GEOPAK Road 2001

For Bridge

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I.1 Introduction

GEOPAK is a comprehensive software package that covers every project phase from conceptualization to final quantities. The software works within the MicroStation graphic environment providing true *interactive design*. For example, a horizontal alignment can be created graphically, it can be calculated with the coordinate geometry component of GEOPAK or some interactive combination of the two. Dynamic on-screen design provides immediate interpretation of plan view geometrics for making design choices through visualization.

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

For GEOPAK support, please contact the CADD Support Center.

I.2 File Names

GEOPAK uses and/or creates files during the design process. The files you need to be familiar with are listed below:

job###.gpk This binary file is created when the user starts a coordinate geometry (COGO) session for the first time or through Project Manager and may be appended to during the design process. All coordinate geometry elements are stored in this file. Multiple users can access this file at the same time, and only one file should be created for each project. The "###" is the only variable in this name. It represents a job number (up to 3 alphanumeric characters) unique to a project and is defined by the user upon creation. MoDOT users should use the last 3 digits of the job number. Example J1P0999 -> job999.gpk

fname**.inp** Any ASCII input file for running GEOPAK processes. Name is user defined with a .inp extension. Example: **shape.inp**

fname.**log** ASCII file used to capture results from processing input files, proposed cross sections, and earthwork.

fname###.**i**oc ASCII input file for loading data during a COGO session. "###" represents the job number and "oc" is the operator code (users initials). Example: **align999.iho**

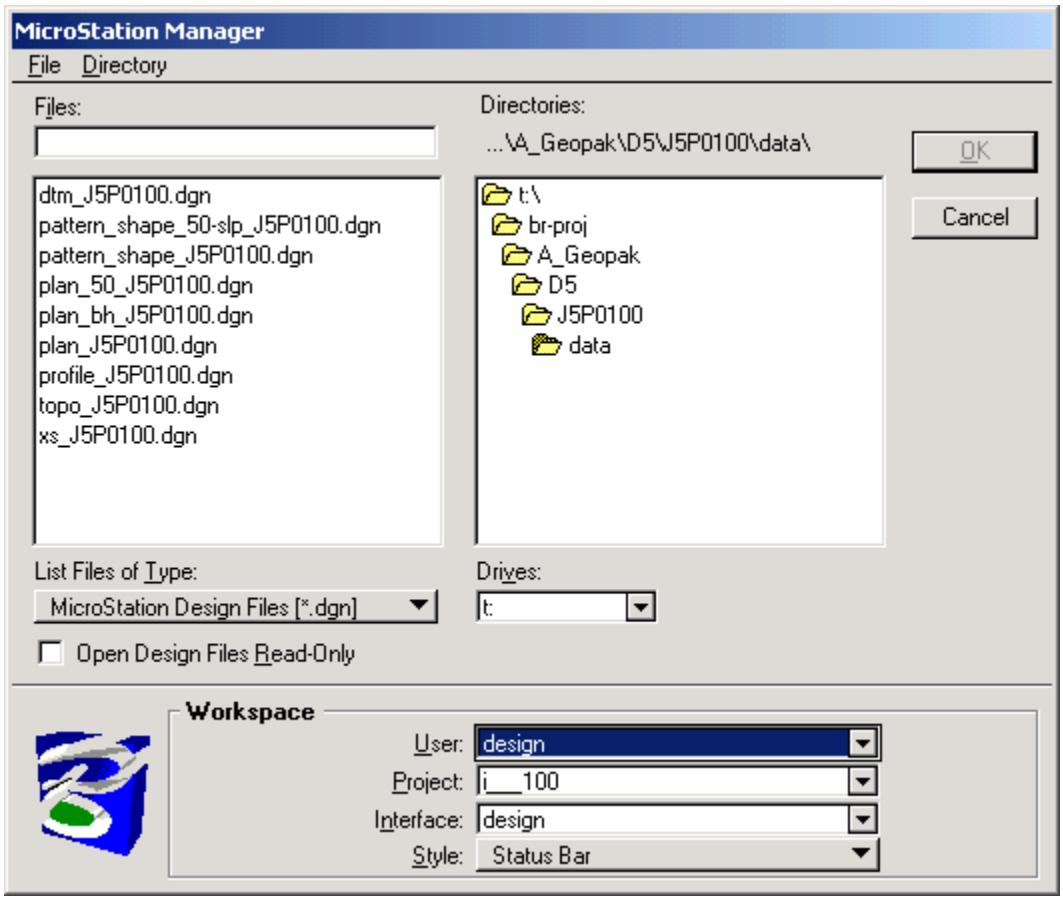
fname###.**o**oc ASCII output file created by GEOPAK during a COGO session. Variables are the same as defined above. Example: **align999.oho**

fname.**dat** A binary file that contains string and point information to be used for digital terrain model construction.

fname.**tin** A binary file containing triangular surfaces also known as the digital terrain model (DTM)

project.**prj** Binary file resulting from the creation of a new project.

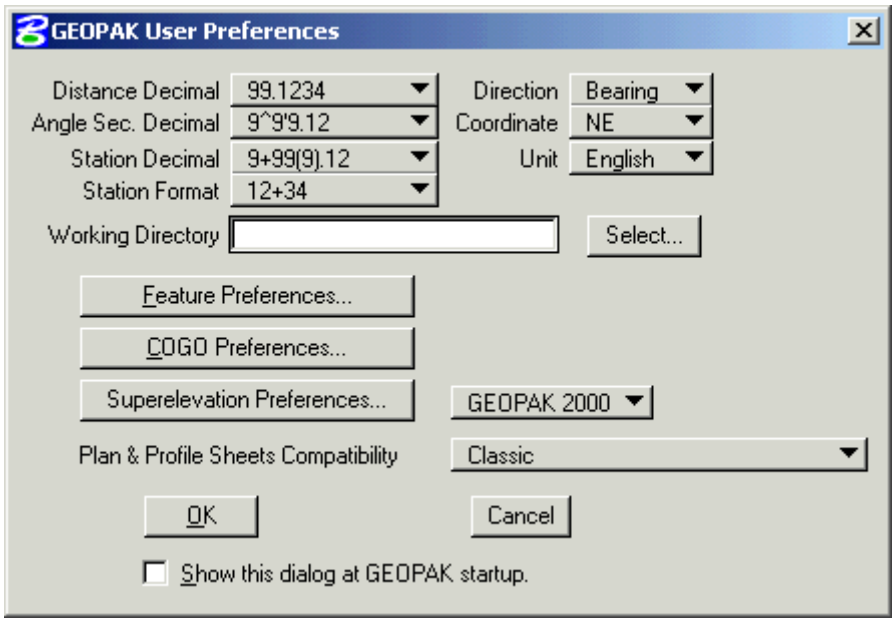
I.3 Accessing GEOPAK Road



GEOPAK is started upon entering a MicroStation File with **User:** set to **design**, as shown in the dialog to the right. To verify that GEOPAK is active, scan the MicroStation menu bar where the Applications menu appears. Simply pull down **Applications > GEOPAK Road**. When each GEOPAK tool is selected, the corresponding dialog will appear. To utilize the full potential of GEOPAK, usage of the GEOPAK dialogs may be interspersed with generic MicroStation commands. In addition, several dialogs may be opened simultaneously.

To close a dialog, simply click the X in the upper right corner of the dialog. In addition, the Coordinate Geometry dialog and Design and Computation Manager may be closed by selecting the **File > Exit** option. Other various dialogs will have a **Cancel** button, which will exit the dialog. Exiting the MicroStation file automatically closes all GEOPAK dialogs.

I.4 User Preferences

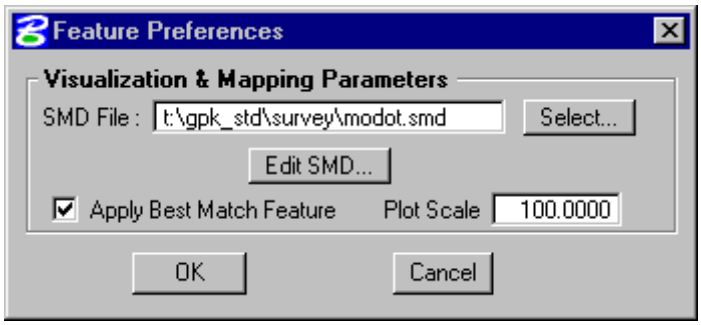


The **User Preferences** dialog is used to set items that determine how distances, directions, and stationing is displayed and calculated, as well as the units that are used. The **User Preferences** dialog can be accessed from **Applications>>Geopak Road>>User Preferences**. The following dialog appears.

Most of the settings in this dialog will be set when the project is setup.

The **Working Directory** is used to tell Geopak where the data files for a particular project can be found. If a user does not want to work within a specific project, they can delete the information out of this field, and Geopak will use the directory that the open MicroStation file is located in.

I.4.1 Feature Preferences

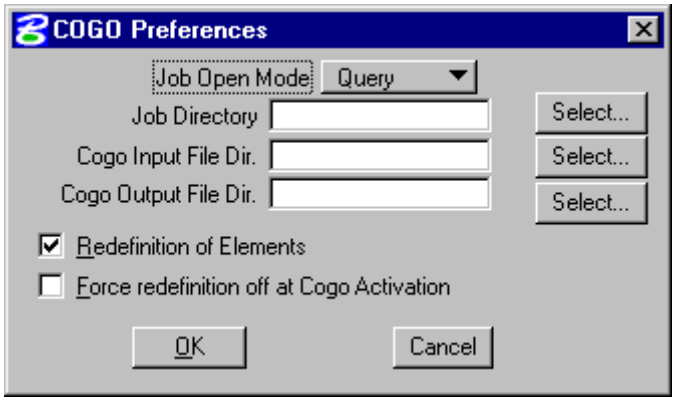


The **Feature Preferences** button will activate the following dialog.

The **SMD File** is used to control the symbology of survey elements. Users will not be able to edit the **SMD File**, however, the **Edit SMD…** button can be used to view the feature codes. The **Apply Best Match Feature** toggle should be checked to allow for proper import of survey data. The scale of the features can be controlled using the **Plot Scale**. This should be set to the scale of the plan sheets to be created.

I.4.2 COGO Preferences

The **COGO Preferences** button will activate the following dialog.



The **Job Directory** can be set to indicate the location of the coordinate geometry database (.gpk). If this field is not set, GEOPAK will look for the coordinate geometry database (.gpk) in the **Working Directory**. The **COGO Input File Dir.** and **COGO Output File Dir.** can be set to indicate the location of the COGO input and output files respectively. If these fields are not set, GEOPAK will look in the **Job Directory**.

The **Redefinition of Elements** toggles on or off the COGO redefine option. This option is discussed further in Chapter 5. The **Force redefinition off at Cogo Activation** will turn the COGO redefine toggle off whenever GEOPAK's coordinate geometry tools are activated.

I.4.3 Superelevation Preferences

There are two options for using GEOPAK Superelevation, **GEOPAK 2000** and **Classic**. **GEOPAK 2000** will use the tools made available in GEOPAK 2000 and later versions. The **Classic** option will bring up the tools available prior to GEOPAK 2000.

****Note:** The **Classic** option will not be supported within MoDOT. Only the **GEOPAK 2000** option will be supported.

The **Superelevation Preferences** have been set by CADD Support and do not need to be modified by the user.

I.4.4 Plan & Profile Sheets Compatibility

Three options are available for creating Plan & Profile Sheets, **Classic**, **GEOPAK 2001+**, and **GEOPAK 2001+ with Raster Manager**. At the present time only the Classic Plan & Profile Sheets tool is configured to MoDOT standards. Consequently the user should choose **Classic**.

Chapter 1

Start Job

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1.1 Objectives

- Be able to start a new Geopak job with the **Start Job** dialog.

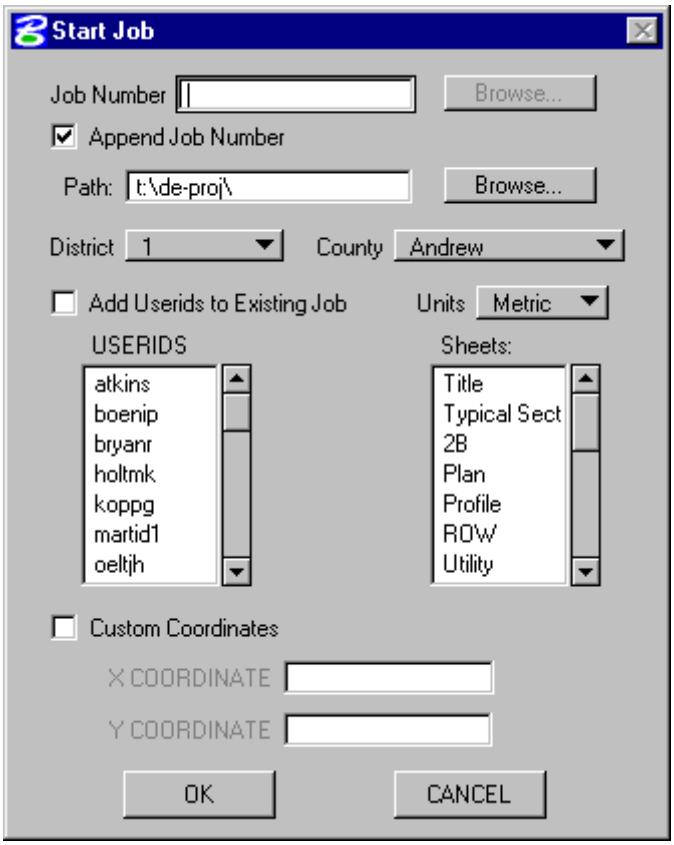
1.2 Definition

Start Job is a tool that will set up a Geopak job for a user, or add users to an existing job. **Start Job** will create the job directories, copy default MicroStation files to the directories, and set the global origin in the MicroStation files. **Start Job** will also append the job number to the end of the copied MicroStation files. Once a job has been created, **Start Job** will add a user to the job. **Start Job** is only available in the design user interface in MicroStation.

1.3 Accessing

Start Job can be accessed from the MicroStation menu **MoDOT>>Start Geopak Job/Add User**.

1.4 Start Job Dialog



Once the user has accessed the **Start Job** dialog box, shown right, they will need to fill in or choose the **Job Number** and the **Path** in which to place the job directory. Once the job number and path have been chosen, the **District** and **County** can be chosen.

If the user is creating a new job, do not check the **Add Users to Existing Job** toggle, just choose the userids of the people that will be working on the job. If a job already exists, and the users are being added to the job, check the **Add Users to Existing Job** toggle.

For a new job, select the **Units** and the **Sheet** types that will be used for the job. This will create a directory for each **Sheet** type selected to place the sheets into as they are created.

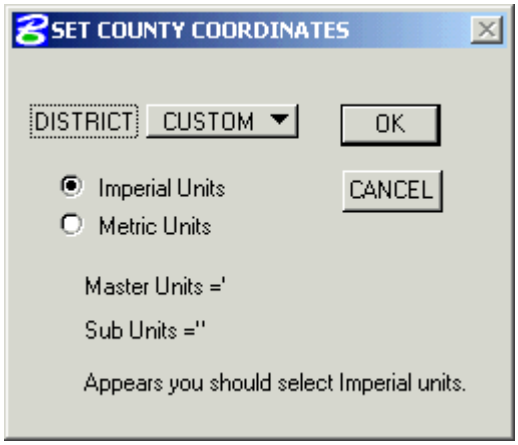
If the job is not based on the modified state plane or the state plane coordinate systems, **Custom Coordinates** must be set to shift the global origin. If the modified state plane or state plane coordinate systems were used for the project, the **County** selected will determine the global origin shift.

Once all fields have been filled in, select the **OK** button. The job directories will be set up as shown below.

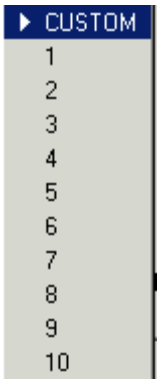
```
T:\
└── br-proj\
    └── A_Geopak\
        └── D# (last digit of district number)
            └── job number
                ├── data
                │   ├── dtm.dgn
                │   ├── pattern_shape.dgn
                │   ├── plan.dgn
                │   ├── profile.dgn
                │   ├── topo.dgn
                │   └── xs.dgn
                ├── plan_sheets
                │   ├── 100
                │   └── 20
                └── project
                    └── projdbs
                        ├── userid1
                        └── userid2
```

The **data** directory contains any project data. This is the directory that contains the MicroStation drawings, the Geopak coordinate geometry database (.GPK), and any input or output files. The **plan_sheets** directories contain the detail sheets drawn at specific scales for the project. The **project** directory contains the Geopak project manager file (.PRJ), and the userid directories. The **userid** directories contain the user runs for the job.

1.5 Set County Coordinates



To change the coordinates of an existing MicroStation file, select **MoDOT>>Tools>>Set County**. This will bring up the dialog shown to the right. To use the tool, click on the pull-down box to the right of DISTRICT and select CUSTOM or the district number and click OK. The pull-down options are shown in the figure to the left. Another dialog will appear that will let you enter the custom ordinates or select the county within the district chosen. Click APPLY in this dialog to reset the coordinates or CANCEL to exit the tool without changing the coordinates. Once the coordinates are changed, click OK in the County Coordinates dialog to unload the tool. Consult your MicroStation manual for more information on the tool.



Chapter 2

Project Manager

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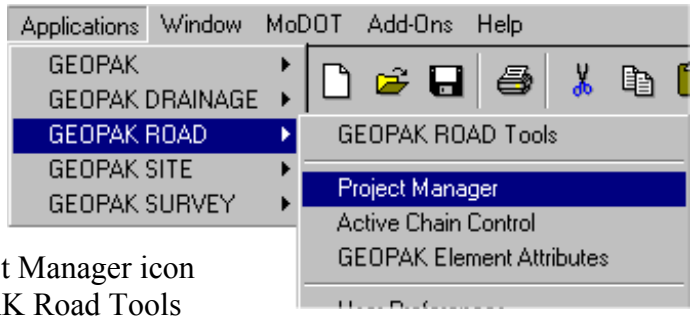
2.1 Objectives

- Learn how to set up a project using **Project Manager**.
- Learn how to utilize **Project Manager** as a workflow guide.
- Learn how to access GEOPAK dialogs from the **Project Manager**.

2.2 Definitions

Project Manager is a GEOPAK tool that associates a project with its respective **gpk** job number, users, working directories and project files. Project Manager provides the user with an easy workflow system that keeps records of processes run throughout the design of a project.

2.3 Accessing

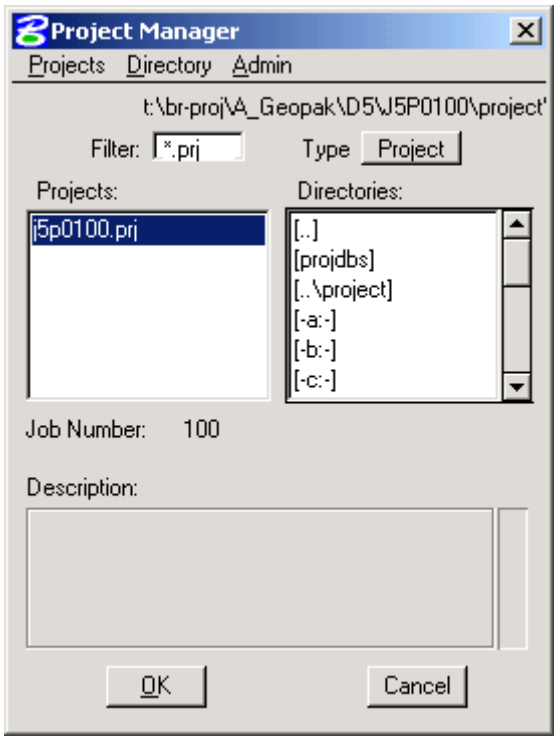


To access Project Manager:

- Select **Applications >> GEOPAK Road >> Project Manager** (as shown in the figure to the right) or

- Select the Project Manager icon from the GEOPAK Road Tools (both are shown to the left), which are opened by selecting **Applications >> GEOPAK Road >> GEOPAK Road Tools**.

The following dialog depicted to the right appears:



2.4 Project Manager Dialog

2.4.1 General Description

The current directory is displayed at the top of the dialog box, which can be changed by navigating to a different directory in the **Directories** list box. **This navigation is the first step in selecting an existing project or creating a new one.** Project files (.prj) are displayed in the **Projects** list box. The project files should be located in the t:\br-proj\A_Geopak*district**jobnumber***project** directory.

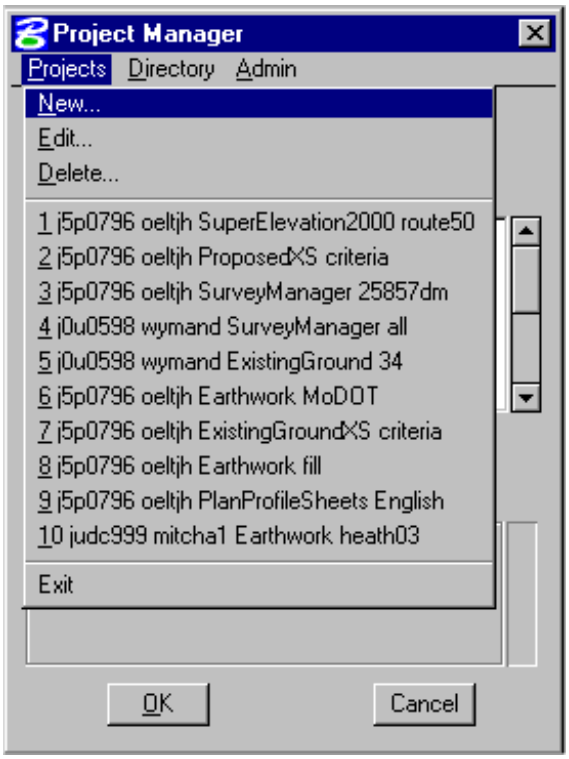
The remainder of the Project Manager dialog box displays information after a project has been

selected from the **Projects** list box. At the bottom of the dialog are the **OK** and **Cancel** buttons. If the user wishes to exit Project Manager, the **Cancel** button should be selected. To continue in the Project Manager process, the **OK** button should be selected.

2.4.2 Project Manager Menu Bar

There is three pull down choices on the Menu Bar: **Projects**, **Directory**, and **Admin**. Each of these choices has options contained in the pull down.

2.4.2.1 Project Tools



There is four choices under the **Projects** pull down: **New**, **Edit**, **Delete**, and **Exit** as shown below.

As can be seen from this dialog box, the Windows motif also keeps track of the last few processes that have been executed. These may be recalled as needed by selecting the desired process.

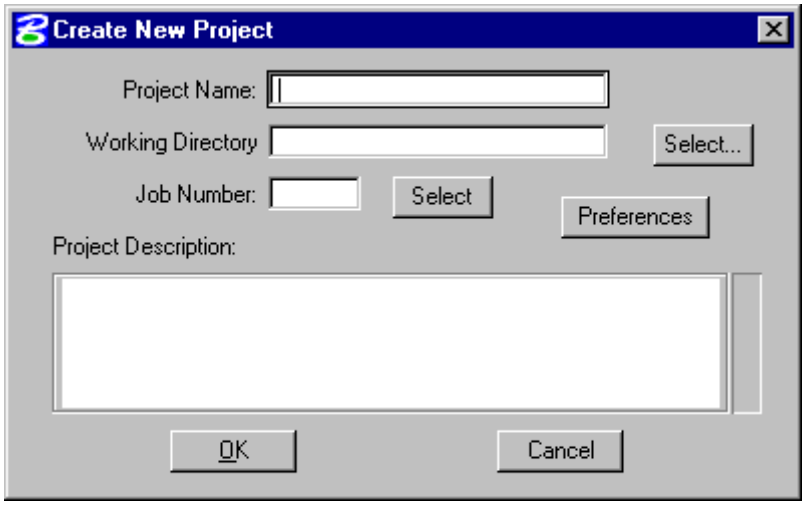
2.4.2.1.1 New…

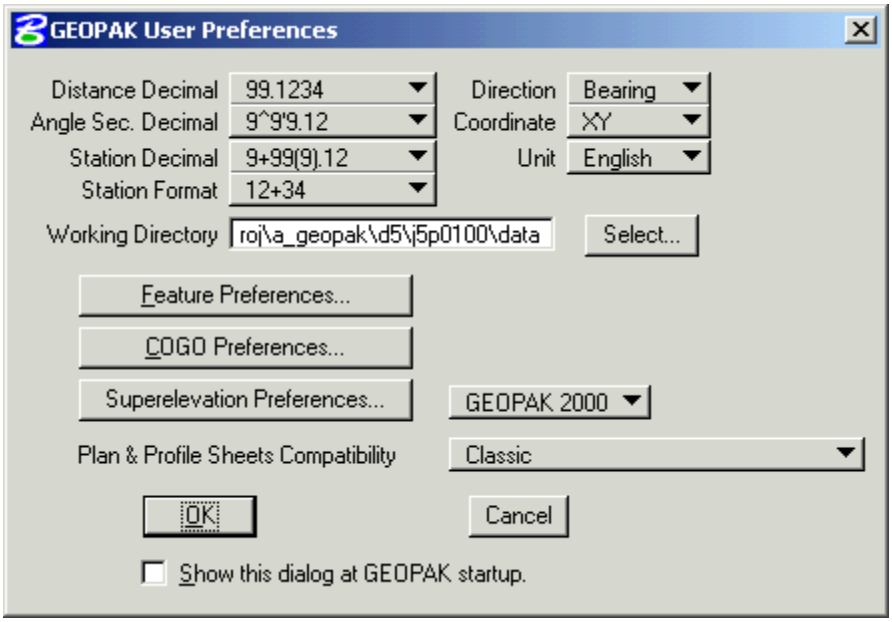
The **New** menu option is used to create a new project. The .prj file will be stored in the directory shown in the Directory path at the top of the Project Manager dialog box. When the **New** menu option is selected, the **Create New Project** dialog appears (shown at the bottom of the page).

The **Project Name** can be any number of alphanumeric characters. For MoDOT projects, the **Project Name** needs to be the same as the job number. (i.e. j1p0999.prj) The **Working Directory** specifies the location of the project data files. The **Working Directory** may be keyed in or the **Select** button may be chosen and the appropriate directory selected. For MoDOT Bridge, the **Working Directory** should be set to t:\br-proj\A_Geopak*district**jobnumber***data**.

The next field is for typing in the COGO job number, or the **Select** button may be chosen and the appropriate COGO job number selected.

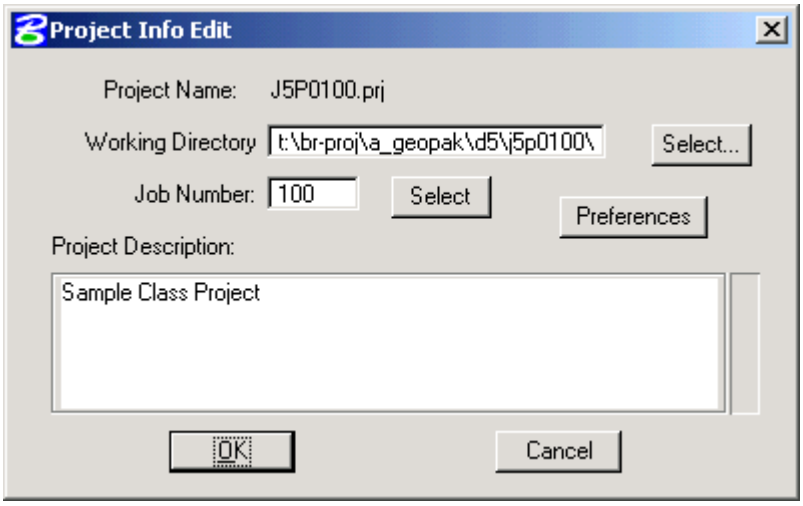
Next the **Preferences** button should be chosen and the **Project Preferences** dialog appears, which is depicted on the following page.





The user may set the particular parameters for each project as well as the **Working Directory**. This keeps the user from re-setting them when changing projects since the project's preferences are recalled when entering the project. After all of the information is entered, select **OK** to accept the changes, or **Cancel** to reject them. For more about **User Preferences**, see **Section I.3** in the Introduction.

Shown below is a sample project that includes a project description, which may be keyed in at the bottom of the **Create New Project** dialog box, with the **Working Directory** set to t:\br-proj\a_geopak\d5\j5p0100\data.



2.4.2.1.2 Edit…

The **Edit** menu option is used to change any settings associated with the currently selected project. When chosen, the **Project Info Edit** dialog box appears.

2.4.2.1.3 Delete…

The **Delete** menu option is used to delete any project that has been stored. The user highlights the project in the **Projects** and selects **Delete**.

2.4.2.1.4 Exit

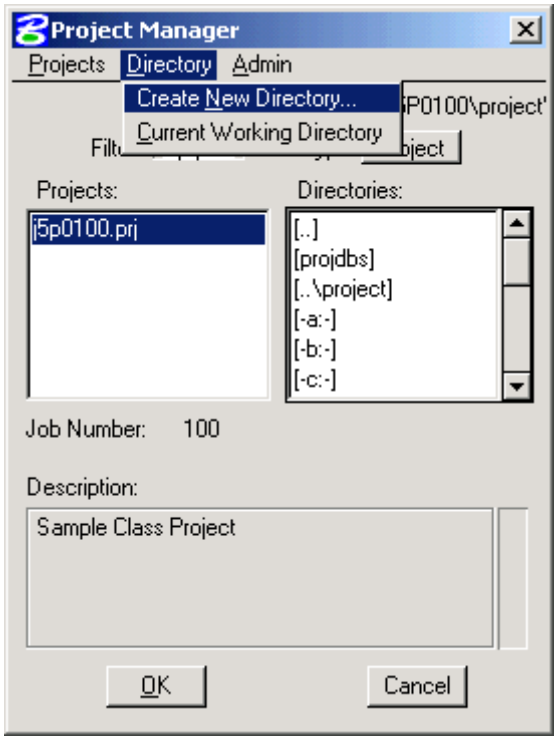
The **Exit** menu option closes the Project Manager and writes the settings to a resource file.

2.4.2.2 Directory Tools

There are two options under the **Directory** pull down, **Create New Directory** and **Current Working Directory** as shown.

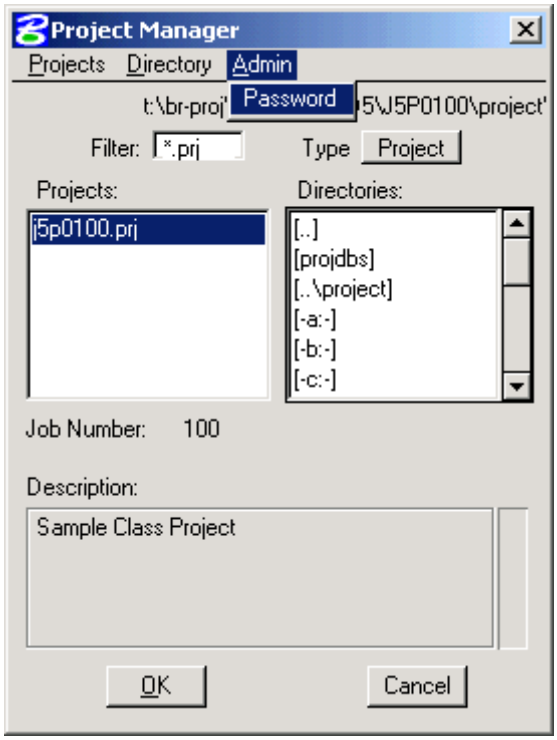
The **Create New Directory** option will create a new directory on the disk.

If the **Current Working Directory** option is chosen, the directory path in Project Manager is changed to that directory.



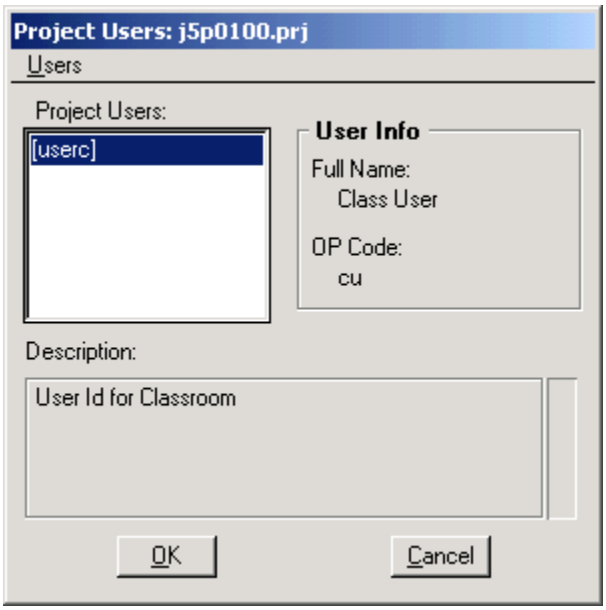
2.4.2.3 Administration Tools

The **Administration** menu option is used to set a password on a project. It is recommended that a password **not be used** since the project will need to be accessed by more than one user.

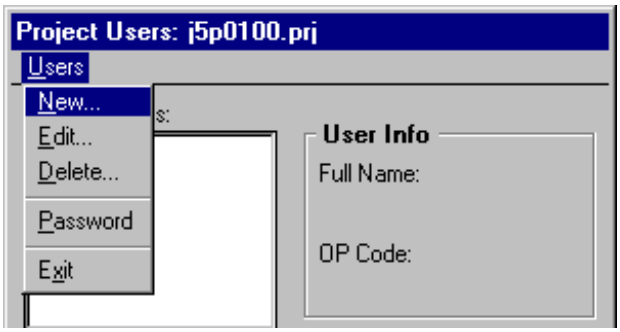


2.5 Project Users Dialog

Once a project is highlighted and **OK** is selected, the **Project Users** dialog appears.



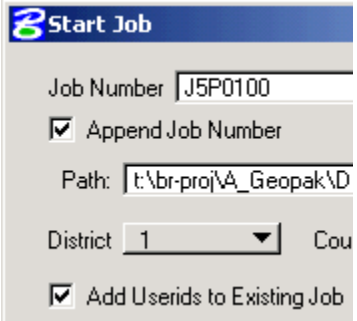
This dialog has three sections: **Project Users**, **User Info**, and **Description**. The **Project Users** list displays a list of users that have been created to work with any project that resides in the current projects home directory. The names shown in **Project Users** will be the userid's of the people working on that project as specified in the **Start Job** dialog. Within the **User Info** group box, the **Full Name** field further identifies the user, and displays the full name of the user that is currently selected. The **OP Code** field displays the GEOPAK Operator Code of the currently selected user. The GEOPAK Operator Code is used for all coordinate geometry operations during this session. The Operator Code, along with the Job Number, will be utilized whenever an input or output file is created by the software. The Operator Code will be the user's first and last initials. The **Description** field displays the description of the currently selected user.



Four tools are supported on the Project Users pull down as depicted in the exploded view to the right.

2.5.1 New

The New pull down menu option creates new users. **This option is not to be used in MoDOT.** To create a new user for a project, use **Start Job/Add User** under the MoDOT menu with **Add Userids to Existing Job** activated, as show in the following figure. Start Job/Add User must be used for the user to have the default MoDOT runs.



2.5.2 Edit

The **Edit** pull down menu option allows the user to change any of the parameters of the currently selected user. (Note: The User cannot be changed. This will change the user information for the current project only.)

2.5.3 Password

The **Password** tool creates or modifies a password for the selected user. If the selected user already has a password, the user will be prompted to enter the current password before continuing.

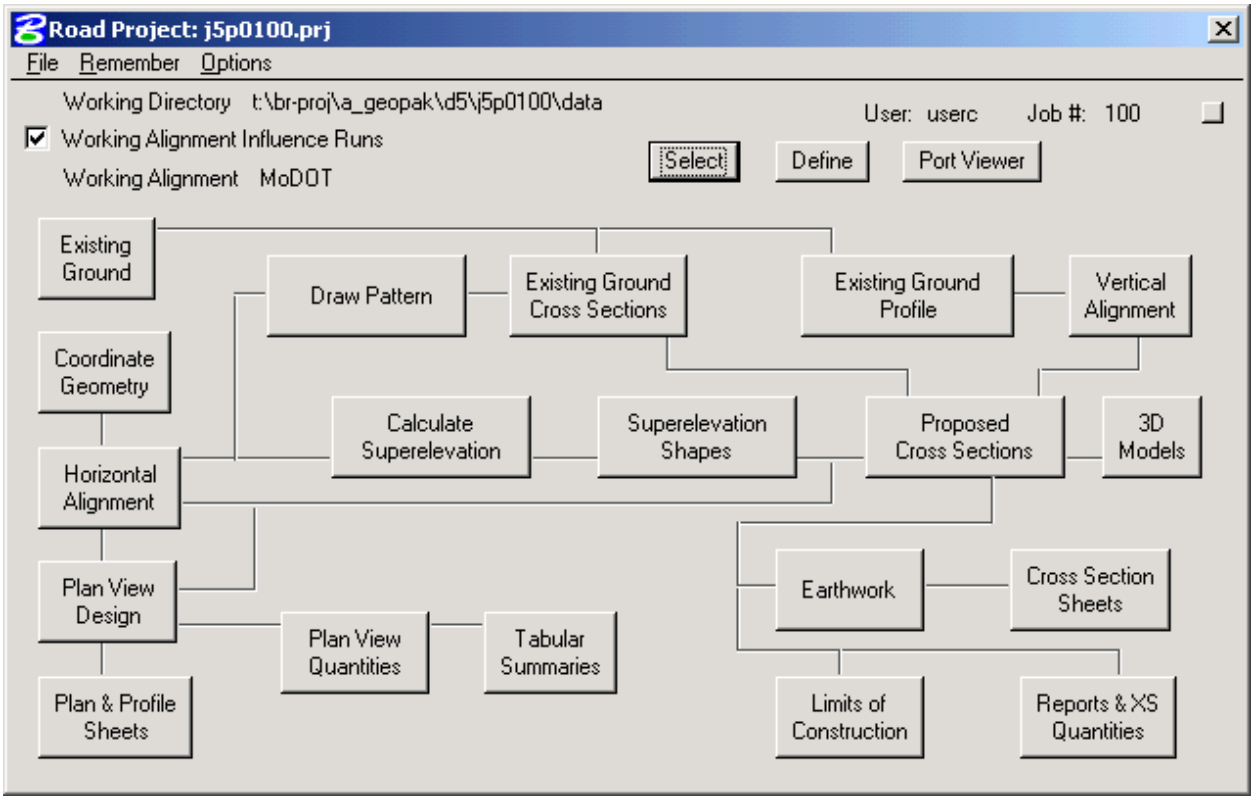
2.5.4 Exit

The **Exit** option closes the User dialog and returns back to the Project Manager dialog.

2.6 Road Project Dialog

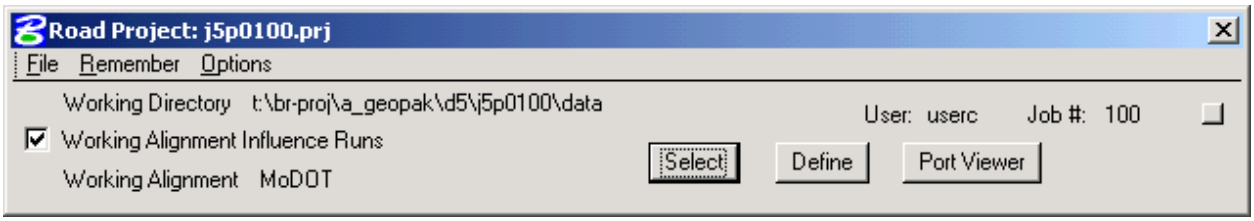
After a minimum of one user has been defined, selecting the **OK** button on the lower left corner of the Project Users dialog or double clicking on a Project User will open the Applications dialog as depicted.

When the Road option is selected, the following dialog appears.

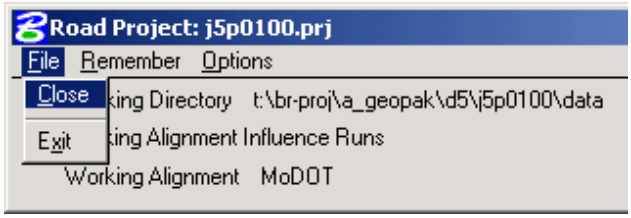


2.6.1 General Description

The top of the dialog displays the **Working Directory**, **Working Alignment** (if defined), **User** and **GEOPAK Job Number**. In addition, a toggle for **Working Alignment Influence Runs** is also supported. The bottom portion of the dialog box displays the various processes supported during the design process. The small square in the upper right corner (to the right of the Job Number) will condense the dialog as depicted in the graphic below.

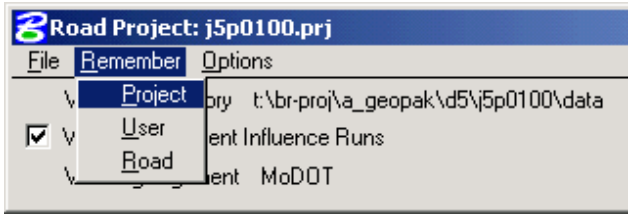


2.6.2 Road Project Dialog Menu Bar

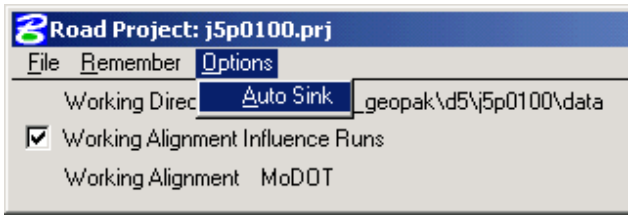


There are three pull down menu bar options: **File**, **Remember**, and **Options**. When the **File** option is selected, the choices are **Close** and **Exit**.

If the **Close** option is selected, the user is returned to the **Applications** dialog. If **Exit** is selected, the user is exited from Project Manager.



When the **Remember** option is selected, the user can instruct the software to remember the **Project**, **User**, or **Road** in subsequent sessions. For example, if all three toggles are activated, and the Project Manager is completely closed, the invocation of the Project Manager immediately invokes the Road Project dialog (flow chart) and utilizes the project name, username, etc., which were active when the **Remember** toggles were selected. If only the **Project** and **User** toggles are activated, the user is returned to the Applications dialog in later sessions. If only the **Project** toggle is activated, the user is returned to the Project Users dialog in subsequent sessions. This option is particularly useful when numerous users are working on one project.

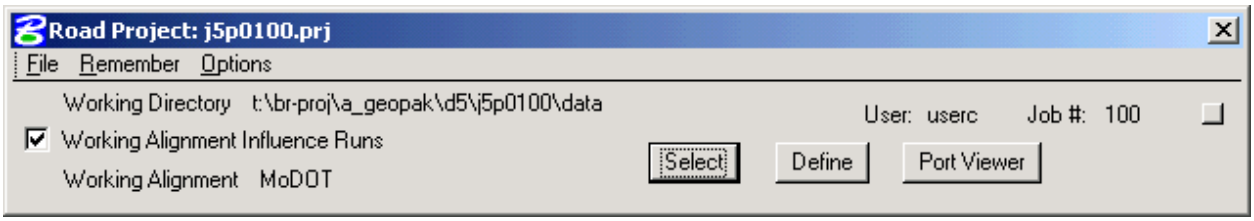


The **Options** menu allows the user to toggle on the **Autosink** option. When toggled on, this option will sink (move behind the open drawing views) the Road Project Manager dialog when a tool is chosen from the Project Manager. When a tool is closed, the Road Project Manager dialog will become the active dialog.

2.6.3 Working Alignment

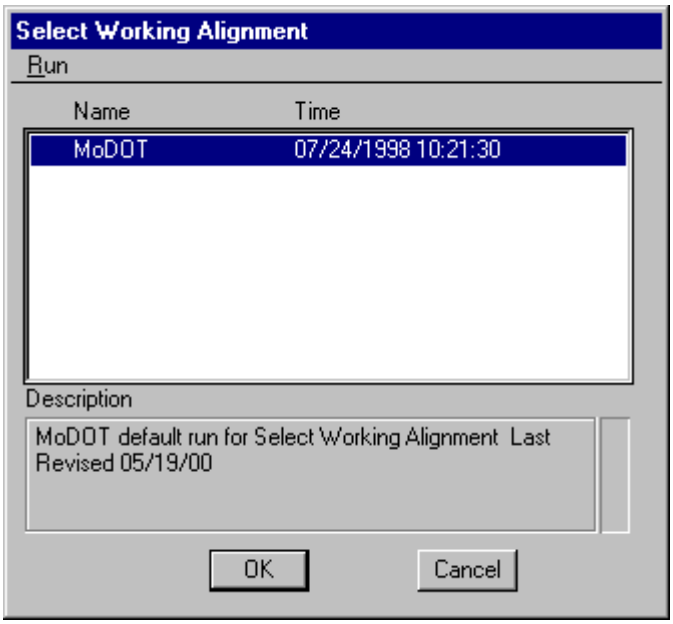
The concept of a working alignment enables the designer to organize a project and to access project information without continually typing the required information. On a simple project, only one working alignment may be needed. However, on a more complicated project, an unlimited number of working alignments may be defined. The designer can easily change from one working alignment to another by highlighting the desired alignment listed in the **Select** dialog. Three tools relating to working alignments are located at the top of the Road Project dialog:

- **Select Button**
- **Define Button**
- **Working Alignment Influence Runs** (toggle on left side of dialog)



2.6.4 Select Option

When the **Select** button is pressed, the **Select Working Alignment** dialog appears as depicted to the right. If no working alignments have been defined, MoDOT appears in the Run List box. If working alignments have been defined, they are listed with the last run time. The description of the working alignment can be seen in the bottom of the dialog when each Name is highlighted. To select a previously defined working alignment, highlight the run from the list then press the **OK** button at the bottom of the dialog. Double clicking on the Name also selects a previous working alignment for subsequent processing. Pressing the **Cancel** button will close the **Select Working Alignment** dialog without any working alignment change. Several file option are supported as depicted in the exploded view below. These include **New**, **Copy**, **Rename**, and **Delete.**

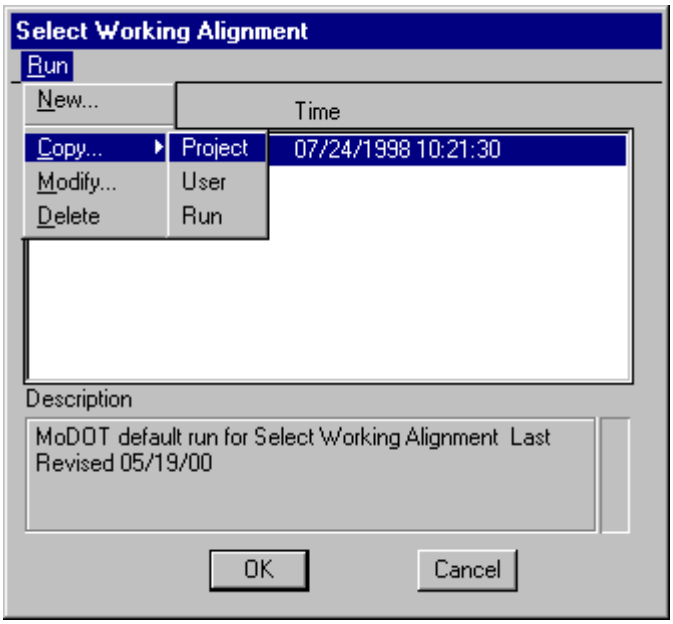


- **File>>New** – allows the user to create a new working alignment. (Do not use this option as it will not copy the default MoDOT settings for the working alignment. Instead, use Run>>Copy>>Run to copy the MoDOT run.)

- **File>>Copy** – allows the user to copy and existing Project, User or Run.

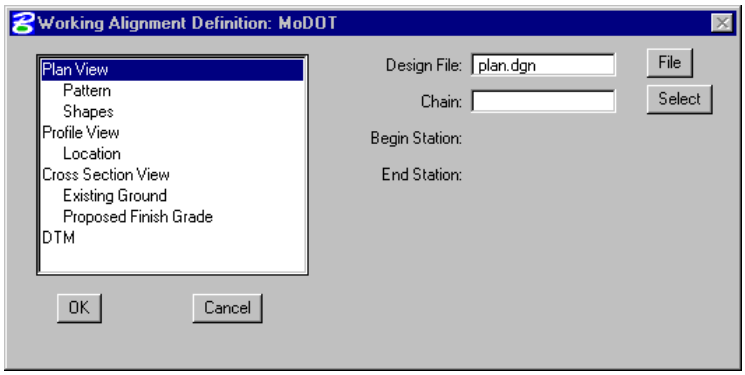
- **File>>Rename** – allows the user to change the name of the existing working alignment.

- **File>>Delete** – allows the user to delete an existing working alignment.

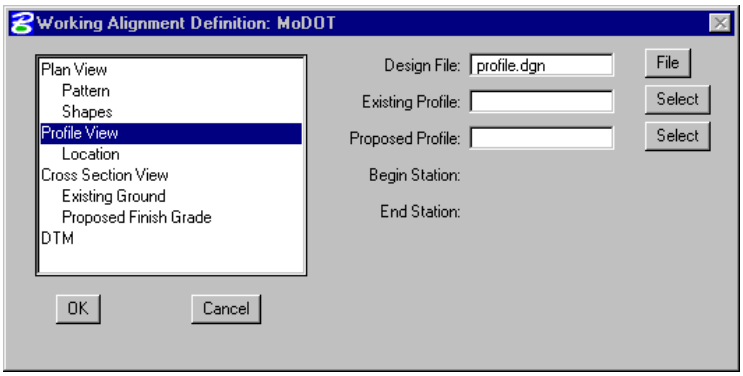


2.6.5 Define Option

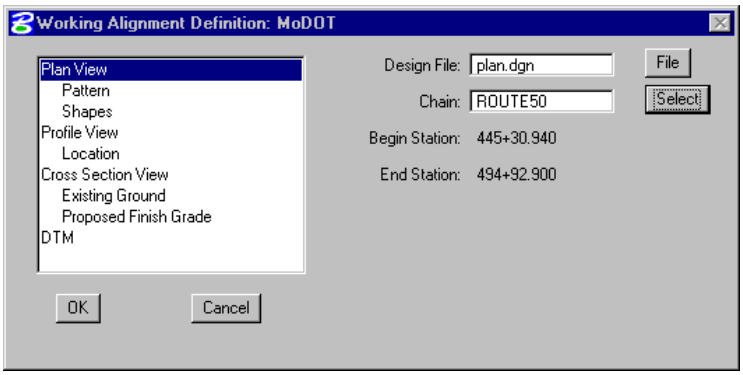
Once a Working Alignment has been selected, pressing the **Define** button invokes the dialog depicted to the right. The information that can be associated with a working alignment is listed in the left portion of the dialog box. As each option is chosen, the right side of the dialog box will change to reflect the information needed as can be seen in the dialog box to the right after Profile View was selected.



All information entered in these fields can be used in subsequent processes run from Project Manager. In the beginning of a project, much of this information will not be known but, as the user goes through the deign process, it can be added to the working alignment definitions.



For example, as soon as the chain has been stored in COGO, the user can enter that information in the Plan View fields as depicted to the right. For a more complete explanation of each option shown, please see the *GEOPAK Manual*.



2.6.6 Port Viewer

The **Port Viewer** is a tool that enables the user to view all three major aspects of a road design simultaneously even though they are located in different files. The three views include:

- **Plan**
- **Profile**
- **Cross Section**

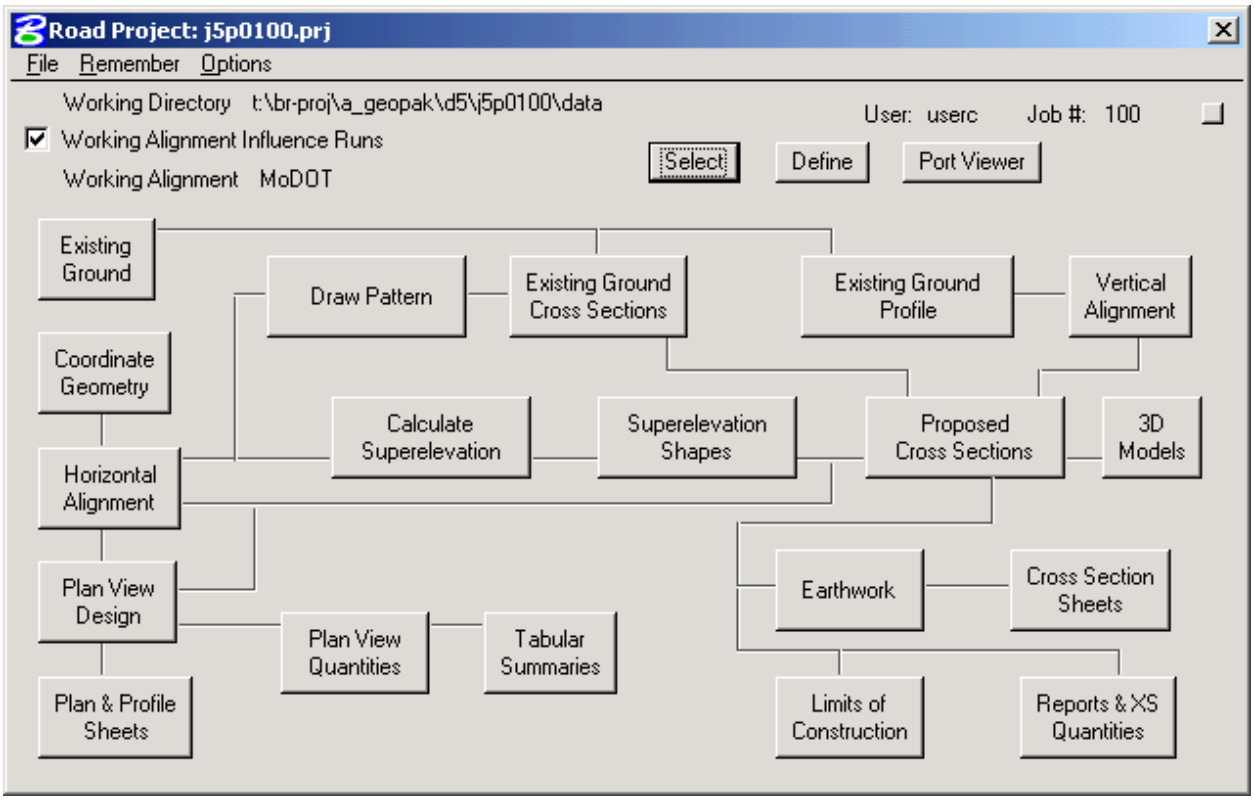
As a prerequisite to invoking the **Port Viewer**, a working alignment must be defined with the following information.

- **Alignment Specification**
- **Plan View Design File and Chain**
- **Profile Information**
- **Cross Section File**
- **Digital Terrain Models**

The **Port Viewer** will be covered in more detail in Chapter 16 in the GEOPAK Road 2 part of the manual.

2.7 Project Manager Process

The primary **Project Manager** dialog is depicted below. The advantage of utilizing the **Project Manager** rather than selecting functions directly from the **Road** menu is that pertinent information stored within the **Project Manager** is automatically displayed within the invoked dialog. Therefore, job numbers, chain names, stationing, file names, and data associated with the project do not have to be typed in each time a dialog is utilized. However, the user can change information in the fields.

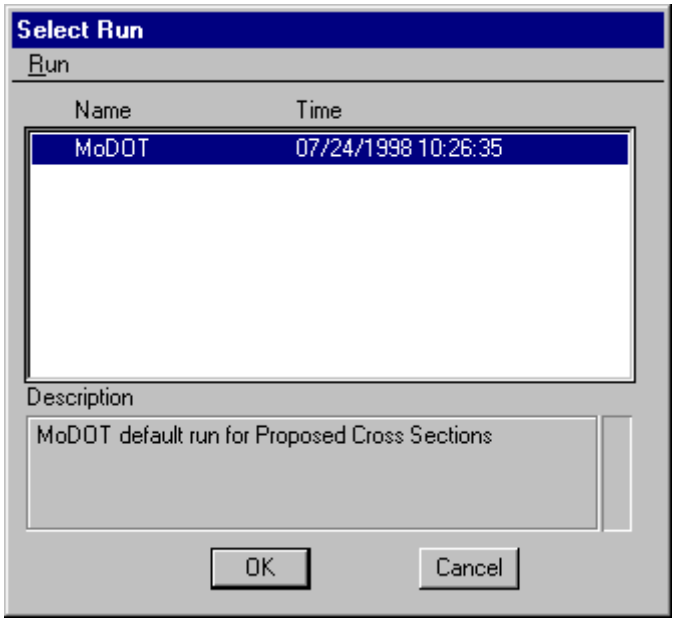


Many of the **Project Manager** processes function identically to their corresponding dialog's invocation from the Road menu. However, some of the procedures will invoke the **Select Run** dialog prior to invoking the actual dialog. The **Select Run** dialog allows the user to set up different options to use in alternative design choices.

Each of the Road Project dialog processes will be covered individually in the separate remaining chapters.

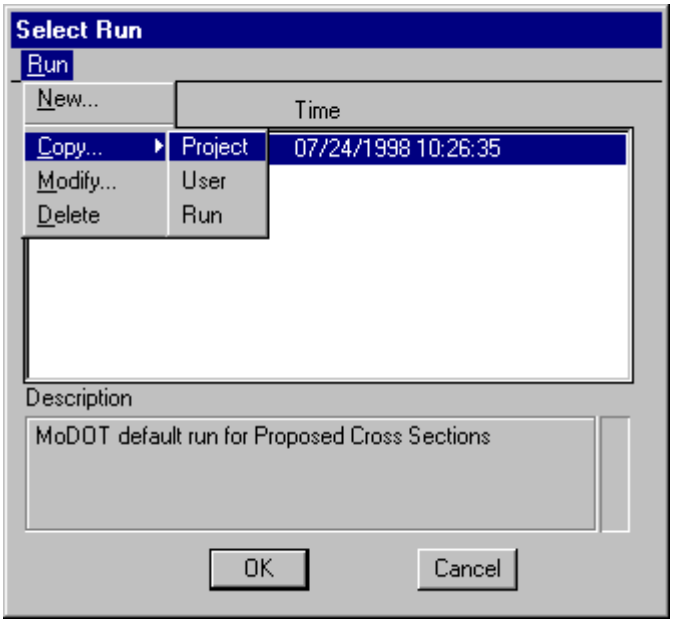
2.7.1 Select Run Option

When certain procedures are selected from the **Project Manager** dialog, the **Select Run** dialog will be invoked. The **Select Run** dialog allows the user to save the settings for each procedure in a **Run** that can then be recalled whenever the user needs to execute that procedure. With the individual runs, a user can keep a history of the project, and can access the various procedures



with the settings that were previously used. This way a user can repeat various procedures with the same settings previously used.

When the **Select Run** dialog is invoked, MoDOT appears in the Run List box. (Some Select Run boxes will display default run names such as English, Metric, I_XS_10, etc.) If **Runs** have been defined, they are listed with the last run time. The description of the **Runs** can be seen in the bottom of the dialog when each Name is highlighted. To select a previously defined **Run**, highlight the run from the list, and then press the **OK** button at the bottom of the dialog. Double clicking on the Name also selects a previous **Run** for subsequent processing. Pressing the **Cancel** button will close the **Select Run** dialog without any run settings change. Several file option are supported as depicted in the exploded view below. These include **New**, **Copy**, **Rename**, and **Delete.**



- **File>>New** – allows the user to create a new run. (Do not use this option as it will not copy the default MoDOT settings for the procedure selected. Instead, use Run>>Copy>>Run to copy the MoDOT run.)

- **File>>Copy** – allows the user to copy and existing Project, User or Run.

- **File>>Rename** – allows the user to change the name of the existing Run.

- **File>>Delete** – allows the user to delete an existing Run.

Exercise 2-1

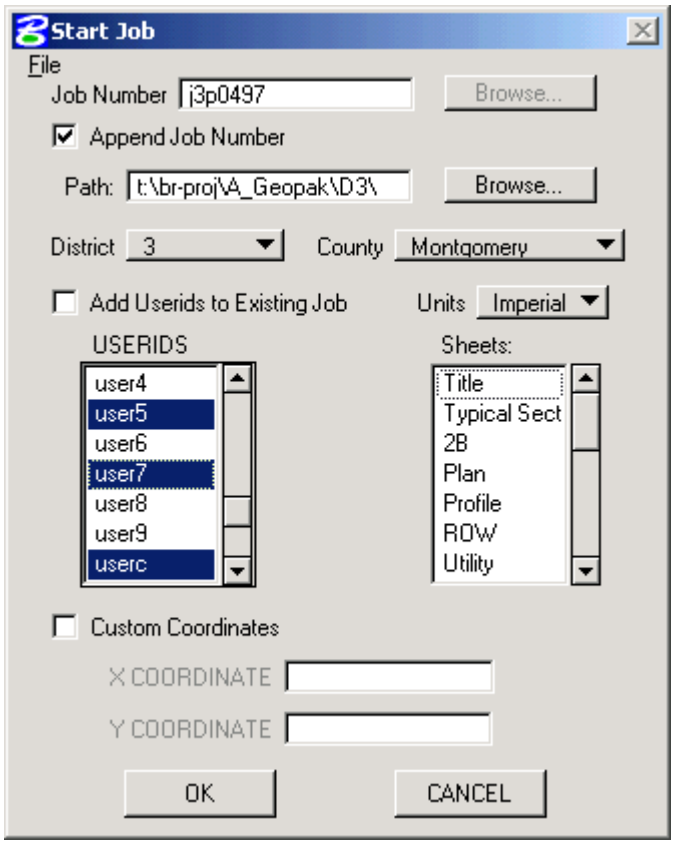
This is an individual exercise to practice setting up the directory structure and files for a new GEOPAK job.

1. Open any MicroStation file.

2. Create the following job with the **Start Job** dialog (MicroStation menu path:

   MoDOT > Start GEOPAK Job/Add User).

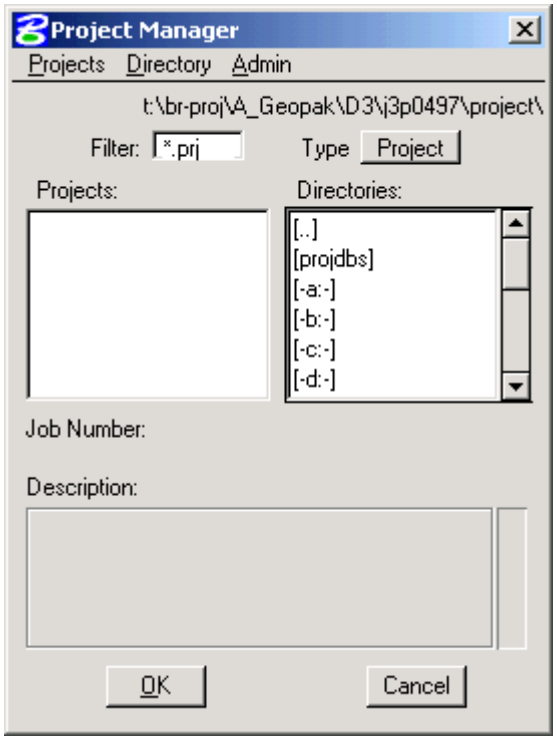
   Use the settings shown in the following dialog.



3. Review the directory structure and the files created in the directory.

4. Use the **Project Manager** dialog to create the following project:

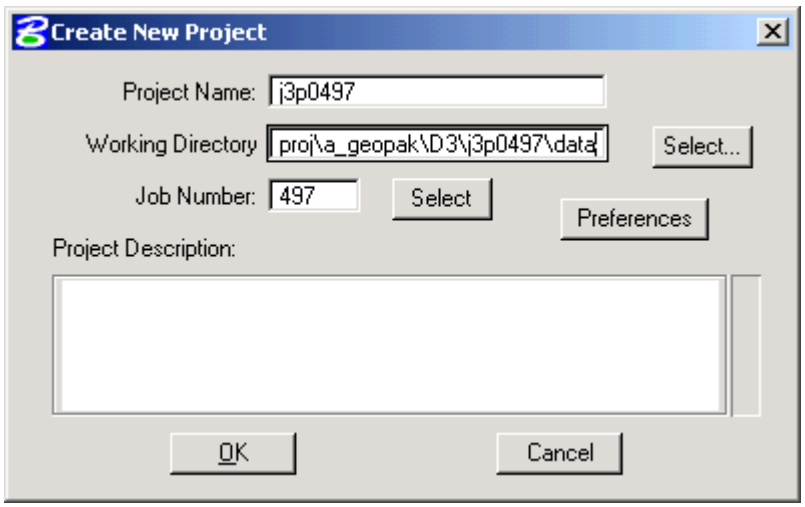
   Go to the directory **t:\br-proj\A_Geopak\D3\j3p0497\project**



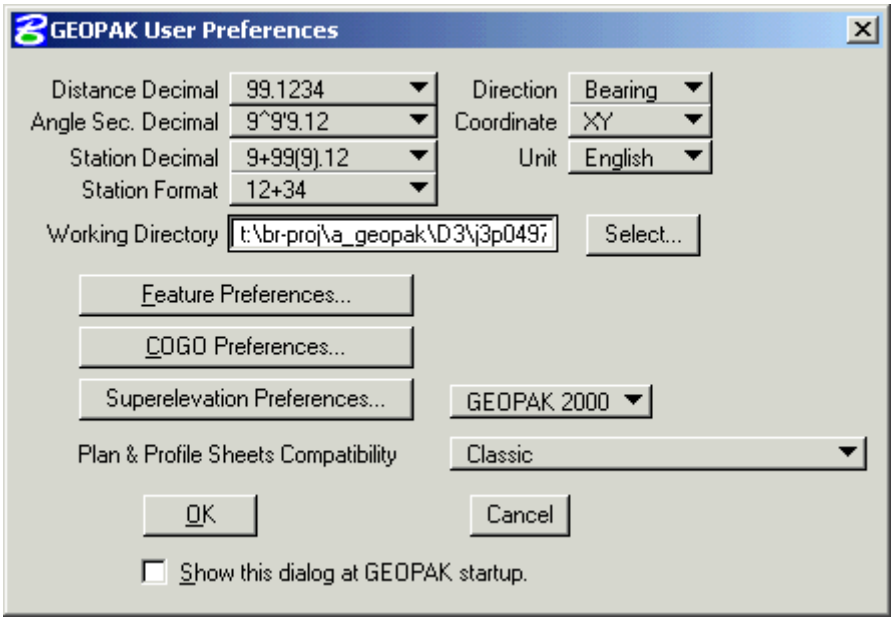
   Choose **Projects>>New**.

   Enter the following information in the **Create New Project** dialog as shown below.

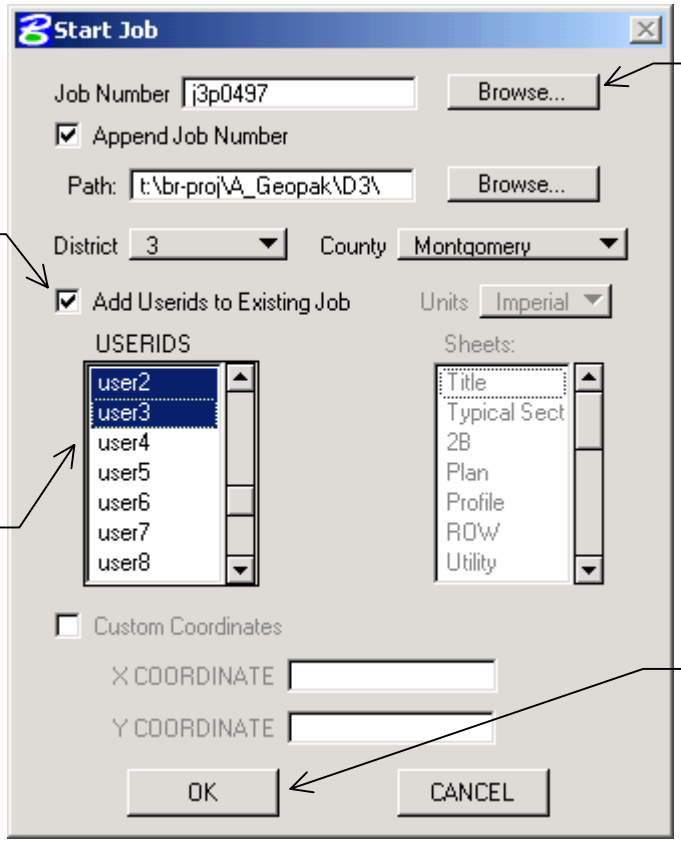
Project name:	**j3p0497**
Working Directory:	**t:\br-proj\A_Geopak\D3\j3p0497\data**
Job Number:	**497**



   Set up the **Preferences** as shown below:



5. Add User2 and User3 as users to the project.



A) Start by toggling on **Add Userids to Existing Job**.

B) Continue by using this Browse button to choose the **Job Number** and **Path**.

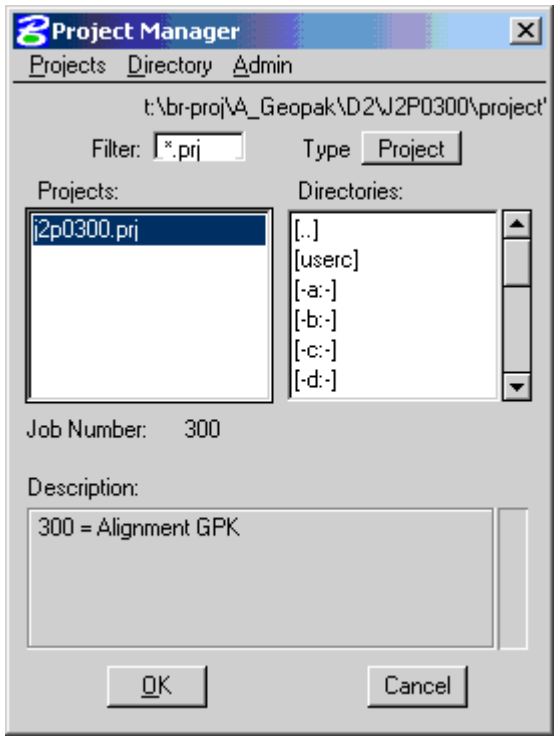
C) Select the **USERIDS** to be added.

D) Click **OK** to finish the process.

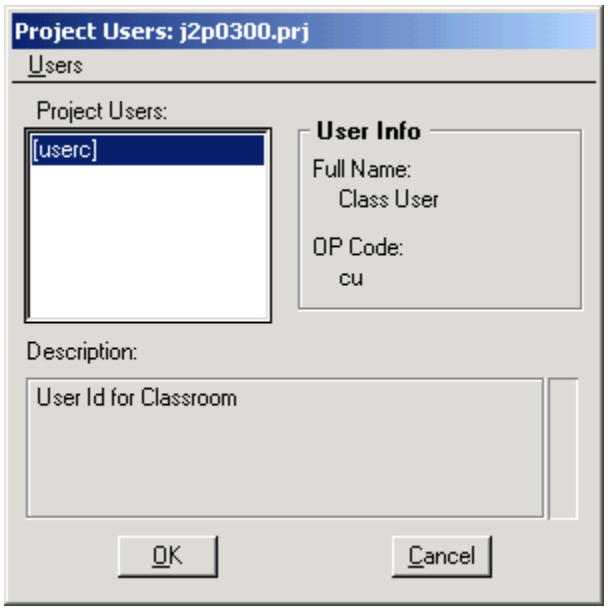
Exercise 2-2 This is an individual exercise to practice setting up a new working alignment.

1. Open the Microstation file **t:\br-proj\a_geopak\d2\j2p0300\data\topo_j2p0300.dgn**.

2. Open the project **t:\br-proj\a_geopak\d2\j2p0300\project\j2p0300.prj**.

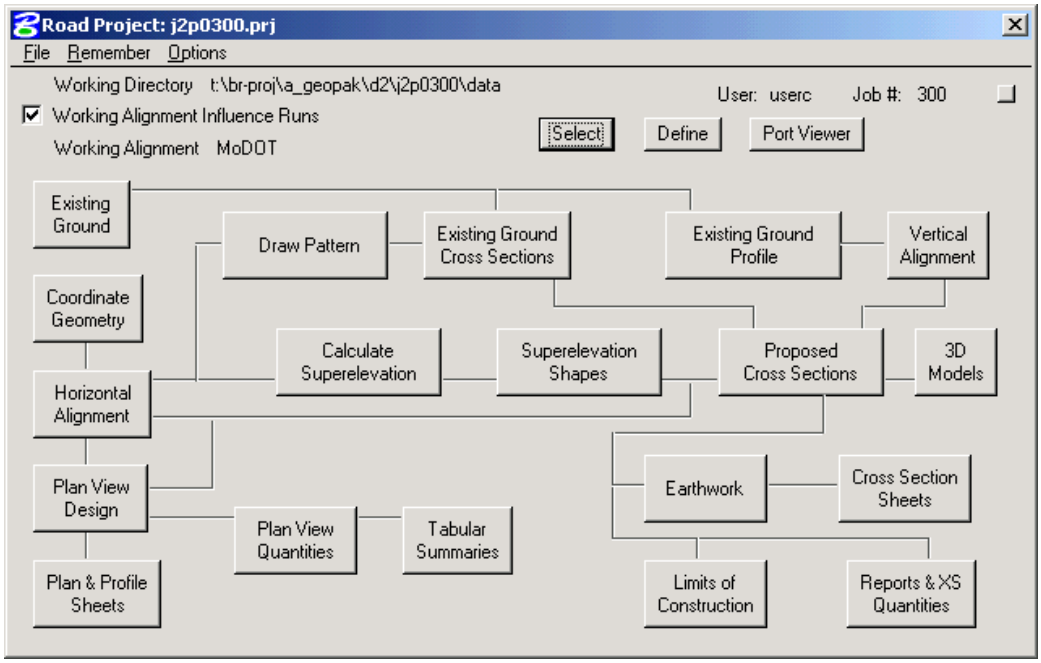


3. Select **userc** as the Project User.

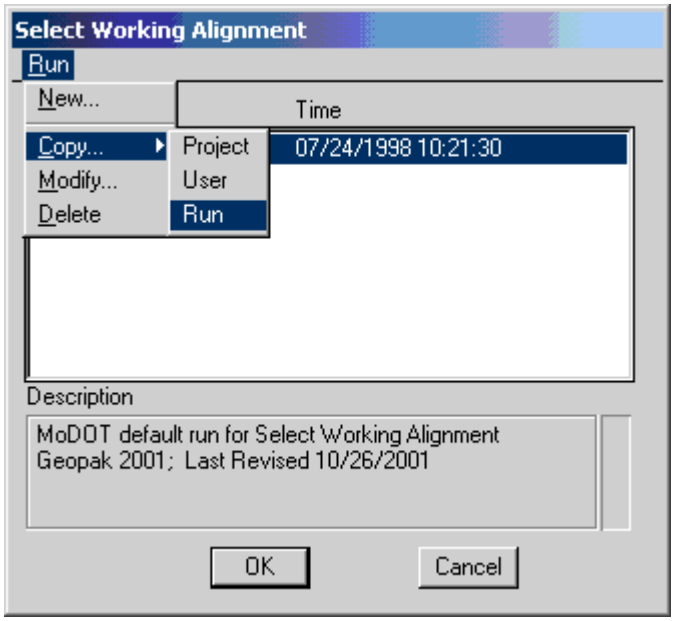


4. Select the **Road Project**.

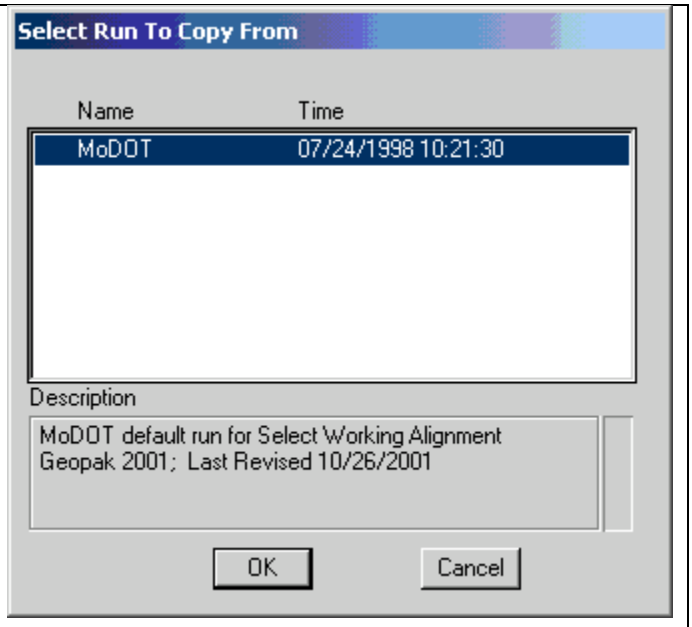
5. Click on **Select** button at the top of the Road Project dialog as depicted below.



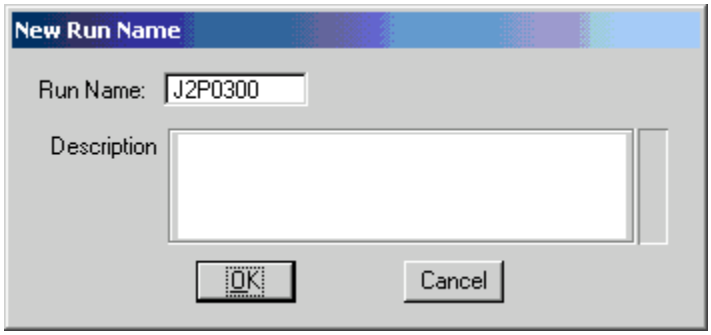
In the Select Working Alignment dialog that appears, select the menu option:
Run > Copy… > Run.



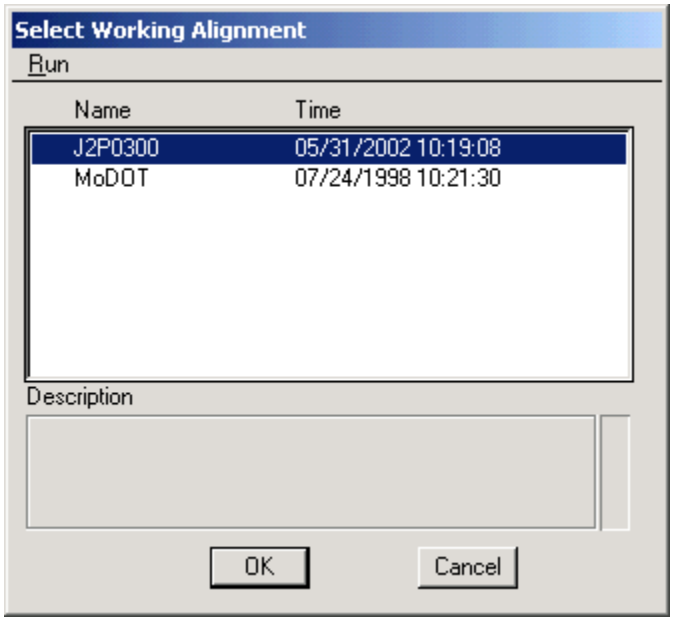
This will display the **Select Run to Copy From** dialog shown to the right. Select the default MoDOT run and click **OK**.



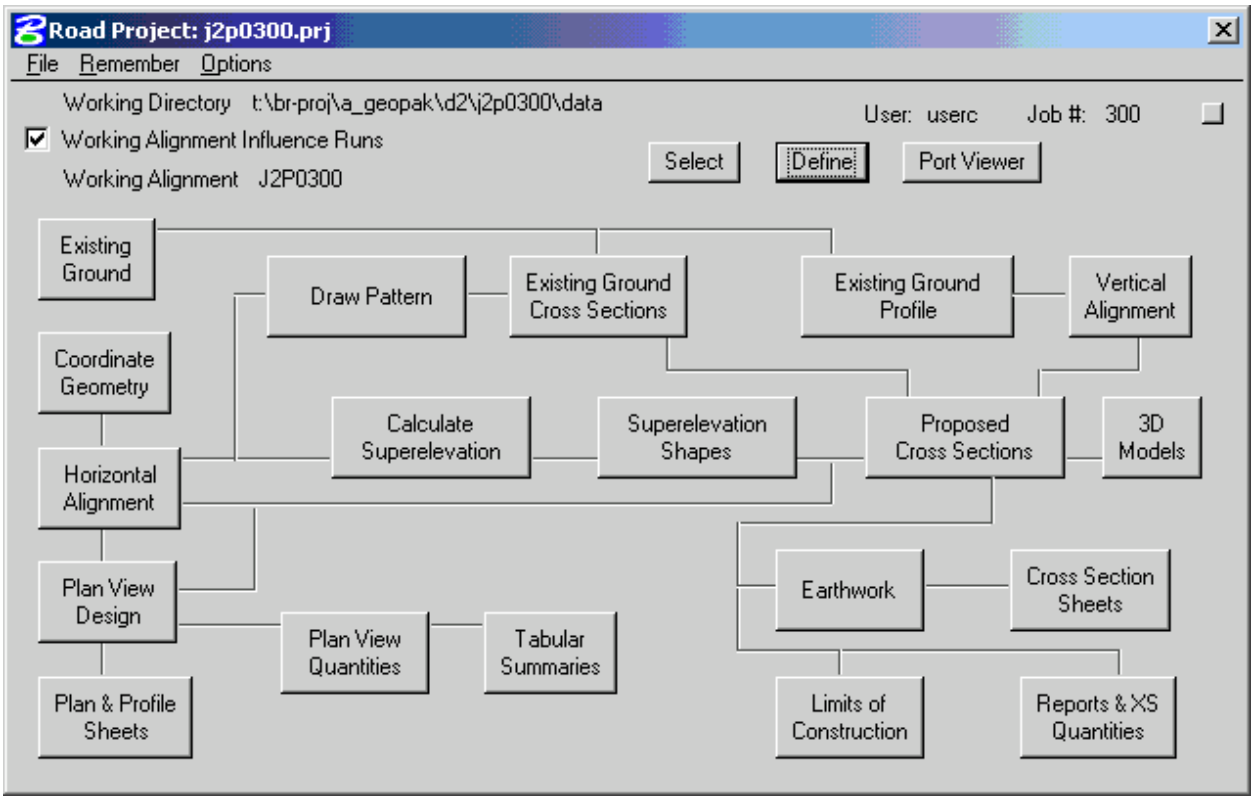
Enter **J2P0300** in the new **Run Name** field as depicted in the figure to the right and click **OK** to create the new run.



Select the **J2P0300** working alignment as shown below and enter the alignment by clicking **OK**.

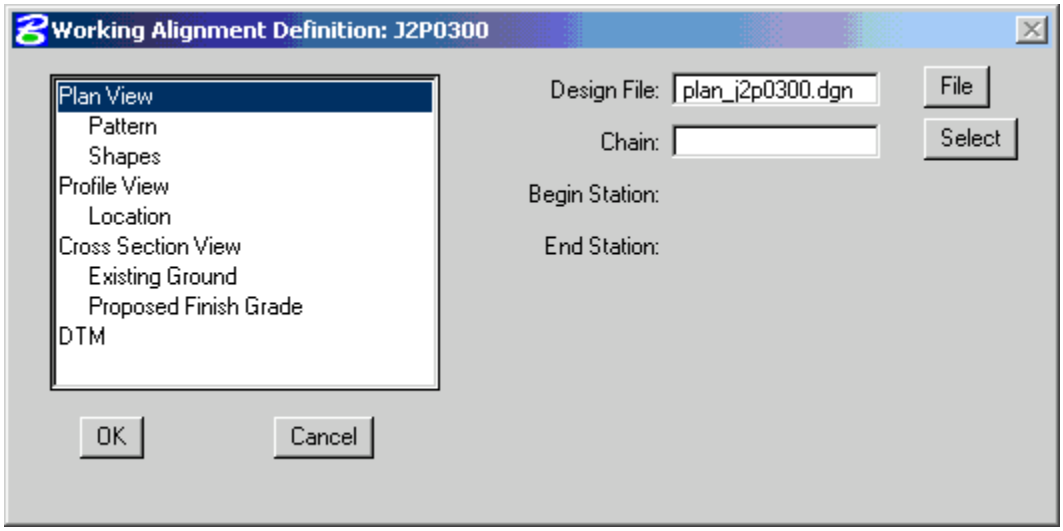


6. Enter the working alignment definition by clicking on the **Define** button to the right of the Select button in the Road Project dialog as shown below.

