Bentley Civil Workshop

2013 MACC Conference

Day 2

OpenRoads Technology Workshop: Horizontal and Vertical Geometry

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Preface

In this workshop, you will construct a roadway interchange horizontal and vertical layout utilizing the V8*i* SELECTseries 3 Horizontal Civil Geometry tools. We have structured the contents of the exercises herein to allow your interaction with a broad range of available tools. However, we will not use every tool. Also, it is impossible to engineer a complete interchange in the time frame of this workshop, but we will use the tools in their real-life context, so you can see how to utilize them in your own engineering projects.

This workshop is equally applicable for MX, InRoads or GEOPAK families of products. Each product contains the identical toolset and identical workflow. The only differences between the three products for the tools are slight differences in the use of feature definitions and some differences in the back-end interaction with other native toolsets such as drainage.

There are more exercises in this manual than we will have time to cover today. We will all complete the basic set of exercises, and for those veteran users in the group who complete them and still have time left in the exercise session, you are welcome to work on the optional exercises.

In order for all participants to design the same layout and to stay on course and on time, we request that all participants utilize the files as listed in the workshop materials. At the beginning of each chapter, we will start with a fresh set of data. This ensures that everyone is using the same data, plus we have added data to avoid redundant work. For example, we draw some of the edges of pavement in the lab so you can understand the workflow, but have drawn the remainder in for expediency of time.

The workshop guide is yours to take with you. If you don't finish all the exercises, or just want to work with the dataset upon return to your office, the datasets (both initial and completed files) are provided on the Conference DVD. This workshop also has videos of all exercises on the DVD.

Note	Prerequisite Knowledge Level: Participant should have a basic understanding of road design principles and be fluent in use of MicroStation and the native application (MX, InRoads or GEOPAK) or one of the Power products.

SESSION DESCRIPTION

This hands-on workshop provides introductory training for the creation, manipulation, and annotation of new horizontal geometry in Bentley civil SELECTseries 3 products. Can you live without dialogs and menus? Learn to use these new intuitive, context-sensitive horizontal geometry tools. This workshop is targeted for all Bentley civil users.

LEARNING OBJECTIVES

After this course you will be able to:

- Import horizontal geometry from native products.
- Create horizontal geometry elements from task navigation.
- Edit / manipulate elements using edit handlers / manipulators.

Note	At the end of this training session, an assessment will be given. We will review all assessment questions and answers to see what you have learned.

Chapter 1: Introduction to Horizontal Geometry Tools

OVERVIEW

Civil Geometry is a dynamic, interactive, rules-based approach to geometry that provides an unprecedented level of associativity by preserving design intent, snaps and Civil AccuDraw input. The results of the tools are intelligent graphic elements which can be dynamically edited and associations between elements which are automatically updated.

The results of the tools are graphical geometry elements stored as MicroStation elements. There is no external geometry file. The geometry elements are MicroStation elements with additional intelligence applied to store the rules and associations.

The Civil Geometry tools are installed as a part of GEOPAK, InRoads and MXROAD products. In order to be consumed by processes within GEOPAK, InRoads and MXROAD, the civil geometry must be written to the native application coordinate geometry file (ALG, GPK or FIL). This can be configured to be handled automatically based on properties of feature definitions, or else it can be done manually.

PROJECT DESCRIPTION

In this workshop, we will construct a mainline alignment, a cross-road alignment, and an interchange including ramps, loops and access roads. Note the view is rotated so the mainline is displayed in a west-east orientation.

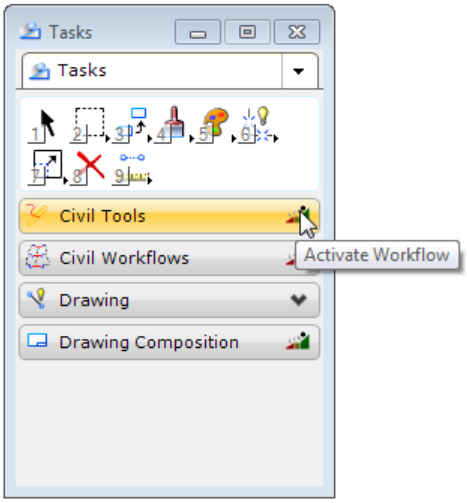
Alignments created with horizontal geometry tools

The table below details the dimensions that will be used throughout the project.

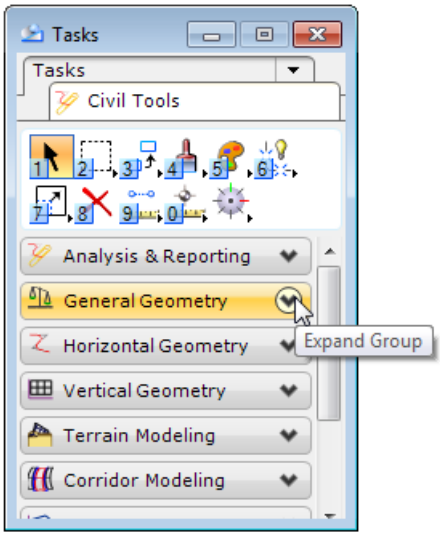
DESCRIPTION	VALUE
Units	Metric
Lane Width	3.6m
Ramp Width	5.0m
Median Width	3.5m centerline, 3.0 loop/ramp
Entrance Taper	1:50
Exit Taper	1:15
Stationing Format	1+234

NAVIGATING TASKS

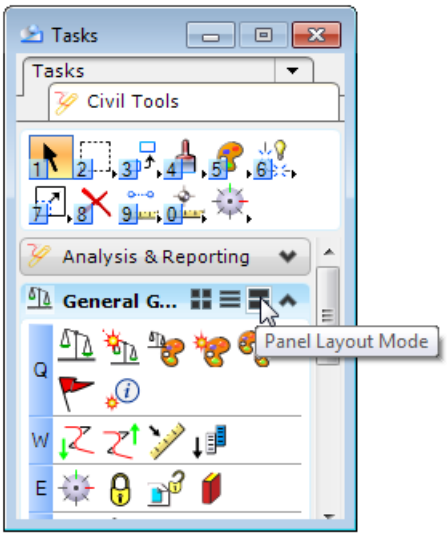
Within the Tasks dialog, the General Geometry and Horizontal Geometry tasks are located in the Civil Tools Workflow.



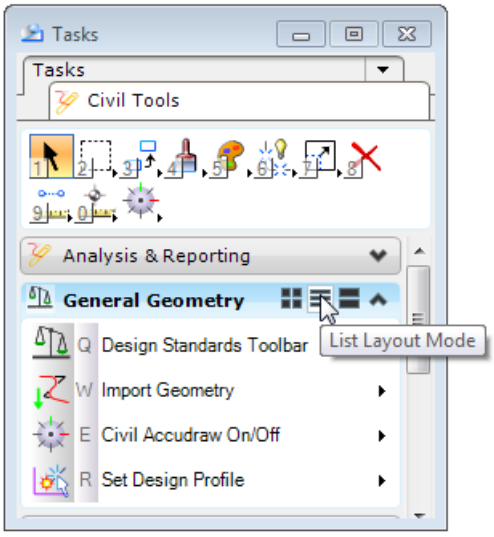
Click Activate Workflow to view the main tasks. To open the toolset, click Expand Group. Click the same icon to Collapse the Group.



There are several ways the Groups can be displayed. For this workshop, we'll use the Panel Layout Mode, which is the default.

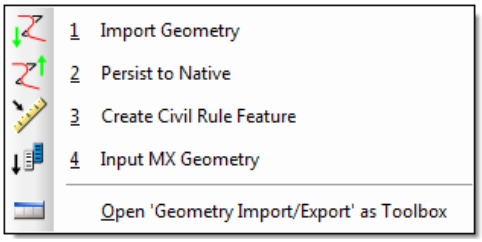


If you prefer listings rather than icons, you may prefer the List Layout Mode.

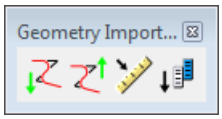


Your preference may be to not use the Task dialog. Other options include:

- Select any tool from Tools > Civil Geometry from the Power product main menu bar.
- Select <F2> from your keyboard, which opens the main workflows pop-up menu. This may vary depending on what products are installed and any task customization. Select Civil Geometry. Select <F2> from your keyboard and General Geometry from the pop-up menu. Then you can use Q, W, E, R, T, or A (corresponding to the letters to the left of the group). For example, selection of W opens the Geometry Import/Export pop-up menu.



To use the classic toolbox for any sub-group, right-click on the line and select Open '…' as Toolbox.



You can also customize which tools are displayed. Other customizing options can be found by right-clicking on the navigation groups. Customization of task navigation is outside the scope of this workshop, but you may want to experiment in your spare time or after the workshop is concluded.

Hint	If the Task dialog disappears or you accidentally close it, select Tools > Tasks from the Power product main menu bar to bring it back.

GETTING STARTED

In this section, we will review some of the tools and settings that will be used throughout the workshop. For easy accessibility, we will dock the tools within the MicroStation view.

Exercise: Open Design File and Tools

Lesson Objective:

We'll set up for Design Standards, Features, and Messages for subsequent exercises.

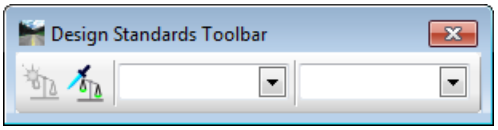
Tools Used:

General Geometry Group	Icon	Tool
		Design Standards Toolbar
		Features Toggle Bar
		Civil Message Center
MicroStation > File > Project Explorer		Project Explorer

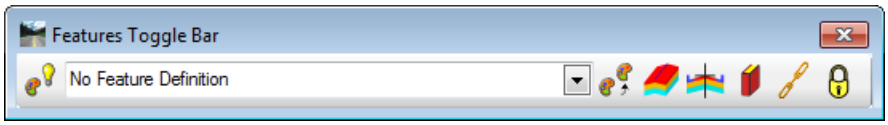
Procedure:

1. Double-click the Power InRoads or GEOPAK icon on your desktop.
2. In the lower right corner of the File Open dialog, set the **User** to *Examples*, **Project** to Bentley-Civil-Metric, and **Interface** to Bentley – Civil.
3. Navigate to the class folder as directed by the instructor, select *Start_ch1.dgn* and click **Open**.

4. Select the **Design Standards Toolbar** tool from the General Geometry group. Dock the Design Standards Toolbar on the top.

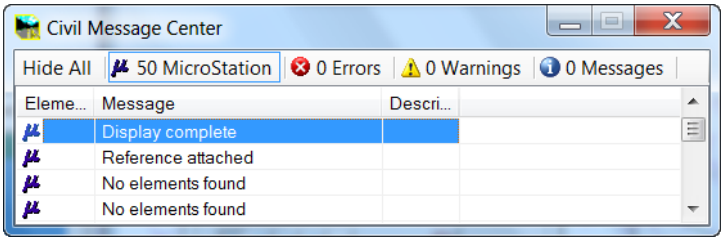


5. Verify that the **Features Toggle Bar** tool is already docked on top. If not, select it from the General Geometry group, dock and pin. Don't select any feature for now.



6. Verify that the Civil Message Center tool is already docked on the bottom. If not, select it from the General Geometry group, dock and pin.

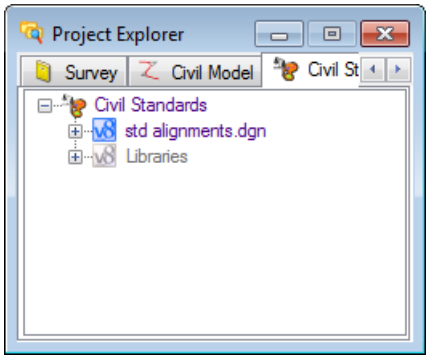
   This is for feedback on our design standards and geometry tools.



7. Verify that the Project Explorer is docked on the left side. If not, from the Power product main menu bar, select **File > Project Explorer,** dock and pin.

Hint	The Project Explorer can also be found in the Primary Tools toolbar, but is hidden by default. Right-click on the toolbar and select Project Explorer to enable access from the toolbar.

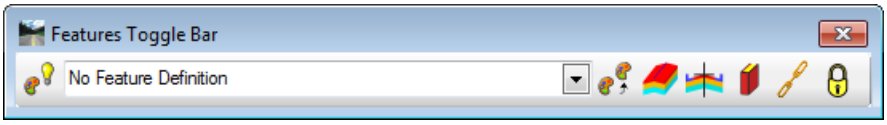
   This is for reviewing design standards and feature definitions.



Note	The tabs shown on your Project Explorer may be different from those shown in the image above. You can control what tabs are displayed by going to the Settings > Project Explorer dialog and disabling or enabling the desired tabs. The only tab we will be using in this workshop is the Civil Standards tab.

Features and Feature Definitions

In our initial set-up, we opened the Features Toggle Bar.

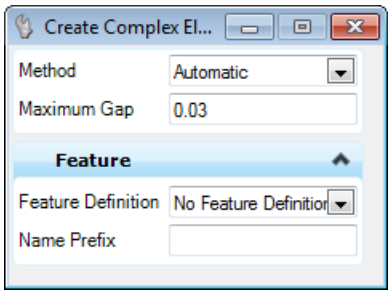


Feature definitions are used to define options when creating features. These are the items which are created in advance, usually used across multiple projects, and define symbology, annotation and quantities. The feature definition is assigned (usually) in the plan model, and optionally in profile and 3D feature definitions.

A Feature is anything that can be seen or located and is a physical part of your design, representing a real world entity. Examples include curb and gutter, pavement, power lines, trees, etc.

A feature's definition is one of its properties. At any given time in the design process, the feature will have horizontal geometry, vertical geometry, 3D geometry or a combination to define its location. Generally, the feature's definition is assigned at time of creation, but can be assigned after-the-fact.

Most Civil tools have entry fields for Feature Definition in their dialog. One example is illustrated below.



The rules applied to Feature Definitions are:

- If no Feature Definition is selected, the active MicroStation symbology is used and no feature is defined, but you can define a Name Prefix.
- If a Feature Definition is assigned, a Name Prefix is applied, and the symbology, attributes, and annotation defined in the feature definition are applied to the element.

Note	It is often useful to set the tool to "Active Feature" and then control the active feature to be used in the Features Toggle Bar. Alternatively, you can choose a specific feature directly in the tool dialog and ignore the toggle bar.

Importing Data

To begin any project, you will need some type of existing data. It may be CAD files from prior projects, survey information, or even historical paper plans. You can mix and match the type of data you have for your project. If you have no data, you can even start with a blank file.

In our project, we will use some historical data to create one of our crossing road centerlines. For another alignment, we will import our mainline alignment from another project. We will then modify the alignment to adhere to our design standards.

Exercise: Import the Existing Centerline

Objective:

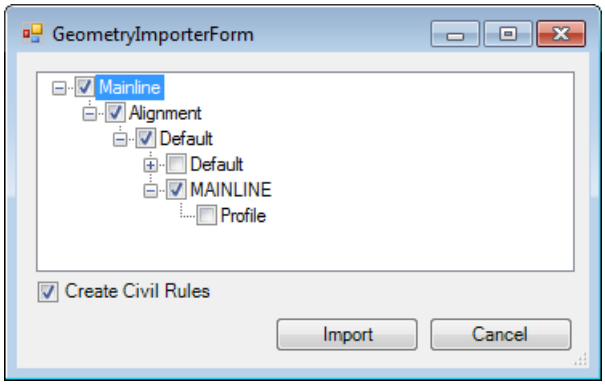
Import the mainline alignment and display in our file.

Geometry Tools Used:

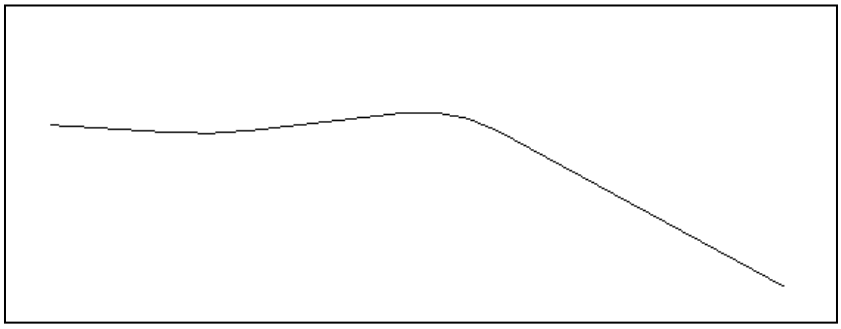
GENERAL GEOMETRY GROUP	ICON	TOOL
		Import Geometry

Procedure:

1. Continue in *Start_ch1.dgn*.
2. Select the **Import Geometry** tool.
3. Power InRoads: Select *mainline.alg* (in your project folder) and click **Open**.
4. Power GEOPAK: Select *job99.gpk* (in your project folder) and click **Open**.



5. Navigate the tree and toggle on MAINLINE. Note the upper part of the hierarchy is toggled on also. We will not import the profile in this workshop. Note your dialog may vary slightly depending on the native product being used to import.
6. Verify that **Create Civil Rules** at the bottom of the dialog is toggled ON.
7. Click **Import**.
8. Note our view is rotated so it will display in a west-to-east direction. Since we did not select a feature definition, a default feature definition or the active MicroStation symbology was used.



Imported existing mainline alignment (shown without background file)

USING HISTORICAL DATA

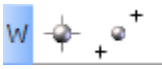
We will use some historical survey points to create the centerline for the intersecting highway. This stretch of roadway is a tangent section, so it's easy to create. We could just use the Line Between Points tool, but we want to maintain the location of the historical points. So, we'll place the points first, and then draw a civil element (line) between them.

Exercise: Create Cross-Road from Historical Data

Objective:

Create two historical points which will be displayed as triangles. Then we'll connect them with a civil geometry line. Note this alignment will be in a north-south direction and drawn in red.

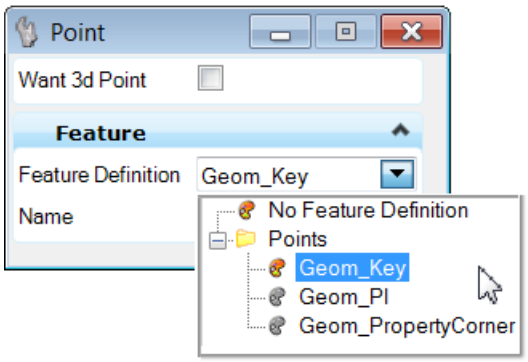
Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Point
		Line Between Points

Procedure:

1. Continue in *Start_ch1.dgn*.
2. Select the Saved View "Cross Highway."
3. Open Views 2 and 3 (which has the areas of the points in large scale for easy viewing).
4. Select **Utilities > Key-in** from the Power product main menu bar. We'll use this for the coordinate data input.

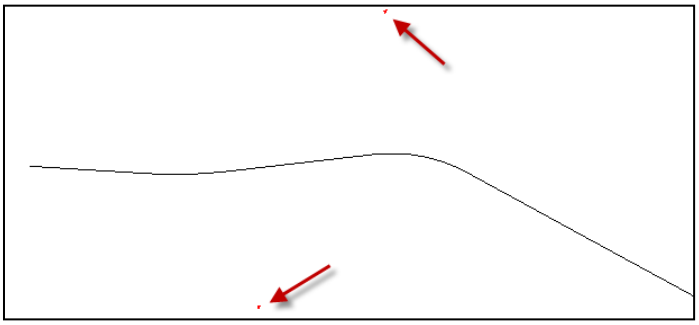
5. Select the **Point** tool.
6. Set the **Feature Definition** to Geom_Key (using the pick list). Note your list may vary from the illustration below.



7. Now we'll follow the heads-up prompts attached to the cursor to draw our points:

HEADS-UP PROMPT	USER ACTION
Enter Data Point	In the Key-in dialog opened in step 4, carefully type in: (do not space before or after the equal sign and include the comma) xy=767641.50,179118.90 <enter>
Enter Data Point	In the Key-in dialog opened in step 4, carefully type in: (do not space before or after the equal sign and include the comma) xy=767283.123,179478.032<enter>

Two orange X's are drawn into the file.



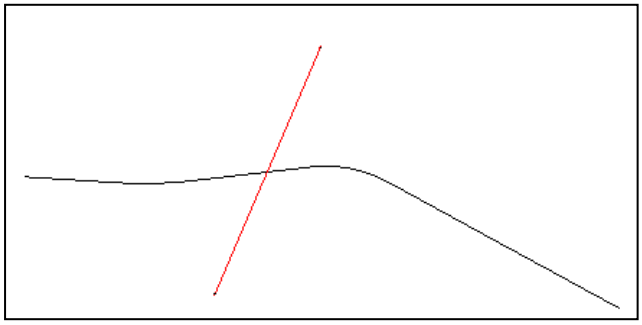
Note If the orange X's do not display, then the preference setting pointing to the correct native feature file (.XIN, .DDB, .PSS) is not set correctly.

8. Select the **Line Between Points** tool.
9. In the dialog, select the **Feature Definition** Geometry > Geom_Secondary from the pick list.

   Notice the list is different than when we defined the Points. The pick list differentiates between linear and point feature definitions.
10. Follow the heads-up prompt attached to the cursor to draw our alignment.

HEADS-UP PROMPT	USER ACTION
Enter Start Point	Select the southern point you just placed. You can zoom in and out to reach the point or use view 3.
Enter End Point	Select the northern point you just placed (using view 2 for a close-up).

11. We now have the existing cross road alignment drawn in red. If yours is another color, then you didn't set the Feature Definition correctly. Simply undo the element and place again.



Two existing alignments are now displayed

STATIONING AND STATION EQUATIONS

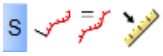
When creating an alignment, the stationing is set to zero by default. However, you may want to station your alignments or add station equations. In order to add stationing, we need to specify the station value and define the point where the station should be applied. For this workshop, we will station our cross road alignment. Please note that station equations are outside the scope of the workshop.

Optional Exercise: Adding Stationing to Cross Road Alignment

Objective:

Add initial stationing of 10+000 to our cross road alignment.

Geometry Tools Used:

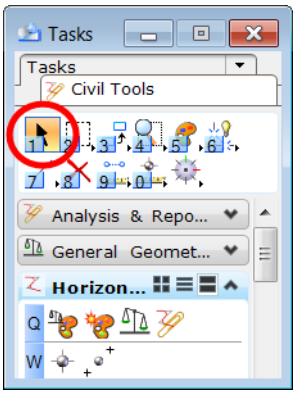
HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Start Station

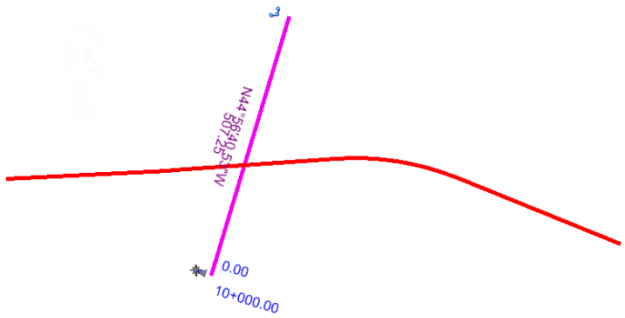
Procedure:

1. Continue in *Start_ch1.dgn*.
2. Select the **Start Station** tool.
3. As we are not drawing any elements, this dialog does not have a feature definition.
4. Now we'll follow the heads-up prompt attached to the cursor to station our alignment.

HEADS-UP PROMPT	USER ACTION
Locate Element	Select the cross road alignment near the southern end.
Start Station Position / Start Distance	Type 0 <enter>. Then data point on screen to move to the next prompt.
Enter Starting Station / Start Station	Type 10+000 <enter>. Then data point in the workspace to complete.

5. Just above the Civil Geometry group task, click on **Element Selection**. Then select the alignment. The edit manipulators and station are now displayed.





The Element Selection icon is used to select civil geometry elements and display edit manipulators.

Hint	The size and colors of the manipulators can be user-defined in the Workspace > Preferences > View Options – Civil.

CHAPTER SUMMARY

In this chapter, we have learned how to import horizontal geometry from an existing ALG file (created in Power InRoads) or GPK file (created in Power GEOPAK), and also how to manually enter points from historical data. We created a single line alignment and added stationing.

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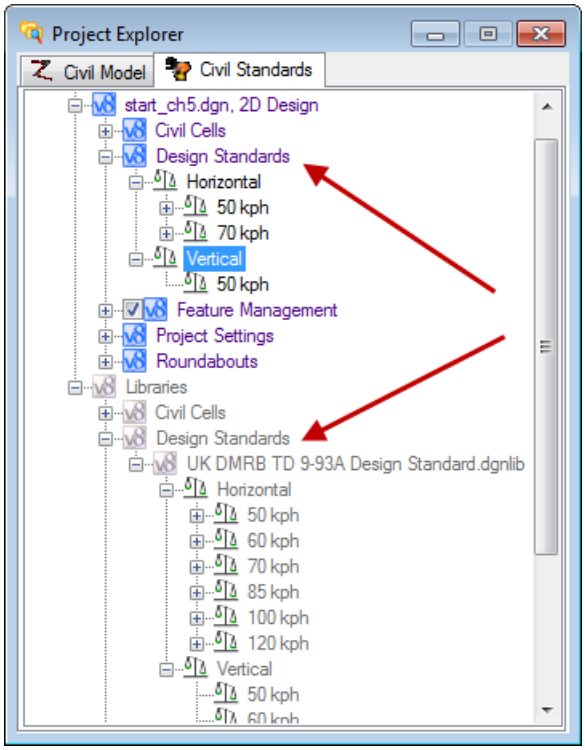
Chapter 2: Alignments and Standards

Design Standards

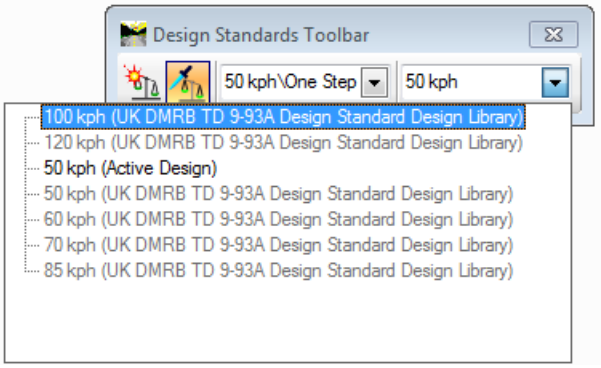
Design standards should be used throughout the design of your project. It ensures that you are meeting minimal standards, generally based on design speed. They can also be based on type of roadway, and other geometric or design characteristics.

Design standards are developed for both horizontal and vertical geometry (vertical new in Bentley Civil V8i SELECTseries 3!) and are stored in DGNLibs. Several default libraries are provided in the installation packages. They are utilized by including the file / path in your MS_ DGNLIBLIST configuration variable. An organization can modify the default libraries or create them from scratch, depending on your standards. Multiple standards can be utilized, i.e., consulting firm doing work for multiple governmental agencies who all have their own standards.

As you select a standard, it is copied from the DGNLib into your design file. Therefore, your organization can maintain the integrity of the standards by having them "read-only" in a central location, but a designer has the flexibility to override for a project-specific circumstance. The Project Explorer has one set of standards derived from DGNLibs, and another set shown for the design file.



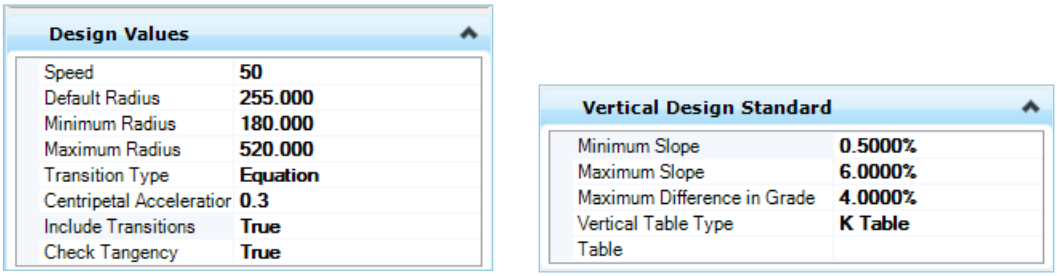
In the Design Standards Toolbar, the Active Design vs. Design Library standards is clearly marked. Either can be selected for use.



Using Design Standards

Design standards can be used to maintain required curvature and other horizontal and vertical alignment checks when performing geometric layouts. They work at two levels:

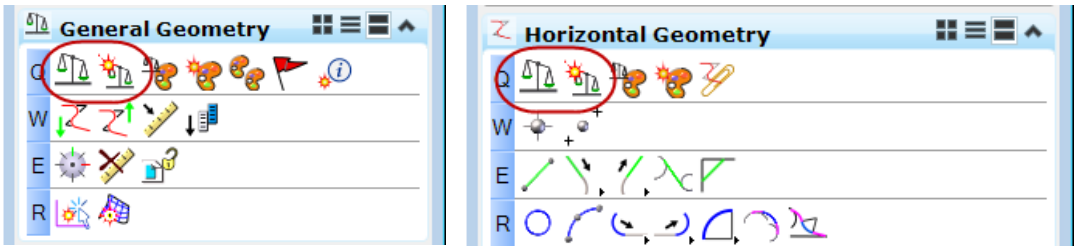
- Provide values for the element creation tools (for example, minimum radius and transition lengths in horizontal geometry, maximum slopes and K values for vertical geometry)
- Check the suitability of complex elements (for example, check for kinks in both horizontal and vertical geometry)



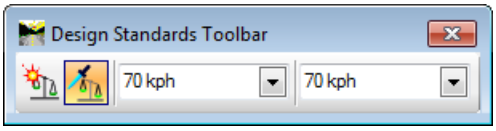
Examples of horizontal (left) and vertical (right) design standards

Design Standards Toolbar

The Design Standards Tool bar is accessible in either the General Geometry or Horizontal Geometry tool panels:



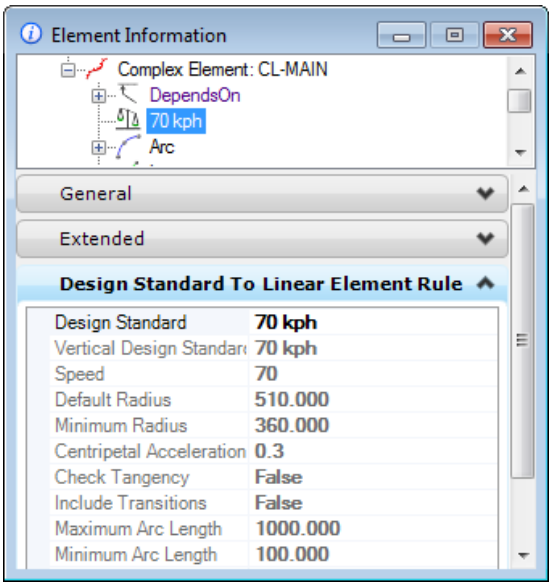
There is one icon for the Toolbar and a separate icon for the **Set Design Standard** tool, which is located on the Design Standards Toolbar.

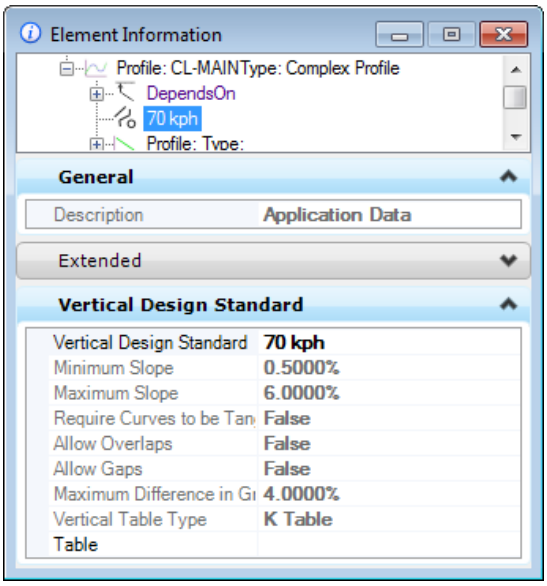


This toolbar allows you to set an active design standard subsequently used by most geometry tools. The leftmost icon is **Set Design Standard**, which can be used on previously created geometry elements.

