

A Practical Guide for Using InRoads XM

Colorado Department of Transportation

CADD and Engineering Innovation
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Version DRAFT



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Software Versions

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MicroStation® version 08.09.04.88
InRoads® version 08.09.02.16
0209 – Version 04.00 CDOT Configuration

Document Conventions

There are several conventions that are used throughout this document to indicate actions to be taken or to highlight important information. The conventions are as follows:

<u>Item</u>	<u>Meaning</u>
View Perimeter	a command name or a file that you are to select
Tools > Options	a command path that you are to select – usually from the pull-down menus
<i>Document Name</i>	the name of a document that is not hyperlinked
<i>Emphasis</i>	style used when referring to important word or phrases
Hyperlink	style used when you have a direct link to another document on the web
Key in	entering data with the keyboard
<i>Quote</i>	style used to indicate an external source quotation
Note: text	information about a command or process that you should pay particular attention to
1. Numbered Steps	actions that you are to perform as part of the lab activities
<D> or Data	press the data button on the mouse
<R> or Reset	press the reset button on the mouse
<T> or Tentative	press the tentative button on the mouse

Preface (Under Development)

- How to contact CDOT CADD Manager
- Message from CADD Manager
 - ◆ real success of manual is through participation by the users for updates
 - ◆ Living document
 - ◆ this is the opportunity to influence the development of the document
- How to use this manual

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Chapter 1 - Getting Started In InRoads

InRoads XM Resource Locations

This Section identifies the standard location of the InRoads XM resources in the CDOT XM configuration. In addition, the location of InRoads resources CDOT users create through the design process will be identified.

Section Objectives:

- ◆ Identify the location of InRoads XM resources delivered in the CDOT Workspace
- ◆ Identify the location of the user generated InRoads XM resources

Delivered InRoads XM Resources

There are four InRoads XM resources that are delivered in the CDOT Workspace.

- ◆ **CDOT_Civil.xin** - The CDOT_Civil.xin is a XML based preference file that replaces several files used by InRoads 2004. This file is in the following location:

\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Preferences

The new CDOT_Civil.xin preference file replaces the CDOT-Preferences.ini, CDOT-Styles.ini, CDOT-Survey_Features.fwf, CDOT-Survey_Preferences.fxp, Impexp.ini, and CDOTCTL.tiw. Existing Ini's, fwf's, fxp's and tiw's cannot open in InRoads XM.

- ◆ **CDOT_XM Disciplines.reg** - The CDOT_XM Disciplines.reg file is only used once to setup the InRoads Project Defaults with variables that are defined in the Project Configuration File (pcf). This file is in the following location:

\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Preferences

The registry file supplied for XM does not replace the 2004 registry file. The project defaults for the two versions of InRoads are stored in two different locations. If the 2004 version of the registry file was used, it is required to run the XM version to update the variables in the project defaults to XM.

- ◆ **CDOT_Template-Library.itl** - The CDOT_Template.itl file contains the CDOT standard InRoads templates and components. This file is in the following location:

\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Templates

When building project templates and components, it is imperative the user copies the **ITL** file from the configuration into the project folder. The location of this project specific file is \JPC#\ [Discipline]\InRoads. All modifications to the **ITL** file located in the configuration will be erased on log in.

The new XM **ITL** file replaced the CDOT-Typical Sections.tml file. Existing tml's cannot open in InRoads XM.

- ◆ **Superelevations Tables** - The superelevation tables for the AASHTO 2001 and 2004 are found in the following location:

\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Superelevation Tables

These tables are the same as those used in InRoads 2004.

User Created InRoads Files

Throughout the design process several InRoads files will be created by the user. These files are named with the Job Project Code (JPC) number and are stored in the \JPC#\ [Discipline]\InRoads folder.

- ◆ **JPC#.rwk** - The *rwk* file is the InRoads Project file. It contains the location of the files used for the project. InRoads uses this file to load and save data to multiple files at one time. The location varies by the discipline that creates the file. This location is \JPC#\ [Discipline]\InRoads.

The *rwk* file in XM is the same file extension and serves the same purpose as the *rwk* file in InRoads 2004. Existing *rwk*'s must be edited to reflect the new files used in InRoads XM.

- ◆ **JPC#.dtm** - The *dtm* file is the InRoads Digital Terrain Model file and is stored in the project. The existing *dtm* is located in \JPC#\ROW_Survey\InRoads\DTM\. The location of the proposed *dtm*'s will vary by the discipline that creates the file. This location is \JPC#\ [Discipline]\InRoads.

InRoads 2004 generated design *dtm*'s will open in XM but will not have the same functionality as InRoads XM *dtm*'s. This process doesn't require a translation. Existing *dtm*'s generated by the survey division work properly with either version of the software.

- ◆ **JPC#.alg** - The *alg* file is the InRoads Geometry file and is stored in the project. The location will vary by the discipline that creates the file. This location is \JPC#\ [Discipline]\InRoads.

InRoads 2004 generated *alg*'s will open in XM with no translation. The horizontal and vertical alignments are fully functional. Superelevations defined in the 2004 *alg* are not used by InRoads XM. They can be imported in the new Roadway Designer, *ird* file or recreated using the Superelevation Wizard. Importing the superelevation will require editing in the new interactive superelevation diagrams.

- ◆ **JPC#.ird** - The *ird* file is the InRoads Roadway Definition file and is stored in the project. The location will vary by the discipline that creates the file. This location is \JPC#\ [Discipline]\InRoads.

The new InRoads XM *ird* file replaced the *rwl* file in InRoads 2004. It contains the corridor definition, template drops, point controls, and superelevation data. Existing *rwl* files cannot be opened in InRoads XM.

Section Summary:

- Identify the location of InRoads XM resources delivered in the CDOT Workspace
- Identify which InRoads XM resource files need to be copied to the project file and why
- Identify the location of the user generated InRoads XM resources

Project Requirements for InRoads XM

Several changes have been made to the InRoads environment that impacts the current CDOT workspace. A new workspace has been developed for the XM environment located at **C:\Workspace\Workspace-CDOT_XM** as opposed to the 2004 environment located at **C:\Program Files\Workspace-CDOT**. This section explores these changes and how a project setup should be completed.

Proper project setup will greatly increase productivity and reduce errors.

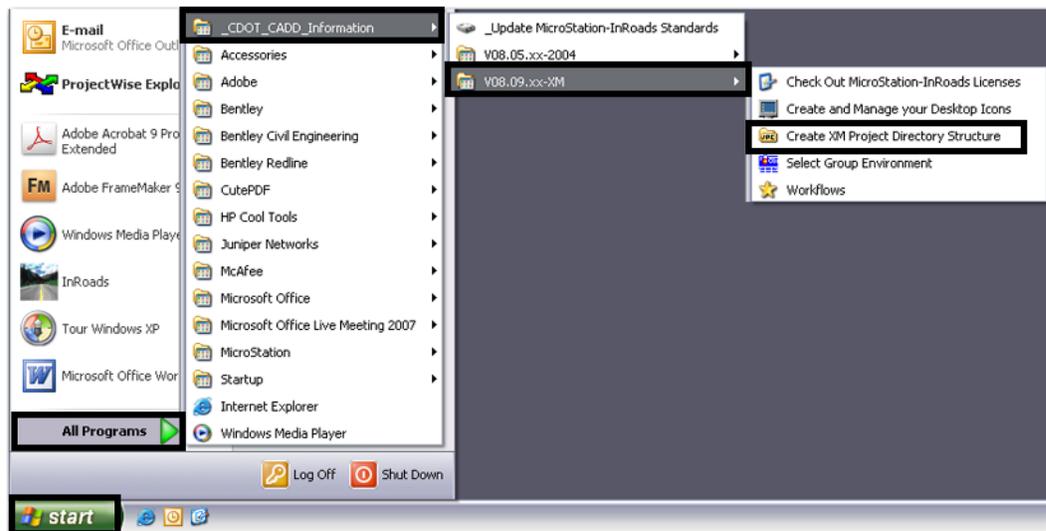
Section Objectives:

- ◆ Create a project folder using the Project Creation Utility
- ◆ Store project specific files in correct folders

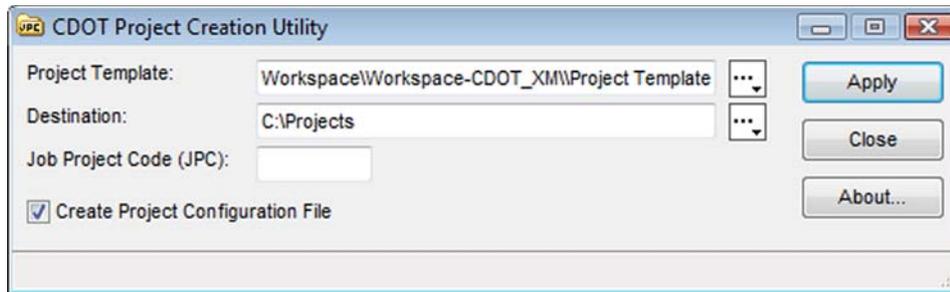
Creating the Project Directory

The project directory structure is created using the CDOT Project Creation Utility to perform two functions; first it creates a project specific folder and file structure based on CDOT standards, and second, it creates a Project Configuration File (PCF) which stores variables to simplify file management for the user. The PCF file is utilized by both MicroStation and InRoads environments.

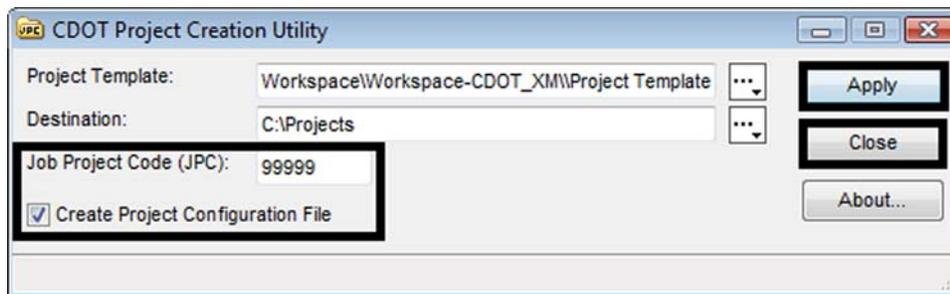
1. The project directory is created by running the **Project Creation Utility** program. To access this program go to **Start > All Programs > _CDOT_CADD_Information > 8.9.xx – XM > Create XM Project Directory Structure**.



- After selecting the Create Project Directory Structure program, the following dialog box will appear.



- Enter the 5 digit Job Project Code (JPC) specific to your project. Verify the **Create Project Configuration File** box is checked **ON**. This should be on by default. This will create a customized PCF file for the project identified in the JPC field.
- Select **Apply**. After the program has executed, select **Close**.



- Open up Windows Explorer and browse to **C:\Projects** and verify the project folder and corresponding folder structure was created.

Project File Setup

Project files are stored in a project specific directory. Base project files must be copied into the correct folder locations, either by you or the discipline that is supplying the data.

- Project survey data and existing topographical features are stored in the project DTM file. This DTM file will be the base for design. **Copy** the existing project surface **DTM** file into the **C:\Project\#####\ROW_Survey\InRoads\DTM** folder.
- Project survey models contain the graphic output of the projects existing DTM. This DGNs will be the reference base for design. **Copy** the existing project **DGN** files into the **C:\Project\#####\ROW_Survey\Drawings\Reference_Files** folder.
- The project template file will contain the project typical sections used to create model DTM's. Refer to [Chapter 10 -Typical Sections "Creating a Project Template Library"](#) on page 112

Converting to XM

- Refer to [Migrating CDOT Projects and MicroStation XM Update Guide.pdf](#) document for existing project conversions.

Section Summary:

- ◆ Roadway design and modeling are significantly different in InRoads XM. Template and roadway libraries will need to be redone.

InRoads Project Setup

Several changes have been made to the InRoads environment that impact the current CDOT workspace. Prior to opening or creating InRoads data, proper setup of the InRoads environment will streamline loading and saving project files created in InRoads.

Section Objectives:

- ◆ Identify how to setup a new Project Default
- ◆ Identify how to edit an existing Project Default
- ◆ Identify how to load a DTM
- ◆ Identify how to load an ALG

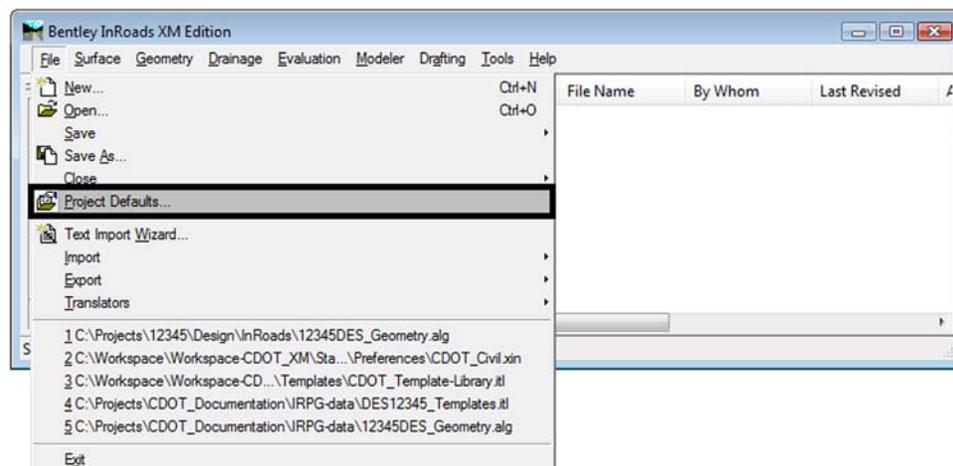
Project Defaults

InRoads project defaults perform two functions; first they load the appropriate CDOT standard resource files such as the standard XIN file, annotation resources, XML style sheets, etc. Additionally, they define default paths to project specific directory folders that contain project data such as DTM's, alignments, survey data, etc.

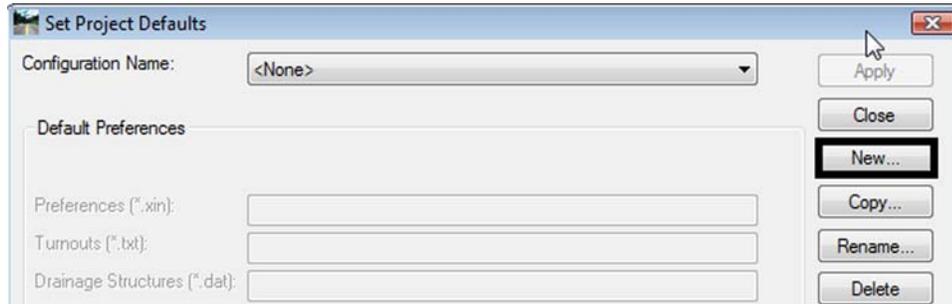
Creating a New Project Default

To create a project specific Project Default Configuration:

1. Open the Project Defaults by Selecting, **File > Project Defaults...**



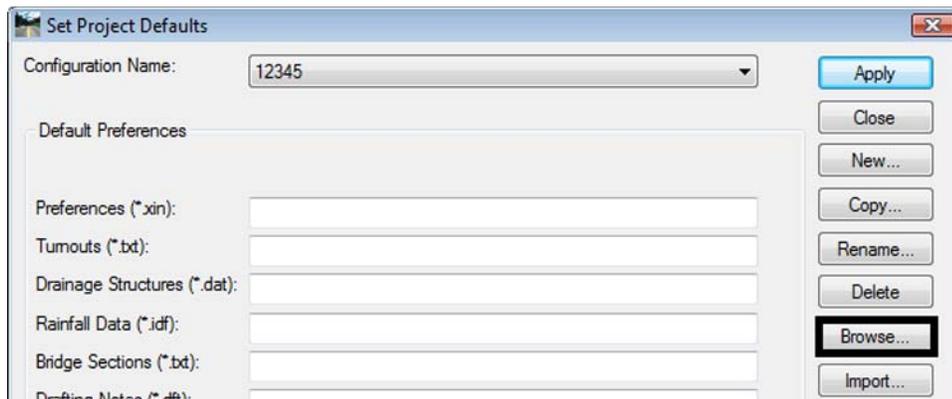
2. <D> on the **New** button.



3. Enter in the Name of the New Configuration, **12345** and <D> on **OK**.



4. Fill in Preferences by <D> in the data entry field and <D> the **Browse...** button.

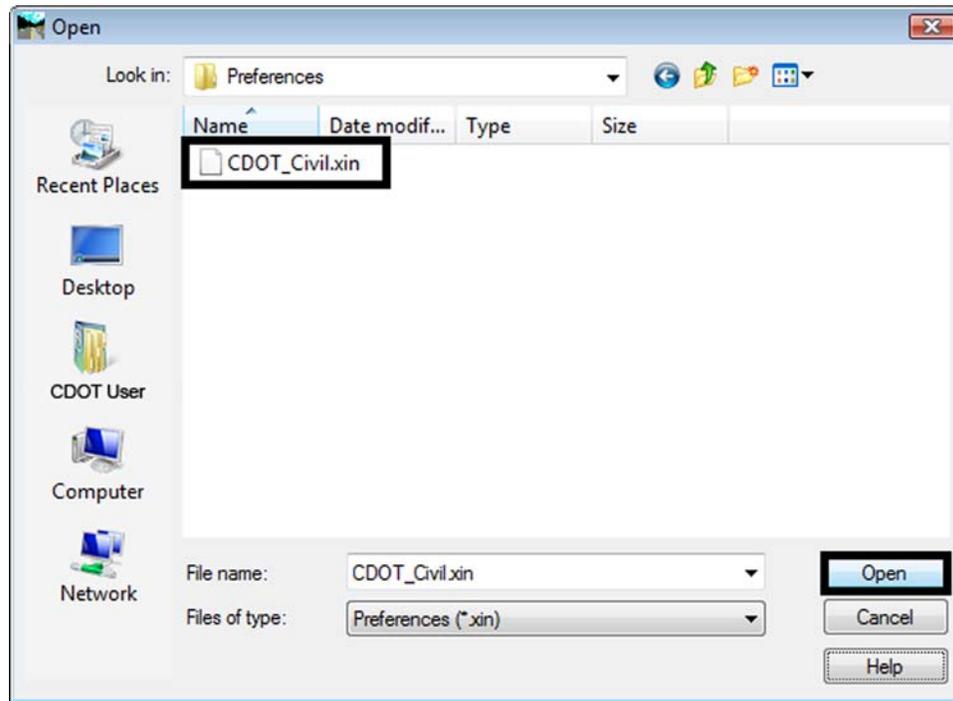


Note: The Default Preferences section specifies files. These files will load into InRoads directly. The Default Directory Paths section specifies a folder, not files. Any files within the folder will not load, but when opening the file the browse dialog box will open to that folder.

5. Browse to the **C:\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Preferences** folder.



6. Select **CDOT_Civil.xin** and <D> on the **Open** button.

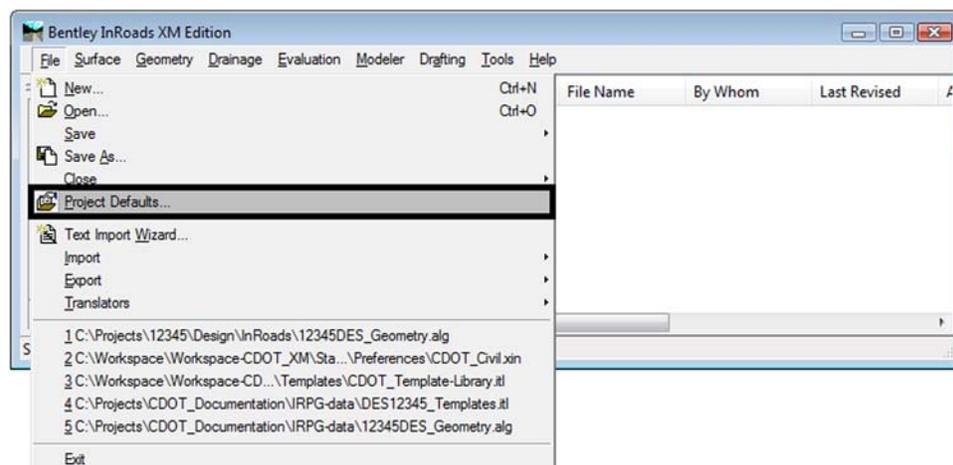


7. When finished identifying files and folders <D> on **Apply** and <D> on **Close**.

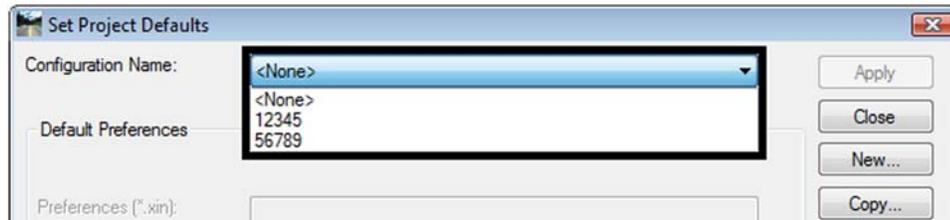
Editing an Existing Project Default

To edit a project specific Project Default Configuration:

1. Open the Project Defaults by selecting, **File > Project Defaults...**



2. Select the project to modify by <D> on the **Configuration Name** pull down.



3. Edit the Files and Folder paths that are required.
4. <D> on **Apply** when finished.

Discipline Project Defaults

The workflow, [CDOT InRoads XM Project Defaults Management.pdf](#), utilizes a **Project Configuration File** (PCF) which is created at the start of a project. This PCF file is created by running the **Project Creation Utility**. The resulting PCF stores system variables to simplify file management for the user. This PCF file is utilized by both the MicroStation and InRoads environments.

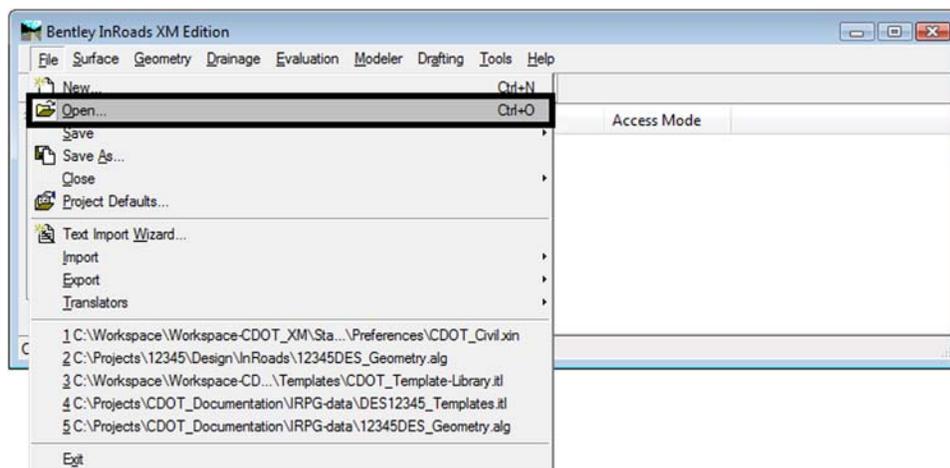
InRoads Resources

Prior to designing in InRoads XM, load the base InRoads project resource files.

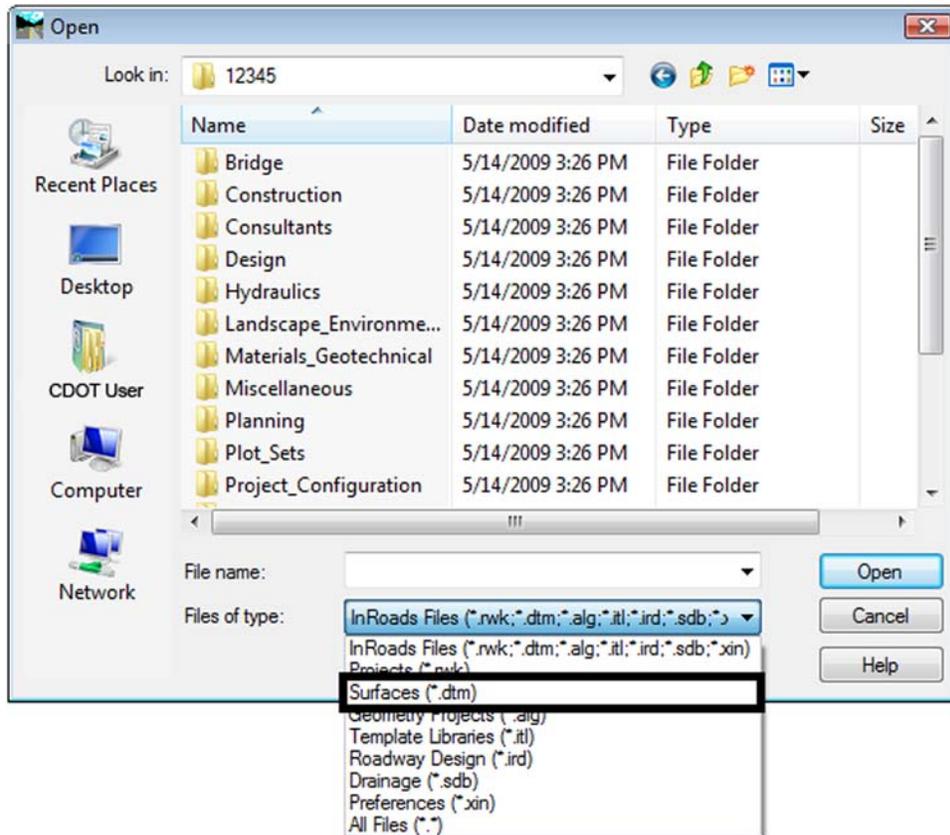
Loading a DTM

To open a DTM file:

1. Open an existing DTM file by selecting, **File > Open**.

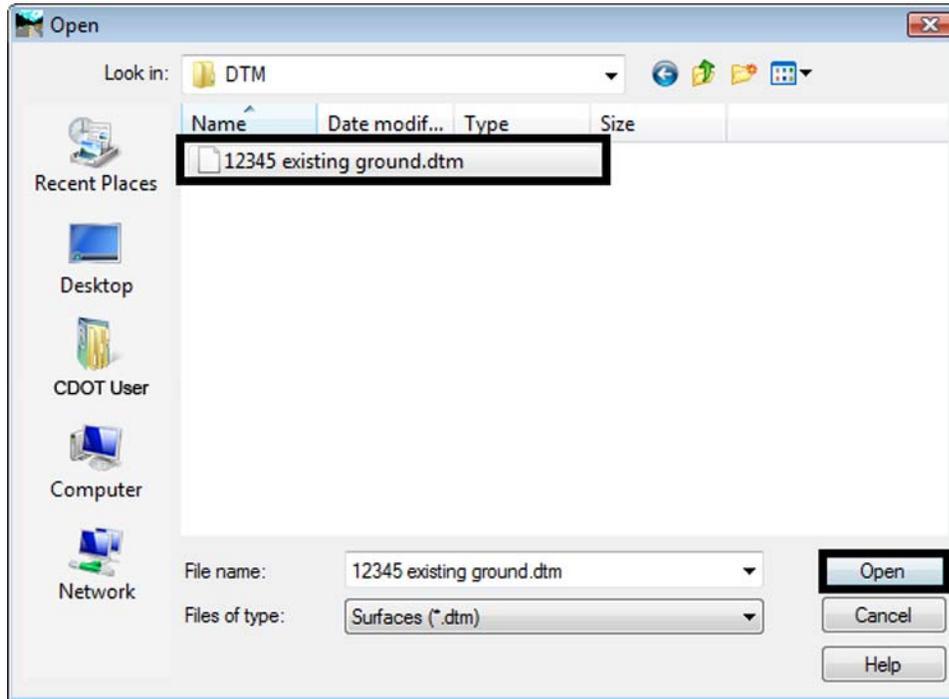


2. Change the file type to Surfaces (*.dtm) by <D> on Files of Types:

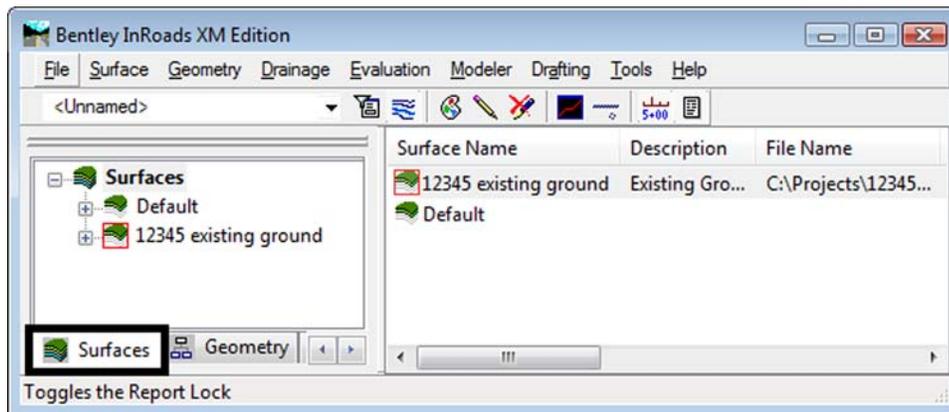


Note: Once the file type is selected, the path will change if identified in the Project Defaults.

3. <D> on file 12345_existingground.dtm and <D> on Open.



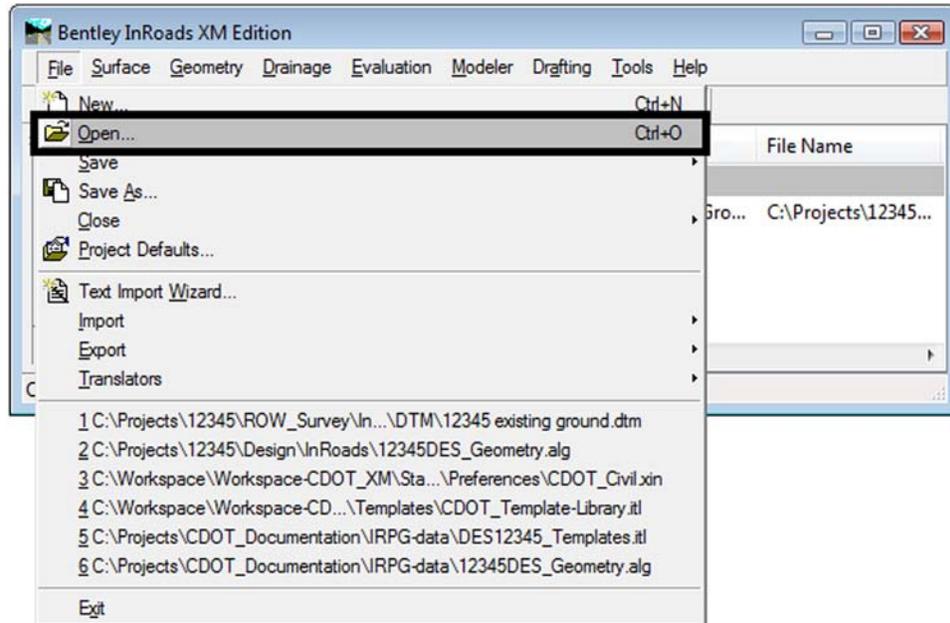
4. <D> on **Cancel** to close the dialog box.
5. <D> on the **Surfaces** tab to view the loaded DTM.



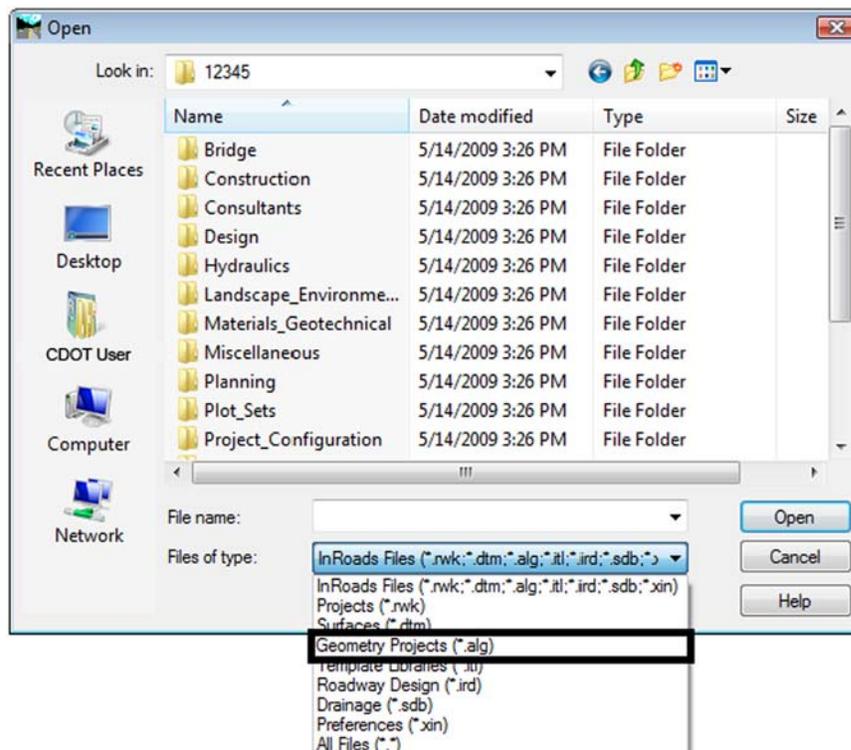
Loading an ALG

To open an ALG file:

1. Open an existing ALG file by selecting, **File > Open**.

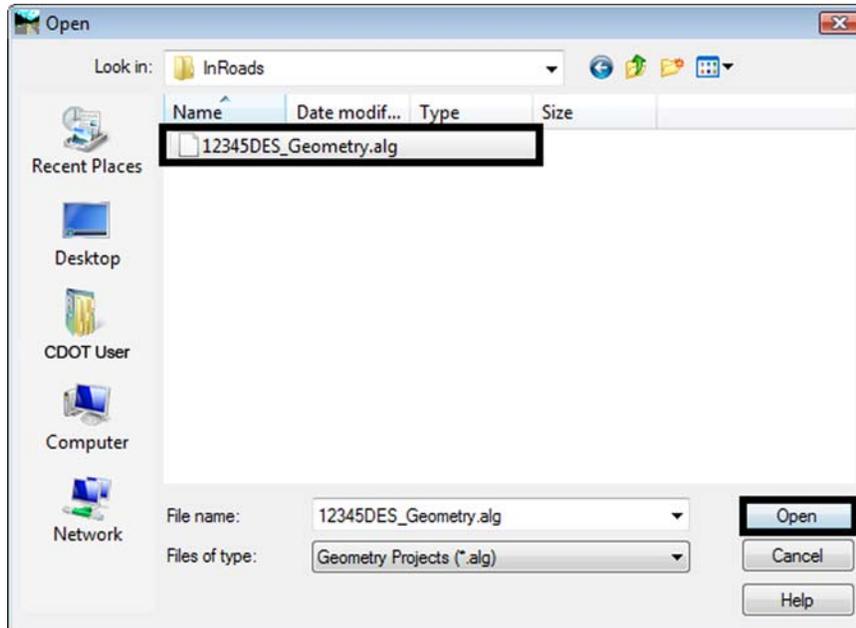


2. Change the file type to Geometry Projects (*.alg) by <D> on Files of Types:

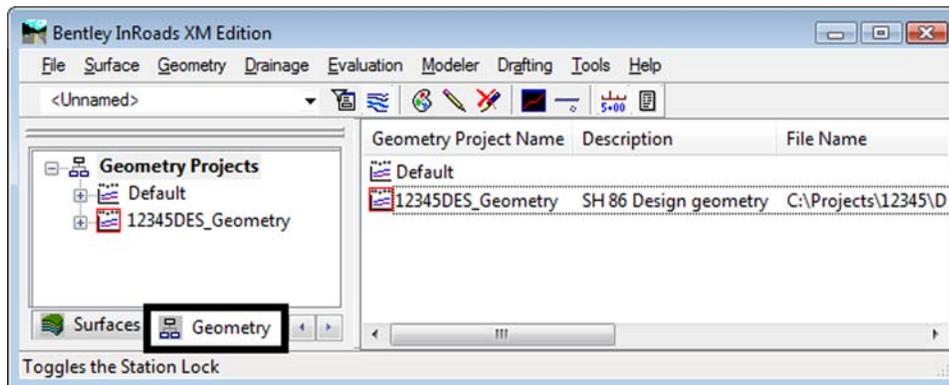


Note: When the file type is selected, the **Look in** folder location will change to the path defined in the Project Defaults.

3. <D> on file **12345DES_Geometry.alg** and <D> on **Open**.



4. <D> on **Cancel** to close the dialog box.
5. <D> on the **Geometry** tab to view the loaded ALG.



Section Summary:

- ◆ Understand the process to create a new Project Default in InRoads
- ◆ Understand the process to edit an existing Project Default in InRoads
- ◆ Understand Projects Defaults when using the CDOT_XM Disciplines.reg file with a PCF
- ◆ Understand the process to load a DTM
- ◆ Understand the process to load an ALG

Chapter 2 - InRoads Options

InRoads has a number of options and global settings that affect the availability of commands and operation of the program. This chapter discusses the locks and options settings for InRoads XM.

Chapter Objectives:

- Discuss the function of each of the InRoads Locks.
- Discuss the Options dialog box and identify the tabs that users can modify.

InRoads Locks

The locks in InRoads determine what can be displayed, how displayed items are updated, and how items are selected for use by the program.

Section Objectives:

- ◆ Describe the Feature Filter Lock
- ◆ Describe the Feature Highlight Lock
- ◆ Describe the Style Lock
- ◆ Describe Write modes.
- ◆ Describe the Locate Lock
- ◆ Describe the Snap Lock
- ◆ Describe the Station Lock
- ◆ Describe the Report Lock

Feature Filter Lock



The Feature Filter lock is used to limit the number of features displayed in menu pick lists, based on used defined criteria. This lock has two parts, the Filter Name drop down menu and the Feature Filter Lock (on/off switch).

- **Filter Name** – Lists the name of the Feature Filter that is currently active. It has no affect if the Feature Filter lock is off. If the Feature Filter lock is on, it will limit dialog boxes to showing only the features that pass the filter. Feature Filters are stored in the CDOT-Civil.xin file and are accessed by using the drop-down arrow next to the name.
- **Feature Filter lock** – If on, activates the current filter. If off, has no affect and all surface features are shown in boxes that list features.

Feature Highlight Lock



This lock highlights features in the MicroStation view window that are selected in an InRoads dialog box. This lock should be left off until needed because many of the InRoads dialog boxes open with all of the features selected and it can take a long time to highlight all the features.

Style Lock



The Style lock, if on, forces many of the Surface View commands to display the requested data (triangles, contours, etc.) without bringing up the dialog box. The preference used is the one associated with the surface under Surface > Surface Properties. Style lock also forces the Cross Section Annotation command to use the named symbology associated with the feature for annotation properties. If off, the Style lock has no affect.

Write Modes



The Write Mode determines how InRoads graphic elements will behave when the data that generated the graphics changes. There are two modes; Pencil and Pen.

- **Pencil mode**  - The graphics are updated whenever the same display command is selected again. For example, if contours are displayed, then a different preference is selected and they are displayed again, the old contours are deleted and new contours are displayed.
- **Pen mode**  - The graphics are not updated when the same display command is selected again. Instead, another copy is placed in the design file.

Delete Ink



Delete Ink overrides the Pen mode so that the graphics are treated like Pencil mode and the old ones are removed before new ones are placed.

Note: The Write mode of an element is saved with that element. For example, contours that are displayed in pencil mode will still be deleted if the command is reused, even if the Write mode has been switched to Pen mode.

Locate Lock



There are several commands in InRoads that will work on either DTM Features or on MicroStation graphical elements (Drape Surface, for example). These commands will “look” for features if toggled to Locate Features  and for MicroStation elements if it is set to Locate Graphics. It is shown here in Locate Graphics  mode.

Point Snap



Point Snap is used primarily when creating geometry and for some surface editing commands. It can lock on to COGO points or feature vertices, or it can import a geometry element's length and bearing into a dialog box input field. Point Snap has three modes: No Snap, Point Snap and Element Snap

- **No Snap**  – No affect. This is the mode used most often.
- **Point Snap**  – Some geometry commands (especially cogo commands) will lock onto the nearest geometry point's coordinates when you select something graphically. This is useful when you need to identify a PC or PT, for example. Also, some DTM editing commands, such as Partial Delete Feature, will lock onto the vertices or points that make up the feature.
- **Element Snap**  – In Geometry when commands require a distance or a bearing, the Element Snap can be used. An existing geometry element needs to be identified (such as part of an existing alignment) and it will read the elements length or bearing (whichever is required).

Station Lock



Station lock locks onto even stations in the event that the alignment does not start on an even station. The station will be determined by the interval that is specified. For example, if an alignment is stationed at 100 ft. intervals, the displays will show even 100 ft. stations. This affects not only station displays but virtually everything that uses a stationing interval, such as cross sections, profiles and modeling.

Report Lock



Some commands will return information if this lock is on. For example, if a cogo point is stored and the Report lock is on, a Results box will pop open showing the coordinate and point number of the new point. If the Results box is left open, it will keep a running list of messages, which can be saved to a text file if desired.

Section Summary:

- ◆ The Feature Filter lock is used to limit the number of choices in surface related dialog boxes.
- ◆ The Feature Highlight Lock Shows features selected in an InRoads dialog box in the MicroStation view window also. It should only be used when needed as it can be slow to update.
- ◆ The Style Lock tells InRoads to use predefined settings when displaying data. It also takes away the users ability to make settings changes.
- ◆ The Write modes determine if InRoads graphics are updated when the command is rerun or not.
- ◆ The Locate Lock is used “snap” to either surface features or MicroStation graphics.
- ◆ The Snap Lock is used to “snap” to COGO points or feature vertices, or to place geometry element data into dialog box input fields.
- ◆ Station Lock forces processing to occur at even (*+00.00) stations, even when the alignment starts at an odd station.
- ◆ The Report Lock allows InRoads to supply the user with feedback.

The Options dialog box

The Options dialog box contains global settings that affect the overall function of the InRoads software. Most of the settings are predefined for CDOT work and do not have to be modified. However, some settings affect element display and must be changed by the user to fit their needs.

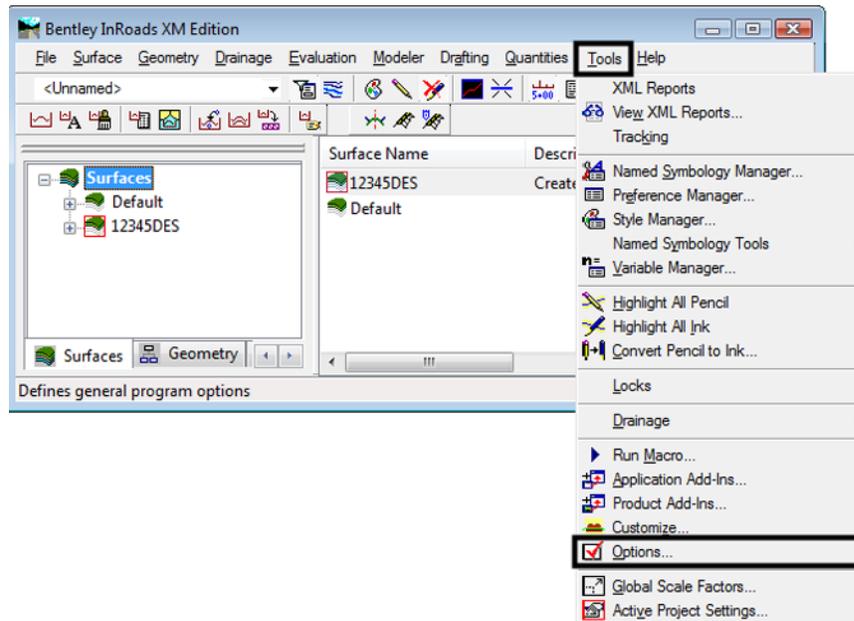
Section Objectives:

- ◆ Describe the Options Precision tab.
- ◆ Describe the Options Factors tab.

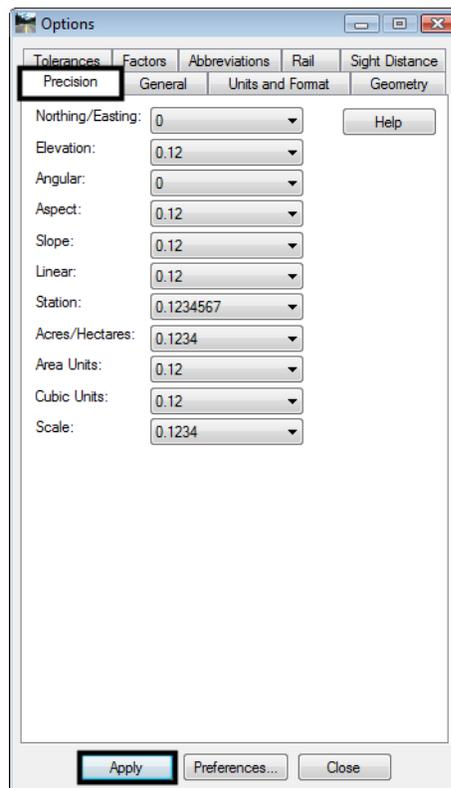
The Precision tab

The settings on this tab determine the number of decimal places InRoads displays in the dialog boxes. To change the precision:

1. Select **Tools > Options** from the InRoads menu bar.



2. <D> the **Precision** tab.
3. Use the drop down menus for set the precision.
4. <D> **Apply** to accept the change.



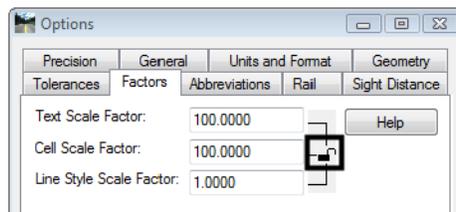
5. <D> **Close** to dismiss the dialog box.

The Factors tab

The settings on the Factors tab controls scale factors for MicroStation elements displayed by InRoads. InRoads displays three element types; Lines, Cells, and Text. Each element type has a Factors setting.

To access the Factors settings:

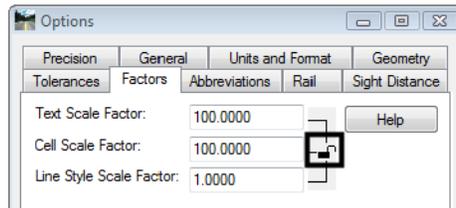
1. Select **Tools > Options** from the InRoads menu bar.
2. <D> the **Factors** tab.



The Text Scale Factor and the Cell Scale Factor should both be set to the same value, equal to the plot scale for the drawing. The Line Style Scale Factor should be set to 1, this is modified by the Annotation Scale set in MicroStation.

To change the Factors settings:

3. Toggle the “Lock” icon open.



4. Key in the desired value for the *Text Scale Factor*.
5. Key in the desired value for the *Cell Scale Factor*.

Note: The *Text Scale Factor* and the *Cell Scale Factor* should match.
6. Key in **1** for the *Line Style Scale Factor*.
7. <D> **Apply** to accept the change then <D> **Close** to dismiss the *Options* dialog box.

Section Summary:

- ◆ The options dialog box contains settings used throughout the InRoads program.
- ◆ Users should only have to access the Precision and Factors tabs.
- ◆ Precision settings change the readout in InRoads dialog boxes.
- ◆ Factors affect the display of MicroStation elements created from InRoads.

- ◆ The Line Style Scale Factor is affected by the MicroStation Annotation Scale but the Text Scale Factor and the Cell Scale Factor are not.

Chapter Summary: The InRoads locks can be used to limit items in pick lists, force the program to use predefined display settings, automatically update graphics when data is changed, locate particular data types, and adjust processing locations.

Options are used to set the precision displayed in dialog boxes and set the scale factor for MicroStation elements created from InRoads.

Chapter 3 - Initial Surface Procedures

In the CDOT process, existing ground surfaces are created by Survey and any proposed models by Design. When presented with either of these for the first time, it is good practice to review the surface information and familiarize yourself with the data contained in the surface. It is also good to double-check the surface for any errors or omissions before they become larger issues after the surface has been used for modeling or volume calculations.

Using the techniques outlined here, you can review the data in the surface and view the data graphically, both of which allow you to check for problems and familiarize yourself with the data.

Chapter Objectives:

- To become familiar with the process used to analyze the data in an unknown surface.
- To be able to view DTM data graphically for a visual analysis of a surface.

Reviewing Surface Data

InRoads provides useful tools for reviewing surface data, including surface point data as well as the properties of features and components that are contained in the surface.

Section Objectives:

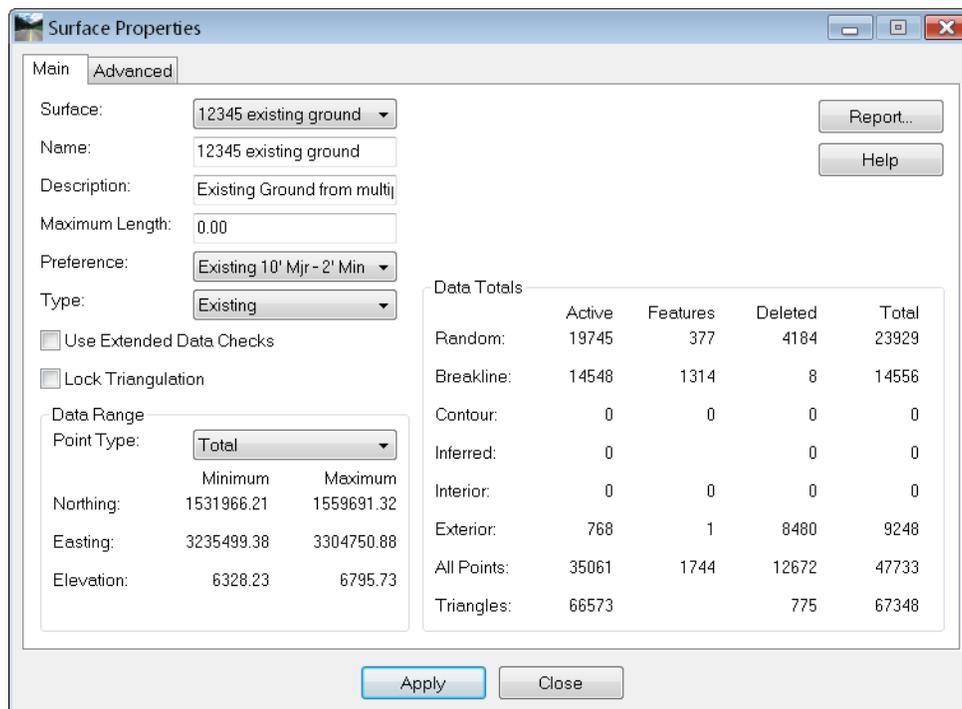
- To learn the techniques available to review surface information before viewing the data.
- To be able to spot potential issues in a surface prior to it causing major problems.

Surface Properties

The *Surface Properties* dialog allows you to change the name, description or preference associated with the surface. By accessing the *Advanced* tab, you can also set the named symbology to be used when displaying the surface ground line in profiles and cross sections. The *Advanced* tab also allows the establishment of *Offsets* that can later be displayed when creating or updating a profile.

The *Surface Properties* dialog is accessed from several locations including the *More* option on the *Triangulate Surface* dialog. It may also be accessed directly from the pull-down menu or from the right-click menu in the workspace bar of the InRoads menu.

1. Select **Surface > Surface Properties**



On the *Main* tab, you can:

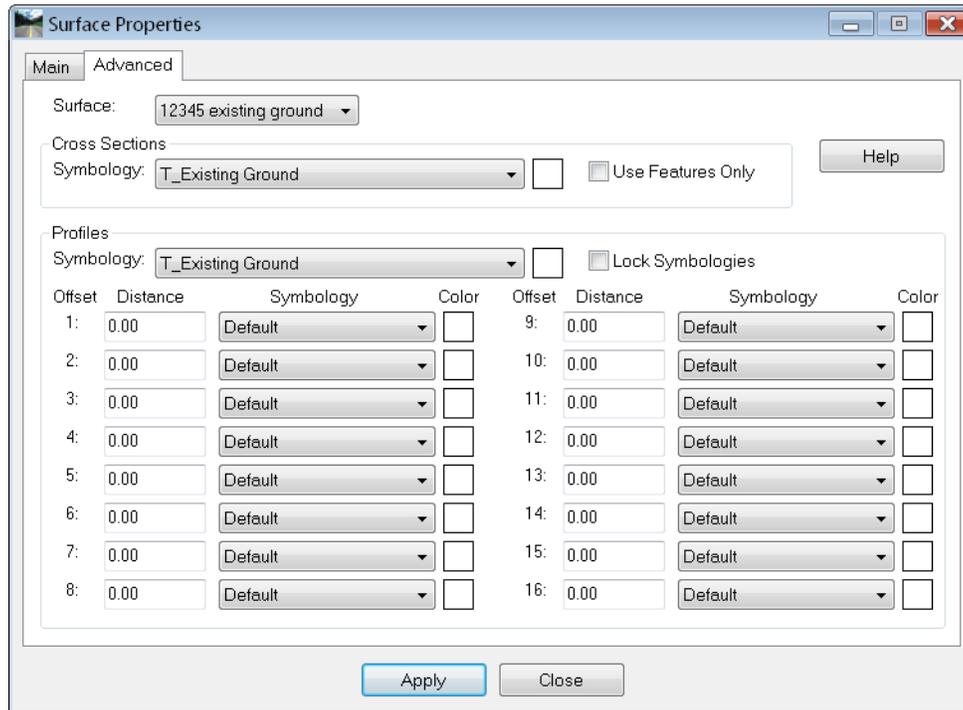
2. Select a *Surface* from the drop-down - this is set to the active surface by default.
3. Change the *Name* of the DTM as it is shown in dialog boxes. This does not change the name of the DTM file on the hard drive.

4. Change the *Description* of the surface.
5. Set the *Maximum Length* - see the explanation on *Maximum Length* in the Triangulation section.
6. Set a *Preference*. The available preferences are surface display preferences. Selecting one here and toggling on the *Style* lock forces the view commands to use this preference and does not allow the dialog box to display for *View Contours*, *Triangles*, etc.
7. Set the *Type* of the surface. The type is critical to how the surface reacts in *End Area Volumes*. Options include *Existing*, *Design*, *Substratum* and *Ignore*. For details on these options, see the *InRoads Online Help*.
8. *Extended Data Checks* - toggle on to check DTM integrity (during triangulation) for crossing breaklines and miss-matched elevations.
9. *Lock Triangulation* - sets the triangulation so InRoads' commands will not automatically retriangulate the surface. For example, if this is a surface from survey that you do not want to alter, toggle this option on.

Note: Compressing the surface retriangulates it even if this option is on.

10. The *Data Range* category allows you to select a type of features and review the coordinate range it includes.
11. The *Data Totals* allow you to review the numbers of points and features for each type of feature.
12. The *Report* button generates a separate window summarizing surface properties. The generated report can be printed, written to the CAD file, or stored as an ASCII file.

On the *Advanced* tab:

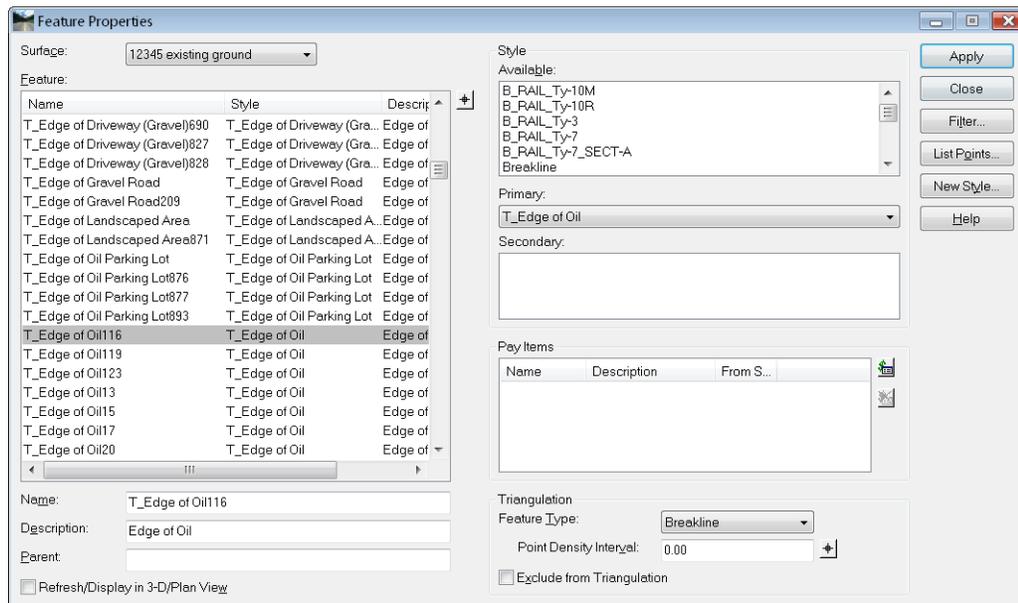


13. **Cross Section Symbology** sets the named symbology used for the display of ground lines on cross sections. In the *CDOT XIN* file, there are symbologies created for use here. **T_Existing_Ground** for the existing topo and **D_SURFACE_*** for design surfaces.
14. **Use Features Only** prevents the surface line on the cross section from following the triangles. Instead, it is drawn by connecting the dots between the features in the surface. This should typically be off for existing surfaces and on for design surfaces.
15. **Profile Symbology** sets the named symbology used for the display of ground lines on profiles. In the *CDOT XIN* file, there are symbologies created for use here. **T_Existing_Ground** for the existing topo and **D_SURFACE_*** for design surfaces.
16. **Lock Symbolologies** will force each of the offsets to use the same symbology specified above.
17. The **Offset** category is for establishing surface offsets for display on profiles. Up to 16 offsets may be specified by defining the offset distance - positive values for offsets to the right and negative values for offsets to the left of the centerline. Each offset may have its own symbology.
18. Choose **Apply** if you make any changes.
19. Choose **Close**.

Feature Properties

The *Feature Properties* dialog allows you to review a DTM by analyzing the individual features, and make changes to names, descriptions, etc.

1. Select **Surface > Feature > Feature Properties**.



2. Select the *Surface* from the drop-down.
3. The *Feature* list shows all the features in the selected surface along with their styles and descriptions.

Note: The dialog honors the active feature filter if the *Feature Filter* lock is on.

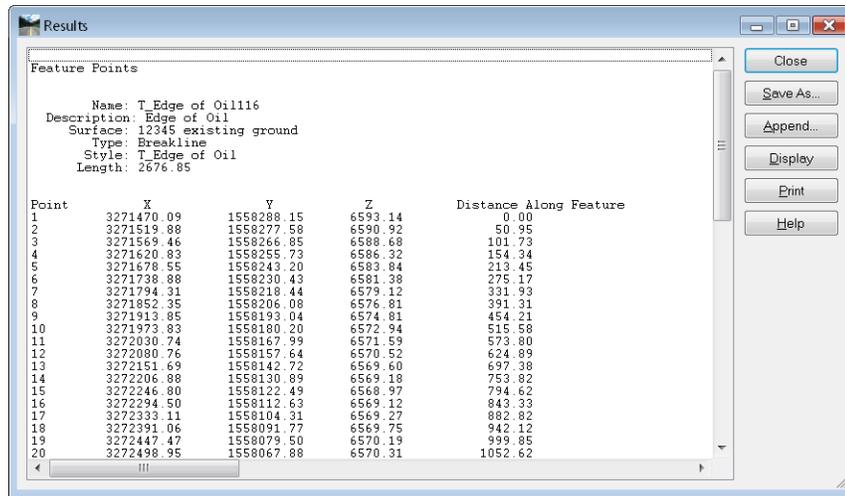
Important! Features that appear red indicate their Style cannot be found in the currently loaded *XIN* file. Check to see if the correct Style is associated with the feature. If so, check to see that the correct *XIN* is loaded.

4. The *Name* and *Description* of the highlighted feature may be edited.

Note: Options other than *Name* can be edited for multiple features at one time. Select the features from the list using <Ctrl> or <Shift> keys or by using the Right-click menu to *Select All*.

5. If features are edited, before choosing Apply, the *Refresh/Display in Plan View* option can be toggled on to update the graphics with the new attributes.

- For a listing of the coordinates for each vertex in a feature, highlight the feature and select **List Points**. This is a good way to evaluate the elevations of the feature.



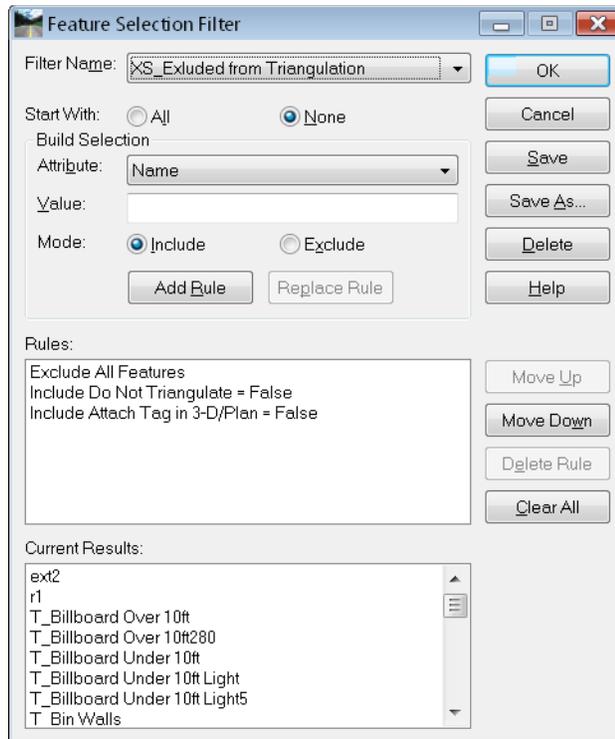
See the *InRoads Online Help* for additional information on other options.

- If changes are made to a feature, be certain to choose **Apply**.
- Close the dialog when done reviewing the features.

Feature Selection Filters

Feature Selection Filters provide a method of segregating features for use in other commands. For example, if you are working with the breaklines that form a ditch, you can use a selection filter containing just those breaklines, then turn on the *Feature Filter* Lock. Future commands that use features will show only those specified by the filter as being available.

Feature Filters are stored in *CDOT-Preferences.ini*. The CDOT configuration contains predefined filters.



Locks affecting Features

Filter Name – Lists the name of the **Feature Filter** that is currently active. It has no affect if the **Feature Filter** lock is off. If the **Feature Filter** lock is on, it will limit dialog boxes to showing only the features that are within the filter. Feature Filters are stored in the **XIN** file and are accessed by using the drop-down arrow next to the name.



Feature Filter lock – If on, activates the current filter. If off, has no affect and all surface features are shown in boxes that list features. Shown here in the off position.



Feature Highlight lock – If on, when you choose a feature from a dialog box, the feature will graphically highlight whether it is displayed in the design file or not. Shown here in the off position. This lock should typically be kept off; if on, the opening of dialogs that list features is much slower as all the features will highlight initially.

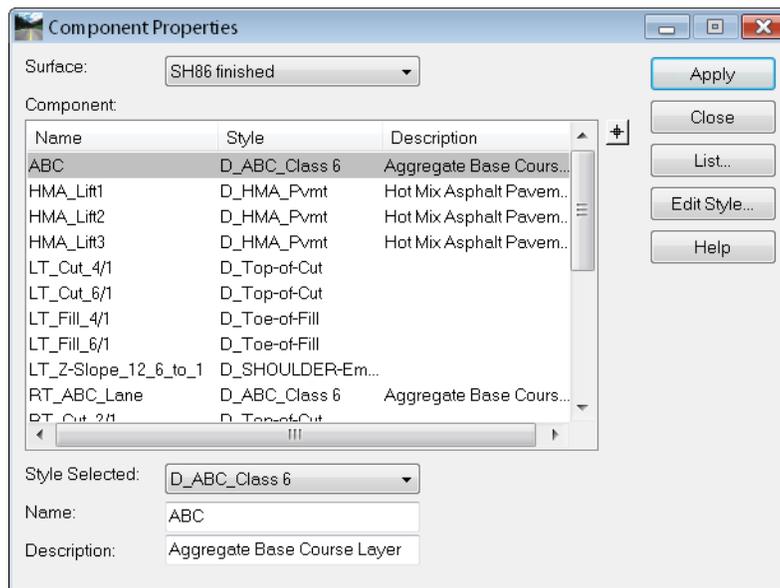


Component Properties

The *Component Properties* dialog allows you to review each of the components contained in the selected surface. You can also make changes to the *Name*, *Description* and *Style* as necessary.

Important! The Style associated with a component determines how the component's volume is categorized in *End Area Volumes*. Components with like Styles are automatically totaled in the reports.

1. Select **Surface > Feature > Component Properties**.



2. Select the *Surface* from the drop-down.
3. The *Component* list shows all the components in the selected surface along with their styles and descriptions.

Important! Components that appear red indicate their Style cannot be found in the currently loaded *XIN* file. Check to see if the correct Style is associated with the component. If so, check to see that the correct *XIN* is loaded.

4. The *Name* and *Description* of the highlighted feature may be edited and a new Style assigned.

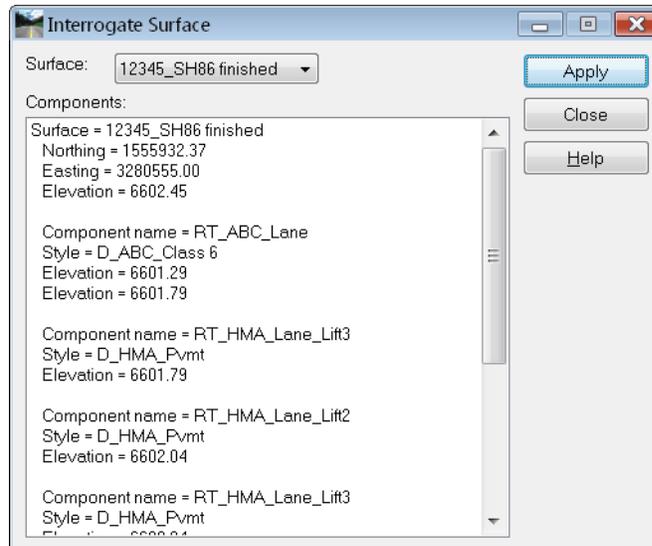
Note: Options other than *Name* can be edited for multiple features at one time. Select the features from the list using <Ctrl> or <Shift> keys or by using the Right-click menu to *Select All*.

5. Select **List** to generate a report of the *Start* and *Stop* stations of the highlighted component along with a list of the features making up the component.
6. Choose **Apply** if there are changes made to a component.
7. Choose **Close**

Interrogate Surface

Interrogate Surface is used to report information about surface components at a given coordinate. The command generates a report listing each component encountered at the specific location, including the elevation. If the component is encountered twice (for example the top and bottom of a lift), it is listed twice in the report, with an elevation for each occurrence. This command is only valid for design surfaces containing components.

1. Select **Surface > Utilities > Interrogate Surface**.

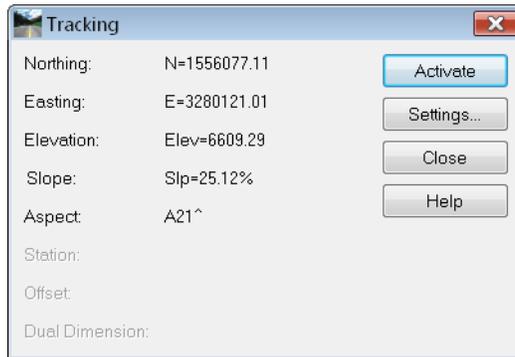


2. Select the **Surface** you want to inquire on from the drop-down list.
3. Choose **Apply**.
4. <D> at the location (or key in a coordinate) where you want to inquire.
5. The information on each component encountered at the location is listed in the dialog.
6. Continue Data Pointing and the report information will update with the new location information.
7. Choose **Close**.

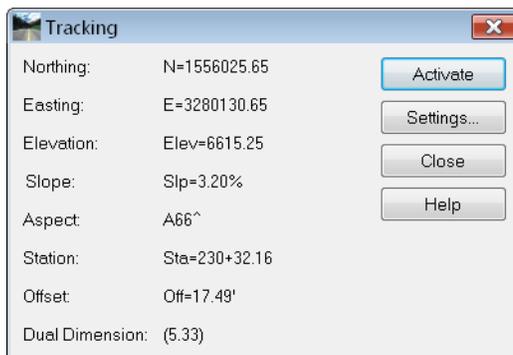
Note: The horizontal alignment used in creating the surface must be loaded as well as the surface.

Tracking

The **Tools > Tracking > Tracking** command allows you to move your cursor and get a readout of the coordinate location and the interpolated elevation, as long as you are in a triangulated area. By toggling on the information you want, then choosing **Activate**, you can also Data point at any location and have the information written into the design file.



Note that the station and offset are also available for tracking when a geometry project is loaded and has an active alignment.



Section Summary:

- The **Surface Properties** dialog gives an overall picture of the surface in question including data coordinate ranges. Here, you can often spot elevations that are out of the ordinary range.
- **Feature Properties** allows the analysis of surface data on an individual feature level, including elevations of the vertices of features.
- **Feature Selection Filters** allow you to create a subset or group of features to view or review.
- **Component Properties** show the individual components that make up a surface.
- DTM issues, such as bad elevations can often be spotted using **Review** commands.
- If you want surface coordinate or slope information, use the **Tracking** tool. You can also write this information into the **DGN** file. If you have a geometry project loaded, this command will also provide station / offset data.

Viewing a Surface

After reviewing surface data, you may also want to visually inspect the surface data. InRoads offers several surface view commands that can be used to spot surface problems and to become familiar with the surface.

Section Objectives:

- To learn how the *View Surface* commands work in InRoads.
- To learn how to use the *Locks* that affect DTM displays.
- To be able to apply the appropriate preference to meet CDOT standards.

Locks affecting Surface Displays

Two locks affect surface displays.



Style lock – If *Style* lock is on, the dialog box for the view command is not displayed. Instead, the display will be executed using the active surface and the preference assigned to the surface in the **Surface > Surface Properties** dialog.

Important! If you choose one of the View Surface commands and the dialog box does not appear, most likely the *Style* lock is on.



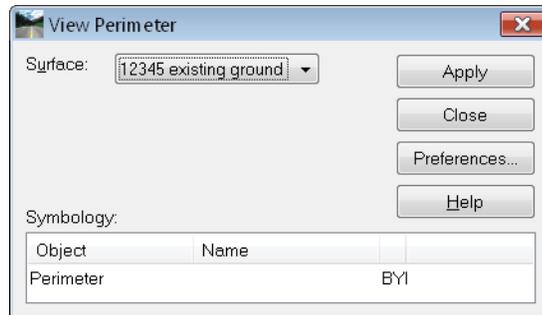
Pen / Pencil and Delete Ink – If the *Pencil* mode  is selected (as shown here), the graphics are updated whenever the same display command is selected again. For example, if you display the contours, then change to a different preference and display again, the old contours are deleted and the new contours are displayed.

If *Pen* mode  is selected there are two options. If *Delete Ink*  is off, the graphics are not updated when the same display command is selected again. Instead, another copy is placed in the design file. If *Delete Ink* is on, the graphics are treated like *Pencil* mode and the old one removed before the new ones are placed.

Viewing the DTM Perimeter

The perimeter of a DTM is an outline of the current triangles, and therefore can only be displayed after a surface is triangulated. It should not be confused with an exterior boundary, which actually limits the triangulation. However, if there is an exterior boundary on the surface, the perimeter will be in the same location.

1. Choose **Surface > View Surface > Perimeter**.



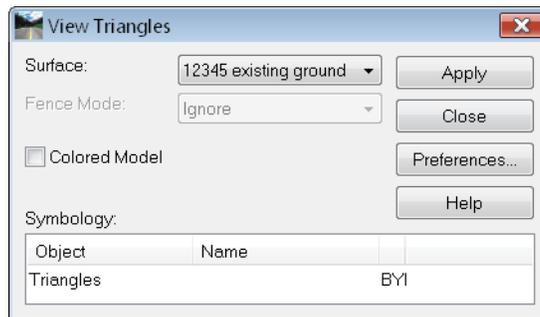
2. Select **Preferences** and choose the appropriate CDOT preference.
3. Choose **Load**, then **Close** the *Preference* dialog.
4. Select the *Surface* from the drop-down list.
5. Select **Apply** and the perimeter is drawn in the MicroStation file.
6. Select **Close**.



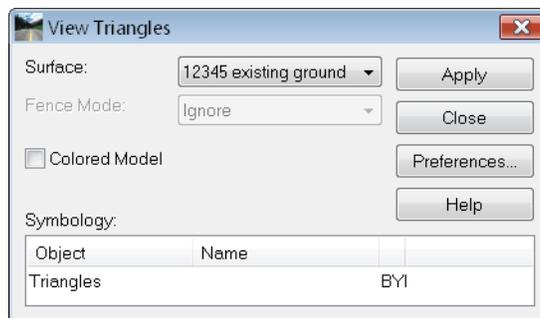
Viewing Triangles

It is sometimes useful to display triangles when evaluating a surface. You can check to see if a feature is triangulating, if the triangles are being formed correctly or if there are erroneous or extraneous triangles in your model.

1. Choose **Surface > View Surface > Triangles**.



2. Select **Preferences** and choose the appropriate CDOT preference.

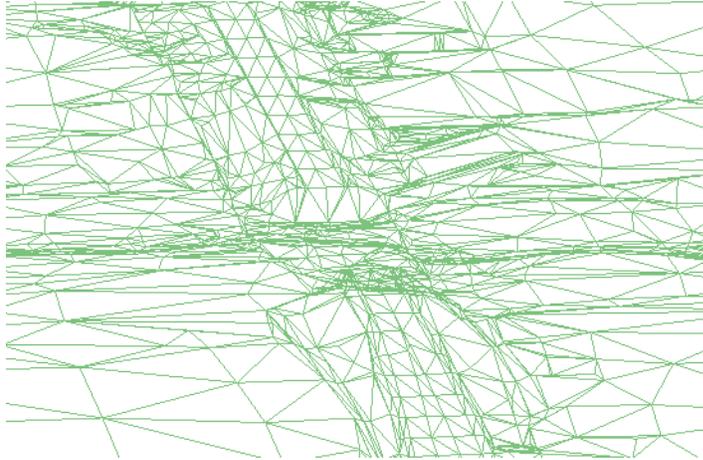


3. Choose **Load**, then **Close** the *Preference* dialog.

Note: If you are just displaying triangles for review, you may skip the preference step and use the default CDOT preference.

4. Select the *Surface* from the drop-down list.
5. The *Colored Model* toggle will display the triangles, and if two adjacent features share the same Style, the triangles formed in between the features are 'color-coded' according to the plan symbology of the Style.

6. Select **Apply** and the triangles are drawn in the MicroStation file.



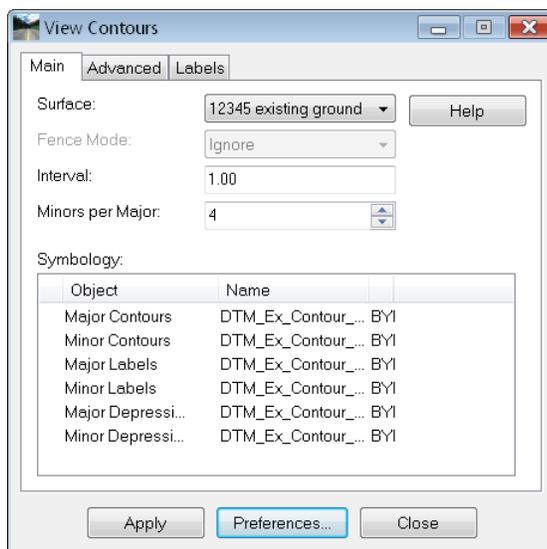
7. Select **Close**.

Note: The triangle display is a MicroStation graphic group. If you need to delete the triangles, they will delete as one if the **Graphic Group** lock is on.

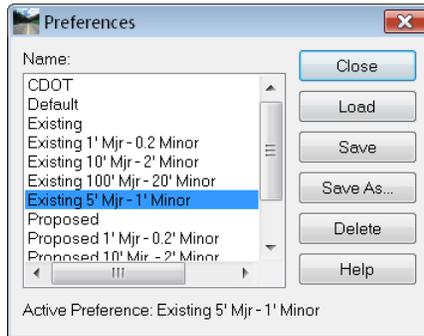
Viewing Contours

The contours for a model may be displayed using the **Surface > View Surface > Contours** command. There are several preferences available in this command, depending upon the type of surface and contours you want to display.

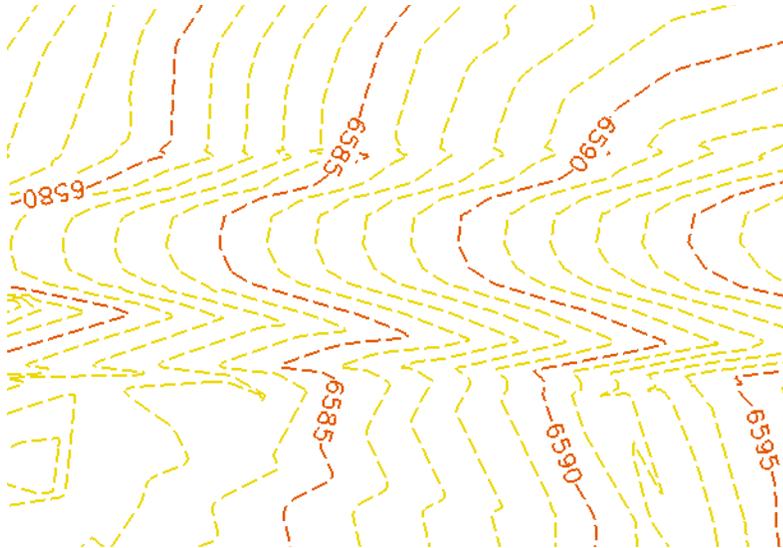
1. Choose **Surface > View Surface > Triangles**.



2. Select **Preferences** and choose the appropriate CDOT preference. The preferences are named according to proposed or existing and the interval. All display major and minor contours and the elevation labels. In addition, the **Proposed** preference displays major and minor depression contours. The preferences also set the level for displaying the contours, which in turn sets the ByLevel symbology.



3. Choose **Load**, then **Close** the **Preference** dialog.
4. If you do not want labels, you may toggle them off.
5. Select the **Surface** from the drop-down list.
6. Select **Apply** and the contours are drawn in the MicroStation file.



7. Select **Close**.

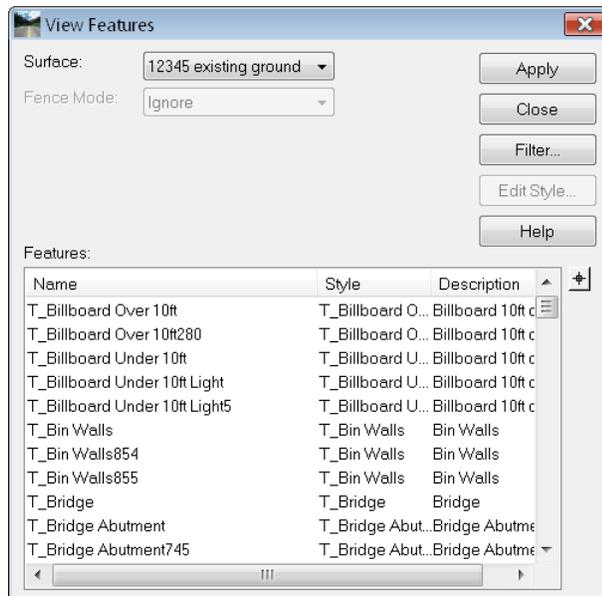
For information on additional options, see the **InRoads Online Help**.

Note: The contour display is a MicroStation graphic group. If you need to delete the contours, they will delete as one if the **Graphic Group** lock is on.

Viewing Features

The features for a model may be displayed using the **Surface > View Surface > Features** command. There are several preferences available in this command, depending upon the type of surface and contours you want to display.

1. Choose **Surface > View Surface > Features**.



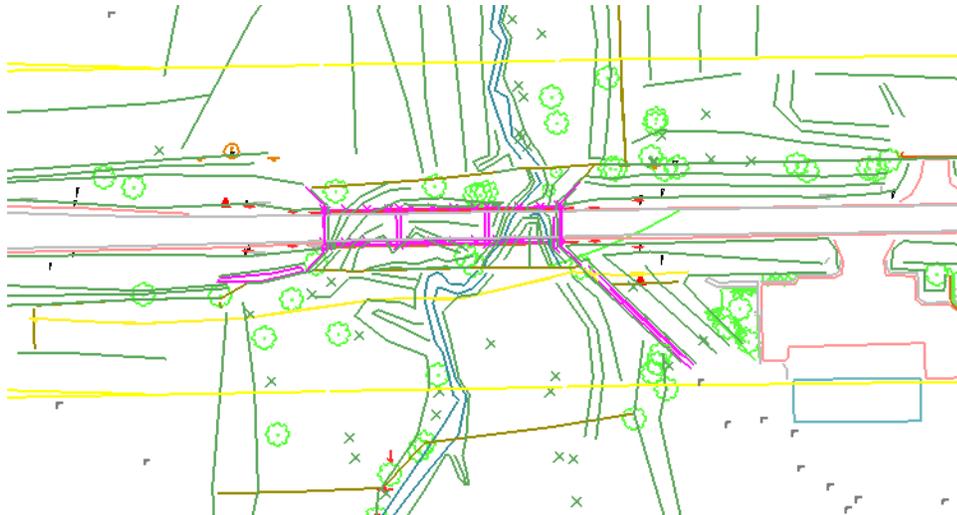
2. Select the **Surface** from the drop-down.
3. The **Feature** list shows all the features in the selected surface along with their styles and descriptions.

Note: The dialog honors the active feature filter if the **Feature Filter** lock is on.

Important! Features that appear red indicate their Style cannot be found in the currently loaded **XIN** file. Check to see if the correct Style is associated with the feature. If so, check to see that the correct **XIN** is loaded.

4. Highlight the feature or features you want to display. You can right-click and choose **Select All**, **None** or **Invert** the selection.

5. Select **Apply** and the features are drawn in the MicroStation file, using the associated Style to determine the Named Symbolology to use.



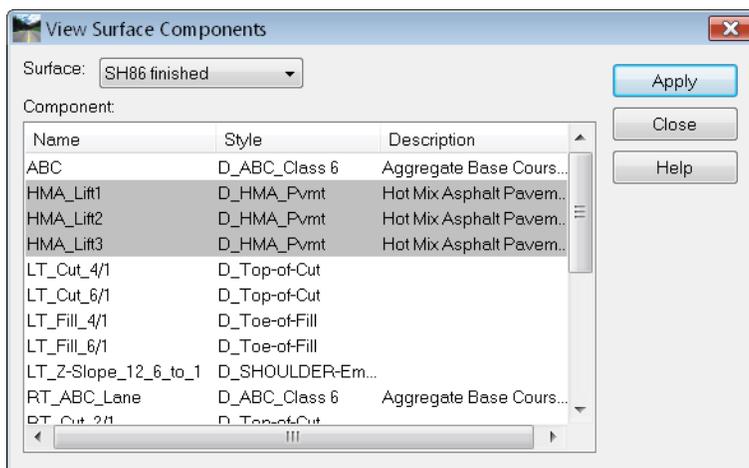
6. Select **Close**.

Note: The feature display is not a MicroStation graphic group. If you need to delete the features, they must be deleted individually, as a selection set, with a fence or using Update 3D/Plan Surface Display as described below.

Viewing Components

Components are 3D shapes created by Roadway Designer as defined in Templates. They typically only reside in proposed models. Since they are critical to accurate volume calculations when shown on cross sections, it is often necessary to view them in the design file for evaluation purposes.

1. Choose **Surface > View Surface > Components**.

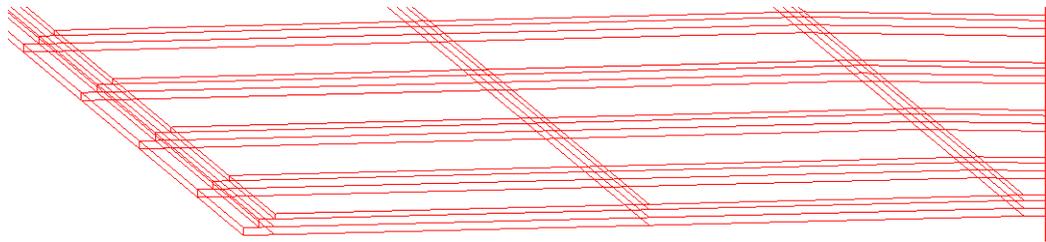


2. Select the **Surface** from the drop-down.

3. The **Component** list shows all the features in the selected surface along with their styles and descriptions.

Important! Components that appear red indicate their Style cannot be found in the currently loaded **XIN** file. Check to see if the correct Style is associated with the component. If so, check to see that the correct **XIN** is loaded. If not, you can change the Style associated with a component using **Surface > Feature > Component Properties**.

4. Highlight the component or components you want to display. You can right-click and choose **Select All**, **None** or **Invert** the selection.
5. Select **Apply** and the components are drawn in the MicroStation file, using the associated Style to determine the Named Symbology to use.



6. Select **Close**.

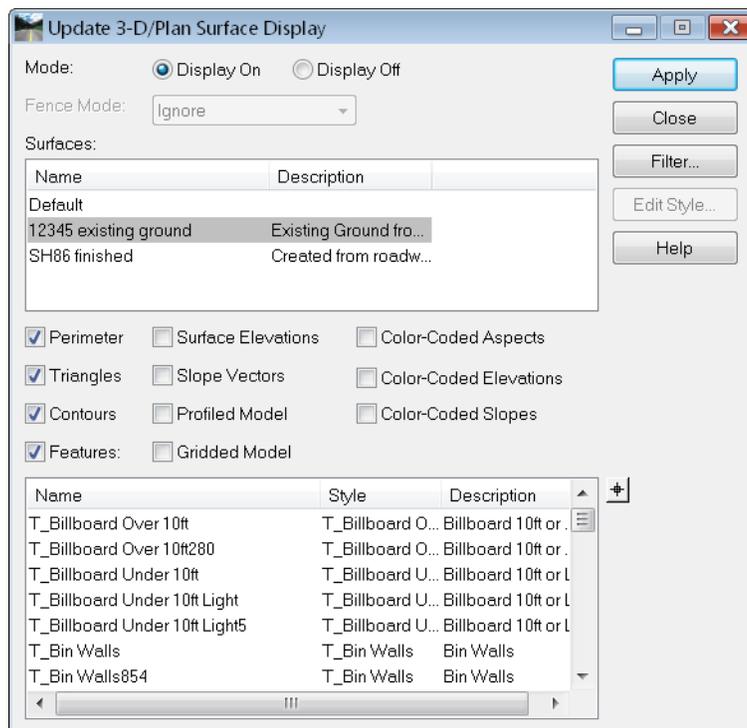
Update 3-D/Plan Surface Displays

The Update 3D/Plan Surface Display command is very useful for displaying surface information in the MicroStation file. Rather than choosing individual surface display commands, you can use this one command to display the perimeter, triangles, contours, features, etc. What makes it even more useful is the option to turn these same displays off.

Note: While this command describes its actions as *Display On* and *Display Off*, it is actually doing the same thing as the other display commands when set to *Display On* and deleting with MicroStation when set to *Display Off*. It is not just turning levels on and off.

The one down-side to using this command is the inability to choose a preference to control the display. If *Style* lock is off, the displays requiring a preference automatically use the *Preferred Preference* as defined by the *XIN* file - in this case, the preference named *CDOT*. If *Style* lock is on, they use the preference assigned to the surface in *Surface Properties*.

1. Choose **Surface > Update 3D/Plan Surface Display**.



2. Select the *Mode* to either *Display On* or *Display Off*.
3. If using a fence, select the appropriate *Fence* Mode.
4. Select the *Surface* from the list of loaded surfaces.
5. Select the Item or Items to turn on or off in the design file.
6. If *Features* is chosen, the Feature list shows all the features in the selected surface along with their styles and descriptions.

Note: The dialog honors the active feature filter if the **Feature Filter** lock is on.

Important! Features that appear red indicate their Style cannot be found in the currently loaded **XIN** file. Check to see if the correct Style is associated with the feature. If so, check to see that the correct **XIN** is loaded.

7. Highlight the feature or features you want to display. You can right-click and choose **Select All**, **None** or **Invert** the selection.
8. Select **Apply** and the items chosen are either drawn in the file or deleted depending upon the Mode.
9. Select **Close**.

Note: The feature display is not a MicroStation graphic group. If you need to delete the features, this is a very handy method, since you do not have to create a selection set or make certain they are inside a fence to delete the entire set of features at once.

Section Summary:

- The view surface commands provide a visual look at the DTM.
- Several preferences are available to ensure the displays meet CDOT standards.
- The **Update 3D/Plan Surface Display** dialog is a quick interface to most of the surface display commands.

Chapter Summary:

- DTMs should be reviewed and checked for accuracy when presented for the first time, or when created.
- Existing ground DTMs are created by Survey and can be reviewed and/or viewed as a check and familiarization process.
- Review commands provide a means of checking elevations, features, styles, etc. without displaying the DTM in the MicroStation file.
- View commands display the DTM for a visual check.

Chapter 4 - Surface Fundamentals (Under Development)

A digital terrain model (DTM) is a mathematical representation of topography that includes points and triangles and is often referred to as a surface. The triangles allow the DTM to provide elevation information at any location by interpolating the elevations of the three points making up the triangle in question.

Using Delauney's criteria, InRoads calculates the smallest triangles possible for a given set of point data. Delauney's criteria states that any triangle formed may be circumscribed and no other point will fall within the circle. Linear features must sometimes violate Delauney's criteria in order to hold a constant slope between points. In other words, linear features will not allow triangles to cross them.

You may load as many DTMs as you need into memory when using InRoads. It is typical to have several DTMs loaded, since you will have an original and several design surfaces (such as multiple finished grades or alternative surfaces). At any given time, only one surface is active, meaning it will be the default when using any command requiring a surface.

When a digital terrain model is saved to the hard drive, it takes on an extension of *DTM*.

Chapter Objectives:

- To learn what a DTM is and how it is used in the CDOT design process.
- To learn the capabilities of an intelligent DTM and what it means for a DTM's use in design.
- To learn how to manipulate DTMs after they have been created.

Introduction to DTMs

Before working with either existing or design surfaces, a basic understanding is needed of what is contained in a surface. This section introduces you to the different DTM point types and the purpose of these points. It also explains the concept of intelligent features in a surface and the proper use of features styles and named symbologies associated with these features.

Section Objectives:

- To become familiar with the point types used in a DTM and how they affect triangulation.
- To learn the make-up of an intelligent DTM including how *Features*, *Styles* and *Named Symbologies* work together.
- To learn the basics of how a DTM is created.

DTM Point Types

Everything that is used in a DTM is a feature, and each feature is assigned a point type. The point type determines how the feature reacts during triangulation. Random points triangulate to the closest point around them, while the other, linear, features will not allow triangles to cross meaning they hold a constant slope between their points.

The following point types can be used in an InRoads' DTM.

Random

- Normal topo shots
- Often used for spot shots, local highs and lows

Breakline

- Used to represent linear features such as ditches, ridges, and edges of pavement, and named accordingly
- No triangles cross breaklines — they take precedence over random points
- Must have at least two points to form a breakline (lines, linestrings, curvestrings and complex chains are acceptable for import)
- Can be densified or thinned

Contour Points

- Use when data comes from contours, e.g., digitized from aerial maps
- Work much like breaklines with a constant elevation
- Converts lines, linestrings, curvestrings and complex chains into DTM points
- Can be densified or thinned
- Inferred breaklines
- Only used with contour points
- Generated by the software
- Eliminate flat spots by forcing a slope on every triangle
- Add overhead to your surface

Interior

- Used to model holes in your surface where there is unknown survey data or areas you do not want considered in the DTM
- Requires at least three points to model a closed shape
- No triangles are formed inside an interior boundary
- You can have more than one interior boundary per surface, but they can not overlap

Exterior

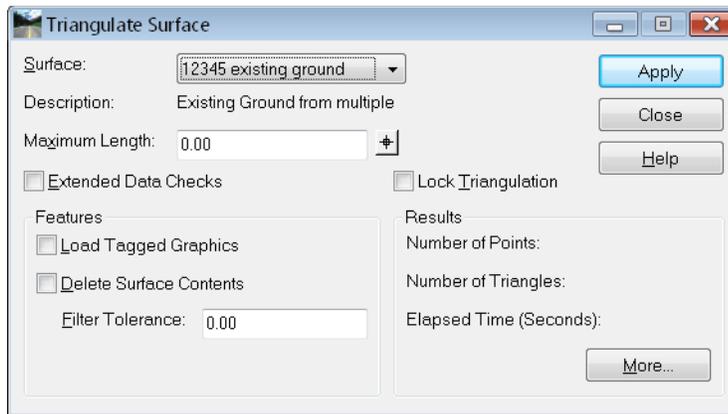
- Define limits of triangulation
- Requires at least three points to model a closed shape
- There is only one exterior boundary per surface

Surface Triangulation

In order for a surface to be used for contouring, modeling, etc., it must be triangulated. The original ground surface received from Survey will already be triangulated, however, if any changes or edits are made to a surface it will have to be triangulated again before the changes show up in displays of the surface either in Plan, Profile or Cross Section.

To triangulate a surface:

1. Select **Surface > Triangulate Surface**



Note: A surface may also be triangulated by right-clicking it in the *InRoads Explorer* menu and selecting **Triangulate** from the list of available commands.

2. Choose the **Surface** from the drop-down list

The **Maximum Length** prevents the formation of any triangles with a leg longer than what is specified. This is useful for eliminating long, slender extraneous triangles that often appear around the edges of a surface, but care must be taken that the value entered is not small enough to prevent the formation of ‘good’ triangles in the middle of the surface. If the value is set to **0.00**, it is ignored and all triangles are formed.

Extended Data Checks evaluate the surface for crossing or overlapping features. Leave this toggle off for faster processing unless you receive an error when triangulating.

The **Features** category is used when you are loading graphics to create the surface at the same time you're triangulating. For details on these options, see the InRoads Online Help.

3. **Apply** and the surface is triangulated.
4. Results show you the numbers of points and triangles formed, as well as the elapsed time. For more information, <D> the **More** button to access the Surface Properties dialog box.

Intelligent DTMs

InRoads' digital terrain models are intelligent models. By using **Feature Names**, **Feature Styles** and **Named Symbologies** as described below, the models will know what types of features can be displayed in which views as well as the symbology to use for displays.

Feature Name
Unique identifier for each feature in a DTM.
Surface > Ftr > Ftr Prop.

Feature Style
Tells the feature what it can display and where.
Tools > Feature Style Mgr

Named Symbology
Gives the feature its level and other graphical attributes.
Tools > Symbology Mgr

The screenshot displays several software windows:

- Feature Properties:** A table listing features with columns for Name, Style, and Description. The feature 'T_Edge of Gravel Road' is highlighted.
- Style Manager:** A table listing styles with columns for Name, Description, Alpha Code, Numeric Code, Pay Item, and Surface Named Symbology. The style 'T_Edge of Gravel Road' is highlighted.
- Named Symbology Manager:** A table listing named symbologies with columns for Name, Description, Default, and Plan. The symbology 'T_Edge of Gravel Road' is highlighted.
- Edit Style:** A dialog box for editing the style 'T_Edge of Gravel Road'.
- Edit Named Symbology:** A dialog box for editing the named symbology 'T_Edge of Gravel Road'.

Feature Names

Everything in a DTM is a feature and every feature must have a unique name. Often, when creating new features, you will be asked to supply a **Seed Name**. This seed name is used as the base for a unique feature name. For example, if you use **creek** as the **Seed Name**, and you load more than one (with a level or selection set, for example) the second will be named **creek1**, third **creek2**, etc.

A feature can be either triangulating, such as breaklines representing ditches, centerlines, etc. or it can be non-triangulating, such as utilities that are below or above the ground surface. These types of non-triangulating features can be shown on cross section, profiles and in plan view without affecting the triangulated network.

Feature names are stored within the DTM.

Feature Styles

Feature Styles are assigned to features in the DTM. They control where and what the features is “allowed” to display, as well as assigning a named symbology. For example, when you assign a feature style to a feature, you are determining if it can be displayed in plan using lines, points and/or annotation; if it can be displayed in sections using points and/or annotation, etc.

Feature Styles are stored in *CDOT-Preferences.ini*.

Named Symbology

Named Symbologies are just what they sound like — setups, such as color, weight, line style, font that can be saved by name. They even go one step farther allowing these setups to share a name while establishing different symbologies for plan, cross sections and profiles. This way, one entity that uses a named symbology can still display using different setups in plan vs. cross section vs. profile. Just about anywhere you assign symbology, you can use a named symbology instead. CDOT named symbologies are setup to use ByLevel symbology.

Named Symbologies are stored in *CDOT-Preferences.ini*.

Creating a DTM

In the CDOT Process, the existing ground DTM is provided by Survey and proposed DTMs are created by InRoads tools such as Roadway Designer. However, there may be times when you may have to create or supplement one of these DTMs. If so, the data used to create the DTM may be in one of several formats. The most common formats are described below.

ASCII (text) Files

ASCII data can be loaded from several different formats. Using **File > Text Import Wizard**, you can specify the format for your data. This wizard takes you through the import process step by step. Some commonly used formats include:

- x,y,z
- northing, easting, elevation
- station, offset, elevation (baseline alignment required)

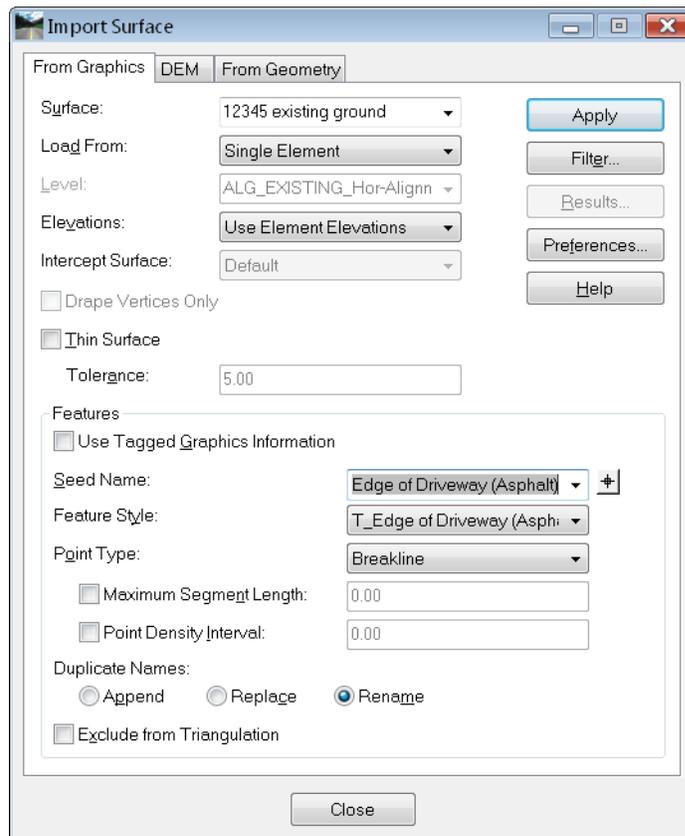
Note: These formats can have additional columns for ‘pen-up, pen-down’ to define separate linear elements in one file, for feature names, features styles, etc.

See the *InRoads Online Help* for additional information.

Surface from graphics

Graphical data is sometimes used to generate existing or proposed surfaces using **File > Import > Surface > From Graphics**. When using graphics, some key points are listed below.

- Elevations may be taken from the element or from surface (if the surface has been triangulated already).
- Elevations may be taken from text if you're loading random points that are graphically displayed in the correct location, with text listing the elevations.
- Linear features that contain curves can be densified using the chord height tolerance (set under **Tools > Options > Tolerances**).
- Linear elements can be densified by setting a maximum segment length or a point density interval.
- Points on linear elements can be thinned upon input using the **Thin** (and **Tolerance**) option.



See the **InRoads Online Help** for additional information.

In the **Surface Editing Tools** chapter of this document, you will find additional information on creating features using a variety of tools.

Section Summary:

- Random points are for local high/low topo shots.
- Linear features in a DTM ensure a constant slope between the feature points.
- Exterior and Interior features limit the location of triangles (an exterior forms a boundary and an interior forms a hole).
- Each feature in a DTM has a unique name.
- Features are named to make them intelligent.
- Styles control where a feature can display and assign it a named symbology for it's graphical attributes.
- **Feature Styles** and **Named Symbologies** are stored in **CDOT-Preferences.ini**.
- You can supplement a DTM with data from text files (ASCII) or from MicroStation graphics.

DTM Utilities

There are several DTM utilities that allow you to manipulate the DTM after it has been created, both internally in InRoads memory and externally on the hard drive.

Section Objectives:

- To learn how to manipulate a DTM as a whole.

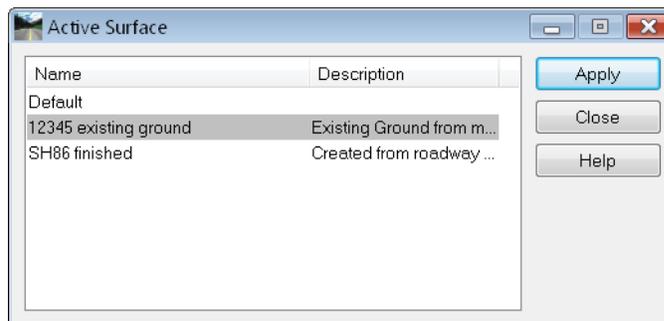
Active Surface

When you access commands in InRoads that require a surface, they always default to the **Active** surface. In most cases, you can simply use a drop-down in the command's dialog box to change to a different surface. However, in some circumstances you are not given that opportunity. Two examples include:

- when **Style** lock is on and you use a **View Surface** command, and
- when you use **Apply Template** with a template whose end condition seeks the **Active** Surface.

In these cases, you must first set the Active surface.

1. Select **Surface > Active Surface**.



2. From the list of loaded surfaces, highlight the one you want.
3. Choose **Apply**.
4. Choose **Close**.

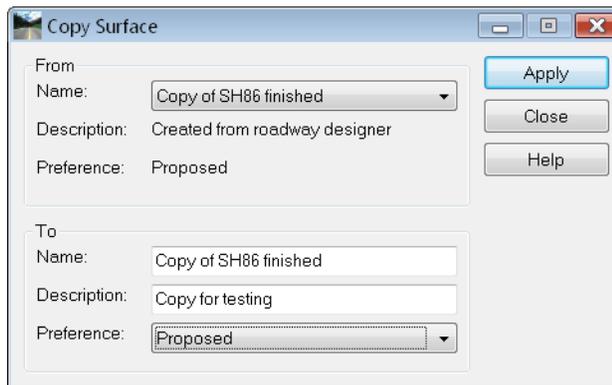
An alternate method is to right-click on the surface in the workspace or explorer portion of the menu and select **Set Active**.

Note: The active surface is shown in the menu with a red box around the surface icon.

Copy Surface

InRoads' surfaces have a name that is used in all the dialog boxes (the internal name) and a name that is used on the hard drive (the external name). Although it is recommended, these two names are not required to match. However, you cannot have two surfaces loaded that are seen as being the same. Therefore, if you copy a surface on the hard drive, InRoads does not realize that it is a separate surface. If you load the original and the copy, it will assume you're loading the same surface twice and will ask if you want to overwrite the first one loaded. Instead of making the copy in this manner, use the *Copy Surface* command inside InRoads.

1. Select **Surface > Copy Surface**.



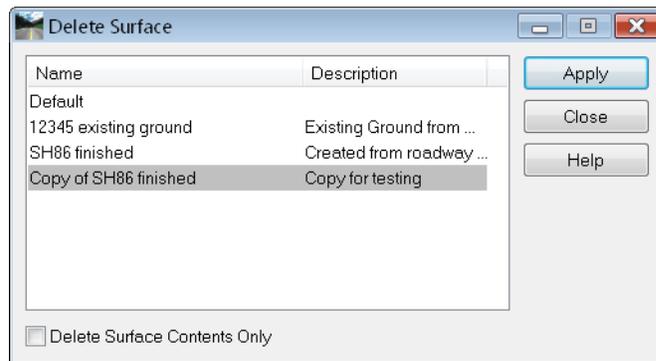
2. Select the Surface you want to copy with the drop-down list in the *From* category.
3. In the *To* category, specify a *Name*, *Description* and *Preference* for the copy. (This is the internal name.)
4. Choose **Apply**.
5. Choose **Close**.

The new surface should now be saved to the hard drive. See the section on *Saving Surfaces* for additional details.

Delete Surface

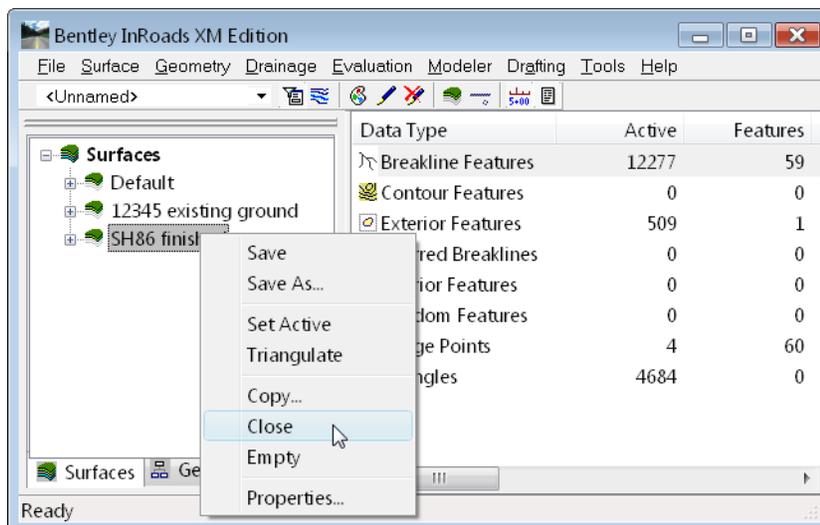
The **Delete Surface** command removes a surface from memory, but does not affect the surface on the hard drive. If you are using the **Create Surface** option within Roadway Designer, you do not have to delete the surface. Instead toggle on **Empty Surface** and it will remove the data from the surface before creating the new model. The **Delete Surface** command should be used when you are through with a surface but are not ready to exit InRoads, or if you want to re-use the name of a surface, but do not need its current contents.

1. Select **Surface > Delete Surface**.



2. Select the **Surface** you want to remove from memory from the list of loaded surfaces.
3. Toggle on **Delete Surface Contents Only** if you want to keep the name and other surface attributes but not the features.
4. Choose **Apply**.
5. Choose **Close**.

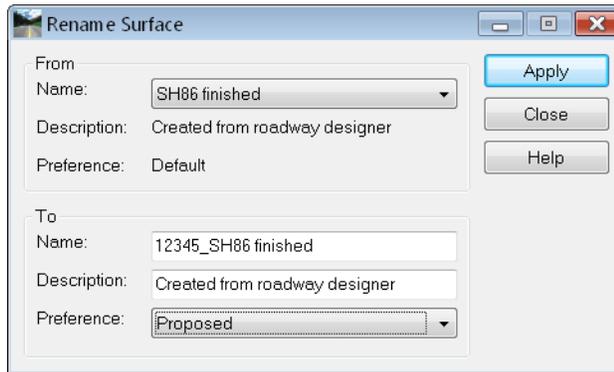
An alternate method is to right-click on the surface in the workspace or explorer portion of the menu and select **Close** to completely remove the surface from memory, or **Empty** to remove only the contents.



Rename Surface

The **Rename Surface** command is used to change the internal name of a surface. It also allows you to change the **Description** and **Preference** associated with a surface.

1. Select **Surface > Rename Surface**.



2. Select the **Surface** you want to rename from the drop-down list in the **From** category.
3. Key in the new name in the **To** category.
4. Change the **Description** and/or **Preference** as desired.
5. Choose **Apply**.
6. Choose **Close**.

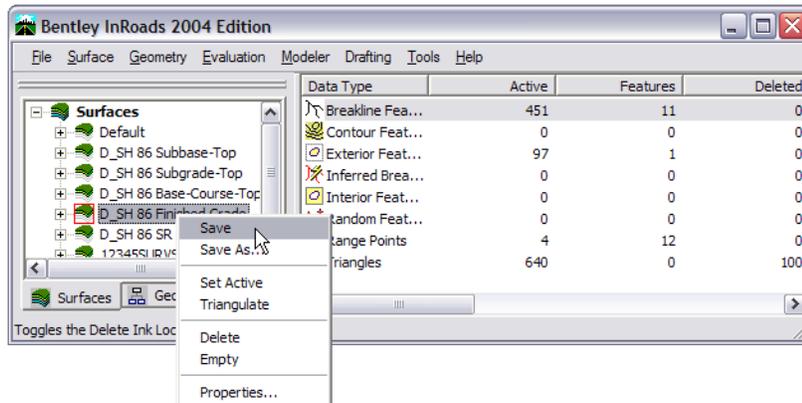
The surface should be saved to the hard drive after making the change.

Important! Do not use the rename command to make a copy of a surface. For example, do not rename a surface and then try to load the original surface again. InRoads still sees the surfaces as the same and will not allow both to be loaded. Instead, use **Surface > Copy Surface**.

Save Surface

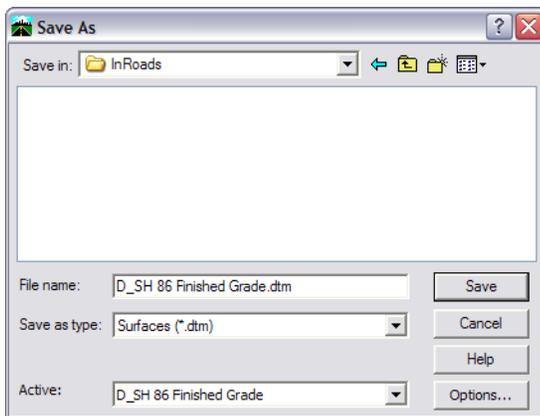
Surfaces can be saved using several methods including:

- Choose **File > Save > Surface**
The active surface is saved.
- Right-click on the Surface in the *Explorer* menu and chose **Save**



The surface you highlighted is saved.

If the surface has never been saved, either of the above methods will bring up the **Save > As** box as shown below.



1. Choose **File > Save As**
2. Set the *Files of Type* to **.dtm*
3. Choose the *Active* surface you want to save
4. The *File name* field should populate with the active surface name. If you want the hard drive name to be different, key in the *File name*
5. <D> **Apply**.