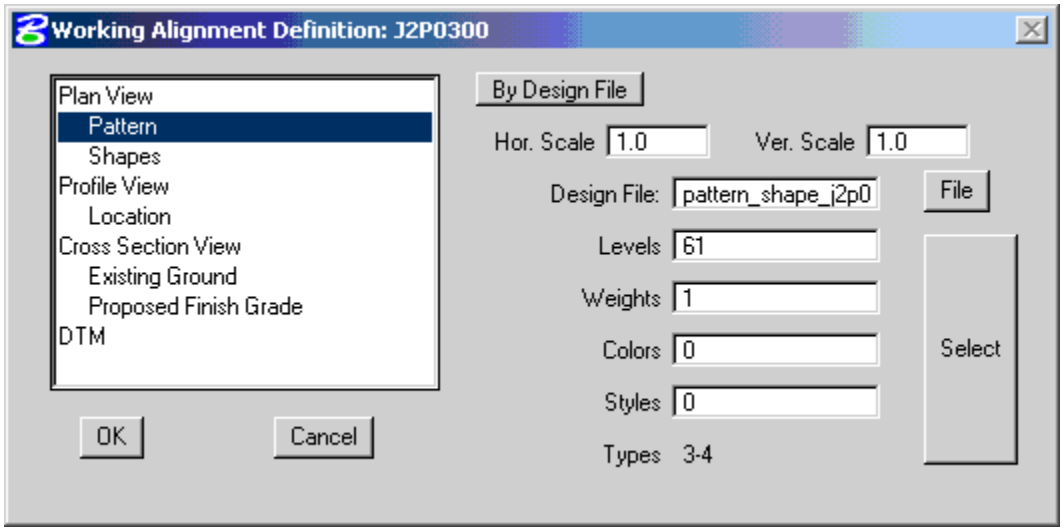


7. Set up the default DGN files for the J2P0300 project as shown below:

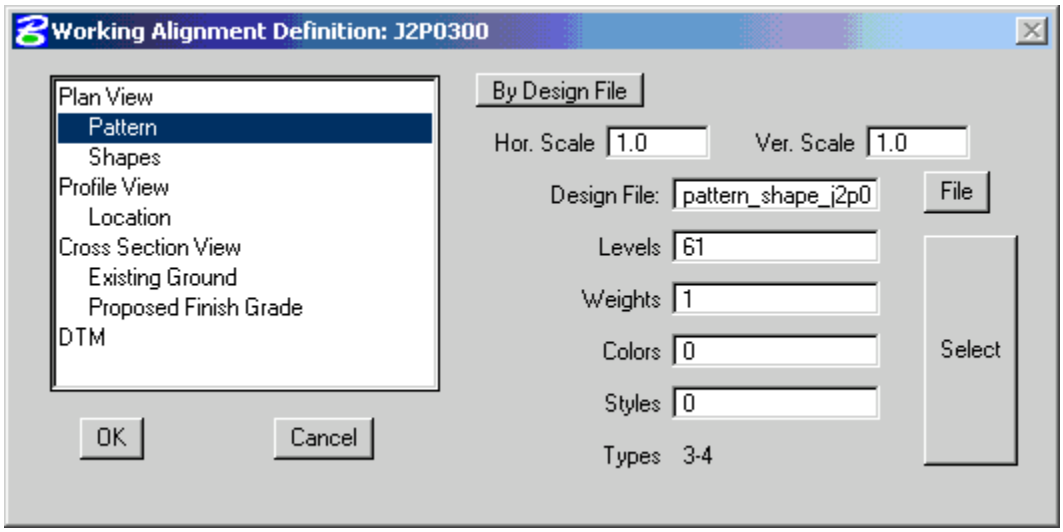
   In the **Plan View** section, change the Design File to **plan_j2p0300.dgn**.



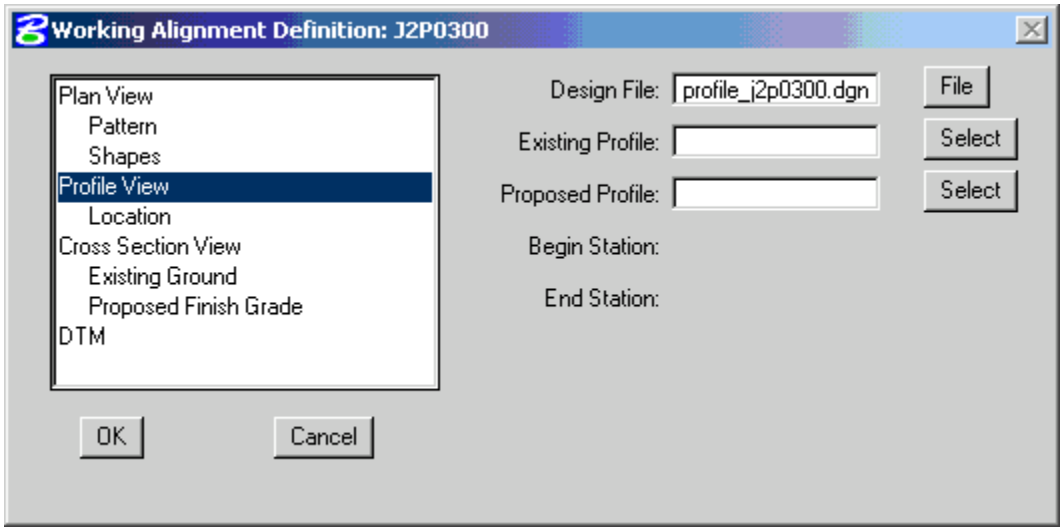
In the **Pattern** section, change the Design File to **pattern_shape_j2p0300.dgn**.



In the **Shapes** section, change the Design File to **pattern_shape_j2p0300.dgn**.



In the **Profile View** section, change the Design File to **profile_j2p0300.dgn**.



Save the changes to the working alignment definition by clicking **OK**. This default alignment for the project will be modified and used as the basis for other parts of the project in later exercises.

Chapter 3

Importing Data

3.1 Objectives 3-1
3.2 Definitions 3-1
3.3 Accessing 3-1
3.4 Importing Photogrammetric Data 3-2
3.5 Importing Survey Data 3-4
3.6 Creating the Digital Terrain Model 3-5
3.7 Mapping 3-5

3.1 Objectives

- Learn how to import photogrammetric data and survey data into Geopak.
- Learn how to map photogrammetric and survey data into a .dgn file.
- Learn how to create a digital terrain model from photogrammetric and survey data.

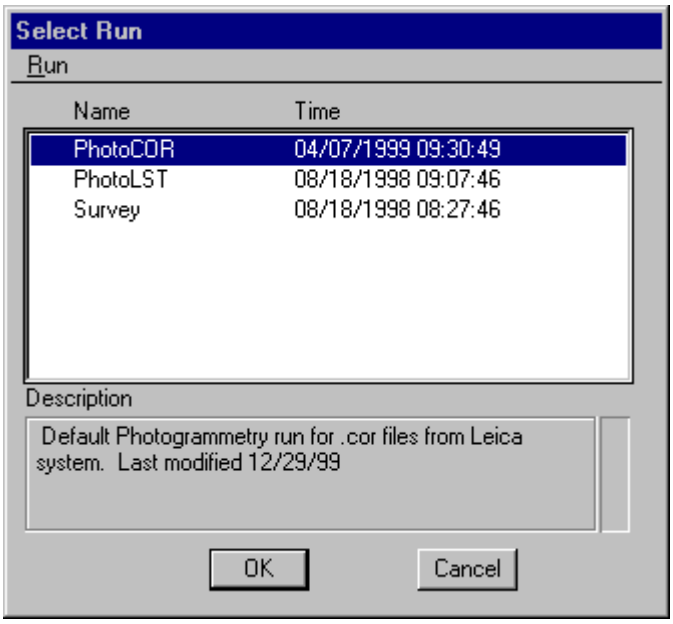
3.2 Definitions

Geopak Survey is a tool for importing survey data into Geopak to be used in the design process. The information from either field surveys or aerial surveys is used to create a digital terrain model of the existing conditions as well as for showing the existing planimetric features.

3.3 Accessing

Geopak Survey can be accessed from the **Project** dialog as shown to the right.

When **Survey** is chosen the following **Run** box is opened.

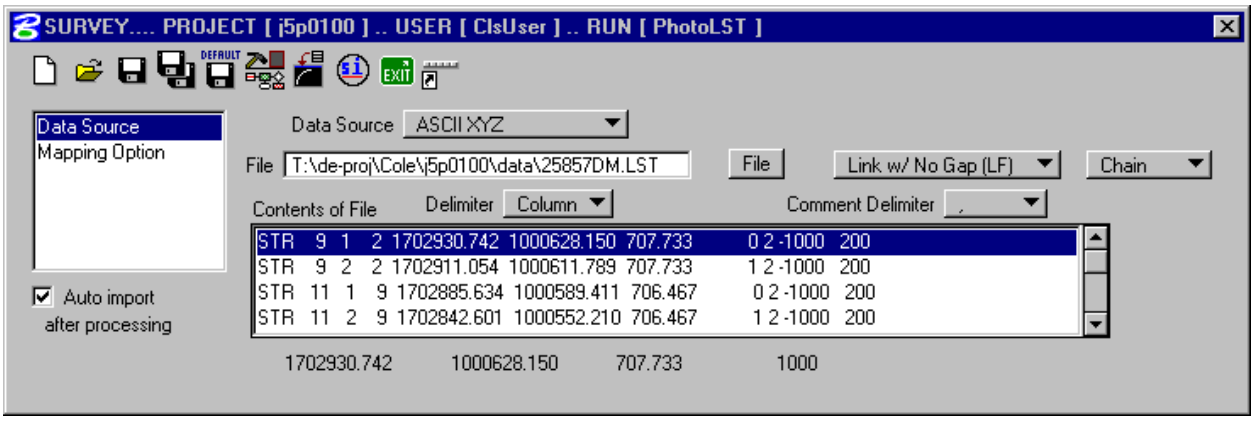


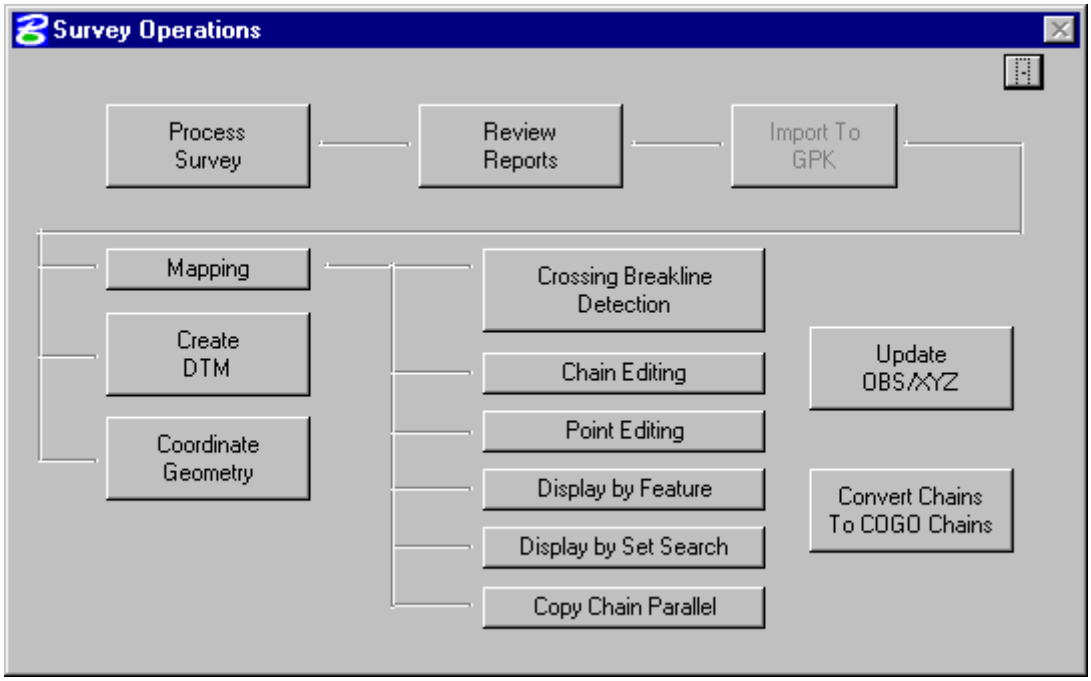
There are three runs to choose from. It is suggested to always copy a run so there will always be a default run available for future runs.

Then three runs available to the user are **PhotoCOR**, **PhotoLST**, and **Survey**. The **PhotoCOR** run is for importing Leica photogrammetric data files (.cor). The **PhotoLST** run is for importing KORK photogrammetric data files (.lst). The **Survey** run is set up to import ASCII XYZ files in the format of point number, X coordinate, Y coordinate, Z coordinate, and point code. If the data file to be imported is in a different format, the **Survey** run will serve as a good starting point for the import process.

3.4 Importing Photogrammetric Data

Once the one of the runs has been chosen, the following dialogs will open. (When the PhotoLST run has been chosen, a columns dialog will also open. **DO NOT** change this dialog. It is set up for importing KORK photogrammetric data.)

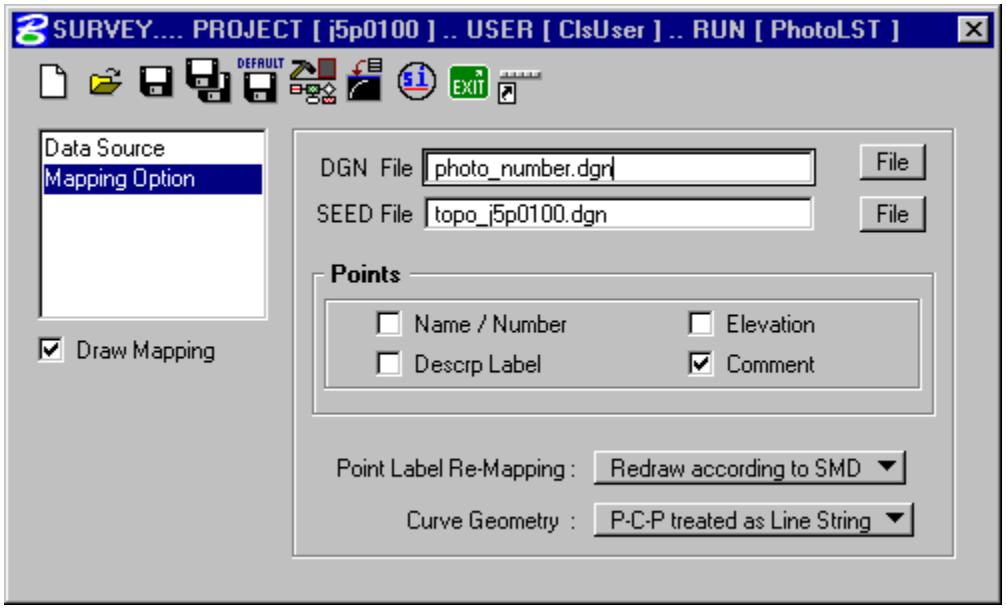




The user can either search for the file to be imported by pressing the **File** button or key-in the file name. On the search box, be sure to change the filter to **All Files [*.*]**.

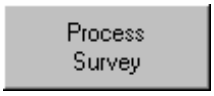
After the file is selected, the data will appear in the **Contents of File** box. If the file contains any header information, the user will need to remove this header information, then select the file again. The user needs to select a line of data from the **Contents of File** box.

From the box on the left side of the dialog select the **Mapping Option** and the following dialog will appear.



Enter the name of the **DGN File** to be created. Be sure the **SEED File** is set to **topo_*jobnumber*.dgn.**. The **topo_*jobnumber*.dgn file** file is a 2D file that has the global origin shifted for the project.

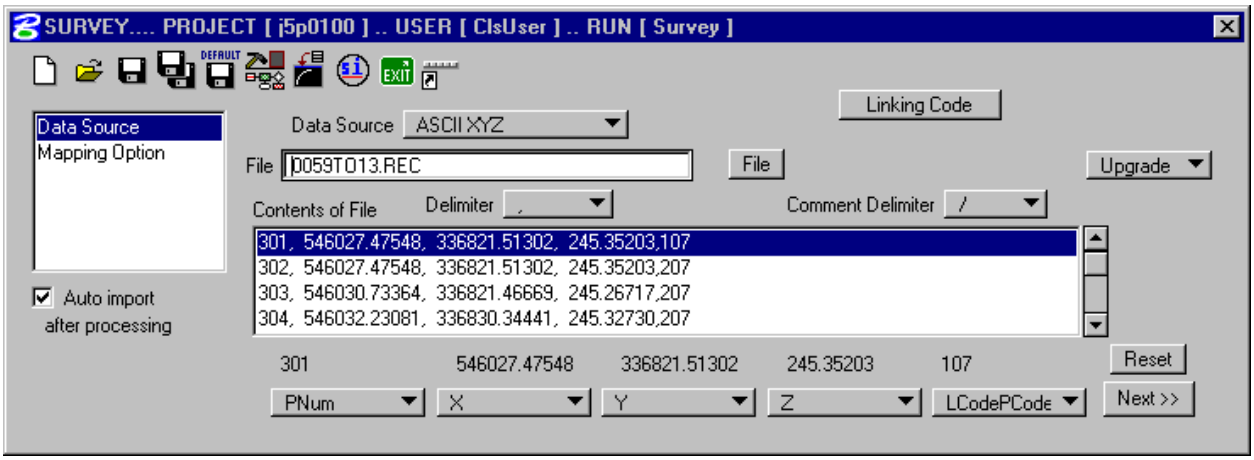
A user can turn on the information about the **Points** to be drawn with the map.



Once the data file is selected, and the DGN File is specified, the user can choose the **Process Survey** button on the **Survey Operations** flow chart. This will import the data to the Geopak database (.gpk) and map the data to the specified drawing.

3.5 Importing Survey Data

The process for importing survey data is the same as it was for importing the photogrammetry data. When the user chooses the **Survey** run, the **Survey** dialog appears as shown below.



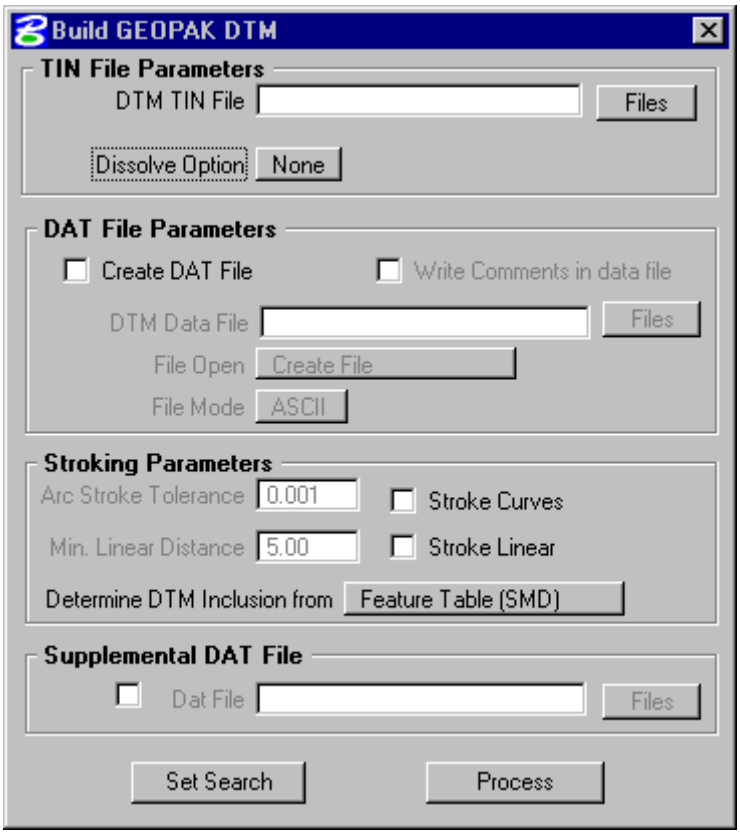
The user needs to select a line of data, specify the name of the DGN file to import to, and select the **Process Survey** button.

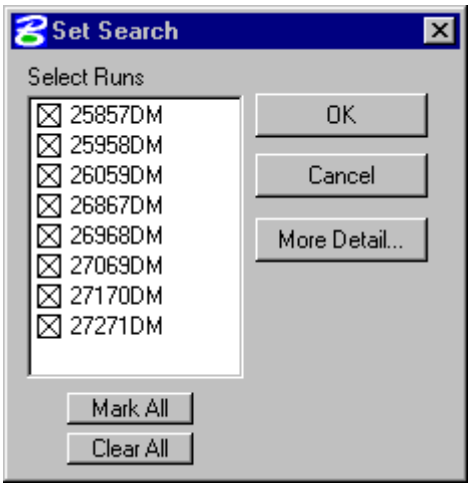
If the file to be imported is not in the format of point number, X coordinate, Y coordinate, Z coordinate, point code, the user can assign the proper columns after selecting a line of data.

3.6 Creating the Digital Terrain Model

Once the import of all the survey files is complete, the user is ready to build the digital terrain model (DTM). To begin this process, the user should select the **Create DTM** button from the **Survey Project Manager** flow chart.

The user can specify the file name of the .tin file to create, and then select the runs to include in the DTM by selecting the **Set Search** button and selecting from the list of available runs.

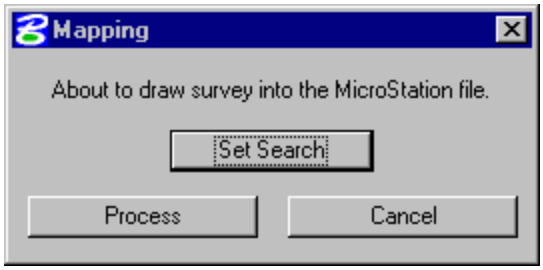




Digital Terrain Models are discussed in further detail in Chapter 4.

3.7 Mapping

If the data was not mapped when survey file was processed, the user can map the data by using the **Mapping** button on the **Survey Manager**. The user can then select the **Set Search** button to select the run(s) they would like to map. Selecting the **Process** button will map the data into the Microstation drawing specified in the **Mapping Option** of the Survey Manager.



Chapter 4

Digital Terrain Modeling

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4.2.1 Digital Terrain Models....4-1
4.3 Accessing 4-4
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4.6.1 Build Triangles....4-6
4.6.2 Additional Build Options....4-7
4.7 Reports 4-7
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4.1 Objectives

- Understand Digital Terrain Models (DTM's)
- Learn how to analyze a digital terrain model

4.2 Definitions

A **Digital Terrain Model (DTM)** represents the topography of a project in the form of a triangulation network. The DTM can be drawn in a three-dimensional file, and rotated to see the existing surface of the project area.

Digital Terrain Models can be generated from various sources including Microstation Elements, survey data, photogrammetry data, **GEOPAK** cross-sections, and geometry data.

Triangulation is a mathematical process applied to stored elevation points and stored elevations along DTM break lines to create surfaces. The result of triangulations is the creation of a .tin file from which original ground profiles and original ground cross sections can be generated.

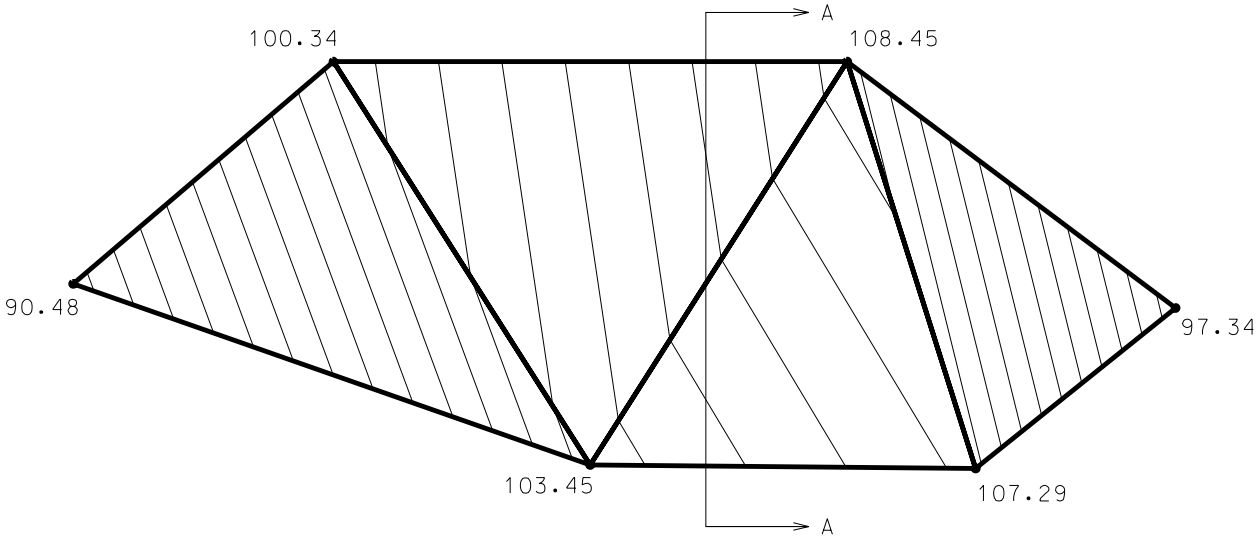
4.2.1 Digital Terrain Models

Digital Terrain Models (DTM) are made up of a network of triangles. A triangle is used because three points define a particular plane in space. This triangle then represents a slope on the existing ground passing through these three points.

The DTM is made up of several types of elements including points, breaklines, boundary, voids, and islands.

POINTS

Points represent a particular location with an X, Y, and Z coordinate. Each of these points will represent a vertex on a triangle in the digital terrain model. Below is an example of a digital terrain model made from a set of points.

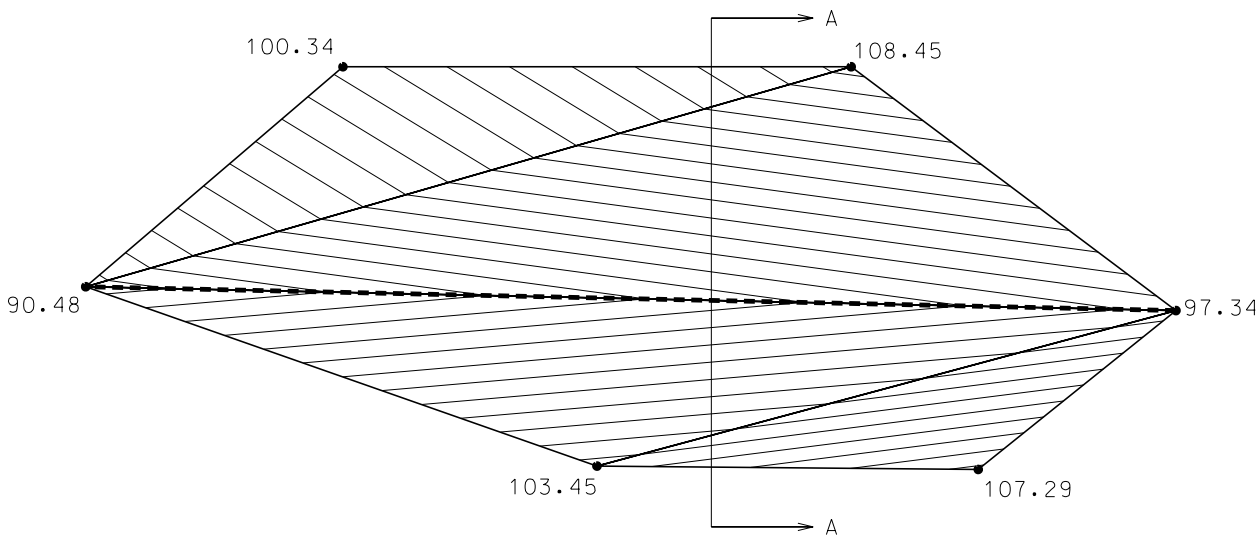


If a section is cut through this digital terrain model at the location A-A, where the elevation of the triangle leg as linearly interpolated between the triangle vertices is plotted along the distance of the section, the section would look as shown in the picture below.

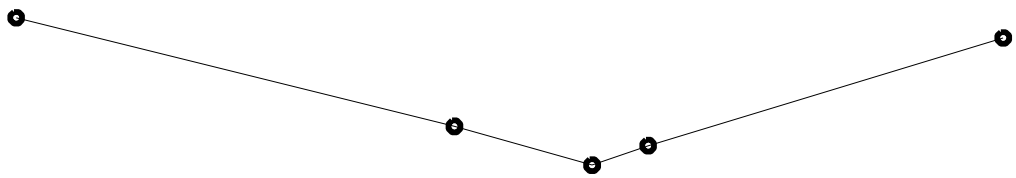
BREAKLINES

Breaklines represent a line along a change in slope. Examples of breaklines may include the edge of shoulder, the toe of a slope, or the flow line of a ditch. A triangle cannot cross a breakline. If a triangle crosses a breakline, it is split into multiple triangles so that no triangle leg will cross the breakline, and the triangles adjacent to the breakline will have a leg that lays on the breakline.

Adding a breakline to the same set of points used above will produce the digital terrain model as shown below.



Cutting a section at the same location will produce very different results as shown in the section below.

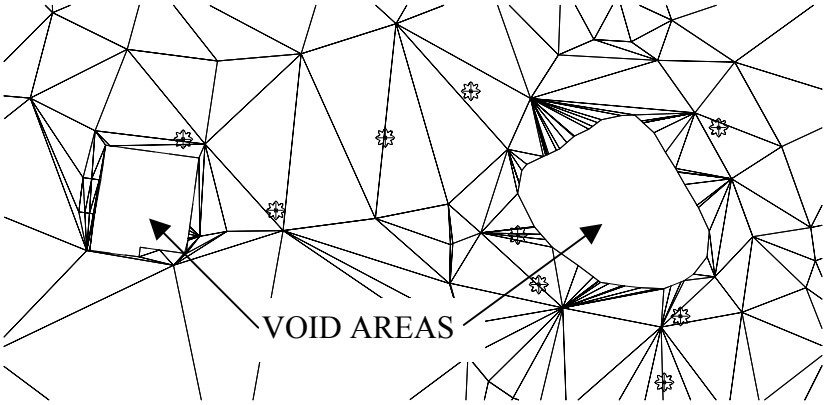


BOUNDARY

A boundary is the maximum external limits a digital terrain model can extend. No triangles will be created outside of this boundary.

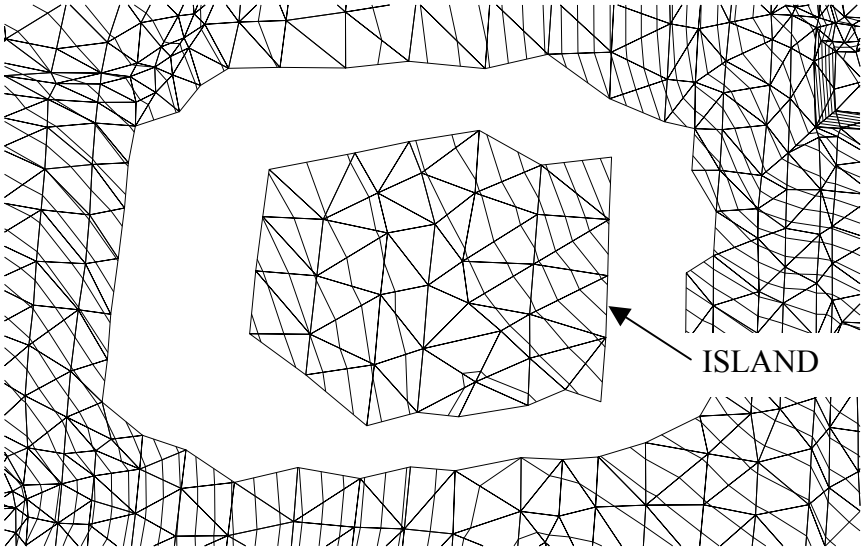
VOIDS

A void is an area where no contours can pass through. Examples of voids include ponds, lakes, buildings, concrete pads, etc.



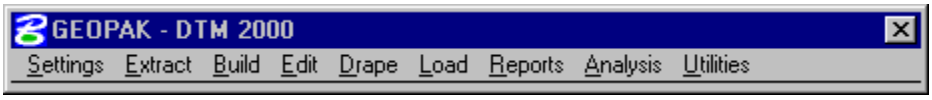
ISLANDS

An island represents an area inside a void that contains contours.



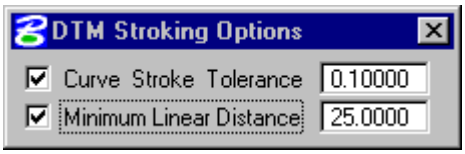
4.3 Accessing

Selecting the Existing Ground push-button from Project Manger or the DTM Tools icon, and selecting a run will bring up the tool palette shown to the right. All of the DTM tools can be accessed from the tool palette or from the DTM menu that can be accessed from the first icon in the tool palette.



4.4 Settings

Two user-defined stroking values need to be defined before graphics can be extracted to create a DTM. Stroking is the process of automatically adding shots to the DTM Input file by interpolating new shots from the linear and curved sections of the data. If the source topography data is mapped in a 3D-design file, stroking may be applied. Stroking is not available if the topography data resides in a 2D-design file.

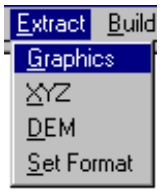


Curve Stroke Tolerance The maximum distance between the arc and the chord used to approximate the arc in the DTM.

Minimum Linear Distance If a linear segment is greater than the Minimum Linear Distance, points are interpolated and added to the segment such that the distance between the points is not greater than the Minimum Linear Distance.

4.5 Extract Graphics

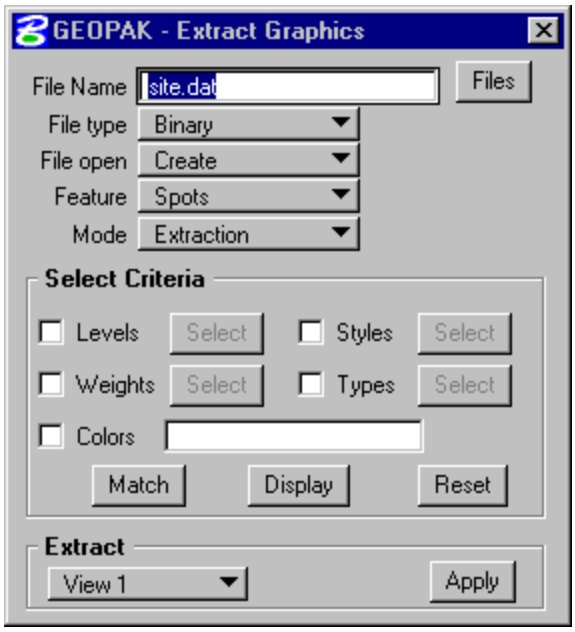
The Extract Parameters tool translates Microstation elements into DTM input data. The dialog box shown below can be accessed from the GEOPAK DTM pull down by single clicking **Extract >> Extract Graphics** or from the Extract Graphics icon in the DTM toolbox.



File Name specifies the name of the file to be created for storing the input data. If file already exists, it may be found using the **Files** button.

File Type specifies the format of the new file. Either format will produce the same results. The difference between the two is ASCII files can be viewed and edited with a text editor while Binary files process faster. For ASCII files, the number of decimal places can be chosen.

File Open indicates if you are creating a new file or appending data to an existing file.



Feature Type determines the type of feature to extract from a design file.

Spots – random survey points. Can be vertices of a line or line string.

Breaks – designate linear features such as edges of pavements, ditch bottoms, ridges, etc.

Boundary – the external boundary of the digital terrain model.

Contours – for use in extracting digitized or otherwise imported contours.

Void – closed shapes representing an area with no contours. (i.e. ponds, headwalls, concrete pads, etc.)

Islands – an area within a void that contains contours.

Graphic Triangles – for use in extracting triangles from a TIN model that has been otherwise created or imported.

Drape Void – same as void, except uses the elevation from the triangulated model.

Break Void – same as void except edges are inserted as breaklines instead of drapelines.

Mode the extraction mode calculates XYZ data directly from the coordinate values of 3D Microstation elements. The interpolation mode produces XYZ data by interpolating between spot elevations along linear Microstation elements. This mode works in both 2D and 3D files.

Select Criteria provides ways to specify the features to be extracted. When an "X" is placed in the box next to Levels, the Select box is activated. You may then click the Select button to indicate only those levels you want GEOPAK to search for when extracting data. If the Levels box is not turned on, GEOPAK will search all levels. The same procedure is true for the other criteria selections. The three buttons located at the bottom of the **Select Criteria** group box **Match**, **Display**, and **Reset** will assist you in interactively defining the search criteria.

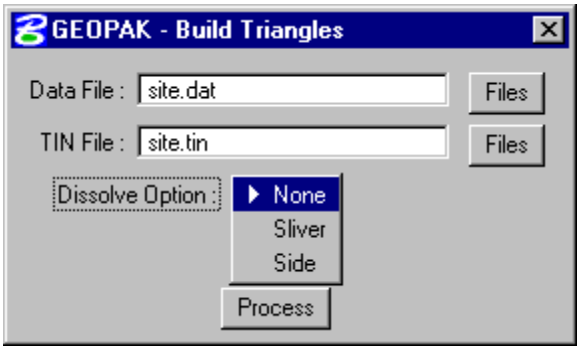
Extract there are four options for data extraction. **Complex Chain** reads those elements along adjoining Microstation elements. **Selection Set** uses a Microstation Selection Set to define elements for extraction. **Fence** will extract all elements within a fence boundary. **View 1** etc. will extract all the elements displayed in the selected view.

4.6 Build

Included under the **Build** pull down and icons are options for creating, manipulating, and merging DTM models.

4.6.1 Build Triangles

Build>>Triangles processes the information stored in a DTM input file (.dat) to create a triangulated model (.tin). The file extension represents a triangular irregular network.



Data File is the name of the DTM input file where the extracted topological features are stored.

TIN File is the name of the file in which the triangulated model will be stored in binary format.

In either of the above cases, you do not have to enter the file extension with the file name and you can always navigate to an existing file using the **Files** button.

The **Dissolve Option** eliminates external triangles that are not representative of the surface. The three options are:

None – no external triangles are dissolved.
Sliver – long, thin triangles are dissolved.
Side – external triangles whose external side is longer than a user specified length are dissolved. (Recommended Option)

4.6.2 Additional Build Options

Build >> Lattice creates a grid (**.lat**) that can be draped over the triangulated data (.tin) to create a three dimensional visual display of the topography.

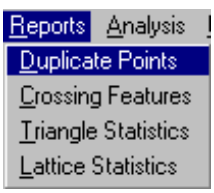
Build >> Merge allows two triangulated models to be merged together as long as the boundary of one model overlaps the other. This process will create a third model (**.tin**) from the combination of the two existing models.

Build >> Clip creates a new model (**.tin**) from a clipped portion of an existing model. The area is defined as internal or external to a user defined clip polygon.

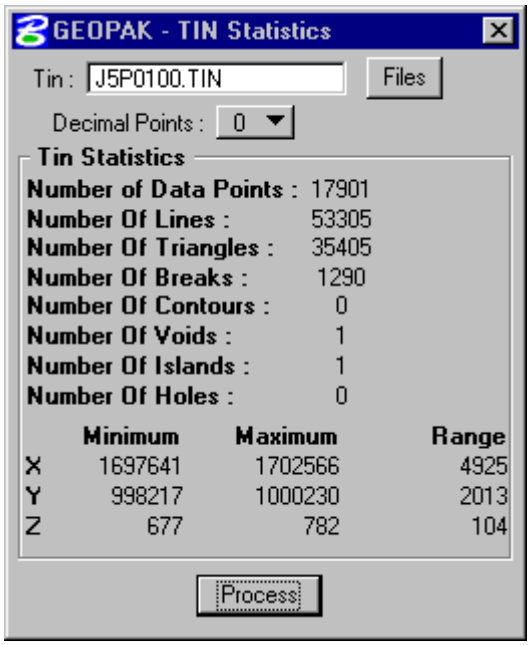
Build>>Pad defines a pad (such as a building slab) and integrates the pad into the existing terrain with a variety of slope options.

Build>>Delta Surface creates a new model based on the difference between two other models, or a model and elevation surface. The Z value in the model that is created is equivalent to the difference between the two specified models, or model and surface.

4.7 Reports



The options under the **Reports** pull down and icons include a way to check for duplicate points or crossing breaklines, and the ability to generate statistics associated with a **.tin** file.



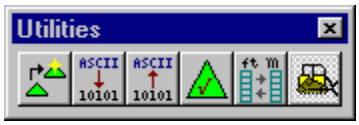
Duplicate Points – reports points with the same x and y coordinates.

Crossing Features – reports intersecting breaklines or contours.

Triangle Statistics and Lattice Statistics - displays a summary indicating the total count of each element type and minimum and maximum X, Y, Z ranges for the specified **.tin** or **.lat** file.

4.8 Utilities

Options under the **Utilities** pull down and icons include a way to check the validity of a triangulated file, converting triangulated files from previous versions of Geopak, converting the DTM data file between ASCII and binary format, converting the DTM from English to Metric, and exporting a DTM to Trimble DTX model.



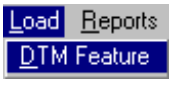
Convert TIN – permits the conversion of a triangulated file from a previous version of Geopak to a Geopak 98 format.

ASCII to Binary and **Binary to ASCII -** permits conversion of the DTM input file (**.dat**)

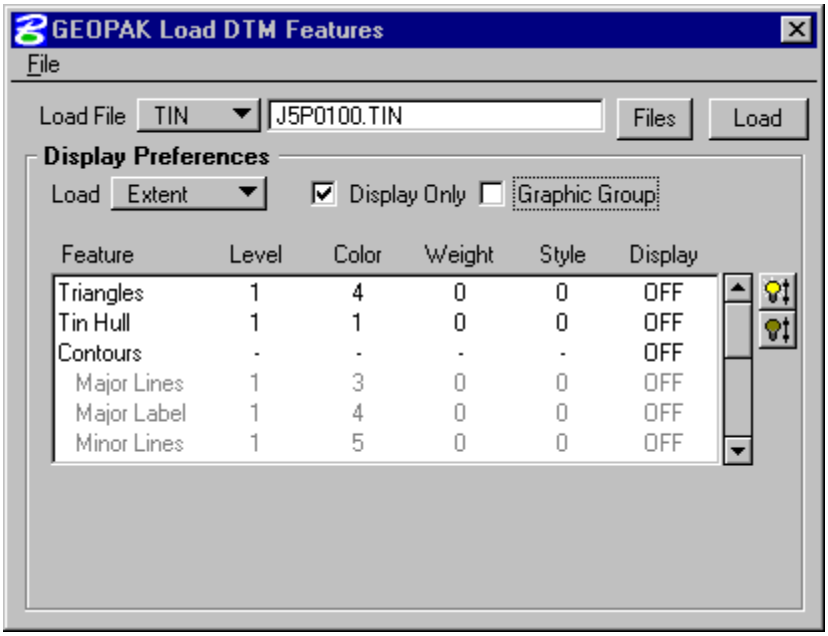
Check Triangulation - starts an internal process that verifies the integrity of the triangulated file. A message will appear indicating "Triangulation Valid".

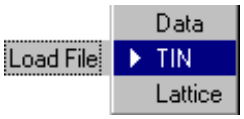
Metric <-> English – converts a file from English to Metric units, or from Metric to English or Imperial units. A custom scale factor can also be used. The DTM can also be translated or rotated. If translation or rotation is desired without scaling, a Custom scale of 1.0 can be used. This process will create a new DTM file.

4.9 Load



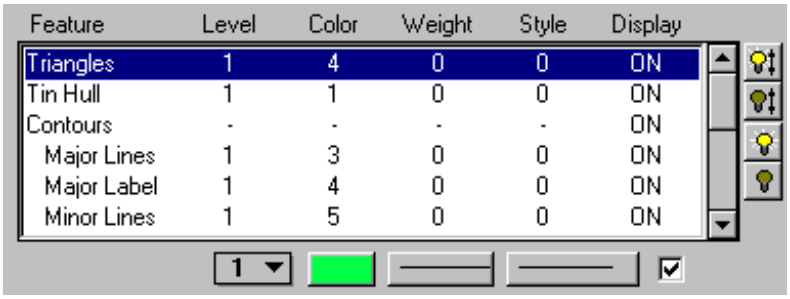
Load is the process by which we can visualize the DTM data, the TIN model, the lattice model, and the contours. By clicking on **Load >> DTM Feature**, or by clicking on the icon, the following dialog will appear.





The user can choose to load the DTM data (.dat), the TIN file (.tin), or the lattice file (.lat). Each of these files can be loaded for the model extents, within a fence, or within a window.

Toggling on **Display Only** will allow the user to view the elements without writing them to the Microstation file. Conversely, toggling **Display Only** off will store the viewed elements as Microstation elements. If **Display Only** is on, updating the active screen will clear the display of these elements. When **Display Only** is off, the elements can be placed as a graphic group using the **Graphic Group** toggle.



Feature	Level	Color	Weight	Style	Display
Triangles	1	4	0	0	ON
Tin Hull	1	1	0	0	ON
Contours	-	-	-	-	ON
Major Lines	1	3	0	0	ON
Major Label	1	4	0	0	ON
Minor Lines	1	5	0	0	ON

The user can set what data to visualize, the symbology, and the contour interval (if **Contours** is turned on).

Will turn on all items.

Will turn off all items.

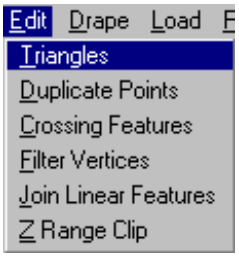
Will turn on only the selected item.

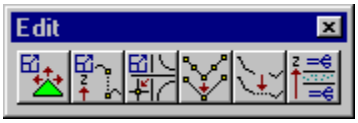
Will turn off only the selected item.

4.10 Other Pull Down Menus

EDIT

The **Edit** pull down provides the ability to edit the digital terrain model.





Triangles - Allows the user to add, delete, or modify triangle vertices, triangle legs, and breaklines.

Duplicate Points – Reports and allows interactive editing of points in a survey data file with the same X and Y coordinates.

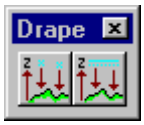
Crossing Features – Reports and allows the correction of crossing breaklines.

Filter Vertices – Reduces the amount of vertices by deleting the vertices based on a user specified distance.

Join Linear Features – Allows the user join two linear features into one feature.

Z Range Clip – Deletes information from the survey data file (**.dat**) based on given elevation information.

DRAPE



GEOPAK provides two tools for draping Microstation elements onto a triangulated model, vertices and vectors.

ANALYSIS

The **Analysis** tools allow the user to view the digital terrain model through many different methods such as a profile, themes, and drainage.

Height – Show the user the x, y, and z coordinates and the slope of a given data point. The contour at that elevation, the triangle the point lies within, and the direction of flow can be displayed.

Profile – Will display the profile of the digital terrain model between two points.

Volumes – Will calculate the volume between two TIN models, the volume between a TIN model and a plane, or the cut and fill totals between two TIN models.

Elevation Differences – Will display the elevation difference, or the amount of cut and fill between two TIN models, or a TIN model and a plane.

Slope Area – Displays the slope area of a TIN model, or a portion of a TIN model.

Themes – Displays the digital terrain model based on different user definable themes such as, elevation ranges, slope percentage, slope degree, or aspect.

Drainage – Allows a user to display and analyze drainage patterns with in a TIN model. Tools include delineating watersheds, drawing flow arrows, determining upstream and downstream traces, and finding high and low points.

Visibility – Displays lines of sight (which triangles can and cannot be seen), or what is visible between two specified points.

For more information on these items, see the *Geopak Manual* or online help.

Exercise 4-1

This is a group exercise to present several GEOPAK Digital Terrain Modeling (DTM) tools.

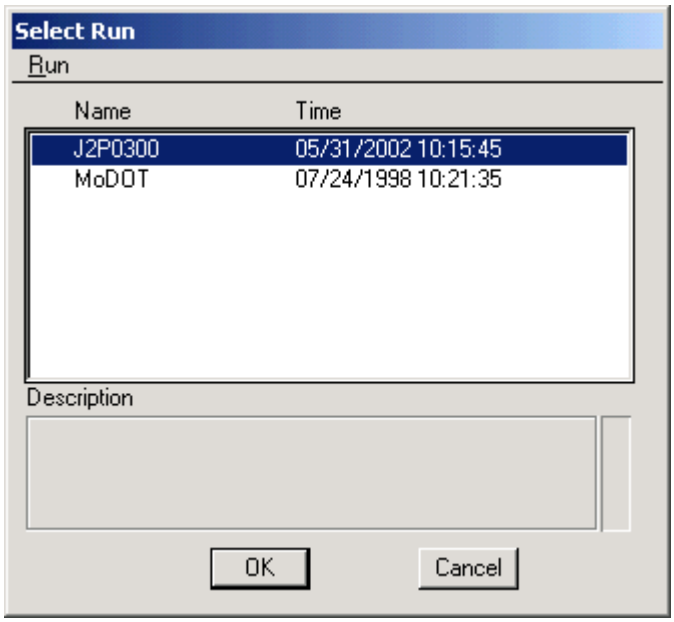
1. Open the Microstation file **t:\br-proj\a_geopak\d2\j2p0300\data\topo_j2p0300.dgn**.

2. Open the project **j2p0300.prj**. Enter the project as user **userc** and select **Road**.

3. Make sure that the Working Alignment is **J2P0300**.

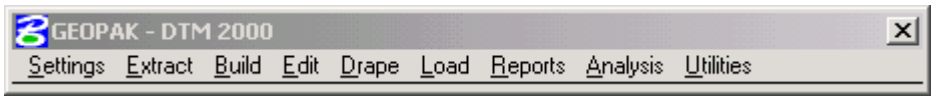
4. Select **Existing Ground** from the upper left corner of the Road Project dialog flow chart.

Copy the **MoDOT** run to **J2P0300**, and open the **J2P0300** run. This is the same **Run > Copy… > Run** process used in creating a new working alignment. GEOPAK uses runs to keep track of specific dialog and tool settings. A run allows the user to repeat a task without having to reenter all of the needed information.



This icon opens the menu bar.

The DTM tools for the following steps may be accessed from either the toolbox shown to the right or the DTM Menu bar depicted below.

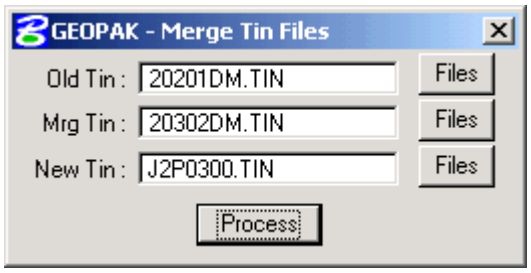


5. Use the **Build Merge TINs** tool (DTM menu path **Build > Merge TINs** or the raised icon shown to the right) to merge the **20201dm.tin** with the **20302dm.tin**.

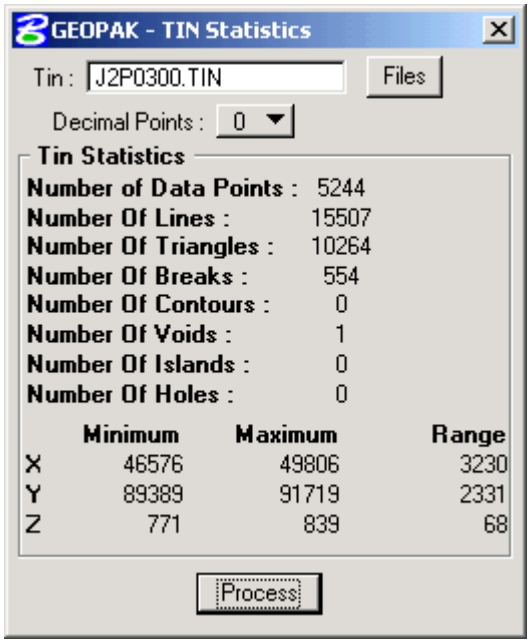
   To do this, set **20201dm.tin** as the **Old Tin** and **20302dm.tin** as the **Mrg Tin**. You can either type in the TIN names or use the **Files** button to select the TINs.

   Set the **New Tin** to **J2P0300.TIN**. This needs to be typed since this file needs to be corrected. This Files button is used only if the already exisits.

   Click on **Process** to initiate the merge tin process.



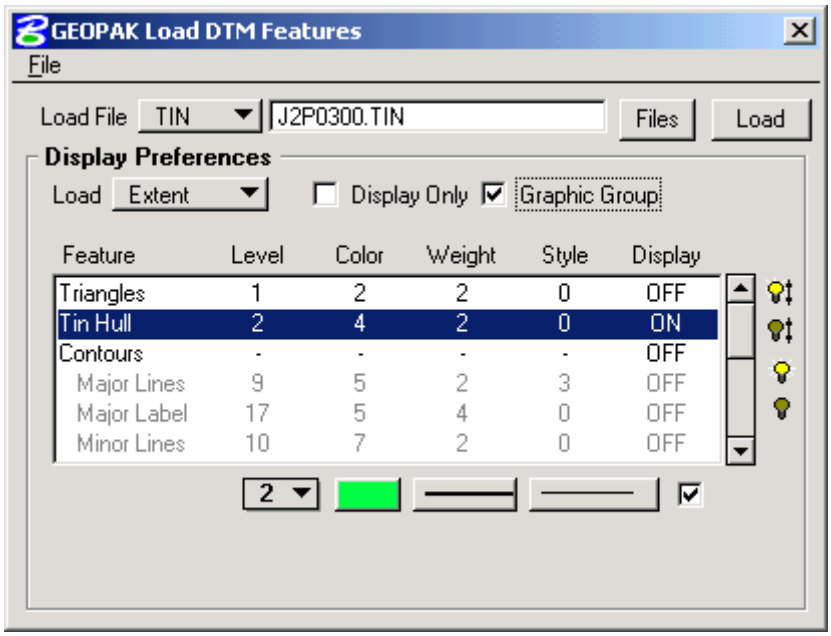
6. Check the **Triangle Statistics** (DTM menu path **Reports > Triangle Statistics TINs** or the raised icon shown to the right) of the tin file **j2p0300.tin**. Use the **Files** button shown below to select the TIN or type its name into the field. Select the **Process** button to calculate and report the TIN statistics.



   It is a good idea to check the statistics for any new DTM to make sure that its information matches the known project data. The minimum X and Y values can be used to set the custom coordinates for a MicroStation file created to display the DTM.

7. Open the **Load DTM Features** dialog (DTM menu path **Load > DTM Feature** or the raised icon shown to the following figure).

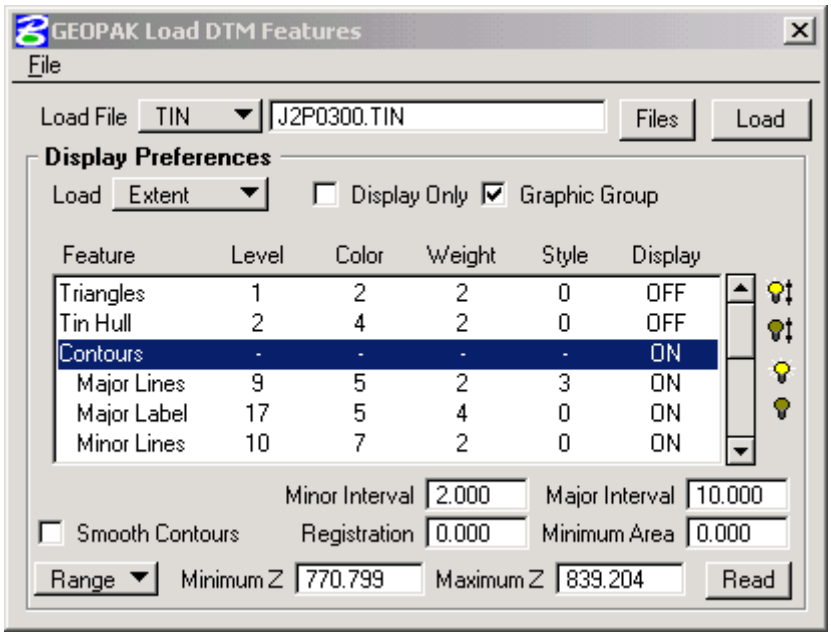
Set the **Load File** to **TIN** and the file to **J2P0300.TN**. Load the Tin Hull as a **Graphic Group**, by setting up the dialog as shown below. (See the manual for instructions on how to use the "light bulb" icons to toggle an items Display on and off.)



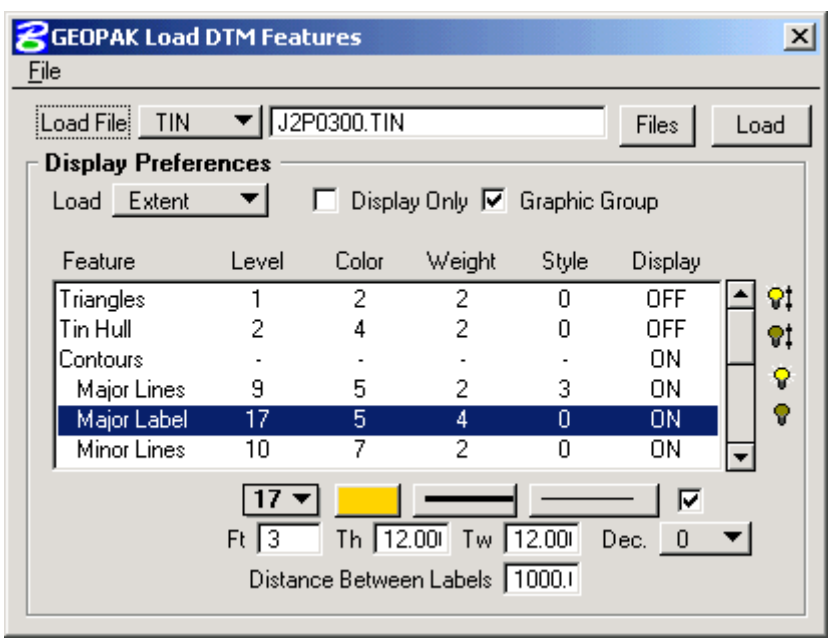
Fit the MicroStation view so you can see the boundary of the TIN model.

8. Turn **off** the **Tin Hull** and **turn on** the **Contours**, **Major** and **Minor Lines**, and **Major Label** items.

   With the Contours line highlighted, click on the **Read** button to set the elevation range of the TIN and set the following parameters:
   Minor Interval: **2.000**
   Major Interval: **10.000**



   Switch to the **Major Label** line. Set the **text** size to **12** and the **Distance Between labels** to **1000**. **Load** the contours as a **Graphic Group**.

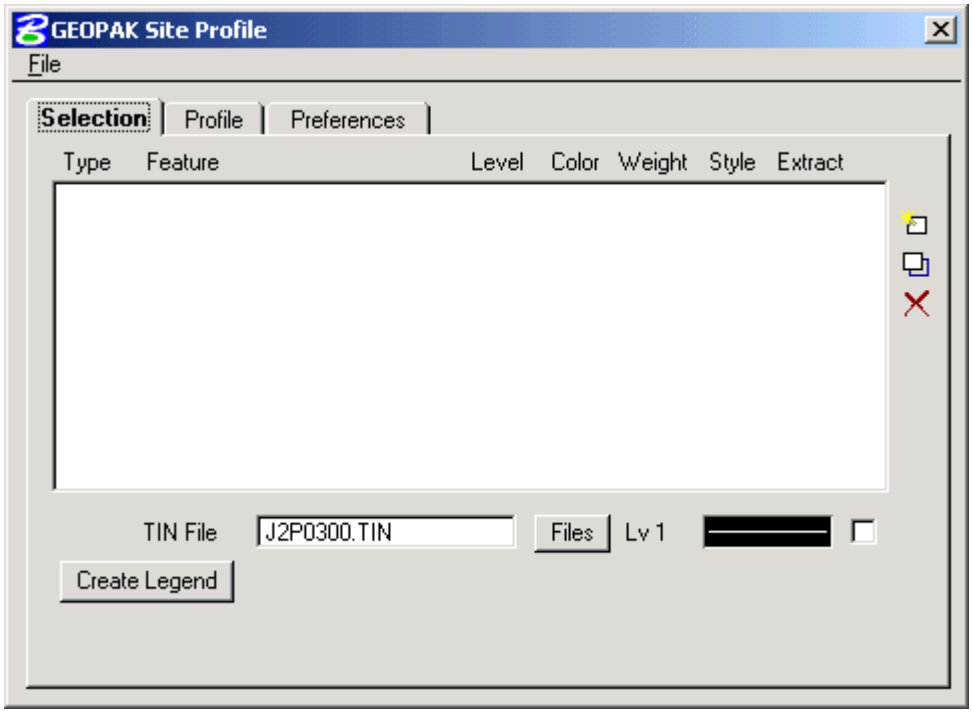


9. Close **Load DTM Features** and **save changes** to the MicroStation drawing.

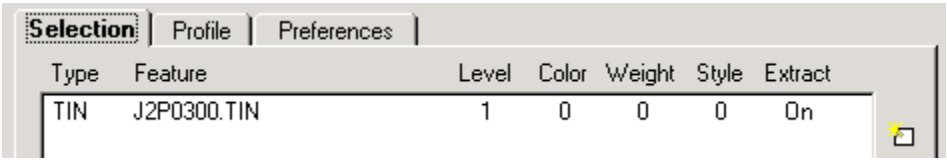
10. Turn on Level 22. It contains a line indicating the location of an upstream valley section.

Open the **Site Profile** tool. It can be opened by going to DTM pull down menu item **Analysis >> Profile** or clicking on the second icon in the Analysis tool box, which is depicted below and is the tool box in the lower left hand corner of the DTM tools pallet.

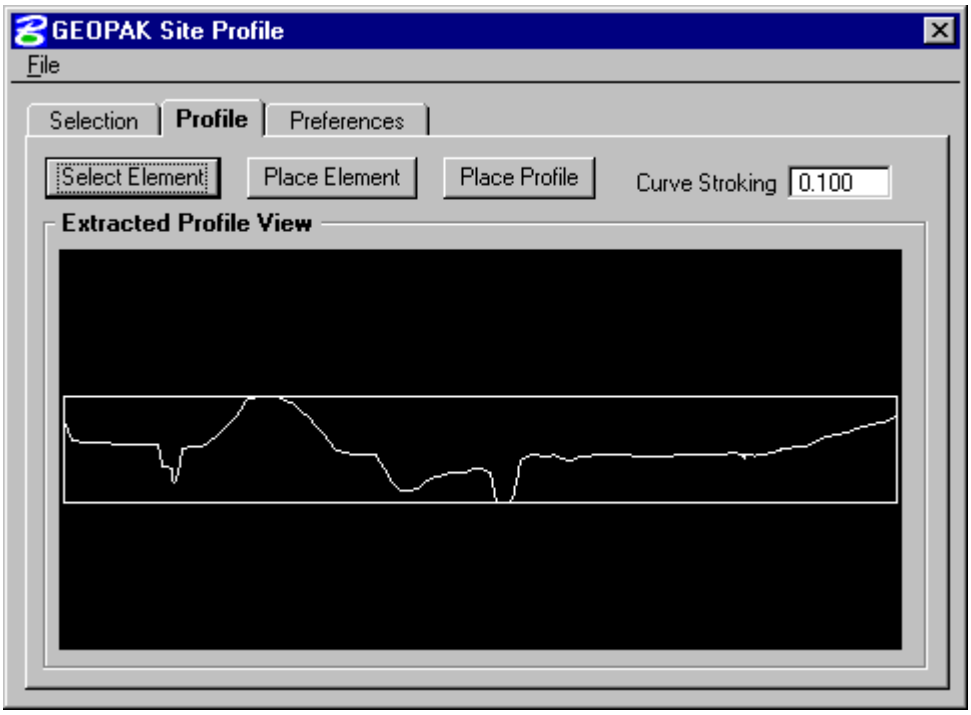
The Site Profile dialog is shown below.



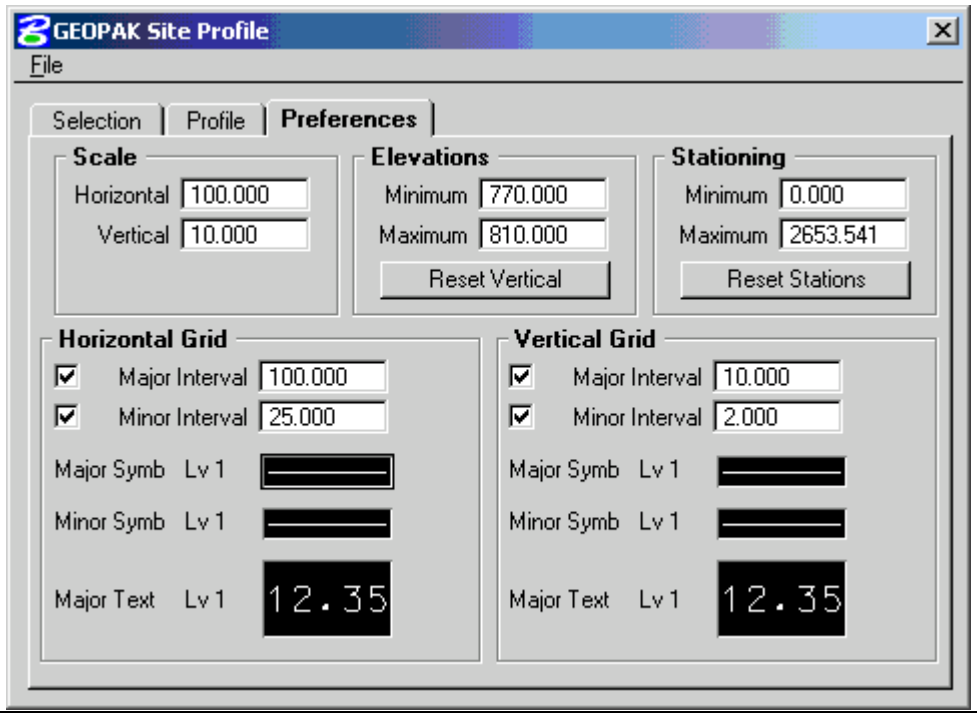
Under the **Selection** tab, **add** the **J2P0300.TIN** to the list by entering it in the **Tin File** field and clicking on the **Add List Item** icon: . Once the TIN has been added to the list, the list area should look like the following:



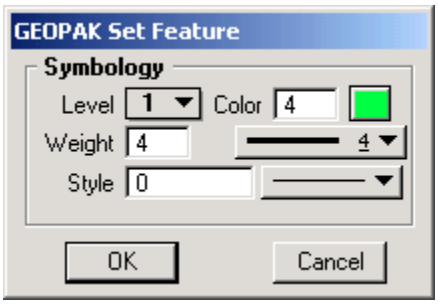
11. Under the **Profile** tab, click on **Select Element**. Data point on the line locating the valley section and accept. This will place the valley section in the dialog, as shown below:



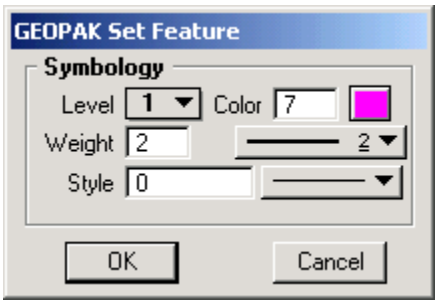
12. Under the **Preferences** tab, set up the preferences to display a grid. Use the settings shown below. Go to **Applications >> GEOPAK Road >> User Preferences** to set the number of **decimal places** shown **2** for stations and distances.



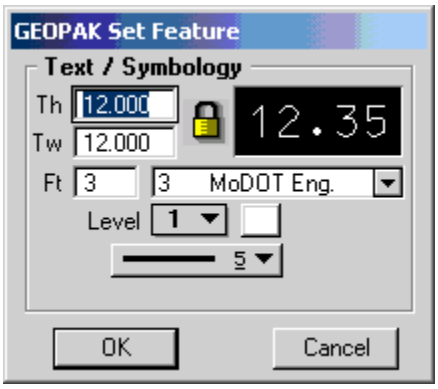
13. Set the **major** horizontal and vertical **grid** symbology to that shown in the following figure. To display this dialog, double click on the line preview area to the right of **Major Symb**. Since the settings for each grid are set independently, you need to change the settings for both grids.



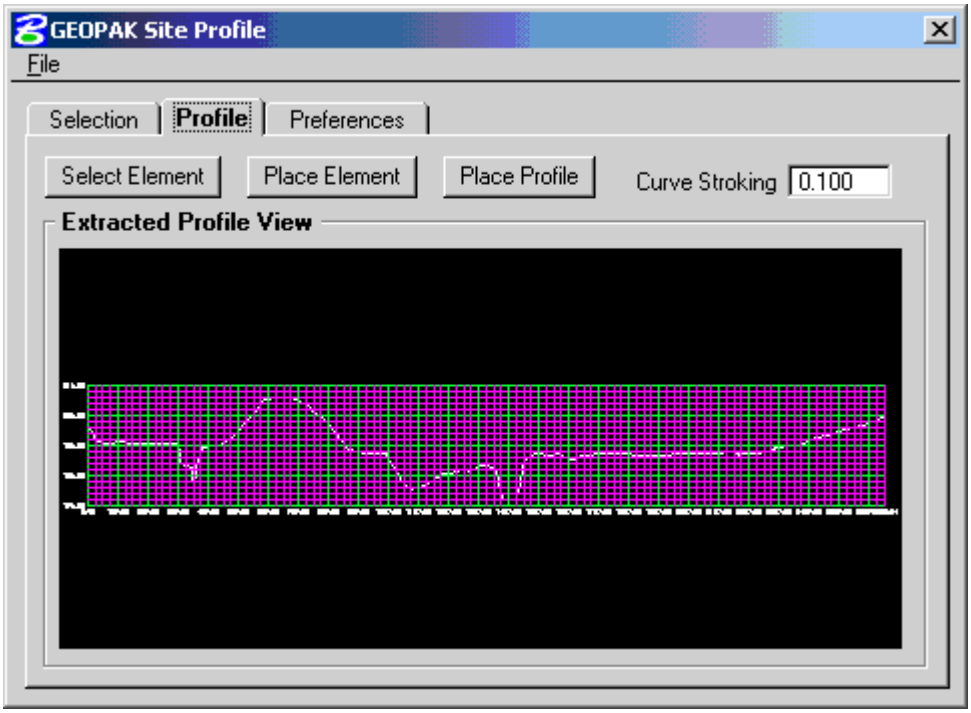
14. Set the **minor** horizontal and vertical **grid** symbology to that shown in the following figure. To display this dialog, double click on the line preview area to the right of **Minor Symb**. Again, this needs to be set for each grid.



15. Set the **major** horizontal and vertical **text** to the properties shown in the following figure. To display this dialog, double click on the text preview area to the right of **Major Text**.



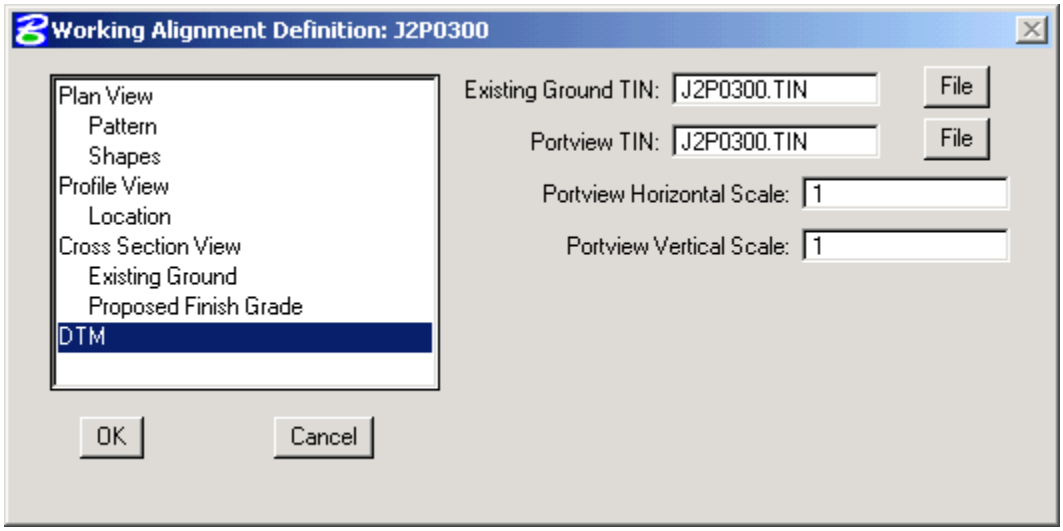
16. Return to the **Profile** tab. The dialog should look similar to the one shown below.



Navigate to a blank area of the MicroStation drawing. Click on **Place Profile** in the Site Profile dialog and place the profile in the MicroStation file.

17. Close all **DTM dialogs** and **save changes** to the MicroStation drawing.

18. Return to the Road Project dialog by selecting the **Project Manager Icon** in the Road toolbox. Click on the working alignment **Define** button. Go to the **DTM** section and set both the **Existing Ground Tin** and **Portview Tin** to **J2P0300.TIN** as shown below.



Click the **OK** button and **Exit Project Manager**.

1. Coordinate geometry elements are stored in
   a. .GPK files.
   b. .INP files.
   c. .IOC files.
   d. .OOC files.

2. .TIN files store triangular surface information.
   a. True
   b. False

3. ____ is a tool for setting up a new GEOPAK job, or adding users to an existing project.
   a. Project Manager
   b. Start Job
   c. GEOPAK Manager

4. **Job Number** in Start Job and **Project Name** in Project Manager should be the same.
   a. True
   b. False

5. The first step in creating a new Project Manager (.prj) file is to
   a. select Project>>New.
   b. navigate to the t:\br-proj\a_geopak\district\jobnumber\data directory.
   c. set the working directory.
   d. navigate to the t:\br-proj\a_geopak\district\jobnumber\project directory.

6. Breaklines are used to define a change in slope.
   a. True
   b. False

Chapter 5

Coordinate Geometry

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5.1 Objectives

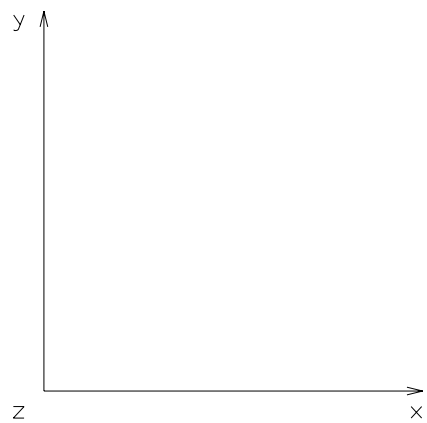
- Learn to set up and access the coordinate geometry database.
- Become proficient in using Geopak Coordinate Geometry.

5.2 Definitions

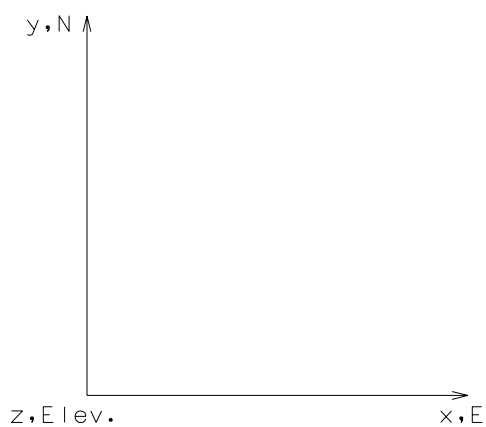
Coordinate Geometry (COGO) is a method of using XYZ coordinates to store geometric elements such as points, lines, curves, spirals, chains, parcels, and profiles. The **Coordinate Geometry** dialog box is an interactive graphical user interface for storing coordinate geometry elements.

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.



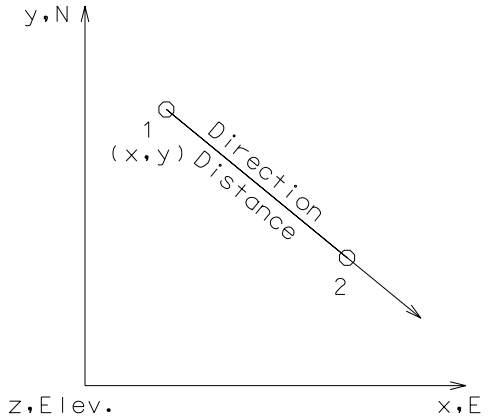
The user must be aware of the coordinate system the data is in, and the coordinate system that GEOPAK is using. When referring to the **XYZ** coordinate system, the coordinates are listed as **(X, Y, Z)**. When referring to the **Northing, Easting, Elevation** coordinate system, the coordinates are listed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

5.2.2 Points

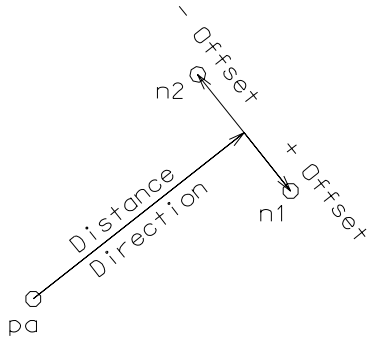
Points are defined by a single set of coordinates. Each **point** will have an X and a Y coordinate. The point may also have a Z coordinate if an elevation is defined.

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 9 characters in length, although limiting the name to 8 characters is recommended.

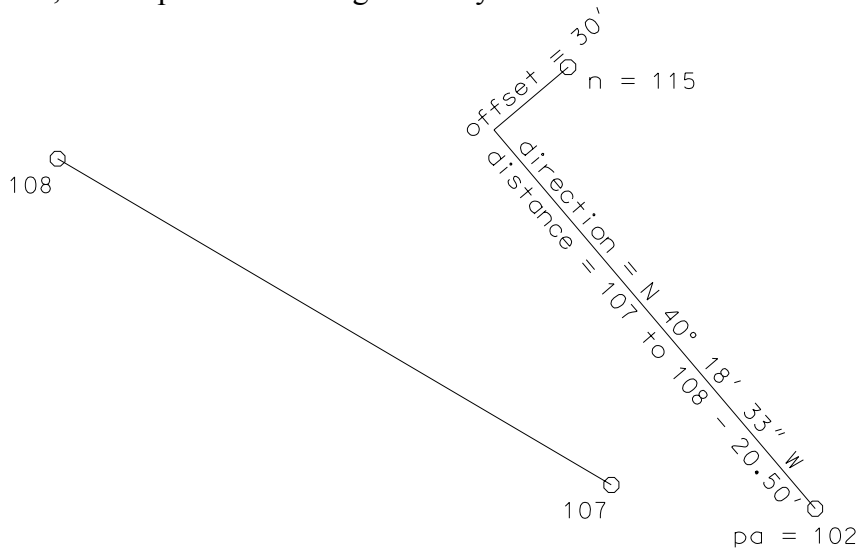
Points can be stored from a set of coordinates, or located from other elements. To define a point from another point, a distance and direction need to be defined.



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



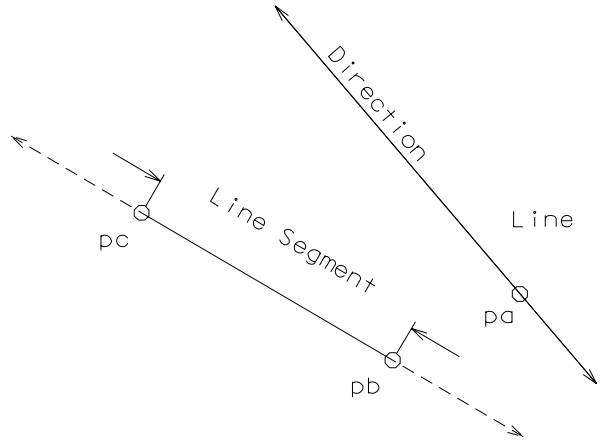
Distances and directions can also be found mathematically. Values can be added, subtracted, multiplied, divided, or computed with a trigonometry function



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 alpha-numeric up to nine characters, but cannot be numeric-alpha.

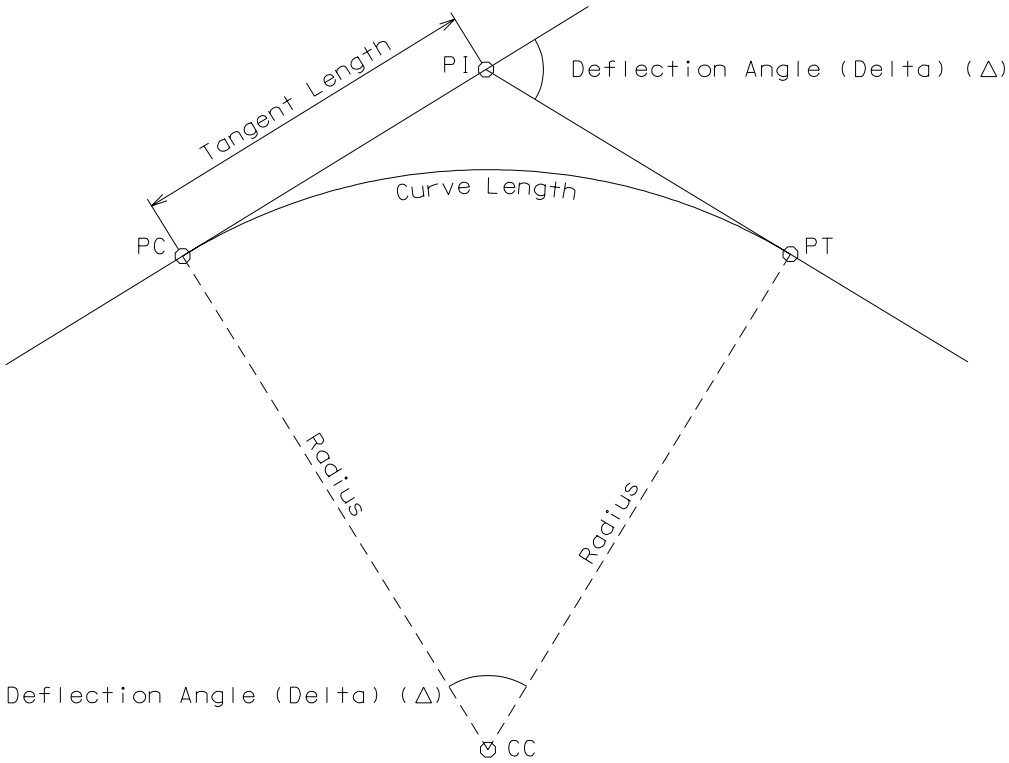


5.2.4 Curves

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.



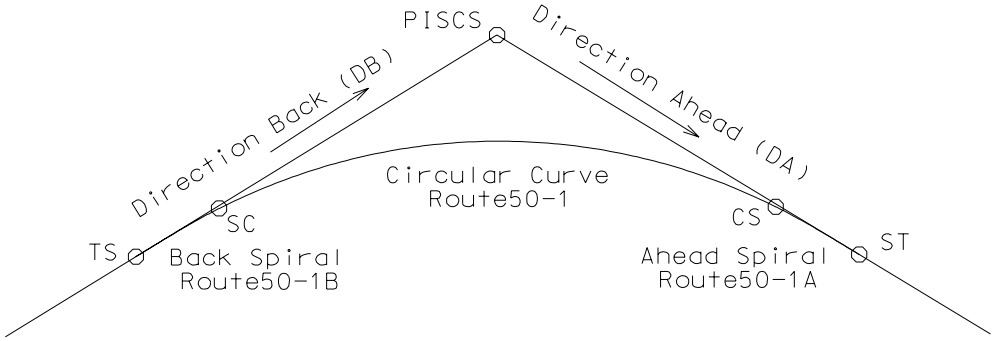
Curve names can be any alpha-numeric characters up to nine characters in length.

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.

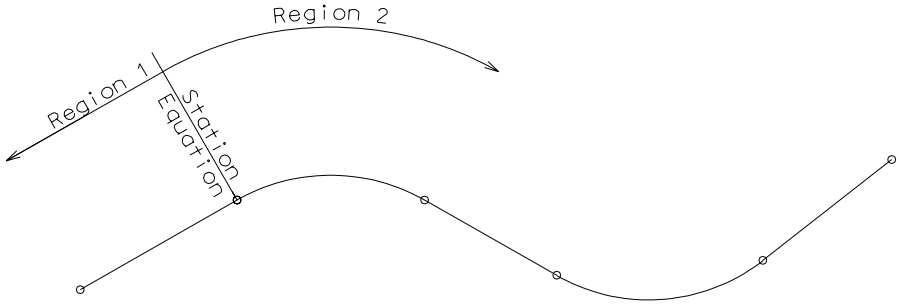
Several points are also stored with a **spiral**. They are as follows:

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

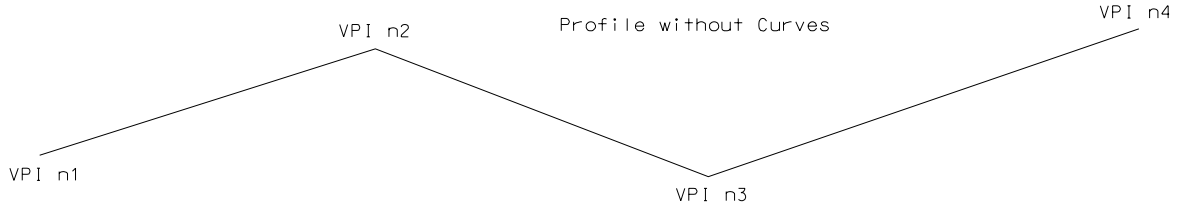
Chains are a combination of other elements. They can consist of points, curves, spirals, or other chains. **Chains** can represent horizontal alignments, or the horizontal location of some element. **Chains** have **stationing** associated with them. Locations along the chain can be determined by the **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.

