once again using the **Open Profile Model** tool (**Survey >> Geometry >> Vertical**) and follow the prompts. <u>You must first have the survey preliminary centerline profile created and visible before projecting any utilities to it</u>, which we previously did in Exercise 4.5.9.



7. Notice that since we projected the existing water line, it now shows in profile view. The "**W**" in the linestyle is vertically exaggerated and cannot be singularly adjusted at this time. **Note:** While there is a vertical exaggeration tool within the **View Attributes** menu for profiles, it adjusts everything rather than just the letter in the utility linestyle. An enhancement has been logged with Bentley so that linestyle vertical exaggerations can be controlled in a future software release.

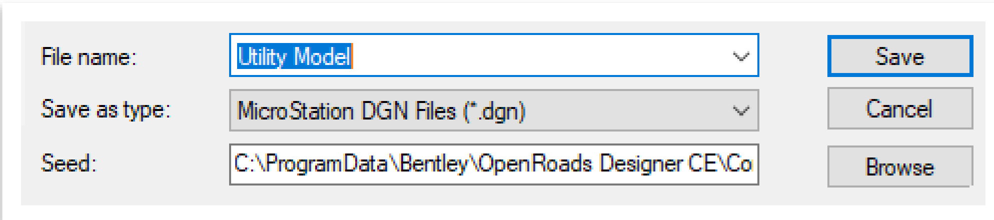


8. You would project the other existing utility lines classified in this exercise in the same manner. Remember, if the projection does not work, it means that the **Plan By 3D Element** tool was not applied to the utility line(s) in the **Survey Model – Edited.dgn** file. Reference Exercise 3.5.4, Steps 7-10.

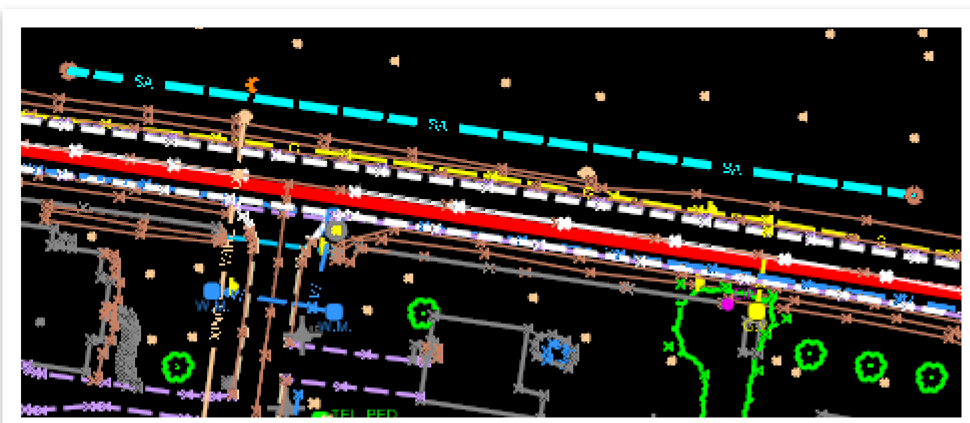
4.6.2 Exercise: Utility Profile Projection – Utility Model

In this exercise, we will project an existing linear sanitary line onto the roadway profile. This process does require a **3D** utility model for the projection so that the pipe depths can be visually displayed automatically. This process would also be applied for **Storm** lines.

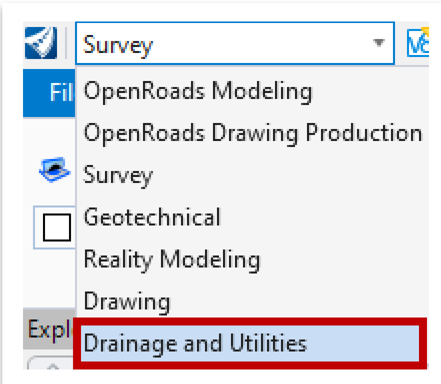
1. Create a new file and name it **Utility Model**. Select the **TDOTSeed2D.dgn** and click **Save**.



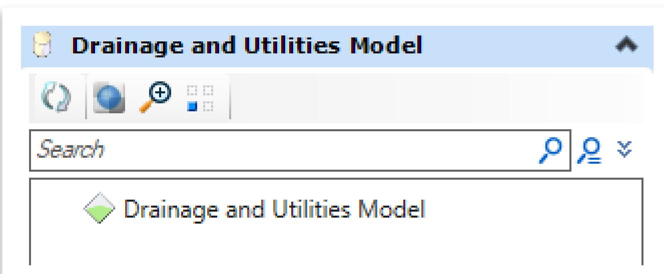
2. Attach the following reference files using the **Coincident World** attachment method and then click **Fit View**.
   - Alignment – Best Fit.dgn
   - Existing Terrain – TIN.dgn (turn off the triangles)
   - Survey Model – Edited.dgn (turn on all levels other than the ROW lines)
   - Survey Model – SA.dgn
3. Notice the existing **Sanitary** (**SA**) line on the north side of the Kirby Rd preliminary centerline (highlighted below). This utility has been added in the **Survey Model – SA** reference file for the purpose of this exercise, because the survey data did not have a linear utility of this kind along the centerline.



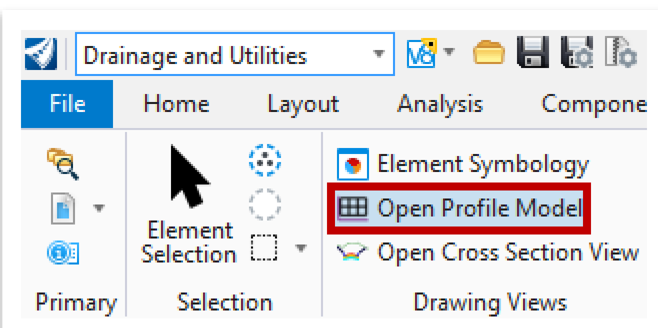
4. First. we must create a **3D utility model** so we can project the **8” SA** line onto the profile. Go ahead and switch to the **Drainage and Utilities** workflow in the top left corner.



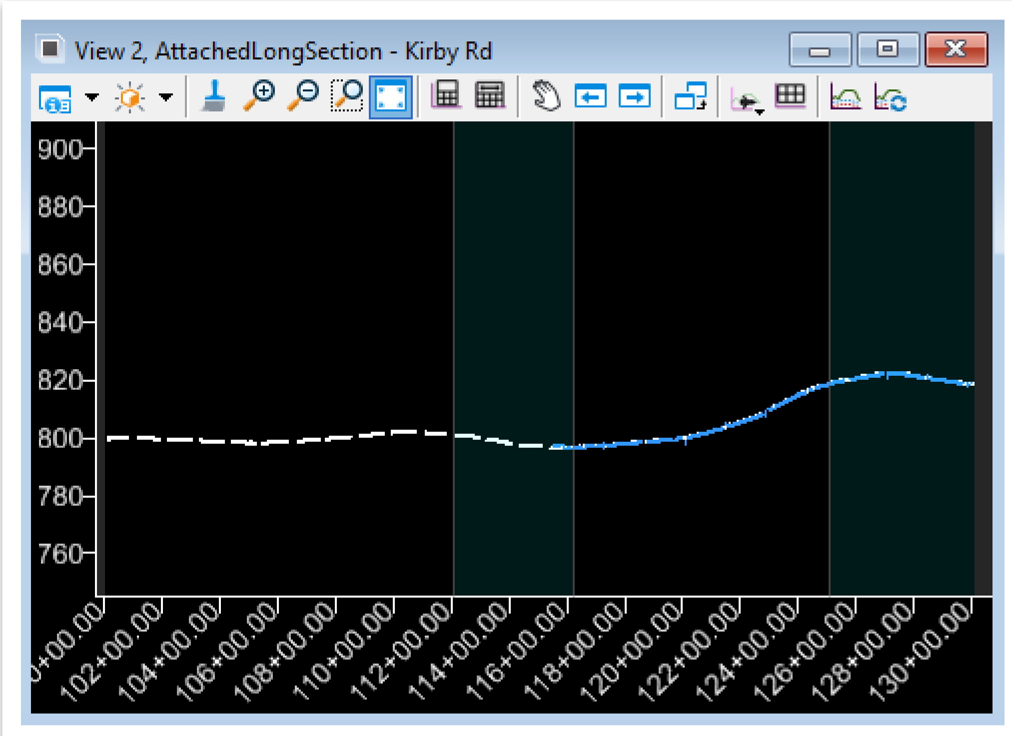
5. Next, expand the **Drainage and Utilities Model** tab within the **Explorer**, which we will reference throughout the exercise.



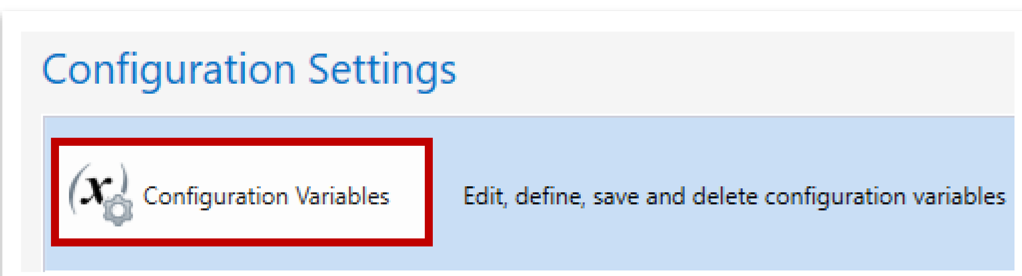
6. Now, **Open Profile Model** (**Drainage and Utilities >> Utilities View >> Drawing Views**) and follow the prompts once again to visualize the **Kirby Rd** profile. Go ahead and select **View 2** for this exercise.



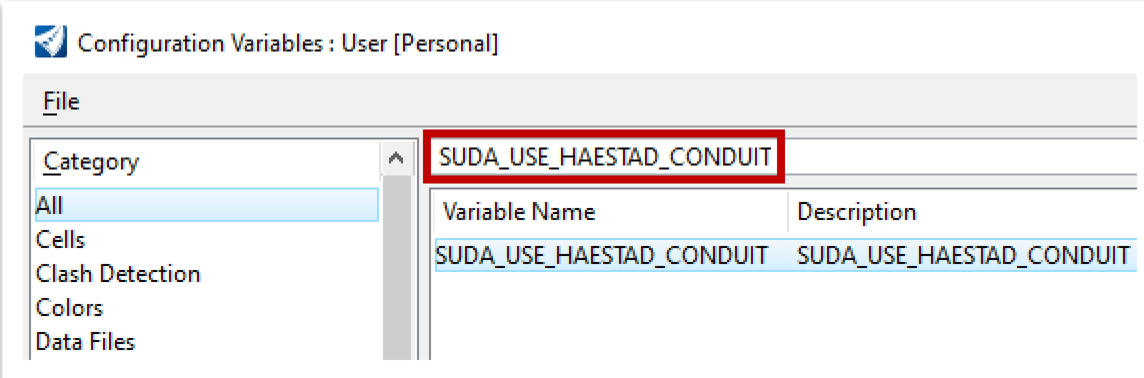
7. You should see the existing centerline profile along with the projected water line that we added in the last exercise.



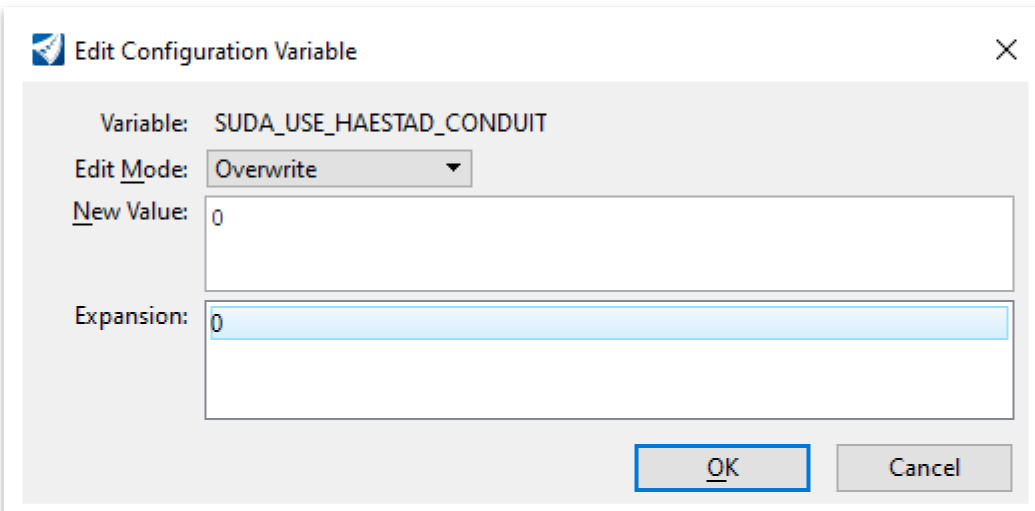
8. Before we create the existing 3D utility model for the **SA** line, we need to modify the **SUDA_USE_HAESTAD_CONDUIT** configuration variable so that the selected conduit feature definition will be applied in the actual profile. In the current software version, the conduit size is not carried over once projected onto the profile, which is a known defect. This modification will need to be done **one time** if you need to project any existing modeled utilities onto the profile. Bentley has indicated that this issue has been fixed in the next software version so Steps 9-13 will not be required.
9. Go to **File >> Settings >> Configuration >> Configuration Variables**.



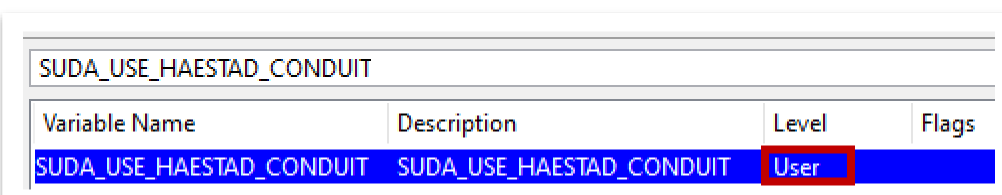
10. Within the **Configuration Variables** window, key-in **SUDA_USE_HAESTAD_CONDUIT** in the search bar at the top.



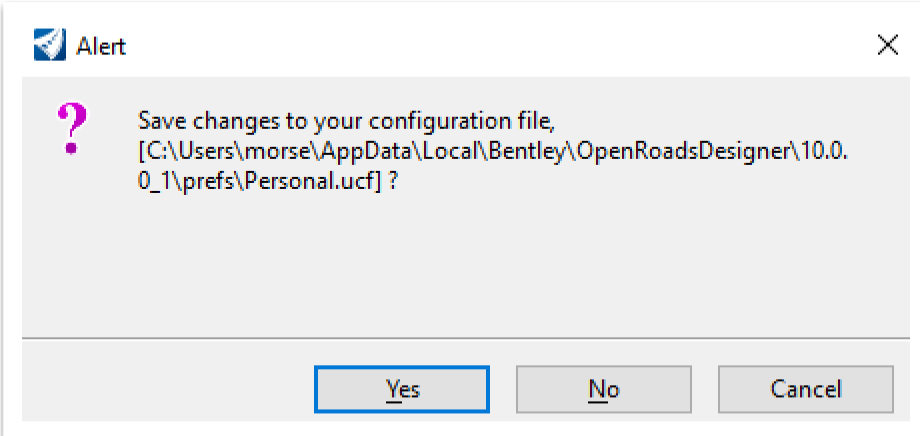
11. The variable should now be selected (left click on it if not). Once selected, click **Edit** on the right side of the window. Within the **Edit Configuration Variable** window, select the following settings and then click **OK**.
    a. **Edit Mode:** Overwrite
    b. **New Value:** 0



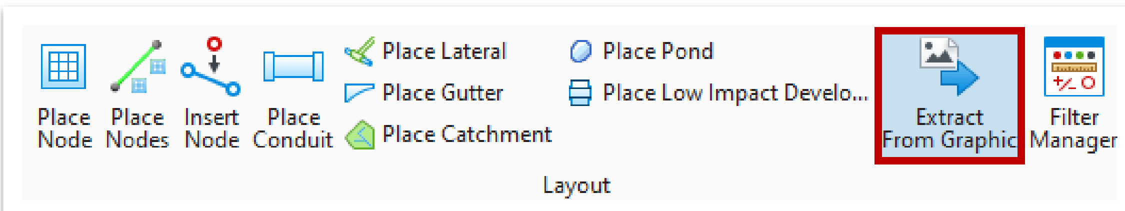
12. Notice that the variable **Level** has now updated from Workspace to **User**. That means that this variable update is applied to your machine only and is not part of the overall workspace configuration settings. Click **OK** once done to close the **Edit Configuration Variable** window.



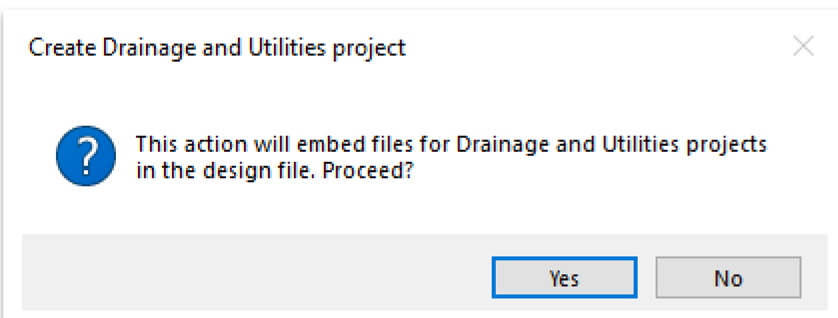
13. You should get an alert asking if you want to save changes to your configuration file. Click **Yes**.



14. Now we will begin creating an existing 3D utility model for the **SA** line. Open the **Extract From Graphic** tool (**Drainage and Utilities >> Layout >> Layout**).



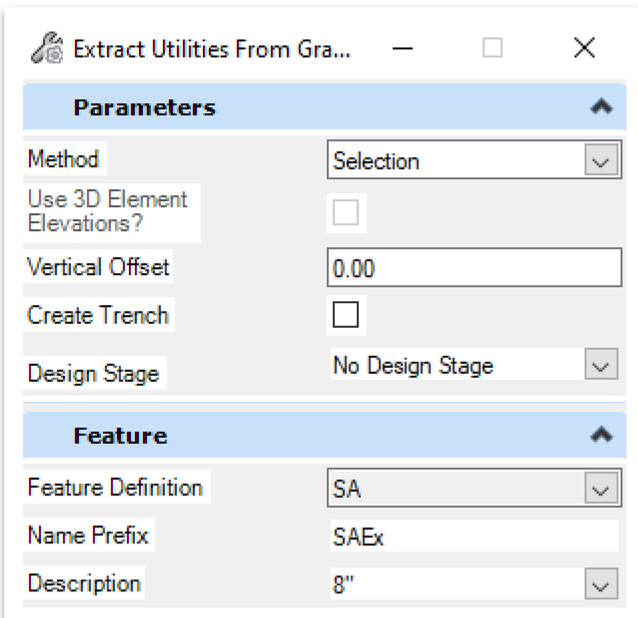
15. A warning will display asking if the you want to embed files for **Drainage and Utilities** projects in the design file. Click **Yes**.



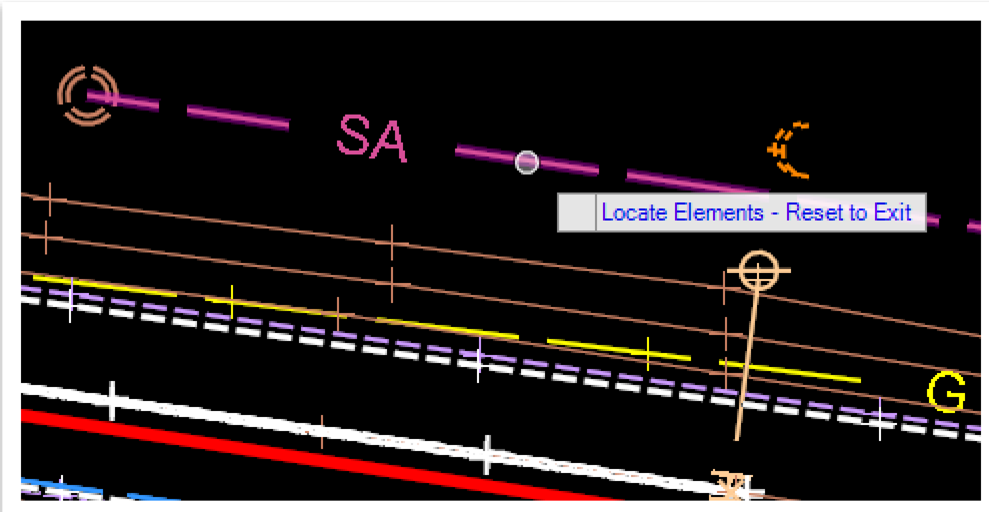
Take Note!

Give the software a minute to load the necessary drainage and utility modeling files in the background. This only occurs in a new file for the first drainage and utility modeling tool that is opened. All other subsequent tools will open immediately from then on in the file.

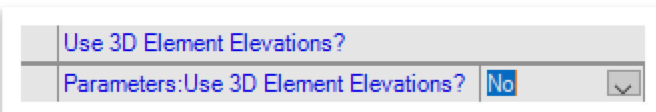
16. Open the **Extract From Graphic** tool once again (**Drainage and Utilities >> Layout >> Layout**) and select the following settings.
    a. **Method:** Selection
    b. **Use 3D Element Elevations:** Unchecked
    c. **Vertical Offset:** 0.00
    d. **Create Trench:** Unchecked
    e. **Design Stage:** No Design Stage
    f. **Feature Definition:** SA (**Conduit >> WasteWaterSegment >> Existing**)
    g. **Name Prefix:** SAEx
    h. **Description:** 8" (This sets the size of the utility)



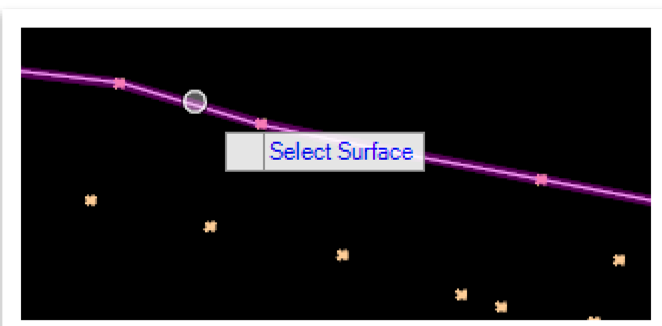
17. Left click to accept the **Method** and then notice the next prompt: **Locate Elements – Reset to Exit**. Select the existing **SA** line on the north side of Kirby Rd and then right click to complete. **Note:** If you had multiple SA lines that were the same size, you could select them all and extract at one time.



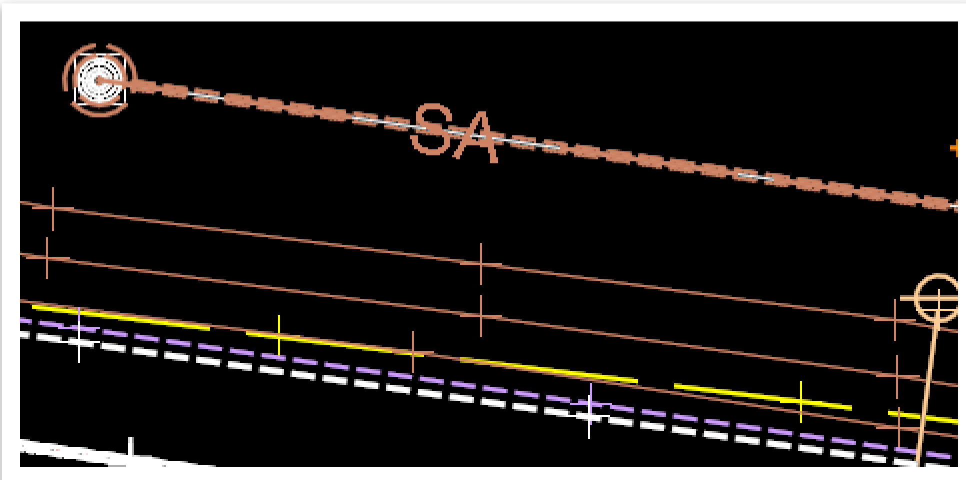
18. Left click to accept the **Use 3D Elements Elevations?** prompt.

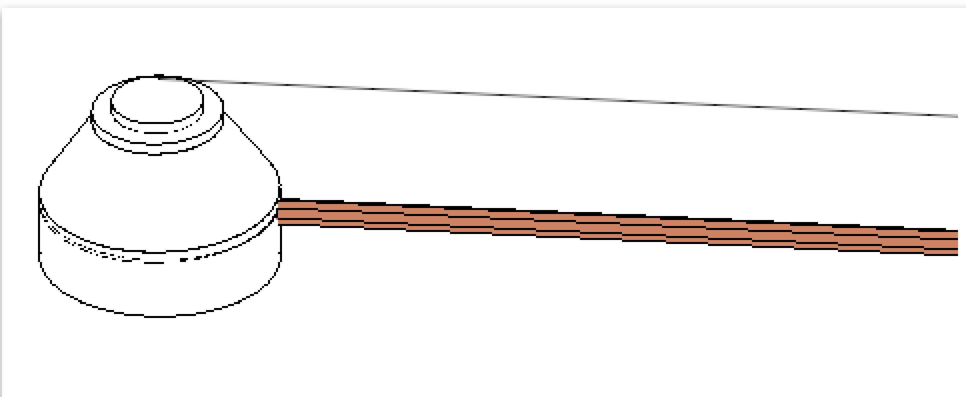


19. Notice the next prompt: **Select Surface**. Select the existing terrain boundary and then left click through the remaining prompts to accept. Right click to clear the tool.



20. You should now see that two generic **nodes** and a 3D utility line (**conduit**) were created on top of the 2D sanitary line. Right click and hold anywhere within **View 1** and select **View Control >> 2 Views Plan/3D** to open the split 2D/3D views, which are shown below. **Note:** Click within **View 2** to activate the view and then turn off all reference files. Feel free to rotate the 3D view **dynamically** to review the SA line.



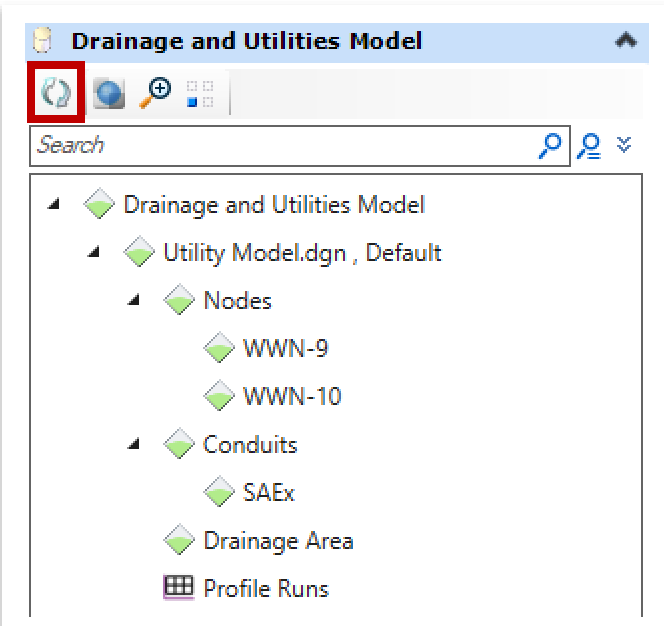


Take Note!

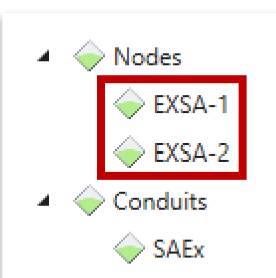
Bentley has indicated that the next software release will allow for a Node feature definition to be selected within the ***Extract From Graphic*** *tool, which will place the correct nodes (structurally and visually) rather than generic nodes.*

21. Go ahead and switch back to the **Default** view in the lower left corner of the drawing window and then close **View 2** for now.

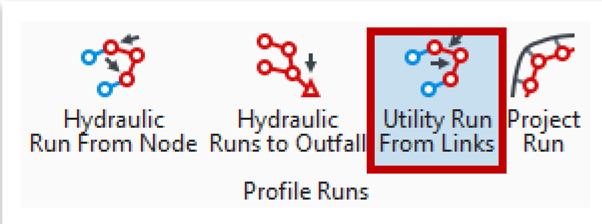
22. Turn off the following reference files:
    - Utility Model.dgn (Default-3D)
    - Survey Model – Edited.dgn
    - Survey Model – SA.dgn
23. Within the **Explorer**, notice that there are now **Nodes** and **Conduits** listed for the **SA** line under the **Drainage and Utilities Model** tab. It's OK if you have different default node numbers in your file because we will update the names in the next step. **Note:** If the nodes and conduits are not showing, click the **Refresh** icon under the **Drainage and Utilities Model** header (highlighted below). If the nodes still do not show, close and re-open the **Explorer**.



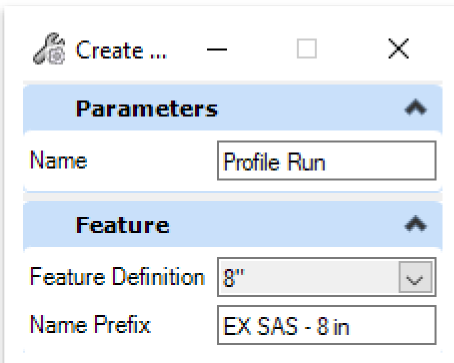
24. Let's go ahead and rename the nodes, which is recommended for each project. Right click on each Waste Water Node (**WWN**) name and select **Rename**. For this exercise, rename the nodes to **EXSA-1** and **EXSA-2**. **Note:** You likely wondered why the nodes were not numbered 1 and 2 by default. There is a defect logged with Bentley regarding the default numbering of nodes for hydraulic conduits and it should be addressed in a future software release.



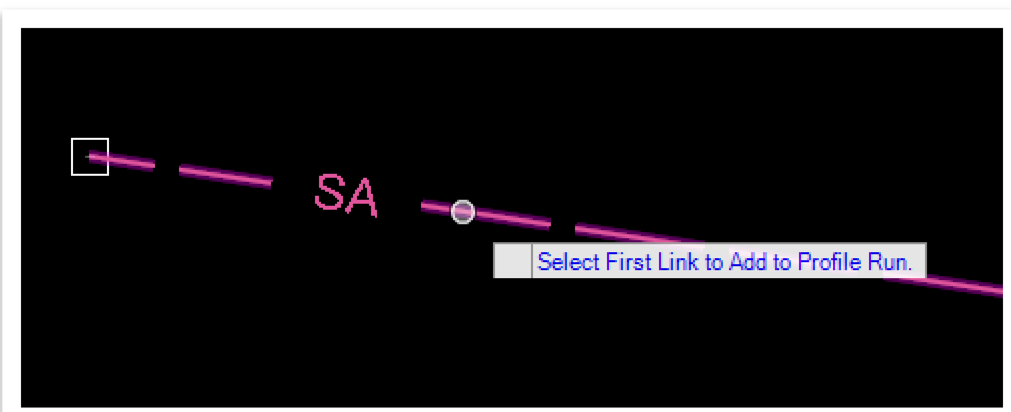
25. Next, we will create the existing **SA** profile line. Open the **Utility Run From Links** tool (**Drainage and Utilities >> Layout >> Profile Runs**).



26. Within the **Create Profile Run** dialog box, select the following settings.
    a. **Name:** Profile Run
    b. **Feature Definition:** 8” (**Linear >> Utilities >> Existing >> Underground >> Sewer >> Sanitary**)
    c. **Name Prefix:** EX SAS - 8 in

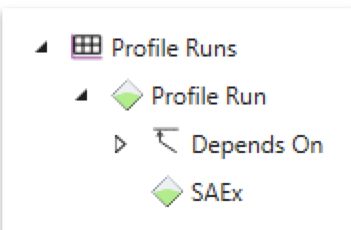


27. Notice the cursor prompt: **Select First Link to Add to Profile Run**. Select the **SA** line.



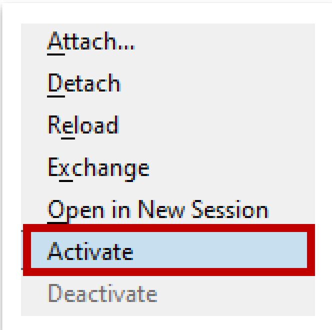
28. Notice the next cursor prompt: **Pick Next Link to Add to Profile Path**. **Reset to Quit Picking**. Right click to finish since we are only profiling one SA line. **Note:** If you had multiple separate **SA** lines, you would need to apply the tool to each individually. When it prompts you to pick the next link, that option only works if you have multiple connected utility segments.

29. Once again, within the **Explorer** notice that a new **Profile Run** has been created under the **Drainage and Utilities Model** tab.



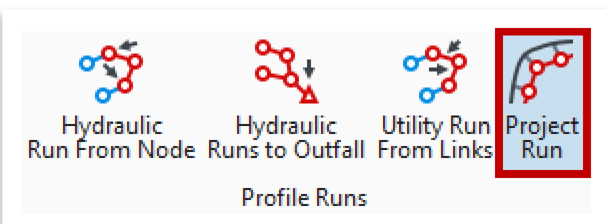
30. Now we need to project the **SA** utility run onto the survey preliminary centerline. This must be done in the alignment file or else the modeled utilities will not show in the overall survey profile when referenced. It is recommended to create all utility models first and then open the alignment file to do the projections. Go ahead and open the **Alignment – Best Fit.dgn** file once again and attach the **Utility Model.dgn** reference file.

31. Before we project the utility run, we need to do a **reference activation** for the **Utility Model.dgn** file due to a defect with the current software version. This process will allow the conduit attributes of the projected **SA** line to be visually correct in profile view, or else the conduit will be solid white. Within the **References** window, right click on the **Utility Model.dgn** file and select **Activate** and give it a second to process.

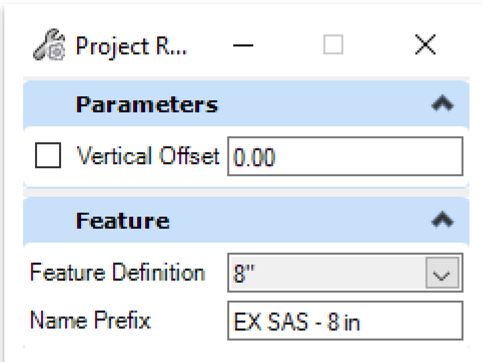


32. Right click on the same reference file once more and select **Deactivate**. This serves as a refresh for the software. Go ahead and close the **References** window for now.

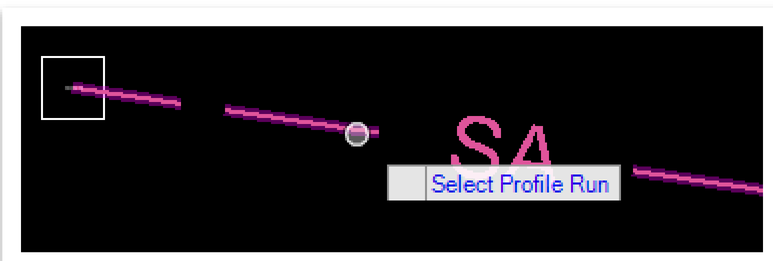
33. Next, open the **Project Run** tool (**Drainage and Utilities >> Layout >> Profile Runs**). Once again, you will get the **Create Drainage and Utilities** project alert because it is the first time we have opened a drainage and utility modeling tool in this file. Go ahead and click **Yes**.



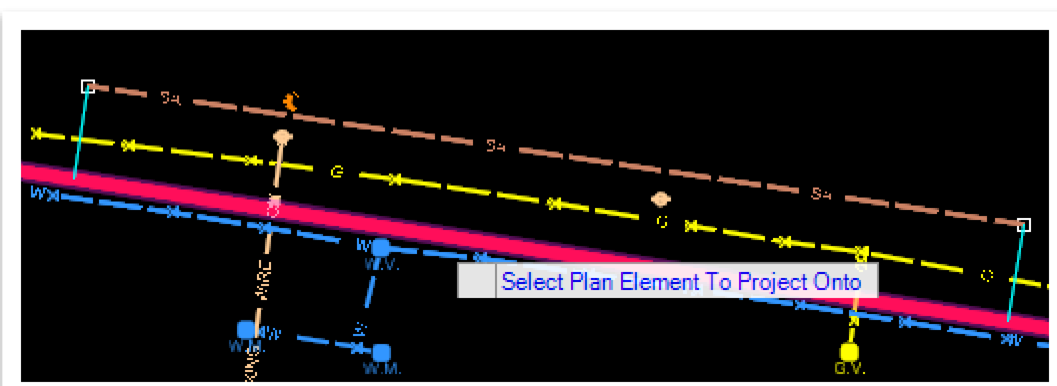
34. Open the **Project Run** tool again. Within the **Project Reach Path** dialog box, select the following settings.
    a. **Vertical Offset:** 0.00
    b. **Feature Definition:** 8" (**Linear >> Utilities >> Existing >> Underground >> Sewer >> Sanitary**)
    c. **Name Prefix:** EX SAS - 8 in



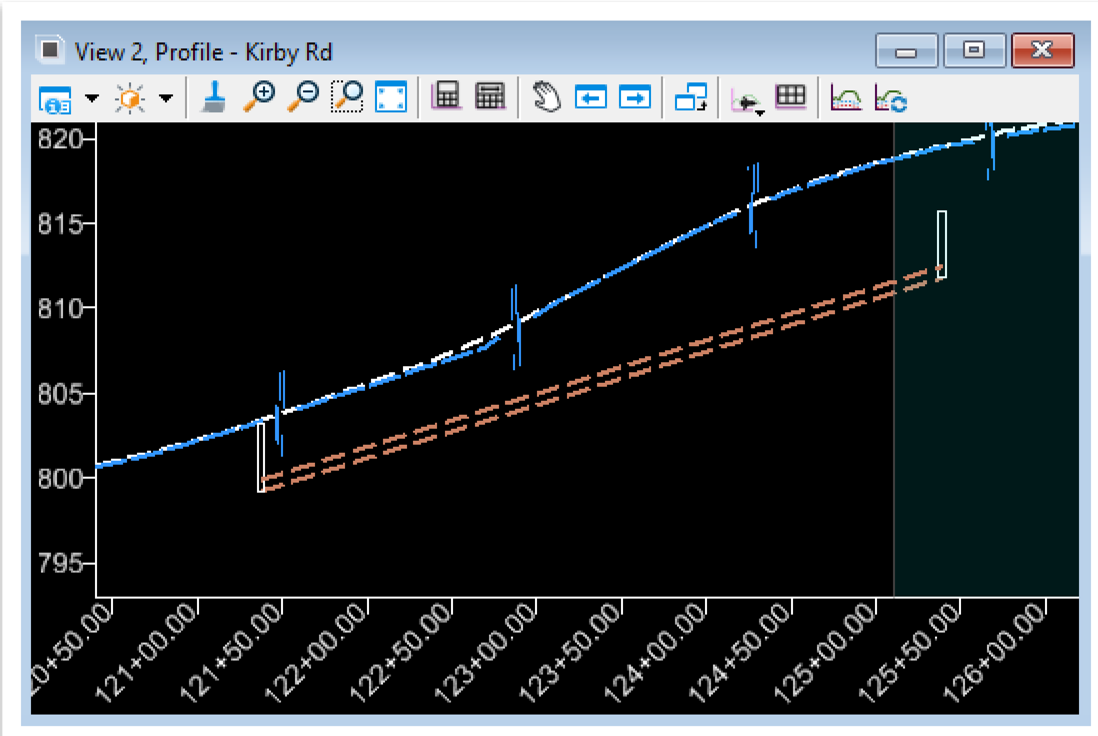
35. Notice the cursor prompt: **Select Profile Run**. Select the **SA** line.



36. Notice the next cursor prompt: **Select Plan Element To Project Onto**. Select the **Kirby Rd** centerline. **Note:** Once again, you should see turquoise lines temporarily between the SA line and the centerline until you physically left click on the centerline.



37. It will look like nothing happened. Go ahead and open **View 2** and then **Open Profile Model** (**Drainage and Utilities >> Utilities View >> Drawing Views**). Select the **Kirby Rd** centerline and then click anywhere within **View 2**. Notice that the **SA** line (conduit) plotted correctly (size and attributes) but the nodes plotted white and on the **Default** level. This is a known defect with the current software version and has been logged with Bentley.



Take Note!

*Bentley has indicated that the next software release will allow the correct attributes to be carried through automatically for **referenced utilities** for both the nodes and conduits.*

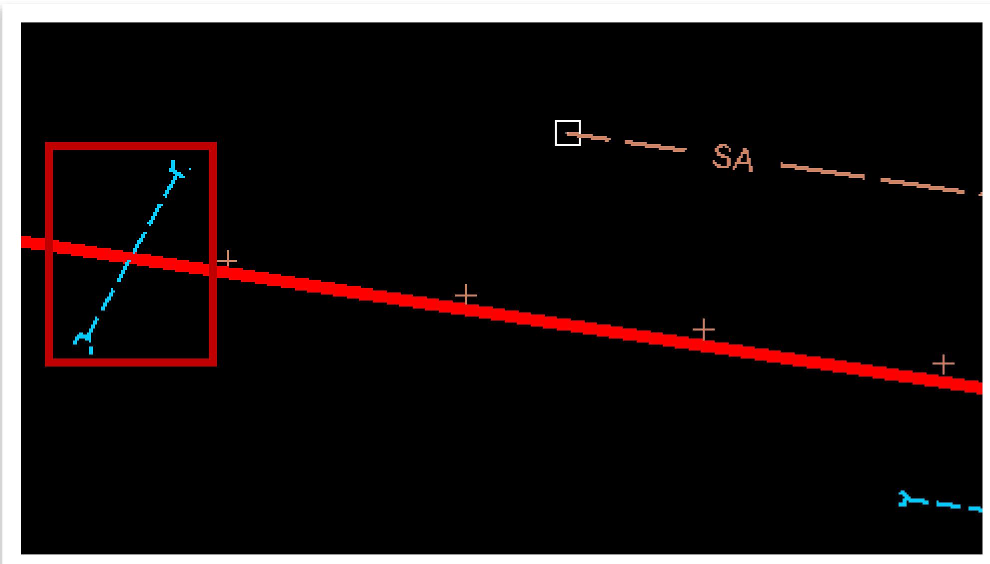
*We will look at how to manually apply the correct attributes to the **SA** line and how annotation is added in Chapter 5 once the profile named boundary has been created, which is a prerequisite.*

*Plotting an existing linear drainage profile would be done in the same manner as the SA profile. This method allows for the pipe depth to be drawn automatically. However, as a reminder, if your utility extractions look erroneous, use the **Nodes** and **Conduits** tools to create the utility model.*

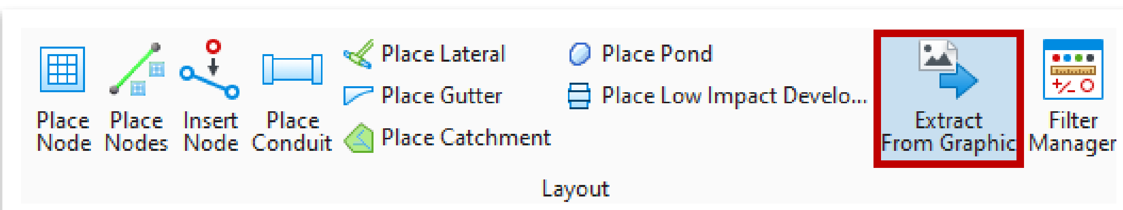
4.6.3 Exercise: Crossing Utilities – Profile

In this exercise, we will add a crossing storm utility (RCP) to the roadway profile. This process also requires a **3D** utility model for the projection so that the pipe depths can be visually displayed automatically. This process would also be applied for **all** other types of utility lines. We will open back up the **Utility Model.dgn** file.

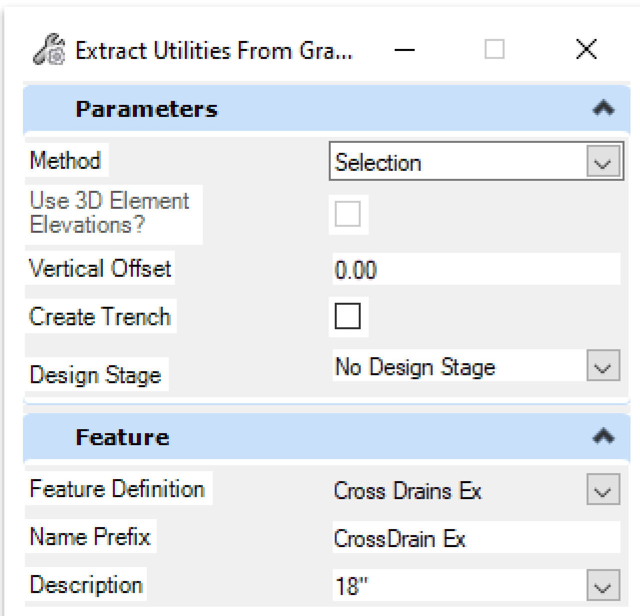
1. Turn on the **Survey Model – Edited.dgn** reference file. Within that file, turn off all levels except **SUR - DRG - Pipe and Culverts**. For this exercise, we will focus on the **18" RCP**, highlighted below.



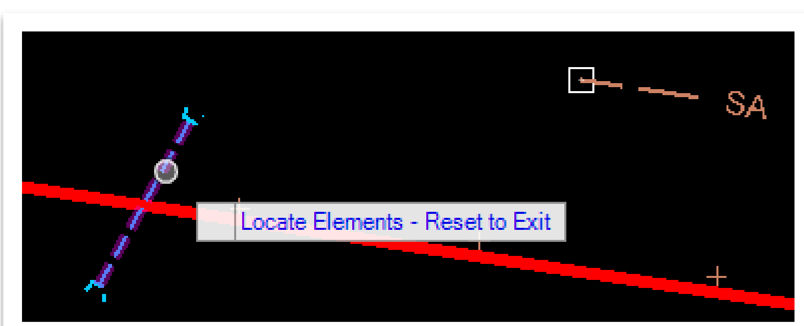
2. Now we will begin creating an existing 3D utility model for the **18" RCP** line. Open the **Extract From Graphic** tool (**Drainage and Utilities >> Layout >> Layout**).



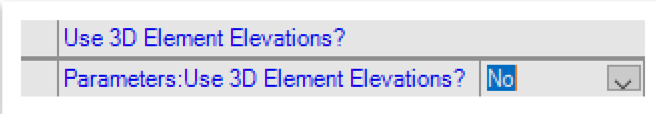
3. Within the **Extract Utilities From Graphics** dialog box, select the following settings.
    a. **Method:** Selection
    b. **Use 3D Element Elevations:** Unchecked
    c. **Vertical Offset:** 0.00
    d. **Create Trench:** Unchecked
    e. **Design Stage:** No Design Stage
    f. **Feature Definition:** Cross Drains Ex (**Conduit >> StormWater >> Culvert Pipes >> Existing**)
    g. **Name Prefix:** Cross Drain Ex
    h. **Description:** 18" (This sets the size of the utility)



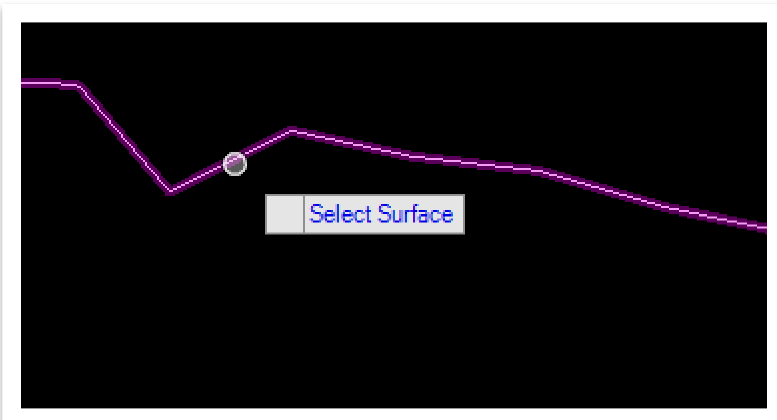
4. Left click to accept the **Method** and then notice the next prompt: **Locate Elements – Reset to Exit**. Select the existing **RCP** crossing Kirby Rd and then right click to complete.



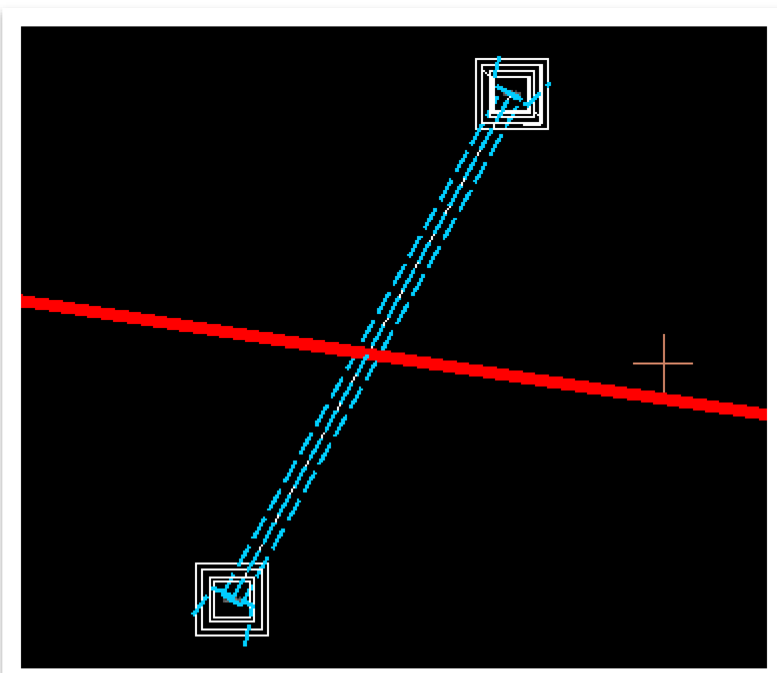
5. Left click to accept the **Use 3D Elements Elevations?** prompt.



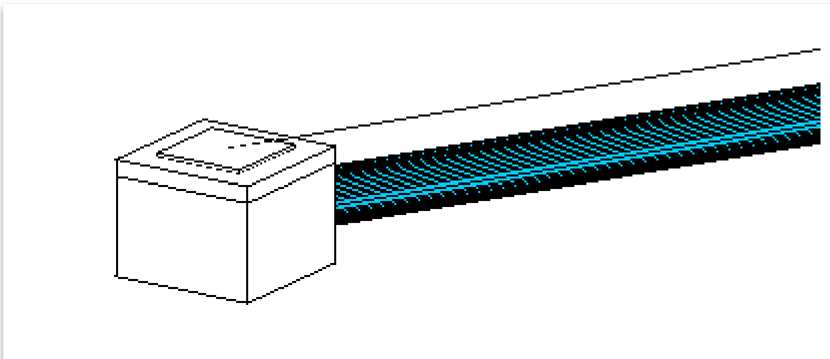
6. Notice the next prompt: **Select Surface**. Select the existing terrain boundary and then left click through the remaining prompts to accept. Right click to clear the tool.



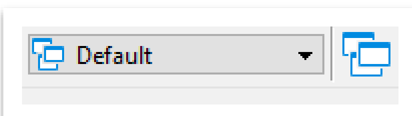
7. You should now see that two generic **nodes** and a 3D drainage pipe (**conduit**) were created on top of the 2D RCP line. The nodes are not critical when profiling crossing utilities since the pipe (conduit) is the only visualized component. **Note:** If you don't see the outer blue lines, make sure that the **Utility Model.dgn** (**Default-3D**) reference file is turned on, including all levels.



8. Once again, to view the 3D view of the existing RCP, right click and hold anywhere within **View 1** and select **View Control >> 2 Views Plan/3D** to open the split 2D/3D views, which are shown below. **Note:** Feel free to rotate the 3D view **dynamically** to review the RCP.

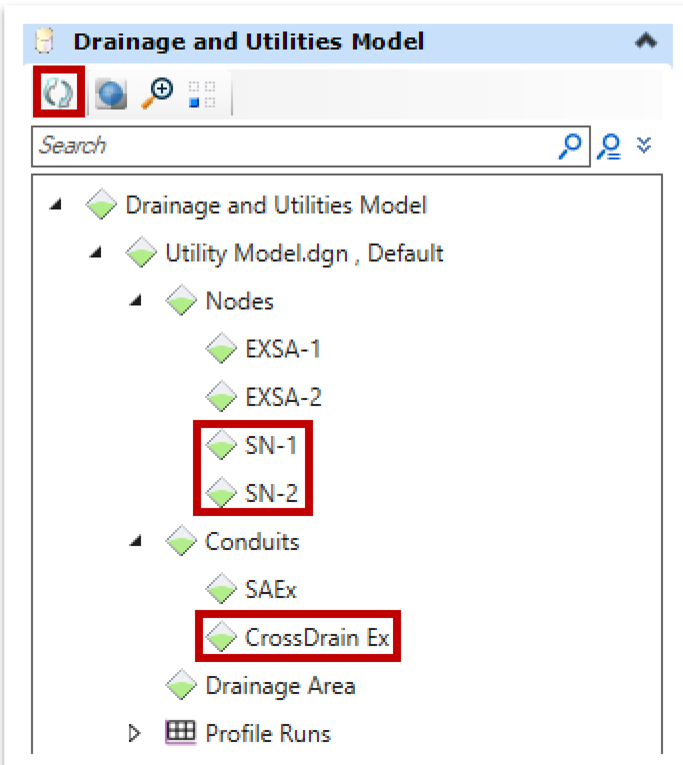


9. Go ahead and switch back to the **Default** view in the lower left corner of the drawing window and then close **View 2** for now, if still opened.



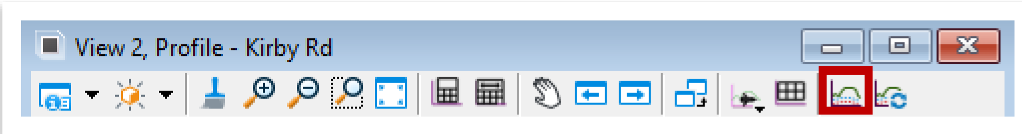
10. Turn off the following reference files:
    - Utility Model.dgn (Default-3D)
    - Survey Model – Edited.dgn

11. Within the **Explorer**, notice that there are now **Nodes** and **Conduits** listed for the **cross drain** under the **Drainage and Utilities Model** tab. We will leave the default names as-is for this exercise. **Note:** If the nodes and conduits are not showing, click the **Refresh** icon under the **Drainage and Utilities Model** header (highlighted below). If the nodes still do not show, close and re-open the **Explorer**.

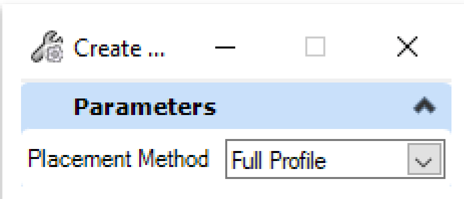


12. Now we need to add the crossing storm utility (RCP) to the survey preliminary centerline profile. As a reminder, <u>this must be done in the alignment file or else the modeled utilities will not show in the overall survey profile when referenced</u>.
13. Open the **Alignment – Best Fit.dgn** file once again and the **Utility Model.dgn** reference file should still be turned on. Go ahead and open **View 2**, which should still show the profile for the **Kirby Rd** centerline. Notice the existing water and sanitary lines that we created in the previous exercises are shown. **Note:** If you do not see the profile, open the **Open Profile Model** tool (**Drainage and Utilities >> Utilities View >> Drawing Views**) and follow the prompts.

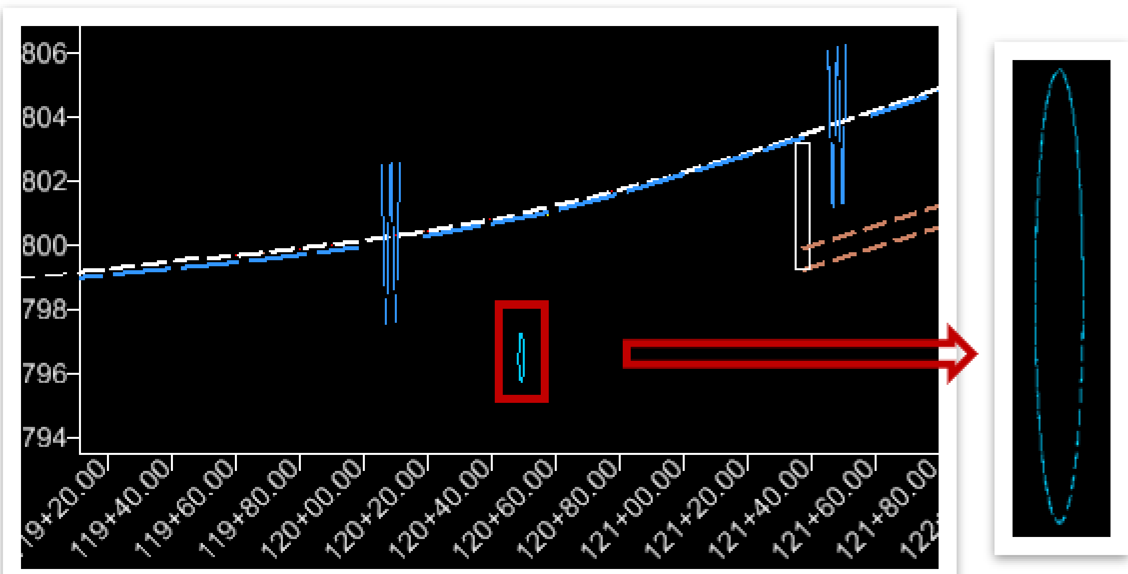
14. Within the **Profile** view (**View 2**), select the **Create 3d Cut** tool.



15. Within the **Create 3d Cut** dialog box, select the **Full Profile** placement method. This option tells the software to find all crossing utilities for the entire profile. The other option is **Corners**, which allows you to draw a specific extent.



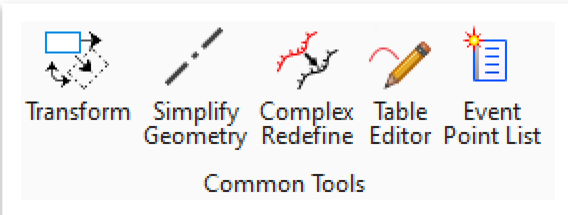
16. Left click anywhere within **View 2** to accept and notice that the existing 18” RCP cross drain is now shown on the profile. **Note:** As a reminder, we will look at how annotation is added in Chapter 5 once the profile named boundary has been created.



4.7 Lecture: Common Tools

These tools should be used with caution and are used to simplify geometry, while also allowing for redefinition and removal of rules (Figure 90).

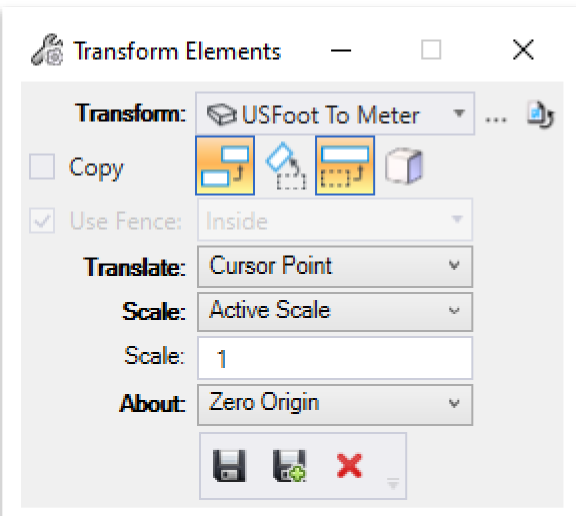
FIGURE 90. COMMON TOOLS



4.7.1 Transform

The **Transform** tool is used any time the user wants to translate, rotate or scale either regular or civil elements (Figure 91). Once civil elements are transformed, they become simplified elements, meaning if the element is a target of a rule then that rule is removed during the transformation process. A warning box appears if the civil elements are about to be transformed.

FIGURE 91. TRANSFORM ELEMENTS DIALOG BOX



4.7.2 Simplify Geometry

This tool allows the user to remove rules and intervals from horizontal and vertical geometry. In addition, it removes rules and relationships from other elements (e.g. snap rules, offset rules, etc). **This tool should not be used for survey**.

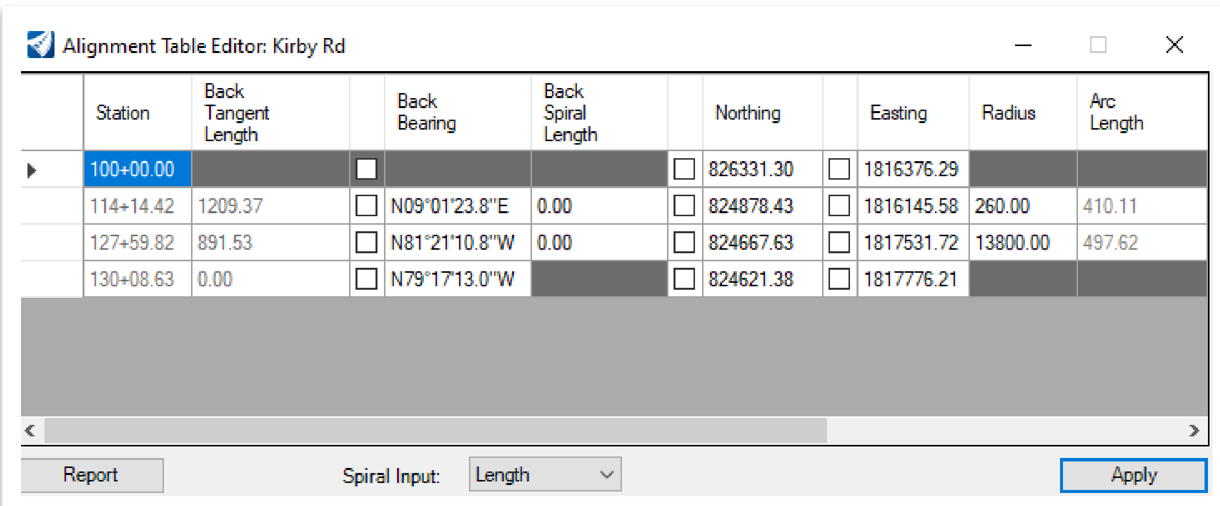
4.7.3 Complex Redefine

This tool allows the user to redefine part of an existing complex alignment while preserving the name of the alignment so that all rules built off the original geometry will update with the new geometry. **This tool should not be used for survey**.

4.7.4 Table Editor

This tool allows the user to edit complex alignments that have been created by defining points of intersection (Figure 92). The user can edit both **horizontal** and proposed **vertical** alignments. To activate, simply select the tool and then the applicable centerline in the drawing.

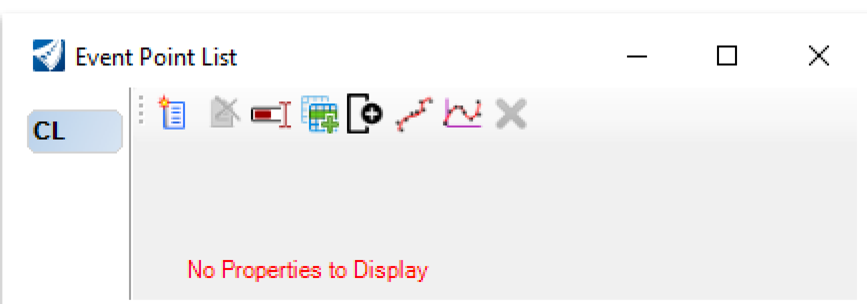
FIGURE 92. ALIGNMENT TABLE EDITOR



4.7.5 Event Point List

This tool allows users to store specific points by **Station Offset** or **Northing Easting** as well as store both horizontal and vertical cardinal points (Figure 93). This tool is typically used in conjunction with creating specific cross sections.

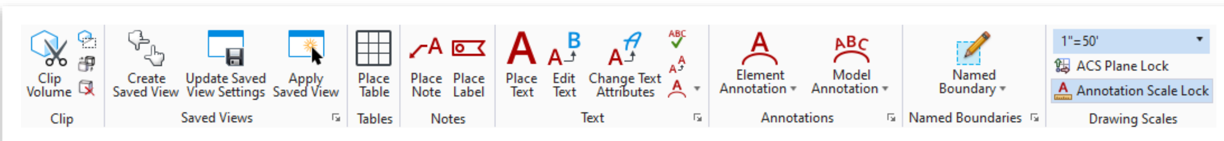
FIGURE 93. EVENT POINT LIST



Chapter 5. Plan Development Tools

The Plan Development tools are located under the **Drawing Production** tab in the Survey workflow (Figure 94). These tools are used to add text, notes, labels and create sheets for plans, profiles and cross sections. Annotation groups have been setup utilizing feature definitions to automatically annotate civil geometry. The Drawing Production tools that are applicable for survey include: Annotations, Place Text, Place Notes (Intelligent Labels), Named Boundaries and Drawing Scales.

FIGURE 94. DRAWING PRODUCTION TAB



5.1 Objectives

At the conclusion of this chapter, participants will be able to:

1. Add element and model annotation for plan view geometry.
2. Modify annotation and add existing ROW labels.
3. Create a TDOT control point table.
4. Create a profile drawing model with annotation.

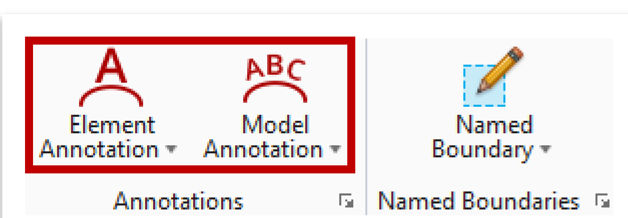
5.2 Lecture: Drawing Production Tools for Survey

Once the survey field data is imported into ORD and all civil geometry (plan and profile) has been added or projected, the drawing production tools should be utilized to add annotation for both plan and profile data. For the plan civil geometry that is created post-import, additional tools will be utilized to place survey-specific labels.

5.2.1 Annotations

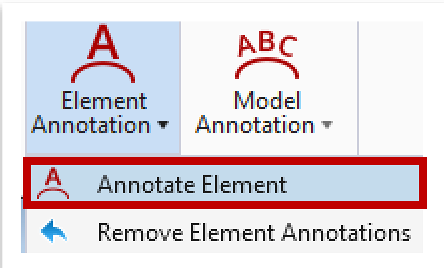
Annotations are permanent text for survey data (imported from text files), and civil geometry (alignments and profiles). The user has the option to annotate **one element** at a time or the **entire model** (Figure 95). Annotating a large model may take several minutes depending on how much geometry is in the file.

FIGURE 95. ANNOTATION TOOLS



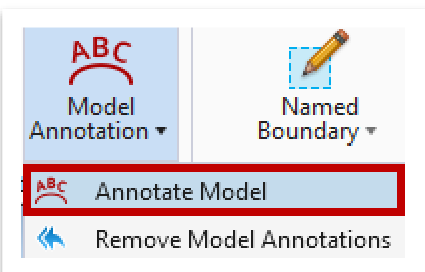
- **<u>Annotate Element</u>:** Enables the single annotation of elements, by way of individual selection or selection sets (e.g. all gas lines) (Figure 96).

FIGURE 96. ANNOTATE ELEMENT TOOL



- **<u>Annotate Model</u>:** Enables the annotation of all elements within the model(s) at one time <u>after selecting the desired annotation group</u> (Figure 97). **Note:** Once the tool is initiated, there is no option to select an annotation group. Everything in the model gets annotated as opposed to just the labels that are tied to the selected annotation group. A defect has been logged with Bentley and should be addressed in a future software release.

FIGURE 97. ANNOTATE MODEL TOOL



Take Note!

*Automated labels have been created for all **linear** features collected by survey and are detailed in Table 3.*

TABLE 3. FIELD CODES

Field Codes	Text to be Displayed	Element Template Used to Plot Label
BRI	Description	\Survey\Annotation\Bridges**Bridge Text**
BEAM, CRKB, DOWN, STRCL, TB, UP	Description	\Survey\Annotation\Bridges**Hydraulic Data Text**

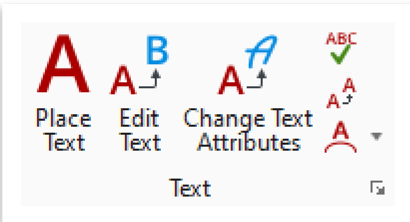
Field Codes	Text to be Displayed	Element Template Used to Plot Label
CV, PIPE (points)	Point Name Invert Elevation	\Survey\Annotation\Pipes and Culverts**Pipes and Culverts Point Numbers** \Survey\Annotation\Pipes and Culverts**Pipes & Culverts Point Elevations**
CV, PIPE (lines)	Description Length of Pipe	\Survey\Annotation\Pipes and Culverts**Pipes and Culverts Text**
ABUT, APRON, DAM, DIKE, DIT, GAGE, LEVEE, RRAP, SPILL	Description	\Survey\Annotation\Pipes and Culverts**Pipes and Culverts Text**
CRK, LAKE, POND, RIVER, RPDS, SINK, WET	Description	\Survey\Annotation\Natural Features**Natural Features Text**
BC, PAD	Description	\Survey\Annotation\Non-Trans Features**Survey Non-Trans Text**
AFLD, CEM, CG, FN, GATE, GRAVE, MISC, PIT, ROCKW, RWP, RWPWF, SEP, SIGNP, SWP, TANK, TOWER	Description	\Survey\Annotation\Non-Trans Features**Survey Non-Trans Text**
CITY, COUNTY, STATE	Description	\Survey\Annotation\ROW**Political Boundary Text**
ESMT, ESMTD	Description	\Survey\Annotation\ROW**Easement Lines Text**
PL, PLWF	Description	\Survey\Annotation\ROW**Property Lines Text**
ROW, ROWWF	Description	\Survey\Annotation\ROW**ROW Lines Text**
BE, BIKE, DR, FE, MED, PK, RWAY, RWT,	Description	\Survey\Annotation\Transportation Features**Tran Features Text**

Field Codes	Text to be Displayed	Element Template Used to Plot Label
RWTWF, SH, TRAIL, TUN		
CU, SWT	Description	\Survey\Annotation\Transportation Features**Curb & SW Features Text**
EP, RD	Description	\Survey\Annotation\Roads**Roads Text**
GRCB, GRL, GRM, GRR, IMP, JB	Description	\Survey\Annotation\Roadside Barriers**Roadside Barriers Text**
RR, RRSS	Description	\Survey\Annotation\Railroads**Railroads Text**
GL (all sizes)	Size	\Survey\Annotation\Underground Utilities**Gas Text**
SAS (all sizes)	Size	\Survey\Annotation\Underground Utilities**Sanitary Sewer Text**
WL (all sizes)	Size	\Survey\Annotation\Underground Utilities**Water Text**
UM	Description	\Survey\Annotation\Overhead Utilities**Poles and Misc Text**

5.2.2 Text Tools

We will use some of the **Text** tools in the upcoming exercises, but they were covered in the Fundamentals (ORD) Manual (Figure 98).

FIGURE 98. TEXT TOOLS

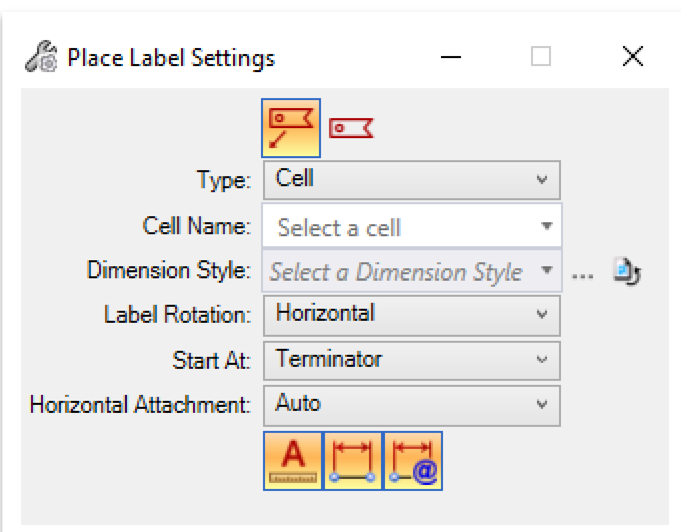


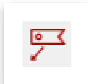
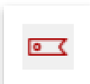
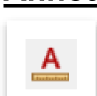
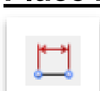
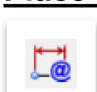
5.2.3 Intelligent Labels

All individual intelligent labels placed after your elements/models are annotated will be via the **Place Label** tool (**Survey >> Drawing Production >> Notes**). Currently, you need to select the applicable **Element Template** first, which will apply the correct attributes. However, the intent is that the attributes are controlled by the cell label and dimension style selected as opposed to the Element Template. **Note:** There is a defect logged with Bentley regarding this issue. In a future software release, you should not need to select any Element Template prior to placing the label.

Element Templates were covered in the Fundamentals (ORD) Manual. By default, the Type should be set to **Cell** in the **Place Label Settings** dialog box (Figure 99). The user will select the appropriate input for each field shown below.

FIGURE 99. PLACE LABEL SETTINGS DIALOG BOX



- **<u>Place Label w/ Leader</u>:** Used to place a label with a leader (e.g. station/offset). This is the most commonly used option.
  
- **<u>Place Label w/o Leader</u>:** Used to place a label without a leader (e.g. property line length, bearing).
  
- **<u>Type</u>:** Cell or Text Favorite. Automatic labels of both kinds have been setup as part of the TDOT workspace. Most **Text Favorites** are tied to annotation groups but will occasionally be selected here to place a label. The more common option will be a **Cell** label when utilizing the Place Label tool.
- **<u>Cell Name / Favorite Name</u>:** Field is dependent on the **Type** field. All <u>cell</u> names used here begin with an underscore (e.g. **_SUR**) and will be listed first in the drop-down menu. The software pulls from <u>all</u> cell libraries within the workspace so please be patient after opening the drop-down menu while the cells load.
- **<u>Dimension Style</u>:** The styles have been setup per TDOT standards (dimensions, text and leader properties, etc). The naming convention starts with the discipline abbreviation to align with the TDOT levels.
- **<u>Label Rotation</u>:** Sets the rotation of the label relative to the leader line (Horizontal, Vertical, Inline). **Note:** An enhancement has been logged with Bentley to add an **Along Element** option.
- **<u>Start At</u>:** Sets whether the label should start from the terminator or the cell. It is recommended setting this option to **Terminator**.
- **<u>Horizontal Attachment</u>:** Sets the leader attachment side (Auto, Left, Right). It is recommended setting this option to **Auto** so that your leader attachment side will be correct based on the angle of your label.
- **<u>Annotation Scale</u>:** Turns on the Annotation Scale. By default, this is taken from the model's annotation scale setting. It is recommended to always keep this enabled so that the labels will scale accordingly.
  
- **<u>Place Label w/ Regular Association</u>:** If this option is enabled and the Place Label w/ Relative Association is turned off, the label is placed with regular association. If you move the element, the label remains at the same place with only the leader line moving in conjunction with the element.
  
- **<u>Place Label w/ Relative Association</u>:** This option is enabled only when Place Label w/ Regular Association is enabled. If you move the element, the label will also move with it meaning that the label will stay at the same location relative to the original snap point.
  

Visually, you can see the linked fields (grey boxes) when placing intelligent labels, such as an existing ROW station/offset label (Figure 100). This **text user preference** can be controlled here: **File >> Settings >> User >> Preferences >> Text**. If you uncheck **Hide Field Background**, the grey boxes will appear (Figure 101). **Note:** There is an erroneous circle that appears at the arrowhead when placing certain cell labels. This is a known annotation defect and has been logged with Bentley. <u>Do not delete the circle or else the linked fields will disappear</u>.

FIGURE 100. LINKED ANNOTATION FIELDS

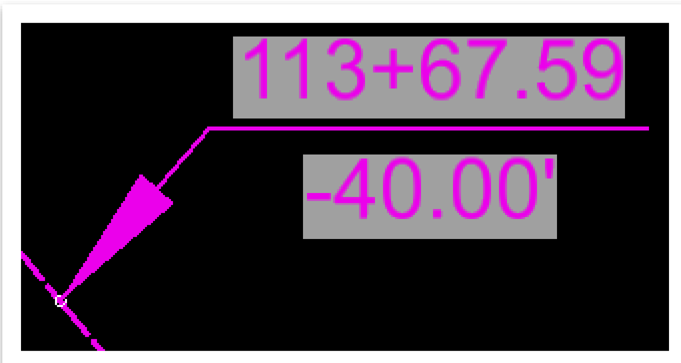
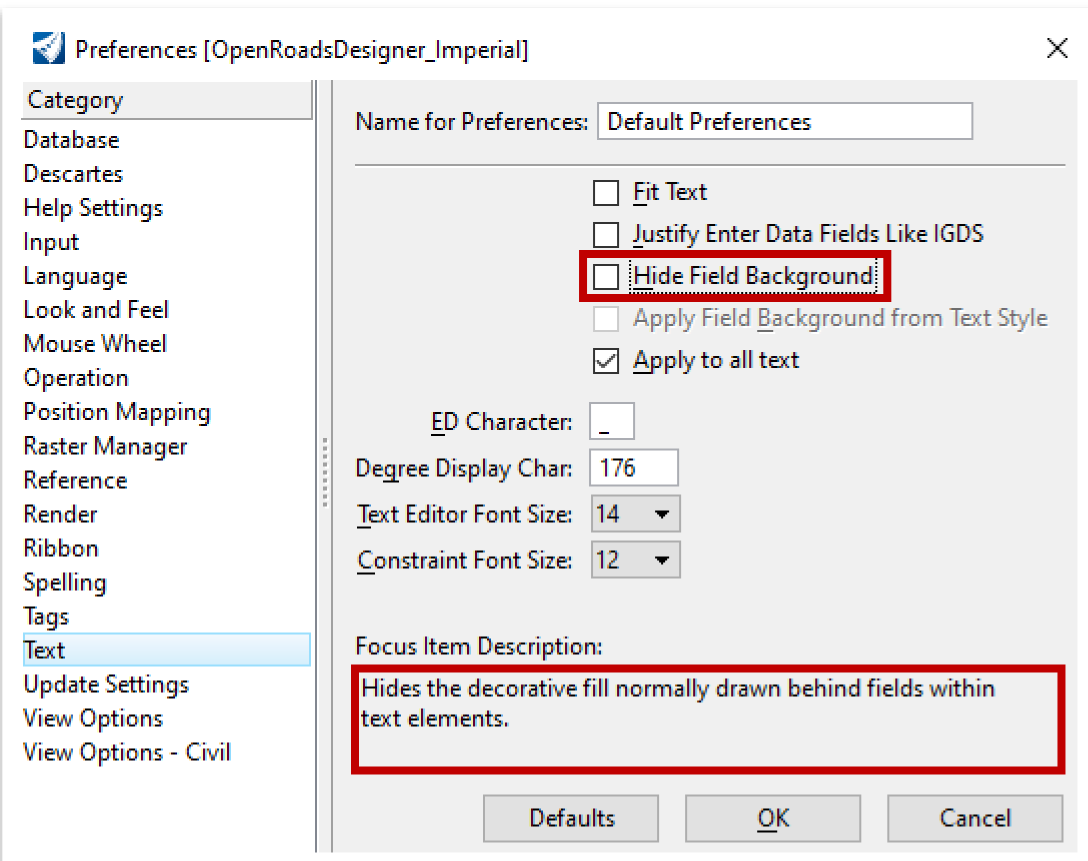


FIGURE 101. HIDE FIELD BACKGROUND OPTION

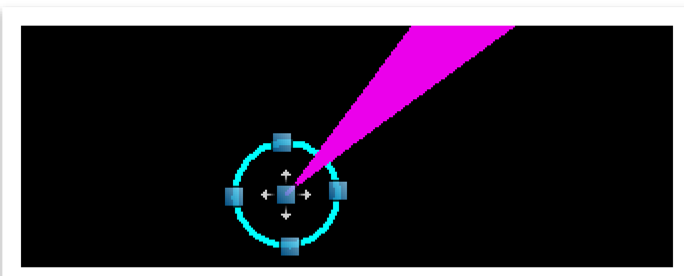


If you associate the label with an element (e.g. centerline), the label will automatically update if the element moves regardless of whether the label is live in the file or referenced. If referenced, however, the label will not visually update until you re-open the reference file that it is in. If the associated element and label are both live in the file, then the label should update instantenously. The key for automatic updates is that the arrowhead snap point must be snapped to an element (e.g. line) as opposed to a point in space. Also, if there is no association with an element when initially placing the label, it will not update. Even after labels are placed, the user can always move the arrowhead to a new location, if necessary, and the label should then update accordingly.

Take Note!

*To move the arrowhead to a new location, you must first select it so that the blue square appears on the tip of the arrowhead (Figure 102). Normally, you would need to initiate the **Element Selection** tool and draw a square around the arrowhead for it to appear. However, since the erroneous circle exists, you can simply left click it. Then, you would left click the blue square and move the arrowhead to the new location. Of course, you could always delete the label and place it again.*

FIGURE 102. ARROWHEAD MOVEMENT

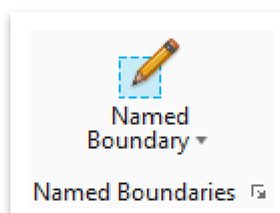


Plan labeling that is not included in the annotation groups will be placed in this manner in the survey **design** model. This method will also be used for profile labeling in the profile **drawing** model after the named boundary has been created.

5.2.4 Named Boundaries

The **Named Boundary** tool is used to automatically create **plan**, **profile** and **cross-section** sheet models along an alignment (Figure 103). The plan sheet creation was covered in the Fundamentals (ORD) Manual. The profile sheet creation will be discussed in this chapter and is necessary for survey because permanent profile annotation cannot be added until a profile named boundary has been created. The same goes for cross sections as well.

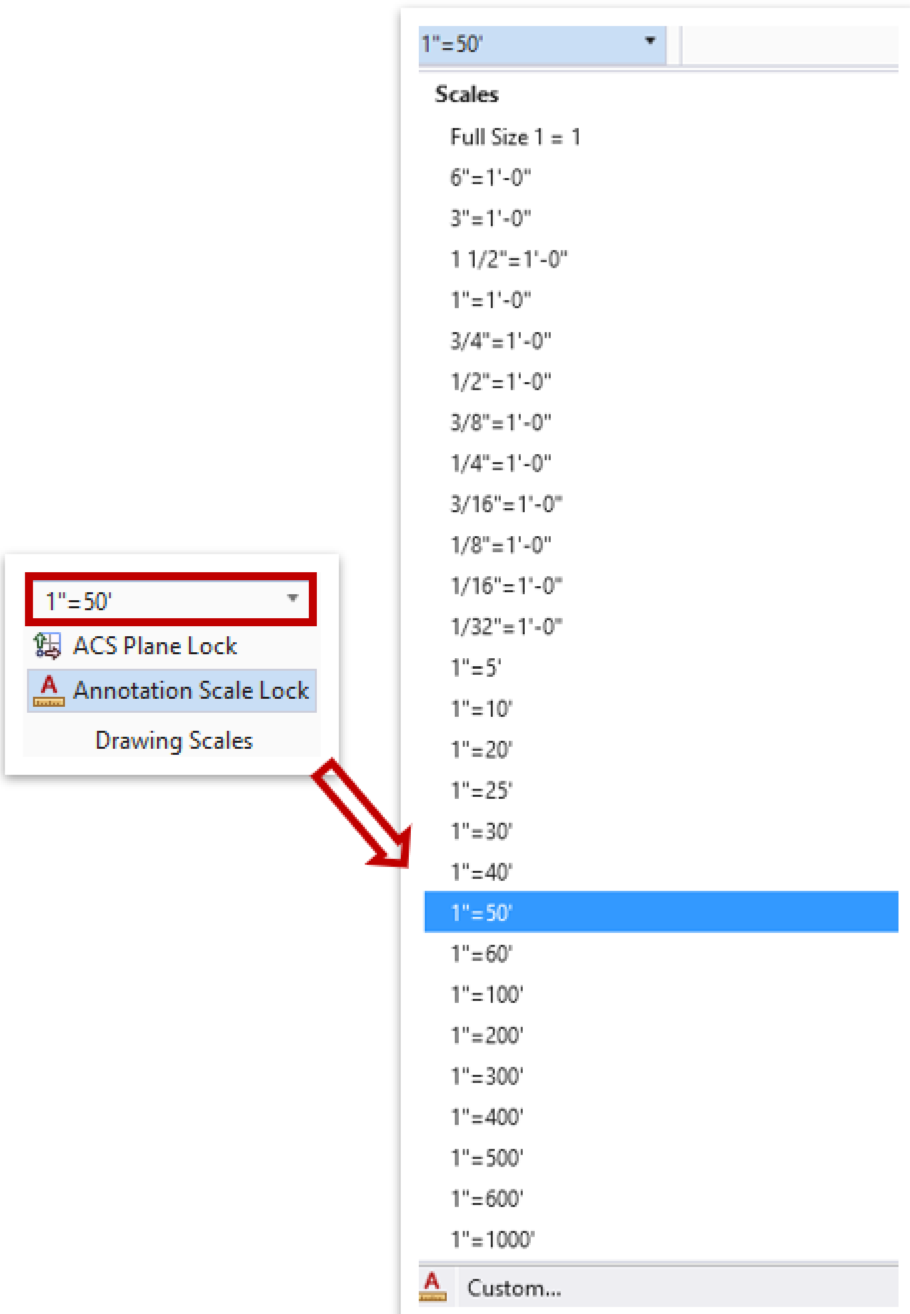
FIGURE 103. NAMED BOUNDARY TOOL



5.2.5 Drawing Scales

The **Drawing Scale** enables the user to adjust the size of the geometry in the drawing by simply selecting the desired scale (Figure 104). Although most elements will scale accordingly, some have been marked as **non-annotatable** (e.g. pavement markings, sign posts, etc) meaning they are true size and will not scale. Because civil geometry is dynamic, the applied scale can occur at any time without having to delete or replace geometry. **The delivered files should be set to the applicable project scale**.

FIGURE 104. DRAWING SCALES



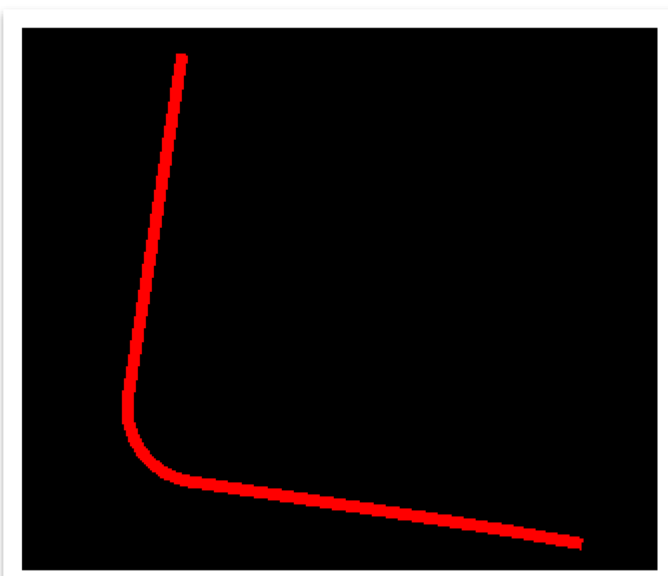
5.2.6 Exercise: Plan Annotation and Drawing Scales

In this exercise, we will add survey centerline and feature plan annotation and utilize the Place Label tool to add additional labels (e.g. existing ROW sta/off). In the current software version, there are multiple known annotation limitations that will be referenced in the upcoming exercises. Bentley has indicated they should be addressed in the next release. We will continue to utilize the same **Alignment – Best Fit.dgn** file.

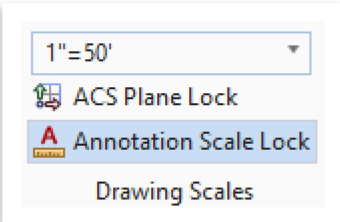
Take Note!	*Remember, elements placed with regular ORD tools (e.g. Place Line) will not be annotated using these tools. Any geometry placed with regular ORD tools instead of Civil Geometry (covered in Chapter 4) will need a Feature Definition assigned to benefit from automatic annotation.*

1. Switch back to the **Survey** workflow in the upper left corner and then make sure the **Default** view is open in the lower left corner of the drawing window.

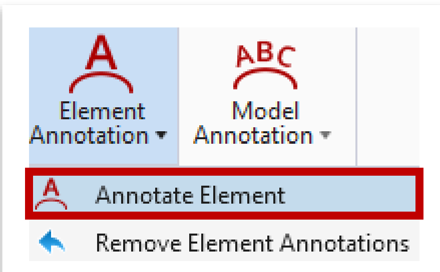
2. Go ahead and close **View 2** (profile) for now if not already closed and turn off all reference files.



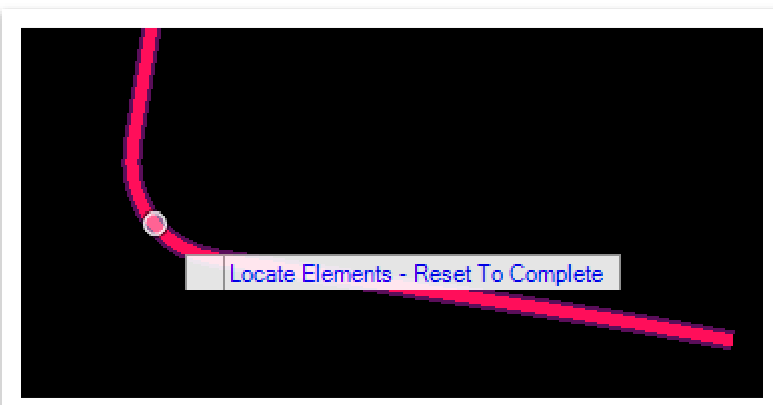
3. We will now apply annotation to the preliminary **Kirby Rd** centerline. Make sure the Drawing Scale is set at **1" = 50'** by going to **Survey >> Drawing Production >> Drawing Scales**. **Note:** This drawing scale should match the project scale.



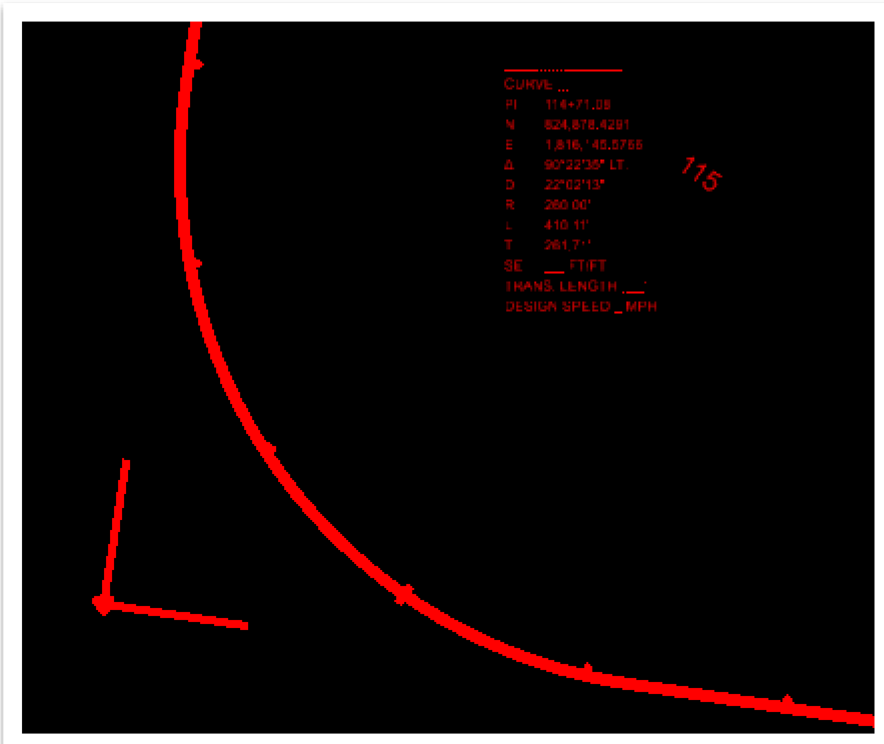
4. Open the **Annotate Element** tool (**Survey >> Drawing Production >> Annotations >> Element Annotation**).



5. Notice the cursor prompt: **Locate Elements - Reset to Complete**. Select the preliminary **Kirby Rd** centerline and then right click to reset.



6. You should now see the centerline annotation (stationing, curve data, tick marks, etc). **Note:** If you don't see any annotation, you'll need to turn on the **SUR - CL - Preliminary Curve Text** and **SUR - CL - Preliminary Text** levels.

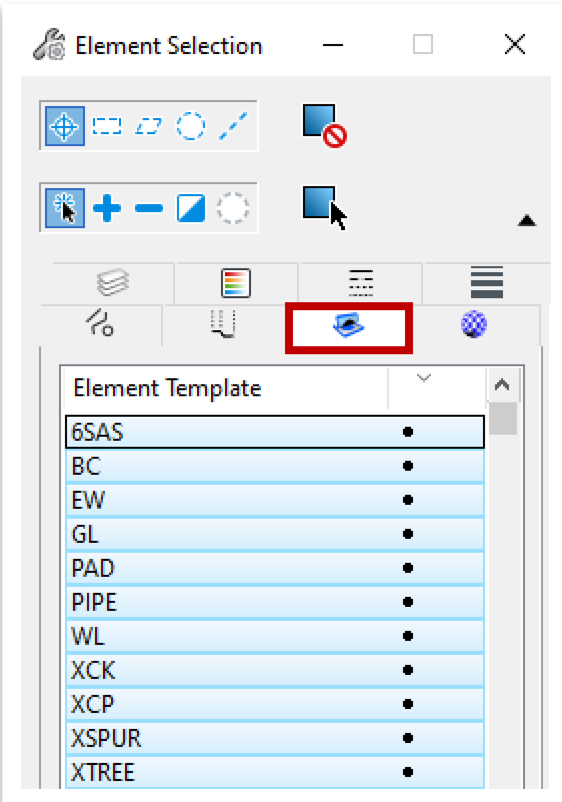


Take Note!

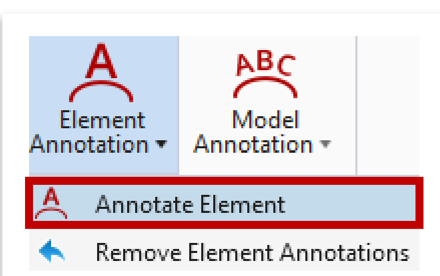
*Remember, if you want to visually see what annotation fields are automatically linked (grey boxes), uncheck the **Hide Field Background** user preference (**File >> Settings >> User >> Preferences >> Text**).*

7. Next, lets open the **Survey Model – Edited.dgn** file once again and turn on all levels in the active file. We will annotate the survey features that were brought in earlier from the field book. Steps 8-9 show the **Element Annotation** method, which would be used if you only wanted to annotate certain features. Currently, however, this method cannot be used for this purpose due to a defect with the tool that Bentley has acknowledged should be fixed in the next software version. If you do not want to see the Element Annotation steps, skip ahead to Step 10 where we will utilize the **Model Annotation** method instead. **Note:** You can ignore any erroneous survey linework for this exercise.

