

5.1 Objectives

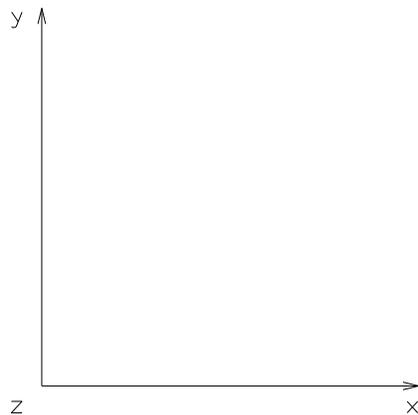
- Learn to set up and access the coordinate geometry database.
- Become proficient in using Geopak Coordinate Geometry.

5.2 Definitions

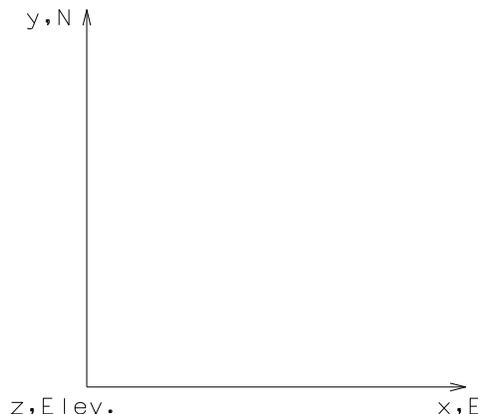
Coordinate Geometry (COGO) is a method of using XYZ coordinates to store geometric elements such as points, lines, curves, spirals, chains, parcels, and profiles. The **Coordinate Geometry** dialog box is an interactive graphical user interface for storing coordinate geometry elements.

5.2.1 Coordinate System

The coordinate system is defined with **XYZ** coordinates. The **X** and **Y** coordinates define a horizontal plane, while the **Z** coordinate defines the vertical dimension. All points in a cogo element are defined by at least an **X** coordinate and a **Y** coordinate. If an elevation is to be stored, the **Z** coordinate will also be defined.



The **XYZ** coordinates can also be referred to in **Northing (N)**, **Easting (E)**, and **Elevation (Z)** coordinates. The **Northing** coordinate refers to the **Y** value, the **Easting** coordinate refers to the **X** value, and the **Elevation** refers to the **Z** value.



Coordinate Geometry

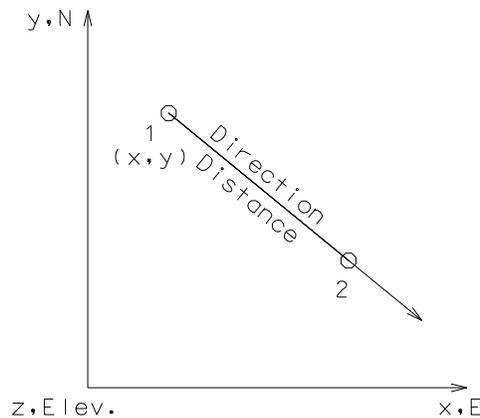
The user must be aware of the coordinate system the data is in, and the coordinate system that GEOPAK is using. When referring to the **XYZ** coordinate system, the coordinates are listed as **(X, Y, Z)**. When referring to the **Northing, Easting, Elevation** coordinate system, the coordinates are listed as **(N, E, Elev.)**. When translating this to the **XYZ** coordinate system, the coordinates would be **(Y, X, Z)**.

5.2.2 Points

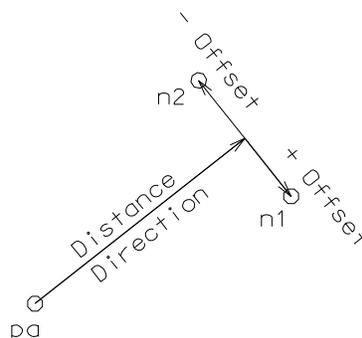
Points are defined by a single set of coordinates. Each **point** will have an X and a Y coordinate. The point may also have a Z coordinate if an elevation is defined.

Point names are alpha-numeric. If alphabetic characters are used, they must come before any numeric characters. The **point** name must contain at least 1 numeric character at the end of the name. Names can be up to 15 characters in length, although limiting the name to 8 characters is recommended.

Points can be stored from a set of coordinates, or located from other elements. To define a point from another point, a distance and direction need to be defined.

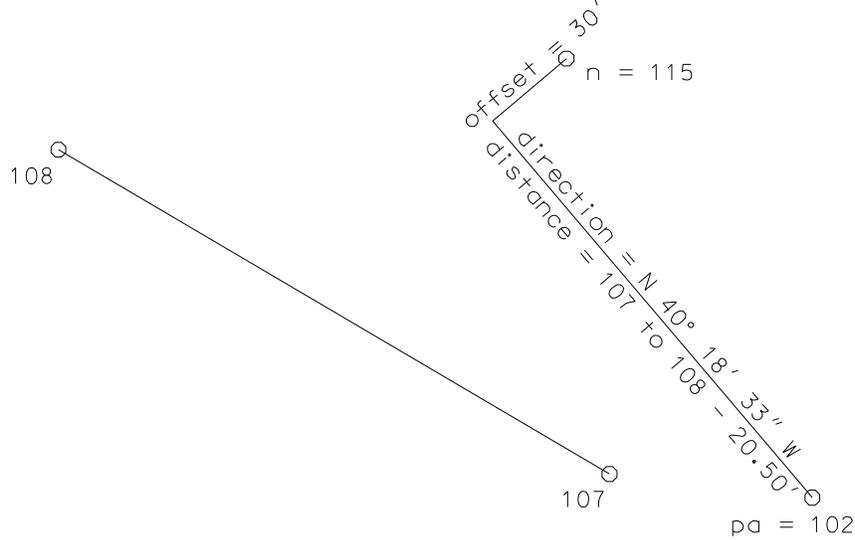


Modifiers can be added to the direction and distance. An offset can be applied. This will locate the point at the specified distance and direction from the starting point, then perpendicular to the specified direction for the specified offset distance. A positive offset will go to the right of the specified direction, and a negative offset will go to the left of the specified direction.



Coordinate Geometry

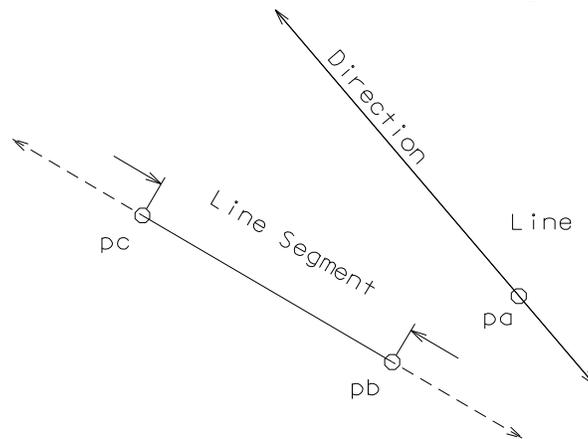
Distances and directions can also be found mathematically. Values can be added, subtracted, multiplied, divided, or computed with a trigonometry function



loc 115 trav 102 dis 107 to 108 m 20.50 n 40 18 33 w off 30

5.2.3 Lines and Line Segments

Lines are defined by a location point and a direction, and are infinite in length. **Line Segments** are a portion of a line that is defined by a beginning and an ending point. **Line Segment** names can be alphanumeric up to 15 characters, but cannot be numeric-alpha.



5.2.4 Curves

Curves are a segment of a circular arc. **Curves** can be defined by either the **arc method** (central angle that produces a 100' arc) or **chord definition** (central angle that produces a 100' chord). MoDOT uses the arc definition for all new alignments, however the chord definition has been used in the past, and may still be shown on old plans.

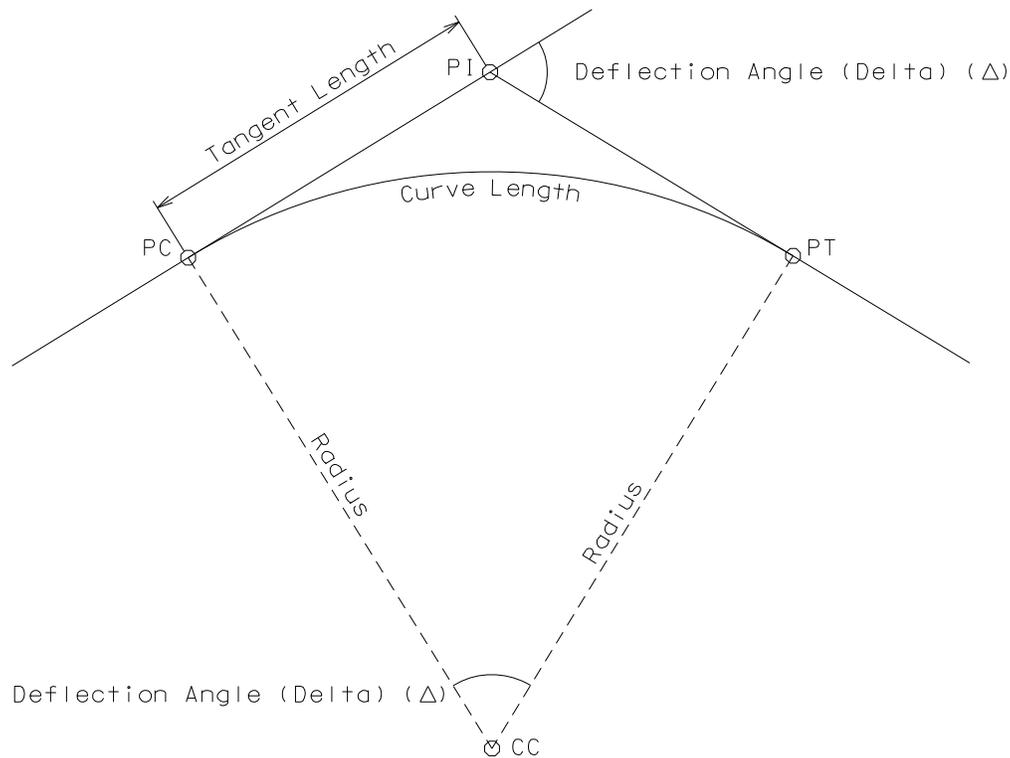
A **curve** has several points associated with it. These points help to define the **curve**, and are stored automatically when the **curve** is stored.

PC – Point of Curvature; Beginning of the curve.

PT – Point of Tangency; End of the curve.

PI – Point of Intersection; Point where the two tangents meet.

CC – Circle Center; Point at the center of the circle from which the curve is segmented.



Curve names can be any alphanumeric characters up to 15 characters in length.

5.2.5 Spirals

Spirals are a transitional curve. Typically a **spiral** will transition from a tangent (infinite radius) to a specified radius defined by a curve. **Spirals** can also transition between 2 specified radii as defined by 2 curves.

Several points are also stored with a **spiral**. They are as follows:

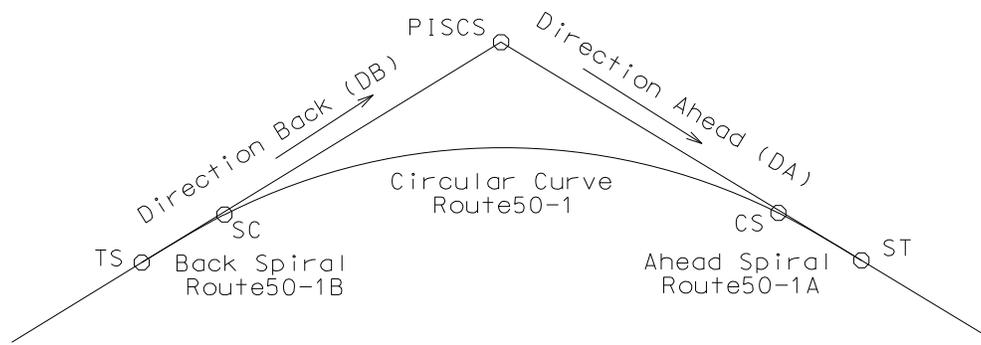
TS – Tangent to Spiral Point

SC – Spiral to Curve Point

CS – Curve to Spiral Point

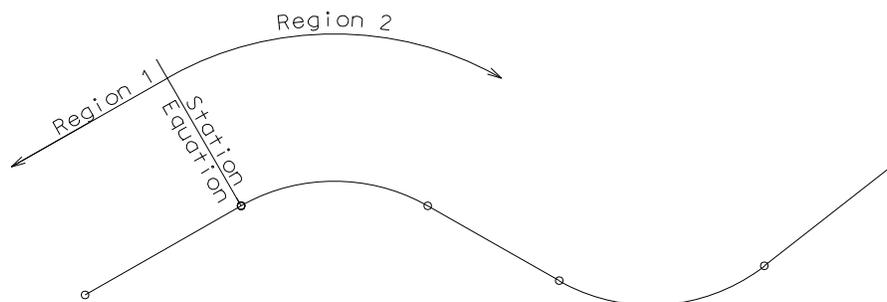
ST – Spiral to Tangent Point

PISCS – Overall Point of Intersection for the spiral-curve-spiral combination.



5.2.6 Chains

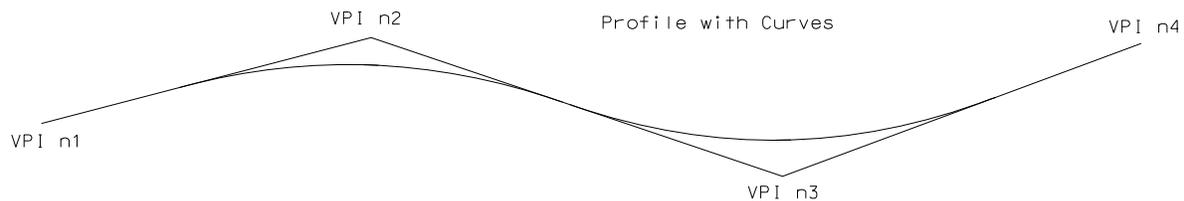
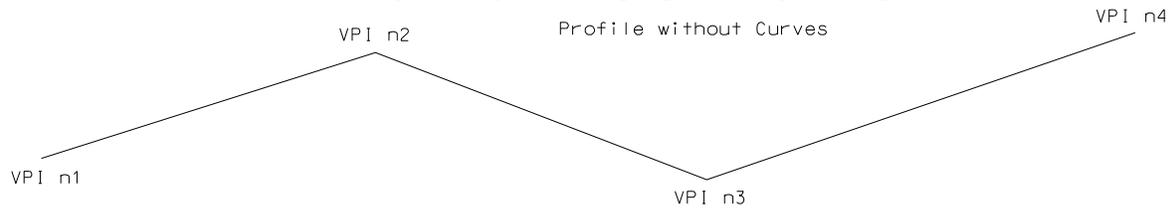
Chains are a combination of other elements. They can consist of points, curves, spirals, or other chains. **Chains** can represent horizontal alignments, or the horizontal location of some element. **Chains** have **stationing** associated with them. Locations along the chain can be determined by the **stationing**. If the **stationing** is adjusted along the **chain** a **station equation** is used. The **stations** from the beginning of the **chain** to the first **station equation** are referred to as Region 1. The **stations** from the first **station equation** to the second **station equation** or the end of the **chain** are referred to as Region 2.



Chain names can be any alpha-numeric characters up to a length of 15 characters.

5.2.7 Profiles

Profiles are vertical alignments defined by stations and elevations. They are generally associated with some horizontal chain. **Profiles** can be stored with or without vertical curves. **Profiles** without curves generally represent the existing ground profile, or a ditch profile. **Profiles** with vertical curves are generally used as proposed alignment profiles.



5.3 Accessing



From **Project Manager** choose **Coordinate Geometry**, or choose the **Coordinate Geometry** icon.