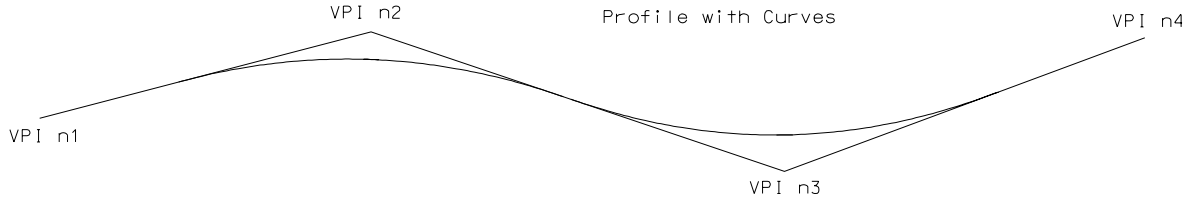


Chain names can be any alpha-numeric characters up to a length of nine characters.

5.2.7 Profiles

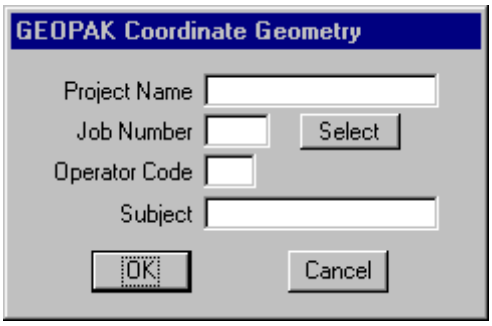
Profiles are vertical alignments defined by stations and elevations. They are generally associated with some horizontal chain. **Profiles** can be stored with or without vertical curves. **Profiles** without curves generally represent the existing ground profile, or a ditch profile. **Profiles** with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





5.3 Accessing

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



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.

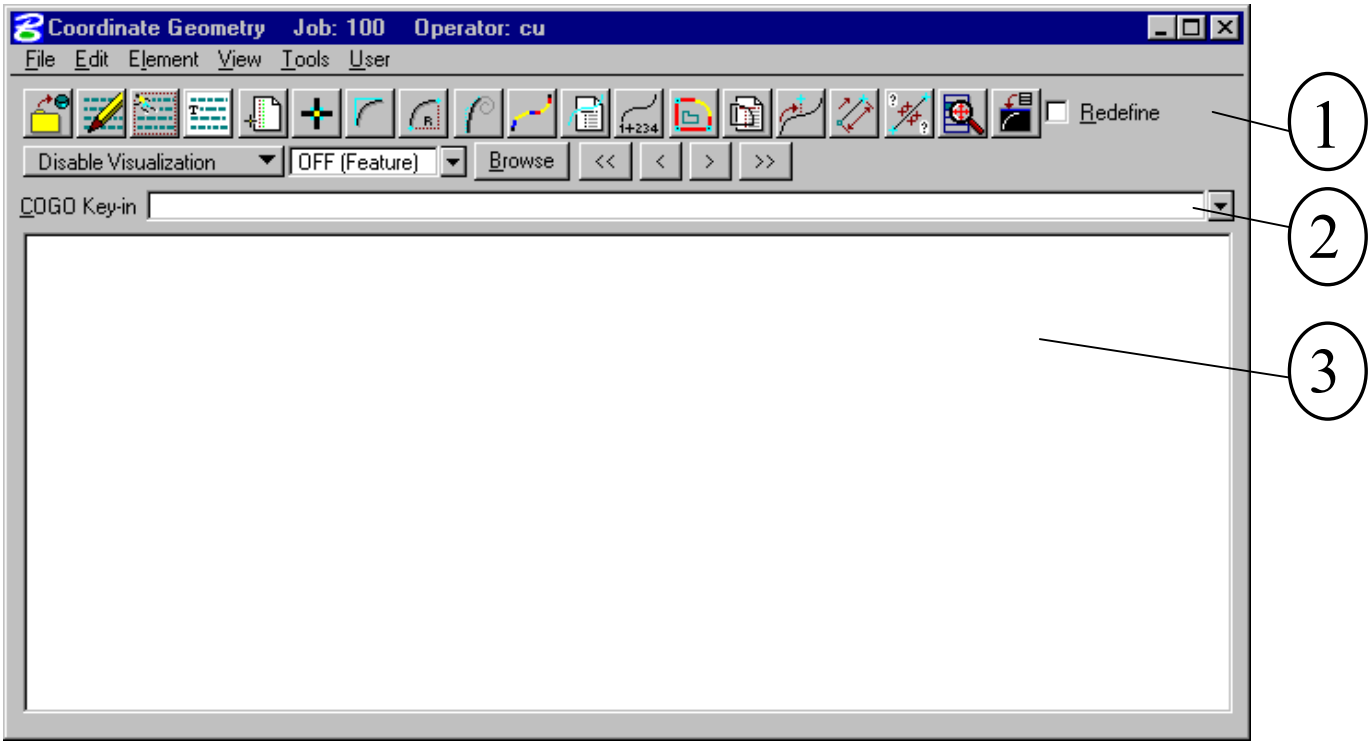
Job Number - identifies coordinate geometry database (3 alphanumeric characters, max) (required). If **Project Manager** is used, this field will be filled in automatically.

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



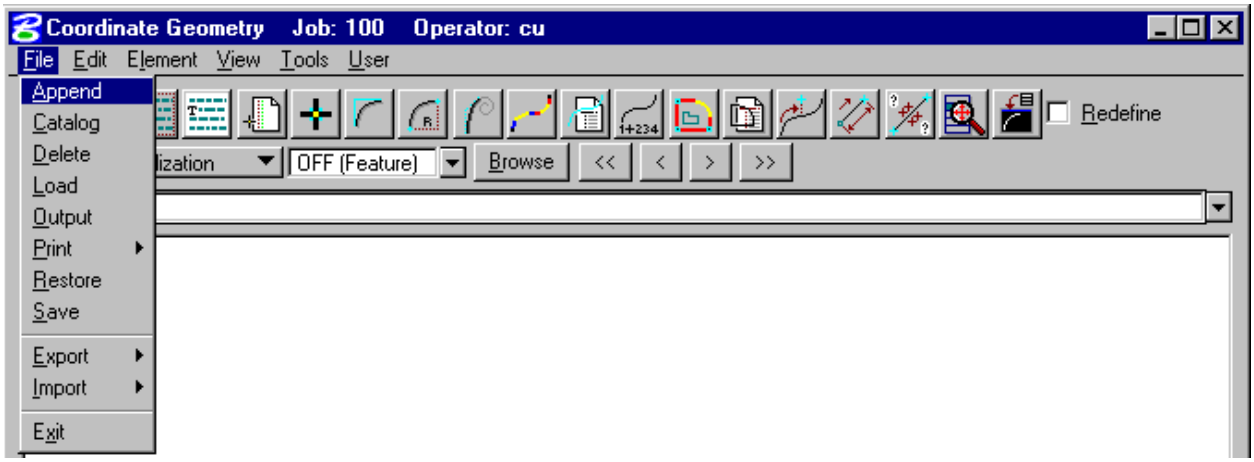
The coordinate geometry dialog box is made up of three separate display areas:

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



Append - this command is for *input files* only. 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.

Load - when selected, a menu appears listing all saved input files. *Highlight* a file then click the **OK** button. The input lines from the highlighted file are now displayed in the output buffer and are ready for modify, delete, edit or read.

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

Print - sends your output/input file to the printer.

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

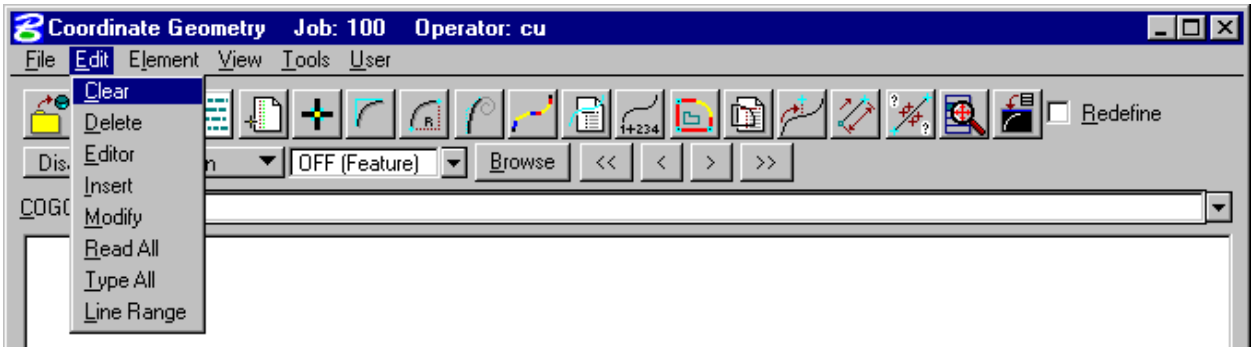
Save - will save the current input buffer to a file. (**Fname999.ioc**)

Export - will export Geopak chains and profiles into RDS format and Geopak chains and points into SDMS format.

Import - will import horizontal and vertical alignments and points from RDS and SDMS format into the Geopak .gpk file.

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.

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.

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

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

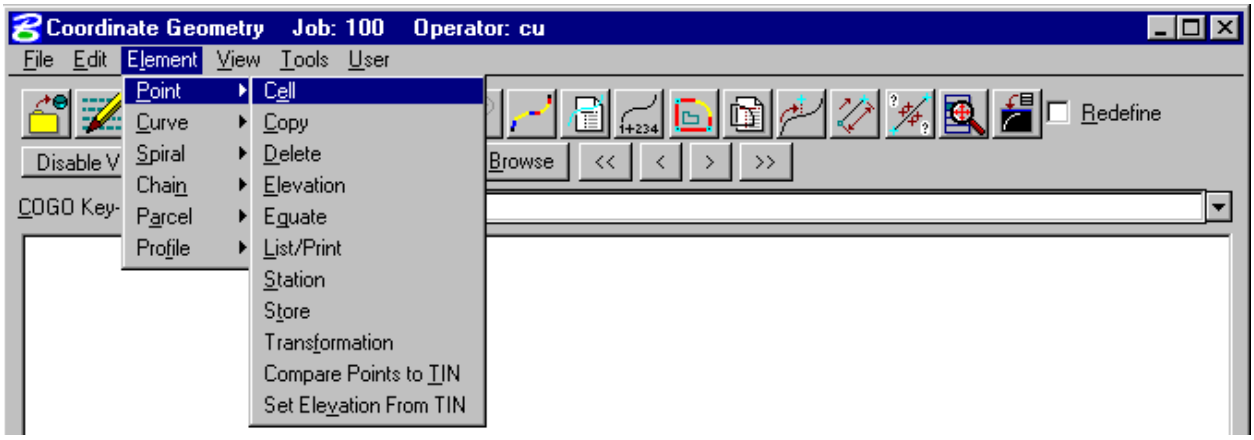
Modify - allows the user to change a word in a command line. The modified command line will not be computed until the operator uses the **Read** command.

Read - 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 - displays the content of the current input file, (**All**) or a portion of the file by specifying a range of line numbers (**Line Range**).

5.4.3 Element Commands

ELEMENT>>POINT



Cell - assigns a cell name to a previously stored point

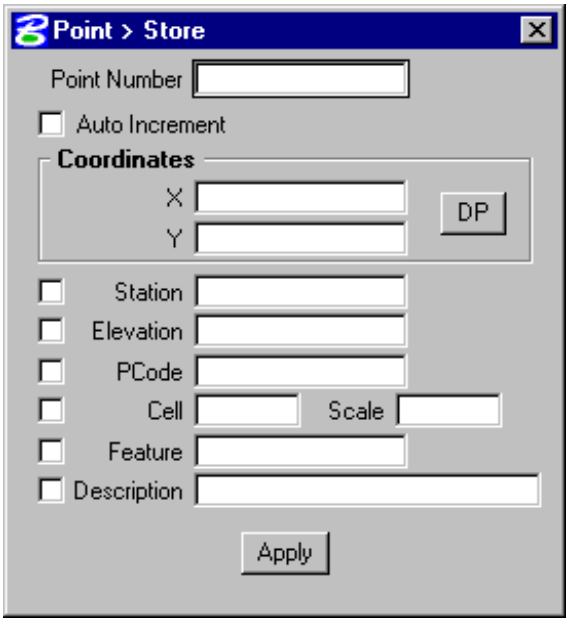
Copy – copies points or a point range to a new point number or range within the same Geopak database

Delete - allows you to input a point number (or range of numbers) to be deleted from the database.

Elevation - assigns an elevation to a previously stored point

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

List/Print - input a range of point numbers; **List** displays only the point numbers currently stored in the .gpk file. **Print** displays point number, x, y, z coordinates, station value and other information in the output buffer for the requested points. If visualization is on, this will cause the points to be displayed.



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

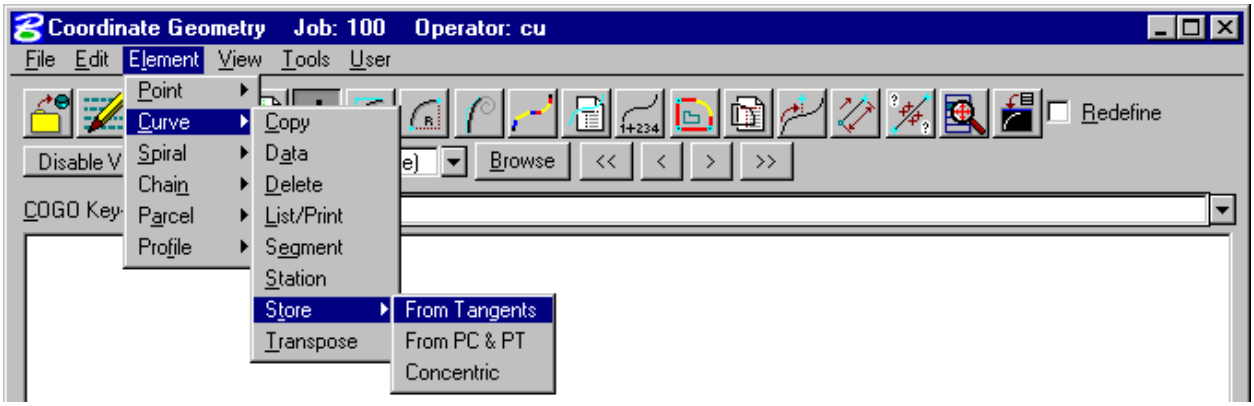
Store - stores a point located by key-in or by digitizing a point on the screen. A station, elevation, point code, cell, feature, or description can be added to the point.

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.

ELEMENT>>CURVE



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

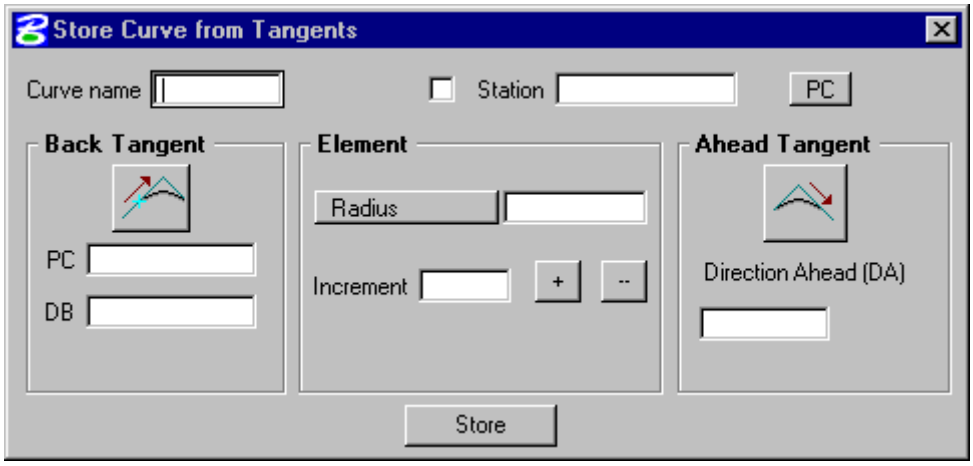
Delete - will delete selected curve from the .gpk database

List/Print - will display all curve data for the selected curve. **List** displays only the curve names currently stored in the .gpk file. **Print** displays the curve data of the selected curve. Also if visualization is on this will cause the curves to be displayed.

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

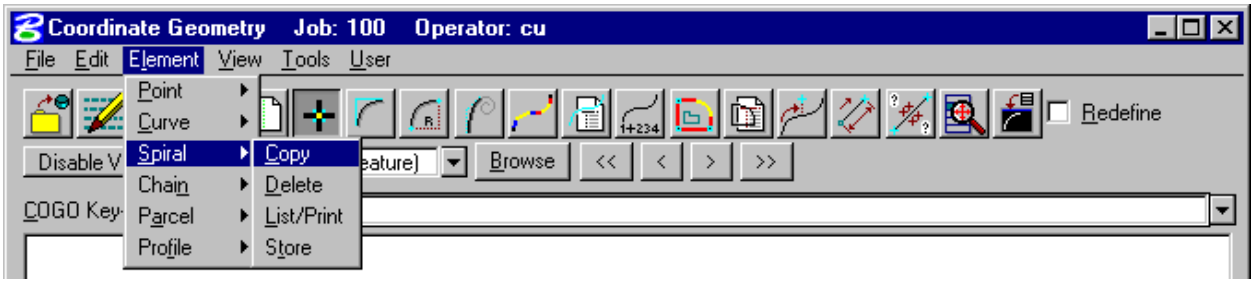
Station - allows the user to identify a curve and the position on the curve (PC, PI, or PT) that a station value may be assigned.

Store - provides various options for defining and storing lines and curves such as **Store Curve from Tangents** as shown to the right.



Transpose – reverses the curve direction.

ELEMENT>>SPIRAL

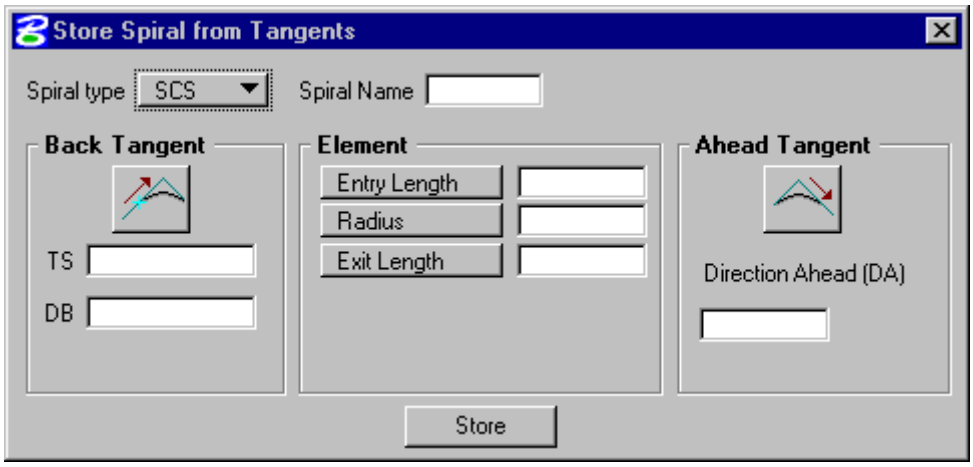


Copy - copy a specified spiral to another spiral name

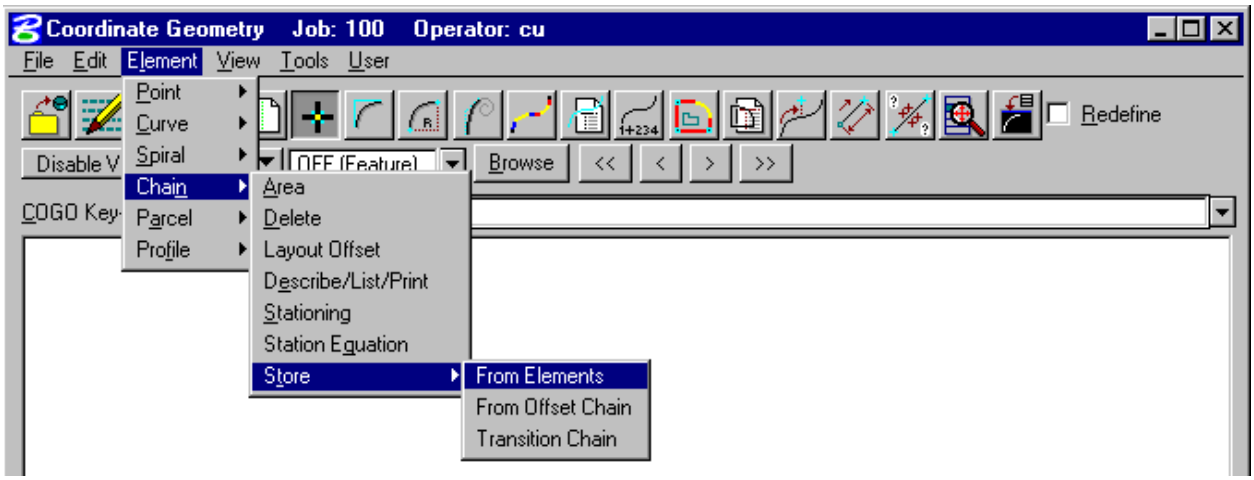
Delete - will delete selected spiral from the .gpk database

List/Print - will display all spiral data for the selected curve. **List** displays only the spiral names currently stored in the .gpk file. **Print** displays the spiral data of the selected spiral. Also if visualization is on this will cause the spirals to be displayed.

Store - provides various options for defining and storing spirals.



ELEMENT>>CHAIN



Area – calculates the area of a closed chain

Delete - deletes selected chains from **.gpk** database

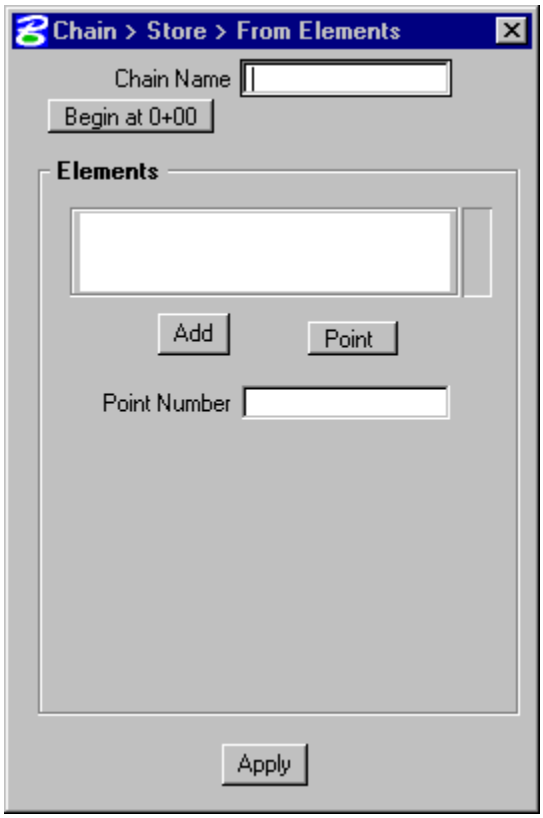
Layout Offset – computes the station and offset of a point or a chain based on a given chain.

Describe/List/Print – displays chain information. **Print** displays the name of each chain element. **Describe** displays the alignment data of each element in the selected chain.

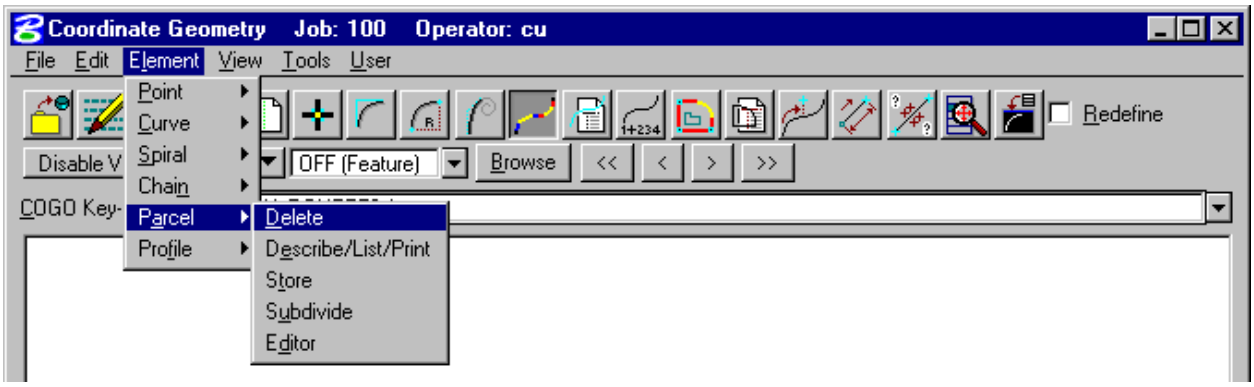
Stationing - provides a method for stationing or re-stationing a chain.

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**.



ELEMENT>>PARCEL



Delete - deletes selected parcels from **.gpk** database

Describe/List/Print - displays parcel information. **Describe** displays the elements of composition, the area of tract stored, taken and remaining and a point, bearing, distance description of the specified tract. **Print** displays the elements of composition, the area of tract stored, taken and remaining.

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

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.

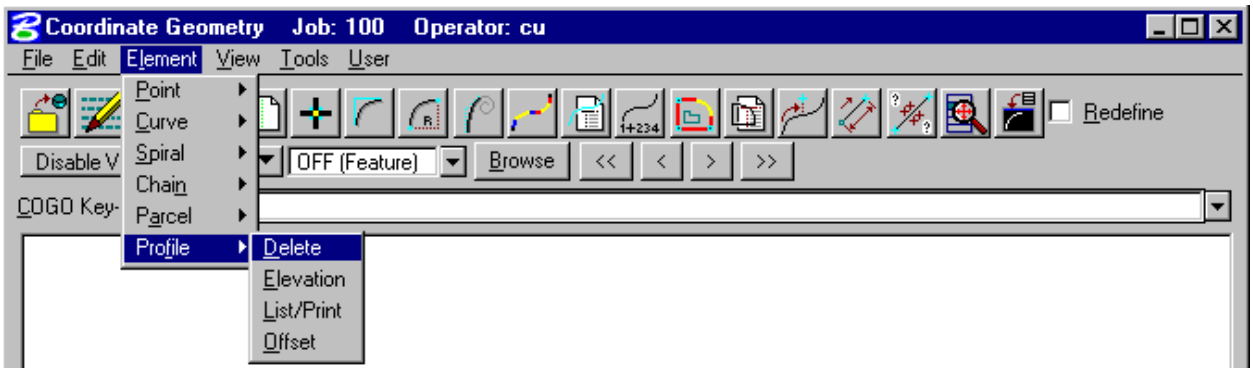
Store Easement - allows you to store an easement by entering point and curve names in either a clockwise or counterclockwise direction.

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 Manual* or the online help.

ELEMENTS>>PROFILES



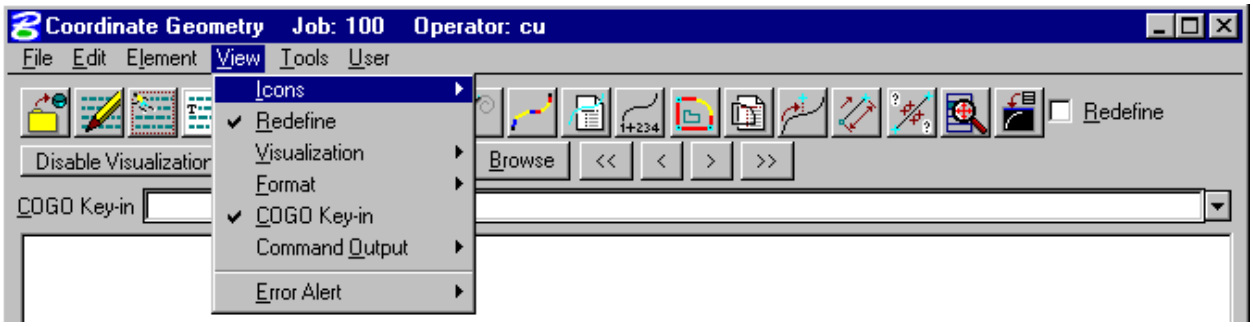
Delete - deletes selected profiles from **.gpk** database

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

List/Print – displays profile information. **Print** displays the data of the selected profile from the **.gpk** database

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

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.

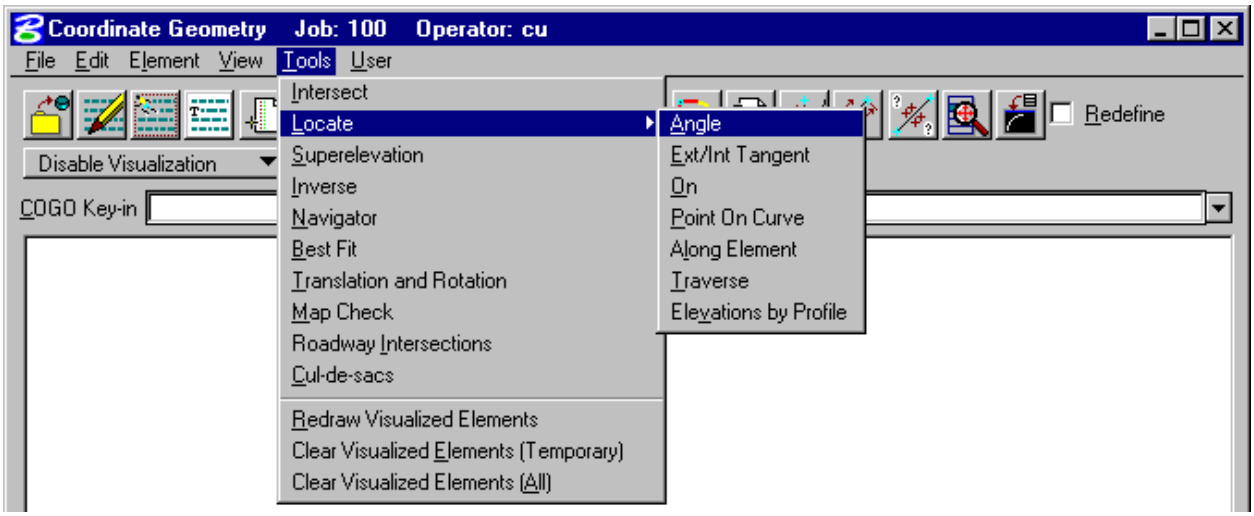
Format – shows the format items (i.e. number of decimals, station format, etc.) on the tool bar.

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

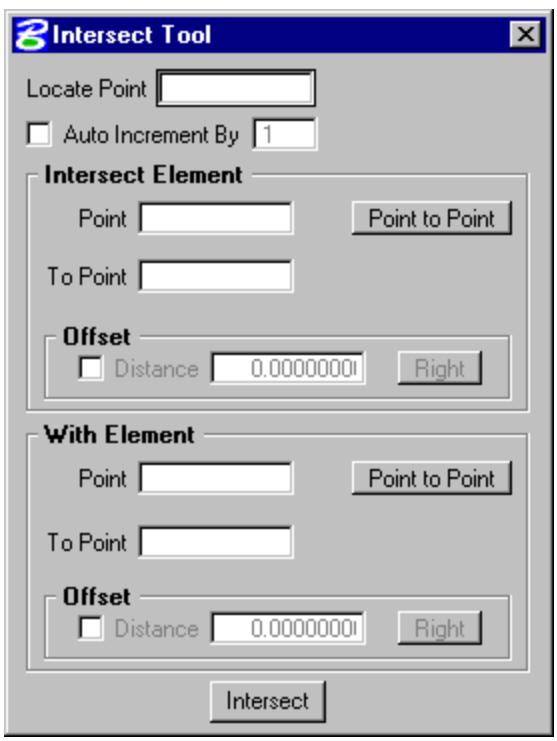
Command Output - show the Command Output Window in the dialog box, and controls options for the Command Output Window.

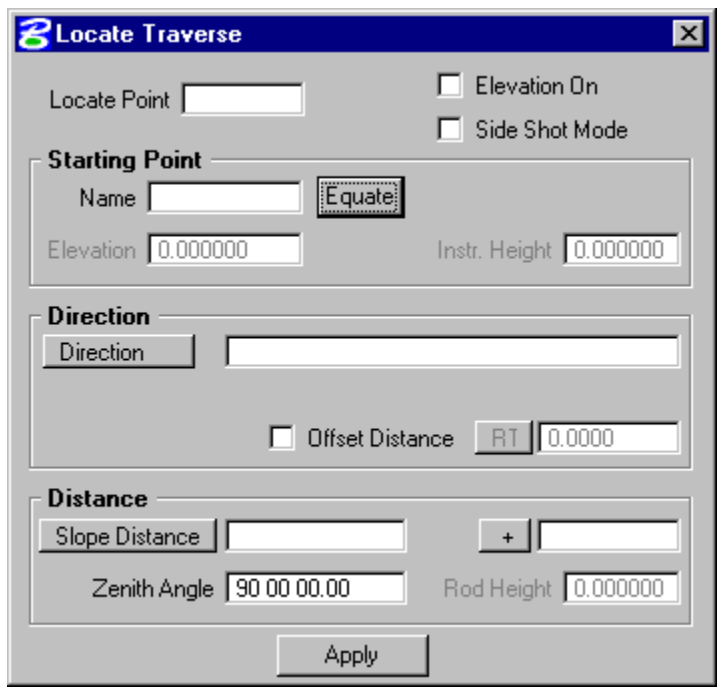
Error Alert – allows the user to turn on a *beep* and/or bring up the COGO dialog when an error occurs.

5.4.5 Tools Commands



Intersect – stores a point at the intersection of the defined elements





Locate – 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)

Superelevation – calculates the superelevation for a given chain. (This will be covered in more detail in Chapter 11)

Inverse – calculates the distance and direction between points.

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

Best Fit – calculates a best-fit chain through a set of points.

Translation and Rotation – moves, rotates, and scales a data set.

Map Check – edits a parcel.

Roadway Intersection – calculates the data for the intersection of two roadways.

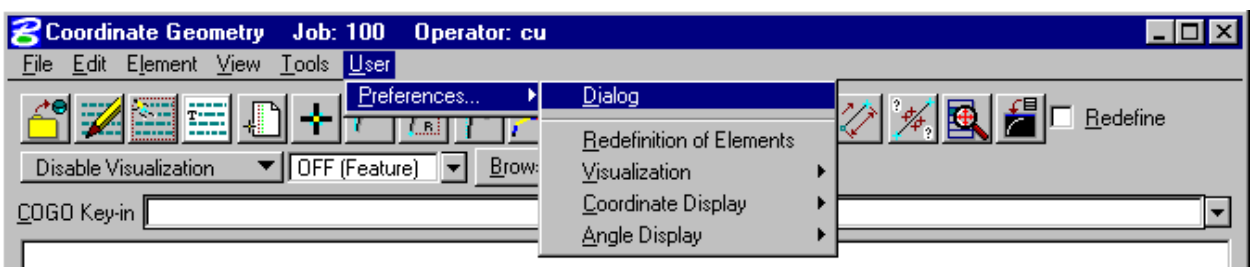
Cul-de-sacs – calculates the data for a cul-de-sac.

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.

5.4.6 User Preferences



Dialog - allows access to COGO Preferences dialog box.

Redefinition of Elements – toggles the **Redefine** option on/off. If **Redefine** is on, COGO data can be redefined/overwritten. (It is recommended to work with **Redefine** off so the user does not overwrite another user's data.)

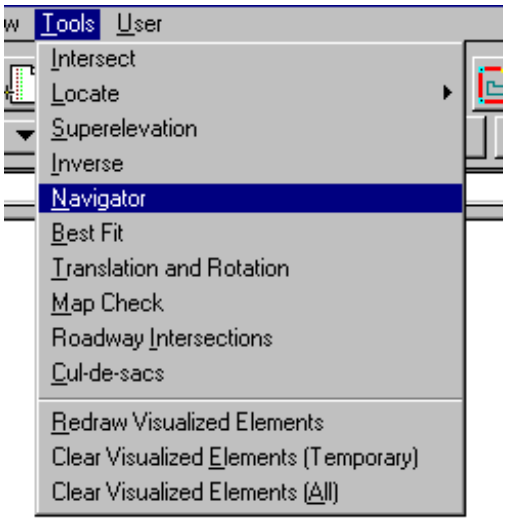
Visualization – allows the elements to be displayed in the Microstation file permanently or temporarily.

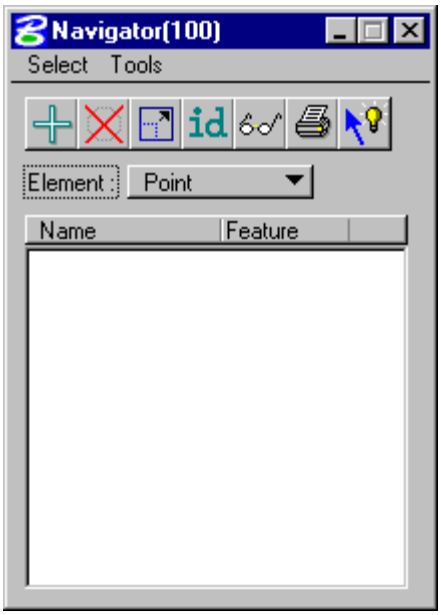
Coordinate Display – toggles between displaying NE or XY coordinates.

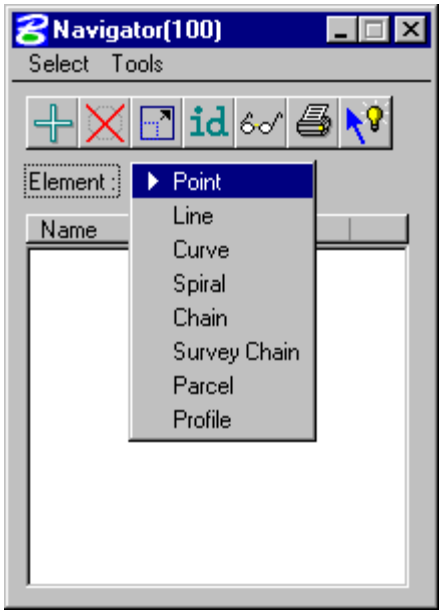
Angle Display – toggles between displaying Bearing or Azimuth.

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. The following dialog box will appear.

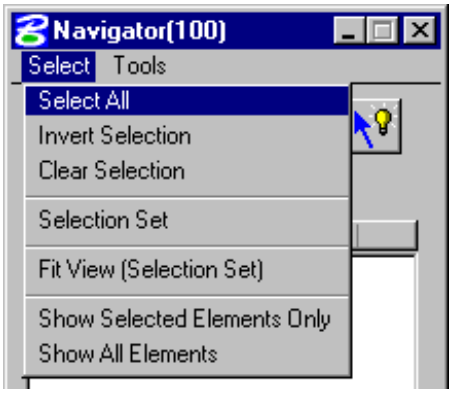






From the **Navigator**, points, curves, spirals, chains, survey chains, parcels, and profiles can be added, deleted, modified, identified, visualized, printed, or selected.

NAVIGATOR>>SELECT



Select All – selects all data items of a certain type. (I.e. all points)

Invert Selection – selects all items not previously selected, and unselects all items previously selected.

Clear Selection – unselects all items.

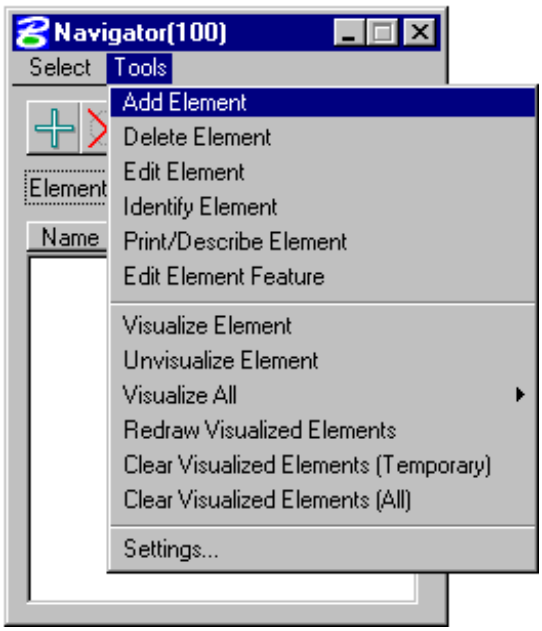
Selection Set - allows the user to create a selection set that meets particular criteria. This is the same as using the **Selection Set** icon.

Fit View (Selection Set) – fits the items selected to the active Microstation window.

Show Selected Elements Only – only the items in the selection set will be displayed in the Microstation window.

Show All Elements – all items in the database will be displayed in the Microstation window.

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 – un-displays the selected elements.

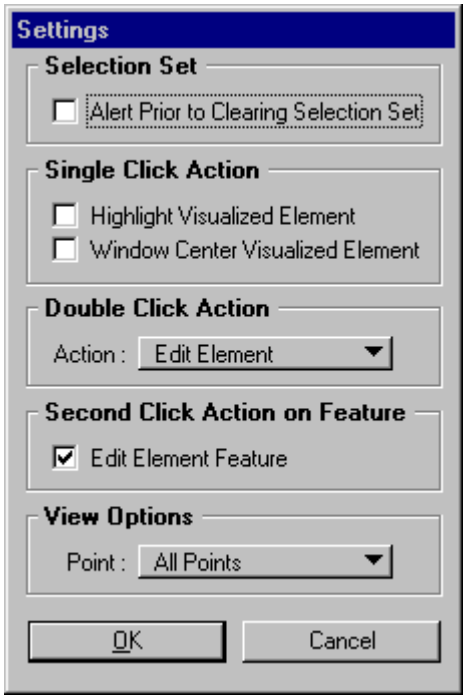
Visualize All – displays all of the elements of a certain type, or all elements.

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.

Settings – allows the user to define certain actions and behaviors of the Navigator.



5.6 Importing CEAL Data

A CEAL interface file can be imported using the following command:

LOAD CEAL FILE *filename*

where ***filename*** is the name of the CEAL interface file. This command will create a Geopak input file that can be saved or read. Points, curves, spirals, chains, and alignment profiles can be transferred to Geopak from CEAL. Once the above command has been executed, to store the data into the .gpk file the input file must be read by going to **Edit>>Read All**.

5.7 Bridge Deck Elevation Commands

COGO solves the deck elevation requirements for the design of highway bridges. The elevations computed by GEOPAK are top of slab elevations within the limits of the bridge. The program computes deck elevations on a per span basis along the edge of the deck, gutterlines, centerline bearings, beams parallel to any line defined by two points, curves or lines concentric to the baseline, or non-parallel lines defined by unequal spacing along the piers. The software is also capable of computing deck elevations between parallel or non-parallel piers. Note these commands are not located on pull down menus and must be keyed in.

Most of the commands in this chapter are provided with graphic illustrations and are indexed in the following order:

BRIDGE name	name of the bridge for output
PROFILE name	a profile already stored in GPK.
TIE value	defines the location of the profile grade line
SE commands	width and slopes across the bridge
ALI name	a chain already stored in GPK.
PIER command	defines the direction of the piers (optional)
SPAN command	defines the layout of the span
CB command	refers to Centerline Bearing Elevations (optional)
FC command	refers to the edge of the deck elevations (optional)
GU command	refers to the gutterline elevations (optional)
BEAM commands	set the framing plan for the current span
End Span command	initiates the calculation
Edit Text command	displays the results of the calculation

The following convention will be used in presenting the bridge deck commands: Words in all upper case letters indicate command names. Lower case words indicate alphanumeric values provided by the user. Since many keywords can be abbreviated, the minimum required is underlined. As always, it is recommended that COGO element names be limited to nine characters. For a full presentation of the COGO conventions go to **Applications >> GEOPAK Road >> Help >> Coordinate Geometry** and select the topic **General Reference / General Conventions**.

5.7.1 Bridge Name

BRIDGE name

The **Bridge name** command stores the name of the bridge. The name of the bridge and the name of the span together form the name of the Deck Elevations Table for the current span.

5.7.2 Profile Name

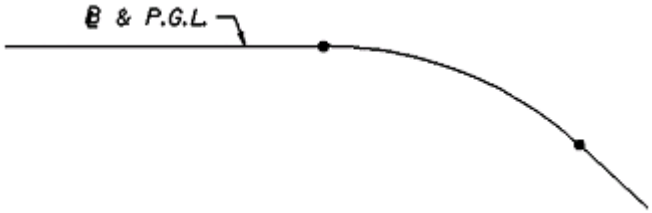
PROFILE name

The **Profile name** command refers to a previously defined profile utilized to define the deck elevations of the bridge. If the profile name is not stored, a message will be printed. Station equations along this profile, if any, must match the station equations along the chain (ALI name).

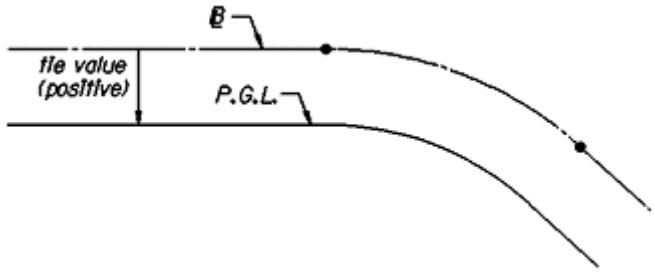
5.7.3 Tie Value

TIE value

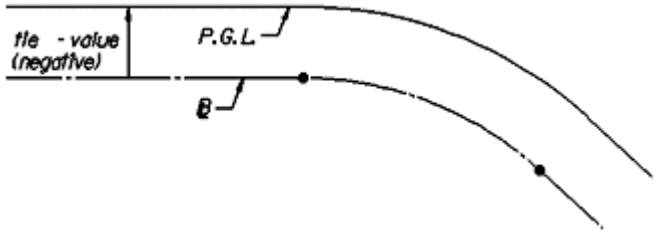
The **Tie Value** command defines the horizontal location of the Profile Grade Line (PGL) by a radial distance (or value) measured from the baseline or centerline of construction of the bridge. When the PGL is located to the left of the baseline the tie value is negative.



When the profile grade line is coincident with the baseline, the Tie value is zero as depicted above.



When the profile grade line is to the right of the baseline, the Tie value is positive as depicted above.

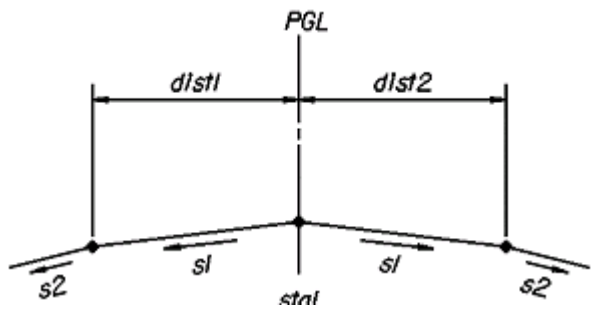


When the profile grade line is to the left of the baseline, the Tie value is negative as depicted above.

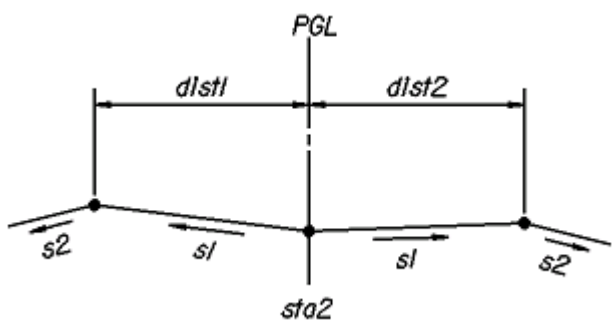
5.7.4 SE Command

SE station (R region) LT slope1 dist1 slope2 RT slope1 dist1 slope2

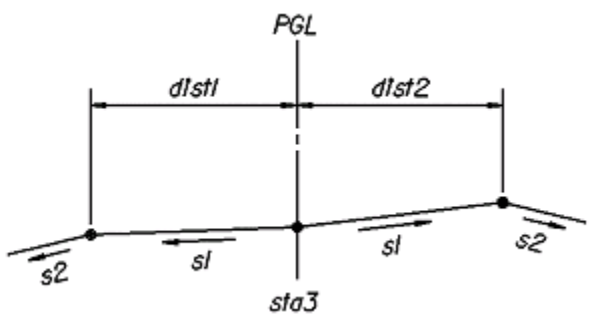
The **SE command** set the slopes in percentage across the bridge from the PGL, left and right. The slope1 in percentage applies across the distance dist1, and slope2 applies to any point beyond the distance dist1 (left and right). Slopes are negative when going down away from the PGL. Three examples are given below.



SE sta1 LT s1 dist1 s2 RT s1 dist1 s2



SE sta2 LT s1 dist1 s2 RT s1 dist1 s2



SE sta3 LT s1 dist1 s2 RT s1 dist1 s2

5.7.5 ALI Name

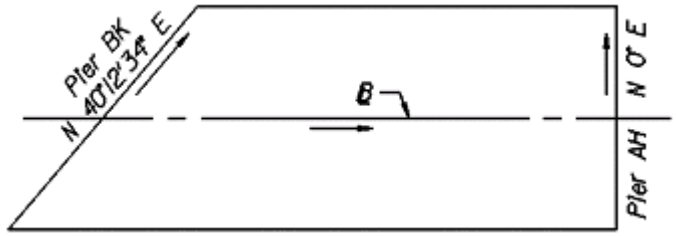
ALI name

The **ALI name** command refers to a chain already stored in the GPK. It defines the stationing of the bridge. Station equations along this alignment or chain, if any, should match the station equations along the profile.

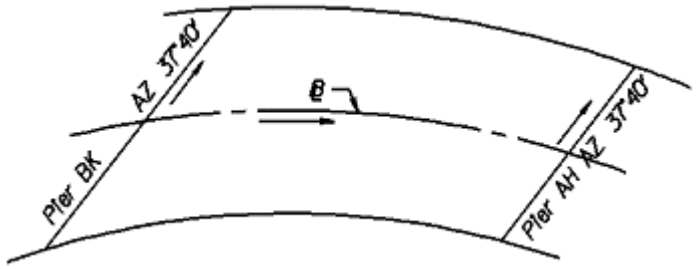
5.7.6 Pier Command

PIER BK direction AH direction

The **Pier command** sets the direction from right to left of the pier centerline. When the Pier command is not used, the piers are assumed perpendicular or radial to the baseline.



Pier BK N 40 12 34 E AH N 0 E

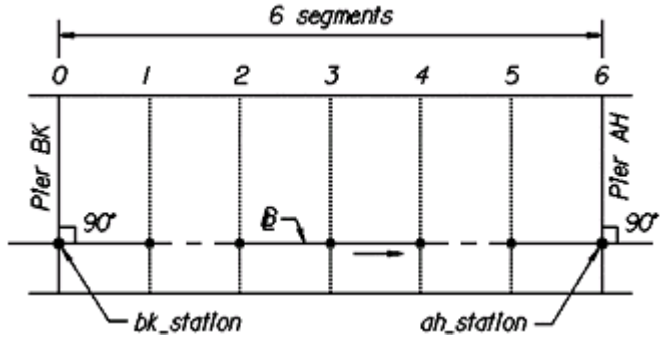


Pier BK AZ 37 40 AH AZ 37 40

5.7.7 Span Command

The **Span** commands define the beginning station (bk_sta) and the end station (ah_sta) of the current span along with the location of the required elevations.

Format A:



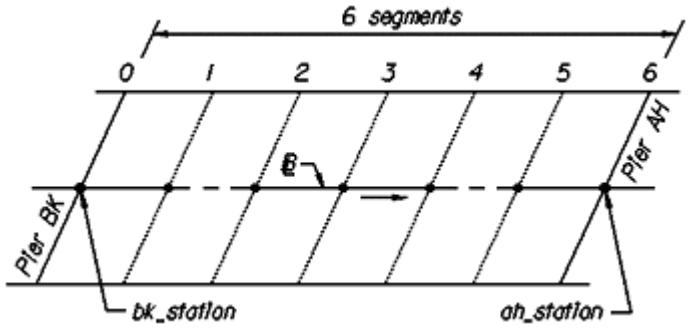
SPAN (name) bk_sta ah_sta segments (+)

Defines the current span defined from pier on bk_sta to pier on ah_sta, where:

name = the name of the span,
bk_sta = the station value for the centerline of the back pier,
ah_sta = the station value for the centerline of the ahead pier, and
segments = the number of equal length segments along the span.

Elevations are calculated perpendicular or radial to the baseline at each segment. The optional (+) calculates elevations on the pier ahead.

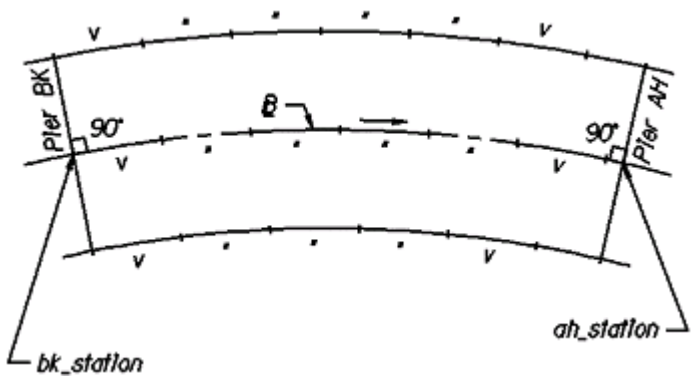
Format B:



<u>SPAN (name) bk_sta ah_sta segments (+) P</u>

Current span defined from pier on bk_sta to pier on ah_sta, with the terms used as defined above. Elevations are calculated at each segment and parallel (**P**) to the pier on bk_sta. The optional (+) calculates elevations on pier ahead.

Format C



<u>SPAN (name) bk_sta ah_sta IN v (+)</u>

Current span defined from pier on bk_sta to pier on ah_sta, where:

v = interval length and the rest of the terms are used as define above.

Elevations are calculated at equal intervals (IN v) measured from the pier on bk_sta. The optional (+) calculates elevations on pier ahead.

5.7.8 CB Command

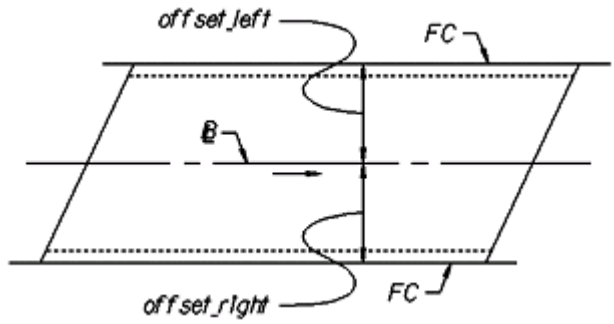
<u>CB value</u>

The **CB** commands calculate deck elevations at the Centerline Bearing of the current span. When **value** is positive, the elevations are computed along a line parallel to and right of the pier on the back station; when **value** is negative the elevations are computed along a line parallel to and left of the pier on the ahead station. Centerline bearing elevations are specified with asterisks (*) in the table of elevations for the current span.

5.7.9 FC Command

The **FC commands** calculate deck elevations along the Face of Coping or edge of the deck. This edge is defined by a line concentric to the baseline at the offset distance **offset_left** or **offset_right**, or along a line designated by two points.

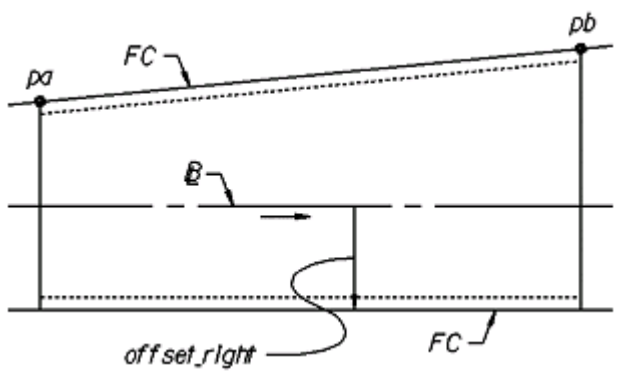
Format A:



FC offset_left offset_right

Deck elevations along a line concentric to the baseline at offset distances, left and right.

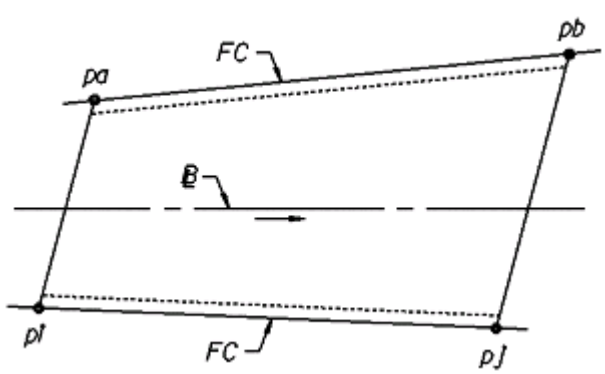
Format B:



FC pa, pb offset_right

Deck elevations along a line to the left of the baseline, from **pa** to **pb**, and along a line to the right and concentric to the baseline at offset distance.

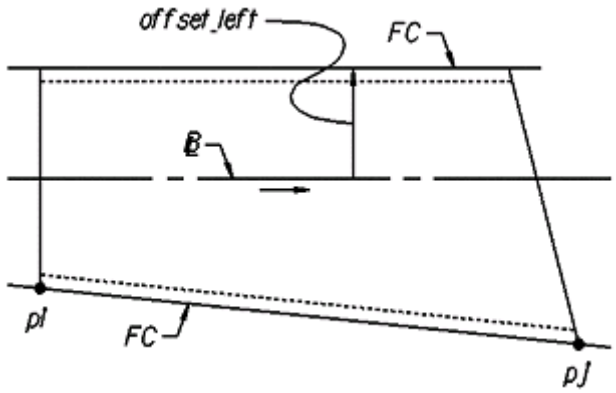
Format C:



FC pa, pb pi, pj

Deck elevations along a line to the left of the baseline, from **pa** to **pb**, and to the right of the baseline from **pi** to **pj**.

Format D:



FC offset_left pi, pj

Deck elevations along a line to the left and concentric to the baseline at offset distance **offset_left**, and along a line to the right of the baseline from point **pi** to point **pj**.

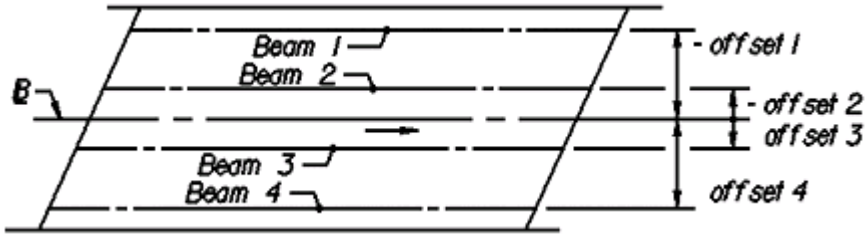
5.7.10 GU Command

The **GU commands** calculate deck elevations along the gutterline of the current span. The gutter is defined by a line concentric to the baseline at the offset distance **offset_left** or **offset_right**, or along a line designated by two points **pa**, **pb** (to the left of the baseline) or **pi**, **pj** (to the right of the baseline). It uses the same four formats as the FC Command

5.7.11 Beam Command

The **Beam** commands calculate deck elevations along beams defined by offset distances concentric to the baseline (Format A); parallel to a line pa, pb (Format B); by points (Format C) or along unparallel lines defined by unequal spacing along the piers (Format D).

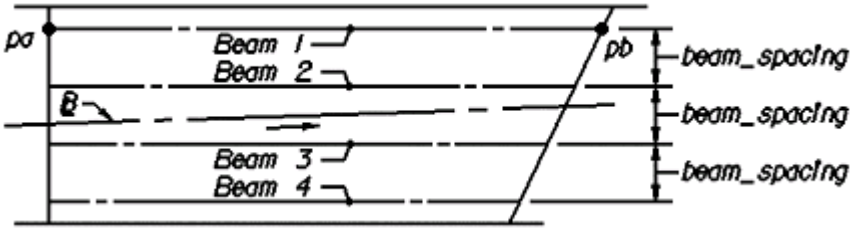
Format A:



BEAM OFF offset1 offset2 offset3 . . . offsetn

Negative offsets are to the left of the baseline and positive offsets are to the right.

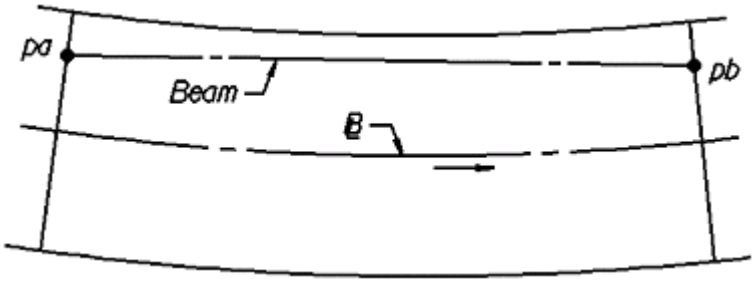
Format B:



BEAM PAR pa, pb beam_spacing number_of_beams

The beams are laid out parallel to the line from **pa** to **pb**, which defines the location of the left most beam as shown above. The value **Beam_spacing** designates the spacing between the beams with the value **number_of_beams** indicates the number of beams.

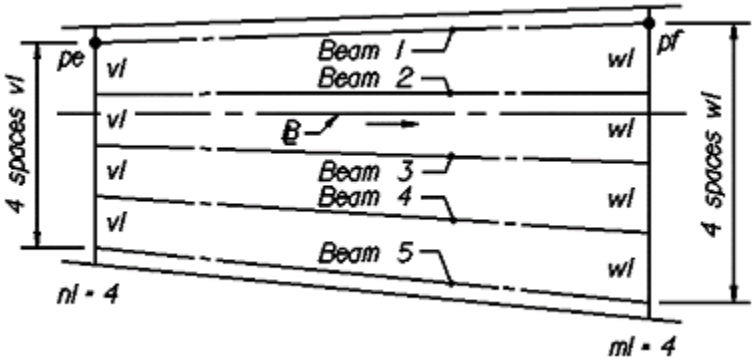
Format C:



BEAM BY POI pa, pb

Locates a single beam running from **pa** to **pb**.

Format D:



BEAM pe, pf FROM n1 SPS v1 n2 SPS v2 . . . TO m1 SPS w1 m2 SPS w2 . . .

The line from the previously defined point **pe** to the previously defined point **pf** locates the left most beam with the other beams located along the back (**FROM**) pier at **n1** spaces of length **v1**, **n2** spaces of length **v2**…and located along the ahead (**TO**) pier at **m1** spaces of length **w1**, **m2** spaces of length **w2**….

5.7.12 End Span Command

END SPAN

The **End Span** command initiates the calculation of elevations for the current span and stores, on disk, a table of elevations with a name composed of the name of the bridge, a hyphen, and the name of the span (bridge-span). An ASCII file is also stored for digital terrain modeling purposes. This ASCII file has a name composed of the name of the span, a dot, and the extension xyz. If no name has been stored for the current span, COGO, assigns numbers to the span starting with number 1.

5.7.13 Edit Text Command

EDIT TEXT bridge-span.TXT

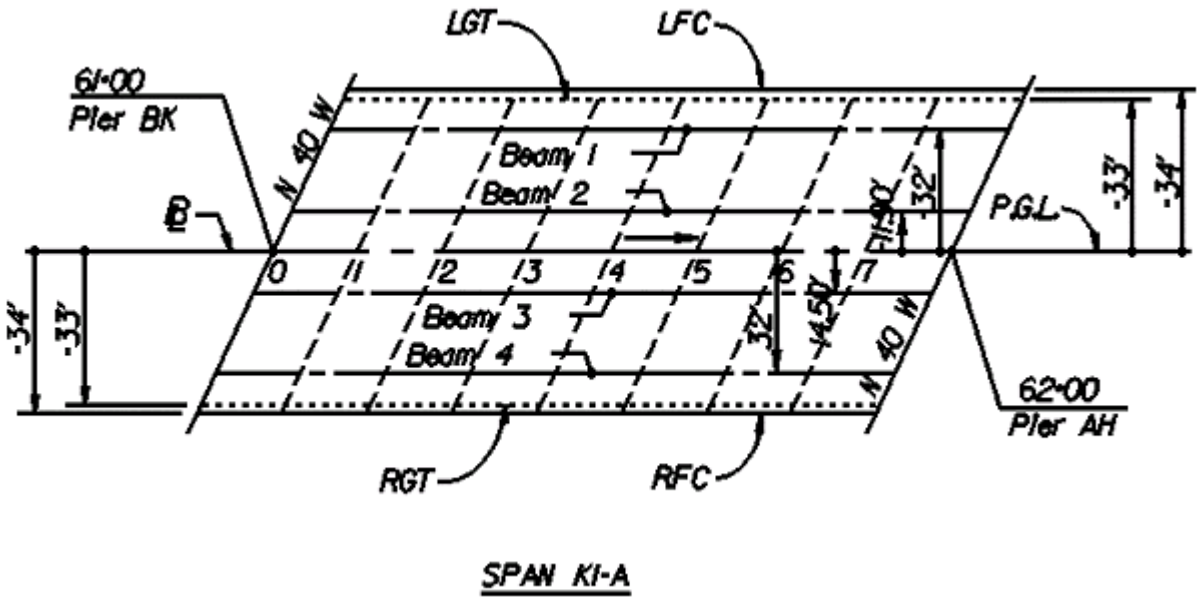
The Edit Text command displays the table of deck elevations stored on disc as bridge-name, hyphen, span-name. When the table exceeds 8 columns, COGO breaks the table into groups of 8 columns. The file can also be viewed with any text editing program.

5.7.14 Point Elevation Command

POI/EL list

The Point elevation commands calculate deck elevations for any points on the deck, which has been stored in the coordinate geometry database file, where **list** is the list of points. This command is active only when the Alignment, Profile, Tie, and Cross-slopes (SE commands) have been previously designated.

5.7.15 Example



The input commands for the above figure are:

```
*1     BRIDGE K1
*2     PROFILE ABC
*3     TIE 0
*4     SE 60+00 LT -2 24 -3 RT -2 24 -3
*5     SE 63+00 LT -2 36 -3 RT -2 36 -3
*6     SE 65+00 LT 4 24 4 RT -4 24 -4
*7     ALIG IN
*8     GU -33 33
*9     FC -34 34
*10    PIER BK N 40 W AH N 40 W
*11    SPAN A 61+00 62+00 8 P
*12    BEAM OFF -32 -11.90 14.50 32
*13    END SPAN
*14    END
```

The resulting output is:

```
Bridge deck elevation
Span K1-A  61+00.00 to 62+00.00
LFC   11.4187  11.1029  11.3712  11.3712  11.3554  11.3396  11.3237  11.3079
LGT   11.4490  11.4331  11.4015  11.4015  11.3856  11.3698  11.3540  11.3381
BM 1  11.4792  11.4634  11.4475  11.4317  11.4159  11.4000  11.3842  11.3684
BM 2  11.9250  11.9042  11.8834  11.8625  11.8417  11.8209  11.8000  11.7792
BM 3  11.8811  11.8603  11.8394  11.8186  11.7978  11.7769  11.7561  11.7353
BM 4  11.4941  11.4783  11.4625  11.4466  11.4308  11.4150  11.3991  11.3833
RGT   11.4644  11.4485  11.4327  11.4169  11.4010  11.3852  11.3694  11.3535
RFC   11.4346  11.4188  11.4029  11.3871  11.3713  11.3554  11.3396  11.3238
PGL   12.1667  12.1458  12.1250  12.1042  12.0833  12.0625  12.0417  12.0208
```

5.8 Additional Information

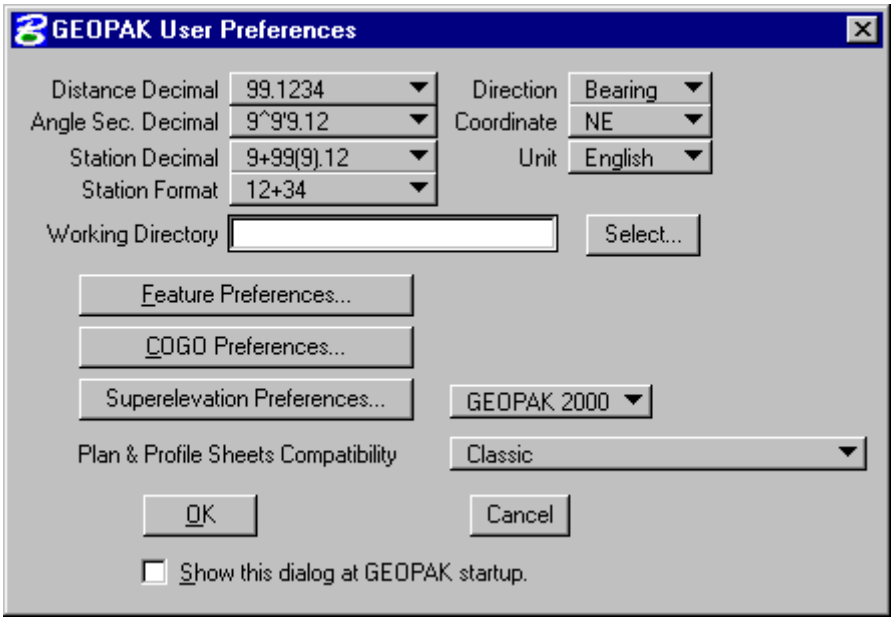
Additional COGO commands and information can be found in the *GEOPAK Manual*.

Exercise 5-1

This is an individual exercise to practice using COGO. All of the steps are given to you. Make sure you understand each step, because later you will need to determine which tools are needed to store COGO elements

1. Open the MicroStation file **t:\br-proj\Exercise_Rte_24\Route_24.dgn**.

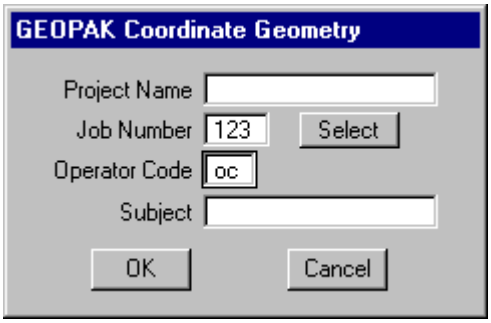
2. Go to **Applications>>Geopak Road>>User Preferences** and delete the working directory



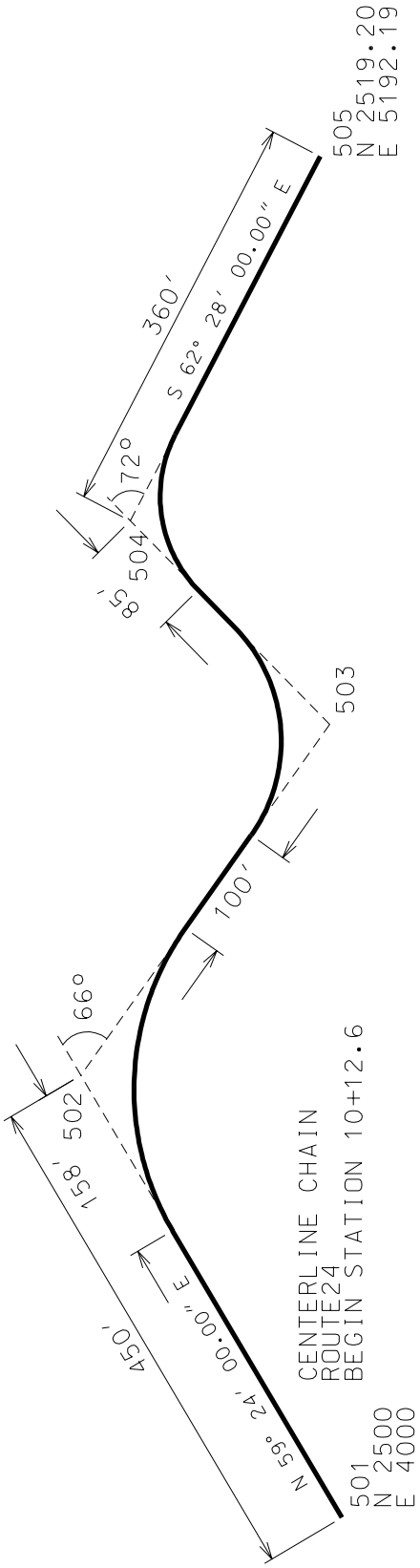
3. Open the **Coordinate Geometry** dialog.

Create **Job Number: 123**

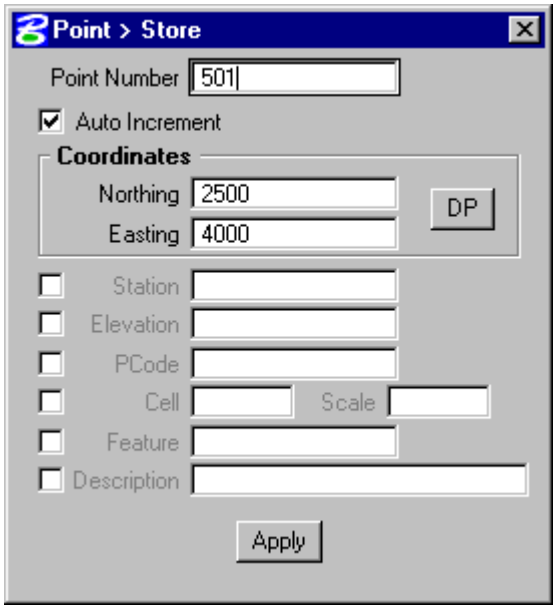
Set the **Operator Code** to your initials.

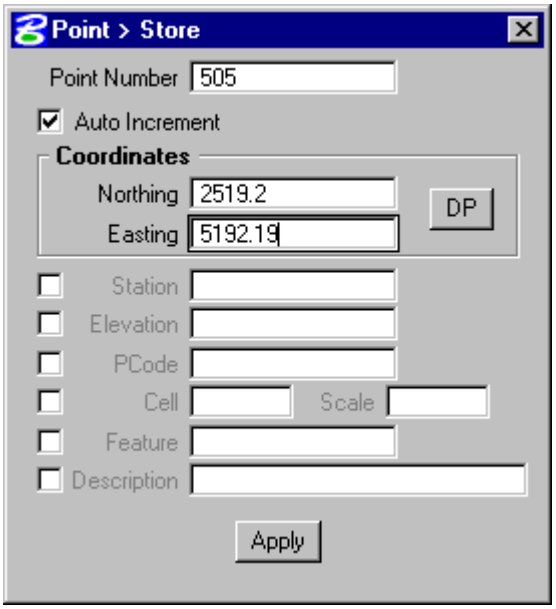


Create the following alignment as shown on the following pages.

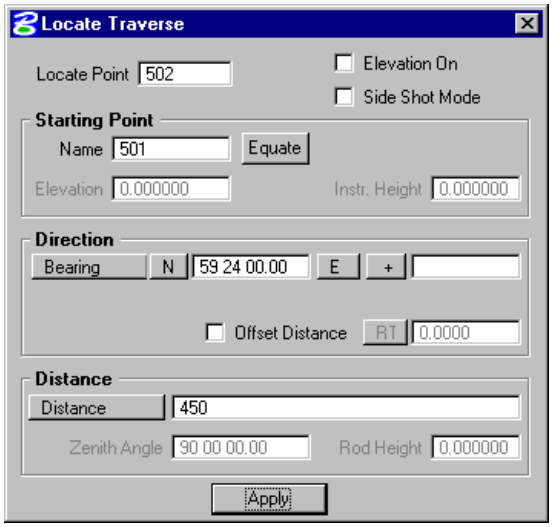


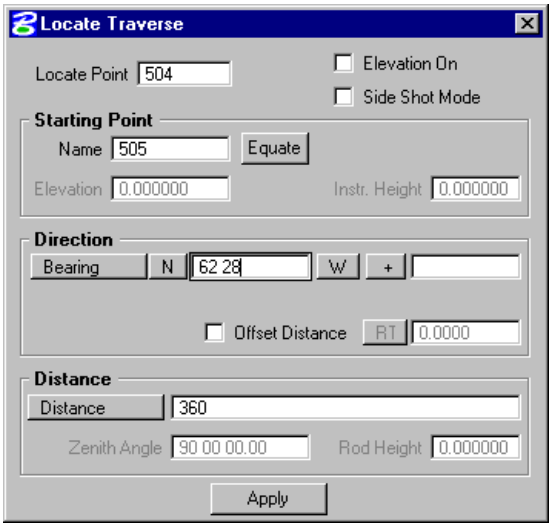
4. Store points 501 and 505 with the coordinates shown.



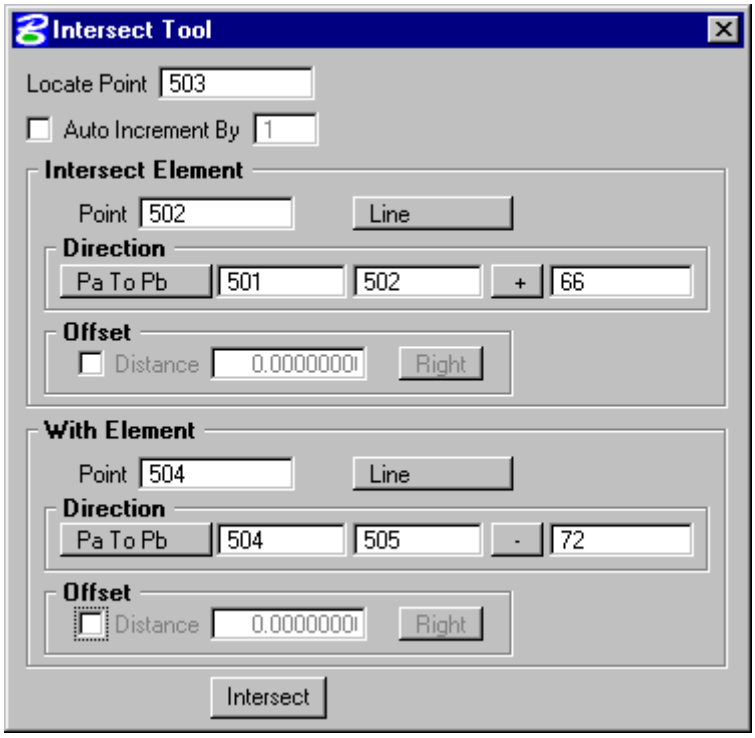


5. Locate points 502 and 504.

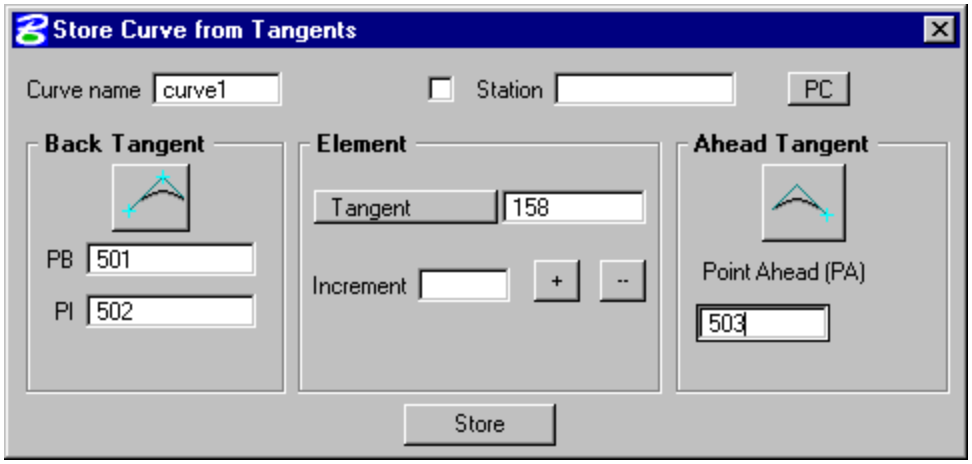




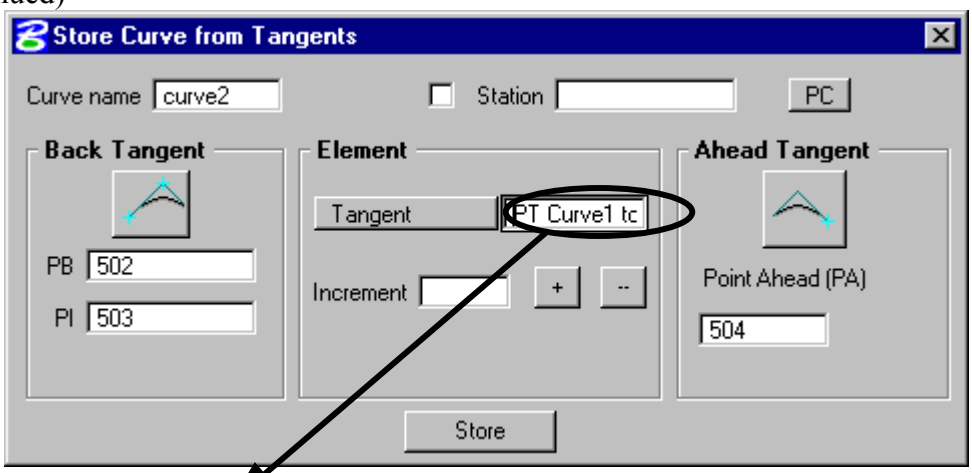
6. Locate point 503 by using the **Intersect** tool.



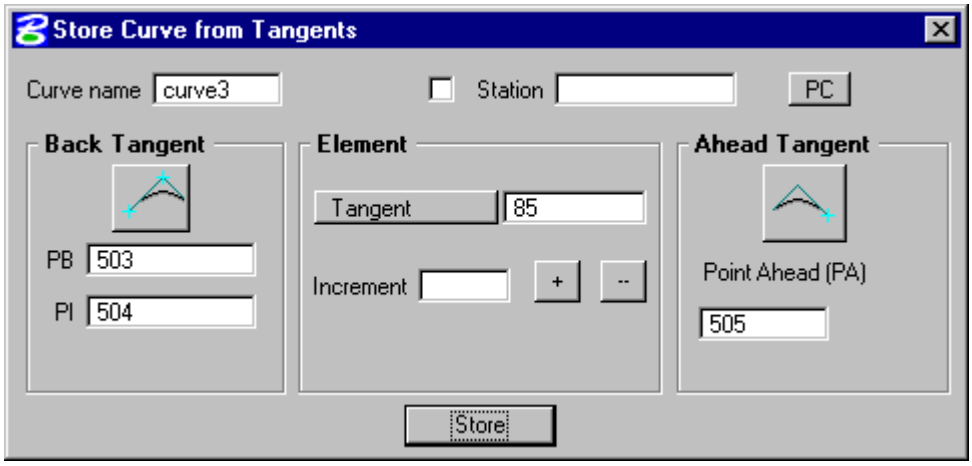
7. Store CURVE1, CURVE2, and CURVE3.



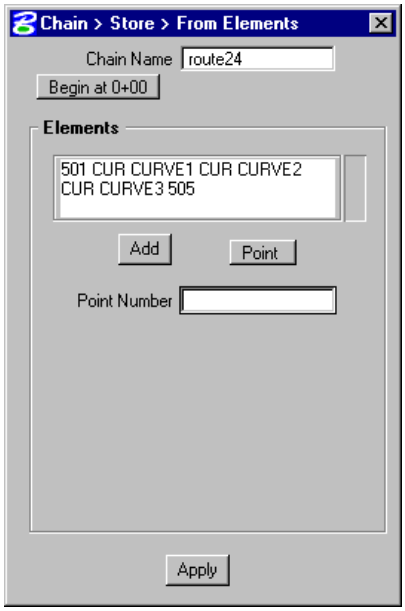
7. (Continued)



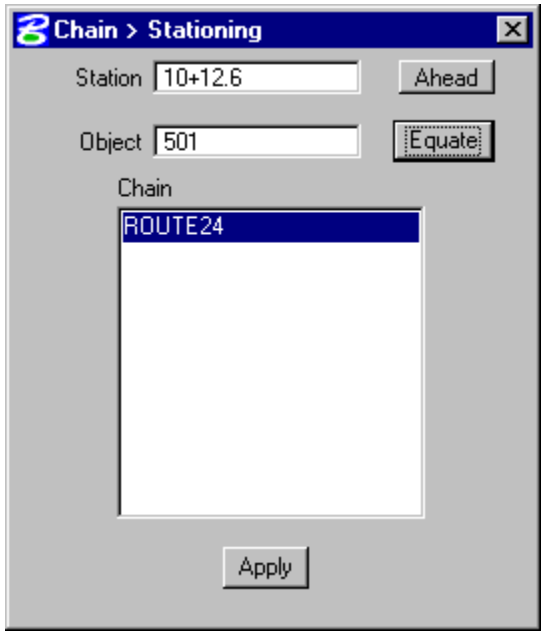
PT Curve1 to 503 m 100



8. Store the alignment chain Route24.



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



10. Describe the chain and save the output file. Review the output file in **UltraEdit**.

11. Use **COGO Navigator** to view the data.

12. Exit Coordinate Geometry.

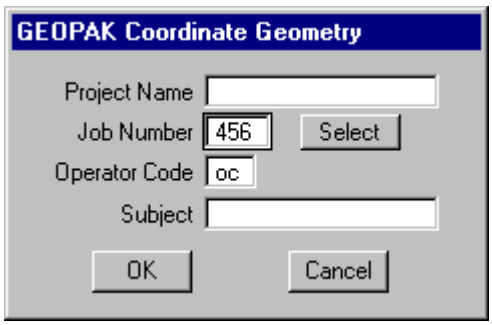
Exercise 5-2 This is an optional individual exercise.

