

# **Location Module**

**Forest Engineering  
Version 5.0**

*Softree Technical Systems Inc.*

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## Introduction

This manual is formatted to provide you with a hands-on tutorial, which can be used by novice or experienced users. The sample files referred to in the examples are provided on the Installation CD. If you inadvertently change any of these tutorial files, be sure to re-install them from the CD before the next user of the tutorial tries to access them.

### *Demonstration Mode*

*Demonstration Mode* was created to allow you to preview functions before purchasing. In *Demonstration Mode*, printing and file saving are disabled. You will be warned that you are running in *Demonstration Mode* when you startup. To find out if you are in demo mode, look for the text "DEMONSTRATION MODE" in the Help|About Location menu.

### *Conventions*

The following conventions are used throughout the manual:

- Menu functions are delimited by a line “|”; e.g. File|Open means click on *File* in the menu bar and then click on *Open* in the pull-down area.
- File names will be in bold font i.e. \Tutorial\Location\combo design.DSN. File extensions are in upper case for file selection purposes only.
- Checkboxes, dialog boxes, column headings, and button names are *italicized*.
- Whenever you are directed to highlight, select, or activate a field or object, it becomes the active field or object. For instance, "highlight the profile window" means that you should click on the profile title bar to activate it.
- The symbols “<>” with words in between require you to perform some keyboard function. For example <shift + enter> requires you to hold down the shift key and then press the enter key.
- Text saved in the sample files, is written within quotations “ ”.

## Function Groups

The tools and procedures available in the Location Module are divided into *function groups*. Different licenses allow full access to different sets of function groups. For example the Auto Balance function group is not licensed to purchasers of the *Lite* versions of RoadEng. Unlicensed function groups can still be used but only in *Demonstration Mode*. To determine the privileges set for each function group:

- 1) Select the menu Module | Setup and then click on the *General* tab.
- 2) Click on the *Menus* button to activate the *Menu Customization Dialog* (see Figure 1.0).

Function group items with a red circle before them are permitted in Demonstration Mode only. A checkmark beside an item indicates it has been enabled.

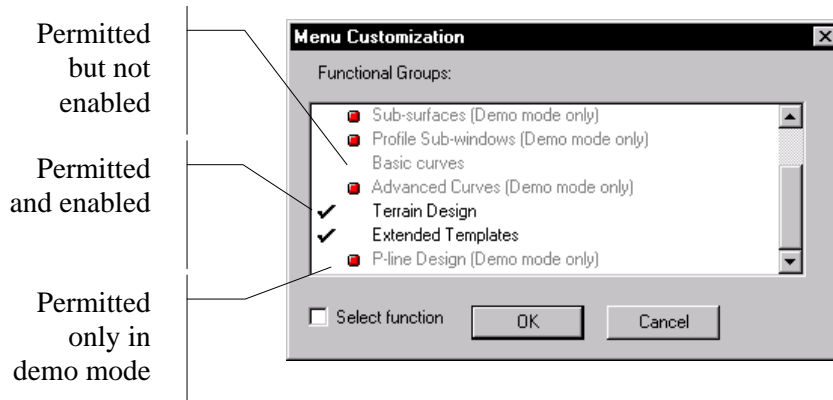
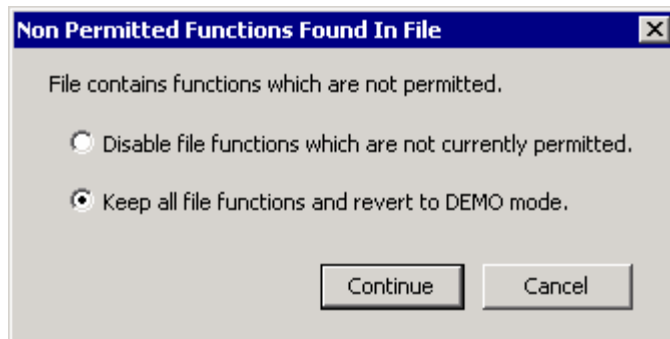


Figure 1.0: Function Groups Displayed in the Menu Customization Dialog Box

### Function Groups Required for Examples

All required function groups are listed prior to each example in this manual. If you do not have permission to use all the required function groups, you may wish to skip the example. Also note that some function groups may be disabled even if *you* have permission to use them – this is so users with a lesser license can still do the example.

If you attempt to open a file containing function groups that are not permitted you will be prompted with the message box below:



*Figure 1.1: Function Groups Not Permitted Prompt*

To continue the example you must respond “*Keep all file functions and revert to demo mode*”. In demo mode printing and saving are disabled.

## *On-line Help*

Help information is available by choosing the *Help* menu or pressing F1. The On-line Help includes detailed technical information about menus, dialog boxes, and operation of the program.

It may be useful to refer to the On-line Help while working through the examples in this manual.

## *Tutorial Units*

The examples in this tutorial are in metric units. To correctly follow the examples you should change to Metric Units before starting. Select Module | Setup. The procedures and concepts described apply to both unit systems.

## Checkpoints

It is not necessary to start at the beginning of this manual or to do all examples in the order they are provided. Checkpoints, indicated by a checkmark in this manual, are places where you can begin an example. All files required to start from a checkpoint are included in the installation.

## *Files required for Examples*

Tutorial instructions refer to files without a full path name. The default directory structure for the Location example files is

**C:\Program Files\Softree\RoadEng\Tutorial\Location** where **RoadEng** is the install folder. The path for the install folder can be changed, files will be referenced as **RoadEng\Tutorial\Location\<file>**.

## Concepts

Examples in this document will illustrate tools at your disposal for solving typical road design problems. The steps in the examples may not be the only way to solve these problems.

There is no single step by step recipe for road design. Like most engineering methods, design will be approached differently by different engineers and will probably involve several design iterations to achieve an acceptable product. The Location software will allow you to design a road while giving you selected feedback so that you can make engineering decisions based on your priorities.

This section contains a glossary of terms and descriptions of program components that are used throughout the examples that follow.

- ◆ **P-Line vs. L-Line:** The P-Line (preliminary line) is a field surveyed road traverse. The L-Line is created in the Location Module and represents the designed centerline alignment in its correct vertical and horizontal positions. When a P-Line is used, by default it is displayed as a solid black line and the L-Line as a dashed red line. These lines appear in both Plan and Profile views.
- ◆ **Vertical Alignment:** In the Profile Window you have the capability of vertically controlling the L-Line position. This is done by creating Profile Points (VPI = Vertical Point of Intersection) along the length of the road. The Vertical Alignment defines grades and vertical curves.
- ◆ **Horizontal Alignment:** In the Plan Window you have the capability of horizontally controlling the L-Line position. This is done by creating Plan Points (PI = Point of Intersection) along the length of the road. The Horizontal Alignment defines the direction of road segments (tangents) and horizontal curves. When a P-Line is defined, initial horizontal alignment follows the P-Line; for lower standard roads further horizontal alignment may not be required.

- ◆ **Profile Points (VIP = Vertical Intersection Point):** These points are created in the Profile Window and they define the vertical alignment of the L-Line. They have no effect on the horizontal alignment. Profile points are represented as red boxes in the Profile Window and large red ticks in the Plan Window. (See Figure 2.0)
- ◆ **Plan Points (IP = Intersection Point):** These points are created in the Plan Window and they define the horizontal alignment of the L-Line. They have almost no effect on the vertical alignment. Plan Points are represented as red boxes in the Plan Window and large red ticks in the Profile Window. (See Figure 2.0)
- ◆ **Reporting Points:** These points are usually created automatically but can be created manually in the Plan or Profile windows. They have no effect on alignment. Report Points are used to display cross sections and to allow a more accurate representation of earthworks and graphic displays. They are represented as small red tick marks in the Plan and Profile Windows. (See Figure 2.0)
- ◆ **Design Points:** This is the term used to describe all alignment points (Plan, Profile or Report – see above). Cross sections are calculated at all Design Points to generate earthworks and graphic displays. (See Figure 2.0)

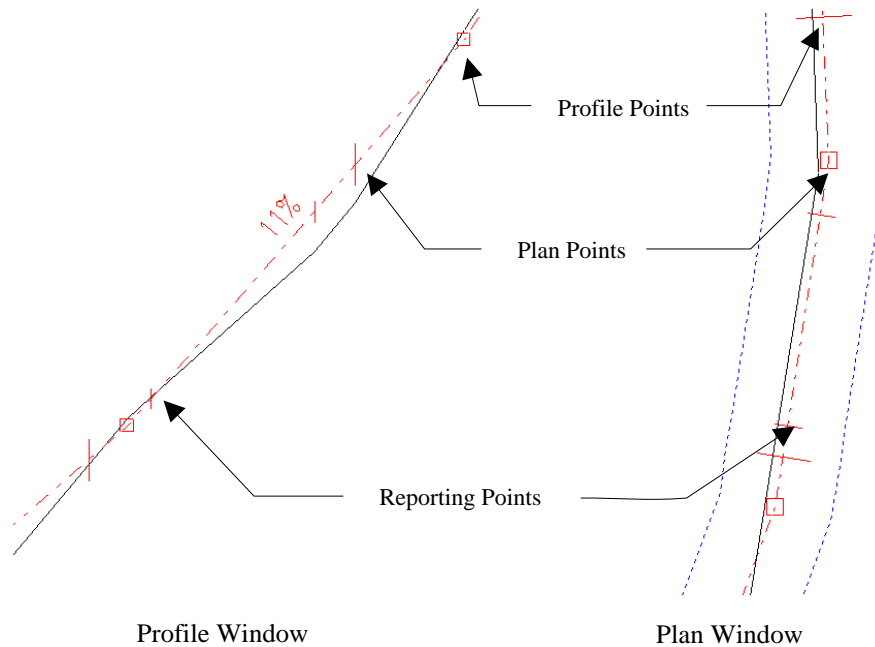


Figure 2.0: Profile and Plan Windows Showing All Three-point Types

- ◆ **Templates:** define the road prism (cross section shape) along the L-Line. Templates can be created as required and assigned by range, for features such as turnouts, passing lanes, cut benches and bridges. Once created, template tables can be saved for use in future designs. A Taper template is provided for transition between different templates.
- ◆ **Window Types:** Location Module has eight window types:



**Plan Window-** displays a plan view of the alignment. Editing in this window manipulates the horizontal alignment



**Profile Window-** displays a profile view of the alignment. Editing in this window manipulates the vertical alignment



**Section Window-** displays the designed cross section at a specific station. Editing in this window manipulates horizontal and/or vertical alignment



**Data Window-** displays text or numeric information for each design point (such as volumes and slope stakes). The data can be exported to a spreadsheet for analysis and graphical output.



**Multi-Plot Window-** generates formatted output by placing other windows, graphics and text on a virtual page (paper space).



**Culvert Panel-** allows creation and placement of culverts.



**Horizontal Curve Panel-** allows creation and adjustment of horizontal curves. Also allows co-ordinate and cogo edit of Plan Points (IPs).



**Vertical Curve Panel-** allows creation and adjustment of vertical curves. Also allows coordinate and cogo edit of Profile Points (VIPs).

*Figure 2.1: Location Module – Window Types*

- ◆ **Window Options:** A number of display options can be chosen for each of the five windows above (not for Panels). Window options are accessed by first, activating the desired window by clicking on its title bar and then choosing the View | [window name] Options menu. Right Click of the mouse also provides access to this menu. For a comprehensive list of all window options, refer to the on line help. Note that window options are saved in Screen Layouts.
  
- ◆ **Screen Layouts:** Options for all Windows can be saved in configuration files called Screen Layouts. Screen Layouts will be used extensively in the examples and are extremely valuable for saving and retrieving the large number of options available. The File | Save Screen Layout menu is used to create a new screen layout while the Screen Layouts pull-down in the standard tool bar is usually used to retrieve one.
  
- ◆ **Tool Bars:** contain buttons and other controls used to activate common functions. (See Figure below). They can be dragged with the mouse to float in the middle of the screen or to dock on any of the four sides of the main window. Use the View | Toolbar menu to create and destroy tool bars. Tool bar configurations are saved with Screen Layouts (see above)

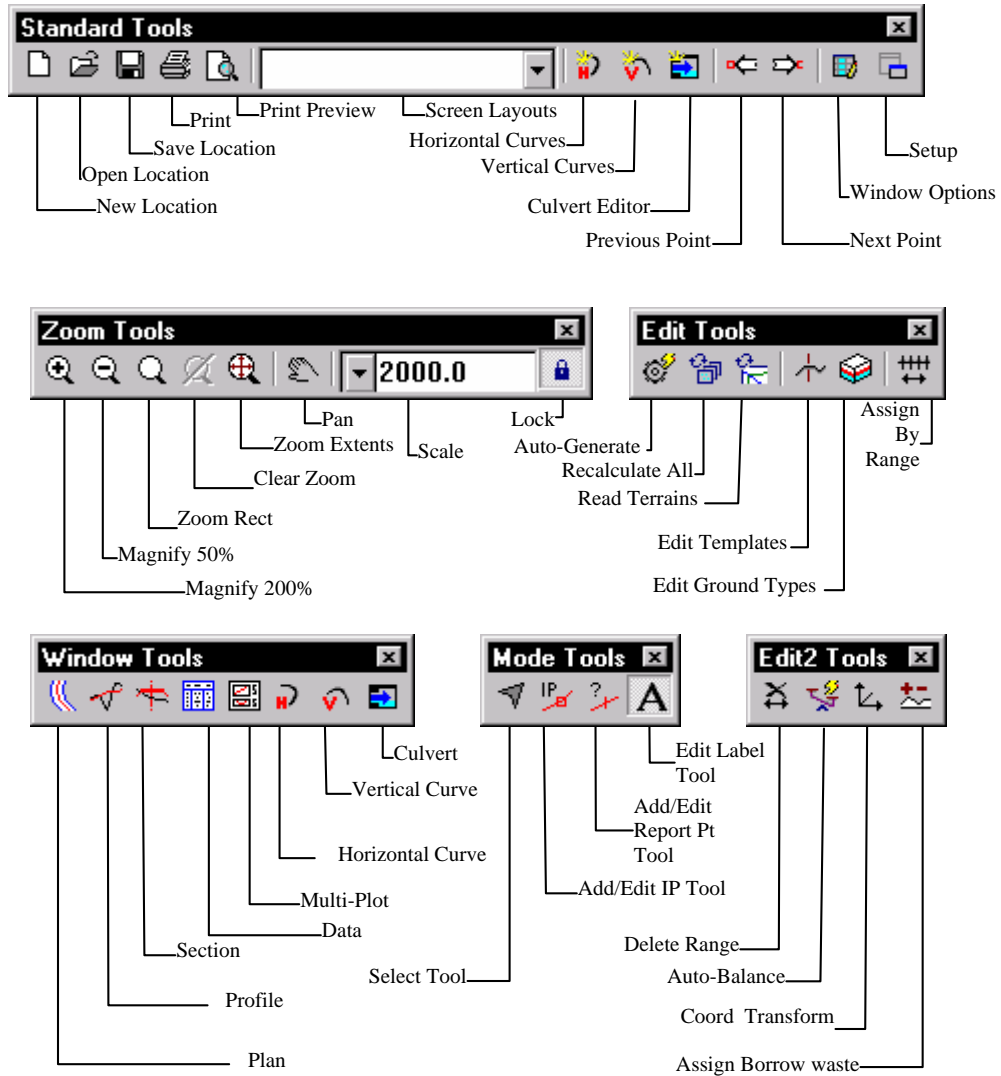


Figure 2.2: Location Tool Bars

## Getting Started

This section introduces basic techniques for using the mouse and keyboard to create and edit alignment. It also covers the concept of window display options and saving and retrieving these options with *Screen Layout* files.

Editing with the mouse is the same in both the Profile and Plan Windows. These are described in one example. Editing with the mouse in the Section Window is a little different so it will be described in its own example and editing using co-ordinates will be described in the last example: editing with panels. First step is to start with simple keyboard editing. These examples do **not** attempt to create real road design projects (see the *Starting a New Design* section below for more realistic examples).

### *Keyboard Editing and Moving Around*

All mouse alignment functions can be accomplished using only the keyboard. One advantage to this is that fine adjustments can be made. Table 1.0 shows the mouse and keyboard equivalent functions. You may wish to try some of these functions in the *Editing with the mouse* example below.

*Table 1.0 Mouse and Keyboard equivalents*

| Mouse functions      | Keyboard equivalents   |
|----------------------|--|
| Left button          | <Enter>  |
| Fine Movement        | <Arrows>   |
| Coarse Movement      | <Control + Arrows>   |
| Scrolling or Panning | <Shift + Arrows>= fine scroll<br><Pg. Up>= page up<br><Pg. Dn.>= page down<br><Shift + Pg. Up>= page left<br><Shift + Pg. Dn.>= page right |


## Editing with the Mouse in Profile or Plan

The following example illustrates how to create and edit L-Line points in the Profile Window. Editing in the Plan window is virtually identical except that the horizontal alignment is modified instead of the vertical alignment. However, a horizontal alignment must be created before Profile editing is possible. In this example a *survey* P-Line file will be used to create an initial Horizontal alignment.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

1. File|New, select **RoadEng\Tutorial\Location\p-line design.TR1**. Press Open (see Introduction, Files required for Examples for file naming conventions). A Profile Plan, Section, and Data Window will appear.
2. File|Retrieve Screen layout, select **RoadEng\Tutorial\Location\profile only.DLT**. Press Open.

This screen layout maximizes the Profile Window and sets line-types and other options. Notice the Profile Window contains a solid black ground line and large red cross-hairs at the start of the P-Line (Station 0.0).

3. Position your mouse cursor in the Profile Window, if you do not see an *Add IP* cursor  appear, **right** click and choose *Add/Edit IP Tool* from the popup menu.
4. Position your cursor roughly at the cross-hairs location shown in the Figure 3.0.

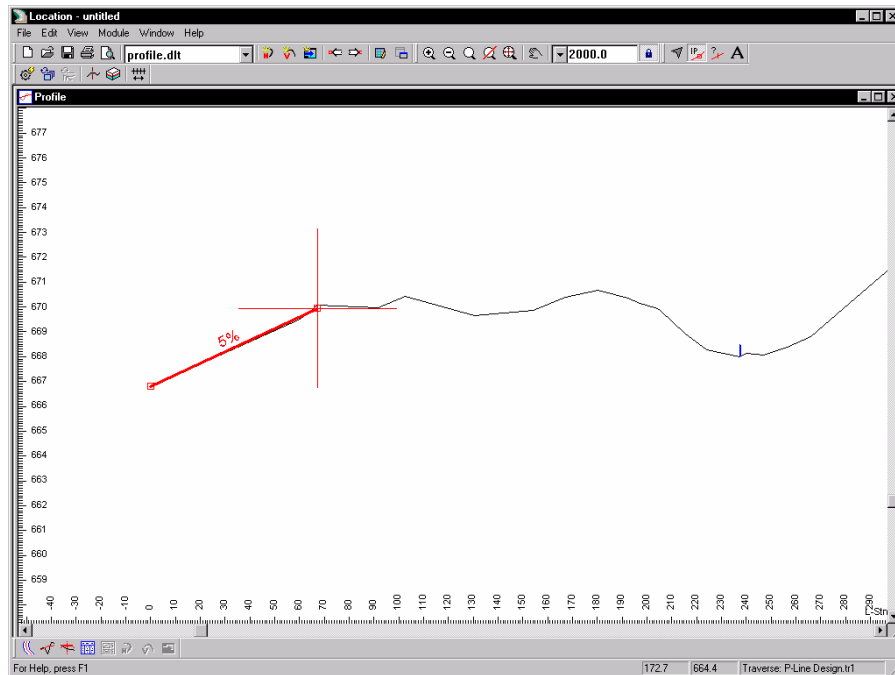




Figure 3.0: 1<sup>st</sup> Design Point

5. Left click once, and the cross-hairs will attach to your cursor. This creates a new, captured, Profile (VIP) Point.

A red dashed line, representing the first designed grade, will be attached to the beginning of your traverse as well as to your cursor. When you move your mouse the grade line will follow it. The cursor is *captured*.

6. Position the cursor as shown in Figure 30. Try to match the grade of 5%. Left click to anchor the design point and release the cursor.
7. Minimize the Profile Window by clicking on the minimize button  in the upper right corner.

Notice that the Section Window now displays the updated current design point. Also, the Data Window shows a line of information about the new point with the station highlighted in red.

8. Maximize the Profile Window by *clicking on the maximize* button  on the right side of its icon (or by double clicking on the Profile Window icon).
9. Add another VIP (Vertical Intersection Point) by positioning the cursor roughly at the cross hair location shown in Figure 3.1. Remember it takes two left clicks to anchor the point.

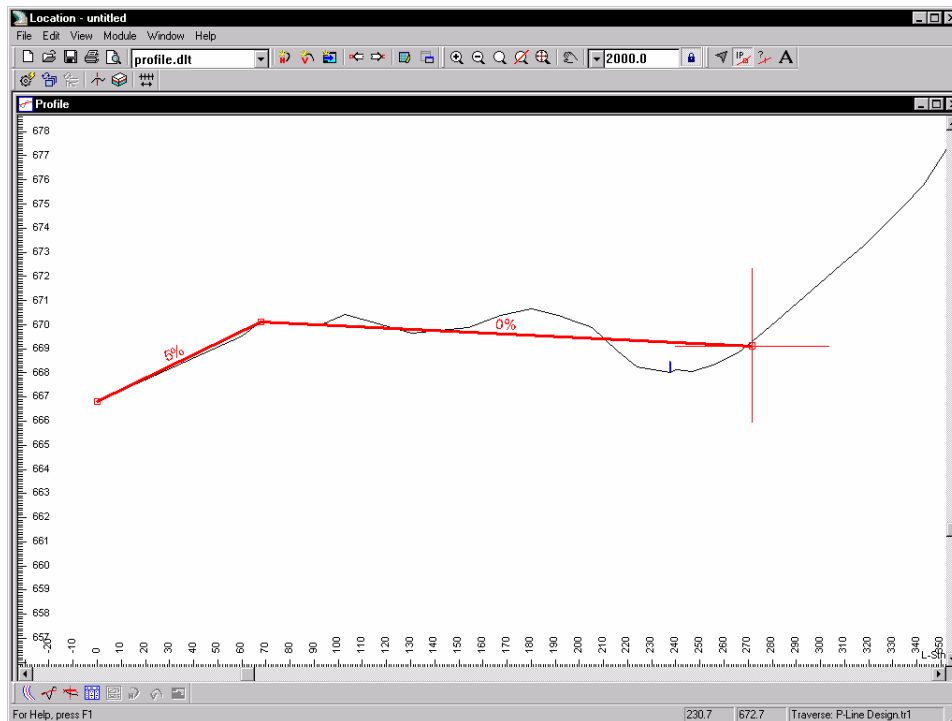



Figure 3.1: 2<sup>nd</sup> Design Point

10. Move the cursor over the previous (middle) design point until it changes to the *Edit* cursor 
11. Left click once, this will capture it and allow you to move the point to a new location.
12. Move the captured point to the position shown in the Figure 3.2. Left click again.

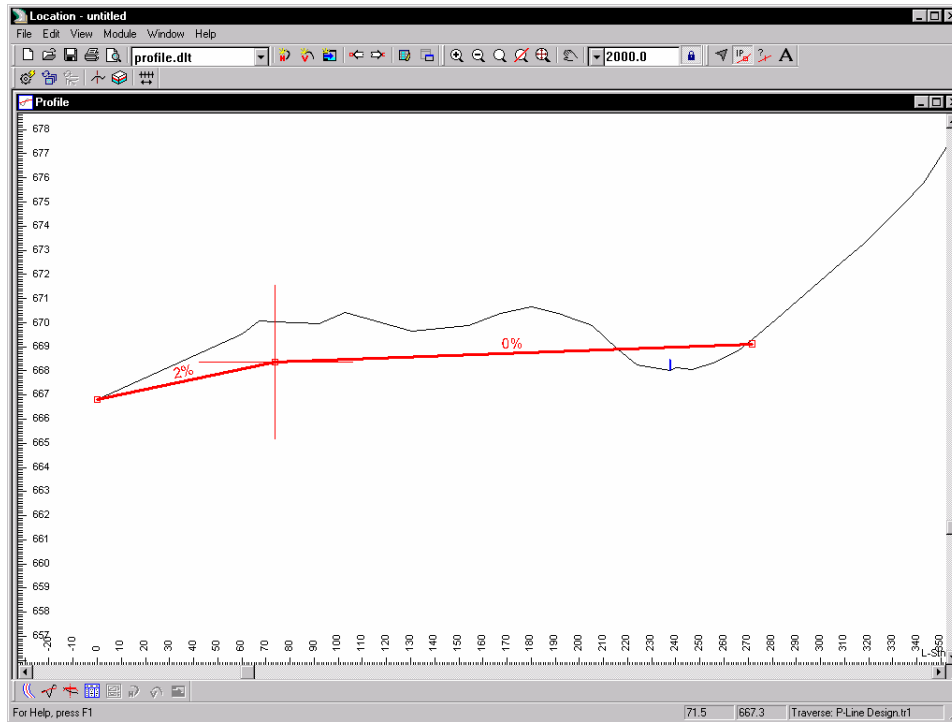


Figure 3.2: Editing 1<sup>st</sup> Design Point

13. Edit | Undo Profile Point Edit, to move the point back to where it was in Figure 3.0.
14. Again, move the cursor over the middle design point and left click once to capture it.

**NOTE:** When a point is captured and the <Delete key> is pressed the point will be deleted.

15. This time press the <Delete> key to remove the point.
16. Move the cursor over the line, it should change to the insert cursor.

17. Left click roughly where the point was before you deleted it (as shown in Figure 3.2). This inserts a new VIP *between* existing points.
18. Move the new captured point to the position shown in Figure 3.0 and left click to anchor it.

You have now used the mouse to do the following:

- Create a new point at the end of the alignment.
- Insert a new point between existing points.
- Edit an existing point.
- Delete an existing point.
- Undo an edit operation.

You can also abort an edit by pressing <escape> when a point is captured. These tasks are performed in the same way in the Plan window (for horizontal alignment) and even for features in the Terrain module.

You may now want to try more of these operations to get used to the interface and train your fingers (by the way, it is wise to use different fingers for the left and right mouse keys).

19. Press Edit|Undo to return the design to this state before continuing below.
20. Left click anywhere to the right of the final point to create a new captured point.
21. Remove your hand from the mouse and type <Control + N>; notice how the captured point moves to the Next point on the ground line. Type <Control + B>; it now moves Back to the previous point on the P-Line.
22. Use <Control + N> and <Control + B> to move the captured point to the position shown in the figure below (Control + N about five times past the last design point).

The profile window will scroll automatically if you press <Control + N> or <Control + B> off the screen.

23. Press the <Enter> key to anchor the point (using the mouse to anchor may inadvertently move the point before anchoring it). See the *Keyboard Editing* section for more information.

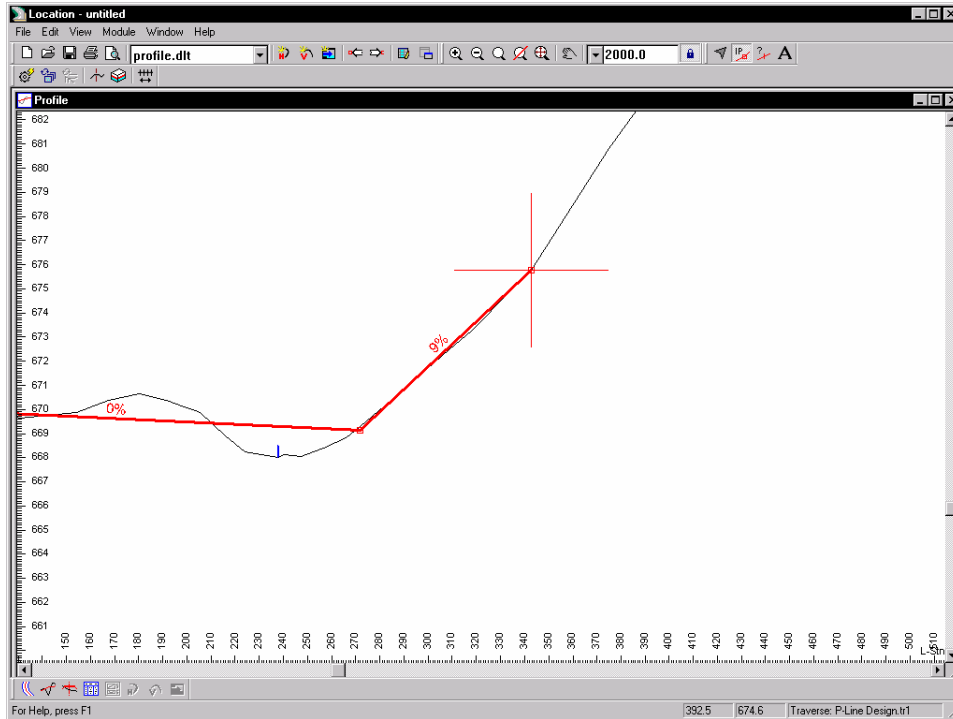




Figure 3.3: 3<sup>rd</sup> Design Point

**NOTE:** <Control + N> and <Control + B> only work on designs with a defined P-Line. The techniques below, however, work for all designs.

24. Move the mouse over the point created above until you see the *Edit* cursor . Do NOT click.
25. Take your hand off the mouse (make sure the cursor does not change back into the *Add IP* cursor ) and type <Enter> to capture the point.

26. Keep your hand off the mouse and type <up arrow> a few times. Notice how the captured point moves. Type <ctrl - up arrow> and notice that the point moves up in larger increments.
27. Type <Enter> again to anchor the point.

You have now done a vertical alignment without changing the station of the Profile point. The arrow keys allow small consistent incremental movements of your design points.

28. File|Close. Do not save changes

## Moving Around in the Design

This section will illustrate a few of the ways to change the current cross section and the active window. Standard window functions (such as the Window menu, scroll bars and moving and sizing windows) are available but will not be covered explicitly in this tutorial.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

1. File|Open, select **RoadEng\Tutorial\Location\survey design 1.DSN**. This is the beginning of a design created in the previous tutorial.
2. Find the Window Tools toolbar in the lower left and click on the *Plan* button - leftmost. This *activates* the Plan window - brings it to the front.

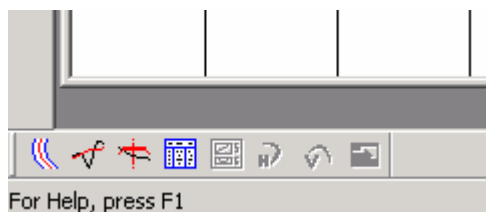

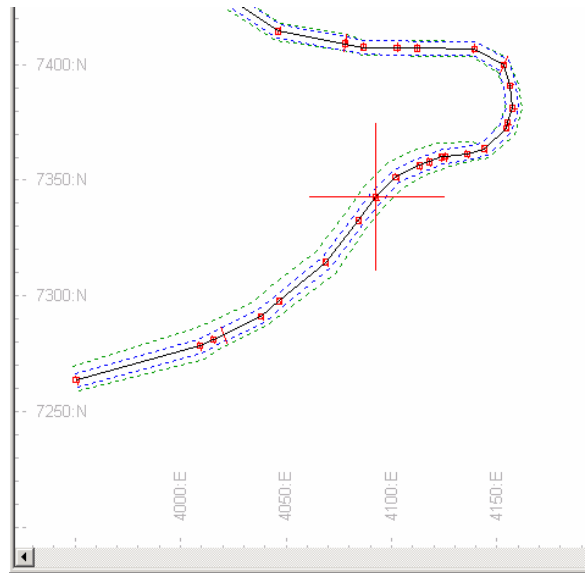


Figure 3.4: Window Tools Toolbar

3. Find the Mode Tools toolbar in the left side panel at the top and click on the *Select Tool* button ; you can also do this with a right click in most of the windows. This changes cursor and the way the mouse behaves.

