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

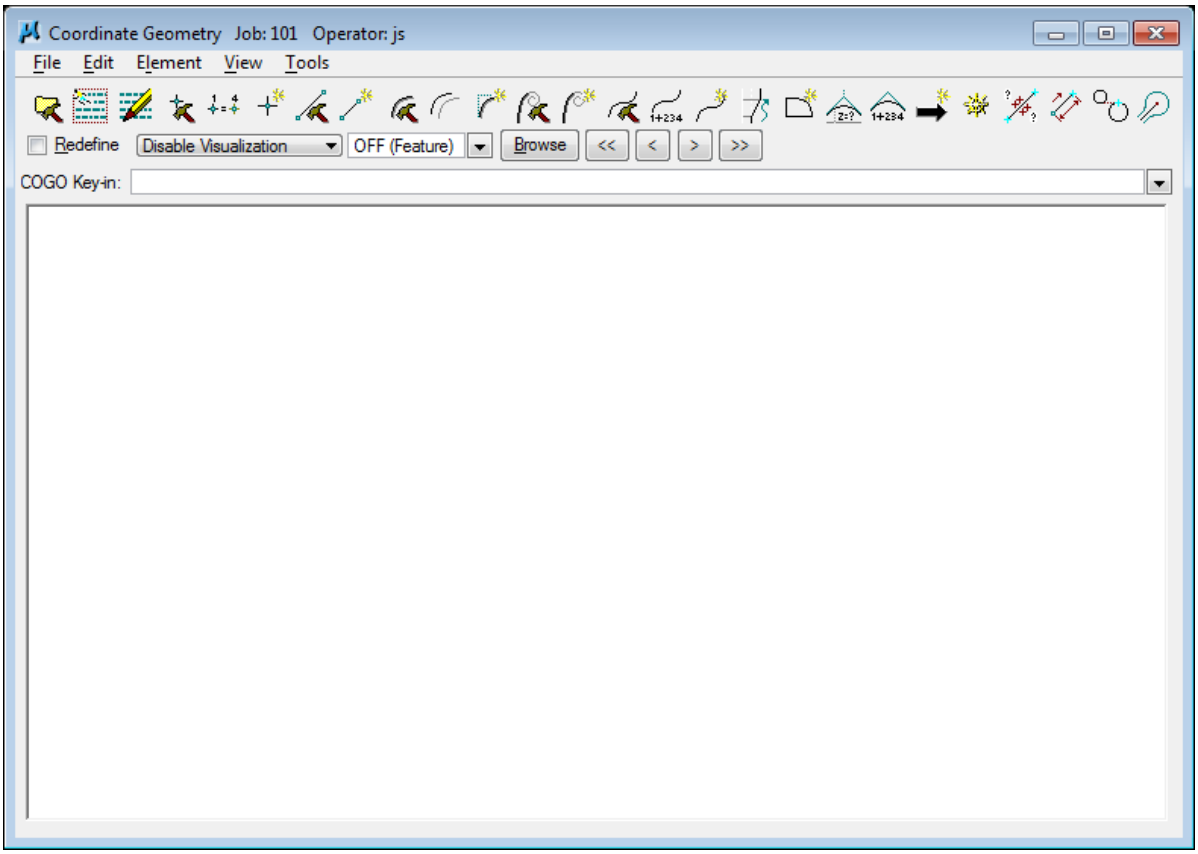
1) Open the MicroStation file

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.

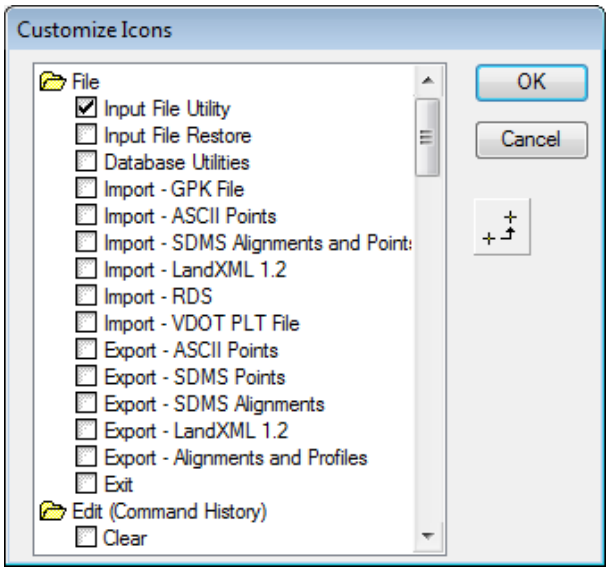
a) COGO Interface

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)

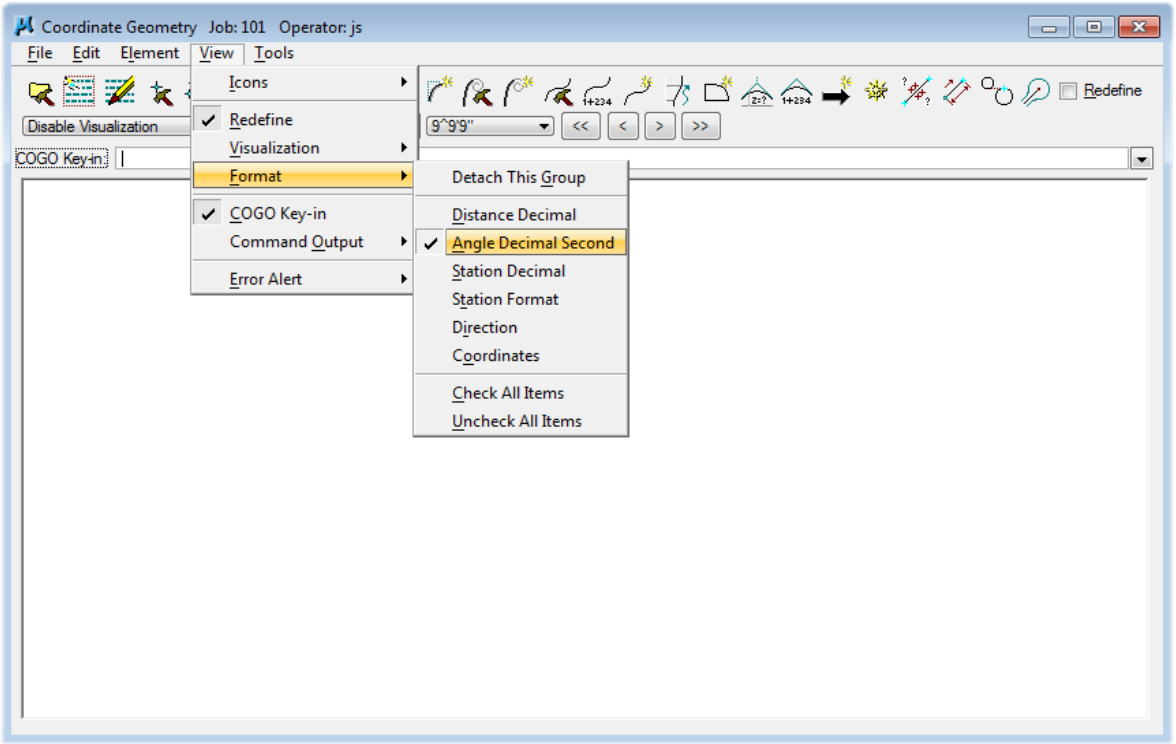
- Store From Elements  (under Element/Chain)
- Store Transition Chain  (under Element/Chain)
- Elevation  (under Element/Profile)
- Navigator  (under Tools)
- Locate Traverse  (under Tools)

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.