1. Open the Microstation file **t:\br-proj\Exercise_B1\B1.dgn**

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

   Create **Job Number**: **456**

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

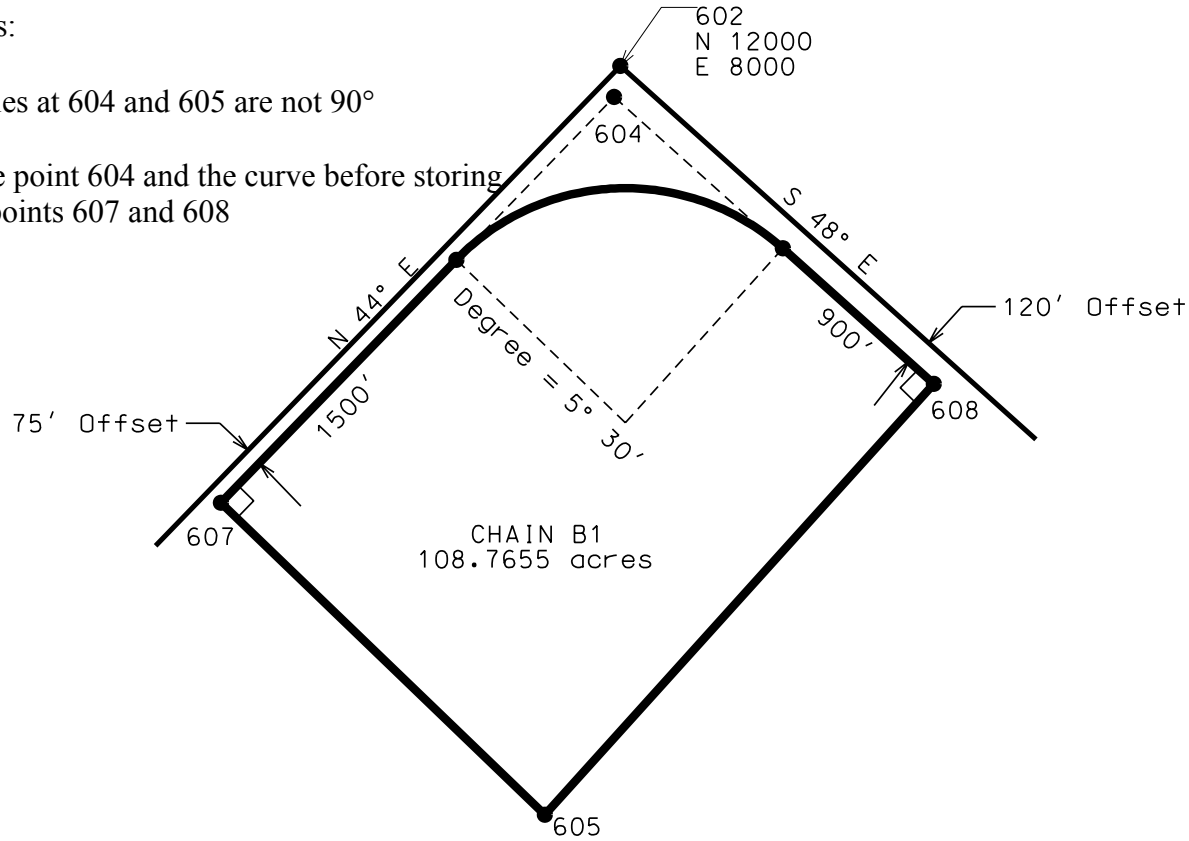


3. Use the **Coordinate Geometry** tools to create chain B1 as shown below. Verify the area of the chain.

Hints:

Angles at 604 and 605 are not 90°

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



Chapter 6

Graphical COGO

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6.7 Manipulate Elements 6-4
6.8 Groups 6-4

6.1 Objectives

- Create and store coordinate geometry elements using the Graphical Coordinate Geometry tools.

6.2 Definitions

Graphical Coordinate Geometry is a set of tools that allows the user to store or modify coordinate geometry elements (points, lines, curves, spirals, chains, and parcels) by key-in or a mouse click. The elements are stored directly into the coordinate geometry database (.gpk) while being created or modified graphically on the screen.

6.3 Accessing

The Graphical Coordinate Geometry tools can be accessed from the Horizontal and Vertical Geometry toolbox or by selecting **Applications>>Geopak Road>>Geometry>>Graphical Coordinate Geometry**. If the user attempts to activate Graphical COGO without an active session of coordinate geometry, a warning dialog will appear advising the user that a coordinate geometry session must be started.

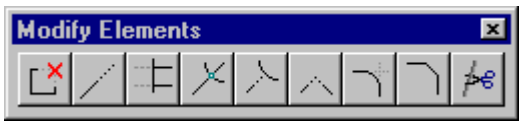
When Graphical COGO is started, the following dialog appears.

6.4 Dialog

The Graphical COGO dialog contains four toolboxes.

Store Elements

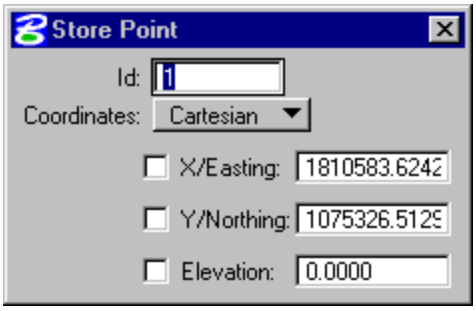
Modify Elements



Manipulate Elements

Groups

When a tool in one of the toolboxes is selected, a dialog box will appear for the user to key-in any required information.



6.5 Store Elements Tools

The Store Elements toolbox is used to store points, lines, curves, and spirals. The following tools are contained in the Store Elements toolbox.

Store Point – stores a point. The user can store a point by either Cartesian coordinates (XYZ), or curvilinear coordinates (station and offset). The XY and/or Z coordinates or the station, offset, and/or elevation can be locked or a data point can be used to place the point.

Store Equally Spaced Points – stores a given number of points spaced equally between two specified points.

Locate Point – stores a point by distance and direction. The distance, direction, offset, and slope can be locked. A line segment can also be stored.

Store Line – stores a line segment between two previously stored points.

Store Line by 2 Points – stores a line segment and its endpoints. The distance and direction of the line segment can be specified.

Store Tangent Line – stores a line segment that is tangent to a curve. The two endpoints of the line segment are also stored.

Store Curve by 3 Points – stores a circular curve by specifying the beginning and ending points, and a point on the curve.

Store Curve by Center – stores a curve by specifying the beginning point of the curve, the center of the curve, and the ending point of the curve.

Store Tangent Curve Constrained – stores a curve tangent to the specified curve or line.

Store Tangent Curve Unconstrained – stores a curve through a specified point, and tangent to the specified line or curve.

Stores Tangent Spiral – stores a spiral tangent to specified line or curve.

6.6 Modify Element Tools

The Modify Elements toolbox is used to modify previously stored cogo elements. The redefine toggle must be turned on to modify existing elements. The following tools are contained in the Modify Elements toolbox.

Partial Delete – deletes part of an element creating two separate elements. Additional points will be stored if needed.

Extend Plan View Element – extends or shortens any cogo element.

Trim Elements – trims or extends elements to intersect with another element.

Intersect Elements – stores a new point at the intersection of two elements. The original elements are not modified.

Extend Element to Intersection – lengthen or shorten an element to another element. Works functionally the same as its Microstation counterpart.

Extend Elements to Intersection – lengthens or shortens two elements to intersect each other. Works functionally the same as its Microstation counterpart.

Construct Circular Fillet – stores a circular curve between two elements. Works functionally the same as its Microstation counterpart.

Construct Chamfer – stores a line and its endpoints between two elements. Works functionally the same as its Microstation counterpart.

Cut Element – cuts an element into segments.

6.7 Manipulate Elements

The Manipulate Elements tools allow the user to adjust previously created elements. If an element is moved, the redefine toggle must be turned on. The following tools are in the Manipulate Elements toolbox.

Move Plan View Element – moves or copies an element.

Rotate Plan View Element – rotates the element about a specified point.

Copy Parallel – moves or copies an element parallel to the original element.

Delete Element – deletes an element from a .gpk file. **Warning**: There is no undo for this command.

6.8 Groups

The Groups tools allow the user to create a chain or parcel. The following tools are contained in the Groups toolbox.

Store Chain – stores a chain from previously stored elements. The user selects the first element, then data points to accept the each element. When all elements are selected, the user is prompted to data point for the direction of the stationing.

Store Parcel – stores a parcel, takings, or easements from previously stored elements. The user can either automatically select the elements as with Store Chain, or manually select the elements. When all of the elements are selected, the user is prompted for the direction of the parcel, and the point of beginning.

Chapter 7

Horizontal Alignments

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7.9 Alignment Tools 7-5
7.10 Manipulate Tools 7-6

7.1 Objectives

- Create and store horizontal chains using graphical tools.

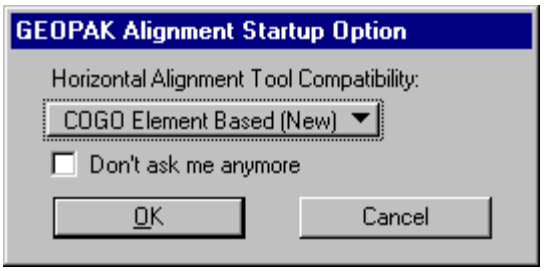
7.2 Definitions

The **Horizontal Alignment** tools enable the user to create or modify horizontal geometry elements. Spirals, curves, tapers, and ramps can all be placed according to user-defined parameters.

7.3 Accessing

The **Horizontal Alignment** tools can be accessed from the menu **Applications>>Geopak Road>>Geometry>>Layout Alignments Horizontal**, from the **Horizontal Alignment** icon, or from the **Horizontal Alignment** button on **Project Manager**.

When the **Horizontal Alignment** tools are started for the first time, the dialog shown to the right will appear. The user has the option to select the **COGO Element Based (New)**, or the **Graphic Element Based Horizontal Alignment** tools.



The **COGO Element Based** tools write the created elements directly into the coordinate geometry database (.gpk) as cogo elements. For this option, a Geopak COGO session must be active.

The **Graphical Element Based** option first creates Microstation graphical elements in the .dgn file. The user then has to store these elements as a COGO element in the coordinate geometry database (.gpk).

If the Don't ask me anymore toggle is set, the user will not see this dialog when going into the **Horizontal Alignment** tools.

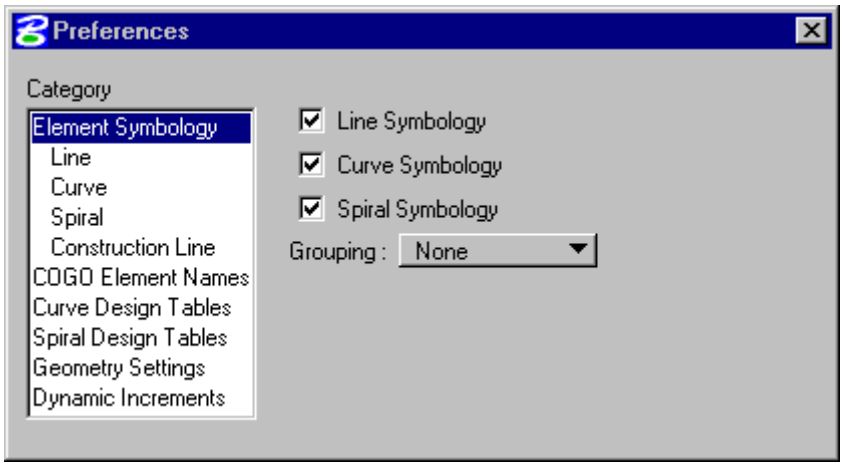
** Note: It is recommended to use the **COGO Element Based Horizontal Alignment** tools. The **COGO Element Based Horizontal Alignment** tools will allow the user to better achieve an efficient, accurate design. Only the **COGO Element Based Horizontal Alignment** tools will be discussed in this class.

When the **COGO Element Based Horizontal Alignment** tools are chosen, the following dialog will open.

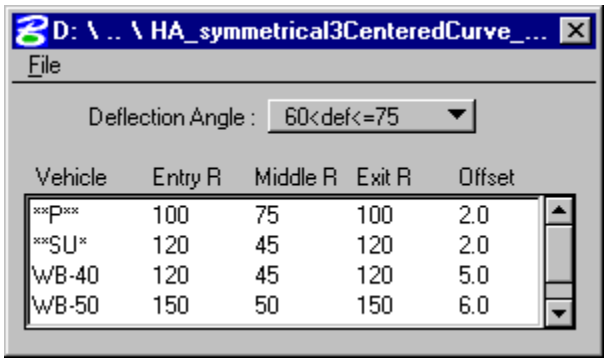
7.4 Dialog

The **Horizontal Alignment Generator** dialog has three menus, **File**, **Design Tables**, and **Tools**.

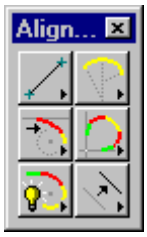
The **File** menu opens the following dialog which allows the user to change various preferences such as element symbology, beginning element names, curve vehicle tables, curve definition and dynamic increments.



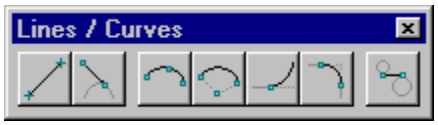
Design Tables allows the user to set up Design Tables for Symmetrical 3 Centered Curves, Asymmetrical 3 Centered Curves, Taper Curves, and Spiral Curves. Entry, middle, and exit radiuses can be set up for various vehicle types and deflection angles.



The **Tools** menu allows access to the Main tool dialog, or to any of the tool boxes to store a Horizontal Alignment.



7.5 Lines/Curves Tools



The **Line/Curves** tools allow the user to place line and curve elements by various methods. The **Line/Curves** toolbox contains the following tools.

Store Line By 2 Points – stores a line and its endpoints.

Store Tangent Line – stores a line tangent to a curve and the endpoints of a line.

Store Curve By 3 Points – stores a circular curve by selecting the beginning and ending points of the curve, and a point on the curve.

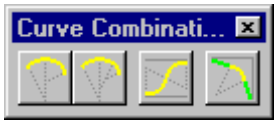
Store Curve By Center – stores a circular curve by defining the center point, radius, and sweep angle.

Store Tangent Curve Unconstrained – places a curve tangent to a line or curve, and through a specified point.

Place Curve Between Two Elements – places a circular curve between two elements.

Place Simple Transition – draws a tangent, curve, or spiral between two arcs.

7.6 Curve Combination Tools



The **Curve Combination Tools** allows the user to place compound curves, three centered curves, reverse curves, and tapered curves.

Place Compound Curves – places a compound curve between two elements.

Place Three Centered Curves – stores a three-centered curve between two elements. Design vehicle parameters from File>>Preferences can be utilized.

Place Reverse Curves – stores reverse curves between two elements. A short tangent section between the curves can also be specified.

Place Taper Curves – places a curve and tapers between two elements. The design vehicle parameters from File>>Preferences can be utilized.

7.7 Spiral Combinations

The **Spiral Combinations** tools allow the user to place spirals with curves, tangents, and other spirals.

Place SC Tangent To Line – stores a spiral curve combination tangent to a specified line.

Place ST Tangent To Curve - stores a spiral tangent combination tangent to a curve.

Place SC Tangent To Curve – stores a compound spiral curve combination tangent to a curve. The spiral will be placed between the curves.

Place SCS (Intersecting Elements) – stores a spiral curve combination tangent to a line.

Place STS (Disjoint Curves) – stores a spiral tangent spiral combination between two curves.

Place SCS (Disjoint Curves) – stores a spiral curve spiral combination between two curves.

7.8 Complex Transitions

The **Complex Transitions** tools allow the user to place complex ramp designs.

Place Complex Ramp – places simple to complex ramp geometry.

Place Ramp Connector – places simple to complex ramp connector.

7.9 Alignment Tools

The **Alignment Tools** allows the user to either store an alignment from existing COGO elements or to dynamically place an alignment.

Place Dynamic Element – places an alignment dynamically. The user needs to select a starting element and then specify the length of curves and length of tangents to create the alignment. The degree of curvature can be changed, and spirals can be added as the user moves along the alignment.

Store Chain – stores an alignment by selecting graphical elements. This tool works similar to the Microstation Automatic Create Complex Chain tool.

7.10 Manipulate Tools

The **Manipulate** tools allow the user to move/copy, rotate, extend, and delete elements.

Move Plan View Element - moves or copies an element.

Rotate Plan View Element - rotates the element about a specified point.

Extend Plan View Element – extends or shortens any cogo element.

Delete Element – deletes an element from the coordinate geometry database (.gpk).

Exercise 7-1

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

1. Open the MicroStation file **t:\br-proj\Exercise_7-1\Route_50.dgn**.

2. Use **Coordinate Geometry**, **Graphical COGO**, or **Horizontal Alignment Generator** 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.

3. Upon completion of storing the alignments in coordinate geometry, close **coordinate geometry**, **graphical cogo**, and **Horizontal Alignment Generator**.

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

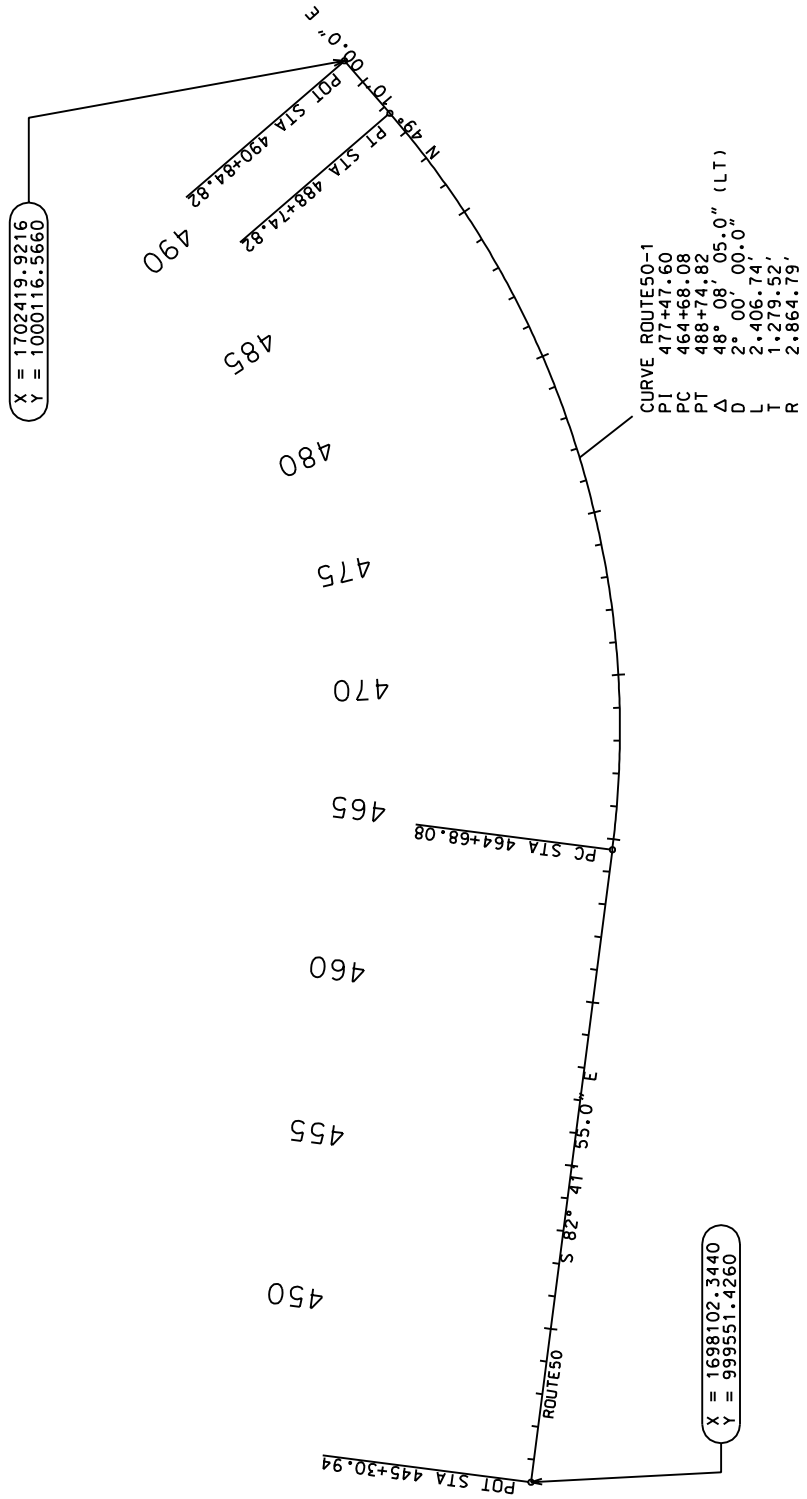
Degree of Curve = 2° 00’ 00”

Direction Ahead of Curve = N 49° 10’ 00” E

Station the chain beginning at 445+30.94

Name the alignment **Route50**.

Route 50


X = 1698102.3440
Y = 999551.4260
POT STA 445+30.94
ROUTE50
S 82° 41' 55.0" E
450
455
460
PC STA 464+68.08
465
470
475
480
485
490
CURVE ROUTE50-1
PI 477+47.60
PC 464+68.08
PT 488+74.82
Δ 48° 08' 05.0" (LT)
D 2° 00' 00.0"
L 2,406.74'
T 1,279.52'
R 2,864.79'
PT STA 488+74.82
N 49° 10' 00.0" E
POT STA 490+84.82
X = 1702419.9216
Y = 1000116.5660

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"

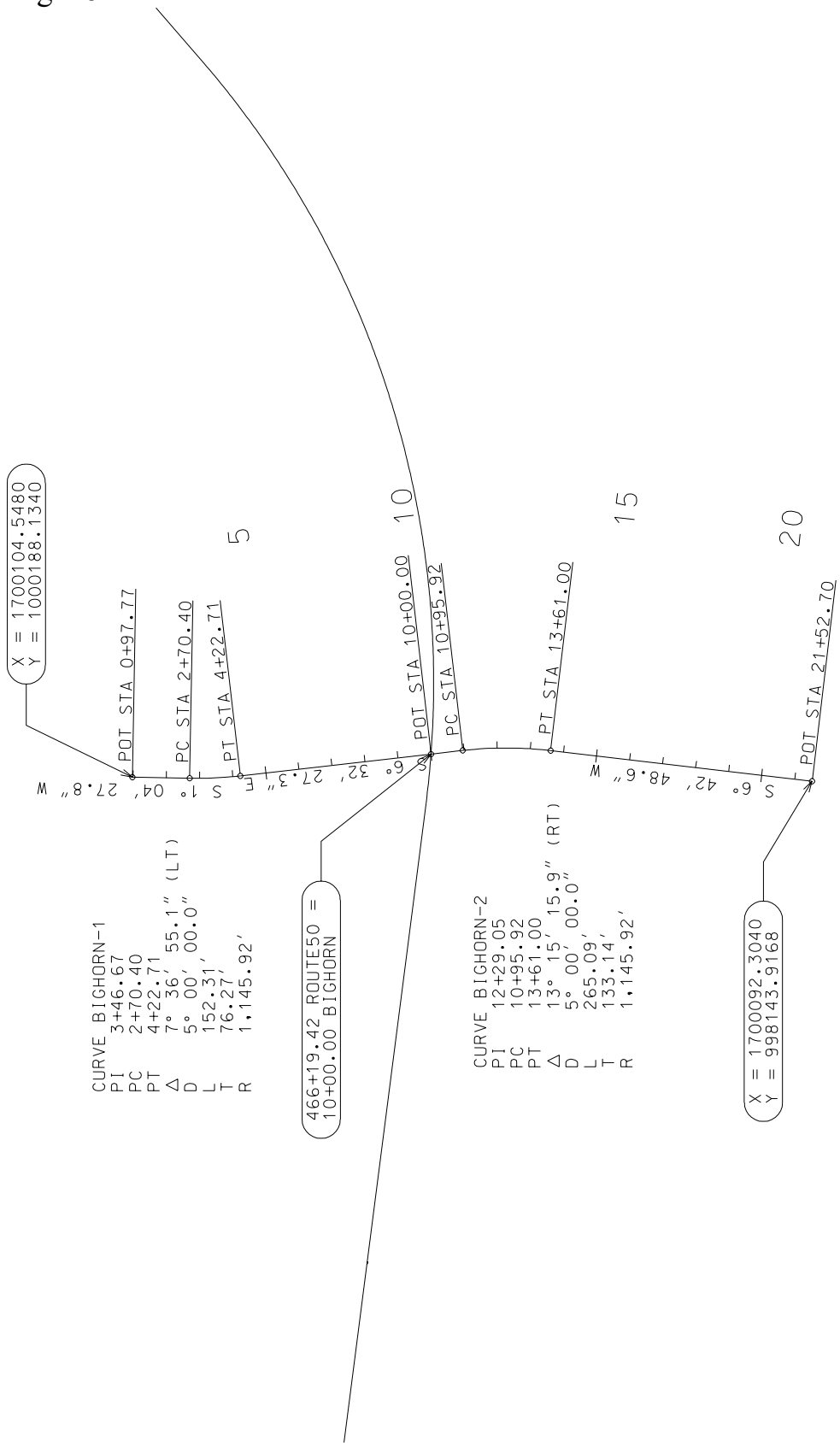
Direction Ahead of second curve = S 6° 42' 48.6" W

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.

Big Horn


X = 1700104.5480
Y = 1000188.1340
POT STA 0+97.77
PC STA 2+70.40
PT STA 4+22.71
POT STA 10+00.00
PC STA 10+95.92
PT STA 13+61.00
POT STA 21+52.70
5
10
15
20
S 1° 04' 27.8" W
S 6° 32' 27.3" E
S 6° 42' 48.6" W
CURVE BIGHORN-1
PI 3+46.67
PC 2+70.40
PT 4+22.71
Δ 7° 36' 55.1" (LT)
D 5° 00' 00.0"
L 152.31'
T 76.27'
R 1,145.92'
466+19.42 ROUTE50 =
10+00.00 BIGHORN
CURVE BIGHORN-2
PI 12+29.05
PC 10+95.92
PT 13+61.00
Δ 13° 15' 15.9" (RT)
D 5° 00' 00.0"
L 265.09'
T 133.14'
R 1,145.92'
X = 1700092.3040
Y = 998143.9168

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.

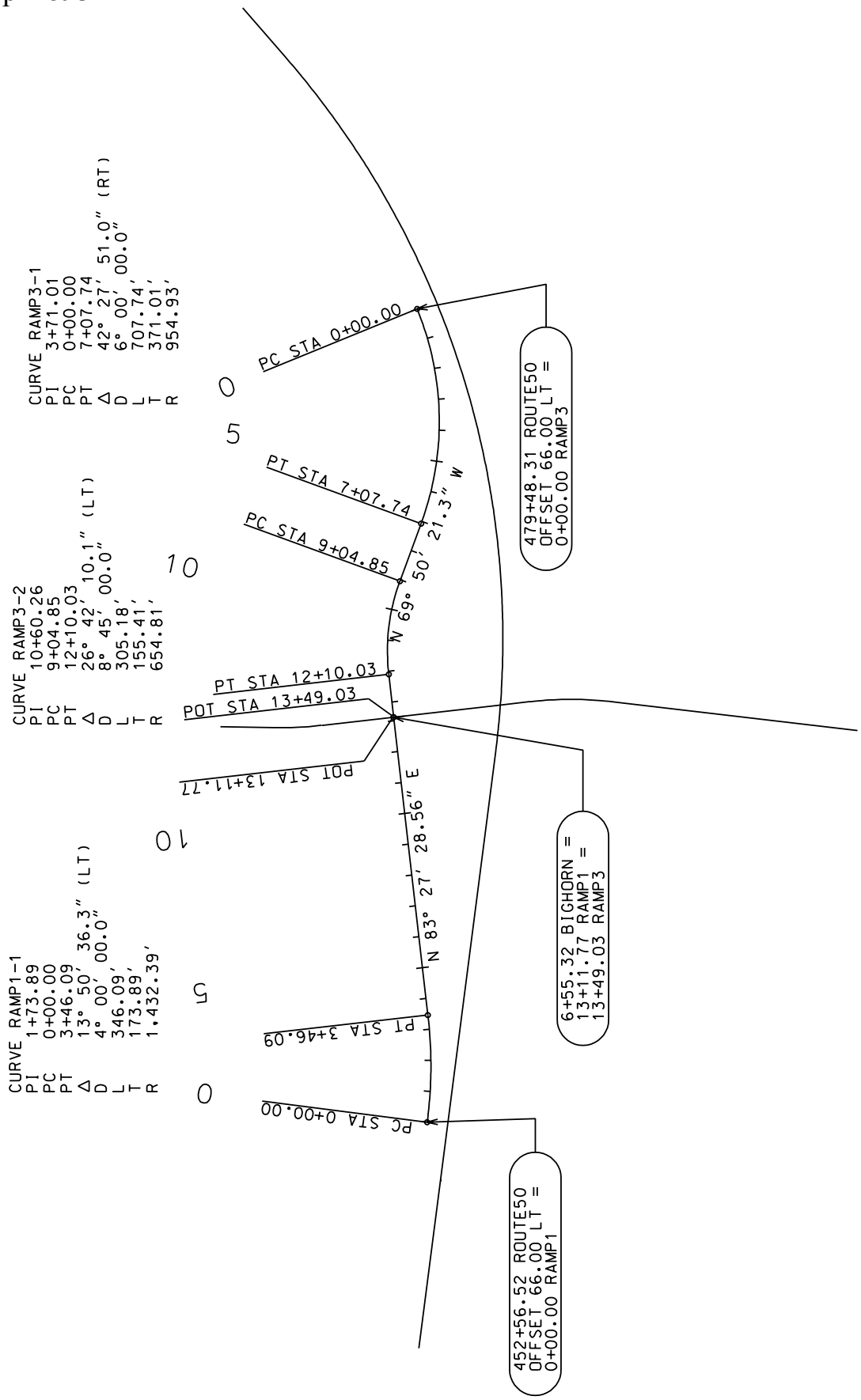
Degree of Curvature for the second curve = 8° 45' 00"

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


CURVE RAMP1-1
PI 1+73.89
PC 0+00.00
PT 3+46.09
Δ 13° 50' 36.3" (LT)
D 4° 00' 00.0"
L 346.09'
T 173.89'
R 1,432.39'
CURVE RAMP3-2
PI 10+60.26
PC 9+04.85
PT 12+10.03
Δ 26° 42' 10.1" (LT)
D 8° 45' 00.0"
L 305.18'
T 155.41'
R 654.81'
CURVE RAMP3-1
PI 3+71.01
PC 0+00.00
PT 7+07.74
Δ 42° 27' 51.0" (RT)
D 6° 00' 00.0"
L 707.74'
T 371.01'
R 954.93'
PC STA 0+00.00
PT STA 3+46.09
N 83° 27' 28.56" E
POT STA 13+11.77
POT STA 13+49.03
PT STA 12+10.03
N 69° 50' 21.3" W
PC STA 9+04.85
PT STA 7+07.74
PC STA 0+00.00
452+56.52 ROUTE50
OFFSET 66.00 LT =
0+00.00 RAMP1
6+55.32 BIGHORN =
13+11.77 RAMP1 =
13+49.03 RAMP3
479+48.31 ROUTE50
OFFSET 66.00 LT =
0+00.00 RAMP3

Exercise 7-2

This is an individual exercise to practice storing a horizontal alignment outside of a GEOPAK project.

1. Open the MicroStation file **t:\br-proj\Exercise_7-2\Route_6.dgn**.

2. Use **Coordinate Geometry**, **Graphical COGO**, or **Horizontal Alignment Generator** to create the alignment on the following page.

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

3. Upon completion of storing the alignments in coordinate geometry, close **coordinate geometry**, **graphical cogo**, and **Horizontal Alignment Generator**.

Rte 6

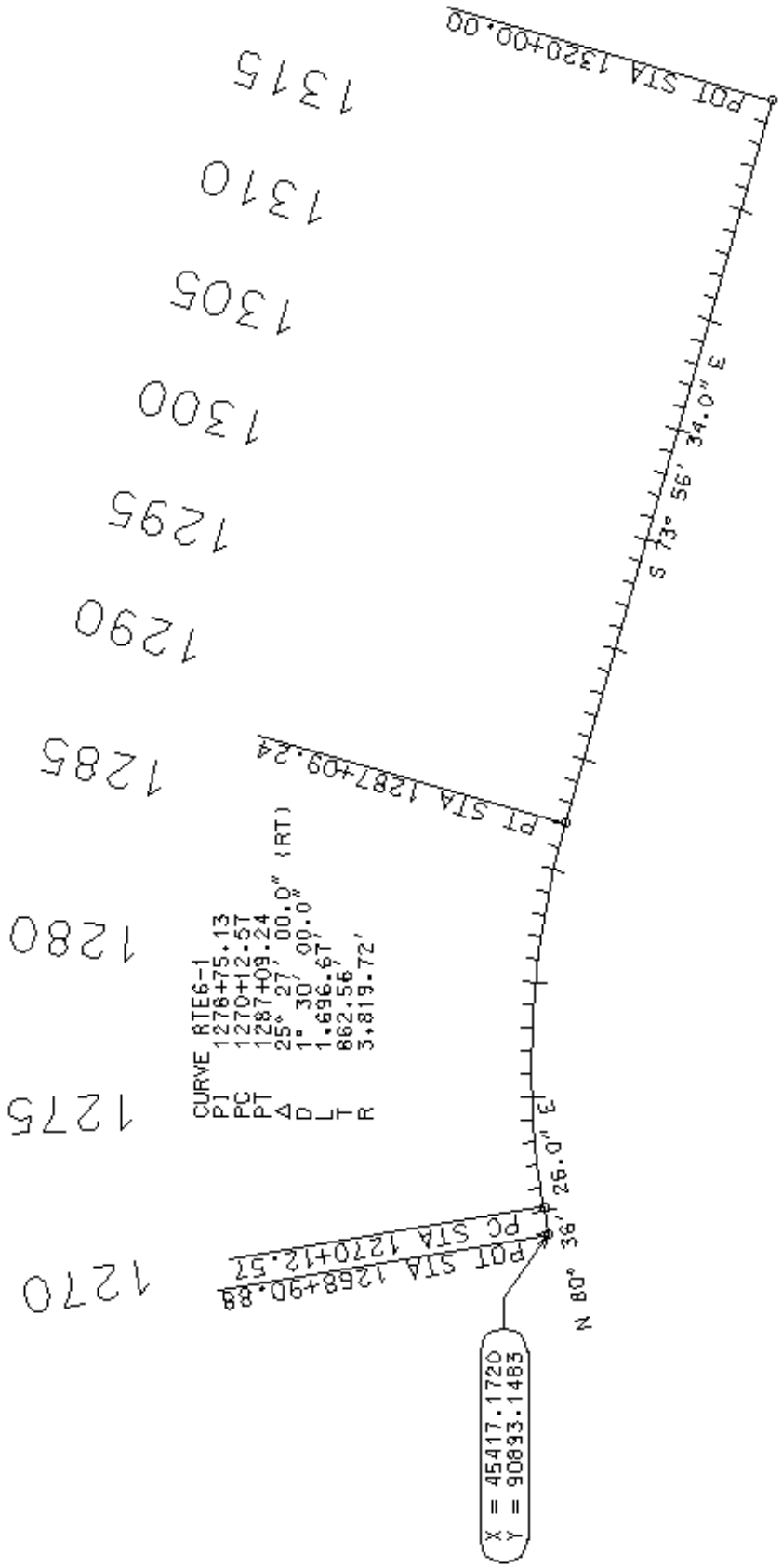
Hints:

Beginning Point is at station 1268+90.8814 with coordinates of X=45,417.1720 & Y=90,893.1483.

The PI of the curve is located 984.25’ from the beginning point along a bearing of N 80° 36’ 26” E.

Curve RTE6-1 has a decree of curvature of 1° 30’ 00.0” and a deflection to the right of 25° 27’ 00.0”.

The end point is located 3290.7634’ from the PT of the curve along a bearing of S 73° 56’ 34” E, which is the ahead bearing for the curve.



1. In the following alignment description, find 3 reasons why this is a poor alignment.

```
Beginning chain CLASS description
==================================================================================
Point 1006     N       999,316.7962  E     1,698,550.3961  Sta     10+00.00

Course from 1006 to PC CLASS-1  N 70^ 06' 55.04" E       Dist 380.0001

                          Curve Data
                         *----------*
Curve CLASS-1
P.I.  Station          22+36.99  N       999,729.7630  E     1,699,716.4028
Delta      =     48^ 20' 00.00" (RT)
Degree     =      3^ 00' 00.00"
Tangent    =          856.9896
Length     =        1,611.1111
Radius     =        1,909.8593
External   =          183.4619
Long Chord =        1,563.7635
Mid. Ord.  =          167.3830
P.C.  Station          13+80.00  N       999,446.0451  E     1,698,907.7401
P.T.  Station          29+91.11  N       999,314.2862  E     1,700,465.9429
C.C.                        N       997,643.8856  E     1,699,540.0247
Back       = N  70^ 40' 00.00" E
Ahead      = S  61^ 00' 00.00" E
Chord Bear  = S  85^ 10' 00.00" E

Course from PT CLASS-1 to PC CLASS-2  N 61^ 00' 00.00" W       Dist 27.8502

                          Curve Data
                         *----------*
Curve CLASS-2
P.I.  Station          36+19.82  N       999,036.4852  E     1,700,967.1091
Delta      =     66^ 10' 00.00" (LT)
Degree     =      6^ 12' 44.06"
Tangent    =          600.8607
Length     =        1,065.1017
Radius     =          922.3047
External   =          178.4584
Long Chord =        1,006.8953
Mid. Ord.  =          149.5263
P.C.  Station          30+18.96  N       999,327.7882  E     1,700,441.5845
P.T.  Station          40+84.06  N       999,399.4866  E     1,701,445.9238
C.C.                        N     1,000,134.4541  E     1,700,888.7267
Back       = S  61^ 00' 00.00" E
Ahead      = N  52^ 50' 00.00" E
Chord Bear  = N  85^ 55' 00.00" E

Course from PT CLASS-2 to 1007  N 52^ 50' 00.00" E       Dist 629.1392

Point 1007     N       999,779.5720  E     1,701,947.2733  Sta     47+13.20

==================================================================================
Ending chain CLASS description
```

2. Coordinate Elements can have up to ____ characters in the name.
   a. 6
   b. 7
   c. 9
   d. 10

3. DB stands for Distance Back
   a. True
   b. False

Chapter 8

Design and Computation Manager

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8.1 Objectives

- Understand the use of the **D&C Manager** in creating construction plans
- Understand the format of the hierarchical database and how to use it
- Be able to use the **D&C Manager** in conjunction with Microstation to store roadway features and calculate their quantities

8.2 Definitions

The **Design and Computation Manager** (D&C Manager) is a tool that allows MoDOT to standardize graphics elements for drafting and pay item quantities.

8.3 Database

A hierarchical database is used with the **Design and Computation Manager**. For MoDOT the default database is either **MoDOT_English.ddb** or **MoDOT_Metric.ddb**. The database stores information concerning functional classification and display preferences for each feature and item used in a Microstation file.

Categories are used to group and classify the features and items used in creating construction drawings. The content the MoDOT databases are divided into three overall categories – **Pay Items**/, **Drafting Standards**/, and **Design Standards/**. These three categories each contain sub-categories. The sub-categories break down each classification into more specific sections. (See dialog box next page).

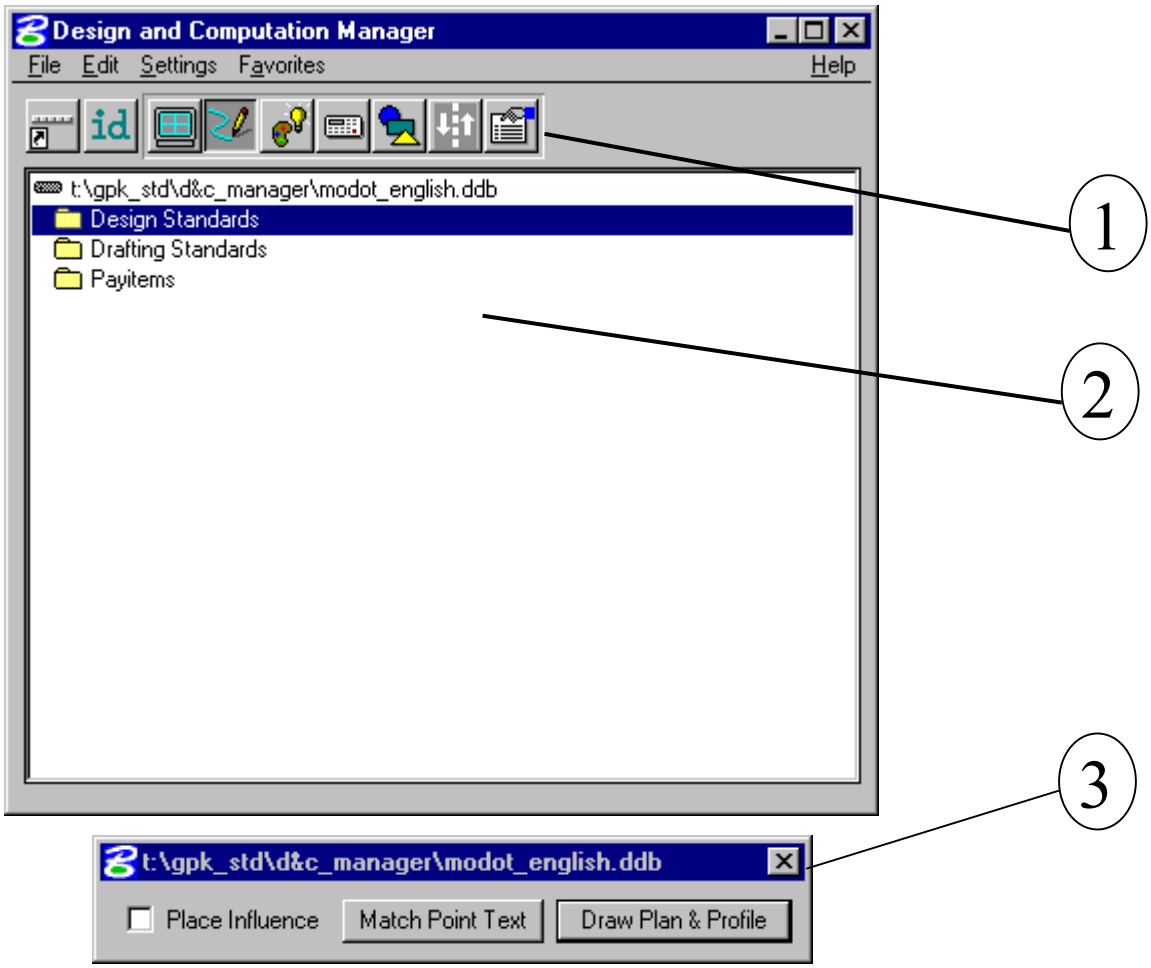
For example, **Pay Items**/ is broken into several additional categories like **Pipes/** and **Lighting and Signals/**. **Pipes/** is broken into many different categories representing various types of pipes and pipe features that may be used in the design of your project like **Flared End Sections/**. Within the category **Flared End Sections/** the different pay items for flared end sections are listed.

CADD Support personnel maintain this database. You will find commands within the D&C menu that require a password before execution. This is a security measure to protect the integrity of the database file and ensure its consistent application on a statewide basis.

8.4 Accessing

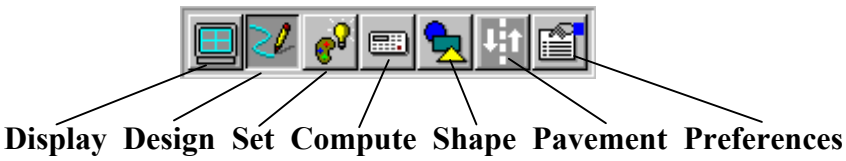
Design and Computation Manager can be accessed from **Project Manager >> Plan View Quantities** or from the **Design and Computation Manager** icon.

The following dialogs will appear.



The D&C Manager dialog box is composed of three distinct areas:

1) The D&C Manager may be configured to operate in seven different modes. A single click on an icon will change operational modes. They are: **Display Design Set Compute Shape Pavement Preferences**

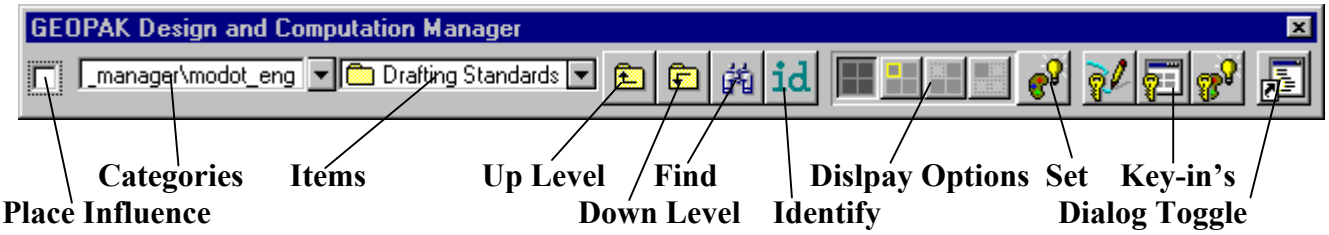


2) The **Content box** lists the sub-categories or items available at your current position within the database structure.

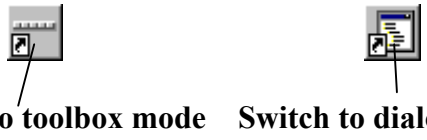
3) The **Operations box** will appear differently depending on the set mode of operation.

The D&C Manager dialog box can be used in two different modes. The dialog mode as shown on the previous page, allows the user to access items in from a "directory tree" structure. The icons at the top of the dialog allow the user to access the different operational modes of D&C Manager.

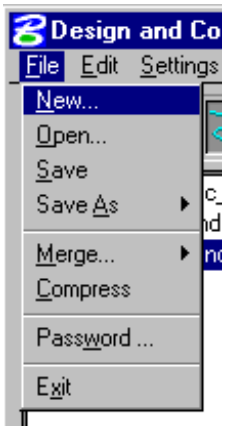
The toolbox mode as shown below, allows the D&C Manager dialog to be docked on the Microstation toolbars. With this format, the user accesses items from the pull-down menus, and can toggle the various tools from the tool bar.



The dialog box can be toggled using the appropriate icons.



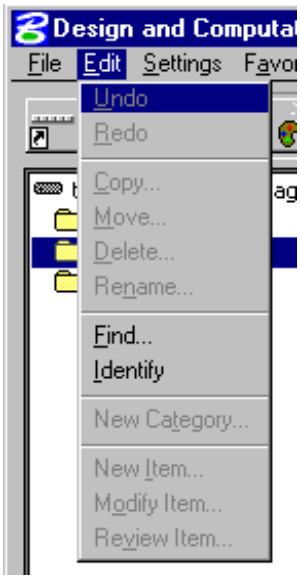
8.4.1 File Commands



For a MoDOT Geopak user, the only file command options needed are **Open** and **Exit**.

MoDOT_English.ddb or **MoDOT_Metric.ddb** will be used for all MoDOT projects. This file is password protected, so the users will not be able to make changes to it.

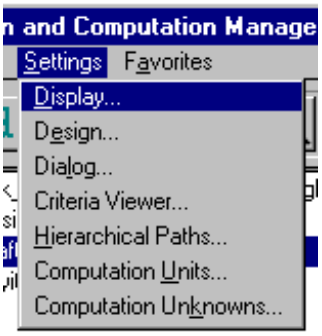
8.4.2 Edit Commands



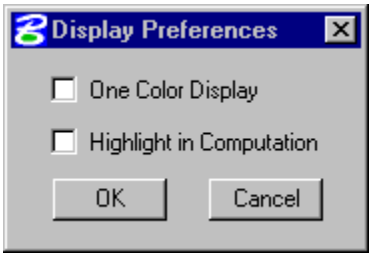
Find - will search the database (from your current location) for an item or category. The display in the D&C Manager dialog box will change to each item/category as it is found.

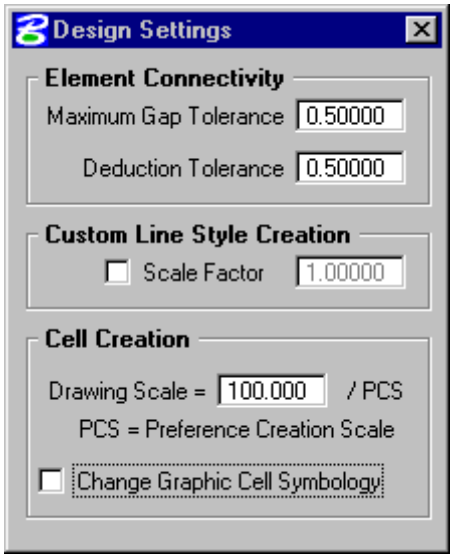
Identify – will show the item name and description attached to an element in the design file.

8.4.3 User Commands



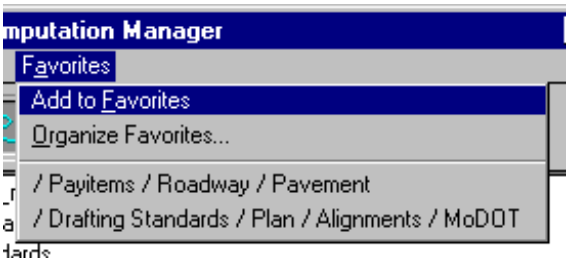
Display Settings - temporarily changes the display of elements on the screen to one common color, then the user may specify additional elements to be viewed in their original colors. This tool enhances visualization when working on a complex project.





Design Settings - sets the *maximum gap* tolerance and *deduction tolerance* used in computations and the drawing scale for placing cells. **Do not use the Custom Line Style Creation option.** The **Project** in the Microstation Manager handles the line style scaling in the MoDOT Microstation configuration. This dialog also sets the cell scale to adjust the cell size appropriate to the drawing scale.

8.4.4 Recall Commands



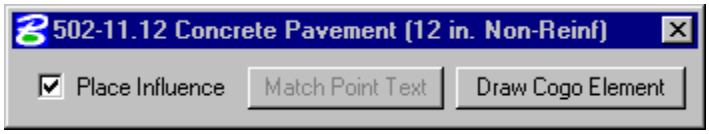
Add to Favorites - saves current D&C Manager path for easy recall in the future.

Organize Favorites – allows the user to edit and save the Favorites list.

8.5 Operational Modes

8.5.1 Design

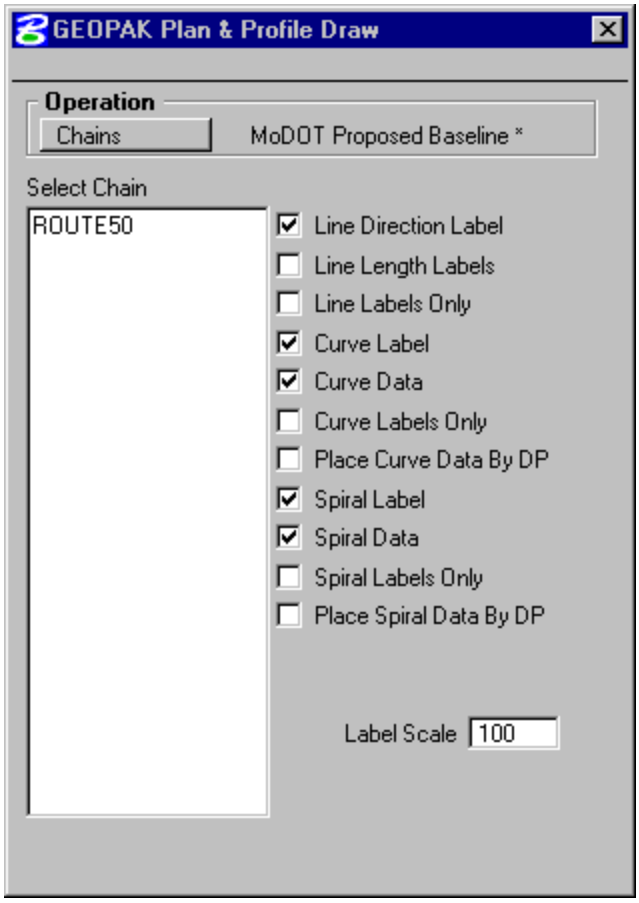
The Design mode allows the user to tag each roadway element as it is placed in the design file based on item parameters and/or write COGO elements to the file.



Place Influence will set the level, symbology and attribute tags of elements drawn or copied using Microstation commands. When **Place Influence** is **On**, elements are drawn using the level, symbology and attributes as defined in the Geopak database file. When **Place Influence** is **Off**, elements are drawn using the active level, symbology and attributes of Microstation.

The **Draw Cogo Element** button is for drawing Cogo elements to a design file. A single click to this button prompts the user for a job number then opens a dialog box that allows the user to choose a COGO item to draw.

If a drafting item is chosen, the **Draw Cogo Element** button changes to **Draw Plan and Profile**. A single click to this button prompts the user for a job number, and then opens the **Geopak Plan and Profile Draw** box shown to the right.



There are nine possible COGO elements that may be recalled from the .gpk file: points, lines, curves, spirals, chains, stationing, parcels, profiles, and parallel chain. Each of these options changes the dialog box to offer relevant draw and label features used when placing an element in a graphics file. When using **Plan and Profile Draw**, be sure to turn off **Place Influence**.

The points and lines dialog boxes have a key-in field that allows the user to specify the names of the COGO elements to be drawn. To use the line operation, the user must use point numbers to specify the ends of the line. The points/lines are drawn immediately after you enter their respective names and press the enter key. To draw more than one point or line, place a dash in-between the point numbers. To draw a line without using consecutive point numbers, use a forward slash.

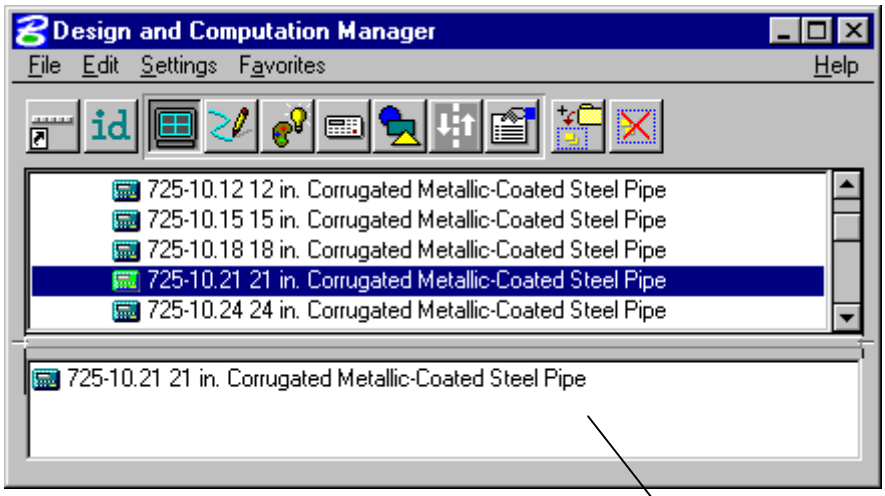
The dialog boxes for curves, spirals, chains, stationing, parcels, and profiles have a list box that display the names of all stored curves and chains. Highlighting one of the available elements causes it to be drawn into the file. Each type of item has a list of options that can be plotted.

**Note that Geopak can draw elements to levels not turned on. After elements are drawn, it may be necessary to turn on appropriate levels and fit screen.

Remember that **Place Influence is for drawing Microstation elements. **Draw Plan & Profile** is for drawing **Cogo** elements. **Do Not** have **Place Influence** on when using **Draw Plan & Profile**.

8.5.2 Display

Display mode is used to enhance on screen visualization.



The pay item to be visualized is added to the **Collection** box. Three display options are available for the display of the items in the **Collection** box.

Highlight - will change those items stored in the collection area to the Microstation highlight color.

Collection Box

Normal Highlight Not Only

Not - simply turns off the display of the collection items leaving everything else on.

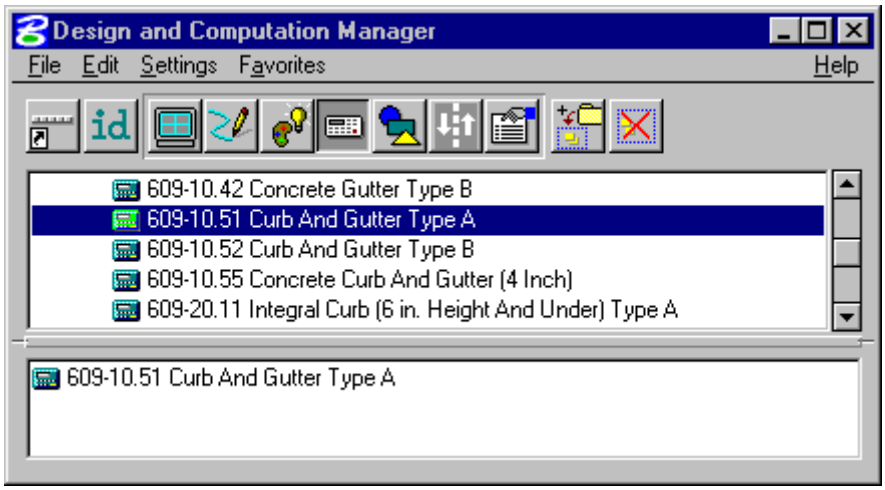
Only - will turn off everything but the collection items.

8.5.3 Set

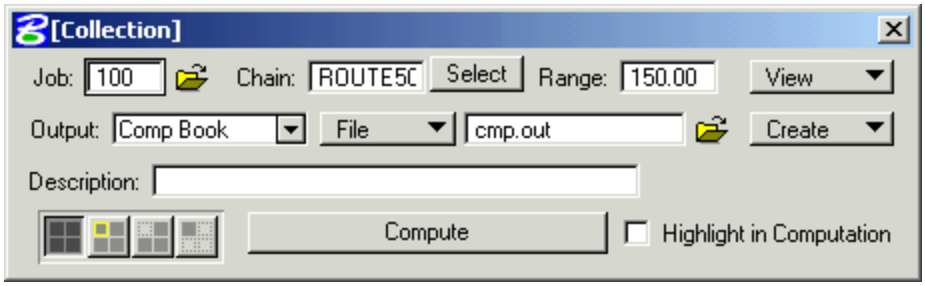
The **Set** mode allows you to assign attributes from the D&C Manager database to existing graphical elements in the file. The **Complex Chain** option automatically creates a chain from graphic elements and applies the attributes of the highlighted item in the content box. With the Complex Chain option is off, the Set mode is the same as Microstation *Element Select*. The user may tag several elements by depressing the Ctrl key while data pointing each element. This allows you to affect multiple elements with one Set command. **ID Element** is used to specify the complex chain to be changed. **Set** activates the command and changes the element attribute.

8.5.4 Compute

The **Compute** mode provides quantity calculations from graphic elements placed using the **D&C Manager**. Desired items for inclusion in the computation are added to the collection box at the bottom of the main D&C dialog as shown to the right.



Chosen items within either the **View** or a **Fence** are calculated, which is set in the upper right hand corner of the dialog. The other fields in the top row are discussed later.



There are six **Output** options:

Comp Book - calculates station/offset and coordinates for items defined in the Collection box within a **Range** left and right of a selected **Chain** in the specified **Job** as set by the first three fields in the top row of the dialog. The icon can be used to select the job. The output file is ASCII format.

Item Report – a total quantity for each item is calculated. For this option, the job, chain, and range fields are inactive. The output file is ASCII format.

Item Tables – contains the same information as an Item Report. It produces an ASCII formatted quantity table to be included in a drawing file or imported into the estimate program.

SDF Item Report – is similar to Item Report, except that the output file is in SDF (standard database format) or CSV (comma separated value) format.

SDF Comp Book – produces a more detailed report that lists not only quantity summaries, but also geometric properties such as plan view coordinates and station/offsets for located elements. Format is in SDF or CSV format.

DBMS – provides very detailed information including calculated and rounded quantities, geometric properties, pay item numbers, descriptions, station / offset values, etc. The format is the selected database (i.e., Microsoft Access, Oracle, SQL Server, and dbase.

To the right of the Output field is the **Preview/File** option. If preview is chosen, a file is not created and the output is displayed in a GEOPAK window. If set to File, GEOPAK creates the file whose file format is based on the Output type and whose name is defined in the key-in field to the right of the File option. The name can be manually entered or selected via the Files (folder) icon. The user can either **Create** a new file or **Append** the output to an existing file by using the option button at the end of the second row. If desired, a full path may be specified, otherwise, the report will be found in the current directory. The icon can be used to select an existing file.

Any information keyed into the **Description**: field will be printed at the top of the report. There is a maximum of 48 characters supported for this field.

The four display options described in section 8.5.2 can be utilized using the buttons shown to the right.

The **Highlight in Computation** toggle will highlight all MicroStation elements utilized in the computations if activated.

Compute commences the computation process.

8.5.5 Shape

Shape mode provides tools for creating shapes to be used for area calculations such as pavement.

Three options are available for choosing the elements to create the shape.

Semi-auto – allows the user to trace around the elements to create the shape. The user picks an element, and then GEOPAK finds an intersection on that element. The user clicks the data point button to accept the intersection, or reset to choose another intersection. GEOPAK will then find the next intersection, which the user can accept or choose another. This is repeated until the beginning of the shape is reached.

Automatic – creates the smallest shape possible. The user selects a data point inside the shape they are trying to create. GEOPAK then moves up until it intersects an element, then traces around intersecting elements to create the shape.

Exclusive – works the same as the **Automatic** mode, but allows the user to select elements that will create a whole in the shape.

8.5.6 Pavement

The **Pavement** mode allows the user to place pavement marking including striping, and symbols.

Striping – allows the user to place single or double, solid or skip pavement stripes.

Separation – allows the user to place traffic separation pavement marking.

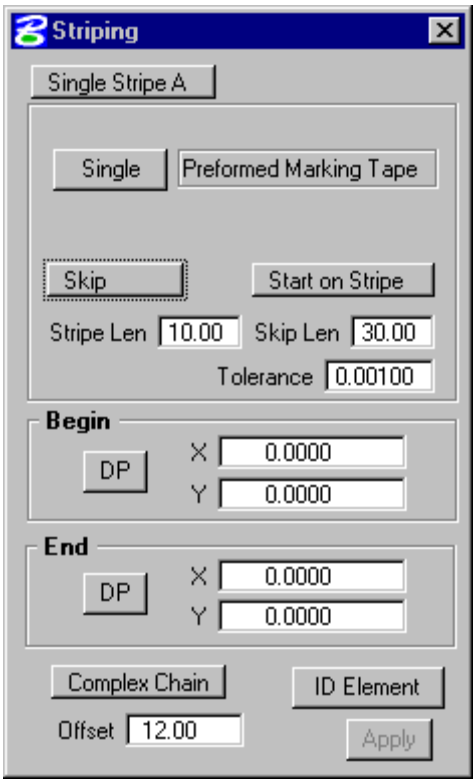
Chevron Diverge – allows the user to place pavement chevrons in areas of diverging traffic.

Chevron Merge – allows the user to place pavement chevrons in areas of merging traffic.

Symbols – allows the user to place pavement marking symbols with a specified pattern.

These are discussed further in the following pages.

SINGLE STRIPING



This box offers predefined configurations for single stripe and double stripe options so the user can easily control the type of striping being placed.

The pay item box will reflect the currently selected pay item in the **D&C Manager** dialog box; the user may change this at any time during the process.

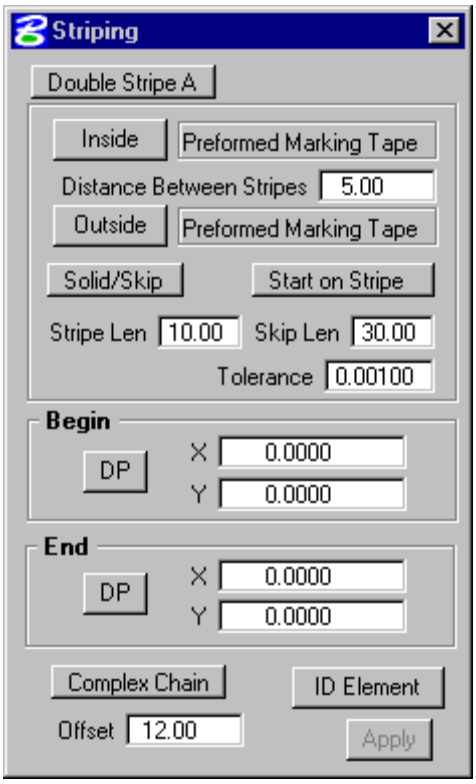
Next, define the start option by selecting **Solid** or **Skip** (or a combination thereof). If Skip is active, the user must define the stripe and skip lengths. If an ending stripe is shorter than the Tolerance value, it will not be drawn.

A beginning and ending point for the limits of striping are entered from digitized points on the screen.

The lower portion of the dialog box provides tools for identifying the reference element on which the striping will be based.

After clicking **Apply**, the user must enter a data point on

either side of the reference element to begin striping. Striping is placed at the indicated offset value; the data point controls whether striping is offset left or right. *Striping is placed as a graphic group.*

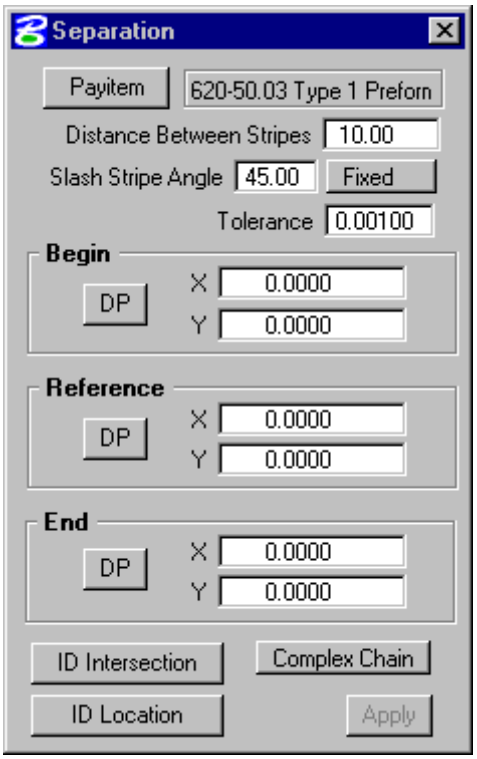


DOUBLE STRIPING

The process for Double Striping is the same as Single, except for having two pay item placement options, Inside and Outside. The user must select either the Inside or Outside button for the highlighted (D&C Manager) pay item to be displayed in the dialog box. Separate quantities are calculated for each stripe.

The remaining process is the same as described above.

SEPARATION



This option draws pavement markings between two sets of selected elements. Elements may be either GEOPAK or Microstation generated.

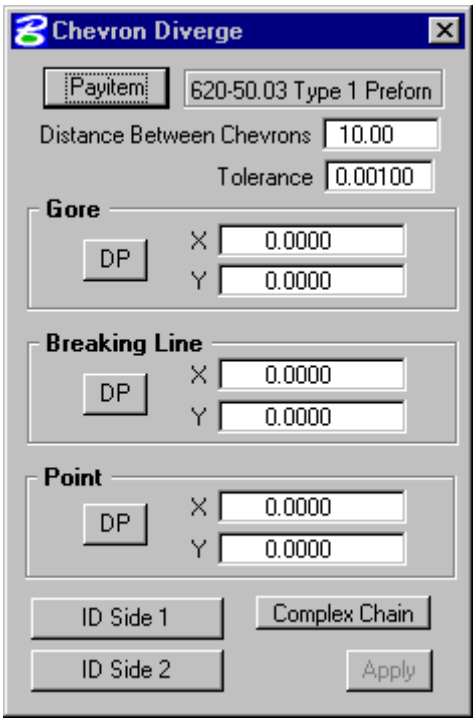
Once a pay item has been selected, the user may set the **Distance Between Stripes** and the **Slash Stripe Angle**. Tolerance functions the same as for striping.

A **Begin DP** and **End DP** should be issued before the **Reference DP** is identified. The Reference DP must fall between the **Begin DP** and **End DP**. It marks the location of the first pavement marking and determines the direction of the slashed stripe. All other markings will be based on the first stripe.

Tools for defining the limits of the pavement markings are located at the bottom of the Separation dialog box. **ID Intersection** identifies the elements where the striping will terminate. **ID Location** is the set of elements from which the striping begins.

After the **Apply** button is selected, the user must issue a data point in the graphics file for the pavement markings to be displayed.

CHEVRON DIVERGE



Once the pay item and its relative parameters have been defined, there are three points needed to define the chevron: **Gore, Breaking Line** and **Point.**

The **Gore** point defines the wide end of the gore.

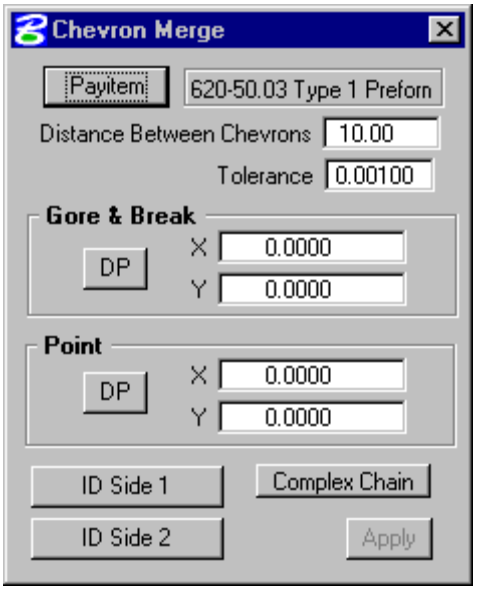
The **Breaking Line** point must fall between the two sides of the gore and sets the location of the point at which the chevron diverts in a different direction.

The **Point** represents the narrow end of the gore where chevrons are to stop.

Use the two **ID** buttons to identify the sides of the gore.

Once the **Apply** button is selected, the chevrons are displayed.

CHEVRONS MERGE



This process works similar to Chevron Diverge except the two points, Gore and Breaking Line, have been combined into one point that serves both functions.

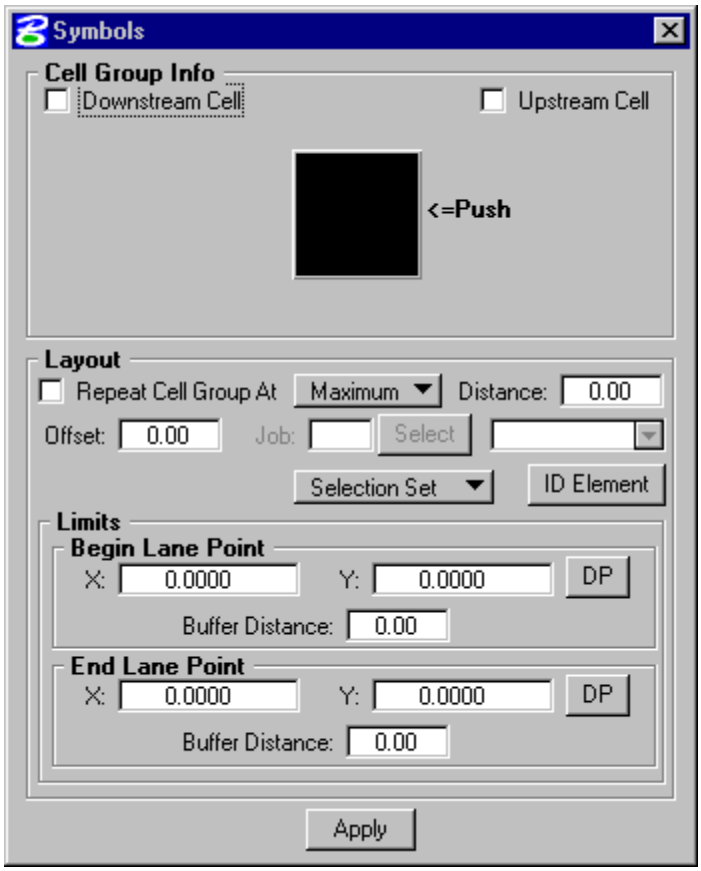
The **Gore and Break DP** should be located near the wide end of the chevron. It simultaneously sets the beginning of the pavement markings and the point at which the chevron will break.

The remainder of the process is as described above.

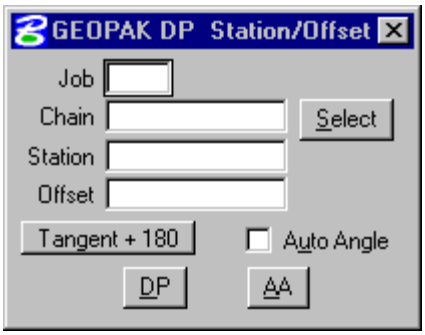
SYMBOLS

Cell Group Info defines the cells to be placed.

Layout allows the user to repeat the cells, and to set the locations of where the cells are placed.

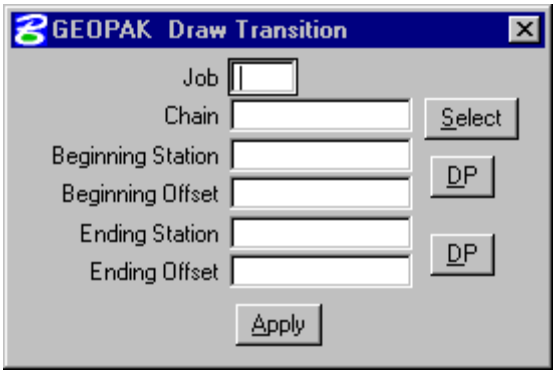


8.6 DP Station/Offset



The **DP Station/Offset** command works in conjunction with Microstation commands and the D&C Manager. It can be used as the *data point* for any Microstation command. **DP Station/Offset** provides precision placement of elements based on a station and offset of a stored chain. Uses for this command include precision placement of elements and window functions.

8.7 Draw Transition



Draw Transition will draw a line/curve based on a beginning station/offset and an ending station/offset relative to a selected chain. Use of this command includes turn lanes, mail box widening and lane transitions.
Note: Elements placed with **Draw Transition** will have Microstation element type **curve** when the beginning and ending offsets are different and will have Microstation element type **line** and/or **arc** when the beginning and ending offsets are the same.

Exercise 8-1

This is a combination group / individual exercise to introduce and practice using three GEOPAK plan view design tools: Design and Computation (D&C) Manager, DP Station/Offset, and Draw Transition. The first part of the exercise will be done together to introduce the tools. The last part is to be done individually to practice using the tools.

1. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\plan_j5p0100.dgn**.

2. In order to show all of the ways to access the plan view design tools, the instructor will open a GEOPAK project. **It is recommended that the students do not open the project**.

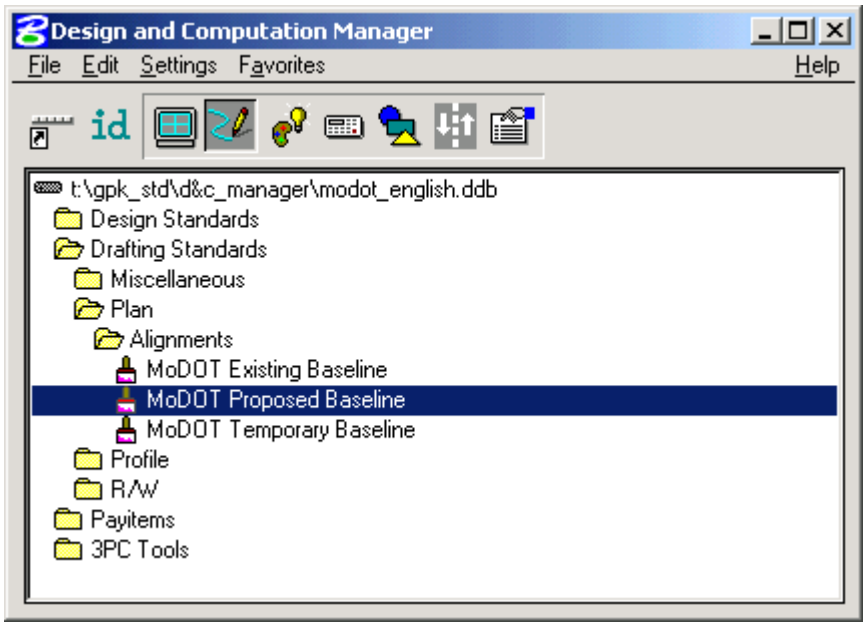
3. Open the **Design and Computation Manager** dialog. To access the tool, go to the MicroStation menu path:

Application > GEOPAK Road Design & Computation Manager

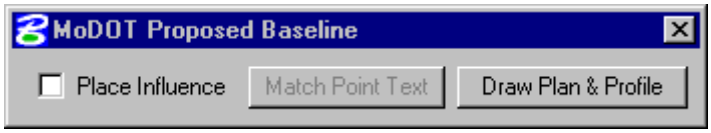
or click on the raised icon shown in the figure to the right.

Select the item:

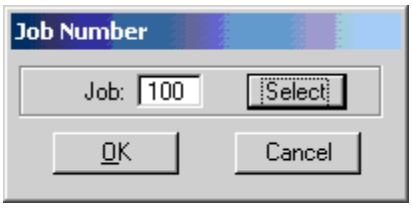
Drafting Standards/Plan/Alignments/MoDOT Proposed Baseline



Select the **Draw Plan & Profile** button.



4. If you open D&C Manager outside of a project, you will get the first dialog shown to the right to indicate which GPK file is to be used. (If you are inside of a project, GEOPAK already knows which GPK file to use.) Click on **Select** to bring up the next dialog shown on the right side of the page. Pick **job100.gpk** in this dialog and click **OK**. (If you do not see job100.gpk listed, ask an instructor for help.) Click **OK** in the first dialog to continue to the third dialog depicted in the bottom figure on the right side of the page.



Select the **Chain** Operation in the Plan & Profile Draw dialog.

Set the **Labeling Scale** to **50**

Have the following options turned on:

Line Direction
Curve Label
Curve Data
Spiral Label
Spiral Data

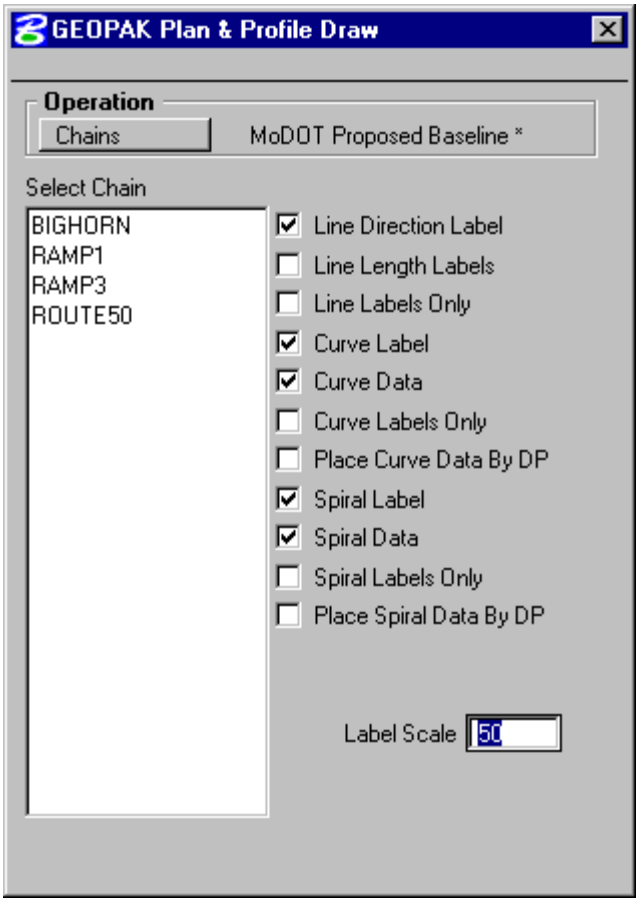
After all of the settings are checked, an item can be plotted by clicking **once** on its name.

Select the Chain **Route50**

Do a MicroStation **fit view** to see the plotted chain.

Select the Chain **Ramp1**

Select the Chain **Ramp3**



5. Select the **Stationing** Operation.

   Be sure the **Labeling Scale** is set to **50**.

   Have the following options turned on:

   Tick Marks
   Tick Mark Stations
   PC & PT & CS … Labels
   PI Labels

   Set the following options:

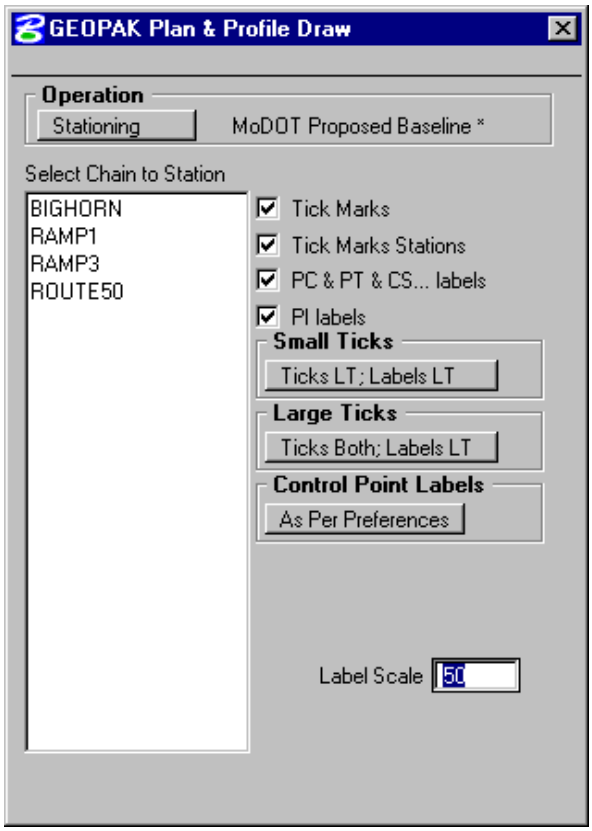
   Small Ticks:
   Ticks LT, Labels LT
   Large Ticks:
   Ticks Both, Labels LT
   Control Point Labels:
   As Per Preferences

   Select the chain **Route50**.

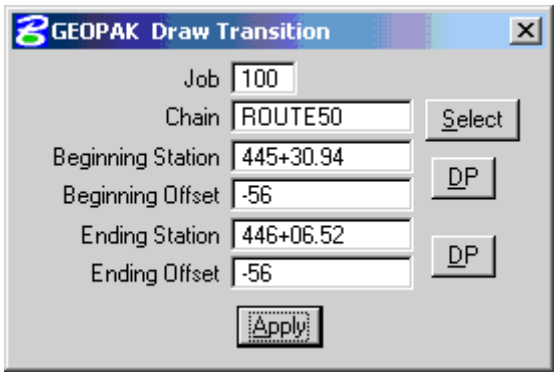
   Select the chain **Ramp1**.

   Select the chain **Ramp3**.

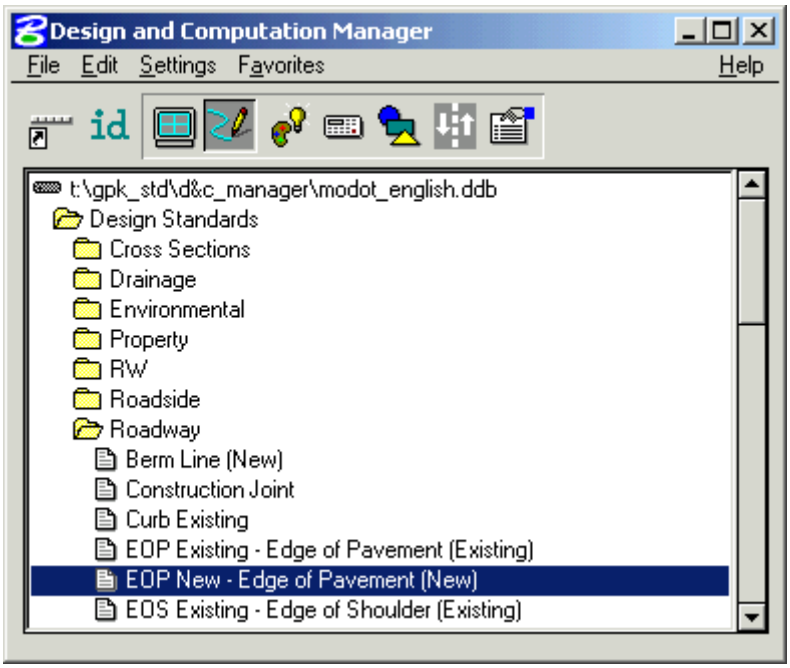
   Close the Plan & Profile Draw dialog.