The screenshot shows the "Coordinate Geometry" dialog box. It has a title bar "Coordinate Geometry" and four input fields: "Project Name:", "Job Number:", "Operator Code:", and "Subject:". The "Operator Code:" field is highlighted with a dashed border. There are "OK" and "Cancel" buttons at the bottom.

When Coordinate Geometry is started, the **Start-Up Dialog Box** appears.

Project Name – shows name displayed on reports (optional entry, 60 alphanumeric characters max). If **Project Manager** is used, this field will be filled in automatically.

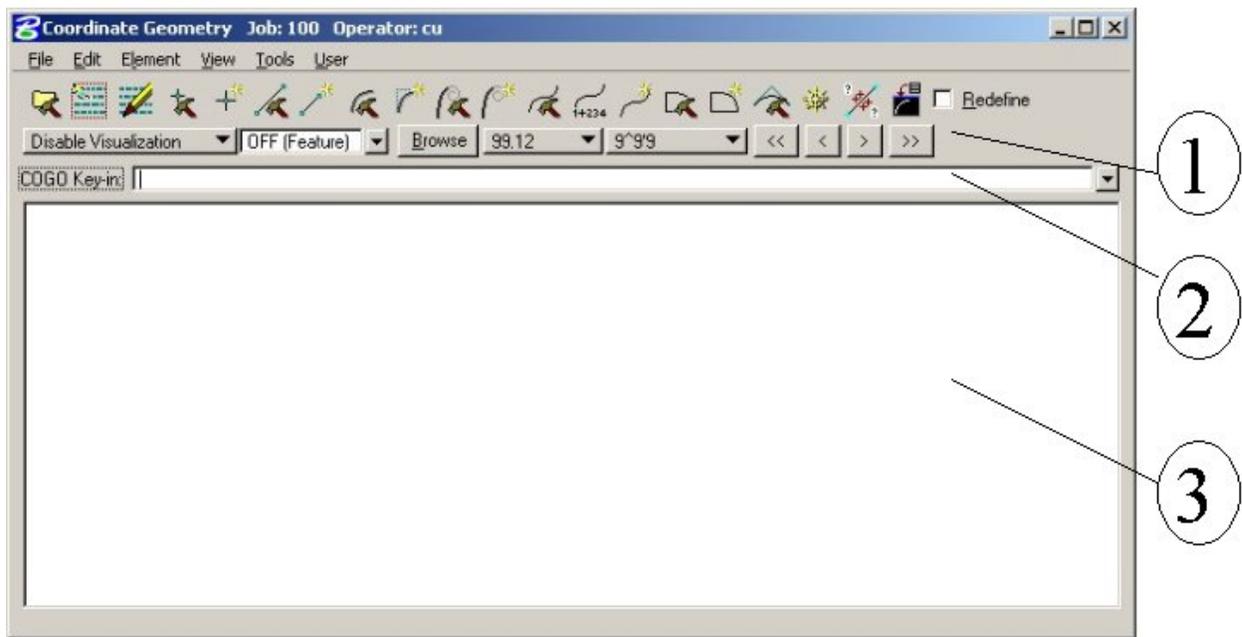
Job Number - identifies coordinate geometry database (3 alphanumeric characters, max) (required). If **Project Manager** is used, this field will be filled in automatically.

Operator Code – identifies a unique 2-character operator code. Allows multiple users access to database. (Required, user's initials suggested). If **Project Manager** is used, this field will be filled in automatically.

Subject - description of work (48 alphanumeric characters, max) (optional)

Once these parameters have been defined, the coordinate geometry dialog box will appear.

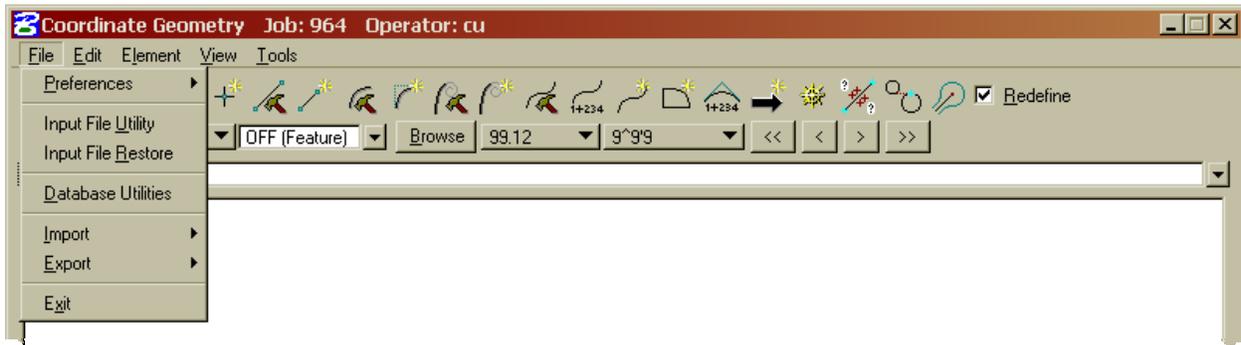
5.4 Coordinate Geometry Dialog Box



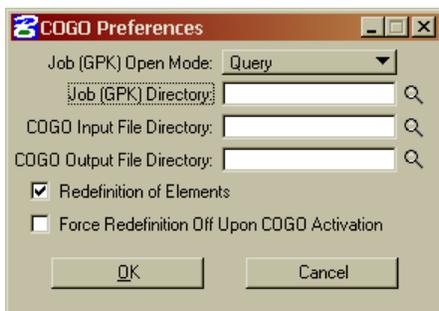
The coordinate geometry dialog box is made up of three separate display areas:

- 1) **Tool Bar** consisting of pull down menus and icons. The icons displayed are customizable.
- 2) **Command Key-in** allows commands to be typed in. The drop down button allows for a history of commands to be seen.
- 3) **Output Window** shows the results generated by the commands.

5.4.1 File Commands



COGO Preferences



Job Open Mode: (Create, No Create and Query)

This determines the file creation constraints imposed on creating new coordinate geometry data files. Coordinate geometry data is stored into a file named job** .gpk where ** is the user-specified job number for a given project. Each time the Coordinate Geometry window is invoked for a job number that does not correspond with a job** .gpk file in the current or specified working directory, GEOPAK creates a new job** .gpk file contingent on the constraints imposed by the Job Open Mode parameter.

- **Create** - Automatically creates a new coordinate geometry database.
- **No Create** - This mode does not permit creation of a new coordinate geometry database and provides a warning.
- **Query** - With this mode, the user is queried when a job number is requested that does not correspond with a job** .gpk file in the current directory. Once queried, the designer may proceed with the database creation or cancel it.

Directories: (Job Directory, Input File Directory, Output File Directory)

Normally, input and output files are stored in the project directory, in which case, these fields would be blank. However, there are times when they are located in other directories, which can be keyed into these fields. In lieu of typing, pressing any of the **Select** buttons invokes the Select Directory Manager, wherein the desired directory may be specified.

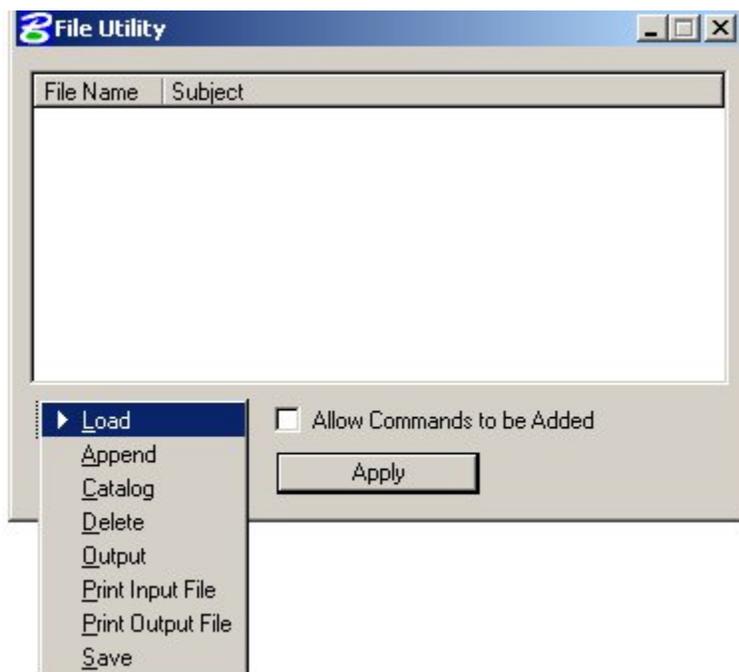
Redefinition of Elements

When the toggle is activated, existing elements in the Coordinate Geometry component can be redefined. For example, point number 8523 that was previously defined to coordinate values can be set to new coordinate values when this toggle is active. Otherwise, the Coordinate Geometry component would not store the new coordinate values with point number 8523 and a warning message "Element already exists" is displayed on the screen. This serves as a protection to the integrity of the coordinate geometry database. The Redefine toggle in the Coordinate Geometry window can achieve the same functionality.

Force Redefinition Off at COGO Activation

When this toggle is activated, and coordinate geometry is invoked, the **Redefine** button is not active, so that no redefinition of elements is permitted. However, at any time during the session, the **Redefine** toggle may be activated.

Import File Utility – this tool is for manipulating *input files*. When this tool is selected, the dialog with a list of available input files below appears. File utilities include **Load, Append, Catalog, Delete, Output, Print, and Save**.



Load - *Highlight* a file then click the **Apply** button. The input lines from the highlighted file are now displayed in the output buffer and are ready for modify, delete, edit or read.

Append - A new input file is created by copying the contents of an existing input file to the end of the current input file; you must use the **Save** command to store this new file.

Catalog - when selected, a menu appears listing all saved input files in the project directory. This is for reference only no action is taken.

Delete - when selected, a menu appears listing all saved input files. *Highlight* a file then click the **OK** button to remove this file from your project directory.

Output - writes a Geopak output file from your current output buffer session to a newly created file for reviewing and printing. (**Fname999.ooc**)

Coordinate Geometry

Print Input File - sends your input file to the printer.

Print Output File - sends your out file to the printer.

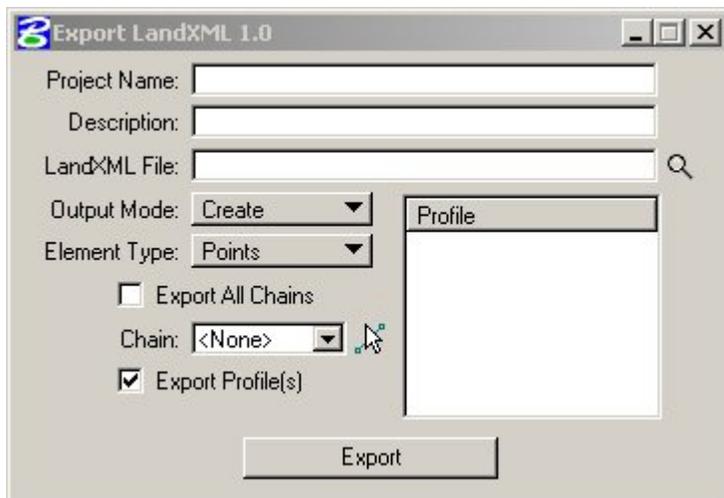
Save - will save the current input buffer to a file. (**Fname999.ioc**)

File Restore – converts an ASCII file of Geopak commands to a Geopak COGO input file.

Import - will import horizontal and vertical alignments and points from RDS, SDMS, LandXML 1.0 Geometry, and Virginia Department of Transportation file format into the Geopak .gpk file.

Export - will export Geopak, points, chains and profiles into into SDMS format and LandXML 1.0 Geometry.

Since most surveying software now reads LandXML format, it is recommended to extract geometry into this format for providing it to contractors.



The Export option in GEOPAK for profile is only activated (visible on the dialog) when you are also exporting chains. You cannot export just a profile by itself as LandXML does not permit this.

Exit - closes the COGO dialog box and ends the coordinate geometry session. A prompt to save the session

appears. **Yes** saves the input buffer, **No** exits without saving, **Cancel** returns to the COGO session. Whether you pick **Yes** or **No** everything you did is still saved in the .gpk file.

Input File Restore

An ASCII formatted file of GEOPAK commands can be converted to a regular GEOPAK input file by means of the **Restore** command. This ASCII file might be created manually via an editor or generated by the Store Graphics tool.

Coordinate Geometry

Database Utilities

Both tools perform utility functions on the specified GPK file. The current Job is shown as the default.



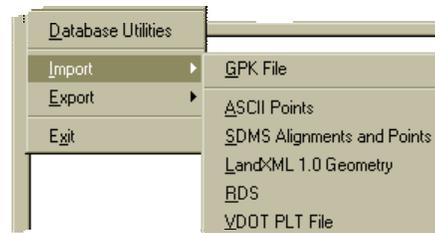
Validate - Looks for problems and errors in the GPK database and reports findings. Does not attempt to clean or compress the database.

Clean and Compress - This command scans the current GPK file and removes any corrupt element(s) as part of the rebuilding process. It also compresses the GPK file. The results of the rebuilding are contained within a log file in the same directory as the GPK file.

Warning: Be sure to back up your GPK file before utilizing this tool, as there is no undo!

Import

The **File > Import** tools supports importing data in a variety of set formats.



Merge GPK File

The Import or Merge GPK File tool merges the specified GPK file into the current GPK file.

Type in the Job or click Select Job File.

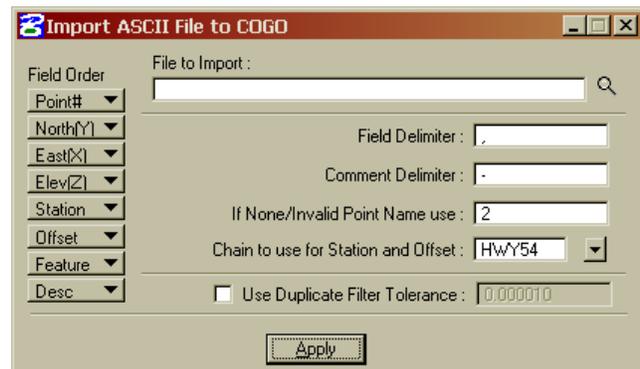
Click Merge to commence processing.



ASCII Points

This tool will directly store plain ASCII XYZ file, no Survey Chains will be created.

The ASCII file must have one line of data per point. Enter the name of the file or click Select. Then set the delimiter (character between each field in the data). If a comment is in the file, it must be at the end of the line, and separated by a unique delimiter. Set the None or Invalid Point Name and Chain name. If the Duplicate Filter Tolerance is on, any point within the specified tolerance of another point is ignored. The last step is to set the order of the fields within each row (Field Order). If the first row is Point#, X, and Y, set the Field Order to Point#, East(X), North(Y), and the rest to None. Click **Apply** to commence processing.



Coordinate Geometry

SDMS Alignments and Points

Key in the name of the **SDMS File** or click **Select**.



Three types of input are supported:

- **Horizontal Alignments,**
- **Vertical Alignments,** and
- **Points.**

Click **Import** to commence processing.

Land XML 1.0 Geometry

GEOPAK supports importing of XML type files.

Enter the name of the file or click Select. Turn on elements to import: Points, Chains or Profiles. Note multiple elements toggled on are supported. Click **Import** to commence processing.