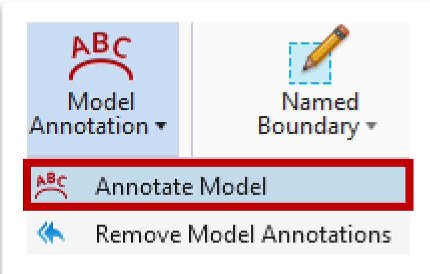
8. Utilizing the **Element Selection** tool, select the specific **Element Templates** (**ET**) that you want to annotate. These correlate to the TDOT survey feature codes. Within the Element Selection window, click the arrow to expand the options and then click the **ET** tab (highlighted). For this example, the highlighted ET's were selected. **Note:** You do not need to hold down CTRL to select all ET's. Simply left click each individually.



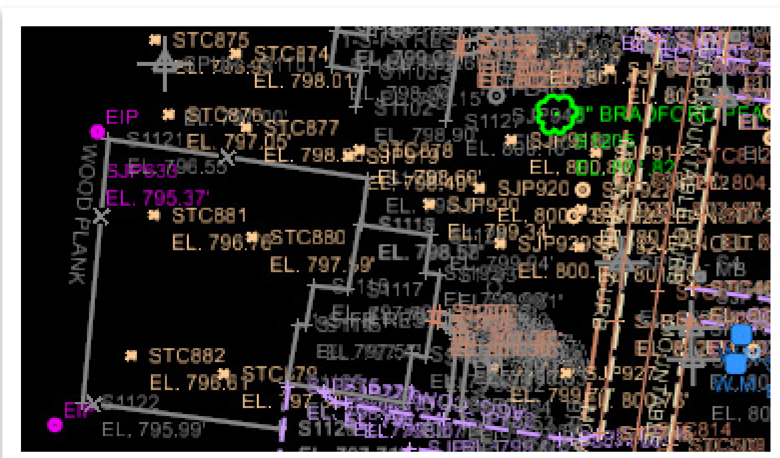
9. Next, you would open the **Annotate Element** tool (**Survey >> Drawing Production >> Annotations**). Notice the cursor prompt: **Data Point to annotate selected elements**. Data-point **ONCE** to accept the annotation of the selected elements and then wait a few seconds for the software to process. The annotation would then be applied to only those elements tied to the selected ET's.



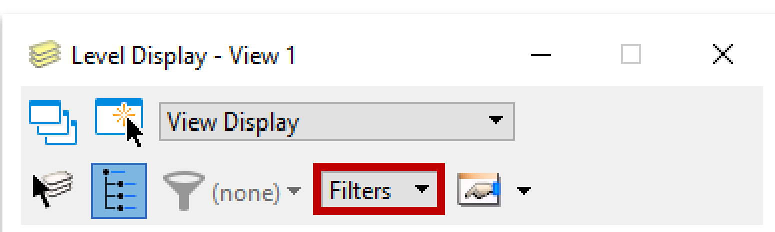
10. As previously mentioned, we will utilize the **Model Annotation** method for this exercise, which will label the field book data automatically based on field codes. Open the **Annotate Model** tool (**Survey >> Drawing Production >> Annotations**).



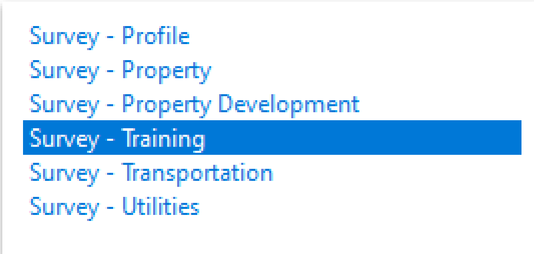
11. Notice the cursor prompt: **Accept Design Model**. Left click to accept and then give the software a minute to process before the annotation is visualized. The screenshot below is just a portion of the overall survey. **Note:** Normally, you would have the option to select a specific annotation group to apply but there is a defect logged with the **Model Annotation** tool as well that should be fixed in the next software version.



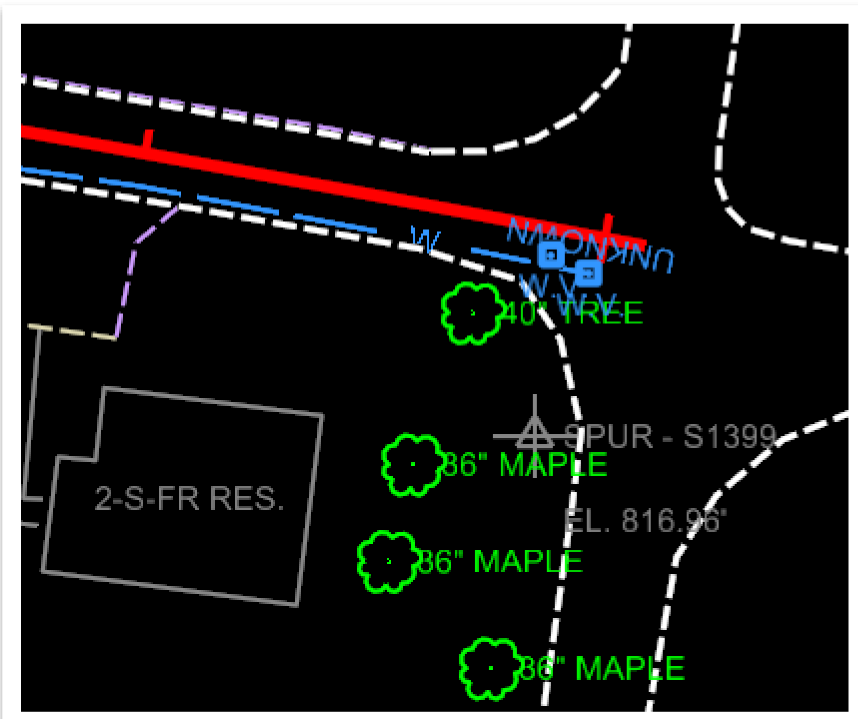
12. For simplicity, a level filter has been setup for training purposes only called **Survey - Training**. Open the **Level Display** and then switch the option to **Filters** (highlighted).



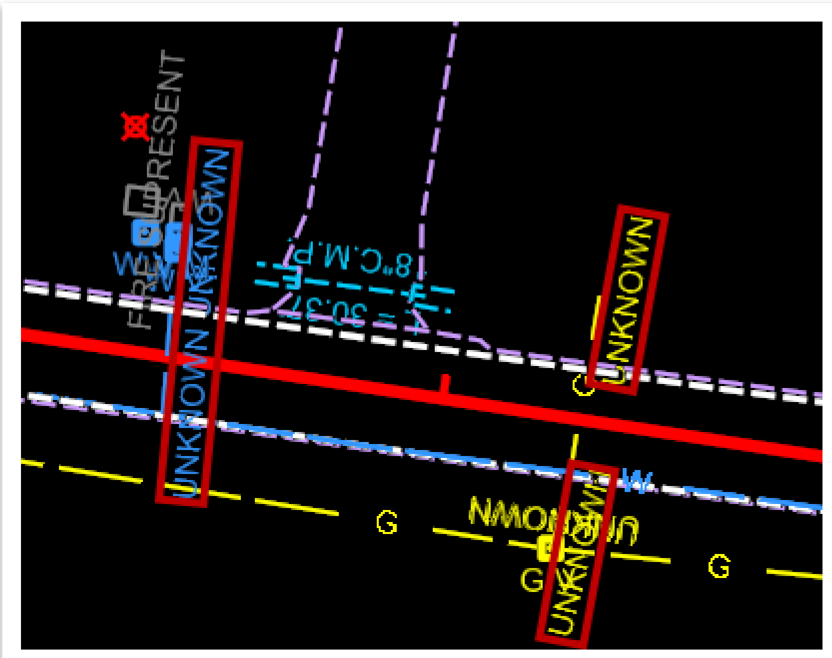
13. Scroll down and select the **Survey - Training** level filter.



14. Zoom in to the far eastern portion of the survey and notice the annotation below. Remember, we changed these tree feature codes earlier in the manual, but it was in the original survey file. For the purpose of the annotation procedure shown in this exercise, you can ignore that. **Note:** Feel free to check out the other ORD level filters that have been setup for survey.



15. Now, let's now look at the gas and water lines in the middle of the survey crossing the road. You will notice that the labels say **UNKNOWN**. This is because the size was not provided in the survey text files. Only the generic **GL** and **WL** feature codes were used for this project, as opposed to 2GL or 2WL for example. It is important to keep in mind that the annotation is only as good as the survey data. <u>The utility annotation (plan view) has been setup to label the size every **500'**, including the beginning and ending points of a given line or complex element</u>. Annotation cleanup is expected in ORD, but for this exercise, we will leave all labels as-is.



16. Next, let's look at the utility annotation. Zoom in to the eastern-most north/south **SA** line and notice there is a **6"** label at each end. This is because the field code used in the text file was **6SAS**. Remember, in ORD, the utility size will not be seen within the linestyle but rather added as annotation. **Note:** You can also see the size of any utility by selecting it and viewing the **Properties**.

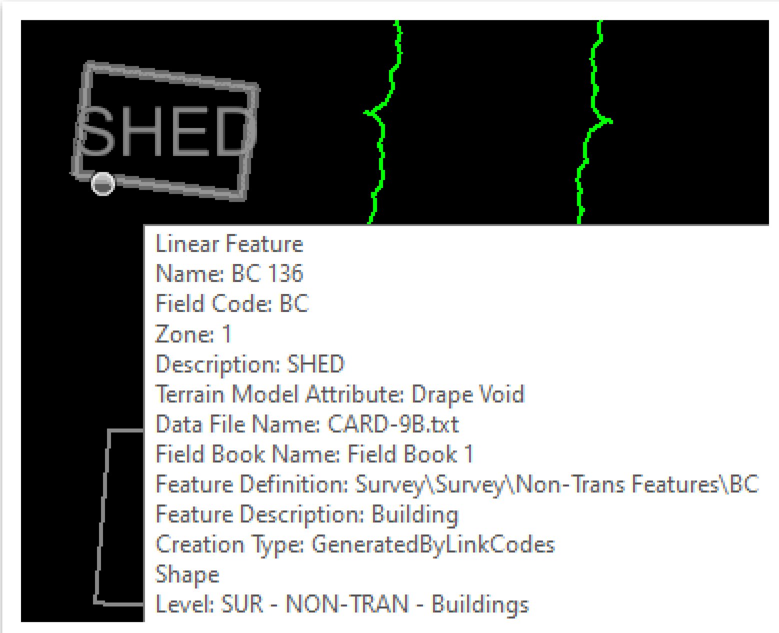
Take Note!

*As a reminder, if you wanted to change the **Feature Code** after the fact, you could make the change in the text file and re-import or you could highlight the Feature Code in the field book and make the change in the **Details** tool. The annotation would then **automatically** update.*

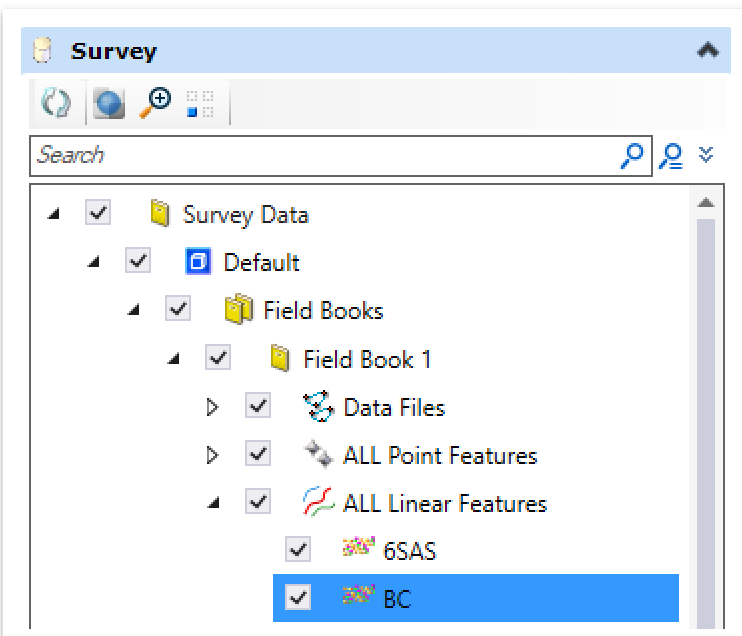
*To move text around to avoid overlaps, you can either left click (and hold) on the text and move your mouse to the new location or open the **Move** tool (**Survey >> Drawing >> Manipulate**). The labels may also be rotated or mirrored using the standard ORD **Drawing** tools. These labels should not be scaled as their sizes are controlled by the **Annotation Scale**.*

17. Let's assume that after annotating, we realized that there was an error in the text file resulting in a misspelling. For this exercise, we will assume that the **SHED** highlighted below was supposed to say **SHED2**. Zoom in so we can edit the label.

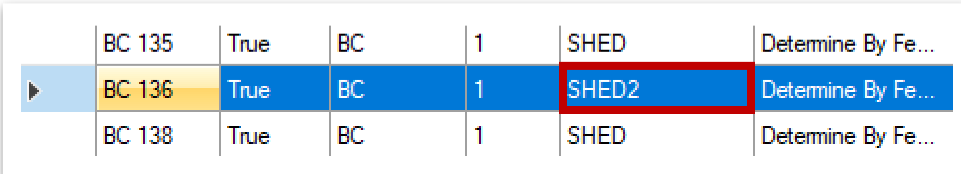
18. Select the outer boundary of the shed and notice that the Field Code is **BC**. You will also notice that the Name is **BC 136**. **Note:** For the purpose of this exercise, it is OK if your number varies.



19. Knowing the Field Code, highlight the **BC** Linear Feature in the field book within the **Explorer**.

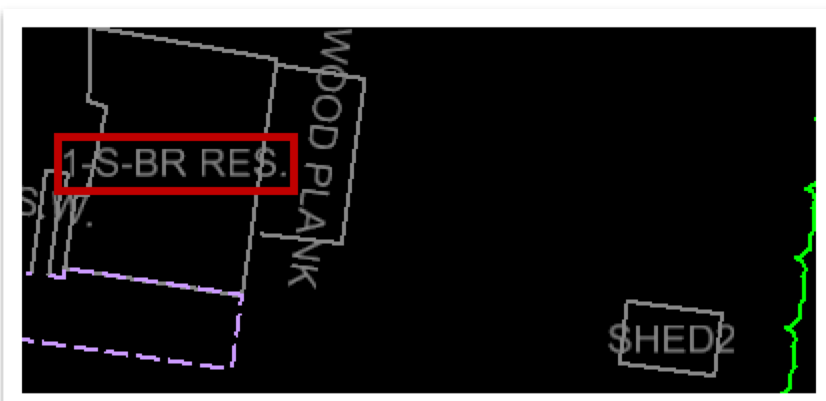


20. Open the **Details** tool (**Survey >> Field Book >> Primary**). Scroll down and select **BC 136** (or the one that matches the shed in your file). Left click in the **Description** column and add a “**2**” to the description, as shown below. Notice that the label automatically updates in plan view. Close the **Survey Details** window once done.

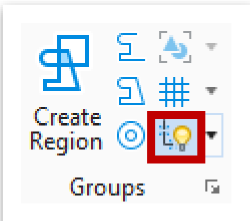


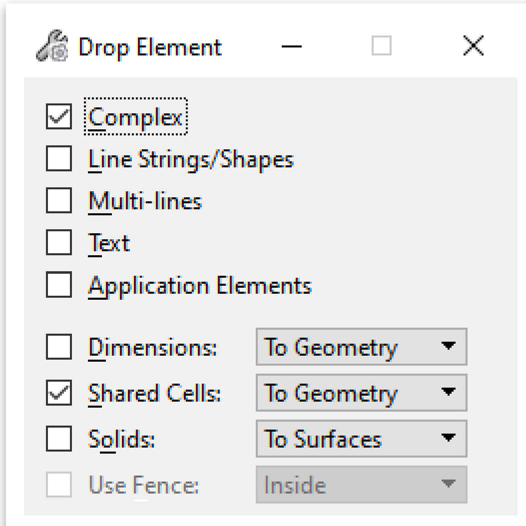
	BC 135	True	BC	1	SHED	Determine By Fe...
▶	BC 136	True	BC	1	SHED2	Determine By Fe...
	BC 138	True	BC	1	SHED	Determine By Fe...

21. Just to the left of the shed is a **1-S-BR RES.** structure. Let’s assume that you wanted to split the label into 2 lines so that it would fit better within the boundary.



22. Go ahead and switch to the **Drawing** workflow and open the **Drop** tool (**Drawing >> Home >> Groups**). **Note:** The desire is to be able to make this type of edit either within the **Details** tool or within the **Text Editor** without having to drop the text first. An enhancement has been logged with Bentley.



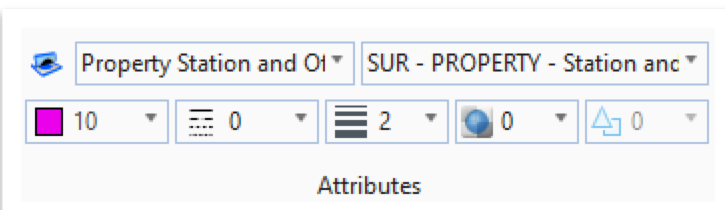


23. Left click on the text to apply the **Drop** and the open the **Element Section** tool. Notice that the text turns white once dropped. Double click on the text to open the **Text Editor** and then make the edit. Left click anywhere outside the editor and notice the update. The label loses its applicable color so that attribute update would need to occur. **Note:** You can **Drop** multiple labels at once, if necessary.

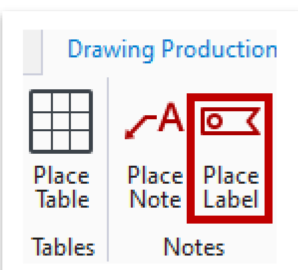
Take Note!

*When annotation is placed utilizing the element or model annotation tools, **all labels are intelligent**. If you edit the spelling within the field book **Details**, the label is still intelligent. If you split the text into 2 lines, the label is no longer intelligent. If you need to **Remove Element** or **Model Annotation** at any time, only intelligent labels will be removed using those tools. Once you re-annotate, you would need to delete any new labels on top of those that you had previously dropped, as shown below. In general, annotation should be placed at the <u>end</u> just prior to delivering the files to design.*

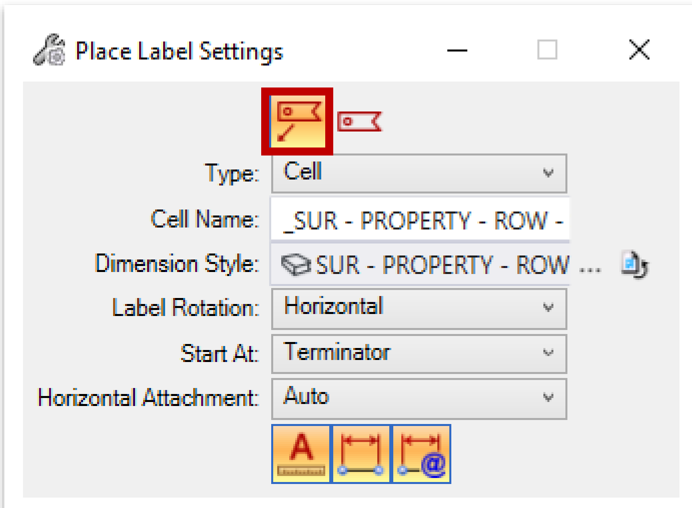
24. Next, we will add **station/offset** and then **bearing/length** <u>intelligent</u> labels to one of the existing ROW lines. Go ahead and switch back to the **Survey** workflow and turn on the **SUR - PROPERTY - ROW Lines** level. Select the **Property Station and Offset** element template (**Survey >> Annotation >> ROW**) which will place the labels with the correct symbology.



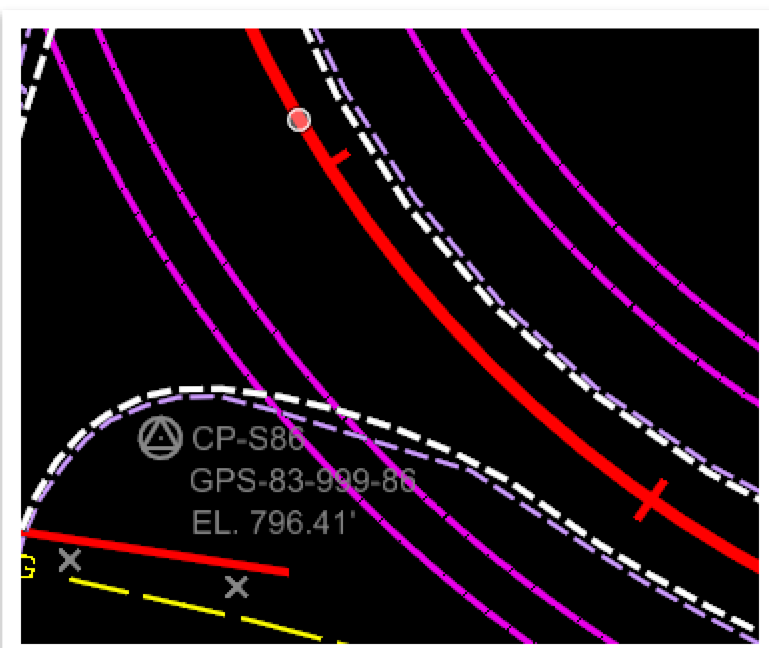
25. Now, open the **Place Label** tool (**Survey >> Drawing Production >> Notes**).



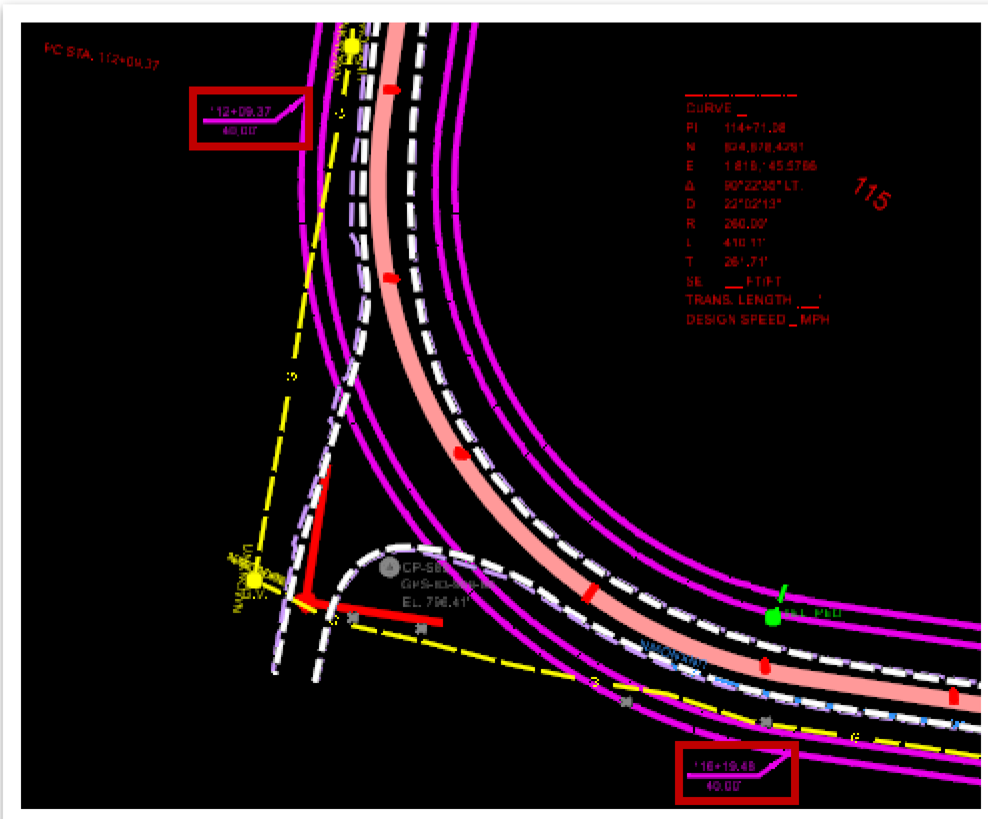
26. Within the **Place Label Settings** dialog box, select the following settings and leave the others as default. **Note:** When selecting the cell name, give the software a second to load since it is pulling from all cell libraries within the TDOT workspace. An enhancement has been logged with Bentley. You can also key-in the cell name, which often will be quicker than the drop-down arrow.
    a. Select the **leader** icon at the top
    b. **Type:** Cell
    c. **Cell Name:** _SUR - PROPERTY - ROW - Station and Offset – Flag
    d. **Dimension Style:** SUR - PROPERTY - ROW Lines Text

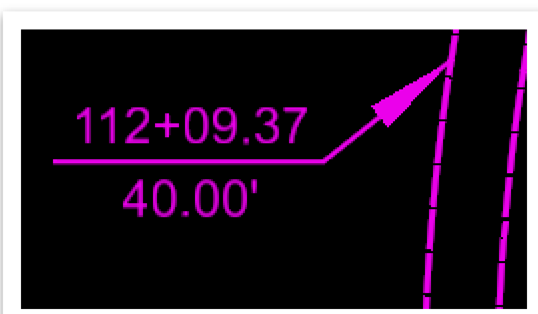


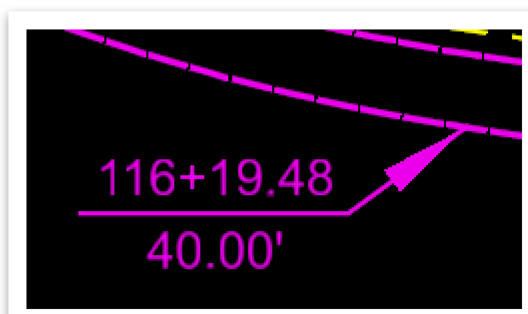
27. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the **Kirby Rd** centerline.



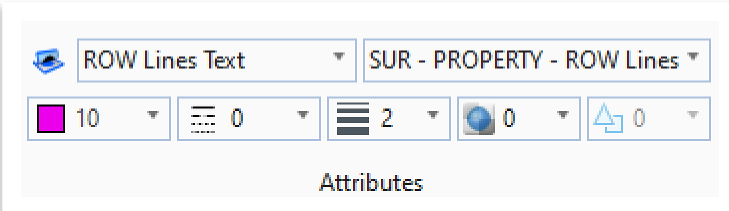
28. Notice the next prompt in the lower left corner: **Select Point Location**. Snap to both radius extents of the southernmost existing ROW line (one at a time), as shown below, to place the labels. **Note:** The labels **will not** populate with the correct data until you have physically accepted the placement of the label.



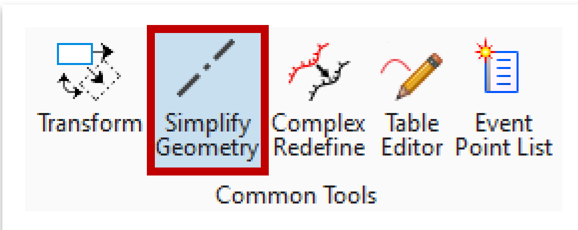




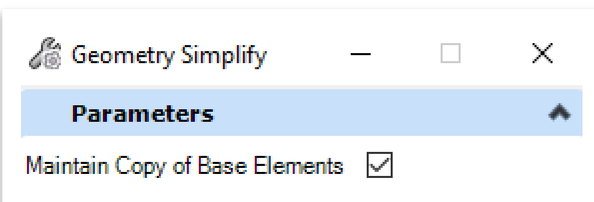
29. Next, we will place a **bearing/distance** label on the same existing ROW line. Select the **ROW Lines Text** element template (**Survey >> Annotation >> ROW**).



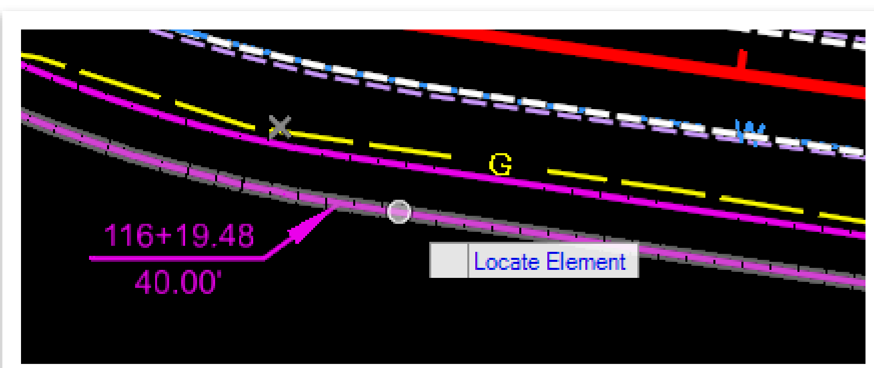
30. Since the existing ROW lines are one element (one chain), we need to simplify the geometry before we can label each individual line. Open the **Simplify Geometry** tool (**Survey >> Geometry >> Common Tools**).



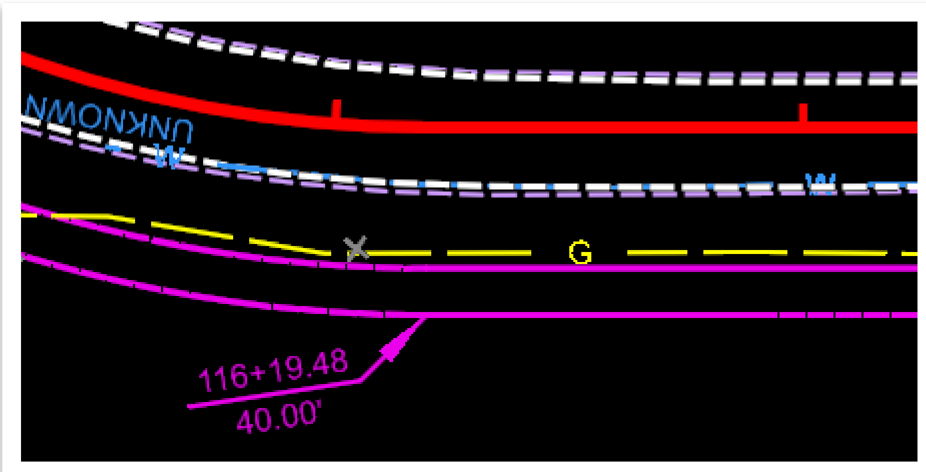
31. Within the **Geometry Simplify** dialog box, toggle on the **Maintain Copy of Base Elements** option.



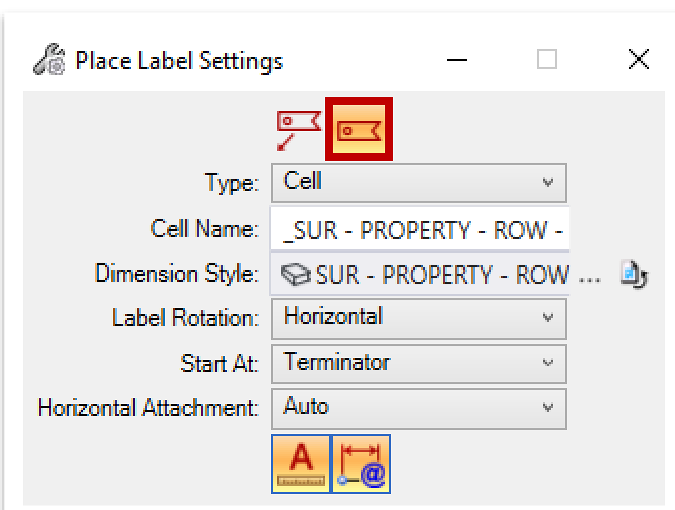
32. Notice the cursor prompt: **Locate Element**. Select the southernmost existing ROW line.



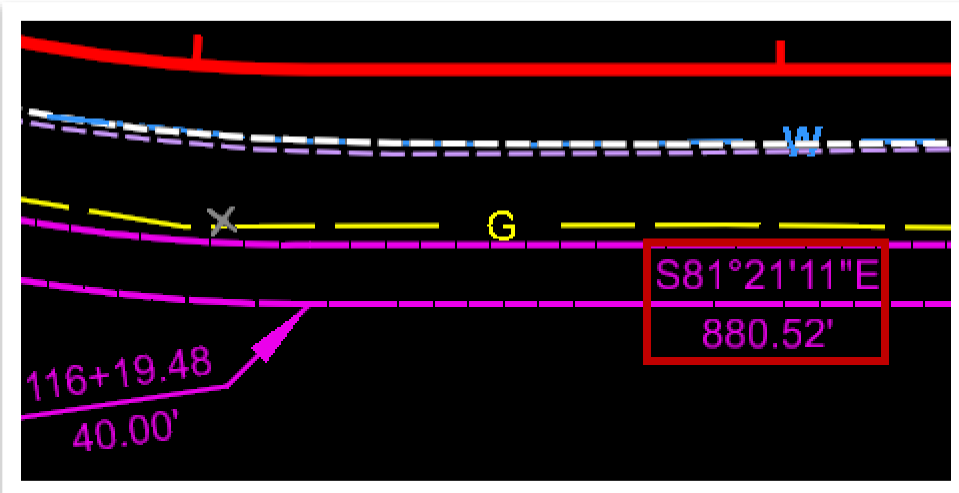
33. Before we place the label, let's rotate the view so that the **bearing/distance** label will be along the existing ROW line. Open the **Rotate View** tool, set the **Method** to **3 Points** and rotate as shown below. You could also utilize the **Dynamic Plan View** tool (**Survey >> Home >> Model Analysis and Reporting**) and select the existing ROW line. **Note:** An enhancement has been logged with Bentley to add an **Along Element** option in the **Place Label** tool in a future software release so that you wouldn't have to rotate the view.



34. Now open the **Place Label** tool once again (**Survey >> Drawing Production >> Notes**). This time we will utilize the **Place a label without a leader** option (highlighted in red). Select the following settings and leave the others as default. to complete the fields.
    a. Select the **non-leader** icon at the top
    b. **Type:** Cell
    c. **Cell Name:** _SUR - PROPERTY - ROW - Bearing and Distance
    d. **Dimension Style:** SUR - PROPERTY - ROW Lines Text



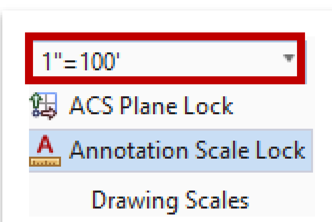
35. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the existing ROW line segment and left click anywhere along the line to accept placement. **Note:** To rotate the view back to due North, open the **Rotate View** tool once again and set the **Method** to **Top** since this file utilized a **3D** seed.



Take Note!

*This process to place existing ROW line labels would also be used to label **easements**, **property lines/parcels**, **political boundaries**, etc. The key is selecting the applicable element template, cell label and dimension style.*

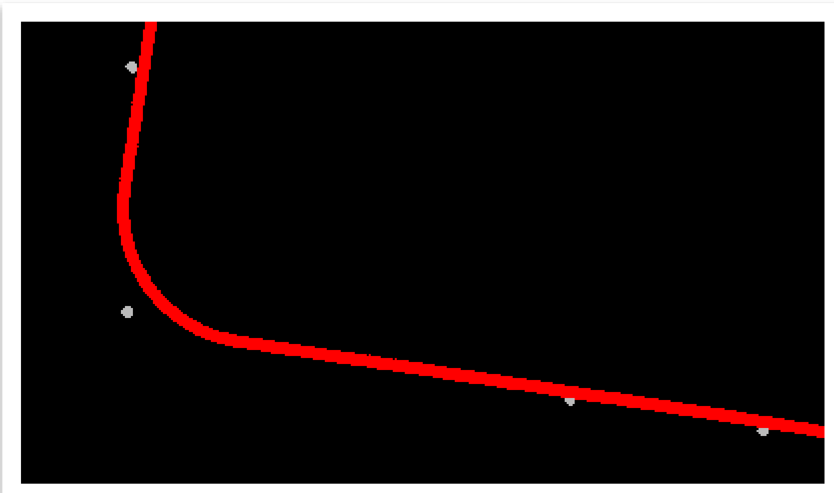
36. Lastly, go ahead and change the **Drawing Scale** from **1"=50'** to **1"=100'** (**Survey >> Drawing Production >> Drawing Scales**) and notice how the annotation adjusts automatically for all survey features. Change it back to **1"=50'** once you are done reviewing. **Note:** Give the software a second to process the scaling updates.



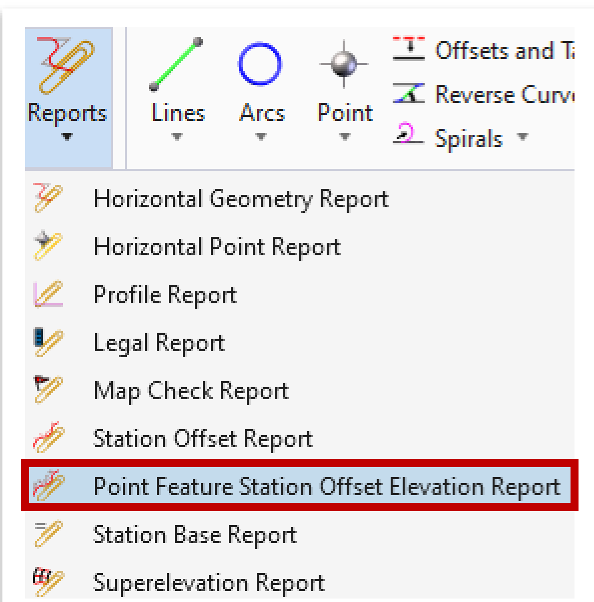
5.2.7 Exercise: Control Point Table

In this exercise, we will create a TDOT control point table and then place it in the survey file. We will continue to utilize the same **Survey Model – Edited.dgn** file.

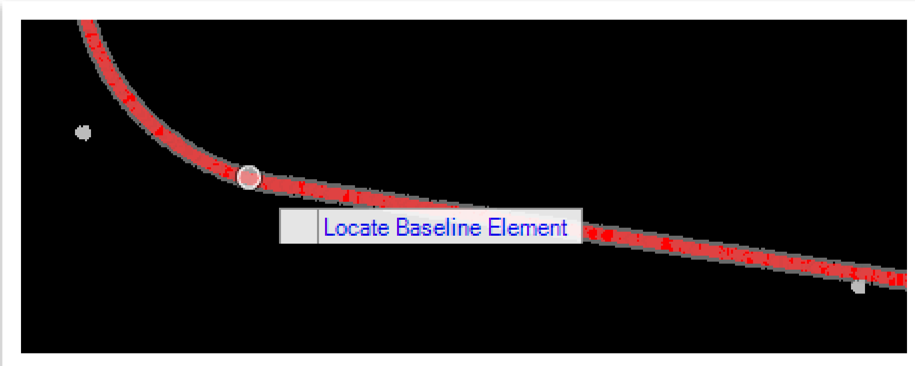
1. For simplicity, turn off all levels in the active file other than **SUR - CTRL - Points**. Within the **Alignment – Best Fit.dgn** reference file, turn off all levels other than **SUR - CL - Preliminary**. Then select all **four** grey control points.



2. Now, open the **Point Feature Station Offset Elevation Report** (**Survey >> Geometry >> General Tools >> Reports**).



3. Notice the cursor prompt: **Locate Baseline Element**. Select the **Kirby Rd** centerline.



4. Left click to accept the selected elements and the **Station Offset Elevation Feature Report** should automatically open. Remember, you can go to **Tools >> Format Options** within the **Bentley Civil Report Browser** to edit any formats or decimal places, if necessary.

Station Offset Elevation Feature Report

Report Created: Friday, April 9, 2021
Time: 10:49:25 AM

Project: Default

Description:

Baseline (Active) Alignment: Kirby Rd

File Name: C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\TDOT_Standards\WorkSets\SURVEY_Training\dgn\Survey Model - Edited.dgn

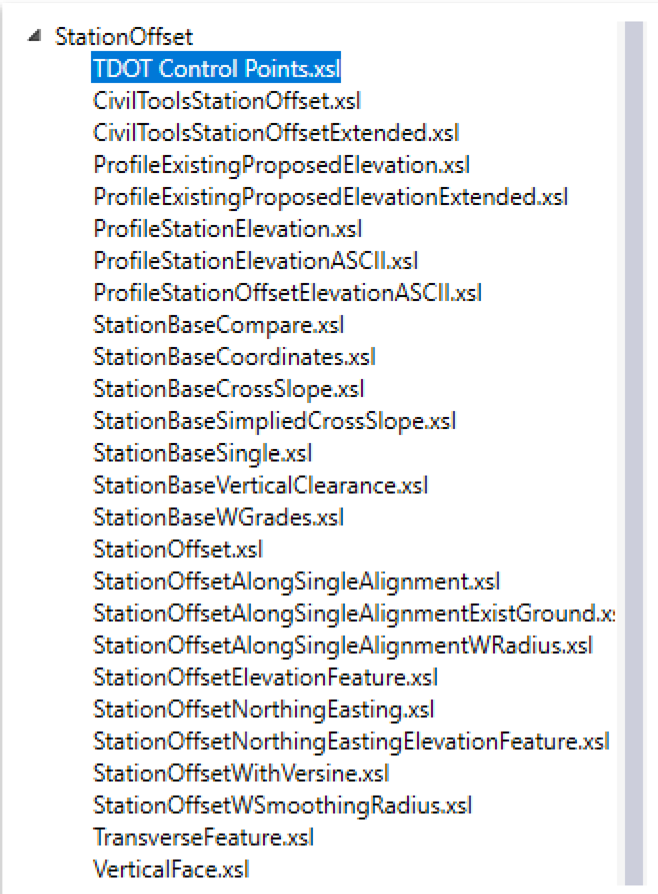
Last Revised: 4/9/2021 10:48:36

Input Grid Factor:

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

Point	Description	Station	Offset	Elevation	Feature
S85	83-999-85	9+66.65	24.94	801.2740	XCP
S86	83-999-86	14+11.66	63.06	796.4070	XCP
S87	83-999-87	22+61.07	14.85	807.9080	XCP
S88	83-999-88	26+39.13	17.76	821.3680	XCP

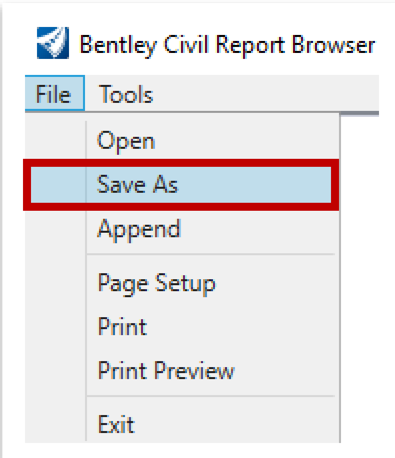
5. A custom TDOT report has been created for control points. Within the **Bentley Civil Report Browser**, select the **TDOT Control Points.xsl** option under the **StationOffset** category on the left-hand side.



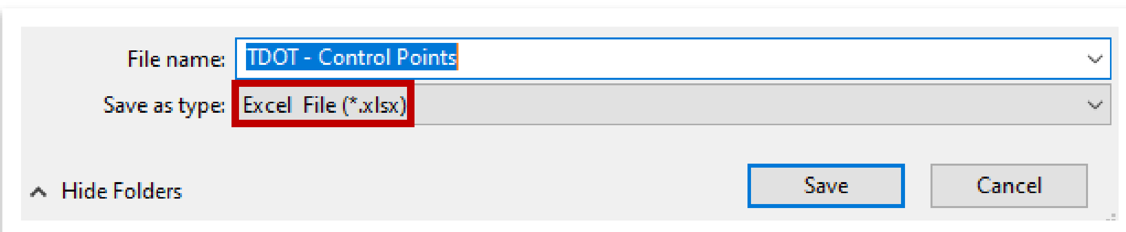
6. You should now see the **control point table** generated on your screen, as shown below.

CONTROL POINTS							
Point	**Northing**	**Easting**	**Elevation**	**Feature**	**GPS Point**	**Station**	**Offset**
S85	825368.9221	1816198.2196	801.2740	XCP	GPS83-999-85	9+66.65	24.94
S86	824896.3469	1816189.5290	796.4070	XCP	GPS83-999-86	14+11.66	63.06
S87	824726.1694	1817048.0004	807.9080	XCP	GPS83-999-87	22+61.07	14.85
S88	824665.7880	1817421.0331	821.3680	XCP	GPS83-999-88	26+39.13	17.76

7. Next, let's export the table as an **Excel** file, which can then be added into the survey file prior to delivering to Design. Within the **Bentley Civil Report Browser**, go to **File >> Save As** and browse to your WorkSet directory.



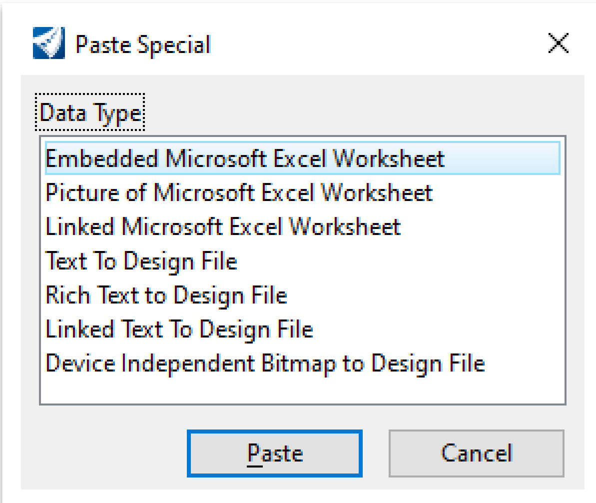
8. Name the file **TDOT – Control Points** and change the **File Type** to **Excel File (*.xlsx)**. Go ahead and close the **Bentley Civil Report Browser**.



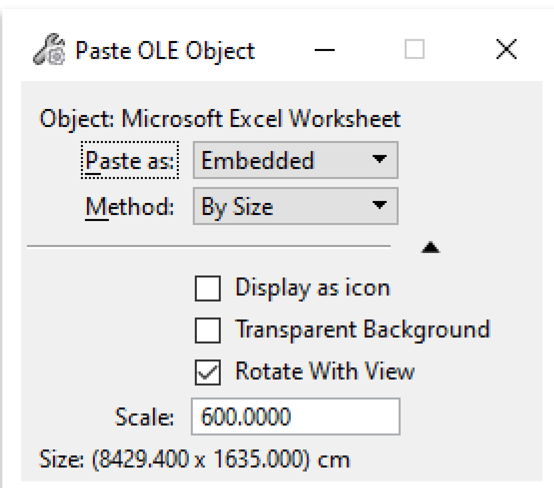
9. Within **File Explorer**, open the Excel file and make any additional customizations as necessary.

CONTROL POINTS							
Point	**Northing**	**Easting**	**Elevation**	**Feature**	**GPS Point**	**Station**	**Offset**
S85	825368.9221	1816198.2196	801.2740	XCP	GPS83-999-85	9+66.65	24.94
S86	824896.3469	1816189.5290	796.4070	XCP	GPS83-999-86	14+11.66	63.06
S87	824726.1694	1817048.0004	807.9080	XCP	GPS83-999-87	22+61.07	14.85
S88	824665.7880	1817421.0331	821.3680	XCP	GPS83-999-88	26+39.13	17.76

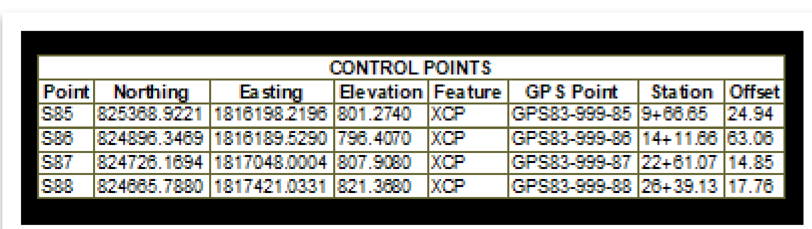
10. Once the excel file has been edited, copy the data. Open the **Paste Special** tool (**Survey >> Drawing >> Selection**) and select the **Embedded Microsoft Excel Worksheet** option.



11. Within the **Paste OLE Object** dialog box, sect the **Method** to **By Size**. Click the grey arrow to expand the box and set the **Scale** to **600** (12' x 50 scale).



12. Left click to place the table anywhere within the **Survey Model – Edited.dgn** file.

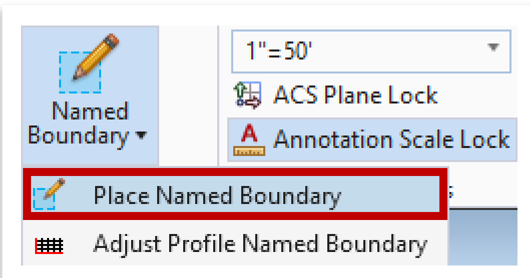


CONTROL POINTS							
Point	Northing	Easting	Elevation	Feature	GPS Point	Station	Offset
S85	825368.9221	1816198.2196	801.2740	XCP	GPS83-999-85	9+66.65	24.94
S86	824896.3469	1816189.5290	796.4070	XCP	GPS83-999-86	14+11.66	63.06
S87	824726.1694	1817048.0004	807.9080	XCP	GPS83-999-87	22+61.07	14.85
S88	824665.7880	1817421.0331	821.3680	XCP	GPS83-999-88	26+39.13	17.76

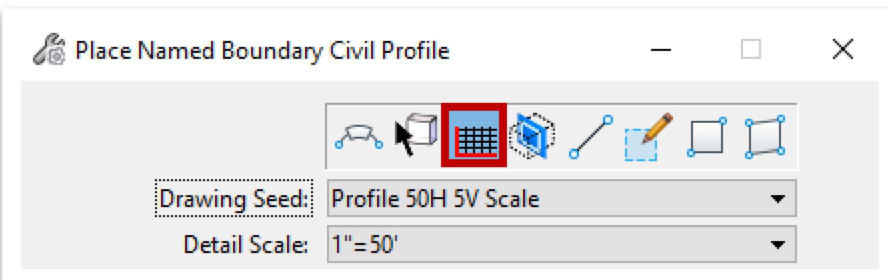
5.2.8 Exercise: Profile Named Boundary and Annotation

In this exercise, we will create a profile named boundary so that **existing annotation** can be applied to the profile drawing model. We will open back up the **Alignment – Best Fit.dgn** file.

1. Go ahead and open the **Kirby Rd** profile (**View 2**). We will now place **one** named boundary for the entire profile, so all annotation can be done in one model. Remember, you must create a profile named boundary in order to place any profile annotation. You cannot add permanent annotation in the dynamic profile window.
2. Next, open the **Place Named Boundary** tool (**Survey >> Drawing Production >> Named Boundaries >> Named Boundary**).

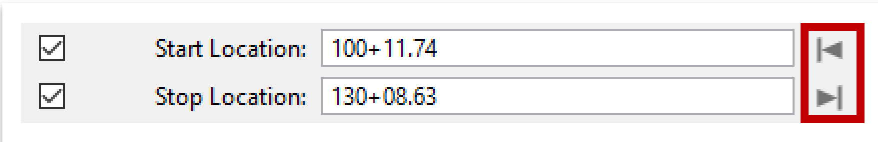


3. Make sure that the **Civil Profile** option is toggled on. Select **Profile 50H 5V Scale** for the Drawing Seed. Most of the fields should automatically populate based on the selected seed.

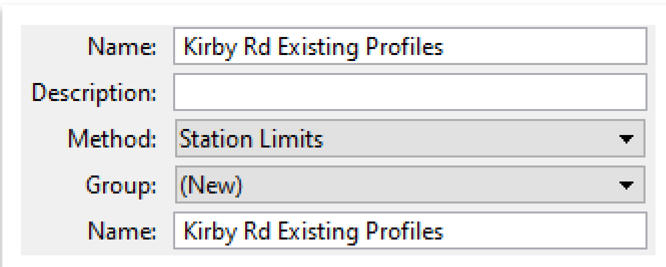


4. Notice the prompt in the lower left corner of the drawing window: **Identify Profile View**. Left click anywhere within **View 2**.

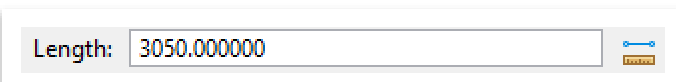
5. Use the grey arrows to lock the **Start** and **Stop Location** to the profile extents so that the entire profile is accounted for. **Note:** You cannot key-in stations until the profile view has been selected in Step 4.



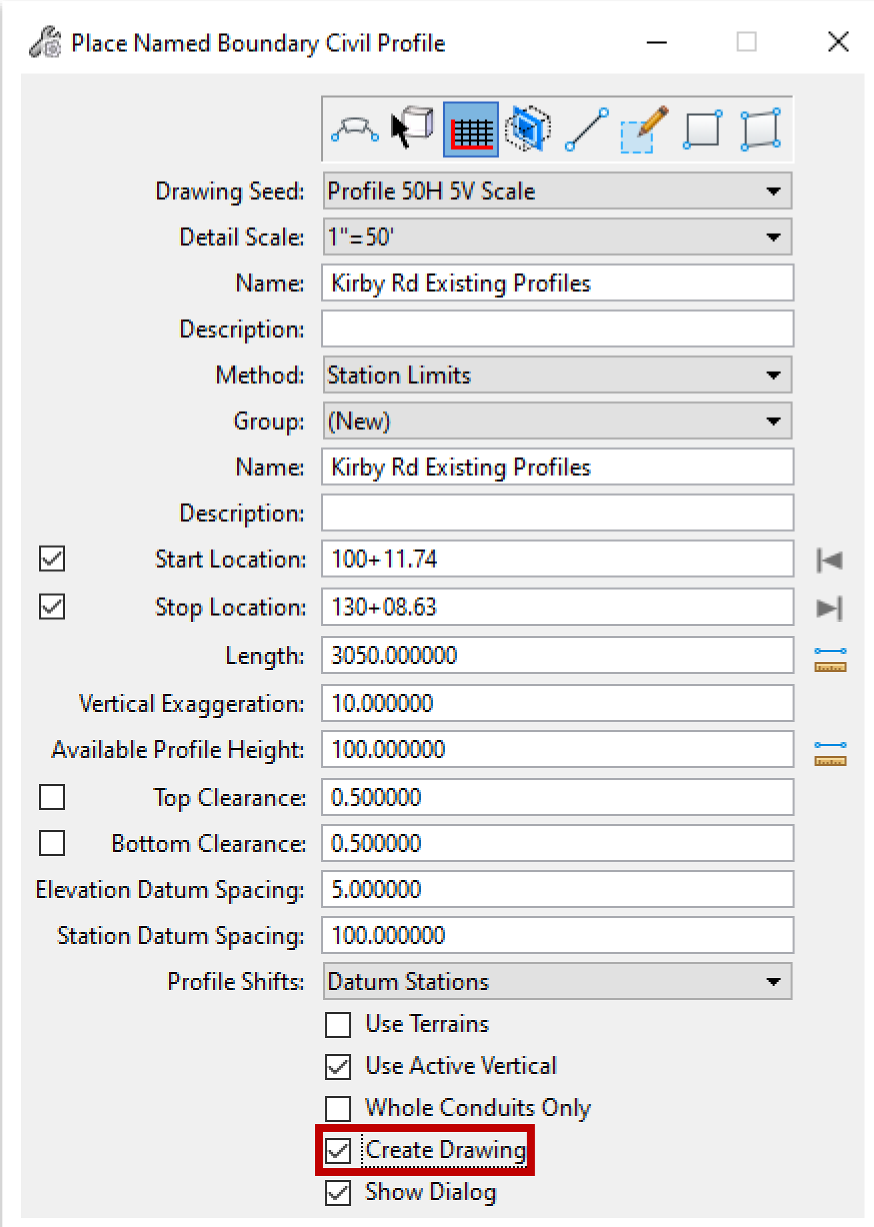
6. Key-in **Kirby Rd Existing Profiles** for both the **Named Boundary** name and the **Group** name.



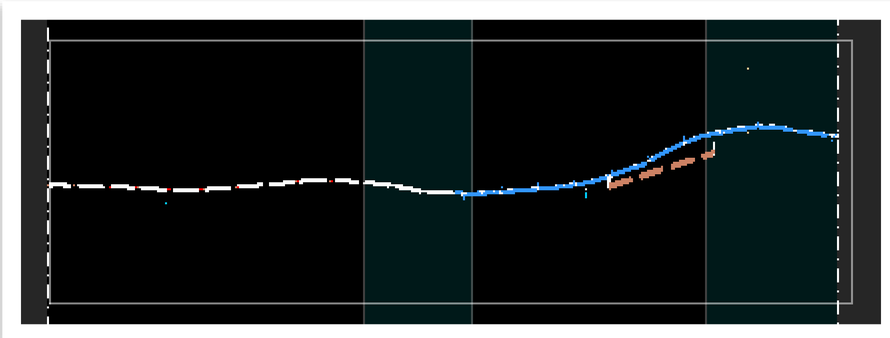
7. To create one overall profile named boundary, the **Length** field will need to be adjusted based on each project length. By default, the value in the seed is set to **1200’** which is setup for Design to plot 50-scale profile sheets. Since Survey does not need to create individual profile sheets, go ahead and edit this value to **3050’** for this exercise. This will allow the creation of <u>one</u> named boundary and ultimately one drawing model rather than multiple drawing models.



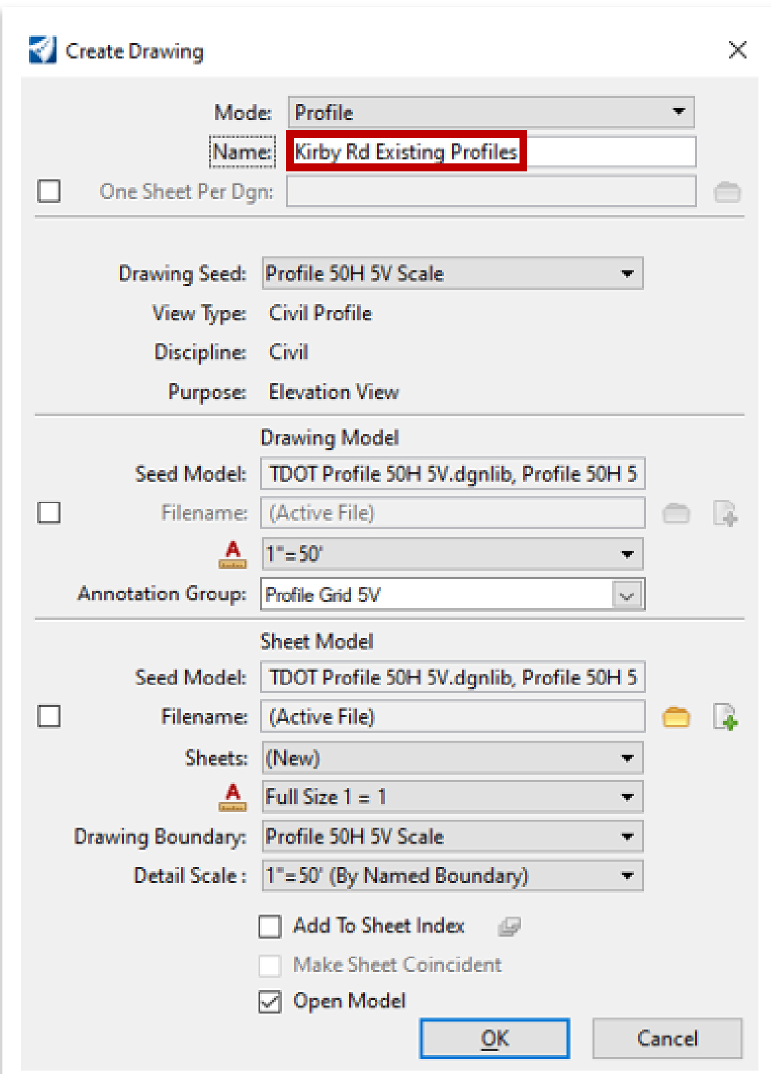
8. Leave the other default values as-is and make sure that the **Create Drawing** option is toggled on at the bottom.



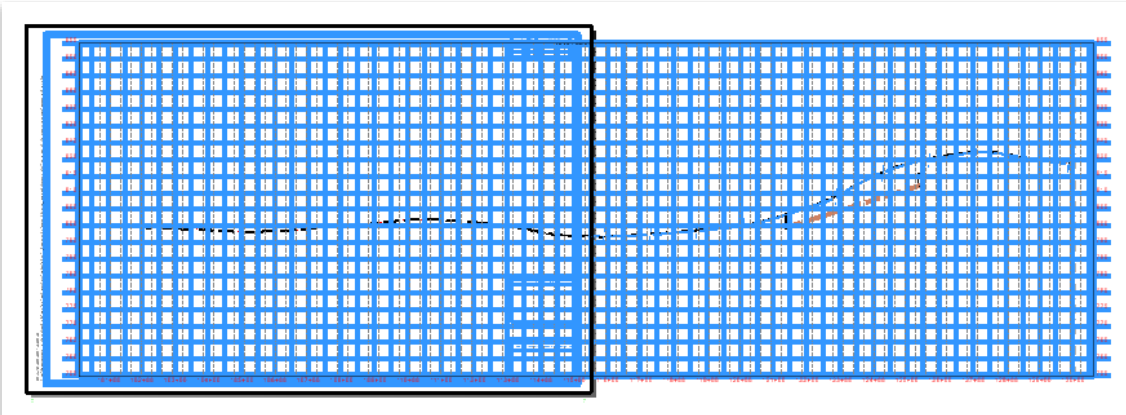
9. Left click anywhere within View 2 **three** times. Zoom out and you should see **one** profile named boundary drawn into the file, represented by a white border.



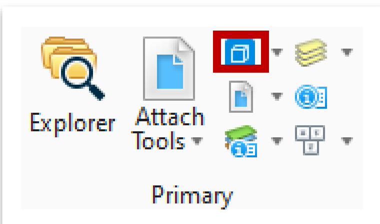
10. The **Create Drawing** window will appear automatically after creating the named boundary, since we toggled it on in Step 8. Click **OK** to accept all default settings. **Note:** If the **Name** field shows the name twice, simply click in the field and remove.



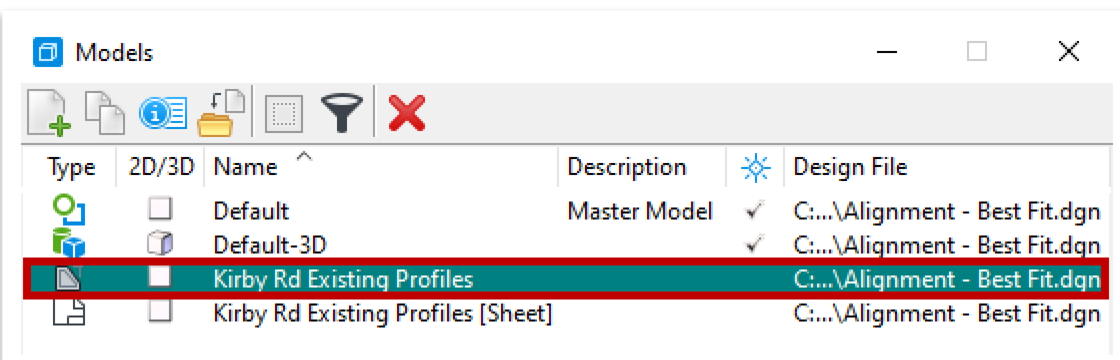
11. As a reminder, the named boundary process creates a sheet and a drawing model for every named boundary. By default, the software should open to the <u>one</u> **sheet** model in **View 1**. **Note:** The sheet model is only needed when printing sheets, so it can be deleted for Survey purposes. We will delete the sheet model later in the exercise. For now, we will focus on annotation which is done in the **drawing** model.



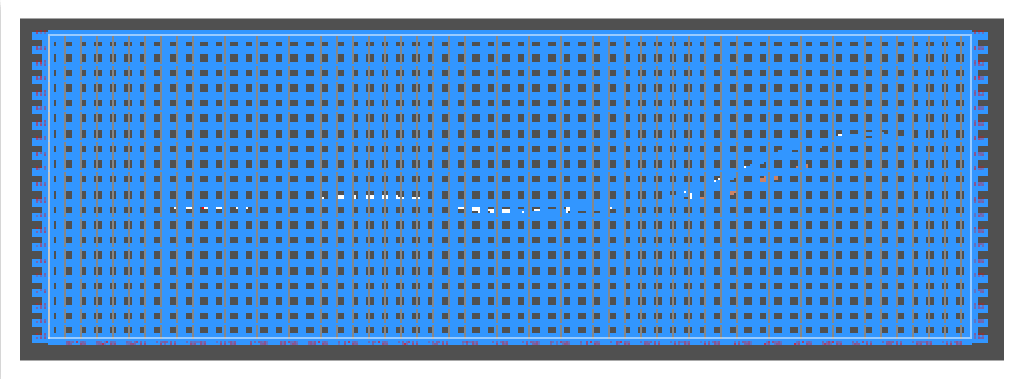
12. Next, open the **Models** window (**Survey >> Home >> Primary**).



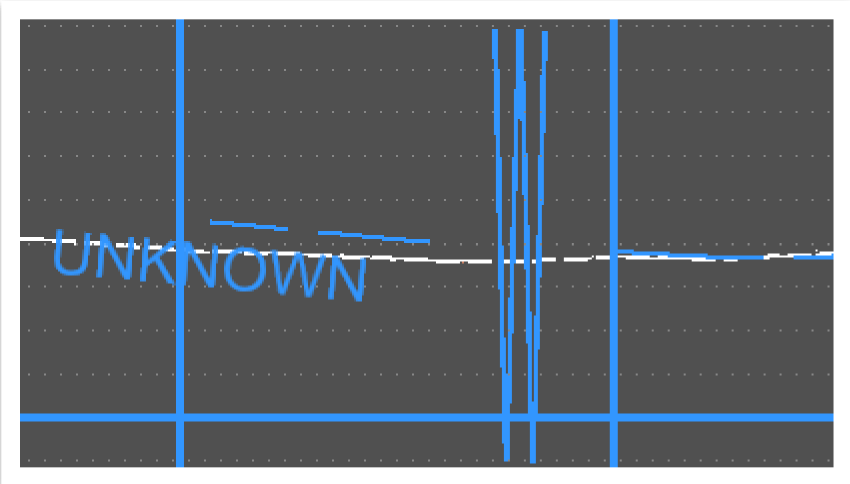
13. You should see **Default**, **Default 3-D**, **Kirby Rd Existing Profiles** and **Kirby Rd Existing Profiles [Sheet]**. Go ahead and double click on the **Kirby Rd Existing Profiles** <u>drawing</u> model to make it active.



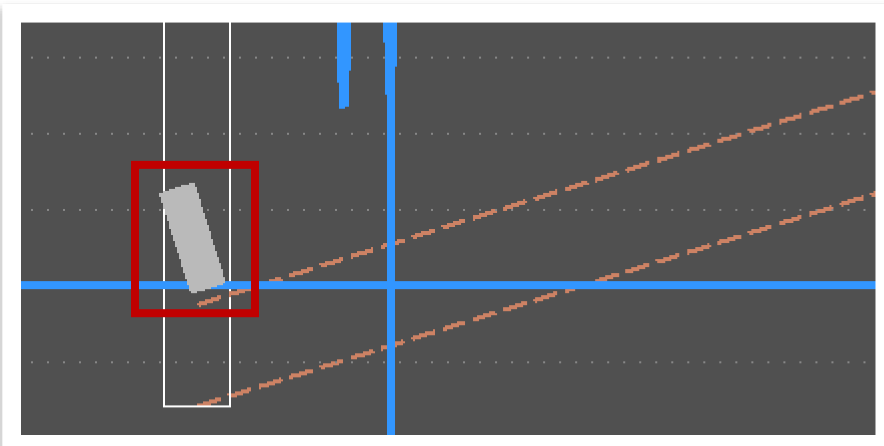
14. You should see the image below. All annotation will be added here for the existing profile features.



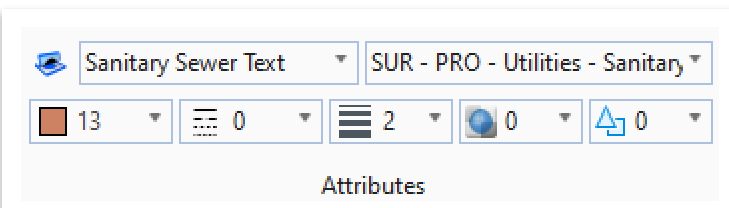
15. Zoom in to the beginning of the **water** line and notice that an **UNKNOWN** label was placed automatically when the profile drawing model was created. Remember, we selected the **Unknown** feature definition earlier when we projected this line since no pipe size was included in the survey. The automatic label is based off the selected feature definition when projecting the utility onto the centerline. **Note:** There is a defect logged with Bentley on projected profile label placement. <u>The utility annotation (profile view) has also been setup to label the size every **500'**, including the beginning and ending points</u>.



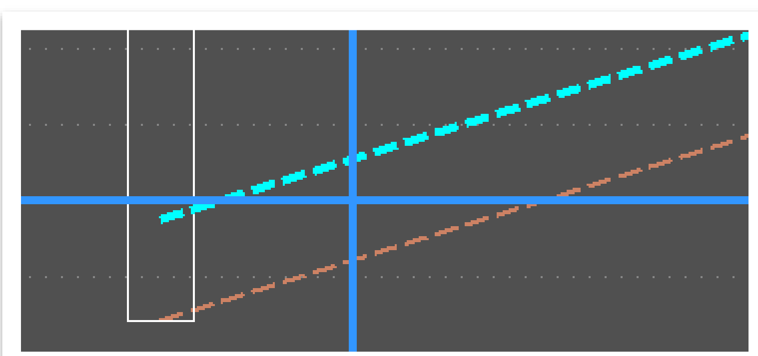
16. Ideally, the existing **SA** line would also be automatically annotated based on the utility pipe size and type, as well as the cross-drain with the pipe size and invert elevation. The automatic profile annotation for a **modeled** utility does not work in the current software version, so there is a defect logged with Bentley. Visually, you will notice the grey field background shown below at the beginning of the **SA** line, indicating a linked label that did not populate. We are working with Bentley on all annotation issues that stem from the software. **Note:** The hide field background toggle was turned off just for this screenshot.



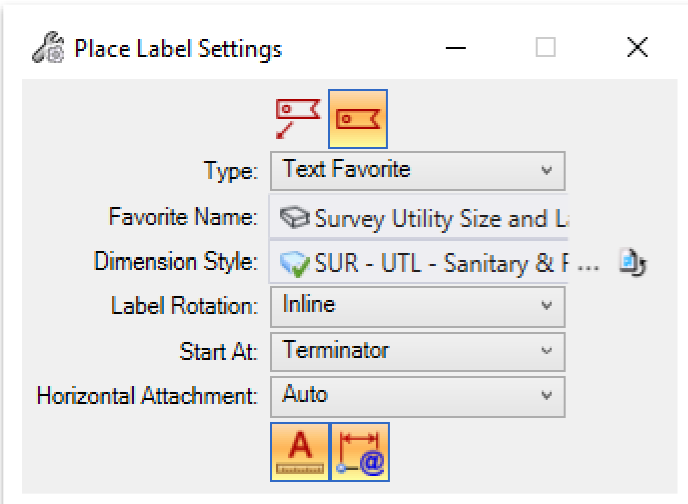
17. In the interim, you can use the labeling tool to add labels for **modeled** utilities in profile view. First, select the **Sanitary Sewer Text** element template (**Survey >> Annotation >> Utilities >> Underground >> Profile**).



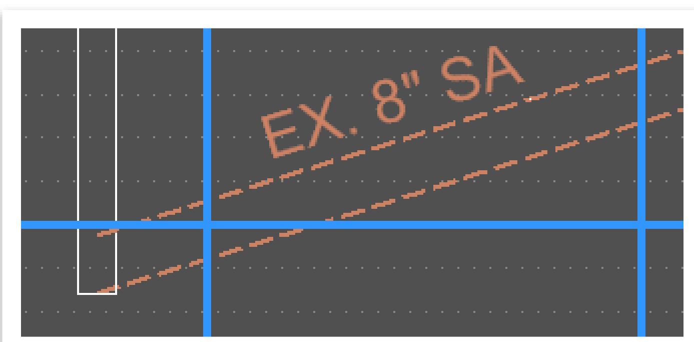
18. Next, using the **Element Selection** tool, select the top of the **SA** line.



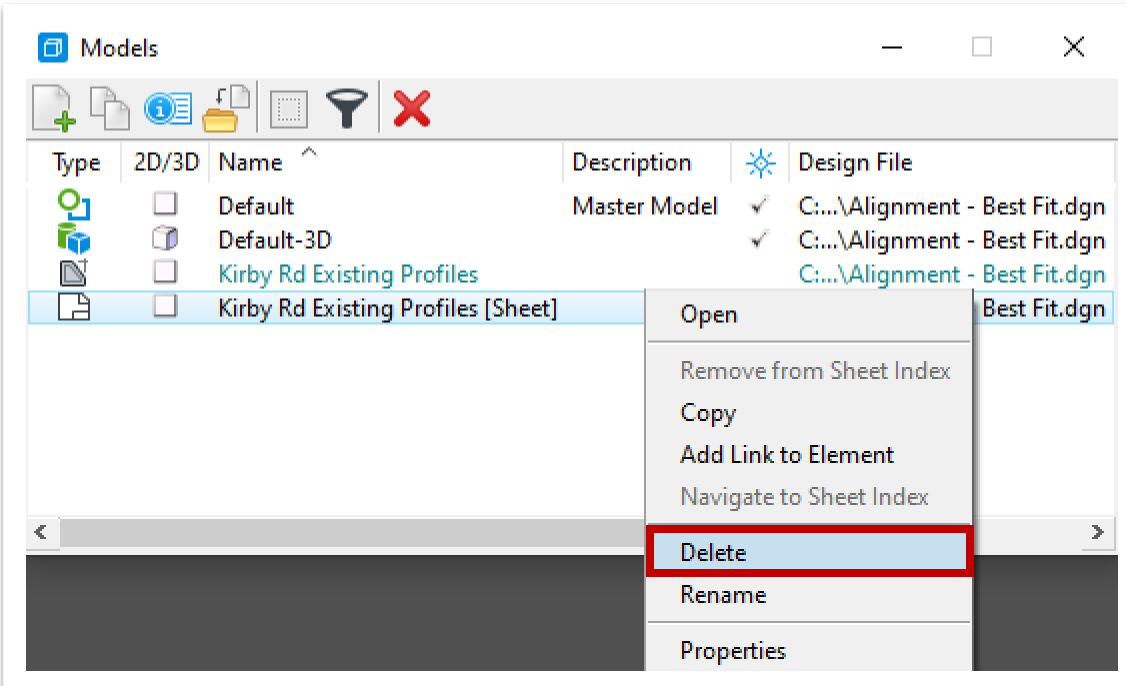
19. Now, open the **Place Label** tool once again (**Survey >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings and leave the others as default.
    a. Select the **non-leader** icon at the top
    b. **Type:** Text Favorite
    c. **Cell Name:** Survey Utility Size and Label (SA)
    d. **Dimension Style:** SUR - UTL - Sanitary & FMS
    e. **Label Rotation:** Inline



20. Notice the prompt in the lower left corner: **Select Point Location**. Snap anywhere along the top of the **SA** line and then rotate the label accordingly for placement, as shown below.



21. As mentioned earlier, the sheet model is primarily used for printing. Within the Models window, go ahead and delete the **sheet** model by right clicking on it and selecting **Delete**. Click **Yes** when the **Alert** appears asking if you are sure you want to delete the sheet model.



Take Note!

*Surveyors will need to create a profile **drawing** model along each existing alignment in which utilities need to be shown. Designers will then take the survey profile(s) and utilize them when creating the proposed profile sheets.*

*Profile **drawing** models are shown by default with the grid and a dark gray background and serve as the location for annotation.*

*With the profile drawing model open, you can open a 2nd view and reference in the **survey model dgn** file, and then click **fit view** and zoom into the plan elements, if desired.*

Chapter 6. Survey Drainage Elements

Within any TDOT survey, there are other drainage and hydraulics related elements (plan and profile) that need specific procedures applied in ORD prior to delivering the files to design. The overall survey alignment file will contain the centerline profile drawing model, but also additional profiles as described in this chapter. While most of the tools have been previously described in the manual, there will be additional tools used for some procedures and thus various workflows utilized.

6.1 Objectives

At the conclusion of this chapter, participants will be able to:

1. Create a bridge sketch via point cloud and survey text files.
2. Create an existing stream alignment.
3. Add an existing box culvert crossing to profile view.
4. Create a flood plain section via survey text files and office chain creation.
5. Create a stream profile.
6. Delineate a culvert drainage area and compare to StreamStats data.
7. Annotate each element listed above after creation.

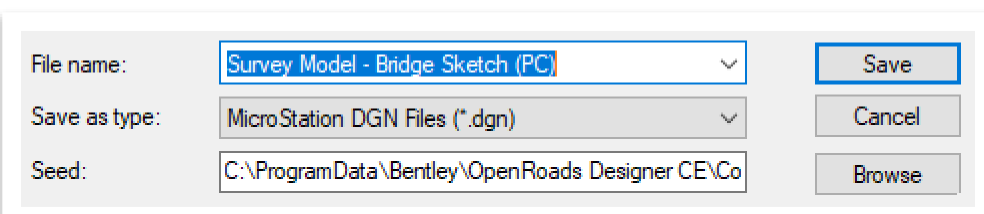
6.2 Lecture: Bridge Sketches

Bridge sketches are typically created to show the profile of existing bridges and then utilized in drainage and hydraulic analysis. With the increase of Lidar data available in Tennessee, these sketches can be created from point clouds or from the traditional survey text files. Regardless of the method, bridge sketches will essentially be profile drawing models in ORD.

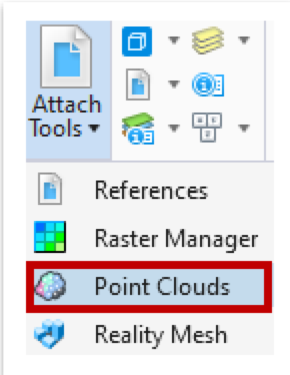
6.2.1 Exercise: Bridge Sketch – Point Cloud

In this exercise, we will create a bridge sketch via point cloud data and then create the overall profile drawing model prior to adding the applicable annotation.

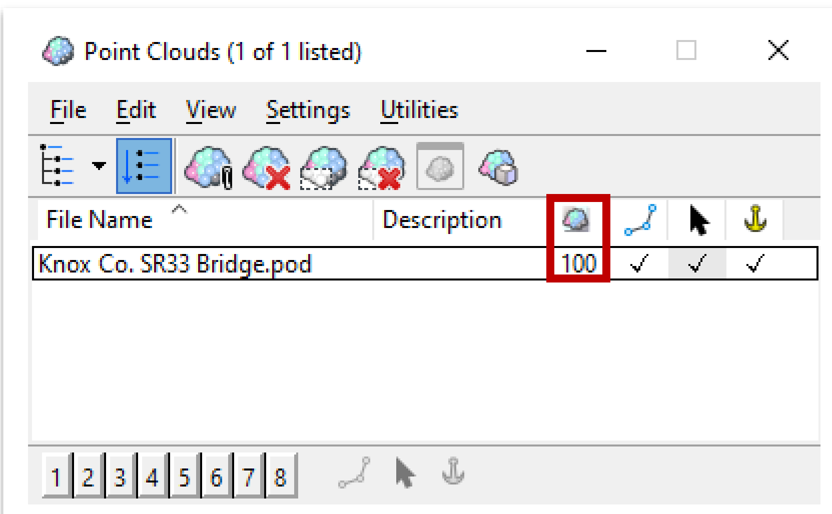
1. Create a new file and name it **Survey Model – Bridge Sketch (PC)**. Select the **TDOTSeed3D.dgn** and click **Save**.



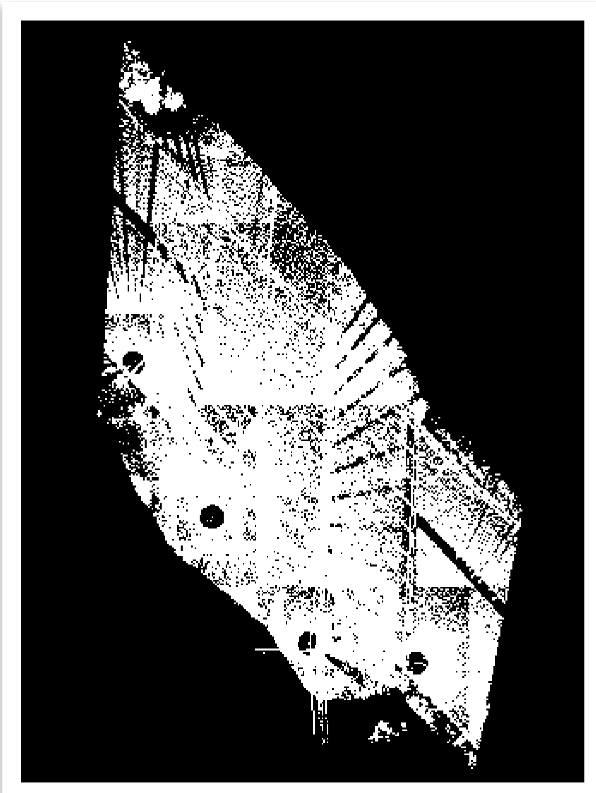
2. Next, we need to import the bridge point cloud file. Open the **Point Clouds** tool (**Survey >> Home >> Primary >> Attach Tools >> Point Clouds**).



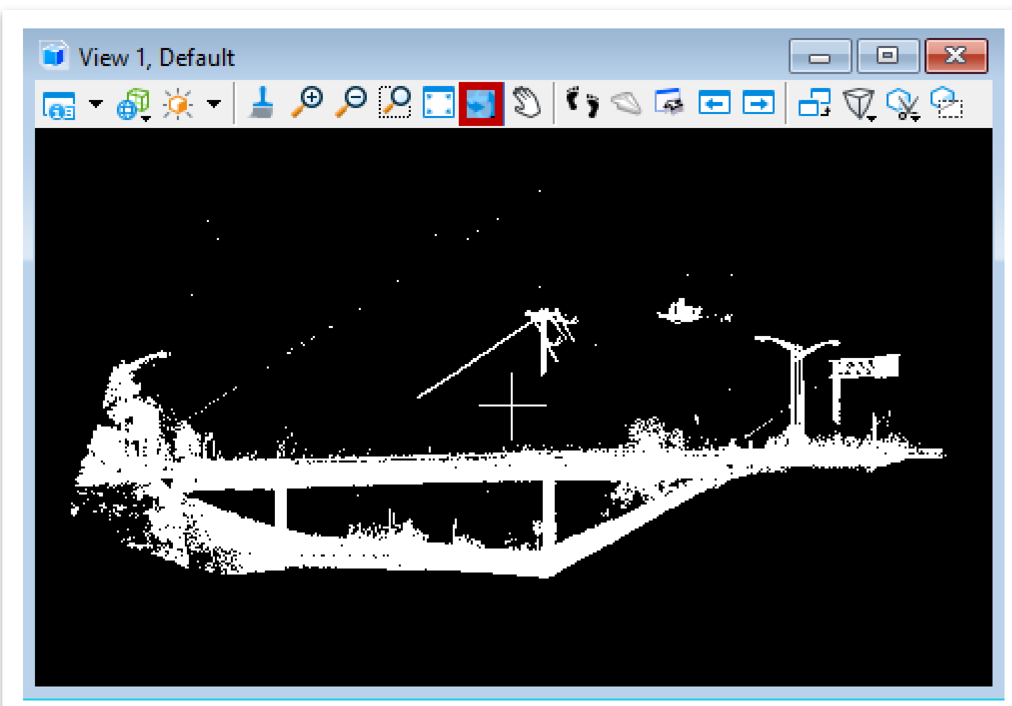
3. Within the **Point Clouds** window, go to **File >> Attach** and select the **Knox Co. SR33 Bridge.pod** file within the **SURVEY_Training** workset dgn subfolder and click **Open**. **Note:** For future reference, point cloud **Density** can be controlled in this window, as highlighted below.



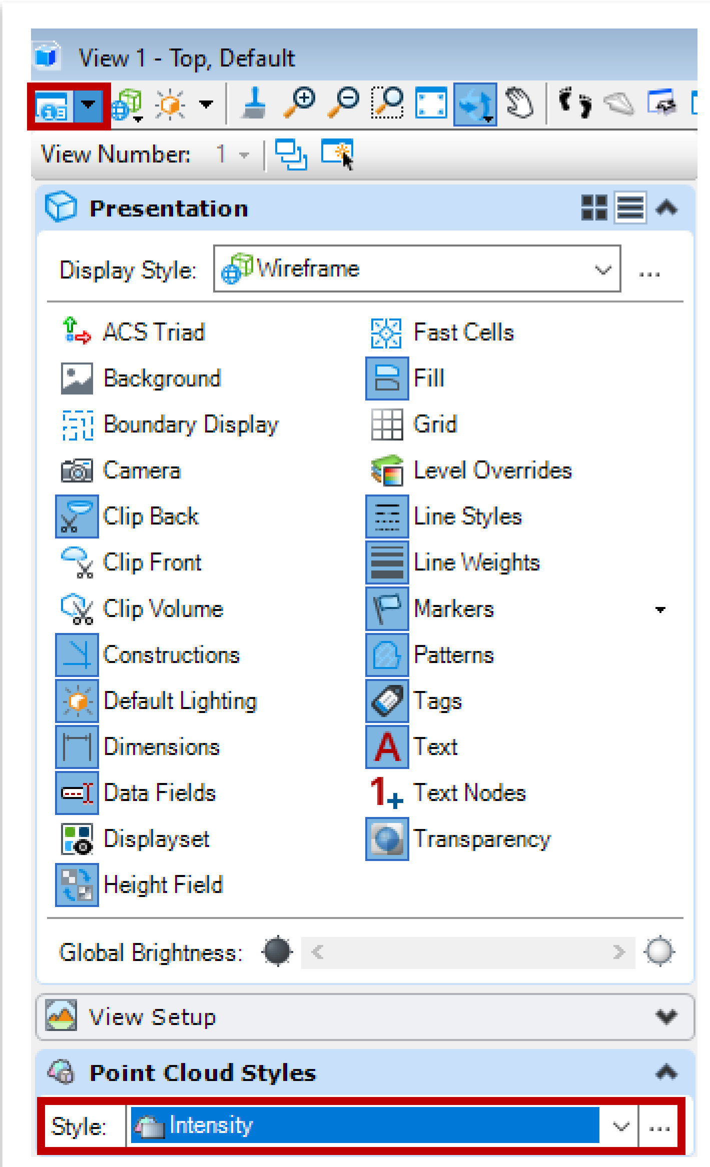
4. Click **Fit View** to visualize the point cloud.



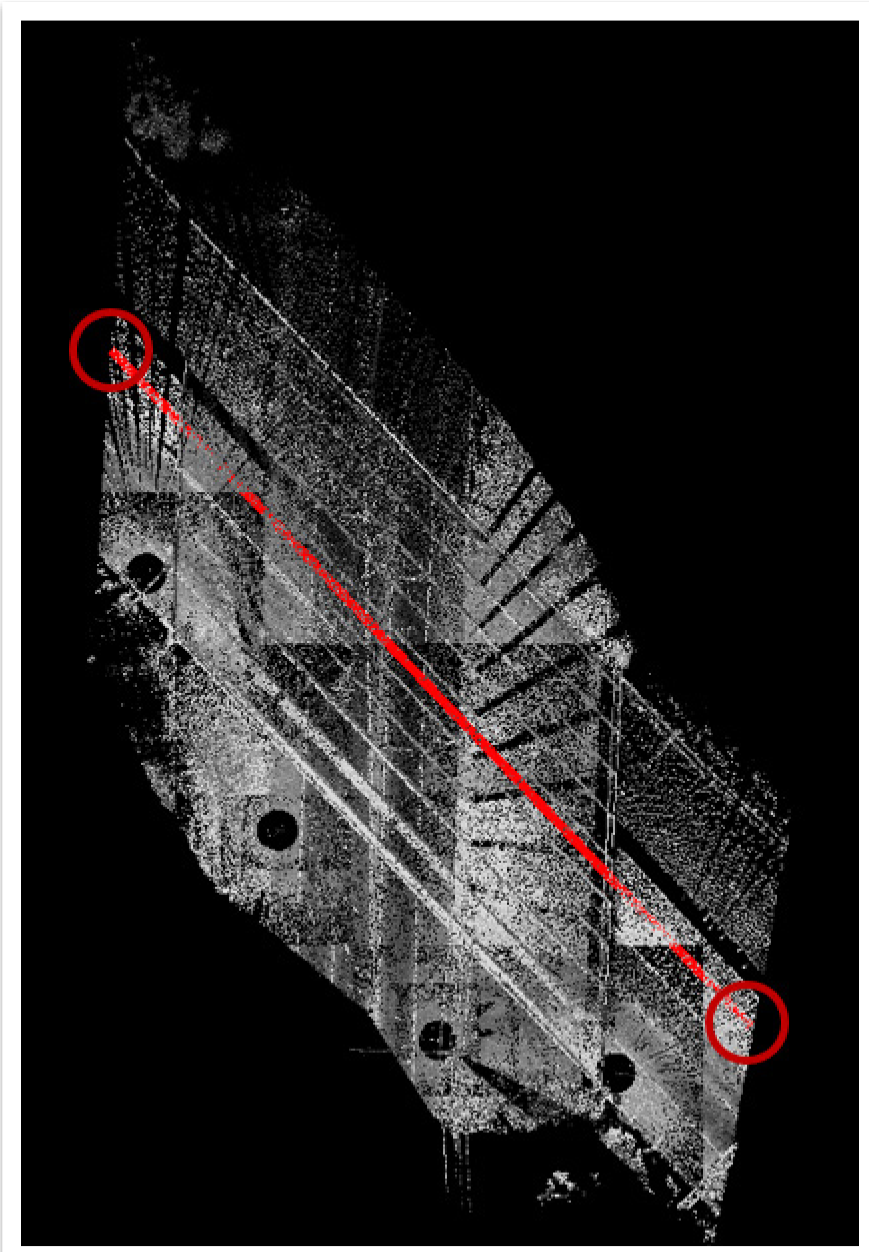
5. Now, click **Rotate View** and set the **Method** to **Dynamic**. Rotate so that you can inspect the point cloud.



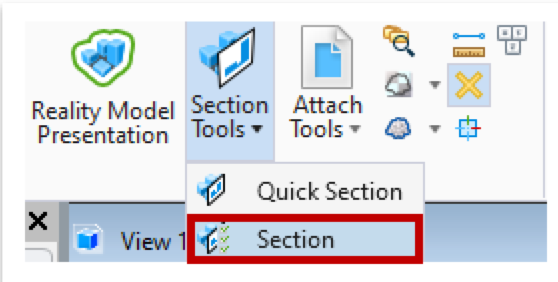
6. Next, we will utilize **smartlines** to outline some of the important features of the bridge, which will help us create a profile view later in the exercise. We need to first isolate one section of the bridge, so we don't have to deal with duplicate columns in the profile view. Go ahead and adjust the **Point Cloud Style** to **Intensity** so you can see the bridge beams better.



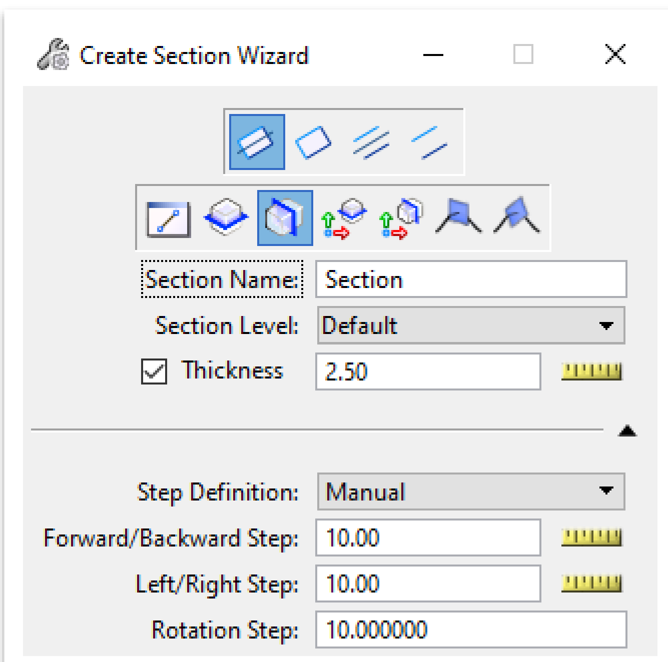
7. Open the **Place SmartLine** tool (**Survey >> Drawing >> Placement**). Draw a line along the center of the bridge point cloud so that it defines a relatively straight section. Do not snap to any of the point cloud points, otherwise the profile will not work correctly. The line has been colored for the purpose of the screenshot, but it is not necessary to set any symbology. **Note:** Rotate your view accordingly. The view below was rotated via the **Top** method and has a point could **Density** of **50**.



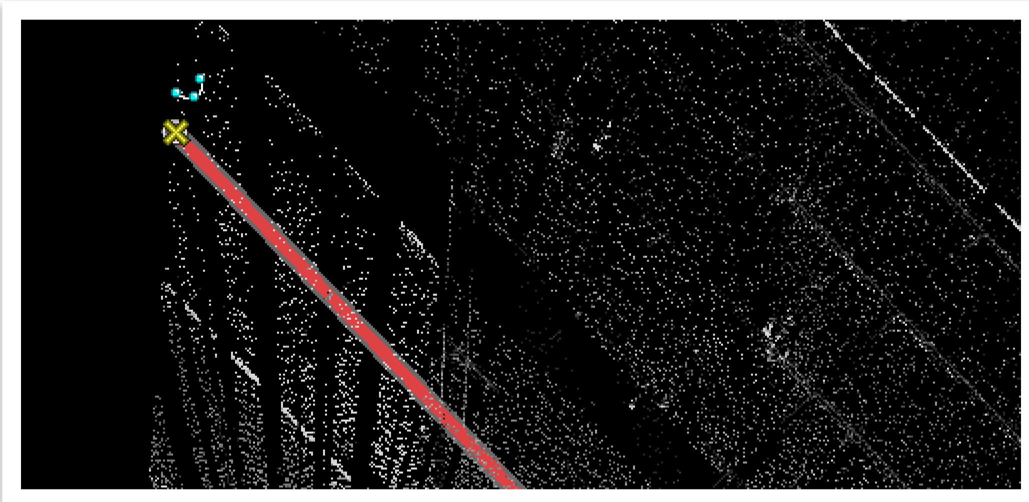
8. Now, let's switch to the **Reality Modeling** workflow in the upper left corner so we can cut a section along the smartline that was just placed. Open the **Section** tool (**Reality Modeling >> Home >> Primary >> Section Tools**).