Note: Surfaces have both an internal name that appears in the dialog boxes in InRoads and a name on the hard drive that has a *.dtm* extension. It is recommended that these names be the same, and care should be taken to make certain you have chosen the correct surface name to match the file name you specify. Otherwise, you could accidentally save over a file on the hard drive with the wrong surface.

The surface may also be saved as part of the project or **RWK** file.

Section Summary:

- The active surface is the default one used in many commands, but can typically be changed with a Surface drop-down option in the command.
- If **Style** lock is on, the active surface is more critical for **View** commands, since the command only works on the active surface.
- Surfaces can be renamed, but InRoads still sees the surface as the same one.
- Surfaces can be copied, in which case InRoads sees them as different surfaces.

Chapter Summary:

- Intelligent DTMs are critical to the CDOT design process.
- Existing DTMs are created by survey and provide the basis for modeling proposed surfaces.
- Existing and proposed DTMs are used to compute volumes.

Chapter 5 - Surface Editing (Under Development)

Chapter 6 - Initial Geometry Procedures (Under Development)

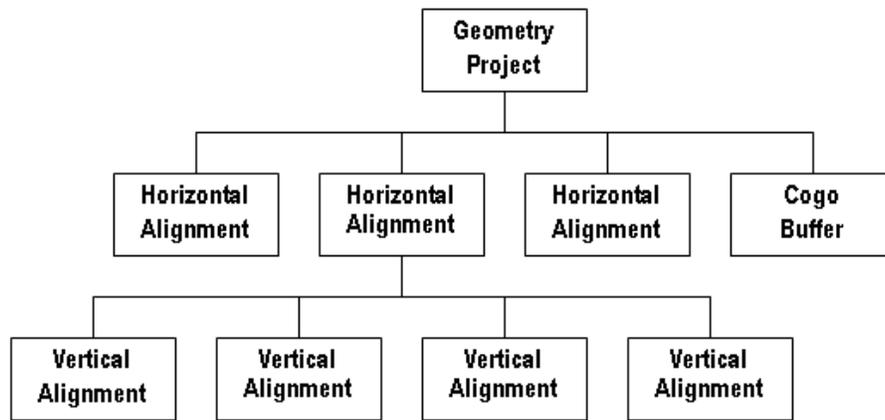
Chapter 7 - Defining Horizontal Alignments (Under Development)

Chapter 8 - Profiles (Under Development)

Chapter 9 - Defining Vertical Geometry

In InRoads, your project's vertical alignment is created after establishing the centerline "path" or horizontal alignment. This vertical geometry is stored in the InRoads geometry project (the *ALG* file).

In the geometry project hierarchy, the vertical alignment is a "child" to the horizontal alignment. Therefore, you must first create the project's horizontal alignment before creating a vertical alignment "child" underneath the horizontal "parent".



InRoads provides tools to help you design the vertical geometry within AAHSTO or CDOT project guidelines. You can also create multiple vertical alignments for each horizontal alignment if you wish to analyze different alternative alignments for cut/fill balancing or other design criteria (vertical curve designs, vertical grades, stopping sight distances, etc.)

This chapter explains how and when to use the *Vertical Curve Set* tools to create your vertical geometry, as well as other tools that you can use to display, modify and annotate this geometry.

Chapter Objectives:

- Explain how vertical alignments are created and their relationship to other project data in the CDOT process.
- Investigate different options for reporting on vertical alignment geometry data and learn when to use each option.
- Explain how to effectively maintain and manage vertical alignments with InRoads.

Creating Vertical Alignments

The process of creating a vertical alignment requires that you first create a horizontal centerline alignment. You can then create a profile of the existing ground conditions along this horizontal alignment. It is directly on this existing ground profile grid where you "lay out" or create your vertical alignment.

You can use the *Vertical Curve Set* tools to place vertical PIs and then define your vertical curves on the profile. You can then move/edit VPIs and curve data as necessary to meet your project's design criteria.

Once you've established your vertical geometry using the best InRoads tools for your design situation, you can:

- Display your vertical alignment on the profile grid
- Annotate critical geometry data and other information directly on the alignment.
- Produce geometry reports noting information like entrance and exit grades and lengths, PVC and PVT locations, high and low point locations, vertical curve lengths, k and r values, etc.

This information is not only critical for interim design checks, but also for final project documentation.

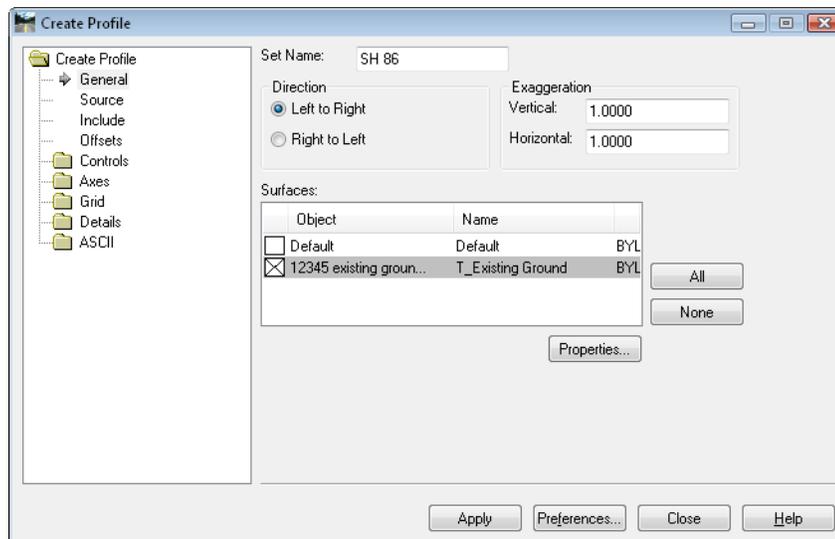
Section Objectives:<

- Demonstrate how vertical alignment slots are created in the geometry project.
- Explain how the Vertical Curve Set tools are used to create a vertical alignment.
- Explain how precision keyins are used for placing vertical alignment VPIs.
- Explain how to edit alignment points (adding, inserting, moving or deleting VPIs).
- Explain how to edit vertical curve data.
- Demonstrate how to add vertical events to the alignment.

Creating Profiles

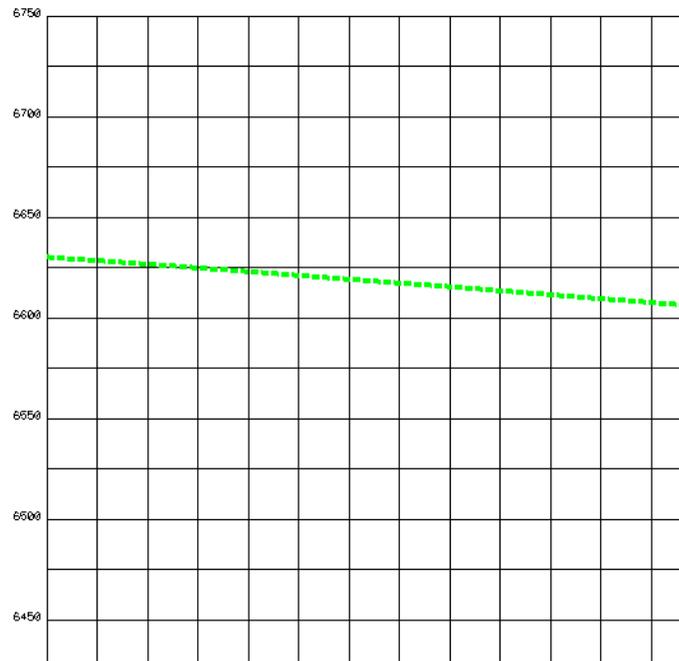
A profile of the horizontal alignment showing the existing surface ground line is required before creating a vertical alignment. The vertical geometry is then created directly on this profile grid.

Select **Evaluation > Profile > Create Profile** and then select the appropriate profile preference.



Make sure the correct horizontal alignment is active for profiling on the **Source** leaf. Multiple surfaces may be shown on one profile by selecting them in the **Surfaces** window on the **General** leaf. You may also show features that cross the alignment and projected features on the profile. These may be toggled on from the **Include** leaf before creating the profile.

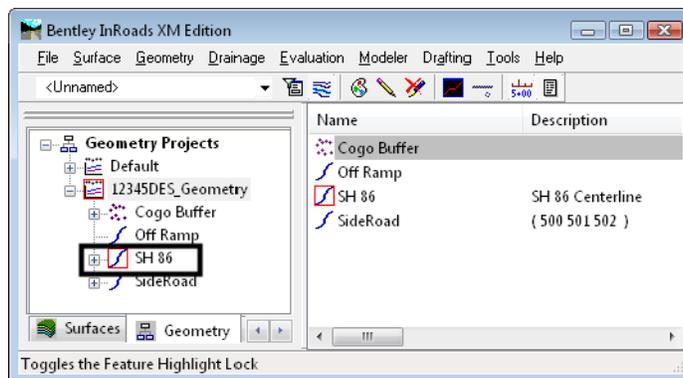
Note: There is no option to select specific features from the Create Profile dialog box. Therefore, it may be better to display features from the *Update Profile* command.



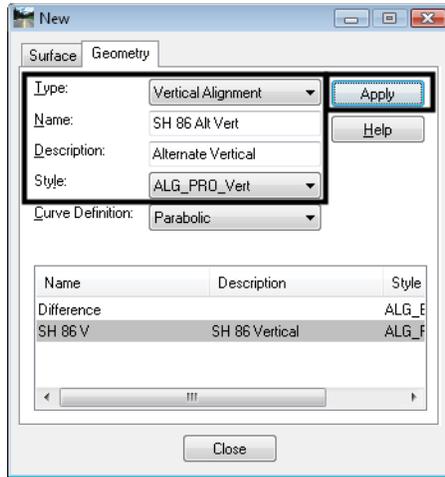
See the *Profiles* chapter for more information on creating profiles.

Creating a new Vertical Alignment Slot

In order to create a new vertical alignment, you must first have a geometry project loaded, with a parent horizontal alignment active.



Once the geometry project is loaded (and correct horizontal is active), you may create a new alignment name using the **File > New > Geometry** command.



For additional information on creating new geometry, see the chapter **Initial Geometry Procedures**.

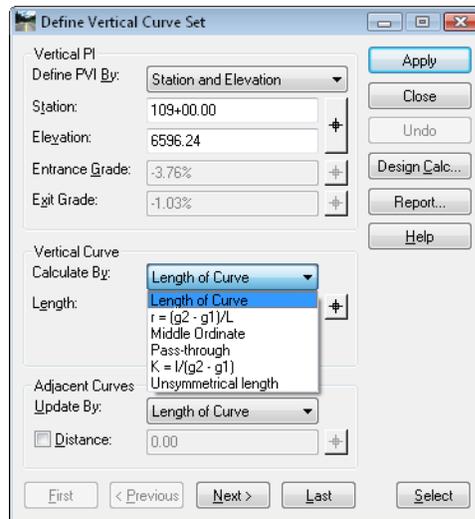
Using the Vertical Curve Set Commands

Use the **Vertical Curve Set** tools to create the initial vertical alignment. These tools consist of five primary commands described below.



- **Add Vertical PI** – used to create a VPI that begins a new alignment, or to add a VPI onto either end of an existing alignment.
- **Insert Vertical PI** – used to add a VPI to an alignment between two existing VPIs.
- **Move Vertical PI** – used to change the location of an existing vertical VPI.
- **Delete Vertical PI** – used to remove a VPI from an existing alignment. For removing more than one VPI, you must choose and accept each one individually. To remove all VPIs associated with an alignment, but leave the alignment name, right-click on the alignment name in the InRoads Explorer window and choose **Empty**.

- **Define Vertical Curve** – used to create a curve at a VPI on an alignment, or to revise an existing curve on an alignment. The **Previous** and **Next** buttons are used to step through the alignment. The tangents forming the VPI where the curve is to be defined will be highlighted graphically.



The **Vertical PI** section of this dialog box allows you to edit the location of a vertical PI. For more information see the section **Editing Vertical Alignments**.

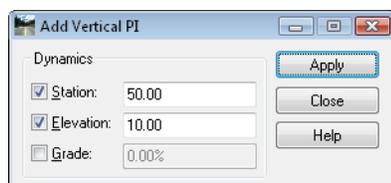
The **Vertical Curve** section of the dialog box is where you enter your vertical curve information. Options for defining vertical curves include:

- ◆ **Length of Curve** – specify the length of the vertical curve.
- ◆ $r = (g_2 - g_1) / L$ – specify the rate of change.
- ◆ **Middle Ordinate** – specify the middle ordinate or external distance.
- ◆ **Pass-through** – specify the pass-through point by station and elevation.
- ◆ $K = L / (g_2 - g_1)$ – specify the vertical curve K value.
- ◆ **Unsymmetrical Length** – specify the length from the PVC to the PVI and the distance from the PVI to the PVC.

Note: You must **Apply** after defining each VPI or curve. If you make a mistake and place a VPI in the wrong location or define a vertical curve incorrectly, you can select **Undo** to return the alignment to its previous values. Only one **Undo** action is available.

Dynamics

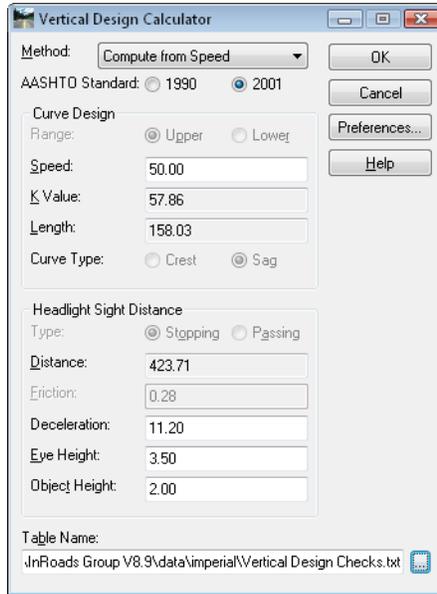
The **Dynamics** dialog allows you to set intervals for placement of the vertical PIs. It locks your cursor into the desired station, elevation and/or grade intervals. This is also useful when editing a VPI because you can lock on a station interval, for example, when moving a VPI.



The Vertical Design Calculator

The *Vertical Design Calculator* is used to compute or look up curve data to ensure your design criteria are met. This tool uses the AASHTO green book design guidelines to compute your curve data based on values you input for:

- Design speed
- Headlight sight distance or
- Curve length.



When using the *Vertical Design Calculator*, ensure that you’re using the correct *Vertical Design Checks.txt* table, which contains data from the *2001 AAHSTO* manual. The table file is located in the *C:\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Design Checks* folder in the CDOT workspace.

Table extracted from "A POLICY on GEOMETRIC DESIGN of HIGHWAYS and STREETS 2001", AASHTO											

DESIGN SPEED (mph)	f	Crest - Upper Stop Dist	Upper K value	Crest - Lower Stop Dist	Lower K value	Sag - Upper Stop Dist	Upper K value	Sag - Lower Stop Dist	Lower K value	Passing Sight Dist. Minimum Dist	K value
20.	.40	115.	7.	115.	7.	115.	17.	115.	17.	710.	180.
25.	.38	155.	12.	155.	12.	155.	26.	155.	26.	900.	289.
30.	.35	200.	19.	200.	19.	200.	37.	200.	37.	1090.	424.
35.	.34	250.	29.	250.	29.	250.	49.	225.	49.	1280.	585.
40.	.32	305.	44.	305.	44.	305.	64.	305.	64.	1470.	772.
45.	.31	360.	61.	360.	61.	360.	79.	360.	79.	1625.	943.
50.	.30	425.	84.	425.	84.	425.	96.	425.	96.	1835.	1203.
55.	.30	495.	114.	495.	114.	495.	115.	495.	115.	1985.	1407.
60.	.29	570.	151.	570.	151.	570.	136.	570.	136.	2135.	1628.
65.	.29	645.	193.	645.	193.	645.	157.	645.	157.	2285.	1865.
70.	.28	730.	247.	730.	247.	730.	181.	730.	181.	2480.	2197.
75.	.28	820.	312.	820.	312.	820.	206.	820.	206.	2580.	2377.
80.	.28	910.	384.	910.	384.	910.	231.	910.	231.	2680.	2565.

Keyins

There are additional keyins that can be useful when creating a vertical alignment and using the *Add*, *Insert* or *Move PI* commands. These include:

- ***SE=station,elevation***

Example: ***SE=34500,8421***

Use this keyin to place a VPI at a specific station and elevation.

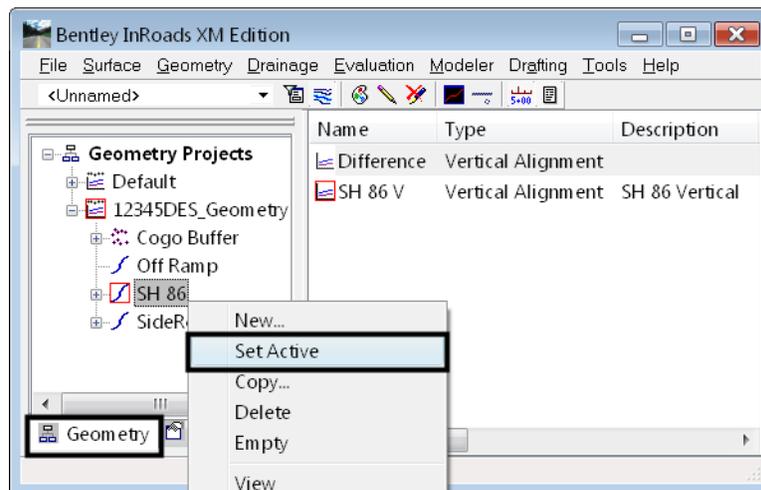
- ***DG=distance,grade***

Example: ***DG=1500,-2.5%*** or ***DG=1500,-.025***

Use this keyin to place a VPI at a specific horizontal distance and grade from the previous VPI. Specify the grade as either a decimal or use the percent sign as shown in the example.

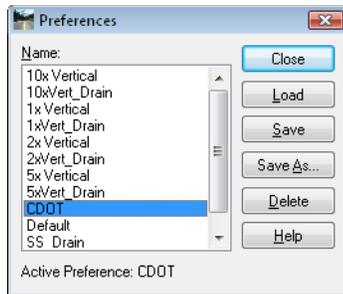
To create a vertical alignment

1. Select **File > Open** to load the geometry project into InRoads memory.
2. In the InRoads Explorer, select the **Geometry** tab, right click on the correct horizontal alignment and **Set Active**.

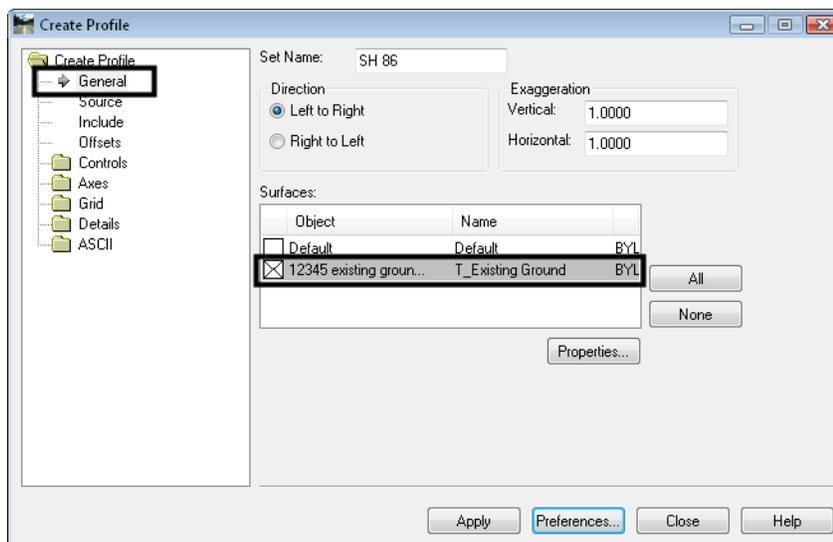


3. Select **File > Open** to load the existing surface into InRoads memory.
4. Create a profile of the existing ground along the horizontal alignment. Select **Evaluation>Profile>Create Profile**.

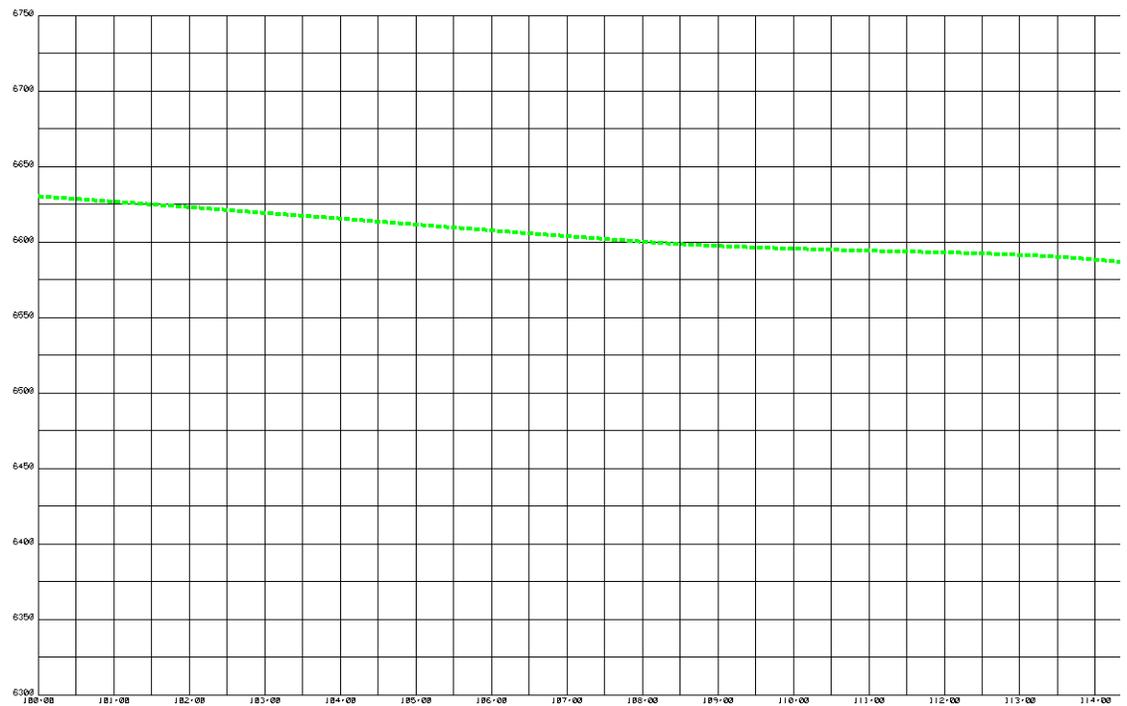
5. On the **Create Profile** dialog box, select **Preferences** and **Load** the desired preference for the profile display.



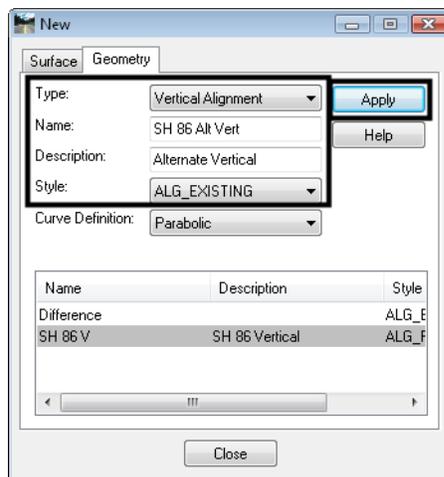
6. On the **Create Profile** dialog box **General** leaf, make sure the existing ground surface is toggled on.



7. <D> **Apply** and then <D> to identify the location of the profile's lower left corner.

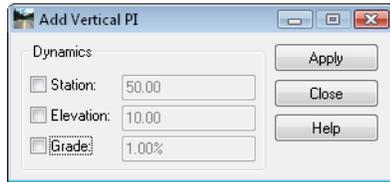


8. You're now ready to create a new vertical alignment. Select **File > New > Geometry** and select the *Vertical Alignment* tab.
9. Key-in a *Name* and *Description* for the alignment and then select the *Style*.



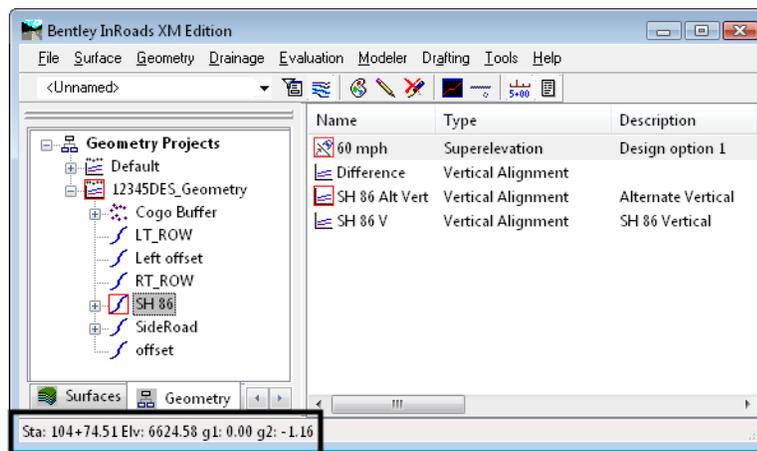
10. <D> **Apply**, then <D> **Close** to dismiss the dialog box.
11. Now input the alignment data. Select **Geometry > Vertical Curve Set > Add PI**.

12. Enable *Dynamics* locks for *Station*, *Elevation* or *Grade* (if desired).

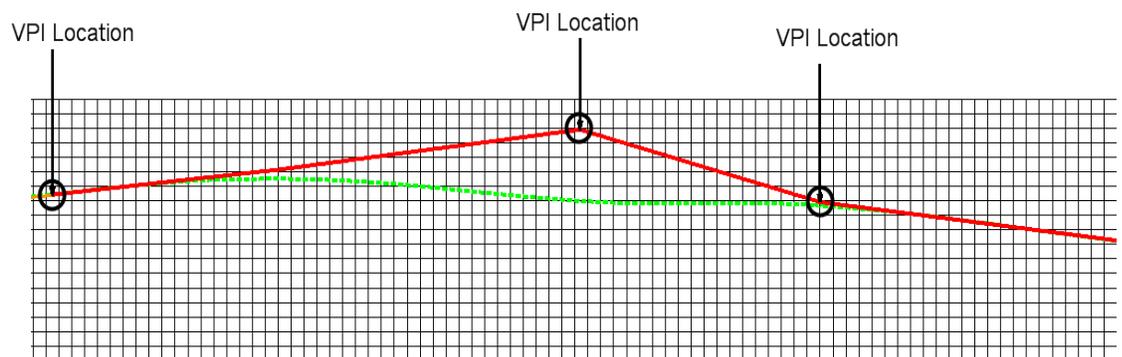


13. <D> **Apply**.

Note: As you drag the cursor in profile window, Station, Elevation and Grade dynamically displays in InRoads status window



14. Enter a data point <D> or snap to a location to define the first VPI, or use the **SE=** keyin to place it at a specific Station, Elevation location.
15. Place additional VPIs with data points <D> or by using either **SE=** or **DG=** (Distance, Grade) keyins.



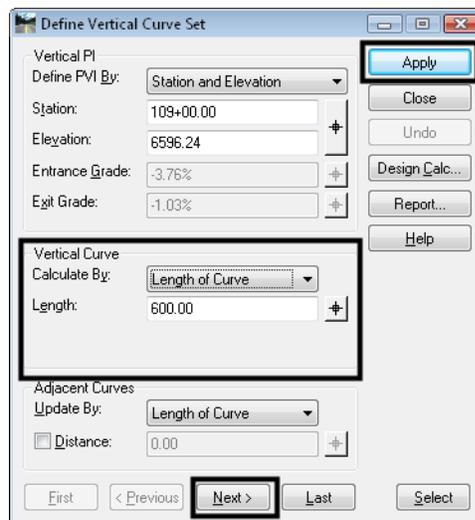
16. <R> when finished placing VPIs.
17. <R> again out of the **Add PI** command.

18. You're now ready to add Vertical Curves data. Select **Geometry > Vertical Curve Set > Define Curve**.

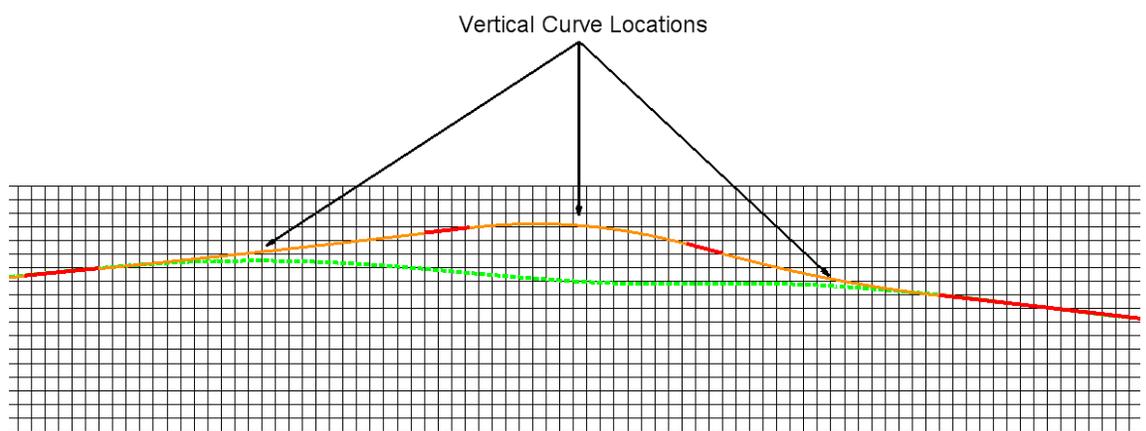
Note: The first two vertical tangents are highlighted.

19. Set **Calculate By** to the desired method (**Length of Curve**, **Unsymmetrical Length**, etc.) and enter the vertical curve value.

Note: Select **Design Calc** to use AAHSTO design guidelines to look up or compute curve data.



20. <D> **Apply** to define the curve.
21. Use the **Next** button to move to the next set of vertical tangents to define the next vertical curve.



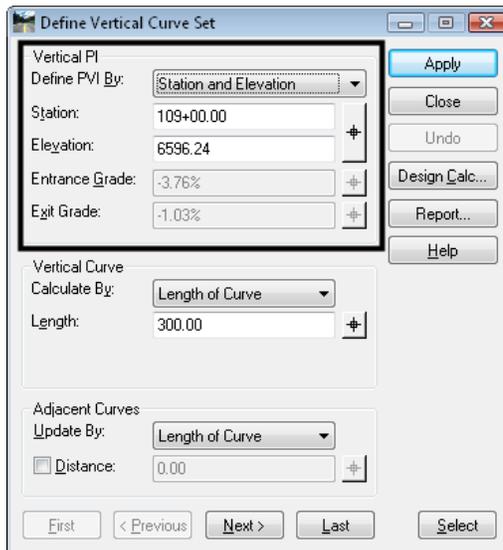
22. **Close** the **Define Vertical Curve** dialog box when done.

Editing Vertical Alignments

There are several options for editing or modifying a vertical PI or curve after it has been placed.

Editing a VPI using the Define Vertical Curve Set command

While the primary purpose of the *Define Vertical Curve Set* command is to define a curve between two vertical tangents, you can also use this command to edit the VPI between these two tangents. By default, the fields in the **Vertical PI** section of the dialog box are populated with values that describe the position of the current VPI relative to the previous and next VPIs. However, you can change these values and then **Apply** to redefine the location of the VPI.



Set the *Define PVI By* option to the method you want to use to determine the PVI location. The four options are:

- ***Station and Elevation***
- ***Station and Entrance Grade***
- ***Station and Exit Grade***
- ***Entrance and Exit Grades***

You can move the PVI location using any of these methods.

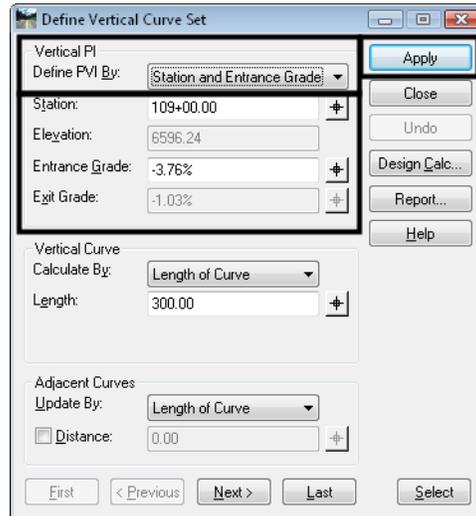
To edit a VPI using the Define Vertical Curve Set command

1. Select **Geometry > Vertical Curve Set > Define Curve**.
2. Identify the curve set containing the VPI you want to move.

Note: You can use the **First/Last** or **Previous/Next** buttons to highlight the curve or use the **Target** button to graphically select the curve on the profile.

Note: You do not have to have a curve defined to edit the VPI. InRoads treats a VPI as a zero length curve. If no curve is defined, the entrance and exit tangents at the VPI are highlighted.

3. Set the **Define PVI By** to the desired option for specifying the move.

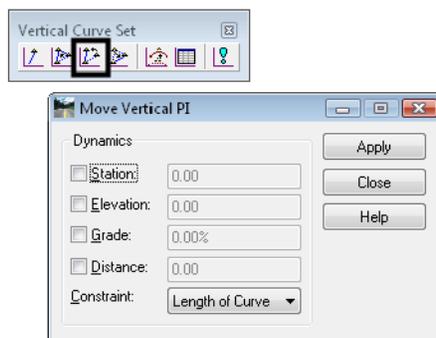


4. Key in the new values for either **Station**, **Elevation**, **Entrance Grade** or **Exit Grade** (depending on the method selected).
5. <D> **Apply**.

The VPI is moved to the new location. For example, if the **Define PVI By** option is set to **Entrance and Exit Grades** you can key in new **Entrance Grade** and **Exit Grade** values. the VPI is repositioned based on the intersection of those grades projected from the previous and next VPIS.

Editing a VPI using the Move Vertical PI command

This command repositions PVI's on the active vertical alignment. Any curves at the moved vertical PI are recomputed and updated.

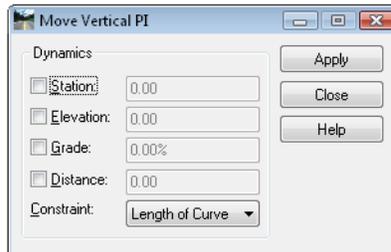


To edit a VPI using the Move Vertical PI command

1. Select **Geometry > Vertical Curve Set > Move PI** or the **Move PI** command from the **Vertical Curve Set** toolbar.

Note: The dialog box appears, and you are prompted to identify the element.

- Using the **Station**, **Elevation**, **Grade**, **Distance**, and **Constraint** options on the dialog box, you can set an interval to control the position of the VPI being placed while using this command. The cursor position is constrained or locked into the interval specified by the values you provide. If no options are selected, the VPI may be moved to any location between its neighboring VPIs.



- <D> Apply.**
- <D>** near the VPI you want to move.

Note: The VPI is attached to your cursor. The command only looks for vertical points (VPIs), therefore you do not have to snap to the VPI. Just place a data point and you will pick up the closest VPI.

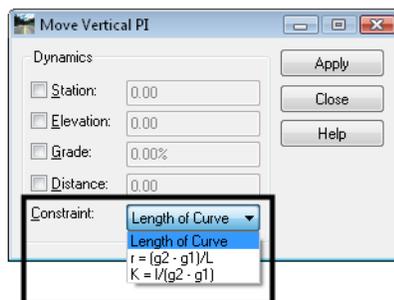
- Specify the new location, either graphically or by precision key-in.

Note: You are prompted to **Accept** or **Reject** the overall solution. Depending on the specifications, the warning message **Solution Overlaps** may be displayed.

- <D>** to accept the new location.

Updating curves

Use the **Constraint** parameter when you make an edit that affects the adjacent curves.



For example, changing the elevation of the current PVI would cause the following to be recomputed: exit grade of the previous curve, entrance and exit grade of the current curve, and entrance grade of the next curve. The previous curve would be recomputed by holding the original PVI station and elevation as well as the entrance grade. The exit grade would be recomputed by holding the length of curve. The next curve would be recomputed by holding the original PVI station and elevation as well as the exit grade. The entrance grade would be recomputed by holding the length of curve.

In adjacent curves, the length of curve is either preserved or recomputed, based on the setting of the *Constraint* parameter.

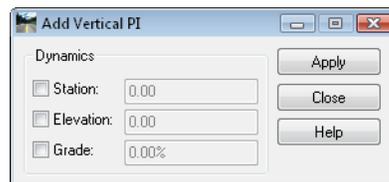
Adding a Vertical PI

If you need to add a vertical PI onto the *end* of the alignment, use the *Add Vertical PI* command. **Do not** use this command to add a VPI *between* two existing VPIs. If you need to do this, use the *Insert Vertical PI* command.

To add a VPI on to the end of a vertical alignment

1. Select **Geometry > Vertical Curve Set > Add PI**.

Note: You can also select **Add PI** from the *Vertical Curve Set* toolbar.



2. Using the *Station*, *Elevation*, *Grade*, *Distance*, and *Constraint* options on the dialog box, you can set an interval to control the position of the VPI being placed while using this command. The cursor position is constrained or locked into the interval specified by the values you provide. If no options are selected, the VPI may be moved to any location between its neighboring VPIs.
3. **<D> Apply**.

Note: You are prompted to *Identify Alignment End*.

4. **<D>** beyond the end of the alignment where you want to add a VPI (either at the beginning or end of the alignment).

Note: The VPI is attached to your cursor. The command only looks for vertical points (VPIs), therefore you do not have to snap to the VPI. Just place a data point and you will pick up the closest VPI.

5. You are prompted to *Specify Point/Reject*. Specify a location for the new VPI, either graphically with a **<D>** or by precision keyin.
6. **<D>** to accept the new location.
7. **<R>** when done.
8. **<R>** again out of the *Add Vertical PI* command.
9. **Close** the *Add Vertical PI* box.

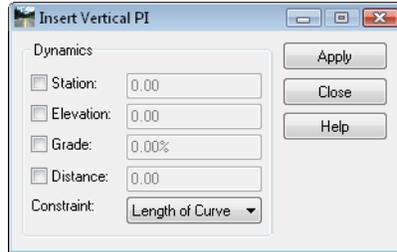
Inserting a Vertical PI

If you need to add a VPI between two existing VPIs, you can insert the VPI on an existing vertical tangent using the *Insert Vertical PI* command.

To insert a vertical PI

1. Select **Geometry > Vertical Curve Set > Insert PI**.

Note: You can also select **Insert Vertical PI** from the *Vertical Curve Set* toolbar.



2. Using the *Station*, *Elevation*, *Grade*, *Distance*, and *Constraint* options on the dialog box, you can set an interval to control the position of the VPI being placed while using this command. The cursor position is constrained or locked into the interval specified by the values you provide. If no options are selected, the VPI may be moved to any location between its neighboring VPIs.

3. <D> **Apply**.

4. You are prompted to *Identify Element*.

5. <D> on the vertical tangent where you want to insert the new VPI.

Note: As you move your cursor, it will “rubber-band” along the tangent.

6. You are prompted to **Specify Point/Reject**. Specify a location for the new VPI, either graphically with a <D> or by precision keyin.

Note: You are prompted to *Accept overall solution/Reject*.

7. <D> to accept the new location.

8. <R> again out of the *Add Vertical PI* command.

Adding Vertical Event Points

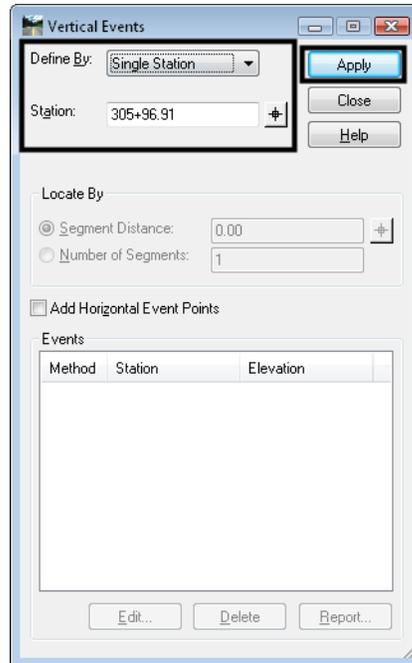
Vertical Events are any special location on the vertical alignment that you may want to display and annotate on the alignment, or where you may want to later cut a cross section. (for example, at a bridge approach or culvert). Later, when you create a corridor along this alignment, you have the option to drop templates at event points and cut a cross section at the events.

To add vertical events points to your alignment

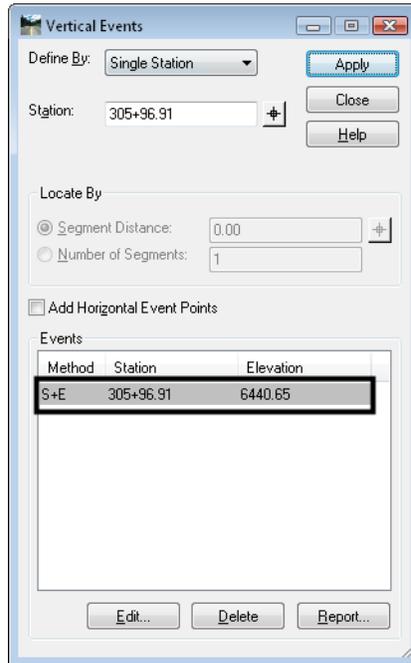
1. Select **Geometry > Vertical Curve Set > Events**.
2. Set the *Define By* option to either *Single Station* or *Multiple Stations*.

Note: *Single Station* is used to define one event point. *Multiple Stations* define multiple events over a station range.

3. Key-in the **Station** for the event or use the target button to graphically select it on the profile grid.
4. If creating multiple events, set **Locate By** to either **Segment Distance** (if event points fall at even increments along the alignment) or **Number of Segments** (for event points spaced equidistantly along the station range). Then, key-in the appropriate values.
5. Toggle on **Add Horizontal Event Points** if you wish to add an event point on the horizontal alignment (to show with horizontal stationing).



6. <D> Apply.



Note: This adds the event point(s) to the alignment. The vertical events can be displayed and annotated with the Vertical Annotation command. See the section *Annotating Vertical Alignments* for more information.

Section Summary:

- A profile must be created and displayed before you can create a vertical alignment.
- The *Vertical Curve Set* tools are used to lay out the initial VPI locations on the vertical alignment.
- The *SE=* and *DG=* precision keyins are used to define specific VPI locations.
- The *Define Vertical Curve* command is used to create a curve at a VPI location.
- There are several methods for creating vertical curves (length of curve, unsymmetrical length, r value, k value, etc.)
- The *Vertical Design Calculator* is used to look up or compute vertical curve data based on AAHSTO design guidelines.
- VPI locations can be edited using several different methods including the *Move Vertical PI* command and the *Define Vertical Curve* command.
- VPIs can be added or inserted on a vertical alignment after it has been created.
- *Vertical Event* points are special locations on the vertical alignment that can be displayed or annotated on the alignment. Cross sections can also be cut at these locations.

Exploring Vertical Alignments

After creating the vertical alignment, you can obtain all of the alignment's geometry data in report format. This information can be graphically annotated directly on the alignment graphics on the profile. You can also interactively track the alignment to obtain alignment information at a specific point location (station, offset, elevation, grade, etc.)

Section Objectives:

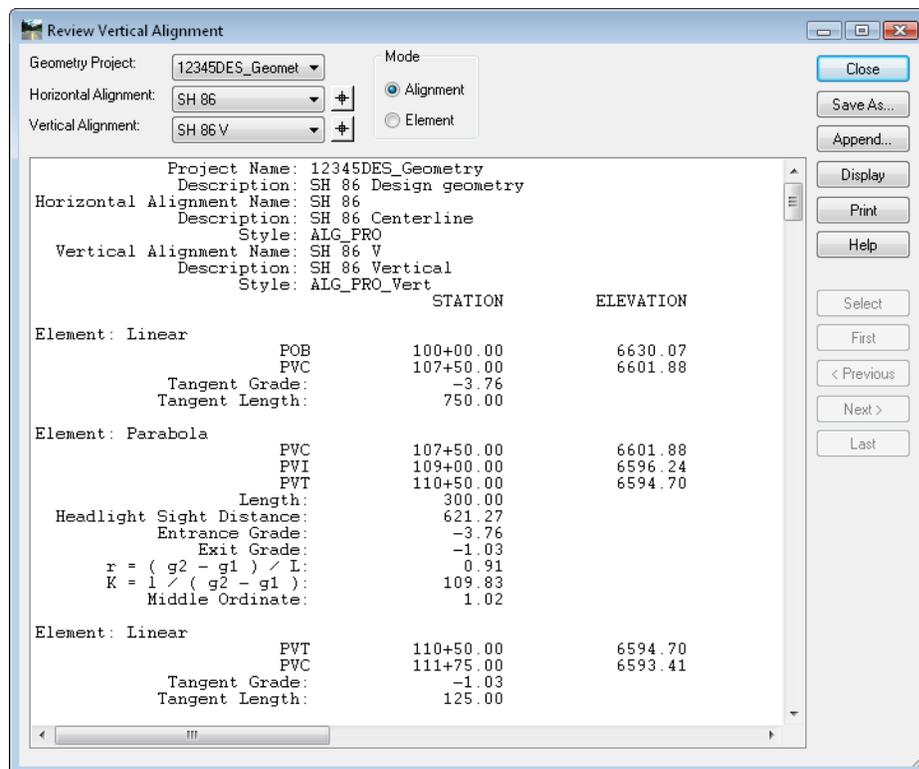
- Explain how to generate a vertical alignment geometry report.
- Demonstrate how to display the vertical alignment on the profile grid.
- Demonstrate how to annotate the vertical alignment point, tangent and curve data.
- Explain how to interactively obtain vertical alignment data at specific points.

Reviewing Vertical Alignments

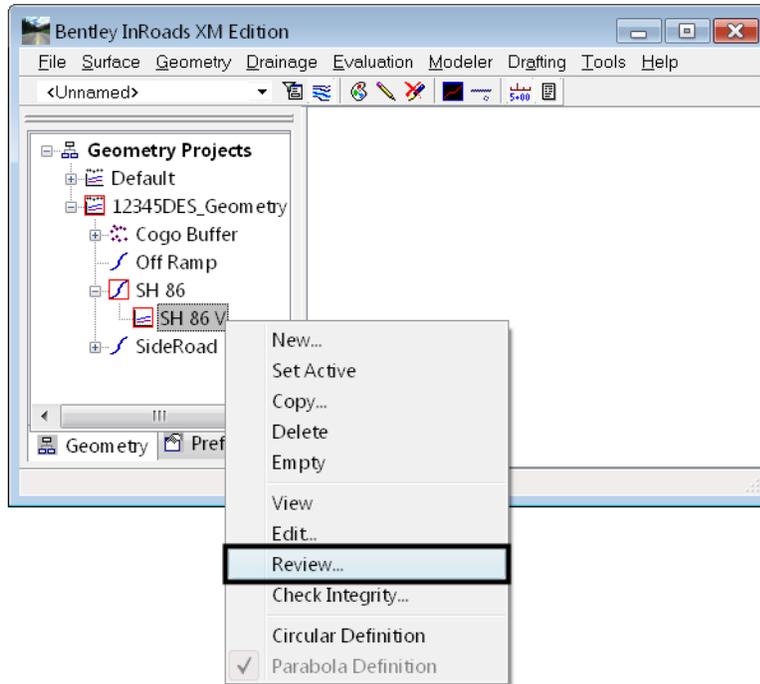
Reviewing vertical alignments is similar to reviewing horizontal alignments. The **Review Vertical Alignment** dialog allows you to easily change between multiple Geometry Projects, Horizontal, and Vertical alignments.

To review a vertical alignment

1. Select **Geometry > Review Vertical**.



Note: The review dialog can also be opened by right-clicking on the alignment in the InRoads Explorer window.



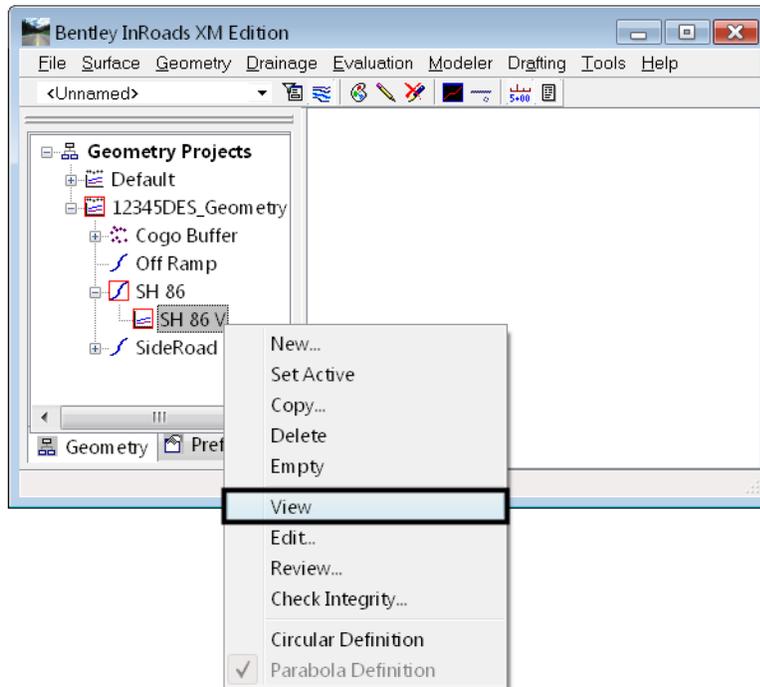
Displaying Vertical Alignments

There are several methods for displaying vertical alignments in InRoads. The method you choose is based on the desired display.

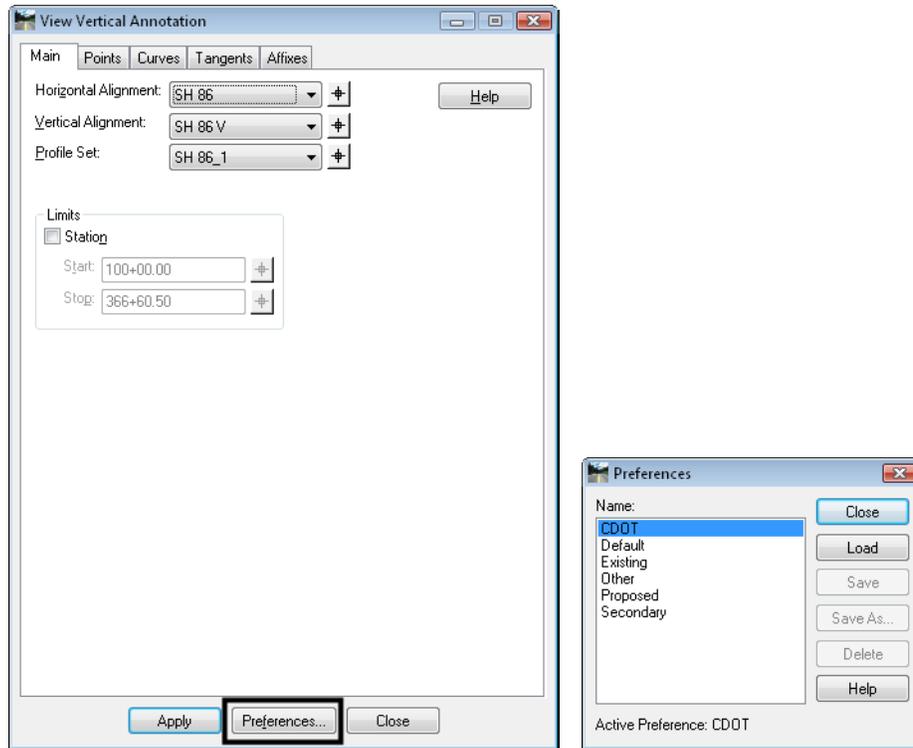
If you choose one of the methods other than *Vertical Annotation*, a geometry style controls the level and therefore the symbology of the display. Geometry styles are associated with individual alignments when they are created. The CDOT standard styles have been pre-defined and are stored in the *CDOT-Civil.xin* file, accessed through the *Tools > Style Manager* dialog.

To display the active alignment, choose *Geometry > View Geometry > Active Vertical* and the active alignment will display on every profile (created from the vertical's parent horizontal) in the design file showing points and line work (no annotation).

To display any alignment, right-click on the alignment name in the Explorer window and choose **View**. The chosen alignment will display on every profile (created from the vertical's parent horizontal) in the design file showing points and line work (no annotation).



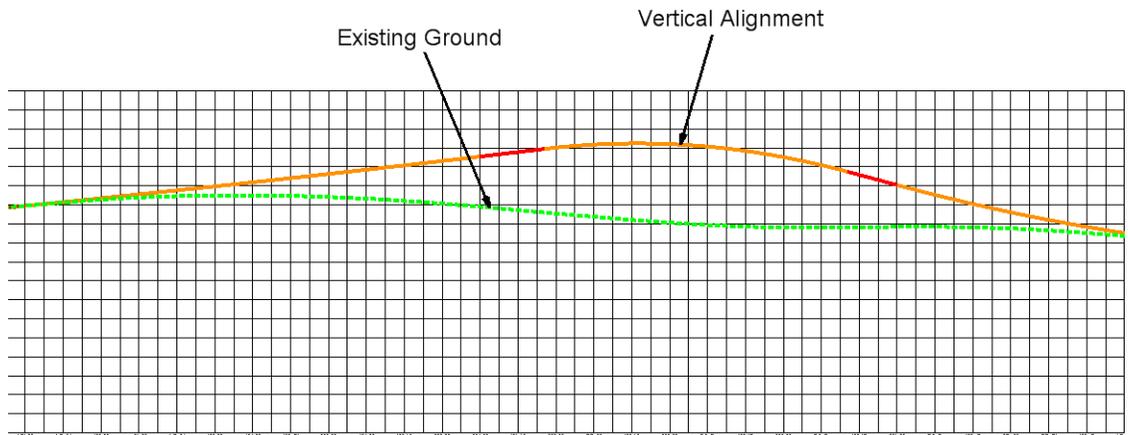
To display the alignment and annotate it at the same time, choose **Geometry > View Geometry > Vertical Annotation**. This command uses a preference to define the symbology of the vertical alignment and to define what and how the alignment is annotated. There are several CDOT preferences available for different types of vertical alignments.



To Display a Vertical Alignment

1. Select **Geometry > View Geometry > Active Vertical** to display a graphic of the active vertical alignment.

Note: Alternately in the you can right-click on the vertical alignment in the InRoads Explorer window and select **View**.



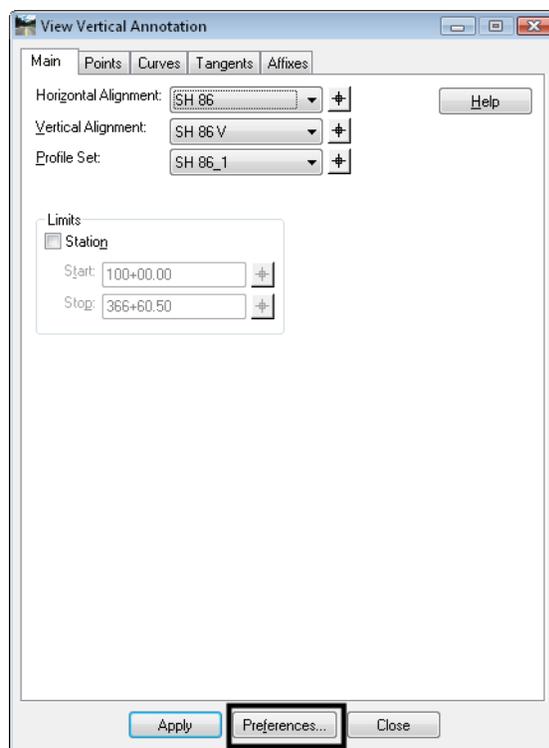
Annotating Vertical Alignments

If you wish to display and annotate the vertical alignment, you can use the **Vertical Annotation** command. This command does not use a geometry style to display the alignment. Instead, you select a preference to not only display the alignments points, tangent lines and vertical curves, but to annotate this geometry as well. The preference determines:

- Which points will be displayed (VPIs, VPCs, low points, high points, vertical event points, etc.) and what will be annotated (Station, Elevation, etc.).
- The display of the vertical tangents and what will be annotated (grade, slope length, etc.)
- The display of the vertical curves and what will be annotated (length, entrance grade, exit grade, sight distance, etc.)
- The location of the annotation along leader or witness lines.

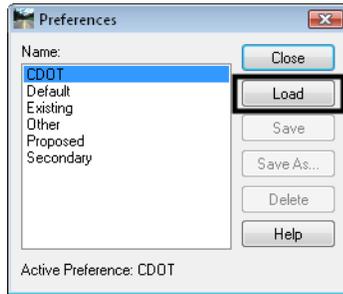
To Annotate a Vertical Alignments

1. Select **Geometry > View Geometry > Vertical Annotation** to view vertical alignment annotation.

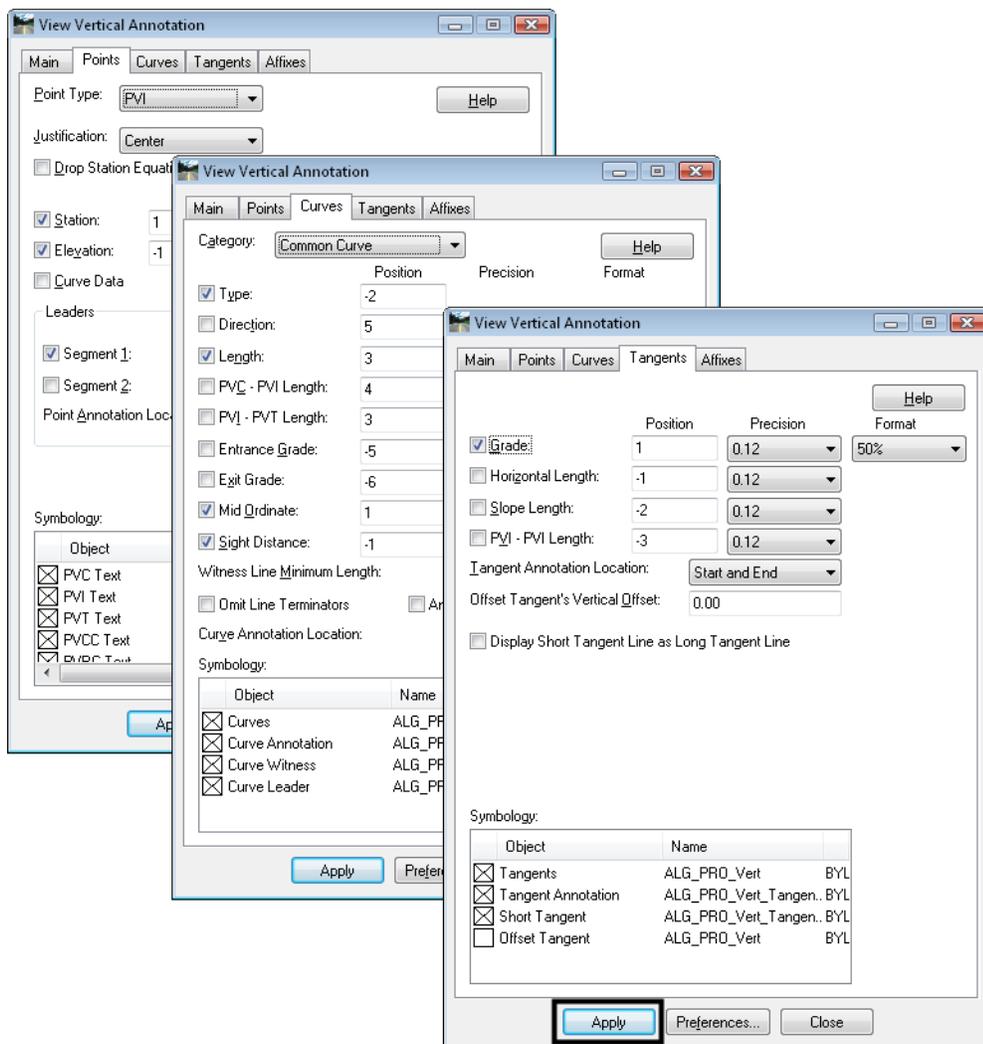


2. Verify the appropriate **Horizontal**, and **Vertical Alignments** are identified in addition to the **Profile Set**.

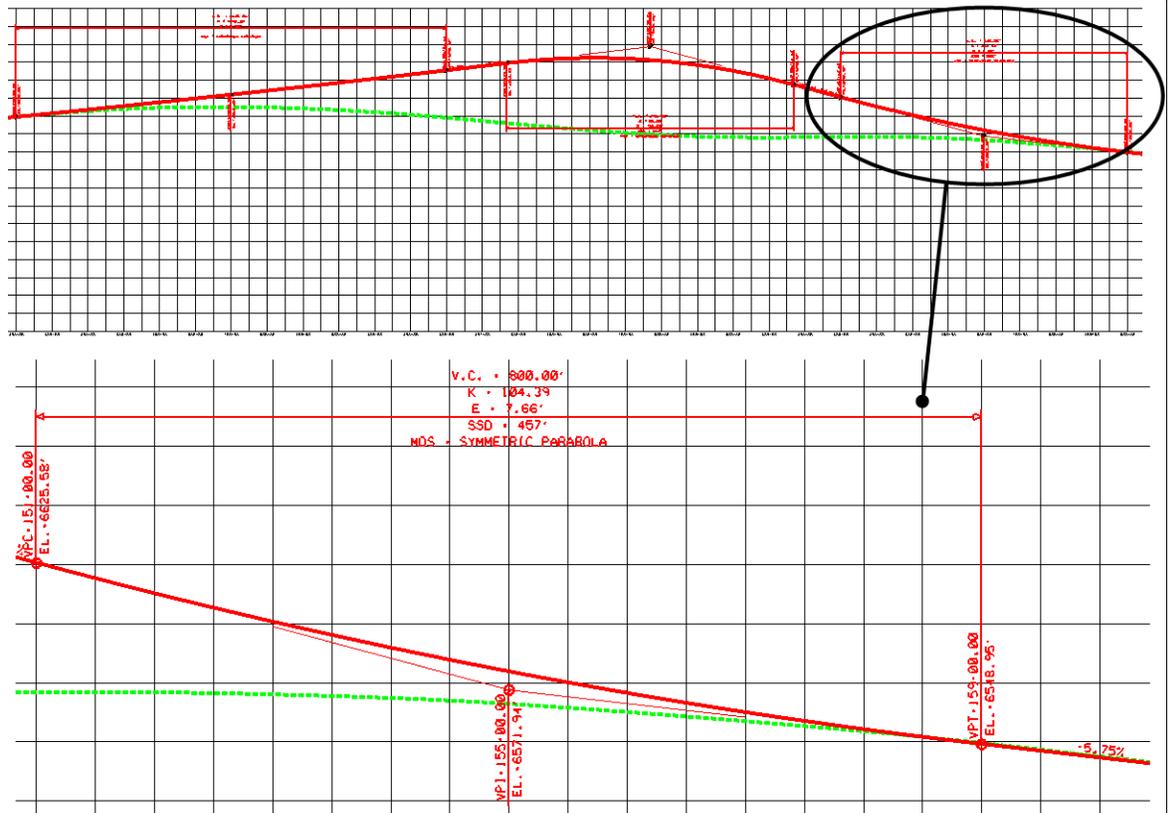
3. Select **Preferences**, **Load** the desired preference then **Close** the **Preferences** box.



4. Take some time and along the top of the **Vertical Annotation** dialog investigate the remaining tabs and the individual settings loaded by the preference for each tab. Note that vertical event points can be displayed and annotated on the **Points** tab.



5. <D> Apply



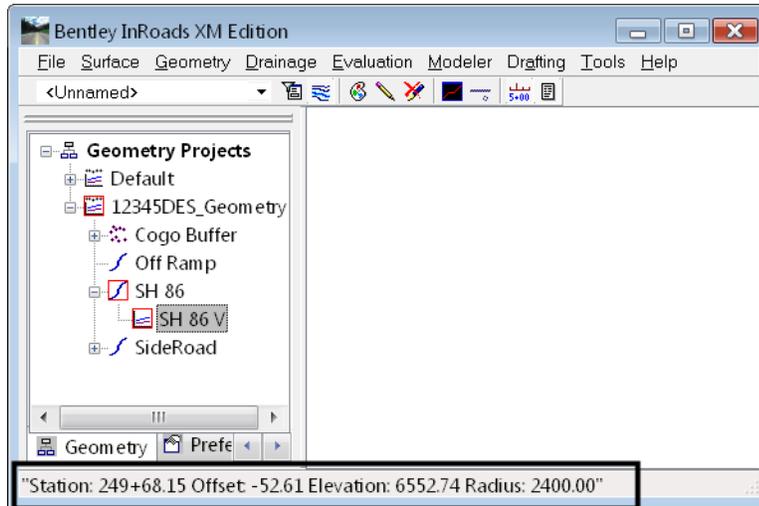
Note: Edit the MDS text on the vertical curve annotation to show the actual design speed.

6. Close the *Vertical Annotation* dialog box when done.

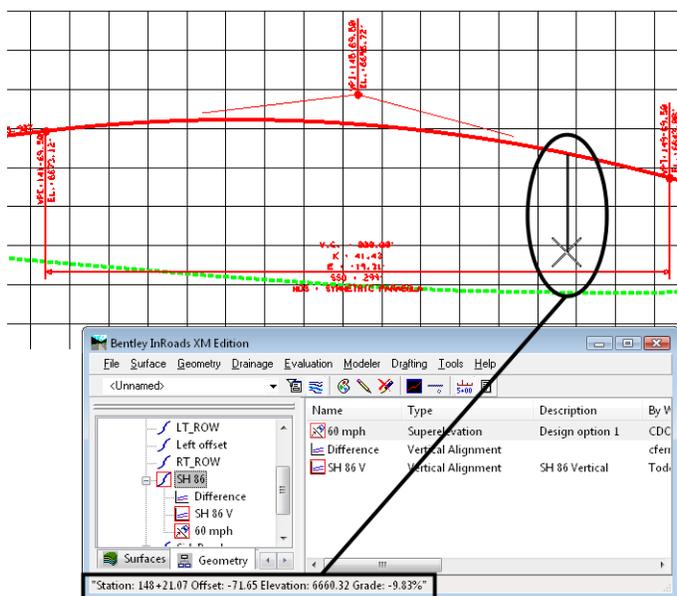
Tracking

Vertical alignments can be interactively queried similar to horizontal alignments using the *Tracking* commands. There are two tracking options:

- **Tools > Tracking > Horizontal Alignment** – tracks the horizontal alignment with a perpendicular line to your cursor. It gives a Station, Offset, Elevation readout in the message field, where the elevation shown is that of the active vertical alignment at the given station.



- **Tools > Tracking > Vertical Alignment** – tracks the vertical alignment on the profile grid with a vertical line to your cursor. It gives a Station, vertical Offset, Elevation and vertical alignment Grade readout at the location of your cursor.



Section Summary:<

- Use the **Review Vertical Alignment** report to generate standard point, tangent and curve data on the vertical alignment.
- Use **Geometry > View Geometry > Active Vertical** to display the vertical alignment on the profile grid using the assigned geometry style (line work only).

- Use **Geometry > View Geometry > Vertical Annotation** to display and annotate the vertical alignment using a CDOT preference.
- Use **Tools > Tracking > Horizontal Alignment** to obtain vertical alignment elevation at any point on the alignment.
- Use **Tools > Tracking > Vertical Alignment** to obtain offset and grade information between your cursor and point on the profile.

Vertical Geometry Management Tools

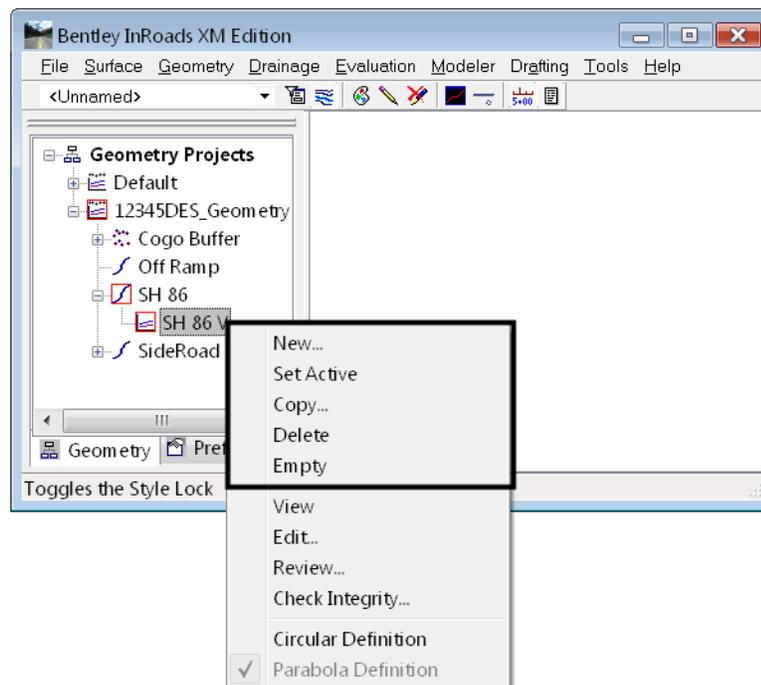
While working with vertical alignment, there are several tools that can help you manage your data. Also, after you have created your alignment, it is important to save the geometry project with the new vertical alignment data.

Section Objectives:<

- Explain how to manage your vertical alignment data.
- Demonstrate how to save your vertical geometry.

Managing Vertical Alignment

There are several utilities that can help manage your vertical geometry.

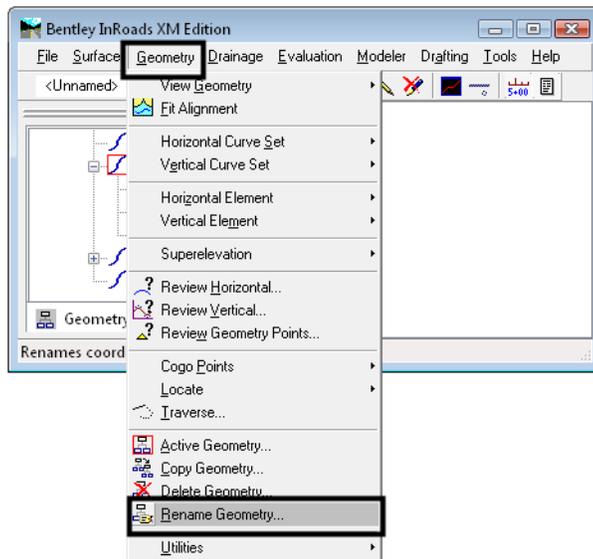


These options, which are accessed from the right-click shortcut menu in the InRoads Explorer, include:

- **New** – to create alignment slot information (name, description, style, etc.)
- **Set Active** – to select the vertical alignment for creating and editing.

- **Copy** – to copy a vertical alignment from the same or different geometry project (e.g. when creating alternative vertical alignments, you can copy a previously created alignment and edit the copy to create the alternate alignment).
- **Delete** – to delete a vertical alignment from the geometry project.
Note: This command works in memory. Be sure to save the geometry project if you no longer want the alignment in the geometry project.
- **Empty** – to empty the data out of a vertical alignment but keep the alignment slot information (name, description, style, etc.)

In addition, use the **Geometry** pull-down menu to access the following:



- **Rename Geometry** – to rename a vertical alignment. For example, when you are using an existing geometry project with alignments from Survey, you can use the **Rename Geometry** command to give the alignments project specific names.

Saving a Vertical Alignment

Alignments are not saved individually. Instead, they are saved when the geometry project is saved. Since you are working on a copy of the geometry project that is loaded in memory, saving is a good idea whenever you make changes to your alignment, and mandatory before exiting – assuming you want to save your changes.

Geometry projects can be saved using two options.

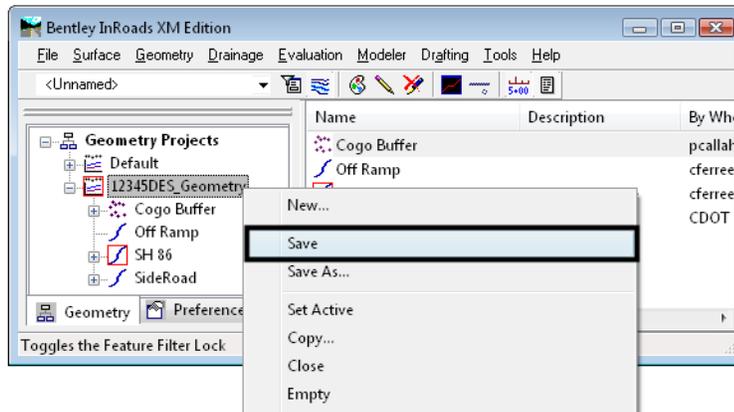
To save a geometry project (option 1)

1. Make sure the geometry project you want to save is active. If not, right-click on the geometry project from the InRoads Explorer window and choose **Set Active**.
2. Choose **File > Save > Geometry Project**.

Note: The active geometry project is saved.

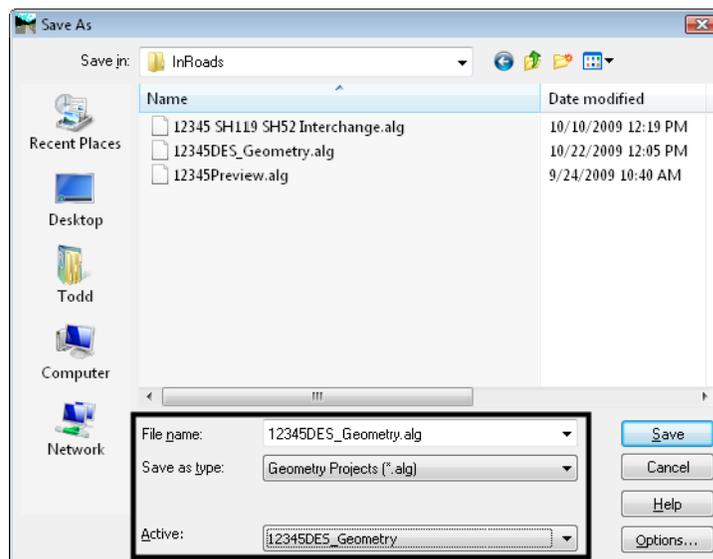
To save a geometry project (option 2)

1. Right-click on the Geometry Project in the InRoads Explorer window and chose *Save*



Note: The geometry project you highlighted is saved.

2. If the geometry project has never been saved, either of the previous methods will bring up the *Save > As* box shown below.



3. Set the *Files of Type* to *(*.*alg)*
4. Choose the geometry project you want to save (from the *Active* list)

Note: After choosing the name from the *Active* list, the *File name* field is populated with the internal name of the geometry project. The *File name* is the hard drive name.

5. If you want to change the name, key in a new file name or keep the default (the default is recommended).

Note: Geometry projects have both an internal name that appears in the dialog boxes in InRoads and a name on the hard drive that has an *.alg* extension. Care should be taken to make certain you have chosen the correct geometry project name to match the file name you specify. Otherwise, you could accidentally save over a file on the hard drive with the wrong geometry project. ***It is recommended that your hard drive name match your internal (active) name.***

6. <D> **Apply** and the file is saved.

Section Summary:

- Use the InRoads Explorer right-click short cut menu to manage your vertical alignment data.
- The **Delete Geometry** command deletes vertical alignment (and other geometry data) from InRoads memory. Be sure to save the geometry project on the hard disk if you no longer want the alignment in the project.
- The **Empty** command will empty all alignment data, but keep the slot information.
- Alignments cannot be saved individually. You must save the entire geometry project with the new alignment data.
- It is recommended that your geometry project's hard drive name match your internal (active) name to avoid confusion and the possibility of overwriting data.

Chapter Summary:<

- A general understanding of how to create an InRoads profile is required before creating and working with vertical alignments.
- Vertical alignments are part of the InRoads geometry project and stored in the *.alg file.
- Vertical alignments are “children” to the “parent” horizontal alignment. Therefore, you must have created a horizontal alignment before creating a vertical “child” underneath it.
- You can create multiple vertical alignments underneath one horizontal for different design scenarios.
- A vertical alignment can be used along with a horizontal to define a corridor in Roadway Designer.
- After creating the vertical alignment, you can obtain geometry data from the alignment from several different sources including reports, interactive tracking, and graphical annotations.

Chapter 10 - Typical Sections

Whether you work on roadways or retaining walls, typical sections (known as **templates** in InRoads XM) provide the tools necessary for creating 3D models for your proposed designs. Anything that can be defined by a typical cross section and horizontal and vertical alignments (not just roadways) can be modeled with templates. For example: channels, walls, ditches and dams can all be modeled using this approach.

The way a template and its points are defined is critical to how it will behave during the modeling process. The resulting model created from the templates is used to provide critical information to Construction. This information is generated from various reports like the Cross Section staking report (see the *Roadway Modeling* and *Reports* chapters for more information).

Typical sections are stored in a template library (ITL) which is saved on the hard drive with an extension of *.itl. A standard template library file is based on the *CDOT Roadway Design Guide 2005* and the *CDOT M&S Standard Plans 2006 Edition*.

Chapter Objectives:

- To become familiar with how typical sections fit into CDOT's design process.
- To learn how to match the CDOT standard templates to your design criteria.
- To gain an understanding of when to use the completed templates included in the default template library on your projects.
- To learn how to prepare typical sections that match your design criteria if the standard ones do not.

Template Library

Section Objectives:

- To create a project-specific template library using the CDOT standard template library.
- To copy templates from other jobs for use in a project-specific template library.
- To become familiar with the Create Template interface for creating and editing templates.

Templates are stored in a template library (.itl). CDOT has created a standard template library that contains several CDOT-specific templates. These CDOT standard templates are based on:

- Typical sections shown in the *CDOT 2005 Roadway Design Guide* manual
- Roadway components or features shown in the *CDOT M&S Standard Plans 2006 Edition*
- Clear Zone criteria
- CDOT's Cut and Fill slope requirements

Standard Template Library

The CDOT standard templates are developed and maintained to facilitate the design process for CDOT projects. The path for CDOT's standard template library is **C:\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Templates\CDOT_Template-Library.itl**. The library consists of models of typical sections as defined in the *CDOT 2005 Roadway Design Guide* and other typical sections commonly encountered by CDOT designers.

Project Template Library

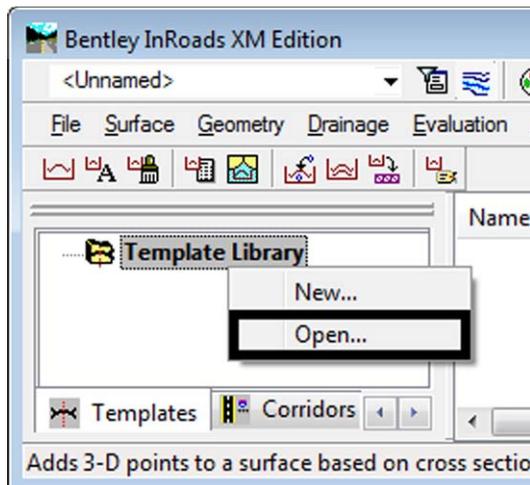
The CDOT library should be copied to the project folder and modified as needed for a particular project or design situation. This is accomplished by copying the **CDOT_Template-Library.itl** to the **C:\Projects\JPC#\ Discipline\InRoads** folder before editing.

Important! Changes made to the standard **CDOT_Template-Library.itl** in the **\Standards-Global** folder will be overwritten by CDOT's file management software **ServerCop** during log in.

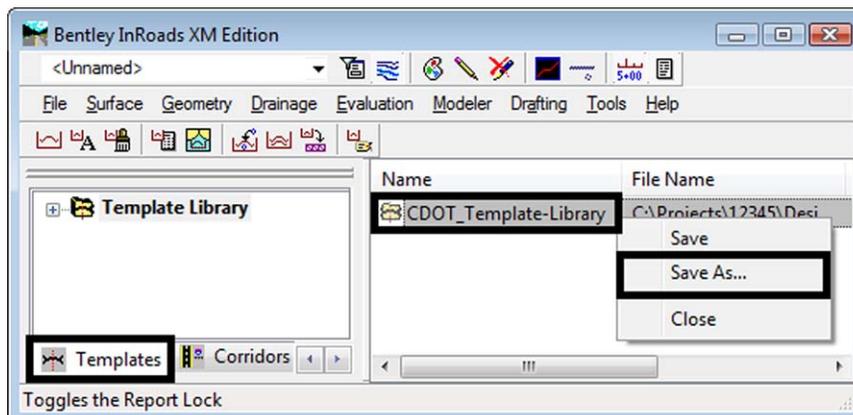
Creating a Project Template Library

To create a project specific template library:

1. From the InRoads main menu, select the **Templates** bottom tab.
2. <R> on **Template Library** in the InRoads Explorer and select **Open** from the menu.



3. Navigate to **C:\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Templates**.
4. Highlight the **CDOT_Template-Library.itl** file and <D> **Open**.
5. <R> on the **CDOT_Template_Library.itl** file in the information pane and select **Save As**.

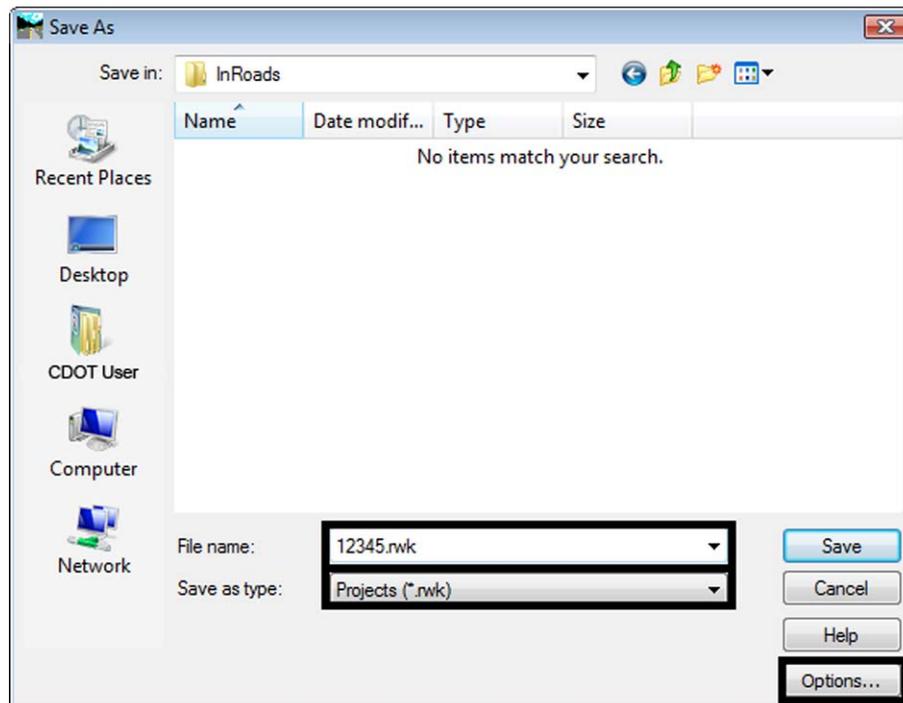


6. Navigate to the project's InRoads folder (**C:\Projects\12345\Design\InRoads** in this example).
7. In the **Save As** dialog box, key in the desired **Name** such as **12345_Template-Library.itl**.
8. <D> **Save**.

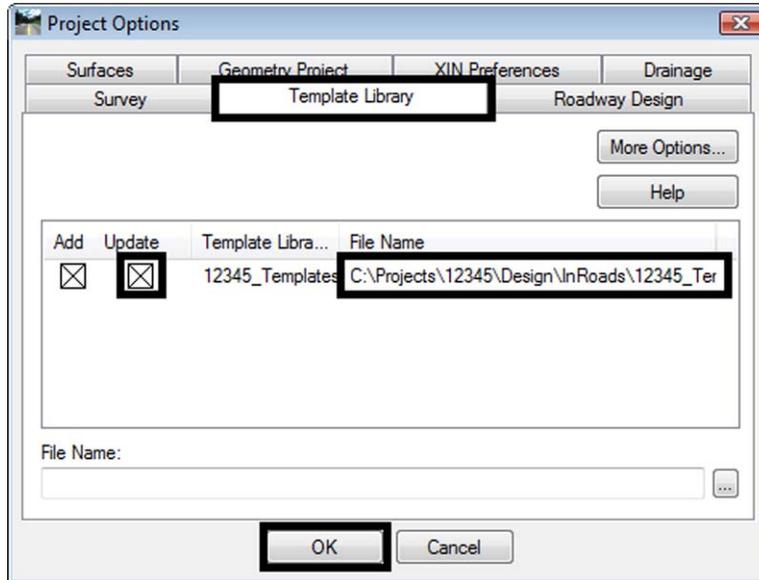
Note: The file may also be copied using Windows commands.

Update the *.rwk file to load the new template library. This ensures the new template library will open with the other InRoads data for the project.

9. From the InRoads main menu choose **File > Save As**.
10. In the Project **Save As** dialog box, navigate to the design folder (**C:\Projects\12345\Design\InRoads** in this example).
11. Choose **Projects (*.rwk)** from the **Save as type:** field
12. Choose an existing project file from the **Save As** dialog box by highlighting it or key in the name of a new project file. (For this example **12345.rwk** is used.)
13. Click on the **Options** button.



- From the **Template Library** tab of the Project Options dialog box, verify the filename of the template library is correct and toggle on **Update**. (The **Add** automatically toggles on as well.)



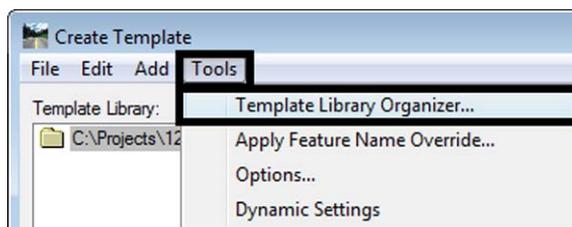
- Click **OK** to accept the changes in the **Project Options** dialog box.
- Click **Save** to save the **InRoads Project** file.
- Click **Cancel** to dismiss the **Save As** dialog box.
- To load the project template library from this point on, open the Project file (**12345.rwk**).

Copying existing Templates to a Project Template Library

Templates created for previous projects can be used in the current project. These templates should be copied from their original libraries into the current project's library. This avoids confusion and the possibility of altering the wrong template.

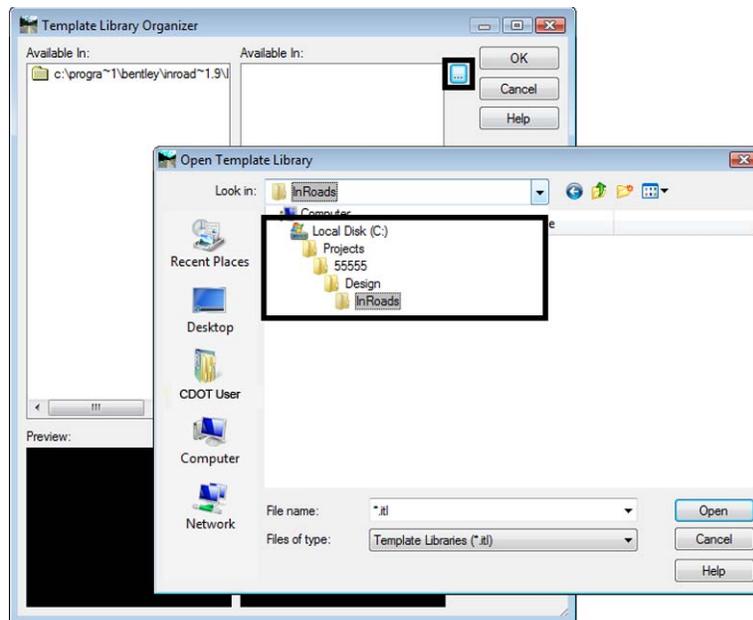
To copy a template into the project template library from another library:

- Select **Modeler > Create Template** from the InRoads menu bar.
- From the **Create Template** menu bar, select **Tools > Template Library Organizer**.



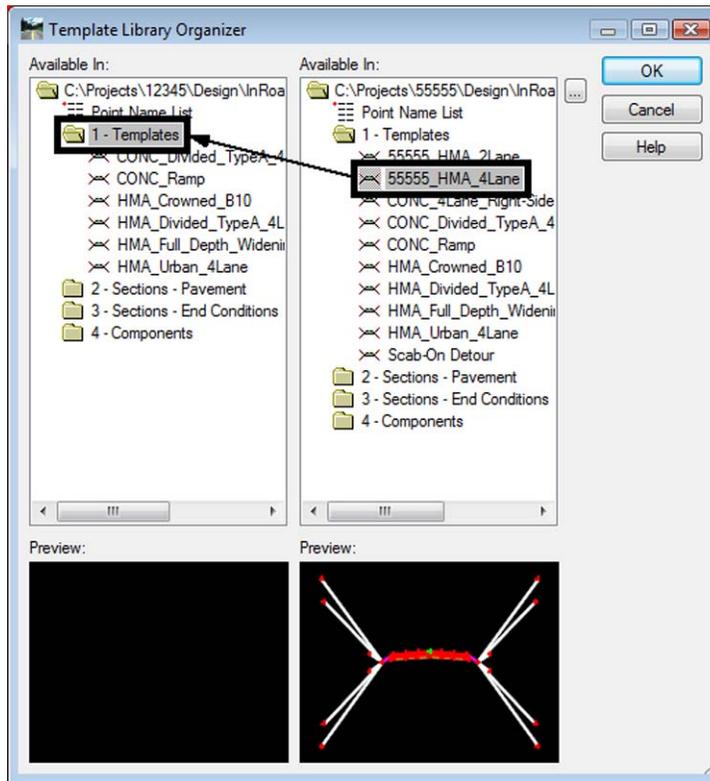
- In the **Template Library Organizer** dialog box, <D> the  button.

- In the **Open Template Library** dialog box, navigate to the folder of the source template library (**C:\Projects\5555\Design\InRoads** in this example).



- Highlight the source template library and **<D> Open**. The selected library is displayed in the right **Available In** area of the **Template Library Organizer** dialog box.
 - Expand the right template library to show the template you want to copy.
 - Expand the left template library to show where you want the template to reside.
 - Drag the desired template from the right library and drop it in the left (**5555_HMA_4Lane** in this example).
- Note:** Be certain to drop the template in the correct location. If it is dropped 'in space' and not in a folder, the template is not copied.
- Repeat for any other templates you need to copy.

10. <D> OK when finished.



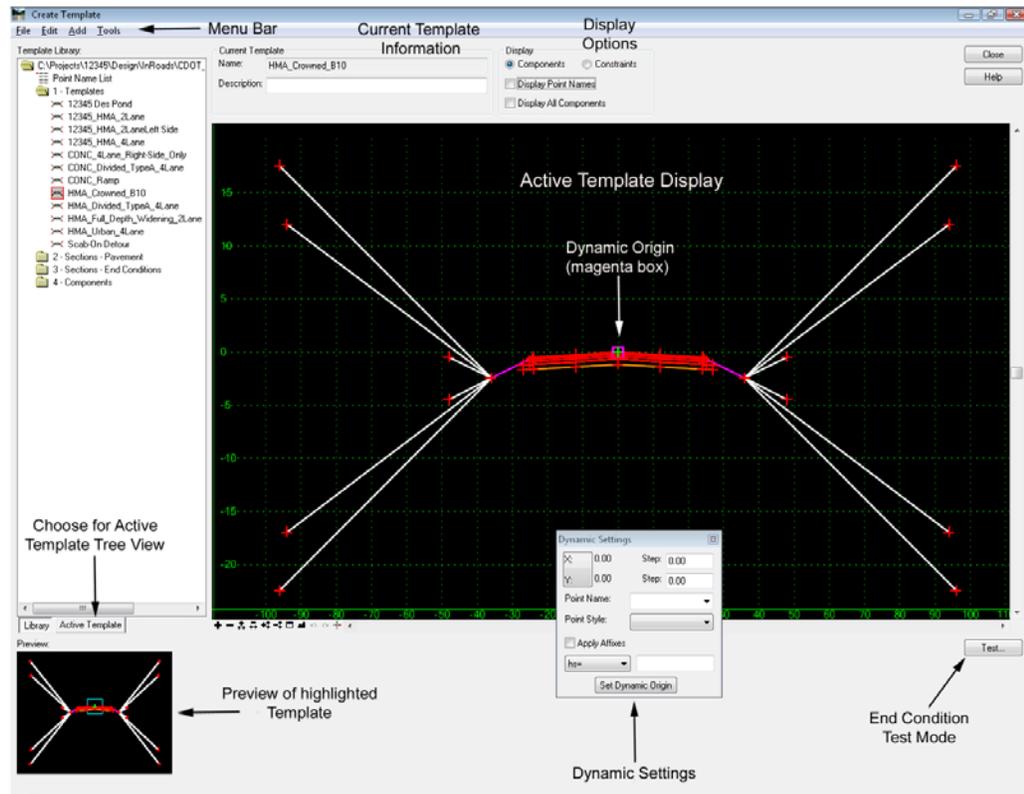
Note: The left *Available In* pane is the library currently loaded in InRoads. Templates can be copied from the left library to the right as well.

Note: Templates are copied into the IRD file when setting up Template Drops (see the [Roadway Modeling](#) chapter for details). If a template you need resides in the IRD, you can open the IRD file here and copy template(s) from the IRD into your ITL.

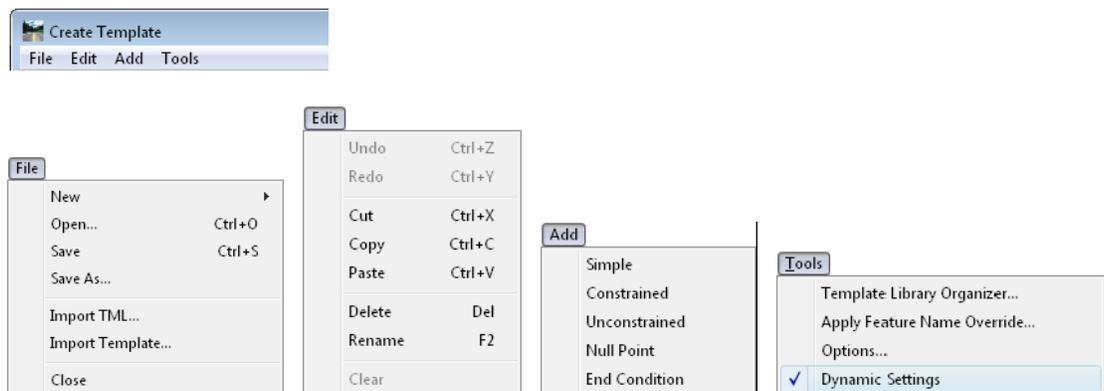
Create Template

The *Create Template* dialog (accessed from **Modeler > Create Template**) is used to create or edit templates within the loaded template library. It is a visual interface that allows you to see the template as it's being created and to test the end conditions prior to using the template in *Roadway Designer*.

The *Create Template* dialog contains several areas as shown and described below.



Menu Bar



The Menu Bar consists of four pull-down menus.

File Menu

The File menu is used to create, load and save the template library (ITL).

Important! While working in *Create Template*, you are working in your computer's memory and you should periodically save your ITL file, such as after any major template edits. If you do not save changes to your ITL file, you will be asked to save upon exiting from the dialog. Once you have closed the dialog, unsaved changes are lost.

To translate a previous InRoads version TML file (InRoads V8.5 and earlier) to the new ITL format, select **File > Import TML** and specify the TML file.

Important! Be careful! Templates are drastically different in this version of InRoads than in 8.5 and prior versions. If you convert a template you must carefully check every aspect of the components and points to ensure they converted properly. In most instances, you are better off creating the template in the current version rather than converting.

To import a template from graphics, you can use **File > Import Template**. You must first draw the template with MicroStation, then make a selection set from the graphics before selecting this option.

Edit

- ◆ The **Edit** menu contains standard edit functions that apply to the highlighted template or folder. See the *Edit Commands* section in the *InRoads Online Help* for more information.

Add

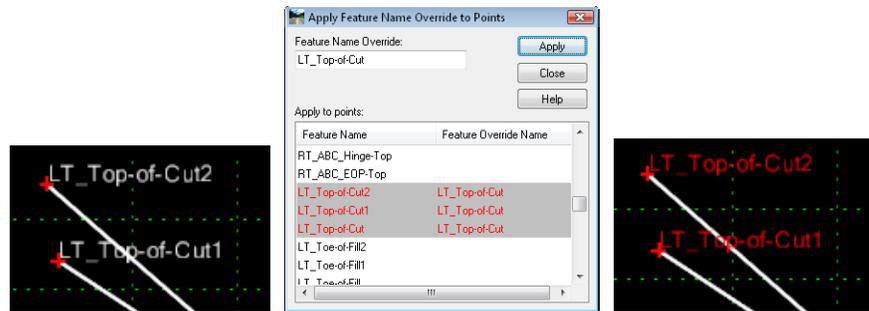
- ◆ **Add > Simple, Constrained, Unconstrained, Null Point and End Condition:** Used to create new components in the active template.

Note: Each of the above **Add** options is described in greater detail in the *Components* section of this chapter.

Tools

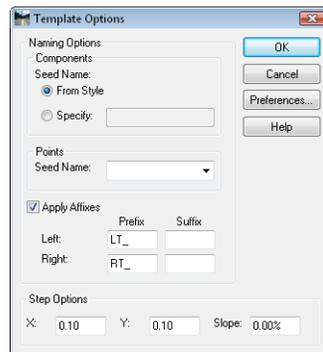
- ◆ **Tools > Template Library Organizer:** Allows templates, point names and folders to be copied between two libraries. See the previous section on *Copying existing Templates to a Project Template Library* for additional details.

- ◆ **Tools > Apply Feature Name Override:** Allows multiple point names in a template to create one feature in the resulting surface. Highlight the point names in the dialog and key in the name you want the combined feature to have, then **<D> Apply**. For example, use this when multiple Cut or Fill slopes would normally result in multiple features, but the desired result is one continuous feature instead. The feature names turn red in the template display to note the override is used. This can also be accomplished in the **Point Properties** for each of the points in question.



This option may also be useful when transitioning between two templates using different named points that you want to result in one continuous feature. For example, if the two templates use CL and Centerline, respectively, you may toggle on **Apply Feature Name Override** for both and use the same name for the resulting feature.

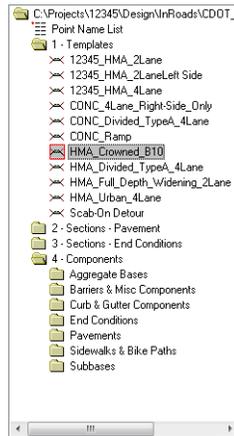
- ◆ **Tools > Options:** Allows the setting of default naming options for components and points. It also controls whether **Affixes** are used and if so, what they are. Steps can be set here for the placement of points and components on a grid, similar to MicroStation's Grid lock.



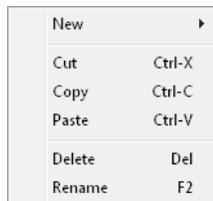
- ◆ **Tools > Dynamic Settings:** Toggles on or off the **Dynamic Settings** box. See the [Dynamic Settings](#) section of this chapter for additional information.

Library Tree

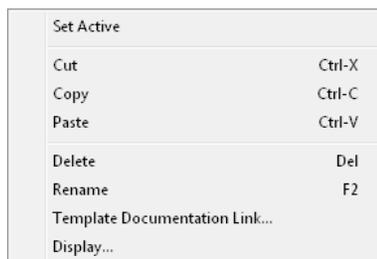
The Library tree is shown on the left pane of the **Create Template** dialog. Folders may be expanded or collapsed as necessary to see the template(s) available for copying or editing. The active template has a red box around its icon and is shown in the large template view at right. The highlighted template is shown in the Preview below the tree.



- Right-click on a folder to create a new folder or template, or access several of the **Edit** functions. See the [Edit Commands](#) section in the [InRoads Online Help](#) for more information.



- Right-click on a template to access several of the **Edit** functions. In addition, you can use:

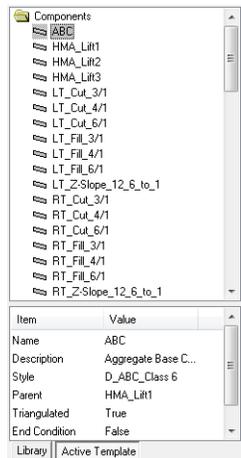


- ◆ **Set Active:** Makes the template active (available for editing and shown in the large template view at right).
- ◆ **Template Documentation Link...:** Assigns a link to the template. This is very useful for documenting the template, section or individual component in the template. You can link a template to almost any type of file, including a word processor document, spreadsheet, text files or web page that explains or defines the template. The file is for reference only and does not affect the processing of the template.

- ◆ **Display:** Brings up the template display dialog, allowing the display of the template on a grid in the MicroStation file. This can be used as the basis for your typical section drawing as an alternative to the CDOT Typical Section Program.

Active Template Tree

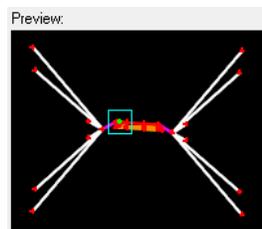
The pane on the left of **Create Template** can also be used to access the **Active Template** tree. At the bottom of the pane, select **Active Template**. Then, expand the portion of the template you want to access: either **Points**, **Components** or **Display Rules**. For each option, you can right-click and **Edit** or **Delete** the individual items.



Note: This is the only place where you can change the name of a **Display Rule**.

At the bottom of the pane, there is a box displaying information about the highlighted item. It is informational only.

Preview



The pane at the left bottom of **Create Template** displays a preview of the highlighted template. From this pane, you can drag the template into the **Active Template** view to make a copy. You can drag it by the default drag-point (shown as a cyan box) or by any other point in the template. Dragging a template into itself is allowed.

Current Template Information

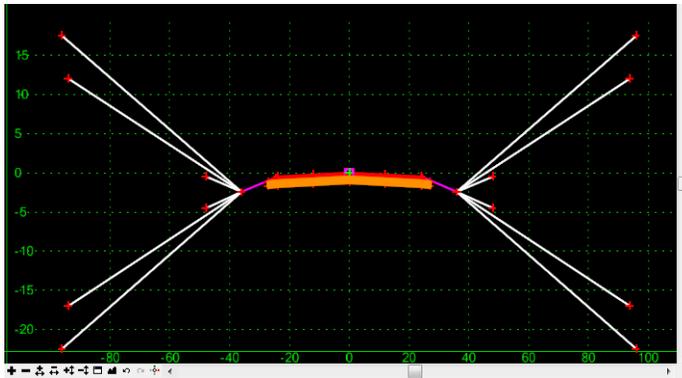
The Current Template information is listed for the active template. In this area, you can add or change the template description but not the name. To change the name, right click the template in the library tree and choose **Rename**.

Display Options

The active template may be shown as **Components** (typical) or as **Constraints** (usually used when analyzing the constraints assigned). **Point Names** may be toggled on or off as desired. **Display All Components** will show any components in the template that are currently not displayed because of **Display Rules**. These components appear as dashed lines.

Important! When reviewing an unfamiliar template, it is always good to toggle on **Display All Components** so you can see any hidden components.

Active Template Display



This view shows the active template. You may delete or rename templates in the list at left, but in order to make changes to a template it must be shown in this view. A template can be activated by double-clicking it in the library tree or by right-clicking on the template and choosing **Set Active**.

- At the bottom left of the view are the active template **View Controls**

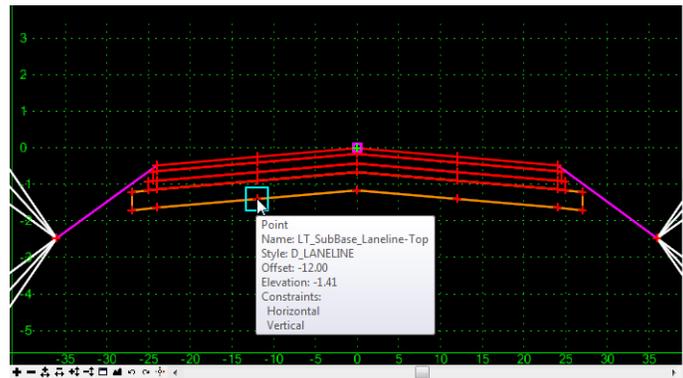
These MicroStation-like controls allow you to **Zoom In**, **Zoom Out**, change the exaggeration in X or Y, **Window Area** and **Fit** the template in the window. Also on this set of commands are short-cuts to **Undo** and **Redo** as well as the toggle for **Dynamic Settings**. The **Undo** and **Redo** buffers are cleared when another template is activated or you close the dialog.

- Mouse Controls

The mouse wheel may be used to zoom in and out in this view. Clicking the wheel and holding it down while moving the mouse pans.

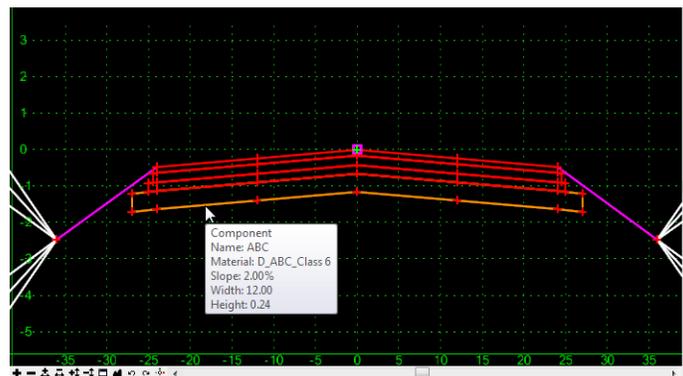
- Hover Options

- ◆ Over a Point



Hovering over a point brings up a pop-up of point information.

- ◆ Over a Line (component)

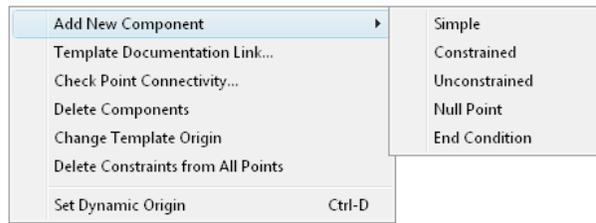


Hovering over a line of a component brings up a pop-up of component and segment information.

- Right-click menus

Right-clicking in the **Active Template Display** area brings up a menu. There are different menus available, depending upon where and when you click: in a clear area, on a point, on a line (component), while creating a component or while dragging component. Some of the commands are also found on the pull-down menus. When a right-click menu is active, the commands may be selected using either the left <D> or right <R> mouse button.

- ◆ Right-click in a clear area.

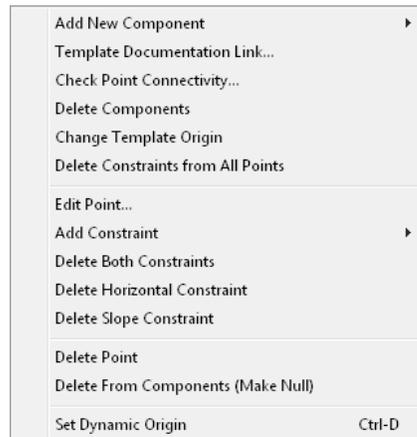


- **Add New Component > Simple, Constrained, Unconstrained, Null, End Condition:** Used to create a new component in the active template. See the [Component](#) section for details.
- **Template Documentation Link...:** Assigns a link to the template. See the description in the previous section.
- **Check Point Connectivity...:** Checks the template to see if any two points are closer together than the specified **Tolerance**. If there are, a box appears that lists the points for a specific location and allows you to choose which is to be deleted. If you want to keep both, choose **<Esc>**. Then, the next set of points are brought up. This is the same as **Merging Points**, but it seeks out the points for merging rather than having to select them individually.
- **Delete Components:** Notice this is plural, which means you can **<D>** and drag your cursor across any number of components and they are deleted when you ‘let go’.
- **Change Template Origin:** While this command is on all three right-click menus, it functions differently depending upon whether it is selected while right-clicking on a point or not. On a point, it moves the template so that the point selected is at the 0,0 coordinate. If not on a point, it prompts you to identify the point you want to move to the 0,0 coordinate.

Note: Remember, the 0,0 coordinate is where the template is applied to the horizontal and vertical alignment.
- **Delete Constraints from All Points:** Removes all constraints from all points regardless of how they are set.
- **Set Dynamic Origin:** This allows the **Dynamic Origin** (magenta box) to be moved to a different location. See the **Dynamic Settings** section later in this chapter for more details.

Important! The **Dynamic Origin** (magenta box) is **not** where the template is applied to the horizontal and vertical alignment.

◆ Right-click on a point.

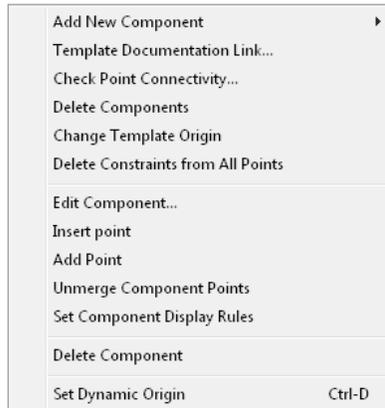


All of the clear area right-click options, plus:

- **Move Point:** Allows the point to be moved graphically, or if *Dynamic Settings* is active the key-ins can be used. This command is only available for points that have no constraints (appear green and can be moved anywhere) or one constraint (appear yellow and must hold the value of the one constraint, e.g. if it has a slope constraint, it must be moved along that slope).

Note: Red points cannot be moved unless at least one constraint is released. You can, however, *Edit* the constrained point and move it by changing the constraint value(s).
- **Edit Point:** Brings up the *Point Properties* dialog and allows the editing of *Names, Styles, Constraints*, etc. See the section on *Points* for details.
- **Add Constraint:** Allows the addition of a constraint to the point and prompts for the identification of the parent for the constraint, along with the value for the constraint. *Add Full Constraint* adds *Horizontal* and *Vertical* constraints at the same time. See the section on *Point Constraints* for additional details on available constraints and when to use each.
- **Delete Constraints:** Menu options change depending upon the constraints currently assigned to the point. Allows the deletion of both or of individual constraints.
- **Delete Point:** Removes the point from the template. If the point is between two points in a component, the remaining points are connected.
- **Delete From Components (Make Null):** Removes the association of the point from the its component(s), but leaves the point along with its constraints intact.