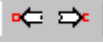
**NOTE:** The selection of toolbars displayed and their position is saved with the design and with screen layouts.

4. Move your cursor over the point in the Plan window marked with cross-hairs in the figure below. Click to make this the current design point. Notice that the section updates to show this station. This works in both the Plan and Profile windows.



*Figure 3.5: Point To Select In Plan Window.*






5. Click on the second button in the Window Tools toolbar (see figure above) activate the Profile window and bring it to the front again. Note that the cross-hair is now between VIPs (Vertical Intersection Points) at the station selected in the previous step.

- Find the Standard Tools toolbar at the top of your screen. Click on the *previous/next point* buttons  and note how the current point changes in all windows and how the views will scroll to always show the new current point. The keyboard can do the same thing with <Shift-Ctrl-B> and <Shift-Ctrl-N>. When you reach a VIP the Data Window will show that row in red – it is set up to only show this kind of point.

You have now practiced changing cross sections and windows. The next section will cover *zooming* and *panning*. The Zoom Tools toolbar allows you to zoom or pan once after selecting a function. If you have a mouse with a middle button and a roller you can zoom and pan at any time.







Figure 3.6: Zoom Tools Toolbar

- Click the *Pan*  button in the Zoom Tools toolbar, move your cursor over the Plan or Profile window and then click and drag with the left mouse button. Note how the view moves with your mouse. When you release the mouse the cursor changes back into its previous shape; you must click the *Pan* button again to initiate a second pan.
- If you have a middle mouse (even if it is a roller), move your cursor over the Plan or Profile window, depress and hold the middle mouse button and note that the cursor changes to the Pan hand . Continue holding the middle mouse and drag to perform a Pan operation.
- Click on the *Zoom Rectangle* button  in the Zoom Tools toolbar, move your cursor over the Plan or Profile window and then click and drag with the left mouse. The rectangle that you see will be the extents of the zoomed window when you release the mouse. The *Zoom 200%*  button has a similar effect while the *Zoom 50%*  button zooms out again.

10. If you have a roller mouse, move your cursor over the Plan or Profile window and move the roller first one way then the other. The view will zoom in such a way that the point under the cursor will remain under the cursor.

Let's assume that you want to see a cross section in the middle of the sharp corner in this design (see Figure 3.5 above) but all the windows are showing some other place.

11. Start from the beginning again. File|Open, select **RoadEng\Tutorial\Location\survey design 1.DSN**. Do not save changes if prompted.
12. Type <Ctrl-J> (or select menu View|Jump To Station). Type **9999** into the station edit box and push OK. Now you are looking at the end of the design (you could have typed in the correct station number if you knew it).
13. Bring the Plan window to the front (see step 2).
14. Zoom out until you can see the whole design using the *Zoom 50%*  button or the *Zoom Extents*  button or the mouse roller.
15. Now zoom in near the sharp corner in the design (use the *Zoom Rectangle* button  or the mouse roller with the cursor over the corner). You may also need to pan if you didn't zoom accurately.
16. Pick the *Select Tool* button  from the Mode Tools toolbar and click on the point shown in the Figure 3.7.

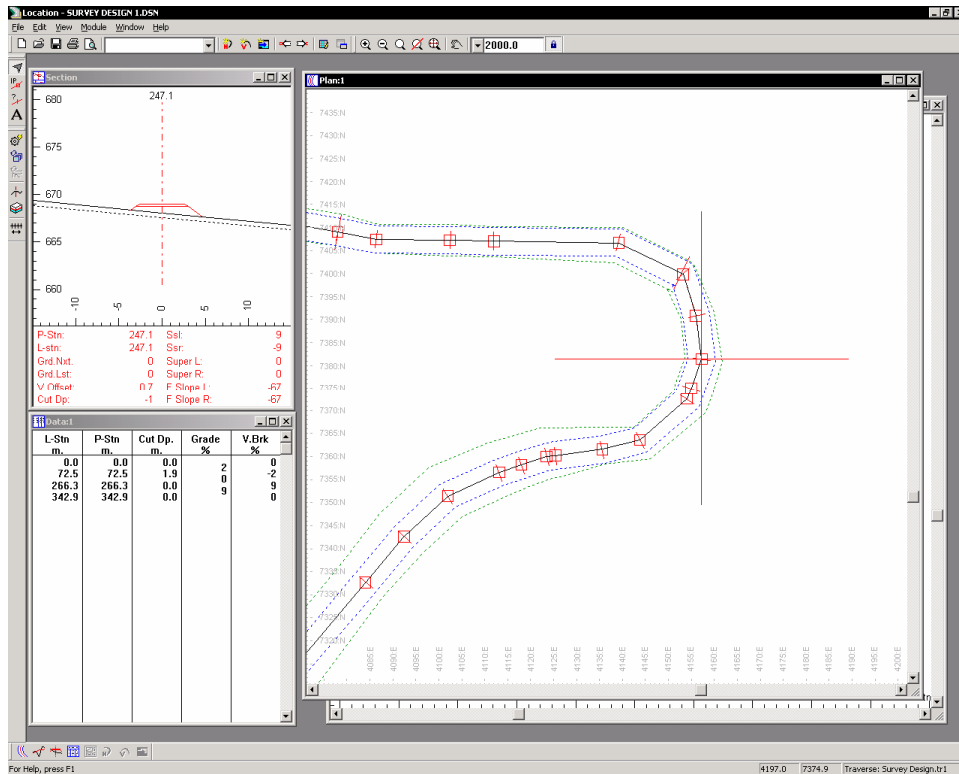




Figure 3.7: Zoomed Plan View With Scale Locked

The zoom function used so far could also be called a *magnify* function because all components of the zoomed window appear smaller (zoom out) or bigger (zoom in). For example, the symbols in the figure above are larger because the Plan window is zoomed in. The scale shown in the Zoom Tools toolbar at the top of the screen has remained unchanged at 2000 and print and print preview do not show the zoom effect. The *Clear Zoom*  button will remove any magnification.

The behaviour of the zoom tools can be modified by un-locking the scale in the Zoom Tools toolbar:

- Be sure that the Plan window is still the active window. Click the *Lock Scale*  button in the Zoom Tools toolbar so that it no longer appears depressed. If the Plan window was zoomed it will lose all magnification.

Use some of the zoom tools demonstrated above to zoom in and out. Notice that the *Scale* changes in the Zoom Tools toolbar and that symbols (and text) do not change size.

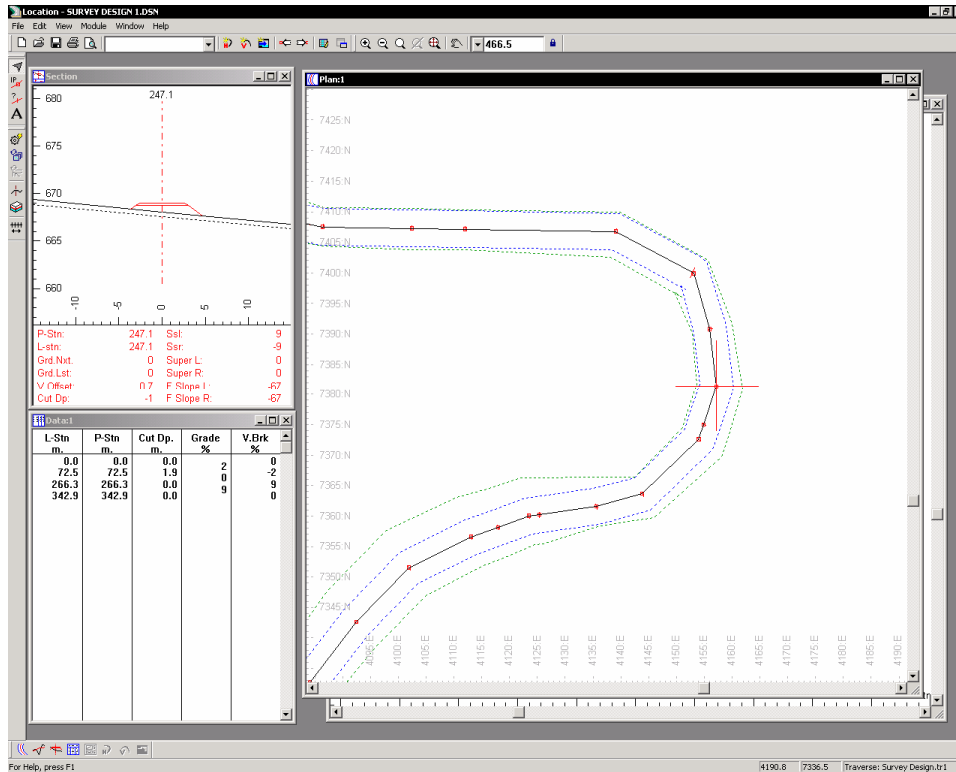






Figure 3.8: Zoomed Plan View with Scale Un-Locked

The state of the *Lock Scale*  button can be different for different windows (if you activate the Profile window you will see that the scale is still locked). When you change the scale of a window you also change the scale of the print output.

This section has demonstrated several ways to move around in a Location design:



- Select with the mouse .
- Next/Previous design point .
- Jump to station <Ctrl-J>.
- Activate windows with the Window Tools toolbar.
- Zoom and Pan with the tool bar.
- Zoom and Pan with middle mouse button and roller.
- Zoom Extents.
- Zoom with the *Lock Scale*  button on or off.

18. File|Close. Do not save changes

## Editing with the mouse in the Section Window

The Section window allows edit of vertical or horizontal alignment (while Profile window only allows edit of the vertical alignment and the Plan window only allows edit of the horizontal alignment).

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

1. File|Open, select **RoadEng\Tutorial\Location\survey design 1.DSN**. This is the same design used in the previous tutorial.
2. Press the *Next Point* button  until the station shown above the cross section reads station 72.5. (see also the previous section: *Moving Around in the Design*)
3. Right click on the Section window and select *Add/Edit IP Tool* from the popup menu. (You could also use the Mode Tools toolbar).
4. Move the cursor over the intersection of the vertical dashed line and the sub-grade. The *Vertical Alignment*  cursor will appear over the section window.

5. Left click and move the mouse up and down. Notice how the sub-grade line moves with your cursor – the cursor is *captured*.

Also note that the cursor moves in the Profile window and that some items in the status area under the section graphic update dynamically (you can see what the grades will be before you anchor the modified point). Instant feedback is available for many kinds of editing task.

6. Move the mouse until the sub-grade intersects the bottom of layer one as shown below and left click a second time. This anchors the elevation of the design point and releases the mouse cursor. Profile and all other window contents are updated.

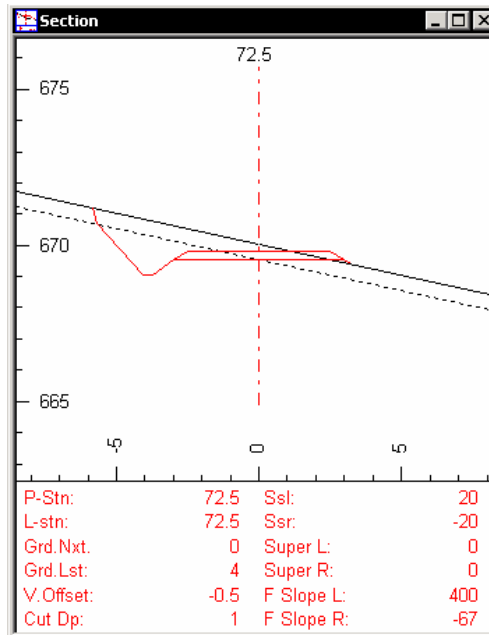

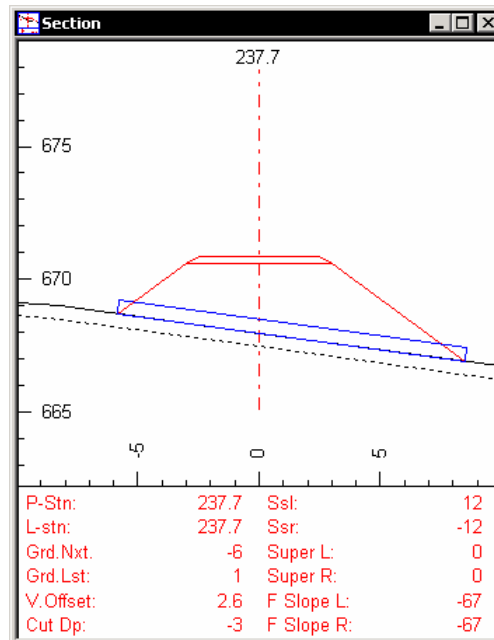


Figure 3.9: Section Window After Vertical Edit

In the previous step a VIP (Vertical Intersection Point ) was modified. If the current point is not already a VIP the same operation will ADD a new VIP.

7. Press the *Next Point* button  until the station shown above the cross section reads station 237.7 and a culvert is shown.
8. Repeat steps 4 and 5 then move the sub-grade **up** this time and click again to anchor. Try to make the section look similar to the figure below.






*Figure 3.10: Section Window After Vertical Edit*

**NOTE:** A new VIP was added at station 237.7 as shown in the Profile and Data windows. Also note that the culvert changed size automatically (culverts are covered in their own section). Although this could have been done in the Profile window it would have been difficult to keep the cursor over the culvert, so you probably would not see the culvert after anchoring the new VIP (the station would be different).

9. Right click on the Section window and select Section Options from the popup menu. (You could also use the View | Section Options menu if the section window is active).

Note that *Vert Alignment* is turned on. Turn *Vert Alignment* off and turn *Horz Alignment* on. Press OK.

10. Switch to the Plan  Window and select the point shown below. Use Next/Previous design point  buttons or change modes temporarily to use the mouse in select mode  (see previous section)

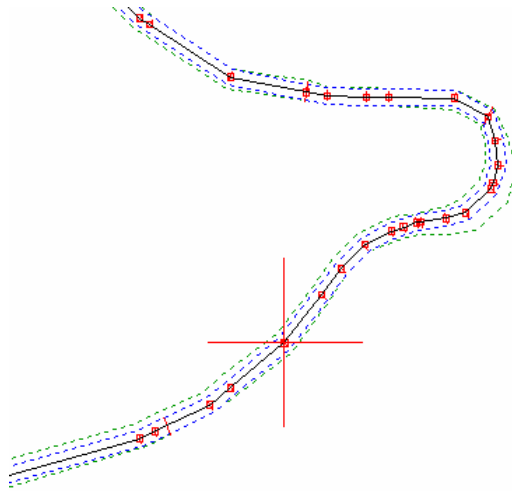



Figure 3.11: The Current Point is an IP (horizontal alignment point)

11. Move your cursor to the Section window and note that the cursor changes to the *Horizontal Alignment*  cursor when you hover over the center of the section (if it does not change, right click to make sure that you are in *Add/Edit IP* mode)

12. Click once over the center of the section to capture the current point and notice that the alignment is constrained to move sideways when you move the mouse. Click again to anchor to the left (up hill) of the centerline.

Notice that the section re-centers the display but now the P-line graphic (a vertical black line) is to the right and the ground is higher. Also note that the Plan window shows the change in alignment.

**NOTE:** Although it is possible to edit both vertically and horizontally at the same time in the Section window, it is not recommended. First it can be confusing unless you can see both the Plan and Profile windows in addition to the Section window. Second, it creates both vertical and horizontal IPs, which will define very sharp breaks if they are close to other IPs.


13. File|Close. Do not save changes.


## Alignment Editing with the Panel Windows

This example illustrates how to create and edit alignment with the Horizontal and Vertical Curve panel windows. These panels create curves and allow IP points to be defined by coordinate or coordinate geometry (cogo). The concepts discussed here are similar for both vertical and horizontal alignment.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

### Adding a new IP in the Vertical Curves Panel

1. File|Open. Select **RoadEng\Tutorial\Location\survey design 1.DSN**. This is the same design used in the previous tutorial.
2. Press the *Vertical Curves*  button to activate the vertical curves panel.

3. Maximize the Profile Window.
4. Press the *Next IP*  button in the panel until you have reached the end of the vertical alignment (the button becomes disabled).

Focus on the *IP and Tangent Parameters* area of the *Vertical Curves* Panel shown in the Figure 3.12.

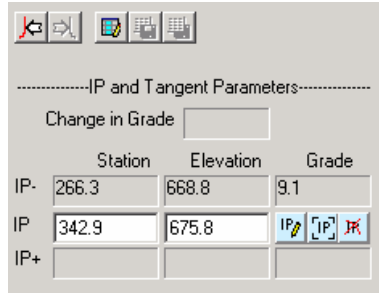

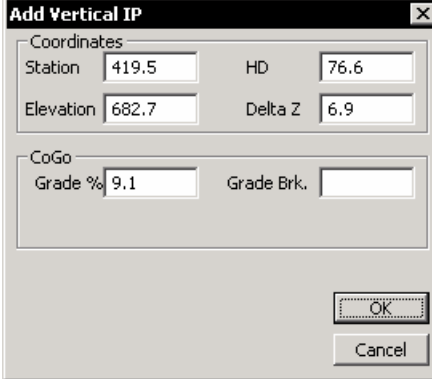


Figure 3.12: *IP and Tangent Parameters Area Vertical Curves*

Notice that there are 5 numbers showing in this area. The *Station*, *Elevation*, and *Grade* of the previous IP (IP-) and the *Station* and *Elevation* of the current IP (IP). Notice that the *Station* and *Elevation* for the current IP can be edited directly here

5. Press the *Add New IP*  button. The dialog box shown below will appear.



The dialog box titled "Add Vertical IP" contains two sections: "Coordinates" and "CoGo". The "Coordinates" section has four input fields: Station (419.5), HD (76.6), Elevation (682.7), and Delta Z (6.9). The "CoGo" section has two input fields: Grade % (9.1) and Grade Brk. (empty). At the bottom right are "OK" and "Cancel" buttons.

| Coordinates |       |
|-------------|-------|
| Station     | 419.5 |
| HD          | 76.6  |
| Elevation   | 682.7 |
| Delta Z     | 6.9   |

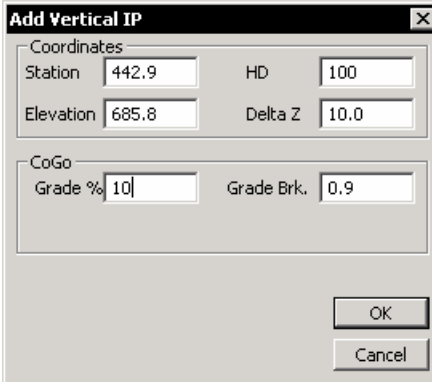
  

| CoGo       |     |
|------------|-----|
| Grade %    | 9.1 |
| Grade Brk. |     |

Figure 3.13: Add Vertical IP Dialog

The default coordinates and grade shown above will create a tangent that is the same length and grade as the previous tangent.

6. Type **100** into the *HD* field, then type **10** into the Grade % field (see Figure below). Notice that the other fields update automatically. Press OK.



The dialog box titled "Add Vertical IP" shows updated values. The "Coordinates" section now has Station (442.9), HD (100), Elevation (685.8), and Delta Z (10.0). The "CoGo" section has Grade % (10) and Grade Brk. (0.9). The "OK" and "Cancel" buttons are at the bottom right.

| Coordinates |       |
|-------------|-------|
| Station     | 442.9 |
| HD          | 100   |
| Elevation   | 685.8 |
| Delta Z     | 10.0  |

| CoGo       |     |
|------------|-----|
| Grade %    | 10  |
| Grade Brk. | 0.9 |

Figure 3.14: 5<sup>th</sup> Design Point

The same result could be achieved by typing in the *HD* and *Delta Z* or *Station* and *Elevation*. The screen should look like the Figure 3.15.

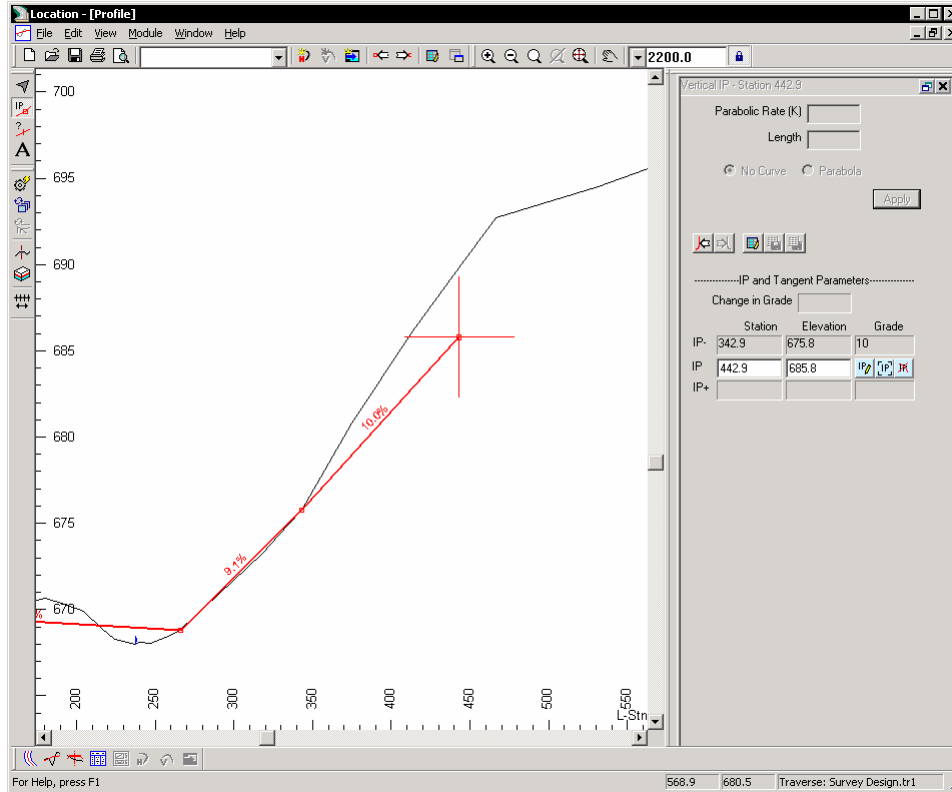






Figure 3.15: 5<sup>th</sup> Design Point in the Profile Window

### Modify an Existing IP in the Vertical Curves Panel



7. Press the *Previous IP*  button twice. This will move the cursor back to the 3<sup>rd</sup> design point at the bottom of the hill.

Notice that the *IP and Tangent Parameters* area shows the *Station* and *Elevation* of the previous, current and next IP. It also shows the *Grade* of the previous and next tangents and the *Change in Grade*.

8. Type **671** into the elevation field at the bottom of the panel. Press *Apply* to accept the change. The Profile window will show the new elevation.

9. Press the *Next IP*  button until you are once again at the end of the vertical alignment.
10. Press the *Modify IP*  button. The *Modify Vertical IP* dialog will appear.
11. Change the *Grade Brk* to 6. Press OK. Notice that even though the numbers have been changed in the panel, there was no change in the Profile window. Press *Apply* to implement the changes.
12. Press the *Delete this IP*  button to delete the current point.

### Editing IPs in the Horizontal Curves Panel

13. Press the *Horizontal Curves*  button to activate the horizontal curves panel. Note that you can now switch between horizontal to vertical panels by clicking on the tabs at the bottom .
14. Maximize the Plan window.

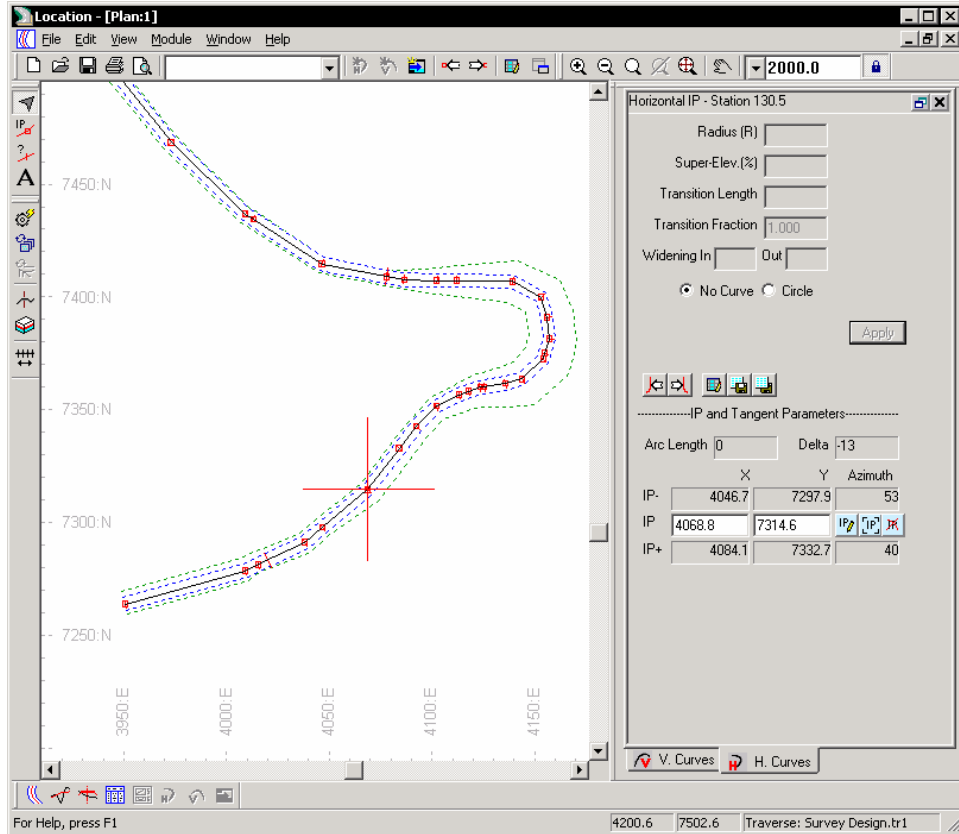








Figure 3.16: Plan Editing with the Horizontal Curve Panel

The previous sections covered editing vertical IPs with the assistance of the vertical curves panel. The horizontal curves panel is conceptually the same. Both panels allow you to:

- Add a point at the end of the alignment (*Add New IP*  button)
- Insert a point after the current point (*Add New IP*  button)
- Edit an existing IP (*Modify IP*  button) or type directly in the fields in the panel – don't forget to press *Apply*)
- Delete the current point (*Delete this IP*  button)

- Define IP locations by coordinate or other values - such as tangent *grade* in the profile and *azimuth* in the plan and *length* in both (*Add New IP*  button or *Modify IP*  button).
15. The curve panels are also covered in the sections dealing with curves. You may wish to experiment further with the horizontal curves panel at this point. When you are finished, File|Close. Do not save changes.

## Window Options and Screen Layouts

Every viewing window has associated display options (the panel windows are somewhat different). Window options can be modified in the associated options dialog box and can be saved for future use in *Screen Layout* files.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

1. Choose File | Open..Select  
**\RoadEng\Tutorial\Location\combo design.DSN.**

The screen should look similar to the Figure 3.17. This is the way it looked when **combo design.DSN** was last saved. The design files contain *design* data (alignment etc.) as well as *screen layout* data (window sizes, positions and options).

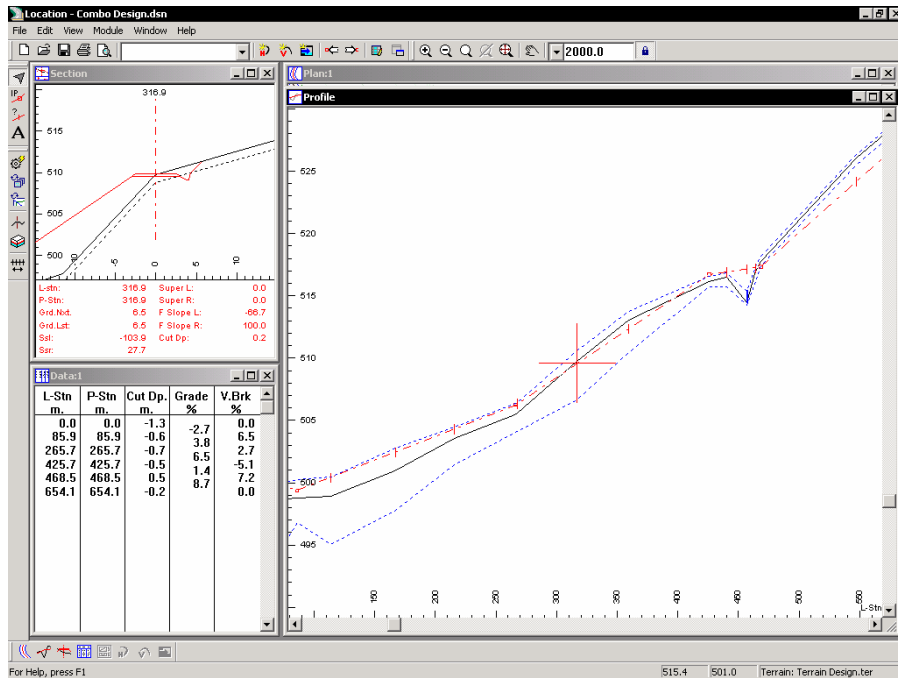


Figure 3.17: Screen Layout Saved with Example Design Files

2. File | Retrieve Screen Layout. Select **\RoadEng\Tutorial\Location\plan and horizontal curves.DLT.**

This will set up the windows and options so the screen looks like the Figure 3:18 – this is the way it looked when the screen layout **\plan and horizontal curves.DLT** was saved. The screen layout file does *not* contain *design data* (alignment etc.) your alignment is unchanged.

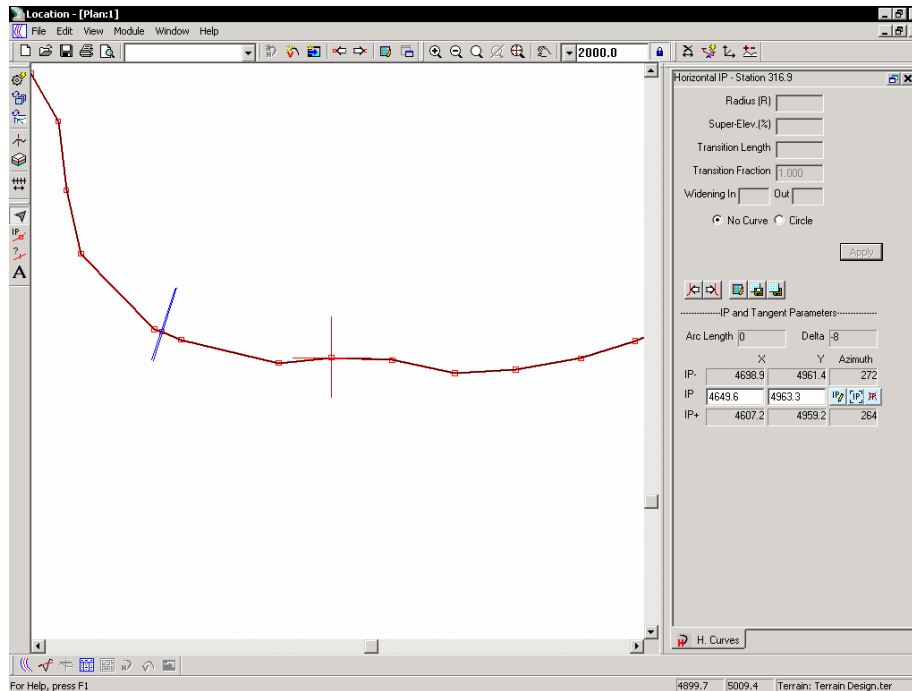


Figure 3.18: Screen Layout From DLT File

3. Click in the screen layout pull down box in the Standard Tools toolbar and select **normal.DLT**.

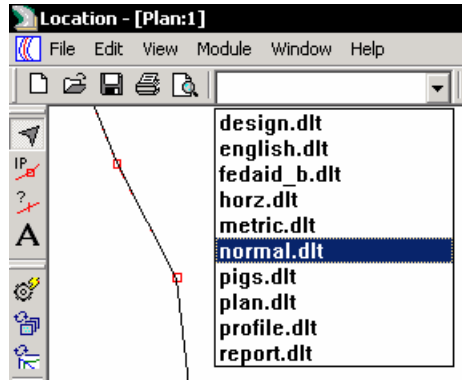


Figure 3.19: Selecting a Screen Layout From the Toolbar

**NOTE:** **normal.DLT** is the File | New default screen layout. Modify **normal.DLT** to change the way a new designs look.

