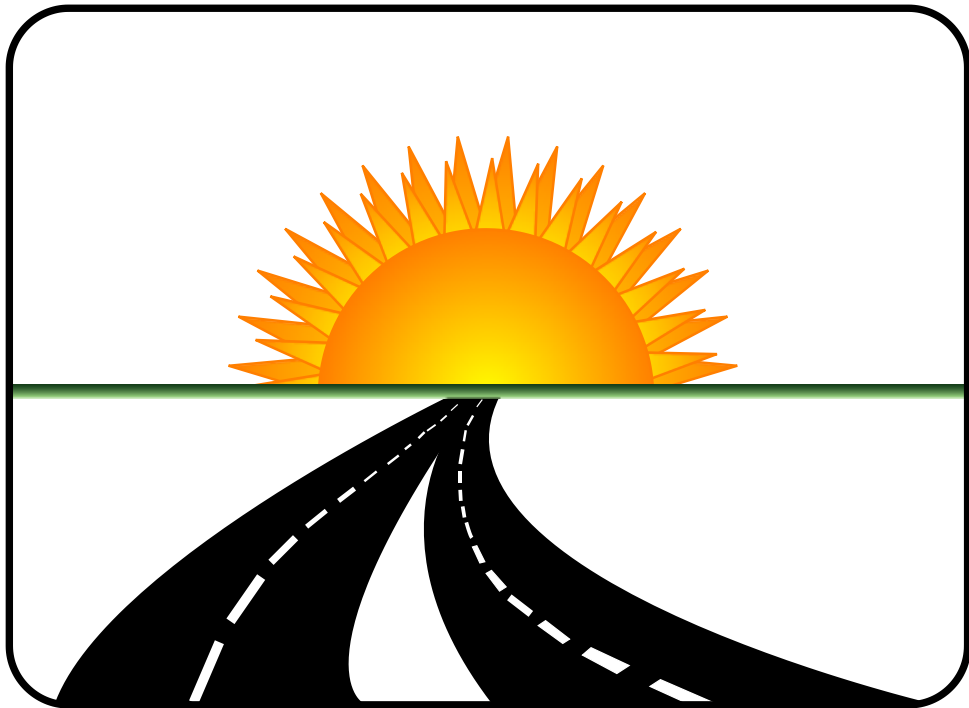


GEOPAK Road Course Guide

GEOPAK V8i (SELECT Series 2)



**Tennessee Department of Transportation
Roadway Design Division**

Trademarks

GEOPAK & MicroStation are registered trademarks of Bentley Systems, Incorporated.

Other brands and product names are the trademarks of their respective owners.

GEOPAK ROAD COURSE GUIDE

TABLE OF CONTENTS

- 0 INTRODUCTION**
- 1 USER PREFERENCES**
- 2 PROJECT MANAGER**
- 3 DIGITAL TERRAIN MODELS**
- 4 COORDINATE GEOMETRY**
- 5 HORIZONTAL ALIGNMENT DISPLAYS**
- 6 EXISTING GROUND PROFILE**
- 7 PROPOSED ROADWAY PROFILES**
- 8 EXISTING GROUND CROSS SECTIONS**
- 9 PROPOSED CROSS SECTIONS – PRELIMINARY**
- 10 PROPOSED ROADWAY TRACKING**
- 11 PROPOSED PROFILE RE-DESIGN**
- 12 D&C MANAGER – ELEMENT SYMBOLOGY**
- 13 SUPERELEVATION**
- 14 PROPOSED CROSS SECTIONS – FINAL**
- 15 EARTHWORK**
- 16 CROSS SECTION SHEETS**
- 17 CROSS SECTION REPORTS**
- 18 DP STATION OFFSET & LABELER TOOLS**
- 19 PLAN AND PROFILE SHEETS**
- 20 D&C MANAGER – ADDITIONAL FUNCTIONS**
- 21 GRAPHICAL COGO – PROPOSED R.O.W.**
- 22 PROPOSED & FINAL TIN CREATION**
- 23 SIDE ROADS**

APPENDICES

- A ADVANCED PLANNING REPORT**
- B SUPERELEVATION STANDARD DWGS, HORIZONTAL & VERTICAL CURVE FORMULAS**
- C AASHTO K VALUES**
- D TYPICAL SECTIONS STANDARD DWGS**
- E SUPPLEMENTALS FOR EXERCISE 12**
- F SUPPLEMENTALS FOR EXERCISE 13**
- G SUPPLEMENTALS FOR EXERCISE 15**
- H SUPPLEMENTALS FOR EXERCISE 22**

Introduction

GEOPAK is a comprehensive software package that was adopted by T.D.O.T. in 2000 for use by all personnel to avoid duplication of effort and to provide a more streamlined data flow between divisions from start to finish of a roadway project.

Using GEOPAK will help ensure consistency and accuracy of design work and generate a significant time savings in the overall effort of producing construction plans.

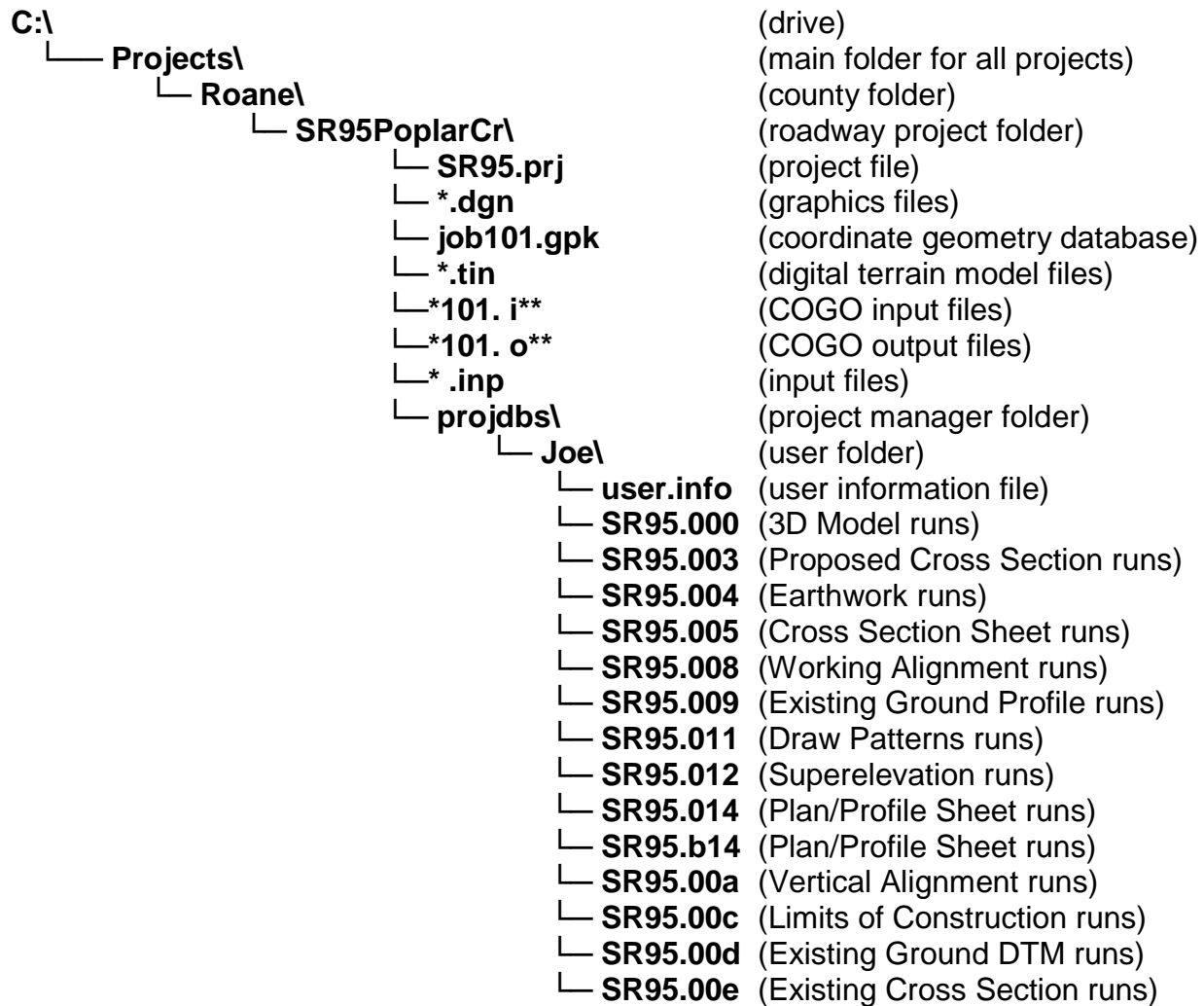
The dialog views, etc. in this course guide reflect GEOPAK V8i (SELECT Series 2), version 08.11.07.615.

Standard GEOPAK Road Project Filenames

job###.gpk	Binary file which contains all coordinate geometry This includes topo features, DTM points, horizontal & vertical alignments as well as property parcels. Only one file will be created for each project. T.D.O.T. Survey personnel initially create this file and add the existing data to it. Design adds proposed information and passes it on to Construction and R.O.W. personnel for completion of the project. The "###" is the only variable in this filename. It represents a job number (up to 3 alphanumeric characters) unique to a project. The first number corresponds to the T.D.O.T. Region.
filename.prj	Binary file resulting from the creation of a new project.
filename.tin	Binary file containing a triangulated surface also known as the digital terrain model (DTM).
filename ###.ioc	ASCII input file for loading data during a COGO session. "###" represents the job number and "oc" is the operator code (users initials). Filename characters are limited to 5 characters plus the 3 job number character designation.
filename###.ooc	ASCII output file created by GEOPAK during a COGO session. Variables are the same as those defined for COGO input files.
filename.inp	ASCII input file for running some GEOPAK processes such as superelevation. Name is user defined with an .inp extension.
filename.dat	ASCII or Binary file that contains string and point information to be used for digital terrain model creation.

GEOPAK Road Project File Structure

(Class project SR95 used as Example)



When making backup copies of project data, do not forget to copy the GEOPAK runs which are found under the users' folder in the **projdbs** folder. All runs use the GEOPAK project name followed by the run extension which depends on the type of run.

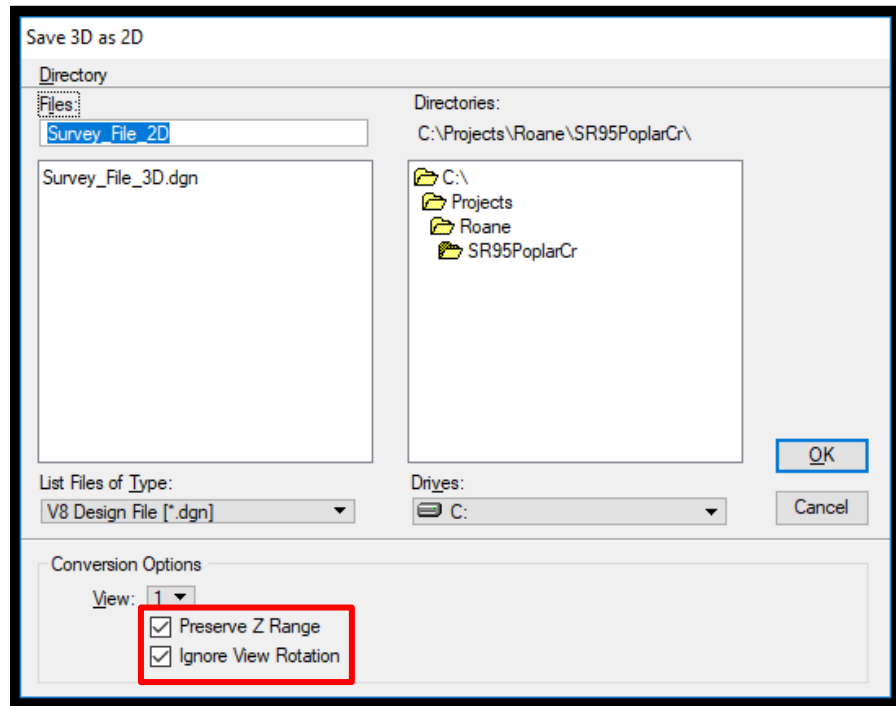
For the user's convenience, most of the class files have been created for you. When the Survey Office submits your actual project files, you will receive the following items: survey dgn, existing TIN file, gpk file, and the R.O.W. Acquisition Table.

The first step in receiving a new project is to **MAKE A COPY** of everything that Survey sends you. Keep the copies you make so you have a backup of the files you received.

The survey file that Survey will send you will be a 3D file that needs to be converted to a 2D file.

Exercise 0

1) Open the 3D Survey File and go to **File** → **Export** → **2D...**



On the left side of the screen is where you name the new 2D file.

On the right side of the screen is where you save the 2D file that was created.

2) **Check** both boxes: Preserve Z Range and Ignore View Rotation

3) **Press OK** and then open the new 2D file and begin your project.

1. User Preferences

This exercise is to familiarize you with GEOPAK's User Preferences which control the output format of data produced when using GEOPAK.

When you set up a Design Road Project as we will do in the next exercise, it stores its own set of "user preferences" which are reloaded each time the project is loaded.

NOTE:

The real advantage of accessing User Preferences as shown in this exercise is "on the fly" settings. You can temporarily make settings to see more decimals, etc. in order to check something, knowing that whenever you reload your project the standard user preferences stored with the project will replace those temporary settings.

I.) Defining Design User Preferences

- 1) Open the MicroStation file:

C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

Make sure the survey file is displayed before moving on.

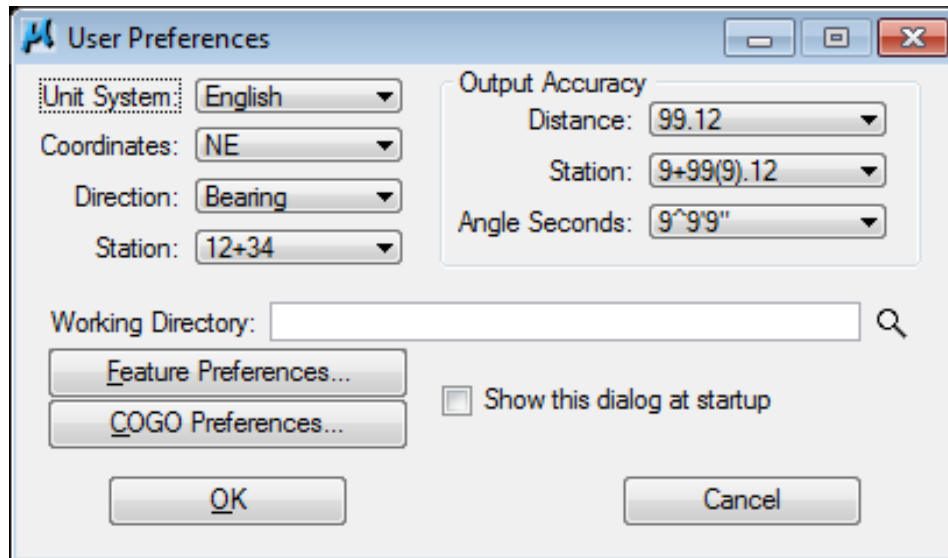
NOTE:

This path above is to be used for this class only. The project folder name is based on the project limits for this roadway. This project is on S.R. 95 in Roane County and its limits are from Poplar Cr. To Westover Drive. It is recommended that the project folder name include the roadway name and the beginning location of its limits. In the case of smaller projects such as bridge or intersection projects, you might use the creek or river name, the intersecting roadway name, or a log mile with the mainline roadway name to set a project folder name.

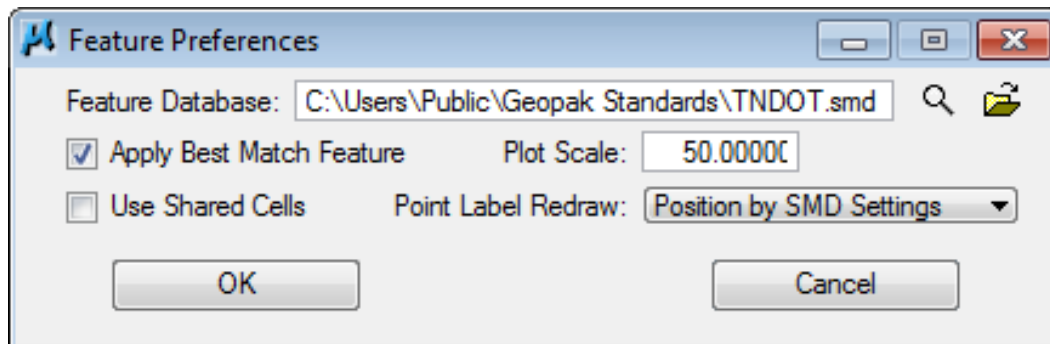
The project folder name that you choose to store your project in should follow this same basic format to avoid conflicts with other projects on the same roadway in the same county.

- 2) Access the GEOPAK User Preferences dialog from the MicroStation menu bar. Applications → GEOPAK → Road → User Preferences.

- 3) The User Preferences dialog should appear as shown. Check the standard settings for formats and output accuracy.



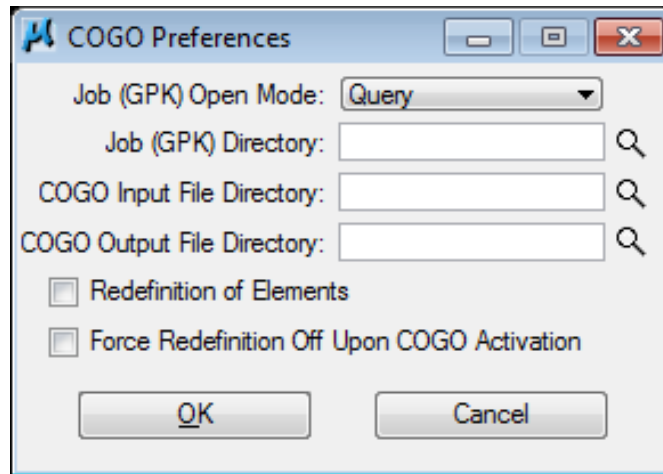
- 4) Press the Feature Preferences button and set the Plot Scale to 50 as shown. The SMD file should be set automatically. Toggle on the Apply Best Match Feature option.



Press OK to save the settings.

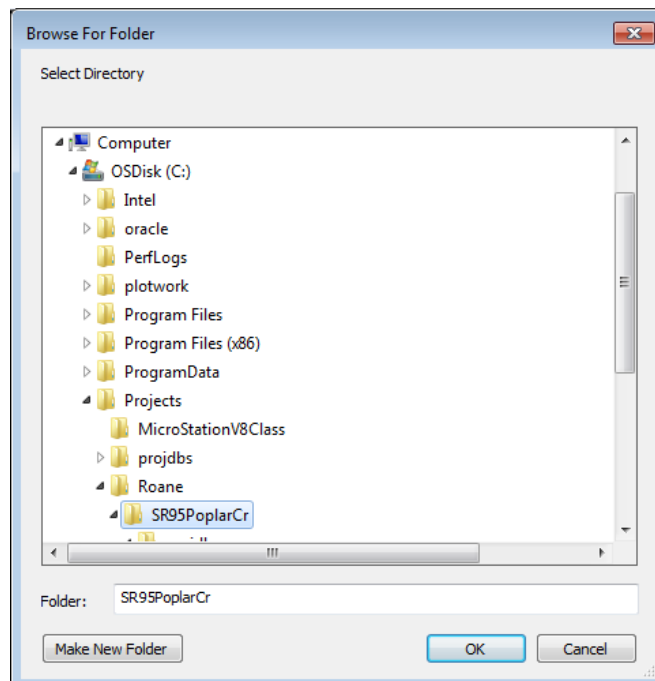
Exercise 1

- 5) Press the COGO Preferences button and review the settings available there. In our standard workflow we do not set special directories for COGO files. Instead, we set a project working directory where all project files go.

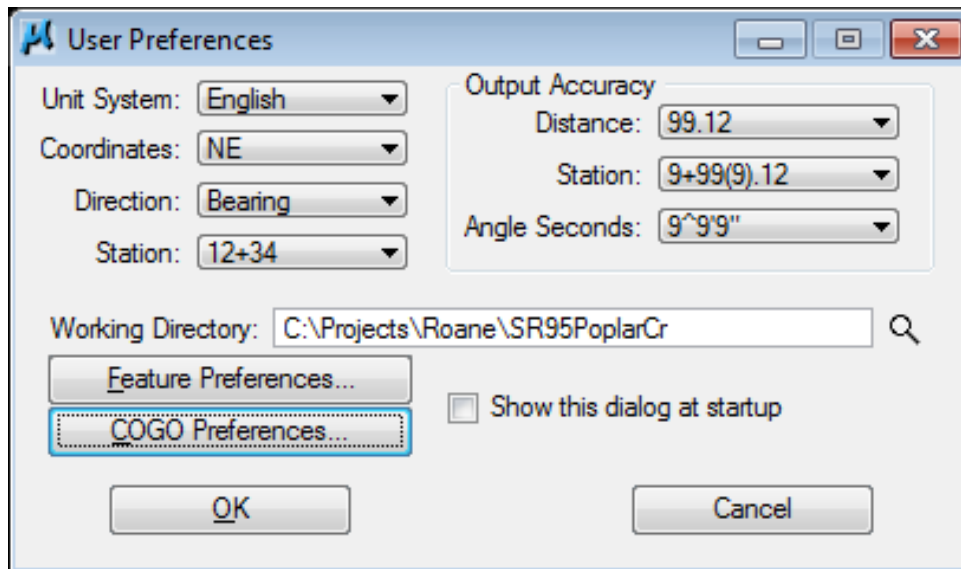


Press Cancel to exit without making any changes.

- 6) Click on the explorer button to the right of the Working Directory keyin field. Navigate to the project working directory as shown and click OK to set.



- 7) Now that all settings are made, the User Preferences dialog should appear as shown.



On the GEOPAK User Preferences dialog, press OK to exit and save settings.

2. Project Manager

This exercise introduces GEOPAK Road's Project Manager. This tool organizes project work with users and their associated runs. **Runs are a way of saving how a particular function was used or setup previously which can save the user valuable time.**

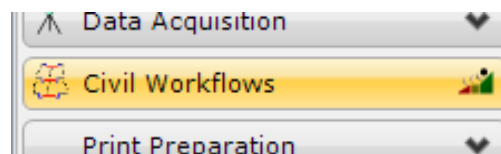
Project Manager also provides a workflow dialog making it easy for the user to find tools/functions which are used most often.

I.) Introduction & Set Up

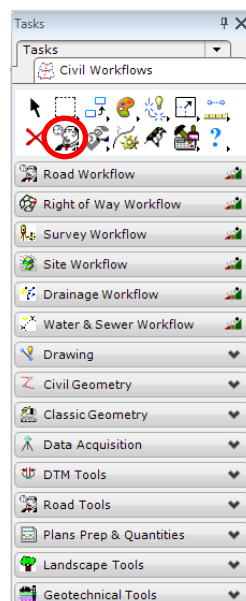
- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

- 2) Activate Geopak by clicking on the dropdown Applications → GEOPAK → Activate GEOPAK
- 3) Click the Civil Workflows option from the Task menu. This will make the basic Road Tools readily accessible in the Main Task options at the top.



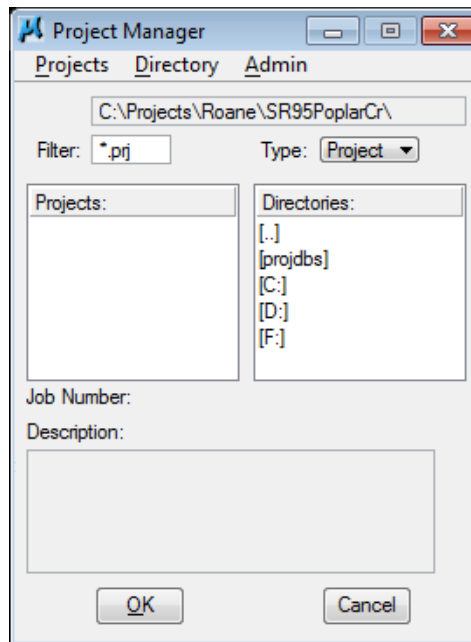
Civil Workflows makes most tools from Geopak Suite available in the Task menu.



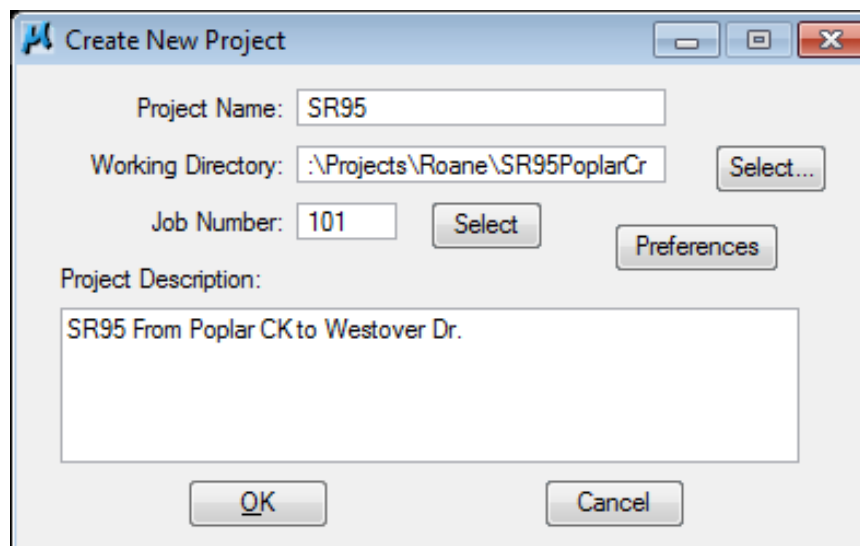
- 4) Access Project Manager using the Project Manager icon from the main tasks.



- 5) From the right side of the Project Manager dialog, in the Directories list box, ensure that the project directory is set to C:\Projects\Roane\SR95PoplarCr



- 6) Select the drop down Projects → New and set up the new project as specified. Fill out the Create New Project dialog as shown below. Use the Select buttons to set the Working Directory and Job Number:

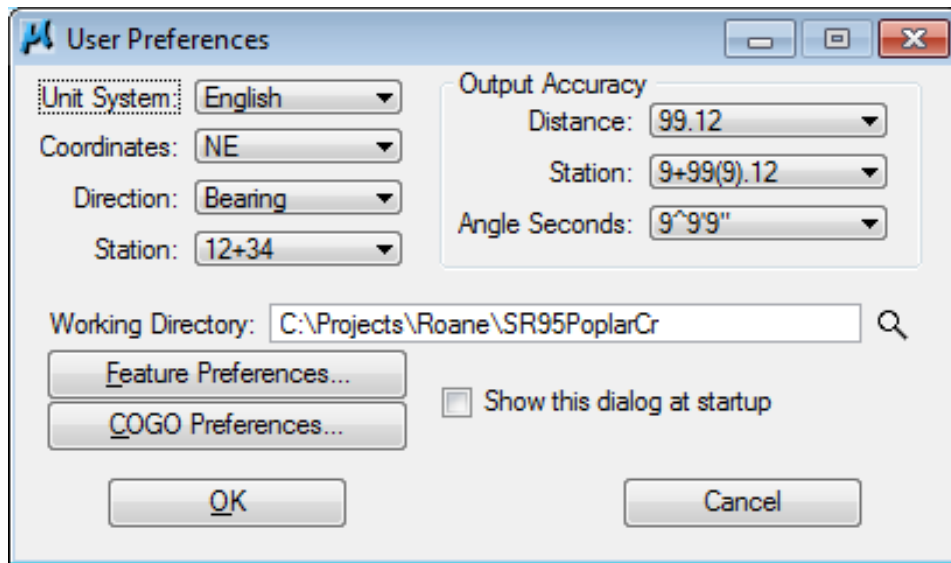


Exercise 2

NOTE:

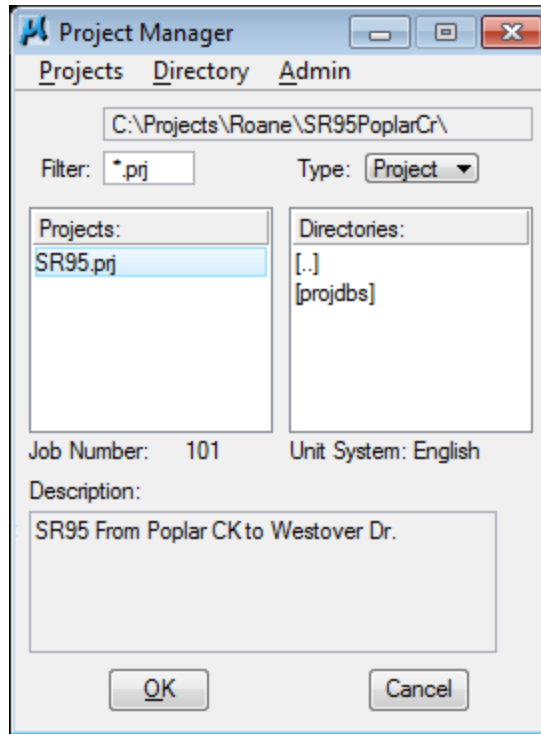
Survey personnel initially sets up the GPK file (indicated by the Job Number), stores existing features for projects and then gives it to Design with the completed survey. Design personnel, in turn, adds proposed features and passes it on to R.O.W. & Construction personnel for their use in completing the project.

- 7) Click Preferences on the Create New Project dialog. Since we set up our standard user preferences in the previous exercise, the settings should appear as shown. These are the project preferences which will be loaded whenever the project is opened.



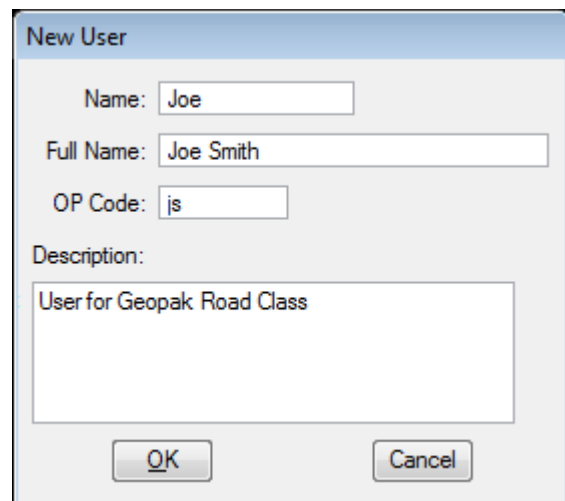
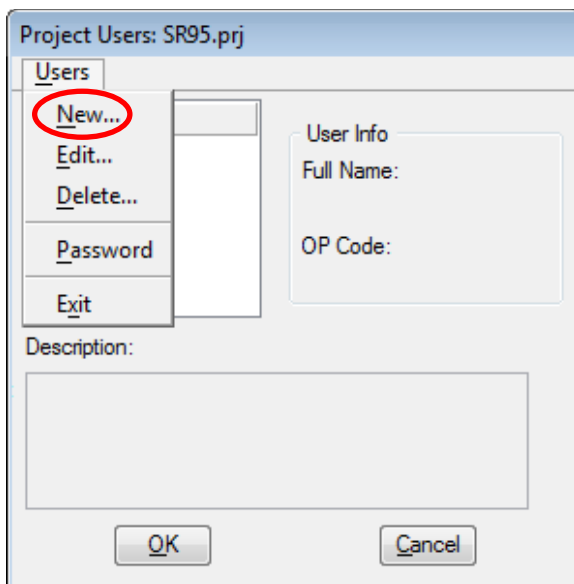
Press OK.

- 8) Exit the Preferences dialog. This will return you to the Create New Project dialog, press the OK button.
- 9) The main Project Manager dialog is now displayed, and the project has been created and ready to be accessed. To access the project, select the project by single clicking on the name of the project in the dialog. The project is highlighted as shown in the dialog with all pertinent information displayed.



Press OK to open the project and invoke the Project Users dialog.

- 10) Create a new user by selecting **Users** → **N**ew from the Project Users menu bar. Complete the New User dialog with your name and operator code (**your initials**) as shown.



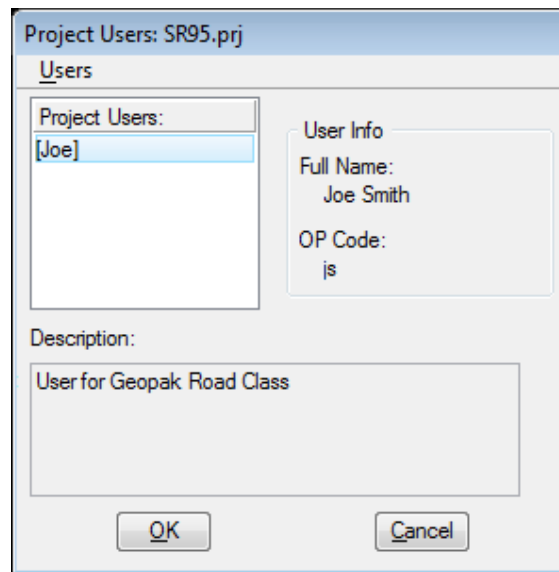
- 11) After populating the dialog press OK. When prompted to define a password for this user, press No.

Exercise 2

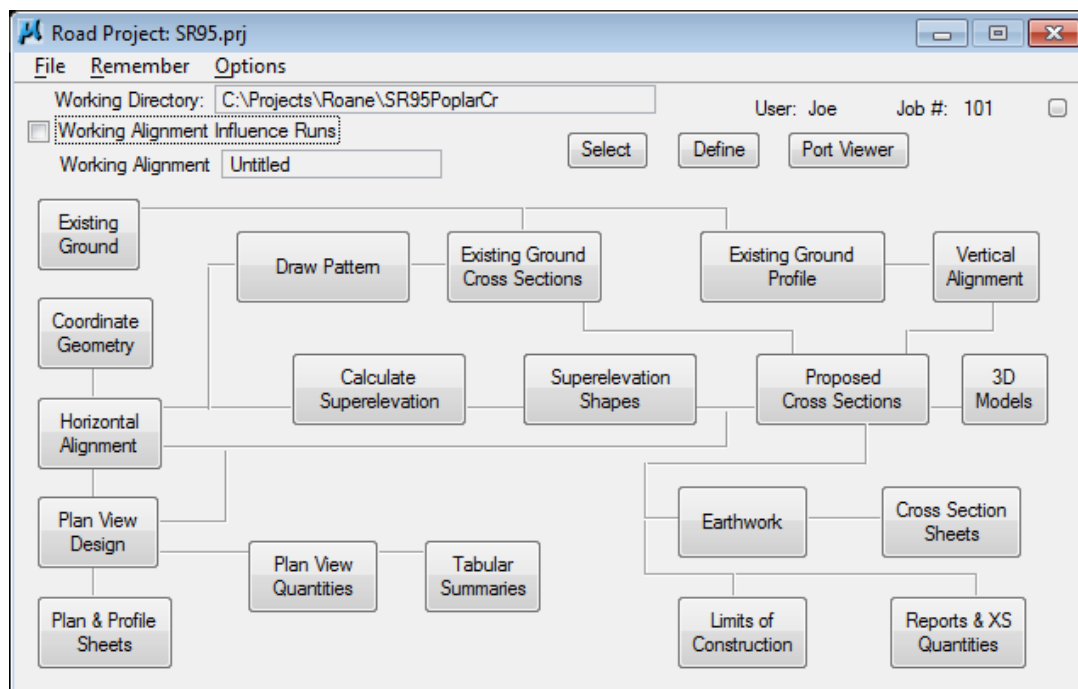
NOTE:

The operator code is used by COGO with input and output files. Those characters control what input files are included for opening or processing and are used when assigning names for input or output files.

- 12) Now, we are back at the Project Users dialog. Double click the user name or select it and click OK to move on.



- 13) You will now see the main Project Manager workflow dialog. From here, we can access many of the GEOPAK functions which we will use.



- 14) Within the project manager dialog, Click on the Remember drop down and toggle on Project and User to set up Project Manager to remember our project and user.

NOTE:

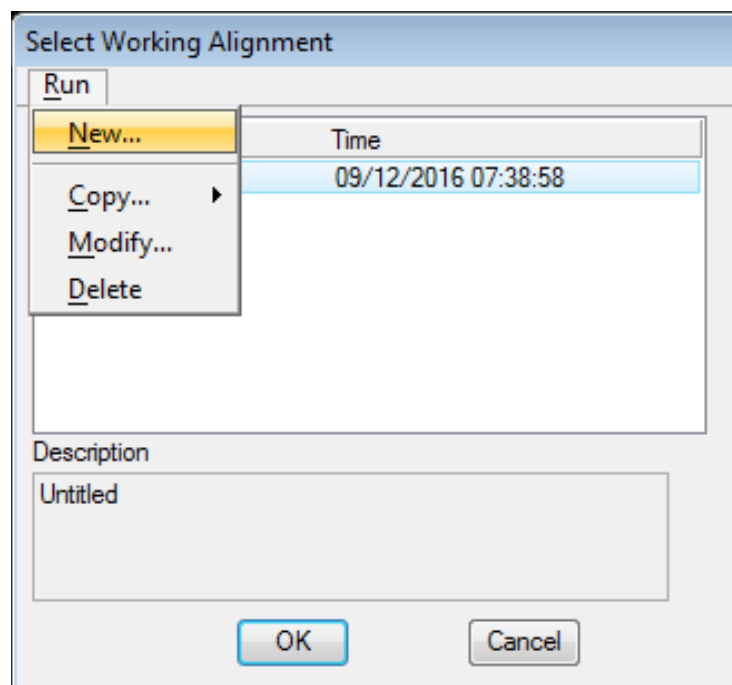
In normal workflows you must be careful with the “Remember” options. If you have more than one project active at one time, you will have to Un-Check both Project and User before moving to another project.

This must be done to ensure that files are placed or looked for in the proper folders to avoid mixing project data. Of course another alternative is to not use the Remember options if you have more than one project. That way you can move to the project you need to be in each time you invoke Project Manager.

II.) Working Alignment – Create

Before leaving this exercise, let’s go ahead and begin to set the stage for further design via the Project Manager by defining the Working Alignment. To do this, we’ll need to use the Select and Define buttons on the Project Manager workflow dialog.

- 1) Press the Select button to create a new Working Alignment. The Working Alignment is the active roadway that we are about to design. In the Select Working Alignment dialog create a new run by clicking the drop down option Run → New.



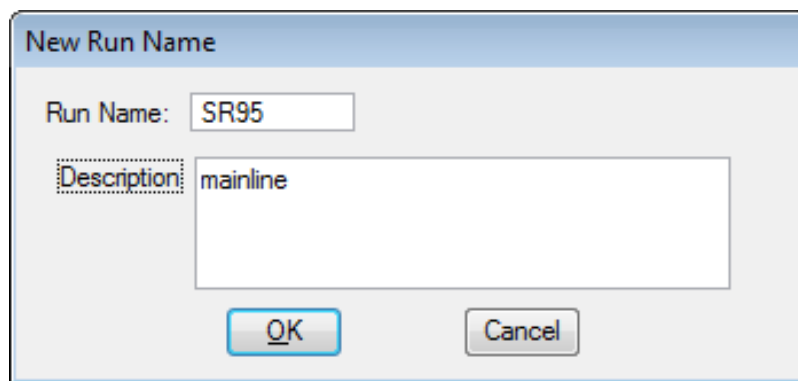
Exercise 2

NOTE:


GEOPAK organizes many functions with “Runs”. Each time you use many of GEOPAK’s tools or functions you will be asked to create a run. Runs store the entries/settings made in a tool so that you can return later to re-run a particular function or even copy it in order to set it up to run a little differently.

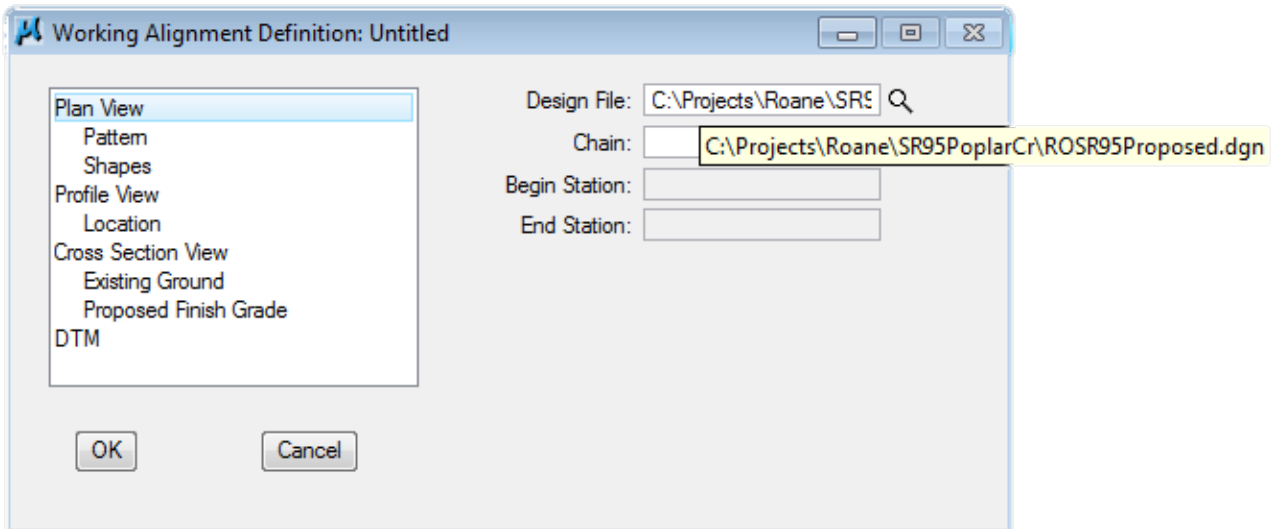
Working Alignment set ups or runs are actually used by other runs. The working alignment will automatically fill in other runs with pertinent data associated with a given roadway thus saving much time and effort for the user.

- 2) Create a new Working Alignment run called “SR95” and a Description for the Run ‘mainline’ as shown below and press OK.



The image shows a dialog box titled "New Run Name". It has two input fields: "Run Name:" with the text "SR95" and "Description:" with the text "mainline". Below the fields are two buttons: "OK" and "Cancel".

- 3) After creating the run, select the run by highlighting it in the dialog and pressing OK.
- 4) You will now return to the main Workflow dialog. Press the Define button to access the Working Alignment Definition dialog.
- 5) Select the Plan View item in the list box and define the Design File as C:\Projects\Roane\ROSR95Proposed.dgn. Click the Browse button  to set this file.



- 6) Press OK to exit and save settings in the Working Alignment Definition dialog.
- 7) Back on the main Project Manager dialog, toggle on the Working Alignment Influence Runs option located at the top left of the dialog. With this clicked on, data defined in the working alignment will automatically fill in runs when they are created or opened.
- 8) Exit Project Manager, select **File** → **Exit**.

3. Digital Terrain Models

In the normal project flow, the existing ground digital terrain model (*.TIN) file is created by Survey personnel.

In this exercise, we will demonstrate some of the tools which are available to pull information from those surfaces.

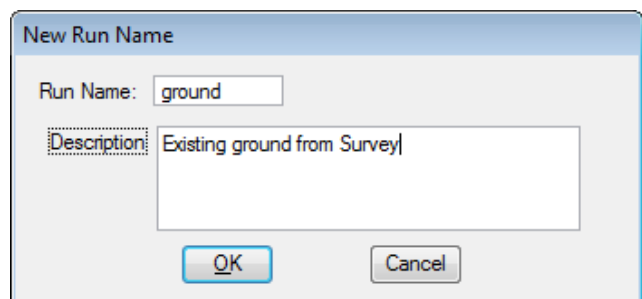
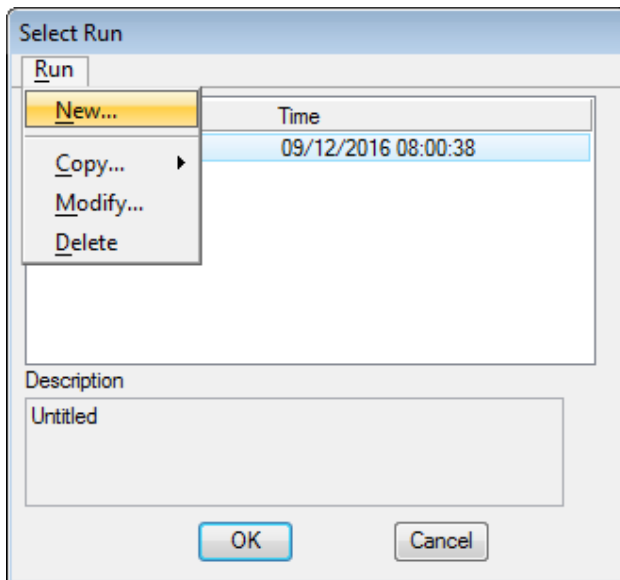
I.) Accessing DTM Tools

- 1) Open the MicroStation file

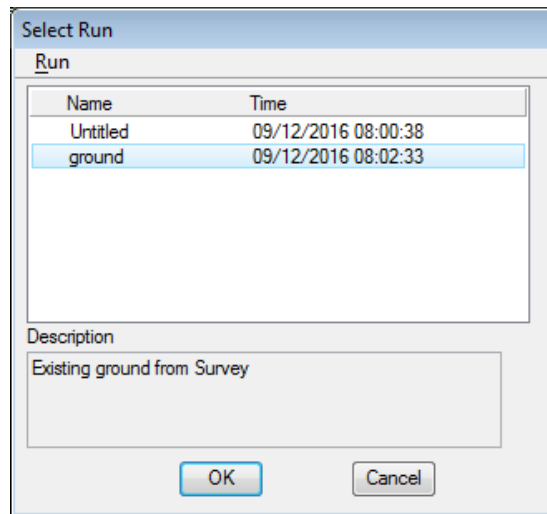
C:\Projects\Roane\SR95PoplarCr\ROSR95Contours.dgn

Access Project Manager. It should automatically access the Road workflow dialog since we “remembered” the options in Exercise 2.

- 2) Select the icon Existing Ground from the Project Manager workflow dialog.
- 3) Create a new run named ground.



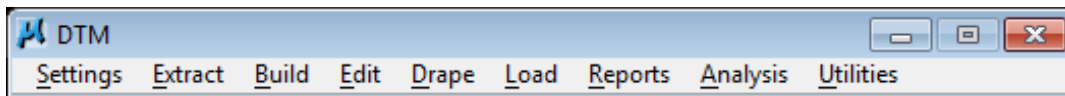
- 4) After creating the run, select the run by highlighting the name of the run in the dialog list box and press OK.



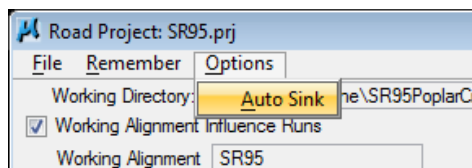
This will invoke the DTM tool frame.



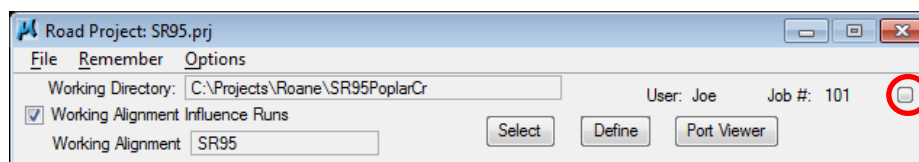
If you prefer a drop down menu click on the menu icon at far left of the tool frame.



- 5) You can set the Project Manager workflow dialog to automatically sink when a tool is chosen by setting the drop down option Options → Auto Sink.



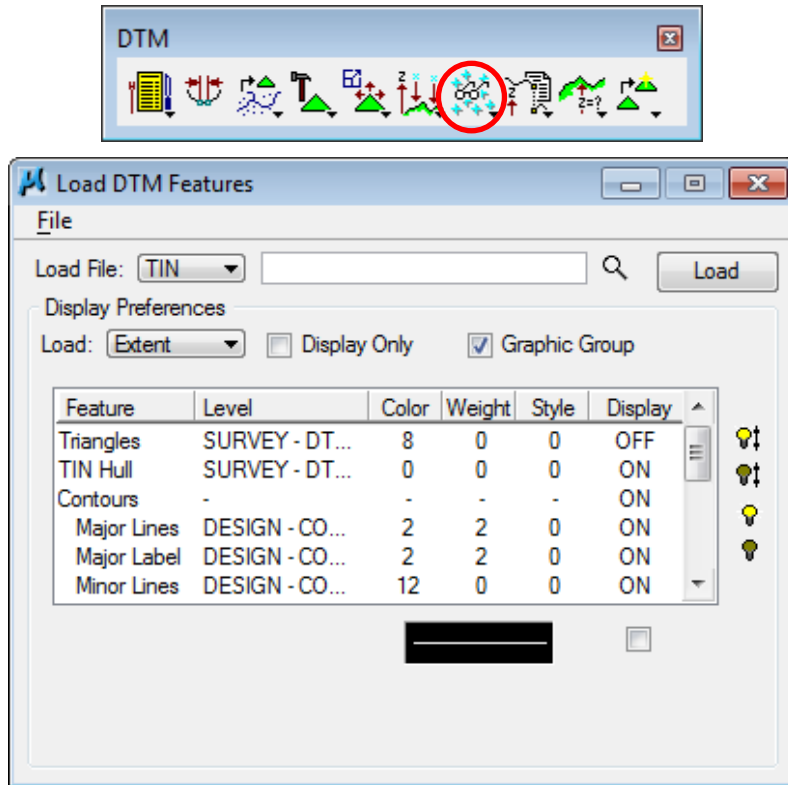
The small button on the upper right of the Project Manager workflow dialog will minimize it to a bar



Use one of these options to help keep your workspace clear.

II.) Display DTM Features


- 1) Select the Load Features icon from the tool frame to invoke the following dialog.



- 2) Use the File → Open drop down to open the preference file tdotEXIST.lpf from the C:\Users\Public\Geopak Standards directory. This will set the symbologies to TDOT standards for existing digital terrain models.

NOTE:

When working with proposed surfaces use tdotPROP.lpf for graphic displays.

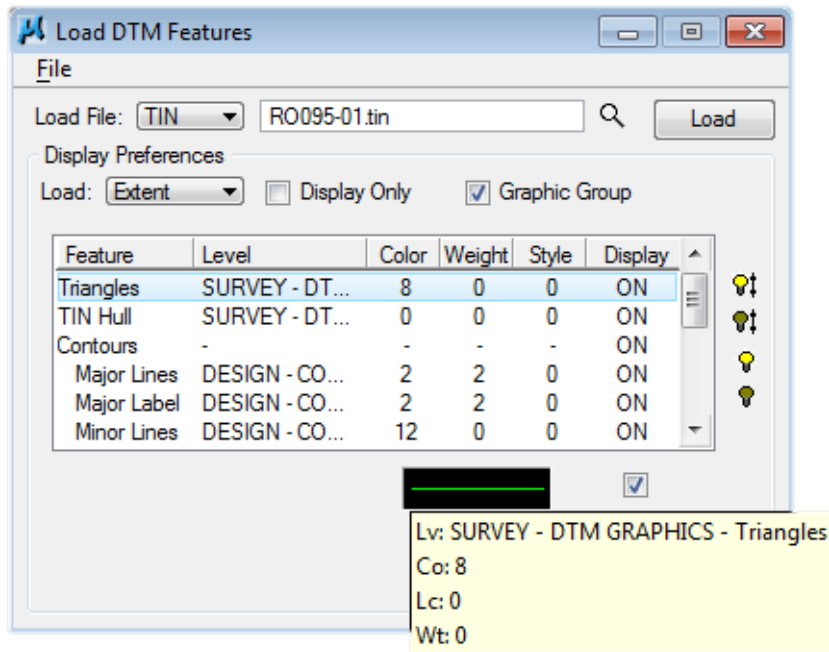
- 3) Set the Load File option to TIN.
- 4) Select the TIN file 'RO095-01.tin' by clicking the navigator  button and going to the project directory C:\Projects\Roane\SR95PoplarCr.
- 5) Select the Triangles Feature by highlighting in the list box at the bottom. Notice that initially the display is set to OFF. You can control the display of an item three ways:

- Use the "light bulb" icons to the right of the dialog
- Double-click on an item

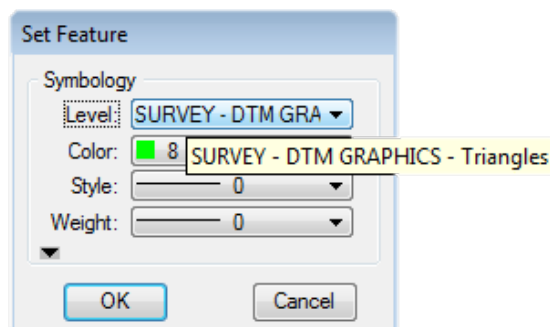


- Use the “display” toggle in the lower right corner of the dialog
Set the Triangles display to ON.

6) Note the display symbology for the Triangles as indicated in the symbology review box in the lower portion of the dialog. Due to the length of the level name, it will usually not appear completely in the main item list. If you float your cursor over the symbology review box, you can see the settings in the pop up info.



If you wish to change the symbology for an item, simply double click in the symbology review box to open the Set Feature dialog



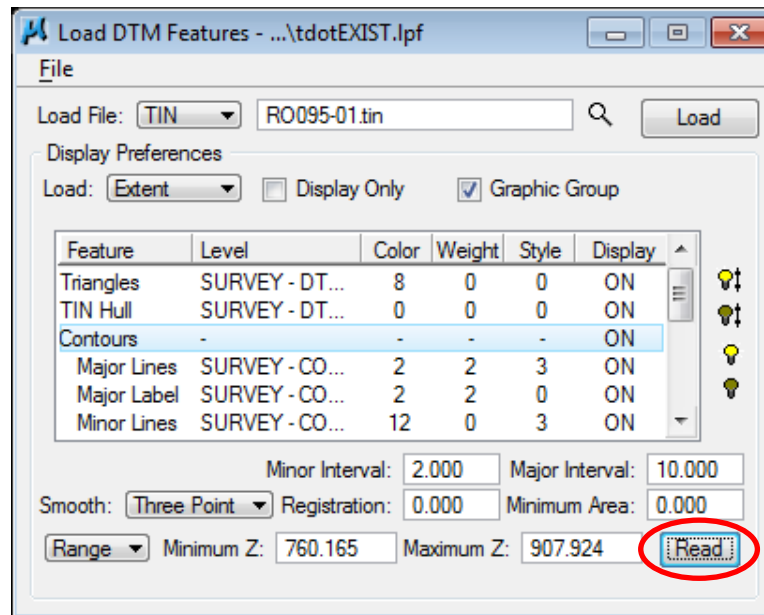
Click Cancel to close this dialog without making any changes.

- 7) Make sure the display of the Tin Hull (the boundary of the surface model) is ON.
- 8) Select the Contours feature and make sure the display is ON.

Exercise 3

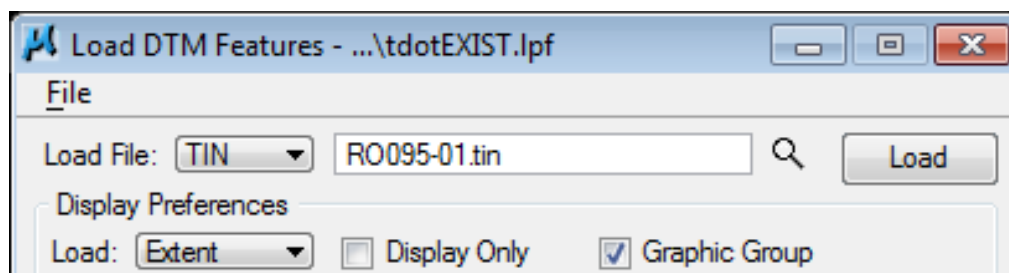
- 9) Complete the bottom of the dialog as indicated below. To complete the Minimum and Maximum Z, Press the Read button, which will review the active TIN file and determine these values.

Once you read the limits of any surface, you can determine what minor and major intervals might work best. For flatter surfaces smaller intervals might be required or in the case of larger differences between the minimum and maximum Z elevations larger intervals might be needed.



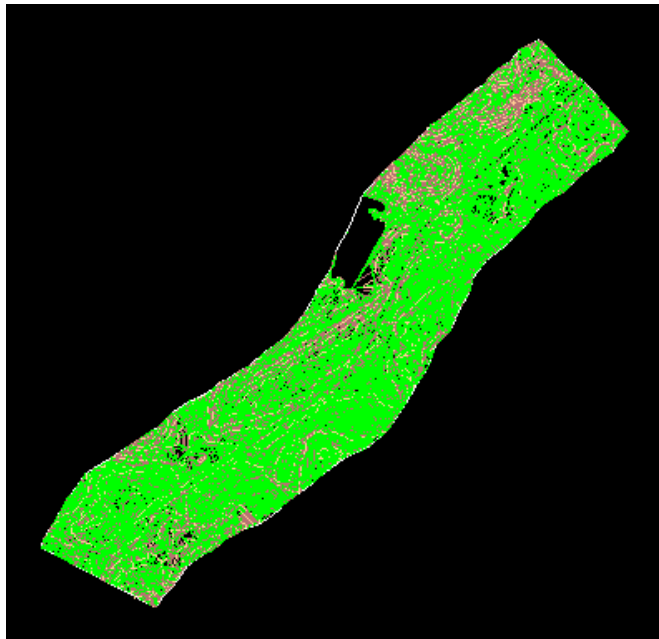
Notice that Major and Minor contour lines and text are controlled separately. Check to make sure all are ON except for Minor Label.

- 10) Set the Load option to Extent, deactivate the Display Only toggle and activate the Graphic Group toggle to write the graphics to this file as a graphic group.



- 11) Press the Load button to initiate the process. Fit the view and check out the resulting graphics. Use MicroStation's Level Display dialog to turn levels on and off in order to see the different features.

Triangles	SURVEY - DTM GRAPHICS - Triangles
TIN Hull	SURVEY - DTM GRAPHICS - Boundary Line
Major Contours	SURVEY - CONTOURS - Index with Text
Minor Contours	SURVEY - CONTOURS - Intermediate with optional Text



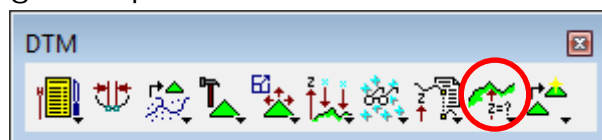
- 12) Turn off the level display for the triangles so you will be ready for the next exercise.
- 13) Close the Load DTM Features dialog and click Yes to Save Settings when prompted.

III.) Analysis Tools

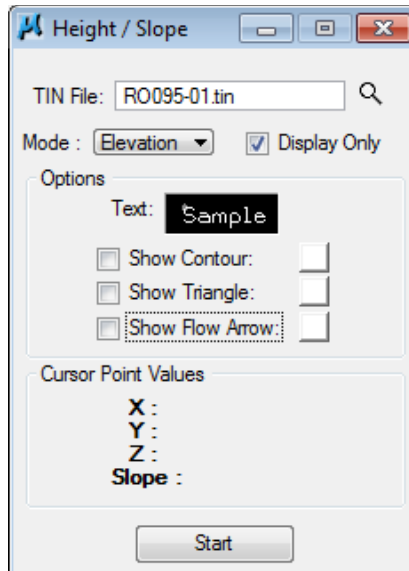
We will review several analysis tools in the following exercises. These include the height/slope tool, drainage tools and the profile tool.

a) Height/Slope Tool

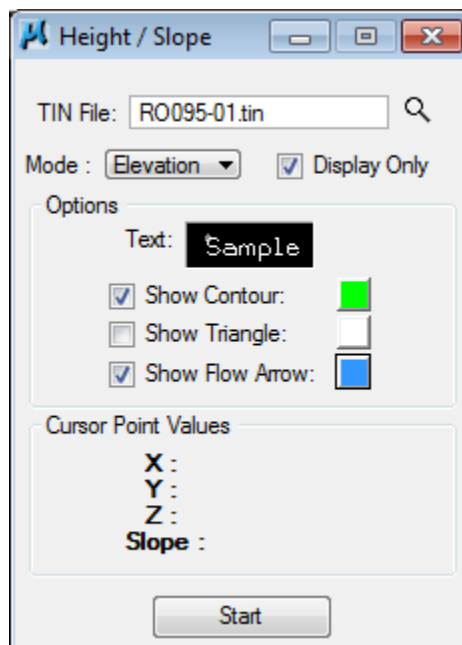
- 1) Select the Height/Slope icon from the DTM tool frame to invoke the following dialog.



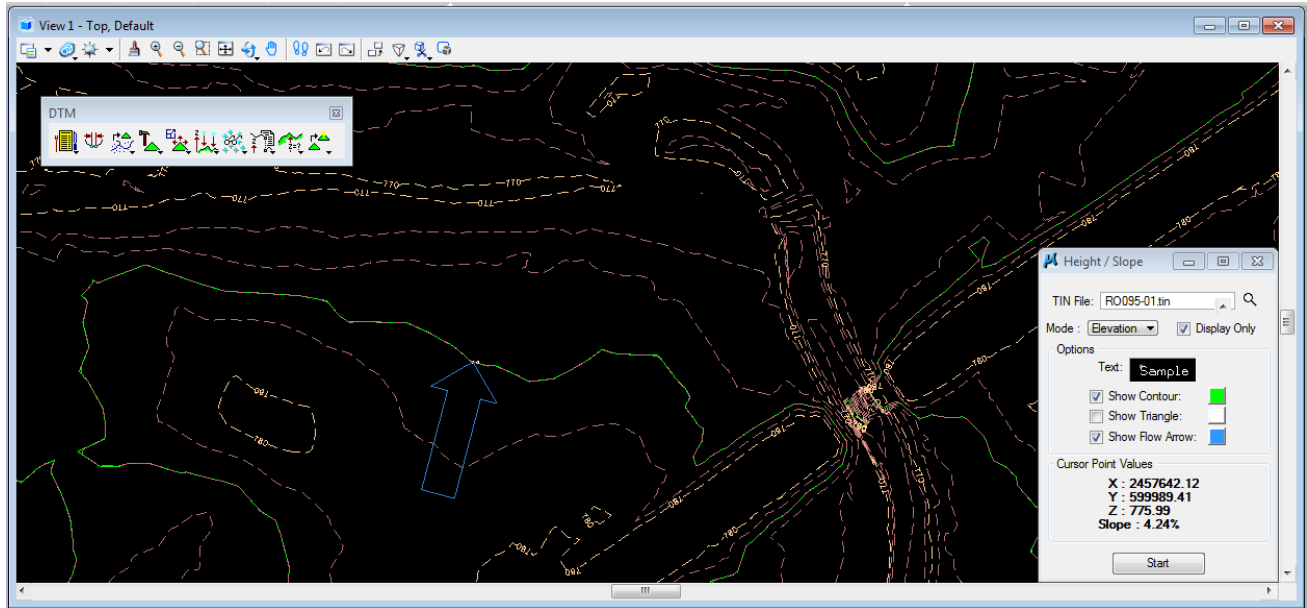
Exercise 3



- 2) Make sure Mode is set to Elevation and Display Only is clicked on. Under Options, activate the Show Contour and Show Flow Arrow toggles. The color may be altered to your choice of colors from the color picker buttons to the right of the Options on the Height dialog. The level, weight and style of the contour line and arrow are controlled by the active MicroStation settings.



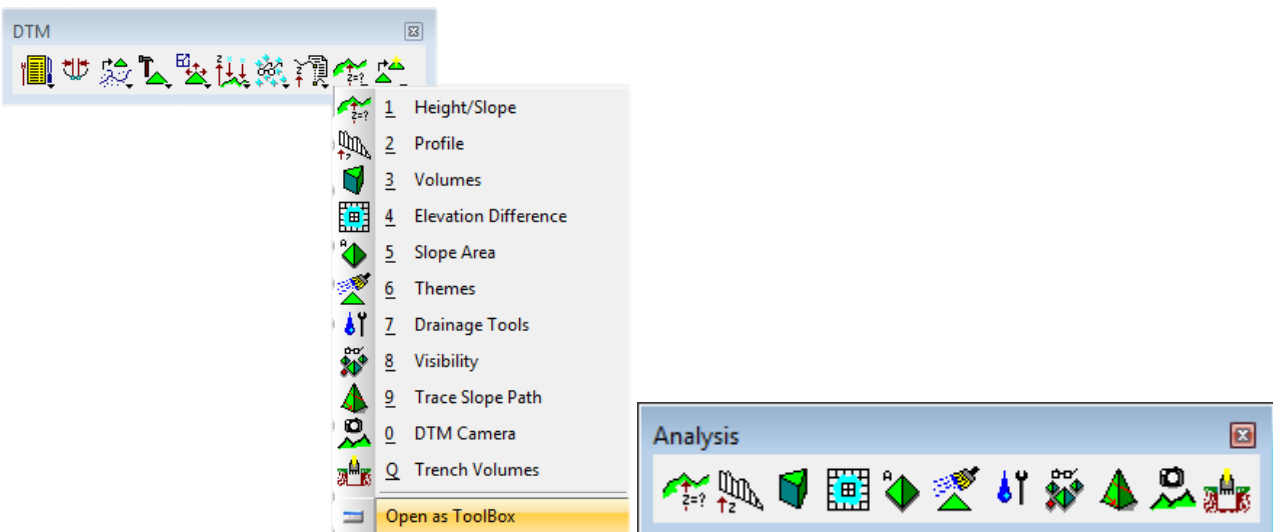
- 3) Click the Start button and scan the surface model with the cursor to display the values for xyz and the slope on the model at the cursor point.



- 4) To actually display these graphics in the file, click off the Display Only option and data point any place you want graphics placed.
- 5) Close the Height/Slope dialog.

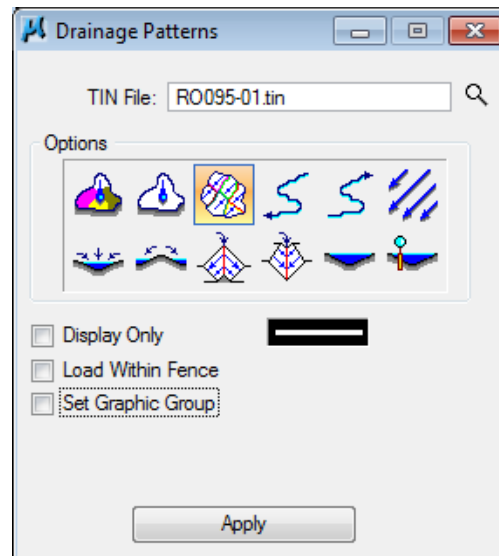
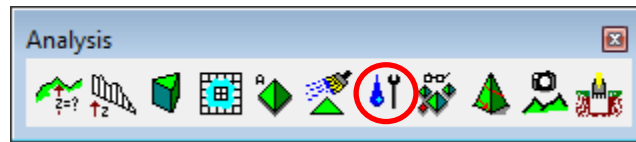
b) Drainage Tools

- 1) Click on the Height/Slope tool holding the mouse button down and drag the pointer away to pop up all of the Analysis tools. Select the Open as Toolbox option at the bottom to access the Analysis toolbox.



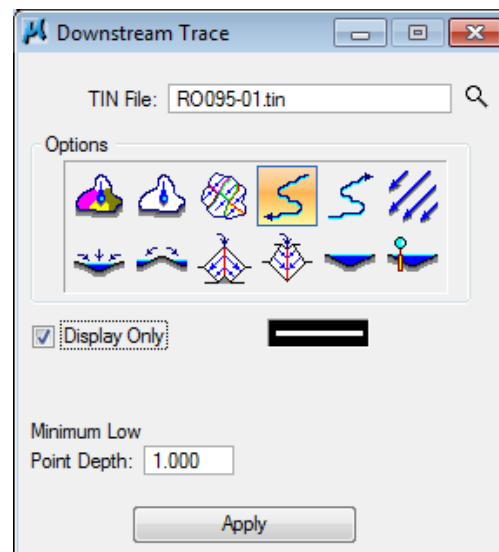
Exercise 3

- 2) Select the Drainage Tools icon from the Analysis tool box to invoke the dialog depicted below.

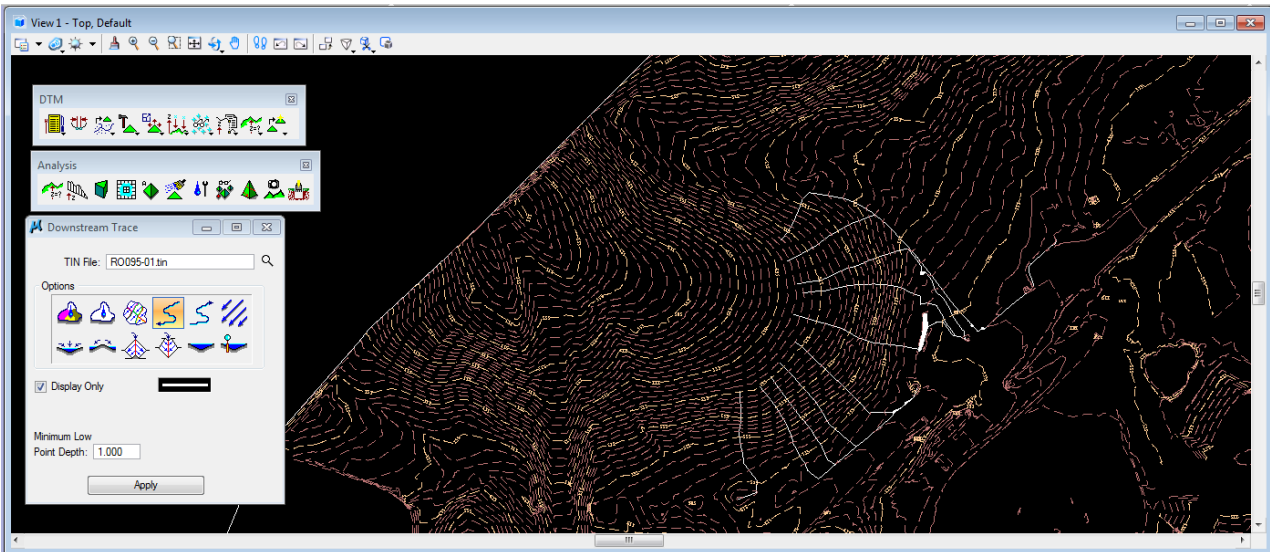


- 3) Ensure that all graphic elements are Fit into View 1 and turn off contour levels.
- 4) From the Drainage Tools dialog, select the Downstream Trace tool as shown. The Downstream Trace Tool delineates the flow path downstream from any given point in the TIN.

Set the Display Only toggle to ON and the Minimum Low Point Depth to 1.



- 5) Press Apply and then data point somewhere on the dtm. The flow path downstream should be displayed in the design file. You may enter several data points consecutively, then reset to exit. You may wish to turn on the contours to get a feel for the results you are getting.

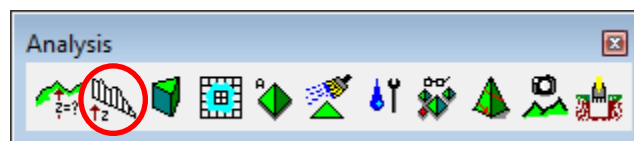


- 6) Take some time to try some of the other Drainage Tools.
- 7) Dismiss the Drainage Tools dialog.

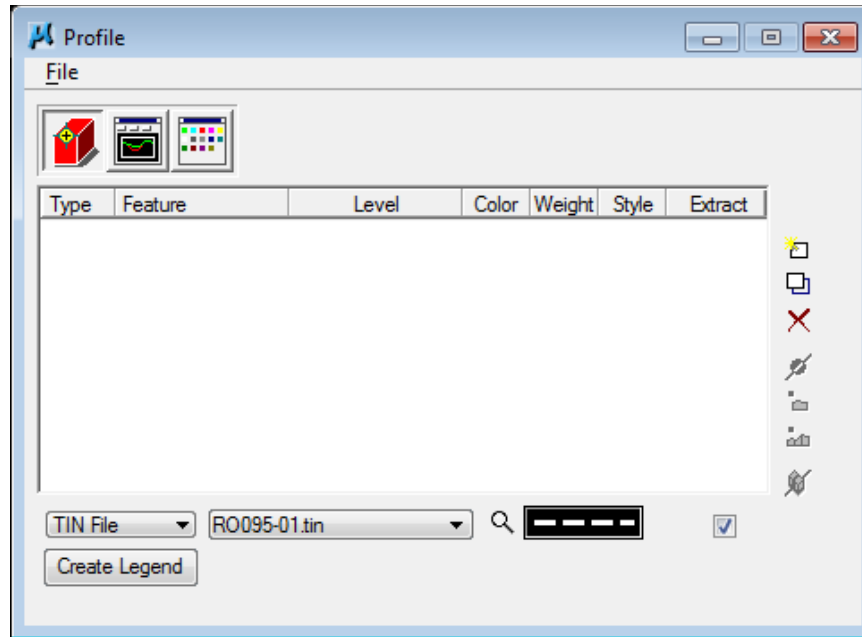
c) Profile Tool


This tool is useful for quick checks of profiles across surfaces but for permanent displays we recommend use of the Draw Profile or Existing Ground Profile tools. They will be shown in later exercises.

- 1) Select the Profile icon from the Analysis tool box to invoke the following dialog.



Exercise 3



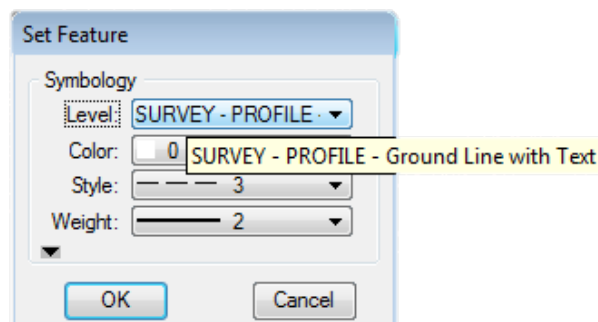
- 2) Under the Object Selection  icon on the left identify your surface model (TIN File) which will be used to generate a profile, and identify the symbology for your profile.

Select the TIN file 'RO095-01 .tin' by clicking the "browser" button and going to the project directory C:\Projects\Roane\SR95PoplarCr


NOTE:

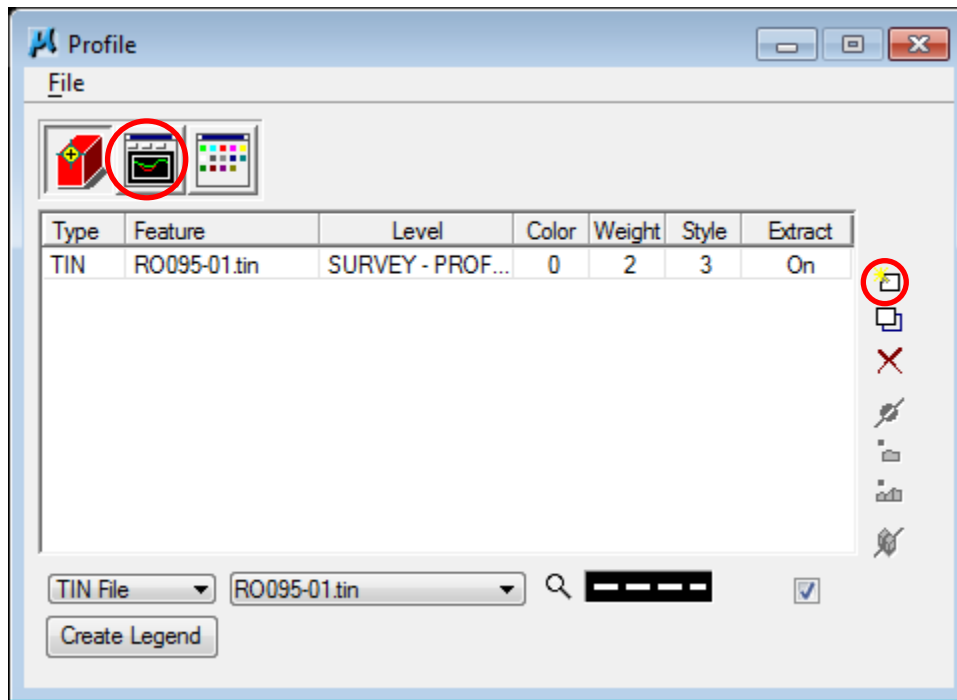
This tool will process multiple surfaces at one time so if proposed surfaces have been created they could be cut at the same time.

- 3) Double-click on the symbology review box on the right of the "browser" (button at the bottom of the dialog) to open the Set Feature dialog. Set the symbology representing the ground surface profile. Make settings as shown and press OK.

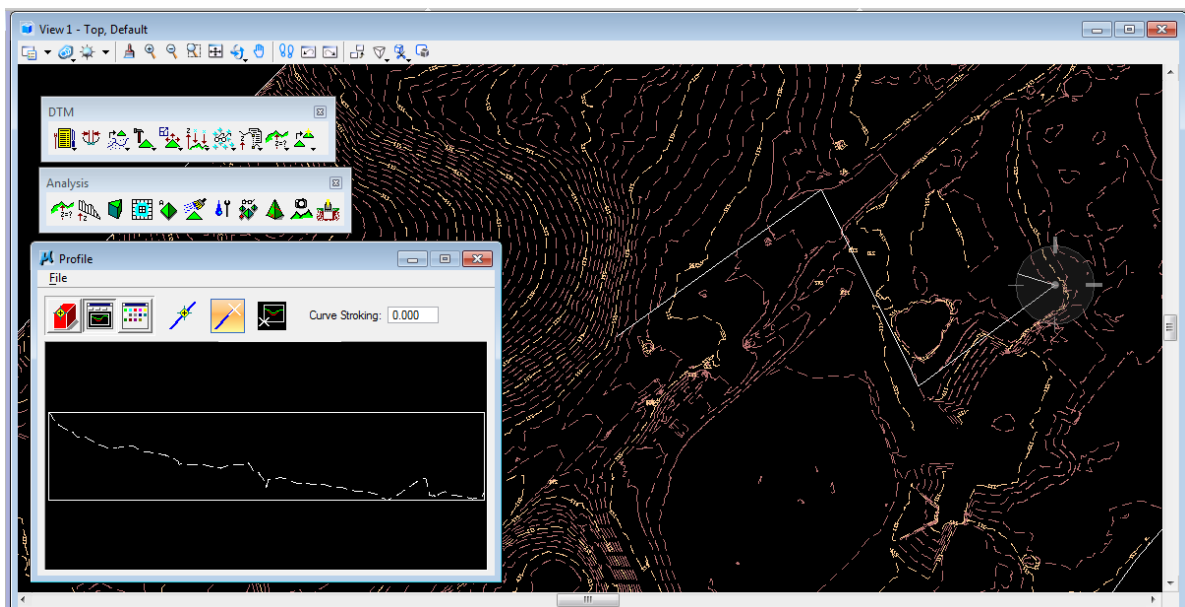


The level name is SURVEY - PROFILE - Ground Line with Text.

- 4) Press the Add icon  to add the feature to the collection box.

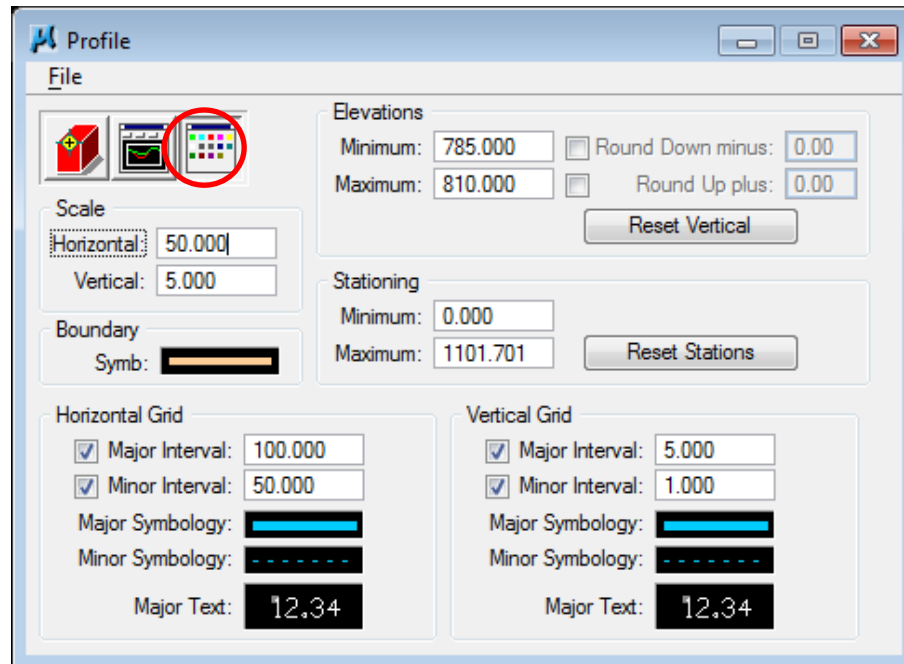


- 5) Select the Create Profile icon circled above.
- 6) Press the Place Element button to cut your actual profile at any desired area by just placing two data points (i.e. a line) or a series of data points (i.e. a line-string) across your surface model at any location.

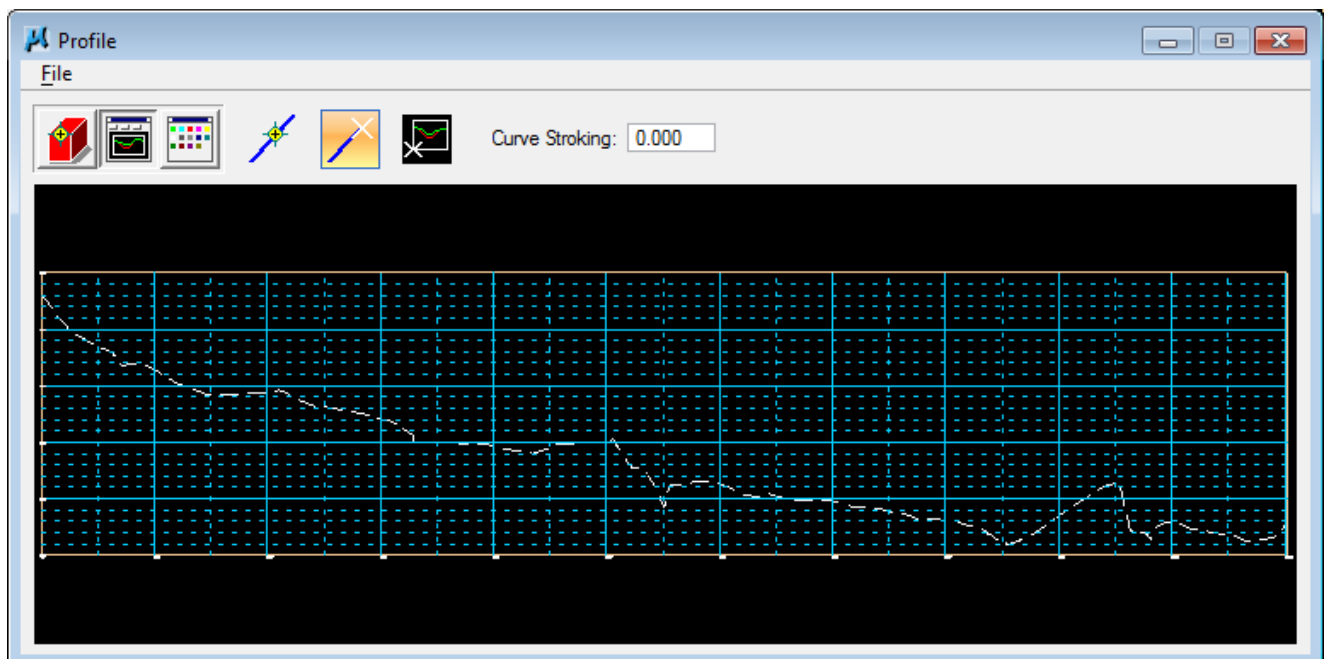


Exercise 3

- 7) You can use the Preferences icon to set up a grid for your profile if desired.

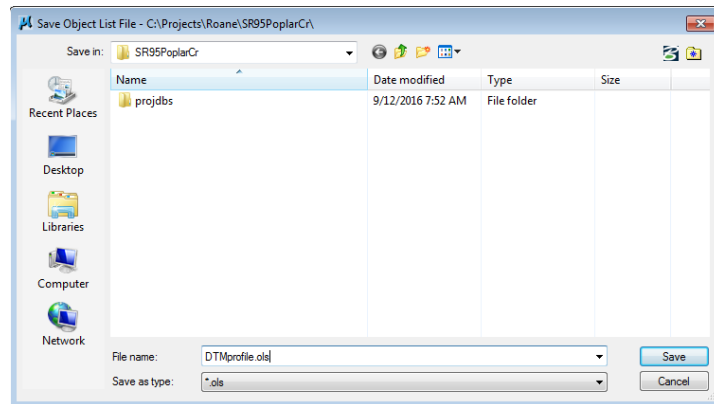


Click on the Profile icon and see your profile with the grid parameters that have been set.



If not happy with your grid settings, go back to Preferences to adjust. You can use the Place Profile icon at the far right to place your profile graphics in MicroStation

- 8) If you think you might use this set up again later you can save all of your settings by going to the drop down option Files → Save.

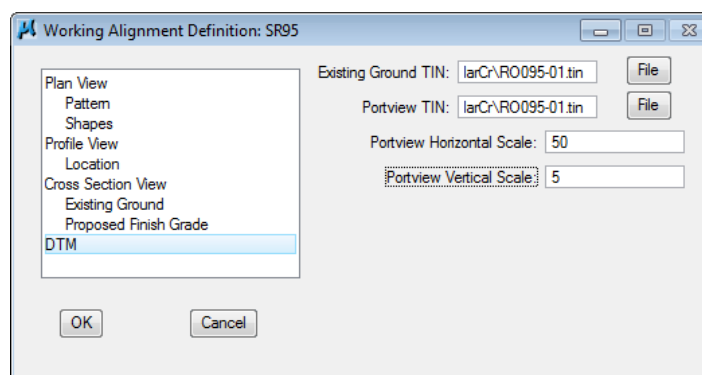


- 9) Close the Profile dialog and the DTM and Analysis tool frames.

IV.) Working Alignment – Define DTM

We now have more information to set in the Working Alignment. To do this, we'll need to use the working alignment Define button on the Project Manager workflow dialog. The Project Manager workflow dialog should still be active. Re-access the dialog by clicking on the Project Manager icon.

- 1) Press the Define button to access the Working Alignment Definition dialog.
- 2) Select the DTM item in the list box and complete the DTM definitions as shown below:



We will discuss the use of the Port Viewer tool in a later exercise.

- 3) Press OK to exit the Working Alignment Definition dialog and to save our new settings.
- 4) Exit Project Manager using the File → Exit drop-down option.

4. Coordinate Geometry

In the normal workflow, Survey personnel develop preliminary centerlines based on the project's Transportation Planning Report (TPR-See Appendix A). When the survey data is passed on to Design, we have to review those preliminary centerlines to determine if they can be used for the proposed design of the roadway. Several issues must be addressed including:

- Standard Design Specifications – do curves meet design specs
- Encroachment – can a vertical alignment be developed which when used with the centerline and typical section does not encroach excessively on properties, historical or archeological sites, wetlands, etc.
- Constructability issues – If traffic is to be maintained on existing roads can the roadway be built as designed while maintaining traffic flow.

With this in mind this exercise takes a preliminary centerline as it might come from Survey and goes through the processes Design might use to alter that centerline chain to meet the requirements encountered through the design process.

As we work with this proposed centerline, we will look at different methods that GEOPAK provides to store coordinate geometry including basic COGO and Horizontal Alignment tools.

I.) Basic COGO

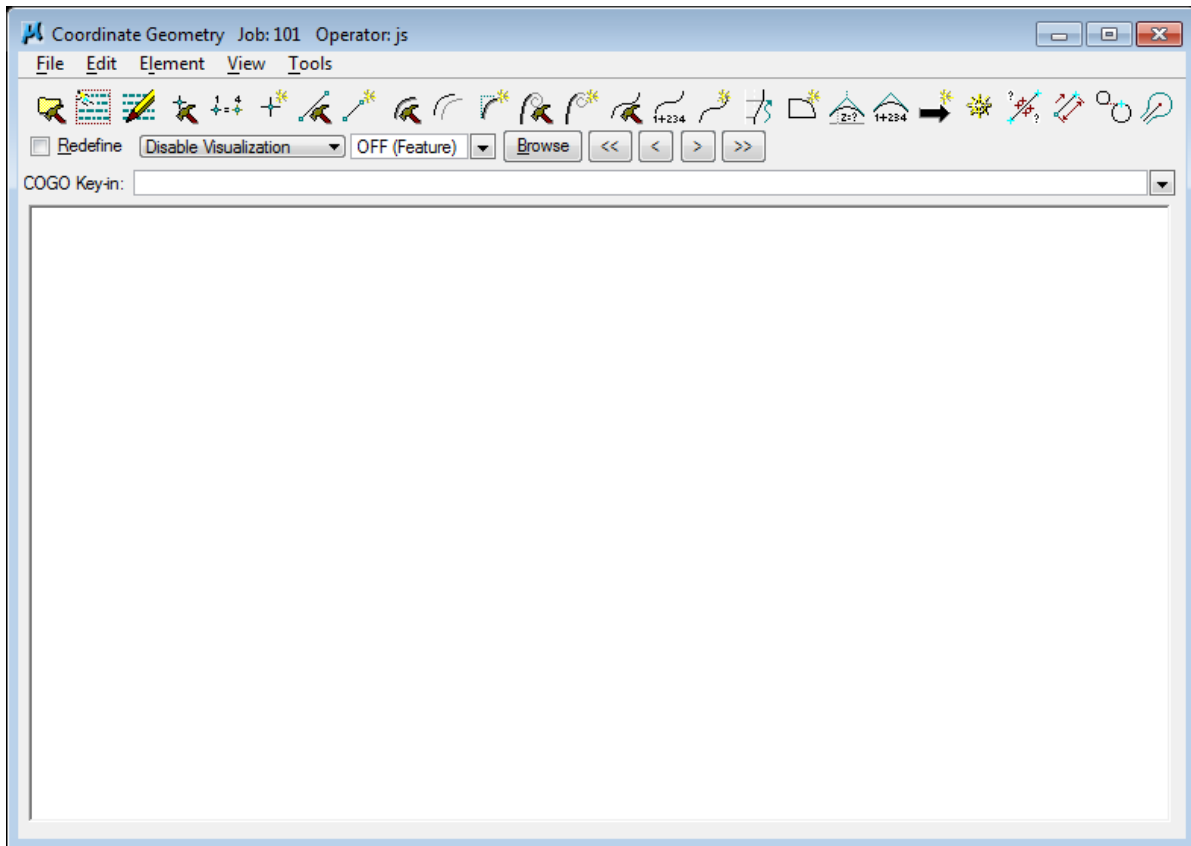
- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

Access Project Manager.

- 2) Select the Coordinate Geometry icon from the Project Manager workflow dialog.

3) The Coordinate Geometry dialog opens as shown below.



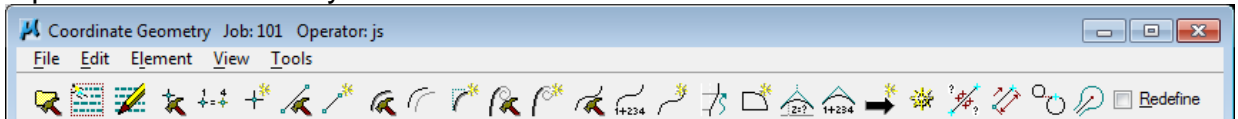
This dialog is completely re-sizable, so you can re-size and position it where you're most comfortable.

a) COGO Interface

In the next few steps, we'll take some time to familiarize ourselves with the COGO interface.

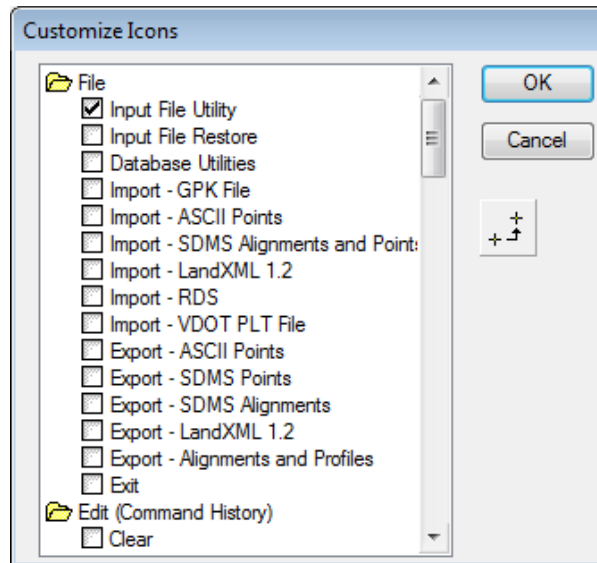
- 4) All basic COGO commands are available through the drop down options from the COGO menu bar. These include the creation of objects such as points, curves & chains, as well tools to report information on those objects.

These tools can also be activated via the icons at the top. The icons shown at the top are customizable by the user.












Click on the drop down option

View → Icons → Customize This Group. The following dialog is opened.



Scroll through the list and make sure the following are clicked on.

- Input File Utility  (under File)
- Equate  (under Element/Point)
- Copy  (under Element/Curve)
- Station  (under Element/Chain)

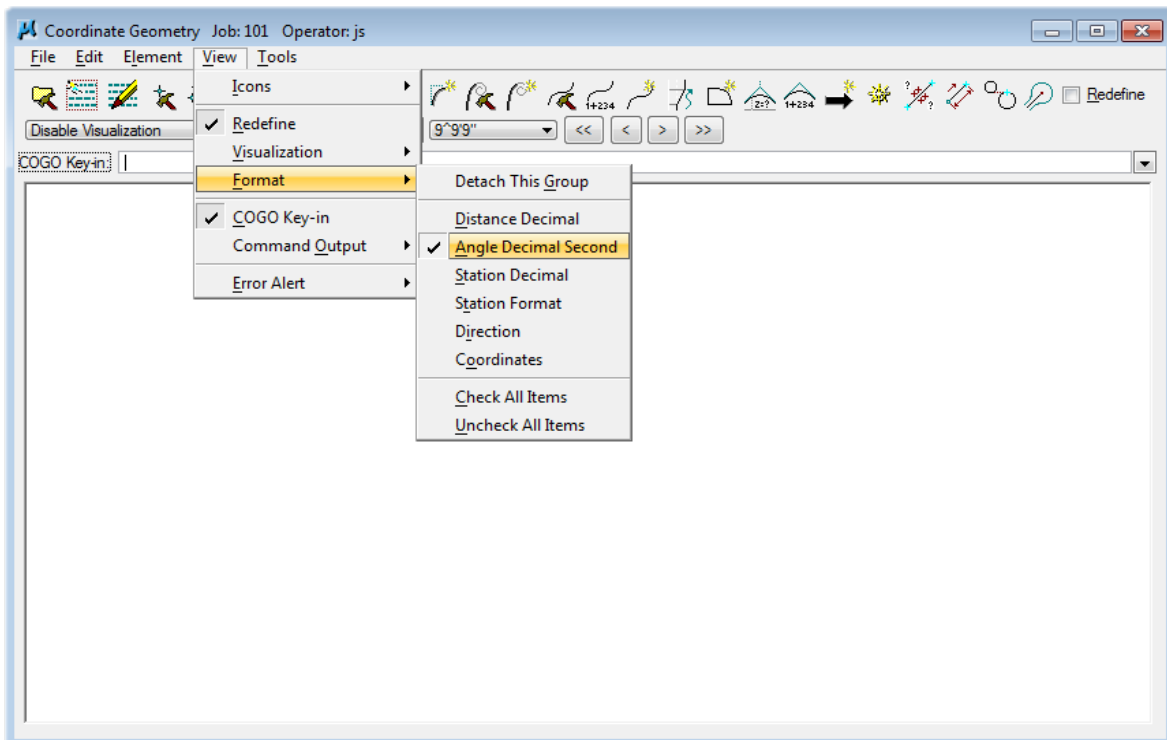
- Store From Elements  (under Element/Chain)
- Store Transition Chain  (under Element/Chain)
- Elevation  (under Element/Profile)
- Navigator  (under Tools)
- Locate Traverse  (under Tools)

In upcoming exercises, we will be using these tools.

Click OK to save settings.

- 5) On the Coordinate Geometry dialog face there are options for decimal values. These are the same controls we accessed previously through User Preferences.

By default, the Distance Decimal and Angle Decimal Second options are turned on. We will not be using those in these exercises, so go to View → Format and turn them off.

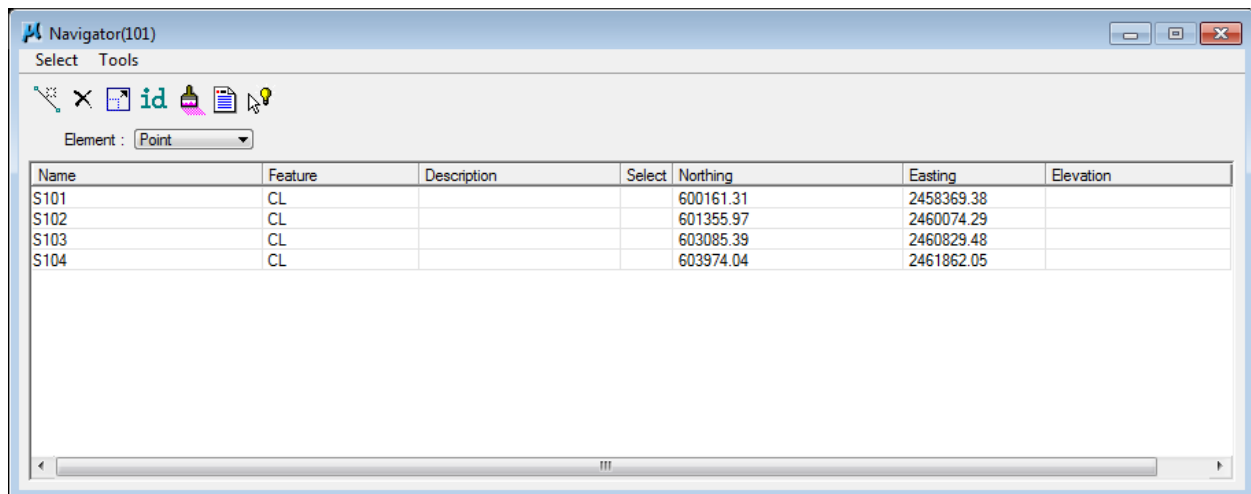


Exercise 4

It should be noted that these decimal values should only be changed temporarily from the project default values since they will affect graphical displays.

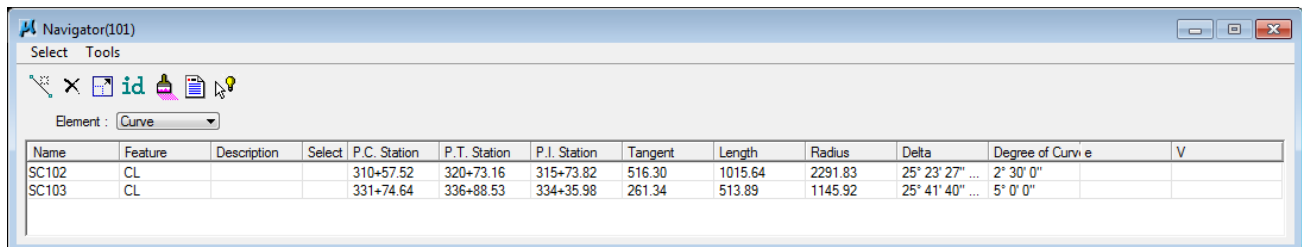
Occasionally, the Distance Decimal and Station Decimal options are handy to have out when checking values that were previously rounded off to the standard 2 decimal places.

- 6) The first tool we want to look at is Navigator. This tool will allow you to access any object stored in the project's GPK file. Click on the Navigator icon to open it up.



Click on the Element option list to look at other object types stored in the GPK file.

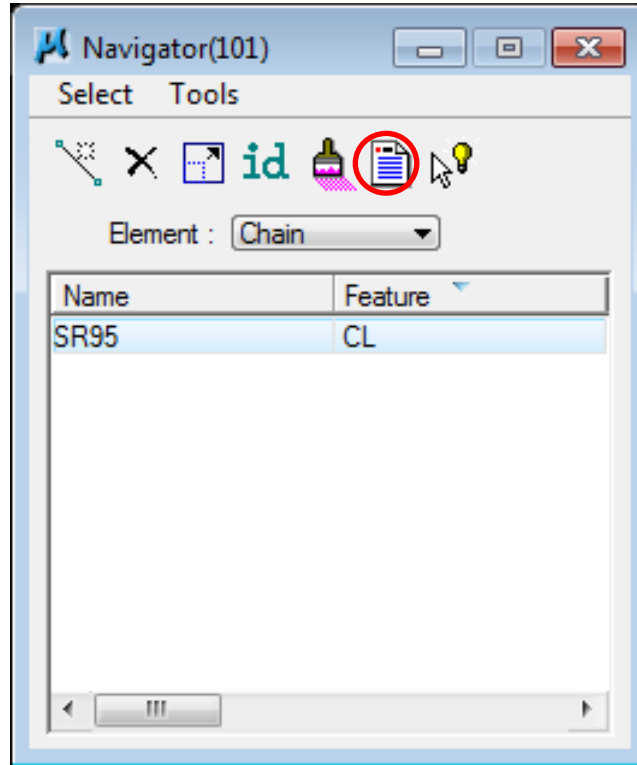
The Navigator is re-sizable and various types of data information are available depending on which Element option is active.



NOTE:

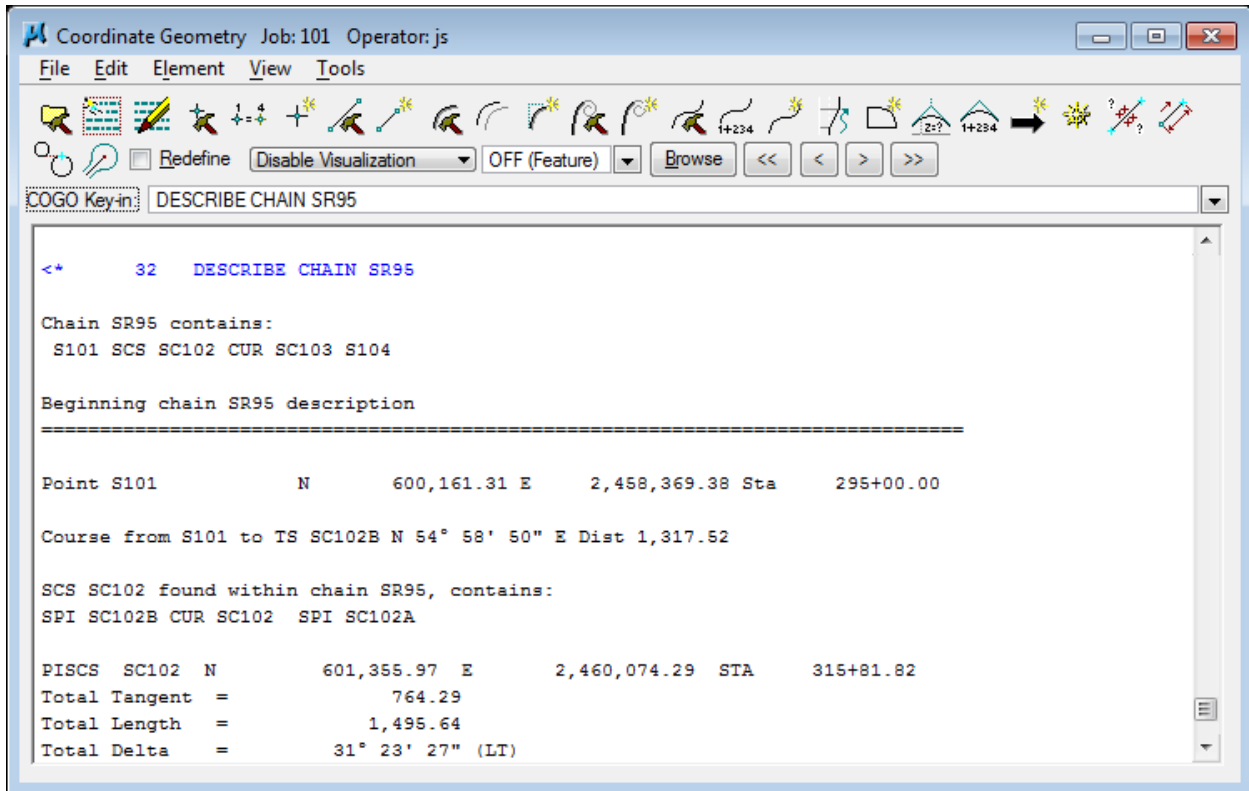
For this class, we are using a stripped down version of the GPK file which only contains the preliminary centerline. Normally this file would also include all other features located by Survey (topo, dtm, parcels).

- 7) Click on the Element option button and set it to Chain.
- 8) Click on preliminary chain SR95 and then click on the Print\Describe Element icon (2nd from right).



- 9) In the COGO output area the coordinate geometry output of the chain is printed. Review the objects which make up this chain.

Exercise 4



10) From our review we can see chain SR95 consists of :

Point S101

Spiral Curve SC102 (Spiral SC102B, Curve SC102, Spiral SC102A)

Simple Curve SC103

Point S104

Go to level display and turn off all levels except for GPK Visualizations so you can see the created chain.

NOTE:

Since all of these objects were stored by Survey, they all include the prefix letter S. Any objects which we store should begin with the letter D for Design that way we can tell who stored any given object in the GPK file.

Spirals always include the ending letters, B (for Back) or A (for Ahead).

b) Re-name Preliminary Centerline Chain

It has been determined that this project should include the Poplar Creek drainage structure so we need to extend the centerline back.

Since we need to keep a copy of the original preliminary centerline for reference and also must keep the proposed centerline name as SR95 to maintain the intelligence

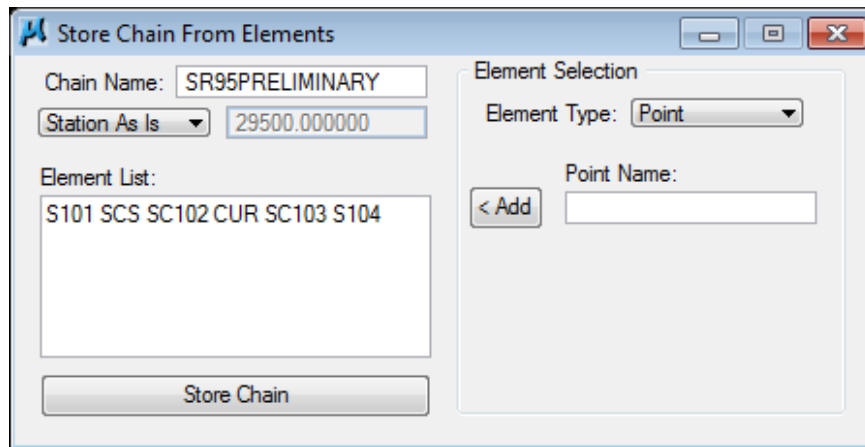
on smart labels placed for present R.O.W. flags, we will first save the preliminary centerline under another name and then revise the original for the new proposed centerline.


- 11) In the COGO dialog, make sure the visualization options are set to Disable Visualization & OFF (Feature). We do not want the preliminary chain to be visualized (graphically displayed).



- 12) Toggle on the Redefine option. Open up COGO Navigator to Chain and double click on the preliminary centerline chain SR95.

In the Store Chain dialog change the name to SR95PRELIMINARY and click on Store Chain. COGO element names can be up to 15 characters long.



- 13) Back in the Navigator, check to make sure you have the new chain SR95PRELIMINARY listed, then click on chain SR95 and click on the Delete icon . When prompted, click Yes to delete the selected elements.

c) Locate New Beginning Point

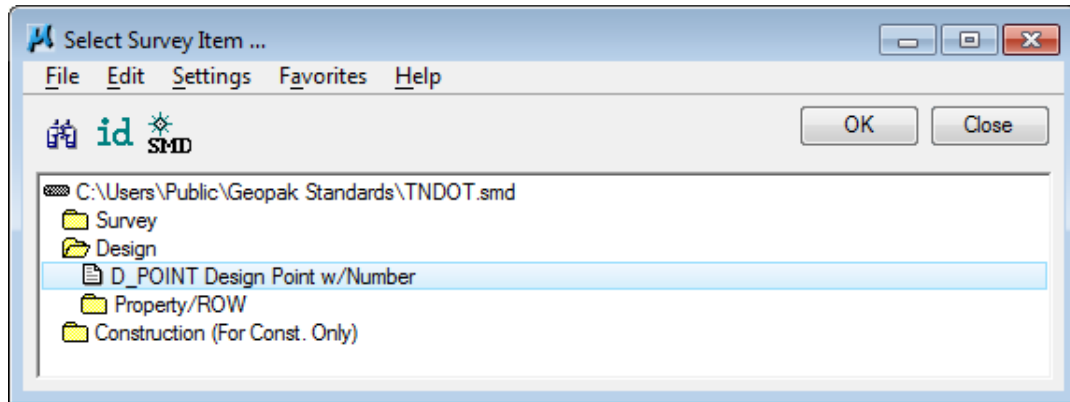
Now, we can set up the objects for our new proposed chain SR95.

The chain currently starts at 295+00 and we want to back it up to include the Poplar Creek drainage structure. A preliminary look at the vertical suggests that our new beginning needs to be at 287+00. To give ourselves additional adjustment room, we will extend the centerline back 1000' to 285+00.

- 1) Zoom in on the beginning of the chain to see the changes as we make them.

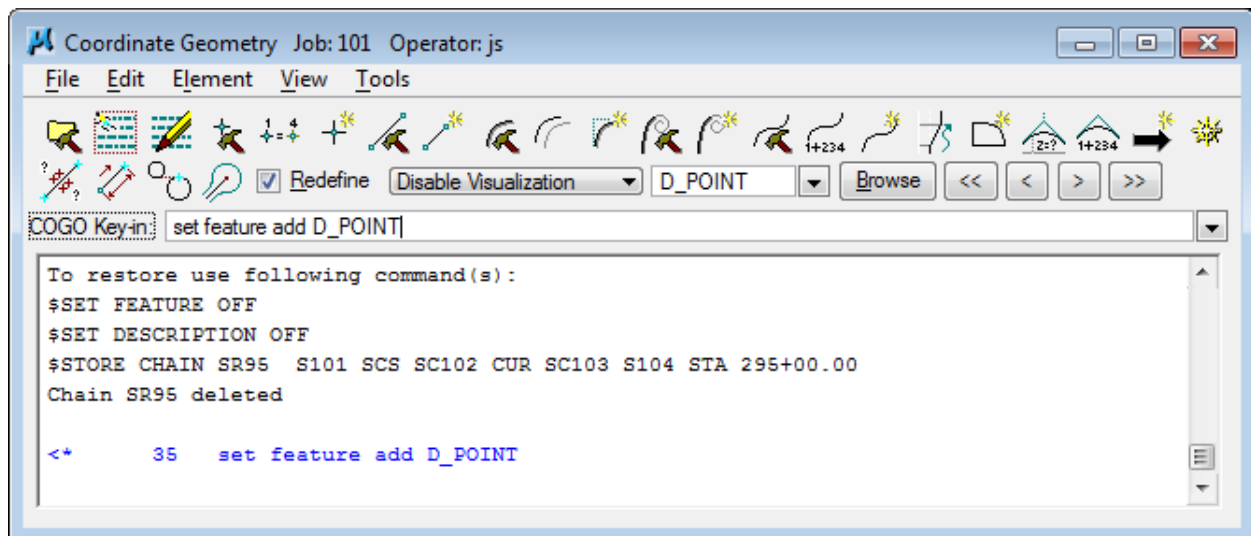
Exercise 4

- 2) Before storing any new objects in COGO, we should set the visualization and feature. In the COGO dialog, click on the visualization control and set it to Permanent Visualization. Click on the Browse button to the right of the feature name field. In the SMD item dialog, go to Design and choose feature D_POINT.



Once the feature has been selected, click OK to accept.

Back in the COGO dialog, we can see our feature name has been set. Feature D_POINT should be used for centerline COGO set up by Design personnel.



NOTE:

Temporary Visualization graphics go away when COGO is exited.
Permanent Visualization writes the graphics to the DGN file so that when COGO is exited the graphics remain.

- 3) After review of the existing roadway, we have determined that we can go back 1000' and still be in the same tangent section. Click on the Locate Traverse icon to locate and store a new beginning point for our chain.



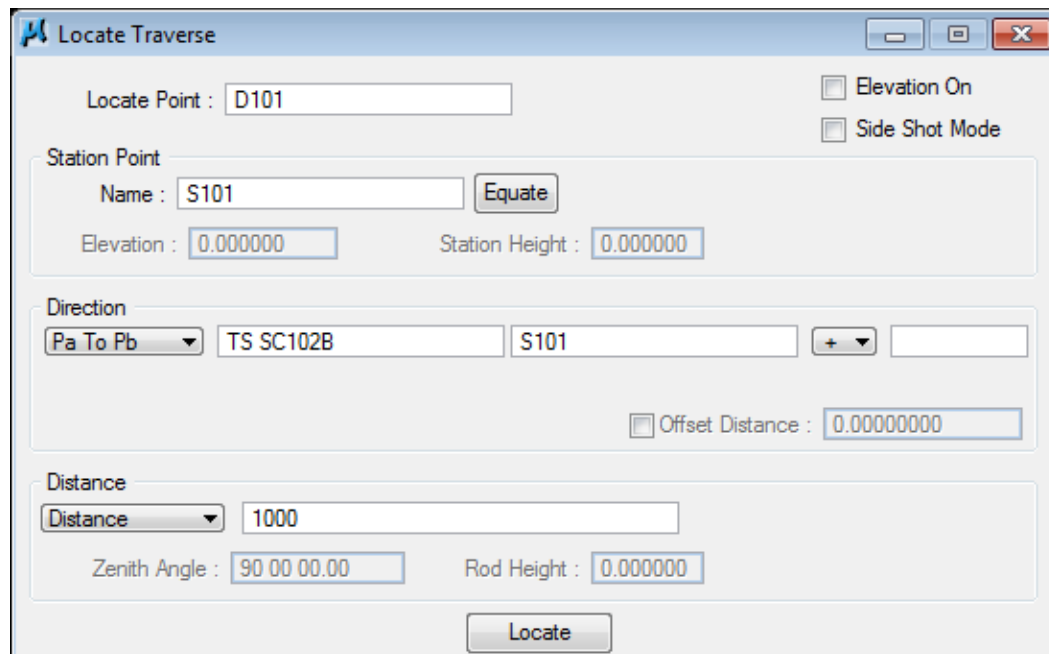
- 4) In the Locate Traverse dialog we need to make the following settings as shown.