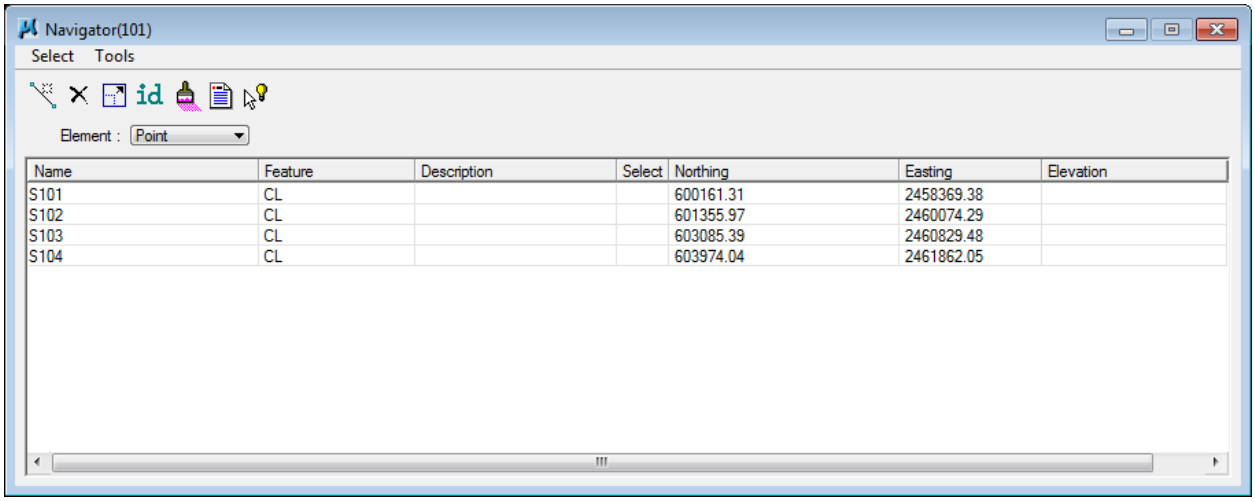
By default, the Distance Decimal and Angle Decimal Second options are turned on. We will not be using those in these exercises, so go to View → Format and turn them off.



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

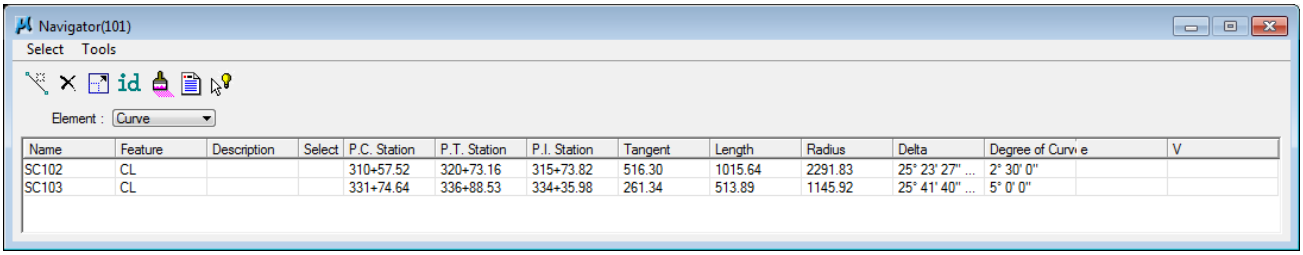
Occasionally, the Distance Decimal and Station Decimal options are handy to have out when checking values that were previously rounded off to the standard 2 decimal places.

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.

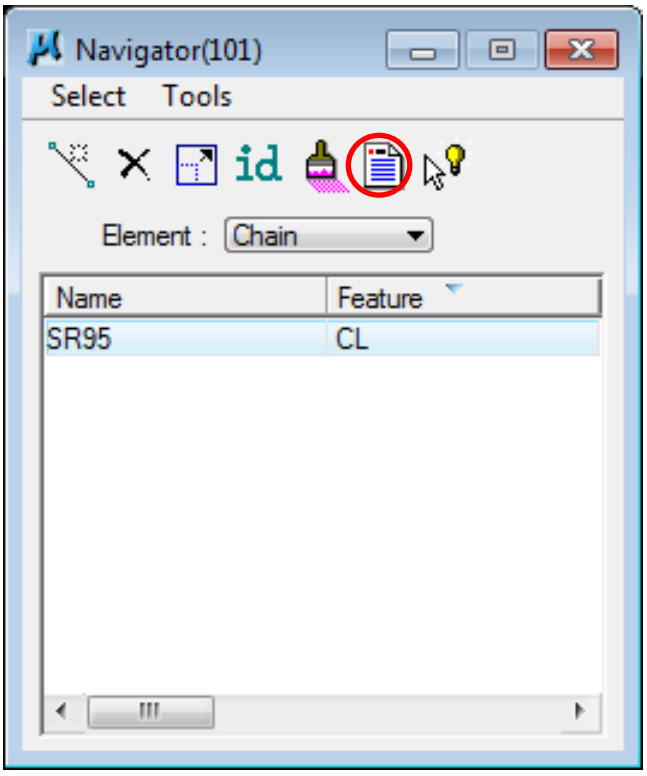
The Navigator is re-sizable and various types of data information are available depending on which Element option is active.



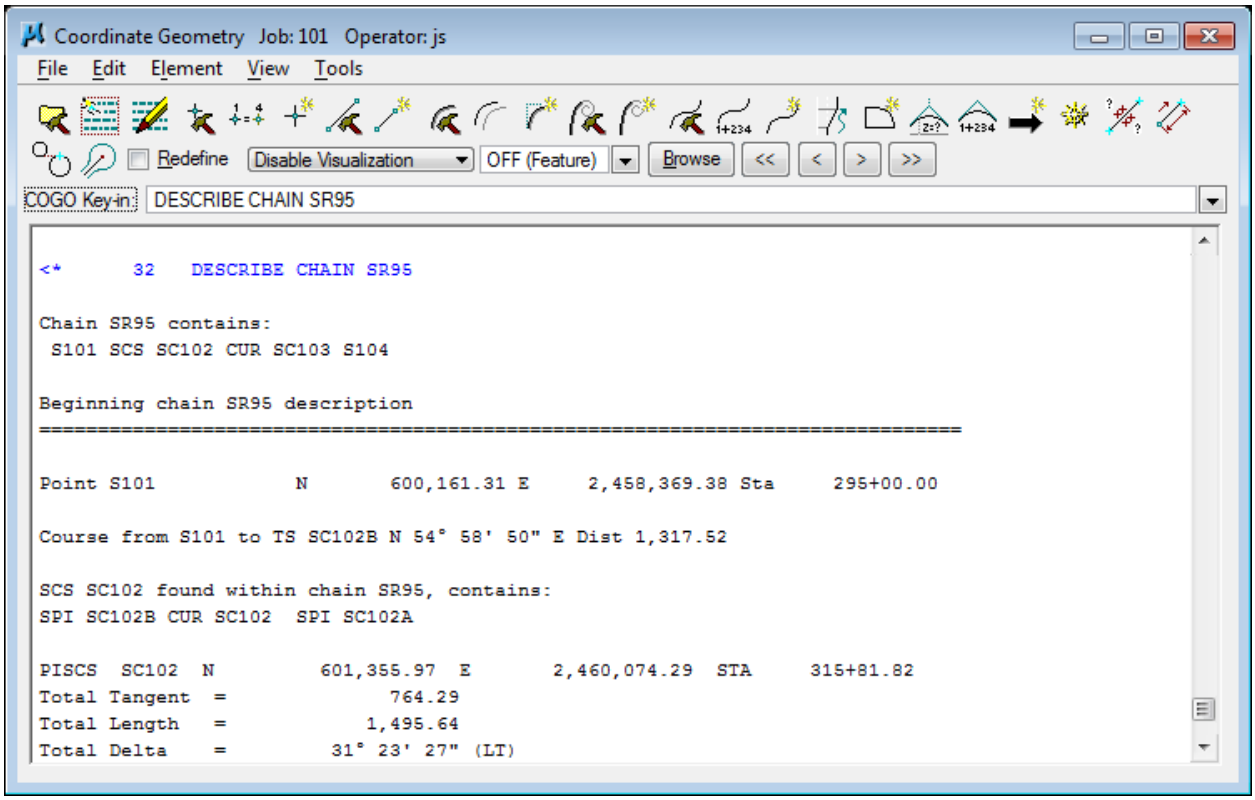
NOTE:
For this class, we are using a stripped down version of the GPK file which only contains the preliminary centerline. Normally this file would also include all other features located by Survey (topo, dtm, parcels).