4. Experiment by selecting different screen layouts from the screen layouts pull down as in the previous step.
5. To create your own screen layouts, modify window options until the screen looks the way you want it, then File | Save Screen Layout.
6. Repeat step 2 to restore the screen layout shown in Figure 3.16.
7. Right click on the Plan window and select *Plan Options* from the popup menu.

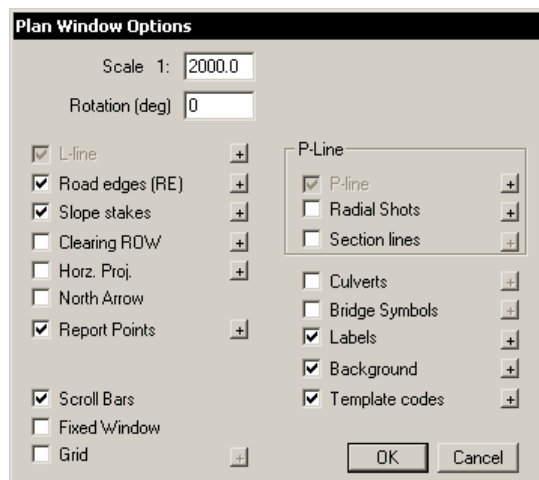




Figure 3.20: Plan Window Options

**NOTE:** The main display windows (Plan, Profile, Section and Data) have similar display options available from the right click menu, the Window Options button  and the View | <window name> Options menu. Note that the toolbar button and menu item open the options dialog for the *active* window.

8. Turn on the Road Edges check box and the Grid check box. Then click the  button beside the *L-Line* item (*L-Line* is disabled and in the lower right); change the line-type to “42 Dash-Dot (.5mm)” and press *OK* then *OK* again to update the Plan view.
9. Restore the Plan window (so it is no longer maximized).
10. Select menu Window | New Window | Section to and create a new Section window.
11. Select menu Window | New Window | Data to create another new window.
12. Right click in the Data window and choose *Data Options* . Select only Plan Points for display (see Figure 3.21 – type the F1 key for help).

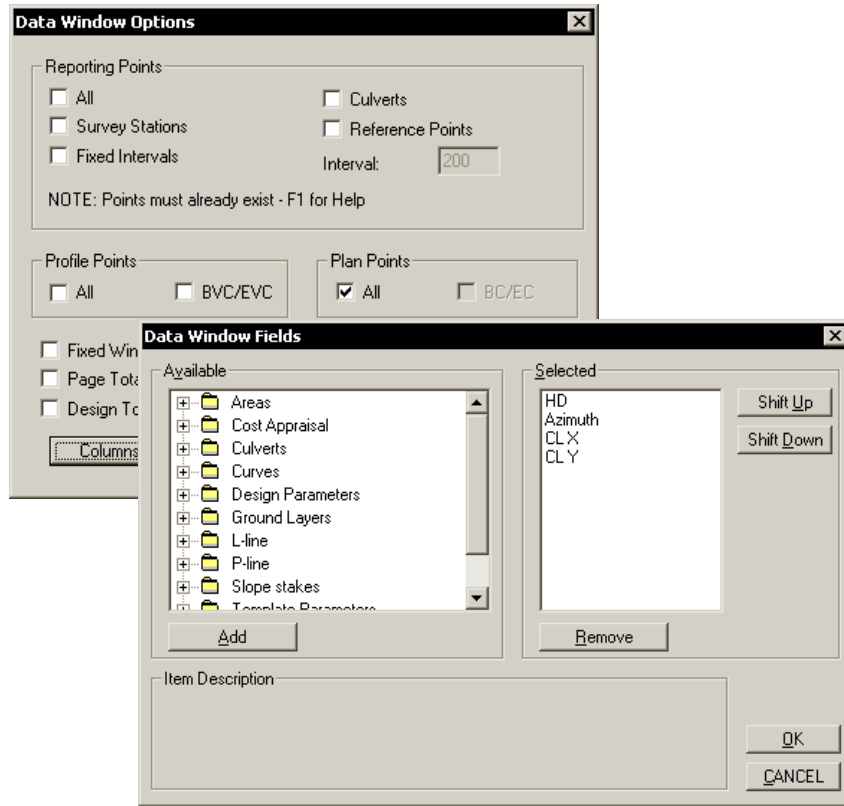


Figure 3.21 Data Window Options after Clicking the Columns Button

13. Press the *Columns* button and choose the *L-Line Azimuth* item from the *Available* list and *Add* it to the *Selected* list (double click works too). Similarly add the *CL X*, *CL Y* and *HD* items. Now use the *Shift Up* button to move *HD* to the top of the selected list. *OK* and *OK* again will update the Data window.
14. Size and move the windows until the screen looks similar to Figure 3.22.

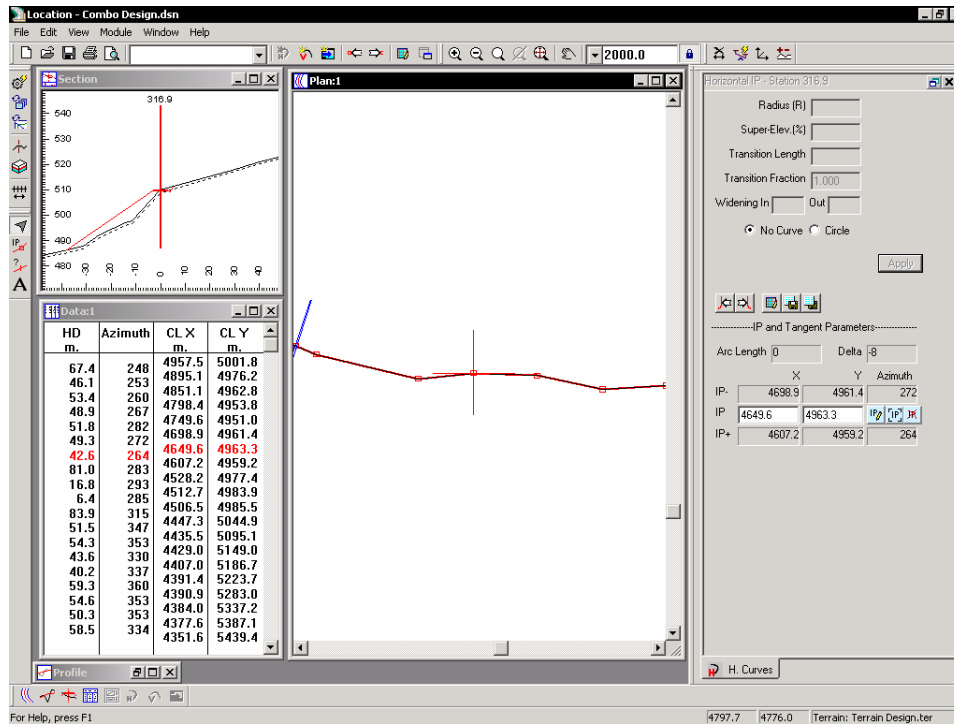


Figure 3.22: A New Screen Layout

- File | Save Screen Layout to create a new screen layout file. Type **Plandatasection** in the file name field and press OK to save the new screen layout to the RoadEng folder on your hard drive. If you are prompted that this file already exists you may want to change the file name – see note below.

**NOTE:** Only screen layout files in the RoadEng folder on your hard drive will appear in the screen layouts pull down in the tool bar. You may, however, save screen layout files to any folder and retrieve them with the File | Retrieve Screen Layout menu.

16. Use the screen layout pull down in the toolbar to select a different screen layout (as in step 3). Your screen will update to a different configuration.
17. Repeat the step above. This time pick **Plan data section.DLT** created in step 8. Your screen will return to the way you set it up in steps 4 to 7.

---

**NOTE:** Screen layouts can save time that might be spent setting up options over and over again. It makes sense to save a screen layout for each design task that needs specific feedback. Screen layouts can also provide new users with the tools they need without them having to learn what options are available and where to set them.

---

18. Use the File | Delete File(s) menu to remove the screen layout file you created above. You will need to select *Screen Layout (\*.DLT)* in the *Files of Type* pull down and then navigate to the RoadEng folder.
19. File | Close. Do not save changes

---

## Starting a New Design

This example illustrates how to create a new location design project. The Location design module creates a model representing a road; this requires a digital version of the ground surface a desired road cross section shape (prism) and finally an alignment. There is no single step by step recipe for road location but there are three steps that are common to all new designs:

- Define the original ground surface topography and materials (including sub-surface layers)
- Choose a table of cross section templates.
- Setup Location design options suitable for your first design task.

The original ground surface can be defined by a traverse with side shots created in the Survey/Map module (\*.TR1 file) and/or by a Digital Terrain Model (DTM) created in the Terrain module (\*.TER file). These two methods will be treated separately in this example.

### *Defining Ground Surface with a P-Line Traverse*

If you do not use the Survey/Map module to enter P-Line traverse notes, skip to the *Defining Ground Surface with a DTM* section below.


**NOTE:** Even if you do create a P-Line traverse it is often desirable to create a Terrain model from your traverse before creating a road alignment; in this case you may use **both** the P-Line and the DTM to define the ground surface.

A P-Line (Preliminary Line) traverse created in the Survey/Map module contains an initial alignment (the main traverse = P-Line) and cross section topography (perpendicular side shots). It also contains comments, ground material types and stream locations. See the Survey/Map module documentation for details and instructions for creating a P-Line traverse.

1. Choose File|New \RoadEng\Tutorial\Location\survey design.TR1.

**NOTE:** Make sure that your traverse is correct. If the survey notes are changed after starting the design, the design points after the change will be affected. This may require some re-design.

The following steps place a background image in the Plan window. An optional background image can display any graphical information that may be of use during the design process.

2. Activate the Plan window then right click in it and select *Plan Options* from the popup menu.
3. Click on the  button beside the *Background* check box then click the *Add* button. Choose \RoadEng\Tutorial\Location\terrain design.TER (see Figure 4.0) Press *Open*, then *OK* and *OK* a second time to load the background image.

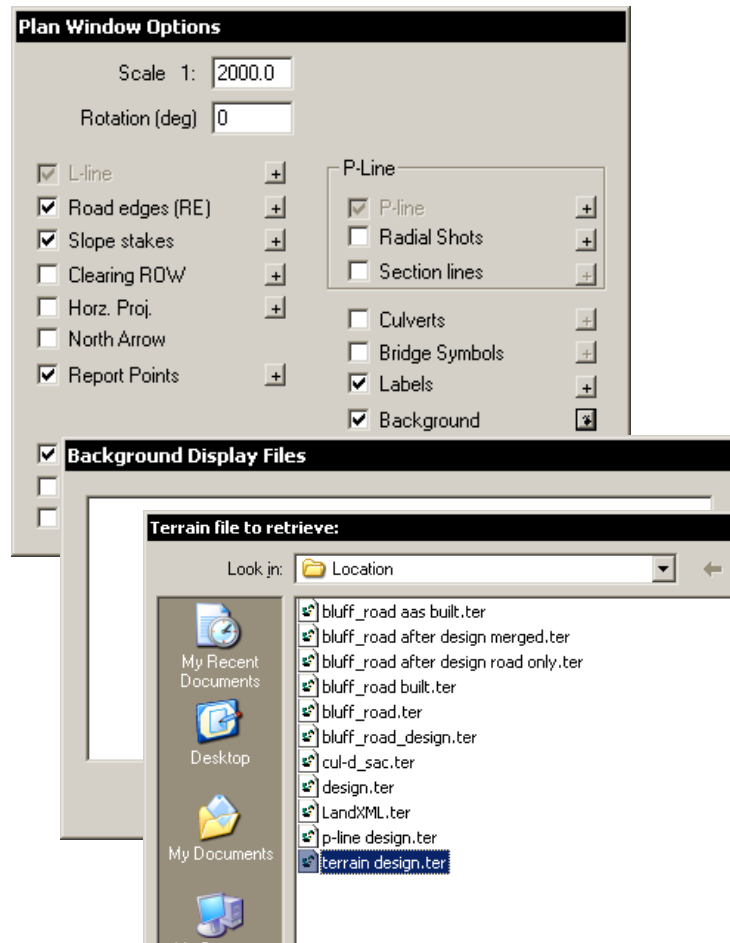


Figure 4.0: Adding a Terrain Background to the Plan Window

## Choose a Table of Cross Section Templates

4. Choose Edit | Edit Templates. Press the *Open* button to get a template table from a file.

5. Select the file **RoadEng\Tutorial\Location\metric.TPL** and Press Open. Press *OK* to leave the Template editor and *Yes* to recalculate (See the Section called *Templates* to learn how to create and assign templates)

---

**NOTE:** This step loads a table of templates for calculating road cross sections. You can create your own template tables (see *Templates*). You can skip this step if you are satisfied with the contents of *normal.TPL* (the File | New default).

---

### *Setup Location design options (retrieve screen layout)*

6. File|Retrieve Screen Layout; select **\RoadEng\Tutorial\Location\plan.DLT** Press Open.

This will set up the windows to display feedback appropriate to the next section in this document (see Figure 4.1)

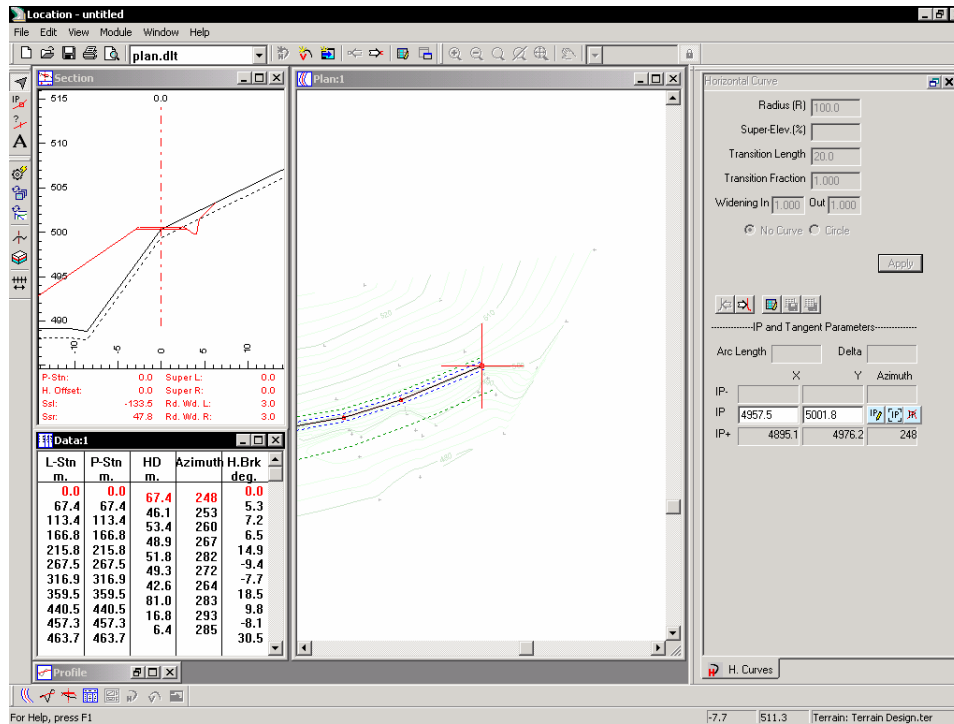


Figure 4.1: After Retrieving Screen Layout

**NOTE:** This step reads the display options for all the windows from a Screen Layout file. You should create your own screen layouts (see *Window Options and Screen Layouts* section) and if you save them in your RoadEng directory they will be available in the Screen Layouts box in the Standard Tools tool bar. You can skip this step if you are satisfied with the contents of **normal.DLT** (the File | New default).

You have now completed the critical three steps common to all new designs. The next steps will depend on the project and your design style.

7. File | Close. Do not save changes.

## Design Techniques

Staying within constraints for a given project requires an iterative design approach where vertical and horizontal alignment and other road parameters are adjusted while trying to balance often-contradictory goals (i.e. high design speed vs. low earthwork volumes). RoadEng is designed to provide you with editing tools and feedback information to accelerate this process. The following exercises illustrate these tools and the various types of feedback; however, they are simplified to make the exercises concise and self-contained.

### *Horizontal Alignment – An Overview*

Horizontal design involves adjusting the alignment as seen in Plan view to provide the best compromise between various constraints. Simple geometric constraints may include a minimum curve radius and right of way boundaries. The horizontal alignment also affects earthwork volumes. However vertical alignment and template shapes also contribute to volumes and must be considered at the same time for a real design.

Before starting the following sections, it is recommended that you review the material covered in *Editing With The Mouse* and *Starting A New Design*.

Horizontal alignment is the same whether you created your design from a P-Line traverse (.TR1 file), from a Terrain model (.TER file) or from both (see *Starting a New Design* section above). These examples start with a design created from both the P-Line *and* the Terrain used in the example above.

### *Horizontal Alignment – Editing Tangents, Small*

#### *Offsets*

The alignment in this example consists of many short tangents with small angles between them and no curves; it is assumed that the corners will be smoothed

during construction of the road. This kind of design is often suitable to low volume road design.

Note: If you are using RoadEng® and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

1. Choose File | Open. Select and open, **\RoadEng\Tutorial\Location\combo design.DSN**
2. File | Retrieve Screen Layout; and select **RoadEng\Tutorial\Location\plan.DLT**. Press Open

This design contains vertical alignment. The horizontal alignment, however, is still coincident with the P-Line survey. This lies on the edge of an escarpment and the road would be better located uphill from the edge (Figure 5.0).

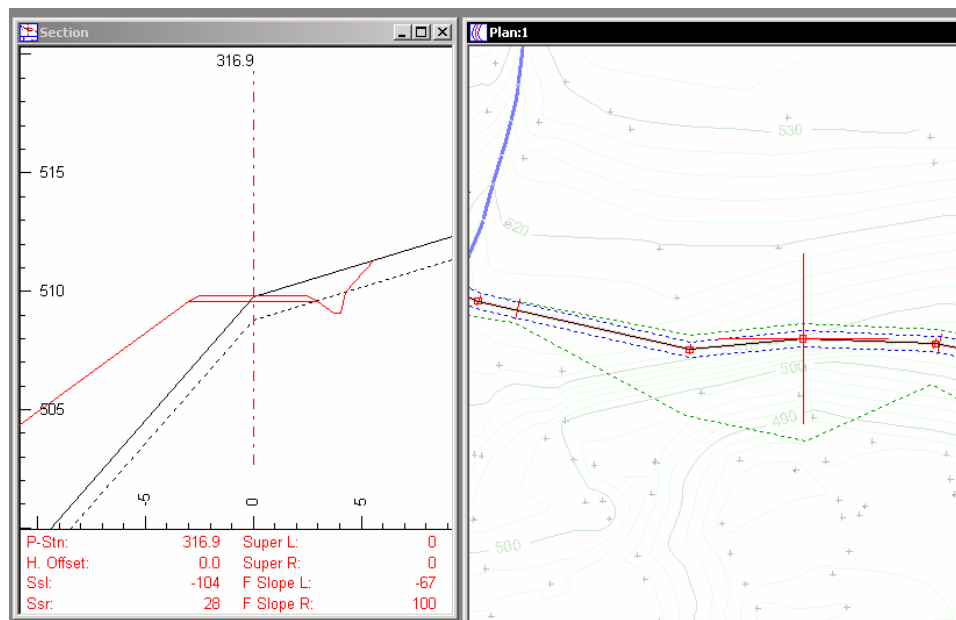


Figure 5.0: Excessive Fill Before Horizontal Alignment

3. Capture the point indicated in Figure 5.0 and move it up before re-anchoring it. You may work in the Plan window or the Section window (see the *Getting Started* chapter for information on point editing).

The green dashed line below the road in the Plan window represents the fill catch point (slope stake); notice how it changes after your edit.

4. Continue to adjust this same VIP until the Section and Plan windows appear similar to the figure below.

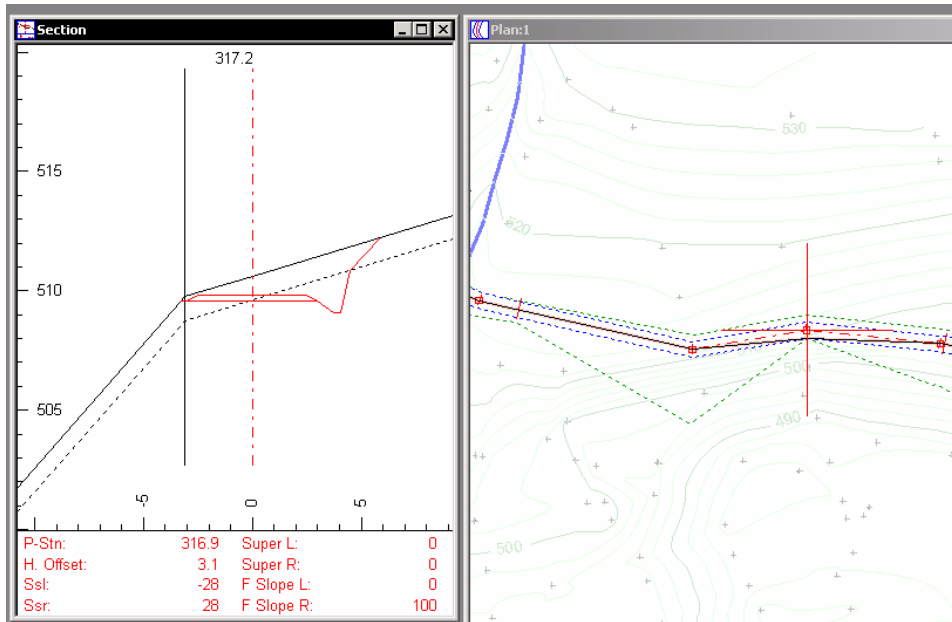


Figure 5.1: No Fill (full bench cut) After Horizontal Alignment

Horizontally align from the start of the road (right hand side in the Plan window) to the creek until there are no more excessive fills (see Figure 5.2). You can move *or* delete horizontal VIPs.

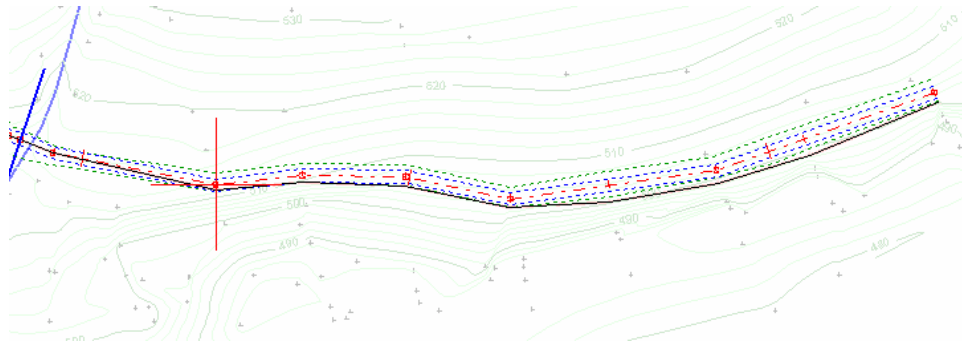


Figure 5.2: After Aligning the First Section of Road

The exercise above could have been accomplished almost in one step with the Edit | Auto Balance function. Figure 5.3 shows how you would set up the Auto Balance dialog box to perform this.

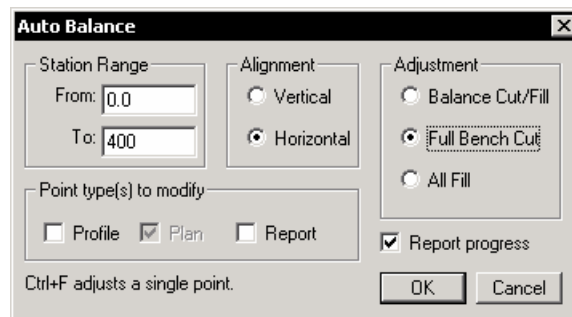


Figure 5.3: Edit | Auto Balance Dialog Box Set Up to Horizontally Align to Full Bench

#### Optional steps:

**Auto Balance** is only available if the **Auto Balance** function group is enabled. Enable this function group if you wish to try the following step. Use the Module | Setup menu, *General* tab, *Menus* button. See the *Functions Groups* section.

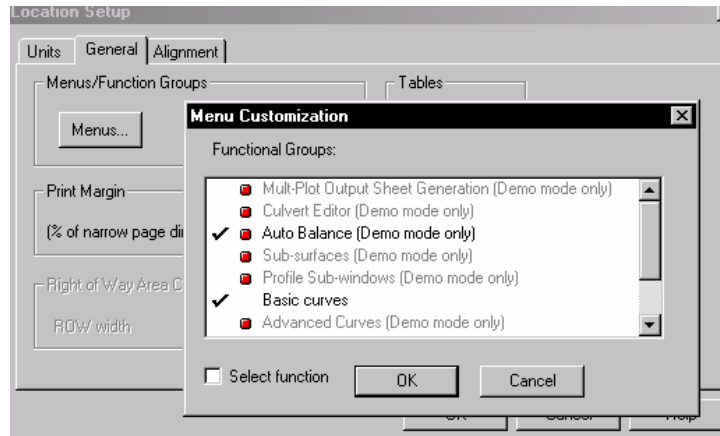


Figure 5.4: Menu Customization Dialog

5. Edit | Undo some of your alignment above so that you can see there is excessive fill once more. Use Edit | Auto Balance to re-align to full bench (as shown in the Figure 5.3- note *Station Range*). You may want to type <F1> once the dialog box is open to see online help.

**Resume from Step 5 here if optional steps were skipped:**

6. Proceed to step 3 in the next example. Or select File | Close to leave example. Do not save changes.

## Horizontal Alignment – Creating tangents for Curves

Horizontal curves (see also next section) require the design of tangents before the curve can be created. The incoming *tangent* intersects with the outgoing *tangent* to define the *curve IP*. This section deals with two ways to create tangents.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

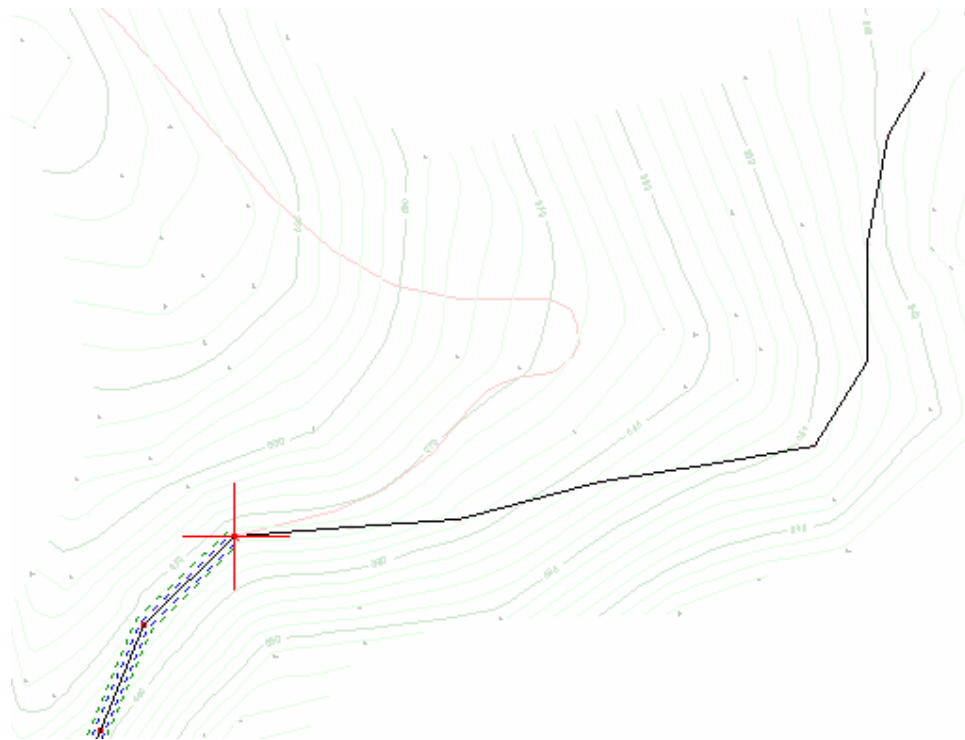
---

**NOTE:** Tangents can also be modified after a curve has been created.

---

Skip the first two steps if you are continuing from the previous example.

1. Choose File | Open. Select and open, **\RoadEng\Tutorial\Location\combo design.DSN**.
2. File|Retrieve Screen Layout; select **\RoadEng\Tutorial\Location\plan.DLT**. This will set up the windows to display feedback appropriate to this example. Press Open
3. View | Jump to Station or <Ctrl-J> then type **9999** in the station field. *OK* will set the last point in the design as the current point.



*Figure 5.5: Plan View Showing the Last Point in the Design*

- Right click in the Plan window and choose *Plan Options*; clear the check boxes beside *Slope stakes* and *Road edges* (Press F1 key for help). After you press *OK*, the alignment will be a bit clearer. Note that slope stakes (catch points) are meaningless until both vertical and horizontal alignments are defined.