◆ Right-click on a line.



All of the clear area right-click options, plus:

- **Edit Component:** Brings up the **Component Properties** dialog and allows the editing of **Name**, **Description**, **Styles**, etc. See the section on [Components](#) for details.
- **Insert Point:** Allows the placement of a new point in between two existing points. The point may be placed graphically or with key-ins using the **Dynamic Settings** box.
- **Add Point:** Only available when right-clicking on a segment of an open component. Allows the placement of a new point at the end of the component closest to where you click.
- **Unmerge Component Points:** Any common points between the component selected and other components are copied so that each component has only unique points. The copied points are named Copy of [original name]. Has no effect if the component does not share points with other components.
- **Set Component Display Rules:** Brings up the **Component Display Conditional Expressions** dialog, which allows the creation or editing of **Display Rules**, and/or the assigning of Rules to the component selected. See the section on [Display Rules](#) for additional details.
- **Delete Component:** Notice this is singular, which means it will delete only the component selected. If the line selected is common to multiple components, you are prompted for which you want to delete.

◆ Right-click while using **Add > Simple**:

Change Placement Point	
Mirror	Ctrl-M
Reflect	Ctrl-R
Cancel	ESC
Set Dynamic Origin	
	Ctrl-D

- **Change Placement Point**: By default, the **Add > Simple** command places the component by the upper left point of the parallelogram. Choosing this command moves the placement point to each of the other points successively around the component.
- **Mirror**: Creates a second identical component (except for naming) mirrored about a vertical line at the 0 horizontal coordinate.
- **Reflect**: Creates the component in the opposite direction.
- **Cancel**: Stops the command without creating a component.
- **Set Dynamic Origin**: See the **Dynamic Settings** section later in this chapter for more details.

◆ Right-click while using **Add > Constrained, Unconstrained**:

Finish	Enter
<input checked="" type="checkbox"/> Closed Shape	Ctrl-L
Mirror	Ctrl-M
Undo Last	ESC
Cancel	
Set Dynamic Origin	
	Ctrl-D

- **Finish**: Stops the placement of the component. Use this after the last point is entered.
- **Closed Shape**: Makes the component being placed a closed shape.

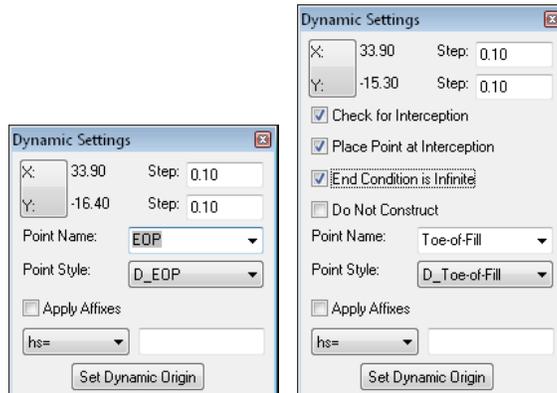
Important! Leaving **Closed Shape** toggled off and drawing the component closed is **NOT** the same as having **Closed Shape** toggled on. This is a component property and may be changed later, however. Components must be listed as **Closed** in order for them to be used in end-area volume calculations.

- **Mirror**: Creates a second identical component (except for naming) mirrored about a vertical line at the 0 horizontal coordinate.
- **Undo Last**: Removes only the last point created. This is very useful when you enter a wrong point, but don't want to start over or wait until finished to correct the error in point properties.
- **Cancel**: Stops the command and does not keep any entered points.
- **Set Dynamic Origin**: See **Dynamic Settings** below.

◆ Right-click while dragging a template into the **Active Template View**. All of these commands are the same as described in the **Right-click while using Add > Simple** section above.

Dynamic Settings

The **Dynamic Settings** dialog can be very helpful when creating and editing templates. You can toggle on the dialog by selecting **Tools > Dynamic Settings** or by choosing the **Dynamic Settings** icon on the view controls toolbar in the **Active Template** view. The dialog changes depending upon if you are dealing with general components (as shown on the left) or end conditions (as shown on the right).



There are several options within the **Dynamic Settings**:

- ◆ The read-out can be shown as either **X:** and **Y:** or **<D>** on the label and it converts to **X:** and **Slope:**. This readout is from the **Dynamic Origin** which is shown as the small magenta box.
- ◆ **Steps:** Lists the steps or intervals as defined in **Tools > Options** and may also be entered here, either in **X** and **Y** master units or in **X** and **Slope**, depending upon the readout selected.
- ◆ **Point Name:** When creating a new point, the name listed is used. It may be chosen from the drop-down (which comes from the **Point Name List**) or keyed in. If a component is created, this name is used as the seed name for all the points.
- ◆ **Point Style:** If the **Name** is chosen from the drop-down, the **Style** is populated automatically from the **Point Name List**. If the name is keyed in, the **Style** may be chosen from the drop-down (which comes from the **Styles** in the current XIN). This style is assigned to the corresponding feature when the design surface is created by **Roadway Designer**.
- ◆ **Apply Affixes:** Toggles on or off the **Affixes**, which are set in **Tools > Options**.
- ◆ **Key-ins:** The drop-down menu lists the different key-ins that can be used when locating a point or component:
 - **xy=** x-value,y-value – based on the template grid
 - **dl=** delta x-value,delta y-value – from the previous point
 - **hs=** delta x-value,slope – from the previous point
 - **vs=** delta y-value,slope – from the previous point
 - **ol=** delta x-value,delta y-value – from the **Dynamic Origin** (magenta box)
 - **os=** delta x-value,slope – from the **Dynamic Origin** (magenta box)

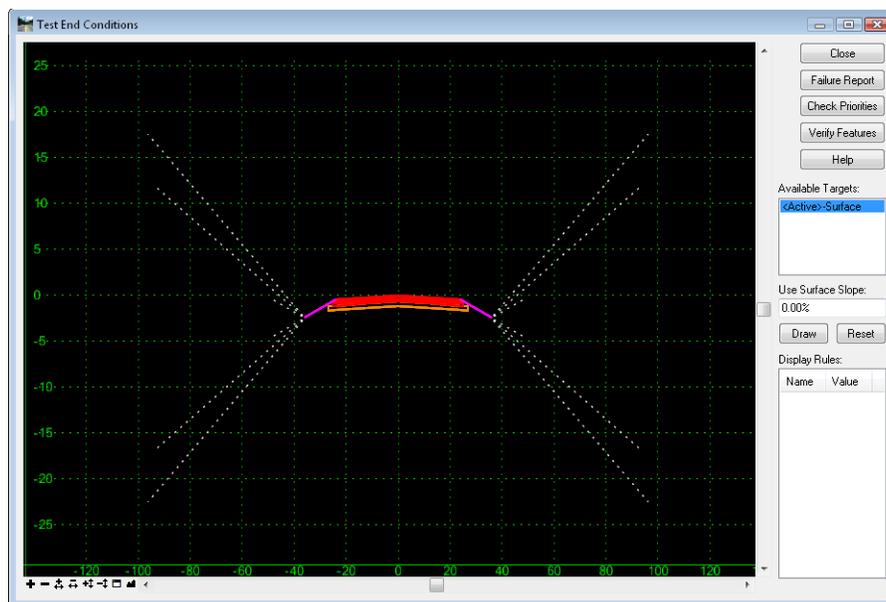
- ◆ **Set Dynamic Origin:** This allows the **Dynamic Origin** (magenta box) to be moved to a different location. Use this when the point being placed is offset a known x and y or x and slope from a point that is not the previous one located. Set the **Dynamic Origin** on the reference point, then use the **ol** or **os** key-ins listed above to locate the new point.

Important! The **Dynamic Origin** is **not** where the template is applied to the horizontal and vertical alignment. The template is applied at the 0,0 coordinate in the template grid. For clarity, you can keep the **Dynamic Origin** at the 0,0 coordinate when not using it as noted above.

Additional options for **End Condition Points** are described in the **CDOT End Conditions** area of this chapter.

Test Mode

This command activates the **Test End Conditions** dialog as shown.



To test the end conditions:

1. Choose the command while the template in question is active. If there are priority conflicts you will first be asked to choose the order of processing for the end conditions.
2. Select a target from the list of **Available Targets** (generated from the active template's end conditions).
3. Choose **Draw** and place the target in the desired position. If more than one target is listed, you may need to place all the targets before seeing a result.
4. After drawing the targets, you may select **Failure Report** for a list of end conditions that did not meet their targets.
5. **Check Priorities** allows the order of end conditions to be changed.
6. **Verify Features** checks the solution to see if there are multiple occurrences of the same feature name.

7. In the **Display Rules** area, there is a list of the **Display Rules** found in the template. To force a temporary **True** or **False** results to see the outcome, select the rule and <D> on the **True/False** toggle.
8. **Reset** removes the targets and starts the process of testing over again.

Section Summary:

- The CDOT standard template library can be copied to start your project-specific library.
- Templates can be copied from previous projects.
- The **Create Template** dialog is used to create and edit templates.
- Right-click menus are available in the **Create Template** dialog. The commands they contain are context sensitive and depend upon where you are and what you are doing when you right click, for example: in a clear area, on a point or on a line of a component.
- The **Dynamic Settings** box allows you to use key-ins for precision placement of points and components.
- The **Dynamic Origin** (magenta box) is not where the template is applied. The 0,0 coordinate of the template is applied to the horizontal and vertical alignments.

Organization of the Template Library

Section Objectives:

- To learn how the CDOT standard template library is structured and where to look for the necessary templates for your project.
- To learn how to modify the standard templates if necessary to meet your design criteria.
- To become familiar with the standard templates, sections and components available by reviewing how the standard templates are put together.
- To learn how the templates will work based on their component and point properties.

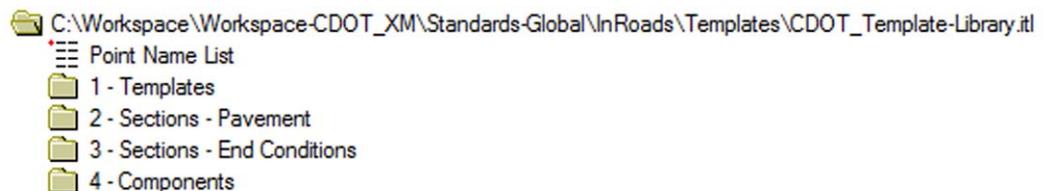
The **CDOT_Template-Library** is structured with complete templates at the top of the folder structure and individual template pieces (called components) at the bottom. The purpose of this folder structure is to:

- 1) Make completed templates more accessible in Roadway Designer and
- 2) To emphasize that when building a new template, the first step is to create an empty template.

Note: In InRoads terminology, a template refers to everything in the template library that is not a folder or the point name list. To help with communication and training, CDOT has further categorized the contents of the template library into templates, sections, and components based on the completeness of the data they contain.

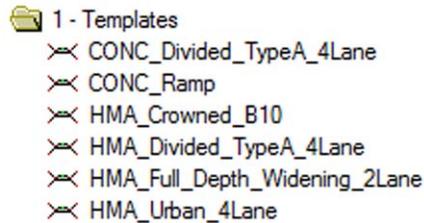
Each folder level in the template library (**Templates**, **Sections**, and **Components**) refers to the completeness of the template as follows:

- **1 – Templates** folder contains complete templates with the basic components of roadway cross sections.
- **2 – Sections – Pavement** folder contains portions of a roadway cross section including pavement and sub base for lanes, shoulders, curb and gutter, and medians.
- **3 – Sections - End Conditions** folder contains Z-slope components, cut and fill slopes, and curb and gutter templates.
- **4 – Components** contain individual building blocks for defining sections or templates.
- The illustration below shows the standard template library's top level folder structure as it appears in the **Create Template** dialog box.



Templates

This folder contains standard templates based on the *CDOT 2005 Roadway Design Guide*. Modify these templates as needed. Save new or copied complete templates to this folder. InRoads XM allows great flexibility in designing templates. With the advent of components, the design models used for CDOT's V04.00.00 configurations adhere as much as possible to the CDOT 2005 Roadway Design Guide and the CDOT Standard Plans- M&S Standard 2006 Edition.



The illustrations on the next several pages show the six templates included in the Templates folder as they appear in the **Create Template** dialog box.

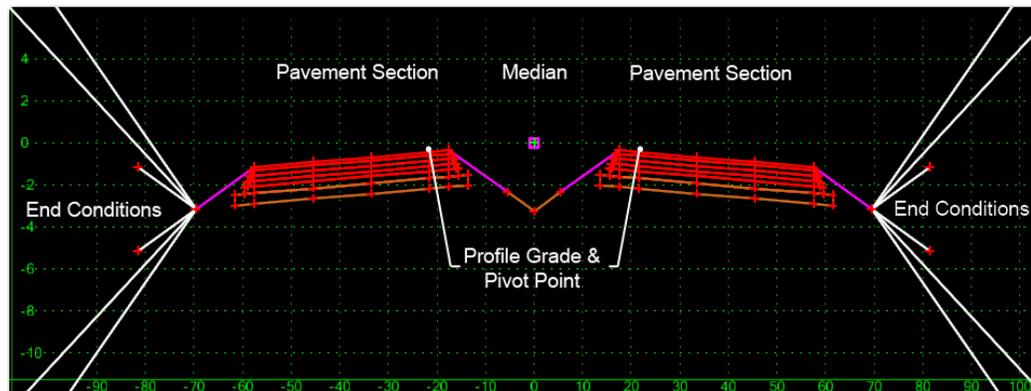


Figure 1: HMA_Divided_TypeA_4Lane

- **HMA_Divided_TypeA_4Lane** – This is the typical design for a four lane divided highway based on **Figure 4-1** of the *2005 Roadway Design Guide*. Each **Pavement Section** contains:
 - ◆ 12 ft lanes (two lanes)
 - ◆ 4 ft inside shoulders
 - ◆ 12 ft outside shoulders
 - ◆ Normal Crown Cross slope

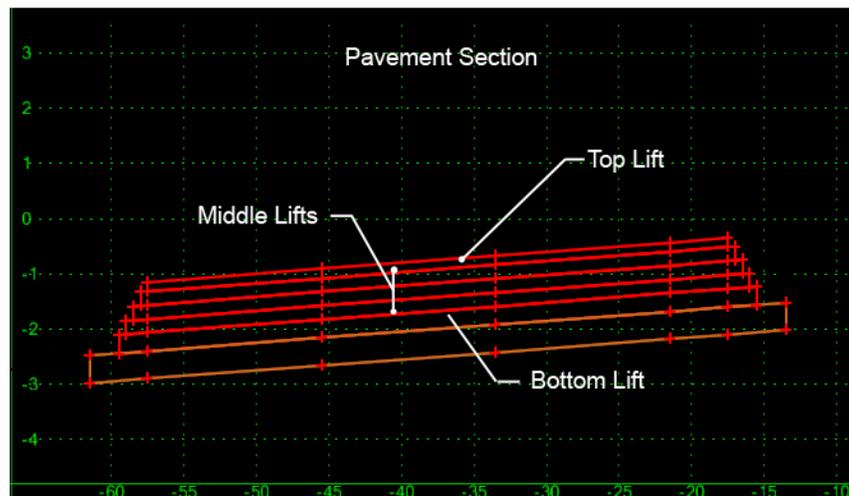


Figure 2: Pavement Section Detail from “Figure 1:HMA_Divided_TypeA_4Lane” on page 132

- ◆ The Hot Mix Asphalt pavement is 15” thick, made up of five lifts:
 - 2 in top lift
 - 3 in middle lifts (three lifts)
 - 4 in bottom lift
 - 6 in layer of Aggregate Base Course Class 6

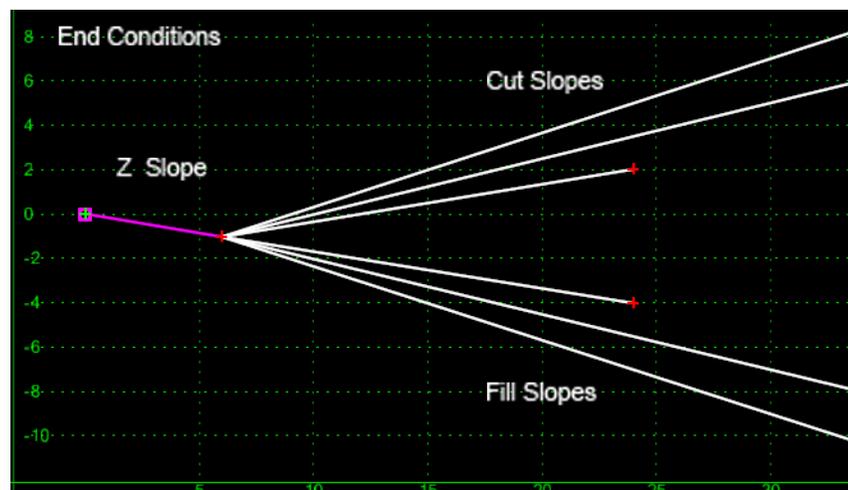


Figure 3: End Conditions Detail

The **end conditions** show the **clear zone treatment** and possible **cut and fill slopes** based on 6:1, 4:1 and 3:1 slopes. Please refer to the **End Conditions** section of this manual for a detailed discussion on the subject.

“Figure 3:End Conditions Detail” on page 133 defines possible cut and fill solutions that tie the pavement section to the existing ground and are based on **Table 4-2 Fill Slopes** of the **2005 Roadway Design Guide**. This end condition includes:

- ◆ Z-Slope with a horizontal measurement of 12’ from the edge of pavement and a slope of 6 to 1
- ◆ (3) fill slopes; 6 to 1, 4 to 1, and 3 to 1
- ◆ (3) cut slopes; 6 to 1, 4 to 1, and 3 to 1

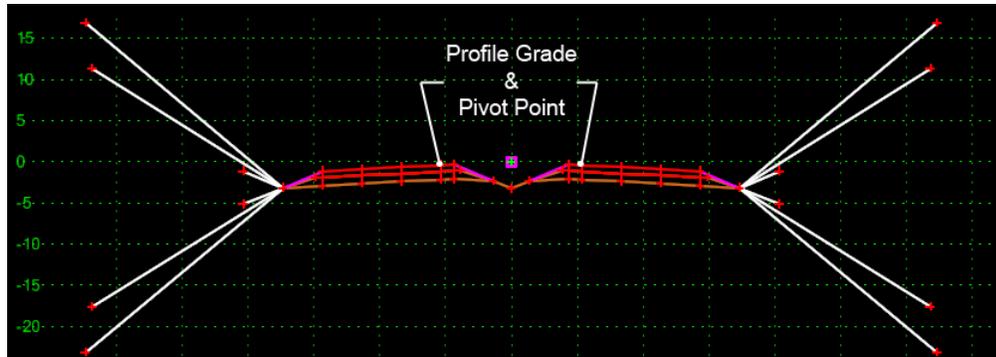


Figure 4: CONC_Divided_TypeA_4Lane

- **CONC_Divided_TypeA_4Lane** – This is the typical design for a four lane concrete highway based on **Figure 4-2** of the **2005 Roadway Design Guide**. Each pavement section contains:
 - ◆ 12 ft lanes (two lanes)
 - ◆ 4 ft inside shoulders
 - ◆ 12 ft outside shoulders
 - ◆ The concrete thickness is 9 in
 - ◆ 12 in ABC Class 6 base extends 2 ft past the edge of concrete and tapers down to the POSS as shown in the detail below
 - ◆ End condition treatments are as shown from **HMA_Divided_TypeA_4Lane**

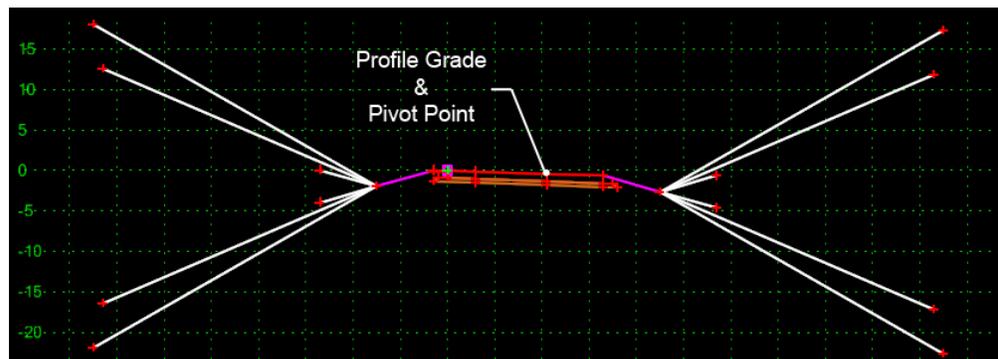


Figure 5: CONC_Ramp

- **CONC_Ramp** – The ramp template based on **Figure 4-3** of the *2005 Roadway Design Guide*. The typical standard pavement section for single lane ramp for CDOT has a 15 ft lane, 4 ft and 6 ft shoulders. The pavement section contains:
 - ◆ 15 ft lane
 - ◆ 12 ft inside shoulder
 - ◆ 6 ft outside shoulder
 - ◆ The concrete pavement is 11 in thick
 - ◆ 3 ft wide Hot Mix Asphalt pavement for guardrail type 3, 2 in thick, is placed along the shoulder edge. Refer to *CDOT M&S Standards M-606-1*.
 - ◆ End condition treatments are as shown for **HMA_Divided_TypeA_4Lane**

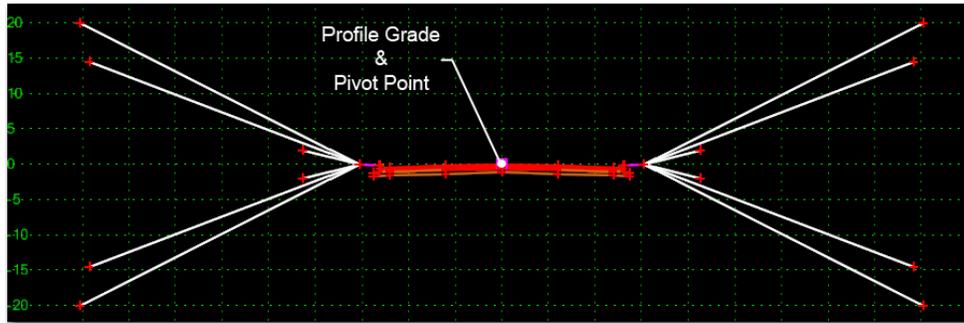


Figure 6: HMA_Urban_4Lane

- **HMA_Urban_4Lane** – This urban highway template is based on **Figure 4-4** of the **2005 Roadway Design Guide**. It contains:
 - ◆ 12 ft lanes in each direction in a normal crown (two lanes)
 - ◆ The asphalt pavement is 8 in thick, made up of:
 - 2 in top lift
 - 3 in middle lift
 - 3 in bottom lift
 - ◆ 6 in layer of ABC Class 6 base runs under the asphalt to 12 in past the curb and gutter
 - ◆ Type2-IIB curb section is used at the edge of pavement. This type of curb and gutter section allows the slope of the gutter pan to match the pavement cross slope for cross slopes greater than +4% or less than -4%

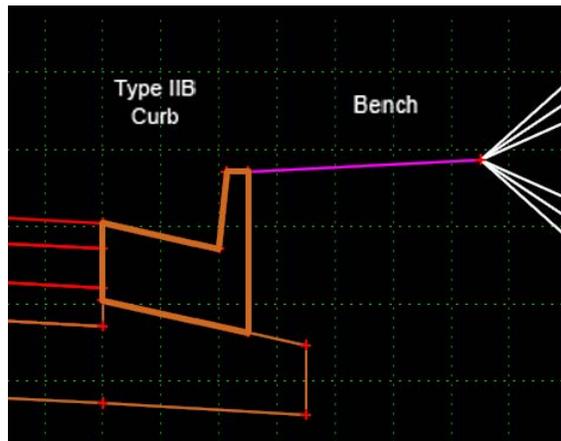


Figure 7: Type2-IIB Curb Section

Note: To see all the attached sections toggle on **Display All Components** in the **Display** section of the **Create Template** dialog box. The template is developed this way so that the end conditions connect properly to the top back of curb. Refer to Curb and Gutter discussions under the Pavement Sections of this manual for additional discussion on Curb and Gutter.

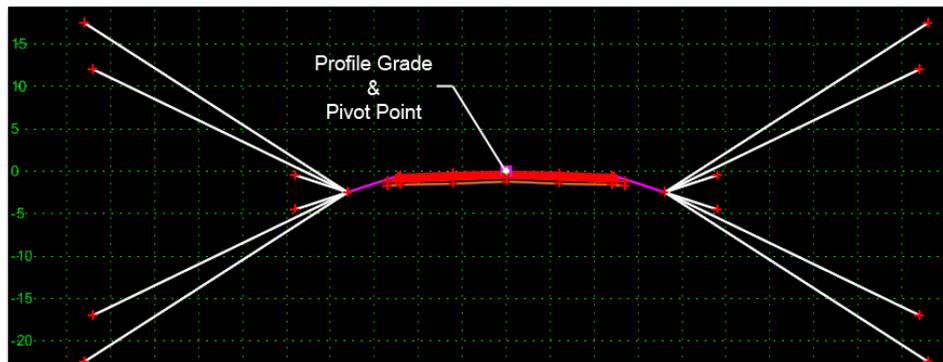


Figure 8: HMA_Crowned_B10

- **HMA_Crowned_B10** – This is a typical two lane normal crown template based on **Figure 4-5** of the *2005 Roadway Design Guide*. It contains:
 - ◆ (1) 12 ft lane in each direction
 - ◆ 12 ft Shoulders
 - ◆ The asphalt pavement is 8 in thick, made up of:
 - 2 in top lift
 - 3 in middle lift
 - 3 in bottom lift
 - ◆ A 6 in layer of ABC extends 2 ft past the bottom lift on each side
 - ◆ End condition treatments are as shown for **HMA_Divided_TypeA_4Lane**

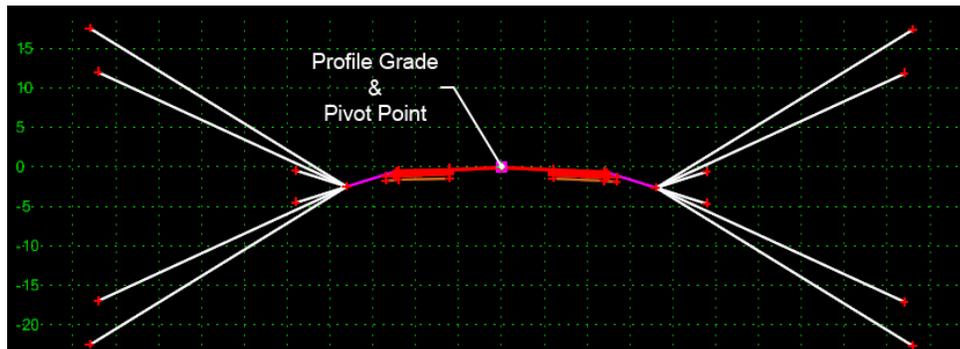
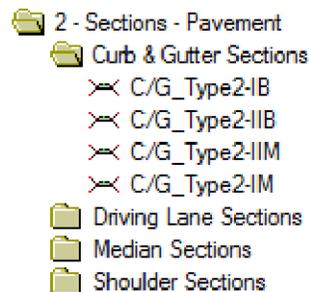


Figure 9: HMA_Full_Depth_Widening_2Lane

- **HMA_Full_Depth_Widening_2Lane** – This template is for use on widening and resurfacing projects based on the *Edge of Pavement Detail* in **Figure 4-5** of the *2005 Roadway Design Guide*. It contains:
 - ◆ 12 ft lane overlaid on the existing pavement each direction
 - ◆ 12 ft shoulders built to a full depth of 8 in of asphalt
 - ◆ HMA is 2 in thick over the existing pavement and 8 in thick at the shoulders. It is made up of:
 - 2 in top lift that extends 24 ft to each side of the centerline
 - 3 in middle lift under the new 12 ft shoulders
 - 3 in bottom lift under the new 12 ft shoulders
 - A 6 in layer of ABC Class 6 under the shoulders extends 2 ft past the bottom lift on each side
 - ◆ End condition treatments are as shown for **HMA_Divided_TypeA_4Lane**

Pavement Sections

The **2 - Sections - Pavement** folders contain full depth segments of the roadway pavement cross section of a template. Pavement sections are partial templates. They represent one segment of the total pavement. For example, sections from the **Driving Lane Sections** folder represent a single pavement section from the finished grade to the subgrade. The reader is encouraged to explore the contents of the **Pavement Sections** sub-directories since only some of the sections are displayed or discussed below. The folder structure for pavement sections is shown in the illustration below.



Curb and Gutter

The **Curb and Gutter Sections** folder shown above contains Curb and Gutters as defined in the **CDOT Standard Plans-M&S Standards M-609-01**.

In the folder;

- ◆ **C/G_Type2-IB** is curb and Gutter Type 2 (Section IB)
- ◆ **C/G_Type2-IIB**, is curb and Gutter Type 2 (Section IIB)
- ◆ **C/G_Type2-IM** is curb and Gutter Type 2 (Section IM) and
- ◆ **C/G_Type2-IIM** is curb and Gutter Type 2 (Section IIM)

The Curb and Gutters are modeled such that:

1. When the curb and gutter is attached to pavement with cross slope of less than 4% while more than -4%, the gutter cross slope will be as defined in **CDOT M&S Standards M-609-1**.
2. When the curb and gutter is attached to pavement with cross slope greater than 4% or less than -4%, the gutter cross slope will match the cross slope of the pavement.

Important! The desire to have the gutter match the cross slope of the pavement is not a given. This is a design decision left up to the CDOT designer or engineer in charge of the project. While the curb and gutter sections in the CDOT standard template library reflect this decision, they can be modified for other design situations. See the section Display Rules and Parent Components on how to use different design criteria with these sections.

Gutter Pan Cross Slope example

The *CDOT M&S Standard M-609-1* was used to model the **Type2-IIB** curb and gutter section. The **Type2-IIB** curb and gutter section shown here is a good example of how the new software is used to accommodate CDOT design decisions.

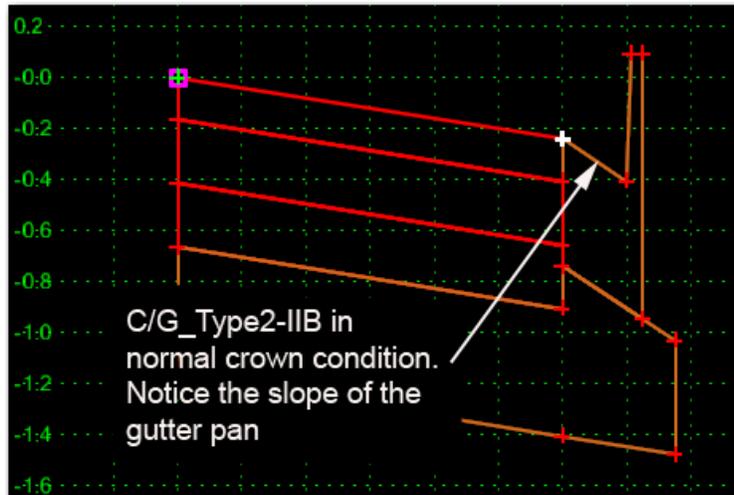


Figure 10: C/G_Type2-IIB Pavement Less Than 4%

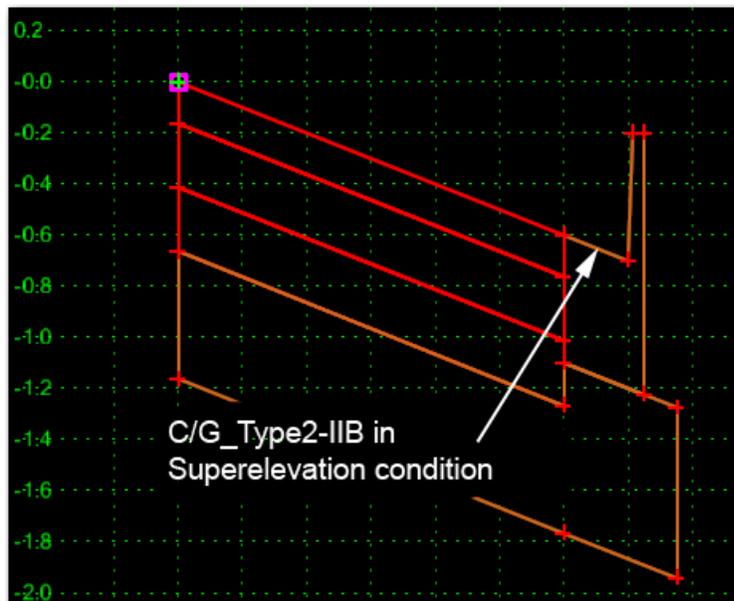


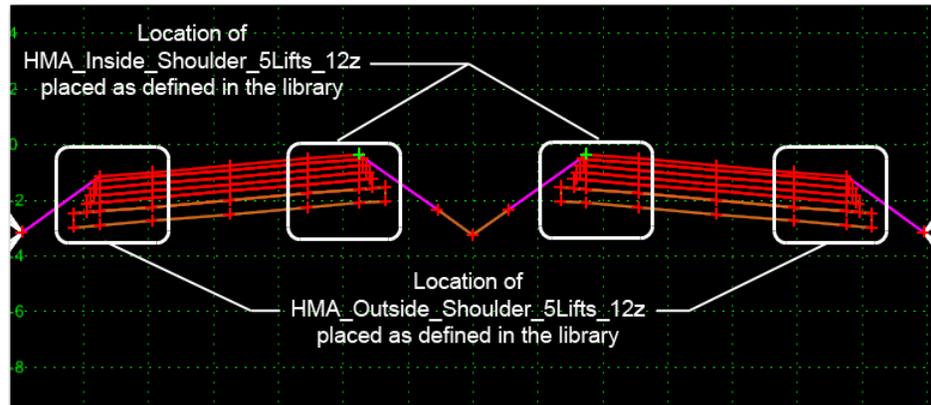
Figure 11: C/G_Type2-IIB Pavement Greater Than 4%

- ◆ *Figure 10:C/G_Type2-IIB Pavement Less Than 4%* - 10 shows **C/G_Type2-IIB** in a normal cross slope condition and
- ◆ *Figure 11:C/G_Type2-IIB Pavement Greater Than 4%* - **C/G_Type2-IIB Pavement Greater Than 4%** shows **C/G_Type2-IIB** in a superelevated cross slope condition.

Shoulder Sections

Shoulders

The figure below shows standard shoulder sections and how they are applied to a template design.

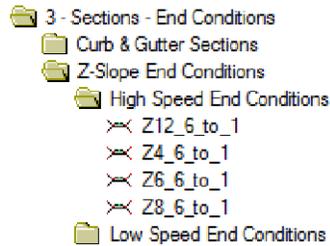


- **HMA_Inside_Shoulder_5Lifts-12z** and **HMA_Outside_Shoulder_5Lifts-12z** – The “stair-step” design of the pavement edge is based on the *Edge of Pavement Detail* in **Figure 4-5** of the *CDOT 2005 Roadway Design Guide*. Both sections contain:
 - ◆ 12 ft wide outside shoulder
 - ◆ The Hot Mix Asphalt pavement is 15 in thick, made up of five lifts:
 - 2 in top lift
 - 3 in middle lifts (three lifts)
 - 4 in bottom lift
 - ◆ 6 in layer of ABC, Class 6 base

Both inside and outside shoulders are created for the right side of the pavement section. The **Mirror** or **Reflect** command is used to place the left side version for this shoulder section.

End Conditions Sections

The **3 - Sections – End Conditions** folder contains predefined sections for end conditions complete with multiple cut and fill solutions. This folder is divided into groups for Curb and Gutter side slopes and Z slopes.



End conditions refer to roadside designs associated with the unpaved **clear zone** area or roadside safety items like **Guardrail type 7**, **Guardrail type 3** and **cut and fill slopes**.

End Conditions treatment or the selection of roadside safety items is influenced by several factors. These factors will vary even within the project.

Below are some of the factors that will influence End conditions or component selection:

1. Clear Zone requirements
2. Design Speed and traffic volumes
3. Roadway Category or designation
4. Local terrain
5. Structures and obstructions
6. Right of Way limitations
7. Drainage requirements
8. Project budget
9. Local preferences

For CDOT, the primary reference material for the determination of End Conditions requirements based on Clear Zone, design speed and traffic volume is the **Roadside Design Guide, 2006 Edition**, published by American Association of State Highway and Transportation Officials (AASHTO). Other references include:

- **CDOT 2005 Roadway Design Guide**
- **CDOT Standard Plans - M&S Standards**

The designer needs to be familiar with the project, factors influencing design decisions and the above references.

Z-Slope End Conditions

Z-Slope End Condition sections describe the horizontal width and slope of the Z-Slope component. For Example, **Z12_6_to_1** defines a Z-Slope component that measures 12' horizontally and has a slope of 6 to 1. The dimensions for the Z-Slope components come from **Figures 4-1** and **4-5** of the *CDOT 2005 Roadway Design Guide*. Cut and fill slopes are based on **Table 4-2 Fill Slopes** of the *CDOT 2005 Roadway Design Guide*.

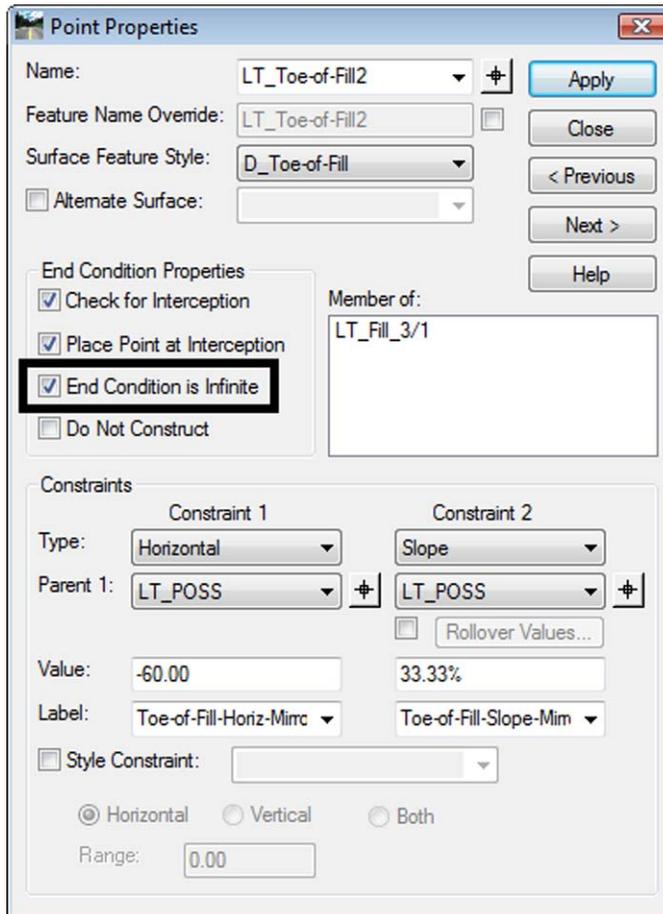
Component and Point Properties

Component and **Point Properties** are major factors in determining how components are modeled. These properties are covered in more detail in later sections of this document but for now it is necessary to mention a few details regarding some of these properties.

The screenshot shows the 'Component Properties' dialog box. The 'Name' field contains 'LT_Fill_3/1'. The 'Style' dropdown is set to 'D_Toe-of-Fill'. The 'Parent Component' dropdown is set to 'LT_Z-Slope_12_6_t'. In the 'End Condition Properties' section, 'Target Type' is 'Surface', 'Surface' is '<Active>', and 'Priority' is '3'. Other fields include 'Horizontal' and 'Vertical' offsets (both 0.00), 'Rounding Length' (0.00), 'Benching Count' (0), 'From Datum' (0.00), and 'Step Elevation' (0.00). Buttons for 'Apply', 'Close', '< Previous', 'Next >', and 'Help' are visible on the right side.

In the **Component Properties** dialog, all of the cut and fill components have their **Target** set to the active surface. This allows the same end condition to be used on multiple projects without having to edit each component that lists the target.

When multiple end condition components begin at the same location in the template, the **Priority** determines the order of processing. The lowest numbered Priority is used first. If the slope does not intercept the existing ground (or other listed target), the next lowest priority is tried, and so on. Once a solution is found, processing stops for that location and no other slopes are tried. If no solution is found, the end condition fails and no sideslope is formed for that location. Processing occurs at each station where a template is 'dropped'. See the [Roadway Modeling](#) chapter for more details on **Template Drops**.



One differentiating factor for end condition sections is whether or not the checkbox for **End Condition Is Infinite** point property is toggled on.

- ◆ When toggled off, the maximum length of the end condition is determined by its constraint.
- ◆ When on, the end condition can extend past the distance defined in the constraint.

Standard fill height maximums for each slope were used to determine the default horizontal measurement (the horizontal constraint value in the Point Properties dialog box) for each slope. The horizontal measurement is not important for slopes that are allowed to be infinite, although it cannot be 0.00.

Following is an example end condition section.

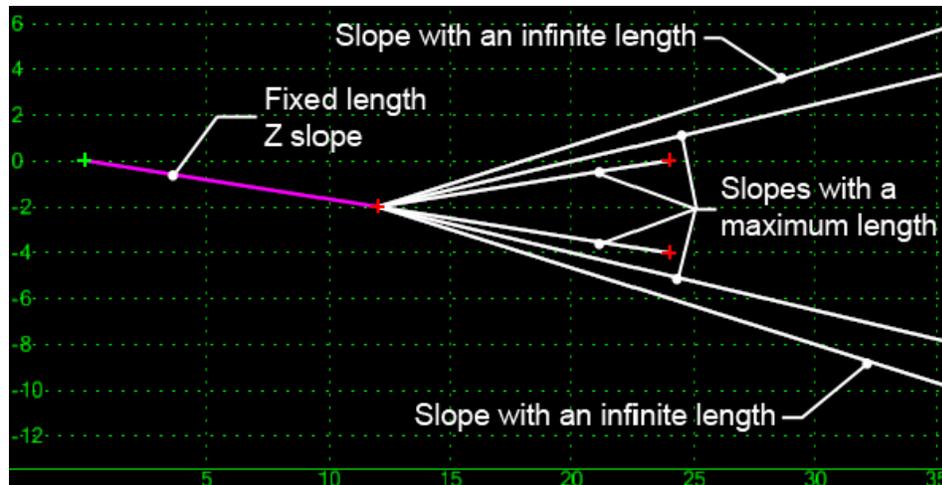
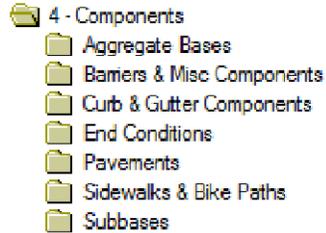


Figure 12: Z12_6_to_1 End Condition Detail

- **Z12_6_to_1** – This section contains:
 - ◆ (1) Fixed Z-Slope component measuring 12' horizontally and a slope of 6 to 1.
 - ◆ (1) 6 to 1 fill slope measuring 12' horizontally. **Priority** is set to 1.
 - ◆ (1) 4 to 1 fill slope measuring 58' horizontally. **Priority** is set to 2.
 - ◆ (1) 3 to 1 fill slope measuring 60' horizontally. **End Condition is Infinite** is toggled on. **Priority** is set to 3.
 - ◆ (1) 6 to 1 cut slope measuring 12' horizontally. **Priority** is set to 4.
 - ◆ (1) 4 to 1 cut slope measuring 58' horizontally. **Priority** is set to 5.
 - ◆ (1) 3 to 1 cut slope measuring 60' horizontally. **End Condition is Infinite** is toggled on. **Priority** is set to 6.

Components

This folder contains the components used to build sections and complete templates. They are sorted into subfolders based on their use. The illustration below shows the subfolder structure of the **4 – Components** folder of the standard template library as it appears in the Create Template dialog box.



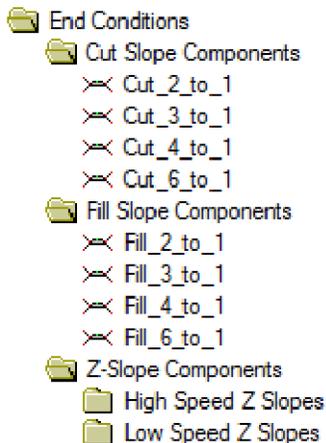
The standard components can be grouped into three functional categories:

- linear elements
- fixed shape elements
- variable shape elements

The examples below represent typical component designs from each of these categories and the unique elements of the different component types.

Linear Elements

Components in the **End Conditions** folder fall into the **linear elements** category. These components are simple linear elements generally used to define options for side slopes.



A typical end condition component, like the one illustrated below, is a single line segment. The right point is constrained to the origin (the left point) with a **horizontal** and a **slope** constraint. The information for defining end condition components comes from **Chapter 4** of the **2005 Roadway Design Guide**.



Figure 13: Fill_6_to_1

- ◆ **Fill_6_to_1** – The typical end condition component, like the one illustrated above, is a single line segment. Its properties are:
 - Check for Interception
 - Place Point at Interception
 - Horizontal constraint with a Value of 12
 - Slope constraint with a Value of -16.67%
 - Both constraints have the point POSS as the Parent

Fixed Shape Elements

The majority of the remaining components are classified as fixed shape elements. Fixed shape elements typically remain constant throughout a model unless design criteria dictates otherwise, in which case they are modified by Superelevation Controls, Points Controls or Parametric Constraints. See the [Roadway Modeling](#) chapter for additional details. The shape may be a polygon or it may be more complex like curb and gutter.

Important! These components have the component property **Close Shape** toggled on in order to be used in End-Area Volume calculations.

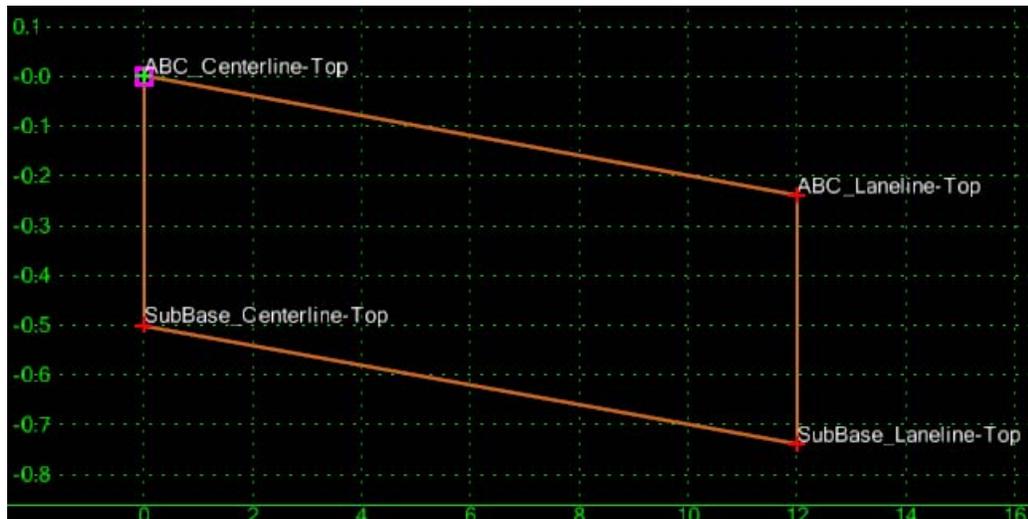
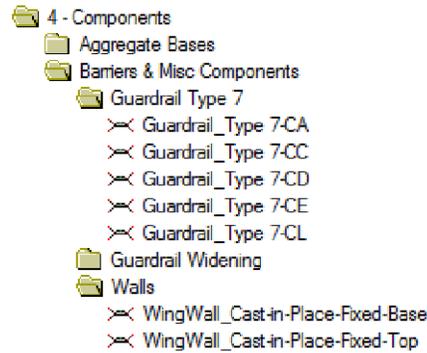


Figure 14: Typical Fixed Shape Element

- **ABC_Lane** – This component is typical of most surfacing and subbase components. It contains:
 - ◆ 4 points
 - ◆ The top right point is constrained to the origin with horizontal and slope constraints. The value of the horizontal constraint is 12. The value of the Slope constraint is -2.00%.
 - ◆ The two bottom points are constrained to the points above by horizontal and vertical constraints. The value of the horizontal constraint is 0. The value of the vertical constraint is -0.50. These values are the same on both points.

Variable Shape Elements

There are few exceptions to the previous example. Currently those exceptions are limited to the **Guardrail Type 7-CE** component in the **\Barriers & Misc Components\Guardrail Type 7** folder and both **Wing Wall_Cast-in-Place** components in the **\Barriers & Misc Components\Walls** folder.



Shapes of variable components are not fixed but depend on other design criteria and are used in areas of the project where a variety of field conditions require on-demand changes to the component design. The two component types previously mentioned are illustrated below.

Median Barrier Example

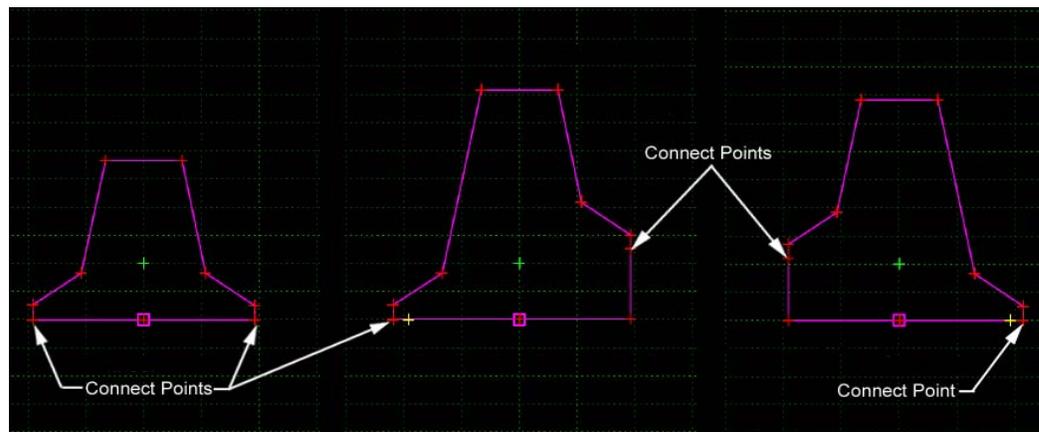


Figure 15: Guardrail Type 7-CE

Guardrail_Type 7-CE – This illustration shows how the shape of the barrier varies with the elevation changes of the travelways on either side of the median in a divided highway. This barrier has base width of 23” at a height of 34” or less. When the height is 34” or more, the base varies in width from 23” to a maximum of 26.75”. The design is based on the **CDOT M-606-13 Guardrail Type 7 F-Shape Barrier** standard.

Details of this component include:

- ◆ Two points on the bottom of the barrier are tied to the elevation on their respective side of the median.
- ◆ The barrier height and width vary with the elevation difference between the two sides.
- ◆ To learn how to apply this median barrier, see Lab 3.4 in the *Labs for InRoads XM* guide.

Wing Wall Example

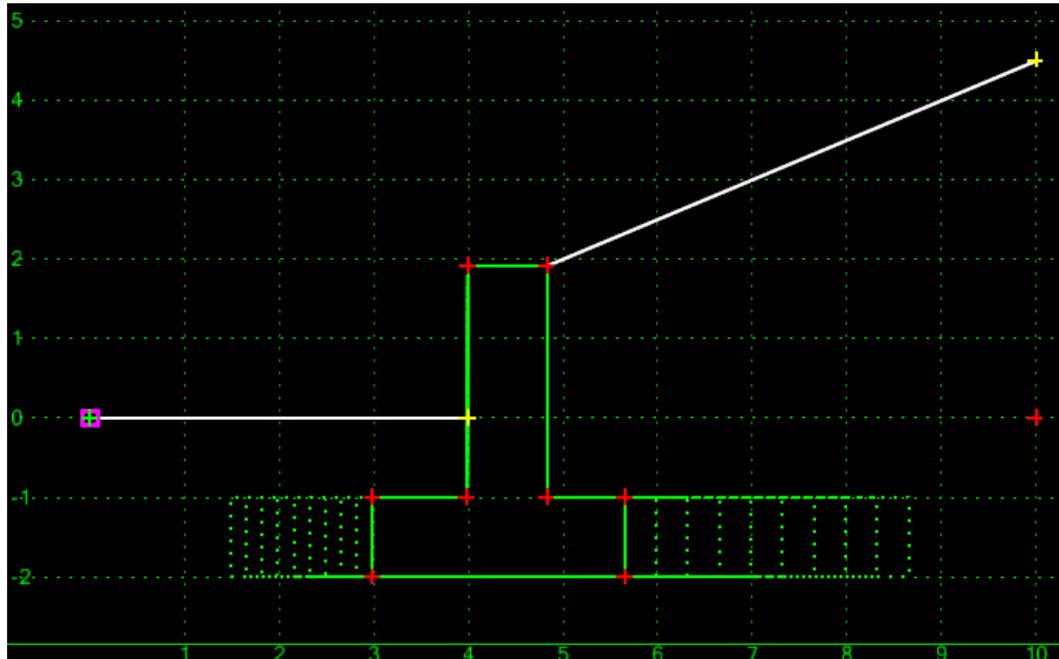


Figure 16: WingWall Cast-in-Place Fixed Base

WingWall_Cast-in-Place-Fixed-Base - This component is set up to adjust the wall height from pavement surface to the top of the wall based on maximum fill heights. It is used when the wall rises above the level of the roadway surface. Its sister component, **WingWall_Cast-in-Place-Fixed-Top** is used when the wall drops below the level of the roadway surface.

- ◆ The design of this component is based on the **CDOT M-601-20 Wingwalls for Pipe or Box Culverts** standard. As the maximum fill height for a wall height is reached, the wall height rises and the base of the wall expands to set base widths.
 - Is made up of 10 wall components with different base widths.
 - **Display Rules** are used that only allow the display of the proper wall component based on the height of the wall.

Section Summary:

- The CDOT standard template library is organized into **Templates**, **Pavement Sections**, **End Condition Sections** and **Components**.
- There are several example templates in the completed template folders that you can use ‘as-is’ or modify to fit your design criteria.
- **Pavement Sections** contain multiple components and can be used to build completed templates if one of the standard templates does not fit your design criteria.
- **End Condition Sections** match CDOT’s the standard sideslope design criteria.
- **Components** are the basic building blocks that can be used to build sections and templates.

Template Development

Section Objectives:

- To become familiar with the different areas of the standard template library and how the sections and components can be used to create templates.
- To develop a background knowledge of how **Points** and **Point Constraints** work so the CDOT standard templates can be used more effectively.
- To learn the differences between **Component** types and how each is used in the CDOT template library.
- To learn how to apply basic **Component Properties** to control their display in the plan and cross sections.
- To learn how to create more complex components using the **Parent** and **Display Rule** component properties.

When constructing a template in InRoads, it is best to use the largest assembly that meets the design criteria. For example, if a 2 lane road with paved shoulders is required, the **HMA_Crowned_B10** template may be used and lane, shoulder widths and lift thicknesses adjusted as required. If a standard template is used, it should be copied and renamed prior to editing. This will identify the template as being used for the project.

It should be noted, however, that because the surfacing components are merged most templates are not suitable for a major overhaul. It would be tedious to add an additional lane to the **HMA_Crowned_B10** template, for example. Therefore, the sample templates should only be used if they are very close to the desired design.

If there is not a template that will work, the sections should be used to create the desired template. There are sections available that cover most design situations with minor modifications. Modifications to the sections should be done prior to placing the section in the template. Editing the section before placing it in the template will reduce the amount of editing required if the section is used more than once.

It should be noted that most sections are set up to be placed on the right side of the origin. To place a section to the left of the origin, **Reflect** the section during placement. If the template design is symmetrical, the section can be placed on both sides using the **Mirror** option.

Certain specialty components may be required for a project (**Type 7 Guardrail** and **Walls**, for example). The component folders also contain these special components as well as all of the parts used to create the sections and templates. Components can be used in the template or used to build a new section, if required.

Finally, if there is not a component that can be used, a new component can be built. If the new component is a single unique part, it can be built directly in the template. If the new component is used multiple times, it should be created by itself in the proper component folder. This makes it easier to place the component in a template multiple times, or to place the component in multiple templates.

The information presented below is in reverse order to the sequence presented above. This was done so that the templates can be explained from the smallest building block to the complete template.

Components

This section describes how template components are made and how they are edited. Examples from the template library are used to highlight key points.

Template Points

All components are made up of points. The points used to define a template become breakline features in the resulting design model. A template point is assigned a name and a style (which, in turn has a named symbology assigned) that determine the name and the style of the feature when the design surface is created with **Roadway Designer**. The features are then saved as part of the surface. Each point on the template must have a unique name. If the same name is used twice, it is appended with a numeric counter.

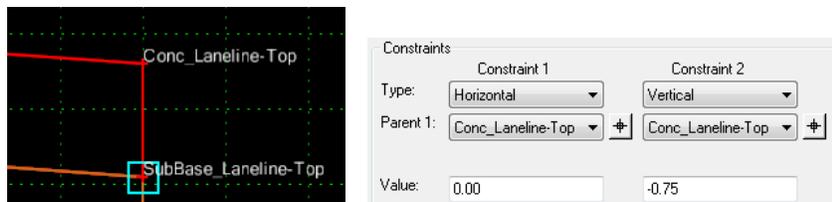
Point Constraints

Each point in a template can have constraints to determine how the points are allowed to move and their connectivity within a template. Many of the constraints have values such as distances or slopes from reference points. These reference points are called **Parents**. When a point moves, any point that lists it as a **Parent** is affected. Since the affected point may also be a parent for other points, there is a domino-type effect. Depending upon the constraint, 0, 1 or 2 parent(s) may be required. Parent points do not have to reside in the same component as the affected point.

Important! **Point Controls** and **Parametric Constraints** override **Point Constraints**. For more information, see [Point Controls](#) and [Parametric Constraints](#) in the [Roadway Modeling](#) chapter.

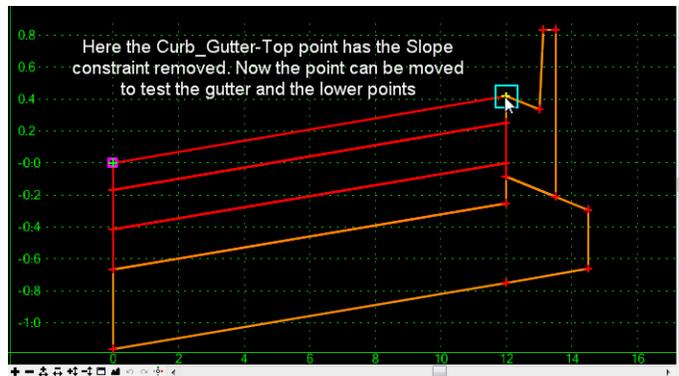
Points may be:

- **Fully** constrained (two constraints). Fully constrained points appear as **RED** plus signs on the template. Most points on a standard template should be fully constrained.



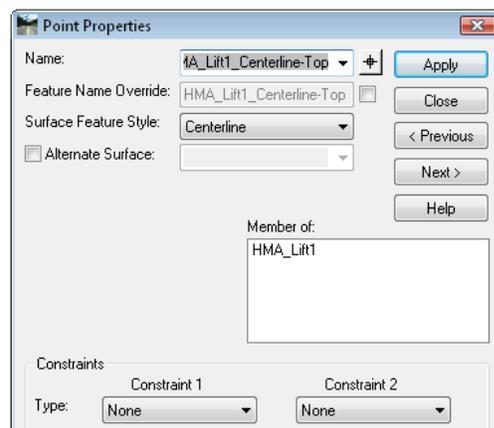
An example of a fully constrained point is shown here. The **SubBase_Laneline-Top** point is constrained Horizontally and Vertically to the **Conc_Laneline-Top** point. When the **Conc_Laneline-Top** moves, the **SubBase_Laneline-Top** point moves with it, maintaining horizontal and vertical distances as defined by the constraint values.

- **Partially** constrained (one constraint). Partially constrained points appear as **YELLOW** plus signs on the template. It is sometimes beneficial to remove one constraint from a fully constrained point just for testing.



For example, you may remove the slope constraint, then move a point to ensure the points below follow (as during superelevation), or that a **Display Rule** works correctly.

- **Unconstrained** (no constraints). Unconstrained points appear as **GREEN** plus signs on the template.



Typically unconstrained points are points that will be assigned to follow a certain path, such as the Centerline of the template which follows the horizontal and vertical alignments. Other points that you know are to be controlled with point controls, such as the centerline of another set of lanes (as in a divided highway) following different horizontal and vertical alignments may also be unconstrained.

In general, points other than the centerline should be fully constrained unless there are special circumstances dictating otherwise. For an example, see the **Point Controls** section of the [Roadway Modeling](#) chapter.

There are several different types of constraints you can place on points:

- **Horizontal:** Requires 1 Parent. The point is locked by a horizontal distance from the parent, as specified by the **Value** entered.



Constraints	
Constraint 1	Constraint 2
Type: <input type="text" value="Horizontal"/>	Type: <input type="text" value="Vertical"/>
Parent 1: <input type="text" value="HMA_Lift1_Laneline"/>	Parent 1: <input type="text" value="HMA_Lift1_Laneline"/>
Value: <input type="text" value="0.00"/>	Value: <input type="text" value="-0.17"/>

An example can be found in most of the CDOT templates including the Section **HMA_DrivingLane-2Lifts**. Here, the **HMA_Lift2_Laneline-Top** point is horizontally constrained to the **HMA_Lift1_Laneline-Top** parent point by a value of 0.00, meaning it will always have the same width from centerline as its Parent.

- **Vertical:** Requires 1 Parent. The point is locked by a vertical distance from the parent, as specified by the **Value** entered.



Constraints	
Constraint 1	Constraint 2
Type: <input type="text" value="Horizontal"/>	Type: <input type="text" value="Vertical"/>
Parent 1: <input type="text" value="HMA_Lift1_Laneline"/>	Parent 1: <input type="text" value="HMA_Lift1_Laneline"/>
Value: <input type="text" value="0.00"/>	Value: <input type="text" value="-0.17"/>

An example can be found in most of the CDOT templates including the Section **HMA_DrivingLane-2Lifts**. Here, the **HMA_Lift2_Laneline-Top** point is vertically constrained to the **HMA_Lift1_Laneline-Top** parent point by a value of -0.167, meaning it always maintains this depth from the top.

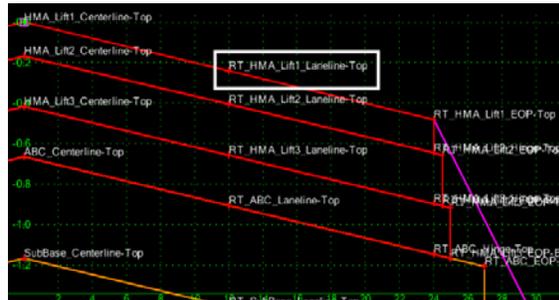
- **Slope:** Requires 1 Parent. The point is locked by a slope from the parent, as specified by the **Value** entered.



Constraints	
Constraint 1	Constraint 2
Type: <input type="text" value="Horizontal"/>	Type: <input type="text" value="Slope"/>
Parent 1: <input type="text" value="HMA_Lift1_Centerline"/>	Parent 1: <input type="text" value="HMA_Lift1_Centerline"/>
Value: <input type="text" value="12.00"/>	Value: <input type="text" value="-2.00%"/>

An example can be found in most of the CDOT templates including the Section **HMA_DrivingLane-2Lifts**. Here the **HMA_Lift1_Laneline-Top** point is slope constrained to the **HMA_Lift1_Centerline-Top** parent point by a value of -2.0%.

- **Vector Offset:** Requires 2 Parents. The point is locked onto a vector as defined by the 2 parents. The point may be offset perpendicular from the vector by entering a **Value**. Positive values are offsets to the right of the vector, Negative values to the left.



Constraints	
Constraint 1	Constraint 2
Type: <input type="text" value="Horizontal"/>	Type: <input type="text" value="Vector-Offset"/>
Parent 1: <input type="text" value="HMA_Lift1_Centerline-Top"/>	Parent 1: <input type="text" value="HMA_Lift1_Centerline-Top"/>
Parent 2: <input type="text" value="RT_HMA_Lift1_EOP-Top"/>	Parent 2: <input type="text" value="RT_HMA_Lift1_EOP-Top"/>
Value: <input type="text" value="12.00"/>	Value: <input type="text" value="0.00"/>

An example can be found in many of the CDOT templates including **HMA_Crowned_B10**. Here the **RT_HMA_Lift1_Laneline-Top** point is locked onto the vector defined by **HMA_Lift1_Centerline-Top** to **RT_HMA_Lift1_EOP-Top**, with a **0.00 Offset**.

Note: The Parent points defining the vector do not have to be on either side of the constrained point, nor do they have to be in the same component. They are simply used to define a vector and can be anywhere in the template. This is most often used when the Parents form a vector that is variable during modeling, such as in superelevation, and you want the constrained point to follow the variable vector.

- **Project to Surface:** No Parent *point* is required, but a parent direction and a surface value must be specified. The point projects in the direction selected until it intercepts the surface listed.

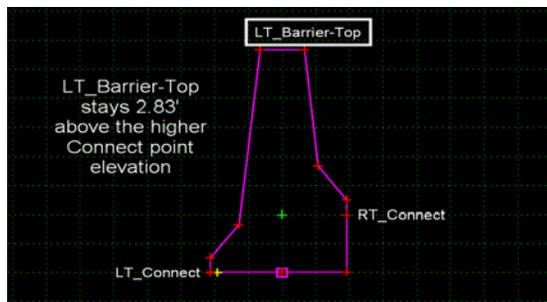


Constraints	
Constraint 1	Constraint 2
Type: <input type="text" value="Horizontal"/>	Type: <input type="text" value="Project To Surface"/>
Parent 1: <input type="text" value="HMA_Lift1_Centerline-Top"/>	Parent 1: <input type="text" value="Any Direction"/>
Value: <input type="text" value="-12.00"/>	Value: <input type="text" value="12345_Existing"/>

An example can be found in several of the CDOT templates including **HMA_Full_Depth_Widening_2Lane**. Here the **RT_** and **LT_HMA_Lift1_Laneline-Top** points are set to follow the existing ground.

Important! If two adjacent points in the same component project to the same surface, the component will ‘trace’ the surface in between the points.

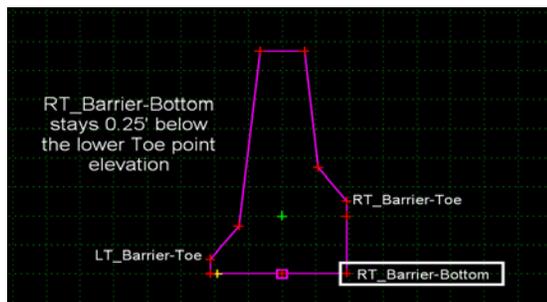
- **Project to Design:** No Parent is required. The point is projected at the slope or vector defined by the second constraint and stops when it encounters the design model. This is most often used when a subgrade must tie to a variable sideslope. The Value listed determines the maximum distance the projection can go and a positive value forces the projection to the right, negative to the left. A zero Value allows an unlimited distance to either the right or left, whichever interception is closer.
- **Horizontal Maximum:** Requires 2 Parents. The point is locked to a horizontal distance from whichever parent is further to the right, with the distance specified by the **Value**.
- **Horizontal Minimum:** Requires 2 Parents. The point is locked to a horizontal distance from whichever parent is further to the left, with the distance specified by the **Value**.
- **Vertical Maximum:** Requires 2 Parents. The point is locked to a vertical distance from whichever parent is higher, with the distance specified by the **Value**.



Constraints	
Constraint 1	Constraint 2
Type: Horizontal	Vertical Maximum
Parent 1: Barrier	LT_Connect
Parent 2:	RT_Connect
Value: -0.33	2.83

An example can be found in the CDOT template **Guardrail_Type 7-CE**. This barrier is designed to be used as a median barrier in a divided highway. The barrier changes height based on the elevations of the different connect points, but must maintain a certain height above whichever connect point is higher. The constraints for the **Barrier Top** are shown. When this barrier is used between sets of lanes that follow different verticals, the top of the barrier will always remain a set height above the higher of the vertical alignments.

- **Vertical Minimum:** Requires 2 Parents. The point is locked to a vertical distance from whichever parent is lower, the distance specified by the **Value**.



Constraints	
Constraint 1	Constraint 2
Type: Horizontal	Vertical Minimum
Parent 1: RT_Barrier-Toe	LT_Barrier-Toe
Parent 2:	RT_Barrier-Toe
Value: 0.00	-0.25

An example can be found in the CDOT template **Guardrail_Type 7-CE**. This barrier is designed to be used as a median barrier in a divided highway. The barrier changes height based on the elevations of the different connect points, but the base must be below whichever connect point is lower. The constraints for the **Barrier Toe** are shown. (The parents are the **Barrier Toe** points which are derived from the **Connect** points.)

- **Angle Distance:** Requires 2 Parents. The point is locked to an angle from the line defined by the two parents and a distance along the defined angle from Parent 1. This is used when you want to maintain a rigid shape, even when the base rotates. An example would be a rigid barrier sitting on pavement that rotates in superelevation.
- **Style:** No Parent is required. The **Style** constraint overrides the other constraints as needed. When toggled on, a Style is specified. When the template is used in Roadway Designer, the active surface and geometry project are searched for an alignment or feature with the specified style. If found, the template point follows the feature or alignment. If the **Horizontal** toggle is on, this overrides the constraint controlling the horizontal placement of the point. If the **Vertical** toggle is on, this overrides the constraint controlling the vertical placement of the point. If the **Both** toggle is on, this overrides both of the listed point constraints and a variable slope and width is used to connect with the feature or alignment. A negative range value sets a horizontal limit and forces a search to the left, positive to the right. If the range is set to 0, the closest instance of the Style is found.

Labels

All of the constraints with the exception of **Style** and **Project to Design** can have a **Label**. A **Label** is a variable that can be assigned start and stop values (by station range) in Roadway Designer using **Parametric Constraints**. If a **Parametric Constraint** is assigned for the label, the value in the template is ignored. If no **Parametric Constraint** is assigned for the label, the value listed for the constraint in the template is used.

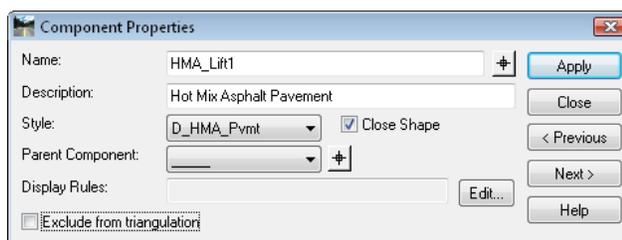
For example, you can assign the same label to each of the lower points in a lift, then with one entry in the **Parametric Constraints** dialog, you can change the lift depth for the entire alignment or any station range, even across multiple templates as long as the same labels are used in the different templates.

Labels must be keyed in for the first use in a template, then are available in the drop-down in for future use in that template.

See the **Parametric Constraints** section of the [Roadway Modeling](#) chapter for details.

Creating Components

A component is a series of points that forms either an open or closed shape used in defining a typical section or template. Components typically represent different types of roadbed materials or sideslopes (asphalt lifts, aggregate base, subgrade, cut, fill, etc.). Components are named and assigned styles (materials).



The **Style** assigned to the component controls its display in **Create Template**, **Roadway Designer** and **Cross Sections**. In addition, the **Style** associated with the component assigns the category of the volume if the component is used in end-area volumes.

There are five different methods of adding new components: **Simple**, **Constrained**, **Unconstrained**, **Null Point**, and **End Condition**.

The first three of these methods create standard components. With each, the first point placed is unconstrained unless it is snapped onto an existing point that already has constraints. The method used to create a general component does not stay with the component once it is created. The points created with either of these methods can be edited or deleted and new points can be inserted.

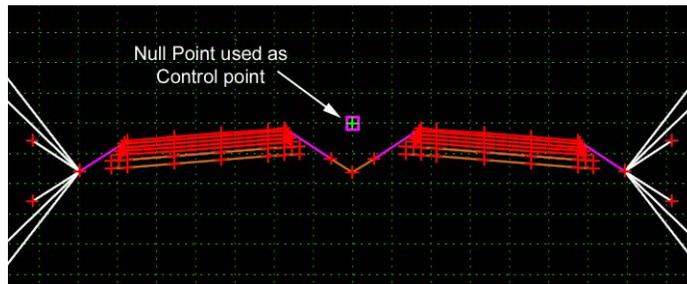
- A component created with the **Simple** command initially consists of four points that form a parallelogram. The shape is defined by slope, width and thickness (default values: 2%, 12 ft and 0.4 ft, respectively). The **Simple** method can be used to create a pavement lift, for example. The upper-right point is constrained to the placement point by slope and horizontal constraints, while the two lower points are constrained to the points above them by horizontal and vertical constraints.

With the following options, you can either sketch in the points that you want, then edit or add constraints to determine the precise locations of each point, or you can use the key-ins available through the **Dynamic Settings**. See the previous section on [Dynamic Settings](#) for key in details.

- A component created with the **Constrained** command is initially made up of points where each is constrained to the previous one with horizontal and vertical constraints, so that if the initial point is moved, all of the other points move as well.
- A component created with the **Unconstrained** command consists of points with no constraints (the points can move independent of each other).

There are two specialized components:

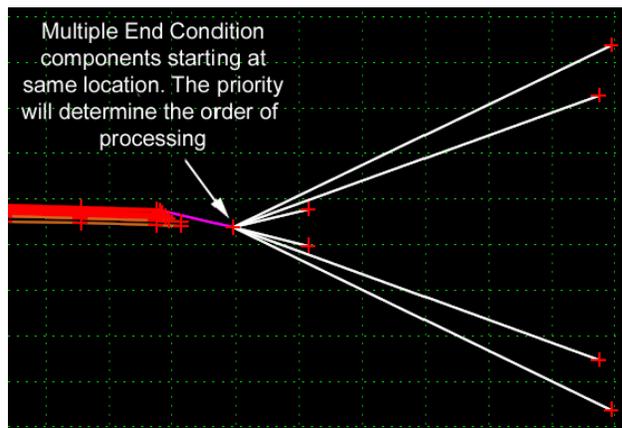
- A **Null Point** is a component made up of one point that is initially unconstrained. **Null Points** can be Parents for points in other components, in effect being used for reference. For example, a **Null Point** can be assigned to follow a right-of-way limit (alignment or feature) using **Point Controls** in **Roadway Designer**, then used as the horizontal constraint for a sideslope preventing it from exceeding the limit.



Another example is when the control point on a divided highway is the imaginary point where the two pavement sections would intercept in the middle, such as the **Control** point in the **HMA_Divided_TypeA_4Lane** CDOT template. In this case, the template is based off the **Control** point, but the point is not part of any of the components.

Note: **Null Points**, by definition, are *not* triangulated. They may, however, be added to the design surface as non-triangulated features when using the **Create Surface** command. See the [Roadway Modeling](#) Chapter for additional details.

- **End conditions** are components that can seek targets like surfaces, alignments or features, and typically form the sideslopes of the design.



Multiple end conditions may be used together to form a complete sideslope and multiple sideslopes or alternates may begin at the same location on the template. When this occurs, the end conditions are assigned a priority determining the order in which they are processed with the first one able to form a complete sideslope being the one that is used at that location while any other sideslopes are discarded. [CDOT End Conditions](#) are discussed in the following section.

Typical CDOT Surfacing Component

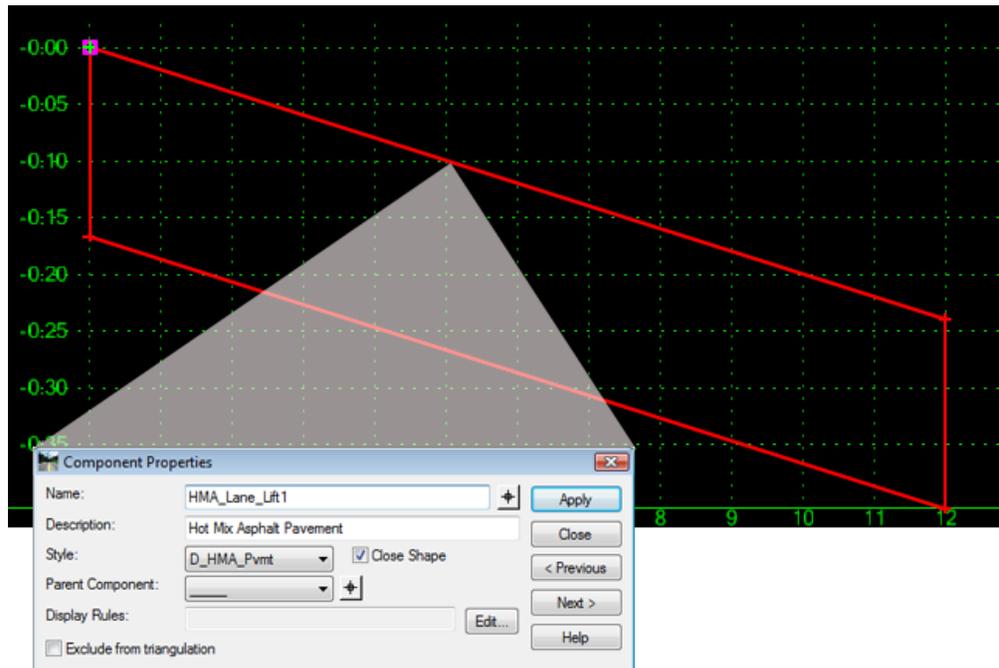
The average surfacing component is a closed shape of four points. It defines a single layer of a specific material (in this example it's hot mix asphalt). Both the points and the shape itself have a list of attributes called properties.

Component Properties

The following steps illustrate how to change component attributes. To edit the component properties:

1. <R> on a line of the shape and choose **Edit Component** from the menu (you can also <D><D> on the line to display the **Component Properties** dialog).
2. Key in the desired **Name**.
3. Key in the desired **Description**.
4. Select the desired **Style** from the drop down menu.
5. <D> **Apply** to accept the changes.

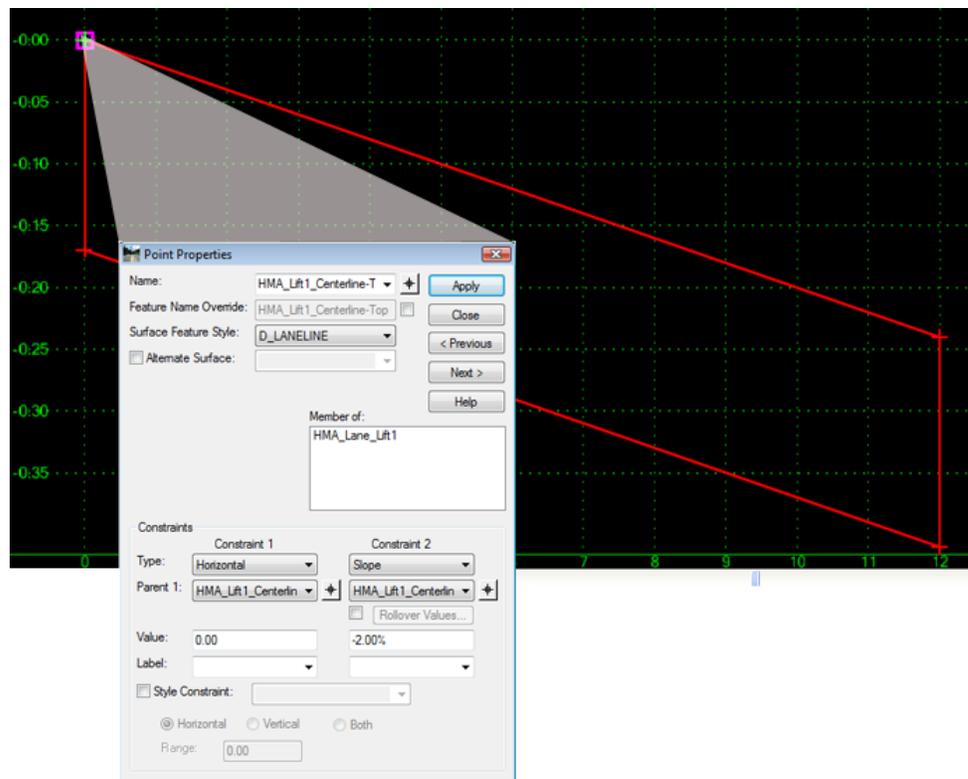
Note: Components use generic styles for the material they represent. Access styles for specific grades of material (based on the *Pay Item Code Book*) through the **Component Properties** dialog.



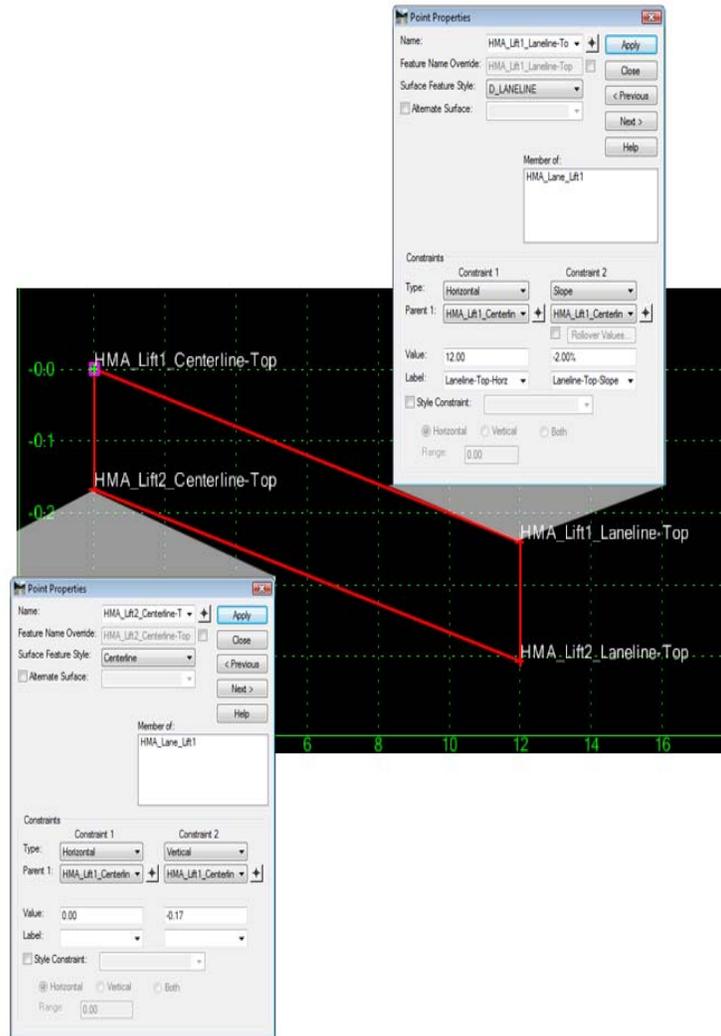
Point Properties

The following steps illustrate how to change point attributes.

1. <R> on the point and choose **Edit Point** from the menu to access the **Point Properties**. (You can also <D><D> on the Point to display the **Point Properties** dialog.)
2. Key in the desired **Name**. The name can also be selected from the drop down menu. Selecting a name from the menu also changes the **Surface Feature Style**. Names selected from the menu can then be edited if necessary.
3. Select the desired **Surface Feature Style**.
4. Select a **Type** for **Constraint 1**. See the previous section on constraints for additional information on the options available.
5. Select a **Parent 1** using the drop down menu or the target button. Select the **Parent 2** if required by the constraint type.
6. Key in a **Value**.
7. Key in a **Label** if desired. See the previous section on **Labels** for more information.
8. <D> **Apply** to accept the change.
9. <D> **Close** to dismiss the **Point Properties** dialog.



Point properties for the example surfacing component:

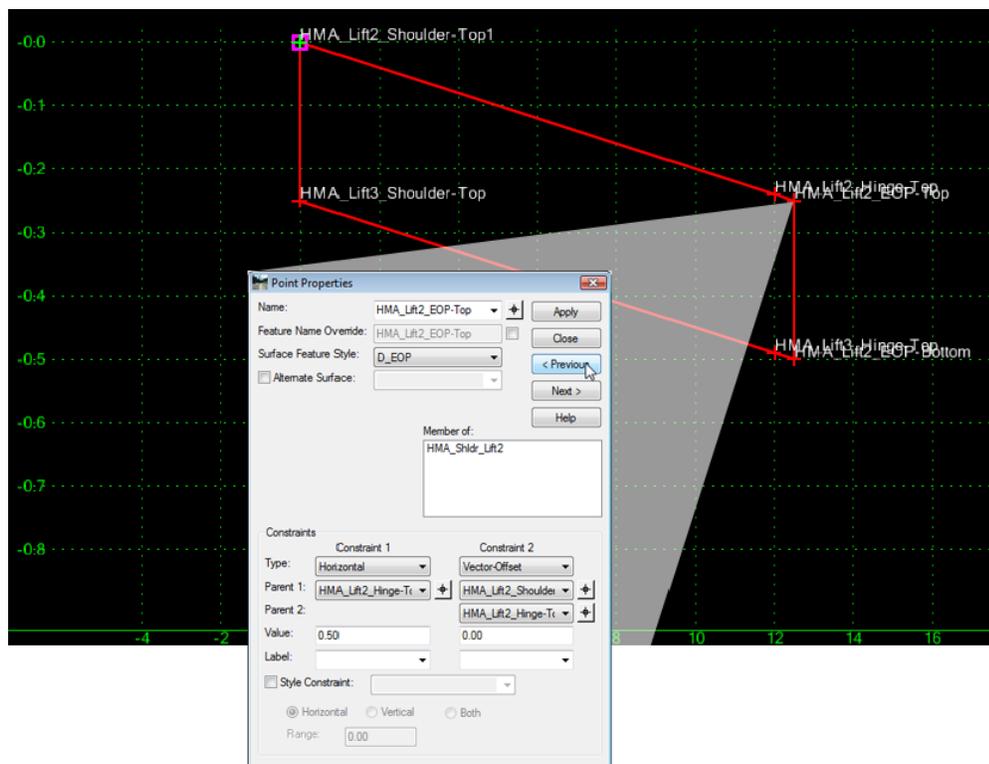


- ◆ The point ***HMA_Lift1_Laneline-Top*** has two constraints (which makes it fully constrained).
 - Constraint 1 is a ***Horizontal*** constraint measured from the point ***HMA_Lift1_Centerline-Top*** with a ***Value*** Of ***12***. This sets the width of the component.
 - Constraint 2 is also measured from ***HMA_Lift1_Centerline-Top***. It is a ***Slope*** constraint that defines the cross-slope of the component, which is set to a ***Value*** of ***-2.00%***. Horizontal and slope constraints are typically used when defining the top point of a component.
- ◆ The point ***HMA_Lift2_Centerline-Top*** also has two constraints.
 - Constraint 1 is a ***Horizontal*** constraint with a ***Value*** of ***0***, which places the point directly under its Parent 1 (***HMA_Lift1_Centerline-Top***).

- Constraint 2 has a **Value** of **0.17** (2") that defines the thickness of the component (measured from its Parent 1 point, **HMA_Lift1_Centerline-Top**). The point **HMA_Lift2_Laneline-Top** has the same constraints as **HMA_Lift2_Centerline-Top**, except the Parent 1 is **HMA_Lift1_Laneline-Top** for both constraints.
- ◆ This configuration of point constraints is the most efficient set-up for pavement components. It allows the user to change the width of the component by controlling a single point (**HMA_Lift1_Laneline-Top**) while maintaining a constant pavement thickness.

Complex Surfacing Component

A variation of a typical surfacing component is **HMA_Outside_Shldr-Lift2**. This component has two additional points that define the stair-step found at the edge of asphalt.

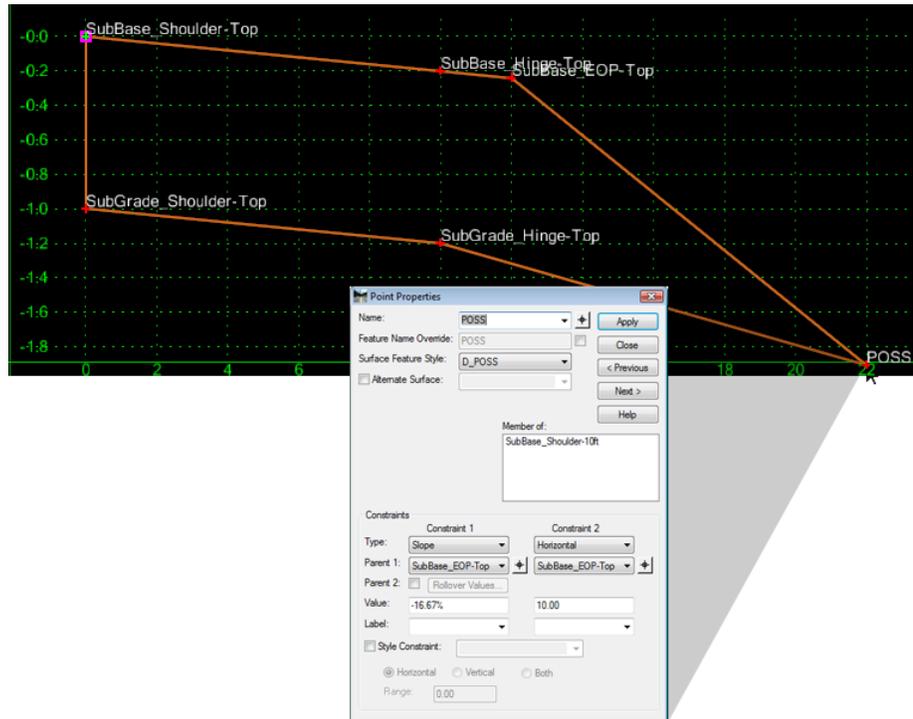


The three bottom points are defined in the same manner as a typical surfacing component for the point **HMA_Lift2_Laneline-Top**. Also, **HMA_Lift2_Hinge-Top** is defined like **HMA_Lift1_Laneline-Top** above. However, the constraints on point **HMA_Lift2_EOP-Top** are different. Constraint 2 uses **Vector-Offset**. This type of constraint projects a line through the two parent points (**HMA_Lift2_Shoulder-Top** and **HMA_Lift2_Hinge-Top**). The **Value** defines a perpendicular offset to that projected line (a positive value is to the right and a negative value is to the left). Because the value in this example is '0', the child point is placed on the projected line.

This constraint forces the segment between points **HMA_Lift2_Hinge-Top** and **HMA_Lift2_EOP-Top** to match the cross-slope of the segment to its left and maintain the continuity of the cross-slope, even through transitions for super elevation.

Subbase component

Subbase components have many of the same features used in surfacing components. The **SubBase_Outside_Shoulder** component has five points that define the subbase under the shoulder. They are set up like the corresponding points in **Surfacing Example 2**. However, the **POSS** uses a **Horizontal** and a **Slope** constraint. This is done in order to maintain the slope from the **Subbase_EOP-Top** to the **POSS**.

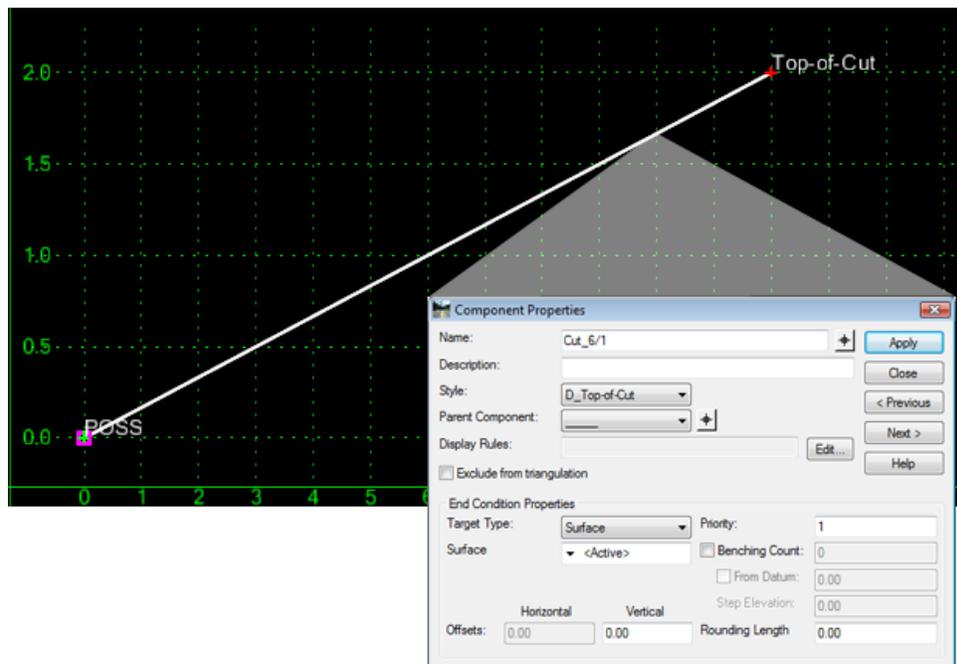


End Condition components

End condition components are used to form the sideslopes of the design. For example, they project from the design pavement to the existing ground. Therefore, they have some unique component and point properties.

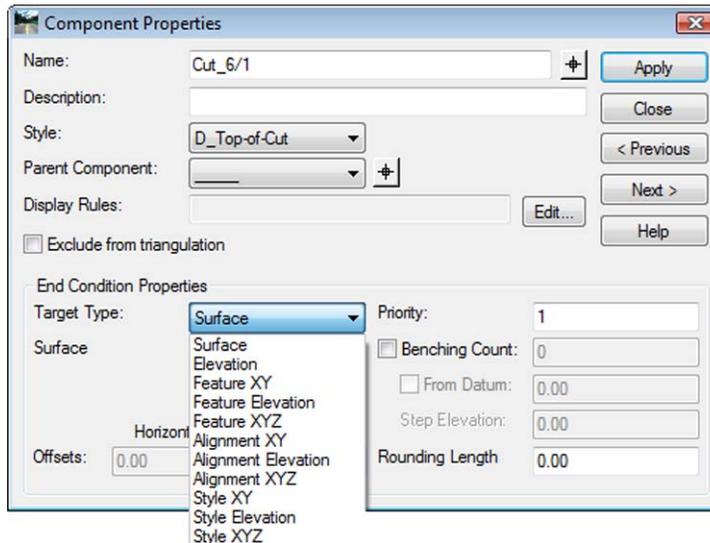
Component Properties

The component properties for End Conditions have an additional area for **End Condition Properties**. These properties list the **Target Type** and **Priority** for processing end condition components.



Target Type

This property determines what the end condition will try to intercept. The **Target Type** affects the way the side slope is constructed. **Feature XYZ**, **Alignment XYZ**, and **Style XYZ** will override the slope constraint and use whatever slope is necessary to tie to the target location. All other **Target Types** observe the slope constraint to locate the point.



Additional drop down menus are displayed below the **Target Type**. These are used to list the target of the type specified in the **Target Type**.

The information required for each **Target Type** is:

- ◆ **Surface** – Set to **Active** (which will tie to whatever surface is active) or to a specific surface. Surface is the most common **Target Type** and used by most CDOT standard sideslopes.
- ◆ **Elevation** – Enter the target elevation in the **Vertical Offset** field. This can be useful for setting elevations of benches, for example.
- ◆ **Feature XY**, **Feature Elevation**, and **Feature XYZ** – Identify a surface (**Active** can be used) and the **Feature Name** that you want to seek. For example, you may need to tie into an existing curb or an existing ditch feature.
- ◆ **Alignment XY**, **Alignment Elevation**, and **Alignment XYZ** – All must have a horizontal alignment specified. **Alignment Elevation** and **Alignment XYZ** also need the Vertical Alignment identified. For example, **Alignment Elevation** can be used to tie a special ditch into the elevation of a vertical alignment.
- ◆ **Style XY**, **Style Elevation**, and **Style XYZ** – Specify a **Style**. These targets work just like the previous Feature and Alignment targets, except the sideslope looks for a **Style** used in the **active surface** or **geometry project** instead of a *specific* feature or alignment listed by name. For example, if you are wanting to tie into an existing curb, but the curb is made up of multiple features, you can tie into the style for the curb and the sideslope finds the first occurrence at each template drop.

Note: The most often used Target Type is **Surface**.

Priority

- ◆ This property determines the order in which end condition components are processed. The processing order is from the lowest numbered priority to the highest. The flattest slopes are set to the lowest numbered priority so that they are processed first. If you do not set the priorities ahead of time, they can be set when the end conditions are tested.

Point Properties

For points that are part of an end condition, four additional check boxes for **End Condition Properties** are added to the **Point Properties**.

- ◆ **Check for Interception** - If on, the point checks for an interception of the target between the previous point and this one. In general, turn this option on for the last point in a cut or fill definition. An example of where it would be turned off is for the foreslope of a ditch that has a flat bottom.
- ◆ **Place Point at Interception** - When on, the point will be constructed where it contacts the target. When off, the point is constructed as defined by its constraints. Turn on this option in most cases when **Check for Interception** is on.
- ◆ **End Condition is Infinite** - When on, the point will extend past its defined width in order to contact its target. When off the point must reach its target within its defined width in order to be constructed. This option is used for the steepest cut and fill slope defined in the template. Since it is off for shallower sideslopes, they will not extend beyond their constrained horizontal distance.
- ◆ **Do Not Construct** - When on, the point will be solved for as normal, but will not be used when creating the component.

Display Rules and Parent Components

Display Rules and **Parent Components** are component properties that determine when a component is displayed. They are often useful for turning off and on different components based on what is happening in other areas of the template and therefore can be used to assist in changing the template based on certain CDOT design decisions.

Display Rules are conditional expressions defined by horizontal or vertical offsets between specified points, the slope between two points, or the display of another component. For example, when the distance between two inside edges in a divided template is $> X$, a median ditch component can be ‘turned on’; when it is $< X$, a barrier can be ‘turned on’ and the median ditch ‘turned off’.

A **Parent Component** controls the display of associated components. For example, a specific component is displayed *only* when its Parent component is displayed.

- Use **Display Rules** to change the basic shape or type of a component used under certain conditions, as in the [Curb & Gutter through superelevation](#) example below.
- Use **Display Rules** to have InRoads decide between a series of components, such as testing the height of wall needed and using different, but standard width bases based on that height, as in the [Wing Wall](#) example below.
- Use **Parent** components for a group of components that operate as a unit and are turned on or off together, as illustrated in the [Benching](#) example.

Curb & Gutter through superelevation

An example of a design decision being built into a template can be found in the CDOT typical section library in the curb and gutter sections. The Curb and Gutters are modeled with unique elements. The elements unique to the Curb and Gutter section are the two curb components attached; one component is modeled with a standard cross slope for the gutter pan and the other is modeled to match the cross slope of the pavement. If this is not desired, see the note at the end of the section on changing or eliminating this decision.

The assumed design decision is:

- When the cross slope is between +4% and - 4%, a -1” per foot slope is used for the gutter.
- When the cross slope is greater than +4% or less than - 4%, the slope of the gutter pan matches the cross slope of the driving lanes.

Conforming to the design standard or design decision in this case is accomplished using **Display Rules**. Display Rules are a list of criteria that determine when a particular component is displayed. The **Parent Component** property is also used. Components that are associated with a Parent component are only displayed when the Parent Component is displayed. In this example the curb components are parents to the ABC components. This insures that the proper ABC components are displayed together with their respective curb components. This is necessary due to the different slope constraints of the two components described in the previous section.

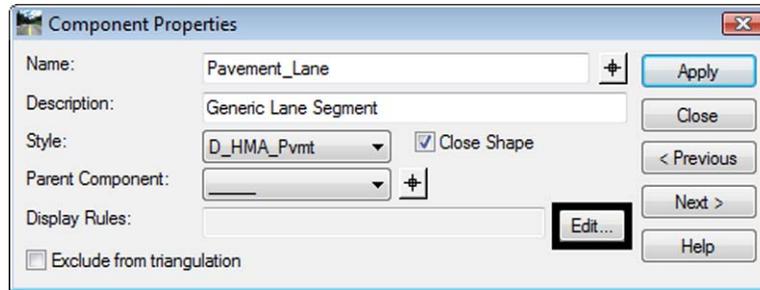
In this example, using the component **C/G_Type2-IIB**, the slope of the gutter pan changes based on the cross slope of the driving lanes (typically needed through superelevated areas). This would be extremely difficult to modify the component using point controls. However this can be accomplished easily using **Display Rules**.

To create a **Display Rule**:

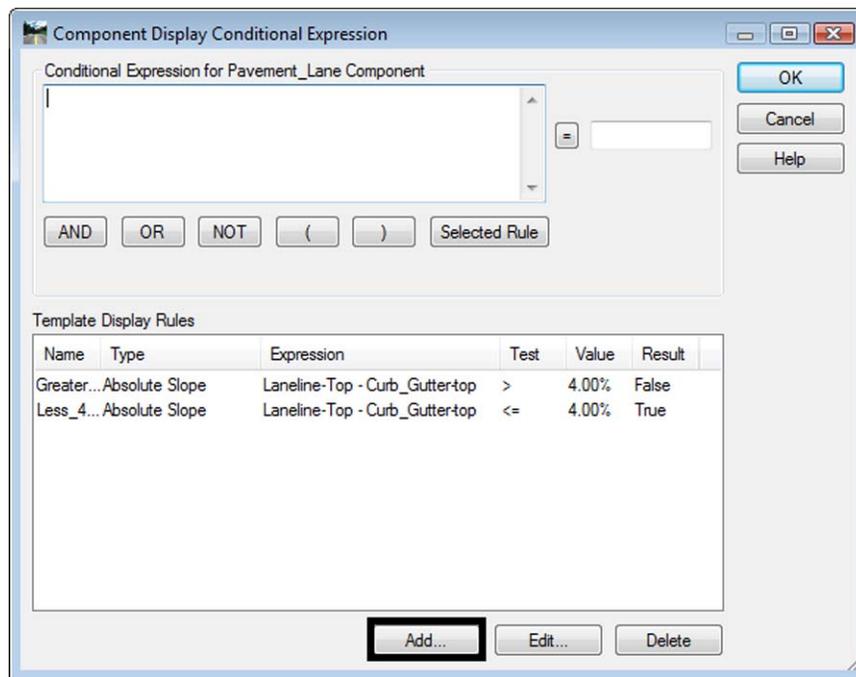
1. <R> on the component and select **Edit Component**.

Note: **Display Rules** can be created while editing any component in the template, then assigned to other components as necessary.

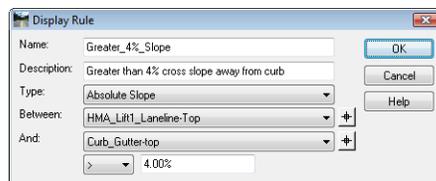
2. <D> the **Edit** button next to the **Display Rules** field. This displays the **Component Display Conditional Expression** dialog box.



3. To create a new rule, <D> **Add**. This will bring up the **Display Rule** dialog box.



Note: The **Template Display Rules** at the bottom of this dialog list all the rules available in the active template. The area at the top of the dialog show the rules assigned to the particular component being edited.

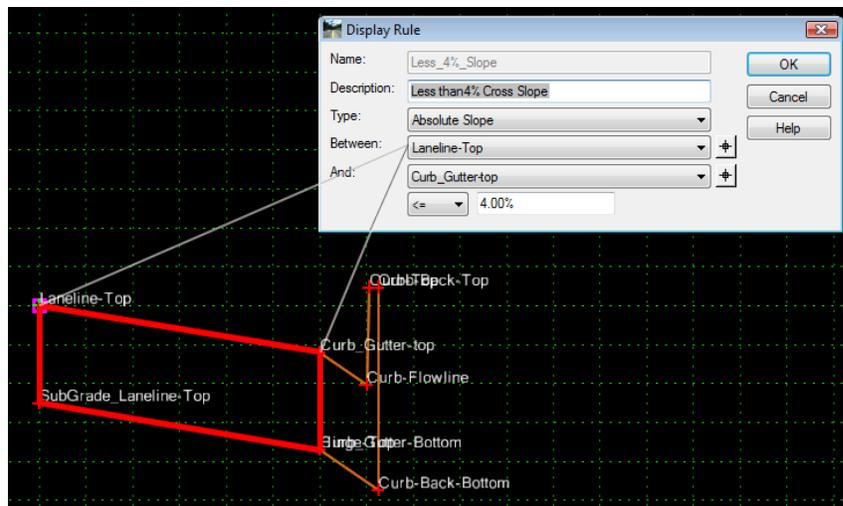


4. Key in a **Name** for the rule (spaces are removed from the name automatically).

Note: The **Display Rule** name cannot be changed in this dialog once it has been created. To change the name, go to the active template tree, right-click on the Display Rule and choose **Edit**.
5. Key in a **Description**.
6. Select the **Type** from the drop down menu. Select the component or point names as required. For the **Component Is Displayed** type, a component name is selected. For all other types, first and second points are selected.

Note: For a list of the different **Types** available and how they are used, see the **Display Rule** section of the [InRoads Online Help](#).

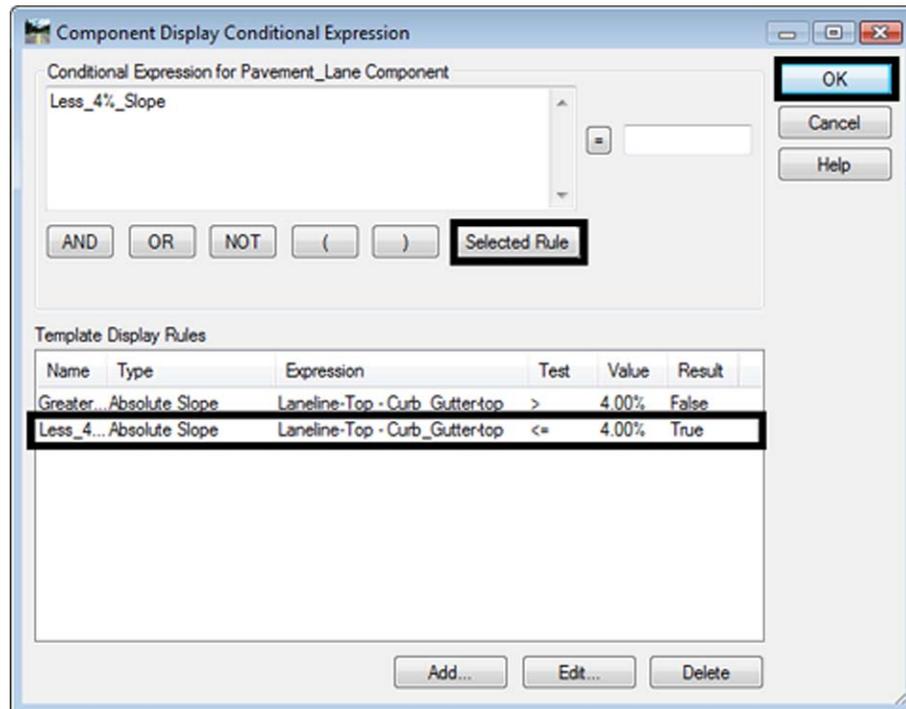
7. Select the mathematical expression to be used.
8. Key in the **Value** that the expression is tested against.
9. <D> **OK**. This dismisses the **Display Rule** dialog box.



In the rule displayed above, if the slope between point **Laneline-Top** and point **Curb-Gutter-top** is less than or equal to +4.00% or -4.00% (because **Absolute** Slope is used) then the component will be displayed. This is determined at every template drop during processing.

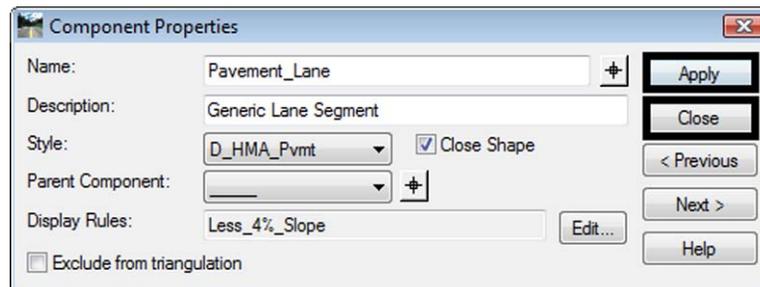
10. Back on the **Component Display Conditional Expression** dialog box, highlight the desired rule from the **Template Display Rules** list.
11. <D> the **Selected Rule** button. This adds the rule to the **Conditional Expression**.

12. <D> OK.



13. In the **Component Properties** dialog box, <D> Apply.

14. <D> Close to complete the process.



This component will now be displayed while the pavement component has a cross slope between +4% and -4%.

Important! If the decision is made that the gutter must match the pavement cross slope at a different slope, edit each of these rules and change the value to a different slope. If you do not want the match the pavement slope in super, edit the section, toggle on Display All Components and delete the two dashed-line components. Then, Delete the two Display Rules or remove them from the two components.

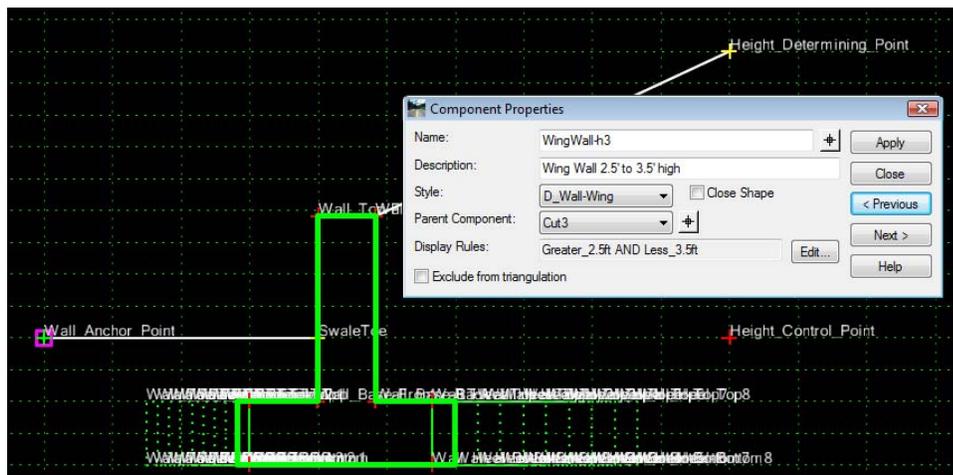
Wing walls

Multiple **Display Rules** can be used to further define when a component is to be displayed. In the component **WingWall_Cast-in-Place-Fixed-Base**, a number of separate components have been used to define the base of the wall. The particular component used is determined by the height of the wall. As in the previous example, this involves an assumed design decision and can be changed as needed.