Procedure:

1. Select the desired standard. When a horizontal standard is selected, the "linked" vertical standard is displayed by default. However, you can override by selecting a different vertical standard from the pick list.
2. Toggle on the Toggle Active Design Standard (directly left of the horizontal design speed). When on (which appears orange), all civil geometry tools will use the values contained in the standard as defaults. When off, the selected standard is ignored.
3. Create geometry elements.
4. Selecting the element and opening Element Information displays the standard and associated values.





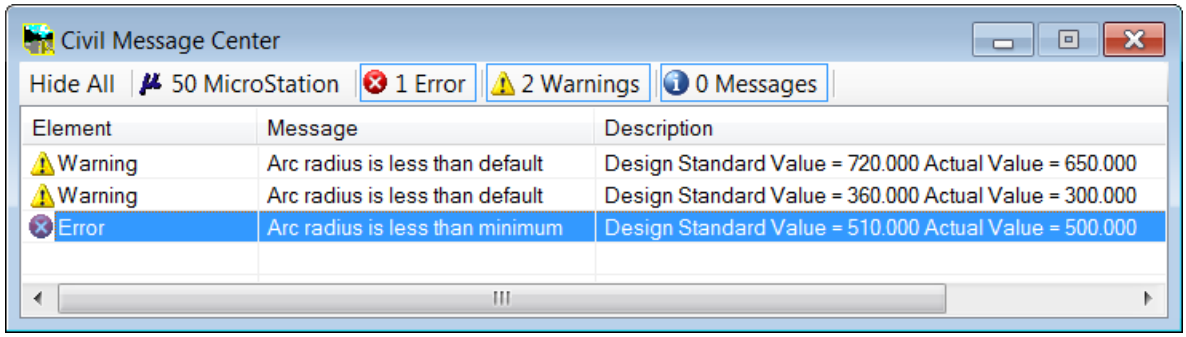
Example of Horizontal and Vertical Design Standards Within Element Information

Hint	To remove a standard from a geometry element, right-click on the standard in Element Info and select Remove Standard.

DESIGN STANDARDS FEEDBACK

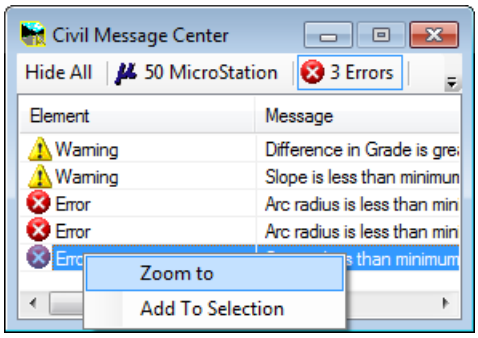
When a design standard is violated, feedback is provided in two ways:

- An icon in the graphics on the element that has the problem. Hover over the icon to reveal a tool tip report of the error.
- In the Civil Message Center.



Sample messages in the Civil Message Center

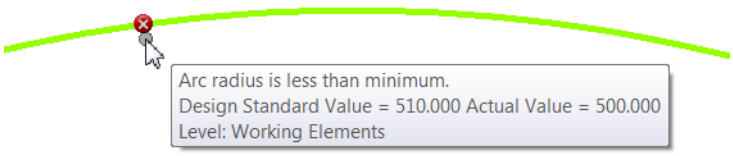
The tabs work like filters, so you can turn off / on MicroStation / Warnings / Errors as desired. To quickly find the location of a problem, right click on the Warning or Error and select Zoom To.



With the exception of the MicroStation messages, onscreen glyphs are displayed in the workspace to pinpoint the location.

Error (left) and Warning (right) Glyphs

Hovering over the glyphs displays a pop-up with the warning / error message.

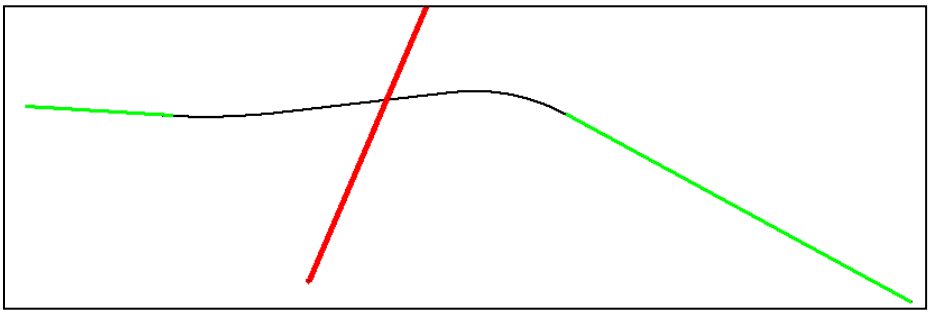


Example Pop-up Warning Message

CREATE THE NEW CENTERLINE BASED ON STANDARDS

Objective:

In this series of exercises, we will utilize the design standards and feature definitions to modify the centerline for our mainline roadway. We'll use the eastern and western tangents, then rebuild the center section with arcs and tangents. The goal is to shift the roadway to lessen the skew between mainline and the intersecting highway. This will help in the design of a full cloverleaf interchange.



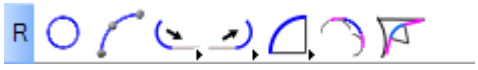
We'll utilize the green sections of our existing alignment, and rebuild the center section (in black).

Exercise: Draw a Northbound Arc from the West End Mainline

Objective:

Using the tangent from our existing alignment, we'll draw an arc heading northward. Its length doesn't matter, as we'll trim it later. We'll use our standards to define the radius of the arc.

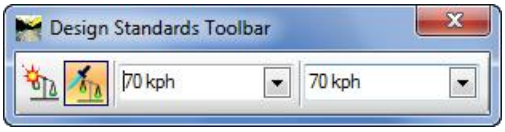
Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Simple Arc From Element

Procedure:

> ***Hint*** Remember if you don't like what is drawn, use the "Undo" tool <ctrl> - Z on your keyboard or Edit > Undo on the Power main menu bar!

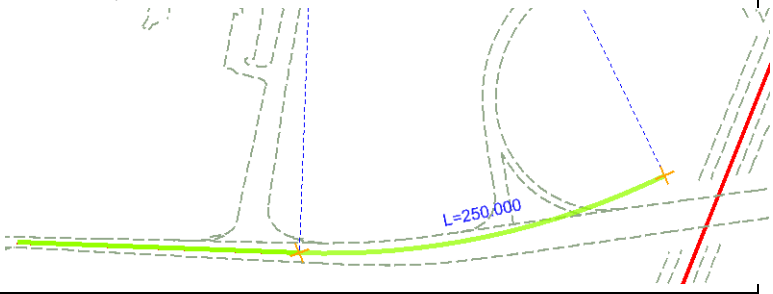
1. Open *Start_ch2.dgn*.
2. Select the **70 KPH** design standard (UK DMRB TD 9-93) from the Design Standards Toolbar. (This was docked in an earlier exercise.)



3. Toggle on the **Toggle Active Design Standard**, so it appears orange.

   Any subsequently created geometry elements will use the selected standard.

4. Select the **Simple Arc from Element** tool and follow the heads-up prompts.

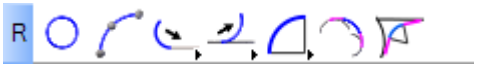
HEADS-UP PROMPT	USER ACTION
Locate Element	Select the green tangent at the west of the project.
Enter Start Point	Snap to the right end of the tangent.
Thru Point or Radius	Data point to accept the Radius of 510 (from our standards). Note the lock to the right of the value in the heads-up prompt.
Define Arc Length	Move the cursor towards the top of the screen (so arc is displayed going northward). As you move the cursor, the Arc Length is changing. Data point when the length is approximately 250m. 
Trim / Extend	Select Back (using the down arrow on your keyboard to toggle through the options) and data point to complete.

Exercise: Adding an Arc on the East End of the Project

Objective:

On the east end, we are going to add an arc starting from the existing tangent and go southward. Again, we'll use our standards for the Radius value and an approximate length. We could use the same tool as the last exercise, but our goal is to practice as many tools are possible. So, we'll use the Arc From Element in this exercise, which has a few more options than the Simple Arc From Element tool.

Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Arc From Element

Procedure:

1. Continue in *Start_ch2.dgn*.
2. Continue using **70kph** and be sure the toggle is on so it appears orange.
3. Select the **Arc from Element** tool and follow the heads-up prompts. Note this tool is accessed by clicking on the small black triangle in the lower right corner of the Arc tools and selecting from the list.

> ***Warning*** It is not the same tool as used in the previous exercise,which was the SIMPLE Arc from Element tool.

HEADS-UP PROMPT	USER ACTION
Locate Element	Select the green tangent at the east end of the project (right side of screen).
Enter Offset	Type 0 <enter>. Data point on the screen to move to the next prompt.
Enter Start Point	Snap to the left end of the tangent.
Thru Point or Radius	We'll use the 510 value from our standards, but DO NOT data point yet! Note the <=> at the right of the Radius value. This indicates additional options. Select the right arrow on your keyboard.
Back Transition Length	We'll use the 0 value for no transition. If it's not 0, change the value. You're your cursor so the angle is pointing downwards on the screen. Data point on the screen to move to the next prompt.
Define Arc Length	Move the cursor towards the bottom of the screen (so the arc is curving downwards) to see the arc dynamically displayed. As you move the cursor, the Arc Length is changing. Data point when the length is approximately 300m. 
Trim / Extend	Select Back (using the down arrow on your keyboard to toggle through the options) and data point to complete the arc and back transition.

Completed arcs

Exercise: Connect the Arcs and Complete the Alignment

Objective:

Now we need to draw the tangent to connect the curves.

Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Line Between Arcs

Procedure:

1. Continue in *start_ch2.dgn*.
2. Select the **Line Between Arcs** tool.
3. Follow the heads-up prompts to draw the line. Note we will be creating our alignment from west to east, so draw the line in that direction.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the western arc.
Start Offset	Set to 0 and data point to accept.
Locate Second Element	Select the eastern arc.
Second Offset	Set to 0 and data point to accept.
Back Transition Length	Set to 0 and data point to accept
Ahead Transition Length	Set to 0 and data point to accept
Solution	Actually, there are four solutions. Click <Alt> on your keyboard to see each solution. When the desired solution is displayed, data point to accept.
Trim / Extend	Use the down arrow on the keyboard for the Both option, then data point to complete.

Tangent is drawn between two arcs, completing our last working element.

COMPLEX ALIGNMENTS WITH FEATURE DEFINITIONS AND NAMING CONVENTIONS

Now we are going to connect all the working elements together in one alignment. At the same time, we'll use a feature definition, so we get the correct symbology, correct naming, and persist back to the ALG file.

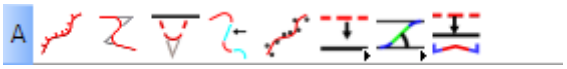
Along with the feature definition, we have a name prefix which functions like an auto numbering process. For example, the first element would be named CL; the next would be CL1, CL2, and so on. But it can also be used for absolute naming which is especially useful for alignments. So, for example, I could have entered a name prefix here of "BOB RD" and since there is no other element with that name, the alignment would be named "BOB RD". In other words, no suffix.

Exercise: Create a Complex Alignment From Elements

Objective:

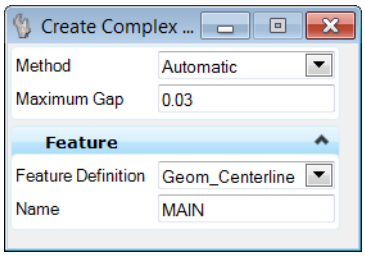
Create one alignment from our various working elements.

Geometry Tools Used:

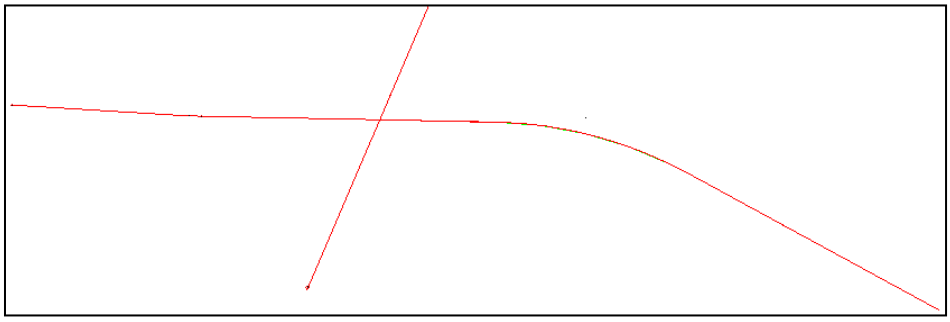
HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Complex By Elements

Procedure:

1. Continue in *start_ch2.dgn*.
2. Select the **Complex By Elements** tool to create the alignment (from left to right on the screen).
3. In the dialog, set the **Method** to Automatic and the **Maximum Gap** to 0.03.
4. Set the **Feature Definition** to Geom_Centerline and the **Name** to MAIN.

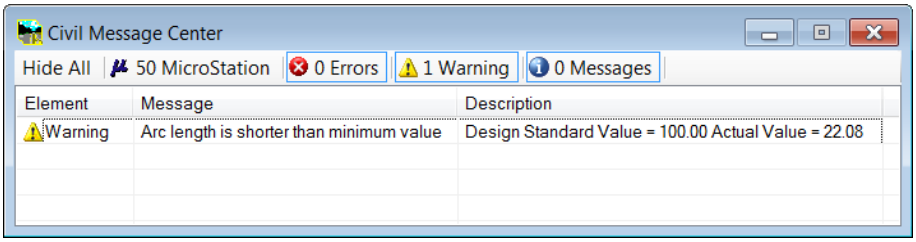


5. When prompted to Locate the First Element, select the western-most tangent, being mindful of the arrows. If the arrow is going the wrong direction, move the cursor until you get the correct direction. Data point to accept the first element, and all the rest will automatically highlight. The alignment is chained together and the symbology is changed to match the feature definition.



Mainline and cross highway alignments have been created

6. Click on the Civil Message Center which was docked in an earlier exercise.



7. To see the location of the warning, right-click over the warning symbol and select Zoom To. Once we have remedied any warning or error messages, the Message Center is updated.

Note	On your projects, you can review and determine which warnings / errors need to be addressed by redesigning / adjusting. The Messages are dynamic, so that when an alignment is changed to comply with standards, the warnings are deleted.

Exercise: Adding Stationing to Mainline Alignment

Objective:

Add initial stationing of 10+000 to our mainline alignment.

Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Start Station

Procedure:

1. Continue in *start_ch2.dgn*.
2. Select the **Start Station** tool.
3. As we are not drawing any elements, this dialog does not have a feature definition.

4. Now we'll follow the heads-up prompt attached to the cursor to draw our alignment.

HEADS-UP PROMPT	USER ACTION
Locate Element	Select the mainline alignment.
Start Station Position / Start Distance	Type 0 <enter>. Then data point on screen to move to the next prompt.
Enter Starting Station / Start Station	Type 10+000 <enter>. Then data point on the screen to complete.

5. Just above the Civil Geometry group task, click on **Element Selection**. Then select the alignment. The edit manipulators and station are now displayed.

Exercise: Reporting on the Mainline Alignment

Objective:

Create a geometry report based on the previously created alignment (MAIN).

Geometry Tools Used:

ANALYSIS AND REPORTING PANEL	ICON	TOOL
		Horizontal Geometry Report

Procedure:

1. Continue in *start_ch2.dgn*.
2. Select the **Horizontal Geometry Report** tool.
3. Now we'll follow the heads-up prompt attached to the cursor to draw our alignment.

HEADS-UP PROMPT	USER ACTION
Locate Element	Select the MAIN alignment. Reset to Complete.
Start Station	Lock to starting station. You can do this either via the dialog toggle or by using the <Alt> key on the keyboard. Data point to accept.
End Station	Lock to ending station. You can do this either via the dialog toggle or by using the <Alt> key on the keyboard. Data point to accept.
Interval	Key in 10. Data point to accept.
Select Profiles	None. Data point to accept.

4. Review the generated report as well as others in the Civil Report Browser.

SETTING FEATURES AFTER-THE-FACT

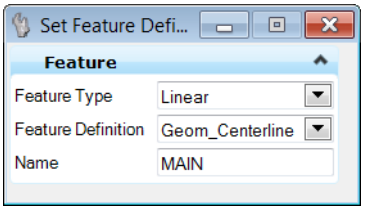
Did your alignment not change to red after creating complex from elements? Perhaps you forget to set (or incorrectly set) the Feature Definition?

No problem, there's a tool to set a Feature Definition after elements are drawn.

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Set Feature Definition

Procedure:

1. Select the **Set Feature Definition** tool.



2. Select the Feature Definition from the pick list (linear options only). Assign a name, if desired. Otherwise, a default name will be applied.
3. Select the elements to apply the Feature Definition. Multiple elements may be selected without reselecting the tool.

Setting Design Standards Features After-the-Fact

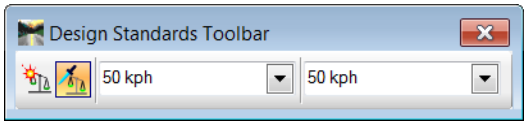
Did you forget to set (or incorrectly set) the Design Standard? Or would you like to check an existing alignment?

No problem, there's a tool to set a Design Standard after elements are drawn.

General Geometry Group	Icon	Tool
		Set Element Design Standard

Procedure:

1. In the Design Standards Toolbar, select the desired Design Standard from the pick list.



2. Select the **Set Element Design Standard** tool.
3. Select the elements to apply the Design Standard. Multiple elements may be selected without reselecting the tool.

Creating Non-Alignment Elements

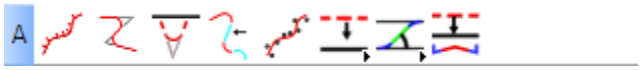
The horizontal geometry tools are used for more than just centerline alignments. In this session, we will utilize more of the horizontal tools in conjunction with feature definitions to construct the edges of pavement and shoulders for the mainline roadway. We need these in place before we develop the loop and ramp alignments.

Exercise: Construct the Edges of Pavement and Shoulders

Objective:

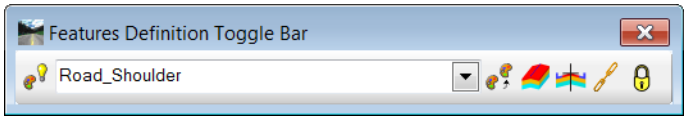
Construct edges of pavement and shoulders for both sides of the mainline alignment. We'll also use the Feature Toggle Toolbar to set the feature definition.

Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Single Offset Entire Element

Procedure:

1. Continue in *start_ch2.dgn*.
2. Disable the design standard by clicking the toggle so it no longer appears orange.
3. Set the **Feature Definition** in the Toggle Toolbar to **Linear > Roadway > Road_Shoulder** and toggle ON the **Override Feature Definition** icon directly to the left of the feature definition (shows orange when toggled on).



Hint The Features Toolbar should be docked from an earlier exercise. If it's not docked, select **Tools > Civil Geometry > Geometry Toggles > Features Definition Tool Bar** from the Power InRoads main menu bar and dock at this time.

4. Select the **Single Offset Entire Element** tool.

   On the tool dialog, note the Feature Definition is already set to Use Active Feature.
5. Now we'll follow the heads-up prompt attached to the cursor to draw our elements:

HEADS-UP PROMPT	USER ACTION
Locate Element	Select the mainline centerline.
Offset	Key in 3.5 <enter>. Note the lock symbol to the right of the offset value. Move cursor to the right side of the centerline and data point to accept the construction and create the offset element.
Mirror	Use the down arrows on your keyboard to toggle between No and Yes. Change the option to Yes and data point to accept.

Now we'll repeat the steps to draw the edges of pavement.

6. Set the Feature Toggle Toolbar to **Linear > Roadway > Road_EdgeOfPavement** and be sure the **Override Feature Definition** icon is still toggled on (orange).
7. Select the **Single Offset Entire Element** tool, if not already active.
8. Now we'll follow the heads-up prompt attached to the cursor to draw our elements:

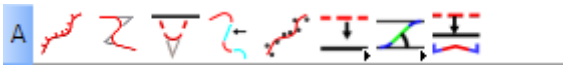
HEADS-UP PROMPT	USER ACTION
Locate Element	Select the mainline centerline.
Offset	Key in 17.4 <enter>. Note the lock symbol to the right of the offset value. Move cursor to the north side of the centerline and data point to accept the construction and create the offset element.
Mirror	Use the down arrows on your keyboard to toggle between No and Yes. Change the option to Yes and data point to accept.

Optional Exercise: Drawing Partial Element for Southern Loops

Objective:

Now we'll draw another parallel element to use for our southern loops, this time just in the area of the interchange.

Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Single Offset Partial Element

Procedure:

1. Continue in *Start_ch2.dgn*.
2. Set the Feature Toggle Toolbar to **Linear > Geometry > Geom_Ramp** be sure the **Override Feature Definition** icon is still toggled on (orange).
3. Select the **Single Offset Partial Element** tool.
4. Now we'll follow the heads-up prompt attached to the cursor to draw our elements:

HEADS-UP PROMPT	USER ACTION
Locate Element	Select the mainline centerline.
Offset	Key in 22.3 <enter>. Note the lock symbol to the right of the offset value. Note the <> to the right of the edit field. This indicates additional prompts. Press the<right arrow> on your keyboard.
Start Distance	Key in 10+200 <enter>. Move the cursor to the south side of centerline and data point.
End Distance	Key in 10+650 <enter>. Data point to complete the construction.
Mirror	No.

Non-alignment elements drawn with offset tools

EDITS AND MANIPULATION OF ELEMENTS

One advantage of placing civil elements is the ability to dynamically edit them. By selecting the element, edit manipulators are displayed. Edit fields are supported for many properties, along with graphic handlers for dynamic movement. The edit fields and handlers are based on the type of element selected and the tool used to place them.

Exercise: Edit the Pavement Widths

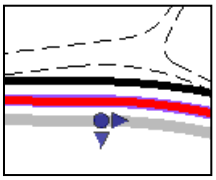
Objective:

In this lesson we will correct an error in the pavement edge calculations. Our section is 3 lanes in each direction (3.6m per lane) plus a (3.5m) median each side of centerline. So the outside edge should have been set at 14.3m not 17.4m.

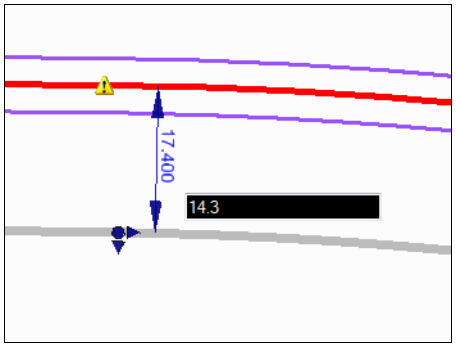
Geometry Tools Used: None.

Procedure:

1. Continue in *Start_ch2.dgn*.
2. Select one of the outside edges of pavement. Note the width drag handle at the midpoint.



3. We could drag this to set the width dynamically, but a more precise entry is needed.
4. Zoom in to the roadway (at mid-point or either end) until you also see a text manipulator for the width. Click on the text to allow changing of the value. Change the offset to 14.3m.



5. Repeat on left side with a value of -14.3m. Don't forget the minus sign, otherwise it will shift to the right side of the roadway, on top of the other edge of pavement.

Hint	If you get it wrong just undo with <CTRL> Z.

CHAPTER SUMMARY

In this chapter, we have utilized Design Standards to develop new alignments and learned how Feature Definitions affect the horizontal geometry elements. We have used the tools to develop non-alignment elements, and then manipulated them.

Chapter 3: Developing Loops

OVERVIEW

In this chapter, we will construct the inside loops. We can use the Arc Between Elements tool to construct the entire loop or ramp in one operation. In addition to spiral transitions, the tool can create arc transitions as well, which allows you to create 2-center and 3-center curves. By using the Design Standards tool, we can draw the elements to the desired design speed. We'll use our mainline and cross road alignments, and use offsets to define the starting and ending points. In that way, if we adjust the alignments, we can also update the loops or ramps.

ELEMENT SELECTION FOR COMPLEX TOOLS

Now that we are starting to build more complex elements, we need to understand the relationship between the various input fields. In this chapter, we need two alignments to fit the loop or ramp. While we can select the elements in any order, each selection has associated transition and taper options. For example, if we select our mainline alignment as our first element, the Back Taper and Transition are based on that alignment. The second selected element relates to the Ahead Transition and Taper options.

The loops have some severe constraints that will reduce the design speed of the ramps. We will develop the inside edge as the alignment, then offset for the outside edge of the loop.

Exercise: Construct The Northeast Loop Alignment

Objective: Construct the inside ramp centerline.

Geometry Tools Used:

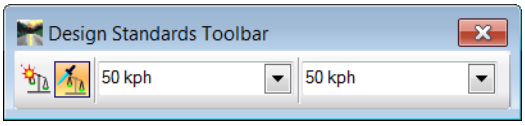
HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Arc Between Elements

Procedure:

Hint	Remember if you don't like what is drawn, use the "Undo" tool <ctrl> - Z on your keyboard or Edit > Undo on the Power InRoads main menu bar!

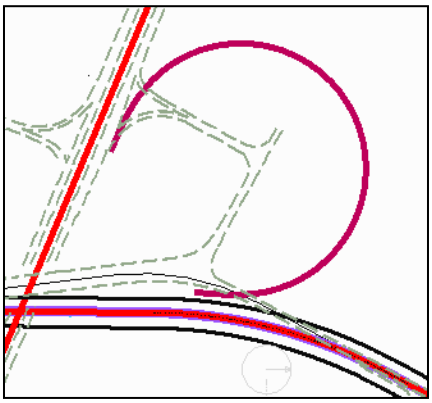
1. Open *Start_ch3.dgn*.

2. Select the **50 KPH** standard from the Design Standards Toolbar. (This was docked in an earlier exercise.) Ensure the icon to the left of 50 KPH is toggled on (indicated by the orange color).



3. Set the Feature Toggle Toolbar **Linear > Geometry > Geom_Ramp** and ensure the **Override Feature Definition** icon is still toggled on (orange).
4. Select the **Arc Between Elements** tool. (You may have to select the small black triangle to expand the tool selection list to see it.)
5. Now we'll carefully follow the heads-up prompts attached to the cursor to draw our loop:

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the cross road centerline.
Enter Back Offset	Key-in 17.6. Move to the right of the centerline and data point to accept.
Locate Second Element	Select the mainline centerline.
Enter Ahead Offset	Use the key-in to enter 22.3 and then data point to the north of the centerline to accept.
Select Construction Sector / Radius	A ramp is displayed on the screen, however, we want a loop. Click <Alt> on the keyboard to toggle between a loop and a ramp. If you are zoomed out quite a distance, you'll see a huge loop, based on our standards. Since we cannot consume that big of a footprint, change the Design Standard to One Step Below Desired Minimum at 50 KPH. (Click the + to the left of 50 KPH to display this option. Note the red loop is substantially smaller and the radius value in the dialog is now set to 127. Be sure your cursor is in the northeast quadrant so you are drawing the northeast loop and data point to complete the construction.



Completed Northeast Loop

Exercise: Construct The Northwest Loop Alignment

This loop has a smaller footprint than the northeast loop we just completed. Therefore, we will need to drop our standard one more step. Another option would be to lower the design speed. We will develop the inside edge as the alignment, then later we can offset for the outside edge of the loop.

Objective: Construct the inside ramp centerline.

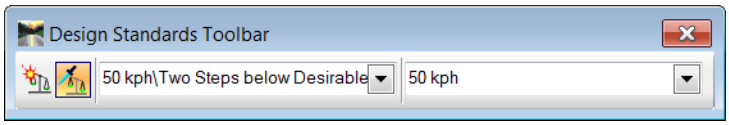
Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Arc Between Elements

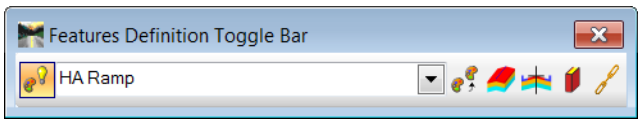
Procedure:

> ***Hint*** Remember if you don't like what is drawn, use the "Undo" tool <ctrl> Z on your keyboard or Edit > Undo on the Power InRoads main menu bar!

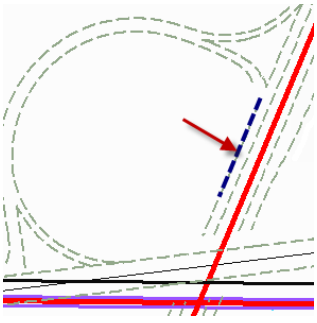
1. Continue in *start_ch3.dgn*.
2. Select the **50 KPH\Two Steps below Desirable Minimum at 50 KPH** design standard from the Design Standards Toolbar and ensure the icon to the left of 50 KPH is toggled on (indicated by the orange color).

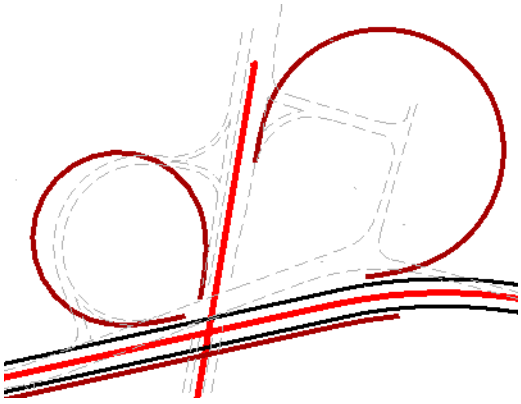


3. Verify the Feature Toggle Toolbar is still set to **Linear > Geometry > Geom_Ramp** and ensure the **Override Feature Definition** icon is still toggled on (orange).



4. Select the **Arc Between Elements** tool.
5. Now we'll carefully follow the heads-up prompts attached to the cursor to draw our loop:

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the cross road centerline.
Enter Start Offset	Snap to the existing edge of pavement to the left side of the centerline, then data point to accept.  However, we could have entered 15m rather than selecting graphically.
Locate Second Element	Select the mainline centerline.
Second Offset	In this case, it's the same as the previous loop, -22.3m. Move the cursor to the north of the mainline alignment and data point to accept.
Select Construction Sector / Radius	Move the cursor into the northwest quadrant to see the northwest loop. Note our radius is different than the northeast ramp, since we changed our Design Standards. It should be a smaller footprint than our northeast loop. Data point to accept.



Completed Northeast and Northwest Loops

EDITS AND MANIPULATION OF ELEMENTS

As we saw in the last session, an advantage of placing civil elements is the ability to dynamically edit them. This is also true of complex elements, such as the loops we just developed.

Optional Exercise: Edit the Northeast Loop

Objective:

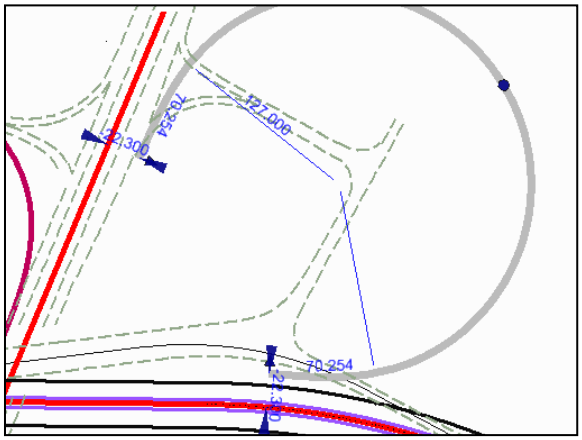
We will review the edit manipulators and handlers for the loop.

Geometry Tools Used:

None.

Procedure:

1. Zoom into the northeast loop so it fills the screen.
2. Select the loop (using the element selector).



3. We can edit the offsets, radii, or transition lengths. Experiment by changing the values and see the dynamic updating.

DEVELOPING THE SOUTHWEST LOOP

For this alignment, we will once again use the Design Standards. However, we will combine it with the Spiral Curve Spiral tool. In this case, the tool does not have the option for offsets, so we need to select the actual elements.