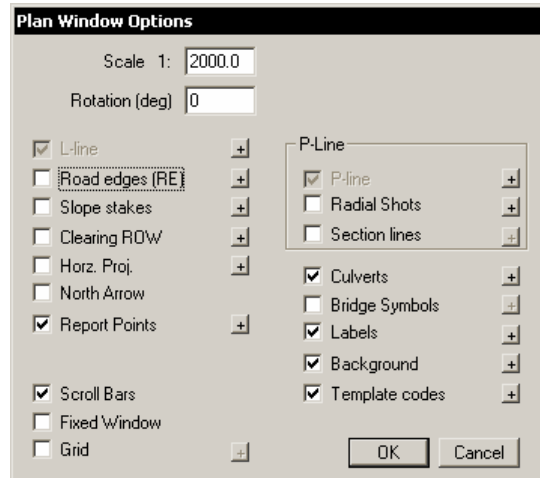

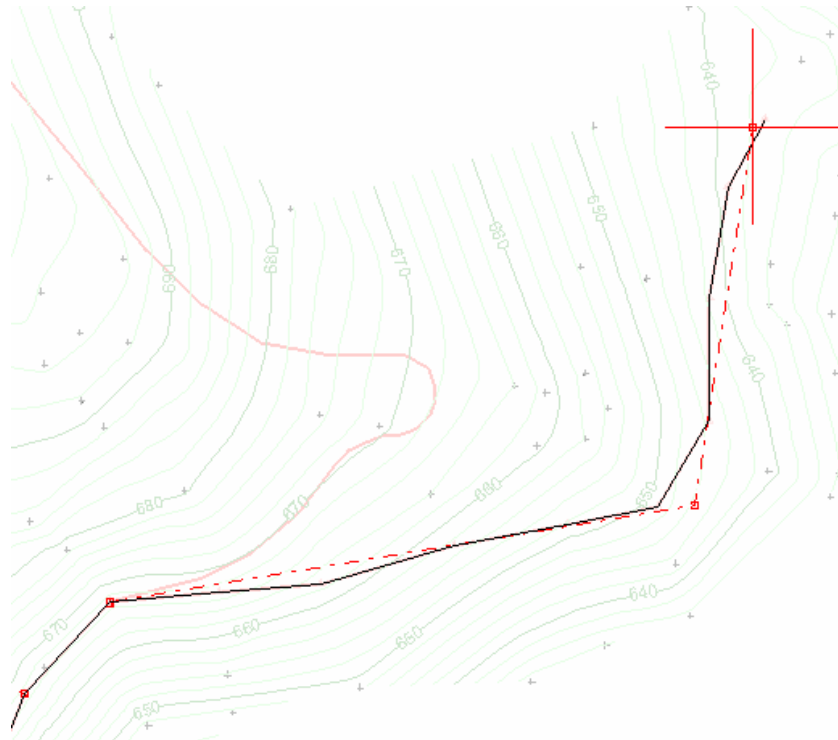


Figure 5.6: Plan Window Options

To complete the pre-curve alignment, new tangents will be created. This process is the same one you would use if there were no initial P-Line alignment – if the cross-hair in the figure were the *only* point in the alignment.

New tangents can be created with the mouse or the Horizontal curve panel (see Editing with the Mouse in Profile or Plan).

- Use the mouse (*Add/Edit IP Tool* cursor ) to create the tangents as shown in Figure 5.7.





*Figure 5.7: Plan View Showing New Tangents*

6. The Data window now shows information about the new tangents.  
Change the Data window to show tangent length and azimuth instead of P-Line offset


The Data window now gives length and direction feedback about all tangents including the two tangents just created with the mouse. The figure above shows the first new tangent is 375.4m long at 81 degrees; the second is 223.0m long at 10 degrees and the angle between them is 72 degrees. The numbers in your display will be different, however, with this feedback available, it is possible to use the mouse to get close to any desired results by trial and error.

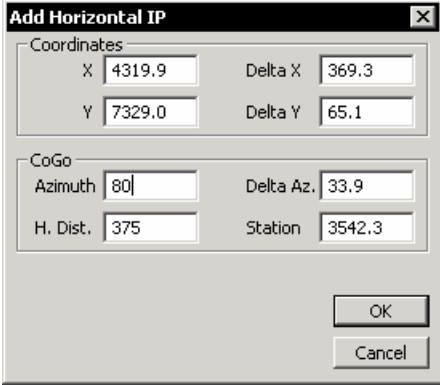
**NOTE:** The changes made to the Plan and Data window options could be saved in a screen layout. If you were to use File | Save Screen Layout you could create an updated version of the screen layout that you used in step 2 of this section; this new screen layout could be used when you encounter this type of design task in the future. See *Window Options and Screen Layouts* section.

To define tangents with exact azimuths and distances it is necessary to use the Horizontal Curve panel.

7. Press the *Next IP*  button (if enabled) in the Horizontal Curve panel to make sure that the cross hair is on the last point in the design.
8. Press the *Delete this IP*  button twice to remove the tangents added above (press *Continue* when prompted).


Your screen should look like it did at the start of this section.

9. Press the *Add New IP*  button. Type **80** into the *Azimuth* field and **375** into the *H.Dist* field. Press OK to add a new point. Confirm that the Data window shows the same values.



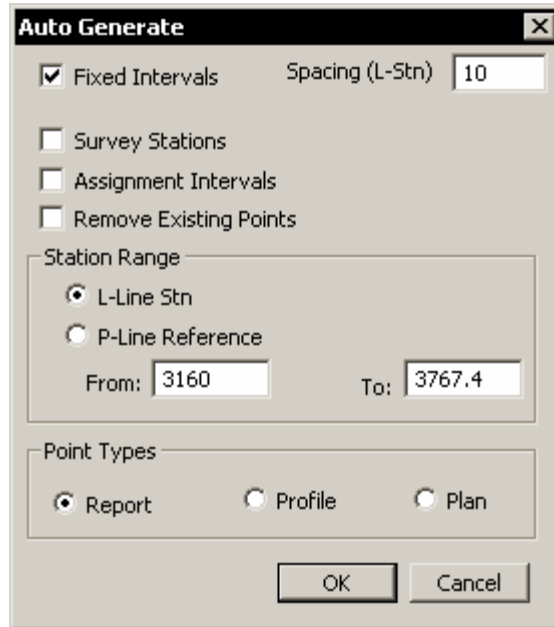
| Add Horizontal IP |        |           |        |
|-------------------|--------|-----------|--------|
| Coordinates       |        |           |        |
| X                 | 4319.9 | Delta X   | 369.3  |
| Y                 | 7329.0 | Delta Y   | 65.1   |
| CoGo              |        |           |        |
| Azimuth           | 80     | Delta Az. | 33.9   |
| H. Dist.          | 375    | Station   | 3542.3 |
| OK                |        |           |        |
| Cancel            |        |           |        |

Figure 5.8: Add Horizontal IP Dialog Box

10. Press the *Add New IP*  button again. This time type **-70** into the *Delta Az.* field and **220** into the *H.Dist* field. Press OK to add a second new point.

Neither of the methods used above for creating tangents is more correct than the other, both allow creation of curves afterward.

11. Select the *Edit | Auto Generate* menu and set it up to look like the figure below. Press *OK* to insert cross sections between the two IPs that you just created.



*Figure 5.9: Auto Generate Dialog Set Up to Insert Cross Sections in the Recently Created Tangents*

**NOTE:** Report points should be inserted into any new horizontal alignment to enhance the accuracy of volume calculations and to improve the display of graphics such as road edges.

You may skip the following step if you plan to continue with the next section.

12. Proceed to step 2 in Adding Horizontal Curves or select File | Close to leave the example. Do not save changes

## *Adding Horizontal Curves- Simple Mode*

The tangents created in the section above are now ready for a horizontal curve. Skip the first step if you are continuing from the previous section.

---

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

---

1. File|Open. Select and open,  
**\RoadEng\Tutorial\Location\simple horizontal curves.DSN.**

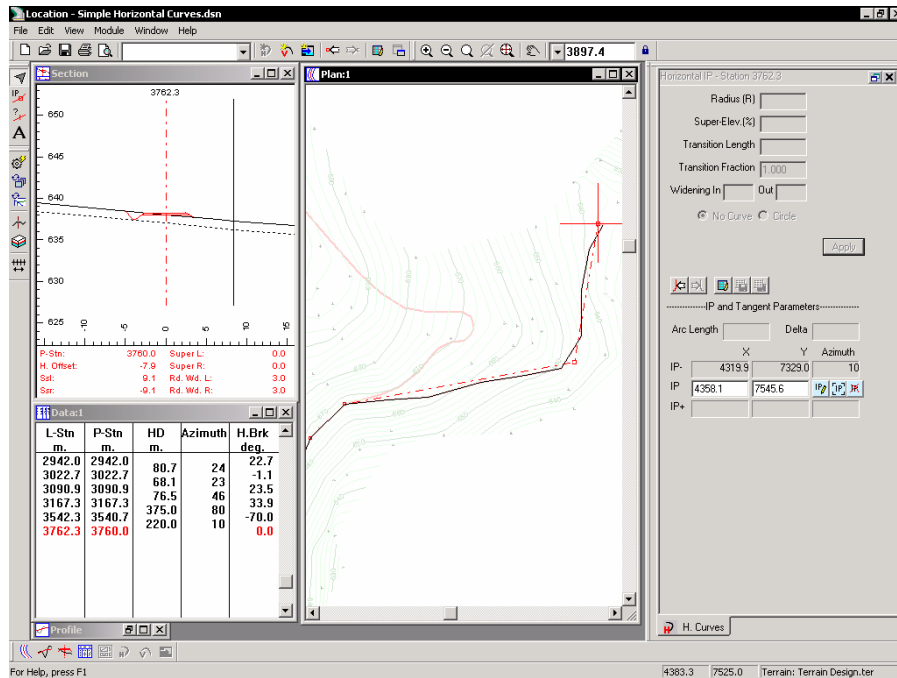



Figure 5.10: Simple Horizontal Curves.DSN

2. Press the *Previous IP*  button in the horizontal curve panel.
3. Select *Circle* in the top of the Horizontal Curve Panel and type in the data shown in Figure 5.11. Press *Apply*

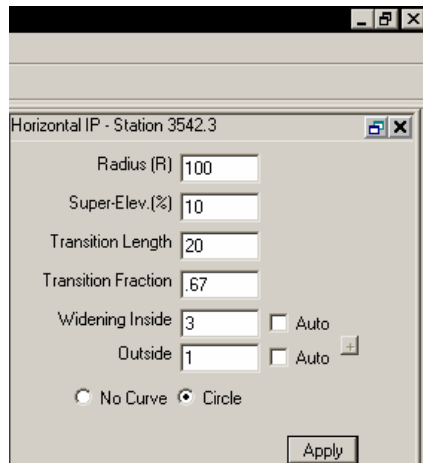


Figure 5.11: Top Part of the Horizontal Curves Panel

The new curve is now visible in the Plan window; note the *BC* (Begin Curve), *EC* (End Curve) and radius labels.

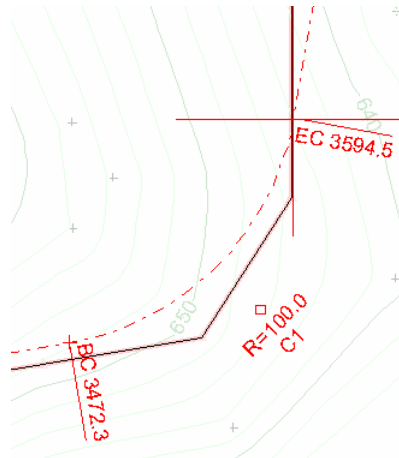






Figure 5.12: Horizontal Curve

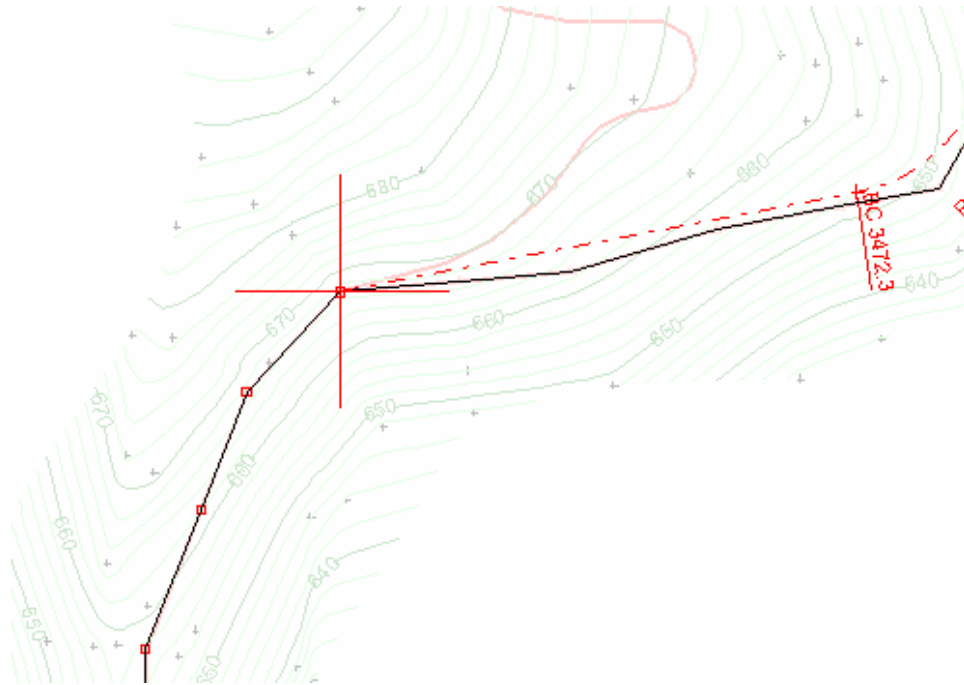
4. Press the *Set Default Curve*  button. This will save curve parameters for future use. Note that default curve parameters are saved with the Template table.

The curve parameters used above specify lane *Widening* and *Super Elevation*. To see how these are applied look at the Section window.

5. Press the *Previous Point*  button in the tool bar (**not** the one in the curve panel) and notice what happens to the Section. Repeat until the current point has passed the beginning of the curve transition (*Super L* and *Super R* are both 0.0).
6. Press the *Next Point*  button repeatedly and watch the Section window as you pass through the curve again.

The transition from no super elevation and no curve widening to full super elevation and full curve widening takes place over 20m (*Transition Length*) at each end of the curve. You may have noticed that the super elevation is 6.7% at the BC and EC points; this is because 2/3 of the transition happens outside of the curve (*Transition Fraction* is 0.67) and the rest happens inside the curve.

7. Press the *Previous IP*  button in the horizontal curve panel until you reach station 3167 (see Figure 5.13).



*Figure 5.13: Station3167, Second Curve Location*

The alignment here is made of several short tangents (it follows the P-Line survey). In the next few steps you will set up tangents suitable for a curve and add the curve.

8. Use the mouse to capture and then delete the two points before the cross-hairs in the figure above (if you try to delete the IP at the cross-hairs you will be prompted to delete the curve you just created).
9. Capture the remaining point and move it so that the tangents resemble Figure 5.14.

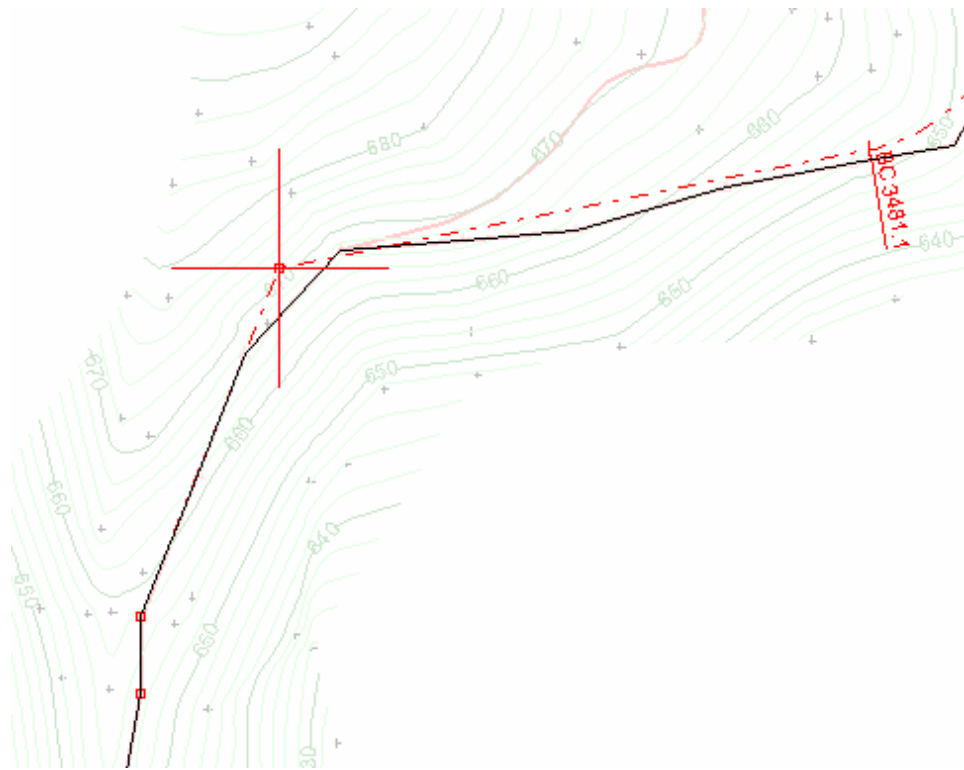


Figure 5.14: Ready for Second Curve



10. Click on the *Get Default Curve*  button in the curve panel and then press *Apply*. A new curve with the same parameters as the first one will be inserted.
11. Zoom and Pan until you can see both curves as shown in Figure 5.15.



Figure 5.15: Two Curves Completed

12. Move the mouse cursor over the new curve IP (next to the radius label); notice that the *edit* cursor  appears (you should still be in *Add/Edit IP* mode). Capture the curve IP and notice that both curves adjust to fit as you move the mouse around. Also notice that the *IP and Tangent Parameters* fields at the bottom of the curve panel are also updating dynamically as you move the mouse.

If you move the IP so that the curve does not fit the tangents the computer should beep and the tangents will stop following the mouse.

13. Modify tangents and add curves throughout the design until you are comfortable with the process.
14. File | Close. Do not save changes.

## Switchbacks

Horizontal curves that change direction much more than 90 degrees (switchbacks) will require two design points and three tangents. When the included angle is greater than or equal to 180 degrees, a two tangent curve becomes impossible to design – there is no intersection point.

---

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

---

Before starting, it is recommended that you review the material covered in *Horizontal Alignment – creating and editing tangents* and *Adding Horizontal Curves*.

1. File|Open, Select **RoadEng\Tutorial\Location\switchback.DSN**. Press Open.

This is an alignment that follows a P-Line survey; in this exercise you want to stay as close as possible to the P-Line. Switchbacks can also be designed without a P-Line traverse; in that case you would create all new tangents; the final result would be similar

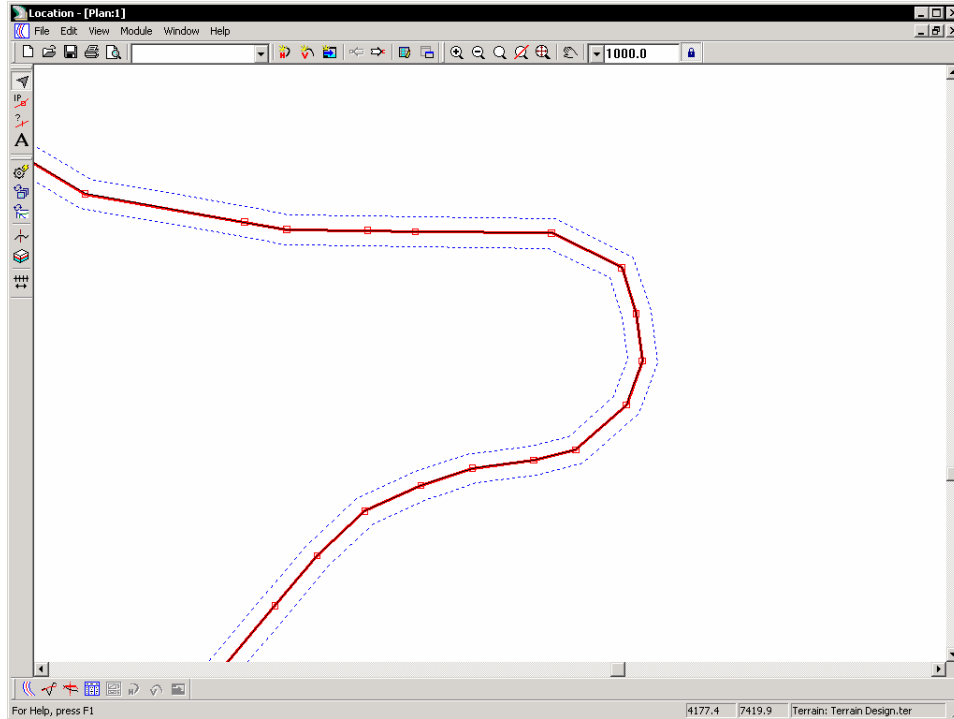
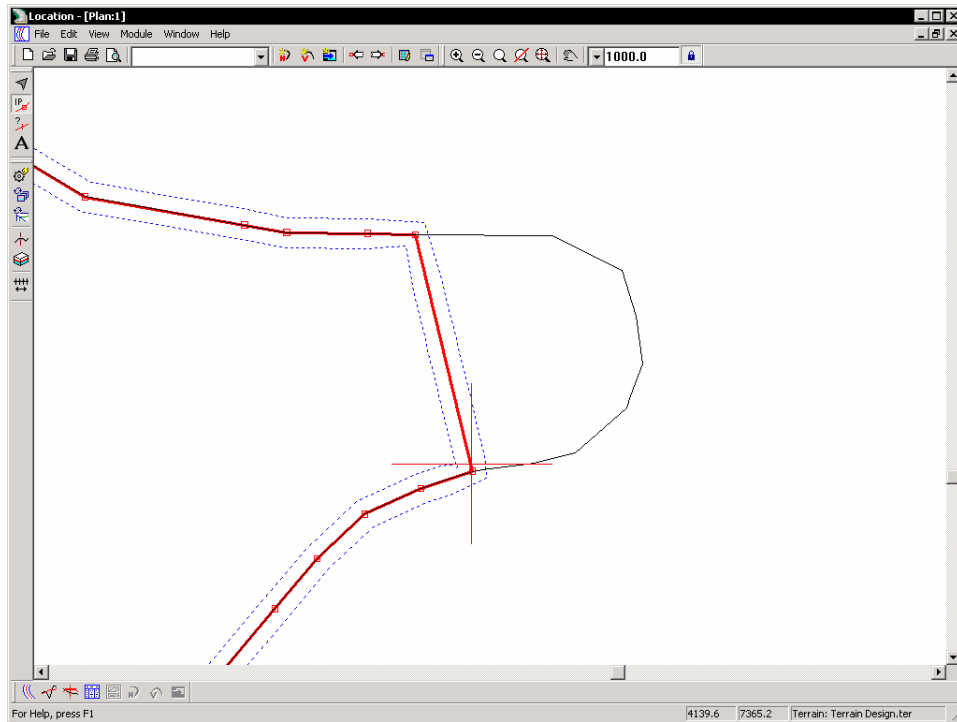


Figure 5.16: Switchback Curve

2. Delete the points that are missing in the Figure 5.17 (Review the section *Editing with the mouse in Profile or Plan* to explain deletion of points). You may safely ignore the P-Line/L-Line reversal warning – this is a temporary problem; click *Do not show me this message again* before *OK*.



*Figure 5.17: After Deletion of Points Along Switchback*

3. Create two new points as shown in the Figure 5.18 (without the labels!).

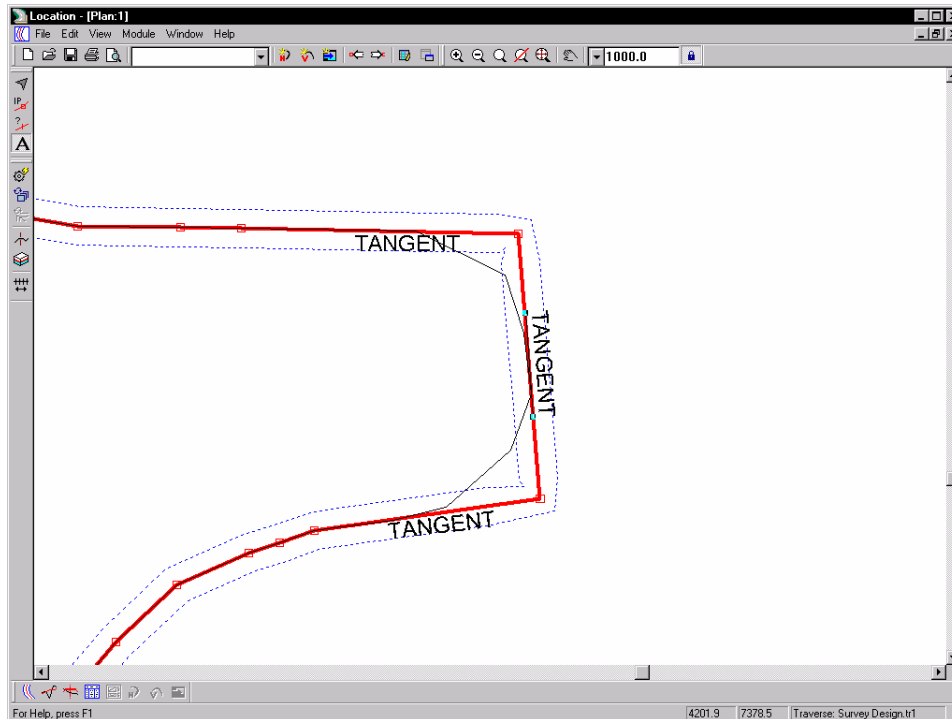





Figure 5.18: Two IPs and Three Tangents

4. Press the *Horizontal Curves*  button to activate the horizontal curves panel.
5. Maximize the plan window again.
6. Press either the *Previous* or *Next IP*   buttons (depending on where the cross-hairs are located) until the current point is the first of the two new IPs (the lower one on the screen).
7. Press *Circle* and then type in the following information in the upper part of the Horizontal Curves Panel and then press *Apply*. The curve will appear (with *BC*, *EC* and *Radius* labels).

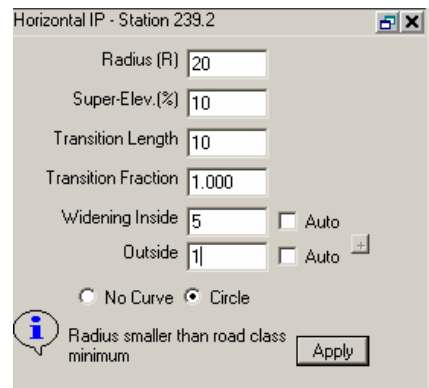





Figure 5.19: Horizontal Curves Panel

8. Press the *Set Default Curve*  button.
9. Press the *Next IP*  button to move to the other IP.
10. Press the *Get Default Curve*  button and press *Apply*. The screen should look similar to the Figure 5.20

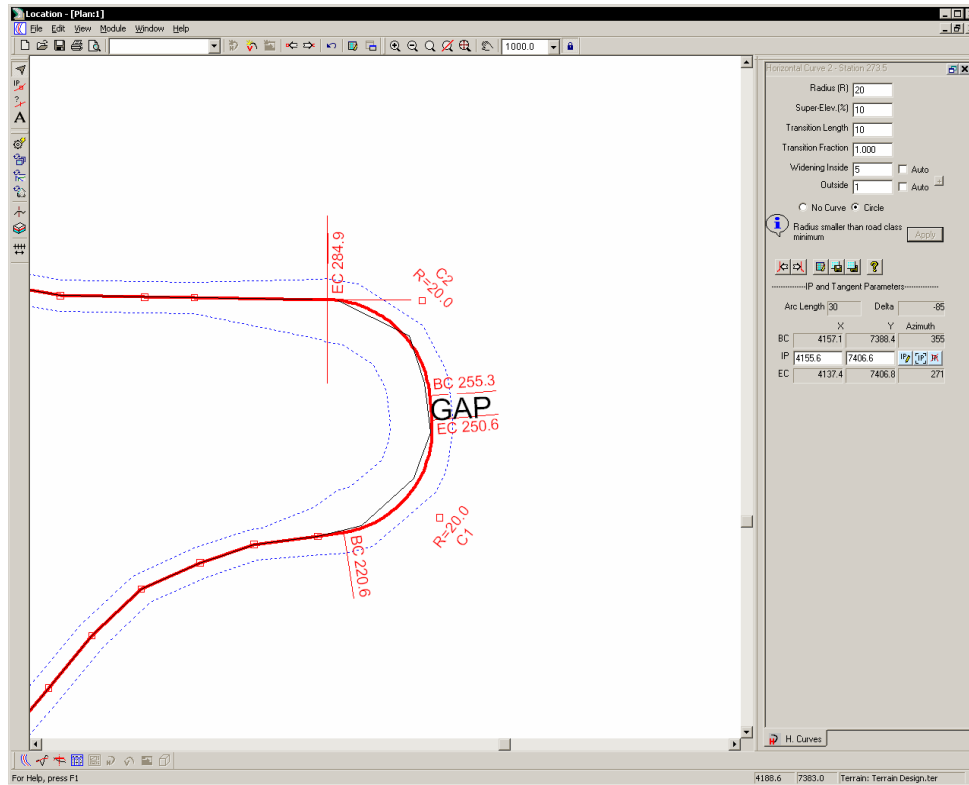


Figure 5.20: Two Curves of 20 Meter Radius

11. There are two ways of closing the gap to make a more continuous curve: move the IPs or change the radii.
12. Change the radius of the current curve to 50.0. This is too large for the tangents and you will be prompted (note that the *Apply* button is disabled).

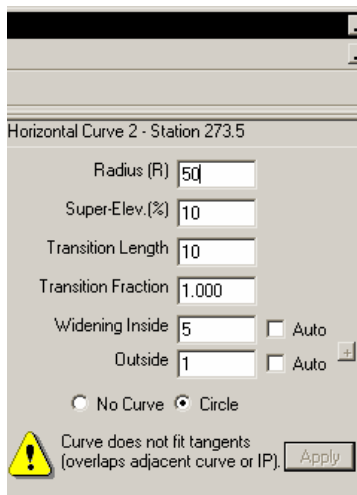


Figure 5.21: Radius Too Large Prevents Curve Application

13. Try smaller and smaller radii until you can *Apply* the updated curve. If your tangents are identical to those in the Figure above  $R=25.0$  will work.

While the previous step reduced the gap it also created an asymmetric curve.

14. Move to the other IP and try changing the radius to be the same as the one that you chose in the previous step. Likely this *Curve does not fit tangents* because the other curve has used up the space in the shared tangent.
15. By trial and error change the radii of both curves so that they are equal and still fit the tangents – don't forget to press *Apply* after every change. If you found in the previous steps that  $R1=20.0$  and  $R2=25.0$  produced curves with a small gap then  $R1=22.5$  and  $R2=22.5$  will probably fit nicely – *split the difference*.
16. Now use the mouse to move one of the two new IPs closer to the other until any remaining gap disappears (the computer beeps when you bump the curves together). Once completed the switchback should resemble Figure 5.22.