The component **WingWall-h3** uses two Display Rules.

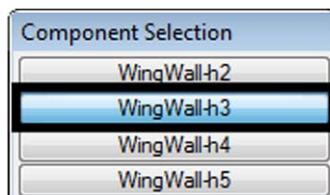
- **Greater_2.5ft**, displays the component if the vertical difference between points **Wall_Top-Front** and **Swale Toe** is greater than 2.5 feet.
- **Less_3.5ft**, displays the component if the difference between the points **Wall_Top-Front** and **Swale Toe** is less than or equal to 3.5 feet.

The **And** between the rules means that both rules must be true before the component can be displayed.



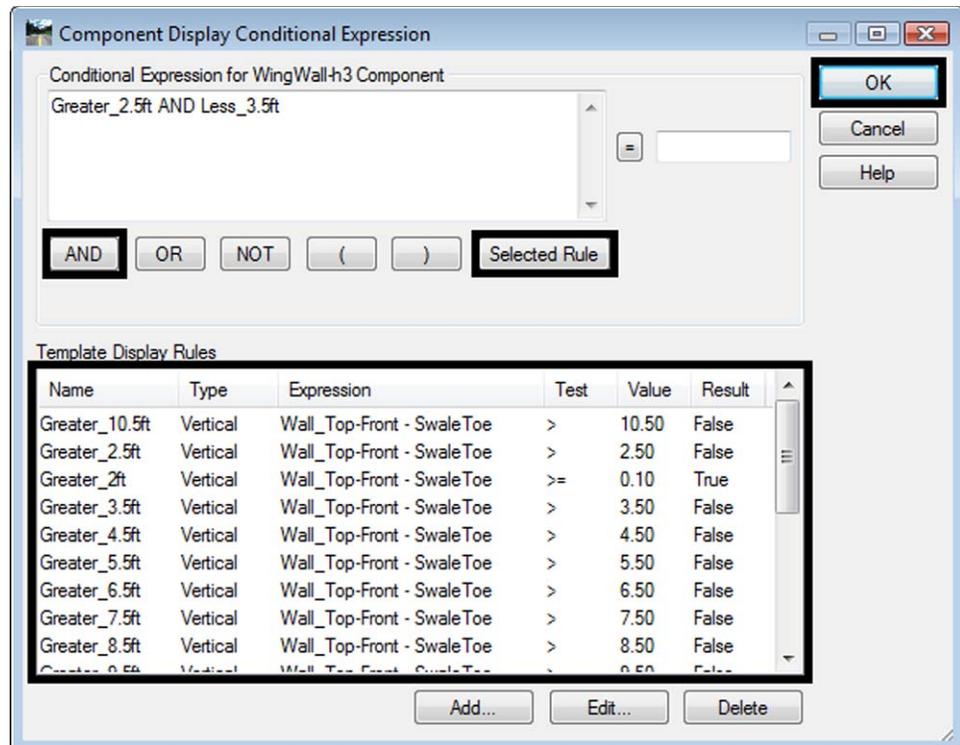
To add multiple display rules to a component:

1. <R> on the component and select **Edit Component**.
2. <D> the **WingWall-h3** component.



3. <D> the Edit button next to the **Display Rules** field. This displays the **Component Display Conditional Expression** dialog box.
4. Highlight the desired rule from the **Template Display Rules** (**Greater_2.5ft** in the example).
5. <D> the **Selected Rule** button.

6. <D> the desired **Boolean Operator** button (**AND** in the example).
7. Highlight the next display rule to be used (**Less_3.5ft** in the example).
8. <D> the **Selected Rule** button.
9. Repeat steps 5, 6, and 7 until all the desired rules are added.
10. <D> **OK**.



11. <D> **Apply** on the **Component Properties** to save the display rule.

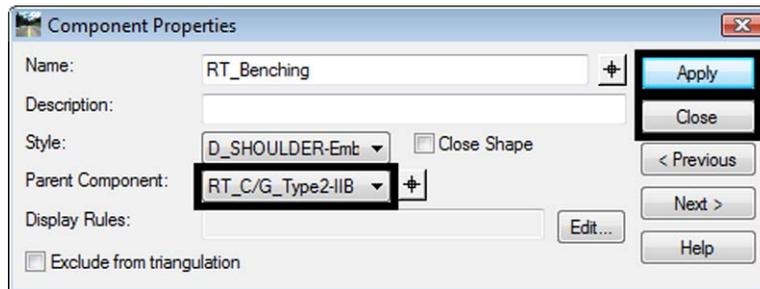
Note: Rules can also be grouped using the parentheses.

Benching

The display of one component can be tied to the display of another by setting a **Parent Component**. Using the **HMA_Urban_4Lane** template as an example, the Benching components are children of the **C/G_Type2-IIB** components (and the cut and fill components are children of the benching components). This displays the sideslopes attached to the curb with the 1” per foot gutter slope only when that curb is displayed. The parent component must exist within the template.

To select a parent component:

1. <R> on the ‘child’ component and select **Edit Component**.
2. Select the **Parent Component** using the drop down menu or the target button.
3. <D> **Apply** on the **Component Properties** dialog box to save the change.
4. <D> **Close** to dismiss the **Component Properties** dialog box.



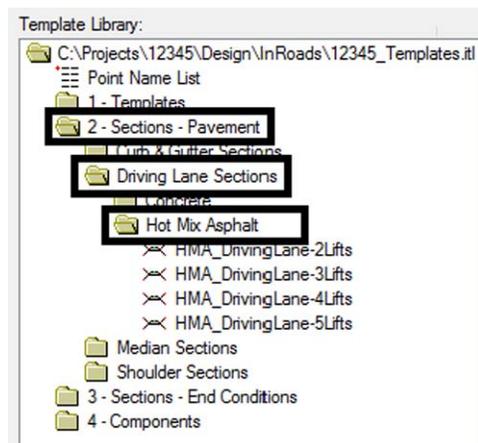
Sections

Components are used to build larger assemblies in the CDOT standard ITL called **Sections** (which are used in turn to build templates). A section is a combination of components that are copied from within the template library and pasted into the new section. Any time a group of components will be used more than once (in the same template or in other templates) it should be built as a section. Building sections makes it easier to assemble templates because multiple components are placed at one time.

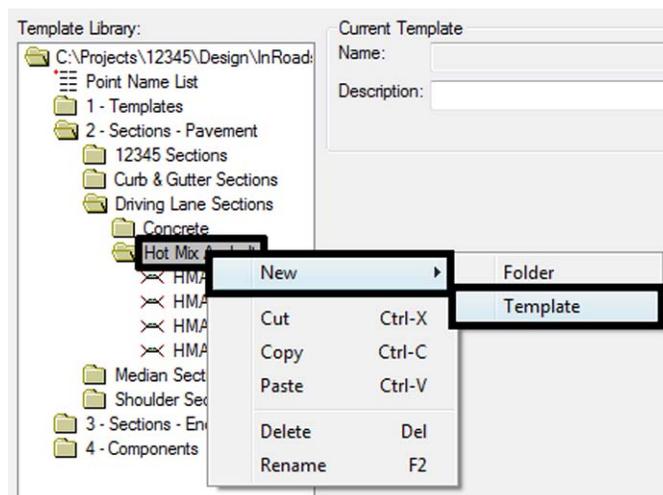
Using Components to Build a Section

This example illustrates the steps used to create an 11' driving lane section with three lifts of asphalt and an aggregate base.

1. Expand the template library folder structure to show **2 - Sections - Pavement > Driving Lane Sections > Hot Mix Asphalt**.



2. <R> on the **Hot Mix Asphalt** folder and select **New > Template** from the menu.

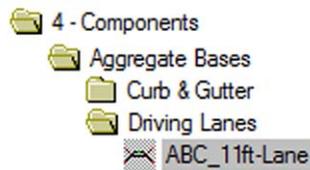


3. Key in the name for the new section (**HMA_11ft_DrivingLane-3Lifts** in this example).

- Expand the template library folder structure to show **4 – Components > Aggregate Bases > Driving Lanes**.



- Press **<R>** on **ABC_Lane** and select **Rename**.
- Key in the new name (**ABC_11ft-Lane** for this example).



- Press **<D> <D>** on the **ABC_11ft-Lane** component in the template library to make the **ABC_11ft-Lane** active.
- Press **<D> <D>** on the **ABC_Laneline-Top** point to edit the Point Properties.
- Change the **Value** of **Constraint 1** (the Horizontal constraint) to **11**.
- Press **<D> Apply**, then **<D> Close**.

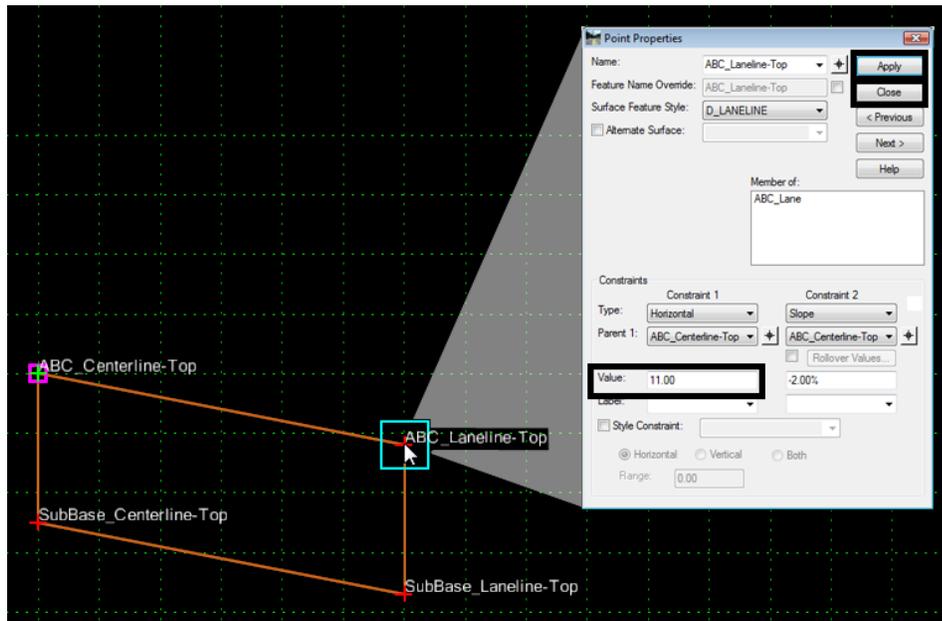
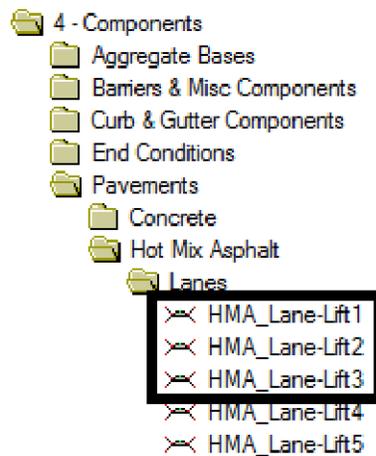


Figure 17: Set Horizontal Constraint

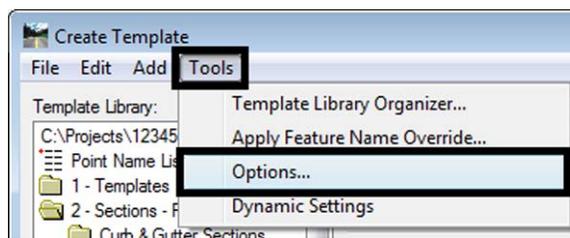
Note: To change the thickness of the component, edit the Vertical constraint on the two bottom points of the component.

The aggregate base component is ready for use. Next, modify the asphalt lane components.

11. Expand the template library folder structure to show **4 – Components > Pavements > Hot Mix Asphalt > Lanes**.
12. Repeat steps 5 through 10 above for **HMA_Lane-Lift1**, **HMA_Lane-Lift2**, and **HMA_Lane-Lift3**. Rename the lanes and change the value of Constraint 1 to 11.

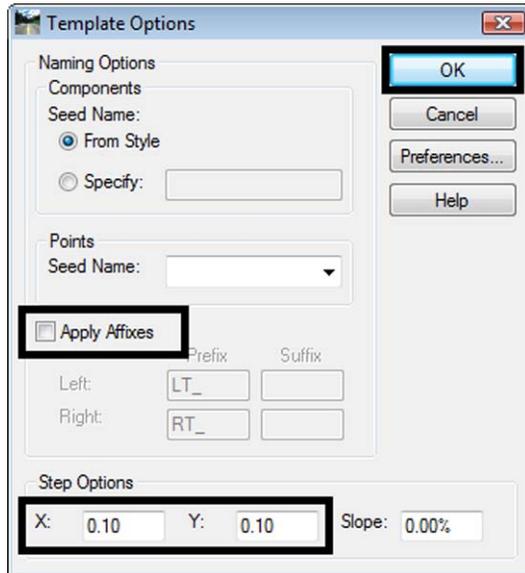


13. Select **Tools > Options** from the **Create Template** menu bar.



14. Turn off the **Apply Affixes** check box.
15. Set the Step Options to **0.1** for both **X** and **Y**.

16. <D> OK.



17. Select **Tools > Dynamic Settings**.

Steps 13 through 17 make it easier to place data into a new section. Turning off the affixes prevents getting LT_LT_ and RT_LT_, etc. appended to point names. The Step options create an invisible grid that helps when placing components. The Dynamic Settings is a dialog box where the step interval can be changed and precision key-ins can be used to place components.

The next steps place the components into the new section.

18. <D> <D> on the new section (**HMA_11ft_DrivingLane-3Lifts**).

19. <D> on the HMA_11ft- Lane-Lift1. This will display the component in the **Preview** window.

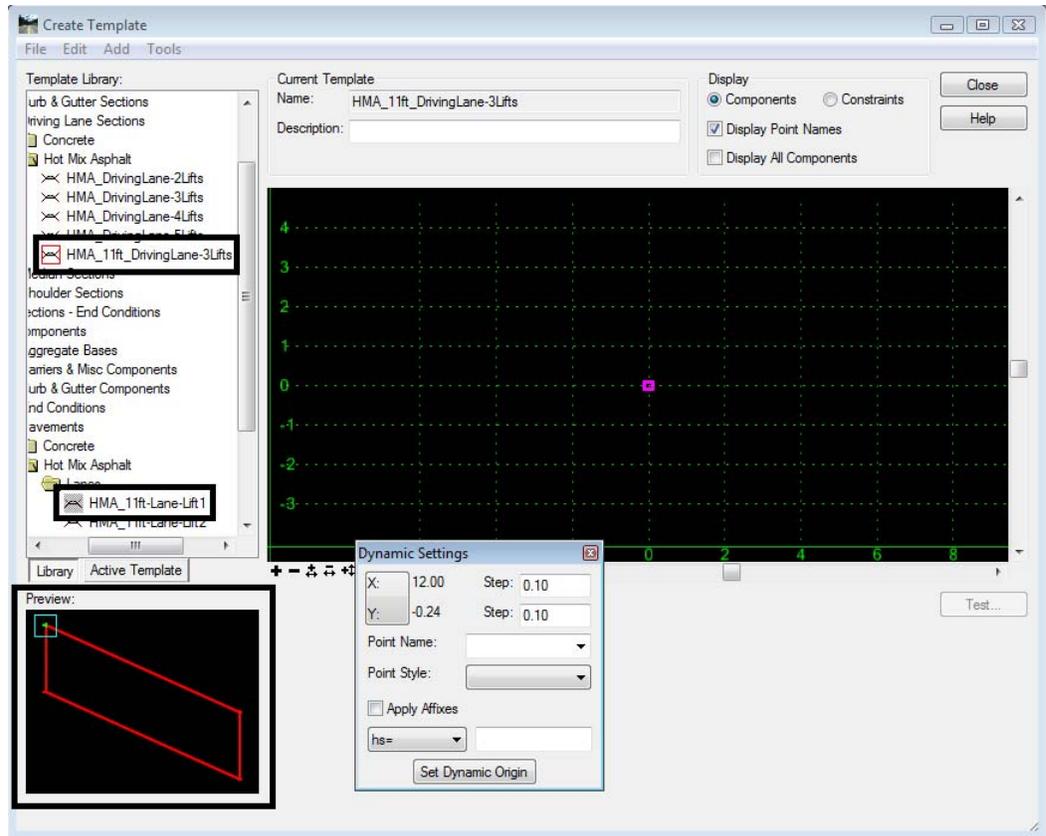
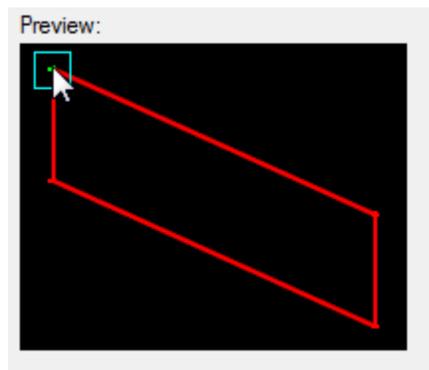


Figure 18: HMA_11ft-Lane-Lift1 Component

20. <D> and hold on the green "+" in the **Preview** window.



21. Move the pointer into the magenta square in the **Template View Window**. The **Dynamic Settings** dialog box will show “**0.00**” for **X** and **Y** when the pointer is on the template origin.

Important! This assumes the magenta square is located at the 0,0 coordinate in the template view. If it is not, you can use **Set Dynamic Origin** to move it there, or make certain you drop the template on the 0,0 coordinate. You can also right-click on the insertion point after it’s dropped and choose **Set Template Origin** to move it to 0,0.

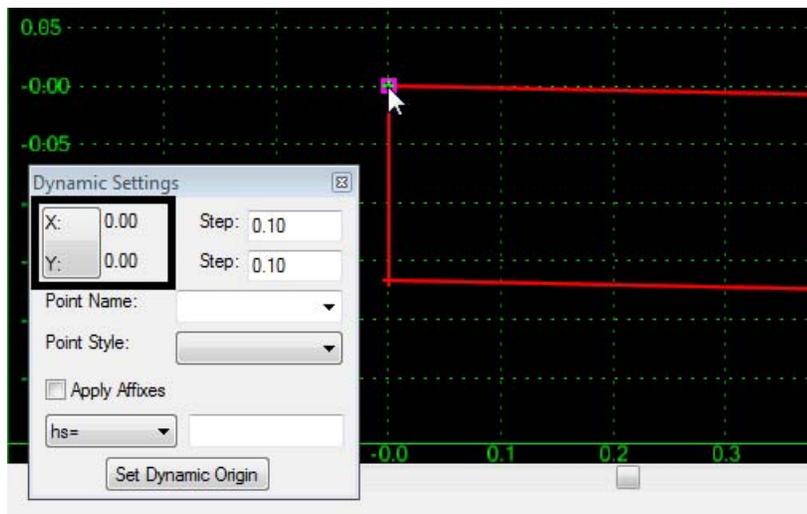


Figure 19: Place First Component

22. Release the left mouse button to place the component.
23. <D> on the HMA_11ft- Lane-Lift2. This will display the component in the **Preview** window
24. <D> and hold on the green”+” in the **Preview** window.

25. Move the pointer onto the **HMA_Lift2_Centerline-Top** point. The “+” turns white to indicate that the points are in the same location.

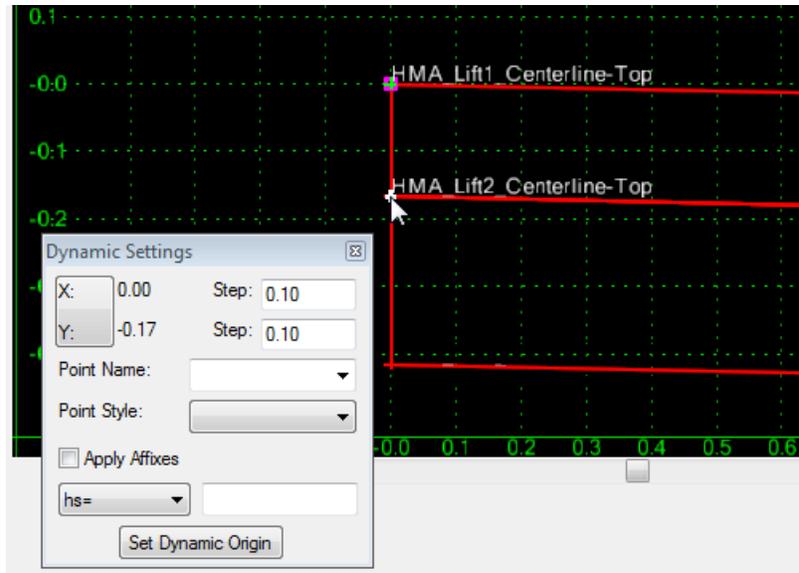


Figure 20: Place Second Component

26. Release the left mouse button to place the component.
27. Repeat steps 23 through 26 for **HMA_11ft- Lane-Lift3** and **ABC_11ft-Lane**.
28. All of the components that make up the section are now placed. However, the point names used between lift 3 and the ABC need to be changed. When components are connected, shared points take the point name of the component placed first.
29. <D> <D> on the point **HMA_Lift4_Centerline-Top** to display the **Point Properties** dialog box.
30. Use the **Name** drop down menu to select **ABC_Centerline-Top**.
31. <D> **Apply**.
32. <D> **Close** to dismiss the **Point Properties** dialog box.

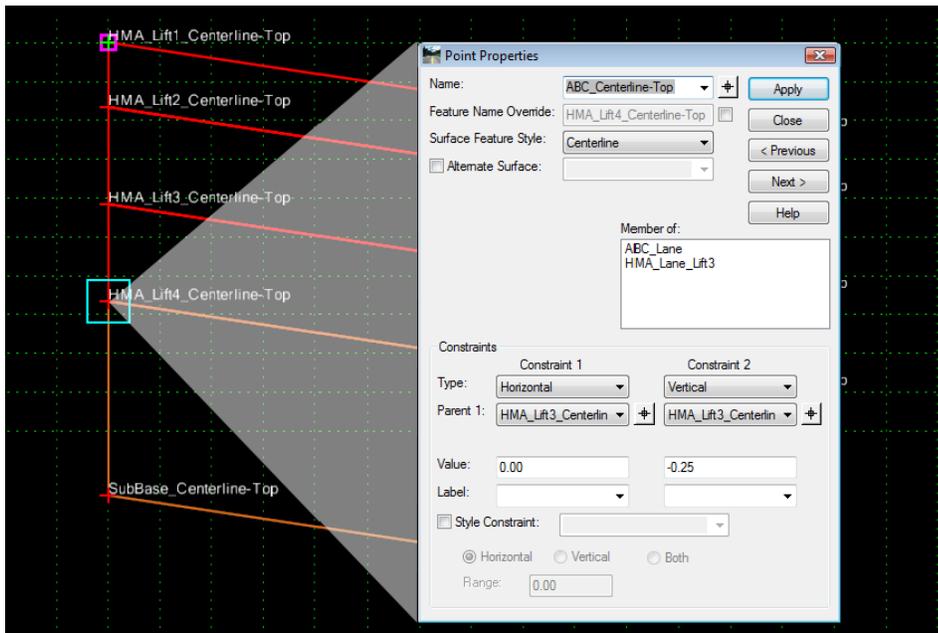


Figure 21: Change Point Properties

33. <D> <D> on HMA_Lift4_Laneline-Top to display the **Point Properties** dialog box.

34. Use the **Name** drop down menu to select ABC_Laneline-Top.

The section is now ready for use in a template.

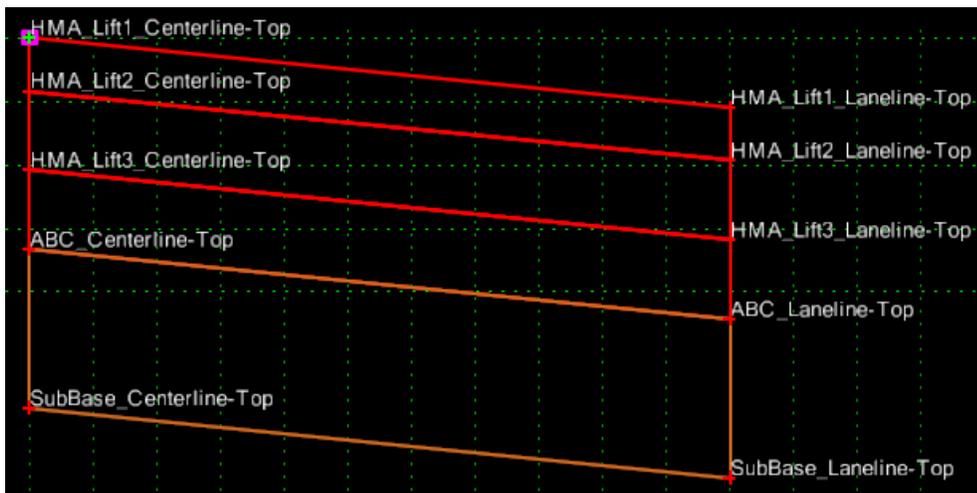


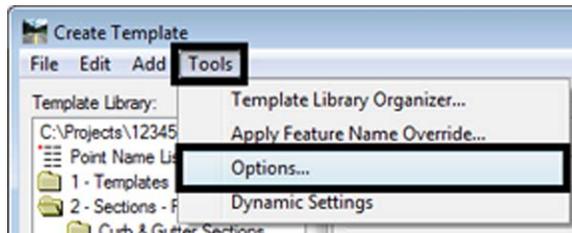
Figure 22: Final HMA_11ft_DrivingLane-3Lifts

Templates

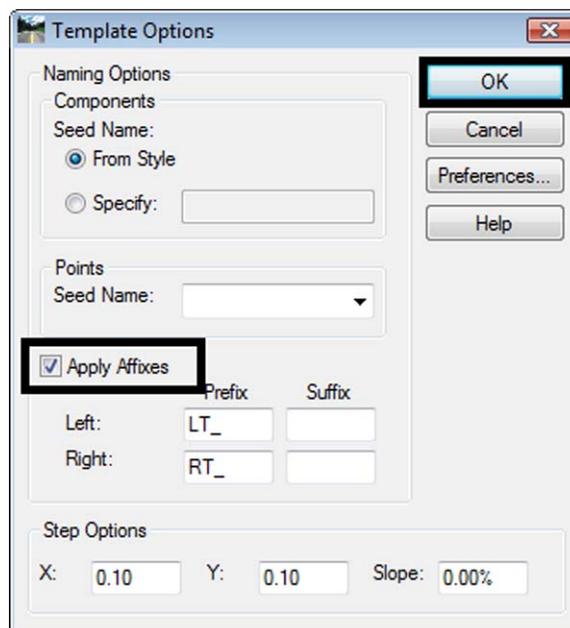
Building a symmetrical template

This example uses the lane section created above along with modified shoulder sections and end conditions to create a complete two lane template.

Select **Tools > Options** from the **Create Template** menu bar.



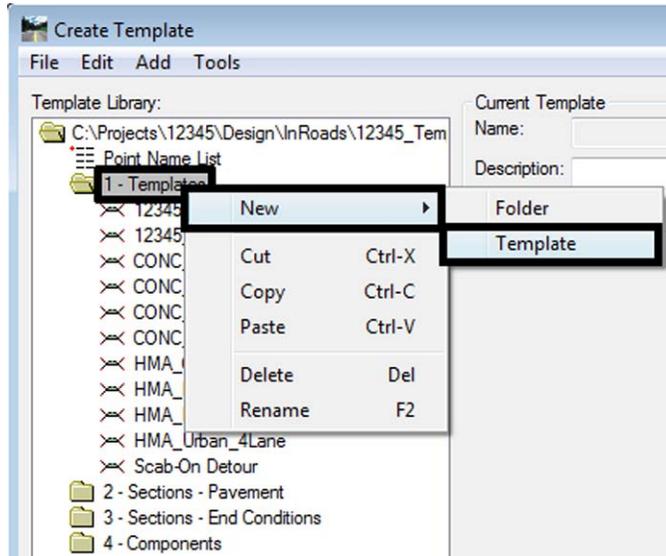
1. Turn on the **Apply Affixes** check box.
2. <D> OK.



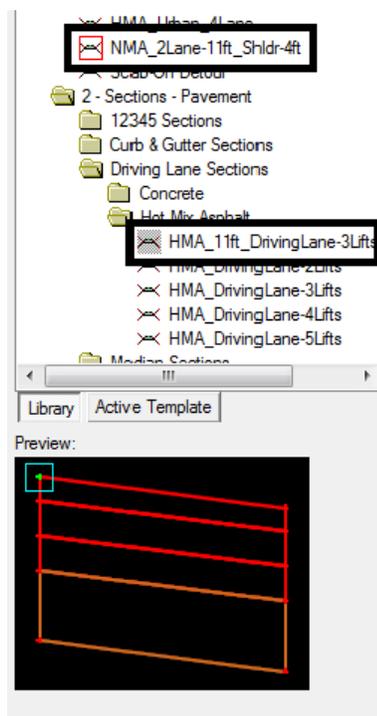
When **Sections** and **Components** are placed, the point names are appended with **LT_** and **RT_**. This will replace the default 1, 2, etc. that is affixed to duplicate point names.

3. Expand the template library folder structure to show **1 – Templates**.

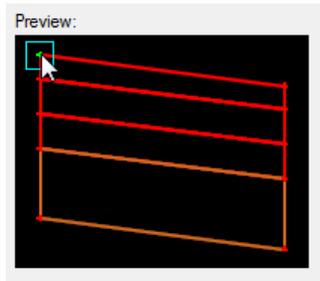
4. <R> on the 1- Templates and select **New > Template**.



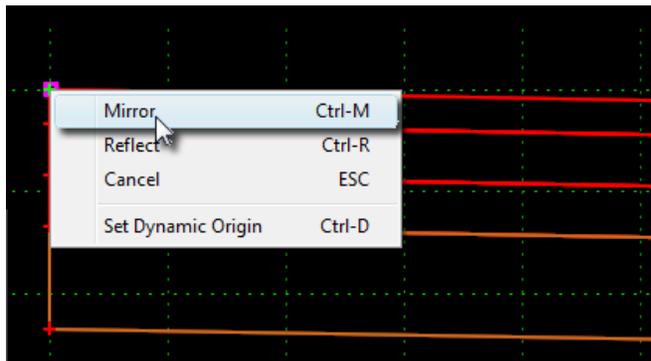
5. Key in a **Name** for the template (*HMA_2Lane-11ft_Shldr-4ft*).
6. <D> <D> on HMA_2Lane-11ft_Shldr-4ft. This makes the new template active.
7. Expand the template library folder structure to show **2 - Sections - Pavements > Driving Lane Sections > Hot Mix Asphalt**.
8. <D> on the HMA_11ft_DrivingLane-3Lifts section so that it is displayed in the **Preview** window.



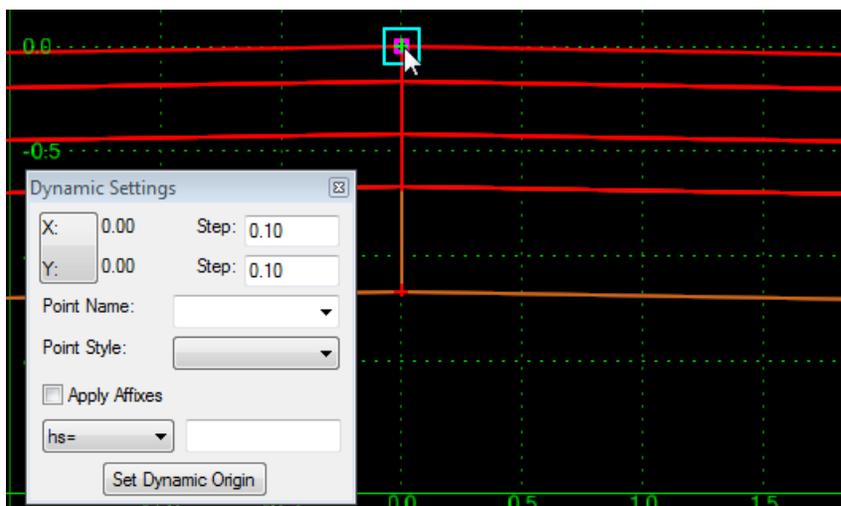
9. In the **Preview** window, <D> and hold the green “+”.



10. Move the pointer into the **Template View** window and <R> while still holding the left mouse button. This displays a right click menu. When the right click menu is displayed, the left mouse button can be released.
11. Select **Mirror** (using either the left or right mouse button).



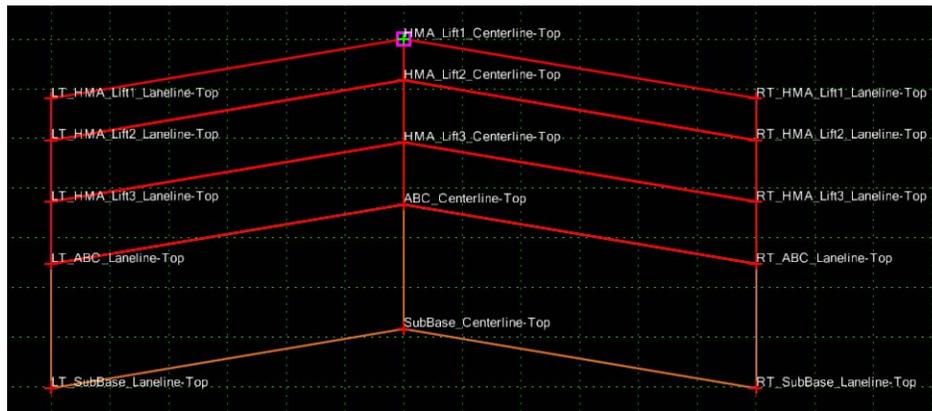
12. Move the pointer to the template origin (magenta square). The **Dynamic Settings** dialog box will show “0.00” for X and Y when the pointer is on the template origin.



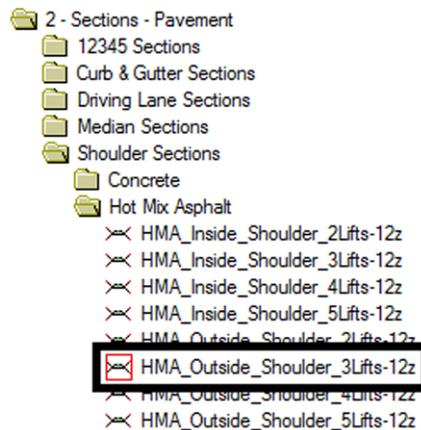
Important! This assumes the magenta square is located at the 0,0 coordinate in the template view. If it is not, you can use **Set Dynamic Origin** to move it there, or make certain you drop the template on the 0,0 coordinate. You can also right-click on the insertion point after it's dropped and choose **Set Template Origin** to move it to 0,0.

13. <D> to place the sections.

By selecting **Mirror** from the right click menu, both the left and right driving lanes were placed at the same time. Turning on the **Affixes** labeled the left side points with the **LT_** prefix and the right side points with the **RT_** prefix.



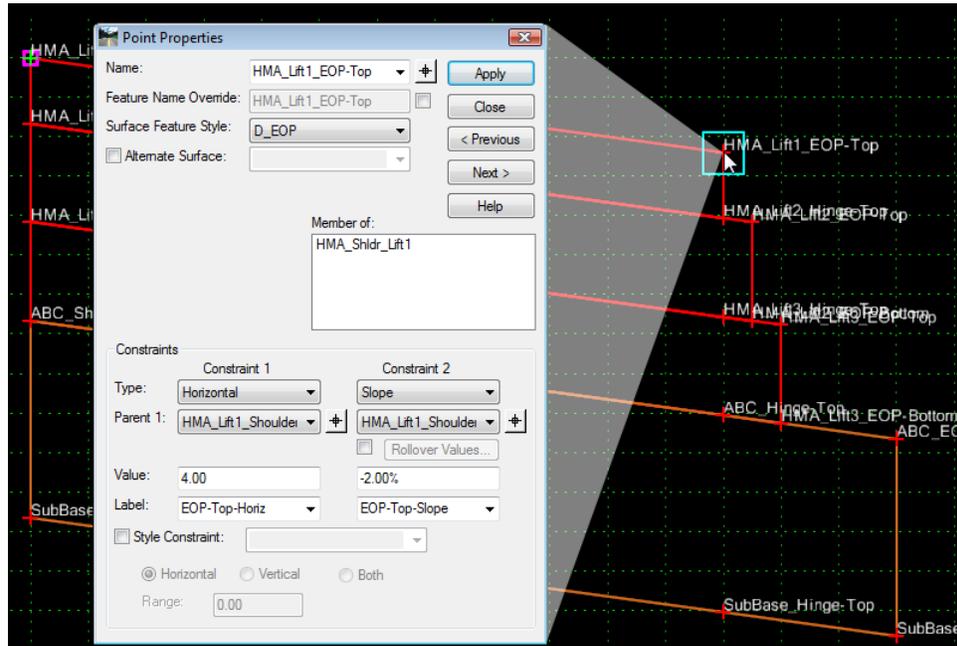
14. Expand the template library folder structure to show **2 - Sections - Pavements > Shoulder Sections > Hot Mix Asphalt**.
15. <D> <D> on the **HMA_Outside_Shoulder_3Lifts-12z**. The section is displayed in the window.



This section models a shoulder to match the pavement section as well as the proper edge of pavement configuration. However, the 12 foot width must be reduced to 4 feet.

16. <D> <D> on the point **HMA_Lift1_EOP-Top** to display the **Point Properties** dialog box.
17. Change the **Value** of **Constraint 1** (the Horizontal constraint) to **4.00**.
18. <D> **Apply**.

19. <D> Close.

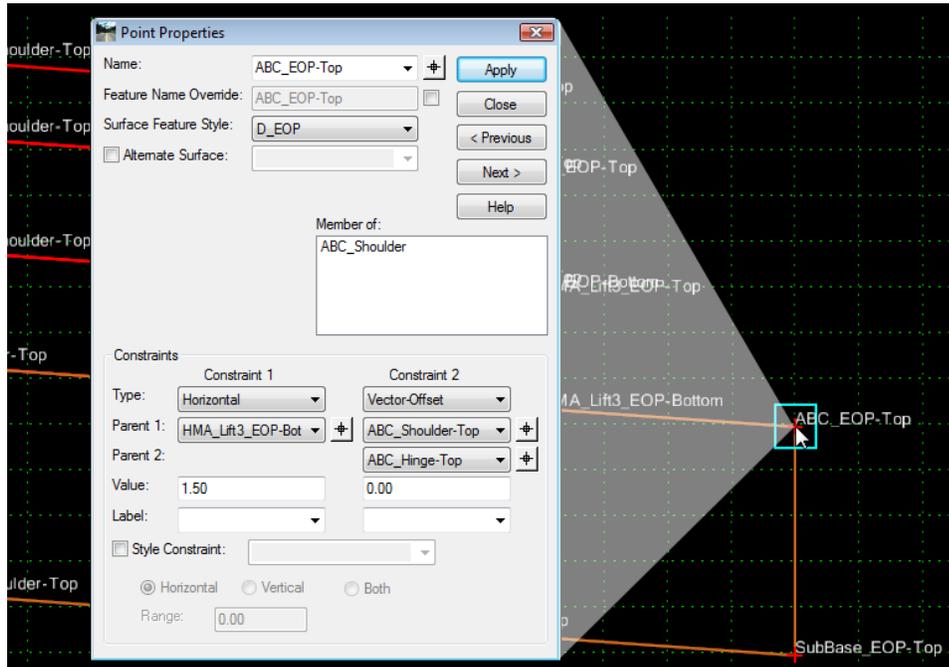


Notice that by changing a single point (**HMA_Lift1_EOP-Top**), all of the lifts in the section were modified.

The width of the ABC lift must be modified, otherwise, it will protrude above the finished grade of the side slope.

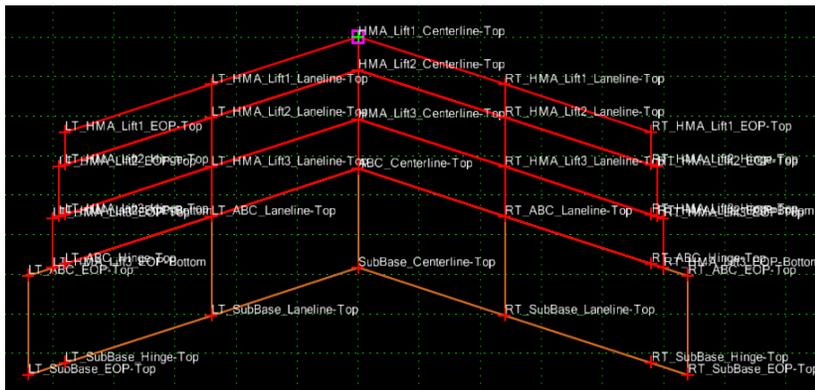
20. <D> <D> on the point **ABC_EOP-Top** to display the **Point Properties** dialog box.
21. Change the **Value** of **Constraint 1** (the Horizontal constraint) to **1.50**.
22. <D> **Apply**.

23. <D> Close.



Next, add the shoulders to the driving lanes.

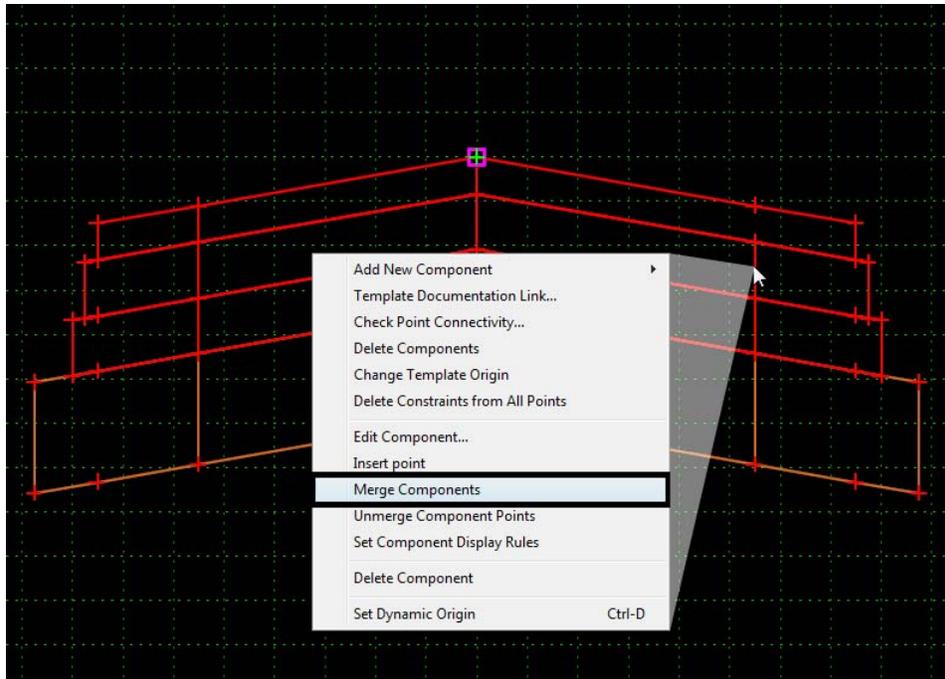
24. <D> <D> HMA_2Lane-11ft_Shldr-4ft.
25. <D> on the HMA_Outside_Shoulder_3Lifts-12z.
26. In the **Preview** window, <D> and hold on the green “+”.
27. Move the pointer onto the point RT_HMA_Lift1_Laneline-Top so that the “+” turns white then release the left mouse button.



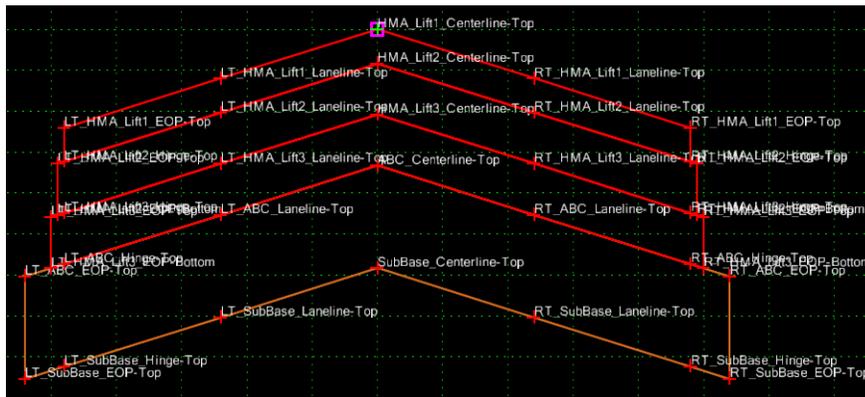
Note: Mirror is still on, so both shoulders are placed.

All of the components that make up the driving surface have been placed. Next, the vertical lines inside the template are removed. This will make each lift a single component.

28. Place the pointer on one of the vertical lines and <R> to display the right click menu.
29. Select **Merge Components**. This removes the vertical line from the template.



30. Repeat steps 25 and 26 for all of the vertical lines inside the template. The final result is illustrated below:

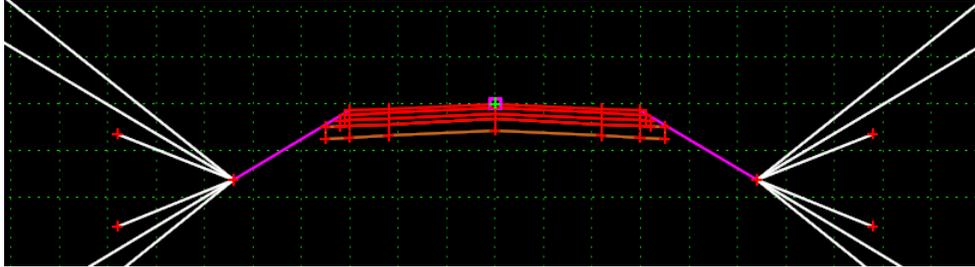


Finally, the end conditions are added to the template.

31. Expand the template library folder structure to show **3 – Sections – End Conditions > Z-Slope End Conditions > Low Speed End Conditions**.
32. <D> on the **Z12_4_to_1** section.
33. In the **Preview** window, <D> and hold on the green “+”.

34. Move the pointer onto the point **RT_HMA_Lift1_EOP-Top** so that the “+” turns white then release the left mouse button.

Both end conditions are placed and the template is complete.



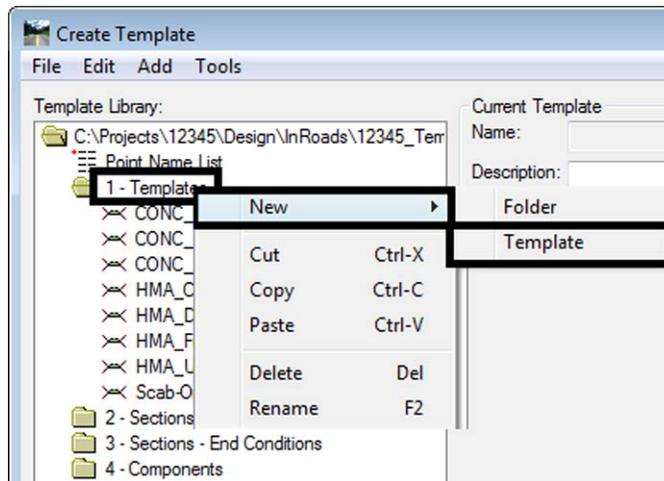
Note: The vertical lines that appear inside the template in the illustration above are actually the point symbols. The points themselves are not connected vertically since the components were merged.

Building an Asymmetrical Template

This example builds one half of a divided highway. It has two 12' driving lanes, a 4' shoulder on the right and a 10' shoulder on the left. The pavement is 12" concrete.

Start by creating an empty template.

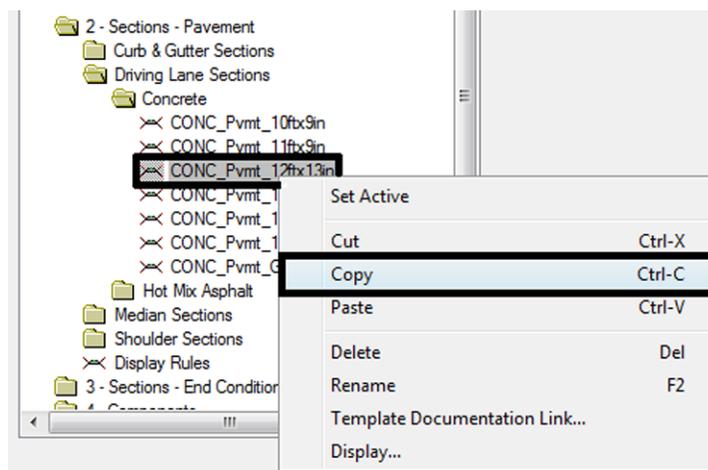
1. Expand the template library folder structure to show **1 – Templates**.
2. <R> on the **1- Templates** folder and select **New > Template**.



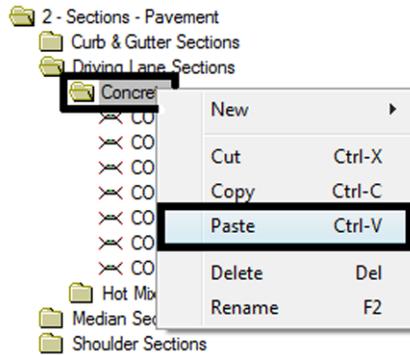
3. Key in a name for the template (**CONC_Divided_4Lane_Left-Side**).

Make a copy of a concrete pavement section and edit the copy to match the pavement design.

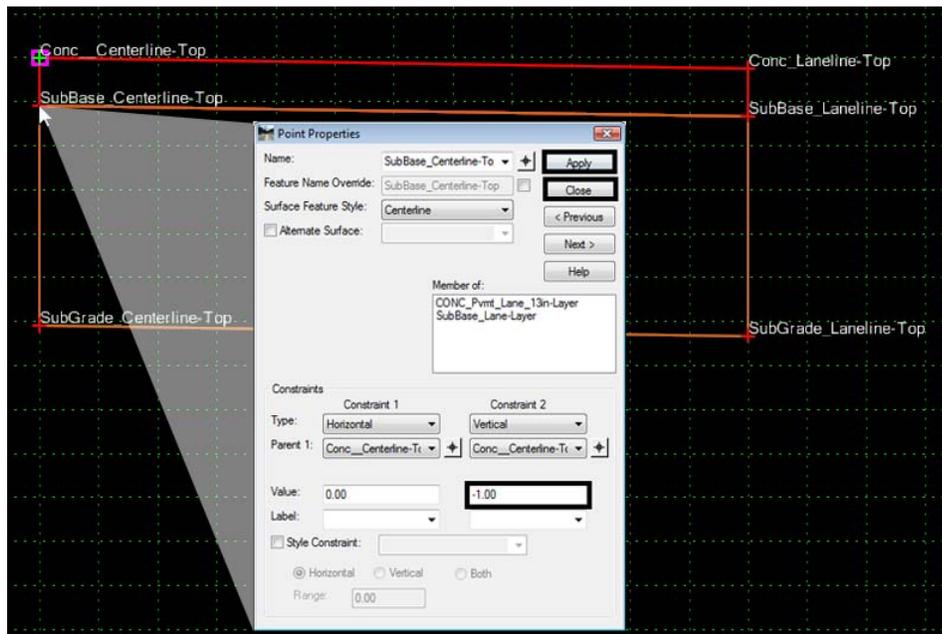
4. Expand the template library folder structure to show **2 – Sections - Pavements > Driving Lane Sections > Concrete**.
5. <R> on the **CONC_Pvmt_12ftx13in** section and select **Copy** from the right click menu.



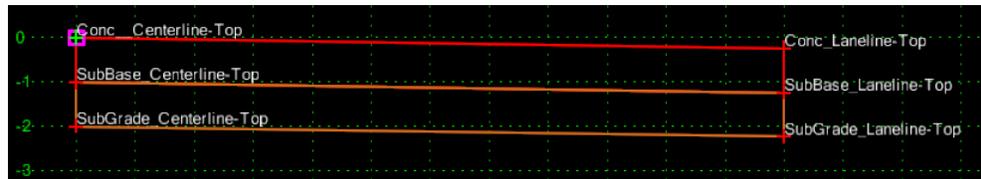
6. <R> on the **Concrete** folder and select **Paste** from the right click menu.



7. <R> on the **CONC_Pvmt_12ftx13in1** section (this is the copy created in steps 5 and 6) and select **Rename** from the right click menu.
8. Key in a new name (**CONC_Pvmt_12ftx12in**).
9. <D> <D> on the **CONC_Pvmt_12ftx12in** section.
10. <D> <D> on the **SubBase_Centerline-Top** point.
11. Change the **Value** for **Constraint 2** (the Vertical constraint) to **-1.00**.
12. <D> **Apply**.
13. <D> **Close**.

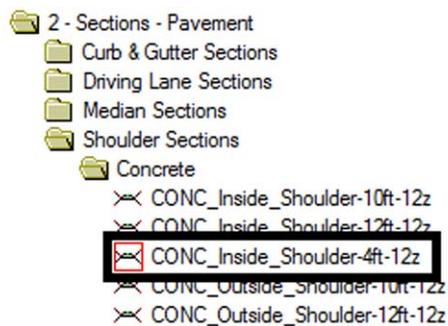


14. Repeat steps 10 through 13 for the point **SubBase_Laneline-Top**, **SubGrade_Centerline-Top**, and **SubGrade_Laneline-Top**.



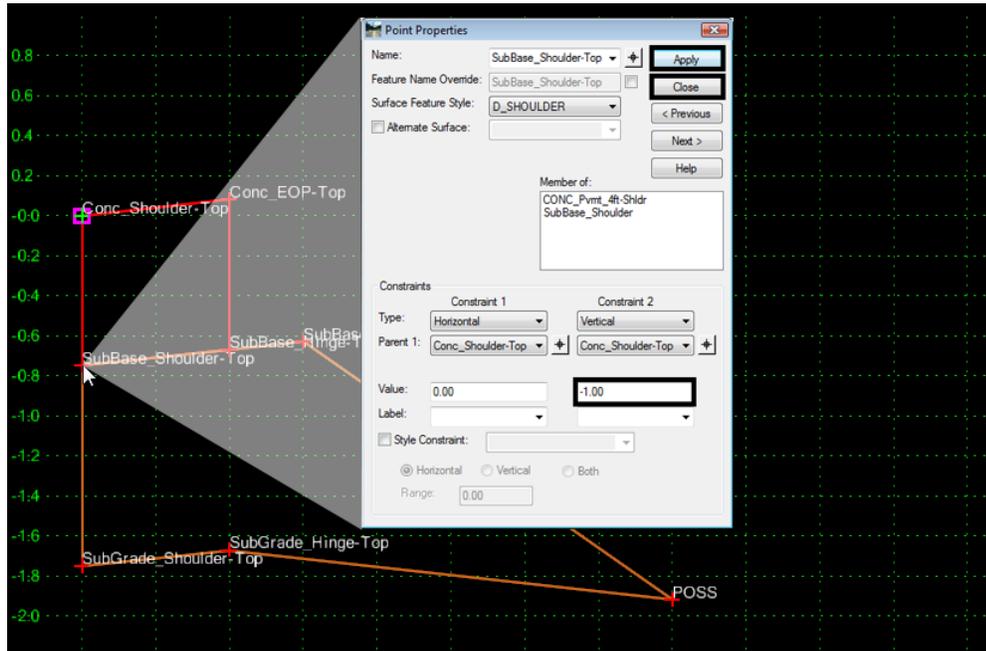
Edit existing concrete shoulder sections to match the pavement design.

15. Expand the template library folder structure to show **2 – Sections - Pavements > Shoulder Sections > Concrete**.
16. <D> <D> the **CONC_Inside_Shoulder-4ft-12z** Section.



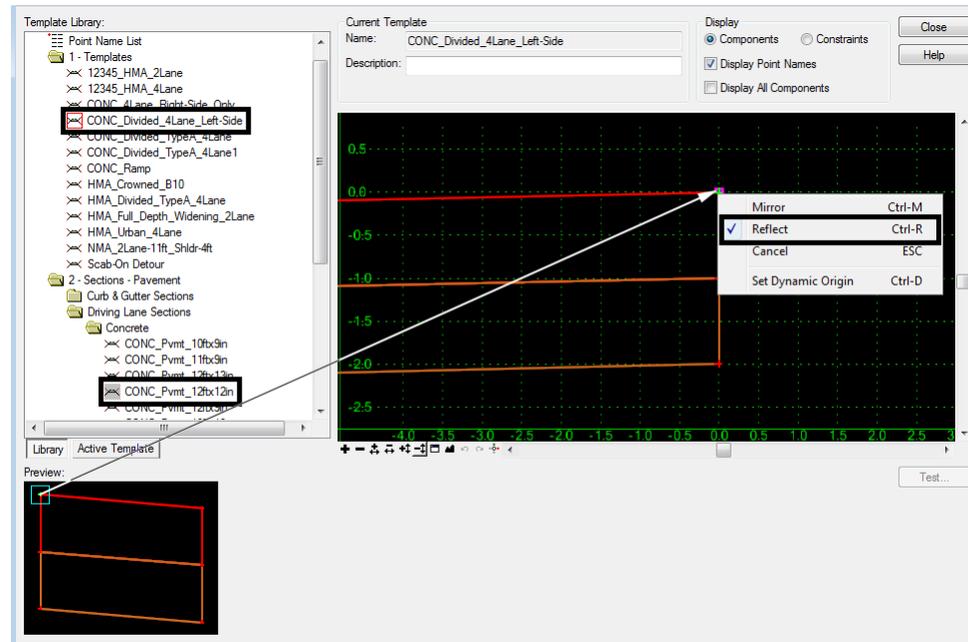
17. <D> <D> on the **SubBase_Shoulder-Top** point.
18. Change the **Value** for **Constraint 2** (the Vertical constraint) to **-1.00**.
19. <D> **Apply**.

20. <D> Close.



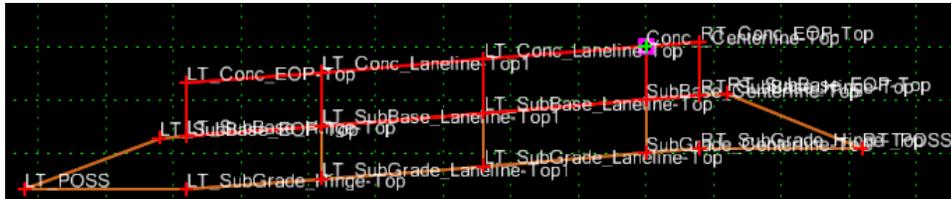
21. Repeat steps 10 through 13 for the point **SubBase_Hinge-Top**.
 22. <D> <D> on the **CONC_Outside_Shoulder-10ft-12z** section.
 23. Repeat steps 17 through 21 for the same points in this section.
- Assemble the template from the modified sections and add the appropriate end conditions.
24. Expand the template library folder structure to show **1 – Templates**.
 25. <D> <D> on the **CONC_Divided_4Lane_Left-Side** template.
 26. <D> on the **CONC_Pvmt_12ftx12in** section.
 27. In the **Preview** window, <D> and hold on the green “+”.
 28. Move the pointer into the **Template View** window and <R> while still holding the left mouse button. This displays a right click menu. When the right click menu is displayed, the left mouse button can be released.

29. Select **Reflect** (using either the left or right mouse button).



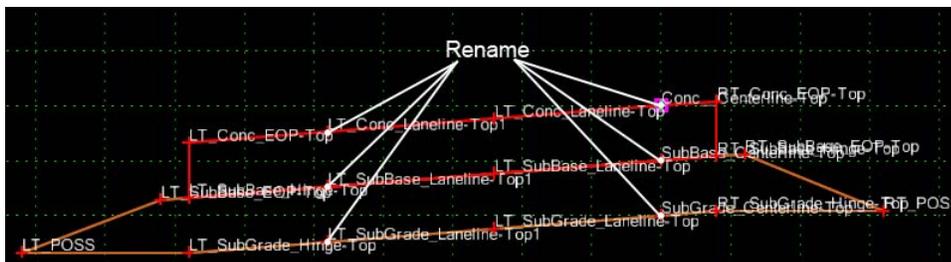
30. If **Mirror** is on, <R> on **Mirror** to turn it off.
31. Move the pointer to the template origin and <D> to place the section.
32. In the **Preview** window, <D> and hold on the green “+”. Note: the same section is used to place the second driving lane.
33. Move the pointer onto the **LT_Conc_Laneline-Top** point and release the left mouse button to place the section.
34. <D> on the **CONC_Outside_Shoulder-10ft-12z** section.
35. In the **Preview** window, <D> and hold on the green “+”.
36. Move the pointer onto the **LT_Conc_Laneline-Top1** point and release the left mouse button to place the section.
37. <D> the **CONC_Inside_Shoulder-4ft-12z** section.
38. In the **Preview** window, <D> and hold on the green “+”.
39. Move the pointer into the **Template View** window and <R>. Select **Reflect**. This turns the reflect option off.

40. Move the pointer onto the **Conc_Centerline-Top** point. <D> to place the section. All of the components for the driving surface have been placed. The template looks like the illustration below.



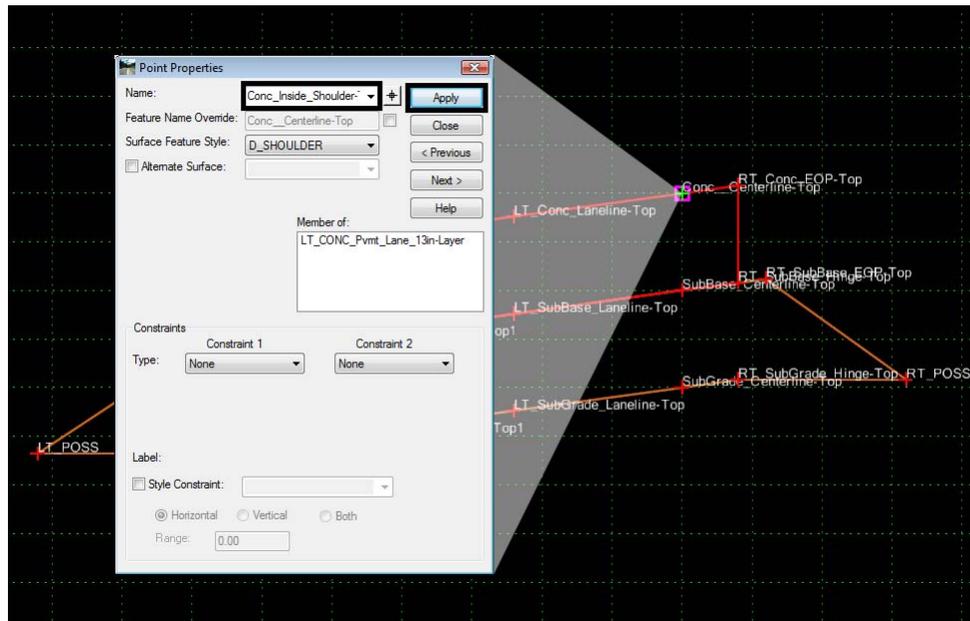
Remove the vertical lines from inside the template.

41. Place the pointer on one of the vertical lines and <R> to display the right click menu.
42. Select **Merge Components**. This removes the vertical line from the template.
43. Repeat steps 41 and 42 for all of the vertical line inside the template.
44. Rename points (indicated in the illustration below) to reflect their location.

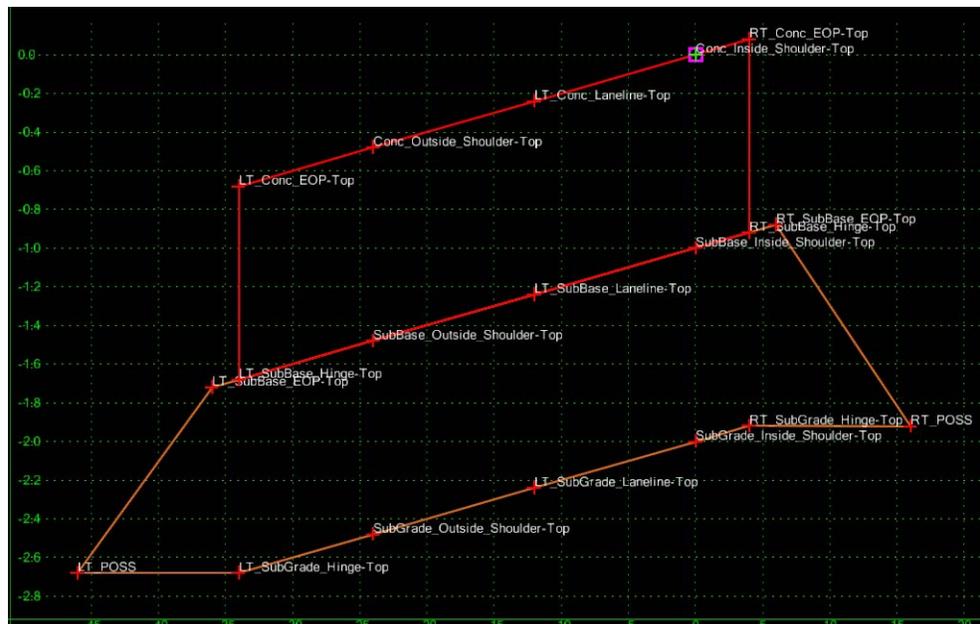


45. <D> <D> on the **Conc_Centerline-Top** point.
46. Select **Conc_Shoulder-Top** from the **Name** drop down menu.
47. Change the name to **Conc_Inside_Shoulder-Top**.

48. <D> Apply.



49. Repeat steps 44 through 47 for the other five points. Select the appropriate material name for each point. Substitute **Outside_** for the three left-most points and **Inside_** for the three right-most points. The template should look like the illustration below.

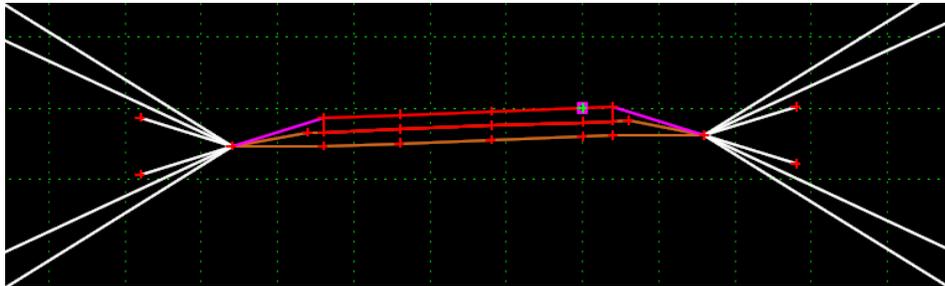


50. <D> **Close** to close the **Point Properties** dialog.

Finish the template by attaching the end conditions.

51. Expand the template library folder structure to show **3 – Sections – End Conditions > Z-Slope End Conditions > High Speed End Conditions**.

52. <D> on the **Z12_6_to_1** section.
53. In the **Preview** window, <D> and hold on the green “+”.
54. Move the pointer onto the **RT_Conc_EOP-Top** point. Release the left mouse button to place the end condition.
55. Using the same end condition section in the **Preview** window, <D> and hold on the green “+”.
56. Move the pointer into the **Template View** window and <R>. Select **Reflect**. This turns the **Reflect** option on.
57. Move the pointer onto the **LT_Conc_EOP-Top** point. <D> to place the section. This completes the template.



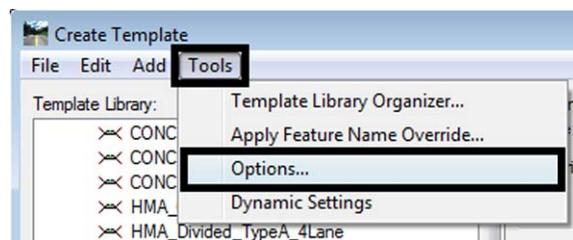
Modifying Templates to Fit a Project

In some instances, the sample templates can be used for a project with only minor modifications. The first example uses the **HMA_Urban_4Lane** template and modifies it by adding a sidewalk component behind the curb. The second example starts with the **HMA_Crowned_B10** template and adds a new component for **Lime Treated Subgrade**.

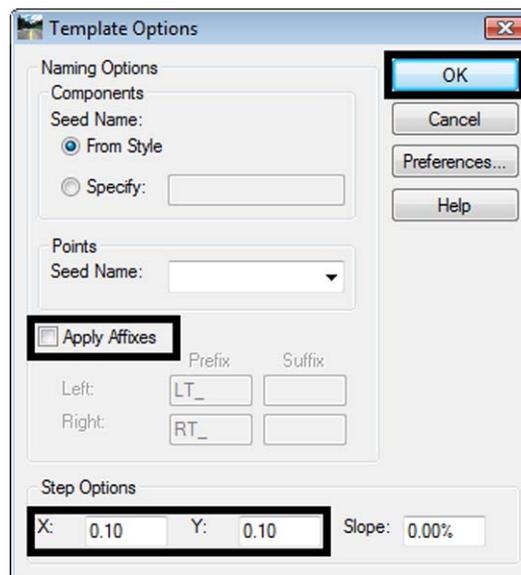
Adding Sidewalk to a Curb & Gutter Template

This example builds a new section containing the **4" _CONC_Sidewalk** component with the **Bench_4_6_to_1** end condition section attached. Next, the **HMA_Urban_4Lane** template is copied and the end conditions are deleted from the copy. Finally, the Sidewalk and End Condition section is added to the template.

1. Select **Tools > Options** from the **Create Template** menu bar.

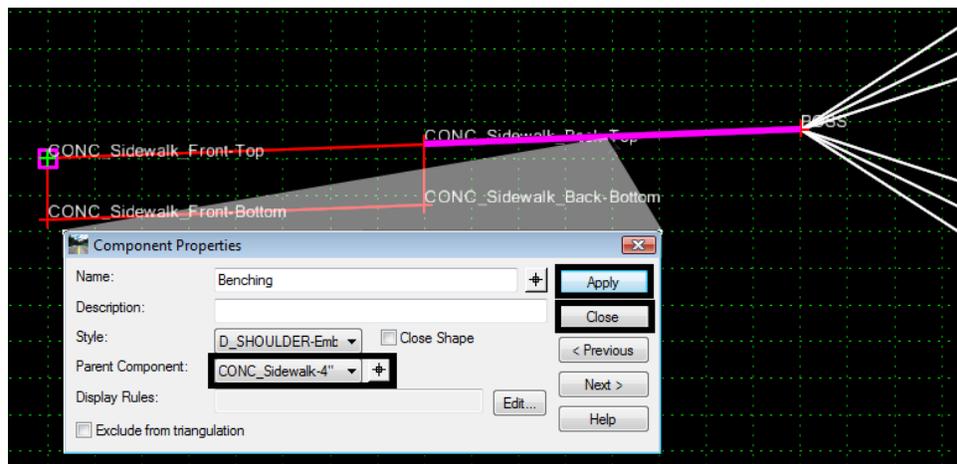


2. Turn off the **Apply Affixes** check box.
3. Set the **Step Options** to 0.10 for both **X** and **Y**.
4. <D> OK.



5. Expand the template library folder structure to show **4 – Components > Sidewalks & Bike Paths > Sidewalks**.
6. <R> on the **4" _CONC_Sidewalk** component and select **Copy** from the menu.

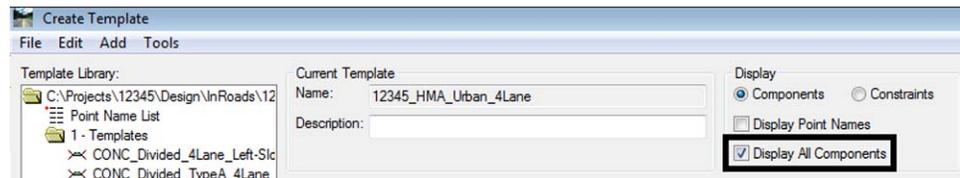
7. Expand the template library folder structure to show **3 – Sections – End Conditions – Curb & Gutter Sections**.
8. <R> on the **Curb & Gutter Sections** folder and select **Paste**.
9. <R> on the **4" _CONC_Sidewalk** component, that is in the **Curb & Gutter Sections** folder, and select **Rename**.
10. Key in a **Name (4" _CONC_Sidewalk_End-Cond** for this example).
11. <D> <D> on the **4" _CONC_Sidewalk_End-Cond** section.
12. <D> on the **Bench_4_6_to_1** section.
13. In the **Preview** window, <D> and hold on the green "+".
14. Move the pointer onto the **CONC_Sidewalk_Back-Top** point. Right-click and toggle make certain **Reflect** and **Mirror** are both off. Release the left mouse button to place the end condition.
15. <D> <D> on the **Benching** component to display the **Component Properties** window.
16. Set the **Parent Component** to **CONC_Sidewalk-4"**.
17. <D> **Apply**.
18. <D> **Close**.



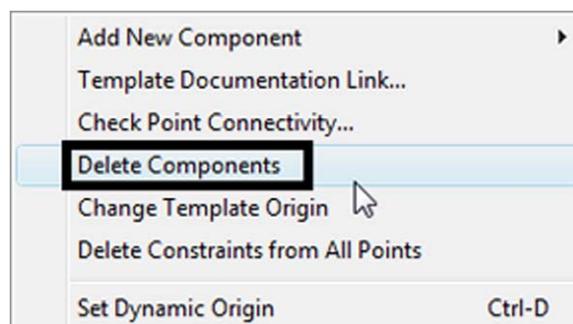
Setting up the parent/child relationships for the section will make it easier to continue the process when the sections are added to the template. Each Curb & Gutter section has two Curb components (one for a normal cross slope and one to match the cross slope of the driving lanes) and the sidewalk/end condition section has to be attached to each. By setting the parent/child relationship in the section, when the section is placed in the template, only one component will have to be edited to make the template work properly.

Next, the **HMA_Urban_4Lane** template is copied and the existing end conditions are removed.

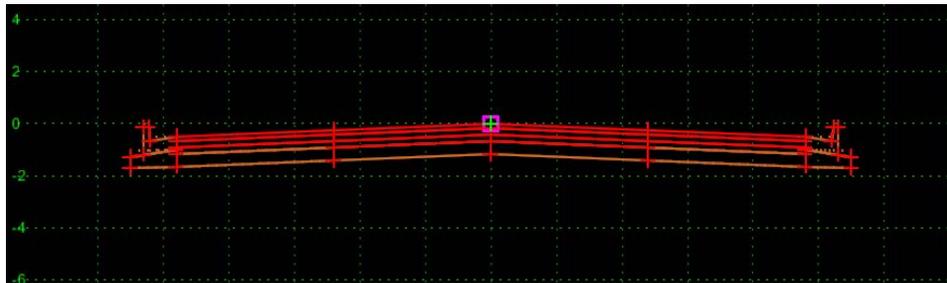
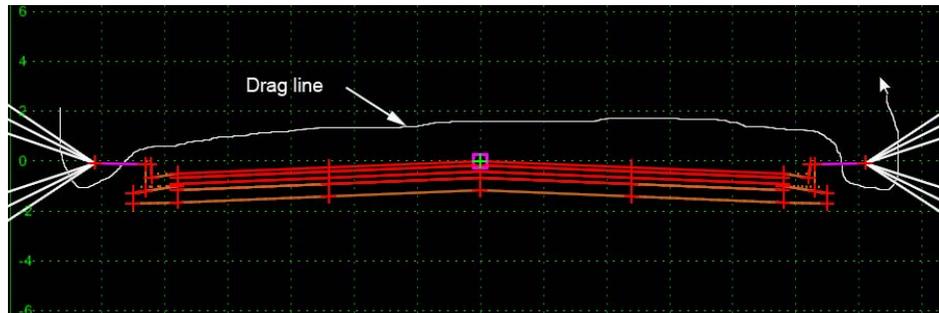
19. Select **Tools > Options** from the **Create Template** menu bar.
20. Toggle on the **Apply Affixes** check box.
21. <D> **OK**.
22. Expand the template library folder structure to show **1 – Templates**.
23. <R> on the **HMA_Urban_4Lane** template and select **Copy** from the menu.
24. <R> on the **1 – Templates** and select **Paste** from the menu.
25. <R> on the **HMA_Urban_4Lane1** template and select **Rename** from the menu.
26. Key in a **Name** (**12345_ HMA_Urban_4Lane** for this example).
27. <D> <D> on the **12345_ HMA_Urban_4Lane** template.
28. Toggle on the **Display All Components** check box. This will show components currently hidden by **Display Rules**.



29. Move the pointer into the **Template View** window (but not on a component) and <R>.
30. Select **Delete Components** from the menu.



31. Position the pointer near the component(s) to be deleted, <D> and hold. Drag through the component(s). Release the left mouse button to complete the process.



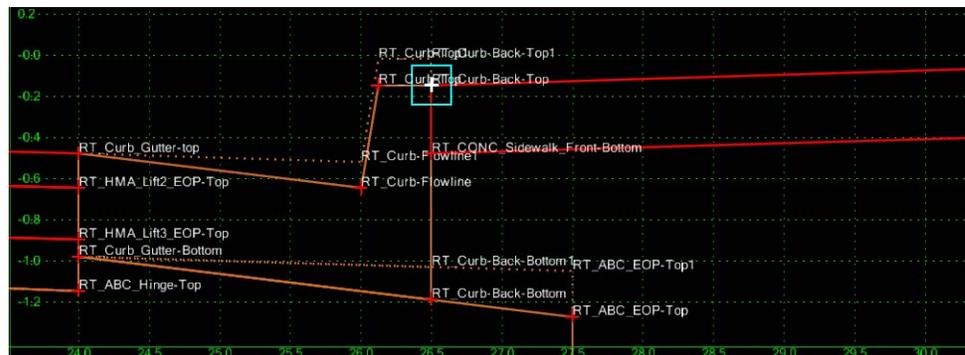
Important! Be careful not to touch components that are to be kept. The **Delete Components** command is only in effect through one drag operation. Once the left mouse button is released, the command must be picked again to delete more components.

Note: If a component is deleted by mistake, select **Edit > Undo** (or Ctrl+Z) to replace the deleted components.

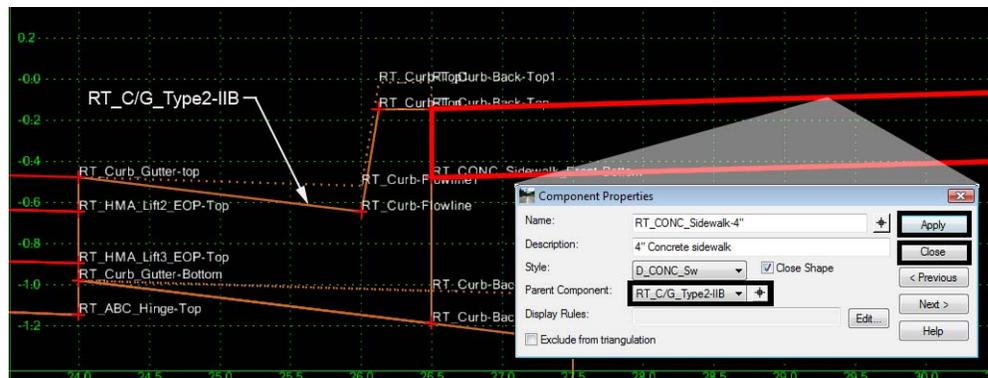
To complete the template, add the sidewalk/end condition section and make the sidewalk component a child of the curb.

32. Expand the template library folder structure to show **3 – Sections – End Conditions – Curb & Gutter Sections**.
33. Make certain **Apply Affixes** is toggled on.
34. <D> on the **4" _CONC_Sidewalk_End-Cond** section.
35. In the **Preview** window, <D> and hold on the green "+".
36. Move the pointer into the **Template View** window and <R> while still holding the left mouse button. This displays a right click menu. When the right click menu is displayed, the left mouse button can be released.
37. Select **Mirror** (using either the left or right mouse button).

38. Move the pointer onto the **RT_Curb-Back-Top** point and release the left mouse button to place the section.

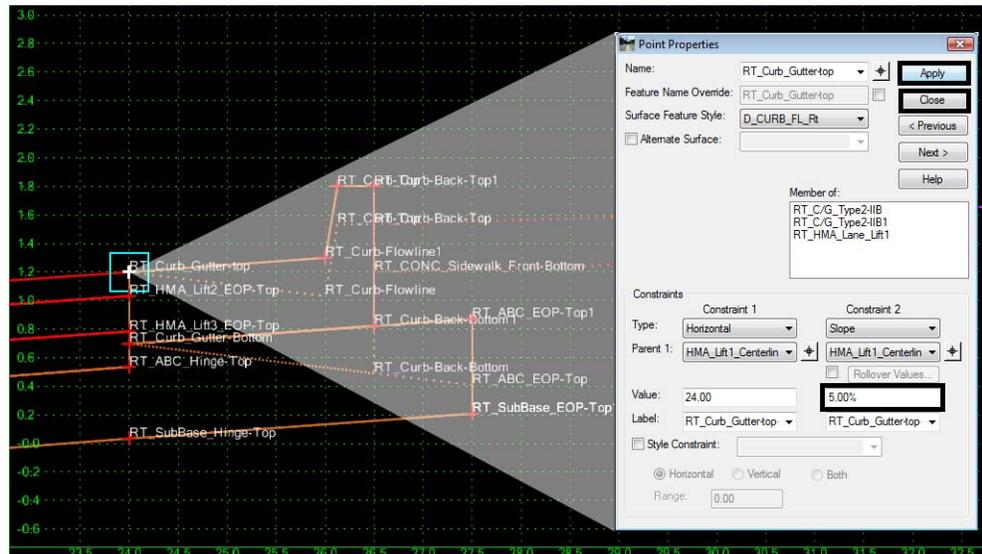


39. <D> <D> on the **RT_CONC_Sidewalk-4"** component.
40. In the **Component Properties** dialog box, set the **Parent Component** to **RT_C/G_Type2-IIB**.
41. <D> **Apply**.
42. <D> **Close**.
43. Repeat steps 38 through 41 on the corresponding components on the left side.



44. <D> <D> on the **RT_Curb_Gutter-top** point.
45. Change the **Value of Constraint 2** (the Slope constraint) to **5.00%**.
46. <D> **Apply**.

47. <D> Close.

48. Repeat steps 43 through 46 on the **LT_Curb_Gutter-top** point (the slope **Value** will be **-5.00%** on this side).

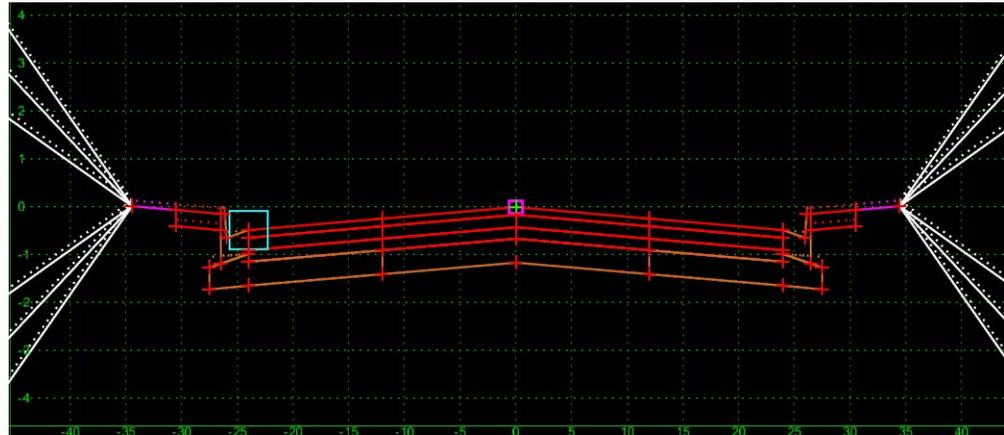
Changing the slope constraint will imitate a supered condition causing the normal curb and its child components not to be displayed. It will activate the display of the supered curb. These steps will form the pavement into a “V”. This will make it easier to place the remaining sidewalk/end condition sections. The pavement will be rotated back to its normal position after the sections are placed.

49. Using the same section in the **Preview** window, <D> and hold on the green “+”.50. Move the pointer onto the **RT_Curb-Back-Top1** point and release the left mouse button to place the section.51. <D> <D> on the **RT_CONC_Sidewalk-4"1** component.52. In the **Component Properties** dialog box, set the **Parent Component** to **RT_C/G_Type2-IIB1**.53. <D> **Apply**.54. <D> **Close**.

55. Repeat steps 50 through 53 on the corresponding components on the left side.

56. <D> <D> on the **RT_Curb_Gutter-top** point.57. Change the **Value** of **Constraint 2** (the Slope constraint) to **-2.00%**.58. <D> **Apply**.59. <D> **Close**.60. Repeat steps 43 through 46 on the **LT_Curb_Gutter-top** point (the slope **Value** will be **2.00%** on this side).

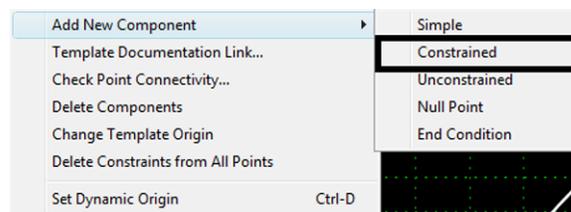
The template is now complete.



Adding a Subgrade Component to a Template

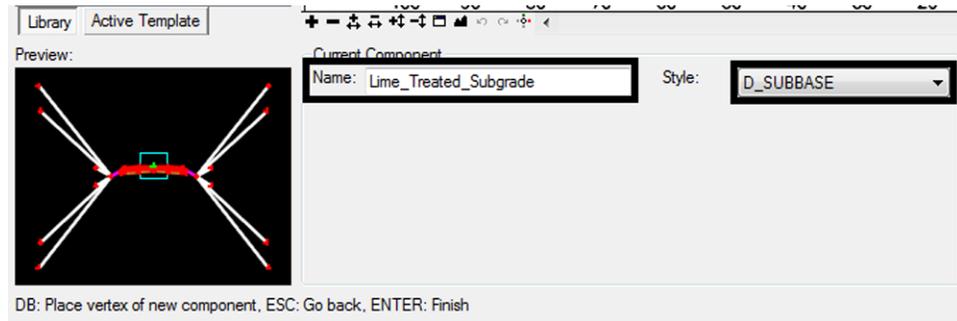
The **HMA_Crowned_B10** template will be modified by creating a new component. This component, representing lime treated subgrade, will be 1' thick and the width of the ABC component that is already in the template.

1. Expand the template library folder structure to show **1 – Templates**.
2. <R> on the **HMA_Crowned_B10** template and select **Copy** from the menu.
3. <R> on the **1 – Templates** and select **Paste** from the menu.
4. <R> on the **HMA_Crowned_B101** template and select **Rename** from the menu.
5. Key in a **Name** (**12345_ HMA_Crowned_B10** for this example).
6. <D> <D> on the **12345_ HMA_Crowned_B10** template.
7. Move the pointer into the **Template View** window (but not on a component) and <R>.
8. Select **Add New Component > Constrained** from the menu.

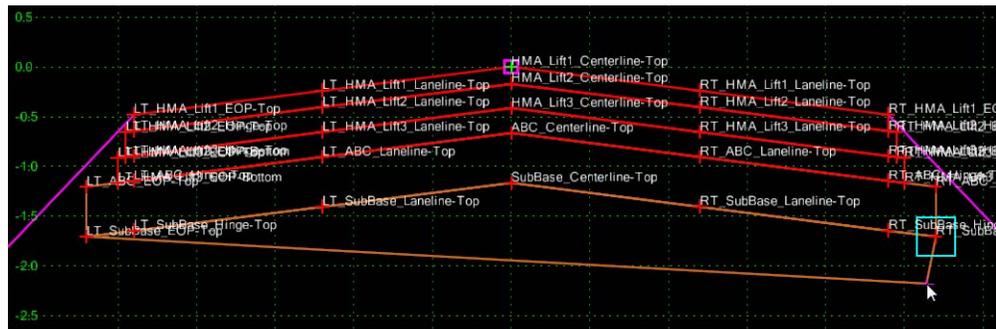


9. In the **Name** field of the **Current Component** area, key in a name for the new component (**Lime_Treated_Subgrade** in this example).

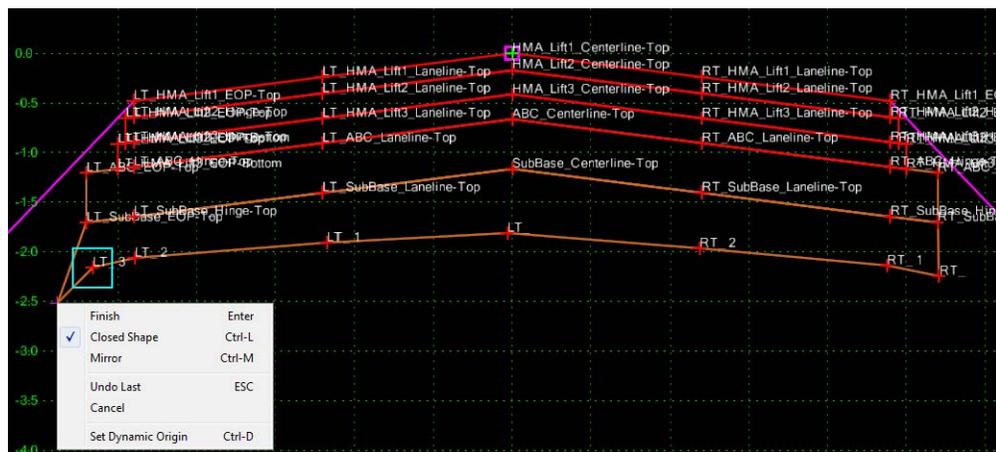
- Use the drop down menu to select the desired Style (**D_Subbase** for this example).



- Move the pointer onto the **LT_SubBase_EOP-Top** point and <D>.
- Continuing to the right, <D> on each point across the bottom of the existing ABC component.

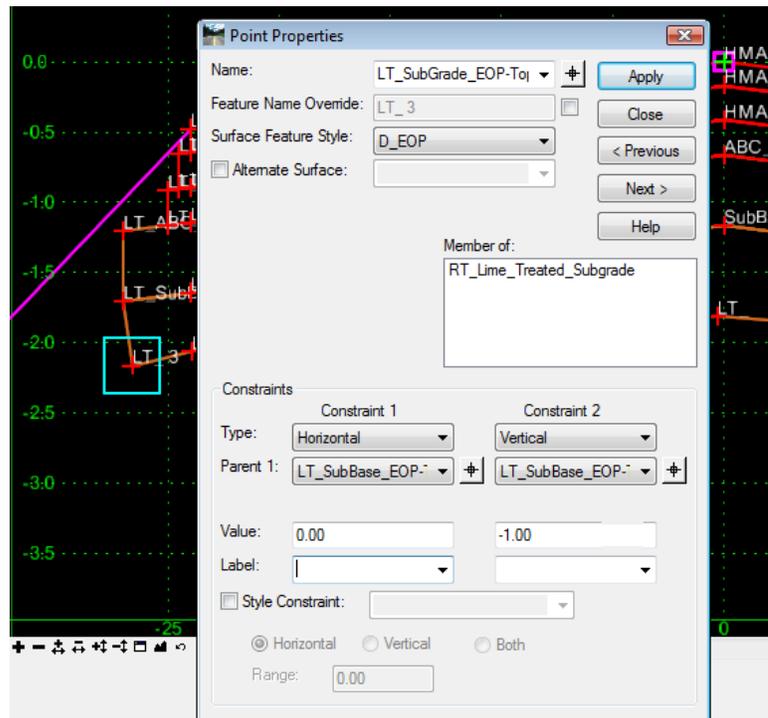


- <D> the same number of new points (in this case 7) below the ABC component.
- <R> in the **Template View** window (but not on a component).
- Select **Finish** from the menu.



All of the points are contained in the new component. Editing the point constraints will move each point to its proper location.

16. <D> <D> on the point **LT_3** to display the **Point Properties** dialog box.
17. Select **SubGrade_EOP-Top** from the **Name** drop down menu.
18. Append **LT_** to the name so that it reads **LT_SubGrade_EOP-Top**.
19. Under **Constraint 1** (the Horizontal constraint), set the **Parent 1** to **LT_SubBase_EOP-Top**.
20. Set the **Value** to **0**.
21. Under **Constraint 2** (the Vertical constraint), set the **Parent 1** to **LT_SubBase_EOP-Top**.
22. Set the **Value** to **-1**.
23. <D> **Apply**.
24. <D> **Close**.



25. Repeat steps 16 through 24 for each of the remaining points. Choose an appropriate name for each of the points. The **Parent 1** is the same for the **Horizontal** and the **Vertical** constraint. The parent point is the point directly above the edited point. The Values for the constraints are the same for all points.

The completed template is shown below.



Section Summary:

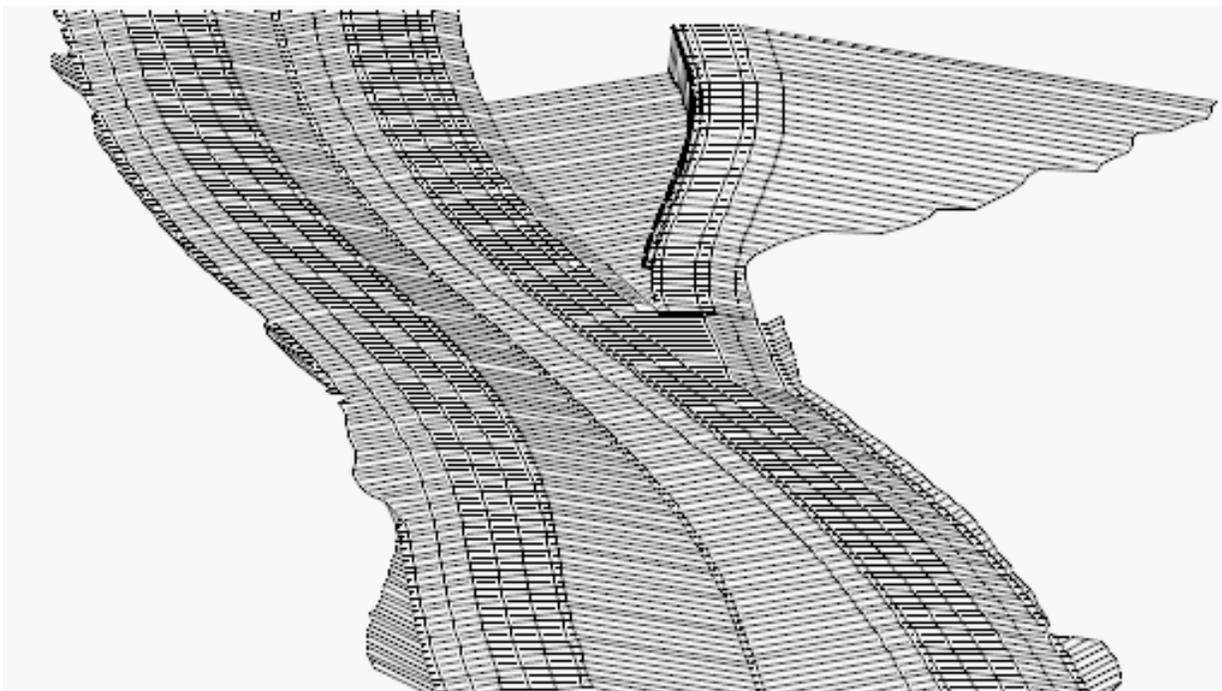
- **Components** are the building blocks for **Sections** and **Templates**.
- There are 5 methods of creating components, but only 3 types of components: **General**, **Null** and **End Conditions**.
- **Component Properties** allow the editing of names, styles, etc. and help define how the components react in different situations.
- **Component Properties** for **End Condition** components contain the target information.
- **Components** are made up of **Points**.
- **Points** are constrained to other points to define the shape of the components and therefore the template. Changing the constraints may affect more than one point, since the constrained point may also be a parent of another point.
- There are many different types of **Constraints** and it is very important to use the correct ones when creating a new point.
- **Display Rules** and **Parent/Child** components can be used to turn on and off components during modeling based on the occurrence of other components, or the result of a mathematical expression derived from the differences between points (horizontal, vertical, slope, etc.)
- Start a new template with the most complete example available that fits your design needs.
- Standard templates may be copied and modified by changing component properties and/or point properties.
- Standard sections may be copied into a new template to create a project-specific design.
- Standard components may be copied into a new template to create a new section.
- Even if your design requires a template that is not completed, many of the components and sections are found in the standard template library and may be used to create new templates.

Chapter Summary:

- The default template library is located in the **C:\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Templates** folder
- The CDOT template library contains several categories of templates in various stages of development, including: **Components** (the building blocks), **Sections** (multiple components forming partial templates, such as all the lifts for a lane), and **Finished Templates** (multiple components that form a complete typical section).
- When evaluating the typical sections needed for a project, you should look first to the standard template library to save time and effort in building your typicals.
- For non-standard and more complex typicals, the building blocks and /or tools are available to create your own templates to accomplish your design.

Chapter 11 - Roadway Modeling

Roadway Modeling is the process of creating a 3D design surface or surfaces of your proposed roadway project. The modeling process utilizes the roadway typical sections discussed in the last chapter and applies these sections to a corridor (a path representing the location of your project). As the typical sections are “pushed” along this path, end condition components “tie-in” to the existing surface (or any other targets you specify) to create your cut and fill sideslopes. Template points are then connected to created 3D longitudinal breakline features along the corridor. Triangulation creates planar surfaces between breakline feature points from which elevations can be interpolated. The resulting 3D surface is known as the proposed model. InRoads **Roadway Designer** is the interface between engineering design data and the proposed surface model.



Chapter Objectives:

- To understand how roadway modeling is accomplished using CDOT standard design criteria and InRoads XM.
- To learn how to create a preliminary model of your project.
- To further define your model by introducing right and left turn lanes, ramps, acceleration lanes, etc.
- To learn how CDOT establishes superelevation design criteria to maintain vehicle stability at the designed speed for each curve on your project.
- To learn how to vary pavement or subgrade depths over a specified range.
- To learn different methods of editing your design model to correct sideslope problems or fit your design to real world conditions.
- To learn how to create a 3D design surface of your project.

Roadway Designer

Roadway Designer is a new interactive approach to modeling with templates in InRoads, allowing you to see the results of your the results of your design simultaneously in plan, profile, and cross section **before** creating your proposed surface.

Roadway Designer is a tool used to:

- Specify the project path (horizontal and vertical alignments or surface features)
- Identify the templates to be used for modeling
- Control template locations along the project path and define transitions
- Define paths for points that don't parallel the centerline, such as tapers
- Define superelevation
- Create the design surface – a 3D model of the proposed design

Section Objectives:

- ◆ To utilize Roadway Designer as a tool to input design data for modeling purposes.
- ◆ To understand the full functionality of Roadway Designer and its tools.
- ◆ To use and interpret plan, profile, section and superelevation diagram information in Roadway Designer's Standard and Superelevation modes.
- ◆ To understand what data is needed to before using Roadway Designer for modeling.
- ◆ To understand what data is created by Roadway Designer and where it is stored.
- ◆ To learn what commands are available on Roadway Designer's menu.
- ◆ To learn how to process Roadway Designer data to create a preliminary view of your design in plan, profile and cross section.
- ◆ To learn how to create a corridor.
- ◆ To learn when and how to add template drops to your corridor.
- ◆ To edit template drops and synchronize templates drops with the template library changes.
- ◆ To understand how **Point Controls** work and when to use them.
- ◆ To add point controls to your design to minimize template drops.
- ◆ To understand the CDOT process of adding superelevation to your roadway.
- ◆ To utilize the **Superelevation Table Wizard** to calculate the initial superelevation.
- ◆ To edit the results of the **Superelevation Table Wizard** to meet your project's design criteria.
- ◆ To understand when and how to use **Secondary Alignments**.

Introduction to Roadway Designer

Roadway Designer Prerequisites

Before running Roadway Designer, you must first have:

- A horizontal and vertical alignment that defines your proposed location (the project centerline and profile grade). You can also use a surface feature to define the path.
- An existing surface or surfaces. These provide the targets for your end conditions. If your target(s) are not surfaces, these targets must also be loaded.
- One or more templates to define the typical section of the proposed design.

Starting Roadway Designer

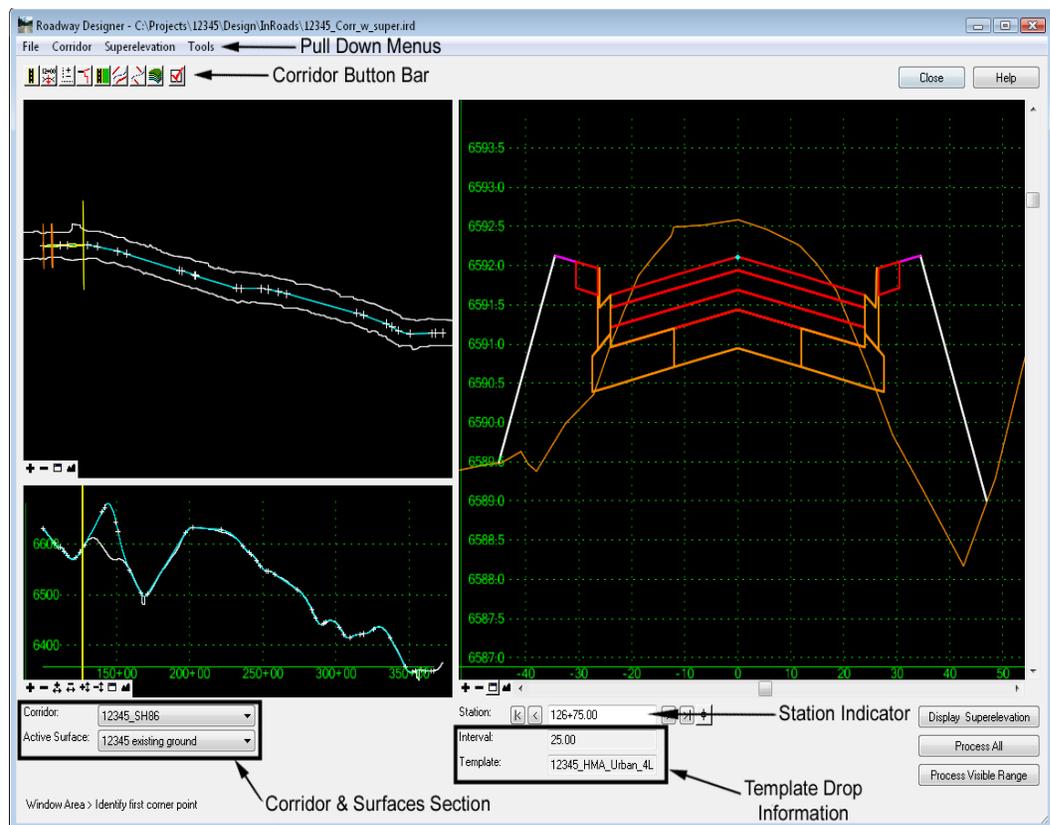
From the InRoads *Explorer* menu, select **Modeler > Roadway Designer** to open the **Roadway Designer** dialog box.

Working Modes

In the **Roadway Designer** dialog box, you can see the results of your model run and work with your data using two different two modes: **Standard** and **Superelevation**.

Standard Mode

Standard mode includes views for plan, profile and cross section.

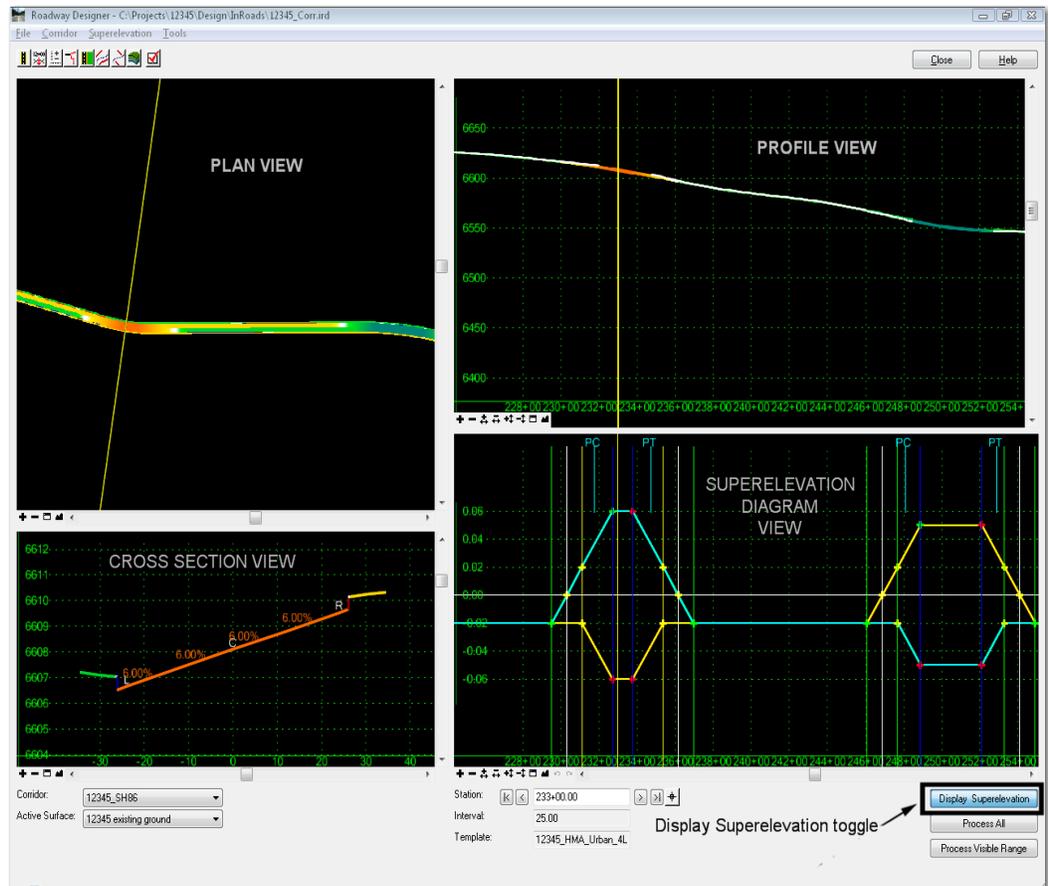


- **Plan Display** – shows the corridor's path, template drops, transition zones, perimeter of the active surface and limits of the active corridor. You can double-click a transition zone to edit template transitions (see [Design Consideration – Template Transitions](#) later in this chapter).
- **Profile Display** – shows the corridor's vertical path along with the active surface.

- **Cross Section Display** – shows the cross section surfaces and components at the current station. You can hover over a point or component to get additional information (name, offset, elevation, style, constraints, material, slope, width, etc.) Double-clicking the cross section display activates the **Edit Station** command, which allows you to interactively edit any station along the corridor. Points and components can be edited at the single station to correct any problems along the alignment (see [Modifying Single Station Template Drops](#) in this chapter).

Superelevation Mode

Superelevation Mode adds a fourth view, the Superelevation diagram. Use the **Display Superelevation** button shown in the diagram below to toggle between superelevation and standard mode. When **Display Superelevation** is on, a color-coded superelevation diagram is shown. This diagram displays station/cross slope control lines for superelevated points in the template. You can right-click to interactively edit superelevation in this view.



InRoads uses extensive color coding in both standard and superelevation modes to illustrate design parameters in plan, profile, cross section and superelevation views.

- ◆ The plan display shows a color-coded representation of cross-slope along the corridor. The colors vary as the template cross-slope changes through superelevation transitions.
- ◆ The cross section display shows a color-coded view of the template backbone along with the cross slope annotations.

- ◆ The profile display shows a color-coded view of all points on the template backbone. You can right-click to control which points are displayed, which allows for interactive viewing of superelevation transitions in vertical sag curves.

For more information on superelevation and color coding, see the [Superelevation](#) section in this chapter.

Roadway Designer Menu Structure



File Menu

All Roadway Designer data is stored in an InRoads Roadway Designer (IRD) file, which is stored as a *.ird file on the hard drive. You should first create an IRD file for your project before any work is done in Roadway Designer.

- ◆ **File > New:** Creates a new IRD file to store all Roadway Designer data for your project.
- ◆ **File > Open:** Opens an existing IRD file. You can also open the IRD file using the **File > Open** command from the *InRoads Explorer* menu.
- ◆ **File > Save:** Saves changes to the IRD file.

Important! While working in Roadway Designer, you are working in your computer's memory and you should periodically save your IRD file. If you do not Save changes to your IRD file, you will be asked to save upon exiting from the Roadway Designer dialog, as you will lose changes otherwise. Therefore, it is important to **save often!**

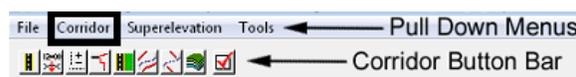
- ◆ **File > Save As:** Allows you to specify a file name and folder location for your IRD file. The first time you save, you are prompted with the **File > Save As** dialog box.
- ◆ **File > Import RWL:** Translates a previous InRoads version RWL file (InRoads V8.5 and earlier) to the new IRD format. You must specify both the RWL file and the template library file (TML) used in conjunction with the RWL file (or translate the TML file first and then load the corresponding ITL file). This is useful if you are migrating project data from a previous version of InRoads to the V8.9 version.

Note: Be careful! This is not a one-to-one conversion and many items needed for Roadway Designer are not translated. You must open the converted IRD file and make necessary changes. You may consider creating a new IRD from scratch and entering the existing project information. Discuss your options with your project manager before proceeding.

- ◆ **File > Close:** Closes the Roadway Designer dialog box. You can also choose the **Close** button in the upper right.

Corridor Menu

This section introduces the Corridor menu.



Note: All of the commands found on the Corridor pull-down menu can also be accessed on the Corridor button bar located directly below the pull-down menus.

The **Corridor** menu is used to setup the following data, which is then used in the modeling process:

- ◆ **Corridor > Corridor Management:** Creates a corridor – either a horizontal and vertical alignment or surface feature defining the “path” of your project.
- ◆ **Corridor > Template Drops:** Specifies a start/stop station range for applying the various templates along the corridor. The area along the corridor between different templates is known as the template transition zone.
- ◆ **Corridor > Point Controls:** Used to set up and manage horizontal and vertical controls for points in a template for widening lanes, introducing ramps, maintaining right-of-way, etc. Point controls are also used for superelevation controls.
- ◆ **Corridor > End Condition Exceptions:** Options for modifying end conditions (e.g. cut and fill sideslopes) along a station range without introducing additional template drops and editing template transitions. There are two different types of End Condition Exceptions:
 - **Overrides** – to replace the end condition on the right and/or left side
 - **Transitions** – to smooth out rapidly changing end conditions over a station range
- ◆ **Corridor > Display References:** Used to display alignments and surface features in the Roadway Designer plan and cross section views. Graphics cannot be referenced.
- ◆ **Corridor > Secondary alignments:** Used to specify alignments that 'kink' the template. The template is run perpendicular to the mainline until it reaches the secondary alignment, then it becomes perpendicular to it.
- ◆ **Corridor > Key Stations:** Similar to event points on an alignment, Key Stations are special stations where you want to drop a template and display a cross section (utility, culvert or railroad crossings, drive entrances, intersections, etc.). Unlike event points, which are stored in the ALG file, Key Stations are stored in the IRD file.
- ◆ **Corridor > Create Surface:** Creates a surface (DTM) or surfaces from the roadway design data. You can create a separate surface for each corridor, including subgrade surfaces, or you can create one merged surface by combining multiple corridors in the design.