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.



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.

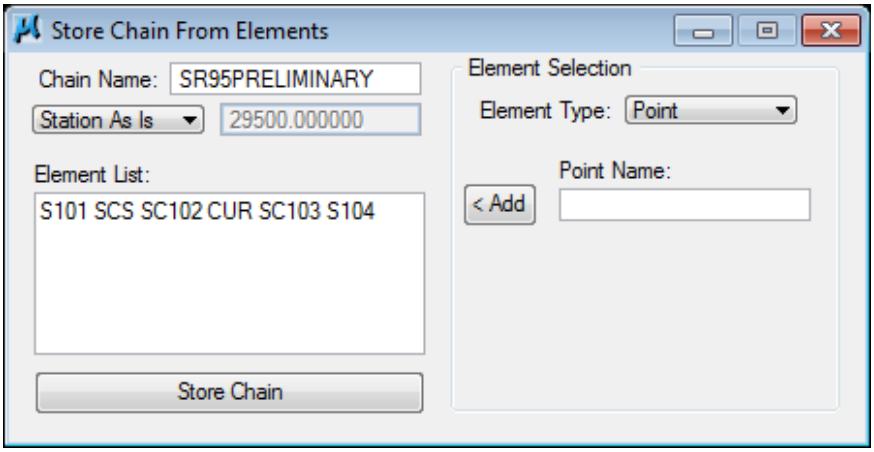
Since we need to keep a copy of the original preliminary centerline for reference and also must keep the proposed centerline name as SR95 to maintain the intelligence

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.

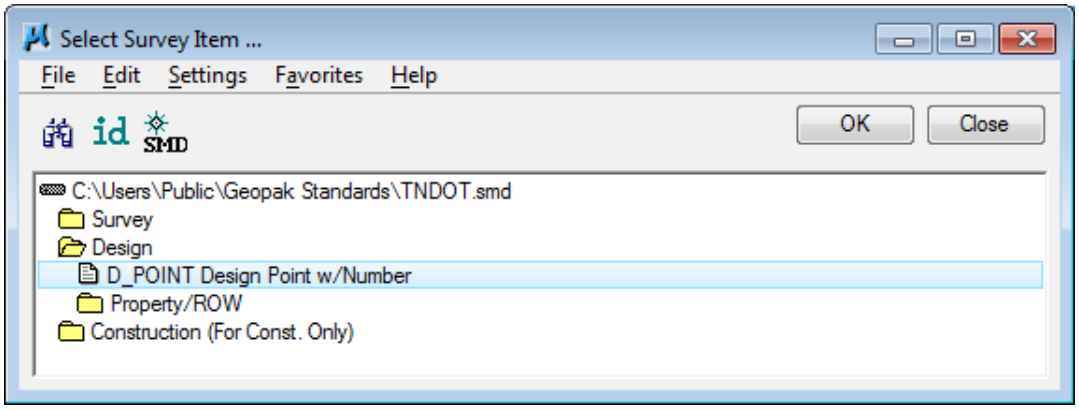
c) Locate New Beginning Point

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.

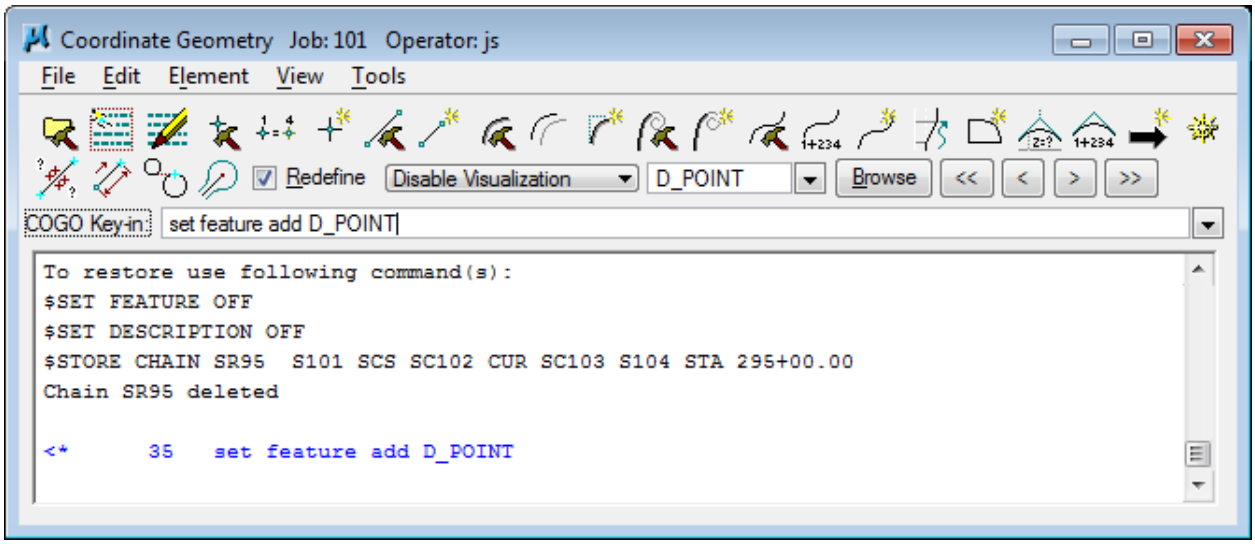
1) Zoom in on the beginning of the chain to see the changes as we make them.

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.



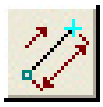
Once the feature has been selected, click OK to accept.

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.



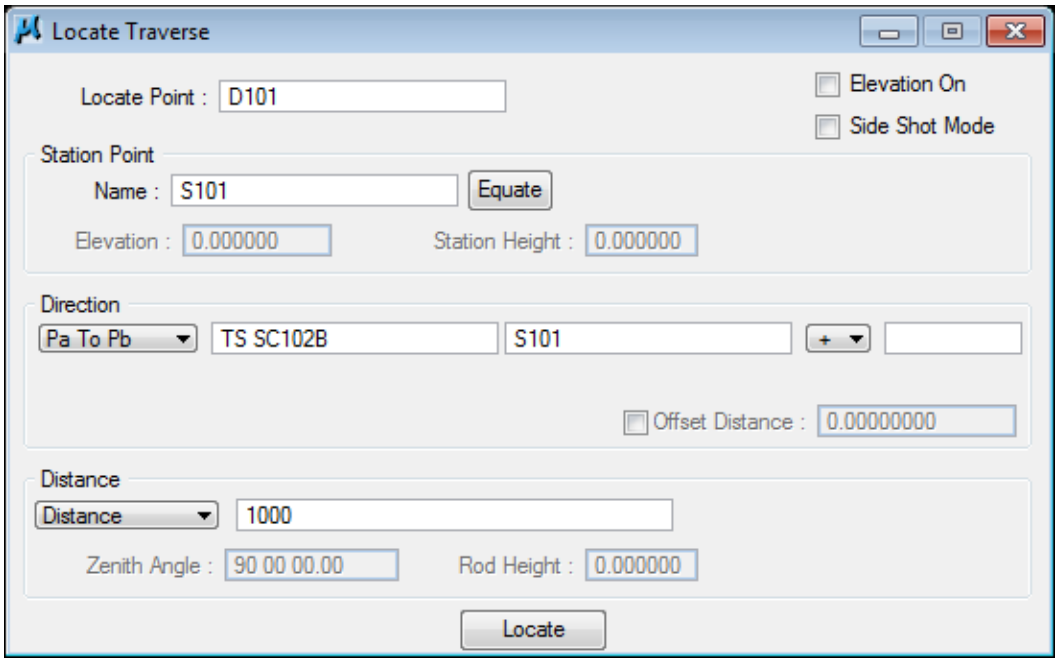
4) In the Locate Traverse dialog we need to make the following settings as shown.