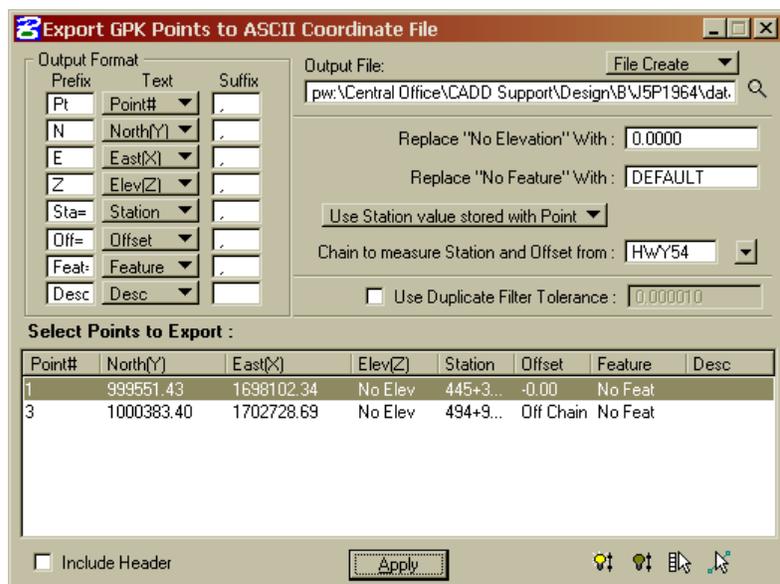
Export

ASCII Points

The dialog is divided into three main sections:

The dialog is divided into three main sections:

- Select Points to Export
- Output Format
- File and Replacement Options



File and Replacement Options

Output File - Name of the output file to be created or appended. The file can be manually typed in, or selected by pressing the Files icon.

File Create / File Append - Determines whether the file is created or appended. If set to File Create, and the file already exists, an Alert message is displayed, prompting whether the file should be overwritten.

Replace "No Elevation" with - If the selected point has no elevation, the specified value is utilized.

Replace "No Feature" with - If the selected point has no feature, the specified feature is utilized.

Use Station Value Stored with Point - When selected, any station stored with the point is utilized in the list box and output. If the point has no stored station, a default station of 0+00 is listed.

Compute Station Value from Chain - When selected, the point is projected onto the specified chain and the station is determined. Note this station is only used within the dialog and the station originally stored with the point is not changed.

Chain to Measure Station and Offset From - Previously stored chain utilized to compute station and offset of points when the Compute Station Value from Chain option is utilized.

Select Points to Export

Points list box - The list box is populated by either a selection set or COGO navigator operation. Once the box is populated, the user must highlight the desired points for exportation.



Select All Points - Utilized after the list box is populated, pressing this icon highlights all entries in the list.



Clear All Points - Utilized after the list box is populated, pressing this icon unhighlights all entries in the list.



Get Points from Navigator - Once a MicroStation selection set has been defined, pressing this icon utilizes the selected COGO visualized elements to populate the list box.



Get Points from MicroStation Selection Set - Once the desired elements have been highlighted in the COGO navigator, pressing this icon populates the list box.

Output Format

Prefix – Syntax which is placed before the actual Text for each data item. Note: may be blank. In addition, to space between the prefix and the text, place blanks in the prefix field.

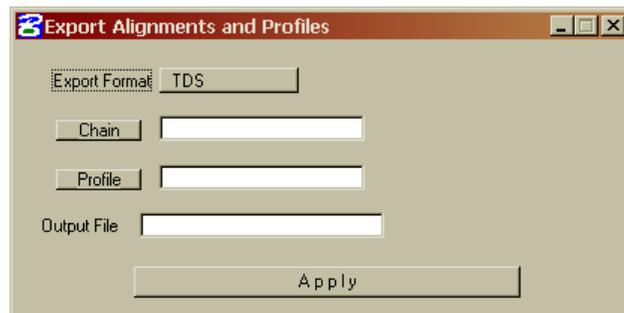
Text – The data options: Point, North, East, Elev, Feature, Station, Desc or None. When each Text option is set, the data is placed in the specified order, with associated Prefix and Suffix, into the output file. For example, if the desired output file contains only the point, X and Y coordinates and is comma delimited, the Output Format group box would resemble the illustration below.



Suffix – Syntax that is placed after the actual Text for each data item. Note: may be blank or used as a delimiter. The key words ENT and TAB are supported within the suffix field. The TAB utilizes a tab in the output file, while the ENT utilizes a CR/LF (carriage control / line feed.)

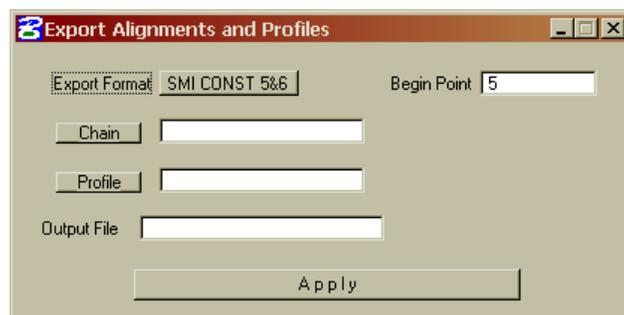
Alignments and Profiles

TDS Format

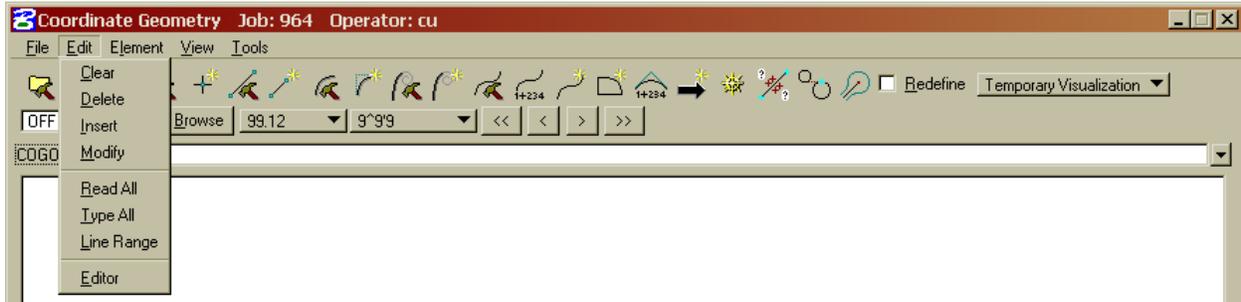


Chain and **Profile** fields may be keyed in. In lieu of typing, selection of the **Chain** (or **Profile**) button invokes a selection dialog, wherein the desired element may be selected. An **Output File** completes the required information, and clicking **Apply** commences the procedure.

SMI Const V Format



5.4.2 Edit Commands



Clear - empties the memory of the current input and output buffers without saving and initializes the line numbers to begin a new sequence of commands.

Delete - deletes input commands in the input buffer by line number (or range of line numbers) and re-sequences the line numbers for the remaining commands.

Insert - allows the user to add a command line to the current input buffer *before* a specified line number; the other command lines will shift down and line numbering will automatically be re-sequenced

Modify - allows the user to change a word in a command line. The modified command line will not be computed until the operator uses the **Read** command.

Read All - the lines in the output buffer are processed. This may be done for the entire file (**All**) or by specifying a range of line numbers (**Line Range**).

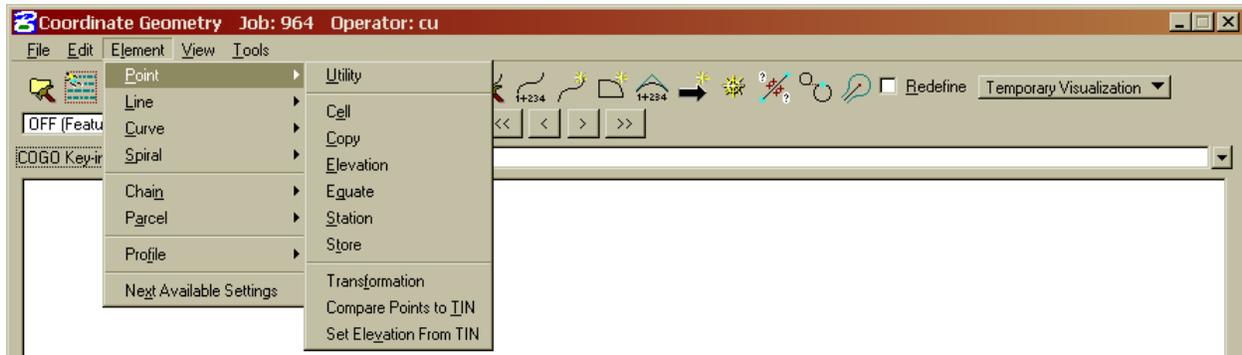
Type All - displays the content of the current input file.

Line Range - displays a portion of the file by specifying a range of line numbers.

Editor - opens the **GEOPAK COGO Command Editor**, which allows the user to edit an input file before executing.

5.4.3 Element Commands

5.4.3.1 ELEMENT>>POINT

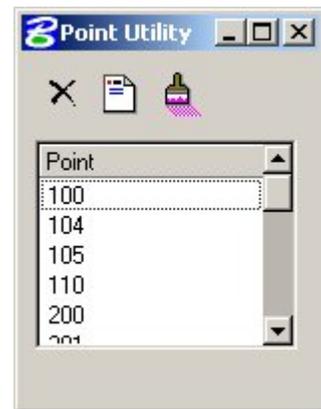


Utility - The Point Utility tool displays a list of all stored points, and has options for deleting, printing, or visualizing points.

 **Delete** – deletes one point or multiple points currently stored in the .gpk file. User must highlight the points to be deleted in the utility tool display list, then click on the delete icon.

 **Print** - prints point data currently stored in the .gpk file including coordinates and other associated data.

 **Visualize**– visualizes currently stored points in the .gpk file according to the visualization settings in the coordinate geometry dialog. If visualization is turned off, points will not be visualized.



Cell - assigns a cell name to a previously stored point

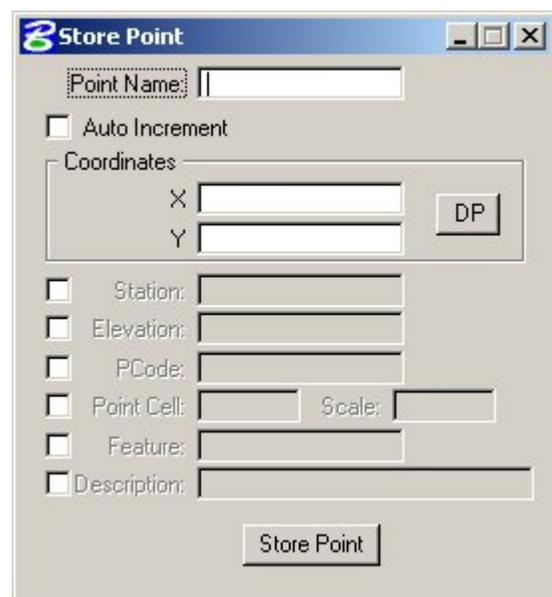
Copy – copies points or a point range to a new point number or range within the same Geopak database

Elevation - assigns an elevation to a previously stored point

Equate - stores a new point with the same values as a previously defined point

Station - allows you to specify a station for an existing point.

Store - stores a point located by key-in or by digitizing a point on the screen. A station, elevation,



Coordinate Geometry

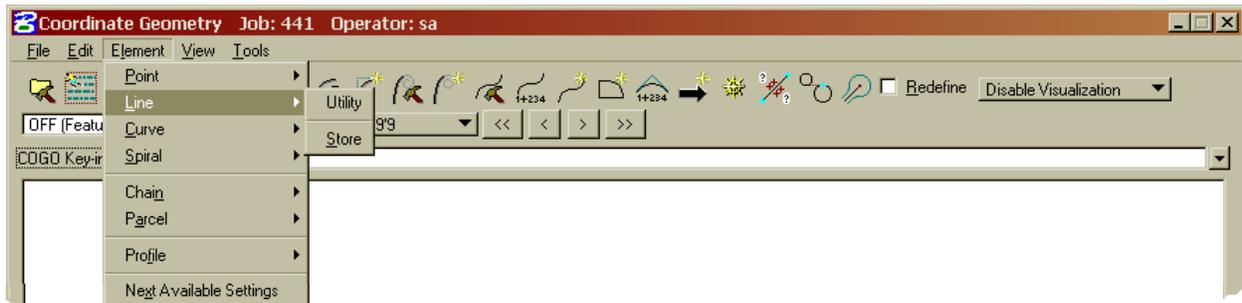
point code, cell, feature, or description can be added to the point.

Transformation - transform one set of points into a new coordinate system.

Compare Points to TIN – computes the elevations of a given set of points based on a given DTM, and outputs the elevations to a text file.

Set Elevation From Tin – computes the elevations of a given set of points based on a given DTM, and stores the elevations to the points.

5.4.3.2 ELEMENT>>LINE



Utility - displays all stored lines, and has options for transposing, deleting, printing, or visualizing lines.



Transpose – Changes the direction of the selected lines.



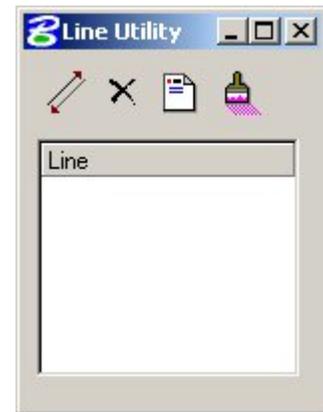
Delete – Removes the selected lines from the GPK.



Print – Writes information about the selected lines to the COGO output window.



Visualize - Plots lines based on current COGO visualization settings.

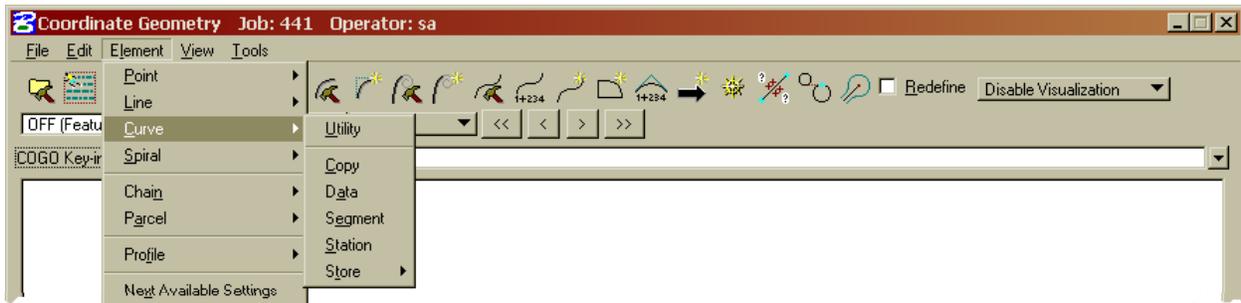


Store - stores a line based on one point and a direction or two points. The line name can be alpha-numeric (but not numeric-alpha) to a maximum of nine characters.



Coordinate Geometry

5.4.3.3 ELEMENT>>CURVE



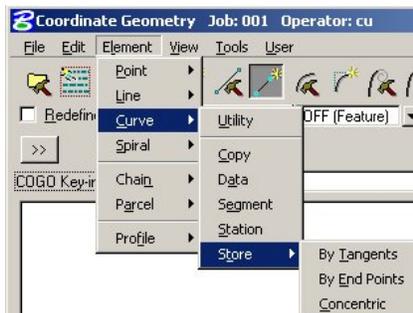
Utility - displays all stored lines in .gpk file, and has options for transposing, deleting, printing, or visualizing lines.