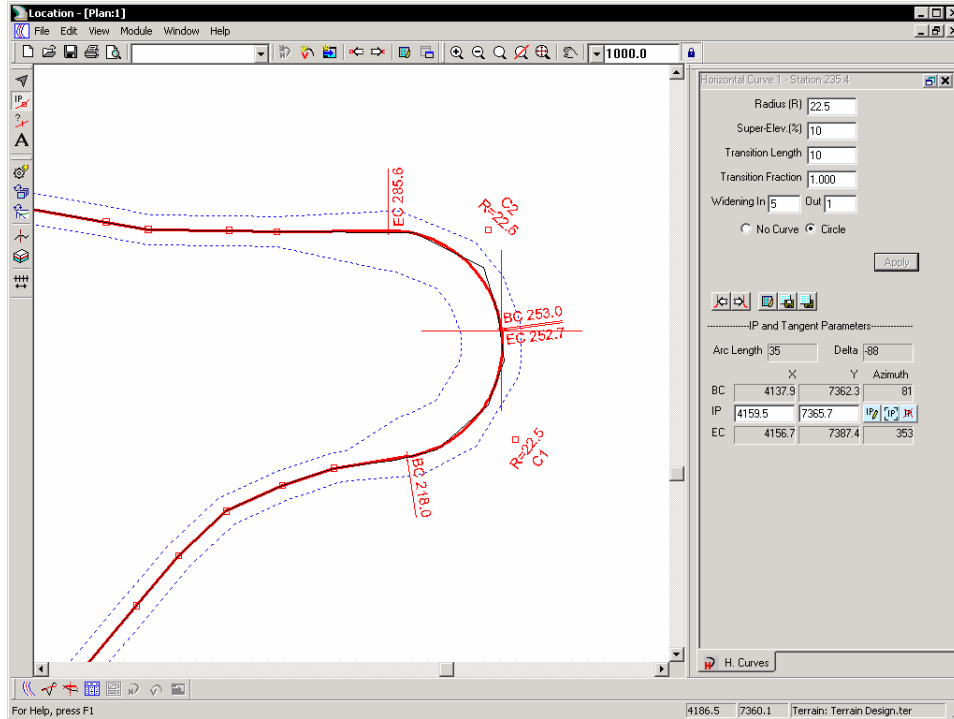


Figure 5.22: Finished Switchback After Moving IP's

An alternate technique:

- Move the IPs away from the P-Line so the bigger radii will fit the tangents.
- Create the two curves with the same desired radius.
- Move the IPs until the alignment is close to the P-Line *and* the curves are continuous.

**NOTE:** There is still a small gap between the two curves in the figure above (0.3m). As of this printing there are technical reasons for a non-zero space between EC and BC for adjacent curves. This may change in future software releases.

Notice that the road edges do not follow the centerline smoothly around the curve. This is a result of not enough calculated cross sections along the curve. This can occur on any kind of alignment but sharp curves are the most visible.

17. Edit|Auto Generate, and type in the information shown in the dialog below. Press OK. The road edges should look more like the Figure 5.23 below. Compare figures and notice that the road edges are smoother after this step. There is a tradeoff: too many cross sections can slow calculations.

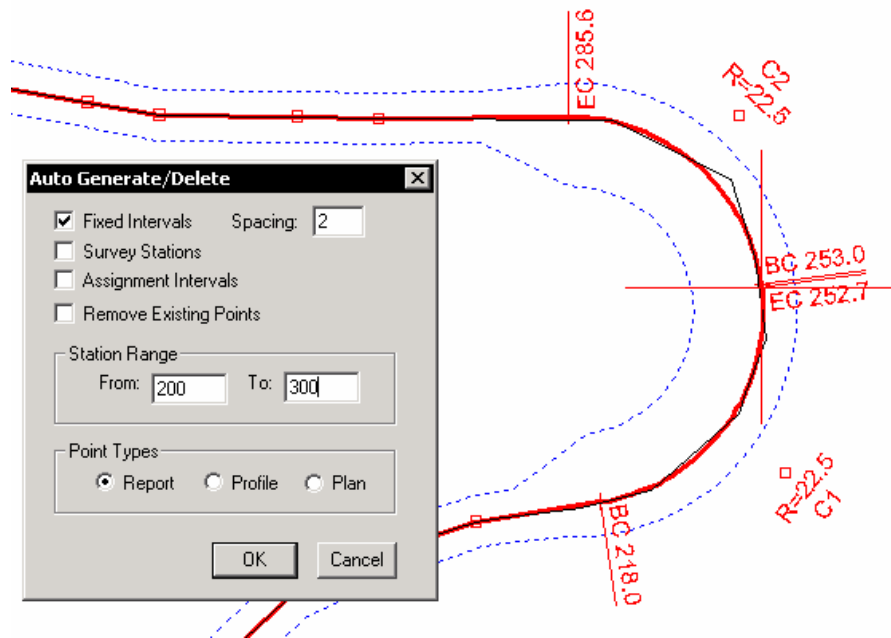


Figure 5.23: Edit | Auto Generate Dialog and the Smoothing Effect of Adding REPORT Points

18. File|Close. Do not save changes.

## Vertical Alignment – An Overview

Vertical design involves adjusting alignment grades and elevations to provide the best compromise between various constraints. Simple geometric constraints may

include minimum curvatures and maximum allowable grade. The vertical alignment also affects earthwork volumes. However, horizontal alignment and template shapes also contribute to volumes and must be considered at the same time for a real design.

Before starting, it is recommended that you review the material covered in *Editing With The Mouse* and *Starting A New Design*.

Vertical alignment is the same whether you created your design from a P-Line traverse (.TR1 file), from a Terrain model (.TER file) or from both (see *Starting a New Design* section). This example starts with a design created from both a P-Line and a Terrain.

## *Vertical Alignment – With Grade and Volume*

### *Constraints*

In this section a segment of road will be vertically aligned while staying within grade constraints and avoiding large fills.

The alignment in this example consists of many short tangents with small grade breaks between them and no curves; it is assumed that the corners will be smoothed during construction of the road. This kind of design is often suitable to low volume road design.

---

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

---

1. File | Open \RoadEng\Tutorial\Location\combo design-V.DSN. Press Open.
2. File | Retrieve Screen Layout; select **RoadEng\Tutorial\Location\profile.DLT**. This will set up the windows to display feedback appropriate to this example.

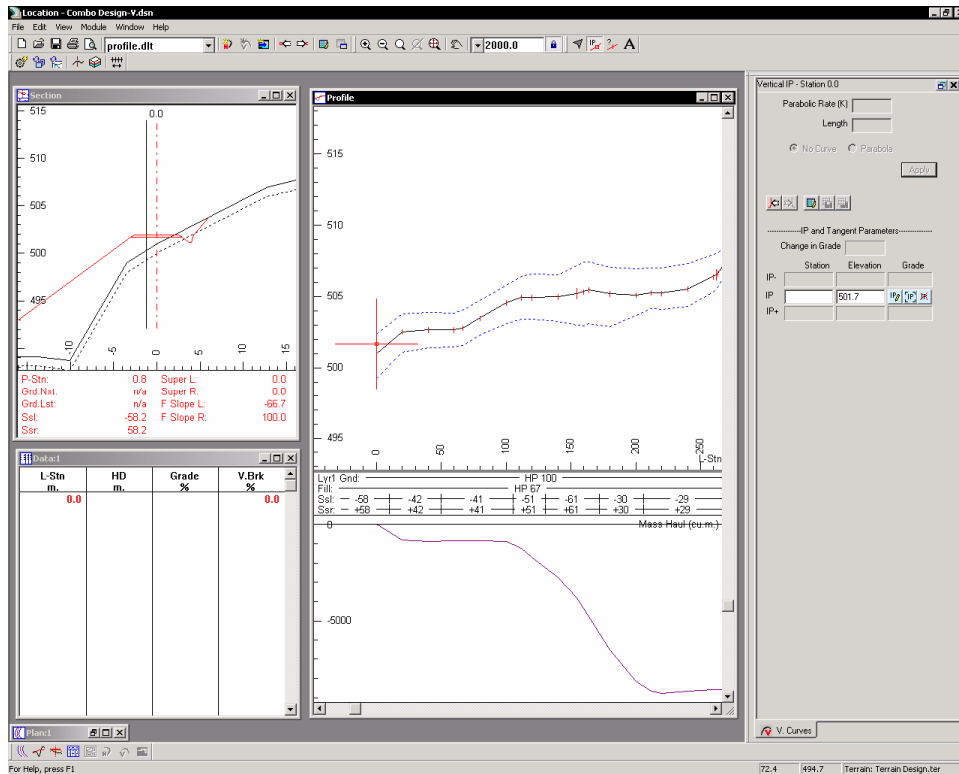
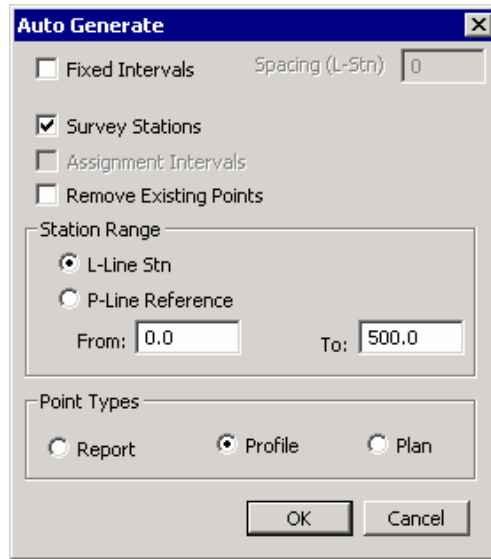


Figure 5.24: Screen After Opening Screen Layout


This design already contains horizontal alignment. Vertical alignment is impossible unless there is some horizontal alignment to follow (even if it is just the default P-Line alignment).

The vertical alignment, however, is undefined (cross sections are assumed to have the sub-grade at the Ground elevation when no vertical alignment is specified).

3. Select the Edit | Auto Generate menu item. Set up the dialog box to create VIPs (Vertical Alignment Points or *Profile* points) at *Survey Stations* (see figure below). Note that the station range does not include the whole road. Press *OK* to create an initial vertical alignment.



*Figure 5.25: Auto Generate Dialog  
Set up to Add IPs at Surveyed Stations*

4. Use the *Next IP*  button in the Vertical Curves panel to move along the alignment. Watch the Section window and keep moving until you get to station 164 (see Figure 5.26).

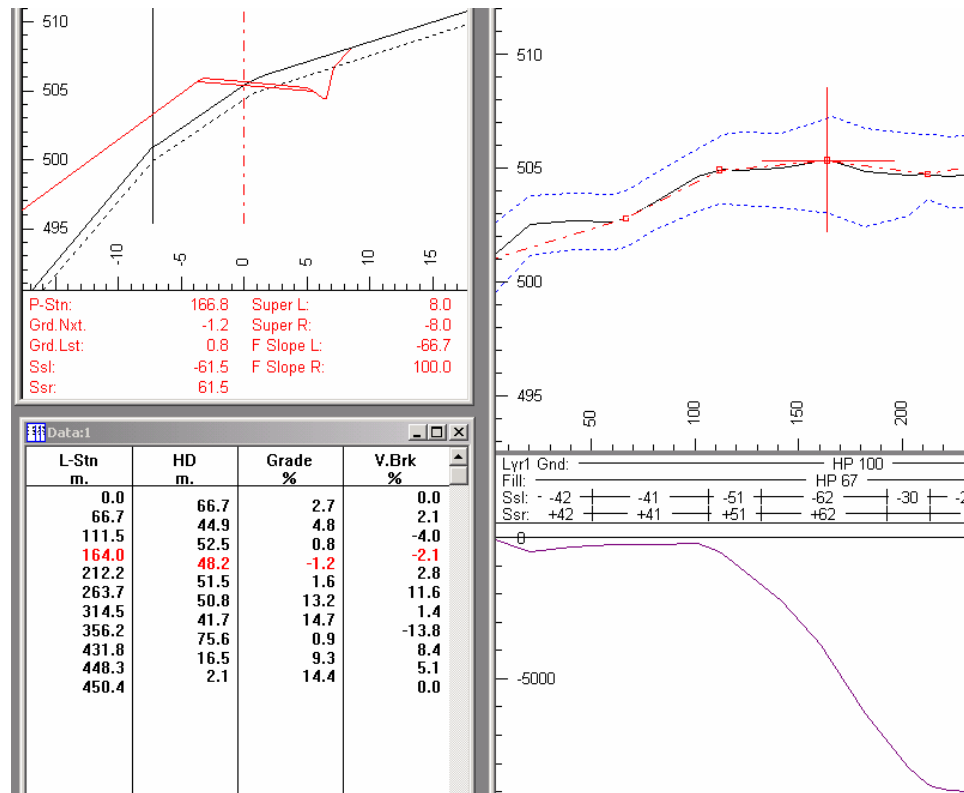


Figure 5.26: Excessive Fill Before Vertical Alignment

The cross section above shows a large fill that could be reduced by lowering the elevation of the alignment at this point. The *Mass Haul* diagram at the bottom of the Profile window also indicates a large fill.

5. Capture the VIP at this station with the mouse and move it *down* before re-anchoring it. You may work in the Profile window or the Section window (see the *Getting Started* chapter for information on point editing).

Notice how the Mass Haul changed after your edit (read the volume axis because it automatically scales).

- Continue to adjust this same VIP until the Section and Profile windows appear similar to the figure below.

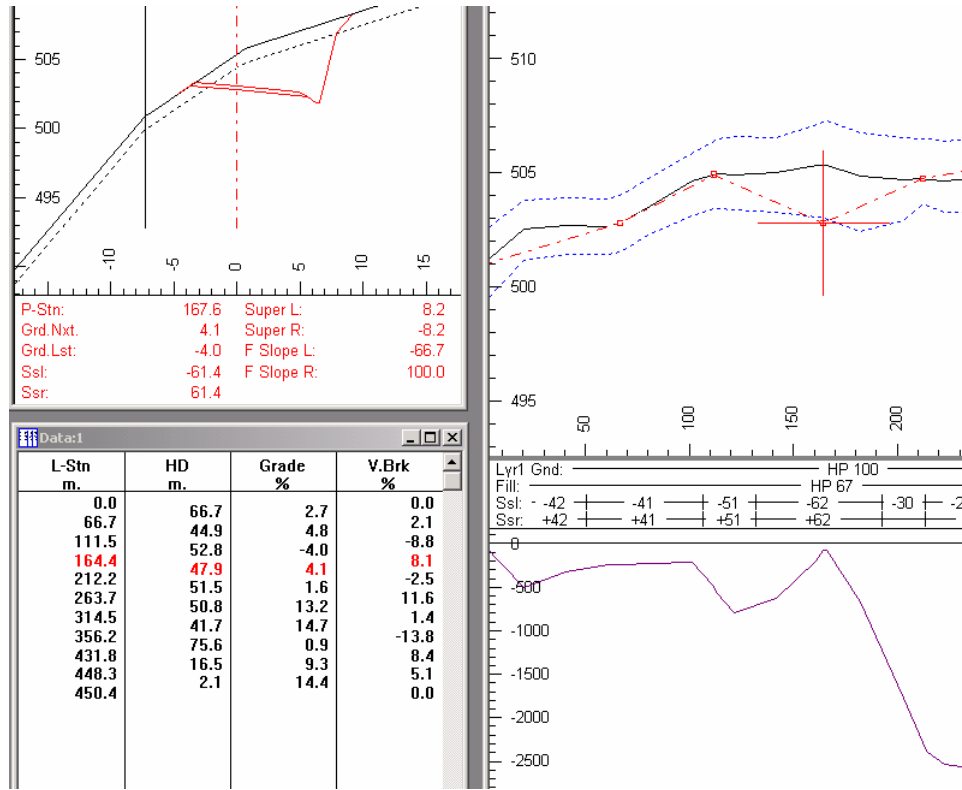
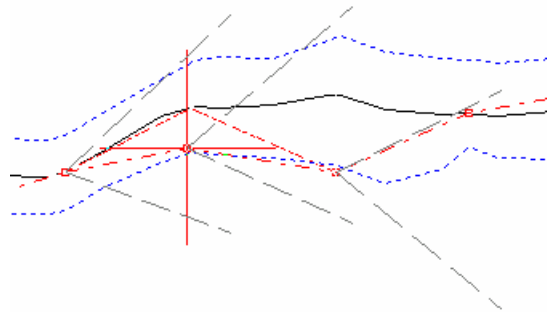


Figure 5.27: No fill (full bench cut) After Vertical Alignment

**NOTE:** The dashed lines (blue) above and below the ground line are vertical projections of the *Road Edges* on ground (enabled in the Profile window options). The grade line must be under the lower of these for a *full bench* cross section (no fill).

7. Move your mouse cursor to the Profile window and capture the VIP just before the one you edited and notice the gray dashed lines that appear as you move the mouse as shown in Figure 5.28. These are *Grade Guides* (enabled and configured in the Profile window options). Also notice that the *Grade Nxt.* and *Grade Lst* items under the Section graphic are updating with you mouse moves.



*Figure 5.28: Point Captured in the Profile Window Showing Grade Guides*

8. Re-anchor your VIP so that the red grade lines lie inside the Grade Guides (shown in figure above).
9. Notice that the Data window shows the current point highlighted in red and the grades and grade breaks for all VIPs.
10. Vertically align from the start of the road to station 350 until there are no more excessive fills, the maximum grade is 10% and there are no grade breaks greater than 6.0% (Figure 5.29). You can move *or* delete vertical VIPs.

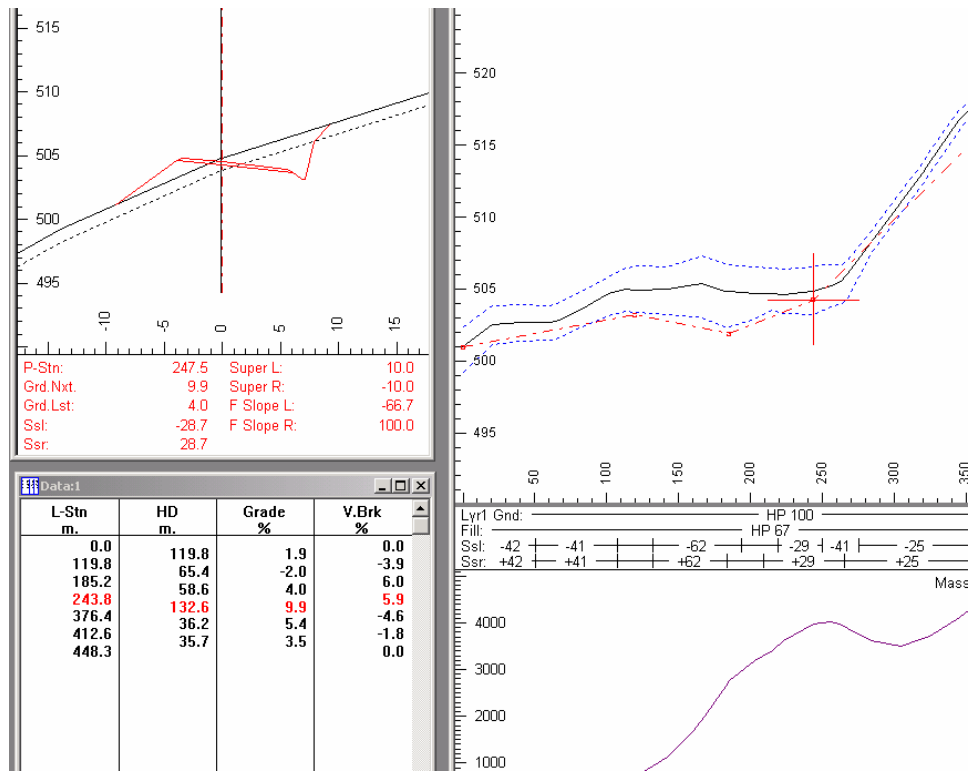


Figure 5.29: After Aligning the First Section of Road

In this section you have vertically aligned a few VIPs while paying attention to several types of feedback:

- Cross section qualitative appearance.
- Mass Haul volumes.
- Profile projection of *Road Edges*
- Profile *Grade Guides*.
- Section Grade display
- Data window *Grade* and grade break (*V. Brk*)

There are other sources of information that may also be useful:

- Profile and Section display of ground side slopes (*Ssl*, *Ssr*)
- Plan window *Slope Stake* display.

Changing the window display options or *Screen Layout* would allow you to see a different set of design parameters.


11. File | Close. Do not save changes.

## Vertical Alignment – Creating tangents for Curves

Vertical curves (see also next section) require the design of tangents before the curve can be created. The incoming *tangent* intersects with the outgoing *tangent* to define the *curve IP*. This section deals with two ways to create tangents.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

For simplicity, volumes and unstable cross sections will be ignored in this example (see the previous section, *Vertical Alignment – With Grade and Volume Constraints*, for more coverage of this).

1. File | Open. Select **\RoadEng\Tutorial\Location\Vertical curves.DSN**. Press Open
2. File | Retrieve Screen Layout. Select and retrieve **\RoadEng\Tutorial\Location\v-curve.DLT**. This will set up the windows to display feedback appropriate to this example
3. Zoom out until you can see the whole profile – if you don’t have a roller mouse use the Zoom Extents  button.
4. Zoom in on the start of the road indicated by the red cross-hair.

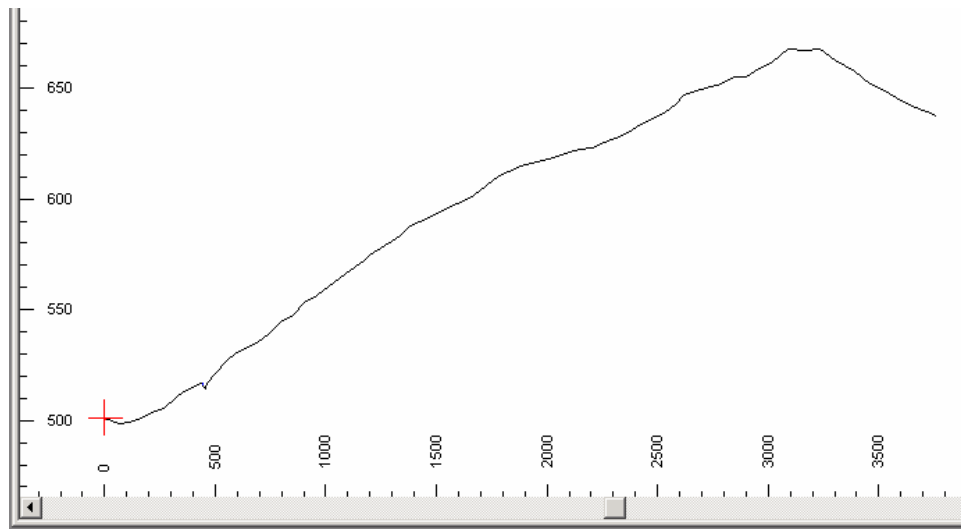



Figure 5.30: The Whole Profile

The next step is to create tangents to create the pre-curve alignment. New tangents will be created with the mouse and the Vertical curve panel (see Editing with the Mouse in Profile or Plan).

5. Use the mouse (*Add/Edit IP Tool* cursor ) to create the tangents as shown in the Figure 5.31.

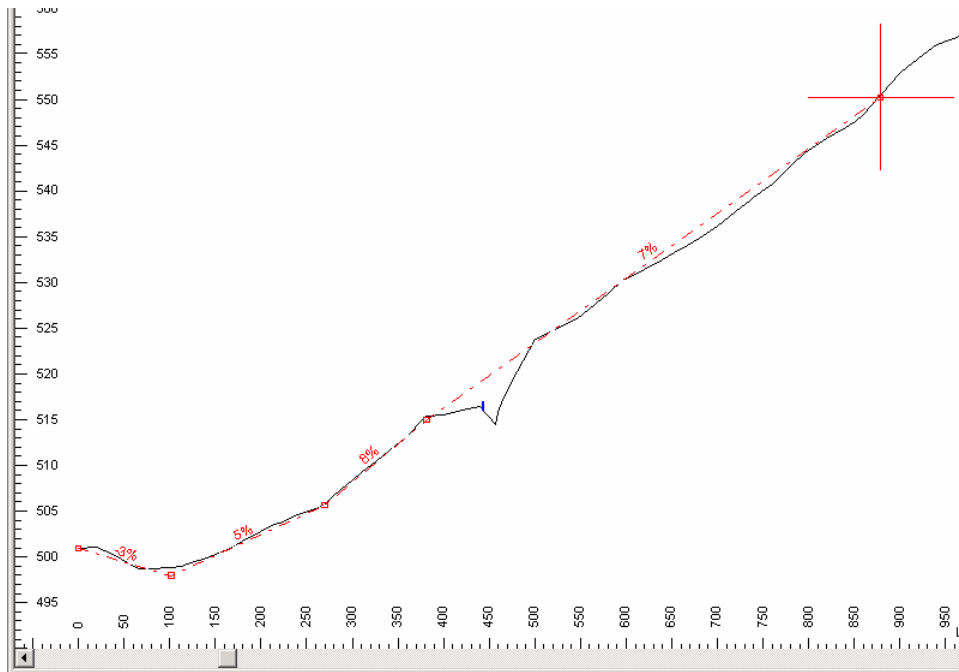


Figure 5.31: Plan View Showing New Tangents


In addition to the labels on the Profile, the Data window shows information about the new tangents as shown below.

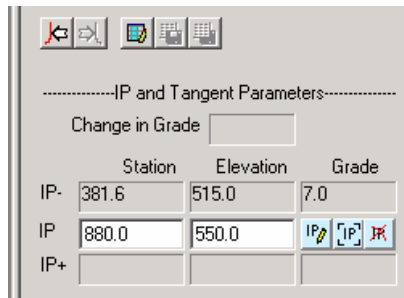
| L-Stn<br>m.  | HD<br>m. | Grade<br>% | V.Brk<br>% |
|--------------|----------|------------|------------|
| 0.0          | 101.6    | -3.0       | 0.0        |
| 101.6        | 168.5    | 4.6        | 7.5        |
| 270.1        | 111.5    | 8.4        | 3.8        |
| 381.6        | 497.0    | 7.1        | -1.3       |
| <b>878.6</b> |          |            | <b>0.0</b> |

Figure 5.32: Data Window Showing Grade and Grade Break (V. Brk.)


The Data window gives length and grade feedback about all tangents. The Vertical Curve panel displays similar information about tangents containing the current point. With this feedback available, it is possible to use the mouse to get close to any desired results by trial and error.

To define tangents with exact grades and lengths it is necessary to use the Vertical Curve panel.

6. Press the *Next IP*  button (if enabled) in the Vertical Curve panel to make sure that the cross hair is on the last point in the design. If it is grayed out, you are at the last IP.
7. Type **880** into the *Station* field and **550** into the *Elevation* field in the *IP and Tangent Parameters* area of the Vertical Curve panel. Press *Apply* to update the design.



The screenshot shows a software interface titled "IP and Tangent Parameters". It features a "Change in Grade" input field at the top. Below it is a table with three columns: "Station", "Elevation", and "Grade". The table contains three rows: "IP-" with values 381.6, 515.0, and 7.0; "IP" with values 880.0, 550.0, and a button labeled "IP" with a pencil icon; and "IP+" with empty fields. To the right of the "IP" row are three buttons: "IP" (with a pencil icon), "IP" (with a magnifying glass icon), and "OK" (with a red X icon).

|     | Station | Elevation | Grade   |
|-----|---------|-----------|---|
| IP- | 381.6   | 515.0     | 7.0   |
| IP  | 880.0   | 550.0     |  |
| IP+ |         |           |   |

*Figure 5.33: Using the Vertical Curve Panel to Define Station and Elevation of an IP*



8. Press the *Add New IP*  button. Type **500** into the *HD* field and **7.5** into the *Grade %* field. Press OK to add a new point. Confirm that the Data window shows the same values.

Figure 5.34: Add Vertical IP Dialog Box

9. Press the *Add New IP*  button again. This time type **-2** into the *Grade Brk* field (the *HD* value will already be the same as for the previous tangent) Press OK to add a second new point.
10. Continue adding and modifying tangents until you are comfortable with the process.

Neither of the methods used above for creating tangents is more correct than the other, both allow creation of curves afterward.

11. File | Close. Do not save changes

## Adding Vertical Curves- Simple Mode

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

The tangents created in the section above are now ready for vertical curves.

1. File|Open. Select and open,  
**\RoadEng\Tutorial\Location\vertical curves 2.DSN.**

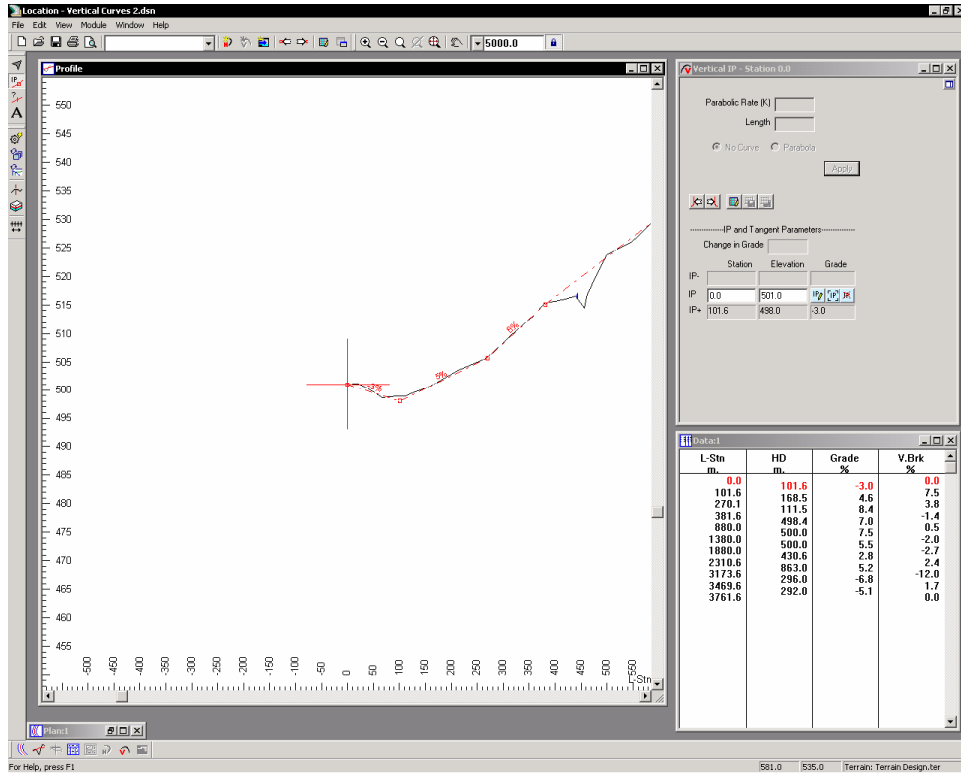



Figure 5.35: Vertical Curves 2.DSN

2. Press the *Next IP*  button in the vertical curve panel.
3. Select *Parabola* in the top of the panel as shown in the Figure 5.36, and then type in *K* or *Length* (*K* and *Length* are **not** independent once the tangent grades are fixed). Press *Apply*.

Vertical IP - Station 101.6

Parabolic Rate (K)

Length

No Curve  Parabola

Apply

-----IP and Tangent Parameters-----

Change in Grade

|    | Station | Elevation | Grade |
|----|---------|-----------|-------|
| BC | 26.5    | 500.2     | -3.0  |
| IP | 101.6   | 498.0     |       |
| EC | 176.7   | 501.4     | 4.6   |

Figure 5.36: The Vertical Curves Panel

The new curve is now visible in the Profile window; note the *BVC* (Begin Vertical Curve), *EVC* (End Vertical Curve) and curvature labels.

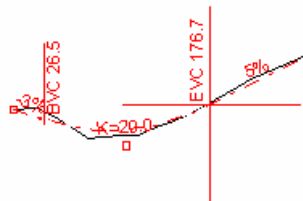






Figure 5.37: Vertical Sag Curve

4. Press the *Set Default Curve*  button. This will save curve parameters for future use. Note that default curve parameters are saved with the Template table.
5. Press the *Next IP*  button in the vertical curve panel.

6. Click on the *Get Default Curve*  button in the curve panel and then press *Apply*. A new curve with the same K value as the first one is inserted.
7. Move the mouse cursor over the new curve IP (next to the K label); notice that the *edit* cursor  appears (you should still be in *Add/Edit IP* mode). Capture the curve IP and notice that both curves adjust to fit as you move the mouse around. Also notice that the *IP and Tangent Parameters* fields at the bottom of the curve panel are also updating dynamically as you move the mouse.