Optional Exercise: Develop the Southwest Loop

Objective:

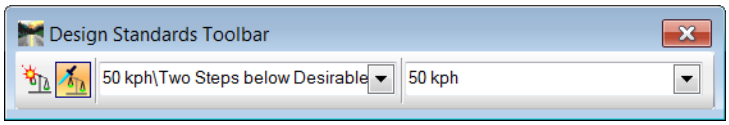
Construct the inside ramp centerline.

Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Spiral Arc Spiral

Procedure:

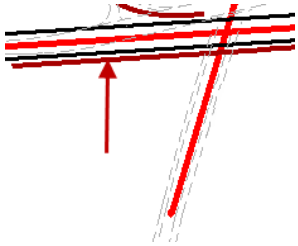
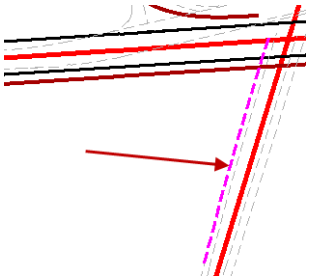
1. Continue in *start_ch3.dgn*.
2. Select the **50 KPH\Two Steps below Desirable Minimum at 50 KPH** design standard from the Design Standards Toolbar. Ensure the icon to the left is toggled on (indicated by the orange color).

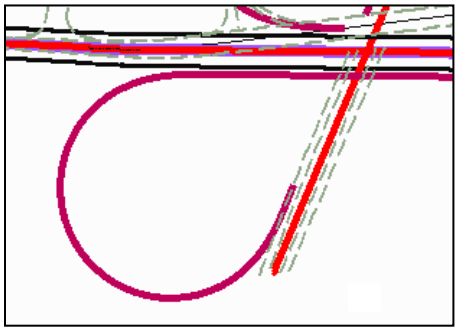


3. Verify the Feature Toggle Toolbar is still set to **Linear > Geometry > Geom_Ramp** and ensure the **Override Feature Definition** icon is still toggled on (orange).

4. Select the **Spiral Arc Spiral** tool.

5. Now we'll carefully follow the heads-up prompts attached to the cursor to draw our loop using the illustrations as a selection guide:

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the east-west element that we created earlier. 
Locate Second Element	Select the outside existing edge of pavement of the cross road. 
Select Construction Sector / Radius	First, note your MicroStation prompt includes <ALT> Loop, so click the <ALT> key on your keyboard. This toggles from loop to ramp. Move the cursor to see the southwest loop. The Radius is displayed. However, we don't have to use Radius as our input. In the heads-up prompt, type d55 <enter>. The Radius field in the dialog changes to the degree input and the loop changes dynamically. Data point to accept.
Trim / Extend Option	Set to Back and data point to accept the construction.



Completed Southwest Loop

DEVELOPING THE SOUTHEAST LOOP

For this alignment, we will once again use the Design Standards. However, we'll combine it with the 3 Center Curve tool. In this case, the tool does not have the option for offsets, so we need to select the actual elements.

Optional Exercise: Develop the Southeast Loop

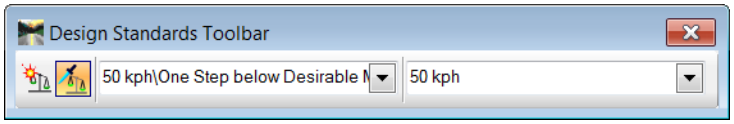
Objective:

Construct the inside ramp centerline.

Geometry Tools Used:

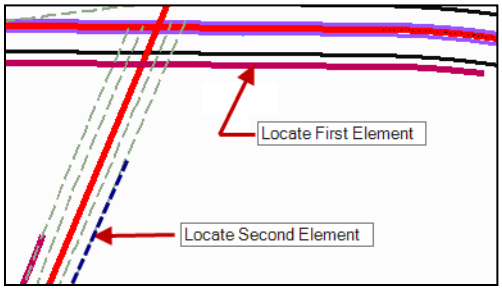
HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		3 Center Arc

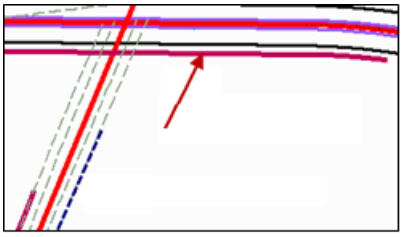
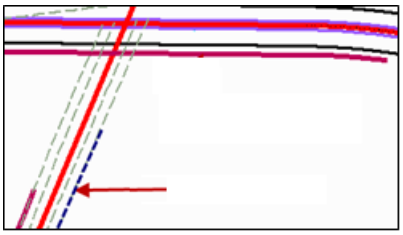
1. Use the **50 KPH\One Step below Desirable Minimum at 50 KPH** design standard from the Design Standards Toolbar. Ensure the icon to the left of 50 KPH is toggled on (indicated by the orange color).

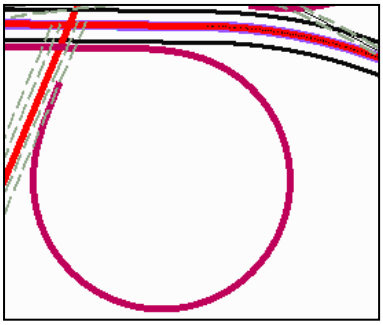


2. Verify the Feature Toggle Toolbar is still set to **Linear > Geometry > Geom_Ramp** and ensure the **Override Feature Definition** icon is still toggled on (orange).

3. Select the **3 Center Arc** tool.
4. Now we'll carefully follow the heads-up prompts attached to the cursor to draw our loop using the illustrations as selection guides.



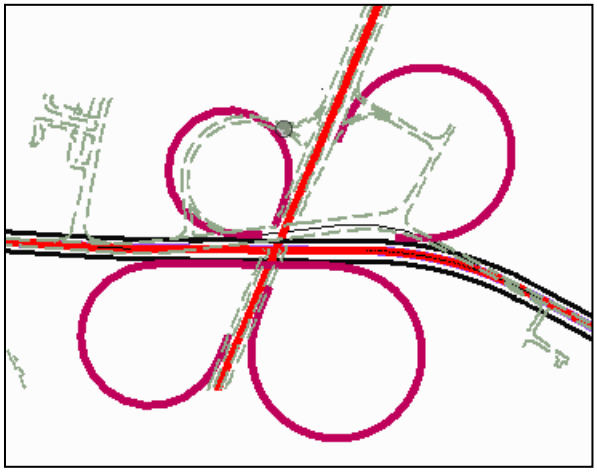
HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the east-west element. 
Locate Second Element	Select the edge of the cross road. 
Select Construction Sector / Radius	Enter <ALT> from your keyboard to toggle to a loop. Move the cursor to see the southeast loop. Use the arrow keys (<>) to move to see the options for Back and Ahead Transitions.
Select Construction Sector / Back and Ahead Transition Lengths	Set the Back and Ahead Transition Lengths to 100. Don't forget to enter after your value to lock it in. When all fields are set, data point to accept.
Trim / Extend Option	Set to Back and data point to accept the construction.



Completed Southeast Loop

CHAPTER SUMMARY

In this chapter, we have utilized the Complex Arcs tool in conjunction with Design Standards to develop new loop alignments. We used a new Feature Definitions to distinguish the loop alignments from the mainline. We also reviewed the element manipulator and edit fields.



Four completed loops

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Chapter 4: Developing Ramps

Overview

Now that we have completed the loops, we can begin work on the ramps. There are a variety of ways to develop the ramps, and numerous different ways (and tools) to accomplish it. Keep in mind that we are demonstrating the tool usage, as we can't design the entire interchange in one short workshop.

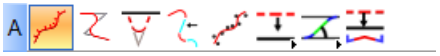
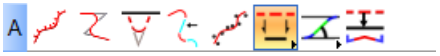
Construct the Northeast Ramp

Exercise: Construct the Northeast Ramp

Objective:

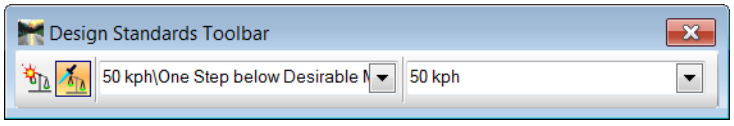
Construct the inside ramp centerline of the northeast ramp.

Geometry Tools Used:

Horizontal Geometry Group	Icon	Tool
		Arc Between Elements
		Complex By Elements
		Single Offset Partial Element

Procedure:

1. Open the file *Start_ch4.dgn*.
2. Use the **50 KPH\One Step below Desirable Minimum at 50 KPH** design standard from the Design Standards Toolbar. Ensure the icon to the left is toggled on (indicated by the orange color).

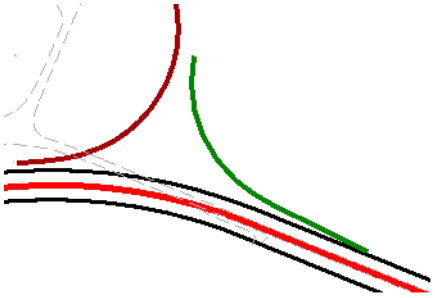


3. Set the Feature Toggle Toolbar to No Feature Definition and turn off the Feature Toggle Override. We'll build the elements and when we connect them, we'll assign a feature definition at that time.
4. Select the **Arc Between Elements** tool.
5. At the top of the dialog, toggle off **Loop**. Note the Radius and Transition fields are populated with our Design Standard.

6. Now let's enter some of our taper information into the dialog.

FIELD	VALUE
Back Taper section	
Method	Ratio-Offset
Offset	5
Ratio	1:15
Back Transition section	
Geometry	Spiral
Method	Length
Length	70.25 (set by standard)
Ahead Taper	
Method	None
Ahead Transition	
Type	None

7. Now we'll carefully follow the heads-up prompts attached to the cursor.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the mainline element.
Enter Back Offset	17.9m. Data point to the north of the alignment to accept.
Locate Second Element	Select the loop alignment.
Enter Ahead Offset	17.6m. Data point to the outside of the alignment to accept.
Select Construction Sector / Radius	Move the cursor to see the ramp. The Radius is displayed from our standard. Data point to accept. 
Trim Options	Set to None and data point to accept.

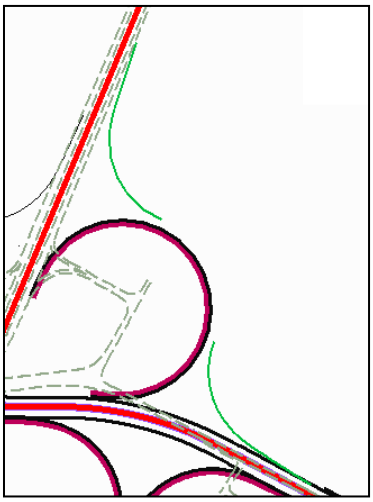
Now we'll repeat the process to get the section of the alignment between the cross road alignment and the ramp.

8. Select the **Arc Between Elements** tool again.
9. We need to change a few entries in the dialog. Be sure the Ahead Taper and Ahead Transition sections are set to None.

FIELD	VALUE
Back Taper section	
Method	Ratio-Offset
Offset	5
Ratio	1:50

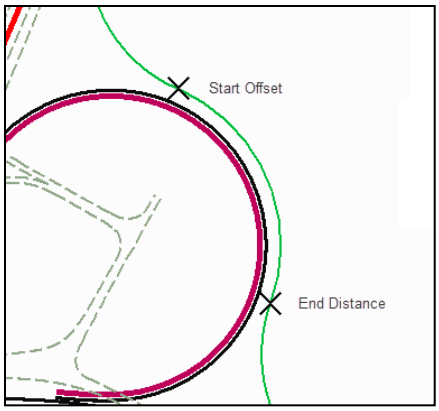
10. Now we'll carefully follow the heads-up prompts attached to the cursor.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the existing edge of pavement on the cross road.
Enter Back Offset	0. Data point to the right of the road to accept.
Locate Second Element	Select the loop alignment.
Enter Ahead Offset	-17.6m. Data point to the outside of the alignment to accept.
Select Construction Sector / Radius	Move the cursor to see the ramp. The Radius is displayed from our standard. Data point to accept.
Trim Options	Set to None and data point to accept.



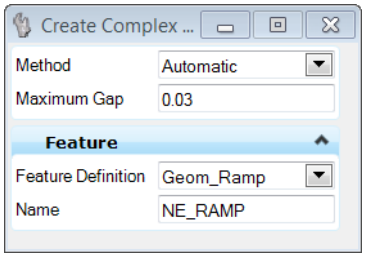
Two segments of the northeast ramp

11. Select the **Single Offset Partial Element** tool.
12. Now we'll carefully follow the heads-up prompts attached to the cursor, based on the illustration below.

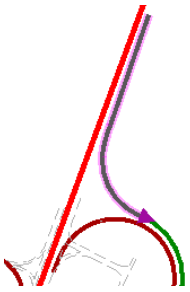


HEADS-UP PROMPT	USER ACTION
Locate Element	Select the northeast loop centerline.
Start Parameters Offset	Snap to the end of the working element we just drew that is connected to the cross highway. Note if the offset is locked you can hit the <End> key to unlock.
End Distance	Snap to the end of the working element we created connecting to the mainline alignment.
Mirror	No.

13. Select the **Complex By Elements** tool to create the alignment (from the cross road alignment to the mainline alignment).
14. In the dialog, set the **Method** to Automatic. Set the **Maximum Gap** to 0.03. We also want to set our **Feature Definition** to **HA Ramp** and set the **Name Prefix** to NE_Ramp.



15. Follow the heads-up prompts, using the green working elements we just created.

HEADS-UP PROMPT	USER ACTION
Locate Element	Select the northeast ramp as shown in the image. Watch that the arrow is pointing in the correct direction. Data point to accept. 
Accept Complex	Once the entire ramp has changed color, data point to accept.

Completed Northeast quadrant – loop and ramp

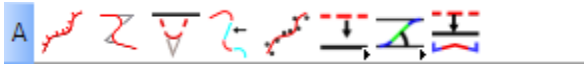
CREATE THE NORTHWEST RAMP

In order to fit the ramp in between the loop and a nearby frontage road, we are going to develop the alignment using the curve points of intersection (P.I.) along with our Design Standards. Then we can dynamically modify to fit our design.

Optional Exercise: Create the Northwest Ramp

In this exercise, we'll use 5 points to create our alignment. Since we are not using Design Standards, we'll need to populate the curve and transition data.

Geometry Tools Used:

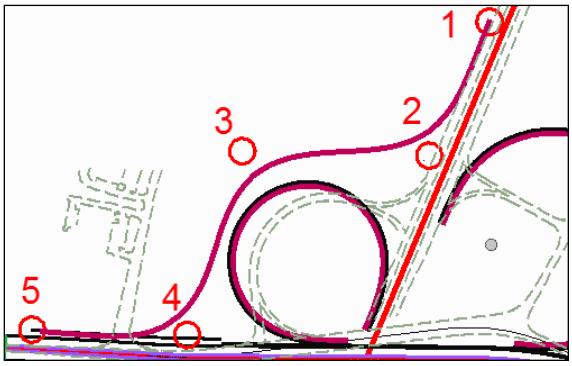
HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Complex by PI

Procedure:

1. Continue in *start_ch4.dgn* and select the Saved View "NW Ramp."
2. Set the Feature Toggle Toolbar **Linear > Geometry > Geom_Ramp** and ensure the **Override Feature Definition** icon is toggled on (orange).

3. Turn off the Design Standard by disabling the icon.
4. Select the **Complex by PI** tool.

5. Follow the heads-up prompts, using the illustration as guidance. Blue triangles have been placed in the file representing the desired locations of the 5 PI locations.



Five points used as P.I. for northwest ramp.

HEADS-UP PROMPT	USER ACTION
Enter First P.I.	Place the point on the edge of the existing cross highway. Note we could also have built a taper first and used that as our starting point, as the P.I. tool does not have offset options.
Enter Next P.I. / Radius	Place the point, still on the edge of the existing cross highway. Enter a Radius of 90 <enter>, then right arrow and set the Back Transition Length to 0, right arrow and set the Ahead Tangent Length to 0. Data point to accept.
Enter Next P.I. / Radius	Place the third data point to the north of the loop ramp. Note the Radius and Lengths values remain set, so we just have to data point our way through the points.
Enter Next P.I. / Radius	Place the fourth and fifth data points as shown in the image. Once the 5th point is placed, reset to complete.

6. If you don't like the placement, select the element, and dynamically adjust or change the edit fields.
7. Using the methods you've learned previously, station the alignment and report on it.

CREATE THE SOUTHWEST RAMP

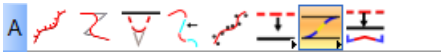
We are going to use a variety of tools for this area. First, we need to realign the southern access so it is perpendicular to the mainline. Then we'll modify the roadway from two way to one way to provide an entrance to the cross highway. This will set us up to realign the access road on the north side of mainline.

Optional Exercise: Create the Southwest Ramp

Objective:

First, we're going to realign the road to the west of the southwest loop. We'll use this for both the southwest loop, and as a new intersection for the access road to the north. We want to be sure it's perpendicular to the mainline alignment. We'll use the Line to Element tool, but we could also use the Line by Points in conjunction with a Perpendicular snap.

Geometry Tools Used:

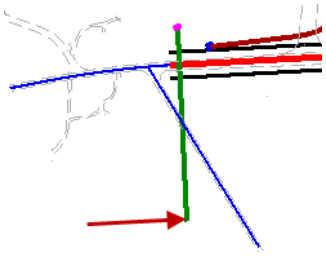
HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Line To Element
		Reverse Curve by Tangent

Procedure:

1. Continue in the file *start_ch4.dgn* and select the Saved View "Southwest Ramp."
2. We won't use any feature definitions for the first steps, so set the Features Toggle Bar to **No Feature Definition**.
3. Select the **Line To Element** tool.
4. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
End Point	We'll place a point on the north side of mainline. Note there is a pink triangle to give you an approximate location.
Locate Element	Select the mainline alignment.
Offset	Use 175m so it intersects the existing alignment and we have some line length to work with later. Data point to accept.
Skew	Use 90. (No need to type the minutes and seconds.) Data point to accept.
Start Distance	0
Select Solution	DP to accept.
Trim/Extend	DP to accept.

5. Set the Design Standard to **50 kph/Two Steps below Desirable Minimum** and toggle on the standard.
6. Select the **Reverse Curve by Tangent** tool.
7. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the working line we just created.
Enter Start Point	Snap to the bottom of the working line. 
Locate Second Element	Select the outside left edge of pavement on the cross road alignment.
Linear Transition Length	Set to 175m and enter.
Start Point	Move the cursor near the original start point until the reverse curves fit, without overlapping the southwest loop. Moving the cursor to the right – left changes the shape of the curves. Data point when you're satisfied with the layout.
Trim / Extend	Back

8. We could use the Complex By Elements tool to connect the working element with the reverse curves. However, we want to use that same element on the north side, so we'll wait to finish up connecting the ramp alignment at that time.

CREATE THE SOUTHEAST RAMP

We are going to use the Taper Arc Taper tool for this ramp. However, the tool does not support offsets, so we have offset the southeast loop for the minimum distance between the two roadways and the mainline to account for the exit ramp. The Offset Partial Element tool was used to create these working elements.

Optional Exercise: Create the Southeast Ramp

Objective:

Create the two segments of the southeast ramp that will be combined with an offset loop segment to create the entire ramp alignment.

Geometry Tools Used:

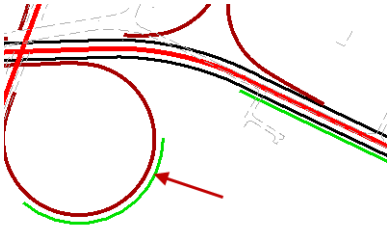
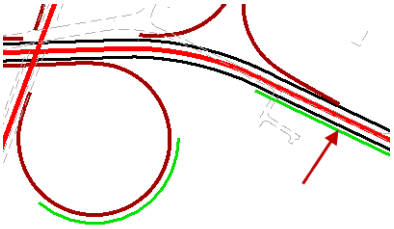
HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Taper Arc Taper

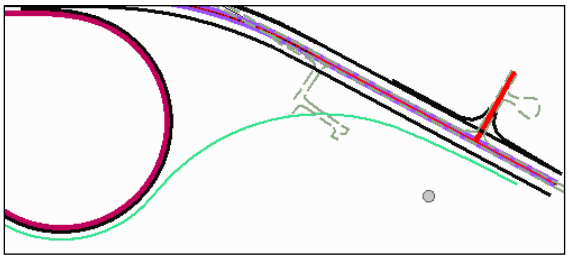
Procedure:

1. Continue in the file *start_ch4.dgn* and select the Saved View "SE Ramp-1".
2. We won't use any feature definitions, so set the Features Toggle Bar to **No Feature Definition**.
3. Set the Design Speed to **50 kph** and enable it.
4. Select the **Taper Arc Taper** tool.
5. In the dialog, set the following:

FIELD	VALUE
Back Taper Method	None
Ahead Taper Method	Ratio-offset
Offset	5 (width of the ramp)
Ratio	1:15 (to fit within our project limits)

6. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the working element offset from the southeast loop. 
Locate Second Element	Select the working element offset from the mainline alignment. 
Select Construction Sector / Radius	The Radius should be set to 255m from our Design Standard. Do NOT data point yet! View the curve and ensure the taper is within project limits, then data point to accept.
Trim / Extend	Both.



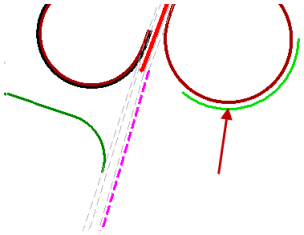
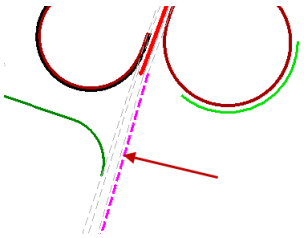
Completed segment of southeast ramp

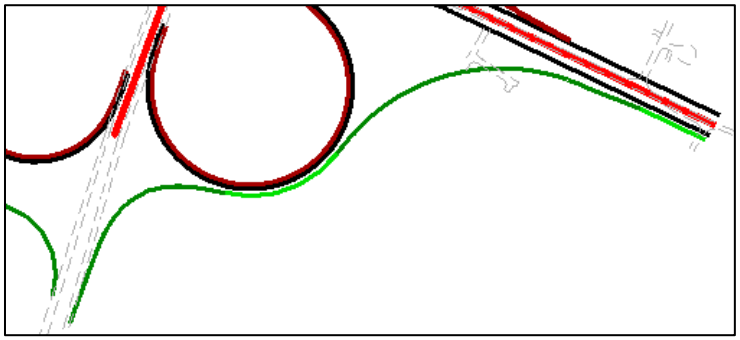
Now we'll use the same tool and process to add the segment from the cross highway to the loop.

7. As we have limited project limits on the cross road alignment, set the Design Speed to **50 kph\ Two Steps below Desirable Minimum at 50 kph**.
8. Select the Saved View "SE Ramp-2."
9. Select the **Taper Arc Taper** tool.
10. Verify the dialog is still set:

FIELD	VALUE
Back Taper Method	None
Ahead Taper Method	Ratio-offset
Offset	5 (width of the ramp)
Ratio	1:15 (to fit within our project limits)

11. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the working element offset from the southeast loop. 
Locate Second Element	Select the outside existing edge of pavement of the cross road alignment. 
Select Construction Sector / Radius	The Radius should be set to 90m from our Design Standard. Data point to accept the construction..
Trim / Extend	Back.

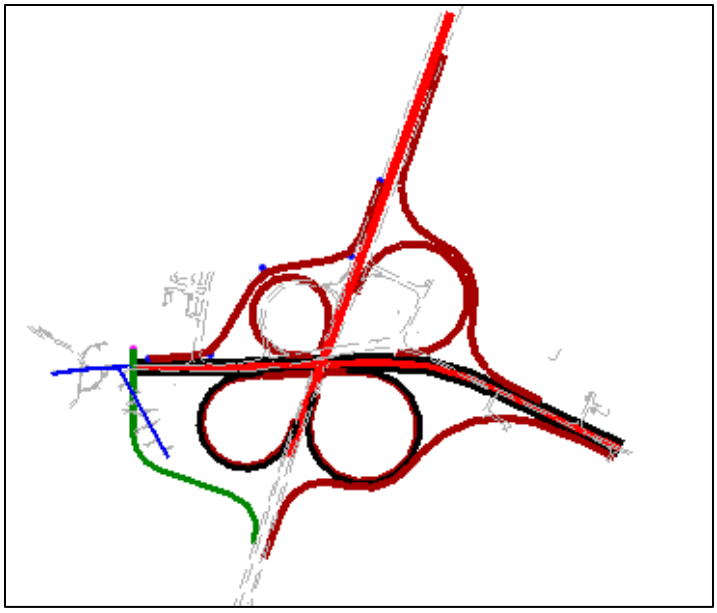


Completed segments of southeast ramp

12. Using the methods you've learned previously, create an alignment, station and report on it.

CHAPTER SUMMARY

In this chapter, we have learned more tools in horizontal geometry, specifically working with complex-type alignments.



Completed Project Illustrating Loops and Ramps

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Chapter 5: Final Clean-up

Overview

Now that we have the mainline, loops and ramp alignments complete, there's still a lot of work to be done. We can add more edges of pavement and shoulders with the Offset tools. We can add tapers and gore areas to complete the plan drawings. Many of these are done using the same tools we have already been working with in previous chapters.

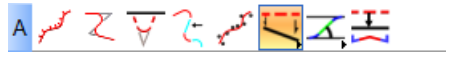
Before we tackle those tasks, we have a few access roads to redesign, and a few more tools to try using!

Realign the Northeastern Side Road

We'll start by using a separate turnout lane (3.6m). This has already been drawn using the Single Offset Partial tool. Next we'll establish the centerline for the existing roadway. Then we'll add the fillets and tapers.

Exercise: Readjust Northeastern Side Road

Geometry Tools Used:

Horizontal Geometry Group	Icon	Tool
		Line From Element
		Line To Element
		Simple Arc
		Variable Offset Taper

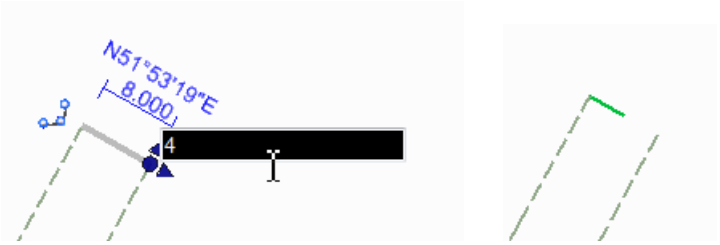
Procedure:

1. Open the file *start_ch5.dgn.*
2. Use the Saved View "Northeastern Side Road."
3. We won't use any feature definitions for these first few steps, so set the **Features Toggle Bar** to **No Feature Definition**.

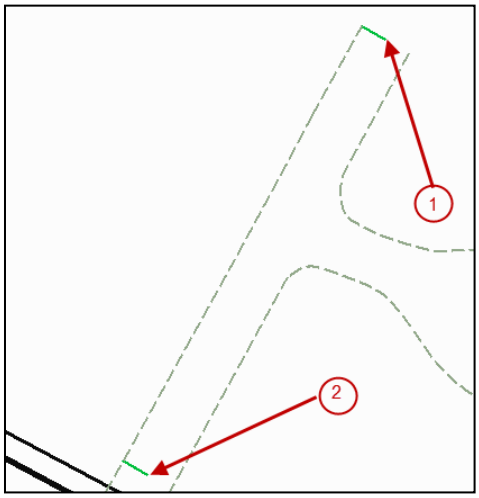
4. Select the **Line From Element** tool. We're going to use it twice to establish two points on the existing centerline.

HEADS-UP PROMPT	USER ACTION
Locate	Select the left edge of pavement of the road.
Enter Offset	0 and data point to accept.
Enter Start Point	Snap to the north end of the edge of pavement.
Enter Skew	Key in 90 <enter>, then right arrow on your keyboard to Start Distance, which you set to 0. Data point to accept and move to the next prompt.
Enter End Distance	Snap to the other side of the roadway.
Trim	Set to Back and data point to accept.

5. Select the element you just drew, which displays the edit manipulators. One edit field is the length of the line. Change the edit field from 8 to 4.0 (be sure to <enter> on the keyboard after typing in the value). The line is now half as long so its endpoint is the center of the existing roadway.



6. Repeat the process again so we have two centerline points of reference.



7. Select the **Line To Element** tool.
8. Set the **Feature Definition** to Geom_Secondary.

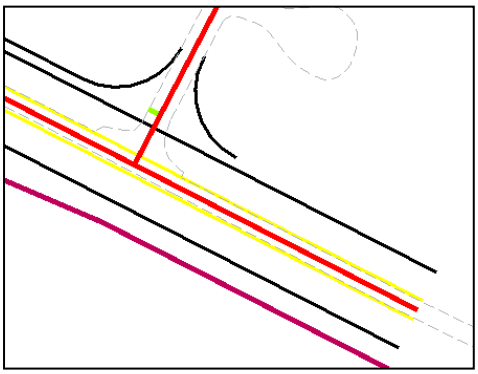
9. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Enter End Point	Snap to the green working element (labeled point 1) at the north end of the roadway.
Locate Element	Select the mainline alignment.
Offset	0
Skew	Snap to the other working element (labeled point 2) we created. If the skew is locked, then press the <End> key on the keyboard to unlock it.
Start Distance	0, then data point to accept.
Select Solution	Select Solution 1.
Trim/Extend	None.

10. Select the **Simple Arc** tool.
11. Set the **Feature Definition** to Road_EdgeofPavement.
12. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the existing edge of pavement.
Locate Second Element	Select the working element which is the edge of the new turnout lane.
Enter Through Point / Radius	25
Trim	Set to Both, as it will not trim the existing pavement (as it's in a reference file).

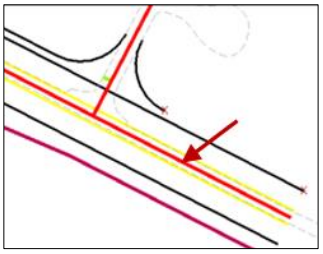
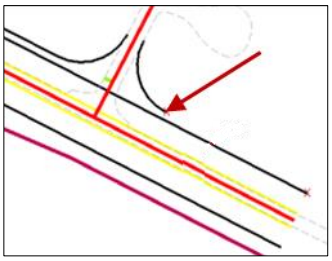
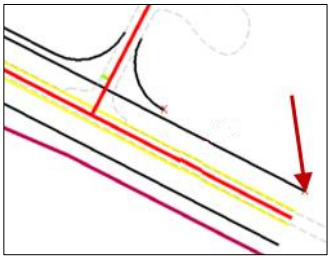
13. Repeat for other radius, but this time set the **Trim** to None.



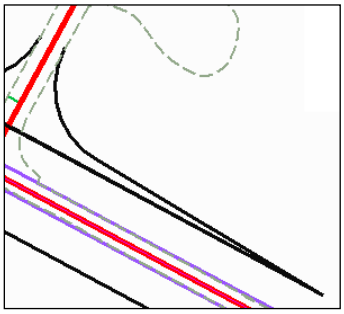
Completed side road

14. To add the taper to the turnout, select the **Variable Offset Taper** tool.
15. Set the **Feature** to Road_EdgeOfPavement.

16. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate Element	Select the mainline alignment. 
Start Offset	Snap to the end of the side road radius. 
End Offset	Snap to the edge of the mainline at the end of the project. 
Mirror	No. Data point to accept.

17. Final clean-up, striping, etc. can be done at the user's discretion.



Completed taper for turnout

REROUTE THE NORTHWEST ACCESS / FRONTAGE ROAD

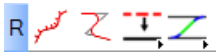
The expanded interchange, and in particular the northwest ramp, have cut off access from the northwest community. A safety issue is the number of accesses onto the main highway, so it is desirable to minimize the number, and make them normal to the mainline highway. Therefore, the original northwest access will be closed, and the road re-routed to the new intersection slightly to the west of the old location. Finally, it's combined into an intersection with the southwest ramp.