Locate Point: D101 (our new point)

Station Point: S101 (the original beginning point, the point we are locating from)

Direction: Pa To Pb TS SC102B & S101 (rather than keying in the calculated angle we will use the point to point option to set the direction)

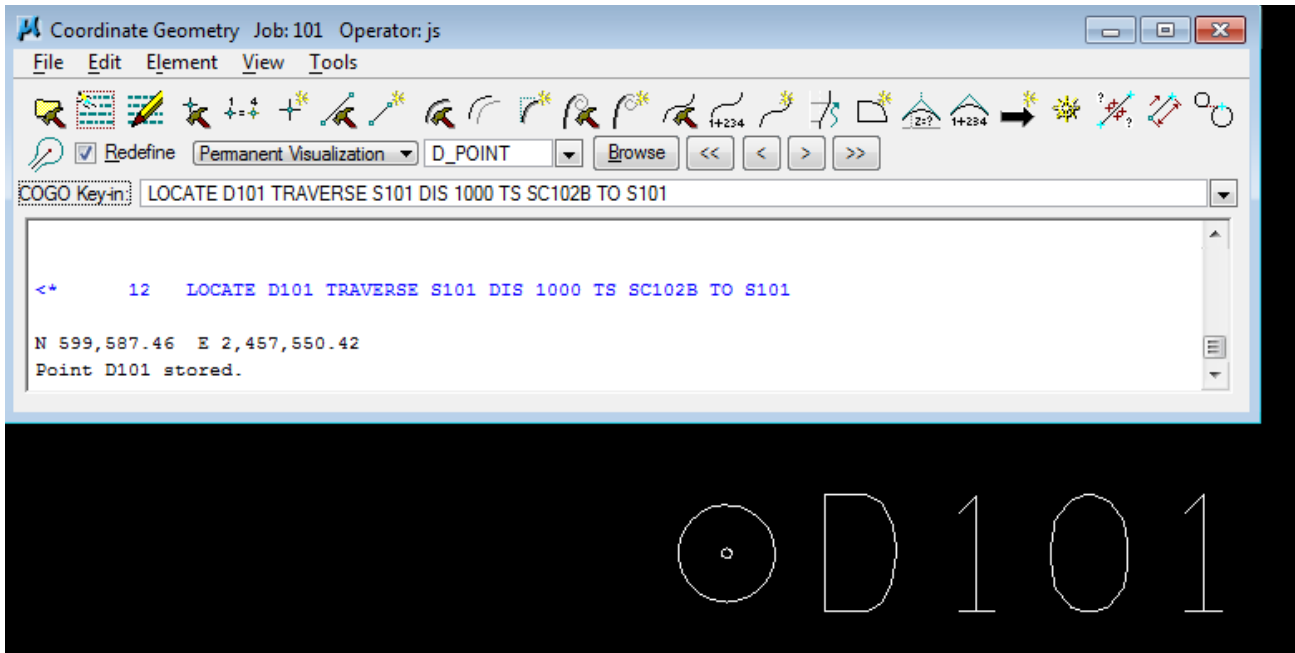
Distance: Distance 1000



Once the settings are made click on Locate to initiate the command and store the new point.

- 5) Close the Locate Traverse dialog. Back in the COGO dialog, we can see our new point has been stored. In graphics our point has been visualized.

Use MicroStation's Fit View command to find your point graphics.

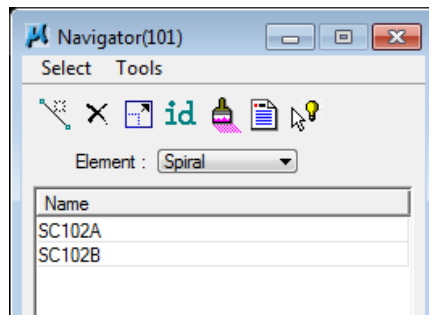


d) Copy COGO Objects

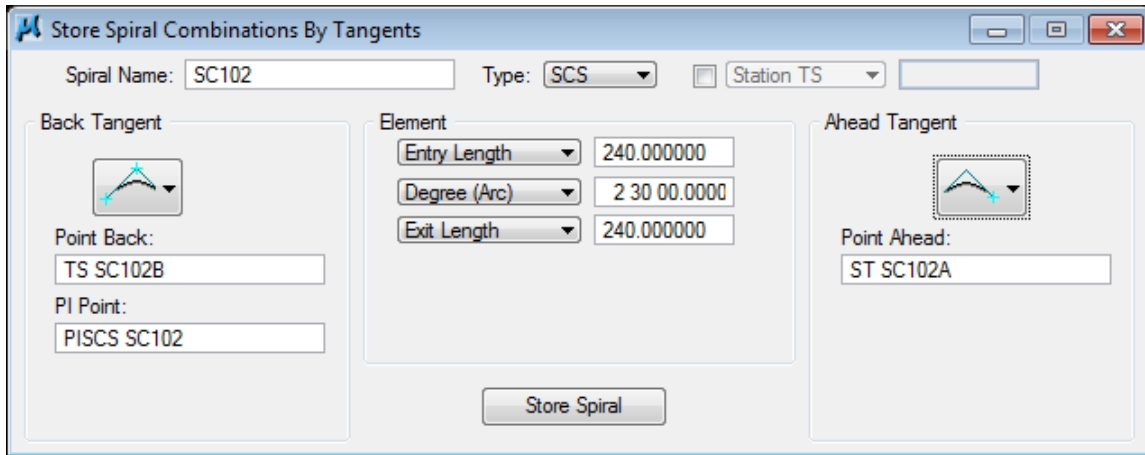
In order to keep the copy of the original survey chain intact, we need to duplicate the remaining objects in the chain which include a spiral curve, a simple curve and the ending point.

e) Spiral Curve

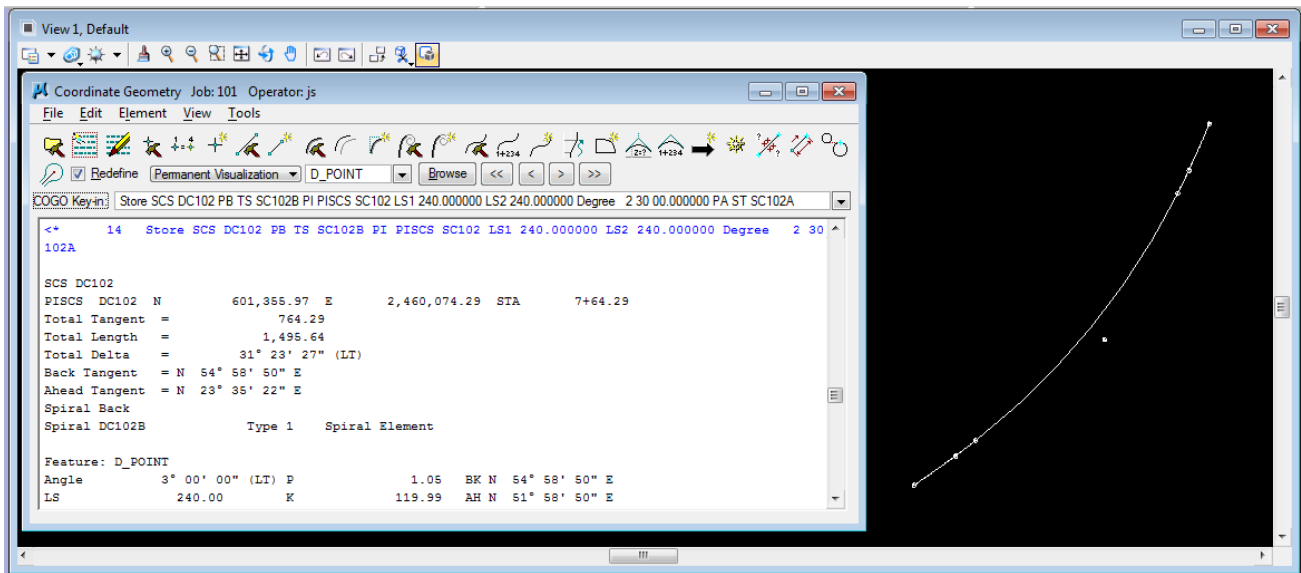
- 1) Since the spiral curve contains 3 objects (2 spirals and a curve), the simplest way to copy it is to just re-define it with a new name. First click on the Redefine option in the COGO dialog. Then in the Navigator go to Spirals and double click on one of the spirals for curve S102. This opens up the Store Spiral Combinations By Tangents dialog with all of the settings for the current curve.



Change the name to DC102 and click on the Store Spiral button.



Dismiss the Store Spiral dialog. In graphics, we can now see our spiral curve.



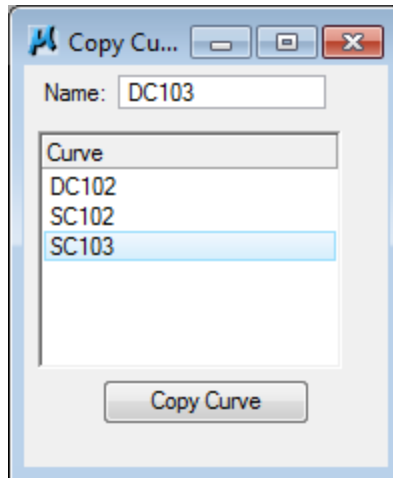
f) Simple Curve

- 2) Since our other curve is just a simple curve, we can just copy it. Click on the Copy Curve icon.



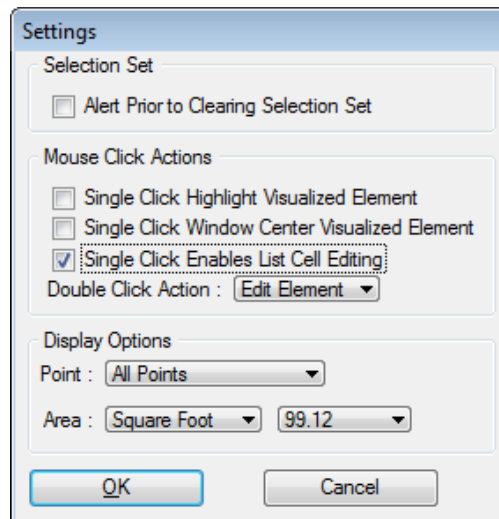
In the Copy Curve dialog, key in new curve name DC103, highlight survey curve SC103 and click on the Copy Curve button.

Exercise 4



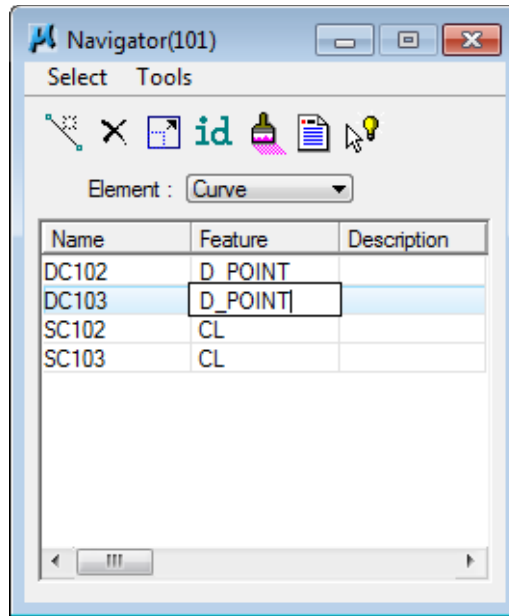
- 3) You may have noticed that the curve was visualized in graphics but it is yellow in color rather than white. This is because copied elements retain their original feature name, in this case survey feature CL.

Open the COGO Navigator and go to the drop down option Tools → Settings. In the Settings dialog, turn on the option for Single Click Enables List Cell Editing. Click OK on the Settings dialog.

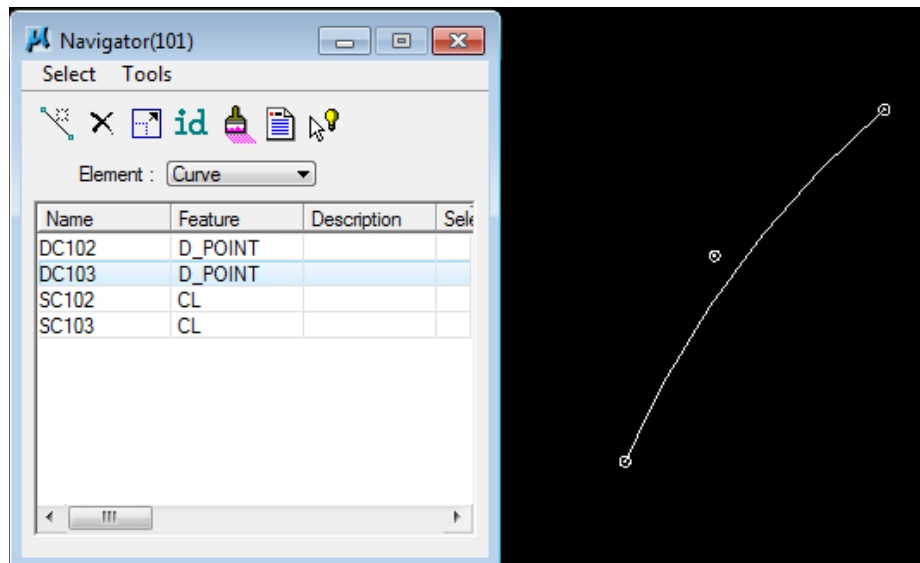


We need to change the curve's feature to our proposed centerline feature D_POINT, so go to Curve. Click on the feature name CL on new curve DC103. The field should open for editing allowing you to key in D_POINT. Once entered hit the enter key to finish the change.

You can Copy & Paste the feature name from the DC102 curve element.



As soon as the Feature name is changed the curve is re-visualized.

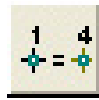


You can click on the Visualize icon on the COGO Navigator to visualize any COGO element (It is the paintbrush icon).

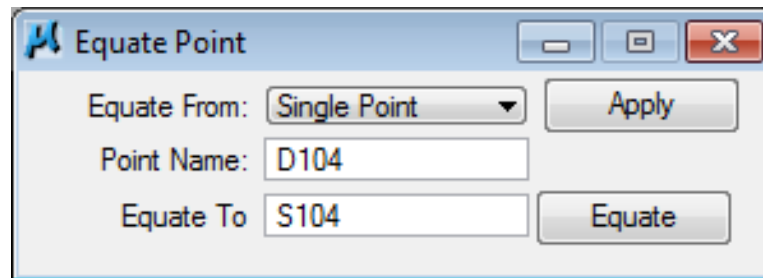
- 4) In the COGO Navigator, go back to the drop down option Tools → Settings. In the Settings dialog, turn off the option for Single Click Enables List Cell Editing. Click OK on the Settings dialog. This should be done to prevent any accidental edits.

g) Point

- 5) All we need now is our ending point so this time click on the Equate Point icon.



In the Equate Point dialog set the Equate From option to Single Point enter our new point name D104 and the Equate To point as S104. Once entered, click on the Apply button to store the new point.



NOTE:

The Equate button can be used to get points from curves and spirals.

h) Store Proposed Centerline Chain

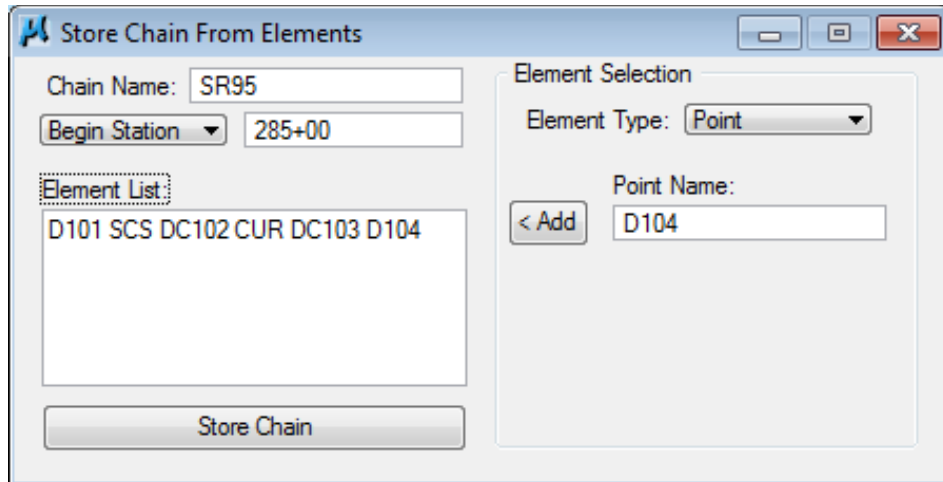
Now that we have all of the objects set up for our proposed centerline, we can store that chain.

- 1) Click on the Store Chain icon or select Element → Chain → Store → From Elements from the COGO menu bar to invoke the appropriate dialog.



- 2) Key in the chain name SR95, select the Begin Station option and enter a beginning station of 285+00 and build the list of COGO elements which will become a part of the chain.

You can fill in the Elements comprising the chain by keyin OR by graphically selecting the visualized elements in the design file. Ensure that the elements are added to the list in the order which you want them to be stored as a chain.



NOTE:

The Element Selection options on the right of the dialog are only used if desired to help build the Element list on the left.

- 3) Press Store Chain. Close the Store Chain dialog.
- 4) In the output area of the COGO dialog, you will see the command where we stored chain SR95. Go to Navigator and click on the describe button to review our new chain SR95. You also may wish to describe chain SR95PRELIMINARY to compare the two. They should be the same except for the beginning point and its station.

II.) Horizontal Alignment Tools

These tools are set up to build special curve combinations for interchanges or intersections, regular SCS spiral curves or even vehicle turning paths. These include 3 center curves, taper curves or the complex curve and spiral combinations sometimes required for ramps in interchanges.

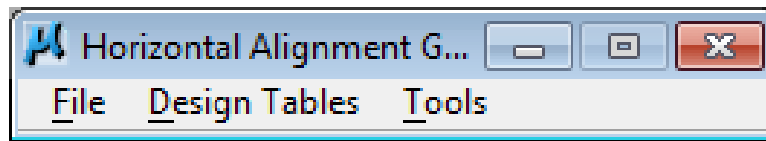
To introduce you to these tools in the following exercise, we will assume that it has been decided to increase the design speed on our spiral curve (SCS DC102) to 60 MPH from 50 as it was originally set up. We could look up the spiral lengths for that curve and use basic COGO to store it but instead we will use Horizontal Alignment tools to design a new curve.

- 1) From the Project Manager workflow dialog click on Horizontal Alignment. If you have not used these tools before, you will get the prompt "Would you like to activate the default design tables?"

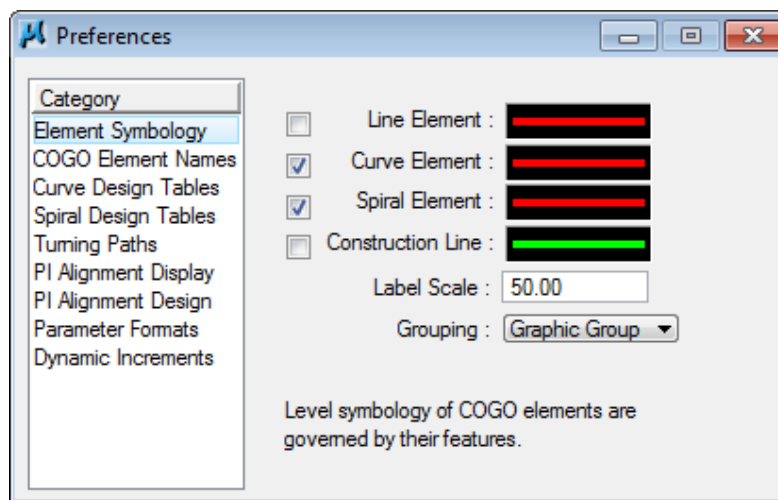
Click Yes.

Exercise 4

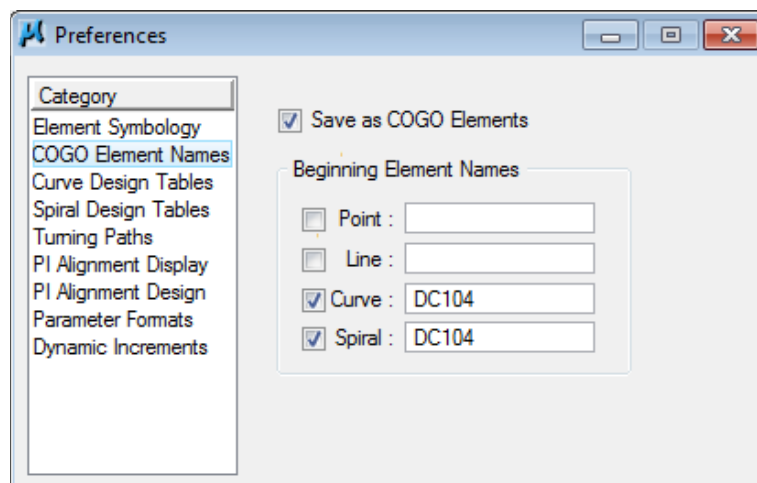
Minimize the COGO dialog. You should see the Horizontal Alignment Generator tool bar.



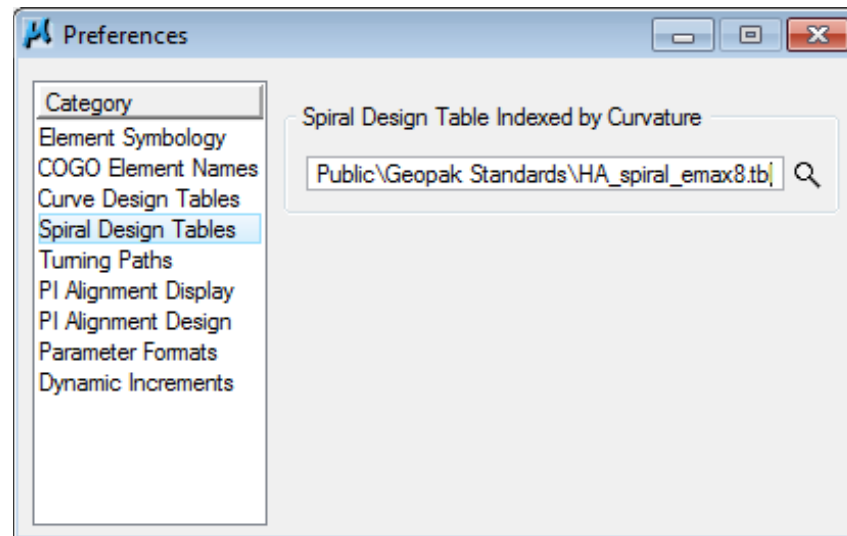
- 2) First, we need to set some preferences. In the Horizontal Alignment Generator tool bar go to the drop down option File → Preferences.
- 3) Under the first category Element Symbology set the Label Scale to 50 set Grouping to Graphic Group. Don't worry about setting symbologies. We will use other methods to display horizontal alignments.



- 4) Click on COGO Element Names and set as shown so we can create new curve DC104.



- 5) We do not need to change anything under Curve Design Tables since they reference tables based on AASHTO green book (“A Policy on Geometric Design of Highways and Streets”) standards which are what we use. Skip down to Spiral Design Tables and using the browser button load the table HA_spiral_emax8.tbl from folder C:\Users\Public\Geopak Standards. This table contains spiral lengths and curve values based on superelevation E Max of 0.080 (8%).



NOTE:

The following tables are available for spiral curve design and are based on values set on T.D.O.T. standard roadway drawings RD01-SE-2 & RD01-SE-3.

HA_spiral_emax4.tbl E Max 0.040, Urban Desirable

HA_spiral_emax6.tbl E Max 0.060, Urban Allowable

HA_spiral_emax8.tbl E Max 0.080, Rural Desirable

HA_spiral_emax10.tbl E Max 0.100, Rural Allowable

We will not deal with Turning Paths in this course but we do have the following tables that are available for that functionality under C:\Users\Public\Geopak Standards. They are based on design vehicles defined in the AASHTO green books of 2001 & 2004 with adjustments for Tennessee use.

HA_Turning_Path_TN_2001english.tbl

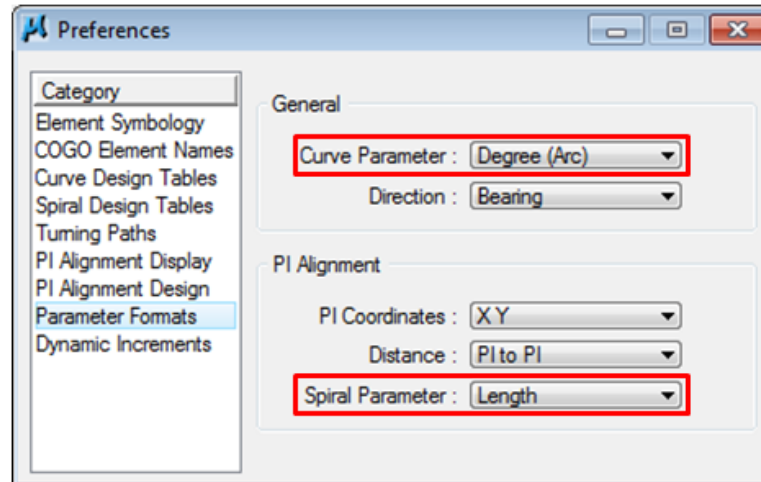
Exercise 4

HA_Turning_Path_TN_2001metric.tbl

HA_Turning_Path_TN_2004english.tbl

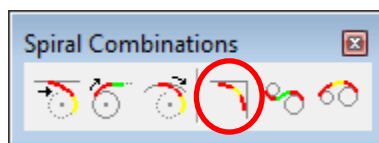
HA_Turning_Path_TN_2004metric.tbl

- 6) Skip down to Parameter Formats. Set the Curve Parameter to Degree(Arc) and Spiral Parameter to Length as shown.

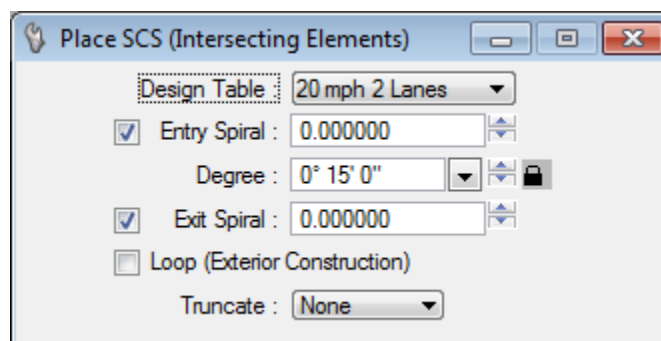


We are finished setting preferences so we can dismiss the dialog.

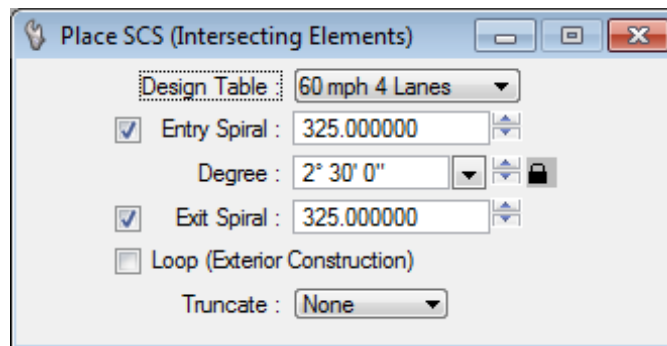
- 7) Back in the Horizontal Alignment Generator tool bar go to the drop down option Tools → Spiral Combinations. This will open the Spiral Combinations tool box.




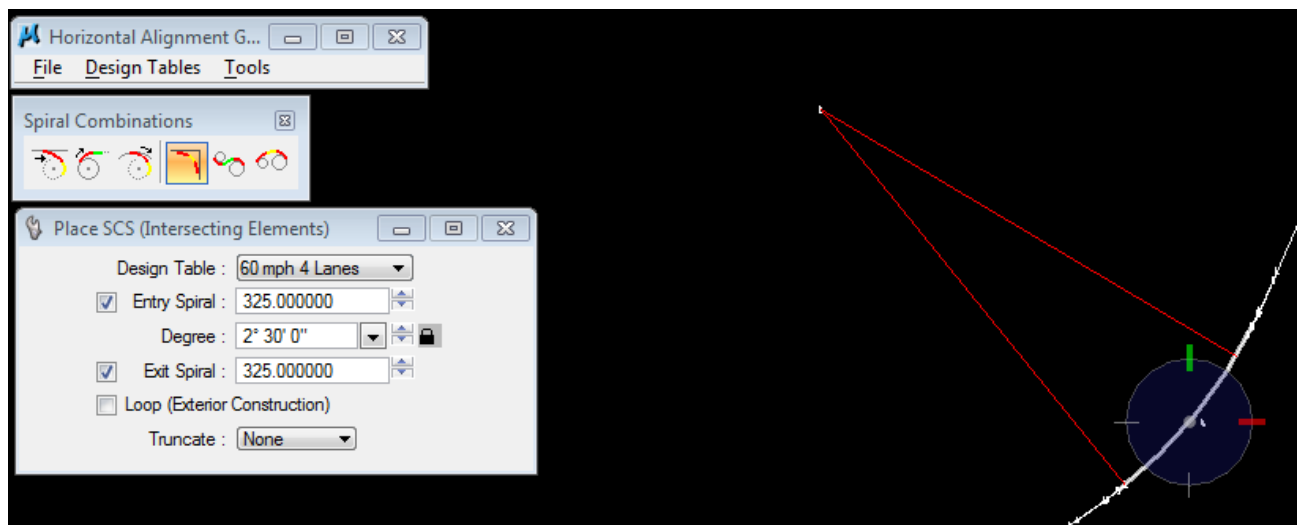
- 8) We need to store a new SCS curve between tangents so click on the Place SCS (Intersecting Elements) icon.



- 9) Set Design Table to 60 mph 4 Lanes and Degree to 2° 30' 0". Make sure Entry Spiral & Exit Spiral are clicked on, Loop option is off and the Truncate option is set to None. Notice that the required spiral lengths are automatically filled in.



- 10) Before we move on make sure you can see the visualized graphics for our proposed centerline. Use MicroStation's Drop Complex  tool to drop the complex status of the complex chain.
- 11) Go back to the Place SCS function. In the status bar you may notice that the tool is ready to go and is prompting us to Identify first element (look toward the bottom status bar, in the middle). Click on the tangent leading to our first curve. Click anywhere to accept that and then click on the tangent past the curve to initiate curve placement

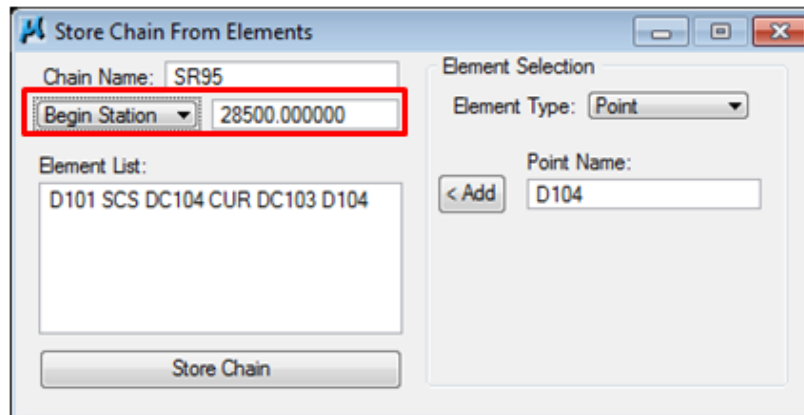


Click to the left of the alignment to accept that curve solution.

- 12) Open the COGO dialog up and review the output window and the spirals and curve that we created.

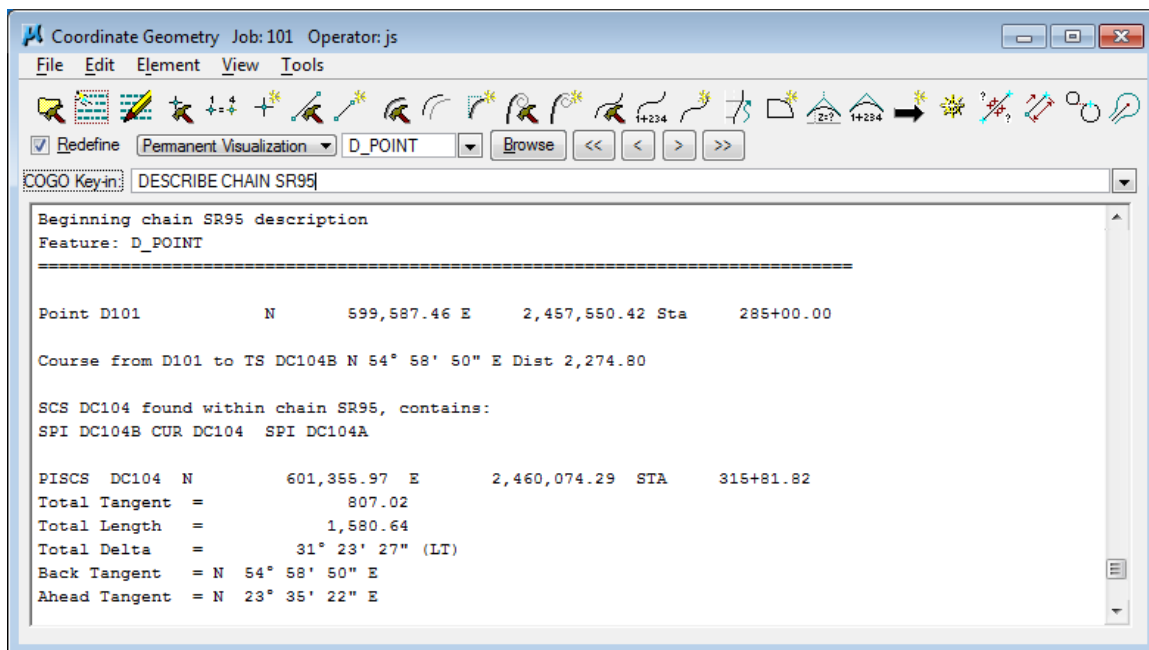
Exercise 4

- 13) Now, we need to use our new curve in our chain. Make sure Redefine is clicked on and go to the Navigator. Double click on chain SR95. In the Store Chain From Elements dialog change curve name DC102 to DC104. **Be sure to reset the Begin Station option so that the chain's objects would be re-stationed. By not doing so, you might accidentally introduce 'station equations' into your chain.**




Click on Store Chain.

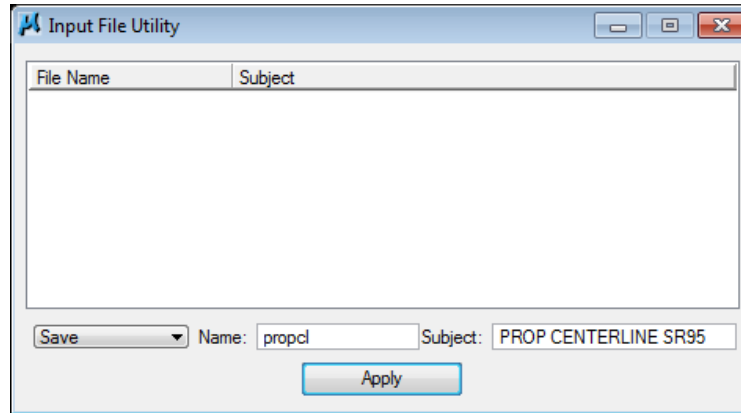
- 14) Highlight chain SR95 in the COGO Navigator and click the describe button. Review the chain description. Check to make sure the end station is 347+89.04.



- 15) You can close the Horizontal Alignment Generator menu bar and tool box since we are finished with them.

III.) COGO File Functions

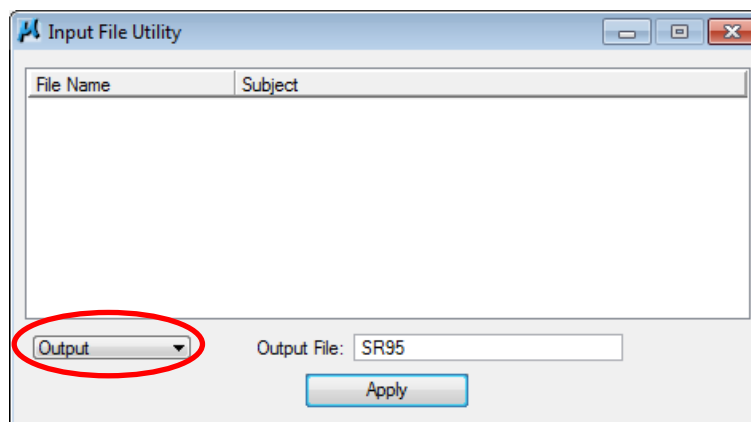
- 1) To save an input file of your commands or output files of the results, from the COGO menu bar, select File → Input File Utility or click on the Input File Utility icon. 
- 2) Set the action option at the lower left to Save, enter a Name such as propcl and a Subject description, then click Apply.



All input commands from this session are written to the file propcl101.i**. Remember the last 2 letters of the name is your operator code.

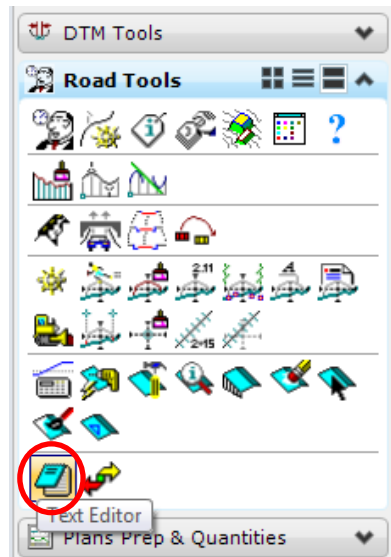
- 3) For an output file, use the Output option, enter a Name such as SR95, then hit Apply. All data currently in the output window is written to sr95101.o**.

Prior to creating an output file you may wish to use the function View → Command Output → Clear to completely empty the output area. Then describe all objects (points, curves, chains, etc.) you wish to save a report on.



Exercise 4

- 4) You may review the input file and/or output file by using the GEOPAK Text Editor accessed from the Road Tools task set. In the Task pane, scroll down to Road Tools and click the expand arrow on the right to open it up. The Text Editor is in the last group of tools.



Here is an output of the SR95 chain.

```
Text Editor: ...\\Roane\\SR95PoplarCr\\SR95101.ojs
File Edit Criteria
Beginning chain SR95 description
Feature: D_POINT
-----
Point D101          N          599,587.46 E          2,457,550.42 Sta          285+00.00
Course from D101 to IS DC104B N 54° 58' 50" E Dist 2,274.80
SCS DC104 found within chain SR95, contains:
SPI DC104B CUR DC104 SPI DC104A
PISCS DC104 N          601,355.97 E          2,460,074.29 STA          315+81.82
Total Tangent =          807.02
Total Length =          1,580.64
Total Delta =          31° 23' 27" (LT)
Back Tangent = N 54° 58' 50" E
Ahead Tangent = N 23° 35' 22" E
Beginning SCS DC104 description
-----
Spiral Back
Spiral DC104B          Type 1          Spiral Element
Feature: D_POINT
Angle          4° 03' 45" (LT) P          1.92 BK N 54° 58' 50" E
LS          325.00 K          162.47 AH N 50° 55' 05" E
Line: 1 Col: 1
```

- 5) Exit the COGO dialog.

- 6) As you exit COGO you may be prompted to save an input file of the session. If you haven't, click Yes to save one.

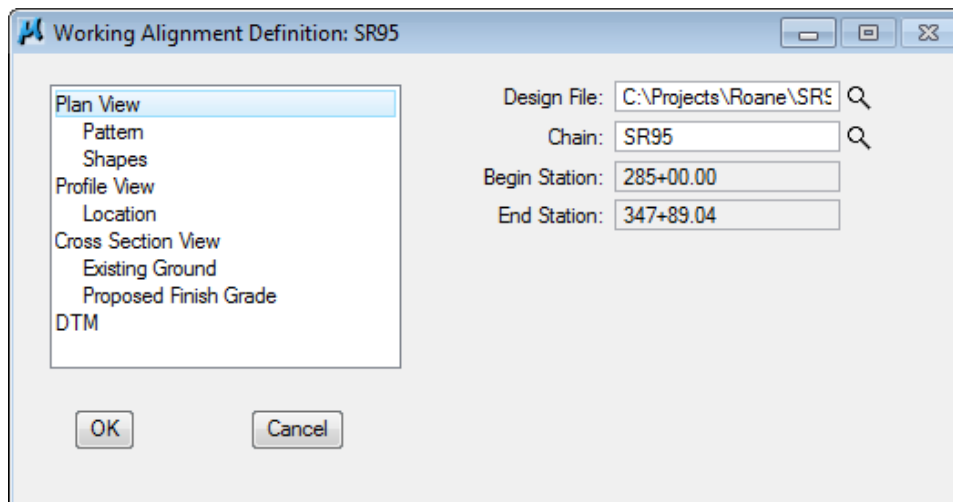
NOTE:

It is NOT required that you save when exiting COGO. Data is automatically written to the COGO database GPK file and this is just a safety measure. It is only recommended when a lot of work has been done so that it could be referenced back to later if needed.

IV.) Working Alignment – Define Chain

Now that we have our proposed centerline chain, we have another piece of information for the Working Alignment definition.

- 1) Access the Project Manager workflow dialog.
- 2) Press the Define button to access the Working Alignment Definition dialog.
- 3) Highlight the Plan View option and use the Browse button to populate the Chain field with our alignment name.



- 4) Press OK to exit and save the new settings.

5. Horizontal Alignment Displays

In this exercise, we display some graphics for our proposed centerline.

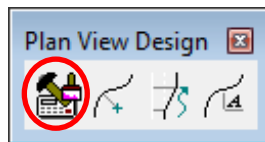
I.) Accessing Design and Computation Manager

- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

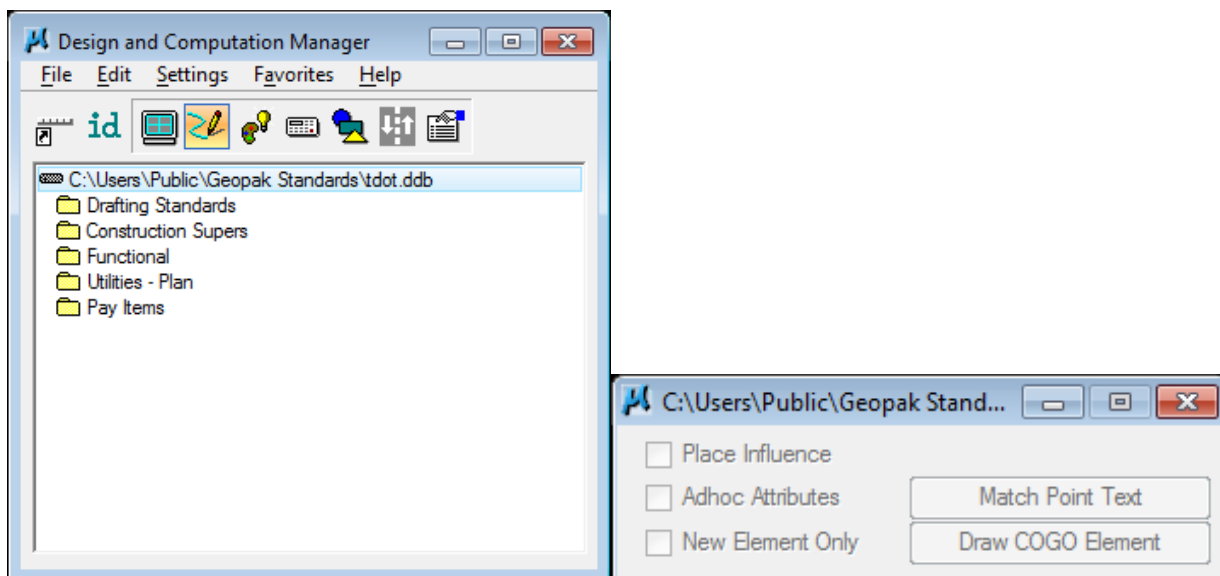
Access Project Manager.

- 2) Select the Plan View Design button from the Project Manager workflow dialog which opens the Plan View Design tool box.



Select the Design and Computation Manager icon to invoke the Design and Computation Manager shown below. It can also be accessed from the Main Task group when the Civil Workflows are set.

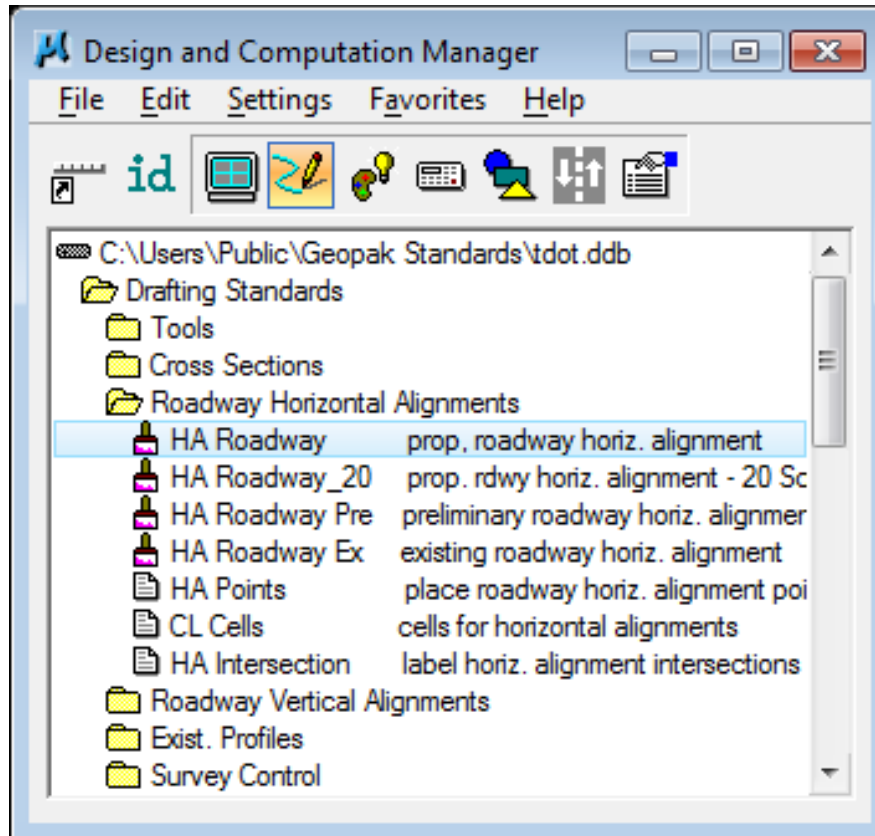
A secondary dialog will appear to be used in conjunction with the Design and Computation Manager dialog.



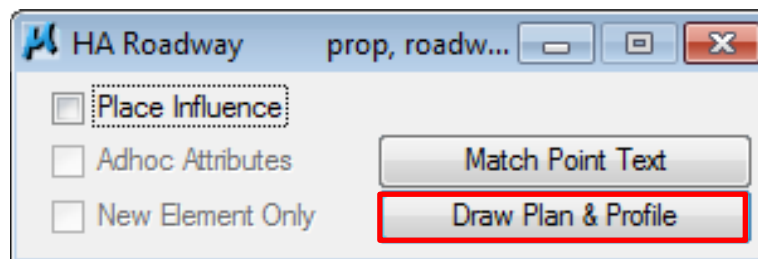
II.) Drawing Horizontal Alignments

- 1) In the Design and Computation Manager dialog, select the following item:

Drafting Standards → Roadway Horizontal Alignments → HA Roadway.

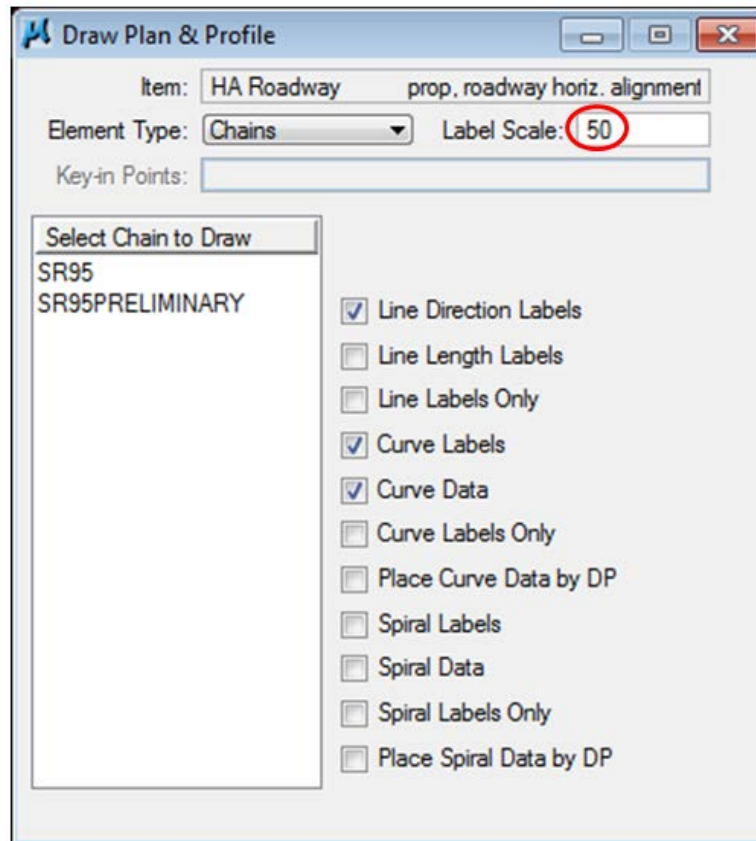


- 2) Next, select the Draw Plan and Profile button from the secondary dialog:

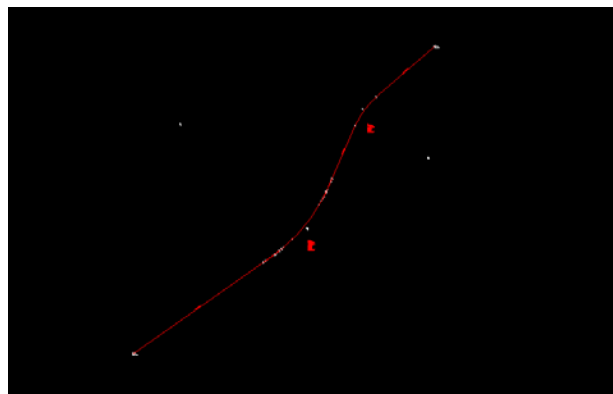


Exercise 5

- 3) Set the Element Type to Chains. Chain SR95 should be displayed in the list box as shown. Notice that the options that are to be drawn with the chain are already activated. Set the Label Scale to 50 if not set.



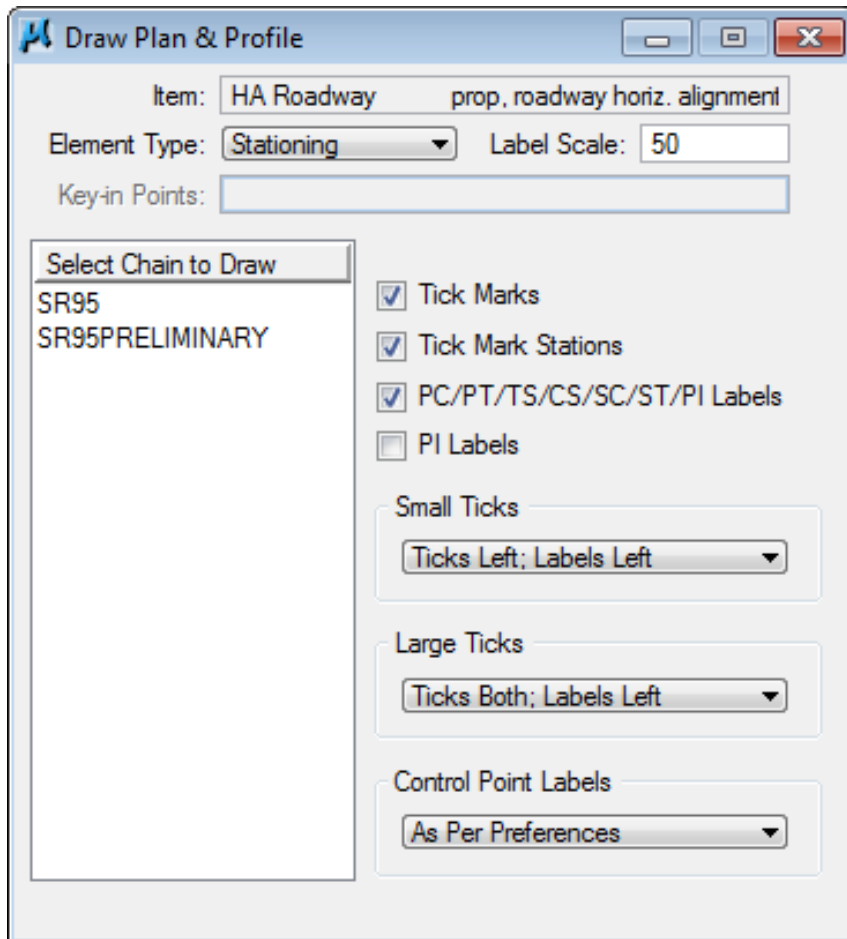
- 4) To draw the chain, click on SR95 in the list box. Use the MicroStation Fit View → Active to see the chain. Make sure all of the chain is in view.



NOTE:

DO NOT double click on the chain name. Each click will display the chain and a double click will place two sets of graphics.

- 5) Change the Element Type to Stationing and make sure the dialog is filled out as shown below. Annotate the alignment SR95 by clicking on the chain name in the list box.



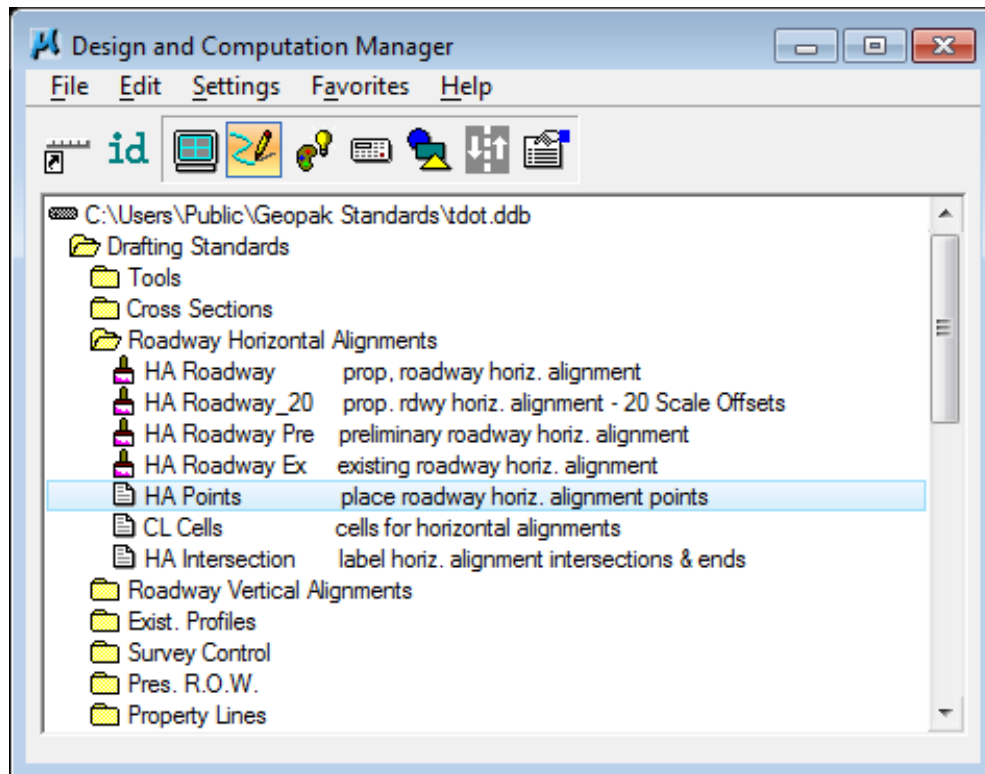
Close the GEOPAK Draw Plan and Profile dialog.

- 6) We have another application in D&C Manager that will place symbols for us at all of the alignment's key points. Before executing the following steps, make sure your entire alignment is shown in View 1.

Exercise 5

- 7) Double-click on the following item in D&C Manager:

Drafting Standards → Roadway Horizontal Alignments → HA Points



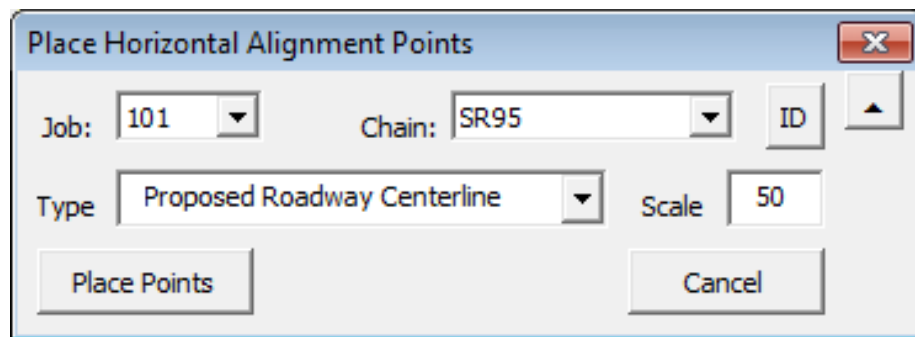
NOTE:

Since this D&C Manager item is run by a separate program double clicking on the item prompts D&C to open the application and run it. These types of items can usually be recognized by their description which starts with a verb such as place, draw, access, etc.

- 8) The Place Horizontal Alignment Points dialog is displayed.

All GEOPAK jobs found within the current active folder are listed in the Job drop down box. If this tool was used previously for that job, the last chain processed is set as well as the last horizontal alignment type which was used. Scale defaults to active scale set in the MicroStation DGN file.

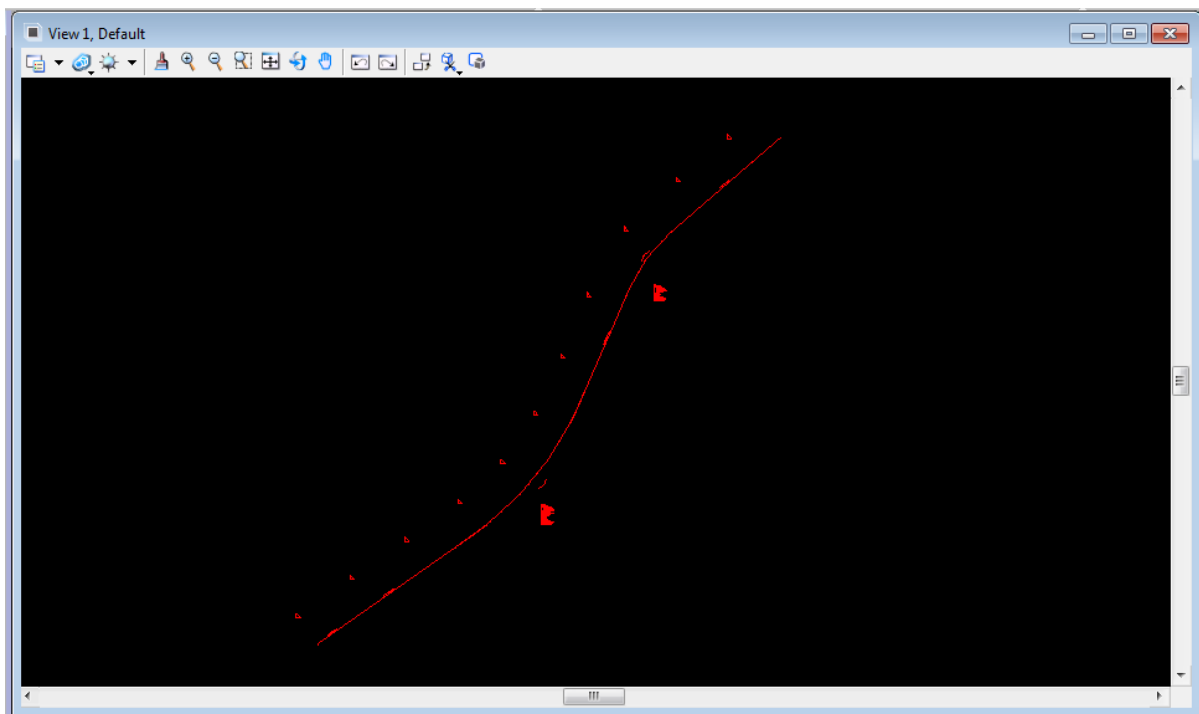
- 9) The Job should be set to 101 and the Chain to SR95. Set the Type to Proposed Roadway Centerline and if not already set, change the Scale to 50.



Click the Place Points button to place the horizontal alignment point symbols for chain SR95.

- 10) Review the results of the previous steps used to display and annotate the proposed centerline SR95.

You may wish to turn off the visualizations from COGO work done for the chain. They are on level DESIGN - CENTERLINE - Proposed GPK Visualizations.



- 11) Exit the Design and Computation Manager dialogs.
12) Dismiss the Plan View Design tool box.

6. Existing Ground Profile

In normal work flows, survey will develop a ground profile for the preliminary centerline. Only when the proposed centerline is altered from that location would it be necessary set up a new ground profile. Since we have altered the preliminary centerline, we need to generate a new ground profile.

In this exercise, we demonstrate the use of the Existing Ground Profile tool from Project Manager which generates and stores a profile in the GPK file which we later display. If only graphics are needed or in cases where multiple surfaces need to be profiled at one time, then the Draw Profile tool should be used.

I.) Extract Existing Ground Profile

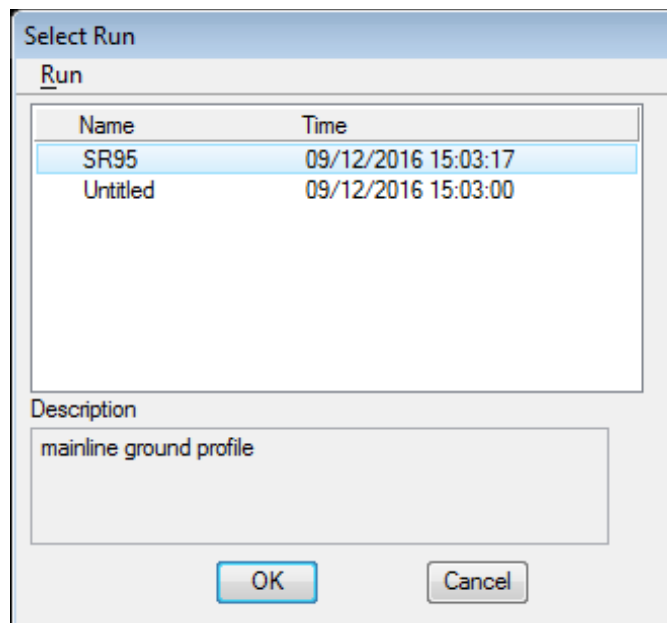
- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

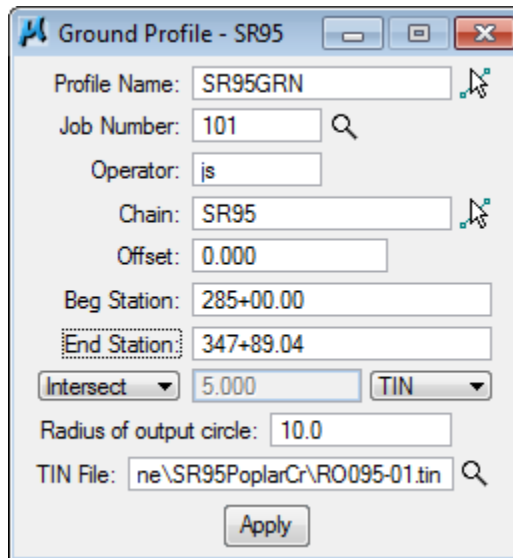
Access Project Manager.

Do a fit view to make sure entire alignment is in viewing window.

- 2) Select the Existing Ground Profile button from the Project Manager workflow dialog.
- 3) Create a new run called SR95 then select the run and press OK.



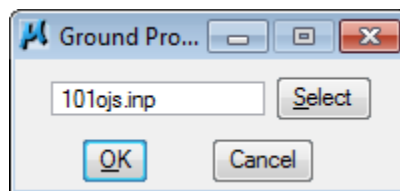
- 4) Populate the Ground Profile dialog as shown and press Apply. Enter the Profile Name as SR95GRN. All ground profiles should include the letters GRN to show that they are existing ground profiles and can be recognized separately from proposed roadway profiles. Intersect mode should always be used for the most accurate profile displays.



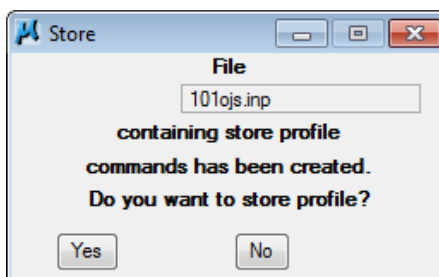
NOTE:

The beginning and ending station of an alignment can be filled in automatically by placing the cursor in the blank field and pressing Enter.

- 5) When prompted for an input file name use the default name j101o***.inp (the asterisks represent the users initials) as shown in the Ground Profile Input File dialog below and press the OK button.

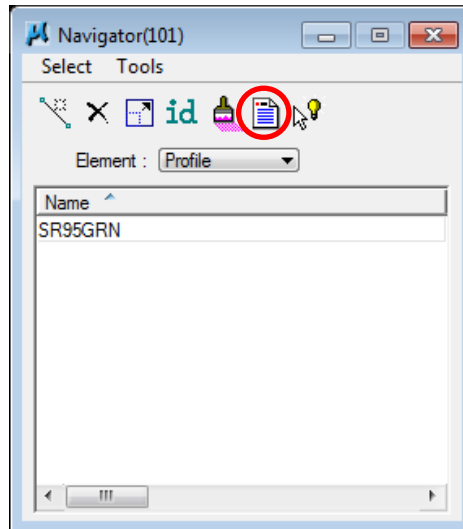


- 6) When prompted to store the profile, press Yes.

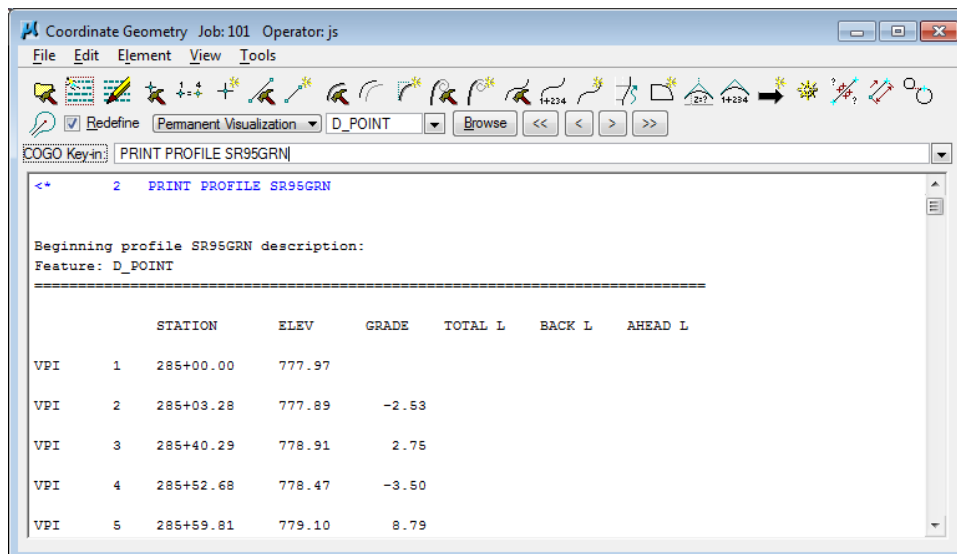


Exercise 6

- 7) Press Yes to delete the 3D line string in the design file.
- 8) After the profile is stored, exit the Ground Profile dialog and Save Settings.
- 9) Access Coordinate Geometry. (Press the Coordinate Geometry button on the workflow dialog).
- 10) Access Navigator and go to Profiles.



- 11) Select the profile 'SR95GRN' and press the Describe icon.
- 12) Review the profile information in the COGO output display window.



- 13) Close the Coordinate Geometry dialog (use X in upper right corner of the dialog). When prompted to save the COGO session press NO.

II.) Drawing Ground Profiles

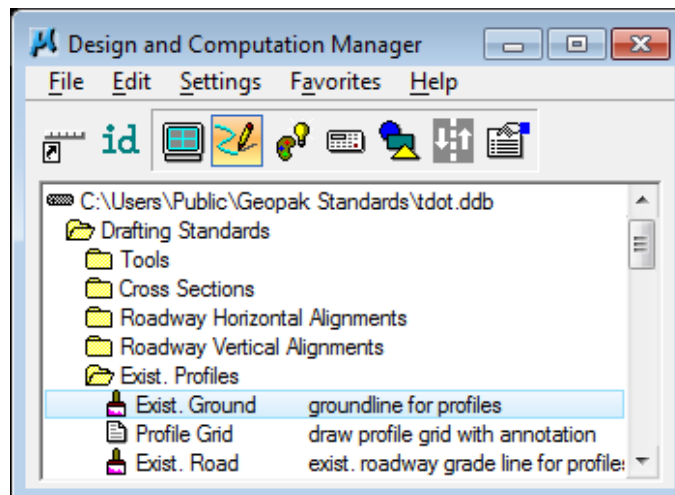
It is necessary to place the profiles far enough away from the plan view area so that graphical information does not overlap. Zoom out as shown in the picture below to place your profile. The next few steps will create the existing ground and proposed profiles at the bottom right of the image.



- 1) Access Design and Computation Manager by selecting the Plan View Design option on the workflow dialog and then selecting the Design and Computation Manager icon from the tool bar or from the Main Task group when the Civil Workflows are set.

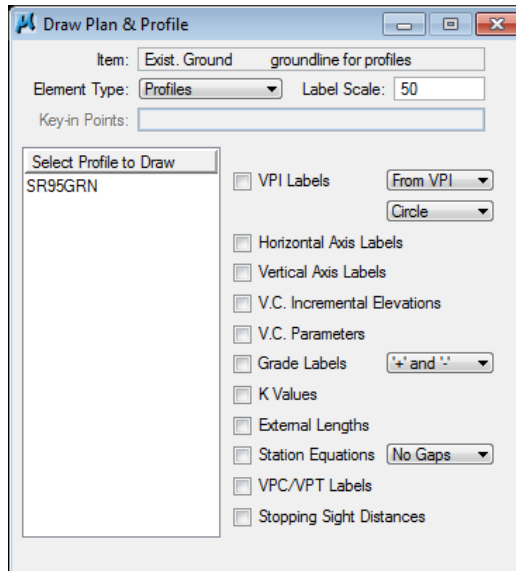


- 2) Select the item Drafting Standards → Exist. Profiles → Exist. Ground.

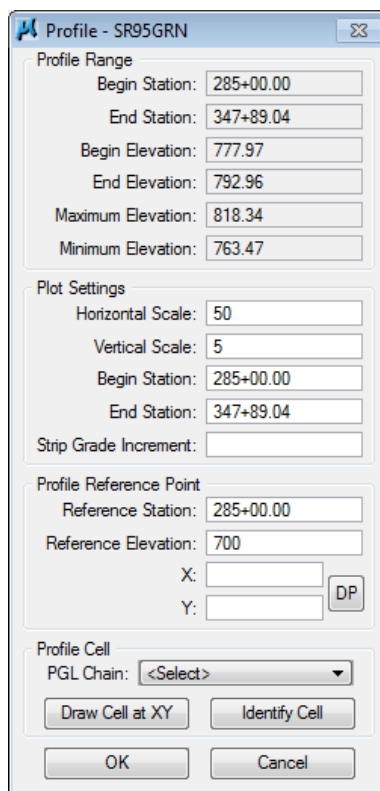


Exercise 6

- 3) Press the Draw Plan & Profile button on the secondary dialog. The Element Type is automatically set to Profiles. The Label Scale should already be set to the desired scale of 50.



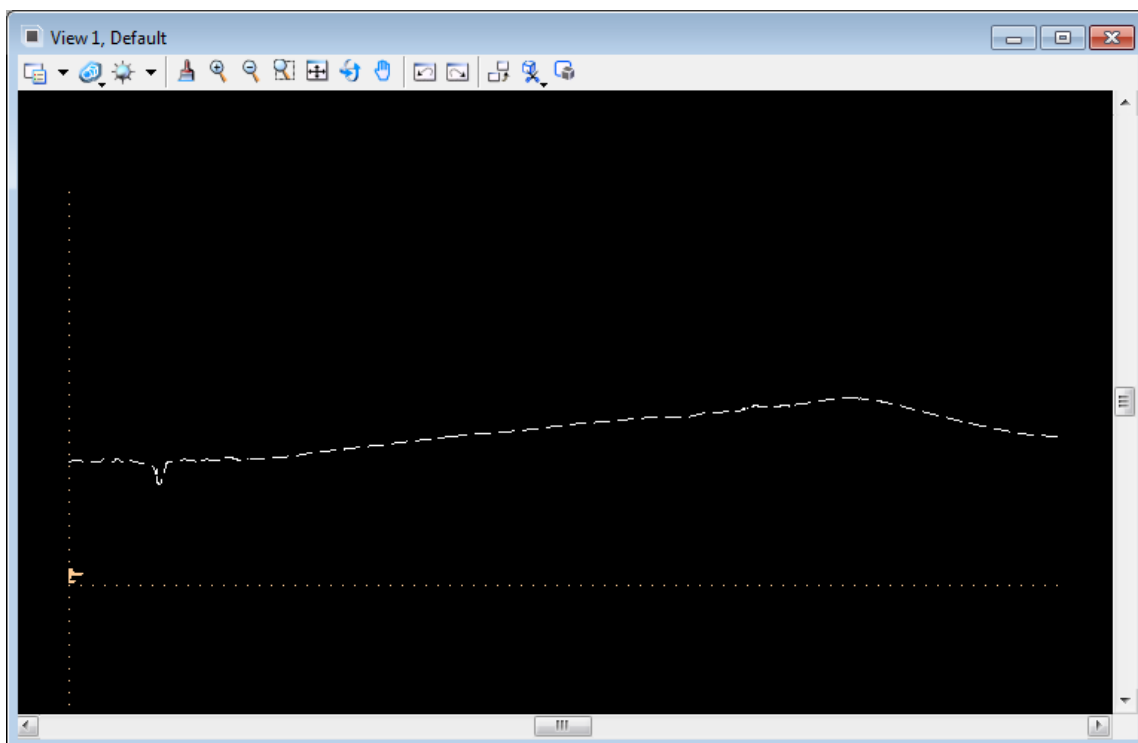
- 4) Click on the existing ground profile 'SR95GRN' to invoke the following profile parameter dialog. Populate it with the station, scale and elevation parameters shown.



NOTE:

You do not need to enter a value in the Strip Grade Increment box. This is used to display elevations along the profile at the spacing entered. Normally this information is not needed.

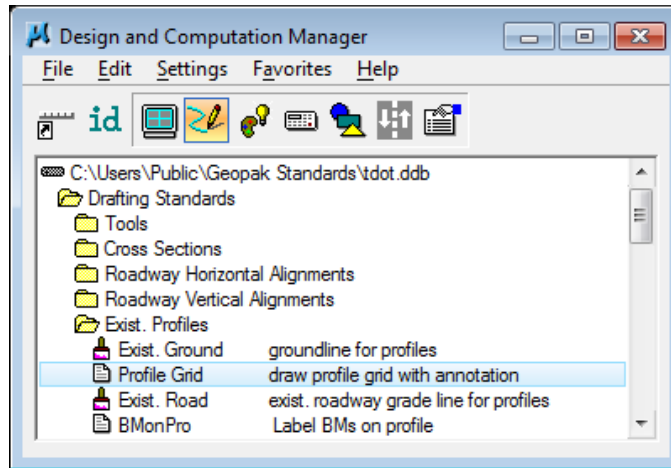
- 5) Set the DP X and Y coordinates by clicking on the DP button and then click in any open area to the right of the Survey profile away from the plan view area to avoid overlapping graphics.
- 6) We will need the GEOPAK Profile Cell later so go ahead and set it up. Click on the drop down for PGL Chain and choose the chain name SR95. Now click on Draw Cell at XY. This places this special cell which holds all of the control data defining this profile set up. It can be identified while using any GEOPAK profile function to define the control information.
- 7) Press OK to display the ground profile. The existing profile should now be plotted in the design file.



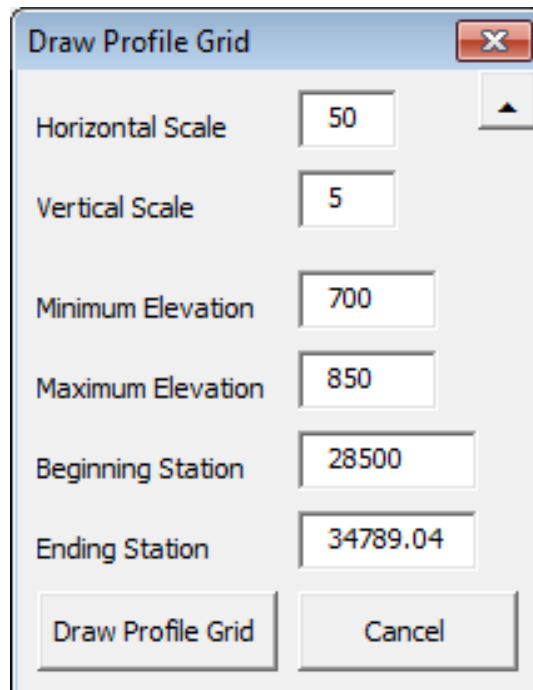
- 8) Exit the GEOPAK Plan and Profile Draw dialog and review your profile.
- 9) **Do not** exit the D&C Manager; go on to the next section.

III.) Drawing Profile Grids

- 1) Go to D&C Manager.



- 2) Double-click the item Profile Grid and the Draw Profile Grid dialog opens. The current active scale is read from the DGN file and is used to set the default Horizontal and Vertical Scale. Fill out the dialog as shown below.



- 3) When all control values have been set, click on the Draw Profile Grid command button.

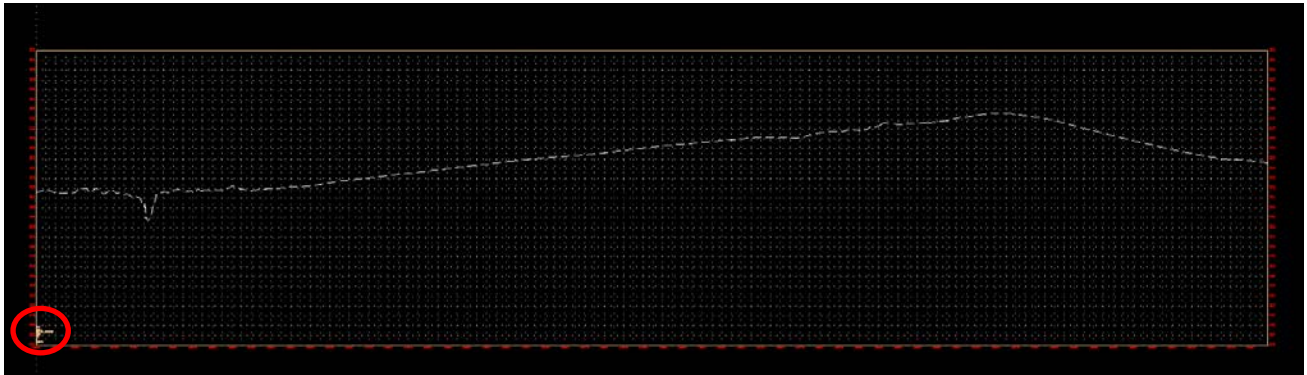
You are prompted to Data Point at Profile Origin. The profile grid range is shown dynamically.

NOTE:

If the profile coverage is not acceptable, you may give a Reset to stop and adjust the control values.

- 4) Data point at the reference origin location of the profile area.

Profile with profile grid displayed.

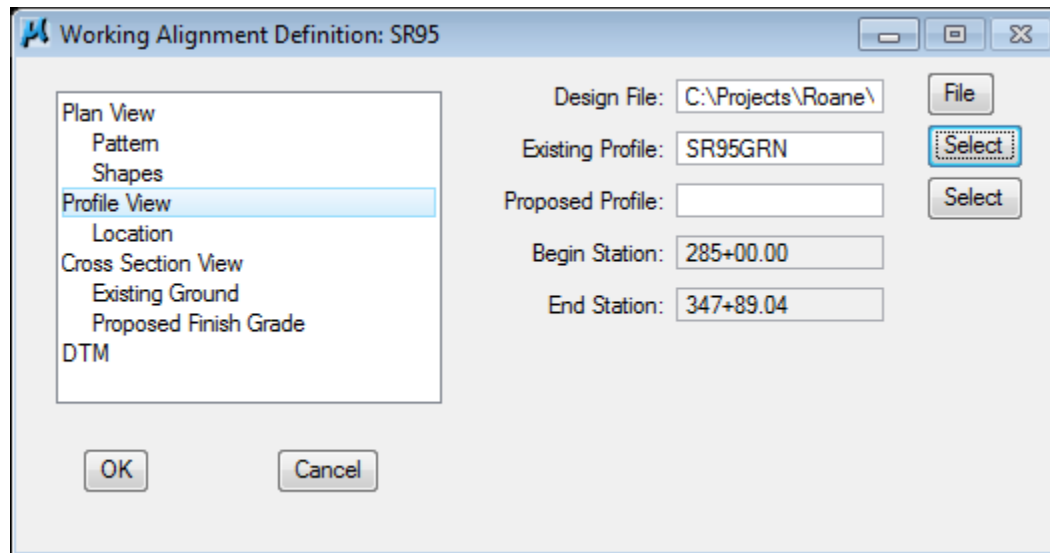


- 5) Click Cancel in the Draw Profile Grid dialog top close the tool and exit D&C Manager.

IV.) Working Alignment - Define Existing Profile

We are setting the Profile View and Location sections of the Working Alignment Definition in Project Manager.

- 1) From the Workflow dialog of Project Manager, press the Define button.
- 2) Select the Profile View option and populate the dialog as depicted below (the Design File is ROSR95Alignments.dgn).

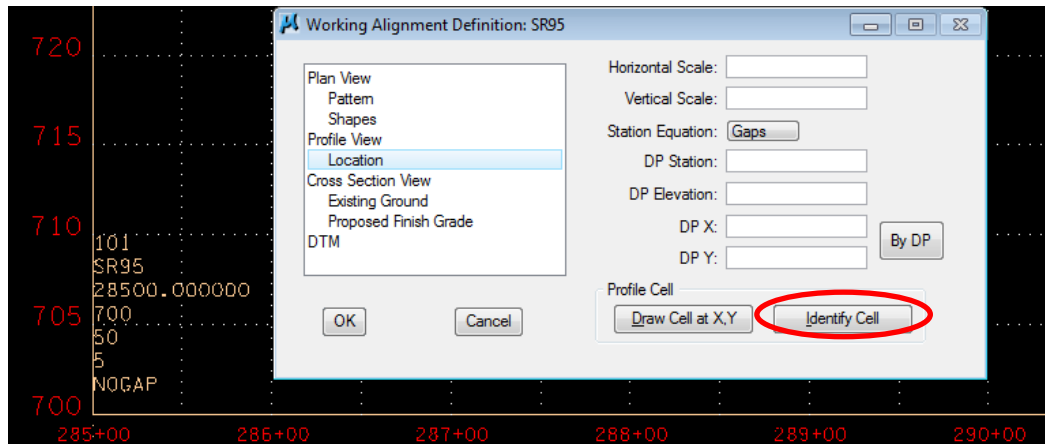


NOTE:

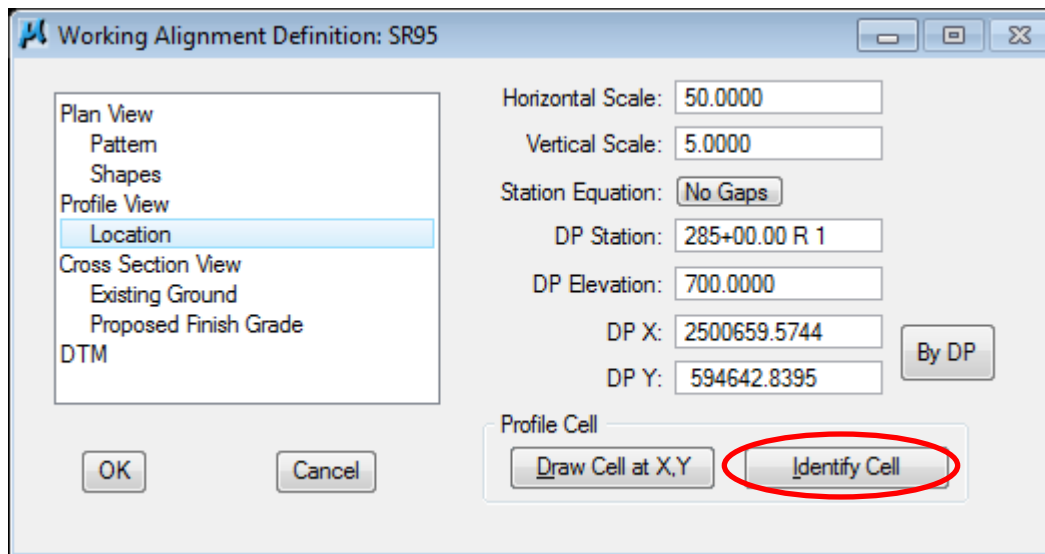
We have not designed the proposed profile; therefore, we will return later to populate this field.

- 3) Select the Location option and populate the dialog as depicted below. This can all be done automatically by clicking on the **Identify Cell** button.

Data point anywhere on the GEOPAK profile cell graphics to identify it and data point to accept.



All control values are filled in.



- 4) Press the OK button to save the updates and close the dialog.

7. Proposed Roadway Profiles

In this exercise, we will use the Vertical Alignment Profile Generator tool to set up the proposed vertical alignment profile for our roadway.

I.) Generate the Proposed Profile

- 1) Open the MicroStation file:

C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

Access Project Manager

- 2) Select the Vertical Alignment button from the Project Manager workflow dialog.
- 3) All of the information in the Settings dialog should be automatically populated based upon the information we set up in our working alignment definition.

The screenshot shows the 'Settings' dialog box with the following values:

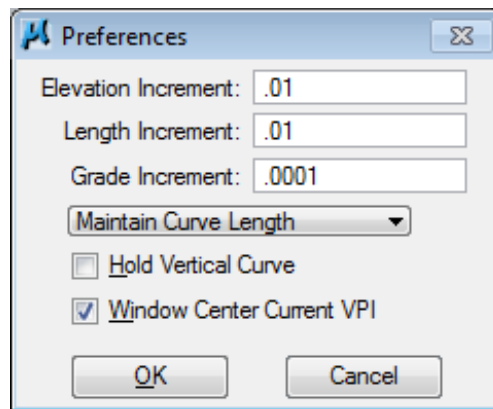
- Job: 101
- Operator Code: js
- PGL Chain: SR95
- Horizontal Scale: 50.000000
- Vertical Scale: 5.000000
- Reference Station: 285+00.00 R 1
- Reference Elevation: 700.000000
- X: 2500659.5744
- Y: 594642.83950

Buttons visible: DP, Draw Cell at XY, Identify Cell, OK, Cancel.

Click the OK button to commence developing of the proposed profile.

- 4) The Profile Generator dialog is opened for us but before we start storing our profile lets look at some additional controls. In the dialog, go to the drop down option File → Preferences

These special controls may be used to control how stations, lengths or grades are set. We use the defaults for the most part but click on Window Center Current VPI so we will always see the area we are defining at the time and set the vertical curve control option to Maintain Curve Length. Click on the OK button once settings are made.



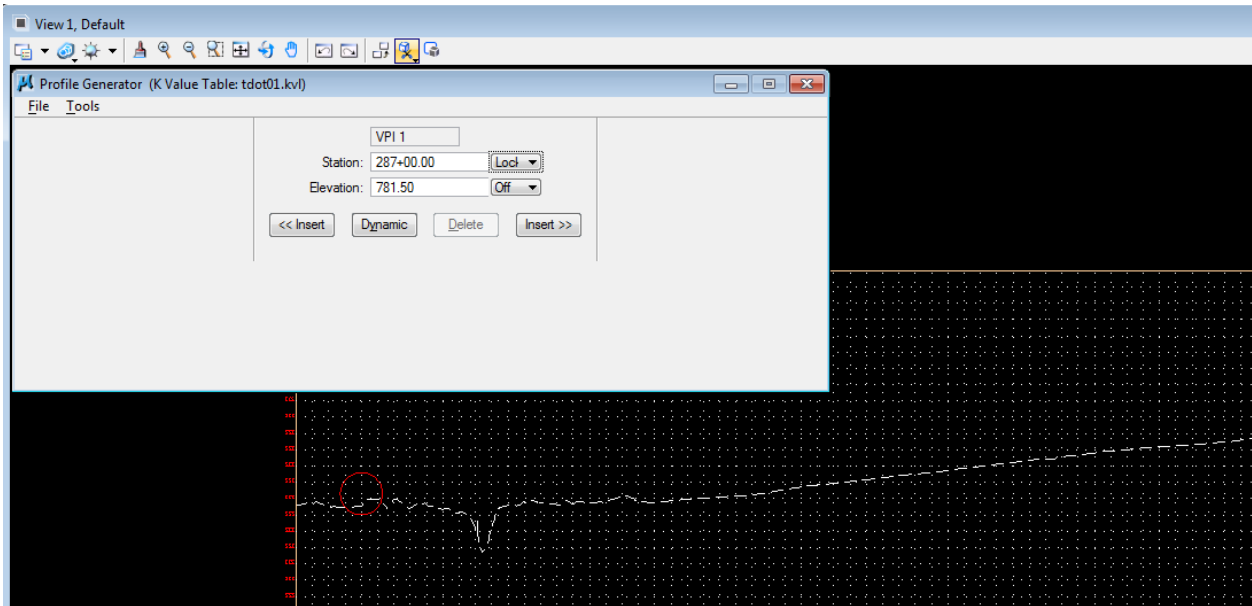
- 5) In the Profile Generator dialog go to the drop down option File → K Value Table. By default the standard K value file tdot01.kvl is loaded. This file contains K values based on T.D.O.T.'s RD01 standard roadway drawings. Click on the Cancel button retain the current settings.

Speed	Sag Minimum	Sag Maximum	Crest Minimum	Crest Maximum
15	10.0	10.0	3.0	3.0
20	17.0	17.0	7.0	7.0
25	26.0	26.0	12.0	12.0
30	37.0	37.0	19.0	19.0
35	49.0	49.0	29.0	29.0
40	64.0	64.0	44.0	44.0
45	79.0	79.0	61.0	61.0
50	96.0	96.0	84.0	84.0
55	115.0	115.0	114.0	114.0
60	136.0	136.0	151.0	151.0
70	181.0	181.0	247.0	247.0

If you need to reset this table, in the K Values dialog select the drop down option File → Open, navigate to the folder C:\Users\Public\Geopak Standards and load the desired file. Click on the OK button once settings are made.

Exercise 7

- 6) Now that we have made our initial settings, we can start setting up our proposed profile. Set the first VPI Station to 287+00 and Elevation to 781.50 as shown in the diagram below. Be sure to press the Enter key after each entry is made.



In graphics, we can see our VPI position point.

- 7) Press the Insert button on the right and complete the VPI Station and Elevation of the subsequent VPIs as detailed in the table below.

VPI	Station	Elevation
2	304+10	787.00
3	333+50	816.50
4	347+50	793.32

NOTE:

The Dynamic button allows you to set VPIs by eye when values are not yet known and can be used in conjunction with the Lock or Inc (increment) buttons to the right of the station & elevation values. Lock will lock that particular value down while the other is dynamic. Inc will force dynamics to use value controls set in preferences.

- 8) Press the Previous button at lower left of dialog to return to VPI #2 as shown in the diagram below.

Profile Generator (K Value Table: tdot01.kvl)

File Tools

VPI 1	VPI 2	VPI 3
Station: 287+00.00	Station: 304+10.00	Station: 333+50.00
Elevation: 781.50	Elevation: 787.00	Elevation: 816.50
Back Grade: 0.3216		Fwd Grade: 1.0034
Length: 1710.00		Length: 2940.00

Control Buttons: << Insert, Dynamic, Delete, Insert >>

Symmetrical Vertical Curve

Speed: 65

Station: [] LP Station: NA K: 193.0000 Station: []

Elevation: [] LP Elevation: NA SSD: [] Elevation: []

Previous 1 < [III] > 4 Next

- 9) Make sure the curve type at the bottom is set to Symmetrical and set the Design Speed to 60. The K value is automatically read from our table and a curve length of 92.72 is computed.

We need an even length of curve preferably in 50 or 100 foot increments and this VPI has a small algebraic difference so go ahead and change the curve length to 200.

Profile Generator (K Value Table: tdot01.kvl)

File Tools

VPI 1	VPI 2	VPI 3
Station: 287+00.00	Station: 304+10.00	Station: 333+50.00
Elevation: 781.50	Elevation: 787.00	Elevation: 816.50
Back Grade: 0.3216		Fwd Grade: 1.0034
Length: 1710.00		Length: 2940.00

Control Buttons: << Insert, Dynamic, Delete, Insert >>

Symmetrical Vertical Curve

Speed: 70

Station: 303+10.00 LP Station: 303+10.00 K: 293.3567 Station: 305+10.00

Elevation: 786.68 LP Elevation: 786.68 SSD: NA Elevation: 788.00

Previous 1 < [III] > 4 Next

The new curve length is used to calculate a new K value which is used with our K value table to indicate that we are now meeting 70 mph vertical design speed criteria.

Exercise 7

- 10) Press the Next button at lower right of dialog to preview the information for VPI #3. We only need a 50 mph vertical curve here but go ahead and set a curve length of 1200 which yields a Design Speed of 70 mph.

Profile Generator (K Value Table: tdot01.kvl)

File Tools

VPI 2
Station: 304+10.00
Elevation: 787.00
Back Grade: 1.0034 Off
Length: 2940.00

VPI 3
Station: 333+50.00 Off
Elevation: 816.50 Off
<< Insert Dynamic Delete Insert >>

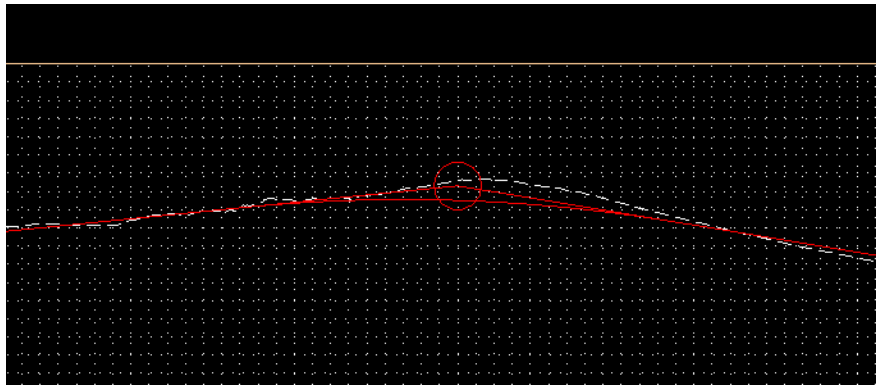
VPI 4
Station: 347+50.00
Elevation: 793.32
Fwd Grade: -1.6557 Off
Length: 1400.00

Symmetrical Vertical Curve

Speed: 70 L: 1200.00
Station: 327+50.00 HP Station: 332+02.81 K: 451.2779 Station: 339+50.00
Elevation: 810.48 HP Elevation: 812.75 SSD: 774.43 Elevation: 806.57

Previous 1 < > 4 Next

In graphics, we can see our curve as specified.



NOTE:

Graphics shown while using Profile Generator are temporary visualizations and disappear when the program is exited. Graphics for the plans are displayed using D&C Manager which we will do in the next section.

- 11) Save the proposed profile by selecting File → Save Profile from the Profile Generator dialog. Enter SR95 for the profile name and click OK to save. Click OK again to dismiss the Confirmation message box.

Save Profile As

Profile: SR95
Input File: i101ojs.inp

OK Cancel

- 12) Exit the Profile Generator dialog. When prompted to save your profile, you can answer NO since we did that in Step 11. When prompted to save your Vertical Alignment settings, press YES.

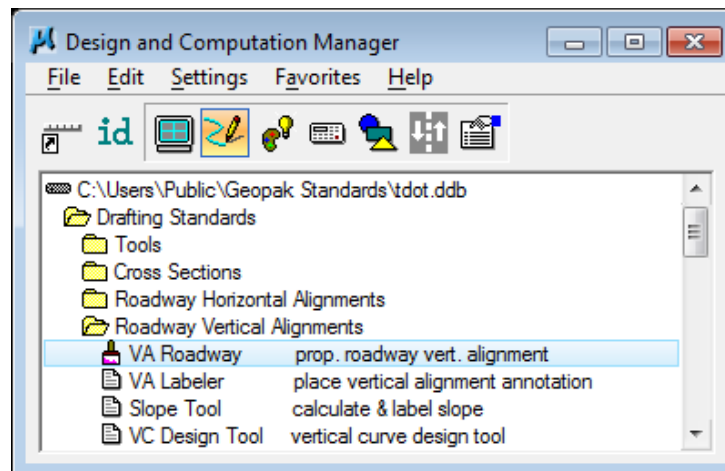
II.) Drawing the Proposed Profile

Next, we are drawing the proposed profile SR95 utilizing D&C Manager.

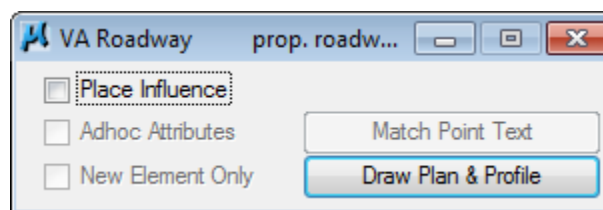
- 1) Access the D&C Manager.

Select the item:

Drafting Standards → Roadway Vertical Alignments → VA Roadway.



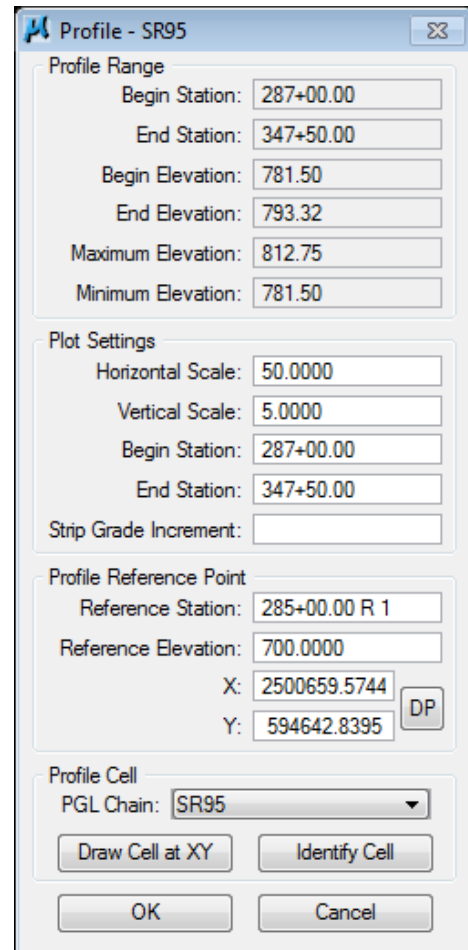
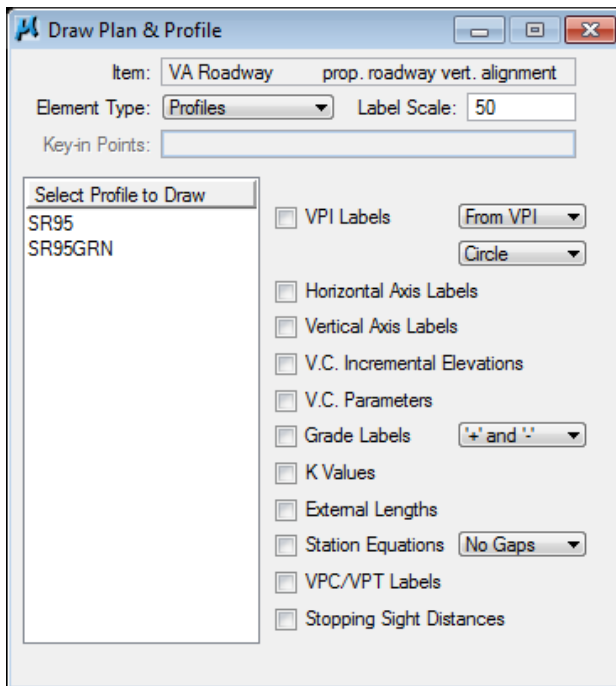
- 2) Press the Draw Plan & Profile button on the secondary dialog.



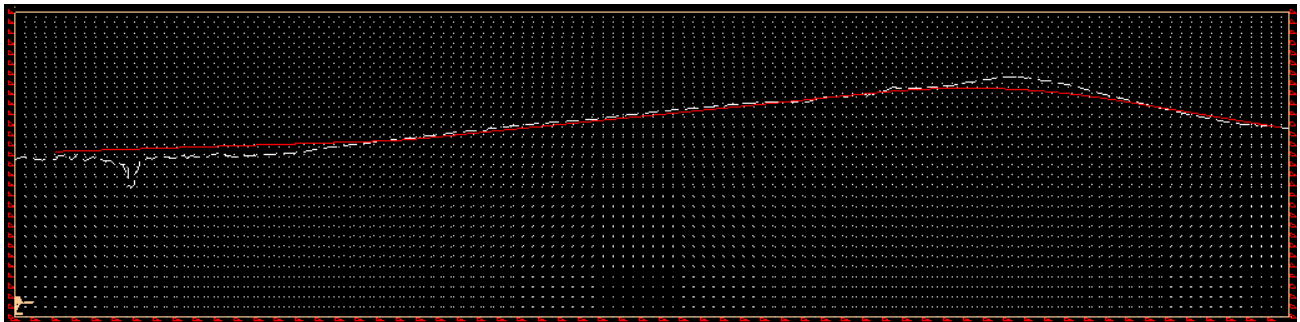
Plot the proposed profile 'SR95' using the parameters as shown in the following dialogs. Options required for proposed roadway profile line work are set by default. **Do not** turn on any annotation options. All annotation is placed with a separate program which we will use next. Single click on the profile name in the Draw Plan & Profile dialog.

Exercise 7

Since we have our profile control information set up in the working alignment, all of that data in the Profile dialog is filled in automatically. Review the data then click OK to draw the profile.

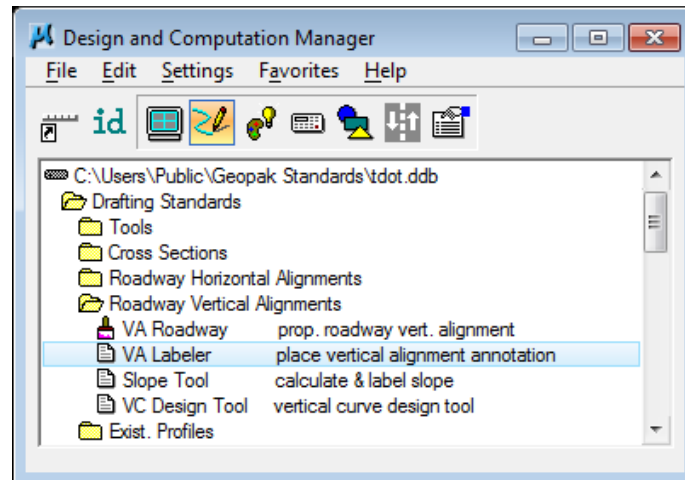


- 3) Exit the Draw Plan and Profile dialog then review the proposed vertical alignment line work in MicroStation.

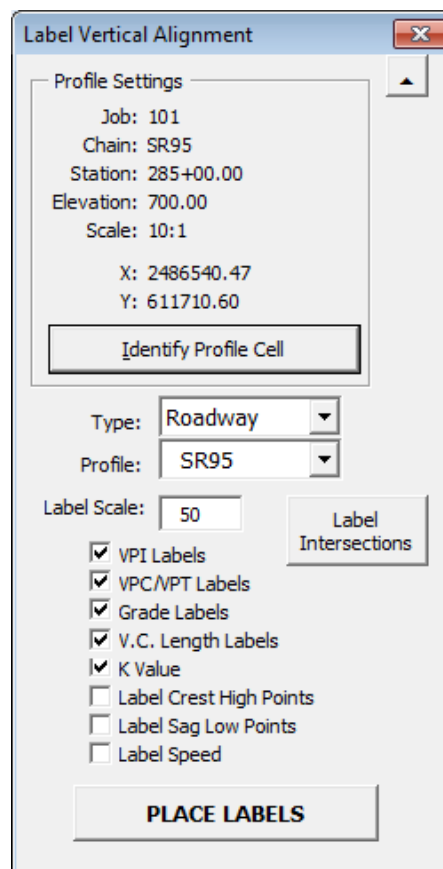


- 4) We run a separate special program to place all of the vertical alignment annotation. Double-click the item:

Drafting Standards → Roadway Vertical Alignments → VA Labeler



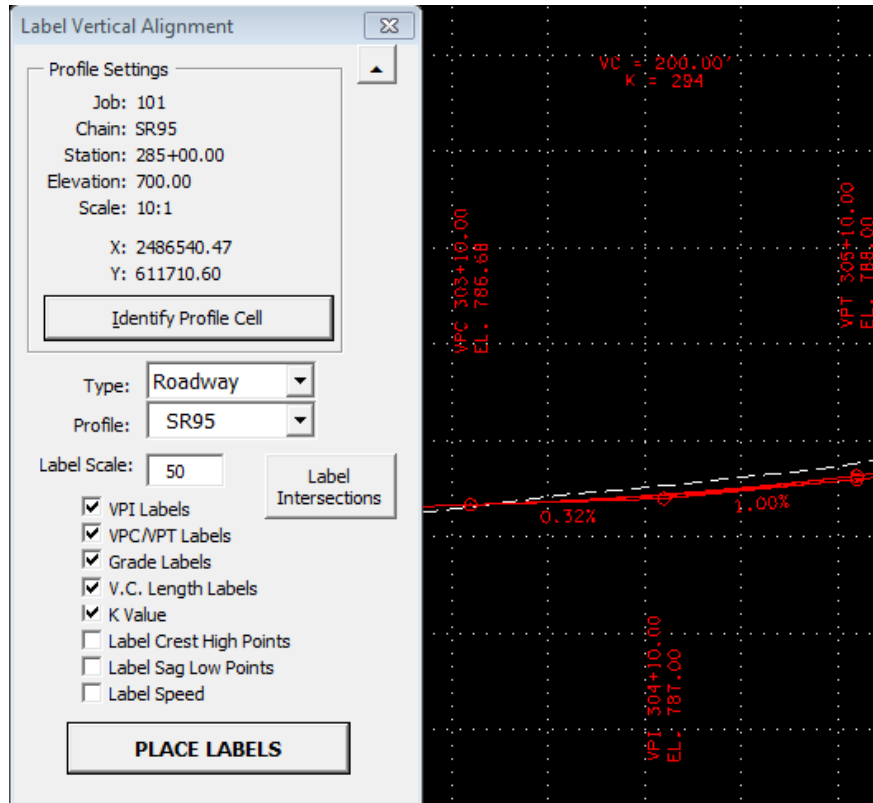
- 5) The Label Vertical Alignment Dialog is opened.



Exercise 7

- 6) Click on the Identify Profile Cell command button and click on the Geopak profile cell for our profile. The window shade button on the upper right of the dialog can be used to get the dialog out of the way as you identify the profile cell. Just click it again to enlarge the dialog after identifying the cell.

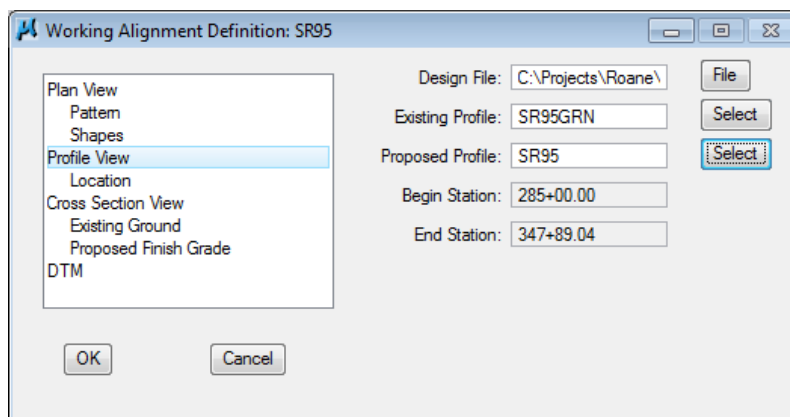
After reading the profile cell and populating the Profile Settings at the top of the dialog, the GPK file is read for all profiles/vertical alignments applicable for display on this profile and fills the profile list box.
- 7) Next, set the Type of profile to be labeled. The default is Roadway which is what we need. Options to label special ditches or private drives are also available. The type controls text sizes, orientation and symbology.
- 8) Set the Profile option to SR95.
- 9) Set the Scale to 50 if not set already. The current active scale is read when the program is started to fill in this field automatically.
- 10) Finally, the label options can be adjusted as needed. The type of profile to be labeled determines which default options are turned on. For this class, we will use the defaults for Roadway.
- 11) Now that all control values are set, click on the Place Labels command button and the vertical alignment is annotated. Review the annotation graphics and click the red X to close the dialog. You can close D&C Manager as well.



III.) Working Alignment - Define Proposed Profile

We are completing the Profile View of the Working Alignment Definition in Project Manager.

- 1) Press the Define button from the workflow dialog of Project Manager.
- 2) Highlight the Profile View option and populate the Proposed Profile field as depicted below using the Select button.



- 3) Press the OK button to save the updates and close the dialog.

8. Existing Ground Cross Sections

In this exercise, we will start setting up our cross sections by first defining the locations where we want them with MicroStation lines or line strings called “pattern” lines by GEOPAK. Then we will use the Draw Cross Section tool to cut existing groundlines from our existing TIN file.

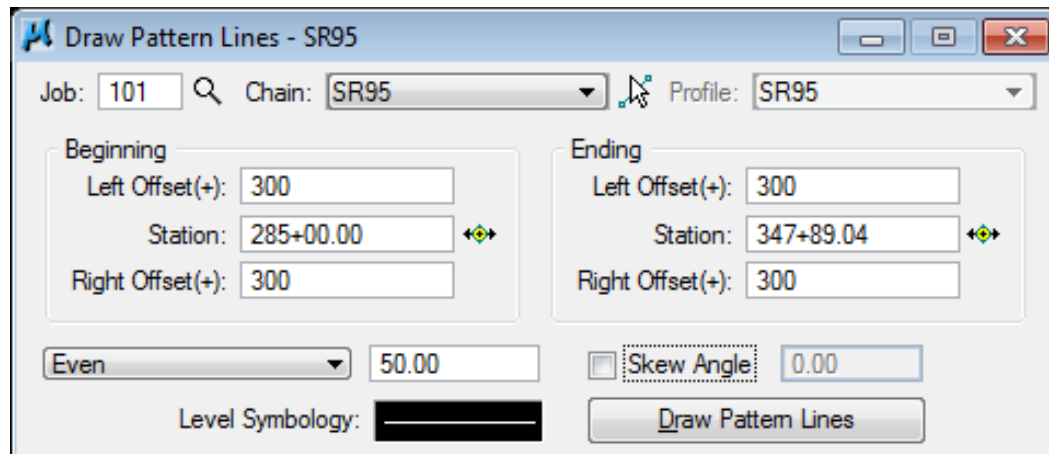
I.) Draw Patterns

- 1) Open the MicroStation file:

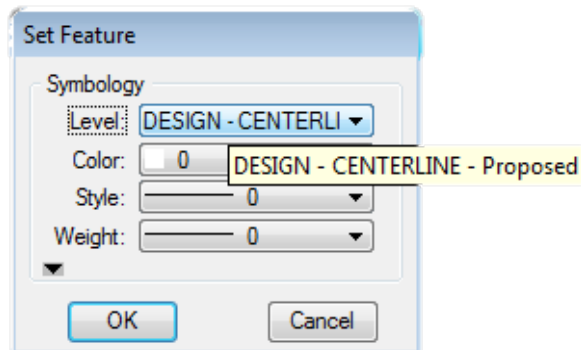
C:\Projects\Roane\SR95PoplarCr\ROSR95RoadwayPattern.dgn

Access Project Manager.

- 2) Select the Draw Pattern button from the Project Manager workflow dialog.
- 3) Create a new run called SR95.
- 4) Populate the dialog as depicted below. Chain name and stations are set automatically. Set the Offsets to 300 and layout option to Even at 50.



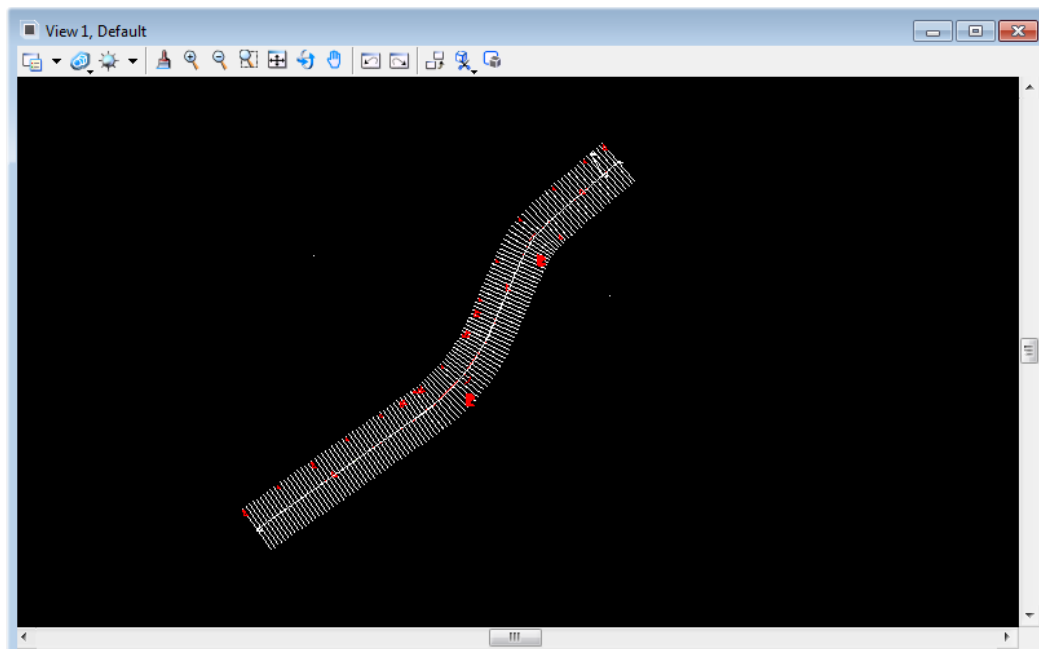
Double click on the symbology review window to make the following settings. Level name is DESIGN - CENTERLINE - Proposed. Click OK to save the settings.



NOTE:

The symbology settings for pattern lines are not critical since they are not used in the plans. If more than one set of roadway patterns are placed in a file, it is important to make some part of their symbology different, such as the level, so that they can be recognized correctly by GEOPAK during cross section processing.

- 5) Press Draw Pattern Lines to initiate the plotting of the patterns into the design file.
- 6) Review the pattern lines in MicroStation. The alignment DGN file has already been referenced to this file and you can see the pattern lines along it.



- 7) Exit the Draw Pattern dialog and Save Settings for the run.

II.) Drawing Skewed Pattern Lines

Skewed pattern lines are used to cut culvert cross sections for drainage structure development. When those structures have been designed, the Pattern line tool can be used to plot the centerline for box structures or pipes at the required length.

This information is provided for reference only. Do not do this for the class. Review and then go on to Section III.

- 1) From Project Manager or the GEOPAK Road tool frame activate the Draw Pattern tool.
- 2) Set the job number and chain name for the roadway.
- 3) Change the placement control at the bottom for placement Once and change symbology settings as desired.

NOTE:

When drawing pipes, the required symbology should be set using proposed pipe items from D&C Manager with Place Influence active so that quantities can be calculated later...