If you move the IP so that the curve does not fit the tangents the computer should beep and the tangents will stop following the mouse.

8. Modify tangents and add curves throughout the design until you are comfortable with the process. Note that small grade breaks do not require a designed curve for a low volume road.
9. File | Close. Do not save changes.

## Templates

Cross section templates define parameters such as road width, ditch depth and cut/fill angles. It is possible to create a set of standard templates for use in common situations. It is also possible to use custom templates to accommodate unusual design situations such as retaining walls or fill widenings.

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Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

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1. File|Open, Select **\RoadEng\Tutorial\Location\template.DSN**. Press Open.
2. Choose menu item Edit|Edit Templates.

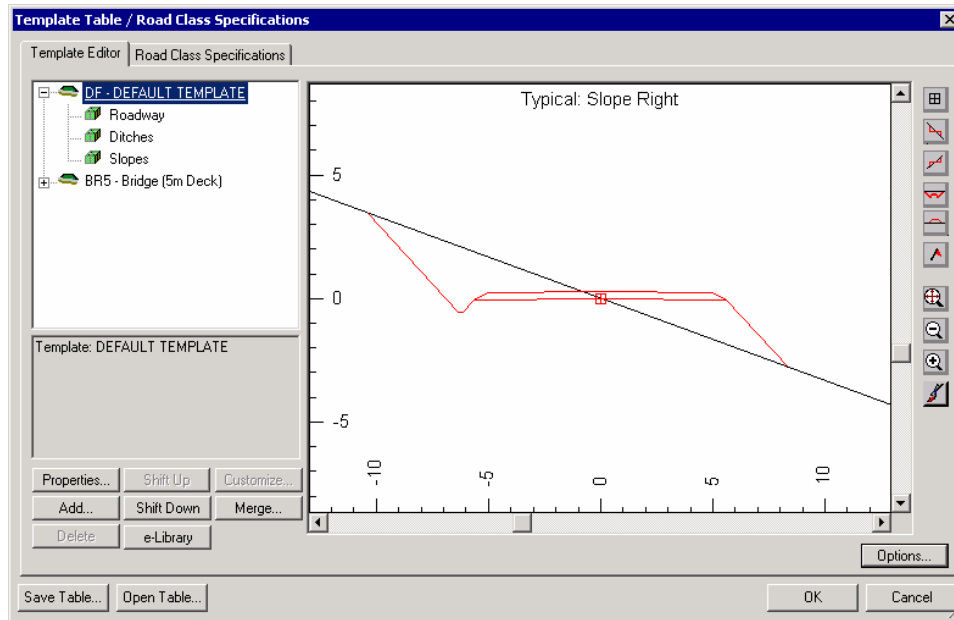


Figure 6.0: Edit / Edit Templates Dialog Box.

3. Click on the + sign beside *DF-DEFAULT TEMPLATE* to view the components (*Roadway*, *Ditches*, and *Slopes*) of the template as shown in the figure above.
4. Double click on *Roadway* to activate the Roadway properties dialog box.

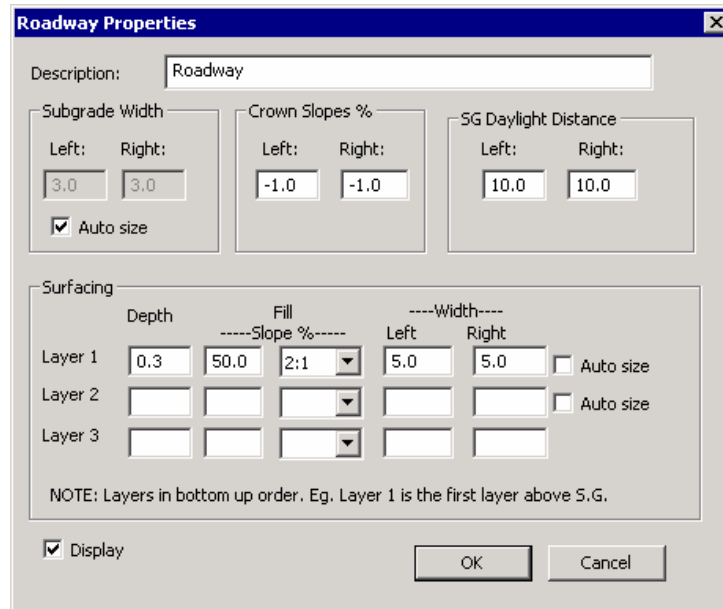


Figure 6.1: Roadway Component Properties

5. In this dialog the user can change sub-grade width, crown slopes, sub-grade daylight distance and add in up to three surfacing layers. For each surface, the depth, side slope and width can be changed. Press *Cancel*.
6. Double click on *Ditches* to open the Ditch Properties dialog box.

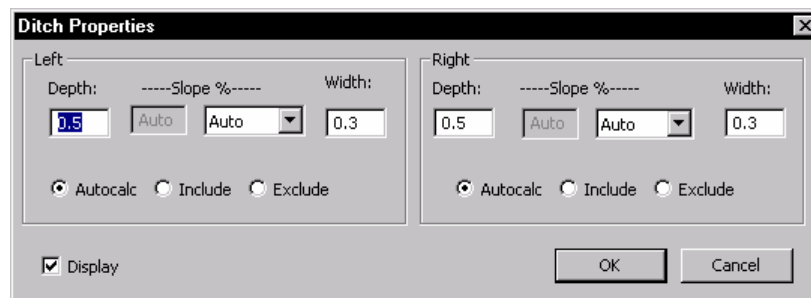


Figure 6.2: Ditch Properties Dialog

7. In this dialog the user can specify a left and right ditch depth from top of sub-grade, side slope and width of the ditch bottom. Also, the ditch can be *Included* or *Excluded* if *Autocalc* does not produce desired results. Press *Cancel*
8. Double click on *Slopes* to examine Slope Properties.

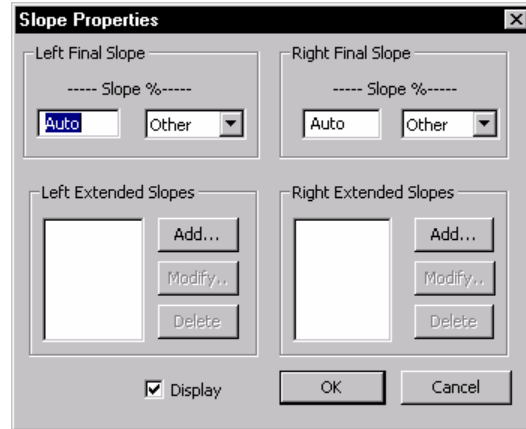


Figure 6.3: Slope Properties Dialog

9. In this dialog the user can change the left or right final slope. If *Auto* is chosen, as is shown in the figure above, the slopes for cuts and fills will be taken from the material types found in the ground or used for fill respectively (*Edit |Edit Ground Types* allows you to define cut and fill angles for a table of materials). Choosing anything other than *Auto* will fix the slope and ignore the ground types. This dialog can also be used to define more sophisticated compound slopes. Press *Cancel*

### Creating a Widening Template

The use of templates will be illustrated by creating and assigning a Widening Template.

- Click to select *DF-DEFAULT TEMPLATE* (this will define the starting parameters for your new template). Press the *Add* button and type in the information shown in the Template Properties Dialog below. Press *OK*.

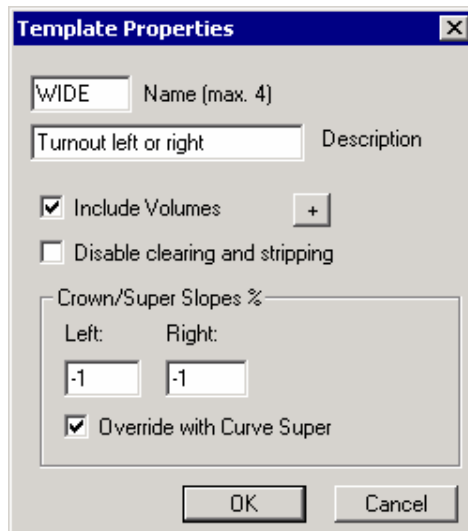


Figure 6.4: Template Properties Dialog

Notice that the *Turnout left or right* template is now added to the template table.

- Double click on *WIDE-Turnout left or right* and the three template components will appear.
- Double click on *Roadway* to activate the Roadway Properties dialog shown in the Figure 6.5

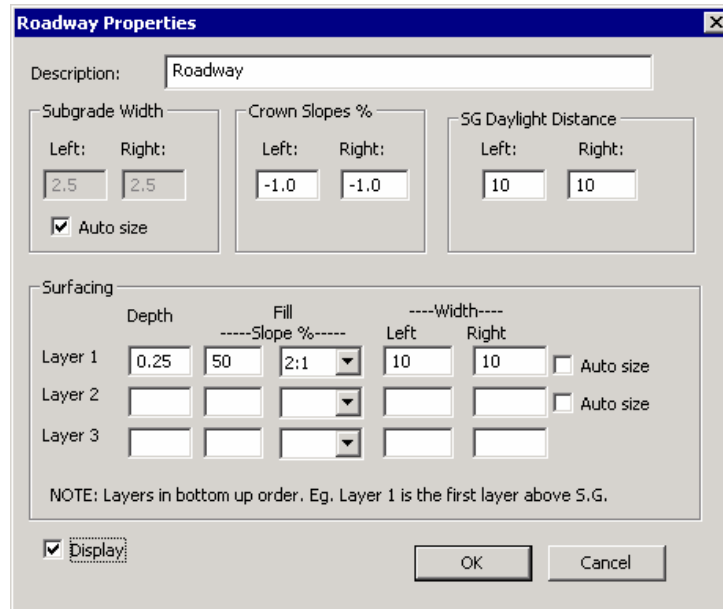


Figure 6.5: Roadway Properties Dialog

13. Change *Layer 1 Left* and *Right* widths to 10 (as shown above). The underlying sub-grade width will automatically adjust to match the surface width because *Match Surfacing* is on. Press *OK* to update the template.
14. Click on the *Road Class Specifications* tab; the dialog box shown below will be exposed. The description and specifications defined here are saved with the template table.

Template Table / Road Class Specifications

Template Editor | Template Codes | Road Class Specifications

Road Classification

Description: Two Lane Grave

Design Speed (km/hr): 60

Driver Limitations:

Reaction Time (s): 2.5

Eye Height: 1.08

Object Height: 0.6

Simple Curves

Vehicle Limitations:

Minimum Radius: 50

Minimum Sag K: 10

Minimum Crest K: 10

Deceleration m/s/s: 2.943

Acceleration m/s/s: 0.981

Max Grade: 10

Min Grade: -10

Max Super Elevation: 10

Save Open OK Cancel

Figure 6.6: Road Class Specifications

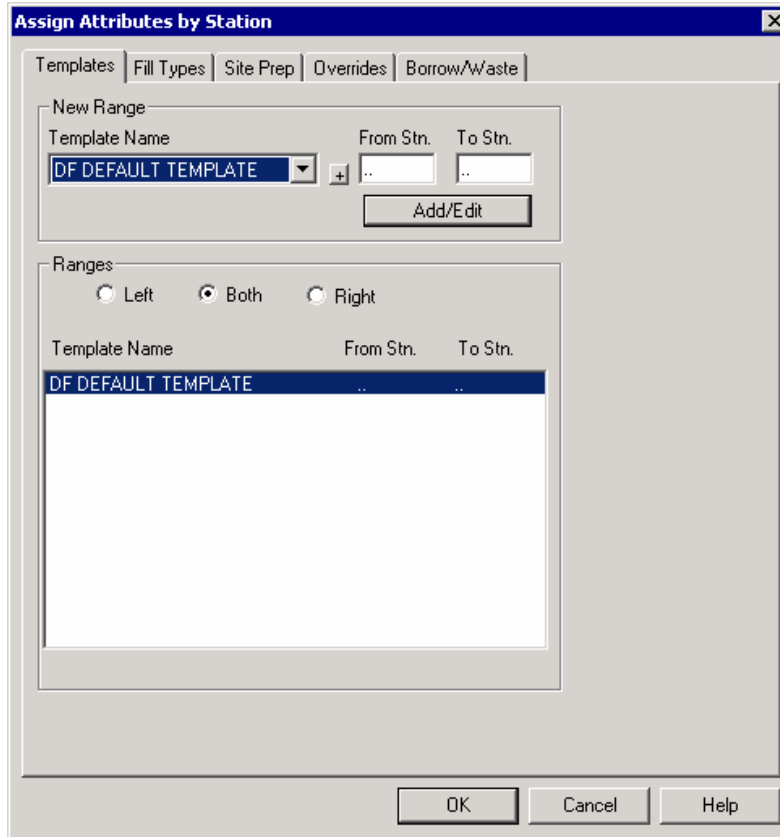
15. Press the *Save* button and you are prompted you to save this template table as a file (\*.TPL), so that you can use it for another design. Press *Cancel* to abort.

**NOTE:** \Roadeng\normal.TPL is the default template table loaded for new designs. You can use the *Save* button in the Edit|Edit Templates dialog box to create your own tables or to modify normal.TPL the *Open* button will load a template table from file.

16. Press *OK* to exit the *Template Table/ Road Class Specifications Edit* dialog box.
17. Respond *No* to the re-calculate the alignment prompt as there were no changes to applied templates.

## Assigning a Widening Template

- Choose the menu Edit | Assign Parameters By Range to open the dialog box shown in the figure below.



*Figure 6.7: Assign Parameters by Range Dialog Box*

The station range for a desired widening is 825 to 875 and it will only be applied to the right side. Before assigning the widening template a Taper template will be assigned.

**NOTE:** A Taper template creates a smooth transition between two different templates.

19. Press the *Right* radio control as shown in the Figure 6.8.
20. Select the Taper template in the *Template Name* pull-down and type **800** in the *From Stn* field and **900** in the *To Stn* field. Press the *Add* button.

| Template Name       | From Stn. | To Stn. |
|---------------------|-----------|---------|
| DF DEFAULT TEMPLATE | ..        | 800.0   |
| TP Taper Template   | 800.0     | 900.0   |
| DF DEFAULT TEMPLATE | 900.0     | ..      |

Figure 6.8: Assign the Taper First

Notice that the Taper template is allocated to the station range 800.0 – 900.0.

**NOTE:** If you leave the *From Stn.* and *To Stn.* fields blank in the *Assign Templates* dialog box and press *Add*, the selected template will be applied over the whole road (0.0+).

21. Select the **WIDE** template in the *Template Name* pull-down and type **825** into the *From Stn* field and **875** into the *To Stn* field. Press the *Add* button.

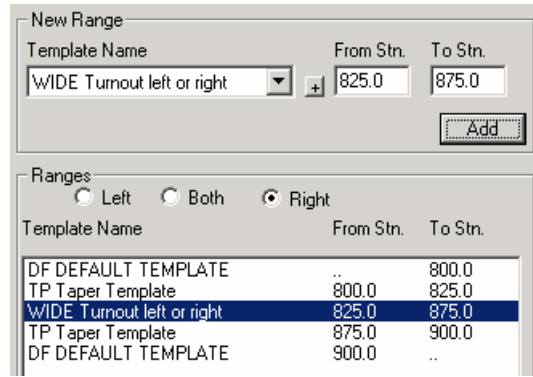


Figure 6.9: Assign the Turnout Next

Notice that the *WIDE* template splits the Taper template station range, leaving 25 meters of taper before and after, as shown in the figure above.

22. Press *Both* and then *Left* and notice that taper (TP) and widening (WIDE) get applied only to the right side and the default (DF) template gets applied to the left.
23. Press OK after you are done, and respond *Yes* to the recalculation prompt.



Figure 6.10: Plan Window After Applying Taper and Widening Templates.

### Assigning a BridgeTemplate

24. Type <Control + J> and jump to station 450.
25. Use the Edit | Assign Parameters by Range dialog box to assign *BR5 Bridge (5 m deck)* template to *both* sides in the station range 440-460 (no taper) – see figure below. Press OK, and respond *Yes* to recalculation prompt.

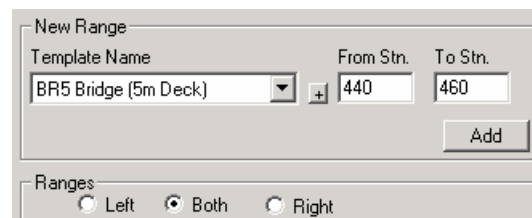


Figure 6.11: Assign the Bridge Over the Creek

Note that the cross section no longer shows fill slopes.

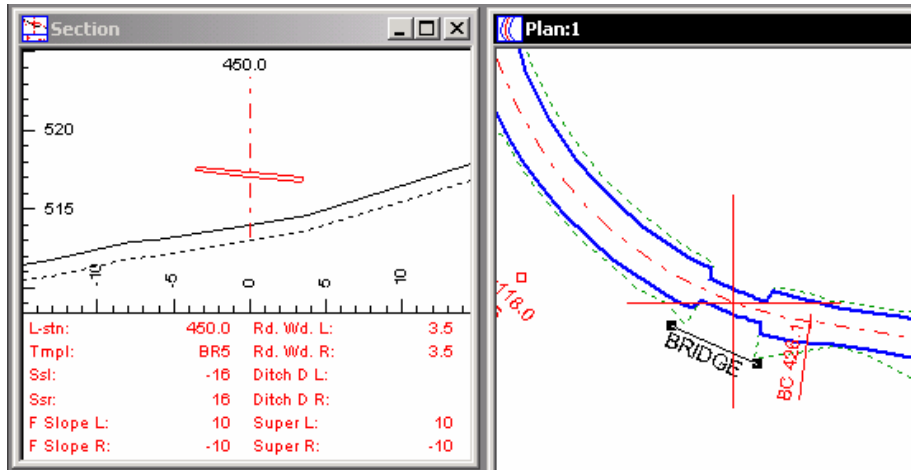



Figure 6.12: After Applying Bridge Template.


### Smart Templates

Properties of the template can be over-riden by Culvert and Curve properties. This greatly reduces the number of templates and assignments required.

26. Use <Control + J> to jump to station 189.1. Note the ditch depth of 1.0m shown in the cross Section (*Ditch D R*).
27. Use the *Next Point*  button to move away from the culvert and watch the Section window change.

**NOTE:** Culverts can override the template ditch parameters to create an automatic catch basin (see the *Culverts* chapter).

28. Use <Control + J> to jump to station 500. Note super elevation and extra road width shown in the cross Section and Data windows.

29. Use the *Next Point*  button to move through the curve and watch the Section window change.

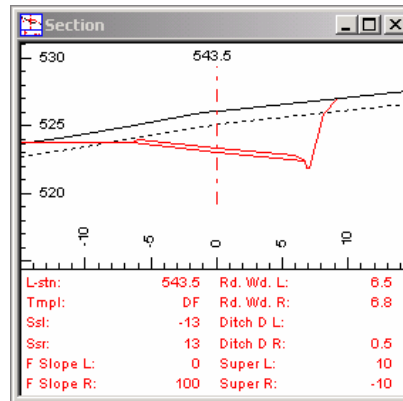


Figure 6.13: A Section Showing Curve Widening, Super Elevation, Daylighting and Cut Slopes Based on Material Type.

**NOTE:** Curves can override the template crown slope and road width parameters to automatically super-elevated and widen the road (see the *Adding Horizontal Curves* section).

**NOTE:** Materials in the ground (see figure above) can override the template cut/fill slopes.

30. File|Close. Do not save changes.

### Template Editor Tips - Did you know...

- ◆ You can merge one library of templates with another library by pressing the *Merge* button in the *Template Table and Road Class Specifications* dialog box.

- ◆ That you can change the *Daylighting distance* by double-clicking on the *Roadway* component and changing the *Sub-grade Daylight Distance*. Daylighting is defined in the figure below. If the horizontal distance from the road edge to the ground surface is less than the *Daylighting distance* the road will be extended horizontally until it meets ground, and no ditch will be created.

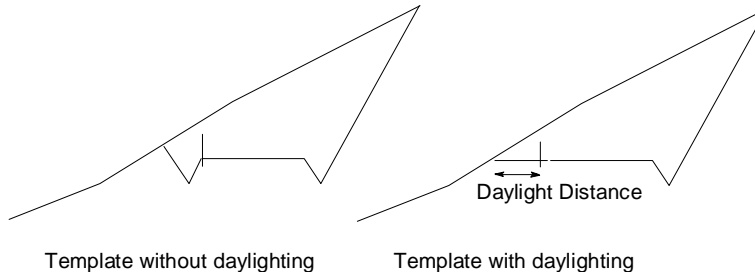


Figure 6.14: Daylight Distance

- ◆ You can add up to three surfacing layers, shoulders and their corresponding depths on top of the sub-grade elevation by double-clicking on the *Roadway* component.
- ◆ Power users can customize template components if the standard three (*Roadway*, *Ditches*, and *Slopes*) are not flexible enough. User defined template points can be displayed in the Plan Profile and Section windows (see the *Template Codes* tab in the Edit | Edit Templates dialog box – this requires the *Extended Templates* function group)

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## Culverts

Correct placement of culverts is important to road design. This section demonstrates how to design drainage structures at streams and cross drain culverts.

### Stream Crossing Culverts

If you use a P-Line traverse to create a new Location design (see the *Starting a New Design* chapter), a culvert will automatically be added at every stream defined in the traverse (*CRK* = creek column in the notes).


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Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

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In this example you will create a culvert at a stream crossing manually.

1. File|Open, Select **\RoadEng\Tutorial\Location\template.DSN**. Press *Open*.
2. File|Retrieve Screen Layout, Select and open **\RoadEng\Tutorial\Location\culvert.DLT**.

This screen layout was saved with the Culvert Panel open; you can also open the Culvert Panel from the Standard Tools toolbar , or from the Window | New Window menu.

3. Type <Control + J> and enter station **445**. Press *OK*.

Note the stream crossing the road just ahead of station 445 in the Plan window, shown in Figure 7.0

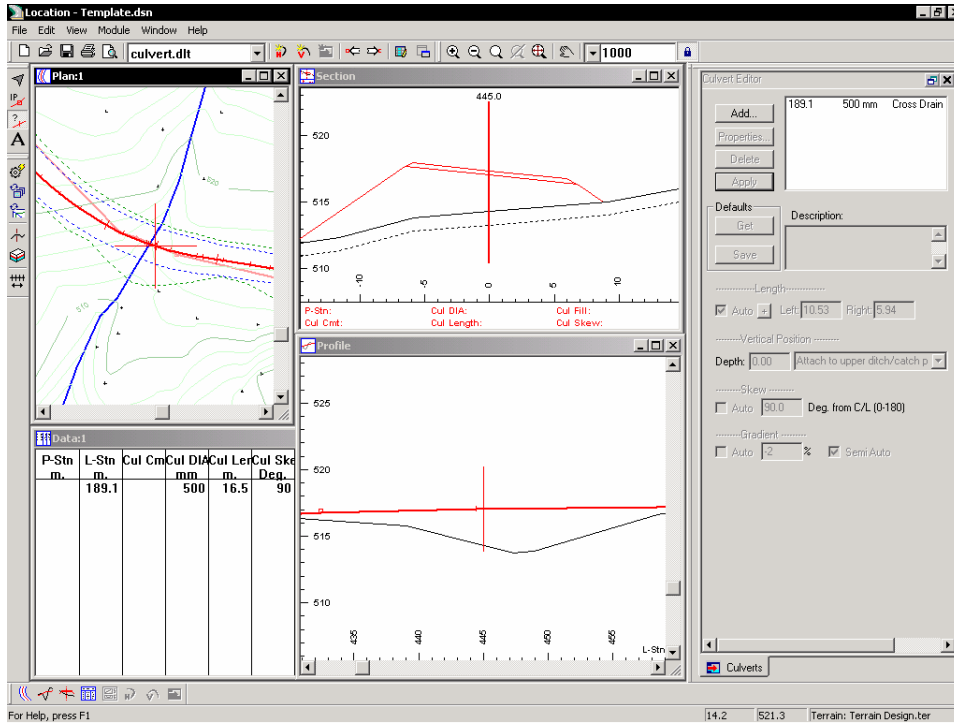


Figure 7.0: The Plan Window Shows a Stream (background Terrain graphic)

4. Right click in the Plan window and select the *Add/Edit Report Point Tool* (you could also use the *Mode Tools* toolbar).
5. Click in the Plan window to create a new Report point then move it over the stream (in figure above) and anchor. The Section will update to show the cross section at this point – it should be at approximately station **447**.
6. Click the *Add* button in the Culvert Panel (top right of your screen) and then select *Natural Channel (stream)*. Press *OK* to update the culverts list and all windows.

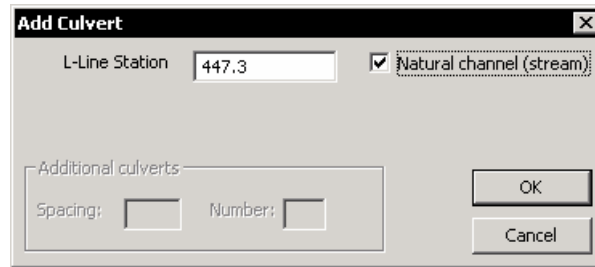


Figure 7.1: Adding a New Stream Crossing Culvert

- Note that the culvert does not calculate *Auto Length* very well. Type **-0.5** in the *Vertical Position, Depth* field (see figure below). Press *Apply*.

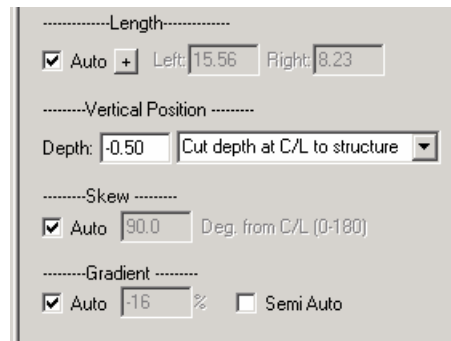


Figure 7.2: Parameters for a Culvert that Follows the Ground

Your culvert should now appear similar to the Figure 7.3. The *Auto Length* option causes the culvert to just fit between the fill slopes. The  $-0.5\text{m}$  value entered above is the *Cut Depth* at centerline; the negative value means that the culvert is above original ground instead of cut into it. The *Auto Gradient* option dips the culvert to fit the ground slope.

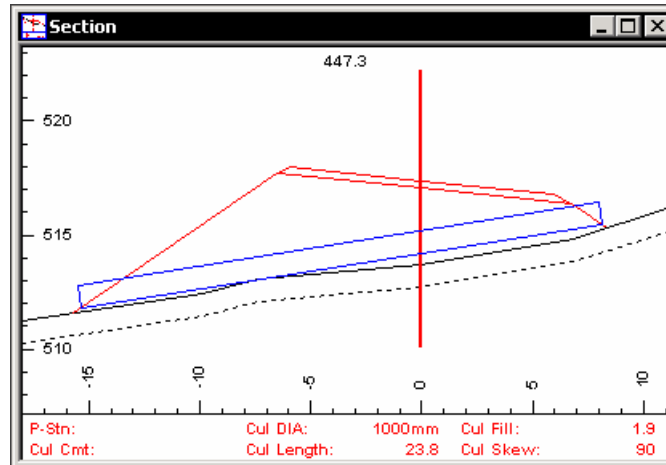


Figure 7.3: A Culvert that Follows the Ground

8. Try moving the alignment up and down a little (use the mouse in the Section window (don't forget to change to *Add/Edit* mode) – answer *OK* to the *Delete curve* prompt) and notice that the culvert is attached to the ground and changes length to fit between the fill slopes.

The following steps will convert the culvert into an open bottom arch, cut into the stream bed.

9. Press the *Properties* button in the culvert editor and change the dialog to match Figure 7.4. Press *OK*.

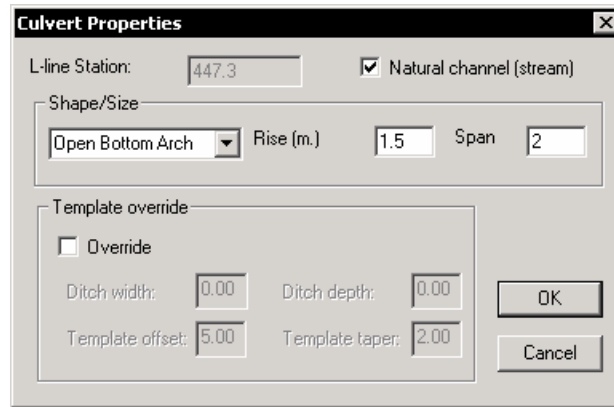


Figure 7.4: Culvert Properties Dialog

10. Set up the main culvert parameters as shown in the figure below. Turn off the *Auto Length* check box and leave set the lengths a little longer (**16m left and 9m right.**), Set the *Vertical Position, Depth* field to **+0.5** to bury the edges of the arch. Finally adjust the skew to fit the stream as shown in the Plan: turn of *Auto* and set the *Skew* to **103** degrees. Press *Apply* to update all windows.

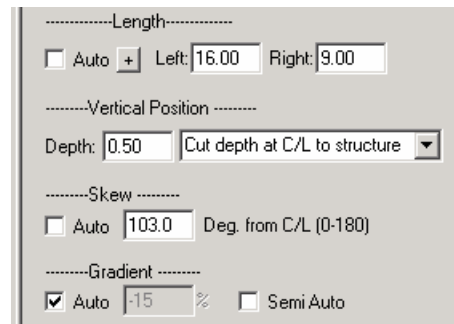


Figure 7.5: Parameters for the Pipe Arch Culvert

Your final culvert design should be similar to Figure 7.6.

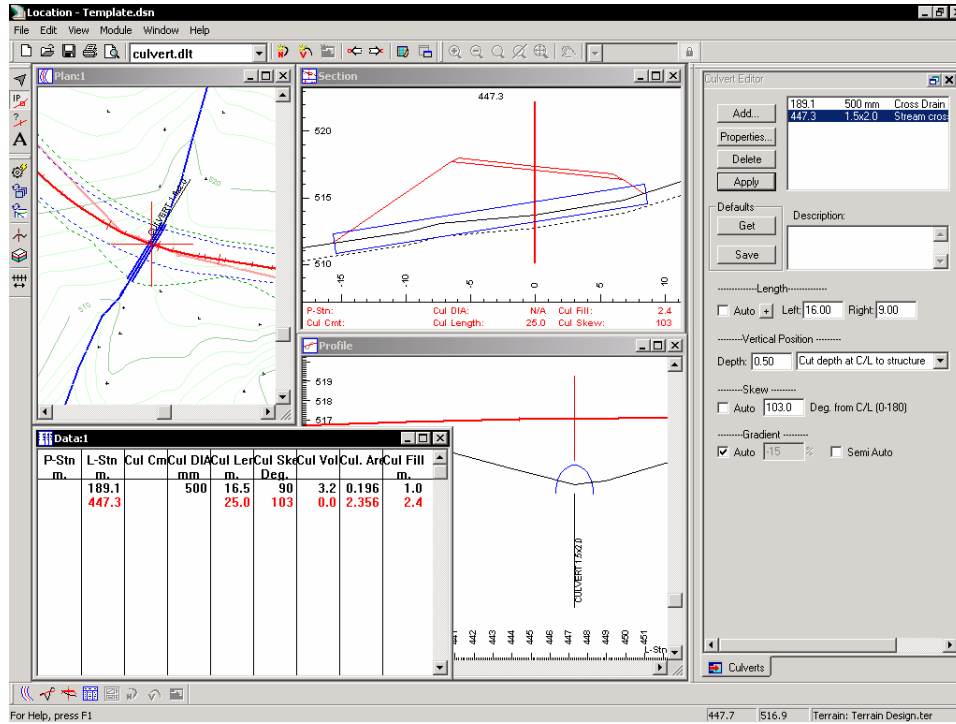


Figure 7.6: Pipe Arch Culvert

## Cross Drains

Cross drains are added periodically along a road to drain the ditch. Unlike the stream crossing above cross drain culverts are more convenient if they move with the alignment.