Copy - copy a specified curve to another curve name

Data - calculates the geometric parameters of a curve, displaying values for Delta, Degree, Tangent, Length and Radius

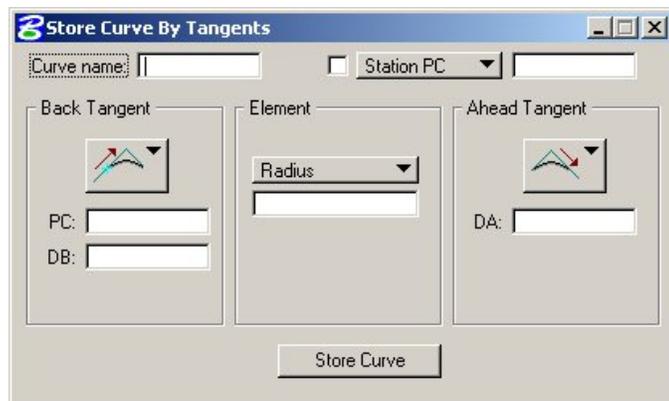
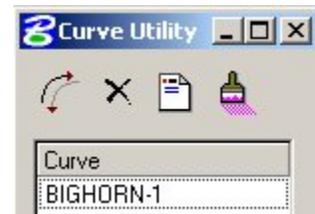
Segment – defines new curves by dividing a stored curve into segments.

Station - allows the user to identify a curve and the position on the curve (PC, PI, or PT) that a station value may be assigned.



Storing a curve **By Tangents** is the most commonly used tool to store curves.

Store - provides various options for defining and storing lines and curves such as **By Tangents**, **By End Points (from PC and PT previously stored)** or **Concentric** as shown to the right.



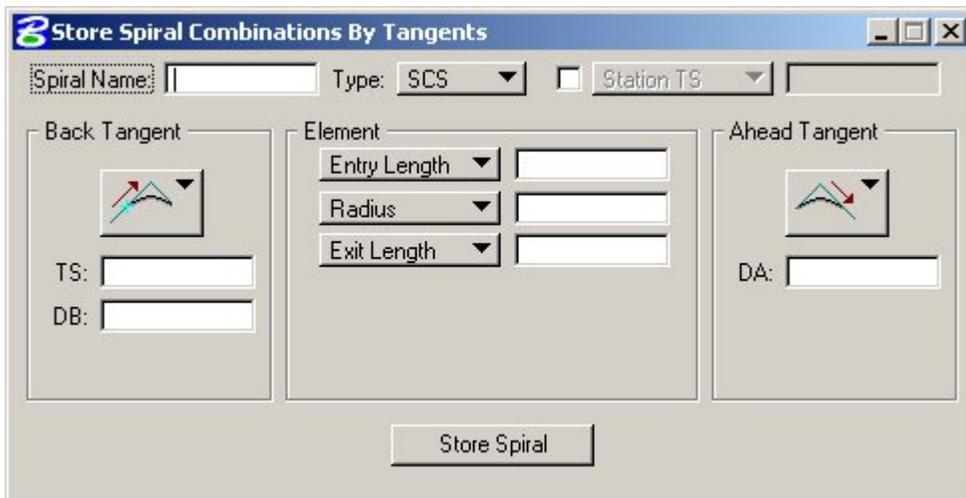
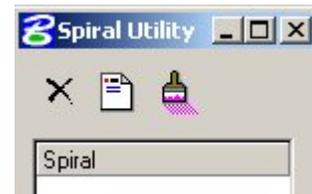
5.4.3.4 ELEMENT>>SPIRAL



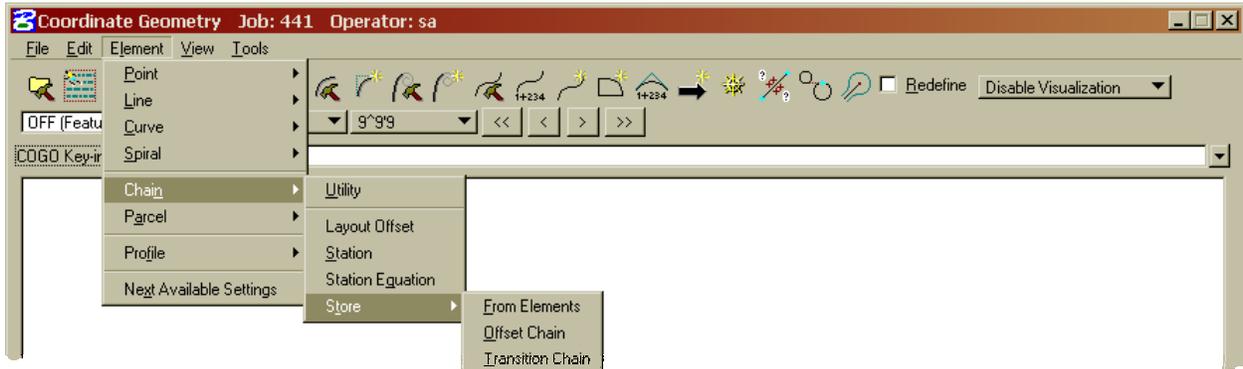
Utility - displays all stored spirals in the .gpk file, and has options for deleting, printing, or visualizing spirals.

Copy - copy a specified spiral to another spiral name

Store - provides various options for defining and storing spirals.



5.4.3.5 ELEMENT>>CHAIN



Utility - displays all stored chains in the .gpk file, and has options for computing area, deleting, printing, describing, or visualizing chains.



Area – calculates the area of a closed chain previously stored in the .gpk file.



Delete – deletes chains stored in the .gpk file.



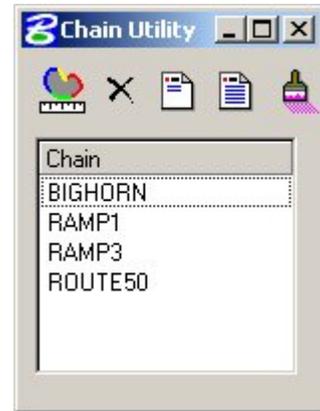
Print – displays the name of each chain element.



Describe – displays the alignment data of each element in the selected chain.



Visualize - plots chains based on current COGO visualization settings.

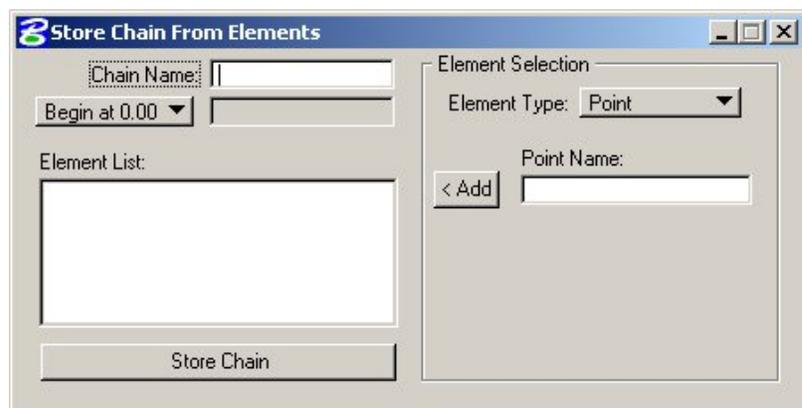


Layout Offset – computes the station and offset of a point or a chain based on a given chain.

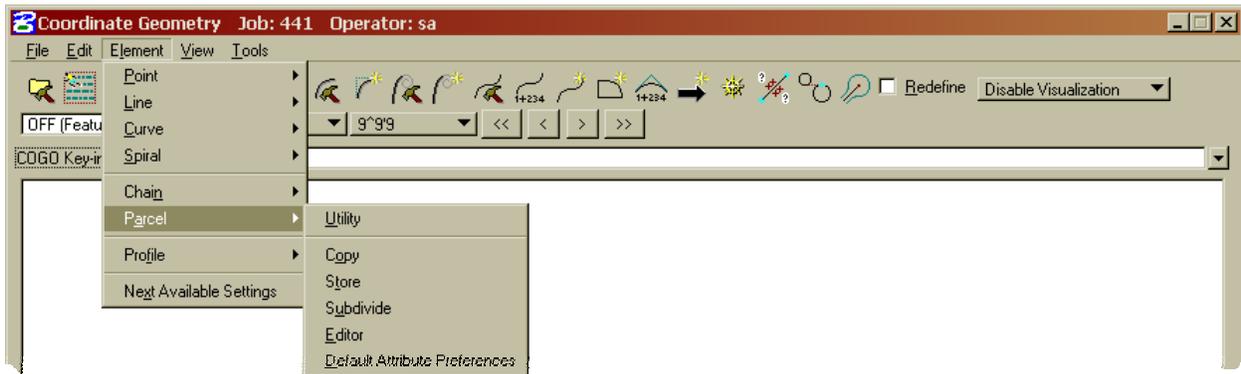
Station - provides a method for stationing or re-stationing a chain.

Station Equation - provides a method for applying a station equation to a chain

Store - provides three options for storing a chain in the database, **From Elements**, **From Offset Chain**, and **Transition Chain**.



5.4.3.6 ELEMENT>>PARCEL



Utility - displays all stored parcels in .gpk file, and has options for describing, deleting, printing, or visualizing parcels.

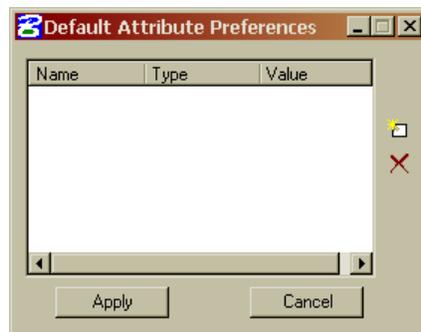
Copy - This command copies a specified parcel to another parcel name.

Store - allows a user to store a parcel by adding points, curves and spirals.

Subdivide – divides a parcel into individual lots.

Editor – edits a parcel

Default Attribute Preferences - The Default Attribute Preferences are assigned to each subsequent parcel that is stored. Attributes can have either numeric value or text string.



Manual Entry - Parcel Commands

Store Taken - allows you to store the portion of a parcel taken by entering point and curve names in either a clockwise or counterclockwise direction.

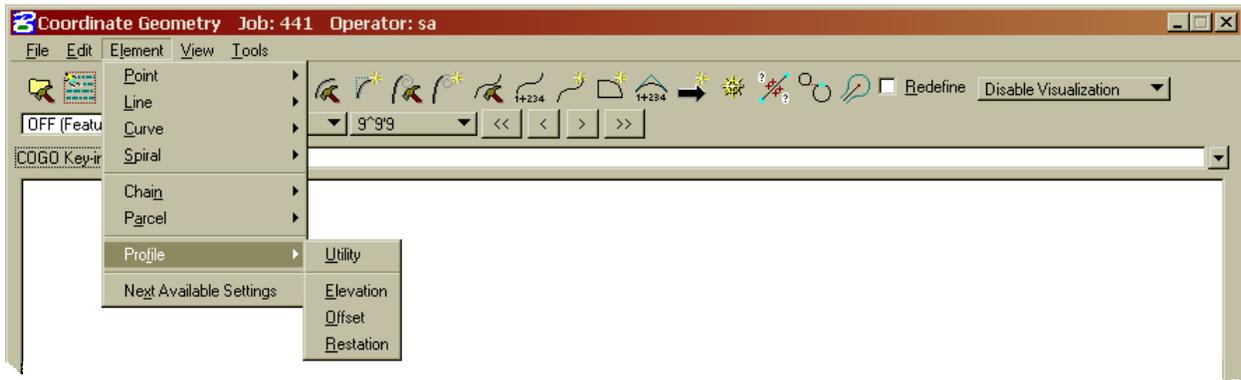
Store Easement - allows you to store an easement by entering point and curve names in either a clockwise or counterclockwise direction.

Own Parcel - stores the name of the owner associated with a previously stored parcel.

Make Legal - creates a legal description and writes it to a user named text file.

For more detailed parcel information, the *Geopak Help Manual*.

5.4.3.7 ELEMENTS>>PROFILES



Utility - displays all stored profiles in .gpk file, and has options for deleting or printing profiles.

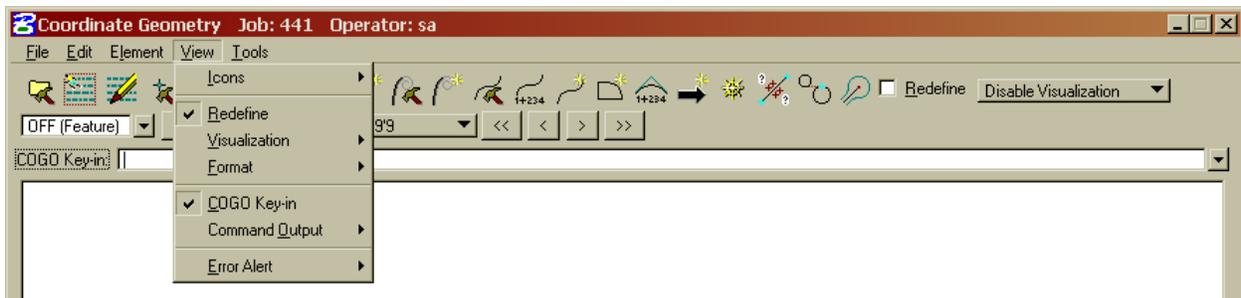
Elevation - provides three options for reporting elevations along a selected profile, **Station**, **Even Station**, **Incremental Stations**

Offset – stores a new profile at a given vertical offset.

Restation - creates a **Target Profile** based on a **Source Profile** and **Chain**, but uses the **Begin Station** specified in the dialog.



5.4.4 View Commands



Icons – allows the user to customize which icons appear in the tool bar.

Redefine – shows the **Redefine** box on the tool bar.

Visualization – shows the visualization items on the tool bar. **Format** – shows the format items (i.e. number of decimals, station format, etc.) on the tool bar.

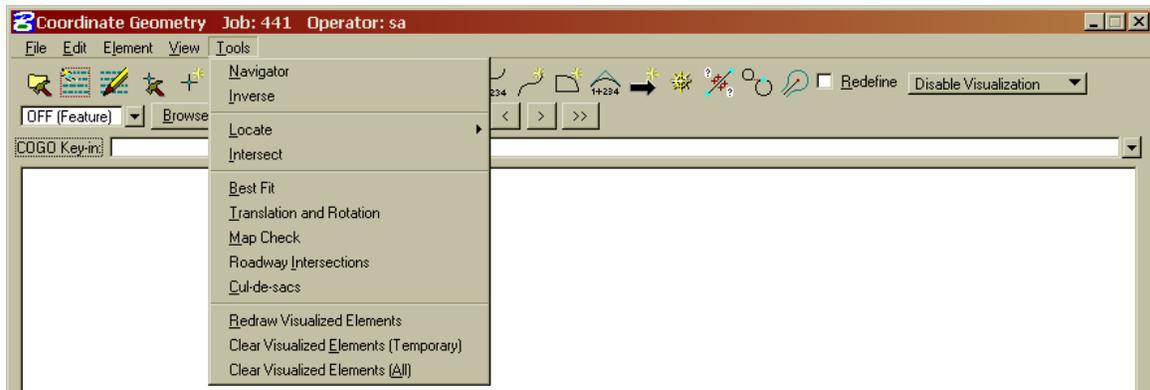
COGO Key-in – shows the COGO Key-in box for entering commands in the dialog.

Coordinate Geometry

Command Output - show the Command Output Window in the dialog box, and controls options for the Command Output Window.

Error Alert – allows the user to turn on a *beep* and/or bring up the COGO dialog when an error occurs.

5.4.5 Tools Commands

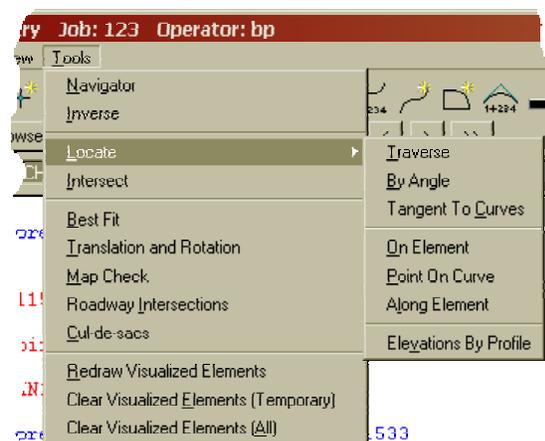


Navigator – starts the COGO Navigator. (This will be covered in more detail in Section 5.5 of this chapter)

Inverse – calculates the distance and direction between points and multiple points.