- 4) Only the Beginning side of the dialog should be active now and there you now can set the Offset LT, Station & Offset RT.
- 5) If the drainage structure is at 90 degrees (0 degrees on dialog) you can go ahead and hit Draw Pattern Lines to draw the pattern line for the structure. If the structure is skewed click on the Skew Angle option.
- 6) Enter the Skew value. Skew values in this dialog are measured from a normal 90 degree line not the centerline as we normally consider them. So to get the skew value to enter in the dialog, subtract the skew from 90.

Skews to the left should be entered as positive and skews to the right as negative. (Example: 60 degree skew left is $90-60=30$)

- 7) Hit Draw Pattern Lines to draw the structure centerline or pipe.

III.) Generate Existing Ground Cross Sections

- 1) Open the MicroStation file

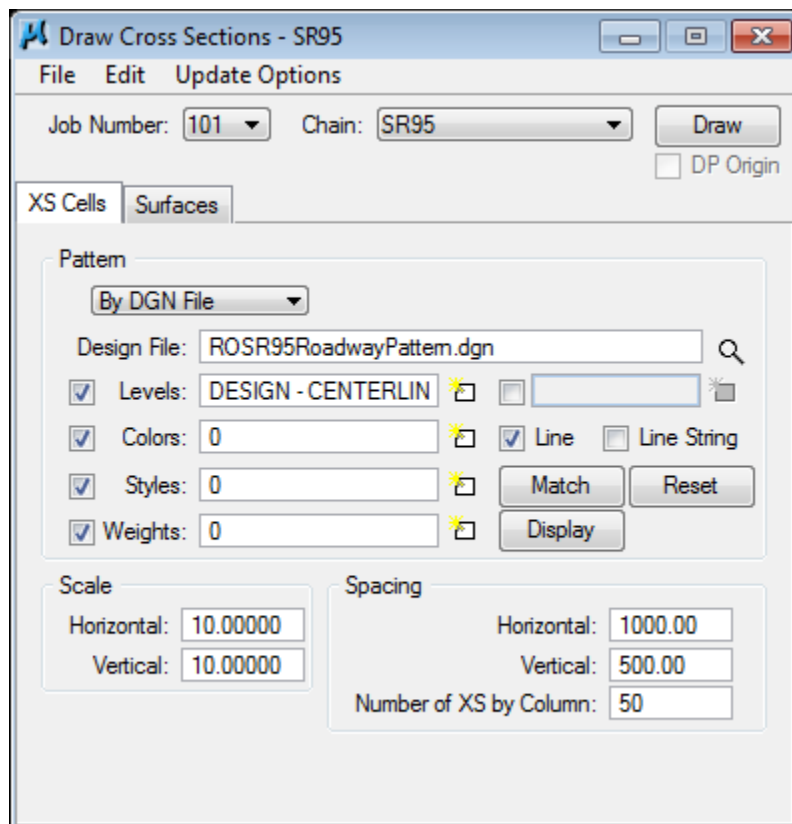
C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

NOTE:

When creating a new cross sections design file, always use the seed file **SeedXS.dgn**. This file has special settings which are different from the normal seed2d.dgn DGN seed file. This is required for proposed cross section processing and if not used can generate errors and fail to build proposed sections.

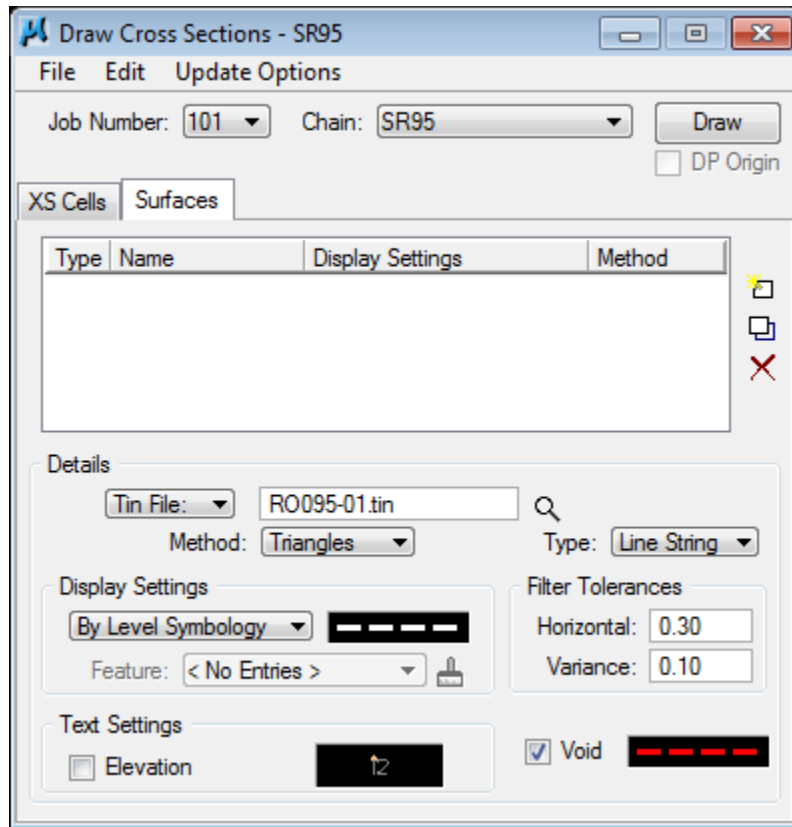
- 2) Press the Existing Ground Cross Sections button on the Project Manager dialog.
- 3) Create a run called SR95.
- 4) Set up the existing ground cross-sections by populating the dialog as shown.

Start by changing the XS Cells option to By DGN File which will change the items shown in the dialog. Pattern line symbology should be set as we did in the previous section.



Exercise 8

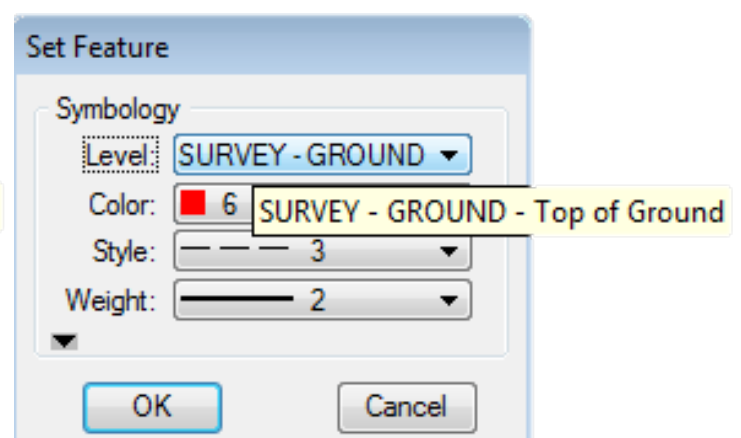
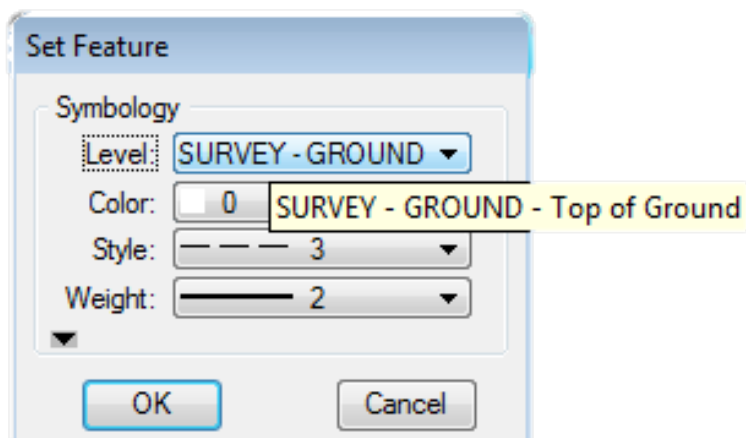
Click on the Surfaces tab to open this dialog display. Make the settings in the lower portion first. Double click on the symbology review windows to set the symbology for groundlines and voids as shown below this dialog.



Void symbology is the same as groundlines except for the color which is red (6).
Level name is SURVEY - GROUND - Top of Ground.

Display Settings

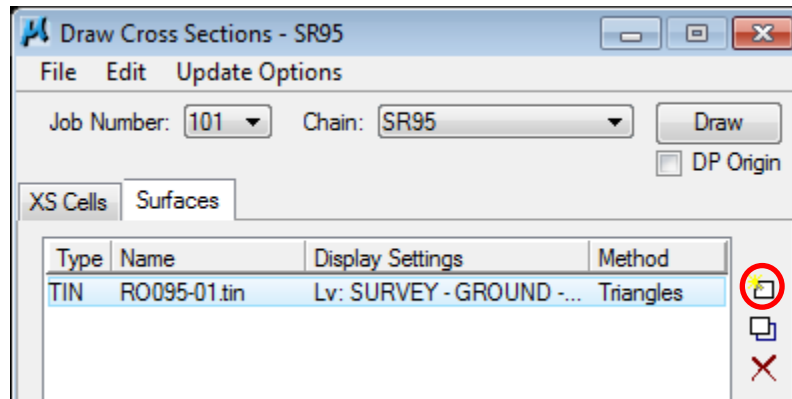
Void



NOTE:

It is critical for plotting purposes that Line Strings always be used for groundline displays. When lines are used with line code 3, short pieces of line will appear solid on plots making them difficult to see on gridded cross section sheets.

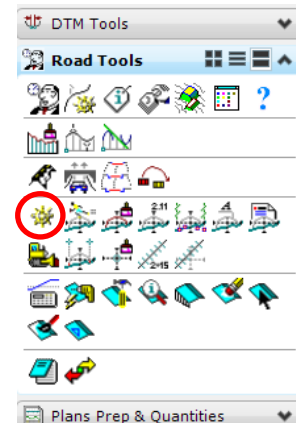
- 5) When the settings in the lower portion are complete click the Add Surface button on the side.



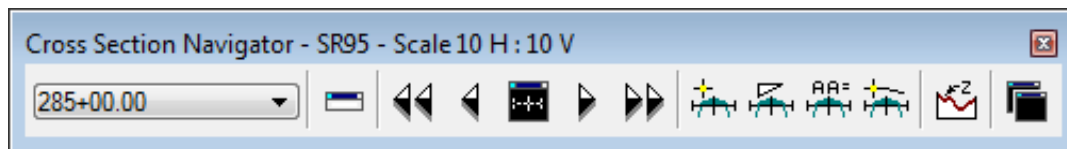
- 6) Next, press the Draw button to place the cross section graphics.
- 7) Exit the dialog and Save Settings for the run.

IV.) Review Cross Sections

- 1) Open the Road Tools task group and select the Cross Section Navigator tool from the cross section tools.



- 2) Use the Cross Section Navigator to browse and check your existing cross sections.



- 3) **Exit** the XS Navigator dialog when done.

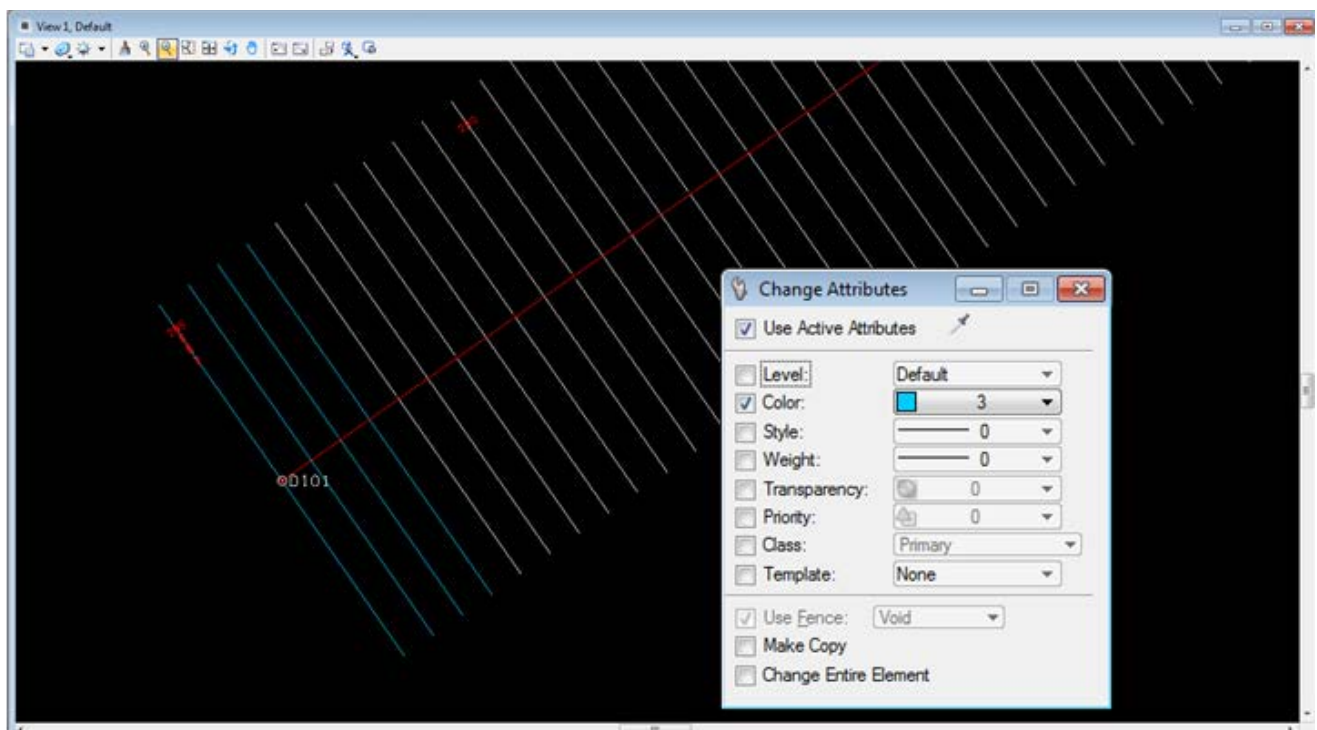
V.) Modify Pattern Line Symbology

In preparation for the following exercise, complete this step:

- 1) Re-open the MicroStation file

D:\Projects\Roane\SR95PoplarCr\ROSR95RoadwayPattern.dgn

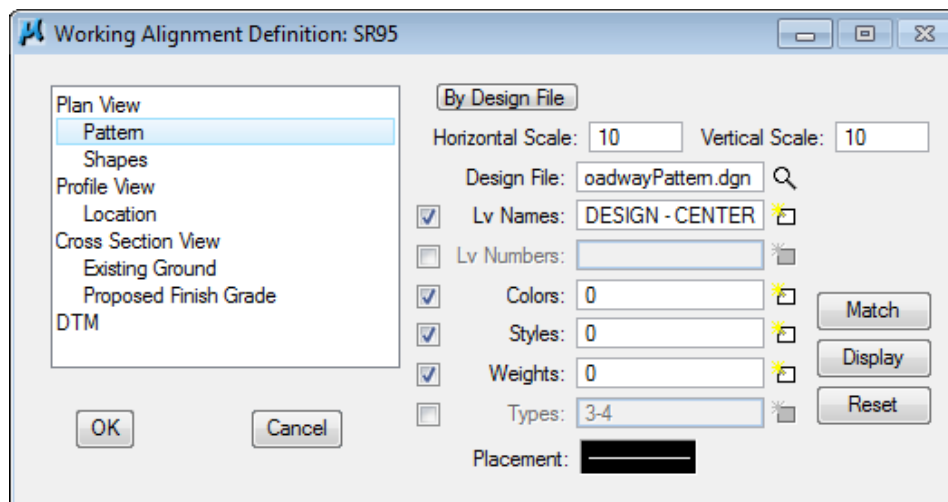
Utilizing the MicroStation Change Element Attributes command, modify the color of the pattern lines drawn at stations 285+00 through 286+50 and station 347+89.04 to **color = 3**. This will limit the processing of the proposed cross sections to the station range of the proposed roadway profile (287+00 to 347+50).



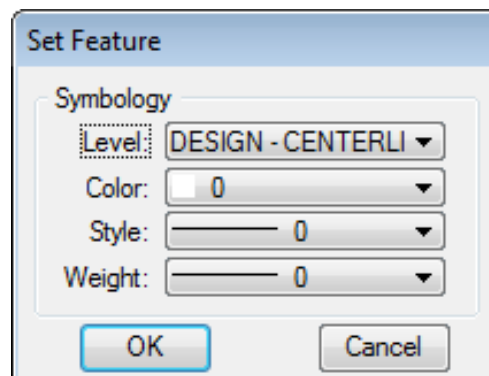
VI.) Working Alignment - Define Patterns & Cross Sections

We are completing the Pattern, Cross Section and Existing Ground sections of the Working Alignment Definition in Project Manager.

- 1) From the workflow dialog of Project Manager, press the Define button.
- 2) Highlight the Pattern option and populate the dialog as depicted below. Since we are in the pattern file, you can use the Match button to accomplish this task rather than manually typing in the information, click the button and data point on one of the white pattern lines to set. These symbology settings control searches for cross section patterns by other tools



- 3) Double click on the symbology review window next to Placement at the bottom and set the same values in the Set Feature dialog. This symbology control will be used if pattern lines have to be placed again for this roadway.



Exercise 8

4) Click OK to save the symbology settings and OK again on the main dialog to save the Pattern settings.

5) Open the MicroStation file

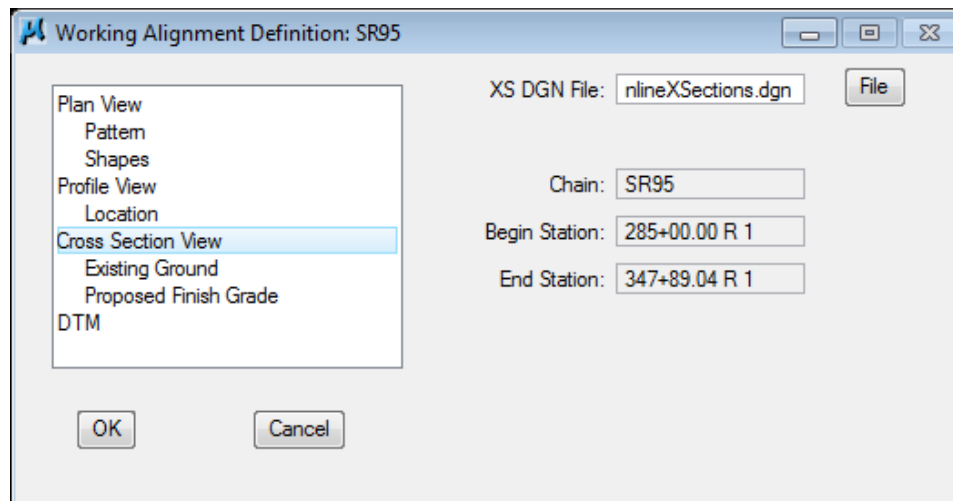
C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

6) Use Cross Section Navigator to go to your first cross section.

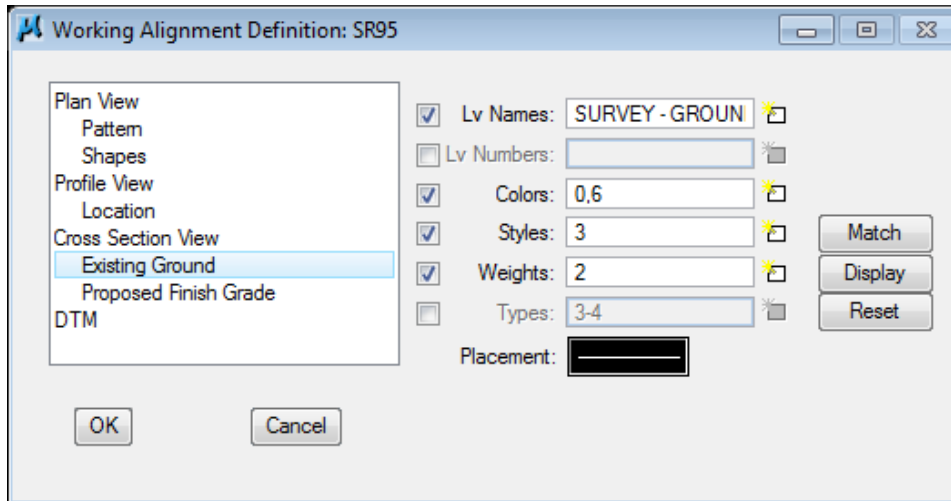


7) From the workflow dialog of Project Manager, press the Define button.

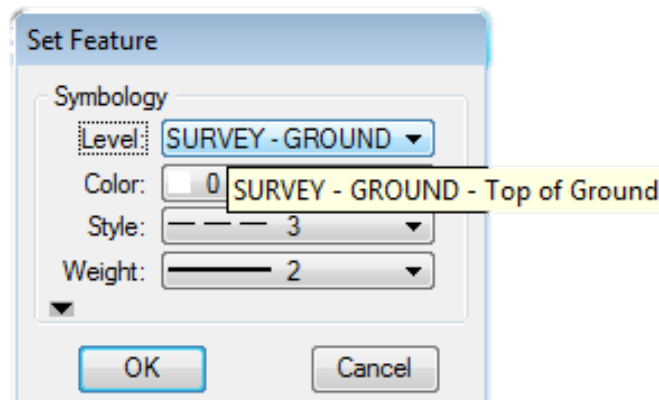
8) Highlight the Cross Section View option and using the File button identify the roadway cross section file. Notice that chain & station limits are read from the file.



- 9) Highlight the Existing Ground option and populate the dialog as depicted below. Use the Match button and identify the groundline. For possible Void areas add the **color 6** as shown.



- 10) Double click on the symbology review window next to Placement at the bottom and set the same values in the Set Feature dialog (use **color 0**).



- 11) Click OK to save the symbology settings and OK again on the main dialog to save all of the Cross Section and Existing Ground settings.

9. Proposed Cross Sections - Preliminary

This exercise is set up to illustrate setting up preliminary roadway cross sections without superelevation or special transition areas specified. This basic set up is all that is needed to do horizontal and vertical alignment investigation.

For our class project, a 4-lane divided median rural section will be used from Station 287+00 to Station 328+25, and a 5 lane urban section will be used from Station 328+25 to Station 347+50. The purpose of this exercise is to process a preliminary cross section run to check slopes, etc.

NOTE:

This project is set up to illustrate different roadway types as well as transitioning between them. When using this as a reference, consider the type of roadway on your project and look at the sections which would apply. See Appendix D for typical sections.

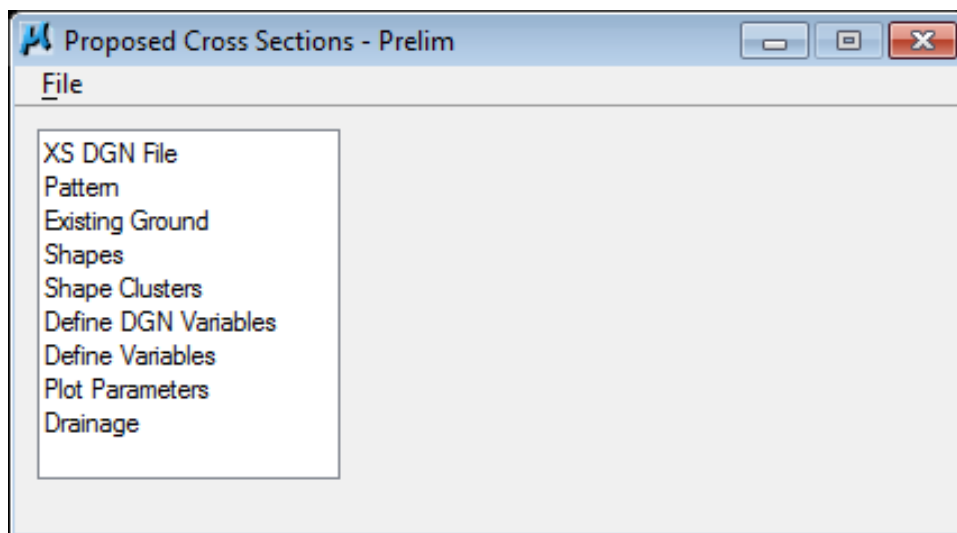
I.) Initial Set up

- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

Access Project Manager.

- 2) Choose Proposed Cross Sections from the Project Manager dialog and create a run called Prelim. Then double-click Prelim and the following dialog will appear.



- 3) Click on each of the following items and make the settings in the dialog as given.

XS DGN File: This filename should be automatically defined as ROSR95MainlineXSections.dgn

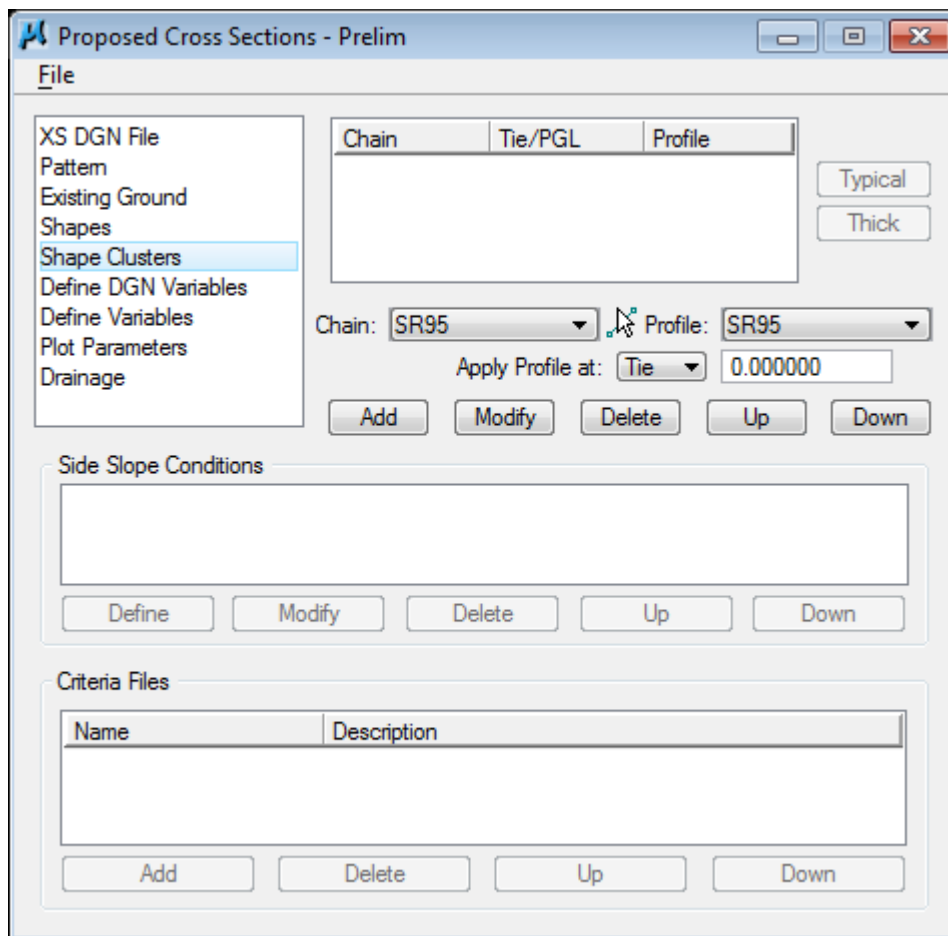
Pattern: Use Working Alignment Definition

Existing Ground: Use Working Alignment Definition

Shapes: Set the Shape Option to Shapeless. We will not be setting superelevation for this preliminary run.

II.) Define Roadway/Shape Clusters

- 1) Next, select the Shape Clusters item to invoke the following dialog display.



First, we will define the Chain, Tie and Profile for the shape clusters.

Exercise 9

- 2) Press the selection arrow button next to Chain and choose chain SR95.
- 3) Press the selection arrow button next to Profile and choose profile SR95.
- 4) Next, enter a Tie distance of -24 in the Apply Profile at: Tie field and press the Add button to include this shape cluster in the list box as shown below:

Chain	Tie/PGL	Profile
SR95	-24.000000	SR95

Chain: SR95 Profile: SR95

Apply Profile at: Tie -24.000000

Add Modify Delete Up Down

This shape cluster is for building the left side of our 4 lane with depressed median section. Now, we can go ahead and set up the other roadway areas.

NOTE:

Whenever the finished grade is a constant offset from the centerline, then a Tie value is specified. Only when that offset value varies from section to section will the alternate setting for a PGL chain be used. We will illustrate this in a later exercise

- 5) Repeat Step 4 for a Tie of 24 and for a Tie of 0.

Your list box should look the same as shown below:

Chain	Tie/PGL	Profile
SR95	-24.000000	SR95
SR95	24.000000	SR95
SR95	0.000000	SR95

Chain: SR95 Profile: SR95

Apply Profile at: Tie 0.000000

Add Modify Delete Up Down

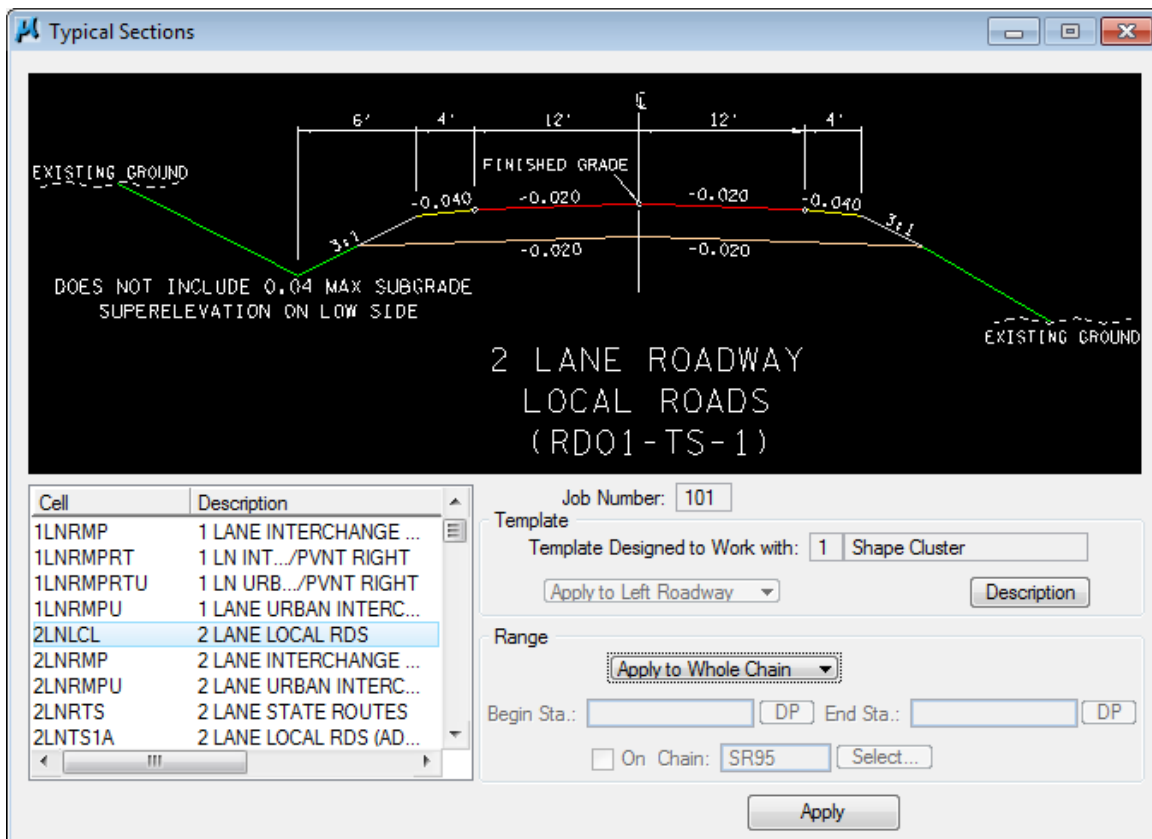
- 6) To define the Side Slope conditions and the Criteria Files required to produce our preliminary proposed cross sections, we simply highlight the first cluster in the list box (Tie -24) and press the Typical button.

Note:

The Typical button will not be available until a shape cluster has been selected from the list box.

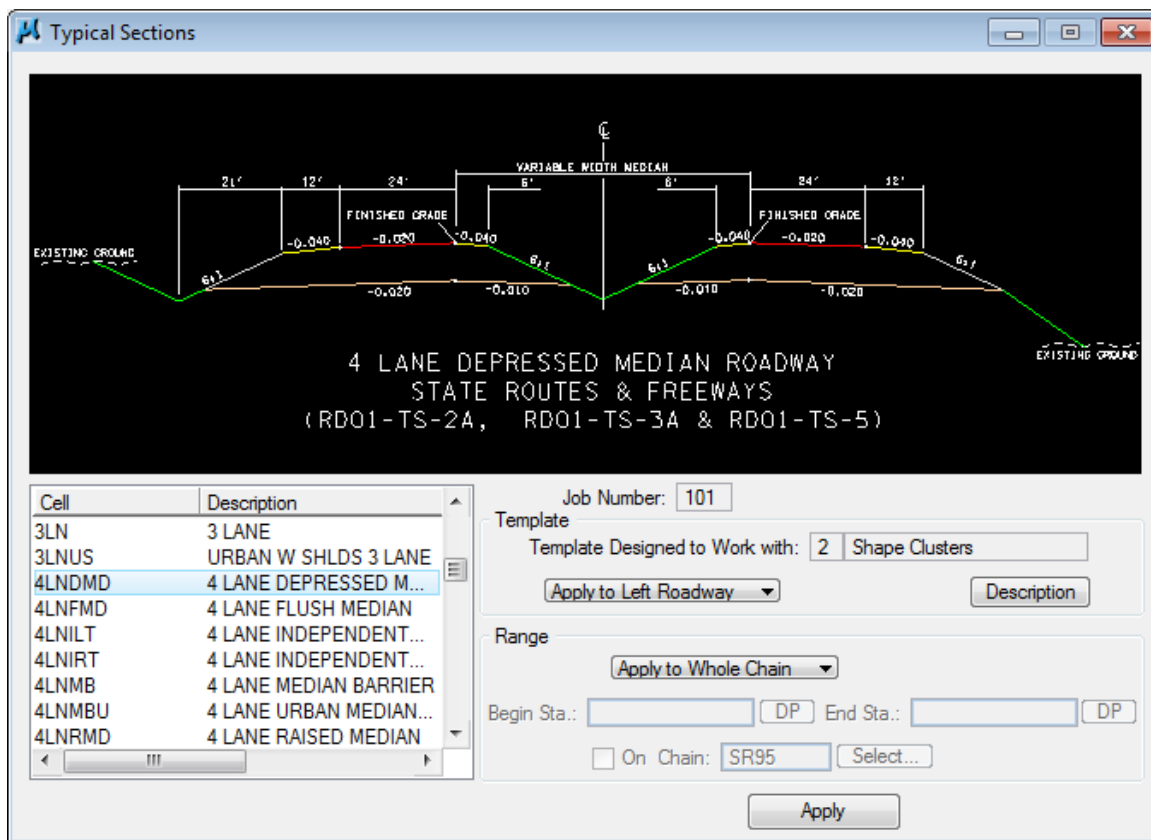
- 7) You will now be able to traverse the Typical Section Library created for T.D.O.T. roadway design standards. Use the scroll buttons to move up and down the list.

As you select a typical section in the list box on the left, the dialog will update to display a schematic of the selected typical section.



Exercise 9

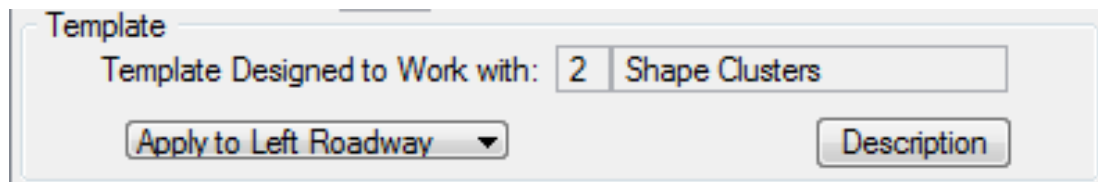
- 8) From the typical section list, select the cell "4LNDMD – 4 LANE DEPRESSED MEDIAN ROADWAY".



Click on the Description button, it will open a document file describing the features and application of the typical section as well as a listing of all variables used to form the section. Review this file then exit using Files → Exit.

- 9) Notice that within the Template area, information describing the process that this template is designed to work with and also the option button is available for you to define the Left or Right side of the Roadway for use with this typical section.

Since we selected the shape cluster with a tie value of -24, we need to set the control to Apply to Left Roadway.



- 10) In the Range area of the dialog, change the Station option to Apply to Station Range and provide a beginning Station of 287+00 R 1 and an ending Station of 328+25 R 1.

Station 328+25 is where this project switches to an urban crown roadway

NOTE:

Setting a chain name in this section is only necessary when applying a typical section to a roadway chain other than the one the cross sections are based on. Some examples of this might be a ramp at an interchange, a frontage road or perhaps a special ditch running outside the proposed roadway section.

- 11) Press Apply on the Typical Sections dialog.

The process of populating the side slope left and right station ranges and the required criteria files for this shape cluster is initiated. During this process all of the required criteria files are copied to your project directory.

After the processing is complete, the Proposed Cross Section dialog will re-appear and will now include the side slope and criteria settings for that roadway cluster.

Chain	Tie/PGL	Profile
SR95	-24.000000	SR95
SR95	24.000000	SR95
SR95	0.000000	SR95

Name	Description
pavement.x	
insideshoulder.x	
mediandep6.x	

Exercise 9

NOTE:

Sometimes the criteria description text does not display under Shape Clusters. This is a minor issue with the software and does not pose a problem.

- 12) Select the Shape Cluster with a +24.0 Tie and repeat the previous steps for the right roadway, this time being sure to change the template information to Apply to Right Roadway.

Template
Template Designed to Work with: 2 Shape Clusters
Apply to Right Roadway Description
Range
Apply to Station Range
Begin Sta.: 287+00.00 R1 DP End Sta.: 328+25.00 R 1 DP
On Chain: SR95 Select...

- 13) Press Apply. Now, we can see that the right roadway of the 4 lane with depressed median area has been set up.

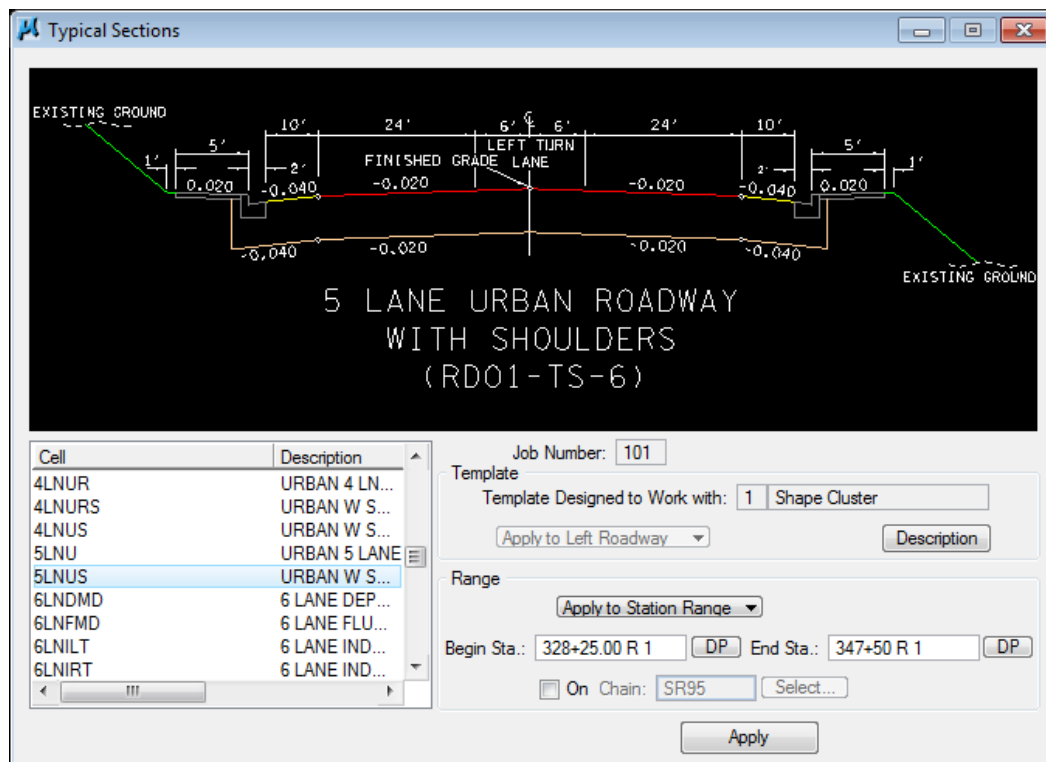
Proposed Cross Sections - Prelim
File
XS DGN File
Pattern
Existing Ground
Shapes
Shape Clusters
Define DGN Variables
Define Variables
Plot Parameters
Drainage
Chain: SR95 Profile: SR95
Apply Profile at: Tie 24.000000
Add Modify Delete Up Down
Side Slope Conditions
LT where sta >= 287+00.00 R 1 and sta < 328+25.00 R 1
RT where sta >= 287+00.00 R 1 and sta < 328+25.00 R 1
Define Modify Delete Up Down
Criteria Files
Name Description
pavement.x Pavement & Subgrade w/Widening.
shoulder.x Outside Shoulder.
case1slopes.x Case 1 variable slopes-Special Ditches-Benching-Fixed S...
Add Delete Up Down

Chain	Tie/PGL	Profile
SR95	-24.000000	SR95
SR95	24.000000	SR95
SR95	0.000000	SR95

NOTE:

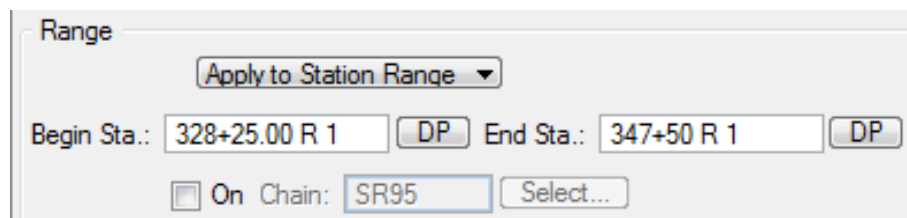
Since the criteria files applied with typical sections are copied to the project directory, it will be necessary to update those files as well as the originals in the standard criteria directory anytime an update is put out by T.D.O.T. Roadway Design Division CADD Support. There is a tool to help you accomplish this from the MicroStation menu bar at T.D.O.T. → Cross Sections → Update Project XS Criteria Files.

- 14) Select the Shape Cluster with a Tie = 0 and press the Typical button.
- 15) Select from the list box, the typical section "5LNUS - URBAN W SHLDS 5 LANE."

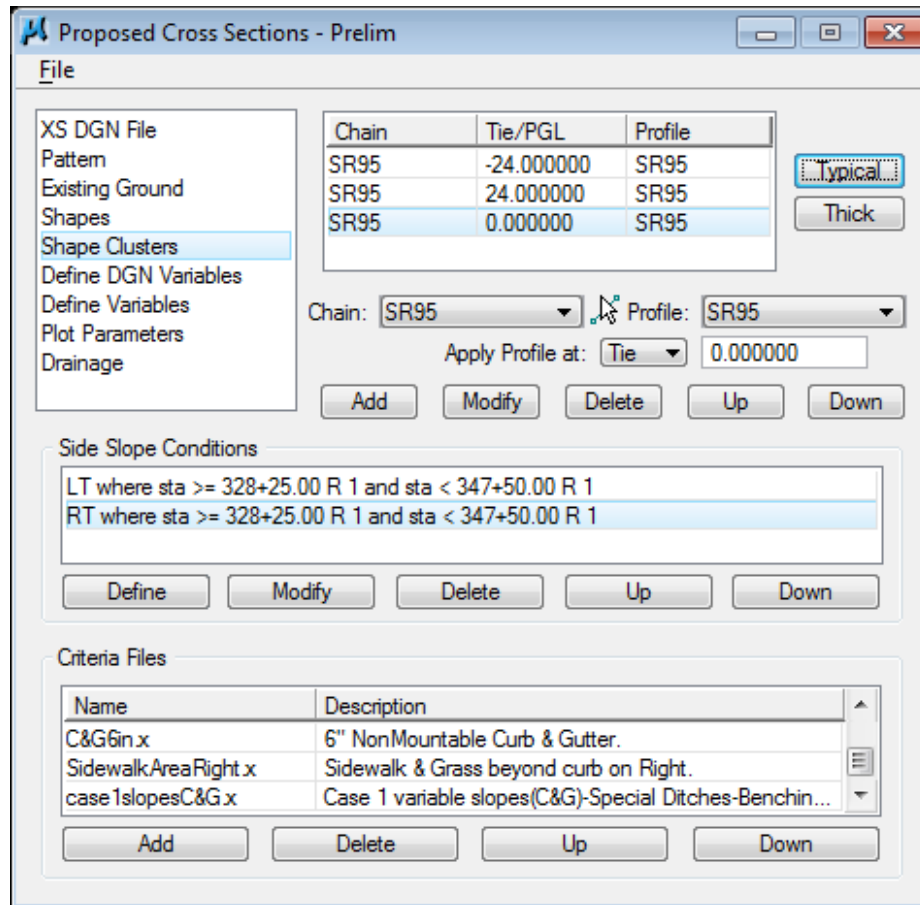


This typical was created to work with a single roadway/shape cluster. Notice in the Template area that the Left and Right Roadway button is no longer available.

- 16) Set the Station Range from 328+25 R 1 to 347+50 R 1 as shown below:



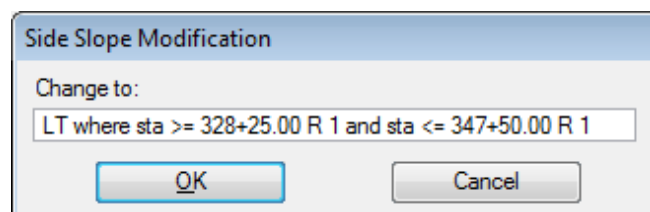
- 17) Press Apply.



- 18) Notice that in the above Side Slope Conditions, the station range to be processed must be “less than” (<) 347+50. This presents a problem since we have a proposed cross section at 347+50.

In the Side Slope Condition area, highlight the Side Slope LT condition and press the Modify button to access the Side Slope Modification dialog.

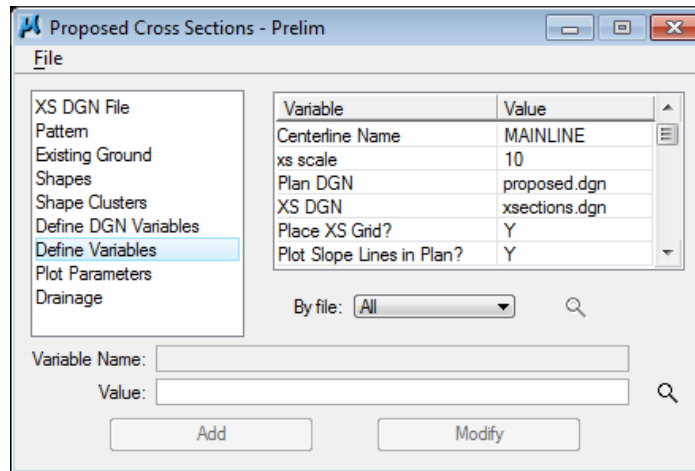
Place your cursor in the dialog keyin field after the symbol “<” and insert the “=” symbol as shown below. Press OK to save the change and return to the main dialog. This will insure that our station 347+50.00 is processed on the left side.



- 19) Repeat the previous step for the Side Slope RT condition.

III.) Define Variables

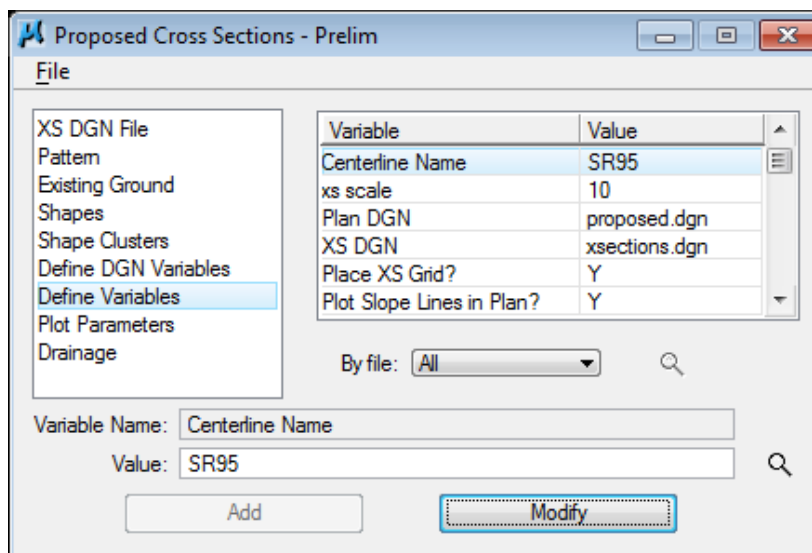
- 1) Select the Define Variables item from the Proposed Cross Section dialog list box to invoke the following dialog. This tool scans all of the criteria files for the Define Variables and allows you to define them for each proposed cross section run.



NOTE:

DGN Variables refer to graphics that control proposed cross section formation. Several of those are automatically set by T.D.O.T. Roadway Design Division criteria files including edge of pavement, shoulder lines and guardrail slope limit lines.

- 2) Select the Variable "Centerline Name" and set the Value to SR95. To do this, enter the name in the Value field and press the Modify button.

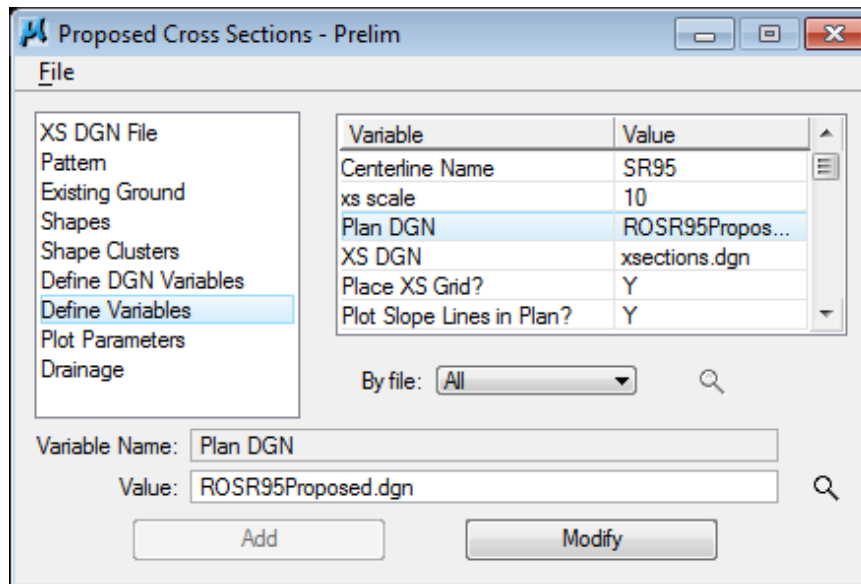


Exercise 9

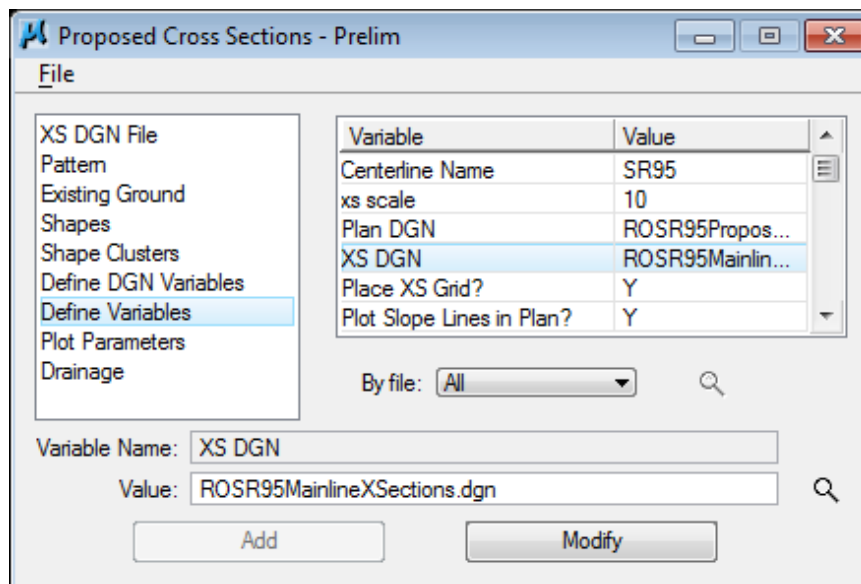
NOTE:

If the Modify button is not pressed, the change will not be made.

- 3) Select the Variable "Plan DGN" and set the Value to ROSR95Proposed.dgn.



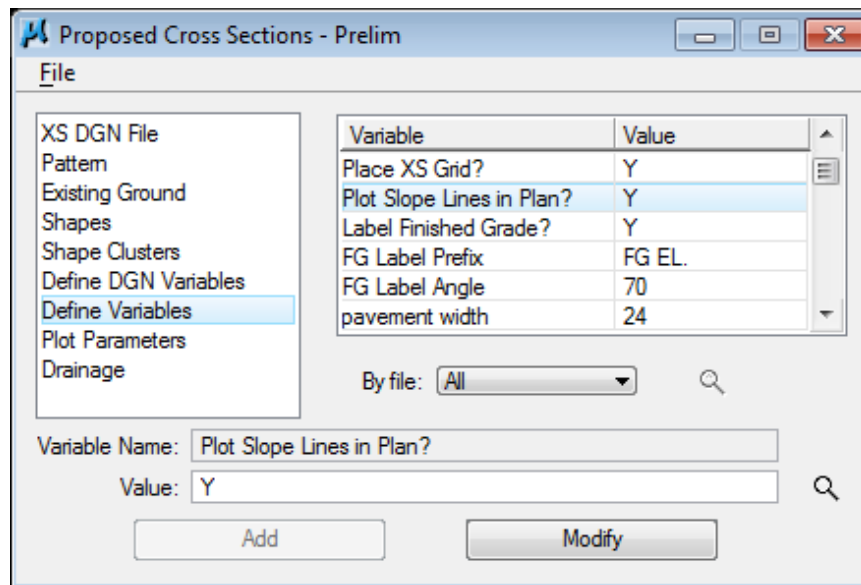
- 4) Select the Variable "XS DGN" and set the Value to ROSR95MainlineXSections.dgn.



5) Review the other variables in the list.

If slope lines are desired in the plan view, then set variable Place Slope Lines in Plan? to Y. These criteria files have been developed to plot the slope lines automatically as the proposed cross sections are being processed.

There are 3 define variables to control labeling of the finished grade elevation by the cross section criteria files. They include an option to place the label or not, label prefix and angle of label. In most cases the defaults can be used. For this exercise use the default values as shown below.

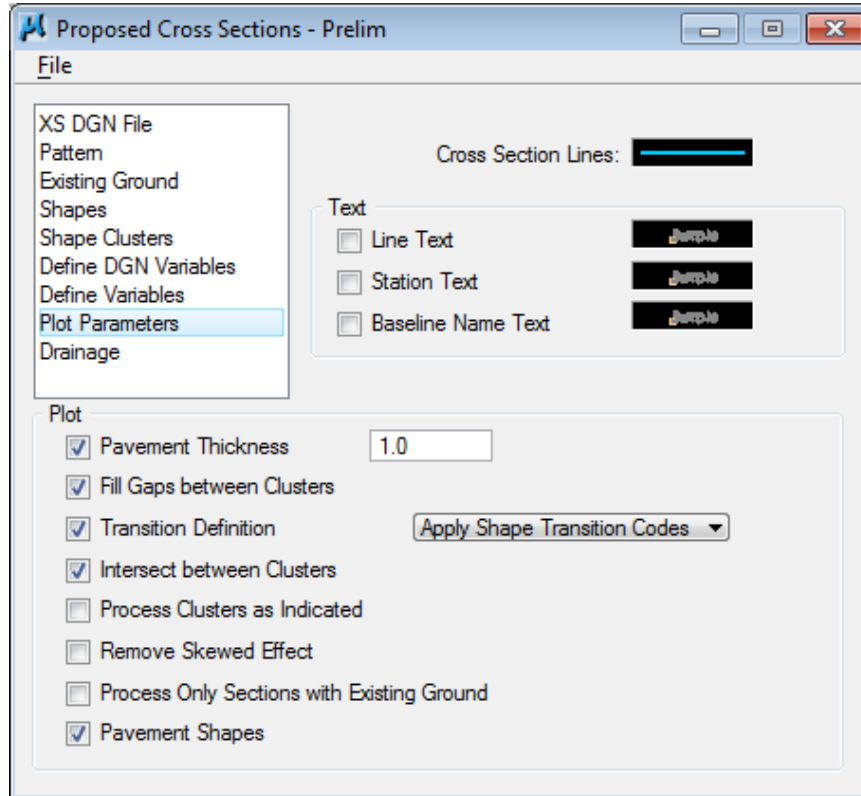


If no finished grade label prefix is desired, then none should be entered for the prefix.

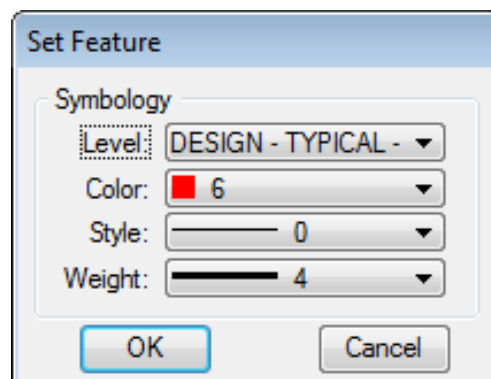
We do not need to change anything else for this roadway but on other projects default values may need to be adjusted. Pavement and shoulder widths are only used when no pavement or shoulder lines are found in the PLAN DGN file and no superelevation shapes are specified (shapeless).

IV.) Plot Parameters

- 1) Select the Plot Parameters item from the Proposed Cross Section dialog list box to invoke the following dialog.



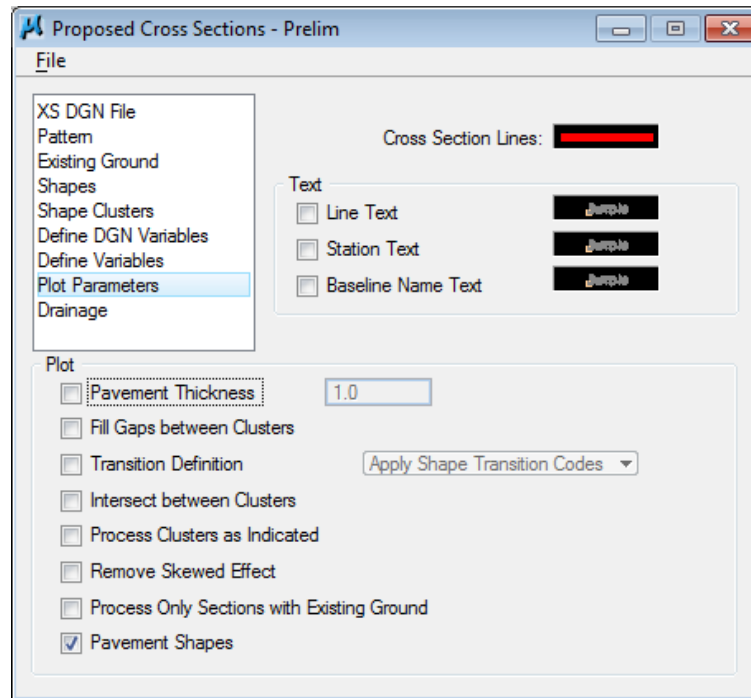
Double click on the Cross Section Lines symbology review box to invoke the following dialog and set symbology as shown. The level name is DESIGN - TYPICAL - Finished Grade and Subgrade.



Press OK when complete.

- 2) The Line Text option is used by Geopak to annotate the finished grade. Since our criteria files take care of that annotation as well as labels for station and baseline chain name, none of the Text options need to be set.

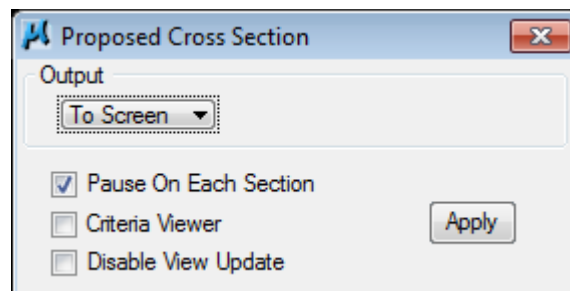
All options except for Pavement Shapes under the Plot section should normally be off when using T.D.O.T. Roadway Design Division Typical Sections and criteria files. They may be applicable in certain special case scenarios. Remove the check marks from all items except for Pavement Shapes under the Plot section.



V.) Processing Proposed Cross Sections

- 1) At this point, we are ready to process the proposed design cross sections for the chain SR95 with the profile defined as SR95. From the Proposed Cross Sections dialog, select drop down option File → Run.

The following dialog is invoked where you may define where you want to see the cross section processing information, in an output file or on the screen only.



Exercise 9

- 2) Select To Screen and activate the Pause on Each Section toggle to view the first design section once it has been drawn.

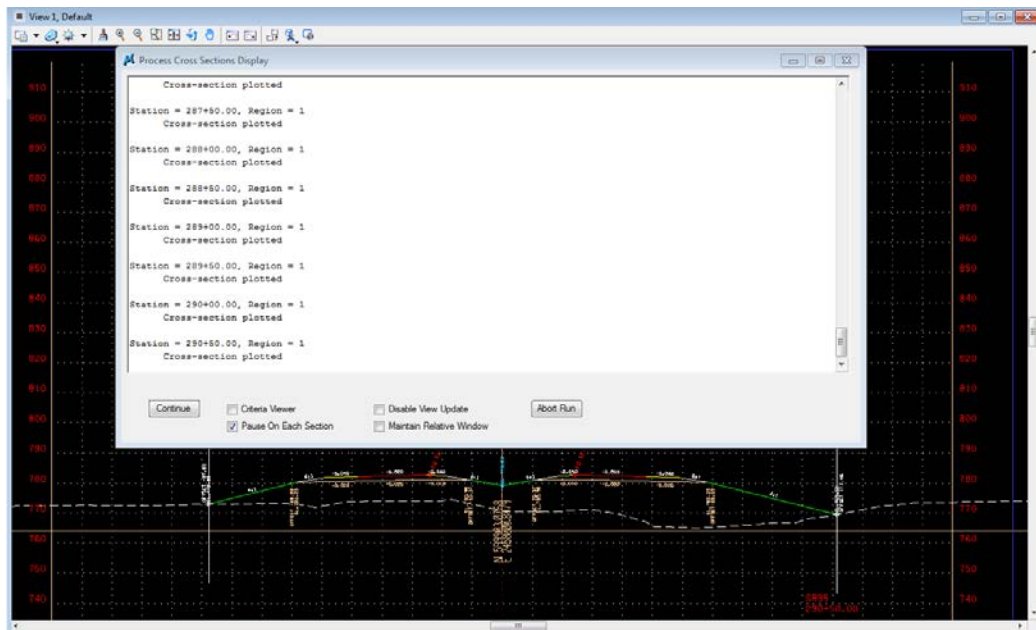
Criteria Viewer is used to step through the criteria file syntax to track problems during development and is usually not needed by designers.

You can use the Disable View Update anytime you are processing cross sections for a long or complicated roadway to speed up processing time.

NOTE:

When errors occur, change the “To Screen” option to “To Log File”, and then press Apply to generate the log file. Use the GEOPAK Editor (or any text file editor) to open the log file to determine the problem. Critical error messages are usually listed at the end of the file. The problem which caused the error is usually in the lines above the error message.

- 3) Press Apply.
- 4) All DGN files are searched for defined control graphics and the first section is plotted. Review the proposed cross section for Station 287+00. Turn off the Pause On Each Section toggle and press the Continue button to complete the proposed cross section generation process.



- 5) When processing is complete, press EXIT to return to the Process Cross Sections dialog.

- 6) Close the Proposed Cross Sections dialog box by using the “X” on the upper right of the dialog or by using the Files → Exit drop down option.

When prompted to save the run, click Yes.

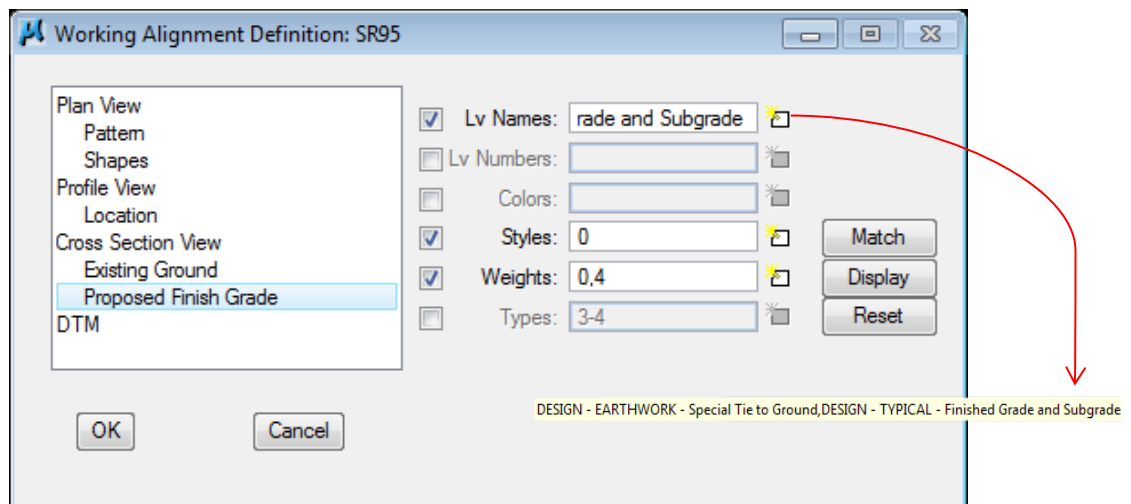
- 7) Take a moment to review your proposed cross sections with the Cross Section Navigator.

VI.) Working Alignment – Define Proposed Finish Grade

Now that we have the information for our proposed cross sections, we need to update our Working Alignment Definition in Project Manager.

- 1) From the Workflow dialog of Project Manager, press the Define button.
- 2) Highlight the Proposed Finish Grade option and populate the dialog as depicted below. Click on Lv Names, Styles & Weights and then click on the Match button and identify any proposed cross section line work.

Projects that include side roads will need to include the level and weight for special ties to the ground. These are used during earthwork calculations. Click the Select buttons on the right and add level DESIGN - EARTHWORK - Special Tie to Ground and weight 0.



- 3) Click on the Display button, all cross section graphics should be highlighted. This is a way to see what elements meet the symbology criteria that you have set. Click on the UnDisplay button to un-highlight.
- 4) Press OK to save your changes and exit the dialog.

10. Proposed Roadway Tracking

This exercise demonstrates tools for tracking along roadways in the plan, profile and cross section views. The first tool we will look at is Port Viewer which allows tracking along all of these at one time. The Active Chain Control tool is shown which can be used for “on the fly” tracking to quickly check stations, offsets, elevations, etc. Tracking on cross sections using the Cross Section Navigator tool is illustrated. Finally 2 of our TDOT Roadway Design Division tools are shown as alternatives that can be used for tracking in plan and profile.

NOTE:

For tracking on existing or proposed digital terrain model TIN files use the Height tool as illustrated in chapter 3.

I.) Port Viewer

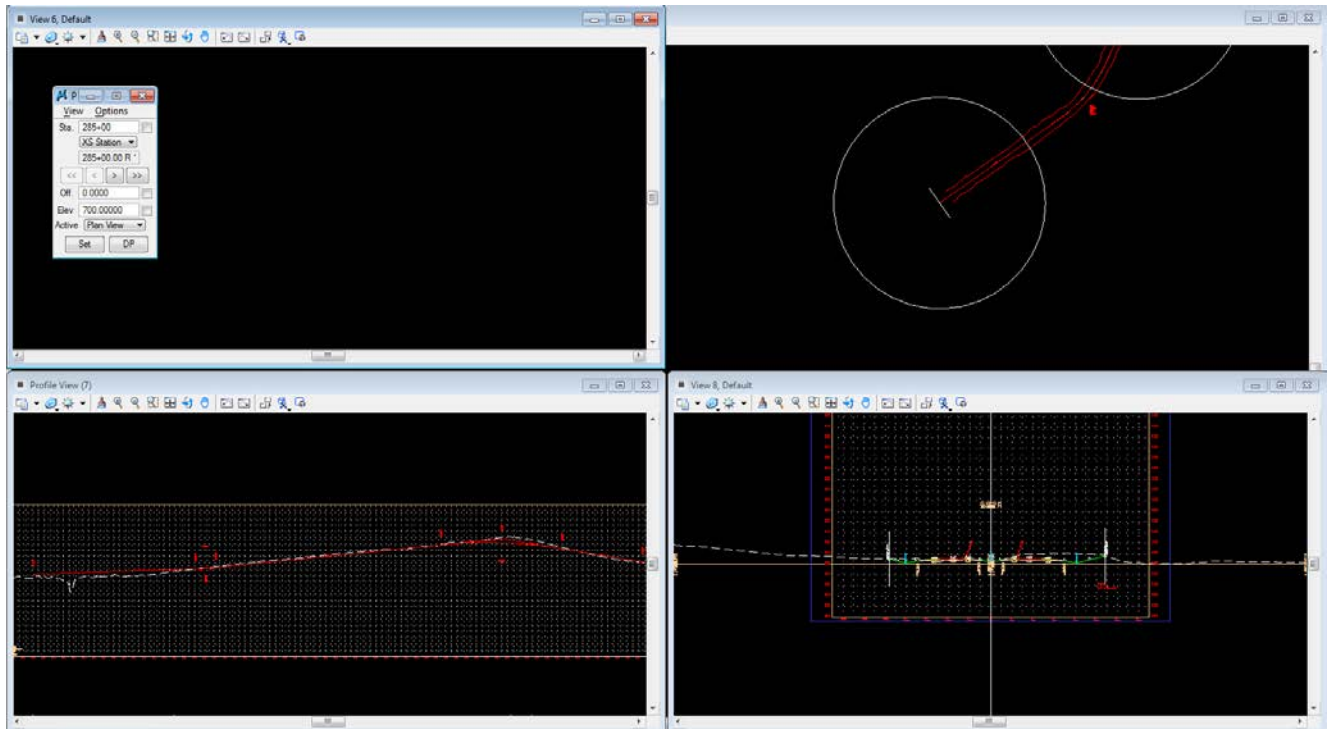
- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

Access Project Manager

- 2) Click on the Port Viewer button at the upper right of the dialog.
- 3) The Port Viewer dialog is displayed as shown below. Views are dynamically turned on to display plan, profile and cross sections from the definitions established in the working alignment.

Depending on how view 1 is set, you may need to go to the drop down option Window → Tile.



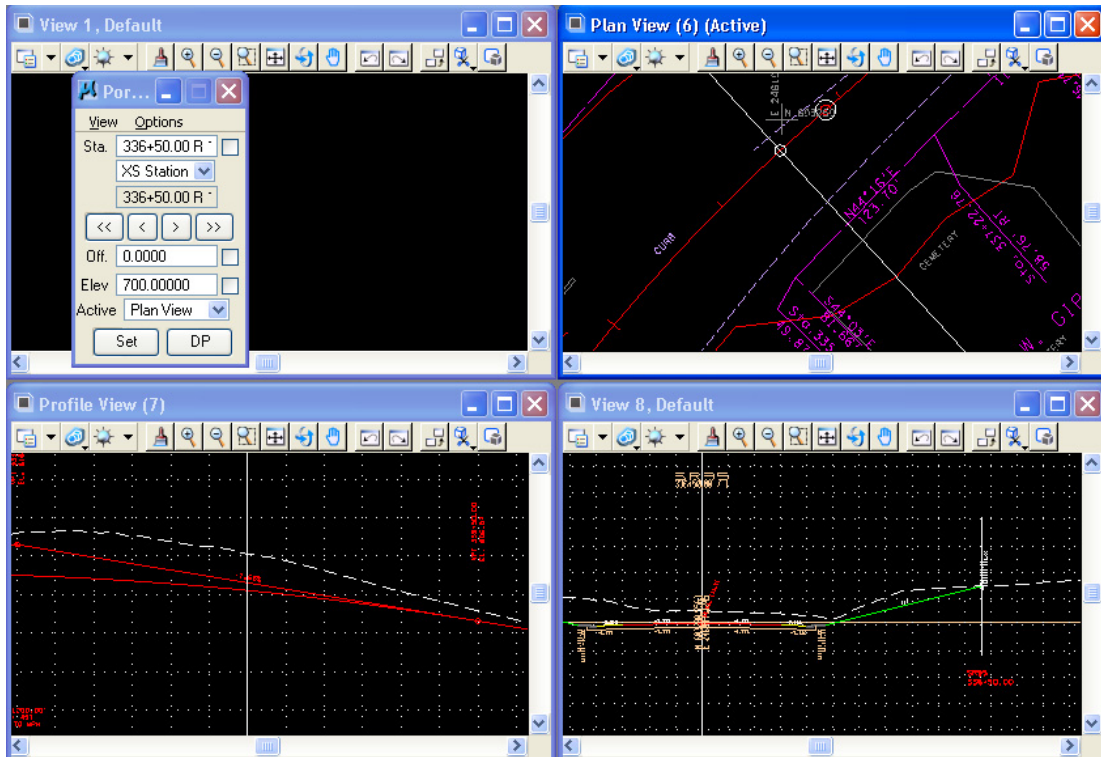
NOTE:

Port Viewer attaches all associated DGN graphics files as references to each other to perform its functions.

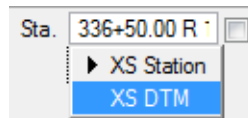
- 4) Use the VCR buttons in the Port Viewer dialog to scroll through the design, profile and cross sections. Views may need to be adjusted by zooming etc. for best view.
- 5) Go to MicroStation's menu bar option File → References and turn on the Survey topo (RO095-01Survey.dgn) reference file display.

Keyin station 336+50 and all views jump to that location. Notice that on the right design produced slopes encroach on a cemetery. In an up-coming exercise, we will update our profile to fix this problem.

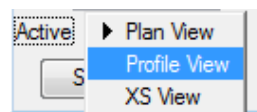
Exercise 10



- 6) Change the Cross Section Option to XS DTM.



- 7) Press the Set button then move your cursor in the Plan View. As you move the cursor around you will be able to preview the dtm/ground information in the XS View.
- 8) Set the Active view to Profile View and click the Set button again. Now, you can pan the cursor in the Profile view and see the dynamic tracking in the other views.



- 9) Close the Port Viewer dialog by clicking on the **X** in the upper right corner.
- 10) Go back into your
 C:\Projects\Roane\SR95PoplarCr\ROSR95Proposed.dgn change the slope lines to the default level. We will be rerunning proposed cross sections and do not want two sets of slope lines on the same level.

II.) Active Chain Control

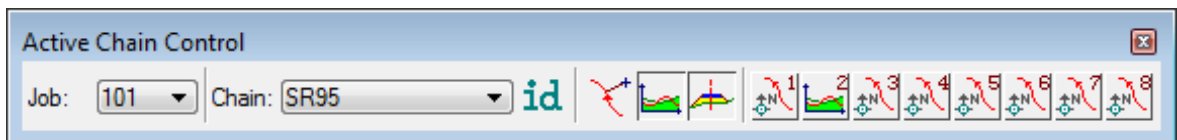
- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

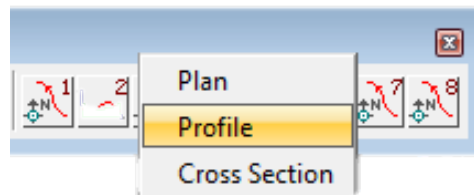
- 2) From the MicroStation menu bar click on the drop down option Applications → GEOPAK → ROAD → Active Chain Control or from the main tasks when using Civil Workflows click on the Active Chain Control icon.



The Active Chain Control bar is opened.

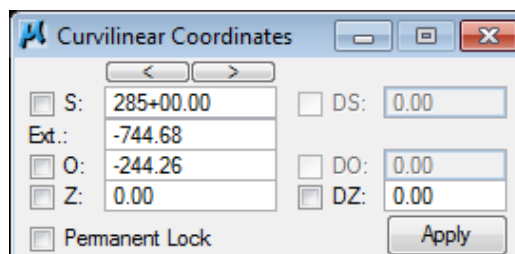


- 3) Set the Chain to SR95 from the chain list.
- 4) The icons on the right numbered 1 through 8 represent the 8 MicroStation views and what type of tracking they are set for. By default they are set to Plan (chain) tracking. If you right click on them you get the option to change setting to Plan, Profile or Cross section tracking.



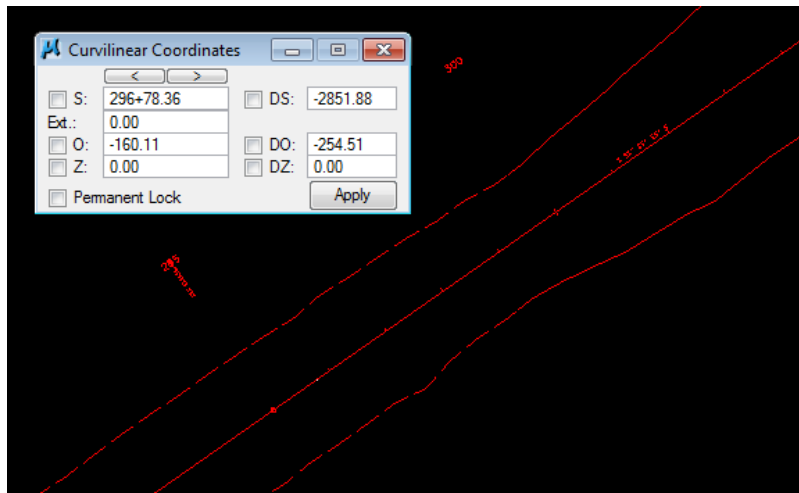
Right click on the icon for View 2 and set it to Profile.

- 5) Click on the Curvilinear Coordinates icon to open the tracking dialog.



Exercise 10

- 6) Move your cursor around in view 1. Notice that you are tracking station and offset along the alignment. You can click the lock toggle to the left of either value and only track the other,



- 7) Turn on view 2. The profile should be showing there already. When we set it to profile tracking, it automatically looked for the GEOPAK profile cell for chain SR95 and used it to set the view.
- 8) Move your cursor around in view 2. Notice that you are tracking station and elevation in this view.



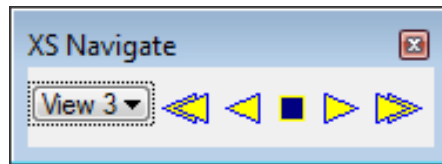
You can actually move from view 1 to 2 and see the tracking change from Plan to Profile.

- 9) Open the MicroStation file

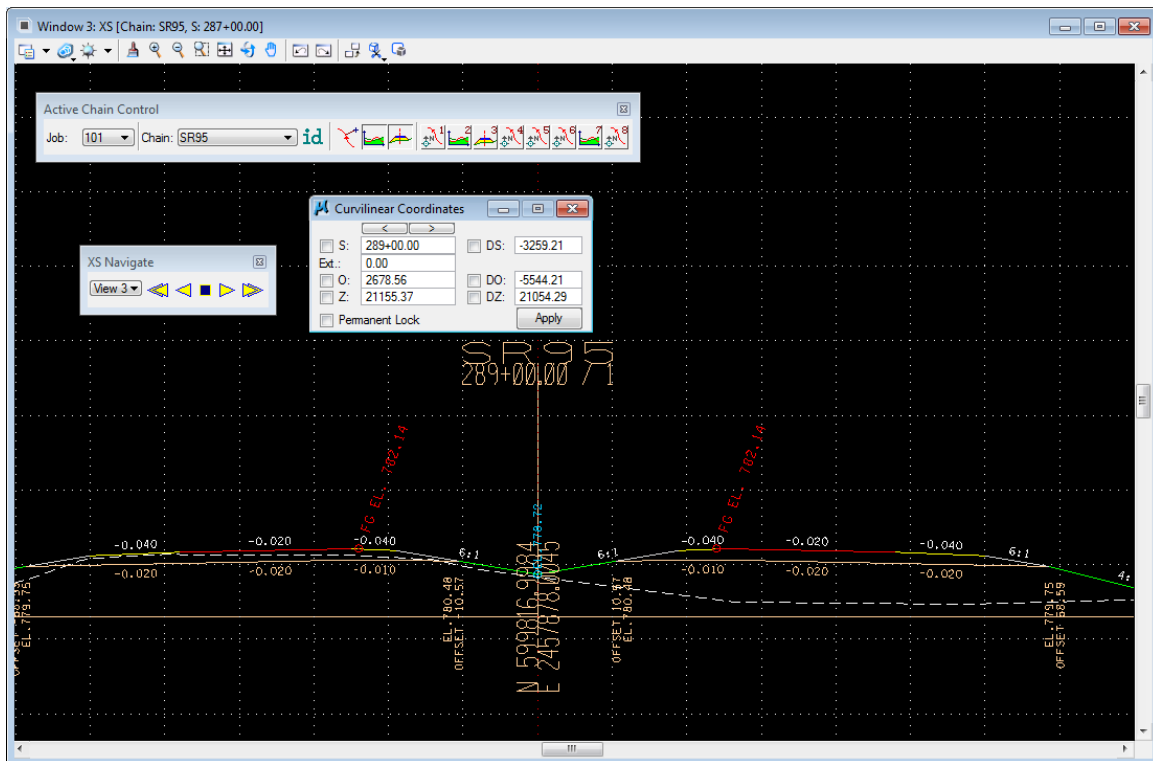
C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

- 10) Right click on the icon for View 3 and set it to Cross Section. Open view 3 in MicroStation.

- 11) Right click on the icon for View 3 again and select the new option now available, Cross Section Navigate.



- 12) Move the XS Navigate tool into view 3, use it to navigate to a given station and then move your cursor around in the view. The offset and elevations are tracked in the Curvilinear Coordinates dialog.

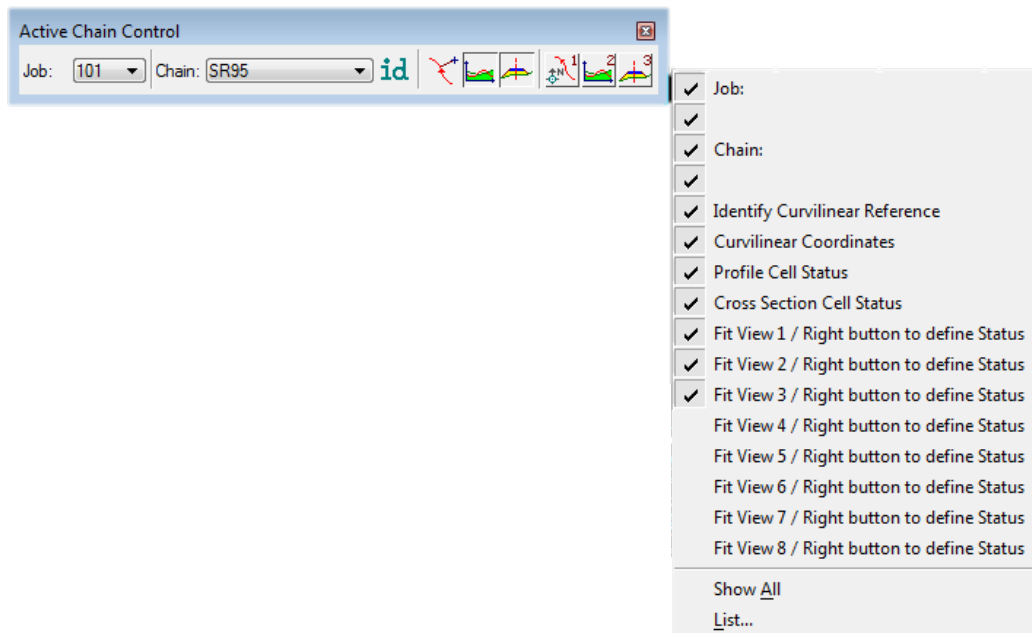


NOTE:

This part of the Active Chain Control tool can be a little cumbersome to use. You can actually use a function on the regular Cross Section Navigator tool to get the same results which is illustrated in the next section of this exercise.

Exercise 10

- 13) If you right click on the Active Chain Control tool away from the icons, you can control what icons are shown on the bar. Right click and turn off the icons for views 4-8.



- 14) Close Active Chain Control by clicking the **X** on the upper right of the bar.

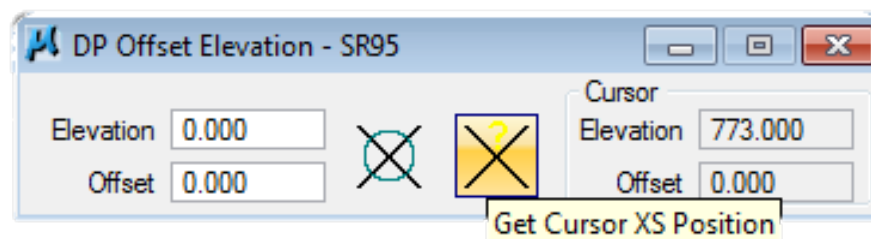
III.) Tracking with Cross Section Navigator

- 1) Select the Cross Section Navigator tool from the Road Tools task group. Navigate to one our proposed cross sections.

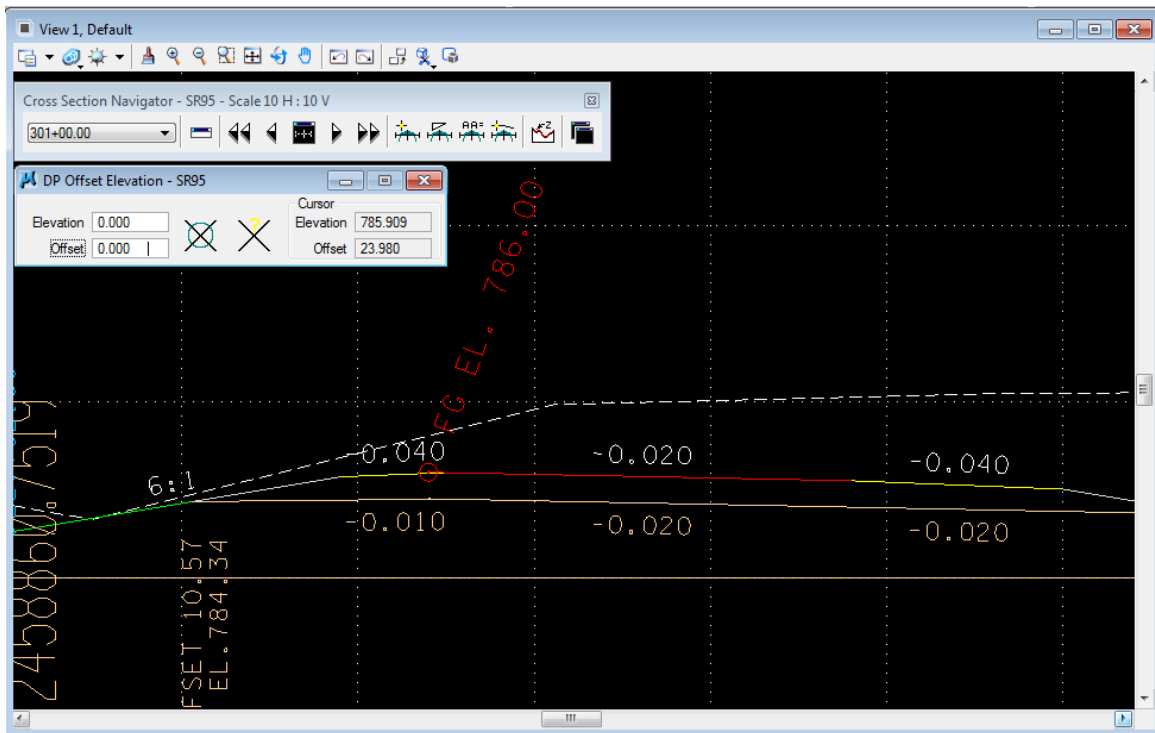
On the Navigator tool bar to the right of the navigate arrows are several drawing tools. Click on the DP Offset Elevation icon.



- 2) This tool is set up to send a data point for you based on elevation and offset values. You can enter those but you can also pick the cursor option. Click on the Get Cursor XS Position icon.



- 3) Move your cursor around in the view. The Elevation and Offset readings are displayed in the tool.



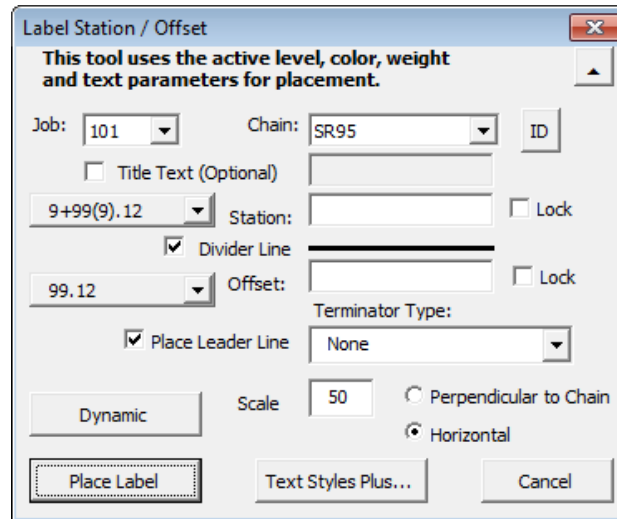
IV.) Tracking with the Label Station/Offset Tool

Although the T.D.O.T. Roadway Design Division Label Station/Offset tool is set up primarily to label stations and offsets in the plans, it can be used as just a tracking tool for these values as shown below.

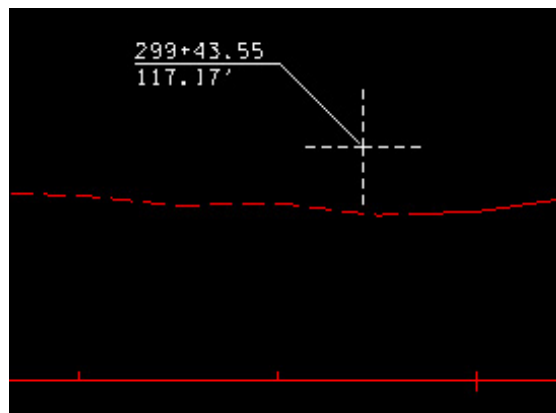
- 1) In D&C manager activate Drafting Standards → Tools → Labeling → StaOffsetLabel or with the T.D.O.T. Roadway Design Division interface choose drop down option TDOT → Tools → Place Station Offset Label. The Label Station/Offset dialog appears.

All Geopak jobs found within the current active folder are listed in the Job drop down box with its chains listed in the Chain drop down box. If this tool has been used previously, the job number and chain name are remembered and will be used to populate those fields. Set those values as needed.

Exercise 10



- 2) Click the Dynamic button to initiate the dynamic mode. Move the cursor off the dialog and a temporary label will follow the cursor with the station and offset values changing dynamically on the screen and within the dialog's text boxes as the cursor moves along the specified chain.

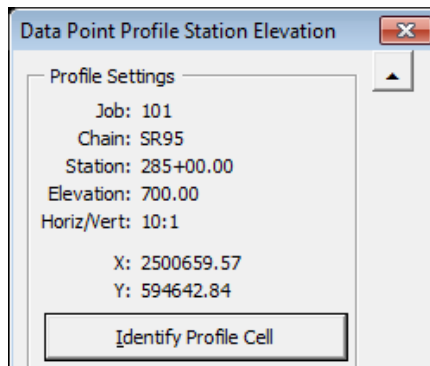


V.) Tracking with the DP Profile Station Elevation Tool

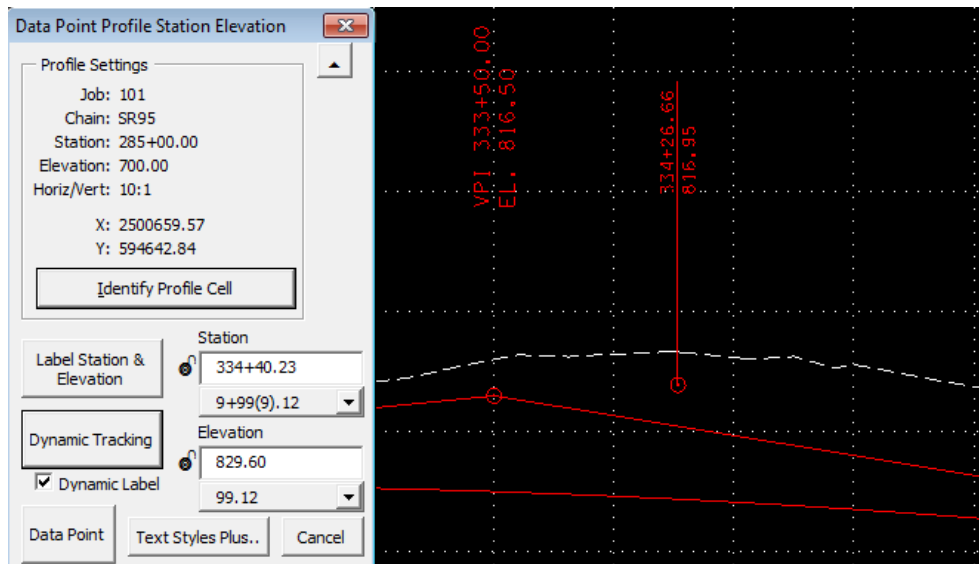
The T.D.O.T. Roadway Design Division DP Profile Station Elevation tool is set up to send data points to the profile based on station & elevation or just to label stations and elevation there. It also includes a dynamic function so it can be used as just a tracking tool for these values as shown below.

- 1) In D&C manager activate Drafting Standards → Tools → Labeling → DP Sta Elev or with the T.D.O.T. Roadway Design Division interface choose drop down option TDOT → Profiles → DP Profile Sta Elev w/Tracking. The Data Point Profile Station Elevation dialog appears.

Before use, the GEOPAK profile cell must be identified. Click the Identify Profile Cell button and select any part of the desired profile cell.



- 2) Click the Dynamic Tracking button to initiate the dynamic mode. Move the cursor off the dialog and a temporary label will follow the cursor with the station and elevation values changing dynamically on the screen and within the dialog's text boxes as the cursor moves along the profile.



11. Proposed Profile Re-Design

After the review of our design using Port Viewer in the last exercise, we know we have a problem with our slopes encroaching on a cemetery near station 336+50. To solve that problem in this exercise, we will adjust our proposed vertical alignment profile.

NOTE:

If you run into similar situations on your project, any number of changes may be necessary to solve the problem, adjustment of horizontal or vertical design, side slopes or even typical section widths in some cases.

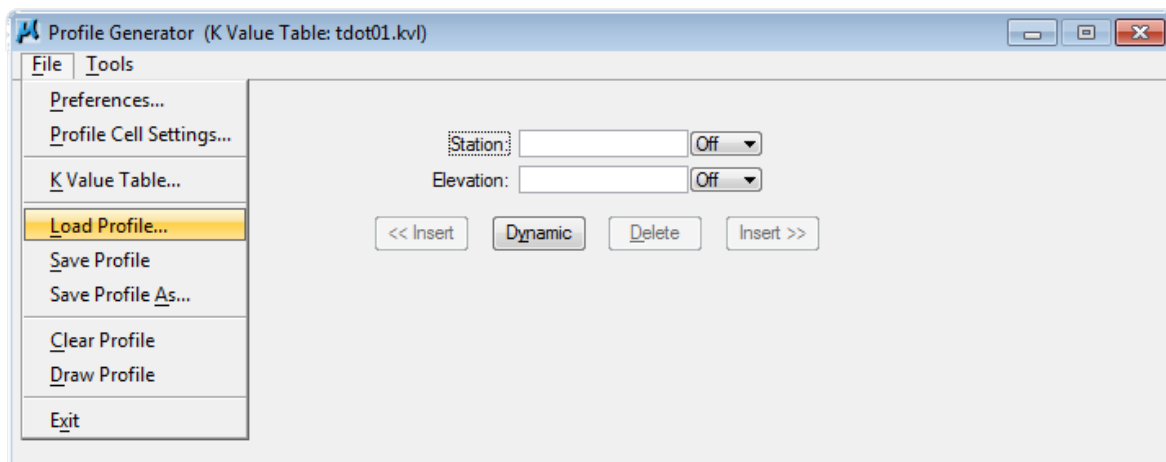
I.) Profile Adjustment

- 1) Open the MicroStation file

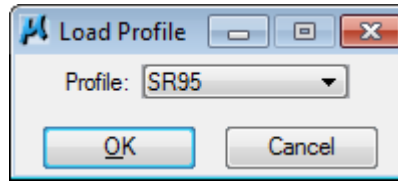
C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

Access Project Manager.

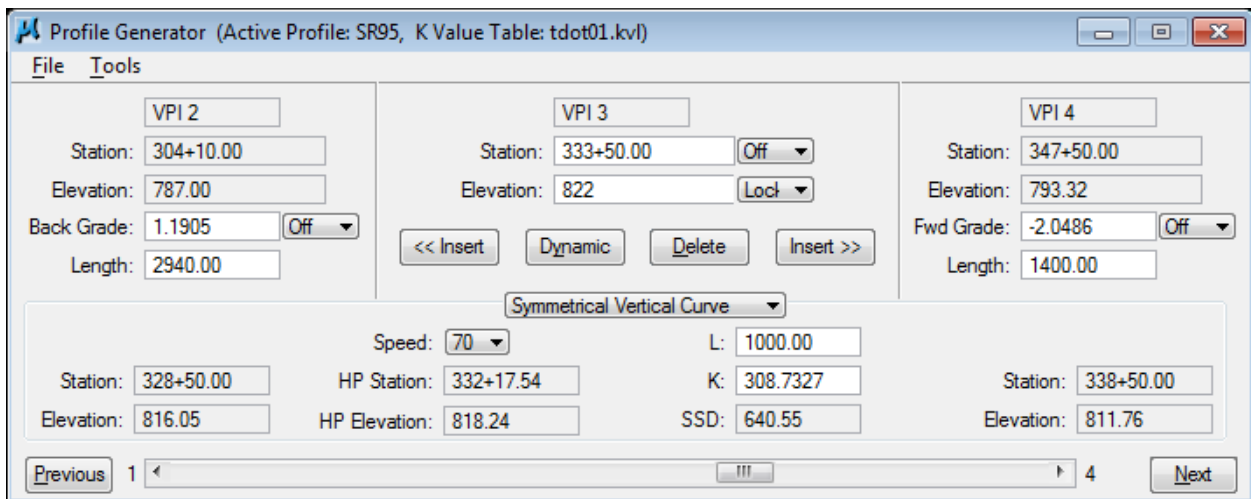
- 2) Select the Vertical Alignment button from the Project Manager workflow dialog.
- 3) All of the information in the invoked Settings dialog should be automatically populated based upon the information we defined in the working alignment. Click the OK button to accept those settings.
- 4) From the Profile Generator dialog, select File → Load Profile.



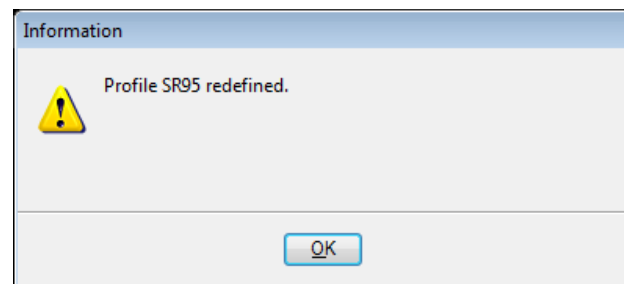
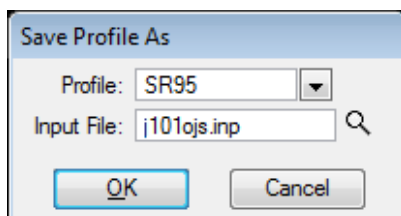
Load the proposed profile SR95.



- 5) Traverse to the VPI Station 333+50. (Utilize the Next button)
- 6) Modify the current elevation from 816.50 to 822.00. Change the vertical curve length to 1000.



- 7) Go to File → Save Profile and save this updated profile as SR95. You should get a message box stating that SR95 has been redefined.

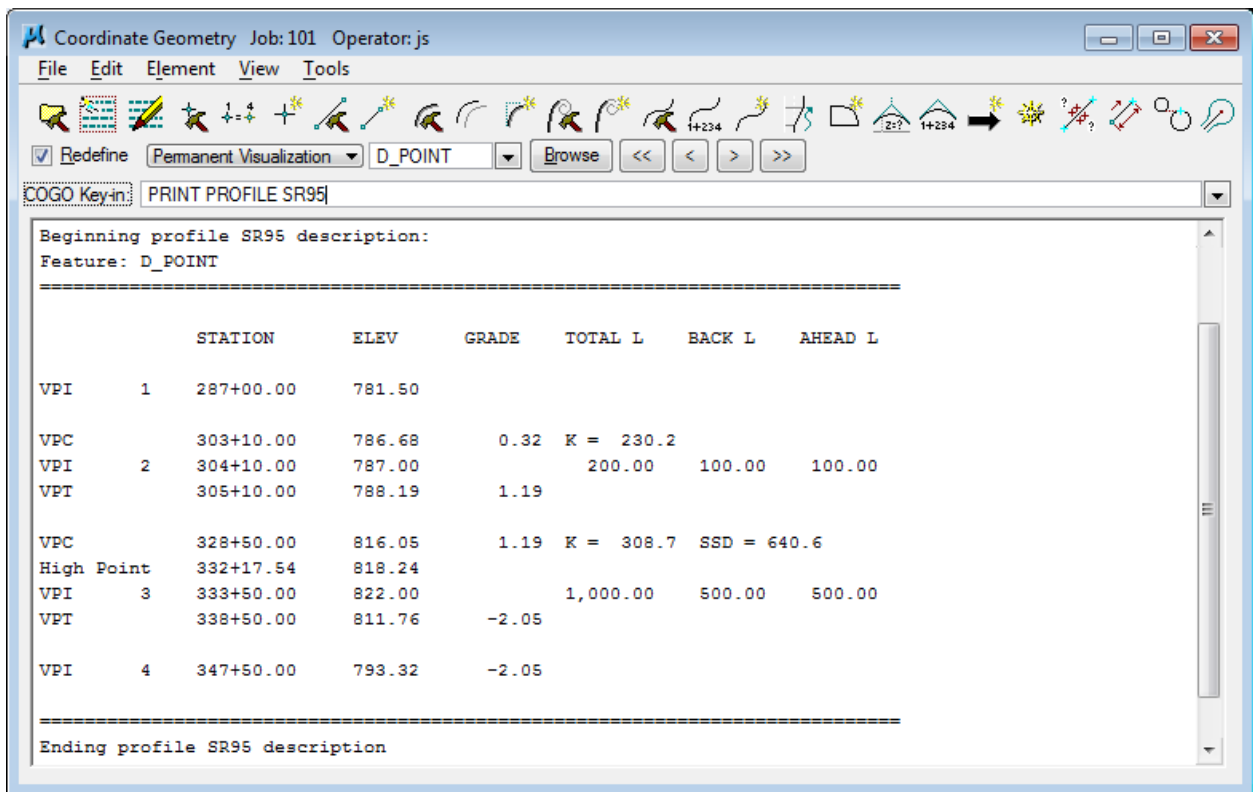


NOTE:

The Redefine option in COGO must be turned on to make changes to a profile since it is stored in the GPK file. If you receive an error saying that Redefine is off, simply open COGO, turn it on and go back to Profile Generator to save your update. **It is recommended that you normally keep Redefine turned off to avoid accidental over writing of valid data.**

Exercise 11

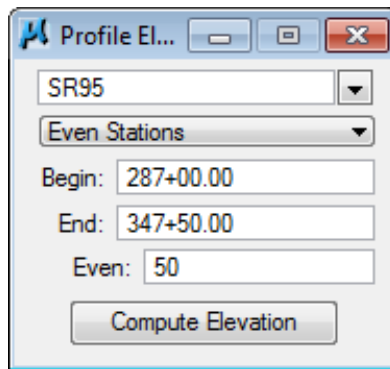
- 8) Close the Profile Generator dialog. When prompted to save your profile, you can answer No since we did it in Step 7. When prompted to save your Vertical Alignment Settings, answer Yes.
- 9) Now that we have a finalized proposed vertical alignment profile, open COGO to review it.
- 10) Go to COGO Navigator → Profiles. Highlight SR95 and click on the describe icon. Profile data is displayed including curve lengths, K values and any high or low points.



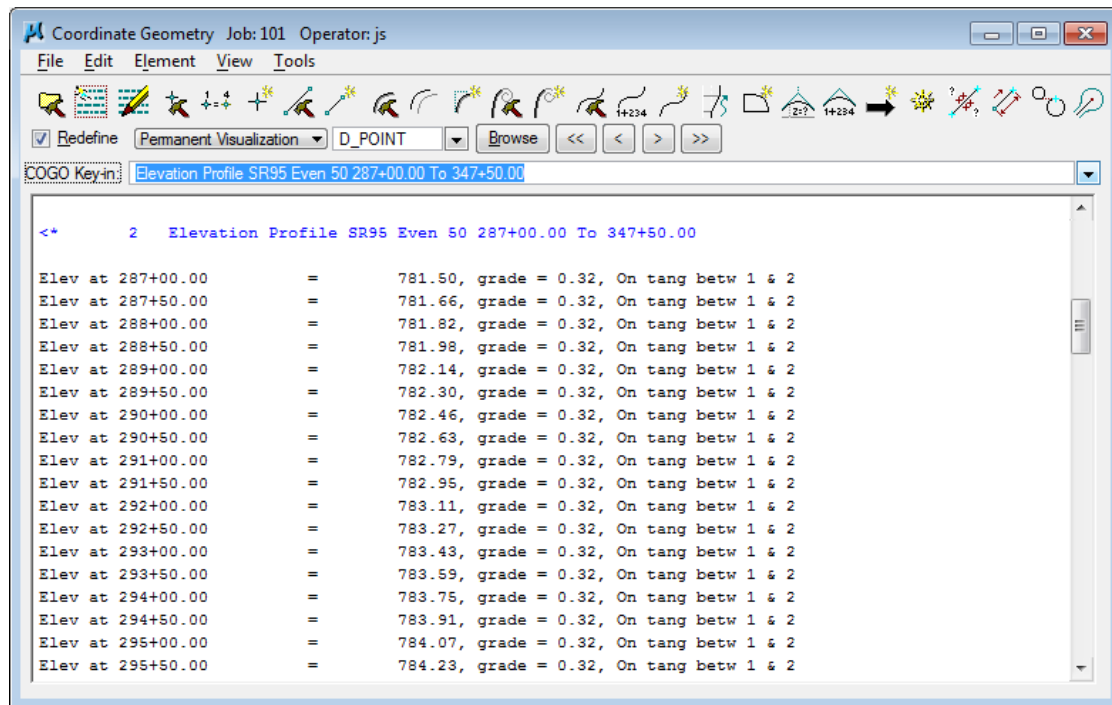
- 11) To find specific elevations along the proposed profile for side road connections, etc. or perhaps a listing of elevations at 50' intervals click on the Profile Elevation icon.



- 12) The following dialog is opened. Set profile SR95, Even Stations and 50 for the Even interval. Begin and end stations default to the profile limits but can be adjusted to limit the area to report on. Click on Compute Elevation.



The elevations are computed and displayed in the COGO output area.



- 13) Close COGO.

II.) Re-drawing the Proposed Profile

On longer profiles in normal workflows, you would delete the area which was changed and in the Profile display controls specify the station limits of revised profile for re-display. In this exercise, we will just delete the entire profile and re-display.

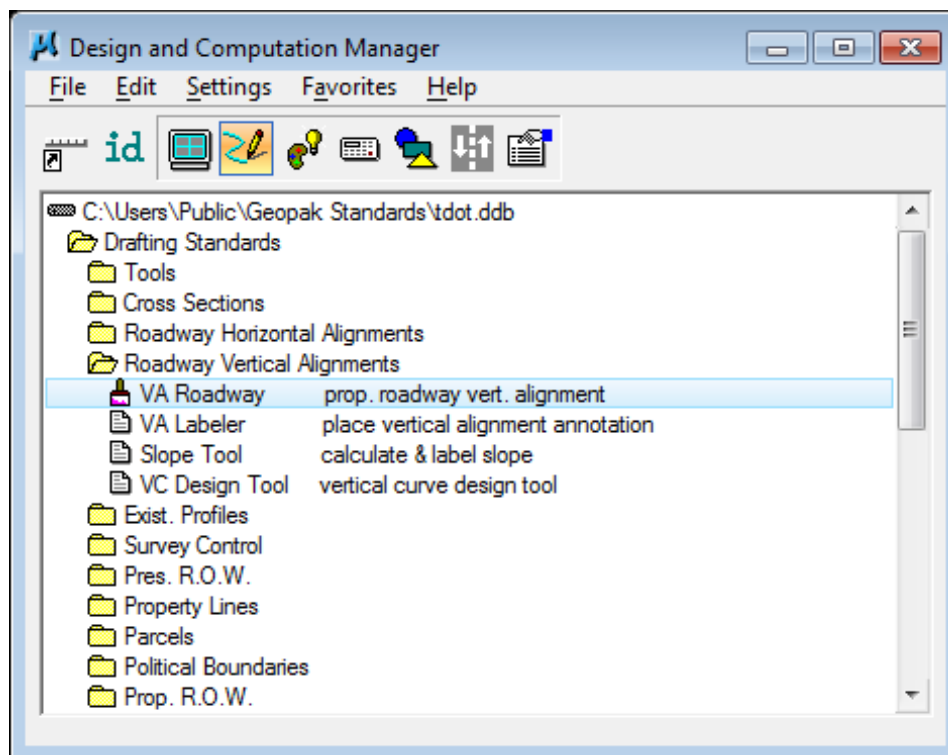
- 1) Delete the proposed profile graphics for SR95 which we displayed previously.

The proposed profile line work and text are in 2 separate graphic groups. Turn on the graphic group lock to easily clean off the graphics. They are plotted on the following levels.

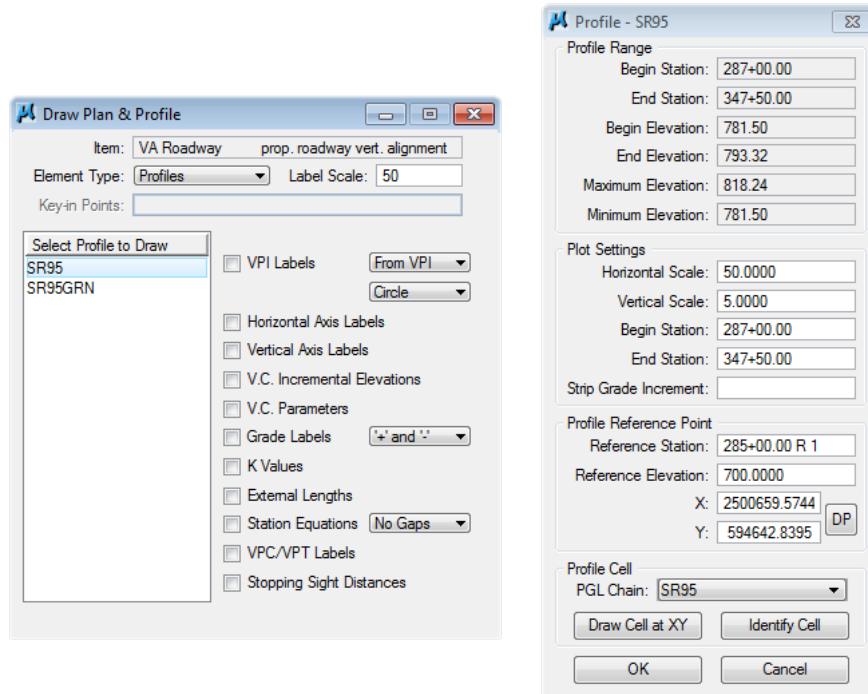
DESIGN - PROFILE - Proposed
 DESIGN - PROFILE - Proposed Curve Text
 DESIGN - PROFILE - Proposed Text

DO NOT delete the existing ground, profile grid or the horizontal and vertical axis labels.

- 2) Access the D&C Manager.
- 3) Select the item
 Drafting Standards → Roadway Vertical Alignments → VA Roadway.



- 4) Press the Draw Plan & Profile button.
- 5) Click on SR95 to plot the proposed profile line work using the parameters as shown in the following dialogs. All items should be set automatically.



Click OK to place the graphics.

- 6) Exit the Draw Plan and Profile dialog.
- 7) We also need to run VA Labeler again to place annotation. Double-click on the Item Drafting Standards → Roadway Vertical Alignments → VA Labeler

Click on the Identify Profile Cell command button and data point on the Geopak profile cell for the profile.

Set the Profile option to SR95.

Click on the Place Labels command button to place the vertical alignment annotation.

- 8) Review the new proposed vertical alignment graphics.
- 9) Close the VA Labeler dialog and exit D&C Manager.

12. D&C Manager – Element Symbology

We have used D&C Manager to display chains and profiles as well as to access special programs. In this exercise, we will demonstrate its use to control symbology when drawing in MicroStation. At the same time we will demonstrate the use of another GEOPAK tool, Draw Transition.

We will be drawing the edge of roadway pavements (traveled way) as well as other line work for the S.R. 95 roadway. These lines are needed for our plans but they will also control certain widths on our proposed cross sections when we re-run them.

I.) Edge of Roadway Pavement

- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95Proposed.dgn

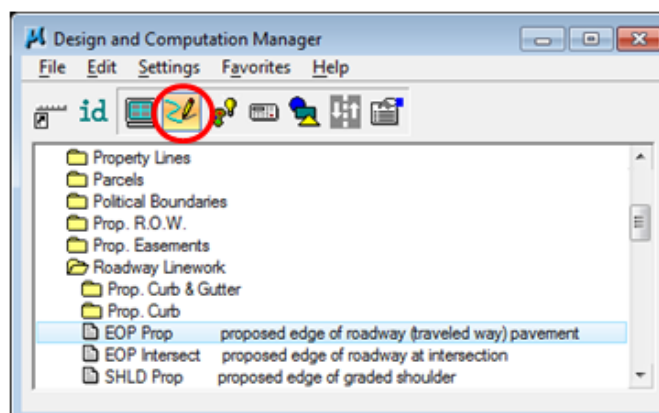
Access Project Manager.

- 2) Open MicroStation's Reference File dialog and turn off all references except for the alignments DGN file (logical name: alignment). You should only see slope lines and the centerline. Go ahead and delete the slope lines (they are a graphic group). Once we fine tune our roadway a little more, we will re-run our cross sections and generate new slope lines.

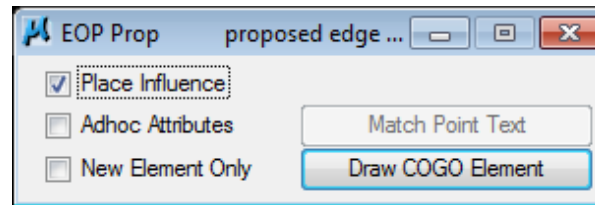
- 3) From the Project Manager dialog, select Plan View Design to open the Plan View Design tool box and access D&C Manager.

Select the item Drafting Standards → Roadway Linework → EOP Prop.

- 4) Check the selected icon at the top of the dialog. Ensure that you are in the Design mode of Design and Computation Manager.



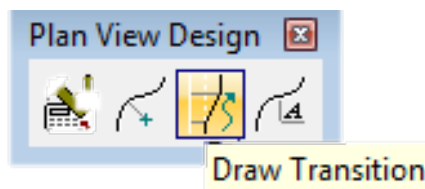
- 5) Activate the toggle for Place Influence. You can find it on the secondary dialog.