Exercise: Rework the Northwest Access / Frontage Road

Objective:

Create the segments of the northwest frontage road that uses the same intersection as the southwest ramp.

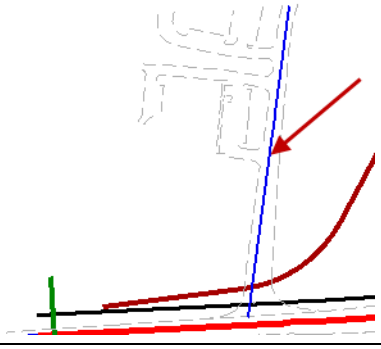
Geometry Tools Used:

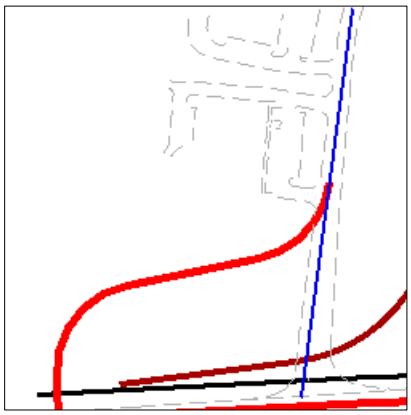
HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Reverse Transition

Procedure:

1. Continue in the file *start_ch5.dgn.* Select the Saved View "Northwestern Access."
2. Toggle off the Design Speed Standard.
3. Select the **Reverse Transition** tool.
4. Set the **Feature** to **Geom_Ramp**.

5. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the existing frontage road at the northern end. 
Enter Start Offset	0; Data point to accept.
Locate Second Element	Select the southwest ramp alignment. 
Offset	0; Data point to accept.
Define Length	Right arrow through the prompts. Set the Back and Ahead Radius to 90. Set the Length around 75. Data point to accept. Then move the cursor until you have a reasonable set of reverse curves and do not encroach upon the mainline pavement.
Enter Start Point	This slides the curves along the existing frontage road. Data point to accept. 
Trim / Extend	Ahead



Completed Northwest Access / Frontage Road

6. Using the methods you learned previously, store the southwest ramp alignment, station and report on it.

SET UP WIDENING AT BEGINNING OF PROJECT

The beginning of the project, the existing highway is two lane, and we are widening into a four lane roadway. Reverse curves are an excellent method for widening tasks, so we'll use the Reverse Curve by Radii Ratio twice, once on the north side of mainline, once on the south side. Then we can complete the intersection by adding the corner radii.

Exercise: Widening Roadway

Objective:

Add and edge of pavement edge to each side of the mainline roadway to account for widening from two lanes to four lanes.

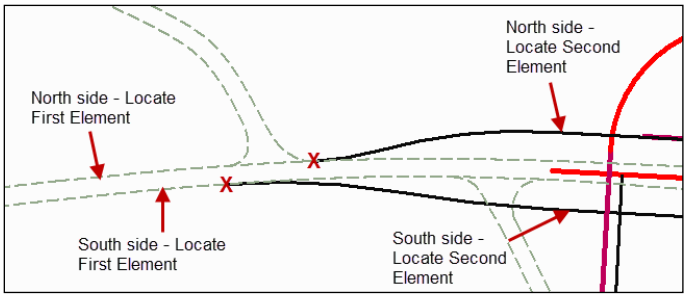
Geometry Tools Used:

HORIZONTAL GEOMETRY GROUP	ICON	TOOL
		Reverse Curve by Radii Ratio

Procedure:

1. Continue in the file *start_ch5.dgn.* Select the Saved View "Widening."
2. Toggle off the Design Speed Standard, as we are not designing alignments.
3. Select the **Reverse Curve by Radii Ratio** tool.
4. Set the **Feature Definition** to **Road_EdgeOfPavement**.
5. In the dialog, set the **Radius Ratio** to 2:1 and lock by toggling on the box to the left of each field.

6. Follow the heads-up prompts, using the illustration below for guidance. We'll start with the north side of mainline first.



Prompts shown for both north and south side widening

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the existing edge of mainline pavement.
Enter Start Point	Snap to mainline near the end of the access road radii (indicated by the X in the illustration).
Locate Second Element	Select the proposed edge of pavement in the area indicated.
Radius	Move the cursor until you have a reasonable set of reverse curves, then data point to accept.
Enter Start Point	In this command it is required to select the Start Point twice. Snap to mainline near the end of the access road radii (indicated by the X in the illustration).
Trim / Extend	Back

7. Repeat the process for the southern widening.

CHAPTER SUMMARY

In this chapter, we have worked with some miscellaneous tools that are helpful in completing tasks to wrap up our project.

Chapter 6: Introduction to Vertical Geometry Tools

OVERVIEW

Civil Geometry is a dynamic, interactive, rules-based approach to geometry that provides an unprecedented level of associativity by preserving design intent, snaps and Civil AccuDraw input. The results of the tools are intelligent graphic elements which can be dynamically edited and associations between elements which are automatically updated.

The results of the tools are graphical geometry elements stored as MicroStation elements. There is no external geometry file. The geometry elements are MicroStation elements with additional intelligence applied to store the rules and associations.

The Civil Geometry tools are installed as a part of GEOPAK, InRoads and MXROAD products. In order to be consumed by processes within GEOPAK, InRoads and MXROAD, the civil geometry must be written to the native application coordinate geometry file (ALG, GPK or FIL). This is handled automatically. Elements are written to and updated in the native application based on properties of feature definitions.

PROJECT DESCRIPTION

In this workshop, we will construct vertical geometry (profiles) for our mainline alignment, a cross-road alignment, and parts of the interchange including ramps, loops and access roads. Note the view is rotated so the mainline is displayed in a west-east orientation.

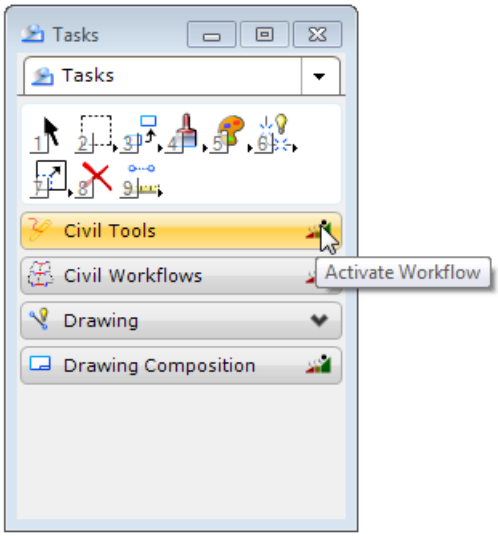
Alignments created with horizontal geometry tools

The table below details the dimensions we'll use throughout the project.

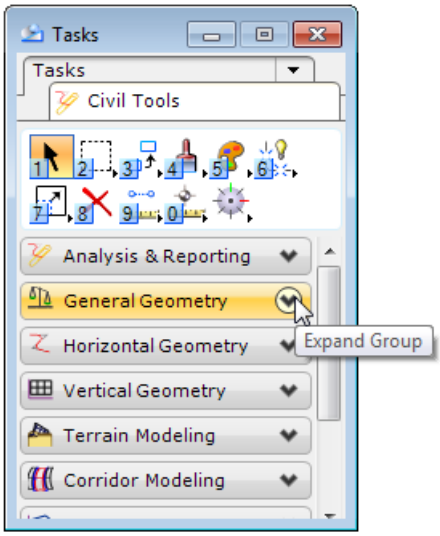
DESCRIPTION	VALUE
Units	Metric
Stationing Format	1+234
Design Standards	U.K. (modified)
Vertical Curve Parameter	K Value

NAVIGATING TASKS

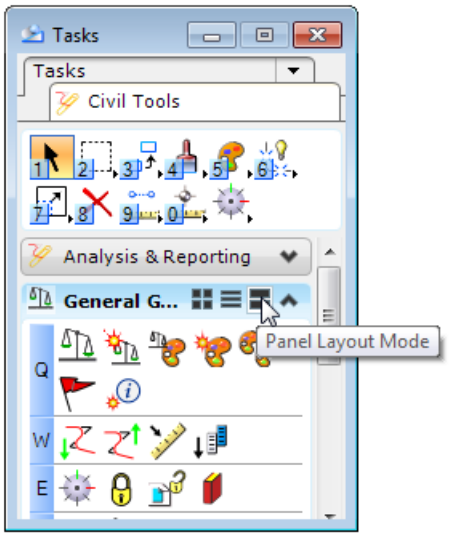
Within the Tasks dialog, the General Geometry and Vertical Geometry tasks are located in the Civil Tools Workflow. (Note your tabs may vary slightly, depending on what Bentley products are installed.)



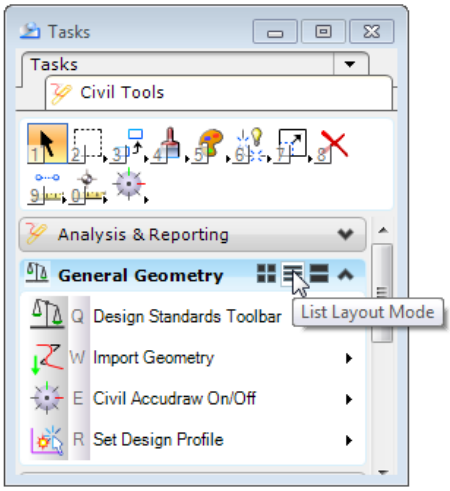
Click Activate Workflow to view the main tasks. To open the toolset, click Expand Group. Click the same icon to Collapse the Group.



There are several ways the Groups can be displayed. For this workshop, we'll use the Panel Layout Mode, which is the default.

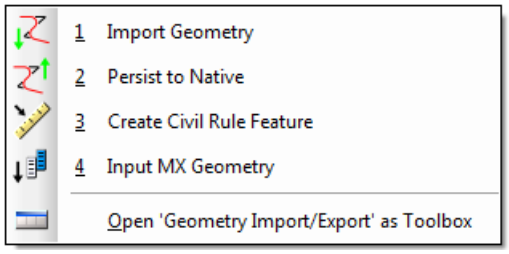


If you prefer listings rather than icons, you may prefer the List Layout Mode.

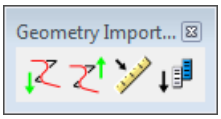


Your preference may be to not use the Task dialog. Other options include:

- Select any tool from Tools > Civil Geometry from the Power product main menu bar.
- Select <F2> from your keyboard, which opens the main workflows pop-up menu. This may vary depending on what products are installed and any task customization. Select Civil Geometry. Select <F2> from your keyboard and General Geometry from the pop-up menu. Then you can use Q, W, E, R, T, or A (corresponding to the letters to the left of the group). For example, selection of W opens the Geometry Import/Export pop-up menu.



To use the classic toolbox for any sub-group, right-click on the line and select Open '…' as Toolbox.



You can also customize which tools are displayed. Other customizing options can be found by right-clicking on the navigation groups. Customization of task navigation is outside the scope of this workshop, but you may want to experiment in your spare time or after the workshop is concluded.

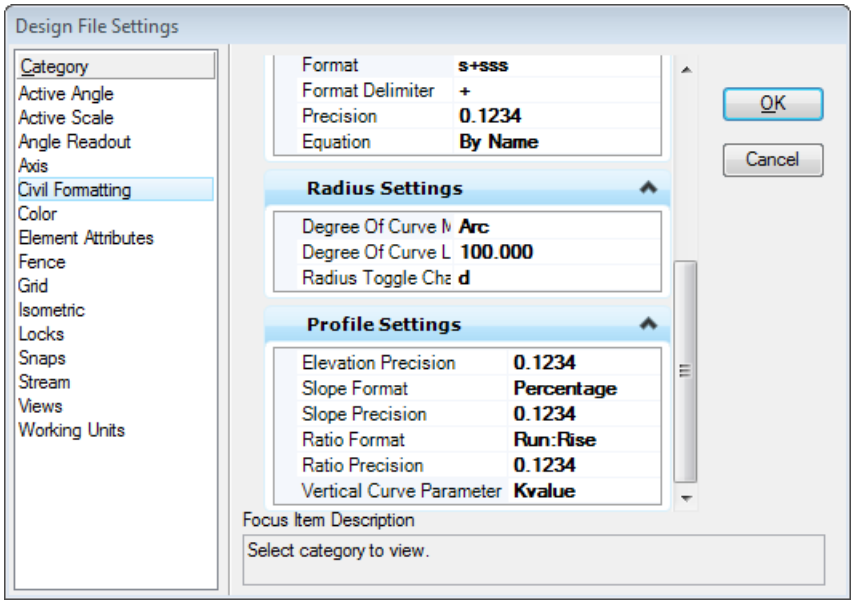
Hint	If the Task dialog disappears or you accidentally close it, select Tools > Tasks from the Power product main menu bar to bring it back.

In this section, we will review some of the tools and settings that will be used throughout the workshop. For easy accessibility, we will dock the tools within the MicroStation view.

PROFILE SETTINGS

When working with vertical geometry, there are several settings that you need to be aware of and set based on your project requirements. These include:

- Stationing
- Vertical Curve Parameter



Exercise: Open Design File and Tools

Lesson Objective:

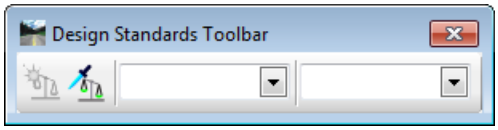
We'll set up for Design Standards, Features, and Messages for subsequent exercises. We'll also verify our profile settings.

Tools Used:

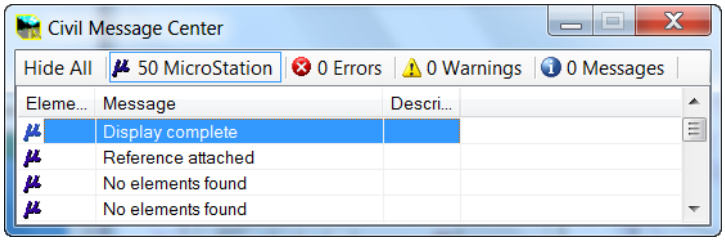
GENERAL GEOMETRY GROUP	ICON	TOOL
		Design Standards Toolbar
		Civil Message Center
MicroStation > File > Project Explorer		Project Explorer
MicroStation > Settings > Design File		Profile Settings

Procedure:

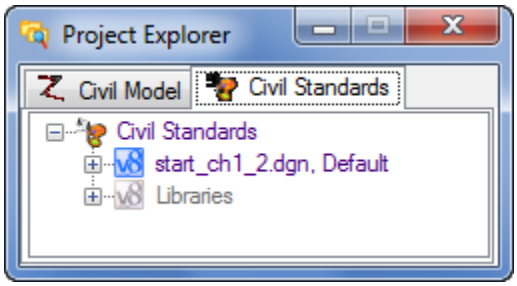
8. Double-click the Power InRoads or GEOPAK icon on your desktop.
9. In the lower right corner of the File Open dialog, set the **User** to *Examples*, **Project** to Bentley-Civil-Metric, and **Interface** to Bentley – Civil.
10. Navigate to the class folder as directed by the instructor, select *Start_ch1_2.dgn* and click **Open**.
11. Select the **Design Standards Toolbar** tool from the General Geometry group.



12. Dock and pin the **Design Standards Toolbar** at the top.
13. Verify that the **Civil Message Center** tool is docked at the bottom of the view.
    This is for feedback on our design standards and geometry tools.

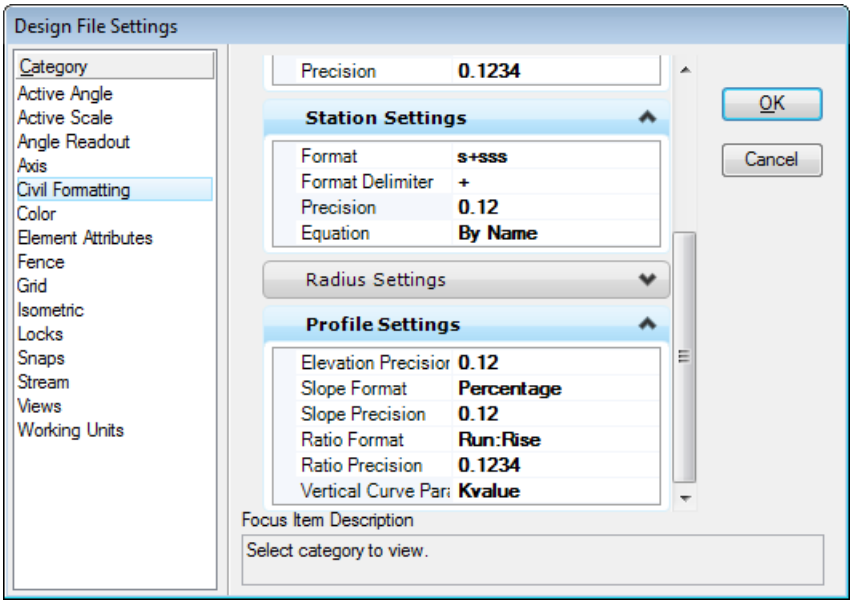


14. Verify that the **Project Explorer**. is docked on the left side of the view.
    This is for reviewing design standards and feature definitions.



Hint The Project Explorer can also be found in the Primary Tools toolbar, but is hidden by default. Right-click on the toolbar and select Project Explorer to enable access from the toolbar.

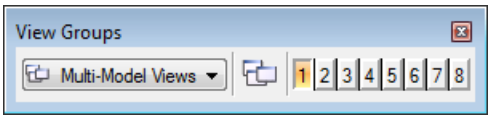
15. Select **Settings > Design File** from the MicroStation or Power product main menu bar.
16. Select **Civil Formatting** in the Category list (left side).



17. Scroll down to **Station Settings** and be sure the **Format** is set to s+sss and **Precision** to 0.12.
18. Scroll down to **Profile Settings** and verify/set the following:

FIELD	SETTING
Elevation Precision	0.12
Slope Format	Percentage
Slope Precision	0.12
Vertical Curve Parameter	KValue

19. Close the Design File Settings dialog.
20. Verify the MicroStation / Power Product View toggles are already docked at the bottom of the view. If not, select Tools > View > View Groups and dock. Only view 1 should be on at this time.

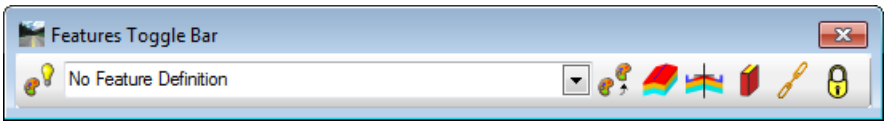


21. On your keyboard, select<Ctrl> <F> to Save Settings.

Features and Feature Definitions

A Feature is anything that can be seen or located and is a physical part of your design, representing a real world entity. Examples include curb and gutter, pavement, power lines, trees, etc. Often it is a physical thing but might be an intangible but measurable entity such as a centerline.

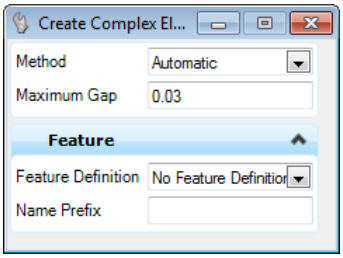
When we create features (geometry elements), we use the Features Toggle Bar to define what the geometry represents, its Feature Definition..

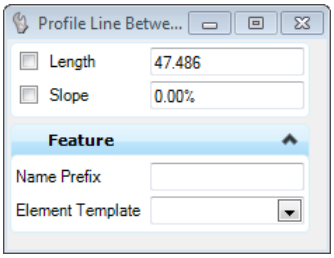


Feature definitions are used to define the nature of the created features. Feature Definitions are usually created in advance, usually used across multiple projects, and define symbology, annotation and quantities. The feature definition is assigned to the base geometry, often in the plan model, but surfaces are 3D elements and thus the feature definition is defined in the 3D model.

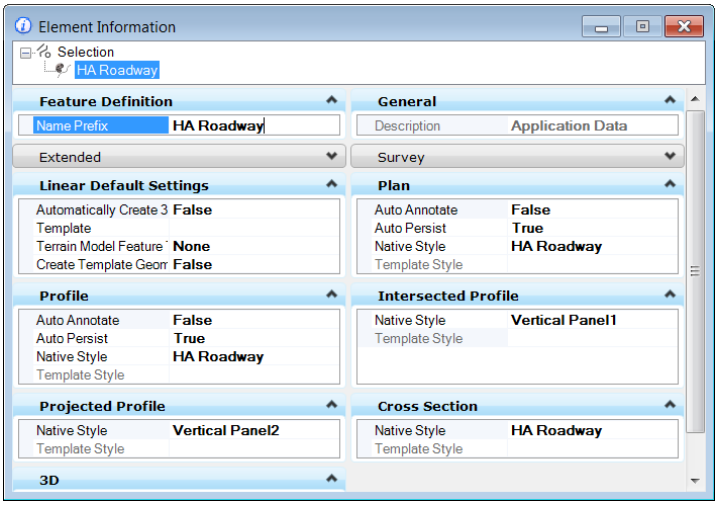
At any given time in the design process, the feature will be defined by horizontal geometry, vertical geometry, 3D geometry or a combination to define its location. Generally, the feature's definition is assigned at time of creation, but can be assigned after-the-fact.

Most horizontal geometry tools have entry fields for Feature Definition in their dialog. One example is illustrated (left) below. An example of a vertical geometry tool is also shown (right) below.



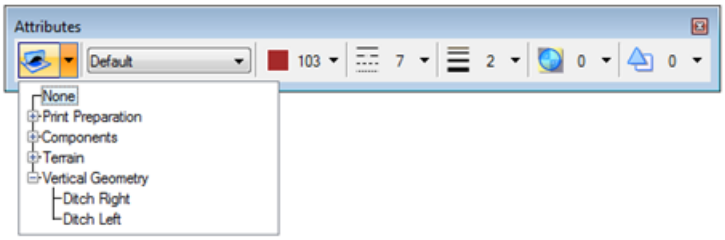


The vertical tool does not have a Feature Definition field. That's because it's utilizing the Feature Definition of its horizontal element (except in the case of a profile from terrain where it uses the terrain feature definition). In other words, the profile is merely a different presentation of the horizontal feature and thus inherits the feature definition. Three presentations are supported: Profile, Intersected Profile and Projected Profile.



It has a Name Prefix, so it doesn't use the same Name Prefix as the horizontal geometry. For example, we can have one horizontal element named CL, but we want the existing ground profile name prefix to be EX. Another example is the naming of special ditch grades with DITCH.

Infrequently, we may want to override symbology of the profiles. For our horizontal element, we may have special ditch grades or other generic offset profiles, and we want them to be easily distinguishable by different symbology and to control which are displayed at a given time. We can use Element Templates for this purpose, which are stored in a DGNlib. One example of Element Templates is illustrated below. It is important to understand that the element template merely overrides the symbology of the element, the feature definition remains unchanged.



Examples of Element Templates for Vertical Geometry

We also have more feature definitions in profiles than in plan view. As noted in the Properties of the HA Roadway, (viewed from the Project Explorer), different styles can be defined for Intersected profiles and Project Profiles. Either Native Styles or Element Templates can be used.

Note	Regardless of the use of the Element Template or Feature Definition, you can always assign a Name Prefix to be used.

CHAPTER SUMMARY

In this introductory chapter, we learned about settings for using vertical geometry, and how features and feature definitions are utilized.

Chapter 7: Using Existing Data

OVERVIEW

To begin any project, you may need some type of existing data. It may be CAD files from prior projects, survey information, terrain models or even historical paper plans. You can mix and match the type of data you have for your project. If you have no data, you can even start with a blank file and develop your horizontal geometry. Then you can begin to work on vertical geometry.

Note	You must have a horizontal geometry element in order to develop vertical geometry.

In our project, we will use some historical data as a starting point for one to develop our mainline vertical geometry. We'll use the import functions for that exercise. Then we'll take a look at whether the existing vertical geometry meets design standards.

Another critical tool is the development of existing ground profiles from terrain models. We'll look at two tools used for that purpose.

IMPORTING DATA

In some projects, you may have data from a previously constructed project. In these cases, we need to use the data in one of the native Bentley products (i.e., MX, InRoads, or GEOPAK).

Note	You must be in the same native product where the data was created in order to import.

We cannot bring in vertical geometry without its accompanying horizontal geometry. During the import process, we'll need to select both the horizontal geometry and which profiles are associated with it. Even though the alignment and profile may have the same name, they are not automatically associated.

Exercise: Import Profiles

Exercise Objective:

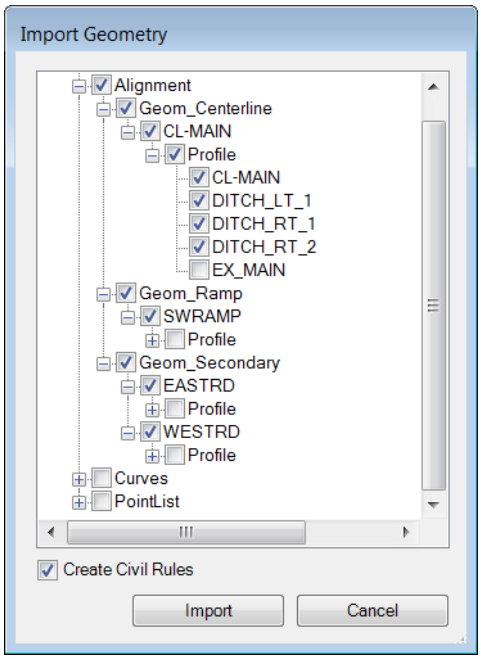
Import the mainline alignment and associated profiles and view in 2D.

Geometry Tools Used:

GENERAL GEOMETRY PANEL	ICON	TOOL
		Import Geometry

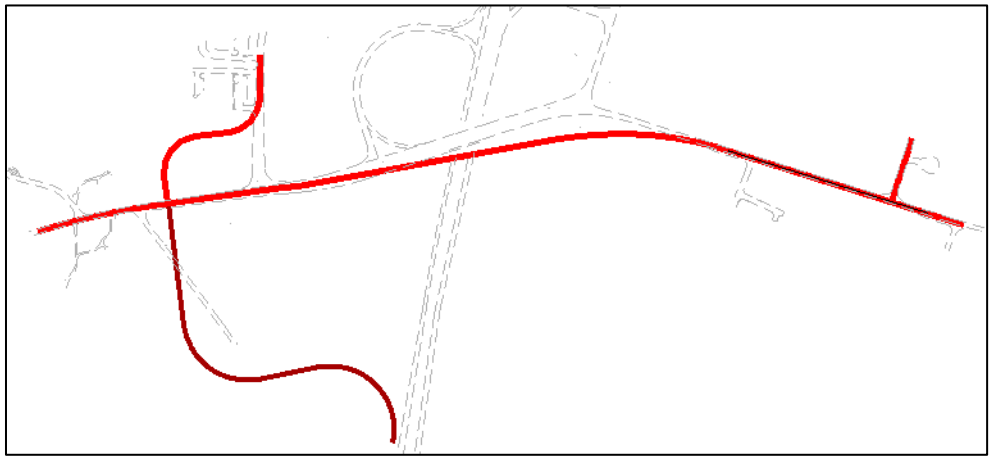
Procedure:

22. Continue in *Start_ch1_2.dgn*.
23. Select the **Import Geometry** tool.
24. Power Inroads: Select *vertical_workshop.alg* (in your project folder) and click **Open**.
    Power GEOPAK: Select *job89.gpk* (in your project folder) and click **Open**.
    Note your dialog may vary slightly from the one illustrated below.



25. Navigate the tree and toggle on Alignment.
26. We'll bring in all the alignments, but we want to be selective on profiles. Under CL-MAIN, toggle on Profile and toggle OFF EX_MAIN, which is the existing ground profile. Note only CL-MAIN has profiles.
27. Ensure that **Create Civil Rules** is toggled on.
28. Click **Import**. (If you are using GEOPAK you may be prompted for the GPK file again. Use job89.gpk.)

Note	Note our view is rotated so it will display in a west-to-east direction.



Imported alignments overlaid on existing roadway topography

Exercise: View Imported Profiles

Exercise Objective:

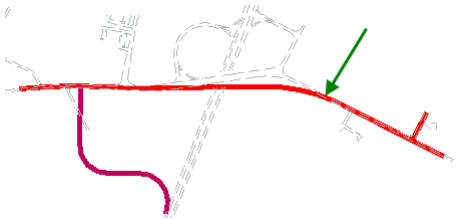
Verify the profiles were imported by viewing in the Profile Model.

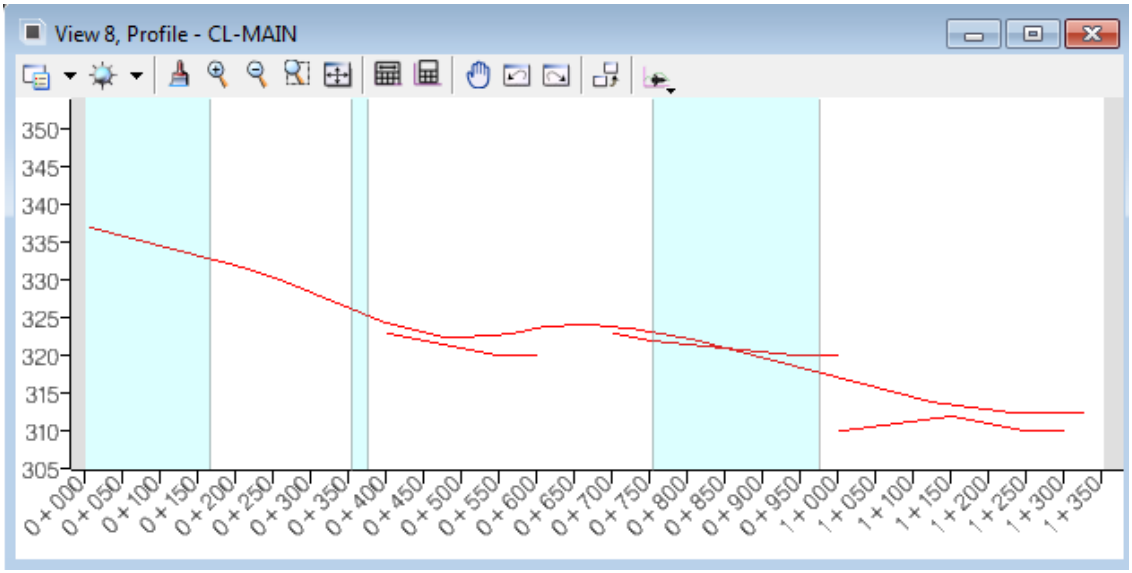
Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL
		Open Profile Model

Procedure:

29. Continue in *Start_ch1_2.dgn*.
30. Select the **Open Profile Model** tool and follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate Plan Element	Select the CL-MAIN alignment in view 1. 
Select or Open View	From the MicroStation or Power product View groups, select view 8. (This toolbox should be docked at the bottom of view 1).



Design Profile and Three Ditch Profiles for CL-MAIN

PROFILE MODEL VIEWS

While working with horizontal and vertical geometry, it is important to keep in mind the following fundamentals:

- A horizontal alignment has one and only one profile space.
- A profile space corresponds to one and only one horizontal alignment.
- A profile space can (and usually does) define multiple profiles.
- Only one of the multiple profiles can be active for design at any given time.
- If the profile for parallel or intersecting horizontal alignments needs to be seen in relationship to the profile then use the project profile commands.