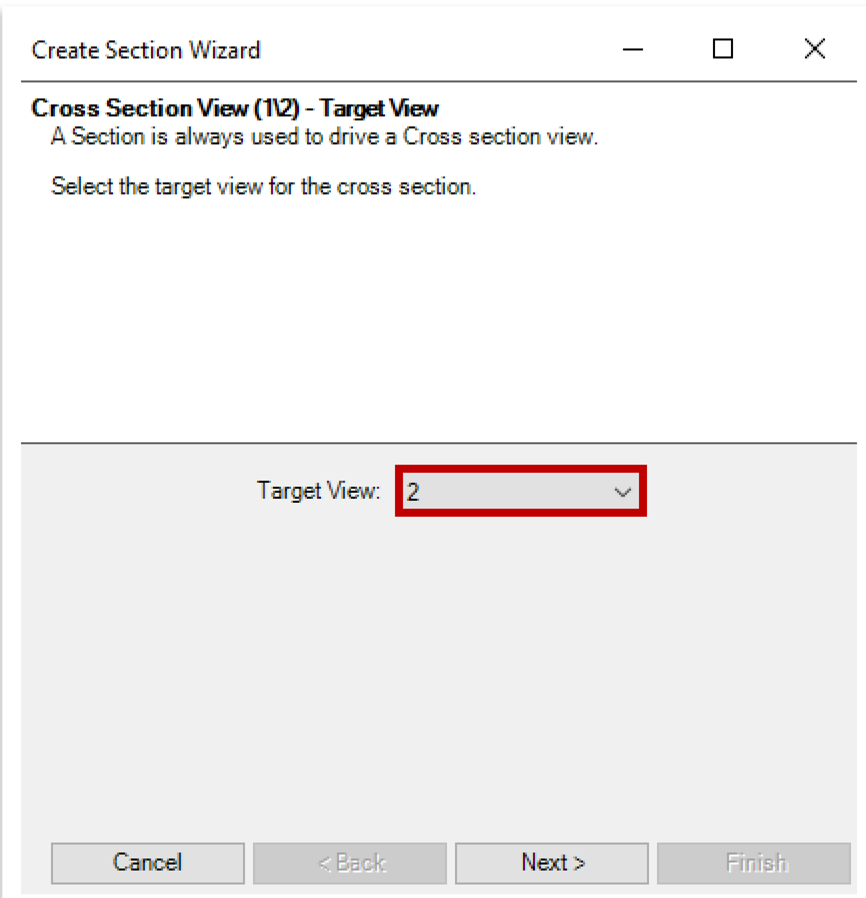
9. Within the **Create Section Wizard** dialog box, select the following settings.
    a. **Section Name:** Section
    b. **Section Level:** Default
    c. **Thickness:** 2.50
    d. **Step Definition:** Manual
    e. **Forward/Backward Step:** 10.00
    f. **Left/Right Step:** 10.00
    g. **Rotation Step:** 10.000000



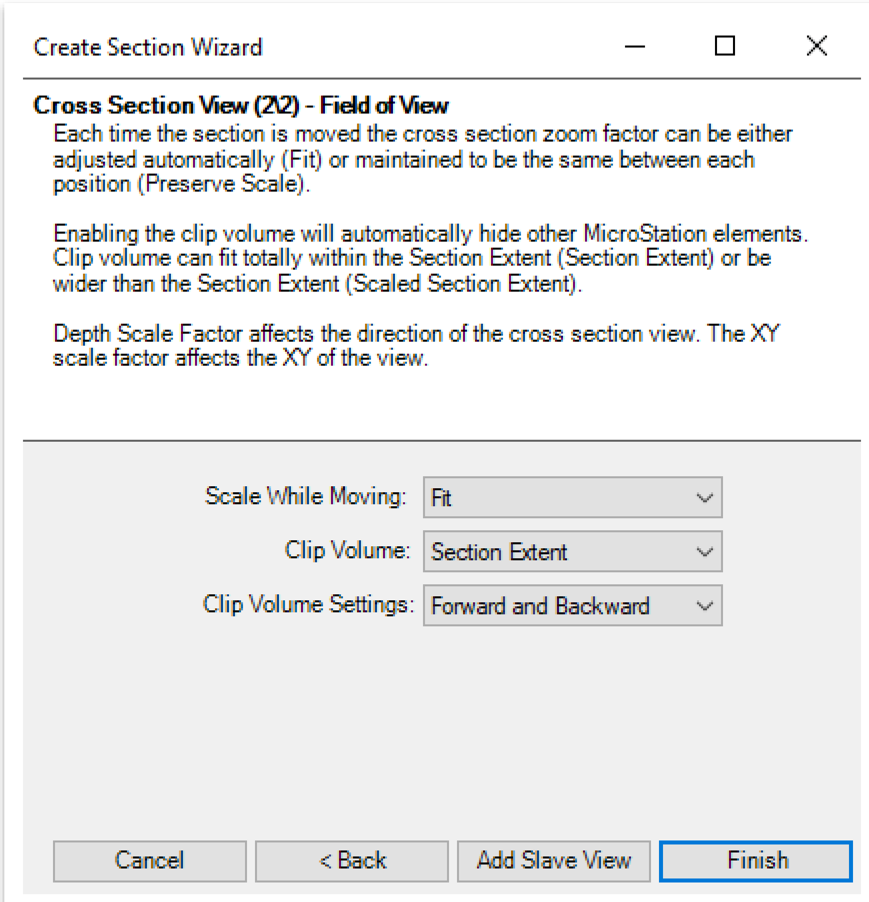
10. Notice the prompt in the lower left corner: **Enter first point on plane**. Snap to the left end of the smartline that you previously drew.



11. Notice the next prompt in the lower left corner: **Enter second point on plane**. Snap to the opposite end of the smartline which should automatically open the **Create Section Wizard**. Select **Target View 2** and click **Next**.

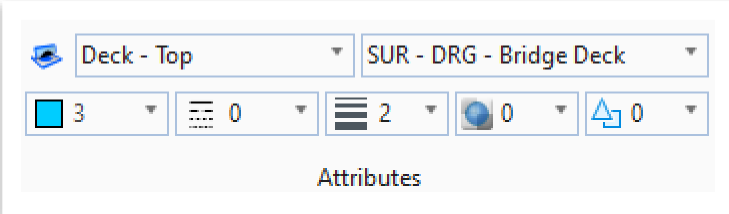


12. Then, select the following settings and click **Finish**.
    a. **Scale While Moving:** Fit
    b. **Clip Volume:** Section Extent
    c. **Clip Volume Settings:** Forward and Backward

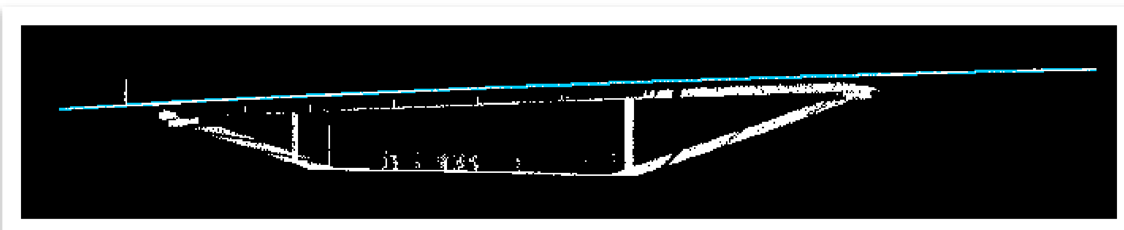


13. **View 2** should open automatically, and you should see a **section** view of the bridge.

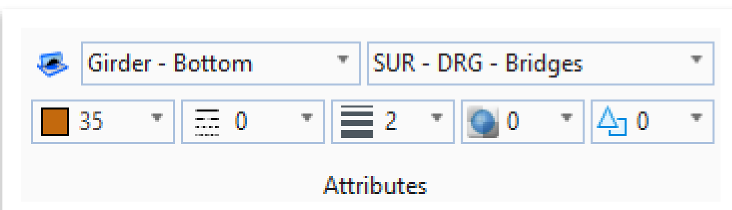
14. We will now begin drawing our lines for the profile in **View 2**. First, select the **Deck - Top** element template (**Survey >> Drainage >> Bridge >> Bridge Sketch**).



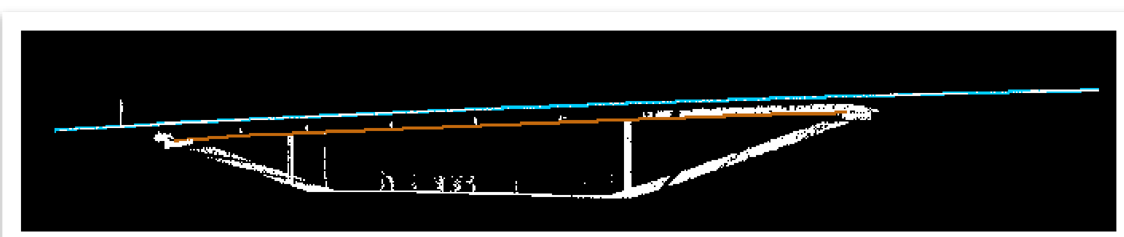
15. Then, switch back to the **Survey** workflow in the upper left corner and open the **Place SmartLine** tool once again (**Survey >> Drawing >> Placement**). Trace the top of the point cloud from one end to the other. Once you complete the smartline, you should see a light blue line along the top of the bridge. **Note:** The **Deck Top - Line** must be more than 2 vertices.



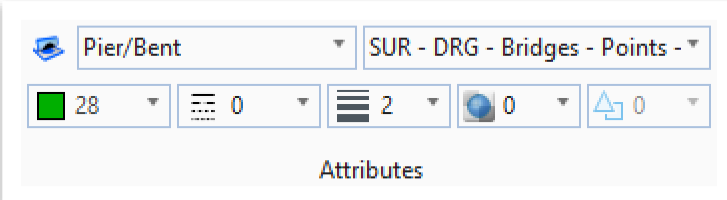
16. Next, we will repeat the same process for the bottom of the bridge. First, however, select the **Girder - Bottom** element template (**Survey >> Drainage >> Bridge >> Bridge Sketch**).



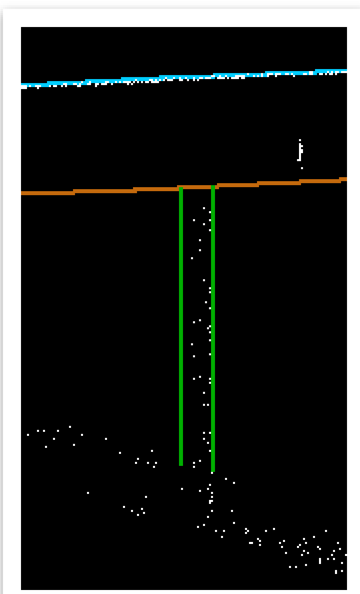
17. Once you complete the smartline, you should see an orange line along the bottom of the bridge.

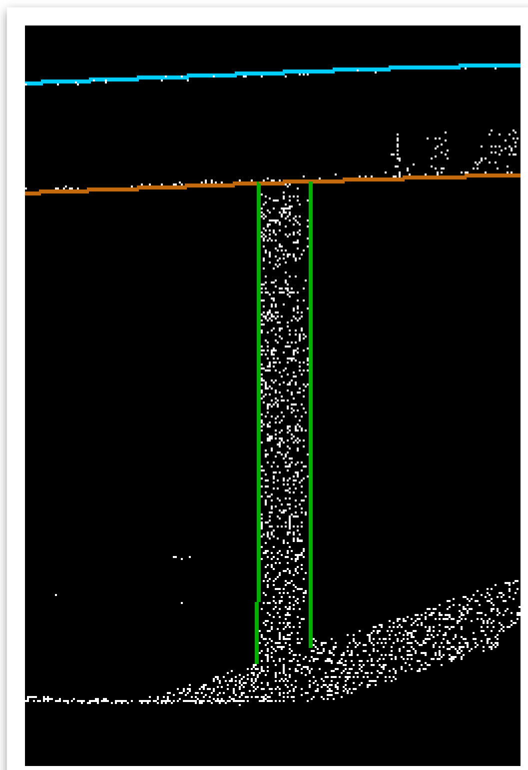


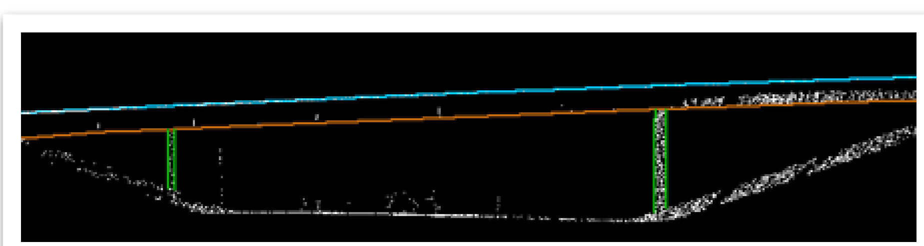
18. Now we will draw smartlines to represent the **column** extents. Select the **Pier/Bent** element template (**Survey >> Drainage >> Bridge >> Bridge Sketch**).



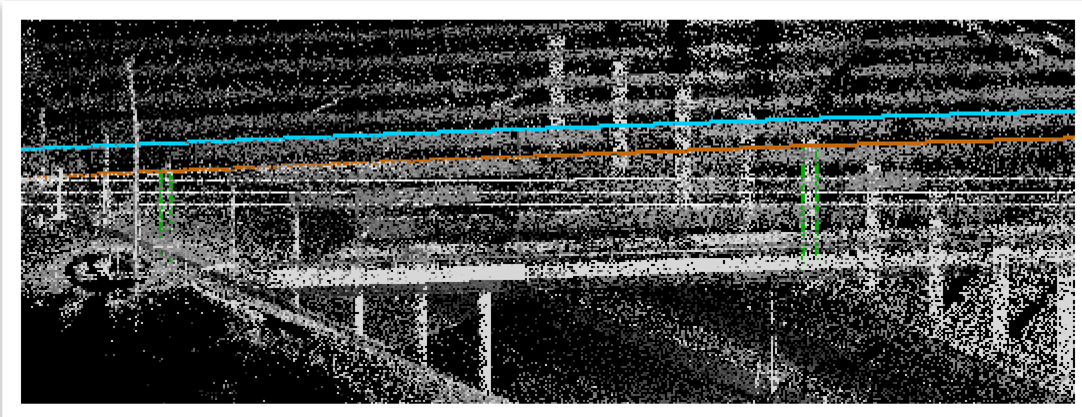
19. Draw a **SmartLine** for each side of the columns, totaling **4** smartlines. A close-up of the left and right columns is shown below, followed by an overall extent. <u>The column extent lines **cannot** be vertical or else the software will crash in an upcoming step</u>. They can be a singular line but must slightly taper. **Note:** You may want to turn on **AccuDraw** for easier control of the lines. Also, the point cloud **Density** was lowered to **10** for this screenshot.



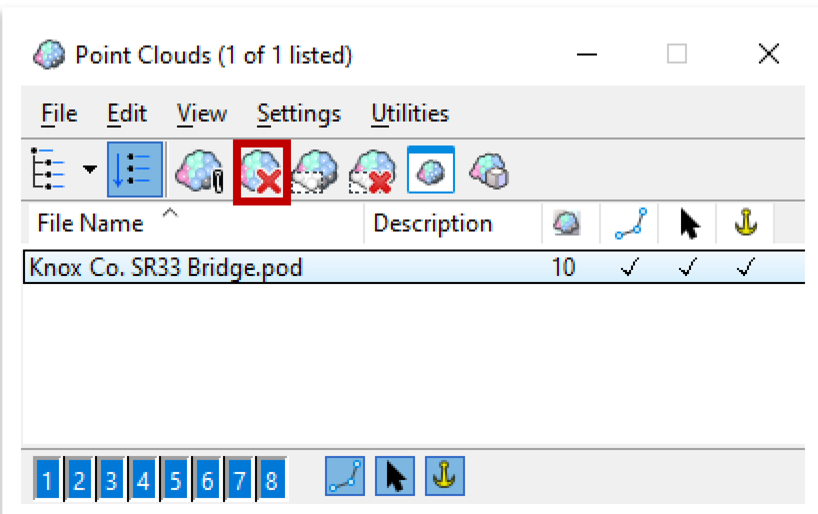




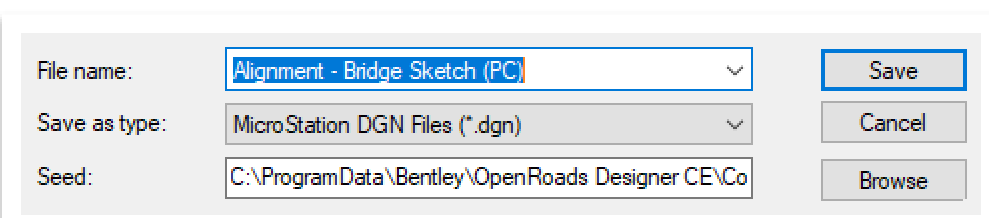
20. Go ahead and close **View 2** and then rotate the view **dynamically** in **View 1** to verify line placement.



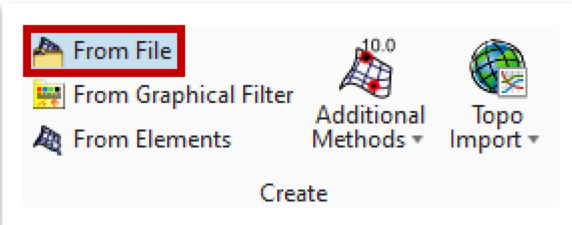
21. Once you have confirmed that the lines look correct, highlight the pod file within the **Point Clouds** window and click **Detach**, and then close the window and save the file. We are now finished with the extraction process.



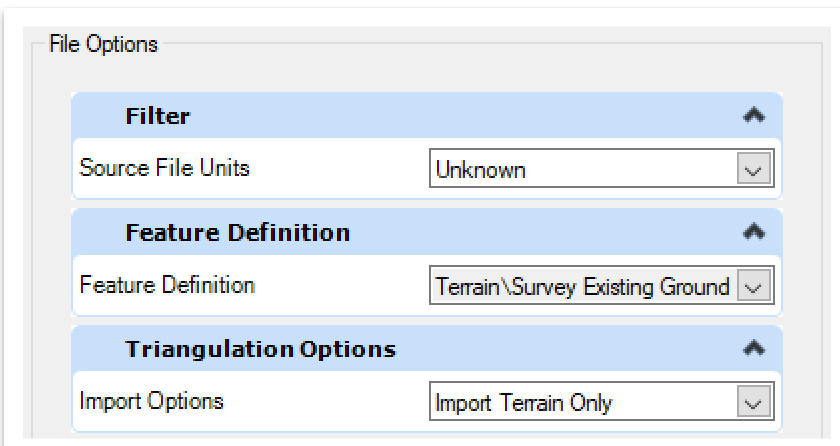
22. Now we need to convert the 3D elements into **2D** elements. Let's create a new file and name it **Alignment – Bridge Sketch (PC)**. Select the **TDOTSeed2D.dgn** and click **Save**. **Note:** The bridge sketch would likely be a profile model within the overall 2D survey alignment file but has been separated out for the purpose of training.



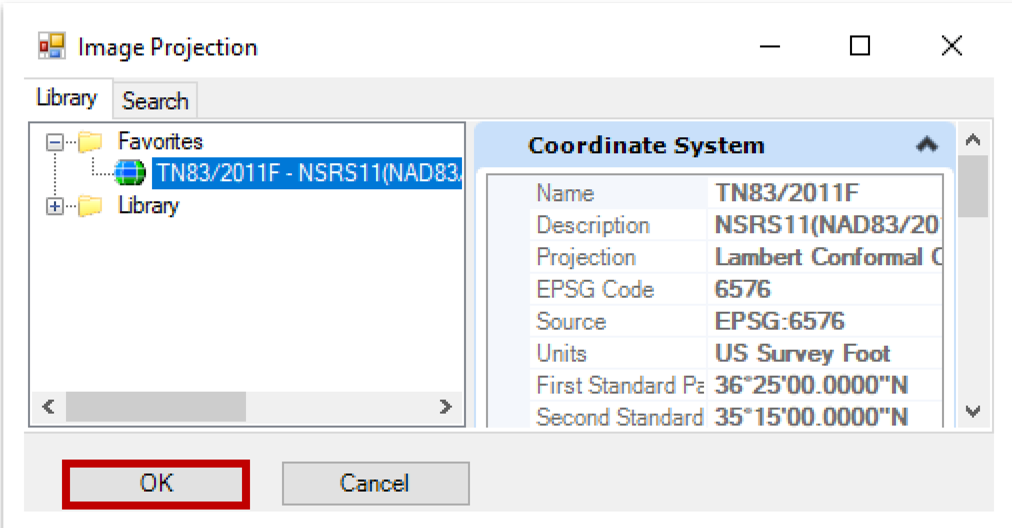
23. Go ahead and switch to the **OpenRoads Modeling** workflow. First, we need to attach the surface. Open the **From File** tool (**OpenRoads Modeling >> Terrain >> Create**).



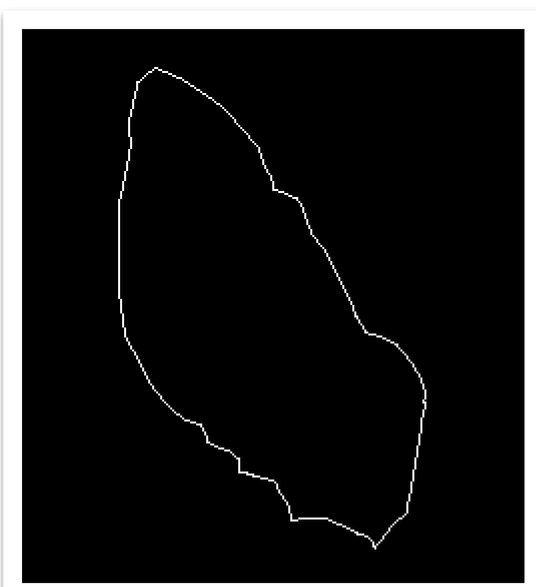
24. Select the **Knox Co. SR33 Bridge.tin** file within the **SURVEY_Training** workset dgn subfolder and click **Done**. Within the **Import Terrain Model(s)** dialog box, skip down to **File Options**.
25. Under **File Options**, select the following settings.
    a. **Source File Units:** Leave as-is. This field will take care of itself and disappear once the geographic coordinate system is selected in the next step.
    b. **Feature Definition:** Terrain\Survey Existing Ground
    c. **Import Options:** Import Terrain Only



26. Under **Geographical Coordinate Systems**, click the ellipses next to the **Source** field. You should already have the correct coordinate system saved as a Favorite (**TN83/2011F – NSRS11 (NAD83/ 2011) Tennessee State Plane Zone, US Foot**) from earlier in the manual. If not, you can browse to it here: **Library >> Projected (northing, easting, …) >> North America >> United States of America >> Tennessee**. Once selected, click **OK**.

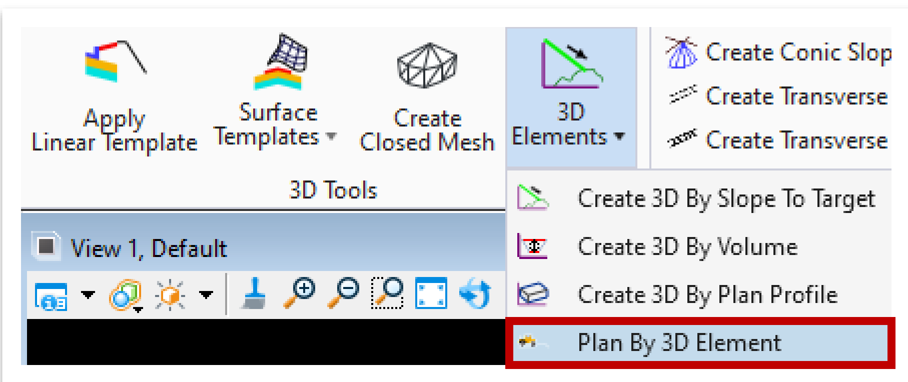


27. Next, click **Import** and then close the **Import Terrain Model(s)** dialog box once processed. Click **Fit View**, turn the **triangles** off and set the terrain to **Active**. **Note:** The white terrain boundary in this 2D file is adequate for this exercise, but if you wanted to view the entire terrain in a 3D model, you would create a 3D file and import the TIN in the same manner.

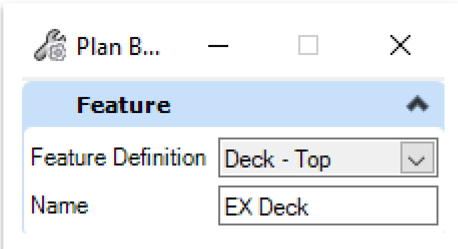


28. Go ahead and attach the previously created file (**Bridge Sketch – Point Cloud.dgn**) as a reference using the **Coincident World** attachment method and then click **Fit View**. Go ahead and turn off the **Default** level in the file you just attached. You should see the light blue line representing the top of the bridge deck.

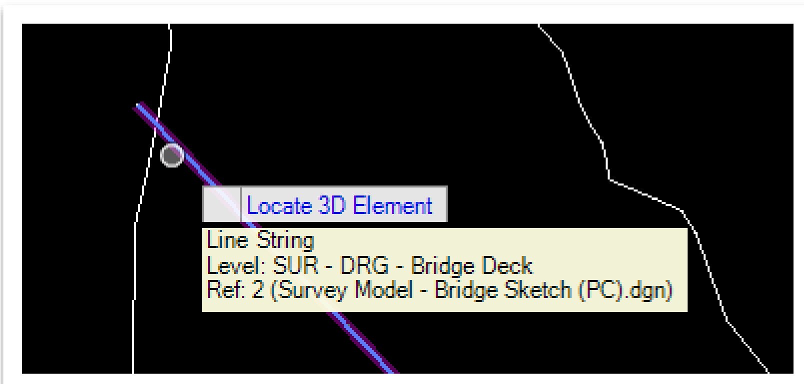
29. Open the **Plan By 3D Element** tool (**OpenRoads Modeling >> Model Detailing >> 3D Tools >> 3D Elements**).



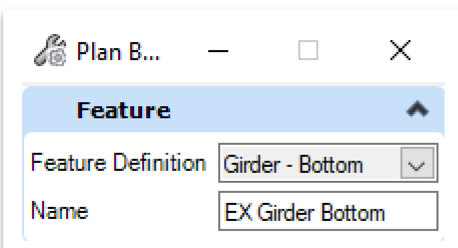
30. Within the **Plan By 3D Element** dialog box, select the **Deck - Top** feature definition (**Linear >> Structures >> Bridge Sketch >> Existing**). You can leave the default **Name** as-is for now.



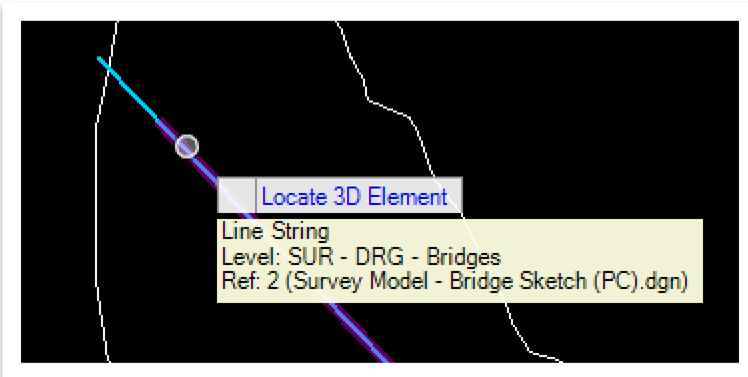
31. Notice the cursor prompt: **Locate 3D Element**. Left click on the **light blue** line representing the top of the bridge deck.



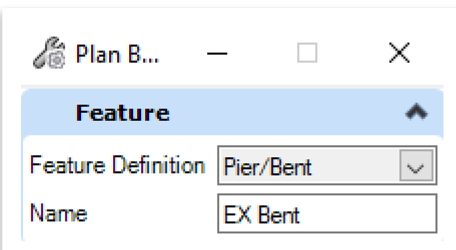
32. Next, we will apply the same process to the bottom of the bridge. Open back up the **Plan By 3D Element** tool, if not already opened, and select the **Girder - Bottom** feature definition (**Linear >> Structures >> Bridge Sketch >> Existing**).



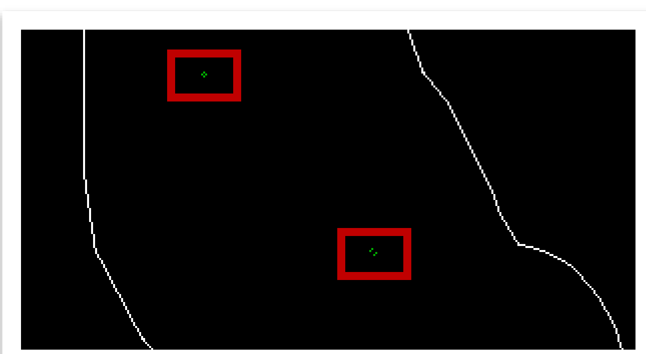
33. Once again, notice the cursor prompt: **Locate 3D Element**. Left click on the **orange** line representing the bottom of the bridge. **Note:** To identify it, right click on the line until you see the "orange" line highlighted because it is likely underneath the blue bridge deck line. Then, left click to Locate 3D Element. If that method is still problematic, turn off the **SUR - DRG - Bridge Deck** level temporarily.



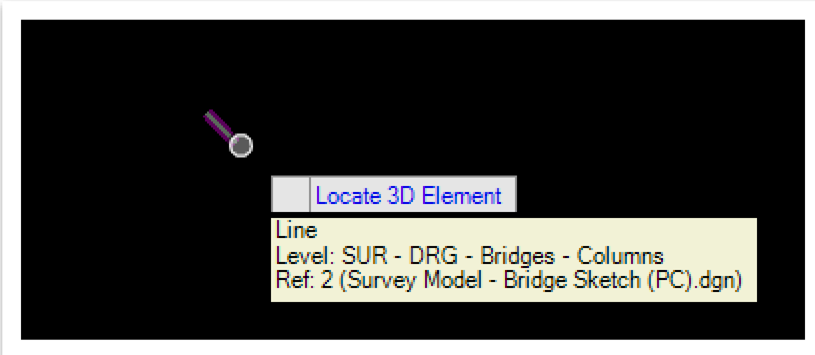
34. Lastly, we will apply the same process to the four bridge column extents. Turn off the **SUR - DRG - Bridge Deck** and **SUR - DRG - Bridges** levels in the active file and all reference files for now. The element template was setup on a different level so that the column extents would be easier to see. Then, open back up the **Plan By 3D Element** tool, if not already opened, and select the **Pier/Bent** feature definition (**Linear >> Structures >> Bridge Sketch >> Existing**).



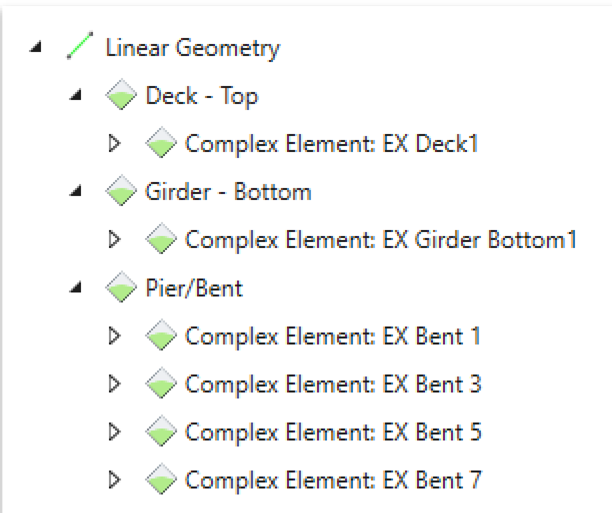
35. Zoom in until you see the two sets of two green column extents, highlighted below.



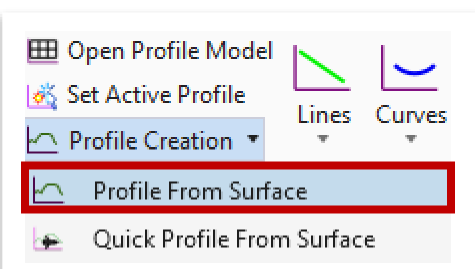
36. Once again, notice the cursor prompt: **Locate 3D Element**. Left click on each **green** column extent, one at a time.



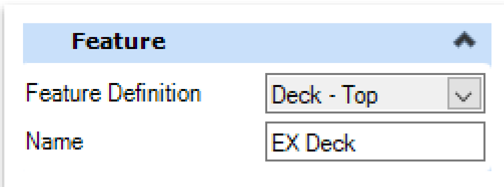
37. It will seem like nothing happened. However, within the **Explorer**, if you open the **OpenRoads Model** tab and go to **Alignment – Bridge Sketch (PC).dgn >> Linear Geometry**, you will notice that the **Deck - Top**, **Girder - Bottom** and **Pier/Bent** categories were created.



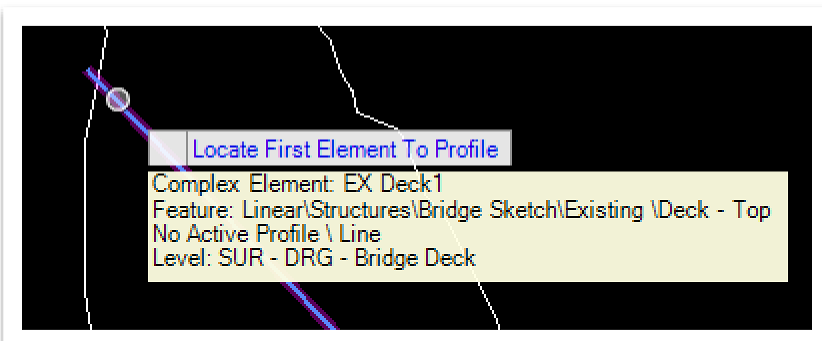
38. Go ahead and turn all levels back on (active file and reference files) other than **Default**. Then, open the **Profile From Surface** tool (**OpenRoads Modeling >> Geometry >> Vertical >> Profile Creation**).



39. Within the **Profile From Surface** dialog box, let's first set the feature settings.
    a. **Feature Definition:** Deck - Top (**Linear >> Structures >> Bridge Sketch >> Existing**)
    b. **Name:** EX Deck

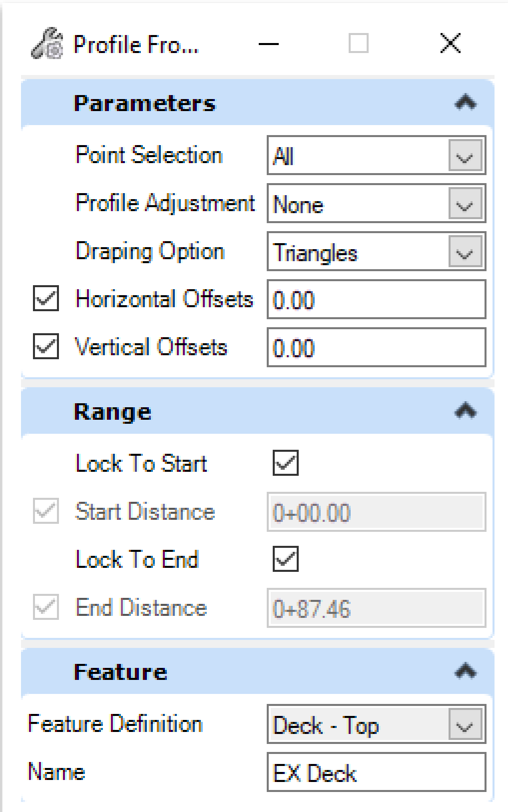


40. Notice the cursor prompt: **Locate First Element To Profile**. Select the **light blue** line representing the top of the bridge deck and then right click to reset. **Note:** Make sure to select the line on either end, as shown below, so you don't accidentally select the orange line.

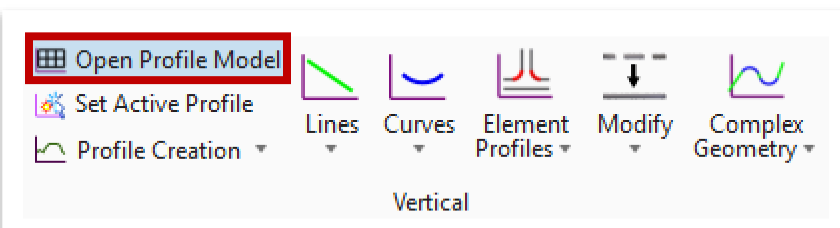


41. Notice the next cursor prompt: **Locate Reference Surface**. Select the terrain boundary and then right click to complete.

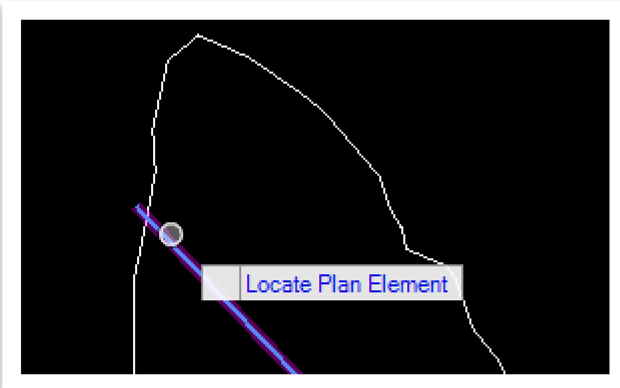
42. Go ahead and **Lock To Start** and **Lock To End**. The stations should automatically populate. Left click to accept all other default settings shown below. **Note:** Your **End Distance** will vary depending on your line length that you drew.



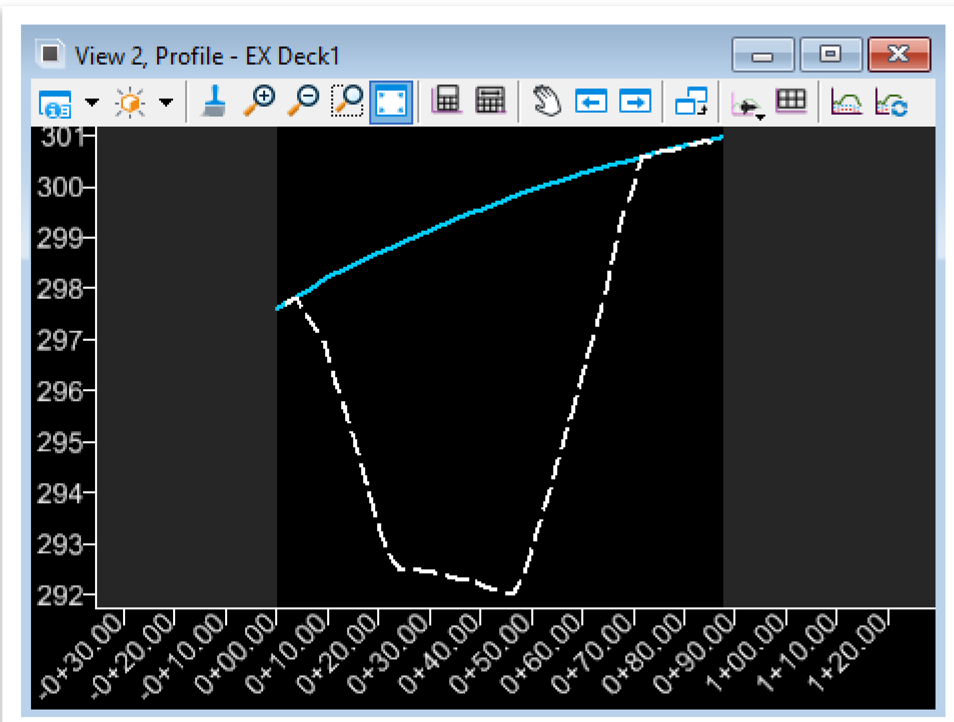
43. Next, we will view the profile of the bridge deck. Open the **Open Profile Model** tool (**OpenRoads Modeling >> Geometry >> Vertical**).



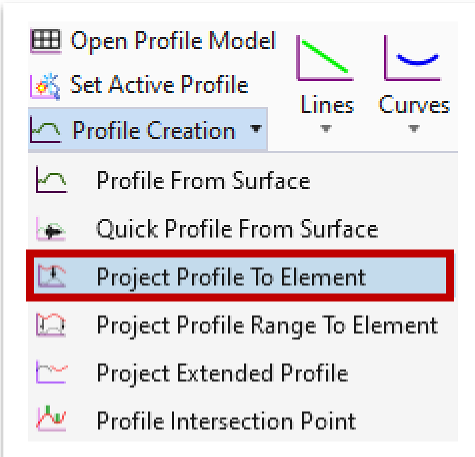
44. Notice the cursor prompt: **Locate Plan Element**. Select the **light blue** bridge deck line.



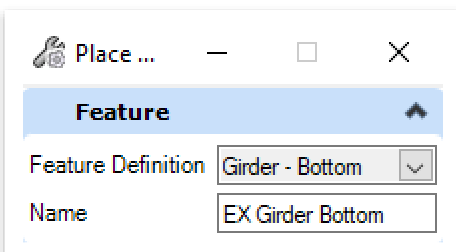
45. Open **View 2** and left click anywhere within that view. You should see the profile, as shown below.



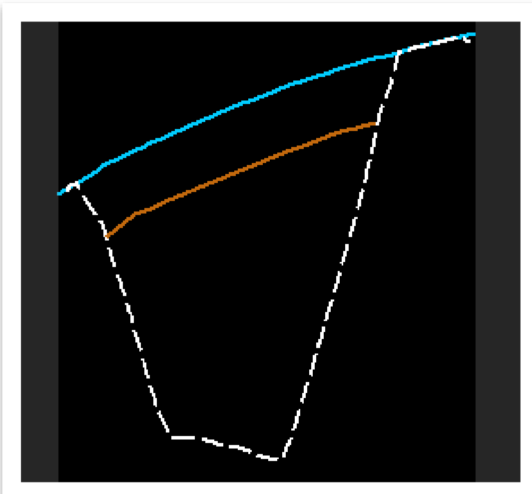
46. Now we will project the bottom of the bridge profile onto the bridge deck profile. Open the **Project Profile To Element** tool (**OpenRoads Modeling >> Geometry >> Vertical >> Profile Creation**).



47. Within the **Place Projected Profile** dialog box, select the following settings.
    a. **Feature Definition:** Girder - Bottom (**Linear >> Structures >> Bridge Sketch >> Existing**)
    b. **Name:** EX Girder Bottom



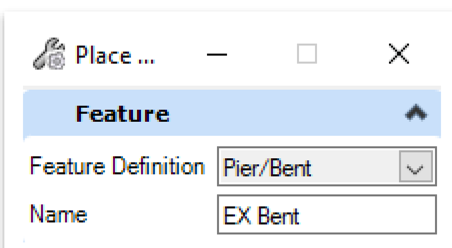
48. Notice the cursor prompt: **Select Element To Project**. Select the **orange** Girder - Bottom line and then select the **light blue** line (bridge deck). This will project the girder profile onto the bridge deck profile. **Note: View 2** should automatically update, as shown below.



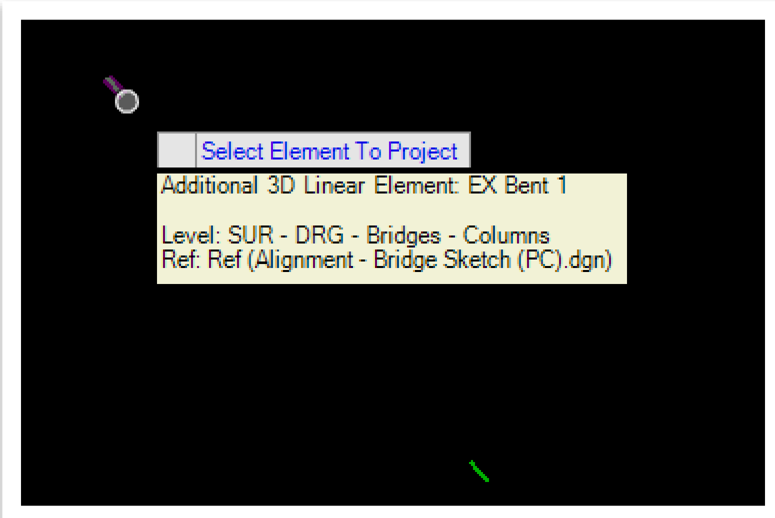
49. We are now going to project the **four** bridge column extents onto the profile using a similar process. To make it easier to see the green column extents, turn off the **SUR - DRG - Bridge Deck** and **SUR - DRG - Bridges** levels in both the active file and reference files. Open the **Project Profile To Element** tool once again (**OpenRoads Modeling >> Geometry >> Vertical >> Profile Creation**) and zoom into the first column extent. Within the **Place Projected Profile** dialog box, select the following settings.

    a. **Feature Definition:** Pier/Bent

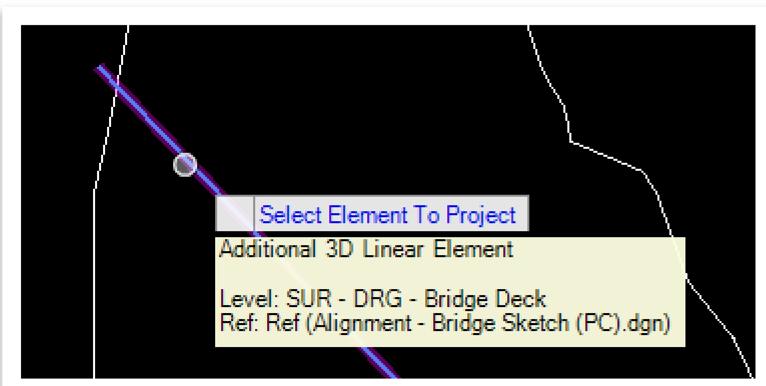
    b. **Name:** EX Bent



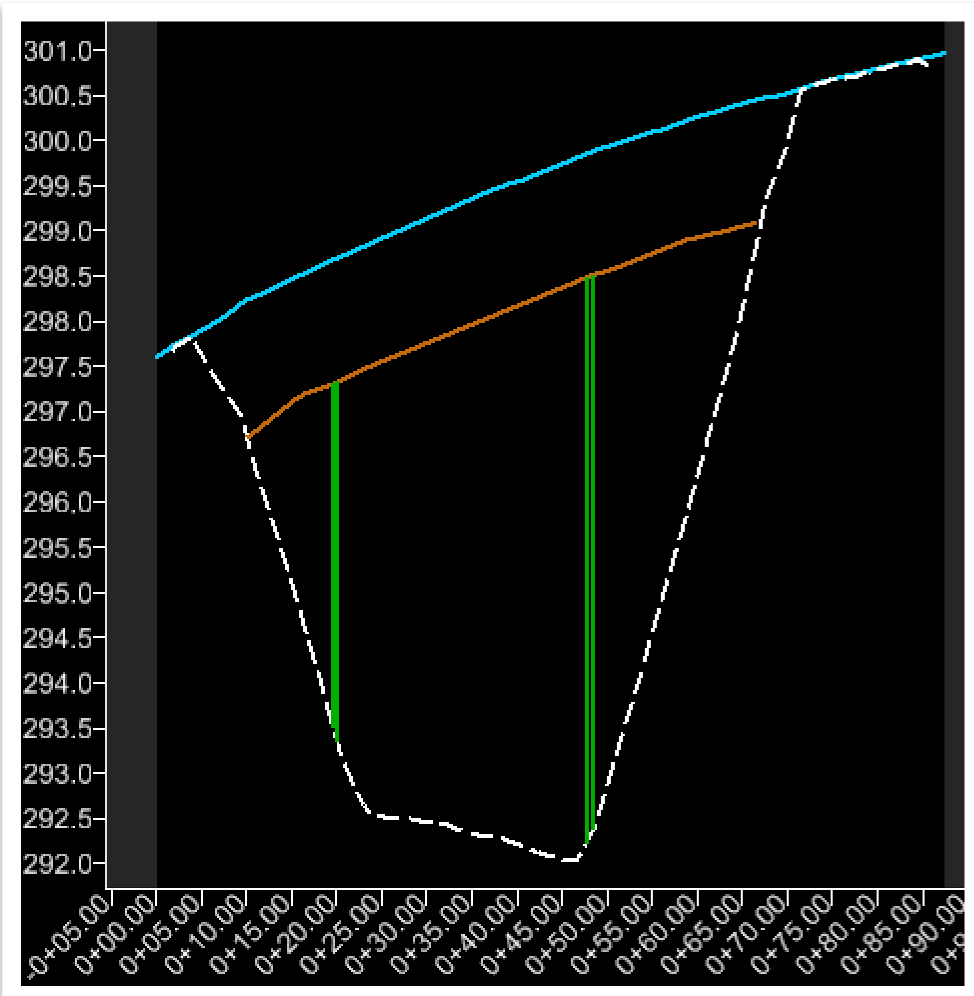
50. Notice the cursor prompt: **Select Element To Project**. Select the first column extent in plan view.



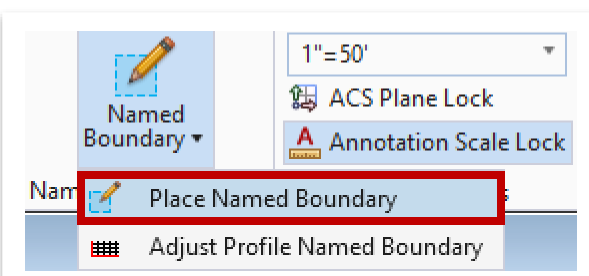
51. Then, turn on the **SUR - DRG - Bridge Deck** level within the active file and select the bridge deck line to project onto.



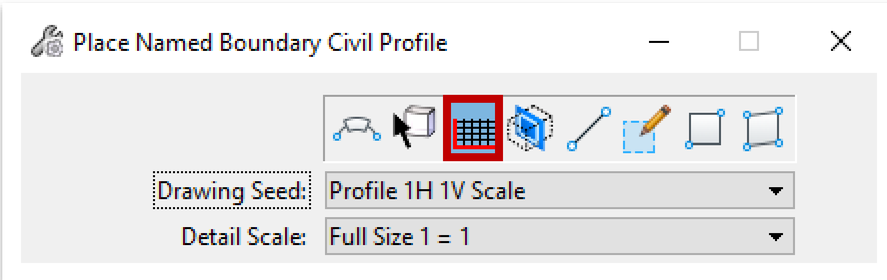
52. Turn off the **SUR - DRG - Bridge Deck** level within the active file once again and repeat Steps 50-51 to project the other 3 column extents. Review the profile once you have completed the projection.



53. As a reminder, in order to place annotation, we need to create a profile named boundary. Open the **Place Named Boundary** tool (**OpenRoads Modeling >> Drawing Production >> Named Boundaries >> Named Boundary**).

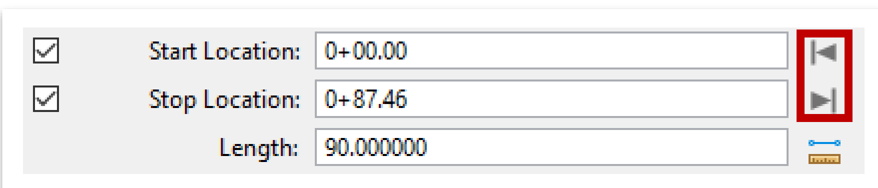


54. Make sure that the **Civil Profile** option is toggled on. Select **Profile 1H 1V Scale** for the Drawing Seed. Most of the fields should automatically populate based on the selected seed.

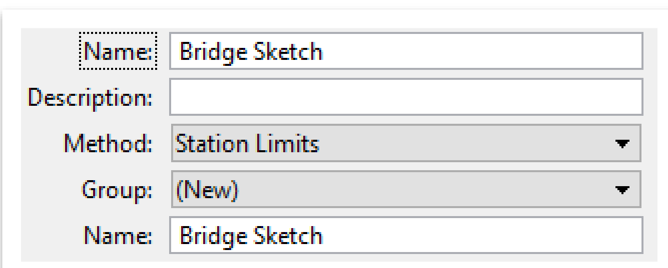


55. Notice the prompt in the lower left corner of the drawing window: **Identify Profile View**. Left click anywhere within **View 2**.

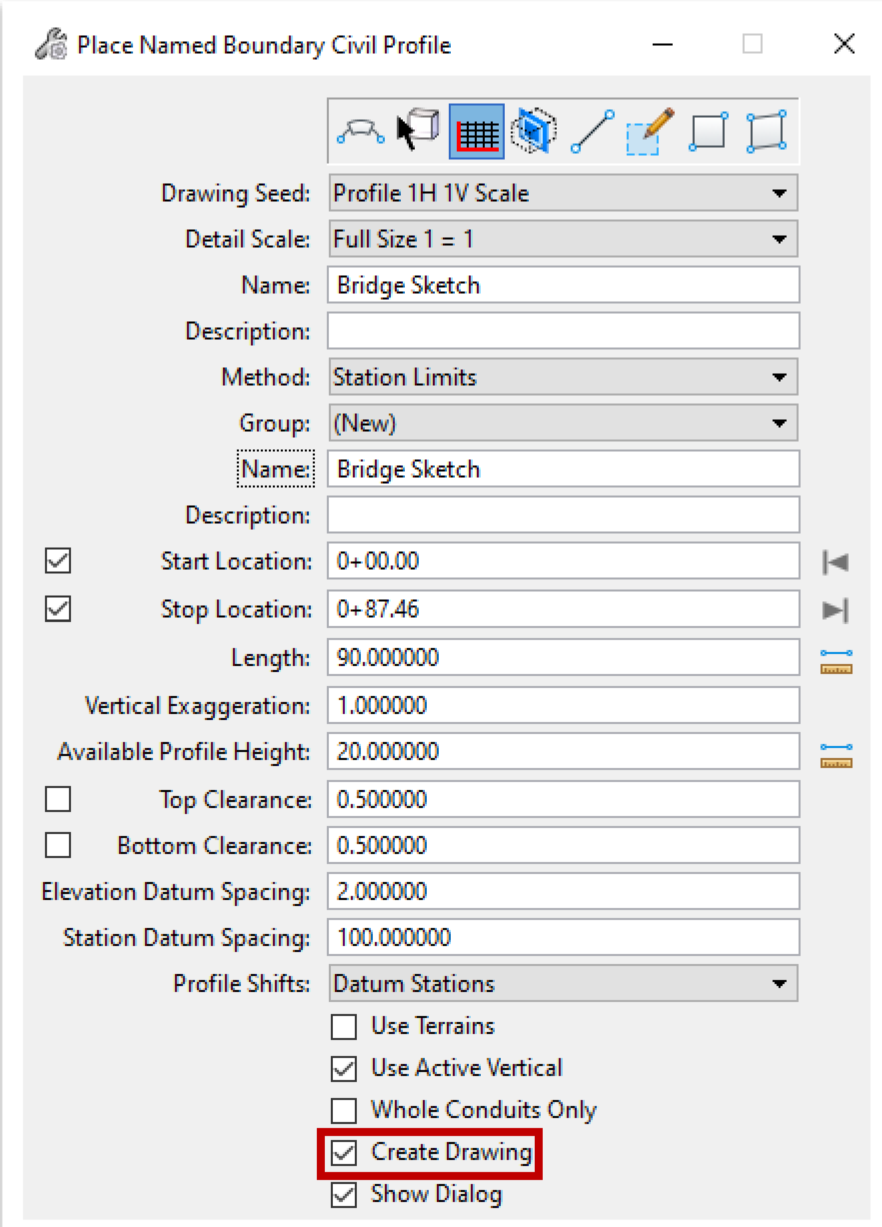
56. Use the grey arrows to lock the **Start** and **Stop Location** to the profile extents so that the entire profile is accounted for. To create one overall profile named boundary, the **Length** field will need to be adjusted based on each project length. Go ahead and edit this value to **90**'. **Note:** You cannot key-in stations until the profile view has been selected in Step 55. Also, your **Stop Location** will vary depending on the length of your centerline.



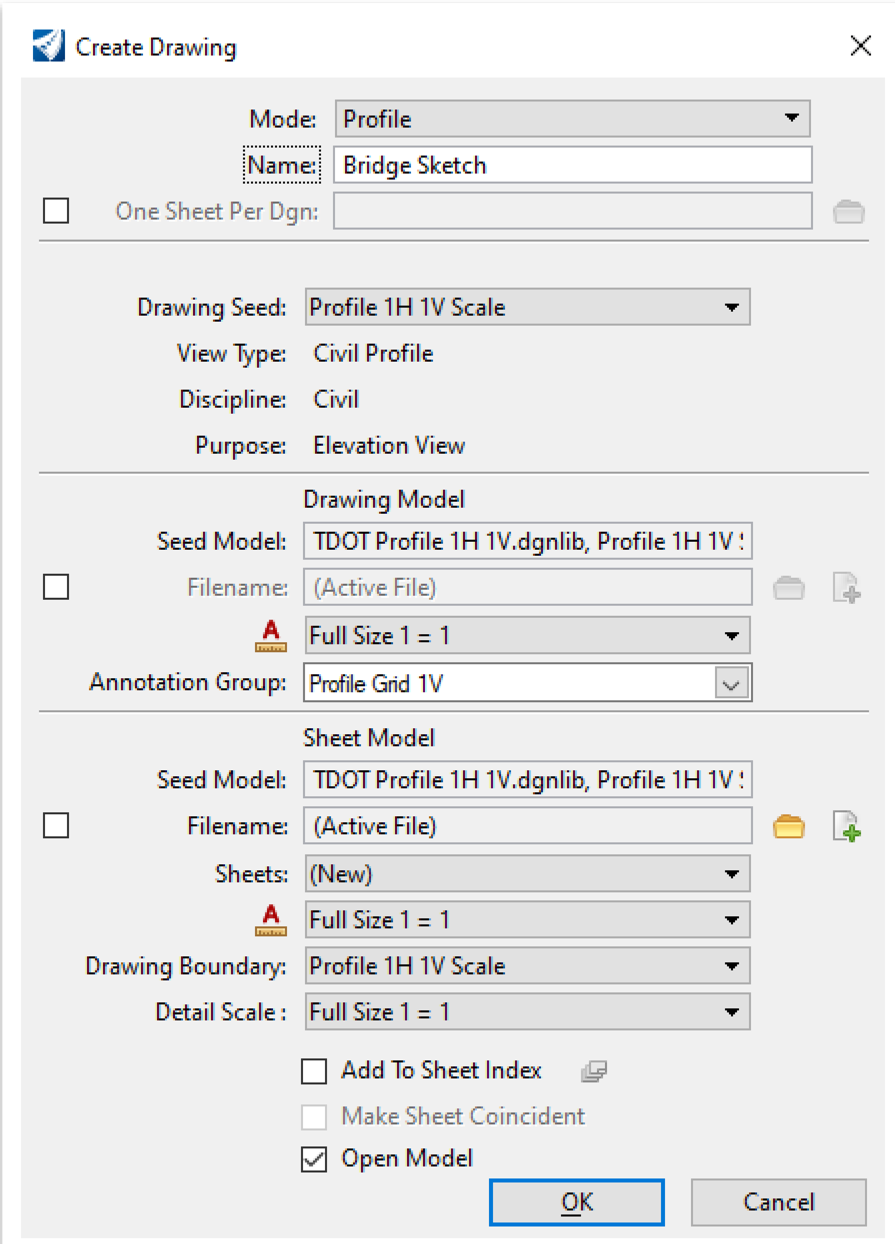
57. Key-in **Bridge Sketch** for both the **Named Boundary** name and the **Group** name.



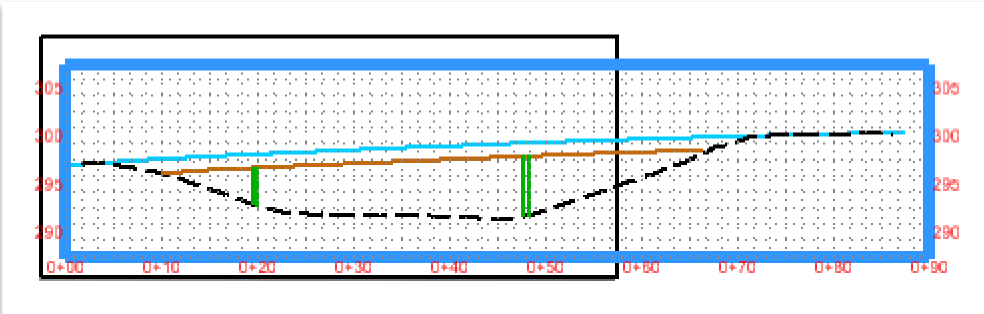
58. Leave the other default values as-is and make sure that the **Create Drawing** option is toggled on at the bottom.



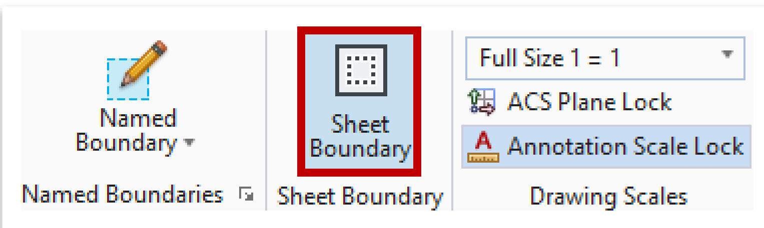
59. Left click anywhere within View 2 **three** times. Zoom out and you should see **one** profile named boundary drawn into the file, represented by a white border. The **Create Drawing** window will appear automatically after creating the named boundary, since we toggled it on in Step 58. Click **OK** to accept all default settings.



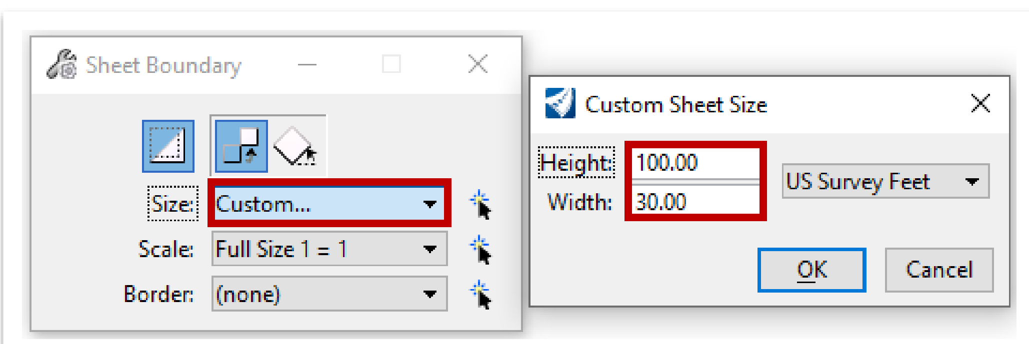
60. The software should open to the <u>one</u> **bridge sketch** sheet model in **View 1**.



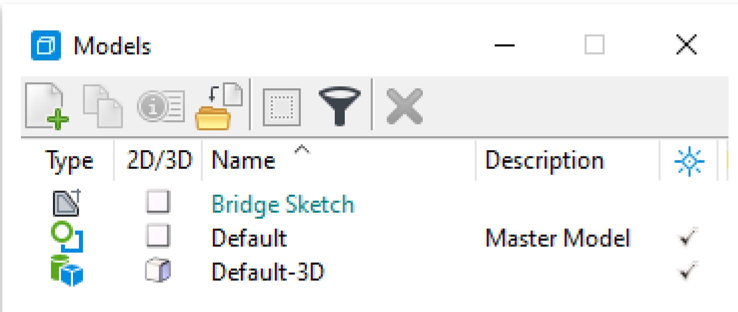
61. Notice that the sheet **paper size** does not match the extent of the profile view. In general, the survey profiles (including bridge sketches) don't typically need to be printed by TDOT Survey. They will be contained as profile drawing models within the overall survey alignment file. We will skip to the annotation, but if printing is desired, please follow Steps 62-64.
62. The paper size can be adjusted by opening the **Sheet Boundary** tool (**Open Roads Modeling >> Drawing Production >> Sheet Boundary**).



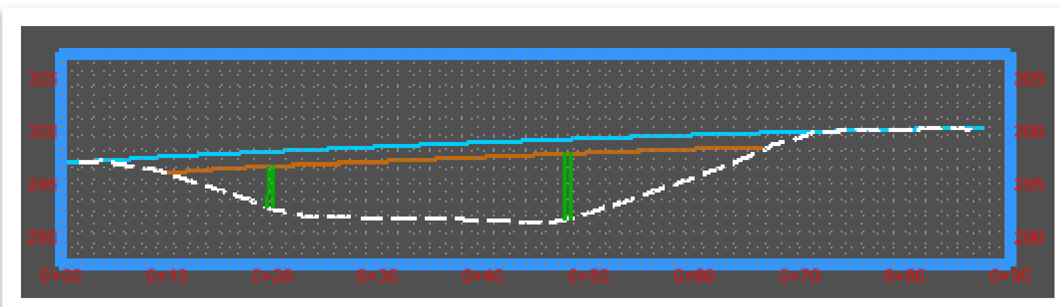
63. Within the **Sheet Boundary** dialog box, you would set a **Custom Size** to match the needs of the bridge sketch length. The **Height** and **Width** are reverse when considering the orientation of the sheet. In this exercise, the following values would be keyed-in and then you would click **OK**.
    a. **Height:** 100.00
    b. **Width:** 30.00



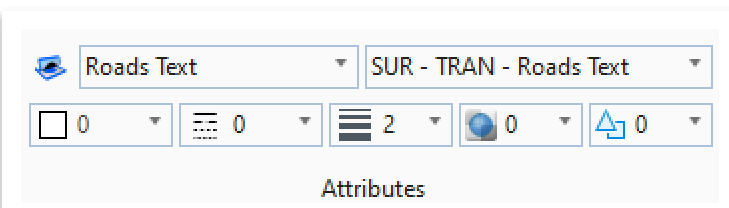
64. The sheet boundary would automatically update and then the sheet model could be printed manually (**File >> Print**) or by adding it to the sheet index and utilizing the **Print Organizer**.
65. For the purpose of this exercise, let's go ahead and delete the sheet model. Open the **Models** tool (**OpenRoads Modeling >> Home >> Primary**) and double click on the **Bridge Sketch** drawing model to activate it. Then, right click on the sheet model and select **Delete**. You should see the following three models once completed. Close the **Models** window once you are done.



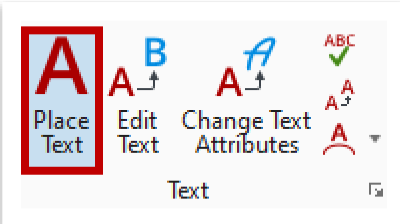
66. You should see the bridge sketch along with the profile grid, stations and elevations. We will next add the applicable annotation, like in the previous exercises.



67. We will first label the existing ground. Go ahead and select the **Roads Text** element template (**Survey >> Annotation >> Roads**).

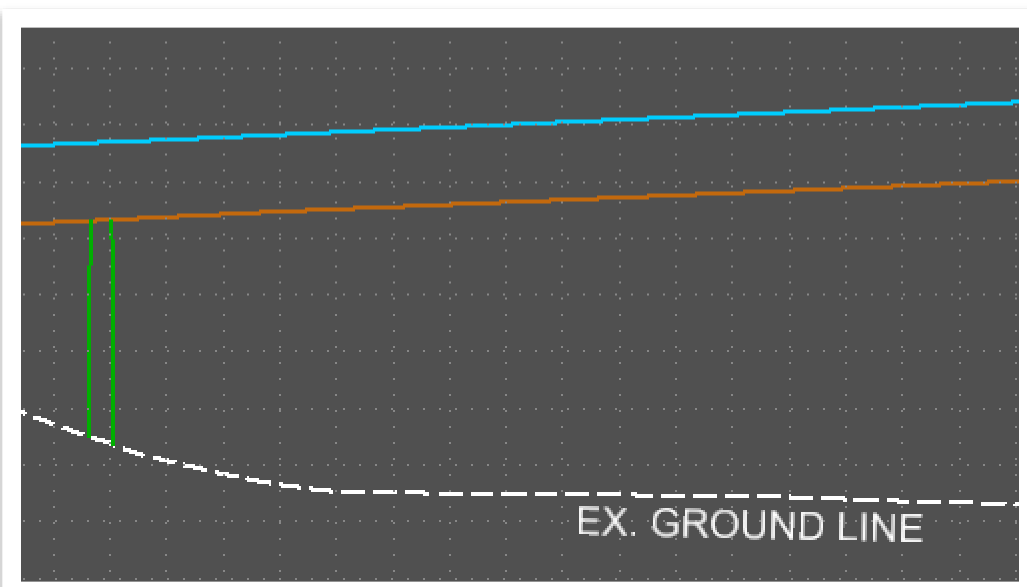


68. Next, open the **Place Text** tool (**OpenRoads Modeling >> Drawing Production >> Text**).

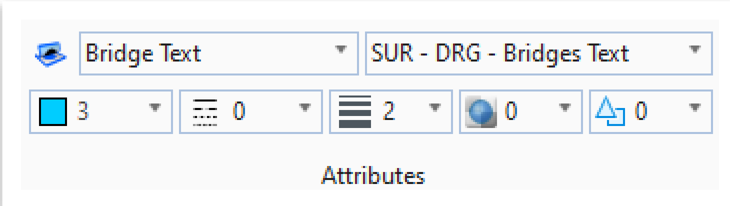


69. Within the **Text Editor**, select the **Str - Bridge Sketch** text style (highlighted below). Notice that the text size and orientation updated automatically. Key-in **EX. GROUND LINE**.

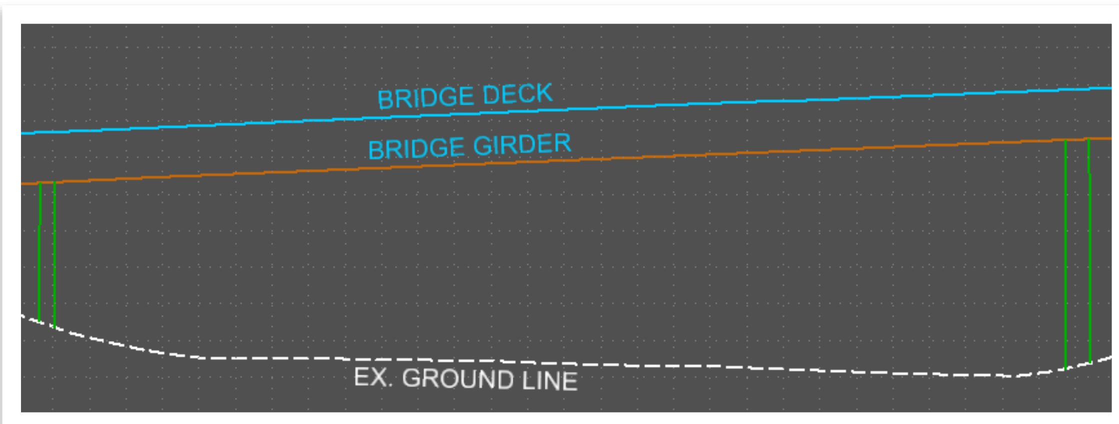
70. Left click anywhere along the existing ground profile to place the text, as shown below. **Note:** You can rotate the text after placement to better align with the profile.



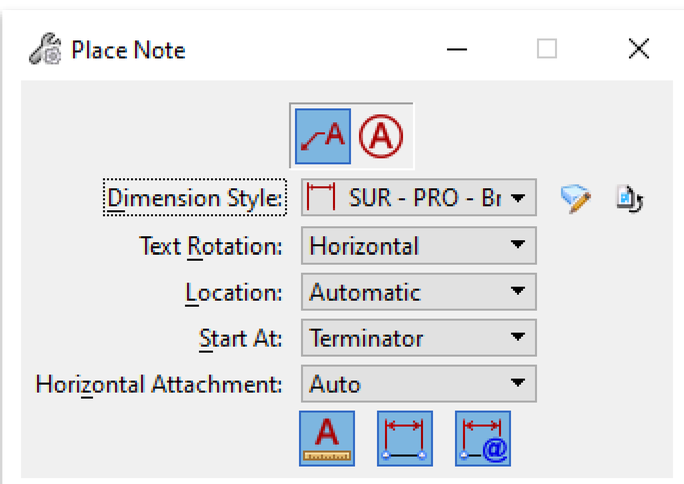
71. Now let's label the bridge deck and girder. Select the **Bridge Text** element template (**Survey >> Annotation >> Bridges**).



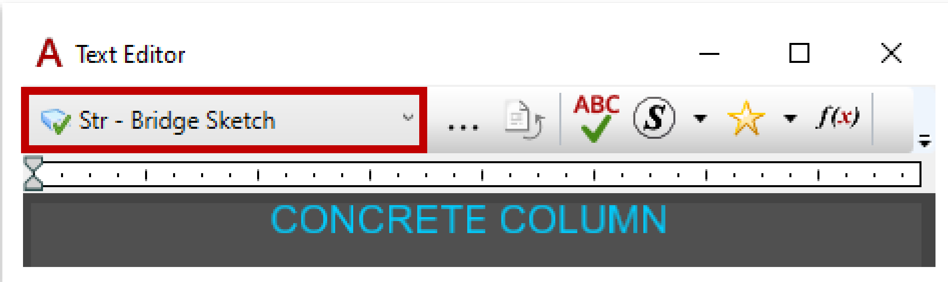
72. Add **BRIDGE DECK** and **BRIDGE GIRDER** text in the same manner as the existing ground, and rotate as necessary. Continue to use the same **Str - Bridge Sketch** text style.



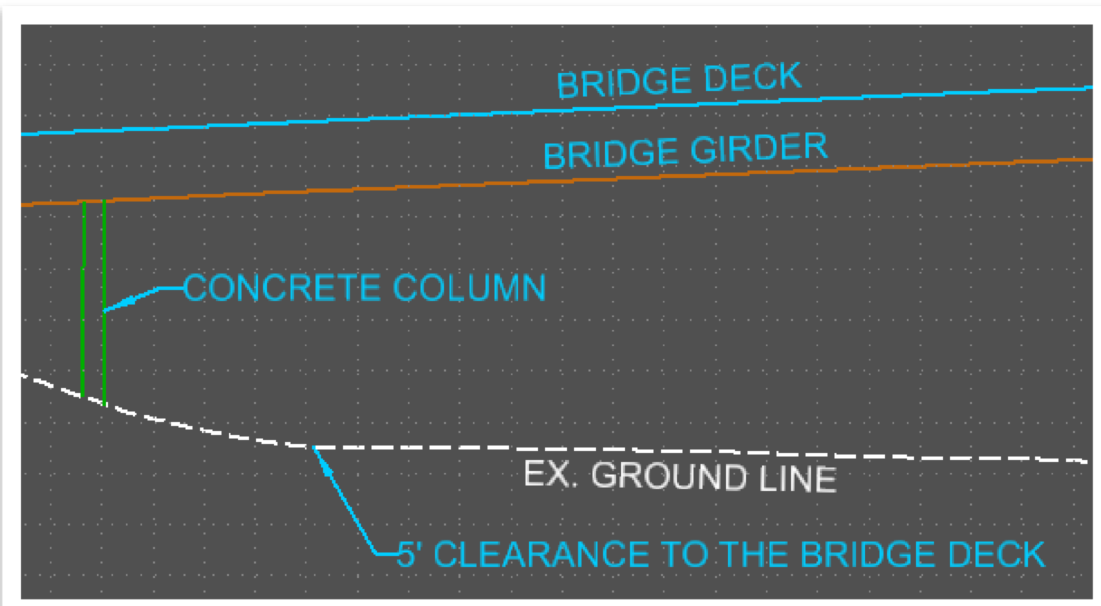
73. Next, let's place a note for one of the concrete columns. Open the **Place Note** tool (**OpenRoads Modeling >> Drawing Production >> Notes**). Within the **Place Note** dialog box, select the **SUR - PRO - Bridge Sketch** dimension style and leave the other settings as-is.



74. Within the **Text Editor**, the **Str - Bridge Sketch** text style should still be active (if not, go ahead and re-select it). Key-in **CONCRETE COLUMN** and then place the note, as shown below.



75. Snap to the column extent and then left click again to place the label, as shown below. You can also add various other notes using this option, such as **5' CLEARANCE TO THE BRIDGE DECK**.

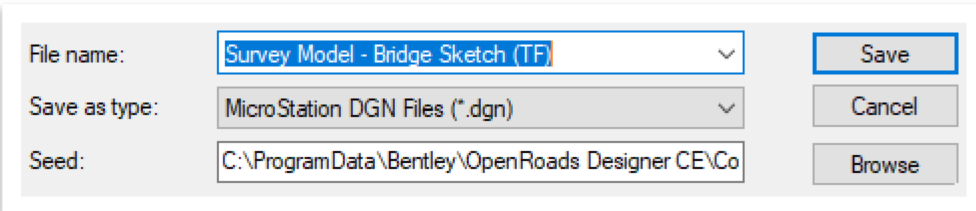


76. If you need to add dimensions, switch to the **Drawing** workflow to access the tools (**Drawing >> Annotate >> Dimensioning**).

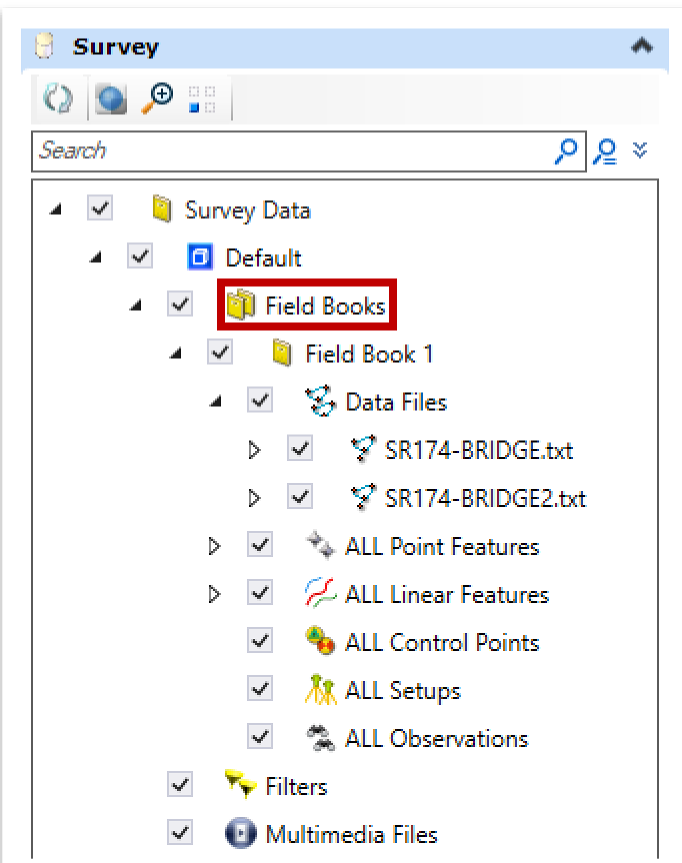
6.2.2 Exercise: Bridge Sketch – Survey Text Files

In this exercise, we will create a bridge sketch via text files and then create the overall profile drawing model. The data already includes the section view, and you will notice some similar procedures compared to the previous exercise.

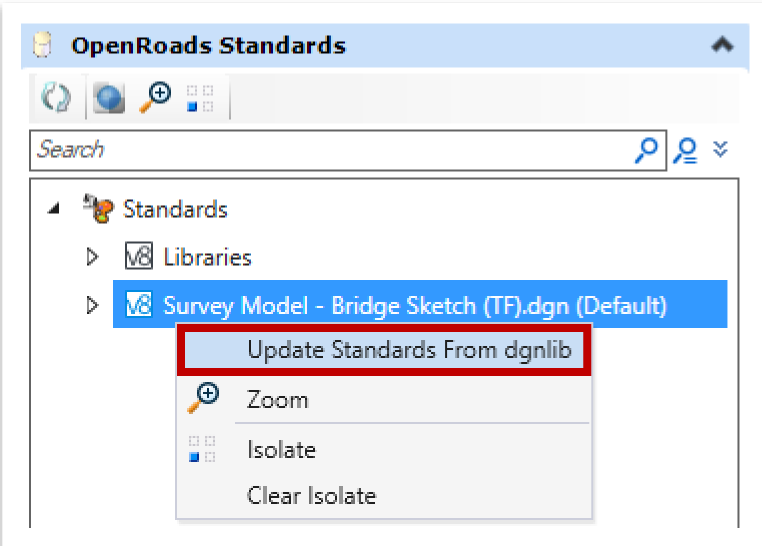
1. Create a new file and name it **Survey Model – Bridge Sketch (TF)**. Select the **TDOTSeed3D.dgn** and click **Save**.



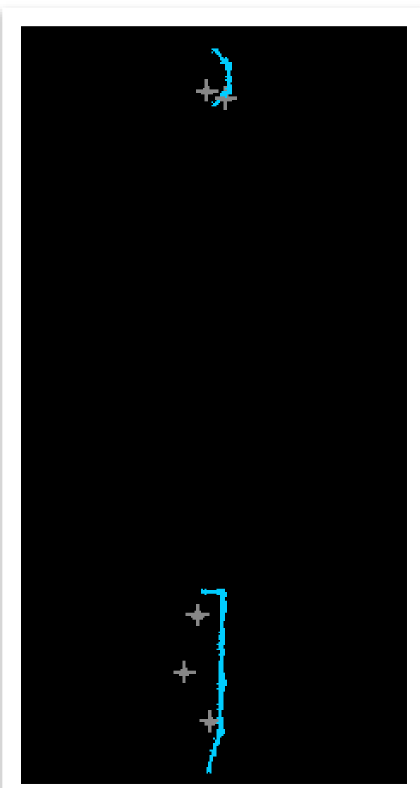
2. Next, we need to import the bridge survey data. Open **File Explorer** and browse to the class files within the **SURVEY_Training** workset dgn subfolder. Select the **SR174-BRIDGE.txt** and **SR174-BRIDGE2.txt** ASCII text files and drag and drop them into the **Field Books** folder within the **Explorer**. Expand the **Field Books** folder and notice the text files have been added, as shown below.



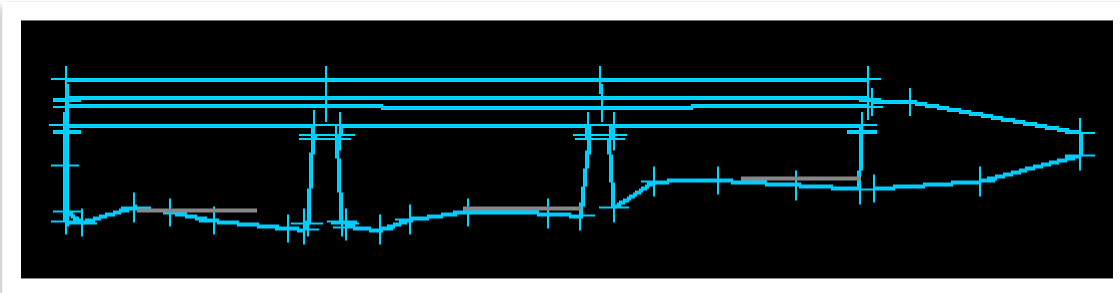
3. As a reminder, the first thing we need to do after import is update the **dgnlib standards** so that all survey **locators** are the correct scale. There is a quirk in the software, so it is good practice to perform this step after any survey text file import. Expand the **OpenRoads Standards** tab within **Explorer**. Right click on the active file (**Survey Model – Bridge Sketch (TF).dgn**) and select **Update Standards From dgnlib**. Give the software a minute to process.



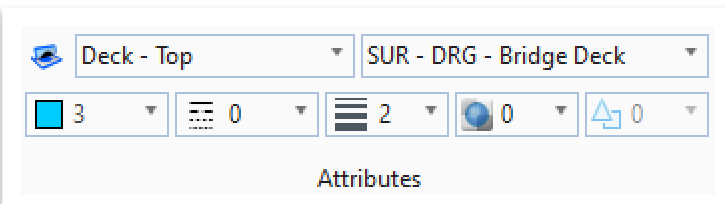
4. Click **Fit View** and review the file. You should see the image below.



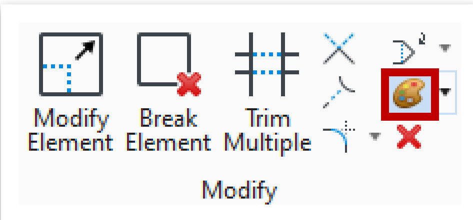
5. Go ahead and switch back to the **Survey** workflow in the upper left corner. Since this is a **3D** file, the data will come in 3D. Click **Rotate View** and set the **Method** to **Left**. Zoom in to the bridge data on the right.

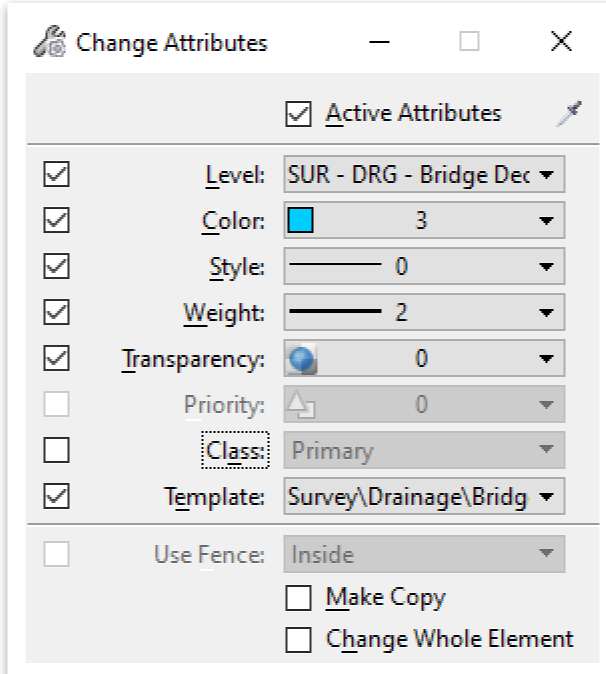


6. Turn off the following two levels in the active file:
    - SUR - CTRL - Temporary Points
    - SUR - DRG - Bridge Deck - Points - Locators
7. We will now apply certain element attributes for key components of the bridge sketch and for some, will need to draw smartlines on top of the surveyed lines. Select the **Deck - Top** element template (**Survey >> Drainage >> Bridge >> Bridge Sketch**).

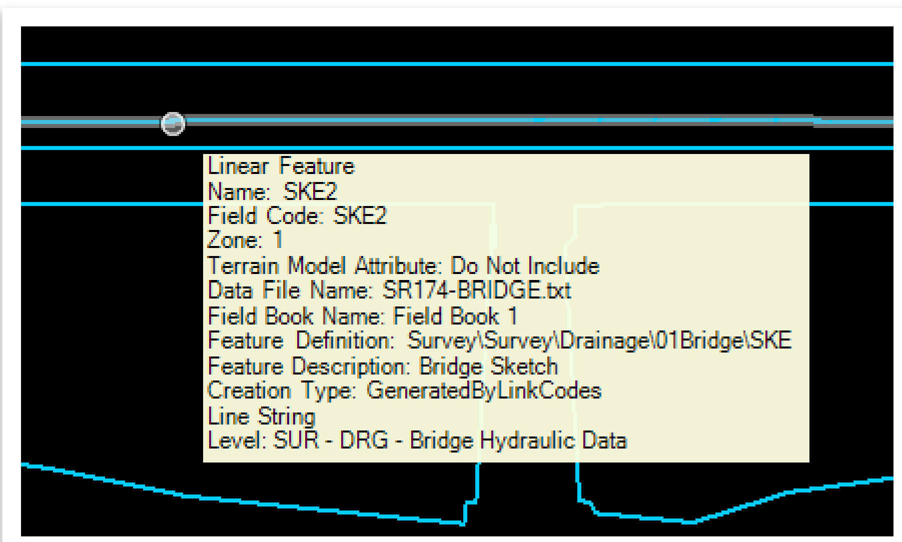


8. Now, open the **Change Element Attributes** tool (**Survey >> Drawing >> Modify**) and make sure the applicable boxes are checked, as shown below.

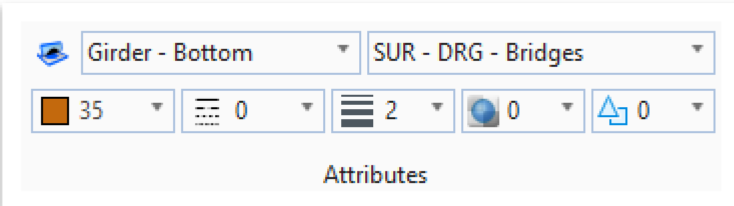




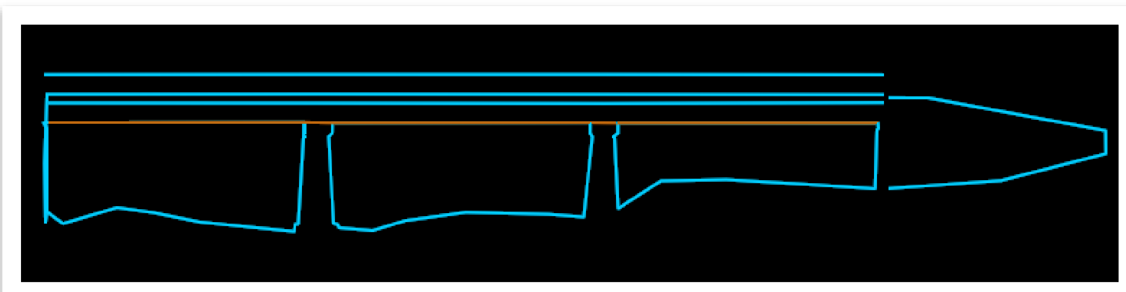
9. Left click on the **Bridge Deck** (2nd line from the top).



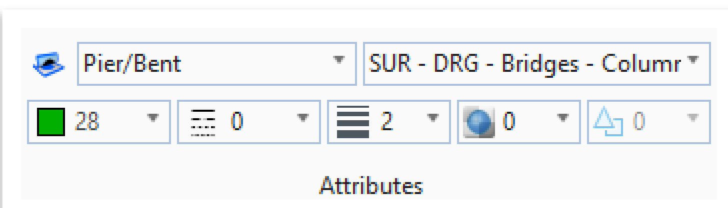
10. Next, we need to trace the remaining applicable components. First, select the **Girder - Bottom** element template (**Survey >> Drainage >> Bridge >> Bridge Sketch**).



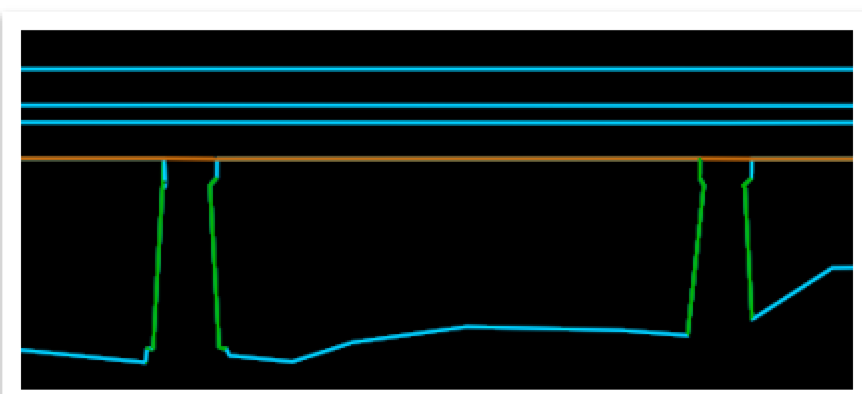
11. Open the **Place SmartLine** tool (**Survey >> Drawing >> Placement**). Trace the top of the openings to get one overall orange smartline, which will represent the bottom of the girder, as shown below. **Note:** Your linework may appear behind the light blue linework once drawn.



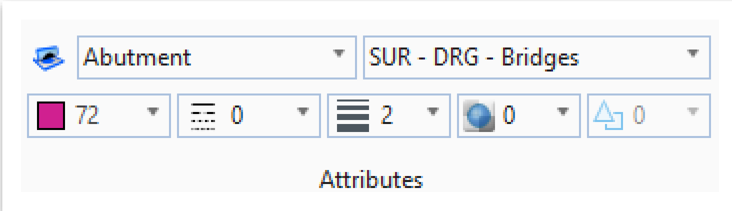
12. Now we will repeat the same process for the **columns**. Select the **Pier/Bent** element template (**Survey >> Drainage >> Bridge >> Bridge Sketch**).



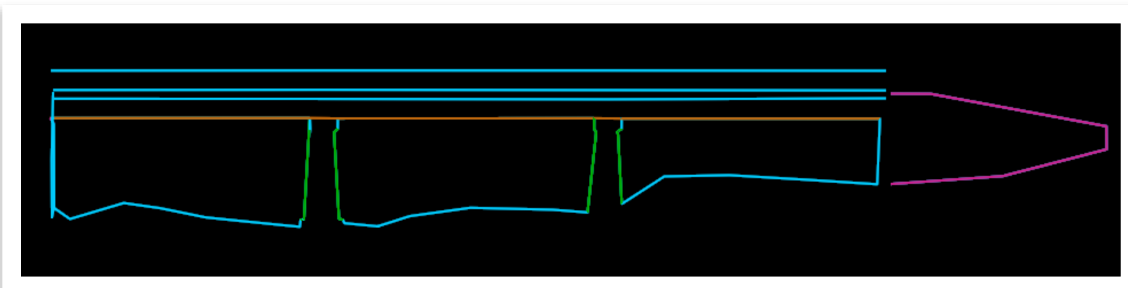
13. Trace the **four** outer extents of the columns (green), as shown below.



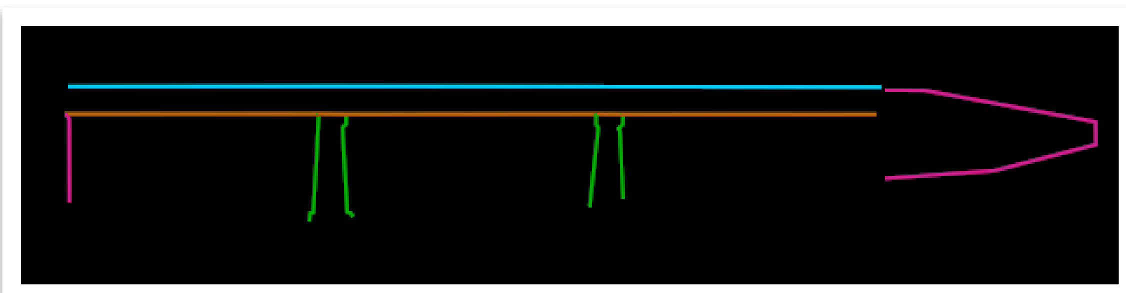
14. Lastly, select the **Abutment** element template (**Survey >> Drainage >> Bridge >> Bridge Sketch**).



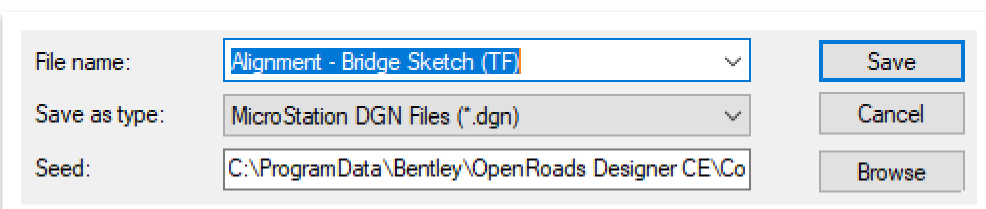
15. Trace the outer extents of the abutments (pink) on each end, as shown below.