NOTE:

Place Influence forces all graphic elements which are created to match the selected item's symbology and can be used with MicroStation's Change Element tools to change existing elements. When running D&C Manager in expanded mode, the New Element Only option will restrict that functionality to affect only elements that are created.

- 6) In the main Project Manager dialog select Plan View Design. From the Plan View Design tool box, select the Draw Transition tool.

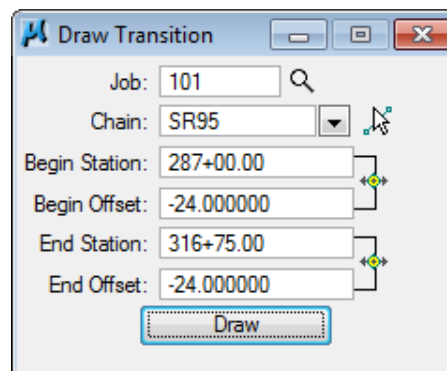


This will access the Draw Transition dialog.

a) Station 287+00 to Station 316+75

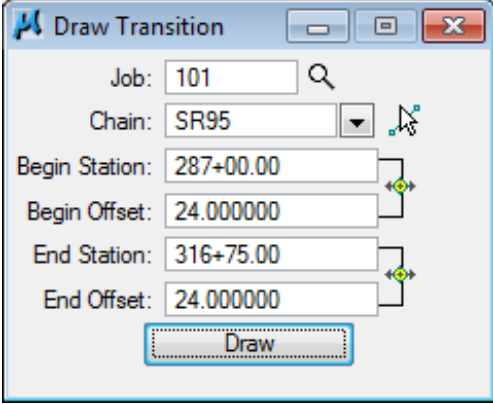
- 7) Set the chain name to SR95.

To draw the left inside edge of pavement at an offset of -24 from Station 287+00 to 316+75, fill out the dialog as shown and press Draw.



Exercise 12

- 8) To draw the right inside edge of pavement from Station 287+00 to Station 316+75, fill out the dialog as shown. Notice that the only difference is the offset, simply remove the negative signs and press Draw.

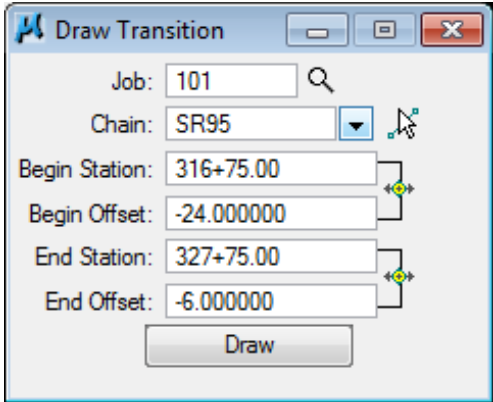


Job: 101
Chain: SR95
Begin Station: 287+00.00
Begin Offset: 24.000000
End Station: 316+75.00
End Offset: 24.000000
Draw

- 9) To draw the **outside** edge of pavements from Station 287+00 to Station 316+75, repeat Steps 7-8 with 48' offsets. Remember to use negative signs with numbers for offsets to the left.

b) Station 316+75 to Station 327+75

- 10) To draw the left inside edge of pavement from Station 316+75 to Station 327+75, fill out the dialog as shown and press Draw.

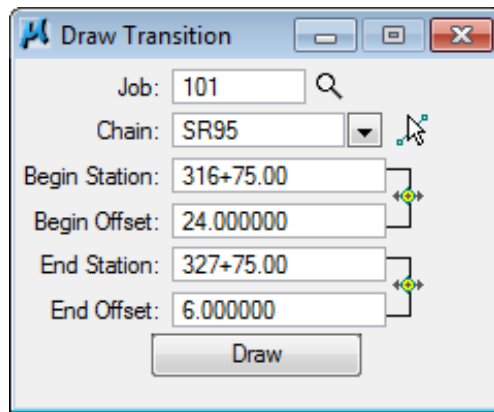


Job: 101
Chain: SR95
Begin Station: 316+75.00
Begin Offset: -24.000000
End Station: 327+75.00
End Offset: -6.000000
Draw

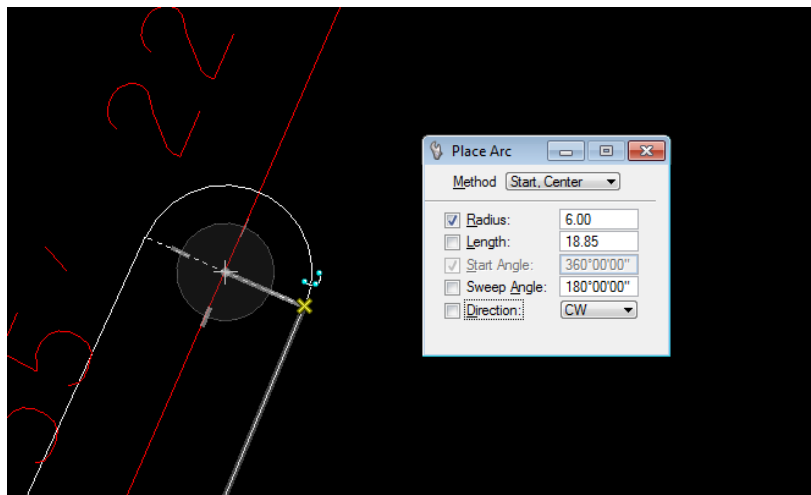
NOTE:

The area from Station 316+75 to Station 328+25 is where we are transitioning from the 4 lane depressed median typical to the 5 lane urban typical and is reflected by the offsets which vary. The pavement transition actually ends at 327+75 allowing an additional distance to transition the finished grade location from the inside edge of pavement to the crown of the roadway. We will discuss this further when we set up superelevation for the roadway.

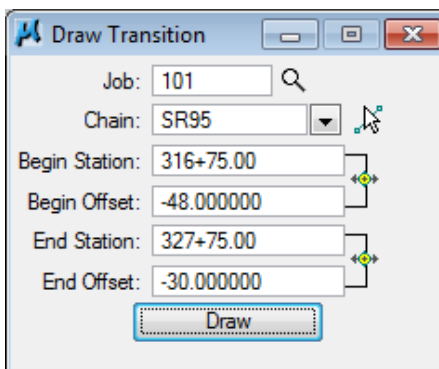
- 11) To draw the right inside edge of pavement from Station 316+75 to Station 327+75, fill out the dialog as shown and press Draw.



- 12) Use MicroStation's Place Arc command to add an ending "nose" to the ends of the inside edge of pavements at station 327+75 (Radius = 6').



- 13) To draw the left outside edge of pavements from Station 316+75 to Station 327+75, fill out the dialog as shown and press Draw.



Exercise 12

- 14) To draw the **right outside** edge of pavements from Station 316+75 to Station 327+75, fill out the dialog as shown and press Draw.

The screenshot shows the 'Draw Transition' dialog box with the following fields:

- Job: 101
- Chain: SR95
- Begin Station: 316+75.00
- Begin Offset: 48.000000
- End Station: 327+75.00
- End Offset: 30.000000

A 'Draw' button is located at the bottom of the dialog.

c) Station 327+75 to Station 347+50

- 15) To draw the left edge of pavement from Station 327+75 to Station 347+50, fill out the dialog as shown and press Draw.

The screenshot shows the 'Draw Transition' dialog box with the following fields:

- Job: 101
- Chain: SR95
- Begin Station: 327+75.00
- Begin Offset: -30.000000
- End Station: 347+50.00
- End Offset: -30.000000

A 'Draw' button is located at the bottom of the dialog.

- 16) To draw the right edge of pavement from Station 327+75 to Station 347+50, fill out the dialog as shown and press Draw.

The screenshot shows the 'Draw Transition' dialog box with the following fields:

- Job: 101
- Chain: SR95
- Begin Station: 327+75.00
- Begin Offset: 30.000000
- End Station: 347+50.00
- End Offset: 30.000000

A 'Draw' button is located at the bottom of the dialog.

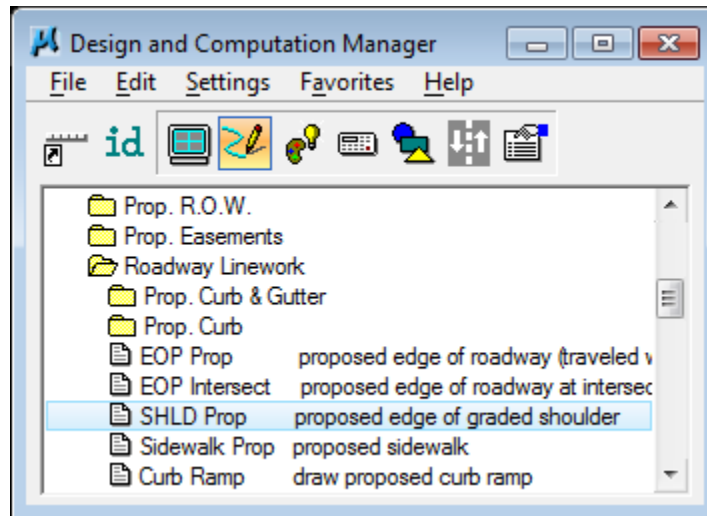
II.) Shoulders and Curbs

a) Station 328+25 to Station 347+50

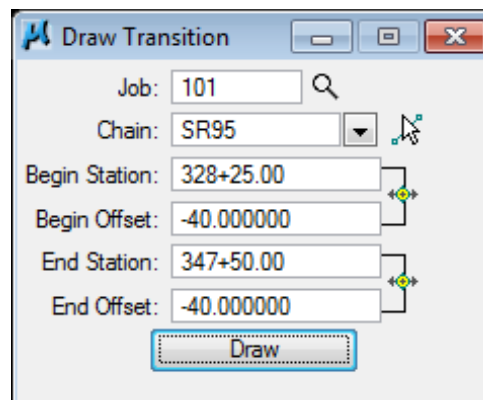
We need to add shoulder lines and linework for 6-30 curb & gutter in the urban section of the job and we can do so continuing with D&C Manager and the Draw Transition tool.

For this exercise, we will ignore side road breaks that would be needed on this project.

- 1) In D&C Manager, select the item Drafting Standards → Roadway Linework → SHLD Prop

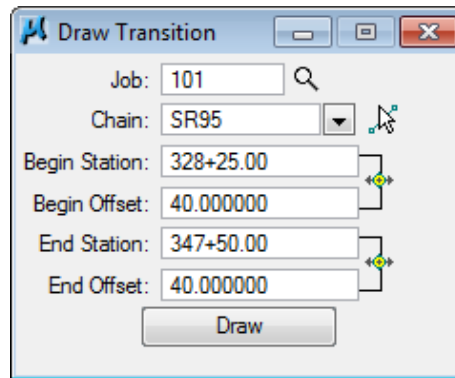


- 2) Our shoulders in the urban section are 10' wide so to draw the left shoulder from Station 328+25 to Station 347+50, fill out the Draw Transition dialog as shown and press Draw.

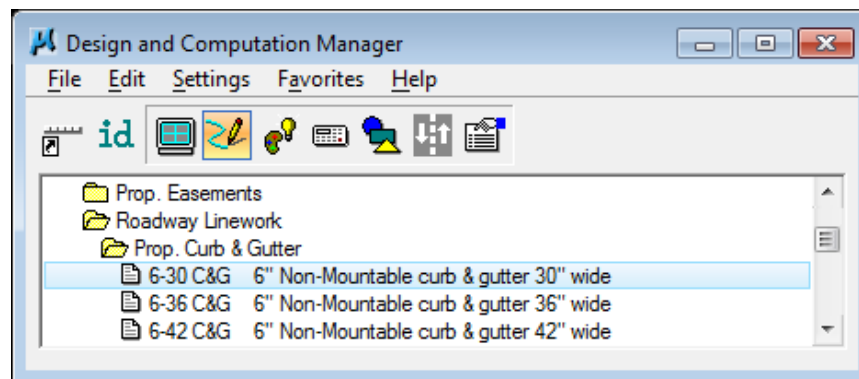


Exercise 12

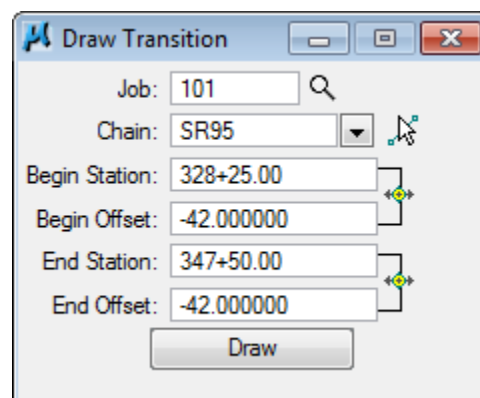
- 3) To draw the right shoulder from Station 328+25 to Station 347+50, fill out the dialog as shown. Notice that the only difference is the offset, simply remove the negative signs and press Draw.



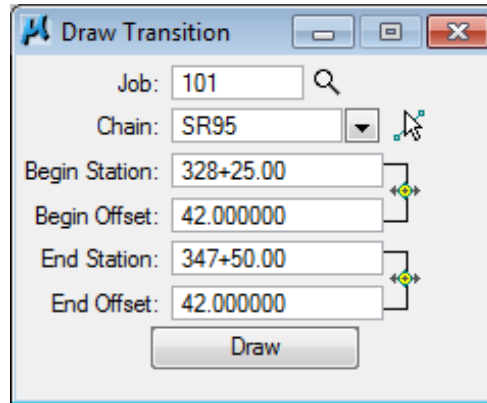
- 4) To draw the curb lines we will need to go back to D&C Manager. Select the item Drafting Standards → Roadway Linework → Prop. Curb & Gutter → 6-30 C&G. Notice this is in a subcategory of Roadway Linework so you have to set the sub-category first and then the item.



- 5) To draw the left curb line from Station 328+25 to Station 347+50, fill out the dialog as shown and press Draw.



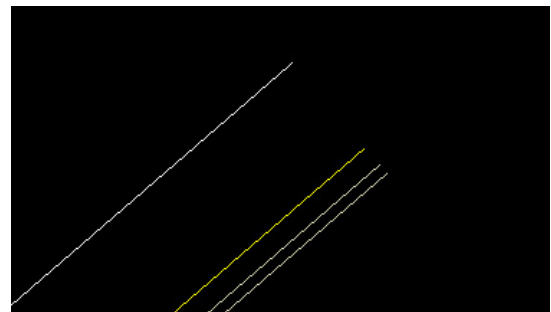
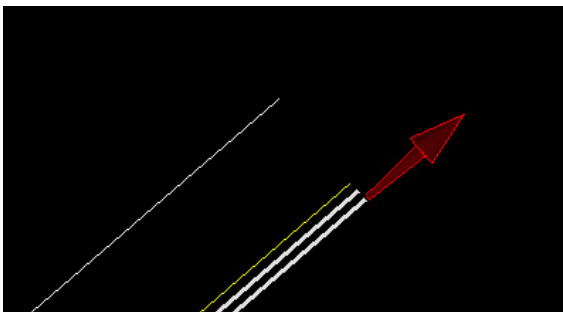
- 6) To draw the right curb line from Station 328+25 to Station 347+50, fill out the dialog as shown. Notice again that the only difference is the offset, simply remove the negative signs and press Draw.



- 7) Curb lines use custom line styles and are built with the lower line as the curb face. Since this is the case it will be necessary to reverse/flip the direction of the right curb line so that it appears correctly. That is easily done with MicroStation's Change Direction command.

Go to the drop down menu option TDOT → Custom Line Styles → Reverse/Flip Pattern.

You are prompted select the element and to click the direction handle to change the direction. **Click on the red arrow** to reverse the line and once more to accept the new direction.



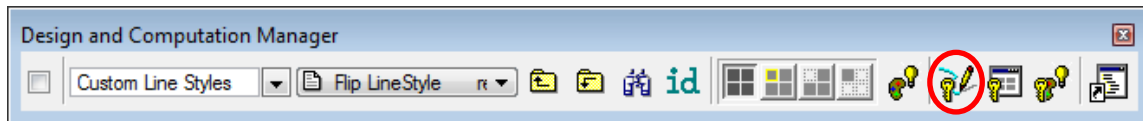
NOTE:

If you do not see the TDOT drop down options from the MicroStation menu bar the TDOT interface has not been activated. Go to File → Close and in MicroStation Manager set the interface option to TDOT. Re-open the DGN file and the TDOT options should now be available.

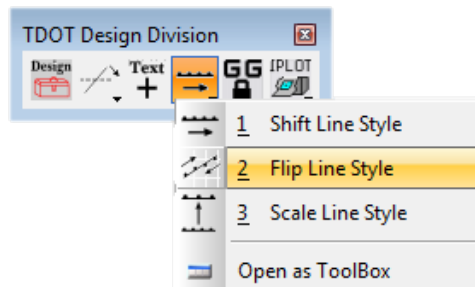
Exercise 12

- 8) Alternate methods of getting the Reverse/Flip Pattern custom line style tool are from D&C Manager or from the TDOT Roadway Design Division tool strip. Most options under the drop down menu are available through D&C Manager. The TDOT drop down menu and the TDOT Roadway Design Division tool strip are provided so that commonly used tools are more accessible.

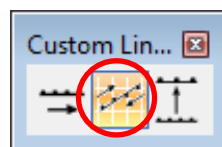
It is found in D&C Manager at Drafting Standards → Tools → Custom Line Styles → Flip LineStyle. To activate the Reverse/Flip Pattern tool with D&C Manager in tool box mode click on the Execute Design Keyin icon. In the expanded dialog mode double click on the item as illustrated in previous exercises.



The TDOT Roadway Design Division tool strip itself can be opened from the drop down menu at T.D.O.T. → Tools → Design Division Tool Strip or from D&C Manager at Drafting Standards → Tools → Design Tool Strip. To activate the Reverse/Flip Pattern tool click on the Custom Line Style Tools and choose the 2nd option as shown.



The Custom Line Style Tools can be opened as its own tool box if you are in the process of cleaning up several instances of custom line styles. Reverse/Flip Pattern is the center icon.

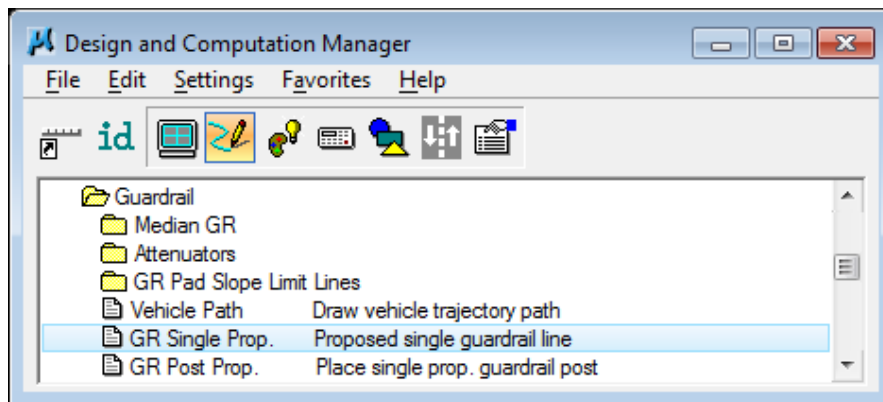


III.) Guardrail

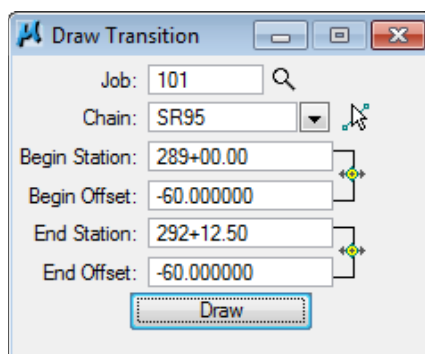
a) Station 289+00 to Station 292+50

It has been determined that we need guardrail on the left from Station 289+00 to Station 292+50. A Type 13 terminal is required at 289+00 and a Type 38 terminal is required at the 292+50 end so we need regular guardrail from 289+00 to 292+12.50.

- 1) Access the D&C Manager.
- 2) Select the item Drafting Standards → Guardrail → GR Single Prop.



- 3) To draw the guardrail from Station 289+00 to Station 292+12.50, fill out the Draw Transition dialog as shown and press Draw.



- 4) Click on the Place Influence option box to turn it off. The programs we use to place the guardrail terminals will be placing multiple graphic elements for us and will handle the symbology settings.

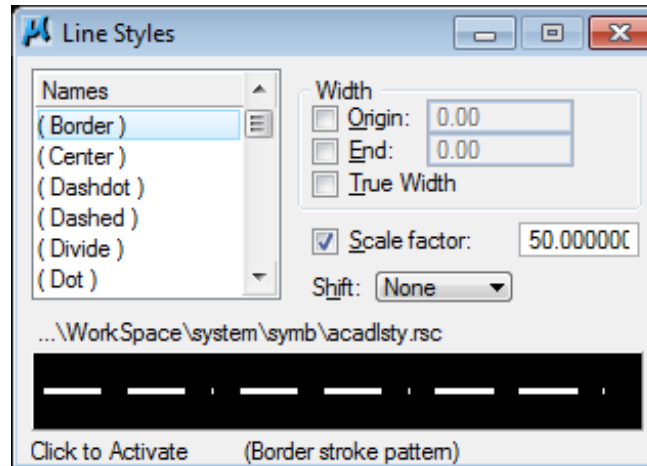
NOTE:

It is recommended that you always turn off Place Influence when you don't need it. This is a powerful function and you may accidentally change graphics without meaning to.

Exercise 12

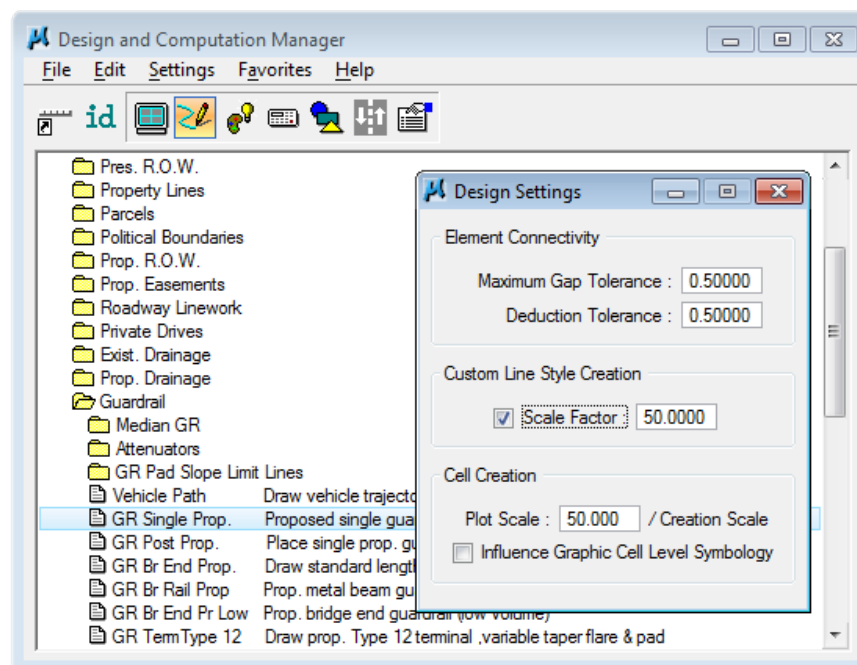
- 5) Special guardrail placement programs accessed through D&C Manager utilize MicroStation commands to place graphics, so the custom linestyle Scale Factor must be set in the MicroStation Line Styles dialog.

From the MicroStation drop down menu, go to Element → Line Styles → Custom and make sure the Scale Factor is set to 50.



NOTE:

When using D&C Manager's Place Influence to draw linework with custom linestyles, the scale is controlled by the setting for Scale Factor under Settings → Design from D&C Manager's drop down options. This can only be accessed with D&C Manager in expanded mode.

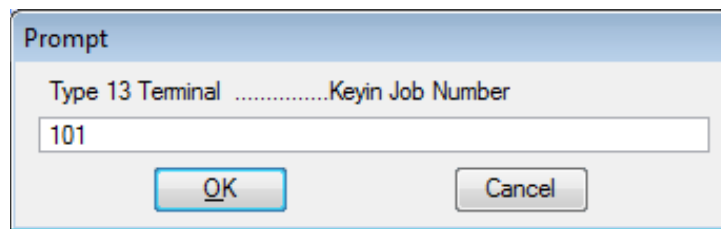


The default value for both of these locations in English files is 50. The only exception to this is for cross section DGN files where the MicroStation setting is 10.

- 6) Now we need to place our terminals. First zoom in on the area from 289+00 to 292+12.50 where we placed our guardrail run so that the ends are visible.

Station 289+00 is the trailing end of this guardrail and this is a roadway with a median so we need to place a Type 13 terminal there. Go to D&C Manager and select item Drafting Standards → Guardrail → GR Term Type 13. Click on the Execute Design Keyin icon.

- 7) You are prompted for a job no. Key in 101 and click OK.

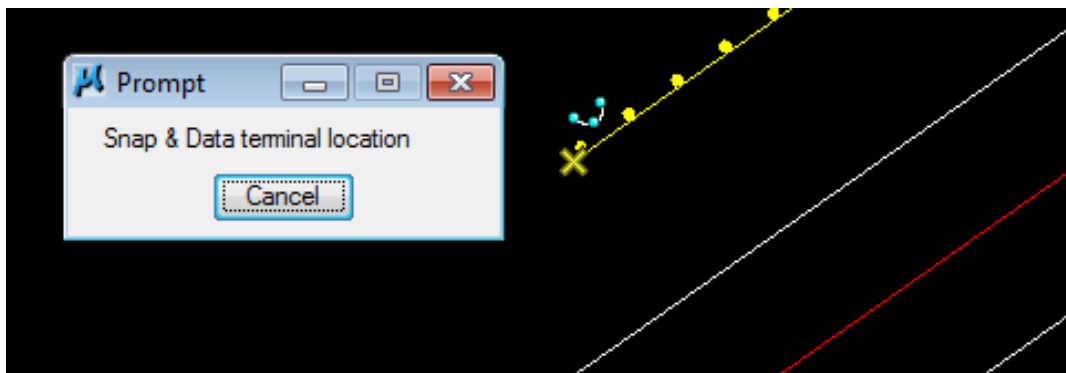


- 8) You are then prompted for the chain name. Key in SR95 and click OK.
- 9) You are then prompted for the terminal location in the guardrail run, Begin or End and Left or Right. Our location is on the left at the beginning so pick **Begin_Left** from the list box and click OK.

NOTE:

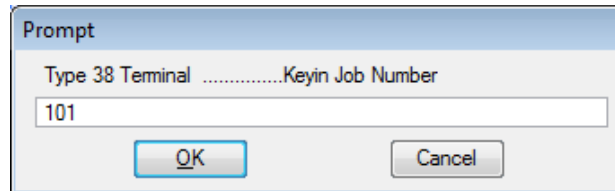
Begin or End and Left or Right are based on the guardrail in relation to the alignment's direction and orientation.

- 10) Finally you are prompted to Snap & Data terminal location. Snap and Data Point on the guardrail at 289+00.

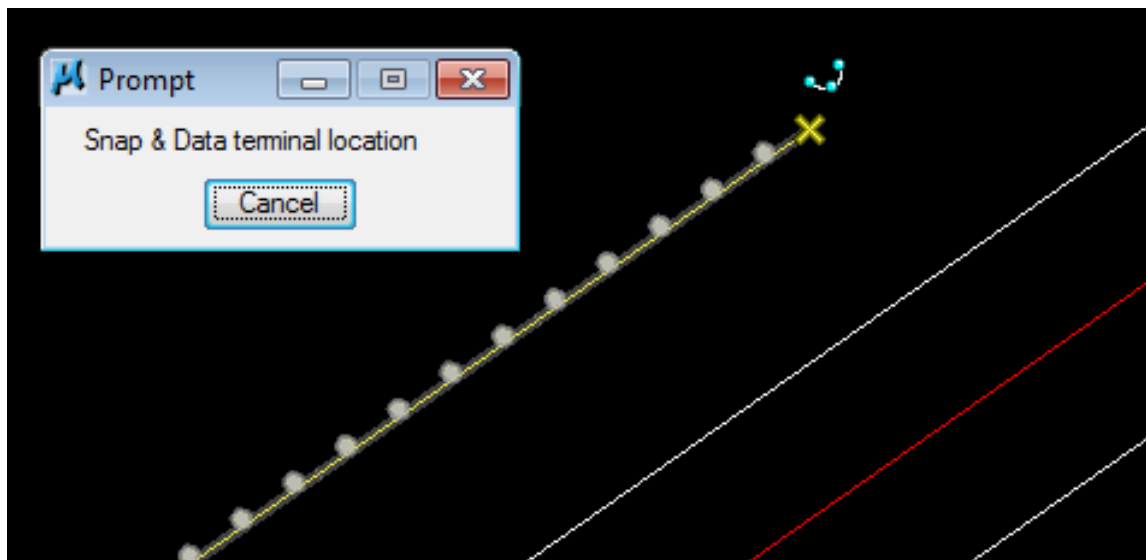


Exercise 12

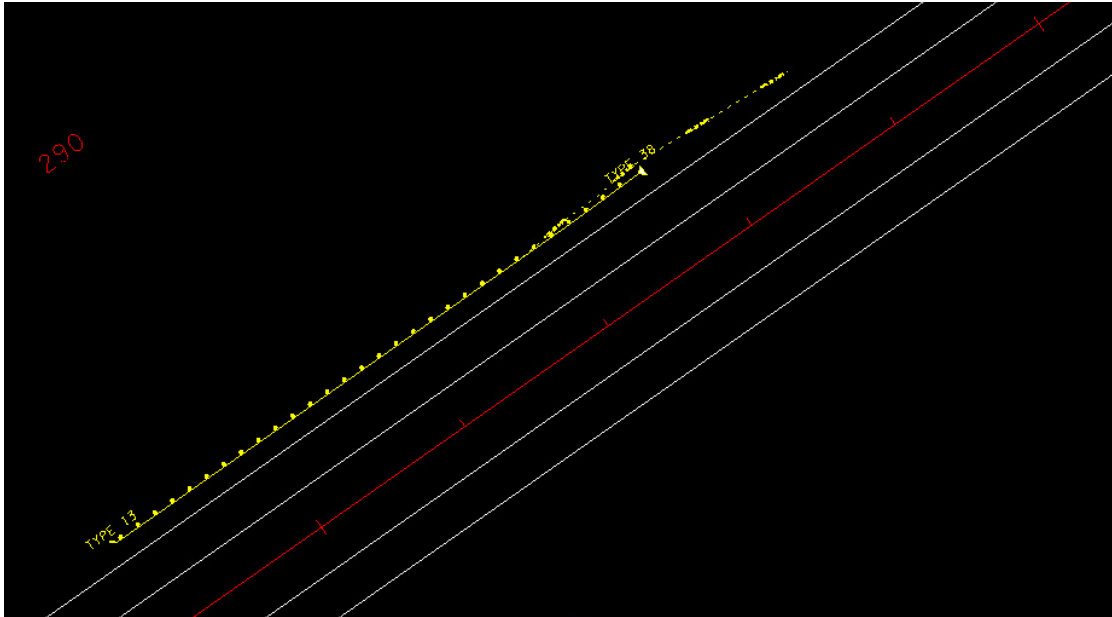
- 11) Now, we can place the Type 38 terminal at the other end. Go to D&C Manager and select item Drafting Standards → Guardrail → GR Term Type 38 and click on the Execute Design Keyin icon
- 12) You are prompted for a job no. Since we have just used a similar tool, it should default to our previous entry. Key in 101 if necessary and click OK.



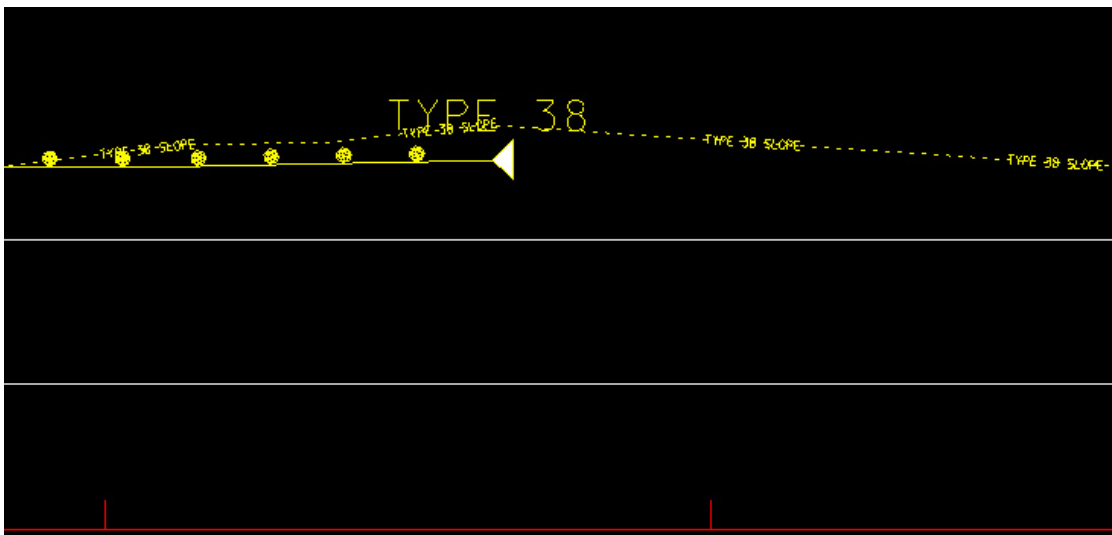
- 13) You are then prompted for the chain name. Key in SR95 if necessary and click OK
- 14) You are then prompted for the terminal location in the guardrail run. Our location is on the left at the end so pick End_Left from the list box and click OK
- 15) Finally you are prompted to Snap & Data terminal location. Snap and Data Point on the guardrail at 292+12.50.



All graphics are placed for the Type 13 and 38 terminals. Now our guardrail run is complete.



You may notice that line work in addition to the type 38 terminal itself was placed. These lines are on the level "DESIGN - TRANSPORTATION - GR Special Slope Limit Lines" and represent the limits of the pad required for installation of this terminal. When cross sections are processed, these lines are recognized by the software and additional widening of the shoulders will be reflected in the cross sections.



13. Superelevation

In this exercise we will be setting up superelevation control shapes for our project. Most roadways have a constant offset from the centerline to where the finished grade is applied. A crown roadway where the finished grade runs right with the centerline like we have in the urban section at the end of our project uses a tie offset of 0. The depressed 48' median section at the beginning of our project applies the finished grade at the inside edges of pavement and so the tie offset is -24 for the left and 24 for the right.

In some areas the tie offset may not be a constant value but instead changes from cross section to cross section. That is the situation where we transition from the 4 lane depressed median section (24' tie offset) to the urban crown section (0' tie offset). For stations 316+75 to 327+75 we will store special transition chains to use as GEOPAK profile grade lines or PGLs. These chains will reflect the transition of the inside edges of pavement from 24' out down to 0' where the urban section with turn lane starts.

NOTES:

PGL transition chains are not needed for transitioning pavement widths. Your pavement lines are read by the cross section criteria files and automatically handle all pavement width changes.

Superelevation shapes do not have to cover the full pavement width. On side roads where the pavement width starts at one width then widens out as it approaches the intersection with the mainline you should never make the shapes wider than the narrowest width. During cross section processing as the pavement lines widen out the criteria will automatically take the cross slope specified by the superelevation shape and project it to the current width of the pavement lines.

I.) Storing Transition Chains for PGLs

a) Left PGL Chain

- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95SEShapes.dgn

Access Project Manager.

- 2) Select the icon Coordinate Geometry button from the Project Manager workflow dialog.

- 3) Set visualization option to Disable Visualization. Storing a transition chain generates numerous points which we do not need to be displayed.
- 4) If Redefine is clicked on, click it off to prevent accidental overwriting of data already stored in the coordinate geometry GPK database.
- 5) Click on the Store Transition Chain icon.



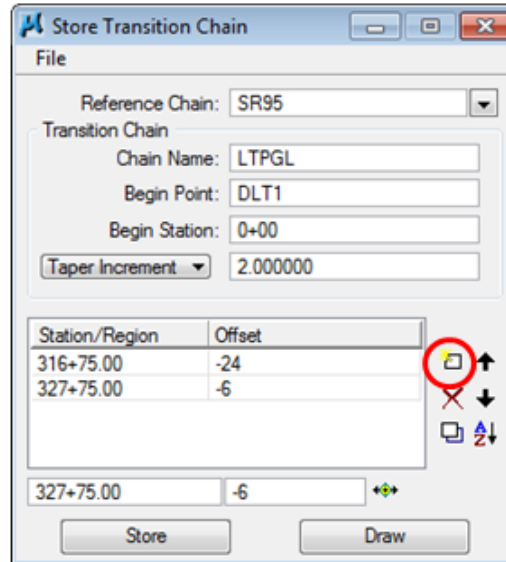
The Store Transition Chain tool will allow you to build a list of station ranges and offsets based upon a Reference Chain and connect the ranges into one chain.

- 6) Complete the Transition Chain information as shown below:
- 7) To build the transition table, in the lower portion of the dialog, enter the SR95 station to begin the transition chain at, 316+75 and the distance from the reference chain (SR95) to the inner left edge of pavement, -24. Press the Add icon to include in the list box (it is the top left icon to the right of the station/offset list).

Station/Region	Offset
316+75.00	-24

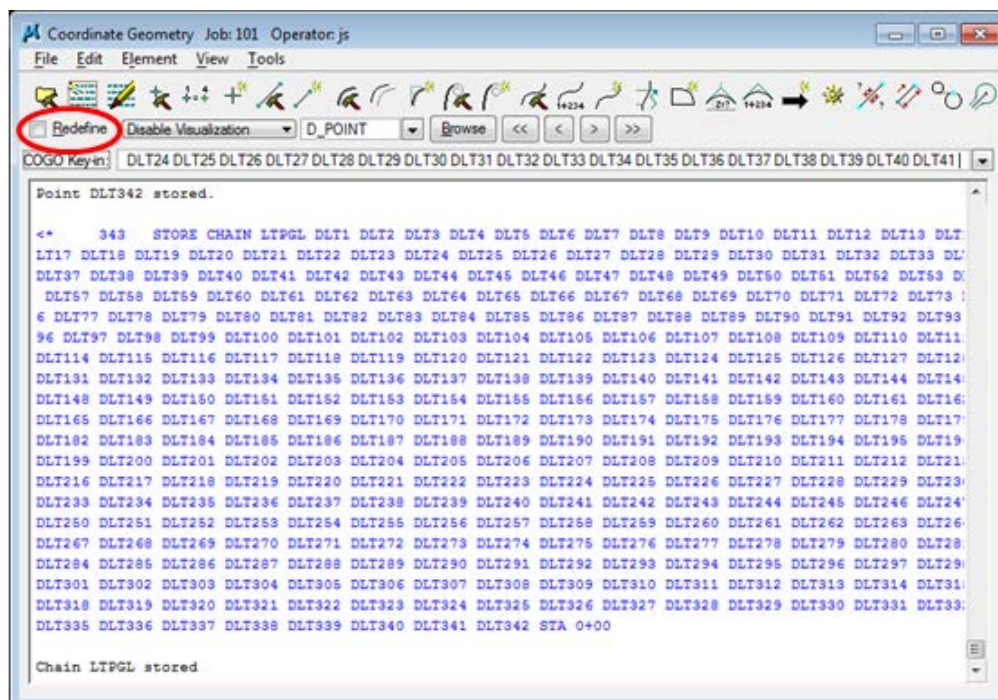
- 8) Continue to build the transition list for the left PGL chain as shown below by entering the SR95 station where the median ending nose radius begins, 327+75 and the distance from the reference chain (SR95) to the inner left edge of pavement, -6. Press the Add icon to include in the list box.

Exercise 13



- 9) Finish the transition list for the left PGL chain by entering the SR95 station where the urban section begins (328+25) and the distance from the reference chain (SR95) is 0. Press the Add icon to include in the list box.
- 10) Press the Store button to compute the transition chain.
- 11) The required points are located along the alignment, sub-chains are formed as needed and the transition chain is stored.

Review the chain LTPGL within the coordinate geometry dialog output list box.



NOTE:

The Taper Increment value used in transition chains can directly affect how Geopak tools that use superelevation shapes react. The response time can be slowed down considerably as more points are defined in these chains. The 2' value used in this exercise works well for this roadway set up which has only 1 transition area. On projects where multiple transition areas are required then a higher value such as 5' should be used.

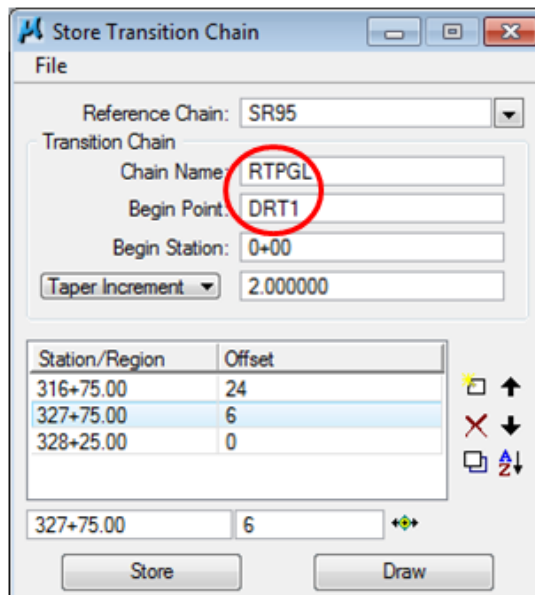
The Store Chain command has a limit for the number of characters it can include in single command. The Store Transition Chain command takes this into account, builds sub-chains when needed and then combines them into the final chain.

b) Right PGL Chain

- 1) In the Store Transition Chain dialog update the Transition Chain information as shown below:
- 2) Since the transition is the same on the right side except for the offsets which are positive, you can edit the existing information in the list box as shown below for the chain RTPGL.

Station/Region	Offset
316+75	24
327+75	6
328+25	0

You can edit an existing item in the list box by highlighting the desired station and offset, modifying the value in the fields at the bottom of the dialog and then pressing the 'Edit' icon (bottom left icon to the right of the station/offset list) as shown below:



- 3) Press the Store button to compute the transition chain.
- 4) Exit the Store Transition Chain dialog. Also, exit COGO and save your session in a subject name of your choosing.

II.) Automated Superelevation

Since our project has multiple pavement configurations, we'll have to process the automated superelevation process for each configuration.

Configuration 1: 4 Lane Divided (287+00 – 316+75)

Configuration 2: 4 Lane Divided with Median Transitioning (316+75 – 327+75)

Configuration 3: 5 Lane Undivided (327+75 – 347+50)

- 1) Open the MicroStation file (if not already open).

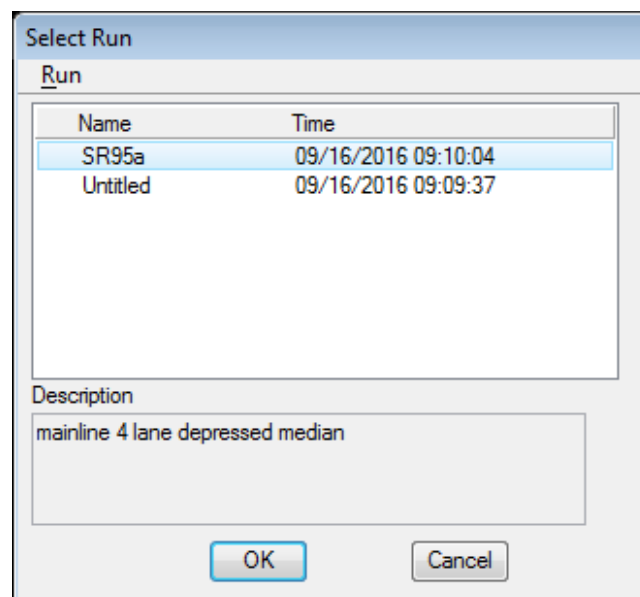
C:\Projects\Roane\SR95PoplarCr\ROSR95SEShapes.dgn

Access Project Manager.

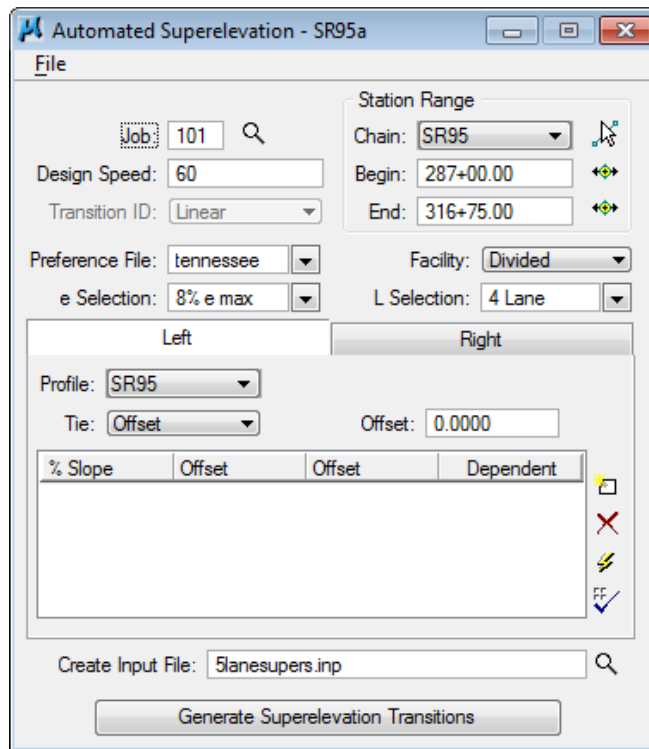
- 2) Select the Calculate Superelevation button from the Project Manager workflow dialog.

III.) 4 Lane Divided (287+00 – 316+75)

- 1) Create a new run called SR95a to represent the computations for the first configuration and press OK.



Once the Automated Superelevation dialog has been invoked, the following dialog will be displayed:



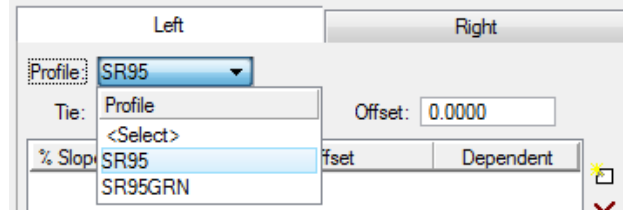
2) For the upper portion of the dialog, complete as follows:

- Job: 101 (Working Alignment should set automatically)
- Chain: SR95 (Working Alignment should set automatically)
- Begin Station: 287+00
- End Station: 316+75
- Design Speed: 60
- Preference File: tennessee
- E Selection: 8% e max
- Facility: Divided
- L Selection: 4 Lane

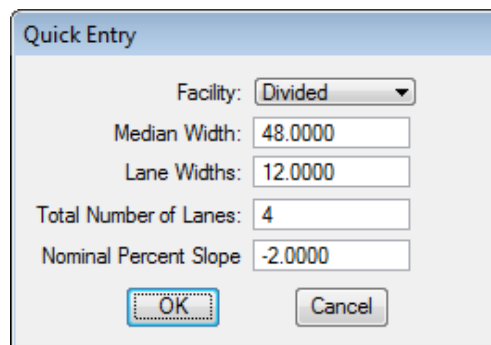
For the lower portion of the dialog, we will build the Left and Right side of the Roadway.

a) Left & Right Roadway (4 Lane Divided)

- 3) Set the profile from which the shapes should be computed to **SR95** for the Left. Click on the Right tab to set it there as well.

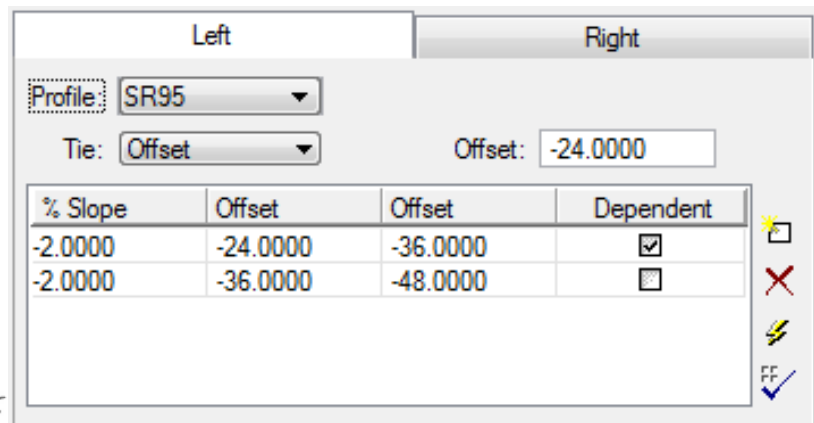
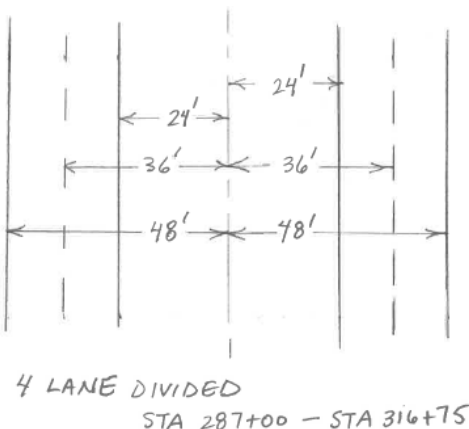


- 4) Click on the Quick Entry icon near the bottom on the right. Fill in the roadway data as shown and click OK.



- 5) All lanes are set up for the left and right sides of the roadway.

The inside lane is identified as Dependent which indicates that its elevation control comes directly from the profile SR95. If this is not clicked on as is the case with the outside lane it indicates that it is Independent and gets its elevation control from the adjoining shape rather than the profile.



- 6) Enter the Input Filename, 4lanesupers.inp, at the bottom of the dialog to store the computed superelevation transition commands for this station range.
- 7) Press the Generate Superelevation Transitions button to initiate the calculation of the transitions for the Left and Right roadway within the defined station range. The input file is created and opened automatically in the GEOPAK Text Editor.

Review the computations within the Text Editor dialog.

```

/* Superelevation Settings and Parameters:
Project Name: C:\Projects\Roane\SR95PoplarCr\SR95.prj
User: C:\Projects\Roane\SR95PoplarCr\projdbs\Joe
Run Name: SR95a
Unit System is english.
Created input file "4lanesupers.inp".
Created activity log file "4lanesupers.log".
Created on Fri, Sep 16, 2016 at 09:21.
Using Preference File "tennessee"
Using e Selection of "8% e max".
Using Length Selection of "4 Lane"
Using Design Speed of 60.000000.

*/

auto shape
job number = 101

auto shape set
shape cluster baseline = SR95
shape cluster profile = SR95
shape cluster tie = -24.0000
dependent shape
chain / offset
SR95 -24.000000
SR95 -36.000000
filler line station / slope
287+00.000000 -2.0000
309+35.289172 -2.0000
310+99.795345 -6.1000 /* Spiral DC104B, Curve DC104 */

```

NOTES:

Transition stations and rates should always be reviewed for errors, etc.

Notice at the top of this input file that at the same time the input file was generated, a special report "log" file with the same name was generated. If problems occur with transitions, that log file should be reviewed for information on the rates and transition lengths which were applied.

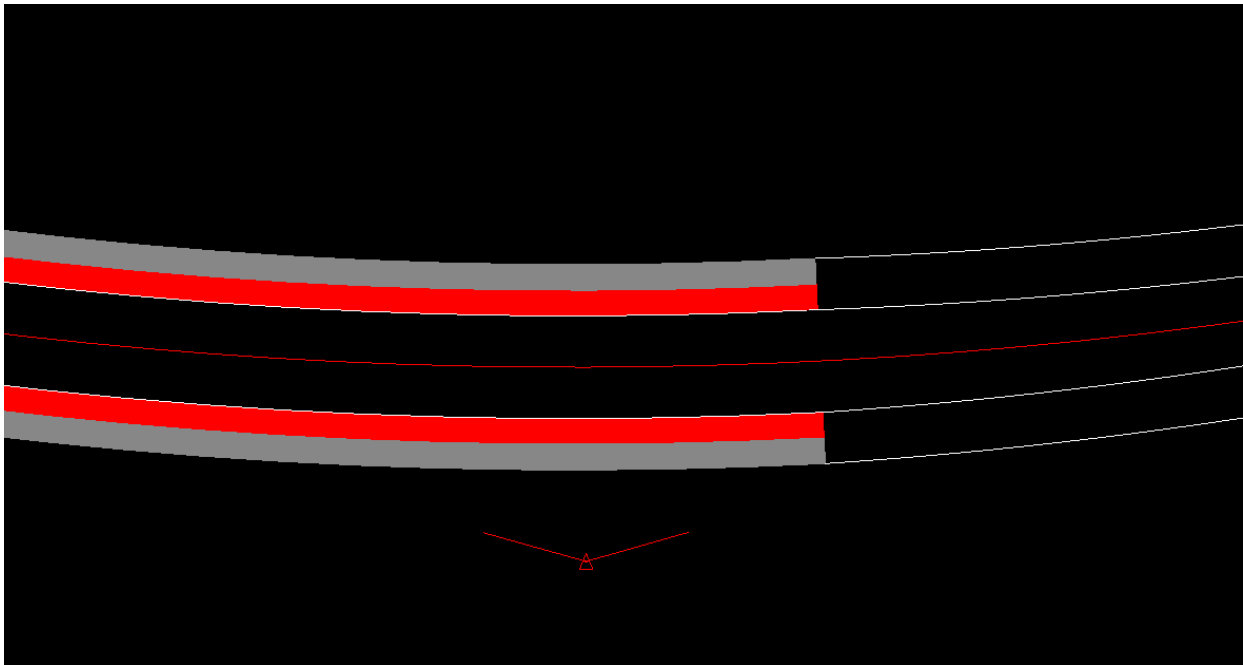
If needed these transitions can be edited or if needed additional cross slope transitions can be added such as when transitioning to existing cross slopes at final roadway tie-ins which are at the beginning and end of the project.

Exercise 13

- 8) To build the superelevation shapes into the graphics file, press the Autoshape Builder icon within the Text Editor dialog.



This will automatically draw the shapes into your design file.



- 9) Close the Text Editor dialog as well as the Automated Superelevation dialog. When prompted to Save Superelevation settings, press Yes.

IV.) 4 Lane Divided with Median Transitioning (316+75 – 327+75)

Next, we will create a new Run to calculate and build the shapes for Configuration 2 which is the transition from a 4 lane depressed median to a 5 lane curb and gutter.

- 1) Select the Calculate Superelevation button from the Project Manager workflow dialog.
- 2) Create a new run called SR95b to represent the computations for the second configuration and press OK.
- 3) For the upper portion of the dialog, complete as follows:

Job: 101 (Working Alignment should set automatically)
Chain: SR95 (Working Alignment should set automatically)
Begin Station: 316+75
End Station: 328+25
Design Speed: 60
Preference File: tennessee
E Selection: 8% e max
Facility: Divided
L Selection: 4 Lane

For the lower portion of the dialog, we will build the Left and Right side of the Roadway.

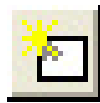
a) Left Roadway (Transition Area)

- 4) Set the profile from which the shapes should be computed to SR95.



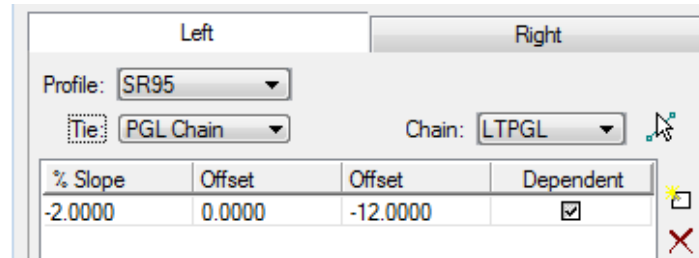
- 5) Set the Tie option to PGL Chain. The PGL Chain should be set to LTPGL for the left transition chain.
- 6) Since our tie offset to the centerline is not constant in the transition area, we will have to use the manual method instead of Quick Entry to set up our lanes.

Click on the New Lane icon to the right, near the bottom of the Automated Superelevation dialog. The settings for normal cross slope and lane width are remembered from our previous run.



Exercise 13

Since we are using a PGL chain the offsets for the super shape are from the PGL chain not the roadway chain as it was in the previous set up so the values of 0 and -12 are correct and do not need editing.

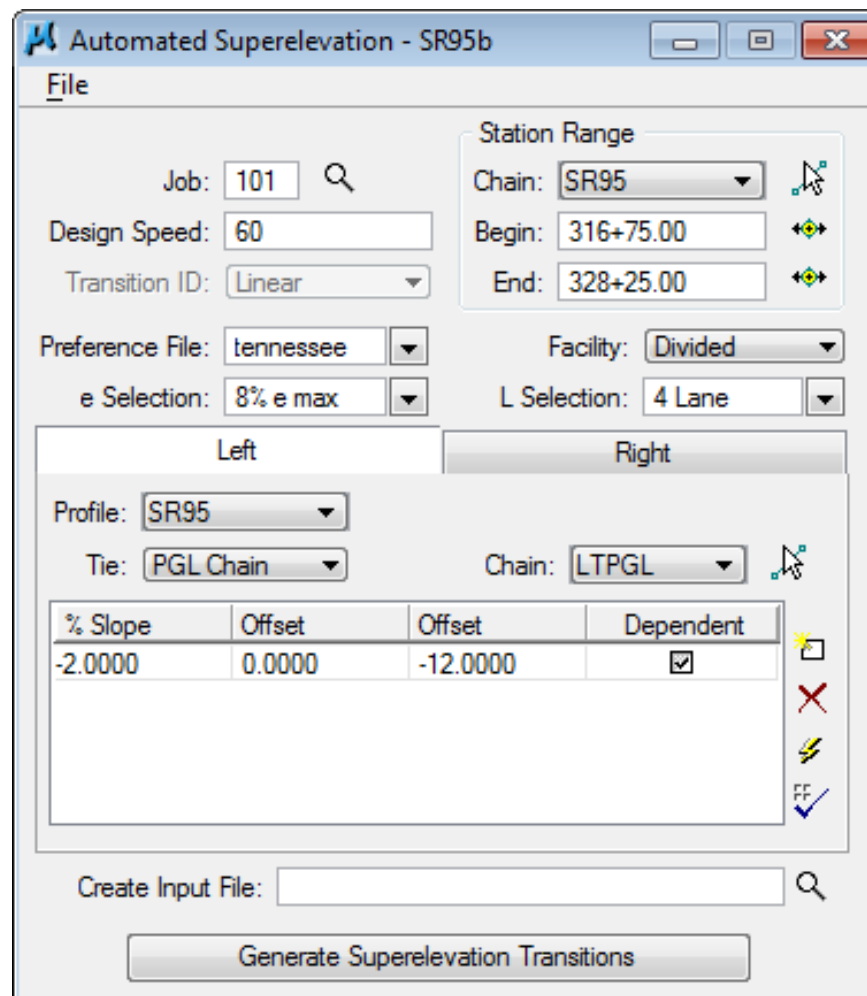


The screenshot shows a dialog box with two tabs: 'Left' and 'Right'. The 'Left' tab is active. It contains the following settings:

- Profile: SR95
- Tie: PGL Chain
- Chain: LTPGL

% Slope	Offset	Offset	Dependent
-2.0000	0.0000	-12.0000	<input checked="" type="checkbox"/>

We are in a transition here so we will only set up the 1 lane. When we re-run our cross sections, the criteria files will take the cross slope and project them to the edge of pavement to maintain the correct pavement widths.



The screenshot shows the 'Automated Superelevation - SR95b' dialog box. It has a 'File' menu and the following settings:

- Job: 101
- Design Speed: 60
- Transition ID: Linear
- Preference File: tennessee
- e Selection: 8% e max
- Station Range: SR95
- Begin: 316+75.00
- End: 328+25.00
- Facility: Divided
- L Selection: 4 Lane

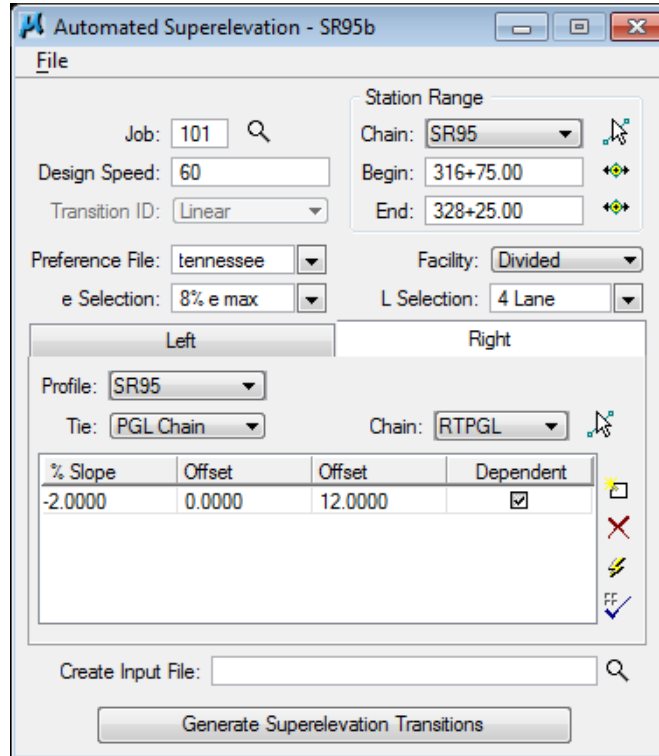
The 'Left' tab is active, showing the same settings as the previous screenshot and the following table:

% Slope	Offset	Offset	Dependent
-2.0000	0.0000	-12.0000	<input checked="" type="checkbox"/>

At the bottom, there is a 'Create Input File' field and a 'Generate Superelevation Transitions' button.

b) Right Roadway Transition Area

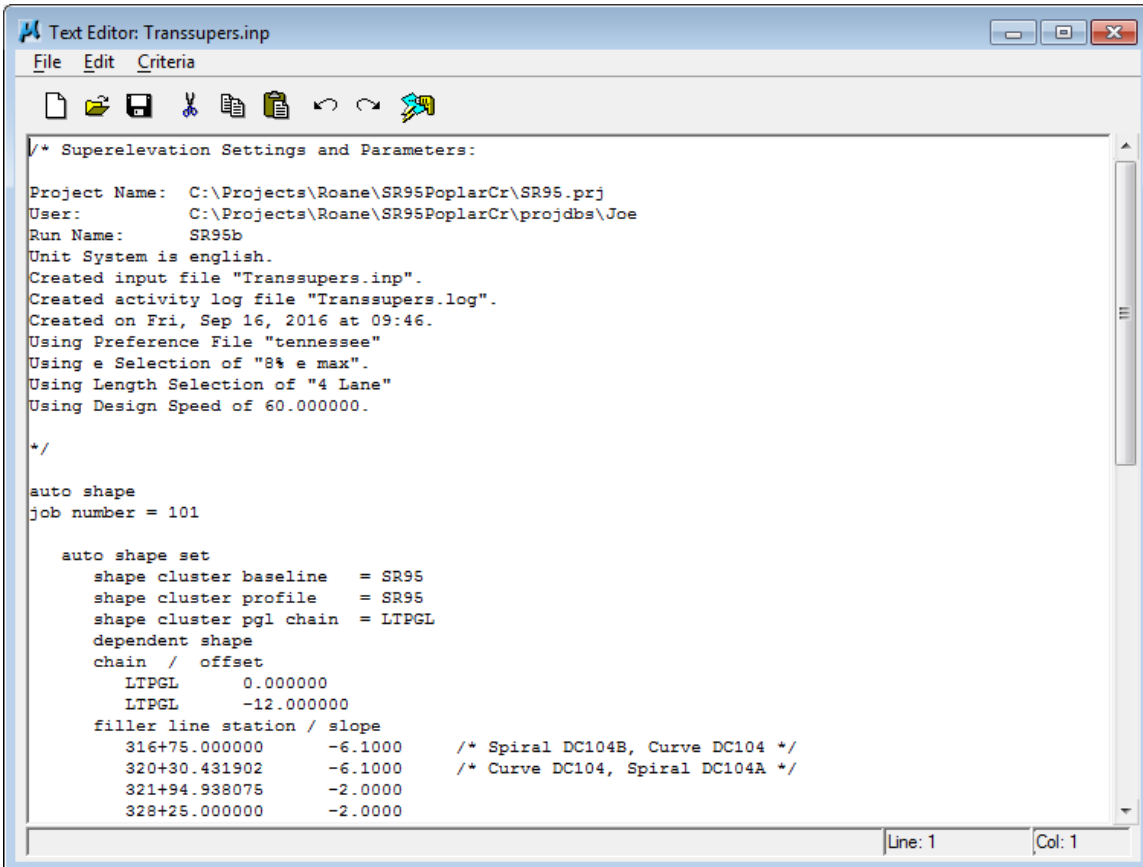
- 7) Repeat steps 5 & 6 for the Right tab (Right roadway) using the PGL chain RTPGL.



- 8) Enter the Input Filename, Transsupers.inp, to store the computed transitions for this station range.
- 9) Press the Generate Superelevation Transitions button to initiate the calculation of the transitions for the Left and Right roadway within the defined station range.

Exercise 13

Review the computations within the Text Editor dialog.



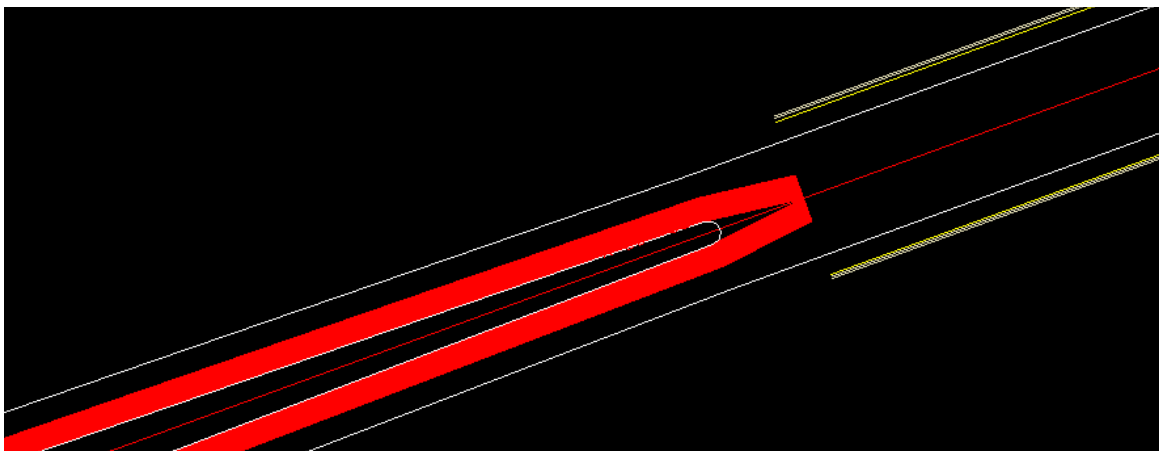
```
/* Superelevation Settings and Parameters:
Project Name: C:\Projects\Roane\SR95PoplarCr\SR95.prj
User: C:\Projects\Roane\SR95PoplarCr\projdbs\Joe
Run Name: SR95b
Unit System is english.
Created input file "Transsupers.inp".
Created activity log file "Transsupers.log".
Created on Fri, Sep 16, 2016 at 09:46.
Using Preference File "tennessee"
Using e Selection of "8% e max".
Using Length Selection of "4 Lane"
Using Design Speed of 60.000000.

*/

auto shape
job number = 101

  auto shape set
    shape cluster baseline = SR95
    shape cluster profile = SR95
    shape cluster pgl chain = LTPGL
  dependent shape
  chain / offset
    LTPGL 0.000000
    LTPGL -12.000000
  filler line station / slope
    316+75.000000 -6.1000 /* Spiral DC104B, Curve DC104 */
    320+30.431902 -6.1000 /* Curve DC104, Spiral DC104A */
    321+94.938075 -2.0000
    328+25.000000 -2.0000
```

- 10) Click the Autoshape Builder icon to build these shapes into the graphics file.



- 11) Close the Text Editor dialog as well as the Automated Superelevation dialog. When prompted to Save Superelevation settings, press Yes.

V.) **5 Lane Undivided (328+25 – 347+50)**

Next, we will create a new Run to calculate and build the shapes for Configuration 3 which is a 5-lane curb and gutter section.

- 1) Select the Calculate Superelevation button from the Project Manager workflow dialog.
- 2) Create a new run called SR95c to represent the computations for the third configuration and press OK.
- 3) For the upper portion of the dialog:

Job: 101 (Working Alignment should set automatically)
Chain: SR95 (Working Alignment should set automatically)
Begin Station: 328+25
End Station: 347+50
Design Speed: 50
Preference File: tennessee
E Selection: 4% e max
Facility: Undivided
L Selection: 4 Lane

- 4) For the lower portion of the dialog, we will define as follows:

Profile: SR95
Tie: Offset
Offset: 0.0

- 5) Since the tie offset is constant here, we will use the Quick Entry method again to populate the shape list box.

Click on the Quick Entry icon on the Automated Superelevation dialog box.

Exercise 13

- 6) Complete the dialog as shown for the 5 Lane section

Quick Entry

Facility:

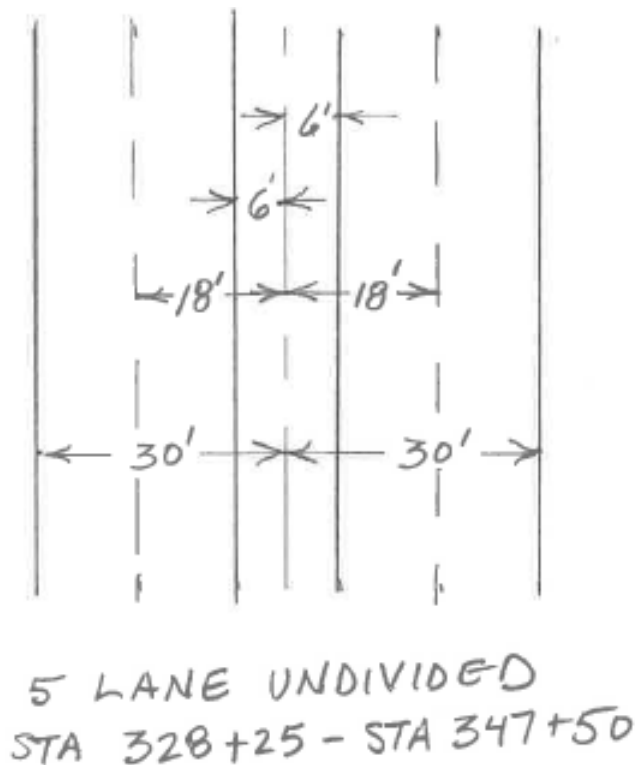
Median Width:

Lane Widths:

Total Number of Lanes:

Nominal Percent Slope:

- 7) Press OK and review that the Left and Right Tabs have been completed to cover the entire pavement left and right of the centerline and profile.



Automated Superelevation - SR95c

File

Job: 101

Design Speed: 50

Transition ID: Linear

Preference File: tennessee

e Selection: 4% e max

Station Range

Chain: SR95

Begin: 328+25.00

End: 347+50

Facility: Undivided

L Selection: 4 Lane

Left Right

Profile: SR95

Tie: Offset

Offset: 0.0000

% Slope	Offset	Offset	Dependent
-2.0000	-0.0000	-6.0000	<input checked="" type="checkbox"/>
-2.0000	-6.0000	-18.0000	<input type="checkbox"/>
-2.0000	-18.0000	-30.0000	<input type="checkbox"/>

Create Input File: 5lanesupers.inp

- 8) Enter the Input Filename, 5lanesupers.inp, to store the computed transitions for this station range.
- 9) Press the Generate Superelevation Transitions button to initiate the calculation of the transitions for the Left and Right roadway within the defined station range.

Review the computations within the Text Editor dialog.

```

Text Editor: 5lanesupers.inp
File Edit Criteria

/* Superelevation Settings and Parameters:

Project Name: C:\Projects\Roane\SR95PoplarCr\SR95.prj
User: C:\Projects\Roane\SR95PoplarCr\projdb\Joe
Run Name: SR95c
Unit System is english.
Created input file "5lanesupers.inp".
Created activity log file "5lanesupers.log".
Created on Fri, Sep 16, 2016 at 09:54.
Using Preference File "tennessee"
Using e Selection of "4% e max".
Using Length Selection of "4 Lane"
Using Design Speed of 50.000000.

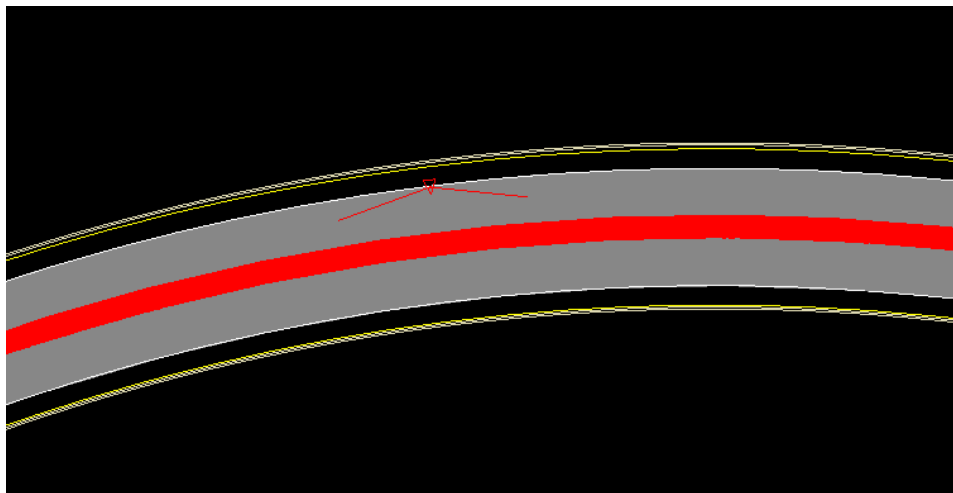
*/

auto shape
job number = 101

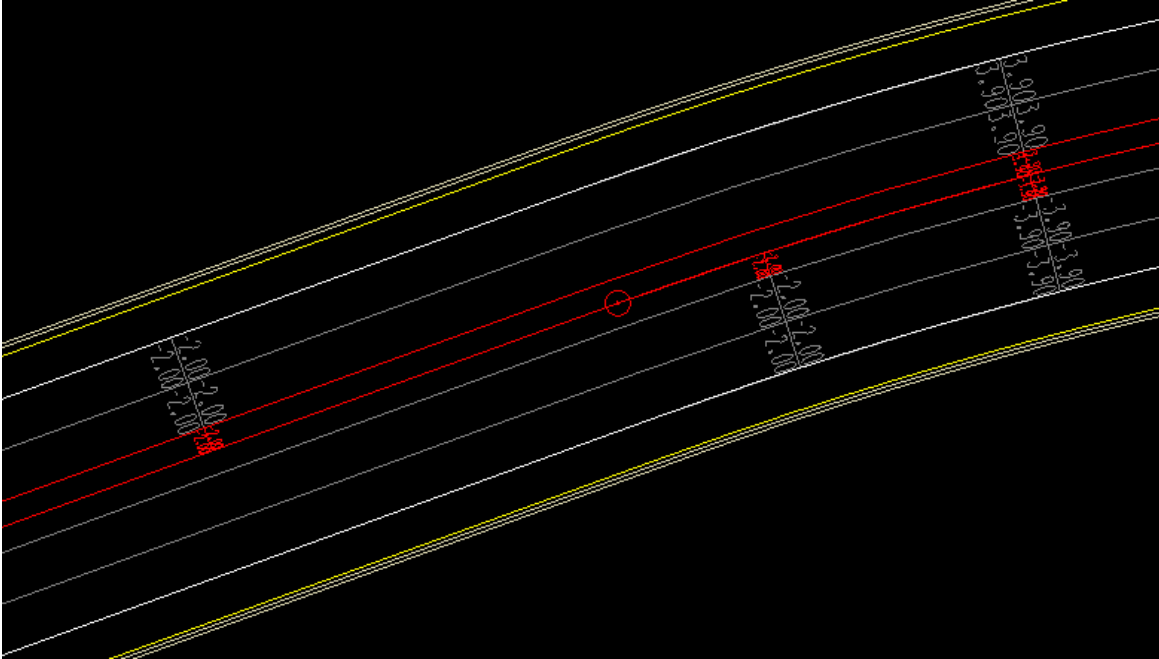
auto shape set
shape cluster baseline = SR95
shape cluster profile = SR95
shape cluster tie = 0.0000
independent shape
chain / offset
SR95 -30.0000
SR95 -18.0000
filler line station / slope
328+25.000000 -2.0000
330+66.684300 -2.0000
332+81.684300 3.9000 /* Curve DC103 */
335+80.572702 3.9000 /* Curve DC103 */

```

10) Click the Autoshape Builder icon to build these shapes into the graphics file.



If Fill is turned off under View Attributes, you can see where super shapes/transitions begin and end as well as the superelevation rates which the shapes will apply.



- 11) Close the Text Editor dialog as well as the automated superlevation dialog. When prompted to Save Superlevation settings, press Yes.

a) Notes on Replacing Superlevation Shapes

If any change is made to the chain on which superlevation shapes are based, you must re-create the shapes.

It is often necessary to adjust the proposed profile. If this is done and the name of the profile is changed you must update the superlevation shapes. There are tools you can use to do this but due to the number of shapes usually encountered this method is problematic at best. It is highly recommended that you avoid changing the profile name if at all possible. You can save the current profile under a different name that can be saved back to the original name if you decide to throw out the profile change. If you do change the profile name then just re-create the shapes rather than trying to edit them.

For these and other reasons it may be necessary to delete superlevation shapes for a roadway and re-create them. When you do this, always compress the MicroStation DGN file afterwards so that GEOPAK cannot read deleted invalid superlevation shape graphics.

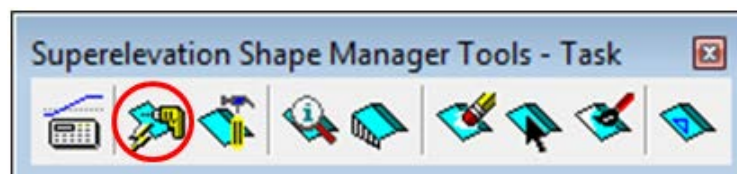
VI.) Shape Manager Tools

Several tools are available to get information from or to check superelevation shapes. The following sections describe some of the more useful of these. Review our graphical superelevation shapes with the following tools before we re-run our proposed cross sections.

The Superelevation Shape Manager tools are available in the Road Tools task group when running Civil Workflows or you can invoke the tool box from the MicroStation menu bar drop down option Applications → GEOPAK → Road → Cross Sections → Superelevation Shape Manager Tools.



You can right click within the tasks to open it as a separate tool box as well.



a) Autoshape Builder

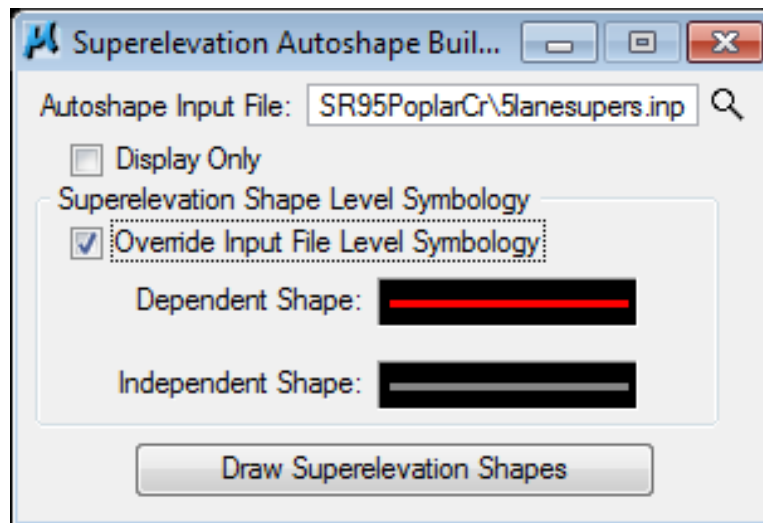
The Autoshape builder tool icon you may recognize from running super shape input files earlier. When you build input files with the Automated Superelevation dialog this icon is added to the GEOPAK Editor so that you can run the input file from there.



What you can do with the icon from this location is run an input file for super shapes without going through the Automated Superelevation dialog. You can take an input file generated earlier, open it up and make some changes to transitions or whatever and then use this tool to build the shapes.

The Display Only option allows you to test run the input file without actually writing the superelevation shape graphics to the file.

The Override Input File Level Symbology option allows you to supersede the definitions specified for the shape's level, color, weight and style in the input file. Double click on the symbology preview boxes to open up Set Feature dialogs to set these alternate values.

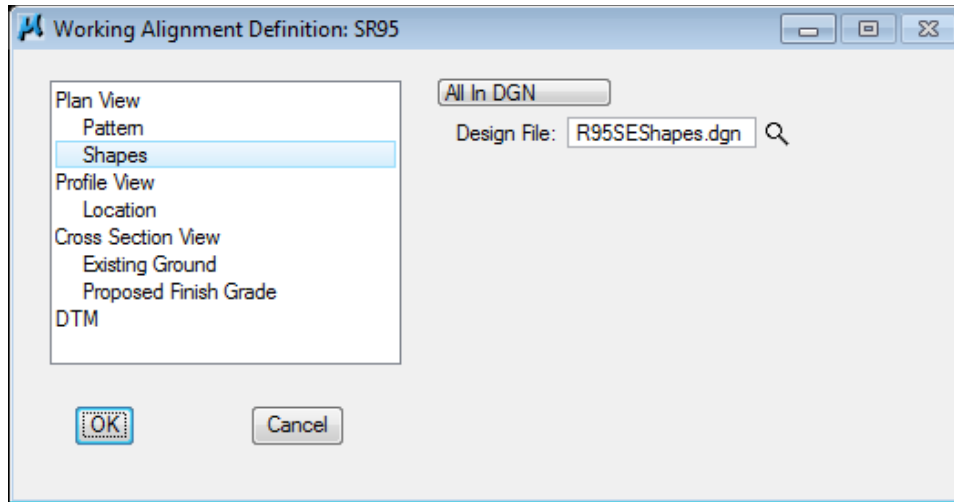


This can truly be helpful in areas where special conditions require extensive non-standard superelevation transition settings which may end up being adjusted multiple times to come up with a design that will work.

VII.) Working Alignment - Define Shapes

We are completing the Plan View of the Working Alignment Definition in Project Manager.

- 1) From the Workflow dialog of Project Manager, press the Define button.
- 2) Highlight the Plan View → Shapes option and populate the Shapes Design file as shown below:



NOTE:

If you place super shapes for multiple roadways in the same DGN file it will be necessary to set up By Search Criteria for this setting instead of All in DGN. We recommend using different levels to separate them. This allows for easy isolation of the graphics in the event that one set may need to be replaced.

- 3) Press the OK button to save the updates and close the dialog.

14. Proposed Cross Sections – Final

Now that we have adjusted our profile, added edge of pavement lines to control pavement widths and set up superelevation shapes to apply superelevation to the pavement and shoulders, we are closer to producing finalized cross sections.

In this exercise, we will apply our superelevation shapes and take this one step further by setting up some special controls for side slopes as well as the application of a special ditch ultimately leading to the final cross sections for S.R. 95.

I.) Initial Set up

- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

- 2) Prior to beginning the process of the final proposed cross section design, we need to delete our preliminary sections but we want to leave on our cross section grids so they will not have to be placed again.

From the Menu Bar in MicroStation, use the following pull down tool to remove your proposed cross sections:

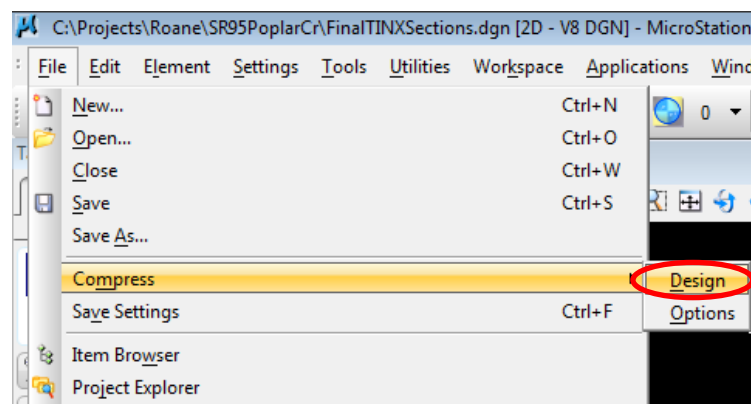
T.D.O.T. → Cross Sections → Delete ALL Prop. XS Graphics

NOTE:

This tool is also available from D&C Manager at

Drafting **Standards** → **Cross Sections** → **Delete XSs**

After deleting proposed cross section graphics, compress the file as shown below.



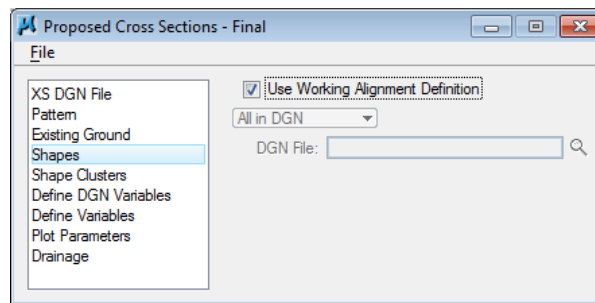
- 3) Access Project Manager.

- 4) Choose Proposed Cross Sections from the Project Manager workflow dialog.

Since most of settings we made in the preliminary run will still be valid for our final cross sections, in the Select Run dialog go to Run → Copy → Run and make a copy of the run Prelim and call it Final.

Open run Final.

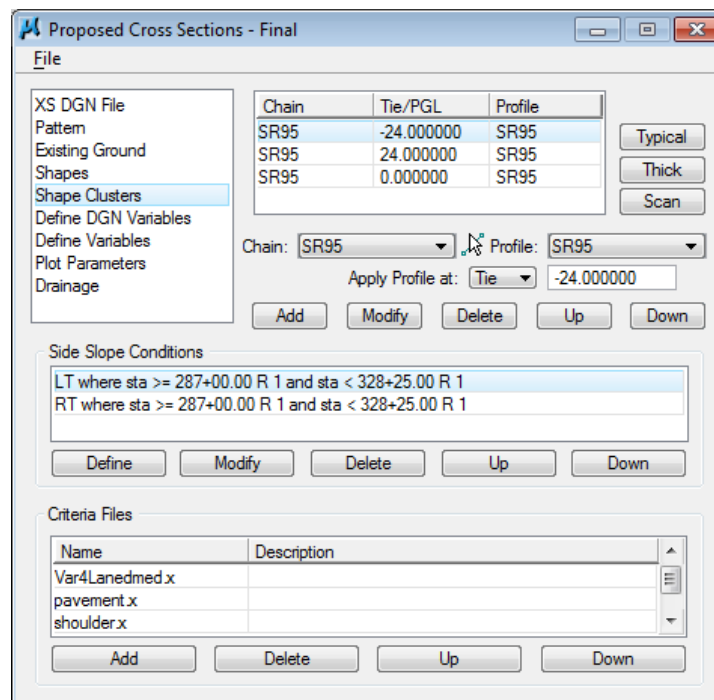
- 5) In the Proposed Cross Section dialog, go to Shapes. First set the control button to All in DGN and then click on Use Working Alignment Definition.



II.) Define Roadway/Shape Clusters

a) Add Shape Clusters

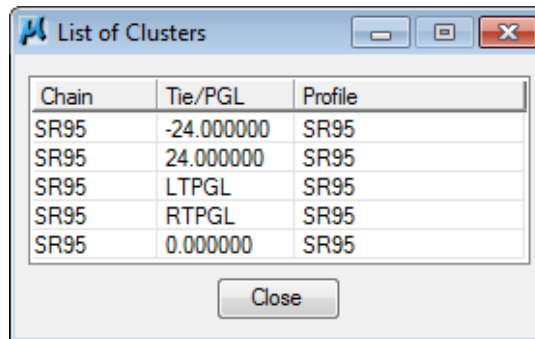
- 1) Next, select the Shape Clusters item.



Exercise 14

We can now see the clusters as we set them up originally in the Prelim run. Notice that since we have activated superelevation shapes in the previous step, a Scan button has been added to the upper right of the dialog to search for shape clusters.

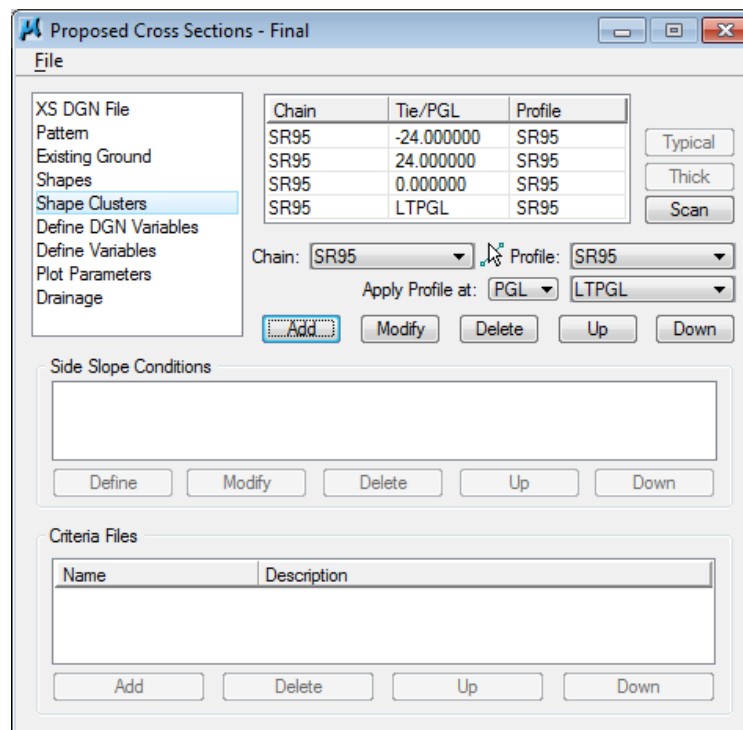
- 2) Press the Scan button to invoke the following dialog. This list reflects all of the superelevation shape clusters specified by our working alignment definition.



We can see that some of the clusters correspond with what we have already set up for Prelim but we do need to add the clusters for the transition area which utilize the special PGL chains.

- 3) Highlight the cluster, Chain = SR95, Tie/PGL = LTPGL, Profile = SR95 in the list. When you do this, it will be used to fill in the Chain, Tie and Profile fields in the main dialog.

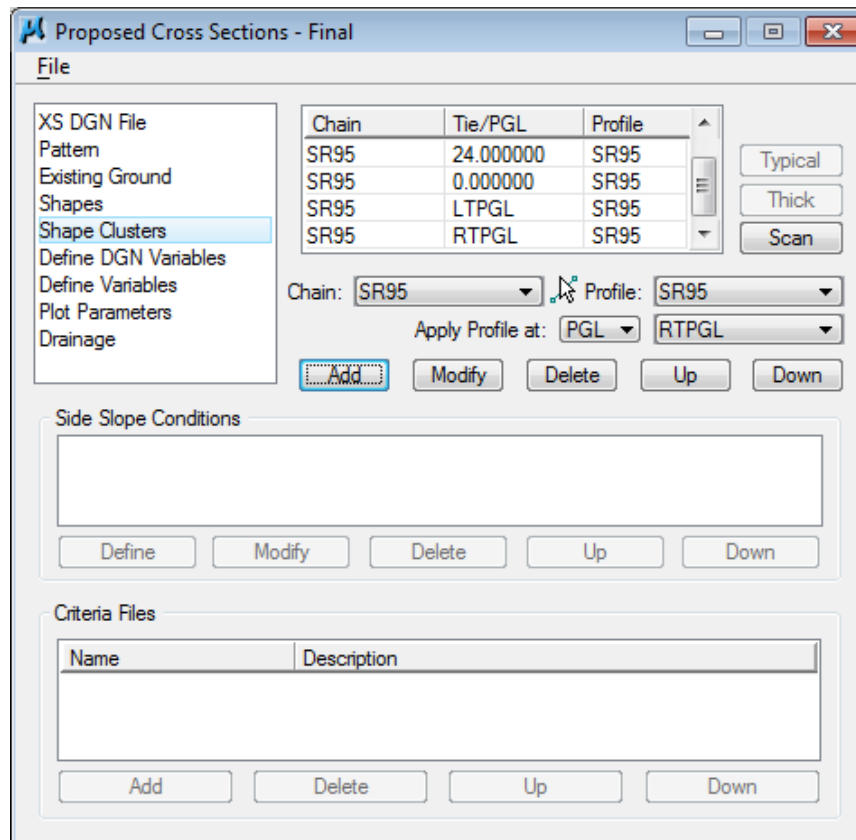
Press the Add button to add the cluster to the processing list.



- 4) Repeat Step 3 to add shape cluster Chain = SR95, Tie/PGL = RTPGL, Profile = SR95 clusters.

Press the Close button on the List of Clusters dialog to dismiss it when done.

Your main dialog should now appear as shown.



NOTE:

The order of the shape clusters does not matter so you do not have to use the Up button to re-organize them.

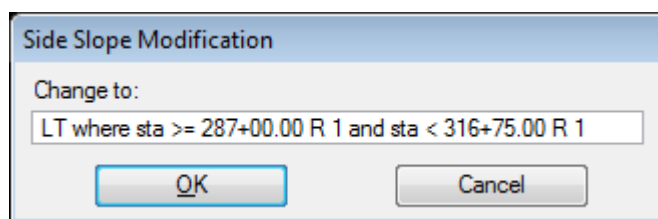
One important concept to remember is that **you should never have more than one shape cluster specified in this list with the same set of parameters**. If you do this, all but the last one will be ignored and not processed. Instead, under the Side Slope Conditions, you will have multiple station ranges.

b) Shape Cluster Station Adjustment

- 5) Highlight shape cluster Chain = SR95, Tie/PGL = -24, Profile = SR95

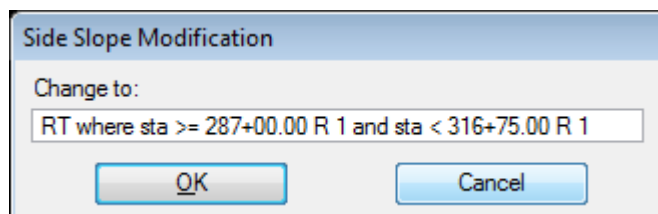
Originally we set this cluster up to go all of the way to the beginning of the urban section at station 328+25. Now that we have special shape clusters for the transition area, we need to edit the final station given for this cluster and its corresponding right roadway cluster at the Tie of 24.

In the Side Slope Condition area, highlight the Side Slope LT condition ending at 328+25 and press the Modify button to access the Side Slope Modification dialog. Change the ending station to 316+75 (beginning of our PGL transition):



Click OK to save the change and return to the main dialog.

- 6) Repeat step 5 for the Side Slope RT condition.



- 7) Highlight shape cluster Chain = SR95, Tie/PGL = 24, Profile = SR95. Repeat steps 5 & 6 for its LT & RT side slope conditions.

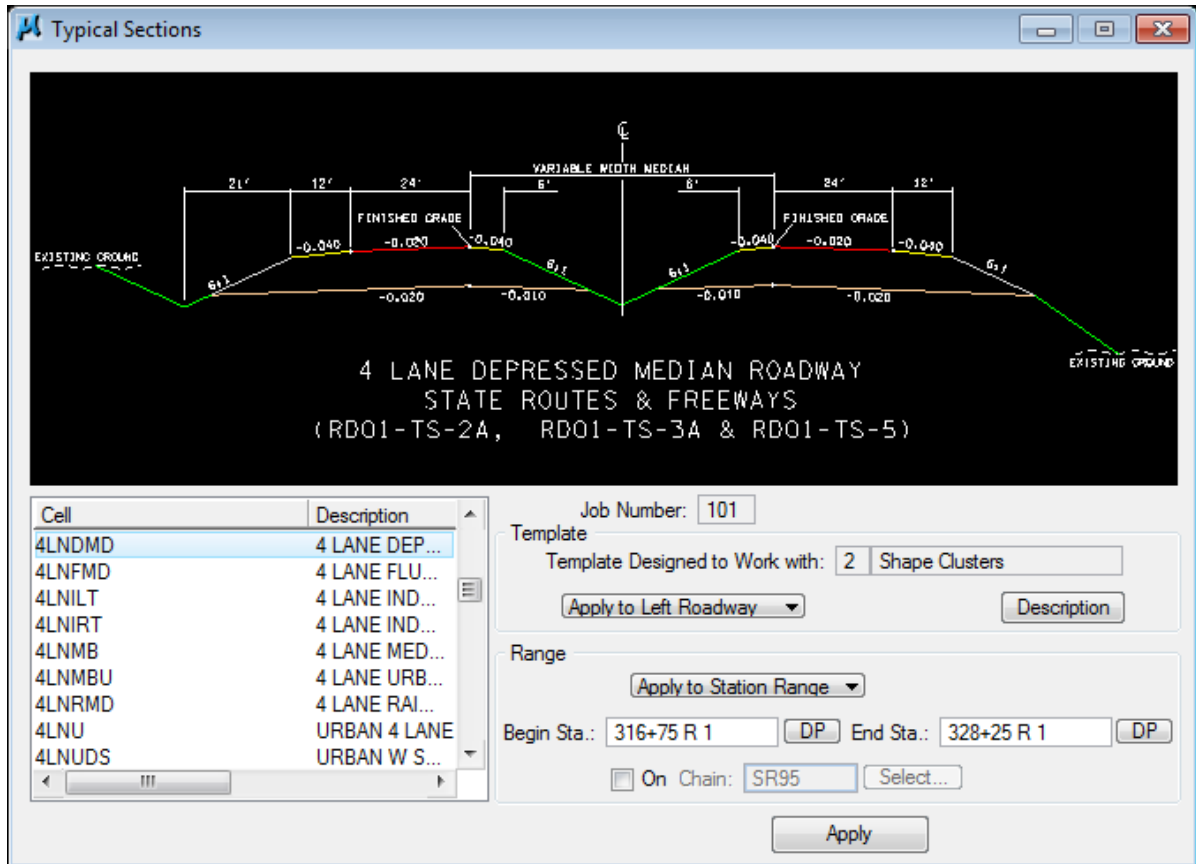
c) Shape Cluster: Chain=SR95, Tie/PGL=LTPGL, Profile=SR95

- 8) This cluster represents the left side transition area of our lane divided roadway section. Highlight the cluster in the list box and press the Typical button

NOTE:

Even though we are transitioning down from the full 4 lane divided roadway section, we will continue to use the same typical. Its criteria files are set up to recognize transition areas and to alter medians, etc. as needed.

- 9) From the typical section List, select the Typical Section "4LNDMD - 4 LANE DEPRESSED MEDIAN".

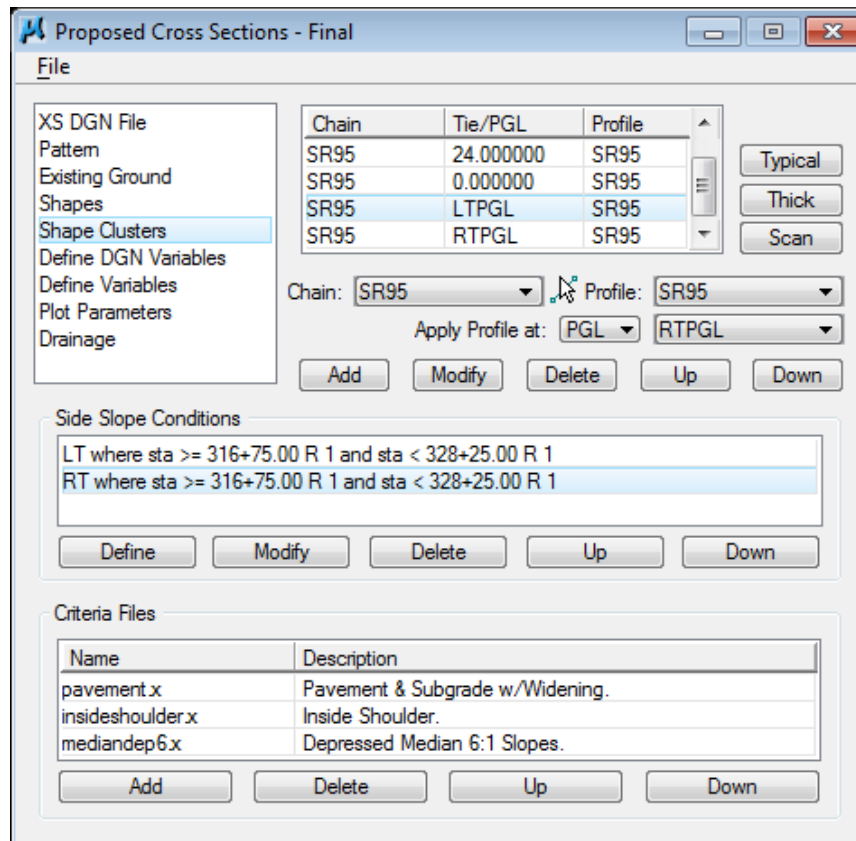


- 10) Since this shape cluster represents the left side of our transition, we need to apply the Typical Section to the left roadway. Set the toggle as shown above.

Also, since our shape cluster runs from Station 316+75 to Station 328+25, we need to apply the Typical Section to that station range.

Once station range is set, press Apply.

The Typical Section Generator will then populate the main dialog with the required Side Slope conditions and associated criteria files.



d) Shape Cluster: Chain=SR95, Tie/PGL=RTPGL, Profile=SR95

- 11) This cluster represents the right side transition area of our lane divided roadway section. Repeat steps 8-10. Apply the Typical Section to the Right Roadway and use a station range of 316+75 to 328+25.

III.) Define Variables

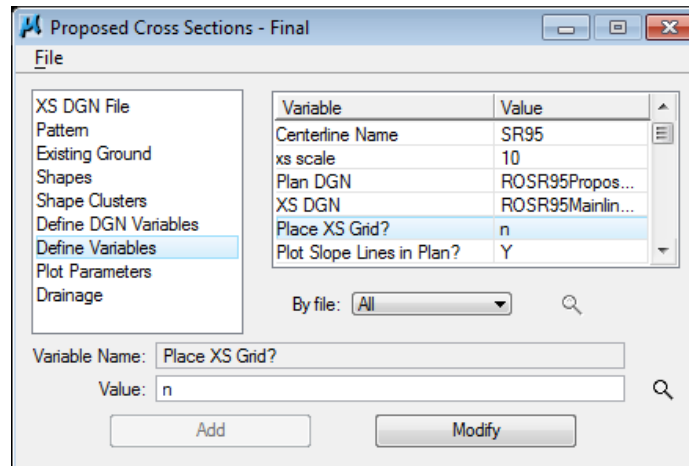
Next, we'll need to re-define our variables as needed. Variables allow us to customize our cross sections. For example, on one project our "Subgrade Depth" may be 1.5', while on another it may be 1.75'. Or we may want to set up different runs on the same project where each run reflects differing variable values.

NOTE:

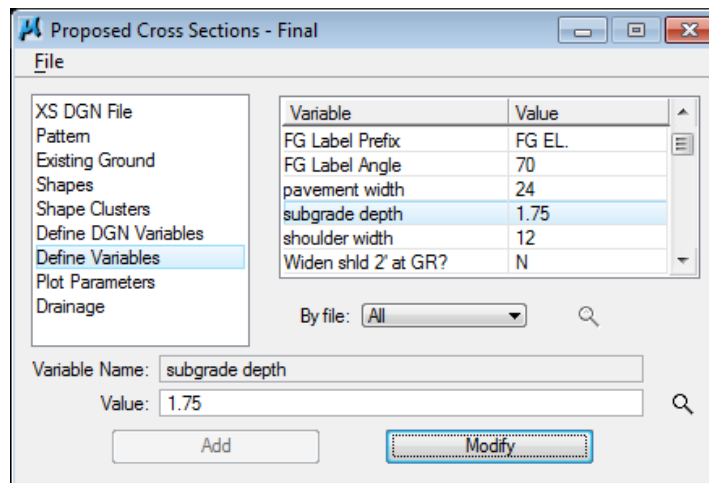
Once a value is set, that value controls the entire cross section run. For example, if we set the "Subgrade Depth" to a value of 1.5', our subgrade depth will be plotted at 1.5' for all of the cross sections.

- 1) Select the Define Variables item from the Proposed Cross Section dialog list box. Most of our variables are already set but we want to make a couple of changes.

- 2) Select the Variable "Place XS Grid?" and set the Value to "N". To do this, enter the change in the Value field and **press the Modify button.**



- 3) Select the Variable "subgrade depth" and set the Value to "1.75".



IV.) Variable Criteria Files

All of the rest of the settings in our run Final are set so we could run our cross sections to see what effects our changes have made but instead let's take this fine tuning of our roadway one step further.

By default, our side slopes are variable and are based on Case I or Case II slope criteria as specified on T.D.O.T. standard roadway drawing RD01-S-11. In certain situations, we may be required to adjust this in certain areas with fixed slopes, special ditches or benching.

We will illustrate how to address some of these in this section by setting up some special re-definable variables in our variable criteria files. Re-definable variables are variables which are set up so that we can vary their values by station range.

Exercise 14

Re-definable controls are available for:

Fixed Fill or Cut Slopes on left or right

Maximum cut or fill slope control to limit maximum slopes applied using normal variable slopes application

Median slopes in guardrail areas for bridge pier or bridge end protection

Special ditch application area:

- along roadway
- at the toe of fill slopes
- at the top of cut slopes

Special ditch defined by:

- centerline & profile (channel changes)
- profile and foreslope
- minimum depth and foreslope

Berm control for top of cut special ditches

Low water keyhole for channel change special ditches

Benching in earth or rock cuts and earth fills

Bench formation defined as:

- single slope to top of rock
- repeating by height
- up to 6 defined elevations

Benching Rock- Earth interface area defined as:

- bench at rock
- trace rock
- single slope

Rules for Variable Criteria File Editing

The following guidelines should be observed when setting up the variable criteria file to alter cross sections to reflect design needs for special areas along the roadway:

1. Comment lines are lines used for explanation only and are not processed as commands. They should begin with */** and end with **/*.
2. If statements are statements that define an area, station to station, within which the commands that follow it will be processed.
3. The begin bracket { and end bracket } signify the beginning and end of variable settings. The settings should follow if statements.

For Alternate Side Slopes, Special Ditches or Benching along Roadway:

1. Copy the lines of text between the lines that contain the “begin” comment and the “end” comment. The copying should begin with the line containing the “if statement” and end with the line containing the end bracket “}”. Make a copy for each “station to station” area needed.
2. Paste these copies at the end of the file after the comment “/* Add all changes below this line */”
3. For each area with different settings,
 - a. Change the station ranges (and region #'s if needed) in the “if statement” text line.
 - b. Set the variables as needed for that area on the LT or RT.
 - c. If it's for the left only, then delete the lines of text for the RT. If it's for the right only, then delete the lines of text for the LT.

When a variable file (Var***.x) is modified for use by a specific roadway it will be necessary to rename it (Example: VarMainline.x). That way it will not be overwritten or used on the wrong roadway. Once this file is modified and re-named, replace the original variable criteria file associated with your roadway in the GEOPAK Proposed Cross Section dialog with this new one.

Any values which need to be applied on the entire roadway can be set in the Define Variables section of the GEOPAK Proposed Cross Section dialog.

a) Special Design Case 1 – Rural Fixed Slopes

To limit the length of box culvert required at Poplar Cr., we need to steepen slopes behind the guardrail on the left side of the roadway from Station 289+00 to Station 292+00.

Fixed Fill Slope Left: 2:1

We need to pull slopes inside present R.O.W. on the right side of the roadway from Station 293+00 to Station 297+00.

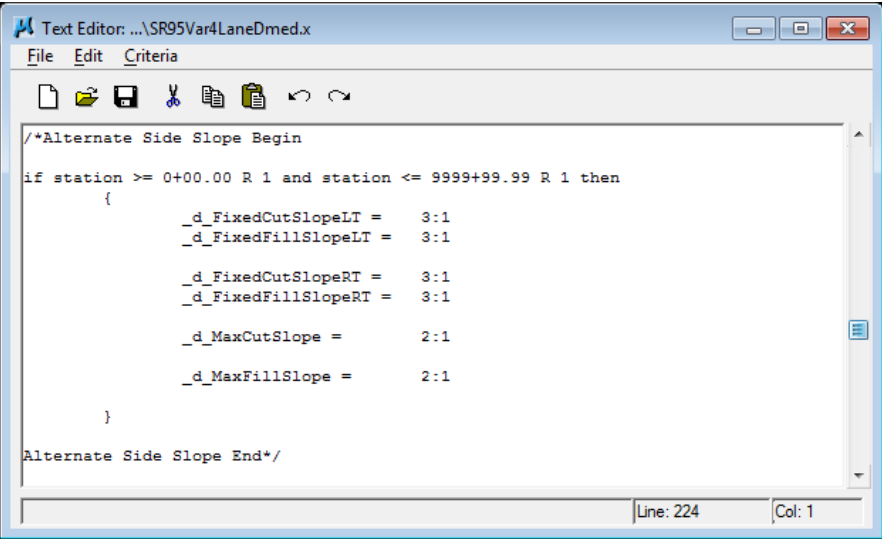
Fixed Fill Slope Right: 3:1

- 1) Access the GEOPAK Text Editor from the Road Tools task group.



Exercise 14

- 2) Using the File drop down, open the variable file Var4LaneDmed.x located in your project directory. Scroll down until you see the section for Alternate Side Slopes as shown below:



```
Text Editor: ...SR95Var4LaneDmed.x
File Edit Criteria

/*Alternate Side Slope Begin
if station >= 0+00.00 R 1 and station <= 9999+99.99 R 1 then
{
    _d_FixedCutSlopeLT = 3:1
    _d_FixedFillSlopeLT = 3:1
    _d_FixedCutSlopeRT = 3:1
    _d_FixedFillSlopeRT = 3:1
    _d_MaxCutSlope = 2:1
    _d_MaxFillSlope = 2:1
}
Alternate Side Slope End*/
```

The instructions for editing variable criteria files shown on the previous page are also given in each variable criteria file.

- 3) Following the rules stated for editing this file, copy the alternate side slope section twice to the bottom of the file and edit this area of the variable file so that it looks as follows:

```
if station >= 289+00.00 R 1 and station <= 292+00.00 R 1 then
{
    _d_FixedFillSlopeLT = 2:1
}
```

```
if station >= 293+00.00 R 1 and station <= 297+00.00 R 1 then
{
    _d_FixedFillSlopeRT = 3:1
}
```

b) Special Design Case 2 – Special Ditch

A special trapezoidal ditch is needed on the left side of the road from Station 300+00 to Station 309+00 to handle a buildup in the volume of water coming down the hill.

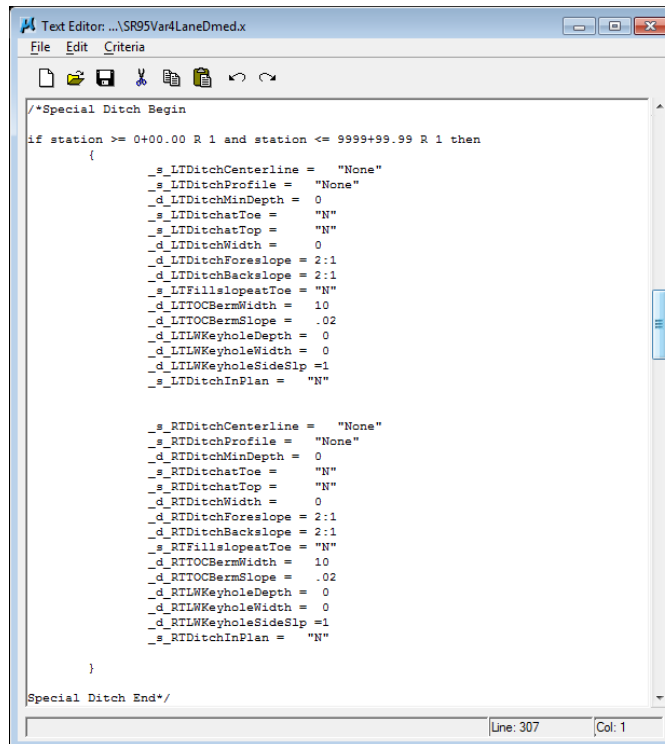
Elevation Control: Minimum Depth of 4'

Ditch Width: 6'

Foreslope: 6:1

Backslope: 2:1

- 1) Access the GEOPAK Text Editor from the Road Tools task group.
- 2) Scroll back up until you see the section for Special Ditches as shown below:



```
Text Editor: ...SR95Var4LaneDmed.x
File Edit Criteria

/*Special Ditch Begin
if station >= 0+00.00 R 1 and station <= 9999+99.99 R 1 then
{
    _s_LTDitchCenterline = "None"
    _s_LTDitchProfile = "None"
    _d_LTDitchMinDepth = 0
    _s_LTDitchchatToe = "N"
    _s_LTDitchchatTop = "N"
    _d_LTDitchWidth = 0
    _d_LTDitchForeslope = 2:1
    _d_LTDitchBackslope = 2:1
    _s_LTDitchFillSlopesToe = "N"
    _d_LTDitchBermWidth = 10
    _d_LTDitchBermSlope = .02
    _d_LTDitchKeyholeDepth = 0
    _d_LTDitchKeyholeWidth = 0
    _d_LTDitchKeyholeSideSlp = 1
    _s_LTDitchInPlan = "N"

    _s_RTDitchCenterline = "None"
    _s_RTDitchProfile = "None"
    _d_RTDitchMinDepth = 0
    _s_RTDitchchatToe = "N"
    _s_RTDitchchatTop = "N"
    _d_RTDitchWidth = 0
    _d_RTDitchForeslope = 2:1
    _d_RTDitchBackslope = 2:1
    _s_RTDitchFillSlopesToe = "N"
    _d_RTDitchBermWidth = 10
    _d_RTDitchBermSlope = .02
    _d_RTDitchKeyholeDepth = 0
    _d_RTDitchKeyholeWidth = 0
    _d_RTDitchKeyholeSideSlp = 1
    _s_RTDitchInPlan = "N"
}
Special Ditch End*/
Line: 307 Col: 1
```

- 3) Following the rules stated for editing this file, copy the special ditch section to the bottom of the file and edit this area so that it looks as follows:

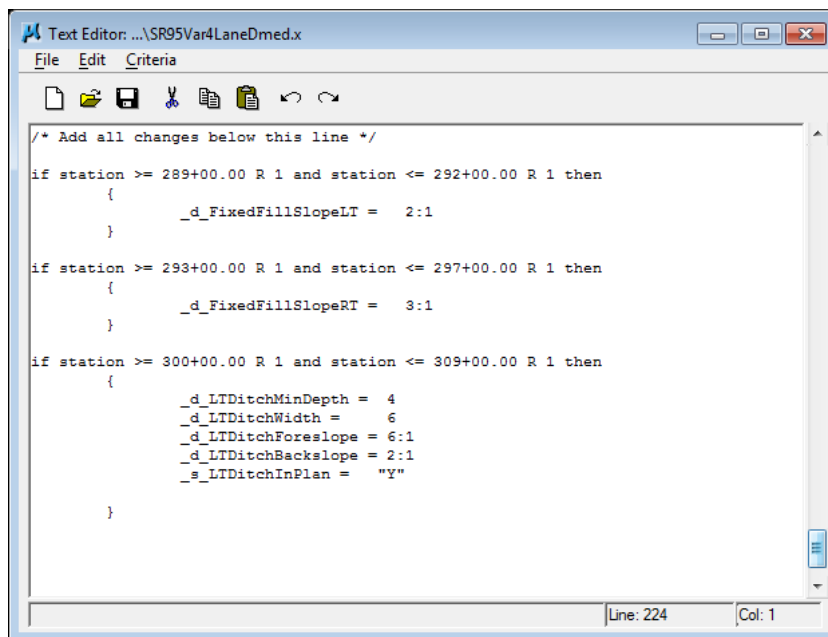
if station >= 300+00.00 R 1 and station <= 309+00.00 R 1 then

```
{
    _d_LTDitchMinDepth = 4
    _d_LTDitchWidth = 6
    _d_LTDitchForeslope = 6:1
    _d_LTDitchBackslope = 2:1
    _s_LTDitchInPlan = "Y"
}
```

- 4) Sometimes, GEOPAK has trouble reading the last line of a criteria file so add a few blank lines at the end of the file to ensure processing without errors.