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)

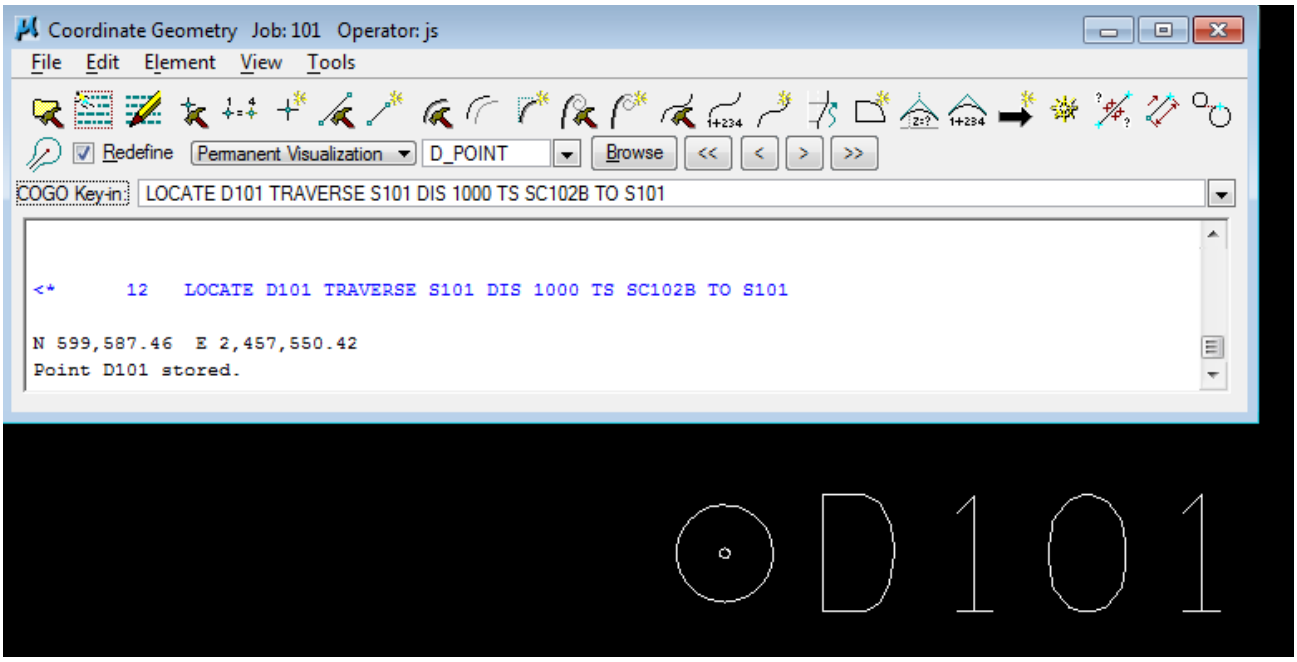
Distance: Distance 1000



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.

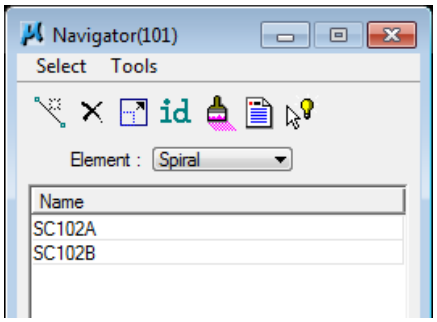


d) Copy COGO Objects

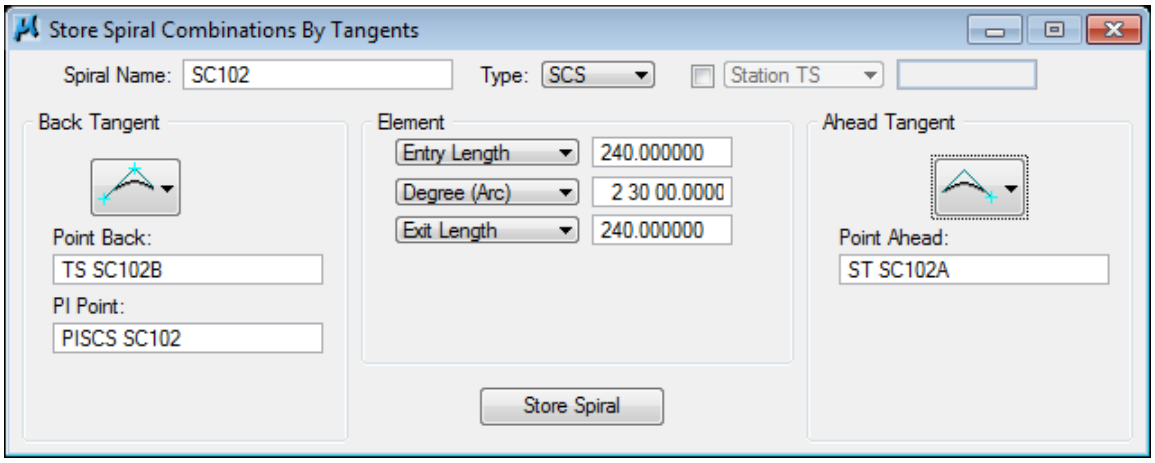
In order to keep the copy of the original survey chain intact, we need to duplicate the remaining objects in the chain which include a spiral curve, a simple curve and the ending point.

e) Spiral Curve

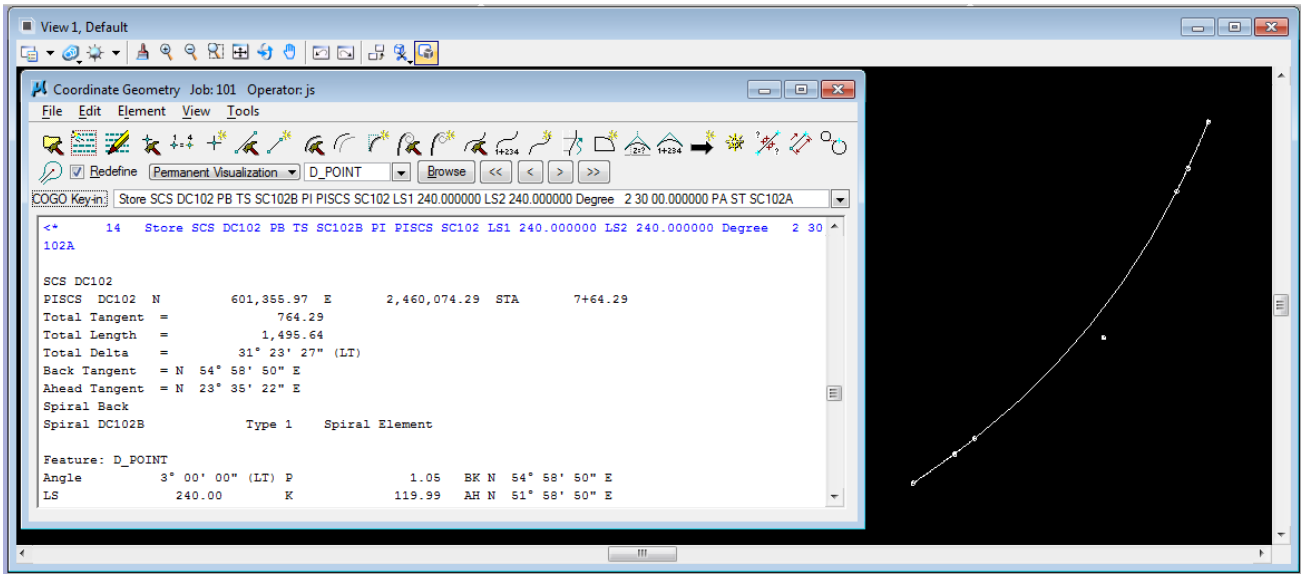
1) Since the spiral curve contains 3 objects (2 spirals and a curve), the simplest way to copy it is to just re-define it with a new name. First click on the Redefine option in the COGO dialog. Then in the Navigator go to Spirals and double click on one of the spirals for curve S102. This opens up the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