6. Open the **Draw Transition** tool by selecting the raised icon shown to the right; it is the third tool in the tool palette. This tool, shown below, can be used to draw linear elements relative to a chain by specifying the job number, chain, a beginning station & offset, and an ending station & offset.



7. Use **Draw Transition** to create the edges of pavement by switching to **D & C Manager** category: **Design Standards/Roadway/** and item: **EOP New – Edge of Pavement (New)**.



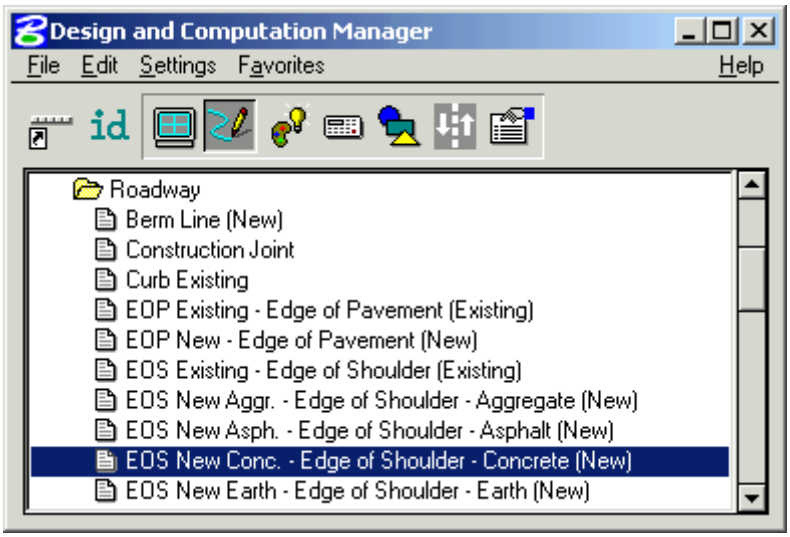
Be sure that **Place Influence** is checked to have the MicroStation symbology match the pay item.

Using the following information to draw the edges of pavement:

	Beginning		Ending	
Chain	Station	Offset	Station	Offset
Route50	Start of chain	-56	446+06.52	-56
	446+06.52	-56	449+06.52	-66
	449+06.52	-66	452+56.52	-66
	454+26.54	-56	474+48.41	-56
	474+48.41	-58	476+88.41	-66
	479+48.31	-66	482+98.31	-66
	482+98.31	-66	485+98.31	-56
	485+98.31	-56	End of chain	-56
Route50	Start of chain	-28	End of chain	-28
Route50	Start of chain	28	End of chain	28
Route50	Start of chain	56	End of chain	56
Ramp1	1+68.30	18	12+10.00	18
Ramp3	2+51.07	-20	3+11.07	-18
	3+11.07	-18	12+58.00	-18

8. On your own, use **Draw Transition** to create the edges of shoulder for the alignment with the following parameters.

   Use **D & C Manager** category: **Design Standards/Roadway/** and item **EOS New Conc. Edge of Shoulder - Concrete (New)**.



   Be sure that **Place Influence** is checked.

	Beginning		Ending	
Chain	Station	Offset	Station	Offset
Route50	Start of chain	-64	446+06.52	-64
	446+06.52	-64	449+06.52	-74
	449+06.52	-74	453+32.03	-74
	455+08.53	-64	474+48.41	-64
	474+48.41	-64	476+47.92	-70.62
	478+70.54	-74	482+98.31	-74
	482+98.31	-74	485+98.31	-64
	485+98.31	-64	End of chain	-64
Route50	Start of chain	-24	End of chain	-24
Route50	Start of chain	24	End of chain	24
Route50	Start of chain	64	End of chain	64
Ramp1	0+75.86	-6	12+10.00	-6
Ramp1	2+49.46	22	12+10.00	22
Ramp3	2+89.88	-22.71	3+11.07	-22
	3+11.07	-22	12+58.00	-22
Ramp3	0+76.31	6	12+58.00	6

Exercise 8-2

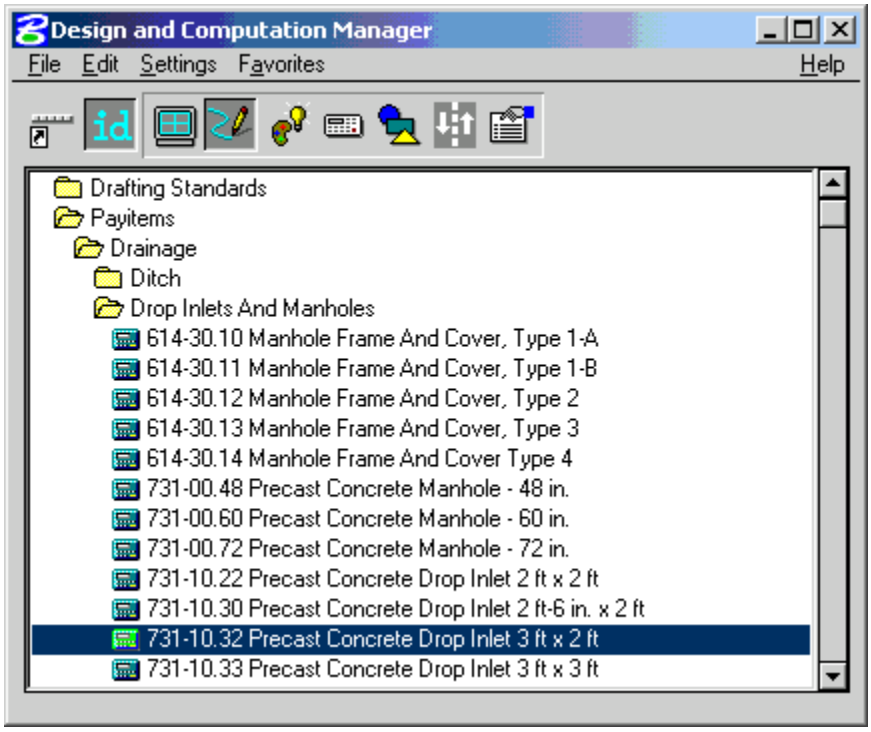
This is a group exercise to introduce additional aspects of thee GEOPAK plan view design tools.

1. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\plan_bh_j5p0100.dgn**. Window in on the area where the ramps intersect Big Horn Drive.

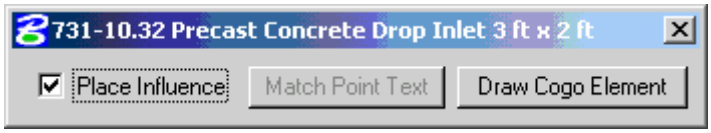
2. DP Station/Offset and Design and Computation Manager will be used to plot some drop inlets and a culvert to demonstrate the use of this tool combination. Open **DP Station/Offset** by selecting the raised icon shown to the right. It is the second icon in that tool palette.

To place the correct item, open D&C Manager category:
Payitems/Drainage/Drop Inlets And Manholes.

Double click on the item: **731-10.32 Precast Concrete Drop Inlet 3 ft x 2ft**. This will activate the MicroStation Place Active Cell tool.



Be sure that **Place Influence** is checked or else the correct cell will not be placed.



3. Place the cell using **DP Station/Offset** at the following locations:

Chain	Station	Offset	Orientation	Auto Angle
BIGHORN	7+00	-20.5	Radial	Checked
	7+12	20.5	Radial	Checked

The dialogs for placing the cells are shown below. After entering the correct information into the dialog, click on DP to place the cell. (**Note**: Before pressing DP, make sure that Place Cell is still the active MicroStation tool since DP Station/Offset will work with and MicroStation or GEOPAK tool that requires as data point.)

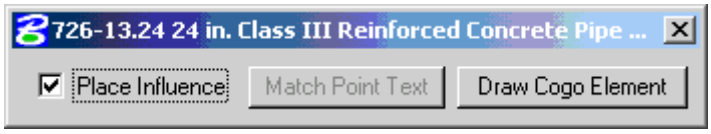
The instructor will demonstrate the other orientation options.

4. Use **DP Station/Offset** or **Draw Transition** to draw the culvert between the two drop using the following beginning and ending stations and offsets.

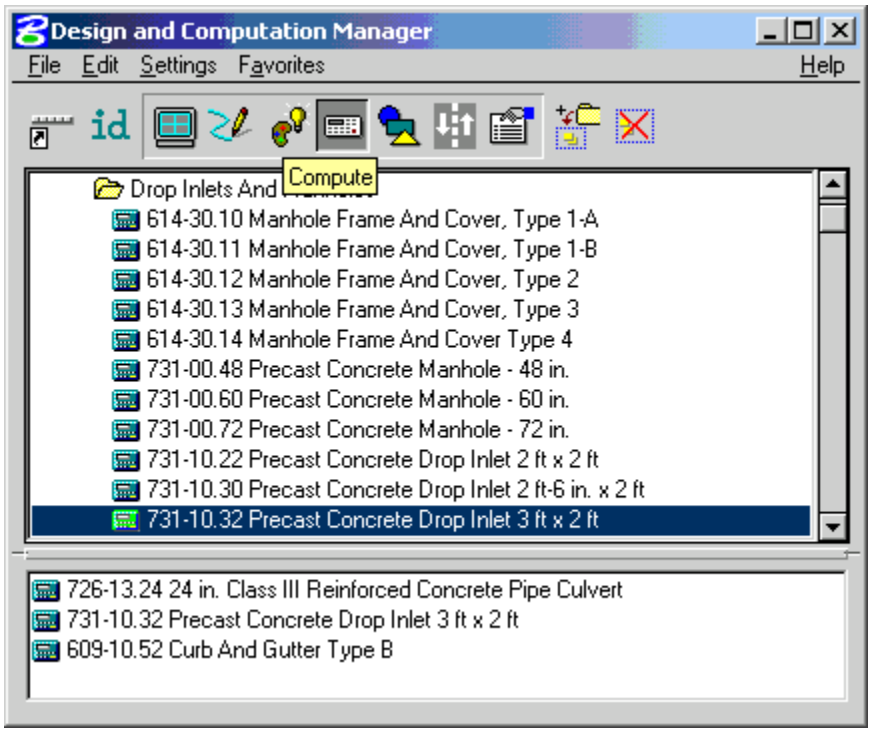
	Beginning		Ending	
Chain	Station	Offset	Station	Offset
BIGHORN	7+00	-19	7+12	19

Use **D & C Manager** category: **Pay Items/Pipes/RCP/**
and item **726-13.24 24 in. Class III Reinforced Concrete Pipe Culvert**.

Be sure that **Place Influence** is checked to have the MicroStation symbology match the pay item. (**Note**: If you use DP Station/Offset, make sure that **Place Line** is still the active MicroStation tool.)

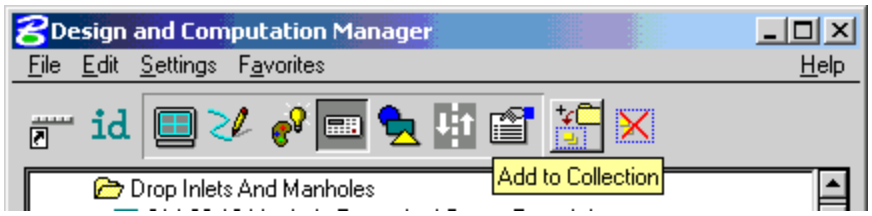


5. After placing the culvert, switch the **D & C Manager Mode** to **Compute** by clicking on the shaded icon shown below. A new section, called the Collection Box, is added to the main D&C Manager dialog. This mode can be used to compute quantities for items placed using D&C Manager.



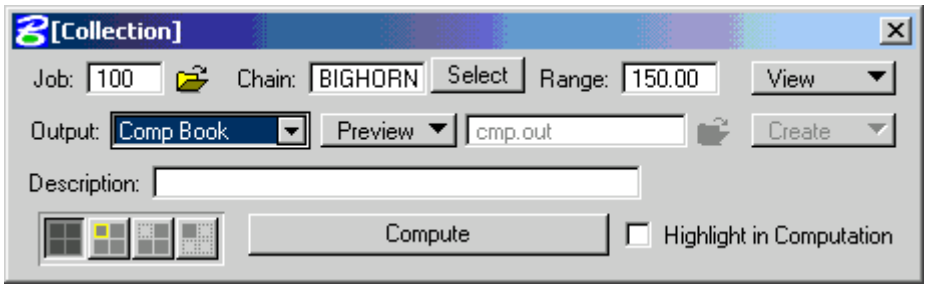
Add the items shown above to the collection box by navigating to the pay item and either double clicking on the item or clicking on the Add to Collection icon shown below.

The **id** icon in D&C can be used to aid in navigating to the items in the Payitems list. This is done by clicking on the icon and then data pointing on the plotted item in the MicroStation file. The instructor will demonstrate the use of this option.

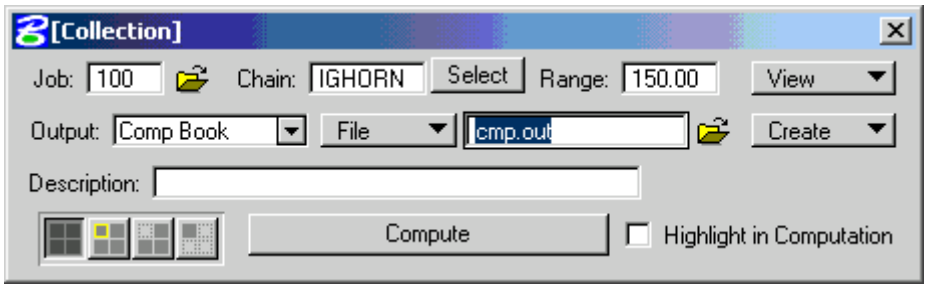


After adding the items to the collection box, zoom out in the MicroStation window until all of BIGHORN chain is visible. This needs to be done in order to compute all of the curb and gutter.

6. When D&C Manager is in Compute Mode, the Operations Box switches to the form shown below.



Set up the dialog as shown above and click compute. The results of the computation will be displayed in an output window. If you want a want a permanent record of the output, switch the **Preview** option shown above to **File** as shown below and type in the name of the output file you wish to use.



To see the other types of computation reports that D&C can generate, switch the **Output** to **Item Report** and **Item Table** and generate a report using these options.

The icons in the lower left hand corner of the above dialog can be used to control the display options for the items in the Collection Box. They are the same icons used in D&C's Display Mode. See the manual for an explanation of these options.

Chapter 9

Labeling

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9.1 Objectives

- Learn how to label information with Plan View, Profile View, and Cross-Section Labeler

9.2 Definitions

The GEOPAK **Labeler** is a tool that allows the user to construct labels using text inserts, computed inserts, and key-in text. The **Labeler** is available for plan view, profile view, cross-section view, and drainage elements.

9.3 Accessing

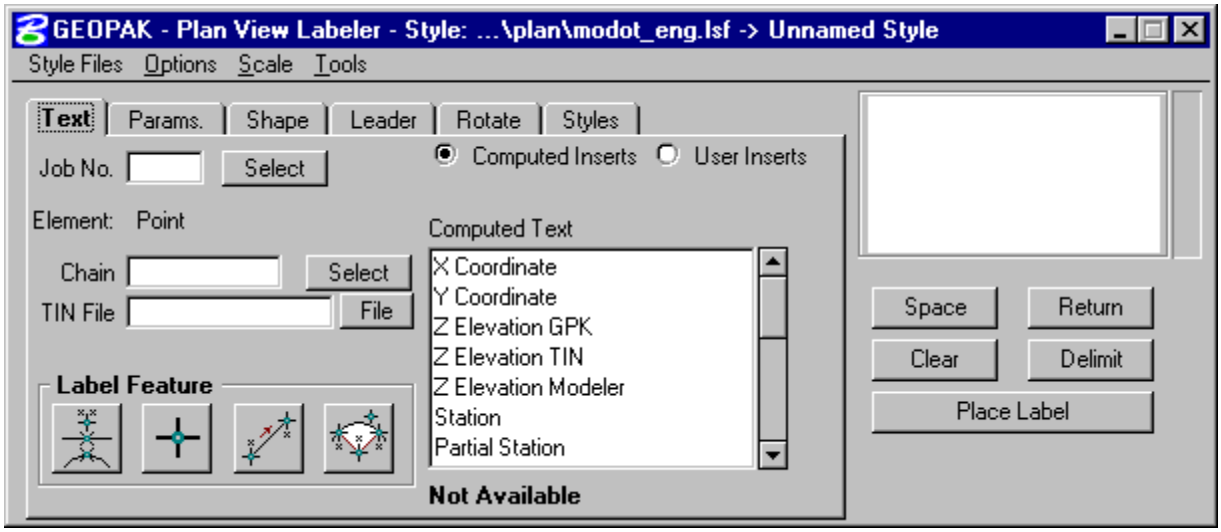
Plan View Labeler can be accessed from the **Plan View Labeling** icon.

Profile View Labeler can be accessed from the **Profile View Labeling** icon.

Cross Section Labeler can be accessed from the **Cross Section Labeling** icon.

9.4 Dialog

GEOPAK's labeling tools allow a user to place "smart" labels in a Microstation drawing. These labels have the ability to calculate XYZ coordinates, station, offset, direction, length, radius, degree of curvature, etc. of the element the label is attached to.

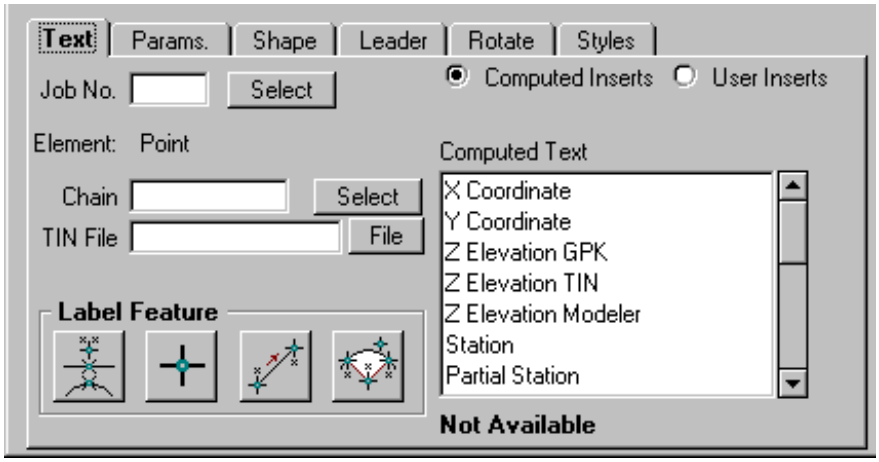


When the **Plan View Labeling** icon is selected, the above dialog appears. The label to be placed will be displayed in the box on the right side of the dialog. The **Space** button will put a space in the label at the cursor position. The **Return** button will start a new line of text. The **Clear**

button will start a new label. The **Delimit** button will place a line above or below a line of text. The **Place Label** button will place the label on the cursor to be placed in the drawing.

The user can select the various tabs to modify the label appearance.

9.4.1 Text



The **Text** screen allows the user to add computed text inserts, or user text inserts. For data to be computed, the job number and the chain need to be selected. If elevations are to be calculated, a .tin file needs to be chosen.

The **Computed Inserts** are items that Geopak has the ability to calculate for the chosen item. The list of **Computed Inserts** changes with the type of element that is chosen. If a line is chosen, the list of **Computed Inserts** will show inserts of bearing, and length. If a curve is chosen the list of **Computed Inserts** will change to show inserts of radius, curvature, chord length, etc.

The user can select different elements by using the icons in the **Label Feature** section.

Allows the user to select a graphical element such as a point, line, or curve.

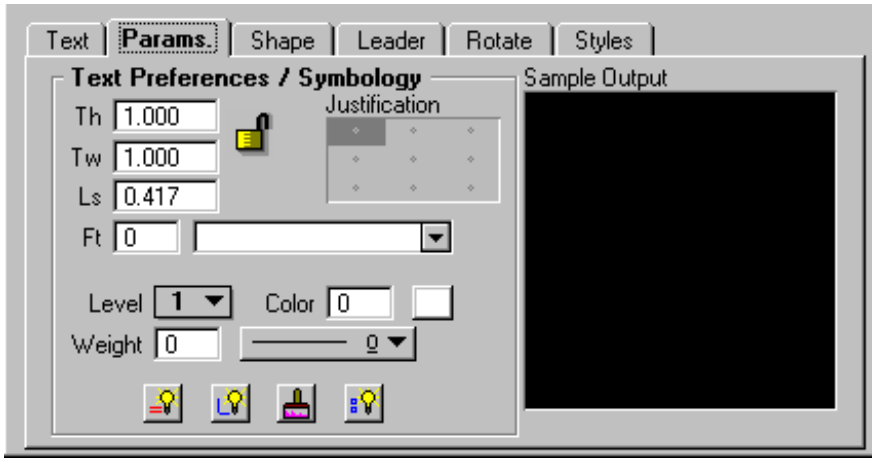
Allows the user to data point a location on the screen.

Allows the user to choose two visualized COGO points to represent a line.

Allows the user to select the PC, PT, and either the center of curve or a point on curve using visualized COGO points.

The **User Inserts** are inserts that a user may use on a regular basis. This list can be customized for a specific user's needs.

9.4.2 Parameters



The **Parameters** tab allows the user set up the text size and symbology for the label.

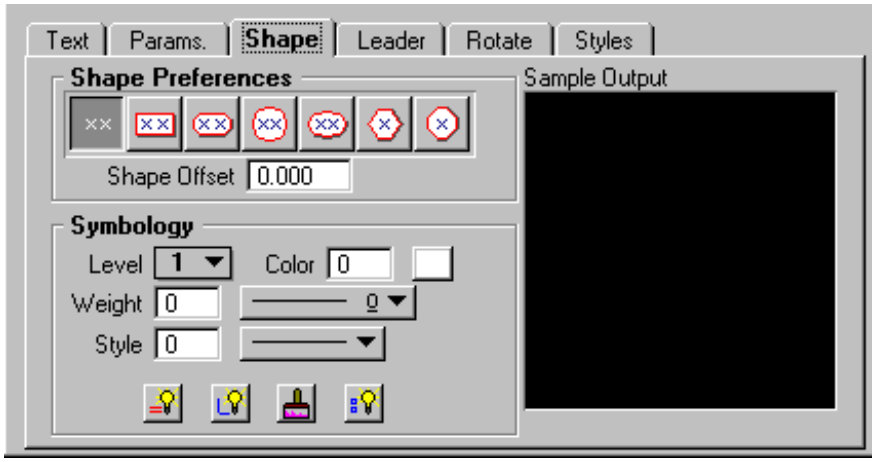
Will set the symbology to the current Microstation settings.

Allows the user to set the symbology by choosing a Microstation element.

Will set the symbology using D&C Manager symbology

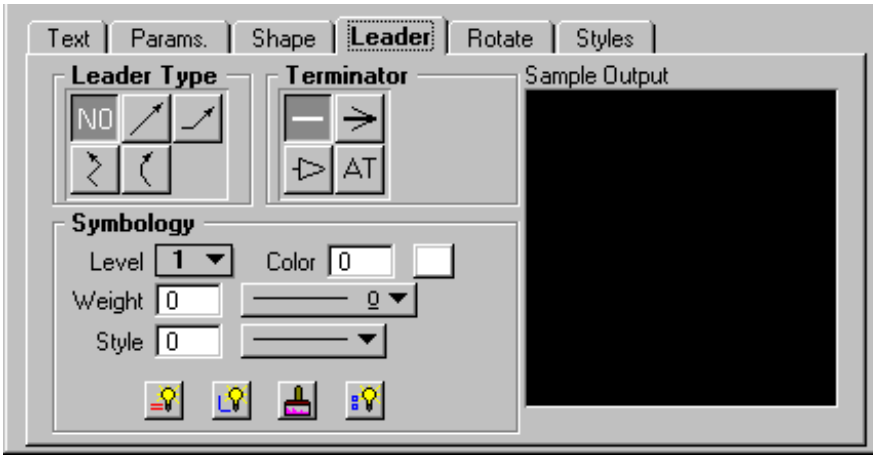
Will set the symbology for all elements in the label (text, delimiters, leader lines, etc.).

9.4.3 Shape



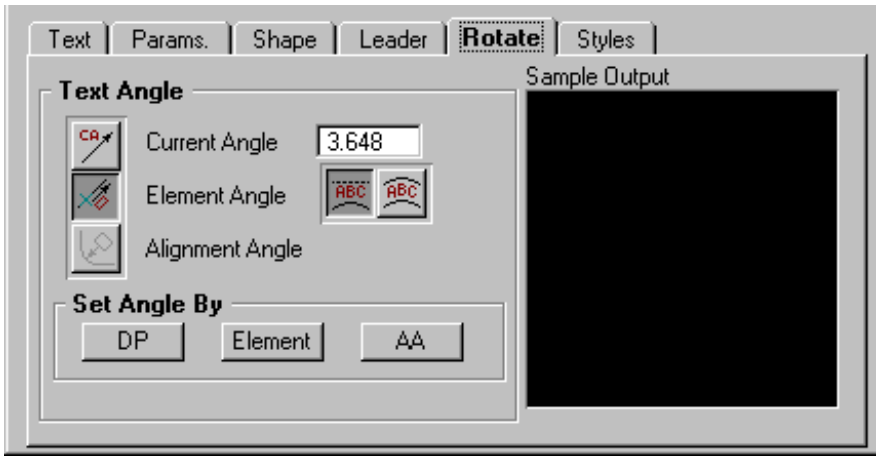
The **Shape** tab allows the user to place a shape around the label and set the symbology for the shape. The user can select the shape to be placed around the text. The **Shape Offset** is used to determine the distance between the shape and the text. The symbology icons are the same as those described under the Parameters tab.

9.4.4 Leader



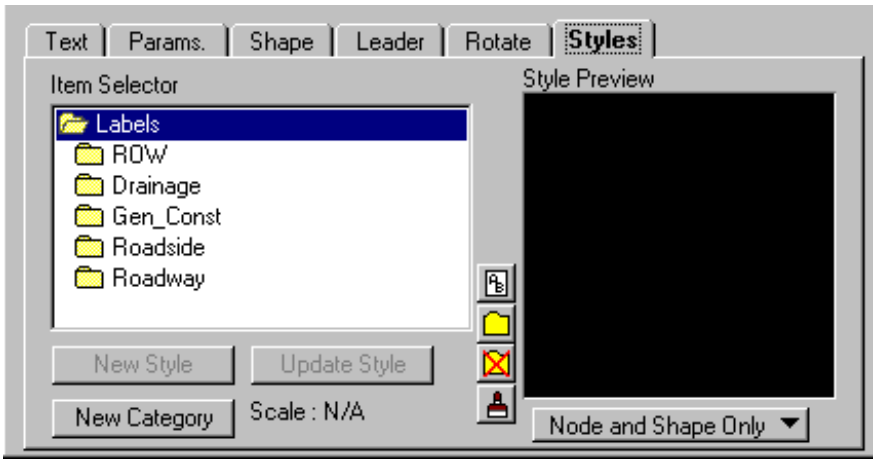
The **Leader** tab allows the user to attach a leader from the label to the point. Different leader types and terminators can be chosen. The active terminator can also be used. The symbology icons are the same as those described under the Parameters tab.

9.4.5 Rotate



The **Rotate** tab allows the label to be rotated. The rotation can be determined from the current angle, the angle of the element, or the alignment angle. Two data points or the active angle can also set the rotation.

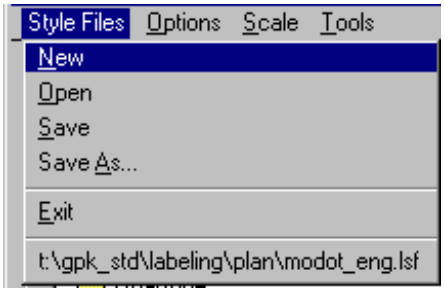
9.4.6 Styles



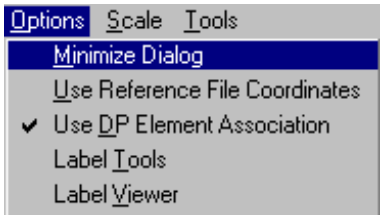
The **Styles** tab allows a user to choose label symbology from a library of pre-defined styles. When the user chooses the style, all of the symbologies, leaders, shapes, etc. is set up for the user.

9.5 Menus

The **Style Files** menu allows the user to open a new style library.



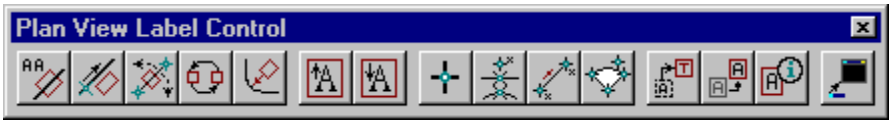
In the **Options** menu, **Minimize Dialog** will minimize the dialog box when **Place Label** is chosen.



The **Use Reference File Coordinates** option will use the coordinates from the attached reference file when placing a label in a plan sheet.

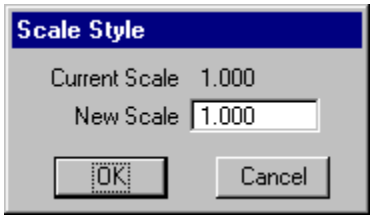
The **Use DP Element Association** option will allow the user to associate the label with an element in the active drawing. When the element changes, the label can be updated with the **Label Updater**.

Label Tools will bring up the toolbox shown below that will allow the user to modify GEOPAK labels.

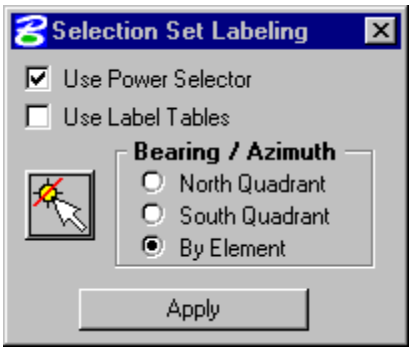


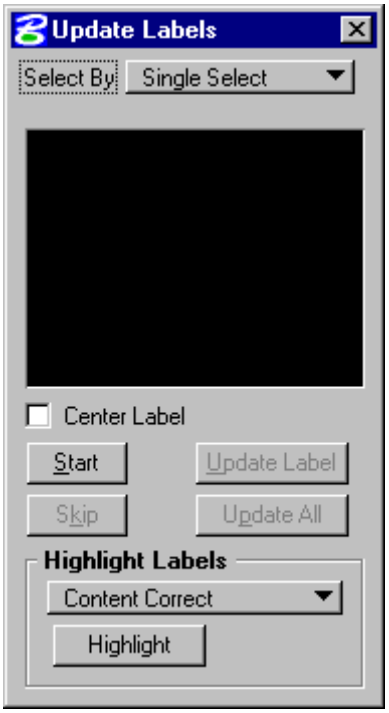
Label Viewer brings up a dialog that allows a user to view and place a label. **Automatic Label** will update the computed inserts in a label as a new data point or element is chosen.

The **Label Scale** menu allows the user to choose a plan scale. All labels will be adjusted according to the plan scale. The user simply keys in a scale, and chooses a **Labeling Style**. The corresponding label will be placed at the correct size for the scale that was chosen.

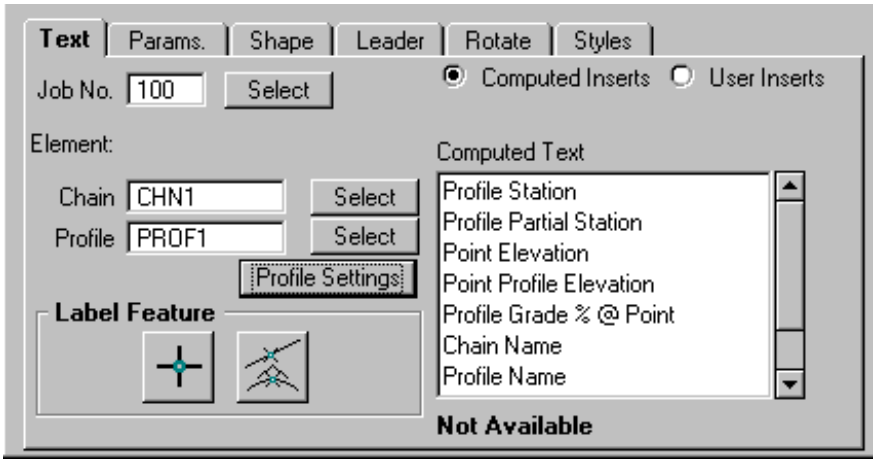


The **Tools** menu allows the user to use a selection set, or update existing labels. **Selection Set Labeling** allows the user to work with multiple labels using a Microstation selection set. The **Label Updater** will allow the user to update a label's computed inserts, symbology, etc.



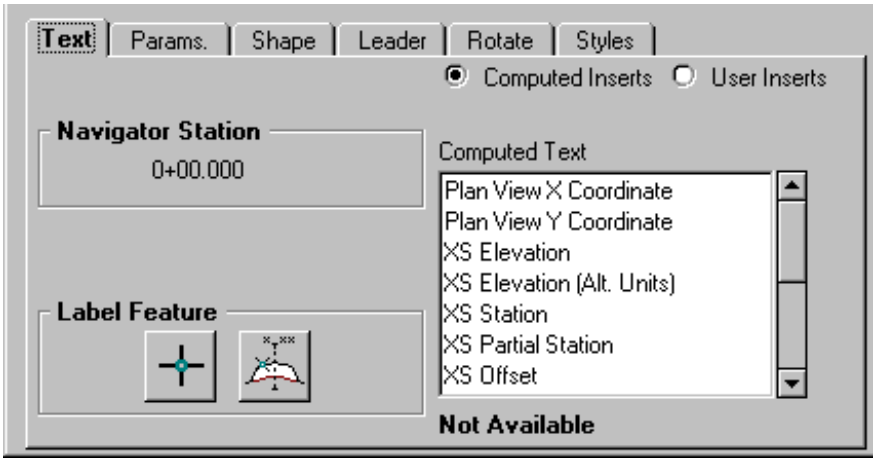


9.6 Profile Labeling



The **Profile Labeling** dialog differs from the **Plan View Labeling** dialog only on the text tab. The **Profile Labeling** dialog allows the user to select a chain and profile, and to set the profile settings. The **Computed** and **User Inserts** contain values and phrases related to profiles.

9.7 Cross-Section Labeling



The **Cross Section Labeling** dialog differs from the **Plan View Labeling** dialog only on the text tab. **Cross Section Labeling** works with the **Cross Section Navigator**. The current **Cross Section Navigator** station is shown on the **Text** tab. The **Computed** and **User Inserts** contain values and phrases related to cross-sections.

Chapter 10

Existing Ground Profiles

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10.2 Definitions 10-1
10.3 Accessing 10-1
10.4 Dialog 10-1
10.5 Reviewing Profiles 10-2
10.5.1 Plotting Profiles 10-3

10.1 Objectives

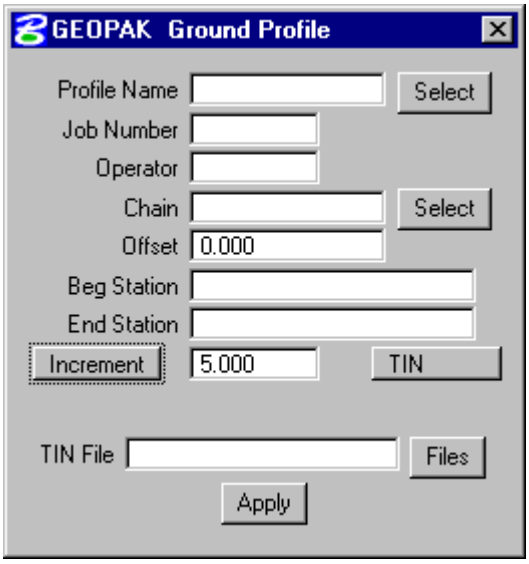
- Learn to calculate original ground profiles based on a DTM.

10.2 Definitions

GEOPAK will generate an existing ground profile based on a stored chain from either a 3D graphic file or from a triangulation file (TIN). The profile information is stored in the .gpk file with the option to create an input (.inp) file.

10.3 Accessing

Existing ground profiles may be generated in either a 2D or 3D graphics file, both methods are similar except that an additional option is available with a 3D file. To access the **Existing Ground Profile** utility, click on **Project Manager >> Existing Ground Profile**, or choose the **Existing Ground Profile** icon. Once the run is chosen, the following dialog box will open.



10.4 Dialog

Profile Name - Name of the profile to be stored.

Job Number and Operator - .gpk job number and user's initials.

Chain - Name of stored chain used for profile stationing.

Offset - Produces a profile at a user specified offset to the selected chain.

Beg Station and End Station - By clearing each field and hitting the Enter key the stationing will default to the beginning and ending station limits of the selected chain. The user may also key-in a station range within the limits of the chain.

There are four options that control the frequency of elevation calculations along the base chain.

Increment - based on the beginning station of the alignment, incremented by a user specified value.

Intersect - an elevation is calculated at every intersection of the alignment with a triangle side.

Even - will compute elevations at even stations rather than an incremented distance along the alignment. This is best used for alignments with station equations.

POT - calculates an elevation at each POT along the alignment

When in the **Increment, EVEN** or **POT** mode, an additional option box will provide two modes of operation for extracting data; **graphic** or **TIN**. (Only available in 3D file)

When using the **Intersect** or **POT** option *with* the graphic option, you will have an additional option for a circle to be drawn into the 3D file at the location of the intersection.

****Note:** It is recommended to use the **Intersect** option, as this will provide the most accurate existing ground profile.

10.5 Reviewing Profiles

Once a profile has been created, it may be reviewed in two ways:

1) Output viewed from the **COGO** dialog box: **Element >> Profile >> Print/List**

2) Profile drawn from the **D&C Manager**: By selecting the appropriate categories, for example:

Drafting Standards >> Profile >> Existing Ground Profile >> Profile Scale

Note: Always set an origin point for the profile display by drawing the Profile Cell.

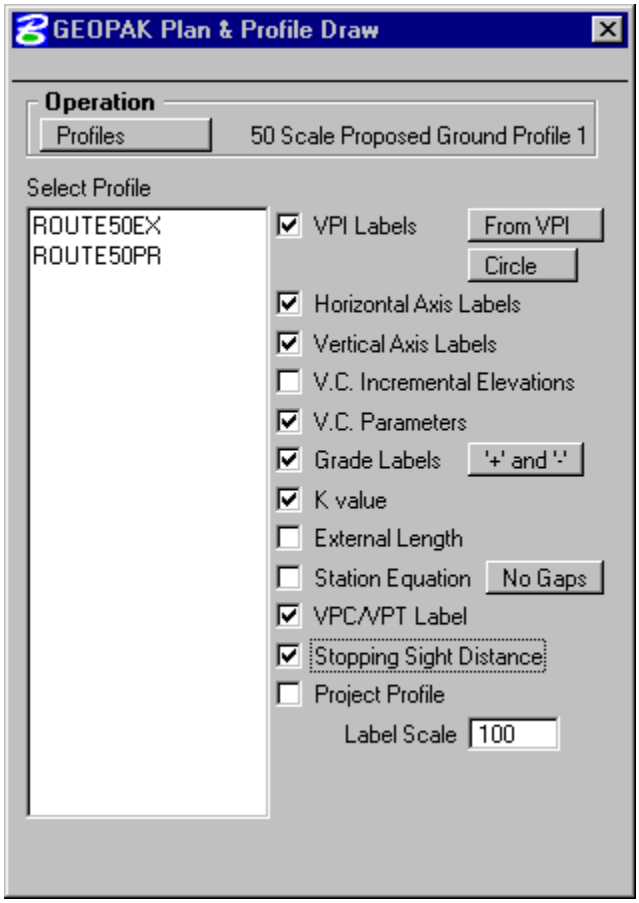
10.5.1 Plotting Profiles

1) Draw a diagonal line to serve as a reference point.

2) Start D&C Manager.

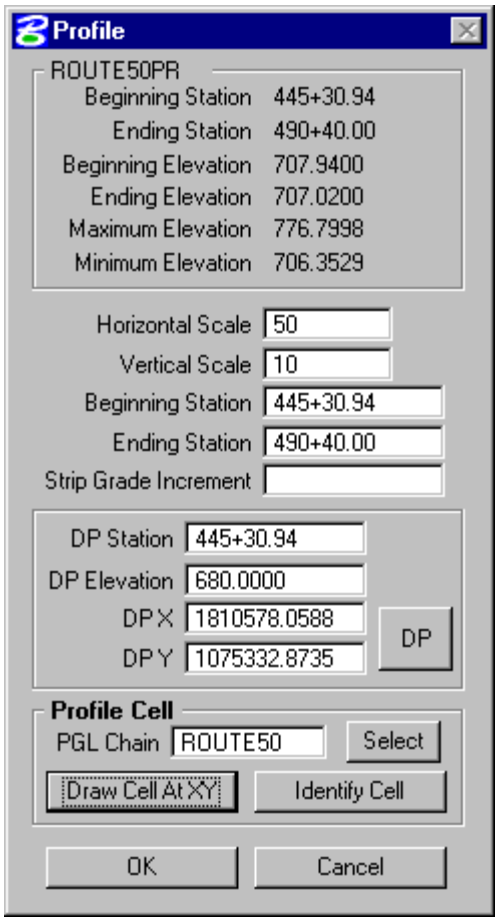
3) From D&C Manager, choose the appropriate scale from the category **Drafting Standards>>Profile>>Existing Ground Profiles** or **Drafting Standards>>Profiles>>Proposed Ground Profiles**.
4) Choose the **Draw Plan & Profile** button.

5) Set the options to be shown on the plotted profile.



6) Choose the profile from the list.

7) Set the horizontal and vertical scales and the station range to be plotted.



8) Determine the station and elevation of the origin point. (Usually the station will be the beginning of the chain, and the elevation will be a rounded value below the minimum elevation of the profile.

9) Select the **By DP** button and snap to the end of the diagonal line plotted in step 1 and accept the location. The coordinates for that location will be filled out.

10) If a profile cell has not been previously plotted, and is desired, set the PGL Chain and choose **Draw Cell at XY**. If a cell has been previously drawn, selecting the **Identify Cell** button and choosing the appropriate cell will fill in the scale, station and DP information.

11) Select the **OK** button.

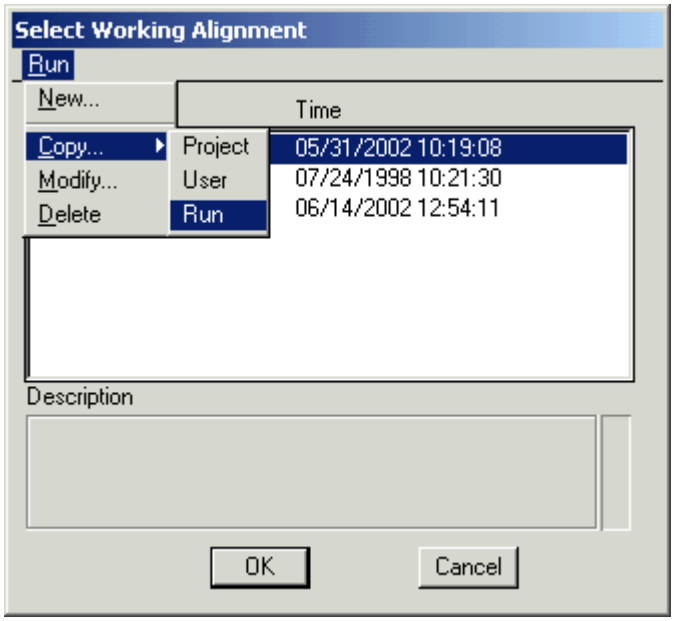
Exercise 10-1 This is a group exercise

1. Open MicroStation file **t:\br-proj\a_geopak\d2\j2p0300\data\topo_j2p0300.dgn**.

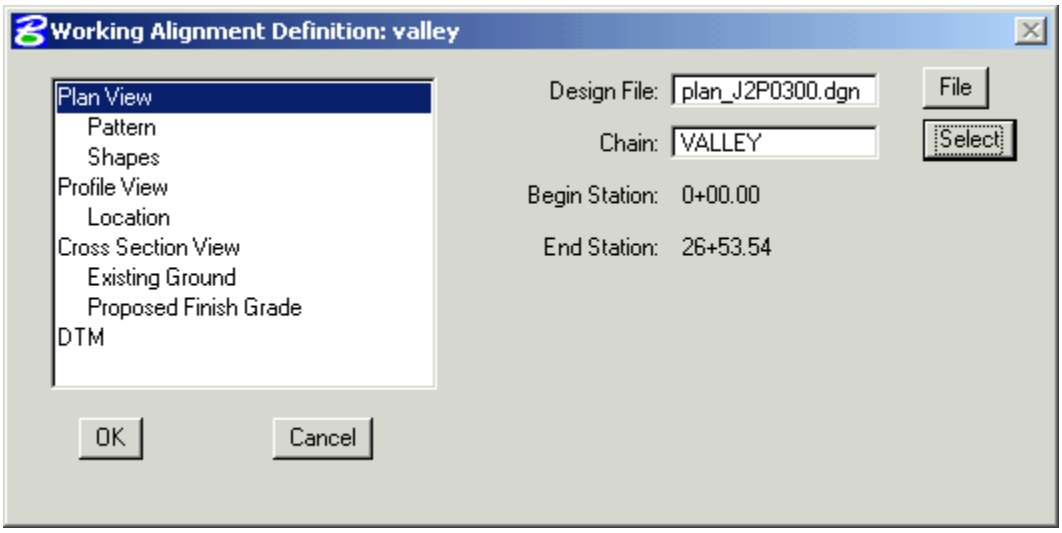
   If the line indicating the location of the valley section is not visible, use Level Manager to turn on Level 22.

2. Open the project **j2p0300.prj** and enter **Road** as user **userc**.

   Copy the J2P0300 working alignment to **Valley** and enter that working alignment.



   Go to the **Plan View** screen in the working alignment definition and select **VALLEY** as the default chain.

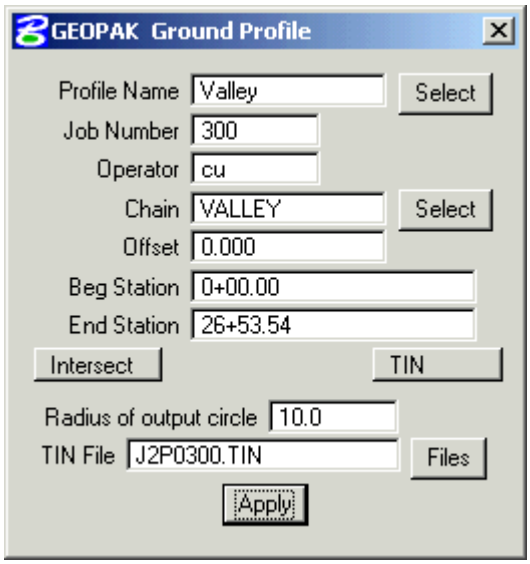


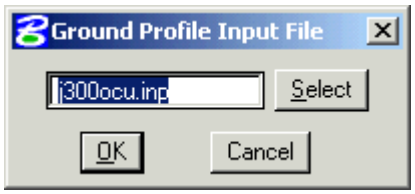
3. Choose **Existing Ground Profile** from the **Project Manager** dialog.

Copy the **MoDOT** run, name the new run **Valley** and enter the new run.

4. Create an original ground profile for the valley section.

Profile Name:	**Valley**.
Job Number:	**300**.
Operator:	**cu**.
Chain:	**VALLEY**.
Offset:	**0**.
Beg. Station:	*Will be filled in when the chain is chosen.*
End Station:	*Will be filled in when the chain is chosen.*
Mode:	**Intersect** **TIN**.
TIN File:	**j2p0300.tin**.





Click **OK** to create the ground profile input file, **Yes** to store the profile, and **Yes** to delete the 3D profile string.

Close the Ground Profile dialog, saving the settings.

5. Open MicroStation file **t:\br-proj\a_geopak_\d2\j2p0300\data\profile_j2p0300.dgn** and attach **t:\br-proj\a_geopak_\d2\j2p0300\data\plan_j2p0300.dgn** as reference files

6. Plot the existing ground profile above the plan view geometry using **D&C Manager** item **Drafting Standards \ Profile \ Existing Ground Profiles \ 1"=100' Existing Ground Profile** and clicking on **Draw Plan & Profile** in the operations box.

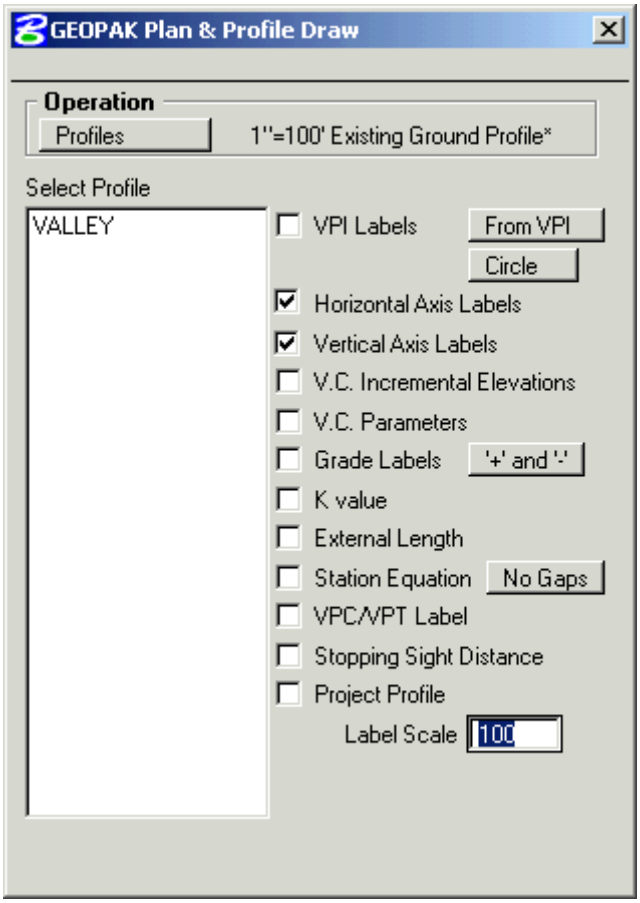
   Set the **Labeling Scale** to **100** and turn on the following options as depicted below in the figure on the left:

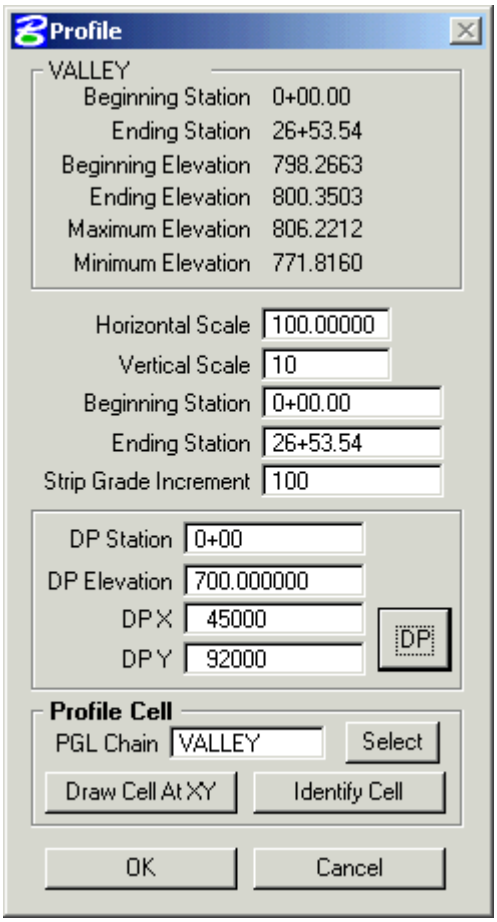
   Horizontal Axis Labels
   Vertical Axis Labels

   Choose the profile **Valley**, to bring up the dialog shown below in the figure on the right.

   Set the following parameters:

Horizontal Scale:	**100**
Vertical Scale:	**10**
DP Station:	**0+00.00**
DP Elevation:	**700**
DP X and Y:	*Press **DP** and data point on the screen in an open area above the plan view data or enter the values shown.*
PGL Chain:	**VALLEY**

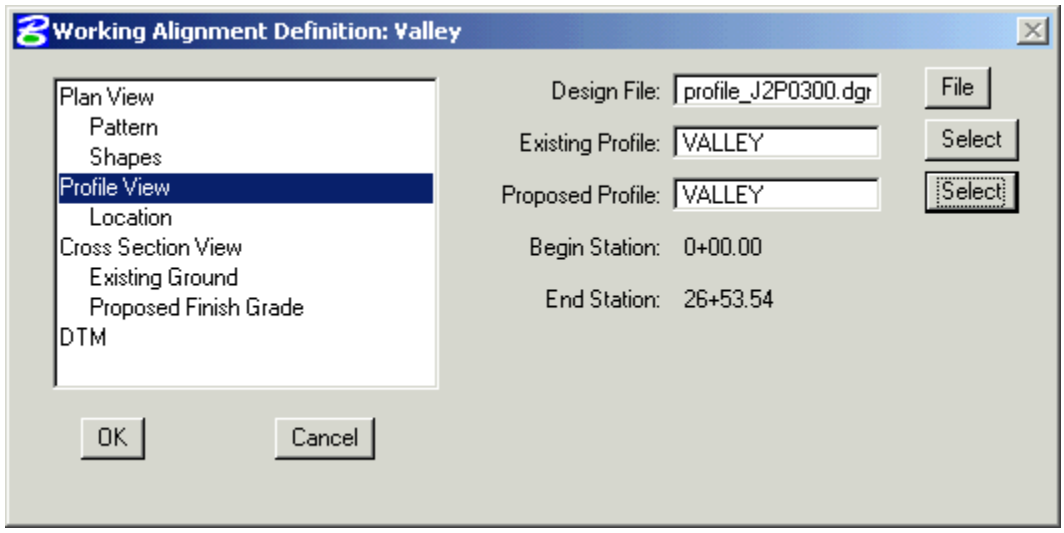




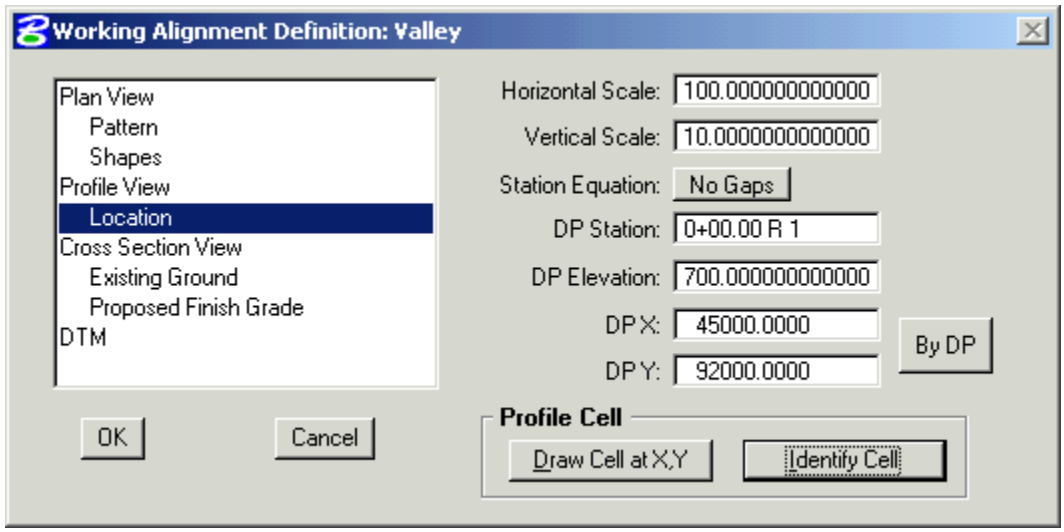
Press **Draw Cell At XY** and **OK** buttons to draw the profile cell and existing ground.

7. Complete the **Profile View** and **Location** sections of the **Valley Working Alignment**.

   Existing Profile: **VALLEY**
   Proposed Profile: **VALLEY**



For the **Location** section, use the **Identify Cell** button to choose the profile cell.



Accept the changes by clicking on the **OK** button.

Chapter 11

Vertical Alignment Generator

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11.1 Objectives

- Create and store vertical alignments using the **Vertical Alignment Generator**.

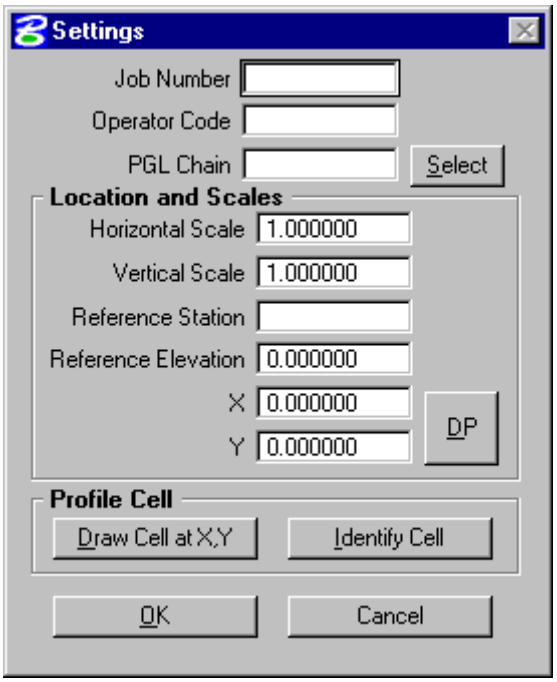
11.2 Definitions

The **Vertical Alignment Generator** is a GEOPAK tool that can graphically create and modify proposed design profiles or modify an existing ground profile. These operations may be accomplished through a dialog box and/or by dynamic manipulation of graphic elements.

A profile may also be created with Coordinate Geometry (COGO) input.

11.3 Accessing

Vertical Alignment Generator may be invoked by **Project Manager >> Vertical Alignment** or by the **Vertical Alignment Generator** icon.

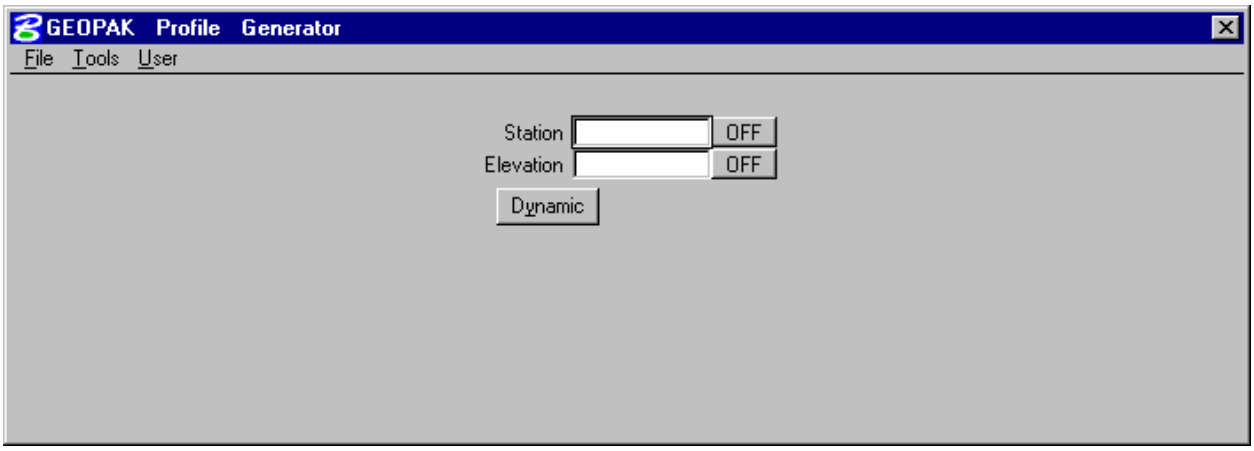


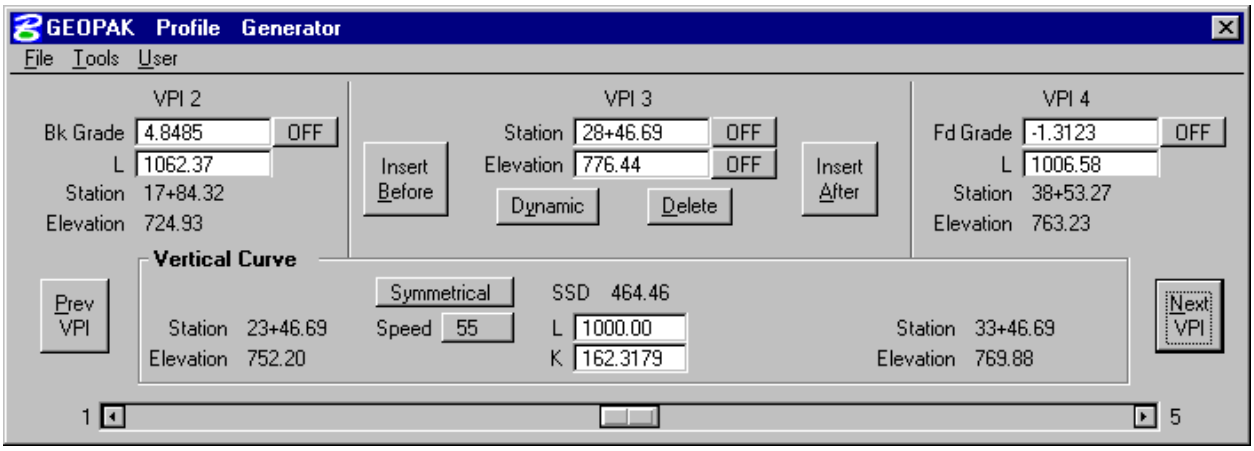
The first dialog box that appears is labeled **Settings**. The entries in this box set the parameters and define the location within the design file where the profile is to be displayed. All fields must be completed before the design process can begin. As the **OK** button is clicked, the Vertical Profile Generator dialog box will appear.

Choosing the **Identify Cell** button and selecting a profile cell can also fill in the information. If a profile cell does not exist, the **Draw Cell at X, Y** can be used to place a profile cell using the location and scale information provided in the dialog.

11.4 Dialog

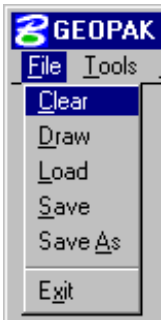
This tool allows a user to load a previously stored profile or create a new profile. You will notice changes in the configuration of this dialog box as you design a vertical alignment.





Various design parameters must be defined prior to designing a new profile; we will discuss those as we look at the options provided under the three headers, **File**, **Tools**, and **User**.

11.4.1 File



Clear - clears the profile display from Microstation graphics and removes all VPI's from the dialog box.

Draw - write the graphic elements of the profile to the Microstation file.

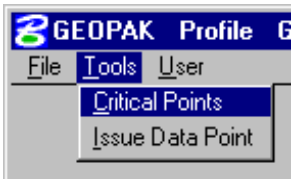
Load - retrieves a previously stored profile from the coordinate geometry database (.gpk)

Save - stores a new profile or updates (redefines) a previously stored profile under the same name.

Save As - is used to store the profile or to save a modified profile under a different name.

Exit - ends the process.

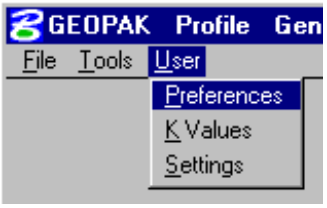
11.4.2 Tools



Critical Points - Vertical curves may also be defined by one or two critical points. If mathematically solvable, the vertical curve will be drawn and the design speed display adjusted to fit the current parameters.

Issue Data Point - Permits the user to type in stations and elevations, issue a data point that can be part of a Microstation place line, place a cell or perform another generic operations. This is useful in displaying visual references within the profile that need to be considered in design of the vertical profile.

11.4.3 User



Preferences - sets the rounding parameters for each of the items listed in the dialog box.

K Values - is a table of stopping sight distance K-values for crest and sag conditions for various design speeds. These values are based on the AASHTO Green Book.

Settings - recalls the **Settings** dialog box that first appeared upon initializing Vertical Layout.

11.5 Creating A New Profile

Step 1 Place the first VPI (Note: The enter key must be used to ensure values are accepted.)
Four options:

i. Type station and elevation of the VPI into dialog box
ii. Enter station of VPI as precision input (type in value) Elevation is defined through dynamic cursor placement on screen
iii. Elevation is defined via precision input Station is defined through dynamic cursor placement on screen
iv. Both values for the VPI can be established dynamically on screen

Step 2 Define ahead (or back tangent)
Station, elevation, grade and length parameters may be defined via precision input, dynamic manipulation or a combination of both.

Step 3 Define remaining VPI's and Grades
A repetition of the process from Step 2 with an option to insert VPI's between two existing VPI' s

Step 4 Define Vertical Curves
Simply define the design speed from the **Speed** option button and GEOPAK will reference the K-value table and draw the vertical curve. If a *curve overlap* occurs,

an overlap message will be displayed in the dialog box along with the overlap length.

Step 5 Adjusting Curve Lengths

The vertical curve can be modified by directly keying in either the K-value, curve length or design speed in the dialog box. You will see the displays in the dialog box automatically adjust to reflect the results of any modifications.

Step 6 Save the Profile

11.6 Precision Placement Options

Options available for creating or modifying vertical curves, VPI's and grade lines:

OFF - Values change.

INC (Increment) - Ensures that the designated profile parameter will be adjusted as defined in the Preferences dialog box.

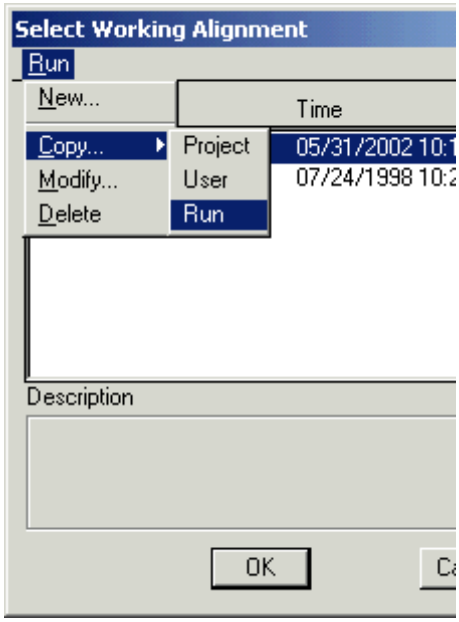
LCK (Locked) - Forces all operations to maintain the designated profile parameters.

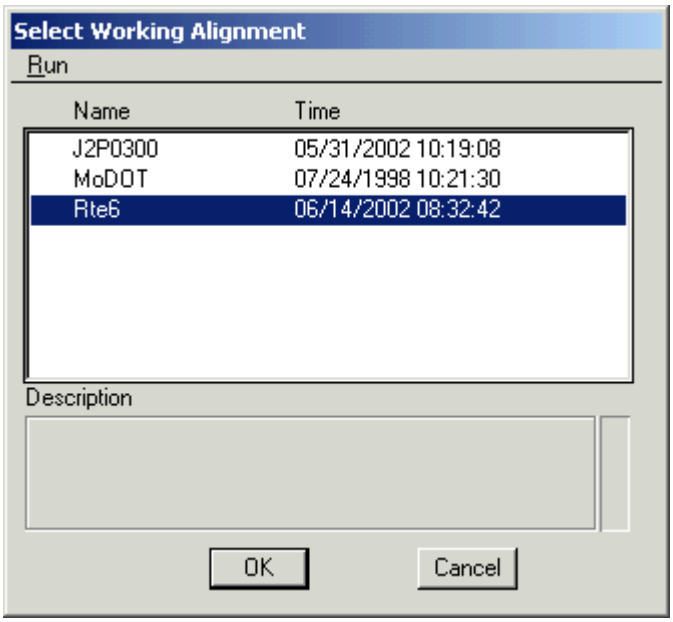
Exercise 11-1 This is a group exercise

1. Open the MicroStation file **t:\br-proj\a_geopak\d2\j2p0300\data\plan_j2p0300.dgn**.

2. Open the project **j2p0300.prj** and enter **Road** as user **userc**.

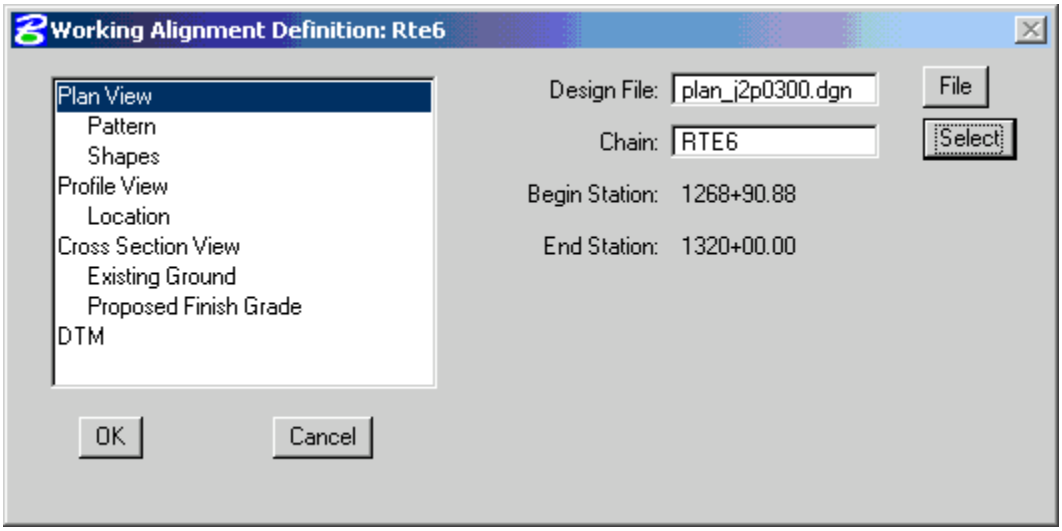
   Copy the J2P0300 working alignment to **Rte6** and enter the Rte6 working alignment.





3. Enter the Rte6 Working Alignment Definition by clicking on **Define** in the Road Project dialog.

   Set the chain to **Rte6** in the Plan View section of the dialog as shown below.

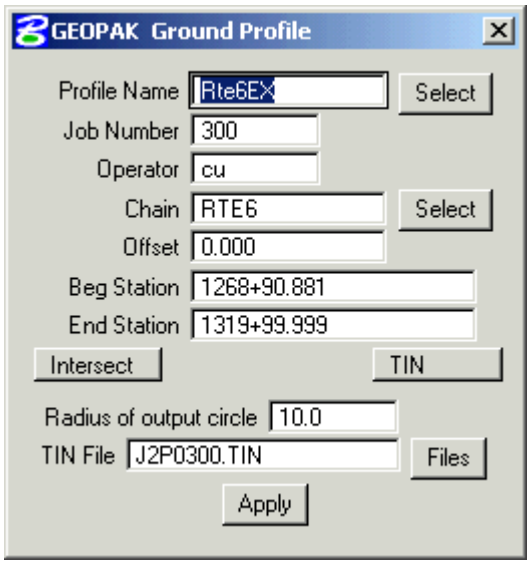


4. Choose **Existing Ground Profile** from the **Road Project** flow chart.

Copy the **MoDOT** run, name the new run **Rte6** and enter the new run.

5. Create an original ground profile for the project.

Profile Name:	**Rte6EX**.
Job Number:	**300**.
Operator:	**cu**.
Chain:	**Rte6**.
Offset:	**0**.
Beg. Station:	*Will be filled in when chain is chosen.*
End Station:	*Will be filled in when chain is chosen.*
Mode:	**Intersect** **TIN**.
TIN File:	**j2p0300.tin**.



6. Open the MicroStation file
t:\br-proj\a_geopak_\d2\j2p0300\data\profile_j2p0300.dgn.

Attach the file **t:\br-proj\a_geopak_\d2\j2p0300\data\plan_j2p0300.dgn** as a reference file, if it is not already attached, and fit the screen.

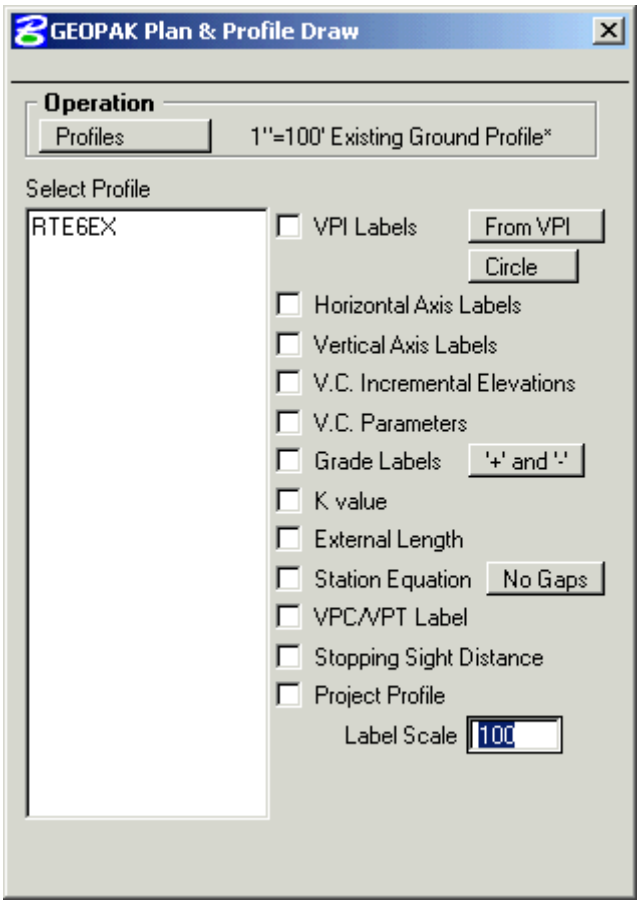
7. Plot the existing ground profile below the plan view geometry using **Design and Computation Manager** item **Drafting Standards \ Profile \ Existing Ground Profiles \ 1”=100’ Existing Ground Profile**.

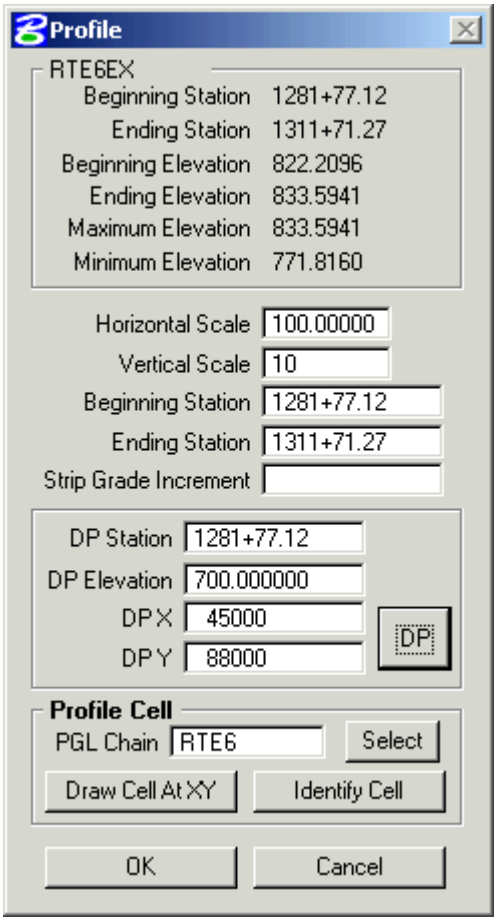
   Be sure all options are turned off, and the **Labeling Scale** is set to **100** as shown below in the figure on the left.

   Choose the profile **Rte6EX**, which will bring up the dialog shown below in the figure on the right.

   Set the following parameters

Horizontal Scale:	**100**
Vertical Scale:	**10**
DP Station:	**1281+77.12**
DP Elevation:	**700**
DP X and Y:	*Press **DP** and data point on the screen in an open area or enter values shown.*
PGL Chain:	**Rte6**

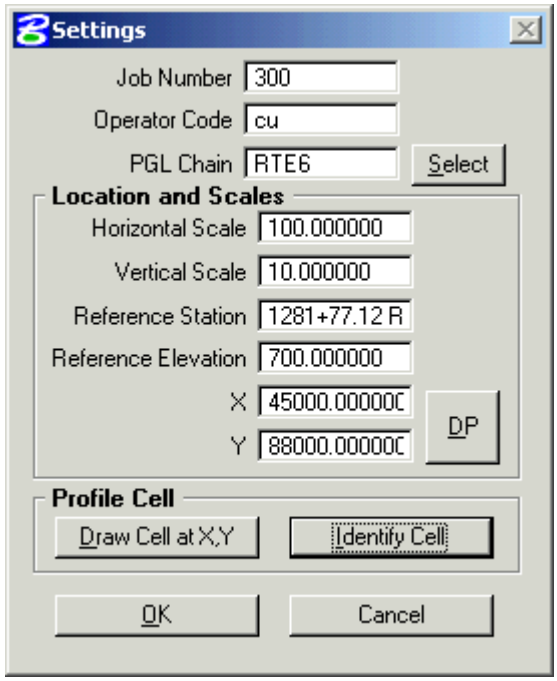




Press **Draw Cell At XY** and **OK** buttons to draw the profile cell and existing ground.

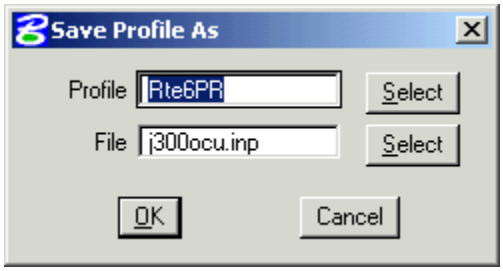
8. Use the **Vertical Alignment Generator** to create the following proposed profile with the given settings.

   With the **Identify Cell** button, choose the profile cell plotted previously. The dialog should fill in as follows.



VPI 1	Sta.:	1281+77.20	Fd Grade:	–6.40		
VPI 2	Sta.:	1285+35.00	Elevation:	799.50	Vertical Curve L:	600
VPI 3	Sta.:	1298+40.00	Elevation:	799.50	Vertical Curve L:	300
VPI 4	Sta.:	1306+80.00	Bk Grade:	–0.01	Vertical Curve L:	660
VPI 5	Sta.:	1311+70.00	Bk Grade:	6.80		

   Save the profile as **Rte6PR**.



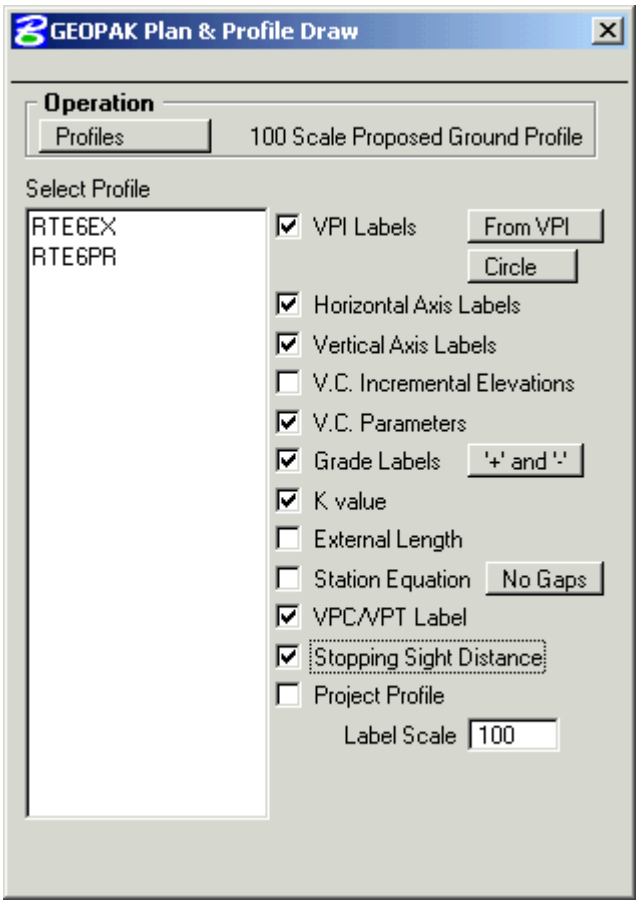
   Exist the Profile Generator. Do not save the profile since it was just stored, but save the vertical alignment settings.

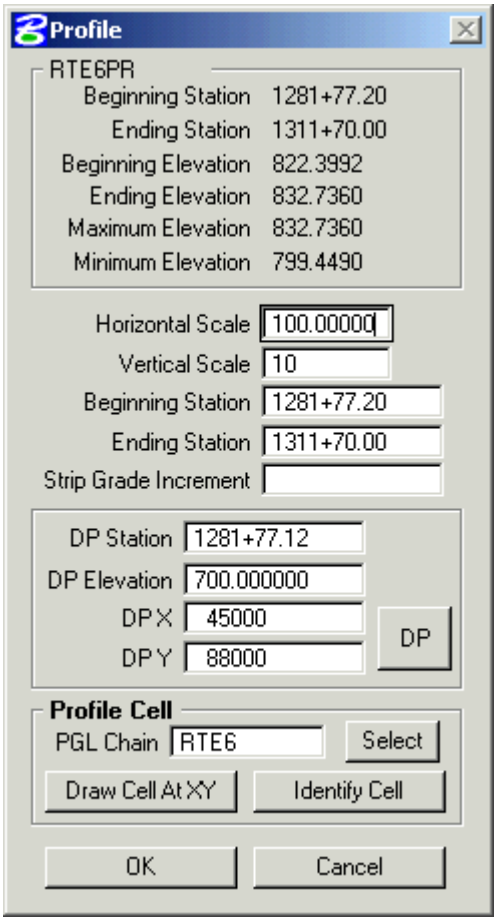
9. Plot the existing ground profile using **Design and Computation Manager** item **Drafting Standards \ Profile \ Proposed Ground Profiles \ 100 Scale Proposed Ground Profile 1”=100’ H & 1”=10’ V**.

   Turn on the following options as depicted below in the figure on the left.

   VPI Labels
   Horizontal Axis Labels
   Vertical Axis Labels
   V.C. Parameters
   Grade Labels
   K Value
   VPC/VPT Label
   Stopping Sight Distance.

   Choose the profile **Rte6PR**, which bring up the dialog shown below in the figure on the right.



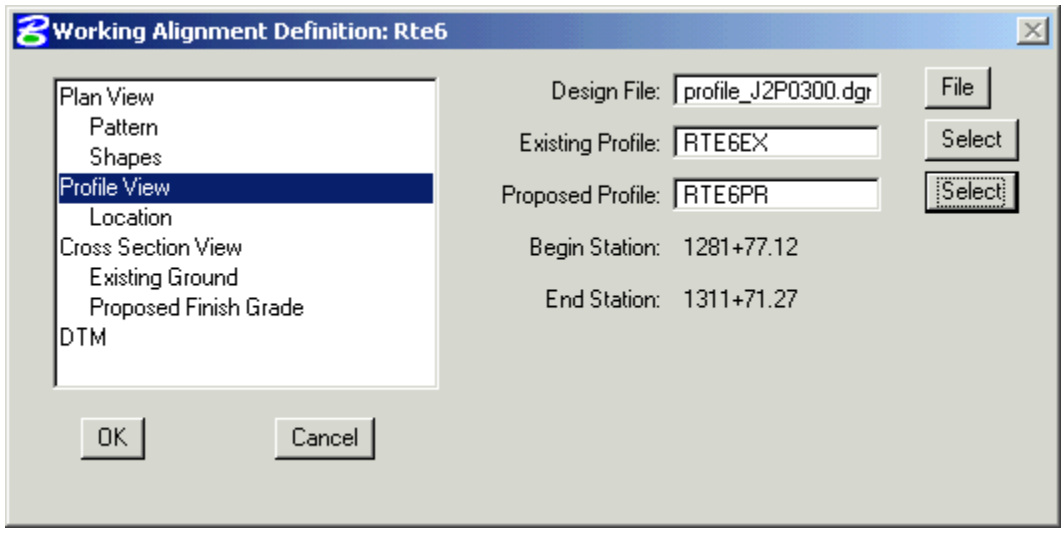


   Use the **Identify Cell** button in the dialog to select the profile cell placed earlier.