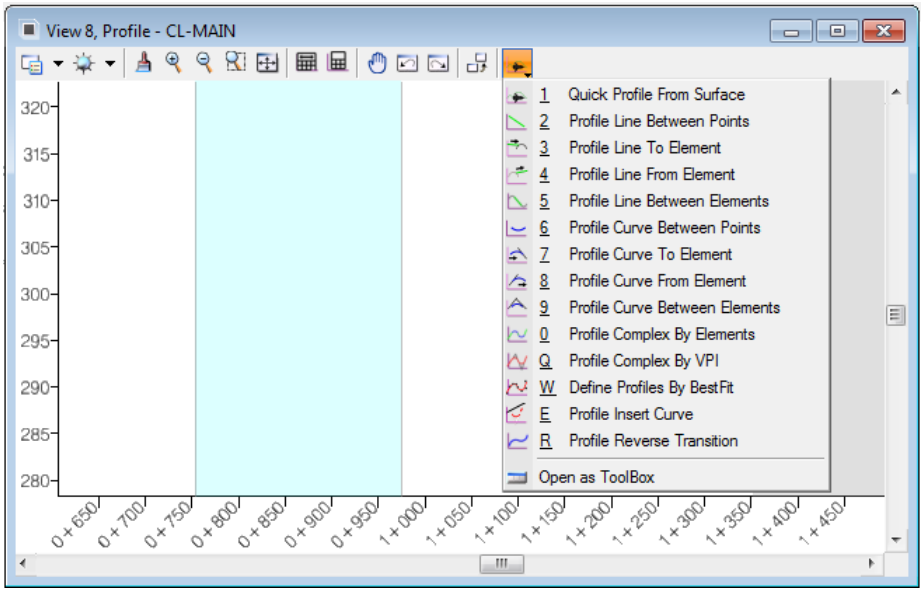
CL_MAIN Design and Existing Ground Profiles

The Profile Model View has some unique characteristics:

- Associated horizontal geometry name is in the title bar of the view.
- Elevation labels on left edge of the view

- Station labels along bottom of the view.
- This is a true profile space whose coordinates are station, elevation instead of X,Y.
- The background colors indicate curvature of the horizontal alignment.
- Normal background = straight
- Cyan background = curve
- Magenta background = spiral
- Civil AccuDraw is profile aware and adjusts its function accordingly.
- When using the vertical commands the cursor gives simultaneous feedback of location both in plan and profile.

The Profile Model View also has easy access to the vertical geometry tools, right from the view window.



Quick Access Profile Menu LIsting

The tools can also be docked as a toolbox.

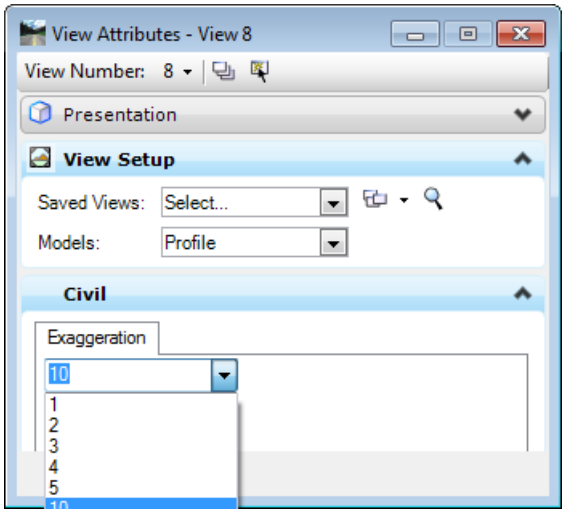
Exercise: Working with the Profile Model View

Exercise Objective:

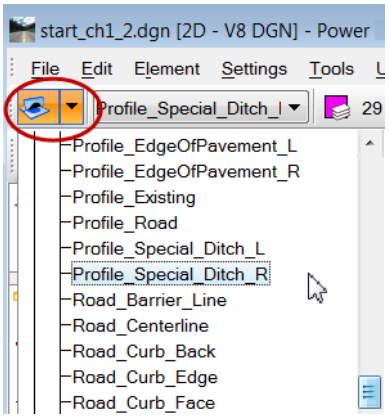
Review the aspects of the Profile Model view, how to customize, and how to change symbology of various profiles.

Procedure:

31. Continue in *Start_ch1_2.dgn*.
32. Open the view attributes box for the profile model and experiment with the vertical exaggeration settings. The view is exaggerated while preserving the true coordinates.



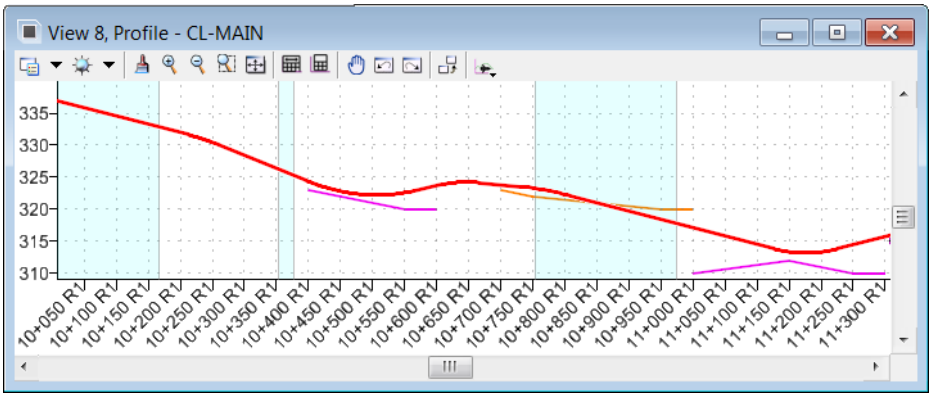
33. Continuing in the Profile Model View, select the longest profile and review the pop-up info to ensure you selected CL-MAIN.
34. Select the Element Templates under **Vertical Geometry** to override the feature symbology. Note the profile options are located under the LINEAR hierarchy.



Select the two right ditch profiles and assign the element template **Profile_Special_Ditch_R.**

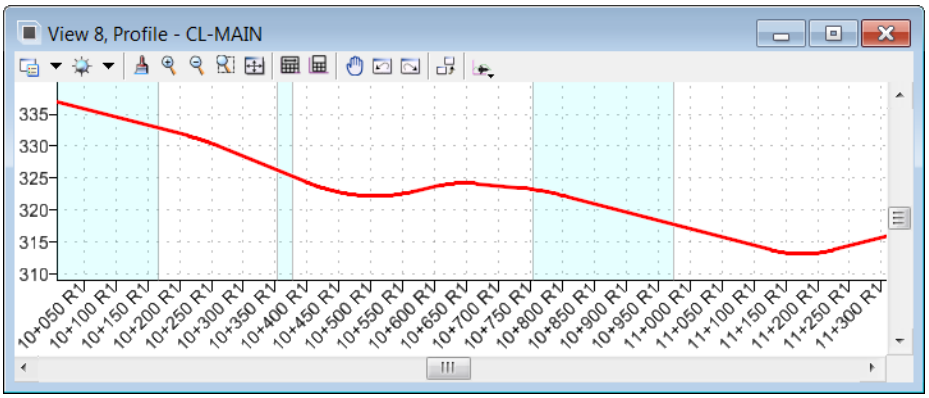
Select the single left ditch profile and assign the element templates **Profile_Special_Ditch_L**.

Hint	Hover over the ditch profiles and the pop-up display shows the feature name, i.e., right or left ditch profile.



All Imported Profiles for CL_MAIN

35. Select Display Levels from the MicroStation or Power product menu. Ensure that it's set to View 8 (or the view of your profiles) and turn off the levels ***Profiles – Ditch Left*** and ***Profiles – Ditch Right***. Use Default as your active level. Turn on the weight attribute and close the View Attributes dialog. You now have just the Design Profile displayed on your screen.



CL-MAIN Design Profile

VERTICAL GEOMETRY REPORTS

As we are working on developing vertical geometry, we'll want to get some hard-copy reports. Many reports are available in the Civil Report Browser, with the default report being the Vertical Alignment Review Report. The report is accessible from the Vertical Geometry navigation task menu or the context pop-up menu.

Exercise: Generating and Reviewing the Vertical Geometry Report

Exercise Objective:

Create the Vertical Alignment Review Report for our imported CL-MAIN vertical geometry.

Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL
		Profile Report

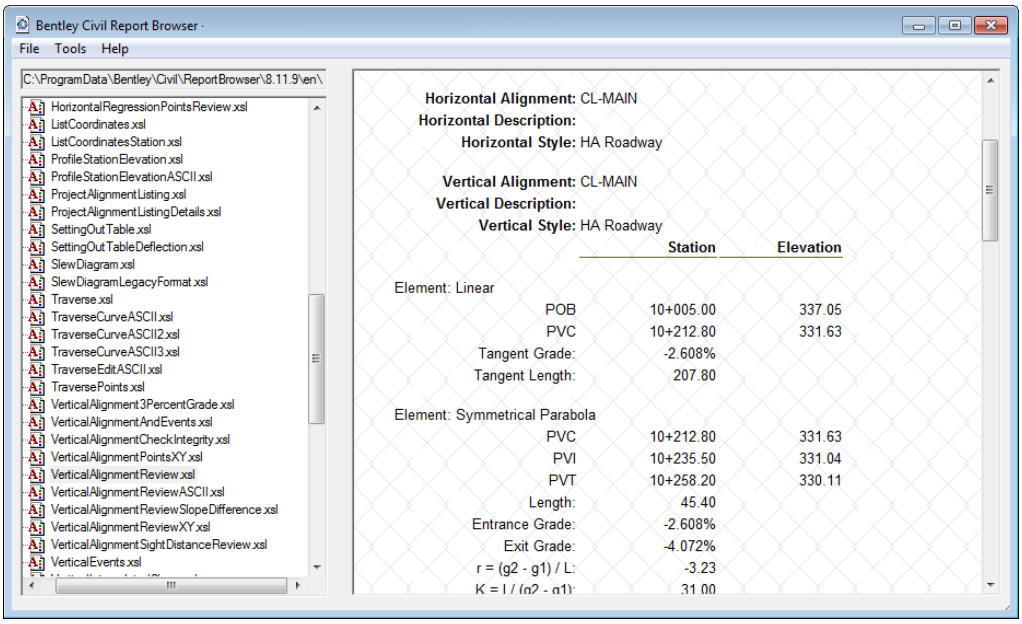
Procedure:

36. Continue in *Start_ch1_2.dgn*.
37. Select the **Profile Report** tool and follow the heads-up prompt.

HEADS-UP PROMPT	USER ACTION
Select First Profile Element	Select the CL-MAIN vertical geometry in View 8.
Locate Next Profile Element – Reset to Complete	Reset.

> ***Hint*** For quicker access to the tool, use the pop-up context sensitive menu!

38. Scroll down in the **Civil Report Browser** to review the report.



39. If time permits, click on some of the other available vertical geometry reports.

USING EXISTING TERRAIN DATA

Generating an existing ground profile for your alignments is a common task in any project. There are three different ways to accomplish this workflow:

- Quick Profile From Surface

- Profile From Surface
- Set Terrain Model

The **Quick Profile From Surface** and **Profile From Surface** tools calculate elevations of an element by matching the elevations of a surface encountered along the element's path. The surface may be a terrain model, a mesh, or mesh solid.

Let's start with the **Quick Profile from Surface** for our CL-MAIN alignment.

QUICK PROFILE FROM SURFACE

As its name implies, the **Quick Profile From Surface** tool is an efficient way to generate a profile from a surface. The only required inputs are indentifying the reference element and the surface.

Exercise: Generate An Existing Ground (Quick) Profile for CL-MAIN

Exercise Objective:

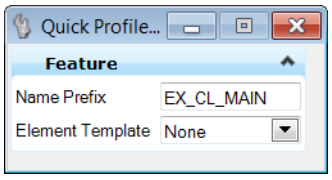
Generate and review the ground profile from our project terrain model of existing ground (which is in a reference file). The symbology of the profile is from the feature definition of the terrain model.

Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL
		Quick Profile From Surface

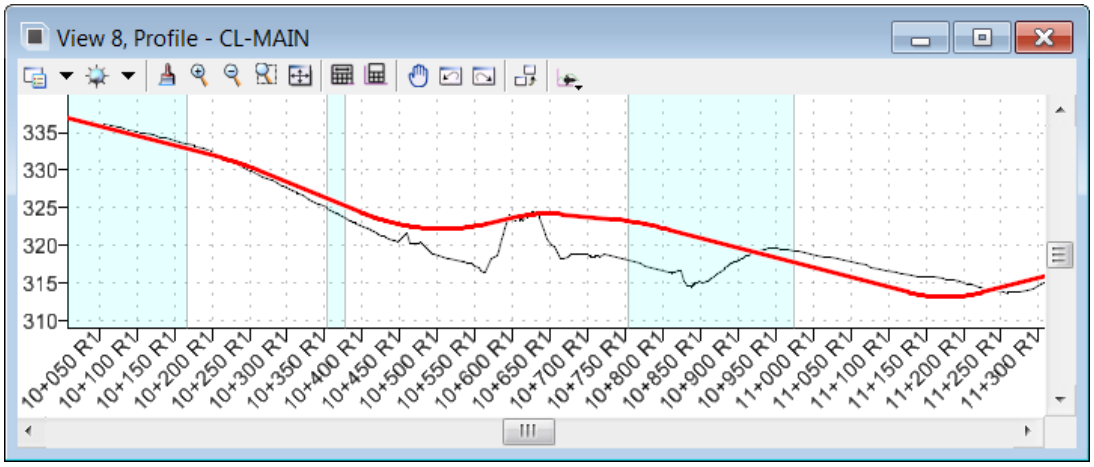
Procedure:

40. Continue in *Start_ch1_2.dgn*.
41. Select the **Quick Profile From Surface** tool from the Profile Model View pulldown menu.
42. In the tool settings, enter the **Name Prefix** as EX-CL-MAIN. Note the **Element Template** is left set to None as the symbology from the terrain model feature definition is used.



43. Follow the heads-up prompt.

HEADS-UP PROMPT	USER ACTION
Locate Reference Element	In the PLAN view (1), select the CL-MAIN alignment. Note if you had either CL-MAIN alignment or profile selected, this reference element is already highlighted and you won't see this prompt.
Locate Reference Surface	In the PLAN view (1), select the boundary of the terrain model (orange dot/dash element).
Locate Next Profile Element – Reset to Complete	Reset.

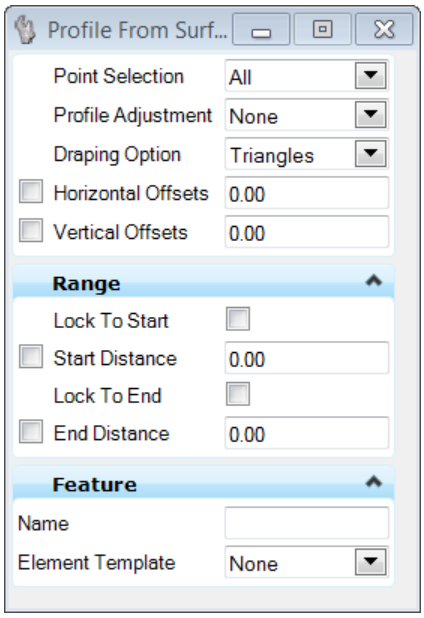


Existing Ground Profile is Overlaid on the Design Profile

44. Close view 8. We can re-open it later as needed.

PROFILE FROM SURFACE

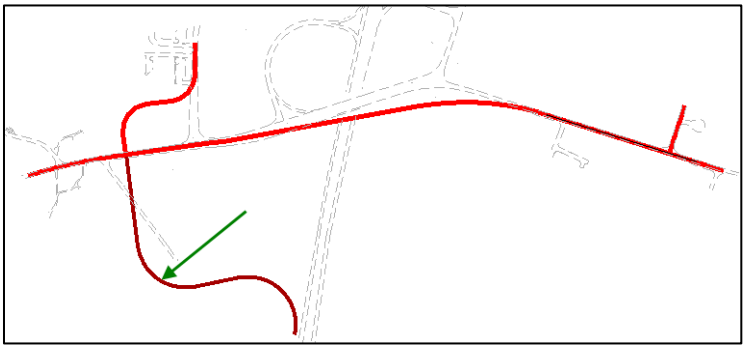
Another tool to generate a ground profile from a terrain model is the **Profile From Surface** tool. It is similar to the **Quick Profile From Surface** tool, but has more settings and options to give more flexibility to the tool. For example, you can create a profile for part of an element or set of elements by specifying the start and end distance. You also have options for horizontal and vertical offsets. These options are not available in the **Quick Profile From Surface** tool.



Optional Exercise: Creating a Profile From a Surface

Objective:

For this exercise, we will use the alignment SWRAMP.



SWRAMP alignment imported from our ALG or GPK File

Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL
		Profile From Surface

Procedure:

45. Continue in *start_1_2.dgn*.
46. Create a Profile Model view for the SWRAMP, using window 4.

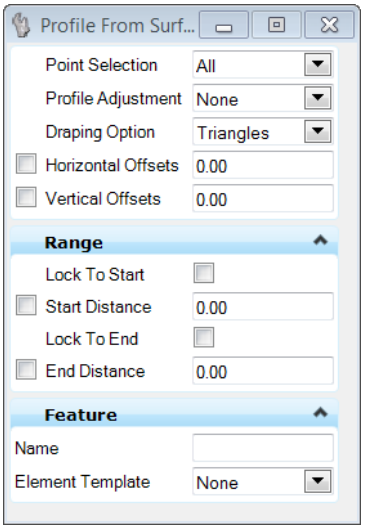
Hint	Use the Open Profile Model tool we learned in the View Imported Profiles exercise.

The view will be empty because we have not created any profiles for this alignment as yet.

47. Select the **Profile From Surface** tool.
48. In the Profile from Surface dialog, input the following:

Name Prefix: Ex_SWRamp

Element Template: None



49. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate First Element to Profile	In the PLAN view, select the first horizontal element (i.e., beginning of alignment if that is what you are profiling) that intersects the surface (terrain model).
Locate Next Element to Profile – Reset To Complete	Keep selecting elements, until all are identified, When you've selected all of the elements you wish to profile, right-click in an empty area to complete the selection and move to the next prompt.
Locate Reference Surface	In the PLAN view (1), select the boundary of the terrain model surface.
Start Distance	In the PLAN view (1), move to the beginning of the alignment and data point to accept..
End Distance	In the PLAN view (1), move to the end of the alignment and data point to accept..
Point Selection	Use the down arrow key (on your keyboard) to navigate the options then <Enter> to execute your choice. We'll use All. All – the entire element is used for elevation determination Vertices – elevations are computed only at the vertices of the element Ends – elevations are computed only at the end points of the element Centroid – elevation is computed only at the centroid
Point Adjustment	Use the down arrow key (on your keyboard) to navigate the options then <Enter> to execute your choice. We'll use None. None – no adjustment is performed Minimum – of the points used in previous step, select the minimum elevation and use this value for the entire profile Maximum – of the points used in previous step, select the maximum elevation and use this value for the entire profile
Draping Option	Use the down arrow key (on your keyboard) to navigate the options then <Enter> to execute your choice. We'll use Triangles. Triangles – determine an elevation at every point where the element crosses a triangle leg Break lines – determine an elevation only when element crosses a break line
Horizontal Offset	Key in 0 then <Enter> to lock it in and data point to accept.
Vertical Offset	Key in 0 and < Enter> to lock it in and data point to accept.

50. Fit the Profile View to see the existing profile for SWRAMP.
51. Close the Profile Model View.

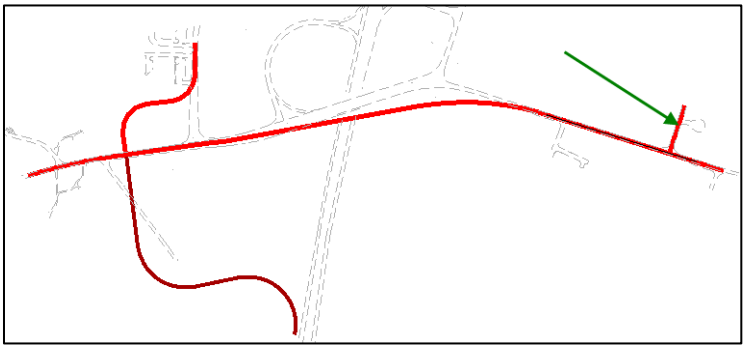
SETTING AN ACTIVE TERRAIN MODEL

The most common use for setting an Active Terrain Model is for existing ground. Among other purposes, defining an active Terrain Model serves to automatically draw existing ground in the profile space and is the target for side slopes which do not otherwise specify a target surface.

Generating a Profile From an Active Terrain Model

Objective:

We'll create an existing ground profile using the existing terrain model and we'll use a quick way to open a Profile Model view. In this exercise, we'll use EASTRD.



EASTRD Alignment Imported From the ALG File

Geometry Tools Used:

GENERAL GEOMETRY PANEL	ICON	TOOL
		Set Active Terrain Model

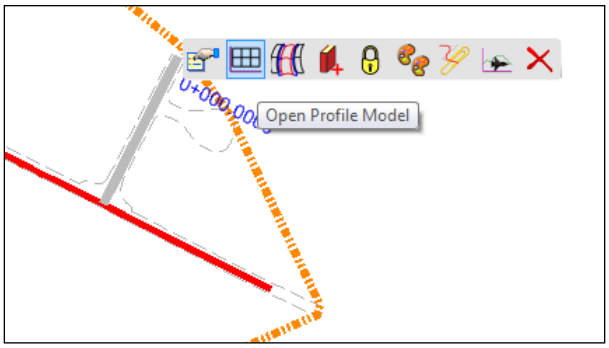
Procedure:

52. Continue in *start_1_2.dgn.*
53. Select the **Set Default Terrain Model** tool.

> ***Note*** Note this is in the General Geometry panel, not in Vertical Geometry. It can also be found in the Terrain Model tools. It can also be selected from the context sensitive pop-up menu.

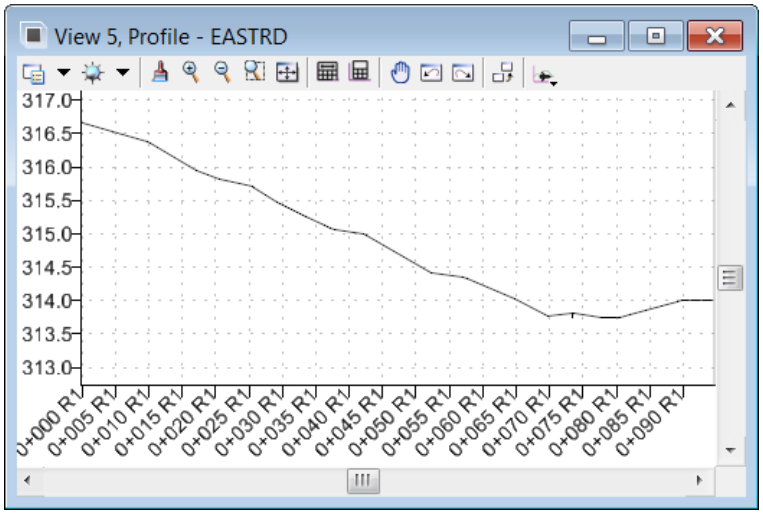
54. Follow the heads-up prompt "Locate Terrain Model to Use as Default" and select our terrain model boundary (orange) in the plan view.

    A message is displayed in the message center that the Active Terrain Model has been set.
55. Use the Element Selection tool to select the EASTRD horizontal geometry in View 1.
56. From the context pop-up menu, select the **Open Profile Model** tool (second from left).



Context Pop-up Menu Displays When Element is Selected

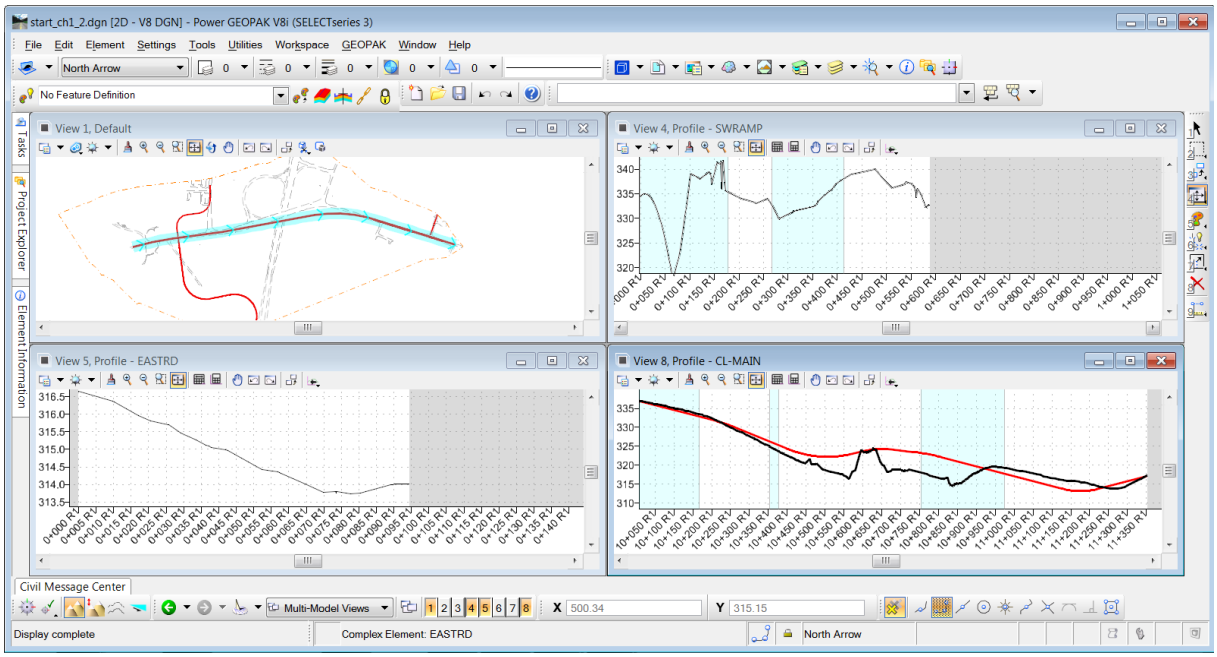
57. Open view 5 from the View Groups toolbox.
58. Data point in View 5 to display the profile. Note you may need to fit the view to see it. The existing ground profile is shown automatically by virtue of setting the active Terrain Model before defining the profile window.



East Rd. Existing Ground Profile

CHAPTER SUMMARY

In this chapter, we have learned about the Profile Model View, and how to import profiles and several ways to generate a profile from a terrain model or mesh.



Summary of Profiles

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Chapter 8: Creating and Manipulating a Design Profile

Overview

Bentley Civil supports a wide variety of vertical geometry tools, so you can find a tool or set of tools for every requirement on your project. In this chapter, we'll start with some fundamentals by building on what we created in earlier chapters.

We'll use the Best Fit tool to create a design profile from our EASTRD. The Best Fit tool is often used on preservation projects to build a design profile from existing centerline pavement profiles.

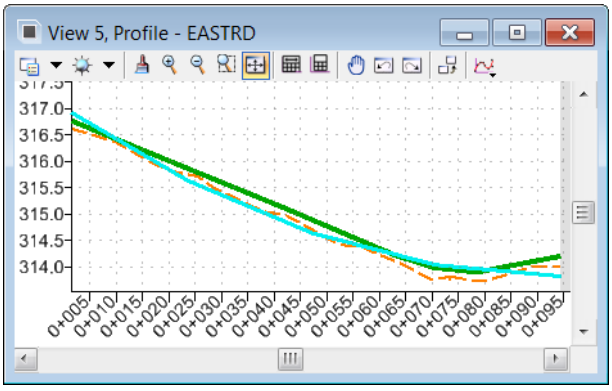
Then we'll take a look at design standards. We'll use our CL-MAIN and check to see if the work done in the planning stages (that we imported) meets our design speed standards. Then we can use the manipulators to improve the quality of the profile so that it meets or exceeds standards.

Best Fit

The Define Profiles by Best Fit tool constructs a profile complex defined by best fitting through a selected profile. For example, pick an existing ground profile and best fit a profile to match the ground.

Two options which widely impact the results are supported:

- Simple Element - computes a single linear profile element with no option for an offset envelope. Aside from Element Template and Name Prefix and selection of the profile, there are no other user input requirements.
- Complex Element - option provides for offset values to define an envelope above and below the selected profile. It will build a complex profile with curves.

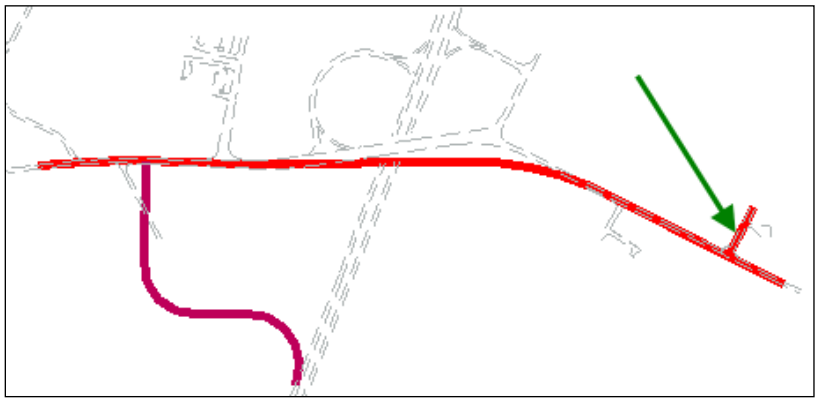


Comparison of Profiles: Initial profile (orange), Simple Element (Aqua), Complex Element (Green)

Generating a Best Fit Profile

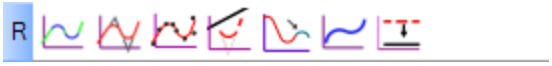
Objective:

We'll create a best fit profile from the existing ground profile for EASTRD that we created in an earlier exercise.



EASTRD Alignment Imported From the ALGor GPK File

Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL
		Define Profiles By BestFit

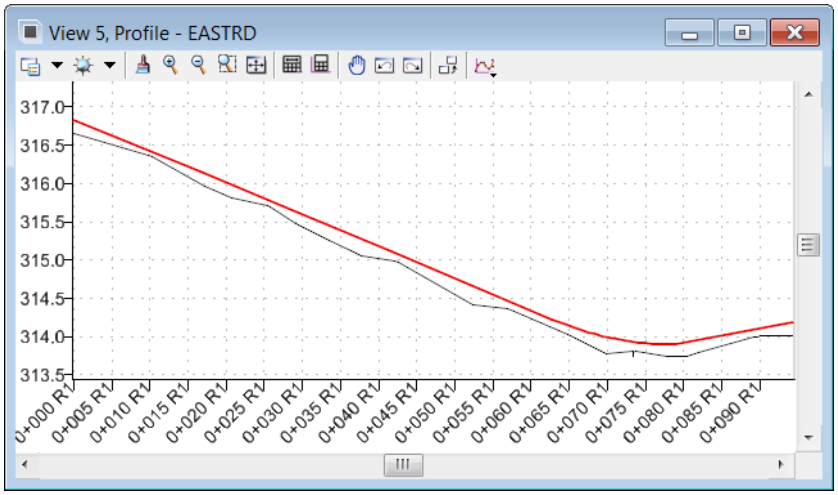
Procedure:

59. Start in *start_ch3.dgn*.
60. Select the **Define Profiles By BestFit** tool.
61. In the dialog, key-in the following:

    Name Prefix: BF-EASTRD

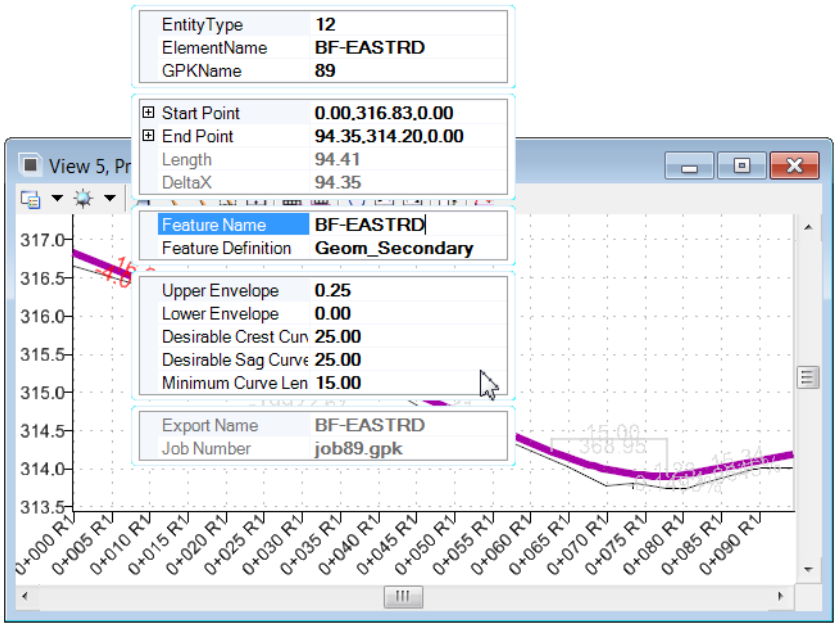
    Element Template: None
62. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Best Fit : Make Complex Element or Simple	Select Make Complex Element and data point to accept and move to the next prompt.
Locate Profile To Fit	Select the existing ground profile for EASTRD (in View 4).
Upper Envelope	Use 0.25.
Lower Envelope	Use 0.0.
Desirable Crest Curve Length	Key-in 25 and <Enter>.
Desirable Sag Curve Length	Key-in 25 and <Enter>.
Minimum Curve Length	Key-in 15 and <Enter>.