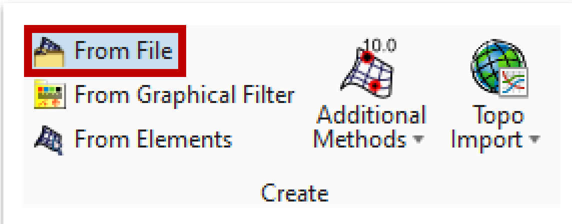
16. Turn off the **SUR - DRG - Bridge Hydraulic Data** in the active file.



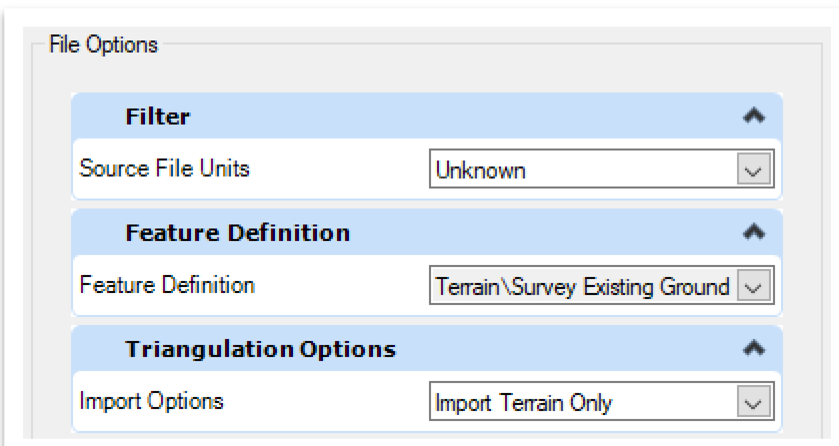
17. Now we need to convert the 3D elements into **2D** elements. Let's create a new file and name it **Alignment – Bridge Sketch (TF)**. Select the **TDOTSeed2D.dgn** and click **Save**. **Note:** Once again, the bridge sketch would likely be a profile model within the overall 2D survey alignment file but has been separated out for the purpose of training.



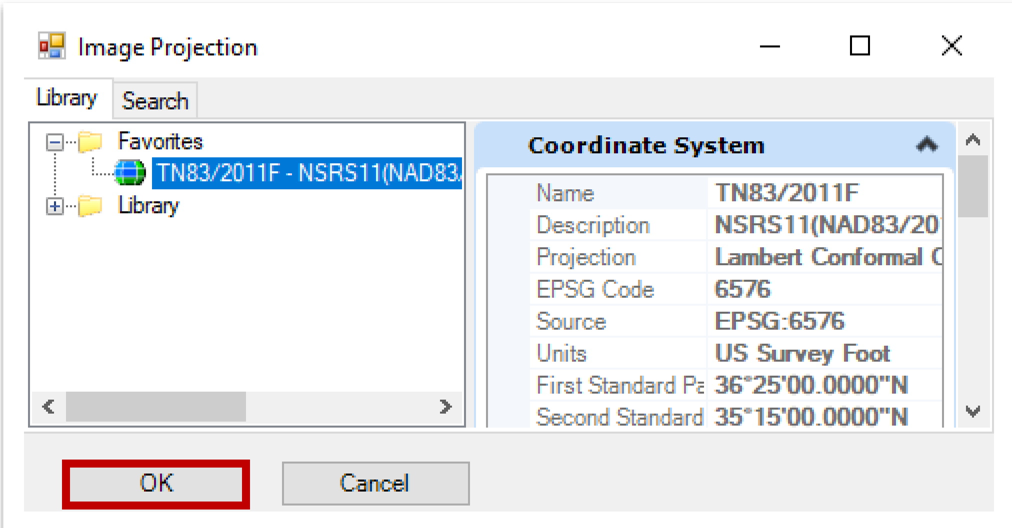
18. Go ahead and switch to the **OpenRoads Modeling** workflow once again. First, we need to attach the surface. Open the **From File** tool (**OpenRoads Modeling >> Terrain >> Create**).



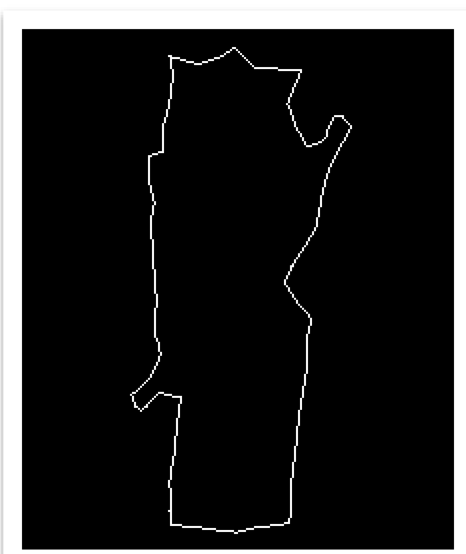
19. Select the **SR174-01DTM.tin** file within the **SURVEY_Training** workset dgn subfolder and click **Done**. Within the **Import Terrain Model(s)** dialog box, skip down to **File Options**.
20. Under **File Options**, select the following settings.
    a. **Source File Units:** Leave as-is. This field will take care of itself and disappear once the geographic coordinate system is selected in the next step.
    b. **Feature Definition:** Terrain\Survey Existing Ground
    c. **Import Options:** Import Terrain Only



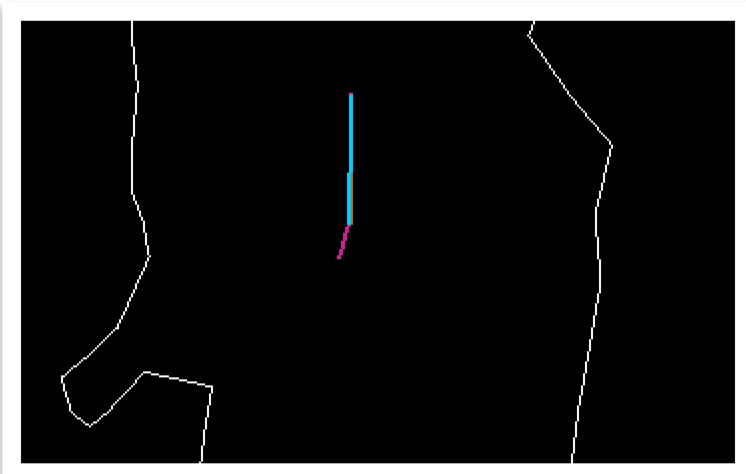
21. Under **Geographical Coordinate Systems**, click the ellipses next to the **Source** field. You should already have the correct coordinate system saved as a Favorite (**TN83/2011F – NSRS11 (NAD83/ 2011) Tennessee State Plane Zone, US Foot**) from earlier in the manual. If not, you can browse to it here: **Library >> Projected (northing, easting, …) >> North America >> United States of America >> Tennessee**. Once selected, click **OK**.



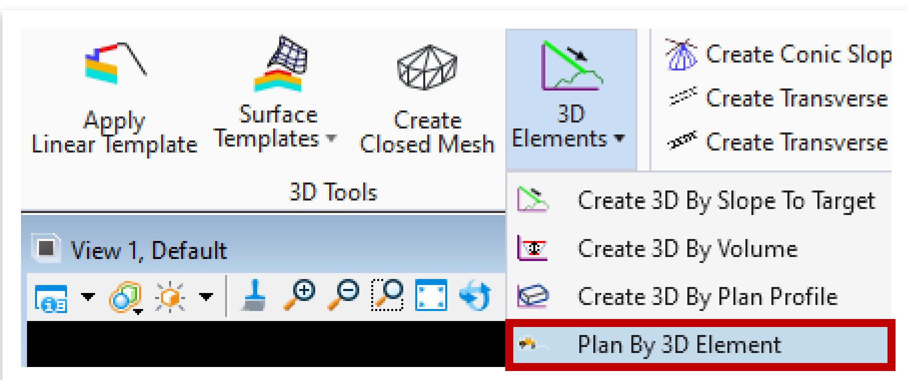
22. Next, click **Import** and then close the **Import Terrain Model(s)** dialog box once processed. Click **Fit View**, turn the **triangles** off and review the terrain. **Note:** The white terrain boundary in this 2D file is adequate for this exercise, but if you wanted to view the entire terrain in a 3D model, you would create a 3D file and import the TIN in the same manner.



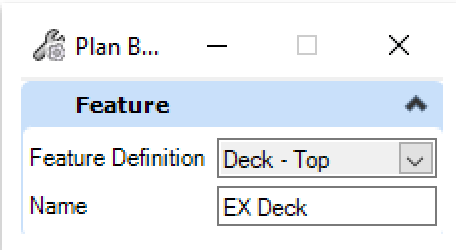
23. Go ahead and attach the previously created file (**Survey Model – Bridge Sketch (TF).dgn**) as a reference using the **Coincident World** attachment method and then zoom in to the referenced lines. You should see **four** different color lines: (1) the light blue bridge deck (2) the orange bottom girder (3) the green column extents and (4) the pink abutments. **Note:** The 2D plan view will look odd for some components, but once projected to the bridge deck, everything will look correct in the profile.



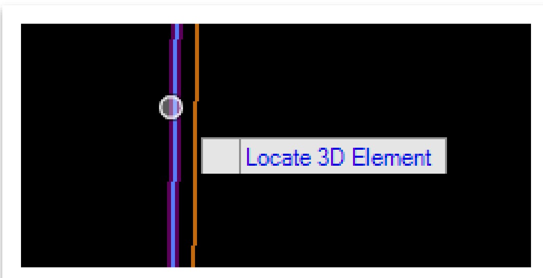
24. Once attached, zoom in and you should see **four different color lines** you drew earlier: (1) the light blue bridge deck (2) the orange bottom girder (3) the green column extents and (4) the pink abutments. Keep in mind that the 2D plan view will look odd for some components, but once projected to the bridge deck, everything will look correct in the profile.
25. Open the **Plan By 3D Element** tool (**OpenRoads Modeling >> Model Detailing >> 3D Tools >> 3D Elements**).



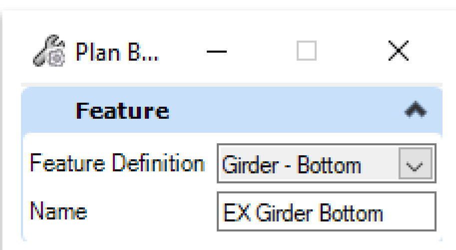
26. Within the **Plan By 3D Element** dialog box, select the **Deck - Top** feature definition (**Linear >> Structures >> Bridge Sketch >> Existing**). You can leave the default **Name** as-is for now.



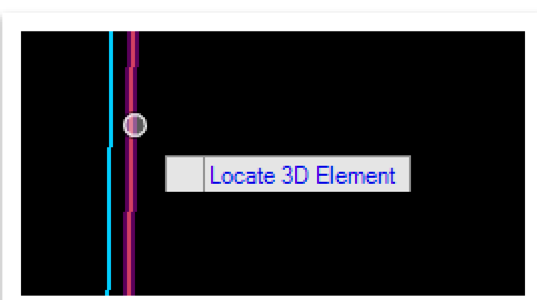
27. Notice the cursor prompt: **Locate 3D Element**. Left click on the **light blue** line representing the referenced bridge deck.



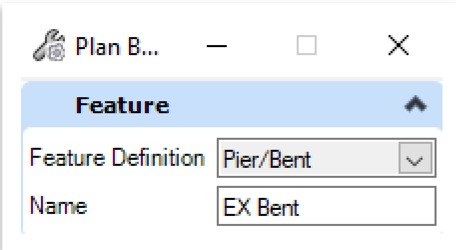
28. Next, we will apply the same process to the bottom of the bridge. Select the **Girder - Bottom** feature definition (**Linear >> Structures >> Bridge Sketch >> Existing**).



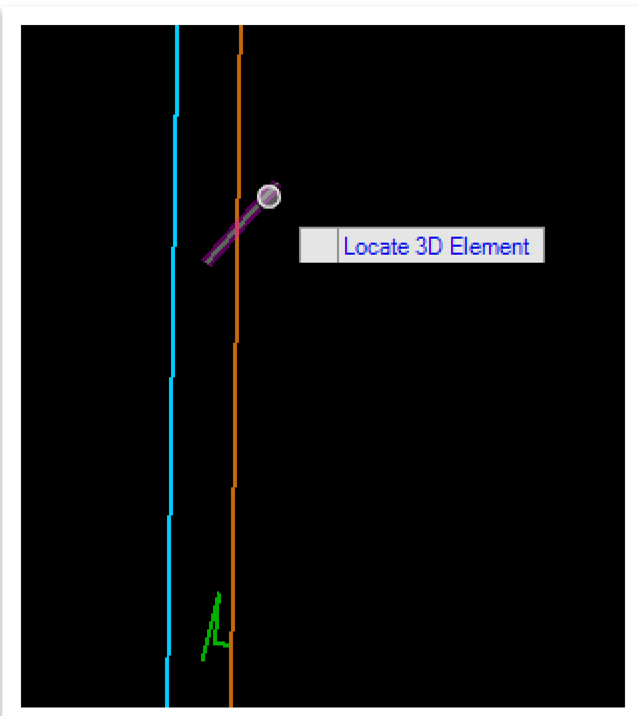
29. Once again, notice the cursor prompt: **Locate 3D Element**. Left click on the **orange** line representing the bottom of the bridge.



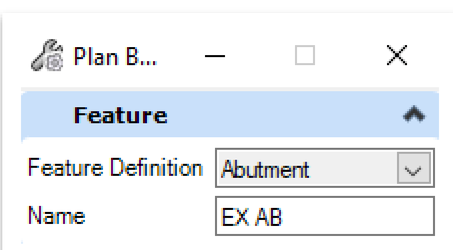
30. Next, we will apply the same process to the **four** column extents. Select the **Pier/Bent** feature definition (**Linear >> Structures >> Bridge Sketch >> Existing**).



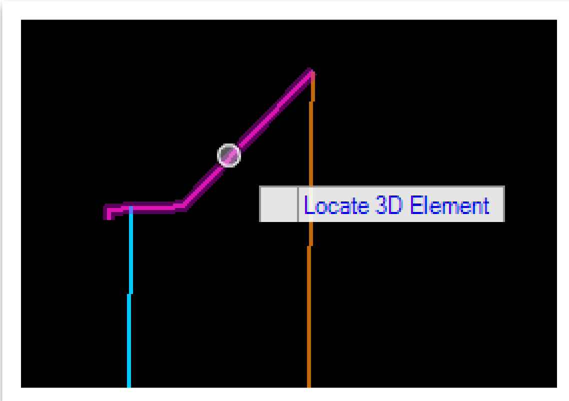
31. Once again, notice the cursor prompt: **Locate 3D Element**. Left click on the first **green** line representing one column extent. Repeat this step for the remaining three column extents.



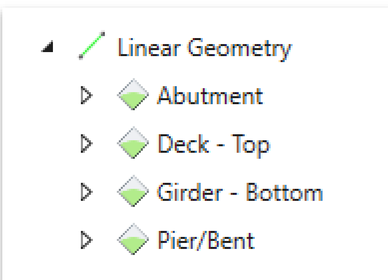
32. Lastly, we will apply the same process to the abutments. Select the **Abutment** feature definition (**Linear >> Structures >> Bridge Sketch >> Existing**).



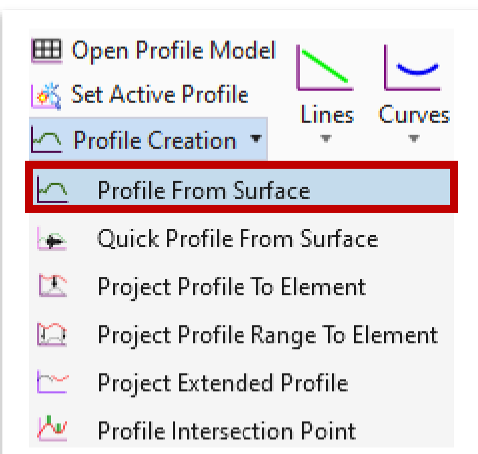
33. Once again, notice the cursor prompt: **Locate 3D Element**. Left click on the first **pink** line representing the first abutment. Repeat this step for the other abutment.



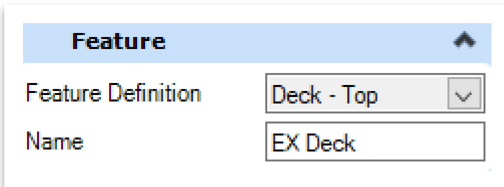
34. It will seem like nothing happened. However, within the **Explorer**, if you open the **OpenRoads Model** tab and go to **Alignment – Bridge Sketch (TF).dgn >> Linear Geometry**, you will notice that the **Abutment**, **Deck - Top**, **Girder - Bottom** and **Pier/Bent** were created. **Note:** You can expand each one to see additional details about the complex elements you created earlier with the smartline tool.



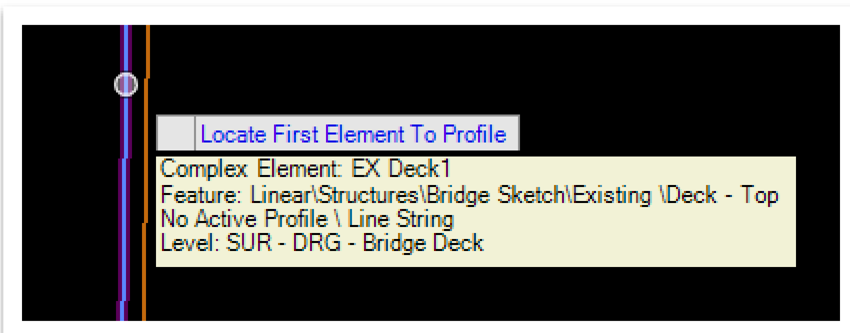
35. Now, open the **Profile From Surface** tool (**OpenRoads Modeling >> Geometry >> Vertical >> Profile Creation**).



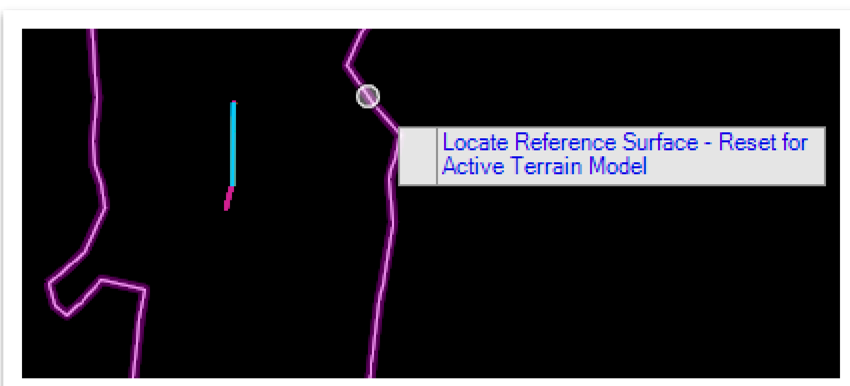
36. Within the **Profile From Surface** dialog box, let's first set the feature settings.
    a. **Feature Definition:** Deck - Top (**Linear >> Structures >> Bridge Sketch >> Existing**)
    b. **Name:** EX Deck



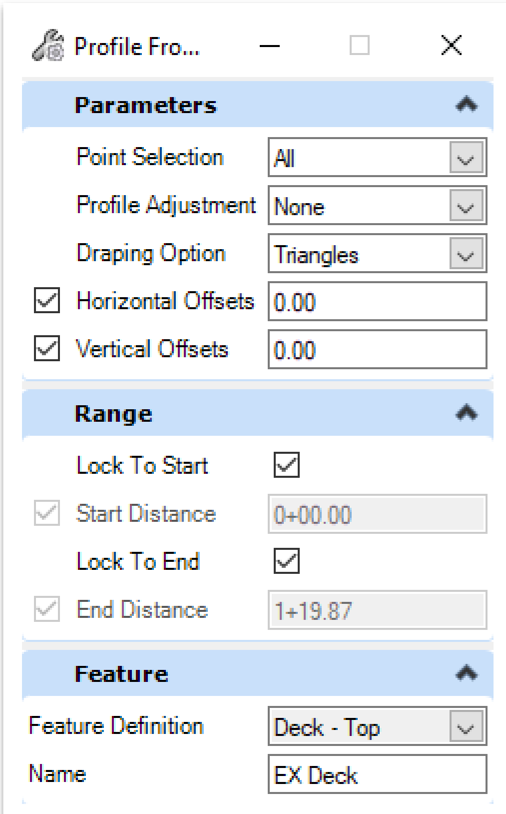
37. Notice the cursor prompt: **Locate First Element To Profile**. Select the **light blue** line representing the top of the bridge deck and then right click to reset.



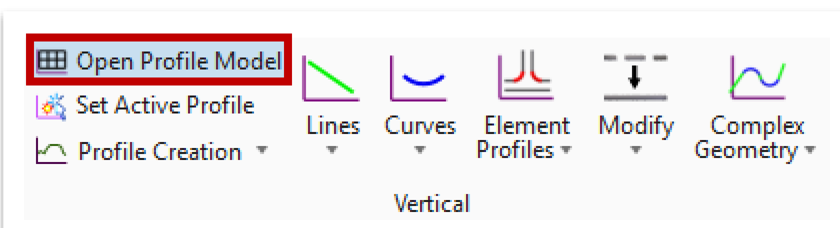
38. Notice the next cursor prompt: **Locate Reference Surface**. Select the terrain boundary and then right click to complete.



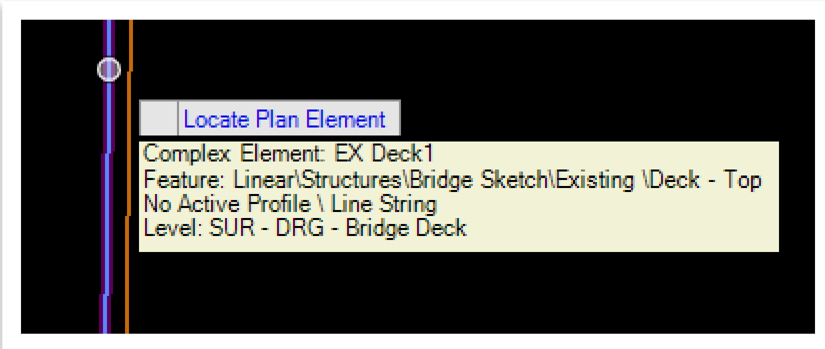
39. Go ahead and **Lock To Start** and **Lock To End**. The stations should automatically populate. Left click to accept all other default settings shown below. **Note:** Your **End Distance** will vary depending on your line length that you drew.



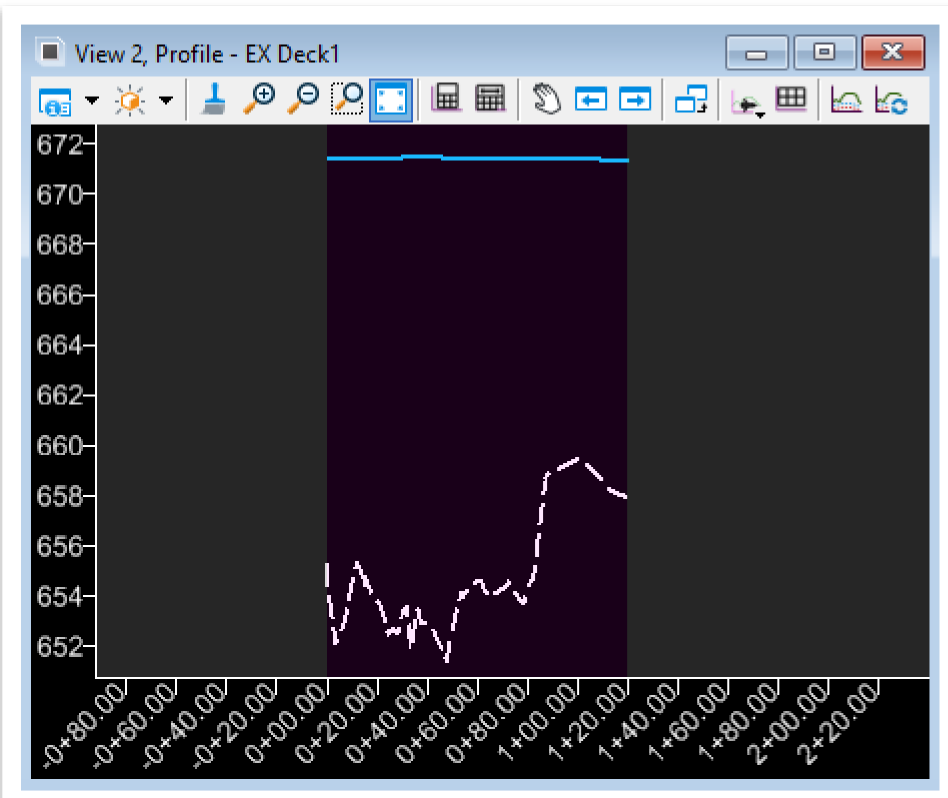
40. Next, we will view the profile of the bridge deck. Open the **Open Profile Model** tool (**OpenRoads Modeling >> Geometry >> Vertical**).



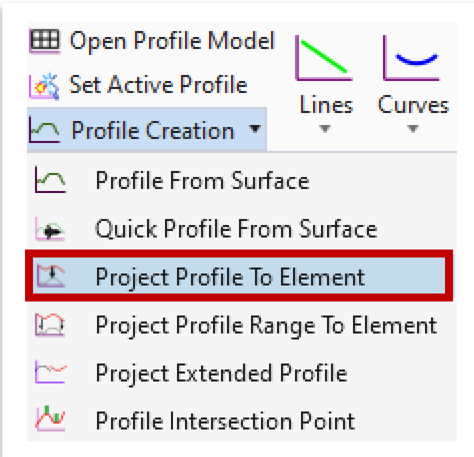
41. Notice the cursor prompt: **Locate Plan Element**. Select the **light blue** bridge deck line.



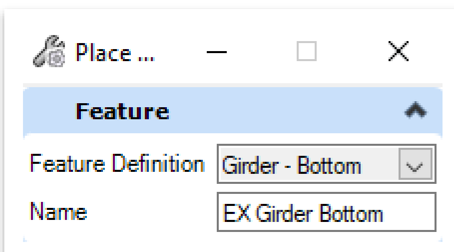
42. Open **View 2** and left click anywhere within that view. You should see the profile, as shown below.



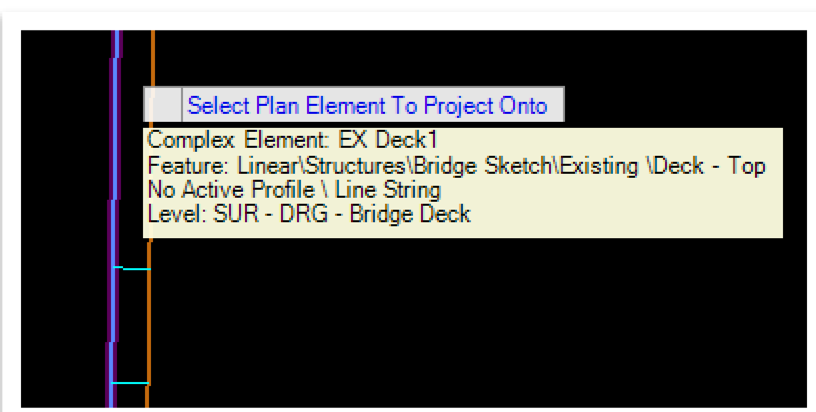
43. Now we need to project the profiles of the other components onto the bridge deck profile. Open the **Project Profile To Element** tool (**OpenRoads Modeling >> Geometry >> Vertical >> Profile Creation**).



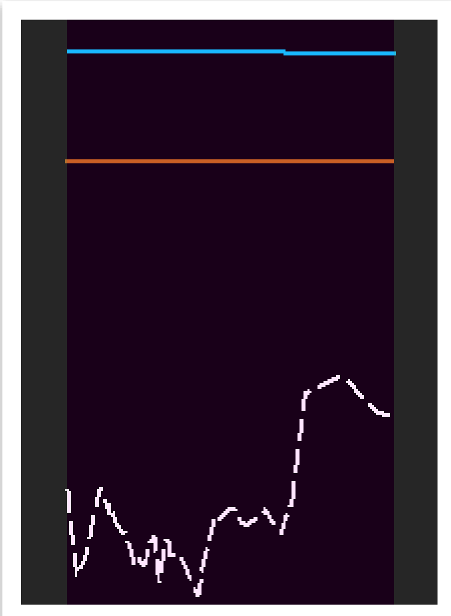
44. Within the **Place Projected Profile** dialog box, select the following settings.
    a. **Feature Definition:** Girder - Bottom
    b. **Name:** EX Girder Bottom



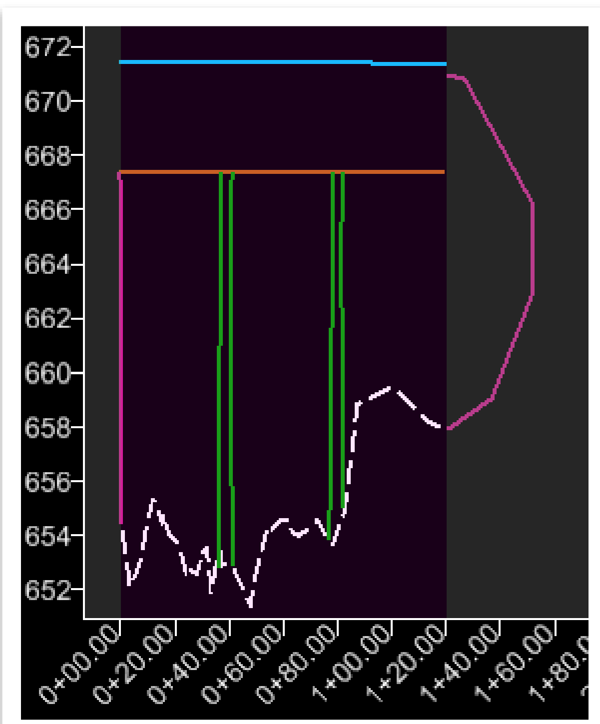
45. Notice the cursor prompt: **Select Element To Project**. Select the **orange** Girder - Bottom line and then select the **light blue** line (bridge deck). **Note:** Prior to selecting the bridge deck, hover over the line and notice the perpendicular light blue lines, which indicate the projection region, as shown below.



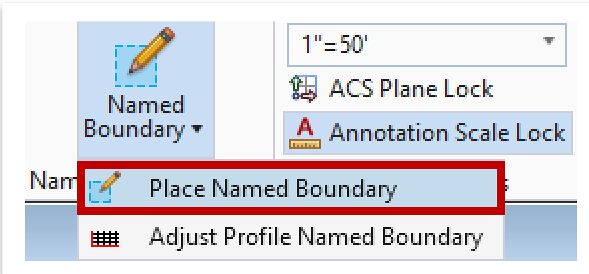
46. This will project the girder profile onto the bridge deck profile. **Note: View 2**, as shown below, should automatically update.



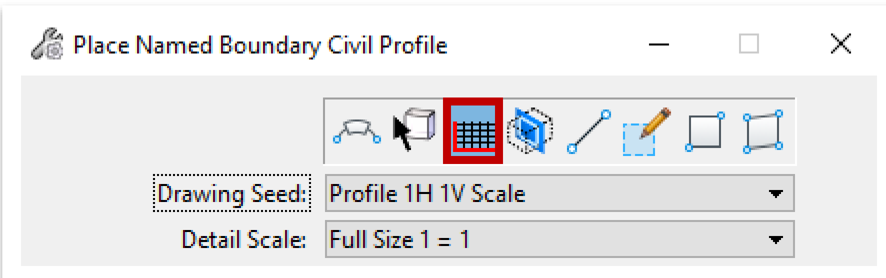
47. Next, project the **four** bridge column extents and the **two** abutments onto the profile using the same process. Make sure and select the applicable feature definition (**Pier/Bent** and then **Abutment**) before projection. Once completed, review your profile and make sure all elements are visible. **Note:** The profile is only as good as the survey data contained within the text file(s).



48. As a reminder, in order to place annotation, we need to create a profile named boundary. Open the **Place Named Boundary** tool (**OpenRoads Modeling >> Drawing Production >> Named Boundaries >> Named Boundary**).

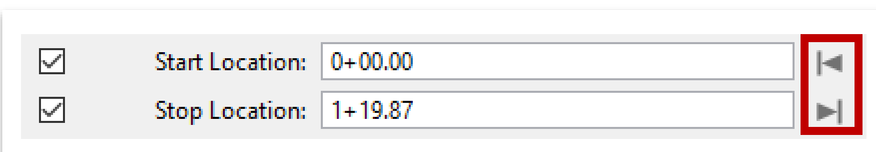


49. Make sure that the **Civil Profile** option is toggled on. Select **Profile 1H 1V Scale** for the Drawing Seed. Most of the fields should automatically populate based on the selected seed.

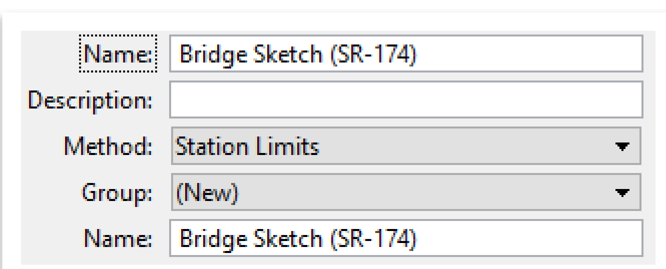


50. Notice the prompt in the lower left corner of the drawing window: **Identify Profile View**. Left click anywhere within **View 2**.

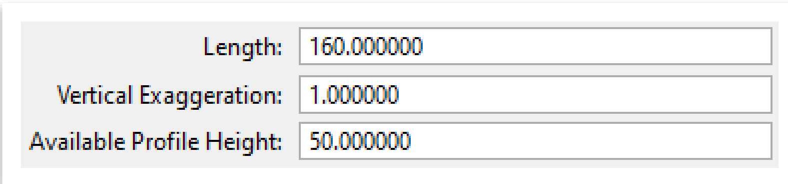
51. Use the grey arrows to lock the **Start** and **Stop Location** to the profile extents so that the entire profile is accounted for. **Note:** You cannot key-in stations until the profile view has been selected in Step 50.



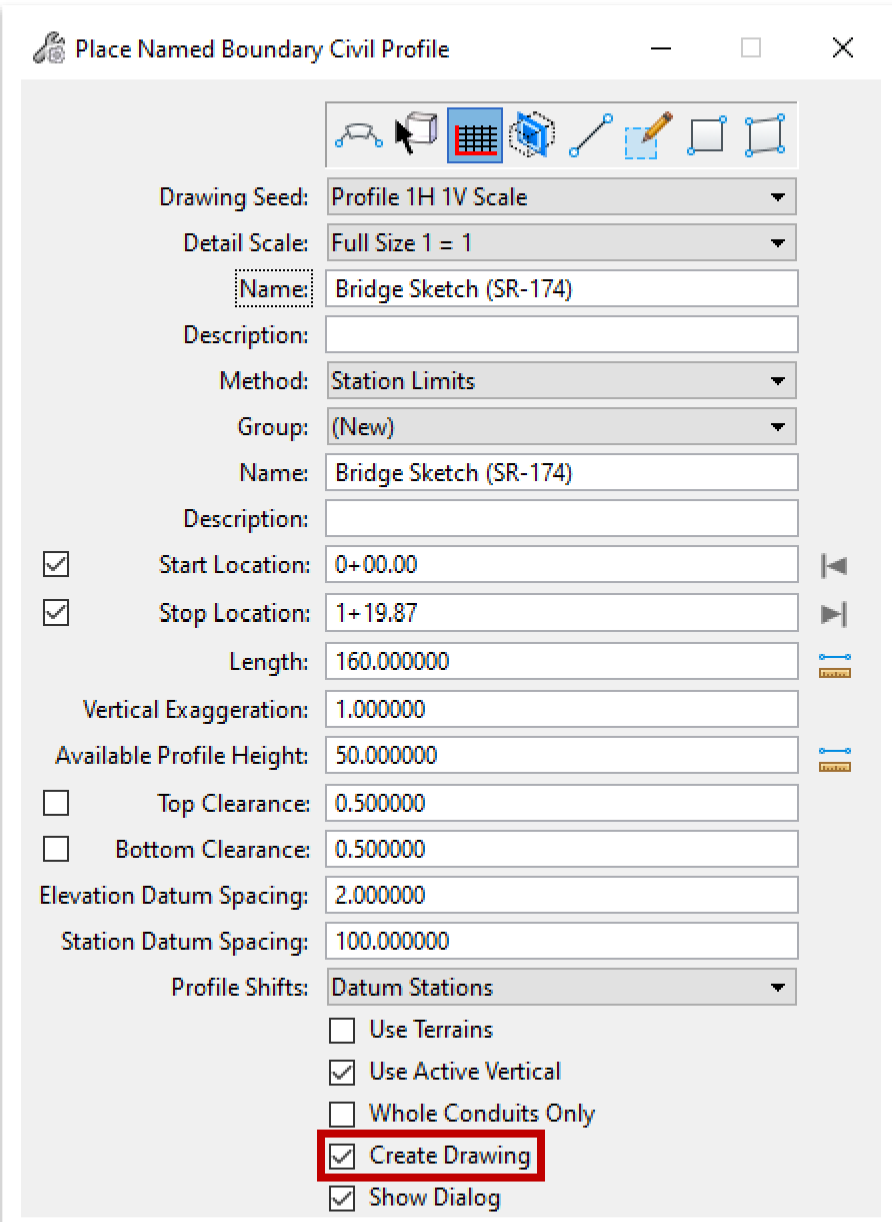
52. Key-in **Bridge Sketch (SR-174)** for both the **Named Boundary** name and the **Group** name.



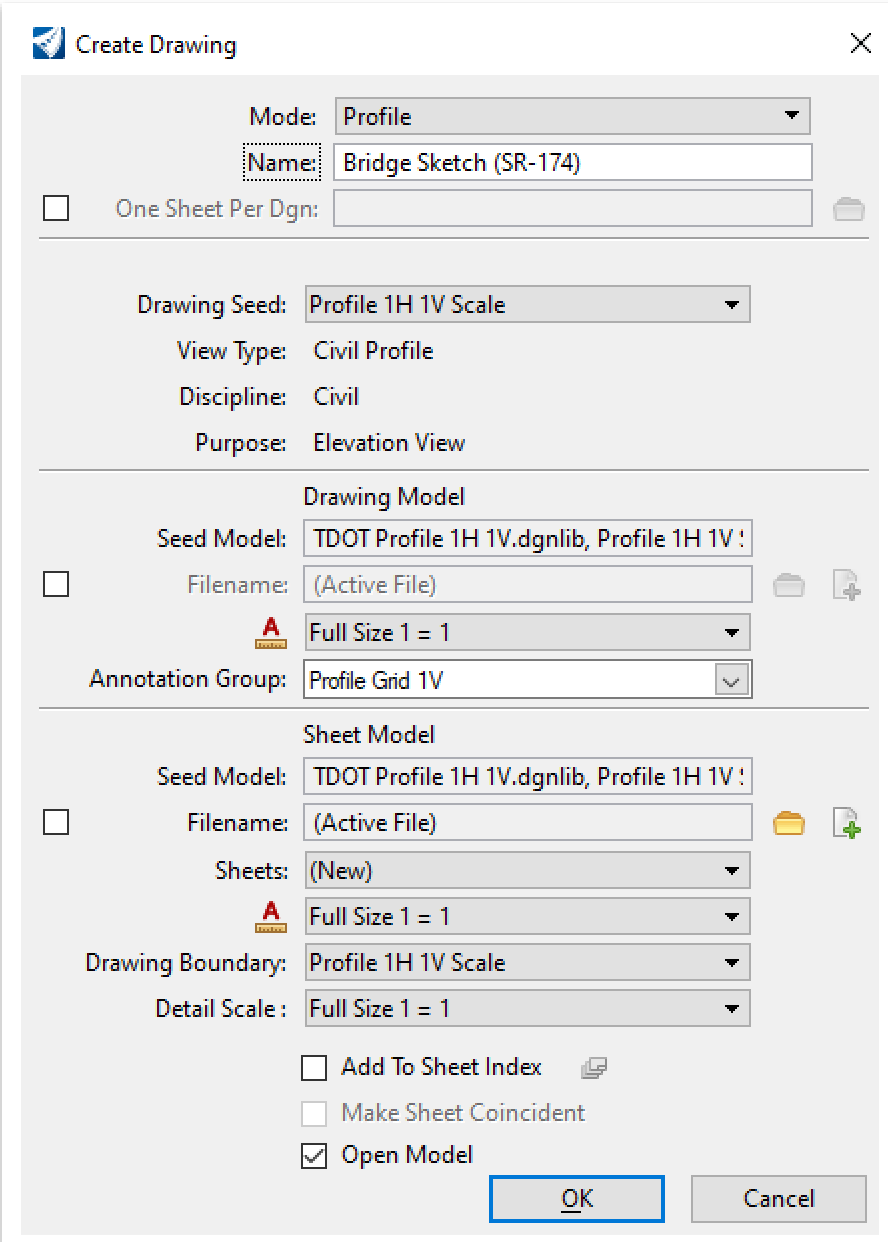
53. To create one overall profile named boundary, the **Length** field will need to be adjusted based on each project length. Go ahead and edit this value to **160’** for this exercise. Also, let’s update the **Available Profile Height** to **50**’.



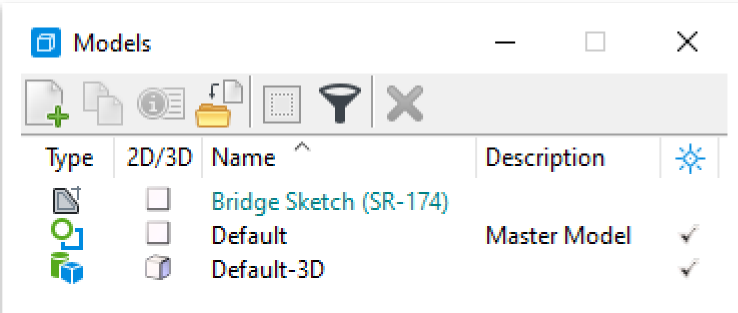
54. Leave the other default values as-is and make sure that the **Create Drawing** option is toggled on at the bottom.



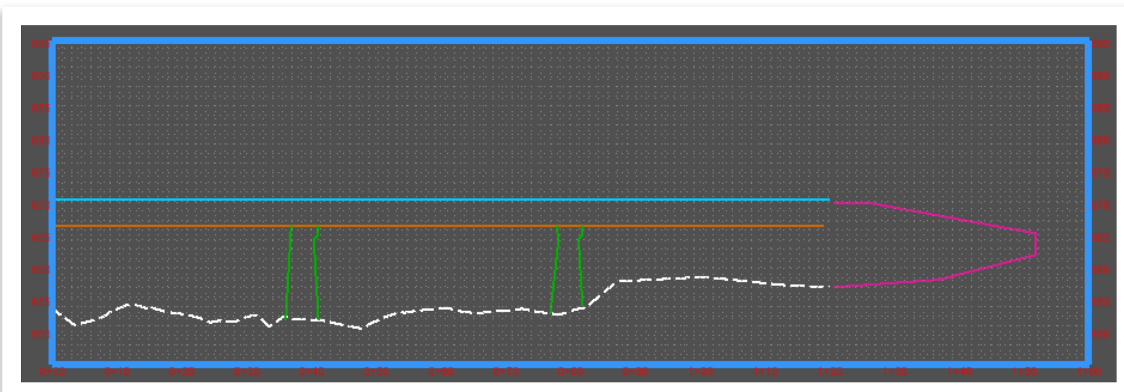
55. Left click anywhere within View 2 **three** times. Zoom out and you should see **one** profile named boundary drawn into the file, represented by a white border. The **Create Drawing** window will appear automatically after creating the named boundary, since we toggled it on in Step 54. Click **OK** to accept all default settings.



56. The software should open to the one **bridge sketch** sheet model in **View 1**. Let's go ahead and delete the sheet model. Open the **Models** tool (**OpenRoads Modeling >> Home >> Primary**) and double click on the **Bridge Sketch (SR-174)** drawing model to activate it. Then, right click on the sheet model and select **Delete**. You should see the following three models once completed. Close the **Models** window once you are done.



57. To apply **annotation**, refer to Steps 67-76 in the previous exercise.



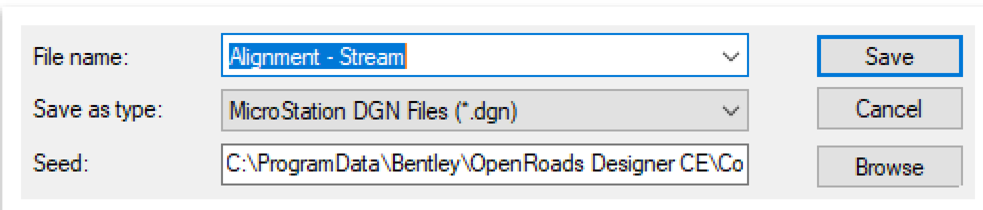
6.3 Lecture: Stream Alignment Creation and Labeling

Once survey field data is imported into ORD, the stream baseline can be addressed. It is essentially treated like a horizontal alignment set with specific attributes. Automatic centerline annotation can then be added in addition to the required begin/end labels for the stream centerline and XS lines, as well as the intersection labels.

6.3.1 Exercise: Stream Alignment Creation and Labeling

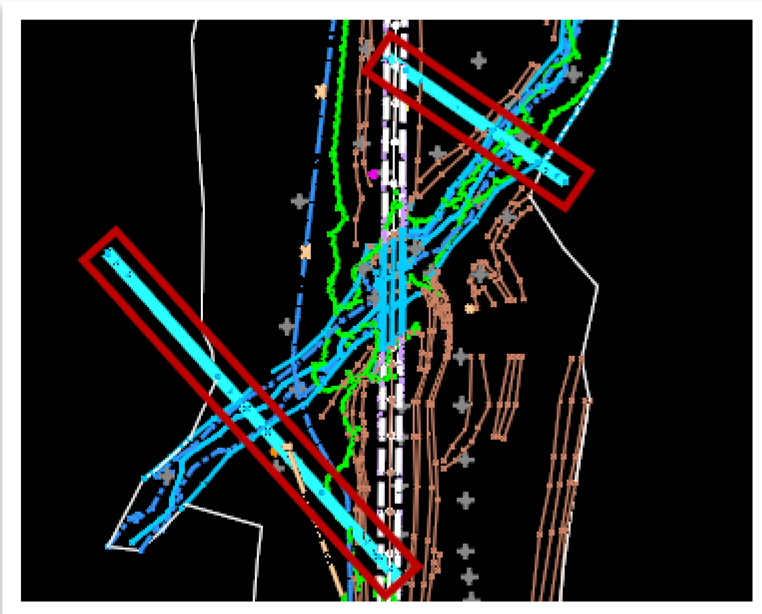
In this exercise, we will create an alignment along the creekbed centerline and incorporate the upstream and downstream XS prior to adding the applicable TDOT annotation. **Note:** The stream alignment would normally be part of the overall 2D survey alignment file but has been separated out for the purpose of training.

1. Create a new file and name it **Alignment – Stream**. Select the **TDOTSeed2D.dgn** and click **Save**.

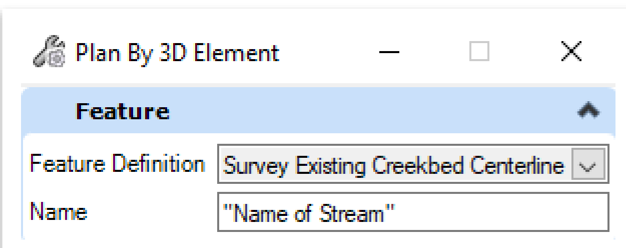


2. Attach the **Survey Model – Stream.dgn** as a reference using the **Coincident World** attachment method and turn off the **SUR - DTM - Spot Points - Locators** level. Then, click **Fit View** and zoom in to the southernmost stream crossing and set the terrain to **active**.

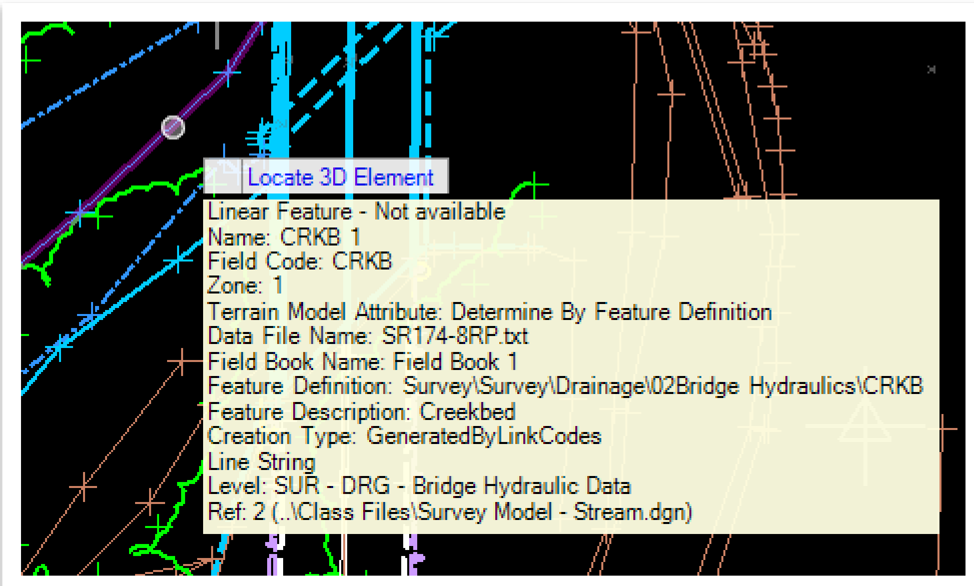
3. Now, select both the **upstream** and **downstream** XS lines and **copy** them into the file (**OpenRoads Modeling >> Drawing >> Manipulate**).



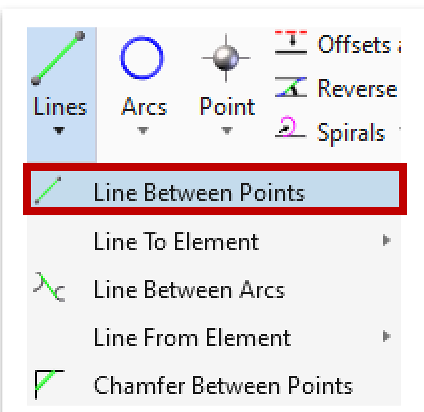
4. Next, we need to **extract** the creek bed centerline from the reference file into the active file. Open the **Plan By 3D Element** tool (**OpenRoads Modeling >> Model Detailing >> 3D Tools >> 3D Elements**). Select the **Survey Existing Creekbed Centerline** feature definition within the **Alignment** folder and leave the **Name** as-is.



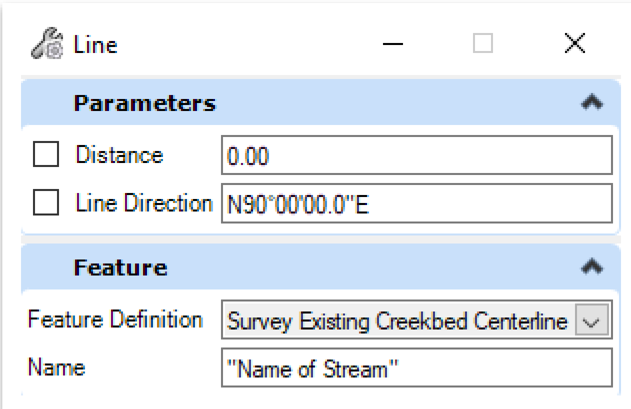
5. Notice the cursor prompt: **Locate 3D Element**. Select the **upstream** creek bed centerline (**CRKB 1**) and then the **downstream** creek bed centerline (**CRKB**). **Note:** There is a gap in the centerline under the bridge. We will address that in the upcoming steps.



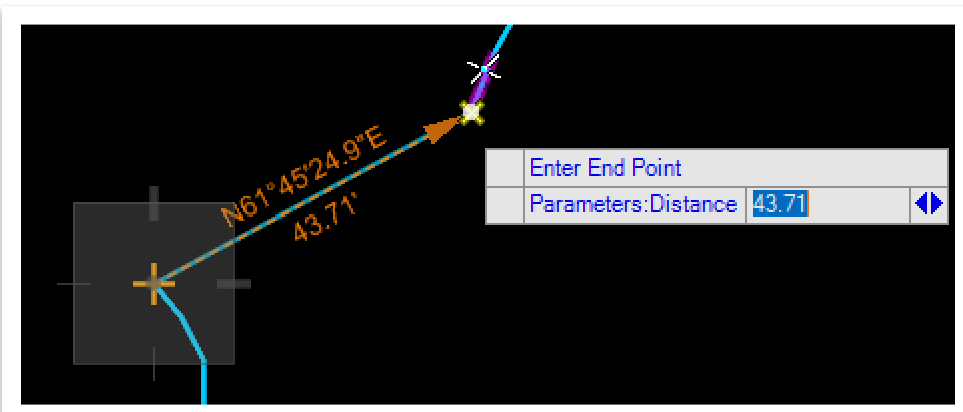
6. Go ahead and turn off the **Survey Model – Stream.dgn** reference file and open the **Line Between Points** tool (**OpenRoads Modeling >> Geometry >> Horizontal >> Lines**).



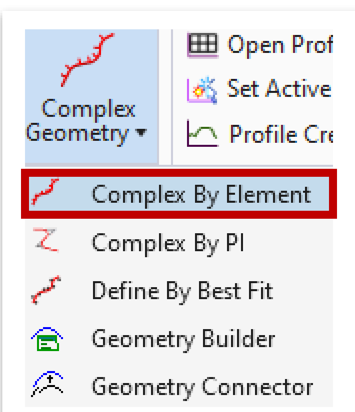
7. Select the **Survey Existing Creekbed Centerline** feature definition within the **Alignment** folder and leave the **Name** as-is. **Note:** You can ignore the **Parameters** values.



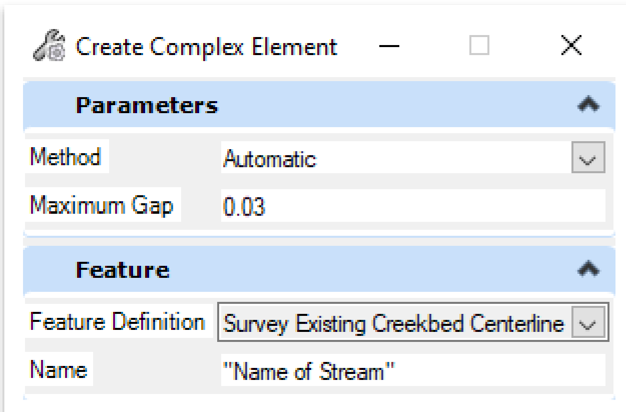
8. Draw a line between the two creekbed centerline segments to fill in the gap, as shown below.



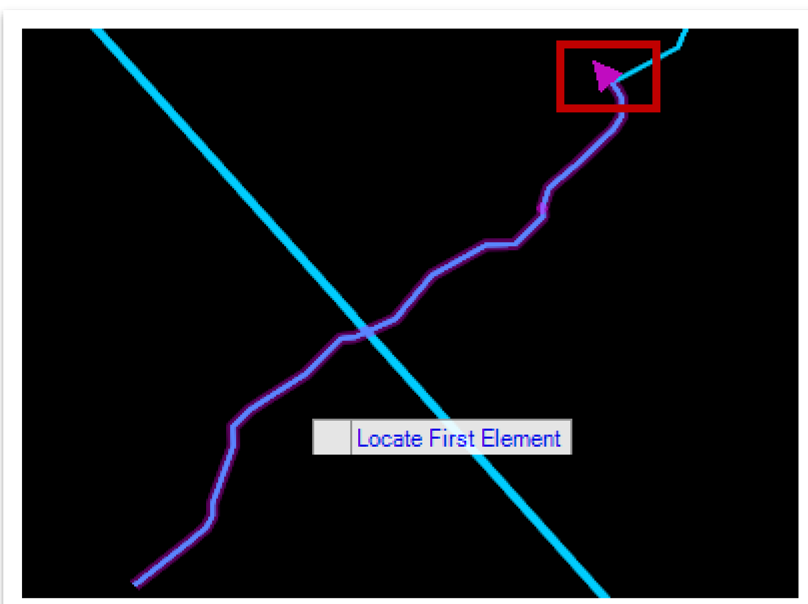
9. Now we need to make the centerline one complex element. Open the **Complex By Element** tool (**OpenRoads Modeling >> Geometry >> Horizontal >> Complex Geometry**).



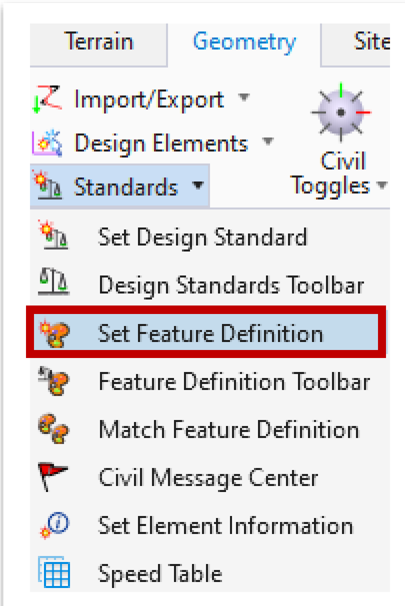
10. Within the **Create Complex Geometry** dialog box, select the following settings.
    a. **Method:** Automatic
    b. **Maximum Gap:** 0.03
    c. **Feature Definition:** Alignment >> Survey Existing Creekbed Centerline
    d. **Name:** Leave as-is



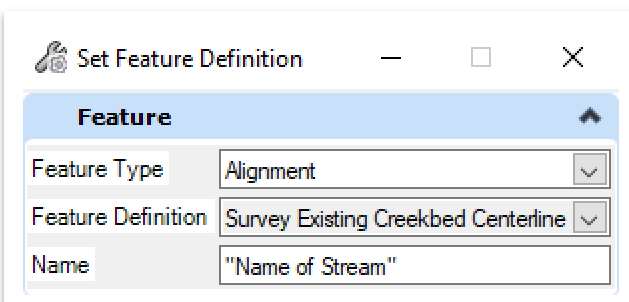
11. Select the **southernmost** segment first. Make sure when you select it that the pink arrow is pointing in the correct direction of the alignment, as shown below. Left click again to create the complex geometry. **Note:** The arrow points in the opposite direction of where your cursor is.



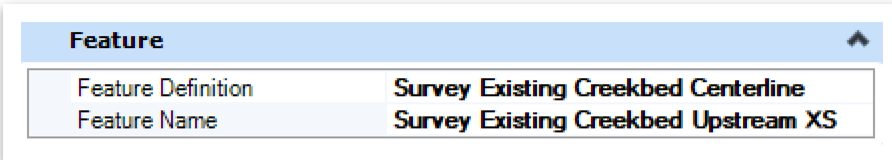
12. For annotation purposes later in the exercise, we need to name the XS lines accordingly. To do this, we first need to apply a feature definition. Open the **Set Feature Definition** tool (**OpenRoads Modeling >> Geometry >> General Tools >> Standards**).

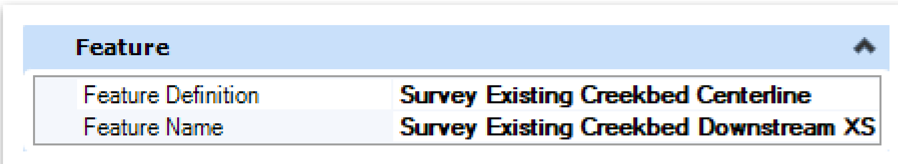


13. Within the **Set Feature Definition** dialog box, select the following settings.
    a. **Feature Type:** Alignment
    b. **Feature Definition:** Alignment >> Survey Existing Creekbed Centerline
    c. **Name:** Leave as-is

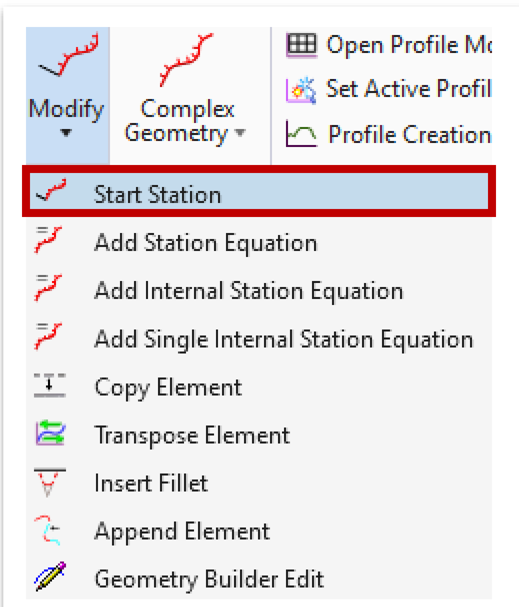


14. Left click both XS lines to select and then right click to accept. Open the **Properties** for each line and edit the **Feature Name** to **Survey Existing Creekbed Upstream XS** and **Survey Existing Creekbed Downstream XS** respectively. **Note:** You could have named them accordingly in the **Name** field when setting the feature definition in the previous step. Also, the southernmost XS line is the **upstream** line.

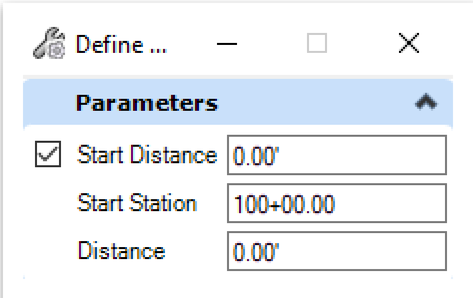


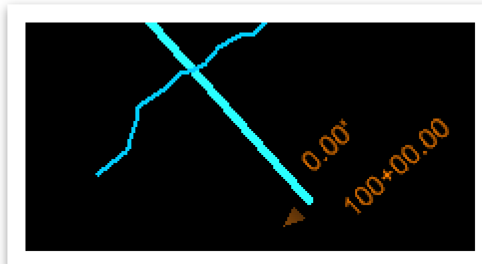


15. Next, let's apply unique stationing to the two XS lines. Open the **Start Station** tool (**OpenRoads Modeling >> Geometry >> Horizontal >> Modify**).

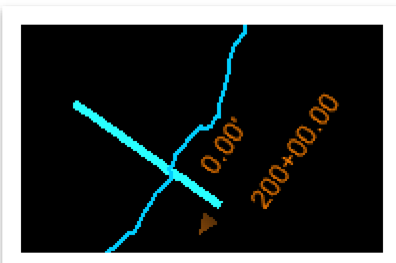


16. We will address the **upstream** XS first. Within the **Define Starting Station** dialog box, set the **Start Distance** to **0.00’** and the **Start Station** to **100+00.00**. Select the upstream XS and then left click through the prompts to accept. Using the selection tool, select the XS and notice that the dynamic stationing (orange text) now shows **100+00.00**.

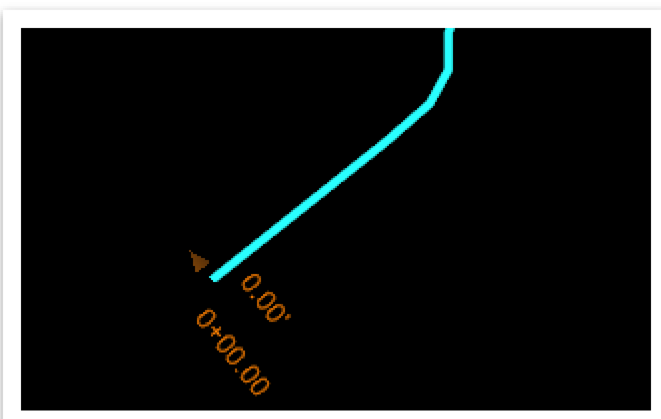


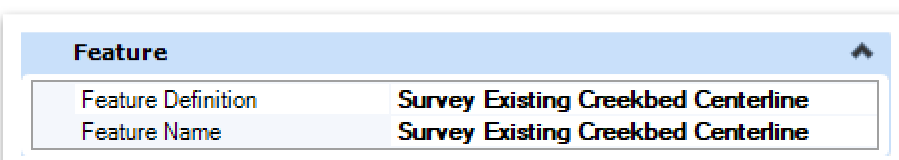


17. Repeat the previous step for the **downstream** XS, except key-in a **Start Station** of **200+00.00**.

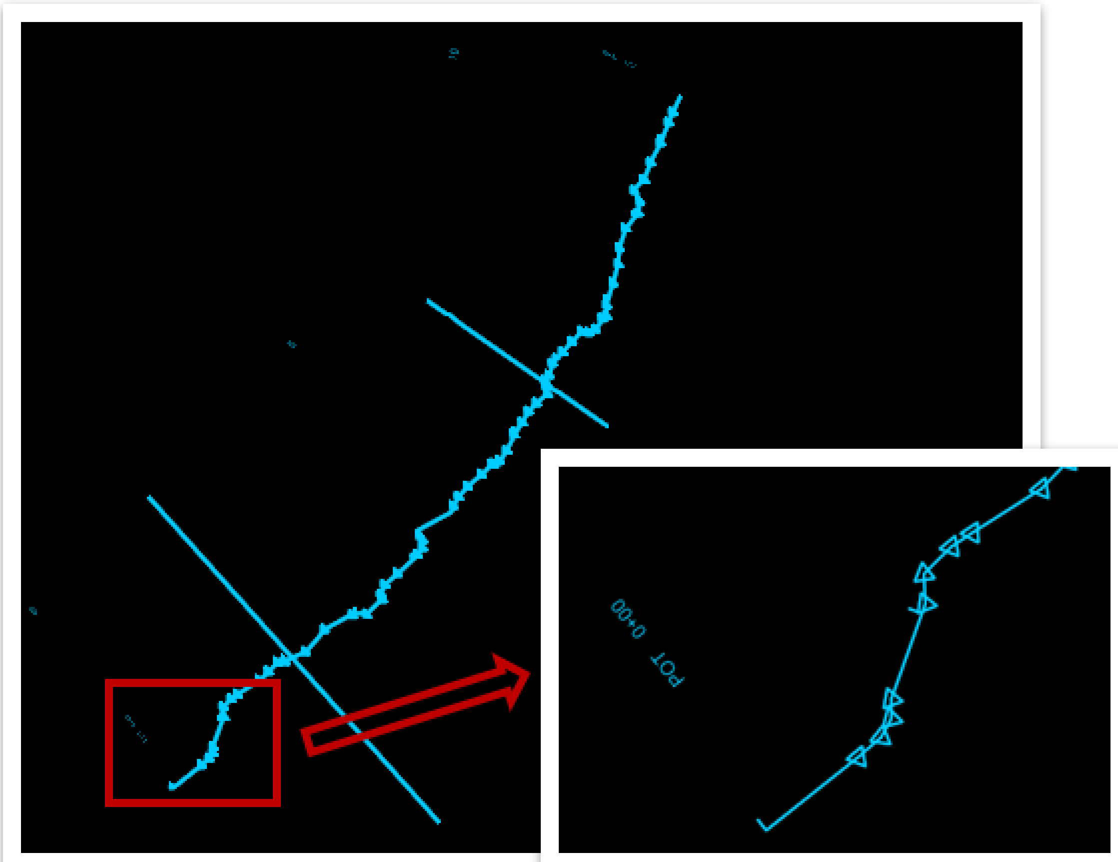


18. Repeat Step 16 for the creekbed centerline, except key-in a **Start Station** of **0+00.00**. Once completed, open its **Properties** and update the **Feature Name** to **Survey Existing Creekbed Centerline**.

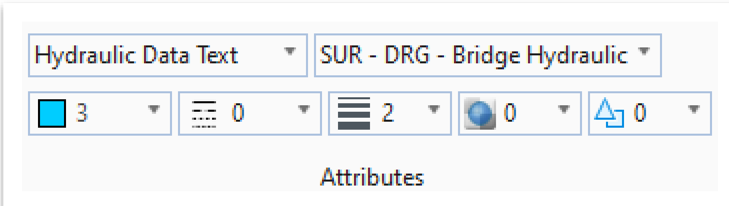




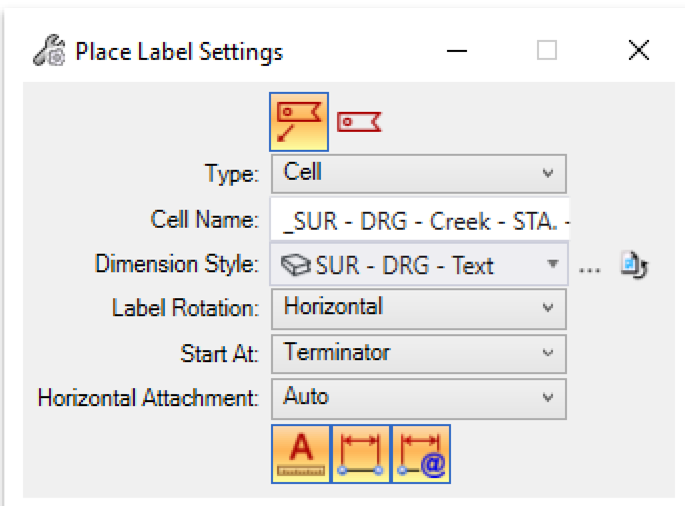
19. Now we will apply automatic annotation to the centerline. Open the **Annotate Element** tool (**OpenRoads Modeling >> Drawing Production >> Annotations >> Element Annotation**) and then select the existing creek bed centerline. Right click to reset and accept annotation placement. Notice that the centerline annotation has been added with the correct symbology.



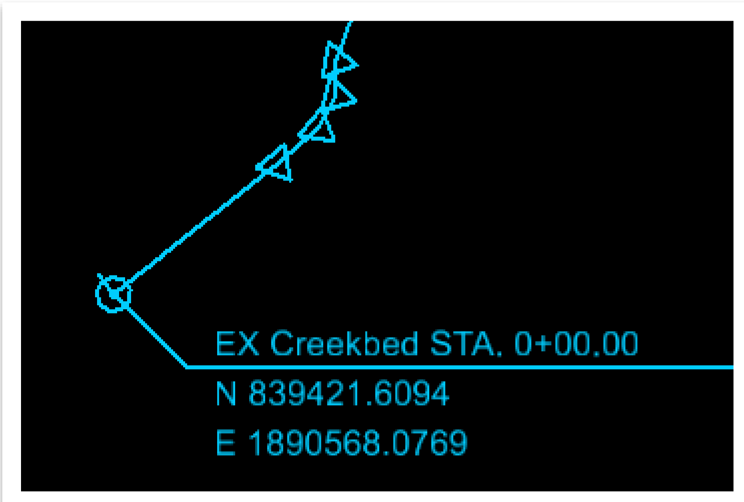
20. Next, we will place the begin/end labels for the creekbed centerline and the upstream/downstream XS lines. Before doing so, select the **Hydraulic Data Text** element template (**Survey >> Annotation >> Bridges**). As a reminder, this is necessary so the labels will place with the correct symbology.



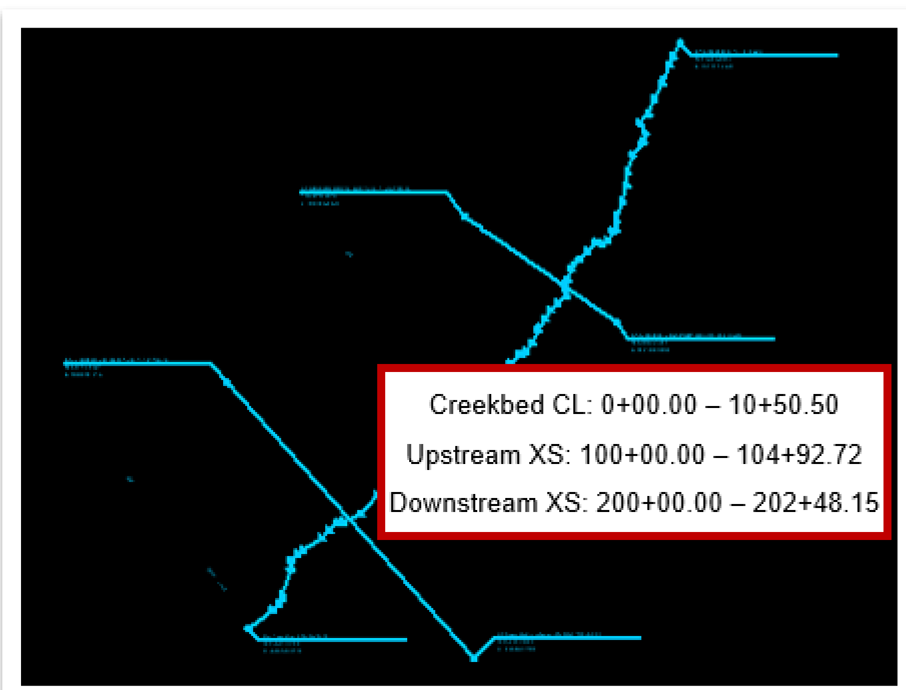
21. Open the **Place Label** tool (**OpenRoads Modeling >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings.
    a. Select the **leader** icon at the top
    b. **Type:** Cell
    c. **Cell Name:** _SUR - DRG - Creek - STA. - N.E.
    d. **Dimension Style:** SUR - DRG – Text



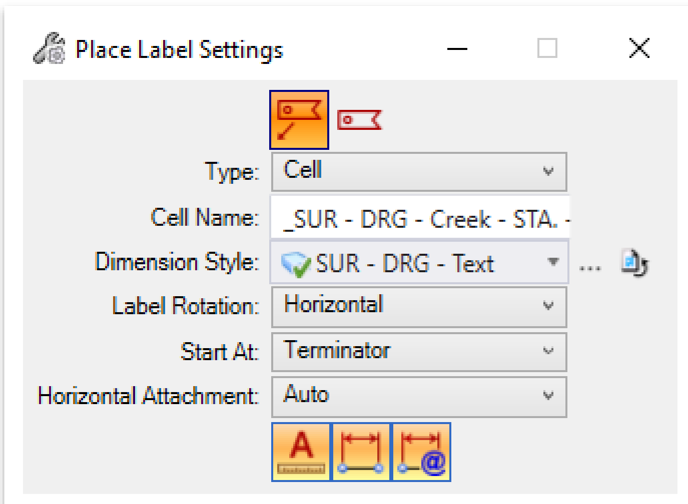
22. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the creekbed centerline so that the applicable station reference is known. Then, snap to the beginning of the centerline at Station **0+00.00** and place the label, as shown below. Notice that the name, station, northing and easting automatically populated once placed.



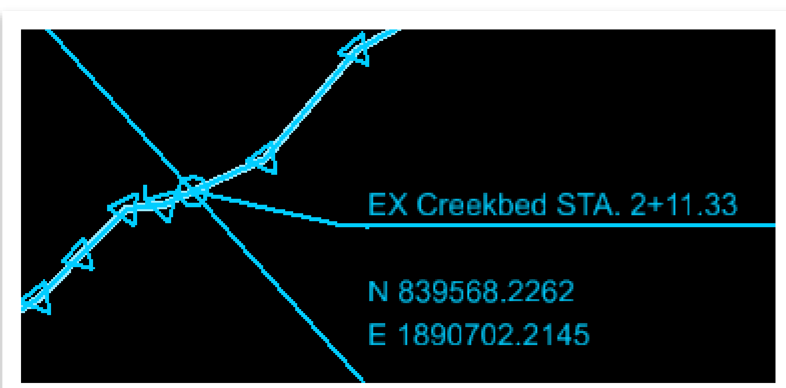
23. Go ahead and place the same label at the end of the creekbed centerline and then at the beginning and end of each XS line. Keep the same element template and **Place Label** settings for all labels. Make sure to select the applicable line before placing the label, otherwise the stationing will be incorrect. **Note:** The station ranges are shown in the image below for reference.



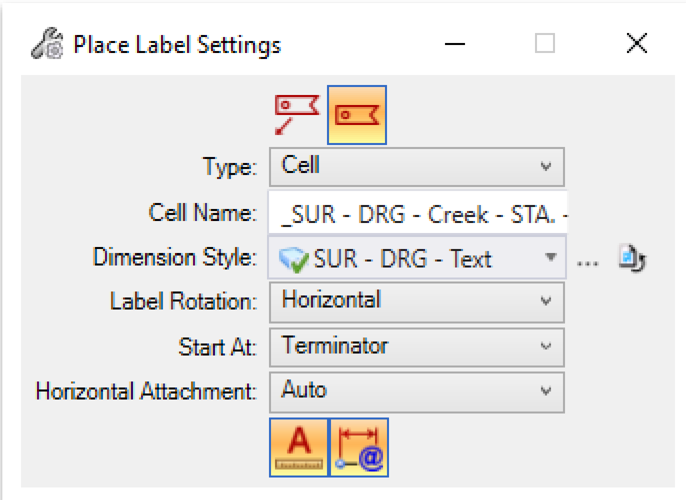
24. Lastly, we will place two intersection labels where the creekbed centerline crosses the XS lines. Currently, ORD cannot reference two alignments within a single label, but a future Bentley release should allow for that. Essentially, two labels will have to be placed to create a single intersection label. Open the **Place Label** tool once again if you had closed it. Within the **Place Label Settings** dialog box, select the following settings.
    a. Select the **leader** icon at the top
    b. **Type:** Cell
    c. **Cell Name:** _SUR - DRG - Creek - STA. - N.E. XSECTION 1
    d. **Dimension Style:** SUR - DRG – Text



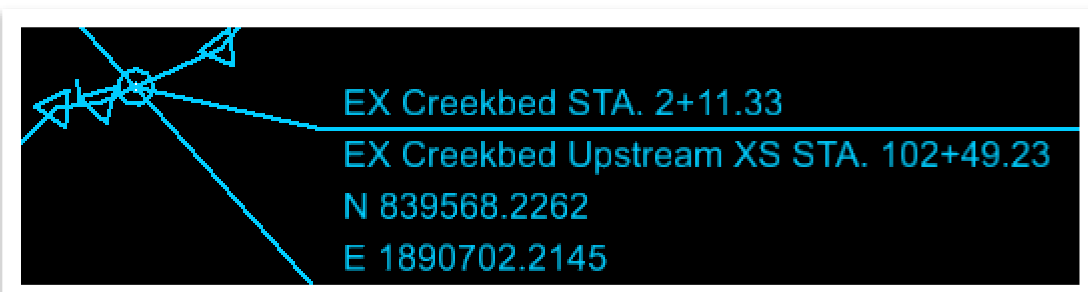
25. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the creekbed centerline, and then select the intersecting point and place the label, as shown below. The creekbed station should be **2+11.33**.



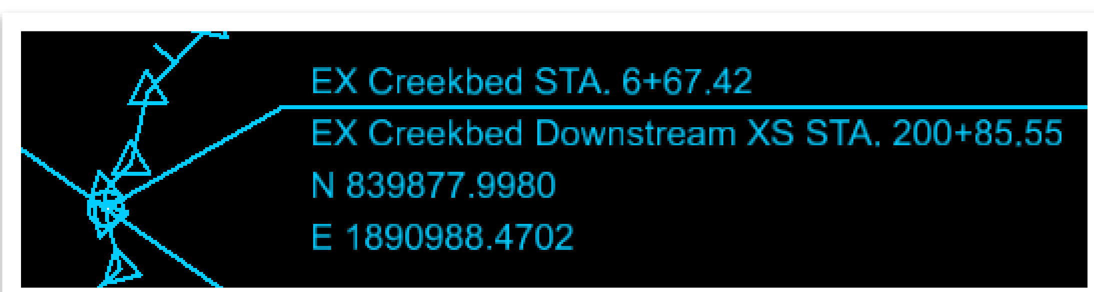
26. Now, we need to place a second label at the same location to add the XS station at the intersecting point. Within the **Place Label Settings** dialog box, select the **non-leader** option and the **_SUR - DRG - Creek - STA. - N.E. XSECTION 2** cell.



27. Make sure to select the XS line this time instead of the creekbed centerline. Then, select the intersecting point once again and snap to the first label leader. That should place the second line of text in the correct location. The XS station should be **102+49.23**. **Note:** There is a defect logged with Bentley pertaining to the label. If a line of text is too long, it overlaps itself. If that occurs, double click on the erroneous text to open the **Text Editor** and then simply left click anywhere within the **drawing window** to close it. This "refresh" updates the label correctly.



28. Repeat Steps 24-27 to place the downstream intersecting label which will complete the annotation. The corresponding stations should be **6+67.42** and **200+85.55**.



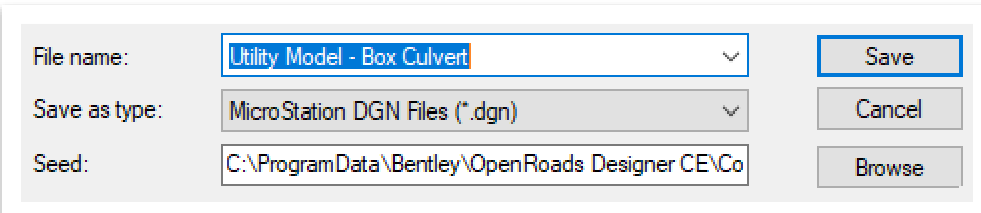
6.4 Lecture: Box Culvert Crossings (Profile View)

When adding existing box culvert crossings to a roadway profile, it is assumed that the existing box culvert <u>plan</u> data has already been imported into the field book. The survey preliminary centerline must be created before this exercise can be done.

6.4.1 Exercise: Crossing – Box Culvert

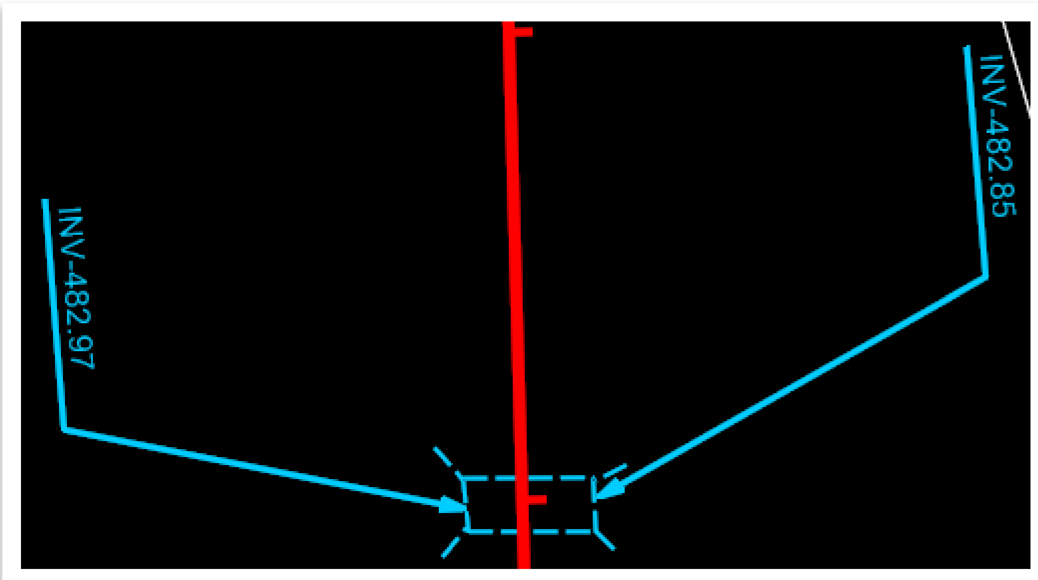
In this exercise, we will add an existing box culvert crossing to a roadway profile, after creating the required **Utility** model. **Note:** The box culvert model would normally be part of the overall 2D survey utility model file but has been separated out for the purpose of training.

1. Create a new file and name it **Utility Model – Box Culvert**. Select the **TDOTSeed 2D.dgn** and click **Save**.

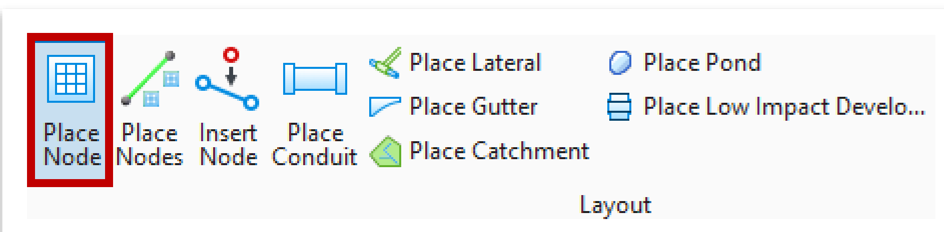


2. Attach the following reference files using the **Coincident World** attachment method and then click **Fit View**.
   - Alignment – Box Culvert.dgn
   - Existing Terrain – Box Culvert.dgn
   - Survey Model – Box Culvert.dgn
3. Within the **Survey Model – Box Culvert.dgn** reference file, all levels should be turned off other than **SURVEY - DRAINAGE - Pipes and Culverts** and **SURVEY - DRAINAGE - Pipes and Culverts Text**.
4. Go ahead and switch to the **Drainage and Utilities** workflow in the upper left corner and then zoom in to the western part of the project where the box culvert crossing is displayed along with the other text (highlighted below).

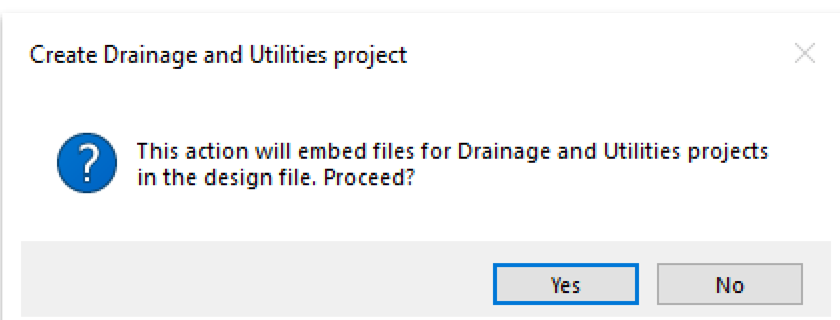
5. Rotate the view so that it is aligned with the box culvert. Identify both the upstream (**482.97'**) and downstream (**482.85'**) sides of the existing **12'x4' RCB** using the invert elevations shown in the survey file (left to right).



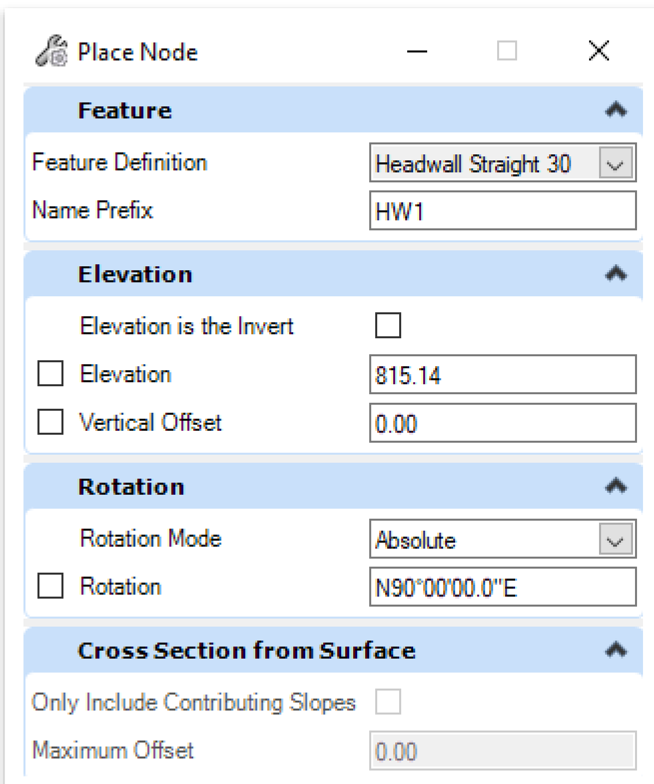
6. We will now build the existing box culvert utility model in plan view. First, we need to place nodes on both ends of the box culvert. Open the **Place Node** tool (**Drainage and Utilities >> Layout >> Layout**).



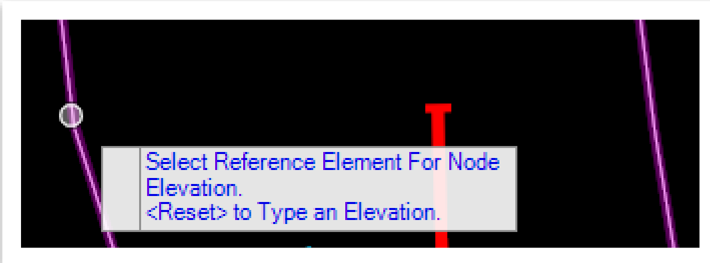
7. A warning will display asking if you want to embed files for **Drainage and Utilities** projects in the design file. Click **Yes**.



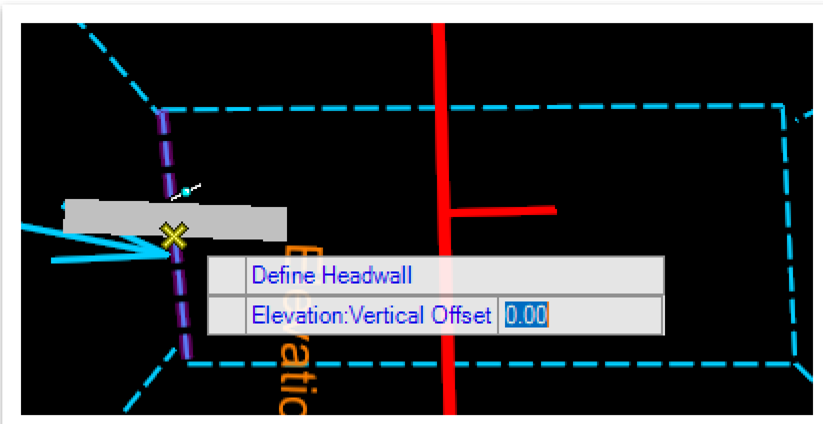
8. Go ahead and open the **Place Node** tool again (**Drainage and Utilities >> Layout >> Layout**). Within the **Place Node** dialog box, select the following settings and leave the others as default. **Note:** This headwall does not match the opening of the box culvert we are going to display in profile view. There are no available features for existing headwalls. The headwalls in this exercise will not be shown or called out on the plans and merely serve the purpose of connecting the pipe between two points.
    a. **Feature Definition:** Headwall Straight 30 (**Node >> StormWaterNode >> Headwalls >> Straight**)
    b. **Name Prefix:** HW1
    c. **Elevation is the Invert:** Toggle Off
    d. **Elevation:** Ignore the value but make sure the checkbox is toggled **off**
    e. **Vertical Offset:** 0.00
    f. **Rotation Mode:** Absolute



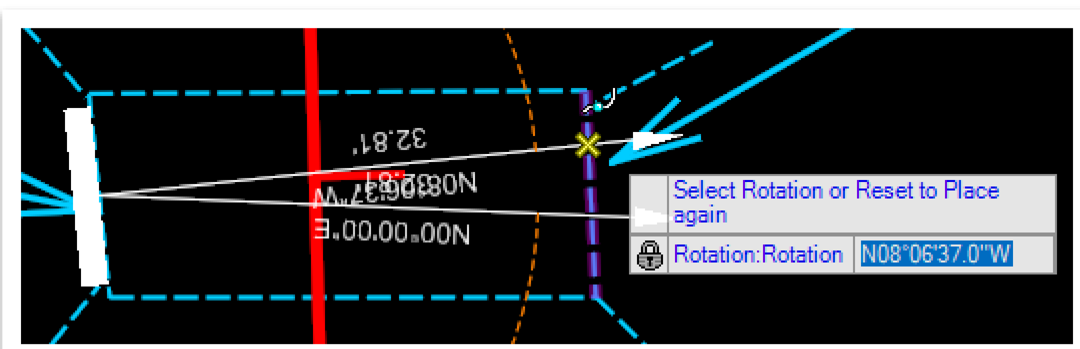
9. Notice the cursor prompt: **Select Reference Element For Node elevation**. Select the terrain boundary.



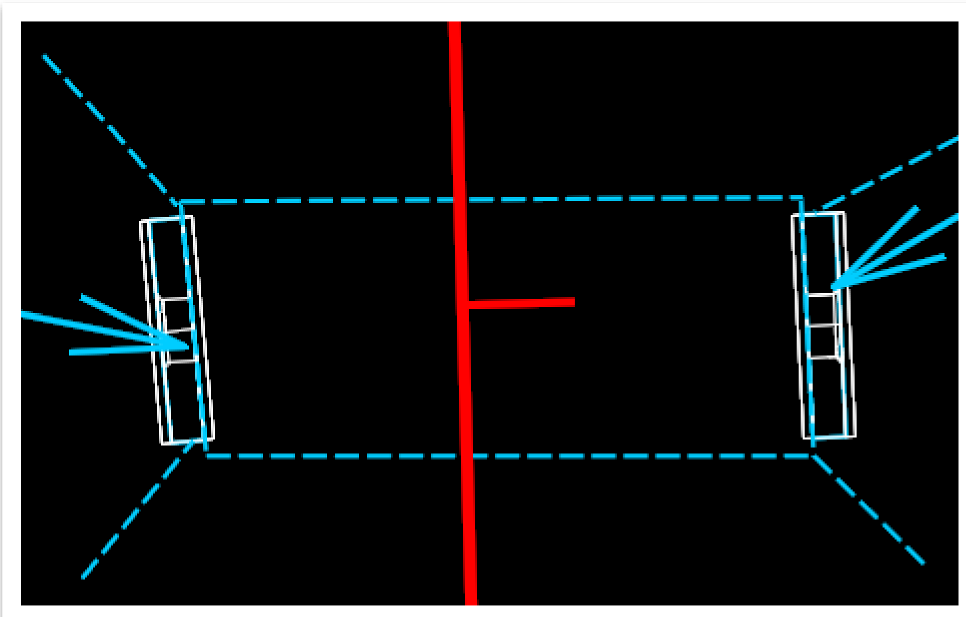
10. Next, locate the **midpoint** on upstream side of the box culvert and **left** click to accept the initial headwall (node) placement.



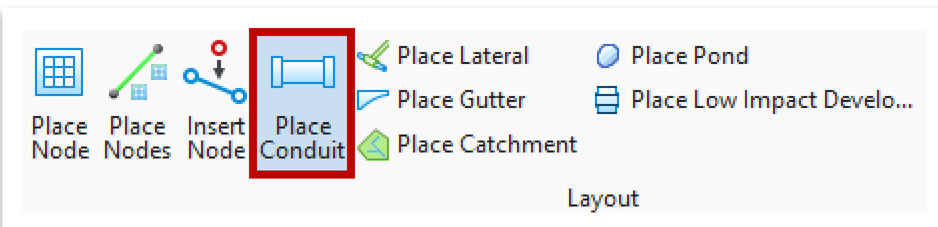
11. Left click to accept the **Absolute** rotation mode and then rotate the headwall to align with the box culvert centerline, as shown below. Once rotated, left click to accept final placement. **Note:** A rotation of **N08°06’37.0”W** was used below.