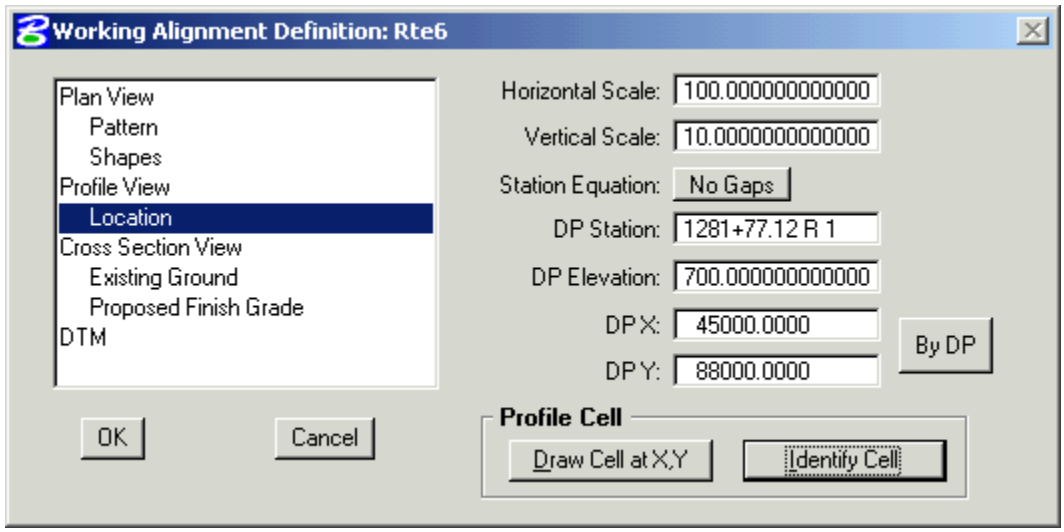
   Plot the profile **Rte6PR** by selecting the **OK** button. Close D&C Manager.

10. Complete the **Profile View** and **Location** sections of the **Rte6 Working Alignment**.

Existing Profile: **Rte6EX**
Proposed Profile: **Rte6PR**



For the **Location** section, use the **Identify Cell** button to choose the profile cell.



Accept the changes by clicking on the **OK** button.

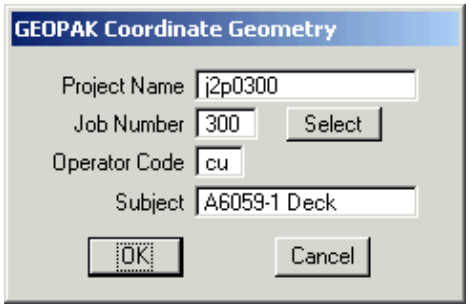
Exercise 11-2

1. Open the MicroStation file **t:\br-proj\a_geopak\d2\j2p0300\data\plan_j2p0300.dgn**.

2. Open the project **j2p0300.prj** and enter **Road** as user **userc**. Select the **Rte6** working alignment.

3. Choose **Coordinate Geometry** from the **Road Project** flow chart.

   Enter Coordinate Geometry with the settings shown to the right:



4. Use Bridge deck commands to find the quarter point elevations for the first span for Bridge A6059.

Bridge Name:	**A6059**.
Profile:	**RTE6PR**.
Tie:	**0**.
Cross Slope	**-2% (Normal Crown)**
Alignment:	**RTE6**.
Pier Direction Rt. to Lt.:	**N 13 56 34 W**.
Back Sta. CL Bearing:	**1288+26.4434**.
Ahead Sta. CL Bearing:	**1288+70.9850**.
Roadway Width:	**36'**.
Beam Spacing:	**8'-2"**.

The needed COGO commands are given below:

```
BRIDGE A6059
PROFILE RTE6PR
TIE 0
SE 1288+00 LT -2 12 -2 RT -2 12 -2
ALI RTE6
PIER BK N 13 56 34 W AH N 13 56 34 W
SPAN 1 128826.4434 128870.9850 4 + P
FC -19.333333 19.333333
GU -18 18
BEAM OFF -16.333333 -8.166667 0 8.166667 16.333333
END SPAN
```

Save the COGO commands (**File >> Same**) as an input file. Name it **59-1** and give it the description: **A6059-1 Deck**.

5. Use Ultra-Edit to view the file:

   t:\br-proj\a_geopak\d2\j2p0300\data\a6059-1.txt.

   Your results should be identical to those shown below. If not, use the COGO Editor (**Edit >> Editor**) to correct your input file. Once it is corrected, do a **Restore/Read**. Save the corrected input file.

```
Bridge Deck Elevation.
----------------------
Bridge A6059
Span A6059-1  1288+26.44 R 1 to 1288+70.99 R 1

           000      001      002      003      004
-----------------------------------------------------
LFC    799.1341 799.1173 799.1133 799.1133 799.1133
LGT    799.1591 799.1433 799.1400 799.1400 799.1400
BM   1 799.1906 799.1758 799.1733 799.1733 799.1733
BM   2 799.3461 799.3369 799.3367 799.3367 799.3367
BM   3 799.5039 799.5000 799.5000 799.5000 799.5000
BM   4 799.3375 799.3367 799.3367 799.3367 799.3367
BM   5 799.1733 799.1733 799.1733 799.1733 799.1733
RGT    799.1400 799.1400 799.1400 799.1400 799.1400
RFC    799.1133 799.1133 799.1133 799.1133 799.1133
PGL    799.5039 799.5000 799.5000 799.5000 799.5000
```

Chapter 12

Plan & Profile Sheets

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12.1 Objectives

- Understand and be able to use the Plan & Profile Sheet Generator

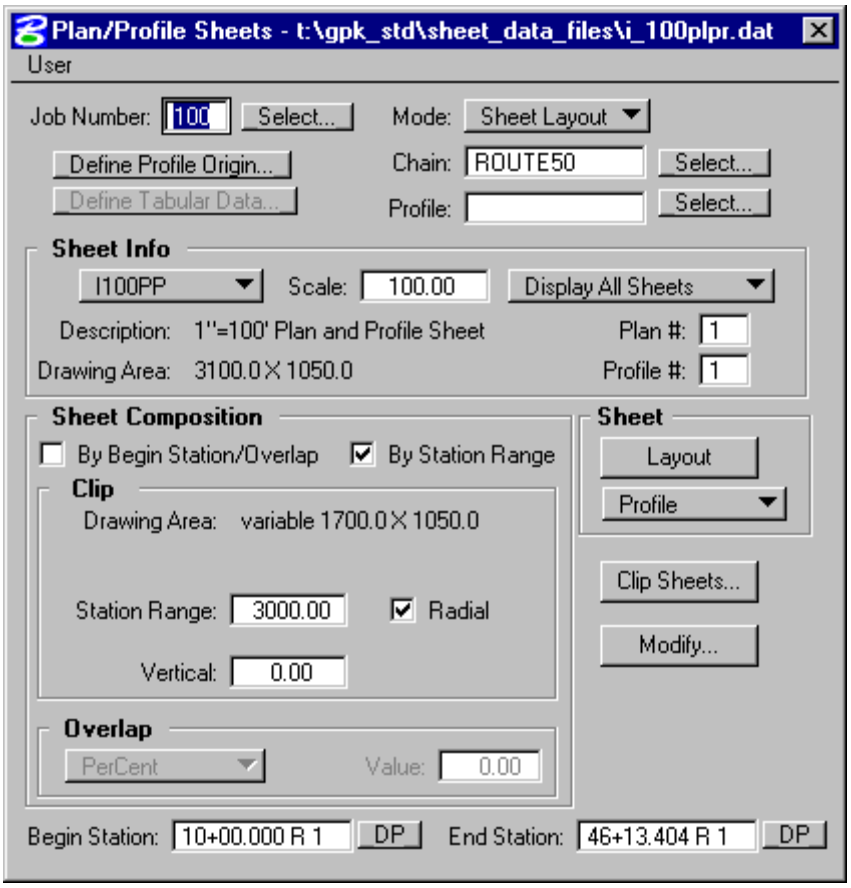
12.2 Definitions

Based on user-defined parameters and sheet size, sheet borders will be placed into a blank design file relative to a specific alignment. Modifications may be made to sheet size and location. Once the sheet boundaries are in the proper location, the designer may then place the sheet(s) into a design file(s) with the appropriate reference files and sheet cell.

The CADD Support Center has set up data files as a basis for generating typical plan and profile sheets. These sample data files include all of the settings that are "***User Definable***" via the Plan and Profile Sheet Preferences dialog box. These settings include the General Settings, Plan Drawing Area, Profile Drawing Area, Grid Settings, Tabular Data, etc.

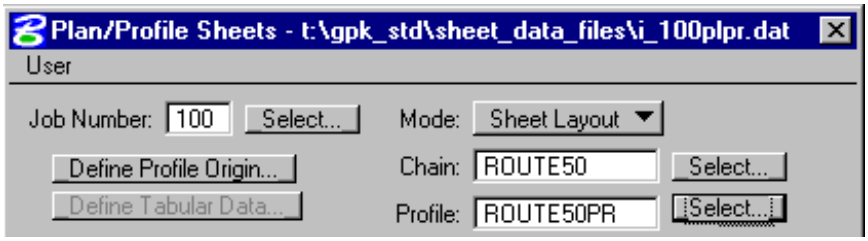
12.3 Accessing

The Plan and Profile Sheets Generator may be invoked via **Project Manager >> Plan and Profile Sheets**. The **Plan & Profile Sheets** dialog appears.

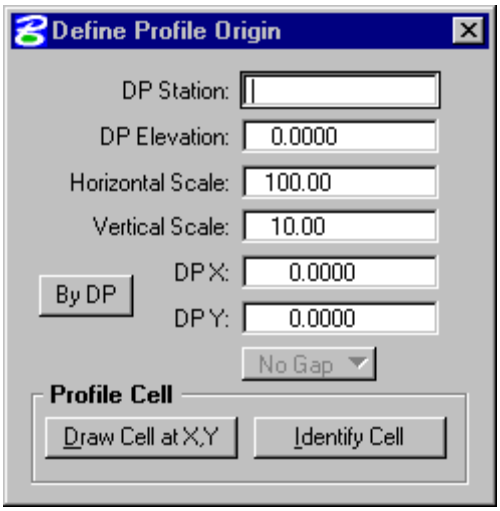


12.4 Plan & Profile Sheet Layout

The user first needs to select the job number, chain name, and profile name to layout the sheets along.



Once the profile is selected, the user needs to reference or plot the profile into the plan sheet. The profile origin needs to be defined by selecting the **Define Profile Origin** button and filling out the dialog box with the proper information.



DP Station – station value of the data point used to define the location of the profile.

DP Elevation – elevation value of the data point used to define the location of the profile.

Horizontal Scale – horizontal scale the profile was plotted at.

Vertical Scale – vertical scale the profile was plotted at.

DP X – the X coordinate of the profile location.

DP Y – the Y coordinate of the profile location.

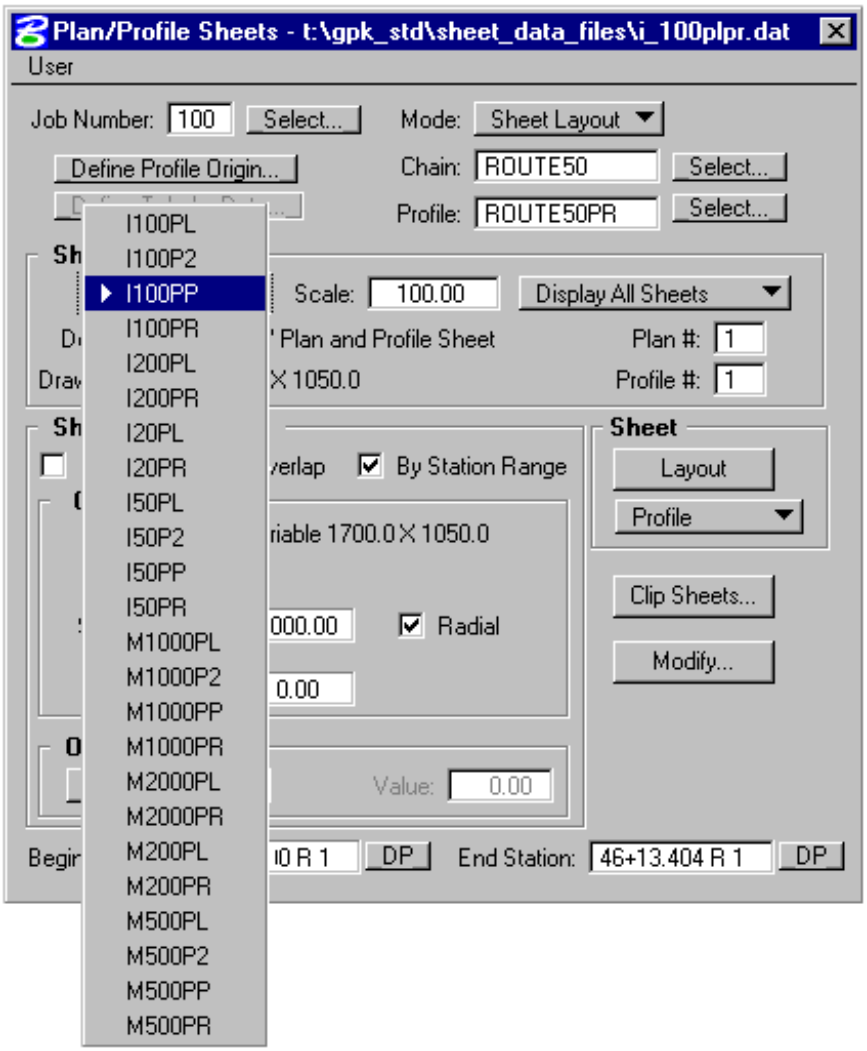
The X and Y coordinates can be selected by choosing the **By DP** button, then selecting the origin point in the drawing file. If the profile has a station equation, the profile can be plotted with gaps or with no gaps.

Choosing the **Identify Cell** button and selecting a profile cell can also fill in the information. If a profile cell does not exist, the **Draw Cell at X, Y** can be used to place a profile cell using the location and scale information provided in the dialog.

The **Beginning Station** and **Ending Station** fields are automatically filled in with the station limits of the chain identified in the upper portion of this dialog box. Should the user want to begin or end at a different location the user has the option to type in the station limits for sheet processing or click the **DP** button and data point a location on the screen along the center line.

12.4.1 Sheet Info

After the chain and profile information has been setup, the user needs to choose the scale and type of sheet to create, and enter the scale value.



From the list, the user needs to select the scale and type of sheets they want to create.

Type	Purpose
I100PL	Creates English Full Plan Sheets 1”=100’
I100P2	Creates English Plan and Plan Sheets 1”=100’
I100PP	Creates English Plan and Profile Sheets 1”=100’
I100PR	Creates English Full Profile Sheets 1”=100’
I200PL	Creates English Full Plan Sheets 1”=200’
I200PR	Creates English Full Profile Sheets 1”=200’
I20PL	Creates English Full Plan Sheets 1”=20’
I20PR	Creates English Full Profile Sheets 1”=20’
I50PL	Creates English Full Plan Sheets 1”=50’
I50P2	Creates English Plan and Plan Sheets 1”=50’

I50PP	Creates English Plan and Profile Sheets 1”=50’
I50PR	Creates English Full Profile Sheets 1”=50’
M1000PL	Creates Metric Full Plan Sheets 1:1000
M1000P2	Creates Metric Plan and Plan Sheets 1:1000
M1000PP	Creates Metric Plan and Profile Sheets 1:000
M1000PR	Creates Metric Full Profile Sheets 1:1000
M2000PL	Creates Metric Full Plan Sheets 1:2000
M2000PR	Creates Metric Full Profile Sheets 1:2000
M200PL	Creates Metric Full Plan Sheets 1:200
M200PR	Creates Metric Full Profile Sheets 1:200
M500PL	Creates Metric Full Plan Sheets 1:500
M500P2	Creates Metric Plan and Plan Sheets 1:500
M500PP	Creates Metric Plan and Profile Sheets 1:500
M500PR	Creates Metric Full Profile Sheets 1:500

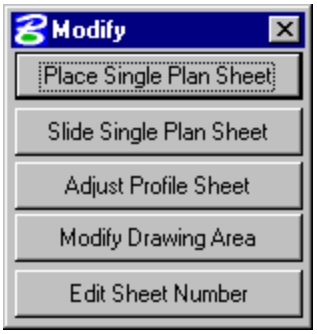
The scale that corresponds to the type of sheet the user chose, needs to be entered into the **Scale** key-in field. The plan number and profile number can be entered into the **Plan #** and **Profile #** fields.

12.4.2 Sheet

Layout - In this mode, sheet borders (not the actual cells) are placed in the master design file based on the Sheet Type selection and the specified alignment and/or profile. The toggle below provides three options for the Layout command.

- **Plan** - Draws the plan clipping area(s) onto a plan sheet
- **Profile** - Draws the profile(s) clipping area(s) onto a plan & profile sheet
- **Plan & Profile** - Draws the Plan & Profile clipping area(s) onto a plan & profile sheet

12.4.3 Modify



Once the above process is complete, the user should review the location of all the sheets. Should any of the sheets need adjusting, the **Modify** mode provides four options for changes in sheet location.

Place Single Sheet - allows the user to manually place one sheet issuing a data point on the screen

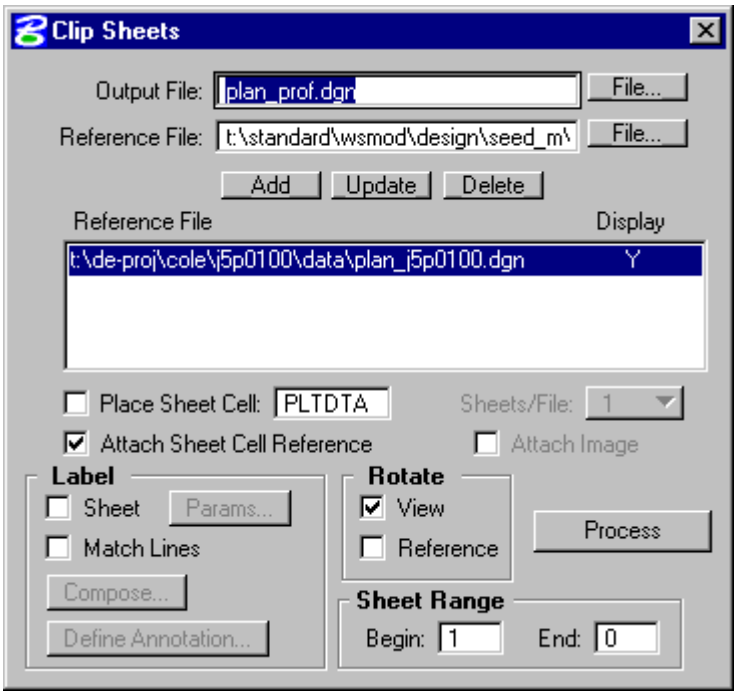
Slide Single Sheet - slides a previously placed sheet along the alignment; adjacent sheets remain in their original location.

Adjust Profile Sheet - allows the user to adjust the location of the profile border(s).

Modify Drawing Area - modifies the Clip borders.

Edit Sheet Number - allows the user to change a previously placed sheet number

12.5 Clip Sheets



Output File - name of design file the sheet(s) will be drawn in. GEOPAK will add a 1, 2, etc. to the end of each file name.

Reference File - name of reference file to be attached to the output design file. After selecting the reference file, the Add button must be clicked in order to add the reference file to the reference list. (Note: the active design file and any files attached to it will automatically be referenced to the output file)

Attach Sheet Cell Reference – attaches the border reference file. (Note: Do not use **Place Sheet Cell**.)

Sheets/File - Indicates how many sheets are drawn per design file. (Note: for **Rotate Reference** only)

Attach Image – attaches a DeCartes image to the plan sheet. (Note: Image Manager must be running at the same time.)

12.5.1 Label

Sheet - places the sheet number, chain name, and angle of rotation next to each sheet.

Match Lines - When selected the **Compose** button becomes un-ghosted.

Compose - will display a dialog box that allows the designer to place text before and after the station label of the match line.

Define Annotation - Allows the user to define a sheet title, sheet number and a project number to be placed on each sheet.

12.5.2 Rotate

View - will attach all reference files and rotate the view to conform to the orientation of the sheet.
This option allows true coordinates for the file. (Note: If **Rotate View** is used, tools such as Plan View Labeler, and DP Station and Offset can still be used.)

Reference - Will rotate each reference file to orient itself with the sheet. (Note: It is suggested to use the **Rotate View** mode.)

12.5.3 Sheet Range

Allows the designer to specify the number of sheets to execute.

12.5.4 Process

When all the information is entered, selecting the **Process** initiates the sheet(s) creation.

Exercise 12-1

This is a group exercise to show how to use the GEOPAK Plan and Profile Sheets tool to create a single plan sheet rotated to the alignment in the area of a stream crossing.

1. Open the MicroStation file **t:\br-proj\a_geopak\d2\j2p0300\data\plan_j2p0300.dgn**. Attach **t:\br-proj\a_geopak_\d2\j2p0300\data\topo_j2p0300.dgn** as a reference file.

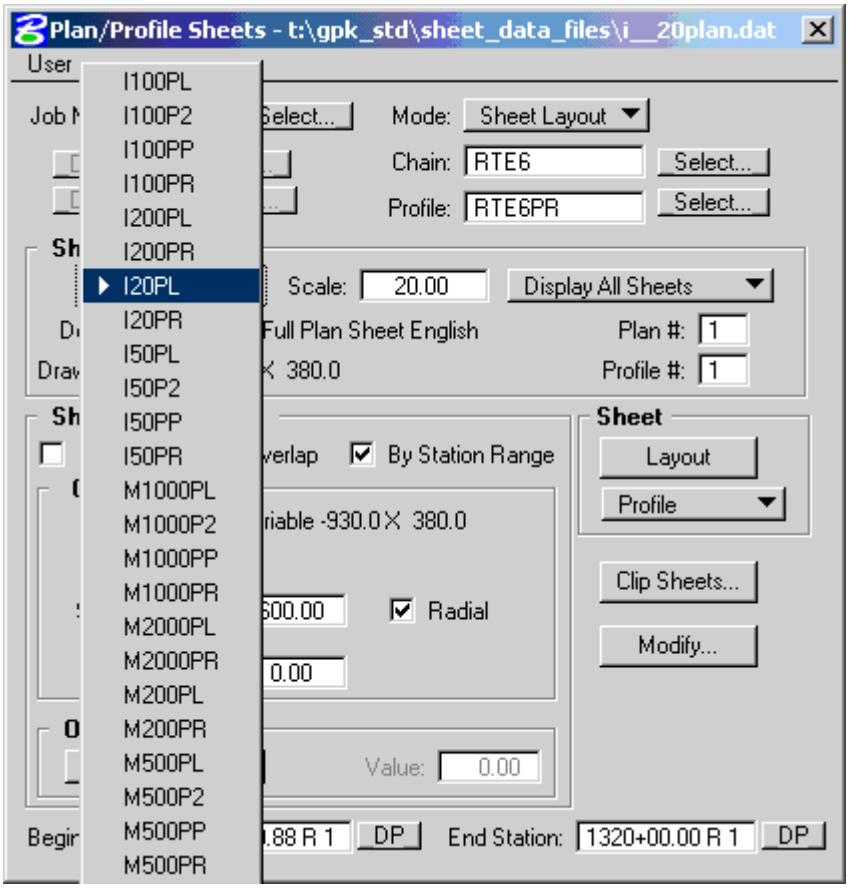
2. Open the project **j2p0300.prj** and enter **Road** as user **userc**. Use the **Rte6** working alignment.

3. Choose **Plan & Profile Sheets** from the **Road Project** flow chart.

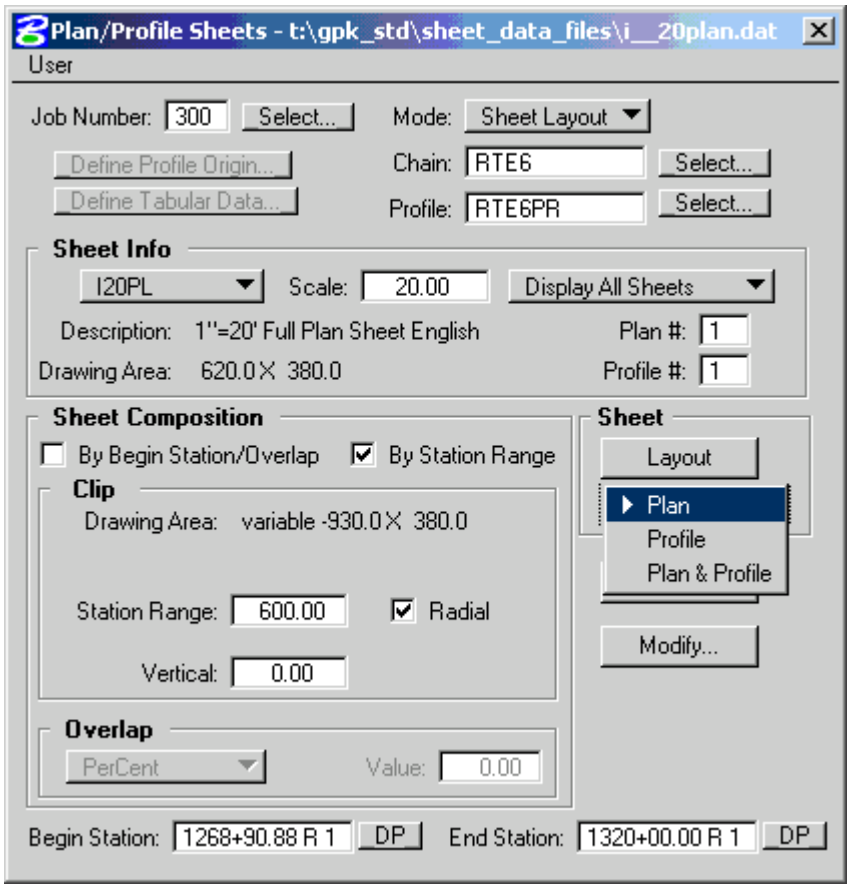
   Plan & Profile Sheets

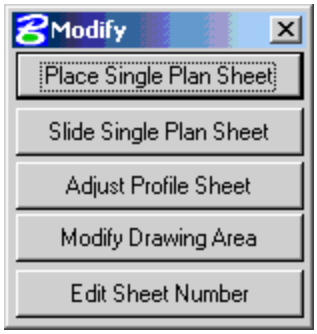
   Copy the **English** run, name the new run **Rte6** and enter the new run.

4. In the **Sheet Info** area of the Plan/Profile change the sheet type to **I20PL**, which is an Imperial 20 scale full plan sheet, and the **Scale** to **20**, as depicted in the following figurre.



5. If a series of full plan sheets were being created, the **Sheet** group would need to be set to **Plan**, as shown in the following dialog.





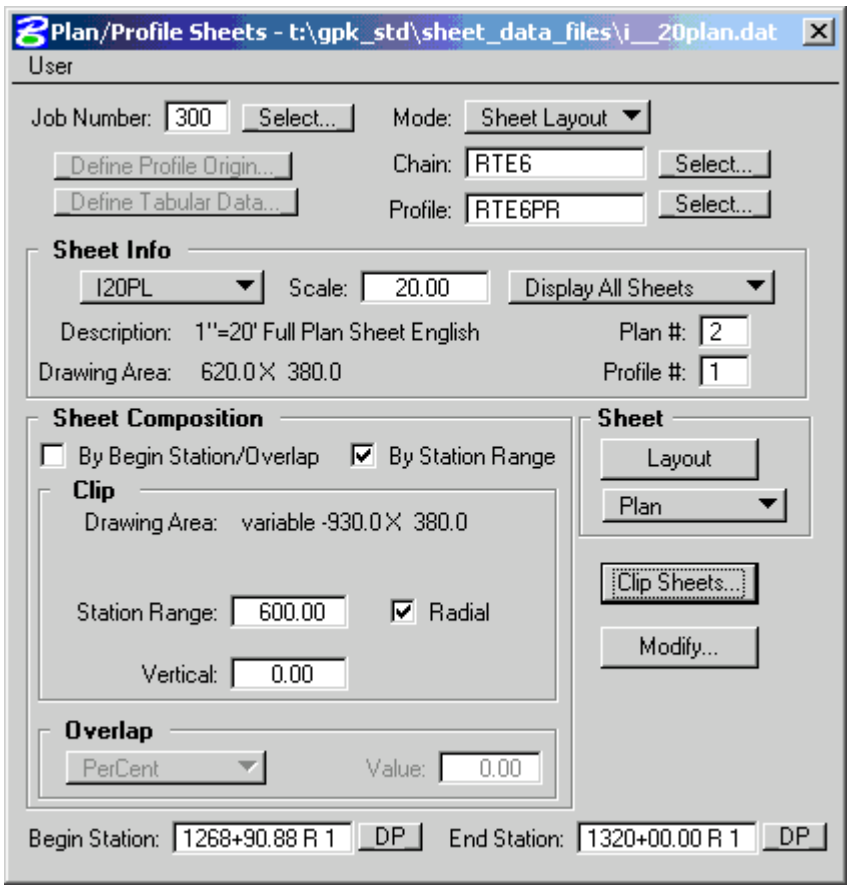
Since a single sheet will be placed, this setting is not important. Instead, click on the **Modify…** button under the Sheet group selection. This will display the Modify dialog shown to the left.

Click on **Place Single Plan Sheet** in the dialog box and move the mouse cursor into the MicroStation window in the area where Route 6 crosses the stream near the middle of the topographical information. Move the mouse until the white box that appears is centered on the stream crossing and data point to accept the sheet's location.

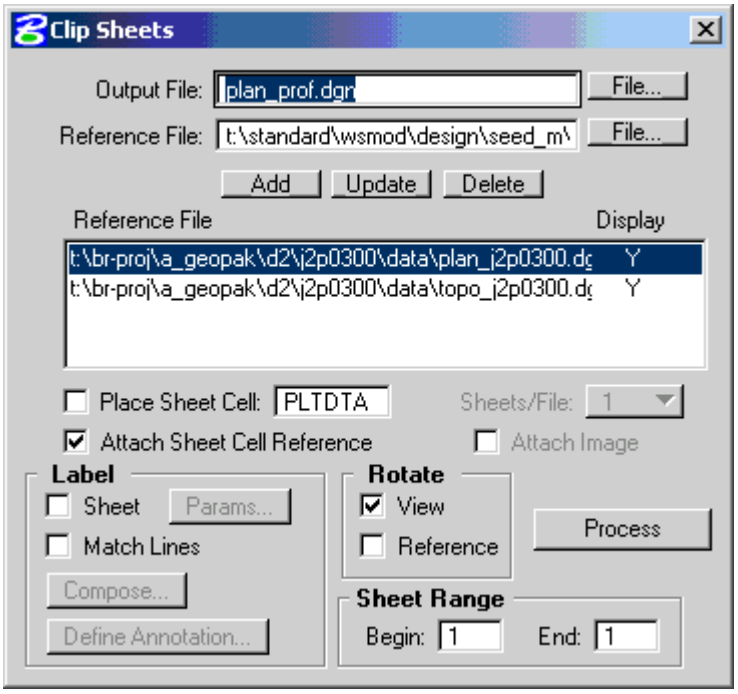
If you need to reposition the sheet, once it is placed, click on **Slide Single Plan Sheet**, which will allow you to reposition the sheet.

Zoom into the area where the sheet was placed. Inside of the white rectangle is a gray dashed line that represents the area that will be clipped and viewed in the sheet file once it is created. This clip boundary can be modified by clicking on **Modify Drawing Area** button and data pointing on one of the corners of the clip boundary. The next data point will locate that corner in a new location. **Close the Modify dialog box**.

6. Save the changes to the MicroStation file. Return to the Plan/Profile Sheets dialog and click on **Clip Sheets**, which is right above the Modify… button.



This will bring up the following **Clip Sheets** dialog, which is okay as it appears. Click on Process to generate the sheets.



The screen will flash and a File is Read Only alert may appear. Accept the alert and a new file will appear called **plan_prof1.dgn**. It is created in the Working Directory. If you had wanted a different name for the file, the other name could have been typed into the **Output File:** field in the **Clip Sheets** dialog.

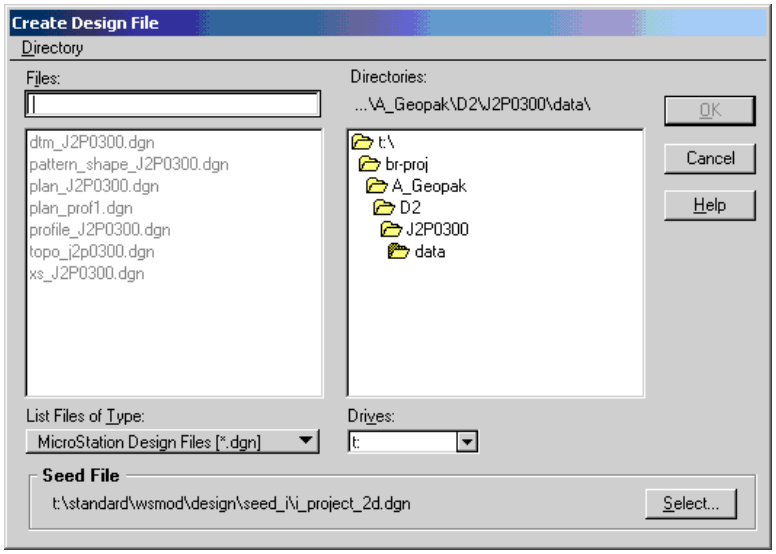
7. Close the Plan/Profile Sheets dialog tool and say **Yes** to **Save Plan/Profile Sheet Settings**. Save the changes to the MicroStation file.

Exercise 12-2

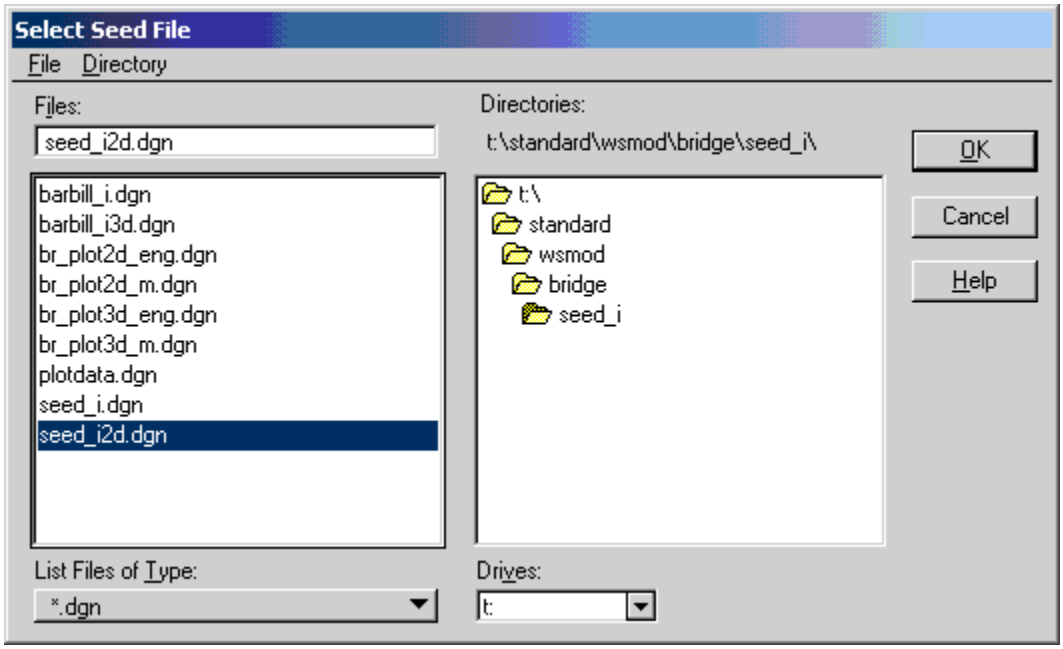
This is a group exercise to show how to create and use a MicroStation drawing with the Bridge working units that will be able to display GEOPAK based on Modified State Plane Coordinates.

1. Open any MicroStation file the **t:\br-proj\a_geopak\d2\j2p0300\data**\ directory.

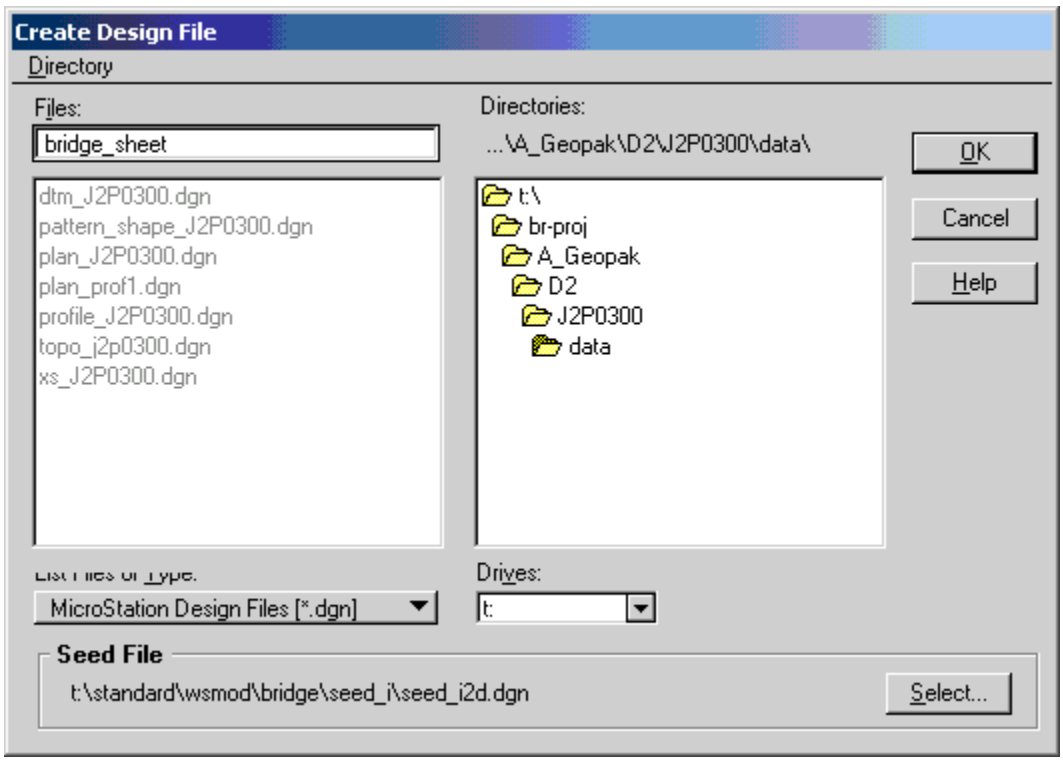
2. From the MicroStation Menu, select **File >New…** This will open the following dialog.



Click on the **Select** button in the lower right hand corner of the dialog to chose a different seed file. In the dialog that appears, navigate to **t:\standard\wsmod\bridge\seed_i**\ and select **seed_i2d.dgn** as the seed file, a shown below. Click **OK** in that dialog.



3. Name the new file **bridge_sheet** in the **Create Design File** dialog shown below.

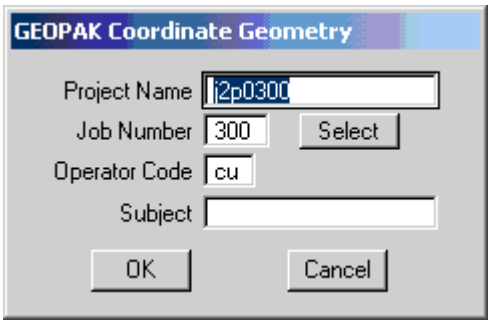


Click OK to create the new DGN.

4. Go to **Applications > GEOPAK Road > User Preferences** and clear out the **Working Directory**.

   The global origin for the file needs to be set to match the coordinates of the project. The best way to do this is to find the southwest most point for the project. This point can be determined from **either** the alignment or the TIN information. Both methods are shown here since on method may work better than the other for a specific project.

   To find the point from the alignment information, do into COGO and describe the alignment chain. For this example, enter COGO with the following information:



5. In COGO, go to **Element > Chain > Describe/List/Print**. The dialog pictured to the right will appear. Highlight the **RTE6** chain in the dialog and click on **Describe**, as shown to the right.

The chain description as output to COGO and saved in a text file is reproduced below:

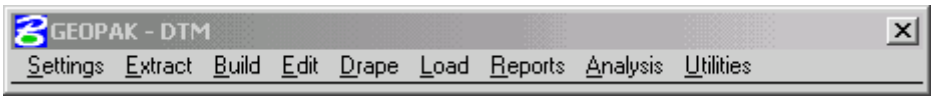
```
Chain RTE6 contains:

 601 CUR RTE6-1 604

Beginning chain RTE6 description
================================================================

Point 601     X 45,417.17  Y 90,893.15  Sta 1268+90.88

Course from 601 to PC RTE6-1  N 80^ 36' 26.00" E  Dist 121.69

                           Curve Data
                          *----------*
Curve RTE6-1
P.I.   Station 1278+75.13  X 46,388.23  Y 91,053.78
Delta     = 25^ 27' 00.00" (RT)
Degree    =  1^ 30' 00.00"
Tangent   =        862.56
Length    =      1,696.67
Radius    =      3,819.72
External  =         96.18
Long Chord=      1,682.75
Mid. Ord. =         93.82
P.C.   Station 1270+12.57  X 45,537.23  Y 90,913.01
P.T.   Station 1287+09.24  X 47,217.14  Y 90,815.20
C.C.                       X 46,160.61  Y 87,144.50
Back        = N  80^ 36' 26.00" E
Ahead       = S  73^ 56' 34.00" E
Chord Bear  = S  86^ 40' 04.00" E

Course from PT RTE6-1 to 604  S 73^ 56' 34.00" E Dist 3,290.76

Point 604     X 50,379.51  Y 89,904.98  Sta 1320+00.00
```

Point **601** has the minimum **X = 45,417.1720**.
CC RTE6-1 has the minimum **Y = 87,144.50**.

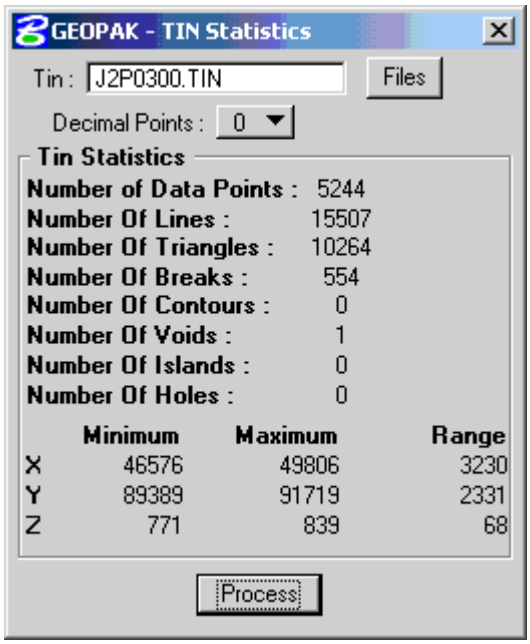
6. To find the minimum X and Y from the TIN, go into the DTM Tools by clicking on the raised icon depicted to the right.

Go into the J2P0300 run, if you are in Project Manager; otherwise, the DTM tools will be displayed outside of a run.

From the DTM menu, shown below, select **Reports > Triangle Statistics**.



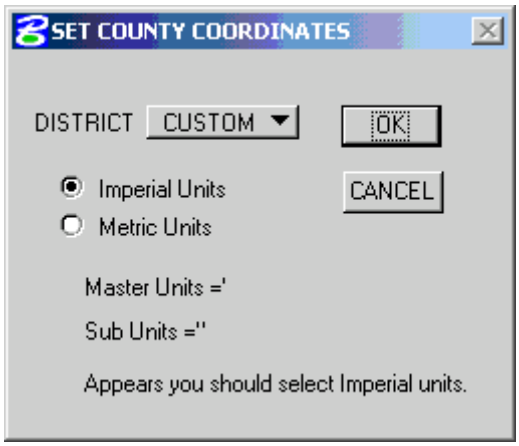
Process the TIN Statistics for the J2P0300.TIN, as shown below.

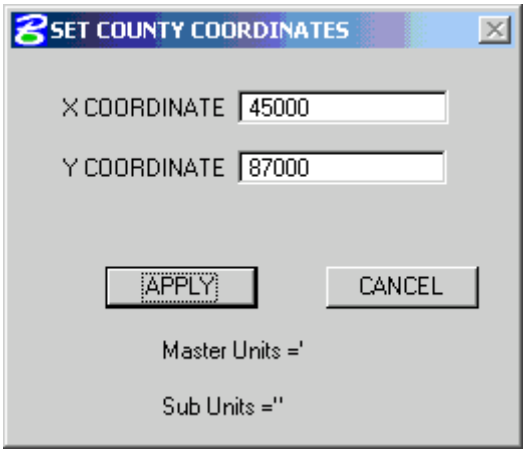


For the **TIN**, the **minimum X = 46,576** and the **minimum Y = 89,389**. Since these values are greater than the ones for the alignment, the values for the alignment control. The global origin for the file will be set at the rounded down vales of:

X = 45,000
Y = 87,000

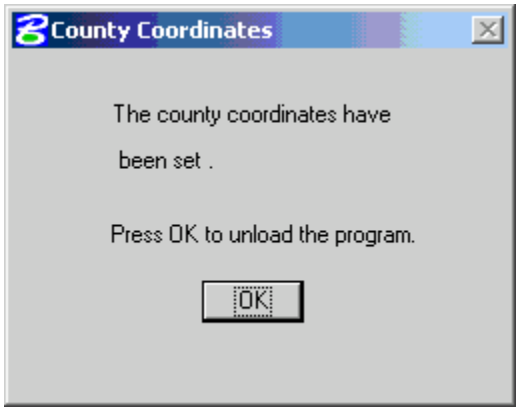
7. Set the origin for the drawing by going to MicroStation menu **MoDOT > Tools > Set County Coordinates**. In the Set County Coordinates, leave the DISTRICT set to **CUSTOM**, **Imperial Units** and click **OK**, as shown below in the figure on the left.





This will display the next dialog, which is shown above in the figure on the right. Set the **X COORDINATE to 45000** and the **Y to 87000** as shown and click **APPLY**.

When the new origin is set, the follow dialog appears. Click **OK**.

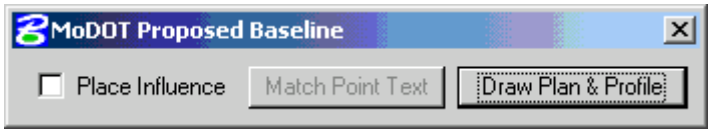


The drawing is ready for plotting information for the project. To demonstrate this, the alignment and the stationing will be plotted. Since the process for placing a border is unique because of using a drawing with Bridge working units in the Design workspace, this will be demonstrated as well.

8. Open D&C Manager and select the item:

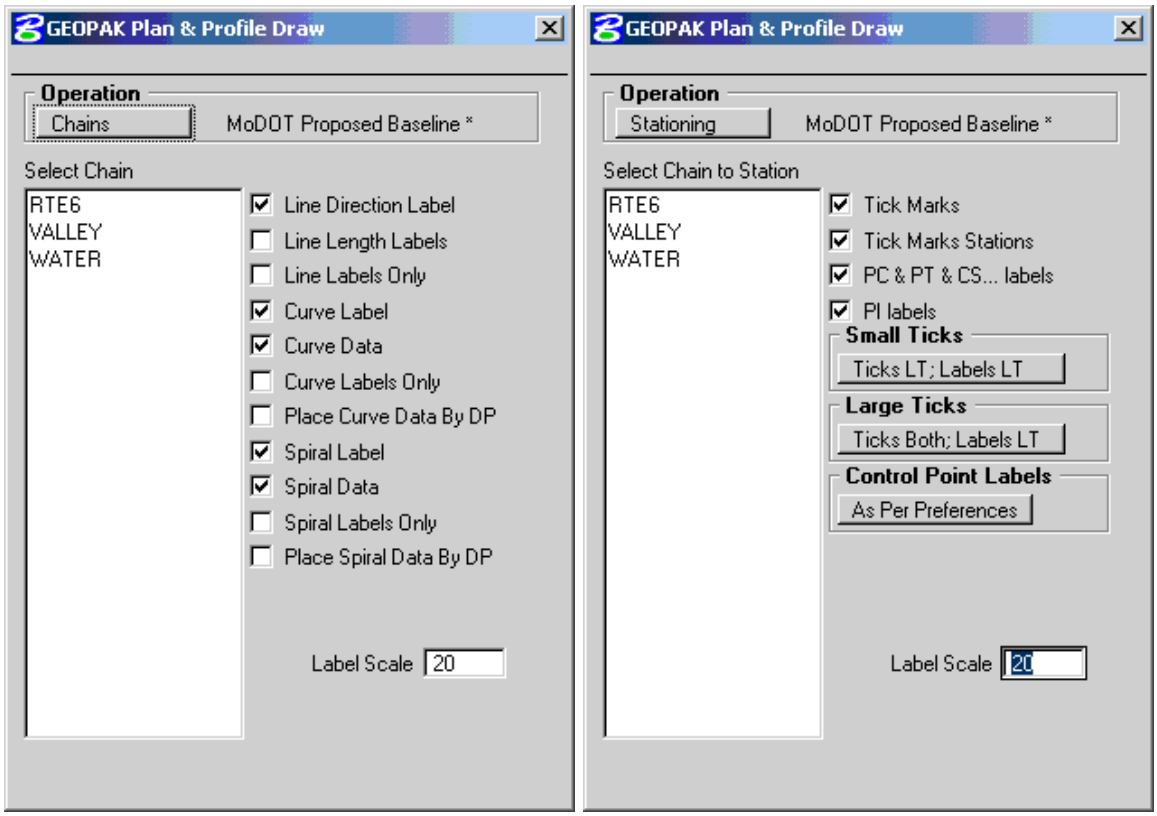
Drafting Standards \ Plan \ Alignments \ MoDOT Proposed Baseline.

Make sure that Place Influence is unchecked, as shown below, and click on **Draw Plan & Profile**.



If asked, select **Job 300**.

Set the **Operation** to **Chains** and the **Label Scale to 20**, as shown below in the figure on the left and click ONCE on **RTE6**. Do a MicroStation **Fit View**. Change the operation to **Stationing** and make sure that Large Ticks is set to **Ticks Both; Labels LT** and click ONCE on **RTE6**.

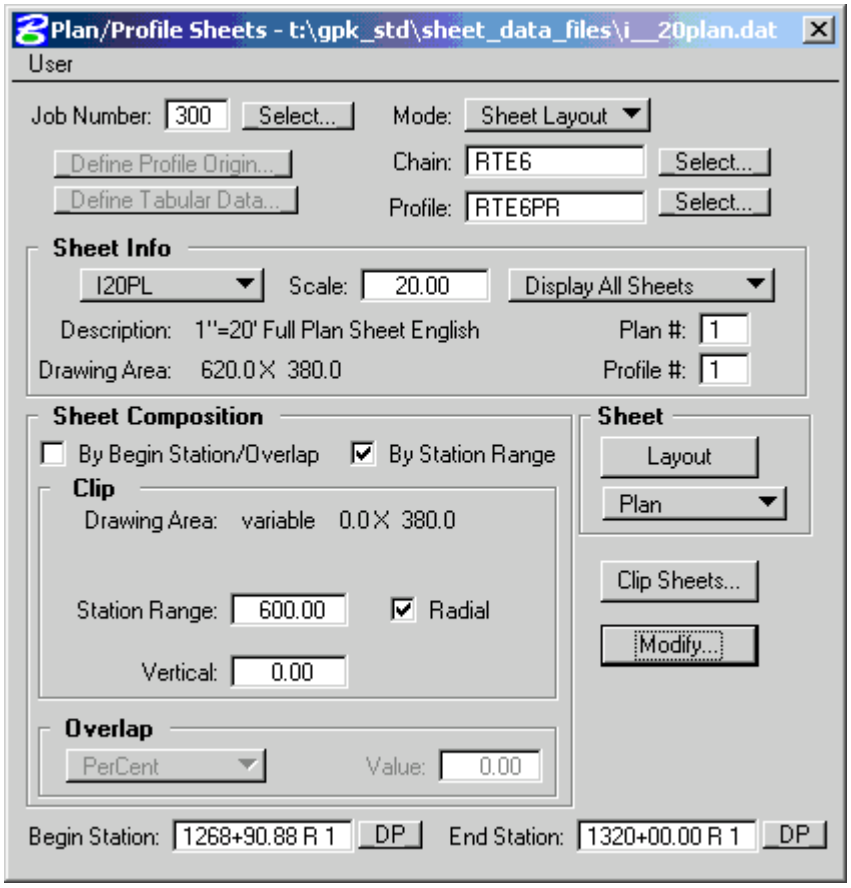


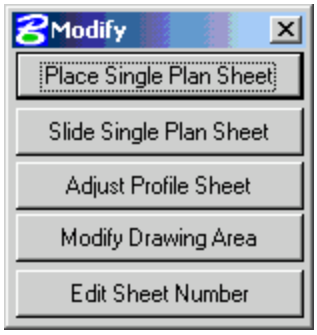
Close D&C Manager and window in on Station 1295+00, which is the second major label after the curve. Save changes to the MicroStation file.

9. Choose **Plan & Profile Sheets** from the **Road Project** flow chart.

Reenter the **Rte6** run since the same size will be cut as before.

10. Check if the settings match those shown in the following figure. Make any need corrections.





When the settings are verified, click on **Modify…**, which is the active button in the above figure. This will display the Modify dialog shown to the left.

Click on **Place Single Plan Sheet** in the dialog box and move the mouse cursor into the MicroStation window. Slide the white box that appears along the alignment until it is **center on Sta. 1295+00** and data point to accept the sheet's location. (Note: Only the digits to the left of the "+" are plotted in the drawing.)

If you need to reposition the sheet, once it is placed, click on **Slide Single Plan Sheet**, which will allow you to reposition the sheet.

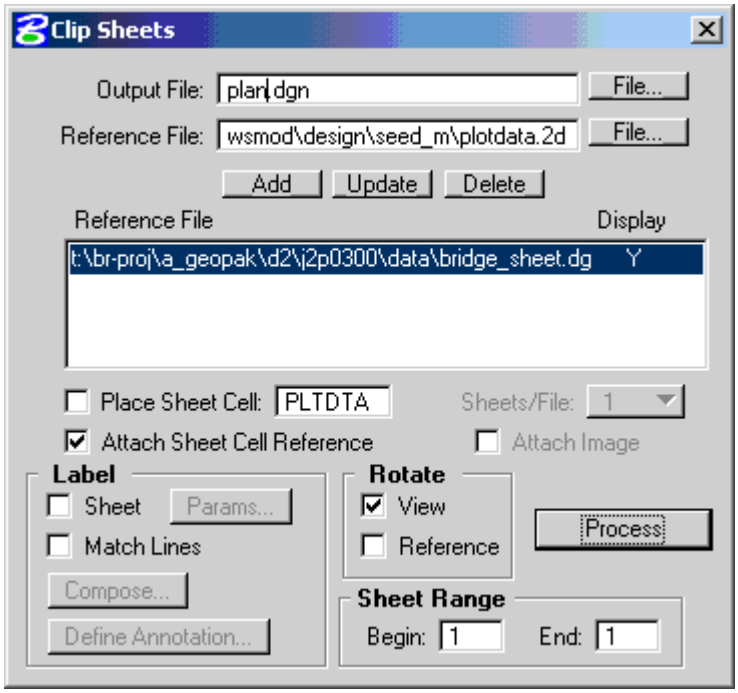
Once the sheet is positioned where you want it, close the Modify dialog box.

11. Save the changes to the MicroStation file.

Return to the Plan/Profile Sheets dialog and click on **Clip Sheets**, which is right above the Modify… button.

12. This will bring up the following **Clip Sheets** dialog

Change the Output File: to plan.dgn, as shown below.



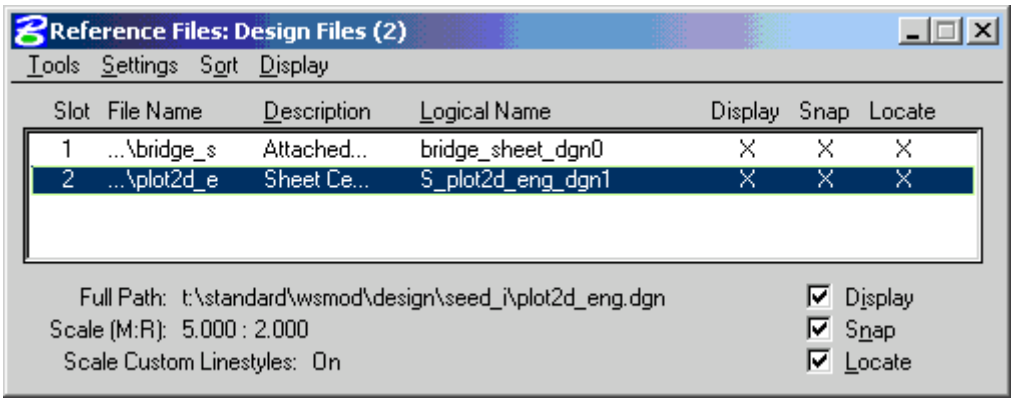
Click on **Process** to generate the sheets.

Once the new file is opened, close the Clip Sheets and Plan/Profile Sheets dialogs.

13. Because working units for an English Bridge seed file are 8 times smaller than a English Design file (the ratio is 12:1 for a metric file), the border is only 1/8 of the needed size.

Adjust the border size by scaling the border file. To do this, open the MicroStation References Files dialog box (Files > Reference).

Highlight the border file as show in the following figure.



13 (continued)

In the Reference File dialog go to **Tools > Scale…** to display the **Scale Reference File** tool depicted below.

Currently, the Scale (Master:Ref) is 5:2. Increase the Master scale by a factor of 8 to 40 as shown below

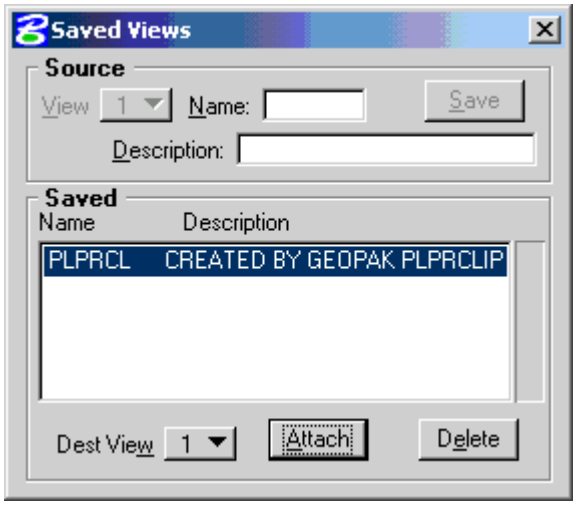
In the lower left hand corner of the screen, the MicroStation prompt is:

"Scale Reference File > Enter point to scale ref file about."

If your border is centered on station 1295+00, snap to the tick mark at that location and accept the snap; otherwise, data point near the center of the border. (Note: prior to scaling the border, a temporary MicroStation element could be place to provide a snap point at the center of the boarder.)

Other Reference File Tools could be used to move reposition the border or to adjust the view are for the bridge_sheet.dgn referenced file.

Since the coordinates of the bridge_sheet.dgn match those of the current file (plan1.dgn), **DO NOT** move, scale, or rotate the bridge_sheet.dgn or else the items plotted will not have real world coordinates. In order that the alignment run from left to right, the view of the file has been rotated. Consequently, east is not necessarily to the right.



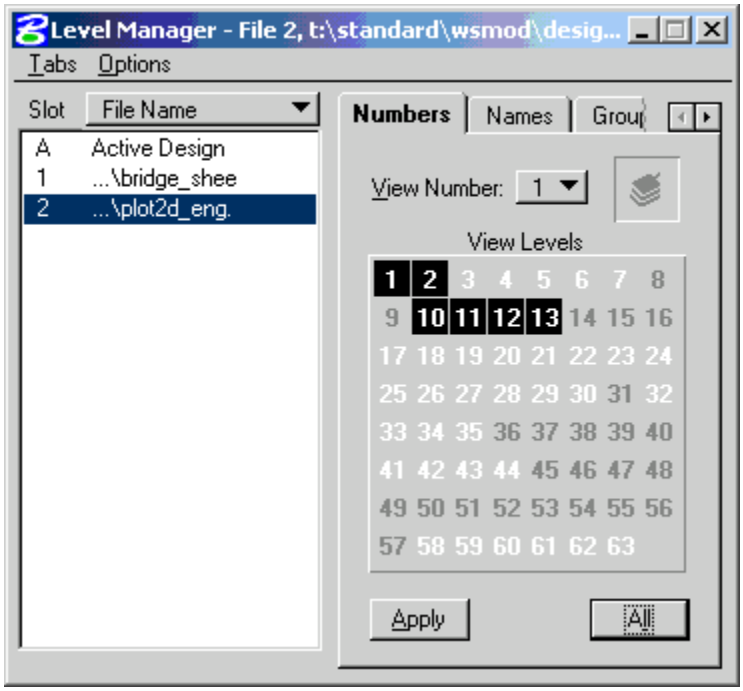
If the view becomes unrotated, attaching the saved view created by GEOPAK will restore the rotated view. To do this, go to MicroStation pull down menu **Utilities > Saved Views**.

When the Saved Views dialog appears, which is shown to the left, select the **PLPRCL** saved view and click on **Attach**.

Do a MicroStation **Fit View** to complete the view restoration.

The saved view was generated as part of the plan and profile clip sheet process.

14. Open the MicroStation Level Manager (**Settings > Level > Manager**). Select the border file in the left part of the dialog as shown below. Levels 1-2 and 10-13 are displayed by default, as noted in the figure.



The title block in the upper corner of the border file is on level 2. **Turn off level 2**. Since the bridge id block is on level 7, **turn on level 7**.

Close Level Manager and save the changes to the MicroStation file.

Chapter 13

Original Ground Cross Sections

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13.2 Definitions 13-1
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13.1 Objectives

To generate original ground cross-sections based on a DTM, and to use the **Cross-section Navigator** tools.

13.2 Definitions

Geopak uses topographic elements to generate original cross sections. These include breaklines and spot elevations. GEOPAK can access and read this data from several basic data formats:

- Field Notes
- RDS cross sections
- DTMs based on Photogrammetric Mapping
- DTMs based on survey information

Of these basic formats, MoDOT primarily uses data from DTM's for generating existing ground cross sections.

13.3 Accessing

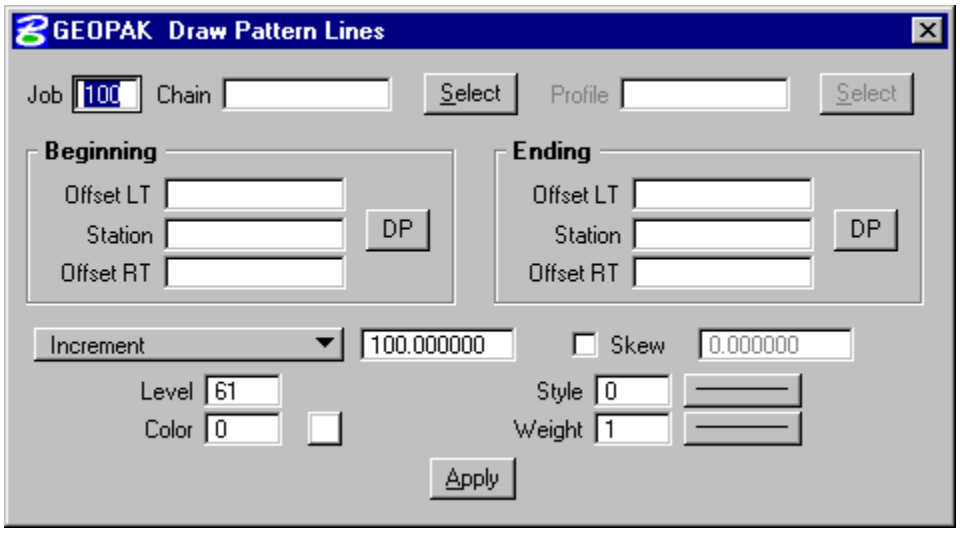
To access the **Draw Pattern Lines** dialog box, go to **Project Manager >> Draw Pattern** or choose the **Draw Pattern** icon.

To access the **Existing Ground Cross Sections** dialog box, go to **Project Manager >> Existing Ground Cross Sections**, or choose the **Existing Ground Cross Sections** icon.

13.4 Pattern Lines

Pattern Lines identify the location of the cross sections. Pattern lines are either a line or a line string drawn into a Microstation drawing. The lines are most commonly drawn using the Microstation Place Line or Place Smartline tools, or by the Geopak **Draw Pattern Line** dialog. The **Draw Pattern Line** dialog allows the user to easily place pattern lines at even intervals, and key alignment locations. The Microstation tools are generally used for specialty sections, such as an existing culvert location, or kinked sections.

From the **Project Manager** select **Draw Pattern**, and choose the run. The following dialog box will appear.



The user selects the **Job Number** and the **Chain** along which to draw the pattern lines. The **Offset LT** and **Offset RT** determine how far from the chain the pattern line is to be drawn, and the **Beginning** and **Ending Stations** determine the station range for which to plot the pattern lines.

Six methods are allowed for drawing the pattern lines.

Increment – starts at the beginning station, and draws a pattern line at the given increment (i.e. for a 100 foot increment on a chain starting at 10+17, pattern lines will be drawn at 10+17, 11+17, 12+17, …)

Even – draws pattern lines at stations divisible by the given value (i.e. for a 100 foot even interval on a chain starting at 10+17, pattern lines will be drawn at 11+00, 12+00, 13+00, …)

Once – draws a pattern line at a given station. (Only the beginning station is active.)

Critical Points - Horizontal – draws a pattern line at each of the critical points (i.e. POT, PC, PT, etc.) within a chain.

Critical Points - Vertical – draws a pattern line at each of the critical points (i.e. VPC, VPT, and high or low point) within a profile.

Superelevation Transitions – draws pattern lines at the beginning and ending of each superelevation shape drawn in the current Microstation file, and any attached reference files. (Locations that are coincident with the horizontal control points are not drawn.)

The cross section **skew** can be set using the **skew** toggle. The pattern line is skewed by the specified angle from the standard pattern line (perpendicular to the baseline). A positive skew

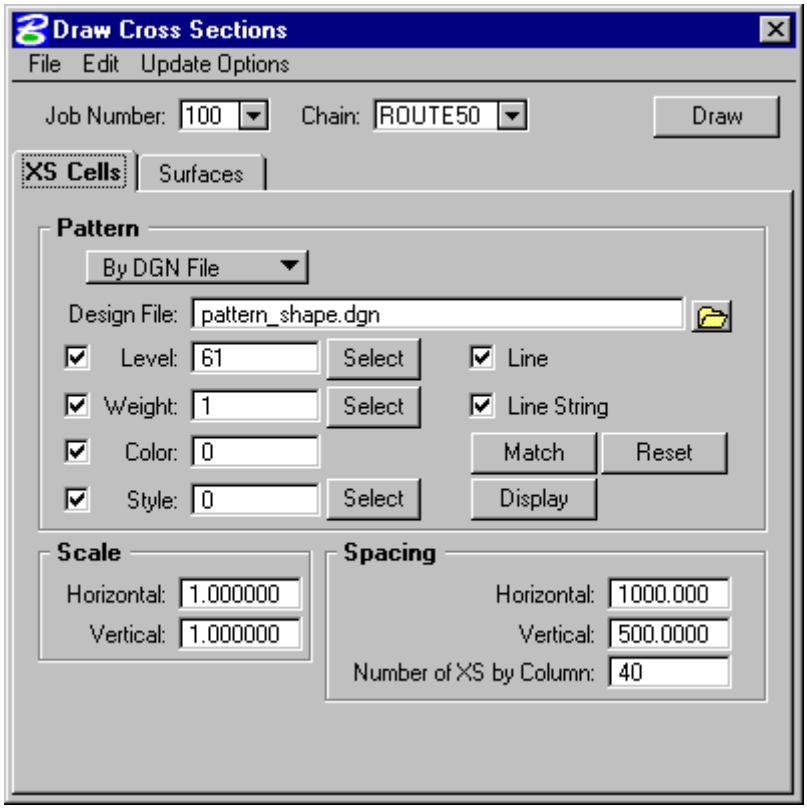
angle will rotate the pattern line clockwise, and a negative skew angle will rotate the pattern line counter-clockwise.

Once all the key-in fields have been completed and the **Apply** button is selected the pattern lines are drawn along the chain into the open Microstation design file (on the specified level, color and style). This is a visual representation of the location of the cross sections to be generated.

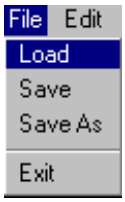
The user can use the Microstation **Place Smartline**, or **Place Line** command to draw additional pattern lines as needed.

13.5 Processing the Existing Ground Sections

Once the pattern lines have been drawn the cross-sections can be processed. To process the cross-sections, go to **Project Manager >> Existing Ground Cross Sections**, or choose the **Existing Ground Cross Sections** icon. After the run is chosen, the dialog box below will appear.

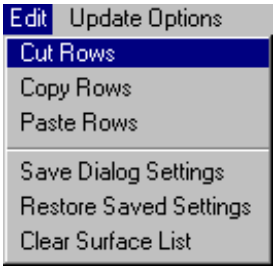


13.5.1 File Menu



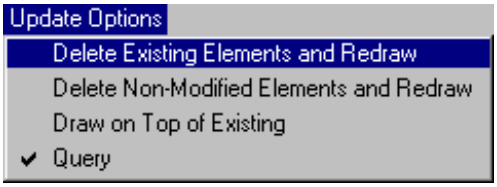
The **File** menu allows the user to save the dialog settings for each chain. The user sets the parameters for each chain, and then selects **File>>Save**. The next time the user accesses this dialog, the current information is completed from the resource files. The user can select **File>>Load** to access the previously saved settings. As the user switches between chains, the dialog settings will change according to how the user saved them. The Project Manager run also performs the same functionality.

13.5.2 Edit Menu



The **Edit** menu allows the user to **Cut**, **Copy**, and **Paste** rows from the **Surfaces** tab. **Save Dialog Settings** will save the information in the dialog box to the resource file. **Restore Saved Settings** will restore the dialog settings from the resource file. (If the resource file is deleted, these settings will be lost and cannot be restored.) The **Clear Surface List** option will clear all surface options from the current list.

13.5.3 Update Options Menu



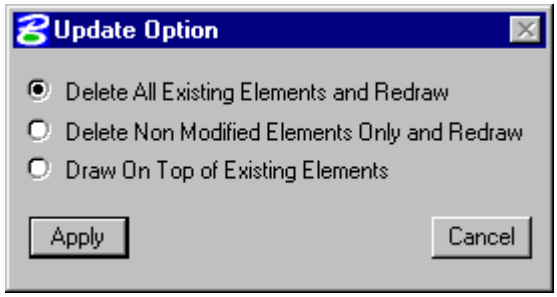
The **Update Options** dialog determines how previously cut original ground section elements will be handled when drawing new original ground section elements on the same cross section cells.

Delete Existing Elements and Redraw – any existing ground lines previously drawn with this tool are deleted and new ground lines are drawn.

Delete Non-Modified Elements and Redraw – only the existing ground lines previously drawn with this tool that have not been modified are deleted and new ground lines are redrawn. Lines that have been modified are left intact.

Draw on Top of Existing – the previously drawn existing ground lines are ignored, and new lines are drawn. This will result in two sets of lines.

Query – brings up the following dialog when the **Draw** button is pressed. The user can choose which option to use.



13.5.4 Job Number

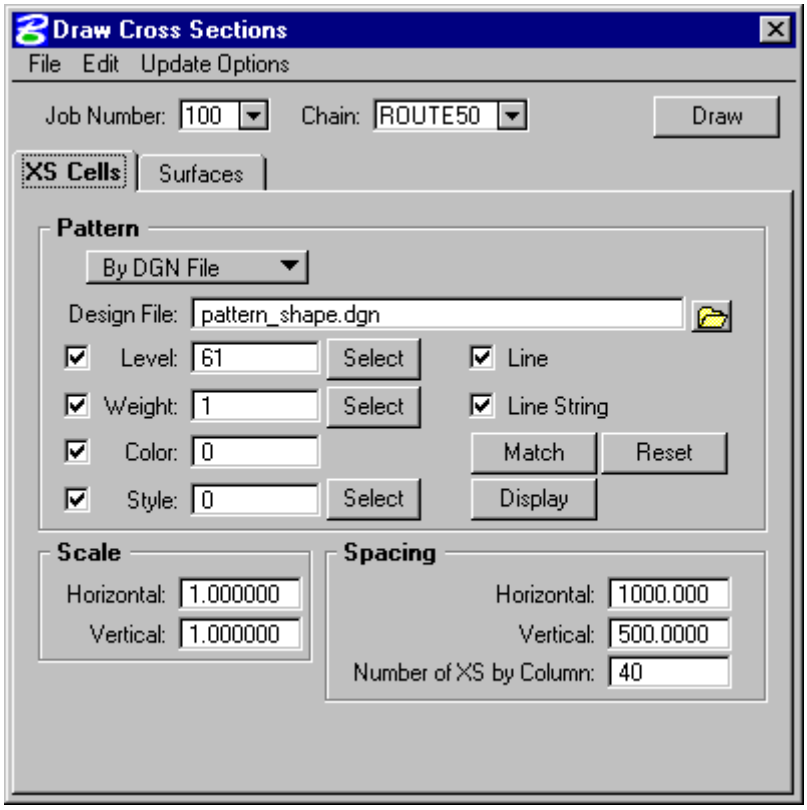
The user must specify the job number that contains the chain on which to base the cross sections. The drop-down arrow will display the .gpk files available in the working directory.

13.5.5 Chain

The user must specify the baseline to be used for the cross sections. The drop-down chain will display the chains available in the specified job number.

13.5.6 XS Cells

The **XS Cells** tab allows the user to determine where each cross section is to be drawn.



Three options are available in the **Pattern** section to determine the location of the cross sections.

By Station – allows the user to specify the **Beginning** and **Ending Stations**, the **Left** and **Right Offsets** and whether the stations should be cut at specified **Even** stations or at a specified **Increment** along the baseline.

By DGN File – uses the pattern lines drawn as discussed in section 13.4. The user needs to specify the Microstation design file in which the pattern lines are drawn, and the symbology of the pattern lines. The **Match** button can be used to select a pattern line with the desired symbology. When accepted, the symbology of the selected element will populate the fields that are turned on. The **Display** button will display all of the elements that match the specified symbology. The **Reset** button will clear all of the symbology fields.

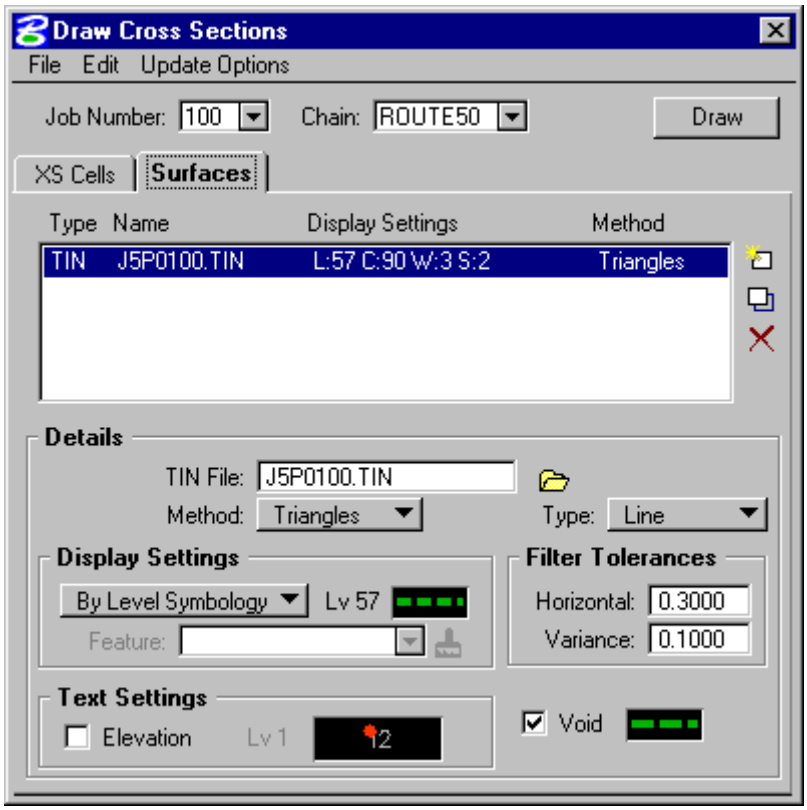
In Existing Only – this option uses the only the cross section cells drawn in the current Microstation Design File.

The **Scale** section can be used to adjust the scale of the cross sections. For MoDOT, the **Horizontal** and **Vertical** scale should always be set to 1.0. MoDOT controls the scaling of the cross sections when the cross section sheets are plotted.

The distance between the cross sections and the maximum number of cross sections in each column can be set using the **Horizontal**, **Vertical**, and **Number of XS by Column** option in the **Spacing** section. It is suggested to leave the **Vertical** and **Number of XS by Column** settings at the default values. The **Horizontal** setting may need to be changed depending on the width of the cross sections. The **Horizontal** setting should be set to a value greater than the total width of the cross section. This will prevent the cross sections from overlapping each other.

13.5.7 Surfaces

The **Surfaces** tab allows the user to specify the surfaces from which to cut the original ground cross sections.



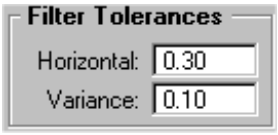
The top portion of the dialog lists the surfaces to be cut, and the symbology to be used when drawing the cross sections for the given surface. The icons on the right allow surfaces to be added, modified, or deleted.

The **Details** portion of the dialog allows the user to specify the TIN file to be used as the cutting surface, select the **Method** of interpolation, and select the **Type** of element to be drawn. When **Breaklines** is selected as the **Method**, the cross section is interpolated between the breaklines, and the triangles are ignored. This is mainly used in a site design application. The method should always be set to **Triangles**, which will include the triangles in the interpolation of the cross section surface. The **Type** allows the cross section to be drawn a **Line**, or a **Line String**.

The **Display Settings** section allows the user to determine how the cross section surface will be drawn. The user can choose **By Level Symbology** or **By Feature**. When using **By Level Symbology**, the user can choose the level, weight, color, and line style for the cross section elements by double clicking on the symbology box next to the **By Level Symbology** / **By Feature** toggle. **By Feature** allows the user to choose an item from the current D&C Manager database. Selecting the paintbrush icon will open the current D&C Manager. The user can select the item to use, which will then be displayed in the **Feature** field. Previously selected items can be viewed by using the pull down in the **Feature** field. Currently, MoDOT does not have any D&C Manager items set up for the cross section view. Therefore, it is suggested to us the **By Level Symbology** option. The **Void** symbology can be set using the **Void** toggle. This will draw any areas that cross a void, or the tin hull using the specified symbology. The following table shows the level symbology currently used in MoDOT.

Surface Name	Level	Color	Weight	Line Style
Existing Ground	57	90	3	2
Void Areas	57	40	3	2
Top of Rock	58	8	3	2
Bottom of Rock (for rock seam)	58	9	3	2

The **Filter Tolerances** section allows for the elimination of short segments that may be created but are less than the tolerance distance in length. The default values are good values to be used for these options.



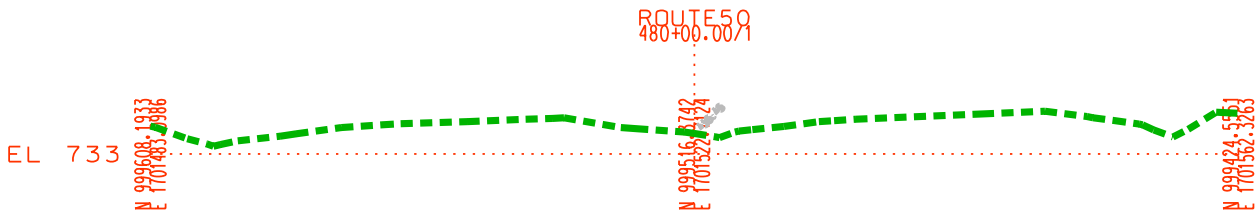
The existing ground elevation at the baseline can be plotted using the **Text Settings** portion of the dialog. To use the text settings option, turn on the **Elevation** toggle. Choosing the symbology box located next to the elevation toggle can set the text symbology.

13.5.8 Draw

Once the cross section location is set up, and the surface and surface symbology is determined, the **Draw** button can be used to draw the cross sections into the active Microstation design file.

13.6 Cross Section

The cross sections consist of mostly Microstation elements. These elements can be modified using Microstation tools. New elements can also be added using Microstation or Geopak drawing tools.



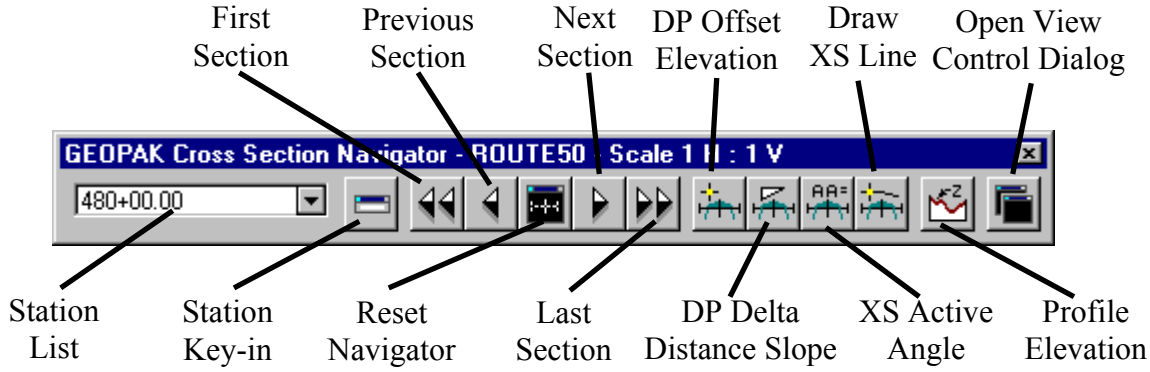
The intelligence of the cross section is built into the cross section cell. This cell is located on level 63. The cell consists of the baseline name, the station and region, the end coordinates for the cross section location, and the coordinates for the location at which the cross section intersects the baseline.

Warning: Do not delete or modify the cross section cells. If the cell is deleted or modified, the intelligence for this cross section will be lost.

13.7 Cross Section Navigator

The **Cross Section Navigator** is a tool used to view and move between cross-sections. It can also be used to draw cross-section information.

The user can access **Cross Section Navigator** by the **Cross Section Navigator** icon. When the icon is chosen, the following dialog appears.



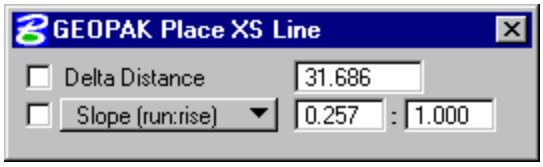
The user can move through the cross-sections by either choosing the station from the pull-down list, by typing the station value into the **Station Key-in** dialog, or by using the **First Section**, **Previous Section, Next Section,** or **Last Section** icons. The **Reset Navigator** icon will center the first station to the view, and reset the navigator to the first station value. Cross-section elements can be added or modified using Microstation tools, and/or the cross-section drawing tools.

DP Offset Elevation – data points at a given offset/elevation, or find the offset/elevation of the cursor location.

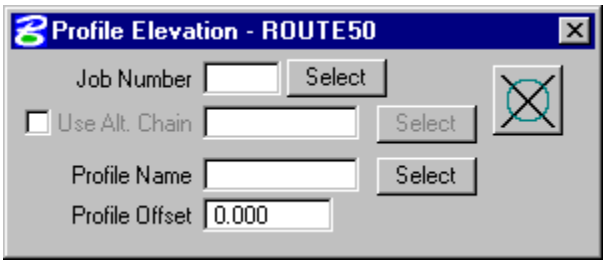
DP Delta Distance Slope – draws a line at a given horizontal distance and slope.

XS Active Angle Tool – sets the active angle to the given value. If a Microstation tool is used with the active angle option, this value will be used.

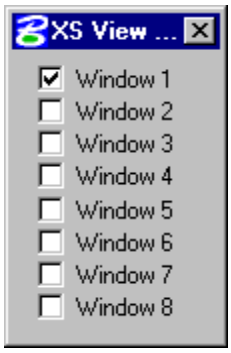
Draw XS Line – draws a cross-section line. An offset or a slope can be specified.



Profile Elevation – issues a data point at the elevation of a specified profile. An alternate chain location can also be specified.



Open View Control Dialog – allows the user to open and navigate through several windows to view different portions of the cross-section at the same time. (I.e. The user can view the whole cross-section in view 1, the left side in view 2, and the right side in view 3.)



13.8 Summary

Basic Steps to Creating Original Ground Cross Sections from a DTM

1. Have an existing triangle file (.tin).
2. Open a 2D Microstation design file for the pattern lines.
3. Draw the pattern lines.
4. Open a 2D Microstation design file for the cross sections.
5. Draw cross sections through GEOPAK.
6. Review and modify (if necessary).