Exercise 14

- 5) Using the File drop down in GEOPAK text editor, use Save As to save your changes as SR95Var4LaneDmed.x.



```
Text Editor: ...SR95Var4LaneDmed.x
File Edit Criteria

/* Add all changes below this line */
if station >= 289+00.00 R 1 and station <= 292+00.00 R 1 then
{
    _d_FixedFillSlopeLT = 2:1
}
if station >= 293+00.00 R 1 and station <= 297+00.00 R 1 then
{
    _d_FixedFillSlopeRT = 3:1
}
if station >= 300+00.00 R 1 and station <= 309+00.00 R 1 then
{
    _d_LTDitchMinDepth = 4
    _d_LTDitchWidth = 6
    _d_LTDitchForeslope = 6:1
    _d_LTDitchBackslope = 2:1
    _s_LTDitchInPlan = "Y"
}
}

Line: 224 Col: 1
```

c) Special Design Case 3 – Urban Fixed Slopes

To minimize encroachment on properties in the urban section, it has been stipulated that we may use 3:1 slopes instead of normal variable slopes in that area from Station 328+25 to Station 347+50.

Fixed Cut Slope Left: 3:1

Fixed Fill Slope Left: 3:1

Fixed Cut Slope Right: 3:1

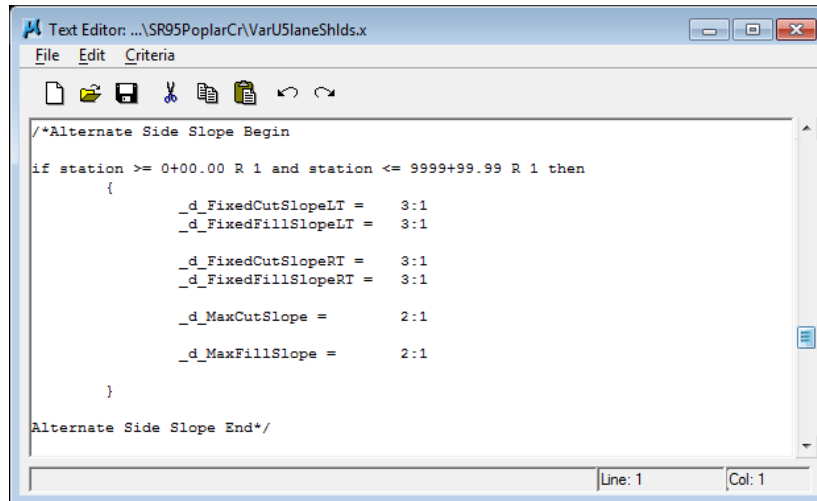
Fixed Fill Slope Right: 3:1

To handle each of these situations, we'll need to edit the appropriate variable criteria file. Each Typical Section has its own variable file. It can be determined by looking at the first criteria file name listed for the left side slope set up for any given roadway shape cluster. On this project they are as follows:

Typical Section	Variable Filename
4LNDMD (4 Lane with Depressed Median)	Var4LaneDmed.x
5LNUS (5 Lane Urban with Shoulders)	Varu5LaneShlds.x

- 1) Since this scenario is in a section of our project covered by the typical 5LNUS, we'll need to use the appropriate variable file to make our changes.

Using the File pull drop down in GEOPAK text editor, open the variable file Varu5LaneShlds.x located in your project directory. Scroll down until you see the section for Side Slopes as shown below:



```
Text Editor: ...SR95PoplarCr\Varu5LaneShlds.x
File Edit Criteria
[*Alternate Side Slope Begin
if station >= 0+00.00 R 1 and station <= 9999+99.99 R 1 then
{
    _d_FixedCutSlopeLT = 3:1
    _d_FixedFillSlopeLT = 3:1
    _d_FixedCutSlopeRT = 3:1
    _d_FixedFillSlopeRT = 3:1
    _d_MaxCutSlope = 2:1
    _d_MaxFillSlope = 2:1
}
Alternate Side Slope End*/
```

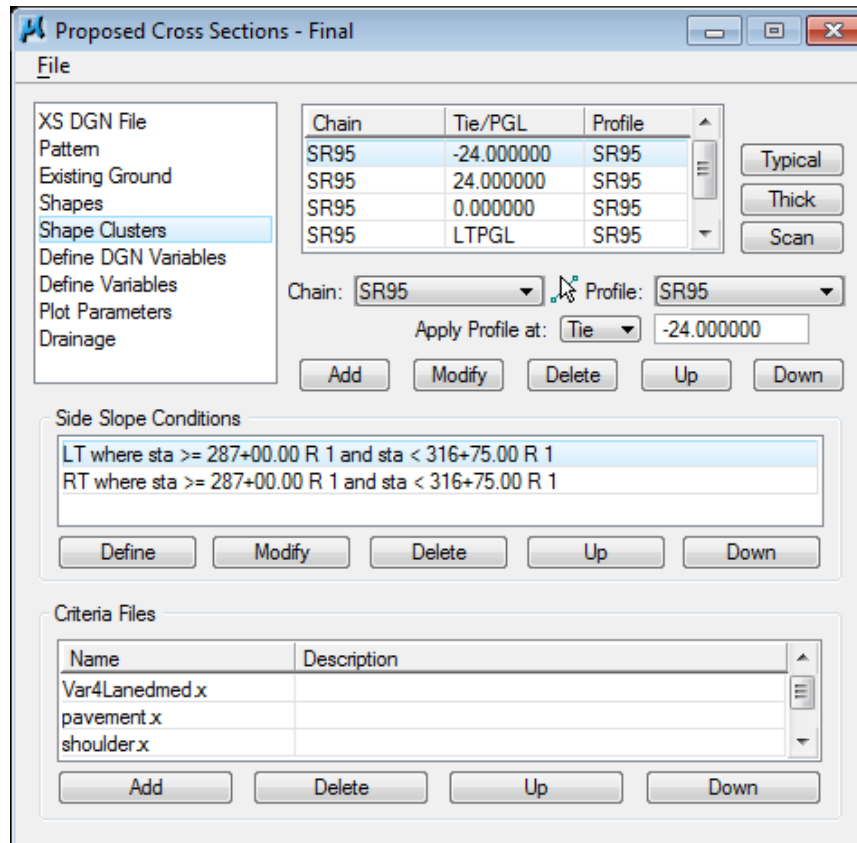
- 2) Copy this section to the bottom of the file and edit this area of the variable file so that it looks as follows:

```
if station >= 328+25.00 R 1 and station <= 347+50.00 R 1 then
{
    _d_FixedCutSlopeLT = 3:1
    _d_FixedFillSlopeLT = 3:1
    _d_FixedCutSlopeRT = 3:1
    _d_FixedFillSlopeRT = 3:1
}
```

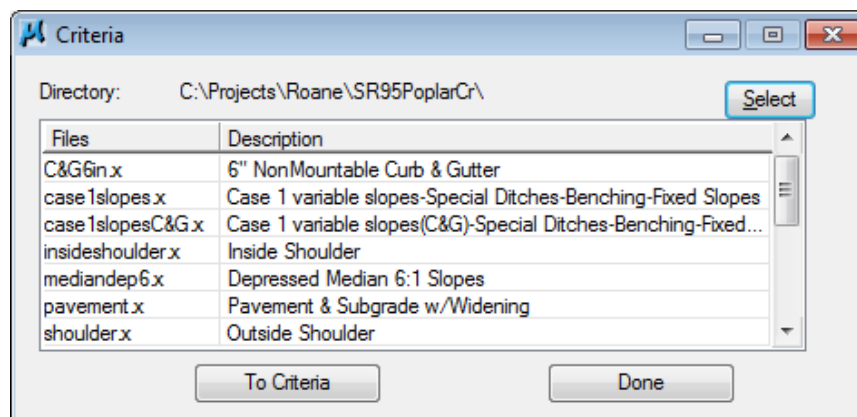
- 3) Using the File drop down in GEOPAK text editor, use **Save As** to save your changes as SR95Varu5LaneShlds.x.
- 4) Exit the GEOPAK text editor.

V.) Re-Assigning Variable Criteria Files

- 1) Return to the Proposed Cross Section dialog and under Shape Clusters select the Shape Cluster identified by Chain=SR95, Tie/PGL=-24 and Profile=SR95.



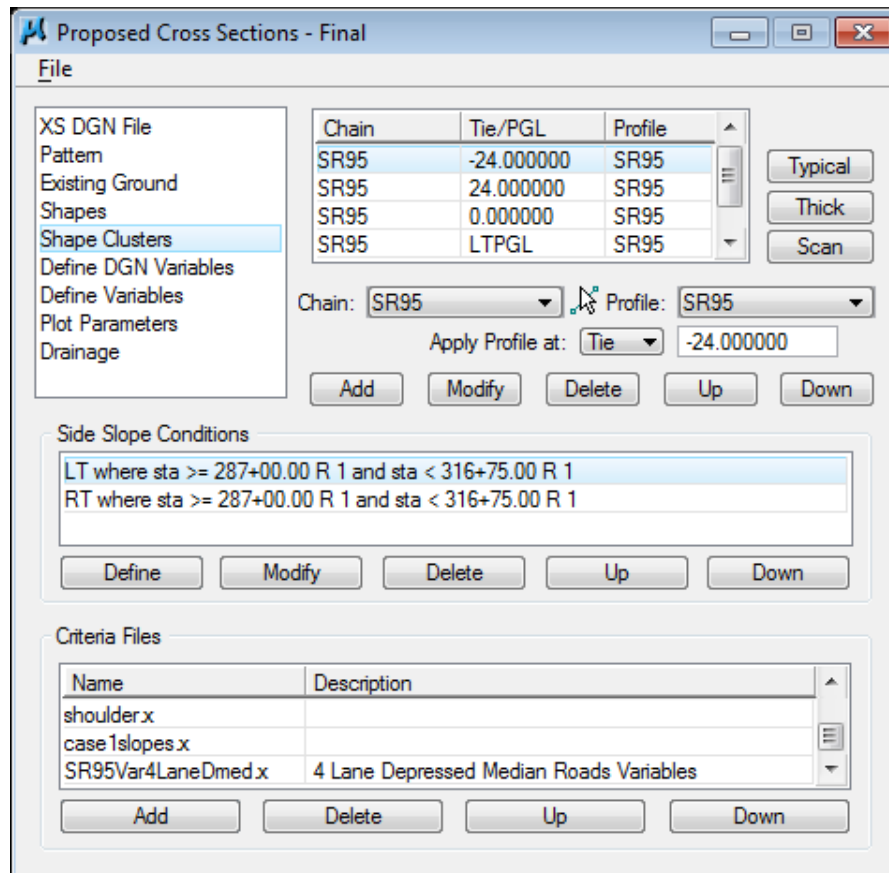
- 2) At the bottom of the dialog below the Criteria File list, press Add and the following dialog will appear.



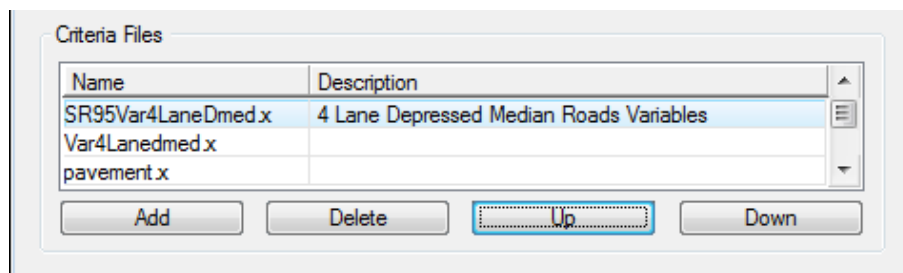
NOTE:

Use the Select button at the upper right of the dialog if you need to change paths to your project working directory.

- 3) Highlight the new variable file SR95Var4LaneDmed.x and then press the To Criteria button or double-click on the file to add the file to the Proposed Cross Section Criteria File list.



- 4) Highlight the new variable file and press the Up as many times as needed to move the file to the top of the Criteria File list.



NOTE:

Since cross sections process from left to right and variables must be defined before other criteria files can be processed, then the variable criteria file must be first in the left slope condition or in some cases where there is no left slope condition, first in the right set up.

Exercise 14

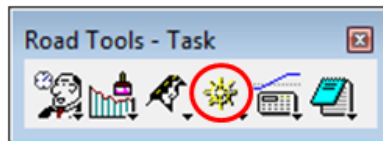
- 5) In the Criteria File area highlight the original variable file, Var4LaneDmed.x at the top of the list and press Delete.
- 6) Answer Yes to delete the criteria file when prompted and the original variable file Var4LaneDmed.x will be removed from the list.
- 7) Select the Shape Cluster identified by Chain=SR95, Tie/PGL=LTPGL and Profile=SR95.
- 8) Repeat previous steps 2-6 to add the new variable file SR95Var4LaneDmed.x and delete the old variable file Var4LaneDmed.
- 9) Select the Shape Cluster identified by Chain=SR95, Tie/PGL=0 and Profile=SR95.
- 10) Repeat previous steps 2-6 to add the new variable file SR95Varu5LaneShlds.x and delete the old variable file Varu5LaneShlds.x.
- 11) We are now finished adding criteria files so can click on the Done button on the Add Criteria dialog.

NOTE:

When replacing variable files, never delete the original file first. Values that have been set under Define Variables will be re-initialized to their original default values so that you would have to set them again for your project.

VI.) Processing Final Proposed Cross Sections

- 1) At this point, we are ready to process our final proposed cross sections. From the Proposed Cross Sections dialog, select drop down option Files → Run.
- 2) Select Screen Only and de-activate the Pause on Each Section toggle.
Press Apply.
- 3) When cross sections finish processing, close the Proposed Cross Sections dialog box and click Yes to save your run when prompted.
- 4) Review your proposed cross sections using XS Navigator. Check the changes that have been made since we originally ran them including:



- (289+00 - 292+00) - 2:1 slopes behind the guardrail on the left
 - (292+00 – 293+50) - Type 38 guardrail terminal pad widening on left at 10:1 slope
 - (293+00 - 297+00) - 3:1 side slopes on the right
 - (300+00 - 309+00) - Special ditch on the left
 - (307+74 – 323+55), (330+66 – 337+95) - Superelevation on our 2 horizontal curves
 - (316+75 - 328+25) - Transition area from 4 lane divided to 5 lane undivided
 - (328+25 - 347+50) - 3:1 side slopes on left & right in the urban section
- 5) Open the Proposed DGN file ROSR95Proposed.dgn and review your slope lines in the following areas:
 - (293+00 - 297+00) - Slope ties pulled inside of existing R.O.W. on right
 - (300+00 - 309+00) - Special ditch on the left
 - (336+00 - 338+50) - Slope ties pulled outside of cemetery area on the right

15 Earthwork

Now that we have final cross sections, we can calculate earthwork for this roadway. In the first part of this exercise, we will go through the procedures to calculate cut & fill quantities where only earth is involved. In part 2, we have a set of cross sections pre-defined on which rock lines have been plotted and some deep cut benching has been developed for the roadway. We will use this data set to process some earthwork where multiple soil types are involved.

NOTE:

Several special non-roadway typical sections are available for plotting rock lines, topsoil lines, existing pavement or un-suitable material onto cross sections using the proposed cross section tool. In the typical list their names all start with P_ (for plot).

I.) Earth Only

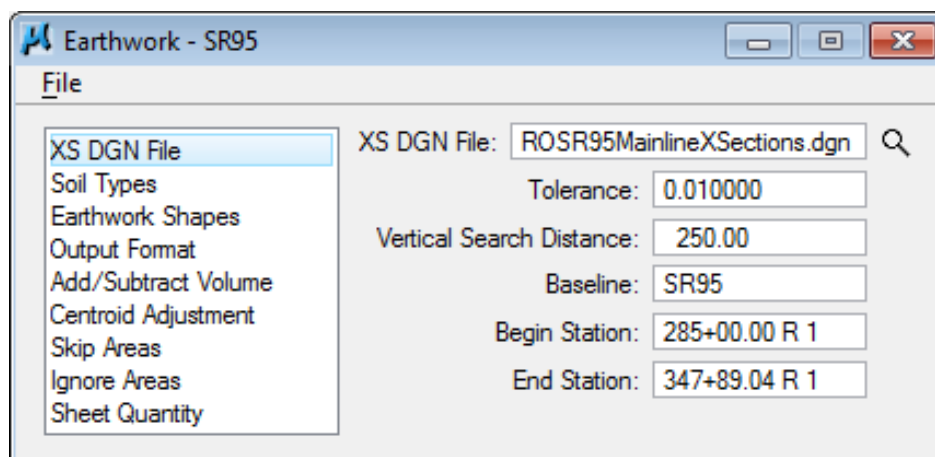
- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

Access Project Manager.

- 2) Choose Earthwork from the Project Manager dialog and create a new run named SR95.

- 3) Populate the XS DGN File section of the dialog as shown below (most settings should fill in automatically from our working alignment definition):



NOTE:

The Vertical Search Distance should never be set at a value greater than 1/2 the distance between cross sections. In our cross sections, that offset distance is 500 feet so we use 250 feet.

If set greater than that, it is possible graphics for one section will be read by the one before or after it. If your graphics go past this half way point, then cross sections will need to be re-generated at a larger distance apart so that the vertical search distance can be set at a higher value.

- 4) In the Soil Types section of the dialog, create the following classifications and soil types utilizing the parameters detailed in the table below.

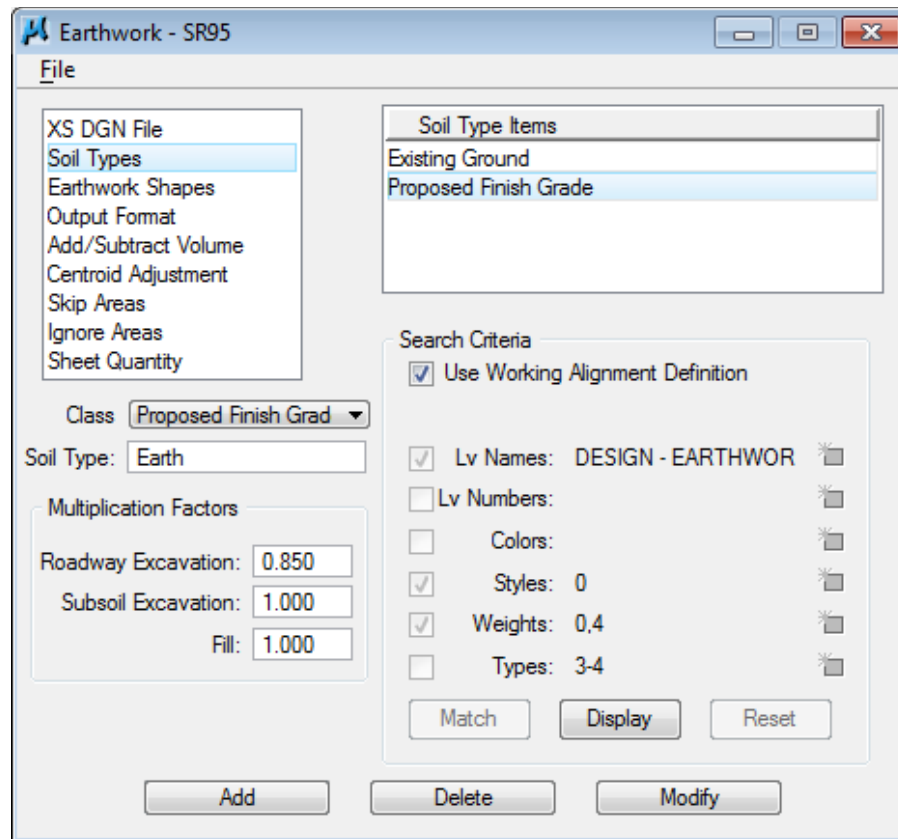
Class	Soil Type	Search Criteria
Existing Ground	Earth	Use Working Alignment Definition
Proposed Finish Grade	Earth	Use Working Alignment Definition

Shrink and Swell factors are set under the Multiplication Factors section. Factors are based on 1 so for a shrinkage of 15% you would set the value 0.85. Set the Multiplication Factor for Roadway Excavation with a value of 0.85. Once a definition is set click the Add button.

NOTE:

If topsoil stripping is desired under fills then you must define Excavation Limit lines in this section. It is the only class that is not an actual soil type. Excavation limit lines are placed by default at slope tie-ins on T.D.O.T. cross sections. The topsoil line itself should be defined as an unsuitable material so that it would not be used as fill material.

Exercise 15



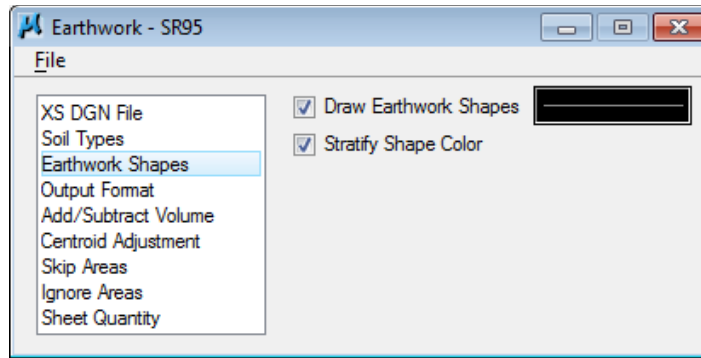
In our case, we are using the Working Alignment Definition to define the symbologies of our materials. If we were not using the Working Alignment Definition, we could manually define the symbologies using the settings in the Search Criteria portion of the dialog. When using these settings, there are also three additional buttons to help you.

Match Prompts you to identify an element. Once you do, it will fill in the symbology settings with the symbology of the identified element.

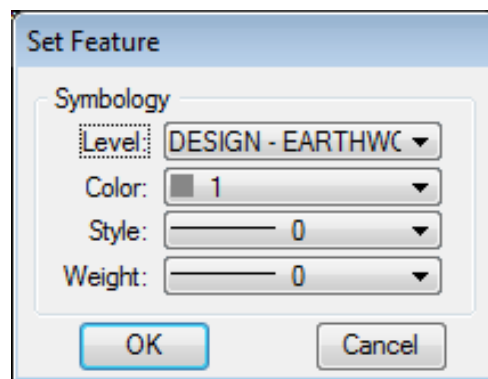
Display Highlights all elements in the design file matching the set symbology.

Reset Clears all symbology settings.

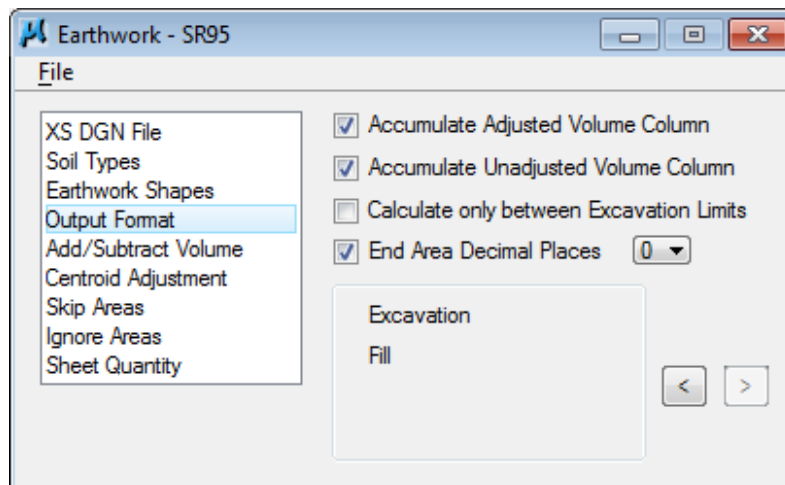
- 5) In the Earthwork Shapes section of the dialog, Toggle on Draw Earthwork Shapes and Stratify Shape Color. Double click on the symbology review area to open the Set Feature dialog.



Populate the dialog with the parameters as shown below. The level name is DESIGN - EARTHWORK - Shapes



- 6) Set the Output Format as shown below.



Use the arrow buttons (< or >) to change the format to Excavation and Fill.

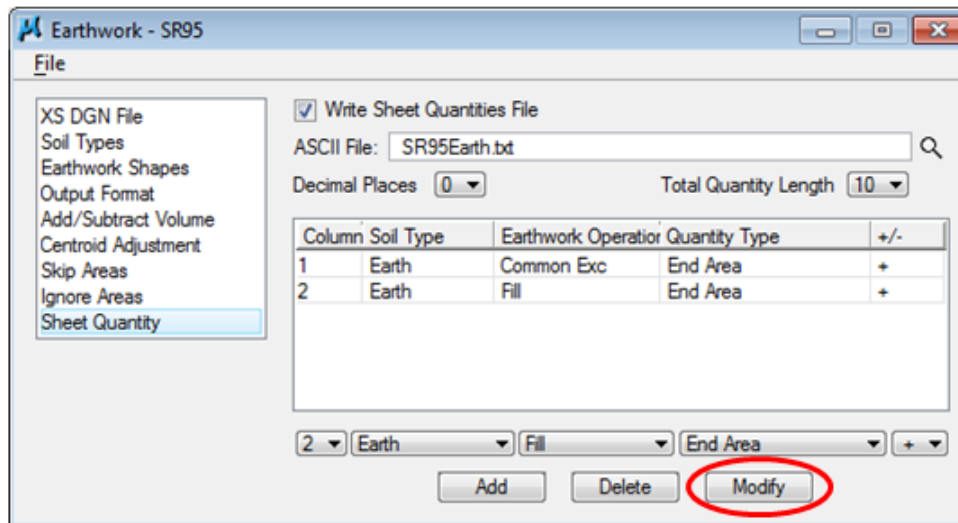
- 7) Skip down to the Sheet Quantity section and toggle on the Write Sheet Quantities File.

Name the file SR95Earth.txt. Add the following columns to the file with Decimal Places = 0 and Total Quantity Length = 10.

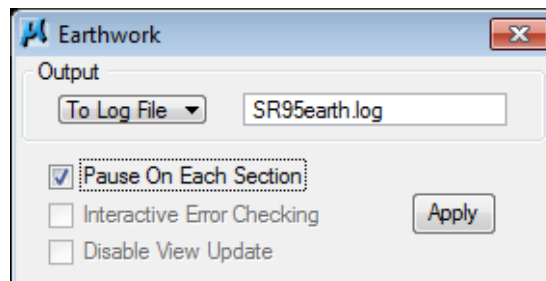
Exercise 15

After setting values at the bottom, click Add to set them up in the list box.

Col.	Soil Type	EW Operation	Quantity Type	+/-
1	Earth	Common Exc	End Area	+
2	Earth	Fill	End Area	+

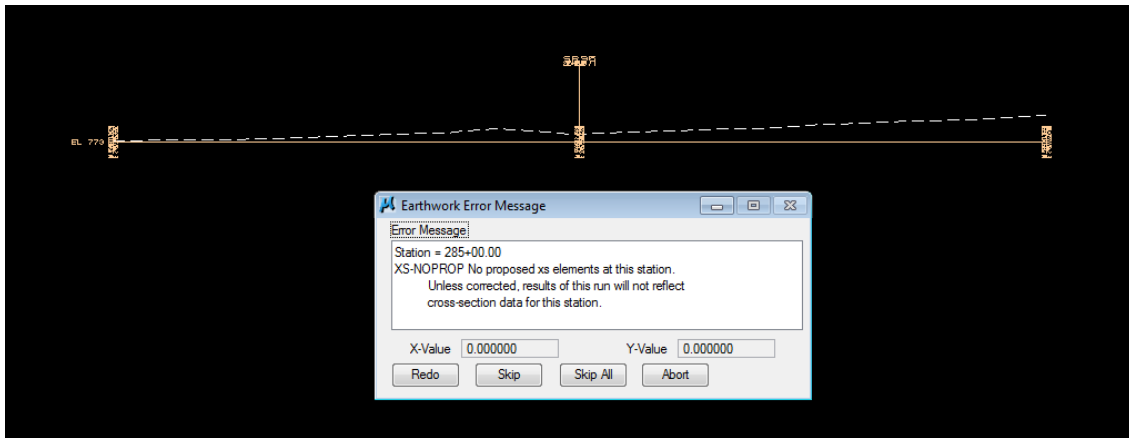


- 8) Using the Files > Run drop down option, run the earthwork for the proposed cross sections. Place your output into a log file as shown in the dialog below and Pause on Each Section. Click Apply to start processing.



If the Pause on Each Section is off the Disable View Update option can be used to eliminate view updates which will reduce the required processing time. This can be an excellent time saver on larger projects.

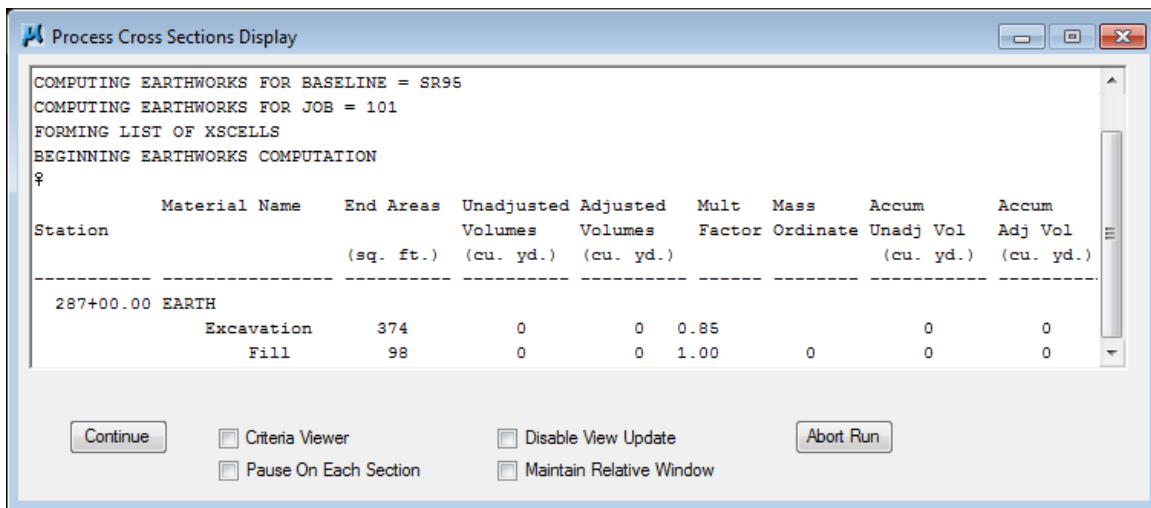
- 9) You will have to skip the first few sections and the last section where there are no proposed cross sections.



If you ever encounter a spot where it says the proposed does not tie with the existing, use MicroStation's Zoom In and click the DP button provided on the earthwork warning box. You will zoom in on the problem spot. If it is between 2 proposed cross section elements, check their symbology to make sure they are correct. If it is at the ground tie in, check to make sure they do in fact intersect.

You should never use the Skip button shown above in bridge or other areas where you do not want earthwork. Instead use Skip Areas & Ignore Areas as described later in this chapter.

- 10) After reviewing the first section at 287+00, turn off the Pause On Each Section option and click Continue.



- 11) When processing is complete, exit the Earthwork dialog and save your run.
- 12) Review the file SR95earth.log using the GEOPAK Text editor. Grand totals and Balance points are listed at the end of the report.

Exercise 15

Process Cross Sections Display

Input File: ewkprj.inp
 Output File: SR95earth.log
 COMPUTING EARTHWORKS FOR BASELINE = SR95
 COMPUTING EARTHWORKS FOR JOB = 101
 FORMING LIST OF XSCCELLS
 BEGINNING EARTHWORKS COMPUTATION

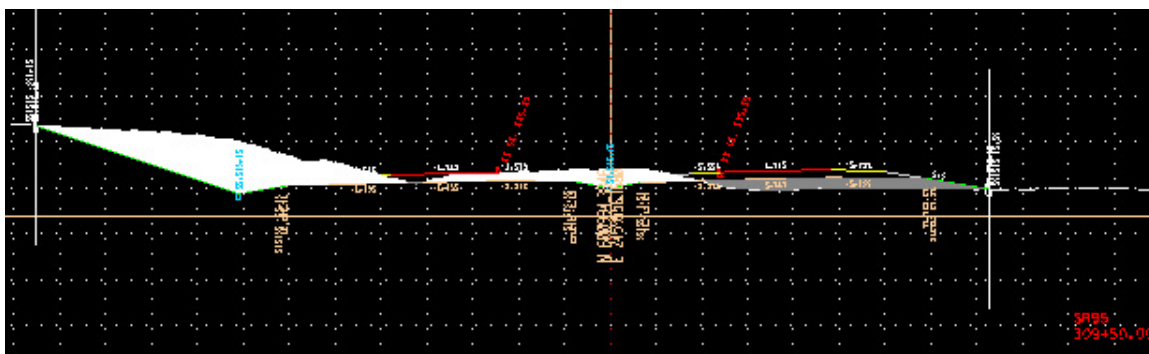
Station	Material Name	End Areas (sq. ft.)	Unadjusted Volumes (cu. yd.)	Adjusted Volumes (cu. yd.)	Mult Factor	Mass Ordinate	Accum Unadj Vol (cu. yd.)	Accum Adj Vol (cu. yd.)
287+00.00	EARTH							
	Excavation	374	0	0	0.85		0	0
	Fill	98	0	0	1.00	0	0	0
287+50.00	EARTH							
	Excavation	306	630	535	0.85		630	535
	Fill	56	143	143	1.00	392	143	143
288+00.00	EARTH							
	Excavation	168	439	373	0.85		1069	908
	Fill	100	144	144	1.00	621	287	287
288+50.00	EARTH							
	Excavation	79	229	194	0.85		1298	1102
	Fill	257	331	331	1.00	484	618	618
289+00.00	EARTH							
	Excavation	53	122	104	0.85		1420	1206
	Fill	372	582	582	1.00	6	1200	1200
289+50.00	EARTH							
	Excavation	45	91	77	0.85		1511	1283
	Fill	603	903	903	1.00	-820	2103	2103

Next Run Exit

NOTE:

The log file is the earthwork documentation to be submitted with plans when turning a job in for construction. This file can be printed on letter size paper from NOTEPAD in landscape mode.

- Review your cross sections using XS Navigator. Notice that GEOPAK has placed shapes onto your cross sections representative of the calculated earthwork areas. These shape areas can be measured to verify earthwork areas if desired. Turn fill on to see where cuts and fills are.



II.) Earth with Rock

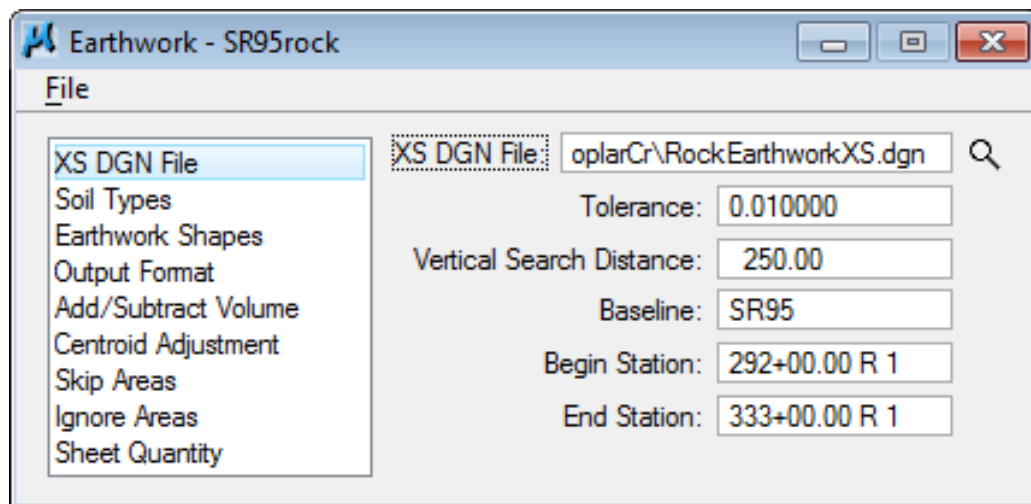
In the second part of this exercise, we'll compute earthwork for a dataset containing rock. To save time going through this exercise, we have already plotted rock lines in on the cross sections.

- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\RockEarthworkXS.dgn

Access Project Manager.

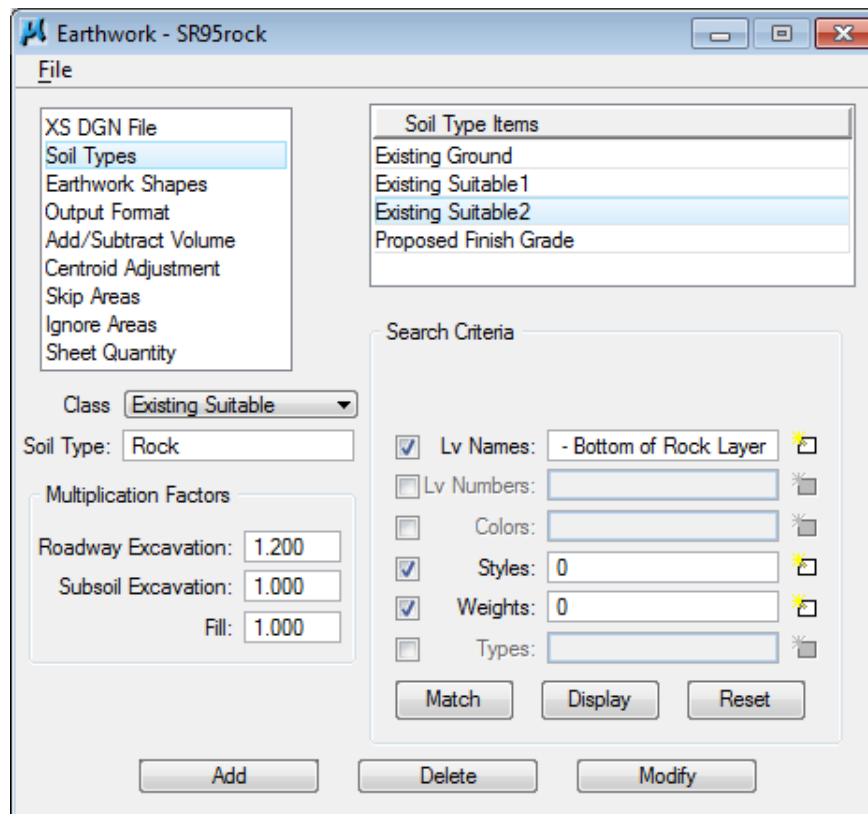
- 2) Choose Earthwork from the Project Manager dialog and create a new run named SR95rock.
- 3) Populate the XS DGN File section of the dialog as shown below:



Exercise 15

- 4) In the Soil Types section of the dialog, create the following classifications and soil types utilizing the parameters detailed in the table below.

Class	Soil Type	Roadway Excavation Multiplication Factor	Search Criteria
Existing Ground	Earth	.85	Use Working Alignment Definition
Proposed Finish Grade	Earth	.85	Use Working Alignment Definition
Existing Suitable 1	Earth	.85	Toggle on Level, Style & Weight
Existing Suitable 2	Rock	1.2	Toggle on Level, Style & Weight



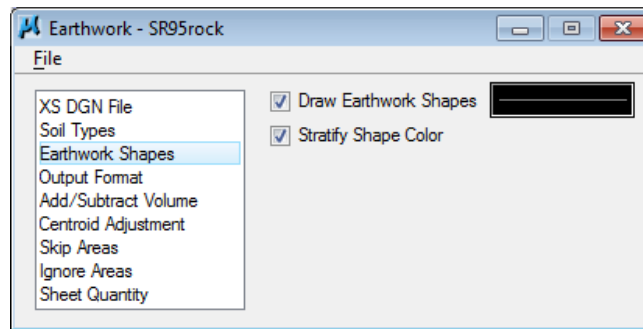
For Existing Suitable 1, click reset, then click match. Then click on the Top of Rock line. Do the same for Existing Suitable 2 except match it with the Bottom of Rock line.

NOTE:

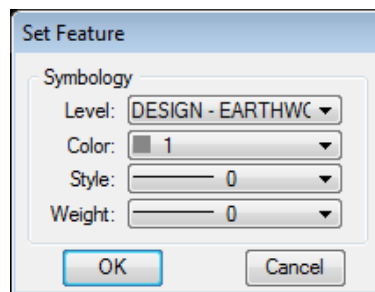
The most important concept to pick up as you set these Soil Types is that any lines found beneath the top of existing ground define the limits of the soil type above them.

In the example we are working, the top of the rock is specified as soil type Earth which is the soil type above that line.

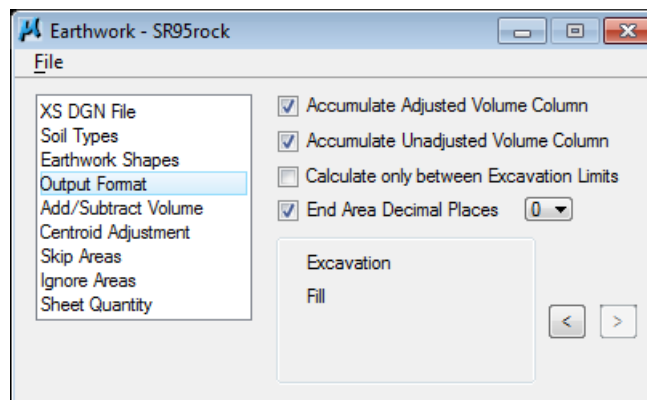
- 5) In the Earthwork Shapes section of the dialog, Toggle on Draw Earthwork Shapes and Stratify Shape Color. Double click on the symbology review area to open the Set Feature dialog.



Populate the dialog with the parameters as shown below. The level name is DESIGN - EARTHWORK - Shapes



- 6) Change the Output Format as shown below.

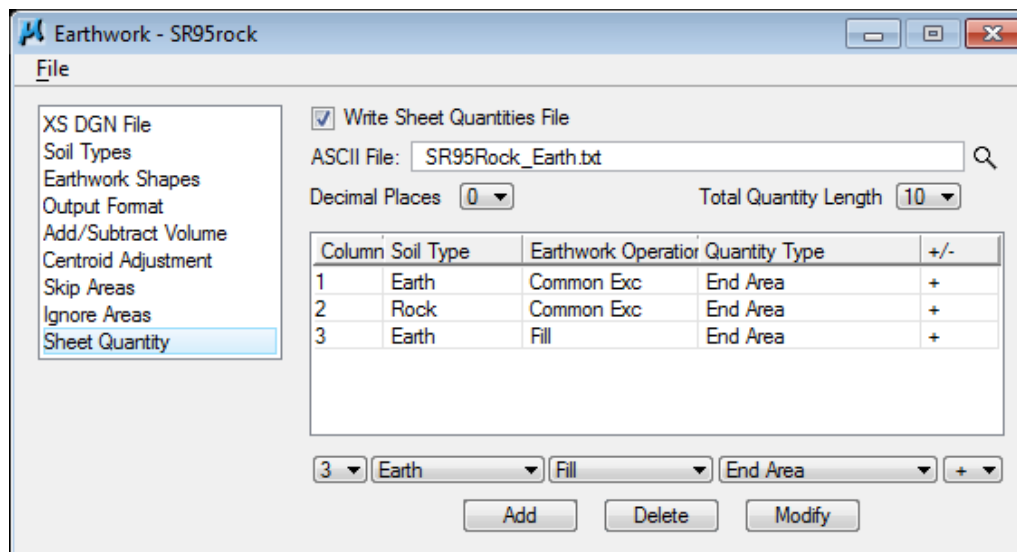


Exercise 15

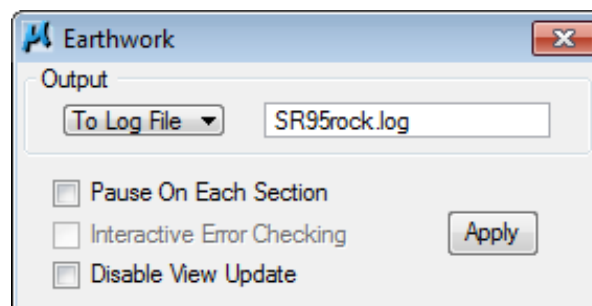
- 7) Skip down to the Sheet Quantity section and toggle on the Write Sheet Quantities File.

Name the file SR95Rock_Earth.txt. Add the following columns to the file with Decimal Places = 0 and Total Quantity Length = 10.

Col.	Soil Type	EW Operation	Quantity Type	+/-
1	Earth	Common Exc	End Area	+
2	Rock	Common Exc	End Area	+
3	Earth	Fill	End Area	+



- 8) Using the Files → Run drop down, run the earthwork for the proposed cross sections. Place your output into a log file as shown in the dialog below and click Apply to start processing.



- 9) Exit the Earthwork dialog and save your run.

- 10) Review the file SR95rock.log using the GEOPAK Text editor.

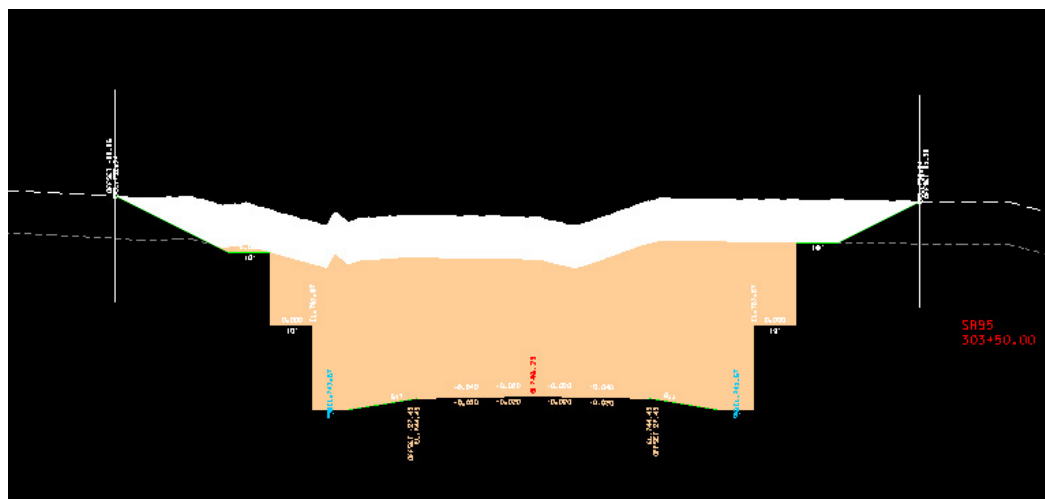
Process Cross Sections Display

COMPUTING EARTHWORKS FOR BASELINE = SR95
 COMPUTING EARTHWORKS FOR JOB = 101
 FORMING LIST OF XSCCELLS
 BEGINNING EARTHWORKS COMPUTATION

Station	Material Name	End Areas (sq. ft.)	Unadjusted Volumes (cu. yd.)	Adjusted Volumes (cu. yd.)	Mult Factor	Mass Ordinate	Accum Unadj Vol (cu. yd.)	Accum Adj Vol (cu. yd.)
292+00.00	EARTH							
	Excavation	1379	0	0	0.85		0	0
	Fill	0	0	0	1.00	0	0	0
	ROCK							
	Excavation	795	0	0	1.20		0	0
	Fill	0	0	0	1.00	0	0	0
292+50.00	EARTH							
	Excavation	1396	2569	2184	0.85		2569	2184
	Fill	0	0	0	1.00	2184	0	0
	ROCK							
	Excavation	894	1564	1877	1.20		1564	1877
	Fill	0	0	0	1.00	4061	0	0
293+00.00	EARTH							
	Excavation	1376	2567	2182	0.85		5136	4366
	Fill	0	0	0	1.00	6243	0	0
	ROCK							
	Excavation	979	1734	2081	1.20		3298	3958
	Fill	0	0	0	1.00	8324	0	0
293+50.00	EARTH							
	Excavation	1364	2537	2156	0.85		7673	6522
	Fill	0	0	0	1.00	10480	0	0
	ROCK							
	Excavation	1109	1933	2320	1.20		5231	6278
	Fill	0	0	0	1.00	12800	0	0

Next Run Exit

- 11) Review your cross sections using XS Navigator. You should see that rock cuts are figured separately from earth cuts.

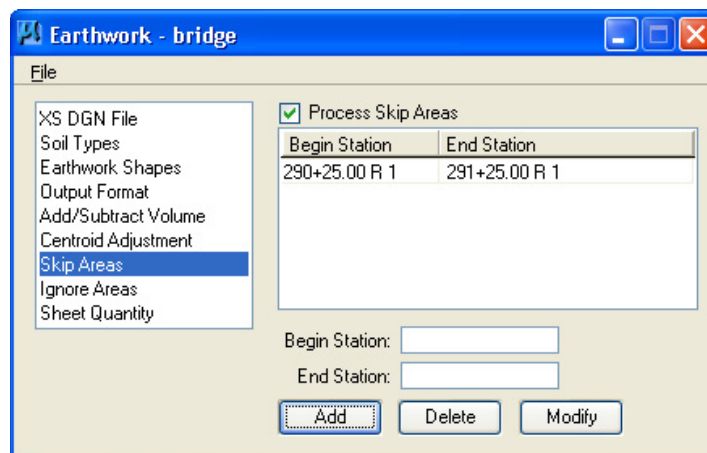


III.) Skip Areas & Ignore Areas

The most common use of Skip Areas and Ignore Areas is to stop earthwork end areas & volumes from being calculated in bridge areas. You cannot use the on the fly Skip option to accomplish this. If you click Skip at any station that earthwork processing stops, then the station is skipped but earthwork will still be calculated across the station which was skipped.

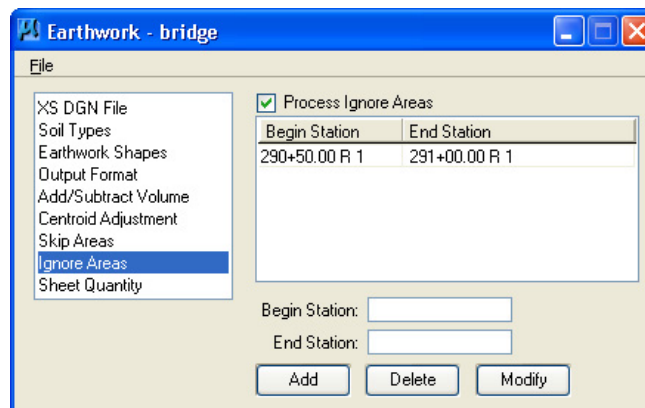
This information is provided for review and reference only.

In the Skip Areas dialog, set up the begin and end stations of the bridge as a skip area to control the limits of earthwork volume calculations. Cross Sections at these stations must be cut with the proposed roadway placed on them in the cross section DGN file in order for Geopak to correctly calculate the earthwork.

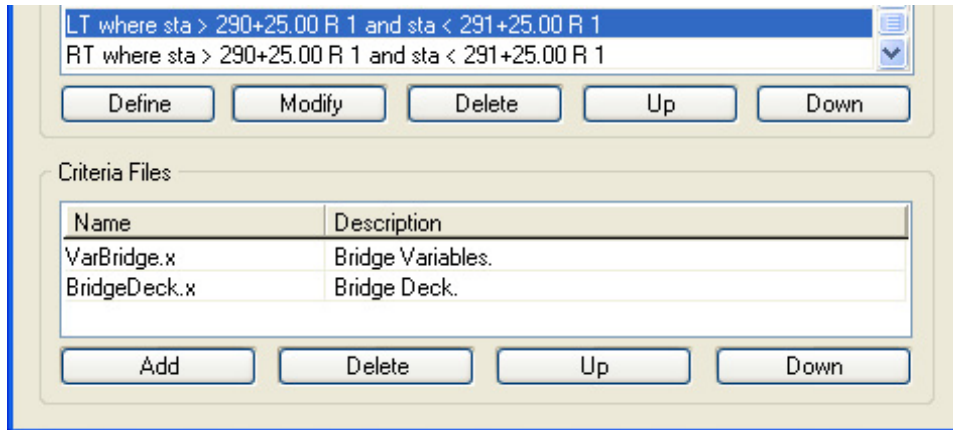


To get GEOPAK to completely ignore the proposed bridge cross section stations, we must set up both Skip Areas and Ignore Areas.

We do not need end areas calculated at proposed bridge cross sections so we also need to set up the Ignore Areas section of Earthwork. The station range should be set to the first station beyond the beginning of the bridge and the last station before the end of the bridge.



In proposed cross section runs, the station limits for the proposed bridge deck should be set to be greater than the begin bridge station and less than the end bridge station. The cross sections at the begin bridge station and at the end bridge station should show the proposed roadway with slopes not the bridge deck. The begin and end stations are used for volume calculations with the cross sections before and after the skipped area.



When set up and processed correctly, the Skip Area station range is shown in the earthwork log file but the earthwork volume totals shown at the begin and end station of the bridge are the same. Due to the settings made in Ignore Areas, no end area data is given for the stations between the begin & end.

Process Cross Sections Display

289+50.00	EARTH							
	Excavation	308.5	639	543	0.85		7792	6622
	Fill	39.6	37	37	1.00	6585	37	37
290+00.00	EARTH							
	Excavation	286.1	551	468	0.85		8343	7090
	Fill	85.6	116	116	1.00	6937	153	153
SKIP STATION RANGE = 290+25.00 to 291+25.00								
290+25.00	EARTH							
	Excavation	278.0	261	222	0.85		8604	7312
	Fill	110.9	91	91	1.00	7068	244	244
291+25.00	EARTH							
	Excavation	369.5	0	0	0.85		8604	7312
	Fill	12.6	0	0	1.00	7068	244	244
291+50.00	EARTH							
	Excavation	410.5	361	307	0.85		8965	7619
	Fill	0.0	6	6	1.00	7369	250	250
292+00.00	EARTH							
	Excavation	555.6	895	760	0.85		9860	8379
	Fill	0.0	0	0	1.00	8129	250	250

Next Run Exit

16. Cross Section Sheets

In this exercise, we will take our proposed cross sections and earthwork end areas calculated in the last exercise and put them on sheets.

NOTE:

GEOPAK's Cross Section Sheet layout tool attaches each cross section as a reference file. As long as no major changes in the proposed profile are made, any updates done to the original working cross sections will be reflected on the sheets.

- 1) Open the following MicroStation file:

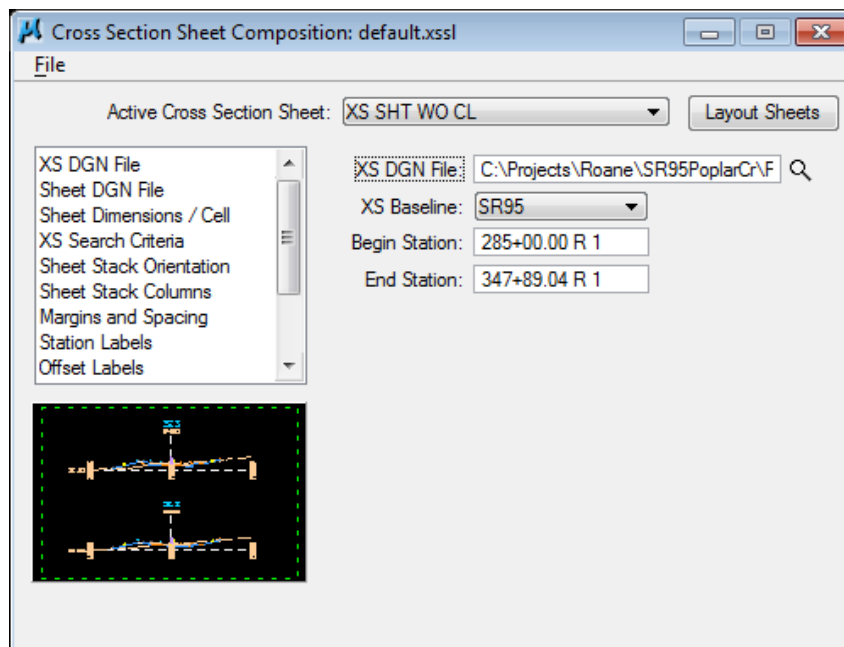
C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSSheets.sht

NOTE:

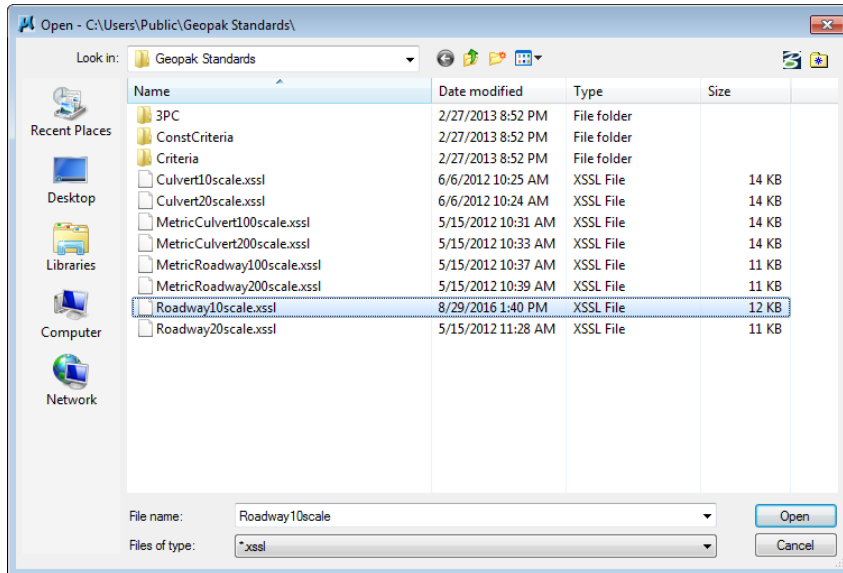
When creating a new cross sections sheet design file, always use the seed file SeedXS.dgn. This file has special settings which are different from the normal seed2d.dgn DGN seed file. This is required for proposed cross section design files and should be used for cross section sheet design files as well to ensure correct scaling of text, sheet cells, etc.

Access Project Manager.

- 2) Choose Cross Section Sheets from the Project Manager workflow dialog and create a new run named SR95. The Cross Section Sheet dialog is displayed.

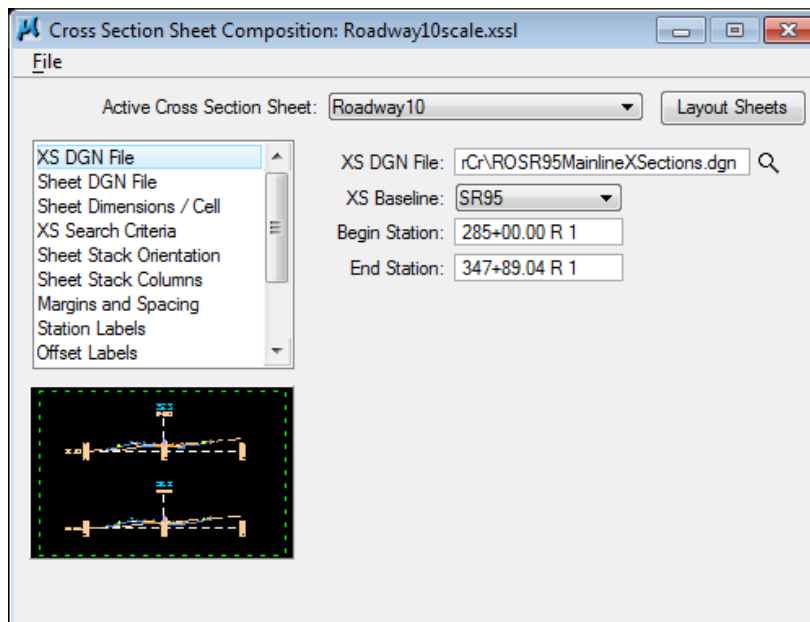


- 3) Go to the drop down option File > Sheet Library > Attach. When prompted go to T.D.O.T.'s Geopak Standards directory **C:\Users\Public\Geopak Standards** and load **Roadway10scale.xssl**.



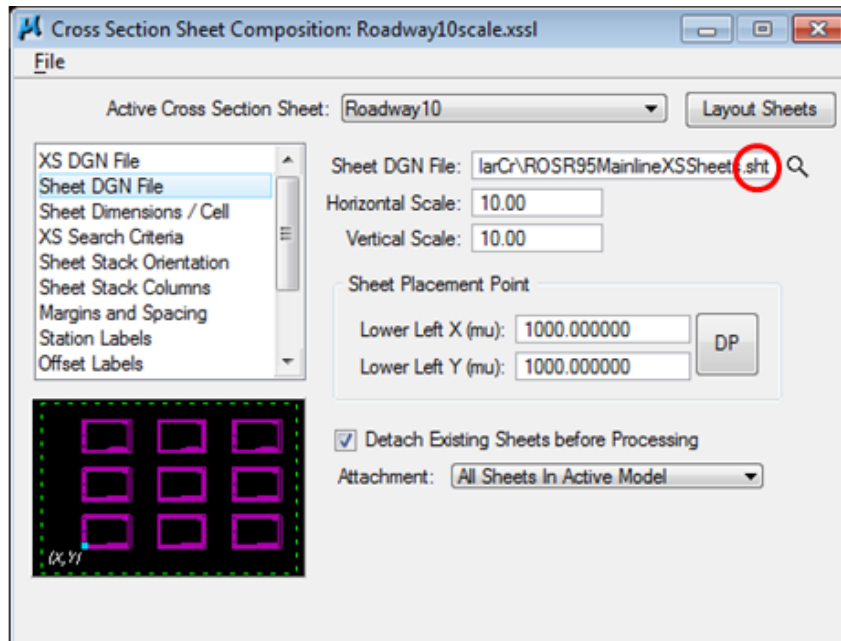
As you can see there are sheet types available for 10 or 20 scale, roadway or culvert cross sections for use on English projects as well as 100 or 200 scale for metric projects. These files make all non-project specific set up for cross section sheet generation.

- 4) Make sure that the XS DGN portion is filled out correctly from our working alignment definition.

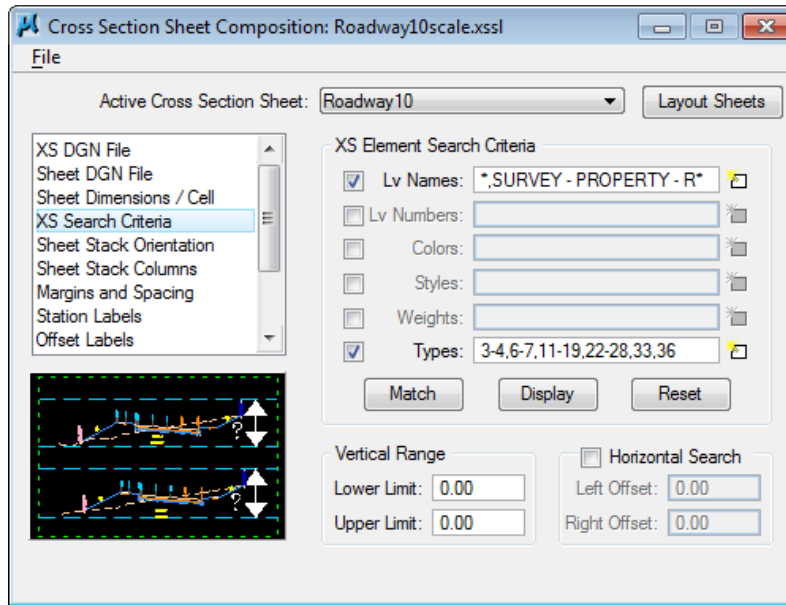


Exercise 16

- 5) Under Sheet DGN use the browser button to select ROSR95MainlineXSSheets.sht to place our sheets in. If needed, you can set the sheet placement point. For this exercise, we will use 1000, 1000. Make sure the option Detach Existing Sheets before Processing is clicked on so that if you need to re-generate cross section sheets you will not have to delete old sheets. The Attachment option should be set to All Sheets In Active Model.



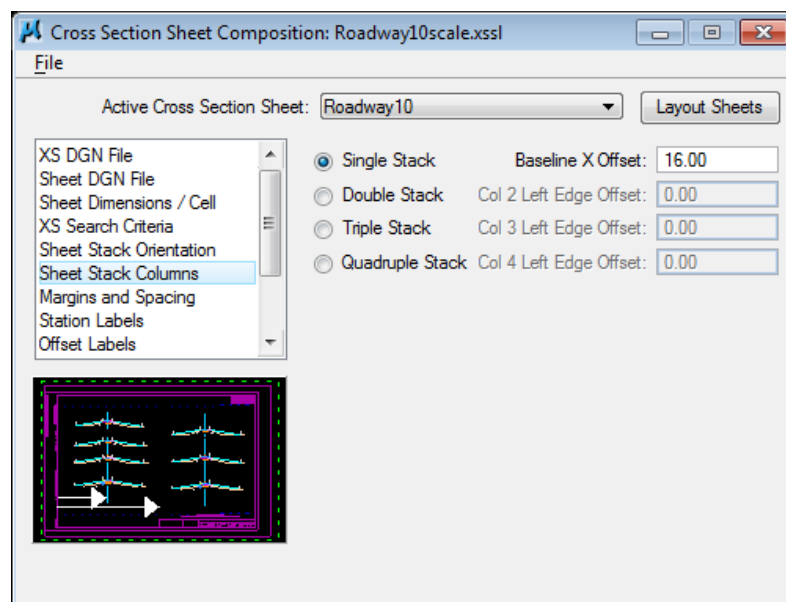
- 6) Skip down to XS Search Criteria and review the settings which should be set already and appear as shown. Lv Names and Types should be on. Lv Names must be set using the wild card symbol (*) due to limited field length and should be entered as
Default,DESIGN - DRAIN*,DESIGN - LINE*,DESIGN - ROW - R*,DESIGN - TYPICAL - B*,DESIGN - TYPICAL - F*,DESIGN - TYPICAL - G*,DESIGN - TYPICAL - R*, DESIGN - TYPICAL - S*,DESIGN - TYPICAL - T*,*Tops*,*Unsuitable*,SURVEY - GROUND - T*,SURVEY - GROUND - E*,SURVEY - PROPERTY - R*



NOTE:

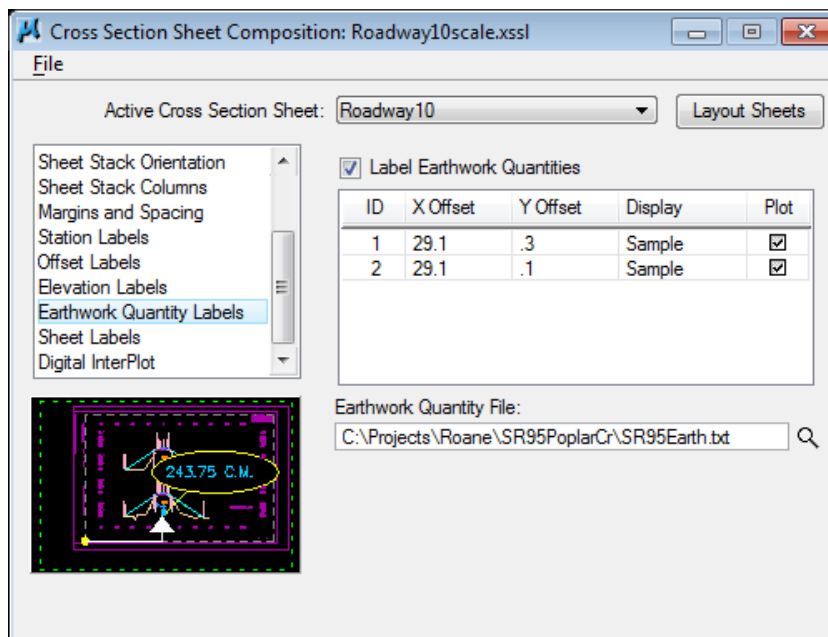
These settings are used to find cross section elements and use them to set the clipping limits for that cross section's reference. The actual elements shown are controlled by what levels are turned on in the original cross section file at the time of sheet generation (cross section reference attachment). In step 12, we will go back to our working cross section file to make sure the correct levels are shown.

- 7) Skip down to Sheet Stack Columns and review the setting for the Baseline X Offset. This value is based on inches from the left side of the sheet. If you ever need shifted cross sections so that left or right has more coverage adjust this value. Our cross sections need to be centered on the sheet so we can use this as is.

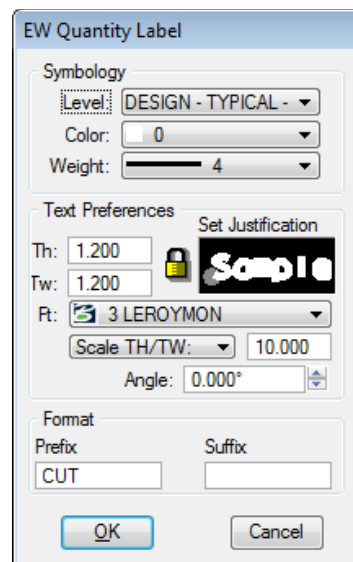


Exercise 16

- 8) Scroll down to Earthwork Quantity Labels. Click on the browser button to select our earthwork text file which contains our end areas, SR95Earth.txt.



- 9) Double click on the word Sample under Display for the first item in the list. From our earthwork exercise we set up item 1 as cut and item 2 as fill so item 1 needs the prefix CUT. That is the default so we do not need to change what is set. Click OK to keep the current settings.



- 10) We set up item 2 as fill so it needs the prefix FILL. Double click on the word Sample for the second item in the list. Again that is the default so we do not need to change what is set. Click OK to keep the current settings.

NOTE:

Our most common earthwork set up is just for earth cut & fill which are the default prefix settings. In other cases such as with roadways that include rock cuts or topsoil removal there may be additional earthwork data items. In those cases you would need to specify these prefixes as EARTH CUT, ROCK CUT or TOPSOIL. In some cases you may have special areas of fill items that might need to be specified such as EARTH FILL and SOLID ROCK FILL. The setting of these prefixes should be based on the order in which you set them up when calculating the earthwork.

When you identify the earthwork text file it is reviewed for the number of earthwork data items and will automatically add controls for any additional items. In those cases you will need to make all of the settings to control placement location as well as level, symbology, etc. Use the following as a guideline when you make these settings:

X Offset: 29.1

Y offset (0.2 increments): .3, .1, -.1, -.3

Level: DESIGN - TYPICAL – Text

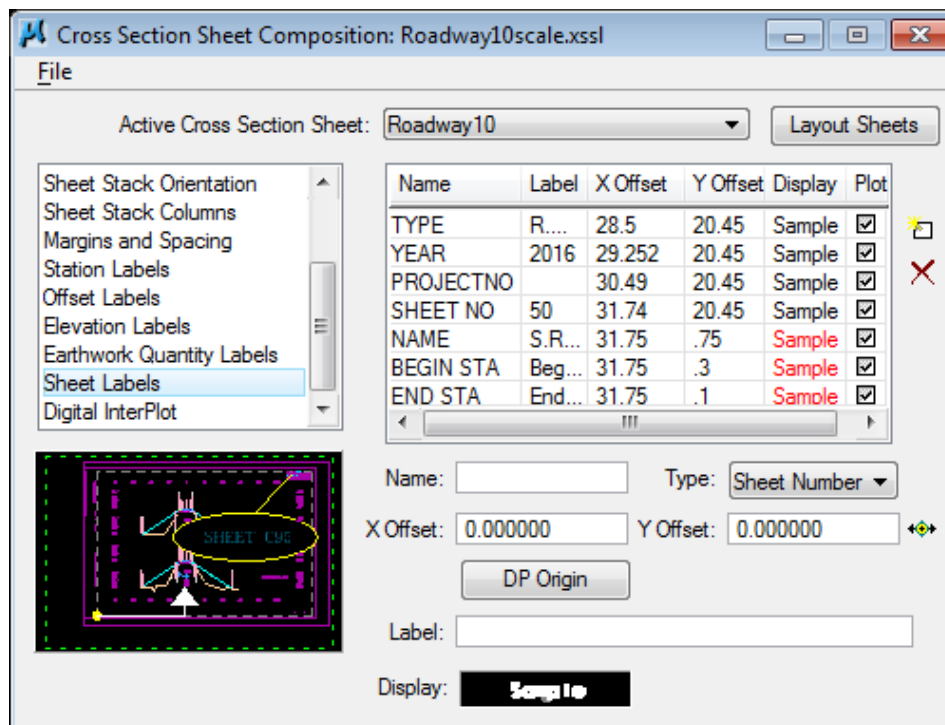
Color: 0

Weight: 4

Th & Tw (text height & width): 1.200

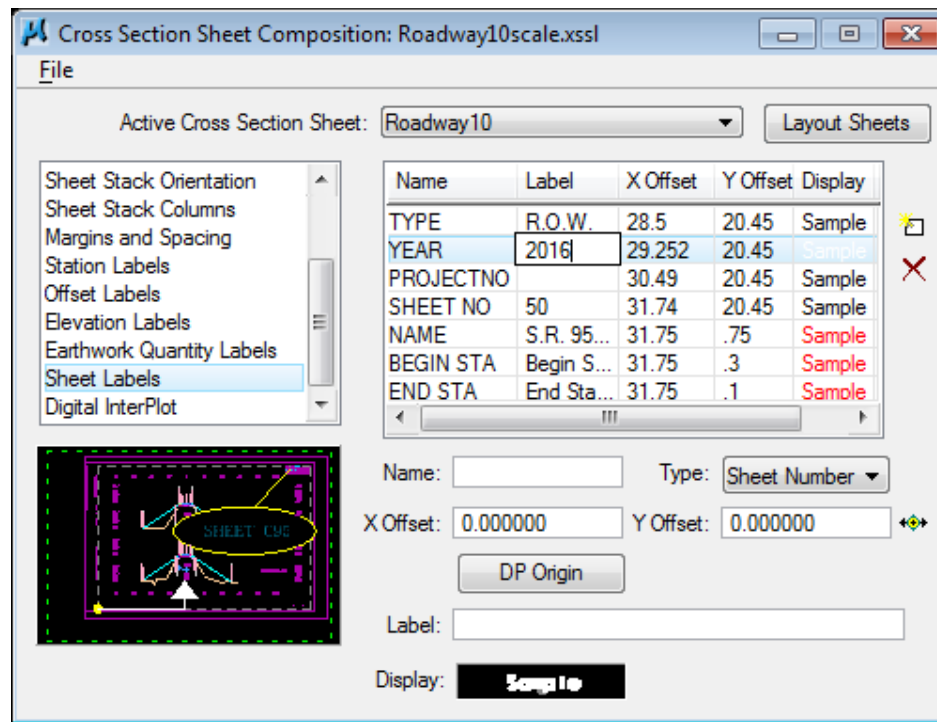
Ft (font): 3 LEROYMON Scale: 10

- 11) Go to Sheet Labels. By default roadway cross section sheets are set up to place project data in the upper right corner as well as a name and the cross section limits of the sheet in the lower right corner. If you know the project number, it could be entered at this point.

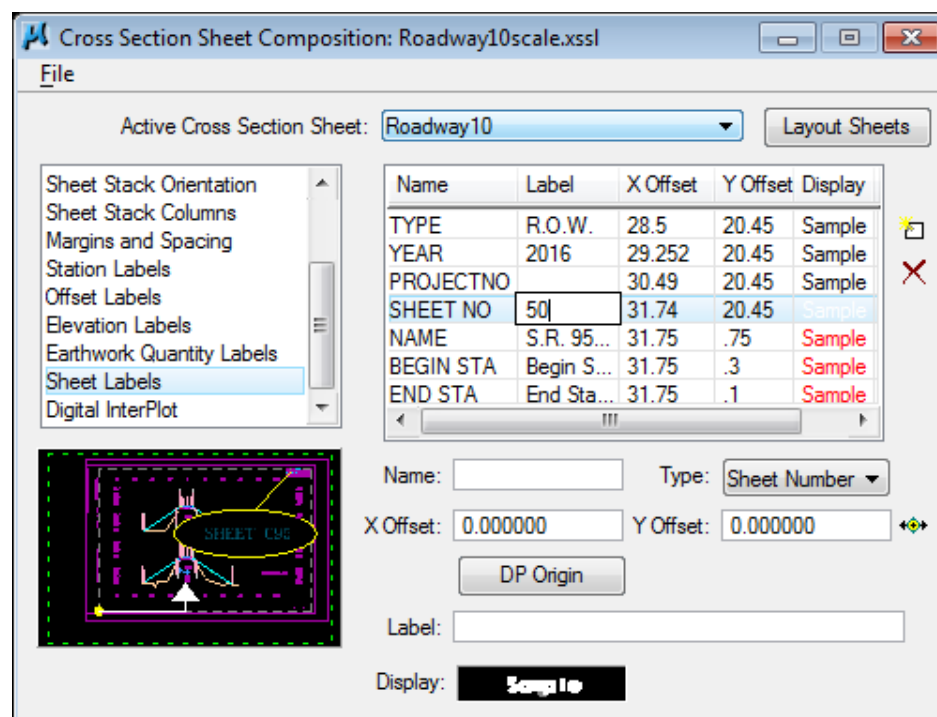


Exercise 16

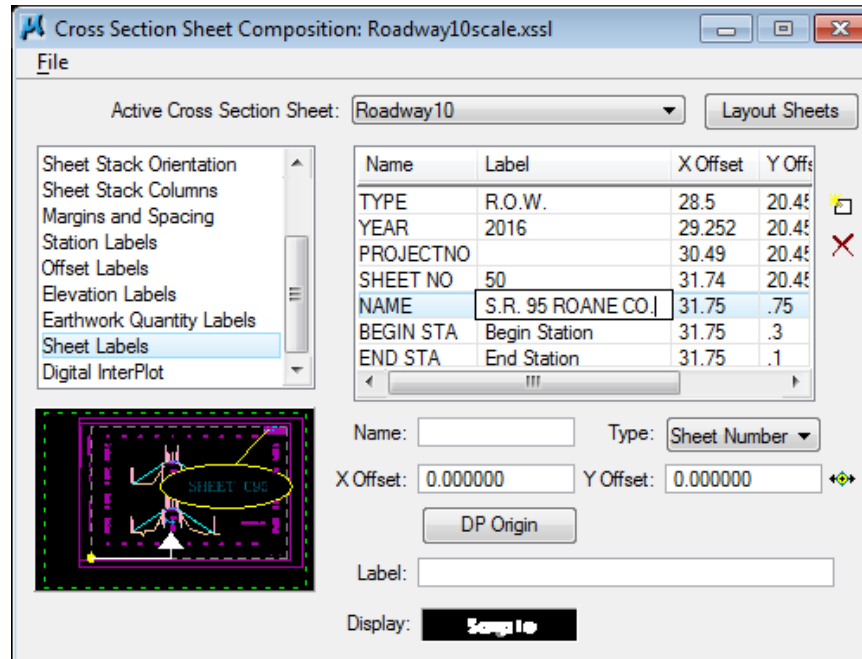
Double click in Label field for the item YEAR, key in the current year and hit enter. You may wish to expand the column by clicking on the divider line in the header and dragging to the right.



Double click in Label field for the item SHEET NO, key in 50 and hit enter. This value is used as the beginning sheet number.



Double click in Label field for the item NAME and enter S.R. 95 ROANE CO. and hit enter. **Each Cross Section Sheet must be labeled with the name of the roadway or side road as it is labeled on the Present and Proposed Layout Sheets in the bottom right corner of the Cross Sections.**



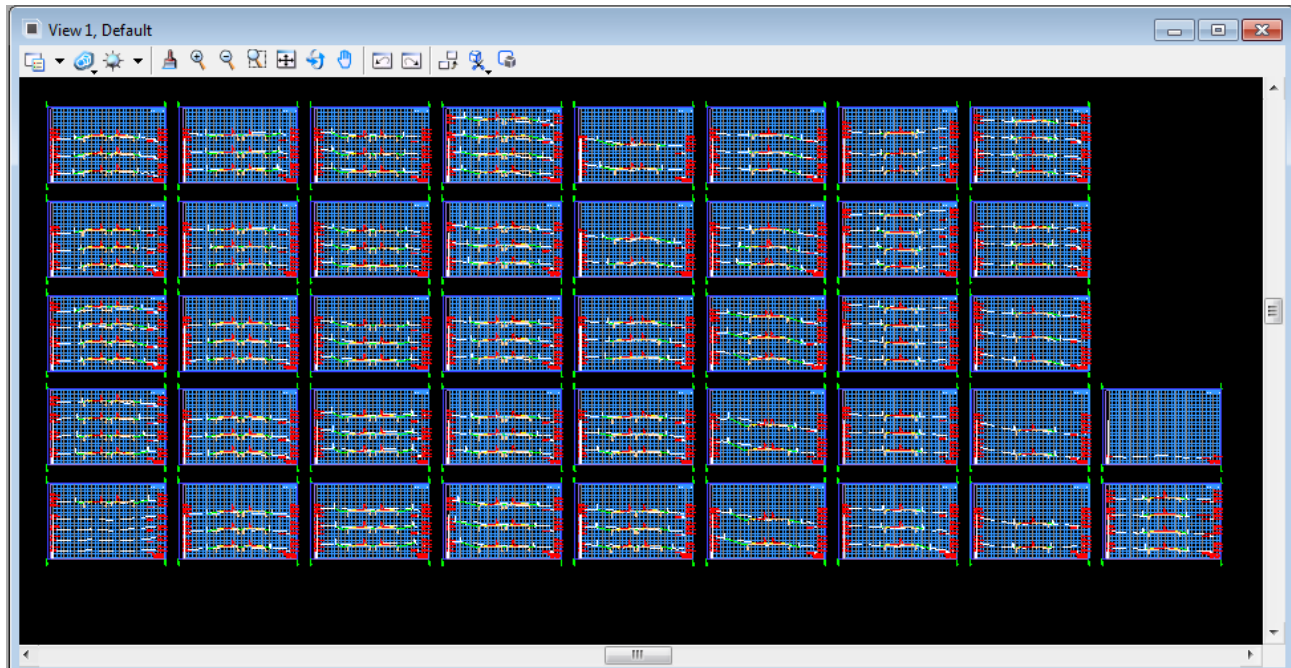
Any of the Sheet Label values can be changed in this manner. Additional items for annotation can be set in the lower part of the dialog and added with the Add New Label icon on the side of the list box.

NOTE:

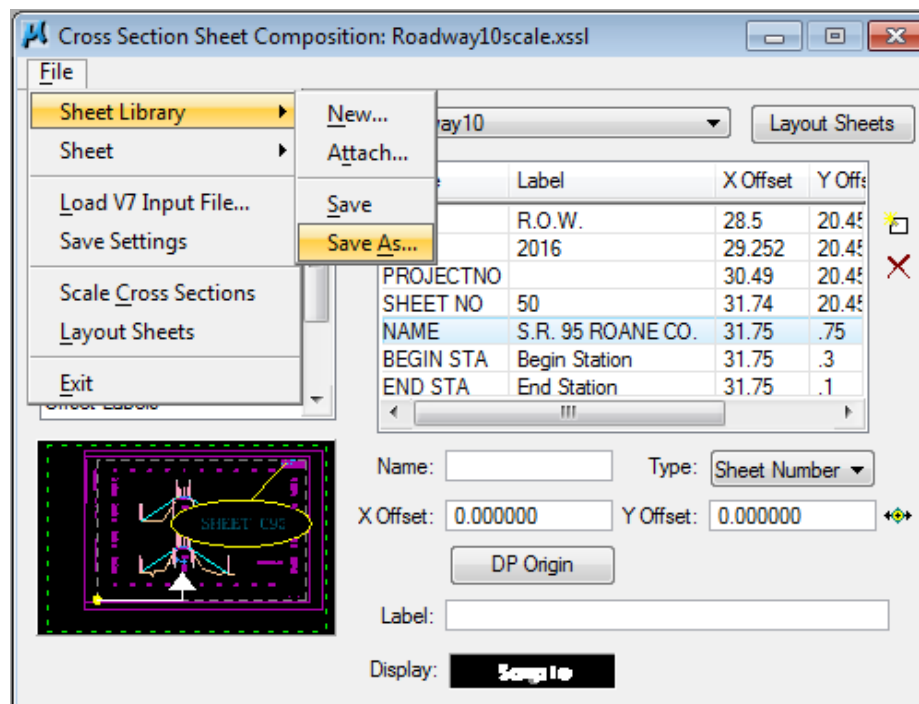
Culvert cross section sheets are set up to place a standard title block layout in the lower right corner of the culvert cross section sheet.

- 12) Before we generate our cross section sheets, open up file ROSR95MainlineXSections.dgn and use the level filter Sheets – Roadway Cross Sections to set the levels on in view 1, Save Settings for the DGN file and then re-open ROSR95MainlineXSSheets.sht.
- 13) Process the cross sections onto sheets by clicking on the Layout Sheets button on the upper right of the Cross Section Sheet Composition dialog.
- 14) Check out your sheets and if needed, make adjustments to your settings and layout again.

Exercise 16



- 15) In order to save all settings that have been applied to set up our cross section sheets we need to save it out as a separate cross section sheet library. Go to the drop down option File > Sheet Library > Save As ...



- 16) Navigate to your project folder C:\Projects\Roane\SR95PoplarCr, set the name to SR95Roadway10scale.xssl and click Save. In the future when you come back to this run, this cross section sheet library will automatically be opened for you.

- 17) Exit the Cross Section Sheet Composition dialog and save your run.
- 18) One additional tool for cross section sheets we will look at is the Place and Annotate Cross Section Sheets program. We have already placed sheets so we will not need those but here we show its use to place plot borders and additional project data annotation.

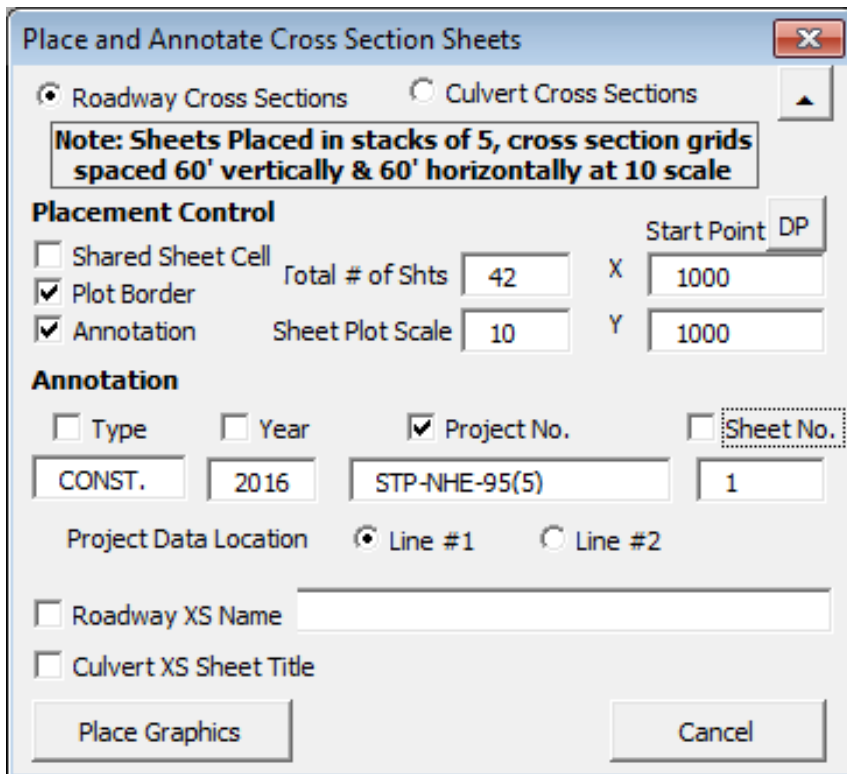
From the Menu Bar in MicroStation, access the following pull down tool:
 T.D.O.T. → Cross Sections → Place and Annotate XS Sheets

This tool is also available from D&C Manager at
 Drafting Standards → Cross Sections → XS Sheets

Our sheets were placed as shared cells so we need plot borders for them and we want to add our project number so first click on those 2 options under Placement Control. Set the total number of sheets to 42 and make sure the scale is set to 10.

Under Annotation, click off all options except Project No. as shown. In the Project No, keyin field enter STP-NHE-95(5). It is not necessary to clear the other keyin fields of their default values.

Under Project Data Location set the option to Line #1.



Exercise 16

- 19) Click on Place Graphics. Look at the upper right corner of your sheets. They should now include the project number.

TYPE	YEAR	PROJECT NO.	SHEET NO.
R.O.W.	2016	STP-NHE-95(5)	89

If you check, you should also find a plot borders overlaying the cross section sheet cells which were placed as shared cells.

We have shown this placement of the project number separately from where it could have been entered in GEOPAK's Layout Cross Section Sheets tool on purpose since this number is often not available at the time of initial sheet generation.

NOTES:

Cross section sheets are placed as shared cells to reduce the file size. Due to the large number of elements and large numbers of sheets often required, this can increase the file size tremendously. Shared sheet cells show a plot border which is a part of the regular cell but since they do not contain the actual graphics, plotting software will not recognize them for automatic batch plotting which necessitates the placement of the plot border by itself.

If at some point in the future project numbers or perhaps the year changes, you should use MicroStation's Find/Replace Text tool to edit that text all at one time in a single DGN file or for multiple DGN files use T.D.O.T. Roadway Design Division's DGN Batch Text Editor.

When preparing the cross section sheets for construction turn in, use the Place and Annotate Cross Section Sheets tool as shown in the previous 2 steps to put in the construction project data information with the Project Data Location set to Line #2.

- 20) To prepare cross section sheets for plotting, levels should be set as needed in the cross section sheet DGN file ROSR95MainlineXSSheets.sht.

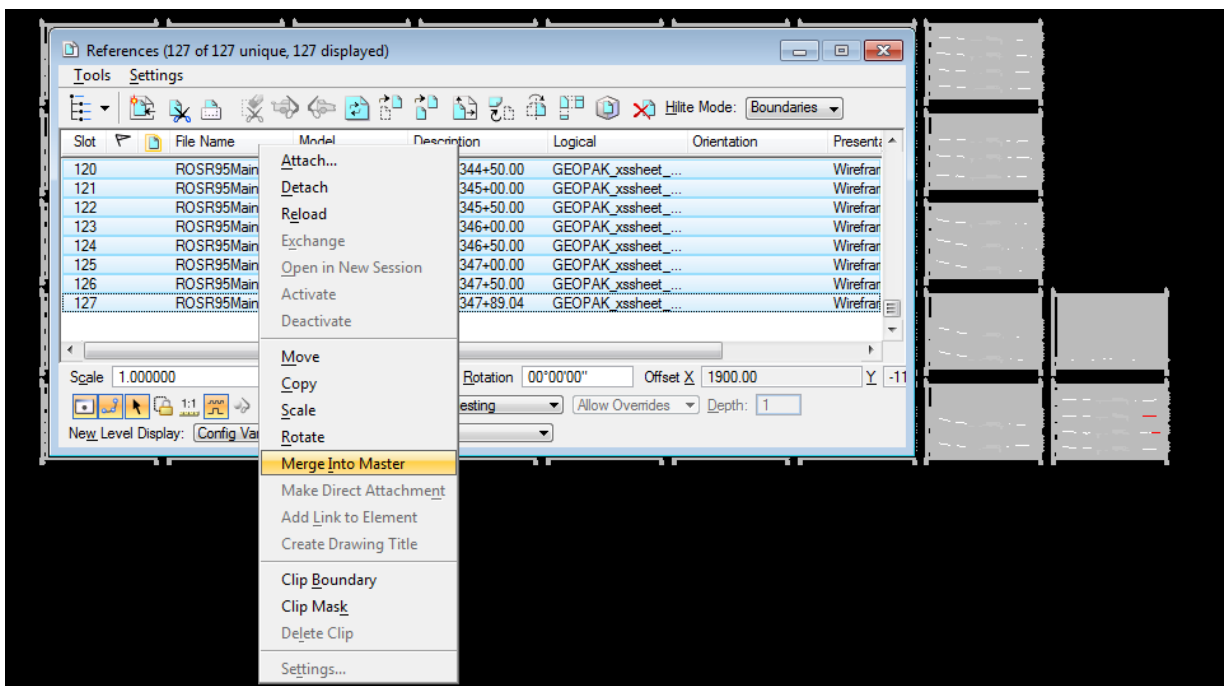
Use Level Display to turn off levels DESIGN - SHEET - Plot Shape and DESIGN - SCRATCH - User 1 in View 1. Save this setting at File → Save Settings.

Memory Problems when Batch Plotting Cross Section Sheets

Batch plotting large numbers of cross section sheets at one time can cause memory problems due to the large number of DGN references used.

If you encounter this problem, then either plot fewer sheets at one time or take the following steps to set up a separate file to plot from.

1. Copy the cross section sheet DGN file.
2. In the copy, open the Reference dialog, highlight all reference files and right click for or go to Tools → Merge Into Master.



3. When prompted to Select View For Merge, data point in View 1
4. You may see the Alert message "You Have Selected 127 References To Merge Into The Current Design. If so, click OK to complete the merge which will eliminate the DGN references.
5. This file can now be used for plotting the entire set of cross section sheets at one time. If the original cross sections are changed in any way then this process will need to be repeated.

17. Cross Section Reports

In this exercise we will take a look at cross section reports and actually run a seeding quantity report from our cross section graphics.

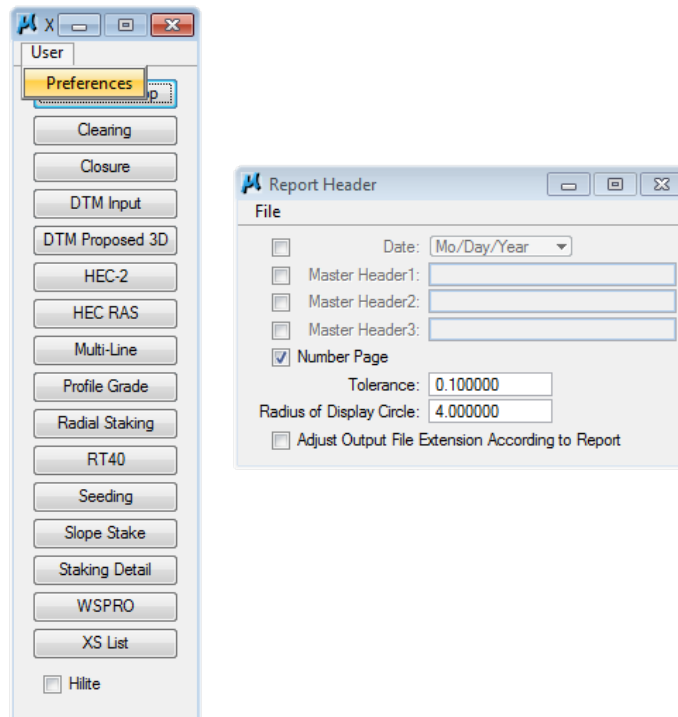
- 1) Open the Microstation file

C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

Access Project Manager.

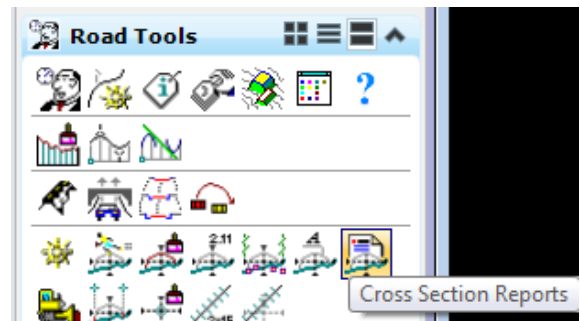
- 2) Select Reports and XS Quantities.

From the XS Reports dialog, select the User → Preferences option.

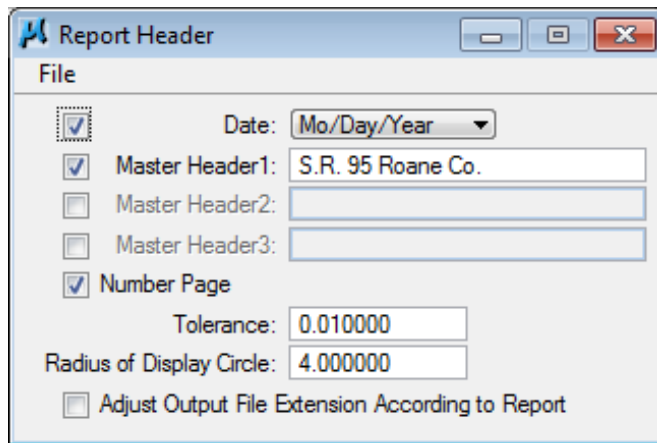


NOTE:

XS Reports can also be accessed from the MicroStation menu bar drop down location Applications → GEOPAK → Road → Cross Sections → Reports or from the cross section task group under Road Tools.

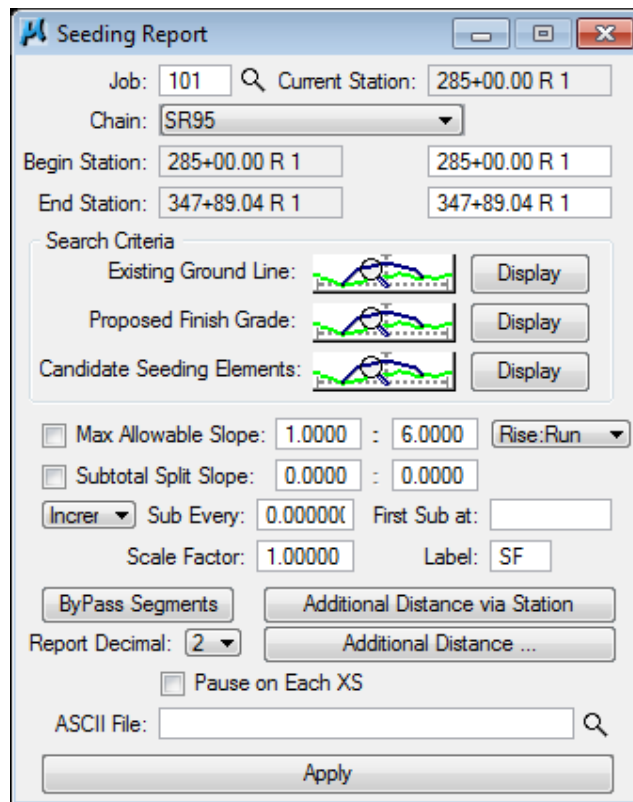


- 3) In the Report Header dialog turn on the Date, click on the first Header option and enter S.R. 95 Roane Co. Set the tolerance to 0.01.

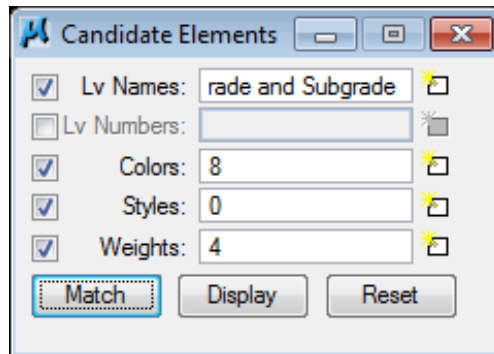


Close the dialog when complete.

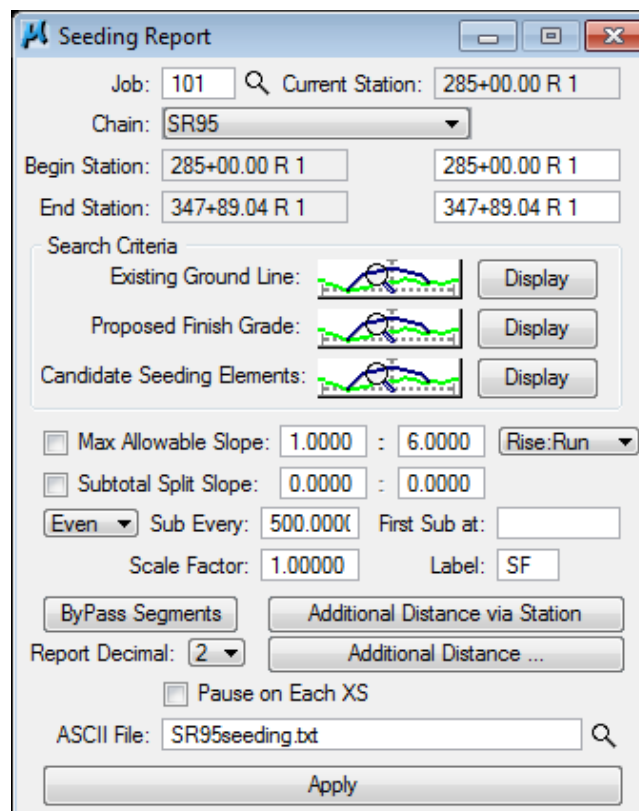
- 4) From the XS Reports dialog, select the Seeding report
- 5) In the Seeding dialog, set the Chain to SR95. The station fields are filled in when the chain is selected.



Click on the Candidate Seeding Elements button and fill in as shown. Use the Match button and data point on a side slope element in your proposed cross sections. The level name is DESIGN - TYPICAL - Finished Grade and Subgrade.



Additional control settings are available at the bottom of the dialog. Change the subtotal option to Even at 500 and key in the report name SR95seeding.txt at the bottom.



Click on the Apply button when complete.

- 6) After processing is complete, dismiss the dialog.

- 7) Using the GEOPAK Text Editor, review the report SR95seeding.txt.

This report yields the square foot area of all grass slopes which can be used in calculation of any quantities related to slopes including seeding, sod, water, etc.

Text Editor: ...SR95PoplarCr\SR95seeding.txt

File Edit Criteria

09/19/2016 S.R. 95 Roane Co. Page# 1
SEEDING REPORT

NUMBER OF LEFT CUT SLOPES TO BE BYPASSED = 0
 NUMBER OF LEFT FILL SLOPES TO BE BYPASSED = 0
 NUMBER OF RIGHT CUT SLOPES TO BE BYPASSED = 0
 NUMBER OF RIGHT FILL SLOPES TO BE BYPASSED = 0
 ROUNDING DISTANCE FROM CUT SLOPE STAKE = 0.00 Ft
 MAXIMUM ALLOWABLE SLOPE FOR SEEDING/SODDING = ****
 ADDITIONAL SEEDING LEFT SIDE = 0.00 Ft
 ADDITIONAL SEEDING RIGHT SIDE = 0.00 Ft
 ADDITIONAL SEEDING IN CUT = 0.00 Ft
 ADDITIONAL SEEDING IN FILL = 0.00 Ft
 SUBTOTALS EVERY 500.0000 Ft BEGINNING AT STATION 285+00.00 R 1 METHOD EVEN
 SCALING FACTOR = 1.00000 WITH LABEL [SF]

STATION	SLOPE DISTANCE		AVERAGE SLOPE DIST		A R E A		SF BOTH	SUBTOTAL		A R E A		SF BOTH
	LT	RT	LT	RT	LT	RT		LT	RT			
287+00.00 R 1	33.15	51.98						0	0		0	
	(85.13)		32.54	51.16	1627	2558	4185					
287+50.00 R 1	31.93	50.33										
	(82.26)		30.70	44.03	1535	2202	3737					
288+00.00 R 1	29.46	37.72										
	(67.18)		28.26	31.16	1413	1558	2971					
288+50.00 R 1	27.06	24.60										
	(51.66)		20.27	26.39	1014	1320	2334					

Line: 1 Col: 1

- 8) Exit the XS Reports dialog.

18. DP Station Offset & Labeler Tools

In this exercise, we look at some tools for placing smart labels in our plans. These labels can automatically calculate values from chains, profiles, cross sections or even drainage structures. We will look specifically at the Plan View Labeler but all other labeler tools work in the same manner.

First, we will take a quick look at what has to be one of the handiest tools GEOPAK has, the DP Station Offset tool, which sends a data point for you based on a station and offset.

I.) DP Station Offset

This tool can be used with any MicroStation or GEOPAK tool that needs a data point. In this exercise, we illustrate its use with MicroStation's Zoom In command.

Remember:

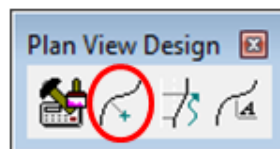
If anything needs a data point, you can send one by station and offset with this tool.

- 1) Open the MicroStation file

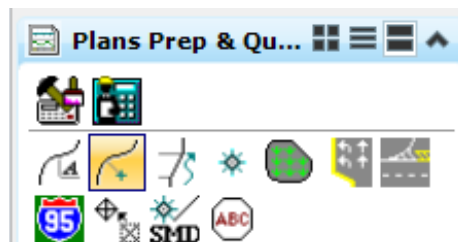
C:\Projects\Roane\SR95PoplarCr\ROSR95Proposed.dgn

Access Project Manager.

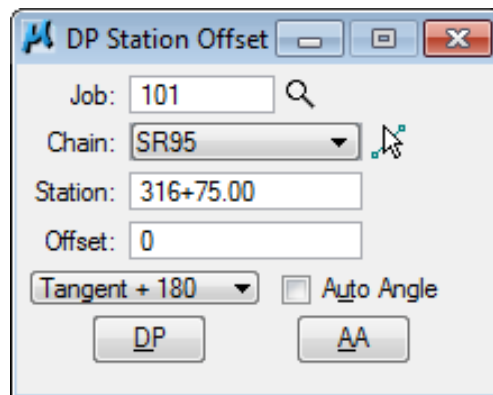
- 2) Select the icon Plan View Design button from the Project Manager workflow dialog.
- 3) From the Plan View Design tool bar, select the DP/Station Offset icon.



This tool is also available from the Plans Prep & Quantities task group under the Horizontal Plans Preparation tools when running Civil Workflows.

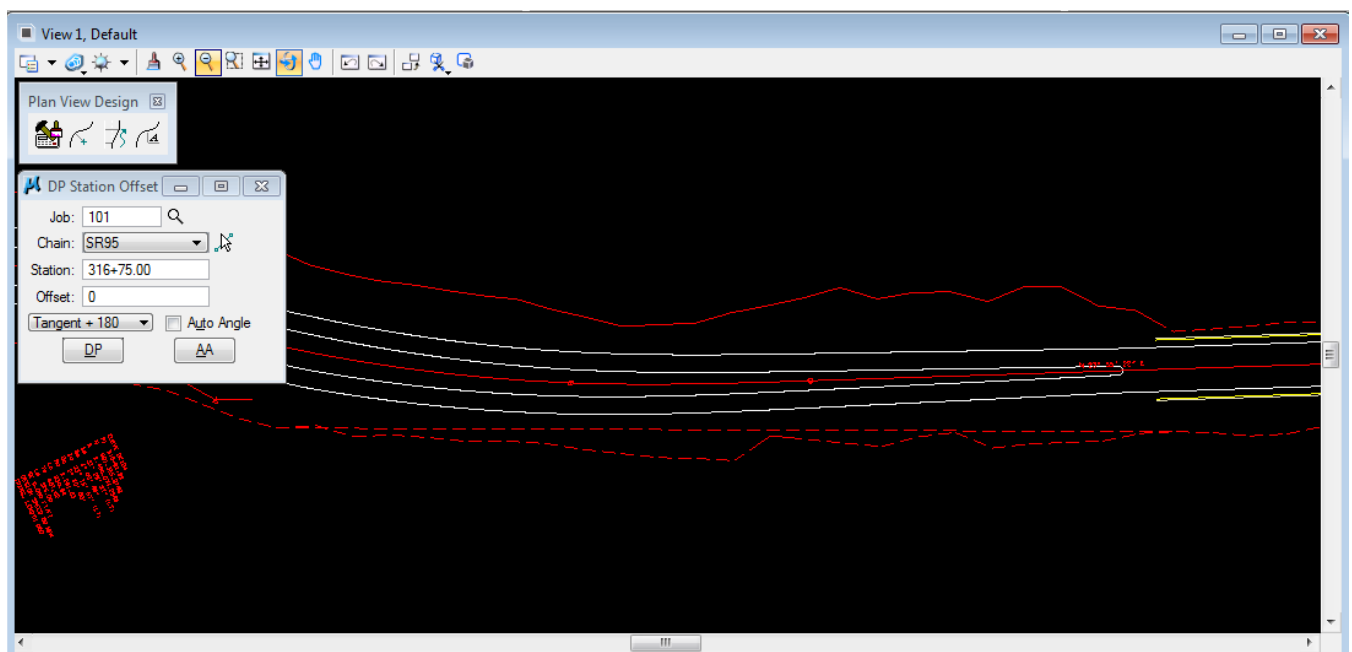


- 4) We need to go to the beginning station of the transition from the 4 Lane Depressed Median section to the 5 Lane Curb & Gutter section at Sta. 316+75 so complete the dialog as shown below.



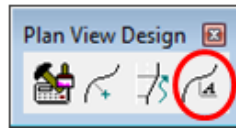
- 5) Next, select the MicroStation Zoom In tool and press the DP button on the above dialog. Continue to click the DP button as the view is zoomed in onto this area of interest.

You may need to turn off the Survey reference file to clear the view and rotate the view so that the transition area is horizontal.

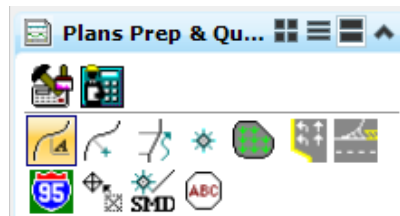


II.) Plan View Labeler

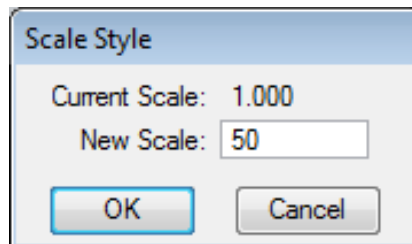
- 1) From the Plan View Design tool box, select the Plan View Labeler icon.



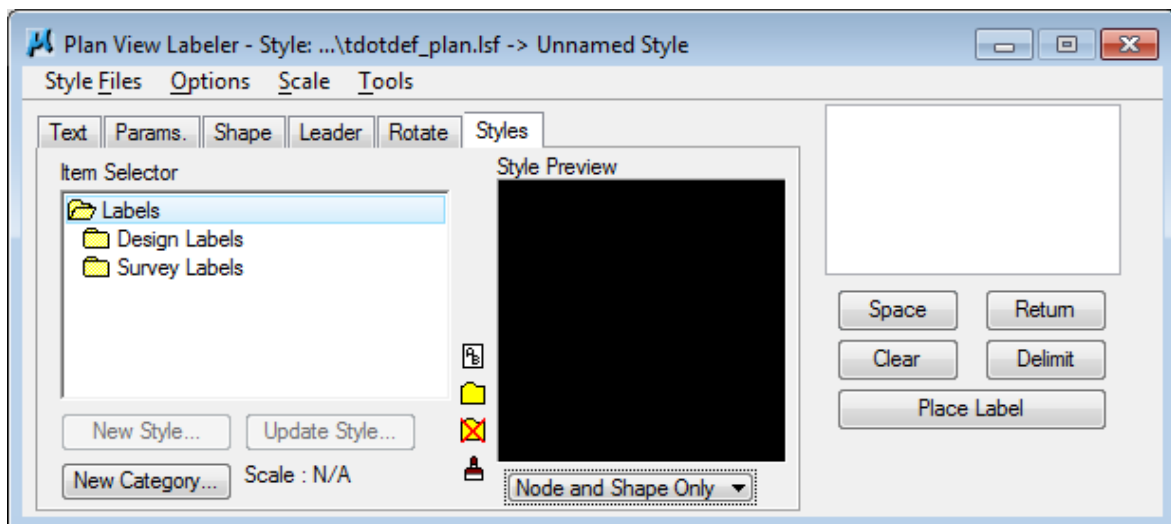
or from the Plans Prep & Quantities task group in the Horizontal Plans Preparation tools.



- 2) In the Plan View Labeler, first go to the drop down option Scale → Change Scale and key in 50. Click OK to set the scale.



- 3) Select the Styles Tab.

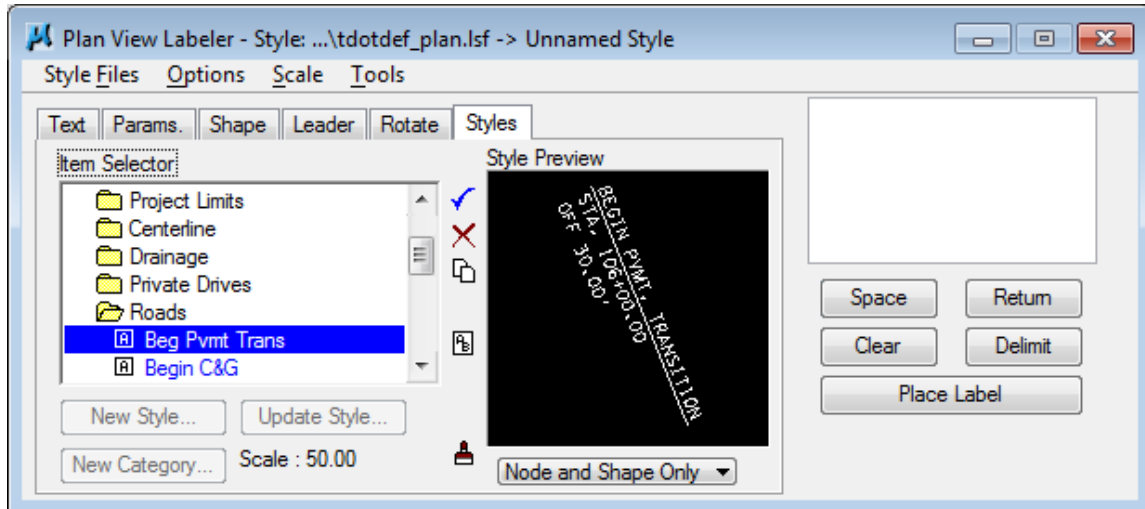


NOTE:

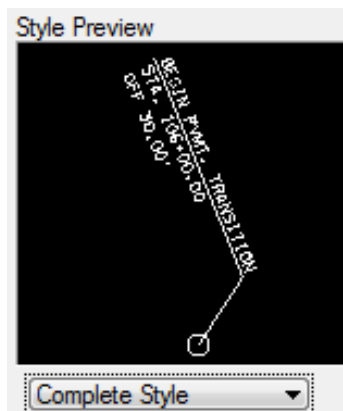
By default, the standard plan view label style file for T.D.O.T. Roadway Design Division, `tdotdef_plan.lsf` is already loaded and available. Label styles are listed in the Item Selector list.

- 4) Traverse within the Item Selector box to locate the following style:

Labels → Design Labels → Roads → Beg Pvmt Trans



- 5) Modify the option from Node and Shape Only to Complete Style to preview the defined style for this label.



- 6) Press the Select Style Item button (checkmark) or double click on the style name to activate this style.

Once activated, the label data is shown in the text display area on the right. You must not type text in here adjacent to any data item such as station and offset values with this style. Doing this will kill the intelligence of the label style.