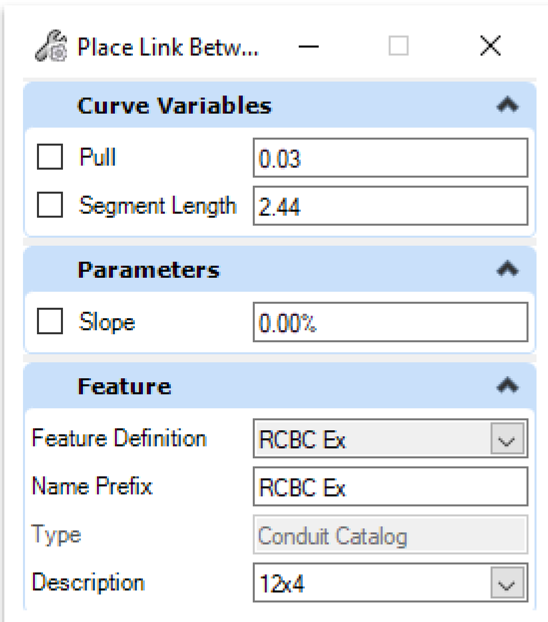
12. Repeat Steps 10-11 to place another headwall (node) at the **midpoint** on the other end of the box culvert and then open the Element Selection tool to clear the tool. **Note:** A rotation of **S05°06'44.8"E** was used below.



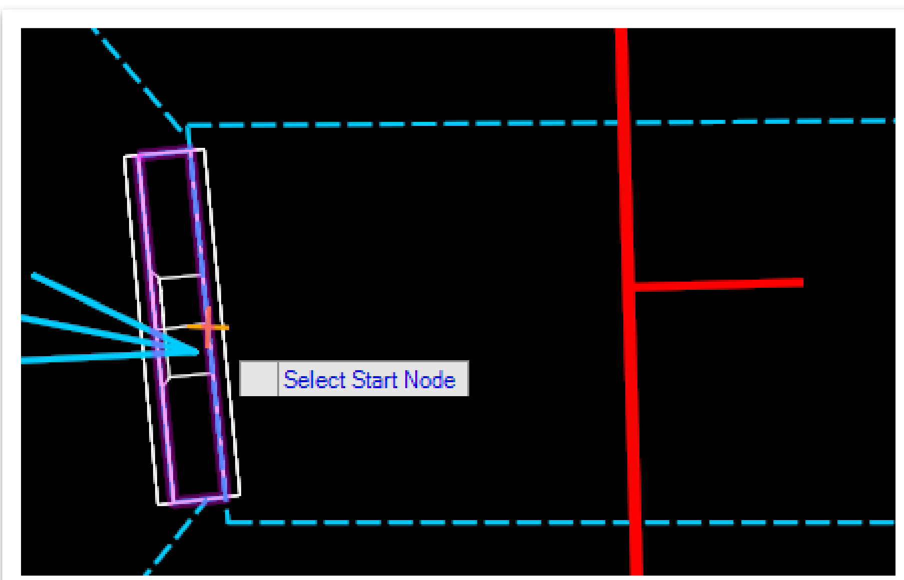
13. Now that the nodes are placed, we need to connect them with conduit. Open the **Place Conduit** tool (**Drainage and Utilities >> Layout >> Layout**).



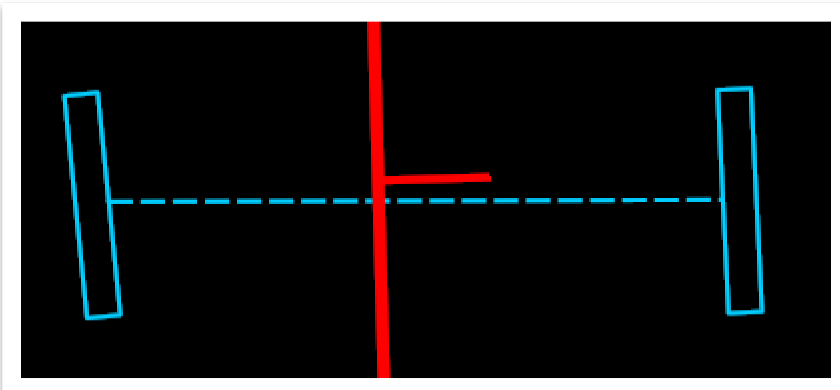
14. Within the **Place Link Between Nodes** dialog box, select the following settings and leave the others as default.
    a. **Feature Definition:** RCBC Ex (**Conduit >> StormWater >> Culvert Pipes >> Existing**)
    b. **Name Prefix:** RCBC Ex
    c. **Description:** 12x4 (If no options appear in the drop-down, close ORD and re-open the file.)



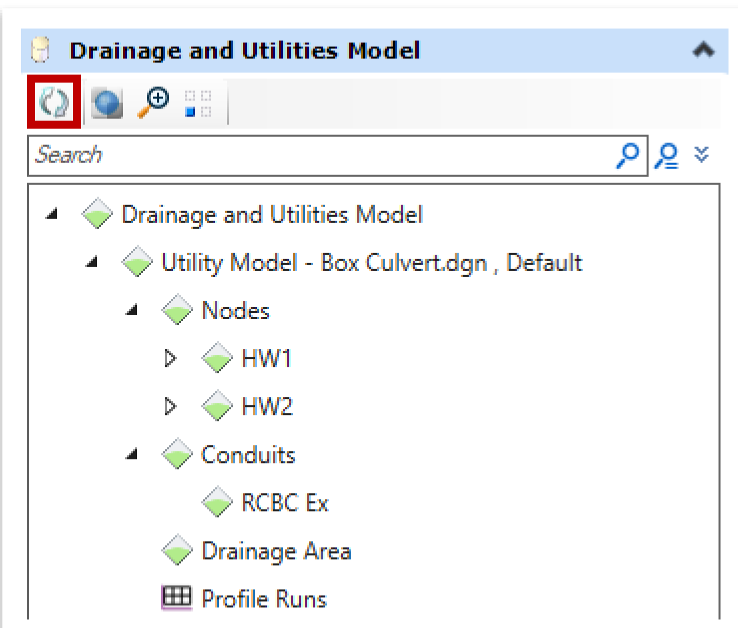
15. Notice the cursor prompt: **Select Start Node**. Select the **upstream** headwall (higher elevation 482.97').



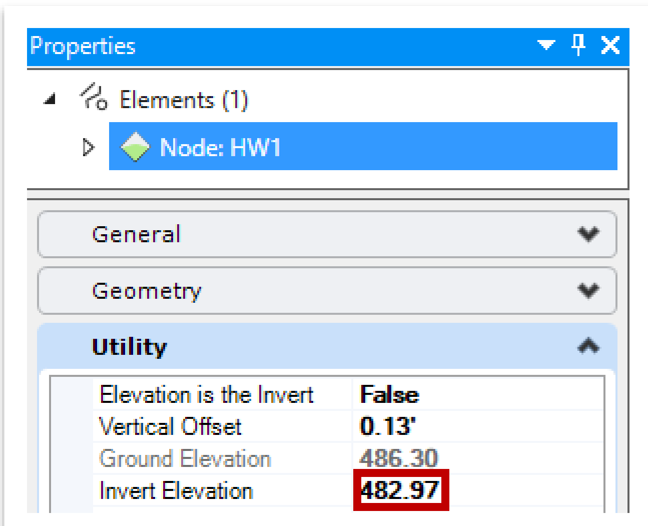
16. Then, select the **downstream** headwall (lower elevation 482.85') to place the conduit and right click to clear the tool. When the conduit is placed, the width (wall) of the box culvert, represented by double lines, is shown within the **3D** reference file. Go ahead and turn off both the **Utility Model – Box Culvert.dgn, Default-3D** and **Survey Model – Box Culvert.dgn** reference files. You should now only see the **2D** headwalls and conduit, as shown below.



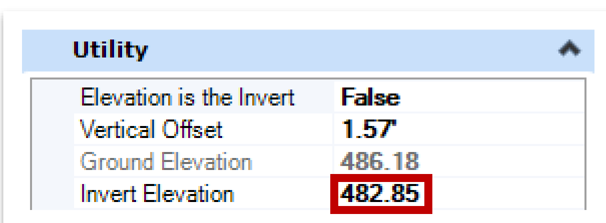
17. Within the **Explorer**, open the **Drainage and Utilities Model** tab and notice that the **nodes** and **conduit** have been added. **Note:** If the nodes are not showing, click the **Refresh** icon under the **Drainage and Utilities Model** header. If the nodes still do not show, close and re-open the **Explorer**.



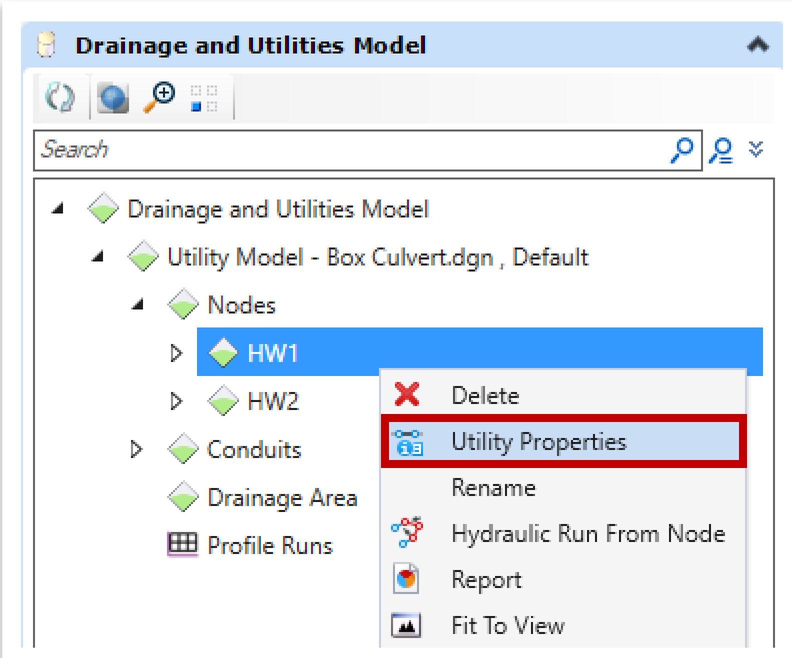
18. Now, let's verify the box culvert invert elevations for each headwall and make sure they match the surveyed elevations. Open the **Properties** window (if not already opened) and then select **HW1** in plan view using the **Element Selection** tool. Under the **Utility** header, update your data as indicated below. **Note:** The key value is the **Invert Elevation**, as the other values will ultimately have no impact on the display of the box culvert in profile view.
    a. **Elevation is the Invert:** False
    b. **Vertical Offset:** Automatically populates
    c. **Ground Elevation:** Automatically populates (**3.33'** higher than the invert) due to the **Elevation is the Invert** setting
    d. **Invert Elevation:** Key-in **482.97**, which will match the upstream invert label in the survey file



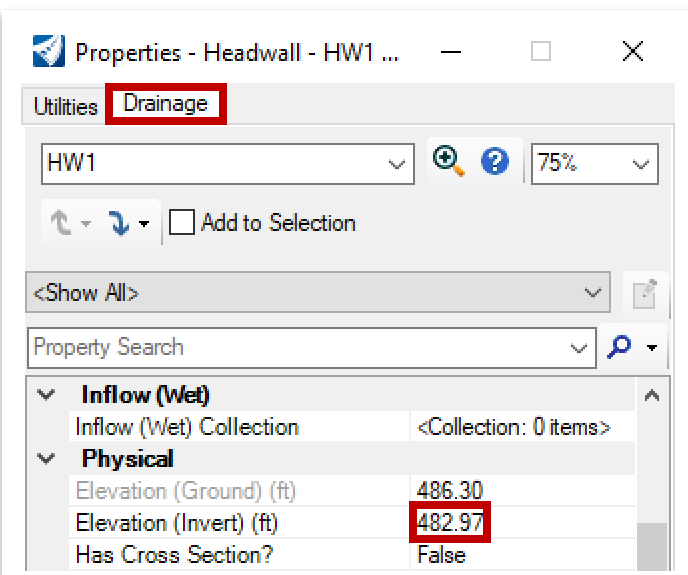
19. Repeat the same process for **HW2**, except set the **Invert Elevation** to **482.85**, which will match the downstream invert label in the survey file.



20. Next, let's review the **Utility Properties** for each **HW** and confirm that the **Invert Elevations** are shown correctly. Right click on **HW1** and select **Utility Properties**.



21. Notice that the correct **Elevation (Invert) (ft)** is shown under **Drainage >> Physical**. Go ahead and also confirm that **HW2** shows an equilvalent value of **482.85**. **Note:** If the **top** of your window differs, (header, HW1 field) you can ignore. That information does not always sync correctly with the selected structure. A defect has been logged with Bentley and should be addressed in a future software release. Also, the order of categories (e.g. Inflow (Wet), Physical, etc) may vary on your screen.



22. Now, open the **RCBC Ex** (conduit) **Utility Properties**. Under **Drainage >> Physical**, make sure that the **Set Invert to Start?** and **Set Invert to Stop?** fields are both **True**. This will make the box culvert inverts (upstream and downstream) match the headwalls. Close the **Utility Properties** window once you are done.

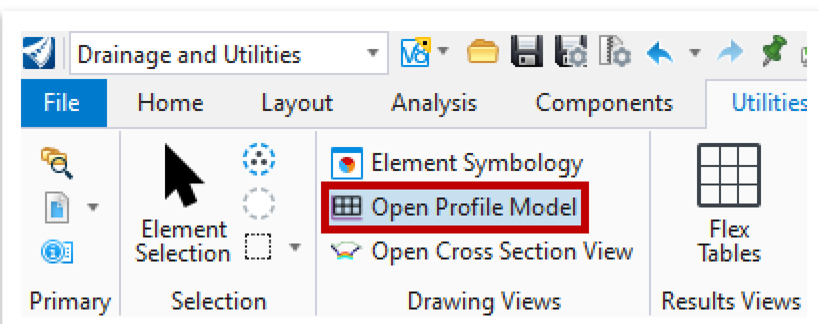
Number of Barrels	1
Manning's n	0.013
Use Local Conduit Description?	False
Conduit Description	Box - 0.00 x 0.00 ft
Set Invert to Start?	True
Invert (Start) (ft)	482.97
Set Invert to Stop?	True
Invert (Stop) (ft)	482.85
Has User Defined Length?	False

23. If you had **two or more** box culverts, you would enter the applicable number in the **Number of Barrels** field within the **Utility Properties**.

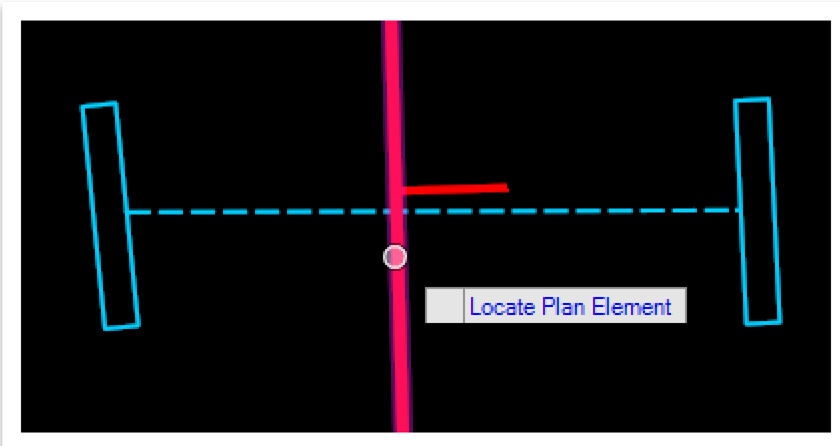
Number of Barrels	1
Manning's n	0.013
Use Local Conduit Description?	False

24. Next, we need to profile the box culvert. Go ahead and open the **Alignment – Box Culvert.dgn** file and attach the **Utility Model – Box Culvert.dgn** reference file. **Note:** The Box Culvert profile would normally be part of the existing profile within the overall 2D survey alignment file but has been separated out for the purpose of training.

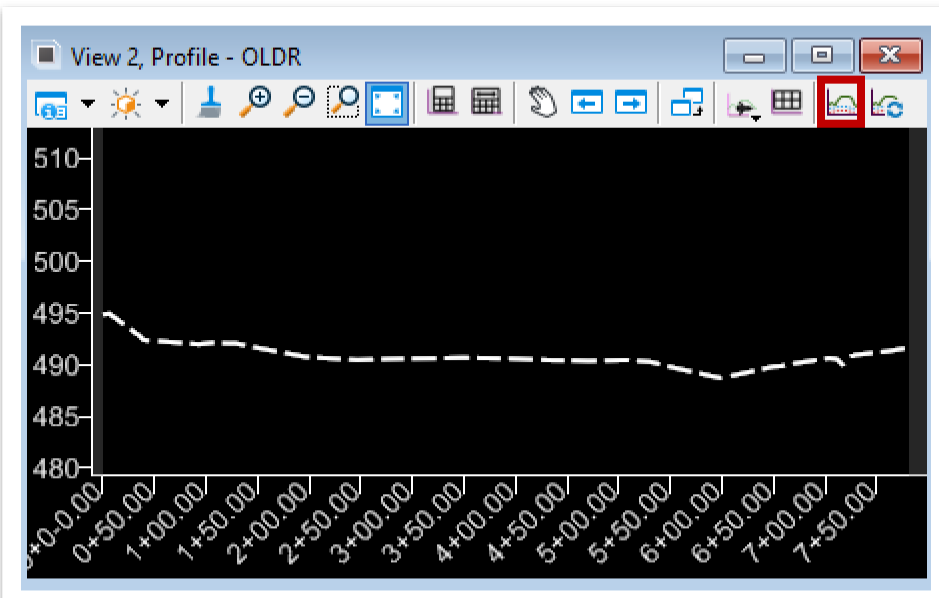
25. Open the **Open Profile Model** tool (**Drainage and Utilities >> Utilities View >> Drawing Views**).



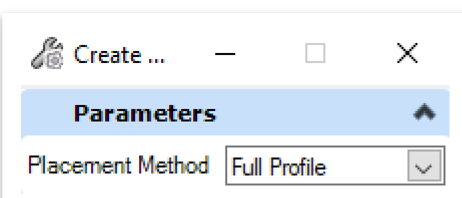
26. Notice the cursor prompt: **Locate Plan element**. Select the red centerline.



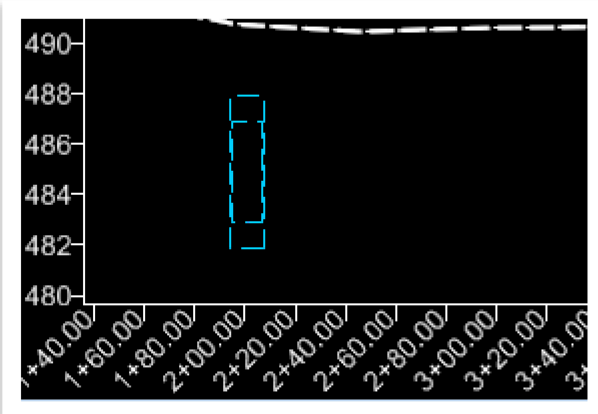
27. Then, open **View 2** and left click anywhere within that view. You should see the existing profile, as shown below. Within the **Profile** view, select the **Create 3d Cut** tool.



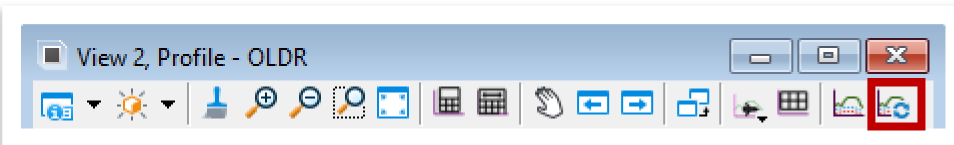
28. Within the **Create 3d Cut** dialog box, select the **Full Profile** placement method this time.



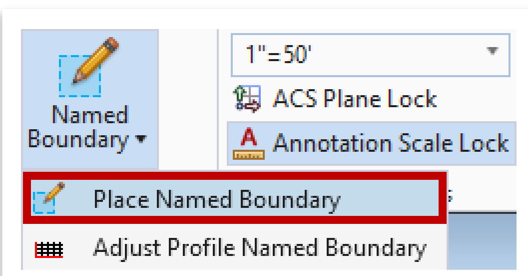
29. Left click within the profile window to accept. Zoom in and notice that the box culvert is now displayed at approximate Station **2+00.00**.



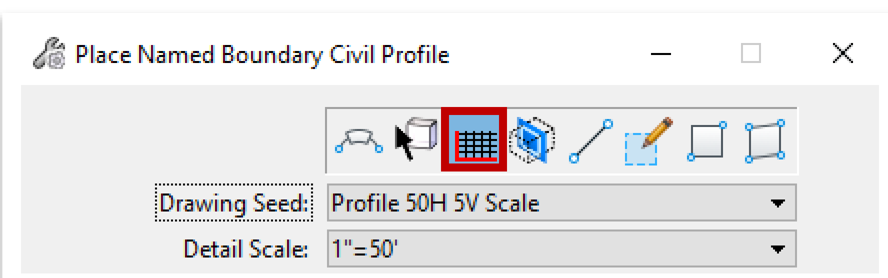
30. If additional edits are made to the inverts, use the **Refresh 3d Cut** tool within the profile view to update the box culvert.



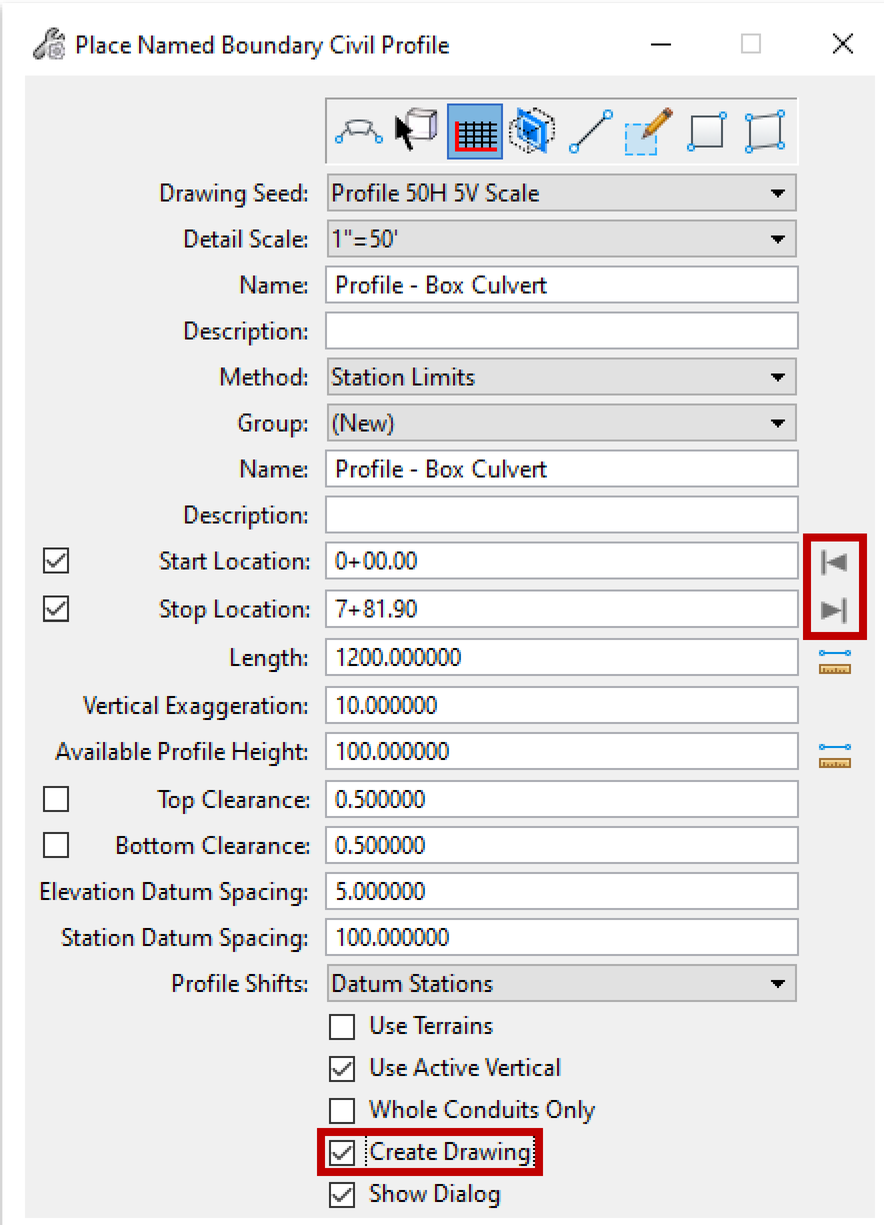
31. As a reminder, in order to place annotation, we need to create a profile named boundary. Open the **Place Named Boundary** tool (**Drainage and Utilities >> Drawing Production >> Named Boundaries >> Named Boundary**).



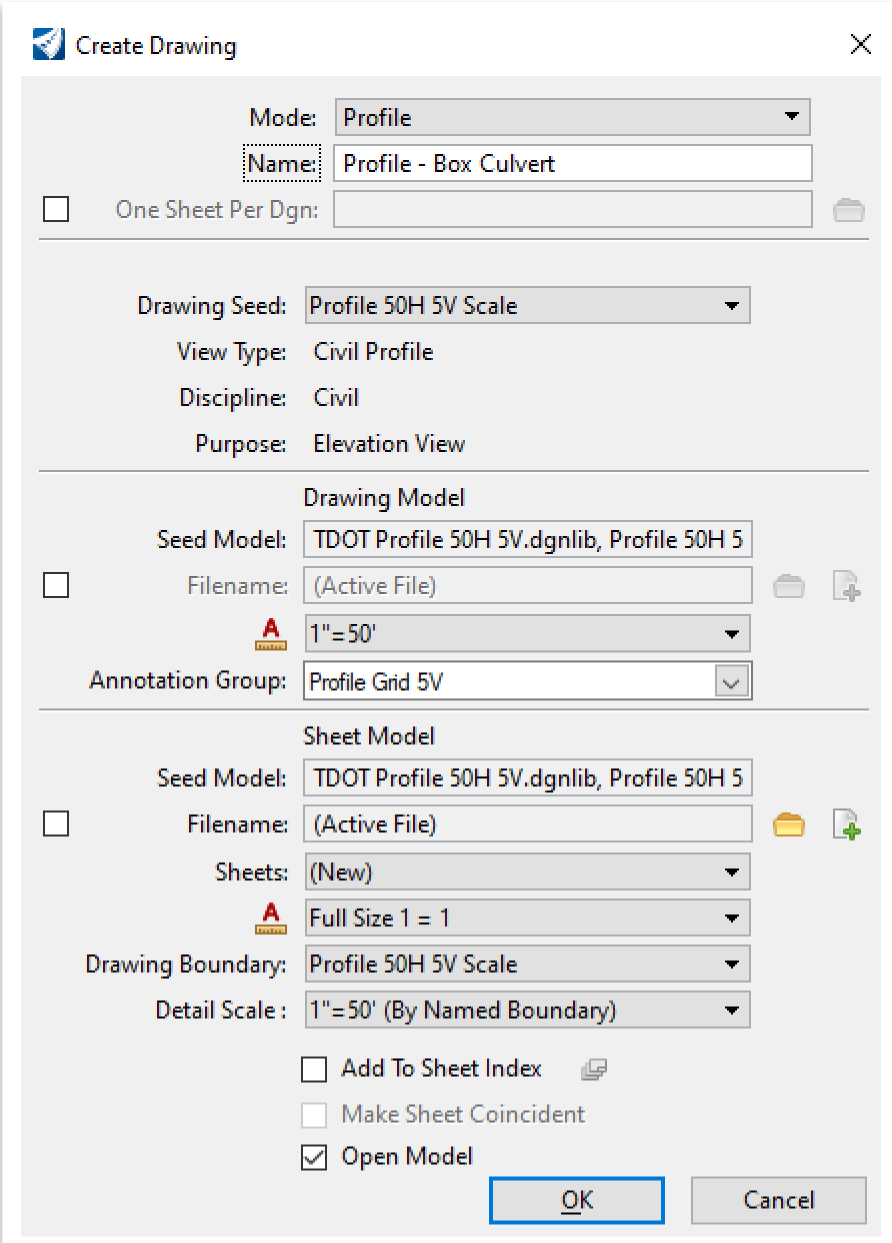
32. Make sure that the **Civil Profile** option is toggled on. Select **Profile 50H 5V Scale** for the Drawing Seed.



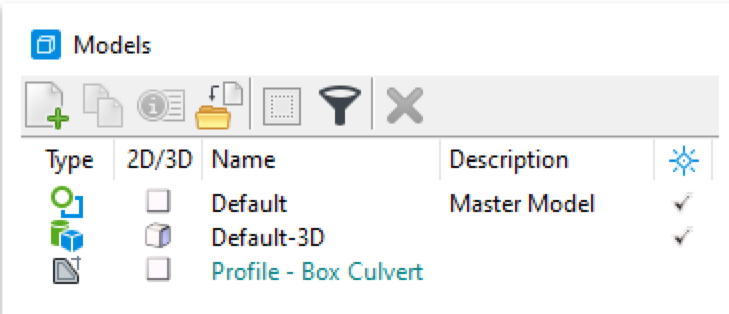
33. Notice the prompt in the lower left corner of the drawing window: **Identify Profile View**. Left click anywhere within **View 2**.
34. Use the grey arrows to lock the **Start** and **Stop Location** to the profile extents so that the entire profile is accounted for. Key-in **Profile – Box Culvert** for both the **Named Boundary** name and the **Group** name. Leave the other default values as-is and make sure that the **Create Drawing** option is toggled on at the bottom.



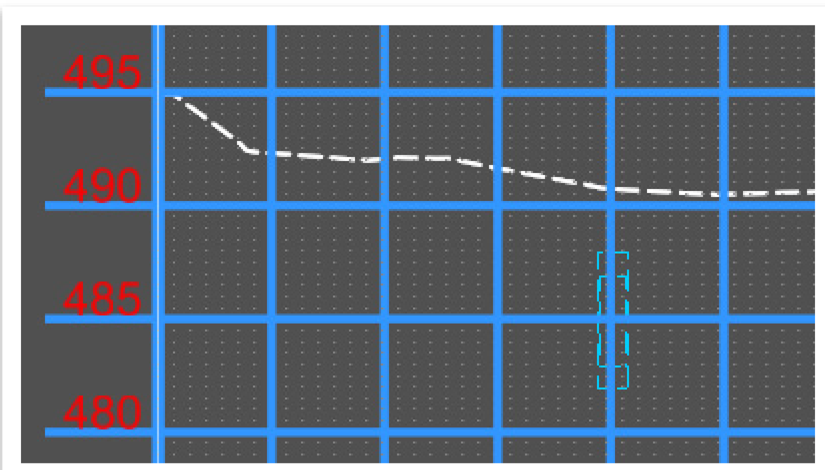
35. Left click anywhere within View 2 **three** times. Zoom out and you should see **one** profile named boundary drawn into the file, represented by a white border. The **Create Drawing** window will appear automatically after creating the named boundary, since we toggled it on in the previous step. Click **OK** to accept all default settings.



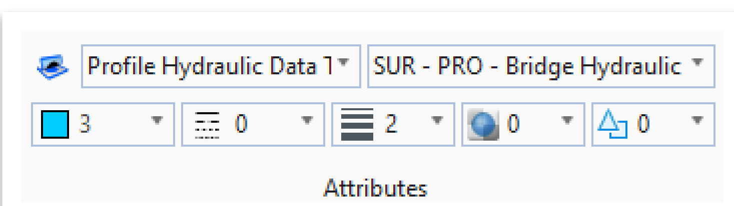
36. Once again, the software should open to the <u>one</u> sheet model in **View 1**, which is only needed when printing sheets. Let's go ahead and delete the sheet model. Open the **Models** tool (**Drainage and Utilities >> Home >> Primary**) and double click on the **Profile – Box Culvert** <u>drawing</u> model to activate it. Then, right click on the <u>sheet</u> model and select **Delete**. You should see the following three models once completed.



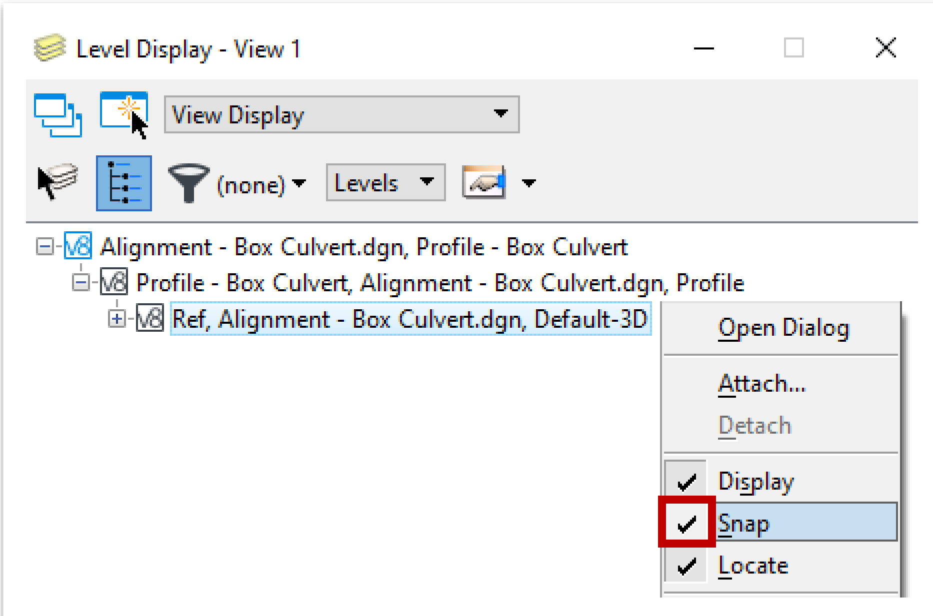
37. Zoom in to the box culvert and notice the profile grid, stations and elevations. We will next add the applicable annotation, like in the previous exercises.



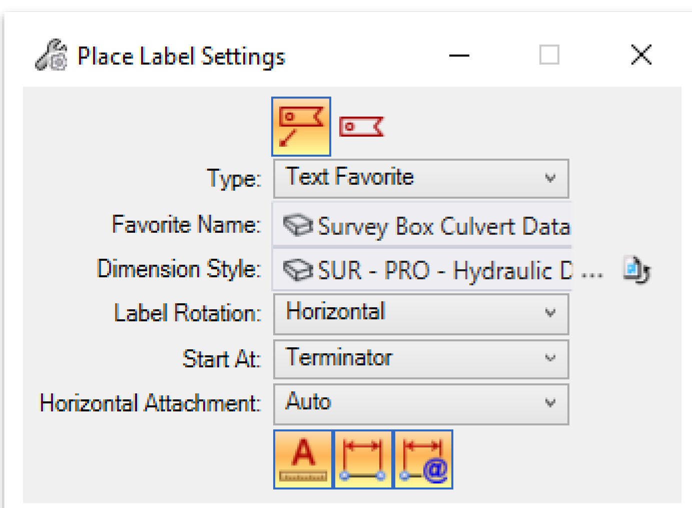
38. Before we add the annotation, select the **Profile Hydraulic Data Text** element template (**Survey >> Annotation >> Profiles >> Bridges**).



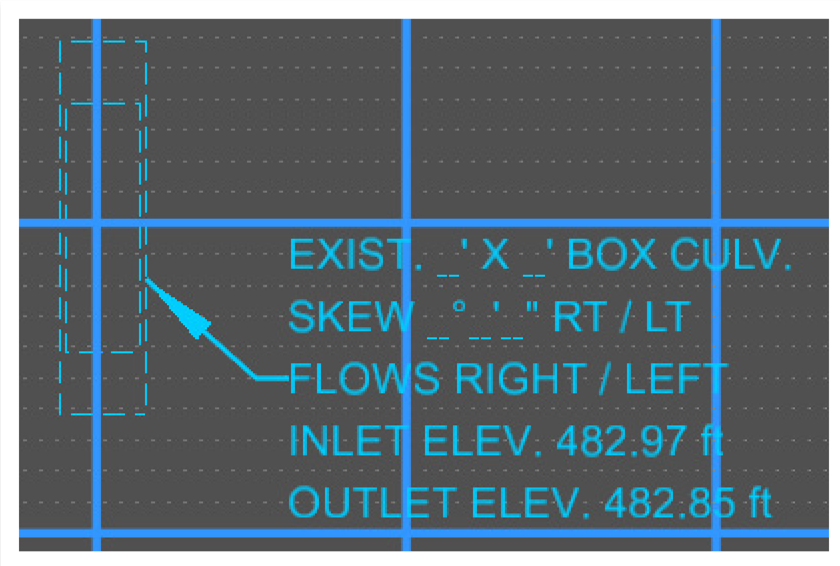
39. Now, open the **Level Display** and right click on **Ref, Alignment - Box Culvert .dgn, Default-3D** and toggle the **Snap** option on. This will allow us to snap to the box culvert when placing annotation. Close the **Level Display** once you are done.



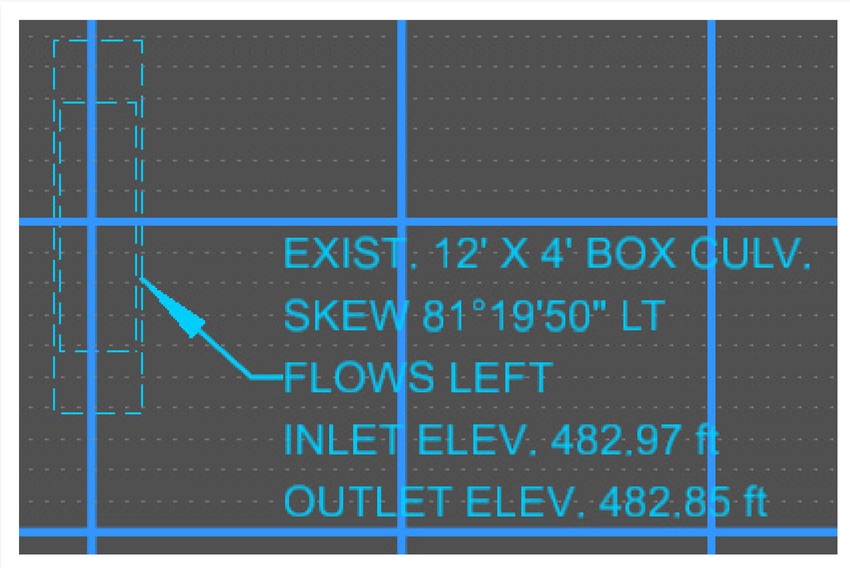
40. Next, open the **Place Label** tool (**Drainage and Utilities >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings.
    a. Select the **leader** icon at the top
    b. **Type:** Text Favorite
    c. **Favorite Name:** Survey Box Culvert Data
    d. **Dimension Style:** SUR - PRO - Hydraulic Data



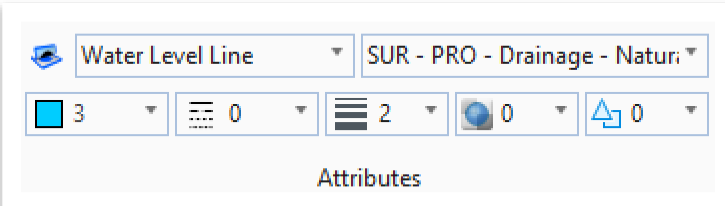
41. Notice the prompt in the lower left corner: **Select Point Location**. Zoom in and snap to the outer wall of the box culvert.



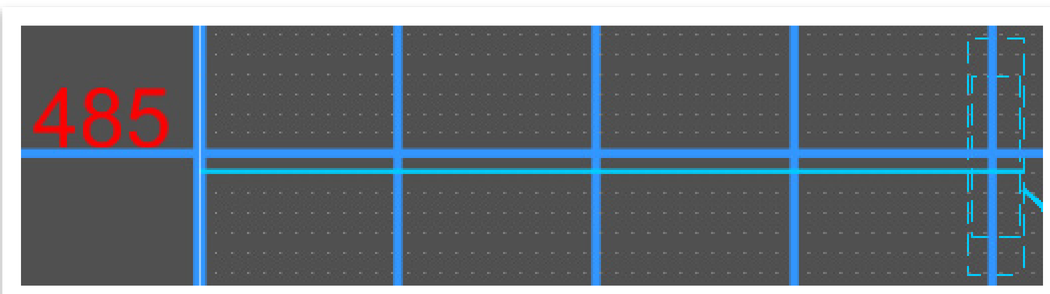
42. Double click within the label to open the **Text Editor** and update the data fields with the applicable survey information, as shown below. **Note:** The data fields have been turned off.



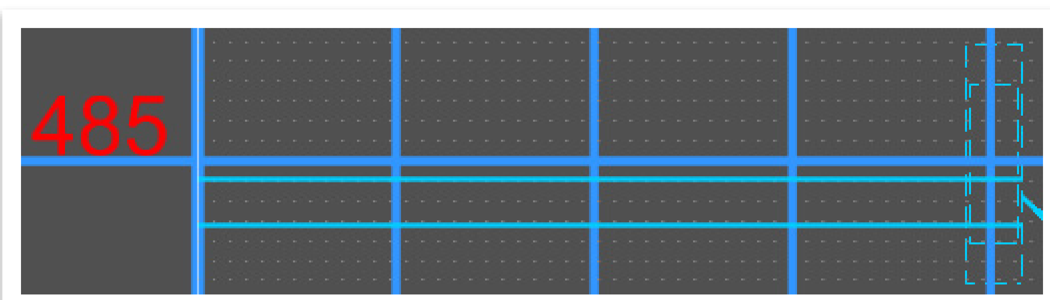
43. Now, let's add the **High Water** elevation label to the profile using a similar procedure. First, however, we must add the physical line that will be labeled. Select the **Water Level Line** element template (**Survey >> Annotation >> Profiles >> Bridges**).



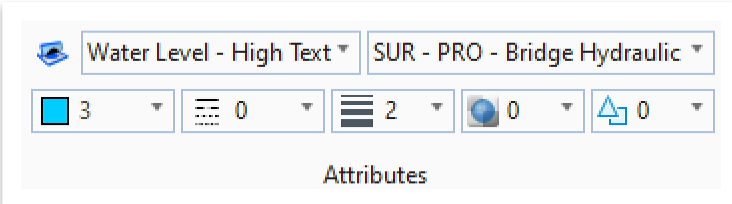
44. Open the **Place SmartLine** tool (**Drainage and Utilities >> Drawing >> Placement**) and draw a **horizontal line** across the profile at the applicable elevation (**484.55'**) to represent **High Water** (HW). For this exercise, draw the line from the Y-axis to the right outer wall. **Note:** This elevation can be obtained in plan view and is typically obtained from conversations with residents in the given area.



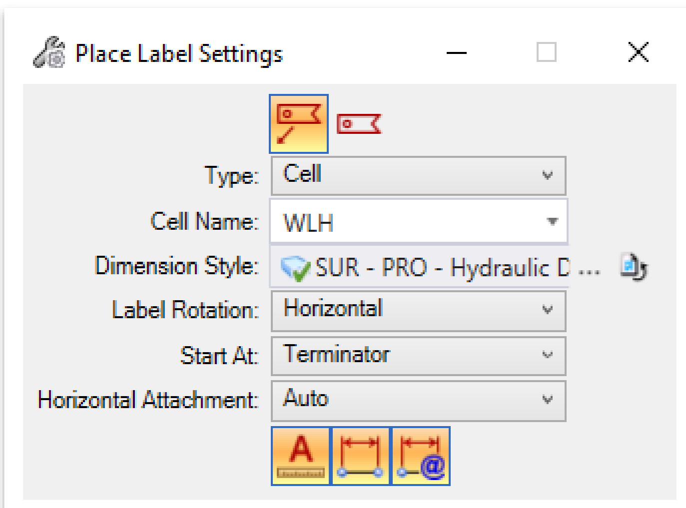
45. Repeat the previous step to place the **Normal Water** (NW) line at the applicable elevation (**483.39'**).



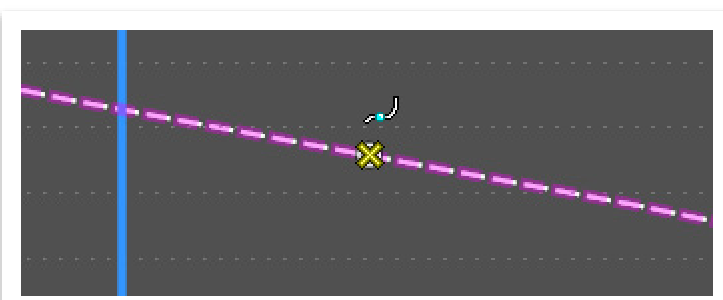
46. Next, let's label the two lines that were just placed. Select the **Water Level - High Text** element template (**Survey >> Annotation >> Profiles >> Bridges**).



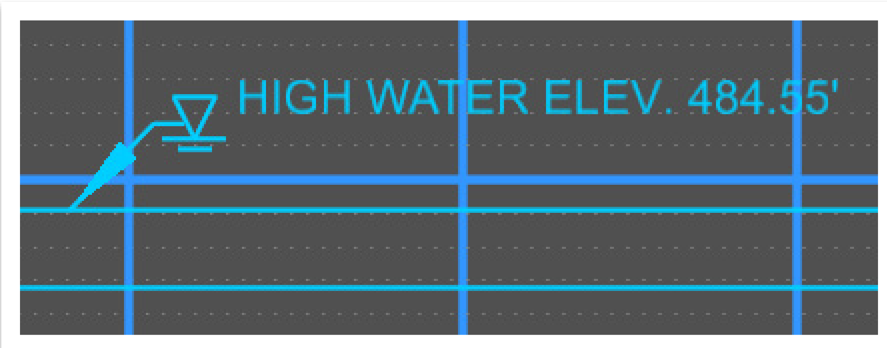
47. Open the **Place Label** tool (**Drainage and Utilities >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings.
    a. Select the **leader** icon at the top
    b. **Type:** Cell
    c. **Cell Name:** WLH (Loads automatically based on the element template selected in the previous step)
    d. **Dimension Style:** SUR - PRO - Hydraulic Data



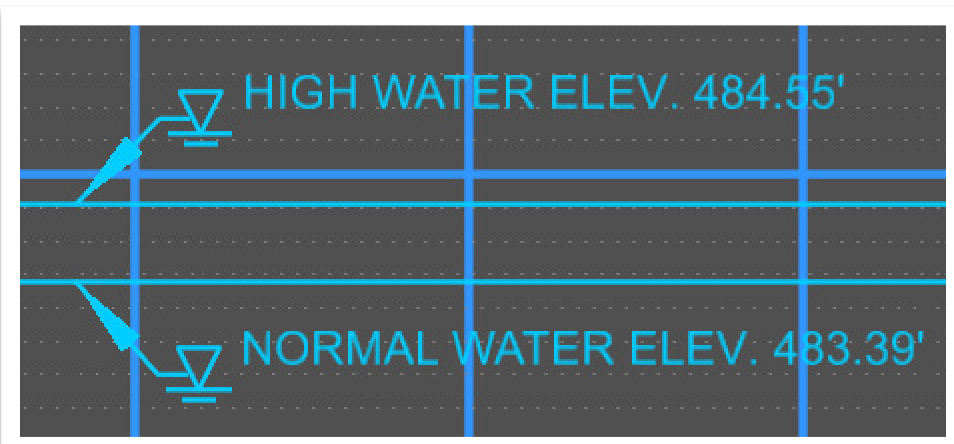
48. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the road centerline profile.



49. Notice the next prompt in the lower left corner: **Select Point Location**. Snap to the **High Water** (HW) line and place the label. Notice that the elevation fills in automatically. **Note:** You could also select the **non-leader** option and place the symbol/label right on the line itself. There is a defect logged with Bentley regarding the origin point of the cell. You'll notice it is offset from the bottom of the triangle.



50. Repeat Steps 45-48 to place the **Normal Water** line label. This time select the **Water Level - Normal Text** element template (**Survey >> Annotation >> Profiles >> Bridges**) and you'll notice that the applicable cell (**WLN**) automatically links.

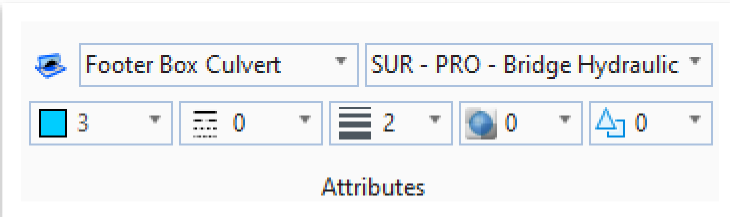


Take Note!

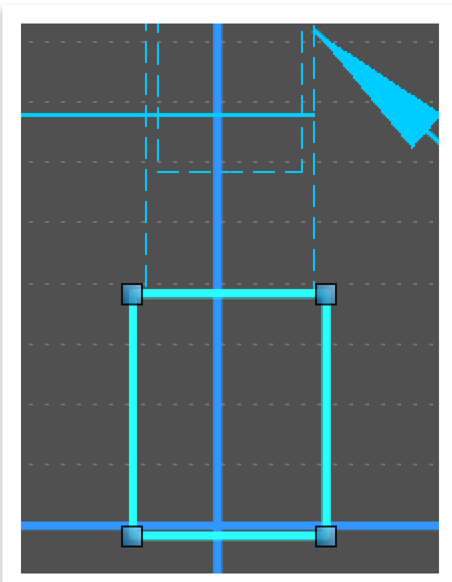
*In ORD, **box culverts** display a generic wall thickness of **12"** for most sizes. The thickness of the wall is displayed in the profile. If the existing structure is a 3-sided slab bridge, the model will still be built as a 4-sided box culvert with the appropriate dimensions and a profile will be displayed. A surveyor might pick up an invert elevation at the footer of the structure, which represents the bottom of the footer slab.*

If the additional footer invert elevation is provided, the linework shall be drawn manually for the footer.

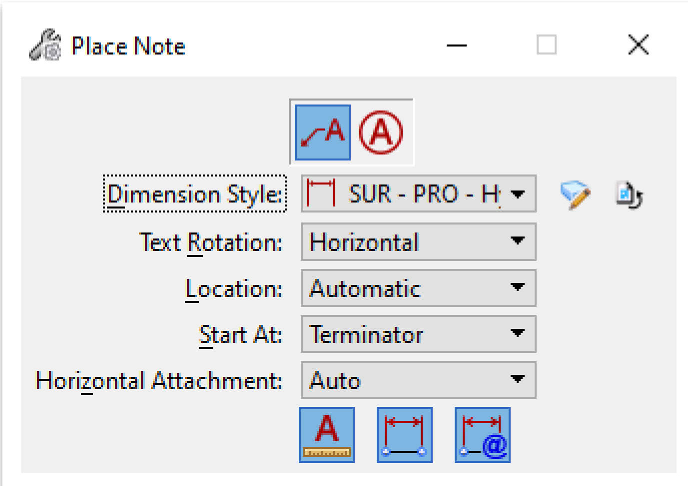
51. For this exercise, let's draw a **16'** wide by **2'** deep footer for representation purposes in the profile. First, select the **Footer Box Culvert** element template (**Survey >> Annotation >> Profiles >> Bridges**).



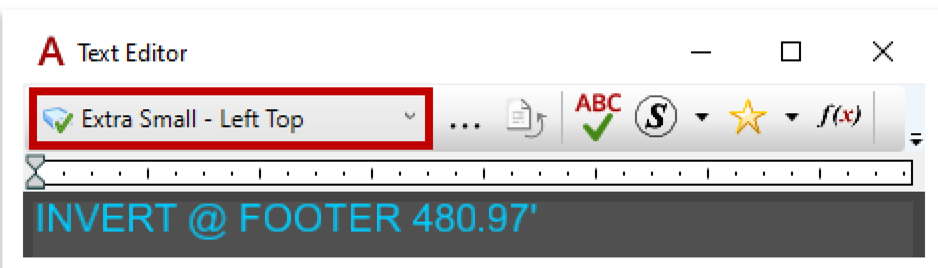
52. Open the **Place SmartLine** tool (**Drainage and Utilities >> Drawing >> Placement**) and draw the footer so that it is aligned with the center of the bottom slab.



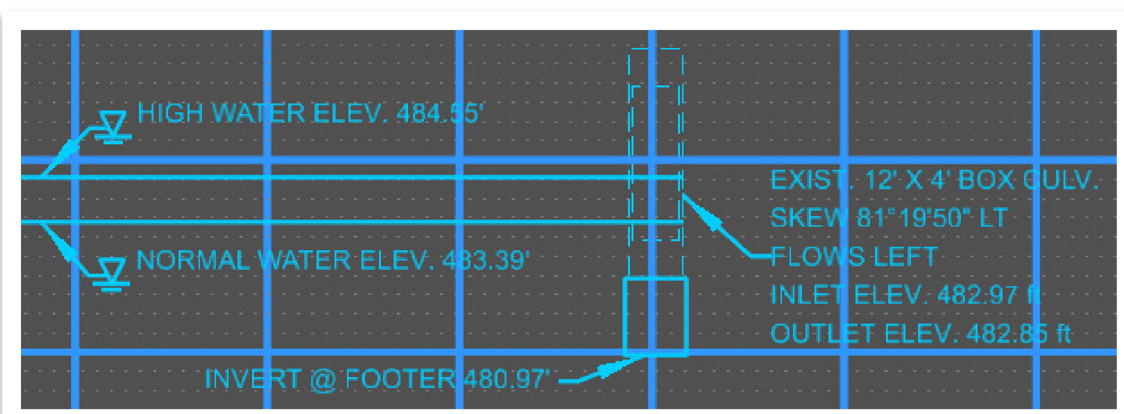
53. Next, select the **Profile Hydraulic Data Text** element template once again (**Survey >> Annotation >> Profiles >> Bridges**) and then open the **Place Note** tool (**Drainage and Utilities >> Drawing Production >> Notes**) and we will create a manual label for the footer. Within the **Place Note** dialog box, select the **SUR - PRO - Hydraulic Data** dimension style and leave the other settings as-is.



54. Within the **Text Editor**, select the **Extra Small - Left Top** text style (highlighted below). Notice that the text size and orientation updated automatically. Key-in **INVERT @ FOOTER 480.97'**, which is the correct elevation for this exercise.



55. Once the **Note** is placed, zoom out and review the box culvert profile.



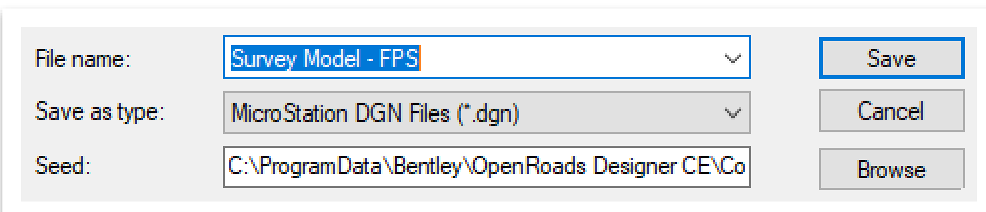
6.5 Lecture: Flood Plain Sections

A flood plain section **perpendicular** to the flood flow should be taken upstream and downstream at a minimum, each looking downstream in the direction of flow. Each section should be a distance from the proposed structure equal to **four times the typical distance between top of banks** or a minimum of **50** feet. The flood plain section should extend across the flood plain to the extreme high water extents and tie in accurately with the survey centerline.

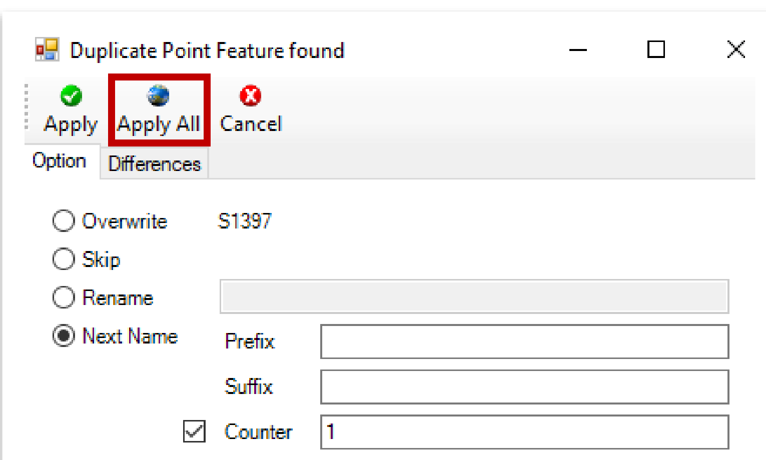
6.5.1 Exercise: Flood Plain Section Creation – Survey Text Files

In this exercise, we will create a **downstream** flood plain section (XS) for a proposed crossing utilizing the XS lines loaded through the **survey text files**. This process would also be used to create an upstream flood plain section or any other XS location. **Note:** The flood plain section plan data would normally be part of the overall 3D survey file but has been separated out for the purpose of training. Exercise 6.5.2 will discuss the procedure on how to create the sections if the XS lines are not imported via text files.

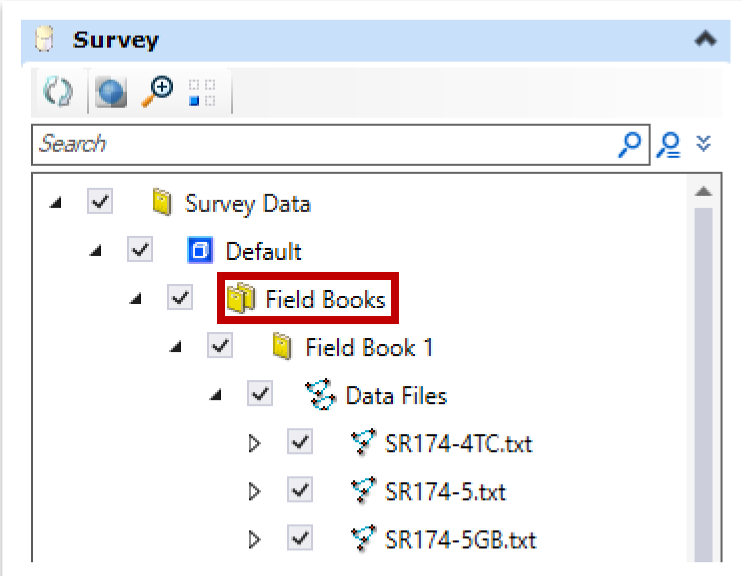
1. Create a new file and name it **Survey Model – FPS**. Select the **TDOTSeed3D.dgn** and click **Save**.



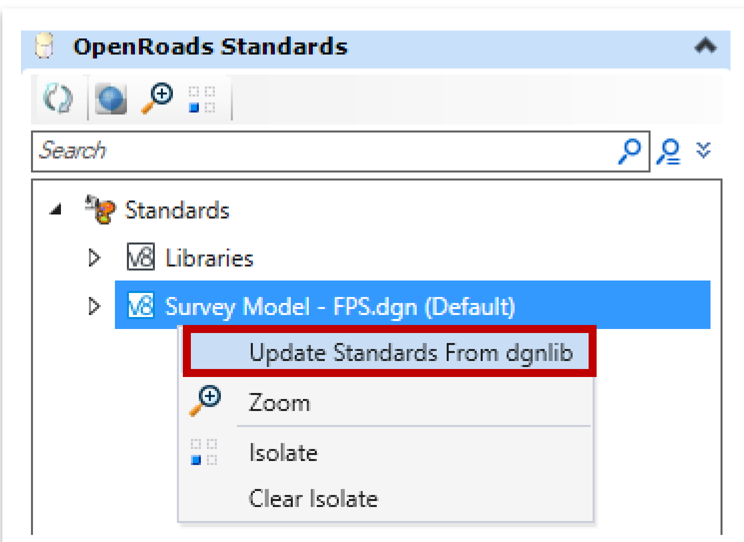
2. Go ahead and switch back to the **Survey** workflow in the upper left corner. Next, we need to import the stream survey data. Open **File Explorer** and browse to the class files within the **SURVEY_Training** workset dgn subfolder. Select the **SR174-1.txt** through **SR174-22.txt** ASCII text files and drag and drop them into the **Field Books** folder within the **Explorer**. Duplicate names of features should be found in the sample data. Select **Next Name** and then click **Apply All**.



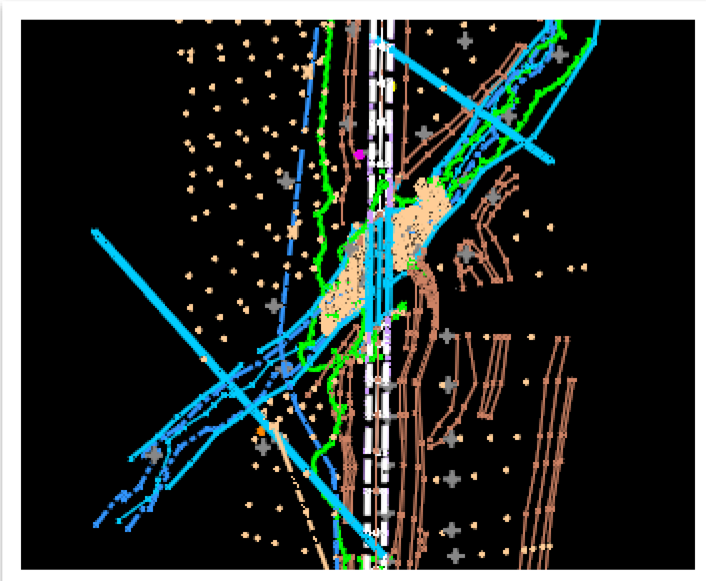
3. Expand the **Field Books** folder and notice the text files have been added. **Note:** Your text file order may vary from what is shown below.



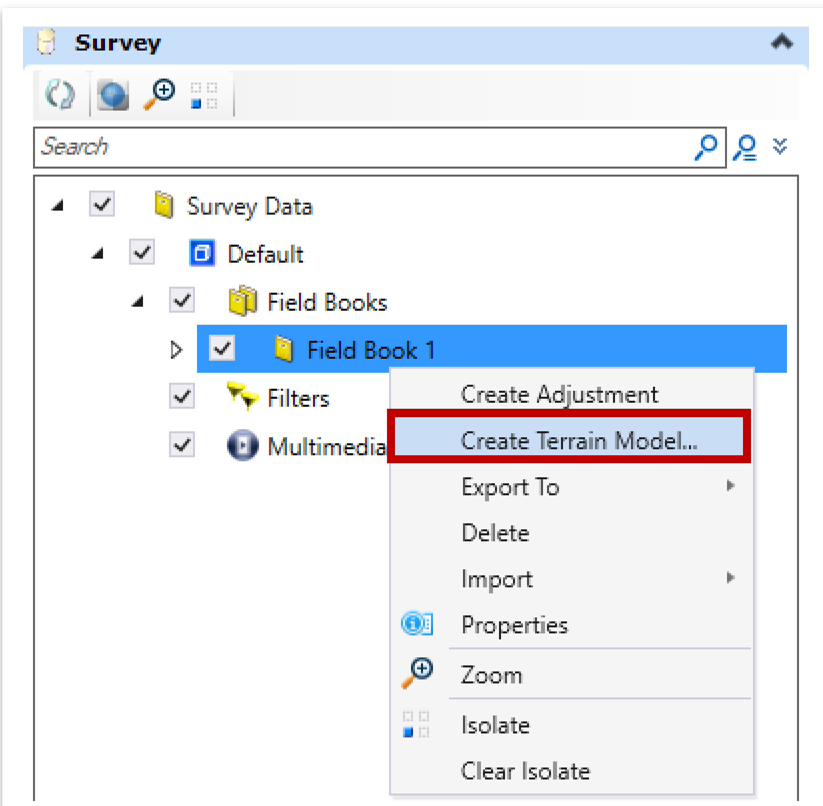
4. As a reminder, the first thing we need to do after import is update the **dgnlib standards** so that <u>all</u> survey **locators** are the correct scale. There is a quirk in the software, so it is good practice to perform this step after any survey text file import. Expand the **OpenRoads Standards** tab within **Explorer**. Right click on the active file (**Survey Model – FPS.dgn**) and select **Update Standards From dgnlib**. Give the software a minute to process.



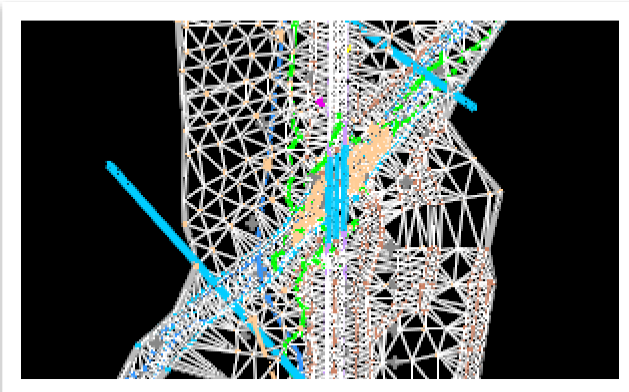
5. Click **Fit View** and then zoom in to the area shown below. There are a couple of errors in the raw field data, which we will ignore for the purpose of this exercise.



6. Now we need to create a **surface**. Within the **Explorer**, go back to the **Survey** tab and right click on **Field Book 1** and select **Create Terrain Model**.



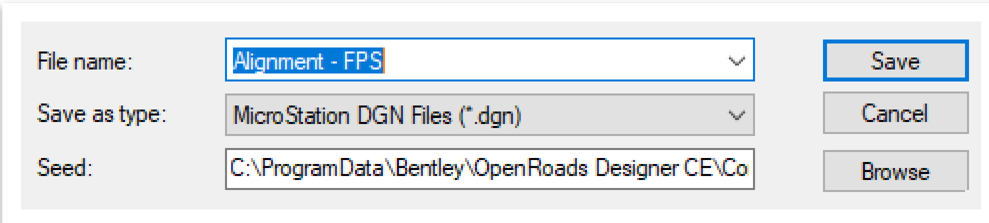
7. Notice the white triangulated terrain that is created.



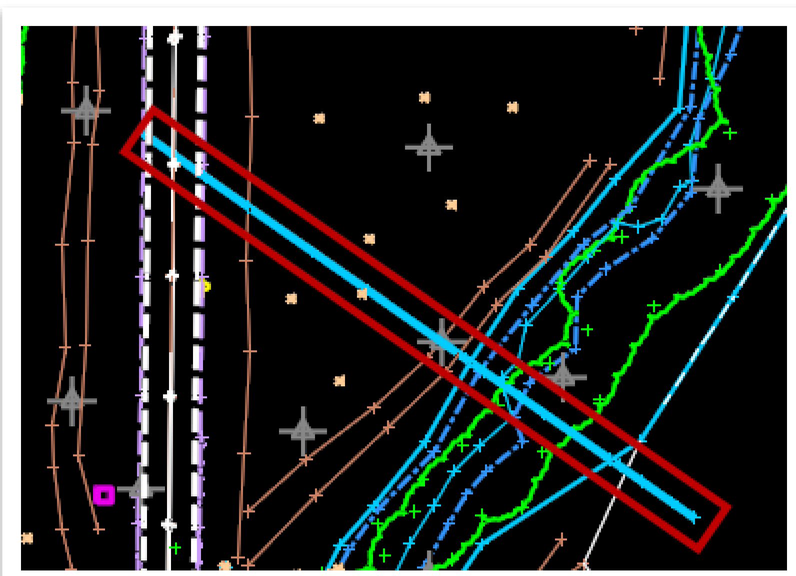
8. Select the border of the triangulated terrain and then open the **Properties** in the heads-up display. Change the **Feature Definition** to **Survey Existing Ground** and then turn the **Triangles** off so we can see the survey data easier.

Name	Terrain Model: Field Book
Number of Points	6,255
Number of Point Featu	3,269
Number of Islands	0
Number of Voids	0
Number of Features	3,427
Number of Contours	0
Number of Breaklines	158
Number of Triangles	11,478
Edge Method	Max Edge Length
Length	100.00'
Major Contours	Off
Minor Contours	Off
Triangles	Off
Spots	Off
Flow Arrows	Off
Low Points	Off
High Points	Off
Breaklines	Off
Boundary	On
Imported Contours	Off
Islands	Off
Holes	Off
Voids	Off
Feature Spots	Off
Feature Definition	Survey Existing Ground
Feature Name	Field Book 1

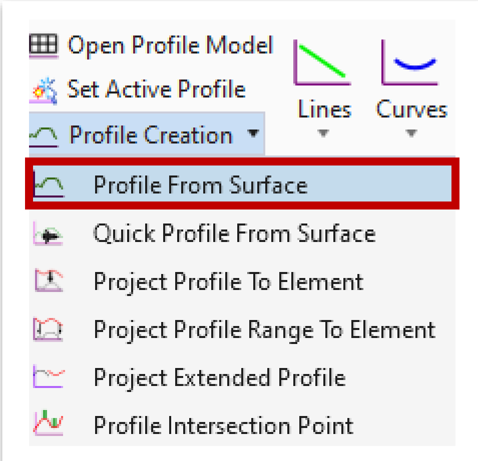
9. Now that the survey field data has been imported and the surface has been created, we need to create the flood plain sections, which must be done in a 2D file. Let's create a new file and name it **Alignment – FPS**. Select the **TDOTSeed2D .dgn** and click **Save**. **Note:** The flood plain section would normally be a profile model within the overall 2D survey alignment file but has been separated out for the purpose of training.



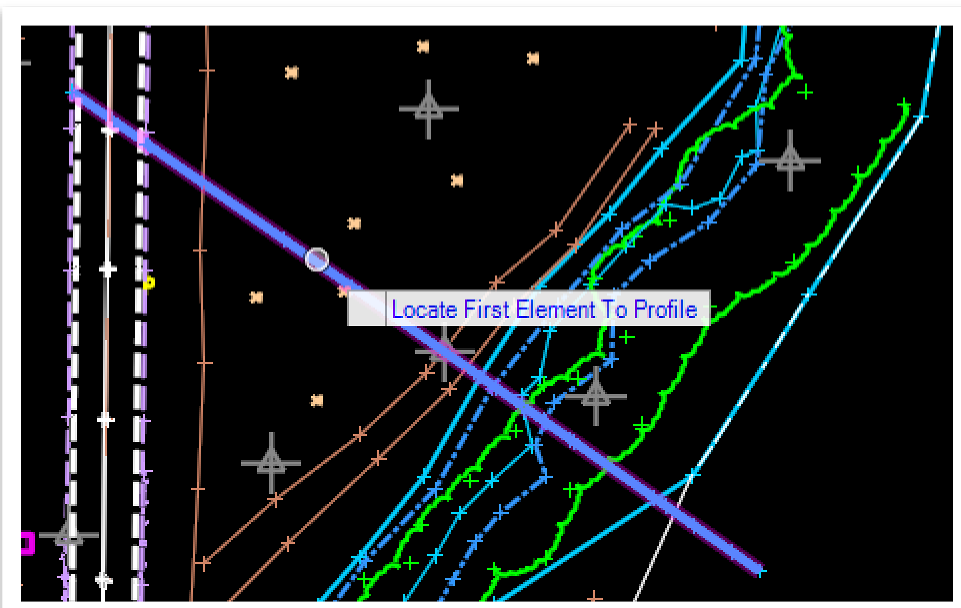
10. Attach the **Survey Model – FPS.dgn** as a reference file using the **Coincident World** attachment method. Then, click **Fit View** and set the terrain to **active**.
11. Locate the southernmost stream crossing once again and zoom in to the **flood plain** XS line on the downstream side (highlighted below). Based on the existing terrain, the stream is flowing in a southwest to northeast direction. Open the **Copy** tool (**Survey >> Drawing >> Manipulate**) and make a copy of the XS line so that it is live in the active file.



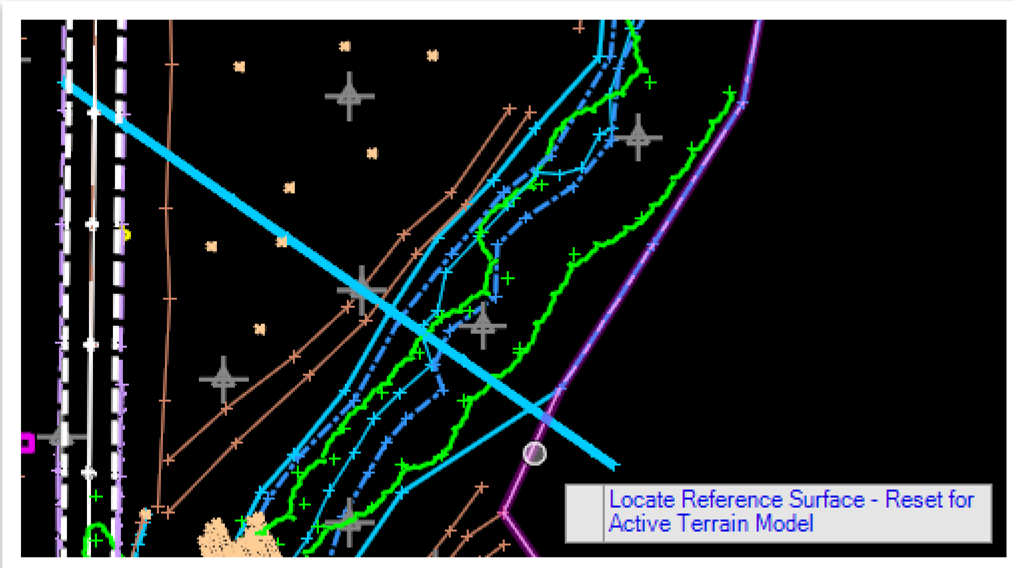
12. Next, open the **Profile From Surface** tool (**Survey >> Geometry >> Vertical >> Profile Creation**).



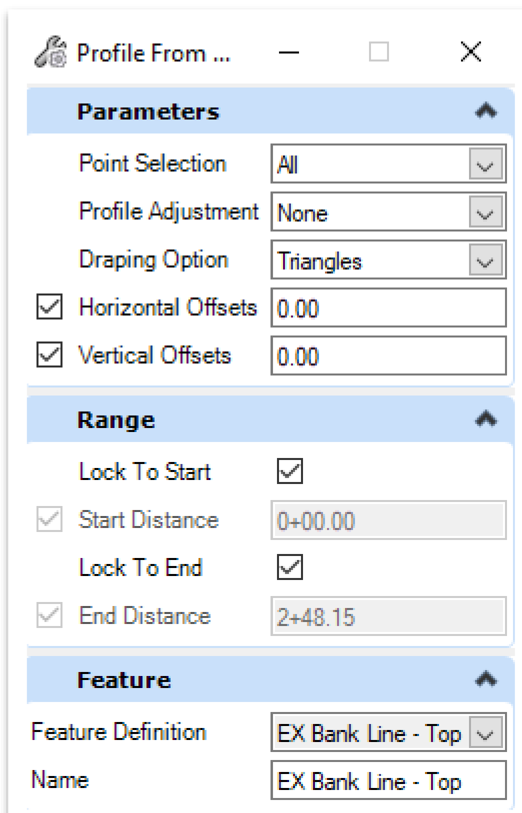
13. Notice the cursor prompt: **Locate First Element To Profile**. Select the downstream XS line that was just copied and then right click to complete.



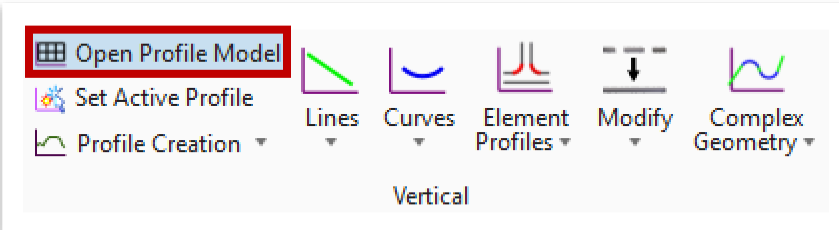
14. Notice the next cursor prompt: **Locate Reference Surface**. Left click on the terrain boundary and right-click to complete.



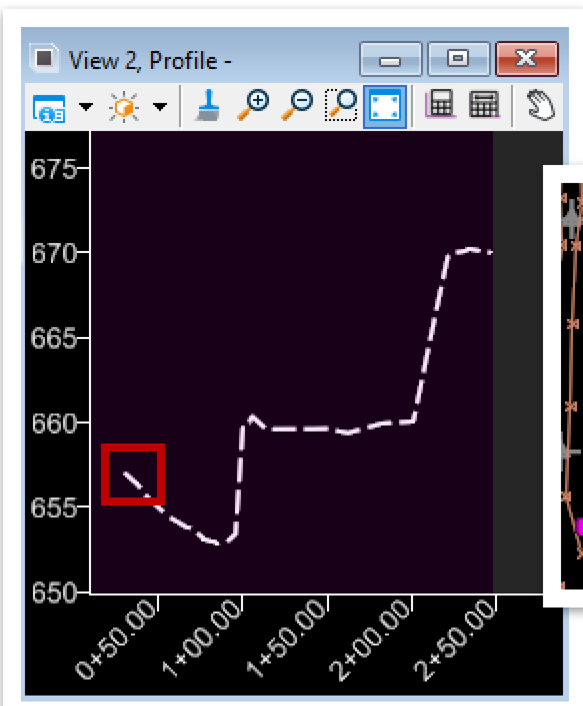
15. Within the **Profile From Surface** dialog box, select the following settings and then left click to accept the prompts. **Note:** The start station (0+00.00) for the surveyed XS line is on the right side, viewing in the direction of flow. The end station is 2+48.15 on the left side.
    a. **Point Selection:** All
    b. **Profile Adjustment:** None
    c. **Draping Option:** Triangles
    d. **Horizontal Offsets:** 0.00 (Checkmark to lock)
    e. **Vertical Offsets:** 0.00 (Checkmark to lock)
    f. **Lock To Start:** Checkmark
    g. **Start Distance:** 0+00.00
    h. **Lock To End:** Checkmark
    i. **End Distance:** 2+48.15
    j. **Feature Definition:** EX Bank Line - Top (**Linear >> Profiles >> Natural Drainage >> Existing**)
    k. **Name:** EX Bank Line - Top

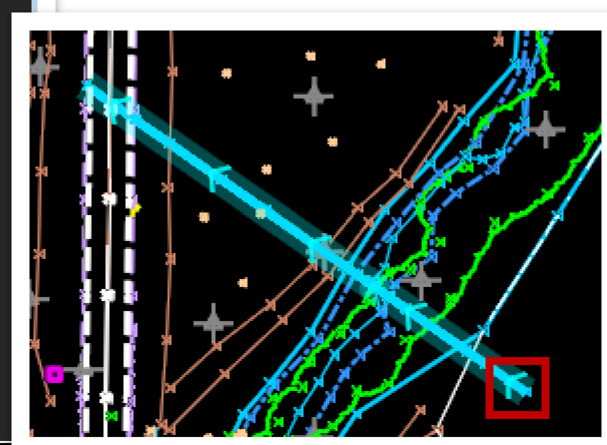


16. It will look like nothing happened, but a profile was created in the background. Go ahead and open the **Open Profile Model** tool (**Survey >> Geometry >> Vertical**). Select the copied XS line and then open **View 2** and left click anywhere within the drawing window.

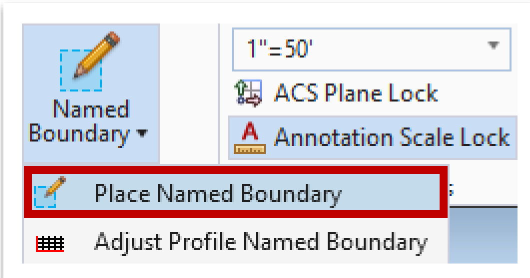


17. You should see a profile line along the downstream XS location. The other thing to notice is that when the profile view is active, the downstream XS line is highlighted in the plan view. The **arrows** indicate the **station direction** (right to left), which means the profile is looking upstream. **Note:** The flood plain sections should typically be cut from left to right, looking downstream in the direction of flow. The reason that the profile does not start at Station 0+00.00 is that the terrain does not extend out that far.

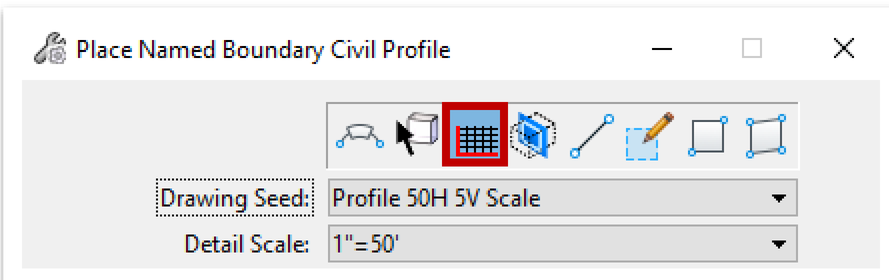




18. As a reminder, in order to place annotation, we need to create a profile named boundary. Open the **Place Named Boundary** tool (**Survey >> Drawing Production >> Named Boundaries >> Named Boundary**).

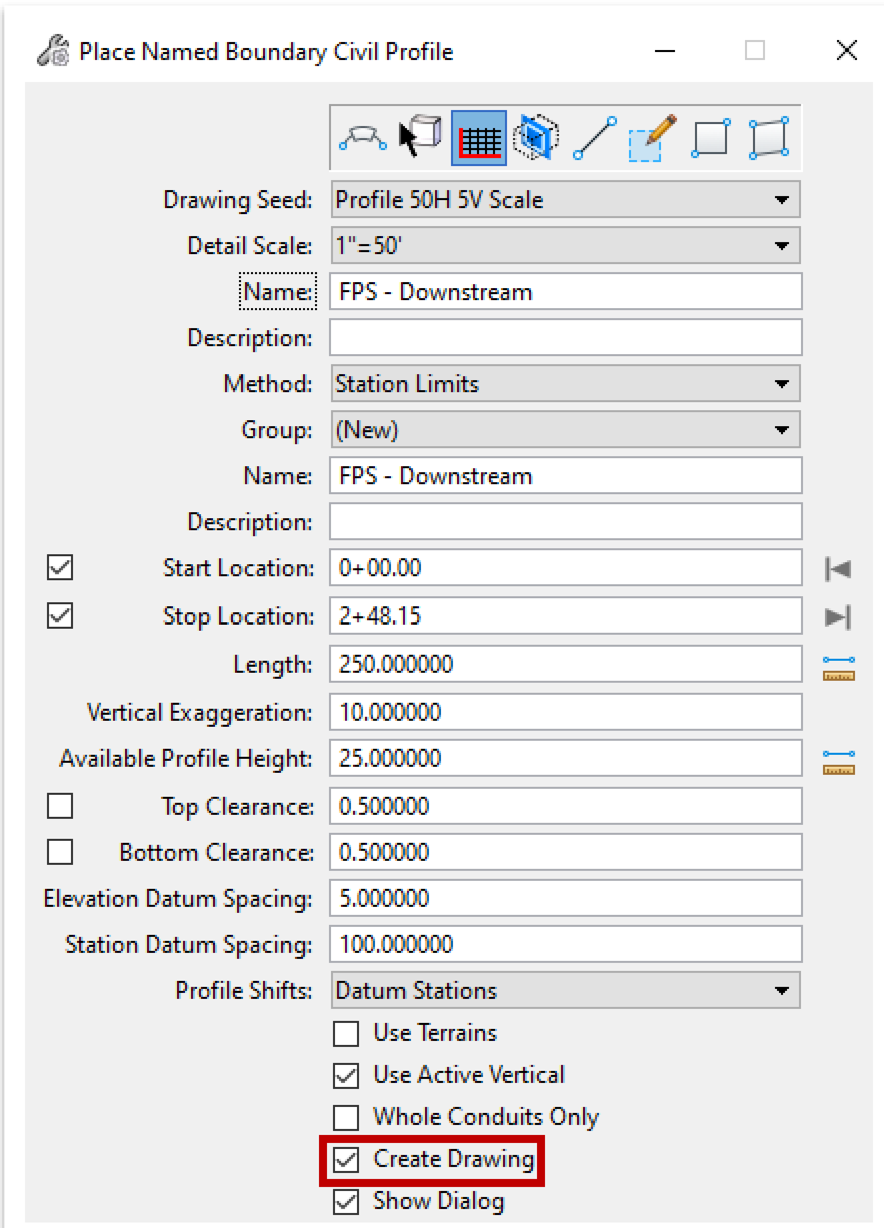


19. Make sure that the **Civil Profile** option is toggled on. Select **Profile 50H 5V Scale** for the Drawing Seed.

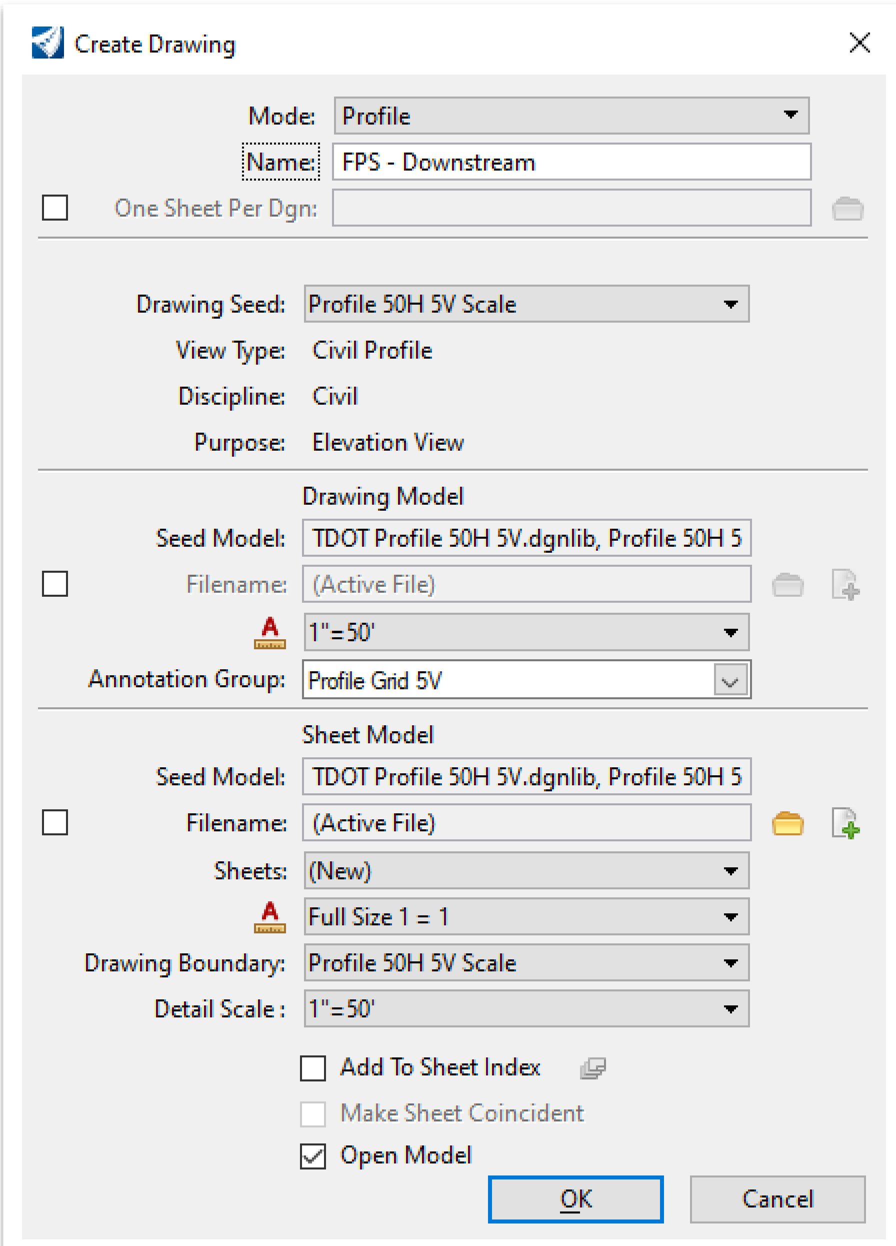


20. Notice the prompt in the lower left corner of the drawing window: **Identify Profile View**. Left click anywhere within **View 2**.

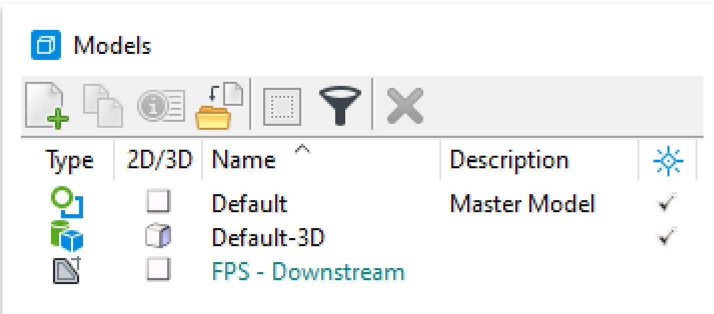
21. Edit the parameters below and leave all other default values as-is. Make sure that the **Create Drawing** option is toggled on at the bottom.
    a. **Name:** FPS – Downstream
    b. **Start Location:** 0+00.00 (Use the grey arrow to lock to Start but notice it is 0+30.28 since the profile doesn't start until then. Manually key-in 0+00.00).
    c. **Stop Location:** 2+48.15 (Use the grey arrow to lock to Stop)
    d. **Length:** 250.00
    e. **Available Profile Height:** 25.00



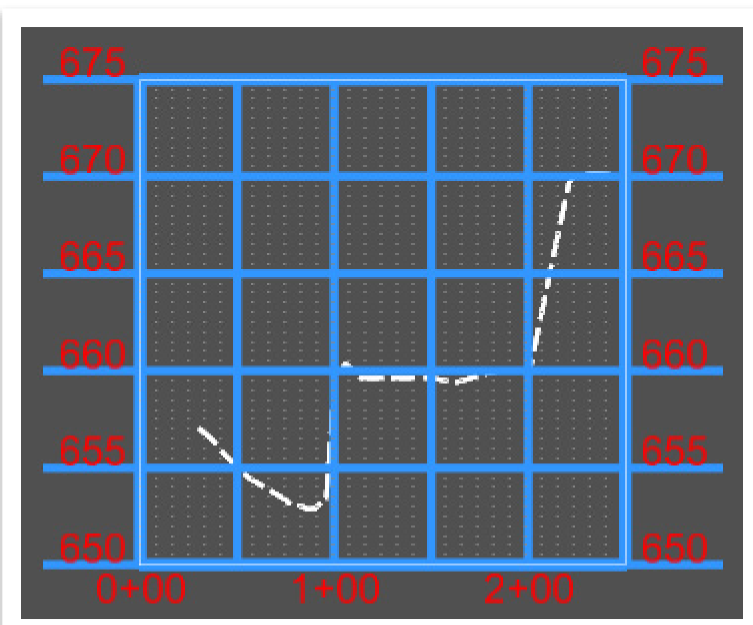
22. Left click anywhere within View 2 **three** times. Zoom out and you should see **one** profile named boundary drawn into the file, represented by a white border. The **Create Drawing** window will appear automatically after creating the named boundary, since we toggled it on in the previous step. Click **OK** to accept all default settings.



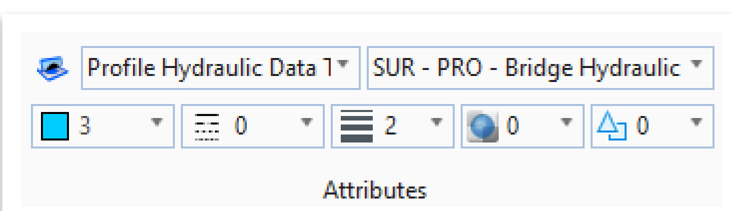
23. Once again, the software should open to the one sheet model in **View 1**. Let's go ahead and delete the sheet model. Open the **Models** tool (**Survey >> Home >> Primary**) and double click on the **FPS - Downstream** drawing model to activate it. Then, right click on the sheet model and select **Delete**. You should see the following three models once completed. Close the **Models** window once you are done.



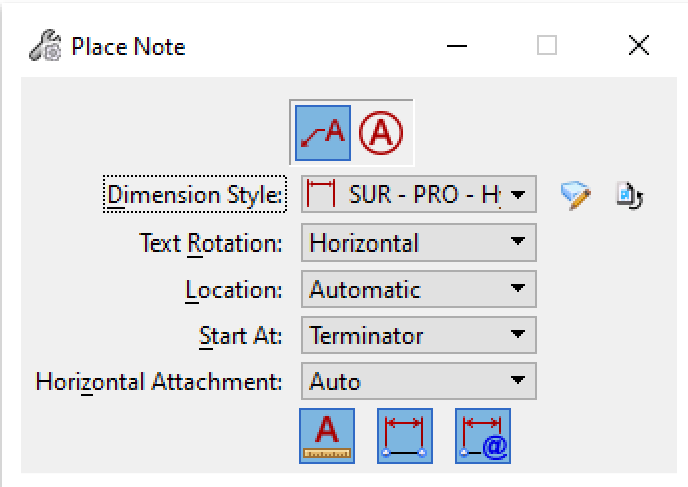
24. You should see the downstream flood plain section along with the profile grid, stations and elevations. We will next add the applicable annotation, like in the previous exercises.



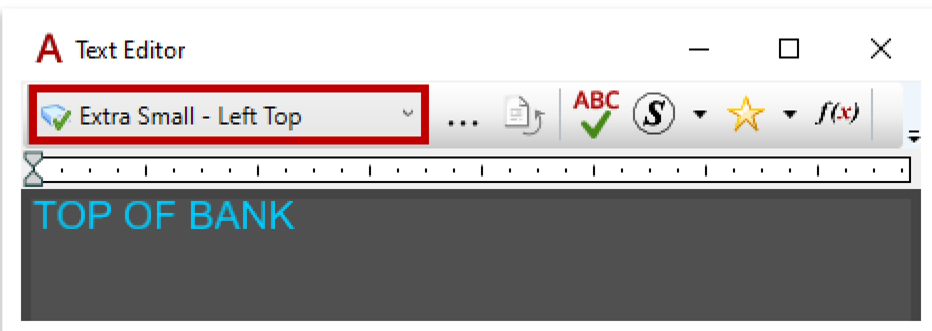
25. Go ahead and select the **Profile Hydraulic Data Text** element template (**Survey >> Annotation >> Profiles >> Bridges**).



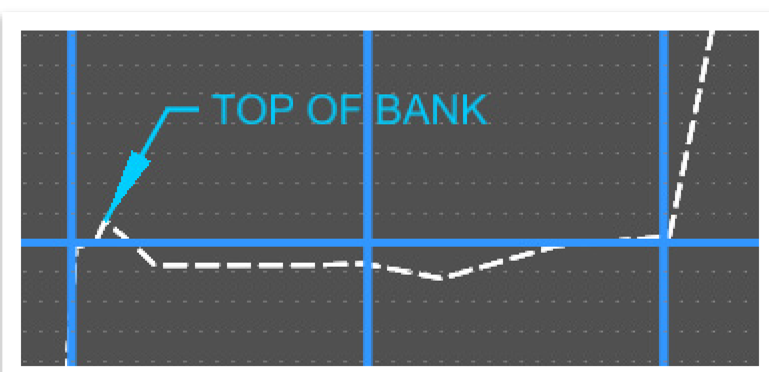
26. Next, open the **Place Note** tool (**Survey >> Drawing Production >> Notes**). Within the **Place Note** dialog box, select the **SUR - PRO - Hydraulic Data** dimension style and leave the other settings as-is.