Superelevation Menu

See the [Superelevation](#) section later in this Chapter.

Tools Menu

- ◆ **Tools > Parametric Constraints:** Used to override labeled point constraint values over a station range without requiring additional template drops. Parametric constraints are commonly used to vary such criteria as pavement thickness, sidewalk width and cross slopes over a station range in the corridor.
- ◆ **Tools > Target Aliasing:** Allows you to override the end condition target defined in the template and specify additional surfaces or corridors as targets in a prioritized order.

- ◆ **Tools > Curve Widening:** Used in widening projects to add horizontal point controls to move points on curves further away from the centerline when widening lanes or edges.
- ◆ **Tools > Vertical Gore Tool:** Allows you to create surface features representing the min/max elevation range of a ramp's vertical alignment to meet cross slope rollover and other design criteria. These features can be shown on the profile to help design gore area cross slopes and match them to the mainline and the ramp cross slopes.
- ◆ **Tools > Design Input Report (ird file):** Generates an XML report from your Roadway Designer setup data. After selecting this command, choose one of the style sheets (XSL files) from the **Roadway** folder in the Report Browser to format the report.
- ◆ **Tools > Results Report:** Generate XML reports of the roadway design results. After selecting this command, choose one of the style sheets (XSL files) from the **Roadway** folder in the Report Browser to format the report.
- ◆ **Tools > Options:** Used to set up additional processing and display options for Roadway Designer. This includes options for dropping templates at specified event points, displaying references and template transitions in plan view, and displaying cut and fill volumes in cross section view.

These concepts are explained in more detail later in this chapter. Additional information can be found by reviewing the topic [Roadway Designer Overview](#) in the [InRoads Online Help](#).

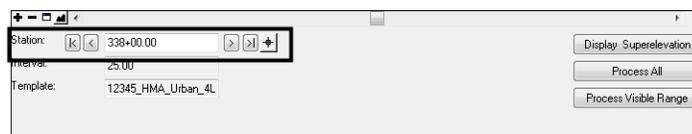
Processing your data

Roadway Designer processes your templates along all specified stations of the corridor. Each view display (plan, profile and section) shows the results of your processed model at each station along the corridor. This allows you to preview the results of your model prior to creation of the 3D design surface.

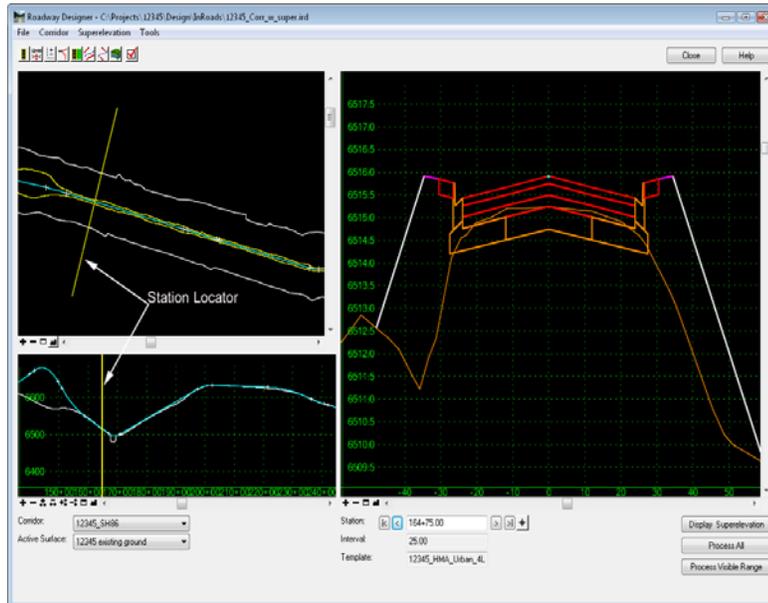
Once you have set up your Roadway Designer data and saved the IRD file, you will need to process the data along the corridor in order to model the project. You can process Roadway Designer data using several different options including:

- “Stepping through” the stations on your corridor using the station navigation buttons (first station, previous, next and last station) as shown below.

Note: This processes your model one station at a time. You can see the results of your template drops and other setup options at each station in the plan, profile and section views. The station interval is set up in **Template Drops**.



- Dragging the current station locator along your corridor in plan or profile displays.



Note: The model is processed along the range you drag the station locator. You can double-click anywhere along the corridor in the plan view and the current station locator will “jump” to that location. Processing starts from this location. Processing is “skipped” in between. The skipped area is shown as two yellow lines.

- Selecting **Process All** to process all stations along the corridor



Creating and Managing Corridors

A CDOT corridor consists of a designated length of roadway and the area within the roadway’s right-of-way, including all assets such as buildings, trees, guardrails, etc.

The corridor defined by InRoads is represented by the horizontal and vertical alignments and all features generated from the typical sections used to create design models (dtm’s). A surface feature can also be used as a substitute for alignments.

Introduction to Corridors

Creating a corridor is the first step in the InRoads Roadway Designer process. A corridor is a way to associate a horizontal and vertical path for the centerline and profile grade and define limits along the path for modeling purposes. A corridor consists of either:

- A horizontal and vertical alignment or
- A surface feature.

The type of project will typically dictate the type of corridor you choose:

- New highway or roadway projects will typically have proposed horizontal and vertical alignments established for the roadway centerline and profile grade.

- If you're modeling a ditch or other corridor based on a surface feature, use the surface feature option. For example, overlay projects may have a surface feature representing the existing centerline provided by Survey (however, this surface feature may also be imported into the geometry project as an alignment).

After designating the path, you assign a name for this path, which is known as the **corridor**. The corridor is the path along which you will drop templates to model the roadway. Your design can consist of one corridor or multiple corridors (e.g. a mainline and ramps). After the design is complete, you can create a separate surface for each corridor or one surface from multiple corridors.

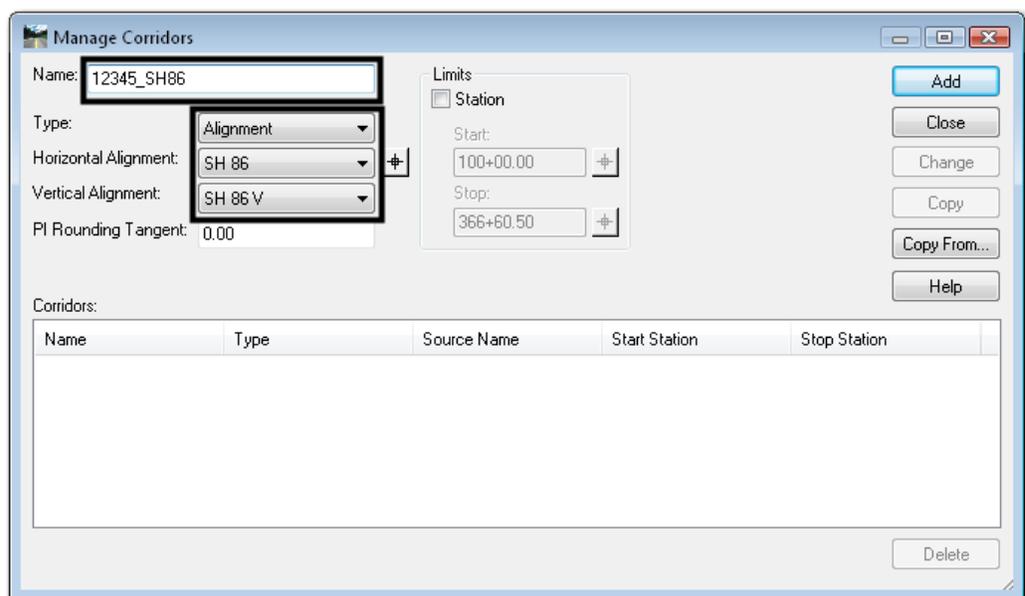
All of the Roadway Designer data is saved with the corridor (template drops, point controls, superelevation, parametric constraints, etc.) The corridor is then saved to the IRD file.

Note: Before creating a corridor, you must have your geometry project loaded (or surface if you're using a feature to define the corridor).

Creating Corridors

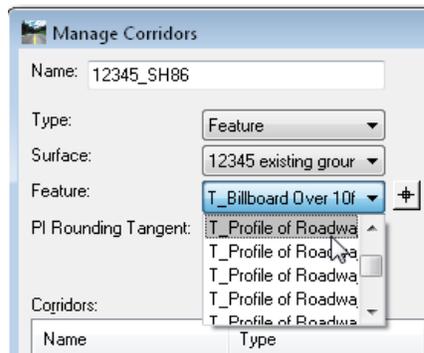
To create a corridor:

1. Select **Modeler > Roadway Designer** from the main InRoads menu.
2. From the **Roadway Designer** menu bar, select **Corridor > Corridor Management** or **<D>** the **Corridor Management** icon  from the button bar.
3. In the **Manage Corridors** dialog box, key in a **Name** for the corridor.



4. Select the **Type** from the drop down menu. The most common type used is **Alignment**.
5. Select the **Horizontal Alignment** the drop down menu.
6. Select the **Vertical Alignment** the drop down menu.

Note: If **Feature** is selected for the **Type** (step 4), select the **Surface** and **Feature** for steps 5 and 6.



- Key in the **PI Rounding Tangent**. Typically this will be 0. This is used to control the template's orientation as it approaches a curve-less PI in order to prevent overlapping of template drops.

Note: Specifying a **PI Rounding Tangent** does not affect alignments with curves at all PIs. It also does not affect alignment stationing.

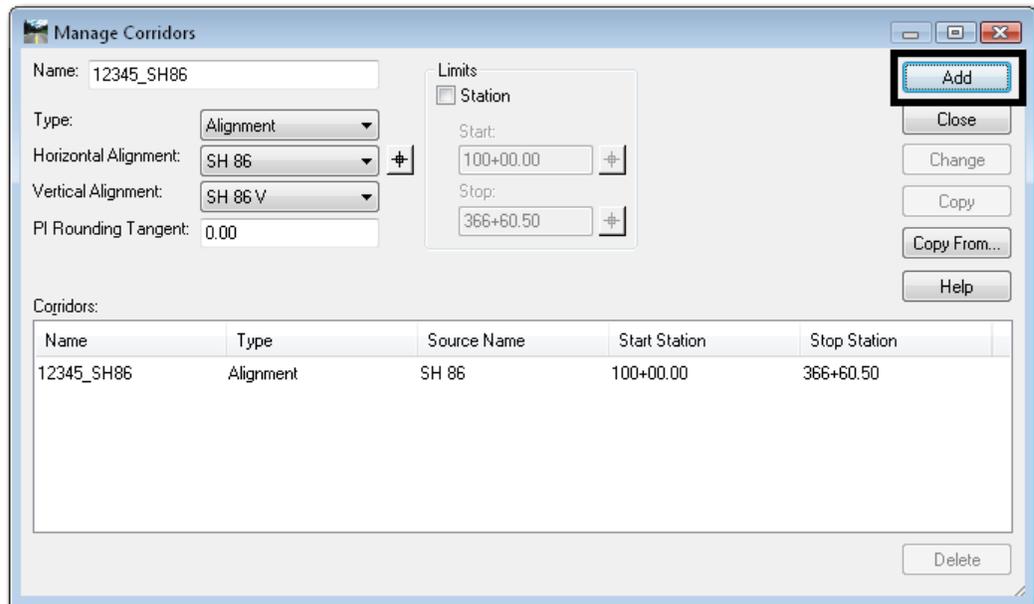
To limit the corridor length along an alignment or feature:

- Toggle on the **Station** check box.
- Key in the **Start** station.
- Key in the **Stop** station.

Note: The target button  can be used to select the **Start** and **Stop** stations from the MicroStation view window.

- <D> **Add** to create the Corridor.

12. Select **File > Save** to save the IRD file with the new corridor.



Template Drops

Template drops are used to specify which templates are used, their locations, and their interval for a particular corridor. Template drops establish the station ranges for roadway transitions.

Introduction to Template Drops

Template drops are defined whenever the typical section of the roadway changes or where the template drop interval changes. Typical section changes include:

- Lane transitions (e.g. two to four lane transition).
- A rural section with shoulders to an urban section with curb and gutter.
- An undivided section to a divided highway section.

Template drop interval changes include:

- Areas where additional definition is needed in the model (e.g. rapidly changing terrain).
- Areas where cross sections are needed at more frequent intervals than the standard template drop interval.

The following examples illustrate when it is appropriate to add template drops.

Typical Section Change Example

Two lane to four lane transition between station 105+00 and 110+00.

Station	Interval	Template
100+00.00	25	12345_HMA_2Lane
105+00.00	25	12345_HMA_2Lane
110+00.00	25	12345_HMA_4Lane

Typical Section Change Example

Two lane to four lane transition between station 105+00 and 110+00.

Station	Interval	Template
200+00.00	25	12345_HMA_4Lane
205+00.00	25	12345_HMA_2Lane

Interval Change Example

Rapidly changing terrain between stations 150+00 and 160+00 where 5 foot drops are needed.

Station	Interval	Template
100+00.00	25	12345_HMA_2Lane
105+00.00	25	12345_HMA_2Lane
110+00.00	25	12345_HMA_4Lane
150+00.00	5	12345_HMA_4Lane
160+00.00	25	12345_HMA_4Lane
200+00.00	25	12345_HMA_4Lane
205+00.00	25	12345_HMA_2Lane

Even though the same four lane template is specified at station 110+00, 150+00, 160+00 and 200+00, there are no superfluous entries because of interval change between stations 150+00 and 160+00.

The following examples illustrate when it is *not* appropriate to add template drops.

Typical Section Change

Two lane to four lane to four lane urban section.

Station	Interval	Template
100+00.00	25	12345_HMA_2Lane
105+00.00	25	12345_HMA_2Lane
110+00.00	25	12345_HMA_4Lane
150+00.00	25	12345_HMA_4Lane
200+00.00	25	12345_HMA_4Lane
205+00.00	25	12345_Urban_4Lane

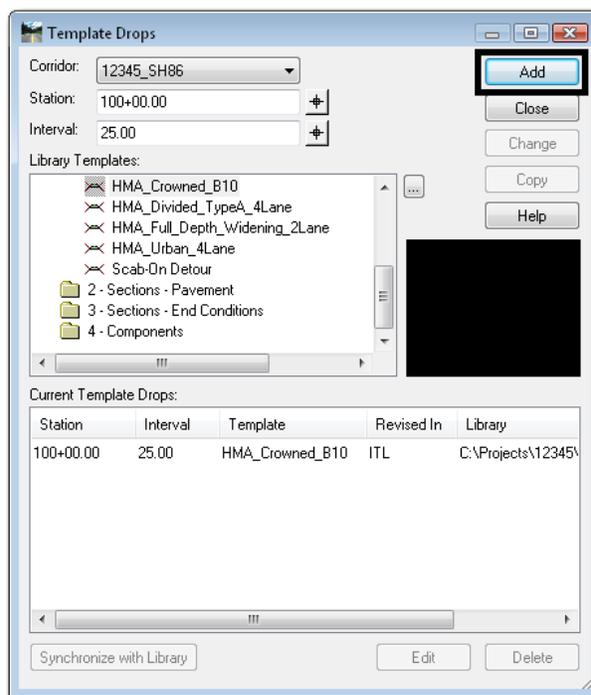
The fourth entry at station 150+00 is not needed because there was no change to the typical section or interval between stations 110+00 and 200+00. It is considered a superfluous entry in the table.

Creating Template Drops

Template Drops are created as follows:

Note: The template library must be opened prior to selecting the **Template Drops** command. You can only select templates from the loaded ITL file.

1. From the **Roadway Designer** menu bar, select **Corridor > Template Drops** or <D> the **Template Drops** icon  from the button bar.
2. In the **Template Drops** dialog box, select the **Corridor** using the drop down menu.
3. Key in the starting **Station** for the template (the start station of the corridor will be selected by default).
4. Key in the **Interval** for the template drops.
5. Expand the **Template Library** folder to show the contents of the **1 – Templates** folder.
6. Highlight the desired template.
7. <D> the **Add** button.



8. Repeat steps 3 through 7 above to add additional template drops.
9. <D> **Close** to dismiss the **Template Drops** dialog box.

Note: If a template, station or interval is incorrect, highlight the entry, make the change and then choose **Change**.

The templates are copied from the template library (ITL file) to the roadway design file (IRD file).

Important! There is no dynamic link between templates in the library and template drops. Changes to templates in the roadway design file (IRD) will not affect templates in the template library (ITL). Likewise, changes to templates in the template library are not automatically updated in the roadway design file.

Therefore, the following are two options for editing templates that are used in the modeling process.

Editing a Template from the Template Drops Dialog Box

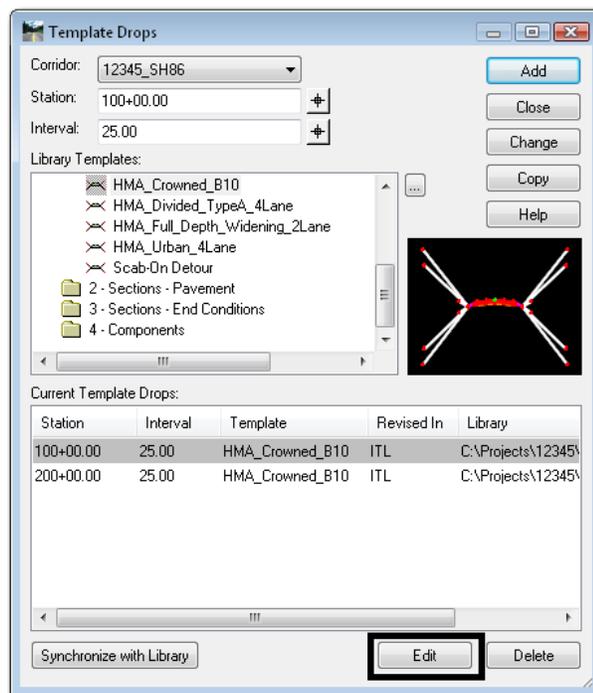
You may want to modify a standard template through an entire template drop station range without modifying the template in the template library. This allows you to use the standard template at another drop location without having to create a separate template in the library.

Note: This type of edit is usually the exception rather than the rule and is not often done. However, there may be special situations that warrant this type of edit, which is accomplished by editing the template directly from the **Template Drops** dialog box.

Important! These modifications will only be used for the station range highlighted. The changes in the template are not carried over to the template library. Instead, the modified template resides in the IRD file only.

To modify a template in this manner:

1. In **Template Drops**, highlight the desired template in the **Current Template Drops** area.
2. <D> the **Edit** button. The **Editing Roadway Designer Template Drop** dialog box appears.



3. Modify the template as described in [Chapter 2 Defining Templates](#) in this document.
4. <D> **OK** to complete the edit.

Templates that have been modified will be shown in red in the **Current Template Drops** section of the **Template Drops** dialog box. Also, the **Revised in** field will read IRD.

Station	Interval	Template	Revised In	Library
100+00.00	25.00	HMA_Crowned_B10	IRD	C:\Projects\12345\
200+00.00	25.00	HMA_Crowned_B10	ITL	C:\Projects\12345\

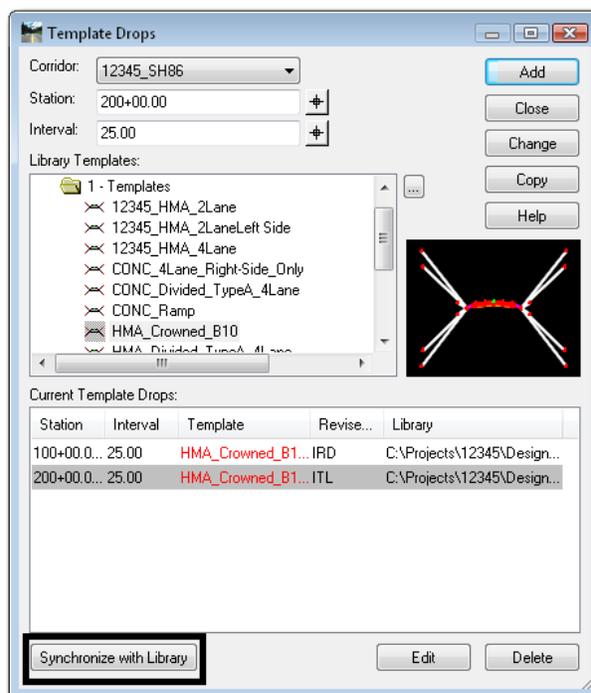
Updating A Template From the Template Library

All changes made to a template in the template library must be updated in the Roadway Designer. This is accomplished by synchronizing the template from the library with the template in the **Template Drops** dialog box.

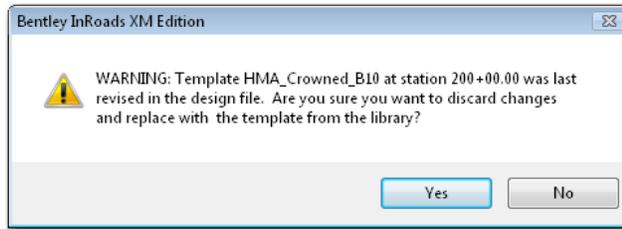
Templates within the template drops list that do not match those in the template library will be shown in red. The Revised In column indicates where the template was changed. Templates modified using the **Create Templates** dialog box have ITL in the **Revised In** column. Those modified in the Roadway Designer have IRD.

To update a template drop to match the Template Library:

1. Highlight the desired template in the **Current Template Drops** area.
2. <D> the **Synchronize with Library** button.



3. If the selected template drop was modified in the **Roadway Designer** dialog box, a warning message will be displayed.



4. Select **Yes** to change the template to match the Library. Select **No** to leave it as modified.

Note: To an IRD edited template elsewhere, you can copy it back to the ITL file using the **Template Library Organizer**.

After templates are synchronized with the library, the template text changes from red to black in the **Templates Drop** box.

Important! When templates in the IRD file are synchronized with the ITL file, template transitions are re-established and the transitions must be re-defined if they were previously edited. For more information on editing template transitions see [Design Consideration – Template Transitions](#) later in this chapter.

You may see other color coded text in the **Current Template Drops** section of the **Template Drops** dialog box. The table below is a summary:

Item	Color	Indication
Station text	Red	Alignment geometry has been modified and the station is no longer valid
Template text	Red	The template was modified in the template library and doesn't match the template in Roadway Designer
Template text	Blue	The template does not exist in the template library
Template Library	Red	The template library from which the template was placed is not the template library currently open

For practice on creating corridors and template drops, see [Lab 4 – Corridors and Template Drops](#) in the [InRoads Lab Guide](#).

Point Controls

Point Controls are used to override the template point constraints and redefine the location of points relative to an alignment, feature, or other corridor point. Using Point Controls will reduce the number of templates required for modeling, especially for corridors varying in lane and/or median width. There are many uses for point controls, including:

- Divided highways that follow different horizontal and vertical alignments.
- Introduction of right and left turn lanes.
- Introduction of ramps, acceleration lanes, etc.
- Following existing surface features for an overlay project.
- Superelevation of template points.
- Placement of independent ditches (ditches that follow a different path from the centerline).
- Maintaining sideslopes within right-of-ways.

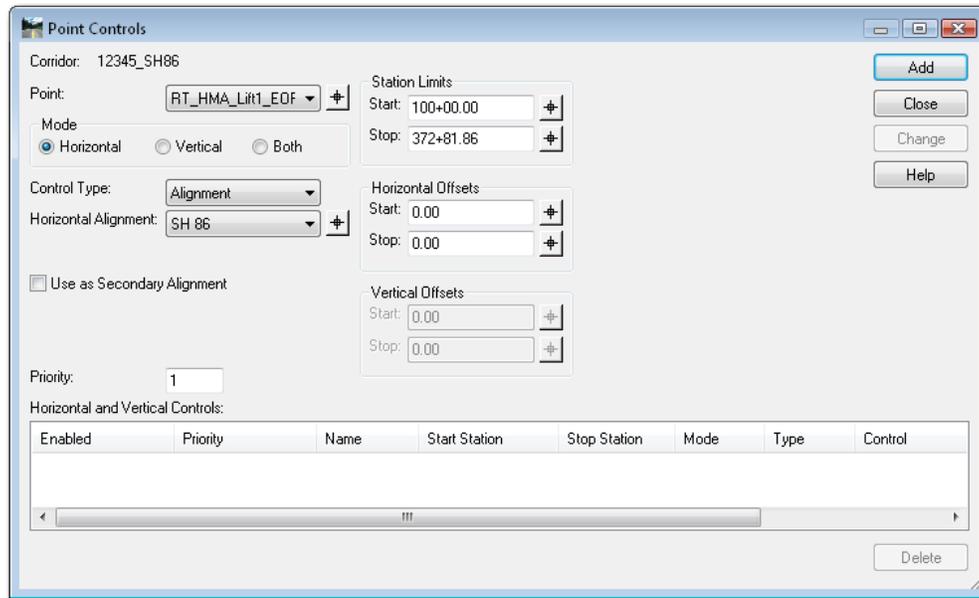
Introduction to Point Controls

Point Controls are defined in the Roadway Designer. Use Point Controls when you want to vary the location of template points without having to create multiple templates and multiple template drops in your corridor. For example, when introducing a right turn lane, instead of creating multiple right-turn lane templates and template drops for all the intermediate transition points, you could instead use Point Controls to assign the right lane point to follow a separate right turn alignment. You can also follow stations and offsets from the mainline alignment (for linear transitions) using either Point Controls or Parametric Constraints (see the section, [Parametric Constraints](#), later in this chapter).

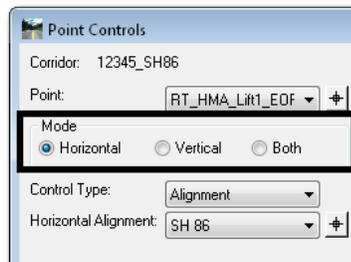
Note: Point Controls override the point constraints defined in the template.

Point Controls are defined and managed in Roadway Designer by selecting **Corridor > Point Controls** from the Roadway Designer menu bar.

There are a number of options that determine how the point will be controlled. These options are:



- **Mode** – Three modes are available, **Horizontal**, **Vertical**, and **Both**.



- ◆ **Horizontal** – This option moves the point in the Left/Right plane. The point is moved closer to or further from the control based on other settings in the point control dialog box. A horizontal control affects any horizontal-type constraint. It does not override a vertical constraint, so slopes and vertical offsets are maintained.

Example: A right turn lane that maintains the thru lane cross slope but develops through tapers or reverse curves.

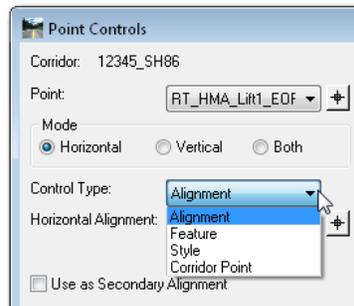
- ◆ **Vertical** – This option moves the point in the Up/Down (elevation) plane. A vertical control modifies a **Vertical**, **Vector-Offset**, and **Slope** constraint.

Example: Points that follow the mainline horizontal (lanes, edges, etc.) but rotate off the mainline vertical alignment in superelevation.

- ◆ **Both** – This option moves the point in both planes. A **Both** control overrides all point constraints.

Example: A divided highway where one set of lanes follows the mainline and the other set has its own horizontal and vertical alignment.

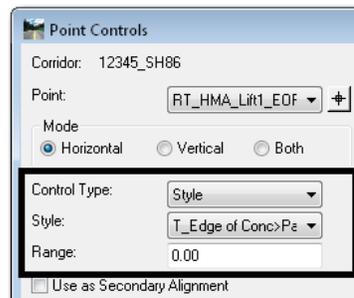
- **Control Type** – This determines the element type that the point will follow. Additional pull down menus are displayed based on the **Mode** selected.



- The choices are:
 - ◆ **Alignment** – The point follows the specified horizontal and/or vertical alignment. This option is available for all modes.

Example: A right edge point following a right turn lane alignment with a reverse curve.
 - ◆ **Feature** – The point follows the specified feature horizontally and/or vertically. This option is available for all modes.

Example: An edge point following an existing edge of pavement feature for an overlay project.
 - ◆ **Style** – The point follows a feature or alignment with the specified style horizontally and/or vertically.

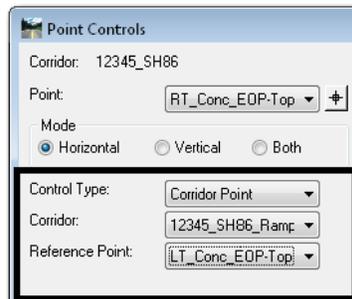


Example: An edge point following multiple edge of pavement features for an overlay project where the features have different names but the same style.

If more than one feature at the same station uses the specified style, the point follows the feature that was created first. A **Range** can be specified when searching for a style. This is a maximum horizontal distance from the point's original location to search for the style. This option is available for all modes. When specifying the range:

- A **negative** range searches to the **left**.
- A **positive** range searches to the **right**.
- A **zero** value finds the **closest** style.

- ◆ **Corridor Point** – The point follows a template point used in another corridor. The specified point is followed horizontally and/or vertically. This option can be used with all three modes.



Example: A shoulder point in the mainline corridor following an edge point in a separate ramp corridor. This can be accomplished “live” in the Roadway Designer without having to create a surface from the controlling corridor. This is usually defined over a specified station range.

- ◆ **Superelevation** – This option is used by the **Superelevation Wizard** to create the point controls for superelevation. It is also used for point controls on manually created superelevation control lines or those imported from a previous versions of InRoads. This option is only used with the **Vertical** mode.

Example: Edge points following superelevation control lines representing the points’ cross slope. The control lines are those displayed on the superelevation diagram view in the Roadway Designer.

- ◆ **Elevation Difference** – This option adds or subtracts the elevation of the specified vertical alignment to the elevation of the corridor’s vertical alignment. This option can be used to create superelevation without using the wizard by building a vertical alignment to represent the elevation changes for the point. This option is only used with the **Vertical** mode. These alignments are often called **vertical difference** alignments.

Example: Edge points following independent “difference” vertical alignments in superelevation.

Note: These are not the same as **Superelevation Control Lines** created using the **Superelevation Wizard** or the **Create Single Control Line** command. For more information on how vertical point controls work in superelevation see the [Superelevation](#) section later in this Chapter.

- ◆ **Elevation and Grade** – This option starts the point at a specified elevation. It then follows the specified grade to the end station. This option is only used with the **Vertical** mode.

Example: A ditch point that follows an independent vertical path (starting elevation and grade) from the mainline vertical alignment.

Note: If the ditch point is constrained horizontally but not with a slope, the foreslope varies. If the ditch is constrained with a slope, but not horizontally, the foreslope is kept and the width varies to meet the new elevation.

- **Station Limits** – These set the beginning and ending stations for the control. The stations default to the length of the controlling element and its location relative to the corridor alignment stationing.
- **Horizontal Offsets** – This is used to move the point a specified distance to the left or right of the control element. If the **Start** offset and **Stop** offsets are different, the point location varies linearly between the start and stop.
- **Vertical Offsets** – This is used to move the point a specified distance above or below the control element. If the **Start** offset and **Stop** offsets are different, the point location varies linearly between the start and stop.

Note: If a separate alignment is not available for a point to follow, you can also vary the point by following horizontal and/or vertical offsets from the mainline alignment. This is useful for linear lane transitions (e.g. right turn lanes). However, if more complicated geometry for the lane is required (like a reverse curve), a separate alignment is needed.

- **Priority** – This determines which control is used on a point with conflicting point controls. When there is a conflict, the control with the lower priority is used.

Note: **Orange** stations in the Point Controls list indicate points with overlapping or conflicting controls. The Control with the lowest priority is used.

Red stations indicate an invalid station. The station may not exist because of changes to the alignment or the stations were keyed-in incorrectly. This could also mean that the alignment is missing.

The following table summarizes the control types available for each Point Control mode:

Point Control Types

	Horizontal	Vertical	Both
Alignment	X	X	X
Feature	X	X	X
Style	X	X	X
Corridor Point	X	X	X
Superelevation		X	
Elev. Difference		X	
Elev. & Grade		X	

Note: Once point controls are established, process the model to see the results.

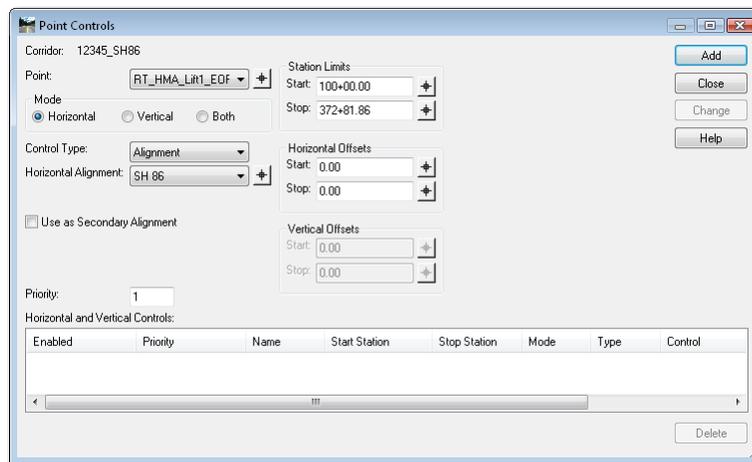
Important! Even though point controls override template point constraints, the constraints still play a role in the final result. By default, point controls override the constraint that most closely matches the control type. For example, a vertical control will override a vertical or slope constraint rather than a horizontal constraint.

While it is generally accepted best practice to fully constrain all points (with the exception of the centerline) in standard templates, there are situations where the constraints may need to be released in order to achieve the desired results with your point control. For example, if the point is horizontally *and* slope constrained and you assign a vertical control, the slope will change to meet the control. However, if the point has *only* a slope constraint and you assign a vertical control, the point will change horizontally by sliding along the slope constraint until it reaches the vertical assigned by the control.

Adding Point Controls

To add a Point Control:

1. Select **Corridor > Point Controls** from the **Roadway Designer** menu bar or <D> the **Point Controls** button from the button bar.



2. Select the **Point** to control using the locate  button and selecting the point from the cross section display, or select the point from the drop down menu.
3. Toggle on the desired **Mode**.
4. Select the **Control Type** to control from the drop down menu.

- Use the drop down menus and key-in fields to specify the controlling element. The options change based on the **Control Type** selected as shown below.

Control Type: Alignment Horizontal Alignment: SH 86 Vertical Alignment: SH 86 V	Control Type: Feature Surface: 12345 existing grou Feature: T_Billboard Over 10f	Control Type: Style Style: ALG_COGO_Points Range: 0.00	Control Type: Corridor Point Corridor: corridor2 Reference Point: ABC_Centerline-Top
Control Type: Superelevation Superelevation: Section1 HMA_Litt1 Reference Point: ABC_Centerline-Top	Control Type: Elevation Difference Horizontal Alignment: SH 86 Vertical Alignment: SH 86 V	Control Type: Elevation and Grade Elevation: 0.00 Grade: 0.00%	

- If you wish to limit the control within the default length of the controlling element, use the **Start and Stop Station Limits**.
- In the **Horizontal Offsets** area, key in the desired **Start** offset.
- Key in the desired **Stop** offset.
- In the **Vertical Offsets** area, key in the desired **Start** offset.
- Key in the desired **Stop** offset.
- Key in the **Priority** for the control.
- <D> the **Add** button to complete the control.
- Repeat steps 2 through 12 for additional controls.
- <D> the **Close** button to dismiss the **Point Controls** dialog box.

Corridor: 12345_SH86

Point: RT_HMA_LIR1_EOF

Mode: Horizontal Vertical Both

Control Type: Alignment

Horizontal Alignment: offset

Use as Secondary Alignment

Priority: 1

Station Limits: Start: 100+00.00, Stop: 132+40.02

Horizontal Offsets: Start: 0.00, Stop: 0.00

Vertical Offsets: Start: 0.00, Stop: 0.00

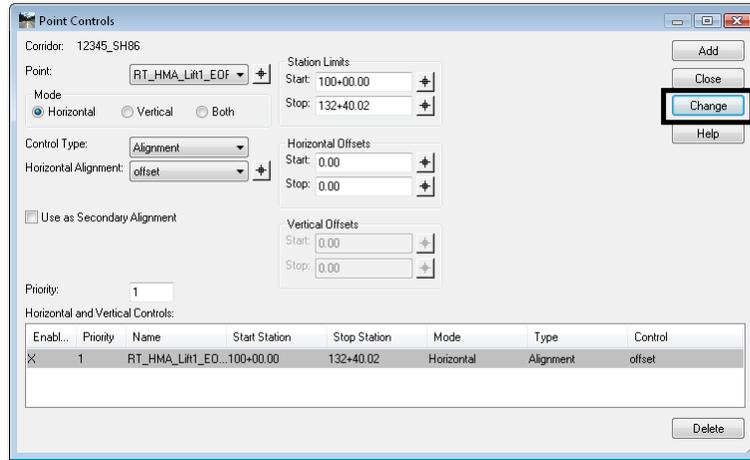
Horizontal and Vertical Controls:

Enabl...	Priority	Name	Start Station	Stop Station	Mode	Type	Control
X	1	RT_HMA_LIR1_EOF...	100+00.00	132+40.02	Horizontal	Alignment	offset

Editing Standard Point Controls

- Select **Corridor > Point Controls** from the **Roadway Designer** menu bar or <D> the **Point Controls** button from the button bar.
- Highlight** the desired control in the **Horizontal and Vertical Controls** area.
- Make the desired changes using the menus in the upper part of the dialog box.

4. <D> the **Change** button to accept the changes.



Note: You can temporarily disable a point control without deleting it by toggling off **Enable** in the control list.

Superelevation

Superelevation modifies a template through a curve so that vehicles can maintain stability at the designed speed. Once you establish your template drops and make necessary template edits, you are ready to add superelevation to your roadway (if needed).

For basic superelevation terminology, refer to the [Glossary](#) located in the [InRoads online Help](#) under [Supplemental Information > General](#).

Introduction to Superelevation

The InRoads superelevation commands compute the necessary super rate and determine how the road will transition from normal crown to full superelevation as well as the locations of these transitions for each curve in the corridor, based on your design criteria.

To establish superelevation on your roadway you will:

- Use the **Superelevation Table Wizard** to establish your initial superelevation for the roadway. This saves time and effort when creating the initial superelevation point controls and control lines.
- Edit the superelevation point properties as necessary to override the Wizard setting and tailor the superelevation to your project's design criteria.

The Superelevation Menu

The **Superelevation Menu** is used to set up superelevation design criteria. Commands include:

- ◆ **Superelevation > Create Superelevation Wizard:** Used to step through the process of entering superelevation criteria. There are three available methods to input the data: **AASHTO**, **Fixed Length** or **Table**. CDOT uses the **Table** method. After running the wizard, superelevation control lines are automatically created and assigned to template points (through Point Controls) to determine how the points (edges, lanes, etc.) will rotate in super.

- ◆ **Superelevation > Create Single Control Line:** An alternate method of setting up superelevation criteria by manually creating superelevation control lines, which controls the cross slope of template points in superelevation. This is also useful if you need to change the cross slope of the roadway when you're not truly in superelevation, such as matching the vertical grade of the main roadway for an approach road.
- ◆ **Superelevation > Apply Shoulder Rollover Lock:** Allows you to create special superelevation control lines and assign point controls to shoulder points, which determine how shoulders will rotate in super. CDOT does not use rollover locks in standard situations, since the shoulders are fully superelevated.
- ◆ **Superelevation > Import Superelevation:** Allows you to import an ASCII superelevation file (pipe delimited format) to create superelevation control lines and assign point controls.
- ◆ **Superelevation > Import Superelevation from Alignment:** Allows you to import superelevation data from an InRoads alignment created in previous versions of InRoads (version 8.5 and earlier). This creates superelevation control lines matching the previous super table.
- ◆ **Superelevation > Superelevation Report:** Allows you to generate an XML report of the superelevated points and/or their corresponding control lines.

Note: The *Superelevation Table Wizard* (CDOT's preferred method of setting up superelevation criteria) is explained below. For information on other methods or the concept of superelevation in general, refer to [Superelevation Overview](#) in the [InRoads Online Help](#) file.

The Superelevation Wizard

The *Superelevation Wizard* steps you through the process of entering your superelevation criteria. This criteria includes selecting the appropriate CDOT superelevation rate table.

Note: CDOT uses the *Table* method to calculate superelevation rates. This method complies with AASHTO guidelines and incorporates CDOT's superelevation standards by utilizing custom superelevation tables located in the CDOT workspace.

The CDOT superelevation tables specify maximum superelevation rates, along with spiral transition lengths, for a range of curve radii. The tables are text files, which can be opened in **Notepad** or any word processor. They are categorized by a maximum superelevation rate and a design speed. For example, a table named *06_55.sup* contains CDOT standards for a 6% maximum superelevation rate at 55 mph design speed.

An example table is shown below:

```

BENTLEY SYSTEMS INROADS SUPERELEVATION RATE TABLE UPDATED BY BOHANNAN HUSTON INC.
From A Policy on Geometric Design of Highways and Streets, AASHTO, 2004, Fifth
Edition pages 168 and 181, and From CDOT M&S Standards 2006, M-203-11 and M-203-12
Design speed in mph
55.000
*
*
* Placeholder      Radius      Super Rate      2-lane      4-lane
* -----      -----      -----      spl_lgt      spl_lgt
*
Curve 9410,000      nc          0.0           0.0
Curve 9409,999      .020       51.0         77.0
Curve 6820,000      .020       51.0         77.0
Curve 6819,999      .022       56.0         84.0
Curve 6110,000      .022       56.0         84.0
Curve 6109,999      .024       61.0         92.0
Curve 5520,000      .024       61.0         92.0
Curve 5519,999      .026       66.0         100.0
Curve 5020,000      .026       66.0         100.0
Curve 5019,999      .028       71.0         107.0
Curve 4580,000      .028       71.0         107.0
Curve 4579,999      .030       77.0         115.0
Curve 4200,000      .030       77.0         115.0
Curve 4199,999      .032       82.0         123.0
Curve 3860,000      .032       82.0         123.0
Curve 3859,999      .034       87.0         130.0
Curve 3560,000      .034       87.0         130.0
Curve 3559,999      .036       92.0         138.0
Curve 3290,000      .036       92.0         138.0
Curve 3289,999      .038       97.0         146.0
Curve 3040,000      .038       97.0         146.0
Curve 3039,999      .040       102.0        153.0
Curve 2810,000      .040       102.0        153.0
Curve 2809,999      .042       107.0        161.0
Curve 2590,000      .042       107.0        161.0
Curve 2589,999      .044       112.0        169.0
Curve 2400,000      .044       112.0        169.0
Curve 2399,999      .046       117.0        176.0
Curve 2230,000      .046       117.0        176.0
Curve 2209,999      .048       123.0        184.0
Curve 2050,000      .048       123.0        184.0
Curve 2049,999      .050       128.0        191.0
Curve 1890,000      .050       128.0        191.0
Curve 1889,999      .052       133.0        199.0
Curve 1750,000      .052       133.0        199.0
Curve 1749,999      .054       138.0        207.0
Curve 1610,000      .054       138.0        207.0
Curve 1609,999      .056       143.0        214.0
Curve 1470,000      .056       143.0        214.0
Curve 1469,999      .058       148.0        222.0
Curve 1320,000      .058       148.0        222.0
Curve 1319,999      .060       153.0        230.0
Curve 1060,000      .060       153.0        230.0
*
*1060' is the minimum curve
*
*While every precaution has been taken in the preparation of the InRoads
*SuperElevation Rate Tables for AASHTO 2004, Bohannan Huston, Inc, assumes
*no responsibility for errors or omissions, or for damages resulting from
*the use of the information contained herein. Good data processing procedure
*dictates that any program, configuration file, or other customized material be
*thoroughly tested before relying on it. The user must assume the entire risk
*of using this material.

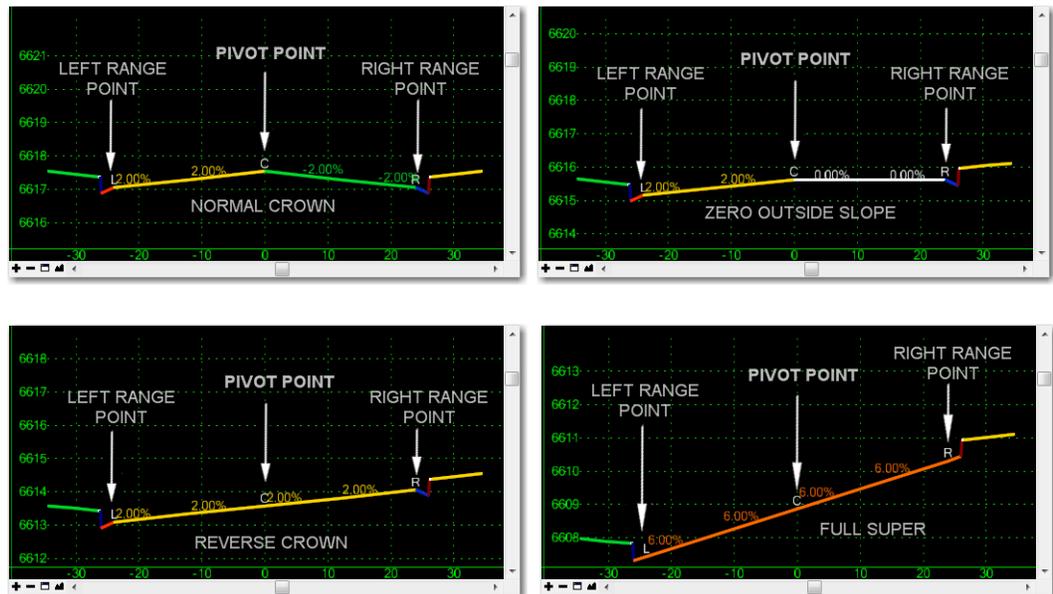
```

For more information on superlevation rate tables, see [Superlevation Rate Table \(.sup\) Descriptions](#) in the [InRoads Online Help](#).

Additional superlevation criteria that is set via the Wizard includes:

- ◆ The pivot point location (e.g. centerline, inside edge),
- ◆ The range point locations (to designate the fully superelevated portion of the template),
- ◆ The station range for different design criteria and
- ◆ The number of lanes to be superelevated.

The illustration below shows an example of pivot and range point locations for a template cross slope as it rotates through superelevation. In this example, the template pivots about the crown point and the range points (the top of gutter points) define the range of points that will rotate to full super.



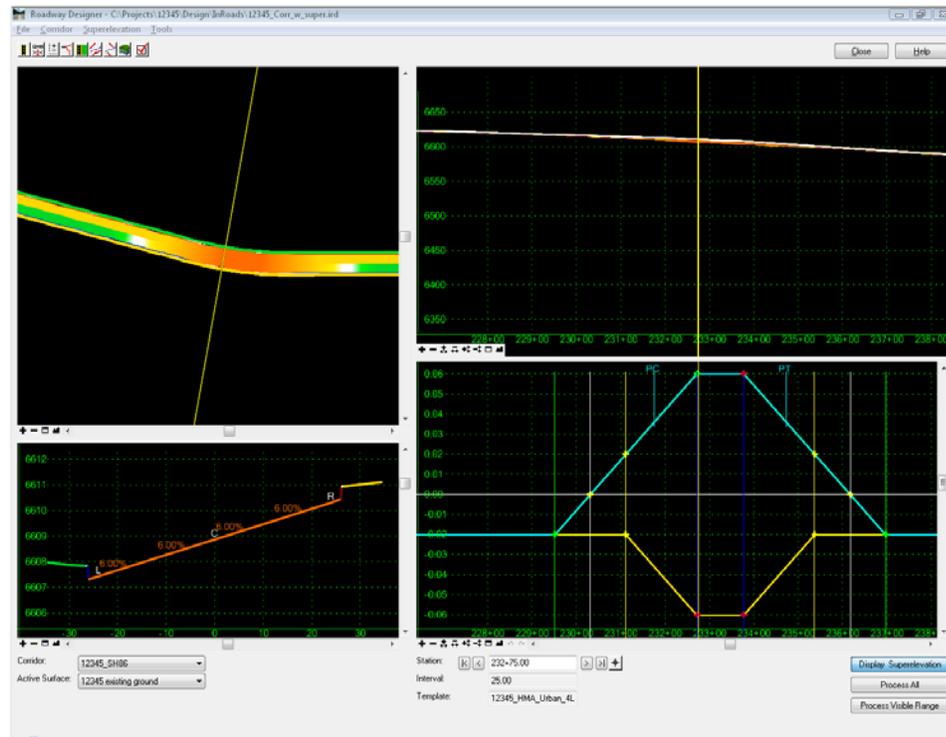
The Wizard stores this information in superelevation **Sections**. These Sections are just a set of super criteria applied to a station range along the corridor. If the super criteria change at any point along the corridor, you will end one section and start another.

Superelevation Wizard Results

When finished, the wizard automatically creates:

- The superelevation control lines for each point superelevated on the template and

- The vertical point controls for these points.

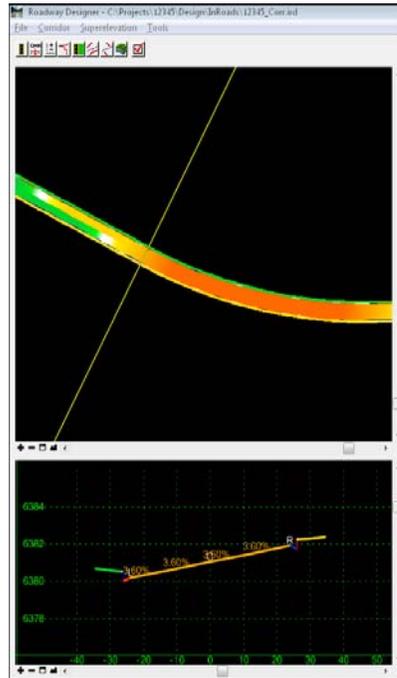


The four Roadway Designer views are updated as follows:

- The plan display shows a color-coded diagram that represents the cross-slopes for the components within the template backbone.
- The cross section display shows a color-coded view of the template backbone along with the cross slope annotations.

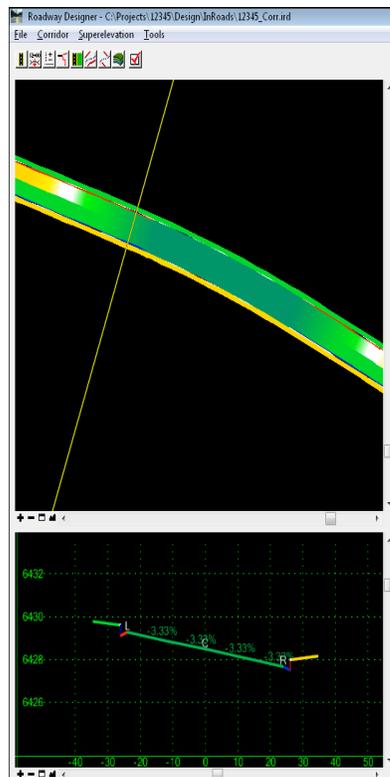
See the illustrations below for more information on how to interpret superelevation color coding in these views:

- ◆ Yellow, orange and red indicate slopes to the **left** as noted in the table below..



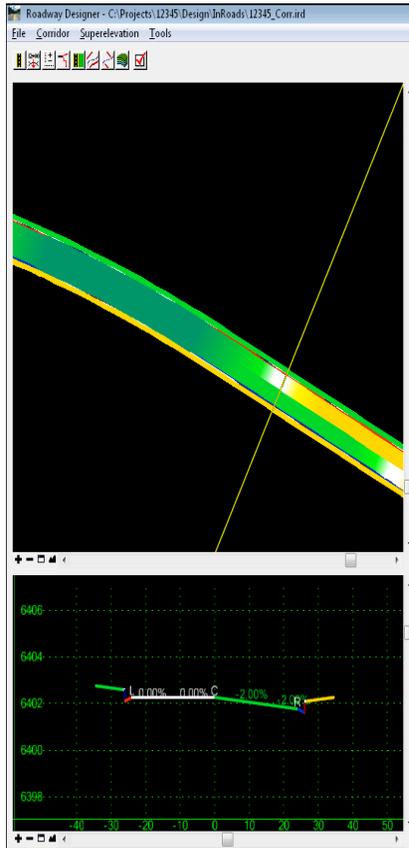
Backbone Cross Slope Color	Superelevation Cross Slope
Yellow-to-Orange/Red	0.5% to 10% to the left
Dark Red	>10% to the left

- ◆ Green, teal and blue indicate slopes to the **right** as noted in the table below.



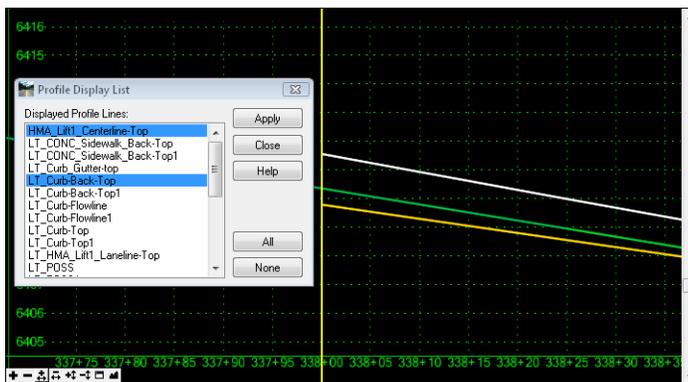
Backbone Cross Slope Color	Superelevation Cross Slope
Green to Teal/Blue	0.5% to 10% to the right
Dark Blue	>10% to the right

- ◆ White indicates a cross slope less than 0.5%.

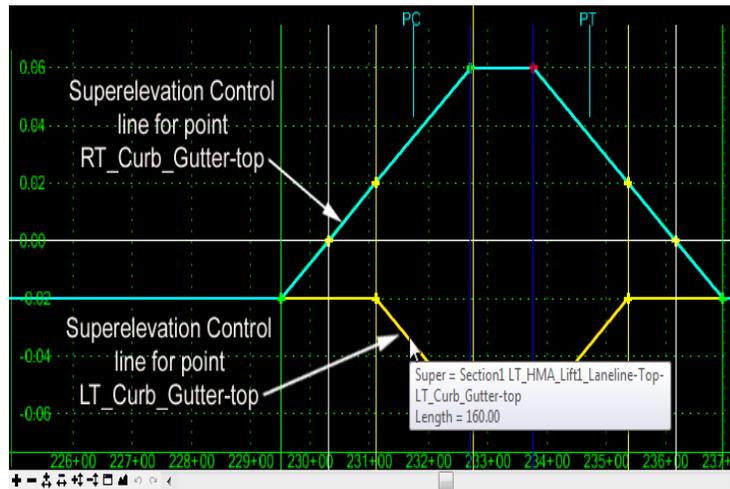


Backbone Cross Slope Color	Superelevation Cross Slope
White	<0.5%

- The profile display shows color-coded grade lines for all points on the template backbone. However, you can right-click to control which template points are displayed (i.e. the left and right edges of roadway).



- The superelevation diagram shows the control lines that represent a percent cross slope.

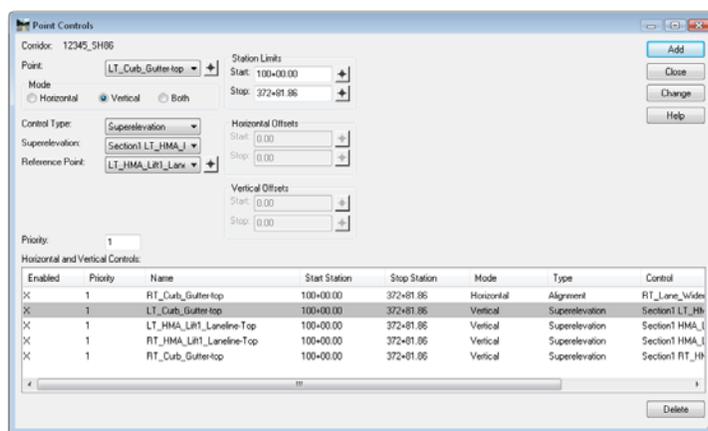


The control lines in the superelevation diagram view are the graphical representations of cross slope over a station range (stationing or length along the x-axis and cross slope on the y-axis). A horizontal line represents a constant cross slope along a station range, whereas a sloped line represents a linear change in cross slope along a station range.

An infinite number of control lines can be assigned to an infinite number of points in a corridor. The control lines can be created to control any change in cross slope between two points in the template (i.e. sidewalk, gutters, etc.)

The control lines are colored in the diagram for visual clarification only. Unlike the plan, profile and cross section views, the line colors **do not** correlate to any superelevation values.

The Wizard automatically creates the vertical point controls that correspond to each superelevation point control line. You can open the **Point Controls** dialog box to review the vertical point controls created by the Superelevation Wizard.

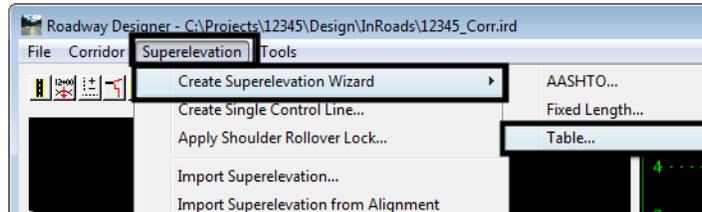


The Wizard also calculates superelevation rates for each curve on the horizontal alignment and stores these in the geometry project (ALG file). The superelevation section definitions (the point controls and control line information) are stored in the IRD file.

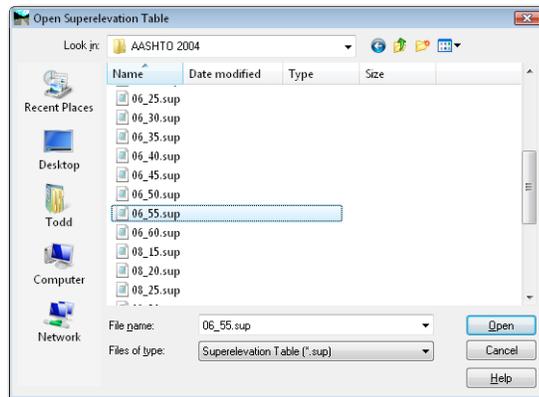
Calculating the Initial Superelevation

To use the Superelevation Wizard:

1. Select **Superelevation > Create Superelevation Wizard > Table** from *the Roadway Designer* menu bar.

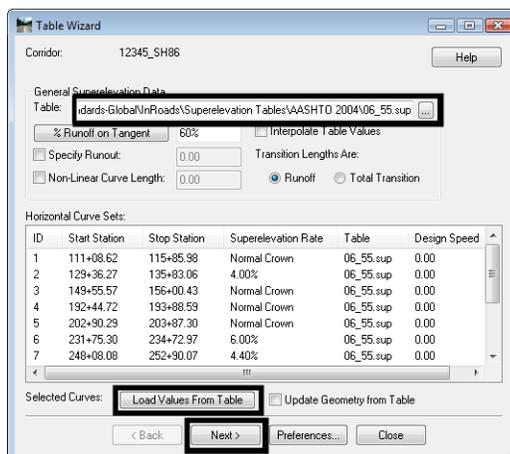


2. In the **Table Wizard** dialog box, select the desired super table. These are located in the **C:\Workspace\Workspace-CDOT_XM\Standards-Global\InRoads\Superelevation Tables** folder.



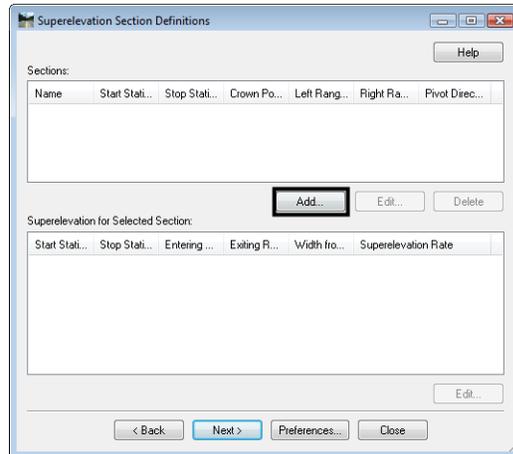
Note: If the curves need different design speeds or maximum super rates (i.e. different tables), highlight the curves to load from this table, then select **Load Values From Table**. Repeat for each curve that needs a different table.

3. <D> the **Load Values From Table** button.

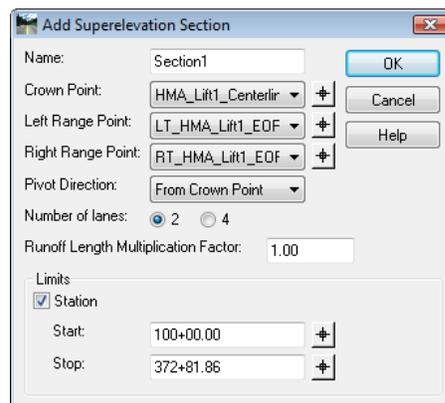


The rate values are read from the table and updated for each horizontal curve set listed in the dialog box or highlighted.

4. <D> Next.

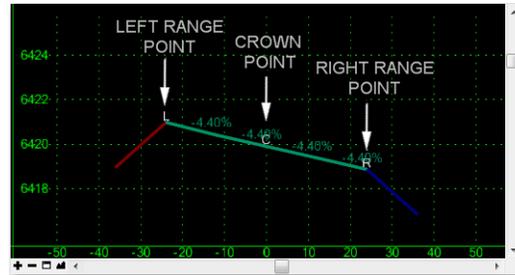


5. <D> the **ADD** button on the *Superelevation Section Definitions* pane. This displays the *Add Super Elevation Section* dialog box.



6. Use the drop down menu or the target  button to select the **Crown Point**.
7. Use the drop down menu or the target button to select the **Left Range Point**.
8. Use the drop down menu or the target button to select the **Right Range Point**.

Note: The range points define the points at the outermost edge of the fully superelevated portion of the template. In the example below, these are the left and right edge of pavement points on the **CDOT HMA_Crowned_B10** template.



9. Select the desired **Number of Lanes**, either **2** or **4**.

10. Key in the desired **Runoff Length Multiplication Factor**.

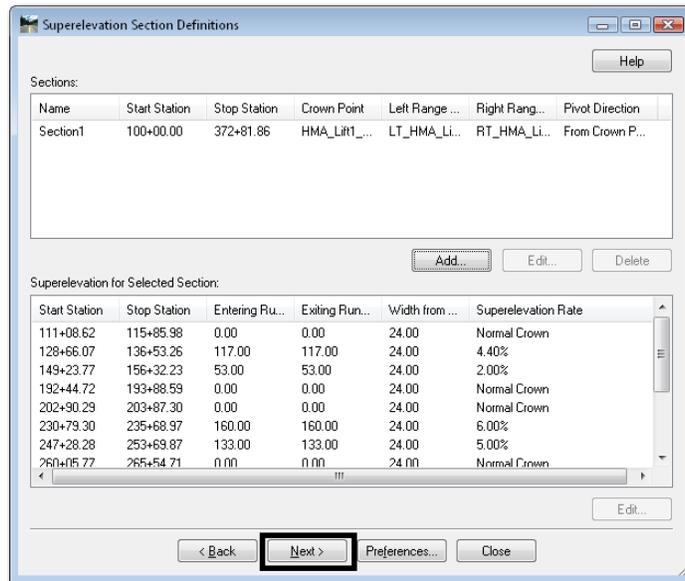
Note: This is typically only used when there are more than four lanes.

11. Set the **Station** limits, if needed.

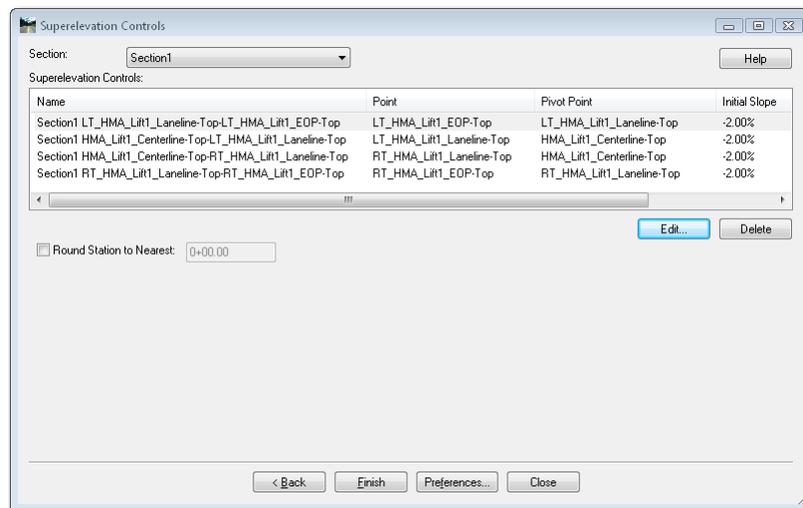
Note: Station limits are used to define superlevation section criteria limits. If superlevation design criteria change (such as different pivot points, range points or different number of lanes), then you must create a new section to specify the different criteria. However, using multiple tables along the alignment **does not** require multiple sections.

12. <D> OK.

13. Repeat steps 5 through 12 to add additional sections if any super design criteria changes.



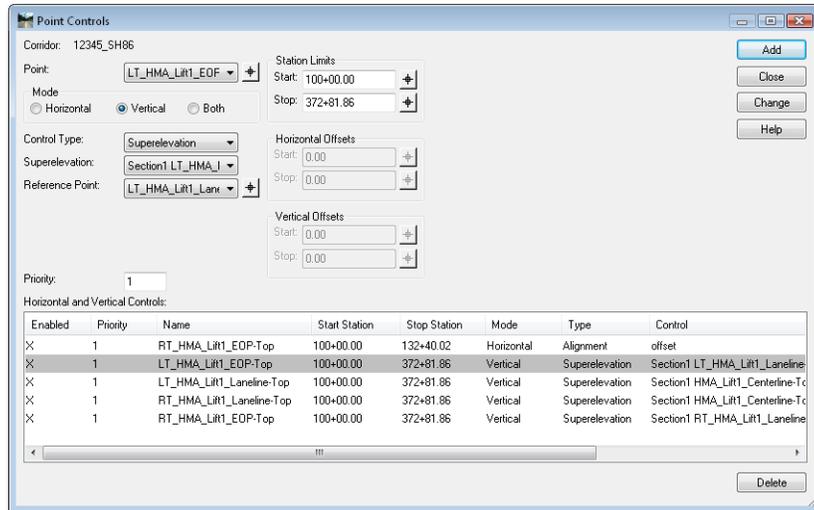
14. <D> **Next** on the *Superelevation Section Definitions* pane. This displays the *Superelevation Controls* pane.



Note: This box lists point controls that are created automatically when you go through the Wizard. The point controls determine the vertical location (by defining a cross slope) of template points (those at and inside the range points) while rotating in superelevation. Use the **Edit** button to make changes in the control lines as needed. Use the **Delete** button to remove unnecessary point controls, like lane line points that may be control by constraints set in the template.

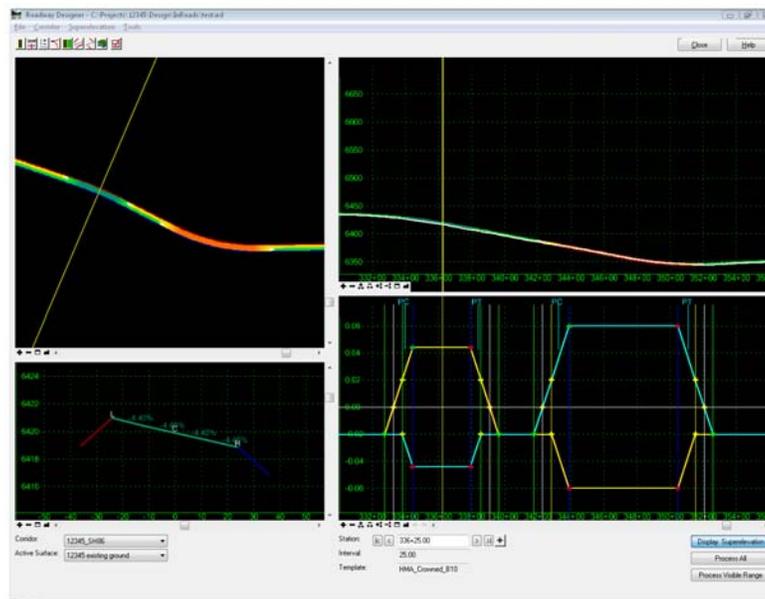
15. <D> **Finish**. This completes the superelevation, and dismisses the Superelevation Wizard.

The Wizard creates superelevation control lines and uses point controls to assign them to the template points within the superelevation range.



You will need to process your design to see the superelevation results. Each point control corresponds to a control line on the superelevation diagram.

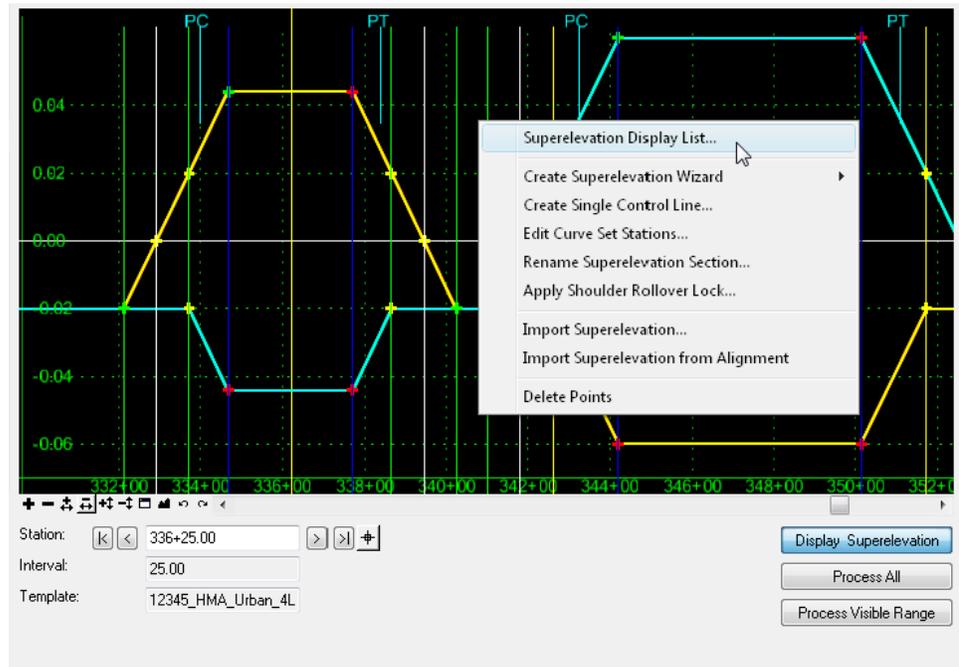
The superelevation control lines are displayed on the superelevation diagram view in Roadway Designer. The control lines represent the percent cross slope (vertical axis) at each station (horizontal axis) for each point that is superelevated in the super range.



Controlling Superelevation Displays

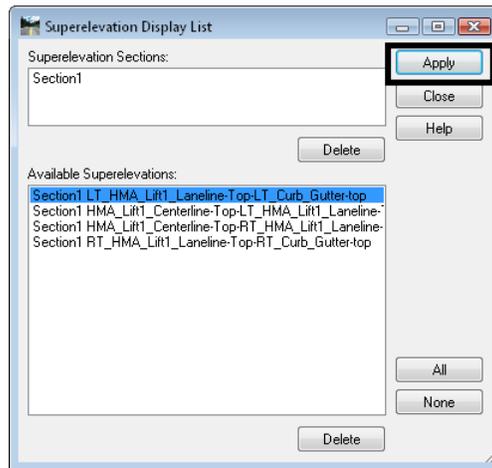
You can set which control lines are displayed in the superelevation diagram:

1. Right-click in the superelevation diagram and select **Superelevation Display List**.



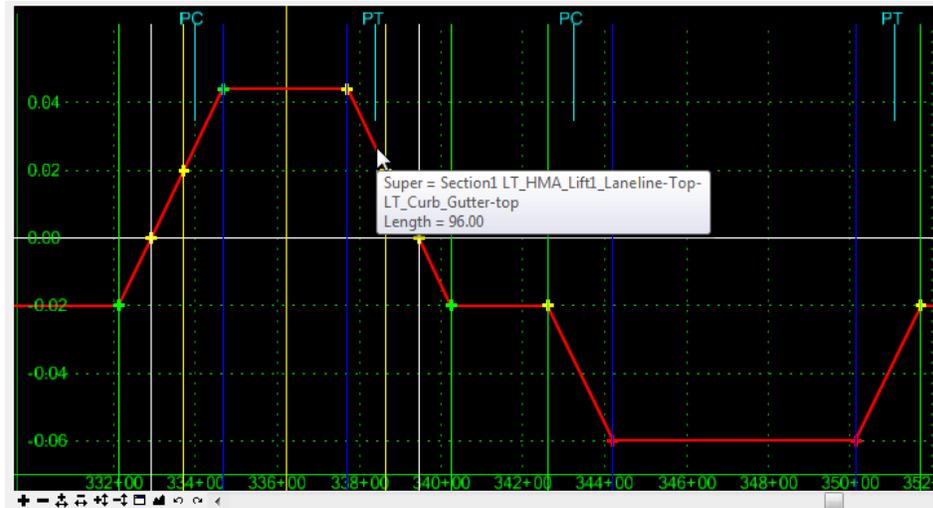
2. In the **Available Superelevation** list, select the control for the line you want to display.

Note: You can press the **Ctrl** or **Shift** keys and select multiple point controls to display more than one control line.



3. <D> Apply.

The superelevation diagram is updated with the control line display.



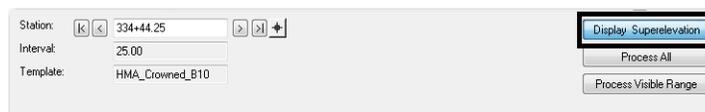
Editing Superelevation

After the Wizard has calculated the initial superelevation, you may need to edit some of the superelevation criteria like a point's cross slope or max super rate, the normal crown, runoff or full super locations, etc. You can do this in the superelevation diagram using one of the following methods:

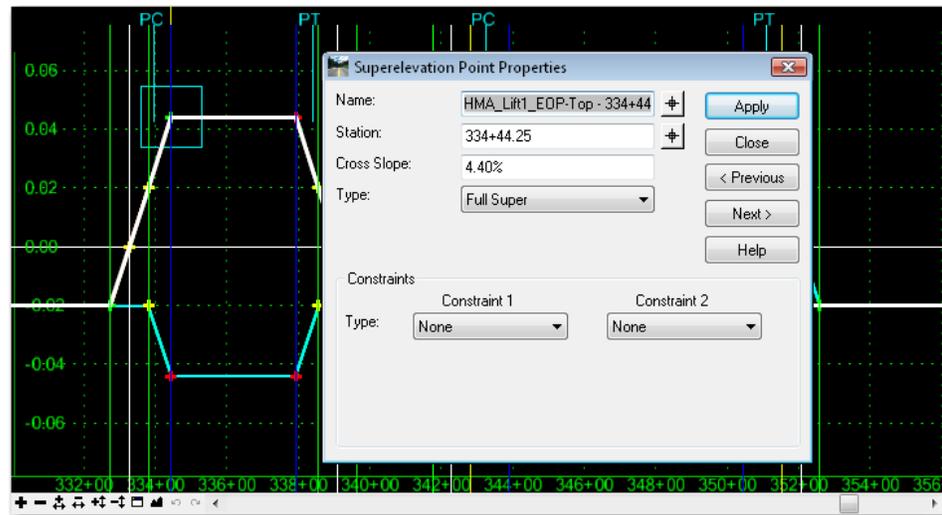
- ◆ Editing superelevation point properties (via dialog box settings).
- ◆ Graphically moving superelevation points (using dynamic settings).
- ◆ Editing **Curve Set Stations** (in table format).

Editing Superelevation Point Properties

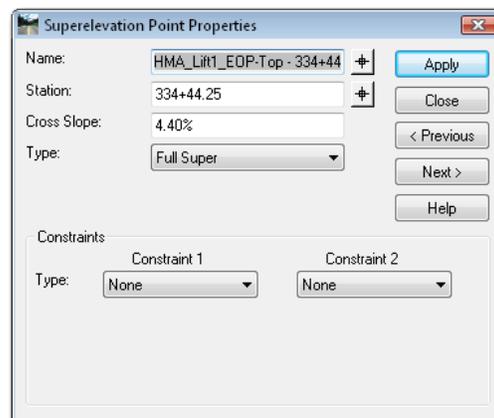
1. From the **Roadway Designer**, <D> on the **Display Superelevation** button if you're not already viewing the superelevation diagram.



2. <D> <D> on the point to edit in the superlevation diagram. This displays the **Superelevation Point Properties** dialog box.



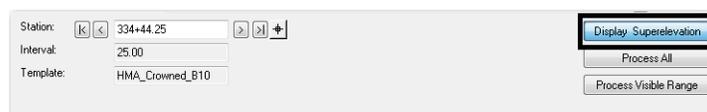
3. Change the **Name**, **Station**, **Cross-Slope**, **Type**, or **Constraints** as desired.
4. <D> **Apply** after the desired changes are made.



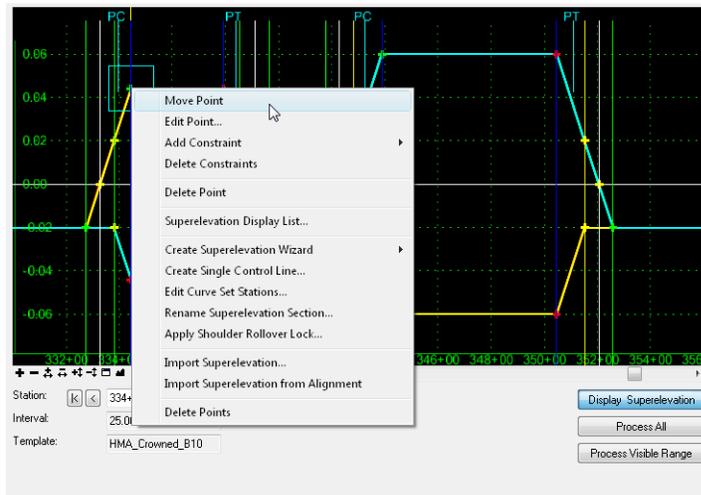
5. <D> **Close** to dismiss the **Superelevation Point Properties** dialog box.

Moving Superelevation Control Points

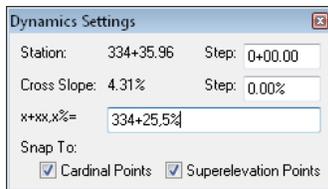
1. From the **Roadway Designer**, <D> on the **Display Superelevation** button if you're not already viewing the superlevation diagram.



2. Right-click on the superelevation control line point to edit and select **Move Point**.



3. In the **x+xx,x%** field, enter the desired station and cross slope to move the point.

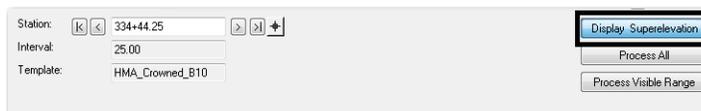


Note: Use the syntax **<Station, Cross Slope>** when keying in the **Dynamic Settings** box. Express the cross slope as either a % or decimal (e.g. **334+25,5%** or **334+25,.05**).

Editing Curve Set Stations

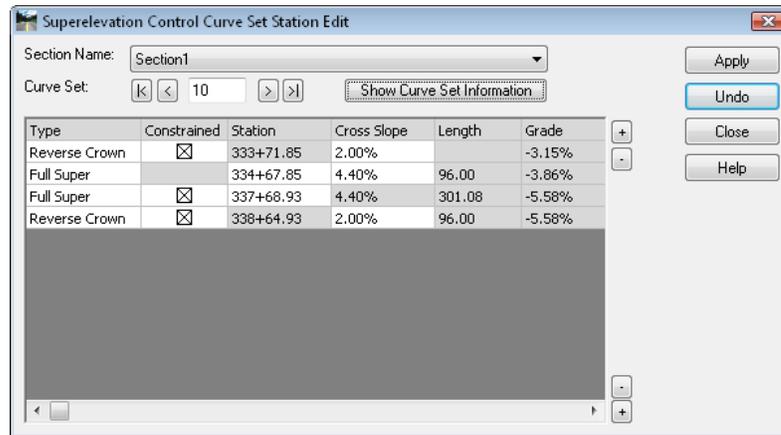
Another option for editing superelevation is to use the **Edit Curve Set Stations** tool. To use this tool:

1. From the **Roadway Designer**, **<D>** on the **Display Superelevation** button if you're not already viewing the superelevation diagram.

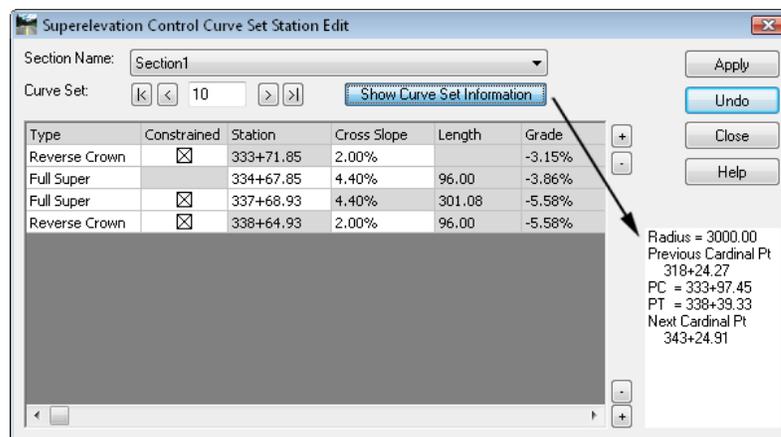


2. Right-click in the superelevation diagram control line view.
3. Select **Edit Curve Set Stations** from the right-click menu while your cursor is in the super diagram view.

- Use the **Curve Set** controls to select the desired curve and verify the desired **Section Name** is correct from the drop down menu.



- <D>** on the **Show Curve Set Information** button to display curve data in the lower right corner of the dialog box.



- Data for other curves within the super section can be added or removed from the list by using the **+** and **-** buttons to the right of the data area. Use the top buttons for data before the current curve, use the bottom ones for after the current curve.

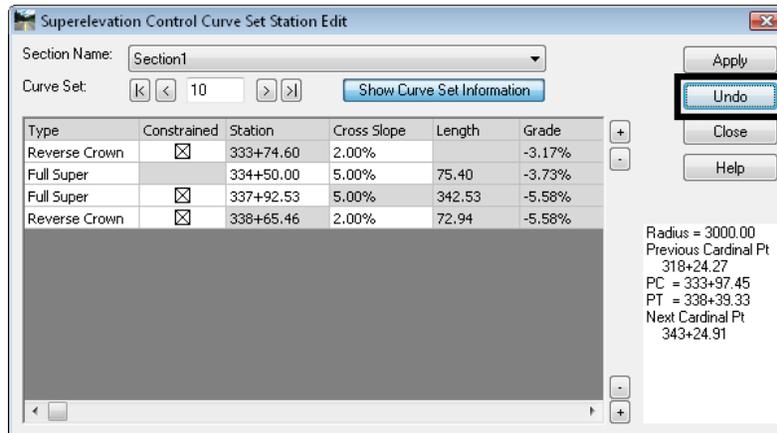
Note: Red stations denote points outside the current curve set.

- Stations** and **Cross Slopes** in white cells can be modified. Press the **Tab** key to move to the next editable field.
- Reverse Crown** stations are edited by toggling off the **Constrained** check box. If the **Constrained** check box is toggled back on, the station will revert back to its original value.

Type	Constrained	Station	Cross Slope	Length	Grade
Reverse Crown	<input checked="" type="checkbox"/>	333+39.85	2.00%		-2.92%
Full Super		334+67.85	6.00%	128.00	-3.86%
Full Super	<input checked="" type="checkbox"/>	337+68.93	6.00%	301.08	-5.58%
Reverse Crown	<input checked="" type="checkbox"/>	338+96.93	2.00%	128.00	-5.58%

Note: Changing previously constrained stations may result in kinks in the control line.

9. <D> **Apply** to accept the changes.
10. <D> the **Undo** button to discard any changes, if desired.



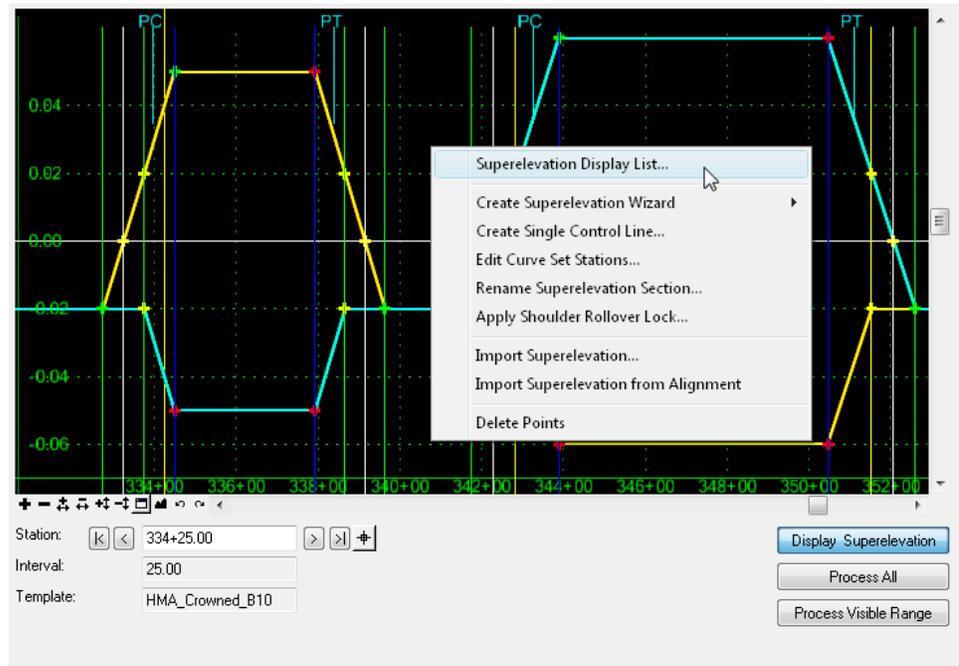
Removing Superelevation

If you make a mistake after running the initial superelevation setup (after running the Wizard) or when editing superelevation and you want to start over with the Wizard, you can remove the superelevation point controls and control lines. When removing super you have two options, you can either:

- Remove individual superelevation point controls or
- Remove the entire superelevation section (all point controls for all curves within that section).

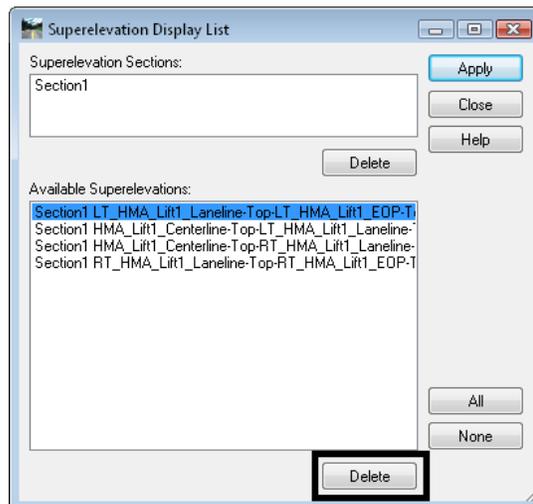
To remove super:

1. Right-click in the superelevation diagram control line view and select **Superelevation Display List...**



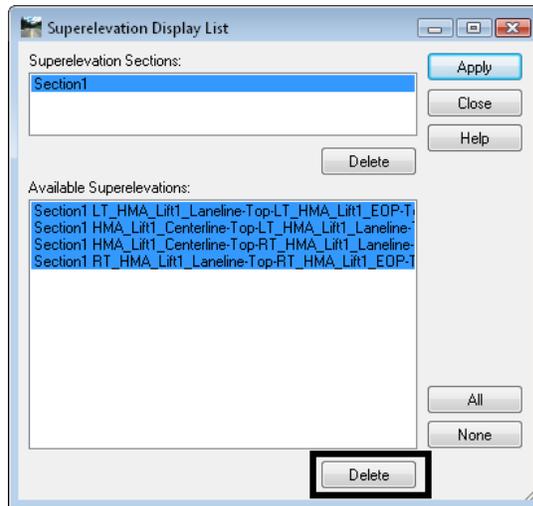
2. To delete just one control line, select the associated point controls from the list of **Available Superelevations**.

Note: You can press the **Ctrl** key and select multiple point controls to delete more than one control line.



3. Select **Delete**.

- To delete all control lines for a superelevation section, select the **Section** from the **Superelevation Section** list (all point controls should highlight).



- Select **Delete**.

For additional practice modifying superelevation, see [Lab 5 – The Superelevation Wizard](#) in the [InRoads Lab Guide](#)

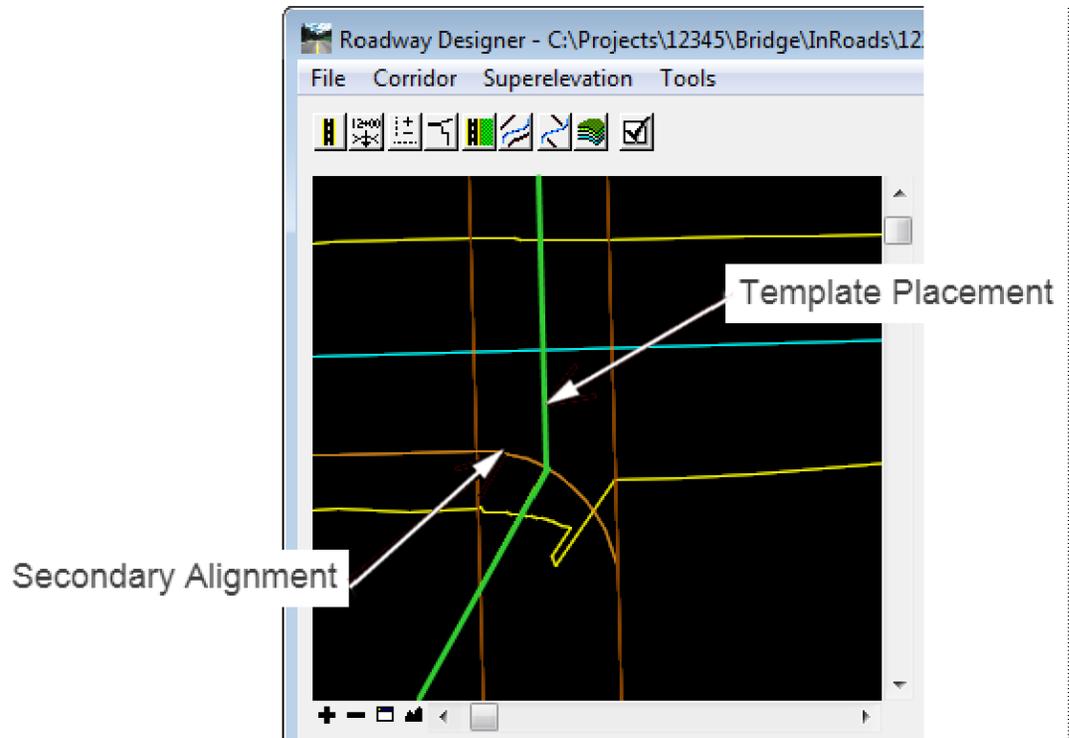
Secondary Alignments

When modeling your roadway, you may need to apply your template perpendicular along two different alignments. For example when modeling an intersection, you want to drop the template perpendicular to the centerline alignment, but also to the intersection return edges on the outside. In this case, you can specify the intersection return as a secondary alignment and have the template “bend” perpendicular when it encounters the this alignment (see the illustration below).

Secondary alignments may be applied in two ways:

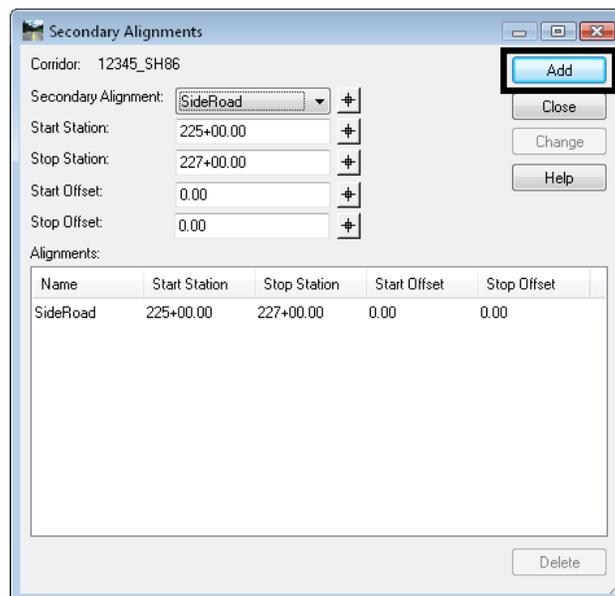
- They modify the angle of the part of the template **outside** secondary alignment **and** change the width to the specified template point to the secondary alignment when specified with **Point Controls**.
- They modify the angle of the part of the template **outside** secondary alignment but do not change the template width when specified with **Corridor > Secondary Alignments**.

In the intersection illustration below, the green line represents the template placement in relation to the corridor alignment (the light blue line) and the secondary alignment (the orange line). This secondary alignment was assigned using **Point Controls**.



To specify a secondary alignment:

1. Select **Corridor > Secondary Alignments**.
2. Select the **Secondary Alignment** from the drop down list.



3. Specify a **Start** and **Stop** station range for InRoads to treat the alignment as secondary and “bend” the template.
4. Specify any **Start** and **Stop Offsets** from the alignment.
5. Select **Add**.

The alignment will only be treated as secondary through the station range specified.

Note: You can only have one secondary alignment per station range.

Note: To have the template widen and ‘kink’, create a point control as previous defined and toggle on the **Secondary Alignment** option.

Section Summary:

- ◆ Roadway Designer is an interactive design modeling tool which allows you to see the results of your design and then make edits **before** creating your proposed 3D surface.
- ◆ Before running Roadway Designer, you must have a horizontal or vertical alignment, an existing surface and one or more templates.
- ◆ The results of this interactive and iterative design process are shown in Roadway Designer’s plan, profile and cross section views.
- ◆ Design data for modeling is stored in the IRD file.
- ◆ A corridor defines a path for your project and can be defined with a horizontal and vertical alignments or with a surface feature.
- ◆ Templates Drops specify which templates are applied where along the corridor for modeling purposes.
- ◆ If templates are changed in the ITL file, then the template drops must be synchronized with the library to see the changes update in Roadway Designer.
- ◆ Point Controls are used to vary a template point by assigning the point to follow a different path.
- ◆ Establishing Point Controls can effectively reduce the number of templates and template drops required for modeling, especially when introducing turn lanes, ramps, etc.
- ◆ A point can be controlled using horizontal point controls, vertical point controls or both.
- ◆ There are several different types of controls that a point can follow including horizontal and/or vertical alignments, horizontal and/or vertical surface features, a feature style assigned to multiple features, or a point in another corridor.
- ◆ Superelevation is added to your roadway model using the Superelevation Table Wizard.
- ◆ Superelevation mode adds a fourth view to the Roadway Designer – a superelevation diagram control line view.
- ◆ The Superelevation Wizard automatically creates vertical point controls for certain backbone template points (lanes, edges, shoulders, etc.) as well as the super control lines for each of these points.
- ◆ The super control lines are displayed in the superelevation diagram control line view.

- ◆ Superelevation can be edited by either editing point properties, graphically moving the super control line points, or editing a Curve Set table.
- ◆ Secondary alignments are used when you want to “bend” the template so that it is applied perpendicular to the secondary alignment (ramps, intersections, etc.).

Advanced Corridor Tools

You can take advantage of a couple of InRoads’ advanced corridor tools in certain design situations:

- If you need to vary template points frequently over several different station ranges, you can use **Parametric Constraints**, which saves time creating multiple templates and template drops.
- If you are working with multiple target surfaces or corridors, or designing a divided highway that may tie to multiple surfaces, then you can use **Target Aliasing** to set priority tie-ins.

Section Objectives:

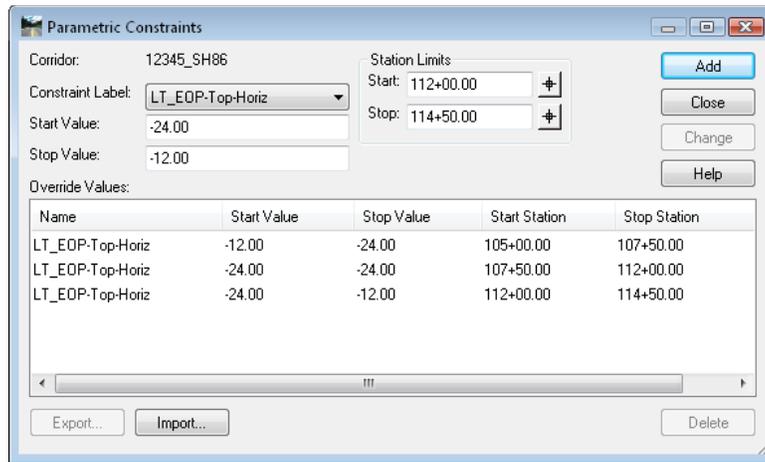
- ◆ To learn how and when to use Parametric Constraints to vary template points.
- ◆ To learn how to assign labels to point constraints.
- ◆ To learn how to assign multiple surfaces and corridors as end condition targets using target aliasing.

Parametric Constraints

Parametric Constraints are another method of modifying template points during processing in Roadway Designer. These override the value of a point’s constraints for the specified station range. This option is only available on point constraints that have been assigned constraint labels in the template library (as shown below).

The screenshot shows the 'Constraints' dialog box with two columns for 'Constraint 1' and 'Constraint 2'.
 - Constraint 1: Type: Horizontal, Parent 1: HMA_Liit1_Centerlir, Value: -24.00, Label: LT_EOP-Top-Horiz.
 - Constraint 2: Type: Slope, Parent 1: HMA_Liit1_Centerlir, Value: 2.00%, Label: LT_EOP-Top-Slope.
 The 'Label' dropdowns for both constraints are highlighted with red boxes. Below the constraints, there are radio buttons for 'Horizontal' (selected), 'Vertical', and 'Both', and a 'Range' field set to 0.00.

Parametric Constraints are defined in the Roadway Designer and can be used to move labeled points in a template without having to edit the points in the template library.



Some examples of when you could use parametric constraints include:

- Varying lift or subgrade depths over a specified station range or
- Introducing linear lane transitions using station/offset values (this can also be done with horizontal Point Controls).

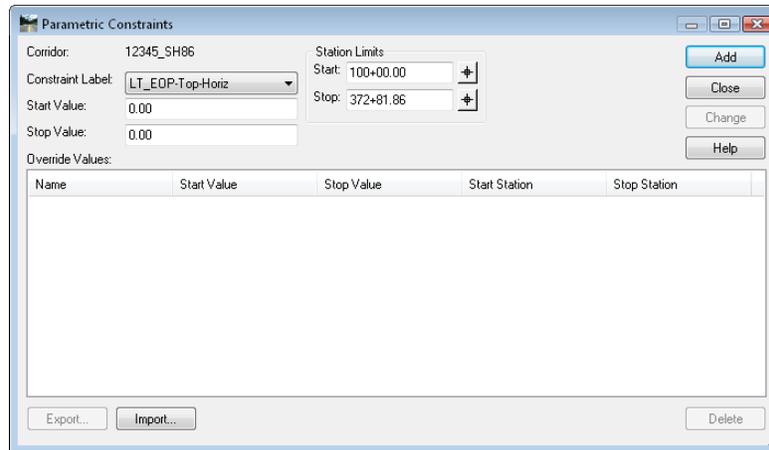
If you wanted to increase the thickness of a lift (e.g. **HMA_Lift1**), you could edit every point in the lift component on the template and change the vertical constraint value. This would be tedious and time consuming, especially if you had multiple template drops (you would have to edit the same points on every template used).

Instead, you could assign an “asphalt depth” label to each vertical point constraint in the template **Point Properties**. Then, you just have to set up one parametric constraint entry to vary this label constraint over a specified station range. When the template is outside this range, it will revert to the thickness as defined in the template.

Any point constraint that has been assigned a label can be varied using parametric constraints. The workflow example below illustrates how to introduce a linear lane transition by varying an edge of pavement point from 12 to 24 feet from the centerline over a 250 ft. station range

Defining a parametric constraint:

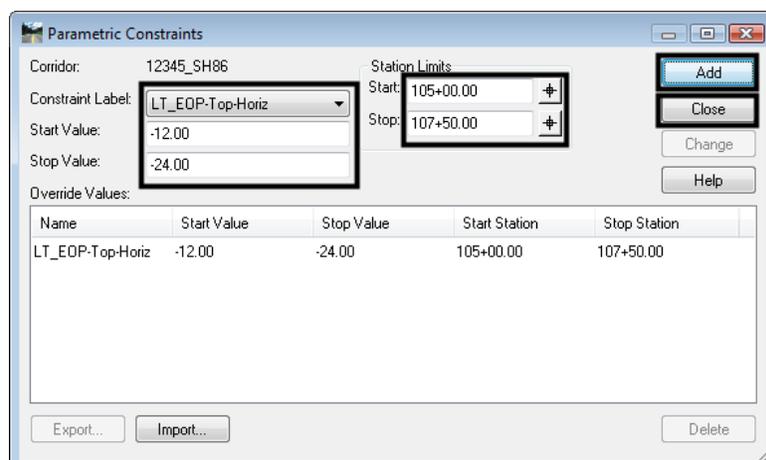
1. Select **Tools > Parametric Constraints** from *the Roadway Designer* menu bar. This displays the **Parametric Constraints** dialog box.



2. Select the **Constraint Label** that you want to vary from the drop down menu.

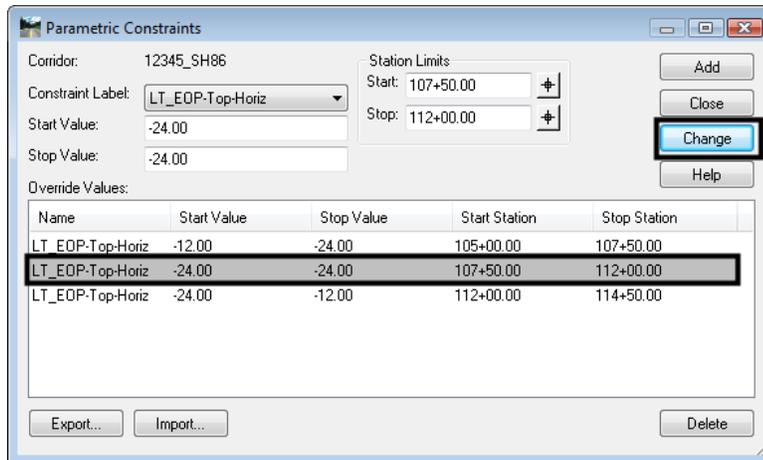
Note: The label must first be assigned to the point constraint in the template library. If you assign the label *after* establishing template drops, you must synchronize the template.

3. Key in the **Start Value**.
4. Key in the **Stop Value**.
5. In the **Station Limits** area, key in or select the **Start** station.
6. Key in or select the **Stop** station.
7. <D> **Add**.
8. Repeat steps 2 through 7 above to create additional parametric constraints. <D> **Close** when finished.



Editing parametric constraints

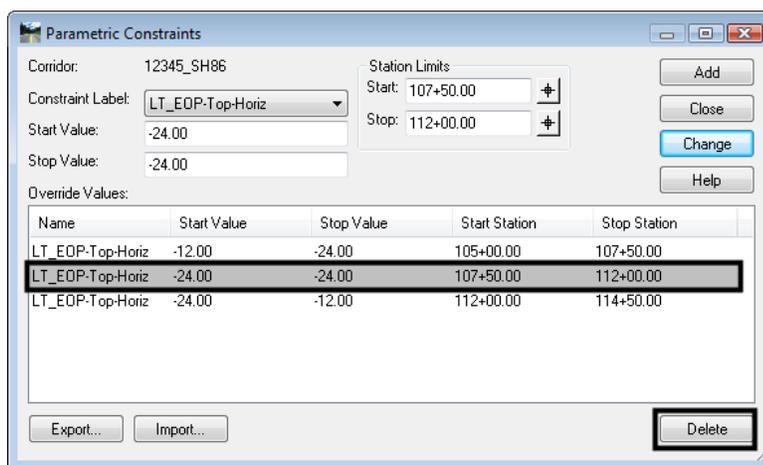
1. From the **Parametric Constraints** dialog box, highlight the desired entry. The data entry fields are populated with the data from the selected entry.
2. Enter the desired data into the data entry fields.
3. <D> **Change** to complete the modification.



Note: You can **Export** parametric constraint values to a text file and edit them in a text editor or a spreadsheet program like Excel. After editing the values, you can **Import** them back in to **Parametric Constraints**.

To delete a parametric constraint:

4. From the **Parametric Constraints** dialog box, highlight the desired entry.
5. <D> **Delete** to remove the entry from the list.



Target Aliasing

Target aliasing is used to redefine the end condition targets assigned in the template library. Multiple targets can be prioritized, and the software attempts to solve the next target should the higher priority fail. Target Aliasing creates a prioritized list of surfaces, surface features, and/or corridor solutions that the current corridor can tie to. For example:

- When you want to tie into multiple targets, as in when you are modeling across adjacent existing surfaces and need to tie to whichever is present at a given location.
- When you want to tie to one surface if it is available, but a secondary surface if it is not. This may occur in the case of a divided highway being modeled as two corridors where you would like one set of lanes to tie to the other design surface if it's close enough and to the existing if it's not. This can be accomplished by creating the first design surface and using it as an alias for the existing, **or** both corridors can be modeled at the same time by using the corridor as the alias for the existing surface.

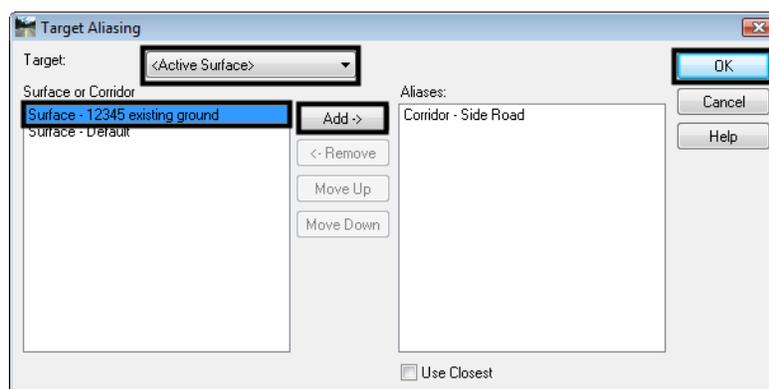
Target aliasing can also be used to remap the active surface. In many cases, a template can be simplified by only targeting **active surface**. However the active surface can easily change. By hard mapping the target alias to the existing surface of choice, you can mitigate opportunities to process the wrong active surface. Also, this allows you to see multiple surfaces in the cross section display window.

Defining a target alias:

1. Select **Tools > Target Aliasing** from the **Roadway Designer** menu bar. This displays the **Target Aliasing** dialog box.
2. Select the desired **Target**. The target list is built from targets defined in the template's end condition components.
3. In the left pane of the **Target Aliasing** dialog box, highlight the first target to be solved for.

Note: This list will change based on the target selected in step 2.

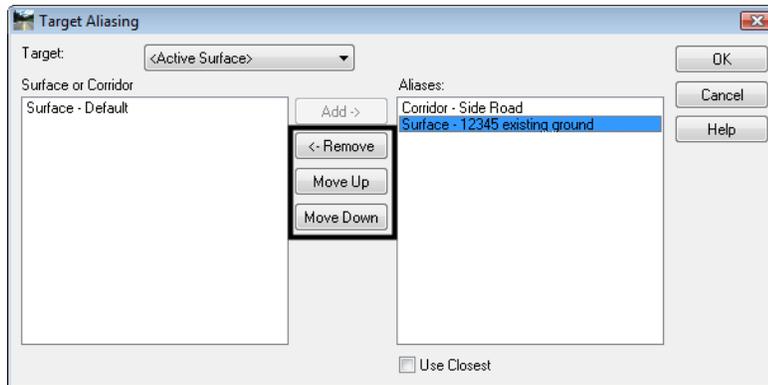
4. <D> **Add** to move the selected item to the right pane.
5. Repeat steps 3 and 4 to add additional items.
6. <D> **OK** to complete the process.



Changing target aliasing

The items selected, as well as their order can be modified. To make changes in Target Aliasing:

1. Select **Tools > Target Aliasing** from the **Roadway Designer** menu bar. This displays the **Target Aliasing** dialog box.
2. Select the desired **Target**.
3. Select the desired alias from the right pane of the **Target Aliasing** dialog box.
4. <D> the **Move Up** or **Move Down** buttons to change the order of the alias list.
5. <D> the **Remove** button to delete the alias from the list.
6. <D> **OK** to complete the changes.



The template end condition will seek the first target in the alias list. If it fails to intercept the first target, the end condition will seek the second target and so on. If the **Use Closest** option is toggled on, the closest of the listed aliases that is encountered is used as the target.

Section Summary:

- ◆ Parametric constraints can be used to vary points in a template without having to edit the points in the template library.
- ◆ In order to set up parametric constraints you must first assign a label to the point's constraints in the template library. The label is used as the constraint variable.
- ◆ Parametric constraints are useful to varying pavement lift or subgrade depths or for introducing linear lane transitions.
- ◆ Target Aliasing is used to create a prioritized list of surfaces, surface features, and/or corridor solutions for target tie-ins.
- ◆ Target Aliasing is useful when you are tying into multiple adjacent existing surfaces.
- ◆ Target Aliasing is also used to set up priorities for divided highways tie-ins (to either the existing surface or adjacent lane surface).