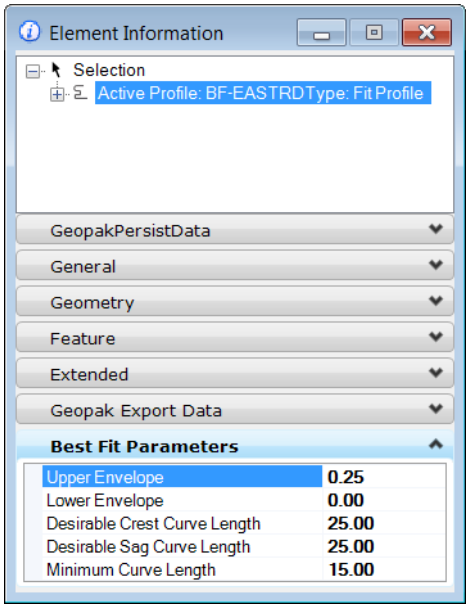
East Road Existing Ground Profile (black) and Best Fit (red)

4. Using the Element Selection tool, select the profile, right-click and select the Properties to see the values used for Best Fit.



Properties Information for East Rd.

Note	The same information is also found in Element Information.



Element Information for East Rd.

5. Close the Profile View.

MANIPULATORS

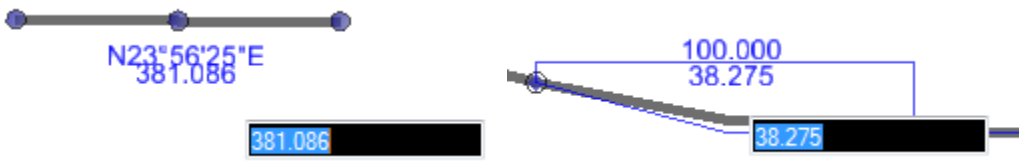
When any element created by a Civil Geometry tool is selected, certain manipulators are displayed dynamically. These manipulators vary by element type.

Manipulators fall into four main types:

- Text manipulators
- Normal Drag Handles
- Snap icons
- Civil AccuDraw drag handles

TEXT MANIPULATORS

These can be clicked to make them editable, which lets you type in new values. Examples include distance and direction text manipulators in horizontal geometry, and length and slopes in vertical geometry.



Examples of Horizontal (Left) and Vertical (Right) Text Manipulators

NORMAL DRAG HANDLES

These are handles that you can click and drag to redefine the element.

- An arrow shaped drag handle – redefines the point with one or more directions constrained. For example, the parallel arrows (that are parallel to the line) are

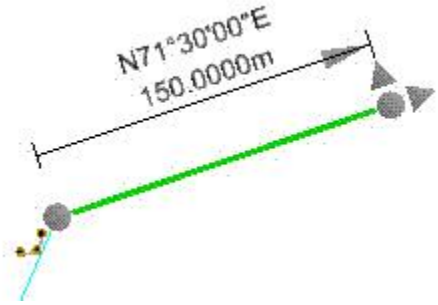
constrained to change the distance only; the arrows that are perpendicular to the line are constrained to change the direction only.

- A circular shaped drag handle – moves the points without constraint

- Interval drag handle – This type of drag handle is present any time one of the MicroStation Modify commands are used on a civil element. This drag handle is used to change the location of the interval end point.

SNAP ICONS

If a point was created by a snap, the manipulator is shown as a circle with the appropriate snap icon next to it.



Hovering over the circle will change it to a normal manipulator. Click and move the dot to remove the snap constraint and replace with new constraints.

CIVIL ACCUDRAW DRAG HANDLES

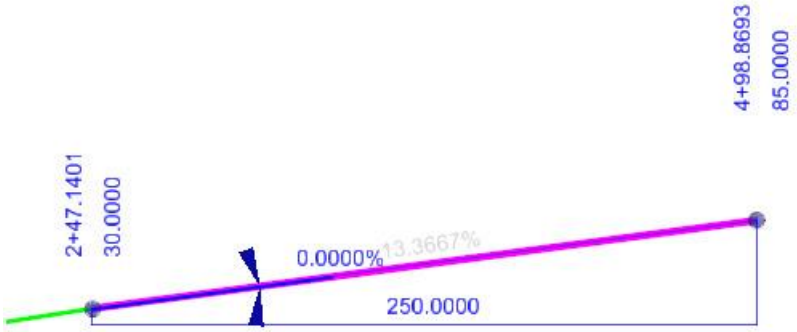
A point that was created with a Civil AccuDraw constraint will show a circle along with text manipulators depicting the Civil AccuDraw constraints which were input.

Hovering over the circle will change it to a normal manipulator. Click and move the circle to break the Civil AccuDraw constraint and replace it with new constraints.

VERTICAL GEOMETRY MANIPULATORS

Vertical geometry also has manipulators for:

- Offset from base element (not shown here)
- Delta Slope
- Length
- Drag a grip to dynamically adjust start and end distance

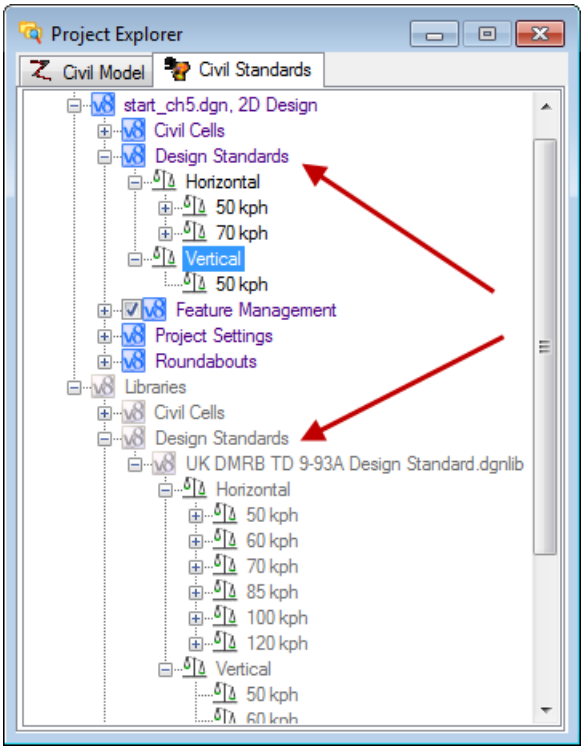


DESIGN STANDARDS

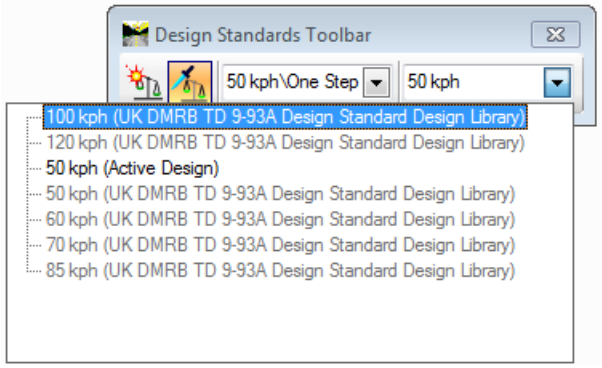
Design standards should be used throughout the design of your project. It ensures that you are meeting minimal standards, generally based on design speed. They can also be based on type of roadway, and other geometric or design characteristics.

Design standards are developed for both horizontal and vertical geometry (vertical new in Bentley Civil V8*i* SELECTseries 3) and are stored in DGNLibs. Several default libraries are provided in the installation packages. They are utilized by including the file / path in your MS_ DGNLIBLIST configuration variable. An organization can modify the default libraries or create them from scratch, depending on your standards. Multiple standards can be utilized, i.e., consulting firm doing work for multiple governmental agencies who all have their own standards.

As you select a standard, it is copied from the DGNLib into your design file. Therefore, your organization can maintain the integrity of the standards by having them “read-only” in a central location, but a designer has the flexibility to override for a project-specific circumstance. The Project Explorer has one set of standards derived from DGNLibs, and another set shown for the design file.



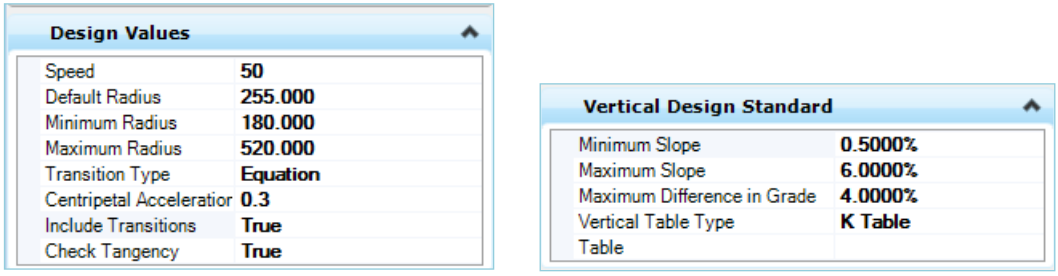
In the Design Standards Toolbar, the Active Design vs. Design Library standards is clearly marked. Either can be selected for use.



USING DESIGN STANDARDS

Design standards can be used to maintain required curvature and other horizontal and vertical alignment checks when performing geometric layouts. They work at two levels:

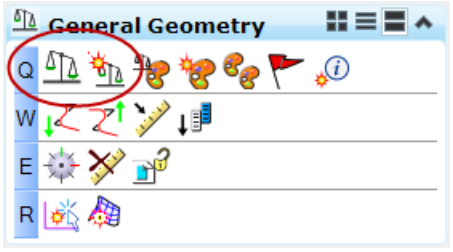
- Provide values for the element creation tools (for example, minimum radius and transition lengths in horizontal geometry, maximum slopes and K values for vertical geometry)
- Check the suitability of complex elements (for example, check for kinks in both horizontal and vertical geometry)



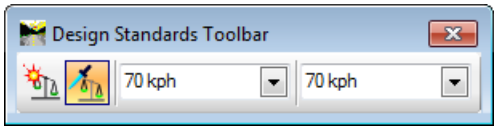
Examples of horizontal (left) and vertical (right) design standards

DESIGN STANDARDS TOOLBAR

The Design Standards Tool bar is accessible in either the General Geometry or Horizontal Geometry tool panels:



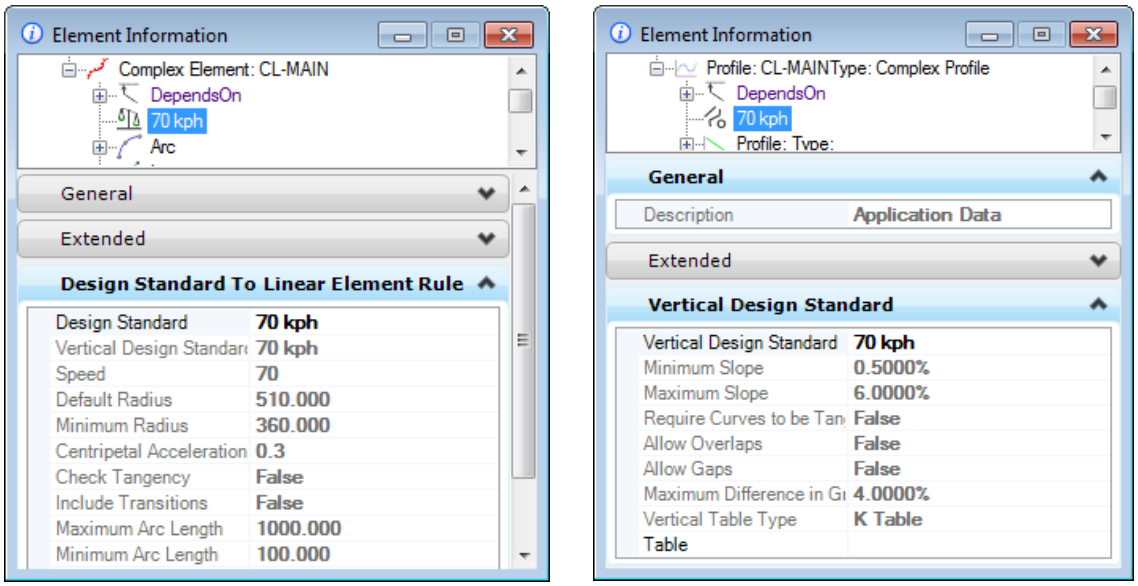
There is one icon for the Toolbar and a separate icon for the **Set Design Standard** tool, which is located on the Design Standards Toolbar.



This toolbar allows you to set an active design standard subsequently used by most geometry tools. The leftmost icon is **Set Design Standard**, which can be used on previously created geometry elements.

Procedure:

63. Select the desired standard. When a horizontal standard is selected, the "linked" vertical standard is displayed by default. However, you can override by selecting a different vertical standard from the pick list.
64. Toggle on the Toggle Active Design Standard (directly left of the horizontal design speed). When on (which appears orange), all civil geometry tools will use the values contained in the standard as defaults. When off, the selected standard is ignored.
65. Create geometry elements.
66. Selecting the element and opening Element Information displays the standard and associated values.



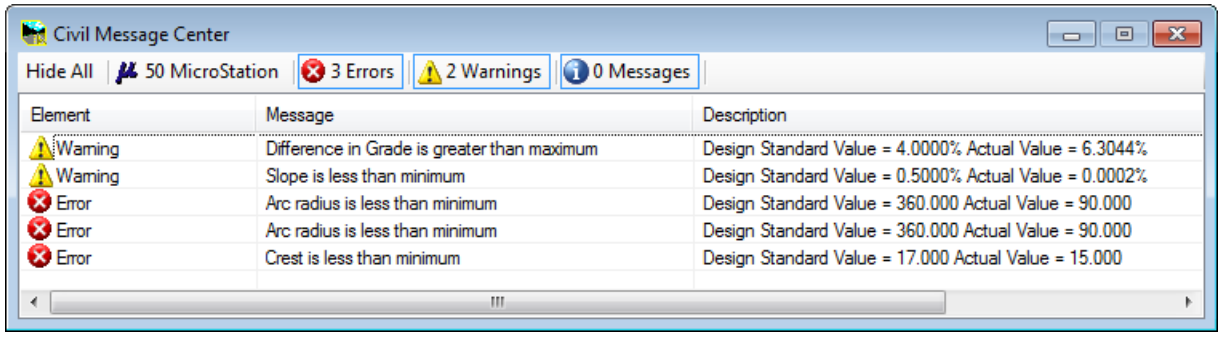
Example of Horizontal and Vertical Design Standards Within Element Information

Hint	To remove a standard from a geometry element, right-click on the standard in Element Info and select Remove Standard.

Design Standards Feedback

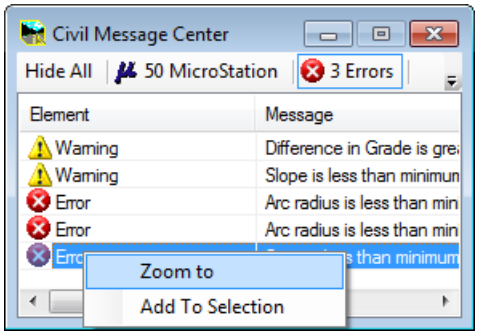
When a design standard is violated, feedback is provided in two ways:

- An icon in the graphics on the element that has the problem. Hover over the icon to reveal a tool tip report of the error.
- In the Civil Message Center.

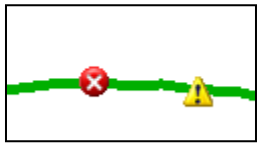


Sample horizontal and vertical geometry messages in the Civil Message Center

The tabs work like filters, so you can turn off / on MicroStation / Warnings / Errors as desired. To quickly find the location of a problem, right click on the Warning or Error and select Zoom To.

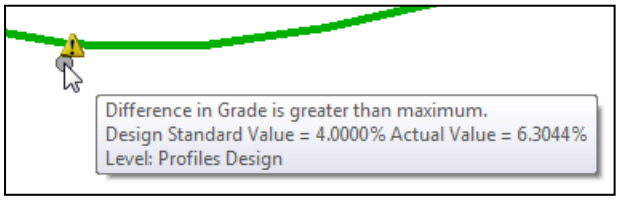


With the exception of the MicroStation messages, onscreen glyphs are displayed in the workspace to pinpoint the location.



Error (left) and Warning (right) Glyphs

Hovering over the glyphs displays a pop-up with the warning / error message.

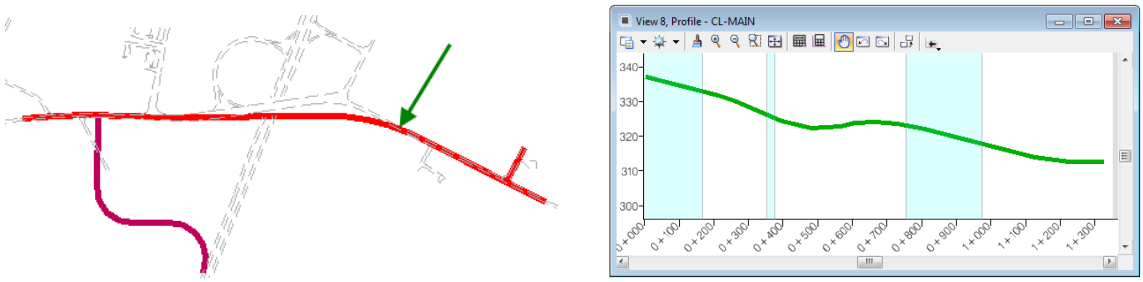


Example Pop-up Warning Message

Check and Manipulate Design Profile for Standards Compliance

Objective:

In this exercise, we'll use the CL-MAIN alignment / profile we imported in an earlier exercise and check to see if the preliminary alignments / profiles meet standards.



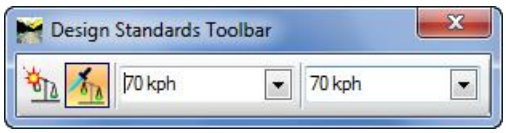
CL-MAIN horizontal and vertical geometry used for design standards checking

Geometry Tools Used:

CONTEXT MENU (ON ELEMENT)	ICON	TOOL
		Open Profile Model
General Geometry Panel	**Icon**	**Tool**
		Set Design Standard

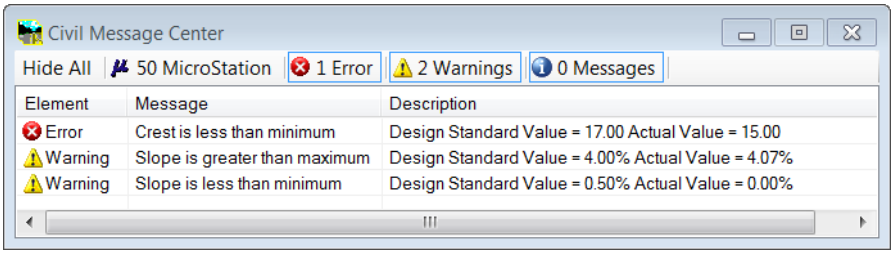
Procedure:

67. Continue in *start_ch3.dgn*.
68. Open View 8 from the View Groups toolbox.
69. Note you may need to fit the view to see it. Turn off the levels of any displayed profiles except the Design Profile. While this is not required, it makes it easier to review / focus on the Design Profile.
70. Select the **70 KPH** design standard from the Design Standards Toolbar. (This was docked in an earlier exercise.)

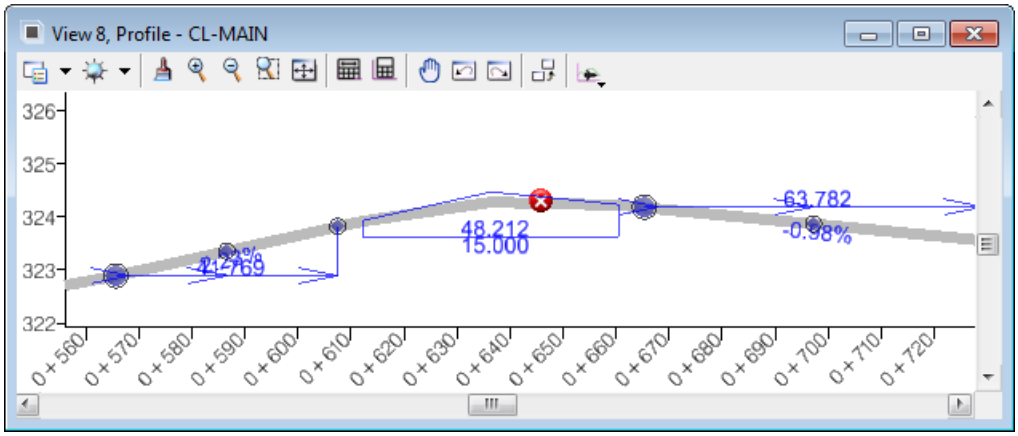


71. Toggle on the **Toggle Active Design Standard**, so it appears orange.
72. Ensure you don't have any elements selected, then from the Design Standards Toolbar, select the **Set Design Standard** tool. When prompted, select the vertical geometry element.

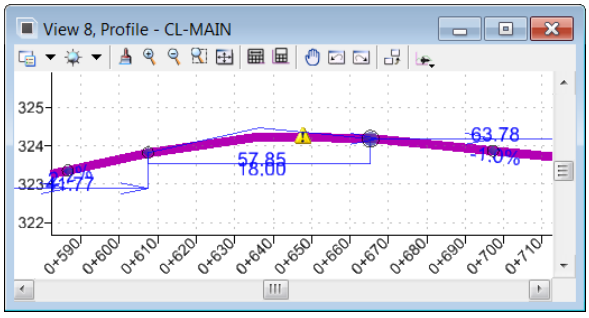
73. Expand the Civil Message Center which was docked earlier view the Warnings / Errors.



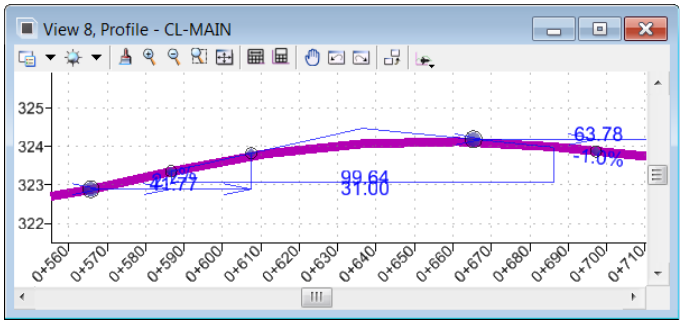
74. Select the Error line, right-click and select Zoom To.



75. According to the Error message, our K Value is 15, but needs to be more than 17 to meet standards. Edit the K Value manipulator (on the bottom, curve length is on top) to 18 and note the glyph changes to a Warning, indicating it exceeds the minimum but does not meet the default.



76. Change the K value to 31 and the glyph disappears and the Warning is removed from the Civil Message Center.



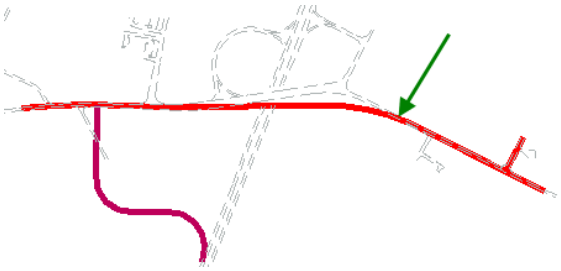
SETTING THE ACTIVE PROFILE

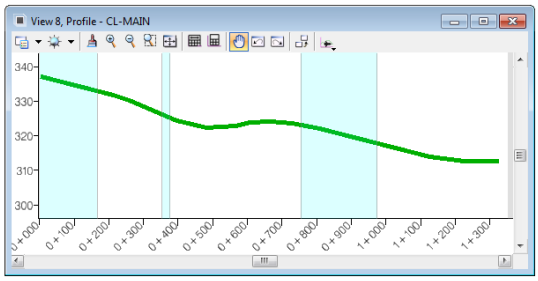
Let's assume for now that we have refined our vertical geometry for design compliance and we're ready to move onto other work. However, we will be using this design profile in subsequent exercises. Whenever we want to use the CL-MAIN horizontal alignment, we want to use the design profile as well, rather than the existing or special ditch grades, etc. Therefore, we will define the design profile as the Active Profile. Another useful function of the tool is that it combines the horizontal and vertical geometry and draws a 3D element automatically for us.

Setting the Design Profile As the Active Profile

Objective:

We'll select our design profile and set it as the active profile for CL-MAIN.





CL-MAIN horizontal and vertical geometry used for design standards checking

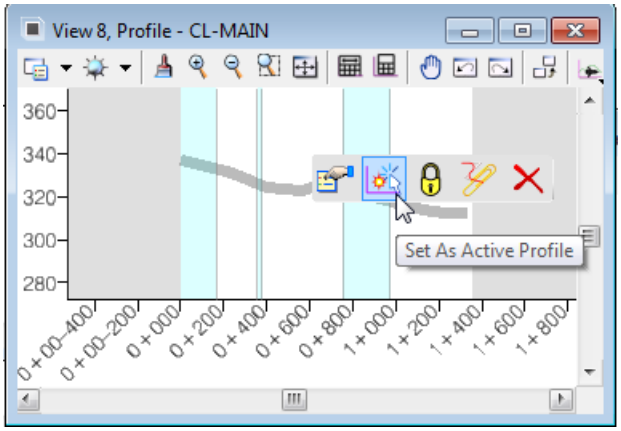
Geometry Tools Used:

CONTEXT MENU (ON ELEMENT)	ICON	TOOL
		Set As Active Profile

Note	This tool can also be accessed from the Context pop-up menu.

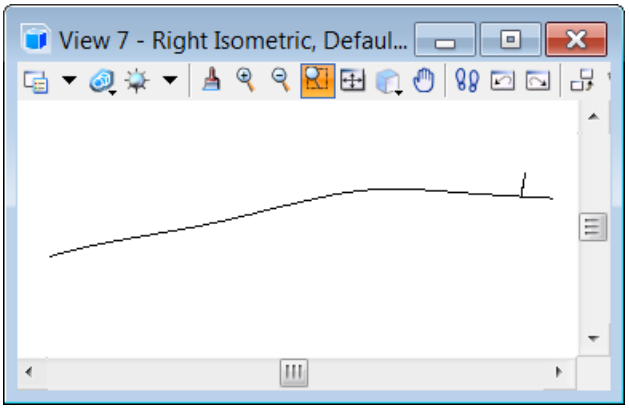
Procedure:

77. Continue in *start_ch3.dgn*.
78. In View 8, select the design profile, hover over it to access the Context Toolbar and then select **Set As Active Profile**.



79. Open View 7.
80. Select View Attributes (<CTRL>+B) and at the bottom in the View Setup section, select the MicroStation Model ***"Default-3D".*** You'll see our CL-MAIN horizontal and vertical geometry combined into a 3D element.

    You may need to fit the view to see the 3D geometry.



3D view (top) of CL-MAIN and East Road Horizontal / Vertical Geometry Elements

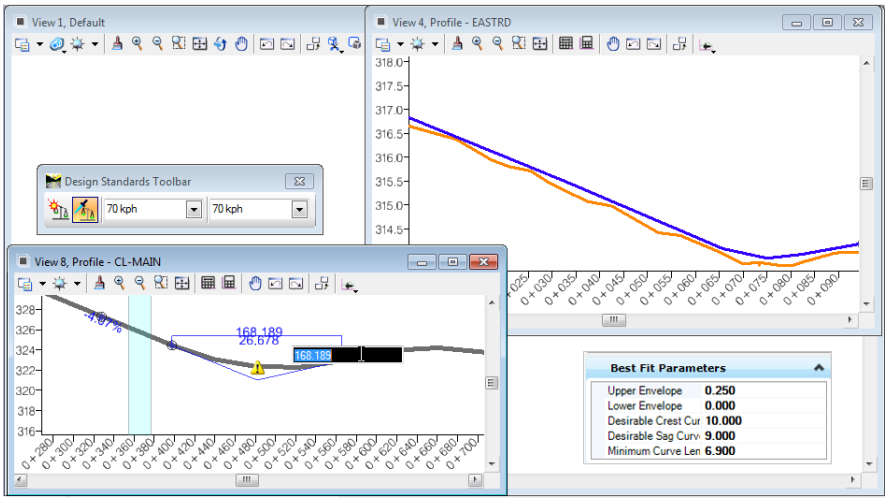
This is probably is not very impressive at this point, but let's summarize what you are seeing:

- The horizontal alignment has been combined with the vertical alignment to create a 3D element.
- This element has been placed in a 3D model created and maintained by the Civil technology.

Hint	Viewing of this model uses MicroStation's dynamic views technology.

CHAPTER SUMMARY

In this chapter, we have learned to generate a Best Fit profile. We also worked with manipulators to remedy deficiencies in our preliminary design profile and reviewing for Design Standard compliance. Then we defined our design profile as the Active Profile to be used in subsequent exercises.



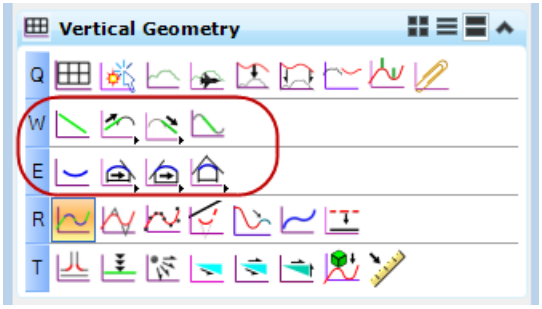
Summary of Profiles

Chapter 9: Component Profiles

OVERVIEW

One method of developing design profiles is by constructing various parabolas, curves, or lines, then connecting them together. This method of building components uses two rows of tools in the Vertical Geometry toolbox:

- Vertical Geometry Lines
- Vertical Geometry Curves



Once the components are built, they are connected together with the Profile Complex By Elements tool (the orange tool in the "R" row).

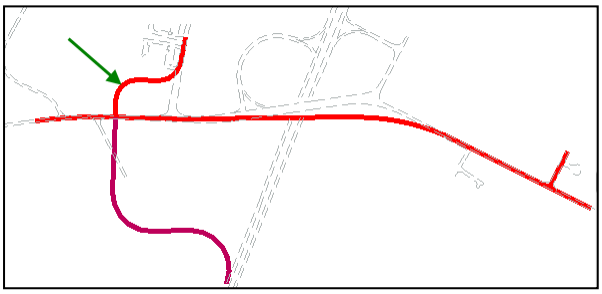
Vertical Design Standards can be utilized with component profiles, or applied after construction.

VERTICAL CURVE TYPES

The options for curve type can be changed in the dialog or by pressing Shift key on keyboard. Supported curve types are:

- Parabola – symmetric parabolic curve
- Asymmetric – asymmetric parabolic curve
- Circular – simple curve defined by radius

DEVELOPING THE WEST ROAD PROFILE



West Access Road in the Project Layout

This exercise will guide you through the process of designing the West access road profile where we will tie to CL-MAIN. Our general workflow is:

- Develop the mainline edge of pavement profile.
- Draw the intersection points of mainline into the West Road Profile Model View.
- Add profile (working) lines to each end of the existing ground profile to tie to ground.
- Construct the reverse transition.
- Add a vertical curve (parabola) to the lower tie down to ground.
- Connect all the elements together.

Defining the Profile For the Mainline Edge of Pavement and Display in 3D

Note the following set-up has already been completed, in order to expedite the actual exercise.