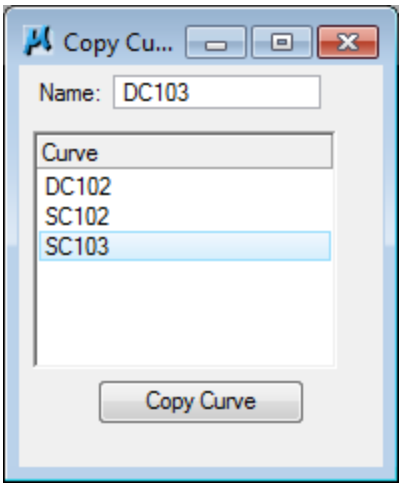
Dismiss the Store Spiral dialog. In graphics, we can now see our spiral curve.



f) Simple Curve

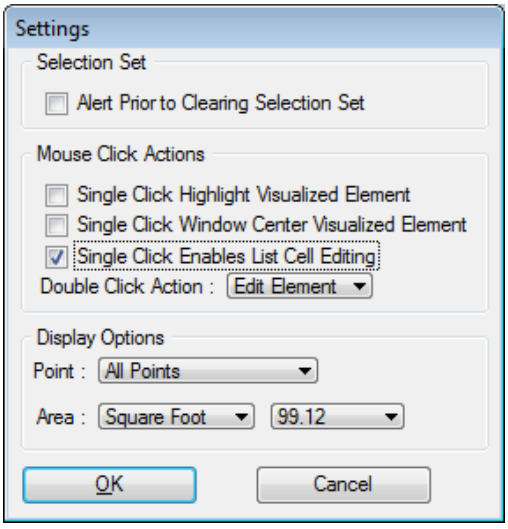
2) Since our other curve is just a simple curve, we can just copy it. Click on the Copy Curve icon.

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



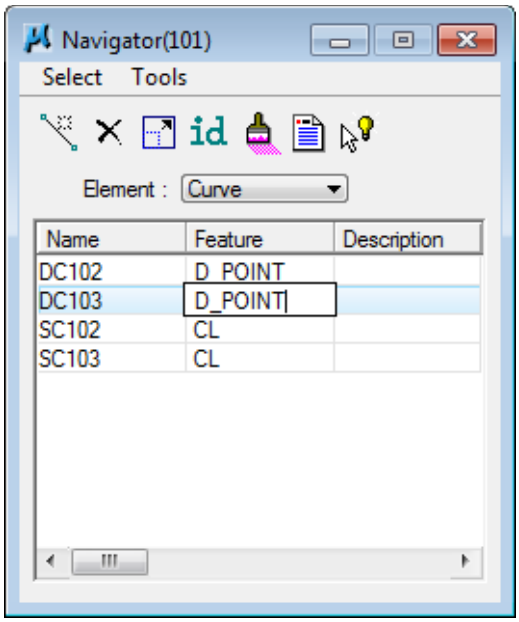
3) You may have noticed that the curve was visualized in graphics but it is yellow in color rather than white. This is because copied elements retain their original feature name, in this case survey feature CL.

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.

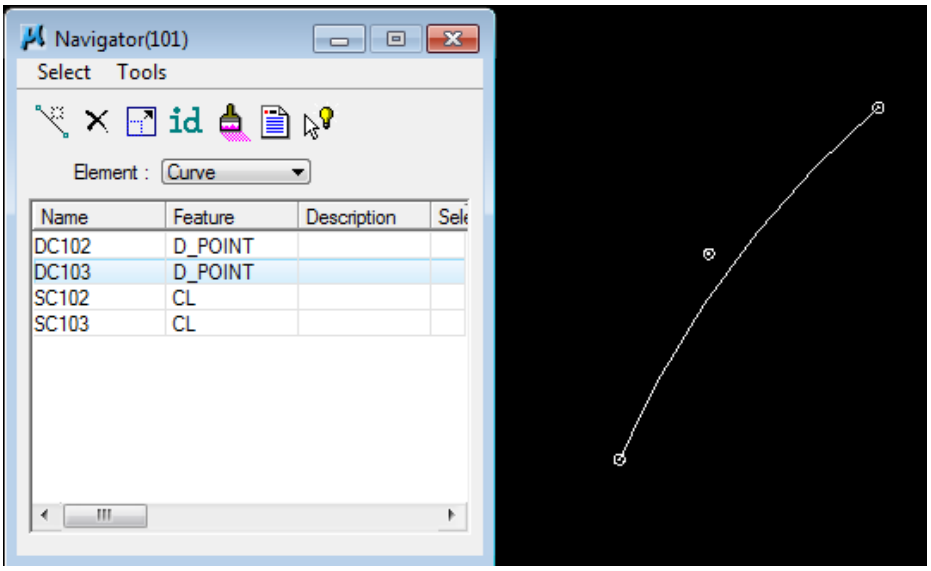


We need to change the curve's feature to our proposed centerline feature D_POINT, so go to Curve. Click on the feature name CL on new curve DC103. The field should open for editing allowing you to key in D_POINT. Once entered hit the enter key to finish the change.

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.

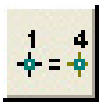


You can click on the Visualize icon on the COGO Navigator to visualize any COGO element (It is the paintbrush icon).

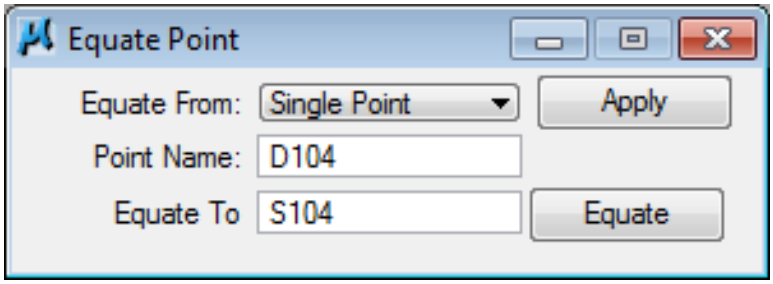
4) In the COGO Navigator, go back to the drop down option Tools → Settings. In the Settings dialog, turn off the option for Single Click Enables List Cell Editing. Click OK on the Settings dialog. This should be done to prevent any accidental edits.

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.

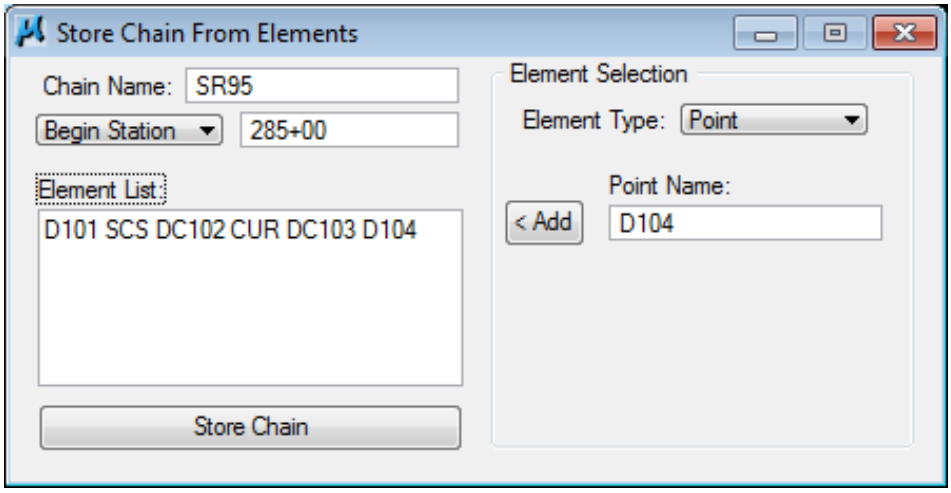
h) Store Proposed Centerline Chain

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

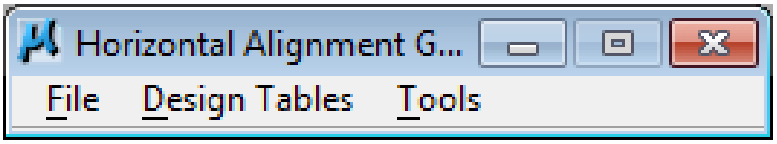
These tools are set up to build special curve combinations for interchanges or intersections, regular SCS spiral curves or even vehicle turning paths. These include 3 center curves, taper curves or the complex curve and spiral combinations sometimes required for ramps in interchanges.