Design Considerations

There are other design considerations that need to be addressed such as:

- How to handle transitions between different templates on your corridor.

- How to smooth out end condition transitions or replace end conditions over a station range.
- How to modify a single template drop to fit real a world condition

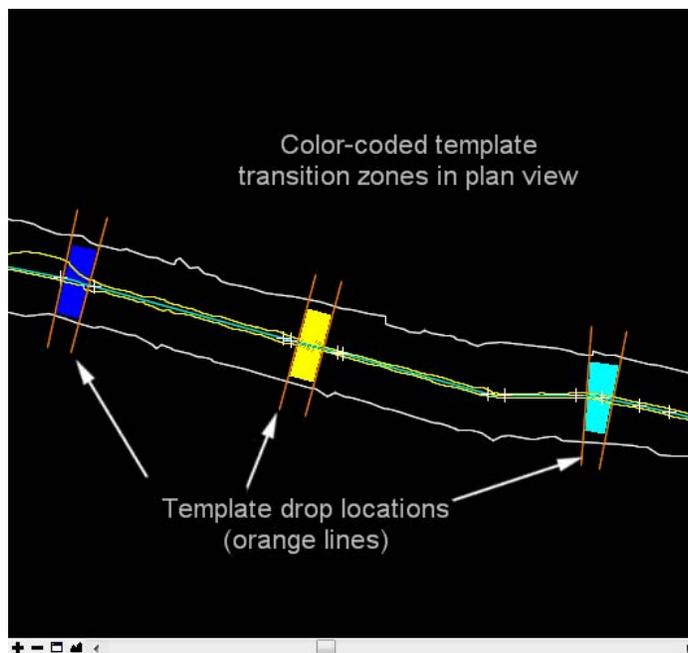
Section Objectives:

- ◆ To learn how to review and edit template transitions for proper point connections between templates on your corridor.
- ◆ To learn when you should edit template transitions.
- ◆ To understand the two different types of end condition exceptions.
- ◆ To learn how to modify end conditions and create end condition overrides and transitions without introducing template drops.
- ◆ To learn how to make a single station template edit to correct minor sideslope problems.

Template Transitions

Template transitions occur when two different templates are specified in the **Template Drops** dialog box. The transition occurs along the entire length between template drop stations. Template transitions are shown color coded in the plan view of the Roadway Designer.

After entering your template drops, the Roadway Designer's plan view is updated to show the template transition range (the station range between different templates in the template drop list). The actual drop stations appear as orange lines in plan along the corridor. The template transition range is color coded as follows:



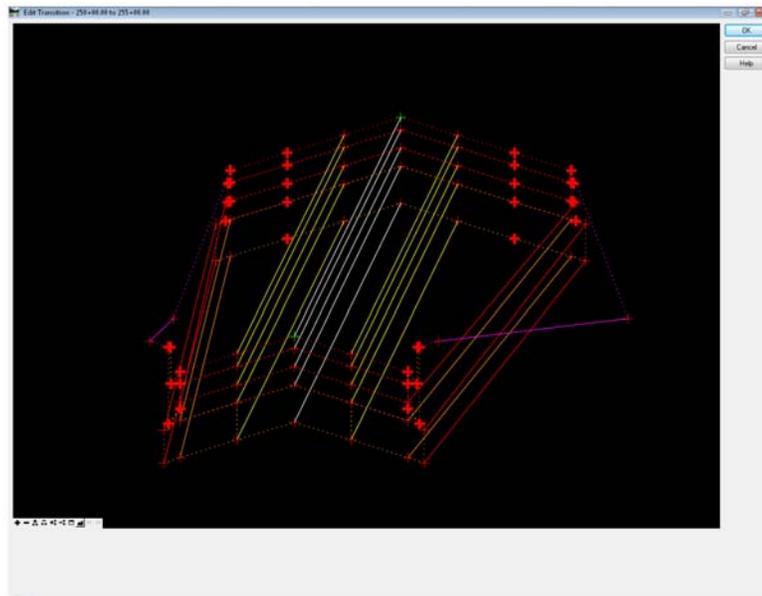
- ◆ **Red** – None of the points between the two templates are connected.
- ◆ **Yellow** – Like named points have been connected by the software, but some points remain unconnected. A typical cause is a different number of points between templates.
- ◆ **Light Blue** – The transition has been reviewed by the user, but there are points still unconnected.

- ◆ **Dark Blue** – All of the template points are connected.

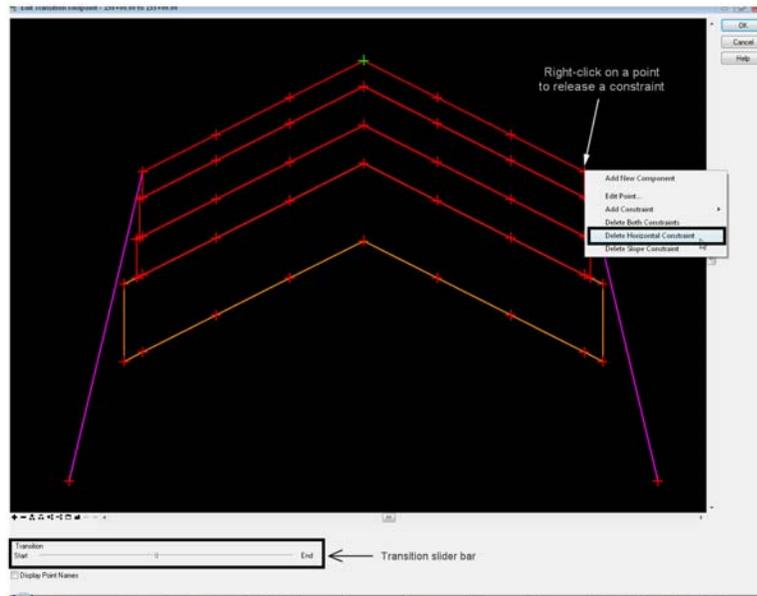
Note: End condition points are not connected by this process; they are automatically connected.

InRoads automatically connects like point names between the two different templates, so it would be unusual to see a red template transition since CDOT uses standard point names contained in the template library. Therefore most template transitions will initially appear dark blue or yellow. Other points, however, must be manually connected.

You can review and manually connect points by double-clicking on the colored template transition zone in the Roadway Designer plan view. This opens the **Edit Transition** dialog box.



After connecting the points in this dialog, you can preview how the templates transition will behave from start to end by using a transition “slider bar”. If your transition doesn’t preview correctly, you may need to release some point constraints. For example, if you’re transitioning from a two lane to a four lane template, the outer-most edge points may have horizontal constraints that need releasing in order to “widen” out for the additional lanes. You can edit point constraints directly from this dialog box, just like you do in the template editor.



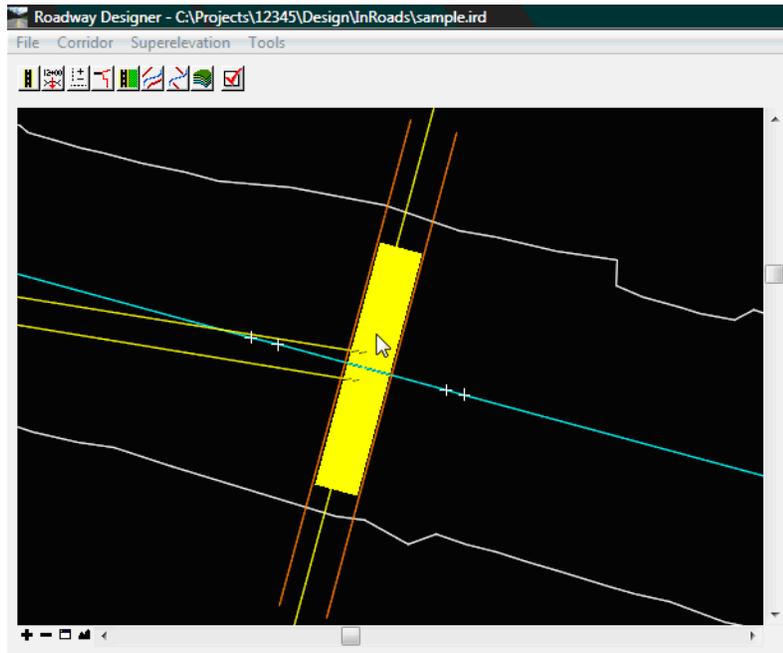
If you missed some point connections after this process, your transition will appear light blue in plan view. Repeat the process until all points are connected and the transition appears dark blue.

Note: You may want to review the transition initially and then wait on making any manual point connections if you plan to later synchronize template library changes to the IRD file. After reviewing the transition, it will appear light blue as a reminder that you need to set the transition after all template changes are complete.

Important! Synchronizing the template library to the IRD file will overwrite your template transitions and you will lose any edits previously made. Always wait until all template changes have been synchronized with the IRD file before editing template transitions.

To edit a template transition:

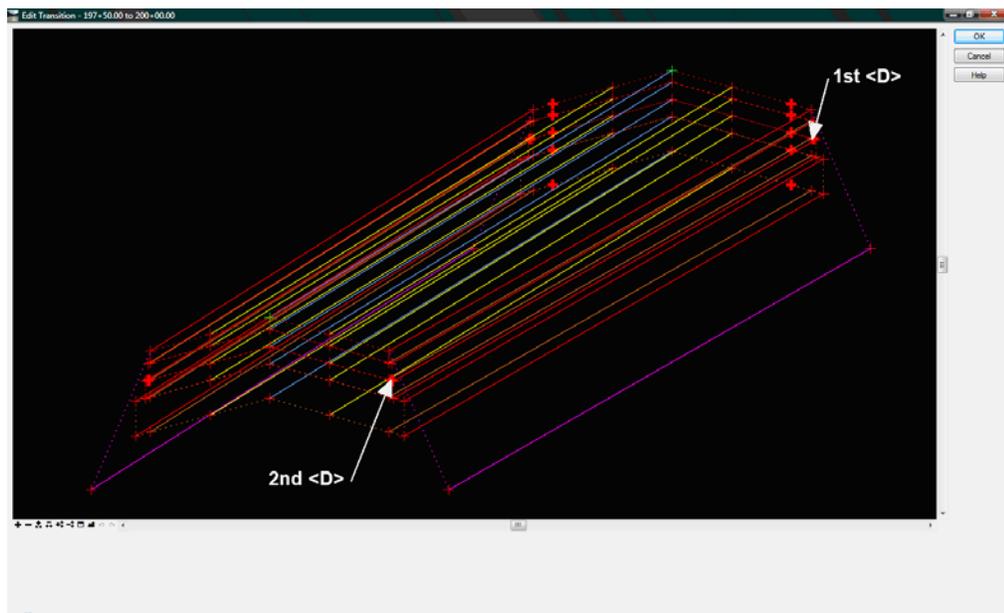
1. Locate the transition in the plan view of Roadway Designer and <D> <D> in the colored area. This displays the **Edit Transition** dialog box.



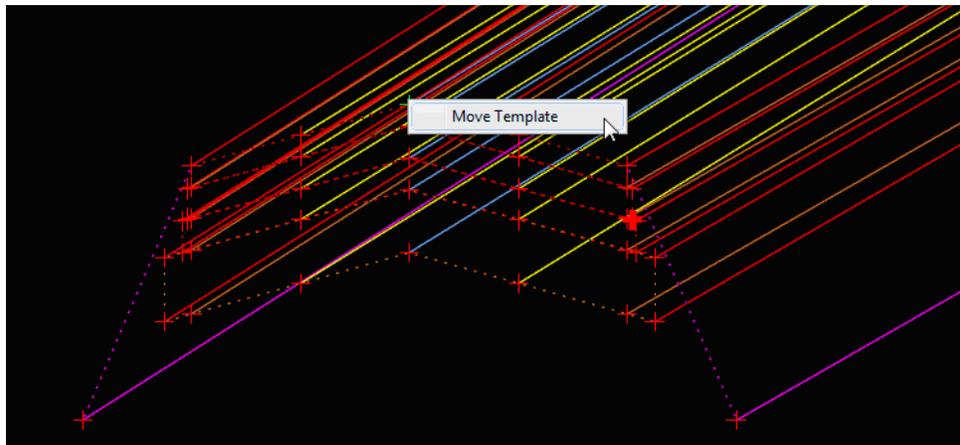
2. <D> on a bold '+' sign then <D> on the desired connection point on the other template.

Note: Unconnected points appear bold. If you're unsure how points are to be connected, hover over the point to get a point name read-out.

Note: The second point selected could have other points connected to it.

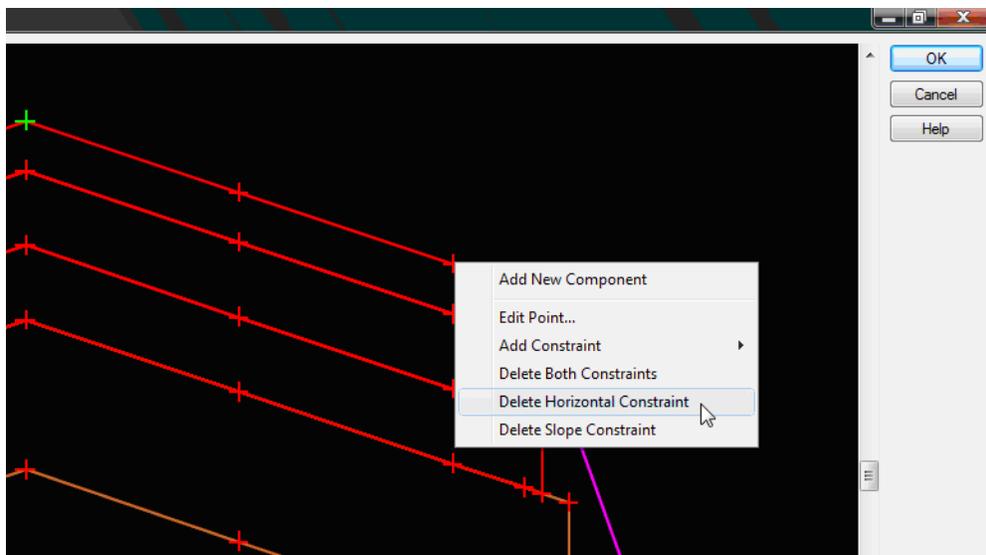


- The orientation of the two templates can be changed to make it easier to see. <R> on the desired template and select **Move Template**.



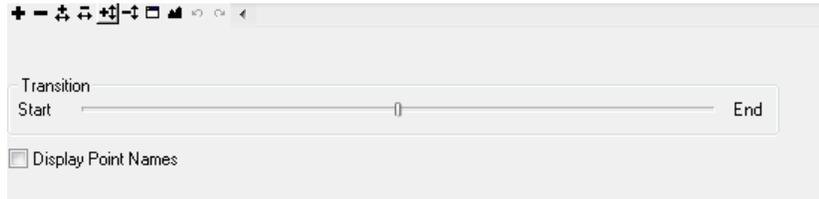
- Repeat steps 2 and 3 until all points are connected.
- To change a connection, <R> on the desired connection line and select **Delete**. The connection is removed and can be relocated as described above.
- <D> **OK** to complete the transition. The **Edit Transition Midpoint** dialog box is displayed.
- Modify point constraints to make the transition work properly. <R> on the desired point and select either, **Edit Point** or one of the **Delete Constraint** options (usually a horizontal constraint needs to be deleted).

Note: You can also add or edit point constraints from this dialog box, just like you do in the template editor. The constraint release or edits apply only to the transition range.



- Repeat step 7 as needed.

- Use the **Transition** slider at the bottom of the dialog box to test the transition.

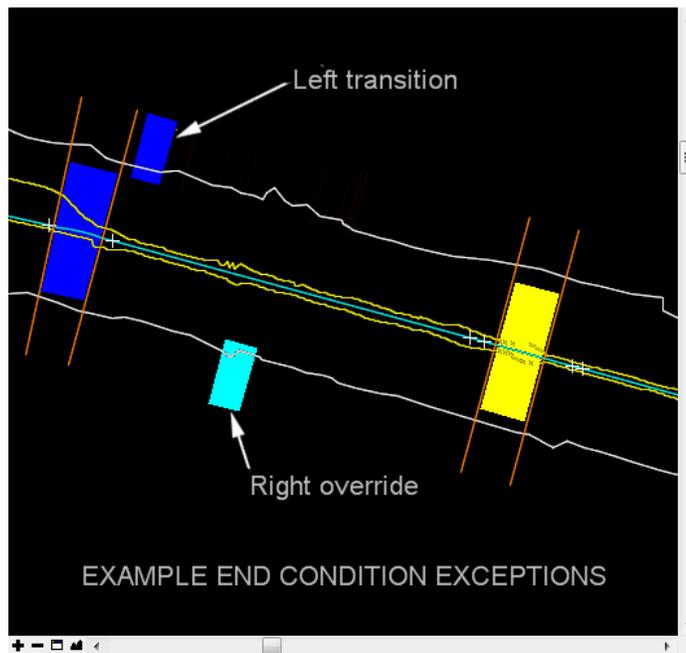


- To change point connections, select **Cancel** in the **Edit Transition Midpoint** dialog box to return to the **Edit Transition** dialog box.
- When editing is complete select the **OK** button. This dismisses the **Edit Transition Midpoint** dialog box.

The transition color in the Roadway Designer plan view changes to dark blue when all points are connected.

End Condition Exceptions

End Condition Exceptions are used to modify end conditions through a station range along the corridor without requiring the creation of additional template drops. This is a powerful tool that allows you to “fine tune” areas where end conditions may have rapidly changing sideslopes or areas where sideslopes may fall outside of right-of-way boundaries. Roadway Designer allows you to preview the end condition exception edits via the cross section view before creating your design surface. This means you don’t have to perform tedious surface features edits to achieve these results.



Types of End Condition Exceptions

End Conditions Exceptions fall into two categories:

- **End condition overrides** – the end condition slope and/or width is overridden, or replaced, with the edited end condition or a completely new end condition for the specified station range.

Example 1: Overriding a 6:1 sideslope from the template with a 3:1 override sideslope through a 300 ft. station range where the 6:1 sideslope falls outside the right-of-way limits.

Example 2: Replacing a v-bottom ditch from the template with a flat bottom override ditch through a specified cut range along the corridor.

- **End condition transitions** – used to “smooth out” an end condition over a station range where the sideslope is changing due to terrain conditions. This is similar to template transitions except the transition occurs on an end condition component.

Example: Smoothing out a fill slope that changes back and forth between a 6:1 and a 3:1 slope over a 200 ft. station range. This is replaced with a gradual 6:1 to 3:1 transition over the same interval.

End condition exceptions are specified on either the right or left side. If you only need the exception on the left side, for example, you can maintain the template end condition on the right side. Or, you can set up different exceptions on the right and left side depending on the terrain conditions and sideslope behavior.

There is also a **Backbone Only** option that removes end conditions from the station range specified, which is useful in bridge or culvert areas.

InRoads uses a color coding system in Roadway Designer’s plan view to denote the two different types of exceptions:

- ◆ **Light Blue** – represents end condition overrides.
- ◆ **Dark Blue** – represents end condition exceptions.

Note: End condition exceptions are shown on the **outside** of the corridor to distinguish them from template transitions zones, which are shown **inside**.

Defining End Condition Exceptions

Defining an end condition exception is a two part process:

- Adding the exception entry by specifying the station range and designating it as a left/right override or left/right transition.
- Editing the exception to modify the behavior of the end condition (this is similar to editing a point on a template and/or editing a template transition).

Follow the steps below to define an end condition exception:

1. Select **Corridor > End Condition Exceptions** from the **Roadway Designer** menu bar, or <D> on the **End Condition Exceptions** button from the button bar to open the **End Condition Exceptions** dialog box.



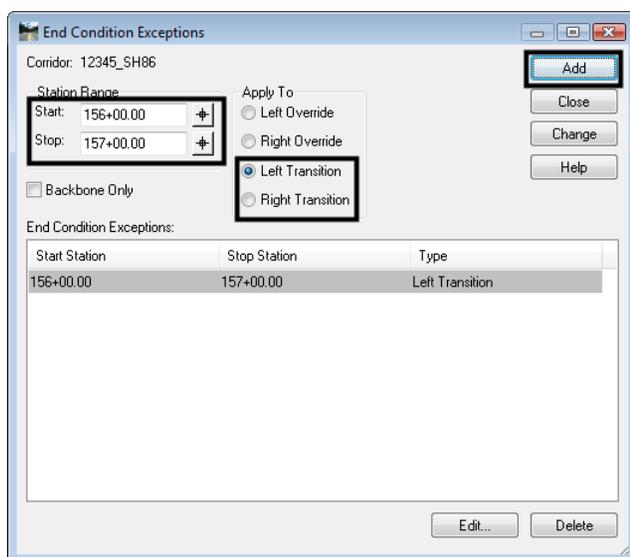
End Condition Transitions

To define an End Condition Transition, first add the entry:

1. In the **End Condition Exceptions** dialog box, key in the **Start** station or use the locate station button and select the station from the plan view.

Note: You can use the **Ctrl** key to select the station from the drawing file.

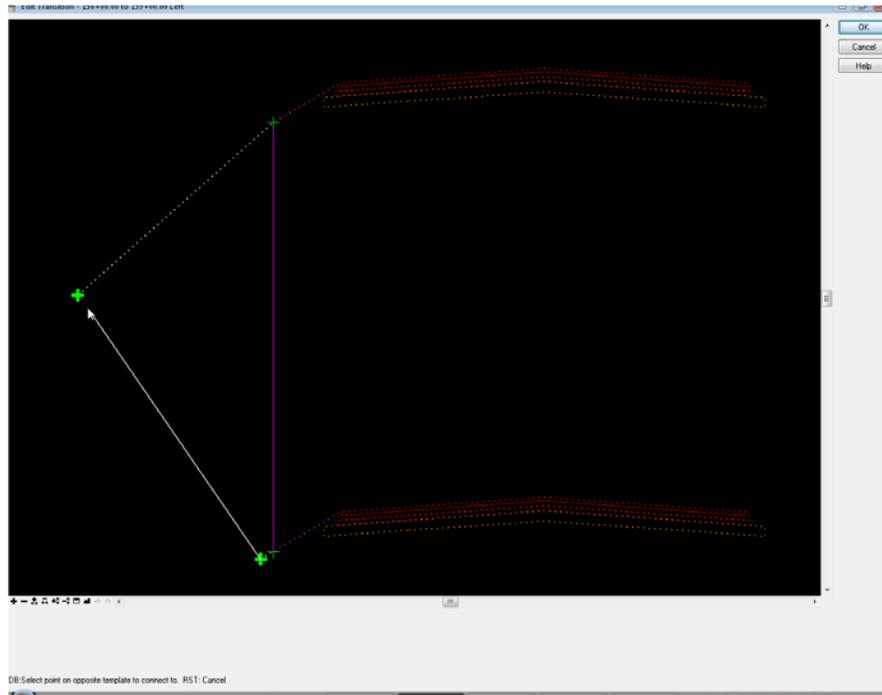
2. Key in the **Stop** station.
3. Toggle on the desired transition side (**Left Transition** or **Right Transition**).
4. **<D> Add**. The data is listed in the **End Condition Exceptions** area of the dialog box.



Next, edit the entry to define the transition:

5. Highlight the desired entry in the **End Condition Exceptions** list.

6. <D> Edit. The **Edit Transition** dialog box is displayed.



7. Follow steps 2 through 11 in the **Template Transitions** section to complete the transition.

Note: You may need to set a point as **Infinite** through the transition range by right-clicking and editing the point in the **Edit Transition Midpoint** dialog.

End Condition Overrides

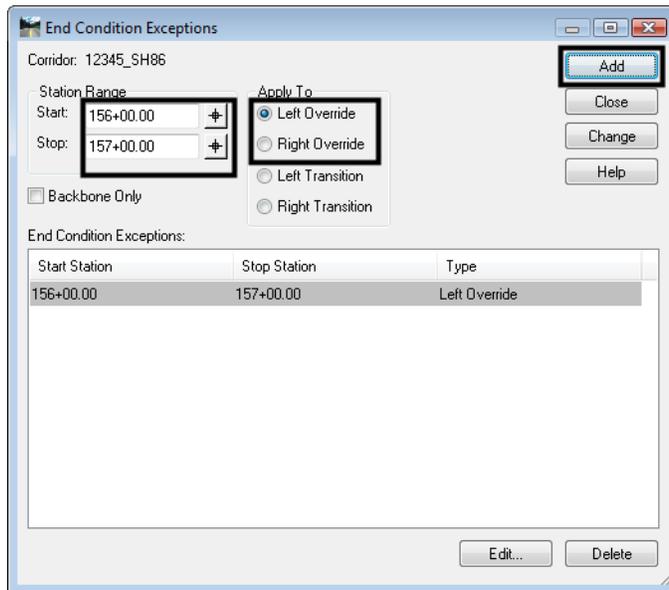
To modify or completely change an end condition through specified station range, first add the entry:

1. In the **End Condition Exceptions** dialog box, key in the **Start** station or use the locate station button and select the station from the plan view.

Note: You can use the **Ctrl** key to select the station from the drawing file.

2. Key in the **Stop** station.
3. Toggle on the desired override side (**Left Override** or **Right Override**).

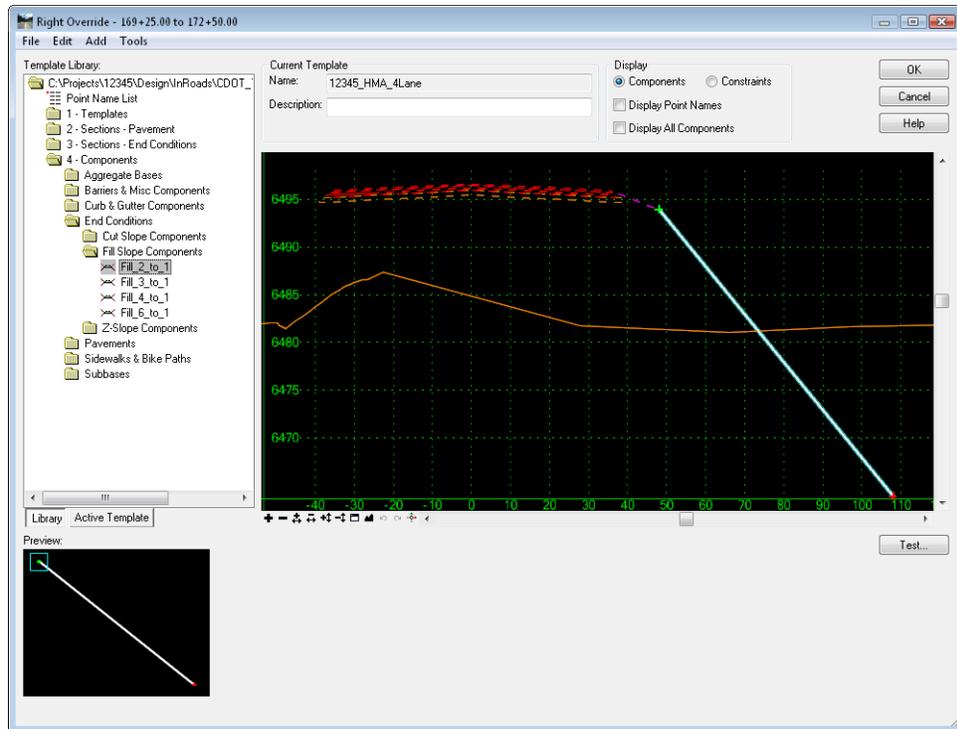
4. <D> **Add**. The data is listed in the *End Condition Exceptions* area of the dialog box.



Next, edit the entry to define the override:

5. Highlight the desired entry in the *End Condition Exceptions* list.
6. <D> **Edit**. The *Override* dialog box is displayed.

7. Edit the end condition. This dialog box works just like the **Create Template** dialog box (see the *Defining Templates* chapter in this document) except that only the end condition can be modified.



Note: All of the templates from the loaded template library are available for use when editing the override. Therefore, if you want to replace the end condition, you can delete the current end condition while in the **Override** box and then drag and drop a new end condition from the library onto your template.

Deleting or modifying end conditions through this command does not delete them from the template in the template library. It is best practice to create or modify the end condition that you wish to use as the override first in the library.

Important! Even though the **Override** dialog shows only the first station of the edit range, you may encounter multiple sideslope requirements over the course of the override. Therefore, be certain to include both cut and fill sideslopes if both will be encountered.

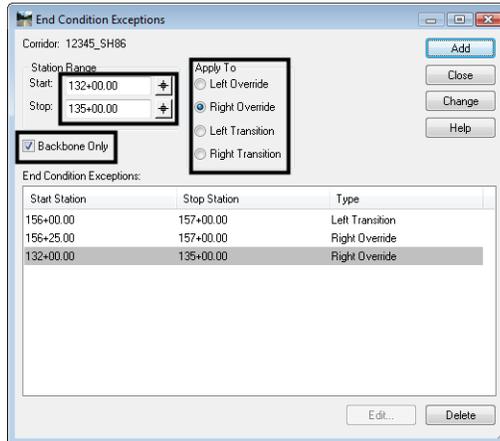
8. <D> **OK** to complete the edit.

Backbone Only Exceptions

There is an option to turn off the end condition without having to edit the exception. This works for both transitions and exceptions, though in a slightly different manner. To create a **Backbone Only** exception:

1. In the **End Condition Exceptions** dialog box, key in the **Start** station.
2. Key in the **Stop** station.

3. Toggle on the desired override or transition side.
4. Toggle on **Backbone Only**.
5. <D> **Add**. The data is listed in the **End Condition Exceptions** area of the dialog box.



Note: If a **transition** is selected, the end condition is deleted from all template drops between the Start and Stop stations, **excluding** the Start and Stop stations.

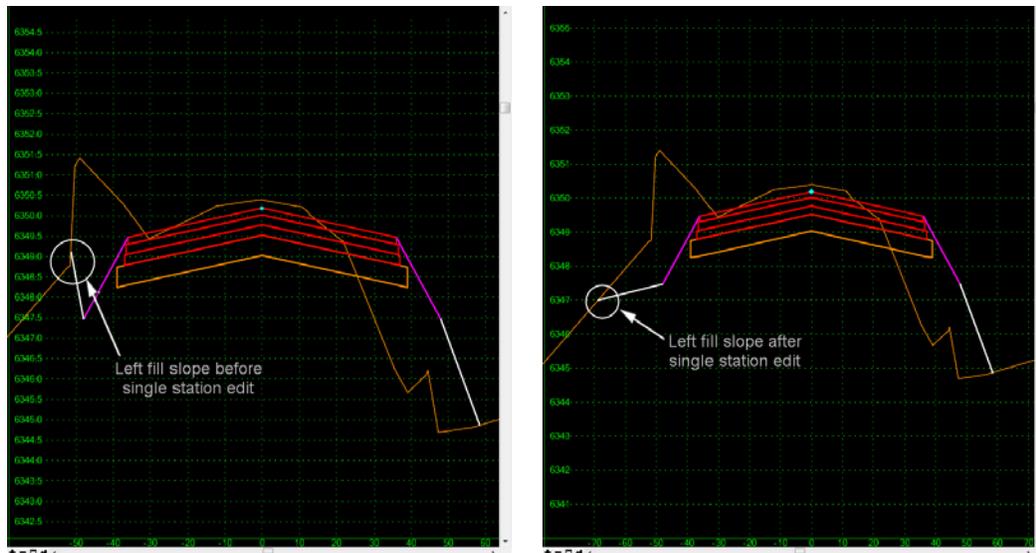
If an **override** is used, the end condition is deleted from all template drops between the Start and Stop stations, **including** the Start and Stop stations.

Modifying Single Station Template Drops

There may be instances where an end condition needs to be modified at only one station instead of a range of stations. This occurs when:

- A sideslope ties at an odd location due to existing terrain conditions or
- Where you want to tie a sideslope to a specific location (like an existing ditch) or
- Where you want to pull a sideslope inside the right-of-way at just one station.

In these cases, you can modify a single station template drop. The figures below illustrate an example where you would want to edit a single station template to modify the location of the sideslope.



Single station template drops can be modified within the Roadway Designer section view. Changing a template in this manner creates a new entry in the **Template Drops** dialog box. The data for the changed template is stored in the **IRD** file as shown below.

Station	Interval	Template	Revise...	Library
155+00.0...	25.00	12345_HMA_4Lane	ITL	C:\Projects
195+00.0...	25.00	12345_HMA_4Lane	ITL	C:\Projects
200+00.0...	25.00	HMA_Urban_4Lane	ITL	C:\Projects
250+00.0...	25.00	HMA_Urban_4Lane	ITL	C:\Projects
255+00.0...	25.00	12345_HMA_4Lane	ITL	C:\Projects
360+50.0...	Single Station	12345_HMA_4Lane	IRD	

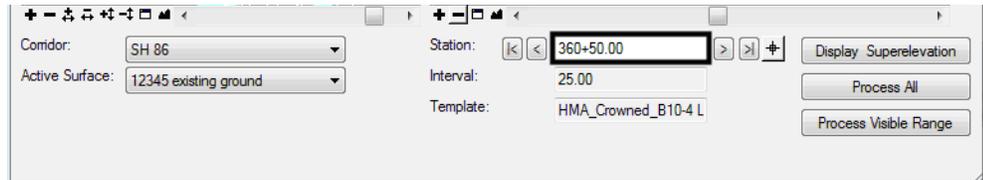
Synchronizing this template drop will **not** change the template back to its original condition. To remove the edit, you must highlight it in the template drops and select **Delete**.

Important! Modifying templates in this manner should be done sparingly to correct minor problems at single locations. Stations modified in this manner will not be processed by designer, in effect ‘freezing’ them in time and space. For example, changing the alignment **will no longer change** this template drop!

Note: For larger scale edits over a defined station range along the corridor, use other Roadway Designer tools like **End Conditions Exceptions**, **Parametric Constraints**, **Point Controls**, etc.

To edit a single template drop:

1. Select the station to edit with the **Station Indicator**.

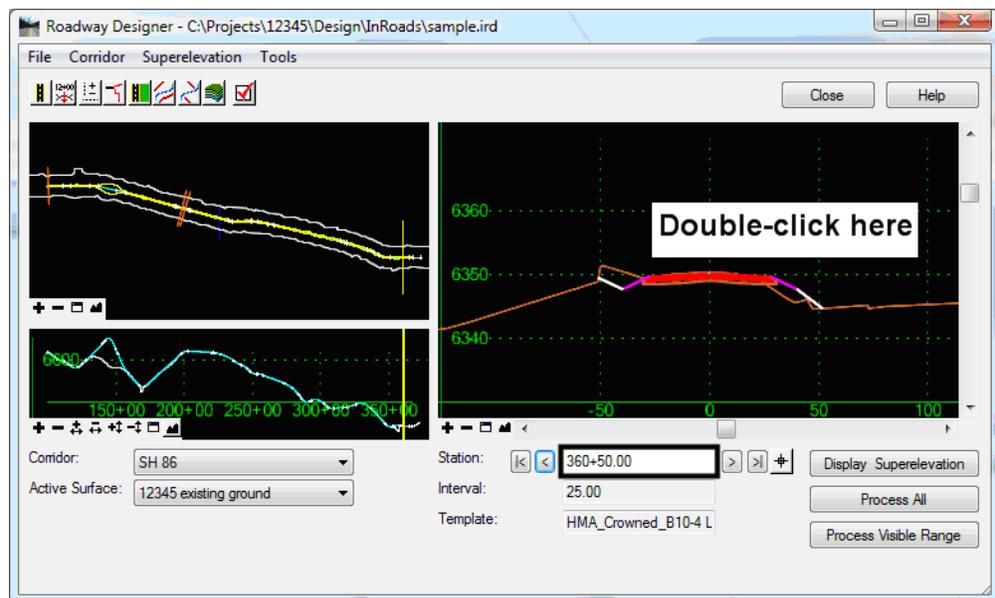


2. Double-click in the section view. The **Edit Template At Station Only** dialog box appears.
3. This dialog box works just like the **Create Template** dialog box (see the [Defining Templates](#) chapter in this document). All points and components can be modified, deleted, or replaced.

Example of Modifying Single Template Drop

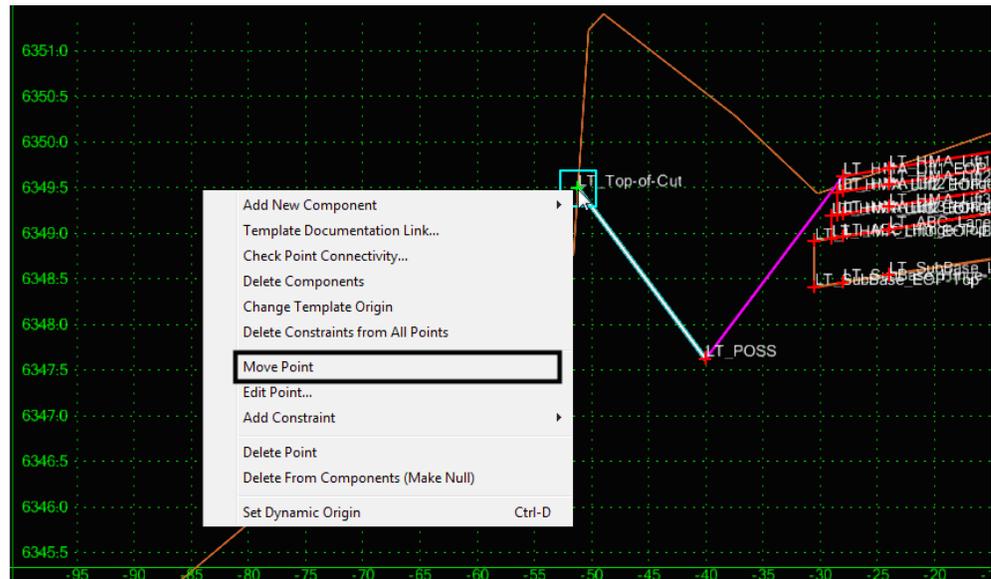
In this example a template drop is cutting a ditch in the middle of an area of fills. This example demonstrates how to remove the ditch from this template drop.

1. Station **360+50** is selected with the Station Indicator.
2. Double-click in the section view to display the **Edit Template At Station 360+50 Only** dialog box.



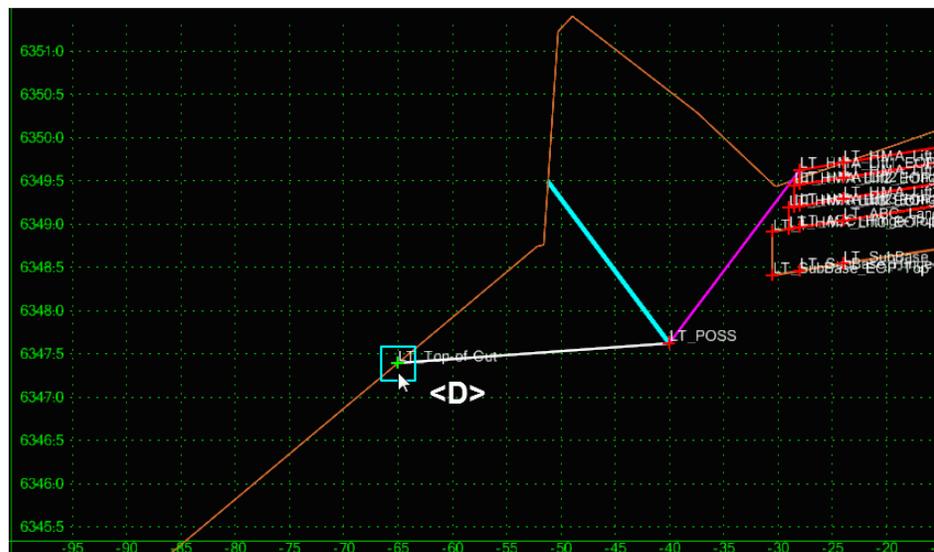
3. <R> on the LT_Top-Of-Cut point.

4. Select **Move Point** from the right click menu.

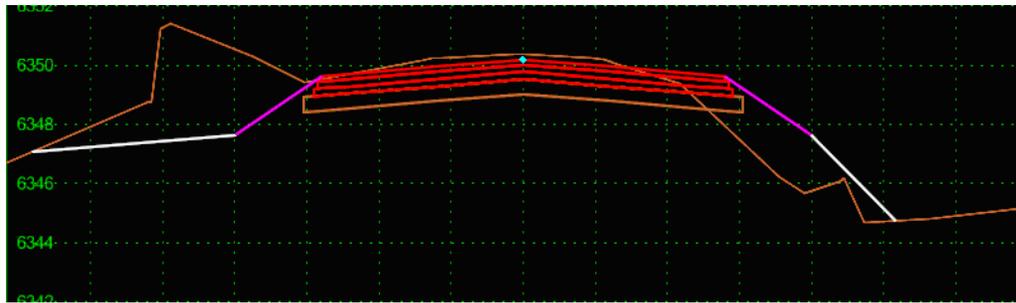


5. Move the point to the desired location and **<D>**. Because it is an end condition, it will snap to the existing surface.

Note: For reference, the original end condition component location displays in light blue.



6. <D> OK to accept the change. The modification is reflected in the Roadway Designer section view.



Section Summary:

- ◆ Template transitions occur between different templates in the template drop list.
- ◆ Template transition zones are color-coded in plan view to indicate the status of point connections between templates.
- ◆ InRoads automatically connects like point names between two different templates. Other points must be manually connected.
- ◆ Edit the template transition to manually connect the template points.
- ◆ Synchronizing the template library to the IRD file will overwrite your template transitions and you will lose any edits previously made. Generally wait until all template changes have been synchronized with the IRD file before editing template transitions.
- ◆ End Condition Exceptions allow you to “fine tune” end conditions without creating additional templates or template drops.
- ◆ There are two types of end condition exceptions: end condition **overrides** and end condition **transitions**.
- ◆ End condition overrides replaces the template end condition with a modified one or a completely new end condition from the template library.
- ◆ End condition transitions are used to “smooth out” an end condition over a station range where the sideslope is changing due to terrain conditions.
- ◆ End condition exceptions are color coded in plan view to indicate either overrides or transitions.
- ◆ Modify a single station template to correct minor sideslope tie-in problems.
- ◆ When you edit a single station from the Roadway Designer cross section view, a new entry is created in the Template Drops box and stored in the IRD file.
- ◆ Deleting a single station template drop will change the template back to its original condition and the changes will be lost.

Generating Design Surfaces

The goal of the roadway modeling process is to create a 3D terrain model or surface of your proposed design. Roadway Designer provides numerous tools necessary to input the engineering data to create, preview and modify your design interactively so that you can see the results of the modeling process and make necessary edits **before** creating the final design surface. After the interactive design iterations are complete, you're then ready to generate the design surface.

Section Objectives:

- ◆ To understand the concept of surface features and components.
- ◆ To understand the difference between triangulated and untriangulated features.
- ◆ To understand how to use the **Create Surface** command to take your Roadway Designer data to a 3D surface.
- ◆ To learn how to create a design surface from a single corridor.
- ◆ To understand the difference between a finished grade surface and alternate surfaces and learn how to create alternate surfaces.
- ◆ To learn how to create one surface from multiple corridors.

Elements of a design surface

A design surface contains both features and components including:

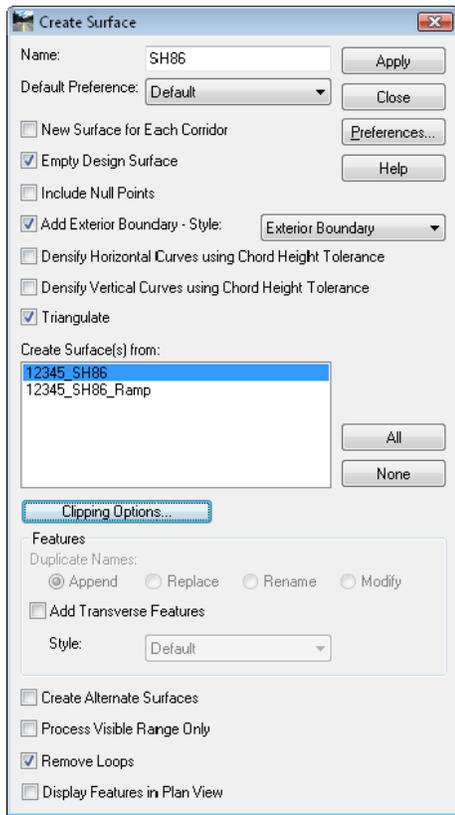
- **Triangulated Features** – Unless specified in the component, the topmost set of points in the template are triangulated and used to create the finished grade surface.
- **Untriangulated Features** – Those features below the finished grade surface are stored within the dtm as untriangulated features. They can be displayed in plan, cross sections, or profiles, but are not used in creating the surface.
- **Components** – These are the material definitions built into the template. They are used to adjust end area volume calculations. Components can also be shown on cross sections.
 - ◆ You can create vertical components (like pavement lifts or walls), and show these “true vertical” components on your cross sections since they are not part of the triangulated network when you generate a design surface.
 - ◆ When calculating end area volumes, you can choose to exclude component volumes from the mass ordinate volume if you want separate material volumes for each component.

When creating a design surface, you have the option of creating:

- A single surface – the finished grade from topmost set of template points.
- Separate finished and alternate surfaces – e.g. for subgrade surfaces.
- A multiple corridor surface – combining design surfaces from multiple corridors (mainline, ramps, crossing streets, etc.) into one surface.

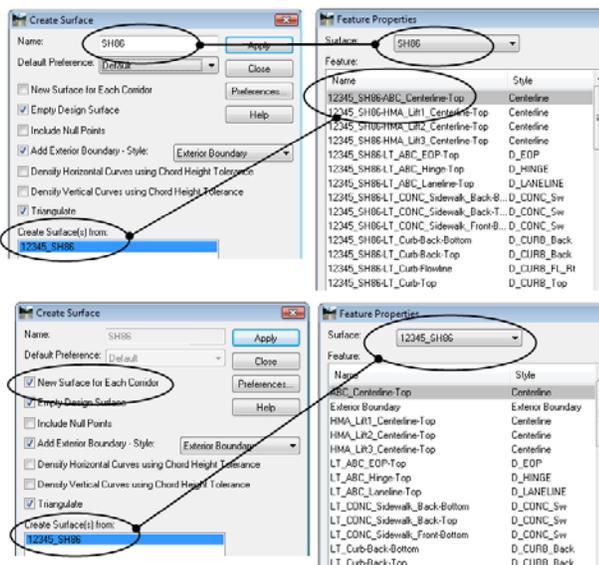
The Create Surface command

Use the **Create Surface** command to create a proposed surface or surfaces from the data stored in the Roadway Designer IRD file.



This command contains several options including:

- Surface Name** – when the surface is created, you have the opportunity to give it a name. The name becomes the name of the resulting surface, and the **Corridor** name is prefixed onto each of the features that are created. If you toggle on **New Surface for Each Corridor**, the **Corridor** name instead becomes the surface name and the features are not prefixed. See the illustration below.



- **Empty Design Surface** – if the surface has already been created, turn this option on to delete all features from the current surface before re-creating it. This ensures you don't have left-over, duplicate or bogus features in your surface.
- **Add Exterior Boundary** – turn this option on to automatically create an exterior boundary for the design surface(s). An exterior boundary defines the limits of triangulation. No triangles will form outside the exterior boundary, thereby eliminating bogus or bad triangles from forming in corners or concave areas. After turning this option on, specify a feature **Style** for the boundary, which controls its display properties.
- **Create Surfaces From** – select the corridor(s) used to create the design surface(s).
- **Clipping Options** – if running multiple corridors, use this option to determine how the surfaces will be clipped in overlapping regions. This option is used in conjunction with **Target Aliasing**. The corridor that uses Target Aliasing will be used to clip the other corridor.
- **Create Alternate Surfaces** – toggle on this option if you've assigned template subgrade points to an alternate surface name. In addition to the finished surface, the alternate surface(s) are created.
- **Triangulate Surface** – turn this option on to automatically triangulate surface feature points to create the triangulated network (in addition to adding the features and components to the surface). If this option is turned off, you can triangulate the surface later using the **Surface > Triangulate Surface** command.
- **Remove Loops** – turn this option on to eliminate loops on features or overlapping features that may cause surface problems. Loops/overlaps occur with non-colinear alignments and can occur with secondary alignments (e.g. intersection returns).

Single corridor surface

Use the **Create Surface** command to create the design surface (DTM) from the selected corridor(s).

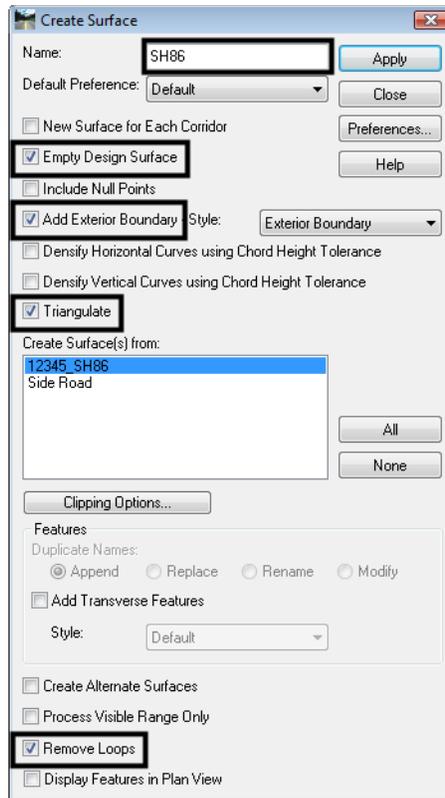
To create a design surface:

1. Select **Corridor > Create Surface** from the **Roadway Designer** menu bar or <D> the **Create Surface** button from the button bar.



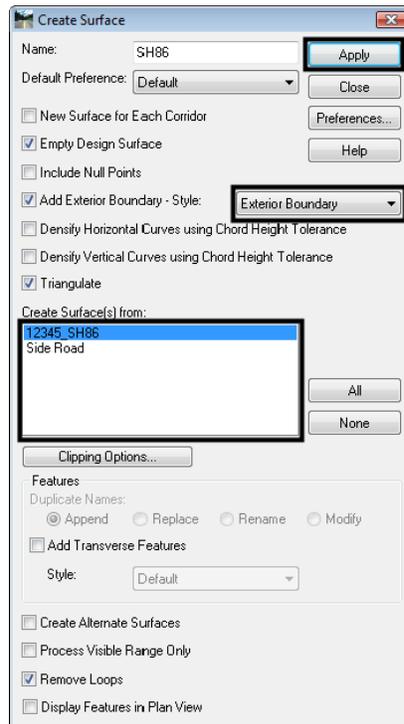
2. Key in a **Name** for the surface.

3. The following check boxes should be toggled on, except in special circumstances: **Empty Design Surface**, **Add Exterior Boundary**, **Triangulate Surface**, and **Remove Loops**.



4. Set the **Exterior Boundary Style** to Exterior Boundary.
5. Toggle on other options as needed.
6. Select the corridors to be modeled from the **Create Surface(s) From** area.

7. <D> **Apply**. The design dtm is created and a **Results** window is displayed.



8. The **Results** report contains point control information and other settings used in the corridor. **Save** and/or **Print** the **Results** file as desired.
9. <D> **Close** on the **Results** dialog box.
10. <D> **Close** on the **Create Surfaces** dialog box.

Alternate surfaces

Typically, when a design dtm is created from Roadway Designer only the finished grade is constructed as a triangulated model. The subsurface points are stored in the design dtm as untriangulated points. To create surface from subsurface points (or a combination of finished grade and subsurface points) the **Alternate Surface** option is used. This option requires that you first assign an alternate surface name to the point via the template point properties before using Roadway Designer for modeling.

Note: A template point can belong to the finished grade surface plus one alternate surface.

To create an Alternate Surface:

Assign the alternate surface name to the template points

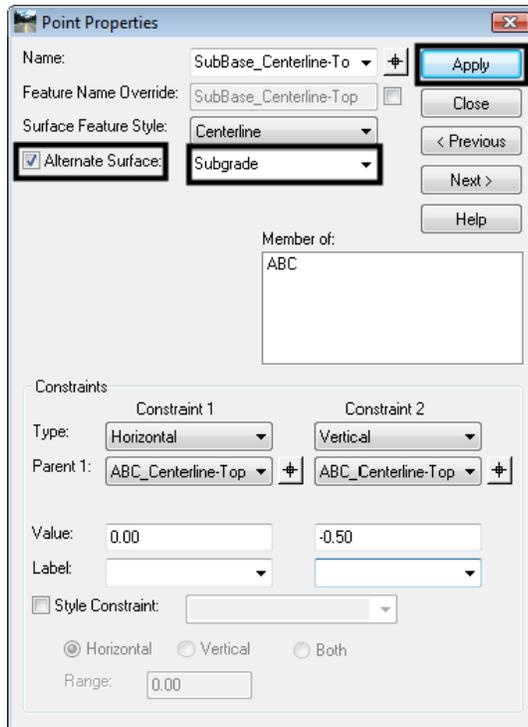
Note: If these steps were done before the corridor was created, skip to step the [Create Design Surfaces](#) section below.

1. Select **Modeler > Create Template** from the InRoads menu bar.
2. <D><D> on the desired template from the **Template Library** pane of the **Create Template** dialog box.

3. <D><D> on the desired point.
4. Toggle on the **Alternate Surface** check box.
5. Key in the **Name** for the **Alternate Surface**.

Note: Use the same name for all points used to create the alternate surface. After it is keyed in the first time in a template, it is available in the drop-down list for other points.

6. <D> the **Apply** Button.

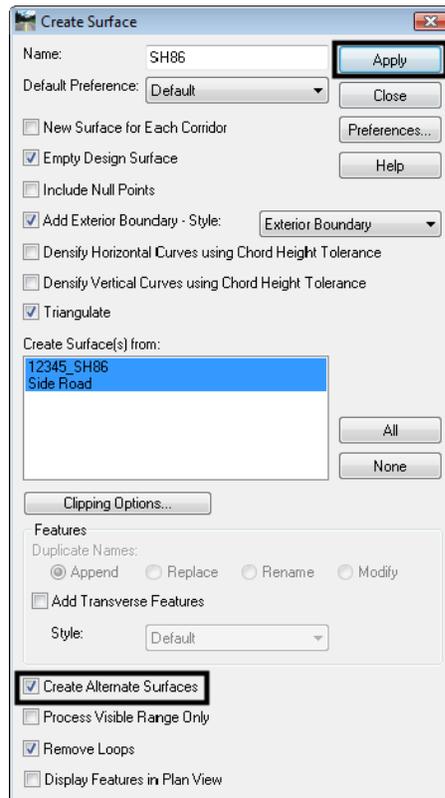


7. <D> **Close**.
8. Repeat steps 3 through 7 to add additional points to the alternate surface.
9. Select **File > Save** from the **Create Template** menu and **Close** the **Create Template** dialog box.
10. Select **Modeler > Roadway Designer** from the InRoads menu bar.
11. Select **File > Open** from **Roadway Designer** menu bar and open the desired **IRD** file.
12. Select **Corridor > Template Drops**.
13. **Synchronize** the entries as needed.
14. **Close** the Template Drops dialog box.

Create the Design Surfaces

1. Select **Corridor > Create Surface**.

2. Toggle on the **Create Alternate Surfaces** check box.
3. Make the other settings as desired.
4. **<D> Apply**. The alternate surface(s) are created along with the finished grade surface. It is stored in its own DTM.



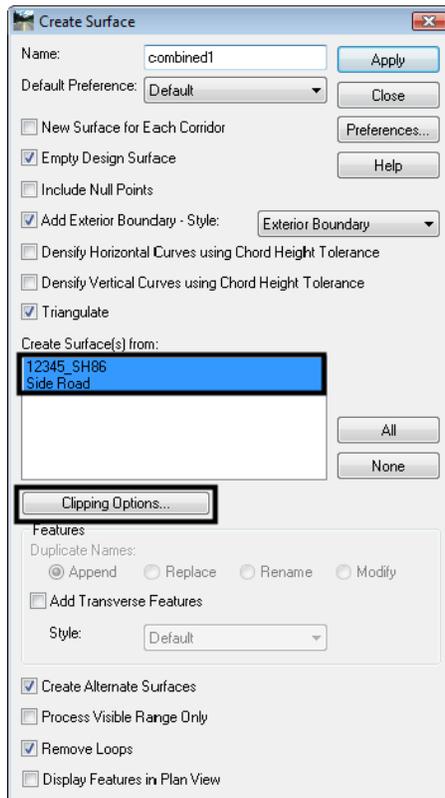
Multiple corridor surface

With InRoads XM, ramps and crossing streets can be combined into a single model (DTM). To use the clipping options with combined surfaces, **Target Aliasing** must be used (see [Target Aliasing](#) section in this chapter).

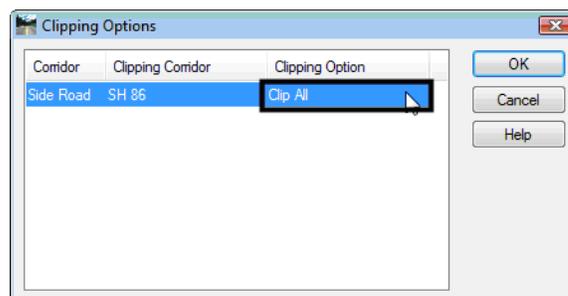
To create a combine corridor:

1. Select **Modeler > Roadway Designer** from the InRoads menu bar.
2. Select **File > Open** from **Roadway Designer** menu bar and open the desired IRD files.
3. Select **Corridor > Create Surface**.
4. In the **Create Surface(s) From** area, highlight the corridors for the combined surface.

5. <D> the **Clipping Options** button.



6. In the **Clipping Options** dialog box, <D> in the **Clipping Option** column to select the desired method. The corridor that uses **Target Aliasing** will be used to clip the other corridor using one of the following methods:
- **Clip All** – All components and features are removed from the clipped corridor in the overlap area. This option is mainly used for intersections.
 - **Clip End Conditions Only** – Only the end condition components and features are removed from the clipped corridor in the overlap area. This option is mainly used for entrance and exit ramps.
 - **Clip None** – All components and features from both corridors are retained.



7. <D> **OK** to return to the **Create Surface** dialog box.
8. Make the other settings as desired.

9. <D> **Apply**. The combined surface is created.
10. <D> **Close** to dismiss the **Create Surface** dialog box.

Section Summary:

- ◆ A design surface is composed of triangulated and untriangulated features as well as components.
- ◆ Triangulated features are the linear features that result from the topmost set of points in the template and are used to create the finished grade surface.
- ◆ Untriangulated features are linear features that result from the points below the finished grade do not contribute to the triangulated network, unless they are specified as an **alternate surface**. Additional untriangulated features can come from components, such as barriers, where **Component Properties** are set to **Exclude from Triangulation**.
- ◆ Components are typically material definitions that can be shown on cross section and used in volume calculations. They can also be shown in plan view, where you can dynamically rotate the view to visually analyze the components in 3D.
- ◆ Use the **Create Surface** command to process your Roadway Design data to a 3D design surface.
- ◆ When using the **Create Surface** command, you have the option to create a finished grade surface from one corridor (with or without alternate surfaces) or a merged surface by combining corridors.
- ◆ To create an **alternate surface**, you must first assign an alternate surface name to the template point.
- ◆ A point can belong to the finished grade surface plus one alternate surface.
- ◆ Alternate surfaces typically are used for subgrade surfaces and you can create as many alternate surfaces as you like. Each point, however, can only be part of one alternate surface.

Chapter Summary:

- Roadway modeling is the process of creating a 3D design surface or surfaces of your proposed roadway by applying roadway typical sections along a corridor and tying the template end conditions into an existing surface or other target.
- **Roadway Designer** is the tool used to accomplish the modeling process in InRoads.
- The initial design is created using CDOT design criteria and engineering data as input information to the modeling process.
- Several tools allow you to refine your model by creating transitions, introducing lanes, ramps, etc.
- CDOT's superelevation design criteria is used to add superelevation to your design.
- You can model, review, and edit your design in an interactive and iterative process until you have successfully refined your roadway design.
- Some of the refinements you can make include modifying transitions, adjusting lift depths, adjusting sideslopes to fall within right-of-ways, replacing end conditions where needed and correcting sideslope problems at specific locations.

- Once your model is finalized, you can create a 3D design surface from the Roadway Designer data.

Chapter 12 - Cross Sections

Changes in template design and the data stored in the DTM have made it necessary to change the Create Cross Section dialog box. At the same time, the dialog box layout has been redesigned. To display a set of Cross Sections:

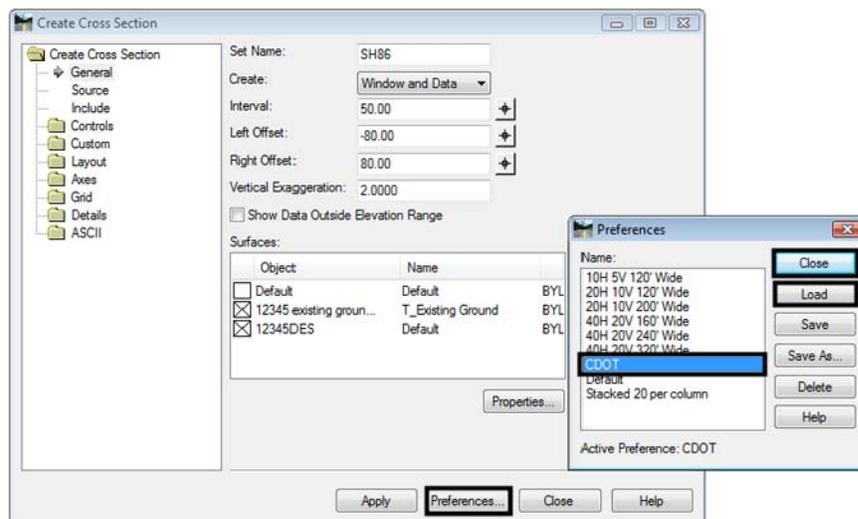
Chapter Objectives:

- Demonstrate the process of creating and displaying cross section
- Illustrate how to annotate a set of cross sections
- Describe updating cross sections

Creating and Displaying Cross Sections

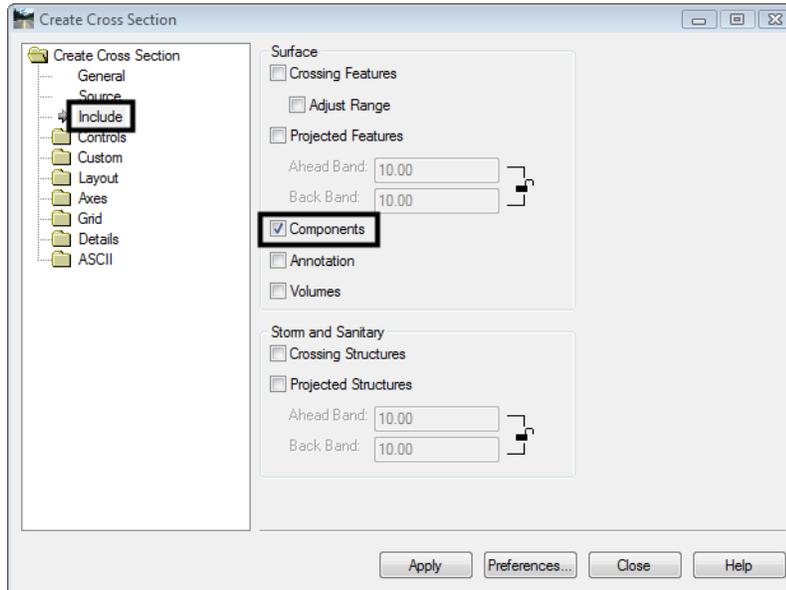
While completing the following steps, pay particular attention to the preferences and settings used to create and display cross sections. Understanding what preferences and settings to use will save a lot of time.

1. Select **Evaluation > Cross Section > Create Cross Section** from the InRoads bar menu.
2. From the **Create Cross Sections** dialog box, <D> the **Preferences** button.
3. From the **Preferences** dialog box, highlight the desired preference and <D> **Load**.
4. <D> **Close** to dismiss the **Preferences** dialog box.



5. Toggle on the surfaces to include in the cross sections.
6. Select **Include** from the dialog box explorer.

7. Verify that **Components** is toggled on.



8. Toggle on other options as desired.

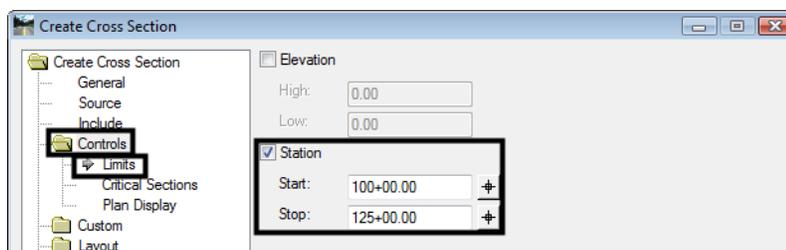
Note: The user does not have the option to choose which features are displayed from this dialog box. All features from the selected surfaces that can be displayed will be displayed.

Note: **Annotate** runs the Annotate Cross Section command using the preference specified in the Surface Properties for the annotation preference.

Note: **Volumes** runs the End Area Volumes command using the Tools > Options > General > Preferred Preference as the preference for the volumes command.

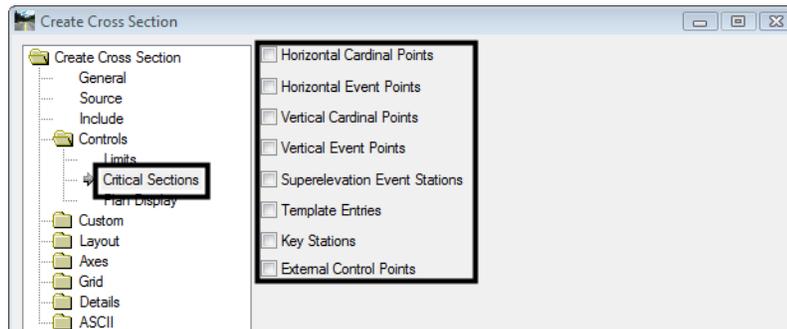
9. Select **Controls** > **Limits** from the dialog box explorer.

10. Set the **Station Limits** as desired.



11. Select **Controls** > **Critical Sections** from the dialog box explorer.

- Toggle on the desired critical sections.

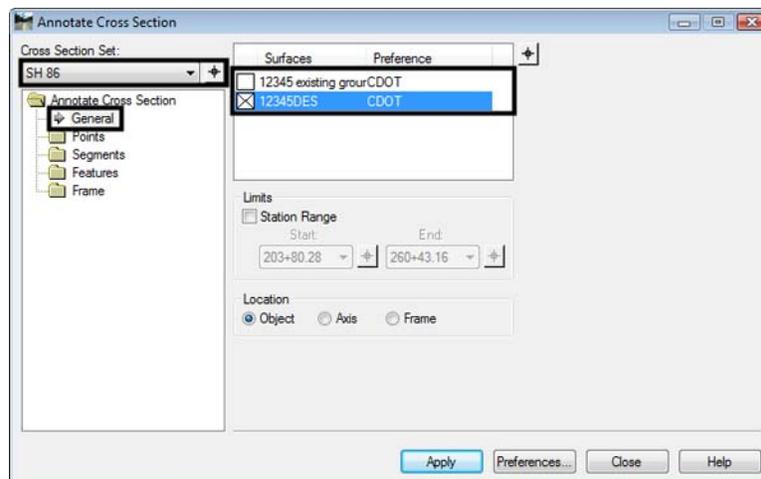


- <D> **Apply**, then <D> in the view window to place the cross sections.
- <D> **Close** to dismiss the **Create Cross Sections** dialog box.

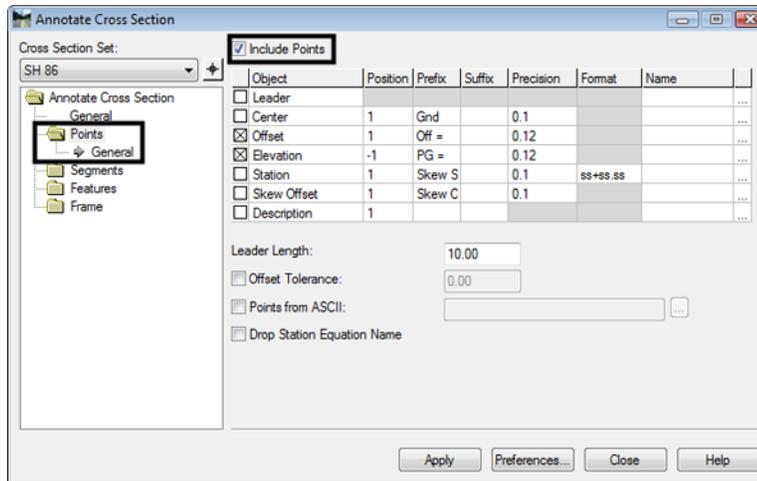
Annotating Cross Sections

Annotation from the **Create Cross Section** command is controlled by the preference defined in the surface properties. Use the **Annotate Cross Section** command to specify the data to display in the cross sections and how the data will be displayed.

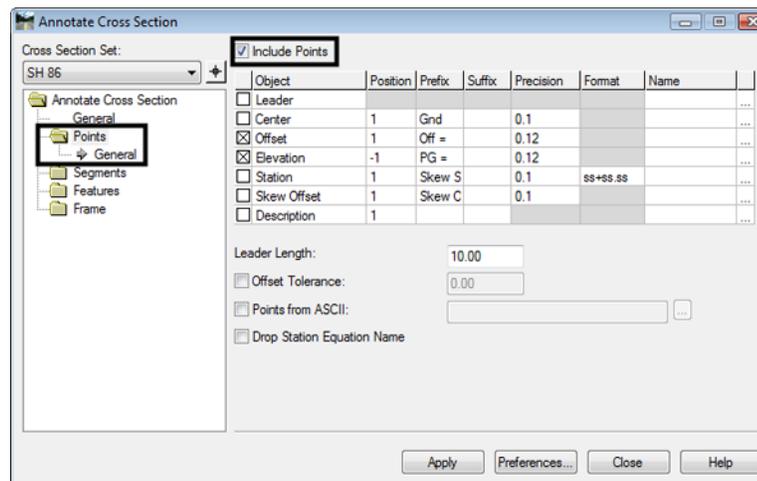
- Select **Evaluation > Cross Section > Annotate Cross Section** from the InRoads bar menu.
- From the **Annotate Cross Sections** dialog box, <D> the **Preferences** button.
- From the **Preferences** dialog box, Highlight the desired preference and <D> **Load**.
- <D> **Close** to dismiss the **Preferences** dialog box.
- Select the desired **Cross Section Set** from the drop down menu or use the target button.
- Select **Annotate Cross Section > General** from the dialog box explorer.
- Toggle on the surface(s) to annotate.



8. Select **Points** from the dialog box explorer.
9. Toggle on **Include Points** to display point annotation.

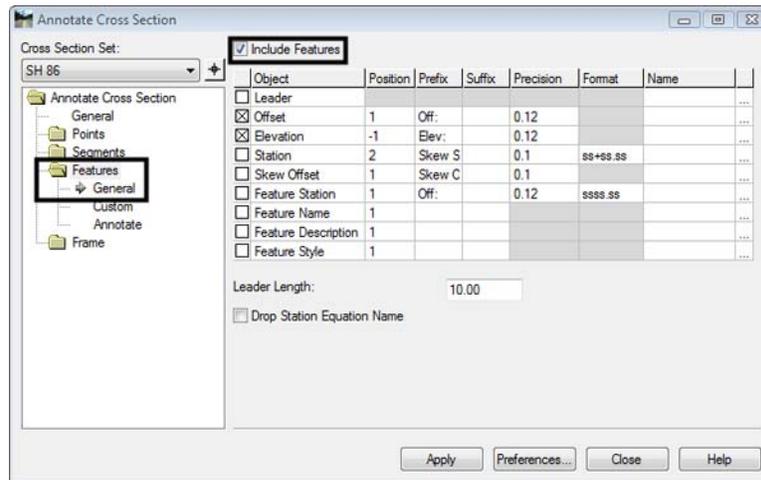


10. Select **Segments > General** from the dialog box explorer.
11. Toggle on **Include Segments** to display segment annotation.



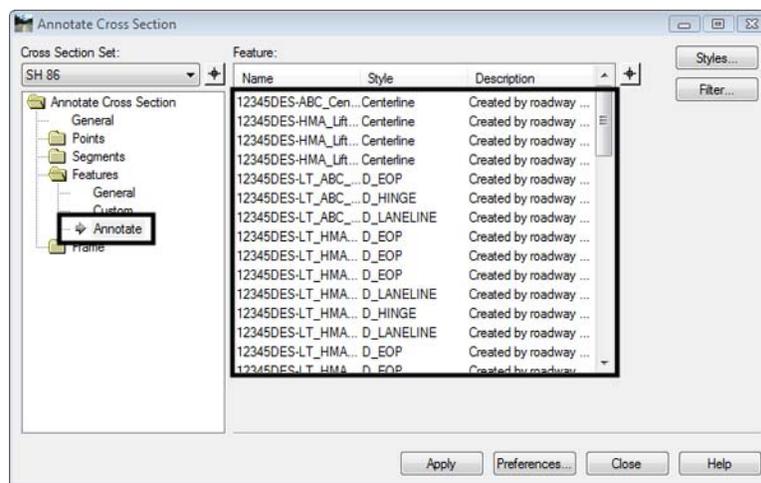
12. Select **Features > General** from the dialog box explorer.

13. Toggle on **Include Features** to display feature annotation.



14. Select **Features > Annotate** from the dialog box explorer.

15. Highlight the features to annotate.



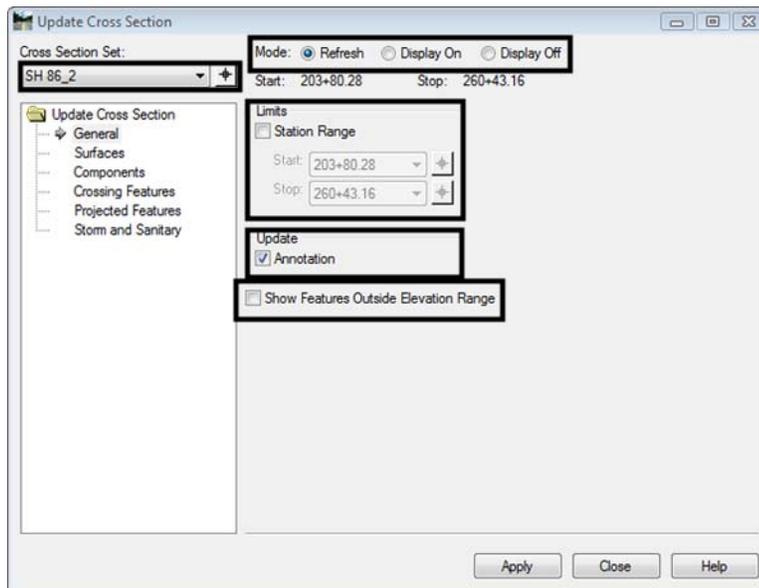
Note: Only features that are currently displayed in the cross sections can be annotated.

16. <D> **Apply** to annotate the cross sections.
17. <D> **Close** to dismiss the dialog box.

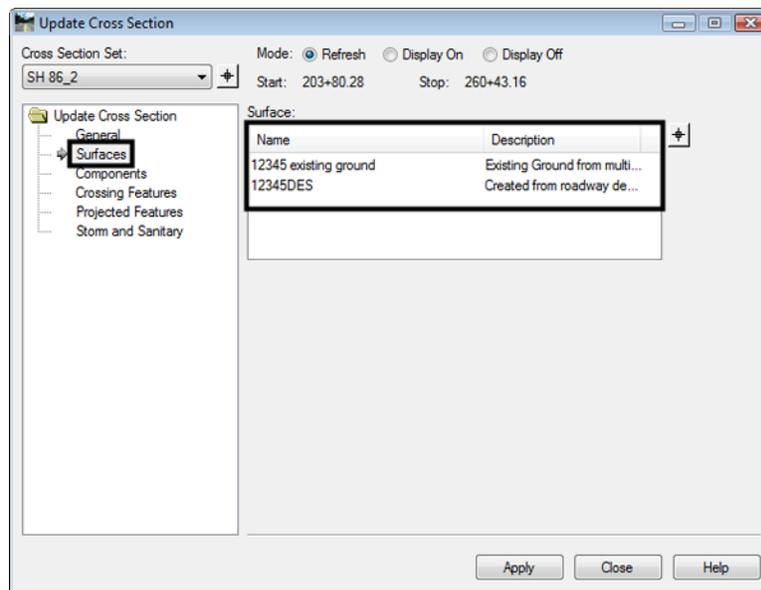
Updating Existing Cross Sections

Cross sections retain their association with the surfaces and features they display and therefore they can be updated as desired. Update Cross Section is used for three general situations; when the currently displayed data has changed, when new data is needed, and when currently displayed data needs to be removed from the sections. The process for updating cross sections is described below.

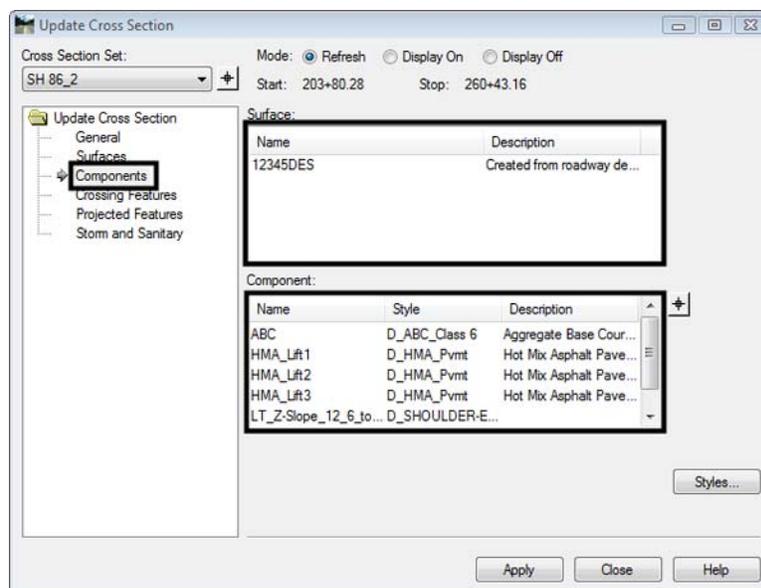
1. Select **Evaluation > Cross Section > Update Cross Section** from the InRoads bar menu.
2. From the **Update Cross Section** dialog box, on the General leaf, select the **Cross Section Set** to be updated using the drop down menu or <D> the “target” button then <D> on the desired cross section.
3. Toggle on the desired **Mode**. These are:
 - ◆ **Refresh** - used to update existing cross section data.
 - ◆ **Display On** - used to add additional data to the cross sections.
 - ◆ **Display Off** - used to remove data from the cross sections.
4. Set the **Station Range** as desired. To update the whole cross section set, toggle off **Station Range**. To update part of the set, toggle on **Station Range** and key in the desired **Start** and **Stop** stations.
5. If the data being updated has annotation, this can be modified as well. Toggle on **Annotation** in the **Update** area.
6. Features that fall above or below the cross section grid are not usually displayed. To display those features, toggle on **Show Features Outside Elevation Range**.



7. Select the **Surfaces** leaf.
8. Highlight the surface(s) to be updated.



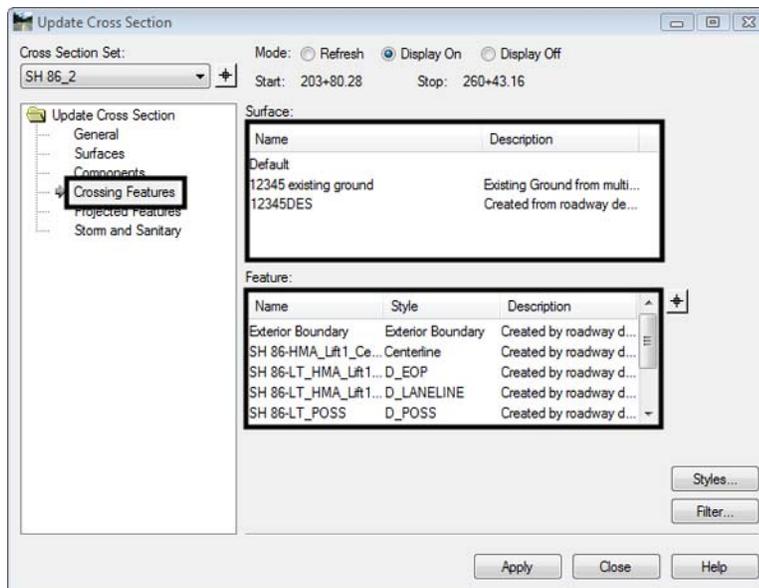
9. If the surface to be updated is a design surface, Select the **Components** leaf.
10. In the **Surface** list, select the desired surface(s).
11. In the **Component** list, select the desired component(s). To select all of the components, <R> in the **Component** list and <D> **Select All**.



To add or modify surface features in the cross sections, select the Crossing Features and/or the Projected Features leaves. Crossing features generally run parallel to the alignment. Typical crossing features are pavement features in the design surface, right of way lines, or utility lines. Projected features generally run perpendicular to the alignment. Typically, these are drainage structures or utility lines.

To display or update Crossing Features:

12. Select the Crossing Features leaf.
13. In the **Surface** list, select the desired surface(s).
14. In the **Feature** list, select the desired features(s). To select all of the features, <R> in the **Feature** list and <D> **Select All**.

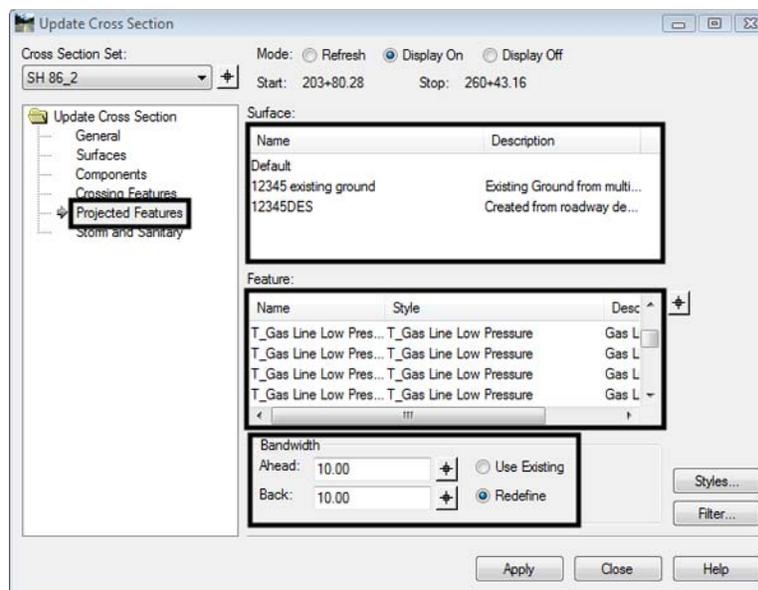


To add or modify projected features:

15. Select the Projected Features leaf.
16. In the **Surface** list, select the desired surface(s).
17. In the **Feature** list, select the desired features(s). To select all of the features, <R> in the **Feature** list and <D> **Select All**.

The Bandwidth sets the distance from the cross section station that data can be used for display. To set the Bandwidth:

18. Toggle on **Redefine**.
19. Key in the desired *Ahead* and *Back* values.



After making all of the desired settings:

20. <D> **Apply** to execute the command, then <D> **Close** to dismiss the Update Cross Section dialog box.

Important! Always use this command to turn off features displayed from a design surface before running **Roadway Modeler** and recreating the same surface. Otherwise, the features will not be recognized by the new surface and cannot be turned off or updated later.

Chapter Summary:

- Use the predefined preferences before changing the dialog box settings.
- Cross section annotation and volume data can be displayed when cross sections are generated. These options use the surface Preference and the Preferred Preference.
- Annotate Cross Section is used to add text data to the cross sections.
- Update Cross Section is used to redisplay modified data, add new data, and remove unwanted data from cross sections.

Chapter 13 - Volumes

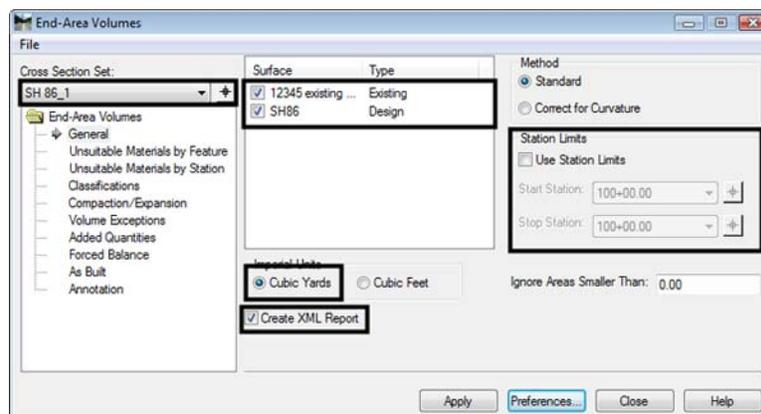
The changes in templates and surface data have made it necessary to change end area volumes as well. The use of components stored in the design surface allows the program to calculate volumes with greater accuracy than previously. To calculate End Area Volumes:

Chapter Objectives:

- Calculate basic end area volumes
- Create an end area volume report
- Add unsuitable material to calculations
- Add a volume exception

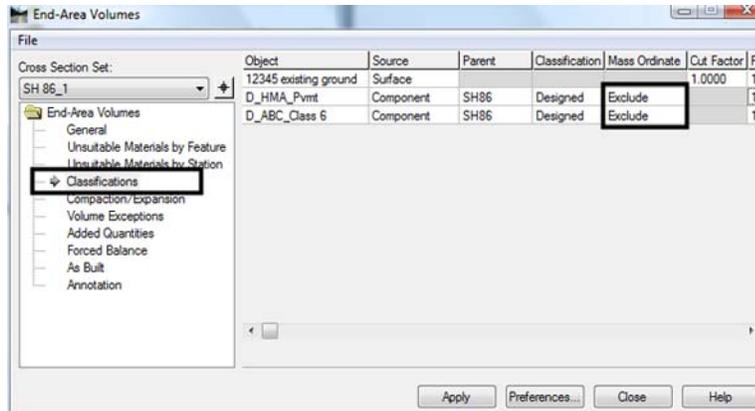
Calculating Volumes

1. Select **Evaluation > Volumes > End-Area Volumes** from the InRoads menu bar.
2. Select **General** leaf from the dialog box explorer.
3. Select the desired Cross Section Set from the drop down menu.
4. Toggle on the desired surfaces.
5. Toggle on **Cubic Yards** in the **Imperial Units** area.
6. Toggle on **Create XML Report** if desired.
7. Toggle on **Station Limits** if desired. If used, key in **Start Station** and **Stop Station**.

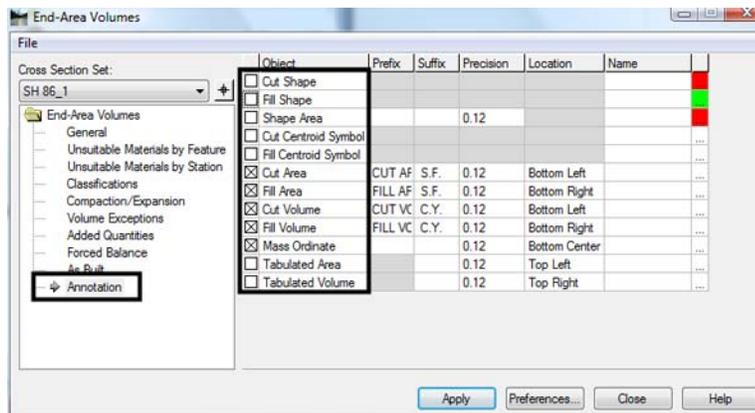


8. Select **Classification** leaf from the dialog box explorer.

- To change the status of a material, <D> in the **Mass Ordinate** cell of the desired material. **Include** adds the material to the volume calculation, **Exclude** does not add the material to the volume calculation.



- Select **Annotation** leaf from the dialog box explorer.
- Toggle on or off the desired objects.



- <D> **Apply** to calculate the volume. Cut and fill areas and volumes are displayed under each cross section.
- <D> **Close** to dismiss the dialog box.

Volume Reports

End Area Volume XML Report

If **Create XML Report** was toggled on in [Step 6](#) above, a Bentley InRoads Report Browser window is displayed. This window uses style sheets to determine the layout of the data. To select a style sheet:

- Select **Tools > Style Sheet Root** from the **Bentley InRoads Report Browser** menu bar. The Browse For Folder dialog box is displayed.

2. Navigate to: **C:\Workspace\Workspace-CDOT\Standards-Global\InRoads\XML Style Sheets**
3. <D> **OK**. The style sheet folder structure is displayed in the left pane of the **Bentley InRoads Report Browser**.
4. <D> on the **Evaluation** folder to expose its style sheets.
5. <D> on the desired end-area volume style sheets to format the data in the right pane.

End Area Volume Report

Report Created: 3/4/2009
Time: 2:08pm

Cross Section Set Name: SH 85_1
Alignment Name: SH 85
Input Grid Factor: 1.000000 Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Station	Cut				Fill				Mass					
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted
100+00.00	1.00	54.76	0.00	0.00	1.00	16.75	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
100+50.00	1.00	58.17	104.56	104.56	1.00	24.63	38.32	38.32	1.00	0.00	0.00	1.00	0.00	0.00
101+00.00	1.00	61.69	110.98	110.98	1.00	19.41	40.78	40.78	1.00	0.00	0.00	1.00	0.00	0.00
101+50.00	1.00	65.08	117.37	117.37	1.00	7.08	24.53	24.53	1.00	0.00	0.00	1.00	0.00	0.00
102+00.00	1.00	66.88	122.18	122.18	1.00	3.92	10.19	10.19	1.00	0.00	0.00	1.00	0.00	0.00
102+50.00	1.00	63.57	120.79	120.79	1.00	2.54	5.98	5.98	1.00	0.00	0.00	1.00	0.00	0.00
103+00.00	1.00	58.22	112.77	112.77	1.00	5.15	7.12	7.12	1.00	0.00	0.00	1.00	0.00	0.00
103+50.00	1.00	59.48	108.98	108.98	1.00	0.49	5.23	5.23	1.00	0.00	0.00	1.00	0.00	0.00
104+00.00	1.00	59.71	110.36	110.36	1.00	4.81	4.91	4.91	1.00	0.00	0.00	1.00	0.00	0.00
104+50.00	1.00	51.92	103.36	103.36	1.00	6.85	10.80	10.80	1.00	0.00	0.00	1.00	0.00	0.00
105+00.00	1.00	38.70	83.91	83.91	1.00	8.26	14.00	14.00	1.00	0.00	0.00	1.00	0.00	0.00
105+50.00	1.00	32.02	65.49	65.49	1.00	11.68	18.47	18.47	1.00	0.00	0.00	1.00	0.00	0.00
106+00.00	1.00	32.82	60.04	60.04	1.00	11.33	21.31	21.31	1.00	0.00	0.00	1.00	0.00	0.00
106+50.00	1.00	29.12	57.36	57.36	1.00	8.33	18.21	18.21	1.00	0.00	0.00	1.00	0.00	0.00
107+00.00	1.00	27.68	52.60	52.60	1.00	2.90	10.40	10.40	1.00	0.00	0.00	1.00	0.00	0.00
107+50.00	1.00	29.27	52.73	52.73	1.00	2.40	4.91	4.91	1.00	0.00	0.00	1.00	0.00	0.00
108+00.00	1.00	32.27	56.99	56.99	1.00	2.02	4.09	4.09	1.00	0.00	0.00	1.00	0.00	0.00
108+50.00	1.00	36.13	63.34	63.34	1.00	1.44	3.20	3.20	1.00	0.00	0.00	1.00	0.00	0.00

The formatted data can be copied and pasted into Excel or Word.

Unsuitable Material

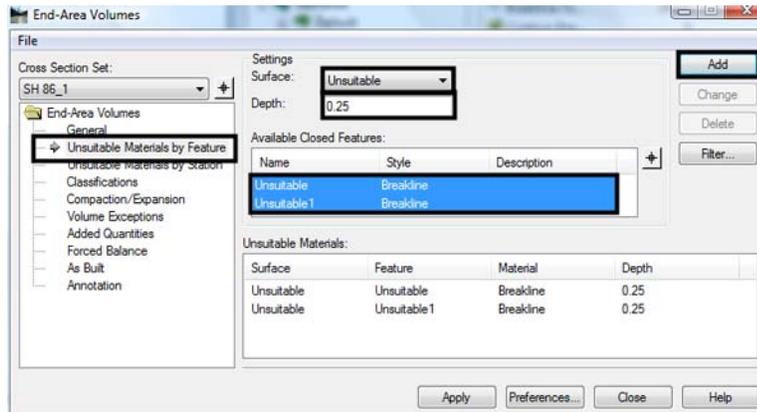
InRoads has the option to modify end area calculations for unsuitable material (like topsoil and muck). There are two options for determining the area of unsuitable material: by feature and by station extents. If both are used, the station extents override the feature method.

Unsuitable Material by Feature

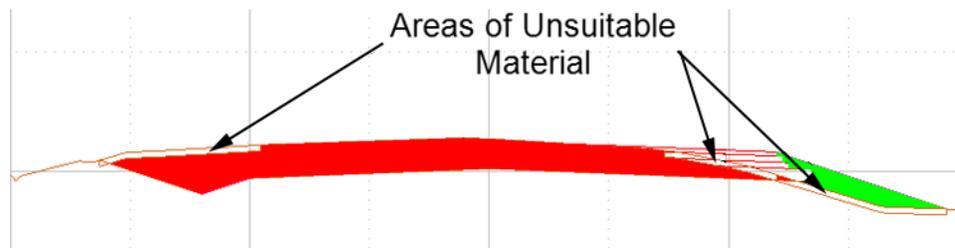
Before using this option a closed shape feature(s) must be created that defines the area of the material. The feature(s) do not have to reflect the actual elevation of the surface. It can be placed in its own surface at a zero elevation. To use the Unsuitable Material by Feature option:

1. Repeat steps 1 through 11 under Calculating Volumes.
2. Select the **Unsuitable Material by Feature** leaf from the dialog box explorer.
3. Select the desired **Surface** from the drop down menu.
4. Key in the desired **Depth**.
5. Highlight the desired features from the **Available Closed Features** area.

6. <D> **Add**. The data is added to the Unsuitable Materials list.



7. <D> **Apply** to calculate the volumes. The area of unsuitable material is shown on the cross sections.



Note: Unsuitable material located under fill is included in the Mass Ordinate calculation. This occurs because materials removed from under fills must be replaced with embankment material.

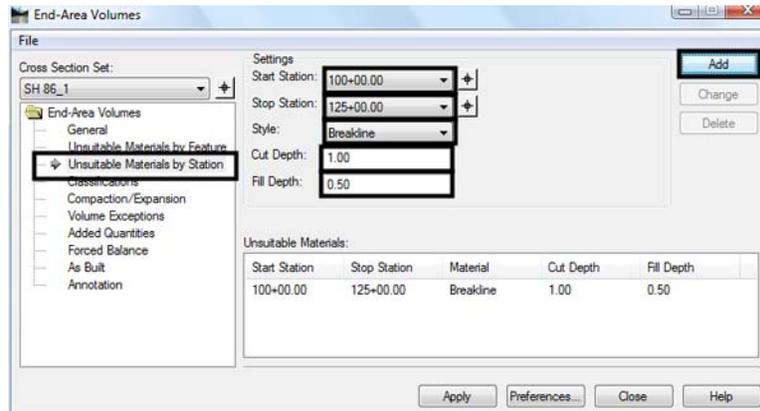
8. <D> **Close** to dismiss the *End-Area Volumes* dialog box.

Unsuitable Material by Station

There are no prerequisites for using this option. To use the Unsuitable Material by Station option:

1. Repeat steps 1 through 11 under Calculating Volumes.
2. Select the **Unsuitable Material by Station** leaf from the dialog box explorer.
3. Select the **Start Station** using the drop down menu.
4. Select the **Stop Station** using the drop down menu.
5. Select the **Style** using the drop down menu.
6. Key in the **Cut Depth**
7. Key in the **Fill Depth**.

8. <D> Add. The data is added to the Unsuitable Materials list.



9. <D> **Apply** to calculate the volumes. The area of unsuitable material is shown on the cross sections. The calculations and displays are the same as those used for the Unsuitable Material by Feature option.
10. <D> **Close** to dismiss the *End-Area Volumes* dialog box.

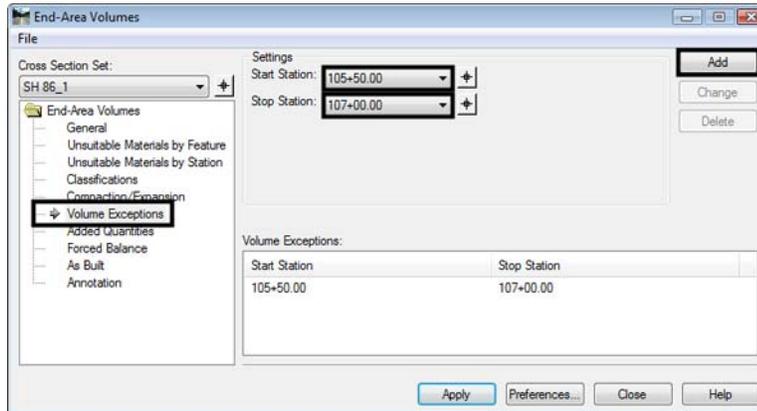
Volume Exceptions

Volume exceptions are used to remove the amount of earthwork calculated for an area where no work is done but is present in the design model (in the area of a bridge, for example). Using a volume exception allows the user to create a single design dtm for the project and still account for areas where no earthwork will take place.

The cross section set must have a cross section at the beginning station of the exception and the ending station of the exception. Horizontal Event Stations or Key Stations (from Roadway Designer) can be used to include these stations if they do not fall on normal intervals. To set up a volume exception:

1. Repeat *Step 1* through *Step 11* under *Calculating Volumes*.
2. Repeat the steps under *Unsuitable Material by Feature* and/or *Unsuitable Material by Station*.
3. Select the **Volume Exceptions** leaf from the dialog box explorer.
4. Select the **Start Station** from the drop down menu. This is the last station where a volume will be calculated before the exception.
5. Select the **Stop Station** from the drop down menu. This is the last station where no volume will be calculated at the end of the exception.

6. <D> **Add**. This adds the data to the **Volume Exception** area.



7. <D> **Apply** to calculate the volumes. Below is an example of an End-Area Volume Report with an exception.

End Area Volume Report

Report Created: 3/5/2009
Time: 10:37am

Cross Section Set Name: SH 86_1
Alignment Name: SH 86
Input Grid Factor: 1.000000 **Note:** All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities						Added Quantities						Mass Ordinate		
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor		Volume	Adjusted
100+00.00	1.00	88.40	0.00	0.00	1.00	16.75	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
100+50.00	1.00	91.57	166.64	166.64	1.00	24.63	38.32	38.32	1.00	0.00	0.00	1.00	0.00	0.00	128.33
101+00.00	1.00	95.00	172.75	172.75	1.00	19.41	40.78	40.78	1.00	0.00	0.00	1.00	0.00	0.00	260.30
101+50.00	1.00	98.83	179.47	179.47	1.00	7.08	24.53	24.53	1.00	0.00	0.00	1.00	0.00	0.00	415.24
102+00.00	1.00	103.11	186.98	186.98	1.00	3.92	10.19	10.19	1.00	0.00	0.00	1.00	0.00	0.00	592.03
102+50.00	1.00	101.52	189.47	189.47	1.00	2.54	5.98	5.98	1.00	0.00	0.00	1.00	0.00	0.00	775.52
103+00.00	1.00	91.30	178.54	178.54	1.00	5.15	7.12	7.12	1.00	0.00	0.00	1.00	0.00	0.00	946.93
103+50.00	1.00	92.90	170.55	170.55	1.00	0.49	5.23	5.23	1.00	0.00	0.00	1.00	0.00	0.00	1112.26
104+00.00	1.00	91.84	171.05	171.05	1.00	4.81	4.91	4.91	1.00	0.00	0.00	1.00	0.00	0.00	1278.40
104+50.00	1.00	83.52	162.36	162.36	1.00	6.85	10.80	10.80	1.00	0.00	0.00	1.00	0.00	0.00	1429.96
105+00.00	1.00	66.31	138.73	138.73	1.00	8.26	14.00	14.00	1.00	0.00	0.00	1.00	0.00	0.00	1554.69
105+50.00	1.00	59.31	116.31	116.31	1.00	11.68	18.47	18.47	1.00	0.00	0.00	1.00	0.00	0.00	1652.54
106+00.00	1.00	61.03	0.00	0.00	1.00	11.33	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1652.54
106+50.00	1.00	56.48	0.00	0.00	1.00	8.33	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1652.54
107+00.00	1.00	59.52	0.00	0.00	1.00	2.90	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1652.54
107+50.00	1.00	60.52	111.15	111.15	1.00	2.40	4.91	4.91	1.00	0.00	0.00	1.00	0.00	0.00	1758.77
108+00.00	1.00	66.63	117.73	117.73	1.00	2.02	4.09	4.09	1.00	0.00	0.00	1.00	0.00	0.00	1872.41
108+50.00	1.00	71.36	127.77	127.77	1.00	1.44	3.20	3.20	1.00	0.00	0.00	1.00	0.00	0.00	1996.98
109+00.00	1.00	64.90	126.17	126.17	1.00	1.83	3.02	3.02	1.00	0.00	0.00	1.00	0.00	0.00	2120.12
109+50.00	1.00	63.71	119.08	119.08	1.00	2.44	3.96	3.96	1.00	0.00	0.00	1.00	0.00	0.00	2235.25

8. <D> **Close** to dismiss the **End-Area Volumes** dialog box.

Chapter Summary:

- Surfaces are compared based on their Type property. There must be an Existing and at least one Design type surface loaded to calculate volumes.
- The end area volume report can be created when the volumes are calculated.

- Unsuitable material locations can be defined based on a station range or a closed feature. Volumes within these areas are adjusted to account for the removal of this material.
- Volume exceptions ignore earthwork quantities through a given cross section range. This allows the user to calculate a single quantity for the project instead of separate quantities between each area of no construction.

Chapter 14 - Reports

Reports are a method of taking data stored in the various InRoads files and presenting it in a readable format.

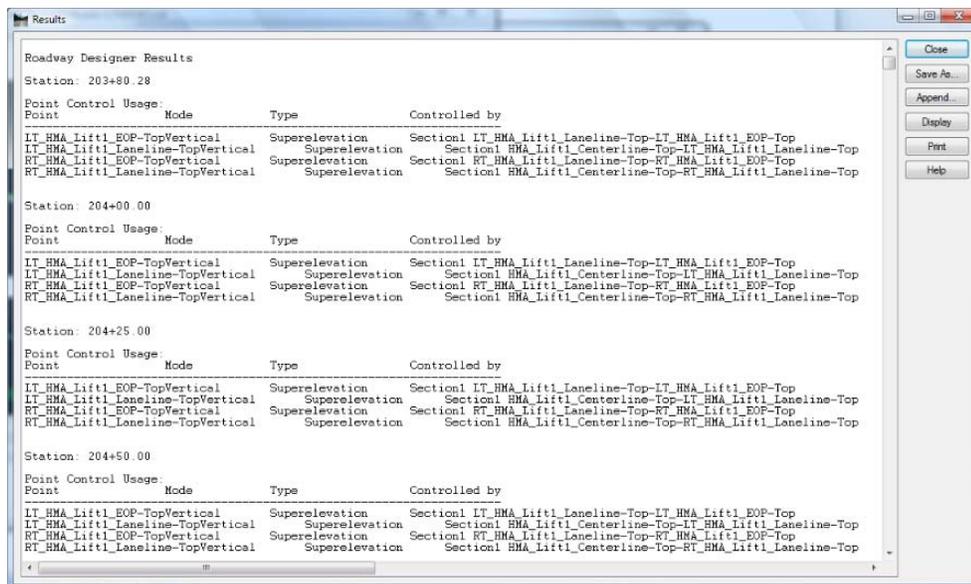
Chapter Objectives:

- To describe where the data used to generate reports is stored.
- To present commonly used reports.
- To create various reports and use different report styles.
- To learn how to change the basic format of XML Reports.

Where Reports Come From

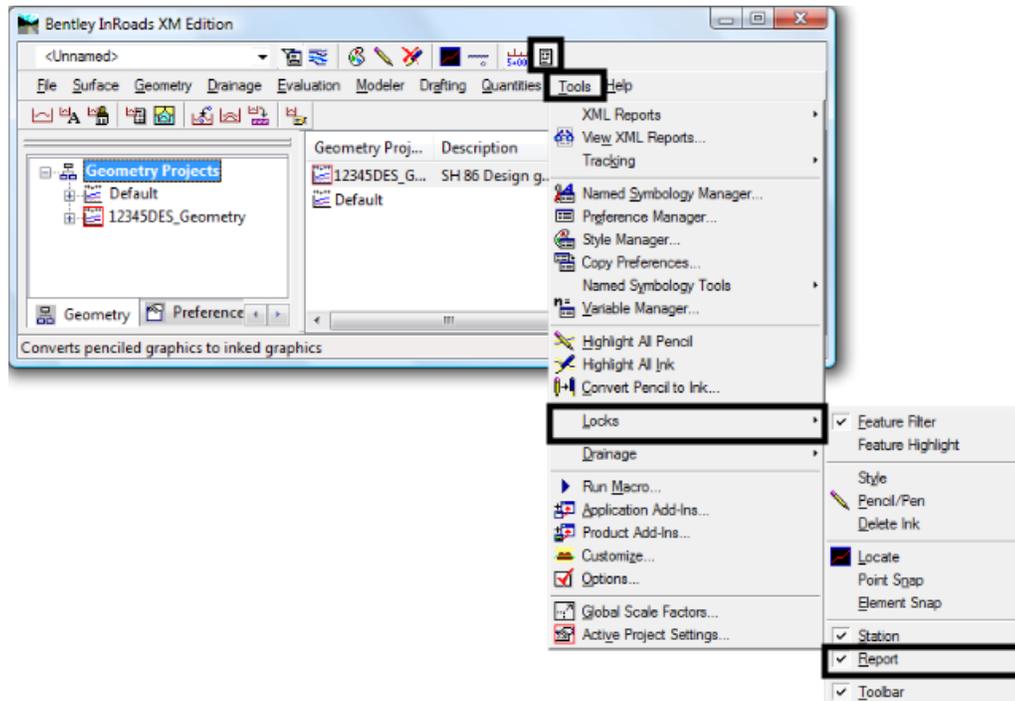
Command Generated Reports

Some reports are generated automatically as part of a command's execution. These are typically displayed in a Results window. An example of this type of report comes from processing a corridor in Roadway Designer.



The data in the **Results** window can be saved by selecting the **Save As** button. The saved file is in Plain Text format and can be opened in **Notepad**, **Wordpad**, or **Word**. The data can also be printed by selecting the **Print** button.

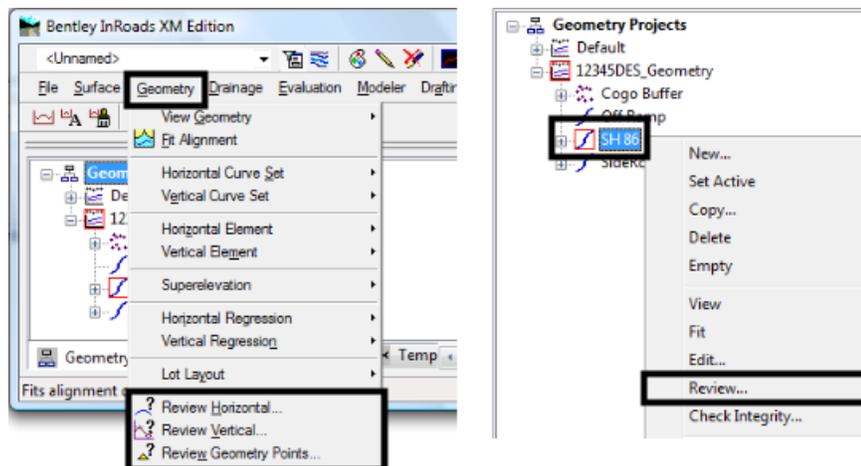
Command generated reports are enabled/disabled by toggling on or off the **Report Lock**. The **Report Lock** is under **TOOLS > LOCK** on the InRoads menu bar or on the button bar.



the format of command generated reports is set in the program and cannot be changed.

Review Reports

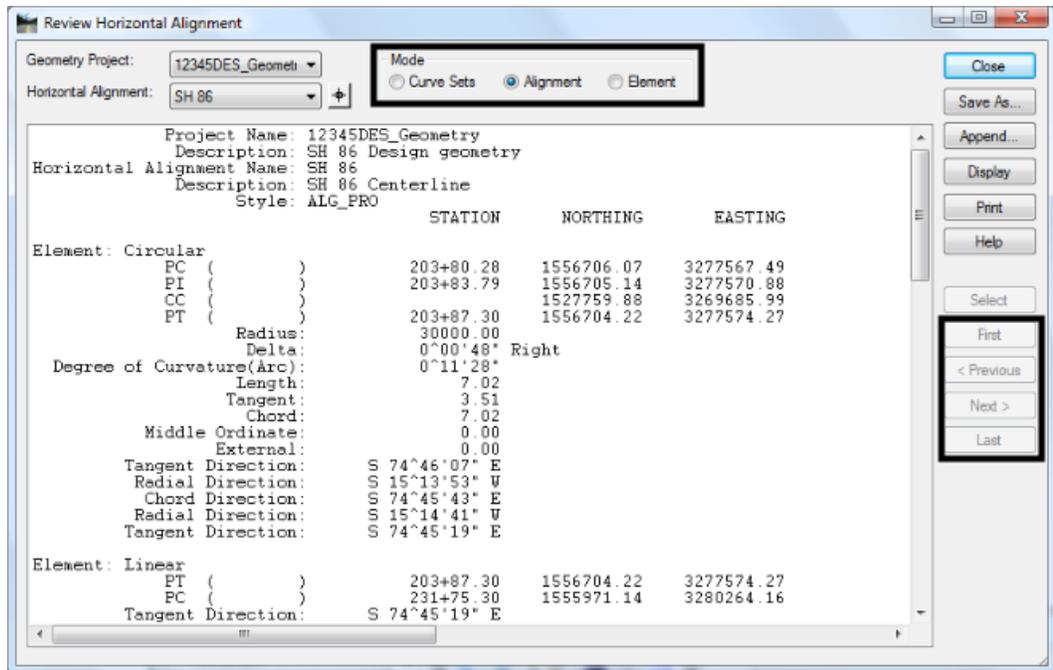
Review reports are generated by reviewing data (usually horizontal or vertical geometry). These are displayed by selecting **Geometry > Review Horizontal**, **Review Vertical** or **Review Geometry Point** from the InRoads menu bar or by <R> on the desired alignment and selecting **Review**.