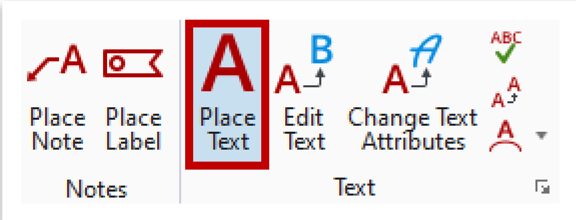
27. Within the **Text Editor**, select the **Extra Small - Left Top** text style (highlighted below). Key-in **TOP OF BANK**.



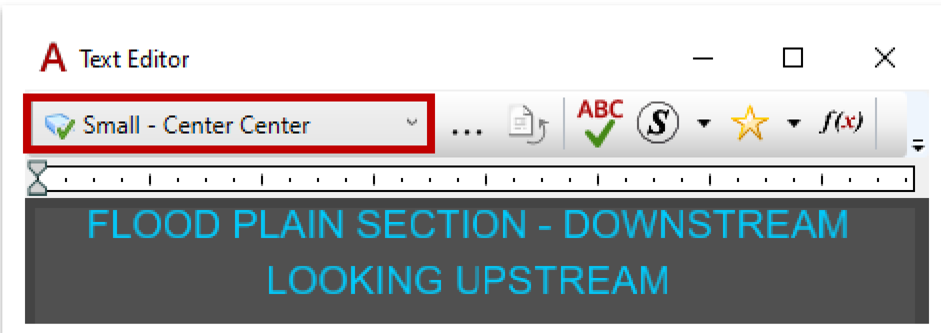
28. Snap to the **Top of Bank** and place the **Note**, as shown below.



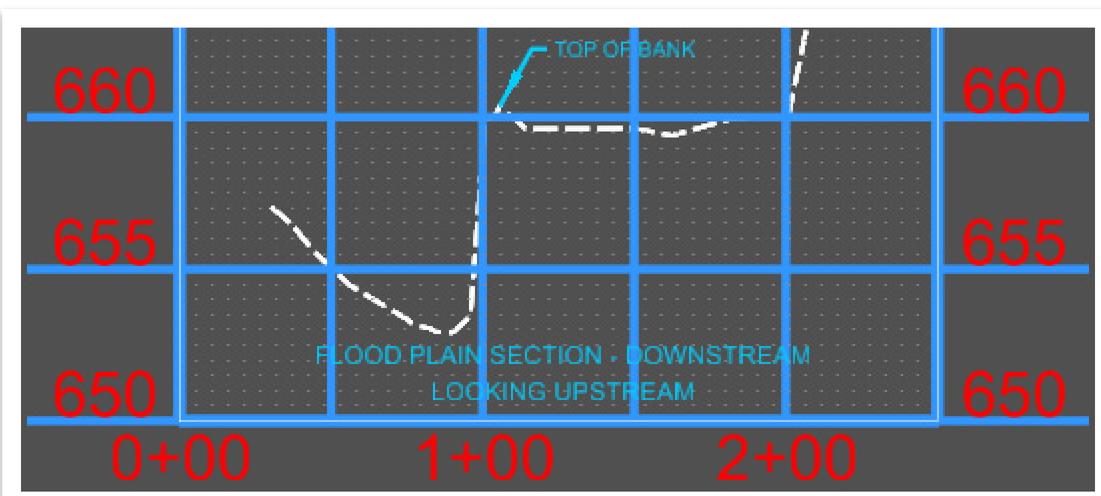
29. Next, open the **Place Text** tool (**Survey >> Drawing Production >> Text**) so we can label the title of this XS. The same element template should still be active.



30. Within the **Text Editor**, select the **Small - Center Center** text style (highlighted below). Key-in **FLOOD PLAIN SECTION – DOWNSTREAM / LOOKING UPSTREAM**.



31. Place the text at the bottom of the XS, as shown below, and then right click to clear the label. Close the **Text Editor** once you are done.

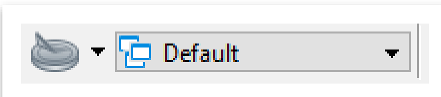


32. You can add additional annotation (labels and notes) as necessary, such as the **High/Normal Water Elevation** labels. Refer to Exercise 6.4.1 (Steps 42-49) for that procedure. Also, as a reminder, if you need to add dimensions, switch to the **Drawing** workflow to access the tools (**Drawing >> Annotate >> Dimensioning**). You would use the same dimension style as we have been using (**SUR - PRO - Hydraulic Data**).

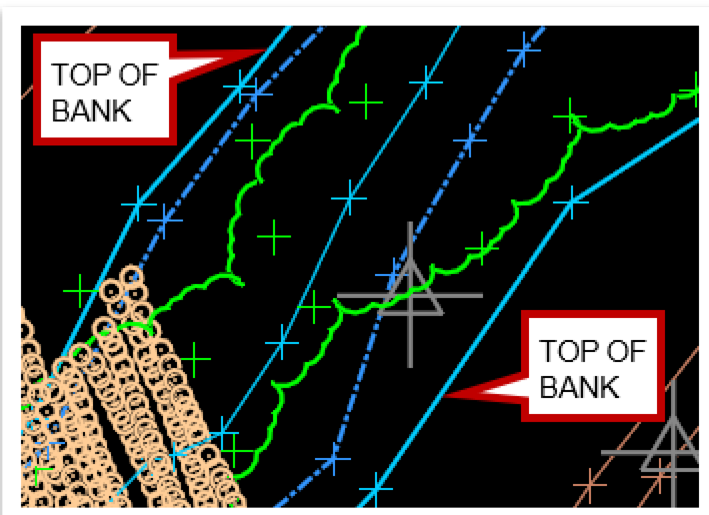
6.5.2 Exercise: Flood Plain Section Creation – Office

In this exercise, we will create a **downstream** flood plain section (XS) for a proposed crossing after creating a XS **chain** in the *office*. This method would be utilized if the flood plain XS lines are not included in the survey text files. The chain will be created from **left** to **right** looking in the direction of flow. We will continue to utilize the same **Alignment – FPS.dgn** file.

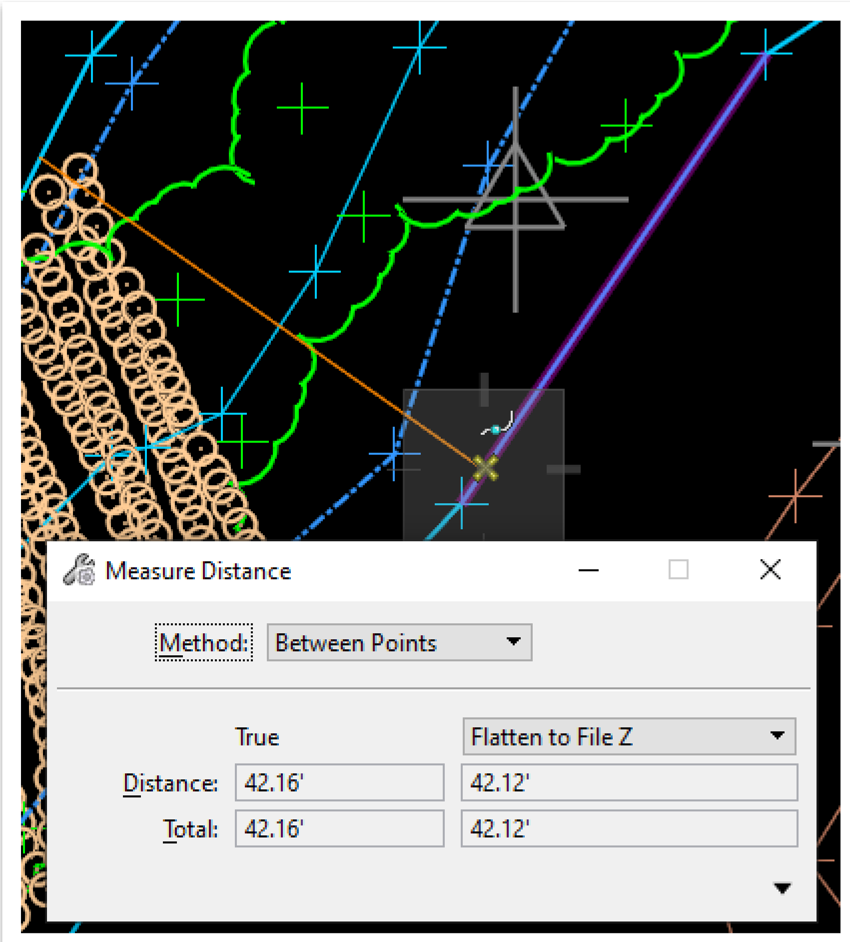
1. Switch back to the **Default** model in the lower left corner of the drawing window and close **View 2**, if opened.



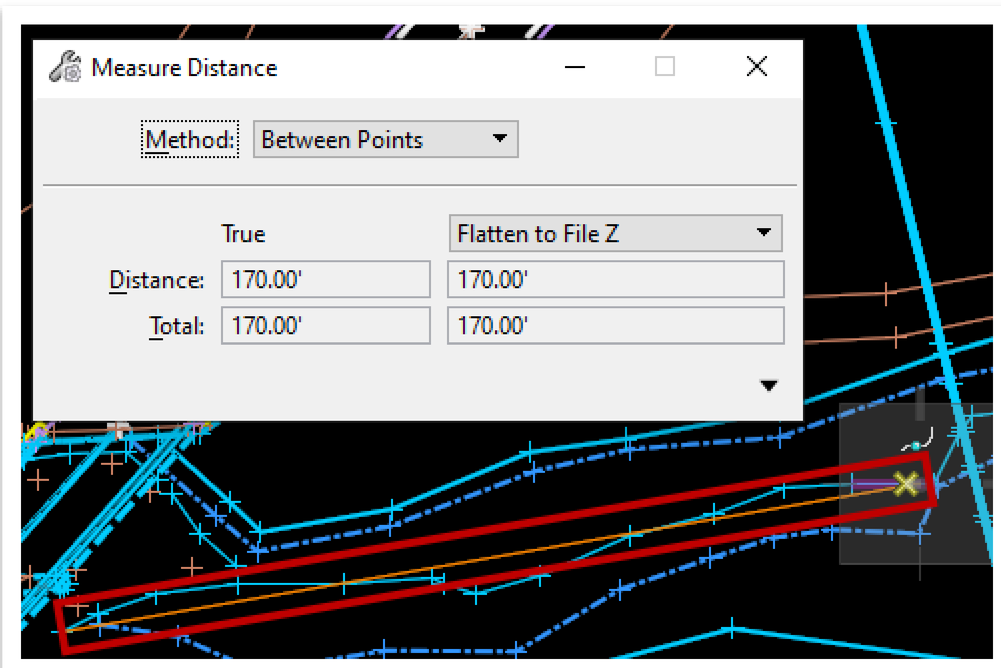
2. Zoom in to the downstream side of the stream once again. The **top of banks** are represented visually by solid light blue lines (Level: **SUR - DRG - Bridge Hydraulic Data**) on either side if the stream.



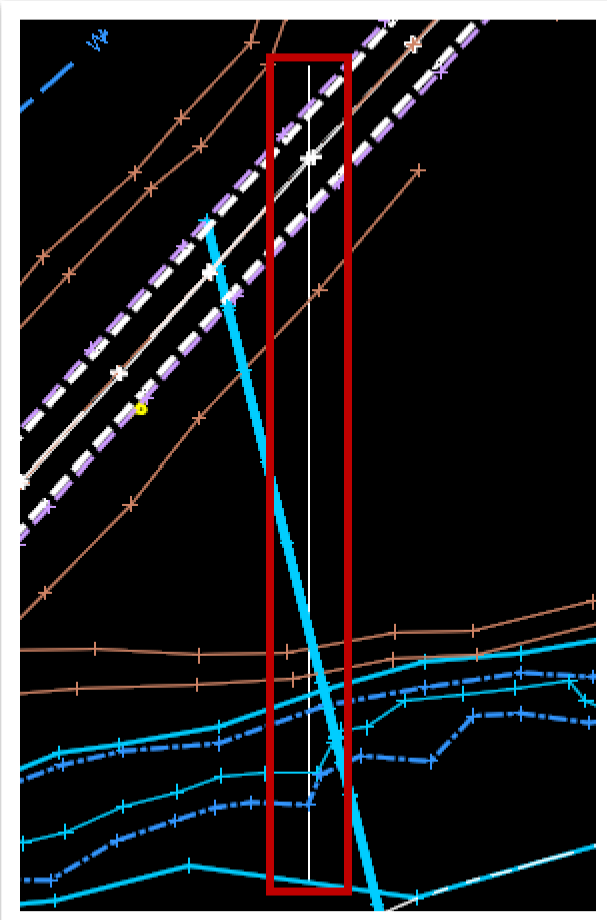
3. Open the **Measure Distance** tool (**Survey >> Drawing >> Measure**) and take a few horizontal width measurements in this general area between **top of banks**. You should get widths ranging between **40 – 50** feet. **Note:** The orange line represents a single measurement.



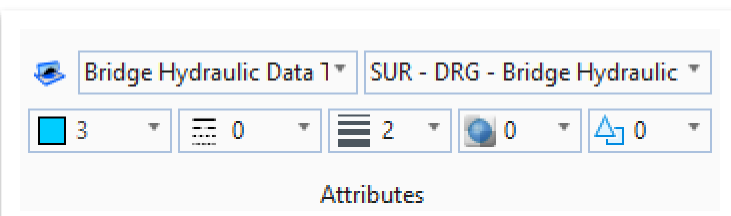
4. For this exercise, we will use a **42.5'** typical **width** between top of banks. Based on this, the upstream and downstream XS lines should be located approximately **170'** from the existing bridge **along the stream centerline** (four times the typical width). Go ahead and turn off the following levels in the **Survey Model – FPS.dgn** reference file.
    - SUR - CTRL - Temporary Points
    - SUR - DTM - Spot Points – Locators
    - SUR - VEG - Features
    - SUR - VEG - Features - Points – Locators
5. We will now place the **downstream** XS line. Rotate the view to be along the stream centerline and then measure an approximate straight-line distance of **170'**. The flood plain section will be drawn <u>perpendicular to the stream CL</u>.



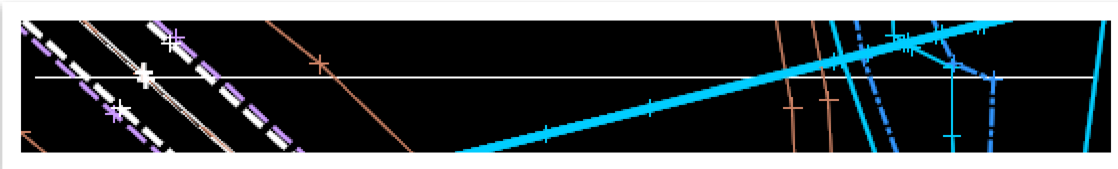
6. Open the **Place SmartLine** tool (**Survey >> Drawing >> Placement**) and draw the flood plain section (initial **perpendicular** line) at approximately **170'**. Make sure that the line crosses the roadway to the north and extends to the southern top of bank line, as shown below. **Note:** Ignore the line symbology for now.



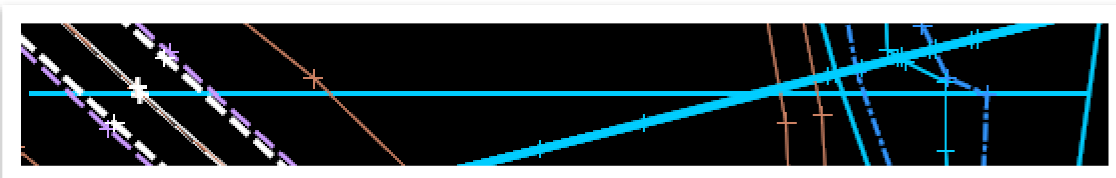
7. Next, select the **Bridge Hydraulic Data Text** element template (**Survey >> Drainage >> Natural >> Existing**).



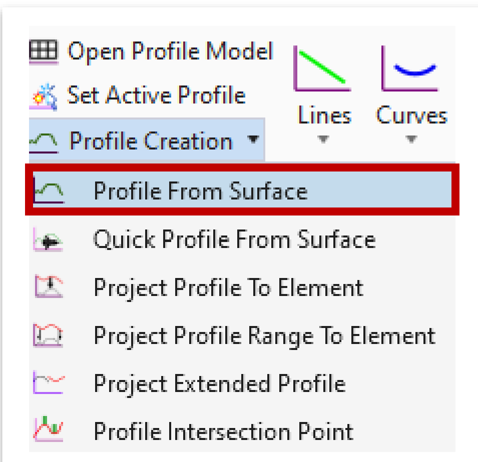
8. Rotate the view along the white line, from **left** to **right**, using the **2 Points** method.



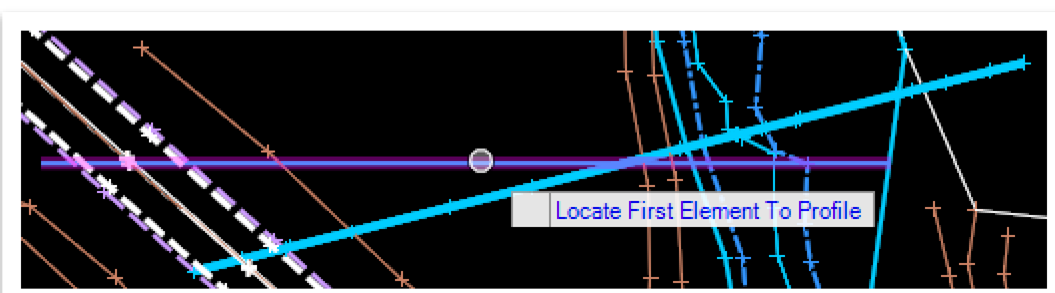
9. Now, draw a line from **left** to **right** on top of the white line and notice it is on the correct symbology. The section stationing is dependent on the direction in which you draw the line. Regardless of how you created the initial line, this will ensure the direction is correct. Go ahead and delete the white line underneath.



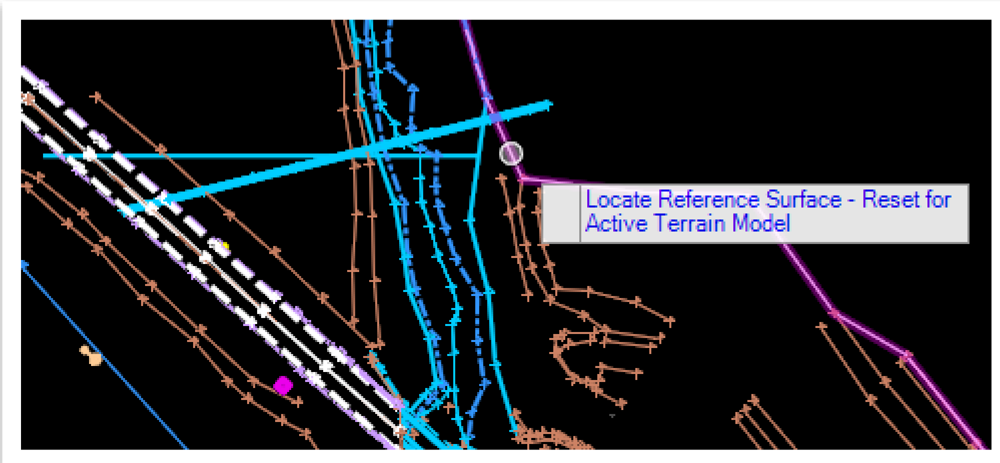
10. To create the flood plain section, we will follow the same procedure shown in the previous exercise. Open the **Profile From Surface** tool (**Survey >> Geometry >> Vertical >> Profile Creation**).



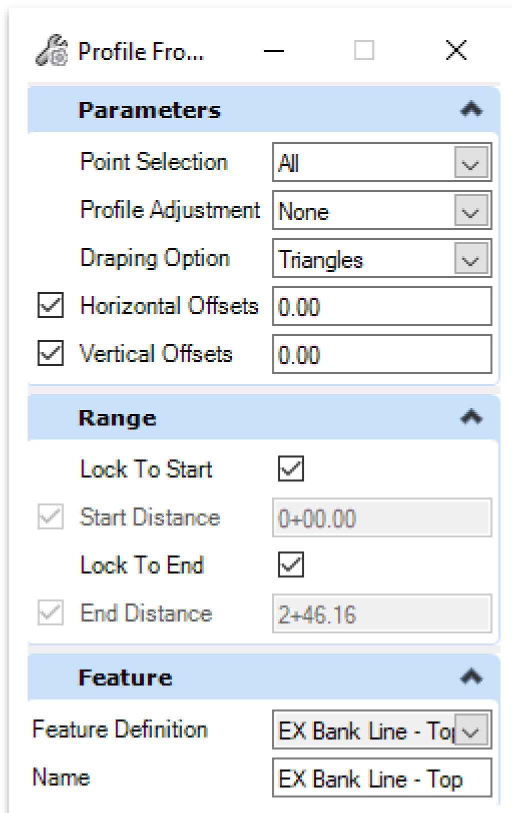
11. Notice the cursor prompt: **Locate First Element To Profile**. Select the downstream XS line that was just created and then right click to complete.



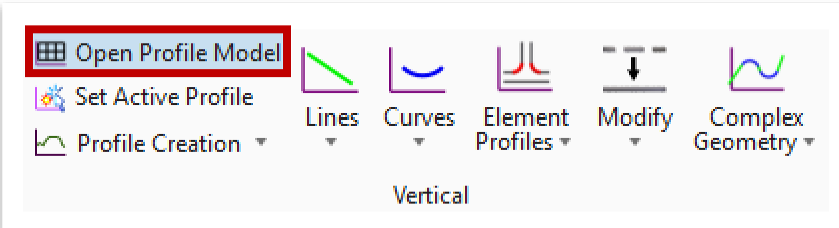
12. Notice the next cursor prompt: **Locate Reference Surface**. Left click on the terrain boundary and right-click to complete.



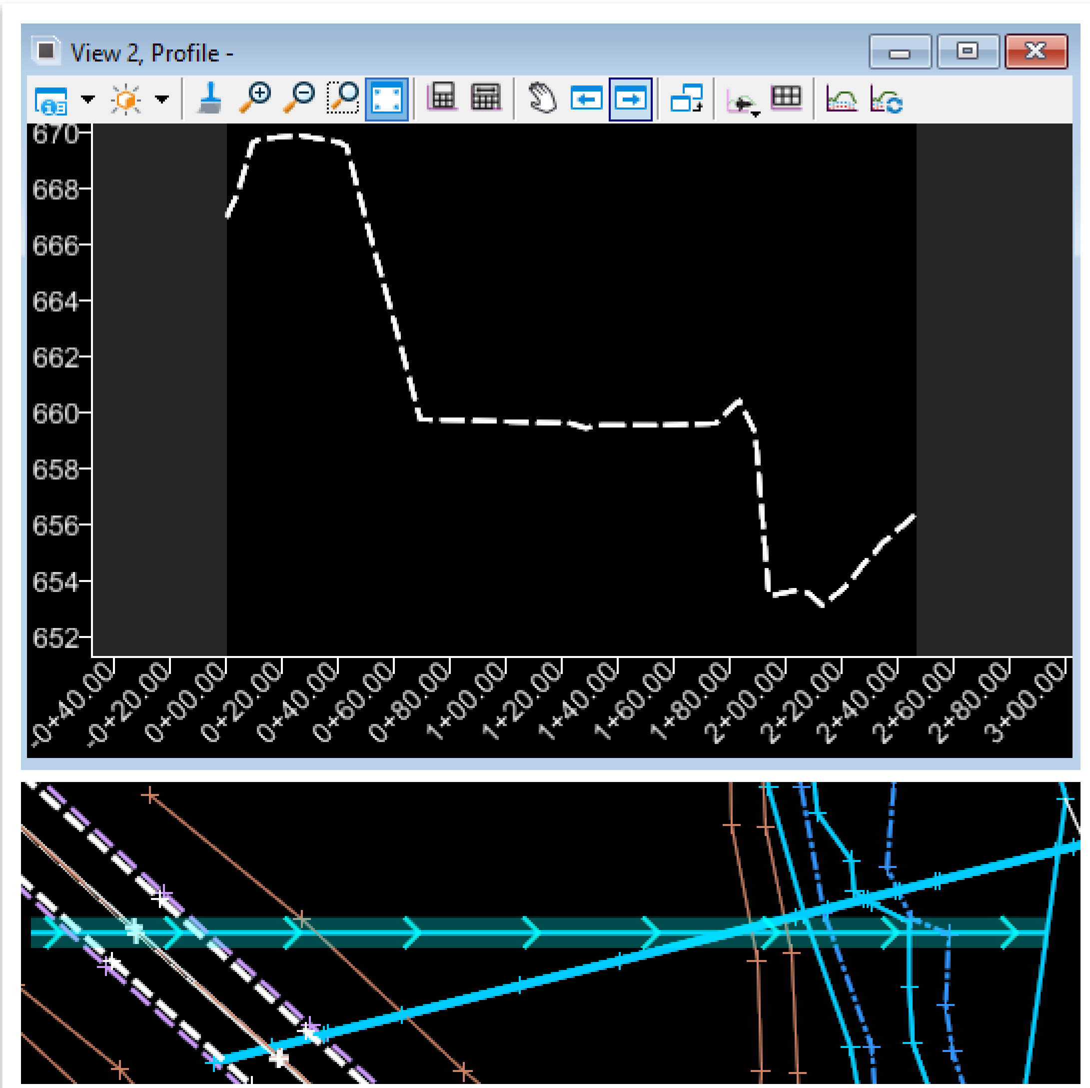
13. Within the **Profile From Surface** dialog box, select the following settings and then left click to accept the prompts. **Note:** The start station (0+00.00) for the surveyed XS line is on the left side, viewing in the direction of flow. The end station will vary depending on the length of your XS line.
    a. **Point Selection:** All
    b. **Profile Adjustment:** None
    c. **Draping Option:** Triangles
    d. **Horizontal Offsets:** 0.00 (Checkmark to lock)
    e. **Vertical Offsets:** 0.00 (Checkmark to lock)
    f. **Lock To Start:** Checkmark
    g. **Start Distance:** 0+00.00
    h. **Lock To End:** Checkmark
    i. **End Distance:** 2+46.16
    j. **Feature Definition:** EX Bank Line - Top (**Linear >> Profiles >> Natural Drainage >> Existing**)
    k. **Name:** EX Bank Line - Top



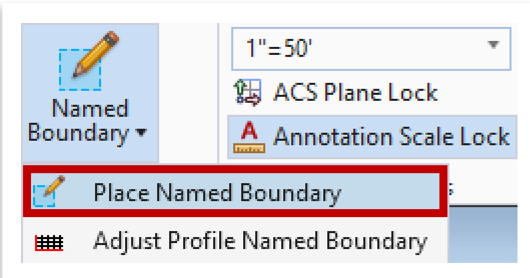
14. It will look like nothing happened, but a profile was created in the background. Go ahead and open the **Open Profile Model** tool (**Survey >> Geometry >> Vertical**). Select the XS line and then open **View 2** and left click anywhere within the drawing window.



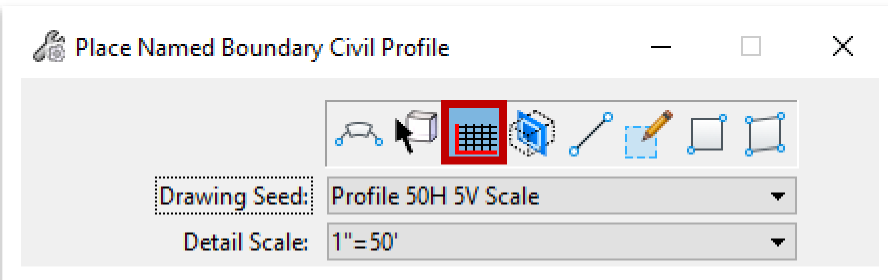
15. You should see a profile line along the downstream XS location. Once again, the **arrows** indicate the **station direction**, which this time is correct (left to right).



16. As a reminder, in order to place annotation, we need to create a profile named boundary. Open the **Place Named Boundary** tool (**Survey >> Drawing Production >> Named Boundaries >> Named Boundary**).

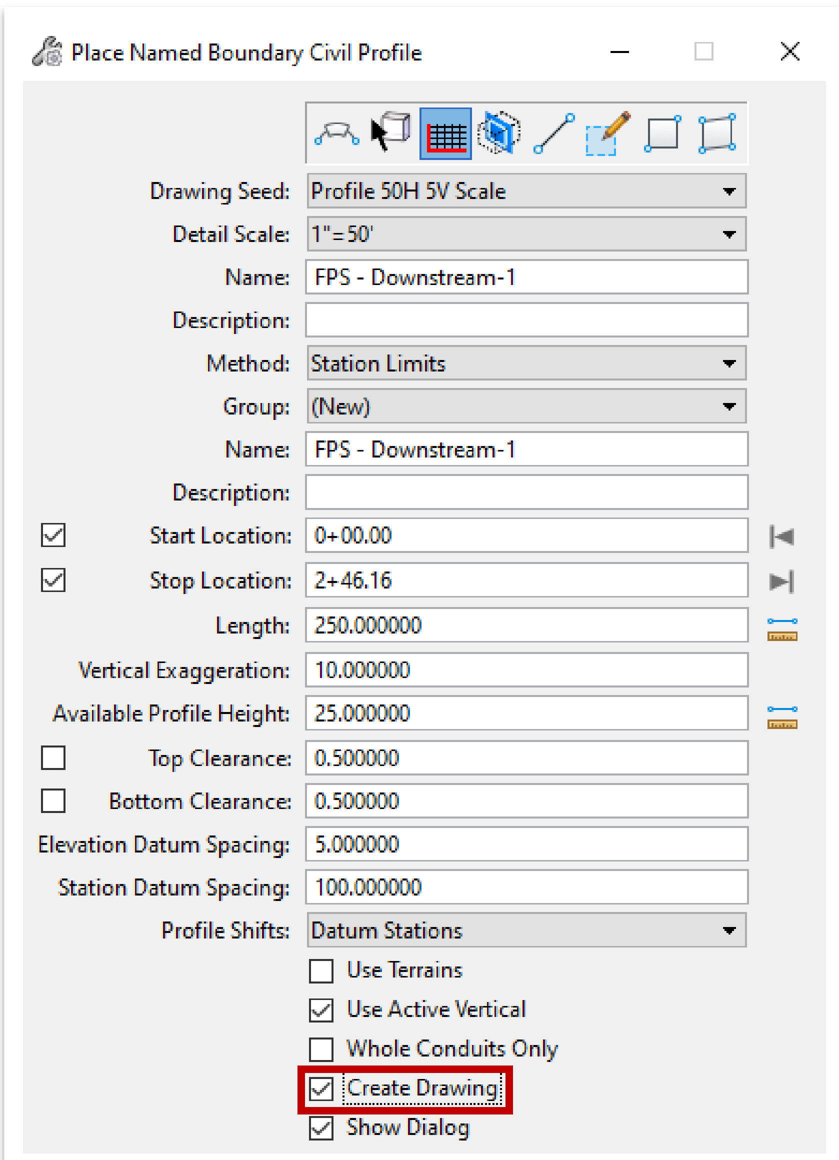


17. Make sure that the **Civil Profile** option is toggled on. Select **Profile 50H 5V Scale** for the Drawing Seed.

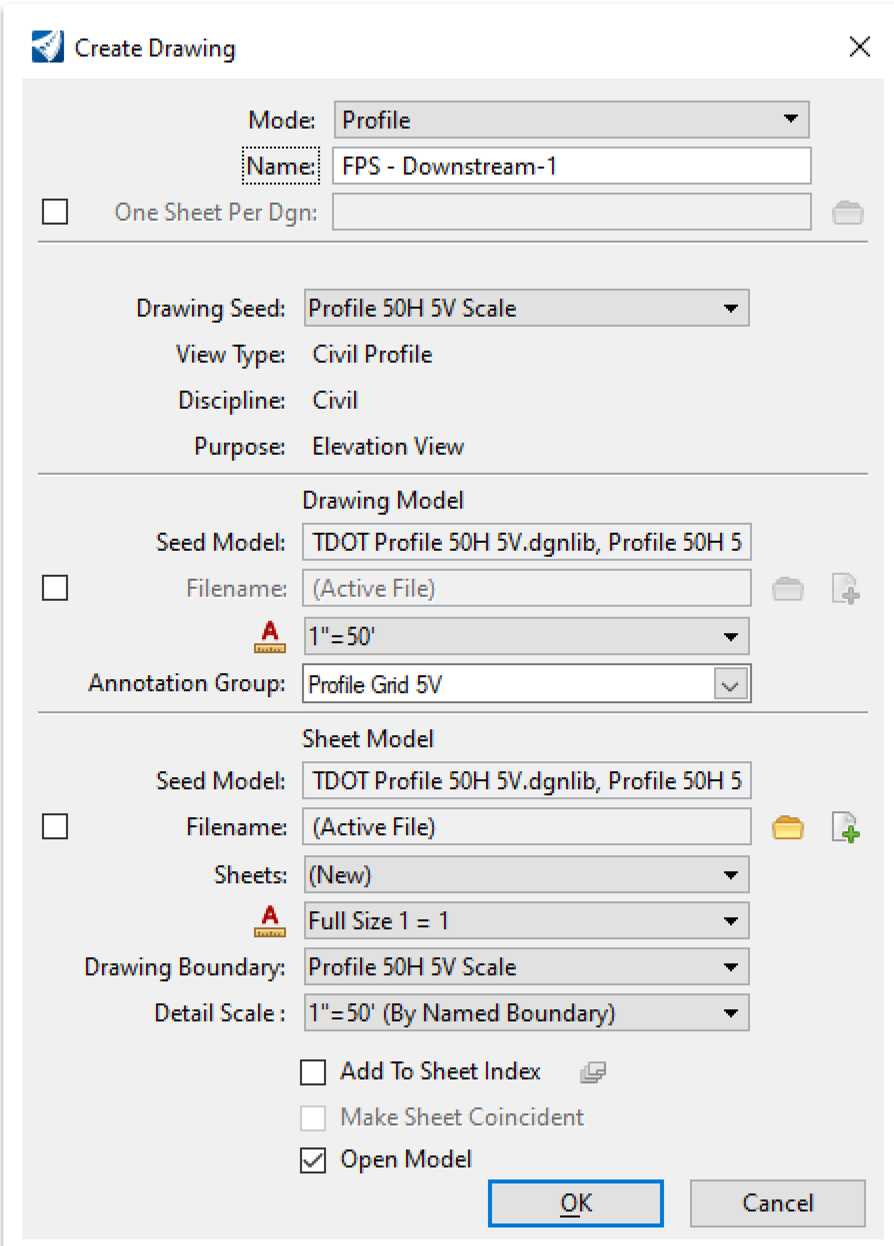


18. Notice the prompt in the lower left corner of the drawing window: **Identify Profile View**. Left click anywhere within **View 2**.

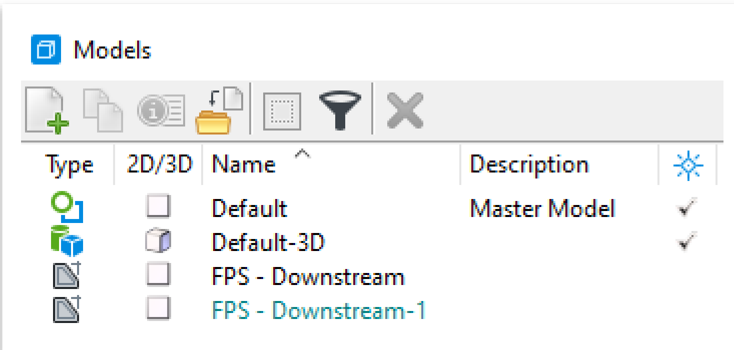
19. Edit the parameters below and leave all other default values as-is. Make sure that the **Create Drawing** option is toggled on at the bottom.
    a. **Name:** FPS – Downstream-1 (The software will not allow the same named boundary name to be used twice within a given dgn file. Since we are using the same file (and name) from the previous exercise, it will automatically add a **-1** to the name after the sheet and drawing models are created. However, for this exercise, go ahead and key-in the -1.)
    b. **Start Location:** 0+00.00 (Use the grey arrow to lock to Start)
    c. **Stop Location:** 2+46.16 (Use the grey arrow to lock to Stop. Your station will vary depending on the length of your XS line).
    d. **Length:** 250.00
    e. **Available Profile Height:** 25.00



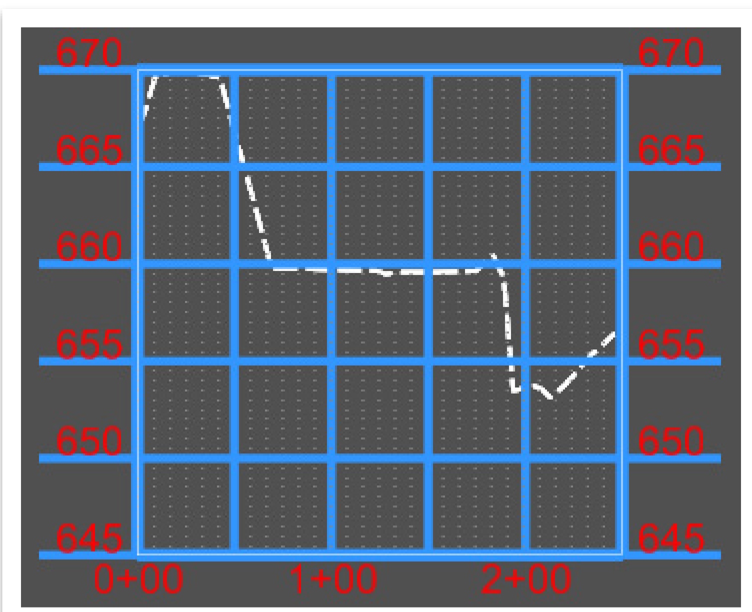
20. Left click anywhere within View 2 **three** times. Zoom out and you should see **one** profile named boundary drawn into the file, represented by a white border. The **Create Drawing** window will appear automatically after creating the named boundary, since we toggled it on in the previous step. Click **OK** to accept all default settings.



21. Once again, the software should open to the <u>one</u> sheet model in **View 1**. Let's go ahead and delete the sheet model. Open the **Models** tool (**Survey >> Home >> Primary**) and double click on the **FPS – Downstream-1** <u>drawing</u> model to activate it. Then, right click on the <u>sheet</u> model and select **Delete**. You should see the following four models once completed. Close the **Models** window once you are done. **Note:** This is essentially how you would create multiple sections/profiles in a single file along different alignments.



22. You should see the downstream flood plain section along with the profile grid, stations and elevations. For this exercise, we will not add any annotation. Refer to the previous exercises if you want to place High/Normal Water elevations, notes or section titles, since the process is the same.



6.6 Lecture: Stream Profile

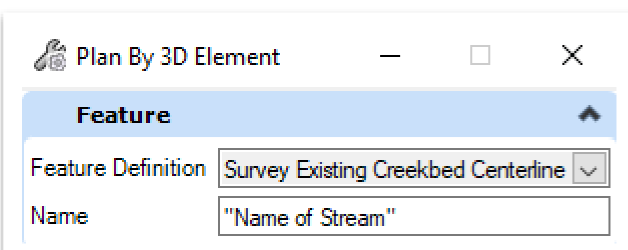
Stream profiles provide the **water elevation** along a stream. The requirements per Section 3.11.2 within the TDOT Survey Manual are as follows:

- The DTM shall be generated such that a stream bed, water surface and top of one bank profile can be developed for a distance equal to **six** times the typical distance between top of banks or a minimum of **50** feet, upstream and downstream of the proposed structure.
- DTM shots shall be taken at regular intervals (depending on the size and uniformity of the stream) and at any point the water velocity changes.
- The type of material in the stream bed shall be described and it shall be noted if banks are subject to scour.
- Depth-finders may be used on major streams and rivers.
- The top of bank data is required only for those streams with well-defined stream channels.

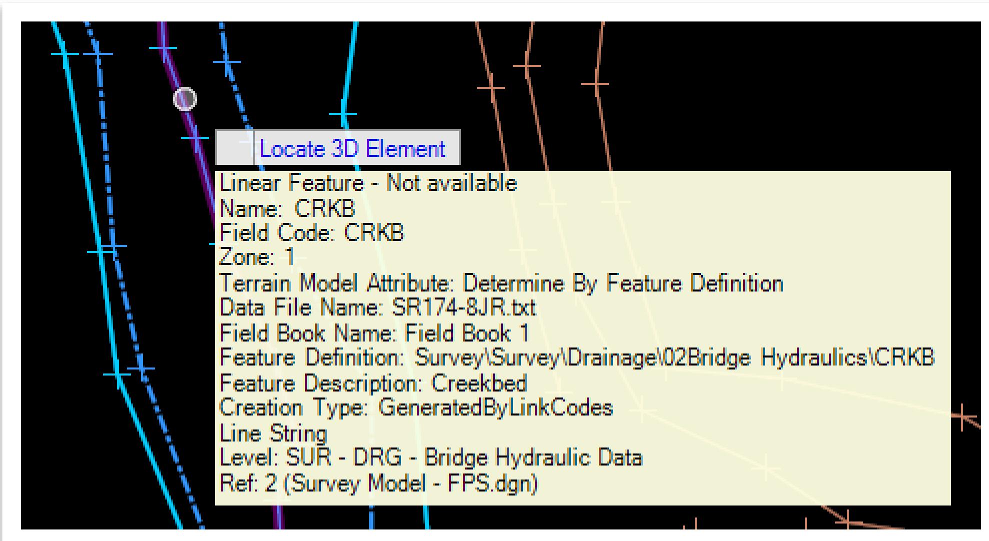
6.6.1 Exercise: Stream Profile

In this exercise, we will create a profile of the existing stream centerline along the creek bed and produce a single drawing model to annotate, like in the previous exercises. We will continue to utilize the same **Alignment – FPS.dgn** file.

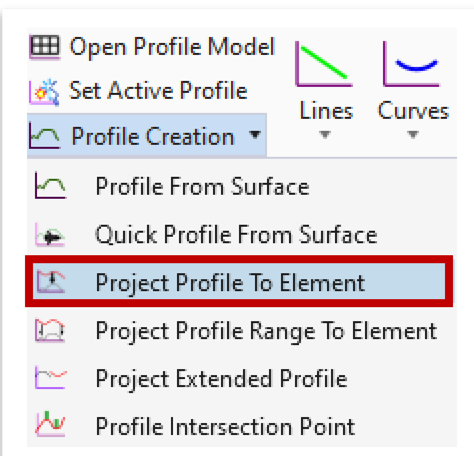
1. Switch to the **OpenRoads Modeling** workflow in the upper left corner. Then, select the **Default** model in the lower left corner of the drawing window and close **View 2**, if opened.
2. We need to first create **3D** elements from the survey data that is referenced into the file. Open the **Plan By 3D Element** tool (**OpenRoads Modeling >> Model Detailing >> 3D Tools >> 3D Elements**). Select the **Survey Existing Creekbed Centerline** feature definition within the **Alignment** folder and leave the **Name** as-is.



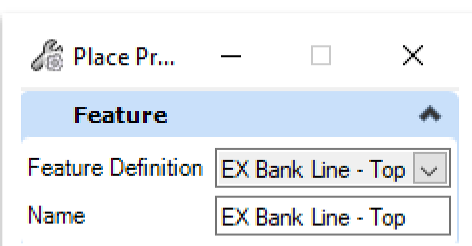
3. Notice the cursor prompt: **Locate 3D Element**. Select the creekbed centerline (**CRKB**), as shown below. It will seem like nothing happens once you select the line.



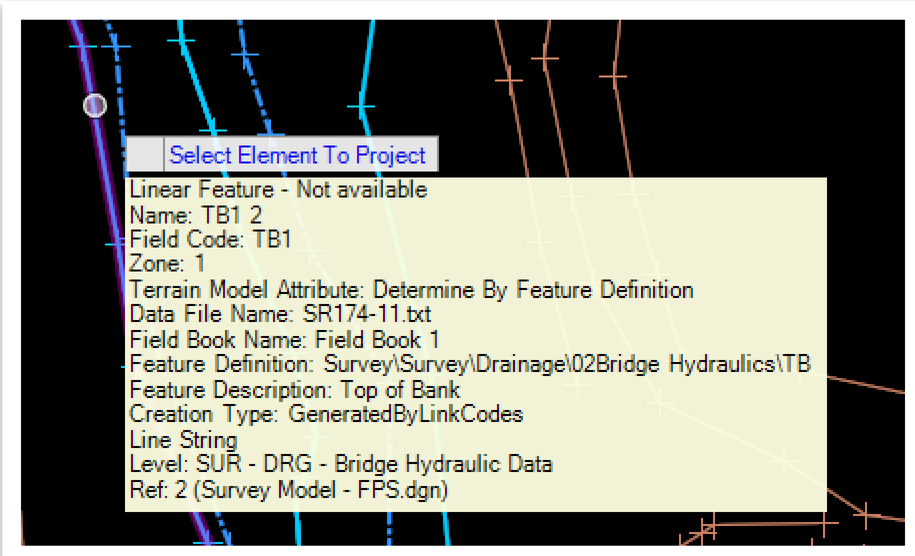
4. Next, we need to project the **top of bank** onto the creekbed. Open the **Project Profile To Element** tool (**OpenRoads Modeling >> Geometry >> Vertical >> Profile Creation**).



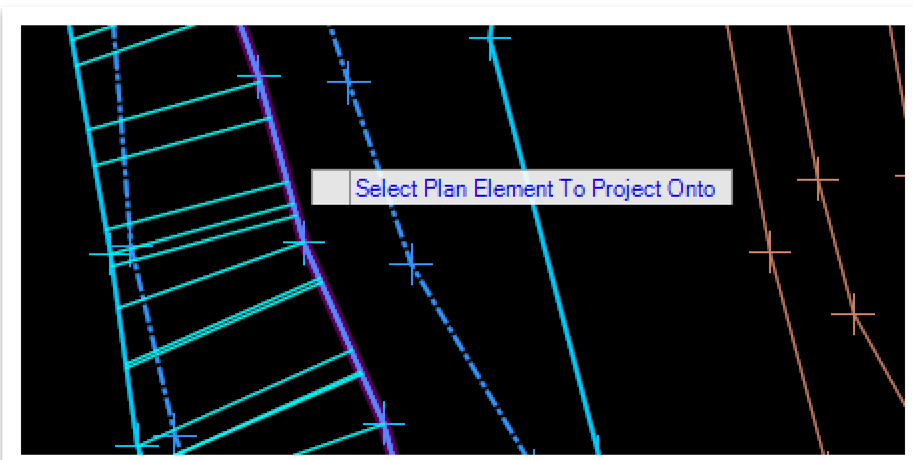
5. Within the **Place Projected Profile** dialog box, select the **EX Bank Line - Top** feature definition (**Linear >> Profiles >> Natural Drainage >> Existing**).



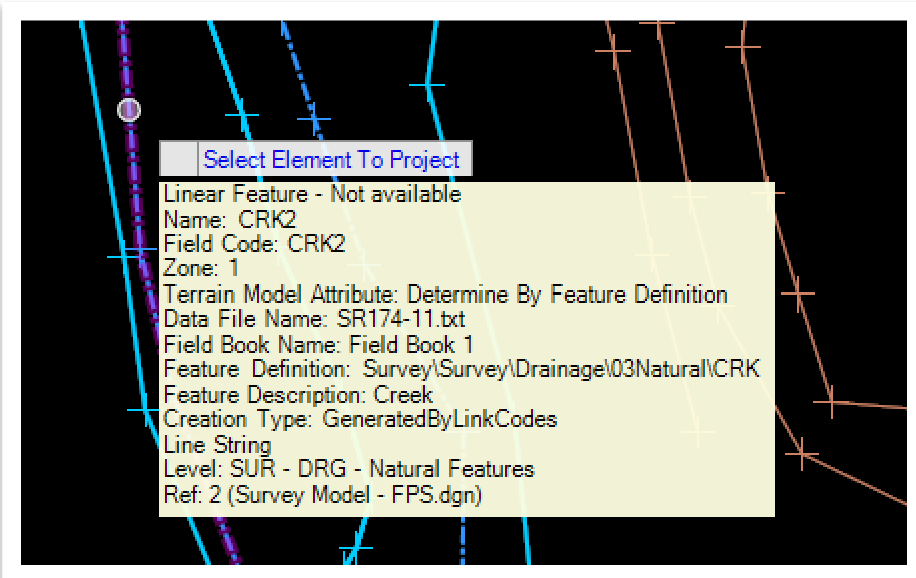
6. Notice the cursor prompt: **Select Element To Project**. Select the **top of the bank** line located on the **left** side of the stream, as shown below.



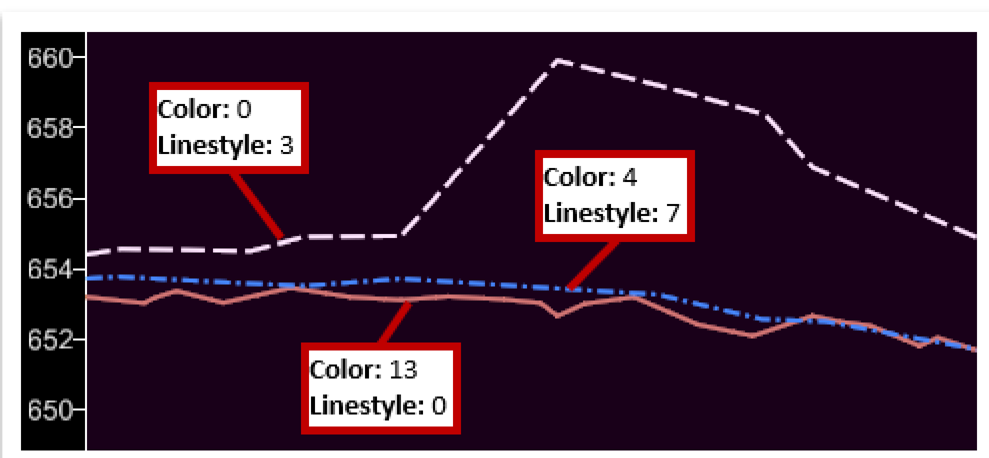
7. Notice the next cursor prompt: **Select Plan Element To Project Onto**. Select the creekbed centerline, as shown below. Once again, prior to selecting the centerline, notice the perpendicular light blue lines indicating the projection region.



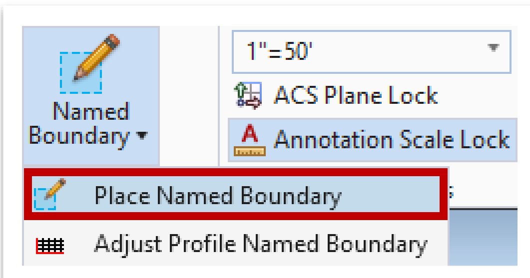
8. Repeat Steps 5-7 to project the **top of water** onto the creekbed. This time select the **EX Water Line - Top** feature definition (**Linear >> Profiles >> Natural Drainage >> Existing**).



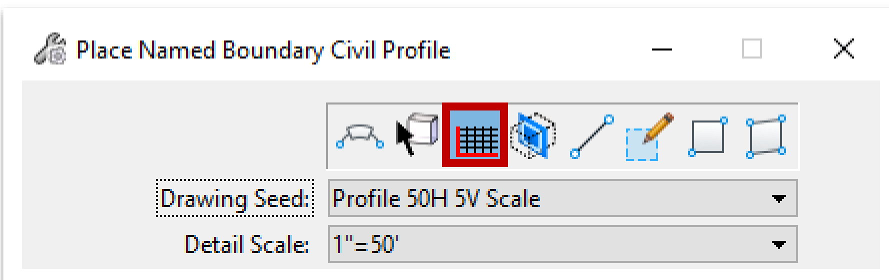
9. Next, we will visualize the projection in profile view. Open the **Open Profile Model** tool (**OpenRoads Modeling >> Geometry >> Vertical**). Select the creekbed centerline and then open **View 2** and click anywhere within the drawing window.
10. Notice that the **Top of Bank**, **Top of Water** and **Creek Bed** (**CL**) profiles are shown. It is likely that some of your attributes will not match what is shown below by default, due to a defect in the current software version. The profile elevations and feature definitions are correct, but you will need to manually update the linestyle and color within the **Properties**. Select each line and update, as necessary, per the screenshot below. Bentley has indicated this issue should be fixed in the next release. **Note:** Only a portion of the profile is shown in the image below.



11. If you wanted a creekbed baseline (**BL**) report, you would open the **Horizontal Geometry Report** tool (**OpenRoads Modeling >> Geometry >> General Tools >> Reports**) and select the creekbed centerline. If you also wanted elevation data, you would need to select the applicable profile. For this exercise, we will move on to create the profile named boundary so we can place the annotation. **Note:** As a reminder, once the report is run, you can view all other reports, including vertical, within the **Bentley Civil Report Browser**.
12. Open the **Place Named Boundary** tool (**OpenRoads Modeling >> Drawing Production >> Named Boundaries >> Named Boundary**).

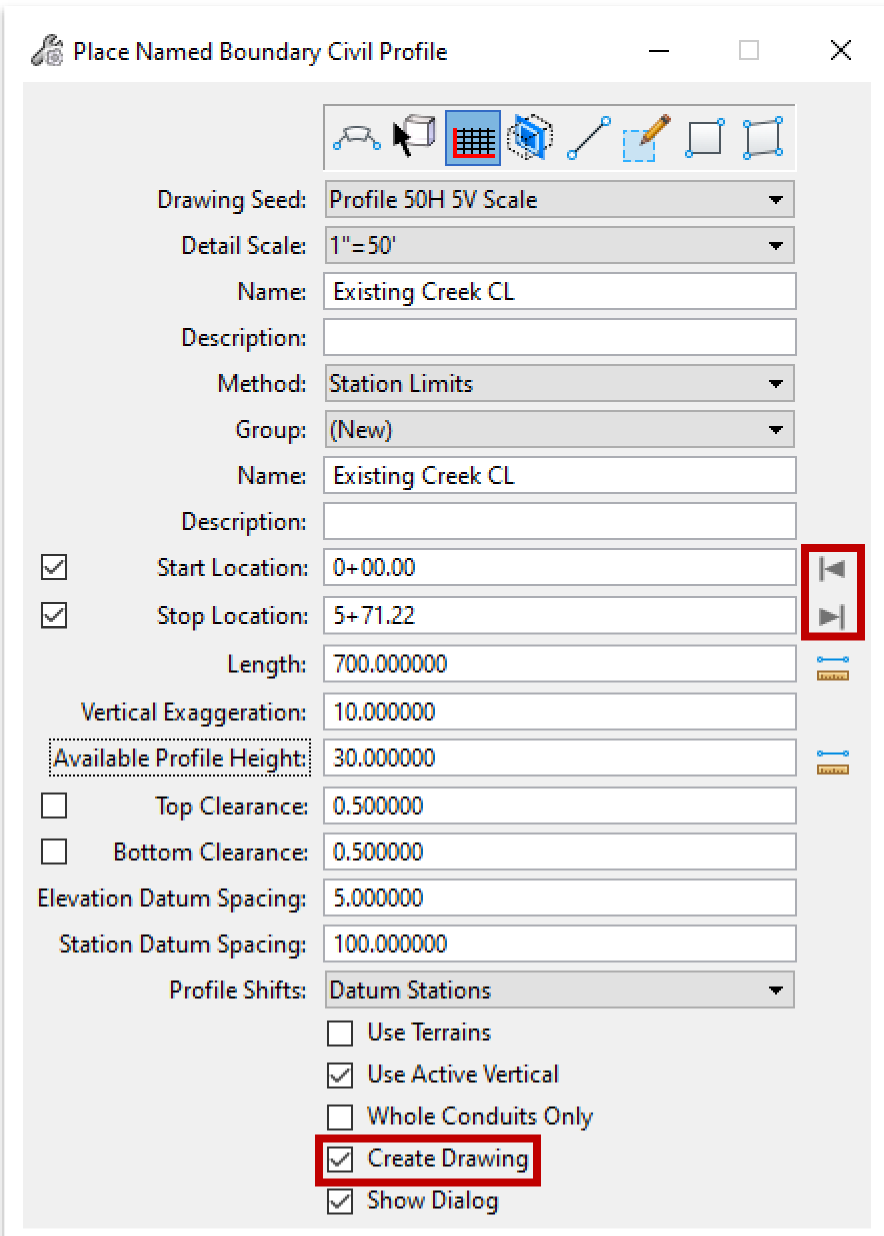


13. Make sure that the **Civil Profile** option is toggled on. Select **Profile 50H 5V Scale** for the Drawing Seed.

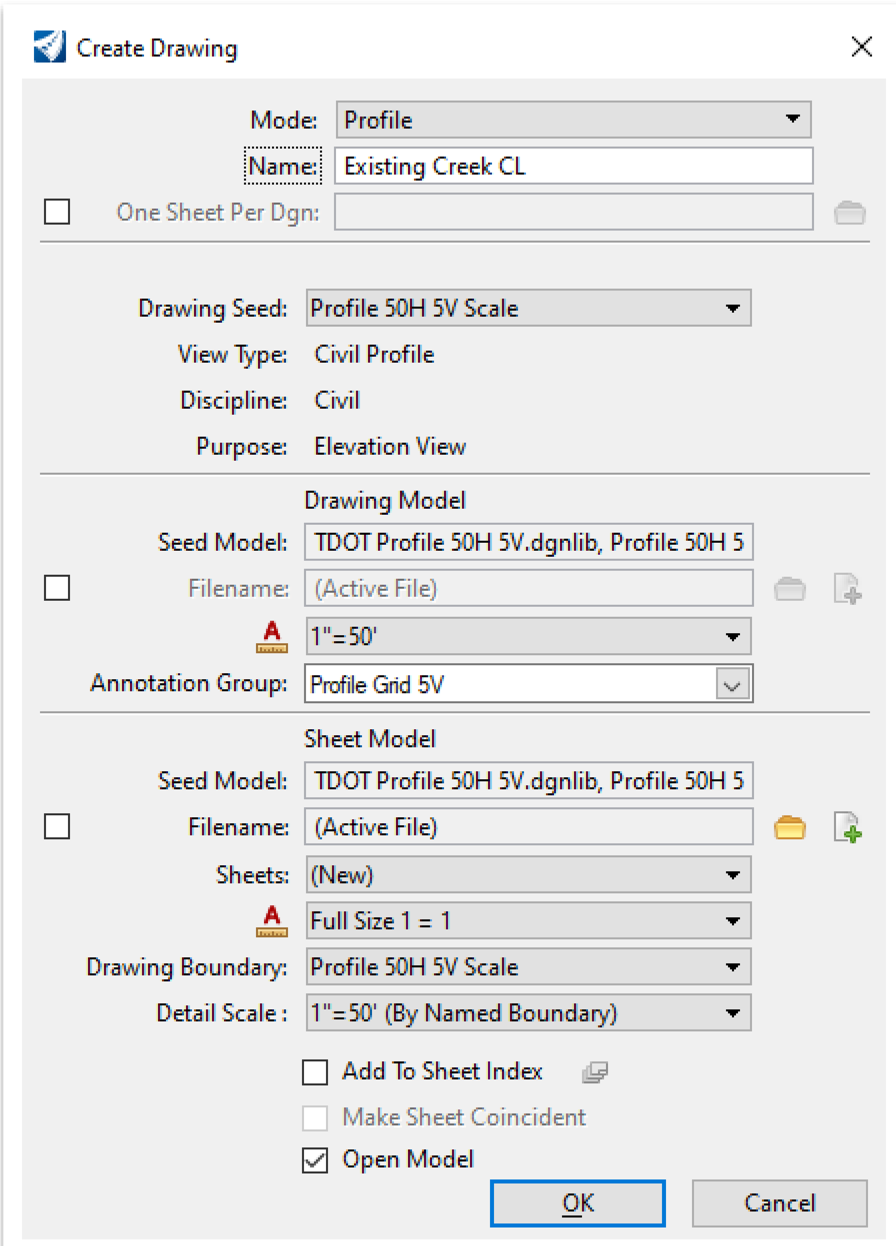


14. Notice the prompt in the lower left corner of the drawing window: **Identify Profile View**. Left click anywhere within **View 2**.

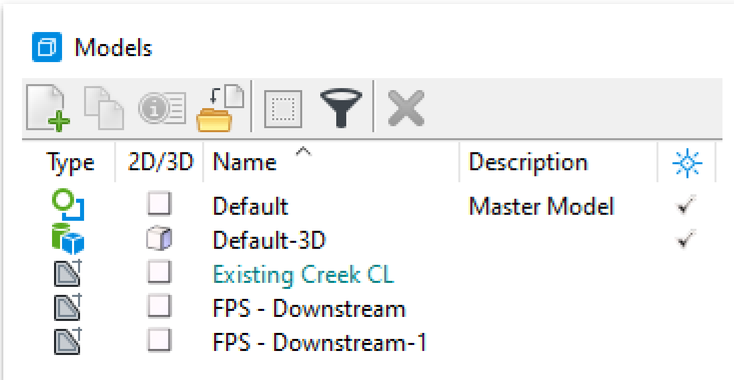
15. Edit the parameters below and leave all other default values as-is. Make sure that the **Create Drawing** option is toggled on at the bottom.
    a. **Name:** Existing Creek CL
    b. **Start Location:** 0+00.00 (Use the grey arrow to lock to Start)
    c. **Stop Location:** 5+71.22 (Use the grey arrow to lock to Stop)
    d. **Length:** 700.00
    e. **Available Profile Height:** 30.00



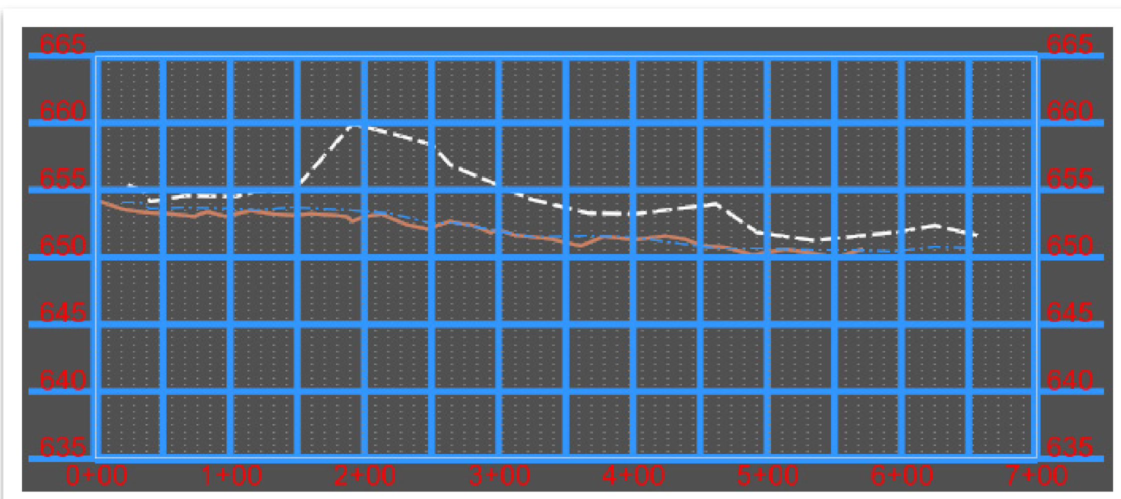
16. Left click anywhere within View 2 **three** times. Zoom out and you should see **one** profile named boundary drawn into the file, represented by a white border. The **Create Drawing** window will appear automatically after creating the named boundary, since we toggled it on in the previous step. Click **OK** to accept all default settings.



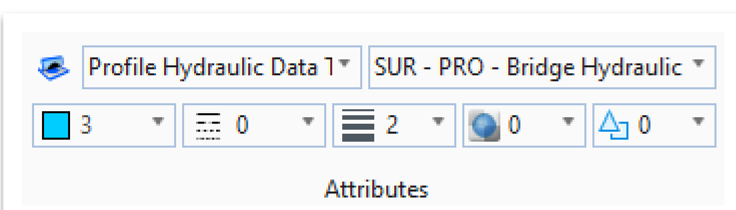
17. Once again, the software should open to the <u>one</u> sheet model in **View 1**. Let's go ahead and delete the sheet model. Open the **Models** tool (**Survey >> Home >> Primary**) and double click on the **Existing Creek CL** <u>drawing</u> model to activate it. Then, right click on the <u>sheet</u> model and select **Delete**. You should see the following four models once completed. Close the **Models** window once you are done.



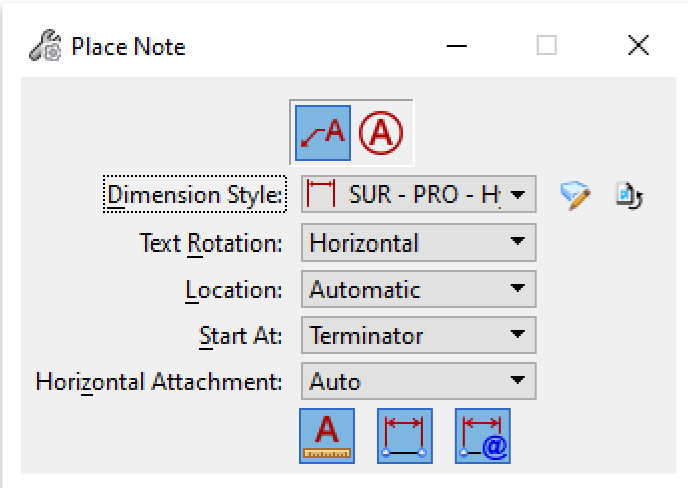
18. You should see the downstream flood plain section along with the profile grid, stations and elevations. We will next add the applicable annotation, like in the previous exercises.



19. Now, before we add annotation, select the **Profile Hydraulic Data Text** element template (**Survey >> Annotation >> Profiles >> Bridges**).

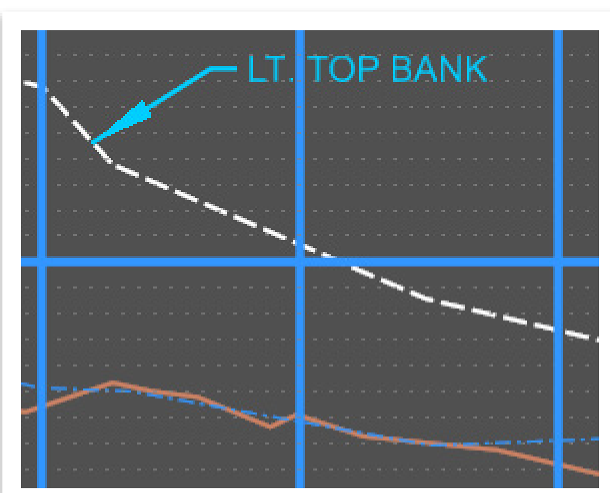


20. Next, open the **Place Note** tool (**OpenRoads Modeling >> Drawing Production >> Notes**). Within the **Place Note** dialog box, select the **SUR - PRO - Hydraulic Data** dimension style and leave the other settings as-is.

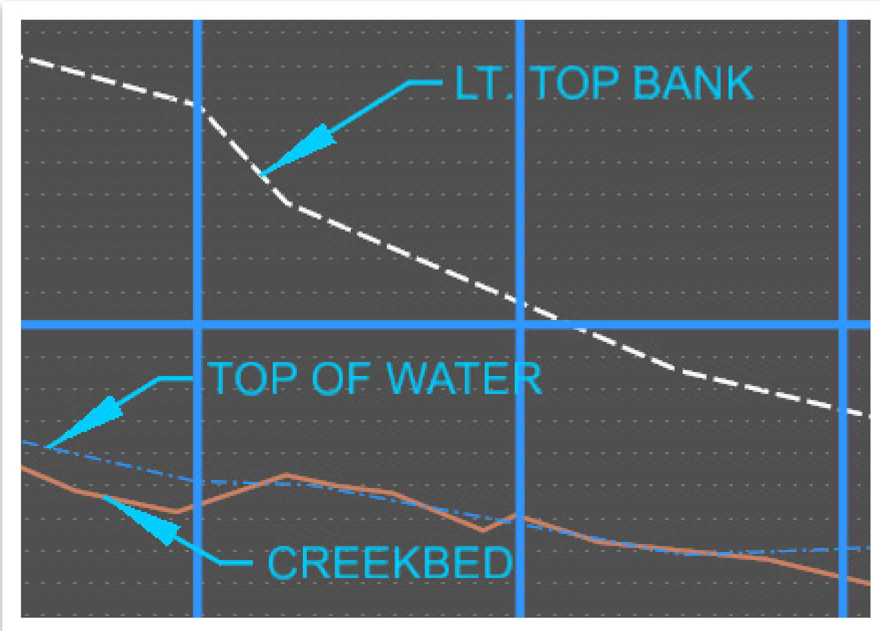


21. Within the **Text Editor**, select the **Extra Small - Left Top** text style (highlighted below). Key-in **LT. TOP BANK**.

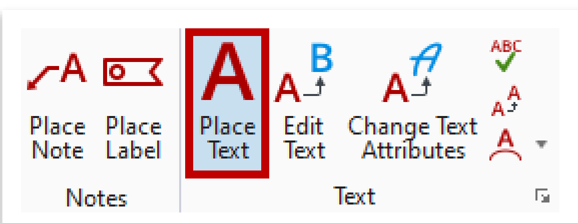
22. Notice the prompt in the lower left corner: **Define start point**. Snap to the **Top Of Bank** and place the **Note** as shown below.



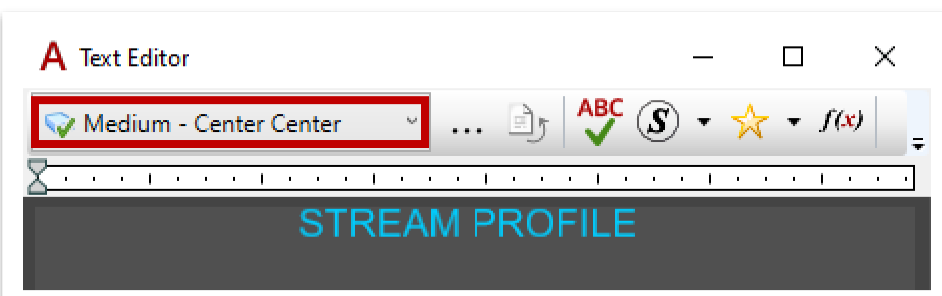
23. With the **Text Editor** still open, repeat the previous two steps and place the **Top Of Water** and **Creek Bed** notes. Close the **Text Editor** once completed.



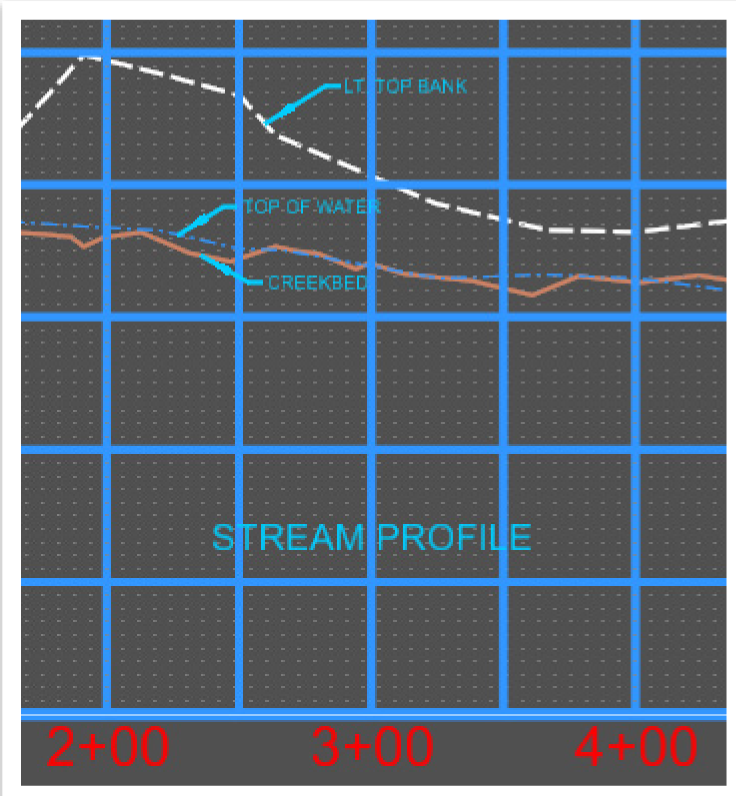
24. Next, open the **Place Text** tool (**OpenRoads Modeling >> Drawing Production >> Text**) so we can label the title of this XS. The same element template should still be active.



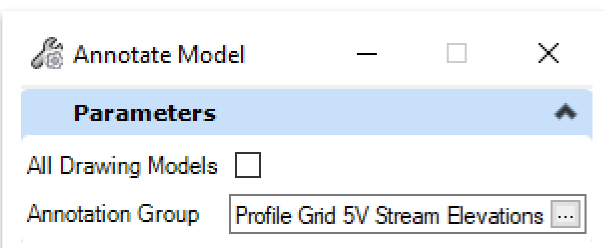
25. Within the **Text Editor**, select the **Medium - Center Center** text style (highlighted below). Key-in **STREAM PROFILE**.



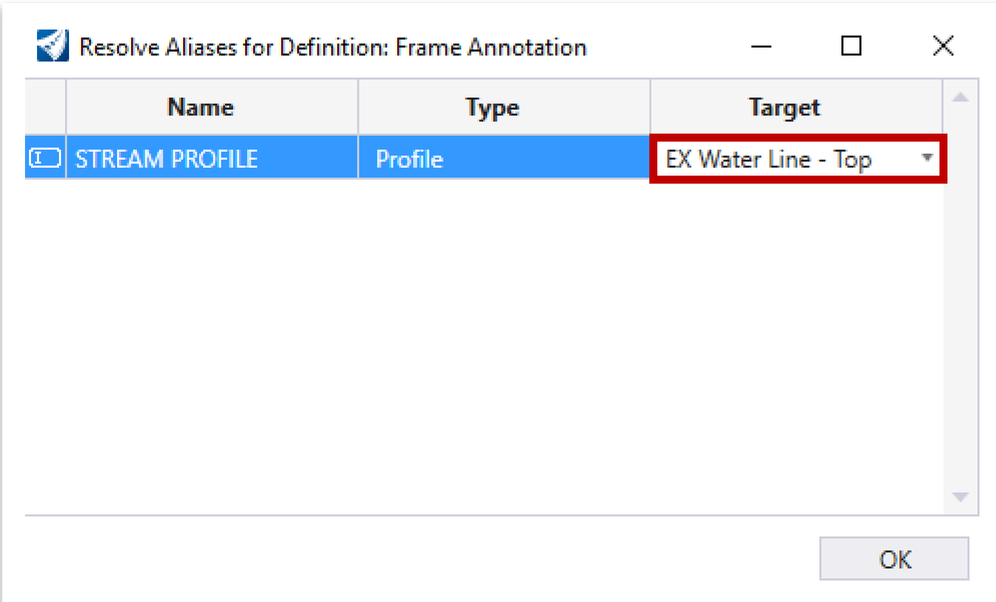
26. Place the text at the bottom of the profile, as shown below. Click **ESC** to clear the tool.



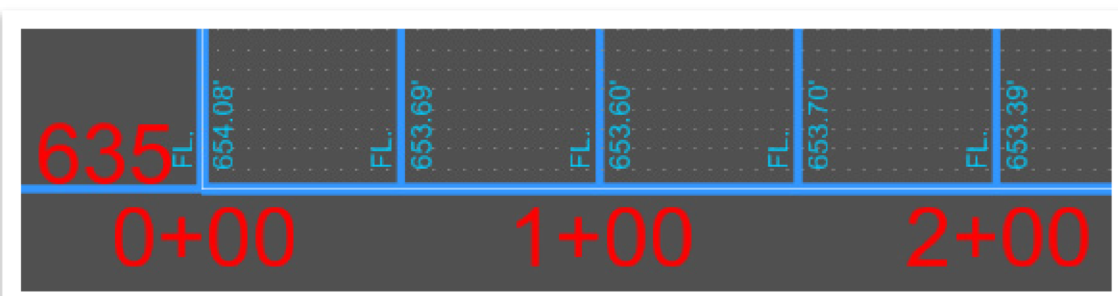
27. To label the **50'** stream (flow) elevations, an annotation group has been setup to automatically place the labels. Open the **Annotate Model** tool (**OpenRoads Modeling >> Drawing Production >> Annotations >> Model Annotation**). Within the **Annotate Model** dialog box, leave **All Drawing Models** unchecked. Click the ellipses next to **Annotation Group** and select **Profile Grid 5V Stream Elevations** (**Profile >> Drawing**).



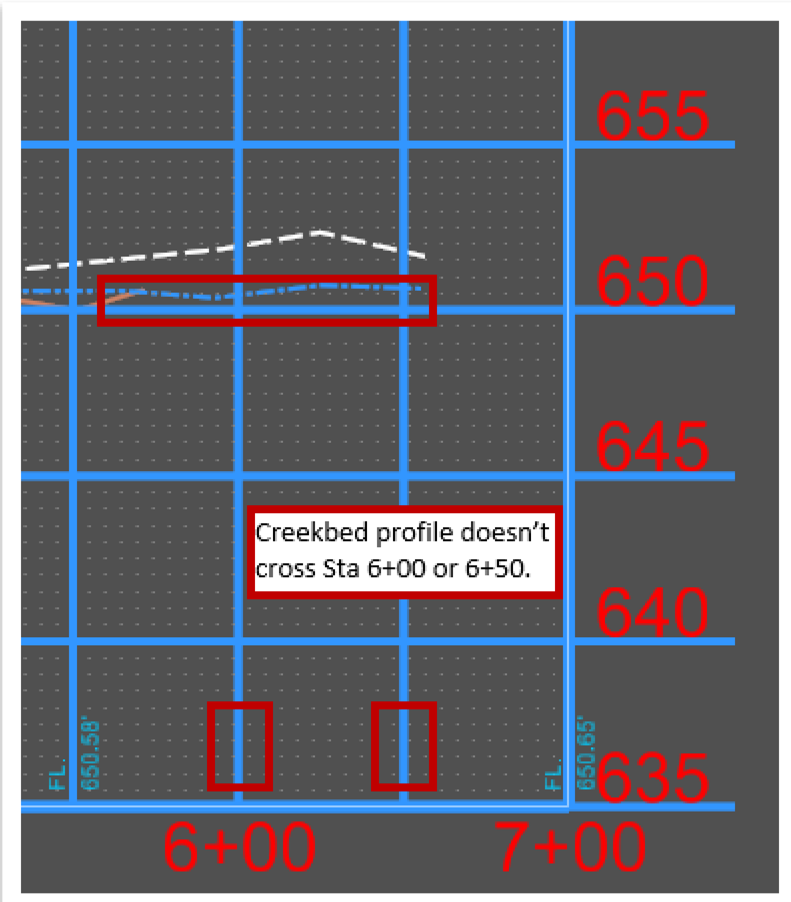
28. Left click twice to accept the settings. A **Resolve Aliases for Definition: Frame Annotation** window should appear automatically for the **STREAM PROFILE**. Left click within the **Target** column and select the **EX Water Line -Top** option and then click **OK**.



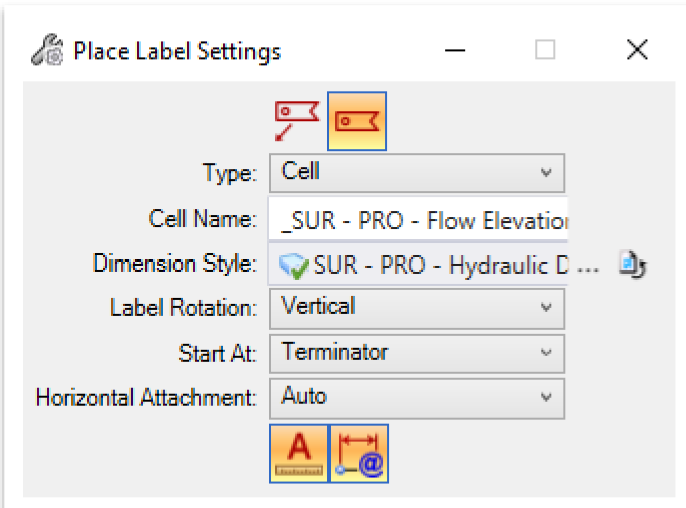
29. Notice that the flow labels are automatically added at the bottom of the grid with the correct flow elevation, per the target (**EX Water Line -Top**) selected in the previous step. No labels were added at Station 6+00 or 6+50, which will be discussed in the next step. **Note:** The first and last label (Station **0+00** and **7+00**) display the correct respective elevations at the beginning and ending points of the profile target line, even if it doesn't extend to grid extents.



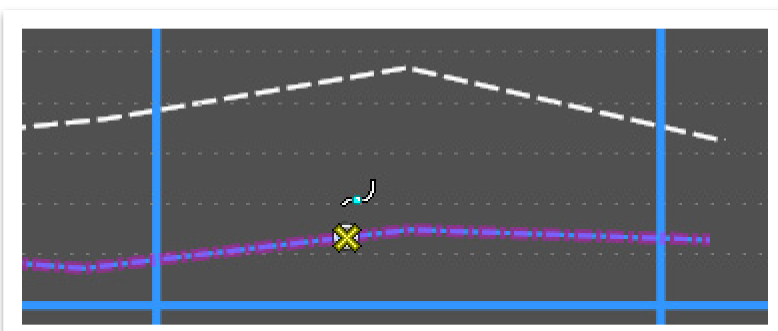
30. As previously mentioned, the labels at Station **6+00** and **6+50** did not place. The labels will only be placed with the extent of the profile that the named boundary was created from. In this case, we created the named boundary along the brown **Survey Existing Creekbed Centerline**, so the flow elevation labels will only be physically placed within the extent of that profile, regardless of what the target is set to. Since the **EX Water Line - Top** profile extends further, we will manually add the other two flow elevation labels.



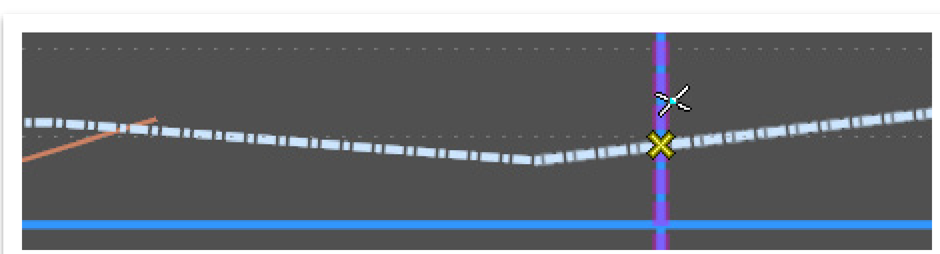
31. Open the **Place Label** tool (**OpenRoads Modeling >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings.
    a. Select the **non-leader** icon at the top
    b. **Type:** Cell
    c. **Cell Name:** _SUR - PRO - Flow Elevation
    d. **Dimension Style:** SUR - PRO - Hydraulic Data
    e. **Label Rotation:** Vertical



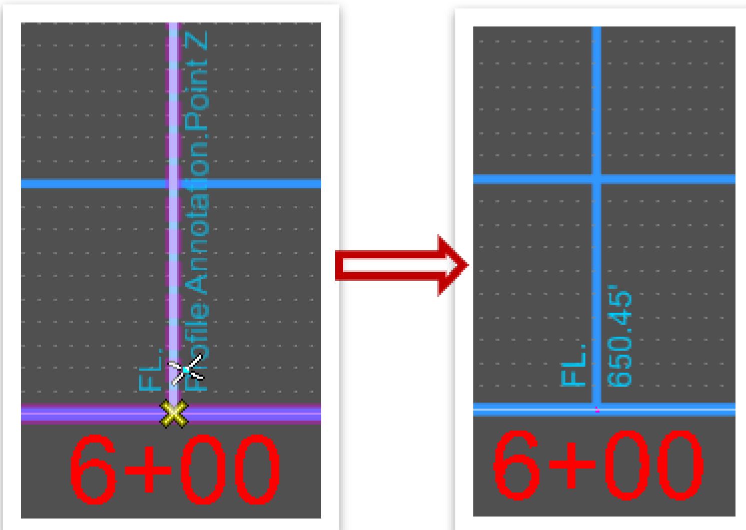
32. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the **EX Water Line - Top** profile.



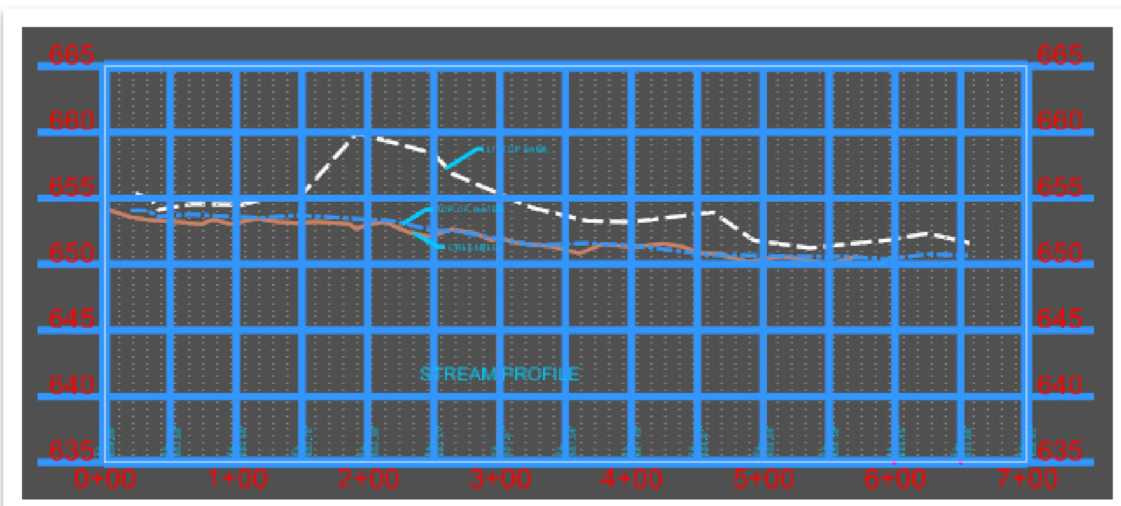
33. Notice the next prompt in the lower left corner: **Select Point Location**. Snap to the intersection point of the **EX Water Line - Top** and the Sta **6+00** grid line.



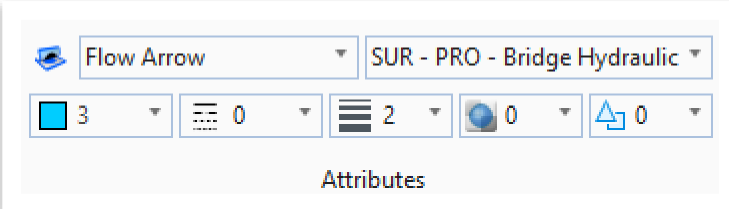
34. Then, snap to the bottom of the y-axis to accept label placement (**FL. 650.45'**), which should align with the other labels. **Note:** Remember that the elevation will not populate until you accept placement. Also, there is a defect with the software that places a small erroneous circle at the origin point of the cell.



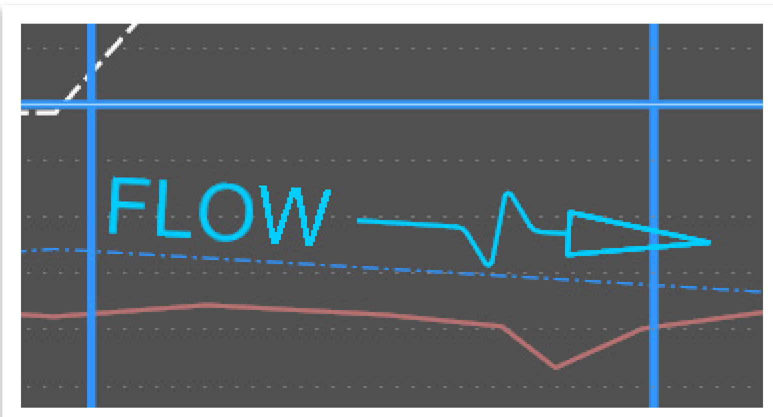
35. Repeat Steps 33-34 to place the flow elevation at Sta **6+50**, which should be **650.66'**.



36. Lastly, to add the flow arrow, first select the **Flow Arrow** element template (**Survey >> Annotation >> Profiles >> Bridges**).



37. Then, open the **Place Active Cell** tool (**OpenRoads Modeling >> Drawing >> Placement > Cells**) to place the arrow. With the same element template selected, open the **Place Text** tool and add **FLOW**, as shown below. Select the **Extra Small - Center Center** text style within the **Text Editor**. **Note:** The label can be rotated, if necessary.



6.7 Lecture: Drainage Area Delineation

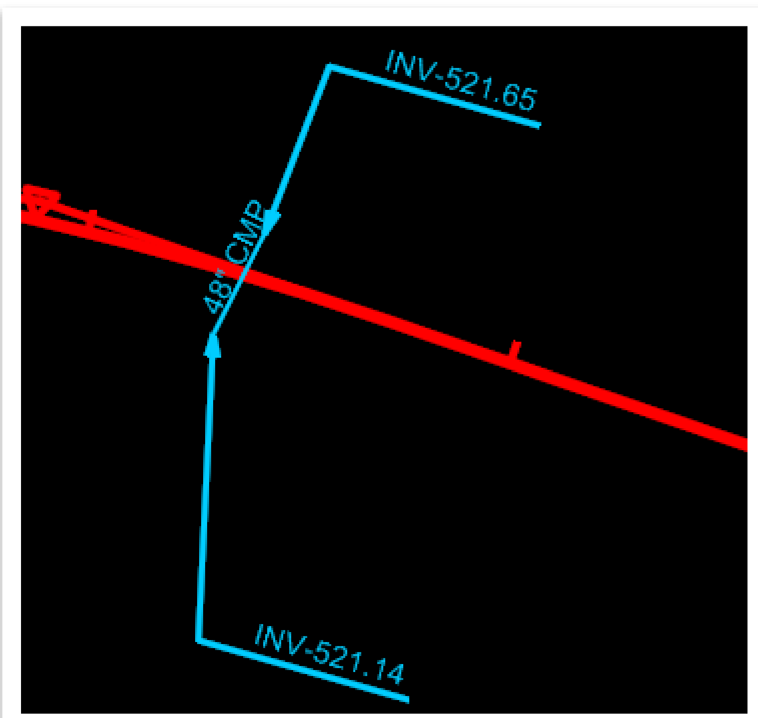
A **Drainage Area** (also known as a **Watershed**) is defined as the area which will contribute runoff to a given point and is required to estimate the runoff generated to an outfall point.

A **Drainage Map** created by TDOT Survey provides the delineated drainage areas for every pipe crossing that spans the survey preliminary centerline. Large areas are typically delineated using **USGS quad maps** or aerial mapping whereas smaller areas are surveyed in the field. Drainage areas are also verified using **USGS StreamStats**. Mapping is digitized and entered in the planimetrics file (Survey Model) where possible.

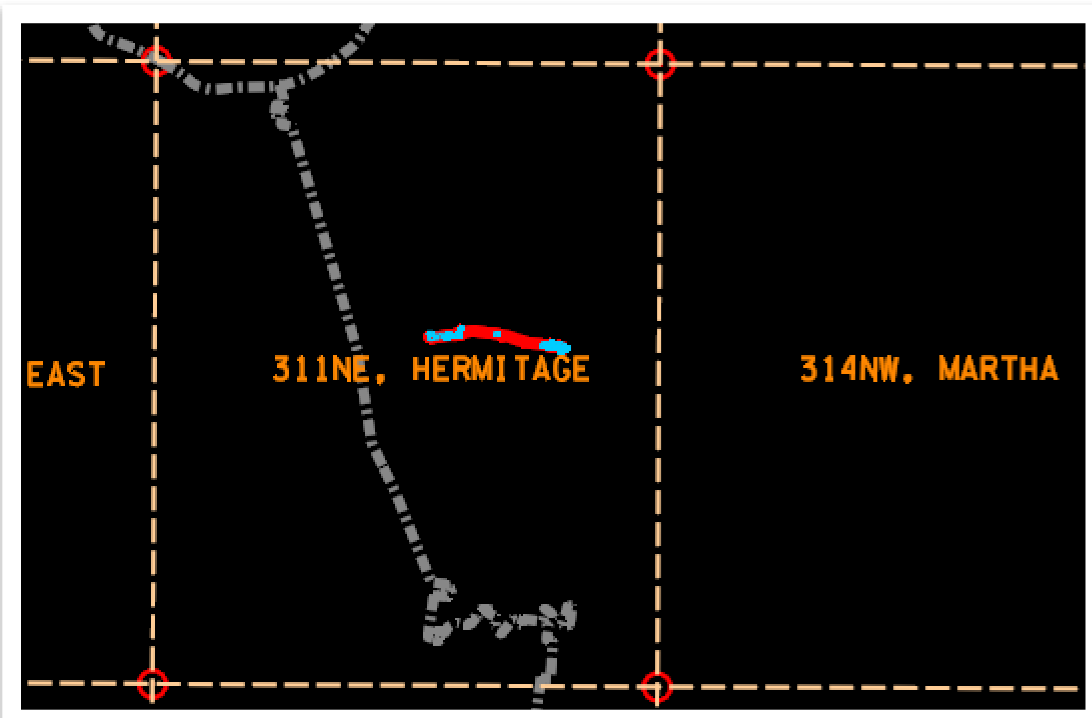
6.7.1 Exercise: Drainage Area Delineation

In this exercise, we will delineate a drainage area for a culvert that spans a survey preliminary centerline and then verify it using USGS StreamStats. Once again, the survey preliminary centerline must be created before this exercise can be done. We will utilize a project dataset located in Mt. Juliet, TN. **Note:** This exercise assumes the user has a basic understanding of reading contour maps, such as top of hills, flow lines, ridge lines and saddles. A quick review of the contour map and definitions is shown in **Appendix B**.

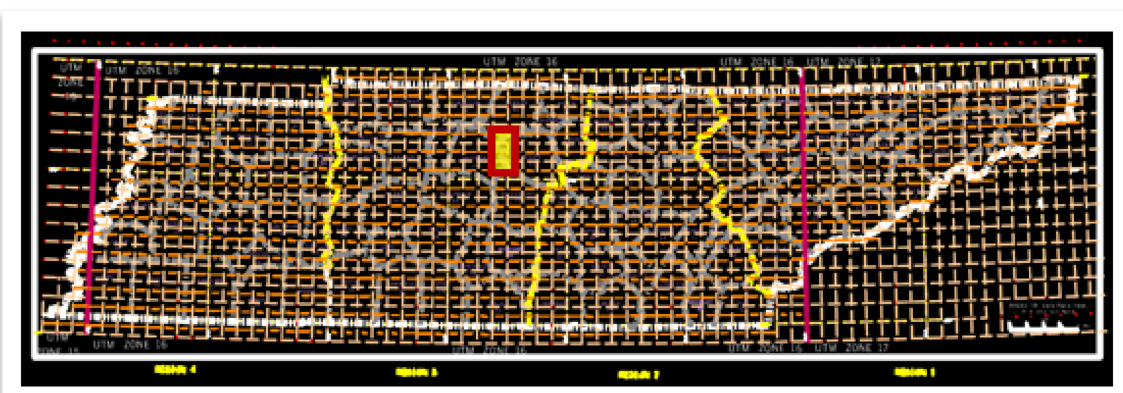
1. Open the **Survey Model – DA.dgn** file within the **SURVEY_Training** workset dgn subfolder. Switch back to the **Survey** workflow in the upper left corner.
2. Zoom in to the existing **48" CMP** located at approximate Station **152+37.00**.