5.4.6 Locate tools

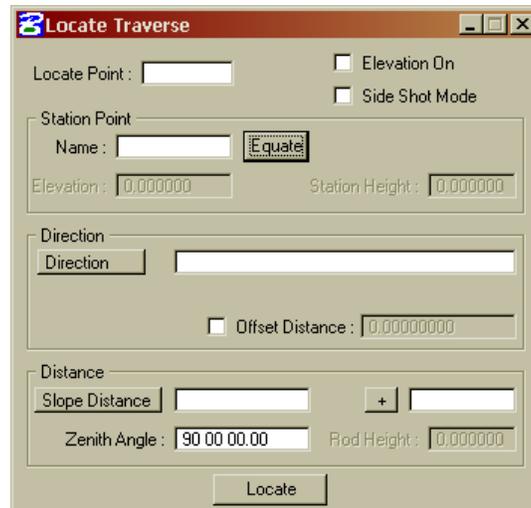
Locate Commands enable the user to locate and store point(s) by reading and processing from previously stored points, geometry and/or stationing.



LOCATE TRAVERSE TOOL – locates a point from another point by several methods such as distance and direction, or station and offset. (To locate by distance and bearing, use the Tools >> Locate >> Traverse)

Coordinate Geometry

Traverse commands locate and store a new point expressed as a direction and distance from a previously stored point. If an offset is specified, it is located at a radial offset distance from the line defined by the previously defined point and direction.



Elevation On - When active, indicates a 3D traverse. In this case, the **Elevation** and **Instru.**

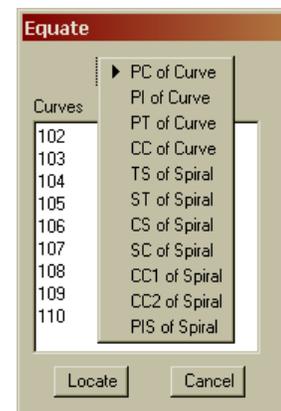
Heights fields are unghosted. When inactive, 2D traverse is performed and the Elevation and Instru. Heights fields are ghosted.

Side Shot Mode - When the **Side Shot** toggle is active, the Starting Point remains the same and only the Locate point increments. If the **Side Shot** toggle is not active, (indicating traverse mode), after each new point is located the Starting Point becomes the point just located.

Locate Point - New point number to be located.

Starting Point: Name - Initial point to be traverse from.

Equate - Opens the Equate dialog, wherein the control point (PC, PT, etc.) and curve or spiral name are selected. Once the curve or spiral is highlighted and the **Apply** button is clicked, the dialog automatically closes, returns to the Traverse dialog and populates the dialog.



Elevation - elevation of the initial point. Only active if the Elevation option is toggled on, indicating a 3D traverse.

Height of Instrument - Height of instrument - utilized in 3D traverse.

Coordinate Geometry

Direction - These include **Value**, **Bearing**, **Azimuth**, and **From pa To pb**, the direction between two previously stored points. As the Direction options are selected, the dialog keyin fields reflect the various options.

Offset Distance Right/Left - Optional field active when toggled. Specify the distance in terms of master units (i.e., feet or meters) and select **Right** or **Left**. The **Signing Convention** for offsets is: POSITIVE to the RIGHT of direction and NEGATIVE to the LEFT of direction ("-" required). Even though an offset has been specified, it will not be utilized if the toggle is not activated.

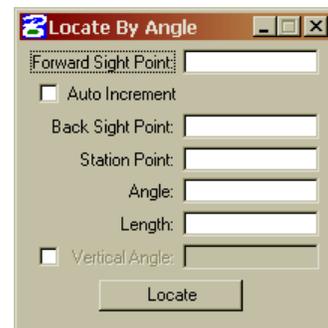
Distance - Horizontal distance in terms of master units (i.e., feet or meters) to be traversed. The **Value** option is specified in master units, i.e. feet or meters. Optionally, another value may be added or subtracted to the original value. The **From pa To pb** supports the distance between two previously stored points. Optionally, another value may be added or subtracted to the distance between the points. The **Radius Curve** option is also specified in master units, i.e. feet or meters. There is no option for adding or subtracting an additional value.

Zenith Angle – Zenith angle.

Rod Height – Rod height.

Apply – Commences the traversing procedure.

LOCATE BY ANGLE TOOL - The **Locate By Angle** commands locate and store a forward sight, expressed as an angle sweeping clockwise or counterclockwise from a line formed between a back sight, a station line and a length. The optional vertical angle in the command line is required when the forward sight point is in a horizontal plane which varies from that of the station point.



Forward Sight Point - Key in the new point name.

Auto Increment - If the toggle is activated, each click of **Locate** increases the **Forward Sight Point** number by one.

Back Sight Point - Previously stored point.

Station Point – Previously stored point.

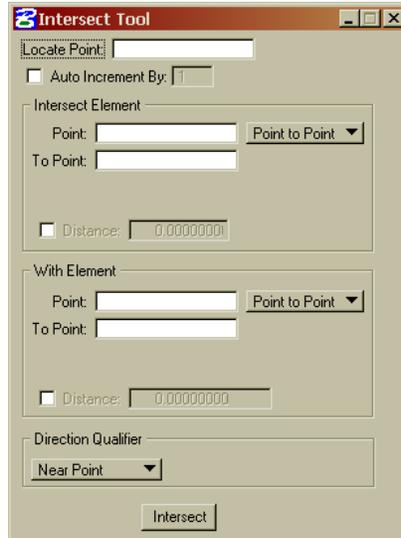
Angle – Must be in degree format.

Length – Master units (i.e. feet or meters).

Vertical Angle - Must be toggled on to be utilized and is required when the **Forward Sight Point** is in a horizontal plane, which varies from that of the **Station Point**.

Locate – Commence locating.

INTERSECT TOOL– The Intersect commands enable the user to locate and store point(s) by reading and processing from previously stored points, curves, lines, spirals and chains, all from one dialog.



At the top of the dialog is the new point number to be located. When the **Auto Increment** toggle is active, the point number increments by one each time the Intersect button is pressed. The rest of the dialog is split into two groups each defining one element of the intersection. As each element type is selected, the dialog dynamically changes to reflect the selection. For example, in the dialog above, when Line is selected, input requirements include Direction and Point. However, in the bottom of the dialog where the element is Chain, the input requirement is simply chain name. Supported intersection elements include:

- Point to Point
- Line
- Arc
- Spiral
- Curve
- Chain

Point-to-Point - The line input requirements consist of two Point fields. The optional Offset can be utilized by toggling on the desired offset and typing in the **Distance** value, in terms of master units, i.e., feet or meters. Standard surveying convention is utilized for selection of **Right** and **Left**.

Coordinate Geometry

With Element
Point: 502 Point to Point
To Point: 503
 Distance: 24.00000000

Line - The line input requirements consist of **Point** and **Direction** options. These include **Bearing, Azimuth, QDD.MMSS, Pa TO pb,** and **Direction Back, Direction Ahead** and **Direction of Chord** for **Curves** and **Spirals**. Optional offsets can be utilized by toggling on the desired offset and typing in the **Distance** value, in terms of master units, i.e., feet or meters. Standard surveying convention is utilized for selection of **Right** and **Left**. If the intended directions do not create an intersection, one or both lines are extended to make an intersection. A warning message is printed to indicate extended lines.

With Element
Point: 502 Line
Direction
Direction
 Distance: 24.00000000

- Direction
- Azimuth
- Bearing
- QDD.MMSS
- Pa To Pb
- DA Curve
- DB Curve
- DC Curve
- DA Spiral
- DB Spiral
- DC Spiral

Intersect Tool – Line option

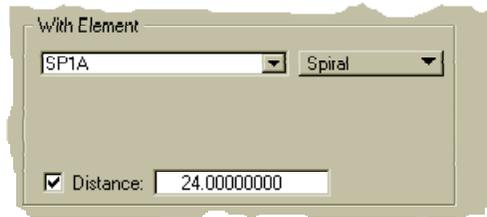
Arc- The **Arc** group box consists of the **Center Point** and **Radius** keyin fields, but no offsets. The **Center Point** number must be a previously defined point and the **Radius** is specified in terms of master units. Note that arc-chain and arc-curve intersections are not supported.

With Element
Point: 502 Arc
Radius: 500.00000000

Intersect Tool – Arc option

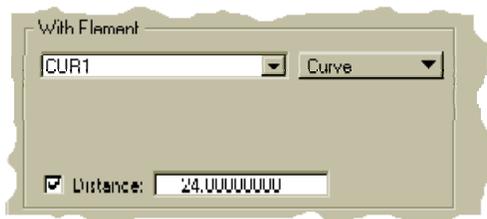
Spiral - The **Spiral** group box consists of the **Spiral Name** key-in combo field and optional **Offset**. The **Spiral Name** can be selected from the list of stored curves or typed into the field. The toggle to the left of the Distance activates the optional Offset. Specify the desired **Offset** (in master units), then select the **Right** or **Left** option.

Coordinate Geometry



Intersect Tool – Spiral option

Curve - The Curve group box consists of the **Curve Name** key-in combo field and optional **Offset**. The **Curve Name** can be selected from the list of stored curves or typed into the field. The optional **Offset** is activated by the toggle to the left of the **Distance**.. Specify the desired **Offset** (in master units), then select the **Right** or **Left** option.



Intersect Tool – Curve option

Chain - The Chain group box consists of the **Chain** key-in combo field and optional **Offset**. The **Chain** can be selected from the list of stored curves or typed into the field. The toggle to the left of the Distance activates the optional Offset. Specify the desired **Offset** (in master units), then select the **Right** or **Left** option.



Intersect Tool – Chain option

Three directional qualifiers (**Back**, **Ahead**, and **Near Point**) are supported in intersection options where multiple solutions are possible. The qualifiers signal to the software which intersection is desired when there are two solutions. When the dialog is completed, clicking **Intersect** commences the computation.

BEST FIT TOOL – calculates a best-fit chain through a set of points.

Coordinate Geometry

TRANSLATION AND ROTATION TOOL – moves, rotates, and scales a data set.

MAP CHECK TOOL – edits a parcel.

ROADWAY INTERSECTION TOOL – calculates the data for the intersection of two roadways.

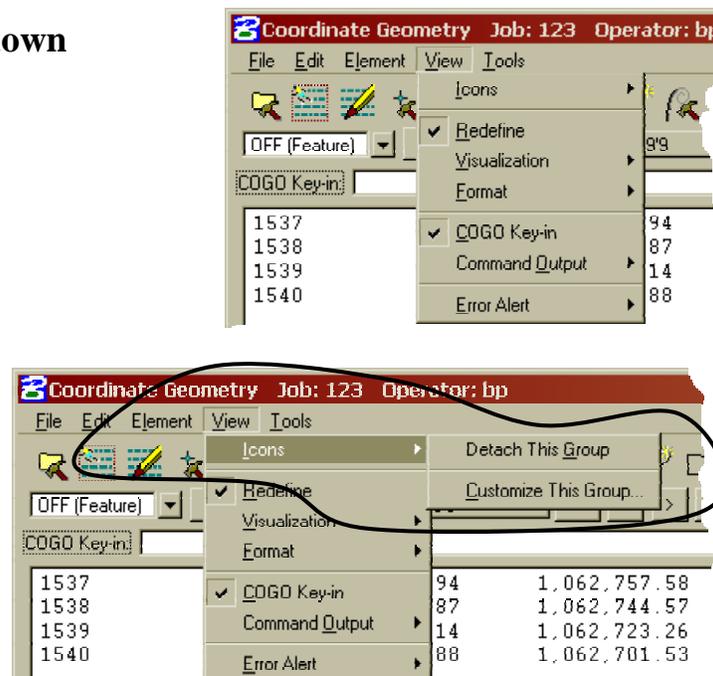
CUL-DE-SACS TOOL – calculates the data for a cul-de-sac.

REDRAW VISUALIZED ELEMENTS – re-syncs the coordinate geometry data with the data displayed in the Microstation file.

CLEAR VISUALIZED ELEMENTS (TEMPORARY) – clears the temporary visualized elements from the view.

CLEAR VISUALIZED ELEMENTS (ALL) – clears the visualized elements from the Microstation file.

5.4.7 View pulldown

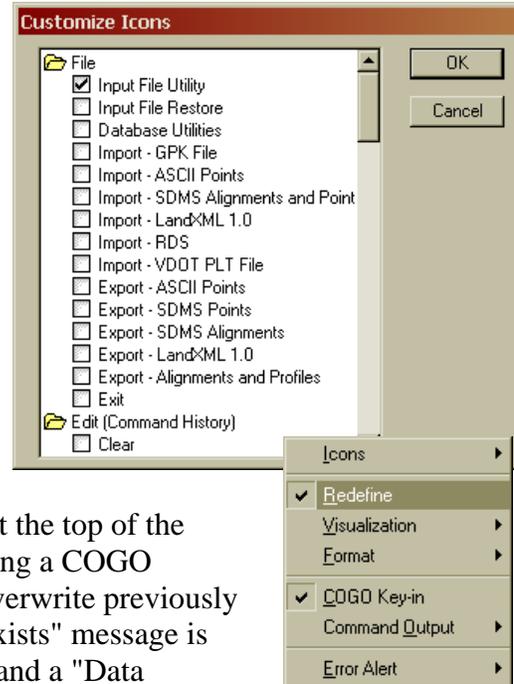


Icons - COGO command dialogs (i.e., store point, describe chain, etc.) can be invoked from icons, in addition to the pulldown options. Quite often, depending on the task, the user utilizes the same commands repetitively. Rather than continually selecting the pulldown, the icon for each dialog can be displayed. Pressing the icon invokes the same dialog as the pulldown. The user selects which icon or group of icons is displayed from the View Icon tools, described in the table below.

Coordinate Geometry

Detach This Group – Allows the user to remove a tool bar from the Coordinate Geometry dialog box.

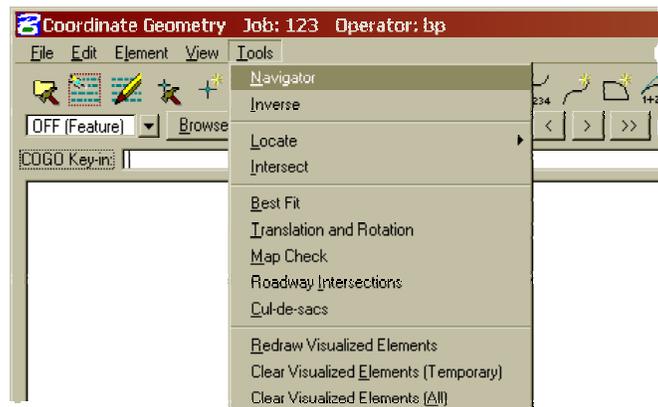
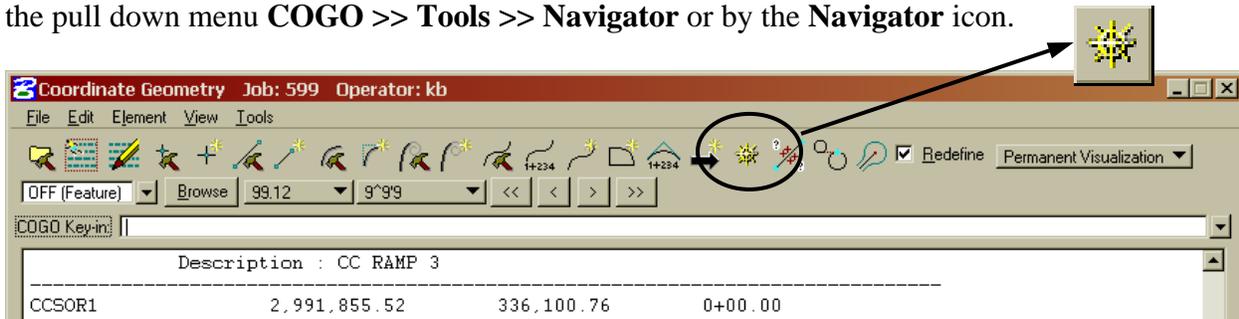
Customize This Group - Selection of this pulldown invokes the Customize Icons dialog, wherein group or individual icons may be activated or deactivated.