Exercise 13-1

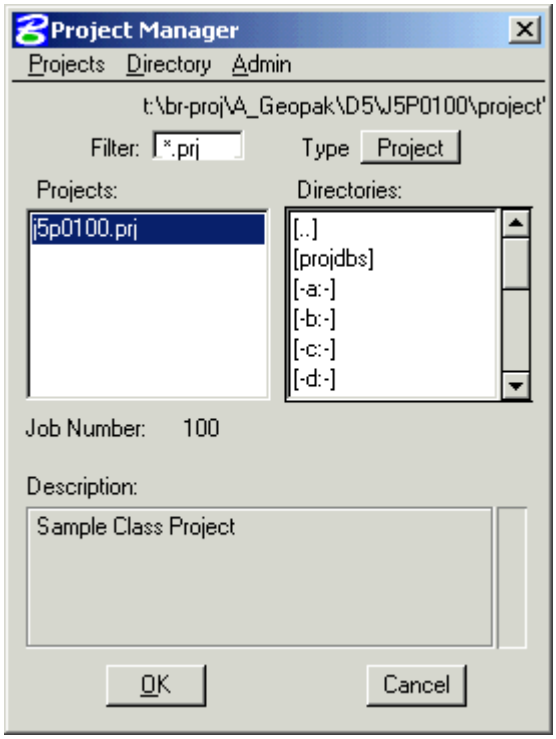
This is a group exercise to demonstrate the process for specifying the location of cross sections using pattern lines and creating existing ground at those locations.

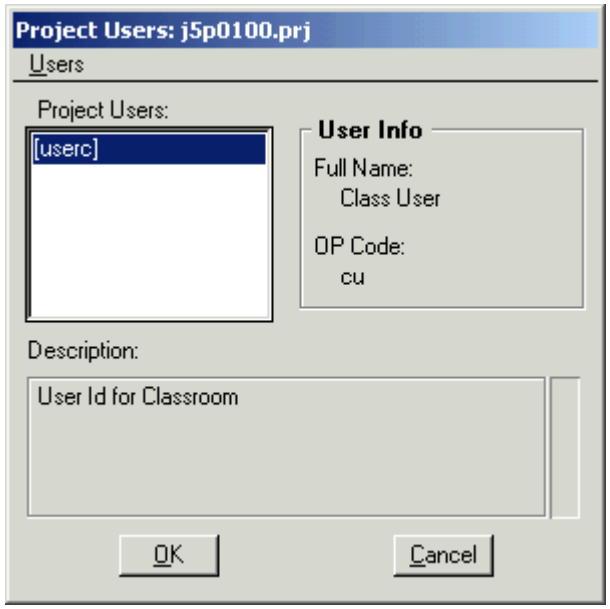
1. Open the MicroStation file
   t:\br-proj\a_geopak\d5\j5p0100\data\pattern_shape_j5p0100.dgn.

   Attach the following files as references:
   t:\br-proj\a_geopak\d5\j5p0100\data\plan_50_j5p0100.dgn and
   t:\br-proj\a_geopak\d5\j5p0100\data\plan_bh_j5p0100.dgn.

   Save changes to the MicroStation file **pattern_shape_j5p0100.dgn**.

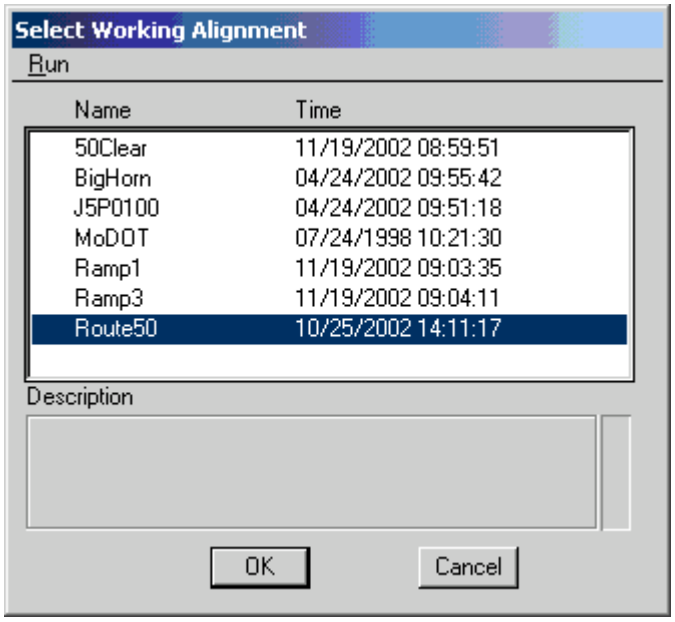
2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**. Select user **userc**.





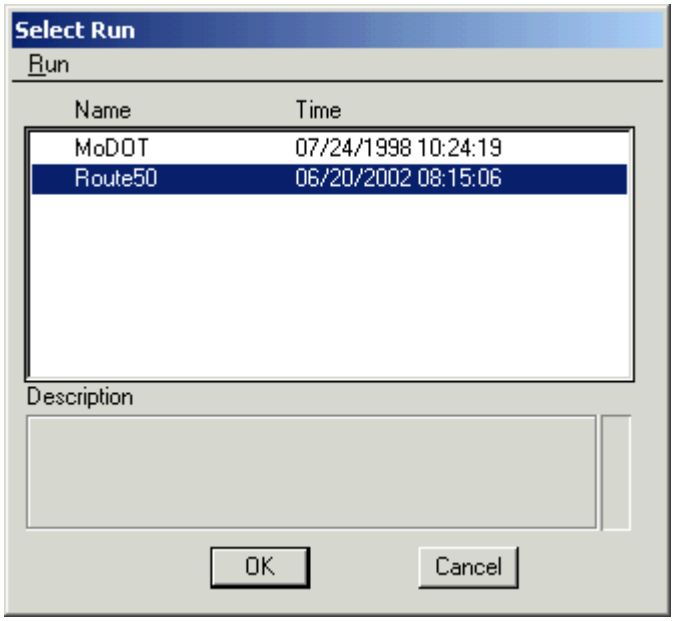
Enter **Road**.

3. Select the **Route50** working alignment.



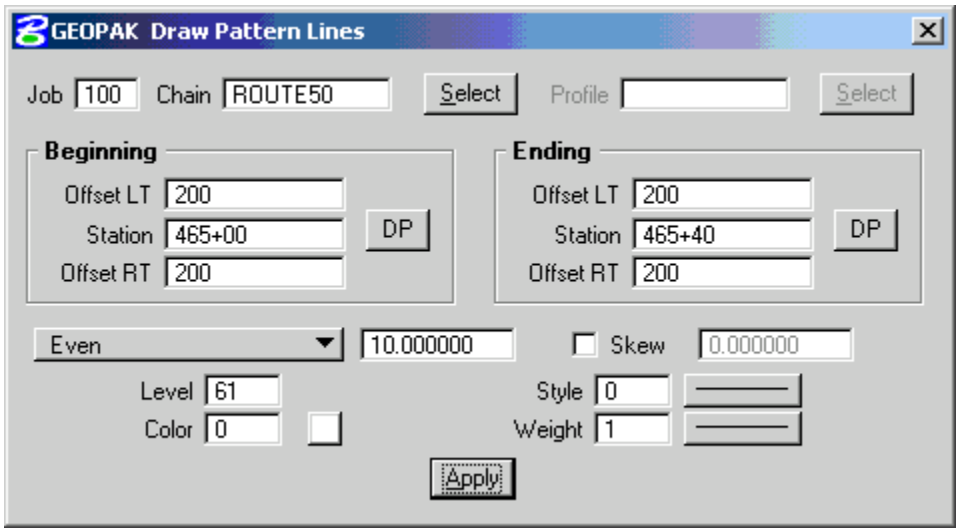
4. Choose **Draw Pattern** from the **Road Project** dialog.

Copy the **MoDOT** run and name the new run **Route50**.



5. Create the pattern lines for the Route50 alignment in the vicinity of Big Horn Dr. but away from the proposed bridge ends by using the following settings.

Job:	**100**		
Chain:	**Route50**		
Beginning		Ending	
Offset Lt:	**200**	Offset Rt:	**200**
Station:	**465+00**	Station:	**465+40**
Offset Lt:	**200**	Offset Rt:	**200**
Even:	**10**		

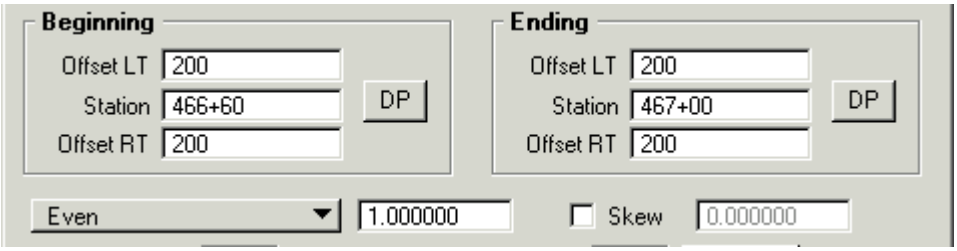


After enter this information in the Draw Pattern Lines dialog, plot the pattern lines by clicking on **Apply**.

Repeat the process with a beginning station of **465+90** and ending station of **466+50**.

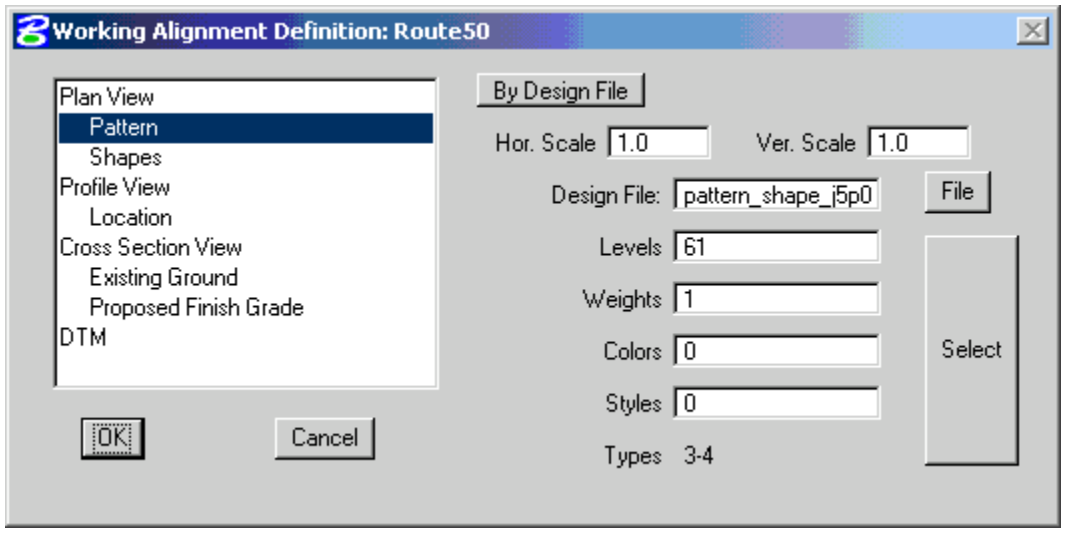
6. Add pattern lines at 1' increments in the vicinity of the proposed bridge ends. To do this, change the **Even** value to **1** and add the following two ranges of pattern lines as follows. **Make sure you do not add pattern lines on top of any already plotted lines**.

Beginning Station	**465+50**	Ending Station:	**465+80**
Beginning Station	**466+60**	Ending Station:	**467+00**



7. Exit Draw Pattern and save the changes to the MicroStation file.

8. In the **Pattern** section of the Route 50 **Working Alignment Definition** note that the Design file is **pattern_shape_j5p0100.dgn** and the symbology for the pattern lines.

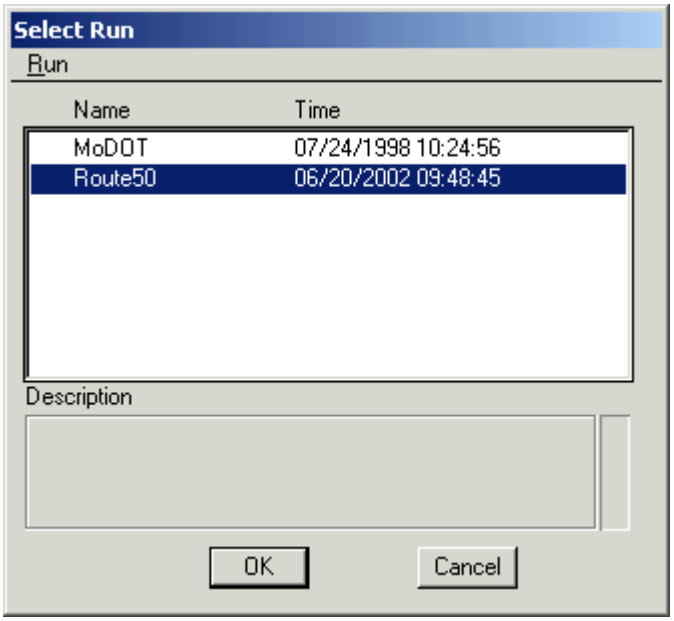


9. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\xs_j5p0100.dgn**.

   Save the file as **xs_50_j5p0100.dgn** so xs_j5p0100.dgn remains a blank file.

10. Choose **Existing Ground Cross Sections** from the **Road Project** dialog.

   Copy the MoDOT run to **Route50** and enter that run.

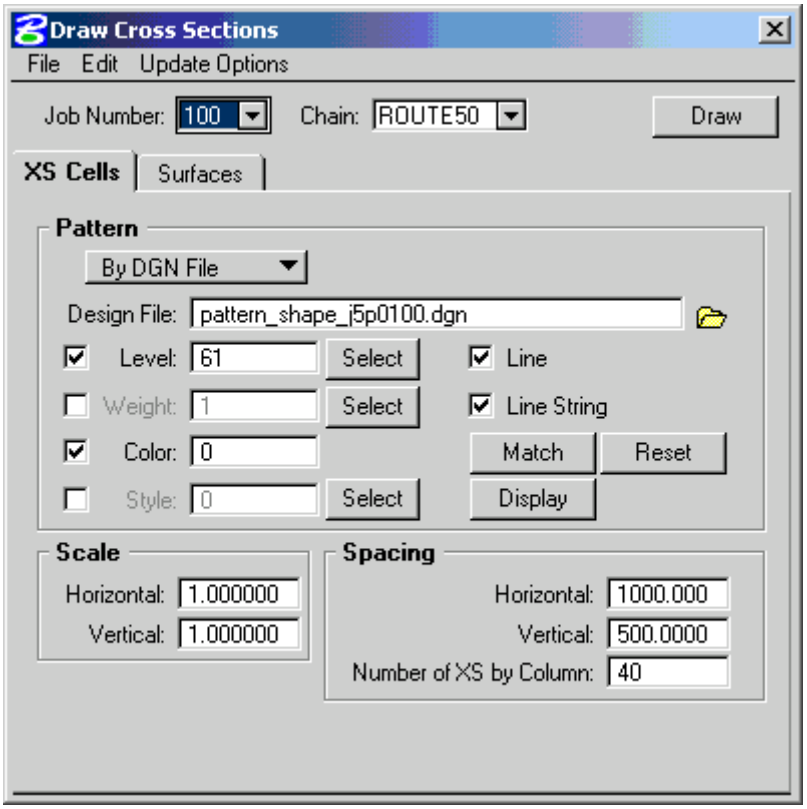


11. Cut the existing ground cross sections with the following parameters in the top portion of the dialog:

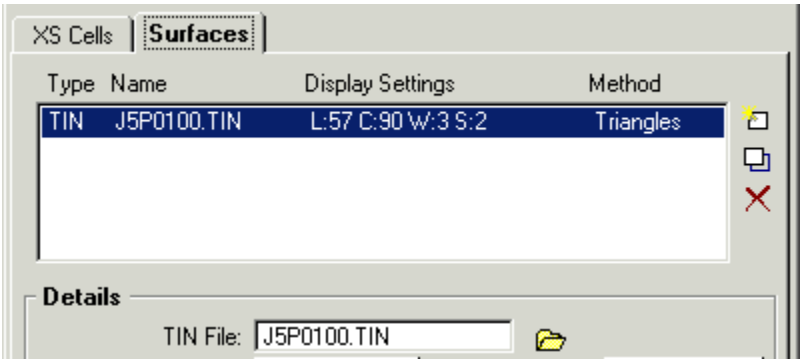
Job Number:	**100**
Chain:	**Route50**

In the **XS Cells** tab, set the following:

Pattern:	**By DGN File**
Design File:	**pattern_shape_50_j5p0100.dgn**



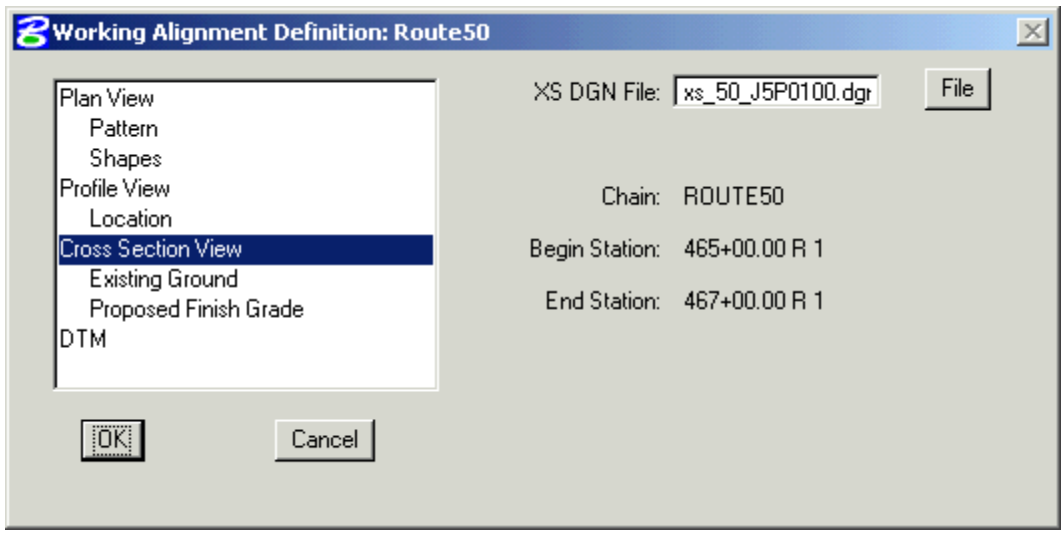
In the **Surfaces** tab, set the **TIN File** to **j5p0100.tin**.



Click on **Draw** to cut the cross sections.

12. Exist Draw Cross Sections and save the changes to the run and the MicroStation drawing **xs_50_j5p0100.dgn**.

13. In the **Cross Section View** section of the **Route50 Working Alignment Definition** set the **XS DGN File** to **xs_50_j5p0100.dgn**.



Chapter 14

Superelevation

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14.1 Objectives

- Learn how GEOPAK defines a roadway slope.
- Learn to use GEOPAK **Auto Shape Maker** and **Graphics Shape Maker** to apply superelevation to a roadway.

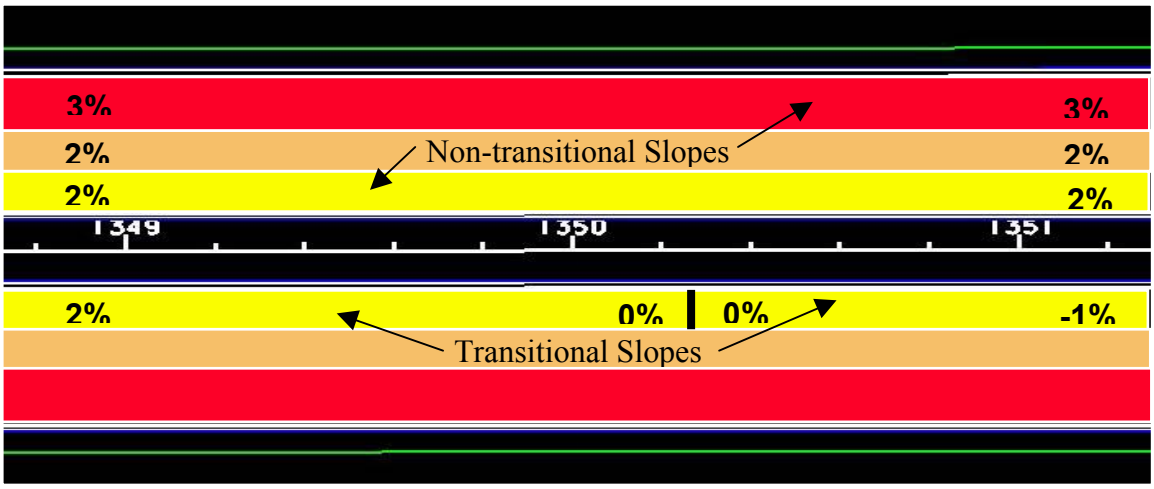
14.2 Definitions

GEOPAK uses two tools to calculate superelevation transition locations for any chain stored in the coordinate geometry database. One tool results in an ASCII file that lists the stations and slopes for each superelevation transition break. Microstation shapes represent the roadway crown and depict the superelevation transition breaks. GEOPAK Superelevation uses the following tools for shape creation.

- **Auto Shape Maker -** is a tool used to create an input file for applying superelevation transition locations along a specified alignment. Using this tool will result in an ASCII file that lists the stations and slopes for each superelevation transition break. This file is then processed to draw the shapes into the Microstation drawing.
- **Graphics Shape Maker** permits interactive creation of superelevation shapes defined by graphic elements drawn in a Microstation file.

14.2.1 Shapes

Shapes are Microstation complex shapes that are placed into a design file to represent an area of pavement slope. **Non-transitional** shapes have a constant slope for the entire length of the shape. **Transitional** shapes have a different slope at each end of the shape, and will either linearly or parabolically interpolate between the slopes.



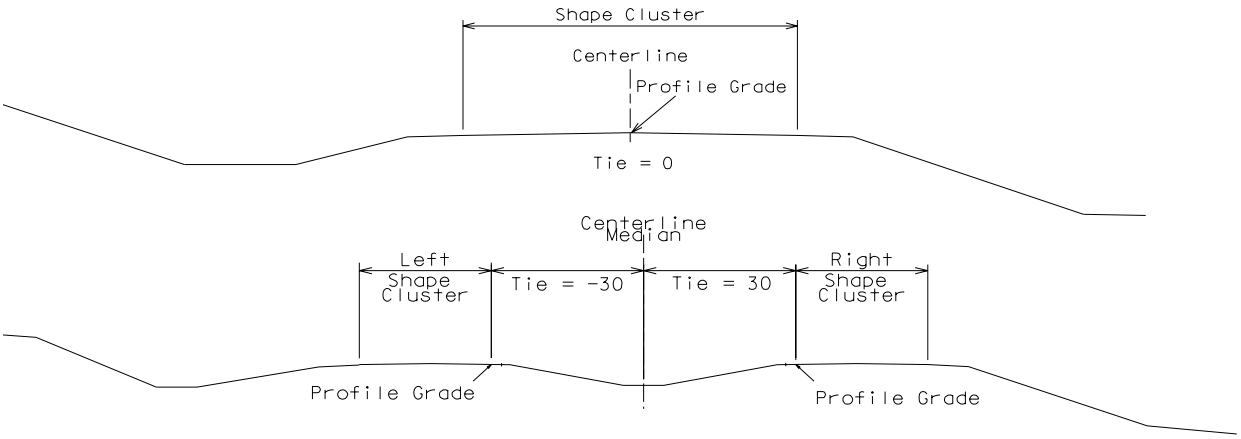
SHAPE CLUSTERS

Four attributes are associated with each shape depending on the definition of the profile grade line.

Baseline – roadway baseline

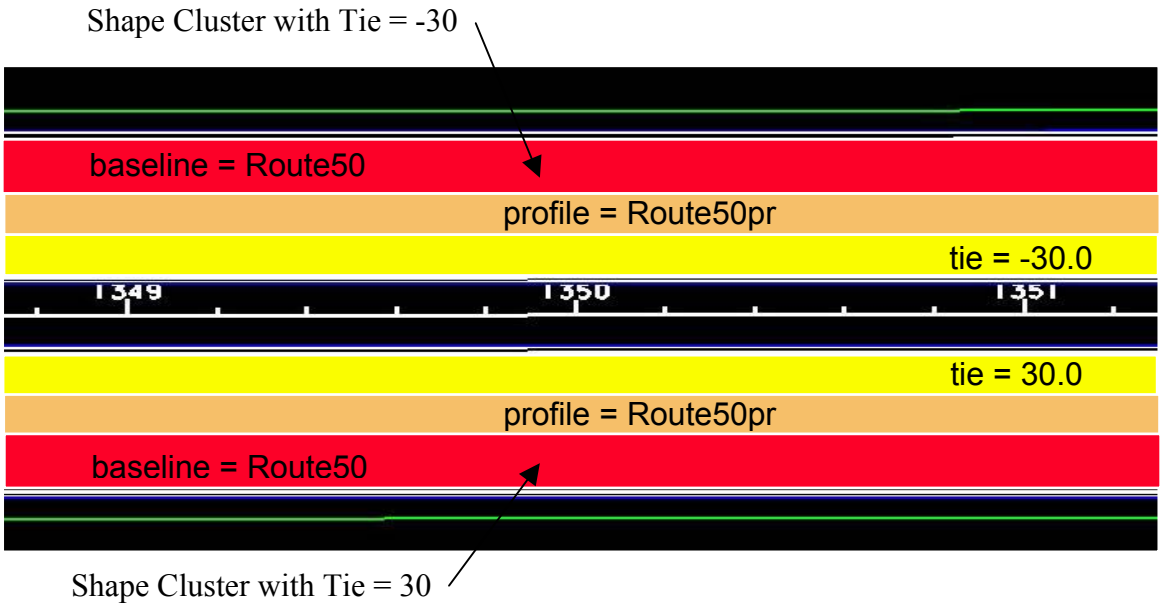
Profile – roadway profile

Tie – distance between the roadway baseline and roadway profile



PGL-Chain – (optional) defines the location of the profile if the distance between the baseline and profile is not constant. (If the distance is constant the tie distance can be used.)

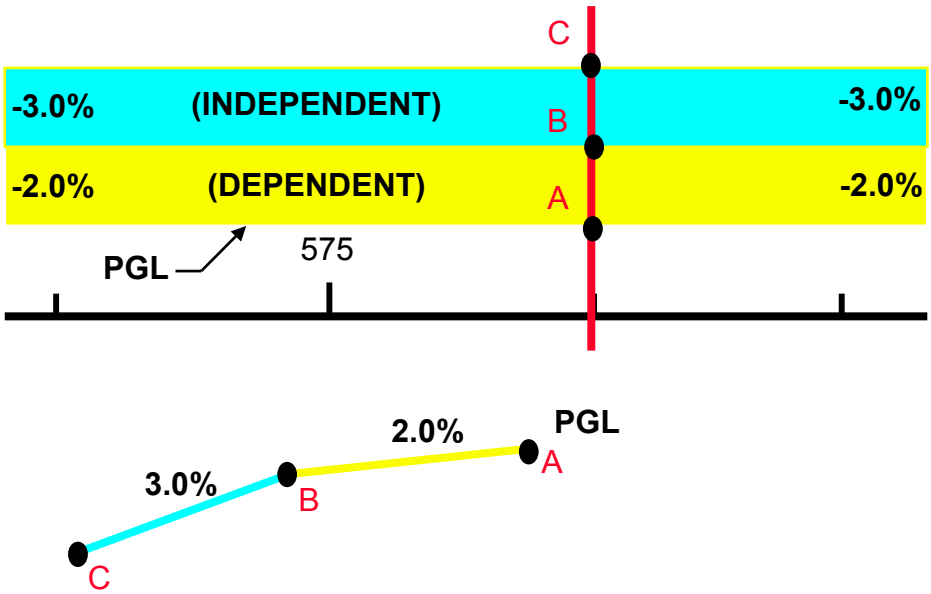
A group of shapes with the same shape attributes is called a "Shape Cluster".



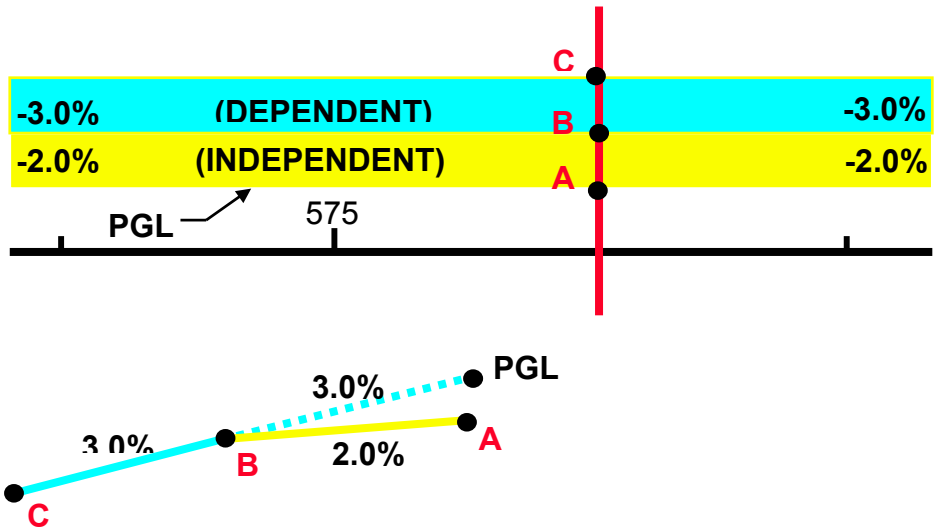
SHAPE CLASS

There are two classifications of shapes, **Dependent** and **Independent,** which determine how the pavement elevations are computed. **Dependent** shape pavement elevations are determined directly from the profile. **Independent** shape pavement elevations are determined from adjacent shapes.

The figure below shows the dependent shape adjacent to the profile grade line (PGL). Therefore, the elevation of the shape at point A will be the elevation of the profile at point A. The elevation of the shape at point B will be calculated based on the width and slope of the dependent shape. This will be the starting elevation for the independent shape. The elevation of point C will be calculated based on the width and slope of the independent shape.



The figure below shows the independent and dependent shape reversed from the figure above. In this case, the independent shape is located next to the PGL. The starting elevation of the dependent shape, point B, is calculated based on the slope of the dependent shape and the



distance between the dependent shape and the profile. The end of the dependent shape, point C, is calculated based on the width and slope of the dependent shape. The end point of the independent shape, point B, is at the same elevation as the dependent shape at that point, and the beginning of the independent shape, point A, is calculated based on the width and the slope of the independent shape.

It is good practice to use one dependent shape for each shape cluster.

SHAPE ELEMENTS

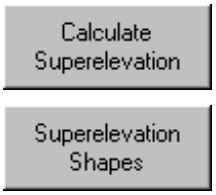
Shapes consist of a series of connected Microstation elements that form a closed surface. The types of elements can be classified into two types, **longitudinal edges**, and **filler lines**.

Longitudinal Edges - Typically, these consist of the roadway edges of pavement or lane lines. These lines do not represent slopes.

Filler Lines - These lines represent the beginning and ending slopes of a pavement shape. Each of these lines always represents a slope value.

14.3 Accessing

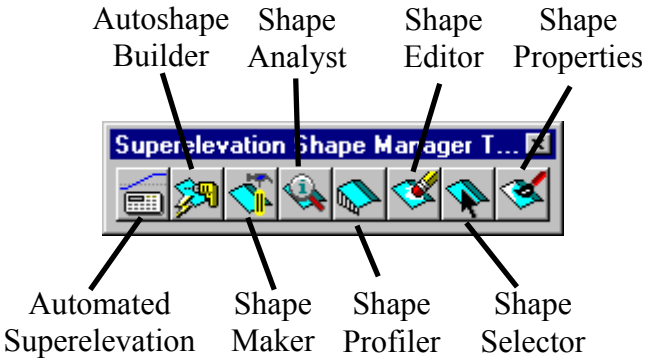
The superelevation tools can be accessed from the cross section toolbox by choosing the **Superelevation Shape Manager** tool. When selected, the superelevation toolbox will be displayed.



The Automated Superelevation can also be accessed from **Project Manager >> Calculate Superelevation**, and the **Shape Maker** can also be accessed from **Project Manager >> Superelevation Shapes**.

14.4 Dialog

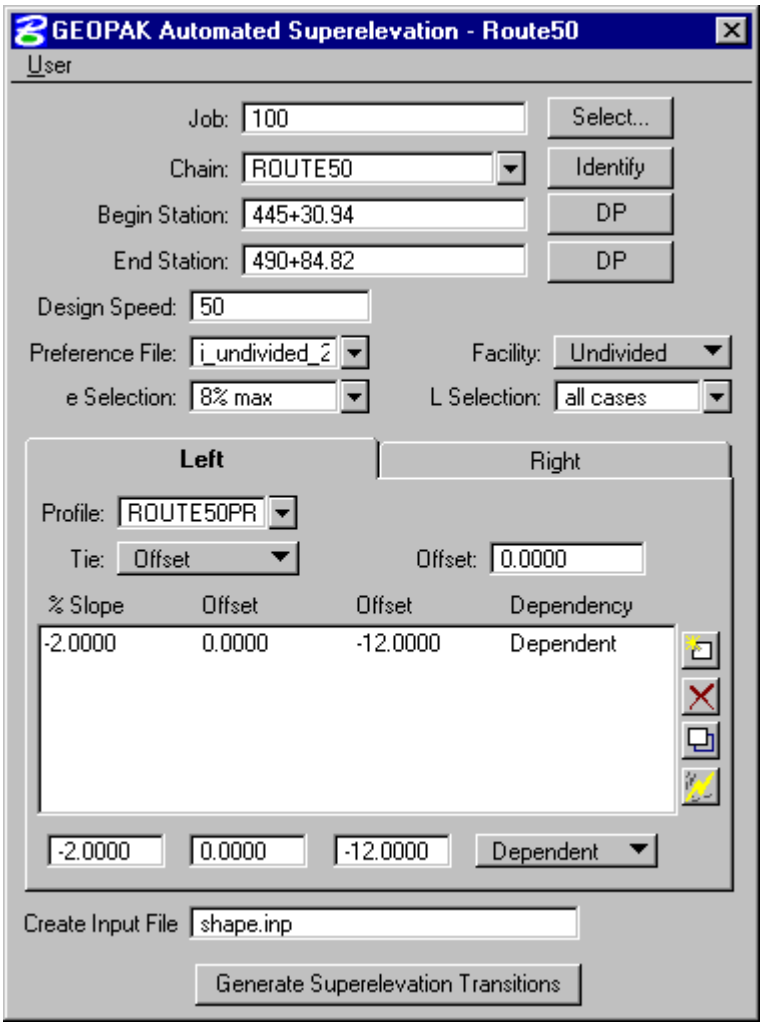
The superelevation toolbox is shown below.



14.4.1 Automated Superelevation

The **Automated Superelevation** dialog is the dialog most commonly used to create superelevation. It allows the user to specify the parameters needed for superelevation, and then

creates an input file the user can modify according to the specific design for the project. When the **Automated Superelevation** icon is chosen, the following dialog will appear.



If project manager is used, the **Job Number**, **Chain**, and **Beginning** and **Ending Stations** will be filled in using the current **Working Alignment**. The user can specify the design information as follows.

Job – Job number of the .gpk file for the project.

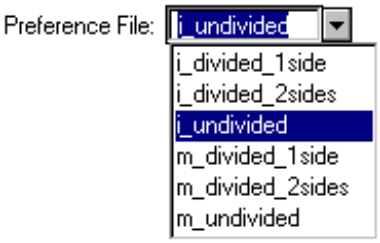
Chain – Baseline chain name for the project. This may be the centerline of roadway for an undivided roadway, the centerline of median for a divided roadway, or the edge of pavement for a ramp.

Beginning Station – station to begin the shapes.

Ending Station – station to end shapes.

Design Speed - the design speed for the project that determines the rate of superelevation for curves.

Preference File – the file to use in calculating the superelevation rates and transition stations. The user should choose the preference file according to the standard plan being used for superelevation calculations.



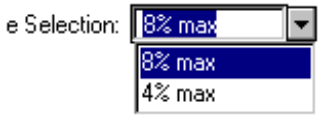
i_divided_1side – imperial, divided roadway, using standard 203.21G, when calculating only 1 side of the median

i_undivided – imperial, undivided roadway, using standard 203.20E

m_divided_1side – metric, divided roadway, using standard M203.21G, when calculating only 1 side of the median

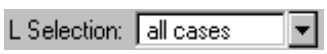
m_undivided – metric, undivided roadway, using standard M203.20E

e Selection – the maximum superelevation value to be used for the alignment.



Facilitiy – set according to if the roadway is Undivided or Divided

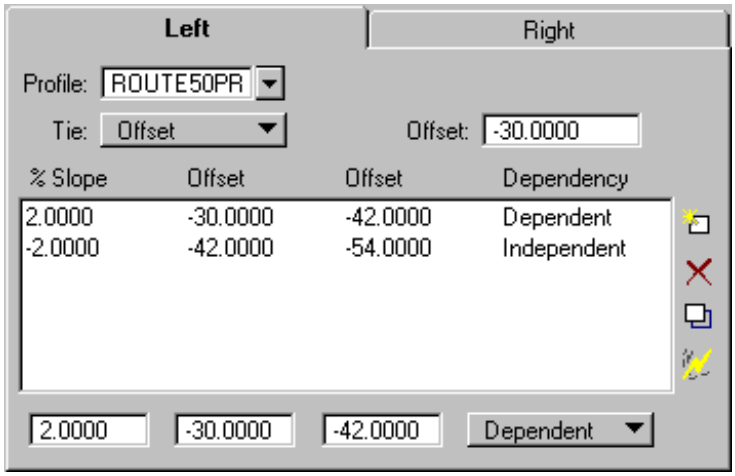
L Selection – this should be set to **All Cases** for all situations.



Profile – choose the profile for the left and right sides. For undivided roadways, the left and right profiles should be the same. For divided roadways, the left and right profiles may or may not be the same.

Tie/PGL Chain – set to either **Tie** or **PGL Chain**. The tie distance is the distance between the baseline and the profile. If this distance is variable, a PGL chain can be used to define the location of the profile.

The **% Slope**, **Offset**, and **Dependency** field define the shape characteristics.

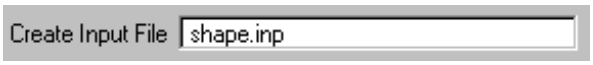


% Slope – define as the normal slope for this section of roadway.

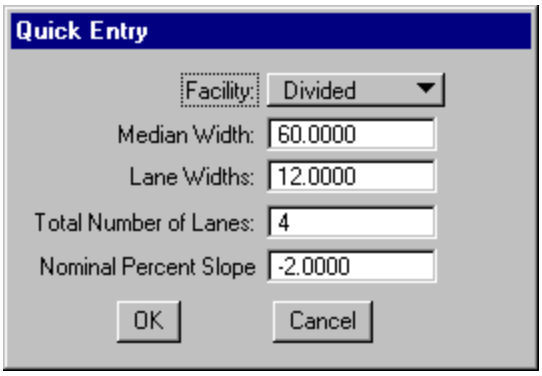
Offset – define one **Offset** as the distance between the baseline and the inside edge of the shape, and the other as the distance between the baseline and the outside edge of the shape.

Dependency – defines whether the shapes elevation is determined by the profile, or by the adjacent shapes. **Dependent** shapes obtain the elevation from the profile and the slope of the shape as discussed in section 14.2. **Independent** shapes obtain the elevation from adjacent shapes.

Create Input File – specifies the name o the shape input file to be created that creates the shape information. This file needs to be run to plot the shapes into the Microstation drawing.



Shapes can be added by specifying the % Slope, offsets, and dependency, then pressing the add button. Once listed, the shapes can be deleted, or modified using the respective buttons.



The **Quick Entry** button will bring up the **Quick Entry** dialog. This dialog can be used to create shapes without calculating the required offsets for multiple lanes. The user chooses the type of **Facility** as divided or undivided. If divided is chosen, the **Median Width** can be specified. The **Lane Widths**, **Total Number of Lanes**, and the **Nominal Percent Slope** are specified. When the dialog has been completed, the **OK** button is pressed, and the number of lanes and their corresponding offsets are automatically entered into the shape cluster list boxes.

When the **Automated Superelevation** dialog has been completed, the user presses the **Generate Superelevation Transitions** button. This will create the input file specified in the **Create Input Field** dialog.

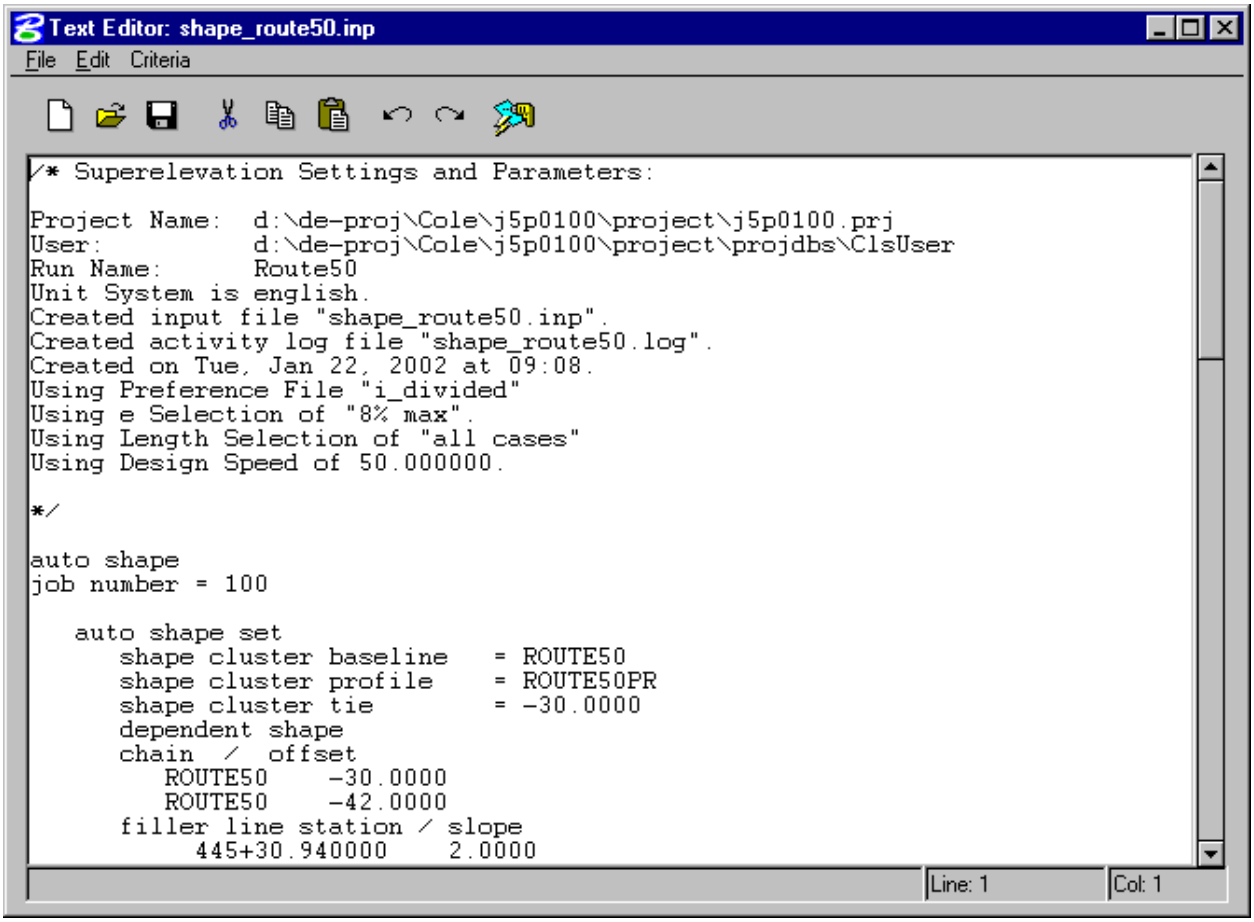
14.4.2 Superelevation Input File

A **Superelevation Input File** with an .inp extension is created and placed in the project directory. This input file shows where the location superelevation critical points by indicating the station and slope along the roadway. This is an ASCII file that may be reviewed and/or edited. A sample input file is provided below.

```
/* Superelevation Settings and Parameters:
Unit System is english.
Created input file "shape.inp".
Created activity log file "shape.log".
Created on Mon, Oct 08, 2001 at 20:49.
Using Preference File "i_divided"
Using e Selection of "8% max".
Using Length Selection of "8% max"
Using Design Speed of 50.000000.
*/

auto shape
job number = 100

  auto shape set
    shape cluster baseline   = ROUTE50
    shape cluster profile    = ROUTE50PR
    shape cluster tie        = -30.0000
    dependent shape
    chain  /  offset
      ROUTE50    -30.0000
      ROUTE50    -42.0000
    filler line station / slope
        445+30.940000    2.0000
        462+89.133015    2.0000
        465+18.080384   -3.8000  /* Curve ROUTE50-1 */
        488+24.816494   -3.8000  /* Curve ROUTE50-1 */
        490+53.763863    2.0000
        490+84.817000    2.0000

  auto shape set
    shape cluster baseline   = ROUTE50
    shape cluster profile    = ROUTE50PR
    shape cluster tie        = -30.0000
    independent shape
    chain  /  offset
      ROUTE50    -42.0000
      ROUTE50    -54.0000
    filler line station / slope
        445+30.940000   -2.0000
        464+47.027752   -2.0000
        465+18.080384   -3.8000  /* Curve ROUTE50-1 */
```

```
      488+24.816494   -3.8000  /* Curve ROUTE50-1 */
      488+95.869125   -2.0000
      490+84.817000   -2.0000

  auto shape set
    shape cluster baseline   = ROUTE50
    shape cluster profile    = ROUTE50PR
    shape cluster tie        = 30.0000
    dependent shape
    chain  /  offset
      ROUTE50    30.0000
      ROUTE50    42.0000
    filler line station / slope
      445+30.940000    2.0000
      464+47.027752    2.0000
      465+18.080384    3.8000  /* Curve ROUTE50-1 */
      488+24.816494    3.8000  /* Curve ROUTE50-1 */
      490+53.763863    2.0000
      490+84.817000    2.0000

  auto shape set
    shape cluster baseline   = ROUTE50
    shape cluster profile    = ROUTE50PR
    shape cluster tie        = 30.0000
    independent shape
    chain  /  offset
      ROUTE50    42.0000
      ROUTE50    54.0000
    filler line station / slope
      445+30.940000   -2.0000
      462+89.133015   -2.0000
      465+18.080384    3.8000  /* Curve ROUTE50-1 */
      488+24.816494    3.8000  /* Curve ROUTE50-1 */
      490+53.763863   -2.0000
      490+84.817000   -2.0000

  Plot Parameters
    Dependent Shape
      lv = 63
      co = 6
      lc = 0
      wt = 2
    Dependent Text
      lv = 63
      co = 6
    Independent Shape
      lv = 63
      co = 1
      lc = 0
      wt = 2
    Independent Text
      lv = 63
      co = 1

Write shapes into dgn = d:\de-proj\Cole\j5p0100\data\pattern_shape_j5p0100.dgn
```

The input file is also opened into the Geopak text editor. The input file can be edited in the text editor. Once any changes have been made, and the input file has been saved, the text editor can be used to process the input file by clicking on the **Create Superelevation Shapes** button.



14.4.3 Superelevation Log File

When the **Superelevation Input File** is created, the **Superelevation Log File** is also created. The **Superelevation Log File** contains information pertaining to the creation of the input file. A sample log file is shown below.

Beginning calculation of superelevation for chain ROUTE50 in job 100.

Computing superelevation rates . . .
Curve ROUTE50-1, radius 2864.7890: Superelevation rate computes to be 3.8000.

Computing transition lengths . . .
Note: Because the roadway width consists of 4 lanes,
lengths are to be adjusted after initial calculation.
Curve ROUTE50-1: Super rate of 3.8000 yields
unadjusted runoff length of 150.0000.
Transition Length adjusted to 150.0000 for 4 lanes.

Checking for transition conflicts . . .
No transition conflicts were found.

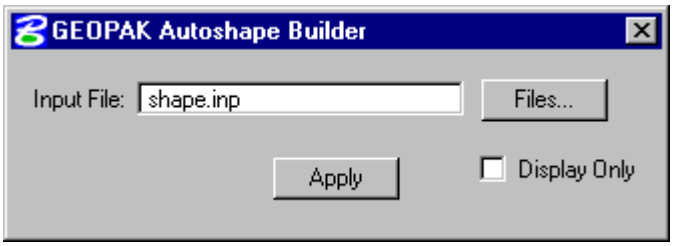
Superelevation Calculation Complete.
Output written to file "shape.inp"

The log file indicates the superelevation rate computed for each curve, the transition length for each curve, and any transition conflicts between curves.

The **Superelevation Log File** should be reviewed prior to the processing of the input file to check for errors, and verify any transition conflict resolutions.

14.4.4 Autoshape Builder

After the input file has been created and edited, it needs to be processed to plot the shapes into the Microstation design file. The input file can be processed by using the **Create Superelevation Shapes** button in the text editor, or by using the **Autoshape Builder**. The **Autoshape Builder** can be accessed from the Superelevation toolbox. The following dialog will appear.



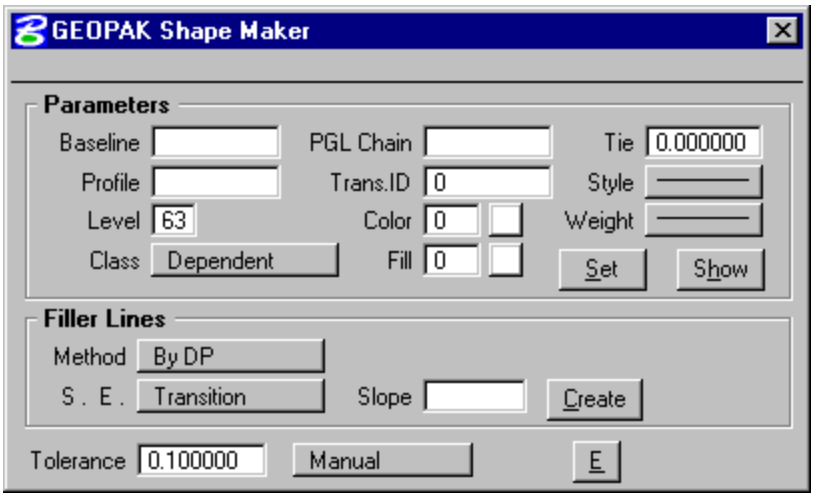
The user selects the input file to process, then presses the **Apply** button to execute the input file. The **Display Only** toggle can be turned on to temporarily plot the shapes into the Microstation design file. When the view is updated, the temporary graphics will be deleted.

14.5 Shape Maker

Not all superelevation transitions can be defined by station and offset. GEOPAK provides the **Graphical Shape Maker** for situations that involve **left turn lanes**, **merging roadways** and in some cases, **widening**.

The user uses simple Microstation elements to depict the area to which superelevation is applied. Once the area is drawn, the **Graphical Shape Maker** dialog box allows the designer to define the roadway information to apply superelevation. The Microstation elements are then identified and a complex shape representing the superelevation is created.

Access Shape Maker from the GEOPAK Project Manager by selecting **Superelevation Shapes** or from the **Shape Maker** icon in the **Superelevation** toolbox. The following dialog is displayed.



Parameters

Baseline - chain corresponding to the shape.

Profile - profile controlling shape.

Level - Microstation level on which shape will be placed.

Class - dependent or independent, as previously discussed

PGL Chain - chain to define the profile location if the tie distance varies.

TransID - determines linear or parabolic transition. Use 0 for linear transition.

Tie - distance between the profile and the baseline.

Set - used to change the parameters of an existing shape

Show - used to display the parameters of an existing shape.

Filler Lines

Method: **By DP -** identify filler line by issuing a data point (DP) on each end of the line
By Line - identify filler line by selecting a Microstation line
By Station - identify filler line by keying in station limits

S.E.: **Transition -** shape is in a superelevation transition
Non-Transition - shape is not in a superelevation transition (full super or normal crown)

Slope - cross slope for the filler line at the beginning and end of the shape

Tolerance - user specified acceptable maximum gap between the Microstation elements that make up the shape

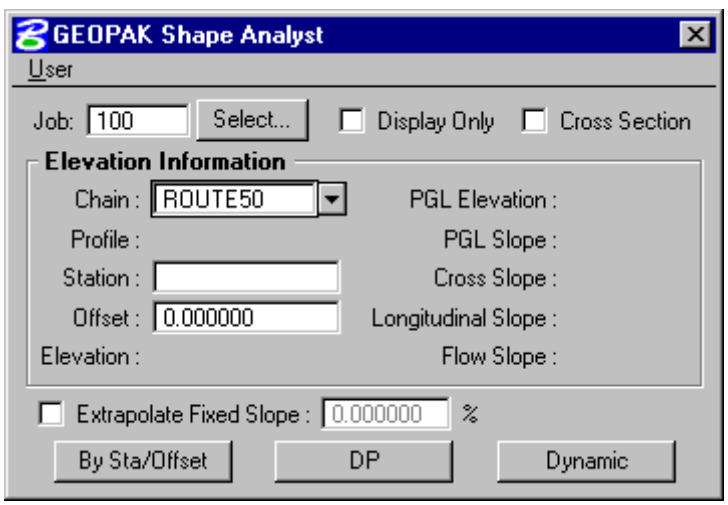
Complete Shape:

Manual - user identifies each element that makes up the shape.
Semi-Automatic - user *accepts* or *rejects* elements that make up the shape.
Automatic - GEOPAK uses all contiguous elements to create the shape.

14.6 Additional Superelevation Tools

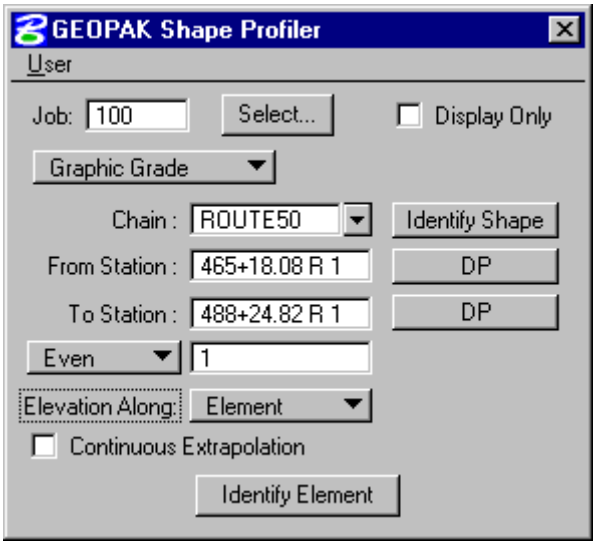
14.6.1 Shape Analyst

The **Shape Analyst** is used to determine the slope of a shape at a particular point. The elevation, profile elevation and slope, cross slope, longitudinal slope, and flow slow are computed and displayed. The elevation can be computed off the shape by using an **Extrapolated Slope** from the edge of the shape. The **Cross Section** option will display the slope of each shape, and the elevation at the edge of each shape.



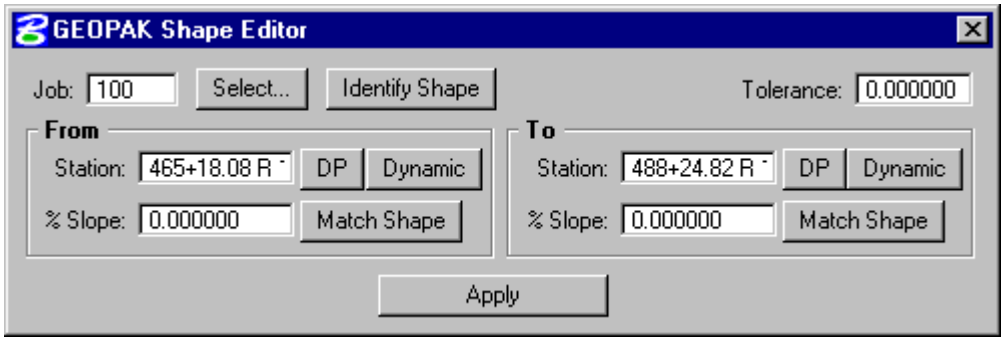
14.6.2 Shape Profiler

The **Shape Profiler** is used to graphically draw the elevations and/or slope arrows into the design file for a specified element or shape. COGO points can also be stored at the given locations.



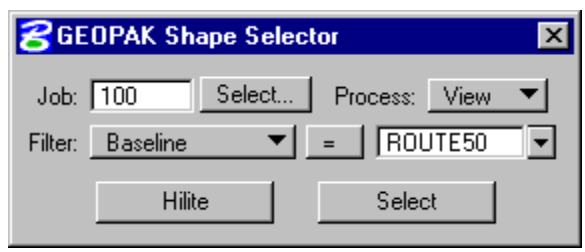
14.6.3 Shape Editor

The user can edit the plotted shapes by using the **Shape Editor**. The Shape Editor allows the user to adjust the slope of the filler lines, or change the location of the filler lines. The filler lines of the adjacent shapes are also adjusted as needed.

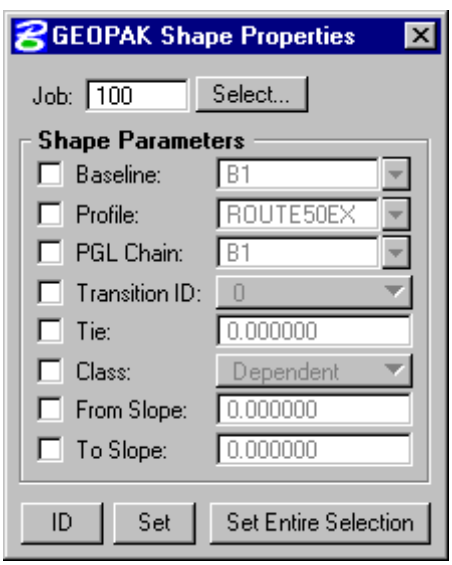


14.6.4 Shape Selector

The **Shape Selector** allows the user to select or highlight shapes based on various attributes of the shape. The attributes include baseline, profile, tie, transition type, class, slope, etc.



14.6.5 Shape Properties

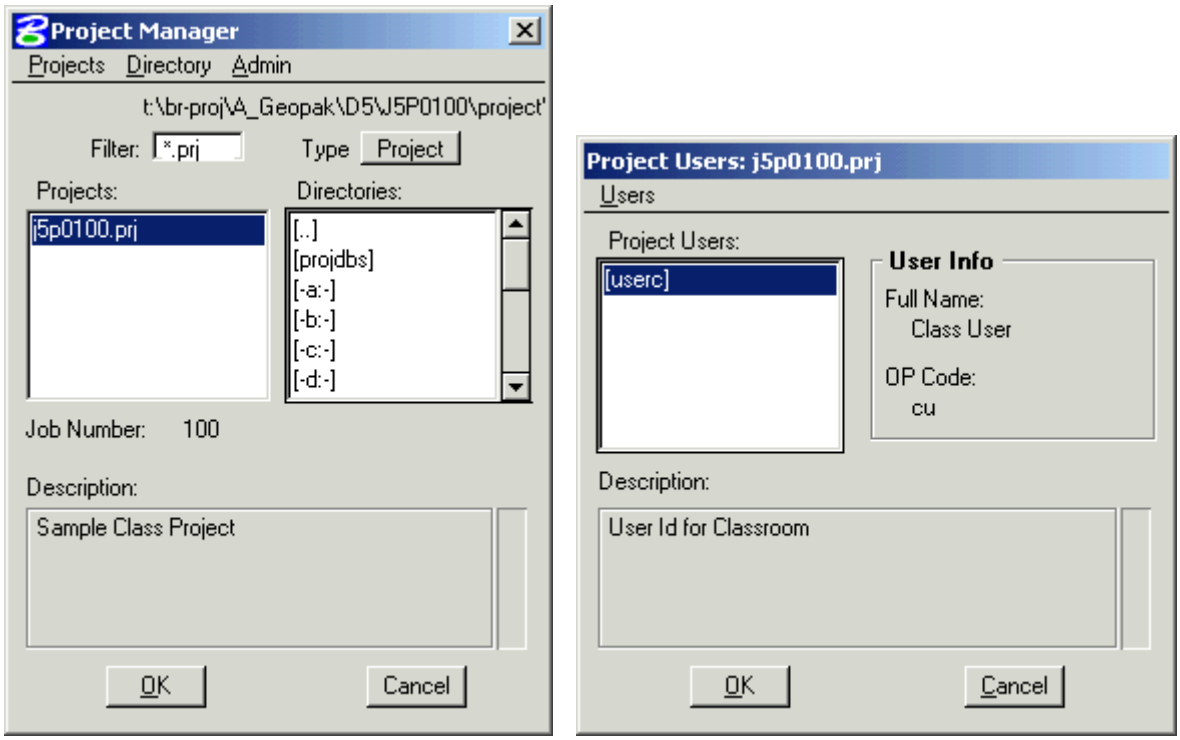


The properties of a shape can be edited using the **Shape Properties** tool. With **Shape Properties**, a user can change the baseline, profile, tie, etc. of a shape.

Exercise 14-1

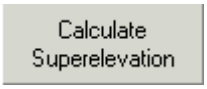
1. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\pattern_shape_j5p0100.dgn**.

2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj** as user **userc** and enter **Road**.



3. Select the **Route50** working alignment.

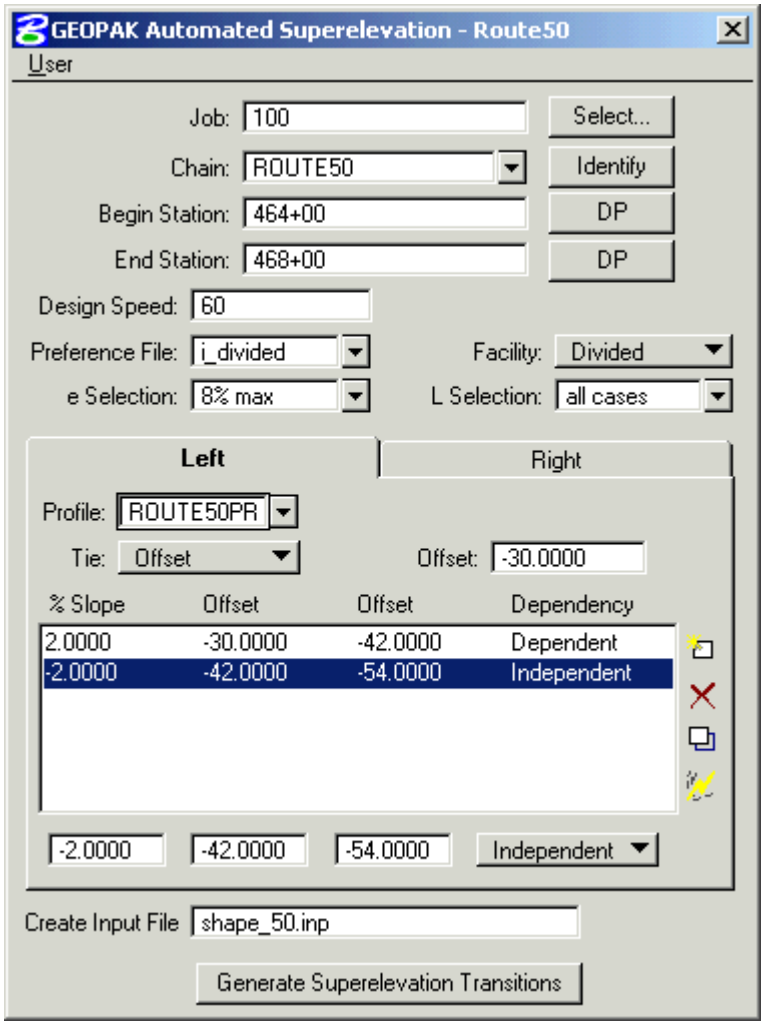
4. Choose **Calculate Superelevation** from the **Road Project** dialog to calculate the pavement cross slopes.



Copy the **MoDOT** run to **Route50** and enter the run.

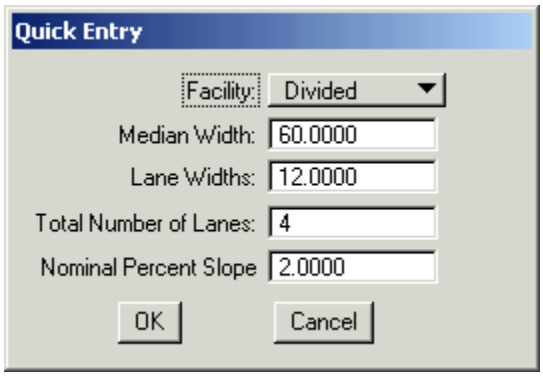
5. Create the Route50 shapes as follows and as depicted in the dialog to the right:

Job:	**100**
Chain:	**Route50**
Begin Station:	**464+00**
Ending Station:	**468+00**
Design Speed:	**60**
Reference File:	**i_dvided**
Facility:	**Divided**
e Selection:	**8% max**
L Selection:	**all cases**
Profile:	**ROUTE50PR**
Tie:	**Offset**



Click on the **Quick Entry** icon circled in red in the dialog box to the right. This will bring up the dialog shown below. Fill it in as shown with the following:

Facility:	**Divided**
Median Width:	**60.00**
Lane Widths:	**12.00**
Total Lanes:	**4**
Normal % Slope:	**2.00**



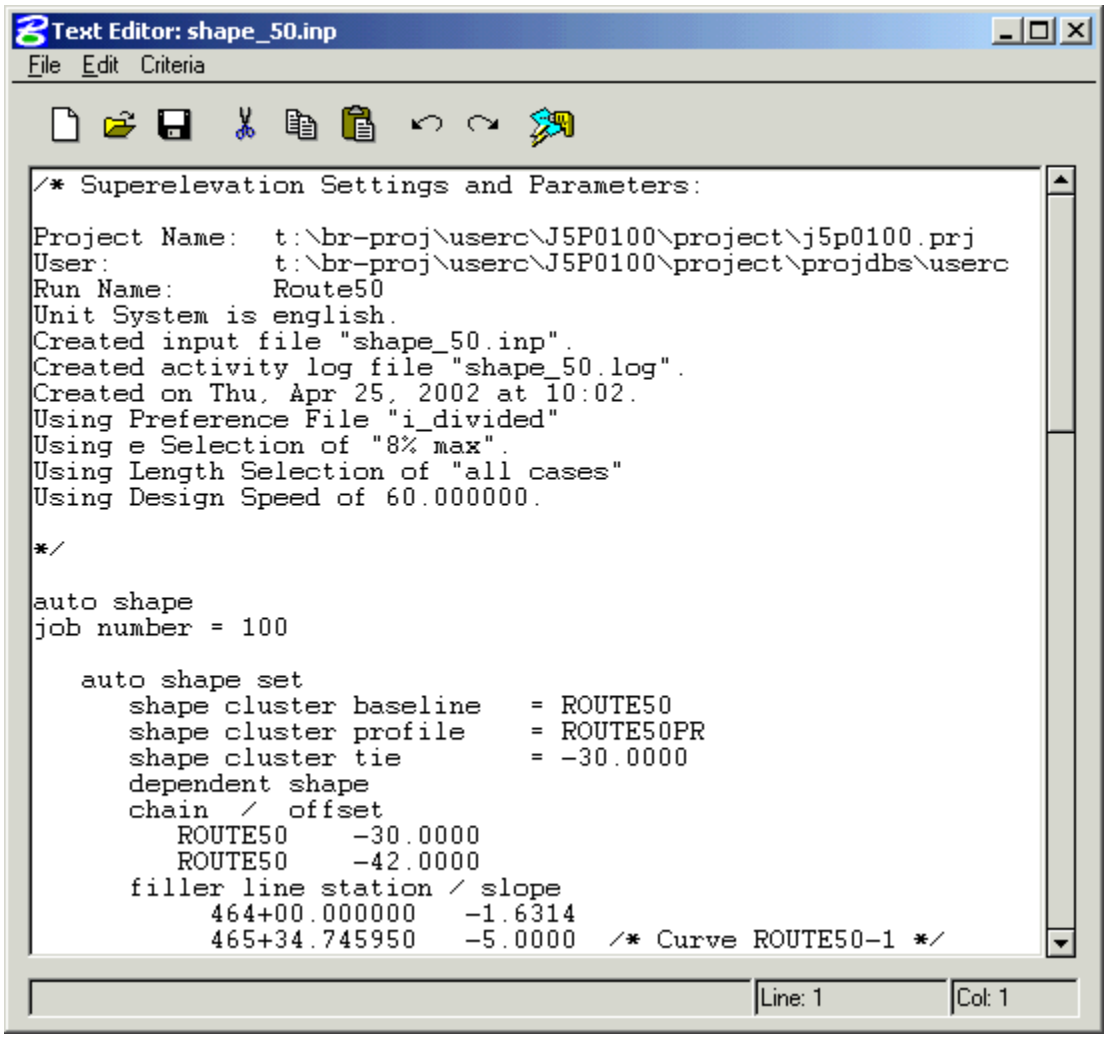
Click **OK**.

Modify the % Slope to –2.0000 for offsets 42-54 on the Left (negative) and Right (positive) sides.

Change the Input File to: **shape_50.inp**

Click on **Generate Superelevation Transitions**.

6. Clicking on the **Generate Superelevation Transitions** button will generate the INP file, which is displayed in the following dialog box.




```
/* Superelevation Settings and Parameters:

Project Name:   t:\br-proj\userc\J5P0100\project\j5p0100.prj
User:           t:\br-proj\userc\J5P0100\project\projdbs\userc
Run Name:       Route50
Unit System is english.
Created input file "shape_50.inp".
Created activity log file "shape_50.log".
Created on Thu, Apr 25, 2002 at 10:02.
Using Preference File "i_divided"
Using e Selection of "8% max".
Using Length Selection of "all cases"
Using Design Speed of 60.000000.

*/

auto shape
job number = 100

   auto shape set
      shape cluster baseline    = ROUTE50
      shape cluster profile     = ROUTE50PR
      shape cluster tie         = -30.0000
      dependent shape
      chain  /  offset
         ROUTE50     -30.0000
         ROUTE50     -42.0000
      filler line station / slope
           464+00.000000   -1.6314
           465+34.745950   -5.0000  /* Curve ROUTE50-1 */
```

7. Use UltraEdit or another text editor to view the log file:
   t:\br-proj\a_geopak\d5\j5p0100\data\j5p0100\data\shape_50.log.

8. Run the input file shape_50.inp by clicking on the **Create Superelevation Shapes** icon in the GEOPAK **Text Editor: shape_50.inp**. It is the icon shown to the right and it the last icon in the tool bar at the top of the dialog. Save the MicroStation drawing after creating the shapes and close the **GEOPAK Automated Superelevation** dialog. Click on **Yes** to **Save Superelevation Settings?** in the Alert dialog.

9. Select the **BigHorn** working alignment.

10. Click on the **Define** button to review the **BigHorn** working alignment definitions. Under the **Shapes** section, change the following symbology settings:

    Levels: **62**
    Colors: **2,7**

    Using different symbology lets the user distinguish between the shapes for the two alignments.

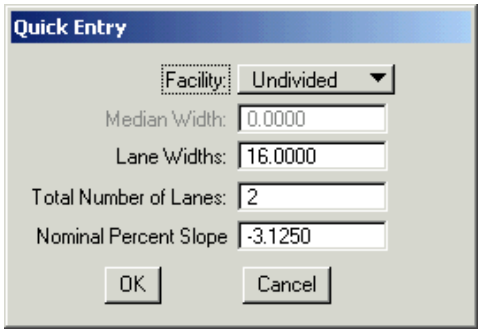
    Close the working alignment definition box by clicking on **OK**.

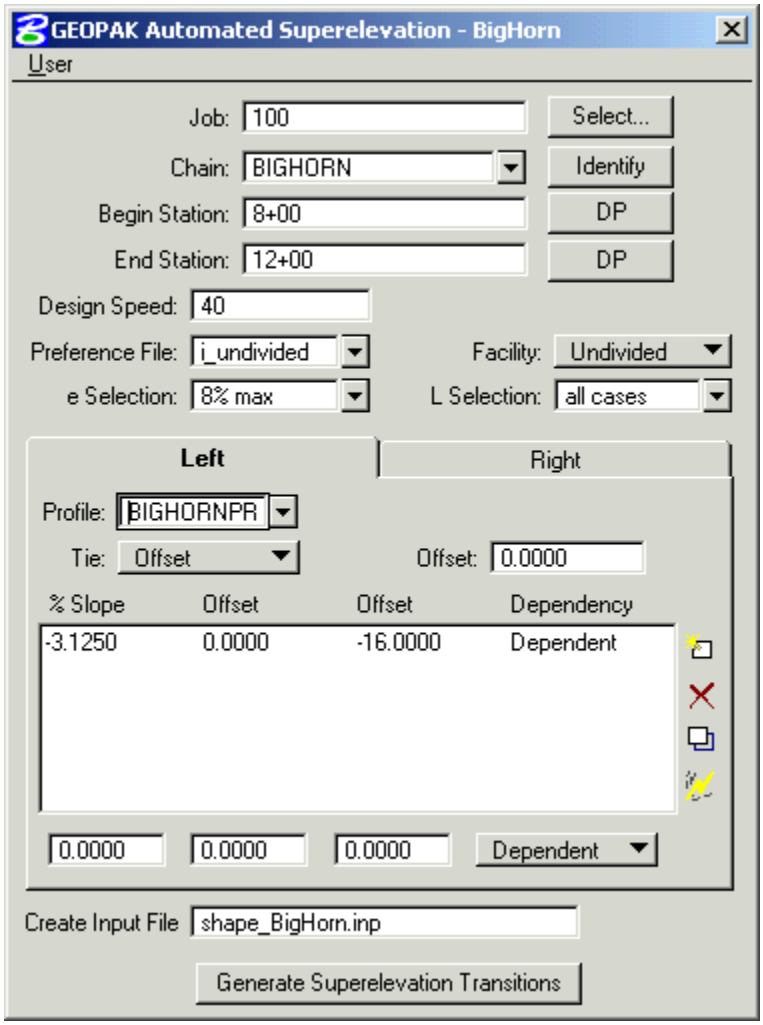
11. Select the **Calculate Superelevation** button from the Project Manager dialog. Copy the MoDOT run to **BigHorn**, and enter the run. Create the Big Horn shapes as follows:

    Job: **100**
    Chain: **BIGHORN**
    Begin Station: **8+00**
    Ending Station: **12+00**
    Design Speed: **40**
    Reference File: **i_undvided**
    Facility: **Undivided**
    e Selection: **8% max**
    L Selection: **all cases**
    Profile: **BIGHORNPR**
    Tie: **Offset**

    Use the **Quick Entry** dialog to set the lane information to the following:

    Facility: **Undivided**
    Lane Widths: **16.00**
    Total Lanes: **2**
    Normal % Slope: **-3.125**

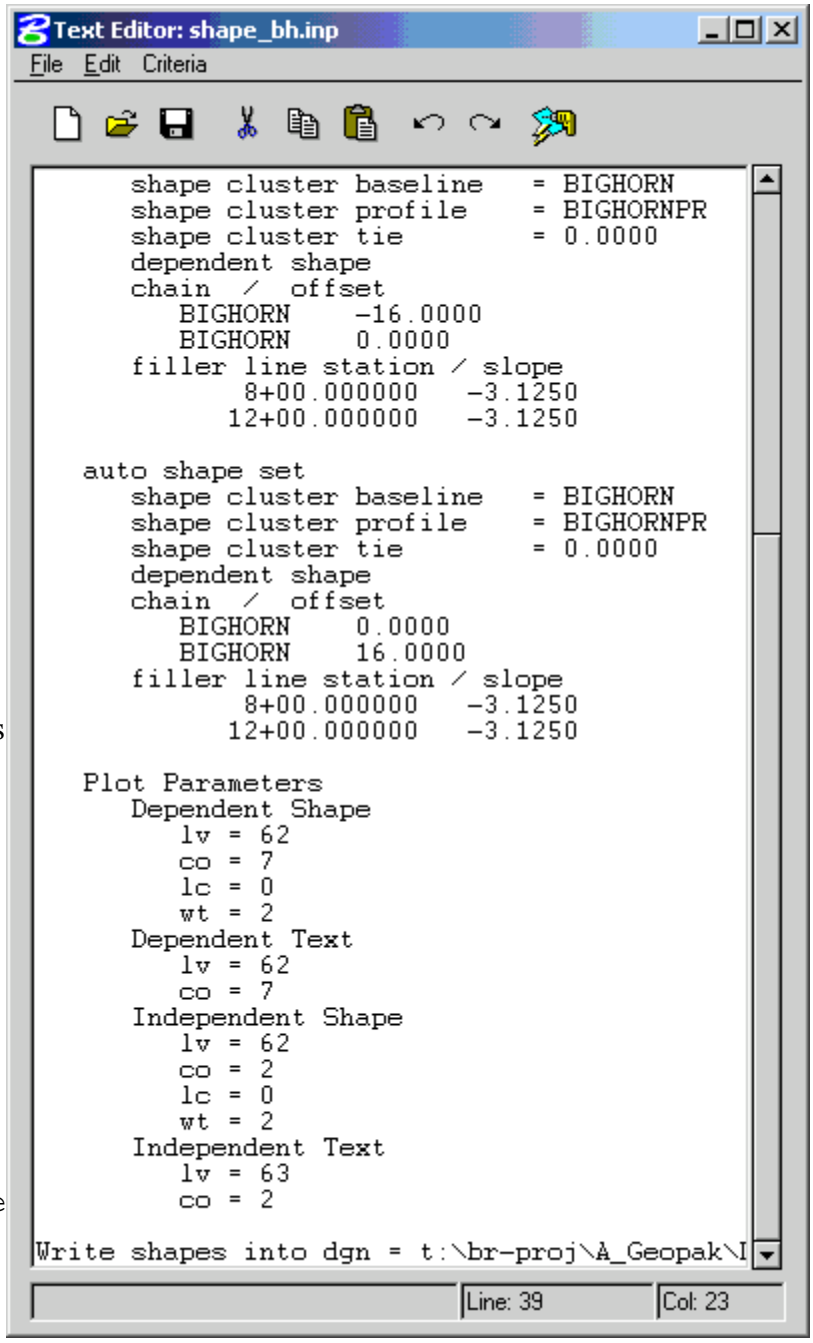




    Change the Input File to: **shape_bh.inp**

    Click on **Generate Superelevation Transitions**.

12. Edit the filler lines for both **auto shape sets** so there is a constant cross slope of **–3.125%** for the full station range and change the second set to an **independent shape**, as depicted to the right. Note: Because the profile grade line is at the center of the roadway, both shapes can get their elevations from the profile (the dependent condition). Changing one of the shapes to independent, however, enables the user distinguish between the two shapes.



Under **Plot Parameters**, change the level (lv) and the color (co) settings to the values shown below in **bold** text, which are the values set in the BigHorn Working Alignment:

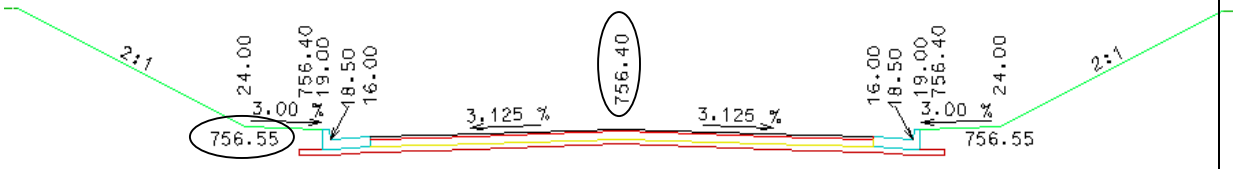
```
Dependent Shape
   lv = 62
   co = 7
   lc = 0
   wt = 2
Dependent Text
   lv = 62
   co = 7
Independent Shape
   lv = 62
   co = 2
   lc = 0
   wt = 2
Independent Text
   lv = 62
   co = 2
```

After editing the input file, save the changes by clicking on floppy disk icon and run it by clicking on the **Create Superelevation Shapes** icon.

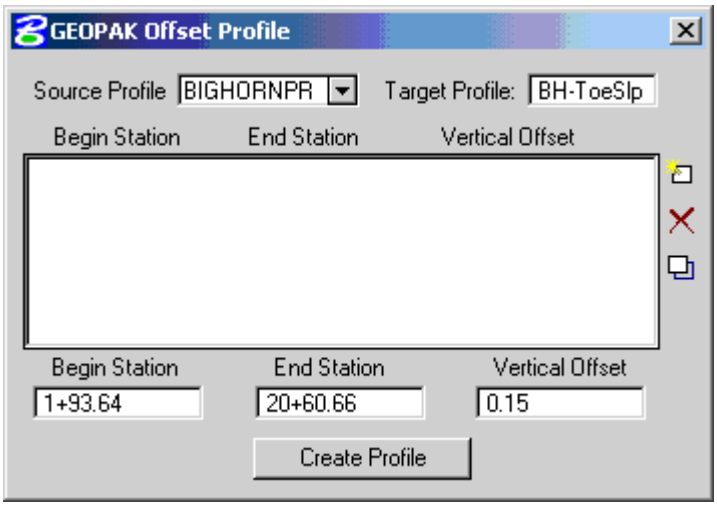
Exit the text editor.

Exit the superelevation run and save the changes to it and the MicroStation file.

13. The fill slopes will also be shaped to determine the bridge length. Since these shapes need to be associated with a profile, a location for the profile needs to be determined. The toe of the slope is the most logical location. From the cross section below, it can be determined that the toe of the slope is 0.15' above the roadway profile with a constant offset of 24' left and right.



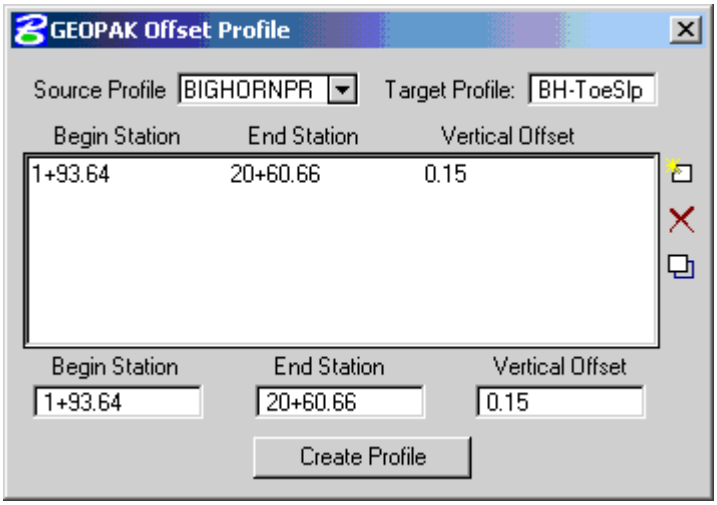
Go into Coordinate Geometry. Select **Element > Profile > Offset**. This will bring up the dialog box shown to the right.



Enter the following information as shown in the top figure to the right:

Source Profile: **BIGHORNPR**
Target Profile: **BH-ToeSlp**
Begin Station: **1+93.64**
End Station: **20+60.66**
Vertical Offset: **0.15**

Once this information is entered, click on the **Add** icon, which is the top icon on the right side of the dialog box. This will add the station range and the offset to the list box as depicted in the bottom figure to the right. To delete an item from the list box, highlight the line and click on the **Delete** icon, which is the middle icon on the right side of the dialog. If changes need to be made to an item in the list box, highlight that line, edit information in the fields at the bottom of the dialog and click on the **Edit** icon.



When the list box is complete, click on the **Create Profile** button. This will store the target profile, as indicated by the following message in the MicroStation Status Bar in the lower left hand corner of the MicroStation window: "*Profile BH_ToeSlp saved. Store Profile commands saved in BH_ToeSlp100.icu.*" This file is stored in the working directory and may be viewed using UltraEdit or any other text editor.

14. Click on the **Select** button in Project Manager. **Copy** the **BigHorn** working alignment to **BH-Slope** and enter the new working alignment.

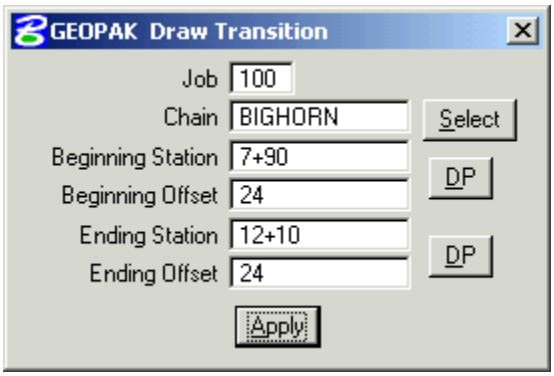
    Click on the **Define** button and adjust the following definitions:
    In the **Shapes** section, change the **Colors** to **3**.
    Under **Profile View**, change the **Proposed Profile** to **BH-TOESLP**.
    Click **OK**.