The format of alignment review reports can be modified in a limited manner by selecting the **Mode**. The modes available for horizontal alignments are **Alignment**, **Element**, and **Curve Set**. The modes for Vertical alignments are **Alignment** and **Element**. The data displayed is based on the mode is as follows:

- **Alignment** – Data pertaining to all elements of the alignment is displayed.

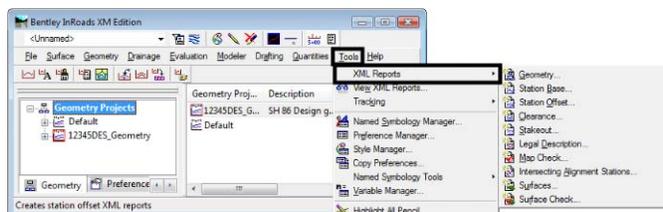
- **Element** – Data pertaining to a single element of the alignment is displayed. Element data is accessed using the **First**, **Last**, **Next**, and **Previous** buttons in the report dialog box.
- **Curve Set** –Data pertaining to all of the arc elements is displayed.



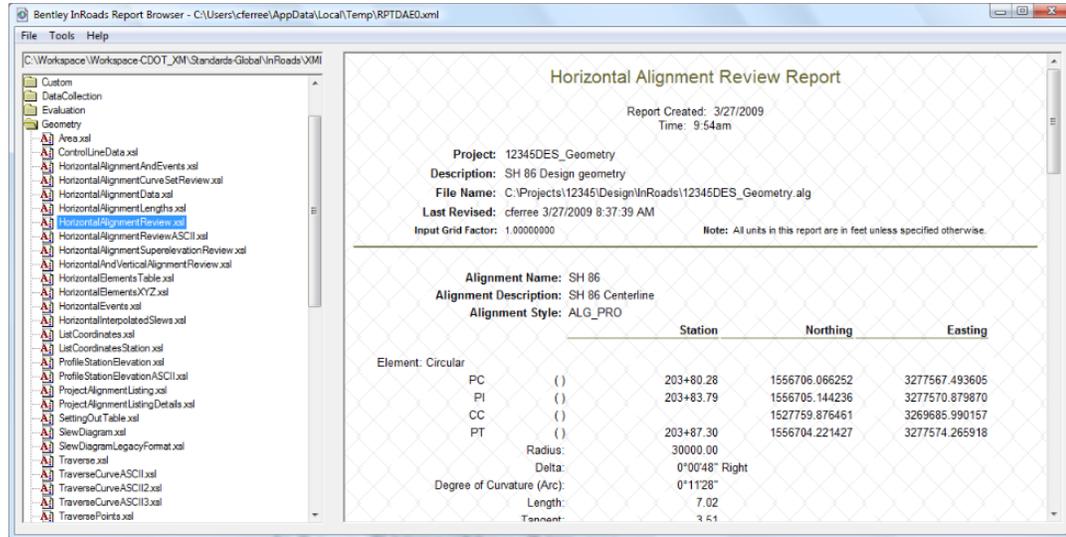
The data in the **Review** window can be saved by selecting the **Save As** button. The saved file is in plain text (TXT) format and can be opened in **Notepad**, **Wordpad**, or **Word**. The data can also be printed by selecting the **Print** button.

XML Reports

With the exception of the End Area Volume report, which is created from the command's dialog box, XML reports are accessed from **Tools > XML Reports** from the InRoads menu bar.



The reports are displayed in the Bentley InRoads Report Browser. XML Style Sheets are used to format the data. The report format is changed by selecting the desired style sheet from the style sheet list on the left side of the dialog box.



Commonly Used Reports

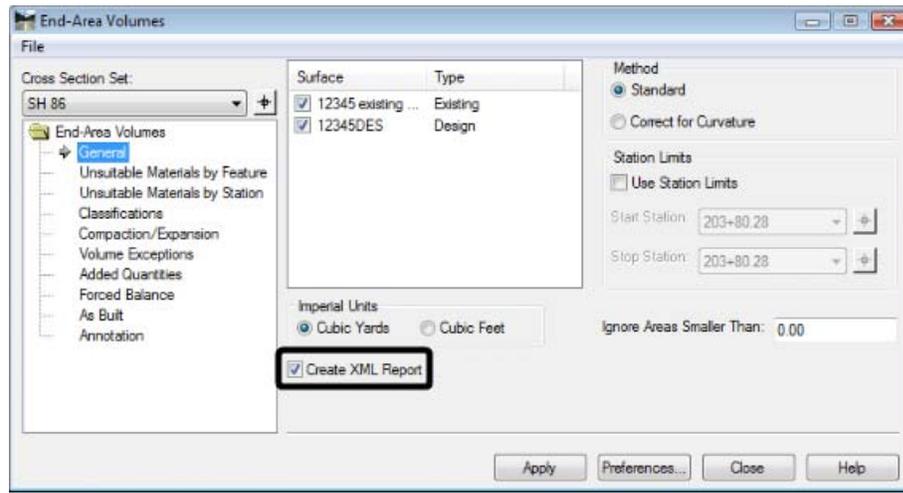
There are many reports and formats that can be generated from InRoads. Some of the more common reports used by CDOT are described in this section.

End Area Volume Reports

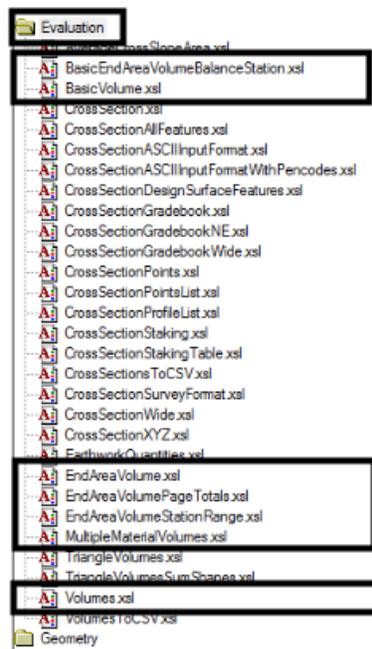
The End Area Volume report presents data generated by InRoads in a tabular format. This report is generated from the *End Area Volumes* command. A set of cross sections with an existing surface and a design surface is required to create this report. Create an End Area Volume report using the following steps:

1. Select **Evaluation > Volumes > End Area Volumes** from the InRoads menu bar.

- Toggle on **Create XML Report**.



- Make the other settings in the End Area Volumes dialog box as desired. These options are explained in [Chapter 13 -Volumes](#).
- <D> **Apply**. The **Bentley InRoads Report Browser** is displayed.
- Select the desired style sheet from the **Evaluation** folder.



The following style sheets are used with the End Area Volume report:

- ◆ **BasicEndAreaVolumeBalanceStation.xml** – This style sheet shows calculated and adjusted areas and volumes, a grand total, and highlights balanced stations.

Baseline Station	Station Quantities								Mass Ordinate
	Cut				Fill				
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	
224+00.00	1.00	0.00	0.00	0.00	1.00	305.99	1290.31	1290.31	1073.18
225+00.00	1.00	0.00	0.00	0.00	1.00	116.51	782.40	782.40	290.78
226+00.00	1.00	24.20	44.81	44.81	1.00	48.26	305.13	305.13	30.46
226+19.70									0.00
227+00.00	1.00	9.86	63.07	63.07	1.00	69.29	217.69	217.69	-124.16
228+00.00	1.00	11.99	40.47	40.47	1.00	59.80	239.06	239.06	-322.75

- ◆ **BasicVolume.xml** - This style sheet shows calculated and adjusted areas and volumes and a grand total.

Baseline Station	Station Quantities								Mass Ordinate
	Cut				Fill				
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	
258+00.00	1.00	148.32	670.37	670.37	1.00	9.26	19.71	19.71	6451.93
259+00.00	1.00	144.85	542.91	542.91	1.00	10.28	36.19	36.19	6958.65
260+00.00	1.00	163.79	571.56	571.56	1.00	10.43	38.35	38.35	7491.87
260+43.16	1.00	163.75	261.80	261.80	1.00	12.51	18.34	18.34	7735.33
Grand Total:			22907.09	22907.09			15171.76	15171.76	

- ◆ **EndAreaVolume.xml** – This style sheet displays the same information as the **BasicEndAreaVolumeBalanceStation.xml** style sheet with added quantities information for cut and fill included.
- ◆ **EndAreaVolumePageTotals.xml** - This style sheet shows calculated and adjusted areas and volumes, Added Quantities volumes, a grand total, and page totals

Baseline Station	Station Quantities								Added Quantities								Mass Ordinate
	Cut				Fill				Cut				Fill				
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted			
256+00.00	1.00	332.21	1224.21	1224.21	1.00	0.00	0.04	0.04	1.00	0.00	0.00	1.00	0.00	0.00	4792.91		
257+00.00	1.00	213.68	1010.92	1010.92	1.00	1.38	2.56	2.56	1.00	0.00	0.00	1.00	0.00	0.00	5801.27		
258+00.00	1.00	148.32	670.37	670.37	1.00	9.26	19.71	19.71	1.00	0.00	0.00	1.00	0.00	0.00	6451.93		
259+00.00	1.00	144.85	542.91	542.91	1.00	10.28	36.19	36.19	1.00	0.00	0.00	1.00	0.00	0.00	6958.65		
260+00.00	1.00	163.79	571.56	571.56	1.00	10.43	38.35	38.35	1.00	0.00	0.00	1.00	0.00	0.00	7491.87		
260+43.16	1.00	163.75	261.80	261.80	1.00	12.51	18.34	18.34	1.00	0.00	0.00	1.00	0.00	0.00	7735.33		
Page Total:		4281.77	4281.77				115.18	115.18		0.00	0.00		0.00	0.00			
Grand Total:		22907.09	22907.09				15171.76	15171.76		0.00	0.00		0.00	0.00			

- ◆ **EndAreaVolumeStationRange.xml** - This style sheet shows calculated and adjusted areas and volumes, Added Quantities volumes, and Station Range Totals. The station range is set to 700 feet.

Baseline Station	Station Quantities				Added and Material Quantities				Mass Ordinate		
	Cut		Fill		Cut		Fill				
Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Volume	Adjusted	Volume	Adjusted
203+80.28	1.00	177.19	0.00	0.00	1.00	7.01	0.00	0.00	0.00	0.00	0.00
204+00.00	1.00	175.71	128.86	128.86	1.00	7.03	5.12	5.12	0.00	0.00	0.00
205+00.00	1.00	165.36	631.61	631.61	1.00	8.79	29.29	29.29	0.00	0.00	0.00
206+00.00	1.00	156.50	596.04	596.04	1.00	16.77	47.33	47.33	0.00	0.00	0.00
207+00.00	1.00	160.17	586.42	586.42	1.00	35.36	96.53	96.53	0.00	0.00	0.00
208+00.00	1.00	154.51	582.73	582.73	1.00	33.00	126.59	126.59	0.00	0.00	0.00
209+00.00	1.00	146.44	557.31	557.31	1.00	62.39	176.65	176.65	0.00	0.00	0.00
210+00.00	1.00	185.74	615.16	615.16	1.00	9.96	133.97	133.97	0.00	0.00	0.00
Station Range Totals:		3698.13	3698.13			615.49	615.49	0.00	0.00	0.00	0.00

- ◆ **MultipleMaterialVolumes.xml** - This style sheet shows calculated and adjusted areas and volumes. It also calculates quantities for existing substrata surfaces.
- ◆ **Volumes.xml** - This style sheet shows calculated and adjusted areas and volumes and the areas and volumes for component materials and unsuitable material.

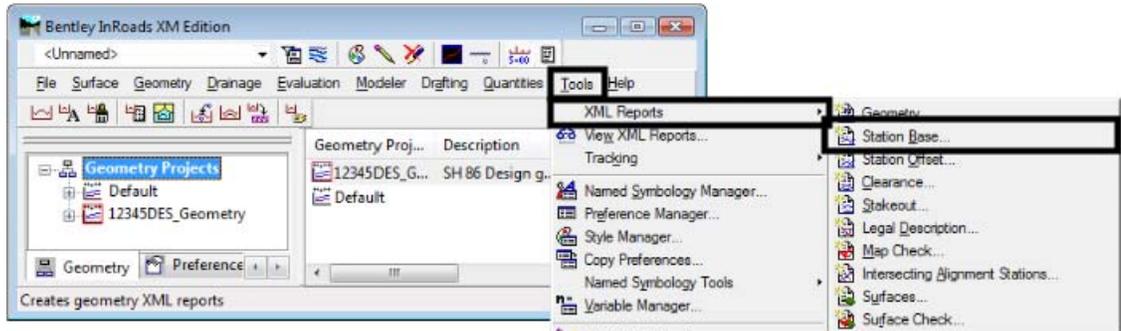
Station	Type	Area	Volume	Factor	Adjusted Volume	Included in Mass Ordinate?	Mass Ordinate
204+00.00							57.95
	Normal Cut:	113.17	83.31	1.00	83.31	Yes	
	Normal Fill:	7.03	5.12	1.00	5.12	Yes	
	Added Cut:	0.00	0.00	1.00	0.00	Yes	
	Added Fill:		0.00	1.00	0.00	Yes	
	Default (replaced):	27.27	20.23	1.00	20.23	Yes	
	Default (not replaced):	62.54	45.55	1.00	45.55	No	
	Total Default:	89.81	65.79	1.00	65.79		
	D_SUBBASE:	108.00	78.87	1.00	78.87	No	
	D_HMA_Pvmt:	36.75	26.84	1.00	26.84	No	
	D ABC Class 6:	27.00	19.72	1.00	19.72	No	

Station Base and Station Offset Reports

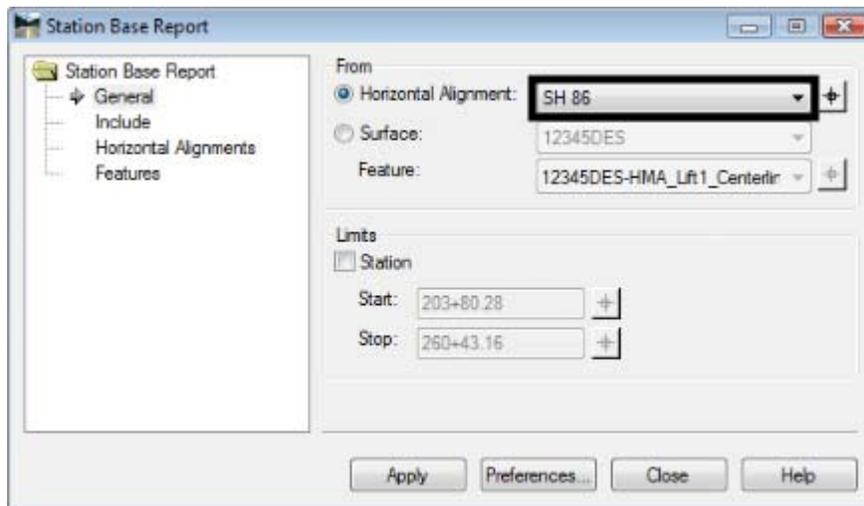
These reports are used to calculate the offset distance between two horizontal alignments, a horizontal alignment and a surface feature, or two surface features. They operate in a similar manner. They both measure from the alignment or feature selected on the General leaf (in the From area) to the specified alignment or feature. Measurements are made perpendicular to the “From” alignment or feature. Stationing for the Station Base report is controlled by the “From” alignment or feature. The specified alignment or feature (identified on the Horizontal Alignments and Features leaves) control stationing for Station Offset reports.

The Station Base and Station Offset Reports are useful in determining gore stations and distances to the right of way. To create a Station Base or Station Offset report (the station base report is used in this example) follow the steps below:

1. Select **Tools > XML Reports > Station Base** from the InRoads menu bar.

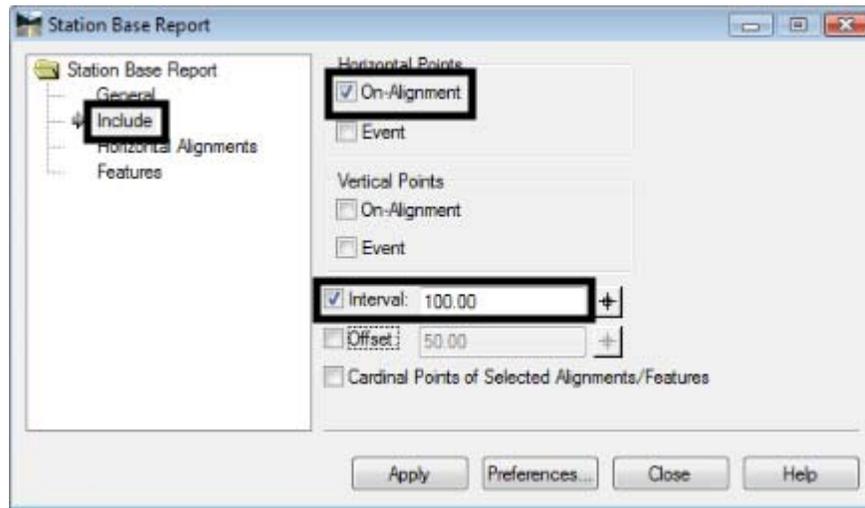


2. On the **General** leaf of the **Station Base Report** dialog box, select the desired **Horizontal Alignment**. In this example **SH 86** is used.

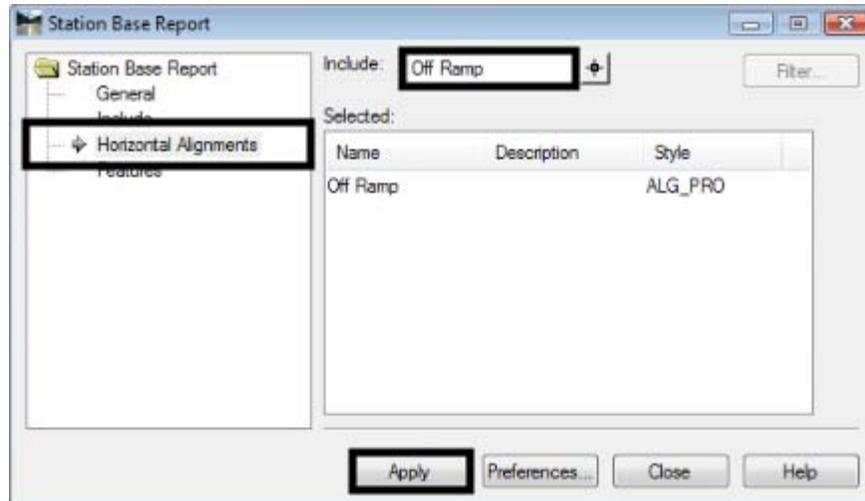


3. Select the **Include** leaf.
4. In the **Horizontal Points** area, toggle on **On-Alignment**.
5. Toggle on **Interval**.

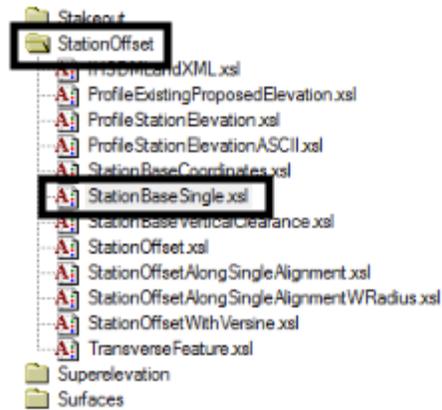
6. In the **Interval** field, key in **100**.



7. Select the **Horizontal Alignments** leaf.
8. In the **Include** field, key in the desired **alignment name** (**Off Ramp** in this example) and press the **Tab** key.
9. **<D> Apply**. This displays the **Bentley InRoads Report Browser**.



10. In the **Bentley InRoads Report Browser**, select the **StationBaseSingle.xml** from the **StationOffset** folder in the left pane.



11. Review the report in the left pane.

Station Base Report

Report Created: 4/1/2009
Time: 1:13pm

Project: 12345DES_Geometry
Description: SH 86 Design geometry
Baseline (Active) Alignment: SH 86
File Name: C:\Projects\12345\Design\InRoads\12345DES_Geometry.alg
Last Revised: cferree 4/1/2009 11:19:47 AM
Input Grid Factor: 1.00000000

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

----- Baseline Alignment -----			----- Offset Alignment -----		
Station	Distance to Offset Point	Radial Direction	Station	Distance to Offset Point	Radial Direction
Offset (Specified) Alignment: Off Ramp					
205+00.00	0.00	S 15°14'41" W	1+00.00	24.00	S 15°14'41" W
206+00.00	0.00	S 15°14'41" W	2+00.00	24.00	S 15°14'41" W
207+00.00	0.00	S 15°14'41" W	3+00.00	24.00	S 15°14'41" W
208+00.00	0.00	S 15°14'41" W	4+00.00	24.00	S 15°14'41" W
209+00.00	0.00	S 15°14'41" W	5+00.00	24.00	S 15°14'41" W
210+00.00	0.00	S 15°14'41" W	6+00.00	24.00	S 15°14'41" W
211+00.00	0.00	S 15°14'41" W	7+00.00	24.00	S 15°14'41" W
212+00.00	0.00	S 15°14'41" W	8+00.15	28.69	S 20°47'52" W

The important columns are:

- ◆ Column 1 – This is the station on the “From” alignment. This is where the measurement originates.
- ◆ Column 4 – This is the station on the alignment selected on the Horizontal Alignments leaf. It is the point measured to.
- ◆ Column 5 – This is the distance measured.

Other style sheets that are used with the Station Base and Station Offset reports are:

- ◆ **StationBaseCoordinates.xml** – This style sheet displays the “From” alignment station, the offset distance, and the X, Y, and Z coordinates of the specified alignment. The Z coordinate is the specified alignment’s vertical alignment.

Active Alignment (SH 86) Station	Perpendicular Distance from Active Alignment to Specified Alignment (Off Ramp) Offset is 0.00	Specified Alignment Coordinates (SH 86 V)		
		X	Y	Z
205+00.00	24.00	3277676.688520	1556651.432611	6600.0000
206+00.00	24.00	3277773.169669	1556625.138358	6600.0000
207+00.00	24.00	3277869.650819	1556598.844106	6600.0000
208+00.00	24.00	3277966.131969	1556572.549853	6600.0000
209+00.00	24.00	3278062.613119	1556546.255600	6600.0000
210+00.00	24.00	3278159.094269	1556519.961348	6600.0000

Note: The vertical alignment listed under *Specified Alignment Coordinates* is the child of the *Active Alignment*. The data in the *Z* column comes from the vertical alignment attached to the *Specified Alignment*.

- ◆ **StationBaseVerticalClearance.xml** - This style sheet displays the “From” alignment station, the offset distance, and the elevation difference between the “From” vertical alignment and the specified vertical alignment. This report is useful when defining vertical alignments for merging alignments.

Active Alignment Station (SH 86)	Perpendicular Distance from Active Alignment to Specified Alignment Offset is 0.00 (Off Ramp)	Vertical Clearance to Off Ramp
205+00.00	24.00	32.7657
205+50.00	24.00	32.6232
206+00.00	24.00	32.4808
206+50.00	24.00	32.3383
207+00.00	24.00	32.1959
207+50.00	24.00	32.0535
208+00.00	24.00	31.9110
208+50.00	24.00	31.7686

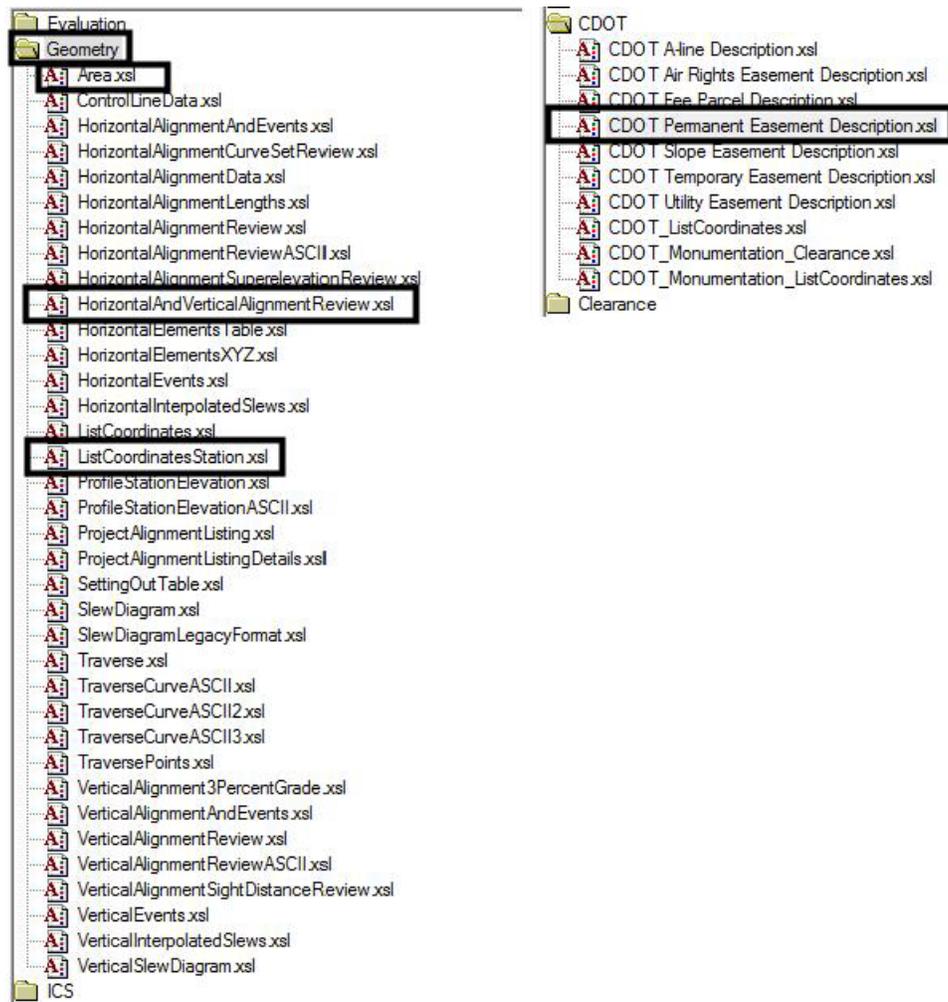
Geometry Reports

A geometry report can be used with a large number of style sheets to produce legal descriptions, calculate areas, and review alignment data. These reports can be generated for a single alignment or multiple alignments. To create a geometry report:

1. Select **Tools > XML Reports > Geometry** from the InRoads menu bar. This displays the Geometry Reports dialog box.
2. In the **Include** field of the **Horizontal Alignments** area, key in the desired **alignment name**. An “*” can be used to select all of the alignments in the geometry project.
3. In the **Include** field of the **Cogo Points** area, key in the desired **point name**. An “*” can be used to select all of the cogo points in the geometry project.
4. Toggle on **Include Vertical Alignments**, if desired.
5. Toggle on **Include Vertical Event Points**, if desired.

6. Toggle on **Include Horizontal Event Points**, if desired.
7. Toggle on **Interval** and key in a value, if desired. With the Interval toggled off, data is collected at alignment cardinal points only. When the Interval is toggled on, data is collected at the interval along the alignment and at the cardinal points.
8. <D> **Apply** to create the report. The **Bentley InRoads Report Browser** is displayed.

Most of the style sheets in the Geometry and CDOT folders can be used with geometry reports. Some useful style sheets are shown in the illustration below as they appear in the style sheet explorer.



Examples of the style sheets highlighted above are shown here. These are by no means the only style sheets that should be used. They are, however, representative of the type of geometry report formats.

Area Report			
Report Created: 4/8/2009 Time: 7:48am			
Project: 12345DES_Geometry			
Description: SH 86 Design geometry			
File Name: C:\Projects\12345\Design\InRoads\12345DES_Geometry.alg			
Last Revised: cferree 4/8/2009 7:47:23 AM			
Input Grid Factor: 1.00000000 Note: All units in this report are in feet unless specified otherwise.			
Lot	Area (sq ft)	Area (acres)	Perimeter (ft)
Lot1	64036.36	1.4701	1343.78

- ◆ **Area.xml** – This style sheet displays the area in square feet, the area in acres, and the length of the perimeter for closed alignments.

Horizontal and Vertical Alignment Review Report				
Report Created: 4/8/2009 Time: 8:46am				
Project: 12345DES_Geometry				
Description: SH 86 Design geometry				
File Name: C:\Projects\12345\Design\InRoads\12345DES_Geometry.alg				
Last Revised: cferree 4/8/2009 7:47:57 AM				
Input Grid Factor: 1.00000000 Note: All units in this report are in feet unless specified otherwise.				
Horizontal Alignment: Off Ramp				
Horizontal Description:				
Horizontal Style: ALG_PRO				
		Station	Northing	Easting
Element: Linear				
POB	()	1+00.00	1556651.432611	3277676.688520
PC	()	7+03.23	1556492.817221	3278258.693853
Tangential Direction:		S 74°45'19" E		
Tangential Length:		603.23		
Element: Circular				
		7+03.23		
Chord Direction:		S 53°17'33" E		
Radial Direction:		S 58°10'13" W		
Tangent Direction:		S 31°49'47" E		
Vertical Alignment: Off Ramp				
Vertical Description:				
Vertical Style: ALG_EXISTING				
		Station	Elevation	
Element: Linear				
POB		1+00.00	6600.0000	
POE		15+00.00	6600.0000	
Tangent Grade:		0.00%		
Tangent Length:		1400.00		

- ◆ **HorizontalAndVerticalAlignmentReview.xml** - This style sheet displays information on all selected horizontal and vertical alignments. The format is the same as the geometry Review Reports (show previously). This report lists the data for the horizontal alignment followed by the data for its vertical alignments.

List Coordinates with Station Report				
Report Created: 4/8/2009 Time: 8:59am				
Project: 12345DES_Geometry				
Description: SH 86 Design geometry				
File Name: C:\Projects\12345\Design\InRoads\12345DES_Geometry.alg				
Last Revised: cferree 4/8/2009 7:47:57 AM				
Input Grid Factor: 1.00000000				
Note: All units in this report are in feet unless specified otherwise.				
Alignment Name: SH 86				
Station	Point Type	Easting (X)	Northing (Y)	Elevation (Z)
203+80.28	PC	3277567.493605	1556706.066252	6633.1067
203+87.30	PT	3277574.265918	1556704.221427	6633.0867
204+00.00	S+O EVT	3277586.517990	1556700.882339	6633.0505
204+49.33	S+O EVT	3277634.108041	1556687.912502	0.0000
204+50.00	S+O EVT	3277634.758565	1556687.735213	6632.9081
205+00.00	S+O EVT	3277682.999140	1556674.588087	6632.7657
205+50.00	S+O EVT	3277731.239715	1556661.440960	6632.6232
206+00.00	S+O EVT	3277779.480290	1556648.293834	6632.4808

- ◆ **ListCoordinatesStation.xml** - This style sheet displays the X, Y, and Z values along the selected alignment at the specified interval. The Z coordinate comes from the vertical alignment.

EXHIBIT "A"	
PROJECT NUMBER: 12345DES_Geometry PERMANENT EASEMENT NUMBER: Lot1 PROJECT CODE: SH 86 Design geometry DATE: April 8, 2009 DESCRIPTION	
A Permanent Easement No. Lot1 of the Department of Transportation, State of Colorado Project No. 12345DES_Geometry containing 64,036 sq. ft. (1.470 acres), more or less, in Section XX, Township X X, Range X X, of the X Principal Meridian, in X County, Colorado, said tract or parcel being more particularly described as follows:	
Commencing at a point, whence XXXX, said point also being the TRUE POINT OF BEGINNING;	
1. Thence S. 74°30'03" E., a distance of 542.27 feet;	
2. Thence N. 21°25'42" E., a distance of 121.41 feet;	
3. Thence N. 75°37'10" W., a distance of 569.50 feet;	
4. Thence S. 07°55'25" W., a distance of 110.60 feet, more or less, to the TRUE POINT OF BEGINNING.	
The above described Permanent Easement contains 64,036 sq. ft. (1.470 acres), more or less.	
The purpose of the above-described Permanent Easement is for the	
Basis of Bearings: All bearings are based on a line between	

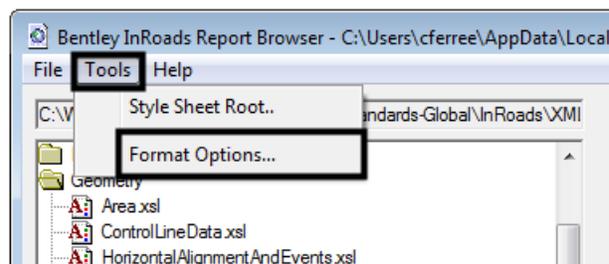
- ◆ **CDOT Permanent Easement Description.xml** - This style sheet was designed specifically for CDOT. It displays the alignment in the proper format for a permanent easement. This report is meant to be saved as a text file and completed in Word.

Formatting XML Reports

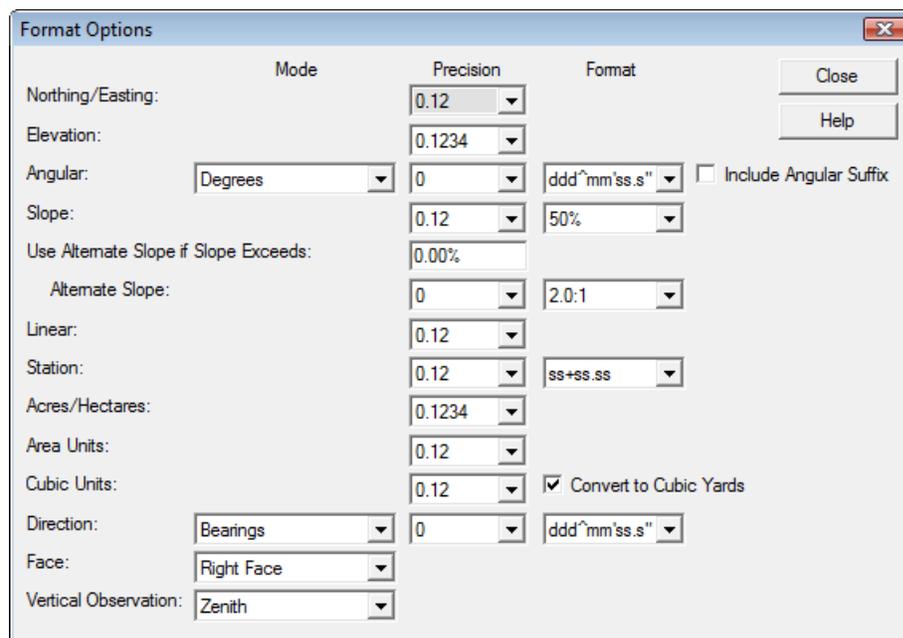
When viewing a Command or Review report, things like precision, station format, and slope format must be set prior to creating the report. With XML reports, data formatting can be changed after the report is generated.

To change the data format in an XML report:

1. Create the desired report as described above.
2. In the **Bentley InRoads Report Browser**, select **Tools > Format Options** from the menu bar.



3. In the **Format Options** dialog box, make the desired changes using the drop down menus. Changes appear in the report as they are made. The illustration below shows the various options available.



4. <D> **Close** to dismiss the Format Options dialog box.

Chapter Summary:

- Reports come from executing a command (like processing Roadway Designer), reviewing geometry, or creating XML reports.
- Some commonly used reports are End Area Volumes, Station Base and Station Offset, and Geometry reports.
- Using the Format Options with the Bentley InRoads Report Browser allows you to make minor changes to the format of the generated report.

Chapter 15 - Creating Plan Sheets

Plan sheets are used to convey design information to various entities involved with the project. These include various design disciplines within CDOT, design and construction contractors outside of CDOT, and the general public who may be impacted by the project. Typically, plan sheets are issued at three stages of the project; FIR (Field Inspection Review), FOR (Final Office Review), and AD (Advertisement).

CDOT uses the concept of model files and sheet files to create plan sheets. Model files contain design data and sheet files contain the border and information relative to the border. For more information on sheet files and model files, consult the *CDOT Sheet File Creation* and *CDOT Working with Model Files and Sheet Files* workflows. Using the model file and sheet file concept greatly reduces the time required for preparing because the model data is updated automatically and only the relevant information in the sheet border needs to be changed.

The InRoads Plan and Profile Generator automates the process of creating sheet files and attaching the model files to them.

Chapter Objectives:

- Discuss the resources required to run the Plan and Profile Generator
- Describe the Plan and Profile Generator preferences
- Discuss user input required on the Plan and Profile Generator tabs
- Discuss editing sheet station extents
- Discuss moving reference files within the sheet border

Required Resources

Prior to running the Plan and Profile Generator, certain InRoads and MicroStation resources must be loaded and/or set. The MicroStation resources required are:

- **JPC#_Prof.dgn** – The sheet profiles generated from the command are placed in this file. This file should be opened when starting Plan and Profile Generator.
- **General.cel** – This cell library contains the default sheet border (*SHEET_Design-Sheet*) and north arrow used by the command to create the P&P sheets. It must be attached to the **JPC#_Prof.dgn** and the **Seed Host File** (explained later) for the **Plan and Profile Generator** to operate correctly. The General.cel library is located in the following folder:

**C:\Workspace\Workspace-CDOT_XM\Standards-
lobal\MicroStation\cells\General.cel**

- **Plan Drawing Files** – Design drawing files and survey topo files are used to create the plan portion of the sheets. These should be located in the proper folders within the project's directory structure.
- **Plot Scale** – Before running the Plan and Profile Generator command, determine the final plot scale of the drawings being created. Current preferences exist for 20, 40, 50, 100, 200, and 500 scale plots. This should match the Annotation Scale of the drawings used to create the sheets.

Note: Annotation Scale does not affect graphic elements displayed by InRoads. The scale factor of the elements is determined by the **Factors** settings in the InRoads Options dialog box (**Tool > Options** then <D> the **Factors** tab).

The following InRoads resources are required:

- **Horizontal Alignment** - Plan view limits are defined relative to a horizontal alignment (length and right/left offsets). Therefore, a project specific Geometry Project must be loaded into memory.
- **Digital Terrain Models** - Profile view limits are determined by the vertical relief of profiled DTM's. At least one project specific DTM must be loaded into memory.
- **InRoads Scale Factors** - The **Global Scale Factor** controls text size, cell scale, and linestyle scale. It must be set to match the **Plan & Profile Generator** preference (horizontal scale) selected. Select **Tools > Options** then <D> the **Factors** tab to set the desired scale (or use the **Global Scale Factor** add-in).

Opening Plan and Profile Generator

The Plan and Profile Generator dialog box is accessed by selecting **Drafting > Plan and Profile Generator** from the InRoads menu bar.

Plan and Profile Generator Preferences

Preferences control various settings within the Plan and Profile Generator dialog box. They define the clipping boundary for the plan view, set the vertical exaggeration for the profiles, and define sheet layouts.

Developed Preferences are:

- **100 Scale Double Plan** – 100 scale (plot factor) double plan sheet
- **100 Scale Full Plan Sheet** – 100 scale (plot factor) plan sheet
- **100 Scale Full Profile 10x** – 100 scale (plot factor) full sheet profile with 10 times vertical exaggeration applied
- **100 Scale Double Profile 10x** – 100 scale (plot factor) double profile sheet with 10 times vertical exaggeration applied
- **100 Scale Full Profile 1x** - 100 scale (plot factor) full sheet profile with 1 times vertical exaggeration applied
- **100 Scale Full Profile 2x** - 100 scale (plot factor) full sheet profile with 2 times vertical exaggeration applied
- **100 Scale P&P (1x Vert)** - 100 scale (plot factor) plan & profile with 1 times vertical exaggeration applied
- **100 Scale P&P (2x Vert)** - 100 scale (plot factor) plan & profile with 2 times vertical exaggeration applied
- **100 Scale P&P (5x Vert)** - 100 scale (plot factor) plan & profile with 5 times vertical exaggeration applied
- 100 Scale ROW Plan Sheet

The preferences listed above have been duplicated for 20, 40, 50, 200, and 500 scales where it is appropriate.

Note: Selecting a preference does not set the **Global Scale Factors**. Setting the Global Scale Factors is described above in [Required Resources](#).

Plan and Profile Generator Tabs

The Plan and Profile Generator dialog box contains nine tabs that control various settings used with the command. The Main, Plan Controls, Profile Controls, Sheet Layout, Border and Title and Symbols and Details tabs require user input prior to executing the command. Settings on the Sheet Index tab are used during the editing process to relocate the plan and profile views within the sheet border.

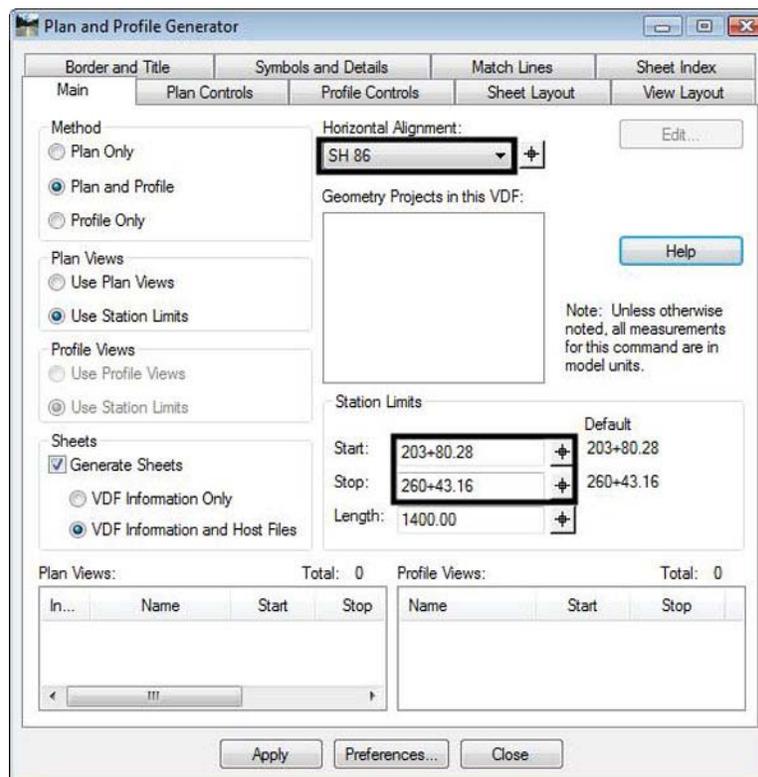
The tabs requiring user input are described below.

Main Tab

The settings on this tab determine the type of sheet being created (Plan and Profile, Plan only, or Profile only). It also specifies the alignment and station extents used for the sheets. The toggles along the left side of the tab determine the sheet type. They are set by the preference selected and require no user input.

On the right side of the tab, the horizontal alignment and station limits are defined by the user. To set these options:

1. Select the desired **Horizontal Alignment** using the drop-down menu. The active alignment is set by default.
2. In the **Station Limits** area, key in the **Start** station.
3. Key in the desired **Stop** station.



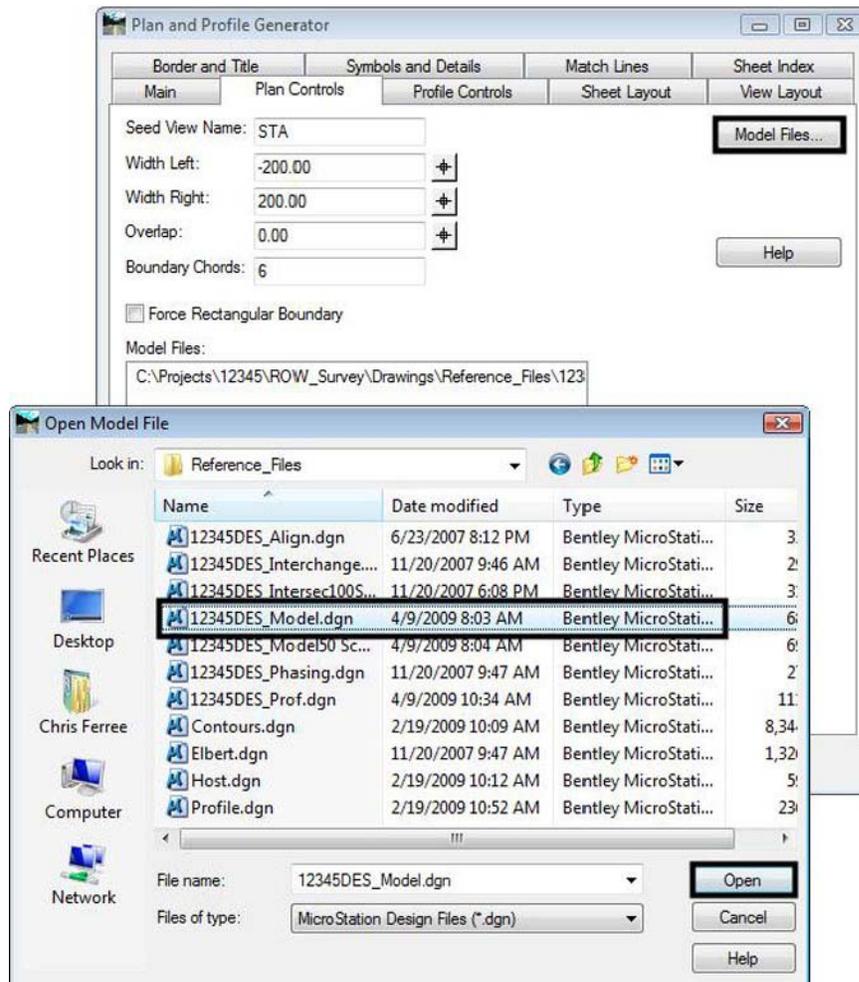
The **Length** option determines the station extents for each sheet. This is set by preference selected.

Plan Controls Tab

The settings on this tab determine the width of the plan area and the model files used for the sheets. The key in fields at the top of the tab set the width of the plan area. These are set by the selected preference and require no user input. Model files make up the plan portion of the sheet. To select model files:

1. <D> on the **Plan Controls** tab.
2. <D> the **Model Files** button. This displays the Open Model File dialog box.
3. Navigate to the desired directory. Typically, this will be:
 - ◆ C:\Projects\JPC#\Dicipline\Drawings\Reference Files\ for design data
 - ◆ C:\Projects\JPC#\ROW_Survey\Drawings\Reference Files\ for existing data
4. Highlight the desired files.
5. <D> **Open**. This dismisses the **Open Model File** dialog box and adds the selected files to the **Model Files** list box.

- Repeat steps 1 through 4 to add additional files.



To remove a file from the Model Files list:

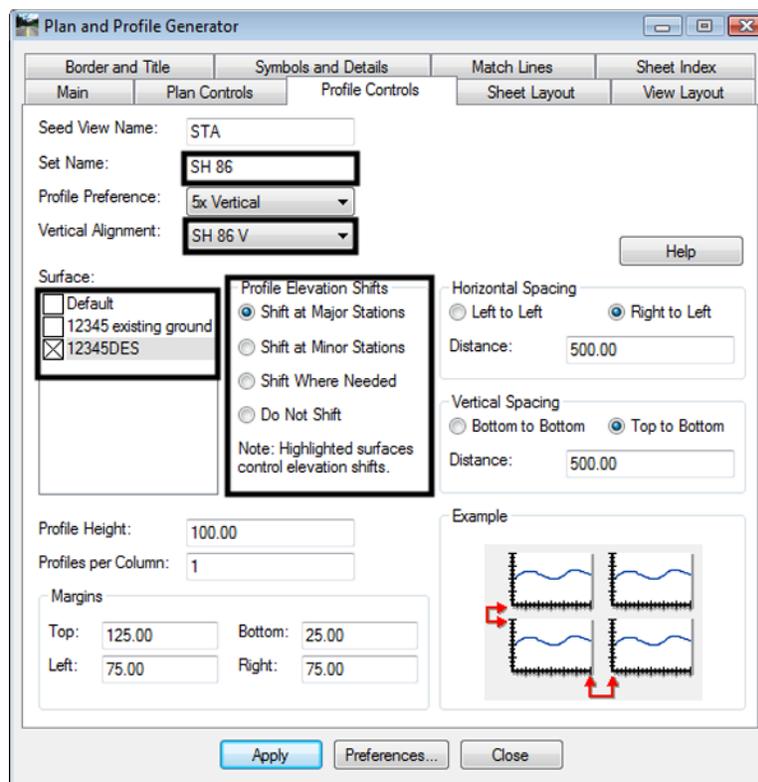
- Highlight the desired file.
- Press the **Delete** key.

Profile Controls Tab

The settings on this tab determine the size and placement (within the dgn file) of the sheet profiles. All options except Set Name, Vertical Alignment, Surface, and Profile Elevation Shifts are defined by the preference and require no user input. To set the Set Name, Vertical Alignment, Surface, and Profile Elevation Shifts:

- <D> on the **Profile Controls** tab.
- In the **Set Name** field, key in the desired **Name** (the default Set Name is the active horizontal alignment at the time the dialog box was opened).
- Select the desired **Vertical Alignment** from the drop down menu.

4. Toggle on the desired **Surface(s)**. The existing ground surface should be selected for display and highlighted. The highlighted surface is used to determine profile shifts when the elevation changes in data will not fit inside the profile window.
5. Toggle on the desired **Profile Elevation Shift**. This determines the horizontal location where a profile shift can occur.
 - ◆ **Shift at Major Stations** are at 500 foot intervals
 - ◆ **Shift at Minor Stations** are at 100 foot intervals
 - ◆ **Shift Where Needed** is at the closest even station
 - ◆ **Do Not Shift** allows the profile to be as large as necessary to contain the data. The profile window may overlap the plan area with this option.

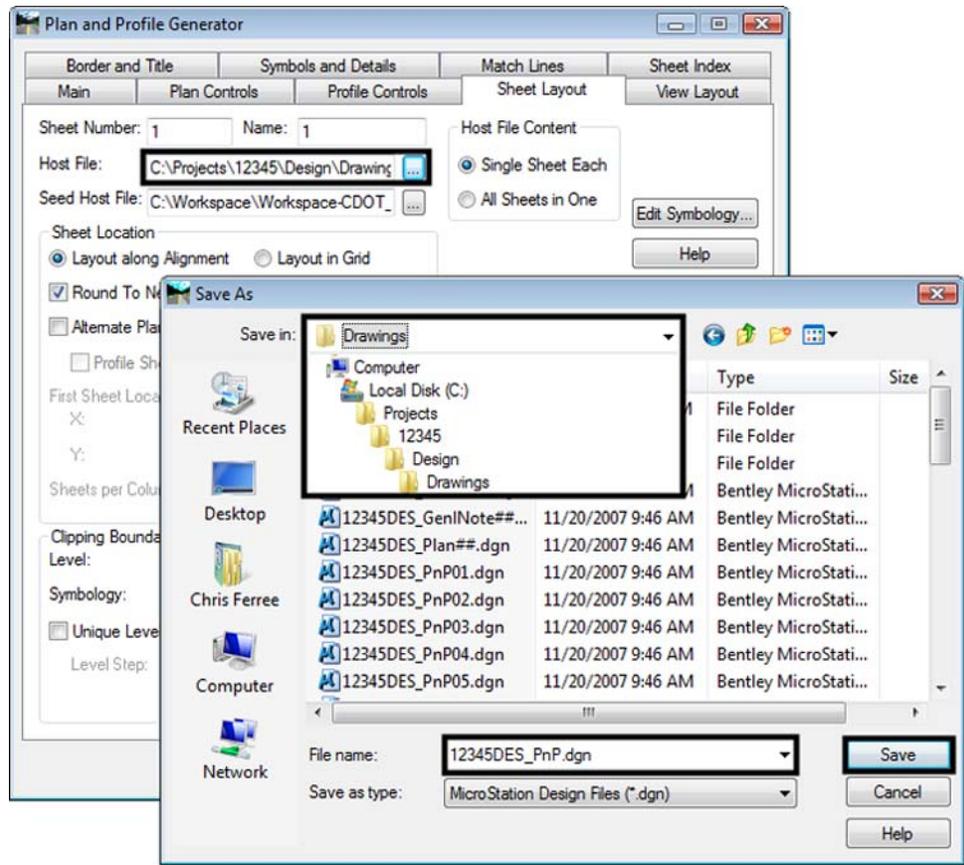


Sheet Layout Tab

This tab controls how the sheet files are made and how the borders are laid out in the files. The only field on this tab that requires user input is the Host File field. To edit the Host File field:

1. <D> on the **Profile Controls** tab.
2. <D> the  button for the **Host File**. The **Save As** dialog box is displayed.
3. Navigate to the **C:\Projects\JPC#\Discipline\Drawings** directory (C:\Projects\12345\Design\Drawings\ for this example).

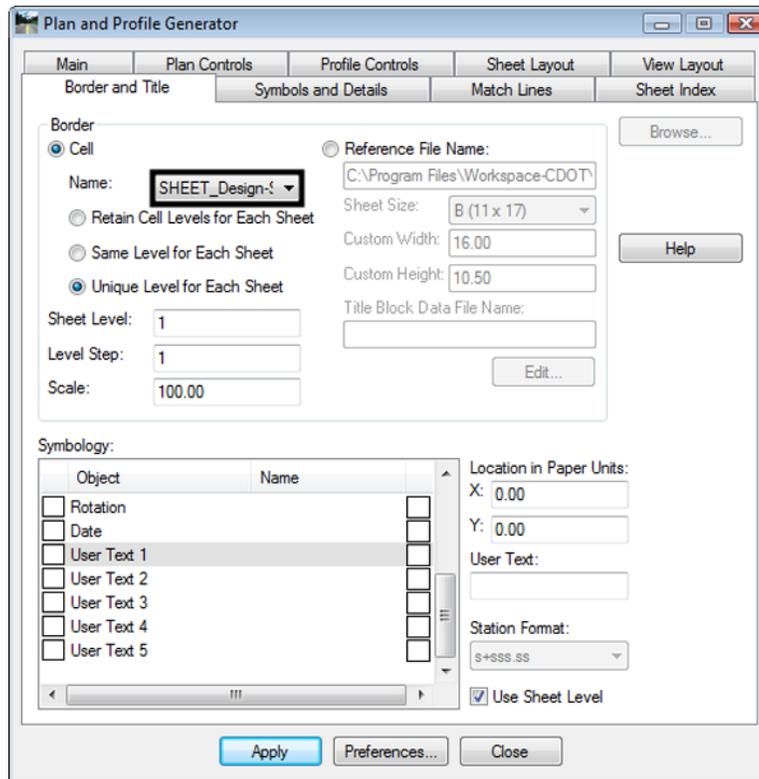
4. In the **File name** field, key in the desired **Name** (12345DES_PnP.dgn for this example).
5. <D> **Save**. This dismisses the **Save As** dialog box and inserts the data into the Host File field.



Border and Title Tab

This tab is used to specify the border cell for the plan sheets. To specify a border cell:

1. <D> the **Border and Title** tab.
2. Select the desired cell using the **Name** drop down menu. The default cell is **SHEET_Design-Sheet** (which is used in this example).

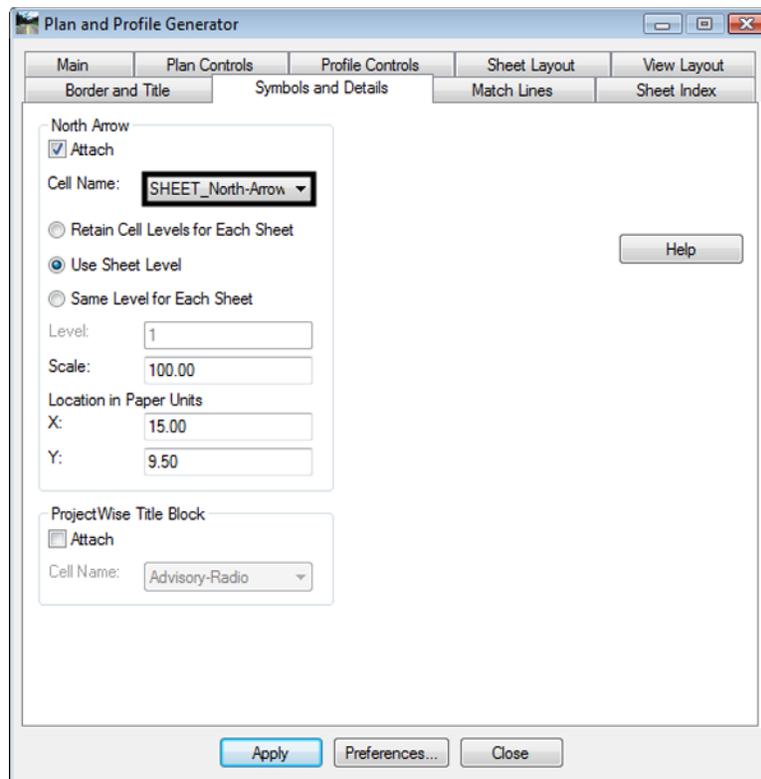


Symbols and Details tab

This tab is used to specify the North Arrow cell for the plan sheets. To specify a North Arrow cell:

1. <D> the Symbols and Details tab.

2. Select the desired cell using the **Name** drop down menu. The default cell is **SHEET_North-Arrow** (which is used in this example).



Executing the Command

There is minimal user input in executing the Plan and Profile Generator command but a lot happens on the screen. The user input required and a description of the command's processing is given below.

User Input

1. <D> **Apply**. This can be done from any tab in the dialog box.
2. <D> the location in the MicroStation view window for the lower left corner of the profile set.

Command Processes

Once the location for the profile set has been identified, The command works through the following processes:

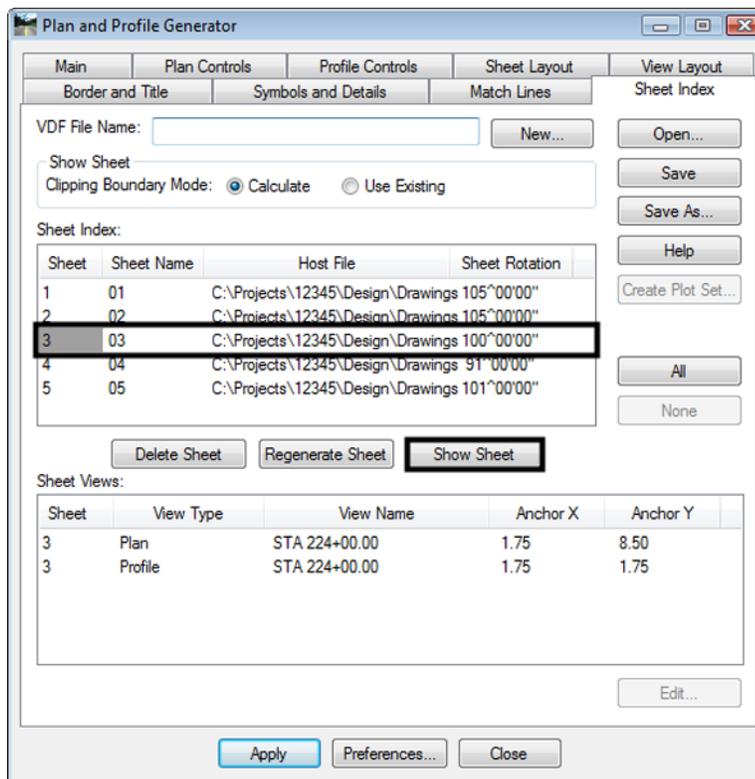
- ◆ A new profile set is created. This set contains one or more profiles for each sheet (sheets with an elevation shift will contain more than one profile). This information is on the **Profile Controls** tab.
- ◆ A copy of the **Seed Host File** is created. The name in the **Host File** field is used for this file. This information is on the **Sheet Layout** tab.
- ◆ Plan view reference limits are established and a Clipping Boundary is created. This information is on the **Plan Controls** tab.

- ◆ The Model Files and sheet profile(s) are attached as reference files. This information is on the **Plan Controls** tab (model files) and the **View Layout** tab (reference location within the sheet border).
- ◆ The sheet border cell is placed in the generated drawing. This information is on the **Border and Title** tab.
- ◆ The North arrow is placed in the generated drawing. This information is on the **Symbols and Details** tab.
- ◆ Match Lines and Stations are placed in the generated drawing. This information is on the **Match Lines** tab.
- ◆ With the exception of the first step, these steps are repeated for each sheet created.
- ◆ After the last sheet is created, the Sheet Index tab of the Plan and Profile dialog box is populated with data on each sheet.

Viewing Sheets

The Sheet Index tab can be used to navigate between plan and profile sheets easily. To display a sheet in MicroStation:

1. <D> the **Sheet Index** tab.
2. Highlight the desired sheet from the **Sheet Index** list (sheet 3 in this example).
3. <D> the **Show Sheet** button. The highlighted sheet is opened in the MicroStation session.



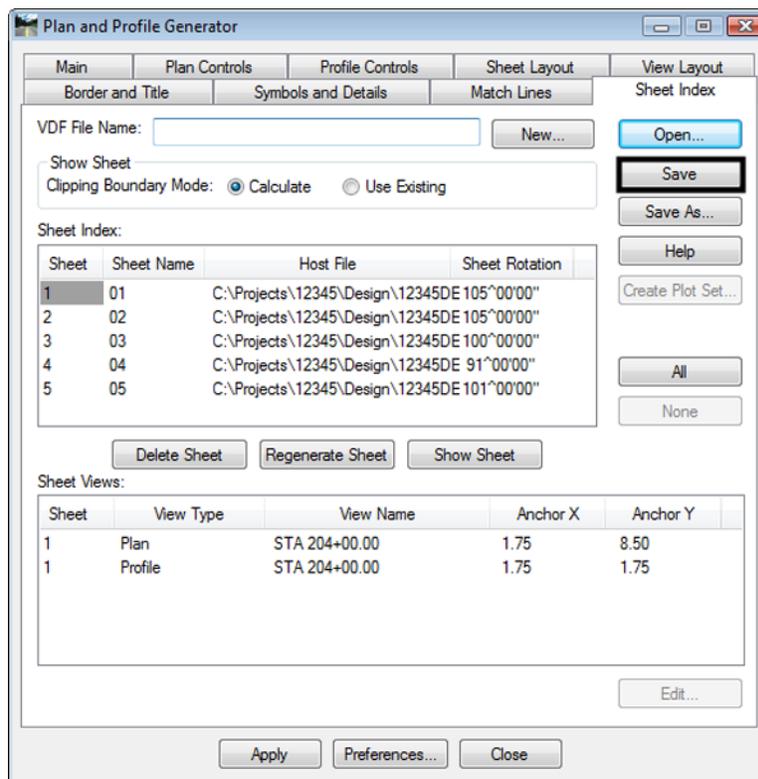
VDF File

The View Definition File (*.vdf) save the dialog box settings made for the Plan and Profile Generator. This file can be used to recreate a set of plan sheets as originally laid out, or as a starting point for a new plan set.

Saving a VDF File

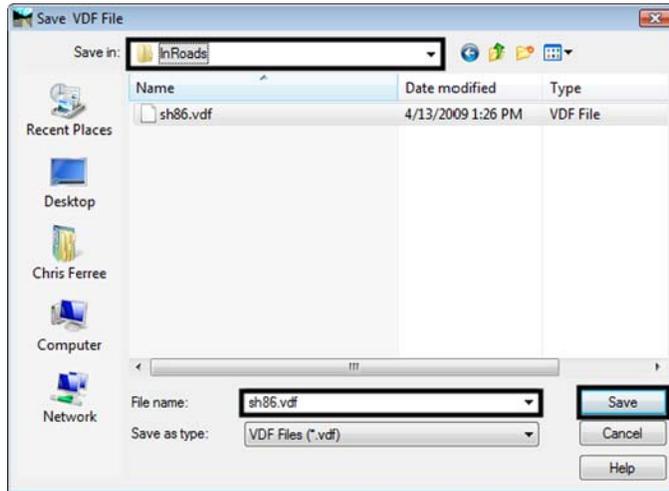
To save the *.vdf file:

1. <D> the **Sheet Index** tab.
2. <D> the **Save** button. This displays the **Save VDF File** dialog box



3. In the **Save VDF File**, Navigate to the desired folder (C:\Projects\12345\Design\InRoads for this example).
4. In the **File Name** field, key in the desired name.

5. <D> **Save**. This creates the file and closes the **Save VDF File** dialog box.

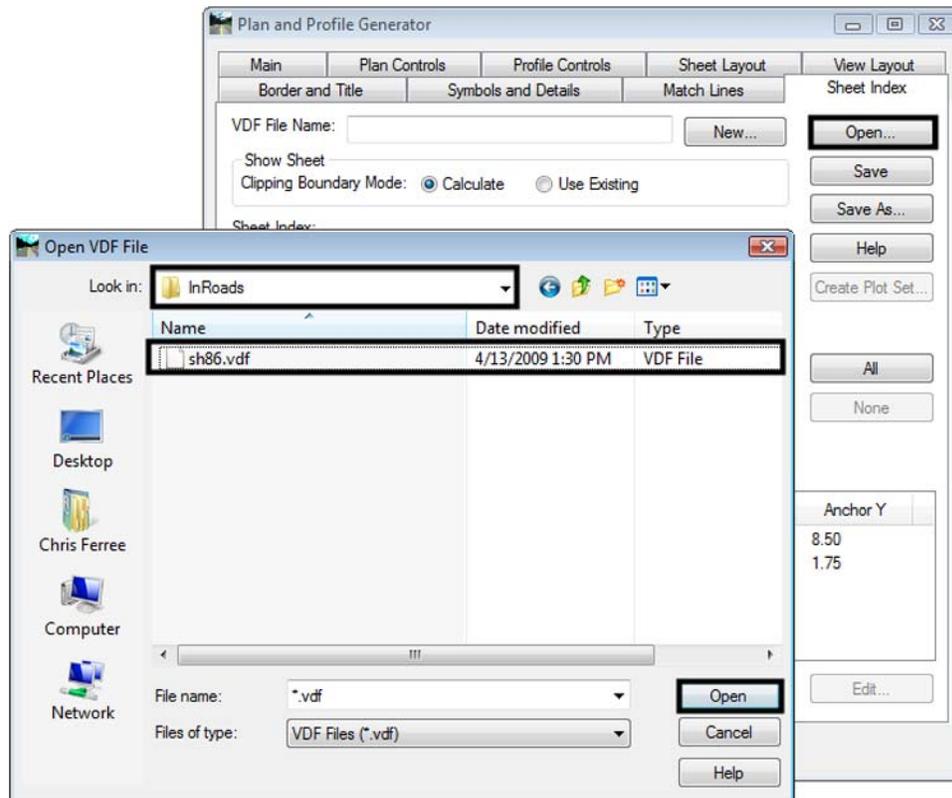


Loading a VDF File

To load a *.vdf file:

1. <D> the **Sheet Index** tab.
2. <D> the **Open** button. The **Open VDF File** dialog box is displayed.
3. Navigate to the folder containing the *.vdf file.
4. Highlight the desired file.

5. <D> **Open**. This dismisses the **Open VDF File** dialog box and updates the the Plan and Profile Generator dialog box.



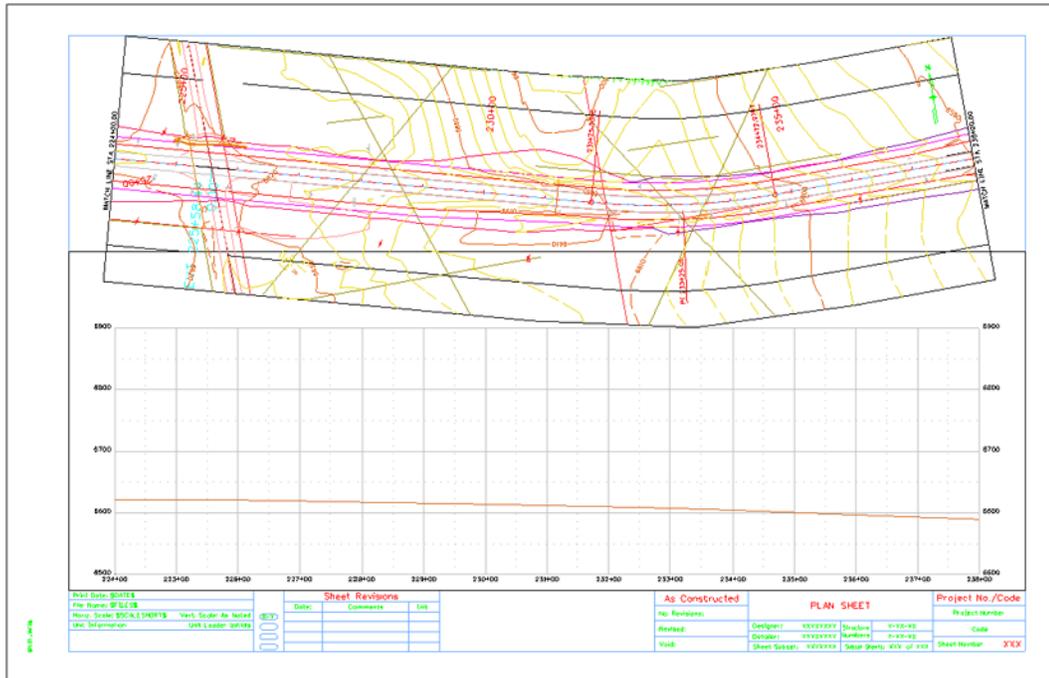
Editing Sheets

The Plan and Profile Generator creates the sheet extents based on the length of the alignment divided by the length of a sheet. This can result in important design features on the edge of a sheet or split between sheets. The example below illustrates how to adjust the sheet extents.

In this example, the project starts at station 204+00 and ends at station 260+00. Running the Plan and Profile Generator has yielded the following sheet extents:

- 12345DES_PnP1.dgn – 204+00.00 to 210+00.00
- 12345DES_PnP2.dgn – 210+00.00 to 224+00.00
- 12345DES_PnP3.dgn – 224+00.00 to 238+00.00
- 12345DES_PnP4.dgn – 238+00.00 to 252+00.00
- 12345DES_PnP5.dgn – 252+00.00 to 260+00.00

On sheet 12345DES_PnP3.dgn, there is an intersection approximately 200' (2" paper scale). The illustration below shows this sheet.



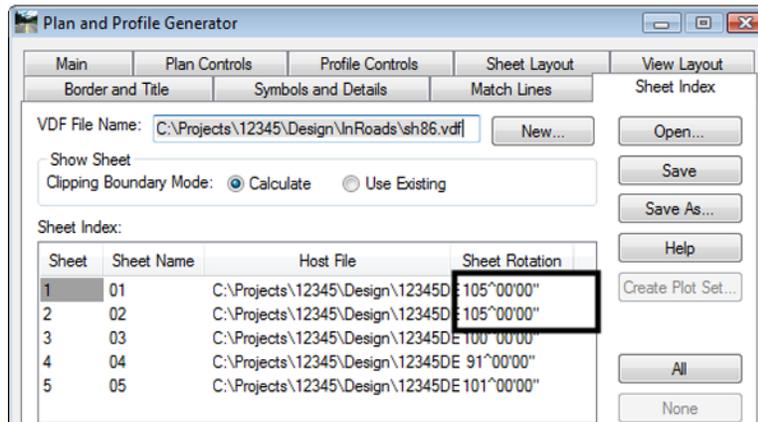
By centering the intersection in the sheet, the intersection design will be displayed on a single sheet and the total number of plan sheets can be reduced to 4. To accomplish this, follow the steps below:

1. Open the profile drawing used for the first Plan and Profile Generator run (12345_DES_Prof.fgn in this example).
2. Using MicroStation, delete the existing profile set.
3. Using InRoads, display the **Plan and Profile Generator** dialog box.

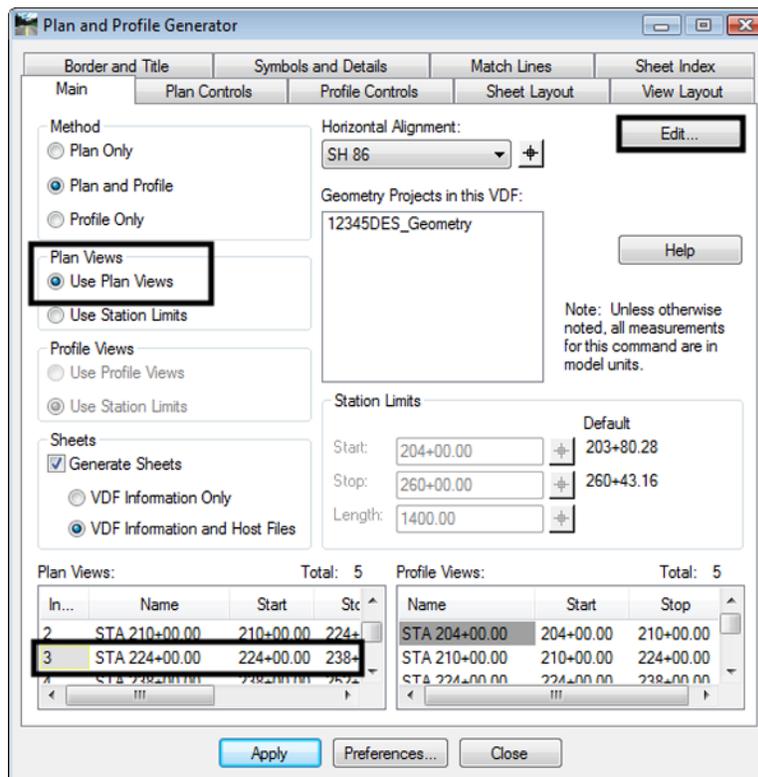
Note: If InRoads has been closed since the first set of plan sheets were created, load the VDF file as described above.

4. Select the **Sheet Index** tab.

5. Note the **Sheet Rotation** of sheets 1 and 2. This is required in a later step.

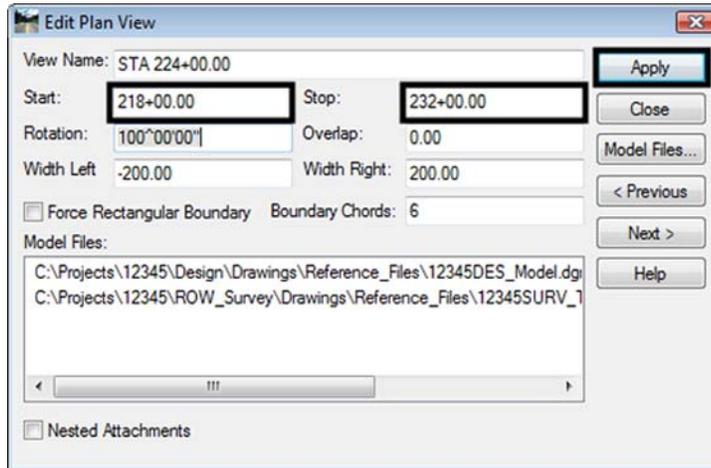


6. Select the **Main** tab.
7. Toggle on **Use Plan Views**.
8. Highlight the desired **Plan Views** from the list (3 in this example)
9. <D> the **Edit** button. The **Edit Plan View** dialog box is displayed.

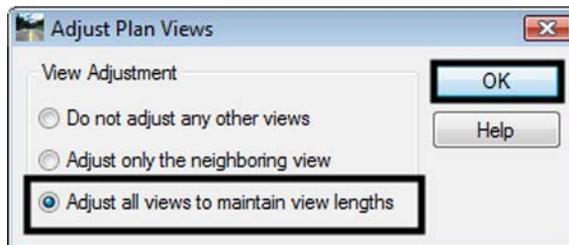


10. In the **Edit Plan View** dialog box, key in **218+00.00** for the **Start** station. This shifts the intersection 600' (6" in paper units) to the right, moving it to the center of the sheet.
11. Key in **232+00.00** for the **Stop** station. This makes the sheet 1400' (14" in paper units) long.

12. <D> **Apply**. The **Adjust Plan Views** dialog box is displayed.



13. In the **Adjust Plan Views** dialog box, toggle on **Adjust all views to maintain view lengths**. This changes the stationing on the other sheets to match with the changes on sheet 3.
14. <D> **Ok**.

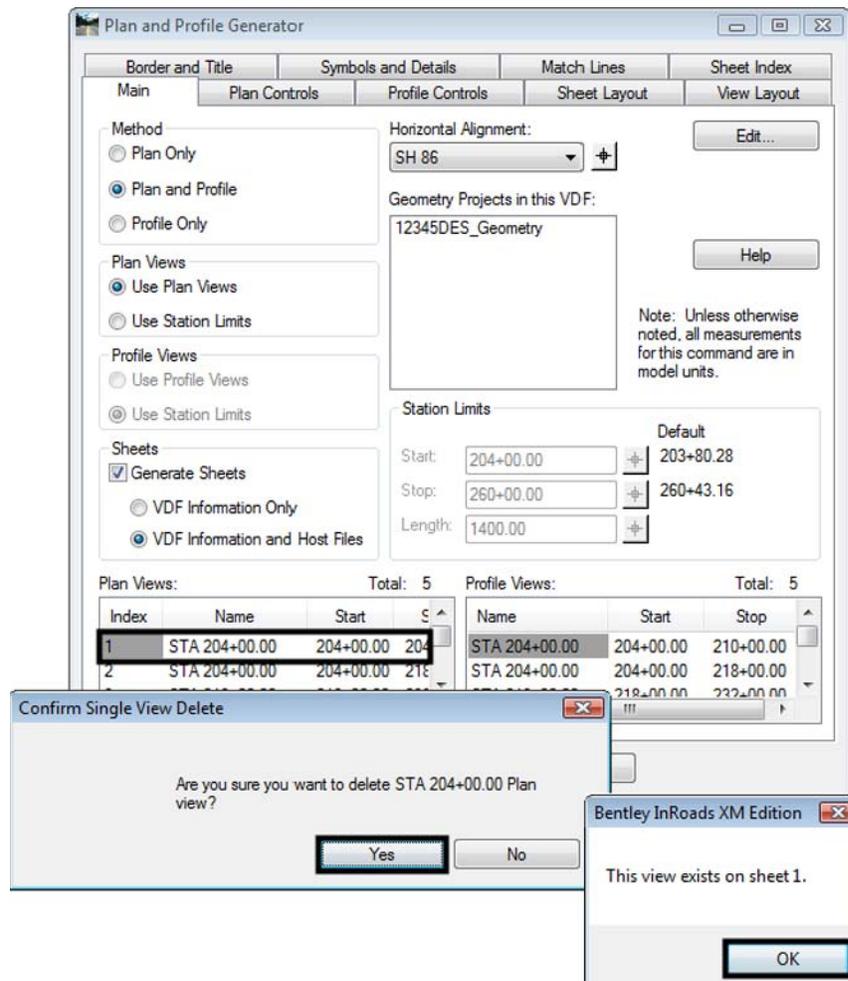


15. A message is displayed reading, **“Update view name in corresponding sheets?”**. <D> **Yes**. This changes the view names to match the modified sheet extents.



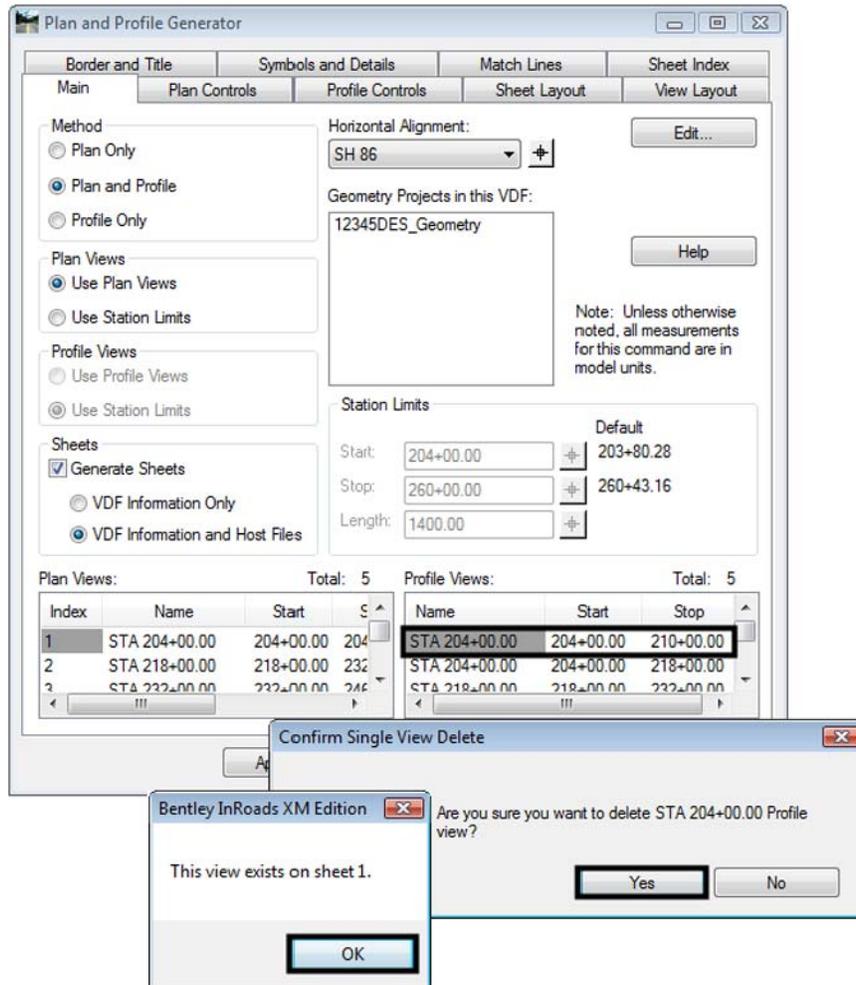
16. Back in the **Edit Plan View** dialog box, <D> **Close** to dismiss the dialog box.
17. On the Plan and Profile Generator Main tab, highlight **1** in the **Plan Views** list.
18. Press the **Delete** key.
19. <D> **Yes** in the **Confirm Single View Delete** dialog box.

20. <D> **OK** in the *This view exists on sheet 1 message* window.



21. Highlight **1** in the *Profile Views* list.
22. Press the *Delete* key.
23. <D> **Yes** in the *Confirm Single View Delete* dialog box.

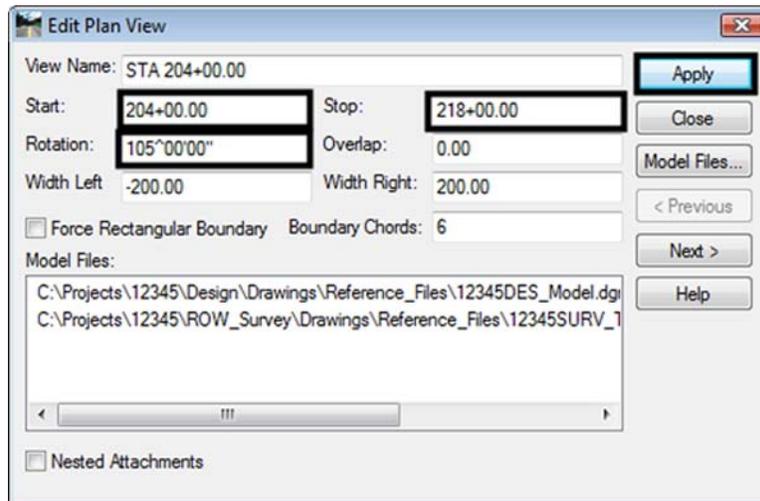
24. <D> OK in the **This view exists on sheet 1 message** window.



During this process the data for the first sheet has changed. This change is the result of a problem with the software. It is corrected by editing the Plan Views entry.

25. Highlight Index 1 in the **Plan Views** list.
26. <D> the **Edit** button.
27. In the **Edit Plan View** dialog box, key in **204+00.00** for the **Start** station.
28. Key in **218+00.00** for the **Stop** station.
29. Key in **105^00'00"** in the **Rotation** field. This is the angle noted in step 5 above.

30. <D> **Apply**. The **Adjust Plan Views** dialog box is displayed.



31. In the **Adjust Plan Views** dialog box, toggle on **Do not adjust any other views**. This changes the first sheet only.
32. <D> **Ok**.

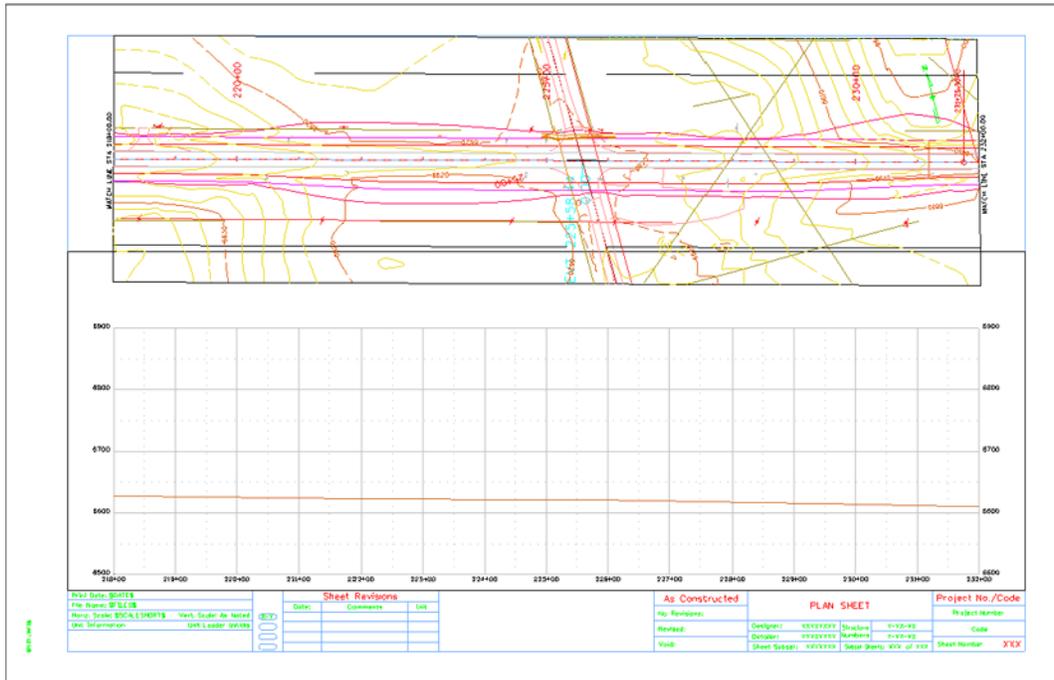


33. A message is displayed reading, **“Update view name in corresponding sheets?”**. <D> **No**. This changes the view names to match the modified sheet extents.



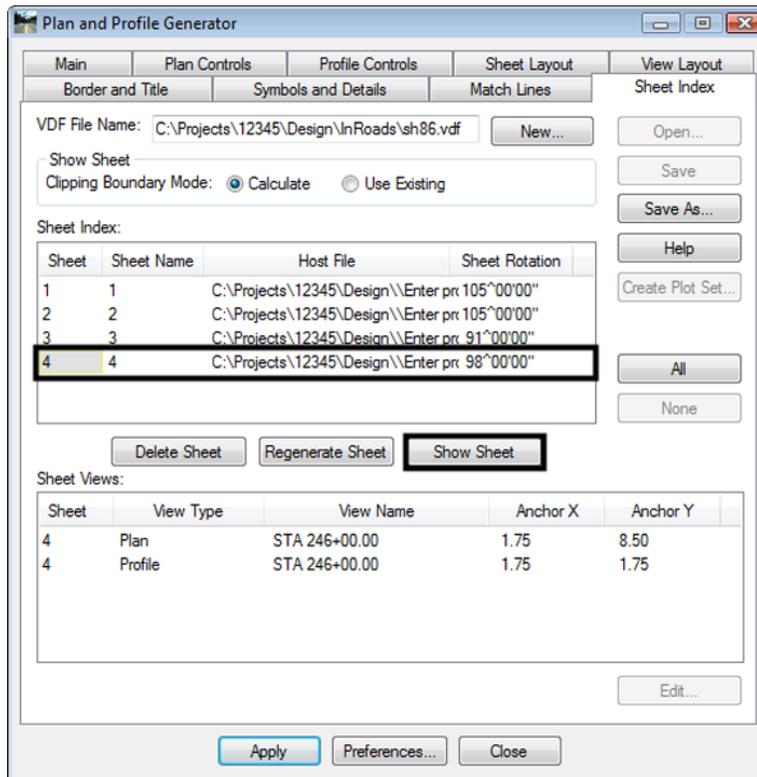
34. Back in the **Edit Plan View** dialog box, <D> **Close** to dismiss the dialog box.
35. <D> **Apply**. This can be done from any tab in the dialog box.
36. <D> **Yes** in the, **“DO you want to regenerate Profile Views?”** message.
37. <D> the location in the MicroStation view window for the lower left corner of the profile set.

The dgn files are recreated using the new data. The illustration below shows the placement of the intersection.

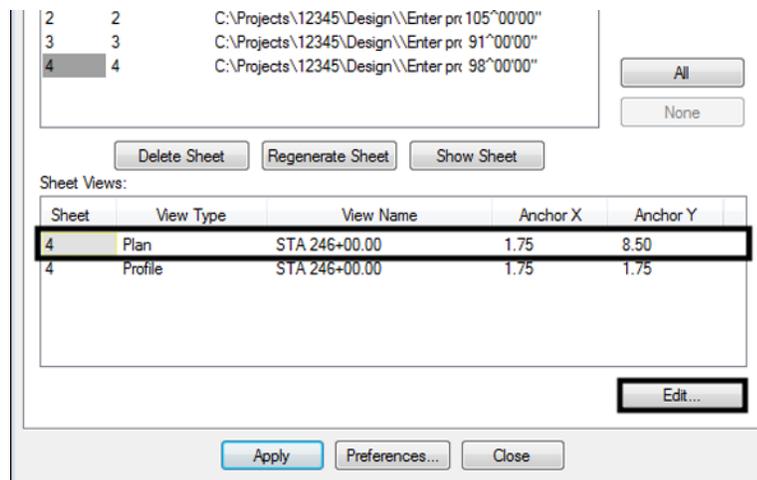


38. Save the VDF file as explained above.

4. <D> the **Show Sheet** button to display the sheet in the MicroStation view window.

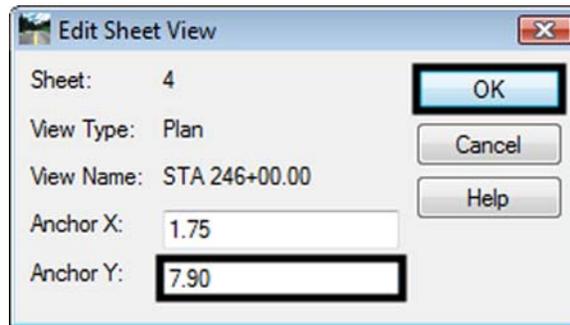


5. In the Sheet Views area of the Sheet Index tab, highlight 4 Plan from the list.
6. <D> **Edit**. The **Edit Sheet Views** dialog box is displayed.



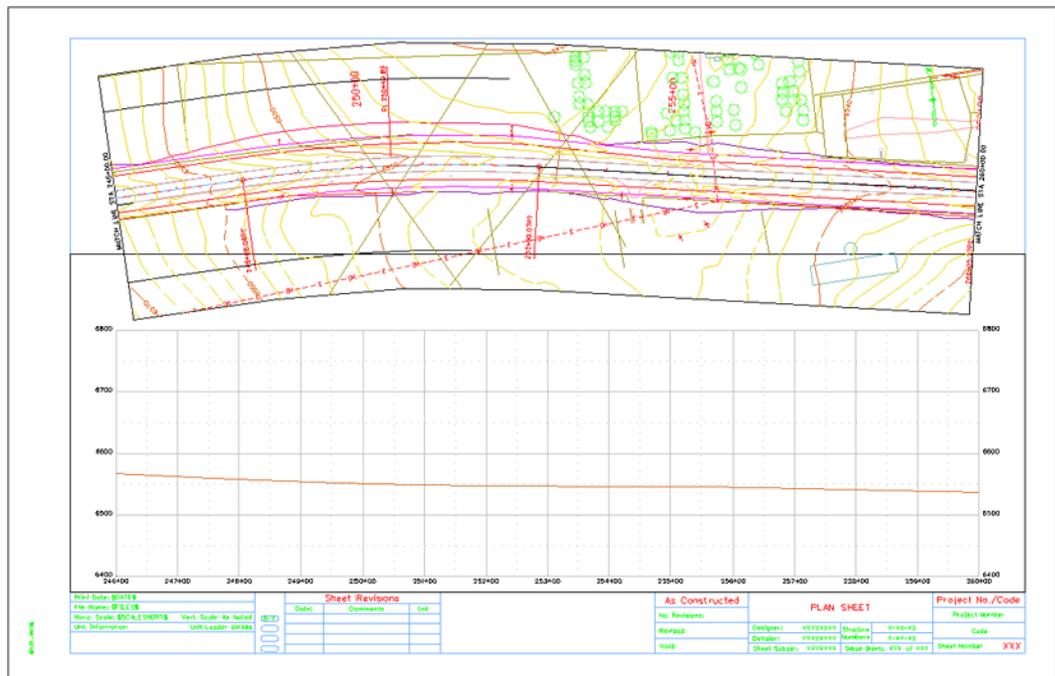
7. In the **Edit Sheet Views** dialog box, key in **7.90** in the **Anchor Y** field.

8. <D> OK.



9. <D> the **Regenerate Sheet** button to update the dgn file.
10. <D> **Yes** in the **“This sheet border and its data will be deleted and re-created. Do you wish to continue?”** message box.

The sheet is redisplayed with the reference files in their new location. The illustration below shows the finished sheet.



11. Save the VDF file as explained above.
12. <D> **Close** to dismiss the **Plan and Profile Generator** dialog box.

Chapter Summary:

- Resources required to run the Plan and Profile Generator include an empty DGN files for the profiles and sheet borders, DGN files containing plan data, cell library containing cells called by the command, and InRoads ALG and DTM files for the project.

- The Plan and Profile Generator preferences are used to make most of the required setting changes.
- The Main, Plan Controls, Profile Controls, Sheet Layout, Border and Title and Symbols and Details tabs require user input.
- Important design elements should be located in the middle of the plan sheet if possible. Sheet station extents are edited to reposition these elements within the sheet border.
- There are times when the plan reference file need to be moved inside the sheet border. This is done on the Sheet Index tab in the Sheet Views area.

Chapter 16 - Tab Sheets

Once the design is completed, pay quantities can be gathered and entered into summary sheets. There are many methods of calculating quantities and many formulae used. Once the quantities have been computed, they are entered into tab sheets and linked to MicroStation sheet border file for printing. This module describes the process of entering calculated quantities into the tab sheet and attaching the sheet to the sheet border for printing.

Files Used

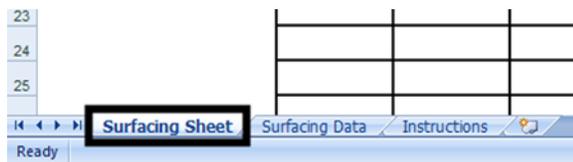
Three files are used to create the final tab sheet for printing. These are:

- **Trnsport_Itemlist.csv** – This file contains the list of pay item codes from the Colorado Department of Transportation Master Item Code Book (Spec Year 05). This file is located in the **C:\Workspace\Workspace-CDOT_XM\Standards-Global** folder and is automatically updated by ServerCop.
- **JPC#SPEC_Tabulation of ????.xls** – This is the file where the quantity data is entered. The first part of the file name is the project code and the three to four letter abbreviation of the specialty group. The last part of the name describes the type of data to be entered. For example, the 88888DES_Tabulation of Guardrail.xls contains quantities and pay items related to guardrail. These files are located in the **C:\Projects\JPC#\Group\Drawings\Tabs** folder.
- **JPC#SPEC_TabMisc##.dgn** – This file contains the sheet border for the printable tabulation sheet. This file can be modified to contain project specific information (project code, RE cell, etc.). It can also be copied if more tabulation sheets are required. This file is located in the **C:\Projects\JPC#\Group\Drawings\Tabs** folder.

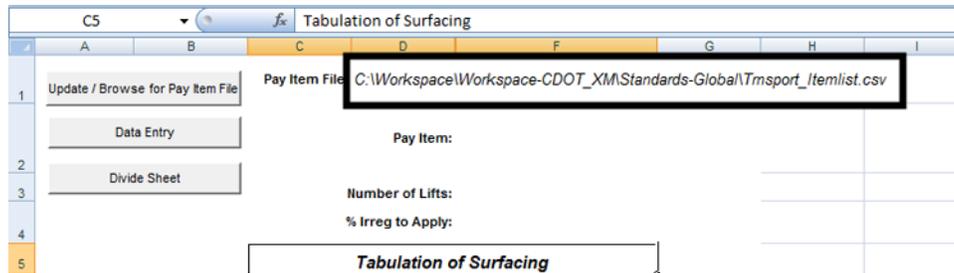
Entering Data into the Spreadsheet

The process of inputting data into the spreadsheet is similar for all of the tab sheets. The examples below use the DES_Tabulation of Surfacing.xls.

1. Open the **DES_Tabulation of Surfacing.xls** file.
2. <D> the **Surfacing Sheet** tab at the bottom of the Excel window. This is where all the work in this file is performed.

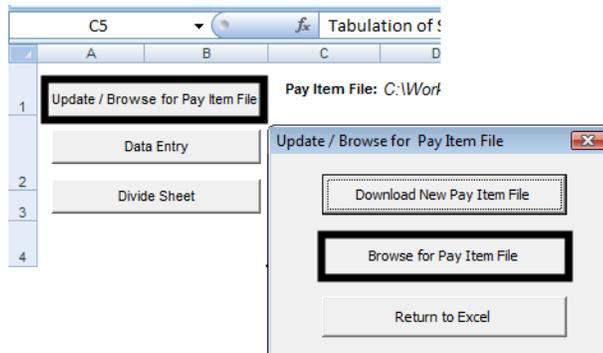


- Verify that the text on line 1 to the right of the buttons is black. Red text indicates that the pay item list file is not found in the specified location.

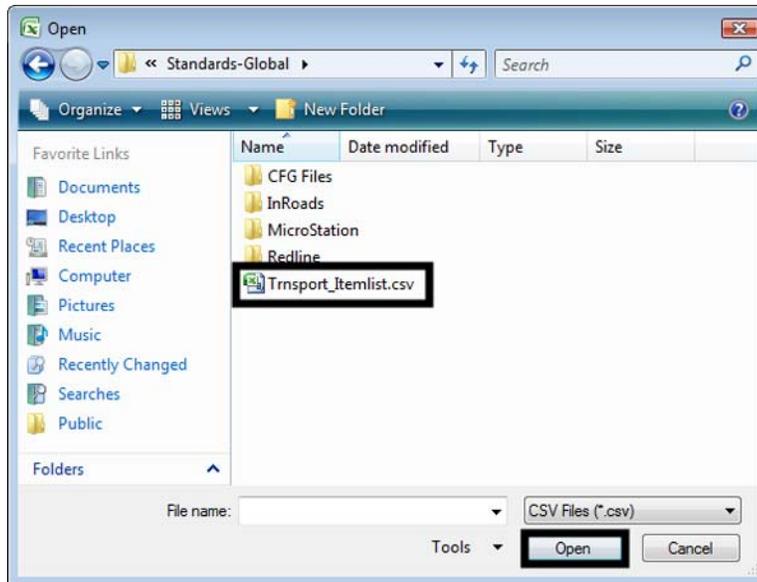


If the text is red, the location of the pay item list file must be specified. To specify the location:

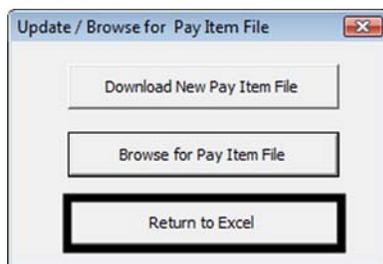
- <D> the **Update / Browse for Pay Item File** button. This displays the **Update / Browse for Pay Item File** dialog box.
- In the **Update / Browse for Pay Item File** dialog box, <D> the **Browse for Pay Item File** button. This displays the **Open** dialog box.



6. In the **Open** dialog box, navigate to the location of the pay item list file, highlight it and <D> **Open**.

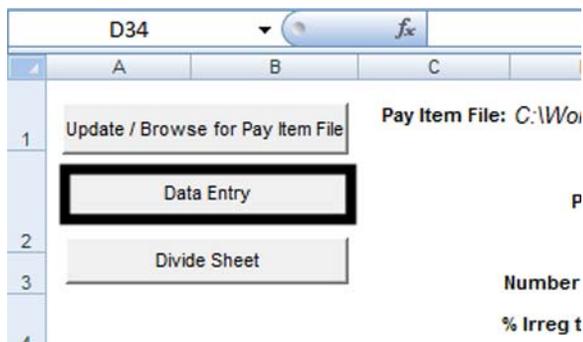


7. In the **Update / Browse for Pay Item File** dialog box, <D> the **Return to Excel** button to dismiss the **Update / Browse for Pay Item File** dialog box.

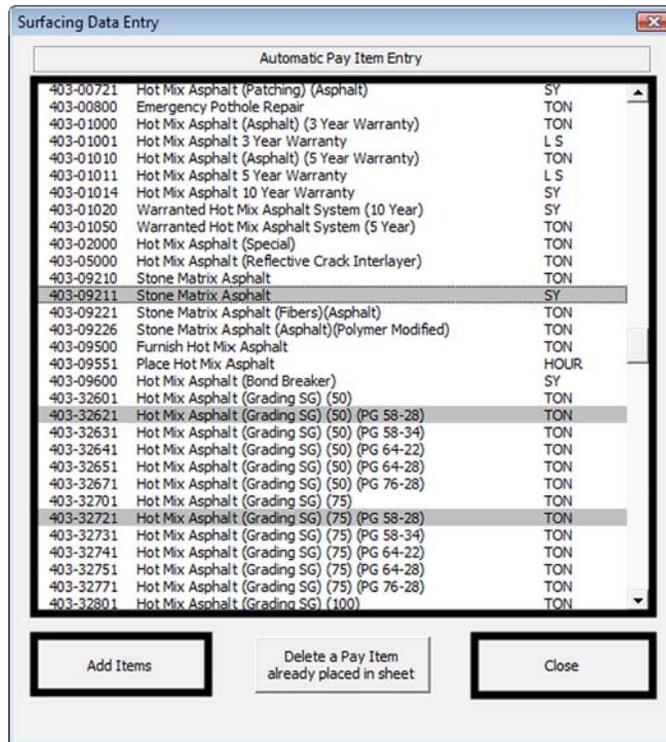


The next step is to add pay items to the spreadsheet. Adding pay items automatically updates the Surfacing Sheet with the proper number of columns in the correct order. The pay items do not have to be selected in order, they will be sorted by the program each time a new pay item is added. To add pay items:

8. <D> the **Data Entry** button. This displays the **Surfacing Data Entry** dialog box.



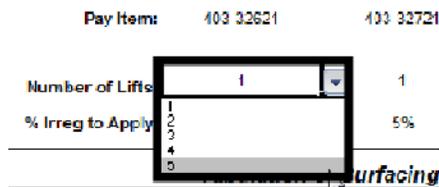
9. Select the desired pay items from the list. Multiple pay items can be highlighted by holding the Ctrl key then selecting the pay items. (Note: holding the Ctrl key and dragging through several items will deselect previously selected items.)
10. <D> the **Add Items** button to update the spreadsheet with the selected pay items.
11. <D> **Close** to dismiss the **Surfacing Data Entry** dialog box.



12. Additional items can be added as explained in steps 8 through 11. The columns are resorted, keeping the column contents with the proper pay item.

Pay items, like hot mix asphalt, activate an additional field above the table to specify the number of lifts used for construction. The default value for this field is 1. To specify a different number of lifts:

13. <D> in the **Number of Lifts** cell below the desired pay item.
14. Use the drop down menu to select the desired number (from 1 to 5).



The table is updated, adding the specified number of columns under the pay item heading. The lift columns are numbered from bottom to top, with the first lift named **Bottom** and the last lift named **Top**. The middle lifts are named **Lift 2** through **Lift 4**.

Tabulation of Surfacing						
Station		Hot Mix Asphalt (Grading SG) (50) (PG 58-28)				
		LIFT				
From	To	Bottom	Lift 2	Lift 3	Lift 4	Top

Each Asphalt pay item also has an irregularity factor that is applied to the total quantity for the Bottom lift. The default value is 5%. To change the irregularity factor:

15. <D> in the % Irreg to Apply cell below the desired pay item.
16. Key in the desired percentage.

Number of Lifts:	
% Irreg to Apply:	5%

Note: If the value is deleted from the function line before entering the new value, enter either; the whole number percentage value with the “%” sign, or the decimal equivalent without the “%” sign. Entering the whole number value without the “%” sign will result in a value 100 times larger than the desired value.

Next, quantity data is added to the sheet. The spreadsheet does not do any calculations. Quantity calculations must be done prior to entering the data into the spreadsheet. To add quantity data to the spreadsheet:

17. <D> in the first available From cell (on row 10 if this is a new sheet).
18. Key in the desired starting (**From**) **Station** number for the quantity and press the **Tab** key.

Note: The “+” sign is automatically inserted into the station number if it is not keyed in. Also, stations are rounded to the nearest whole station.

19. Key in the desired ending (**To**) **Station** number for the quantity and press the **Tab** key. Continue pressing the Tab key until the cursor is in the desired pay item column.
20. Key in the quantity. Tab to additional columns that have quantities for the station extents entered and key in their values.
21. Repeat steps 18 through 20 for each set of station extents.

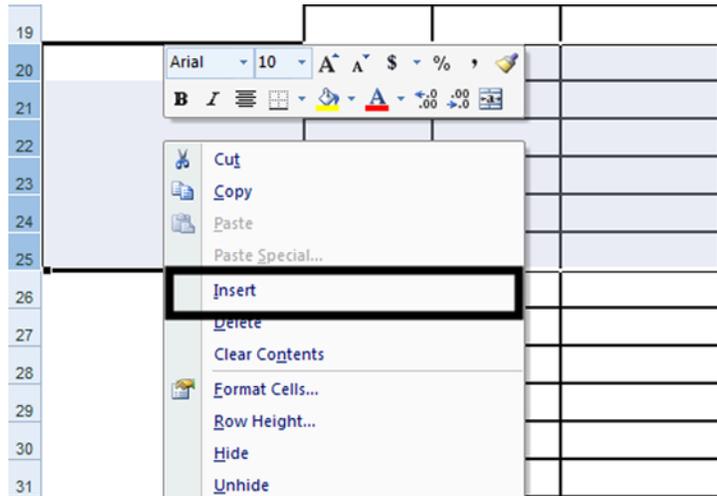
The quantities are automatically totaled and the irregularity factors are applied as each entry is made.

If there are a large number of station extents to enter, additional lines to the table may be required. To add additional lines:

22. <R> on a row number that is within the table (below the headings) that is blank and select Insert from the menu. This adds a row above the selected row number.

To add multiple rows:

23. Highlight the number of blank rows to be added.
24. <R> and select **Insert** from the menu. The additional rows are added above the highlighted rows.



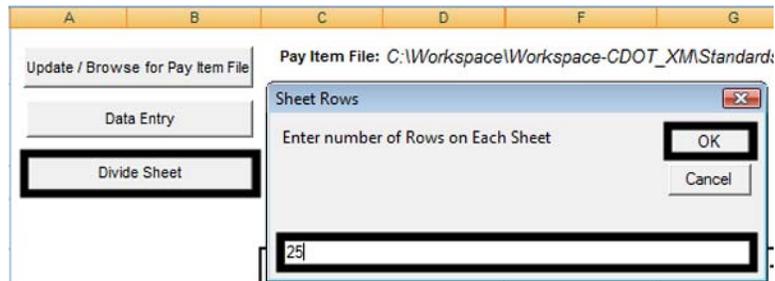
Preparing the Spreadsheet for Linking

Once the data is entered into the Surfacing Sheet, it can be prepared for linking to the MicroStation sheet border file. If the table is small enough to fit within the sheet border, then no further processing is required. However, if the table is too long and/or too wide, additional actions are required to make tables that fit the sheet borders.

Dividing Long Sheets

Sheets with too many rows are divided to create sub tables of data and an additional sheet totals table. To create the sub tables:

1. <D> the **Divide Sheet** button. This displays the **Sheet Rows** dialog box.
2. Key in the desired number of rows of data to be included on each sheet.
3. <D> the **OK** button.



The number of data lines in the master sheet is divided by the number of lines specified for each sub sheet and new worksheet are created and populated with data from the Surfacing Sheet table. These are named Sub Sheet 1, Sub Sheet 2, etc. and it is the tables on the sub sheets that are linked to the MicroStation sheet border files. Additionally, the Sub Sheet Totals worksheet is created which contains a table with the sub sheets' total lines and a grand total.

Note: If the table needs to be re-divided, delete the Sub Sheet and Sub Sheet Totals worksheets prior to executing the command. Failure to do so could result in erroneous Sub Sheets and Sub Sheet Totals.

Dividing Wide Sheets

There is no command to automatically divide sheets by the number of columns. Ideally, the number of columns that can fit in a border should be determined before data entry. That number is then divided into the total number of pay items to determine how many xls files will be needed. The desired xls file should then be copied the required number of times.

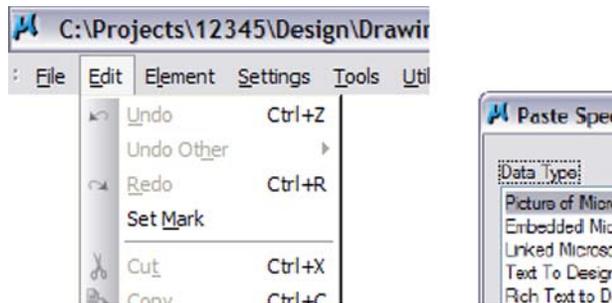
However, if the table is deemed to be too wide after data is entered, use the following procedure:

1. Determine the number of columns that will fit on the sheet.
2. **Save** the original file.
3. Select **File > Save As** from the menu bar. Name the new file the same as the original, changing the end number to make it unique.
4. Reopen the original file.
5. On the **Surfacing Sheet** worksheet, <D> the **Data Entry** button.
6. In the **Data Entry** dialog box, <D> the **Delete a Pay Item already placed in sheet** button. This displays the **Delete Item** dialog box.
7. From the **Delete Item** dialog box, highlight the first pay item to be removed from the first sheet.
8. <D> the **Delete Item** button. This removes the pay item column and any data in that column from the **Surfacing Sheet** worksheet.
9. Repeat steps 7 and 8 until only the pay items for the first sheet are left.
10. Save and close the original file.
11. Open the copied file.
12. Repeat steps 5 through 9, deleting the pay items that appear on the original sheet.
13. Repeat steps 1 through 12 if a third or subsequent sheets are required.