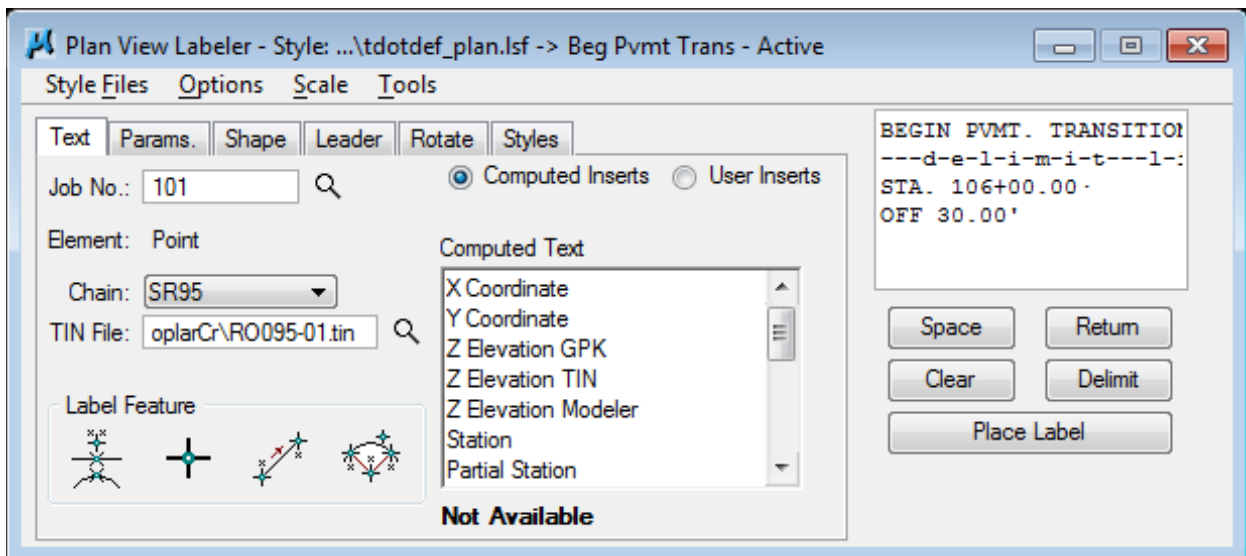
Exercise 18

```
BEGIN PVMT. TRANSITION  
---d-e-l-i-m-i-t---l-:  
STA. 106+00.00 ·  
OFF 30.00'
```

Space Return

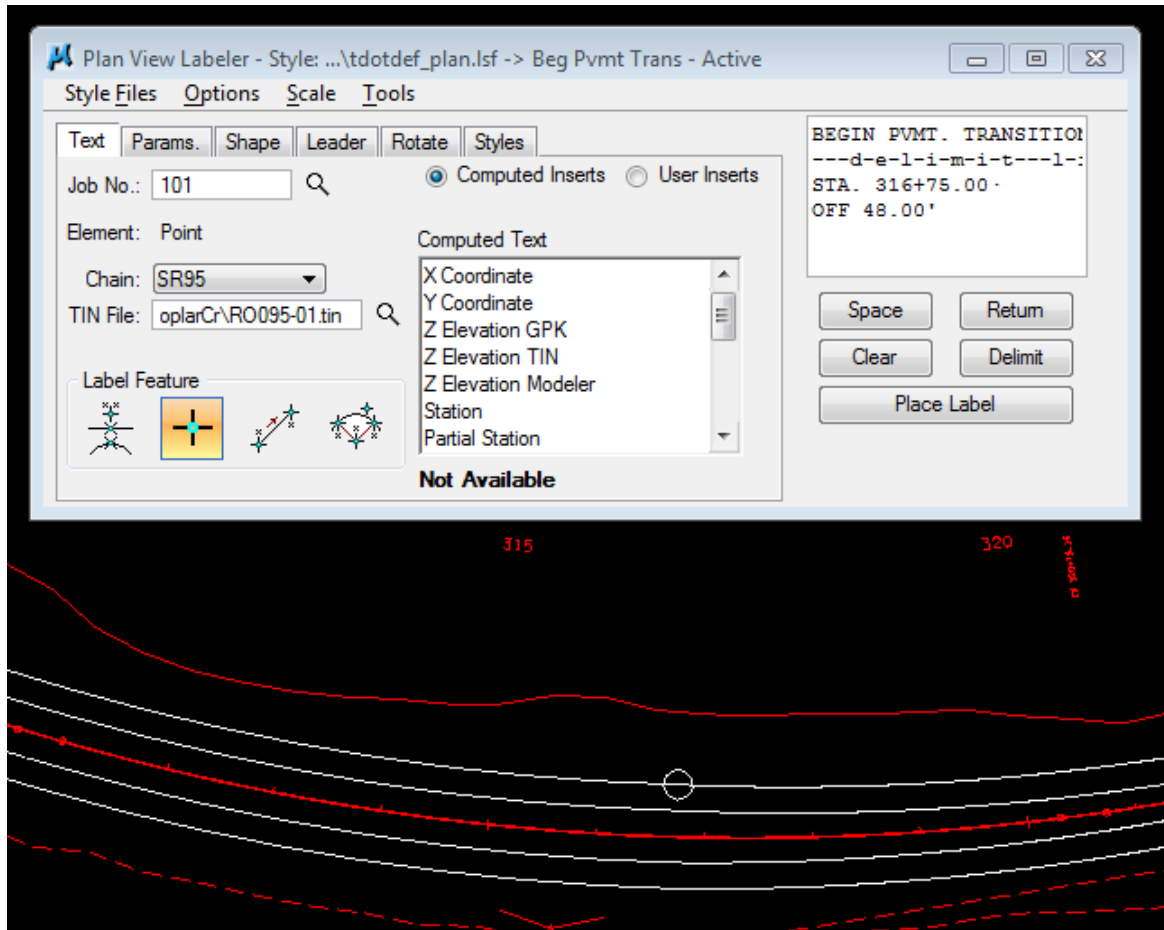
7) Move back to the Text tab and complete the data items on the left as defined below:

Job No.: 101
Chain: SR95
TIN File: RO095-01.tin



In the following steps, we will use the Plan View Labeler to label the beginning and ending station and offset for the transition area of the left and right roadways.

- 8) To begin the process, under Label Feature at the lower left select the Data Point Location button and then data point the location that you wish for the Station and offset to be computed. Snap to the pavement line at the beginning of the pavement transition. The labeler automatically calculates the information.



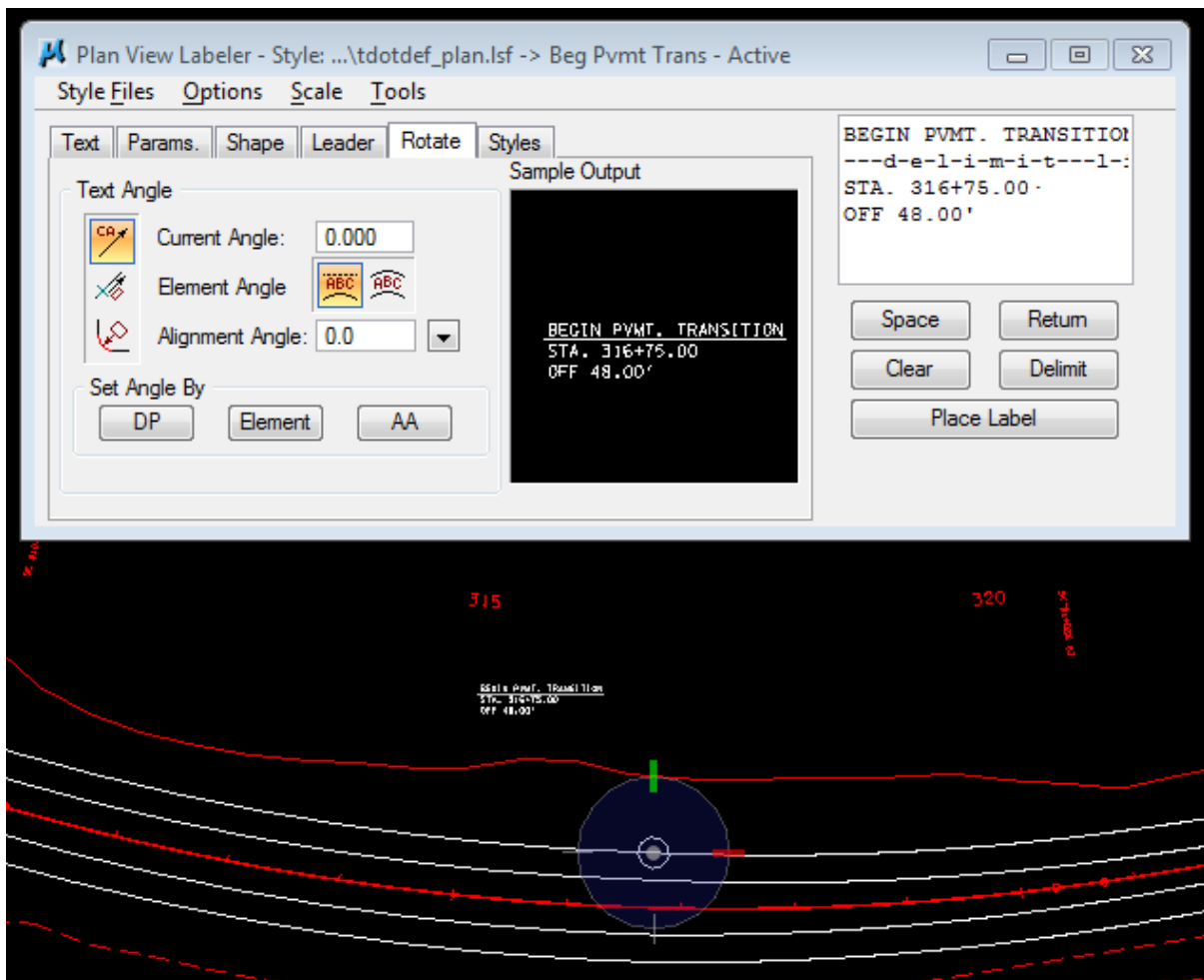
The Label Feature tool used depends on the label type. In our case, we are labeling a point location so we used Data Point Location. If we were labeling a distance on a line, we would use the Select GEOPAK or MS Element label feature tool.

- 9) Use the Shape, Leader and Rotation tabs to experiment with different labeling options. Click the AA button under Rotation to use the current active angle which is normally set to 0. This will force horizontal placement of the label.

Exercise 18

For the best results make sure the Current Angle value is set to 0 prior to picking the desired rotation option. That angle value can influence the others.

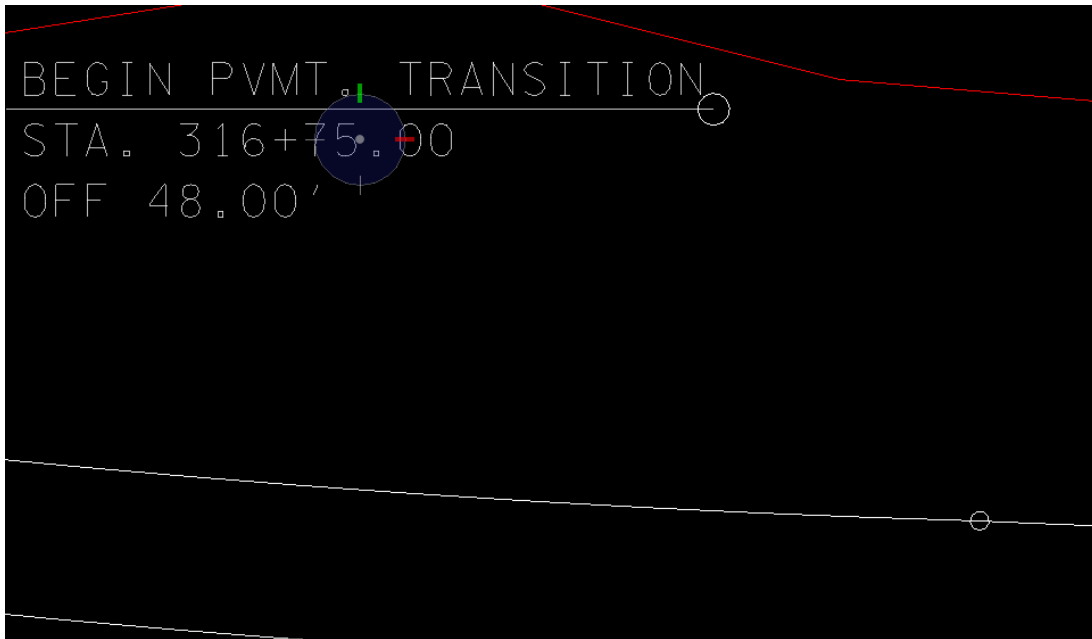
- 10) When you move your mouse pointer out over the view, the label is now attached to your cursor (without the leader for the delimiter). If you do not see the label, press the Place Label button on the right. Use this button anytime you must use other tools such as Zoom In just prior to placement to return focus to placing the label.



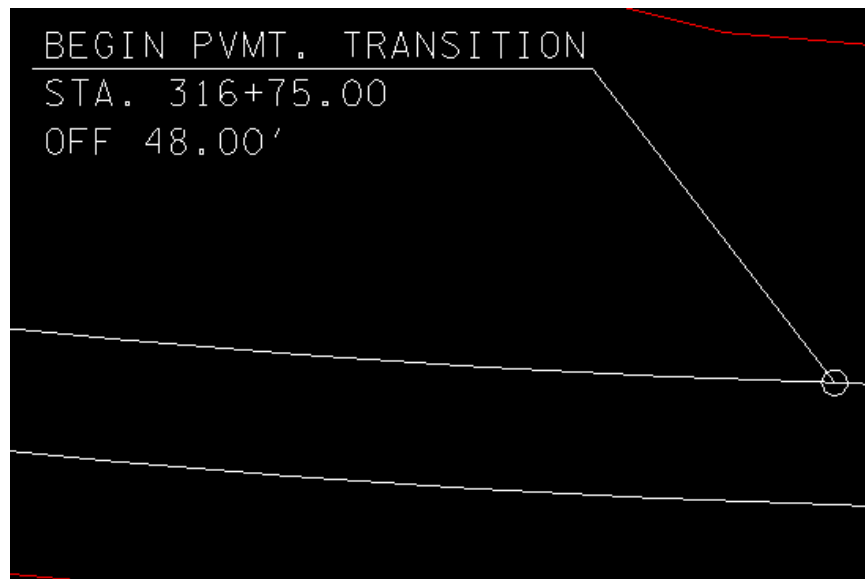
- 11) Data point at the location you wish the text to be located.

- 12) Move your cursor around and notice the small circle jump from one end of the delimiter to the other.

The next data point will define the side of the label to which the leader line will be drawn from the delimiter line to the computed location.



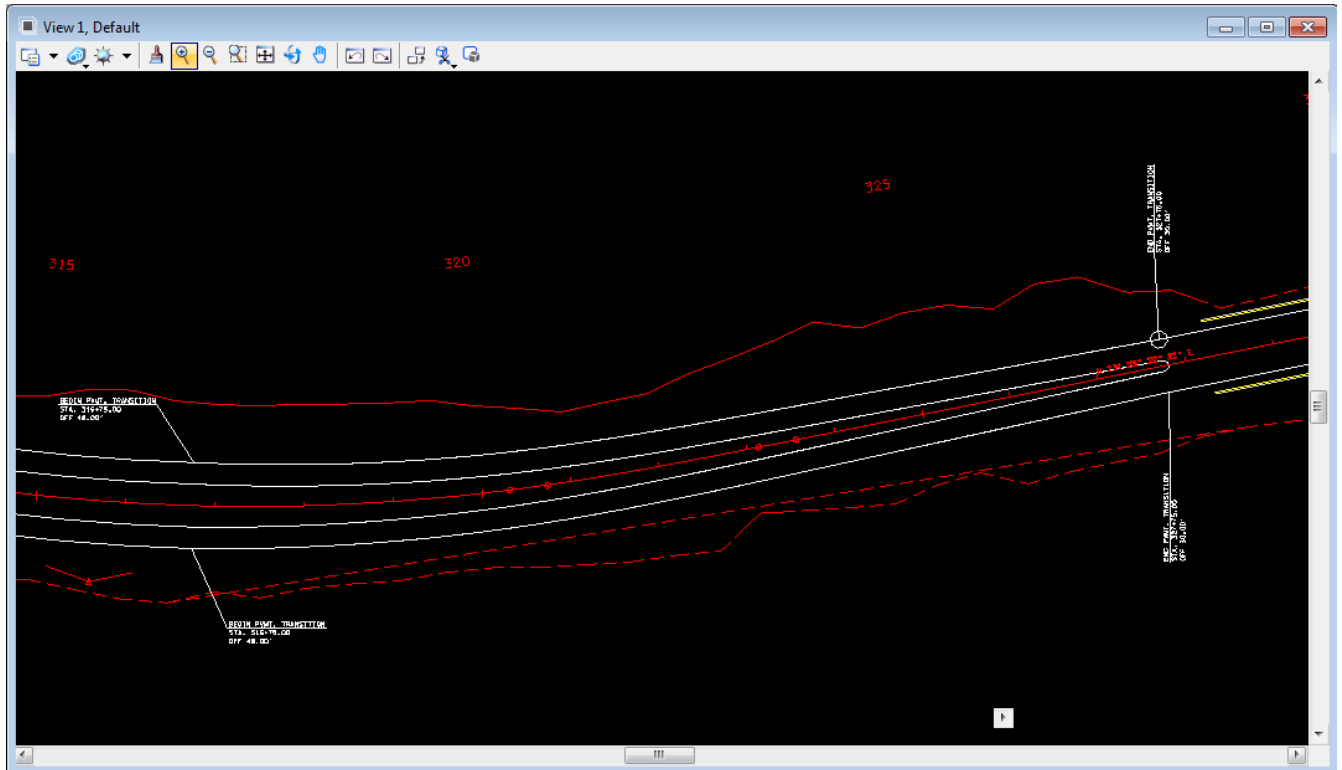
Data point when positioned as desired. The leader line is added.



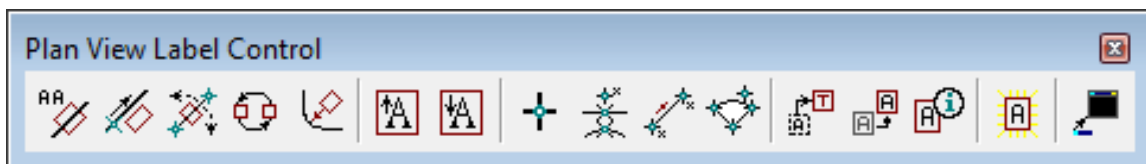
- 13) Using the same label style, repeat steps 8-12 to label the transition on the right side of the roadway.

Exercise 18

- 14) Activate style End Pvmt Trans to label the ends of the transitions. Try another rotation option such as 90 degrees to the alignment.



- 15) Try using the Label Tool Box to start labels and to set rotation options. It can be accessed from the drop down location Options → Label Tools.



III.) Other Labelers

Labelers are also available for labeling Profiles, Cross Sections and Drainage Structures.

All of these labelers function about the same except for the computed inserts which are available. As you might guess, the computed inserts are based on objects found in that area of interest.

If time permits, try out the Profile and Cross section Labelers which can be found at the locations given below. We do not have a drainage project set up on this job so you will not be able to use that one.

1) Profile Labeler:

Task Bar: Civil Workflows → Plans Prep & Quantities → Profile Plans Preparation → Profile Labeling

Menu Bar: Applications → GEOPAK → Road → Plans Preparation → Profile Labeling

Style File: tdotdef_prof.lsf

2) Cross Section Labeler:

Task Bar: Civil Workflows → Plans Prep & Quantities → Cross-Section Plans Preparation → Cross Section Labeling

Menu Bar: Applications → GEOPAK → Road → Cross Sections → Cross Section Labeling

Style File: tdotdef_xs.lsf

3) Drainage Labeler: (GEOPAK Drainage must be activated first)

Tool Box: Drainage Main → Utilities → Labeler

Menu Bar: Drainage → Utilities → Labeler

Style File: tdotdef_drainage.lsf

T.D.O.T. Roadway Design Division Labeling Tools:

Several labeling tools have been developed by T.D.O.T.'s Roadway Design Division for use in plans preparation and can be accessed from Geopak's D&C Manager under Drafting Standards or with the T.D.O.T. Roadway Design Division interface from the MicroStation drop down menu TDOT. Some of these are illustrated in chapter 21.

19. Plan and Profile Sheets

In this exercise we will use GEOPAK's Sheet Layout tools to set up our proposed layout sheets which we will set up as plan/profile sheets.

NOTE:

For complete documentation on Creating PDF Files from MicroStation DGN Files, refer to standard documentation file **CreatingPDFsfromDGNs.pdf** which can be found under Documentation at the T.D.O.T. Roadway Design Division CADD Files web page address:

https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/cadd_files/documents/CreatingPDFsfromDGNs.pdf

For complete documentation on phase stamps to sheets as watermarks, refer to standard documentation file **AddingthePlanPhaseStampWatermarktothePDFPlanSet.pdf** which can be found under Documentation at the T.D.O.T. Roadway Design Division CADD Files web page address:

https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/cadd_files/documents/Adding%20Plan%20Phase%20Stamps%20as%20a%20Watermark%20in%20PDF%20Plan%20Sets.pdf

I.) Set Up Sheet Layout DGN Files

- 1) In order to assign the proper DGN reference files and levels from those references to the top (proposed plan) and bottom (profile) of our sheets, we need to set up "motif" DGN files.

Open the MicroStation file

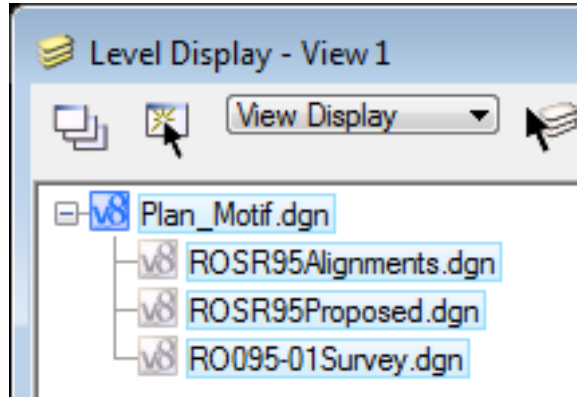
C:\Projects\Roane\SR95PoplarCr\Plan_Motif.dgn

- 2) We will set up the top of our sheets with this motif file. Use MicroStation's Reference tool to attach the following files as references and use Coincident World attachment mode.

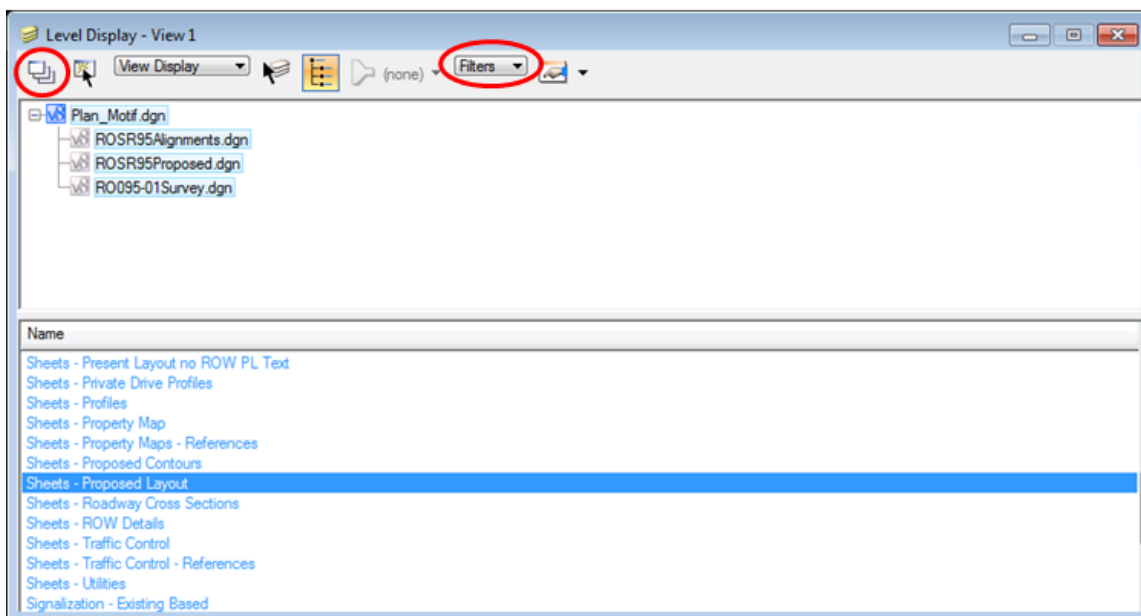
- ROSR95Alignments.dgn
- ROSR95Proposed.dgn
- RO095-01Survey.dgn

- 3) Go to MicroStation's Level Display tool and set levels in the references and the master dgn file for a proposed layout sheet.

In the dialog set the control to View Display and highlight all files.



Set the Level control to Filters and then click on level filter Sheets – Proposed Layout.



Finally, click the icon at the upper left of the Level Display dialog to Apply To Open Views.

Use MicroStation's File > Save Settings to save this set up of levels.

- 4) Open the MicroStation file
C:\Projects\Roane\SR95PoplarCr\Profile_Motif.dgn

- 5) We will set up the bottom of our sheets with this motif file so using MicroStation's Reference tools attach the following files as references and use Coincident attachment mode.
 - ROSR95Alignments.dgn
 - ROSR95Proposed.dgn
 - RO095-01Survey.dgn
- 6) Go to MicroStation's Level Display tool and repeat step 3 using level filter Sheets – Profiles.

Switch back to Levels, click on the reference file ROSR95Alignments.dgn and turn the "DESIGN - SHEET..." levels off. We do not need the working profile grid and annotation from that reference file on our sheets.

Use MicroStation's File > Save Settings to save this set up of levels.

II.) Configure Sheet Settings

- 1) Create a blank DGN file to set up clipping shapes in. In MicroStation go to File → New and in the New dialog keyin filename ProposedLayout.dgn and use seed file Seed2D.dgn which should be set by default.

Use MicroStation's Reference tools to attach ROSR95Alignments.dgn and use Coincident World attachment mode.

NOTE:

The clipping shape DGN file can be referenced later to other files for help in orienting text, etc. to appear correctly on the sheets.

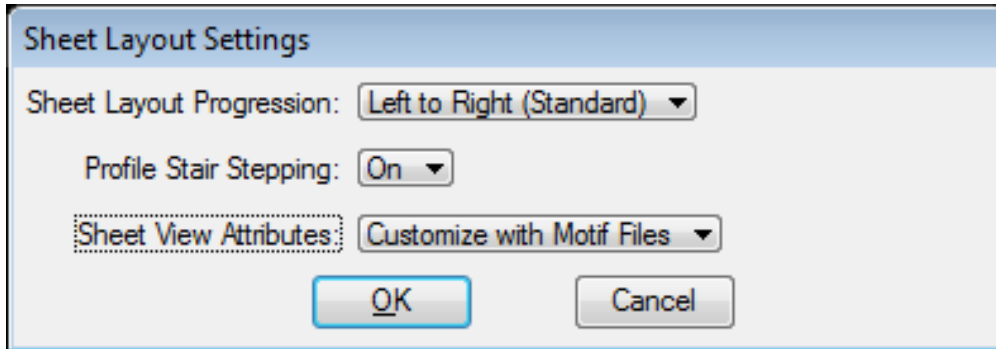
- 2) Access Project Manager. Click the Plan & Profile Sheets button from the workflow dialog.
- 3) Create a run SR95 to set up the plan/profile sheets. The Plan Sheet Layout menu bar will appear.

If the plans sheet library tdot.psl is not already attached, go to drop down option File → Sheet Library → Attach.

Navigate to C:\Users\Public\Geopak Standards\, pick tdot.psl and then click Open.



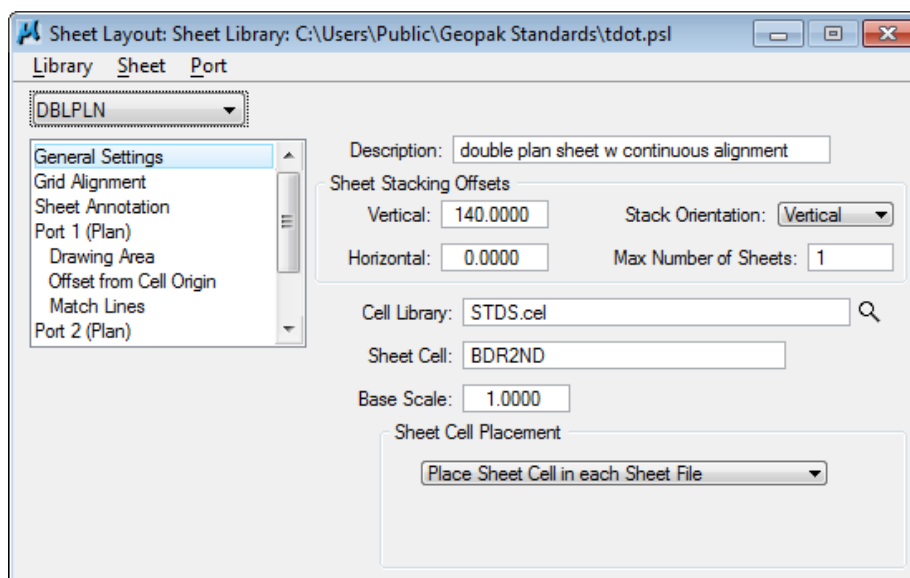
- 4) Select drop down option Settings → Sheet Layout. Change Sheet View Attributes option to Customize with Motif Files then click OK. The completed dialog is shown below.



NOTE:

For sheet layouts where only one set of references is required, you could just use the Use Current Design File option and assign references and levels in the same DGN file where clipping borders are placed. However it is recommended that you use motif files for all sheet set ups to avoid attachment of the sheet clip boundary file as a reference to the plan sheets.

- 5) Review sheet preferences by clicking File → Sheet Library → Edit. Change the sheet type to see settings for different types.

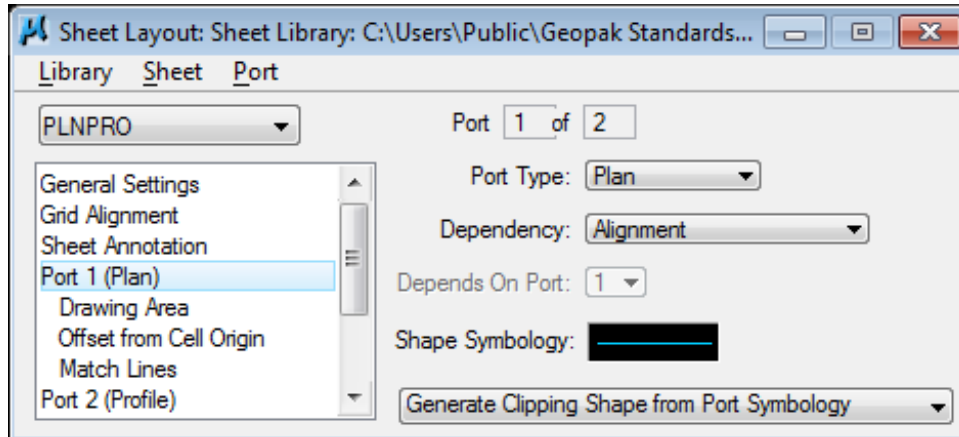


Exercise 19

You usually will never need to adjust these settings but can see we have the following sheet types set up for us already

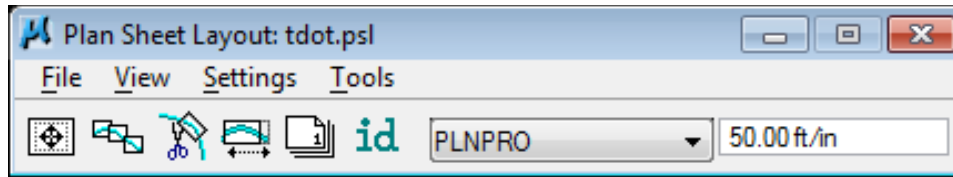
- DBLPLN split plan plan sheets (set up with continuous stationing from top through bottom for resurfacing project plan sheets)
- PLAN full plan sheets (All full plan sheets except Present Layout)
- PLNPLN split plan plan sheets (set up with the same station limit on top & bottom for project phase layouts such as used for Traffic Control or Erosion Prevention Sediment Control sheets)
- PLNPRO split plan profile sheets (Proposed Layout sheets w/Profiles)
- PRESENT full present sheets (Present Layout sheets)
- PROFLE full profile sheets (Profile sheets)

- 6) Set the sheet type back to PLNPRO. Click on the category Port 1 (Plan). The Shape Symbology defines the symbology of the clipping shape that is placed in the layout operation. Review other settings as desired but do not make any changes.



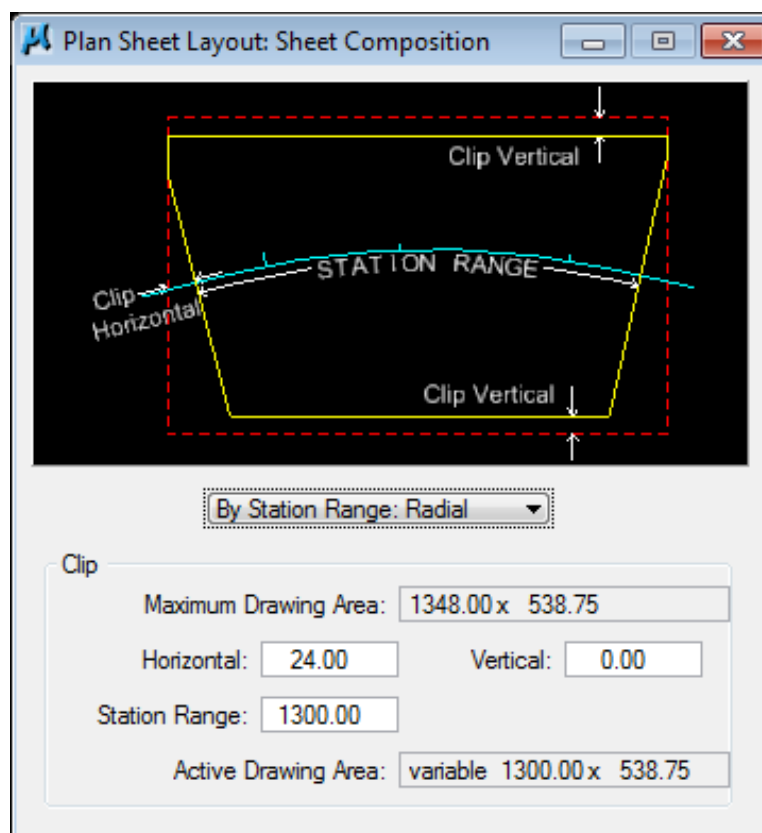
Close the Sheet Library dialog by clicking the **X** in the upper right of the dialog. Do Not save any changes.

- 7) Populate the Plan Sheet Layout menu bar as shown below with sheet type PLNPRO and scale 50.



- 8) Press the Sheet Composition icon (1st from left) on the Plan Sheet Layout menu bar. Populate the Sheet Composition dialog as shown below for 50 scale sheets.

Set By Station Range: Radial and a Station Range of 1300 and other values are updated automatically



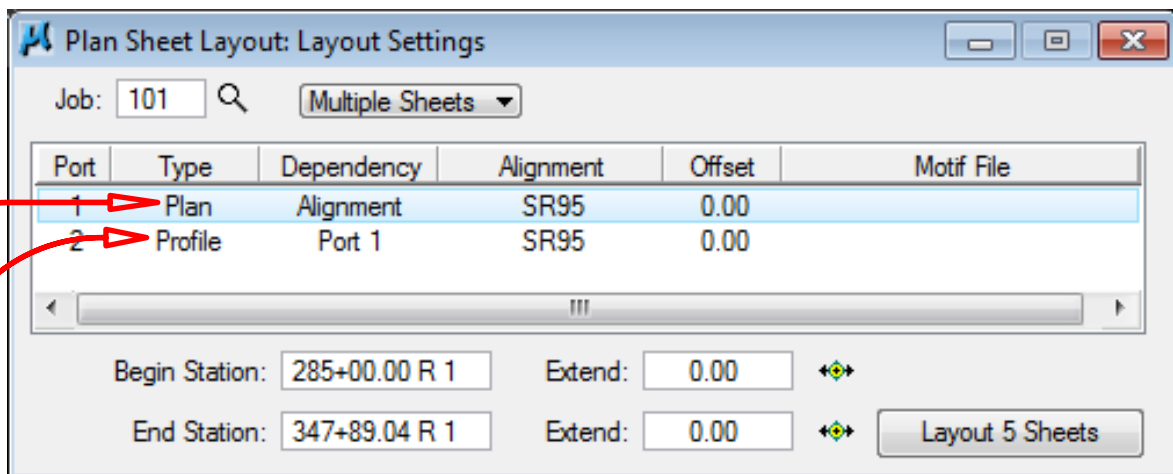
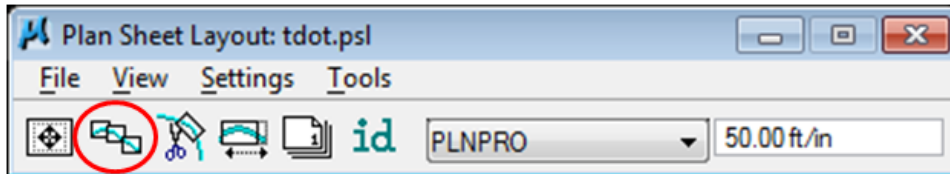
NOTE:

The normal station range for 50 scale sheets is 1300' which is determined by the limits of the grid on profile sheets. The Maximum Drawing Area indicates the area that could be used and is based on the scale being applied. By default, only station ranges in 50' increments can be set.

- 9) Dismiss the Sheet Composition dialog by pressing the **X** in the upper right hand corner.

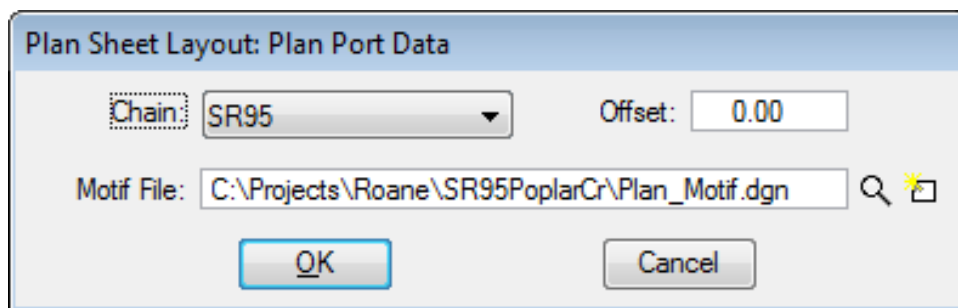
III.) Sheet Layout Process

- 1) Press the Layout Sheets icon (2nd from left) on the Plan Sheet Layout menu bar. In the Layout Settings dialog your Job number should be set but if not click the browser button and select job number 101.



- 2) Double click on **Plan** (1st item in list), to set up the plan port.

Populate the Plan Port Data dialog as shown below. Select the Motif File Plan_Motif.dgn and then click OK.

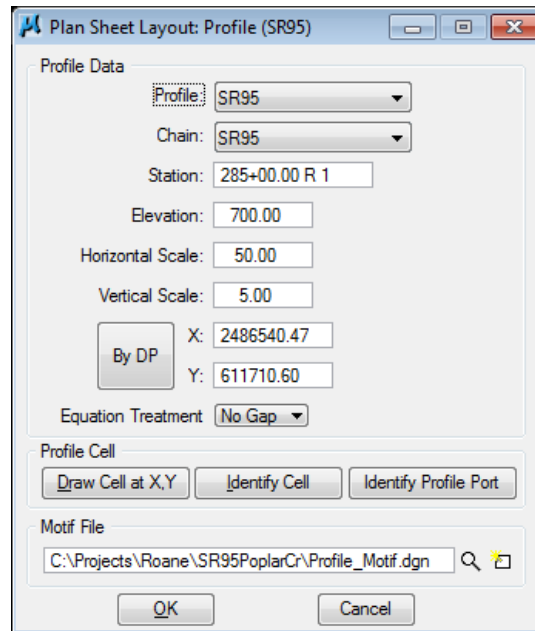


- 3) Double click on **Profile** (2nd item in list) to set up the profile port.

First, select the proposed profile SR95.

Then, populate most of the Profile (Port 2) dialog by pressing the Identify Cell button then graphically identify the profile cell. It may be necessary to turn on level DESIGN - SHEET - Light Grid in the alignments file to see the profile cell.

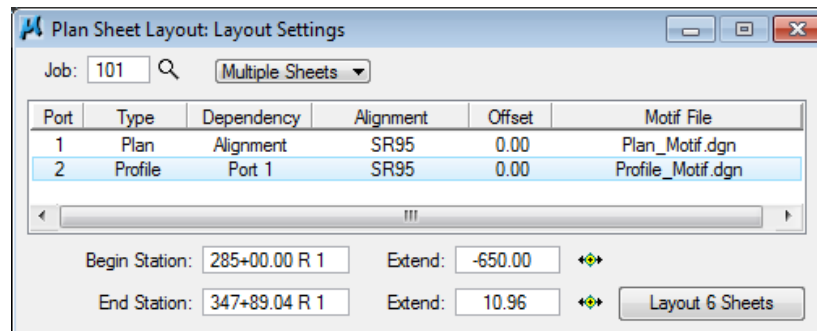
Select the Motif File Profile_Motif.dgn and then click OK.



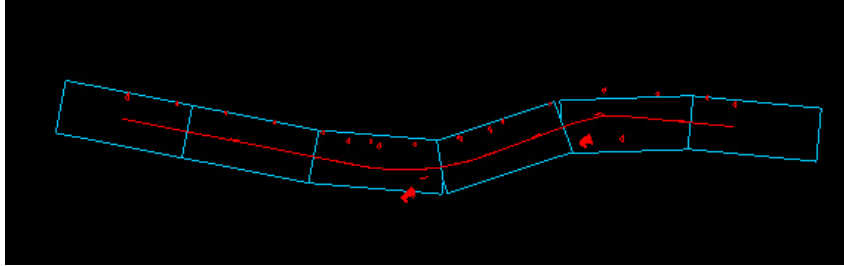
NOTE:

The X and Y coordinates may be different than what is shown in the dialog. They should match the insertion point of your GEOPAK profile cell.

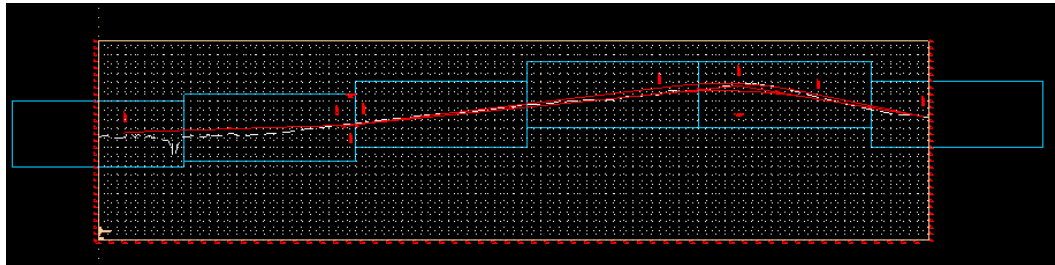
- 4) In the Layout Settings dialog, set the Extend value for the Begin Station to -650. This will force the first sheet to begin 650' before the chain. The dialog should appear as below. Click the Layout 6 Sheets button to draw the clipping borders into the DGN file.



6 clipping shapes should be placed along the proposed centerline for the plan port.



6 clipping shapes should be placed along the proposed profile for the profile port.



NOTE:

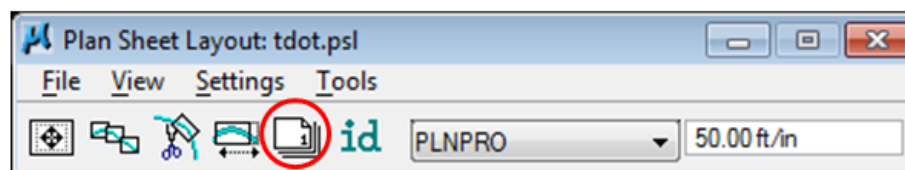
Clipping borders are placed on level "DESIGN - SCRATCH - User 1" so it may be necessary to turn that level on to see these shapes.

- 5) Dismiss the Layout Settings dialog by pressing the **X** in the upper right hand corner.

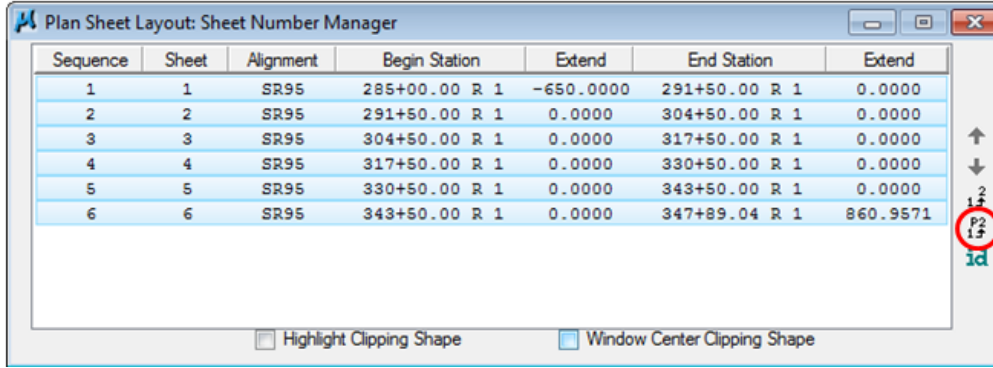
IV.) Modify Sheet Numbers

The following steps demonstrate methods for controlling the sheet numbers applied.

- 1) Click the Sheet Number Manager icon (5th from left) on the Plan Sheet Layout menu bar. This will open the following dialog.

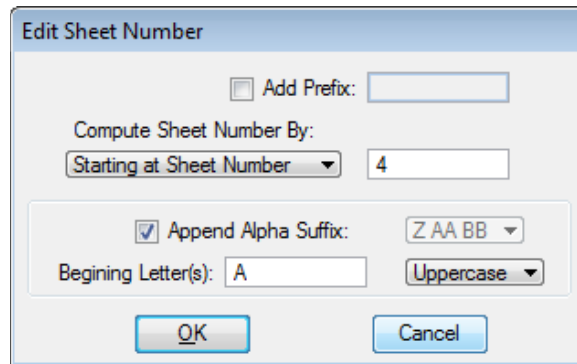


- 2) Click & hold mouse button down while dragging the cursor to highlight all sheets. Then click on the Edit Sheet Number icon on the right.

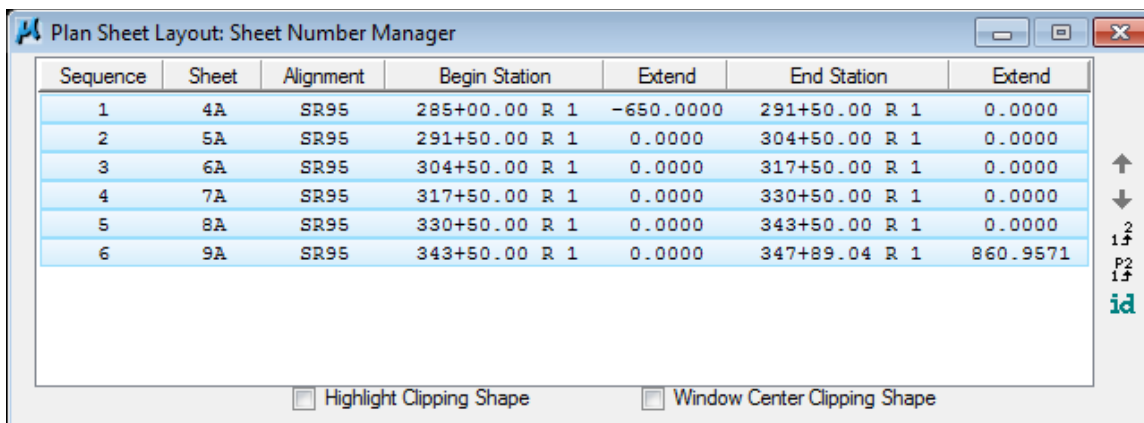


- 3) In the Edit Sheet Number dialog set the Compute Sheet Number By option to Starting at Sheet Number and set the value to 4.

Click on the option to Append Alpha Suffix. Our sheets need the suffix “A” so under Beginning Letter(s): enter the A.



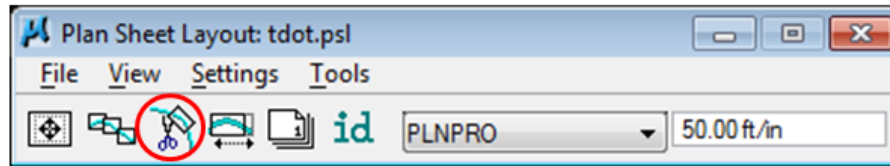
- 4) Click OK to apply the numbering changes. The Sheet Number Manager dialog should reflect the changes you have requested.



- 5) Dismiss the Sheet Numbers Manager dialog by pressing the X in the upper right hand corner. When prompted to Save Changes click the Yes button.

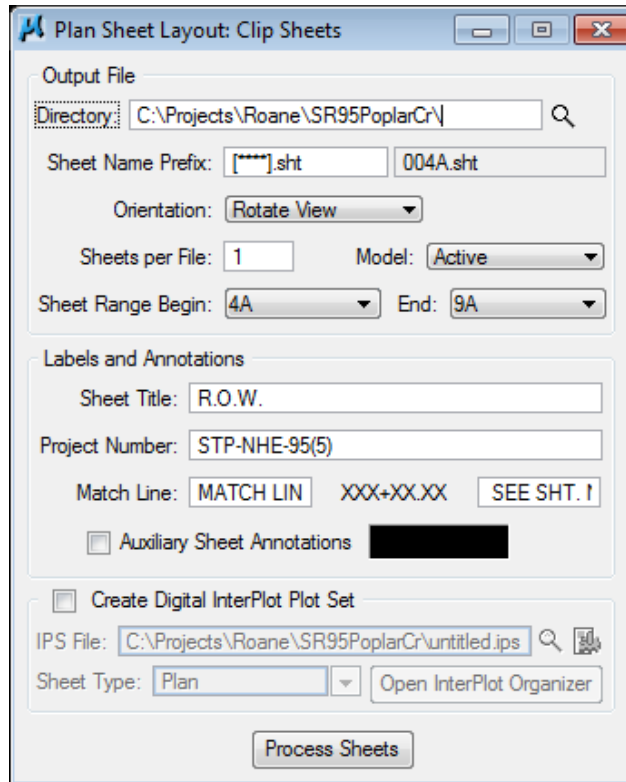
V.) Clip Sheets

- 1) Press the Clip Sheets icon (3rd from left) on the Plan Sheet Layout menu bar. Populate the Clip Sheets dialog as specified.



- Set the project Directory where sheet DGNs should be created.
- The Sheet Name Prefix field is used to control the final format for the DGN filenames which are applied. The number of characters used for the sheet number as well as the filename extension can be set.
Enter square brackets with 4 asterisks for the sheet number, [****] , followed by .sht for the filename extension. You should end up with [****].sht. Notice that the filename format is reflected to the right for the first sheet. See the note on the following page for an explanation of this format.
- Set Orientation to the Rotate View option.
- Keyin a Sheet Title if desired at the time of sheet generation. For this class we will specify R.O.W. This is the label for “TYPE” in the project data block on the upper right corner of our sheets.
- Keyin a Project Number if known at the time of sheet generation. For this class we will specify STP-NHE-95(5).
- Keyin Match Line prefix text: MATCH LINE STA. & suffix text: SEE SHT. NO.

Make sure to include a blank space in the Match Line text prefix field after the period in “STA.”. This will provide a blank space between “STA.” and the computed match line station text. For the same reason you should include a space before “SEE” in the suffix text.



NOTE:

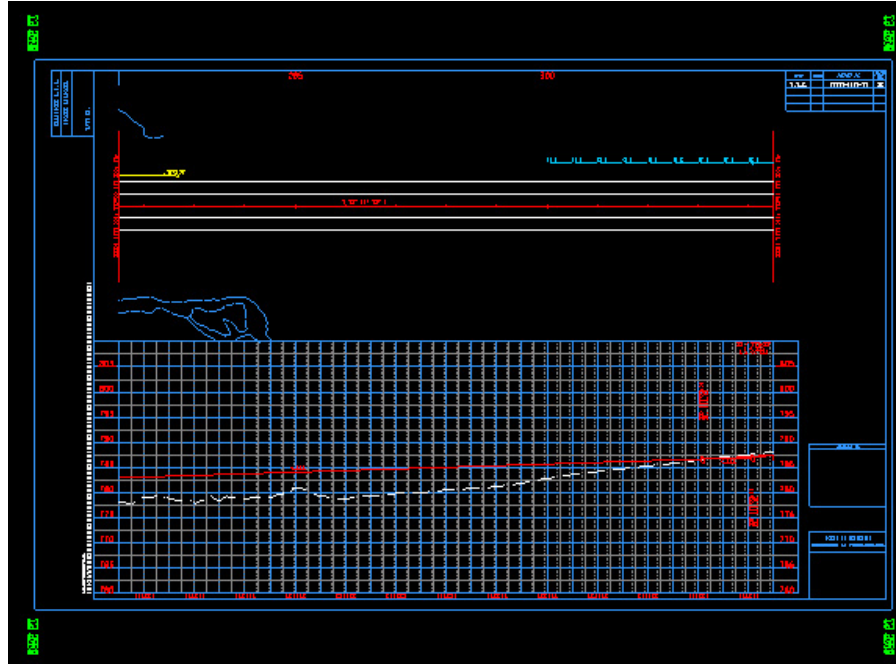
The number of asterisks entered within the square brackets in the Sheet Name Prefix field should be determined by the maximum number of characters expected in any project sheet number plus whatever is required for suffixes in the sheets that are being created. For a project ending in sheet number 126, that would be 3 +1 for 1 suffix letter or 3+2 if double suffix letters are required. If sheets are being created without suffixes simply base it on the highest sheet number such as sheets 31 – 36 in the 126 sheet set would need only 3 asterisks.

The software automatically embeds zeros as needed to fill out the sheet number for sheets with fewer characters which will set up the sheets in alphabetic order.

There are several reasons why the sheet files need to be named in this manner using the sheet number: the project will be easier to plot using InterPlot Organizer or other batch plotting functions since sheets will automatically be read in order alphabetically, the names of the sheet files should be the same as the sheet number so the project can be published to FileNet correctly and so other divisions, such as Right-of-Way and Construction, can find the sheets they need easily.

Exercise 19

- 2) Click Process Sheets button to create the plan and profile sheets.
- 3) Open any of the newly created files to see the resulting sheets. You will need to change your Files of type to Sheet Files [* .s*].



- 4) Close the Plan Sheet Layout menu bar and save settings for the run when prompted.

20. D&C Manager – Additional Functions

In this exercise we will demonstrate other ways to use D&C Manager, to control graphics displayed, cell access and quantity calculation from graphics.

I.) Display Control

- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95Proposed.dgn

- 2) Go to File → References and turn on the display of the Survey topo and Alignments DGN files. Fit the view so that all graphics are showing.

- 3) Access the D&C Manager.

Select the item Drafting Standards → Roadway Linework → EOP Prop

- 4) Set Display mode in Design and Computation Manager. In the expanded dialog, click on the Display icon (computer screen view divisions) which will open up the Display control tool box.



NOTE:

In D&C Manager's tool box mode the Display control icons are shown always and you can pick them as needed.

- 5) The different display control icons change display for a D&C Manager item or items as follows:

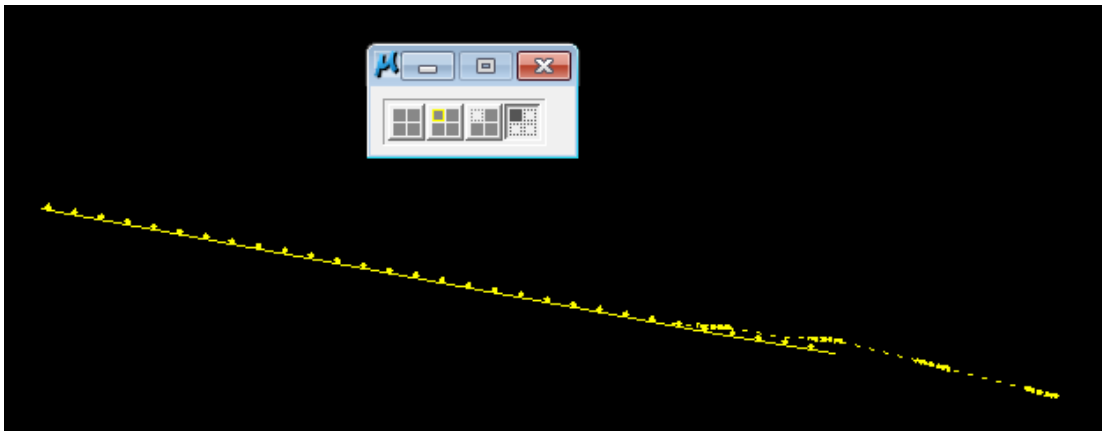
Normal Display	all graphics are shown
Highlight Selection	items are highlighted
Hide Selection	items are turned off
Display only Selection	only items are shown

Try the different modes out while you have EOP Prop selected. You may need to zoom in on the plan view graphics.

NOTE:

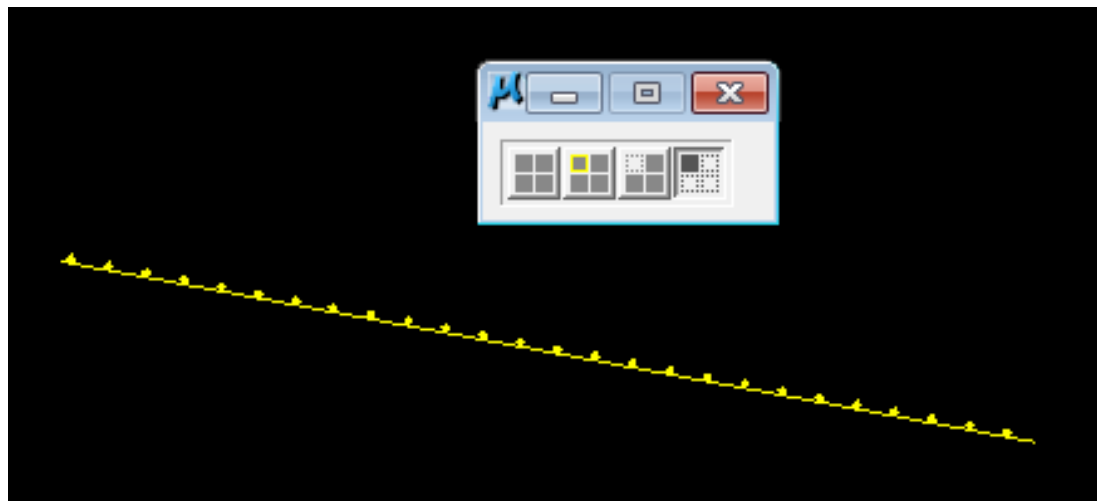
One of the best uses for the Display functions are to check graphics such as pavement lines or guardrail items when they are not being reflected in cross section runs. The Display controls can show you immediately if graphics are not set at the correct level or symbology.

- 6) Back in D&C Manager, select the category Drafting Standards → Guardrail. Select the last display icon, Display only Selection.



Now only the guardrail items placed previously are showing.

- 7) Select the item Drafting Standards → Guardrail → GR Single Prop.



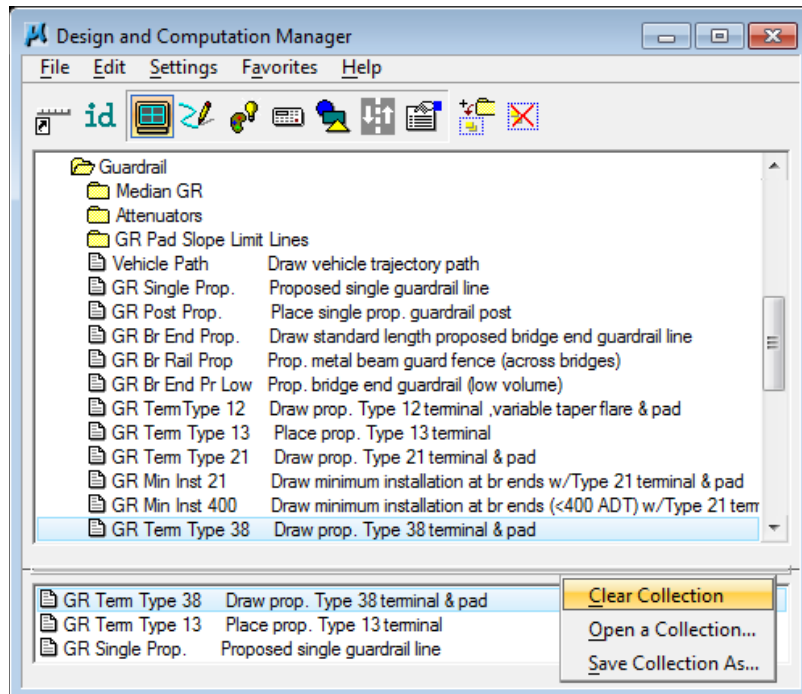
Now only that guardrail item should be showing.

In case you haven't discovered this by accident, if you double click on an item in D&C Manager's expanded mode then it is added to a collection box at the bottom.

Exercise 20

This way you can pick several different items for the Display functions to work on. If you right click in the collection area then you will get options to Clear the collection, Save it or Open one saved previously.

- 8) Try adding different items under guardrail to the collection box and experiment with the Display controls to check the results.



- 9) Right click in the collection area at the bottom of D&C Manager and pick Clear Collection. Select the Normal Display mode so that all graphics are showing again.

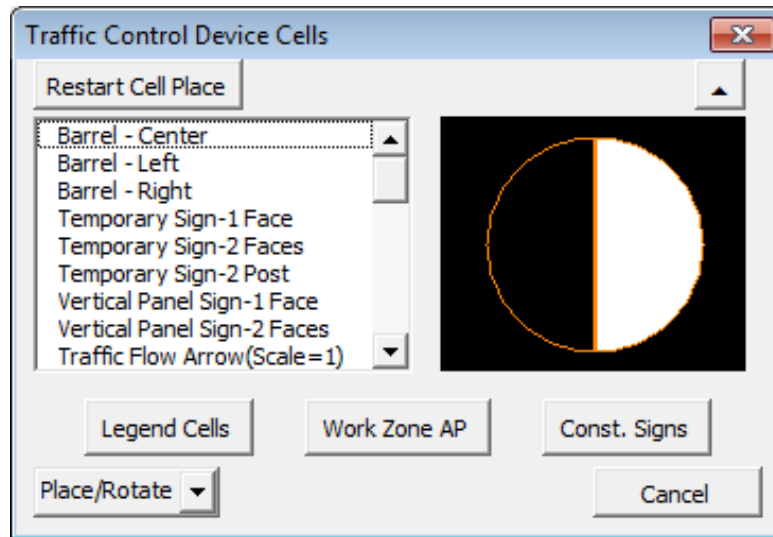
II.) Cell Access

The T.D.O.T. Roadway Design Division cell libraries provide over 1200 standard cells. Although GEOPAK does provide tools for placing individual cells defined as items in D&C Manager, it is just not feasible to set up so many that way. Instead we have MicroStation visual basic applications called from D&C Manager which access groups of cells.

In this exercise we will look at the cell access dialog for Traffic Control Device Cells to illustrate how these cell dialogs function.

- 1) Access D&C Manager and set mode to Design.
- 2) Double click on item
Drafting Standards → Traffic Control (Temporary) → TC Device Cells

The Traffic Control Device Cells dialog is opened.



All cell dialogs are in this same basic format, a cell pick list by description on the left with a viewing window on the right.

At the bottom left of the dialog is the Cell Placement Type option.

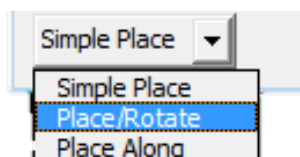
A "window shade" minimize button is located on the upper right.

The Restart Cell Place command button at the upper left can be used anytime other MicroStation commands have been used and you wish to go back to placing the currently selected cell.

Also included at the bottom are other special programs that might be needed or used in conjunction with these cells. In most cases the special tool options on cell dialogs are also accessible from D&C Manager directly.

- 3) When a cell is chosen from the list, the cell is made active and placement is started. The method of cell placement depends on the Cell Placement Type which is set at the lower left. The default value for this option varies and is set to the most common one needed for the cells from the dialog.

Click on the Cell Placement Type button and review the options which are described here:



Simple Place

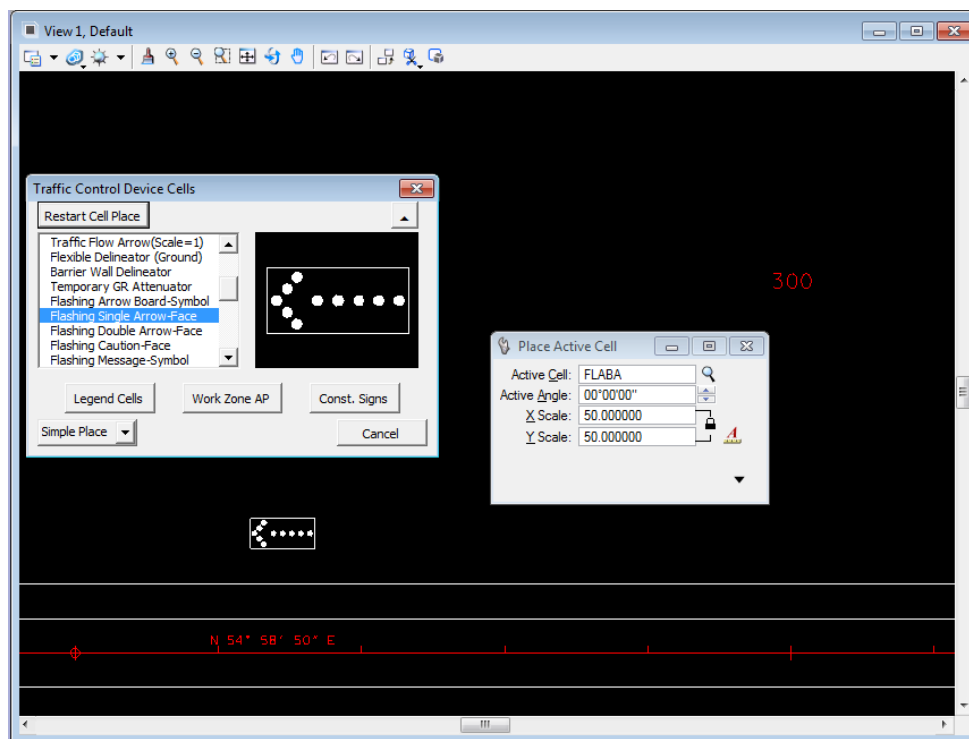
places cell with MicroStation's Place Cell command with settings for angle and scale

Exercise 20

Place/Rotate	places cell by data point with dynamic rotation and setting for scale
Place Along	places cells along an element with settings for spacing, scale and angle
Place Sign With ...	available on the sign cell dialogs, includes placement of sign face with text label, leader line and sign symbol

The Traffic Control dialog defaults to Place/Rotate but instead of using that method click on the option button and set it to Simple Place.

- 4) Scroll down the cell list and pick any cell. MicroStation's Place Cell command is started. Adjustments can be made for angle and scale prior to placing cell as needed using these basic controls.

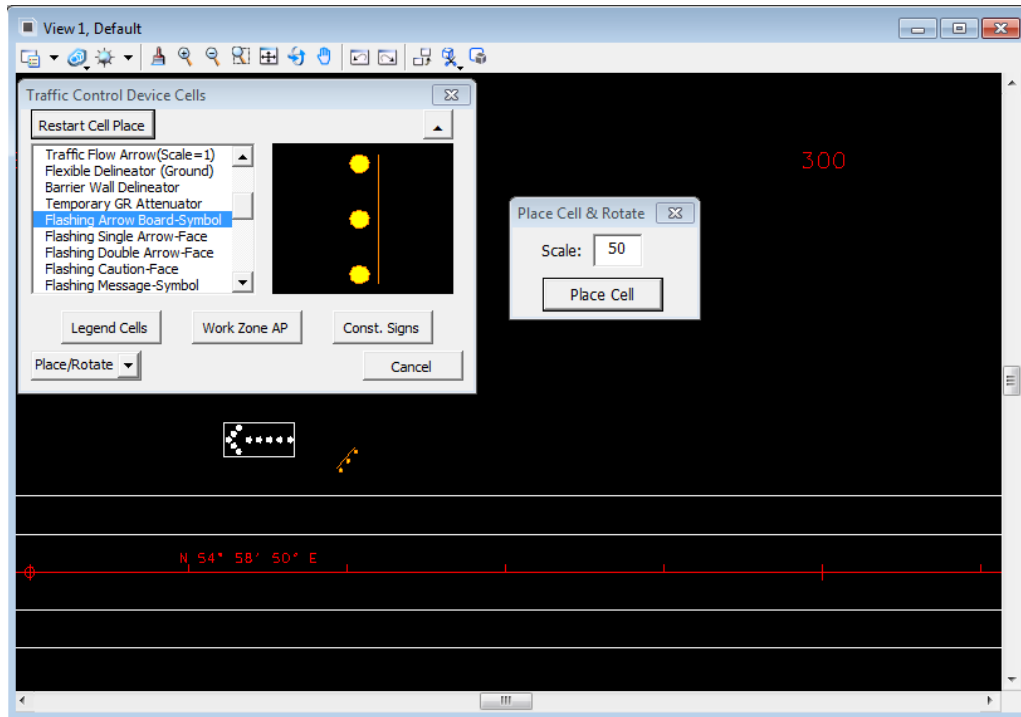


Data Point to place the cell. You may need to turn on level, DESIGN - TRAFFIC CONTROL TEMPORARY – Devices, to see the cell.

- 5) Click on the Cell Placement Type button and set it to Place/Rotate.

Pick another cell from the list. The Place Cell & Rotate dialog opens where you can adjust the scale as needed.

Data point in graphics at a location for the cell. Rotation is started so that the angle can be set dynamically.



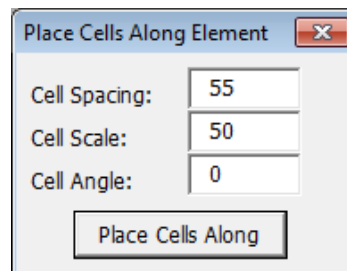
Data point to set the angle and place the cell.

The Place Cell command button on the Place Cell & Rotate dialog can be used anytime other MicroStation commands have been used and you wish to go back to placing the active cell with dynamic rotation

- 6) Click on the Cell Placement Type button and set it to Place Along.

Scroll back up in the cell list and pick the cell Barrel – Left. The Place Cells Along Element dialog opens where you can make control settings as needed.

Set the control settings as shown below: Spacing 55, Scale 50 & Angle 0.



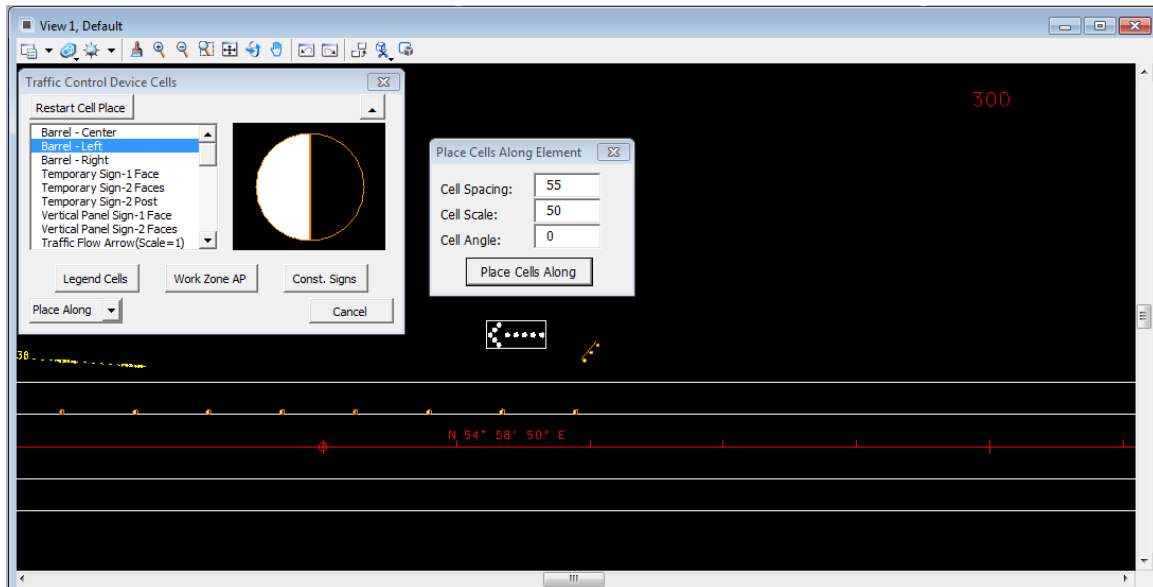
Click the Place Cells Along command button.

Exercise 20

In the prompt field of the MicroStation status bar, we are being prompted to Identify Element at beginning location. Data point anywhere along our inside edge of pavement on the right side of the roadway.

Once the line is identified, we are prompted to Accept/Reject ...Identify direction\end. Accept the pavement line element to the right.

Barrel cells are placed on the 55' spacing along this line between the points given.



NOTE:

For the user's convenience all cell dialogs are available through the following locations:

D&C Manager items

as illustrated in this exercise

T.D.O.T. drop down menu

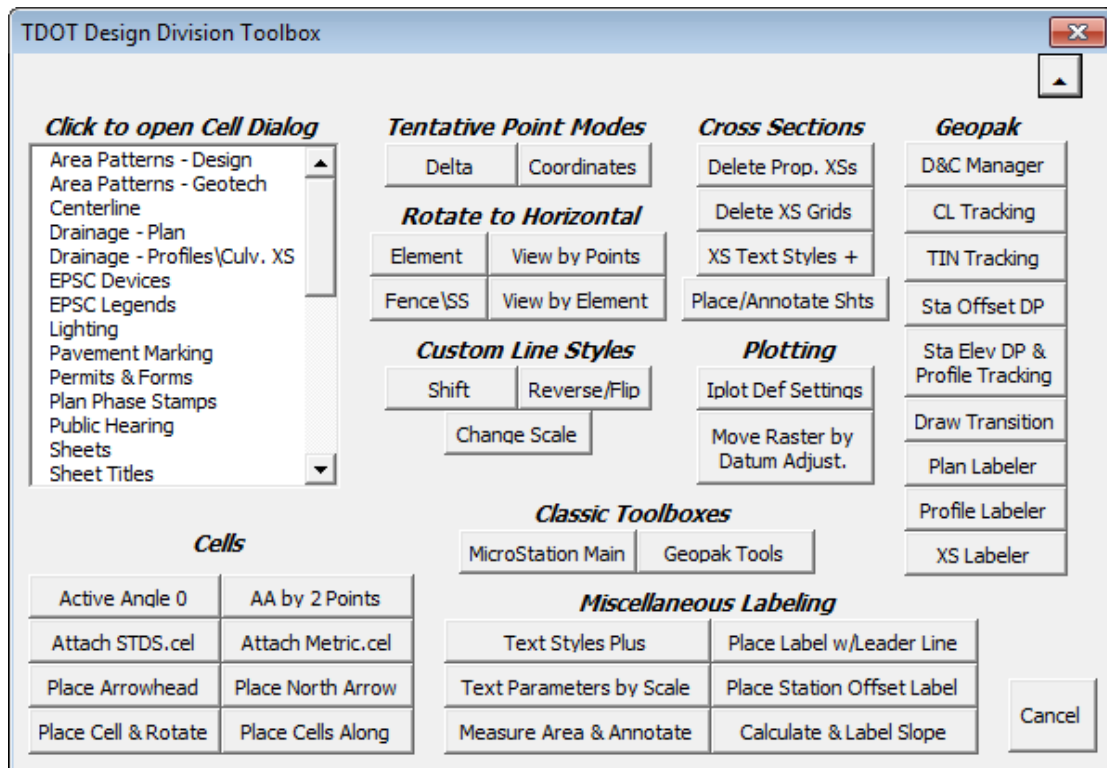
from the MicroStation menu bar with TDOT interface active

TDOT Design Division Tool Box

special tool box with many commonly used functions including GEOPAK & MicroStation tools as well as customized T.D.O.T. Roadway Design Division tools.

The TDOT Design Division Tool Box is available from MicroStation menu bar at
 T.D.O.T. → Tools → Design Division Tool Box

or from GEOPAK's D&C Manager at
 Drafting Standards → Tools → Design Toolbox



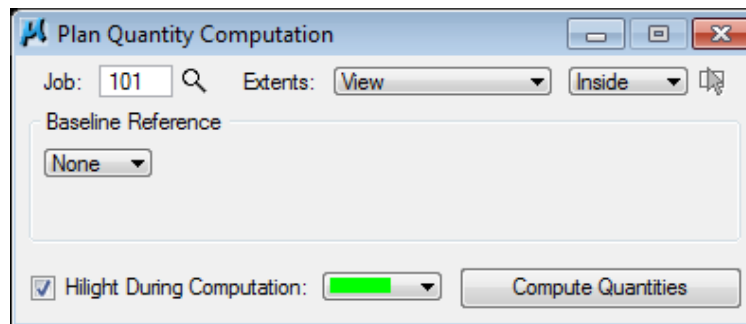
III.) Quantities

- 1) Access the D&C Manager.
- 2) Select the category Pay Items → Guardrail Items
- 3) Set Compute mode in Design and Computation Manager. In the expanded dialog click on the Compute icon (small calculator) which will open up the Plan Quantity Computation dialog.

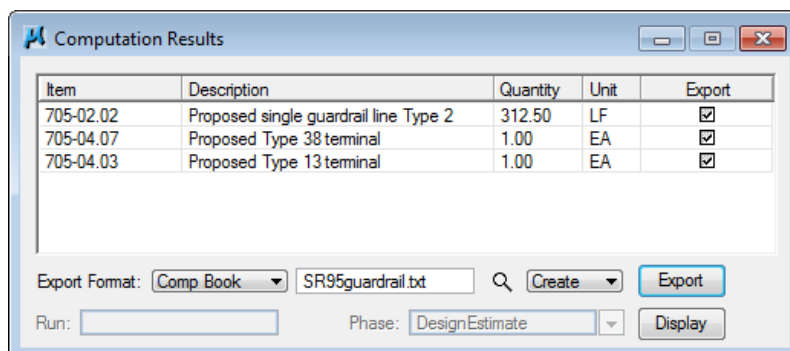


- 4) Make sure the Job is set to 101 and Extents is set to View.

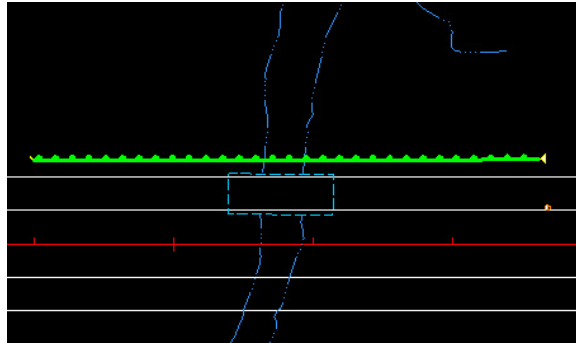
Set the Baseline Reference to None and toggle on the Highlight During Computation option



- 5) Adjust your View 1 as needed so that our guardrail is shown there. Turn on level DESIGN - TRANSPORTATION - Roadside Barriers and refit the view so that you see the guardrail on the left around station 290+00.
- 6) Click on Compute Quantities. The graphics are read and the Computation Results dialog is opened with the totals for items under the selected category.



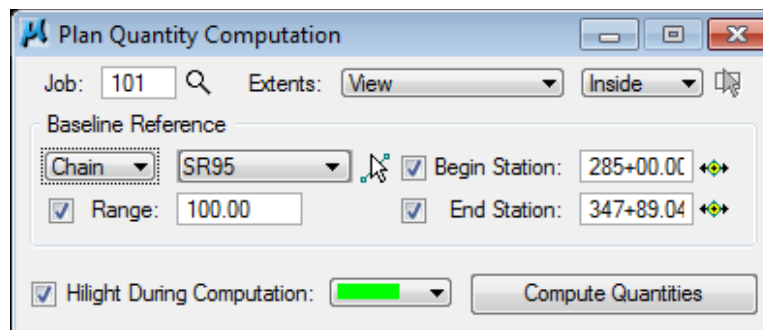
In the MicroStation view, the guardrail items are marked with your highlight color.



NOTE:

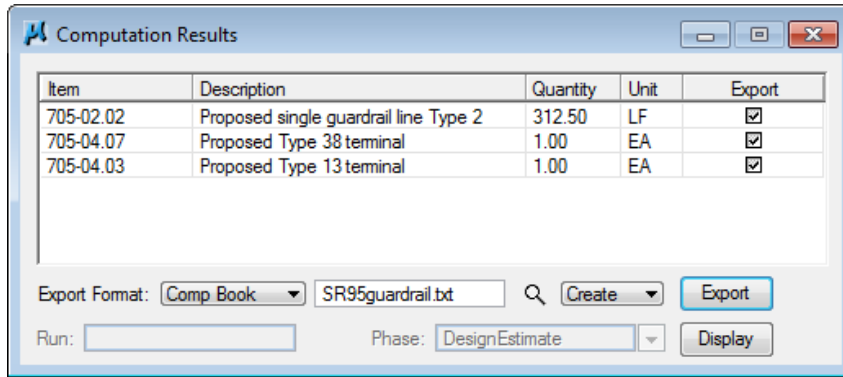
The quantities displayed in the Computation Results dialog can be saved to a CSV file (comma separated values) which can then be used to import quantities directly into the Estimated Roadway Quantities Excel worksheet. In the Computation Results dialog set Export Format to CSV By Item, keyin a filename and click Export.

- 7) Since we need station limits for our guardrail tabulations let's try a different set up. In the Plan Quantity Computation dialog set Baseline Reference to Chain and chain SR95 as shown. The Range setting is used to make sure items on other roadways are ignored and Stations can limit the area of the specified roadway as well.



- 8) Click on Compute quantities. In the Computation Results dialog set Export Format to Comp Book, keyin the filename SR95guardrail.txt and click Export.

Exercise 20



- 9) Use GEOPAK's text editor to open the file SR95guardrail.txt and review the results of your latest computation.

Date: 9/20/2016 7:57:34 AM Page No. 1

LINEAR MEASUREMENT COMPUTATION

Pay Item No. 705-02.02
Unit:LF File Name: SR95guardrail.txt

Pay Item Name: Proposed single guardrail line Type 2

Baseline	[B E G I N]		[E N D]		[O R I G I N A L]			[F I N A L]			Over/Under Run	Remarks
	Station	Offset	Station	Offset	Gross Length	Deduct Length	Net Length	Gross Length	Deduct Length	Net Length		
SR95	289+00.00	-60.00	292+12.50	-60.00	312.50	0.00	312.50					
Totals	Unit:LF				312.50	0.00	312.50					

Date: 9/20/2016 7:57:34 AM Page No. 2

LINEAR MEASUREMENT COMPUTATION

Pay Item No. 705-04.07
Unit:EA File Name: SR95guardrail.txt

Pay Item Name: Proposed Type 38 terminal

Baseline	[B E G I N]		[E N D]		[O R I G I N A L]			[F I N A L]			Over/Under Run	Remarks
	Station	Offset	Station	Offset	Gross Length	Deduct Length	Net Length	Gross Length	Deduct Length	Net Length		
SR95	292+12.50	-60.00	292+62.50	-61.00	1.00	0.00	1.00					
Page Totals	Unit:EA				1.00	0.00	1.00					
Totals	Unit:EA				1.00	0.00	1.00					

Line: 1 Col: 1

NOTE:

Guardrail quantities generated in this way can be used to automatically build the data into our standard tabulation format using the program available in standard Microsoft Excel template

C:\Users\Public\OfficeStandards\TDOTEnglishTabQuantities\GuardrailTabBuilder.xltn.

Before making any changes to this file, use "save as" to save it into your working directory so you do not alter the template.

- 10) Experiment with different modes and export options to familiarize yourself with the computation functions.

If you wish, calculate some quantities on the traffic control devices placed in the previous exercise or perhaps the 6-30 C&G we placed in the urban section at the end of the project.

For the curb and gutter, you can use a rate of 0.07181 cubic yards of concrete per foot which would be used for a gutter thickness of 9". The user is prompted for this rate on each C&G element that is found. It will remember the last rate entered so you only have to key it in once and can just accept it on subsequent elements.

Refer to standard roadway drawings RP-MC-1, RP-MC-2 and RP-NMC-10 for applicable rates of concrete per linear foot for curb and gutter.

As was illustrated with the Display functions at the beginning of this chapter, a Collection area is set up at the bottom of D&C Manager when in Compute mode to allow the selection of various items from different categories under Pay Items.

NOTE:

Only D&C Manager items under the Pay Items category are set up for quantity calculation from graphics.

- 11) Exit the Plan Quantity Computation dialog and Design and Computation Manager.

21. Graphical COGO – Proposed R.O.W.

In this exercise we will demonstrate the use of another set of COGO tools, Graphical COGO. It is set up to store points graphically and can be used with visualized COGO elements to perform MicroStation like manipulations which translate into actual coordinate geometry stored in the GPK database.

For our exercise, we will store some proposed R.O.W. and annotate it using D&C Manager.

NOTE:

For complete documentation on setting up proposed R.O.W. and easements, refer to standard documentation file ProposedROW.pdf which can be found under Documentation at the T.D.O.T. Roadway Design Division web page address:

https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/cadd_files/documents/Proposed%20ROW.pdf

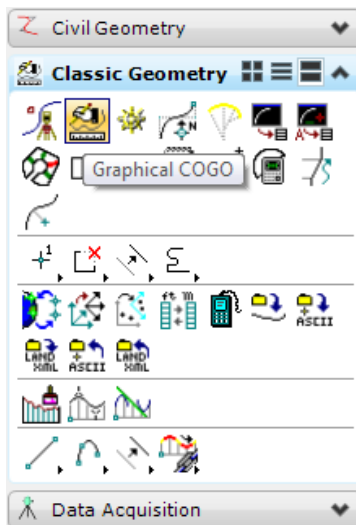
I.) Initial Set Up

- 1) Open the MicroStation file

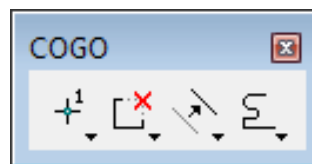
C:\Projects\Roane\SR95PoplarCr\ROSR95Proposed.dgn

Access Project Manager.

- 2) From the Classic Geometry task group, select the Graphical COGO icon (2nd from left).



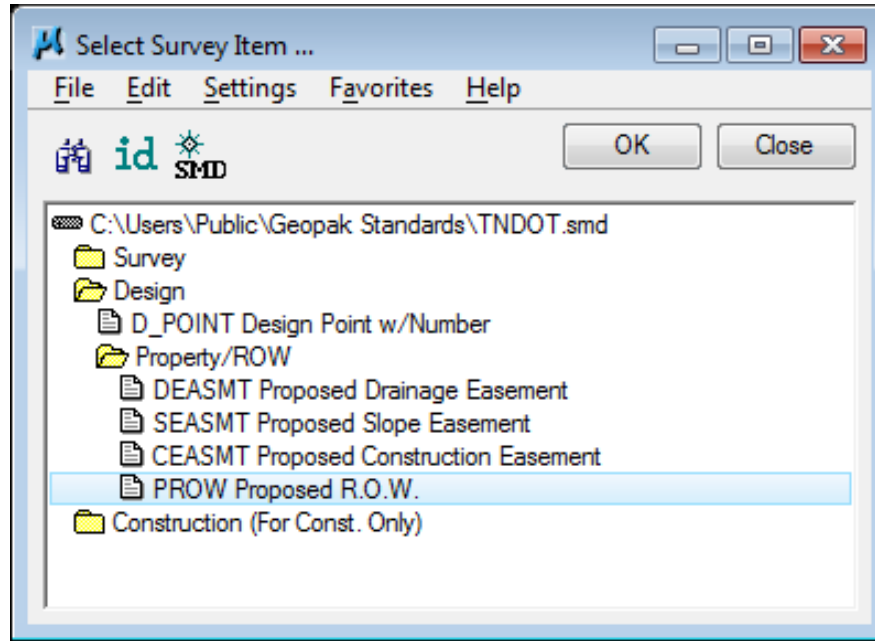
The COGO dialog opens and the Graphical COGO toolbox appears.



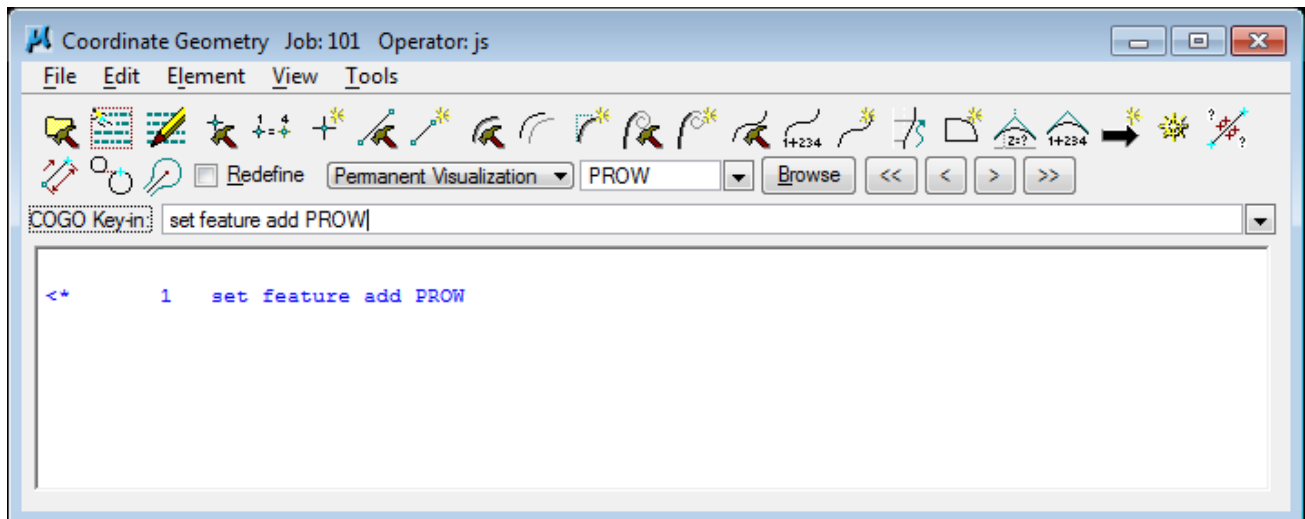
Note that in the Classic Geometry task display the second group of tools are the same so you can go directly to a given Graphical COGO tool if desired.

- 3) Before we store proposed R.O.W. points we need to set the feature PROW in COGO. Turn on Permanent Visualization and click the Browse button to set the feature.

Feature PROW is found under Design → Property/ROW.



- 4) Back in the main COGO dialog we can see our feature has been set. Minimize the COGO dialog to clear your screen area.

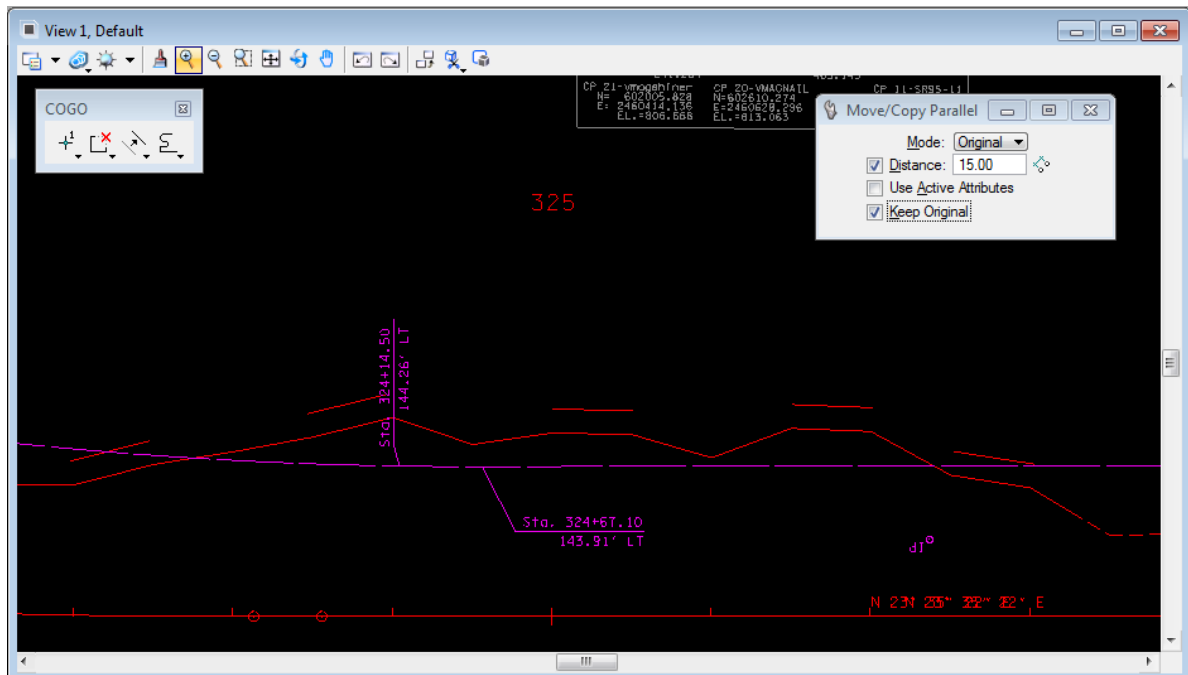


II.) Store Proposed R.O.W. Points/Breaks

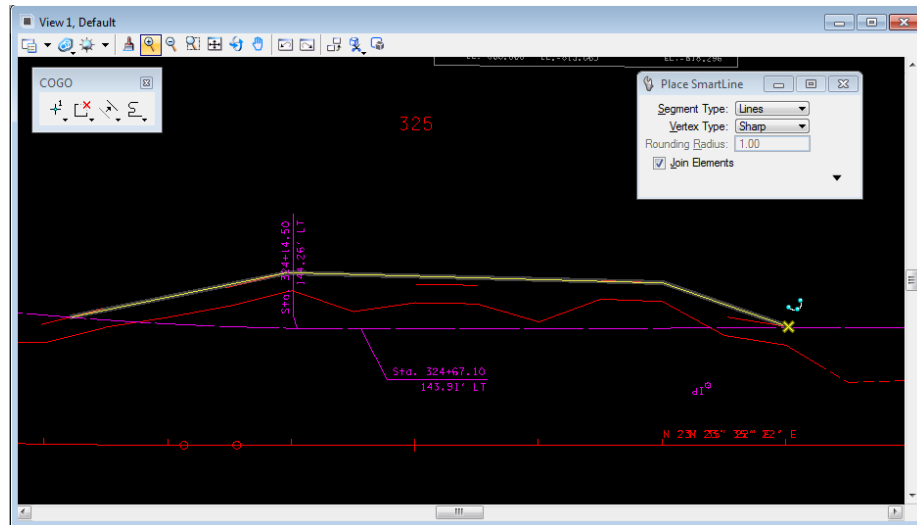
- 5) Zoom into the area near 325+00 and rotate the view to make the centerline horizontal. At this location our slopes go beyond the existing R.O.W. on the left so we will need some proposed R.O.W.

Use MicroStation's Level Display and the level filter Sheets - ROW Details to set the levels in the master file and all reference files. Switch back to Levels and turn on level DESIGN - ROW - ROW and Easement GPK Visualizations in the proposed file.

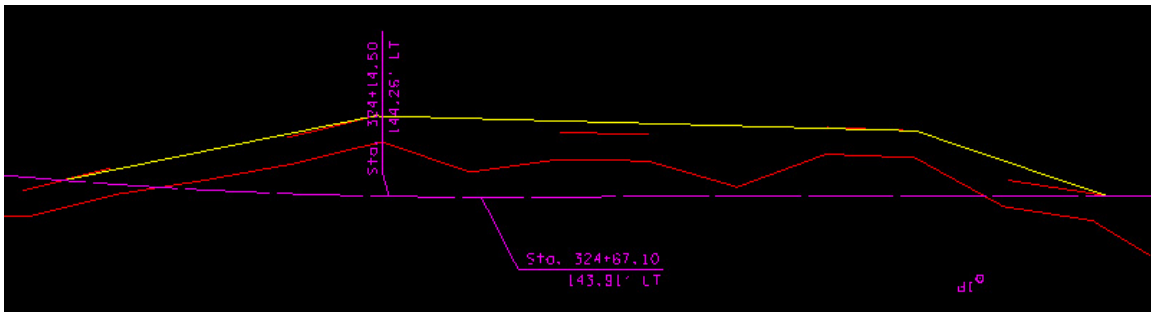
Use MicroStation's Copy Parallel command to locate the extreme points of the needed R.O.W. (Offset 15'). This will give those doing the construction plenty of room to construct the fill slopes. Turn off the graphic group lock so that you do not copy all of them parallel.



- 6) Now use MicroStation's Smart Line tool with sharp breaks to set a preliminary proposed R.O.W. line.



The finished preliminary line should appear similar to the one shown below.

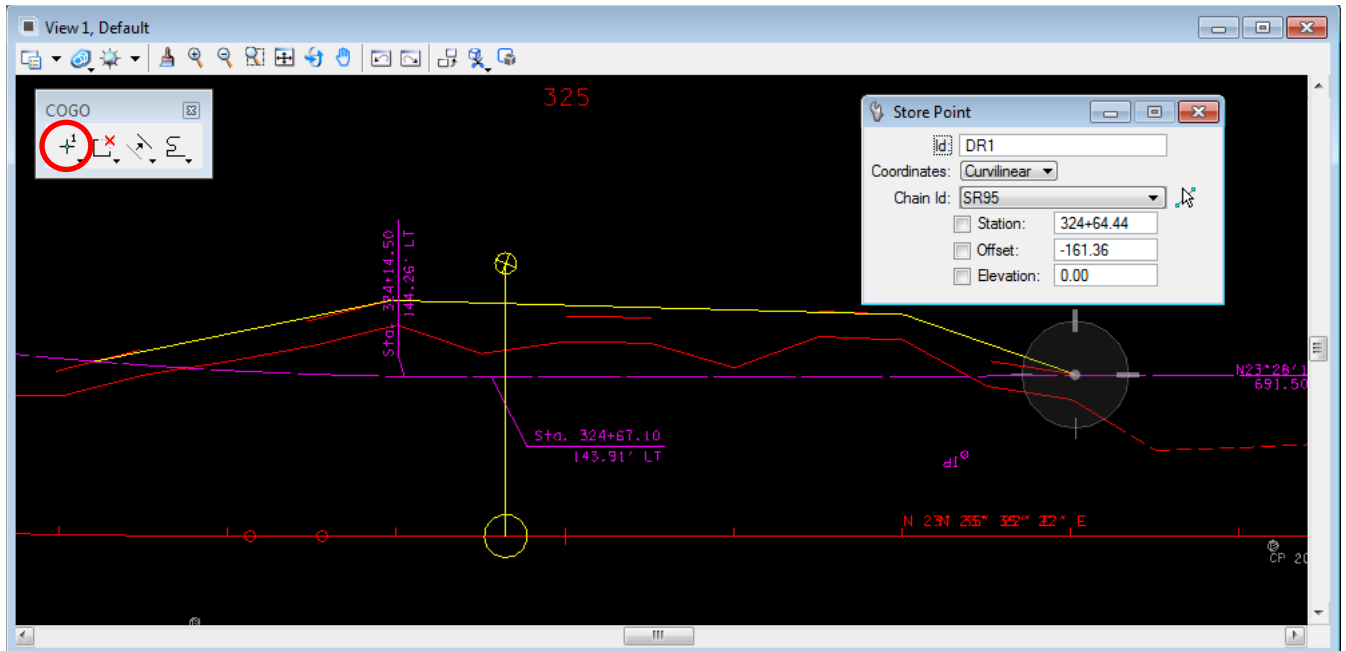


7) Now we are ready to start storing our R.O.W. points.

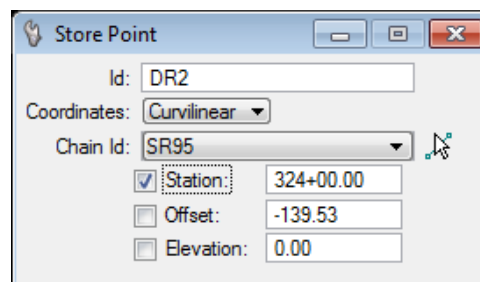
In the graphical COGO tool box or from the Classic Geometry tool options click on the Store Point icon at upper left.

Set the point Id to DR1 (begin point name), Coordinates control to Curvilinear and set chain SR95. You should now be tracking along the centerline.

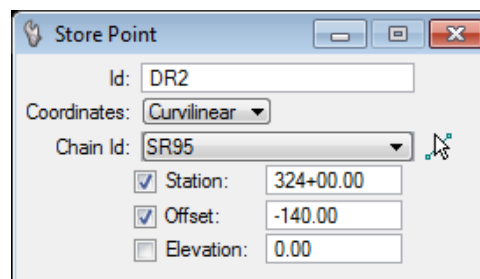
Exercise 21



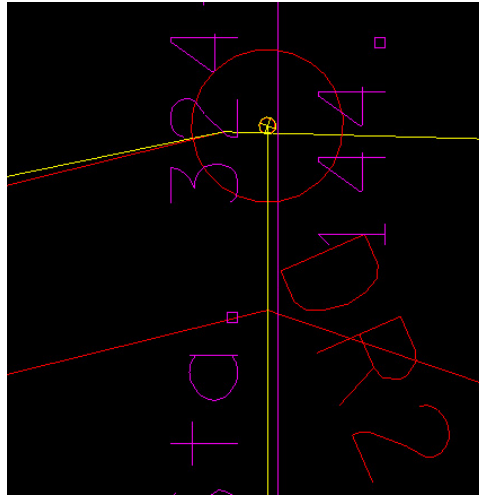
- 8) Using Intersection snap, locate the first point at the intersection with the existing R.O.W. on the left. Data point to store the point DR1.
- 9) Go to the next break in the preliminary R.O.W. line and Keypoint snap to it but do not data point yet. Instead go to the tool settings box click on the Station value and round to the nearest even station which should be 324+00. Click the lock box to hold the new station value



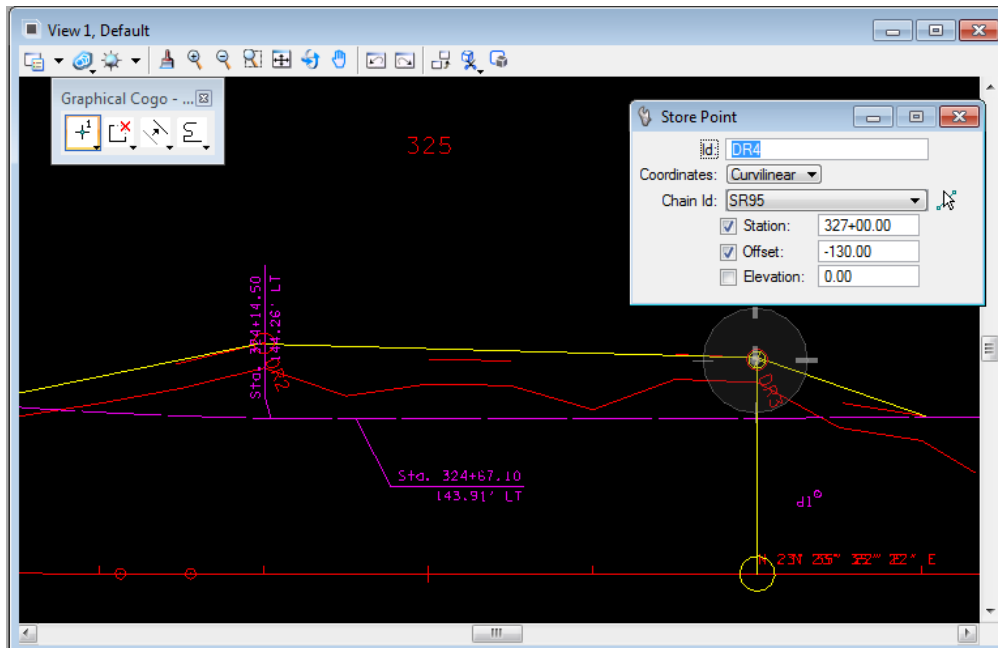
Now go down to the Offset and round to the nearest even foot which should be about -140. Don't forget the negative sign since we are on the left side of the road.



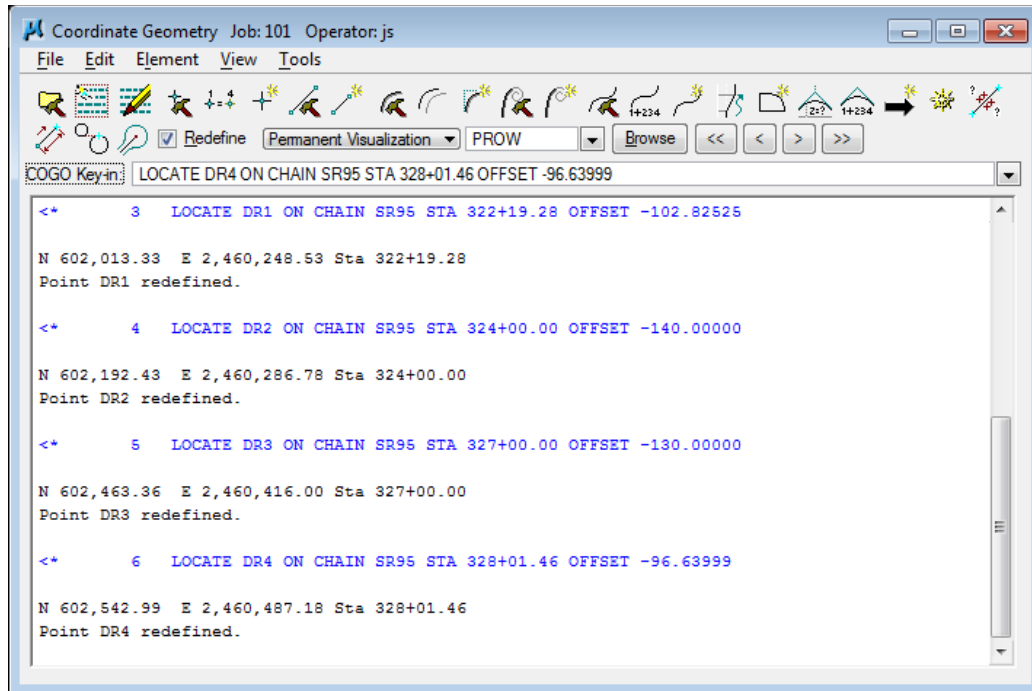
The station & offset should be locked in. Data point in the view to store the point DR2.



- 10) Repeat step 9 to store point DR3 at Station 327+00, Offset -130. You must click on the lock toggle boxes to un-lock the station and offset values and return to dynamic location mode.



- 11) Using Intersection snap, locate the last point at the intersection with the existing R.O.W. on the right. Data point to store the point DR4.
- 12) Open the main COGO dialog and we can see that our proposed R.O.W. points have been stored.

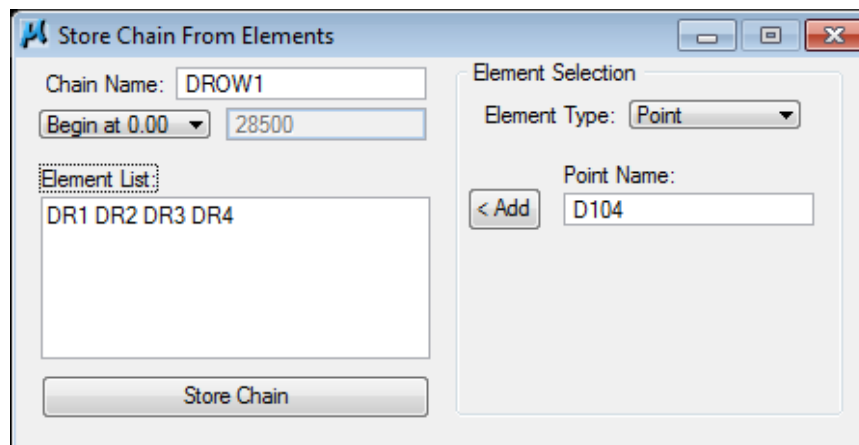


III.) Store Proposed R.O.W. Chain & Annotate

- 1) Now that our points are stored, we can build a chain from them. Click on the Chain from Elements icon in the main COGO dialog.

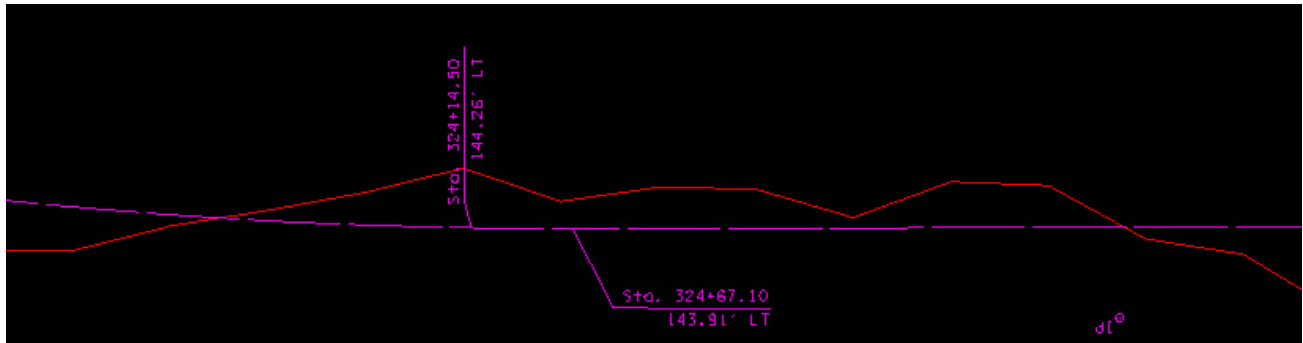


Key in chain name DROW1 and Double click on our visualized points in MicroStation to build the chain element list. Stationing really doesn't matter on R.O.W. chains just set it to begin at 0.

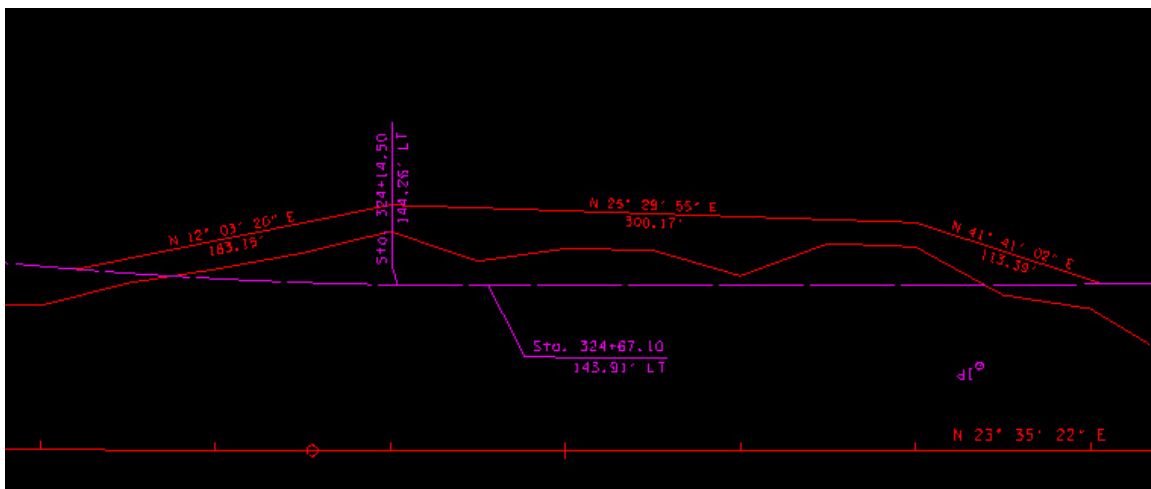


Click the Store Chain button.

- 2) Turn off the level DESIGN - ROW - ROW and Easement GPK Visualizations and delete the remaining temporary construction graphics we created to set our R.O.W.

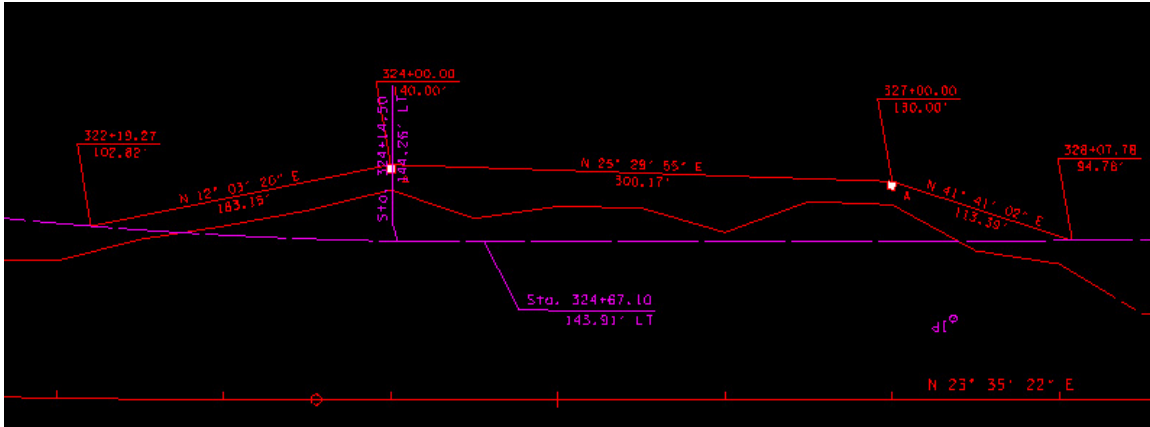


- 3) Open up D&C Manager and select item Drafting Standards → Prop. R.O.W. → R.O.W. Prop. In the secondary dialog, click on the Draw Plan & Profile button. Set the dialog to chains and single click on our proposed R.O.W. chain DROW1. Linework and distance/bearing annotation is placed.



- 4) Add the proposed R.O.W. lines to a MicroStation selection set.
- 5) Double click on D&C Manager item Drafting Standards → Prop. R.O.W. → ROW Flags.

When prompted enter Job number 101, roadway chain SR95 and click OK to place R.O.W. markers.



After applying R.O.W. flags in batch mode always review annotation for any clean up that might be needed so that all text is readable.

- 6) Close COGO and save an input file if you wish.

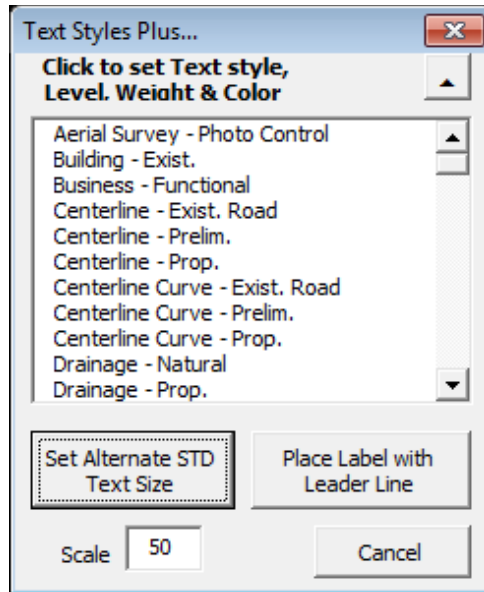
IV.) Alternate Labeling Tools

On the previous page we illustrated ways to apply annotation to proposed R.O.W. in a batch mode annotating multiple locations at one time. In some cases you may wish to annotate single segments or breaks of proposed R.O.W. when small changes are made. The T.D.O.T. Roadway Design Division provides the following tools to deal with those situations. Take the time to try each of these out on the proposed R.O.W. we have developed in this exercise.