Redefine - This option is a display / non-display option, rather than several settings. When activated on the **View > Redefine**, the Redefine option is displayed at the top of the dialog, for easy activation / deactivation at any time during a COGO session. When this toggle is not active, any attempt to overwrite previously stored data will not be processed and a "Data Already Exists" message is displayed. If the toggle is active, the data is overwritten and a "Data Redefined" message is displayed.

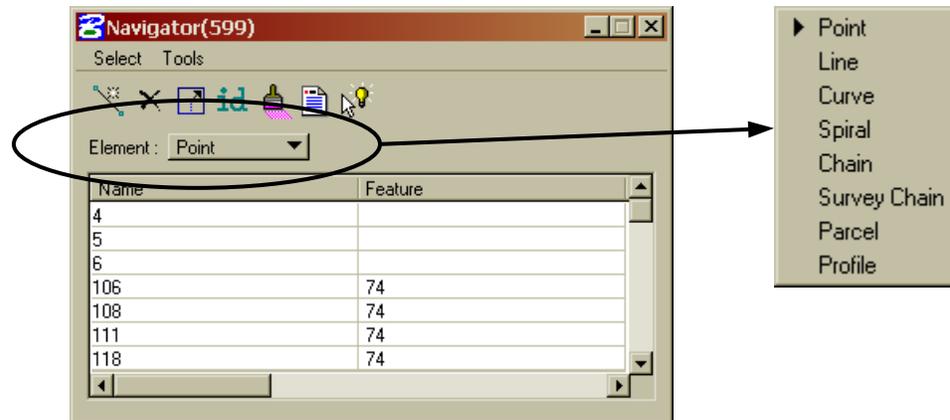
5.5 COGO Navigator

COGO Navigator is a tool to easily view and edit COGO data. **Navigator** can be accessed by the pull down menu **COGO >> Tools >> Navigator** or by the **Navigator** icon.



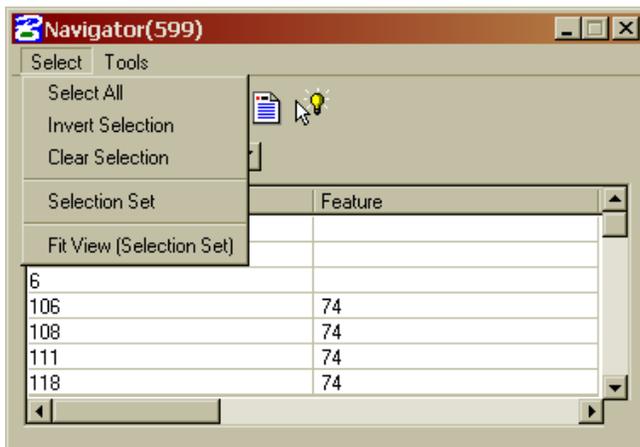
Coordinate Geometry

From the **Navigator**, points, lines, curves, spirals, chains, survey chains, parcels, and profiles can be added, deleted, modified, identified, visualized, printed, or selected.



5.5.1.1 NAVIGATOR>>SELECT MENU

An alternate method of highlighting elements within the Navigator Name / Feature list box is the use of three Selection tools, located on the Select menu in the upper left corner of the Navigator.



Select All – Highlights all elements within the Name / Feature list box regardless of their current status.

Invert Selection – Reverses the highlighting.

Clear Selection – Removes highlighting from those elements in the Name / Feature list that were previously highlighted.



Selection Set - allows the user to create a selection set that meets particular criteria. This is the same as using the **Selection Set** icon.

Three additional tools on the Select pulldown enable the user to manipulate the screen or **Name / Feature** list box.

Fit View (Selection Set) – First, highlight the desired elements in the **Name / Feature** list box. When this tool is selected, the screen is fitted to display only the selected elements.

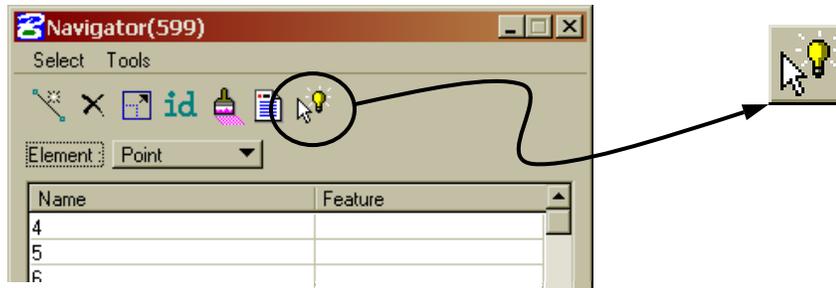
Show Selected Elements Only - First, highlight the desired elements in the **Name / Feature** list box. When this tool is selected, all elements not highlighted are temporarily removed from the

Coordinate Geometry

Name / Feature list box. The subset of displayed elements can be utilized for other Navigator commands until the Navigator is closed or a Show All Elements command is issued.

Show All Elements - When this tool is selected, all elements of the specified element type are displayed in the **Name / Feature** list box. This command is utilized to countermand the **Show Selected Elements Only** command.

The last tool on the Select menu is **Selection Set**, used to create the selection set for use with other Select tools.



5.5.1.2 NAVIGATOR>>TOOLS



Add Element – allows the selected type of element to be stored.



Delete Element – deletes the selected type of element.



Edit Element – allows the selected element to be edited.



Identify Element – allows the user to select an element by selecting it graphically.



Print/Describe Element – Displays the selected element's coordinate or alignment data.

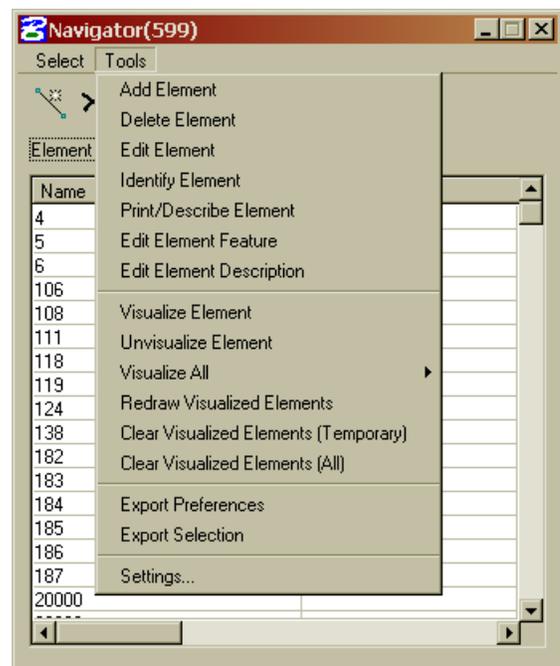
Edit Element Feature – Changes the feature code of the element.



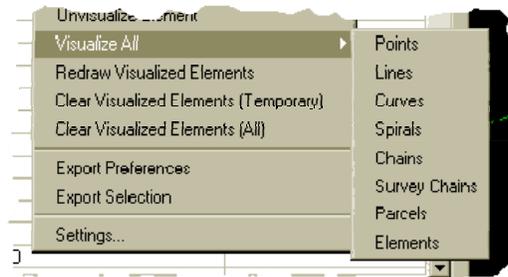
Visualize Element – Displays the selected elements according to their feature codes.

Unvisualize Element – When selected, the visualization of the highlighted elements is deleted. Note the element is not deleted from the database, just its visualization.

Visualize All – If the user wants all points (or all curves, parcels, etc.) visualize, the entire name / Feature list box can be highlighted and the Visualize Element tool can be utilized. However, for



ease of use, utilizing the Visualize All options do not require highlighting any elements within the Name / Feature list box. Simply select the Visualize All and desired element from the option pulldown.



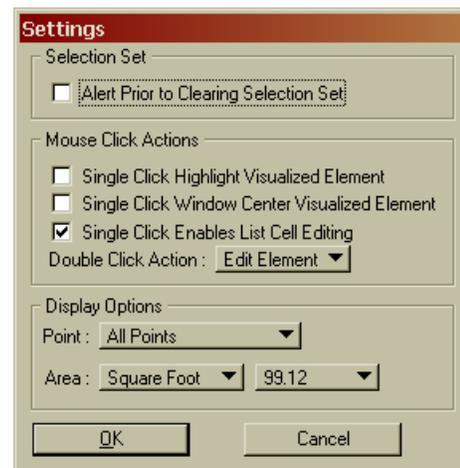
Redraw Visualized Elements - When selected, all visualized elements are redrawn. If the location of an element in the design file does not correspond to its coordinates in the database, the element is redrawn utilizing the database information. If a visualized element was deleted using generic MicroStation commands, the COGO element is redrawn.

Clear Visualized Elements (Temporary) – When selected, all temporary visualized elements are deleted. Note the elements are not deleted from the database.

Clear Visualized Elements (All) – When selected all temporary and permanent visualized elements are deleted. Note, the elements are not deleted from the database.

5.5.1.3 NAVIGATOR TOOL SETTINGS

Settings – Several tool settings are supported for user flexibility. The settings dialog is separated into four sections:



Selection Set

Alert Prior to Clearing Selection Set - When activated and the user selects the a command which requires a new selection set, an Alert message is displayed.

Clicking **Yes** clears the current selection set and the selected command / dialog is processed. If **No** is clicked, the current selection set is not cleared and the selected command request is ignored.

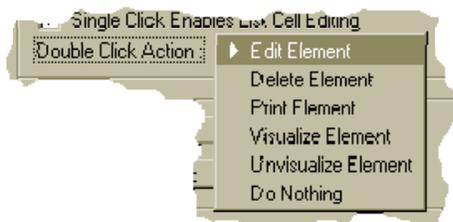
Single Click Action

Two options are supported, which may be selected simultaneously.

Highlight Visualized Element - If the **Highlight Visualized Element** is active, a single click on any element within the Name / Feature list box highlights the element. Note either temporary or permanent visualization must be active.

Window Center Visualized Element - When the **Window Center** option is active, a single click on any element in the **Name / Feature** list box window centers the element. If both toggles are active, the element is centered and highlighted.

Mouse Click Action



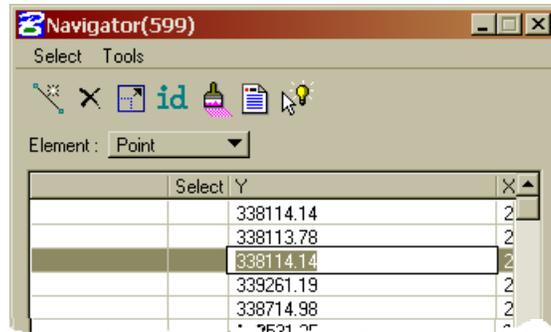
Double Click Action - As a shortcut to many of the frequently used element commands, this option enables the user to select one of the commands listed to the left. When an element in the Name / Feature list box is double clicked, the selected command in the tool settings is invoked. For example, if the **Print Element** command is selected in the tool settings, then when any element in the Name / Feature

list box is double clicked, the print element command is invoked. If the **Visualize Element** command is selected in the tool settings, when any element in the Name / Feature list box is double clicked, the element is visualized. If the **Do Nothing** option is selected, a double click on any element invokes no command.

Note the difference between a double click action and a second click action is simply timing. Two clicks extremely close together is considered a double click, while a single followed closely by a second is considered a second click.

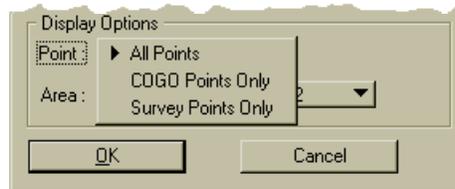
Second Click Enables List Cell Editing - When this toggle is active the various fields in the Navigator list box may be edited. When toggled off, no editing within the Navigator list box is supported.

Coordinate Geometry



Note the difference between a double click action and a second click action is simply timing. Two clicks extremely close together are considered double clicks, while a single followed closely by a second is considered a second click.

Display Options - If the current GPK file has both Survey points (processed through the Import to Database procedure in the Survey Project Manager) and COGO points, stored via COGO commands, the View options support viewing all points (both survey and COGO), COGO only, or Survey Only.

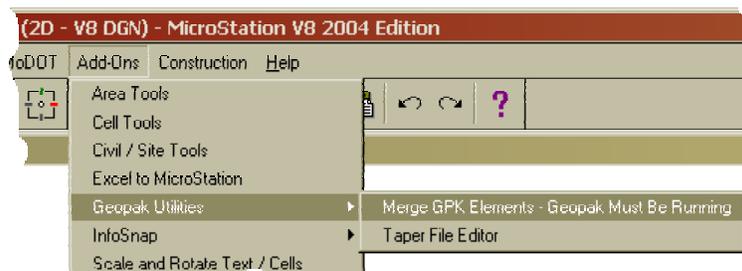


All Points, COGO Points Only and Survey Points Only - If the current GPK file has both Survey points (processed through the Import to Database procedure in the Survey Project Manager) and COGO points, stored via COGO commands, the View options support viewing all points (both survey and COGO), COGO only, or Survey Only.

5.5.1.4 MERGING GPK ELEMENTS

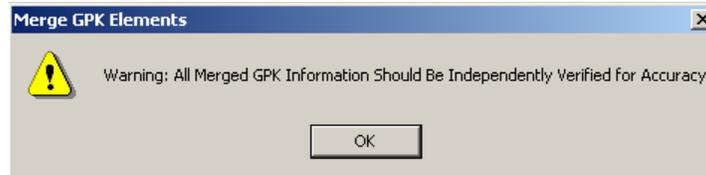
A Visual Basic Application (VBA) is available to allow users to merge elements from one GPK to another. This VBA is located under the MicroStation Add-Ons pull down menu.

Add-Ons>>Geopak Utilities>>Merge GPK Elements – Geopak must be running.



When opening the tool, the user will get the following dialog box. Select OK to dismiss.

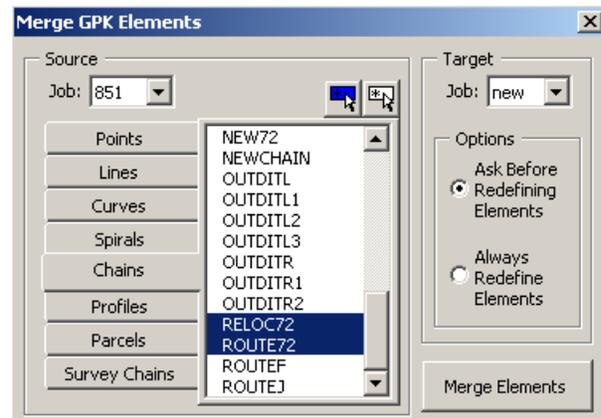
Coordinate Geometry



The tool requires a source and a target GPK. Both databases must exist before running the tool. The source GPK is defined as the database from which the elements are extracted, and the target one is where the elements will be transferred.