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?"

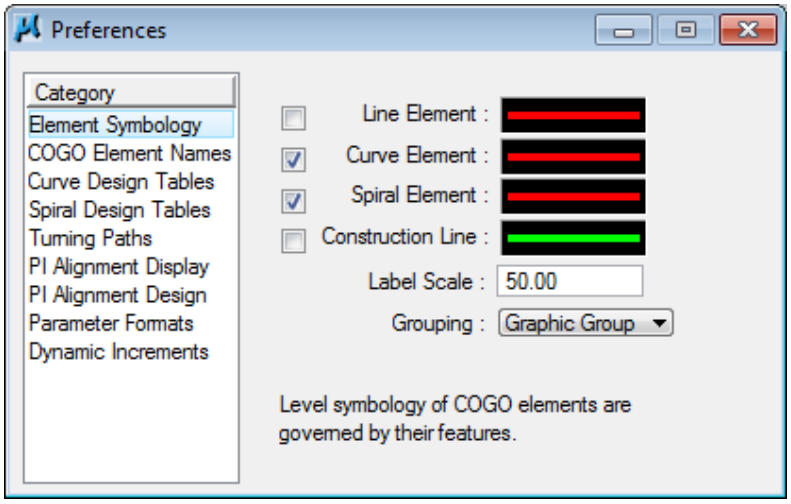
Click Yes.

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

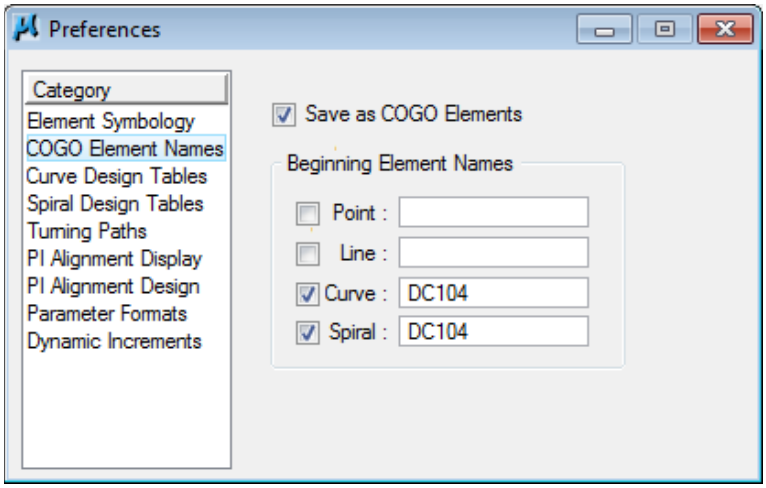


2) First, we need to set some preferences. In the Horizontal Alignment Generator tool bar go to the drop down option File → Preferences.

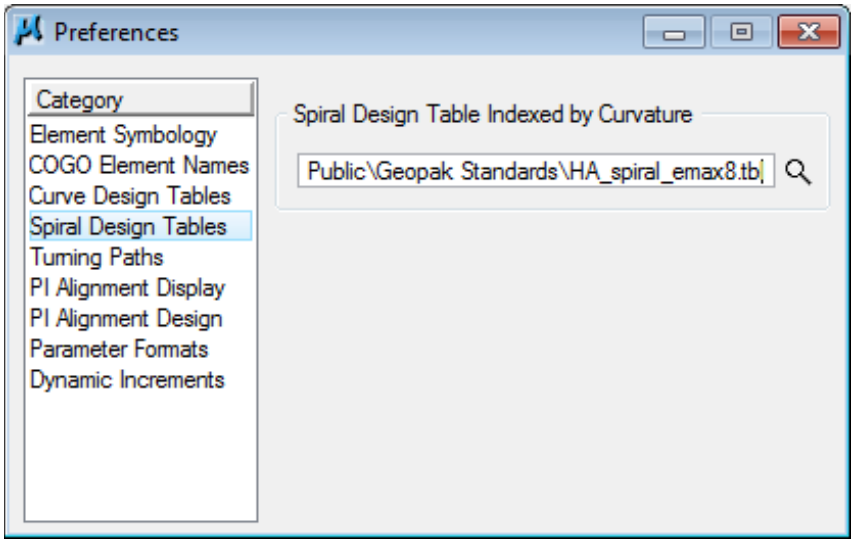
3) Under the first category Element Symbology set the Label Scale to 50 set Grouping to Graphic Group. Don't worry about setting symbologies. We will use other methods to display horizontal alignments.



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.

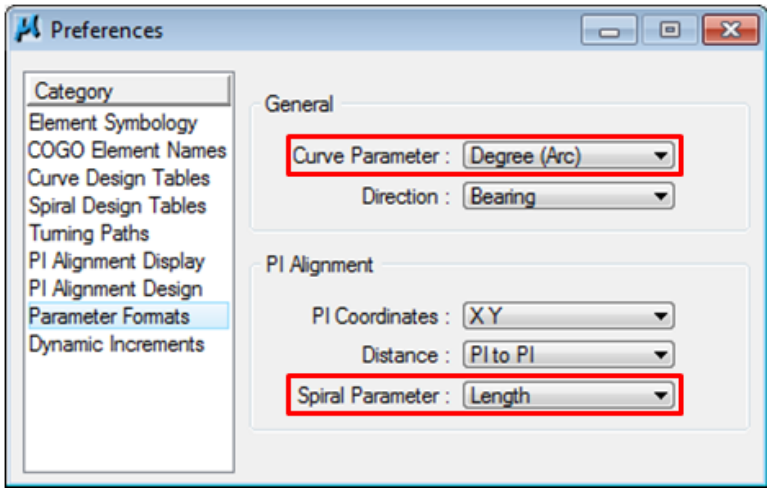
HA_Turning_Path_TN_2001english.tbl

HA_Turning_Path_TN_2001metric.tbl

HA_Turning_Path_TN_2004english.tbl

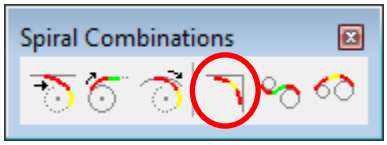
HA_Turning_Path_TN_2004metric.tbl

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

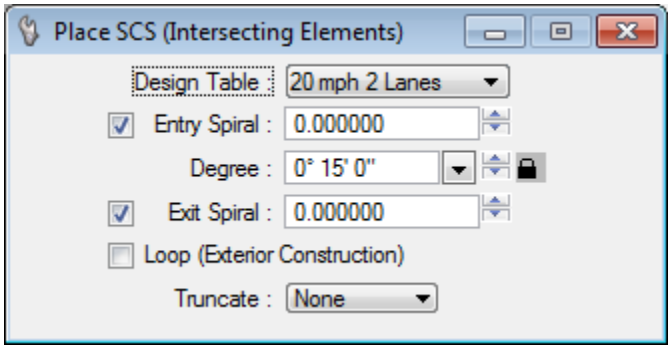


We are finished setting preferences so we can dismiss the dialog.