- View 1 is located near the intersection of CL-MAIN and West Rd.
- View 2 is open and defined as the Profile Model View for WESTRD.
- View 7 has our 3D CL-MAIN element.
- Our preliminary design for CL-MAIN shows a 14.3 meter median / roadway sloping at a constant slope = -2% (away from the centerline). The edge of pavement was drawn (in 2D) using Civil horizontal geometry tools, but no slope / elevation has been applied.

Objective:

Before we start designing the West Road profile, we need to be able to view the cross slope of the mainline roadway. To accomplish that, we'll create a profile for the mainline edge of pavement and use it in conjunction with the centerline profile.

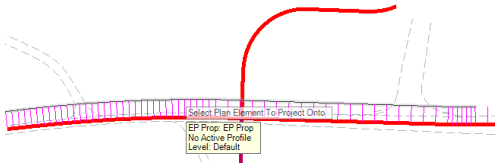
Geometry Tools Used:

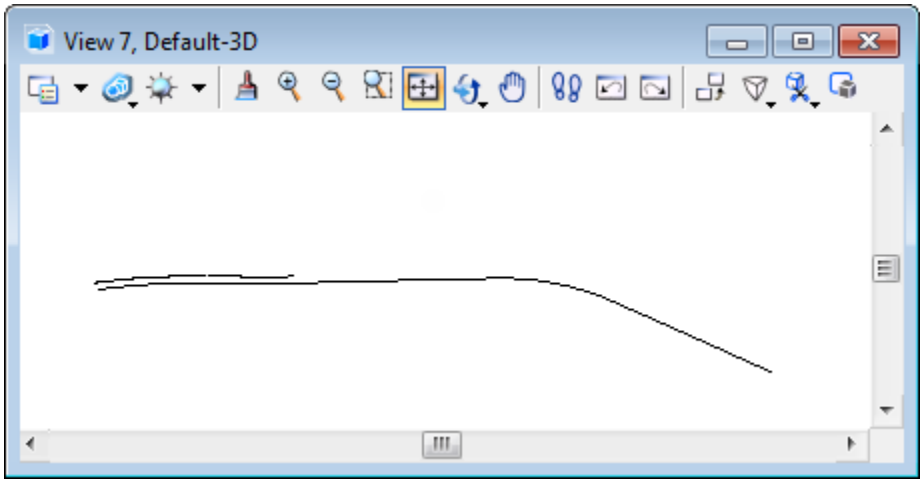
VERTICAL GEOMETRY PANEL	ICON	TOOL
		Profile By Slope From Element
		Profile Intersection Point

Procedure:

1. Continue in *start_ch4.dgn*.

2. Select the **Profile By Slope From Element** tool.
3. Follow the heads-up prompts. Even though we are defining a profile, all element selections are done in View 1.

HEADS-UP PROMPT	USER ACTION
Select First Element to Profile	Select the edge of pavement in view 1.
Select Next Element To Profile – Reset to Complete	Reset
Locate Reference Element	Select the CL-MAIN alignment in view 1. (The selected element must have an active profile.)  .
Slope	Key in -2 <enter> and data point to accept.
Point Selection	All (which is the default) Data point to accept.
Profile Adjustment	None. Data point to accept.
Vertical Offset	0.0 Data point to accept.



CL-MAIN Alignment and Left Edge of Pavement Displayed in 3D

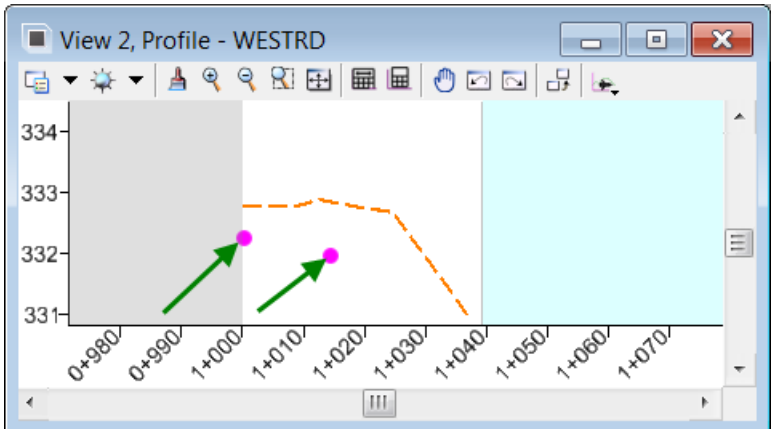
We need to know how these two 3D elements (which form the cross-slope of the mainline) lie in relationship to West Rd.

4. Select the **Profile Intersection Point** tool.
5. Follow the heads-up prompts. Select the WESTRD road centerline as the element to profile.

HEADS-UP PROMPT	USER ACTION
Locate Element to Show Intersection	Select the WESTRD in view 1.
Locate Element Which Intersects	Make sure you are selecting in View 7, which is 3D. Select the edge of pavement.
Locate Next Element Which	Select the CL-MAIN alignment in view 7. Reset to complete the intersections. Note it

Intersects – Reset to Complete	doesn't matter which order you define the 3D elements.

6. Look closely to see the two intersection points.



Intersecting Profiles Displayed as Small Dots

7. Close view 7, as we no longer need it.

Now, let's start the West Road profile design.

Develop the Design Profile For the West Road

Objective:

In this exercise, we will complete the following tasks:

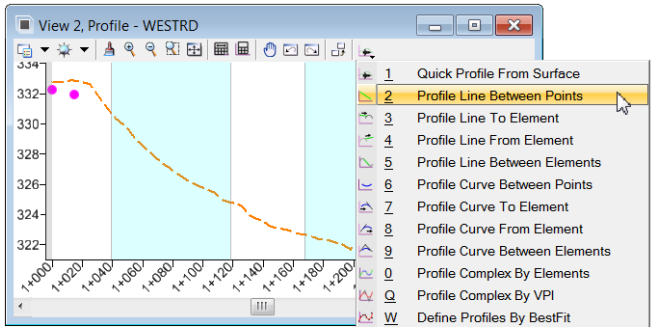
- Add profile (working) lines to each end of the existing ground profile to tie to ground.
- Construct the reverse transition.
- Add a vertical curve (parabola) to the lower tie down to ground.

Vertical Geometry Tools Used:

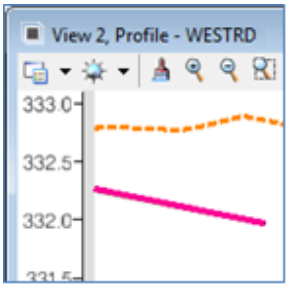
VERTICAL GEOMETRY PANEL	ICON	TOOL
		Profile Line Between Points
		Profile Reverse Transition
		Parabola Between Elements
		Profile Complex By Elements

Procedure:

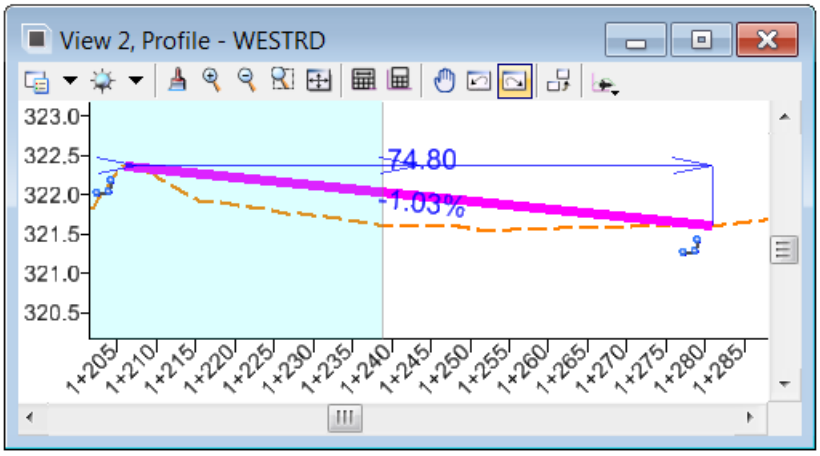
81. Continue in *start_ch4.dgn*. Expand view 2 (Profile – East Rd to fill the screen.)
82. Working in Profile View 2, select the **Profile Line Between Points** tool. Use the quick tools within the view.



83. We'll start at the end where we have the two intersecting points. Snap to the mainline centerline point for start point.
84. Snap to the edge of the mainline pavement for second point.



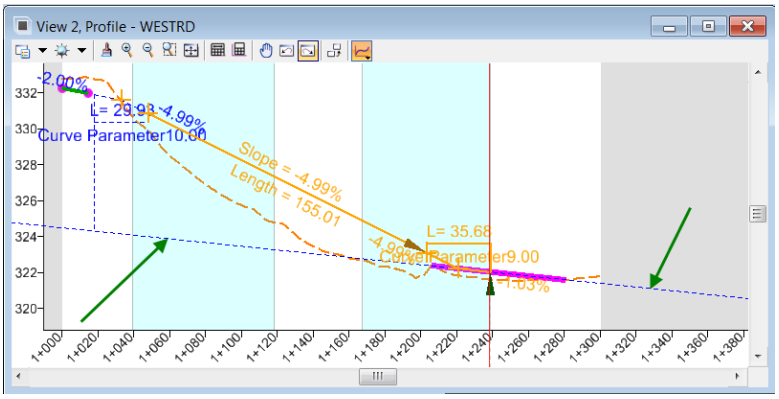
85. Repeat the Line Between Points procedure in the lower right corner (using the illustration as a guide), snapping to existing ground near 1+280 and the high point near 1+206.



86. Set the Design Speed to 50KPH and toggle on **Active Design Standard**.
87. Fit the view to see the entire profile.
88. Select the **Profile Reverse Transition** tool.
89. Follow the prompts.

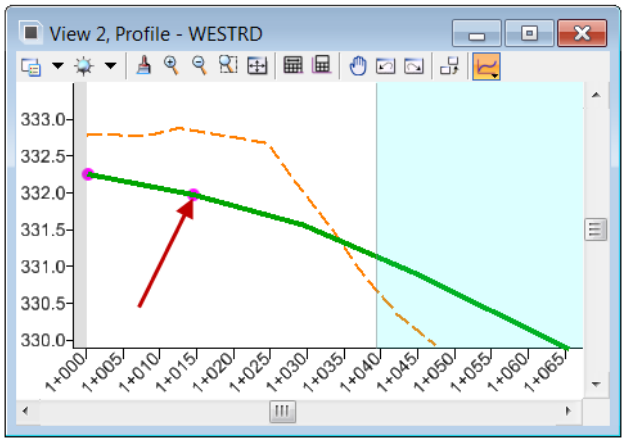
HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the intersecting profile line in the upper left corner.
Back Vertical Offset	Enter 0 and data point.
Locate Second Element	Select the profile element in the lower right corner.
Back Vertical Offset	Enter 0 and data point.

Now the reverse transition dynamically moves along the second profile line (as indicated by the arrows in the illustration below.)

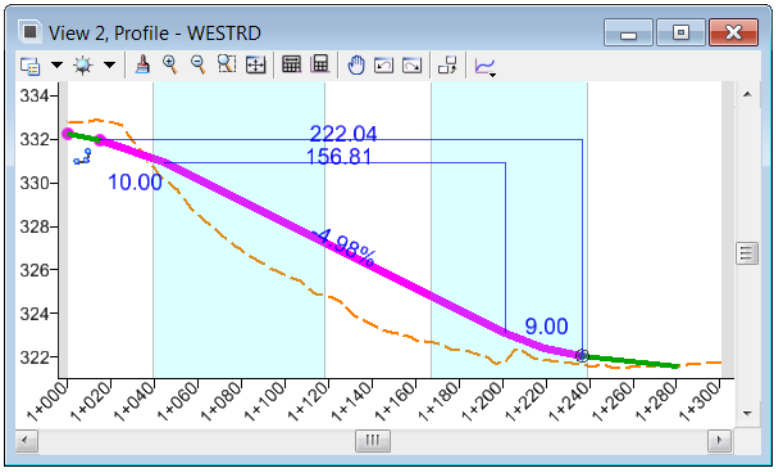


Reverse Transition Construction Controlled By Cursor Movement Along Blue Dotted Line

90. The curves are automatically forced to our Design Standards. We want the tangent grade below 5%, so slide the dynamic to the right (around station 1+240), until the grade is less than 5%. Data point to complete the dynamic.
91. The reverse transition is now attached the cursor. Slide upwards and snap to the edge of pavement in the upper left corner.

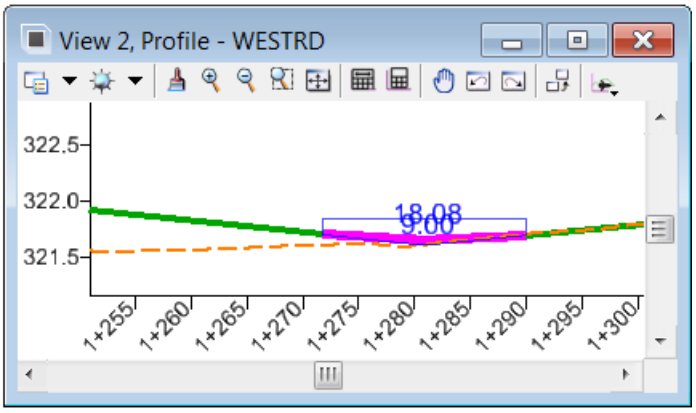


92. Set the **Trim / Extend** option to Both and data point to accept. The construction is complete. The Element Selection shows the manipulators.



93. Select the **Profile Line Between Points** tool and place another line along existing ground from 1+280 (snap to other profile line we placed earlier) to 1+300 (end of the profile).
94. Ensure your Design Standards are still active and select the **Parabola Between Elements** tool.
95. Follow the prompts.

HEADS-UP PROMPT	USER ACTION
Locate First Profile Element	Select the left profile line.
Locate Second Element	Select the right profile line.
Vertical Curve Parameter	Move the cursor until the sag curve is displayed and data point.
Trim / Extend Option	Trim both and data point.



Parabola Created Between Two Profile Lines

Combine the Elements To Complete the Design Profile For the West Road

Objective:

Now we need to combine these individual components into one profile, called a complex.

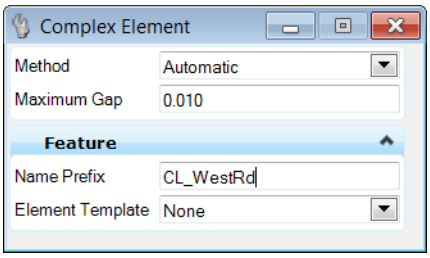
Vertical Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL

		Profile Complex By Elements

Procedure:

96. Continue in *start_ch4.dgn* and fit the view so the entire profile is displayed.
97. Select the **Profile Complex By Elements** tool.
98. We have mostly ignored dialogs today, but you may have to look at the dialog to change the **Method** from Manual to Automatic.
99. Key-in "CL_WestRd" for the **Name Prefix**.



100. Select the first element. All connected elements will highlight.
101. **DP to Accept**. Now we have a vertical alignment for our West Rd.

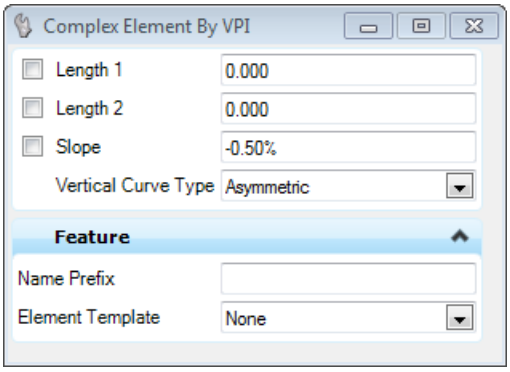
CHAPTER SUMMARY

In this chapter, we have learned how to work with some of the foundation tools for profiles, i.e., building components and then combining them together into a profile. While we don't have time in this workshop, we can also manipulate the elements to rework them as needed for the project.

Chapter 10: Profiles by Vertical Points of Intersection (VPI)

OVERVIEW

The Profile Complex By VPI tool constructs a profile complex defined by vertical points of intersection (VPI). Within the one tool, we can define the VPIs and then assign the associated vertical information. Design standards can also be incorporated into the profile, or they can be set afterwards.



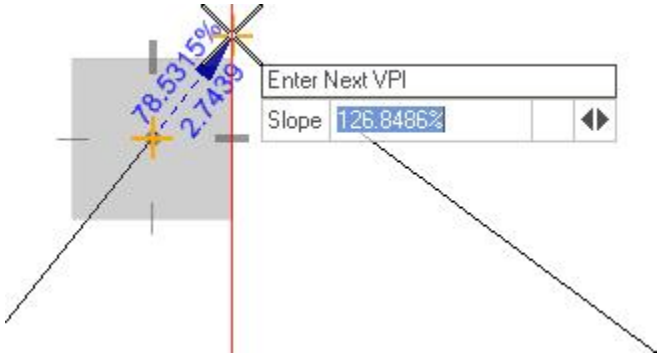
USING THE PROFILE VPI TOOL

First, open the Profile Model View 2 if not already opened and then select the tool.

Note	Checking the box next to any of the fields locks in the associated value.

When you move the cursor into the Profile View, it is equipped with a tooltip that prompts you to "Enter First PI". Place the cursor over the initial point of intersection by left-clicking at the desired location.

The tooltip prompts you to "Enter Next VPI", so use one of the following methods to designate a point through which the curve must pass (navigate the options by striking the left or right arrow keys):



- As you move the cursor, a value is displayed on the tooltip. Left-click at the desired value.
- Enter a value for the Curve Length then strike the Enter key.
- Enter a value for the Curve Parameter then strike the Enter key to lock in the value.
- Enter a value for the Slope then strike the Enter key to lock in the value. The slope can always be locked independently of the length or curve parameter.

Note	The VPI can be positioned dynamically or with the aid of Civil AccuDraw. The heads up prompt can also be used to lock the desired slope value from the previous VPI to the current VPI.

On the 3rd and subsequent VPIs, the Length and/or Curve Parameter can be used to control the curve placed at the previous VPI. For example, the length entered at the 3rd VPI prompt is used to define the curve at VPI 2.

VERTICAL CURVE TYPE

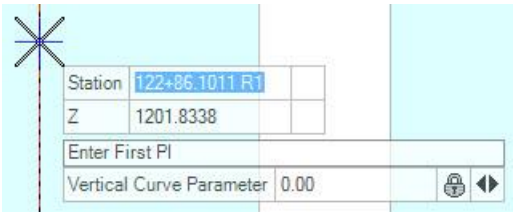
The option for curve type can be changed in the dialog or by pressing the **Alt** key on your keyboard. Supported curve types are:

- Parabola – Symmetric Parabolic Curve
- Asymmetric – Asymmetric Parabolic Curve
- Circular – A simple curve defined by radius

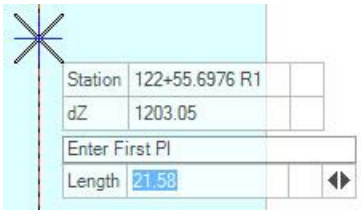
USING CIVIL ACCUDRAW WHEN DRAWING PROFILES

In order to use precision key-in values in conjunction with the Complex by PI tool, Civil AccuDraw should be employed. When activated, the heads-up prompt changes from its generic display and has the following benefits.

a. With Civil AccuDraw active, we can key in exact values for stations and elevations.
b. Parameter can be K-Value or R-Value which is defined in design file settings.
c. The arrows on right of prompt indicate another input is possible here.



Click the right arrow or left arrow on your keyboard to change the prompt to curve length.

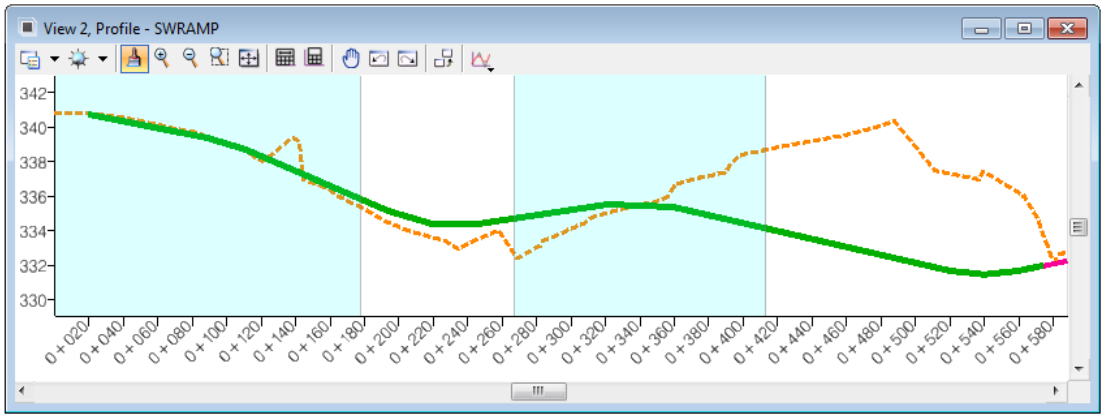


Hint	While hovering, the tooltip will give an indication of what the value is or what the handle will do.

Exercise: Vertical Alignment By VPI

Objective:

We'll use the **Profile Complex By VPI** tool to construct six VPIs for our SWRAMP profile. We'll tie to existing ground at the beginning (south end of the road), and connect to the edge of CL-MAIN on the end. Stationing runs from south to north. CL-MAIN pavement has already been drawn into the profile view. Our completed profile is illustrated below for reference.



Geometry Tools Used:

GENERAL GEOMETRY PANEL	ICON	TOOL
		Activate Civil AccuDraw Toggle
VERTICAL GEOMETRY PANEL	**ICON**	**TOOL**
		Profile Complex By VPI

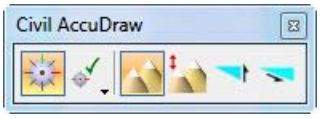
Procedure:

Note	These instructions are very detailed in the use of Civil AccuDraw. For those who are already familiar with its use, the data for each VPI is summarized at the end of these instructions.

102. Open *start_ch5.dgn.* We'll be using View 4 previously created for SWRAMP.

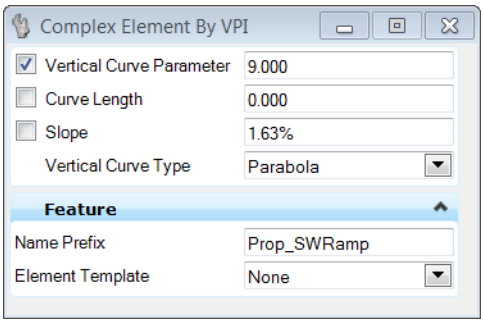
103. Set the Design Standards to **50 KPH** and enable the Active Design Standards toggle.

104. Activate the Civil AccuDraw toolbar and enable **Civil AccuDraw.**



105. Select the **Profile Complex BY VPI** tool.

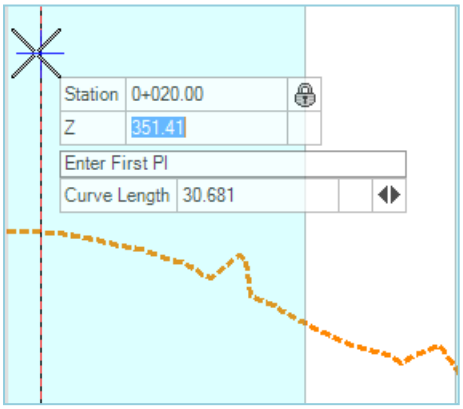
106. In the Complex Element dialog, enter the **Name Prefix** as Prop_SWRamp.



107. **First VPI:**

Our first VPI is going to tie to existing ground. As the alignment runs along the existing roadway, we'll move in slightly to sta. 0+020.

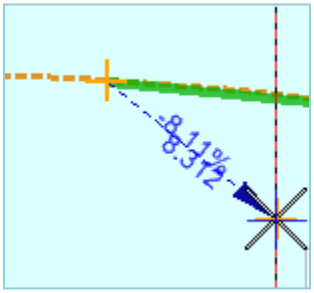
a. Tab through the options in Civil AccuDraw until the cursor is in the Station field. Key in 20 and <ENTER>. Note there is lock now on the stationing. Since our stationing is 0+020, we only have to enter 20 and the rest fills in!



b. Dynamically move the cursor up and down along the red line, which shows the station value is locked. When the X indicating you're on existing ground appears, data point to accept.

Hint	Use the "Nearest" snap to lock to the existing ground at station 0+020.000

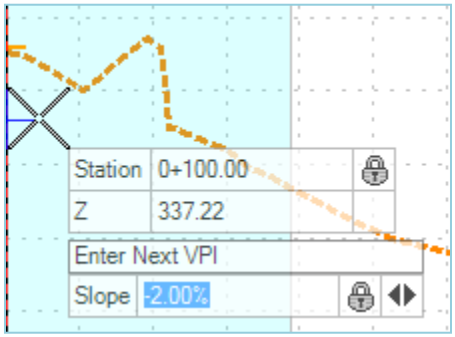
c. That completes the first VPI. Note the first VPI is fixed in place and the profile is attached to the cursor.



108. **Second VPI:**

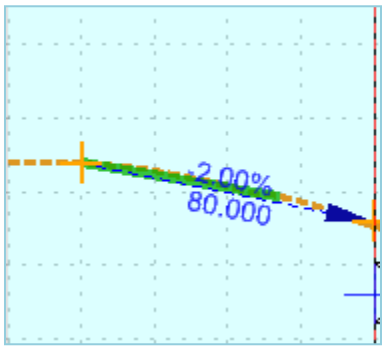
We'll want our first vertical curve to be outside the tie down point, but somewhat centered within the horizontal curve area (indicated by the coloring on the profile). We also want to miss the peaks in the terrain model, some questionable field data that needs further investigation.

a. Enter the station as we did in the first VPI using 0+100. Key in the station as 100 and <ENTER>. This time we'll use a slope so tab until you are in the Curve Length field where you see the <> arrows. This tells us there's more prompts available. Using the right arrow on the keyboard, arrow through the choices until you have it set to Slope. Key in -2 and <ENTER>.



Note	The parameters for the vertical curve (such as length) are set by our vertical design standards.

b. Place a data point in the workspace to complete the second VPI.

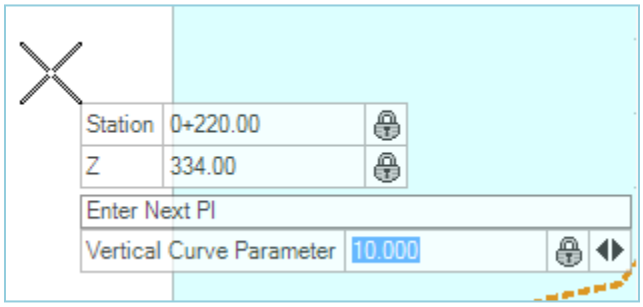


109. **Third VPI:**

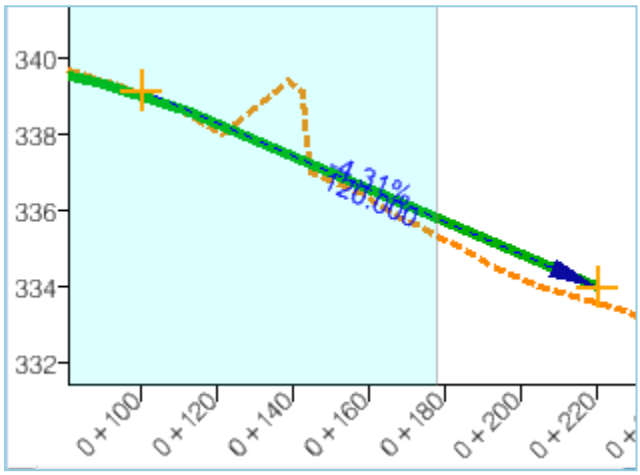
For the third VPI, we want to decrease elevation, but we still want to be in a fill situation. Then we can use up some of the excess dirt we'll have from the next 500m along the alignment.

a. Enter the station as we did in the first VPI using 0+220.

b. Tab to the elevation field, key in 334.00 and <ENTER>.



c. Place a final data point in a blank area of the workspace to complete the third VPI.

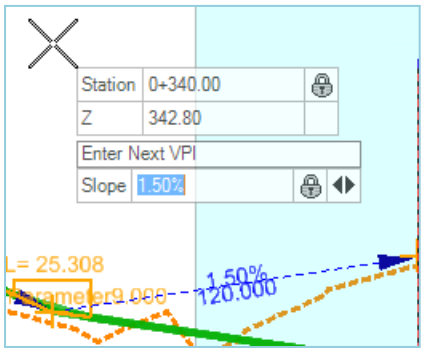


110. **Fourth VPI:**

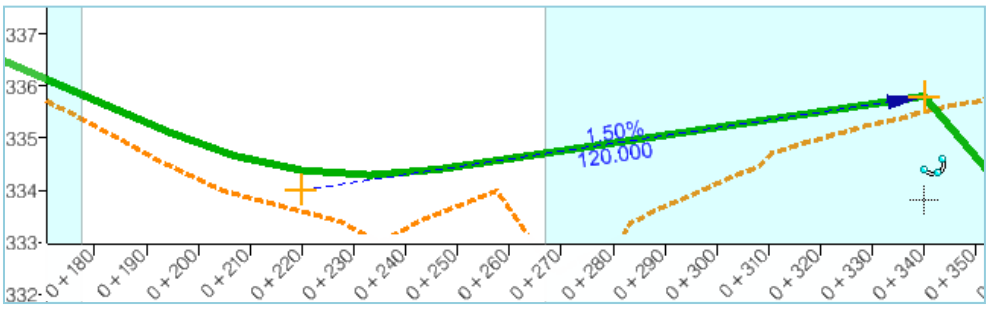
We'll set our grade heading uphill slightly. We also want to fit our vertical curve inside the horizontal curve area. We also want to consider the algebraic difference of adjoining grades. Since coming into the VPI is -4.3% and we don't want to exceed 6% (which is our standard), we use 1.5%.

a. Enter the station as we did in the first VPI using 0+340.

b. Tab to the Vertical Curve Parameter field, right arrow to Slope and key in 1.5 <ENTER>. (Note this is a positive value).



c. Place a final data point in a blank area of the workspace to complete the fourth VPI.



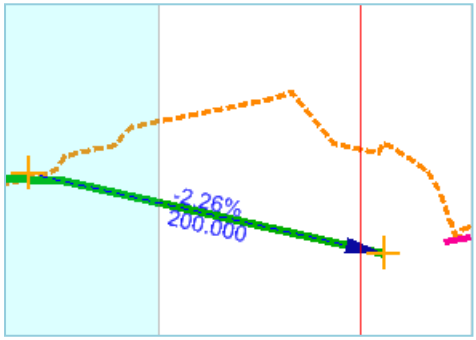
111. **Fifth VPI:**

We'll continue to decrease our elevation in order to tie to the mainline pavement (shown pink at the far right side of the profile). We also want to fit our vertical curve inside the horizontal curve area.

a. Enter the station as we did in the first VPI using 0+540 and <ENTER>.

b. Tab to the Elevation field and key in 331.28 and <ENTER>.

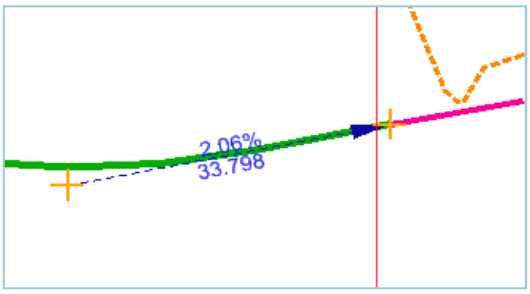
c. Place a final data point in a blank area of the workspace to complete the fifth VPI.