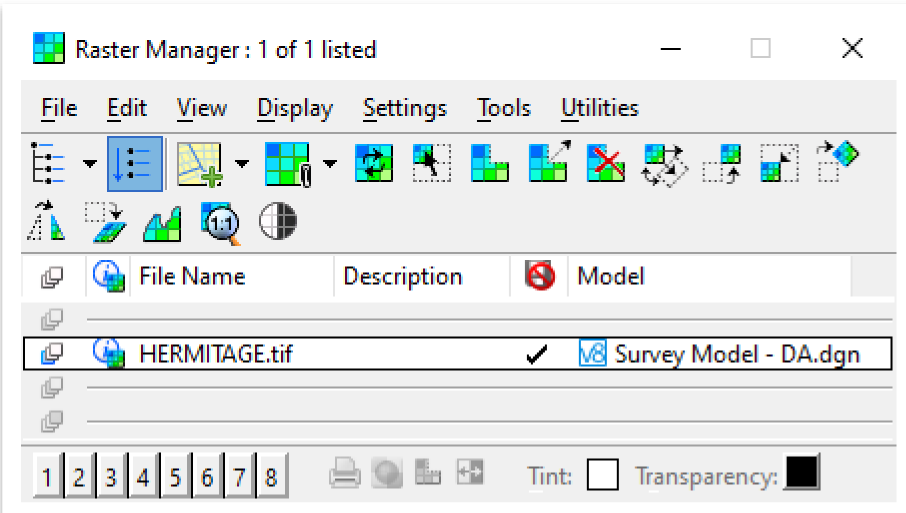
3. Review the provided invert elevations and notice that the flow is entering on the northern side (**upstream**) and discharging to the south (**downstream**). This means that the contributing drainage area should be on the northern side of the structure.
4. Go ahead and attach the **83StatePlaneNameIndexV8.dgn** reference file. Notice that the project location is correctly located within the **Hermitage** Quad Map in **Wilson** county. **Note:** This is TDOT's NAD83 State Plane Index showing the USGS QUAD Names. For an actual project, TDOT Survey staff can find this file under the **PROJECTS** folder located here: **This PC\PROJECTS (\\AG03SDCWF00010.net.ads.state.tn.us) (V:)\QuadSheets\Nad83 Named**



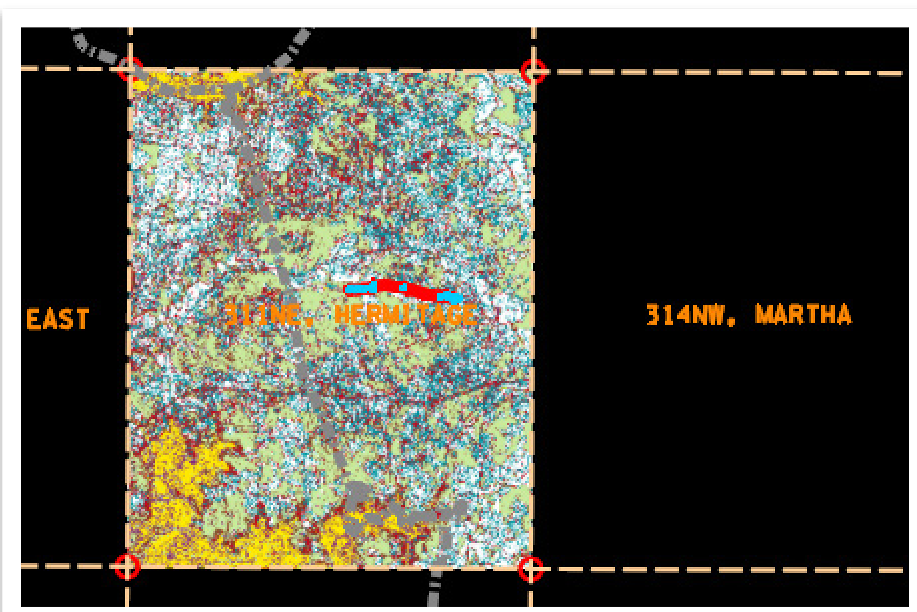
5. Click **Fit View** and notice the statewide overview of the Quad Index is shown. **Note:** The project location is highlighted below in red.



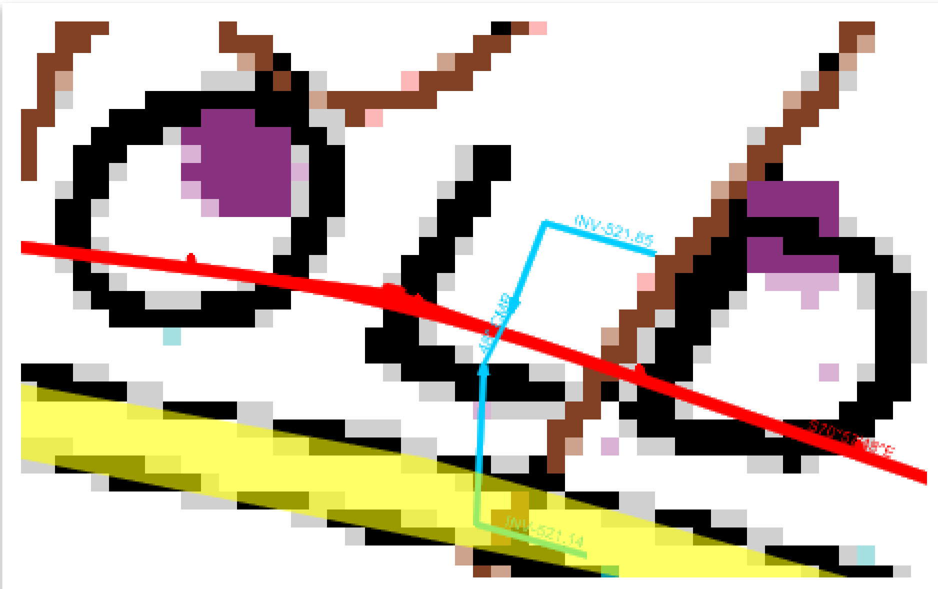
6. The **Index** name corresponds to a **.tif** file with that same name, which we will be referencing. For this exercise, the **HERMITAGE.tif** file is already provided in the class files. For an actual project, you would need to find all applicable .tif files for your project as referenced on the Index map.
7. Open the **Raster Manager** (**Survey >> Home >> Primary >> Attach Tools**). Go to **File >> Attach >> Raster** and attach the **HERMITAGE.tif** file. Accept all default attachment options and click **Attach**. Close the Raster Manager once completed.



8. Notice that the raster now appears within the **HERMITAGE** grid.

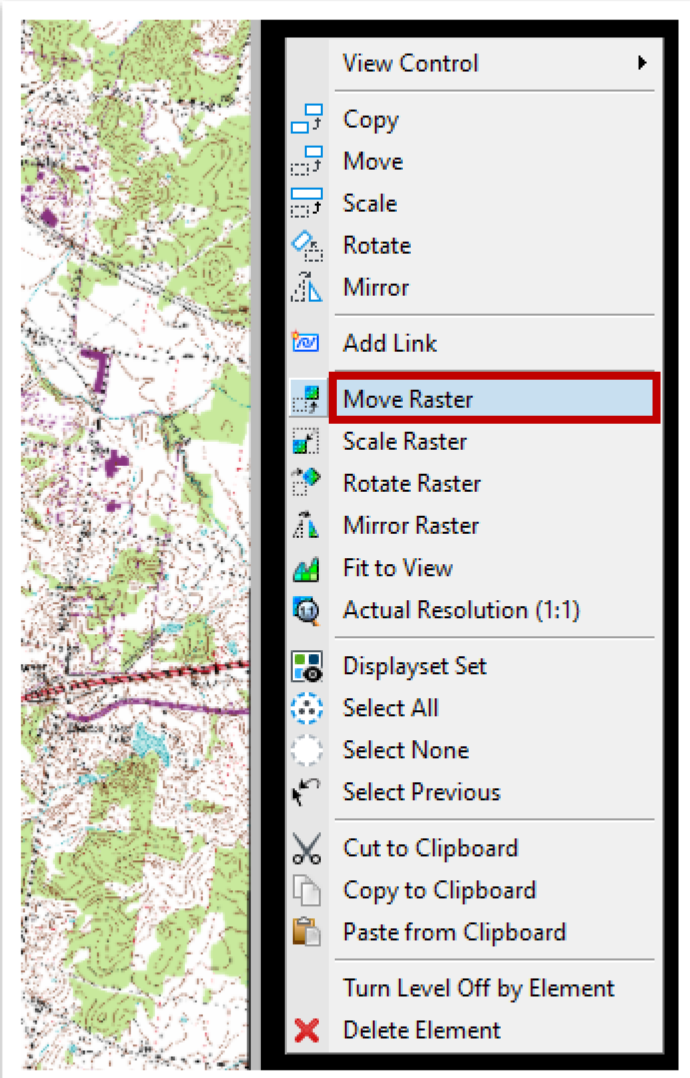


9. Once again, zoom in to the existing **48" CMP** located at approximate Station **152+37.00**. Notice that the referenced centerline in the geometry file (red line) does not align with the centerline in the Quad map (yellow shading).



10. This could be due to the scale factor in the geometry reference file. Since the scale factor for the **.tif** is unknown, we will move the raster to align with the Alignment reference file. Pan to the **east** of the **48" CMP** and locate the intersection shown below.

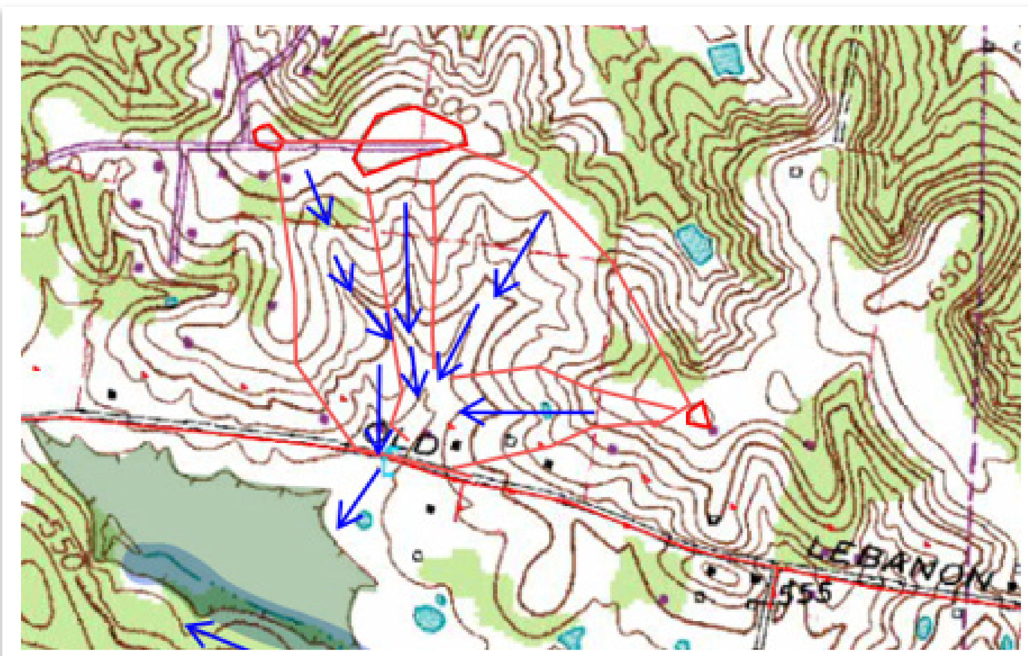
11. Turn off the **83StatePlaneNameIndexV8.dgn** reference file. Right click and hold on the Quad map border and select **Move Raster**.



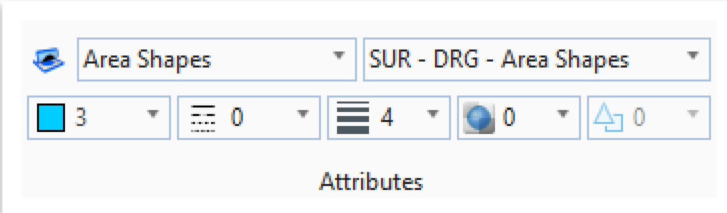
12. Left click to snap at the approximate intersection point within the Quad map (it appears like nothing happened). Then, left click again at the red line intersection point within the referenced alignment file. Notice that the Quad map intersection has now moved. **Note:** Your intersection alignment will vary depending on the initial snap point location.

13. Once again, zoom in to the existing **48" CMP** located at approximate Station **152+37.00**. While reviewing the map, key items to look for are major water features such as streams and creeks. Also, identify the hills and ridges, which represent drainage area boundaries. The Boundary lines are typically drawn at the centerline of a ridge and drawn perpendicular to each contour line.

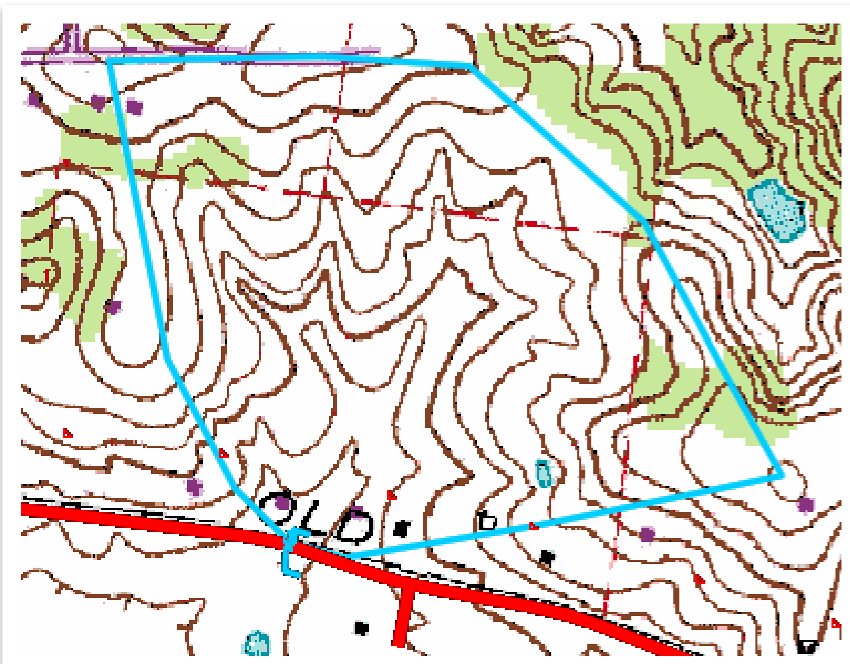
14. Before we draw the drainage area for the existing 48” CMP, let’s examine the different components that have either been drawn in or highlighted in the image for your reference.
    a. **Stoners Creek** has been highlighted in blue on the southern side of the crossing.
    b. Blue **flow direction arrows** have been drawn between the ridges based on the contours. They identify the “V” shape of the contours in the direction of the inflow point.
    c. Small red polygons and lines have been drawn in to represent the top of **hills** and **ridges** respectively.
    d. The **marsh** has been highlighted in dark green on the southern side of the crossing. Notice the tick marks pointing inwards from the contour line. Also, notice that the flow at the 48” CMP is discharging to this marsh.
    e. The large red outer polygon represents the approximate drainage area. It is created by connecting all the **high points** and the **outermost ridges** (shown on the northern side draining to the CMP).



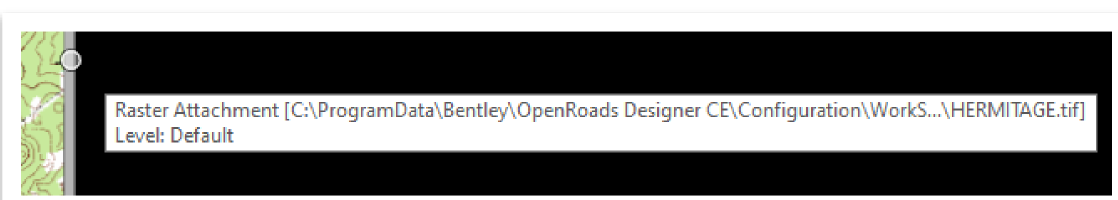
15. Now that the project area has been examined, select the **Area Shape** element template (**Survey >> Drainage >> Natural**).



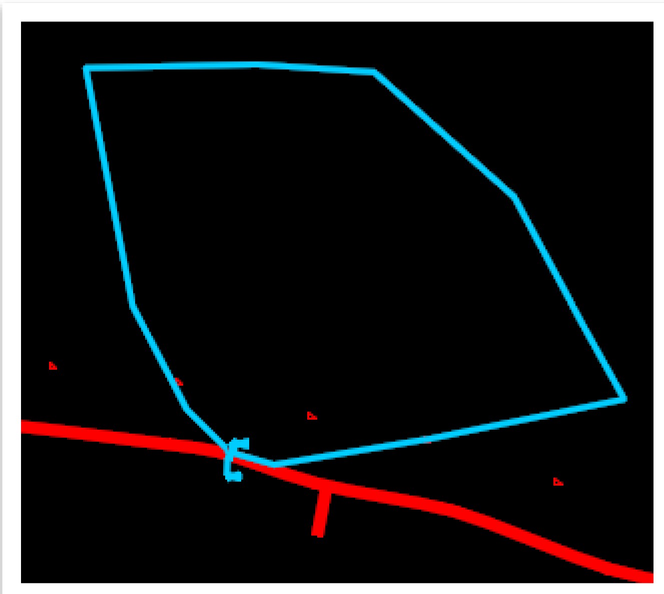
16. Next, open the **Place SmartLine** tool (**Survey >> Drawing >> Placement**) to start delineating the drainage area. Reference the outer polygon in Step 14e, if necessary. Complete the blue polygon to create the drainage basin boundary, as shown below.



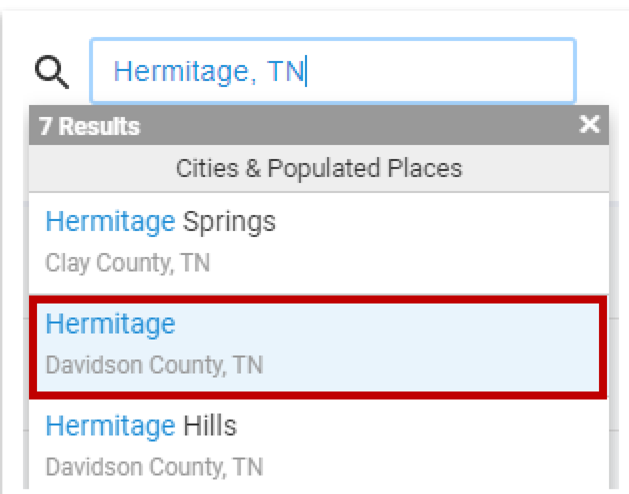
17. Go ahead and turn off the raster level. You can hover over the raster boundary to see what level it is on. By default, the level should be **Default**. **Note:** If your raster is on a different level, turn off the applicable level.



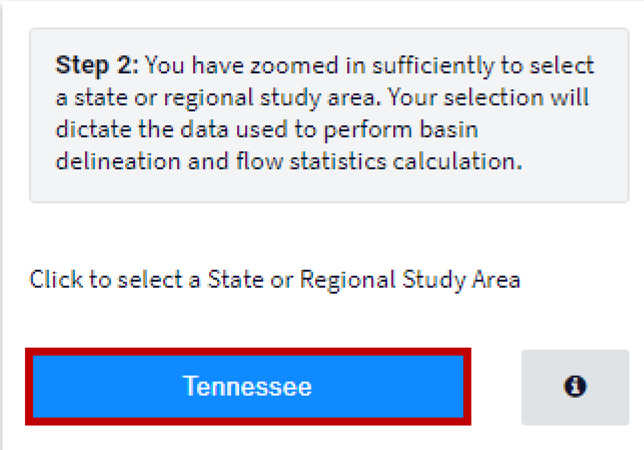
18. Notice that the delineated area is now clearly shown within the dgn file. You would then measure the area, which is **53.33** acres, and place the drainage area text. **Note:** You will have a different acreage depending on your overall shape of the drainage area. We will place the drainage area text in the next exercise.



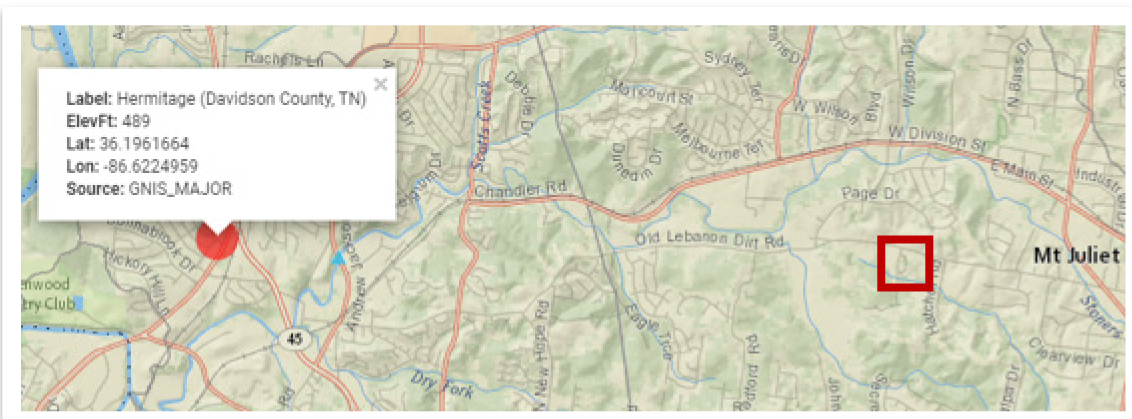
19. Next, we will verify the delineated area using **USGS StreamStats**. Open the USGS StreamStats site: https://streamstats.usgs.gov/ss/. If an **Active News** popup window appears, go ahead and close it. Type **Hermitage, TN** in the search bar on the left side of the screen. Select the option that has **Davidson County, TN** in the name.



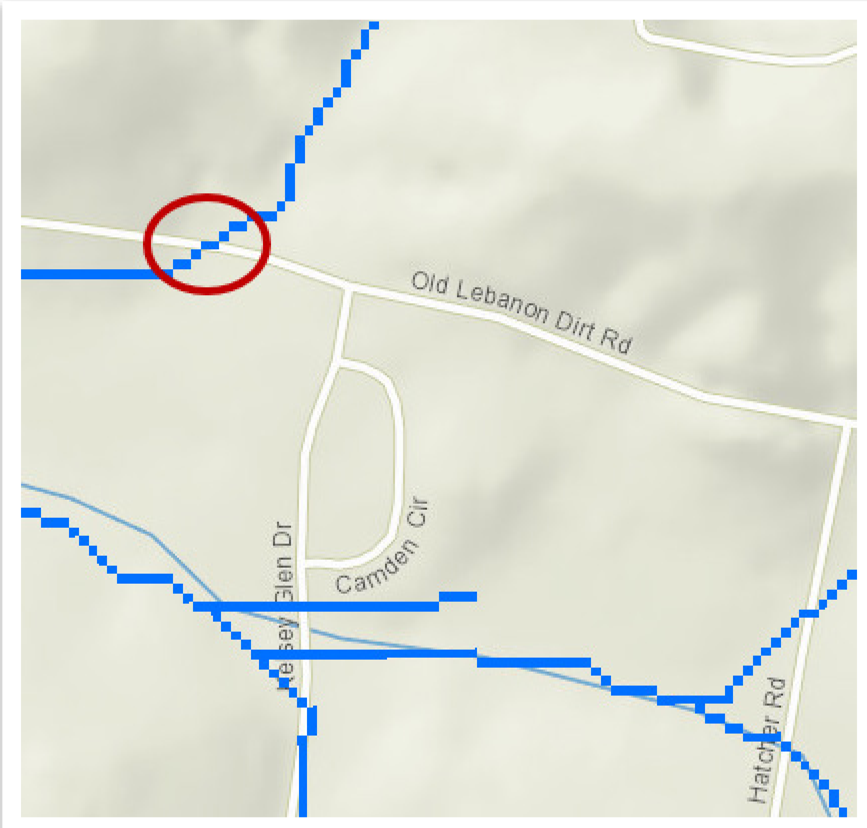
20. Once the map zooms into Hermitage, TN, click **Tennessee** on the left side of the screen and notice the blue tributaries appear.



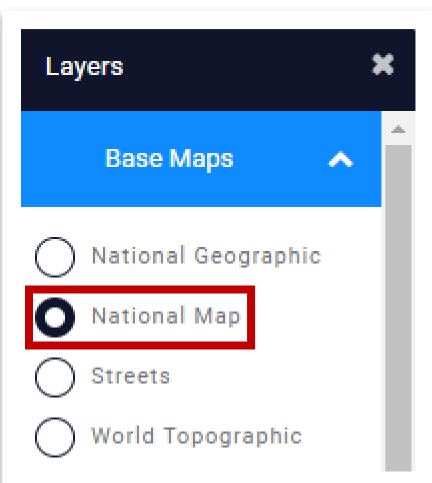
21. Within the map area, pan east past the county line and zoom in to the highlighted portion within the project area (**Old Lebanon Dirt Rd @ Kelsey Glen Dr** intersection).



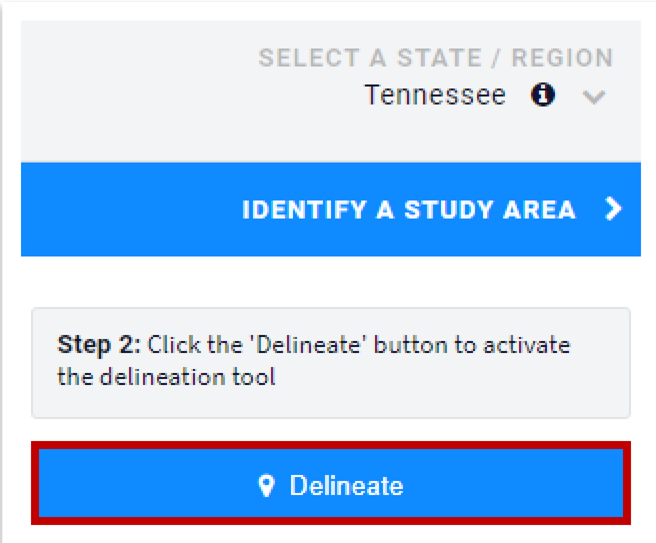
22. Notice a blue **tributary** crossing old **Lebanon Dirt Road**, which is highlighted below. This represents the upstream and downstream flows through the **48" CMP**.



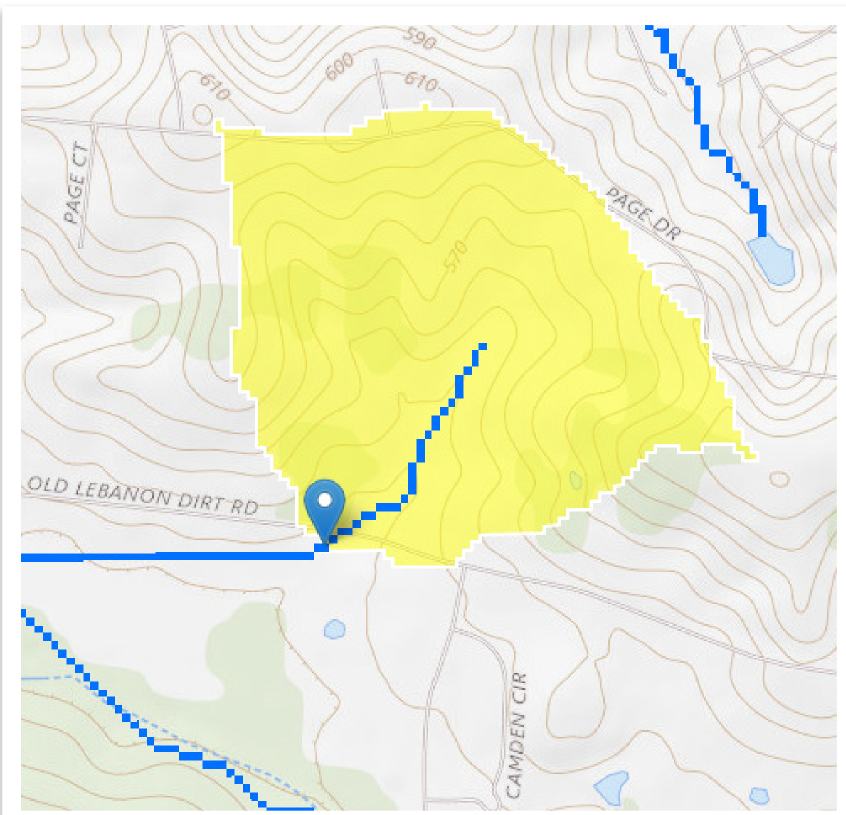
23. Next, expand the **Base Maps** layers on the right side of the screen and select **National Map**. Notice that the contours now appear in the background.



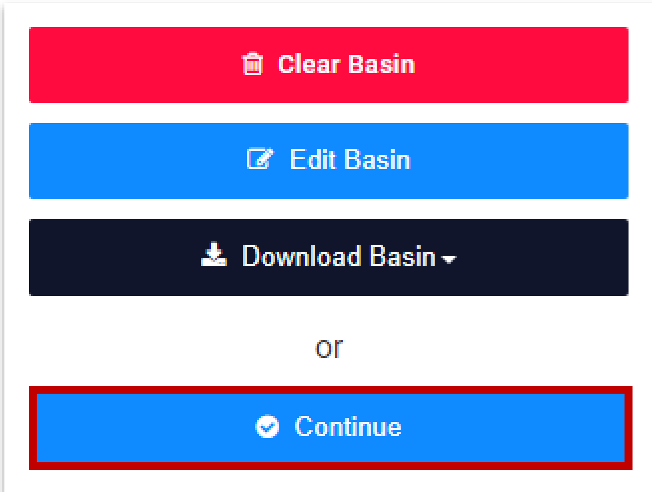
24. Now, click **Delineate** on the left side of the screen.



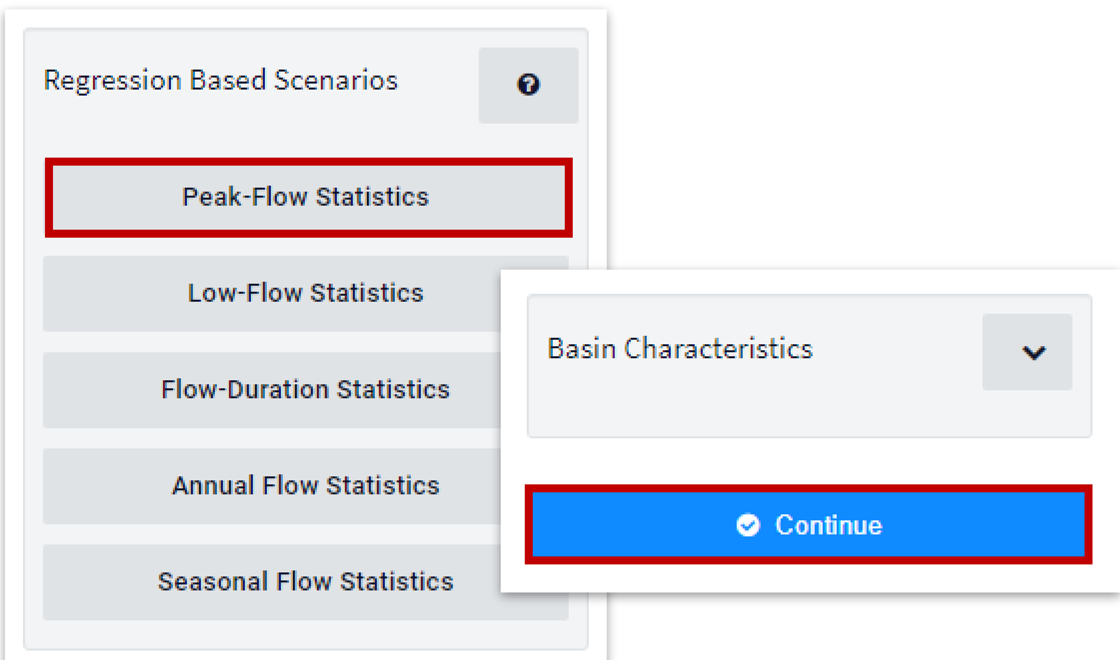
25. Left click on the **downstream** side of the stream, just south of Old Lebanon Dirt Road. Give the software a minute to process and notice that a yellow shaded area now appears, which represents the **delineated area**.



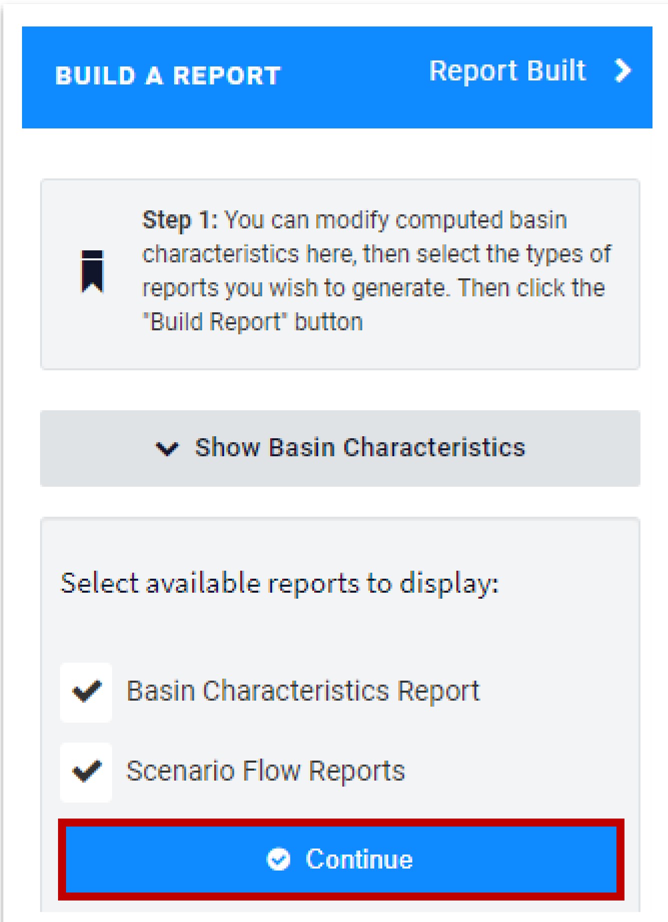
26. Compare this USGS StreamStats delineation boundary to the one you drew in ORD in Step 16. Click **Continue** on the left side of the screen. The program will now calculate the **runoff** using **regression equations**.



27. Next, click **Peak-Flow Statistics** on the left side of the screen and then click **Continue**.



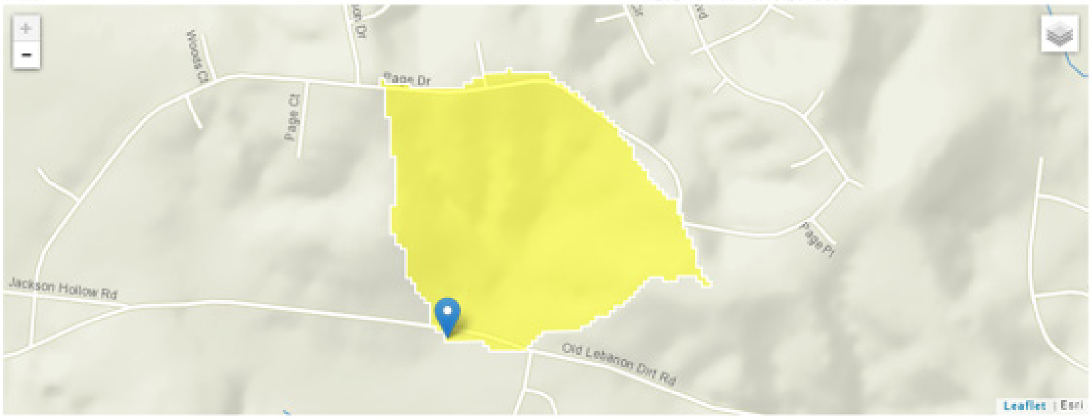
28. Click **Continue** again to build the report.



29. The delineated area draining to the selected point is summarized below, along with peak flows. **Note:** The data below will vary slightly depending on the point that you selected within the map.

StreamStats Report

Region ID:	TN
Workspace ID:	TN20210106161905740000
Clicked Point (Latitude, Longitude):	36.19554, -86.54098
Time:	2021-01-06 10:19:25 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.08	square miles
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	229.82	feet per mi

Peak-Flow Statistics Parameters(MultiVariable Area 3 CDA LT 30.2)

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.08	square miles	0.173	30.2
CSL10_85	Stream Slope 10 and 85 Method	229.82	feet per mi	2.12	132

Peak-Flow Statistics Disclaimers(MultiVariable Area 3 CDA LT 30.2)

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report(MultiVariable Area 3 CDA LT 30.2)

Statistic	Value	Unit
50_percent_AEP_flood	37.9	ft^3/s
20_percent_AEP_flood	64.5	ft^3/s
10_percent_AEP_flood	83.5	ft^3/s
4_percent_AEP_flood	108	ft^3/s
2_percent_AEP_flood	128	ft^3/s
1_percent_AEP_flood	147	ft^3/s
0_2_percent_AEP_flood	191	ft^3/s

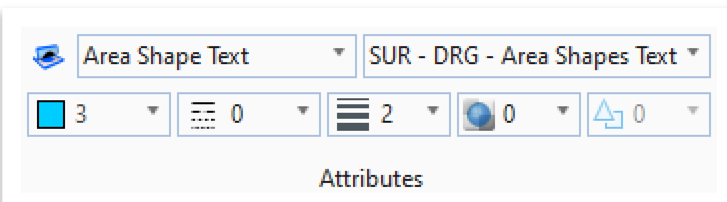
30. The last step is to convert the **Contributing Drainage Area** in the report (highlighted in orange) from **0.08** square miles to **acres**, which yields **51.20** acres. This value should be relatively close to the drainage area drawn earlier in ORD (**53.33** acres). With this verification, the drainage map delineation is complete. **Note:** If there is a large discrepancy between the two drainage areas, re-assess the contour map.

Parameter Name	Value	Units
Contributing Drainage Area	0.08	square miles
Stream Slope 10 and 85 Method	229.82	feet per mi

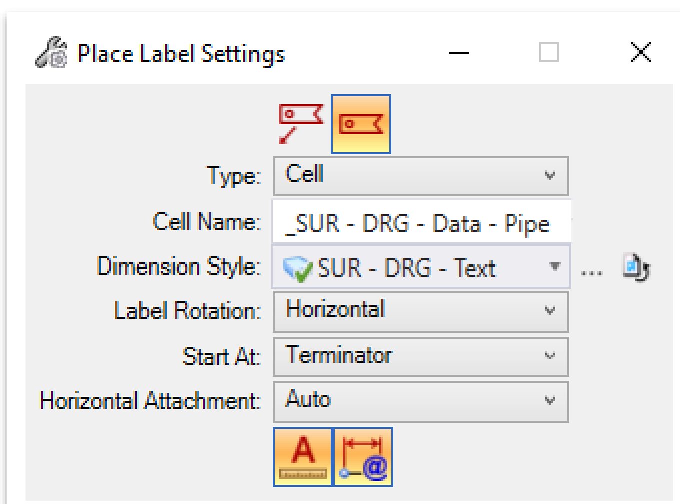
6.7.2 Exercise: Drainage Area Labeling

In this exercise, we will place a drainage data label for the 48" CMP that was assessed in the previous exercise. We will continue to utilize the same **Survey Model – DA.dgn** file.

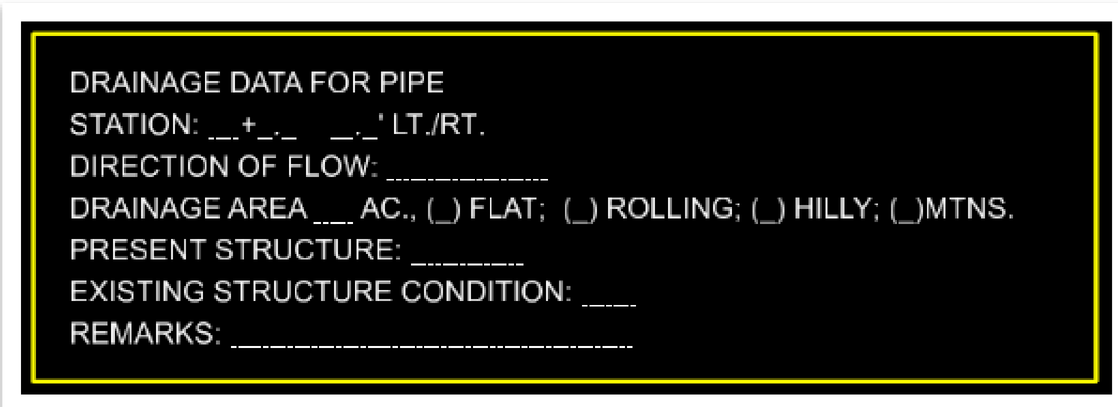
1. Before we place the drainage data cell, select the **Area Shape Text** element template (**Survey >> Annotation >> Drainage**), so the label will place on the correct level.



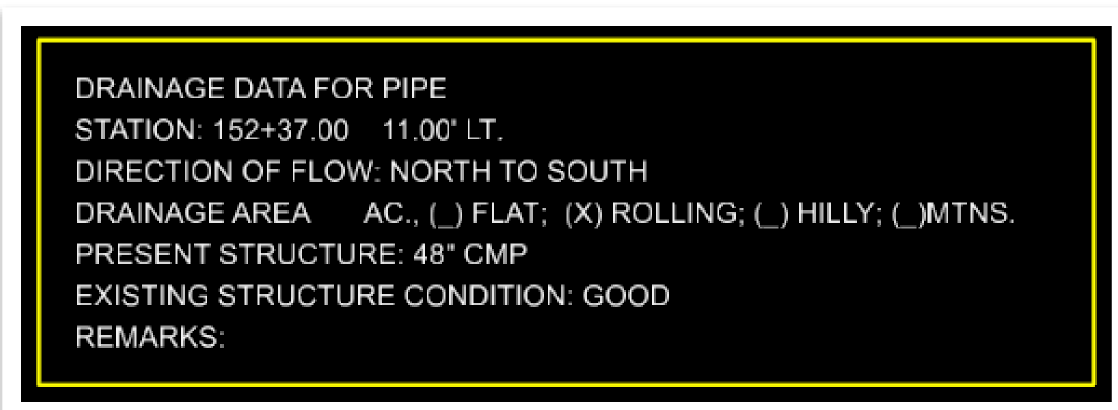
2. Open the **Place Label** tool (**Survey >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings.
   a. Select the **non-leader** icon at the top
   b. **Type:** Cell
   c. **Cell Name:** _SUR - DRG - Data - Pipe
   d. **Dimension Style:** SUR - DRG - Text



3. Left click anywhere within the Drainage Area to place the label. **Note:** If you had multiple drainage areas overlapping, you could toggle on the **leader** option within the **Place Label Settings** dialog box and point to the limits of the area.



4. Double click on the label to open the **Text Editor**. Manually key-in the data for the structure, as shown below. Left click within the drawing window to accept the updates. **Note:** The data fields have been turned off.



Chapter 7. Additional Survey Elements

In addition to the linear profiled survey elements shown earlier in the manual, there are also **point** survey elements from plan view that need to be included on an existing profile. This includes, but not limited to, Low Wire Crossings, Control Points and Benchmarks. In order for automatic placement on the profile to occur, we need to utilize the tools within the Drainage and Utilities workflow once again throughout this chapter. Sample text files have been edited and pre-imported into the exercise files for this chapter for the purpose of training. There are a few limitations with the current software release, but future enhancements and/or possible VBA's should make the procedures more efficient.

7.1 Objectives

At the conclusion of this chapter, participants will be able to:

1. Add model annotation for Low Wire Crossing Points, Control Points and Benchmarks in plan view.
2. Create a utility model for each element.
3. Create one overall profile drawing model to build upon and add label annotation for each element.

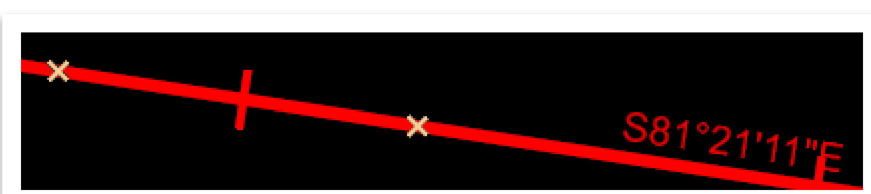
7.2 Lecture: Low Wire Crossings

When **low wire crossings** are surveyed, they are represented in plan view by a point indicating the intersection point above the roadway centerline. The point label contains the station and elevation of the low wire and will also be displayed on the profile. A temperature reading shall be recorded and shown on the profile, as well, for all high-tension lines. The actual low wire utility linework is not displayed on a present layout or profile sheet.

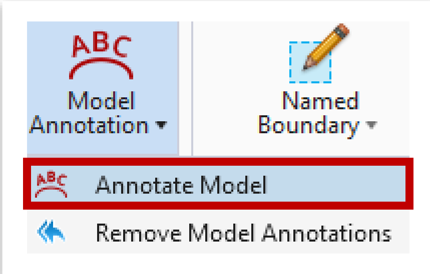
7.2.1 Exercise: Low Wire Crossing – Plan

In this exercise, we will place Low Wire Crossing annotation on imported survey data in plan view. Once again, the survey preliminary centerline must be created before this exercise can be done. **Note:** The Low Wire Crossing plan data would normally be part of the overall 3D survey model file but has been separated out for the purpose of training.

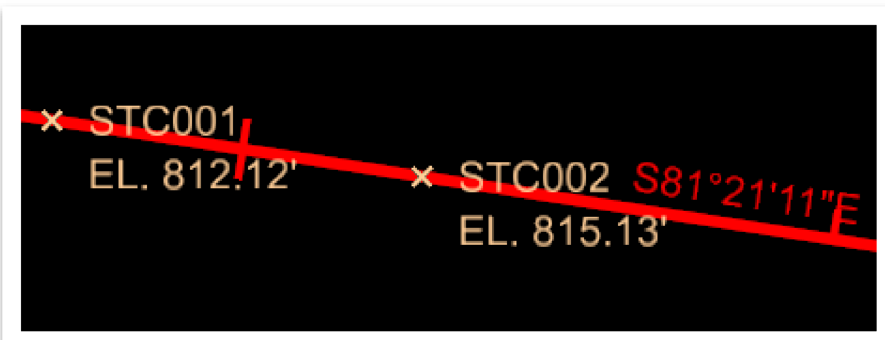
1. Open the **Survey Model – LWC.dgn** file within the **SURVEY_Training** workset dgn subfolder. **Two** low wire crossing points (**XLW**) have already been imported via ASCII text file. Zoom in to Station **120+00.00** and notice the **two** Low Wire crossing nodes, indicated with a crosshair.



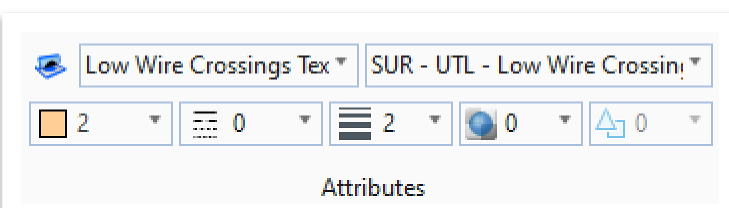
2. Let's annotate the model by opening the **Annotate Model** tool (**Drainage and Utilities >> Drawing Production >> Annotations >> Model Annotation**).



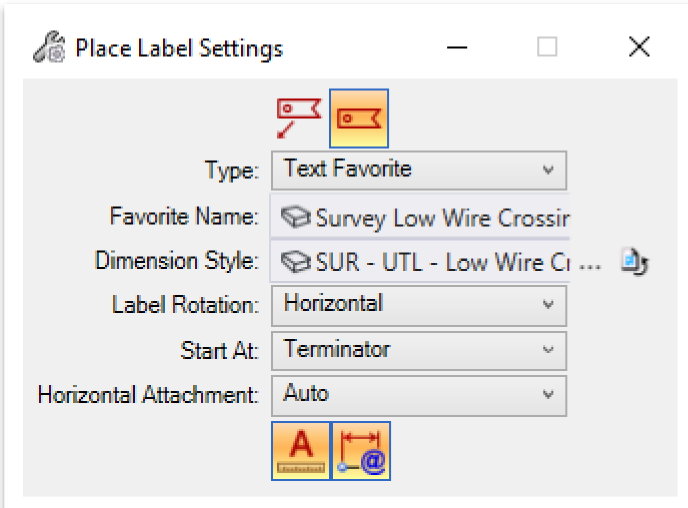
3. Notice the cursor prompt: **Accept Design Model**. Left click to accept and notice the annotations are added. **Note:** As a reminder, normally you would have the option to select a specific annotation group to apply but there is a defect with the **Model Annotation** tool. Also, there is a defect with the **Element Annotation** tool and cannot be used for imported survey data. Bentley has indicated that both issues should be fixed in the next software version.



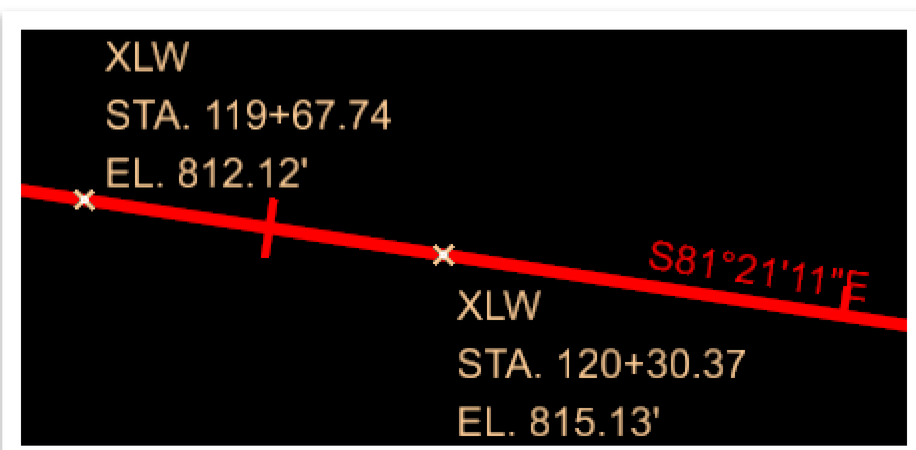
4. This annotation is useful for surveyors but the actual annotation that is displayed on plan sheets is slightly different. Go ahead and turn off the following levels:
   - SUR - UTL - Low Wire Crossings - Points - Elevations
   - SUR - UTL - Low Wire Crossings - Points - Numbers
5. We will now annotate the **LWC** point features using a **Text Favorite**. Select the **Low Wire Crossings Text** element template (**Survey >> Annotation >> Overhead Utilities**).



6. Open the **Place Label** tool (**Drainage and Utilities >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings.
    a. Select the **non-leader** icon at the top
    b. **Type:** Text Favorite
    c. **Favorite Name:** Survey Low Wire Crossing
    d. **Dimension Style:** SUR - UTL - Low Wire Crossing



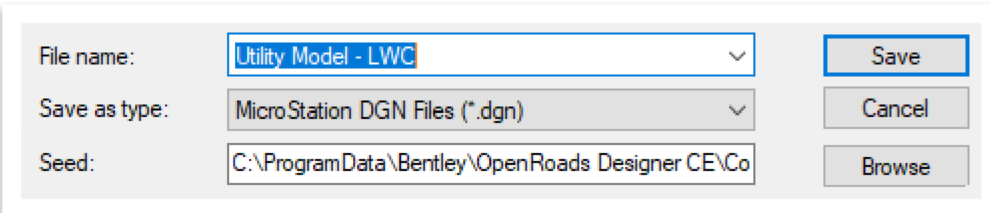
7. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the roadway centerline and then turn off the **SUR – CL – Preliminary** level in the reference file (this will make it easier to snap). Then, snap to the center of the first **XLW** point and then left click anywhere offset to place the label. Repeat the process to place the other label, as shown below, and then turn the **CL** level back on. **Note:** Remember, intelligent labels don't populate until they have physically been placed. Also, there is an erroneous white circle placed at each snap point, which is a known defect and has been logged with Bentley.



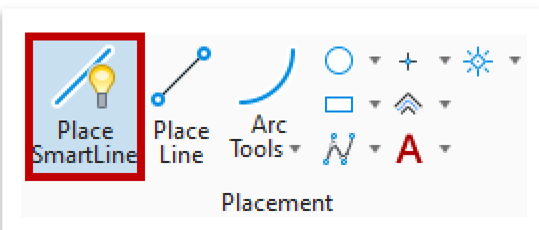
7.2.2 Exercise: Low Wire Crossing – Profile

In this exercise, we will add Low Wire Crossing points to a roadway profile after creating a **Utility** model. **Note:** The Low Wire Crossing utility model would normally be part of the overall 2D utility model file prior to projection in the alignment file but has been separated out for the purpose of training.

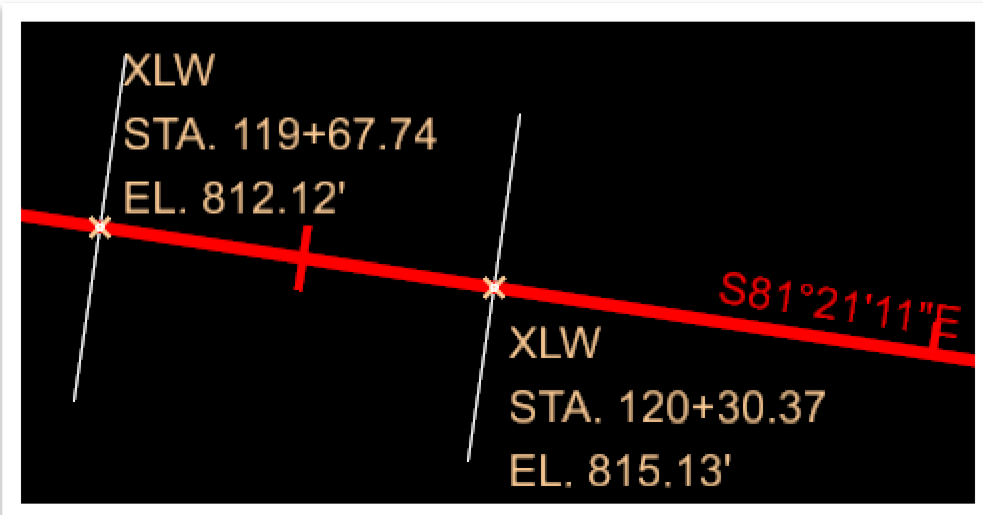
1. Create a new file and name it **Utility Model – LWC**. Select the **TDOTSeed2D.dgn** and click **Save**.



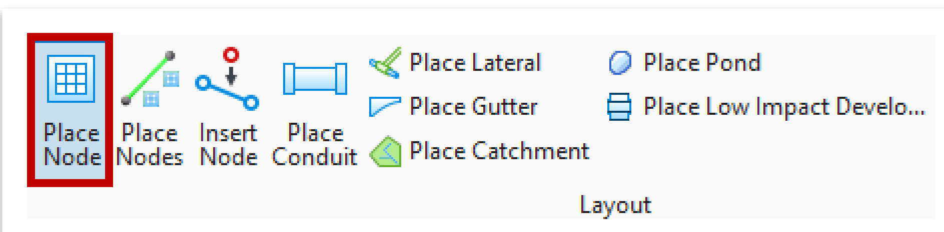
2. Attach the following reference files using the **Coincident World** attachment method and then click **Fit View**.
   - Alignment – Additional Elements.dgn
   - Survey Model – LWC.dgn
3. Toggle on **Civil Accudraw** and then open the **Place SmartLine** tool (**Drainage and Utilities >> Drawing >> Placement**).



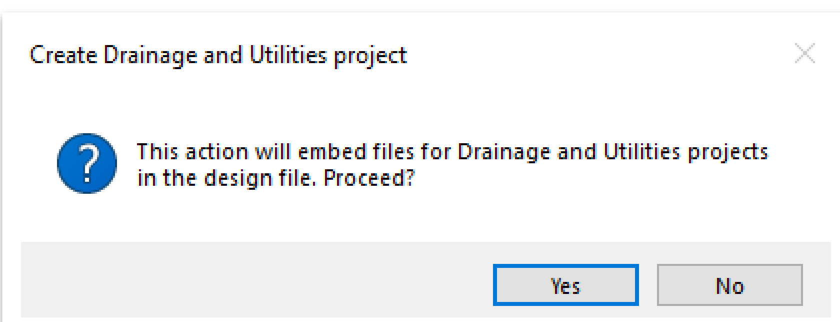
4. Next, draw an arbitrary line that passes through each of the **XLW** points. **Note:** If the point was at an offset from the centerline, it would be important for the lines to cross the centerline and be **perpendicular** so that the profile stationing will be correct.



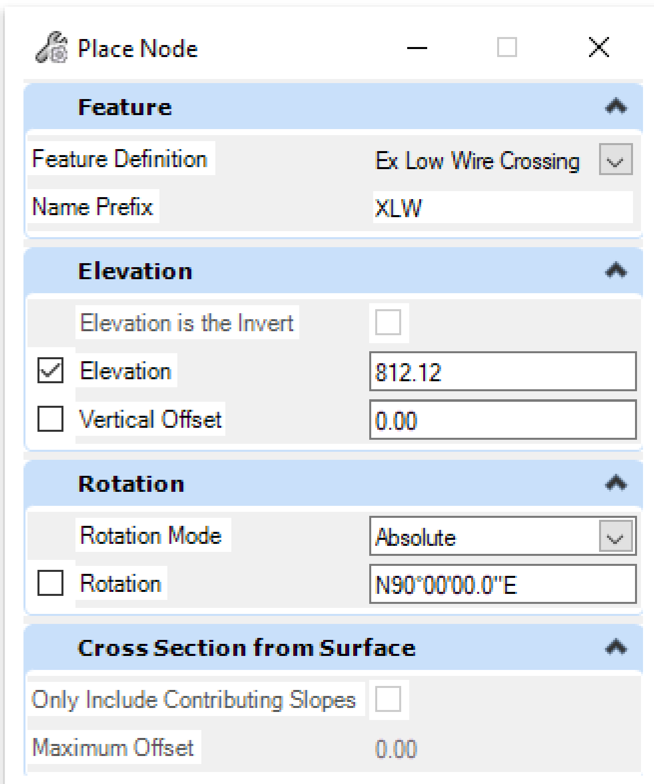
5. We now need to draw nodes and conduits at the same elevation of each surveyed crossing point. Open the **Place Node** tool (**Drainage and Utilities >> Layout >> Layout**).



6. A warning will display asking if you want to embed files for **Drainage and Utilities** projects in the design file. Click **Yes**.



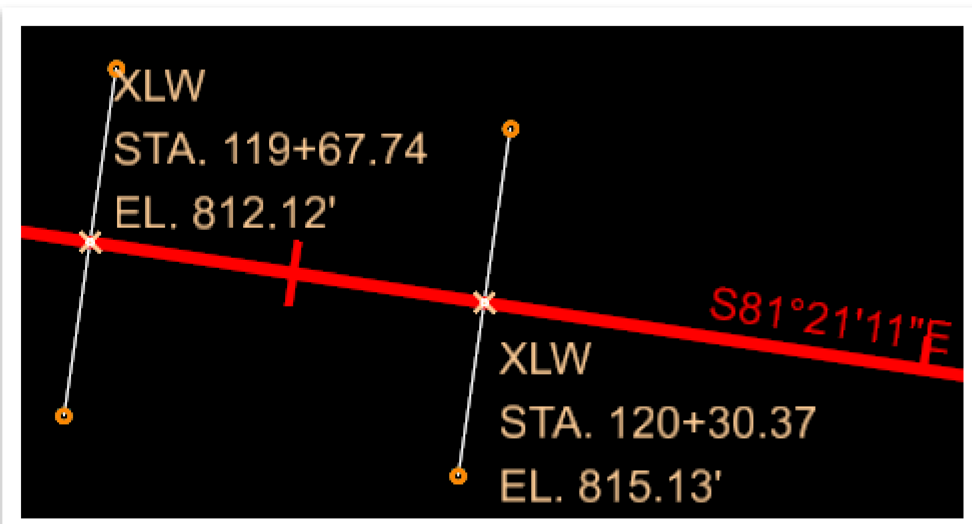
7. Go ahead and open the **Place Node** tool again (**Drainage and Utilities >> Layout >> Layout**). We will address the westernmost **XLW** crossing first. Within the **Place Node** dialog box, select the following settings and leave the others as default.
    a. **Feature Definition:** Ex Low Wire Crossing (**Node >> ElectricalNode >> Existing**)
    b. **Name Prefix:** XLW
    c. **Elevation: 812.12'** (matches the elevation shown in the label). Make sure that the Elevation checkbox is toggled on.
    d. **Rotation Mode:** Absolute



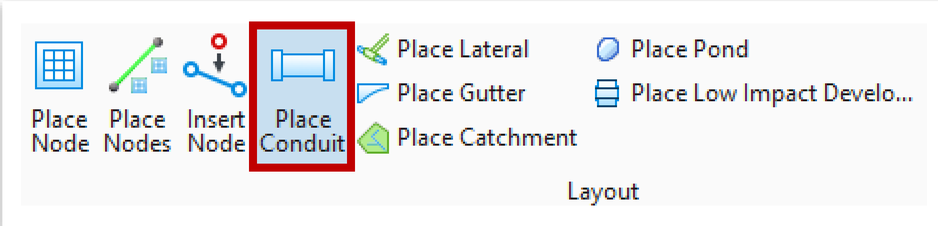
8. Notice the cursor prompt: **Select Reference Element For Node elevation**. Since the **XLW** points already have a specific elevation, right click to **Reset**.

9. Notice the next cursor prompt: **Define Electrical Node**. Left click on either end of the westernmost arbitrary line to define the node location. Left click twice more to accept the **Rotation Mode** and **Rotation Angle** and notice that an orange node has been placed. **Note:** Since the node is circular, the rotation angle is irrelevant.

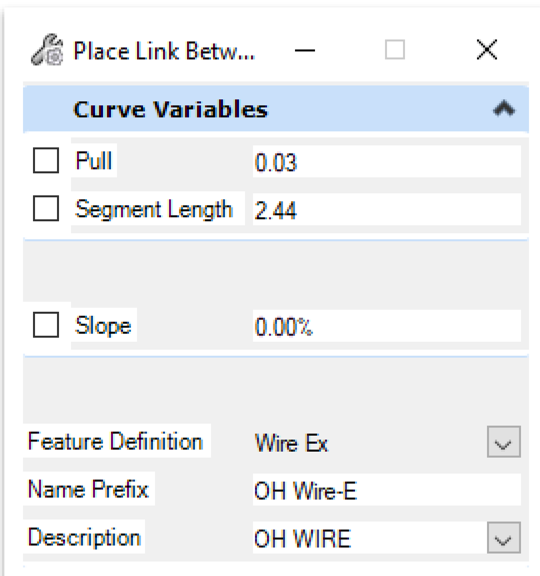
10. With the **Place Node** tool still active, place another node on the other end of the westernmost arbitrary line. Repeat the process to place the remaining 2 nodes. Make sure to key-in the applicable elevation within the **Place Node** dialog box before placement. Once completed, hit **ESC** to clear the tool.



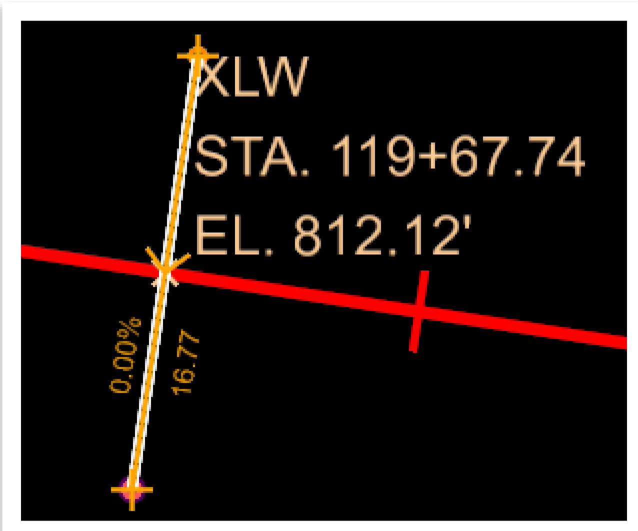
11. Now that the nodes are placed, we need to connect them with conduit. Open the **Place Conduit** tool (**Drainage and Utilities >> Layout >> Layout**).



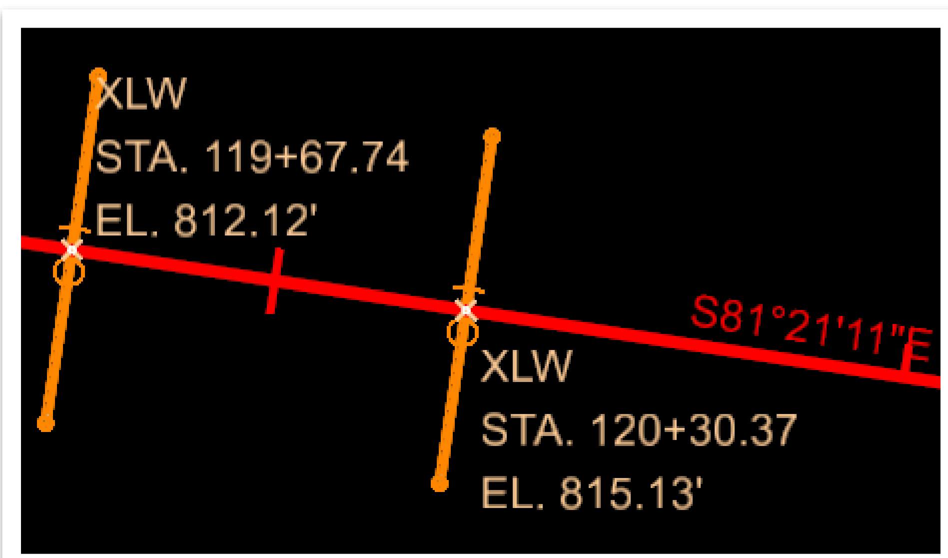
12. Within the **Place Link Between Nodes** dialog box, select the following settings and leave the others as default.
    a. **Feature Definition:** Wire Ex (**Conduit >> ElectricalSegment >> Existing >> Overhead**)
    b. **Name Prefix:** OH Wire-E
    c. **Description:** OH WIRE



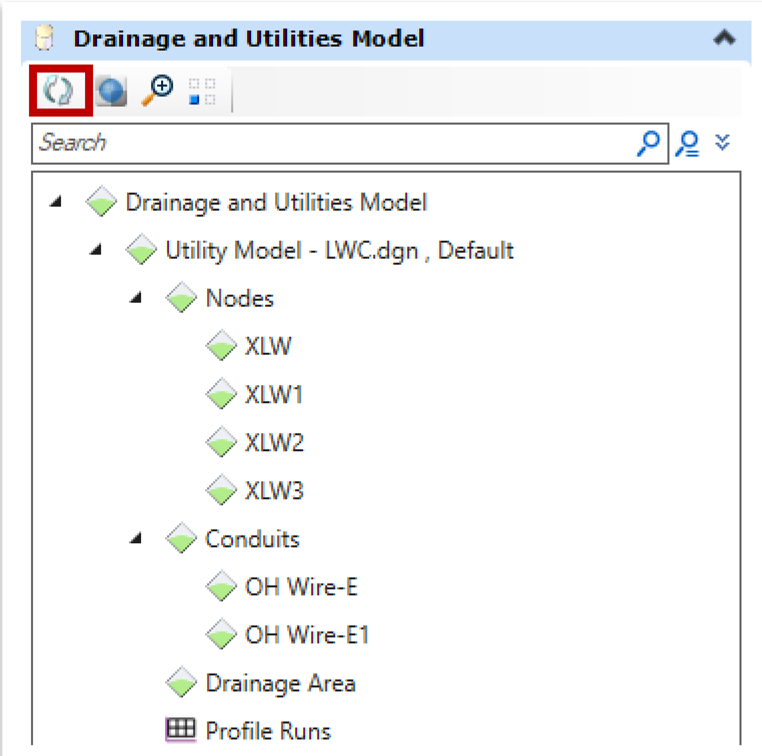
13. Notice the cursor prompt: **Select Start Node**. Select either node on the westernmost arbitrary line and the conduit will appear on the cursor. Select the second node (**next node**) **to make a connection** and place the conduit. **Note:** Since both nodes have the same elevation along the respective line, the order of node selection and thus the conduit direction is irrelevant for this exercise. Also, your slope should be **0.00%** but the length will vary depending on the arbitrary lines you drew earlier.



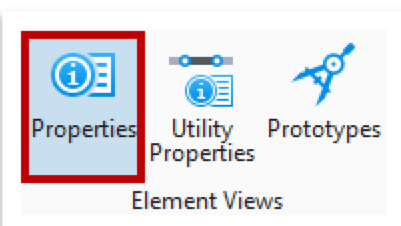
14. Once placed, you will see the **OH** linestyle added between the nodes. Repeat the previous step to add the conduit for the other **XLW** crossing and then right click to clear the tool.



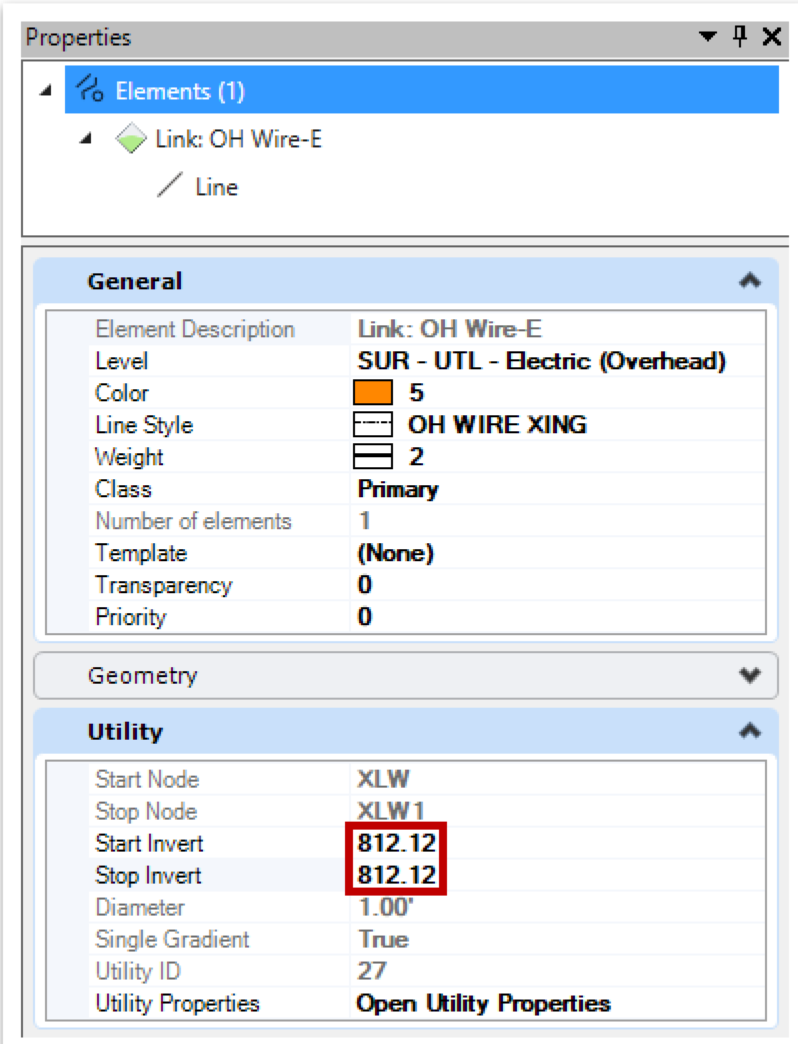
15. Within the **Explorer**, open the **Drainage and Utilities Model** tab and notice that all **nodes** and **conduits** have been added. **Note:** If the nodes are not showing, click the **Refresh** icon under the **Drainage and Utilities Model** header. If the nodes still do not show, close and re-open the **Explorer**.

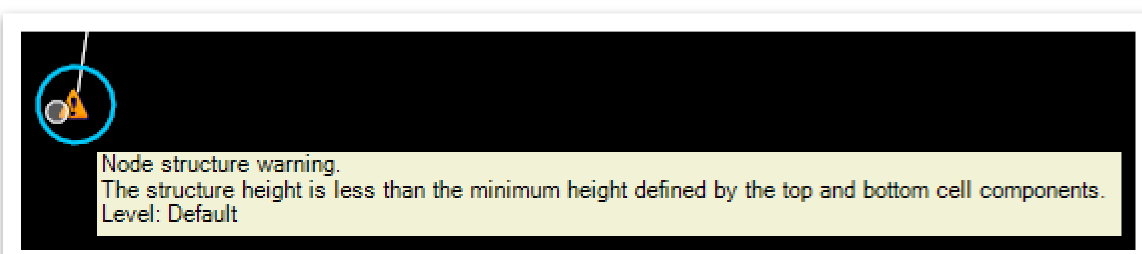


16. Next, let's review the element properties of the conduit. First, turn off the **Utility Model – LWC.dgn** (**Default-3D**) reference file. Then, select the first conduit and open the **Properties** (**Drainage and Utilities >> Utilities View >> Element Views**).

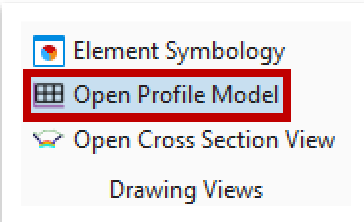


17. Under the **Utility** header, key-in the correct **Start** and **Stop Invert** elevations (**812.12**) to match the surveyed elevation of the first **XLW** crossing. **Note:** You'll notice a **Node structure warning** (yellow triangle) at each node once the elevation has been updated. For the intent of the exercise, you can ignore the warning.

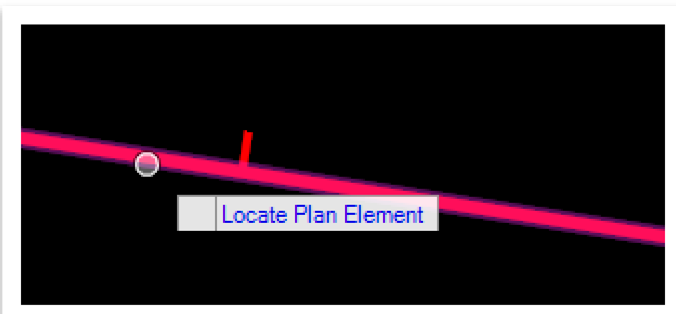




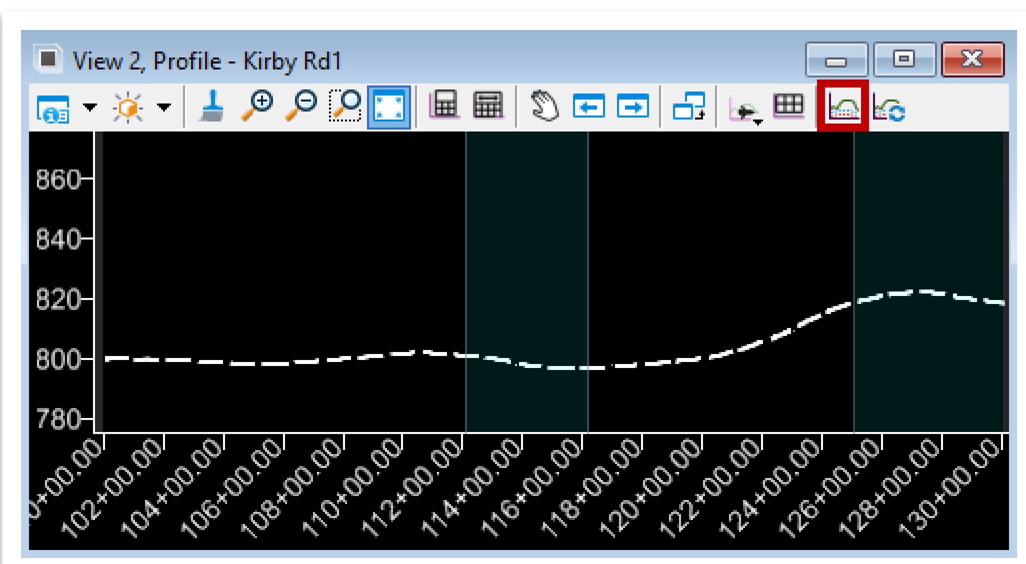
18. Repeat the previous step for the other conduit and edit the **Start** and **Stop Invert** elevations in the **Properties**.
19. Now we need to project the **Low Wire Crossings** onto the survey preliminary centerline. Go ahead and open the **Alignment – Additional Elements.dgn** file and attach the **Utility Model – LWC.dgn** reference file.
20. Open the **Open Profile Model** tool (**Drainage and Utilities >> Utilities View >> Drawing Views**).



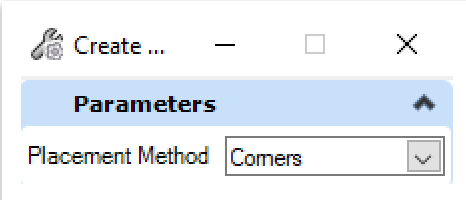
21. Notice the cursor prompt: **Locate Plan element**. Select the red centerline.



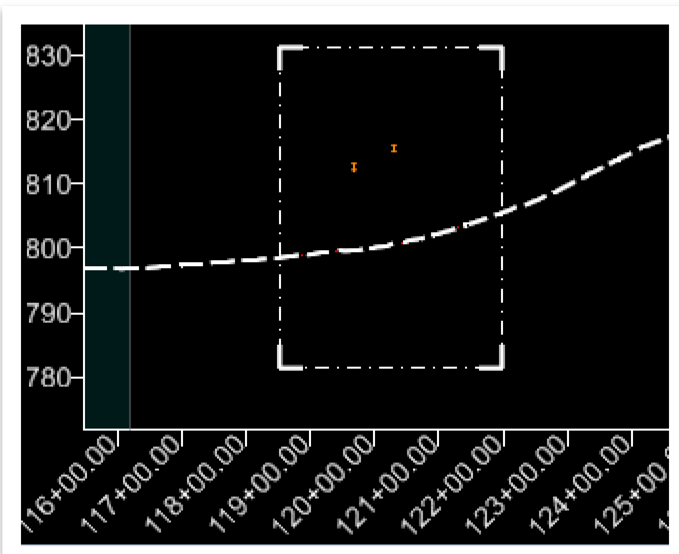
22. Then, open **View 2** and click anywhere within the drawing window. Notice that the **existing** profile has now been created along the roadway centerline. Within the **Profile** view, select the **Create 3d Cut** tool.



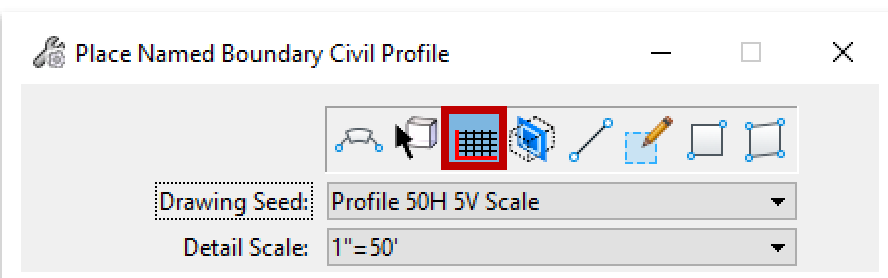
23. Within the **Create 3d Cut** dialog box, select the **Corners** placement method.



24. Left click within the profile window to start drawing a rectangle. At minimum, make sure to include the station range of **119+00** to **121+00**, which contains the location of the two **XLW** crossings. Left click again to complete the rectangle and notice the **two** XLW conduits have been projected onto the profile at the correct elevations. **Note:** Your 3d Cut boundary will vary depending on your extents. We will show how to adjust the boundary in the next exercise.

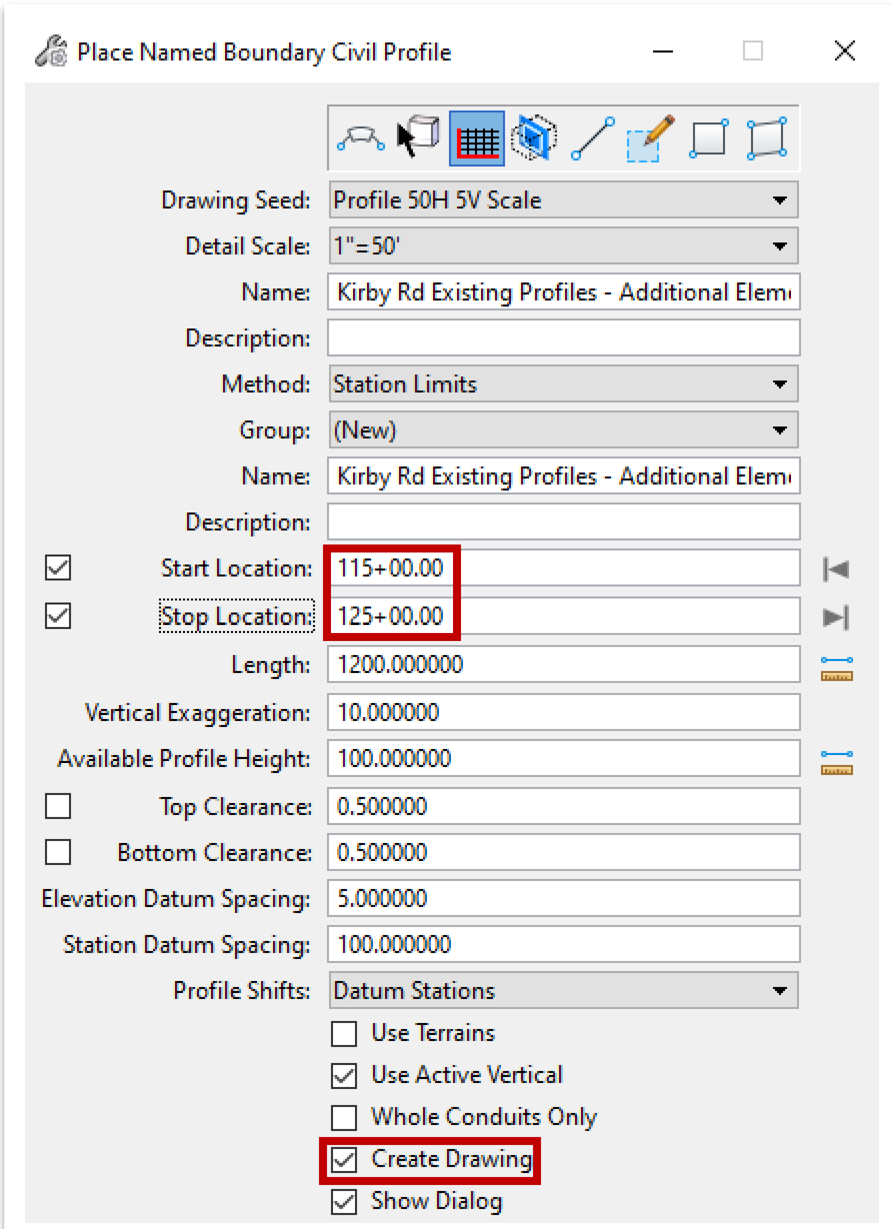


25. Open the **Place Named Boundary** tool (**Drainage and Utilities >> Drawing Production >> Named Boundaries >> Named Boundary**). Make sure that the **Civil Profile** option is toggled on. Select **Profile 50H 5V Scale** for the Drawing Seed.

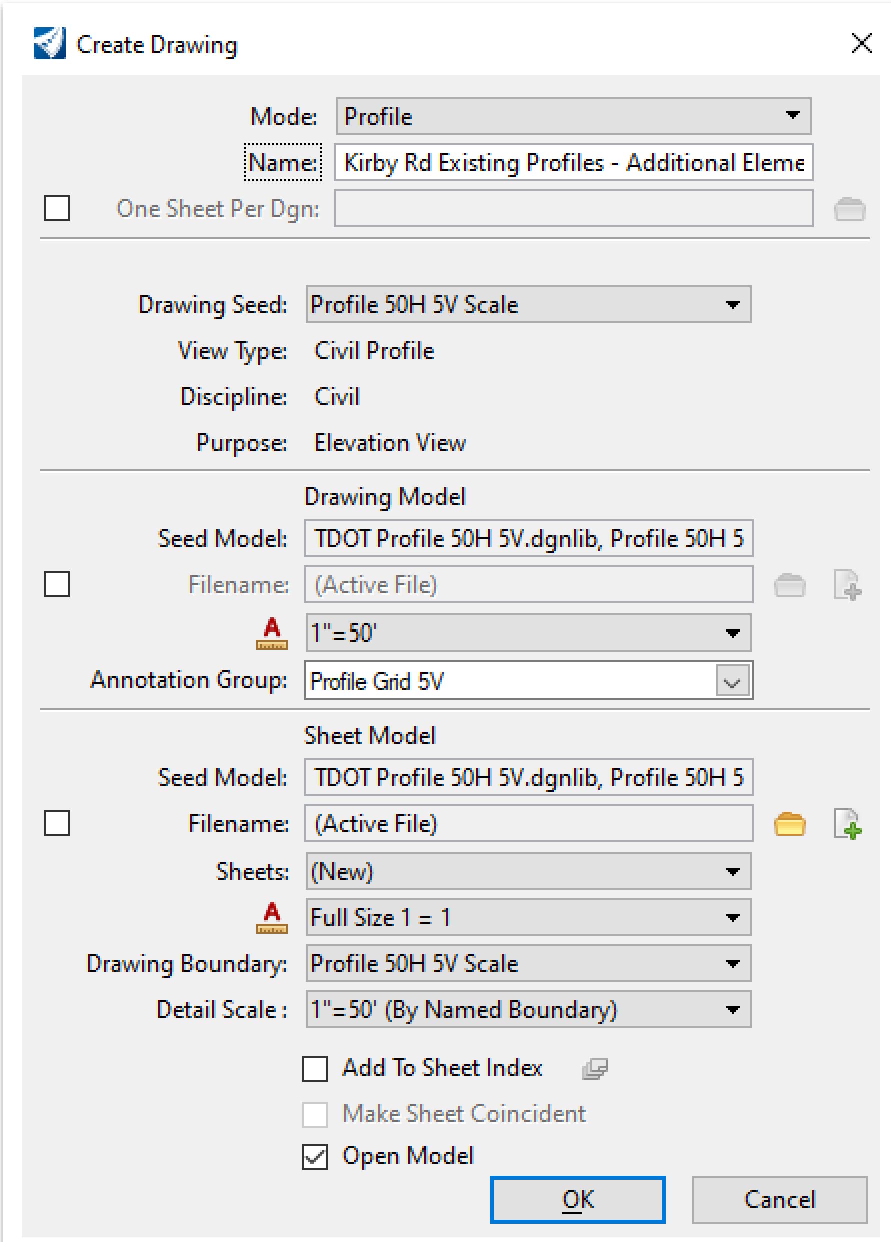


26. Notice the prompt in the lower left corner of the drawing window: **Identify Profile View**. Left click anywhere within **View 2**.

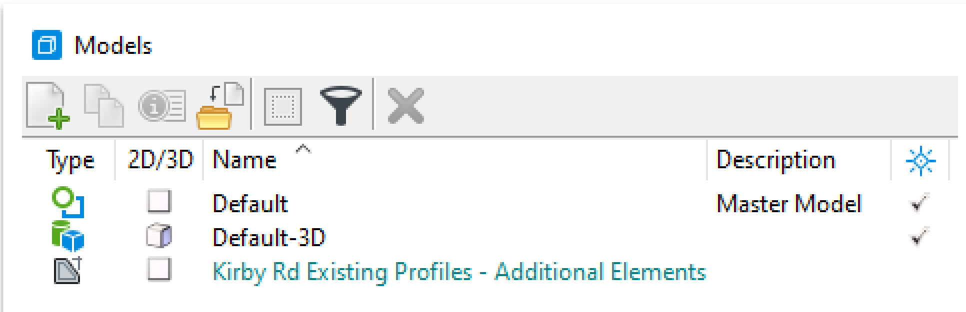
27. Edit the parameters below and leave all other default values as-is. Make sure that the **Create Drawing** option is toggled on at the bottom.
    a. **Name:** Kirby Rd Existing Profiles – Additional Elements
    b. **Start Location:** 115+00.00 (key-in)
    c. **Stop Location:** 125+00.00 (key-in)



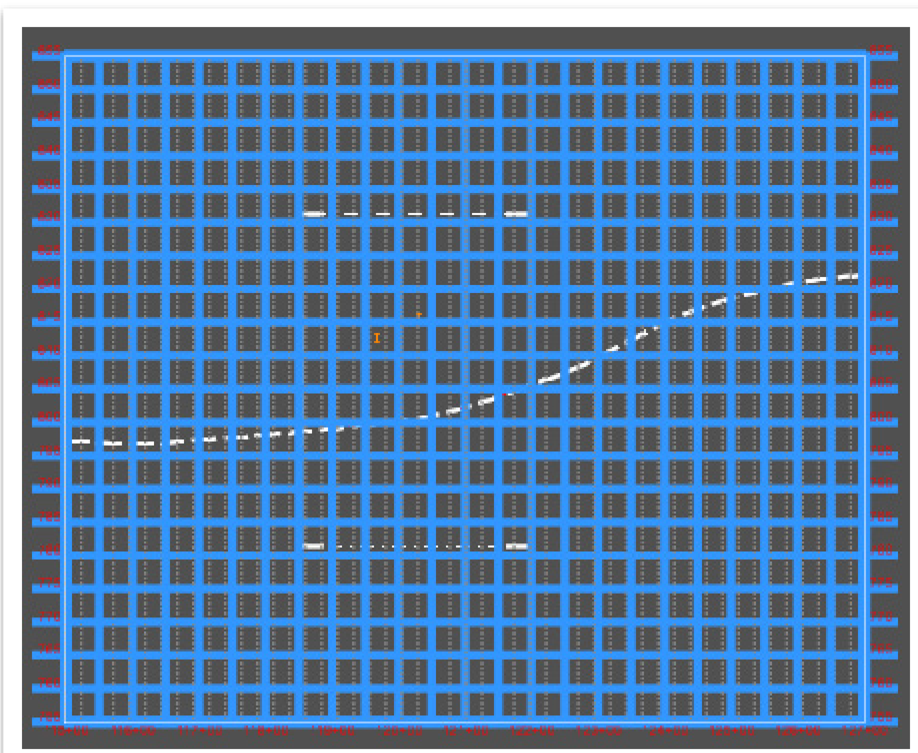
28. Left click anywhere within View 2 **three** times. Zoom out and you should see **one** profile named boundary drawn into the file, represented by a white border. The **Create Drawing** window will appear automatically after creating the named boundary, since we toggled it on in the previous step. Click **OK** to accept all default settings.



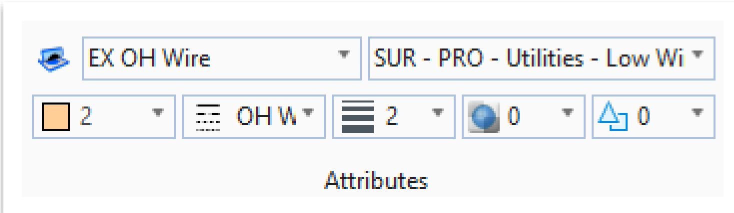
29. Once again, the software should open to the <u>one</u> sheet model in **View 1**. Let's go ahead and delete the sheet model. Open the **Models** tool (**Drainage and Utilities >> Home >> Primary**) and double click on the **Kirby Rd Existing Profiles – Additional Elements** <u>drawing</u> model to activate it. Then, right click on the <u>sheet</u> model and select **Delete**. You should see the following three models once completed. Close the **Models** window once you are done.



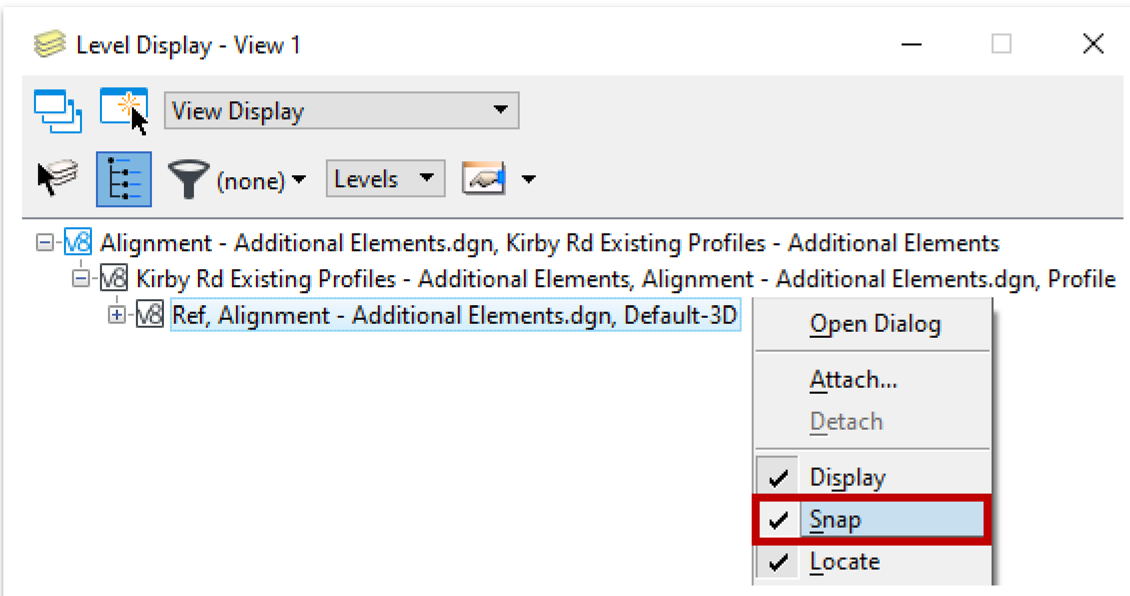
30. You should see the centerline profile and **XLW** conduits along with the profile grid, stations and elevations. We will next add the applicable annotation, like in the previous exercises. **Note:** The white **3d Cut** boundary is on the **Default** level within the **Alignment – Additional Elements.dgn** reference file and can be turned off if necessary.