The user can select multiple type geometry at one time. To select an element, first select the type of geometry and then high light from the available list. The tool offers two options for handling existing geometry in the target GPK with the same name. One is to always “**Ask Before Redefining Elements**”, and the second one is to “**Always Redefine Elements**”. If any redefinition of elements must be done, the Redefine toggle must be checked on in the Coordinate Geometry dialog box.

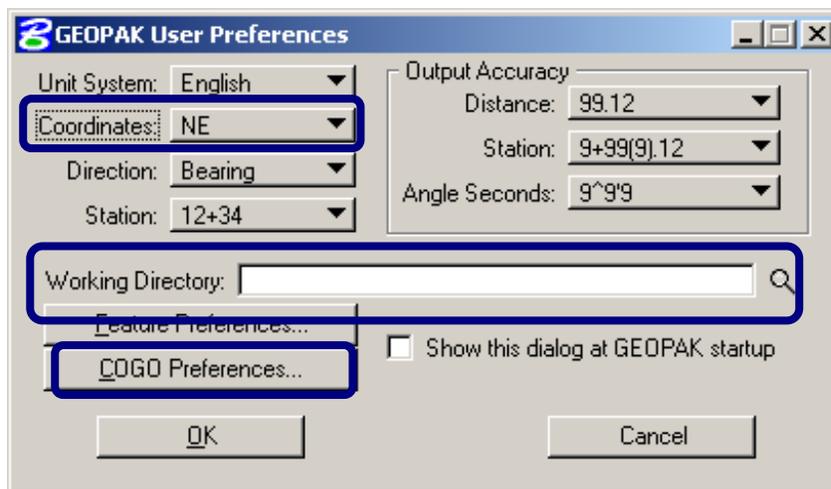
Once the tool is set up, select **Merge Elements**. Once the tool is done merging elements, the user will get the message to the right. To view the log file select **Yes**.



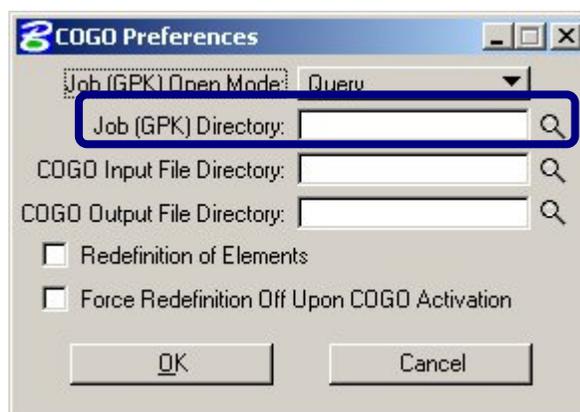
Exercise 4-1

1. Open the MicroStation file `t:\de-proj\Carter\Exercise_Rte_24\Route_24.dgn`.

2. Go to **Applications>>GEOPAK Road>>User Preferences** and delete the working directory.



Then select **COGO Preferences** and delete the Job (GPK) Directory as well.

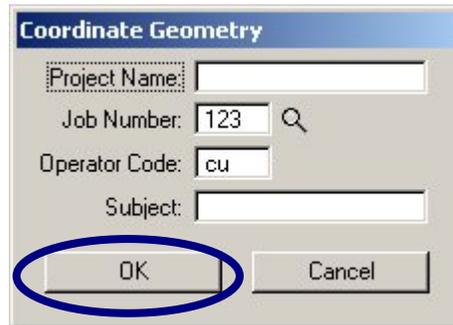


Coordinate Geometry

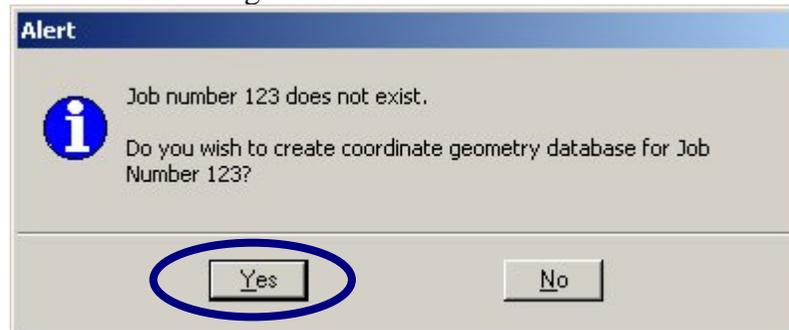
3. Open the **Coordinate Geometry** dialog. 

Create **Job Number: 123**

Set the **Operator Code** to your initials.



Since this coordinate geometry database does not exist, you will get the following message. Select **Yes** to the alert dialog to continue.

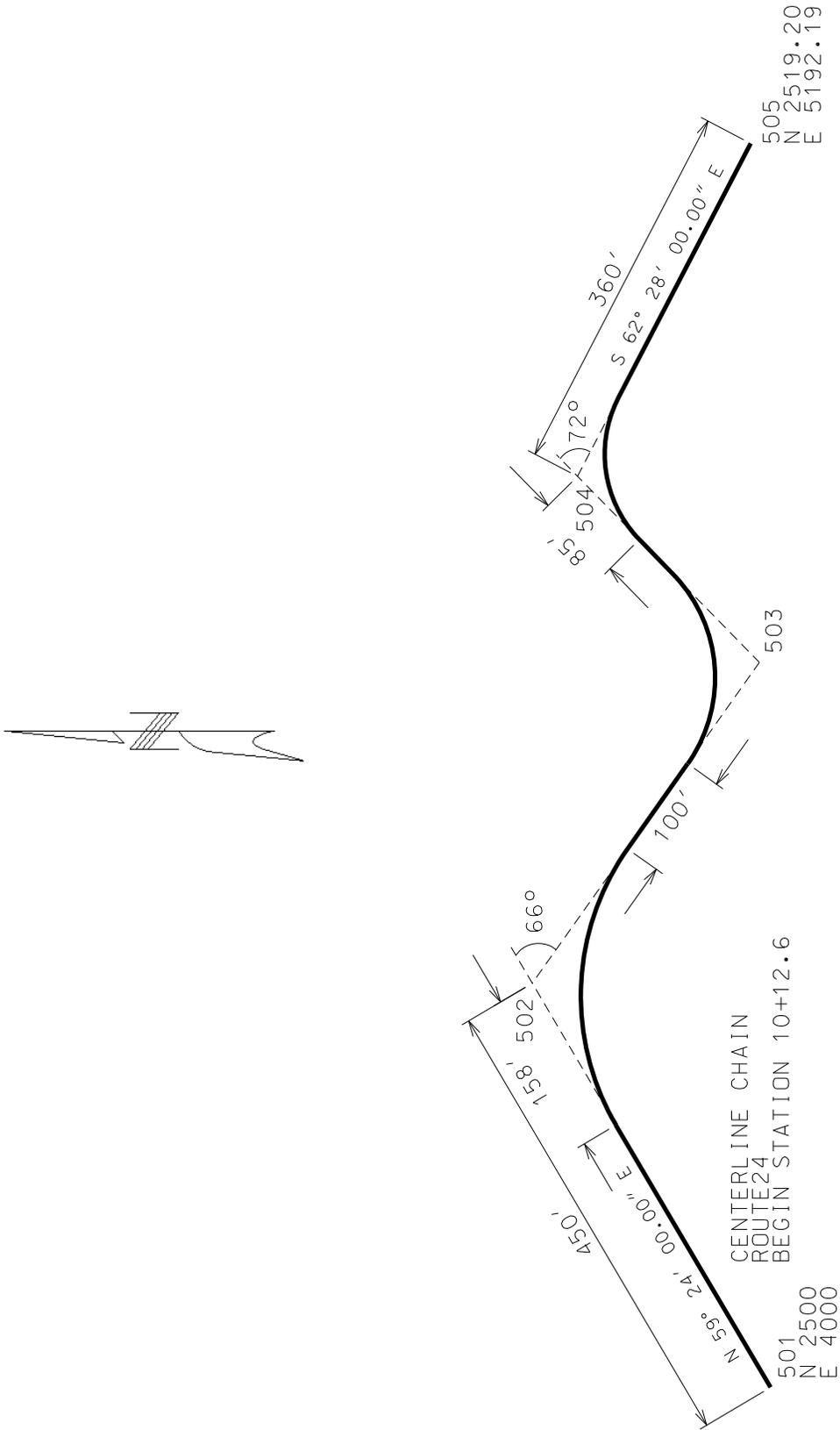


4. To see the elements as you stre them turn on **Permanent Visualization**.



Create the following alignment as shown on the following pages.

Coordinate Geometry



Coordinate Geometry

5. Store points **501** and **505** with the coordinates shown.

The 'Store Point' dialog box for point 501 shows the following fields and options:

- Point Name: 501
- Auto Increment
- Coordinates:
 - Northing: 2500
 - Easting: 4000
- Station: []
- Elevation: []
- PCode: []
- Point Cell: [] Scale: []
- Feature: []
- Description: []
- Store Point button (circled in blue)

The 'Store Point' dialog box for point 505 shows the following fields and options:

- Point Name: 505
- Auto Increment
- Coordinates:
 - Northing: 2519.2
 - Easting: 5192.19
- Station: []
- Elevation: []
- PCode: []
- Point Cell: [] Scale: []
- Feature: []
- Description: []
- Store Point button (circled in blue)

6. Locate points **502** and **504**.

The 'Locate Traverse' dialog box for point 502 shows the following fields and options:

- Locate Point: 502
- Elevation On
- Side Shot Mode
- Station Point:
 - Name: 501
 - Equate button
 - Elevation: 0.000000
 - Station Height: 0.000000
- Direction:
 - Bearing: N 59 24 00 E + []
 - Offset Distance: 0.0000
- Distance:
 - Distance: 450
 - Zenith Angle: 90 00 00 00
 - Rod Height: 0.000000
- Locate button (circled in blue)

The 'Locate Traverse' dialog box for point 504 shows the following fields and options:

- Locate Point: 504
- Elevation On
- Side Shot Mode
- Station Point:
 - Name: 505
 - Equate button
 - Elevation: 0.000000
 - Station Height: 0.000000
- Direction:
 - Bearing: N 62 28 W + []
 - Offset Distance: 0.0000
- Distance:
 - Distance: 360
 - Zenith Angle: 90 00 00 00
 - Rod Height: 0.000000
- Locate button (circled in blue)

7. Locate point **503** by using the **Intersect** tool.

Intersect Tool

Locate Point: 503

Auto Increment By: 1

Intersect Element

Point: 502 Line

Direction

Pa To Pb 501 502 + 66

Distance: 0.00000001

With Element

Point: 504 Line

Direction

Pa To Pb 504 505 - 72

Distance: 0.00000000

Direction Qualifier

Near Point

Intersect

8. Store **CURVE1**, **CURVE2**, and **CURVE3**.

Store Curve By Tangents

Curve name: curve1 Station PC

Back Tangent

Element

Ahead Tangent

Tangent Length

158

PB: 501

PI: 502

PA: 503

Store Curve

7. (Continued)

Store Curve By Tangents

Curve name: Station PC

Back Tangent: PB: PI:

Element:

Ahead Tangent: PA:

The **Tangent Length** needs to be typed in, also m = minus, p = plus

Store Curve By Tangents

Curve name: Station PC

Back Tangent: PB: PI:

Element:

Ahead Tangent: PA:

9. Store the alignment chain **Route24**.

Store Chain From Elements

Chain Name:

Element List:

Element Selection:

Coordinate Geometry

10. Station the centerline at the beginning with station 10+12.6



11. Describe the chain and save an output file. Review the output file in any text editor like **UltraEdit** or **Notepad**.

12. Use **COGO Navigator** to review the data.

13. Exit Coordinate Geometry.

Coordinate Geometry

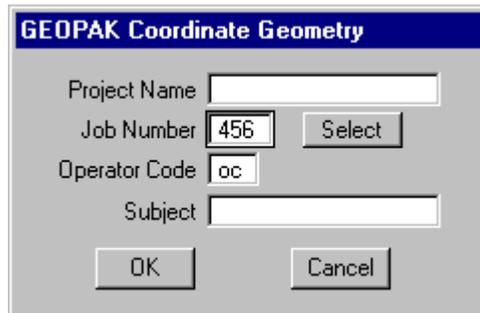
Exercise 4-2

1. Open the MicroStation file **t:\de-proj\Carter\J3P0497\data\topo_J3P0497.dgn**

2. Open the **Coordinate Geometry** dialog under **Geometry**.

Create **Job Number: 456**

Set the **Operator Code** to your initials.



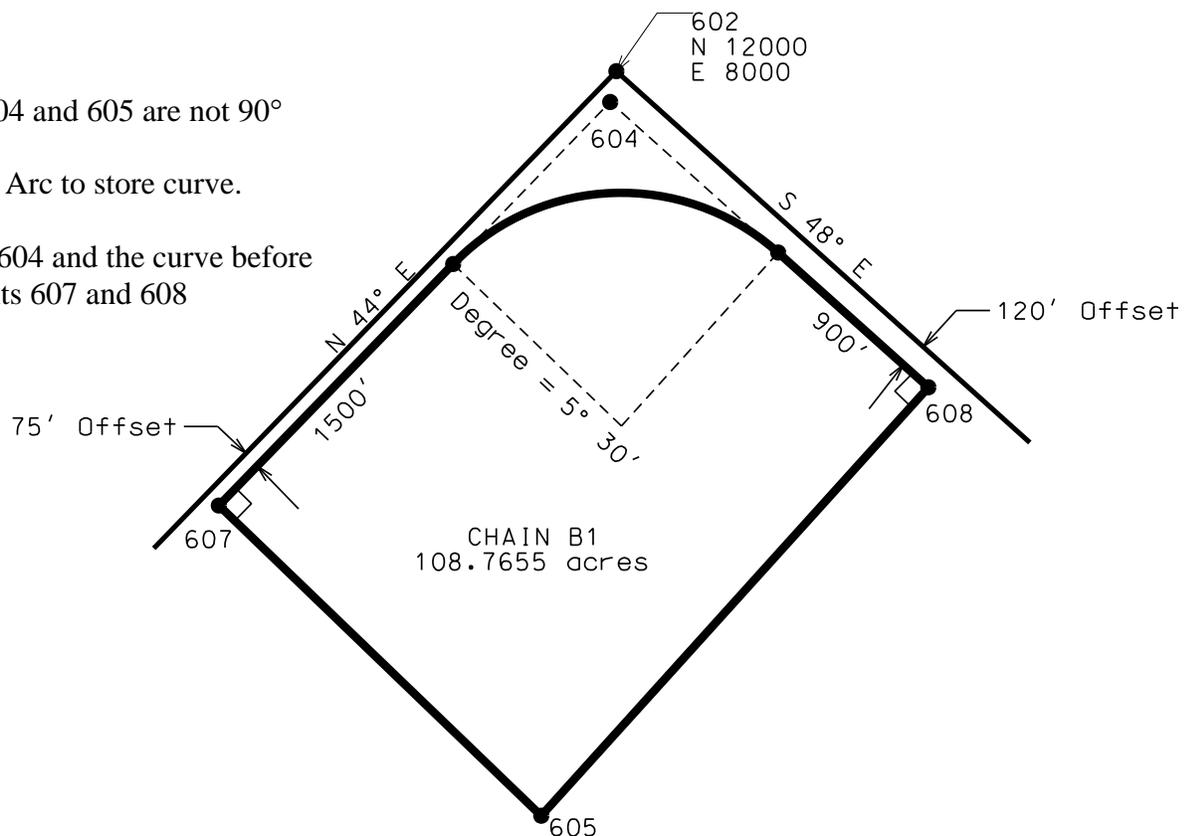
3. Use the **Coordinate Geometry** tools to create chain B1 as shown below. Verify the area of the chain.