112. **Sixth (and final) VPI:**

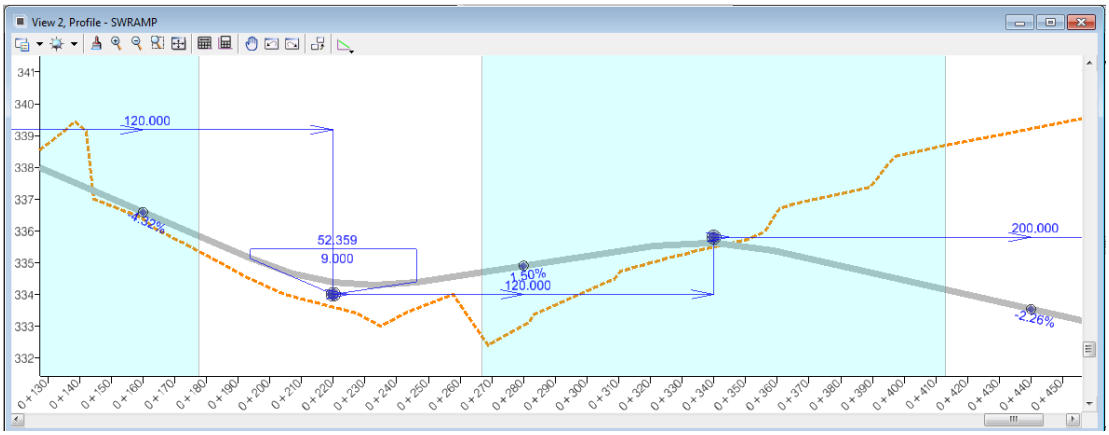
For this VPI, we want to connect to the edge of the mainline roadway, already drawn in the file. We'll add a vertical curve in the swale area between our decreasing profile grade and the slope of the pavement.

a. Hover over the edge of pavement until you see the X, then data point to accept. This completes the sixth VPI and our profile.



b. Reset to exit the tool and complete the profile.

c. Disable Civil AccuDraw.



Completed SWRAMP Profile Using the Profile Complex by VPI Tool

Note Note that the display of manipulators is dependent on your view. If you are zoomed way out, you won't see any manipulators. As you zoom in, they are displayed based on the type of element and what is visible on the screen. Hover over the VPI to see its Station / Elevation. If you don't see them, zoom in or out to change them.

VPI SUMMARY

VPI NUMBER	STATION	ELEV.	GRADE
1	0+020	340.78 (snap to ground)	
2	0+100		-2.0%
3	0+220	334.0	
4	0+340		+1.5%
5	0+540	331.28	
6	0+573.8 (snap to road)	331.97 (snap to road)	

Optional Exercise: Manipulate / Modify the Vertical Alignment By VPI

Objective:

We'll review the type of manipulators that are used with the VPI tools. Our design standards drew default vertical curves, so we can improve those by graphical manipulations.

Procedure:

113. Continue in *start_ch5.dgn* using the SWRAMP profile.
114. Check the connection between the new centerline pavement and the tie to our SWRAMP profile. Zoom in closely. If you didn't quite snap to the correct location, adjust by moving the end of the SWRAMP profile. Use the Element Selection tool to highlight the profile and see the manipulators.
115. Increase the length of curves to more closely match the horizontal curve lengths (which are color coded.)

CHAPTER SUMMARY

In this chapter, we have learned how to build a profile using VPI information. We also learned how to utilize the power of Civil AccuDraw, with its command of station / offset / slope and other vertical geometry information.

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Chapter 11: Miscellaneous Profiles

Overview

There are still a few tools that we have not utilized yet, so in this chapter we'll look at some examples of these tools and real-life project scenarios. They include:

- using data drawn with generic MicroStation tools
- dummy profiles
- ditch profiles
- offset profiles for overlays or subsurface design
- profiling curb returns

Using Data Drawn With Generic MicroStation Tools

Not all of our project data may be drawn with civil horizontal and vertical geometry tools. We may want to utilize MicroStation elements or data from an external source, such as governmental agencies (counties, states, and cities) or consultants.

We'll use a tool to attach rules to the MicroStation elements, which changes them from generic elements to those that have edit manipulators and handlers. Then they can be used in conjunction with other civil elements. The tools are available for either horizontal or vertical elements.

Turning Generic MicroStation Elements into Horizontal Civil Elements

Objective:

Change generic MicroStation elements comprising the Northeast and Northwest Loops into Civil elements.

Geometry Tools Used:

Horizontal Geometry Panel	Icon	Tool
		Create Civil Rule Feature

Procedure:

116. Open *start_ch6.dgn*.
117. Select the **Create Civil Rule Feature** tool from the Horizontal Geometry panel.
118. Select the N.E. Loop elements.
119. Reset to complete the procedure.

120. Use Element Selection to view the edit manipulators, which tells us rules have been created. You may have to zoom in to see the manipulators for the transitions.

121. Repeat the process for the N.W. Loop.

122. Set the **Feature Definition** to Geom_Ramp and **Name Prefix** to NE LOOP or NW LOOP and create complex horizontal elements for each loop.

MAKING DUMMY PROFILES AT A CONSTANT ELEVATION

There are occasions when you may need a profile, but don't need or have specific data for it. For example, in order to create a corridor, you need a profile. If you're working on a divided highway, the baseline may run down the median, but the actual profiles are down the edges of pavement. In this case, you still need a profile for the baseline, even though it's not used for anything.

While you could use an existing terrain profile, we can also build a profile with a constant elevation very quickly as well. The **Define Profile By Constant Elevation** tool defines a flat profile at a given elevation for the entire element.

Create a Profile at a Constant Elevation

Objective:

We'll create a constant profile for N.E. Loop while we wait for additional terrain model data.

Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL
		Profile By Constant Elevation

Procedure:

123. Continue in *start_ch6.dgn*.

124. Select the **Profile By Constant Elevation** tool.

Do not assign Name Prefix or Feature Definition at this time.

125. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Locate First Element	Select the NWLOOP in view 1.
Locate Element – Reset End	Reset to end the selection phase.
Enter Elevation	Enter 330 and <ENTER>. Data point to complete.
Locate First Element	We could do other alignments, as this tool loops back to the beginning. Select Element Selection to exit from the tool.

126. Open a Profile Model View and verify the elevation is a constant 330 meters, appearing horizontal in the view.

127. Close the Profile Model View.

SPECIAL DITCH PROFILES

There are numerous methods of developing special ditch profiles and a variety of tools are supported. Some ditch profiles are developed with station / elevation information and do not require vertical curves. There are several tools we could use to do this, but the simplest way is to use the Profile Line Between Points in conjunction with Civil AccuDraw to enter station / elevation or slope. Another option is to utilize a horizontal element and develop the profile using any of the methods we've already learned. To display the ditch profile overlaid on the roadway centerline, we can use the Project Profile tool.

Create a Special Ditch Grade Using VPI's

Objective:

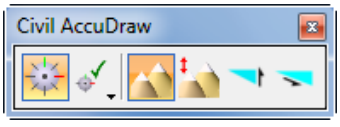
We'll create a VPI-based profile using the Profile Line Between Points tool in conjunction with Civil AccuDraw.

Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL
W		Profile Line Between Points
R		Profile Complex By Elements
GENERAL GEOMETRY PANEL	**ICON**	**TOOL**
E		Activate Civil AccuDraw Toolbar
Q		Features Toggle Bar

Procedure:

128. Continue in *start_ch6.dgn*.
129. Open the Profile Model View for CL-MAIN in view 8.
130. Activate the Civil AccuDraw toolbar and then enable Civil AccuDraw.



131. Select the **Profile Line Between Points** tool.
132. In the Features Toggle Bar, enable the toggle to **Chain Commands**. This will make this tool much more efficient in its use, as this will force the last VPI of the previous line placement to be used as the first VPI of the subsequent line placement.

133. Don't worry about setting a Name Prefix or Element Template at this time.

Follow the heads-up prompts to enter VPI's at the following locations:

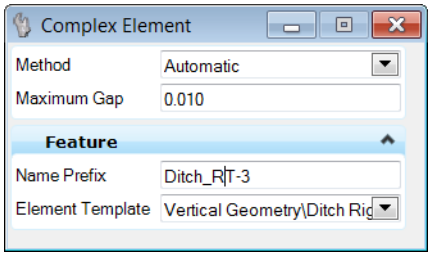
STATION	ELEVATION
1+100	313.0 m
1+150	312.5 m
1+200	312.0 m
1+250	311.5 m

Once the fourth and final VPI is entered, Reset to exit the command.

134. Disable Civil AccuDraw.

135. Open the **Profiles Complex by Element** tool.

136. Configure the dialog as shown.



137. Identify the first element and accept the complex.

138. Fit the view.

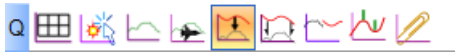
139. Close the Profile Model View (8).

Display A Special Ditch Profile Onto the Roadway Profile

Objective:

We'll project the already created ditch grade back onto the roadway profile.

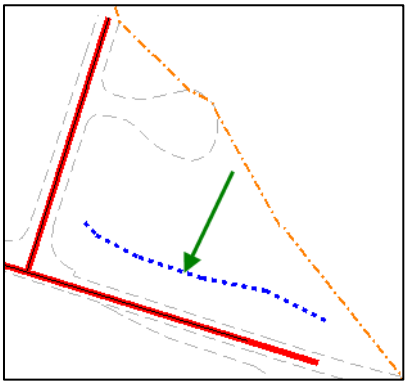
Geometry Tools Used:

VERTICAL GEOMETRY PANEL	ICON	TOOL
		Project Profile to Element
		Project Profile Range to Element (Not used in this exercise, but can be used to project part of an element.)

Procedure:

140. Continue in *start_ch6.dgn*.

141. In View 1, select the MicroStation saved view “Northeastern Side Road.”

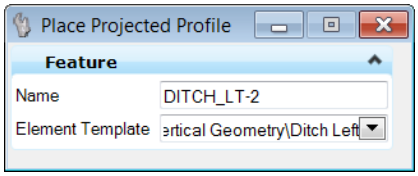


CL-MAIN and Special Ditch (Green Arrow)

142. Open the Profile Model in view 6 for DITCH_LT-2.

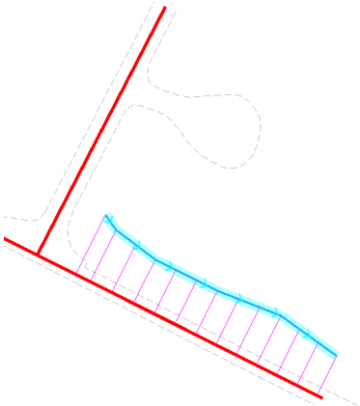
143. Select the **Project Profile to Element** tool.

144. Set the Name Prefix and Element Template.



145. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Select Element to Project	Select the DITCH_LT-2 in the profile View 6 (blue dash line).
Select Plan Element to Project Onto	Select CL-MAIN in View 1.



146. Close Profile Model View (6).

147. Open the Profile Model View (8) for CL-MAIN.

148. Note the project ditch profile near the end (Station 1+280 to end). Use the Element Selection tool to view its properties.

OFFSET PROFILES FOR SUBSURFACE DESIGN

On some projects with varying types of geotechnical materials, it is necessary to vary the depth of aggregates and base materials under the roadway. One way to accomplish this is with offset profiles. Using the design profile of the roadway, we can store a subsurface profile to be utilized within Corridor Modeler.

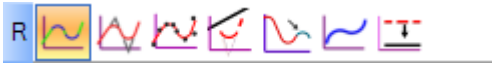
Another example of offset profiles is for mill and overlay projects. Offset profiles for milling depths or proposed top of pavement can be generated from the existing ground profile, and then optionally used in the Profile By Best Fit tool.

Create a Subsurface Profile

Objective:

We'll create a subcut profile for the mainline alignment.

Geometry Tools Used:

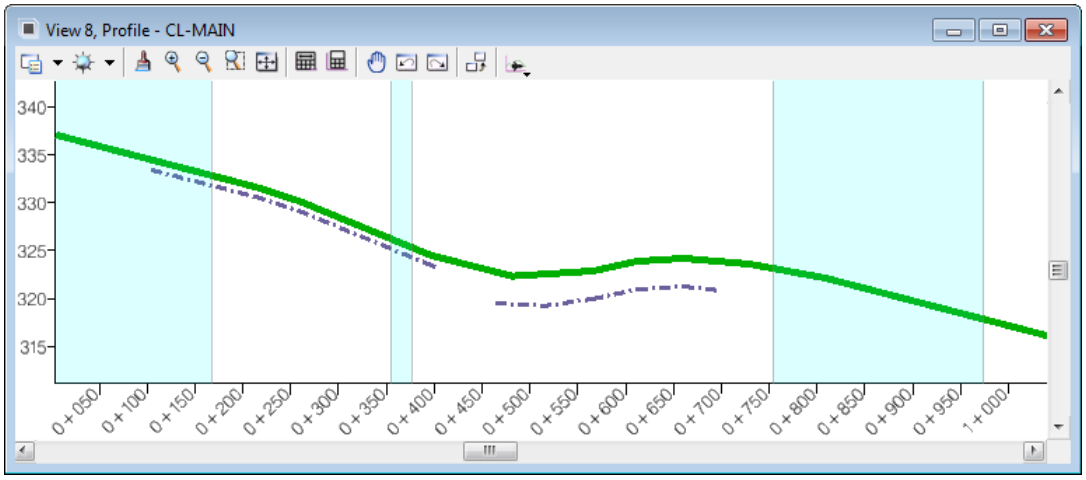
VERTICAL GEOMETRY PANEL	ICON	TOOL
		Profile Offset Transition
		Profile Complex By Elements
		Profile Line Between Points

Procedure:

149. Continue in *start_ch6.dgn*.
150. Open the Profile Model View for CL-MAIN in View 8.
151. Turn off all levels except the main design profile.
152. Select the **Profile Offset Transition** tool.
153. Set the **Element Template** to Vertical Geometry > Subsurface.
154. Follow the heads-up prompts.

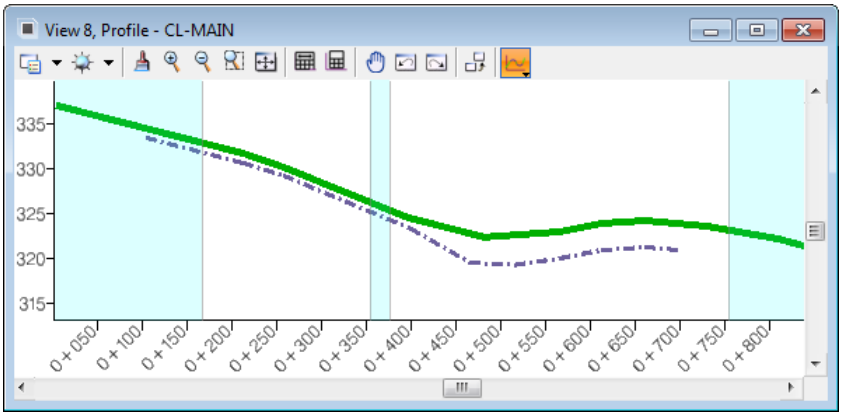
HEADS-UP PROMPT	USER ACTION
Locate Element	Note that if an Active Profile is set, you will not receive this prompt as it will by default use the active profile. If no active profile is set, then select the Design Profile in View 8.
Start Parameters –Start Offset	Enter -1.0 <ENTER> but do not data point yet! Notice the black arrows to the right of the value, which indicate more prompts.
Start Parameters – Start Distance	Using the right arrow on your keyboard to view the Start Distance field. Enter --0+100. Data point to accept.
End Parameters – End Distance or Station	Using the right arrow on your keyboard to view the End Distance or Station field. While we could enter a value, let's just use the cursor to define the distance. Move the cursor to approximately 0+400. Data point to accept.
Mirror	Use the arrows on your keyboard to set to No and data point to accept.

155. Repeat the tool to place a -3m offset between stations 0+460 and 0+ 700.



Segments of CL-MAIN Subcut Profile

156. Select the **Profile Line Between Points** tool and connect the two offsets.



CL-MAIN Design Profile (green) and Subsurface Profile (Dashed Blue)

157. Select the **Profile Complex By Elements** tool and connect the three elements. Name as Subcut and use the **Element Template** to Vertical Geometry > Subsurface.

158. Close the Profile Model view.

PROFILING CURB RETURNS

We have already created the edges of pavement for parts of CL-MAIN at the west end of the project near the SW Loop. We have a filet drawn as a horizontal geometry element. As the both edges of pavement have vertical geometry, we can create a quick profile for the curb return and review for drainage requirements. The Define Quick Profile Transition between Elements tool defines the profile of an element by matching the slope and elevation of adjoining elements. Two methods are supported:

- The Parabolic method forms a smooth convex or reverse curve between the profiles of the adjacent elements. The instantaneous elevations and slopes are used to constrain the profile.
- The Linear method simply connects a straight profile line between the profiles of the adjacent elements. The slope is not considered.

Note	The adjoining elements must have a design profile.

Create a Profile Transition for the Curb Returns

Objective:

We'll create a profile transitioning for the curb return in our S.W. Ramp and CL-MAIN intersection. The alignments and edges of pavement (except for the fillets) already have profiles attached. So we'll use those profiles to generate the transition.

Geometry Tools Used:

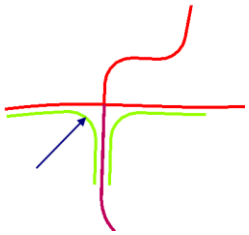
VERTICAL GEOMETRY PANEL	ICON	TOOL
		Quick Profile Transition

Procedure:

159. Continue in *start_ch6.dgn*.
160. Select the MicroStation Saved View "Curb Return."
161. Open View 7 to view the 3D geometry.
162. Select the **Quick Profile Transition** tool.

Do not assign Name Prefix or Element Template at this time.

163. Follow the heads-up prompts.

HEADS-UP PROMPT	USER ACTION
Quick Transition Method	Parabolic. Data point to accept.
Locate What To Define	Select the curb return fillet on the west side of the road. 

164. Repeat for the curb return on the east side of the road.
165. Open a Profile Model View to view one of the curb return profiles. Leave the view open.
166. Open a Profile Model View for the SW Ramp. The elevation is a constant 330m.
167. Select the edit manipulators and change the elevation to 333. Note the change in the curb return profile as well as the 3D geometry.

CHAPTER SUMMARY

In this chapter, we have learned how to work with various project scenarios including ditch profiles, subsurface vertical geometry, utilizing non-Civil geometry elements, and quick profile transitions.

Assessment

1. True or False: Civil horizontal geometry elements can be manipulated / edited.

True. Elements are easily manipulated by clicking on the element to display the element handlers. Then the element can be adjusted by clicking on the edit field and changing the value, or by selecting one of the graphic manipulators and dynamically moving.

2. Which is NOT a Civil horizontal geometry tool?

A. Start Station

B. Place SmartLine

C. Define Horizontal by Best Fit

D. Create Complex by PI

Answer: B. Place SmartLine is a MicroStation tool, not a Civil horizontal geometry tool.

3. How can you use a Design Standard for horizontal geometry elements?

A. Select the desired design standard first, then place the civil horizontal geometry element.

B. All civil horizontal geometry elements automatically have design standards.

C. Use the Set Design Standard tool to assign a standard to a previously drawn civil element.

D. A. and C.

Answer: D – Design Standards can be assigned at the time of civil geometry creation or after the creation by using the Set Design Standard tool.

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Appendix A: Setting Up the Workshop in Your Office

OVERVIEW

The workshop can easily be set up to run on your office computer or laptop. The Civil Workspace used for this workshop is delivered with the installation package of the SELECTseries 3 products. Basic steps include:

- Copy dataset from DVD to computer
- Select the Civil Workspace when opening the first file, just as you did in the workshop.

Note	Note that many of the workshops use references files and other resources that are path dependent. Therefore, you may want to utilize the same path as you did in the actual workshop.

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Glossary

2D Point Feature	Contains no elevation (Z). 2D Point Features are defined and stored in plan model.
3D Geometry	3D geometry is created in 3D model by mathematically combining the horizontal and vertical geometry to create 3D elements. These 3D geometry elements in turn define a design model.
3D Model	This is created and managed automatically. User can interact with it but this is not usually required. The mathematical combination of Plan Geometry and Profile Geometry is stored in the 3D model.
3D Point Feature	3D points can be defined in plan model or 3D model. They are stored in 3D model but represented in both plan and 3D.
Active Object	The current object to which is added all geometry which is created.
Active Profile	Of the multiple possible profiles for an element, the active profile is the one used for design. The active profile is combined with the horizontal geometry to build a 3D element which is used in the 3D model.
Active Terrain Model	One terrain model can be designated as “Active”. The active terrain model is the one used to display “existing ground”; in other words the one which displays automatically in a profile model when it is opened. The active terrain model is also the one which is targeted by side slopes unless the template defines a different target by name.
ALG	A legacy (proprietary) InRoads file containing coordinate geometry information, superelevation, and alignment information for a specific geometry project.
Alignment	A linear feature which serves the special purpose of defining the centerline or baseline of a roadway.
Apply Linear Template	Applies a corridor template along a feature while hiding some of the complexity of creating a corridor.
Apply Surface Template	Applies a corridor template to a terrain model for the purpose of creating components (such as pavement layers) under the terrain model.
Arc Definition	Curve definition method generally used in roadway applications. The radius R is used to define the curve and is defined by the equation R=5729.58/D where the degree of curvature D is the central angle subtended by a 100-foot arc. Set in the Design File Settings > Civil Formatting under Radius Settings. *See also Chord Definition.*

Aspect	An angular measure of the direction that the face of a surface is oriented. The format of the value is dependent on angular settings In the DGN file.
Base Geometry	In many instances the geometry element will be trimmed. The original (or base), untrimmed element is always preserved as it is the storage for the rule.
Boundary (Terrain Model)	Used to constrain the external boundary of the terrain model. No triangles are created outside the boundary. In addition, any point data outside the boundary is ignored.
Break Line	A surface feature consisting of a collection of spatial coordinates that have an implied linear relationship. No triangle side (in the triangulated surface) can cross over a break line.
Break Void	A closed area of missing or obscured data that uses the elevations of each vertex, while the void lines between successive void coordinates are inserted as break lines. Therefore, break voids change the slope and elevations of the TIN surface.
Cardinal Points	One of the points used to define the geometry of an alignment. Cardinal points include PC, PT, PI, and CC points for horizontal geometry and VPC, VPI and VPT for vertical geometry.
Centroid (triangle)	Geometric center of a triangle in a terrain model.
Chord Definition	Curve definition method generally used in railway applications. The radius R is used to define the curve, and is defined by the equation R=50/SIN(0.5*D) where the degree of curvature D is the central angle subtended by a 100-foot chord. *See also Arc Definition.*
Civil Cell	Used as a mechanism to preconfigure commonly used complex geometric layouts. These layouts will commonly be stored in DGNLIB files for reuse across multiple projects but it is possible and sometimes useful to store directly in an active DGN file for use in that single location. The civil cell will contain horizontal geometry and can also contain the vertical geometry.
Civil Message Center	Used to display a continuous updating log of Civil messages, including warnings and errors. As errors and warnings are resolved, they are removed from the list. New messages are added whenever the conditions warrant. Most messages relate to civil geometry, superelevation, and corridor modeling.
Civil Template	A civil design concept used most often for corridor modeling but also has other applications. The Civil Template defines the cross-sectional shape of the object being modeled. This cross-section is then “extruded along” a 3D geometry element to form the final model. The corridor template can create or target features such as road edges. The result is the creation of a corridor.
Clipping Reference	Clipping allows you to remove areas of overlap when working with multiple corridors in a single surface. For example, in a corridor intersected by a crossing roadway, clipping would be used to remove all overlapped features within the intersection.
Complex Terrain Model	A terrain model created by merging or appending two or more terrain models.

Context Toolbox	When an element is selected, hovering over the element provide a heads-up and context sensitive toolbar which pops up at the cursor. This toolbar provides a few of the most commonly used tools which operate on the element selected element type. The first tool in this toolbar is always Quick Properties.
Contour	A linear symbol representing points of equal elevation relative to a given datum.
Contour, Isopach	Contours of a delta terrain model which represent cut and fill values as contours, not elevations. A positive contour represents fill, while a negative contour is cut.
Contour, Major	The primary elevation line indicating a specific elevation in a surface model. Usually major contours are drawn with a heavier line weight or using a different color. Elevation text labels are usually drawn in association with major contours.
Contour, Minor	A secondary elevation line indicating a specific elevation in a surface model. Minor contours are often drawn without special color or weight indexing and without elevation text labels.
Corridor	A civil object used for modeling a roadway and is automatically managed by the corridor modeling tools.
Cross Section Model	DGN models (extracted perpendicular to defined horizontal geometry) with special station elevation coordinates defined and other specialized capabilities such as view exaggeration. Cross section stations match the interval in the template drop when a corridor is used as the basis. When horizontal geometry is utilized, the left / right offsets and interval are user-defined.
Curve Stroking	Stroking is the process of automatically adding shots to the terrain model or corridor by interpolating new shots from the curved sections of the data. This distance is used to interpolate new shots along the curved element in corridor processing and applying linear templates. This value is used as a perpendicular minimum distance from chords generated along the arc. Chords are drawn along the arc and the perpendicular distance is measured from the middle of each chord to the arc. If this distance is larger than the Curve Stroking, the process is repeated with a shorter chord length. This process is repeated until the end of the curve is reached. The flatter the curve, the fewer number of points will be calculated. The steeper the curve, the greater number of points that will be calculated.
DDB File	GEOPAK file (Design DataBase) which contains features definitions, associated symbology and annotation settings.
Delta Terrain Model	A surface containing data derived from the difference in elevation between two terrain models or a terrain model and a plane.
Dialog	The tool settings box for the active command. The dialog shows all available options for a command. For most civil commands, most of the time, the dialog can be hidden and ignored since the user is given all necessary instruction and inputs by way of the cursor prompt. The dialog is necessary for configuring command customizations.
Drape	The process of vertically projecting elements onto a surface so that the element elevations are defined by the surface.

Drape Void	A closed area of missing or obscured data where the void coordinates are not included in the triangulation. Voids are inserted post triangulation. The void coordinates and lines are draped on the TIN surface. Even though a user must provide an elevation for the Drape Void vertices, the user elevations are changed to the elevation of the TIN surface at the XY Drape Void coordinate position.
Element Template	MicroStation concept which allows preconfigured definitions for symbology and other miscellaneous display of MicroStation elements and civil features.
End Condition	A specialized component of a corridor template which provides information tie into active surface.
End Condition Exception	Used to modify the behavior of an end condition solution without requiring the use of additional template drops. When an end condition exception is added, it must be edited to change its behavior.
Export to Native	Option to automatically or manually push horizontal and vertical geometry into native products (InRoads - ALG, MX - PSS and GEOPAK - GPK).
Feature	A Feature is anything that can be seen or located and is a physical part of your design, representing a real world thing. A feature's definition is one of its properties. At any given time in the design process, the feature will have a Horizontal Geometry, a Vertical Geometry, 3D Geometry or a combination to define its location.
Feature Definition	Used to define options when creating features. These are the items which are created in advance, usually used across multiple projects and define symbology, annotation and quantities. The feature definition is assigned (usually) in the plan model and profile/3D feature definitions follow from there.
Feature Name	Each Feature can have a name.
Gap	When a feature is trimmed the part(s) which are invisible on the base geometry.
GPK	A legacy (proprietary) GEOPAK database containing coordinate geometry information.
Graphical Filter	Using in developing terrain models, an automated way of storing search settings for graphic elements when creating terrain models using 3D element. A graphical filter can be created for each feature (i.e., spots, breaks, voids) then the filters can be defined as a Graphical filter group.
Heads Up Prompt	Command instructions are given in a heads up and dynamic prompt which floats at the cursor.
Horizontal Geometry	The elements which define the horizontal layout of the design. These elements are 2D elements even if the DGN model is 3D. Horizontal Geometry may be points, lines, arcs, spirals, splines or any combination in a complex element.
Interval	When a feature is trimmed the part(s) which are visible on the base geometry.
Island	Closed area used to place within a void, i.e., islands in the middle of rivers, lakes, etc.

Key Station	Additional station added to the corridor to force processing at the particular location.
LIDAR	(Light Detection And Ranging) is an optical scanning technology which scans ground and other physical features to produce a 3D model.
Linear Feature	In plan model, composed of lines, arcs, spirals, splines or combinations of these. In profile model, composed of lines, parabola, splines or combinations of these.
Linear Stroking	Stroking is the process of automatically adding shots to the terrain model or corridor by interpolating new shots from the linear sections of the data. Linear stroking is measured along the element. Interpolated vertices are added whenever the distance between the vertices is greater than the linear stroking value (in master units).
Manipulators	The heads up, on-screen editing interface. Only the most common properties are presented in manipulators. Manipulators are in two types: graphical and text
Overlay Vertical Adjustment	Within Corridor Model, tool used to develop a vertical geometry (based on milling and overlay parameters) and apply to the corridor.
Parametric Constraints	Used to set up constraint value overrides for specified station ranges.
Plan Model	The usual DGN model, used for laying out horizontal geometry. Best practices will dictate that this is a 2D DGN model but 3D DGN model can be used. This is where geometric layouts and corridor definitions are kept. The geometric layouts are not only alignments but also edges, parking, striping, sidewalks, etc.
Point Features	Defined by a single X,Y (Z optional) location. A point need not be a feature. It may be defined as a non-featurized point by way of AccuDraw, Civil AccuDraw, Snap or a data point. Non featurized points are use to control the construction of Linear Features.
Point Cloud	A set of vertices in a 3D coordinate system and these vertices are defined the by X, Y and Z coordinates. Point clouds are usually created by 3D scanners. These devices measure a large number of points on the surface of an object and output a point cloud as a data file. The point cloud represents the visible surface of the object that has been scanned or digitized.
Point Control	used to modify the behavior of points in a template. These controls take precedence (they override) over existing constraints on the point.
Project Explorer	MicroStation's interface for browsing elements in a DGN file. Extended by civil to accommodate specialized civil needs.
PSS File	MX file (Plans Style Set) which provides the graphical representation for the MX string features.
Reference Element	The rule for some geometry is a calculation from another element. This other element is the reference element.

Secondary Alignment	Used to modify the direction of cross section processing. By default, as any given station, the cross section is created orthogonal to the main alignment/feature. If a secondary alignment exists, then that portion of the cross section which lies outside the secondary alignment will be orthogonal to the secondary alignment instead of the main alignment.
SEP File / Method	Uses the superelevation settings which originated in GEOPAK.
SMD File	GEOPAK file (Survey Manager Database) which contains survey features definitions and associated element and textual settings.
Spot Elevation	A set of X, Y, Z coordinates representing a point on the terrain model surface. There is no implied relationship between regular points.
SRL File / Method	Uses the superelevation settings which originated in MX
Superelevation Lane	The closed area defined by the superelevation tools used for the limits of transition calculations and pivoting location.
Superelevation Section	Area along a horizontal geometry element, where superelevation will be calculated.
Target Aliasing	Used to create the desired results when working with multiple surfaces without having to edit the template from the template library. Target aliases can also be used so that one corridor can target the solution of another corridor.
Template Drop	An area (usually defined by station limits) along a corridor to which a specific template is applied.
Template Library	A file that stores definitions for templates, generally with an ITL file extension.
Template Transition	The transition indicator occurs in the corridor between templates of differing names.
Terrain Model	A three-dimensional DGN element defined by spots, break lines, voids, holes, contours to model a surface on the earth.
Tooltips	When hovering the cursor over an element or a handle, a tooltip is shown which gives explanatory information.
Trace Slope	Upstream - The indicated path follows the steepest ascent from a user-defined point through the terrain model terminating at a high point or the edge of the terrain model. Downstream - The indicated path follows the steepest descent from a user-defined point through the terrain model terminating at a low point or the edge of the terrain model.
Vertical Alignment	A linear feature in profile model which serves the special purpose of defining the elevations of an alignment.
Vertical Geometry	The elements which define the vertical layout of a corresponding horizontal geometry element. These vertical elements are 2D and are stored in a profile model.

Void	Closed shape to demarcate areas of missing data or obscure areas. No point or break data located within the void area is utilized and no triangles are created inside the void areas. The Void coordinates are included in the triangulation and void lines between successive void coordinates are inserted as drape lines on the surface. Therefore, they do not change the slope or elevations of the surface.
Watershed	Defined by either a low point within the terrain model or a low edge point along the terrain model edge, it's the closed area wherein all water would drain to the low point.
XIN File	InRoads file which contains features definitions, associated styles, annotation, and other settings.

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