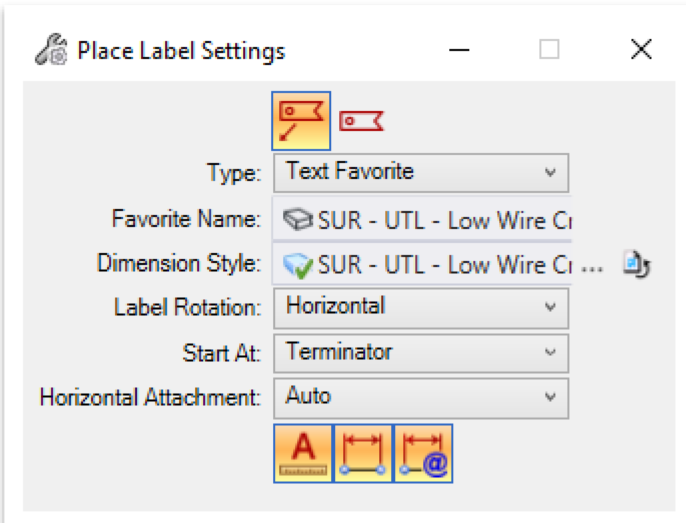
31. Go ahead and select the **EX OH Wire** element template (**Survey >> Utilities >> Overhead >> Profile**).



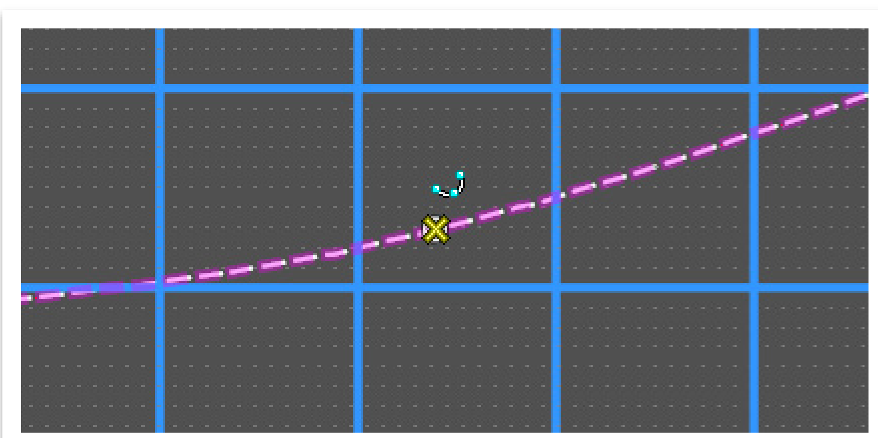
32. Now, open the **Level Display** and right click on **Ref, Alignment – Additional Elements.dgn, Default-3D** and toggle the **Snap** option on, as shown below. This will allow us to snap to the **XLW** conduits when placing annotation. Close the **Level Display** once you are done.



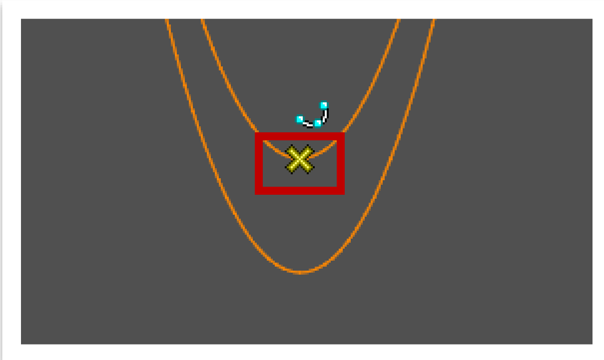
33. Next, open the **Place Label** tool (**Drainage and Utilities >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings and leave the others as default. **Note:** There is an enhancement logged with Bentley to allow a **symbol** to be placed without a leader.
    a. Select the **leader** icon at the top (this allows the correct point symbol to display)
    b. **Type:** Text Favorite
    c. **Favorite Name:** SUR - UTL - Low Wire Crossing (Profile)
    d. **Dimension Style:** SUR - UTL - Low Wire Crossing (Profile)



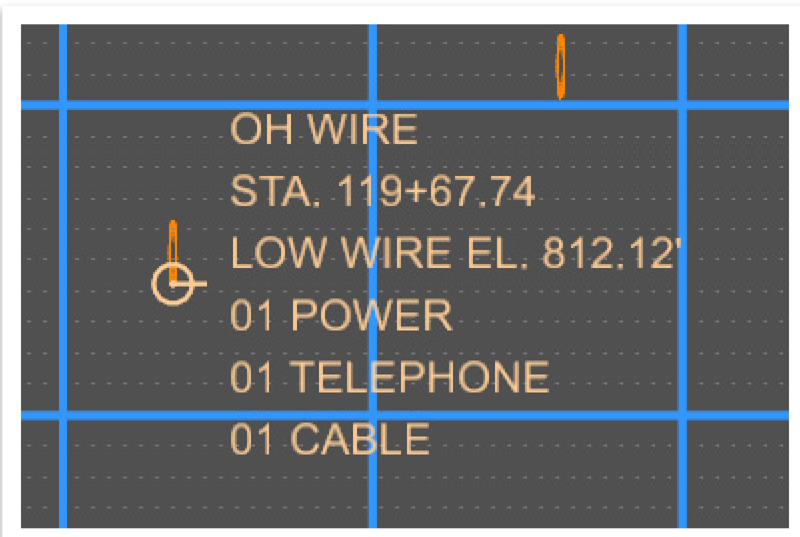
34. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the centerline profile.



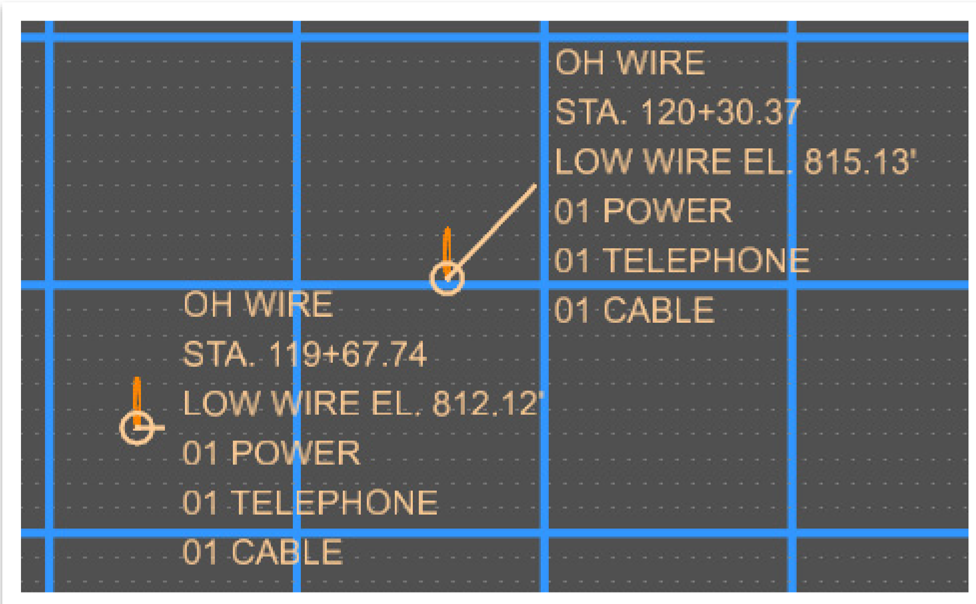
35. Notice the next prompt in the lower left corner: **Select Point Location**. Zoom in to the first **XLW** conduit and snap to the low point on the inner diameter.



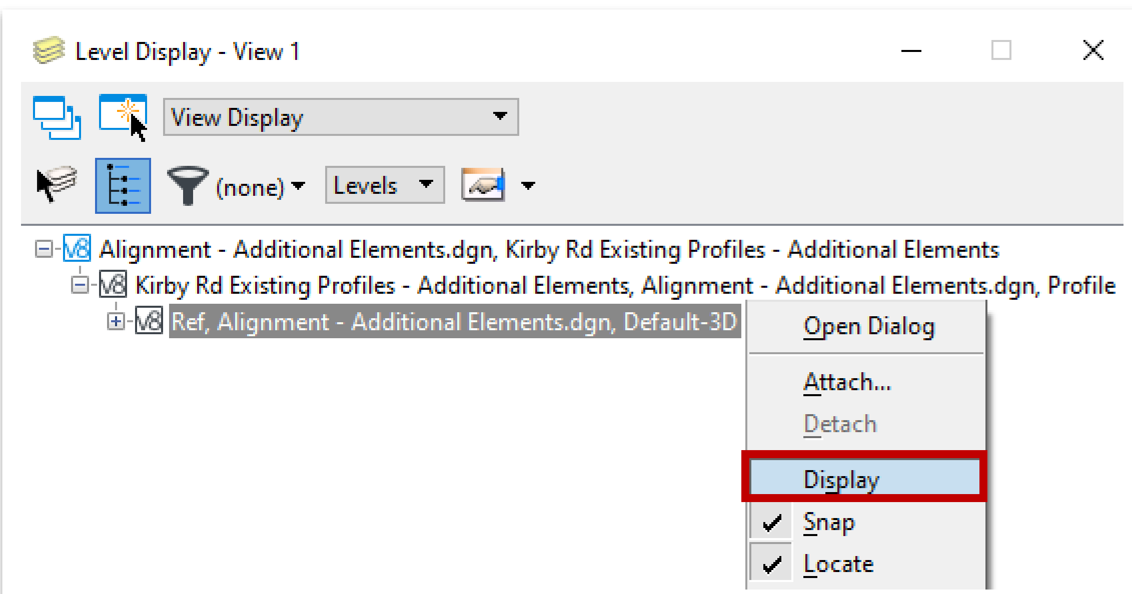
36. Left click again just off to the right to place the label. The offset is necessary so that the symbol stays on when we turn the conduits off later in the exercise. Notice that the label automatically reads the **station** and **elevation**. You would need to manually add the number of **power**, **telephone** and **cable** crossings within the label. For this exercise, we will leave those at **01**. **Note:** The data fields have been turned off.



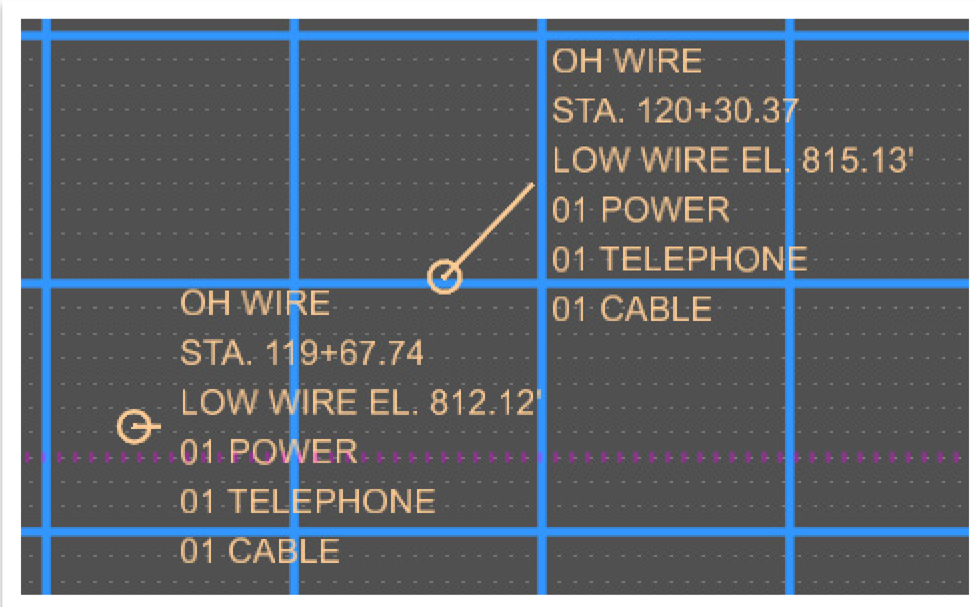
37. Repeat Steps 35-36 to add the label to the other **XLW** conduit. **Note:** The centerline profile does not need to be re-selected before the placement of each label unless the tool was cleared. If ever the station/elevation look erroneous, clear the tool and start again by selecting the centerline.



38. Next, open the **Level Display**, if not still opened, and right click on **Ref, Alignment – Additional Elements.dgn, Default-3D** and toggle the **Display** option off, as shown below. This will turn the conduits off.



39. The final profile view for the **low wire crossing** points is shown below. Remember, the leader option allows the symbol to be placed automatically in profile view.



40. Lastly, switch back to the **Multi-Model Views** (plan/profile) view. To turn off the **XLW** nodes and conduits, activate **View 1** and simply turn off the **Utility Model – LWC.dgn** reference file. If you had other utility models in the file, you could turn off the applicable level(s) instead. On an actual project, you likely would also have the 3D Survey Model planimetric file referenced.

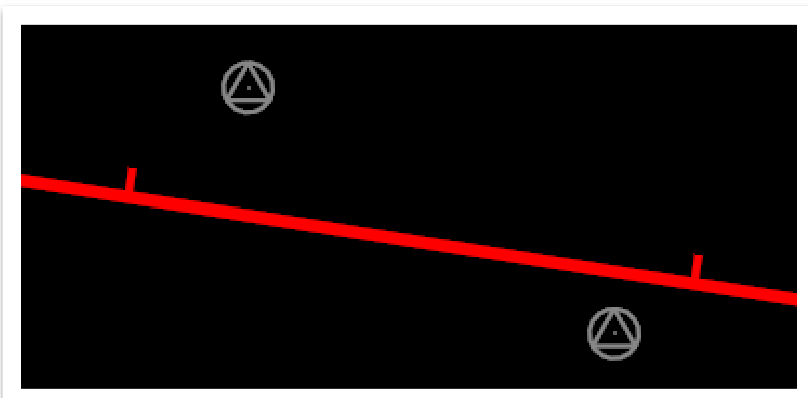
7.3 Lecture: Control Point

Survey **control points** serve as reference points for each project and are typically identified by point number, northing, easting, elevation, station and offset. The station and offset are relative to the preliminary survey centerline. The control point table creation was shown previously in the manual in Exercise 5.2.7.

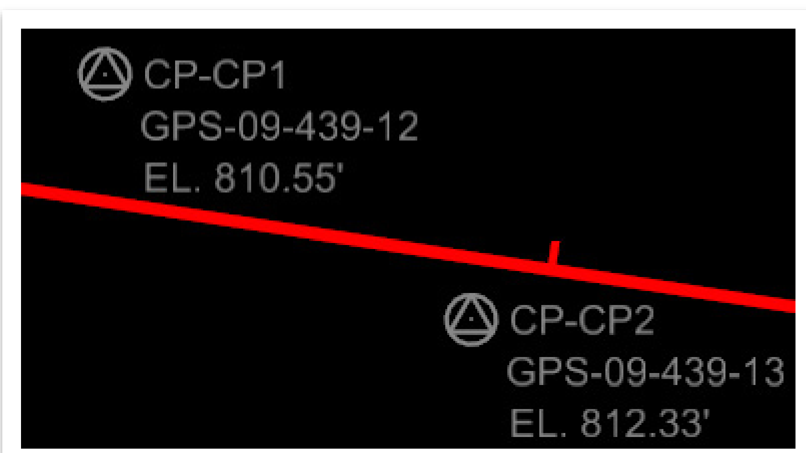
7.3.1 Exercise: Control Point – Plan

In this exercise, we will place Control Point annotation on imported survey data in plan view. **Note:** The Control Point plan data would normally be part of the overall 3D survey file but has been separated out for the purpose of training.

1. Open the **Survey Model – CP.dgn** file within the **SURVEY_Training** workset dgn subfolder. **Two** control points (**XCP**) have already been imported via ASCII text file.
2. Zoom in to Station **117+50.00** once again and notice the **two** Control Points.



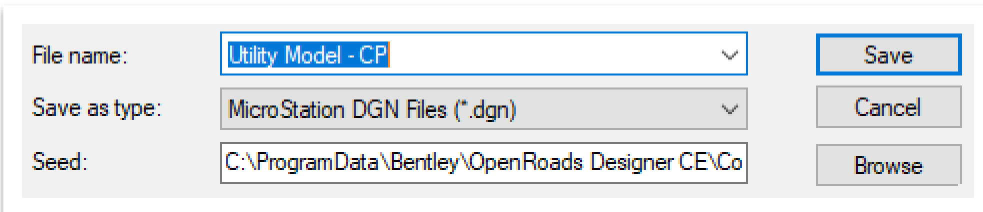
3. Once again, let's annotate the model by opening the **Annotate Model** tool (**Drainage and Utilities >> Drawing Production >> Annotations >> Model Annotation**). Notice the cursor prompt: **Accept Design Model**. Left click to accept and notice the annotations are added.



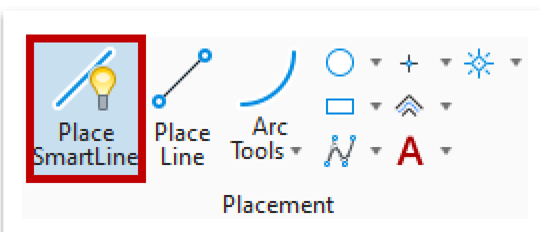
7.3.2 Exercise: Control Point – Profile

In this exercise, we will add Control Points to the same roadway profile from the previous exercise after creating a **Utility** model. **Note:** The Control Point utility model would normally be part of the overall 2D utility model file prior to projection in the alignment file but has been separated out for the purpose of training.

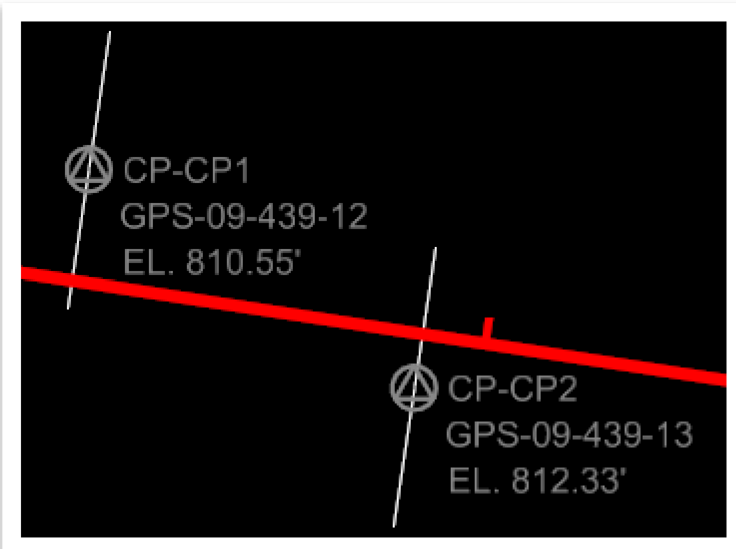
1. Create a new file and name it **Utility Model – CP**. Select the **TDOTSeed2D.dgn** and click **Save**.



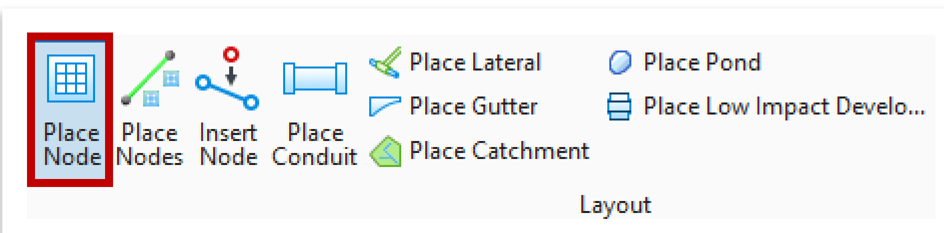
2. Attach the following reference files using the **Coincident World** attachment method and then click **Fit View**.
   - Alignment – Additional Elements.dgn
   - Survey Model – CP.dgn
3. Toggle on **Civil Accudraw**, if necessary, and then open the **Place SmartLine** tool (**Drainage and Utilities >> Drawing >> Placement**).



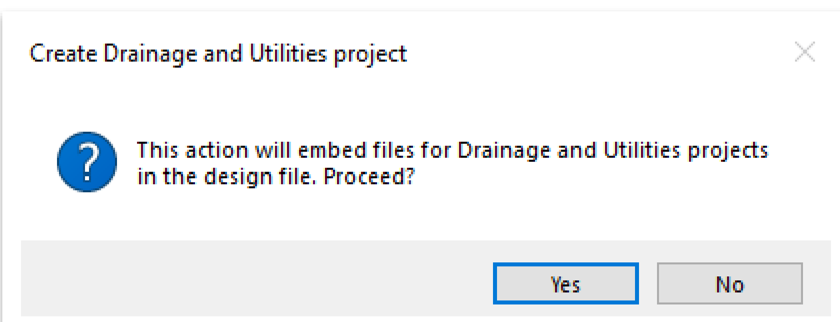
4. Next, draw an arbitrary line that passes through each of the **XCP** points. Make sure the lines are **perpendicular** to the centerline so that the profile stationing will be correct. Also, make sure that the lines cross the alignment, as shown below.



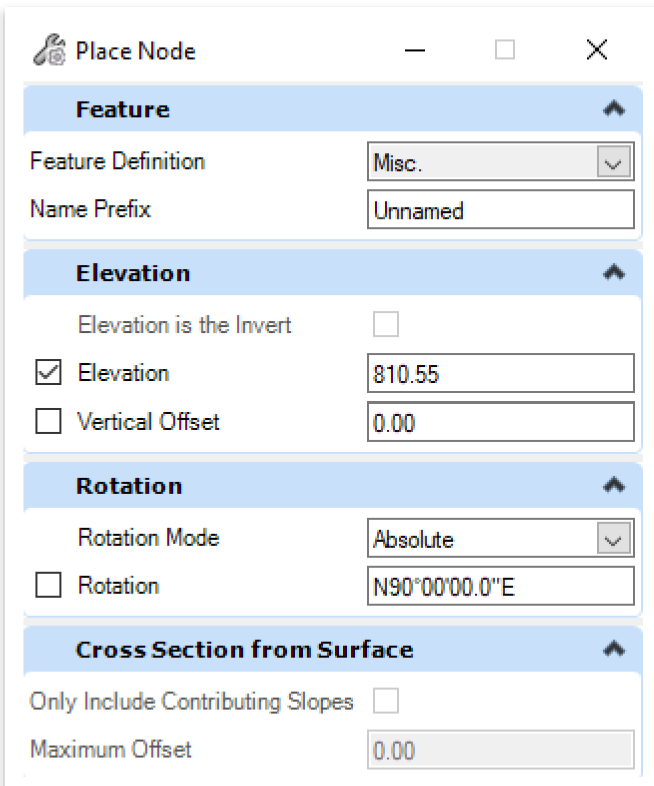
5. We now need to draw nodes and conduits at the same elevation of each surveyed crossing point. Open the **Place Node** tool (**Drainage and Utilities >> Layout >> Layout**).



6. A warning will display asking if you want to embed files for **Drainage and Utilities** projects in the design file. Click **Yes**.

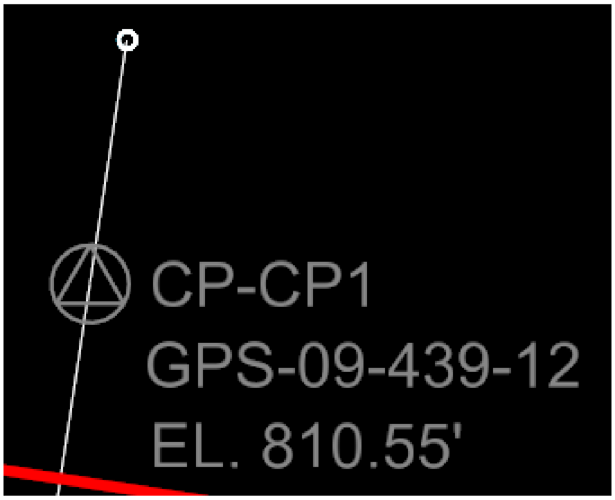


7. Go ahead and open the **Place Node** tool again (**Drainage and Utilities >> Layout >> Layout**). We will address the westernmost **XCP** crossing first. Within the **Place Node** dialog box, select the following settings and leave the others as default.
    a. **Feature Definition:** Misc. (**Node >> GenericNodeAsset**)
    b. **Name Prefix:** Unnamed
    c. **Elevation: 810.55'** (matches the elevation shown in the label). Make sure that the Elevation checkbox is toggled on.
    d. **Rotation Mode:** Absolute



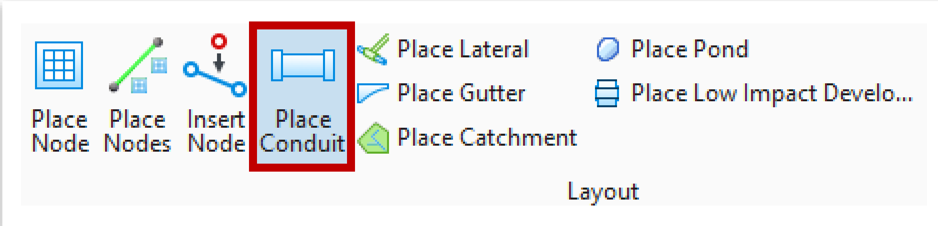
8. Notice the cursor prompt: **Select Reference Element For Node elevation**. Since the **XCP** points already have a specific elevation, right click to **Reset**.

9. Notice the next cursor prompt: **Define Generic Note**. Left click on either end of the westernmost arbitrary line to define the node location. Left click twice more to accept the **Rotation Mode** and **Rotation Angle** and notice that a node has been placed. **Note:** Since the node is circular, the rotation angle is irrelevant.

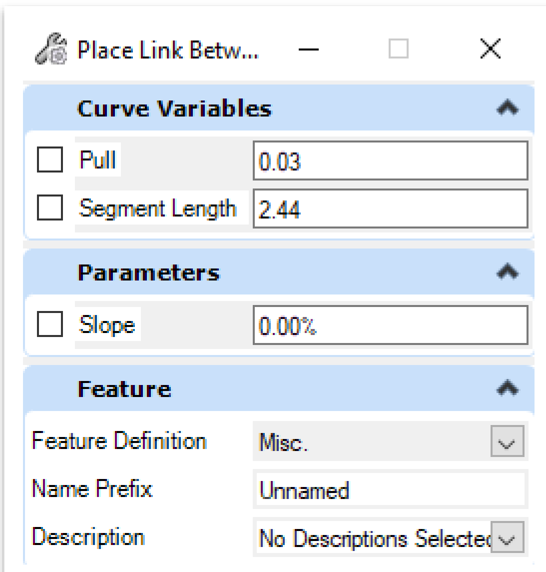


10. With the **Place Node** tool still active, place another node on the other end of the westernmost arbitrary line. Repeat the process to place the remaining 2 nodes. Make sure to key-in the applicable elevation within the **Place Node** dialog box before placement. Once completed, hit **ESC** to clear the tool.

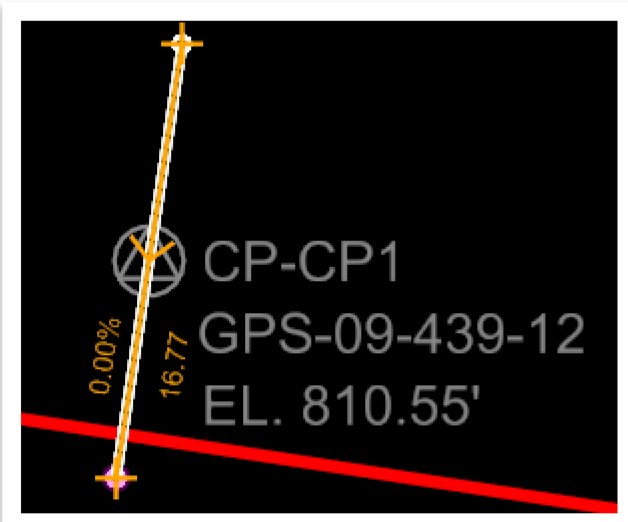
11. Now that the nodes are placed, we need to connect them with conduit. Open the **Place Conduit** tool (**Drainage and Utilities >> Layout >> Layout**).



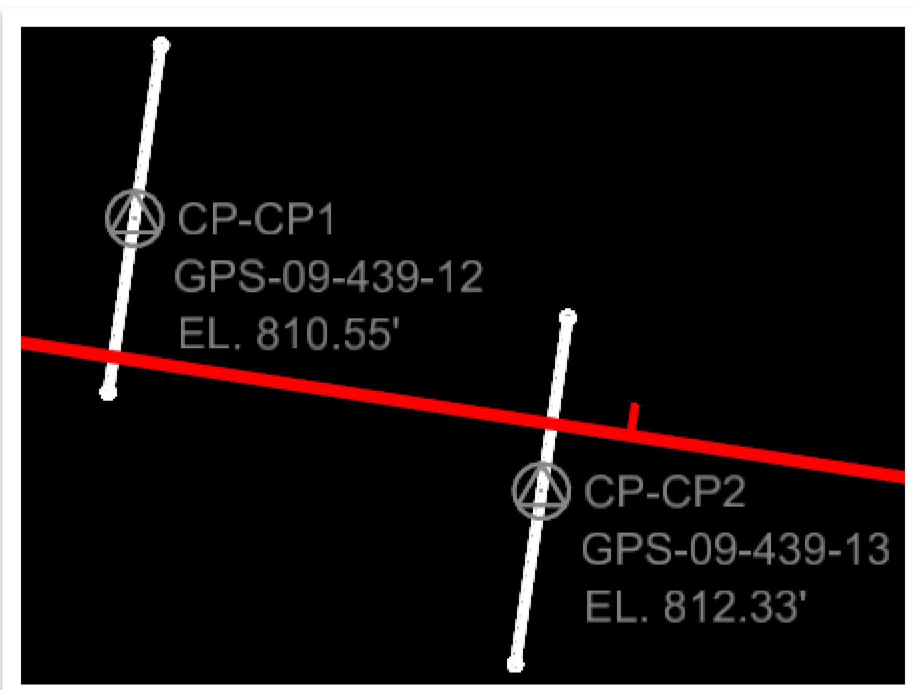
12. Within the **Place Link Between Nodes** dialog box, select the following settings and leave the others as default.
    a. **Feature Definition:** Misc. (**Conduit >> GenericSegmentAsset**)
    b. **Name Prefix:** Unnamed
    c. **Description:** No Descriptions Selected



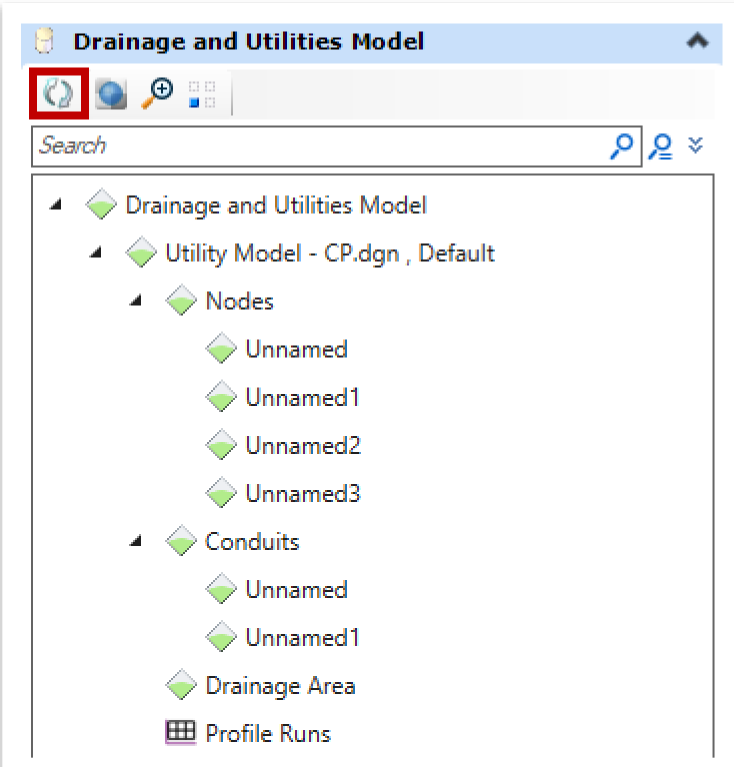
13. Notice the cursor prompt: **Select Start Node**. Select either node on the westernmost arbitrary line and the conduit will appear on the cursor. Select the second node (**next node**) **to make a connection** and place the conduit. **Note:** Since both nodes have the same elevation along the respective line, the order of node selection and thus the conduit direction is irrelevant for this exercise. Also, your slope should be **0.00%** but the length will vary depending on the arbitrary lines you drew earlier.



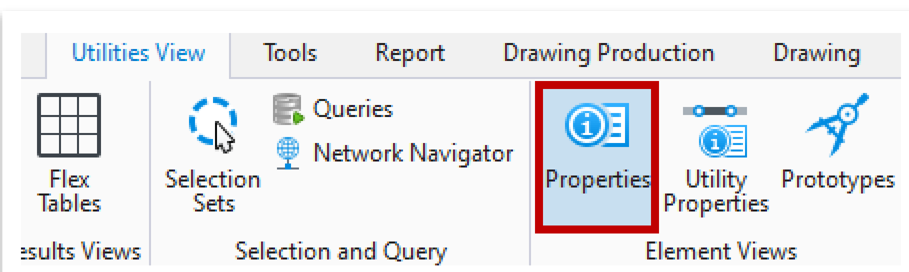
14. Once placed, you will see the linework added between the nodes. Repeat the previous step to add the conduit for the other **XCP** crossing and then right click to clear the tool.



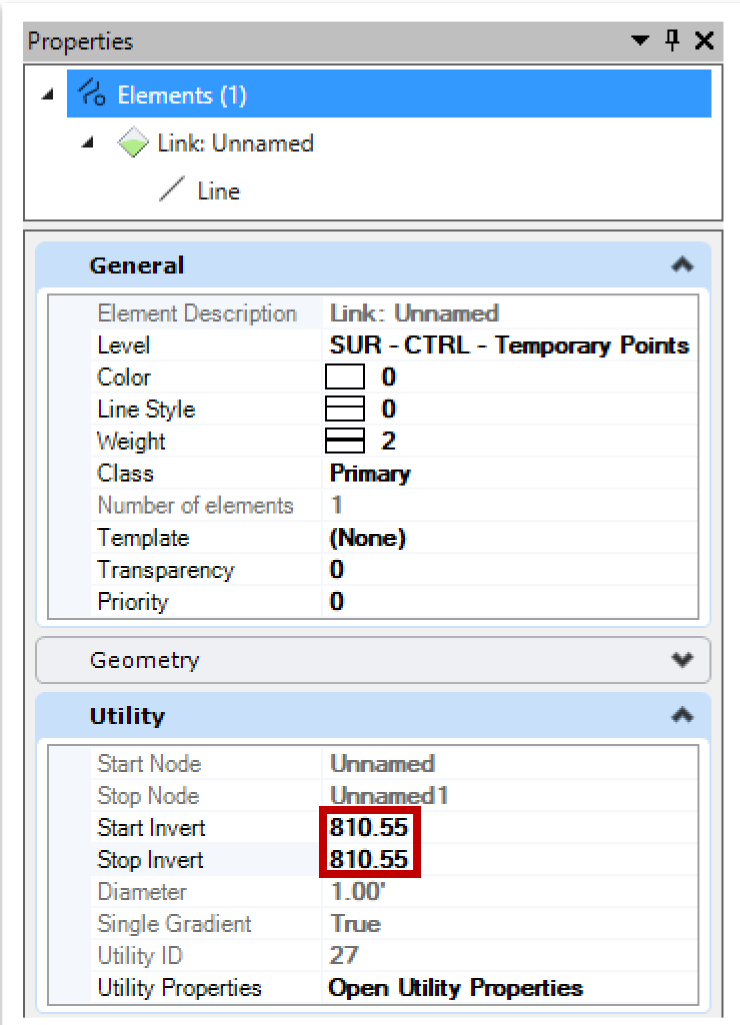
15. Within the **Explorer**, open the **Drainage and Utilities Model** tab and notice that all **nodes** and **conduits** have been added. **Note:** If the nodes are not showing, click the **Refresh** icon under the **Drainage and Utilities Model** header. If the nodes still do not show, close and re-open the **Explorer**.



16. Next, let's review the element properties of the conduit. First, turn off the **Utility Model – CP.dgn** (**Default-3D**) reference file. Then, select the first conduit and open the **Properties** (**Drainage and Utilities >> Utilities View >> Element Views**).

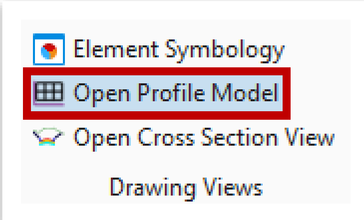


17. Under the **Utility** header, key-in the correct **Start** and **Stop Invert** elevations (**810.55**) to match the surveyed elevation of the first **XCP**. **Note:** Once again, you'll notice a **Node structure warning** (yellow triangle) at each node once the elevation has been updated. For the intent of the exercise, you can ignore the warning.

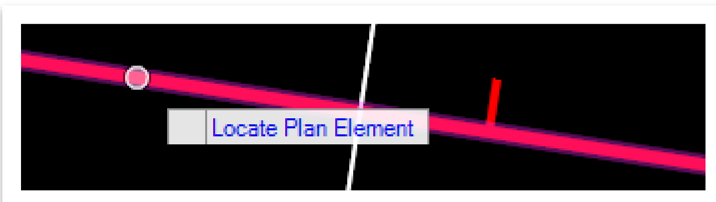


18. Repeat the previous step for the other conduit and edit the **Start** and **Stop Invert** elevations in the **Properties**.
19. Now we need to project the **Control Points** onto the survey preliminary centerline. Go ahead and open back up the **Alignment – Additional Elements.dgn** file and attach the **Utility Model – CP.dgn** reference file. Make sure the **Utility Model – LWC.dgn** reference file is turned off, if not already.

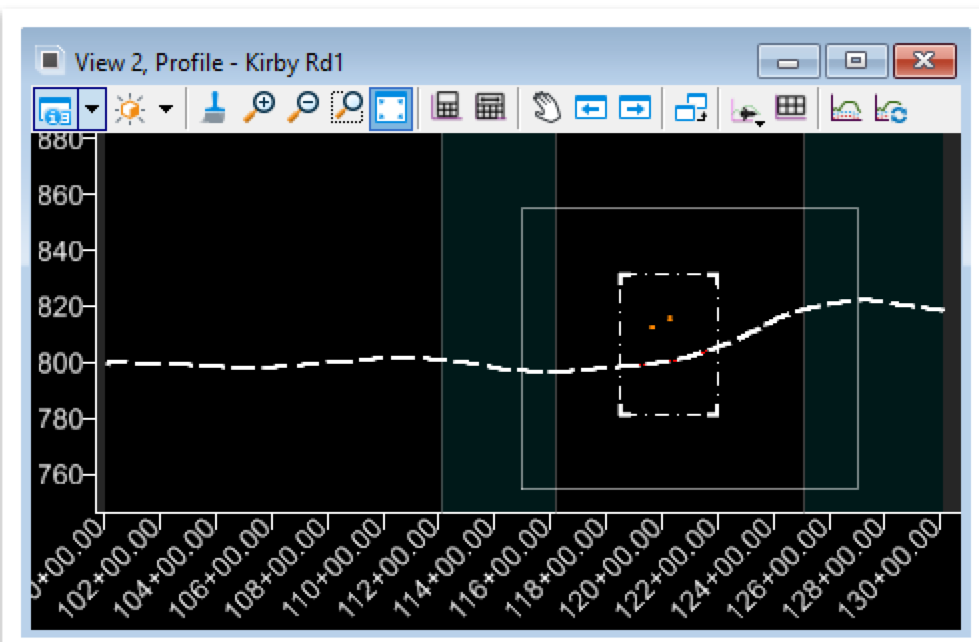
20. Open the **Open Profile Model** tool (**Drainage and Utilities >> Utilities View >> Drawing Views**).



21. Notice the cursor prompt: **Locate Plan element**. Select the red centerline.



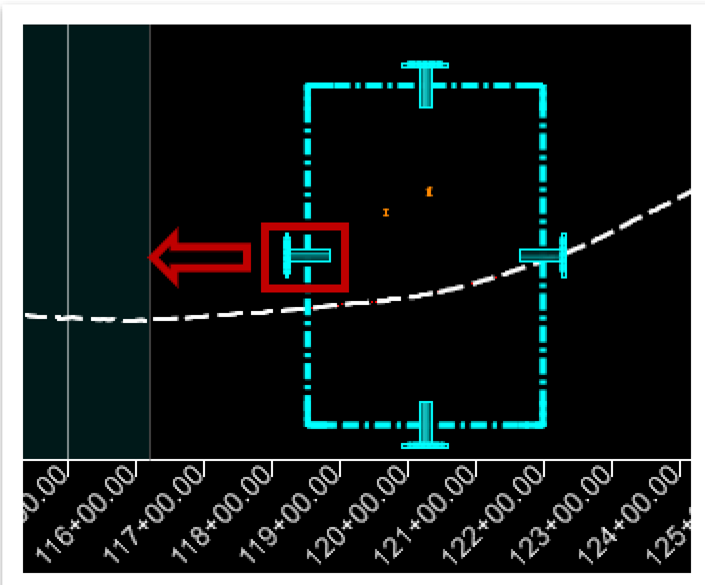
22. Then, open **View 2** and click anywhere within the drawing window. Notice that the **existing** profile is visualized along the roadway centerline. You should also see the **XLW** conduits that we added in the previous exercise, as well as the 3d Cut boundary and the profile named boundary.

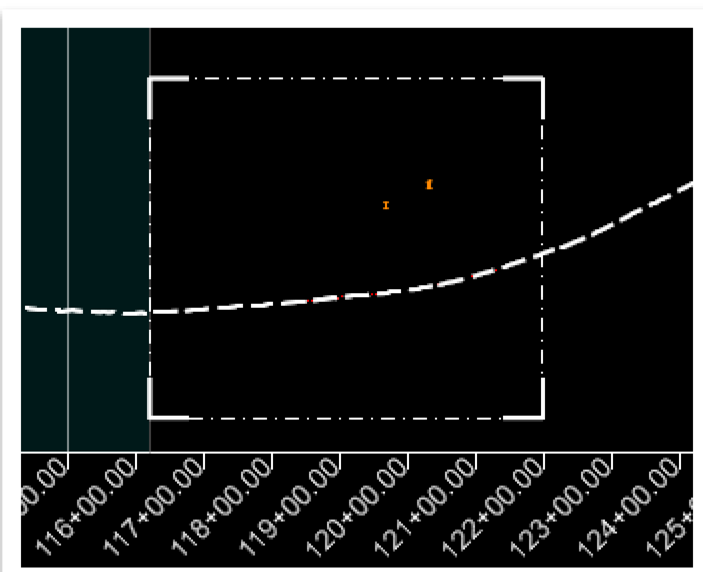


Take Note!

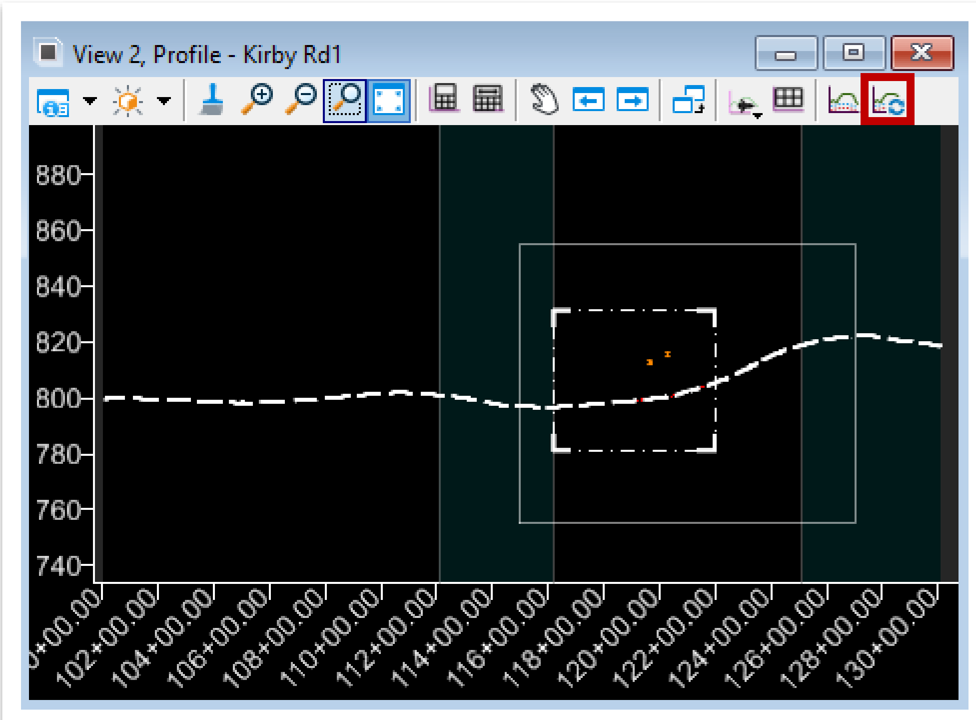
*You may get an alert saying that **Outdated information might be displayed**. This pertains to **Cached Visible Edges** and simply means the **3d Cut** needs refreshing because there are new design elements that are not yet showing in the profile.*

23. Since we previously created the 3d Cut, we in fact do need to **refresh** it because we referenced an additional utility model (**XCP**). If your 3d Cut boundary already encompasses Station 117+50, skip to Step 25. Before we can refresh, we need to adjust the 3d Cut boundary extents since the control points fall outside of the extent shown below (Station 117+50). We intentionally used the **Corners** placement method in the previous exercise so that we could show how to manipulate the boundary. Within the profile view, activate the **Element Selection** tool and select the 3d Cut boundary. Once highlighted, click on the left pick-point to activate the movement and then click again at approx. Station **116+00** to update the boundary. Left click within **View 2** to deselect.

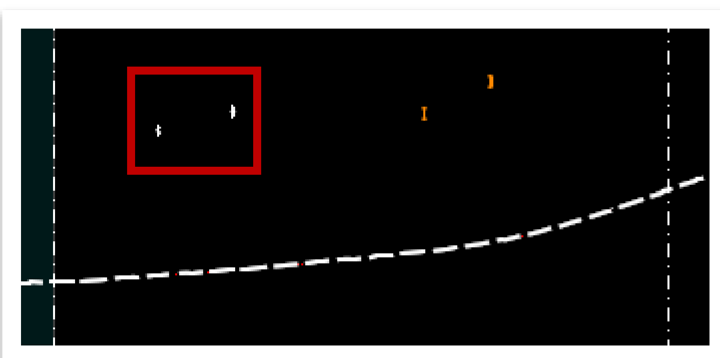




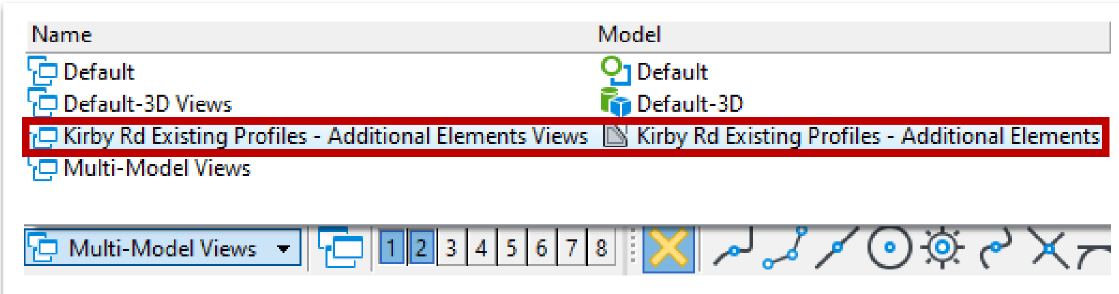
24. Unfortunately, if you were to now select the **Refresh 3d Cut** tool within **View 2**, nothing will happen. You must open a different ORD file and then re-open the **Alignment – Additional Elements.dgn** file, so go ahead and do that.
25. Now, open **View 2** again, if necessary, and select the **Refresh 3d Cut** tool.



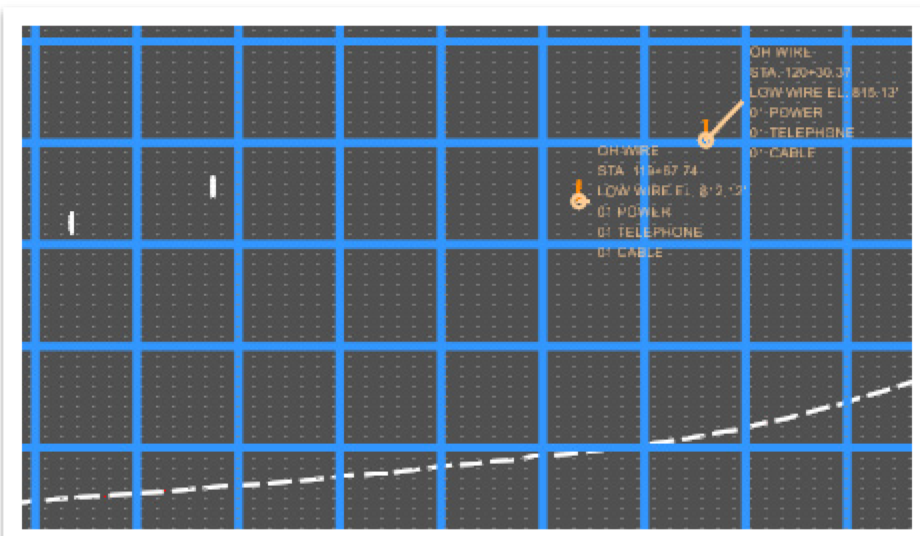
26. Notice that the **two** XCP conduits have now been projected onto the profile at the correct elevations.



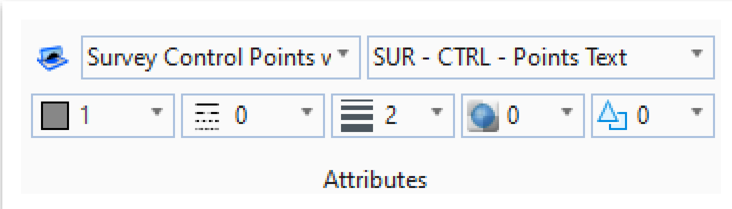
27. Next, we will add the applicable annotation, like in the previous exercises. The important thing to note is that we already created the profile **drawing** model in the previous exercise (**Kirby Rd Existing Profile – Additional Elements**). We do not need to create the profile named boundary again. In the lower left corner, go ahead and switch back to the profile drawing model.



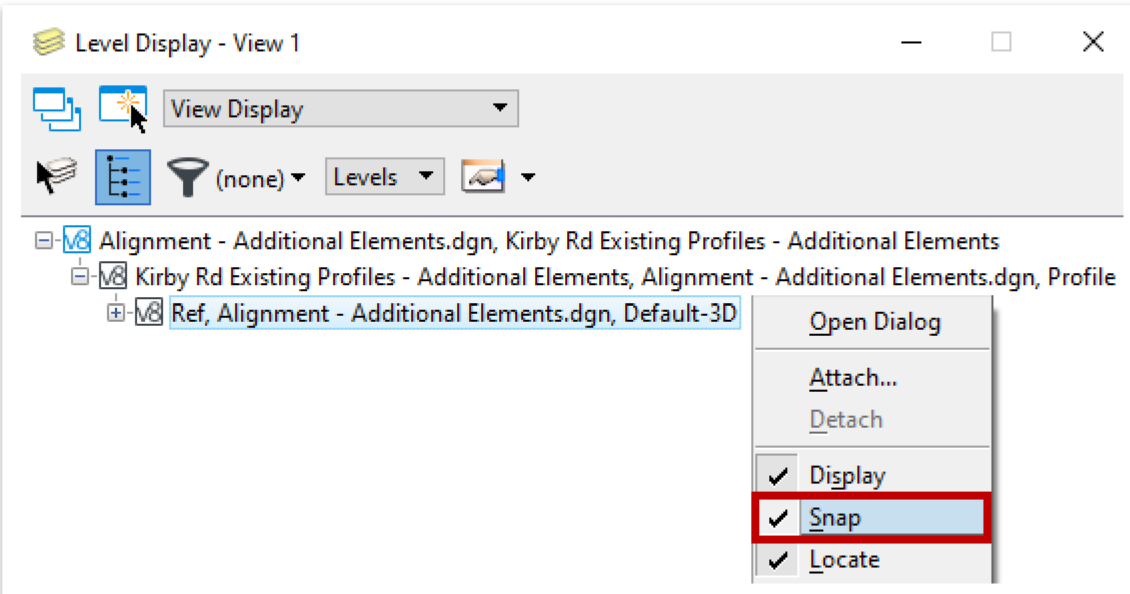
28. You should see the centerline profile, **XLW** conduits (and annotation) and the **XCP** conduits along with the profile grid, stations and elevations. **Note:** The conduits are showing again because the **Display** toggle in the reference file is back on.



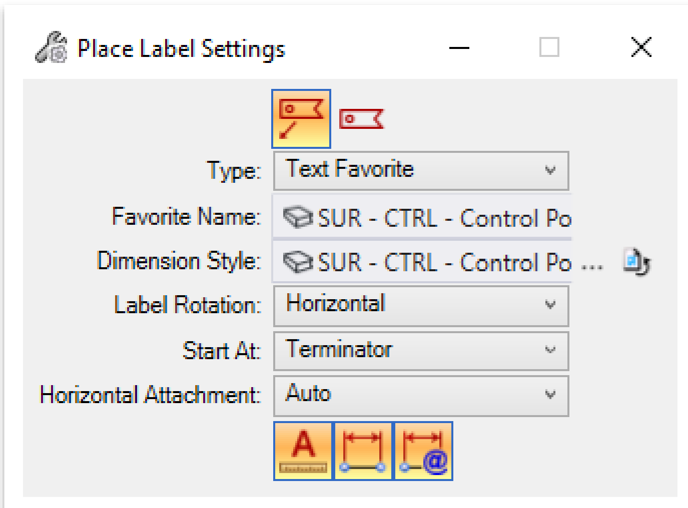
29. Go ahead and select the **Survey Control Points with Text** element template (**Survey >> Annotation >> Control Points**).



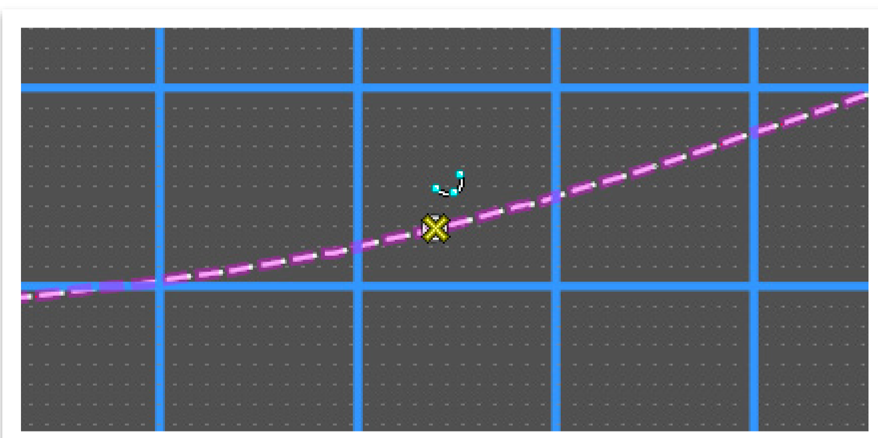
30. Now, open the **Level Display** and right click on **Ref, Alignment – Additional Elements.dgn, Default-3D** and toggle the **Snap** option on, as shown below. This will allow us to snap to the **XCP** conduits when placing annotation. Close the **Level Display** once you are done.



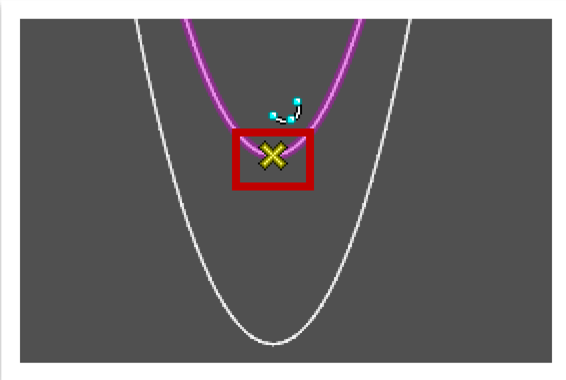
31. Next, open the **Place Label** tool (**Drainage and Utilities >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings and leave the others as default. **Note:** As a reminder, there is an enhancement logged with Bentley to allow a **symbol** to be placed <u>without</u> a leader.
    a. Select the **leader** icon at the top (this allows the correct point symbol to display)
    b. **Type:** Text Favorite
    c. **Favorite Name:** SUR - CTRL - Control Point (Profile)
    d. **Dimension Style:** SUR - CTRL - Control Point (Profile)



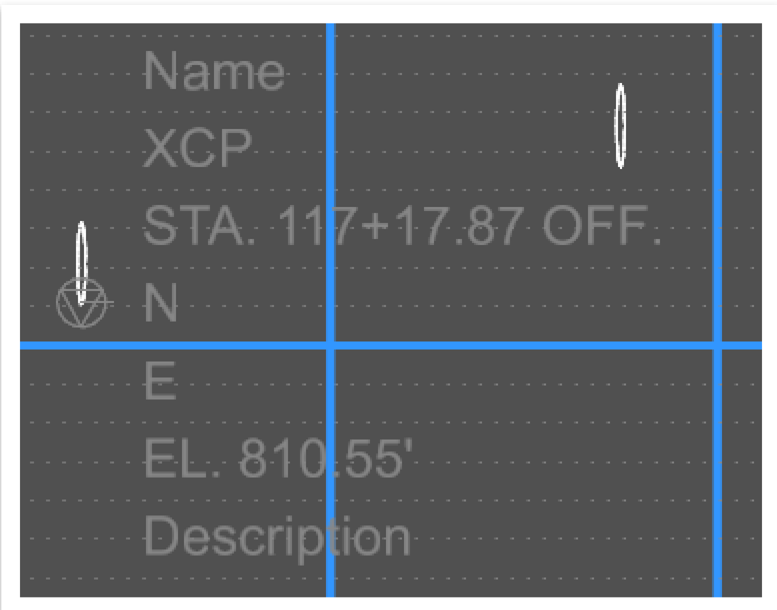
32. Notice the prompt in the lower left corner: **Identify Element or DataPoint**. Select the centerline profile.



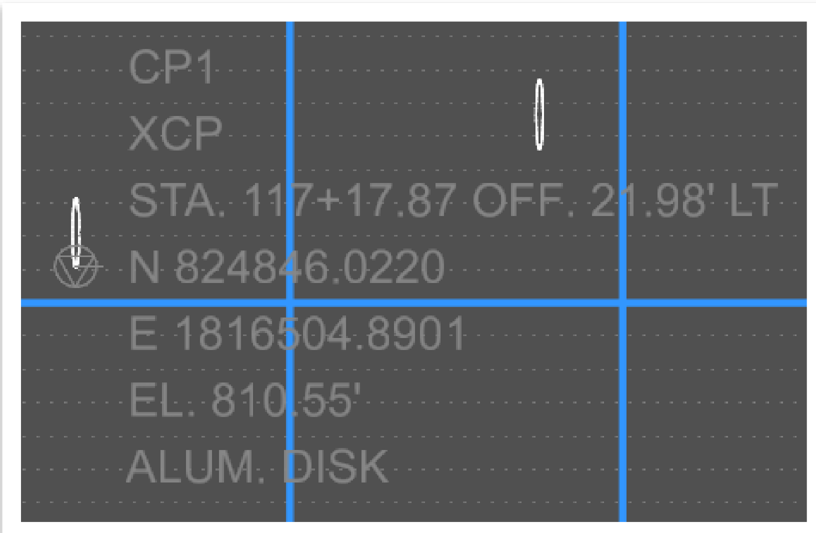
33. Notice the next prompt in the lower left corner: **Select Point Location**. Zoom in to the first **XCP** conduit and snap to the low point on the inner diameter.



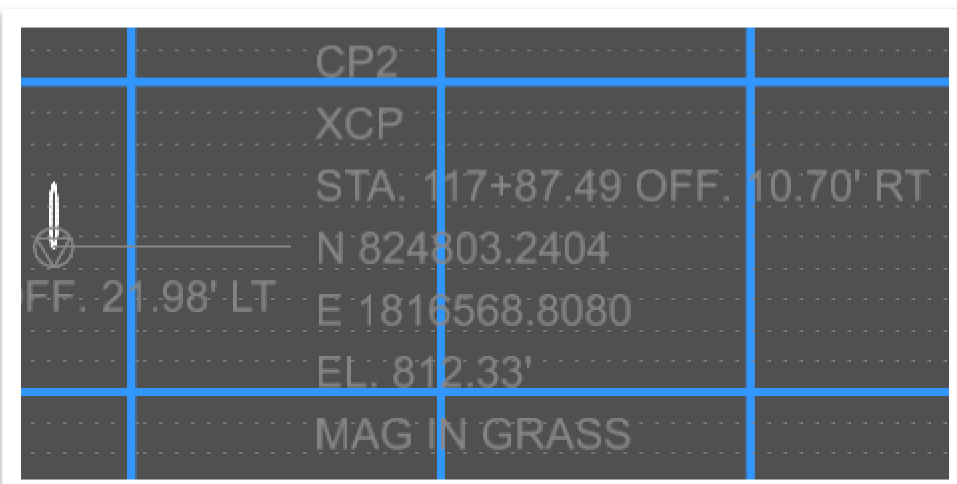
34. Left click again just off to the right to place the label. The offset is necessary so that the symbol stays on when we turn the conduits off later in the exercise. Notice that the label automatically reads the **station** and **elevation**. We will fill in the other data in the next step. **Note:** The control point symbol will freely rotate depending on the direction of the leader even though the cell itself is due North in the library. This is a known defect and has been logged with Bentley.



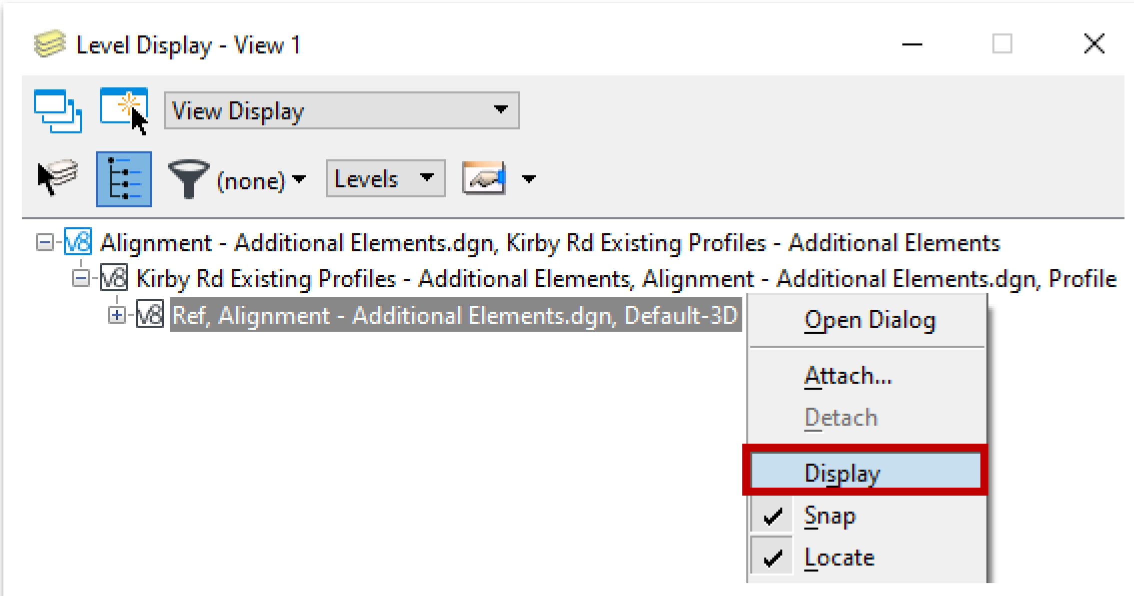
35. Double click on the label to open the **Text Editor**. Fill in the remaining data (**Name**, **Offset**, **N/E**, **Description**), as shown below. For the **Description** field, you would typically key-in **MAG IN GRASS** or **ALUM. DISK**. **Note:** The northing and easting cannot be automatically populated in profile view. An enhancement has been logged with Bentley to allow that automation in a future software release.



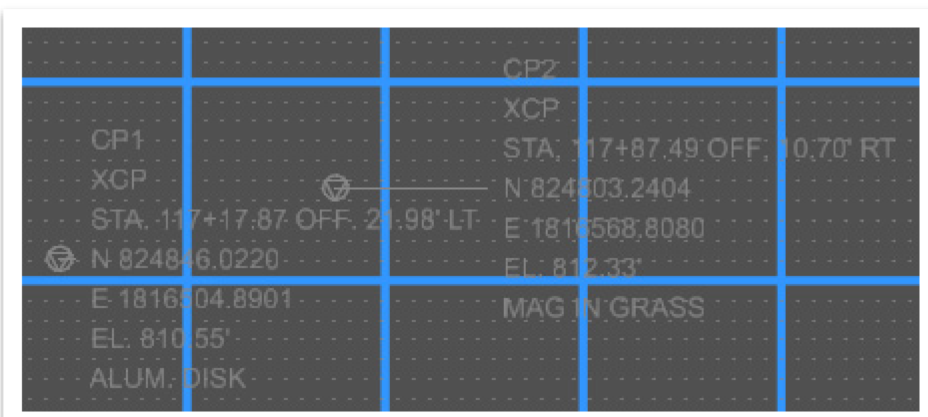
36. Repeat Steps 33-35 to add the label for the other **XCP** conduit. **Note:** As a reminder, the centerline profile does not need to be re-selected before the placement of each label unless the tool was cleared. If ever the station/elevation look erroneous, clear the tool and start again by selecting the centerline.



37. Next, open the **Level Display**, if not still opened, and right click on **Ref, Alignment – Additional Elements.dgn, Default-3D** and toggle the **Display** option off, as shown below. This will turn the conduits off.



38. The final profile view for the **control points** is shown below. Remember, the leader option allows the symbol to be placed automatically in profile view. **Note:** Only the control points are shown in the screenshot below. The low wire crossing points are to the right.



39. Lastly, switch back to the **Multi-Model Views** (plan/profile) view. To turn off the **XCP** nodes and conduits, use the same method as in the previous exercise and simply turn off the **Utility Model – CP.dgn** reference file.

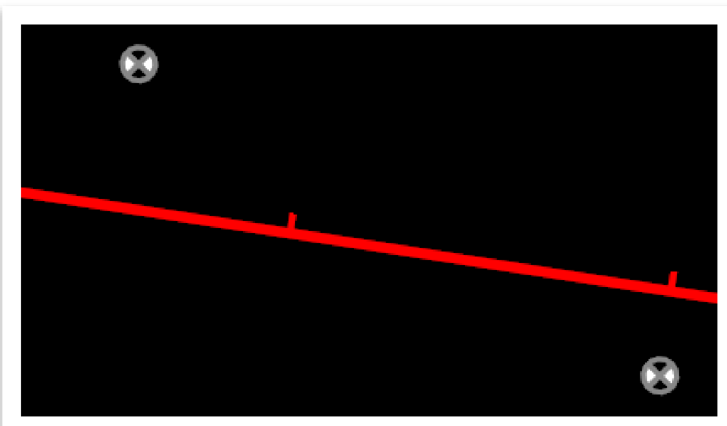
7.4 Lecture: Benchmarks

A **benchmark** is represented by a post or some other permanent mark and indicates a known elevation that is used as the basis for measuring the elevation of other topographical points.

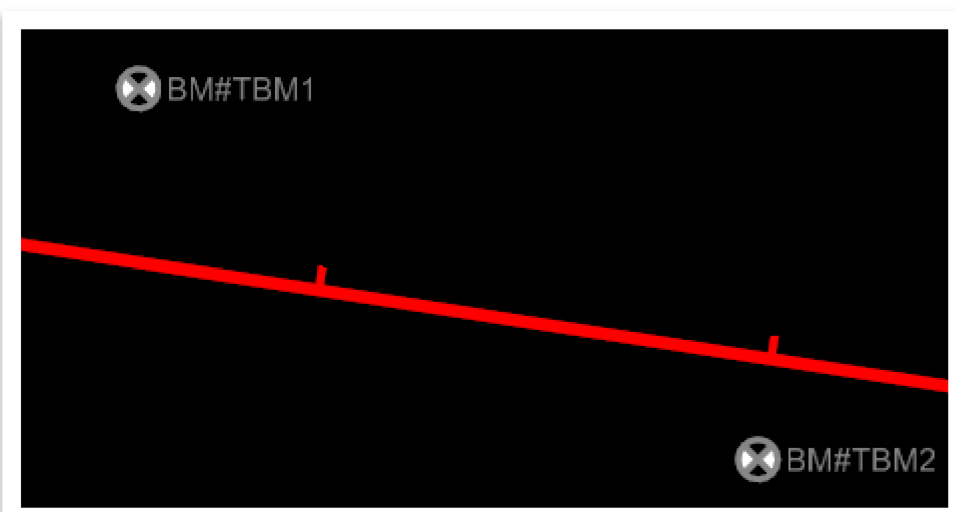
7.4.1 Exercise: Benchmark – Plan

In this exercise, we will place Benchmark annotation on imported survey data in plan view. **Note:** The Benchmark plan data would normally be part of the overall 3D survey file but has been separated out for the purpose of training.

1. Open the **Survey Model – BM.dgn** file within the **SURVEY_Training** workset dgn subfolder. **Two** benchmarks (**XBM**) have already been imported via ASCII text file.
2. Zoom in to Station **117+50.00** and notice the **three** Benchmarks.



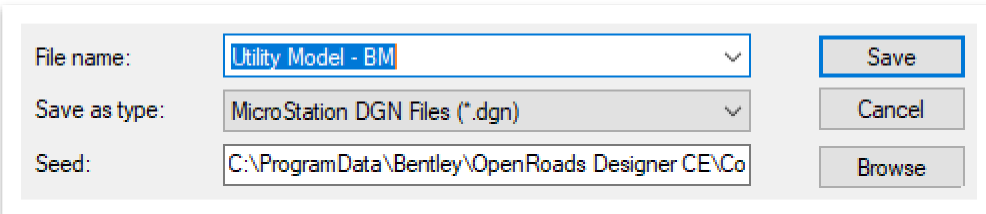
3. Once again, let's annotate the model by opening the **Annotate Model** tool (**Drainage and Utilities >> Drawing Production >> Annotations >> Model Annotation**). Notice the cursor prompt: **Accept Design Model**. Left click to accept and notice the annotations are added.



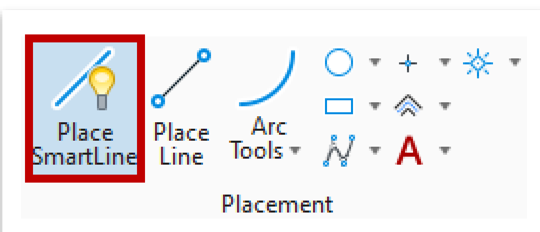
7.4.2 Exercise: Benchmark – Profile

In this exercise, we will add Benchmarks to the same roadway profile from the previous exercise after creating a **Utility** model. The process is essentially the same as in Exercise 7.3.2, so we will reference that exercise primarily. **Note:** The Benchmark utility model would normally be part of the overall 2D utility model file prior to projection in the alignment file but has been separated out for the purpose of training.

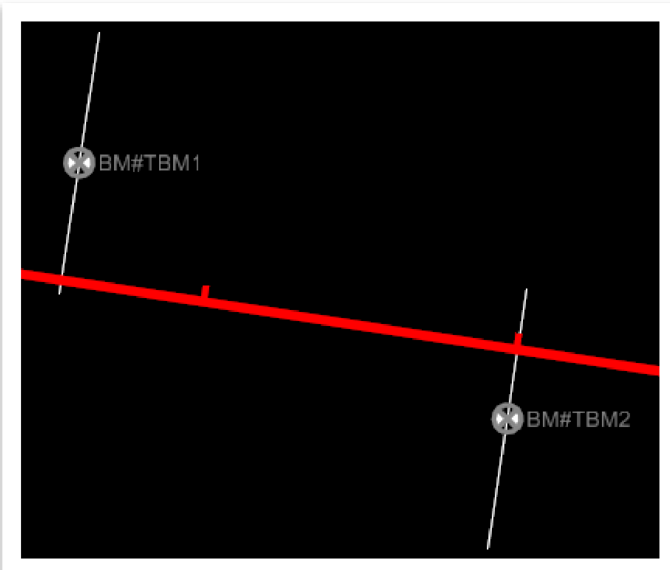
1. Create a new file and name it **Utility Model – BM**. Select the **TDOTSeed2D.dgn** and click **Save**.



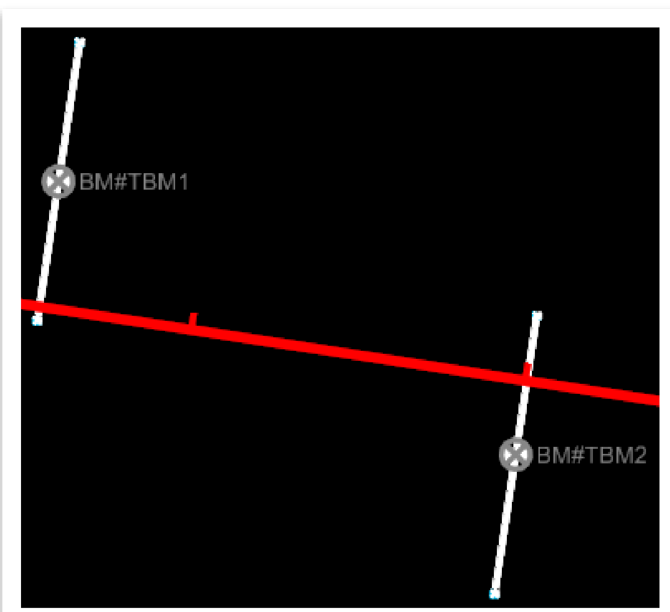
2. Attach the following reference files using the **Coincident World** attachment method and then click **Fit View**.
   - Alignment – Additional Elements.dgn
   - Survey Model – BM.dgn
3. Toggle on **Civil Accudraw**, if necessary, and then open the **Place SmartLine** tool (**Drainage and Utilities >> Drawing >> Placement**).



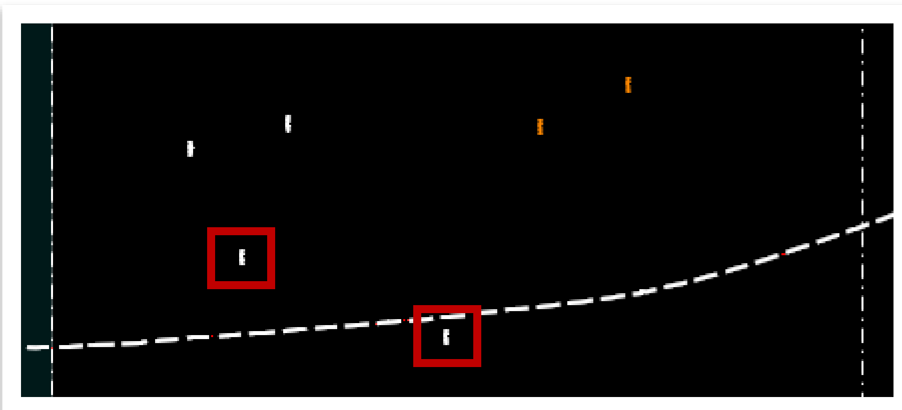
4. Next, draw an arbitrary line that passes through each of the **XBM** points. Make sure the lines are **perpendicular** to the centerline so that the profile stationing will be correct. Also, make sure that the lines cross the alignment, as shown below.



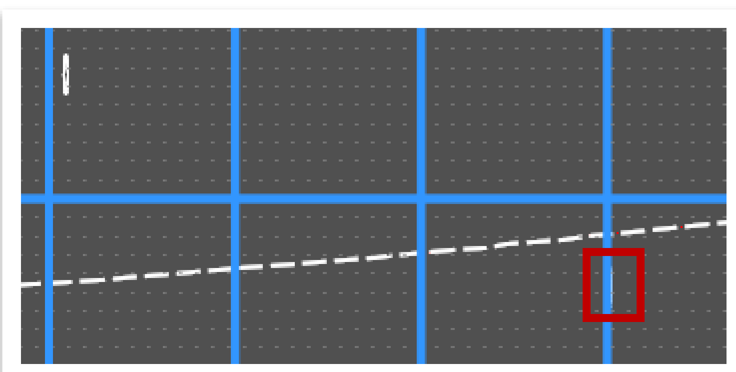
5. Draw the nodes and conduit at the same elevation of each surveyed crossing point (TBM1: **802.82** and TBM2: **797.12**) using the **Misc.** feature definition once again. Make sure to key-in the correct **Start** and **Stop Invert** elevations within the **Properties** for each conduit. **Note:** The screenshot is prior to updating the invert elevations.



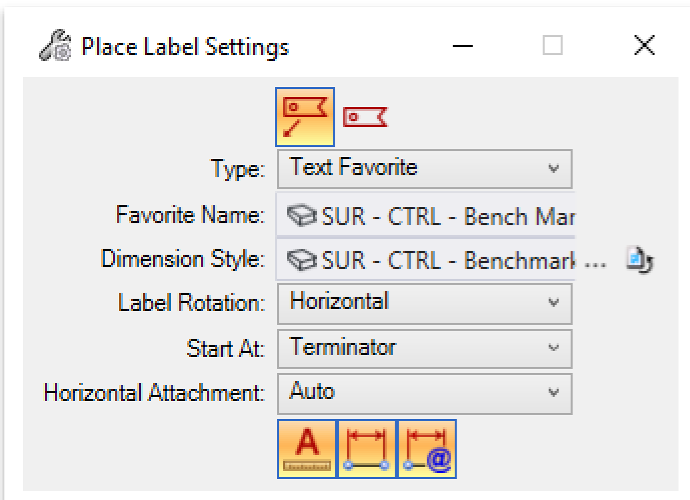
6. Now we need to project the **Benchmarks** onto the survey preliminary centerline. Go ahead and open back up the **Alignment – Additional Elements.dgn** file and attach the **Utility Model – BM.dgn** reference file. Make sure both the **Utility Model – LWC.dgn** and **Utility Model – CP.dgn** reference files are turned off, if not already.
7. Open the profile model (**View 2**) and then select the **Refresh 3d Cut** tool. The **XBM** points are within the boundary extent this time, so no need to adjust the boundary. You shouldn't have to close out and re-open the file but if nothing happens after the refresh, take that route. Notice that the **two** XBM conduits have now been projected onto the profile at the correct elevations.



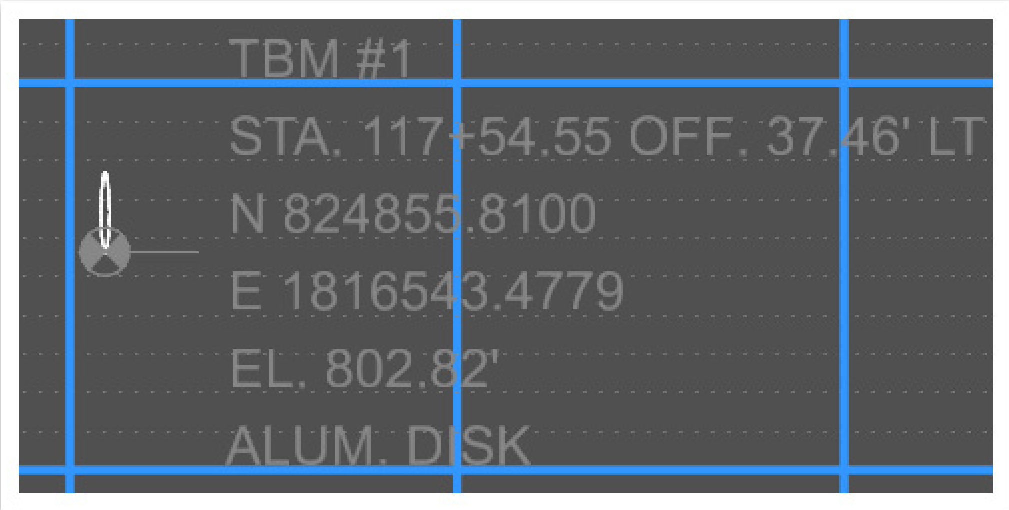
8. Next, switch back to the profile drawing model that was previously created and notice that the **XBM** conduit has been added. **Note:** You will have to zoom in to see TBM2 (highlighted), as it is closely aligned with the blue grid lines.

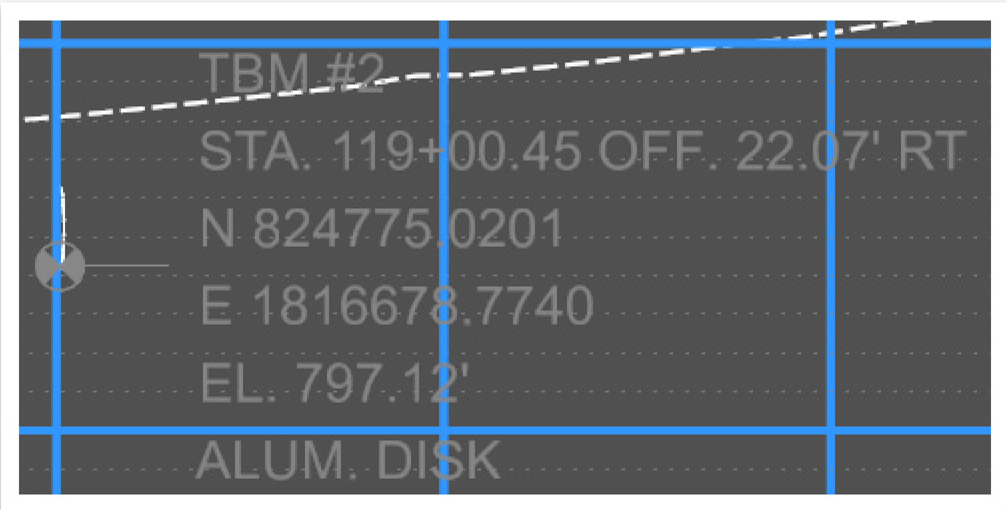


9. Prior to placing the annotation, select the same **Survey Control Points with Text** element template (**Survey >> Annotation >> Control Points**). Then, open the **Level Display** and right click on **Ref, Alignment – Additional Elements.dgn, Default-3D** and toggle the **Snap** option on to allow us to snap to the **XBM** conduits. Close the **Level Display** once you are done.
10. Next, open the **Place Label** tool (**Drainage and Utilities >> Drawing Production >> Notes**). Within the **Place Label Settings** dialog box, select the following settings and leave the others as default. **Note:** As a reminder, there is an enhancement logged with Bentley to allow a **symbol** to be placed <u>without</u> a leader.
    a. Select the **leader** icon at the top (this allows the correct point symbol to display)
    b. **Type:** Text Favorite
    c. **Favorite Name:** SUR - CTRL - Bench Mark (Profile)
    d. **Dimension Style:** SUR - CTRL - Benchmark (Profile)



11. Place both labels and then fill in the remaining data, as shown below. Once all labels have been placed, open the **Level Display**, if not still opened, and right click on **Ref, Alignment – Additional Elements.dgn, Default-3D** and toggle the **Display** option off.



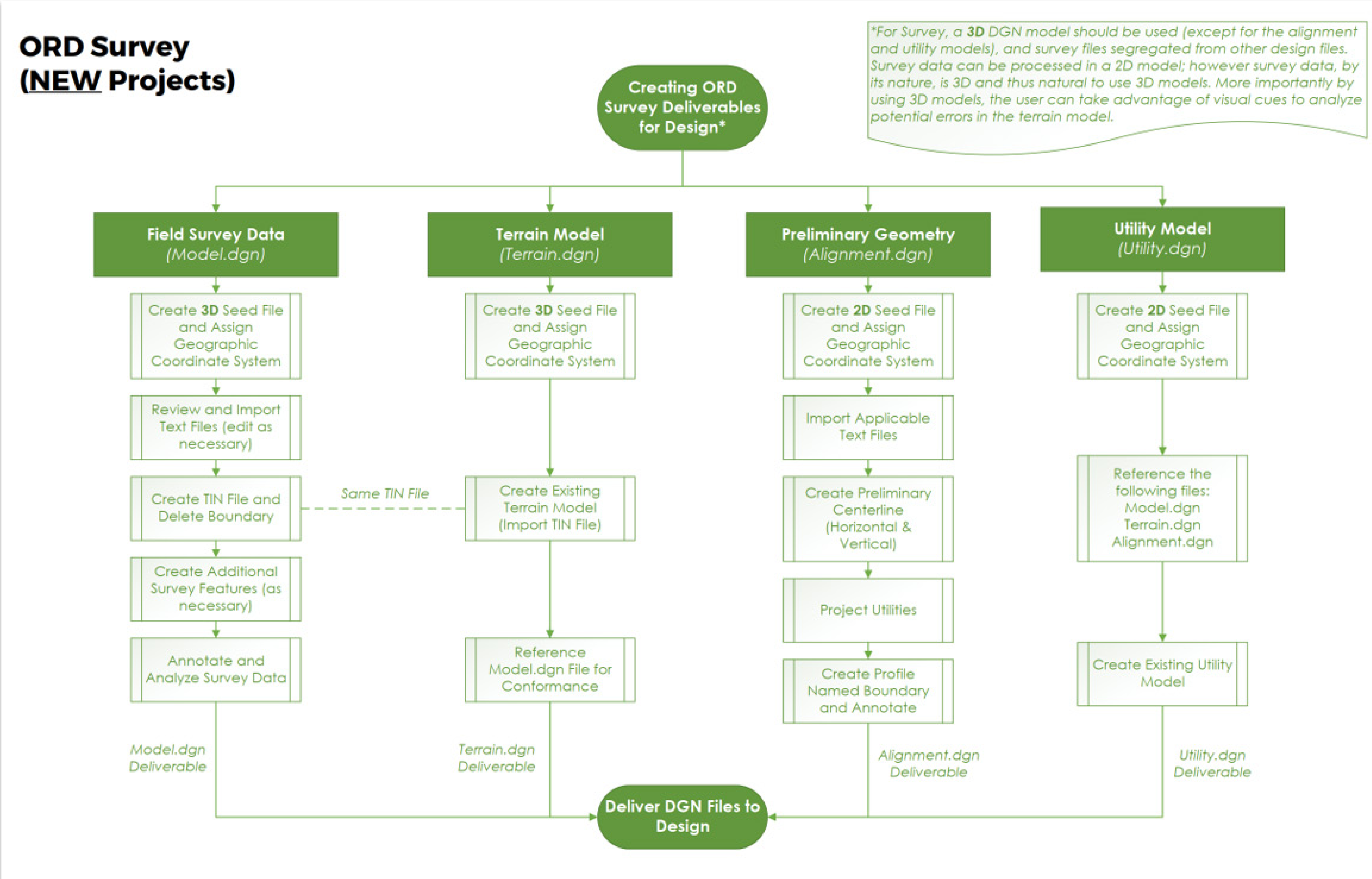


12. Lastly, switch back to the **Default** (plan) view and close **View 2**. To turn off the **XBM** nodes and conduits, use the same method as in the previous exercises and simply turn off the **Utility Model – BM.dgn** reference file.

Revision History

DATE (MONTH/YEAR)	AUTHOR/EDITOR	IB #	SECTIONS MODIFIED

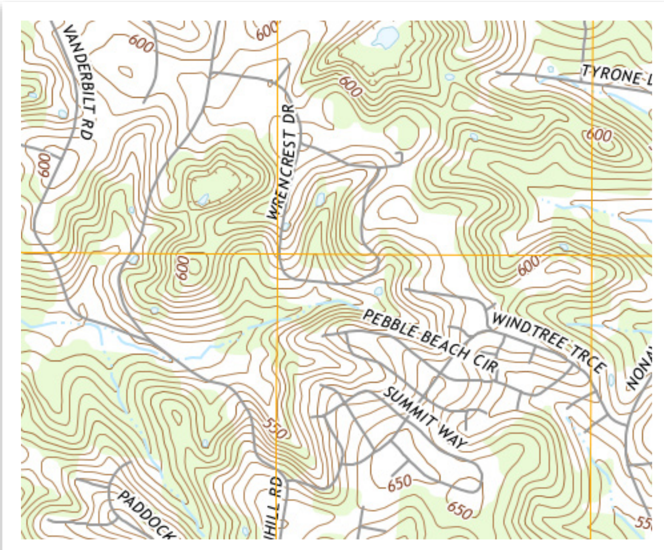
Appendix A. Survey Deliverables Process



Appendix B. Example Contour Map and Definitions

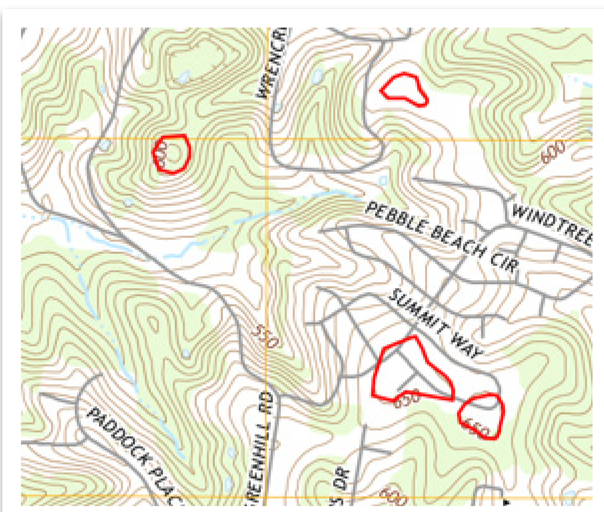
Contour Lines:

- Indicated by linear elements that connect points of equal elevation.
- Always close back on themselves and do not cross.
- Major contours are typically every 5' or 10'.
- Minor contours are typically every 1' or 2'.



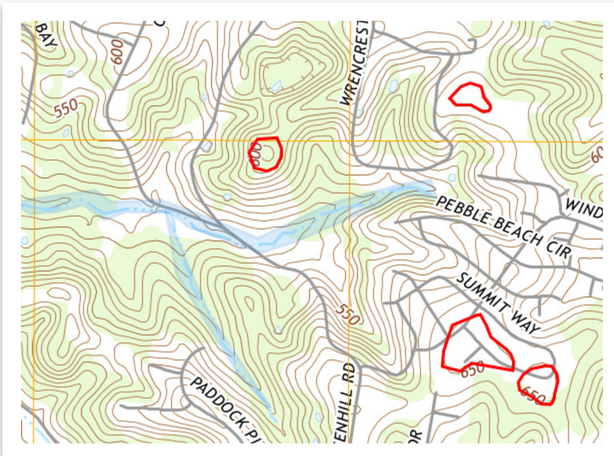
Top of Hills:

- Indicated by irregularly shaped ovals or circles.



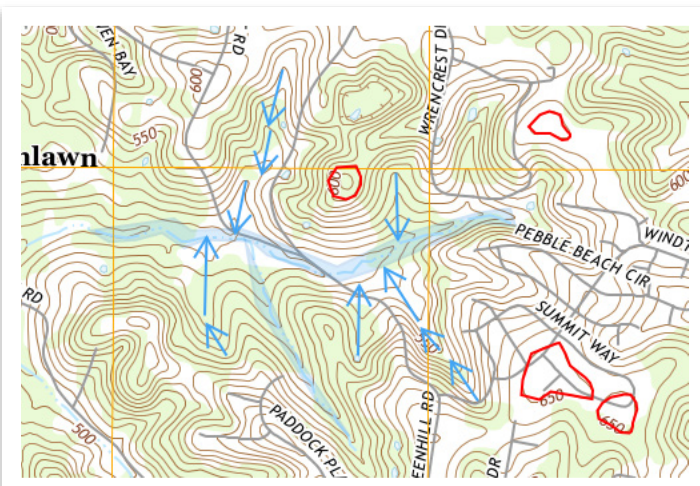
Rivers, Streams and Water Bodies:

- Identified by blue lines/ponds.



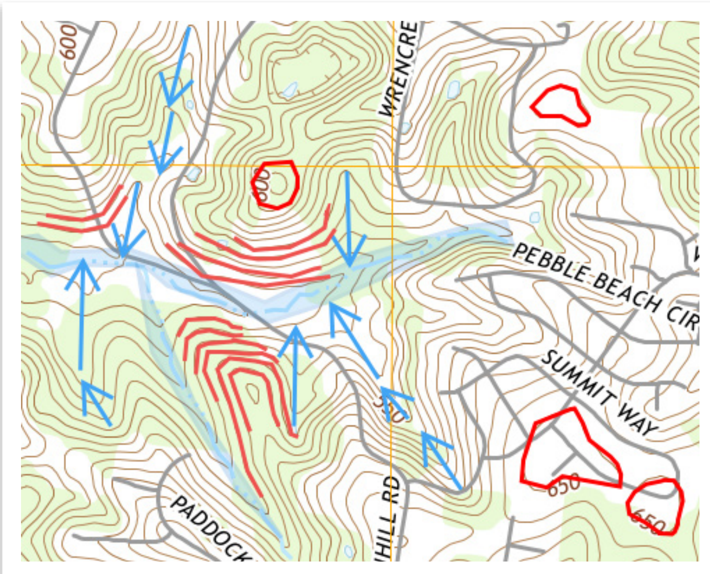
Drainage Paths:

- Identified by "V" shaped contour lines (arrows shown below identify these paths).



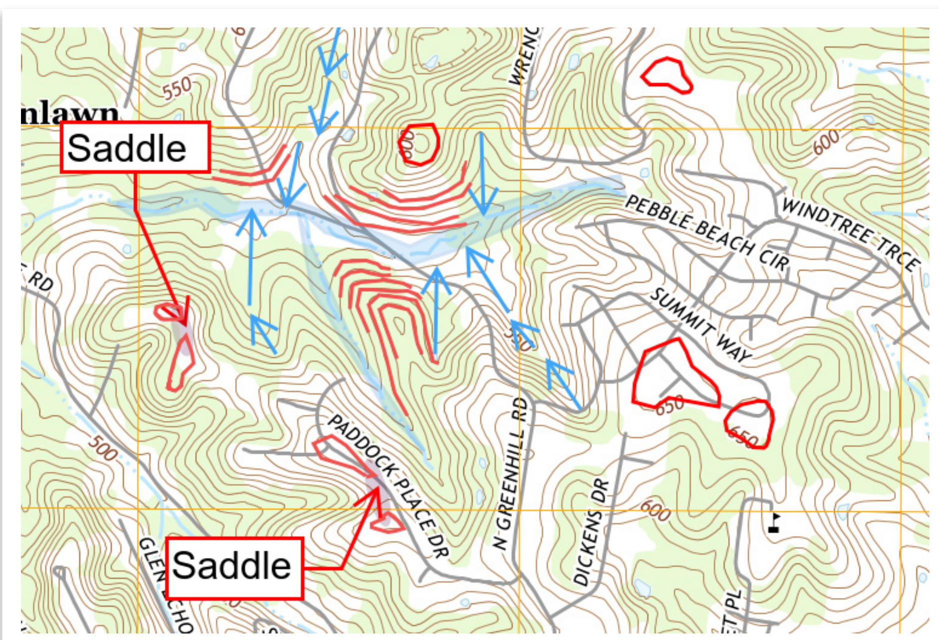
Ridges:

- Indicated by larger rounded "U" shaped contour lines.



Saddles:

- Indicated by a lower area between two adjacent hills.



Closed Depressions (Marshes):

- Indicated by contour lines with hash marks pointing inward.