- 1) Since these tools use the current active symbology and text settings, it is necessary to use T.D.O.T. Roadway Design Division's Text Styles Plus... tool to set those.

It can be accessed from Geopak's D&C Manager at Drafting Standards → Tools → Labeling → Textstyles Plus or with the T.D.O.T. Roadway Design Division interface from the MicroStation drop down menu TDOT → Text Styles Plus... or from the Roadway Design Division Tool Strip. The labeling tool dialogs provide an access point as well.





Make the following choices based on the type of annotation being placed:

ROW & Easements – Prop. For generic labels such as “PROP. R.O.W.”

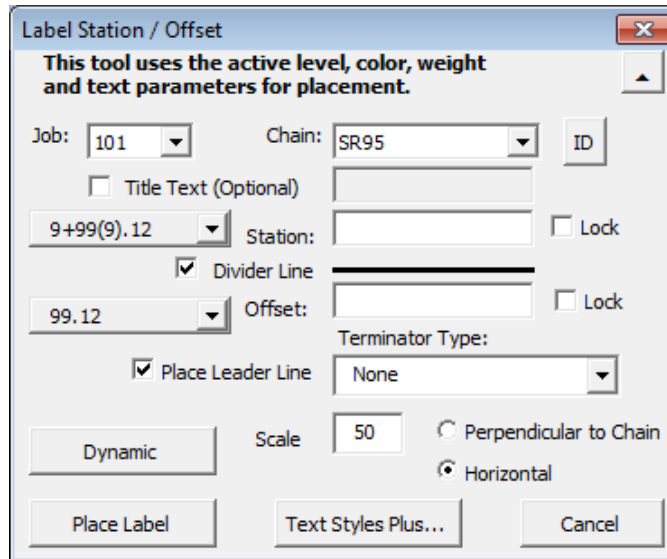
ROW Bearing & Distance – Prop. For prop. R.O.W. & easement segments, also used when labeling arcs which are part of prop. R.O.W. or easements

ROW Sta. & Offset – Prop. For prop. R.O.W. & easement breaks or intersections with R.O.W. or property lines

- 2) The Label Station/Offset tool can be used to label proposed R.O.W. breaks or intersections with property lines.

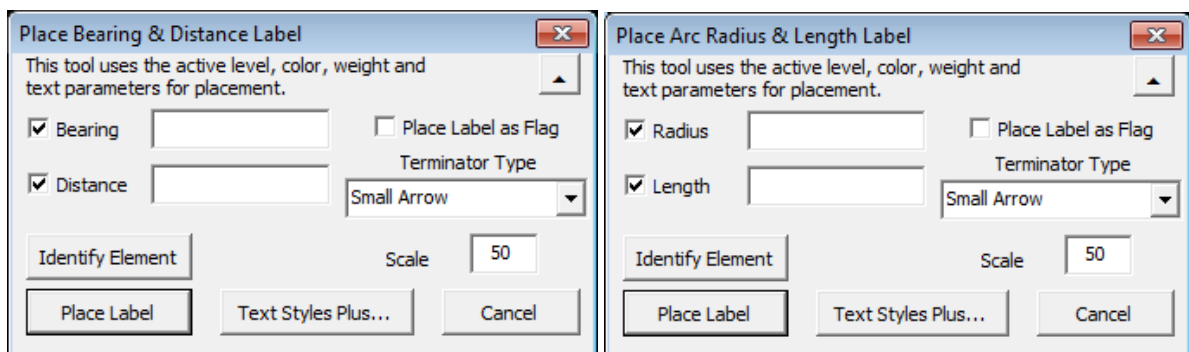
It can be accessed from Geopak’s D&C Manager at Drafting Standards → Prop. R.O.W. → StationOffset or with the T.D.O.T. Roadway Design Division interface from the MicroStation drop down menu TDOT → R.O.W. → Label Station & Offset

Exercise 21



- 3) The Place Bearing & Distance Label and Place Arc Radius & Length tools can be used to label proposed R.O.W. segments. On short prop. R.O.W. lines or arcs these tools may be used to place the annotation with leader lines as a flag.

They can be accessed from Geopak's D&C Manager at Drafting Standards → Prop. R.O.W. → BearingDistance & RadiusLegth or with the T.D.O.T. Roadway Design Division interface from the MicroStation drop down menu TDOT → R.O.W. → Label Bearing & Distance & Label Arc Radius & Length



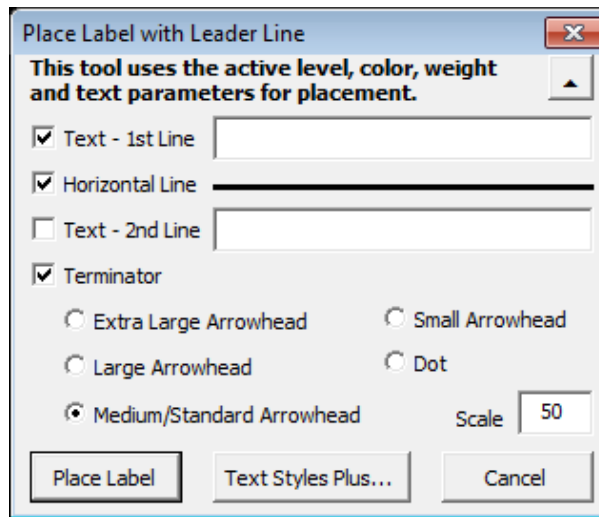
Proposed R.O.W. on Metric Projects

When annotating proposed R.O.W. on metric projects we are required to annotate dimensions in both metric and English units. The tools shown above automatically include both measurements when used in metric DGN files.

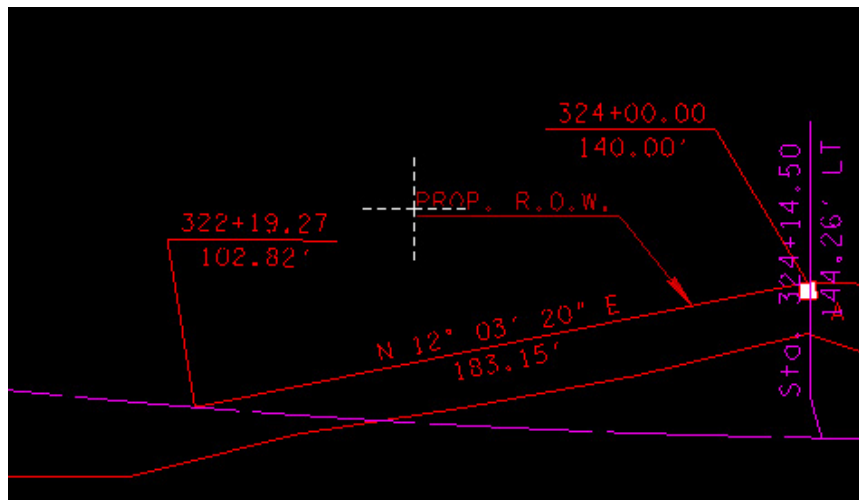
- 4) The Place Label with Leader Line tool can be used to place generic text labels for proposed R.O.W.

It can be accessed from Geopak's D&C Manager at Drafting Standards → Tools → Labeling → LabelwithLeader or with the T.D.O.T. Roadway Design

Division interface from the MicroStation drop down menu TDOT → Tools → Place Label with Leader



Example of label placement:



NOTE:

For complete documentation on special programs developed by T.D.O.T.'s Roadway Design Division for use in MicroStation with Geopak, refer to standard documentation file TDOTRoadwayDesignDivisionPrograms.pdf which can be found under Documentation at the T.D.O.T. Roadway Design Division web page address:

https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/cadd_files/documents/TDOT%20Roadway%20Design%20Division%20Programs.pdf

GEOPAK Plan View Labeler:

As shown in chapter 18, the Geopak Plan View Labeler can be utilized as well to place annotation for proposed R.O.W. and other features in the project.

22. Proposed & Final TIN Creation

This exercise shows the basic steps for building cross section data and forming a proposed and a final TIN for our project roadway. The final tin is the surface as it would be after construction of the roadway; in other words, a combination of the current existing surface and the proposed roadway development.

The proposed tin can be used to help develop side road tie ins. In chapter 23, we will use the proposed tin which we develop in this chapter with the Draw Profile tool to illustrate cutting a profile across multiple surfaces at one time.

Data from the final TIN file is used for both culvert and storm drainage design. In conjunction with the GEOPAK DTM Tools, drainage areas and water flow can be carefully mapped out. With culverts, it is used to set preliminary invert elevations and to cut tail water sections. For storm sewer design, it automatically gets elevations at the gutter line and sets up the spread section at inlets. There are other methods of generating this information but the use of a final TIN is the preferred method.

T.D.O.T uses GEOPAK to create final TIN digital terrain models from proposed cross section graphics. It is important to include cross section data generated at all critical locations. These may include any of the following:

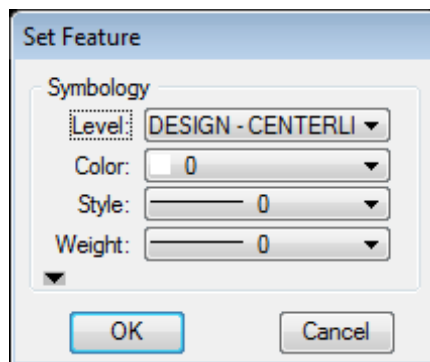
- Superelevation rate transition limits
- Beginning and ending of width transitions
- Locations where typical section changes
- Side road data
- Intersections with large radii should be cross sectioned around the radius
- Ramp data on roadways with interchanges
- Curb Ramps (cross section immediately before & after with 2 within central pathway)

If side roads, ramps or large intersection radii are involved, it will be necessary to repeat some steps to gather data from these additional areas. Due to the time available for this class, we will not include side roads in our final tin.

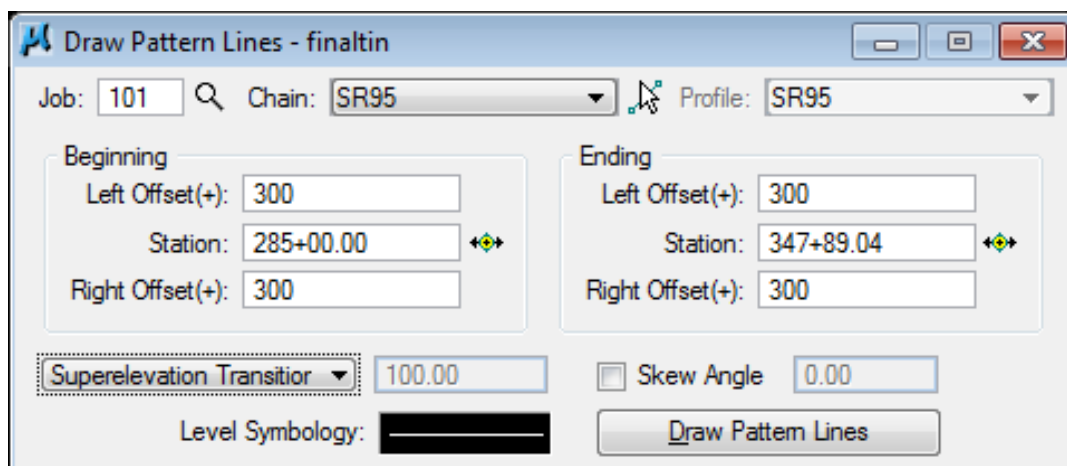
I.) Generating Cross Section Data

- 1) Create two new DGN files, FinalTINPatterns.dgn & FinalTINXSections.dgn, for generation of cross section data, one for patterns from DGN seed file Seed2D.dgn and one for cross sections from seed file SeedXS.dgn.
- 2) Open the MicroStation file FinalTINPatterns.dgn. Access the Project Manager workflow dialog. Click on Draw Pattern and create a new run finaltin

Double click on the symbology review window to make the following settings. Level name is DESIGN - CENTERLINE - Proposed.



Our roadway includes superelevation, so reference the super shapes DGN file ROSR95SEShapes.dgn using the Coincident World setting. In the Draw Pattern dialog, set the placement option to Superelevation Transitions and hit Draw Pattern Lines. This generates pattern lines at all critical superelevation locations.



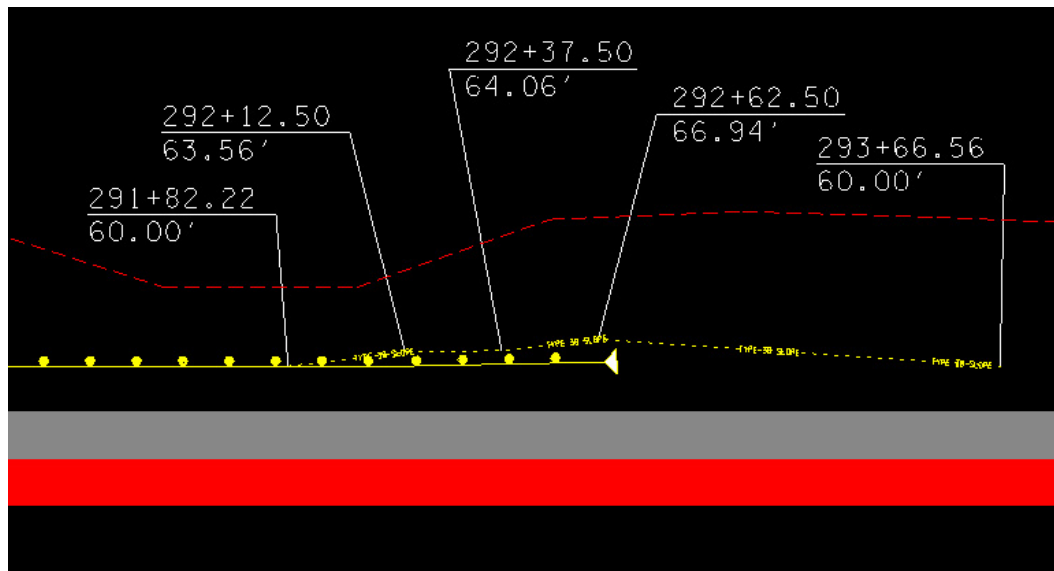
Exercise 22

- 3) Our roadway includes width transitions and a location where the typical section changes so click on Superelevation Transitions and change to Once.

Our pavement transition stations are 316+75 & 327+75 and the typical section changes at 328+25. In the next step, we will place regular pattern lines at a 5' interval so these will be covered then.

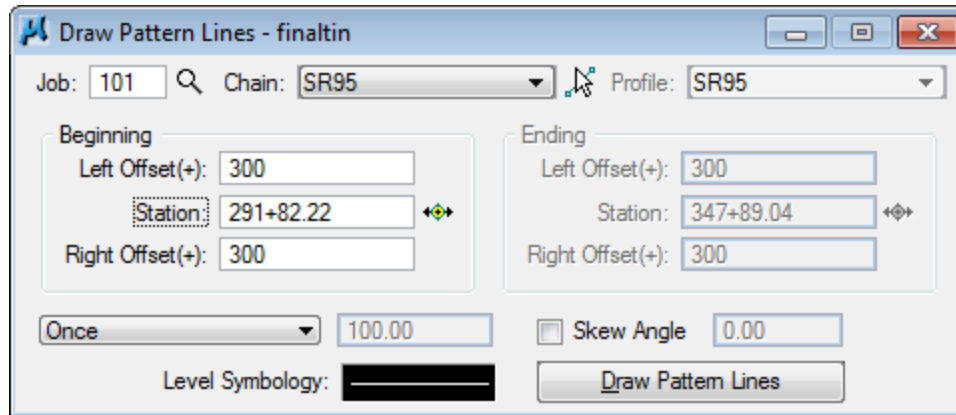
We do have a shoulder transition where the Type 38 terminal pad is located near station 292+50 on the left. We don't know the exact stations but using the Label Station/Offset **tool**, we can snap to each of the five control points of the pad to set their stations. The Label Station/Offset tool is found under **T.D.O.T.** → **Tools** → **Place Station Offset Label**.

Attach file ROSR95Proposed.dgn as a reference using Coincident World and turn on level DESIGN - TRANSPORTATION - GR Special Slope Limit Lines. Go to the guardrail terminal area near 292+50. The stations should be found to be 291+82.22, 292+12.50, 292+37.50, 292+62.50 & 293+66.56. Refer to standard roadway drawing S-GR-38 for Type 38 terminal pad layouts.

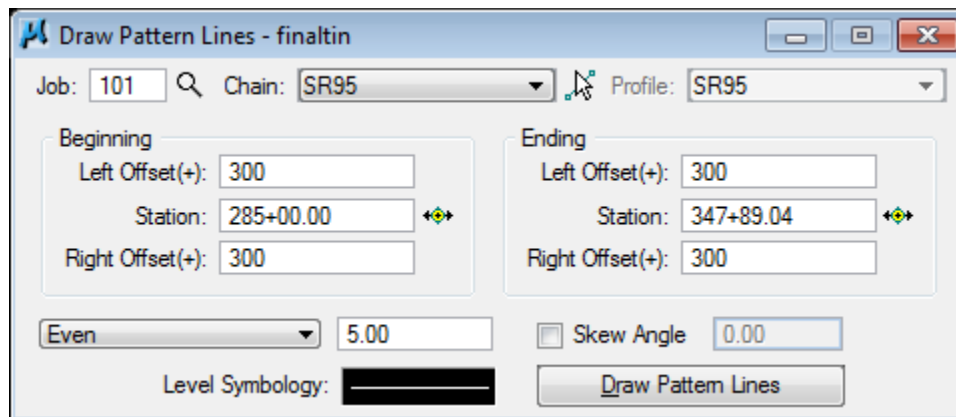


In addition, we need to place lines at locations where the superelevation rate is .000. There are four locations where this is the case, **308+55.12**, **322+75.11**, **331+39.67** and **337+22.58**.

Enter each of these stations and each time hit Draw Pattern Lines to place a pattern line there.



- 4) Change the placement option to Even and set the interval for pattern placement to 5. Reset station values to the beginning and end as shown below in the Draw Pattern Lines dialog and hit Draw Pattern Lines.



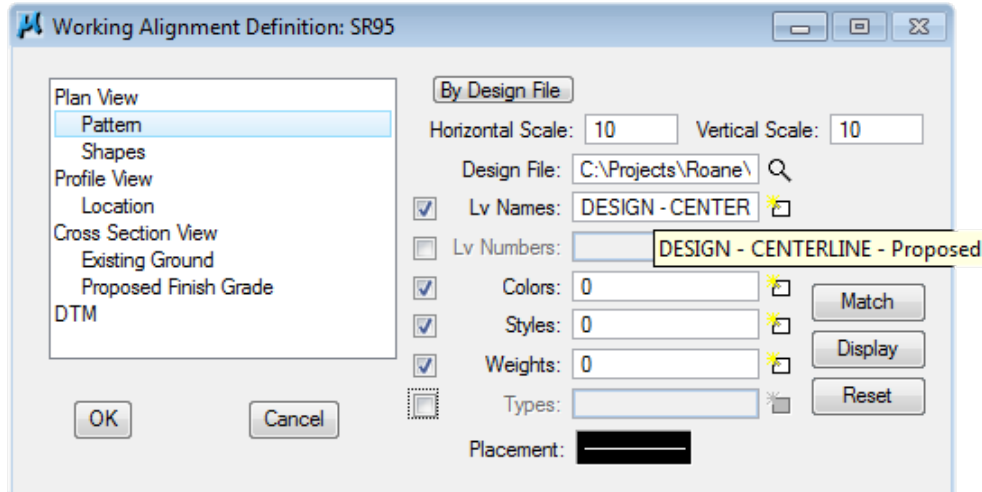
NOTE:

An interval increment of 5' or some other small value is recommended in order to ensure that an accurate proposed tin is formed from the cross section data.

- 5) Close the Draw Pattern Lines dialog and save settings on the run.
- 6) Make a copy of the working alignment run SR95 and call it 95FINAL. We will set it up for producing the final TIN. Open the copied run.

Click on the Define button for working alignments. Access the Pattern dialog and set the filename to FinalTINPatterns.dgn and reset search criteria to match the ones used for your pattern lines.

Exercise 22

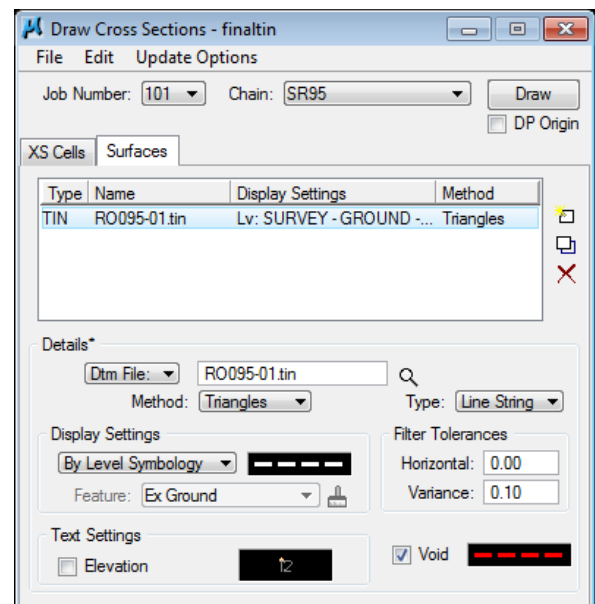
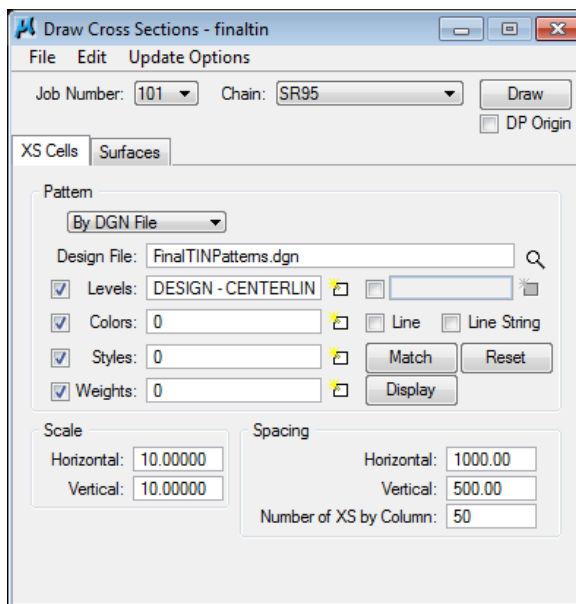


Click OK to save the settings.

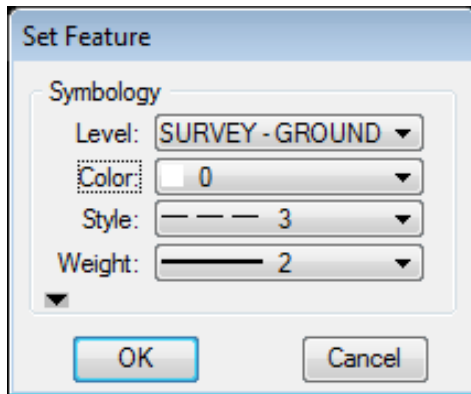
- 7) Open the MicroStation file FinalTINXSections.dgn. Access the Project Manager workflow dialog again and click on Existing Ground Cross Sections. Create a new run named finaltin. Most settings are automatically made from entries in the working alignment definition.

Make sure Type under Surfaces is set to Line String and set symbologies for existing ground and void areas by double clicking on symbology view windows. Both use level SURVEY - GROUND - Top of Ground.

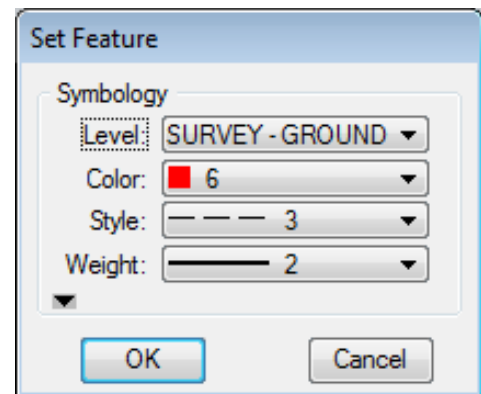
After setting surface values, click the Modify Surface Settings option to the right of the surface list.



Exist. Ground

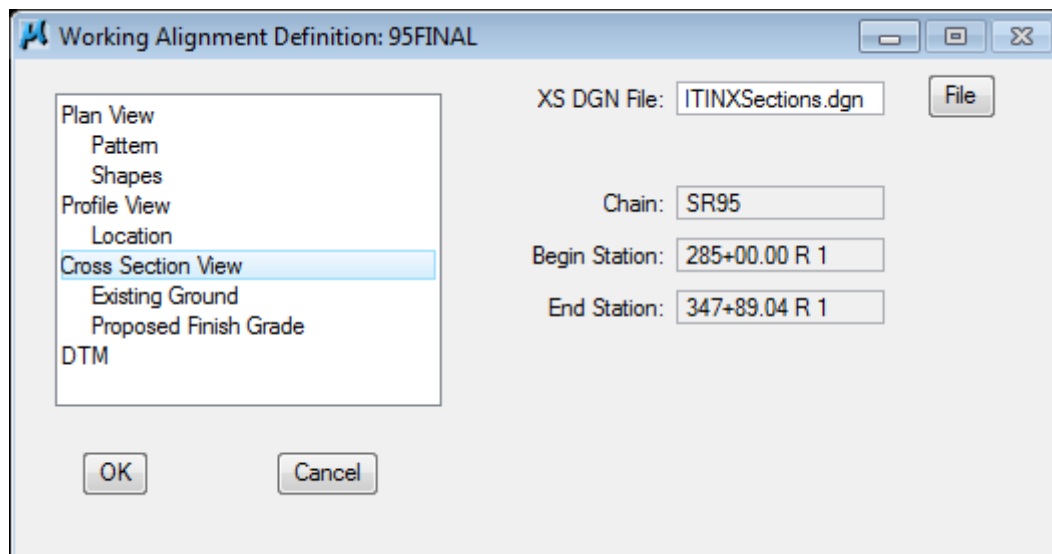


Void



When all settings are made, click on Draw.

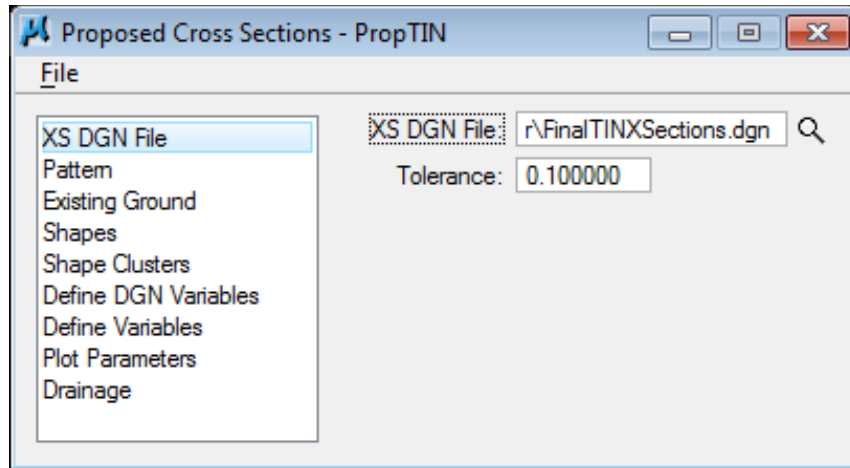
- 8) Close the Draw Cross Sections dialog and save settings on the run.
- 9) Finish setting up the working alignment. Access the Cross Section View dialog and set the filename to FinalTINXSections.dgn.



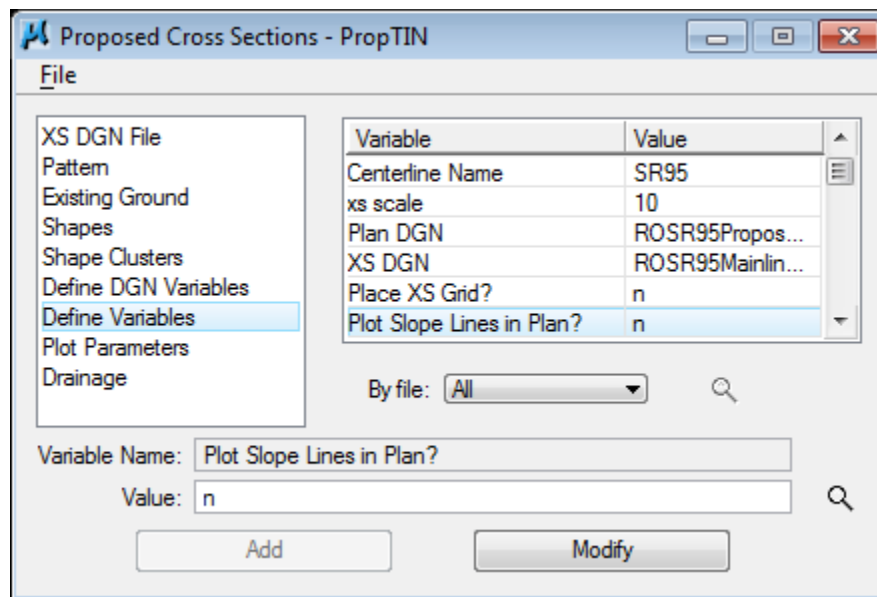
Click OK to save the settings.

- 10) Access the Project Manager workflow dialog again, click on Proposed Cross Sections and copy the run Final which you set up previously to generate regular roadway cross sections and call it PropTIN. Open the copied run.

Exercise 22



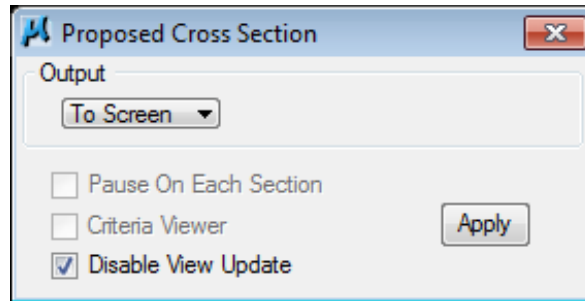
- 11) In the Define Variables dialog of Proposed Cross Sections reset the XS DGN filename to FinalTINXSections.dgn and set Place XS Grid? & Plot Slope Lines in Plan? to N.



- 12) No other changes need to be done to the run so we are ready to generate the proposed cross sections.

Go to the drop down option File → Run on the Proposed Cross Sections dialog. In the Proposed Cross Sections run dialog, make sure Pause On Each Section is clicked off.

Depending on the length of a project the proposed cross sections may take some time to run due to the large number of cross sections being generated. Click on the Disable View Update option so that it doesn't have to update the graphic display constantly.



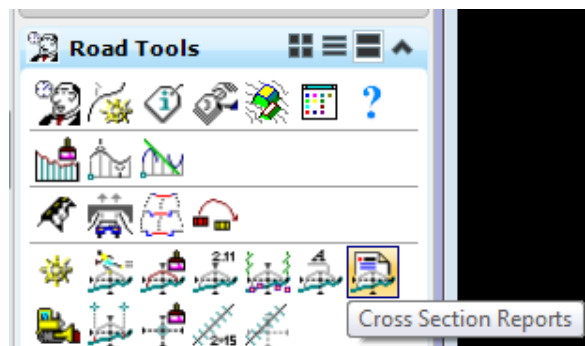
Click Apply.

- 13) Once cross sections are completed, exit the Proposed Cross Sections dialog and be sure and click Yes when prompted to save the settings just made.

II.) Build Proposed & Final TIN

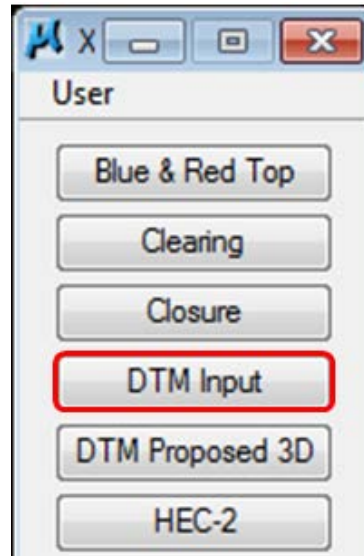
- 1) Open FinalTINXSections.dgn
- 2) Open the XS Reports dialog.

It can be accessed from Project Manager button Reports and XS Quantities, from the MicroStation menu bar drop down location Applications → GEOPAK → Road → Cross Sections → Reports or from the cross section task group under Road Tools.



- 3) On the XS Report dialog, toggle on the Highlight option at the bottom and select the option DTM Input.

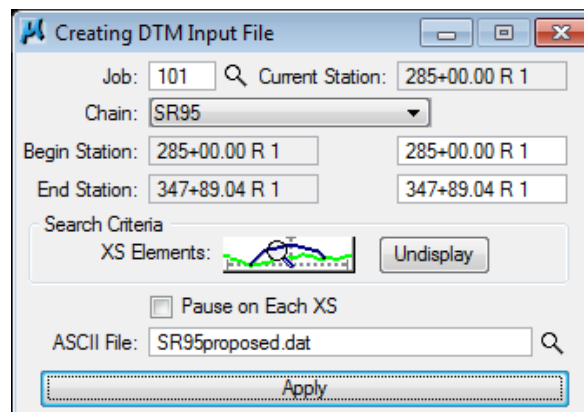
Exercise 22



NOTE:

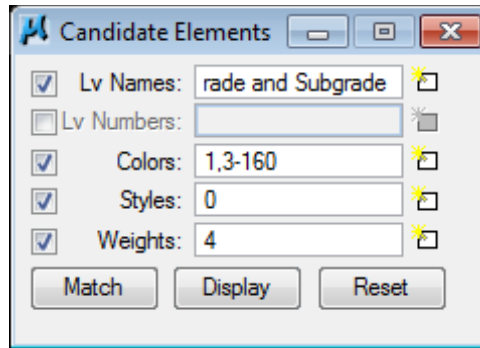
The option DTM Proposed 3D can be used generate the same data but it includes an option for ground line data which we should not use since it will only pull existing ground data from the cross section. We will add all ground data we need in the final TIN from the existing TIN file.

- 4) This opens the Creating DTM Input File dialog. Make settings as shown below. Set the ASCII filename to SR95proposed.dat, click on the XS Elements button to set the Candidate Elements symbology.



Color 2 (subgrade) and color 161 (curb, gutter, sidewalk & wall bottoms) should not be included. The only data desired from proposed cross section graphics is along the finished grade. The level name is DESIGN - TYPICAL - Finished Grade and Subgrade.

Make the settings as shown and use the Display button to check them on your cross section graphics.



Click the red X to dismiss the Candidate Elements dialog and click Apply on the main dialog to start processing.

NOTE:

If your project needs to include data from other cross sections such as side roads or ramps, steps up to this point should be repeated for the other areas. Once done, use Copy & Paste in any text editor to combine the data in one single DAT file.

Where roadways meet, intersection EOP lines should be used to limit proposed cross data to the edge of the travel lanes so that it will not be necessary to edit the resulting proposed surface to delete invalid points such as curb or slope points crossing intersections.

When creating bridge deck surfaces, the level DESIGN - SURFACE - Bridge Surface Construction Lines should be included. Lines placed on this level take care of bridge overhangs and gaps which cause problems during surface creation.

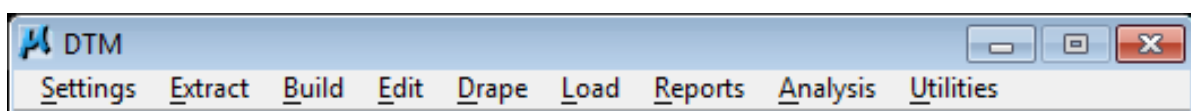
- 5) Now we are ready to create a proposed TIN file from the data which we have put together. Access the DTM Tools from the MicroStation menu bar drop down location

Applications → GEOPAK → Road → DTM Tools or the Existing Ground button on the Project Manager dialog. Create a new run called final.

You may wish to use either the tool box

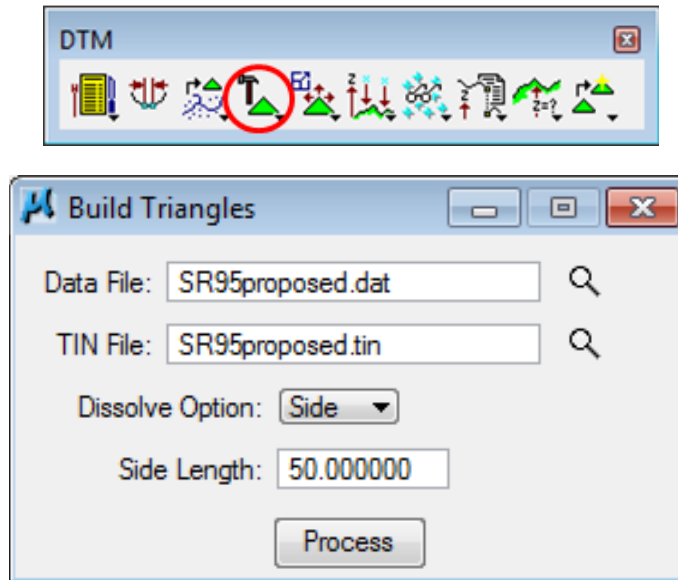


or the Menu bar



Exercise 22

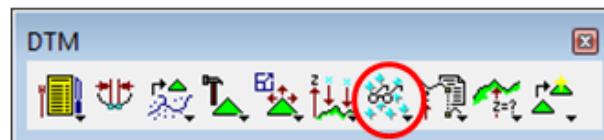
- 6) Open the Build Triangles dialog and enter filenames as shown below. Set the Dissolve Option to Side and set the side length to 50. This control will prevent long skinny triangles from forming along outside of proposed slopes. Once entered hit Process.



NOTE:

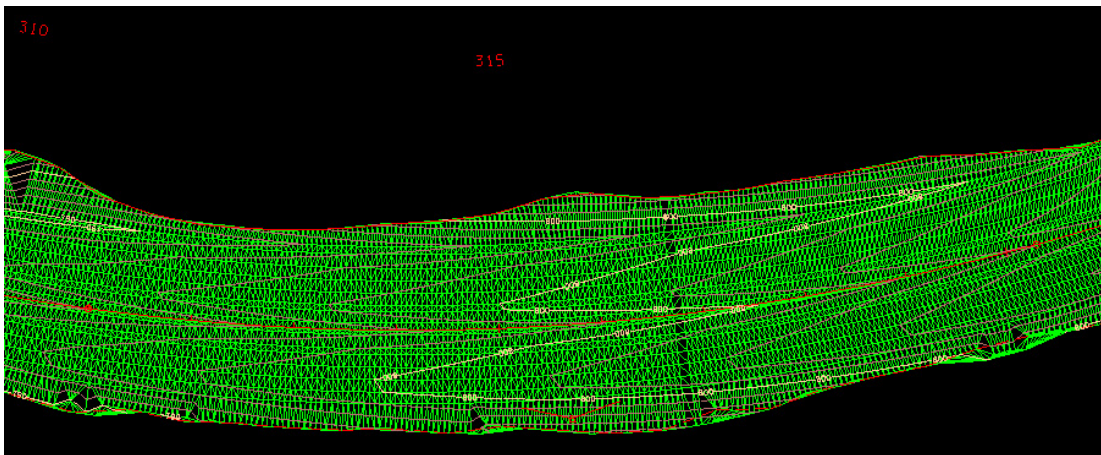
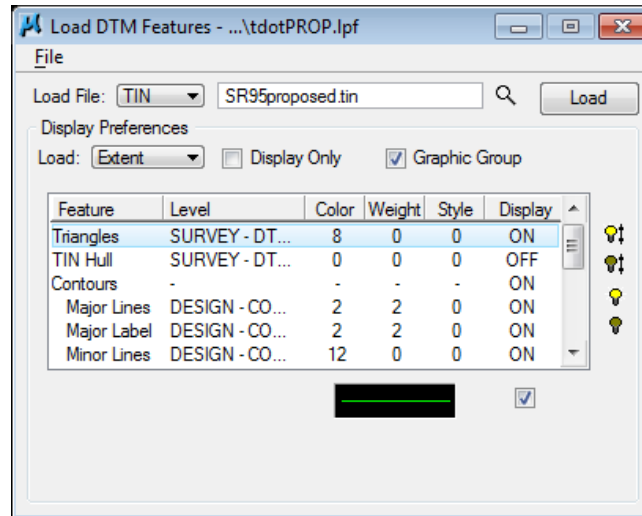
The value entered for the Dissolve Option depends on your job. If cuts and fills are light, a value between 50 & 100 should work. If cuts or fills are large, a larger value should be used to avoid holes in your TIN.

- 7) Review the proposed TIN file just created. Open the FinalTINPatterns.dgn file or some other scratch DGN file. Use the Load DTM Features tool to load triangles, contours, etc.



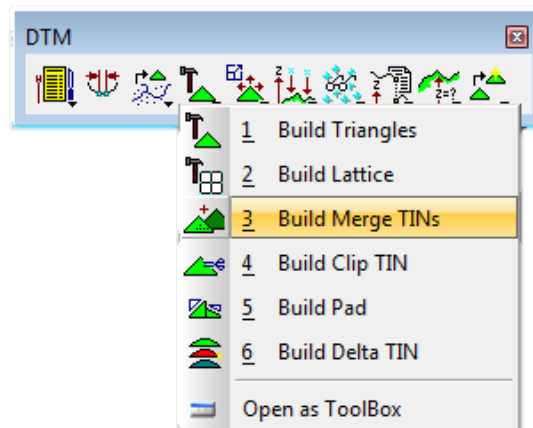
Before displaying graphics, go to File → Open in the Load DTM Features dialog and attach tdotPROP.lpf, found under C:\Users\Public\Geopak Standards, which is set up for proposed TIN surface displays

Make sure the proposed TIN includes no holes or long triangles on the sides. You also may wish to create a temporary cross section file and cut some sections to check your proposed roadway TIN.

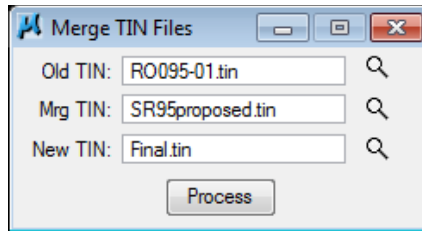


If needed, use the Edit Triangles function under DTM Tools to dynamically delete any invalid points/triangle vertices.

- 8) Once satisfied with your proposed TIN you are ready for the final step. We need to merge the proposed TIN with the existing TIN to form a complete final TIN. In DTM Tools under Build, open the Build Merge TIN Files dialog. Fill in filenames as shown below and hit Process.



Exercise 22



This eliminates all existing points within the area of the proposed TIN file and then combines the proposed data with the remaining existing data in the new TIN file.

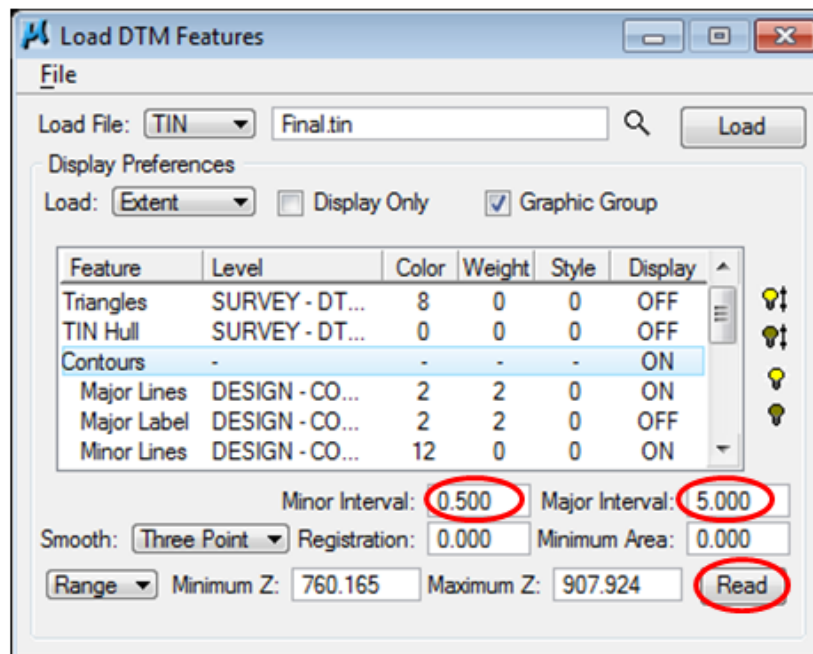
NOTE on Long Projects:

Some final TINs created for larger projects may prove cumbersome to use or create. If problems are encountered on larger jobs, it is suggested that some controlling drainage feature such as a ridgeline across the project be located and then used as a dividing line so that two separate final TINs be can be formed that will function on their own.

- 9) Create a new MicroStation DGN file named FinalTIN.dgn using seed file **Seed3D.dgn**.

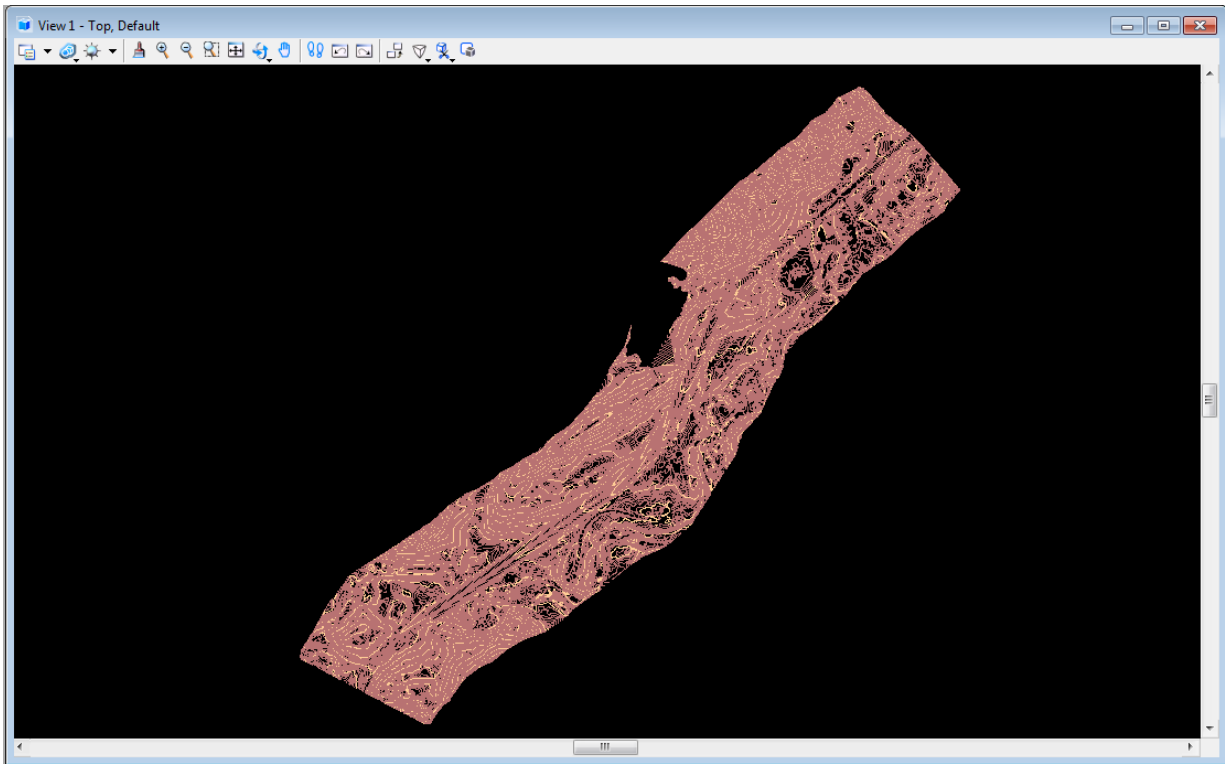
At this point review the final TIN by generating final contours in a 3D DGN file.

Open the Load DTM Features tool. Turn off all feature items but Major and Minor Contour lines. Under the main Contour feature make interval settings as shown, Minor:0.5, Major:5. Click read after the settings have been adjusted.

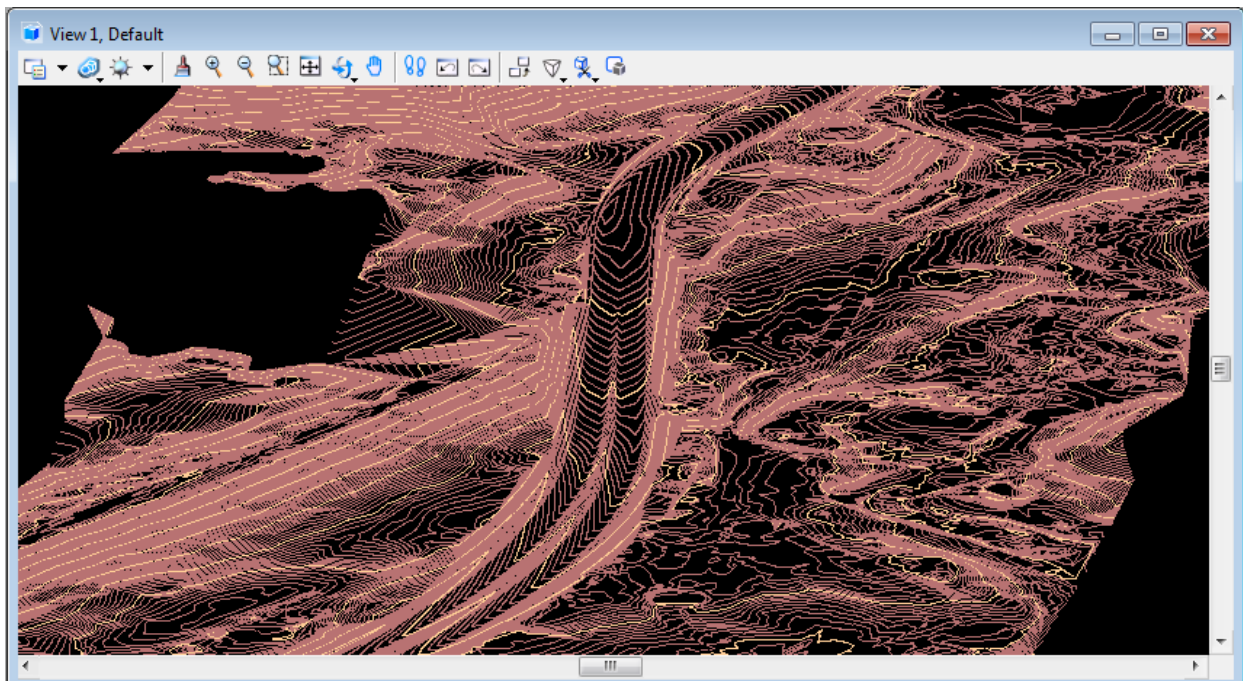


Once set, click on Load.

Delete the Global Origin note text and circle and then Fit View in MicroStation.



Use MicroStation's Rotate View tool and choose Method: Dynamic. Use Zoom commands to check out your surface. This view is looking down through our transition area.



23. Side Roads

In this exercise we will use Graphical COGO & the Draw Profile tool to begin the design of a side road. All of the functions we have worked with to design our mainline roadway S.R. 95 can be used to develop side roads as well. The tools in this chapter are presented as an alternative to some of the functions we used previously for S.R. 95.

Private Drives:

Any private drives, businesses and field entrances with possible slope encroachments, in extreme cuts or fills or any that need more complex vertical alignments will need to be designed using regular roadway design functions presented in this manual.

We do have a batch process developed for automatic production of private drive profiles which can be used on drives that do not involve any of the design situations listed above that would require more in depth study. For complete documentation on batch processing of private drive profiles, refer to standard documentation file PvtDrProfiles.pdf which can be found under Documentation at the T.D.O.T. Roadway Design Division web page address:

https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/cadd_files/documents/Private%20Drive%20Profiles.pdf

NOTE:

For complete documentation on the determination of the line of sight, refer to standard documentation file **LineofSightInvestigation.pdf** which can be found under Documentation at the T.D.O.T. Roadway Design Division, CADD Files web page address:

https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/cadd_files/documents/Line%20of%20Sight%20Investigations.pdf

I.) Initial Set Up

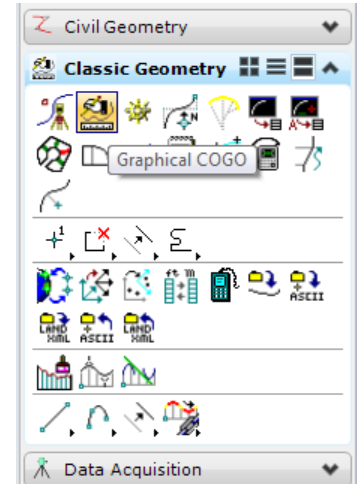
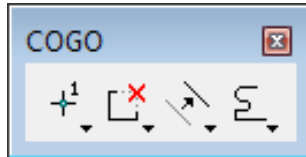
- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95Alignments.dgn

Access Project Manager.

- 2) From the Classic Geometry task group, select the Graphical COGO icon.

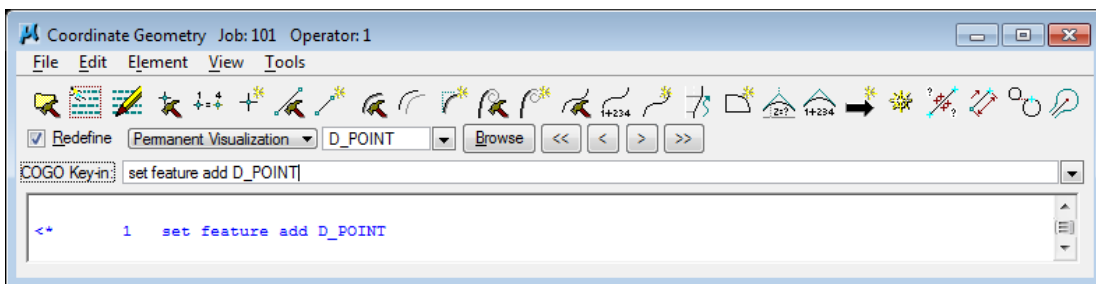
The COGO dialog opens and the Graphical COGO toolbox appears.



- 3) Before we store proposed centerline points, we need to set the feature D_POINT in COGO. Turn on Permanent Visualization and click the Browse button to set the feature.

Feature D_POINT is found under Design→D_POINT.

- 4) Back in the main COGO dialog we can see our feature has been set. Minimize the COGO dialog to clear your screen area.



II.) Graphical COGO Centerline

In this section we are going to use Graphical COGO to store 2 points to define a centerline chain for Westover Dr. We will use this chain later to illustrate the use of the Draw Profile tool.

NOTE:

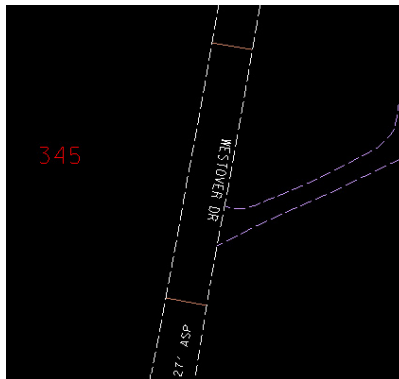
In the normal workflow existing centerlines for side roads are set up and provided by Survey. If realignment for the side road is indicated in the APR for the project, Survey will develop a preliminary proposed centerline as well. Design personnel would then determine whether those centerlines can be used in the final design.

- 1) Zoom in on Westover Drive near the end of our SR95 chain.

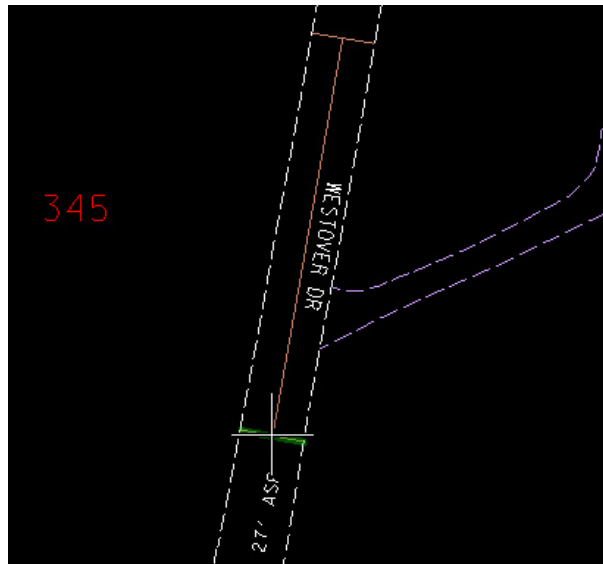
Using MicroStation, draw 2 perpendicular lines across Westover Drive between the existing edge of pavement lines. It may be necessary to turn on the Survey

Exercise 23

reference file RO095-01Survey.dgn and level SURVEY -
TRANSPORTATION – Roads.

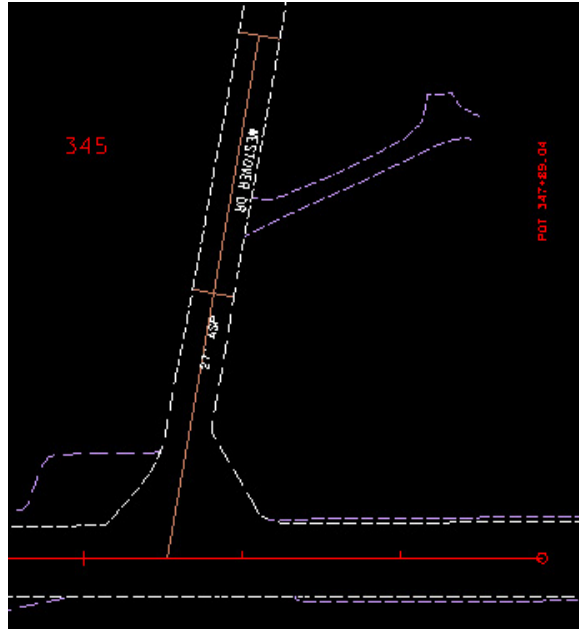


Using Midpoint snap, draw a line from the middle of the first line to the middle of the second.

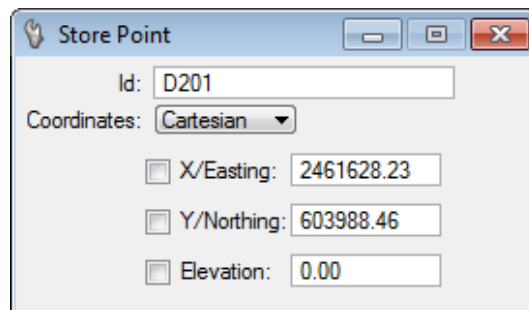


Use MicroStation's Extend to Intersection tool to extend the line to the SR95 centerline chain.



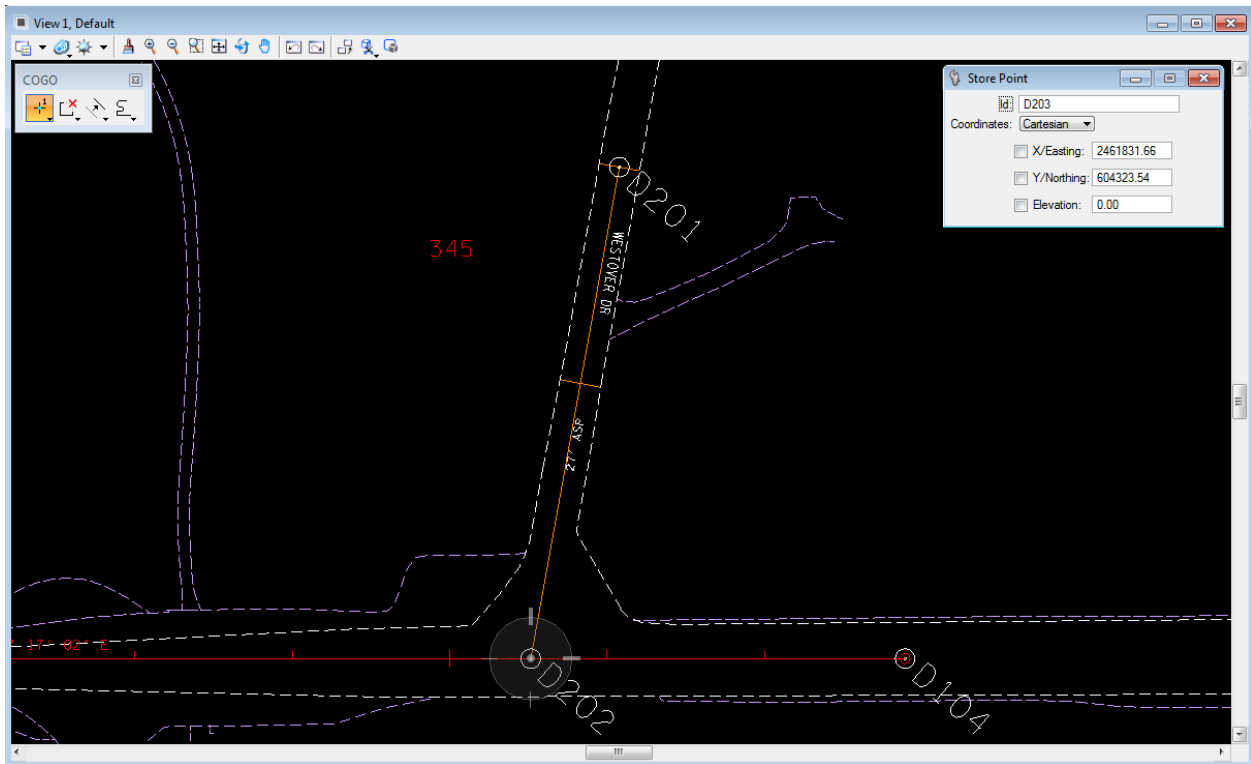


- 2) Access the Graphical COGO Store Point command. Set the point name to D201 and switch the Coordinates option to Cartesian.



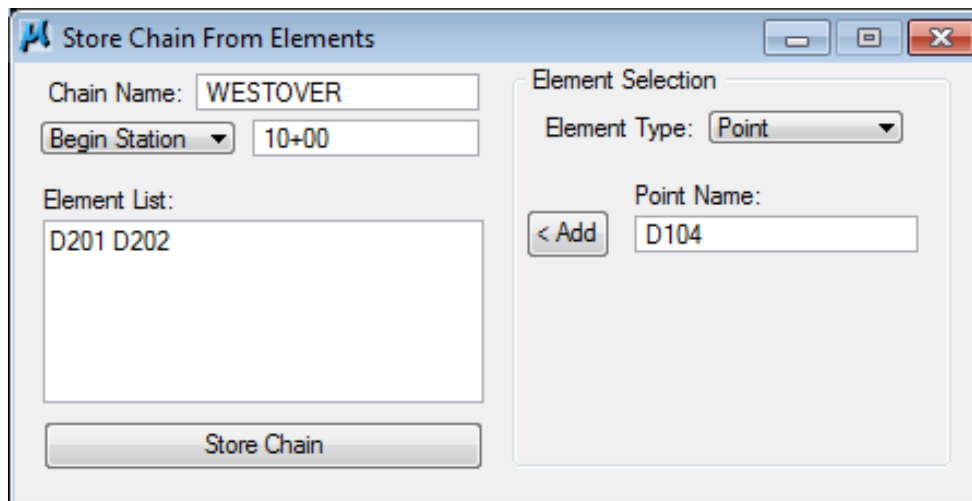
- 3) Keypoint snap and data point at the ends of our constructed centerline to store points D201 and D202.

Exercise 23



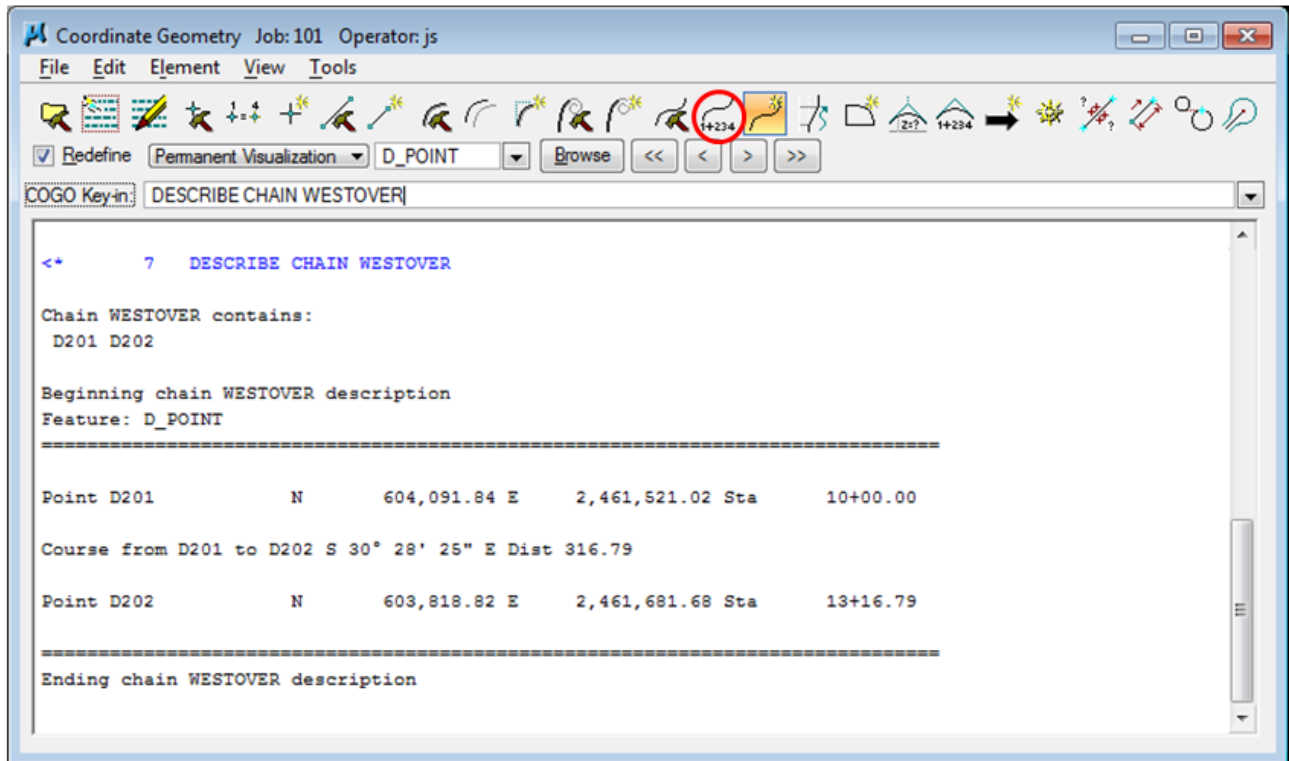
- 4) Now that our points are stored, we can build a chain from them. Click on the Chain from Elements icon in the main COGO dialog.

Key in chain name WESTOVER and for now set the begin station as 10+00. Double click on our visualized points in MicroStation to build the chain element list.



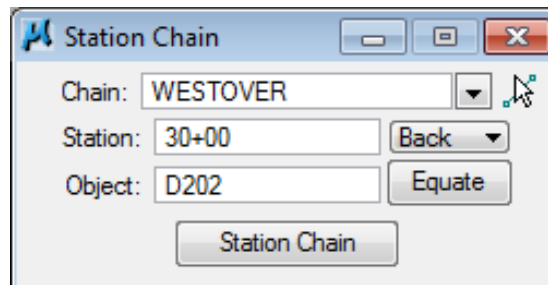
Click the Store Chain button.

- 5) Go to COGO Navigator and describe the chain WESTOVER.



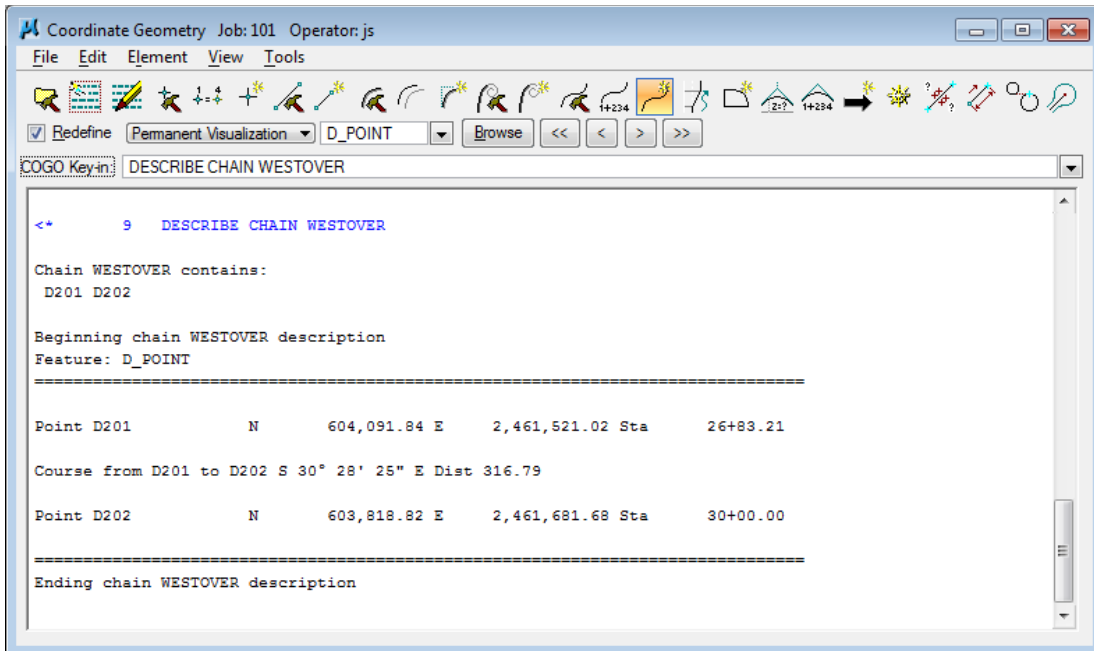
We can see that our chain ends at SR95 with an odd station. This station value will vary depending on where point D201 was stored.

- 6) Click on the Station Chain icon on the main COGO dialog.
- 7) In the Station Chain dialog set chain WESTOVER, station 30+00 Back and object point D202. This will back our stationing in from the end giving an even station at the SR95 intersection. When re-stationing a chain, the object stationed from must be a part of the chain.



Turn on Redefine in the main COGO dialog and click the Station Chain button.

- 8) Go to the Navigator and describe the chain again. It should now end at 30+00.



- 9) Close COGO and save an input file if you wish.

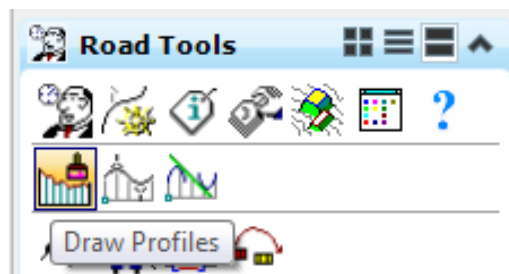
III.) Draw Profile

The proposed tin created for the mainline roadway can be used to help develop side road tie-ins. In this section, we will use the proposed tin which we developed for S.R. 95 with the Draw Profile tool to illustrate cutting a profile across multiple surfaces at one time.

- 1) Open the Draw Profile dialog. It can be accessed from the MicroStation menu bar drop down location.

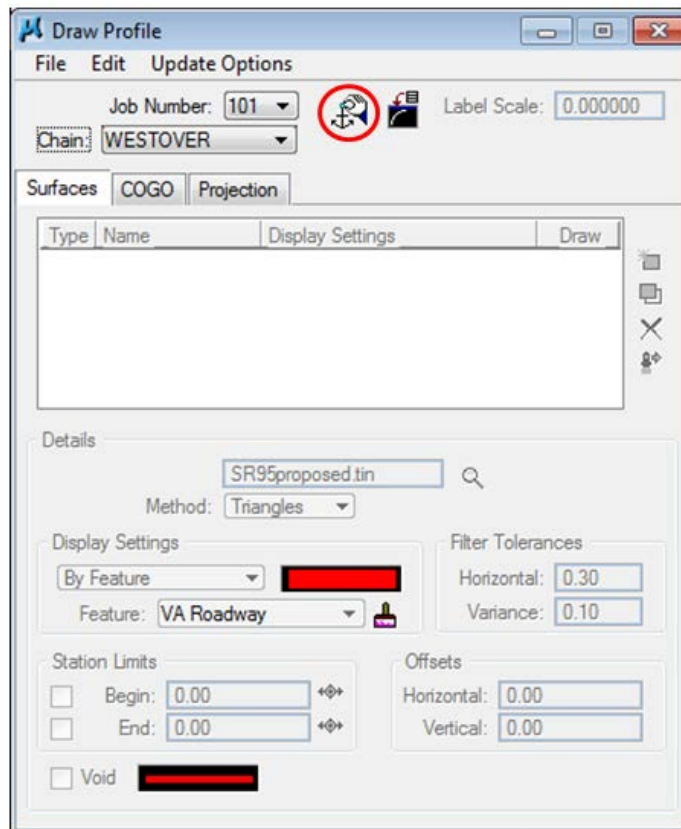
Applications → GEOPAK → Road → Plans Preparations → Draw Profiles

or from the Road Tools task group, select the Draw Profiles icon.



- 2) The Draw Profiles dialog is opened. You may notice that it is similar in layout to the Draw Cross Sections tool. Set the Job Number to 101 and the chain to our new

side road chain, WESTOVER. Many items on the dialog will be dimmed out since we have not created a GEOPAK profile cell or configured a working alignment for this roadway.

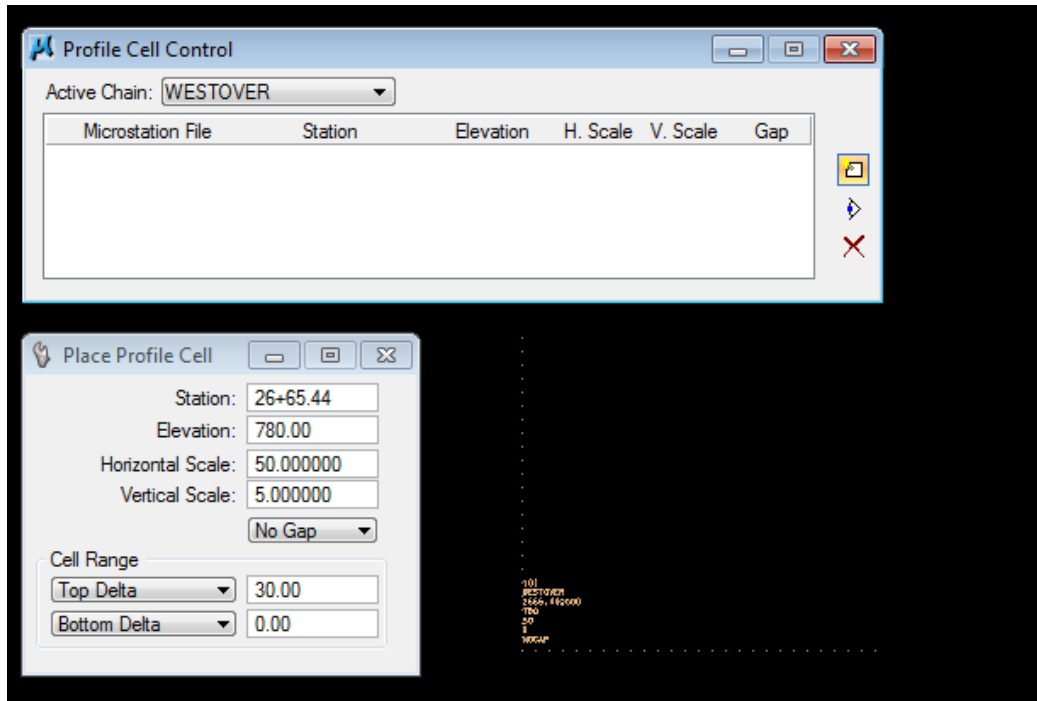


- 3) Zoom out and find a location somewhere below the SR95 profile to place our new profile for WESTOVER. If your view is rotated, you will need to un-rotate it.

Click on the Dialog Profile Cell Control icon near the top of the Draw Profiles dialog.

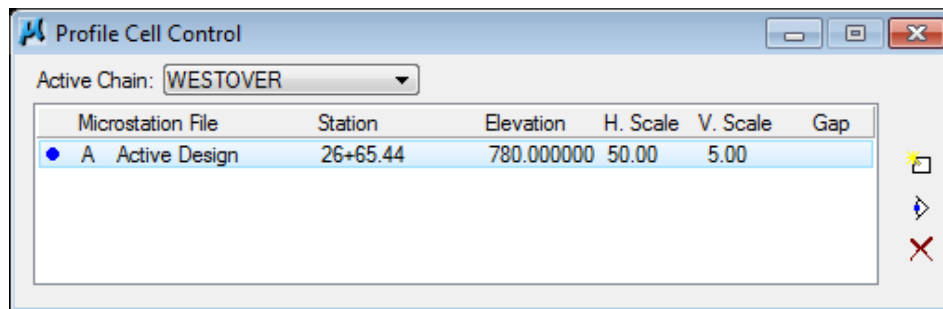
Now we can place a GEOPAK profile cell for our side road. Make settings as shown after clicking on the Place Profile Cell icon to the right of the Profile Cell Control dialog. The beginning station is filled in automatically. The value of that station depends on where point D201 was located and may vary from what is shown.

Exercise 23



Once settings are made move your cursor into the view, the profile cell is on your cursor waiting for a data point for placement. Data point somewhere below the limits of the SR95 profile cell.

- 4) Our profile cell data now appears in the Profile Cell Control dialog. We can dismiss this dialog now.

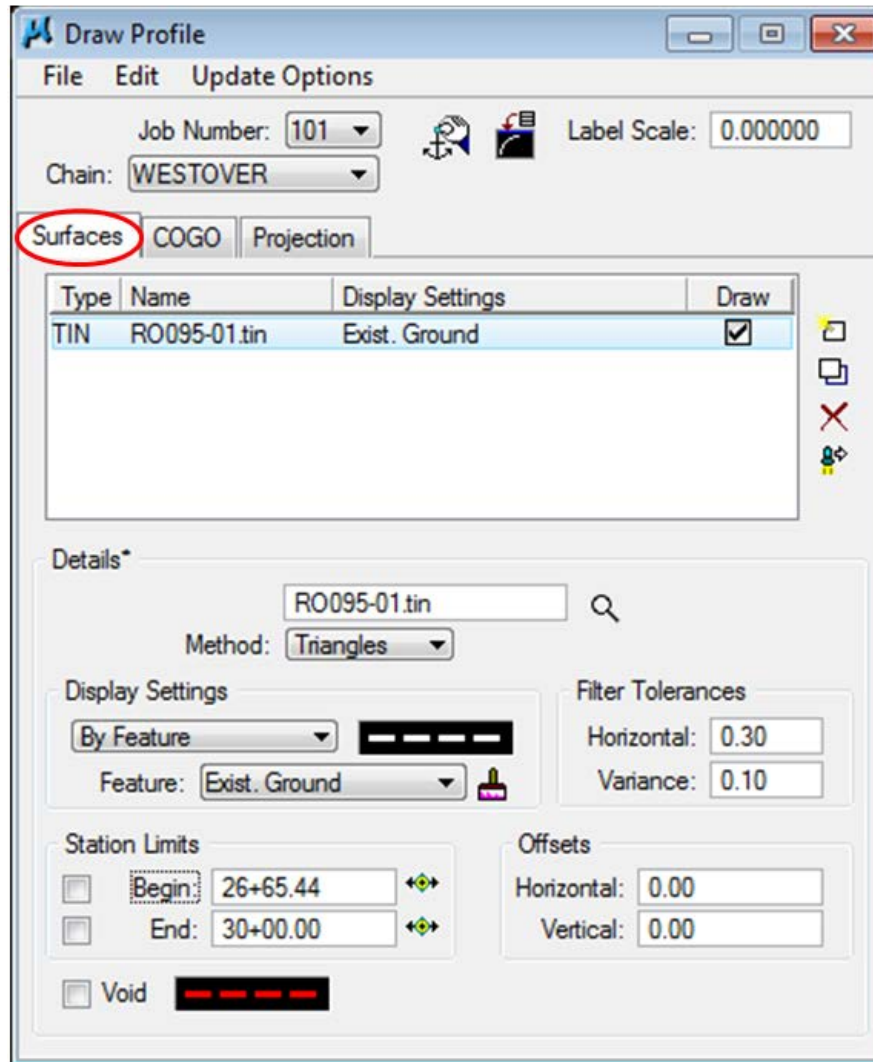


- 5) In the Draw Profile dialog, we can now set up our surfaces. First, set up the existing as shown.

Use the browse button to set our existing TIN File RO095-01.tin.

Set Display Settings to By Feature and use the D&C Manager item Exist. Ground (found under Existing Profiles in D&C). Click on the paint brush icon to browse the D&C Manager items.

When settings are made, click the Add button to the right of the surface list area.



NOTE:

In most cases, Void areas are not encountered along profiles but if needed set the level and symbology to SURVEY - PROFILE - Ground Line with Text, color 6, line code 3 and weight 2.

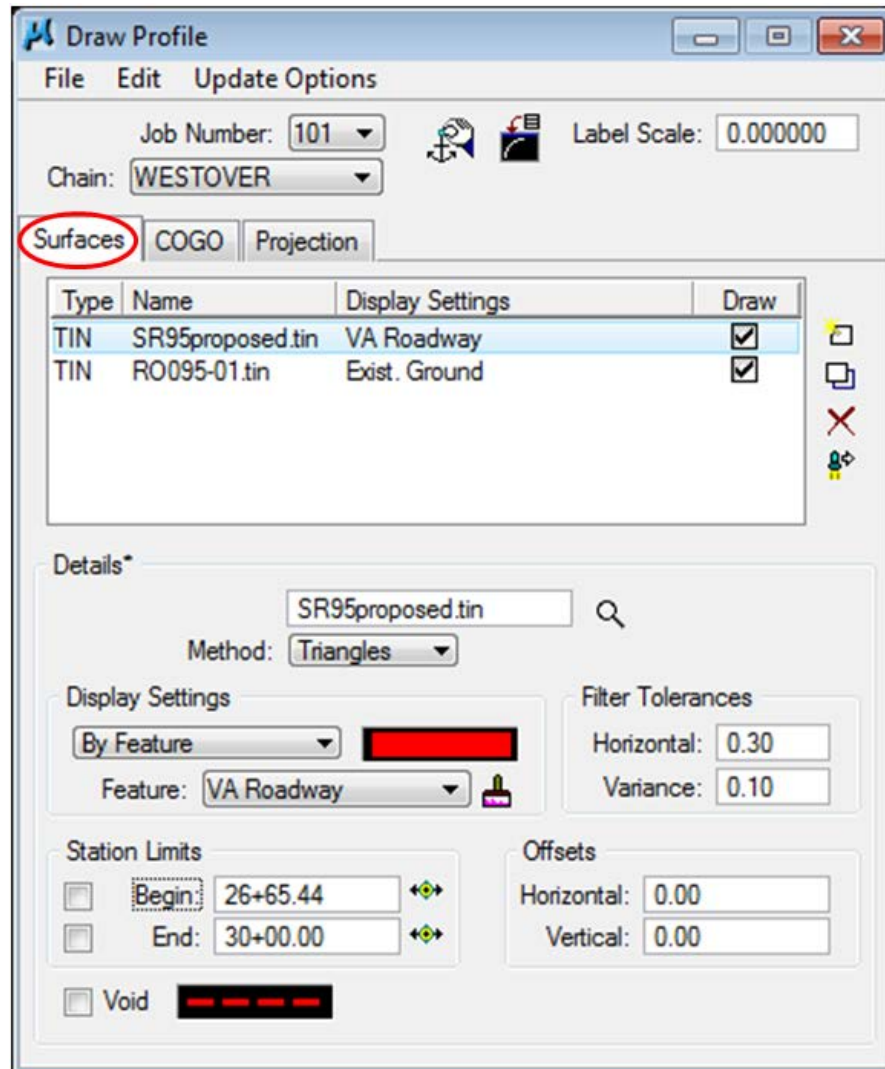
Exercise 23

6) Now set up the proposed surface for SR95 as shown.

Use the browse button to set our proposed TIN File SR95proposed.tin.

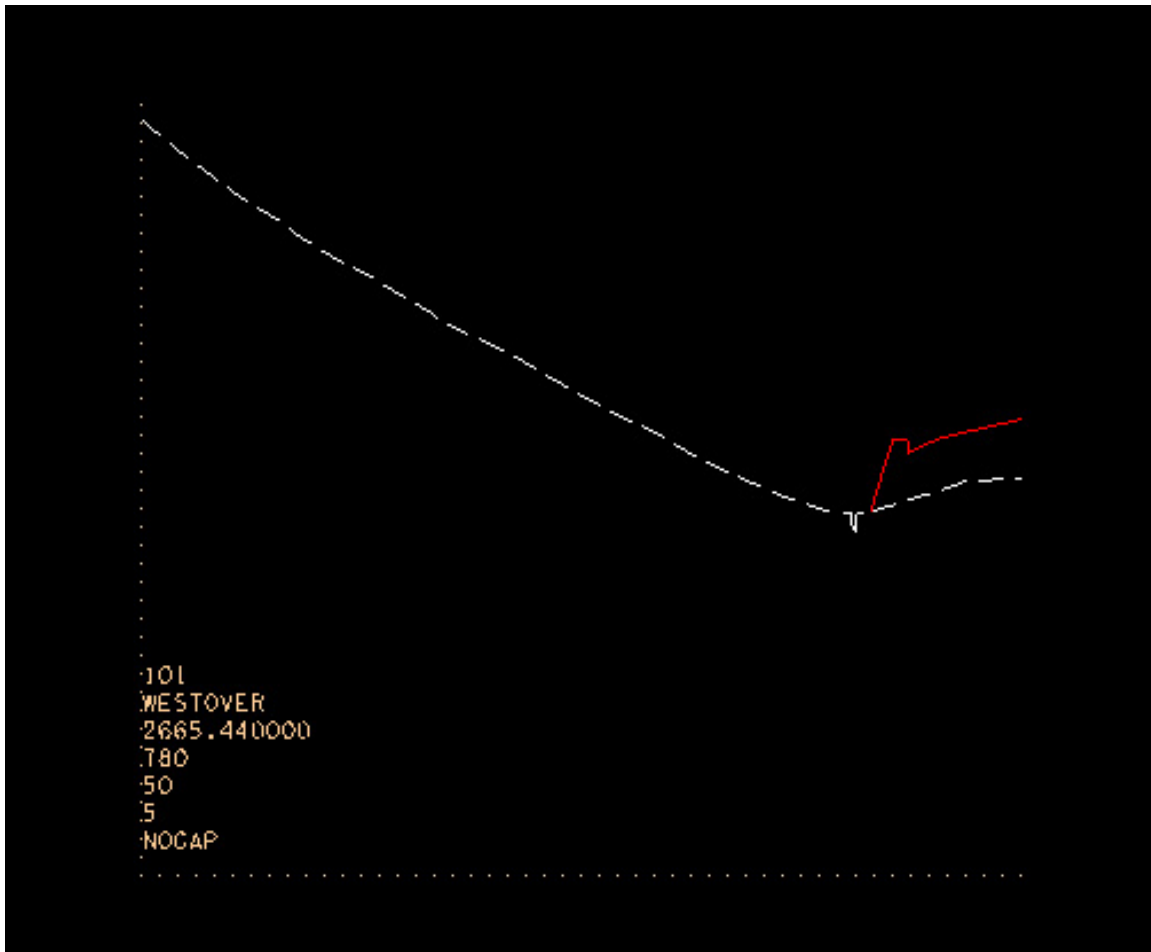
Use the D&C Manager item VA Roadway (found under Roadway Vertical Alignments in D&C).

When settings are made, click the Add button.



- 7) You may have noticed that as we added the surfaces they are automatically displayed in graphics. Now the Profile Generator tool could be used to develop a proposed vertical alignment profile for Westover Drive.

We did not take the time to set up intersection EOP lines across the side road intersection so we can see that the shoulder, curb & sidewalk were included on the proposed TIN surface in that area. The Westover Drive proposed vertical alignment would need to tie in to the outside edge of the SR95 travel lanes.



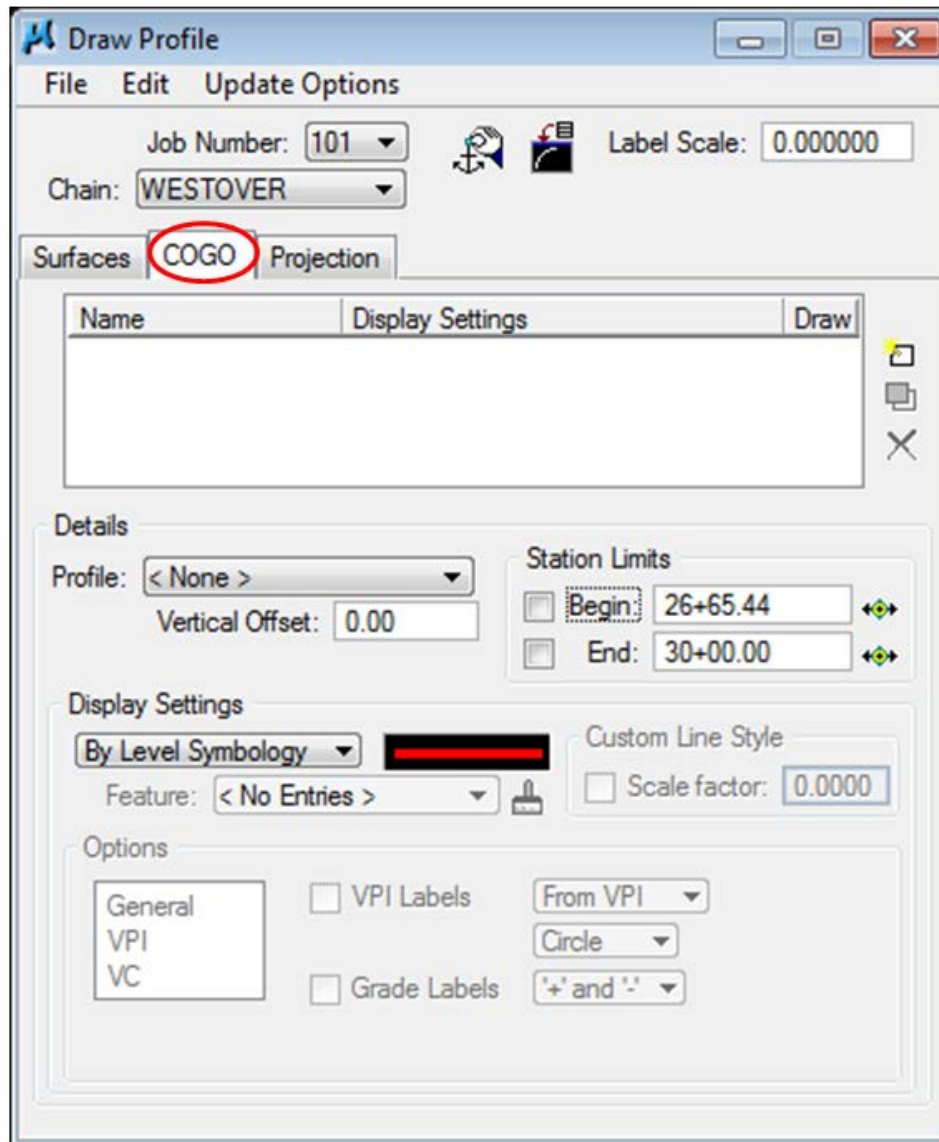
NOTE:

It is not necessary to develop a proposed tin for the mainline to develop side road profile tie-ins. We simply used this as an example to demonstrate the Draw Profile tool.

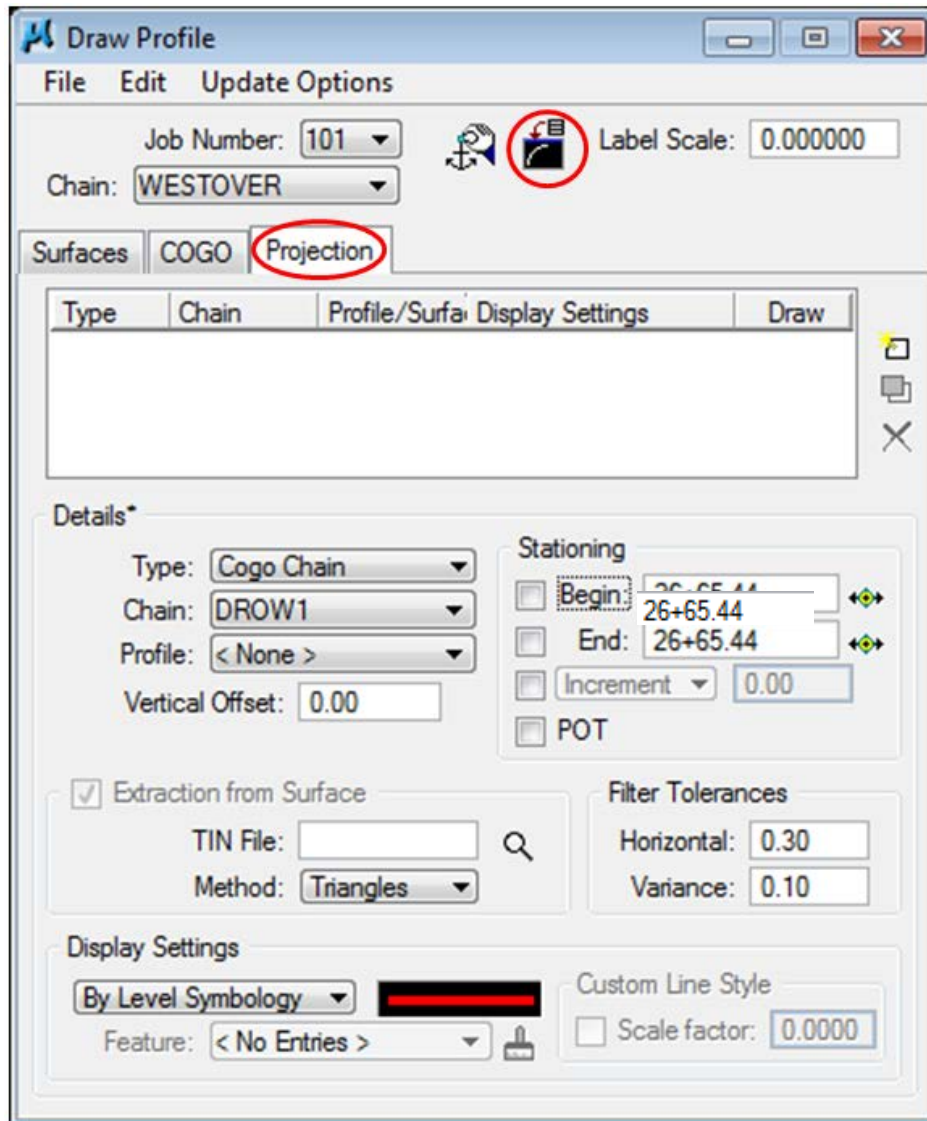
The information needed to tie in to a mainline road: finished grade elevation, cross slope and grade on the mainline can all be found using the Shape Analyst tools for roadways with superelevation. If the mainline doesn't have superelevation, then the Profile Elevation tool in COGO will provide the information required.

Exercise 23

- 8) We will not do anything with the other tabs in the Draw Profile dialog but take a moment to look at them. The COGO tab can be used to display profiles for this chain which have been developed and stored in the GPK file.



- 9) The Projection tab can be used to project profiles from other chains as well as survey chains onto this profile. This portion of the tool is used on bridge replacement projects to project existing centerline profiles onto the proposed profile.



- 10) Anytime data is changed and profiles need to be updated simply open the Draw Profile tool and click the Update Profile icon near the top of the dialog.
- 11) Close the Draw Profile dialog.

APPENDIX A

ADVANCE PLANNING REPORT

**STATE ROUTE 58/95
FROM I-40 TO THE FOUR LANE SECTION
NEAR WESTOVER DRIVE IN OAK RIDGE
ROANE COUNTY**

PREPARED BY
TENNESSEE DEPARTMENT OF TRANSPORTATION
BUREAU OF PLANNING AND DEVELOPMENT

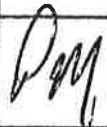


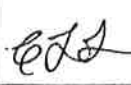
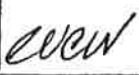
Approved by: 

Director, Bureau of Planning and Development

7-7-95

Date

REVISION

Recommended by:	INITIALS	DATE	Recommended by:	INITIALS	DATE
TRANS. DIRECTOR PLANNING DIVISION	GAB	5/25/95	TRANS. DIRECTOR PLANNING DIVISION		
ENG. DIRECTOR DESIGN DIVISION		6/5/95	ENG. DIRECTOR DESIGN DIVISION		
ENG. DIRECTOR STRUCTURES DIVISION		6/6/95	ENG. DIRECTOR STRUCTURES DIVISION		
TRANS. DIRECTOR PROG. DEV. DIVISION		6/14/95	ENG. DIRECTOR PROG. DEV. DIVISION		
ASST. EXEC. DIRECTOR PLN. AND DEV.		6/28/95	ASST. EXEC. DIRECTOR PLN. AND DEV.		
ASST. EXEC. DIRECTOR PLAN. AND DEV.		6/16/95	ASST. EXEC. DIRECTOR PLAN. AND DEV.		

PURPOSE OF STUDY

This study has been conducted in compliance with the Department's Accelerated Primary Highway Plan that was passed by the Legislature in 1986 as part of the "Urgent Highway Needs" listing. The SR-58 portion of the study is also included in the State's TIP. The purpose of this study is to evaluate the existing conditions of the sections of State Routes 58 and 95 from Interstate Route 40 to the four (4) lane section near Westover Drive to determine improvements needed to handle both present and future traffic demands. In addition, cost estimates for the improvements will be developed and a preliminary analysis of environmental concerns will be made.

DEFICIENCIES

Geometrics X Structures X Operational X R/R Crossing _____

Accident Rate .52 Statewide Average Rate 1.74

Other

PROPOSED IMPROVEMENT

The subject project has been divided into seven (7) sections for study and scheduling purposes. Improvements proposed for these sections of State Route 58/95 consist of reconstructing the existing two (2) lane facilities. Land use, environmental concerns, the existing roadway and the design year traffic projections were considered in determining the type typical cross sections appropriate for the subject highway. Due to the variables considered, the templates recommended vary at different locations between urban and 4 and 5 lane typicals to rural 4 lane divided typicals.

Section I (length 1.41k - 0.91 mile) begins at the existing four lane section north of the I-40 and State Route 58 (Gallaher Road) Interchange and ends at Poplar Springs Road. The typical cross-section proposed for this section consists of 2 @ 7.2m (24') traffic lanes, a 3.6m (12') turn lane, 2 @ 3m (10') shoulders, 2 @ .6m (2') curbs and gutters and 2 @ 2.4m (8') grass plots within 30m (100') of right-of-way. A 65km (40mph) design speed is proposed for this improvement. There is presently 30m (100') of existing right-of-way therefore only slope easements will be necessary to construct this improvement.

It is felt that the 5-lane urban template, that is recommended for this section, is the most appropriate because of the existing development. There also exists the potential for further development.

Section II (Length 3.7±k - 2.3± miles), begins at Poplar Springs Road and ends 0.6±k (0.4 mile) south of the Clinch River. The proposal for this section is to widen the existing route to the left (northwest) side leaving the right side undisturbed. The left side widening is to avoid a blue line stream that parallels the highway on the right for approximately 490m (1,600'). The typical cross section proposed for this section consists of 2 @ 7.2m (24') traffic lanes, a 3.6m (12') turn lane, 2 @ 3.6m (12') shoulder with ditches within a minimum of 45m (150') of right-of-way. A 100 kmh (60 mph) design speed is proposed.

The template proposed is recommended because the area within the study section presents both rural and urban characteristics. Presently it is built up to a certain degree and there is the potential for more development. Because of the existing development and the probability of future development continuation of the 5-lane template, proposed in Study Section I, is warranted. Because this study section is more rural in nature than Study Section I a higher travel speed will be appropriate. In order to achieve a faster design speed and meet design standards for a five-lane typical the curbs and gutters, included in the Study Section I proposal, will have to be dropped and shoulders and ditches will be utilized.

Section III (Length 2.6±k - 1.6± miles), begins 0.6±k (0.4± mile) south of the Clinch River and ends 0.5±k (0.3± mile) north of Perimeter Road. The end terminus of this study section is located at one of the entrances to the Department of Energy's K-25 Plant. Portions of the K-25 facility are eligible for the National Register of Historical Places either as individual units or as a district. This has not been determined at this time. The proposal for this section is to transition the widening from the left of the existing roadway, as proposed for Section II, to the right side within the horizontal curve at the beginning of the study section. The typical cross section proposed from the beginning of the project to Perimeter Road consist of 2 @ 7.2m (24') traffic lanes, a 3.6m (12') flush median with barrier rail, 2 @ 3.6m (12') shoulders within a minimum of 45m (150') of right-of-way. From Perimeter Road to the end of the study section geometrics of the proposed typical are the same, however, the barrier rail will not be included in the median. A 100 kmh (60 mph) design speed is proposed. The Clinch River and Bear Creek Road Bridges will be widened to accommodate the proposed typical section. Modification of the existing interchange at Bear Creek Road is proposed. The proposal is to construct a half clover leaf type interchange on the north side of the cross road. The proposed improvement will transition back into the present 4 lane roadway just north of Perimeter Road.

The typical section proposed is being recommended to minimize right-of-way requirements, to better facilitate widening the Clinch River Bridge and the interchange bridge at Bear Creek Road while accomplishing the goal of separation directional traffic flow. At the beginning of this study section the highway passes thru/beside flood plains of the Clinch River. This link of highway is also located adjacent to the Department of Energy's property which eliminates the possibility of any future development. The barrier rail is being dropped from the median near Perimeter Road to allow access for both

east and west travel to and from SR-58 and Perimeter Road. The median is also being dropped to transition into the existing adequate roadway (Study Section IV) that passes in front of the Department of Energy's K-25 facility.

Section IV (Length 1.6±k - 1.0± mile), from 0.6±k (0.3± mile) north of Perimeter Road to State Route 327 (Blair Road) is an adequate 4-lane facility, therefore no work is proposed for this section.

Section V (Length 0.6±k - 0.4± mile), from State Route 327 (Blair Road) to 0.8±k (0.5± mile) south of State Route 95 is recommended to be reconstructed to the same design standards as Section III.

This section of highway lies between two existing 4-lane sections (Study Section IV and VI) which have been determined to be adequate and will not require any improvements. There are two options for improving this section of highway. The alternate chosen is to extend the existing 4-lane barrier section that is presently in place that is included in Study Section VI. It is determined that this type template is the more appropriate because the highway passes thru a rural area that is not developed and in all probability will not be. The property belongs to the Department of Energy. As there is no need for turning movements the barrier provides a better design than a flush median and because of the short length of the section it would not be practical to add another type design.

Section VI (Length 1.6±k - 1.0± mile), from 0.8±k (0.5± mile) south of State Route 95 to 0.6±k (0.4± mile) north of State Route 95 is adequate, therefore no improvements are recommended for this section.

Section VII (Length 4.5±k - 2.8± miles) begins 0.6±k (0.4± mile) north of State Route 95 and ends near Westover Drive in Oak Ridge. The typical cross section proposed for the portion from the beginning of the study section to near Wisconsin Avenue consists of 2 @ 7.2m (24') traffic lanes, a 15m (48') median, 2 @ 3.6m (12') shoulders and a minimum of 45m (250') right-of-way. This section will transition at the end of the study to a typical consisting of 4 @ 3.6m (12') traffic lanes, 2 @ .6m (2') curbs and gutters, 2 @ 3m (10') shoulders and 2 @ 3m (10') grass strips and 28m (92') of right-of-way. The improvement will end at the Historic Guard House located near Westover Drive. The widening varies from side to side to avoid encroachment on wetlands and channel changes to East Fork Poplar Creek. A new structure is proposed over East Fork Poplar Creek. Care should be taken to avoid Scott Cemetery which is located on the south side of the subject route across from the Wisconsin Avenue intersection and the TVA tower that is located to the north just west of the juncture.

This 2.8± miles of the subject route passes thru rural property owned by the Department of Energy and a portion of the adjacent land is utilized as the Oak Ridge Wildlife Management Area. The median templates has been chosen partly because of the route length and there does exist a minimal number of recreational and access roads/trails throughout the study section presenting turning desires. The short 4-lane template has been chosen to provide turning opportunities at local roads that intersect the study route toward the end of the project, to better facilitate transitioning into the existing roadway

and to avoid adverse impacts to the historical g rd houses at the end terminus.

The following is a list of levels of service for each study section.

	<u>Existing Route</u>		<u>Proposed Route</u>	
	1995	2015	1995	2015
Section I	E	F	B	D
Section II	E	F	B	D
Section III	E	F	B	D
Section IV	C	E	No Work Proposed	
Section V	D	F	C	E
Section VI	B	D	No Work Proposed	
Section VII	D	E	B	D

DISPOSITION OF EXISTING ROUTE

N/A

DATA TABLE

<u>Item</u>	<u>Existing</u> Rural and Urban Principal Arterial	<u>Proposed Section I</u> Rural Principal Arterial
<u>Functional Class</u>	NHS	NHS
<u>System Class</u>	NHS	NHS
<u>Length (Kilometers)</u>	16.10± k	1.4± k
<u>Length (Miles)</u>	10.0 ± mi.	0.9± mi.
<u>Cross Section (Meters)</u>	2 - 4 Lane	25.2 m/ 30 m
<u>Cross Section (Feet)</u>	2 - 4 Lane	84'/100'
<u>Present ADT (1995)</u>	12,700 - 16,030	13,210 - 13,300
<u>Future ADT (2015)</u>	20,330 - 25,620	21,100 - 21,140
<u>DHV</u>	2,033 - 2,562	2,110 - 2,124
<u>% Trucks</u>	4%	4%

<u>Estimated Right-of-Way Acquisition (Hectares)</u>	0
<u>Estimated Right-of-Way Acquisition (Acres)</u>	0
<u>Estimated Right-of-Way Tracts Affected</u>	0
<u>Estimated Family Displacements</u>	0
<u>Estimated Business Displacements</u>	0
<u>Estimated Non-Profit Displacements</u>	0

<u>Estimated Right-of-Way Cost</u>	\$ 100,000 *
<u>Estimated Utility Cost Reimbursable</u>	\$ 20,000
<u>Estimated Utility Cost Non-Reimbursable</u>	\$ 350,000
<u>Estimated Construction Cost</u>	\$1,850,000
<u>Estimated Preliminary Engineering Cost</u>	\$ 170,000

Total Estimated Project Cost \$2,490,000

*Estimate for construction and slope easements.

DATA TABLE

<u>Item</u>	<u>Proposed Section II</u> Rural Principal Arterial	<u>Proposed Section III</u> Rural and Urban Principal Arterial
<u>Functional Class</u>		
<u>System Class</u>	NHS	NHS
<u>Length (Kilometers)</u>	3.7± k	2.6± k
<u>Length (Miles)</u>	2.3± mi	1.6± mi.
<u>Cross Section (Meters)</u>	2 @ 7.2m/25.2m/45m	2@ 7.2m/25.2m/45m
<u>Cross Section (Feet)</u>	2 @ 24'/84'/150'	2@ 24'/84'/150'
<u>Present ADT (1995)</u>	13,460 - 14,180	12,930 - 14,180
<u>Future ADT (2015)</u>	21,500 - 22,660	20,660 - 22,660
<u>DHV</u>	2,150 - 2,266	2,066 - 2,266
<u>% Trucks</u>	4%	4%
<u>Estimated Right-of-Way Acquisition (Hectares)</u>	6.96± HA	5.75± HA
<u>Estimated Right-of-Way Acquisition (Acres)</u>	17.19±	14.22±
<u>Estimated Right-of-Way Tracts Affected</u>	33	1
<u>Estimated Family Displacements</u>	12	0
<u>Estimated Business Displacements</u>	3	0
<u>Estimated Non-Profit Displacements</u>	1	0
<u>Estimated Right-of-Way Cost</u>	\$1,820,000	\$ 105,000
<u>Estimated Utility Cost Reimbursable</u>	0	\$ 15,000
<u>Estimated Utility Cost Non-Reimbursable</u>	\$ 695,000	\$ 40,000
<u>Estimated Construction Cost</u>	\$3,590,000	\$8,925,000
<u>Estimated Preliminary Engineering Cost</u>	\$ 325,000	\$ 810,000
<u>Total Estimated Project Cost</u>	\$6,430,000	\$9,895,000

DATA TABLE

<u>Item</u>	<u>Proposed Section IV Urban Principal Arterial</u>	<u>Proposed Section V Urban Principal Arterial</u>
<u>Functional Class</u>		
<u>System Class</u>	NHS	NHS
<u>Length (Kilometers)</u>	1.6± k	0.6± k
<u>Length (Miles)</u>	1.0± mi.	0.4± mi.
<u>Cross Section (Meters)</u>	13.4m/17m/90m (Ex.) 15.8m/90m(Ex.)	2 @ 7.2m/25.2m/45m
<u>Cross Section (Feet)</u>	44'/56'/300' (Ex.) 52'/300'(Ex.)	2 @ 24'/84'/150'
<u>Present ADT(1995)</u>	12,930	16,030
<u>Future ADT(2015)</u>	20,660	25,620
<u>DHV</u>	2,066	2,562
<u>% Trucks</u>	4%	4%
<u>Estimated Right-of-Way Acquisition (Hectares/Acres) *</u>		0
<u>Estimated Right-of-Way Tracts Affected</u>		0
<u>Estimated Family Displacements</u>		0
<u>Estimated Business Displacements</u>		0
<u>Estimated Non-Profit Displacements</u>		0
<u>Estimated Right-of-Way Cost</u>		\$ 0
<u>Estimated Utility Cost Reimbursable</u>		\$ 0
<u>Estimated Utility Cost Non-Reimbursable</u>		\$ 0
<u>Estimated Construction Cost</u>		\$ 605,000
<u>Estimated Preliminary Engineering Cost</u>		\$ 55,000
<u>Total Estimated Project Cost</u>		\$ 660,000

*See Proposed Improvement Item

DATA TABLE

<u>Item</u>	<u>Proposed Section VI</u>	<u>Proposed Section VII</u>
<u>Functional Class</u>	<u>Urban Principal Arterial</u>	<u>Urban Principal Arterial</u>
<u>System Class</u>	NHS	NHS
<u>Length (Kilometers)</u>	1.6± k	4.6± k
<u>Length (Miles)</u>	1.0± mi.	2.8± mi.
<u>Cross Section (Meters)</u>	2@7.2m/25.6m/90m(Ex.) 10.9m/22.5m/90m(Ex.)	21.6m/28m 2@7.2m/36.6/75m
<u>Cross Section (Feet)</u>	2@24'/84'/300'(Ex.) 36'/74'/300'(Ex.)	72'/92' 2@24'/120'/250'
<u>Present ADT(1995)</u>	12,700 - 16,030	12,700
<u>Future ADT(2015)</u>	20,330 - 25,620	20,330
<u>DHV</u>	2,033 - 2,562	2,033
<u>% Trucks</u>	4%	4%
<u>Estimated Right-of-Way Acquisition (Hectares)</u>	*	22.66± HA
<u>Estimated Right-of-Way Acquisition (Acres)</u>		56.0±
<u>Estimated Right-of-Way Tracts Affected</u>		2
<u>Estimated Family Displacements</u>		0
<u>Estimated Business Displacements</u>		0
<u>Estimated Non-Profit Displacements</u>		0
<u>Estimated Right-of-Way Cost</u>		\$ 590,000
<u>Estimated Utility Cost Reimbursable</u>		\$ 0
<u>Estimated Utility Cost Non-Reimbursable</u>		\$ 375,000
<u>Estimated Construction Cost</u>		\$5,810,000
<u>Estimated Preliminary Engineering Cost</u>		\$ 530,000
<u>Total Estimated Project Cost</u>		\$7,305,000

*See Proposed Improvement Item.

DATA TABLE

<u>Item</u>	<u>Proposed Total</u> Rural and Urban Principal Arterial
<u>Functional Class</u>	
<u>System Class</u>	NHS
<u>Length (Kilometers)</u>	16.10± k
<u>Length (Miles)</u>	10.0± mi.
<u>Cross Section (Meters)</u>	4 - 5 Lane
<u>Cross Section (Feet)</u>	4 - 5 Lane
<u>Present ADT(1995)</u>	12,700 - 16,030
<u>Future ADT(2015)</u>	20,330 - 25,620
<u>DHV</u>	2,033 - 2,562
<u>% Trucks</u>	4%
<u>Estimated Right-of-Way Acquisition (Hectares)</u>	35.37± HA
<u>Estimated Right-of-Way Acquisition (Acres)</u>	87.41±
<u>Estimated Right-of-Way Tracts Affected</u>	36
<u>Estimated Family Displacements</u>	12
<u>Estimated Business Displacements</u>	3
<u>Estimated Non-Profit Displacements</u>	1
<u>Estimated Right-of-Way Cost</u>	\$ 2,615,000
<u>Estimated Utility Cost Reimbursable</u>	\$ 35,000
<u>Estimated Utility Cost Non-Reimbursable</u>	\$ 1,460,000
<u>Estimated Construction Cost</u>	\$20,780,000
<u>Estimated Preliminary Engineering Cost</u>	\$ 1,890,000
<u>Total Estimated Project Cost</u>	\$26,780,000

CHECK LIST OF DETERMINANTS FOR LOCATION STUDY

If any of the following facilities or ESE categories are located within the project area or corridor, place an "x" in the blank opposite the item. Where more than one alternate is to be considered, place its letter designation in the blank.

- 1. Agricultural land usage..... _____
- 2. Airport (existing or proposed)..... _____
- 3. Commercial area, shopping center..... X
- 4. Floodplains..... X
- 5. Forested land..... X
- 6. Historical, cultural, or natural landmark..... X
- 7. Industrial park, factory..... X
- 8. Institutional usages
 - a. School or other educational institution..... X
 - b. Church or other religious institution..... X
 - c. Hospital or other medical facility..... _____
 - d. Public building, e.g., fire station..... _____
 - e. Defense installation..... _____
- 9. Recreational usages
 - a. Park or recreational area..... X
 - b. Game preserve or wildlife area..... X
- 10. Residential establishment..... X
- 11. Urban area, town, city, or community..Oak Ridge..... X
Population: 27,310
- 12. Waterway, lake, pond, river, stream, spring..... X
(Permit required: Coast Guard X Section 404 X
TVA Section 26a review X NPDES X
Aquatic Resource Alteration Permit _____)
- 13. Other Cemetery X
- 14. Location coordinated with local officials..... _____
- 15. Railroad Crossings..... _____
- 16. Hazardous Material Site.(U.G.T.)..... X

TENNESSEE DEPARTMENT OF TRANSPORTATION
DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE

ROUTE State Route 58/95 ALTERNATE _____ SECTION I
REGION I COUNTY Roane PROJECT NO. _____

LOCATION: FROM: I-40
TO: Poplar Springs Road

1995 ADT.....	13,260
2015 ADT.....	21,180
PERCENT TRUCKS.....	4%
DHV	2,118
FUNCTIONAL CLASSIFICATION.....	Rural Principal Arterial
MINIMUM DESIGN SPEED.....	65 kmh (40 mph)
ACCESS CONTROL.....	N/A
MAXIMUM CURVE.....	Existing
MAXIMUM GRADE.....	Existing
MINIMUM STOPPING SIGHT DISTANCE..	Existing
SURFACE WIDTH.....	2 @7.2m (24')
NUMBER OF LANES.....	4
USABLE SHOULDER WIDTH.....	2 @.3.6m(12') Incl.C&G
MEDIAN WIDTH.....	3.6m (12') turn lane
MINIMUM RIGHT OF WAY.....	*30m (100')Ex.
SIGNALIZATION.....	N/A

REMARKS: *Easement may be required outside the right-of-way limits.