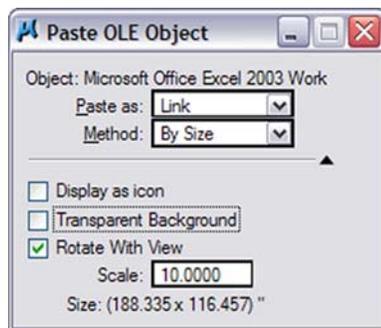
If sheets need to be divided by both length and width, divide them by width first. This is because the Sub Sheets are not automatically updated by the addition or deletion of pay items.

Linking Excel Documents

1. Open the MicroStation tabulation file. These files are located in the ...**Drawings** folder of each specialty group within the project directory.
2. From the MicroStation file menu, select **Edit > Paste Special**. In the **Paste Special Dialog Box**, <D> **Linked Microsoft Office Excel 2003 Worksheet** and <D> **Paste**.



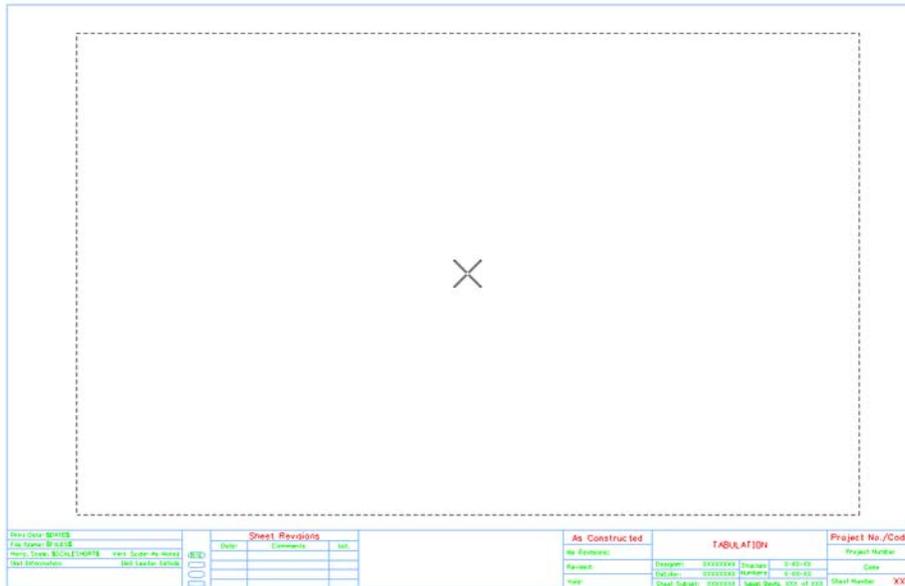
3. This brings up the **Paste OLE Object** dialog box. Select **Link** in the **Paste as:** option, **By Size** as the **Method:** and enter a **Scale** of **8.5**.



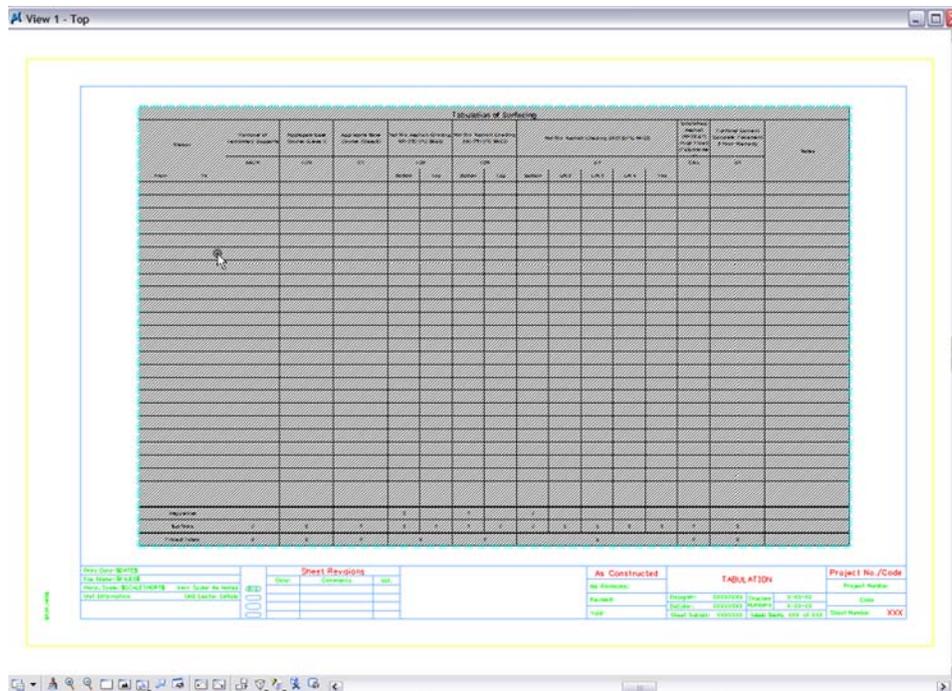
4. The Arial font is the default font used in the standard CDOT Excel tab sheet documents. The Arial 10 pt font in Excel is equivalent to CDOT Standard Text (.07"), and the Arial 12 pt font is equivalent to CDOT Title Text (.10") for a 1"=1' drawing when the Excel file is placed at a Scale of 8.5 as noted above.

Note: To insert a standard spreadsheet into a border that is not at a 1"=1' scale, multiply the scale of the Border by 8.5 to calculate the scale for the Excel link.

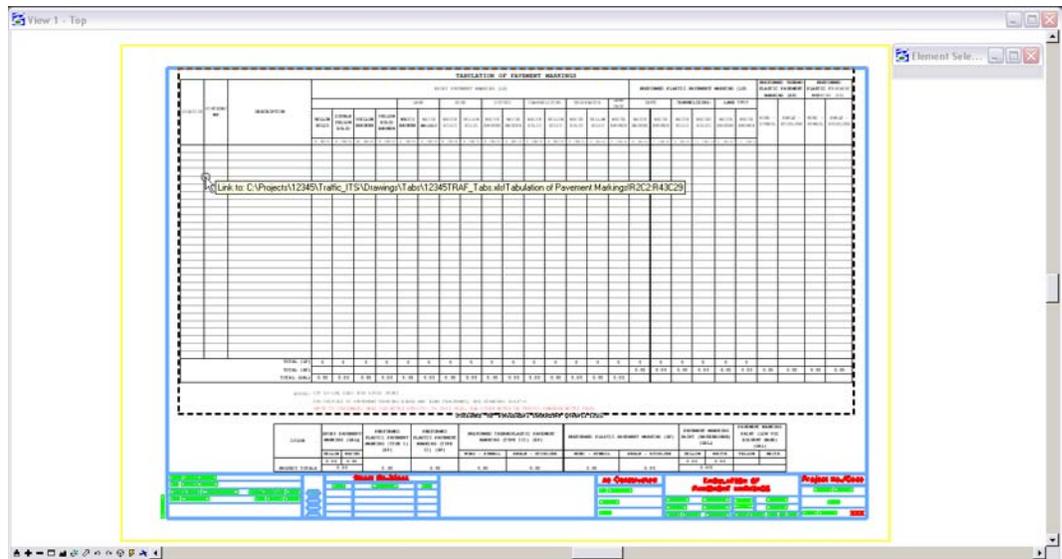
- The limits of the selected Excel data to be placed in the MicroStation sheet will display in the MicroStation Window. Select the origin point for the Excel File and <D> to place the file. The location of the link can easily be adjusted after it is placed.



Note: The link will display with hatching which indicates that the Excel file containing the linked data is currently open. If you close out of your Excel file, the hatching will go away.



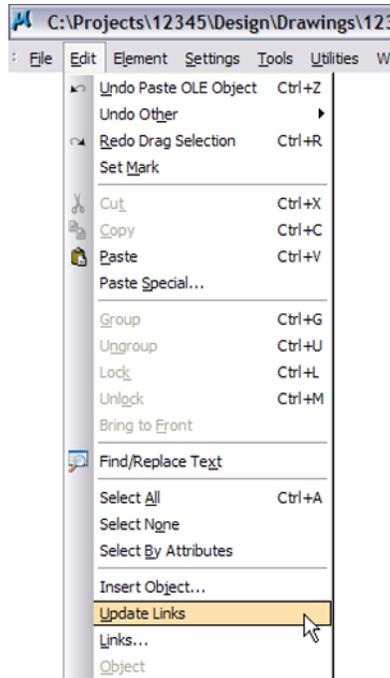
Note: Do not resize the linked window with the handles, as the text size will also resize and will not plot as desired.



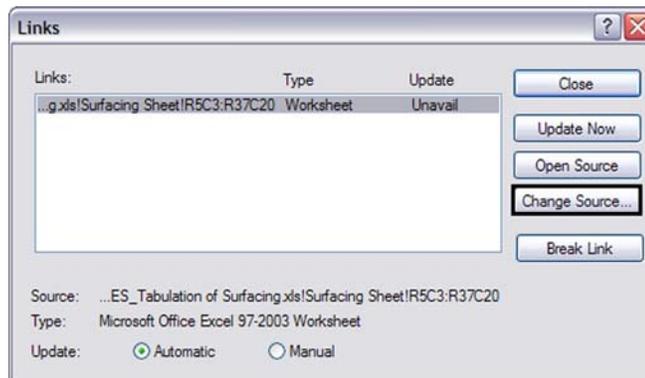
6. Hover over the linked image to display the location of the Excel file.
7. Double click the link to open the Microsoft Excel document. Edit the Excel file, close the file, and the updates will be displayed in the MicroStation file.

Updating Document Link Source and Properties

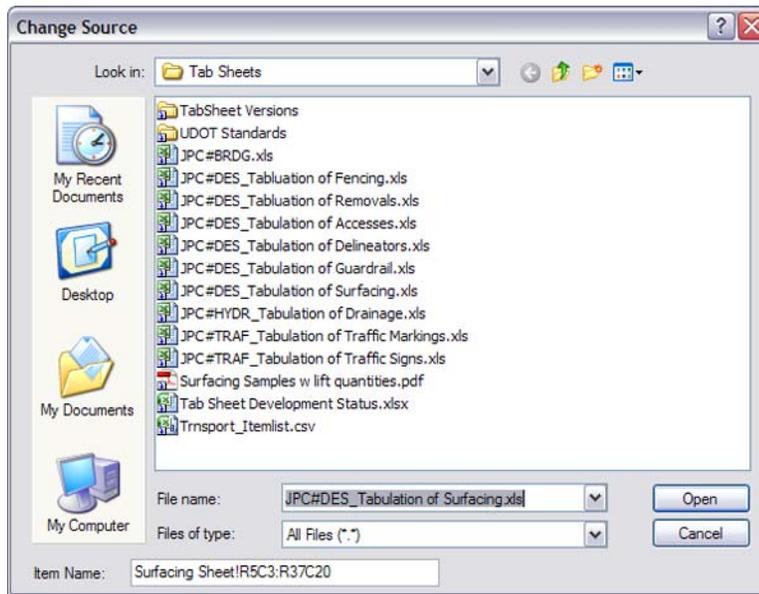
1. If an Excel document has been moved or renamed, you will need to update the existing link. This is also the case for MicroStation files with links that were created with the **Create Project Directory** program. These files are linked to the Excel files in the standard template directory and need to be updated to link to the Excel files in the **Project Directory Structure**.
2. From the MicroStation menu, select **Edit > Links...**



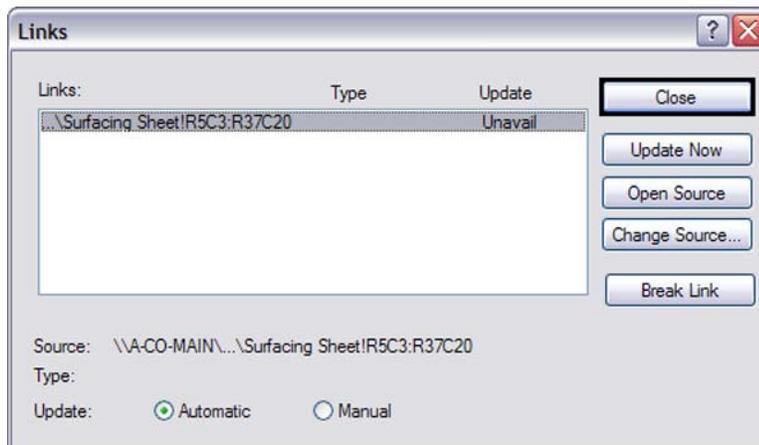
3. This will bring up the **Links** dialog box. Select an available document link and **<D> Change Source**.



4. This brings up the **Change Source** dialog box. Navigate to and select the correct Excel file and **<D> Open**.



5. Once a new source is chosen the **Links** dialog box will return. Continue to select additional documents to update the link or <D> **Close** to exit the **Update Links Dialog** box.



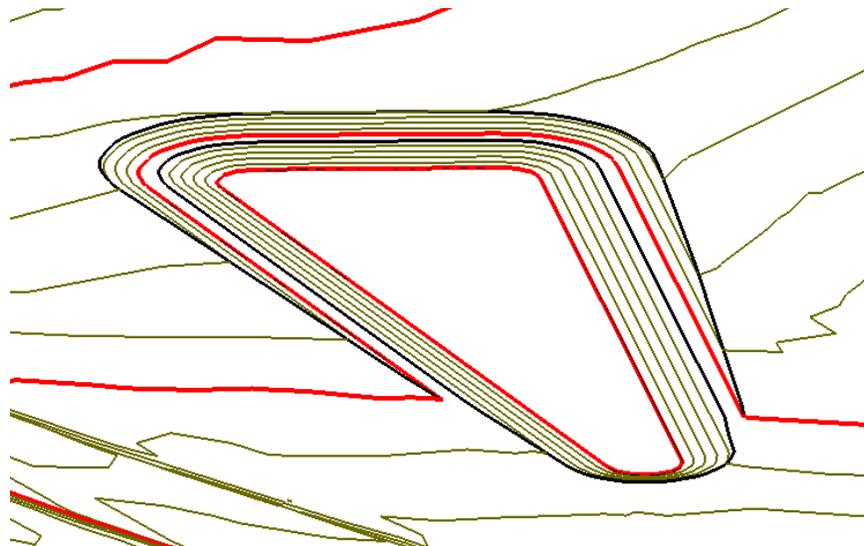
Note: Select either to have the link update manually or automatically by selecting the method you prefer. If a **Manual** update is chosen, <D> **Update Now** button to update the file manually.

Chapter 17 - Surface Editing Tools

It is not unusual for a project to require more detail than a surface generated by Roadway Designer can provide. Nor is it unusual to need a surface that cannot be easily created using templates. A few of the many examples that may require an additional level of detail include:

- Intersections
- Interchanges
- Divided highways
- Bridge abutments
- Borrow pits
- Pedestrian refuges
- Ponds
- Parking areas

Rather than try to build a final surface by using typical sections alone, then merging or running many corridors at once to build a parking lot, for example, you can build breakline features for your surface using multiple methods. With this approach, you can use a variety of tools to contribute to the model. Instead of trying to force one workflow (e.g. Typical Sections and Modeling) to create everything, use individual commands designed specifically to create or modify features, combining their resulting breaklines for your overall model.



Section Objectives:

- To learn techniques for refining a design DTM, such as a composite model made up of more than one design surface.
- To accomplish project-specific design scenarios by manipulating individual features.
- To learn how to manipulate features for grading in areas that don't lend themselves to the Roadway Modeling process, such as slopes around bridges, borrow pits or ponds.
- To learn where the Surface Creation and Editing tools fit into the overall CDOT Design process and how they can be used to your advantage.

Locks



Before working with features, there are lock settings that should be understood: **Feature Filter**, **Feature Highlight**, **Pen/Pencil**, **Delete Ink**, **Locate Features / Locate Graphics** and **Point Snap/Element Snap/No Snap**. Suggestions on when to use each are listed below. For additional details on the locks, see the **InRoads Online Help**.

Feature Filter



Feature filters can be created to segregate the features listed in InRoads dialog boxes. For example, you can create a filter based on any number of criteria, such as whether or not a feature is triangulated. When you toggle on the lock, only features that meet the active filter criteria are shown in dialogs, and therefore available for editing. This can be handy, for example, when you are working with a surface containing hundreds or thousands of features, but you only want to see/edit edges of oil. Set up a filter to look for only features with 'oil' in the name, then toggle the lock on.

Filters are stored in your XIN file and standard filters already exist for your use.

Feature Highlight



When the **Feature Highlight** lock is toggled on, any command that includes a feature list field will highlight the feature in plan view when it is selected in the list, whether it is displayed or not. This is a good check to visually verify the feature you want to display and / or edit.

Important! Turning on the **Feature Highlight** lock slows the opening of dialog boxes that include feature lists.

Pen / Pencil



When the features you are editing are displayed with **Pen/Pencil** set to **Pencil**, the modified features are kept 'up-to-date' in the graphics file. If set to **Pen**, original graphics are left in place and modified features are added, resulting in multiple graphical copies of features, although the DTM only contains the most recent update.

Delete Ink



When **Delete Ink** is toggled on, the **Pen** setting acts very much like **Pencil**, as all previous versions (Pencil or Pen) of a feature are deleted when the feature is modified.

Locate Graphics / Locate Features



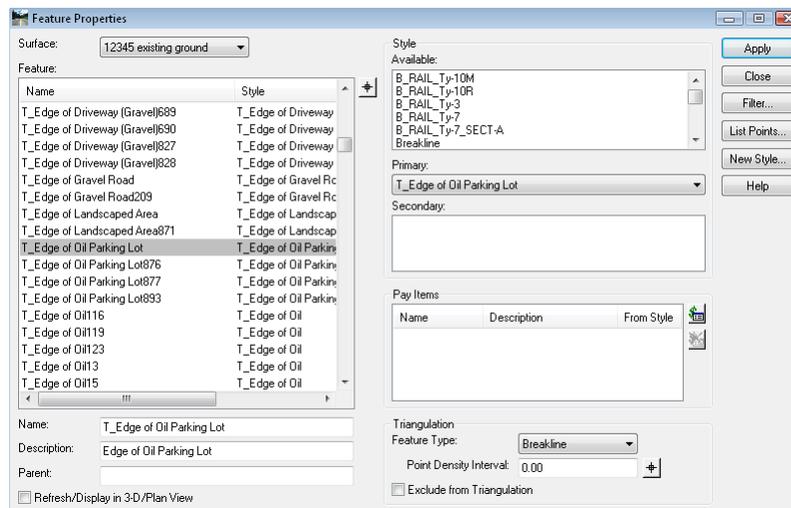
Several of the commands described in this chapter are dual purpose. They can create features or they can create graphics. Likewise, they can use graphics or features as input. On most commands, you will note this difference when you Apply the command and it prompts for either features or elements, based on this lock's setting. For others, the current **Locate** mode is shown at the top of the dialog box, some also have a **Generate Graphics Only** toggle.

Point Snap



When using **Partial Delete** or **Break Feature**, the **Point Snap** limits the selected points to existing points on the feature. In other words, no new points are added at the beginning and end of the break. **Element Snap** has no effect on surface editing tools. For information on how the snaps affect geometry, see the **InRoads Online Help**.

Feature Properties



The **Feature Properties** command (**Surface > Feature > Feature Properties**) provides a list of all of the features contained in the surface and the style assigned to each feature. Use this dialog box for a variety of functions including:

- Changing feature properties like **Name**, **Description**, **Point Type**, **Point Density Interval**, etc.
- Making a non-triangulating feature part of the triangulated network, or vice-versa.
- Assigning the feature a parent name or secondary style for filtering purposes.

In addition, you can select **List Points** to generate a report on basic feature information along with the feature's length and coordinate information for each vertex on the feature. This is helpful when checking a feature's elevation.

Note: If the feature's **Style** doesn't exist in the current XIN, it will display red in the list.

Creating Features

There are many options within InRoads that assist in CDOT's design process besides typical sections and roadway modeling. Using these tools, you can build surfaces from scratch or add to previously created surfaces (design or existing).

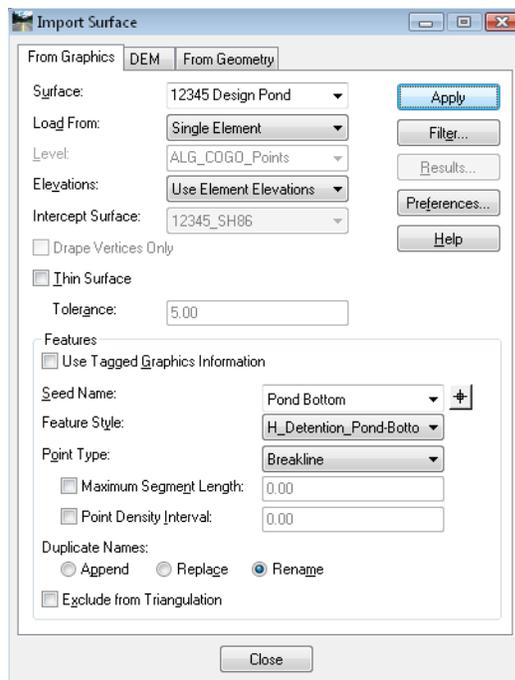
Section Objectives:

- To be able to create new features from scratch.
- To develop an understanding of when each of the feature creation commands should be used.
- To learn techniques that will help refine existing surface models by adding features.

Import Surface from Graphics

MicroStation graphics can be imported into a surface to form features. If you are comfortable drawing with MicroStation, you might find it useful to first draw what you want in the design file, then import the graphics as features as opposed to creating the features from scratch. This is especially useful in situations where the graphics are relatively simple, or when you want the new feature to take on the elevations of a known surface so you do not have to worry about setting the z-coordinate manually. You can also use this command to create a “flat” feature, then use **Generate Longitudinal Feature (GLF)** to add elevations. See the **Generate Longitudinal Feature** section in this chapter for details.

1. Draw the graphics with MicroStation.
2. Select **File > Import > Surface > From Graphics**.



3. Specify the **Surface** where the feature is being imported.

Note: If the surface has not been created, you may type the name in and it will be created when you Apply.

4. Specify the **Load From** option.

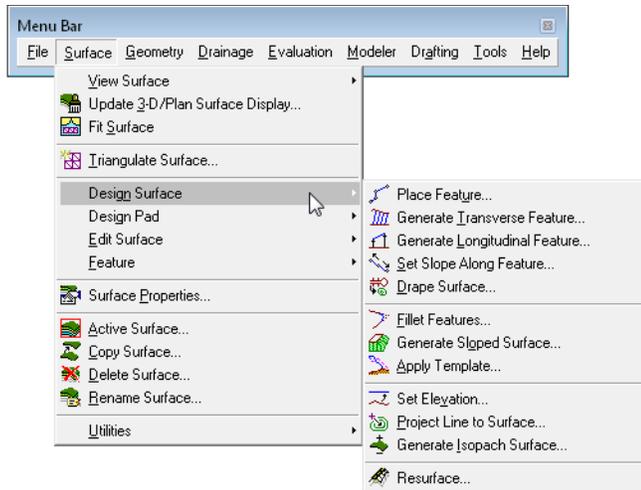
Note: To use a selection set, choose the **Single** option. When you Apply, you'll be asked if you want to use the active selection set.

See the **InRoads Online Help** for information on the other options in this dialog.

5. **<D> Apply** and follow the prompts to load your feature(s) into the surface.

Accessing Design Surface commands

While there are many commands in InRoads that create features, several of them are grouped under **Design Surface**. You can access them from the **Surface > Design Surface** pull-down menu, or from the **Design Surface** toolbar. Most are described in the following section.

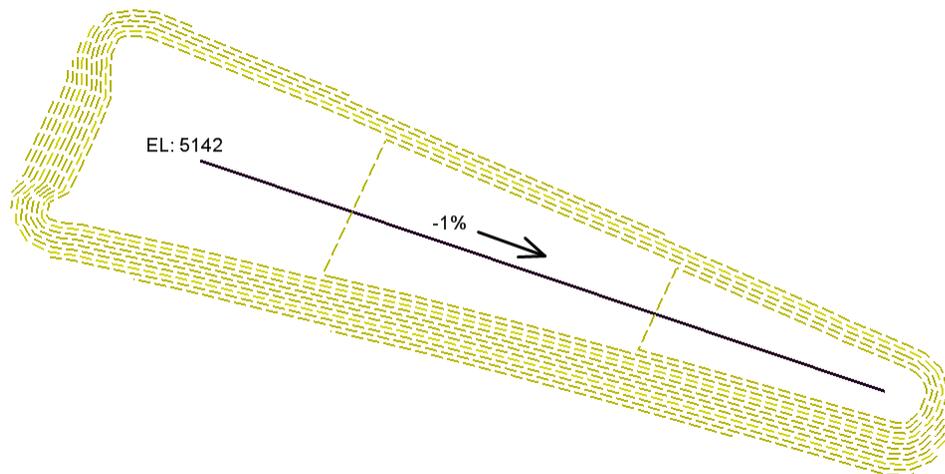


Generate Longitudinal Feature

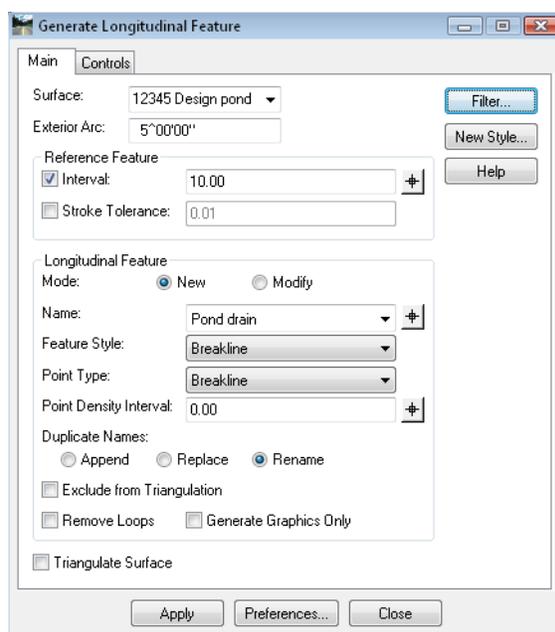
Generate Longitudinal Feature (GLF) is used to create and/or modify 3D MicroStation elements or features in a DTM. It is an extremely powerful tool that allows much easier manipulation in 3D than MicroStation alone.

When using this command to create a new feature, one of the easiest methods is to draw the feature in plan view with MicroStation without regard to the elevation, then use **GLF** to copy the element, creating a feature while adding elevations at the same time.

In this example, a drain line is added to the bottom of a pond. The design calls for the drain to start at a fixed elevation and proceed at a longitudinal grade along the prescribed route.



1. Use MicroStation to draw the drain line in the plan view.
2. Select **Surface > Generate Longitudinal Feature**.



The Main tab

1. Specify the *Surface* where a feature is being added or modified.

Note: The *Exterior Arc* is used when the new feature is horizontally offset from the original. In this case, it is set to 5^\wedge . When the copy is offset to the outside of a corner, the resulting feature will fan out from the corner in 5^\wedge increments, giving the effect of a fillet. The smaller the setting, the smoother the fillet.

Reference Feature

This category is for specifying how many vertices will be created in the resulting feature. Either *Interval*, *Stroke Tolerance* or both must be toggled on.

Interval is a master-unit setting that determines how often along the reference feature or element a new vertex is created.

1. In this case, the *Interval* is toggled on and set to **10**. In general, this setting should reflect a similar interval to the surrounding features. Here, the pond bottom has a similar interval.
2. Toggle on *Stroke Tolerance*. This option has two functions:
 - First, if the reference element contains a curve or arc, this setting is used to stroke the curve or arc into a series of vertices. See the *InRoads Online Help* for more information.
 - Second, it ensures the creation of a vertex at each occurrence of a vertex in the reference.

Longitudinal Feature

1. Set the *Mode* to *New*.

Longitudinal Feature options are available or not depending upon two things:

- If *Generate Graphics Only* is toggled on or off – if on, several of the feature settings do not apply, since only graphics result from the command. In this case, it is toggled off.
 - If the *Mode* is *New* or *Modify* – if *Modify*, several of the feature settings do not apply, as they are already established for the feature or element being modified.
2. Key in a *Name* for the new feature.
 3. Assign the new feature a *Feature Style*.

Hint: If there is already a feature using the desired style, save time by selecting it as the *Name* to populate the *Feature Style* field, then type over the name with your new one.
 4. Select a *Point Type* from the drop-down.
 5. For *Point Density* key in **0**.

Note: *Point Density* is a densification factor applied to the feature when it is triangulated. Fixed vertices are not added to the feature using this option – but triangulation vertices are. This setting can be added or changed after the fact in **Feature Properties**.

Note: The **Duplicate Names** area is only applicable if you have chosen a name that already exists in the surface. The options are:

- **Append:** The feature added is appended to the end of the named feature. As points are added, there is rubberbanding in the graphics file to show which end of the feature is being appended. If it is not the desired end, use **Surface > Edit Surface > Reverse Feature Direction** to first change the orientation of the original feature
- **Replace:** The old feature is removed and the new one added in its place
- **Rename:** A numeric suffix is added onto the name and used for the new feature

6. Toggle off **Exclude from Triangulation**.

Note: Toggle this option on if the feature is a utility, right-of-way, or some other breakline that you want to show on profiles and cross sections but do not want to affect the triangulation.

7. Toggle off **Remove Loops**.

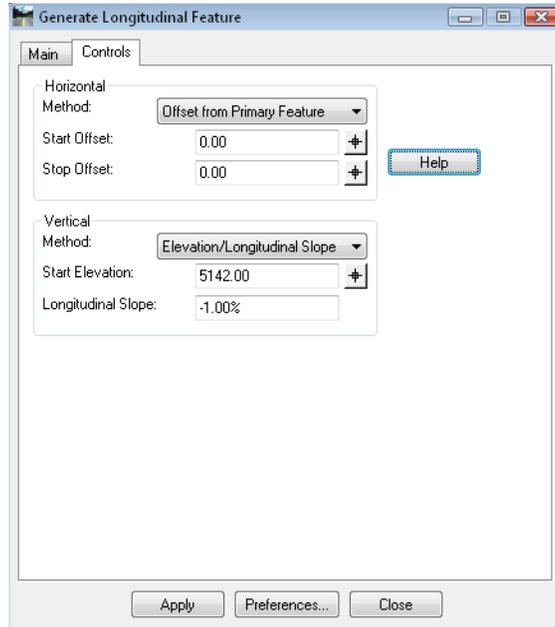
Note: If **Remove Loops** is on, this option will remove the loops when you are copying a feature or element with horizontal offsets that would result in loops in interior corners.

8. Toggle off **Triangulate Surface**.

Note: Toggle on **Triangulate Surface** if it's desired to see results of re-triangulation after each feature is added or modified.

The Controls Tab

On this tab, the horizontal and vertical location of the new or modified feature is set. For details on each of the options, see the *InRoads Online Help*.



1. For the *Horizontal Start* and *Stop Offsets* key in **O**, since the drain line has been drawn in the correct horizontal location.
2. Set the *Vertical Method* to *Elevation/Longitudinal Slope*. Here, the beginning of the drain line starts at 5142 and will slope at -1%.
3. <D> **Apply**.

Note: You are prompted to identify *Primary* and *Reference* elements or features based on the *Locate Graphics / Locate Features* lock settings. This lock may be toggled in the middle of the command, so you can identify a *Primary Feature*, then toggle to *Locate Graphics* and identify a *Reference Element*.

Remember, the *Primary* element or feature is what you are copying or modifying and the *Reference* is for:

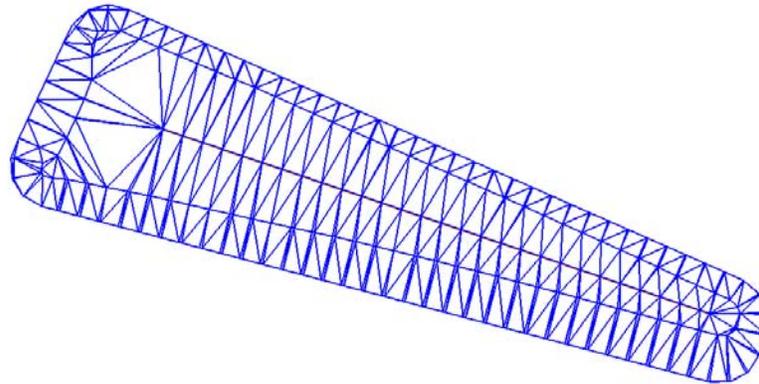
- ◆ Applying the interval
- ◆ Specifying what the result is perpendicular to, and
- ◆ Stroking

For a situation such as the drain line created here, the original element is both the *Primary* and *Reference*.

4. <D> on the drain line for the *Primary* element and <D> to accept.
5. <D> on the drain line for the *Reference* element and <D> to accept.

Note: Once the **Primary** and **Reference** are identified and accepted, the **Identify Location** prompt is shown. When the copy or modification is horizontally offset, it is necessary to <D> on the side of the desired result. When it's not horizontally offset, you can accept anywhere.

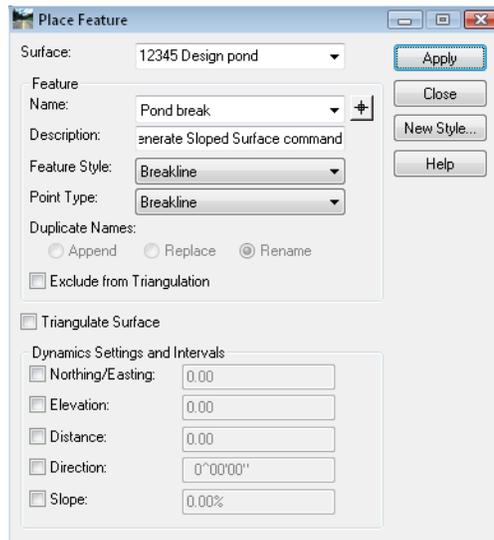
6. Since there is no horizontal in this case, <D> anywhere in the view to finalize the result.
7. View the triangles (**Surface > View Surface > Triangles**) and contours (**Surface > View Surface > Contours**) to see the results.



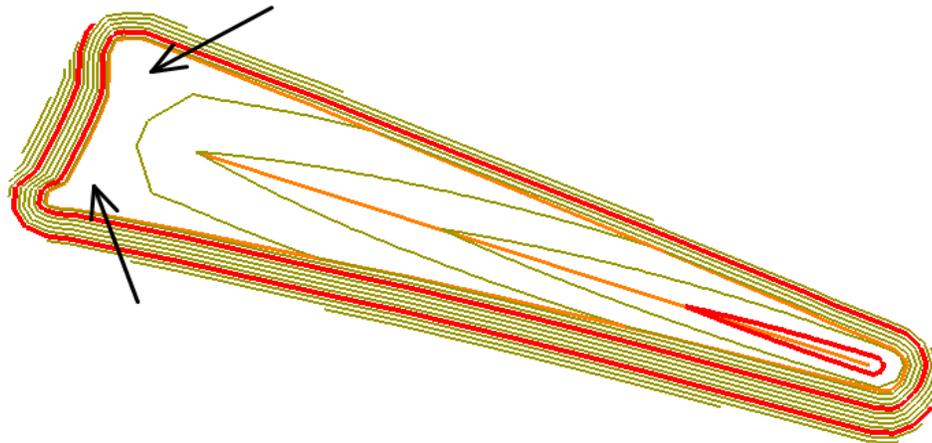
Here, you'll notice that there are triangles cutting across the corners, causing some erroneous contours. See the process for **Place Features** in this chapter for a suggestion on how to combat this situation and further enhance the surface.

Place Feature

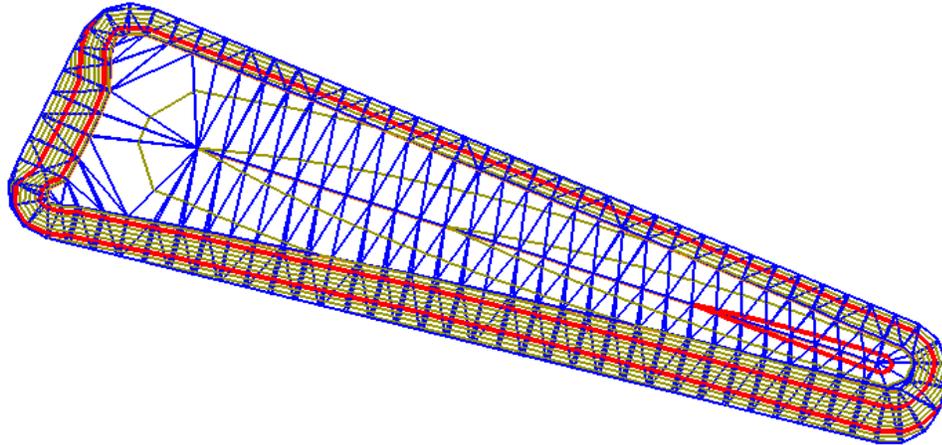
The **Place Feature** command is used to create individual 3D features in a DTM. This is useful in various situations, such as adding a utility to a DTM, controlling triangulation in a specific area, or just adding a breakline for a portion of the design.



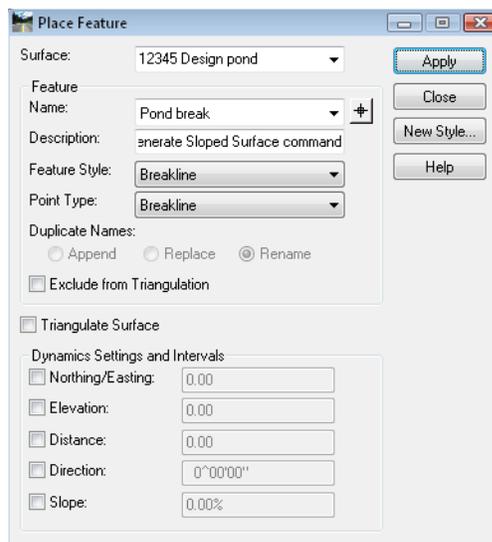
In this example, a breakline is added to enhance the triangulation of a sloped bottom pond. Notice how the contours do not follow the shape of the pond bottom in the corners.



Displaying the triangles shows why; in the corners the triangles have all three points touching the edge of the pond bottom, with nothing projecting to the drain line in the middle of the pond. Breaklines can help resolve this issue, resulting in a better surface model.



1. Select **Surface > Design Surface > Place Feature**.



2. Specify the **Surface** to add the feature to in the drop-down list.

Note: If it is a brand new surface, the name can be typed in here and the surface is created when the command is applied.

Note: The **Feature** area of the dialog is automatically populated with information from the first feature in the active surface. This is the area where the new feature information is entered.

3. Either key in a **Name** or choose one from the drop-down.

Note: See the **Duplicate Name** information below regarding what happens if an existing feature name is chosen.

4. Enter a **Description** (optional).
5. Choose a **Feature Style** from the drop-down list that matches the feature being created. These styles are stored in CDOT's XIN file.

Hint: If there is already a feature using the desired style, save time by selecting it as the **Name** to populate the **Feature Style** field, then type over the name with your new one.
6. Set the **Point Type** to **Breakline**.
 - ◆ In general, this command is used to create breakline features, although you can also create **Random**, **Contour**, **Interior** or **Exterior** features.
 - ◆ Random features do not show up on cross sections or profiles.

Note: The **Duplicate Names** area is only applicable if you have chosen a name that already exists in the surface.

 - **Append:** The feature added is appended to the end of the named feature. As points are added, there is rubberbanding in the graphics file to show which end of the feature is being appended. If it is not the desired end, use **Surface > Edit Surface > Reverse Feature Direction** to first change the orientation of the original feature.
 - **Replace:** The old feature is removed and the new one added in its place.
 - **Rename:** A numeric suffix is added onto the name and used for the new feature.
7. Toggle off **Exclude from Triangulation**.

Note: Toggle this option on if the feature is a utility, right-of-way, or some other breakline that you want to show on profiles and cross sections but do not want to affect the triangulation.
8. Toggle off **Triangulate Surface**.

Note: Toggle this option on if it's desired to see results of re-triangulation after each feature is added.
9. Toggle off all options under **Dynamic Settings and Intervals**.

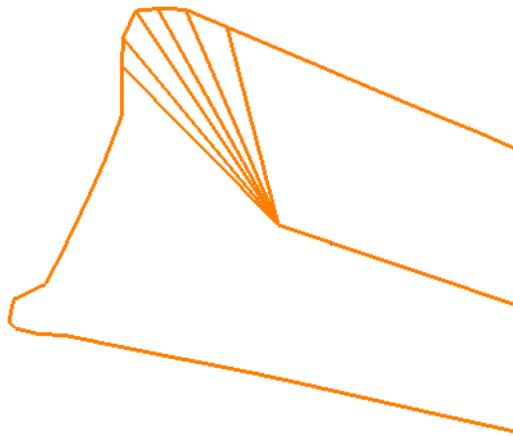
Note: These options are intervals, not actual values. For example, if you set the **Distance** interval to **100**, the vertices of the feature being placed are locked into multiples of 100 master units apart. This is useful if the breakline represents pipe that must be placed in fixed lengths, for example.
10. <D> **Apply** to open the **Set Elevation** dialog box and begin the process of entering the feature.

The Set Elevation Box

A second dialog appears when the command is applied. This dialog allows the elevation of the cursor to be overridden for each vertex.

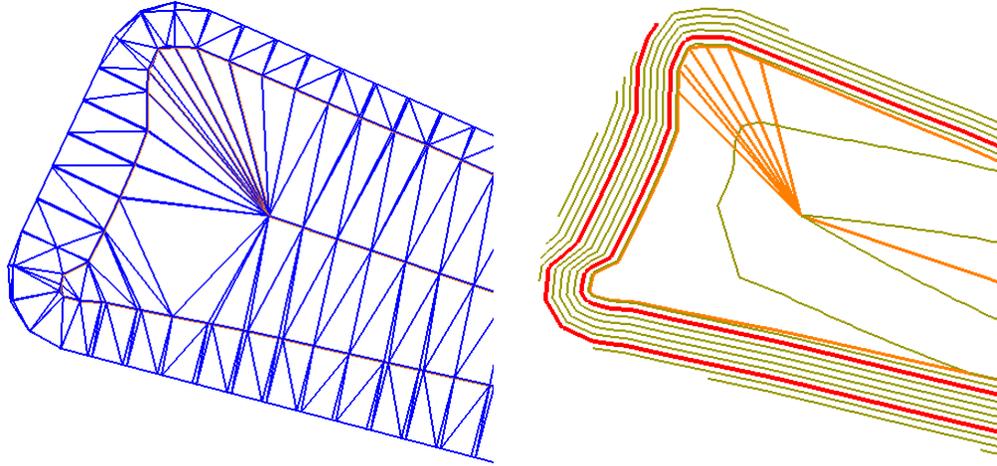


1. Toggle off both *Specify Elevation* and *Elevation from Surface*.
 - ◆ If you toggle on *Specify Elevation* the elevation of each vertex can be entered.
 - ◆ If you toggle on *Elevation from Surface* each vertex pulls its elevation from the listed surface. This surface does not have to be the same as the to which the feature is being added. An *Elevation Adjustment* is also allowed for adding the feature a specified distance above or below the listed surface. This is useful for specifying coverage for a utility.
 - ◆ If you leave both toggles off the elevations are taken from the cursor location (element's elevation if you snap to something or active depth if you do not).
2. Snap to the drain line end, then the pond bottom, to pick up the elevations and place the feature.



Note: Additional features can be added as necessary.

3. Triangulate the surface (*Surface > Triangulate Surface*) when done, and view the contours to see any improvement.



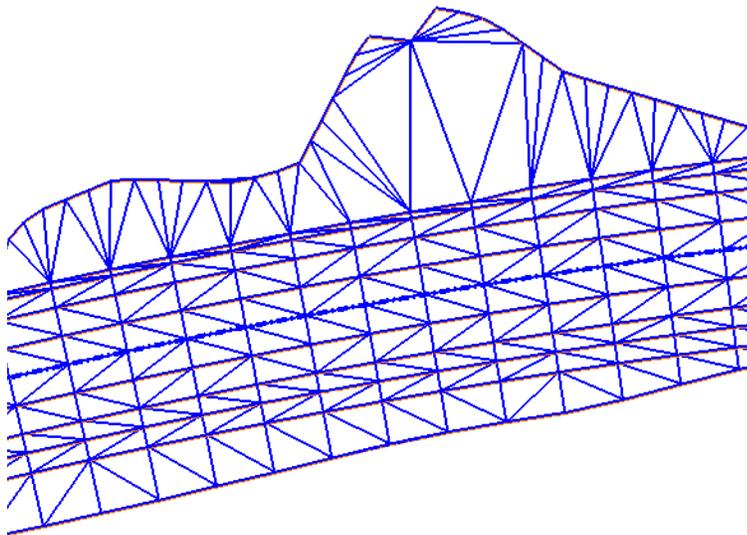
This process is iterative and a choice must be made as to the value of continual refinement to the DTM, the goal being not to pass the point of diminishing returns.

Generate Transverse Feature

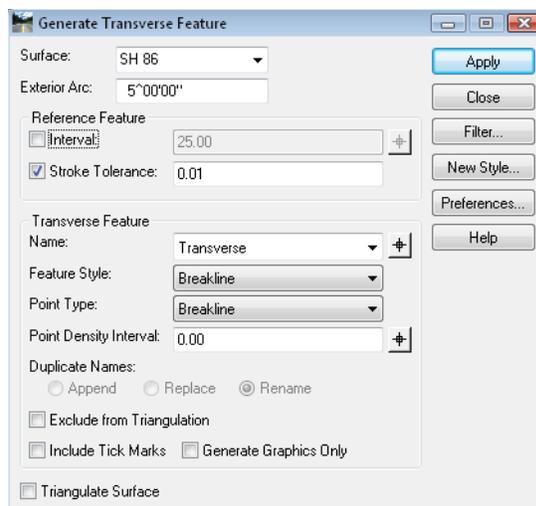
The **Generate Transverse Feature** command creates a new feature that consists of lines at a specified interval connecting two known features. The lines are perpendicular to, and the interval is specified along, a reference feature. You can also work in **Graphics Only** mode and identify MicroStation elements as either of the known or the reference lines.

Transverse features are useful when triangulation is not forming the slopes between the two known features as you need. For example, if one feature has less points than the other, there may be large, irregular triangles formed, or if one or both of the known features have concave areas where triangles are cutting across and touching only one of the features.

In the diagram below, notice the sideslopes in the fill area are created with triangles that are not perpendicular to the centerline. This could happen in cases where you create the sideslope after the backbone model is formed or when you're using **Surface Edit** tools to create a new model.



1. Choose **Surface > Design Surface > Generate Transverse Feature**.



2. Specify the *Surface* to add the feature to in the drop-down list.

Note: If it is a brand new surface, the name can be typed in here and the surface is created when the command is applied.

3. For *Exterior Arc*, key in 5^\wedge .

Note: The *Exterior Arc* is used when the reference feature has exterior corners between the two known features. In this case, it is set to 5^\wedge . When the transverse feature is created to the outside of a corner, the resulting feature lines will fan out from the corner in 5^\wedge increments, giving the effect of a fillet. The smaller the setting, the smoother the fillet.

Reference Feature

This category is for specifying at how many locations that transverse lines will be created in the resulting feature. Either *Interval*, *Stroke Tolerance* or both must be toggled on.

4. Set the interval to 25. In general, this setting should reflect a similar interval to the surrounding features.

Note: Interval is a master-unit setting that determines how often along the reference feature or element a new transverse line is created.

5. Toggle on *Stroke Tolerance* and set to **0.01**.

Note: Stroke Tolerance has two functions:

- ◆ First, if the reference element is a curve or arc, this setting is used to stroke the curve or arc into a series of vertices. See the *InRoads Online Help* for more information.
- ◆ Second, it ensures the creation of a vertex at each occurrence of a vertex in the reference feature or element.

6. Toggle *Generate Graphics Only* off. If on, several of the feature settings do not apply since only graphics result from the command.

7. Key in a new *Name* for the transverse feature you're creating.

8. Choose a *Feature Style* that matches the feature being created. These styles are stored in CDOT's XIN file.

Hint: If there is already a feature using the desired style, select it as the *Name* to populate the *Feature Style* field, and then type over the name with your new name.

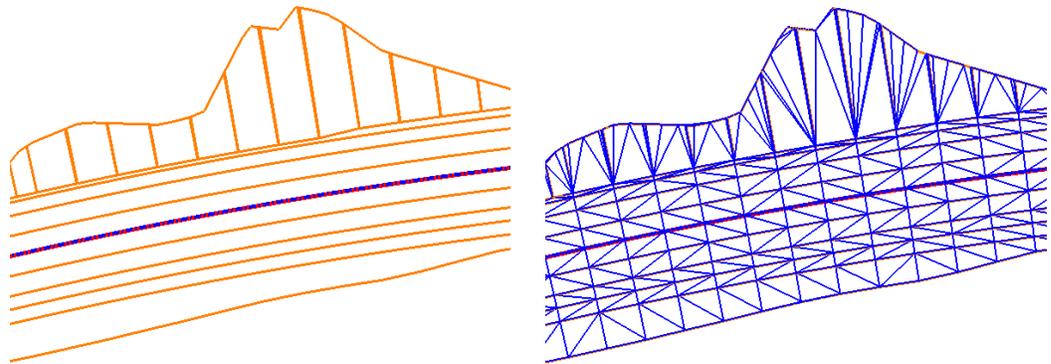
9. Set the *Point Type* to *Breakline*.

- ◆ In general, this command is used to create breakline features, although you can also create *Random*, *Contour*, *Interior* or *Exterior* features.
- ◆ Random feature do not show up on cross sections or profiles. Use breaklines for that purpose, even though they do not have to be triangulated.

For details on other options, see the *InRoads Online Help*.

10. <D> **Apply** and follow the prompts and <D> to identify the **Primary**, **Secondary** and **Reference** lines.

Note: These can be either graphics or features as specified by the **Locate Graphics / Locate Features** lock. Here, the POSS is the **Primary** Feature (where the transverse lines are coming from), the Fill slope is the **Secondary** Feature (where the transverse lines are going) and the POSS is the **Reference** (what the transverse lines are perpendicular to, and where the interval is measured).



Notice in this case, you may need to add additional features to “catch” each of the vertices in the new toe of slope.

Fillet Features

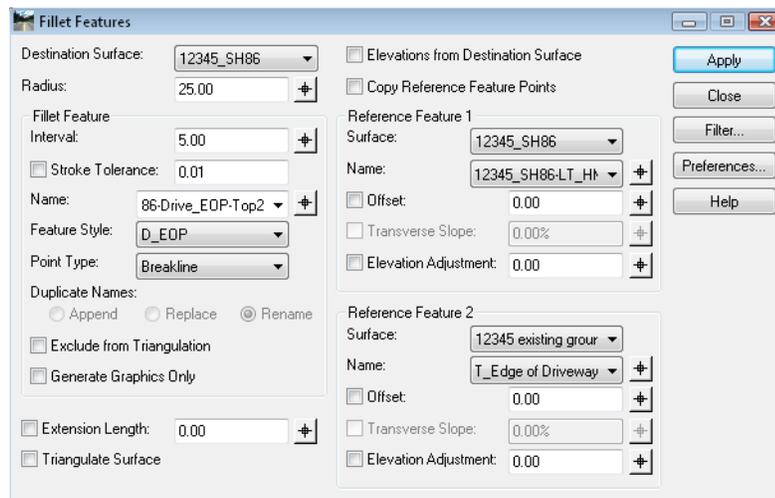
The **Fillet Features** command is used to create a 3D fillet between two existing elements or features. The result can be either a new feature or a graphic element, depending upon the **Generate Graphics Only** toggle. While it can be used anytime a fillet is needed, one of the most common uses is to create a return for a driveway. Intersection returns are typically handled with templates. See the **Roadway Modeling** chapter for additional details.

Note: This command produces a 3D linestring or feature, not a true arc.

Note: The **Multi-Center Curve** command can also be used in this situation, creating a horizontal and vertical alignment for the 3D return, followed by running a template for the return.

To create a driveway fillet:

1. Select **Surface > Design Surface > Fillet Features**.



2. Select the **Destination Surface** where you want the fillet placed. In this case, it's the proposed model.
3. Set the **Radius** desired for the fillet.
4. For **Interval** key in **5**.
5. Toggle off **Stroke Tolerance**.

Note: The **Interval** and **Stroke Tolerance** determine the density of the vertices in the resulting feature.

6. Specify the **Name** of the feature.

Hint: If you choose a name that exists already, it will populate the **Feature Style** and the **Point Type** so you don't have to. You can then type over the existing name with a new one.

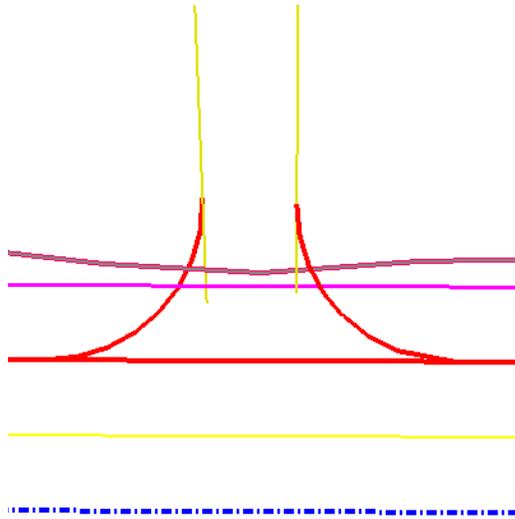
7. Select **Reference Features 1** from the drop-down list or use the target locator button to graphically select the feature.

- Repeat for **Reference Feature 2**.

Note: **Reference Feature 1** and **2** are the features from which you are creating the fillet. The order in which you select the features determines the direction of the resulting fillet feature (direction is from 1 to 2).

For details on the other options, see the **InRoads Online Help**.

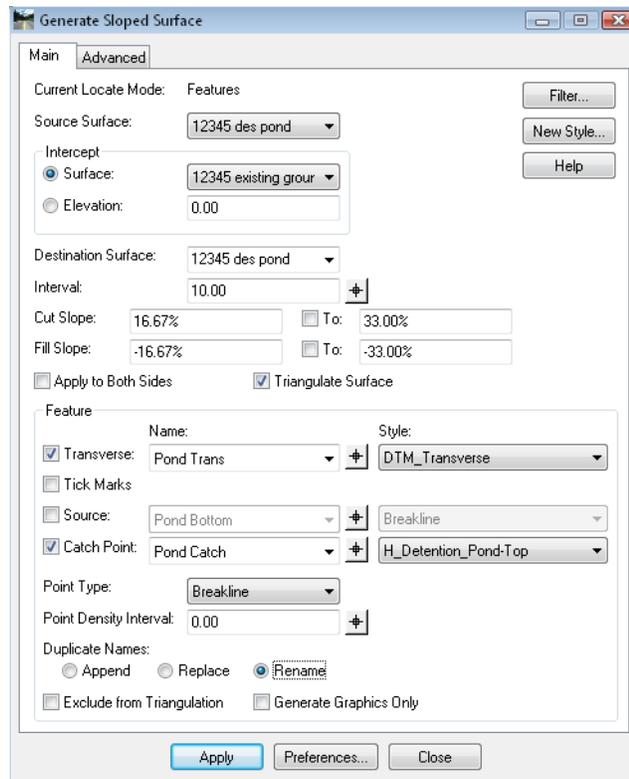
- <D> **Apply** and when prompted, identify the quadrant where you want the fillet.
- Accept with a <D>.



Generate Sloped Surface

The **Generate Sloped Surface (GSS)** command can be used anywhere you need to generate a slope extending from a known feature or graphic element to a surface. In this case, it is used to create a sideslope for a pond.

1. Select **Surface > Design Surface > Generate Sloped Surface**.



Note: The *Current Locate Mode* is determined by the *Locate Features / Locate Graphics* lock.

2. Set the *Source Surface* to the surface where the origin of the slope is located.
3. Set the *Intercept Surface* to the surface that you are intercepting with the slope.

Note: You can also tie into an elevation, such as when you want to bench the slope at an elevation.

4. Set the *Destination Surface* to the surface where the slopes are placed. The surface can exist already, or you can type in the name of a new one and it is created when you Apply.
5. Key in the values for the *Cut* and *Fill* Slopes.

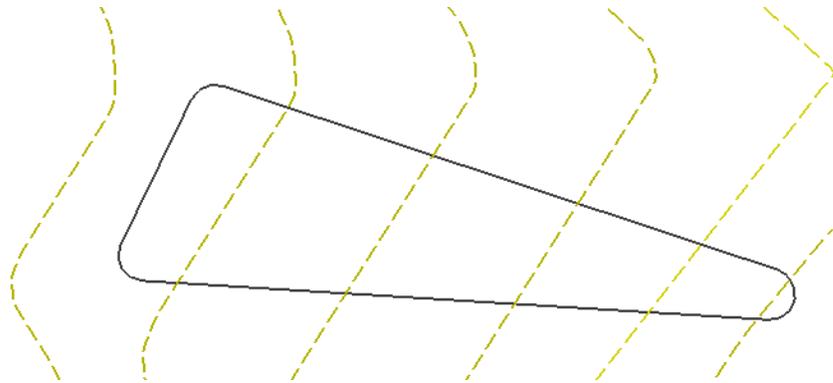
Note: For the *Cut* and *Fill* Slopes, there is a percentage and a *To:* option. Use this when you want to transition between two sideslopes.

- Toggle off *Apply to Both Sides*.

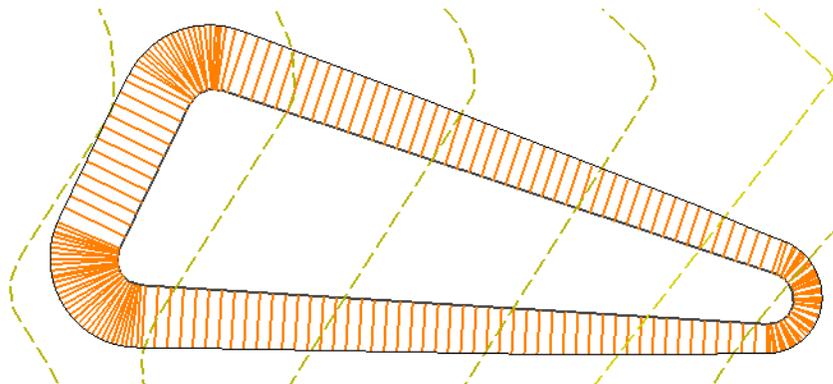
Note: Use *Apply to Both Sides* when you want slopes extending from both sides of the feature or element, such as when you are creating a ditch.

For details on the other options, see the *InRoads Online Help*.

- <D> **Apply** and when prompted, identify the feature you're sloping from.



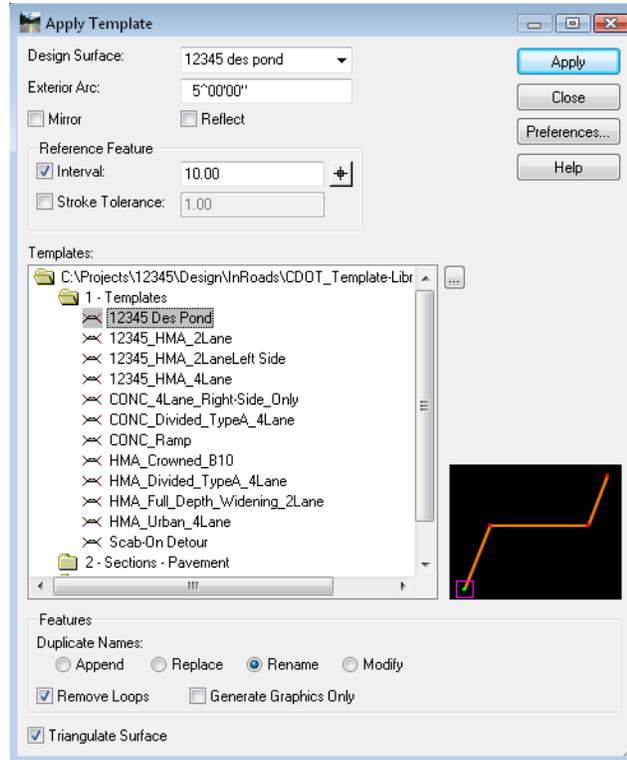
- When prompted, <D> to identify the beginning point of the sideslope, then <D> again for the ending point. Optionally, you <R> to use the entire feature, as shown here.
- <D> to accept the sideslope on the side of the original feature where you want the sideslopes to be formed.



Apply Template

Apply Template basically allows you to use any MicroStation element or InRoads feature as the horizontal and vertical control for creating a DTM from a template, without having to set up a corridor using Roadway Designer. This is very useful, for example, when creating:

- Sideslopes from a pond or pit that are more complex than **Generate Sloped Surface** is capable of producing
- Walls created without Designer, such as the terraced walls under an interchange bridge



While the same templates can be used for Roadway Designer's **Template Drops** and the **Apply Template** command, keep in mind that **Apply Template** cannot transition between different templates or use any of the other advanced modeling options available in Designer such as **Point Controls** and **Parametric Constraints**.

In this example, a pond is being modeled from a known bottom (created previously with **Generate Longitudinal Feature**). The sideslope of the pond is set to slope up to a certain elevation, berm and then proceed in cut until interception with the existing ground.

Note: Most CDOT end condition templates are created with the **Target** listed as **Active Surface**. If this is the case for the template being used with **Apply Template**, be certain the correct surface is active before Applying.

1. Select **Surface > Design Surface > Apply Template**.
2. Toggle off **Generate Graphics Only**, or the command will not create features.
3. Specify the **Design Surface**.

Note: The *Design Surface* is where the resulting features are placed, not the target surface for the template.

4. Toggle off *Mirror* and *Reflect*.

Note: The direction of the graphic or feature determines the direction the template is run. If necessary, you can reverse the direction (for a graphic, use **Change Element Direction**; for a feature, use **Reverse Feature Direction**) or you can *Reflect* the template. If you want to run the template down both sides of the graphic or feature, select *Mirror*.

5. Select your template from the library and set the other options as shown.

For details on the other options, see the *InRoads Online Help*.

6. <D> **Apply** and identify the graphic or feature the slopes are coming from (in this case, the pond bottom).

Note: You are prompted based on your *Locate Graphics / Locate Features* toggle for either a *Primary Element* or a *Primary Feature*.

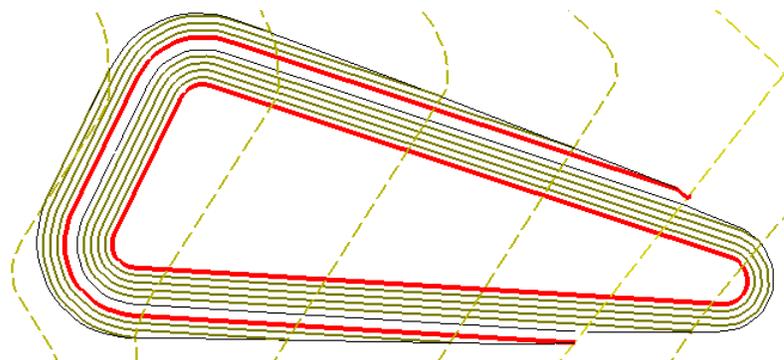
7. <D> on the bottom of the pond to identify it as the *Primary*.
8. Next, you are prompted for the *Reference*. <D> on the bottom of the pond as the reference.

Note: The template is applied perpendicular to the Reference, and the interval is applied to the Reference. In this case, the bottom of the pond is both the Primary and the Reference. An example of when they might not be the same is when you are applying the template to an edge of pavement, but you want the results perpendicular to the centerline alignment.

9. You are then prompted to identify the beginning (and subsequently the end) of the pond bottom or if you Reset <R>, the entire feature is used. In this case, <R> to identify the entire pond bottom. Notice also there is tracking so you can see the direction of the feature.
10. <D> to accept the solution and the sideslopes are created.

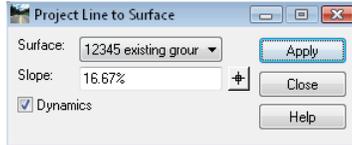
Note: When the *Triangulate Surface* option is toggled on, the features created by **Apply Template** are incorporated into the triangulated DTM.

11. View the triangles or contours to see the results.



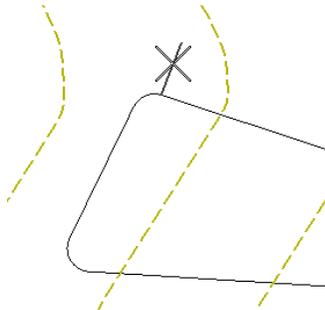
Project Line to Surface

The **Project Line to Surface** command is useful when you need to know where a certain slope intercepts a surface before creating a sideslope. It can also be used for line-of-site studies. The input for the command is a MicroStation graphic to start from and the result of this command is a MicroStation line; no features are used or created.

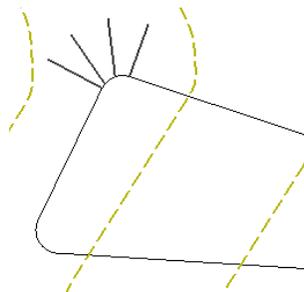


1. Select **Surface > Design Surface > Project Line to Surface**.
2. Set the **Surface** to the one you want to intercept.
3. Key in a **Slope** of the resulting line.
4. Toggle on **Dynamics**.
5. **<D> Apply**.
6. When prompted, snap to the element you're sloping from.

Note: In the direction defined by the location of the cursor, a line extends until it intercepts the given surface. A **<D>** creates the line as an element. If you want to come from the same point in a different direction, you can continue to move your cursor and **<D>** wherever necessary.

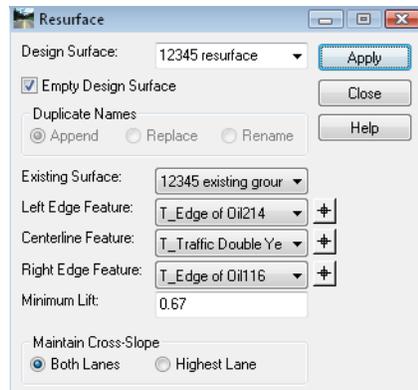


In this case, multiple points are checked along the element to see where the slope intercepts. The endpoints of these lines could be joined with a linestring and loaded as a feature for the toe of slope, or you can now use **Generate Sloped Surface** to create the features after identifying the desired slope with the **Project Line to Surface** command.



Resurface

The **Resurface** command is useful when you need to define features for a resurfacing project that ‘clear’ the existing surface plus a minimum lift. Using the **Maintain Cross Slope – Both Lanes** toggle, the features are created so that when the existing cross slope on each side of the roadway is maintained, the new features form a surface that is the lift-height above the closest orthogonal point to the new surface. In order to use this command, you must have features for the existing centerline and pavement edges.



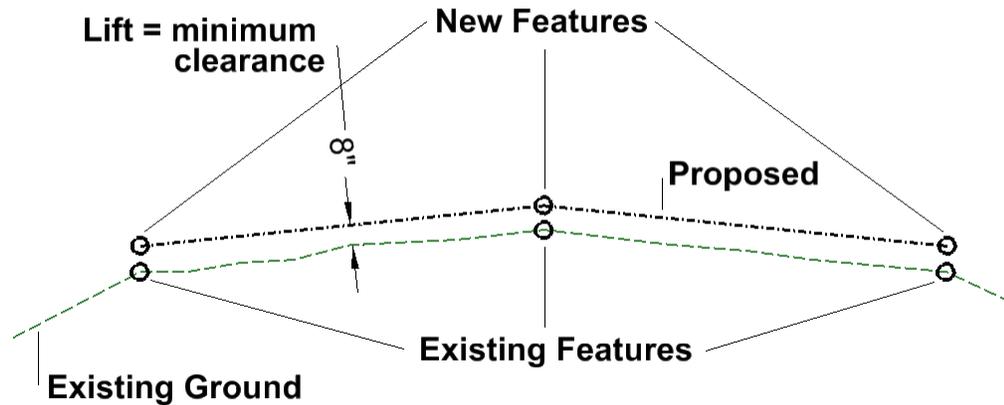
Resurface is an **Application Add-In** that must be toggle on prior to use. Select **Tools > Application Add-Ins** and toggle **Resurface** on if you don’t initially see it on your menu.

1. Select **Surface > Design Surface > Resurface**.
2. Set the **Design Surface** to the surface where you want the new features to be created.
3. Set the **Existing Surface** to the surface where the current features for the Centerline, Left and Right Edge features are located.
4. Key in the minimum lift.

For details on the other options, see the **InRoads Online Help**.

5. <D> **Apply** to create the new features.

At each vertex along the centerline feature, the current cross slope is measured, the highest orthogonal distance from that cross slope is determined, and new features are added so that the same cross slope can be maintained along with a minimum clearance between the existing surface and new cross slope equal to the lift value.



Since there are no components added to the proposed surface using this command, the real value comes from using these new features as controls when creating a model using Templates and Roadway Designer. See the *Typical Sections* and *Roadway Modeling* chapters in this guide for additional information.

Section Summary:

- Design surfaces do not have to be created from Roadway Designer alone.
- Commands that create features allow you to enhance a surface created with other tools or create a new surface from scratch.
- Templates can be used with surface manipulation commands without using Roadway Designer or setting up corridors.
- Features resulting from these commands can be used in combination with Roadway Designer, such as for **Point Controls** or horizontal and verticals control for a corridor.

Modifying Features

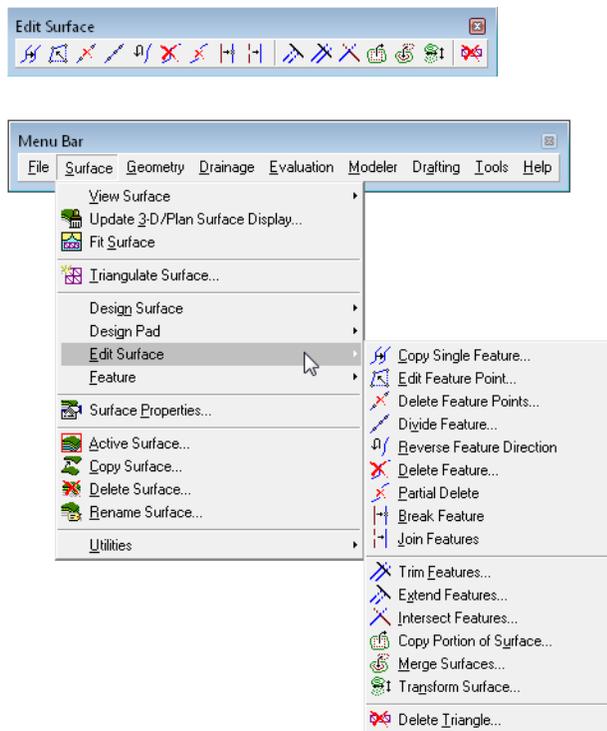
There are many options within InRoads that assist in manipulating design models by changing current features. These tools are used when creating surfaces from scratch, such as ponds or parking lots, or when modifying previously created models such as roadways developed with Roadway Designer.

Section Objectives:

- To be able to modify horizontal and vertical locations of existing features.
- To develop an understanding of when each of the feature editing commands should be used.
- To learn techniques that refine existing surface models by modifying features.

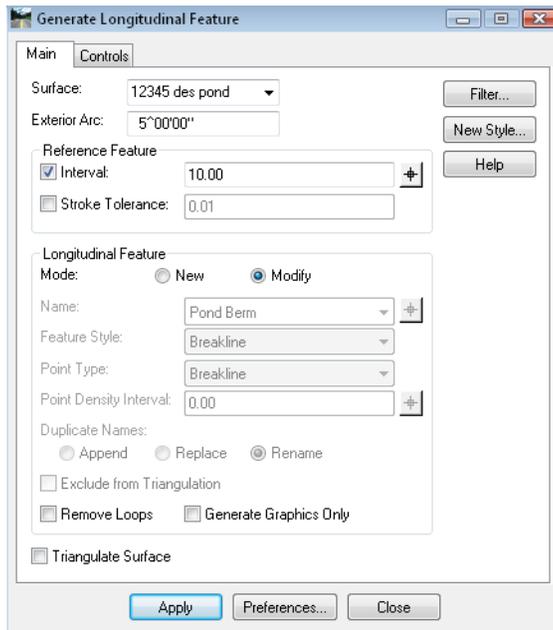
Accessing Edit Surface Commands

While there are many commands in InRoads that modify features, several of them are grouped under **Edit Surface**. You can access them from the **Surface > Edit Surface** pull-down menu, or from the **Edit Surface** toolbar. Most are described in the following section.



Generate Longitudinal Feature

Generate Longitudinal Feature (GLF) is used to create and/or modify 3D MicroStation elements or features in a DTM. It is an extremely powerful tool that allows much easier manipulation in 3D than MicroStation alone.

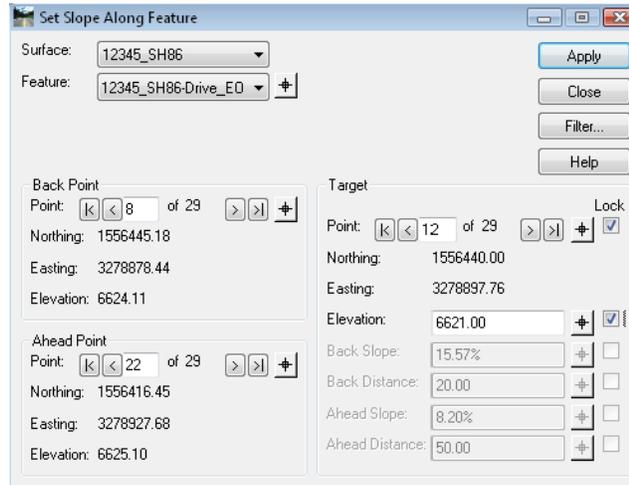


When using this command to modify existing features, several of the options are not available, as they are already set for the feature (such as *Name*, *Style*, etc).

For information on using **GLF**, see the **Generate Longitudinal Feature** topic in the **Creating Features** section of this chapter.

Set Slope Along Feature

The **Set Slope Along Feature** command is used when you need to modify elevations of points in a feature by defining a slope along the feature, but you do not want to modify the XY location of any of the points. For example, use this command when you need to ensure a drain line slopes to a low point on the feature.

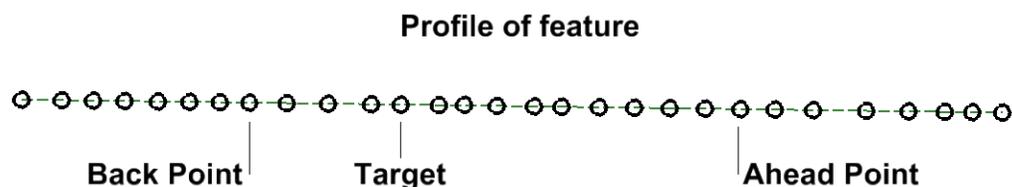


In this example, a low point is needed in the middle of a return.

1. Select **Surface > Set Slope Along Feature**.
2. Set the **Surface** to the surface containing the feature you are changing.
3. Select the **Feature** from the drop-down list, or use the **Locate** button to select the feature graphically.

For this example:

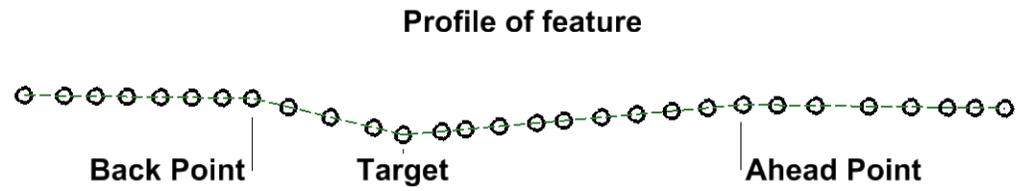
4. Set the **Back** and **Ahead Points** to the points you want to hold constant.
5. Set the **Target** to the point you want to assign a new elevation.



6. In the Target section, toggle on **Lock** for the **Point** and **Elevation** and key in the elevation.

Note: When setting the target, you have the option of locking two of several inputs to create the desired results. In this case, we want the Target **Point** locked (so a new point is not created), and we want the **Elevation** locked for that point. All points between the **Back** and **Ahead** are adjusted in elevation to accommodate the modified point.

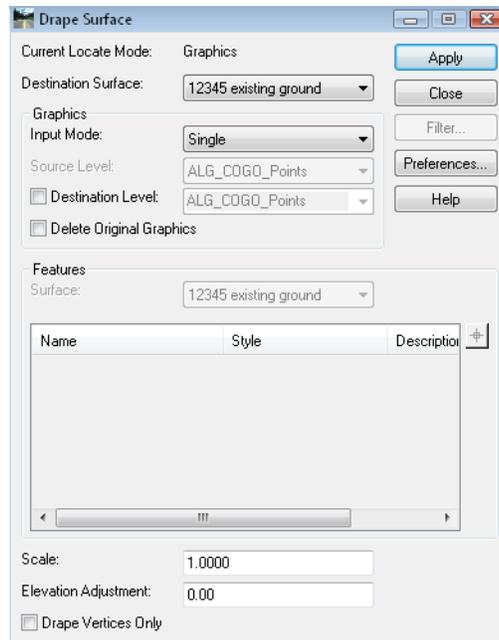
7. <D> **Apply** to modify the feature.



For details on using the other *Target* options, see the *InRoads Online Help*.

Drape Surface

Drape Surface is used when you want to force a graphic element or a feature (based on the *Locate Graphic / Locate Feature* toggle) to take on the elevations of an existing DTM. This command increases the number of vertices, since not only are the original vertices assigned the elevations of the surface, but a vertex is added everywhere a triangle is crossed. The exception is when *Drape Vertices Only* is on, in which case only the original vertices are assigned new elevations.



The *Destination Surface* determines the elevations and is where the new feature is created if the *Destination* and *Features Surfaces* are not the same. (If they are the same, the feature is modified.)

In the following example, the outer perimeter of a pond is known, so to begin modeling the pond, this perimeter must first be draped onto the existing surface. If the perimeter was draped as a feature, it would then reside in the existing surface model. Since the pond is modeled in a separate surface, it is draped as a graphic, then imported.

1. Set the *Locate Graphics / Locate Features* toggle to *Locate Graphics*.
2. Draw the perimeter of the pond with MicroStation if it doesn't already exist.
3. Select **Surface > Design Surface > Drape Surface**.
4. Set the *Input Mode* to *Single*.

Note: You can use a Level or Fence from the drop-down. You can also use a MicroStation selection set by having it active first, then choosing *Single*.

5. Toggle off **Destination Level** and **Delete Original Graphic**.

Note: If **Destination Level** is toggled on, the new draped graphic is created on that level. If not, it is created on the level of the original graphic, which may or may not be deleted based on the **Delete Original Graphics** toggle.

6. For **Scale** key in **1**.

Note: The **Scale** is used to exaggerate the display of the results. It does not affect the actual elevations if creating a feature.

7. For **Elevation Adjustment** key in **0**.

Note: **Elevation Adjustment** is used when you want to add or subtract a set amount from the elevation of each vertex. For example, you can use this to drape an underground utility to 6' below the existing ground.

8. <D> **Apply** and <D> on the graphic to drape.

9. <D> to accept the results and the new graphic is created.

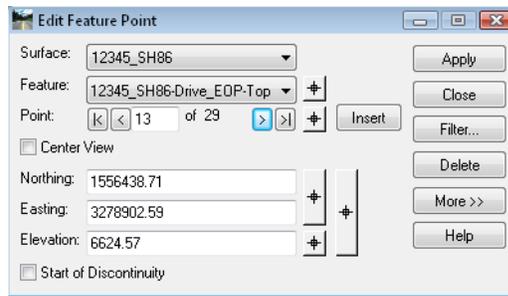
Important! If you want to drape a feature onto one surface but have it placed in another, you can use the **Drape Vertical** option in **Generate Longitudinal Feature** or **Import Surface from Graphics** with the **Drape** option.

The draped graphic may now be imported or used with either **Generate Sloped Surface** or **Apply Template**.

Edit Feature Point

Edit Feature Point is useful when you need to edit or delete one vertex of a feature at a time. For example, if you have a spike in a surface caused by a zero-elevation point that was accidentally included in a breakline, use this command to delete it.

1. Select **Surface > Edit Surface > Edit Feature Point**.



2. Set the **Surface** to the surface that contains the feature you want to edit
3. Select the **Feature** that you want to edit.
4. Select the feature **Point** that you want to edit.

Note: You can step through the points, or you can use the **Locate** button to choose the point graphically. When the point is active, there is a target symbol identifying it in the MicroStation view. If the **Center View** option is toggled on, MicroStation will center the current view on the selected point.

5. Change the **Northing**, **Easting** and/or the **Elevation** by keying in new values or by using the appropriate **Locate** button and setting the values graphically.
6. Select the **More >>** button to access additional options for setting the location of the active point. These options are similar to those found on the **Set Slope Along Feature** command.

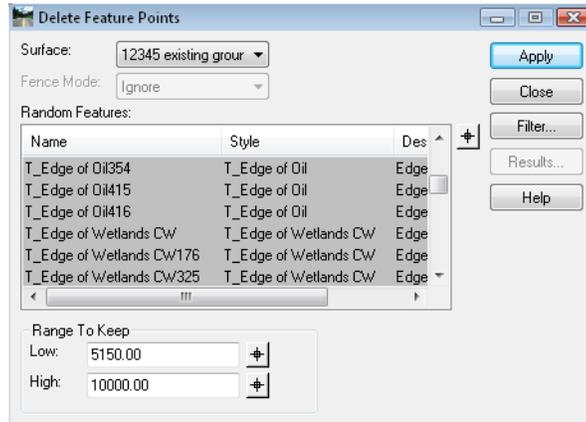
Note: You can edit more than one point in a feature before you choose Apply, but changes are not made in the surface or reflected graphically until you do.

7. **<D> Apply** to edit the point(s).

For details on the other options, see the **InRoads Online Help**.

Delete Feature Point

The **Delete Feature Point** is useful when you want to delete Random points in a DTM that are outside of an elevation range. For example, if you have several points with a zero elevation, you can use this command to get rid of them all at once without having to find and delete them individually.



Note: The features containing the points that are out of the **Range to Keep** specified must be highlighted before choosing Apply. Only Random point features are shown in the dialog, and you can use **Feature Filters** to further limit the features shown.

Reverse Feature Direction

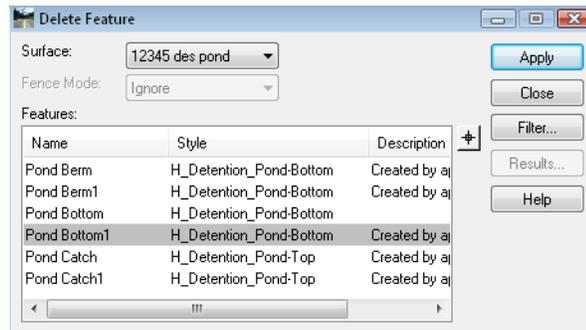
The **Reverse Feature Direction** command is very much like the **Change Element Direction** command in MicroStation. It is useful when you have a feature running in one direction and you would like it to run in the other. For example, if you are using the feature for the horizontal and vertical control in a corridor (in place of a horizontal and vertical alignment) and the feature was built in the opposite direction you want your model created.

1. Select **Surface > Edit Surface > Reverse Feature Direction**.
2. When prompted, <D> to identify the feature.
3. Once highlighted, the name of the feature is shown in the message field and you can **Accept** <D> or **Reject** <R> the feature. Reject it and the next closest feature is highlighted for you to Accept or Reject.

Note: There is no dialog box for this command, so be sure to read the prompts.

Delete Feature

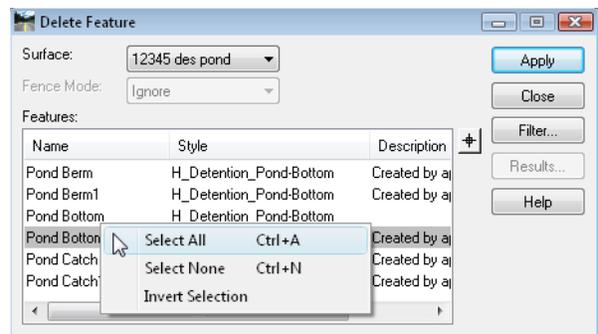
The **Delete Feature** command allows you to remove one or more features from a surface. In the dialog box, the list of features is controlled by the **Feature Filter** lock, so you can segregate out just the features you want to see, if necessary.



1. Choose **Surface > Edit Surface > Delete Feature**.

Note: If there is a fence active, you can choose from **Ignore**, **Inside** or **Outside** options. These modes act like the **Clip** option in MicroStation. If a feature extends out both sides of the fence, using the **Inside** option results in a feature with a gap.

2. In the feature list, **<D>** to highlight the feature or features you want to delete. **<R>** on the list for a menu that allows you to **Select All**, **Select None** or **Invert Selection**.



Note: **Select All** can be accessed with **<CTRL> A** and **Select None** with **<CTRL> N** without right-clicking.

3. **<D> Apply** and the feature or features selected are deleted from the surface.
4. Select **Results** to see how many feature points were removed with the action. (**Results** will only show points deleted from Random, Breakline and Interior Features, even though other types may be deleted.)

Note: If you want to delete all the features in a surface, **<R>** on the surface in the Explorer portion of the InRoads menu and select **Empty**.

Partial Delete

The **Partial Delete** command works much like the MicroStation **Partial Delete**, except it works with features. The MicroStation display of the feature is also updated if it was originally displayed in *Pencil* Mode.

1. Select **Surface > Edit Surface > Partial Delete**.
2. When prompted, <D> on the feature to identify it.
3. <D> to *Accept* the feature or <R> to *Reject* the feature when it highlights and its name appears in the prompt field.
4. <D> on a *Starting* point for the delete.
5. <D> on an *Ending* point for the delete.

The results are one feature with a gap where you partially deleted it. To make two features out of the gapped feature, see the following **Break Feature** command.

Note: There is no dialog box for this command, so be sure to read the prompts.

Important! When you **Partial Delete** a feature, a point is added at each end of the delete. If you want to only retain original points in the feature, turn the *Snap* lock to *Point Snap* and the starting and ending points of the deletion are forced to fall on existing vertices.

Break Feature

Break Feature quite simply make two features out of one. The second feature has the same name as the first with a counter appended on the end. This command does not leave a gap, but rather leaves the two features with a common point where they meet. If the feature already has a gap, you can break the feature at either end of the gap to get two features.

1. Select **Surface > Edit Surface > Break Feature**.
2. <D> the feature you want to break.
3. *Accept* <D> if the correct feature name is shown, *Reject* <R> if not.
4. Once the feature is accepted, a tracking line is displayed from the feature to your cursor. Locate the point where you want to break the feature and <D>.

Note: There is no dialog box for this command, so be sure to read the prompts.

Important! When you break a feature, a point may be added to each feature at the break point. If you want to only retain original points in the feature, turn the *Snap* lock to *Point Snap* and the break point is forced to fall on an existing vertex.

Join Features

The **Join Features** command is very similar to the MicroStation **Create Complex Chain** command. It allows you to select two or more features to combine into one. Where it differs from the MicroStation command is in how the features are accepted. In MicroStation, you can select that next line with the accept of the current one. In joining features, you must select and accept each feature before moving on to the next one.

Use the **Join Feature** command when you want to combine more than one feature to use as the basis of a Roadway Designer **Corridor**, the **Apply Template** command, or as a target for an end condition, for example.

1. Select **Surface > Edit Surface > Join Features**.
2. <D> on the first feature, and <D> again to accept if it is the one that highlights and whose name is listed in the prompt field.

Note: The first feature selected determines the name of the resulting combined feature.

3. <D> on the second feature and <D> again to accept.

The second feature is deleted as it becomes part of the original feature.

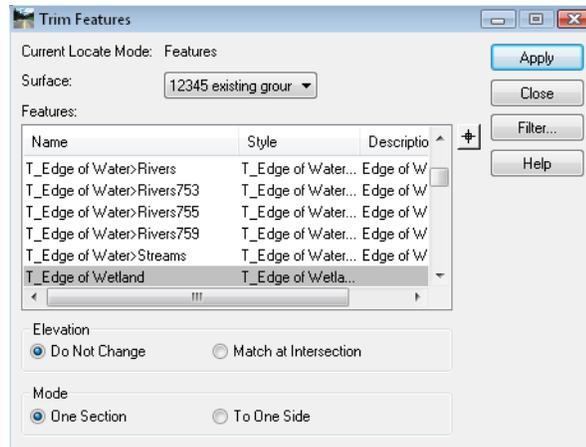
4. Continue to identify features and accept them until you have all the features you want combined.

Important! When the features do not touch, they are joined with a straight line closure. If the features overlap, they will still overlap after combining (i.e. they are not trimmed automatically). Since overlaps may cause DTM tolerance problems when triangulating, you can **Trim** or **Partial Delete** the features prior to joining. For more information about these commands, see their sections in this chapter.

Trim Features

The **Trim Features** command is similar to the **Trim** command in MicroStation. It allows you to trim a single feature or groups of features based on a cutting feature or cutting element. You can use **Trim Features** after combining features from different models where there is overlap, for example.

1. Select **Surface > Edit Surface > Trim Features**.



Note: Notice the current **Locate Mode**, which is controlled by the **Locate Graphics / Locate Features** lock. This determines whether you can identify a graphic element or a feature as the cutting element.

2. Select the **Surface** where the features reside.

Note: If you are clipping with a feature, it must reside in the same surface. If it does not, you can display it graphically, then use the **Locate Graphics** toggle.

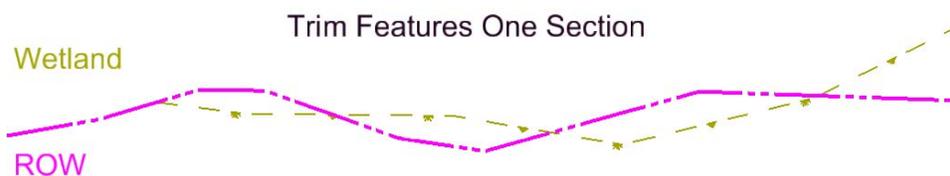
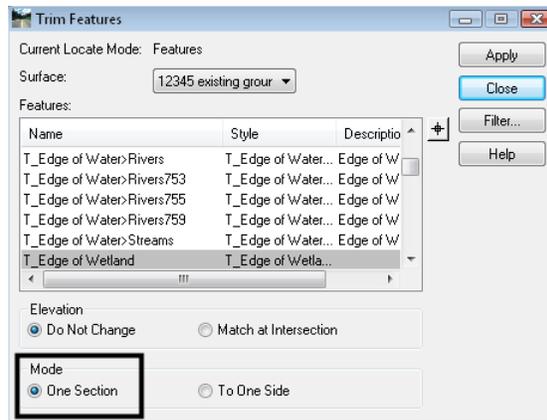
3. In the feature list, highlight one or more features using the **<Shift>** or **<Ctrl>** keys when necessary. **<R>** on the list for a menu that allows you to **Select All**, **Select None** or **Invert** the current selection. (You can use **Feature Filters** to narrow the list of features.)

Note: **Select All** can be accessed with **<CTRL> A** and **Select None** with **<CTRL> N** without right-clicking.

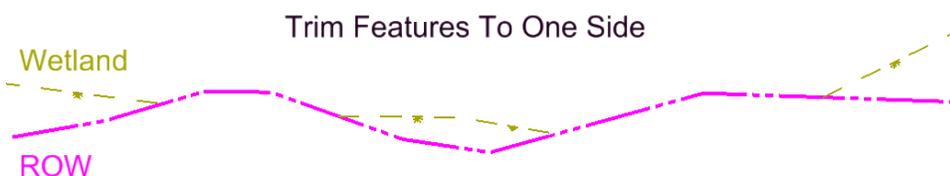
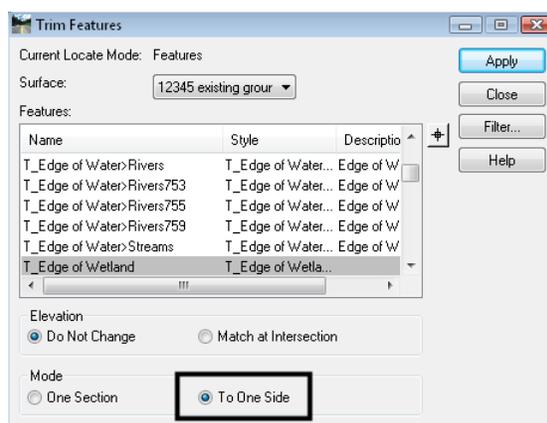
4. In the **Elevation** section:
 - ◆ Select **Do Not Change** when you want all features to retain their original elevations.
 - ◆ Select **Match at Intersection** when you want the feature being clipped to adjust their elevations at the clip point to match that of the clipping feature or element.

- Select one of the **Mode** options. The **Mode** refers to how many trims you want to make on each feature.

◆ **One Section** is typical, when you want to trim the end of a feature back to another.



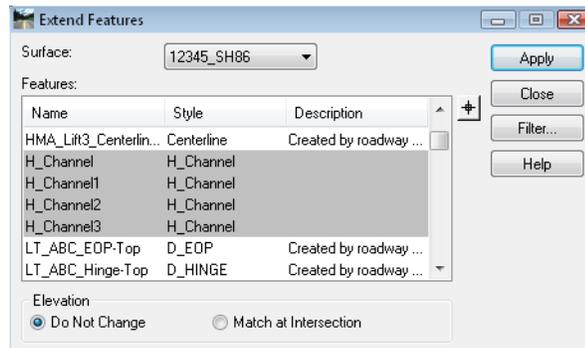
- Use **To One Side** when you want to only keep the portion of a feature that is on one side of another. For example, if you have a wetland feature and a ROW feature that overlap back and forth, and you're only concerned with the wetland if it's inside of your ROW. Highlight the wetland feature in your feature list, then identify the ROW as the clipping feature. With the mode set to **To One Side**, you'll be able to keep all parts of the wetland that are on one side of the ROW.



6. <D> **Apply** and select the clipping graphic or feature.
7. <D> to *Accept* the clipping graphic or feature.
8. <D> on the side you want to delete.

Extend Features

The **Extend Features** command is similar to the **Extend Line** command in MicroStation. It allows you to extend a single feature or groups of features until interception with another feature or graphic element.



1. Select **Surface > Edit Surface > Extend Features**.
2. Select the **Surface** where the feature(s) you are extending reside. If you are extending to a feature, it must reside in the same surface. If it does not, you can display it graphically, then use the **Locate Graphics** toggle.
3. In the feature list, highlight one or more features using the **<Shift>** or **<Ctrl>** keys when necessary. **<R>** on the list for a menu that allows you to **Select All**, **Select None** or **Invert** the current selection. (You can use **Feature Filters** to narrow the list of features.)

Note: **Select All** can be accessed with **<CTRL> A** and **Select None** with **<CTRL> N** without right-clicking.

4. In the **Elevation** Section
 - ◆ Select **Do Not Change** when you want the features to extend at the same slope as the last segment of the feature.
 - ◆ Select **Match at Intersection** when you want the feature being extended to match the elevation of the feature or element to which it's being extended.
5. **<D> Apply** and select the graphic or feature to which you're extending.

Note: The **Locate Graphics / Locate Features** lock determines whether you can identify a graphic or a feature.

6. <D> to **Accept** the graphic or feature.

Features Before Extension

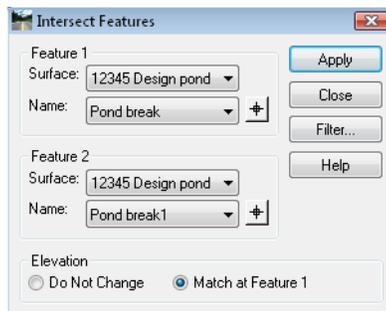


Features After Extension



Intersect Features

The **Intersect Features** command is similar to the **Extend Elements to Intersection** command in MicroStation. It allows you to extend two features until they intercept, and optionally change the elevation of the second to match that of the first at the intersection point.



1. Select **Surface > Edit Surface > Intersect Features**.
2. Select the **Surfaces** and **Features** you are intersecting. If you are not matching elevations, the order does not matter.
3. <D> **Apply**.
4. You are prompted to accept the intersection to keep. If there is more than one intersection, you can move your cursor to see additional intersections and <D> to keep the one you want.

Delete Triangle

The **Delete Triangle** command allows you to delete one or more triangles from a surface. It is useful when the triangulation routine creates triangles that you do not wish to keep. Sometimes, this is most obvious when creating contours which are derived from the triangles.



1. Select **Surface > Edit Surface > Delete Triangle**.



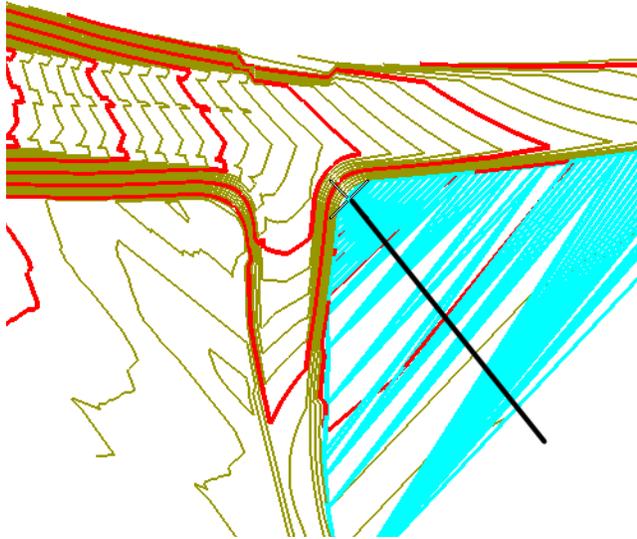
2. Select the **Surface** where the triangles exist.
3. <D> **Apply**.

If you are deleting one triangle:

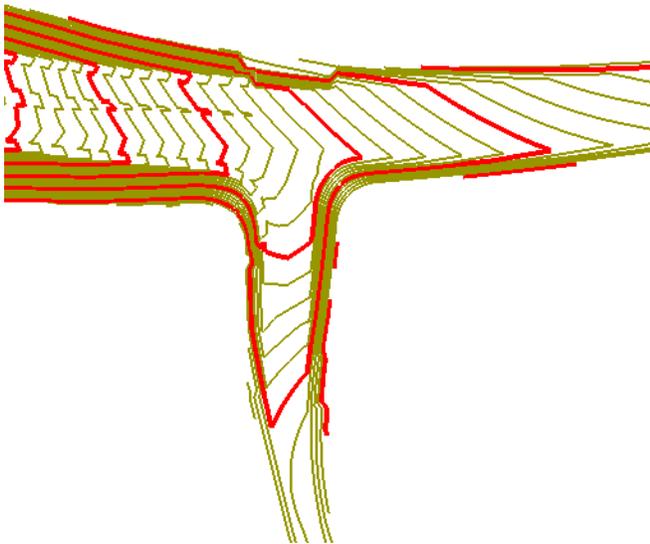
4. <D> on the same triangle twice, and <D> to **Accept**.

If you are deleting a series of adjacent triangles:

5. <D> on a starting point and move the cursor, drawing a line across the triangles you want to delete.



6. <D> to end the selection.
7. <D> again to accept the highlighted triangles as the ones to delete.

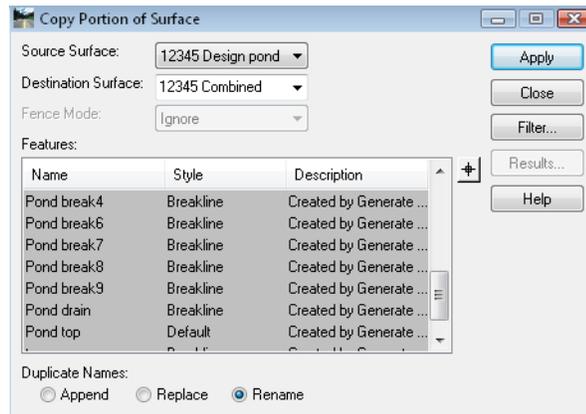


Note: The triangles do not have to be displayed. When you select them, they highlight. If you drag the cursor across a series of triangles, they are temporarily displayed; only the highlighted ones when you accept are actually deleted.

Important! If you delete triangles and the surface is re-triangulated, the triangles are re-created. To make certain the deletions are permanent, you can either add an exterior if the triangles are on the edge of the model as shown in this example, or add an interior if they are on the inside.

Copy Portion of Surface

The **Copy Portion of Surface** command is for copying features from one surface into another. You can combine two surfaces by copying all features, or you can selectively choose features to copy.



When copying an exterior from one surface to another, keep in mind there can only be one exterior in a surface and the last exterior added will be the exterior used in the surface.

1. Select **Surface > Edit Surface > Copy Portion of Surface**.
2. Specify the *Source Surface* where the feature currently resides.
3. Specify the *Destination Surface* where the features are going. If the surface does not exist, you can key in the name and it will be created when the command is applied.
4. In the feature list, highlight one or more features to copy using the **<Shift>** or **<Ctrl>** keys when necessary. **<R>** on the list for a menu that allows you to **Select All**, **Select None** or **Invert** the current selection. (You can use **Feature Filters** to narrow the list of features.)

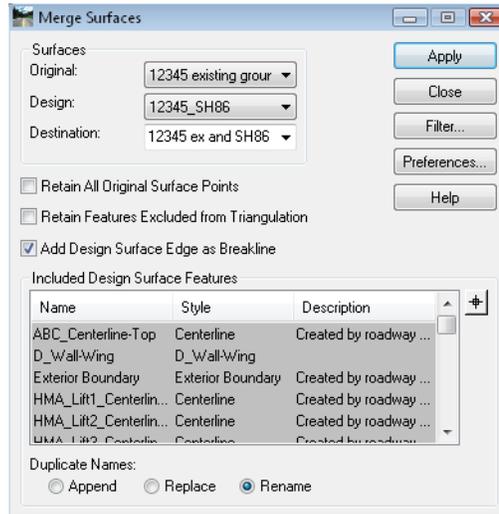
Note: **Select All** can be accessed with **<CTRL> A** and **Select None** with **<CTRL> N** without right-clicking.

5. **<D> Apply** to copy the features.

For details on other options, see the *InRoads Online Help*.

Merge Surfaces

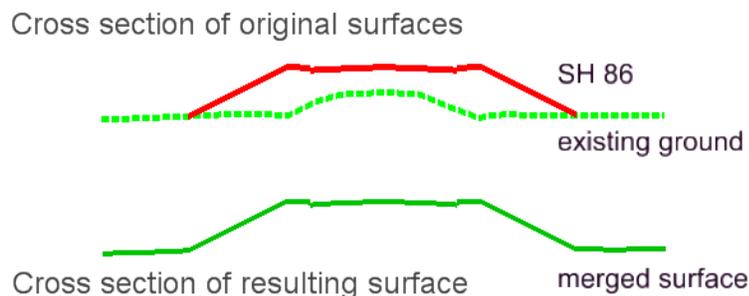
The **Merge Surfaces** command combines two surfaces. It is most useful for creating an ‘as-designed’ model, since it removes the portion of an **Original** surface that overlaps a **Design** surface. After using this command, you can create contours for the combined model showing what the surface should look like after the design is built.



1. Select **Surface > Edit Surface > Merge Surfaces**.
2. Specify the **Original** and **Design** surfaces.
3. Specify the **Destination Surface** where the combined model is created.

Note: If the surface does not exist, you can key in the name and it will be created when the command is applied. While you can replace the existing surface with the combined, it is not recommended.

4. **<D> Apply** and the surfaces are combined and the resulting merged surface is triangulated as shown in these before and after cross sections.

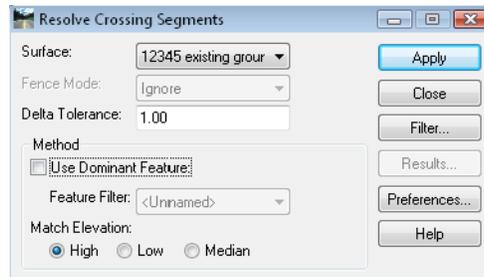


For details on other options, see the **InRoads Online Help**.

Note: Multiple merges typically begin to bog down the surface. This is not a good option for combining several surfaces, such as for the different models that may be created in designing an interchange. Use either **Copy Portion of Surface** or run multiple corridors at once with Roadway Designer.

Resolve Crossing Segments

The **Resolve Crossing Segments** command assists in correcting crossing linear features in a surface. When two linear features cross at the same elevation, a point is assumed at the crossing and the surface triangulates as normal. When the features cross but at different elevations, the software cannot triangulate the area since triangles cannot cross linear features. This command resolves those situations.



1. Select **Surface > Utilities > Resolve Crossing Segments**.
2. Key in the **Delta Tolerance**. This is the maximum difference in elevation you allow this command to correct. Anything larger and the crossing will be reported as unresolved.
3. If you have several crossings and there is a dominant feature or features, you can create a **Feature Filter**, toggle on **Use Dominant Feature** and select it from the list.

For example, if you have several drives that cross edges of pavement, you can set up a filter to filter everything but the edge of pavement features. In that case, anywhere there is a crossing within the specified vertical tolerance, the crossing is resolved by adding a point at the elevation of the edge of pavement.

4. Select one of the **Match Elevation** options.

Note: If the crossing does not involve an edge of pavement, or if it involves two edges of pavement, the **Match Elevation** toggle controls, forcing the new point to take on the elevation of the **High** feature, **Low** feature, or the **Median** elevation between.

5. <D> **Apply** and the crossing segments that meet the **Delta Tolerance** criteria are resolved.
6. Select **Results** to see a report of which feature crossings were resolved and which were left unresolved.

For details on other options, see the **InRoads Online Help**.

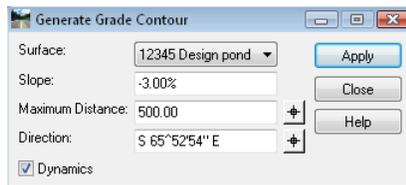
Note: If the crossing features are in an existing ground surface, you should report the problem to the Survey group for correction.

Generate Grade Contour

The **Generate Grade Contour** command is a great tool for finding a path down a sideslope that meets a certain longitudinal grade. For example, if you need to create a haul road into a pit or an access road down a sideslope and you are required to meet a certain longitudinal grade, this command helps designate the path.

Here, it is used to traverse the sideslope of a pond, helping define the path of an access road.

1. **Generate Grade Contour** is an **Application Add-in**, so toggle it on before starting.
2. Select **Surface > Utilities > Generate Grade Contour**.

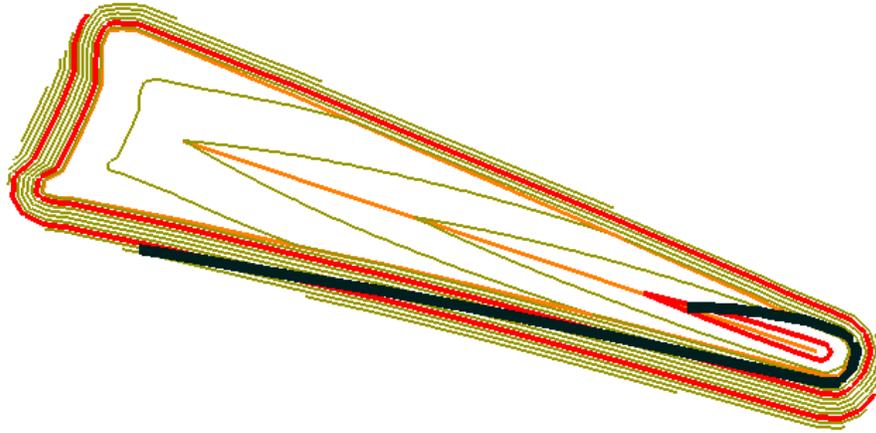


3. Select the **Surface** from the drop-down.
4. Key in the longitudinal **Slope** desired.
5. Key in the **Maximum Distance** for the path created.
6. Key in (or use the **Locate** button to define) the starting **Direction**.

Note: The direction does not actually define a fixed direction for the resulting path. It just lets the command know the general direction you want the path to take (i.e. to the right or left around the pond in this example).

7. Toggle on **Dynamics** to see the path before accepting it.
8. <D> **Apply**.
9. Move your cursor along the slope and a path dynamically follows.

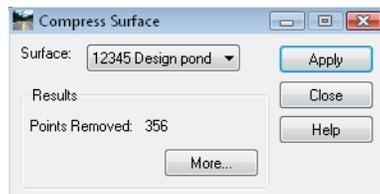
10. <D> where you want the path to start.



The result is a 3D MicroStation linestring that follows the defined longitudinal slope, traversing the surface selected. Vertices are created for the linestring at each crossing of a triangle. You can now import the graphic as a horizontal and vertical alignment using **File > Import > Geometry from Graphics**, refine the alignments as necessary, and use them in Roadway Designer to create the access road.

Compress Surface

When working with features in a surface, you are often deleting portions of features or deleting points in features. These points are marked for deletion in the surface and are no longer triangulated, but are not actually removed from the surface. Since they cannot be recovered, they are taking up space and memory unnecessarily and should be periodically removed from the surface using **Compress Surface**. This command not only removes points that have been deleted with surface editing commands, but also removes any duplicate Random points, or Random points that are duplicates of other type points.



1. Select **Surface > Utilities > Compress Surface**.
2. Select the *Surface* you want to compress from the drop-down menu.
3. <D> **Apply** and the points are removed.

Section Summary:

- Features can be manipulated within a surface using tools similar to MicroStation editing tools.
- Point elevations, slopes of features and location of features or individual points can all be modified.
- There are tools available for modifying features one at a time, and also for modifying groups of features.

Chapter Summary:

- Create and Edit feature tools allow you to design surfaces that do not fit the mold of a typical section following a horizontal and vertical alignment.
- Using these tools with surfaces created by Roadway Designer allow you to refine and enhance your designs that *do* fall into the category of templates following a horizontal and vertical alignment.
- Using each InRoads Surface Creation or Surface Editing tool for what it does best allows you to be more efficient in your design process.
- The Surface Creation and Editing tools can be an integral part of the CDOT design process when used to their full potential.

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