11. Press the *Add* button and change the Add Culvert dialog box to match Figure 7.7. Press *OK*.

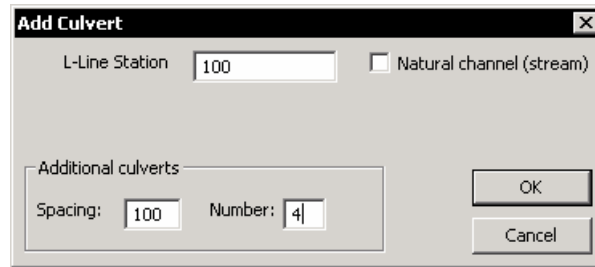


Figure 7.7: Add Culvert Dialog

12. Click with your mouse on each of the four new culverts to see what it looks like.
13. When you get to the culvert at station **300**, press the *Delete* button to remove it. This is a bad place for a cross drain.
14. Click on the station 100 culvert again, then press the *properties* button and change the *Diameter* to 600mm as in the figure below. Note the Template override information – this is why the ditch appears deeper and wider near cross drain culverts. Press *OK* then press the *Apply* button to update.

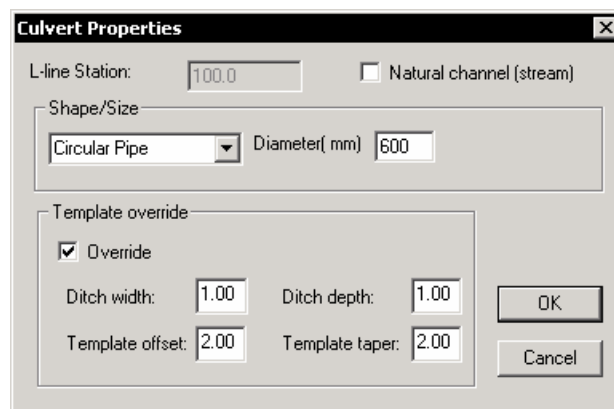


Figure 7.8: Culvert Properties Dialog

15. Press the *Save* button in the *Defaults* area. Respond *OK* to the warning prompt.

You have now modified the cross drain defaults. If you create any new culverts they will now be *600mm* in diameter. New designs get their default culverts from the **normal.DLT** screen layout – after this, culverts are stored with the design and will not be changed by retrieving layouts.

Default culverts can also be applied to *existing* culverts:

16. Select the three culverts between 189.1 and 400 by clicking and dragging with the mouse in the list of the culvert editor. Now press the *Get* button in the *Defaults* area and notice that all selected culverts in the list have been set to 600mm. Press *Apply*.
17. Click on the station 100 culvert again. Move the alignment up and down a little (use the mouse in the Section window – answer *OK* to the *Delete curve* prompt) and notice that the culvert moves up and down with the road. There is often no need to re-design culverts after alignment changes.

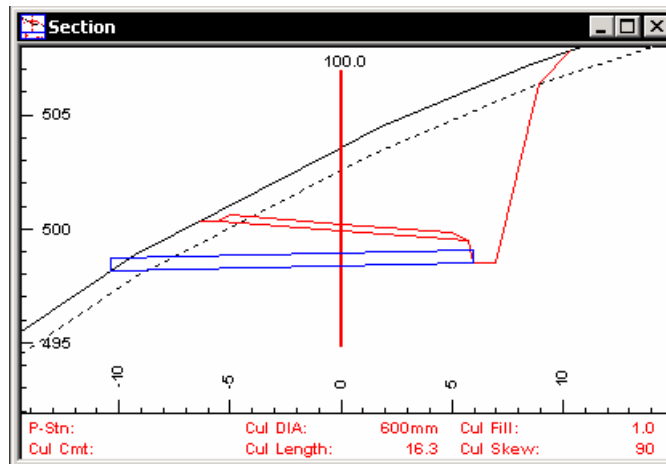


Figure 7.9: A Cross Drain Culvert with Ditch Template Override

18. File|Close. Do not save changes.


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## Drafting

This section describes basic functions for adding text, changing line-types, symbols and background graphics to create a finished drawing.

### *Labels*

Labels displayed in the Plan and Profile Windows are formatted in two places. The View | [Plan or Profile] Options menu provides access to label formatting for the window (*group formatting*). The *Edit label tool* button  in the toolbar allows you to modify individual labels (*point formatting*) with the mouse. The Plan Window is used in the following examples but the same principles apply to the Profile Window.

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Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

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#### Group Formatting Labels

1. File|Open. Select **RoadEng\Tutorial\Location\drafting.DSN**. Press *Open*.
2. Click on the title bar of the Plan Window to activate it. Select View|Plan Options.

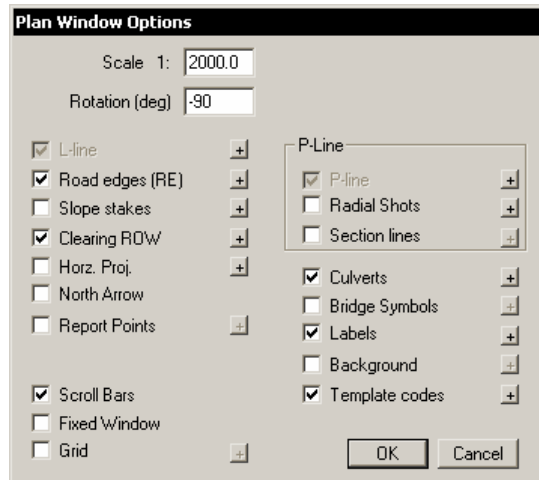



Figure 8.0: Plan Window Options Dialog Box

3. Click on the  button adjacent to the *Labels* item to activate the label Selection and Formatting dialog box.

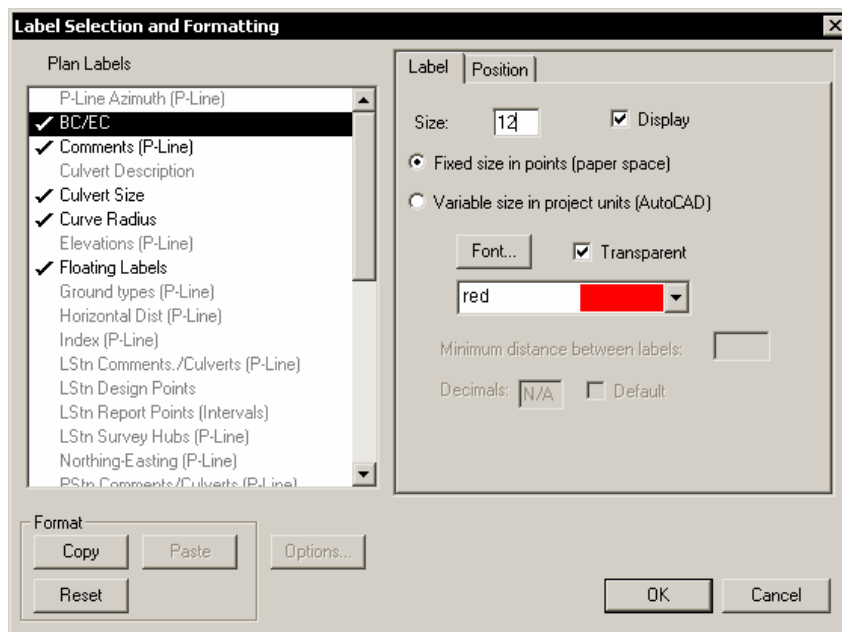


Figure 8.1: Label Selection and Formatting Dialog Box

The *Label Selection and Formatting* dialog box controls which labels are displayed (add or remove items with a double click in the list) and how they are formatted. See On-line Help (type F1) for details. Each item in the list refers to a group (or class) of labels. All labels in a group will have the same formatting unless *point formatting* is applied (see the next section).


4. Turn on the *Culvert Size* item and change the *BC/EC Labels* to font size **12** as shown in the figure above. Press *OK* to accept the label formatting and *OK* again to accept the rest of the Plan options. Note the changes in the Plan window.

**NOTE:** Label *group formatting* is saved in screen layouts. The previous three steps would have been unnecessary if you had retrieved a screen layout with the correct options and formatting defined.

There are two types of labels: Labels that are attached to traverse or design points and Floating Labels.

- **Feature Labels** are “attached” to traverse points or design points.
- **Floating Labels** are not associated with any specific feature.

### Point Formatting Labels

5. Right click in the Plan window and select *Edit Label Tool*. This will change the cursor to the *Edit Label tool*  cursor (alternately you could press the *Edit label tool* button **A** in the toolbar).
6. Use <Control + J> to jump to *L-Line Station 666.6*.
7. Move your mouse cursor over the red *BC 666.6* label, when the cursor changes to a simple cross left click once. The label is now *selected* and should look like the one in the figure below.

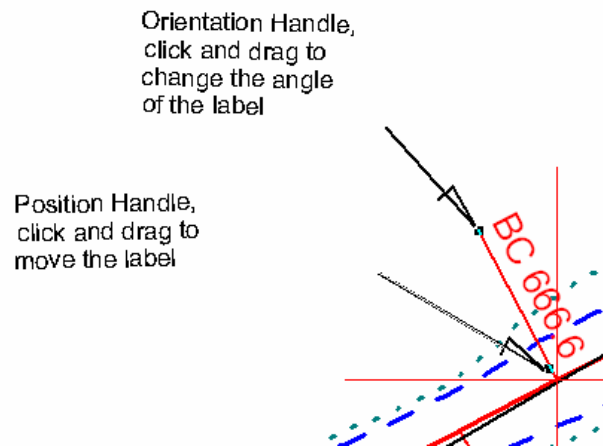


Figure 8.2: Selected Label with Edit Handles Visible

#### Moving a label:

Notice when you place the cursor over the *text* of a selected label it changes to

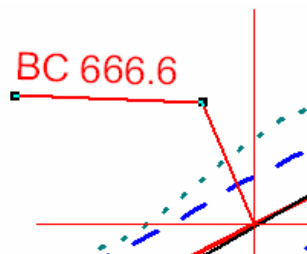
the  $\leftrightarrow$  Move cursor. Clicking and dragging with the Move cursor will reposition the label.

**Rotating a label:**

Notice when you move the cursor over the *Orientation Handle* it changes shape to the  $\curvearrowright$  Orientation cursor. Clicking and dragging with the Orientation cursor will allow you to rotate a label.

The curve label is a *Feature label* as it is attached the curve; the anchor point will move only when the curve moves.

8. Re-orient and re-position the label until it appears as shown in the figure below.



*Figure 8.3: Label After Reorienting and Repositioning.*

9. Double click on the text of the label you just edited. This opens the *Label Selection and formatting* dialog box.

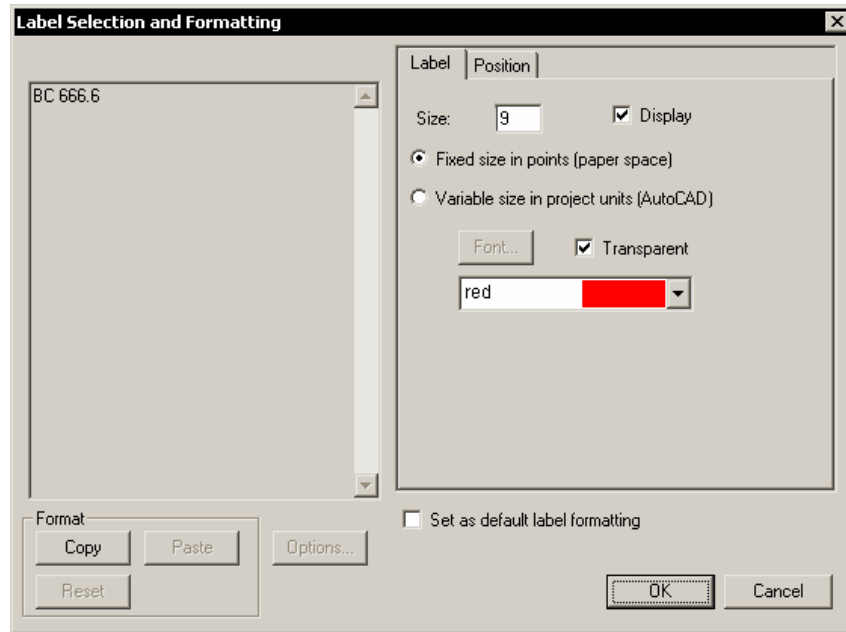


Figure 8.4: Label Selection and Formatting Dialog Box.

10. You could further edit the label here instead, select *Reset*, to undue the previous *point formatting*. Press *OK*. Note that the label has returned to the previous *group formatting*.

11. <Control + J> to jump to L-Line Station **290**.

Notice that the EC, BC and curve radius labels are bunched up, and because of their orientation, the labels themselves are not clear.

12. Reorient and reposition the labels, so that they appear similar to Figure 8.5.

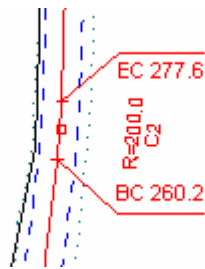




Figure 8.5: Labels after Repositioning and Reorienting

### Floating Labels

Floating Labels can be added anywhere in the Plan or Profile Windows. Unlike Feature Labels, Floating Labels can have their anchor point moved.

13. If you are not still in *Label Edit* mode, press the *Edit Label Tool*  button in the toolbar, and the cursor will change to the label edit tool .
14. Click on the left mouse button in the Plan Window, and the Label Selection and Formatting dialog box shown in the figure below will appear.

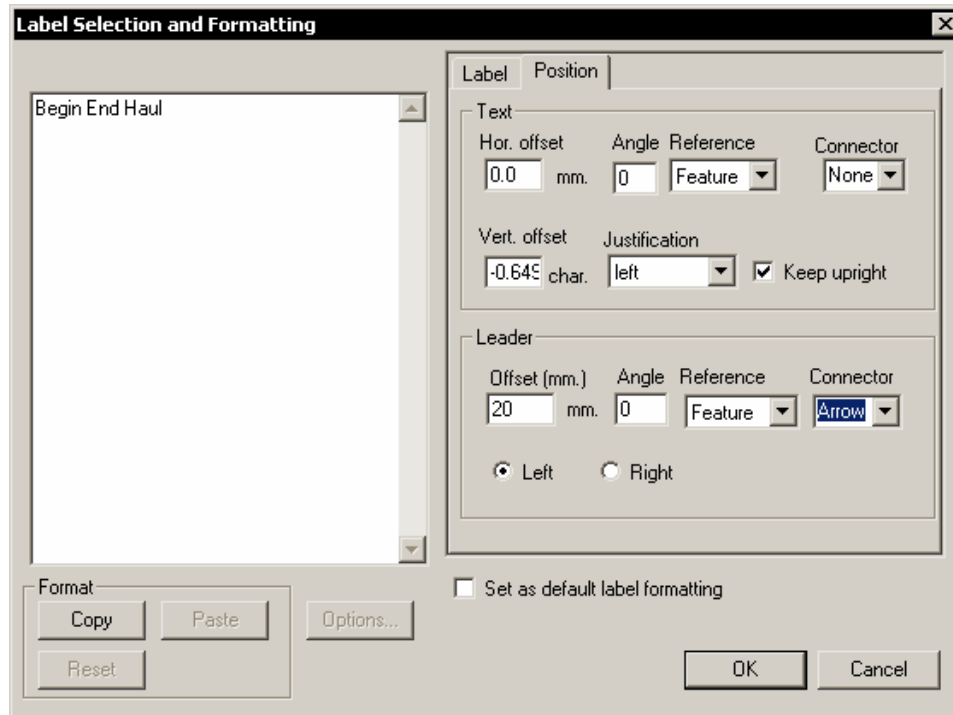


Figure 8.6: Edit Label Dialog Box

15. Change “xxxxxxx” to “Begin End Haul”. Click on the *Position* tab and change the *Leader* to have a 20mm *Arrow* (as in the figure above). Press *OK*; the floating label will appear where you first clicked the mouse.
16. Adjust the label with the mouse until it looks similar to Figure 8.7. Click and drag on the arrowhead handle to move the whole label.

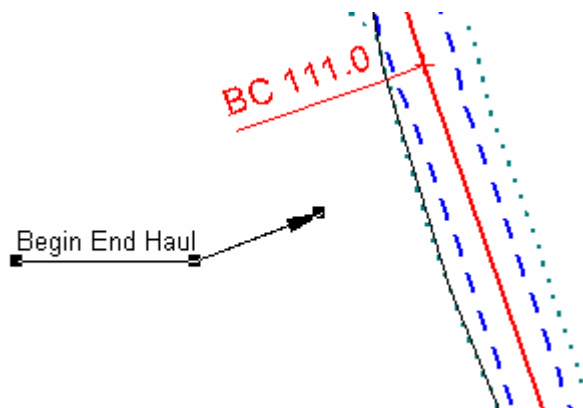


Figure 8.7: Floating Label

It is possible to change the Floating Label *group formatting* so that all new floating labels look like the label above.

**NOTE:** Floating Labels and label *point formatting* are saved in design files while *group formatting* is saved in design *and* screen layout files.


17. File|Close. Do not save changes.

## Line-types and Symbols

Symbols and Line-types may be changed in any of the graphic windows for most of the items displayed. Let's experiment by changing the road edges in the Plan window.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

1. File|Open. Select **RoadEng\Tutorial\Location\drafting.DSN**. Press *Open*.

- Click on the title bar of the Plan Window to activate it. Select menu View|Plan Options, and press the  button opposite *Road edges*. This opens the formatting dialog box shown below.

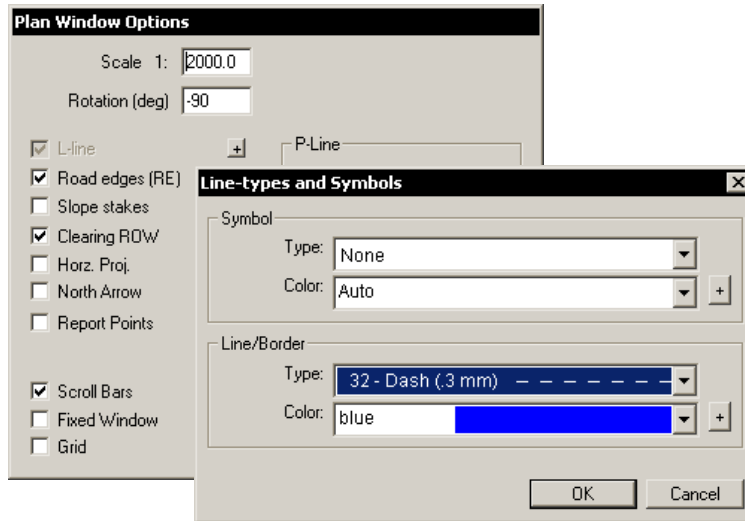


Figure 8.8: Line-types and Symbols Selection Dialog

- Change the *Color*, *Line-type* and *Symbol*. Press *OK* and *OK* again. The line-type will change for both road edges.

**NOTE:** You can modify and create line-types and symbols in the Module | Setup dialog box, *General* tab. Line-types and Symbols tables are saved with the design but they can also be saved and retrieved to external files. **RoadEng\normal.TRF** contains the default Line-types and Symbols for new designs.

- File|Close. Do not save changes

## Background Terrain

A background terrain file may be displayed in the Plan Window for presentation or to assist in design. For example, special attention can be given to wet areas or unstable terrain if this information is displayed in the Plan Window. Property boundaries, rights of way and existing structures can be displayed. A background can also display contours.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

1. File|Open, Select **RoadEng\Tutorial\Location\drafting.DSN**. Press *Open*.
2. Activate the Plan Window. Select View|Plan Options to open the *Plan Window Options* dialog box shown below.

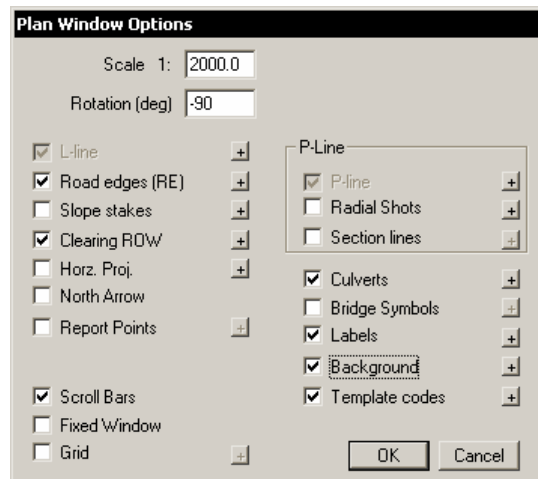

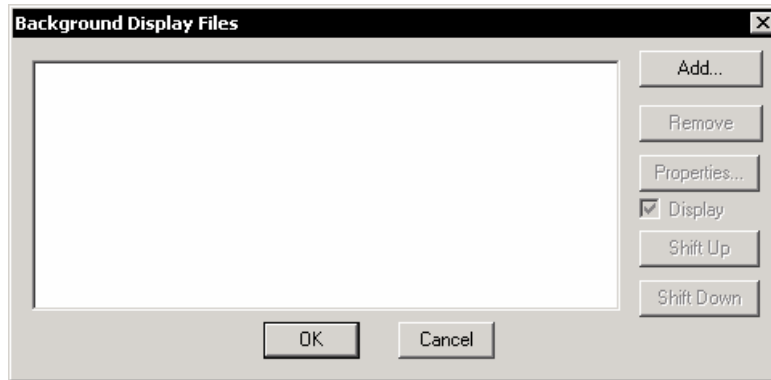


Figure 8.9: Plan Window Options Dialog Box.

3. Select *Background*, and then press the plus button  adjacent. This opens the Background Display Files dialog box shown in the figure below.



*Figure 8.10: Background Display Dialog Box*

4. Press the *Add* button. Select and open **\RoadEng\Tutorial\Location\terrain design.TER..**
5. Press the *Properties* button to open the dialog box below. Remove all but the file name from the *Terrain File Path* field.

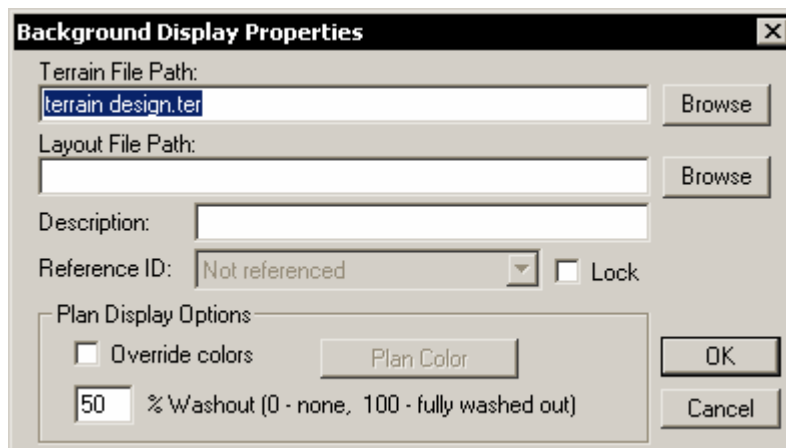


Figure 8.11: Background Display Properties with a Relative File Name

**NOTE:** Only the *name* of the Terrain background file is saved in the design file. It is wise, therefore, to use a *relative* file name whenever possible (instead of *full path*) so that if the files are moved to another folder or computer, Location design will still be able to find the background file.

The *Washout* factor allows you to control the intensity of the background graphics – the larger the washout factor the more faded the background image appears (so as not to distract from the foreground).

6. Press OK three times to close the dialog boxes and update the Plan window.

Your Plan window should look similar Figure 8.12.

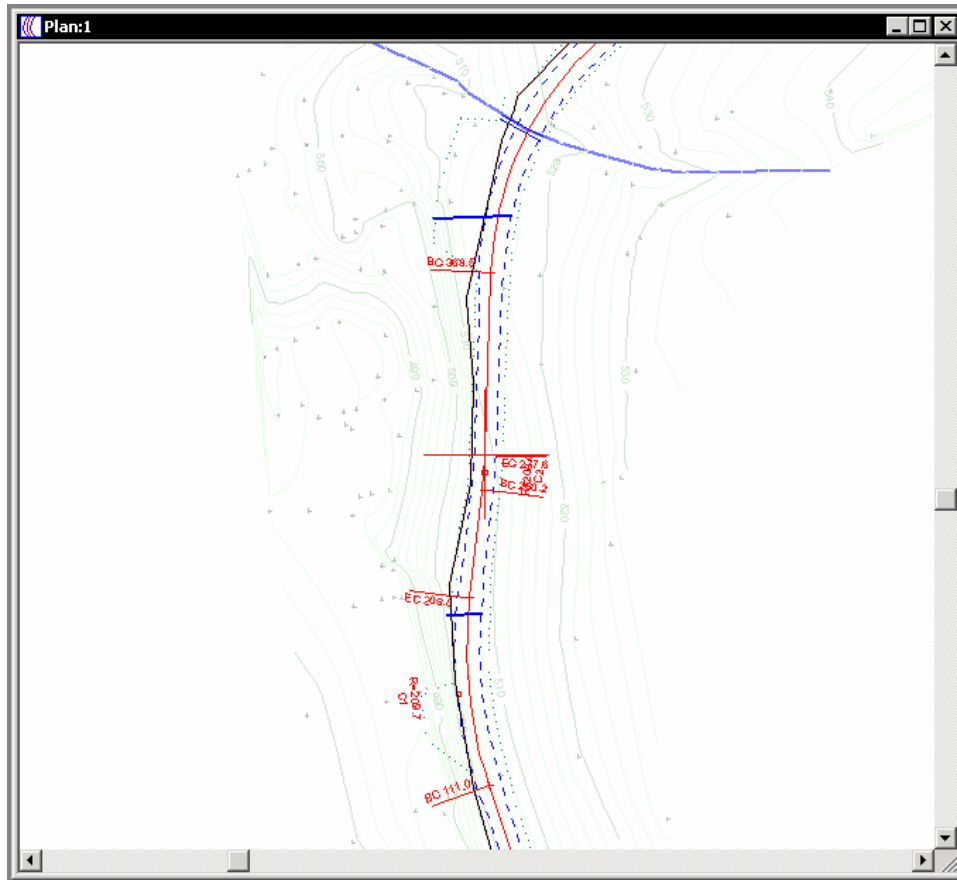


Figure 8.12: Background Terrain Added to a Road Design.

Background files are created in the Terrain Module (Module | To Terrain); see the Terrain Module tutorial and online help. If the Terrain file is modified you can update the Plan window by using the Edit | Read Terrain(s) menu.

7. File | Close. Do not save changes.

---

---

## Output

**M**ulti-plot is a page layout tool for creating output. Any of the main windows (Plan, Profile, Data, and Section) can be placed on a Multi-Plot sheet with other items such as a legend, a scale bar, a bitmap graphic, a Terrain file, Curve Tables, Template assignments, or a title block. This feature can be incorporated with screen layouts to retrieve most commonly used options and formats. In this section, you will learn how to create a Multi-Plot of a standard Plan over Profile Window.

To do the examples in this section the *P-Line Design*, *Multi-Plot Output Sheet Generation* and *Sub-surfaces* function groups should be enabled. See *Function Groups* in the introduction above and in the On-line help for more information.

### Multi-Plot Example

1. File|Open, Select \RoadEng\Tutorial\Location\drafting.DSN. Press *Open*.

---

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

---

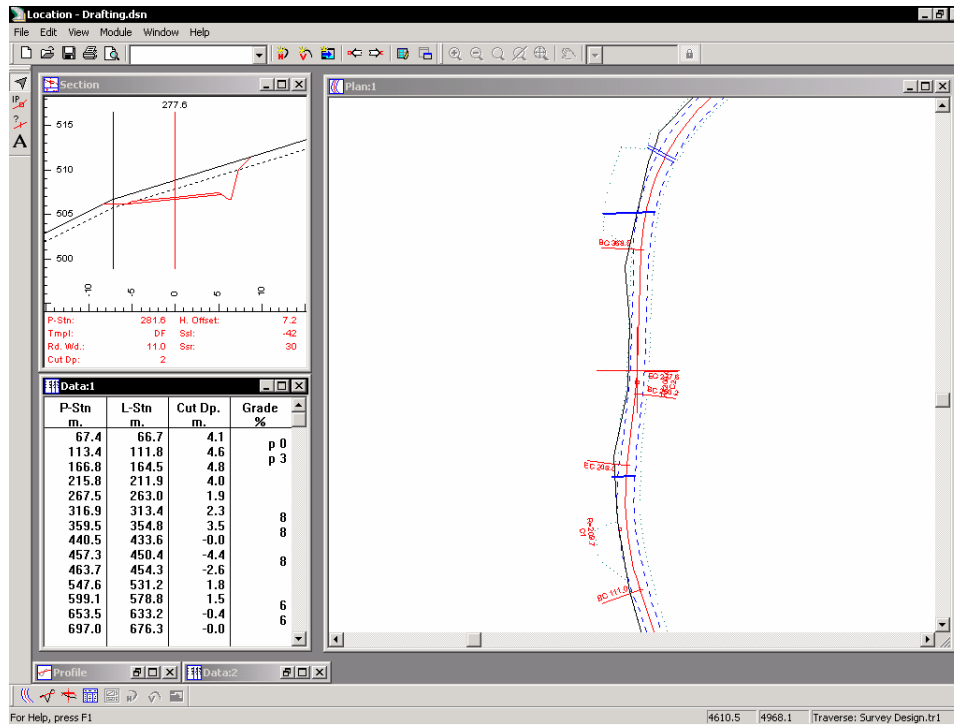


Figure 9.0: Drafting.DSN

- From menu Window | New Window, select Multi-Plot. This will display the Multi-Plot Window. Maximize this new window.

**NOTE:** Multi-Plot setups apply to a specific paper size and orientation.

The orientation and size of the blank sheet, within the Multi-Plot Window, is determined by the selected printer set-up.

- Use File | Print Setup to open the setup dialog box, change the orientation to Landscape, and the Paper size to 8.5" by 14" (legal). Press *OK*.

4. Select View | Multi-Plot Options to activate the dialog box. You can also access this dialog box by double clicking in the gray area in the Multi-Plot Window.

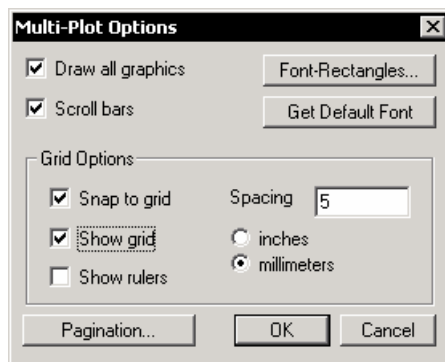


Figure 9.1: Multi-Plot Options Dialog Box.

5. Select *Show grid* and increase the *Spacing* to **5**mm as shown in the figure above. Press *OK*. A dot grid will cover the entire Multi-Plot sheet
6. From the menu Edit | New sub-view, select Plan:1. A *Plan sub-view* should appear in the center of your Multi-Plot Window.