TENNESSEE DEPARTMENT OF TRANSPORTATION
DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE

ROUTE State Route 58/95 ALTERNATE _____ SECTION II

REGION I COUNTY Roane PROJECT NO. _____

LOCATION: FROM Poplar Springs Road

TO 0.6tk (0.4± mile) Southwest of Clinch River

1995 ADT..... 13,885

2015 ADT..... 22,175

PERCENT TRUCKS..... 4%

DHV 2,217

FUNCTIONAL CLASSIFICATION..... Rural Principal Arterial

MINIMUM DESIGN SPEED..... 100 kmh (60 mph)

ACCESS CONTROL..... N/A

MAXIMUM CURVE..... 4° - 45' (SE:0.08)

MAXIMUM GRADE..... 3%

MINIMUM STOPPING SIGHT DISTANCE.. 160m - 200m (525-650')

SURFACE WIDTH..... 2 @ 7.2m (24')

NUMBER OF LANES..... 4

USABLE SHOULDER WIDTH..... 2 @ 3.6m (12')

MEDIAN WIDTH..... 3.6m (12') Turn Lane

MINIMUM RIGHT OF WAY..... * 45m (150')

SIGNALIZATION..... N/A

REMARKS: *Actual right-of-way to be determined by slope limits.

TENNESSEE DEPARTMENT OF TRANSPORTATION
 DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE

ROUTE State Route 58/95 ALTERNATE _____ SECTION III

REGION I COUNTY Roane PROJECT NO. _____

LOCATION: FROM 0.6±k (0.4± mile) South of the Clinch River

TO 0.5±k (0.3± mile) North of Perimeter Road

1995 ADT..... 13,555

2015 ADT..... 21,660

PERCENT TRUCKS..... 4%

DHV 2,166

FUNCTIONAL CLASSIFICATION..... Rural and Urban Principal Arterial

MINIMUM DESIGN SPEED..... 100 kmh (60 mph)

ACCESS CONTROL..... N/A

MAXIMUM CURVE..... 4° - .45' (SE:0.08)

MAXIMUM GRADE..... 3%

MINIMUM STOPPING SIGHT DISTANCE.. 160m - 200m (525 - 650')

SURFACE WIDTH..... 2 @ 7.2m (24')

NUMBER OF LANES..... 4

USABLE SHOULDER WIDTH..... 2 @ 3.6m (12')

MEDIAN WIDTH..... *3.6m (12')

MINIMUM RIGHT OF WAY..... **45m (150')

SIGNALIZATION..... N/A

REMARKS: *A barrier rail will be included in the median from the beginning of the study section to west of Perimeter Road. From Perimeter Road to the end terminus the barrier rail will be excluded from the median.

**Actual right-of-way to be determined by slope limits.

TENNESSEE DEPARTMENT OF TRANSPORTATION
 DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE

ROUTE State Route 58/95 ALTERNATE _____ SECTION IV Excluded

REGION I COUNTY Roane PROJECT NO. _____

LOCATION: FROM 0.6±k (*0.3± mile) North of Perimeter Road

TO State Route 327 (Blair Road)

1995 ADT..... 12,930

2015 ADT..... 20,660

PERCENT TRUCKS..... 4%

DHV 2,066

FUNCTIONAL CLASSIFICATION..... Urban Principal Arterial

MINIMUM DESIGN SPEED..... Existing

ACCESS CONTROL..... Existing

MAXIMUM CURVE..... Existing

MAXIMUM GRADE..... Existing

MINIMUM STOPPING SIGHT DISTANCE.. Existing

SURFACE WIDTH..... Existing

NUMBER OF LANES..... Existing

USABLE SHOULDER WIDTH..... Existing

MEDIAN WIDTH..... Existing

MINIMUM RIGHT OF WAY..... Existing

SIGNALIZATION..... N/A

REMARKS: No work is proposed for this section.

TENNESSEE DEPARTMENT OF TRANSPORTATION
DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE

ROUTE State Route 58/95 ALTERNATE _____ SECTION V

REGION I COUNTY Roane PROJECT NO. _____

LOCATION: FROM State Route 327 (Blair Road)

TO 0.8±k(0.5± mile) Southwest of State Route 95

1995 ADT..... 16,030

2015 ADT..... 25,620

PERCENT TRUCKS..... 4%

DHV 2,562

FUNCTIONAL CLASSIFICATION..... Urban Principal Arterial

MINIMUM DESIGN SPEED..... 100km (60 mph)

ACCESS CONTROL..... N/A

MAXIMUM CURVE..... 4° - 45' (SE: 0.08)

MAXIMUM GRADE..... 3%

MINIMUM STOPPING SIGHT DISTANCE.. 160m - 200m (525 - 650')

SURFACE WIDTH..... 2 @ 7.2m (24')

NUMBER OF LANES..... 4

USABLE SHOULDER WIDTH..... 2 @ 3.6m (12')

MEDIAN WIDTH..... 3.6m (12') Barrier Rail

MINIMUM RIGHT OF WAY..... * 45m (150')

SIGNALIZATION..... N/A

REMARKS: *Actual right-of-way to be determined by slope limits.

TENNESSEE DEPARTMENT OF TRANSPORTATION
 DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE

ROUTE State Route 58/95 ALTERNATE _____ SECTION VI Excluded

REGION I COUNTY Roane PROJECT NO. _____

LOCATION: FROM 0.8±k (0.5± mile) South of State Route 95

TO 0.6±k (0.4± mile) North of State Route 95

1995 ADT..... 14,365

2015 ADT..... 22,980

PERCENT TRUCKS..... 4%

DHV 2,298

FUNCTIONAL CLASSIFICATION..... Urban Principal Arterial

MINIMUM DESIGN SPEED..... Existing

ACCESS CONTROL..... Existing

MAXIMUM CURVE..... Existing

MAXIMUM GRADE..... Existing

MINIMUM STOPPING SIGHT DISTANCE.. Existing

SURFACE WIDTH..... Existing

NUMBER OF LANES..... Existing

USABLE SHOULDER WIDTH..... Existing

MEDIAN WIDTH..... Existing

MINIMUM RIGHT OF WAY..... Existing

SIGNALIZATION..... Existing

REMARKS: This section is excluded from the project.

**TENNESSEE DEPARTMENT OF TRANSPORTATION
DESIGN CRITERIA FOR LOCATION AND DESIGN PHASE**

ROUTE State Route 58/95 ALTERNATE _____ SECTION VII

REGION I COUNTY Roane PROJECT NO. _____

LOCATION: FROM 0.6±k (0.4± mile) North of State Route 95

TO Near Westover Drive in Oak Ridge

1995 ADT..... 12,700

2015 ADT..... 20,330

PERCENT TRUCKS..... 4%

DHV 2,033

FUNCTIONAL CLASSIFICATION..... Urban Principal Arterial RD-T5-3A

MINIMUM DESIGN SPEED..... 100km (60 mph) CEG- RD-T5-6

ACCESS CONTROL..... N/A

MAXIMUM CURVE..... 4° 45' (SE:0.08)

MAXIMUM GRADE..... 3%

MINIMUM STOPPING SIGHT DISTANCE.. 160m - 200m (525 - 650')

SURFACE WIDTH..... 2 @ 7.2m (24')

NUMBER OF LANES..... 4

USABLE SHOULDER WIDTH..... 2 @ 3.6m (12')

MEDIAN WIDTH..... 15m (48')

MINIMUM RIGHT OF WAY..... * 75m (250')

SIGNALIZATION..... N/A

REMARKS: *Actual right-of-way to be determined by slope limits.
Transition from four lane divided section at end of project to four
lanes with curbs and gutters (28m-92') right-of-way to avoid
cemetery and historical property and to transition into existing
roadway.

COST DATA SHEET
SECTION I

PROJECT: State Route 58/95, From I-40 to Poplar Springs Road,
Roane County

LENGTH: 1.4± k (0.9± mi) CROSS SECTION: 25.2m/30m(84'/100')

Right-of-Way

Land, Improvements, and Damages (0 Hectares)	
(0 Acres).....	\$ 100,000
Incidentals.(0 Tracts).....	\$
Relocation Payments (0 Residences).....	\$
(0 Businesses)	
(0 Non-Profits)	
 Total Right-Of-Way Cost.....	\$ 100,000*

Utility Relocation

Reimbursable.....	\$ 20,000
Non-Reimbursable.....	\$ 350,000
 Total Adjustment Cost.....	\$ 370,000

Construction

Clear and Grubbing.....	\$ 5,000
Earthwork.....	\$ 95,000
Pavement Removal.....	\$ 25,000
Drainage.....	\$ 270,000
Structures.....	\$ N/A
Railroad Crossing.....	\$ N/A
Paving.....	\$ 930,000
Retaining Walls.....	\$ 40,000
Maintenance of Traffic.....	\$ 25,000
Topsoil.....	\$ 3,000
Seeding.....	\$ 2,000
Sodding.....	\$ 30,000
Signing.....	\$ 5,000
Signalization.....	\$ N/A
Fence.....	\$ N/A
Guardrail.....	\$ N/A
Rip Rap or Slope Protection.....	\$ 5,000
Other Const. Items (8.5%).....	\$ 130,000
Mobilization.....	\$ 115,000
10% Eng. & Cont.	\$ 170,000
 Total Construction Cost.....	\$1,850,000

Preliminary Engineering (10%)..... \$ 170,000

TOTAL SECTION COST.....\$2,490,000

*Estimate for construction and slope easements.

COST DATA SHEET
SECTION II

PROJECT: State Route 58/95, From Poplar Springs Road to 0.6±k
(0.4± mile) South of Clinch River

LENGTH: 3.7± k (2.3± mi) CROSS SECTION: (2@ 24' / 84' / 150') 2@ 7.2m / 25.2m / 45m

Right-of-Way

Land, Improvements, and Damages (6.96± Hectares)	
(17.19± Acres).....	\$1,378,000
Incidentals. (33 Tracts).....	\$ 94,000
Relocation Payments (12 Residences).....	\$ 348,000
(3 Businesses)	
(1 Non-Profits)	
 Total Right-Of-Way Cost.....	 \$1,820,000

Utility Relocation

Reimbursable.....	\$ 0
Non-Reimbursable.....	\$ 695,000
 Total Adjustment Cost.....	 \$ 695,000

Construction

Clear and Grubbing.....	\$ 25,000
Earthwork.....	\$ 320,000
Pavement Removal.....	\$ 50,000
Drainage.....	\$ 260,000
Structures.....	\$ N/A
Railroad Crossing.....	\$ N/A
Paving.....	\$ 2,085,000
Retaining Walls.....	\$ N/A
Maintenance of Traffic.....	\$ 50,000
Topsoil.....	\$ 17,000
Seeding.....	\$ 15,000
Sodding.....	\$ 5,000
Signing.....	\$ 5,000
Signalization.....	\$ N/A
Fence.....	\$ N/A
Guardrail.....	\$ 35,000
Rip Rap or Slope Protection.....	\$ 10,000
Other Const. Items (8.5%).....	\$ 255,000
Mobilization.....	\$ 135,000
10% Eng. & Cont.	\$ 325,000
 Total Construction Cost.....	 \$3,590,000

Preliminary Engineering (10%).....\$ 325,000

TOTAL SECTION COST.....\$6,430,000

COST DATA SHEET
SECTION III

PROJECT: State Route 58/95, From 0.6±k (0.4± mile) South of Clinch
River to 0.5±k (0.3± mile) North of Perimeter Road

2@7.2m/25.8m/45m

LENGTH: 2.6± k (1.6± miles) CROSS SECTION: (2@ 24'/84'/150')

Right-of-Way

Land, Improvements, and Damages (5.75± Hectares)		
	(14.22± Acres).....	\$ 102,000
Incidentals.(33 Tracts).....		\$ 3,000
Relocation Payments (0 Residences).....		\$ N/A
	(0 Businesses)	
	(0 Non-Profits)	
Total Right-Of-Way Cost.....		\$ 105,000

Utility Relocation

Reimbursable.....	\$ 15,000	
Non-Reimbursable.....	\$ 40,000	
Total Adjustment Cost.....		\$ 55,000

Construction

Clear and Grubbing.....	\$ 35,000	
Earthwork.....	\$ 940,000	
Pavement Removal.....	\$ 30,000	
Drainage.....	\$ 280,000	
Structures.....	\$3,580,000	
Railroad Crossing.....	\$ N/A	
Paving.....	\$1,655,000	
Retaining Walls.....	\$ 40,000	
Maintenance of Traffic.....	\$ 100,000	
Topsoil.....	\$ 22,000	
Seeding.....	\$ 18,000	
Sodding.....	\$ 10,000	
Signing.....	\$ 25,000	
Signalization.....	\$ N/A	
Fence.....	\$ 15,000	
Guardrail.....	\$ 390,000	
Rip Rap or Slope Protection.....	\$ 25,000	
Other Const. Items (8.5%).....	\$ 635,000	
Mobilization.....	\$ 315,000	
10% Eng. & Cont.	\$ 810,000	
Total Construction Cost.....		\$8,925,000

Preliminary Engineering (10%)..... \$ 810,000

TOTAL SECTION COST.....\$9,895,000

COST DATA SHEET
SECTION V

PROJECT: State Route 58/95, From State Route 327 (Blair Road) to
0.8±k (0.5± Mile) South of State Route 95

2@7.2m/25.2m/45m

LENGTH: 0.6± k (0.4± miles) CROSS SECTION: (2@ 24'/84'/150')

Right-of-Way

Land, Improvements, and Damages (0 Hectares)		
(0 Acres).....	\$	N/A
Incidentals. (0 Tracts).....	\$	N/A
Relocation Payments (0 Residences).....	\$	N/A
(0 Businesses)		
(0 Non-Profits)		
Total Right-Of-Way Cost.....	\$	N/A

Utility Relocation

Reimbursable.....		\$ N/A
Non-Reimbursable.....	\$	
Total Adjustment Cost.....	\$	N/A

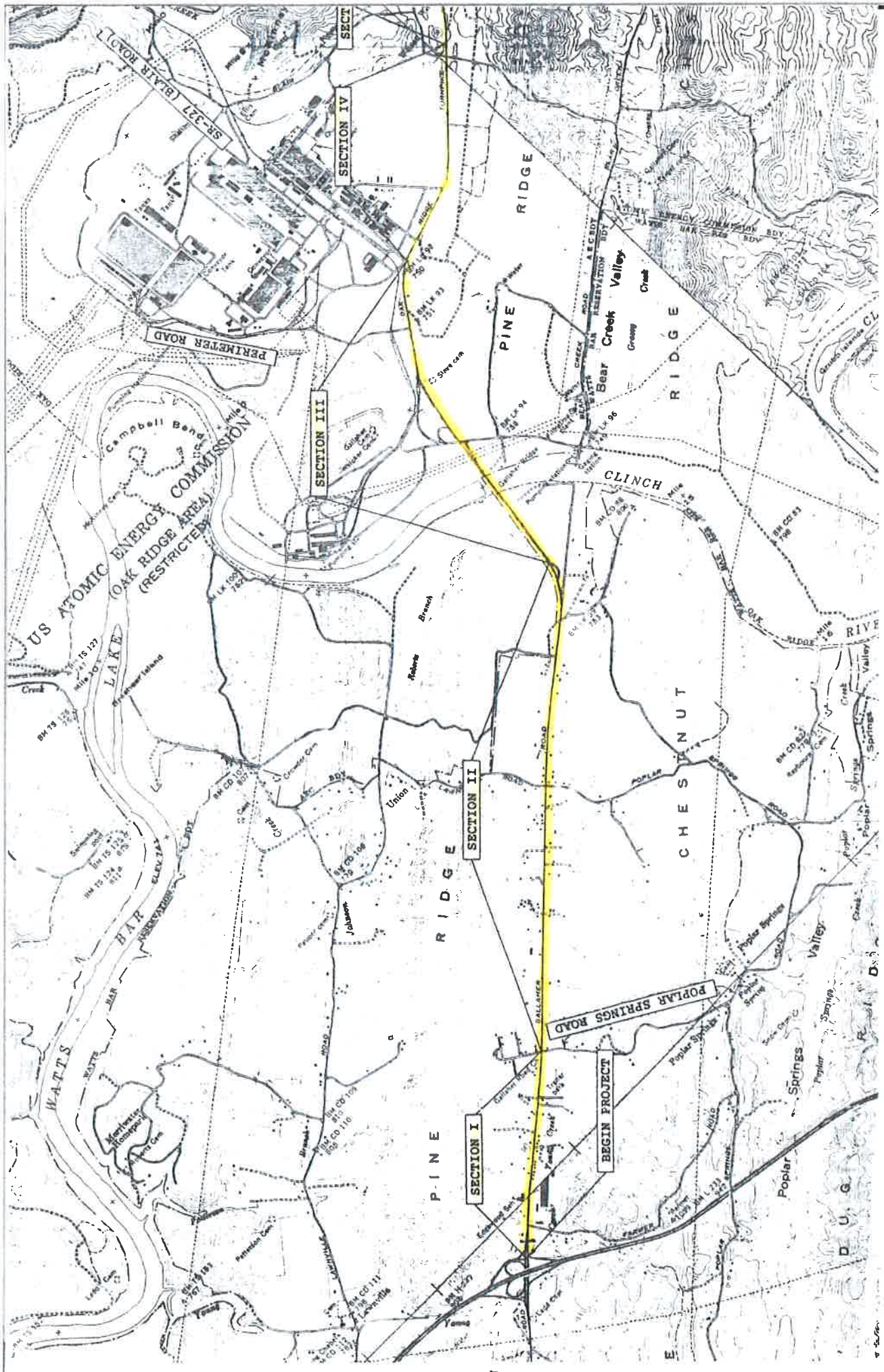
Construction

Clear and Grubbing.....		\$ 5,000
Earthwork.....	\$	60,000
Pavement Removal.....	\$	10,000
Drainage.....	\$	75,000
Structures.....	\$	N/A
Railroad Crossing.....	\$	N/A
Paving.....	\$	225,000
Retaining Walls.....	\$	N/A
Maintenance of Traffic.....	\$	20,000
Topsoil.....	\$	3,000
Seeding.....	\$	2,000
Sodding.....	\$	3,000
Signing.....	\$	2,000
Signalization.....	\$	N/A
Fence.....	\$	N/A
Guardrail.....	\$	75,000
Rip Rap or Slope Protection.....	\$	N/A
Other Const. Items (8.5%).....	\$	45,000
Mobilization.....	\$	25,000
10% Eng. & Cont.	\$	55,000

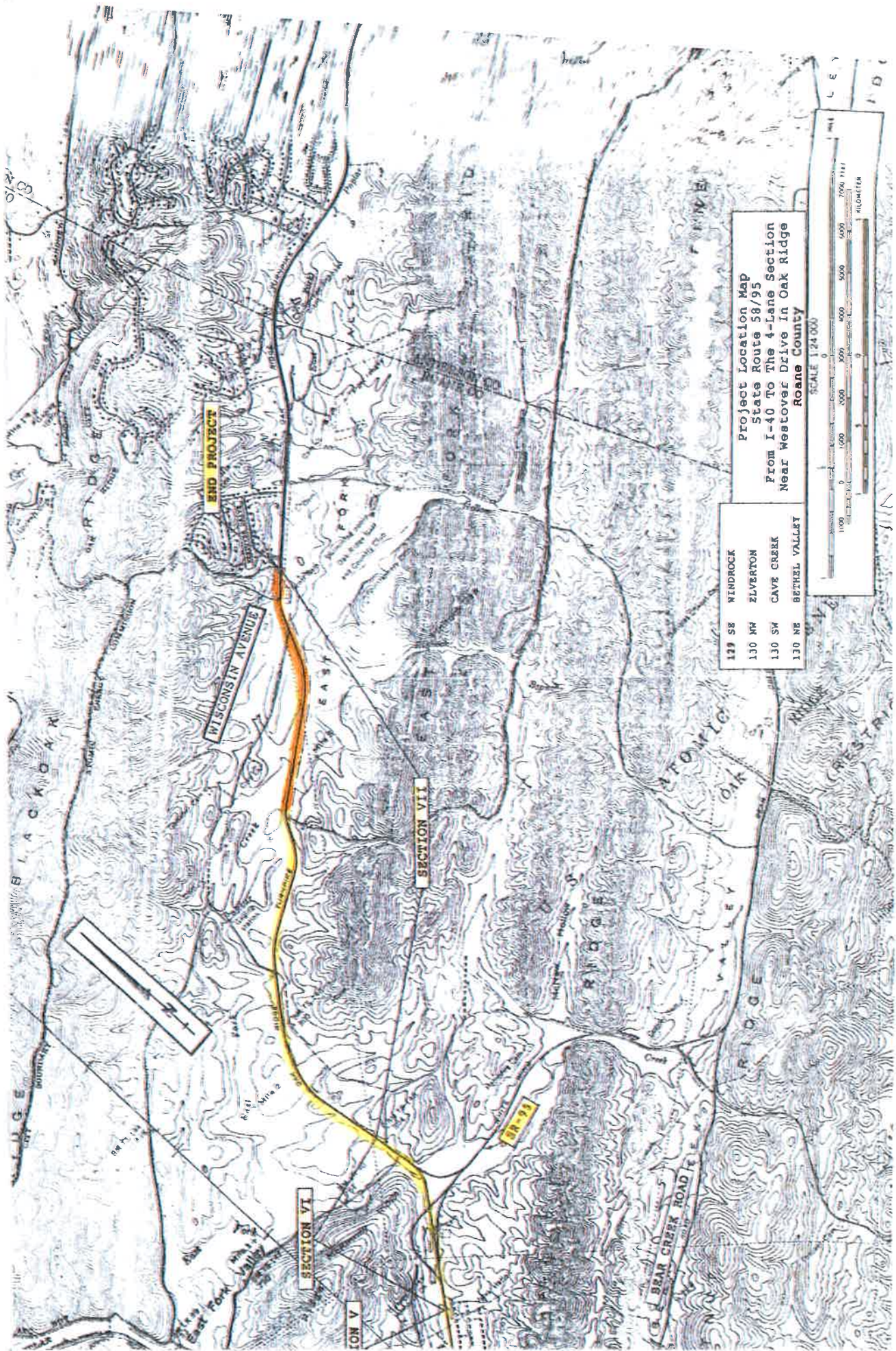
Total Construction Cost.....\$ 605,000

Preliminary Engineering (10%).....\$ 55,000

TOTAL SECTION COST.....\$ 660,000



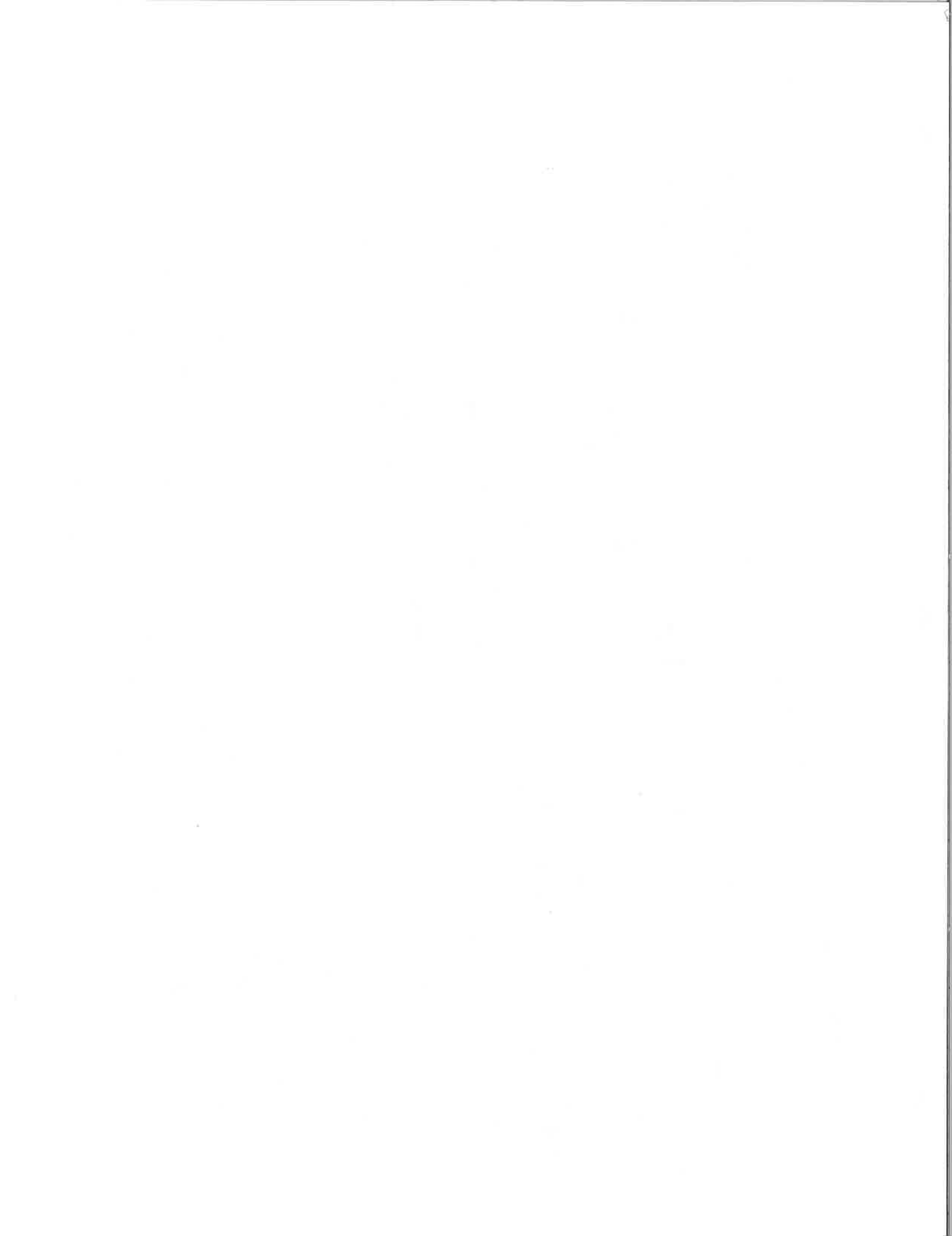




139 SE NINDROCK
 130 MH ZLVERTON
 130 SM CAVE CREEK
 130 NE BETHEL VALLEY

Project Location Map
 State Route 58/95
 From I-40 To The 4-Lane Section
 Near Westover Drive In Oak Ridge
 Roane County





APPENDIX B

Exercise 4

p. 4-17 - 4-21

STANDARD RATES OF SUPERELEVATION AND
 MINIMUM LENGTH OF TRANSITION FOR URBAN HIGHWAYS

E MAX=0.04 DESIRABLE

D	R	FT.	V=20 (MPH)		V=30 (MPH)		V=40 (MPH)		V=50 (MPH)		V=60 (MPH)	
			F	LIFT. 1	F	LIFT. 1	F	LIFT. 1	F	LIFT. 1	F	LIFT. 1
0'-15"	22.918	NC	0	0	0	0	0	0	0	0	0	
0'-30"	11.459	NC	0	0	0	0	0	0	0	0	0	
0'-45"	7.639	NC	0	0	0	0	0	0	0	0	0	
1'-00"	5.120	NC	0	0	0	0	0	0	0	0	0	
1'-15"	3.820	NC	0	0	0	0	0	0	0	0	0	
1'-30"	2.865	NC	0	0	0	0	0	0	0	0	0	
1'-45"	2.250	NC	0	0	0	0	0	0	0	0	0	
2'-00"	1.810	NC	0	0	0	0	0	0	0	0	0	
2'-15"	1.430	NC	0	0	0	0	0	0	0	0	0	
2'-30"	1.140	NC	0	0	0	0	0	0	0	0	0	
2'-45"	0.910	NC	0	0	0	0	0	0	0	0	0	
3'-00"	0.700	NC	0	0	0	0	0	0	0	0	0	
3'-15"	0.540	NC	0	0	0	0	0	0	0	0	0	
3'-30"	0.420	NC	0	0	0	0	0	0	0	0	0	
3'-45"	0.330	NC	0	0	0	0	0	0	0	0	0	
4'-00"	0.260	NC	0	0	0	0	0	0	0	0	0	
4'-15"	0.200	NC	0	0	0	0	0	0	0	0	0	
4'-30"	0.150	NC	0	0	0	0	0	0	0	0	0	
4'-45"	0.110	NC	0	0	0	0	0	0	0	0	0	
5'-00"	0.080	NC	0	0	0	0	0	0	0	0	0	
5'-15"	0.060	NC	0	0	0	0	0	0	0	0	0	
5'-30"	0.040	NC	0	0	0	0	0	0	0	0	0	
5'-45"	0.030	NC	0	0	0	0	0	0	0	0	0	
6'-00"	0.020	NC	0	0	0	0	0	0	0	0	0	
6'-15"	0.015	NC	0	0	0	0	0	0	0	0	0	
6'-30"	0.010	NC	0	0	0	0	0	0	0	0	0	
6'-45"	0.008	NC	0	0	0	0	0	0	0	0	0	
7'-00"	0.006	NC	0	0	0	0	0	0	0	0	0	
7'-15"	0.004	NC	0	0	0	0	0	0	0	0	0	
7'-30"	0.003	NC	0	0	0	0	0	0	0	0	0	
7'-45"	0.002	NC	0	0	0	0	0	0	0	0	0	
8'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
8'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
8'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
8'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
9'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
9'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
9'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
9'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
10'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
10'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
10'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
10'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
11'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
11'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
11'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
11'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
12'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
12'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
12'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
12'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
13'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
13'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
13'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
13'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
14'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
14'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
14'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
14'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
15'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
15'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
15'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
15'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
16'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
16'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
16'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
16'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
17'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
17'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
17'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
17'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
18'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
18'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
18'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
18'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
19'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
19'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
19'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
19'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
20'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
20'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
20'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
20'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
21'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
21'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
21'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
21'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
22'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
22'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
22'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
22'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
23'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
23'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
23'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
23'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
24'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
24'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
24'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
24'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
25'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
25'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
25'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
25'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
26'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
26'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
26'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
26'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
27'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
27'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
27'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
27'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
28'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
28'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
28'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
28'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
29'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
29'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
29'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
29'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
30'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
30'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
30'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
30'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
31'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
31'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
31'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
31'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
32'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
32'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
32'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
32'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
33'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
33'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
33'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
33'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
34'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
34'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
34'-30"	0.001	NC	0	0	0	0	0	0	0	0	0	
34'-45"	0.001	NC	0	0	0	0	0	0	0	0	0	
35'-00"	0.001	NC	0	0	0	0	0	0	0	0	0	
35'-15"	0.001	NC	0	0	0	0	0	0	0	0	0	
35'-30"	0.001	NC	0	0	0							





HORIZONTAL CIRCULAR CURVES

- D = Degree of curve, arc definition
 D_c = Degree of curve, chord definition
 L = Length of curve from P.C. to P.T.
 c = Length of sub-chord
 l = Length of arc for sub-chord
 d = Central angle for sub-chord
 I or Δ = Angle of interior or delta

$$D = \frac{5,729.58}{R}$$

$$\text{Radius by chord definition, } R = \frac{50}{\sin 1/2 D}$$

$$T = R \tan (I/2)$$

$$L = R I \frac{\pi}{180} = \frac{I}{D} (100)$$

$$LC = 2R \sin (I/2)$$

$$c = 2R \sin (d/2)$$

$$d = 1D/100$$

$$M = R [1 - \cos (I/2)]$$

$$E = R \left[\frac{1}{\cos (I/2)} - 1 \right]$$

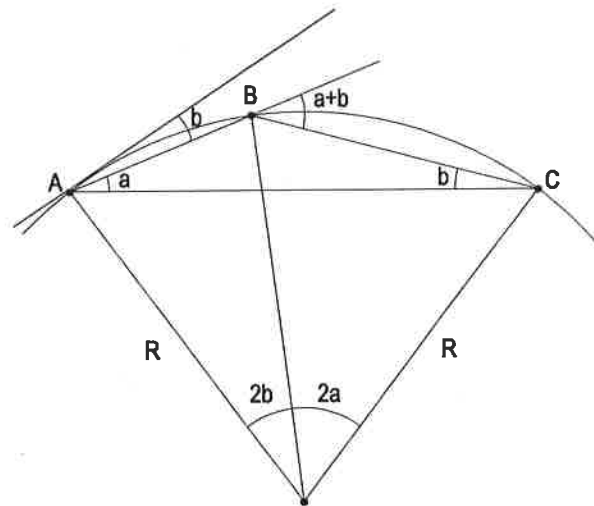
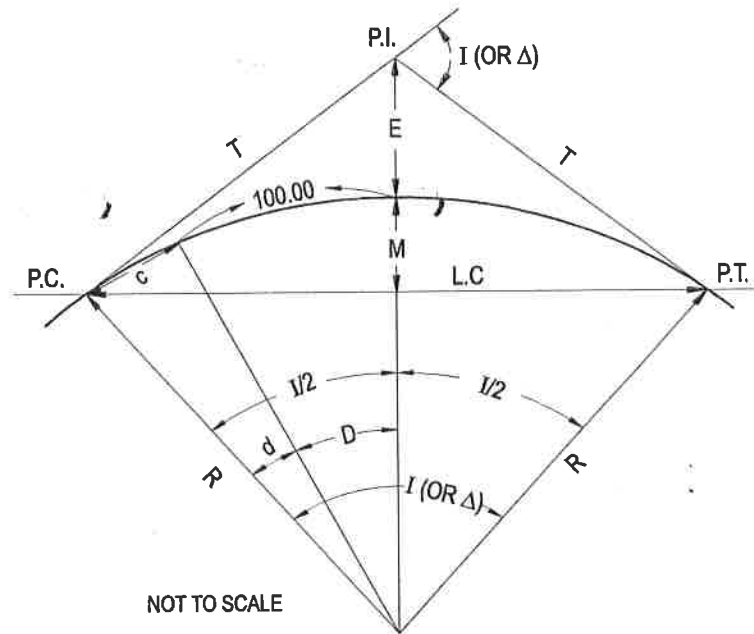
$$\text{Area of sector} = \frac{RL}{2} = \frac{\pi R^2 I}{360}$$

$$\text{Area of segment} = \frac{\pi R^2 I}{360} - \frac{R^2 \sin I}{2}$$

$$\text{Area between curve and tangents} = R(T - L/2)$$

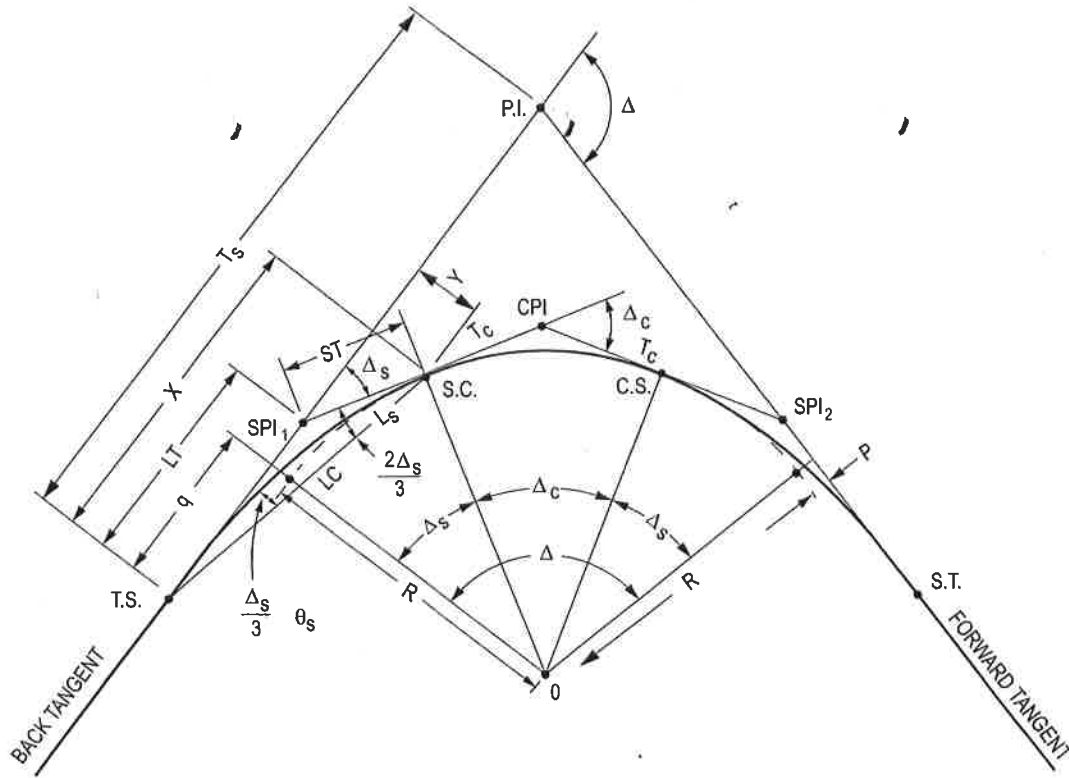
$$R = \frac{AC}{2 \sin (a + b)}$$

$$\text{Equation of a circle, } X^2 + Y^2 = R^2$$





HORIZONTAL SPIRAL CURVES



T.S. – Tangent to spiral

S.C. – Spiral to curve

C.S. – Curve to spiral

S.T. – Spiral to tangent

T_s – Spiral tangent

X – Distance along tangent from T.S. to point at right angle to S.C.

Y – Right angle distance from tangent to S.C.

LT – Long tangent (spiral)

ST – Short tangent (spiral)

L_s – Length of spiral (arc)

LC – Long chord

q – Distance along tangent to a point at right angle to ghost bc (marginally less than $L_s/2$)

P – Distance from tangent that the curve (ghost bc) has been offset

T_c – Circular curve tangent

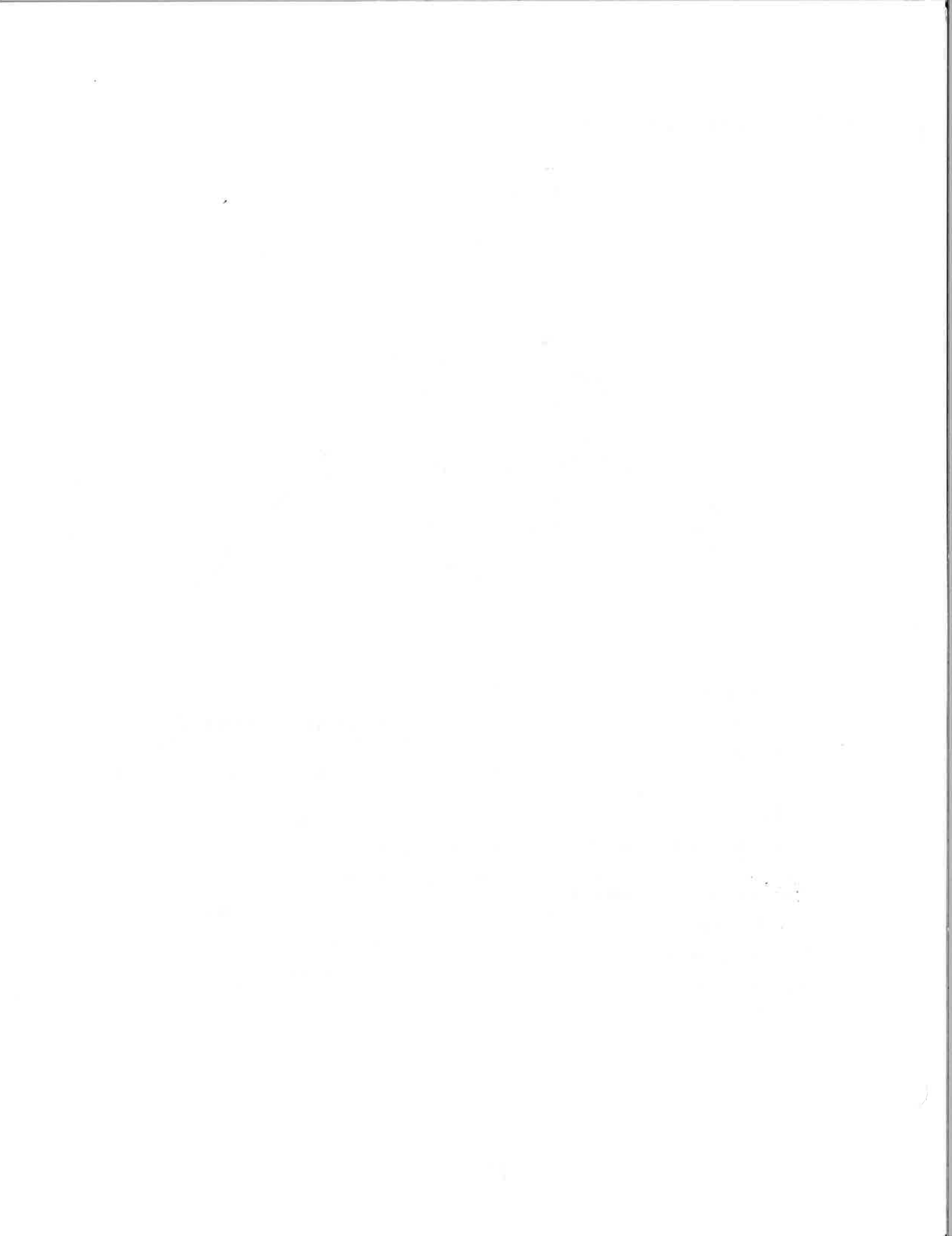
CPI – Circular curve P.I.

SPI – Spiral curve P.I.

P.I. – Point of intersection of curve tangents

L_c – Length of circular curve

L – Length of curve system – T.S. to S.T.



APPENDIX C

Exercise 7

p. 7-2

Metric				US Customary			
Design speed (km/h)	Stopping sight distance (m)	Rate of vertical curvature, K^a		Design speed (mph)	Stopping sight distance (ft)	Rate of vertical curvature, K^a	
		Calculated	Design			Calculated	Design
20	20	0.6	1	15	80	3.0	3
30	35	1.9	2	20	115	6.1	7
40	50	3.8	4	25	155	11.1	12
50	65	6.4	7	30	200	18.5	19
60	85	11.0	11	35	250	29.0	29
70	105	16.8	17	40	305	43.1	44
80	130	25.7	26	45	360	60.1	61
90	160	38.9	39	50	425	83.7	84
100	185	52.0	52	55	495	113.5	114
110	220	73.6	74	60	570	150.6	151
120	250	95.0	95	65	645	192.8	193
130	285	123.4	124	70	730	246.9	247
				75	820	311.6	312
				80	910	383.7	384

^a Rate of vertical curvature, K , is the length of curve per percent algebraic difference in intersecting grades (A). $K = L/A$

Exhibit 3-72. Design Controls for Stopping Sight Distance and for Crest Vertical Curves

Metric			US Customary		
Design speed (km/h)	Passing sight distance (m)	Rate of vertical curvature, K^* design	Design speed (mph)	Passing sight distance (ft)	Rate of vertical curvature, K^* design
30	200	46	20	710	180
40	270	84	25	900	289
50	345	138	30	1090	424
60	410	195	35	1280	585
70	485	272	40	1470	772
80	540	338	45	1625	943
90	615	438	50	1835	1203
100	670	520	55	1985	1407
110	730	617	60	2135	1628
120	775	695	65	2285	1865
130	815	769	70	2480	2197
			75	2580	2377
			80	2680	2565

Note: ^{*}Rate of vertical curvature, K , is the length of curve per percent algebraic difference in intersecting grades (A). $K = L/A$

Exhibit 3-73. Design Controls for Crest Vertical Curves Based on Passing Sight Distance

Generally, it is impractical to design crest vertical curves to provide for passing sight distance because of high cost where crest cuts are involved and the difficulty of fitting the resulting long vertical curves to the terrain, particularly for high-speed roads. Passing sight



Metric				US Customary			
Design speed (km/h)	Stopping sight distance (m)	Rate of vertical curvature, K^a		Design speed (mph)	Stopping sight distance (ft)	Rate of vertical curvature, K^a	
		Calculated	Design			Calculated	Design
20	20	2.1	3	15	80	9.4	10
30	35	5.1	6	20	115	16.5	17
40	50	8.5	9	25	155	25.5	26
50	65	12.2	13	30	200	36.4	37
60	85	17.3	18	35	250	49.0	49
70	105	22.6	23	40	305	63.4	64
80	130	29.4	30	45	360	78.1	79
90	160	37.6	38	50	425	95.7	96
100	185	44.6	45	55	495	114.9	115
110	220	54.4	55	60	570	135.7	136
120	250	62.8	63	65	645	156.5	157
130	285	72.7	73	70	730	180.3	181
				75	820	205.6	206
				80	910	231.0	231

^a Rate of vertical curvature, K , is the length of curve (m) per percent algebraic difference intersecting grades (A). $K = L/A$

Exhibit 3-75. Design Controls for Sag Vertical Curves

Sight Distance at Undercrossings

Sight distance on the highway through a grade separation should be at least as long as the minimum stopping sight distance and preferably longer. Design of the vertical alignment is the same as at any other point on the highway except in some cases of sag vertical curves underpassing a structure as illustrated in Exhibit 3-76. While not a frequent problem, the structure fascia may cut the line of sight and limit the sight distance to less than otherwise is attainable. It is generally practical to provide the minimum length of sag vertical curve discussed above at grade separation structures, and even where the recommended grades are exceeded, the sight distance should not need to be reduced below the minimum recommended values for stopping sight distance.

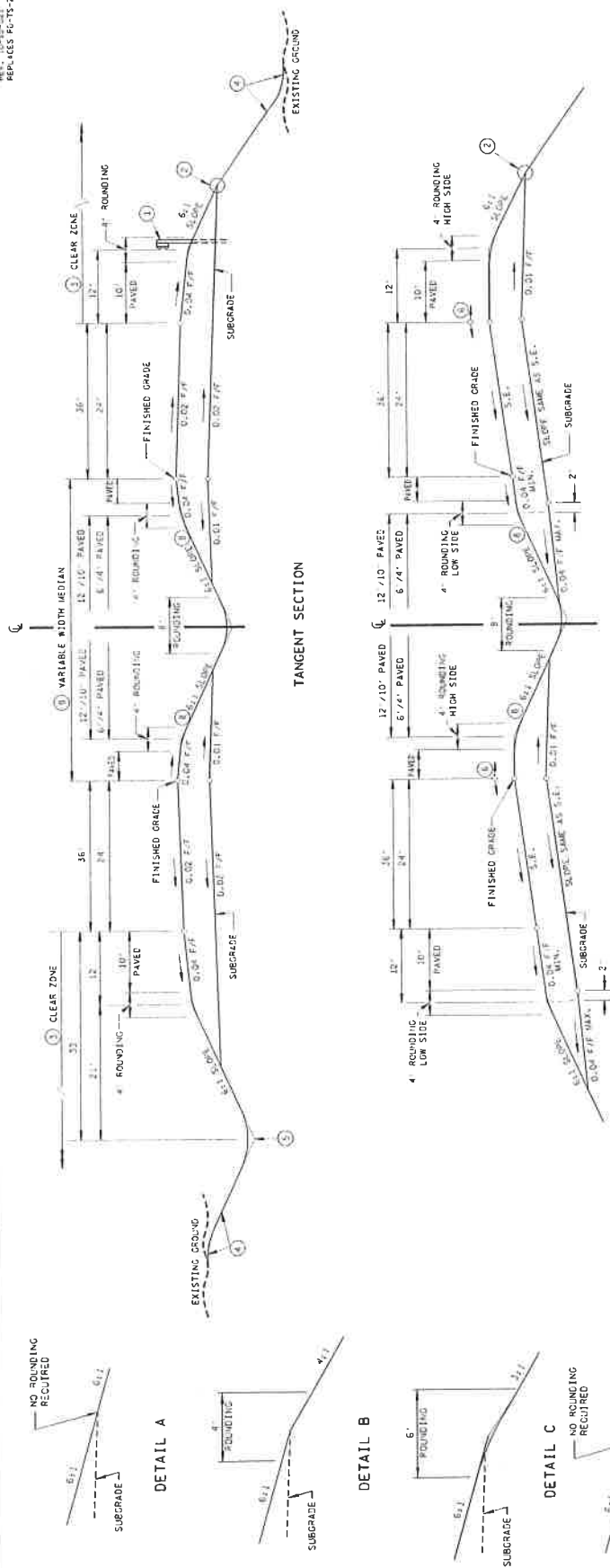
For some conditions, the designer may wish to check the available sight distance at an undercrossing, such as at a two-lane undercrossing without ramps where it would be desirable to provide passing sight distance. Such checks are best made graphically on the profile, but may be performed through computations.



APPENDIX D

Exercise 9

p. 9-4 – 9-10



TANGENT SECTION

SUPERELEVATED SECTION

TABLE I. MINIMUM DESIGN SPEEDS FOR RURAL COLLECTOR ROADS. (SEE PAGE 426)

TYPE OF TERRAIN	MINIMUM DESIGN SPEED (MPH)
LEVEL	50
ROLLING	50
UNDESIRABLE	40

TABLE II. 4 AND 6 LANE COLLECTOR ROADS AND STREETS-DESIGN STANDARDS

DESIGN STANDARDS (FOR GIVEN DESIGN SPEED)	DESIGN SPEEDS (MPH)									
	30	35	40	45	50	55	60	65	70	75
MINIMUM RADIUS - FEET: 0.02 W.A.S.E.	300	420	540	720	900	1080	1260	1440	1620	1800
MINIMUM RADIUS - FEET: 0.05 W.A.S.E.	75	105	135	180	225	270	315	360	405	450
MINIMUM RADIUS - FEET: 0.08 W.A.S.E.	45	63	81	108	135	162	189	216	243	270
MINIMUM RADIUS - FEET: 0.10 W.A.S.E.	36	50	64	85	106	127	148	169	190	211
MINIMUM RADIUS - FEET: 0.15 W.A.S.E.	24	33	42	56	70	84	98	112	126	140
MINIMUM RADIUS - FEET: 0.20 W.A.S.E.	18	24	30	40	50	60	70	80	90	100
MINIMUM RADIUS - FEET: 0.25 W.A.S.E.	14	19	24	32	40	48	56	64	72	80
MINIMUM RADIUS - FEET: 0.30 W.A.S.E.	12	16	20	27	34	41	48	55	62	70
MINIMUM RADIUS - FEET: 0.40 W.A.S.E.	9	12	15	20	25	30	36	42	48	54
MINIMUM RADIUS - FEET: 0.50 W.A.S.E.	7	9	11	15	19	23	27	32	37	42
MINIMUM RADIUS - FEET: 0.60 W.A.S.E.	6	8	10	13	16	19	23	27	31	35
MINIMUM RADIUS - FEET: 0.75 W.A.S.E.	5	6	8	10	12	15	18	21	24	27
MINIMUM RADIUS - FEET: 1.00 W.A.S.E.	4	5	6	8	10	12	15	18	21	24
MINIMUM RADIUS - FEET: 1.50 W.A.S.E.	3	4	5	6	8	10	12	15	18	21
MINIMUM RADIUS - FEET: 2.00 W.A.S.E.	2	3	4	5	6	8	10	12	15	18
MINIMUM RADIUS - FEET: 3.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 4.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 5.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 6.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 8.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 10.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 15.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 20.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 30.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 40.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 50.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 60.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 80.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 100.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 150.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 200.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 300.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 400.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 500.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 600.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 800.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 1000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 1500.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 2000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 3000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 4000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 5000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 6000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 8000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 10000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 15000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 20000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 30000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 40000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 50000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 60000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 80000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 100000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 150000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 200000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 300000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 400000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 500000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 600000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 800000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 1000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 1500000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 2000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 3000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 4000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 5000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 6000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 8000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 10000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 15000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 20000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 30000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 40000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 50000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 60000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 80000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 100000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 150000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 200000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 300000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 400000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 500000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 600000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 800000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 1000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 1500000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 2000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 3000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 4000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 5000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 6000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 8000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 10000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 15000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 20000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 30000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 40000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 50000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 60000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 80000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 100000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 150000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 200000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 300000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 400000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 500000000000.00 W.A.S.E.	1	2	3	4	5	6	8	10	12	15
MINIMUM RADIUS - FEET: 6										



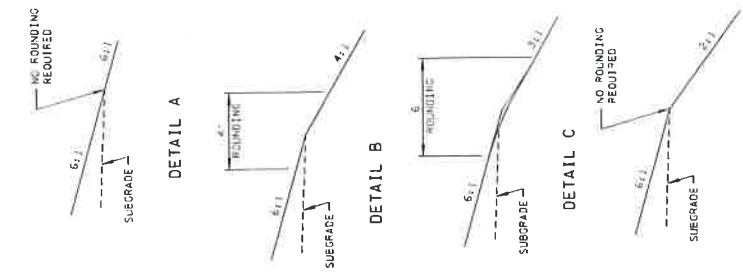
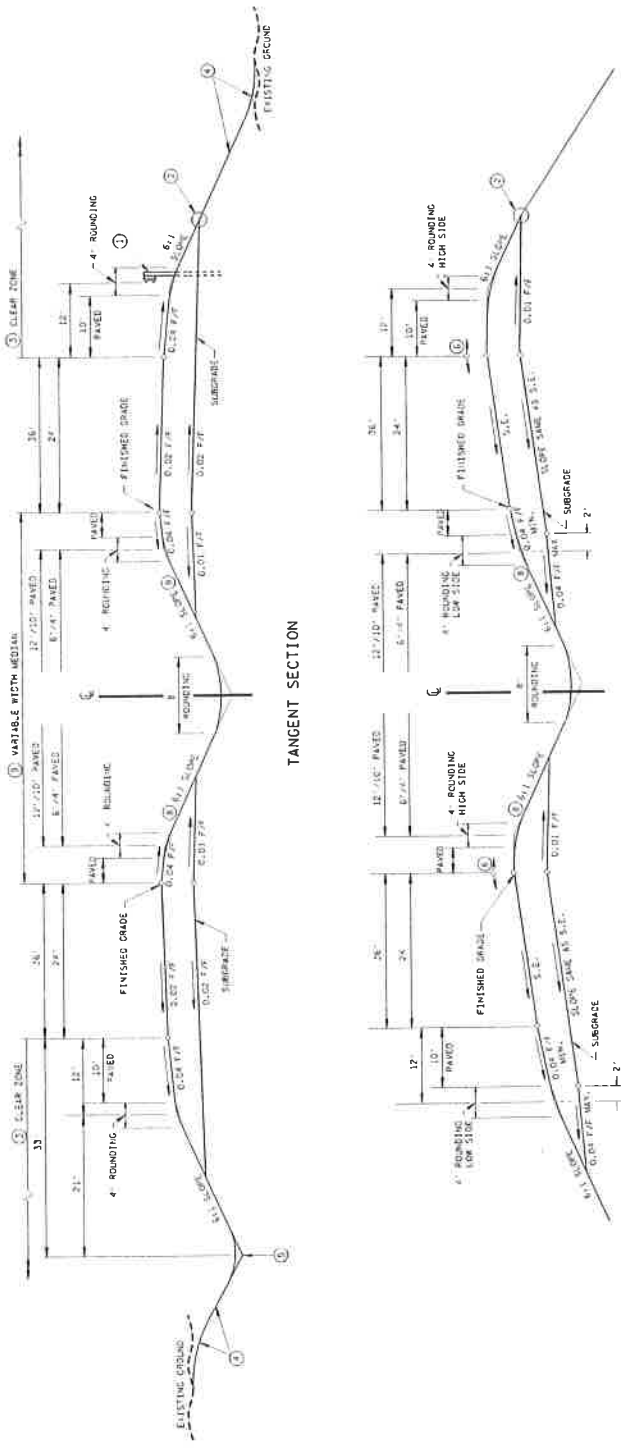


TABLE I. RECOMMENDED RURAL DESIGN SPEEDS (SEE PAGE 448) ①

TYPE OF TERRAIN	DESIGN SPEED (MPH)
LEVEL	70
ROLLING	60
MOUNTAINOUS	50

TABLE II. 4 AND 6 LANE ARTERIAL - DESIGN STANDARDS ②

DESIGN STANDARDS (FOR GIVEN DESIGN SPEED)	DESIGN SPEEDS (MPH)											
	30	35	40	45	50	55	60	65	70	75	80	85
MINIMUM RADIUS (FT.) 0.04 MAX. S.E.	300	450	565	730	930	1190	1505	1870	2295	2880	3630	4545
MINIMUM RADIUS (FT.) 0.06 MAX. S.E.	215	300	370	460	570	705	870	1065	1290	1545	1920	2415
MINIMUM RADIUS (FT.) 0.08 MAX. S.E.	250	350	465	600	760	965	1205	1485	1820	2235	2730	3405
MINIMUM RADIUS (FT.) 0.10 MAX. S.E.	300	420	555	710	895	1125	1395	1715	2085	2535	3105	3885
MINIMUM RADIUS (FT.) 0.12 MAX. S.E.	360	500	660	840	1050	1305	1615	1985	2435	2985	3675	4545
MINIMUM RADIUS (FT.) 0.15 MAX. S.E.	450	620	810	1030	1290	1605	1985	2435	2985	3675	4545	5670
MINIMUM RADIUS (FT.) 0.20 MAX. S.E.	600	820	1080	1380	1740	2160	2655	3235	3915	4710	5730	7065
MINIMUM RADIUS (FT.) 0.25 MAX. S.E.	750	1020	1350	1740	2190	2700	3285	3965	4755	5760	7005	8565
MINIMUM RADIUS (FT.) 0.30 MAX. S.E.	900	1200	1560	2010	2520	3090	3765	4545	5445	6570	7920	9585
MINIMUM RADIUS (FT.) 0.40 MAX. S.E.	1200	1600	2100	2700	3360	4080	4965	5965	7110	8520	10185	12210
MINIMUM RADIUS (FT.) 0.50 MAX. S.E.	1500	2000	2625	3300	4050	4950	5985	7170	8580	10245	12210	14715
MINIMUM RADIUS (FT.) 0.60 MAX. S.E.	1800	2400	3150	3900	4740	5700	6810	8070	9540	11235	13230	15840
MINIMUM RADIUS (FT.) 0.80 MAX. S.E.	2250	2925	3825	4725	5715	6810	8010	9315	10830	12555	14490	17235
MINIMUM RADIUS (FT.) 1.00 MAX. S.E.	2700	3525	4545	5565	6675	7890	9210	10740	12480	14430	16590	19965
MINIMUM RADIUS (FT.) 1.25 MAX. S.E.	3150	4050	5175	6285	7485	8790	10200	11820	13650	15690	18045	21720
MINIMUM RADIUS (FT.) 1.50 MAX. S.E.	3600	4620	5875	7170	8565	10065	11670	13380	15300	17535	20085	23955
MINIMUM RADIUS (FT.) 2.00 MAX. S.E.	4500	5850	7425	8970	10665	12510	14415	16485	18825	21540	24630	29100
MINIMUM RADIUS (FT.) 2.50 MAX. S.E.	5400	6975	8850	10725	12705	14790	16980	19380	22095	25230	28785	33855
MINIMUM RADIUS (FT.) 3.00 MAX. S.E.	6300	8100	10275	12345	14520	16800	19290	22005	25045	28515	32415	37845
MINIMUM RADIUS (FT.) 4.00 MAX. S.E.	8100	10350	13050	15525	18210	21000	23910	27045	30510	34410	38835	45000
MINIMUM RADIUS (FT.) 5.00 MAX. S.E.	9900	12600	15750	18720	21900	25290	28905	32745	36915	41515	46635	53475
MINIMUM RADIUS (FT.) 6.00 MAX. S.E.	11700	14850	18450	21825	25410	29100	32910	36945	41415	46315	51735	58765
MINIMUM RADIUS (FT.) 8.00 MAX. S.E.	15000	19125	23925	28725	33750	39000	44475	50175	56100	62355	68935	76845
MINIMUM RADIUS (FT.) 10.00 MAX. S.E.	18000	22650	28350	34275	40425	46800	53400	60225	67365	74820	82590	91680
MINIMUM RADIUS (FT.) 12.50 MAX. S.E.	22500	28275	35175	42225	49500	57000	64725	72675	80955	89565	98505	108870
MINIMUM RADIUS (FT.) 15.00 MAX. S.E.	27000	33975	42075	50225	58500	67020	75780	84765	94065	103680	113610	123945
MINIMUM RADIUS (FT.) 20.00 MAX. S.E.	36000	45300	55725	66225	76800	87540	98445	109605	121020	132690	144615	156885
MINIMUM RADIUS (FT.) 25.00 MAX. S.E.	45000	56625	69150	81725	94350	107020	120735	134490	149280	164100	178950	194035
MINIMUM RADIUS (FT.) 30.00 MAX. S.E.	54000	67950	82725	97575	112500	127500	143565	159690	175875	192120	208425	224880
MINIMUM RADIUS (FT.) 40.00 MAX. S.E.	72000	90600	109575	128525	147450	166350	185220	204045	222820	241545	260210	278820
MINIMUM RADIUS (FT.) 50.00 MAX. S.E.	90000	112650	135675	158625	181500	204300	227020	249645	272160	294565	316860	339045
MINIMUM RADIUS (FT.) 60.00 MAX. S.E.	108000	135300	161625	187925	214200	239400	264520	289545	314460	339265	363960	388545
MINIMUM RADIUS (FT.) 80.00 MAX. S.E.	144000	180400	217500	254600	291700	328800	365900	403000	440100	477200	514300	551400
MINIMUM RADIUS (FT.) 100.00 MAX. S.E.	180000	225500	273600	321700	369800	417900	466000	514100	562200	610300	658400	706500
MINIMUM RADIUS (FT.) 125.00 MAX. S.E.	225000	281875	340875	399875	458875	517875	576875	635875	694875	753875	812875	871875
MINIMUM RADIUS (FT.) 150.00 MAX. S.E.	270000	338250	408750	479250	549750	619750	689750	759750	829750	899750	969750	1039750
MINIMUM RADIUS (FT.) 200.00 MAX. S.E.	360000	451000	541500	632000	722500	813000	903500	994000	1084500	1175000	1265500	1356000
MINIMUM RADIUS (FT.) 250.00 MAX. S.E.	450000	563750	677250	790750	904250	1017750	1131250	1244750	1358250	1471750	1585250	1698750
MINIMUM RADIUS (FT.) 300.00 MAX. S.E.	540000	675000	808500	942000	1075500	1209000	1342500	1476000	1609500	1743000	1876500	2010000
MINIMUM RADIUS (FT.) 400.00 MAX. S.E.	720000	900000	1080000	1260000	1440000	1620000	1800000	1980000	2160000	2340000	2520000	2700000
MINIMUM RADIUS (FT.) 500.00 MAX. S.E.	900000	1125000	1350000	1575000	1800000	2025000	2250000	2475000	2700000	2925000	3150000	3375000
MINIMUM RADIUS (FT.) 600.00 MAX. S.E.	1080000	1350000	1620000	1890000	2160000	2430000	2700000	2970000	3240000	3510000	3780000	4050000
MINIMUM RADIUS (FT.) 800.00 MAX. S.E.	1440000	1800000	2160000	2520000	2880000	3240000	3600000	3960000	4320000	4680000	5040000	5400000
MINIMUM RADIUS (FT.) 1000.00 MAX. S.E.	1800000	2250000	2700000	3150000	3600000	4050000	4500000	4950000	5400000	5850000	6300000	6750000
MINIMUM RADIUS (FT.) 1250.00 MAX. S.E.	2250000	2812500	3375000	3937500	4500000	5062500	5625000	6187500	6750000	7312500	7875000	8437500
MINIMUM RADIUS (FT.) 1500.00 MAX. S.E.	2700000	3375000	4050000	4725000	5400000	6075000	6750000	7425000	8100000	8775000	9450000	10125000
MINIMUM RADIUS (FT.) 2000.00 MAX. S.E.	3600000	4500000	5400000	6300000	7200000	8100000	9000000	9900000	10800000	11700000	12600000	13500000
MINIMUM RADIUS (FT.) 2500.00 MAX. S.E.	4500000	5625000	6750000	7875000	9000000	10125000	11250000	12375000	13500000	14625000	15750000	16875000
MINIMUM RADIUS (FT.) 3000.00 MAX. S.E.	5400000	6750000	8100000	9450000	10800000	12150000	13500000	14850000	16200000	17550000	18900000	20250000
MINIMUM RADIUS (FT.) 4000.00 MAX. S.E.	7200000	9000000	10800000	12600000	14400000	16200000	18000000	19800000	21600000	23400000	25200000	27000000
MINIMUM RADIUS (FT.) 5000.00 MAX. S.E.	9000000	11250000	13500000	15750000	18000000	20250000	22500000	24750000	27000000	29250000	31500000	33750000
MINIMUM RADIUS (FT.) 6000.00 MAX. S.E.	10800000	13500000	16200000	18900000	21600000	24300000	27000000	29700000	32400000	35100000	37800000	40500000
MINIMUM RADIUS (FT.) 8000.00 MAX. S.E.	14400000	18000000	21600000	25200000	28800000	32400000	36000000	39600000	43200000	46800000	50400000	54000000
MINIMUM RADIUS (FT.) 10000.00 MAX. S.E.	18000000	22500000	27000000	31500000	36000000	40500000	45000000	49500000	54000000	58500000	63000000	67500000
MINIMUM RADIUS (FT.) 12500.00 MAX. S.E.	22500000	28125000	33750000	39375000	45000000	50625000	56250000	61875000	67500000	73125000	78750000	84375000
MINIMUM RADIUS (FT.) 15000.00 MAX. S.E.	27000000	33750000	40500000	47250000	54000000	60750000	67500000	74250000	81000000	87750000	94500000	101250000
MINIMUM RADIUS (FT.) 20000.00 MAX. S.E.	36000000	45000000	54000000	63000000	72000000	81000000	90000000	99000000	108000000	117000000	126000000	135000000
MINIMUM RADIUS (FT.) 25000.00 MAX. S.E.	45000000	56250000	67500000	78750000	90000000	101250000	112500000	123750000	135000000	146250000	157500000	168750000
MINIMUM RADIUS (FT.) 30000.00 MAX. S.E.	54000000	67500000	81000000	94500000	108000000	121500000	135000000	148500000	162000000	175500000	189000000	202500000
MINIMUM RADIUS (FT.) 40000.00 MAX. S.E.	72000000	90000000	108000000	126000000	144000000	162000000	180000000	198000000	216000000	234000000	252000000	270000000
MINIMUM RADIUS (FT.) 50000.00 MAX. S.E.	90000000	112500000	135000000	157500000	180000000	202500000	225000000	247500000	270000000	292500000	315000000	337500000
MINIMUM RADIUS (FT.) 60000.00 MAX. S.E.	108000000	135000000	162000000	189000000	216000000	243000000	270000000	297000000	324000000	351000000	378000000	405000000
MINIMUM RADIUS (FT.) 80000.00 MAX. S.E.	144000000	180000000	216000000	252000000	288000000	324000000	360000000	396000000	432000000	468000000	504000000	540000000
MINIMUM RADIUS (FT.) 100000.00 MAX. S.E.	180000000	225000000	270000000	315000000	360000000	405000000	450000000	495000000	540000000	585000000	630000000	675000000
MINIMUM RADIUS (FT.) 125000.00 MAX. S.E.	225000000	281250000	337500000	393750000	450000000	506250000	562500000	618750000	675000000	731250000	787500000	843750000
MINIMUM RADIUS (FT.) 150000.00 MAX. S.E.	270000000	337500000	405000000	472500000	540000000	607500000	675000000	742500000	810000000	877500000	945000000	1012500000
MINIMUM RADIUS (FT.) 200000.00 MAX. S.E.	360000000	450000000	540000000	630000000	720000000	810000000	900000000	990000000	1080000000	1170000000	1260000000	1350000000
MINIMUM RADIUS (FT.) 250000.00 MAX. S.E.	450000000	562500000	675000000	787500000	900000000	1012500000	1125000000	1237500000	1350000000	1462500000	1575000000	1687500000
MINIMUM RADIUS (FT.) 300000.00 MAX. S.E.	540000000	675000000	810000000	945000000	1080000000	1215000000	1350000000	1485000000	1620000000	1755000000	1890000000	2025000000
MINIMUM RADIUS (FT.) 400000.00 MAX. S.E.	720000000	900000000	1080000000	1								



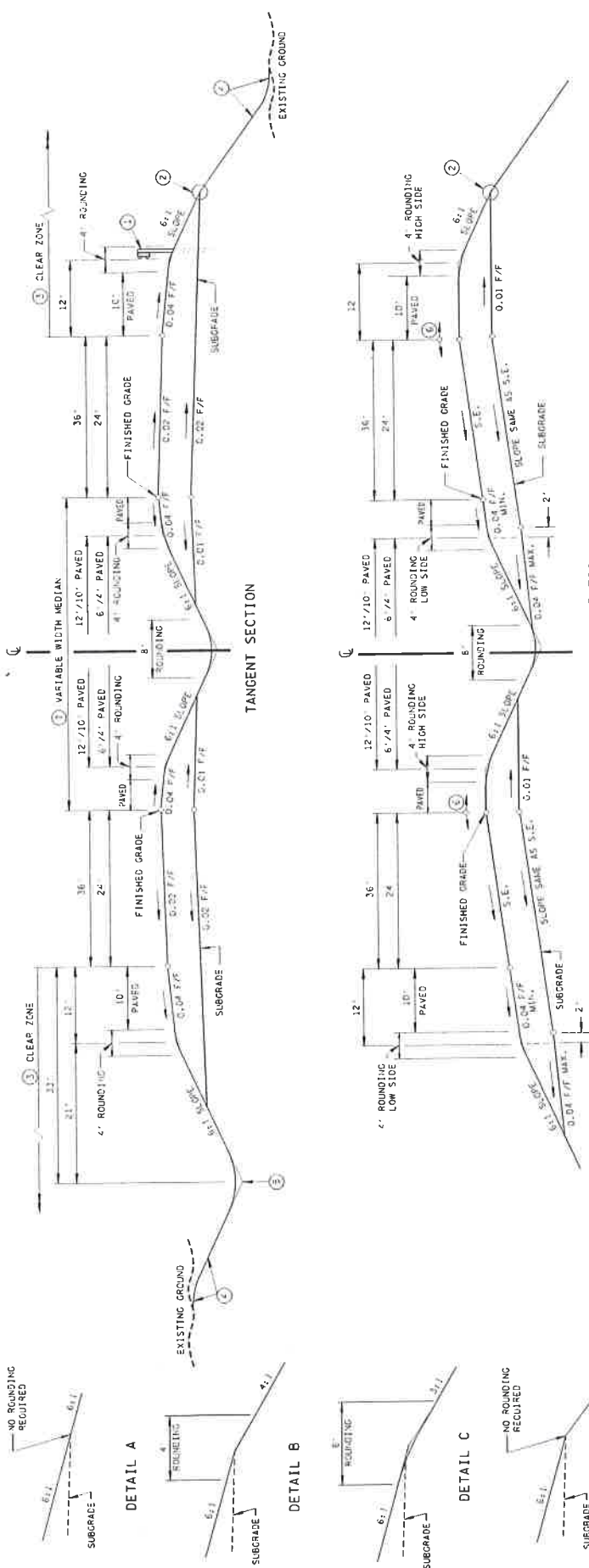


TABLE II. FREEWAY - DESIGN STANDARDS

DESIGN STANDARDS (FOR GIVEN DESIGN SPEED)	DESIGN SPEEDS (MPH)				
	50	55	60	65	70
MINIMUM RADIUS (FT) (0.05 MAX. S.E.)	700	905	1205	1485	1820
MINIMUM STOPPING SIGHT DISTANCE (FT.)	425	495	570	645	730
MINIMUM STOPPING SIGHT DISTANCE (FT.)	344	318	293	267	241
MINIMUM "K" VALUE	86	115	146	177	211
MINIMUM GRADES %	0.5	0.5	0.5	0.5	0.5
MINIMUM GRADES %	0.5	0.5	0.5	0.5	0.5

SEE STANDARD DRAWINGS RD01-SE-2 AND RD01-SE-3

TABLE I. MINIMUM DESIGN SPEEDS FOR FREEWAYS (SEE PAGE 507)

LOCATION	MINIMUM DESIGN SPEED (MPH)
URBAN	50
RURAL	70
MOUNTAINOUS	50

GENERAL NOTES

- FOR SPECIFIC CONDITIONS NOT COVERED ON THIS SHEET, REFERENCE SHOULD BE MADE TO A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS, AASHTO, 2001.
- PAGE NUMBERS REFERRED TO ON THIS DRAWING ARE FROM "A" POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS, AASHTO, 2001, UNLESS OTHERWISE NOTED.
- REFERENCE SHOULD ALSO BE MADE TO THE "ROADSIDE DESIGN GUIDE," AASHTO, 2002.
- DESIRABLE RIGHT-OF-WAY IS SLOPE LINE PLUS TWENTY FEET.
- ALL NEW AND REHABILITATED BRIDGES SHALL BE DESIGNED FOR HS-20 LOADING. THE MINIMUM CLEAR WIDTH FOR NEW AND REHABILITATED BRIDGES SHALL BE WIDTH AS APPLICABLE, WIDTH OF THE APPROACH ROADWAY, CURB-TO-CURB WIDTH, OR THE WIDTH AS APPLICABLE, FOR EXISTING BRIDGES. ELEMENTS TO THE WIDTH OF THE TRAVELLED WAY PLUS 2 FEET CLEARANCE ON EACH SIDE. BRIDGES SHOULD BE CONSIDERED FOR ULTIMATE WIDENING OR REPLACEMENT IF THEY DO NOT PROVIDE AT LEAST 3 FEET CLEARANCE ON EACH SIDE. ARE NOT CAPABLE OF BEING WIDENED OR REPLACED. BRIDGES SHOULD BE CONSIDERED FOR SPECIAL NARROW BRIDGE TREATMENTS SUCH AS SIGNING AND PAVEMENT MARKING.
- FOR INTERSTATES, SEE THE CURRENT EDITION OF AASHTO'S "POLICY ON DESIGN STANDARDS-INTERSTATE SYSTEM."

FOOTNOTES

- SEE QUADRANT STANDARD DRAWINGS FOR TYPICAL GUARDRAIL PLACEMENT.
- SEE DETAILS A, B, C, OR D FOR ROUNDING.
- CLEAR ZONE WIDTH SHALL BE DETERMINED FROM STANDARD DRAWING RD01-S-12, BASED ON THE SIDE DESIGN GUIDE, AASHTO, 2002, FOR FURTHER INFORMATION ON CLEAR ZONES.
- SEE STANDARD DRAWINGS RD01-S-11 AND RD01-S-10 FOR FILL AND CUT SLOPE SPECIAL ROCK CUT TREATMENT.
- SEE STANDARD DRAWING RD01-S-11A FOR ROUNDING OF ROADSIDE DITCH SLOPES.
- THE SLOPES OF THE SHOULDER AND ROADWAY PAVEMENT SHALL NOT EXCEED AN ALGEBRAIC DIFFERENCE OF 0.07 FOOT PER FOOT.
- MINIMUM MEDIAN WIDTH IS TO BE 48 FEET WHEN USING 6 FEET WIDE INSIDE SHOULDERS. MINIMUM MEDIAN WIDTH IS TO BE 64 FEET WHEN USING 12 FOOT WIDE INSIDE SHOULDERS.
- GRADES ONE PERCENT STEEPER THAN THE VALUE SHOWN MAY BE USED FOR EXTREME CASES AND FOR ONE-WAY DOWNGRADES EXCEPT IN MOUNTAINOUS TERRAIN.
- ALTHOUGH THE SELECTED DESIGN SPEED ESTABLISHES THE LIMITING VALUES OF GRADES, THERE SHOULD BE NO RESTRICTION ON THE USE OF FLATTER HORIZONTAL CURVES OR GREATER SIGHT DISTANCES WHERE SUCH IMPROVEMENTS CAN BE PROVIDED AS A PART OF AN ECONOMIC DESIGN. SEE PAGE 591.

D-3



GENERAL NOTES

DESIGN SPEED
 THESE SECTIONS ARE FOR 45 MILES PER HOUR OR LESS.

ALIGNMENT
 SEE APPROPRIATE STANDARD DRAWING IN THE RD01-SERIES AND THE "ROADSIDE DESIGN GUIDE", ASHTO, 2002, FOR MEDIAN BARRIER WARNINGS.

SUPERELEVATION AND MEDIAN BARRIERS
 SEE APPROPRIATE STANDARD DRAWING IN THE RD01-SERIES AND THE "ROADSIDE DESIGN GUIDE", ASHTO, 2002.

SHOULDER CROSS SLOPES
 ON PROJECTS, WHERE IN THE NEAR FUTURE THE SHOULDER MAY BE USED AS A THROUGH TRAFFIC LANE, THE PARKING LANE SHOULD BE LOCATED TO THE OUTSIDE OF THE SHOULDER IN PLACE OF THE 0.04 F/F/SLOPE SHOWN ON THE TYPICAL SECTION. SEE DETAIL FOR SUPERELEVATION OF SHOULDER WITH 0.02 FOOT/FOOT SLOPE.

① THE SHOULDER WIDTH WILL BE AS SPECIFIED IN THE ADVANCE PLANNING REPORT.

② 10 FEET MINIMUM DESIRABLE.

③ ON URBAN PROJECTS THE BACKSLOPE AND FORESLOPE DESIGN WILL VARY FROM PROJECT TO PROJECT, AS A GENERAL RULE USE THE FOLLOWING:
 3:1 SLOPES OR FLATTER ARE DESIRABLE AND ARE TO BE USED IN AREAS WHERE RIGHT-OF-WAY RESTRICTIONS OF COST WARRANTS A STEEPER THAN 3:1 SLOPE. THE MAXIMUM SLOPE IN SECTION 11 IS 3:1.

CONSTRUCTION EASEMENT
 10 FEET MINIMUM DESIRABLE.

SLOPES
 ON URBAN PROJECTS THE BACKSLOPE AND FORESLOPE DESIGN WILL VARY FROM PROJECT TO PROJECT, AS A GENERAL RULE USE THE FOLLOWING:
 3:1 SLOPES OR FLATTER ARE DESIRABLE AND ARE TO BE USED IN AREAS WHERE RIGHT-OF-WAY RESTRICTIONS OF COST WARRANTS A STEEPER THAN 3:1 SLOPE. THE MAXIMUM SLOPE IN SECTION 11 IS 3:1.

MEDIAN CURBS
 MEDIAN CURBS WILL BE SLOPING CURBS. VERTICAL CURBS WILL NOT BE PERMITTED.

SIDEWALKS
 SIDEWALK WIDTH SHALL NOT INCLUDE THE SIX INCH WIDTH OF PROPOSED CURB. SIDEWALK SHALL BE A MINIMUM OF FIVE FEET WIDE.

PARKING LANES
 FOR SPECIFIC CONDITIONS NOT COVERED ON THIS SHEET, REFER TO STANDARD DRAWING RD01-TS-6, ASHTO, 2002 PAGE NUMBERS 437-438 AND 482-483.

SHOULDER CROSS SLOPES
 ON PROJECTS, WHERE IN THE NEAR FUTURE THE SHOULDER MAY BE USED AS A THROUGH TRAFFIC LANE, THE PARKING LANE SHOULD BE LOCATED TO THE OUTSIDE OF THE SHOULDER IN PLACE OF THE 0.04 FOOT/FOOT SLOPE SHOWN ON THE TYPICAL SECTION. SEE DETAIL FOR SUPERELEVATION OF SHOULDER WITH 0.02 FOOT/FOOT SLOPE.

① THE SHOULDER WIDTH WILL BE AS SPECIFIED IN THE ADVANCE PLANNING REPORT.

② 10 FEET MINIMUM DESIRABLE.

③ ON URBAN PROJECTS THE BACKSLOPE AND FORESLOPE DESIGN WILL VARY FROM PROJECT TO PROJECT, AS A GENERAL RULE USE THE FOLLOWING:
 3:1 SLOPES OR FLATTER ARE DESIRABLE AND ARE TO BE USED IN AREAS WHERE RIGHT-OF-WAY RESTRICTIONS OF COST WARRANTS A STEEPER THAN 3:1 SLOPE. THE MAXIMUM SLOPE IN SECTION 11 IS 3:1.

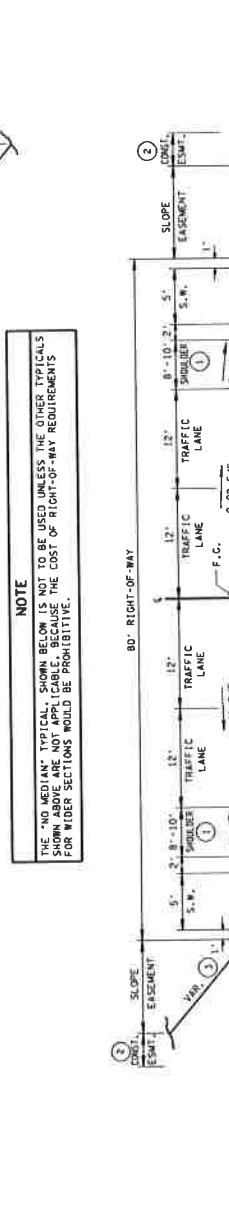
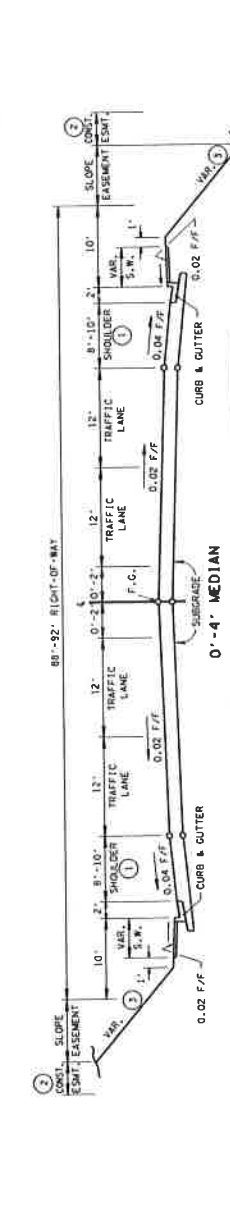
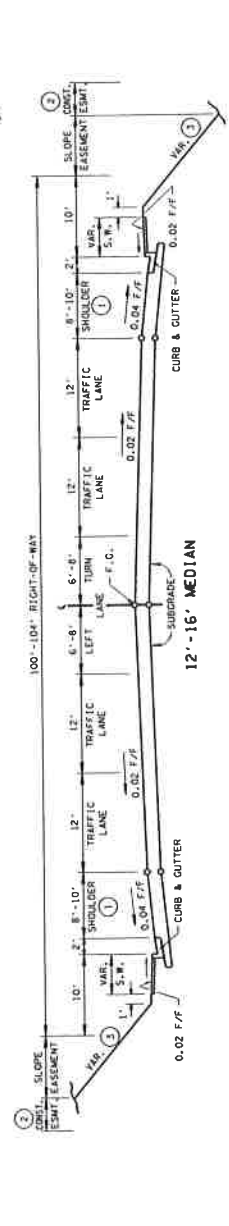
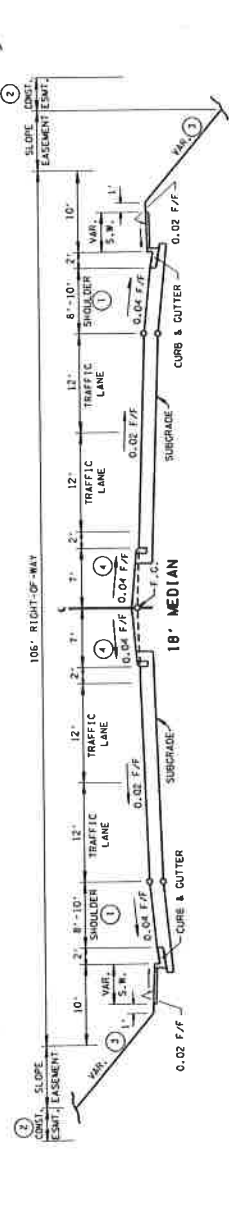
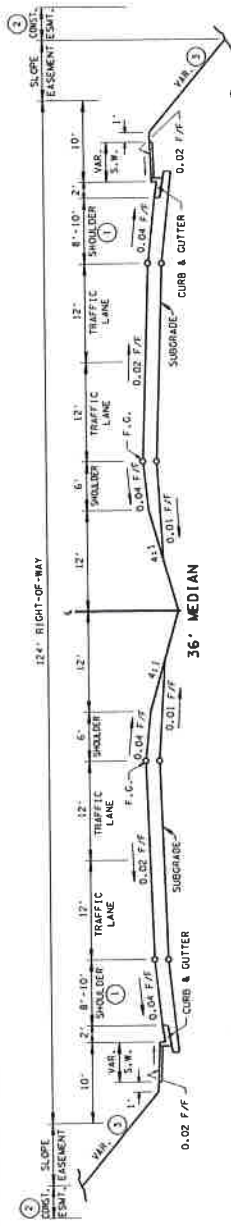
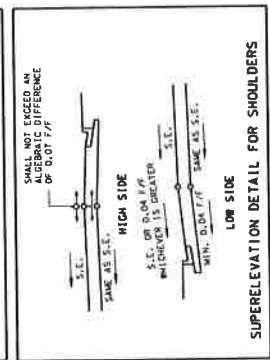
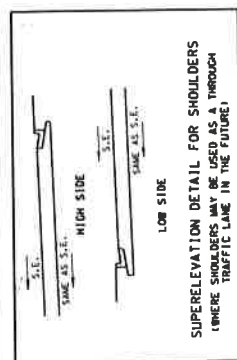
CONSTRUCTION EASEMENT
 10 FEET MINIMUM DESIRABLE.

SLOPES
 ON URBAN PROJECTS THE BACKSLOPE AND FORESLOPE DESIGN WILL VARY FROM PROJECT TO PROJECT, AS A GENERAL RULE USE THE FOLLOWING:
 3:1 SLOPES OR FLATTER ARE DESIRABLE AND ARE TO BE USED IN AREAS WHERE RIGHT-OF-WAY RESTRICTIONS OF COST WARRANTS A STEEPER THAN 3:1 SLOPE. THE MAXIMUM SLOPE IN SECTION 11 IS 3:1.

MEDIAN CURBS
 MEDIAN CURBS WILL BE SLOPING CURBS. VERTICAL CURBS WILL NOT BE PERMITTED.

SIDEWALKS
 SIDEWALK WIDTH SHALL NOT INCLUDE THE SIX INCH WIDTH OF PROPOSED CURB. SIDEWALK SHALL BE A MINIMUM OF FIVE FEET WIDE.

PARKING LANES
 FOR SPECIFIC CONDITIONS NOT COVERED ON THIS SHEET, REFER TO STANDARD DRAWING RD01-TS-6, ASHTO, 2002 PAGE NUMBERS 437-438 AND 482-483.



NOTE
 THE "NO MEDIAN" TYPICAL SHOWN BELOW IS NOT TO BE USED UNLESS THE OTHER TYPICALS SHOWN ABOVE ARE NOT APPLICABLE, BECAUSE THE COST OF RIGHT-OF-WAY REQUIREMENTS FOR WIDER SECTIONS WOULD BE PROHIBITIVE.



APPENDIX E

Exercise 12

p. 12-5

p. 12-8 - 12-11

p. 12-12 - 12-17

Exercise 12 p 12-5:

Transition Length, L:

$L = W \times S$ (for $S \geq 45$ mph)

$S = 60$

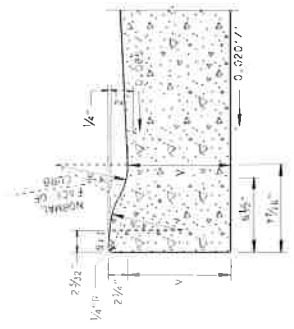
$W = 24 - 6 = 18$

$L = 18 \times 60 = 1080$

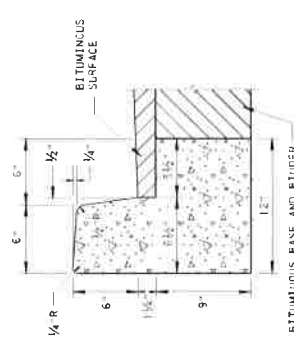
1100' is used



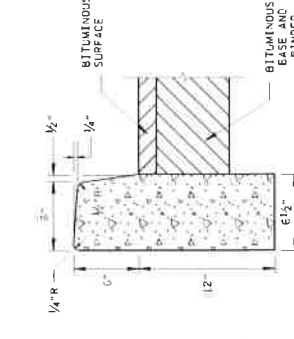
- REV. 11-1-82: REVISION SHEET.
- REV. 11-1-72: CHANGED DETAIL NAME.
- REV. 11-10-72: CHANGED NOTE REGARDING JOINTS IN CURBS AND GUTTERS.
- REV. 11-1-72: CHANGED DRAWING NO. FROM P-2-15 (88) TO P-2-15.
- REV. 1-17-81: CHANGED ITEM NUMBER TO AGREE WITH NEW SPECIFICATION BOOK.
- REV. 10-26-81: DREW NEW SHEET. CHANGED DETAIL NAME TO ONLY ON DRAWING NO. P-2-15 REGARDING 24" HIGH COMBUTABLE DETACHED CURB AND GUTTER. CHANGED DETAIL NAME TO COMBINED CURB AND GUTTER.
- REV. 10-26-81: CHANGED BOTTOM GUTTER FROM 0.0857' TO 0.0207'.
- REV. 10-26-81: CHANGED DETAIL NAME TO COMBINED CURB AND GUTTER. CHANGED SIZE AND QUANTITIES OF EXPANSION JOINT SPOCKING OF EXPANSION JOINT.
- REV. 10-26-81: CORRECTED LABELING OF PAVEMENT ON DETAILS.
- REV. 10-26-81: CHANGED SHEET NAME TO REFERENCE TO CURB FROM NONMOUNTABLE TO VERTICAL.
- REV. 1-22-83: CORRECTED DRAWING NUMBER.



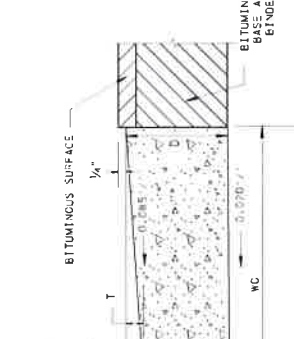
LOWERED CONCRETE CURB



6" DETACHED CONCRETE CURBS



6" CONCRETE COMBINED CURB AND GUTTER



6" CONCRETE COMBINED CURB AND GUTTER

LOWERED CONCRETE CURB NOTES

1. TO BE BUILT AS COMBINED CURB AND GUTTER, DETACHED CURB OR INTEGRAL CURB AS NOTED ON THE PLANS OR AS DIRECTED BY THE ENGINEER.
2. FOR DETACHED CURB, OMIT RADIUS AT FLOW LINE.
3. TO BE USED FOR PROPOSED RAMP OPENINGS.

QUANTITIES FOR DETACHED CURB

HEIGHT OF CURB	CUBIC YARD PER LINEAR FOOT	
	TYPE "A"	TYPE "B"
6"	0.02950	0.03913

6" CONCRETE COMBINED CURB AND GUTTER TABLE

TYPE	TOTAL WIDTH (W) OF GUTTER IN INCHES	VERTICAL DROP (V) OF GUTTER IN INCHES	VERTICAL DEPTH (D) OF GUTTER AT FLOW LINE
6-30	2 3/8	2	12
6-36	2 7/8	2 1/2	12
6-42	3 1/4	3	12

AS NOTED ON SECTIONS
 12" - 11.83"
 12" - 11.91"
 12" - 12.29"

VERTICAL DEPTH (V) MUST ALWAYS EXCEED SIX (6) INCHES.

QUANTITIES FOR COMBINED CURB AND GUTTER

HEIGHT OF CURB IN INCHES	DEPTH (D) OF GUTTER IN INCHES	TOTAL CUBIC YARDS PER LINEAR FOOT	CUBIC YARDS PER LINEAR FOOT		TOTAL WIDTH (W) OF GUTTER IN INCHES	DEPTH (D) OF GUTTER IN INCHES	TOTAL CUBIC YARDS PER LINEAR FOOT
			LINEAR FOOT	PER LINEAR FOOT			
6"	12"	0.0711	0.0571	0.0140	12	12	0.0851
6"	12"	0.0728	0.0581	0.0147	12	12	0.0868
6"	12"	0.0649	0.0502	0.0147	12	12	0.0789
6"	12"	0.0789	0.0642	0.0147	12	12	0.0929

- GENERAL NOTES**
1. FOR SPECIFICATIONS SEE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION, SECTION 702 - CEMENT CONCRETE CURB, GUTTER AND COMBINED CURB AND GUTTER.
 2. THE FRONT FACE OF THE CONCRETE CURBS FOR ALL DEGREES OF CURVATURE SHALL CONFORM TO THE CONTOUR OF THE CURVE AND NO CHORD SECTIONS WILL BE PERMITTED.
 3. CONCRETE EXPANSION JOINT MATERIAL IS TO BE 1/2" PREMOULDED FIBER IN ACCORDANCE WITH SECTION 905 - JOINT MATERIALS OF THE STANDARD SPECIFICATIONS.
 4. EXPANSION JOINTS ARE TO BE PLACED AS FOLLOWS:
 1. AT TANGENT POINTS OF CURVATURE CURBS
 2. BETWEEN CURBS AND ABUTTING RIGID OBJECTS
 3. AT OTHER PLACES WHERE STRESSES MAY DEVELOP
 4. 50 AS TO LINE UP WITH PAVEMENT JOINTS WHERE THE ADJACENT PAVEMENT IS CONCRETE
 5. MAXIMUM SPACING IS TO BE 100 FEET
 5. CONTRACTION JOINTS ARE TO BE SPACED AT 10 FEET. THE SPACING OF 10 FEET MAY BE REDUCED FOR CLOSURES, BUT NOT LESS THAN 6 FEET.
 6. EDGES OF JOINTS SHALL BE FINISHED ON ONE-QUARTER INCH RADIUS.
 7. ALL COST OF JOINTS SHALL BE INCLUDED IN THE UNIT PRICE BID FOR CONCRETE CURBS AND CONCRETE CURBS AND GUTTERS.
 8. THE UNIT PRICE BID FOR CONCRETE CURB, CONCRETE CURB AND GUTTER AND CONCRETE PAVEMENT WILL INCLUDE ANY CIRCULAR SECTIONS REQUIRED TO BE BUILT CONFORMING TO SECTIONS SHOWN ON THIS SHEET.
 9. PAYMENT WILL BE AS FOLLOWS:
 - ITEM NO. 702-01 CONCRETE CURB PER CUBIC YARD
 - ITEM NO. 702-07 CONCRETE GUTTER PER CUBIC YARD
 - ITEM NO. 702-03 CONCRETE COMBINED CURB AND GUTTER PER CUBIC YARD

LEGEND

D- VERTICAL DEPTH OF GUTTER

T- VERTICAL DROP IN GUTTER FROM FRONT EDGE TO FACE OF CURB

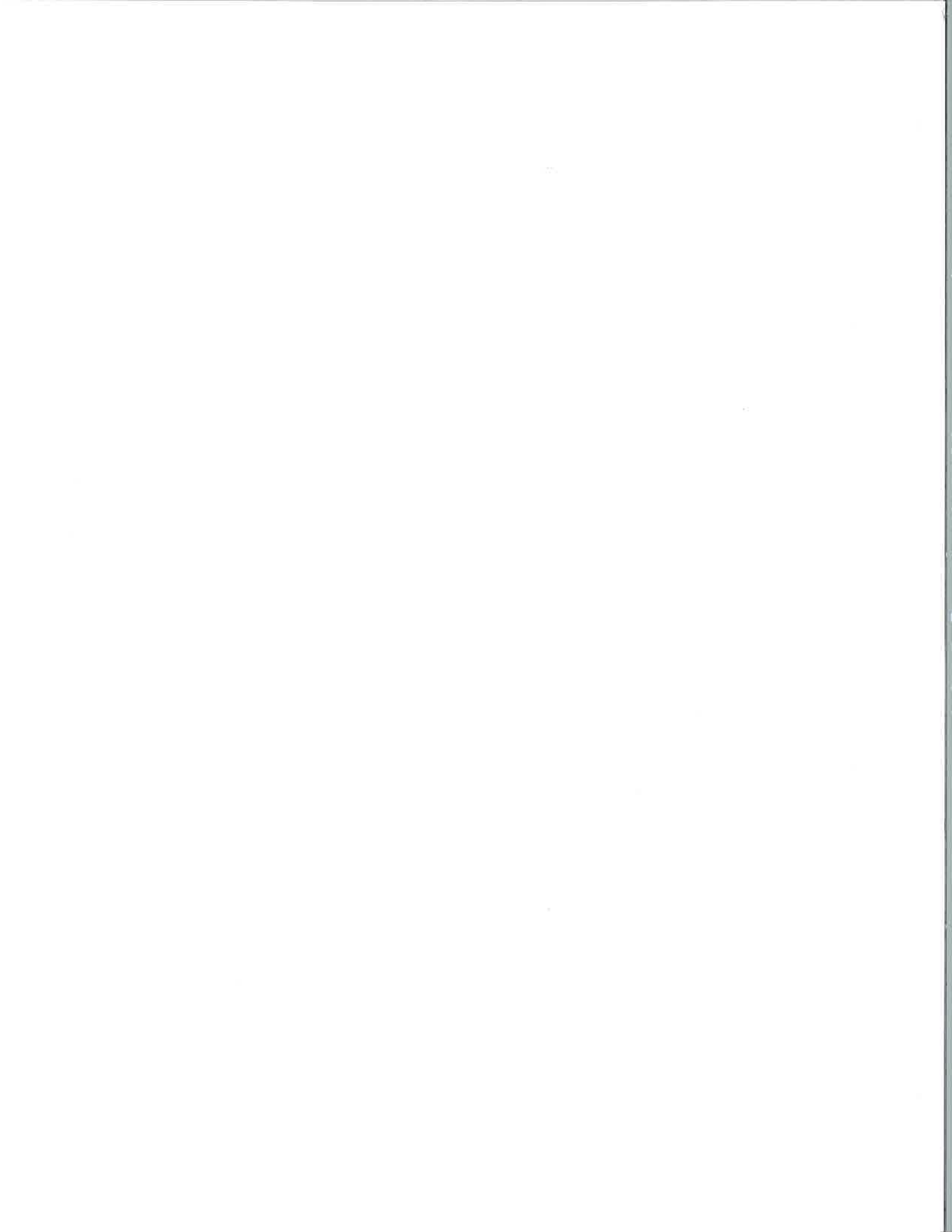
W- TOTAL WIDTH OF COMBINED CURB AND GUTTER

WG- WIDTH OF GUTTER

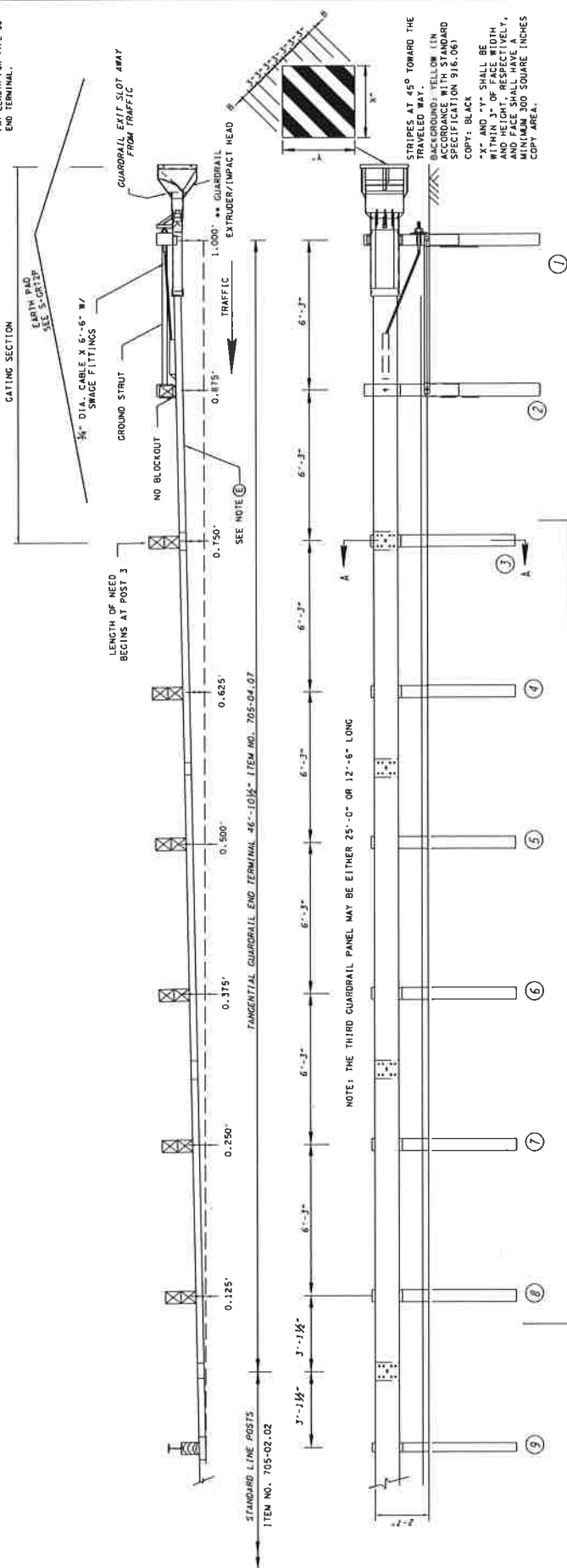
STATE OF TENNESSEE
 DEPARTMENT OF TRANSPORTATION

STANDARD VERTICAL
 (NONMOUNTABLE)
 CONCRETE CURBS AND
 CONCRETE CURBS AND
 GUTTERS

10-26-81 RP-NMC-10



REV. 11-3-74, MODIFIED
PAY LENGTH FOR TYPE 38
END TERMINAL.



50:1 TAPER OVER
50' LENGTH OF
SYSTEM

POST NO.	DECIMAL	
	X	Y
1	0.00	0.00
2	0.125	0.25
3	0.250	0.50
4	0.375	0.75
5	0.500	1.00
6	0.625	1.25
7	0.750	1.50
8	0.875	1.75
9	1.000	2.00

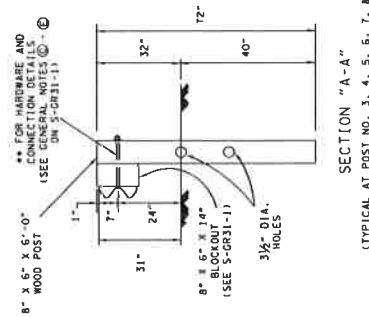
STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
TYPE 38
GUARDRAIL END
TERMINAL
7-11-13 S-GRT-2

NOTE TO DESIGNER
DO NOT USE WITHOUT REFERENCING S-GRT-2P

- GENERAL NOTES
- A SYSTEM IS APPROVED FOR USE ON NATIONAL HIGHWAY SYSTEM ROADS.
 - B FOR ADDITIONAL DETAILS OF TERMINAL SYSTEM, REFER TO THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.
 - C THE TANGENTIAL ENERGY ABSORBING TERMINAL (INCLUDING ANCHOR) IS TO BE INSTALLED UNDER THE PRICE BID FOR ITEM NO. 705-04.07 PER EACH.
 - D METAL POSTS ARE AN ACCEPTABLE ALTERNATE TO WOOD POSTS WHEN THE SYSTEM IS ON APPROVED PRODUCTS LIST, NCHRP 350 COMPLIANT AND INSTALLED IN ACCORDANCE WITH MANUFACTURER'S SHOP DRAWINGS.
 - E TERMINAL SYSTEM MUST BE CONSTRUCTED SO THAT THE FULL LENGTH OF THE TERMINAL SYSTEM GUARD RAILING IS IN STRAIGHT ALIGNMENT. THE GUARD RAIL EXTRUDER/IMPACT HEAD SHALL NOT ENDOUCH UPON THE ADJACENT PAVED SHOULDER OR LAKE.
 - F FIRST 12'-6" FROM END IS GATING. DO NOT USE THIS SECTION IN LENGTH OF NEED.
 - G IF LENGTH OF NEED FOR GUARDRAIL NEEDS TO BE EXTENDED BEYOND THE THIRD POST EXTEND RUN OF GUARDRAIL.
 - H ALL HOLES IN WOOD POSTS ARE TO BE DRILLED BEFORE PRESERVATIVE TREATMENT.
 - I ALL CUTTING, DRILLING, AND WELDING OF STEEL COMPONENTS SHALL BE DONE BEFORE GALVANIZING.
 - J THE FINISHED CABLE ASSEMBLY WILL NOT BE ACCEPTABLE UNLESS IT IS IN TENSION WITH NO SAG.

- SPECIAL INSTALLATION NOTES
- ANY NCHRP 350 OR MASH COMPLIANT TL-3 TANGENTIAL END TERMINAL ON THE T00T QUALIFIED PRODUCTS LIST MAY BE INSTALLED. MANUFACTURER'S SHOP DRAWINGS SHALL BE REQUIRED BEFORE ANY TANGENTIAL END TERMINAL INSTALLATIONS CAN BEGIN. THE CONTRACTOR SHALL HAVE ONE COMPLETE SET OF SHOP DRAWINGS ON SITE DURING INSTALLATION OR REPAIR OF ANY TANGENTIAL GUARDRAIL TERMINAL ANCHOR. THE CONTRACTOR SHALL ALSO PROVIDE THE TANGENTIAL END TERMINAL ANCHOR PERFORMANCE TESTS AND COMPLETE SET OF SHOP DRAWINGS INCLUDING T00T DPL EVALUATION NUMBER.
- FOR THE TYPE 38 GUARDRAIL TERMINAL TO FUNCTION AS IT WAS CRASH TESTED UNDER NCHRP-350 TEST LEVEL 3 THE EARTH PAD MUST BE CONSTRUCTED PER STANDARD DRAWING NO. S-GRT-3P OR S-GRT-3R. DIFFERENT TANGENTIAL TERMINAL SYSTEMS OR PARTS SHALL NOT BE COMBINED ON A RUN OF GUARDRAIL.
- POST MATERIAL SIZE, GUARDRAIL SPlicing LOCATION, TAPER RATE, OFFSET GUARDRAIL HEIGHT EXTRUDER HEAD DIMENSION, AND ALL OTHER MISCELLANEOUS HARDWARE MAY BE DIFFERENT. INSTALLATION SHALL FOLLOW THE MANUFACTURER'S SHOP DRAWINGS.

8" X 6" X 6'-0" WOOD POST (SEE GENERAL NOTE D)





APPENDIX F

Exercise 13

p. 13-10

p. 13-18

Exercise 13 p 13-10:

RD01-SE-3

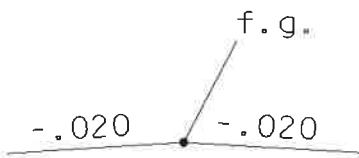
For 2-30' curve, 4 lane road, 60 m.p.h.:

$$\text{s.e.} = .061 \text{ (6.1\%)}$$

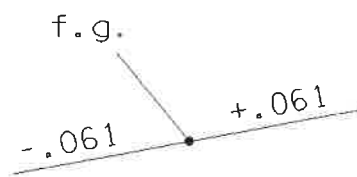
$$\text{Trans. Length} = 325'$$

$$\text{Length of spiral} = 31099.79 - 30774.79 = 325$$

Normal Crown



Full Super



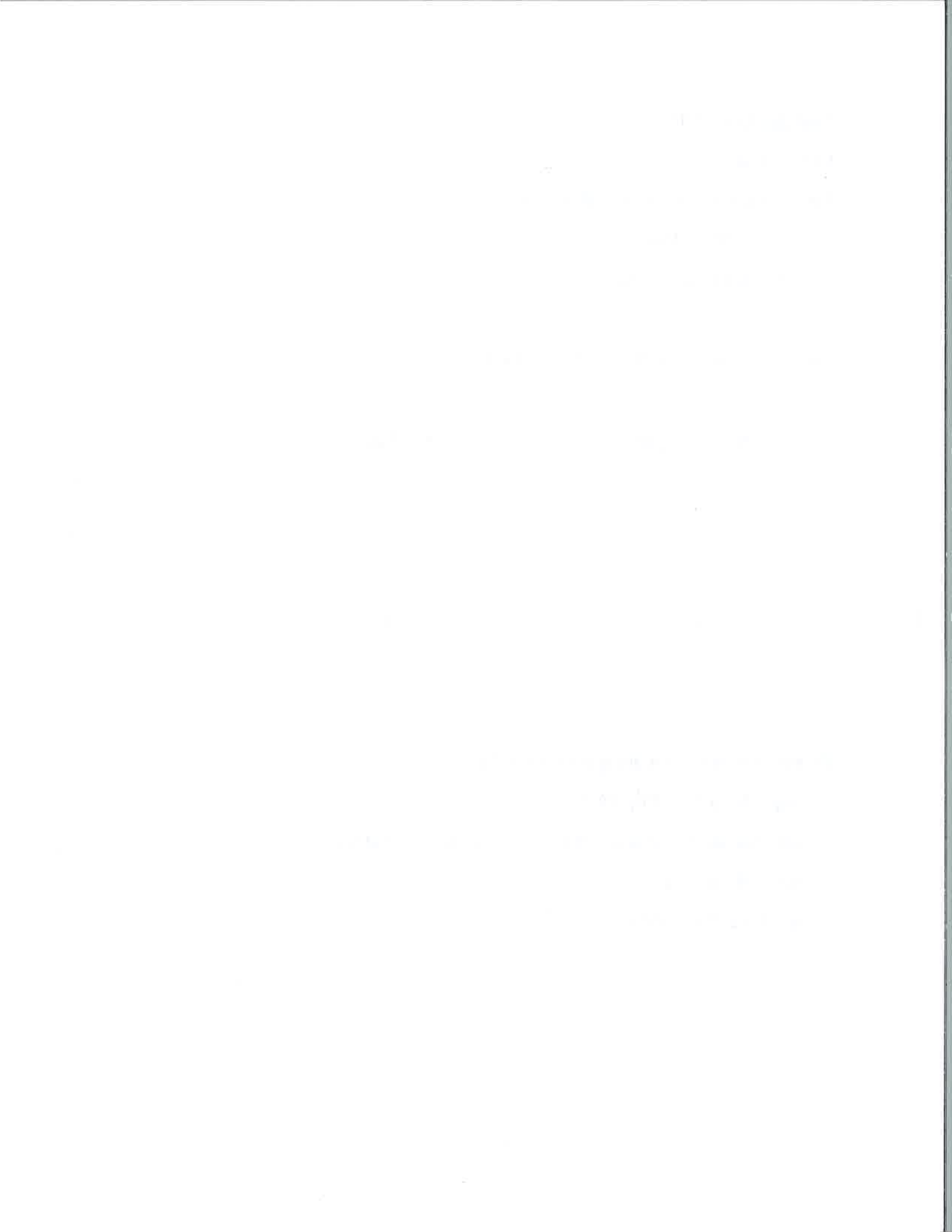
Rt. side, se transitions along full length of spiral

$$\text{Alg. Diff. } 6.1 - (-2.0) = 8.1$$

Lt. side, transition is shorter (31099.79 - 30935.29 = 164.5')

$$\text{Alg. Diff. } 6.1 - 2.0 = 4.1$$

$$4.1/8.1 \times 325 = \underline{164.5}$$



Exercise 13 p 13-18:

RD01-SE-2

For 5-00' curve, 50 mph, 4 lane road:

$$\text{s.e.} = .039 \text{ (3.9\%)}$$

$$\text{Trans. Length} = 215'$$

$$\text{Lt. side, Trans} = 33281.68 - 33066.68 = 215$$

$$\text{Alg. Diff. } 3.9 - (-2.0) = 5.9$$

$$\text{Rt. side, Trans} = 33281.68 - 33212.45 = 69.23$$

$$\text{Alg. Diff. } 3.9 - 2.0 = 1.9$$

$$1.9 / 5.9 \times 215 = \underline{69.23}$$



APPENDIX G

Exercise 15

Yardage Factor:

Earthwork cubic yardage (c.y.):

$$[(A1 + A2)/2 \times L] / 27$$

$$[(A1 + A2) \times L] / 54$$

A1,A2 (sq. ft.)

L (ft.) distance between stations

27 cu. ft./cu.yd.

$(A1+A2) \times$ Yardage Factor

Example, L=50

$$Y.F. = 50/54 = .926$$



GRADING QUANTITIES

CHECKED BY _____ PROJECT _____

HIGHWAY SR 95

COUNTY ROANE

STATION	YDGE. FACTOR	END AREA		GRADE POINT	ROCK CLASS	CUBIC YARDS		BALANCES	
		EXC.	EMB.			EXC.	EMB.	EXC.	EMB.
87+00	.926	374	98			630	143		
+50		306	56			439	144	1069	287
88+00		168	100			229	331	1298	618
+50		79	257			172	582	1420	1200
89+00		53	372			91	903	1511	2103
+50		45	603			75	1261	1586	3364
90+00		36	759			33	2282	1619	5646
+50		0	1705			0	2670	1619	8316
91+00		0	1178			13	1488	1632	9804
0		14	429			28	528	1660	10332
92+00		16	141			31	391	1691	10723
+50		17	281			16	673	1707	11396
93+00		0	446			0	920	1707	12316
+50		0	548			0	1004	1707	13320
94+00		0	536			0	986	1707	14306
+50		0	529			1	924	1708	15320
95+00		1	469						
								X.85	
								1452	



SEEDING GRADING QUANTITIES

COMPUTED BY _____

CHECKED BY _____ PROJECT _____ HIGHWAY _____ COUNTY _____

ST	GN	YDGE. FACTOR	Slope Length		GRADE POINT	ROCK CLASS	Area		BALANCES	
			L	R			L	R	EXC.	EMB.
'87	100	25	33	52						
	+50						1625	2550		
			32	50			1525	2200		
'88	100		29	38			1400	1575		
	+50		27	25			1000	1325		
'89	100		13	28			925	1700		
	+50		16	40			850	2200		
'90	100		18	48			1025	2475		
	+50		23	51			1500	2075		
'91	100		37	32			1400	1700		
	70		19	36			925	1400		
'92	100		18	20						
							<u>11975</u>	<u>19200</u>		



APPENDIX H

Exercise 22

p. 22-3

Determine locations for .000 superelevation

Curve DC104:

Full Super = .061

$.061 - (-.020) = .081$

Transition L = 325'

$.081/325 = .000249$

Normal Crown to .000 S.E., diff = .020

$.020/.000249 = 80.32$ feet

$30774.80 + 80.32 = \underline{30855.12}$

$32355.43 - 80.32 = \underline{32275.11}$

Curve DC103:

Full Super = .039

$.039 - (-.020) = .059$

Transition L = 215'

$.059/325 = .000274$

Normal Crown to .000 S.E., diff = .020

$.020/.000274 = 72.99$ feet

$33066.68 + 72.99 = \underline{33139.67}$

$33795.57 - 72.99 = \underline{33722.58}$