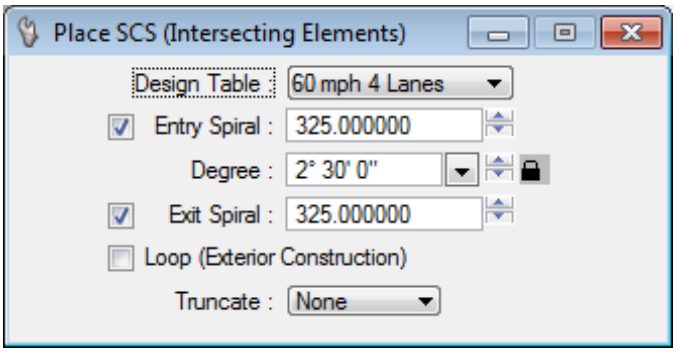
7) Back in the Horizontal Alignment Generator tool bar go to the drop down option Tools → Spiral Combinations. This will open the Spiral Combinations tool box.



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

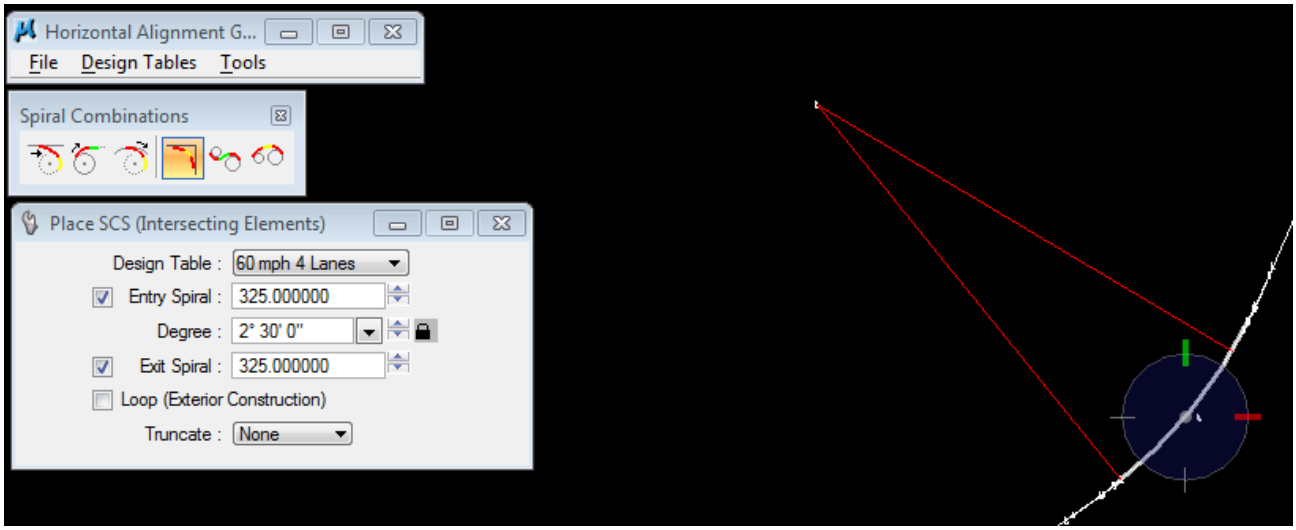


9) Set Design Table to 60 mph 4 Lanes and Degree to 2° 30’ 0”. Make sure Entry Spiral & Exit Spiral are clicked on, Loop option is off and the Truncate option is set to None. Notice that the required spiral lengths are automatically filled in.



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.

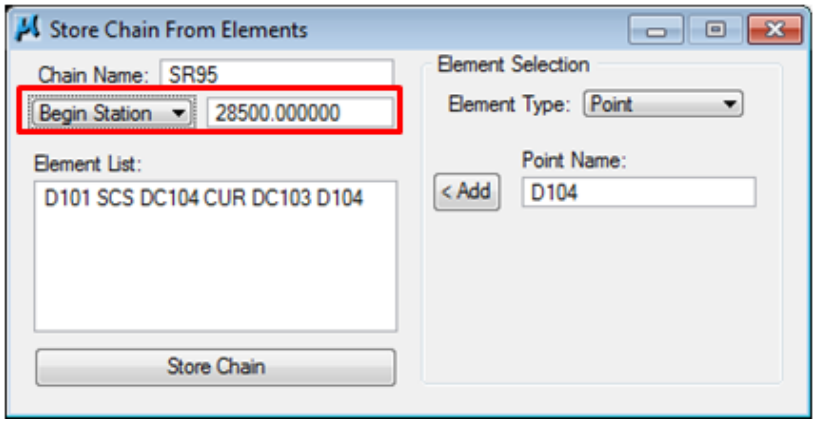
11) Go back to the Place SCS function. In the status bar you may notice that the tool is ready to go and is prompting us to Identify first element (look toward the bottom status bar, in the middle). Click on the tangent leading to our first curve. Click anywhere to accept that and then click on the tangent past the curve to initiate curve placement



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

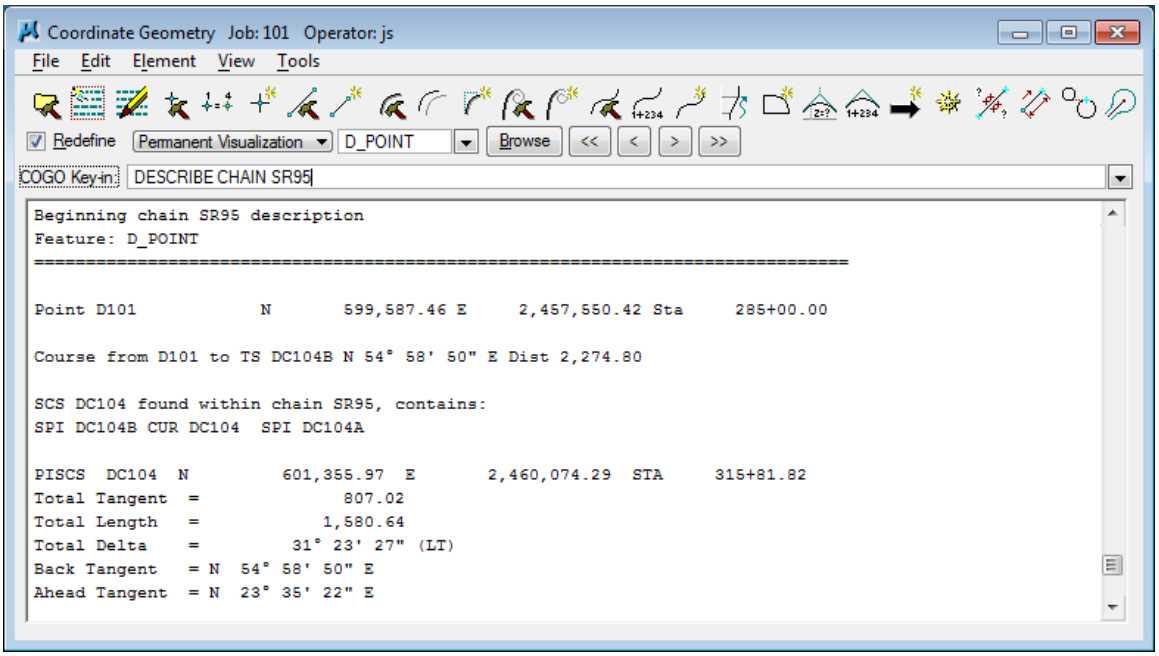
12) Open the COGO dialog up and review the output window and the spirals and curve that we created.

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 accidently 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.