Notice that there are 8 handles that you can click and drag to change the size of the sub-view. Click and drag anywhere else on the sub-view to move it. The <delete> key will remove the selected sub-view(s).

Notice, also, that the Plan is rotated automatically to best fit the rectangle with increasing stations running from left to right. In this case the Plan has been rotated automatically by approximately 90 degrees. See next section: *Plan Rotation*.

7. Resize and reposition the Plan sub-view.

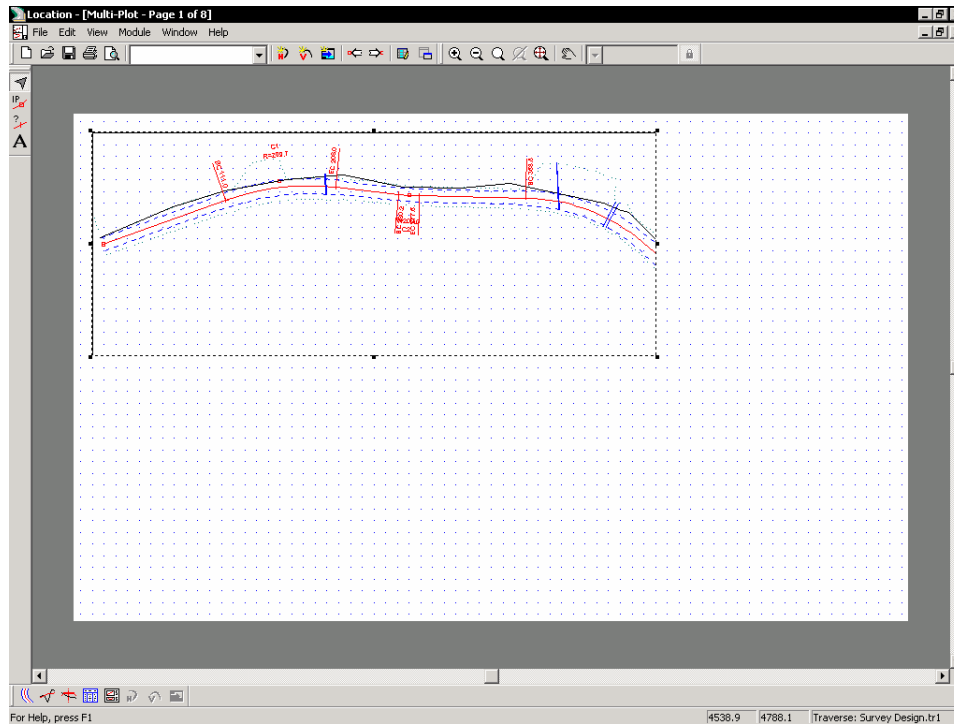


Figure 9.2: Plan Sub-view After Sizing and Positioning

8. From menu Edit | New sub-view, select Profile:1. A Profile sub-view should appear in the center of the Multi-Plot. Adjust it to fit under the Plan sub-view.

A click on a sub-view will select it and deselect the previous sub-view. See also the note below.

**NOTE:** When you click outside all sub-views and drag the mouse you will create a selection rectangle. All sub-views inside or crossing the rectangle will be selected when you release the mouse. Also, <Control> click allows you to select/deselect sub-views without affecting the selection state of other sub-views. Group selected sub-views can be deleted or moved together.

Softree has created a screen layout that will position, orient, and format the Plan and Profile sub-views. In fact, the previous steps are performed automatically by the step below.

9. File | Retrieve Screen layout. Select and retrieve **\RoadEng\Tutorial\Location\output plan over profile.DLT**. Maximize the Multi-Plot Window.

The Multi-Plot Window should now resemble Figure 9.3 below.

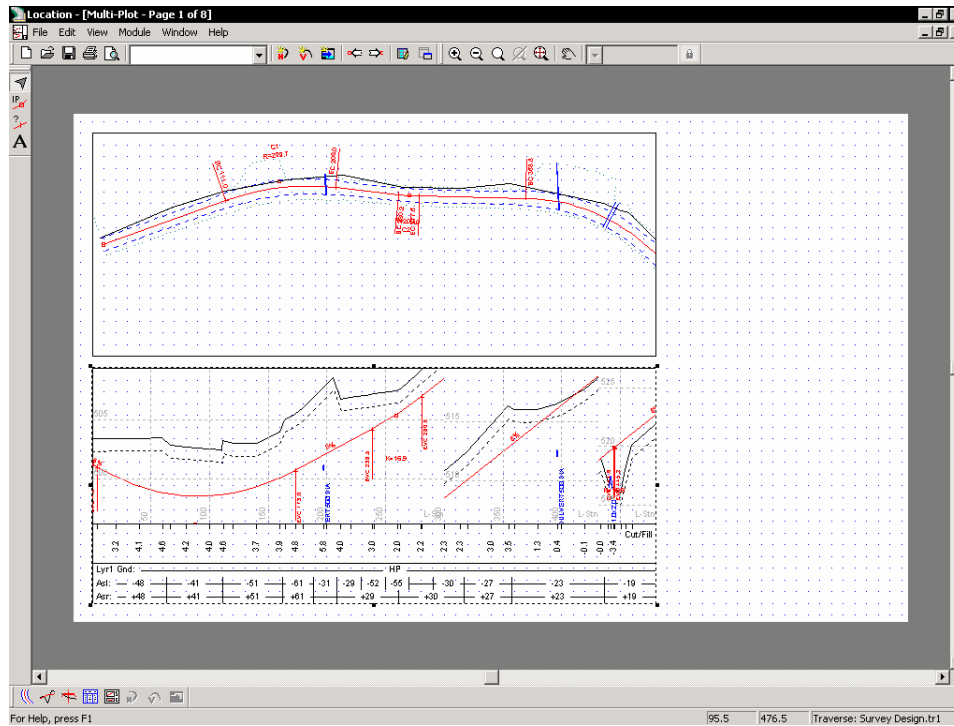


Figure 9.3: Multi-Plot Page 1 After Loading Screen Layout.

10. The Location Multi-Plot Window can automatically produce as many pages as required to show the entire design. Notice that the Multi-Plot Window title bar says that this is Page 1 of 8. Use <Control + N> to see what all the pages look like (View | Jump to Page also works).
11. Choose menu View | Multi-Plot Options; the dialog box, shown in the figure below, will appear. You can also access this dialog box by double clicking outside any sub-views in the Multi-Plot Window.

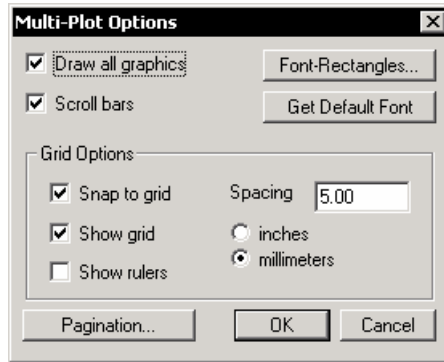


Figure 9.4: Multi-Plot Window Options

12. Click on the *Pagination* button.

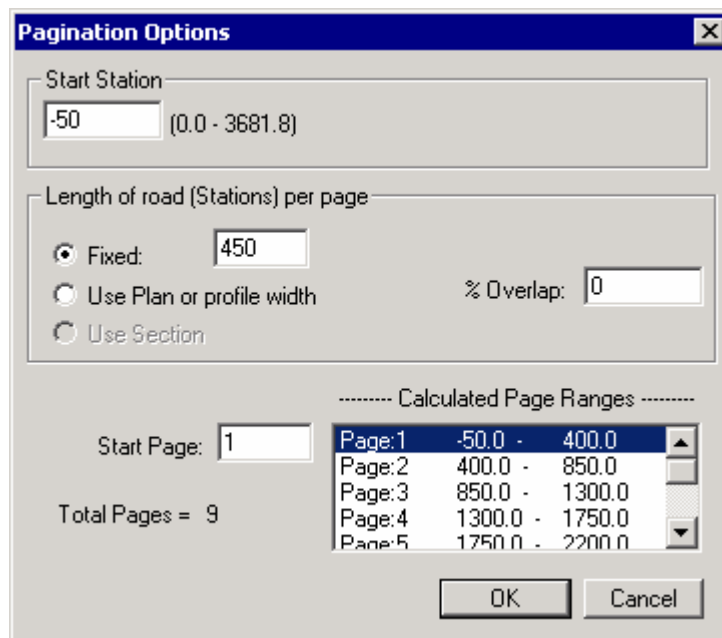


Figure 9.5: Multi-Plot Paging Options

- Change the *Start Station* to **-50** this will leave a gap at the start of the first page. Note that the page size is set to use the size of the plan or profile sub-view – reducing the width of the Profile sub, for example, would reduce the page size from the current value of **480**. Change the *Length* to *Fixed*, **450m** and the overlap to **0** as shown above. Press *OK* and *OK*, again.

## Plan Rotation

In this example the Plan sub-view is acceptable on most pages. The automatic pagination puts the page start station on the left side of the Plan sub-view and the end station on the right. This approach does not always work so it is possible to set the Plan sub-view scroll position and rotation manually.

- Use <Control + N> or <Control + B> to get to page **6**.

15. Double Click on the Plan sub-view or use menu View | Multi-Plot Sub-view Options when the Plan window is selected.

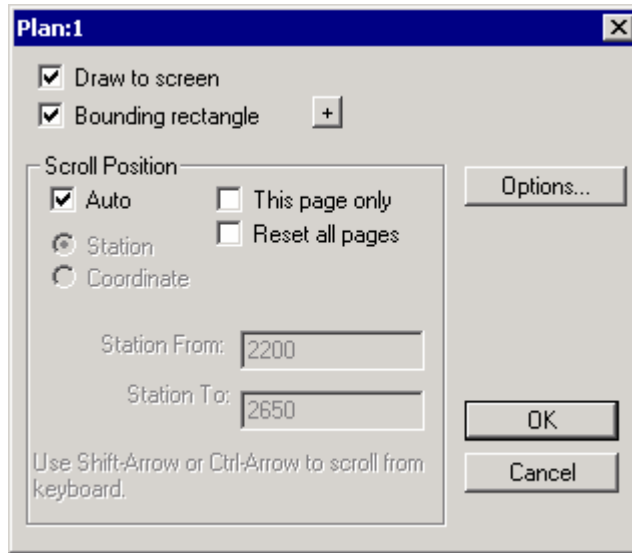


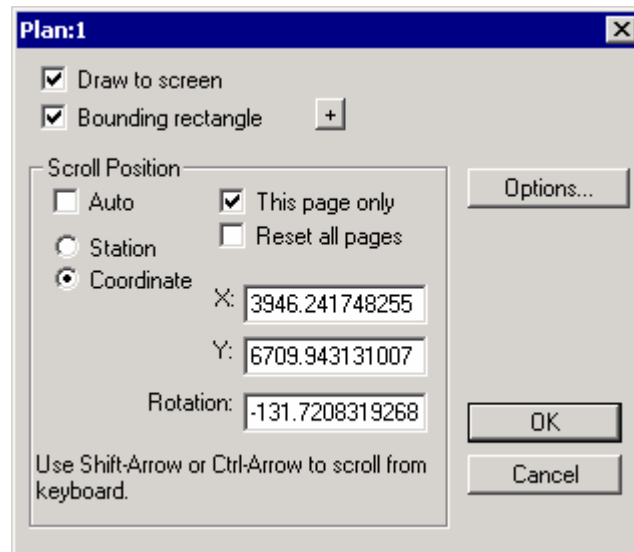
Figure 9.6: Plan Sub-view Options- AutoSetting

There is a similar options dialog box for all types of sub-views.

16. Click on the *Options* button.

**NOTE:** The same dialog box you see now is available from the View | Plan Options menu when the Plan Window is active. All the viewing options defined for the main Plan Window are displayed in the Multi-Plot Plan sub-view with the exception of the rotation angle.

17. Press *Cancel* to close the Plan Options dialog box.
18. Clear the *Auto* check box and click on the *Coordinate* button and set *This page only*. Press OK. Note the Plan position has not yet changed.



*Figure 9.7: Plan Sub-view Options- Coordinate Setting*

19. Type <Shift + arrow> to scroll or <Control + arrow> to rotate . <Shift + arrow> also works for the Profile sub-view if it is selected. (See note). Try to get the Plan sub-view to look like the figure below.

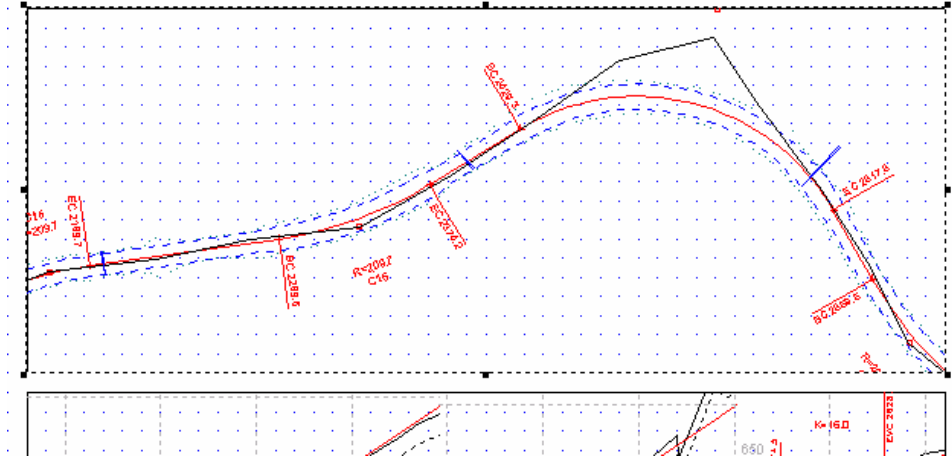


Figure 9.8: Plan Sub-view After Manually Scrolling and Rotating

20. Use <Control + N> or <Control + B> to view all the pages.

**NOTE:** Manual alterations to the Plan or Profile position and orientation can also be done by selecting the window and then pressing <shift+arrows>. A prompt may remind you that *Your Plan/Profile sub-view is set to scroll with the current page station range. Do you wish to scroll manually instead?* This operation will disable the *Auto* check box as in step 18 above. <Shift + arrows > will move the plan or profile in the direction of the arrow. <Control + arrows> will rotate the Plan sub-view around its center.

21. Continue to the next section or File|Close. Do not save changes.

## Merging Multi-Plot Layouts

This exercise will add a title block to a Multi-Plot sheet. This is accomplished by merging the current Multi-Plot with a commonly used title block screen layout. If you are continuing from the exercise above you may omit steps 1 and 2.

---

---

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

---

1. File|Open, Select **RoadEng\Tutorial\Location\drafting.DSN**. Press *Open*.
2. In the File|Print Setup dialog box, change the orientation to *Landscape*, and the Paper size to 8.5” by 14” (legal).
3. File|Retrieve Screen layout. Double click on **\RoadEng\Tutorial\Location\output plan over profile.DLT**. Maximize the Multi-Plot Window. The screen will appear like Figure 9.3 in the previous section
4. File|Merge Multi-Plot Layout. Select **\RoadEng\Tutorial\Location\output title block.DLT**. Press *OK*. The Multi-Plot sheet should now look like Figure 9.9.



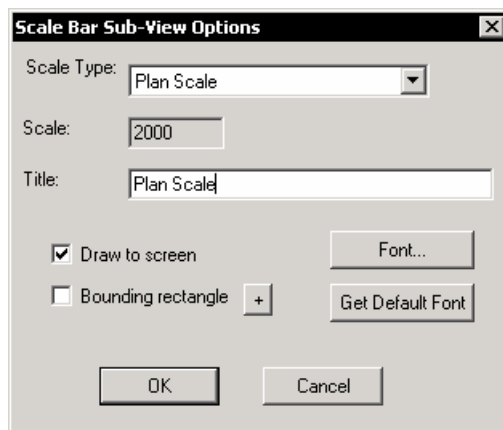


Figure 9.10: Scale Bar Sub-view Options Dialog Box

7. Keep the default *Plan Scale* from the *Scale Type:* pull-down box. Add in the optional *Title* **Plan Scale**. Press *OK*.
8. Resize and Reposition the Scale Bar sub-view, until it appears as in the Figure 9.11 (see note below).

**NOTE:** If you accidentally click on the Plan sub-view the scale bar will be inaccessible. Use the Edit | Shuffle Front to Back or <Control + K> to allow access to the scale bar.

**NOTE:** If the graphics on your screen are taking too long to redraw during moving and sizing operations you can temporarily disable display. Either turn off the *Draw to Screen* check in the sub-view options (see figure above), or turn off the *Draw All Graphics* check in the Multi-Plot options: (Figure 9.1).

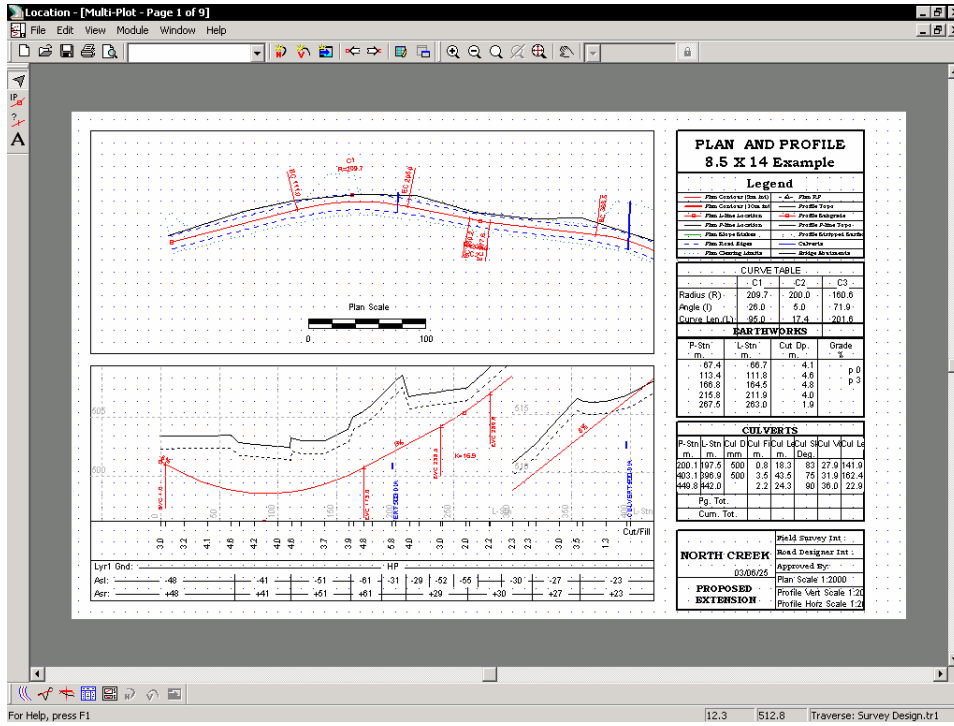


Figure 9.11 Final Multi-Plot Sheet

## Creating a Legend

In this section you will learn how to create and modify a legend by replacing the one that came with the merged title block.

9. Select the legend shown in the figure above and press <delete> on your keyboard to remove the current legend.












| Legend   |   |
|--|---|
|  Plan L-line Location |  Profile Topopgraphy |
|  Plan P-line Location |  Profile Layer 1     |
|  Plan Slope Stakes    |  Culverts            |
|  Plan Road Edges      |  Major contour (10m) |
|  Plan Clearing Limits |  Minor contour (2m)  |
|  Profile Subgrade     |   |

Figure 9.12: Legend

- From menu Edit|New sub-view, select *Legend*. A legend should appear in your Multi-Plot window.

This legend initially contains all the lines and symbols used in your design. However, there will be duplicates (when the same line-type is used in two different windows) and some legend items may not be displayed in the Multi-Plot. You also may want to change some of the descriptions.

- Choose menu View|Multi-Plot sub-view Options (or double click on the Legend); the dialog box shown in the figure below will appear. Note that you can change the title and appearance of the Legend here.

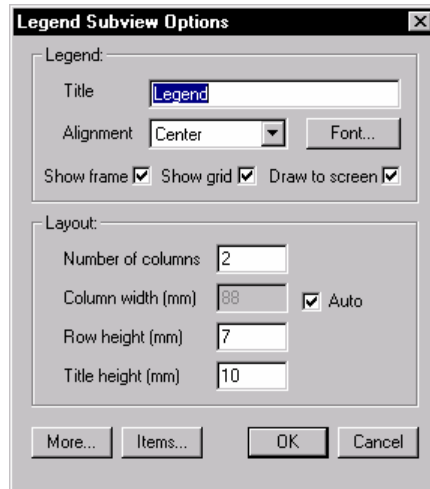


Figure 9.13: Legend Sub-view Options Dialog

**NOTE:** When the *Auto* check box is enabled, the frame in which they are found determines the width of the column. Making the frame smaller or larger by clicking and dragging on any of the eight handles will increase column width. If you disable the *Auto* option, the column width can be changed manually.

12. Press the *More* button to activate the More Legend Sub-view Options

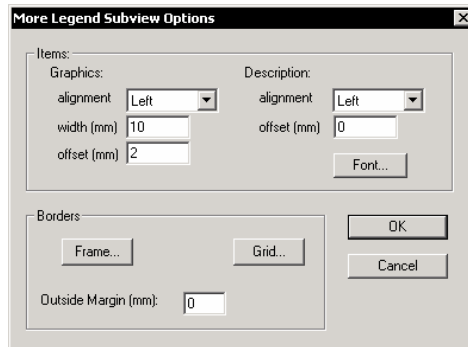


Figure 9.14: More Legend Subview Options Dialog

13. Change the *width* and *offset* items to match the figure above. (Pressing the *Frame* or *Grid* buttons changes the line-types used to draw each of these). Press OK, to return to the main dialog box.
14. Press the *Items* button. The dialog box in the figure below will appear.

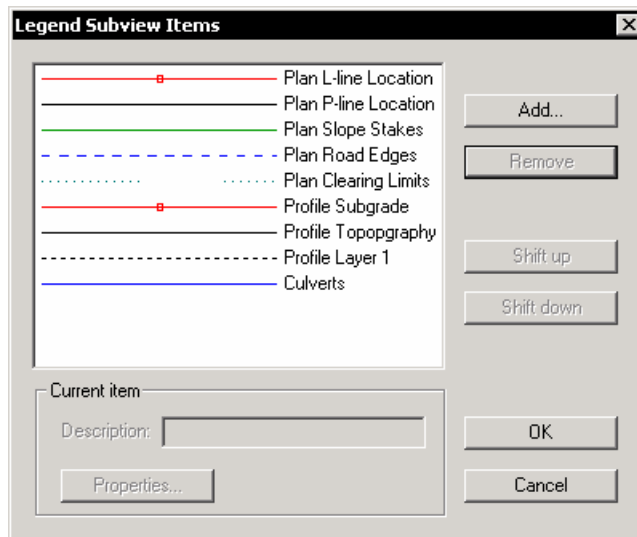


Figure 9.15: Legend Items Dialog Box

15. Change the description of “Plan Culverts” to “Culverts”. Highlight the item and change the name in the *Description* box.
16. Remove all of the Items except for the ones shown above; highlight an item then press the *Remove* button.
17. *Shift down* “Culverts” to the bottom.

To change a line-type for a particular item, double click on the item or click *Properties*. There are no line-type changes for this example

If the Terrain background is turned on in Plan, then you should also display some of the Terrain line-types in the legend.

18. Add in the *Major contour (10m)* and *Minor contour (2m)* items shown in Figure 10.11. Press the *Add* button; choose a line-type or symbol. Press *OK*. Then add a *Description* for the resulting line-type.

19. Once you are done press *OK*, then *OK* again.

The Result is a Legend similar to the one shown in Figure 9.11.

20. Move and resize the legend so that it fills the gap created by deleting the original legend

---

**NOTE:** If this were a real output sheet you would now **save the screen layout** so that you could re-use it to print from any design. Then you would print your design.

---

21. Proceed to step 3 in the next section or select *File | Close*. Do not save changes.

## Creating a Title Block

In this section you will create a title block, similar to the one used in the previous section.

1. *File | Open*. Select **RoadEng\Tutorial\Location\drafting.DSN**. Press *Open*.

---

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

---

2. In the *File | Print Setup* dialog box, change the orientation to *Landscape*, and the Paper size to 8.5 “ by 14 “ (legal).

3. File | Retrieve Screen layout. Select  
**\RoadEng\Tutorial\Location\output plan over profile.DLT.**  
Maximize the Multi-Plot Window. Your screen will appear like Figure 9.3 in the previous section
4. From menu Edit | New sub-view, select *Rectangle*.

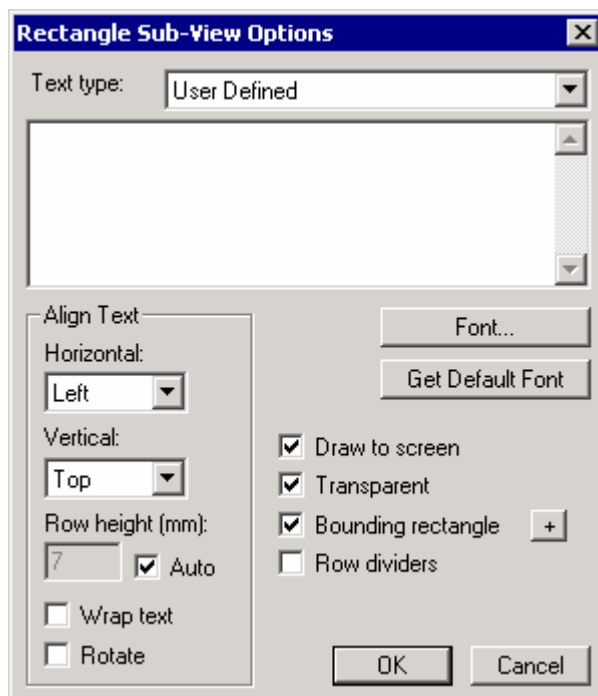


Figure 9.16: Rectangle Sub-view Options Dialog.

Rectangles can hold any text you wish to type (see figure above) or any of a number of pre-defined items found in the *Text type*: pull-down box.

Sometimes it is useful to use an *empty* rectangle just for its border graphic.

5. Type your name or some other text in the text box. Multiple lines are allowed. Change horizontal alignment to *Center*. Check the *Wrap text* option. Click on the *Font* button and change the size to 20. Press *OK* and *OK* again.
6. Arrange the new rectangle to the lower left part of the page.

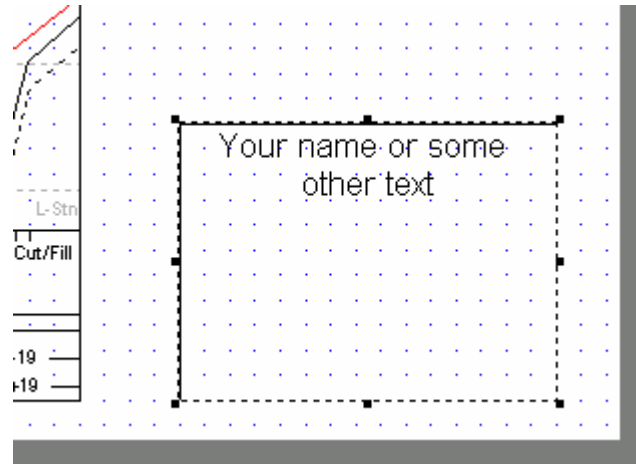


Figure 9.17: A New Rectangle Sub-view with Centered, Wrapped Text in a Large Font.

7. Create two more rectangles. In the first select *Print Date* from the *Text type* combo box. In the second select *Design File Name* and be sure to check *Wrap text*.
8. Arrange the two new rectangles to fit in the first rectangle as shown below. Notice how the snap to grid feature helps line up edges. Don't forget about *Edit|Shuffle Front to Back*, <Control + K>, if you get one rectangle stuck behind the other.

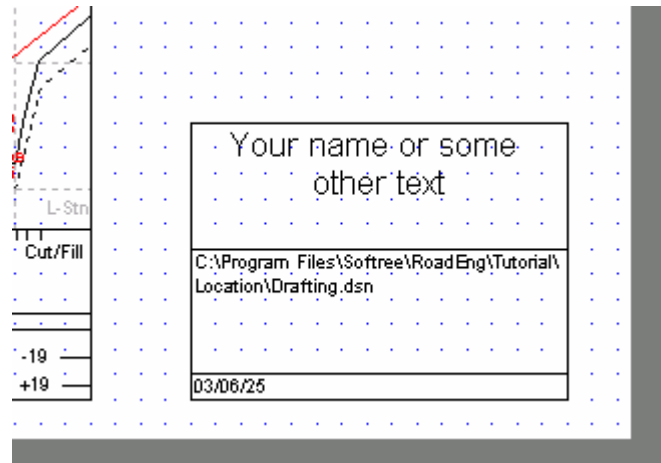


Figure 9.18: The Beginning of a Title Block

9. File|Close. Do not save changes.

## Exporting a Terrain File

In addition to DWG, DXF and ASCII the Location module will export graphics in Terrain format. In this example a road design will be exported to Terrain where it can be contoured and displayed in 3D.

Note: If you are using RoadEng® Lite and the “Non Permitted Functions Found in File” dialog appears, choose “Keep all functions and revert to DEMO Mode”.

1. File|Open. Select **RoadEng\Tutorial\Location\ter\_export.DSN**. Press Open.
2. Select menu File|Save As and under the *Save File as type:* selection box, choose *Terrain File (\*.ter)*.
3. Enter “**Export**” as the file name and press OK. The *Export to Terrain* dialog will appear.
4. Enter the options as shown in Figure 10.0.

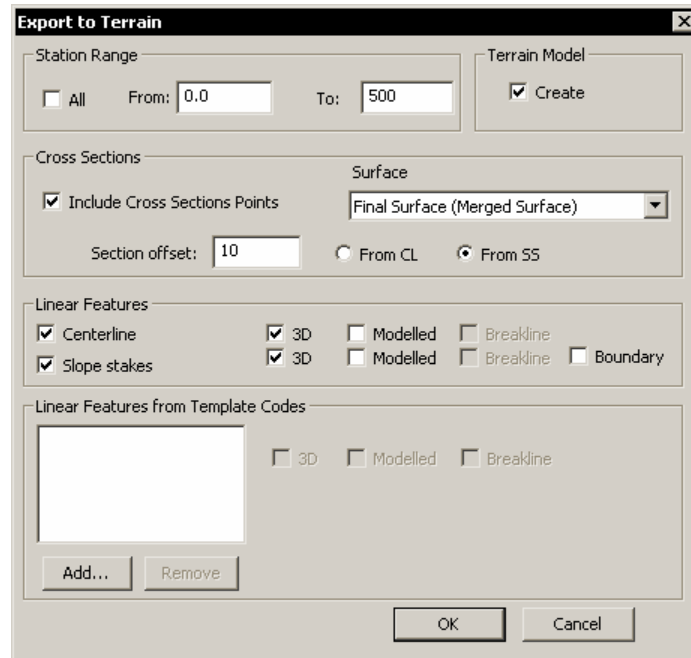


Figure 10.0: Export to Terrain Dialog.

5. Press *OK* to create the **Terrain** file.

The rest of this exercise uses the Terrain module. You may skip the remaining steps and just look at the pictures.

#### Optional Steps:

6. Select Module | To Terrain to start the Terrain module.
7. File | Open the file created above.
8. Choose menu Window | New Window | Graphics | 3D to view a 3D image of the design.
9. Choose menu View | 3D Options and set the color of the triangles as shown to darker color such as (153,153,51).



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