Hints:

Angles at 604 and 605 are not 90°

Use Degree Arc to store curve.

Store point 604 and the curve before storing points 607 and 608



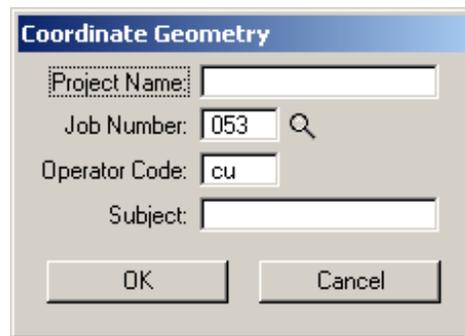
Exercise 4-3

This is an individual exercise to practice storing horizontal alignments. It is to be done outside of a GEOPAK project.

1. Open the following MicroStation file: Open the Microstation file:

t:\de-proj\Carter\J3P0497\data\plan_J3P0497.dgn

2. Enter Coordinate Geometry creating a new GPK called **053**, as shown in the following dialog.



3. Use **Coordinate Geometry** to create the alignments as shown on the following pages.

Do not worry about the graphics (stationing, curve data, etc.) being plotted. These items will be discussed in later chapters.

Coordinate Geometry

Route50

Beginning Point: X = 1698102.3440 Y = 999551.4260

Ending Point: X = 1702419.9216 Y = 1000116.5660

Intersect the PI point using the direction back and direction ahead of curve.

Direction Back of Curve = S 82° 41' 55" E

Degree of Curve = 2° 00' 00"

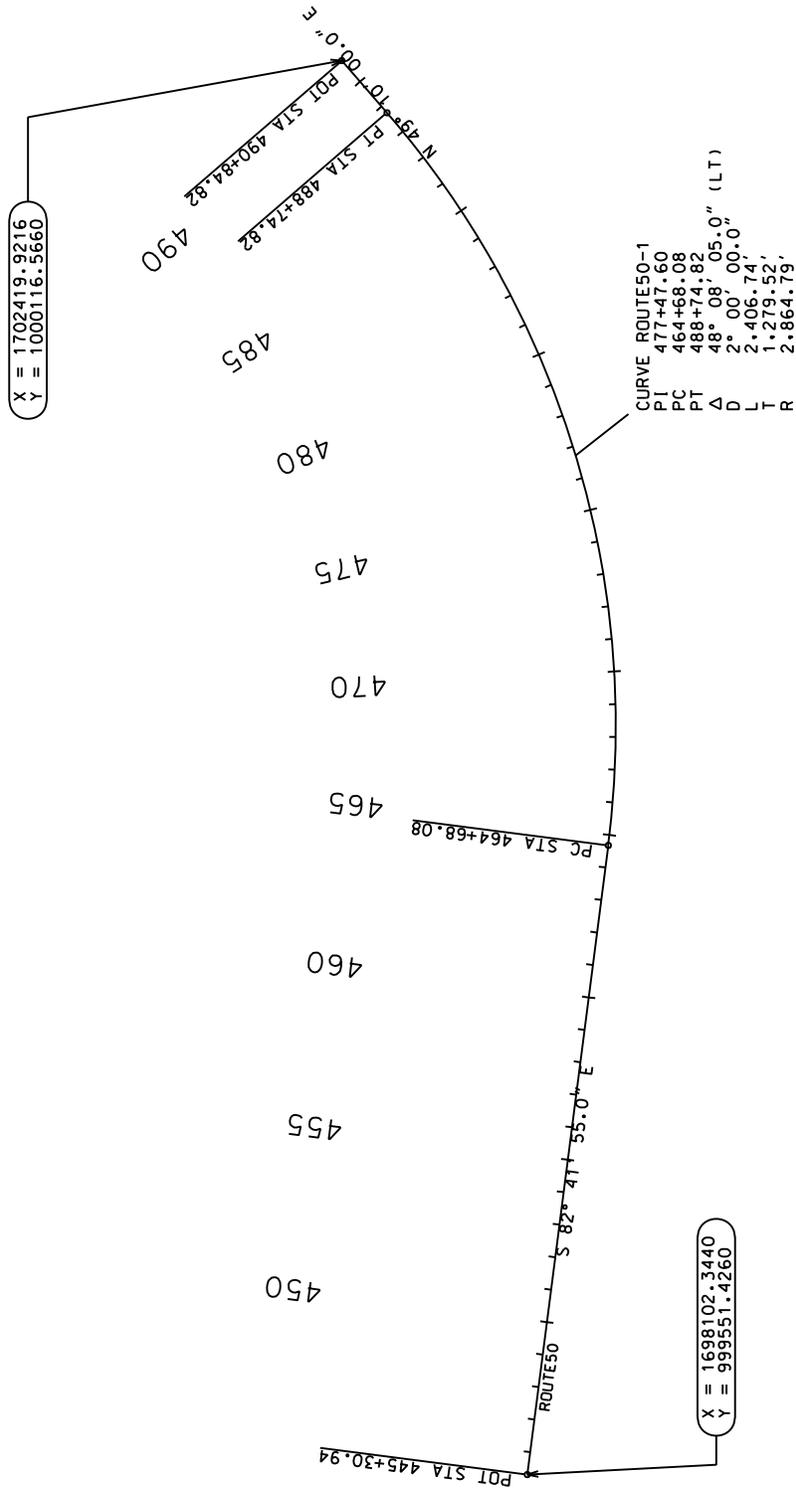
Direction Ahead of Curve = N 49° 10' 00" E

Station the chain beginning at 445+30.94

Name the alignment **Route50**.

Coordinate Geometry

Route 50



Big Horn

Beginning Point: X = 1700104.5480
Y = 1000188.1340

Ending Point: X = 1700092.3040
Y = 998143.9168

PI of the first curve is exactly 248.8954' from the beginning point on a bearing of S 1° 04' 27.8" W

Direction Back of first curve = S 1° 04' 27.8" W

Degree of Curve for first curve = 5° 00' 00"

Direction Ahead of first curve = S 6° 32' 27.3" E

The direction back of second curve matches the direction ahead of the first curve, which is S 6° 32' 27.3" E

Degree of Curve for second curve = 5° 00' 00"

Direction Ahead of second curve = S 6° 42' 48.6" W

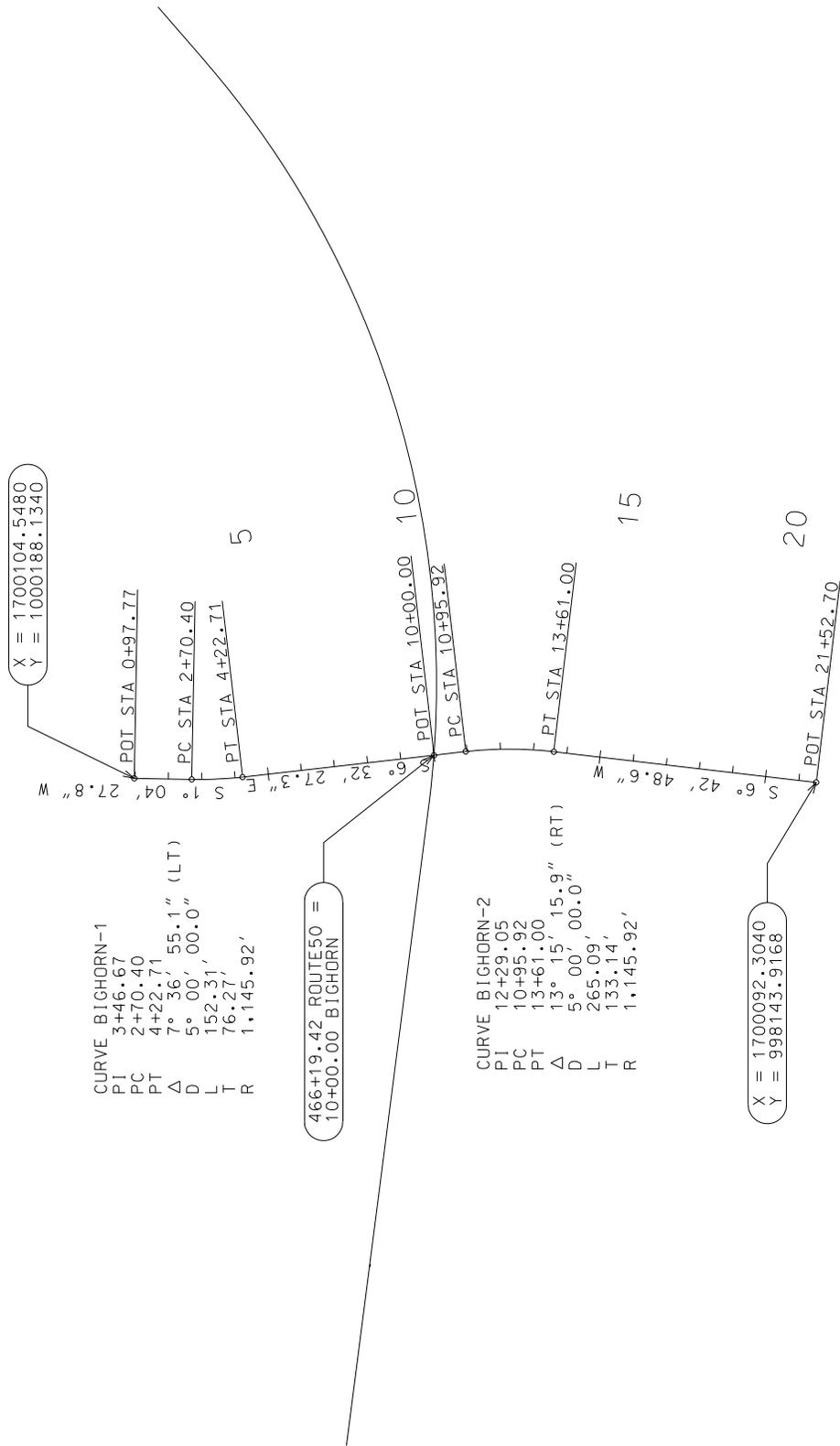
Intersect the alignment chain Route50 with a line segment between the PT of the first curve, and the PC of the second curve. **Note:** The Route 50 station value shown is approximate.

Store the alignment as BigHorn (be sure to include the Route50 intersection point)

Station the alignment with station 10+00 at the intersection point with the Route50 chain.

Coordinate Geometry

Big Horn



Ramp 1

Beginning Point is at station 452+56.52; offset 66' LT of Route 50

The PC of the curve is the Beginning Point

Direction Back of the curve is S 82° 41' 55" E

Degree of Curvature = 4° 00' 00"

Direction Ahead of the curve is N 83° 27' 28.56" E

Alignment ends at Big Horn, at **about** Station 6+55.32

Station the alignment beginning at 0+00

Name the alignment Ramp1

Ramp 3

Beginning Point is at station 479+48.31; offset 66' LT of Route 50

Ending Point is at end of Ramp1; however, use different point numbers for the ending point of each ramp. **Hint:** Element > Point > Equate.

PC of the first curve is the alignment beginning point.

Direction Back for the first curve is S 67° 41' 47.7" W

Degree of Curvature for first curve = 6° 00' 00"

Direction Ahead for the first curve is N 69° 50' 21.3" W

Point Back of the second curve is the PI of the first curve

PI of second curve is at the intersection of a line through the PI of the first curve with a bearing of N 69° 50' 21.3" W and a line through ending point of Ramp1 with a bearing of N 83° 27' 28.56" E. **Hint:** Do not use the same point number as the ending point for both ramps.

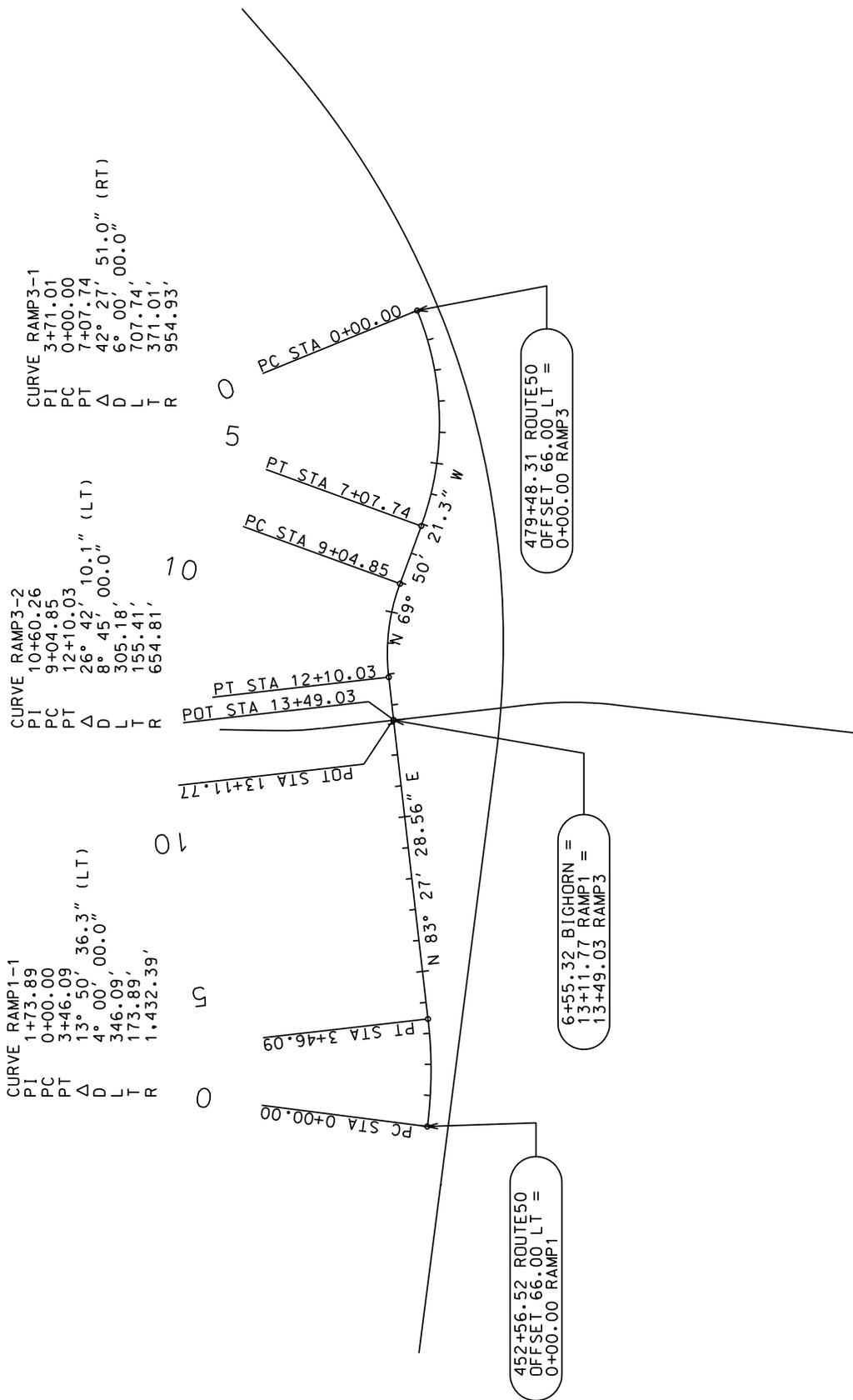
Degree of Curvature for the second curve = 8° 45' 00"

Point Ahead of the second curve is the alignment end point

Station the alignment beginning at station 0+00

Name the alignment Ramp3

Ramp 1 & 3



Coordinate Geometry

4. Upon completion of storing the alignments in coordinate geometry, close coordinate geometry.

5. Delete all of the graphics in the Microstation drawing by going to Edit>>Select All, and then selecting the Delete button.