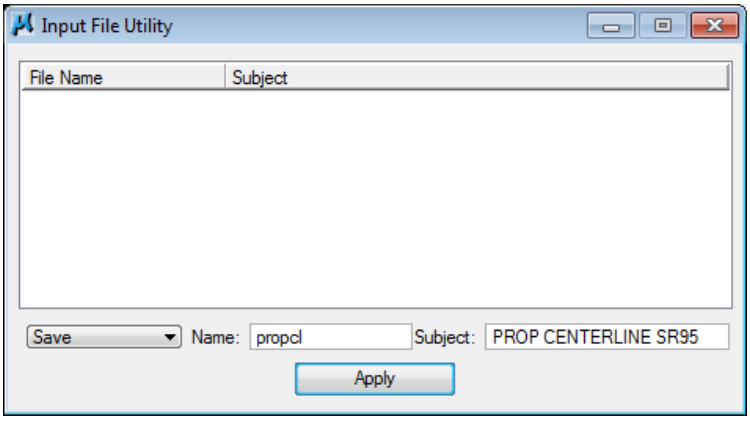


15) You can close the Horizontal Alignment Generator menu bar and tool box since we are finished with them.

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.

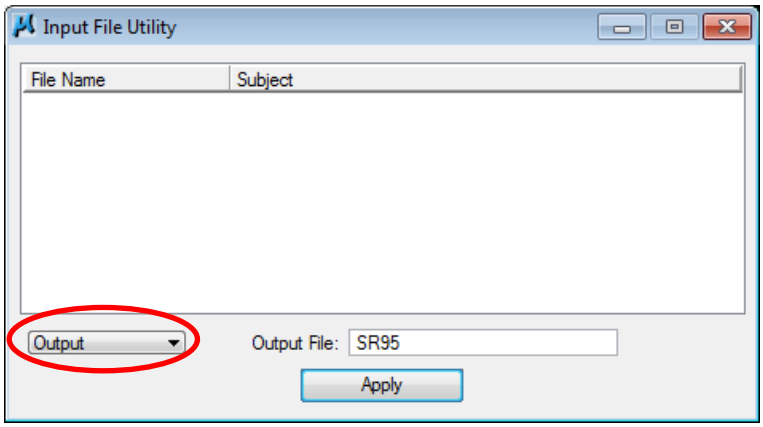
2) Set the action option at the lower left to Save, enter a Name such as propcl and a Subject description, then click Apply.



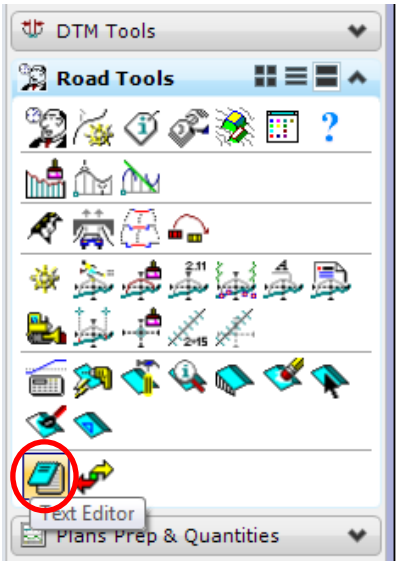
All input commands from this session are written to the file propcl101.i**. Remember the last 2 letters of the name is your operator code.

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**.

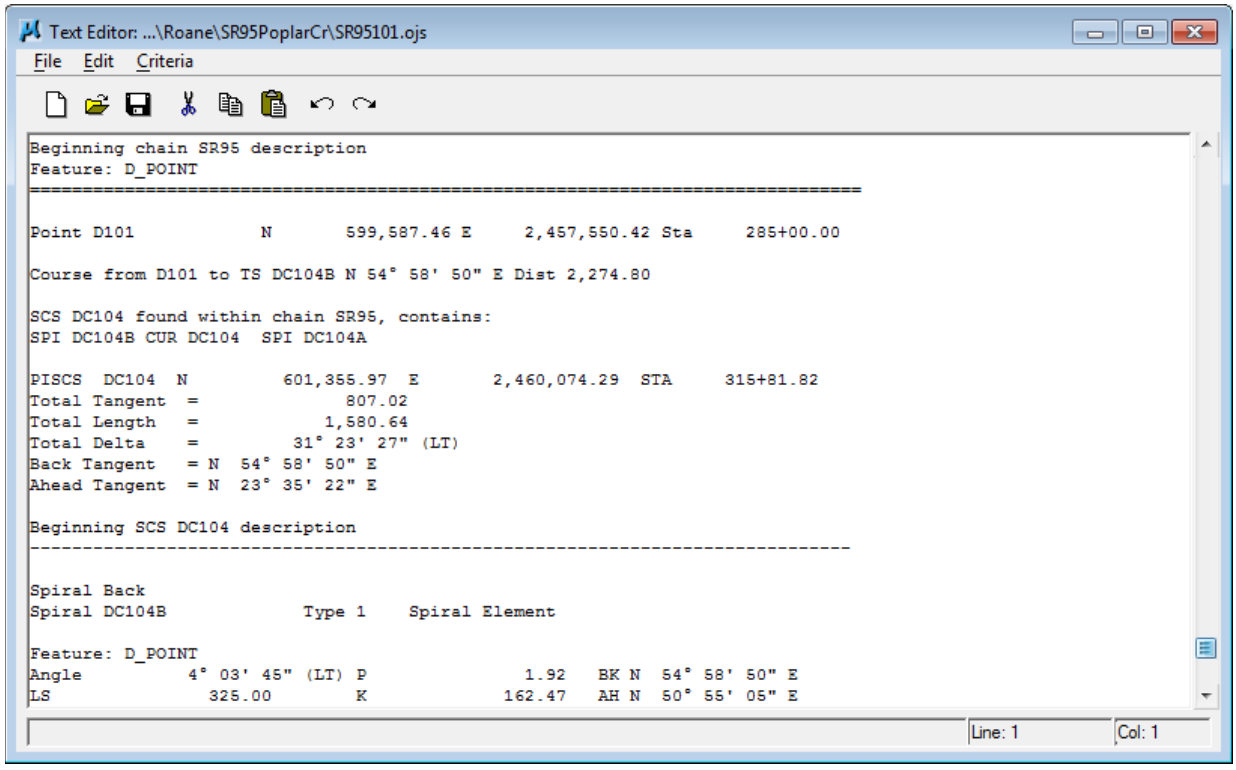
Prior to creating an output file you may wish to use the function View → Command Output → Clear to completely empty the output area. Then describe all objects (points, curves, chains, etc.) you wish to save a report on.



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.



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.

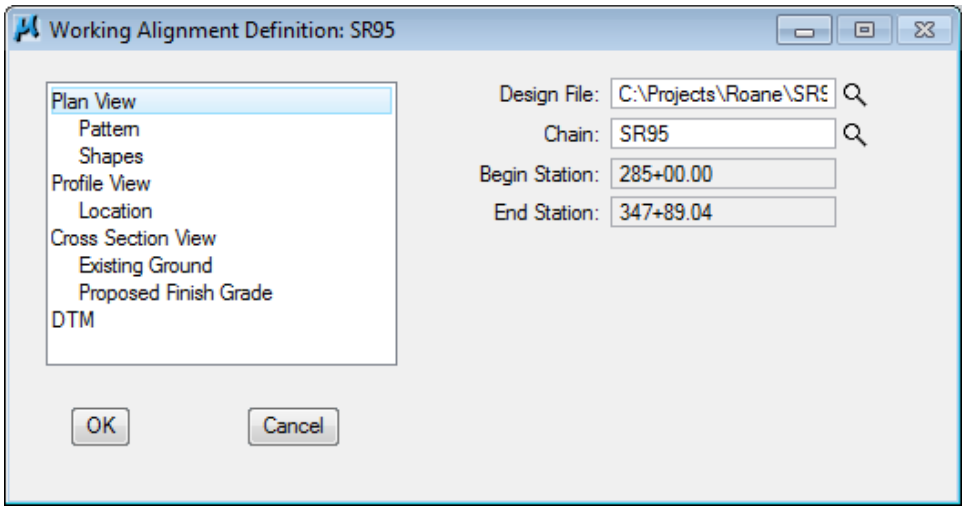
IV.) Working Alignment – Define Chain

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.