    To facilitate the creation of the shapes using **Shape Maker**, set **Level 1** as the **active** level, use **Level Manager** to **turn off levels 61 ans 63**, and **turn off** the display for any **referenced files**. All that should be visible after doing this are the shapes for Big Horn Dr.

    Choose **Plan View Design** from Project Manager. This will bring up the toolbox shown to the right. Select **Draw Transition**, which is the third tool in the toolbox.

    Use Draw Transition to draw the following lines to serve as longitudinal lines for shapes:

Beginning Station	Beginning Offset	Ending Station	Ending Offset
7+90	24	12+10	24
7+90	-24	12+10	-24
7+90	-70	12+10	-70
7+90	70	12+10	70

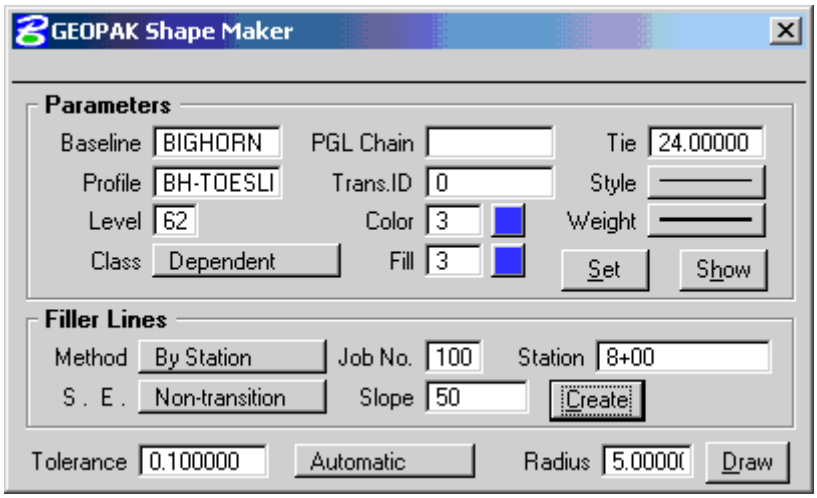


    Close the **Draw Transition** and the **Plan View Design** dialog boxes after the four lines are drawn.

15. Click on **Superelevation Shapes** in Project Manager.

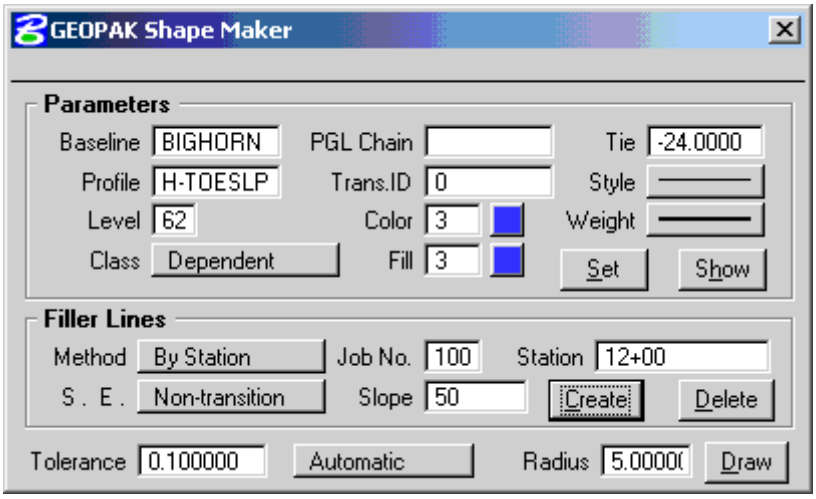
    Fill in the dialog so it is like the one to the right (wt = 2). Once this is completed, click on the **Create** button. This will draw a filler line at station 8+00.

    Change the Station to **12+00** and click the **Create** button a second time to draw the other filler line at Station 12+00.



    Click on the **Draw** button and data point inside the closed in area on the right side of Big Horn Drive. Note: On the screen it is actually to the left of the existing shapes.

16. Repeat the process on the left side of Big Horn Drive, which is to the right of the existing shapes on the screen.



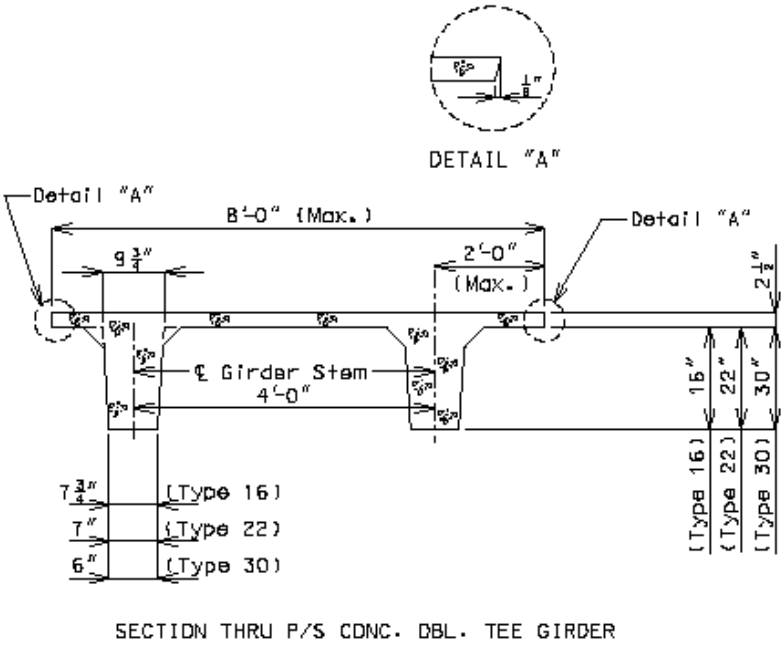
Change the Tie to **–24.00**, set the Station to **8+00** and click on the **Create** button to draw the first filler line.

Change the Station to **12+00** as shown to the right and click on the **Create** button to draw the second filler line.

Click on the **Draw** button and data point inside the closed in area on the left side of Big Horn Drive. Note: On the screen it is actually to the right of the existing shapes.

Refresh the view. Turn on **Level 63** and **save** the changes to the MicroStation drawing. Exit Shape Maker.

17. A profile for Route 50 is needed to define the maximum height of the fill slopes. This profile is based upon the minimum clearance of 1' from the top of the end bent beam to the top of the fill slope (**BM 3.77.2.2-2**, Effective May 2002). Since Big Horn Dr is 39' wide, Type 30 P/S Concrete Double Tee Girders will be used (based on **BM 3.56.1.6-1**, Effective Nov. 2000, as shown on the following page). From the figure below (**BM 3.56.1.1-10**, Effective Nov. 200), the web depth is 30". Allowing ¼" for the bearing pads, ¼" for camber, and 8 ½" for the deck, gives a total depth of 39" (30 + ¼ + ¼ + 8 ½) = 3.25'. Adding the 1' clearance results in the maximum height of the fill slope at 4.25' below the top of the deck.



Using **Offset Profile**, create profile **50-PR-SLP** 4.25' below Route50PR.

Bridge Manual

P/S Concrete Double-Tee Girders – Sec. 3.56 **Page: 1.6-1**

38'-10" ROADWAY **Superstructure**
GIRDER SPAN LENGTH (HS20 & HS20 MILITARY LOADING)

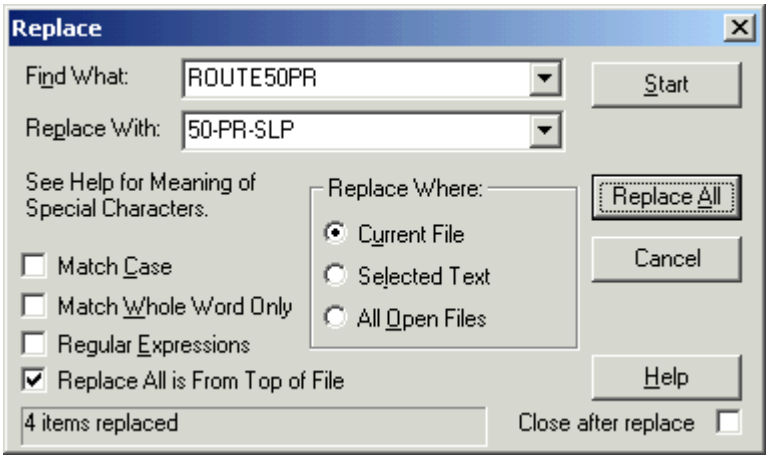
Span Length ℄ to ℄ Bent	Allowable Span Length For P/S Concrete Double-Tee Girder Spans					
	Type 30		Type 22		Type 16	
	Span Length	Girder Seq. No.	Span Length	Girder Seq. No.	Span Length	Girder Seq. No.
20'	20' thru 28'	320	20' thru 29'	230	20' thru 23'	130
21'						
22'						
23'						
24'					24' thru 28'	140
25'						
26'						
27'						
28'						
29'	29' thru 34'	330			29'	151
30'			30' thru 34'	240		
31'						
32'						
33'						
34'						
35'	35' thru 40'	340	35' thru 37'	251		
36'						
37'						
38'			38' & 39'	262		
39'						
40'						
41'	41' thru 44'	351				
42'						
43'						
44'						
45'	45' & 46'	362				
46'						
47'	47' thru 49'	372				
48'						
49'						
50'	50' thru 52'	383				
51'						
52'						

Big Horn Dr.
Width = 39'

Note:
The maximum span lengths shown for P/S Double-Tee Girders are based on a minimum of 2-spans (continuous) being used. If one of these P/S Double-Tee Girders is used as one simple span, then the span lengths should be reduced from the maximum allowable span shown, and the girder design should be checked.

Revised: Nov. 2000 **E5600**

18. The profile **50-PR-SLP** will be used for shapes that represent the maximum height surface for the bridge fill slope. These will be added to pattern_shape_j5p0100.dgn by editing and running an existing INP file.



Open shape_50.inp in UltraEdit. Highlight the shape cluster profile **ROUTE50PR**. Go to the UltraEdit pull down menu **Search > Replace**, to bring up the dialog to the left.

Enter **50-PR-SLP** in the **Replace With:** field as shown. Click on the **Replace All** button to change the name of the profile in the file.

Go to the 2nd and 4th auto shape sets and change the offset range to the values shown below (the value to be changed is shown in bold):

Changes to 2nd auto shape set

```
chain   /   offset
   ROUTE50     -42.0000
   ROUTE50     -64.0000
```

Change to 4th auto shape set

```
chain   /   offset
   ROUTE50      42.0000
   ROUTE50      64.0000
```

Scroll down to the **Plot Parameters** section of the input file and change level (lv) and color (co) symbology to the values shown below in bold.

```
Plot Parameters
   Dependent Shape
      lv = 60
      co = 8
      lc = 0
      wt = 2
   Dependent Text
      lv = 60
      co = 8
   Independent Shape
      lv = 60
      co = 4
      lc = 0
      wt = 2
   Independent Text
      lv = 60
      co = 4
```

Save the file as **shape_50_slp.inp**. This input file will be run later.

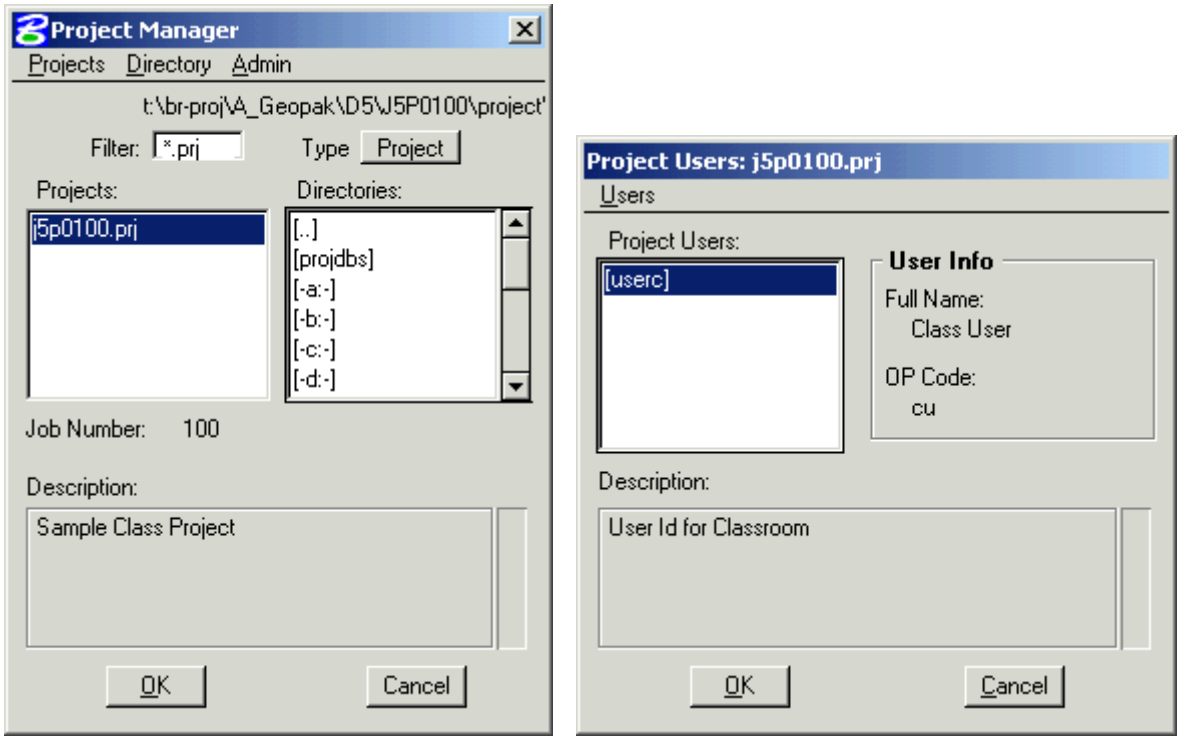
Exercise 14-2

This is a group exercise to demonstrate the use of the GEOPAK superelevation tools to help determine end locations. Specifically, the tools will be used to find elevations from two shapes to locate where they intersect.

This exercise is based on the following design information: End of wing to end of wing length is controlled by the intersection of the spill slopes with the outside edges of the bridge deck. End bent locations are controlled by the requirement to maintain a minimum clearance of 1' from the top of the end bent beam to the top of the spill slope. This clearance needs to be checked at the outside face of the exterior girders unless the crest of a vertical curve for the lower roadway is located directly beneath the bridge. The location of the checks for this exercise was obtained from the cross section of the slab from Bridge Manual page 3.56.2.5-1 shown on the following page.

1. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\pattern_shape_j5p0100.dgn**.

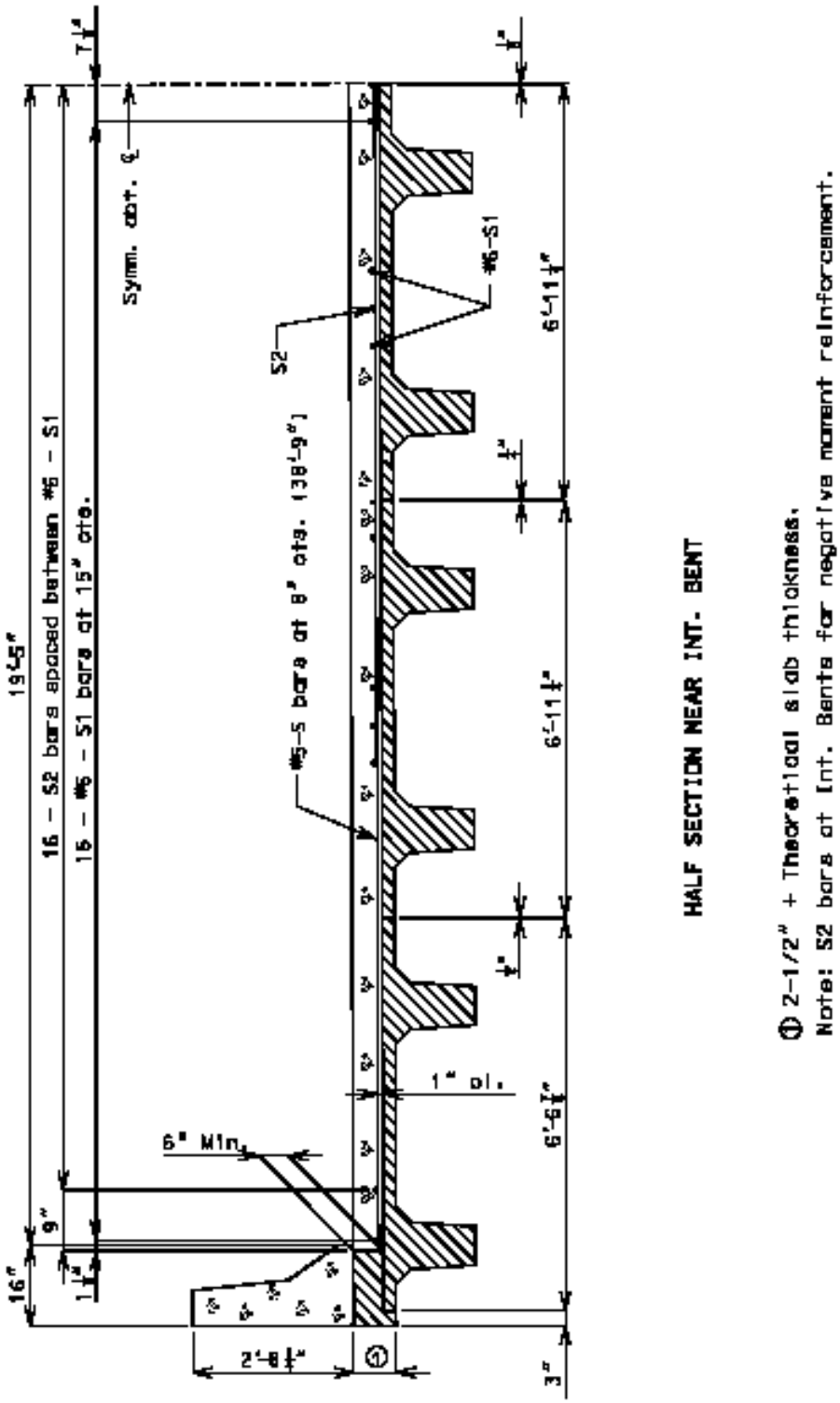
2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj** as user **userc** and enter **Road**.



3. Select the **Route50** working alignment.

38'-10" ROADWAY (HS20 & HS MILITARY)
SLAB REINFORCEMENT

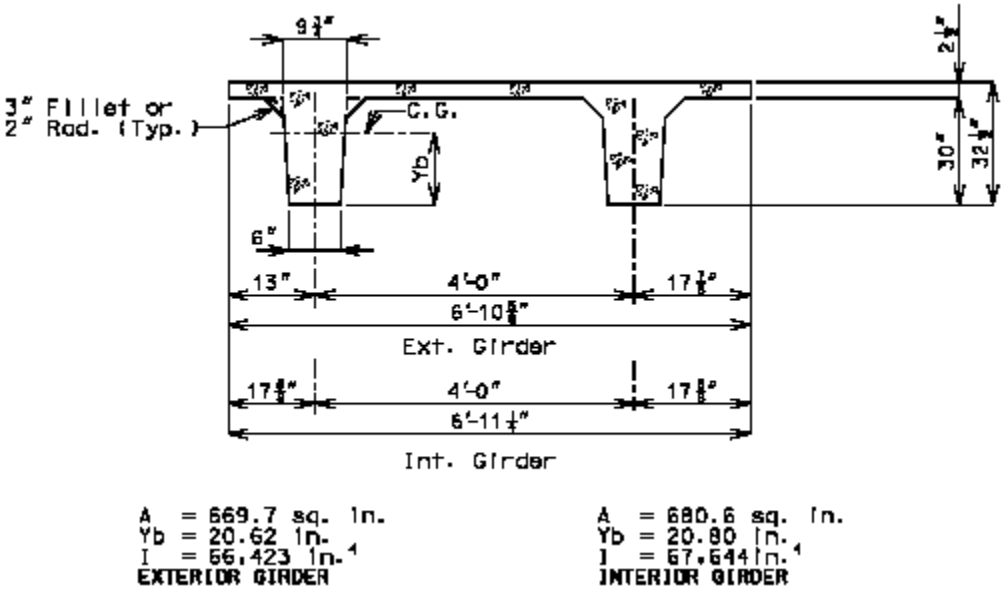
Reinforcement



4. **Determine Critical Offsets:** Away from the bridge, the roadbed width is 40' (6' left shoulder, + two 12' lanes + 10' right shoulder). Centering the structure on the roadbed places the centerline of structure two feet to the right of the centerline of the two driving lanes, which is 42' to the right of the highway's horizontal alignment. Consequently the centerline of structure is 44' (42' + 2') to the right of the alignment. Offsets for the bridge gutterlines are 24'-7" (44' - 19'-5") and 63'-5" (44' + 19'-5"). Adding the 16" barrier, the **offsets for the bridge deck edges are <u>23.25'</u> & <u>64.75'</u>**. These are the offset values that will be use to locate the intersect point of the spill slope with the bridge deck.

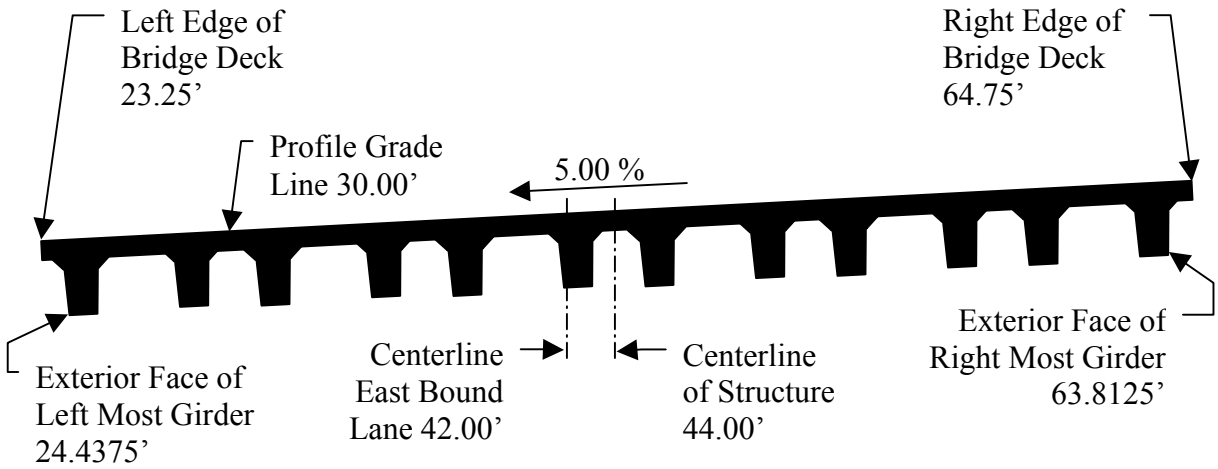
   The figure from the Bridge Manual on the previous page show the horizontal width of the flanges on the interior double-tees as 6'-11 ¼". Because the bridge is curved, this value will be increased to 6'-11 3/8" to reduce the maximum exterior overhang on the outside edge of the curve.

   Also, because the deck is curved to the left, its edge will come in towards the girders at center span by about 1 ½" on the left side and move away from the girder on the right side by about the same amount. To account for that, the deck will be shifted to the right by 1 ½". The following figure from **BM page 3.56.1.6-10** shows that for a 38'-10" roadway and Type 30 girder, the normal overhang from the centerline of the exterior girder is 13". This will be increased to 14 ½" (13" + 1 ½") on the left and reduced to 11 ½" (13" - 1 ½") on the right side at the end of each span. With the 3" full depth cast in place slab overhang on the outside of the girder flange and with the 6" wide web, the exterior faces of the girders at the end bent will also be about 14 ½" from the edge of the slab on the left and 11 ½" from the edge of the slab on the right side of the deck at the end bents.



   Because the four interior girders have been widened by 1/8", the overhangs will be reduced by ¼" (2 girders per half section x 1/8"). Consequently, the **horizontal offsets from the alignment for the exterior girder faces are** 23.25' + 14 ¼" (1.1875') = **<u>24.4375'</u> on the left** side and 64.75' – 11 ¼" (0.9375') = **<u>63.8125'</u> on the right** side. These will be plotted to locate the top of the spill slopes at the ends of the bridge.

5. The location of the critical offsets are shown on the follow cross section of the bridge away from a bent. Because the slope of the roadway under the bridge is less than that of the bridges super elevation, exterior face of the right most girder will control the location of the end bents.



The first set is to determine the change in elevation along the bridge deck from the profile grade line to the critical offset. This change in elevation is based on the 5% superelevation on the bridge plus the offset distance from the profile grade line to the critical point. Based on the above figure this change in elevation is:

0.05 * (63.8125' - 30') = 0.05 * (33.8125') = 1.690625.

The 4.25' distance from the top of deck to the top of the fill slope must be subtracted from this value. Thus the total vertical offset from the Route 50 proposed profile to profile for the top of the fill slope at the exterior face of the right most girder is:

1.690625 – 4.25 = -2.559375.

Based on this information, create the needed profile. To do this, go into Coordinate Geometry for Job **100** with Operator Code **cu**. Use the **Element > Profile > Offset** tool with the following settings:

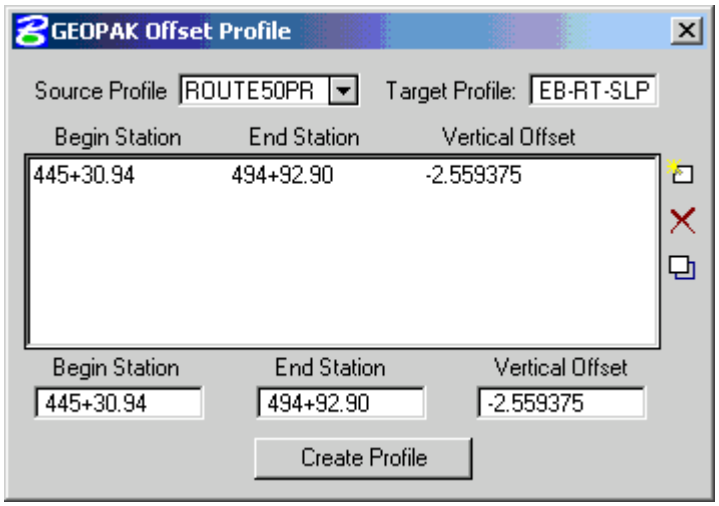
Source Profile = Route50PR

Target Profile = EB-RT-SLP

Begin Station = Route50PR beginning station

End Station = Route50PR ending station

Vertical Offset = -2.559375



6. Several tools from the **Superelevation Shape Manager** will be used to obtain elevation information from the shapes. The icon for the manager (shown above) is the forth icon from the right in the **Cross Sections** toolbox, which is located in the lower left hand corner of the **Road Tools** as shown in the figure to the right. The expanded Cross Sections toolbox is shown below.

Bring up the **Superelevation Shape Manager** shown below.

The tools in this pallet are:

Automated Superelevation,

Shape Maker,

Shape Profiler,

Shape Selector, and

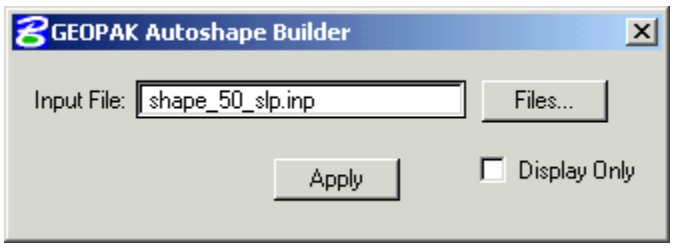
Autoshape Builder,

Shape Analyst,

Shape Editor,

Shape Properties.

Open the **Autoshape Builder**, shown to the right. Click on the **Files…** button and select **shape_50_slp.inp**. Press the **Apply** button to run the input file.



To off level 63.

7. In order to find the needed elevations, plot the outside face of the right exterior girder. Elevations from the shapes will be obtained at set intervals along this line.

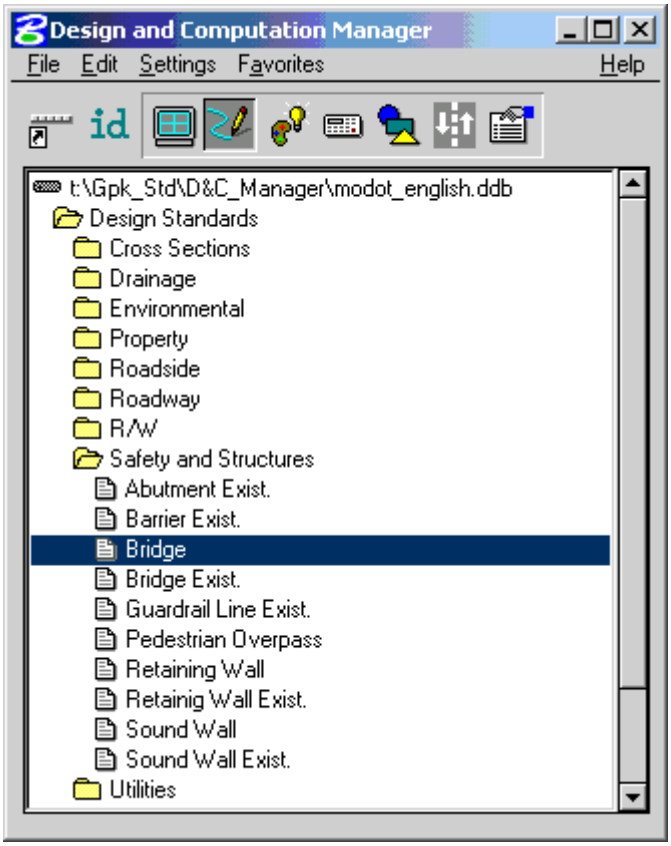
   To do this, open **Design and Computation Manager**.

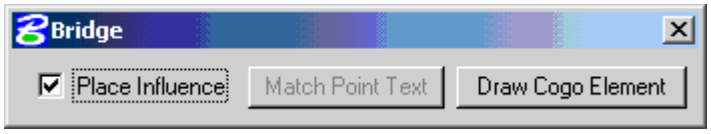
   Expand the **Design Standards** folder.

   Open **Safety and Structures** subfolder as well.

   Select **Bridge** from the list of items in that folder, as shown in the figure to the right.

   Since a Design Standard is being plotted, make sure **Place Influence** is checked in the Operations box as shown in the following figure.



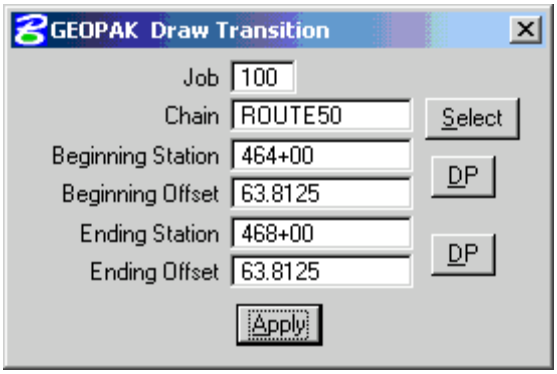


8. Use the **Draw Transition** tool (the third icon in the Plan View Design tool box) to draw the following line relative to the **Route 50** chain:

Beginning		Ending	
Station	**Offset**	**Station**	**Offset**
464+00	**63.8125**	**468+00**	**63.8125**

   The values for drawing the line are shown in the figure to the right.

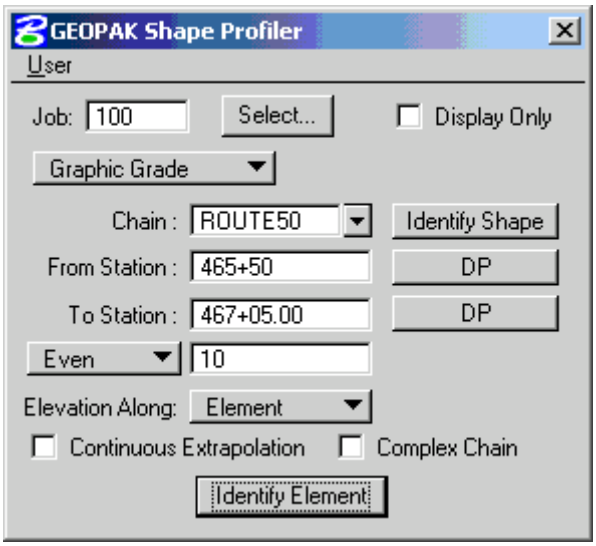
   After drawing the drawing the line, close the D & C Manager and Draw Transition dialogs.

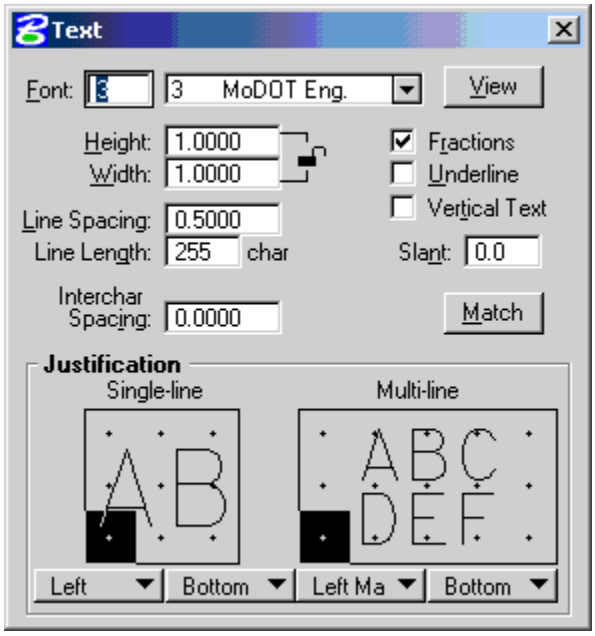


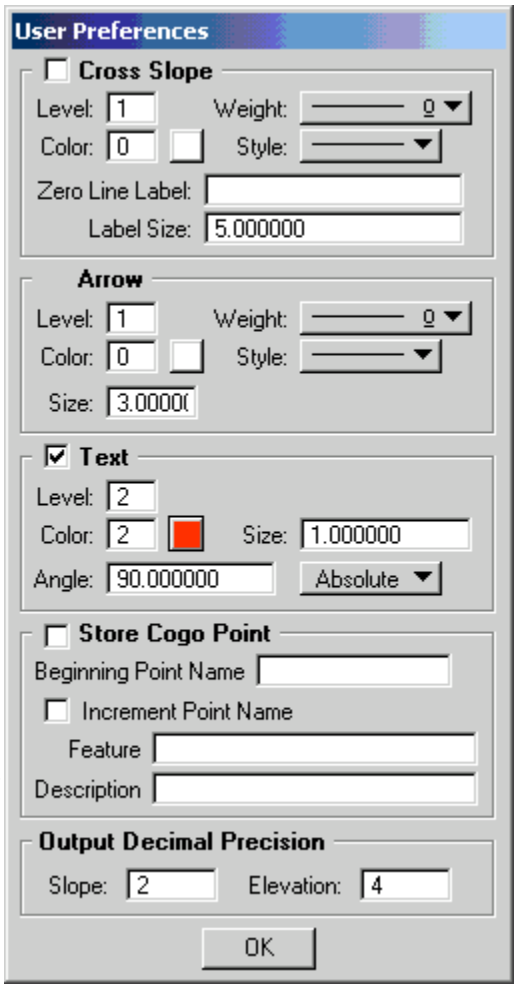
9. Open the **Shape Profiler** tool. This will bring up the top dialog to the right.

   Go to **User > Preferences** in Shape Profiler to customize the profilers output as shown in the bottom figure on the right. Use the setting shown in the figure. Click **OK**.

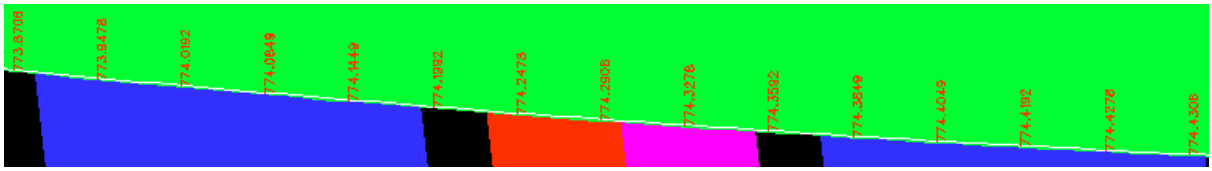
   Go to the MicroStation pull down menu **Element > Text** and set the justification to match that shown in the figure below.



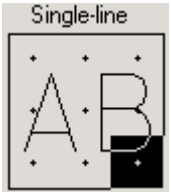




In **Shape Profiler**, click on **Identify Shape** and data point on the shape for the driving lane of eastbound Route 50 where it crosses Bighorn Dr. This will fill in the Chain and Station fields for the shape. Change the **From Station** to **465+50.00** and the **To Station** to **467+05.00**. Click on the **Identify Element** button, **data point** on the line defining the outside edge of the right exterior girder, and data point to **accept**. The end result is depicted in the figure below, which gives the elevations along the girder edge one foot below the top of the end bent beam.

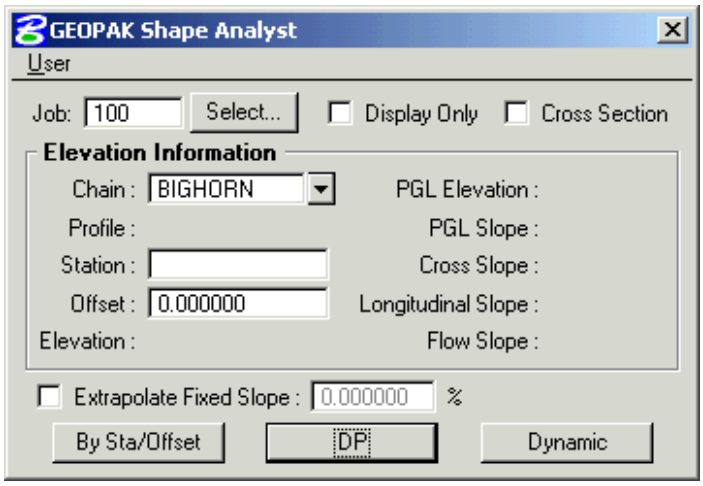


10. To determine the elevations on the fill slopes, use **Level Manager** to turn off levels 60 so only the shapes for Big Horn Dr. are visible.

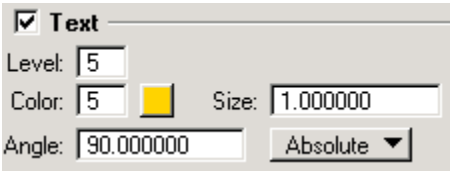


Switch the text justification to the lower right corner, as shown in the figure so the elevations for the fill slope are place opposite of the values just plotted.

Select the **Shape Analyst** tool by clicking on the following icon in the Shape Manager . This will bring up the dialog on the right. Select the **BIGHORN** chain.

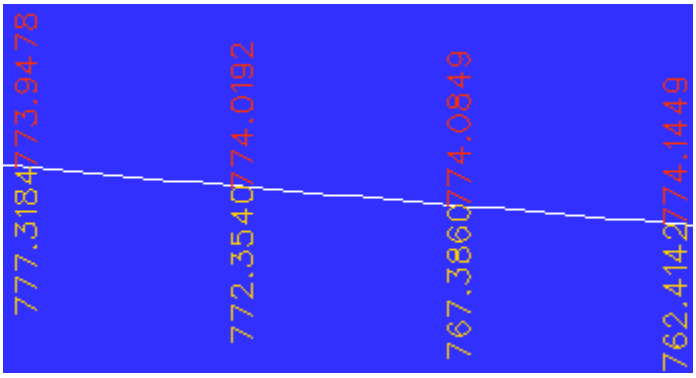


Go to **User > Preferences** and change the text settings to those shown below. Click **OK** to accept the changes.

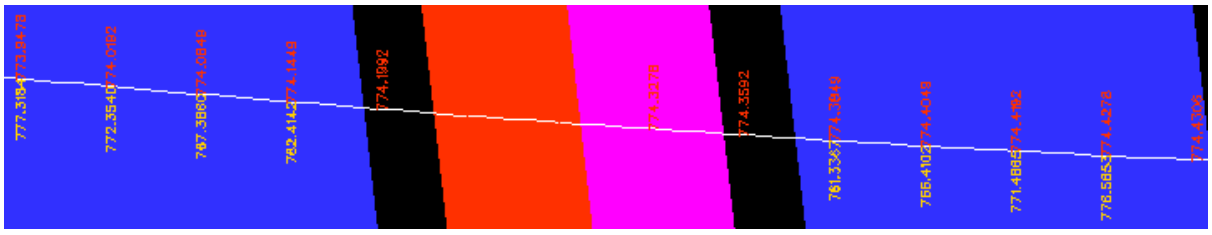


Set the tentative **snap** to **key point**.

Click on the **DP** button in **Shape Analyst**. Tentative snap on text giving the elevation at Station 465+70 (773.9478) and accept the snap, this will plot the fill slope elevation at that location. Repeat the process for the next three values plotted by the profiler. The end result is shown to the right.

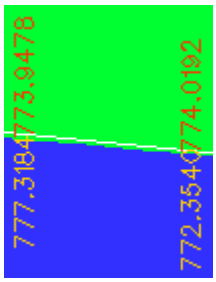


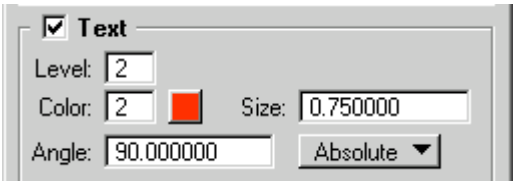
11. Move to other end of the bridge and plot the slope elevations at that end of the bridge, as shown in the following figure.



Turn on the display for level 60.

12. Window in on the SW corner between Station 465+70 and 465+80, as was done to create the figure on the right. The plotted elevations indicate that the projection of the fill slope goes above its maximum allowable height under the bridge deck in this station range. While linear interpolation could be used to establish a crossing point, greater accuracy can be accomplished by using the shapes. To do this, elevation information will be obtained from the shapes at 1' increments.

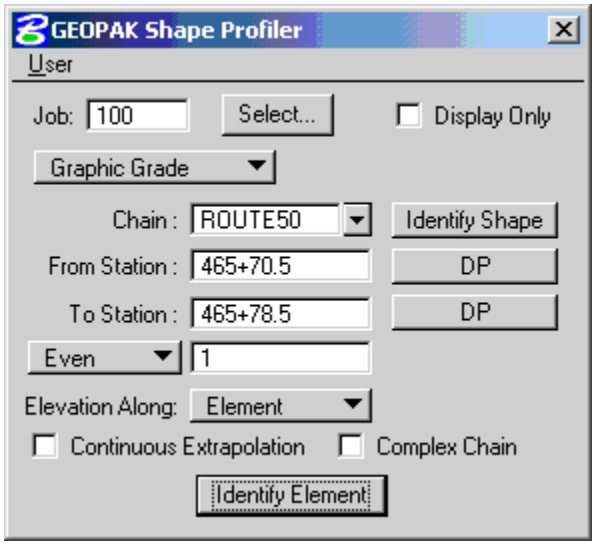




Switch to **Shape Profiler** and adjust the **User > Preferences** text settings to Level 2, Color 2, and Size 0.75 as shown to the left. The change in text size is being done to distinguish the foot from the 10' increment values.

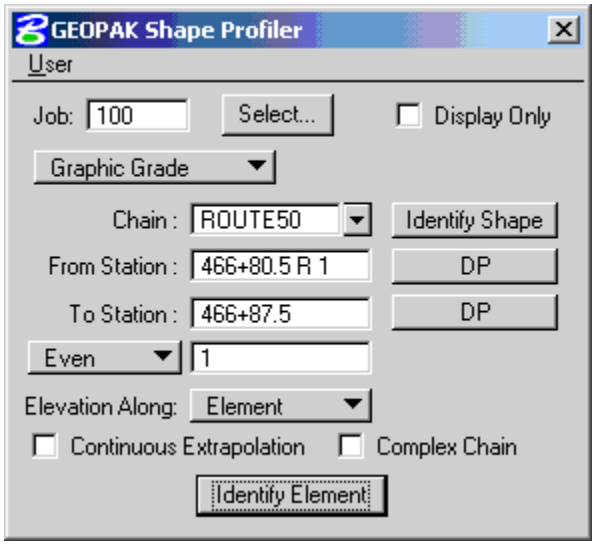
Change the text justification to bottom left, as shown to the left.

Based on the elevations given, the crossing point is between Route 50 Sta. 465+70 and 465+80; therefore, use **Shape Profiler** to plot elevations relative to Route 50 at Sta. 465+71 - 465+78 at 1' increments. Use the following settings as shown in the figure to the right:



Chain:	**ROUTE50**
From Station:	**465+70.50**
To Station:	**465+78.50**
Increment:	**Even 1**

Do the same thing at the other end of the bridge between Route 50 Sta. 466+80 and 466+90. Use the following settings:



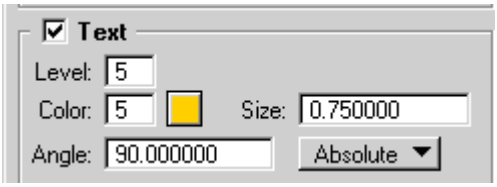
Chain:	**ROUTE50**
From Station:	**466+80.50**
To Station:	**466+87.50**
Increment:	**Even 1**

13. To obtain the elevations on the fill slopes, use **Level Manager** to turn off levels 60 so only the shapes for Big Horn Dr. are visible.

Change the text justification to bottom right.

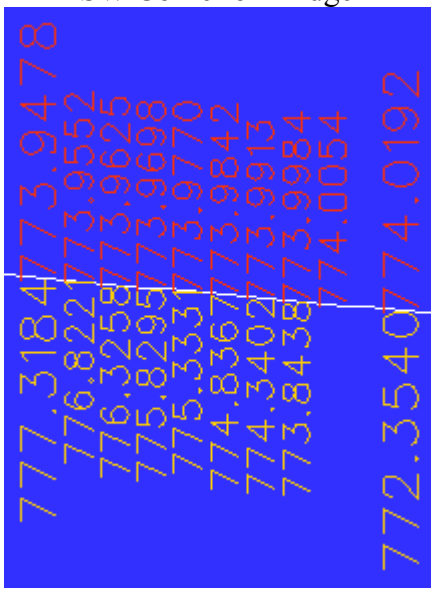
Select **Shape Analyst** by clicking on its icon in the Shape Manager . Select the **BIGHORN** chain.

Go to **User > Preferences** and change the text settings to those shown to the right. Click **OK** to accept the changes.

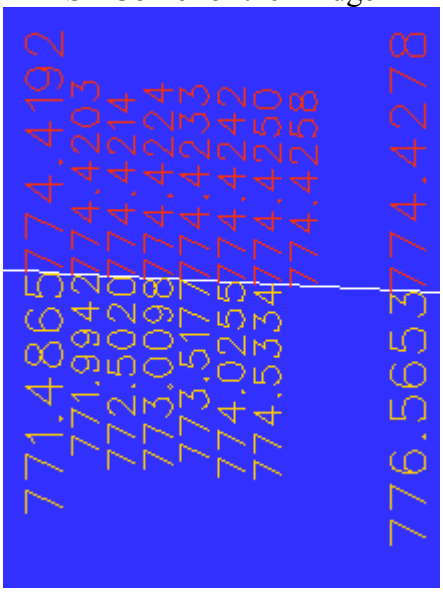


Make sure your **snap** is set to **key point**. Click on the **DP** button in **Shape Analyst**. Tentative snap on text plotted in the previous step. This will plot the fill slope elevation at that location. Screen captures from each corner of the bridge are shown below

SW Corner of Bridge



SE Corner of the Bridge



Compare your elevations to those given below.

Location	Station	Deck Elev. Minus 4.25'	Slope Elevation
SW Corner	465+76	773.9913	774.3402
SW Corner	465+77	773.9984	773.8438
SE Corner	466+85	774.4242	774.0255
SE Corner	466+86	774.4250	774.5334

Exercise 14-3

This group exercise will use the GEOPAK profile tools to plot proposed fill slopes under the bridge as they pass under the right exterior girder. Data from Exercise 14-2 provides the information needed to accomplish this task. Once the fill slopes have been plotted, they can be used to determine the minimum from front face to front face of the end bents. These will be horizontal lengths as measured along the alignment for Route 50.

1. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\profile_j5p0100.dgn**.

   Do a MicroStation fit-view. At the top of the drawing are three diagonal lines. Adjust the MicroStation window so you are zoomed in on the right most diagonal line and the text above it and to the right. This area will be used to plot the right edge of the bridge.

2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**.

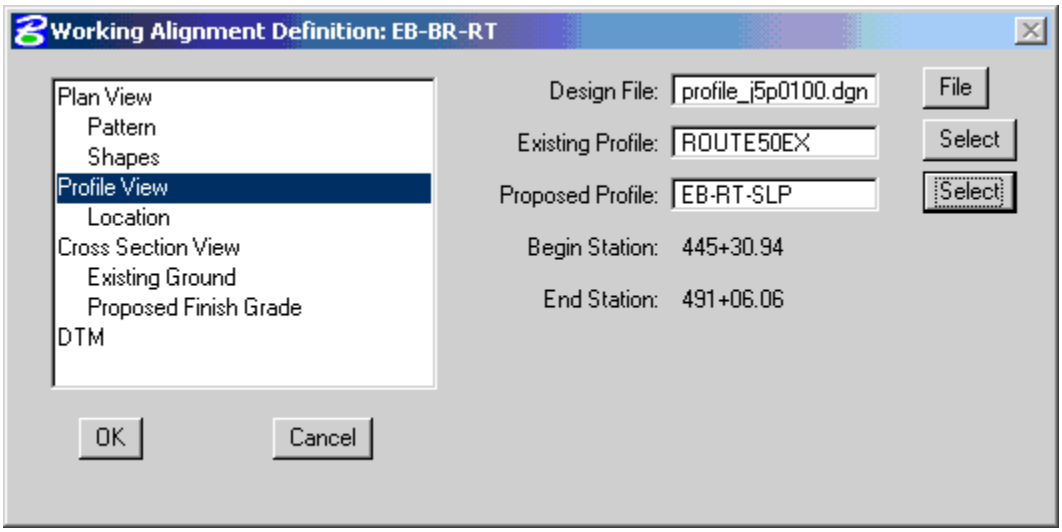
   Enter the as user **userc**.

   Go into **Road**.

3. To keep track of the information for the left edge of the bridge, copy the **Route50** working alignment to **EB-BR-RT** and enter that working alignment.

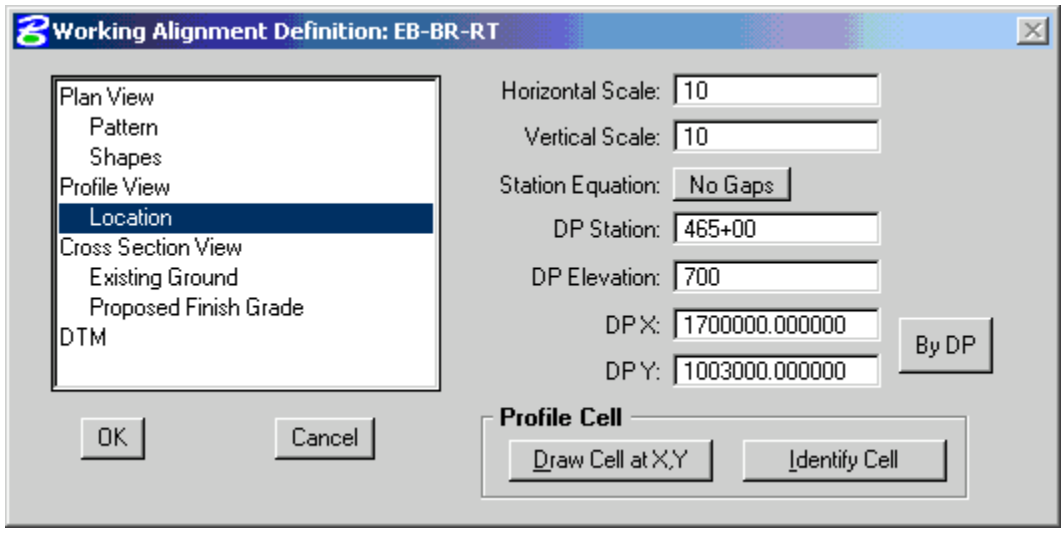
   Make the following changes in the **Profile View** section of the Working Alignment Definition:

   Proposed Profile: **EB-RT- SLP**



Adjust the values in the **Location** section of the Working Alignment Definition to those shown in the following figure:

Horizontal Scale:	**10**
Vertical Scale:	**10**
DP Station:	**465+00**
DP Elevation:	**700**



Click on the **By DP** button and snap to the upper end of the diagonal line and accept. This will set the DP X and DP Y values to those shown above.

Place the profile cell by clicking on the **Draw Cell at X,Y** button. The active MicroStation text setting controls size of the text in the cell.

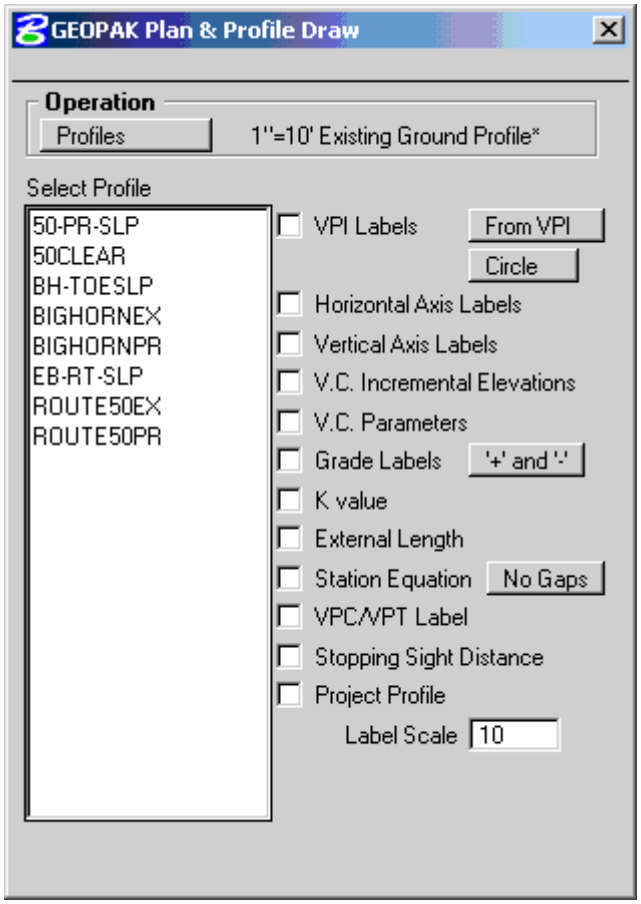
Save the changes to the working alignment definition by selecting the **OK** button.

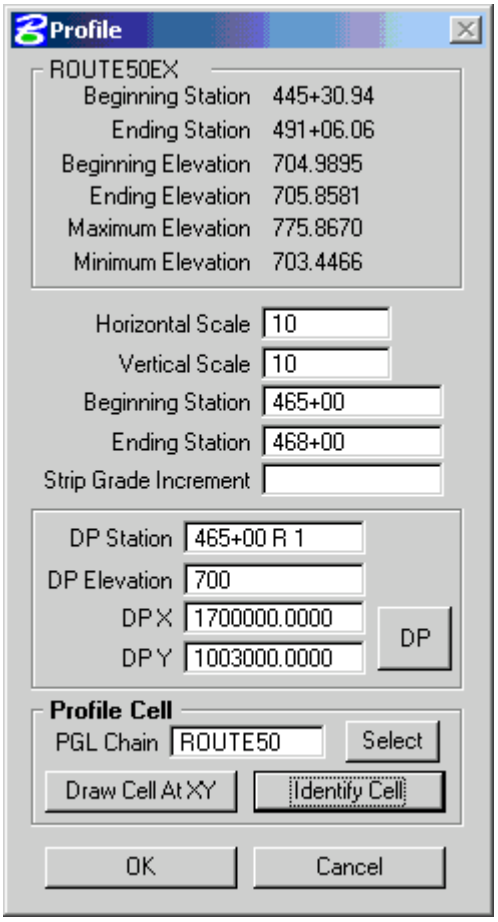
4. Open **Design and Computation Manager** (D&C) from Road Tools using the icon shown to the left. It will be used to plot the profiles for the left edge of the bridge. The first one to be plotted is **EB-RT-SPL**, which defines the maximum height of the fill slope.

Navigate to:
Drafting Standards\Profile\Existing Ground Profiles\1”=10’ Existing Ground Profile.

Click on **Draw Plan & Profile** in the Operations box shown below.

Change the label scale to **10** as depicted to the right and click on **ROUTE50EX** in the Select Profile list. This will bring up the dialog shown below.





Change the following values:

Begin Station: **465+00**
Ending Station: **468+00**

Click on the **Identify Cell** button, data point on profile cell plotted in the previous step, and data point to accept.

Select **OK** to plot the profile.

In D&C Manager, **double-click** on:

Proposed Ground Profiles\10 Scale Proposed Ground Profile 1"=10'' H & 1"=10' V.

This will update **GEOPAK Plan & Profile Draw** to the defaults for proposed profiles.

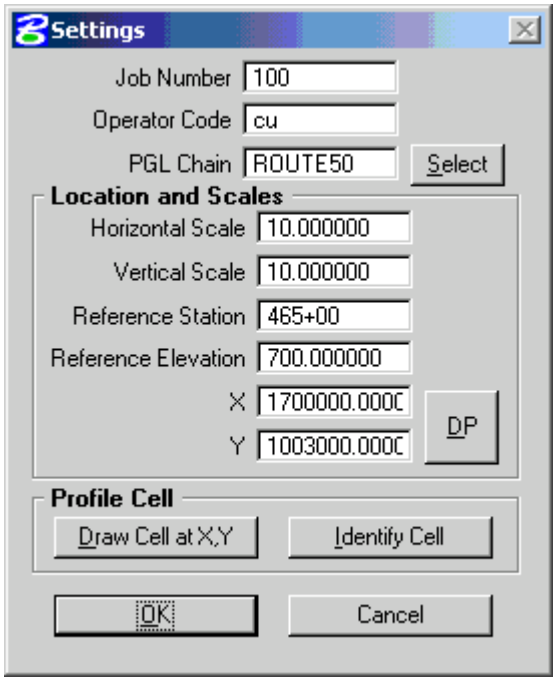
Select **EB-RT-SLP** from the **Select Profile** list.

The settings should be the same as shown above in the figure on the left except for the name of the profile at the top of the dialog and the profile information. Select the **OK** button to plot the EB-RT-SLP profile as the propose profile.

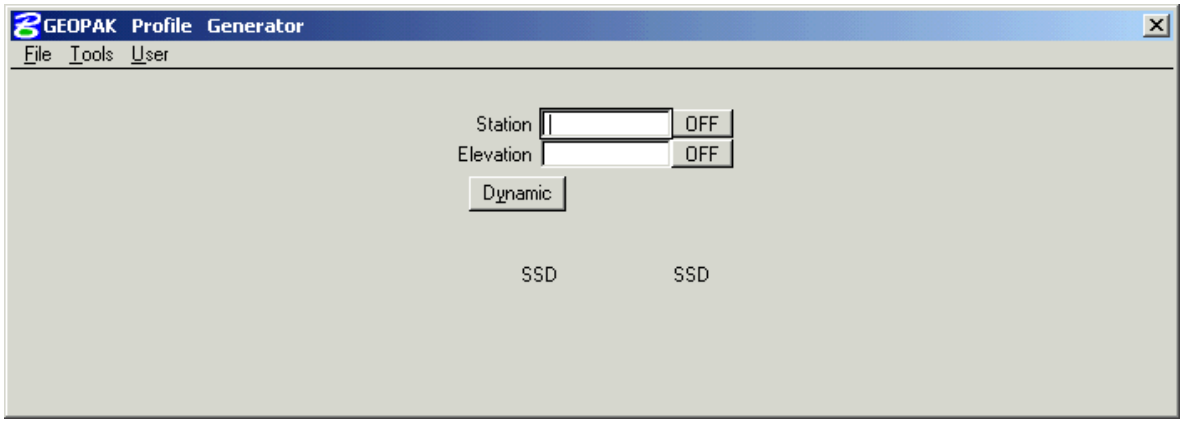
5. In the main D & C dialog, switch to:
   Design Standards \ Cross Sections \ Proposed Surfaces \ Ground (Proposed).

   Make sure **Place Influence** is turned **checked**. This will set the MicroStation symbology to those for fill slope under the bridge. Keep D & C open.

   Go into **Vertical Alignment** from the Road Project Dialog, which will bring up the **Settings** dialog box shown below.

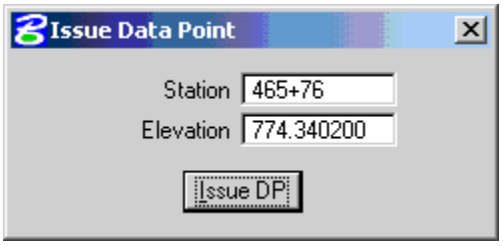


   Everything should be set from the Working Alignment Definition. If your settings do not match those shown above, click on the Identify Cell button in the dialog, data point on the profile cell for the EB-LT profiles. Click the **OK** button. This will bring up the **Profile Generator** dialog box:



   Go to **Tools >> Issue Data Point**.

6. Use the Issue Data Point to plot the fill slopes. To do this, active the MicroStation **Place Line** tool. Enter the following values into the Issue Data Point dialog as shown below:
   Station: **465+76** Elevation: **774.3402**.



   Click the **Issue DP** button to begin a fill slope line.

   Issue data points for the following values to draw the rest of the line:

Station	Elevation
465+77.00	773.8438
465+80.00	772.3540
465+90.00	767.3560
466+00.00	762.4142
466+07.44	758.7149

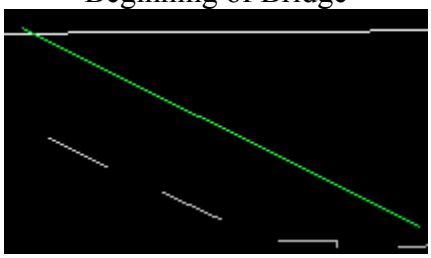
   Do a MicroStation reset to end the line. Draw a second line for the other fill slope using the following values:

Station	Elevation
466+55.20	758.9035
466+60.00	761.3367
466+70.00	766.4102
466+80.00	771.4865
466+85.00	774.0253
466+86.00	774.5334

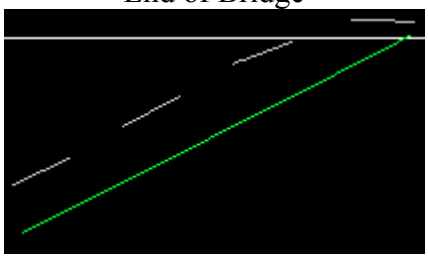
   Close D & C Manager and Profile Generator.

7. The lines plotted in the previous step are shown below. The point of interest is where the solid fill slope line crosses the line parallel to the proposed alignment.

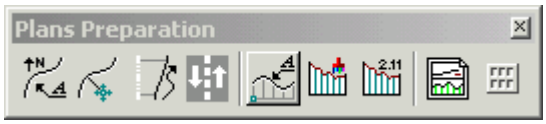
Beginning of Bridge



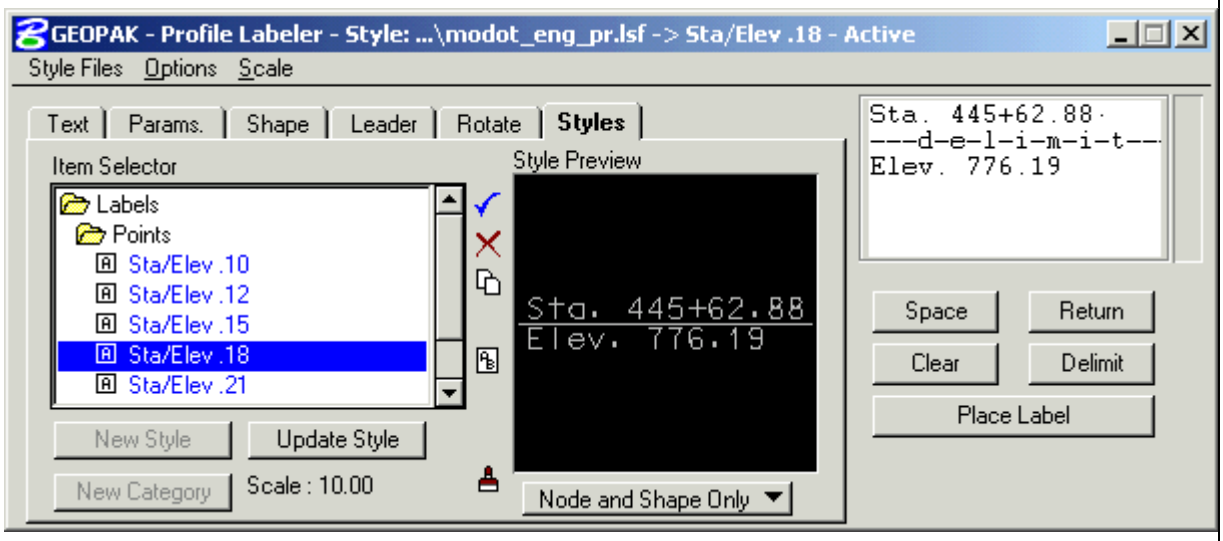
End of Bridge



8. Use the Profile Labeler to find the station and elevation where the fill lines and **EB-RT- SLP** cross. Profile Labeler is the fifth tool in the Plans Preparation toolbox shown below.

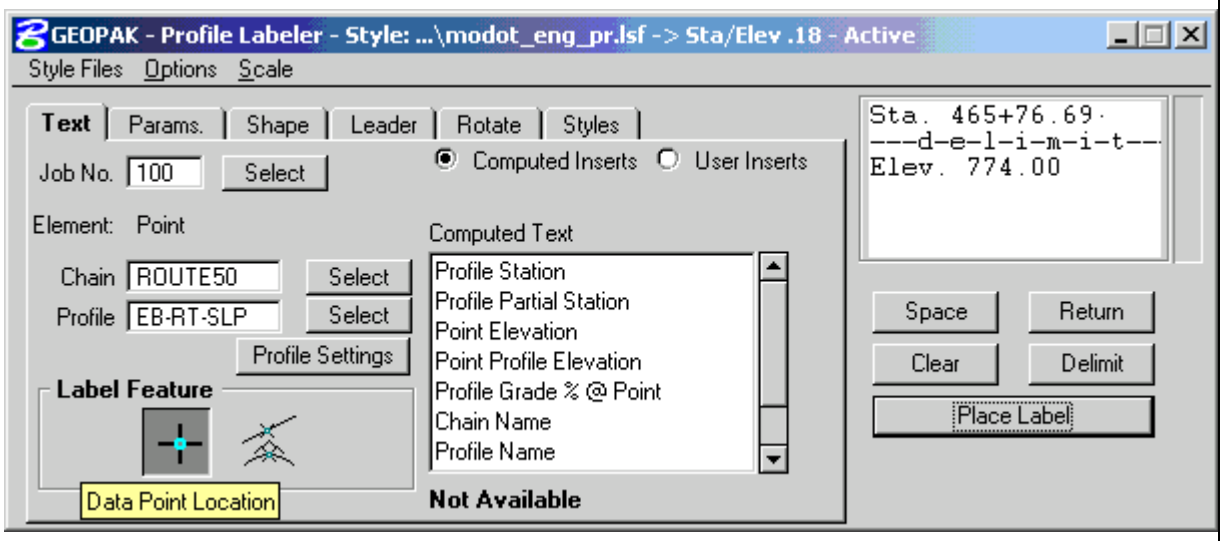


Go to the **Styles** tab in **Profile Labeler**. Open the **Points** folder and double click on the **Sta/Elev .18** style in the **Item Selector** as shown in the following figure.



Go to the **Scale >> Change Scale** pull down menu and make sure the **Scale Style** is set to **10**.

Switch to the **Text** tab and select the **Data Point Location** button indicated in the dialog box depicted below, snap to the intersection of the fill-slope line with the plotted profile and accept the snap.



Click on the **Place Label** button and place the label.

9. Compare your intersection points to the values given below.

Location	Station	Elevation
Bent 1	465+76.69	774.00
Bent 4	466+85.79	774.42

These station values can be used to determine the minimum distance from front face of end bent to front face of end bent along the right exterior girder. Remember, however, that the stationing is measured along the chain, which is at the centerline of median. This needs to be kept in mind when determining the actual bridge length.

Save changes to the MicroStation drawing.

Exercise 14-4

With the information from the previous two exercises, it is possible to layout the eastbound bridge. This group exercise will use COGO to store and plot needed locations.

1. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\plan_50_j5p0100.dgn**. Attach as a reference **t:\br-proj\a_geopak_\d5\j5p0100\data\plan_bh_j5p0100.dgn**. Window in on the intersection of the two alignments so Route 50 stations 465+00 to 468+00 are visible.

2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**.

   Enter the as user **userc**.

   Go into **Road**.

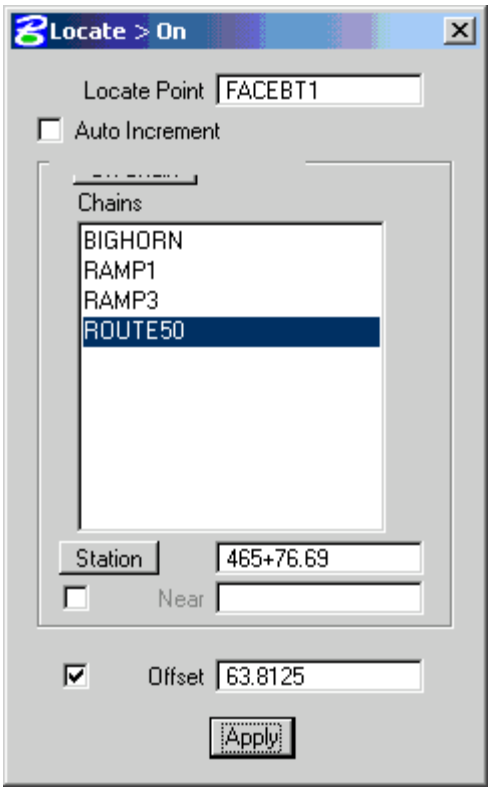
   Switch the Working Alignment to **Route50**.

3. Enter **Coordinate Geometry**.

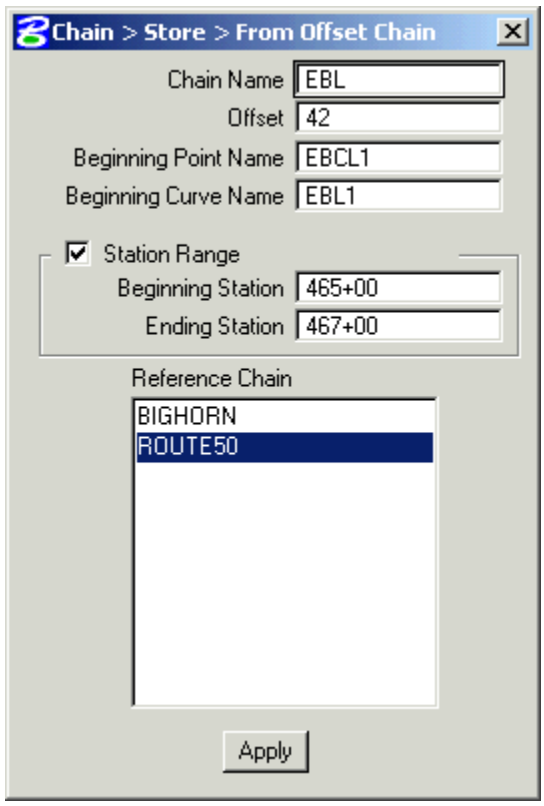
   Go to **Tools >> Locate >> On** to bring up the dialog shown to the right. It can be used to store a point on a curve, a spiral, or a chain. Choose the **On Chain** option. The **Station** option will be used to store points on chain **ROUTE50**.

   Store the points listed in the table below. They are based on information obtained in Exercise 14-2 and locate where the fill slope intersects the profile EB-RT-SLP, which determines the minimum distance from the front face one end bent to the front face of the other end bent. The stationing is for Route 50. The dialog box for storing the first point is shown to the right.

Location	Pt. Name	Station	Offset
Bent 1 Front Face	**EBRT1**	**465+76.69**	**63.8125**
Bent 4 Front Face	**EBRT4**	**466+85.79**	**63.8125**



4. The location of the bents is based on layout lengths along the centerline of the eastbound lane. Storing a chain at this location will ease the calculation of lengths along this line. Since this line is located 42' to the right of chain **ROUTE50**, the store chain from offset chain command will be used. The dialog for this command is located in the COGO menu **Element > Chain > Store > From Offset Chain** and is depicted below.



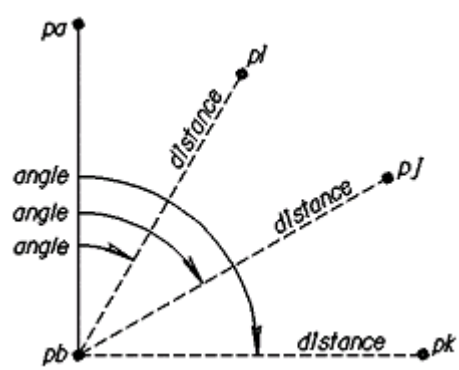
Fill out the top of the dialog box as shown, select **ROUTE50** as the Reference Chain, and press **Apply**.

5. The skew of the bents is based on a radial line to Route 50 running through the intersection of the Route50 and BigHorn alignments so that the bents are roughly parallel to Big Horn Dr. Determine the angle between this radial line and Big Horn Dr. where it crosses Route 50 chain by using the angle command:

ANGLE pa pb pi-pk,

where the point numbers are used as defined in the figure and referenced to the job as follows:

pa = PT BIGHORN-1
pb = 10 (Point at alignment intersection)
pi = CC ROUTE50-1



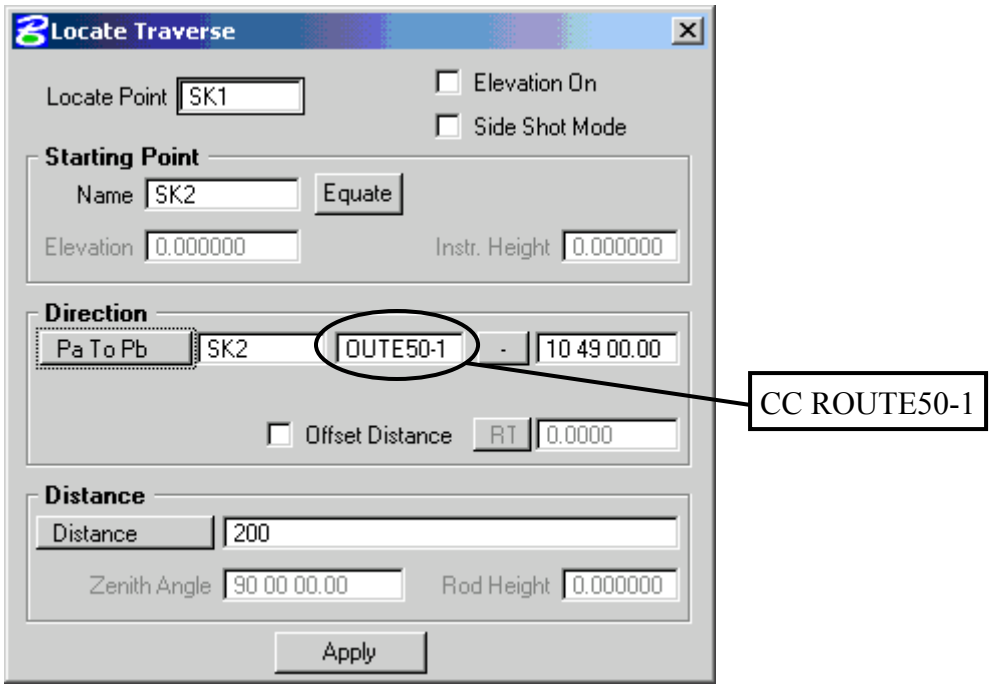
Key in the COGO command: **ANGLE PT BIGHORN-1 10 CC ROUTE50-1**

The returned value will be rounded to a right advance skew of 10° 49'.

6. Store two points (SK1 and SK2) to define the direction of the bents from left to right.

   Locate point SK2 at the intersection of the BIGHORN and EBL chains (Tools > Intersect).

   Locate point SK1 200' from SK2 on a direction 10° 49' to the left of a line from SK2 to the center of curve Route50-1 (Tools > Locate > Traverse). The dialog box is shown below:



7. Determine the minimum distance between centerlines of bearing at the end bents and point SK2 as measured along the centerline of the eastbound lane.

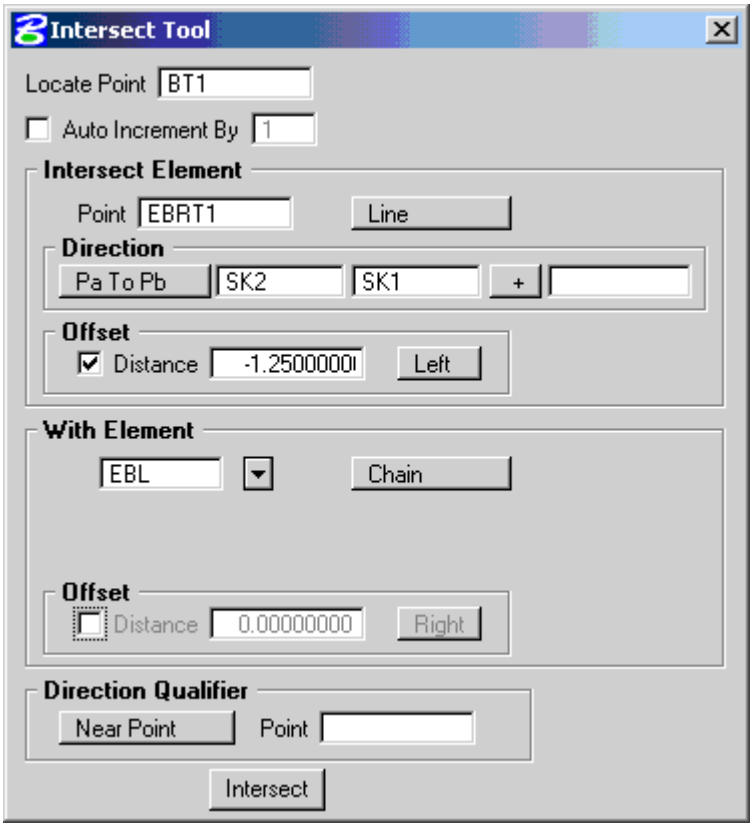
   To locate the points, use the intersect tool (**Tools > Intersect**) to project points **EBRT1** and **EBRT4** onto chain **EBL** using the direction from **SK2** to **SK1** with an offset of 15" (1.25'), which is one half of the with of the end bent beams. Call the new points **BT1** and **BT4**. The COGO Key-in commands are:

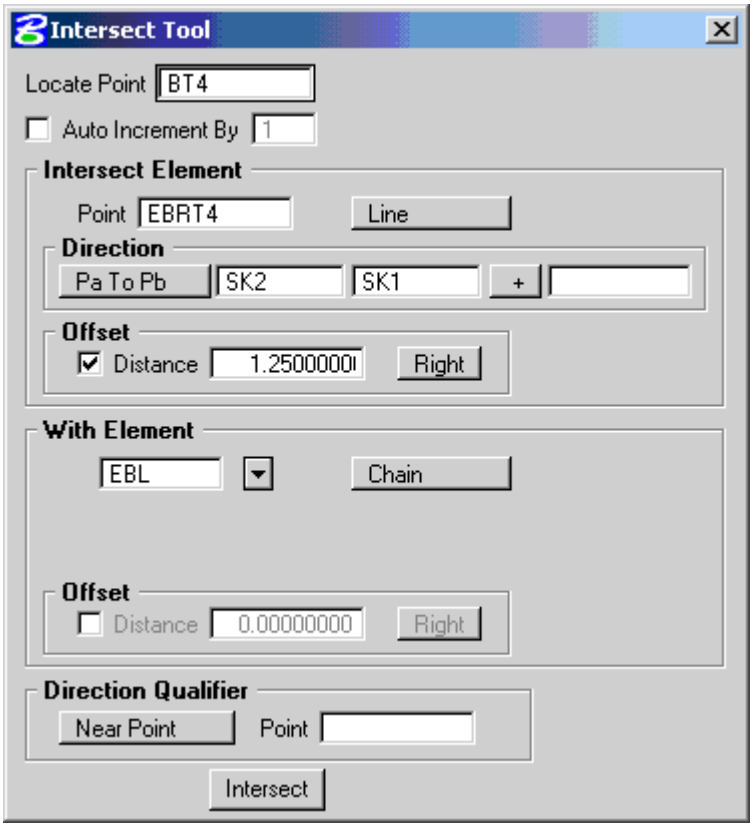
   LOCATE BT1 INTERSECT LINE EBRT1 SK2 TO SK1 OFF -1.2500 CHA EBL

   LOCATE BT4 INTERSECT LINE EBRT4 SK2 TO SK1 OFF 1.2500 CHA EBL

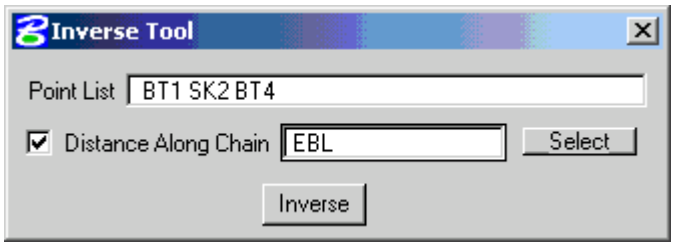
   The dialogs for storing these points are shown on the following page.

7. (Continued)


Intersect Tool
Locate Point BT1
Auto Increment By 1
Intersect Element
Point EBRT1
Line
Direction
Pa To Pb
SK2
SK1
+
Offset
Distance -1.25000001
Left
With Element
EBL
Chain
Offset
Distance 0.00000000
Right
Direction Qualifier
Near Point
Point
Intersect


Intersect Tool
Locate Point BT4
Auto Increment By 1
Intersect Element
Point EBRT4
Line
Direction
Pa To Pb
SK2
SK1
+
Offset
Distance 1.25000001
Right
With Element
EBL
Chain
Offset
Distance 0.00000000
Right
Direction Qualifier
Near Point
Point
Intersect

7. (Continued)
To measure the distance along the EBL chain for the points **BT1**, **SK2**, and **BT4**, us the inverse command (**Tools > Inverse**), as shown in the following dialog. Be sure to **toggle on Distance Along Chain** and enter **chain EBL**.



The COGO output is:

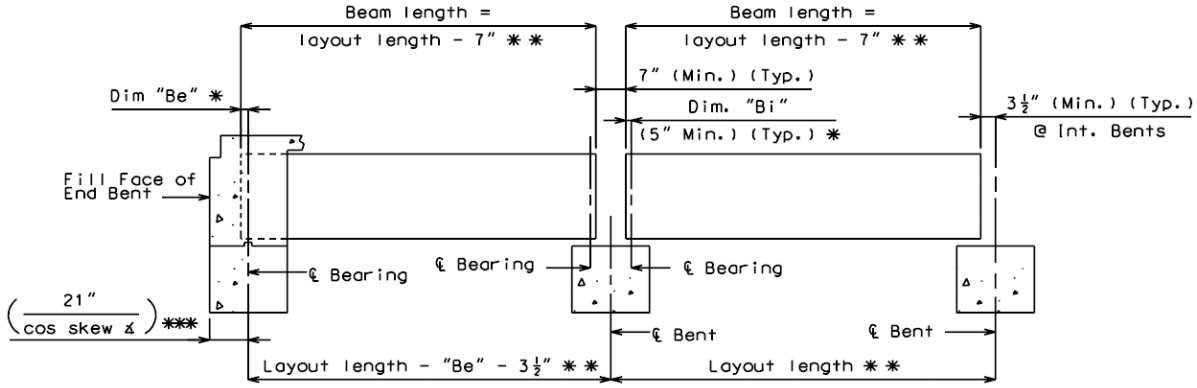
```
Point        X              Y             Station/Region  Offset  Distance
-----  -------------- -------------- --------------- -------- --------
BT1    1,700,121.9709   999,252.1784    465+71.97  1   0.0000
                                                                 57.2216
SK2    1,700,179.1964   999,247.5093    466+29.19  1   0.0000
                                                                 56.8846
BT4    1,700,235.9706   999,243.9813    466+89.07  1   0.0000
```

Consequently, the distance as measure along the centerline of the east bound lane between the centerline of Bent 1 and SK2 must be at least 57.23', 56.89' between SK2 and the centerline of the last bent, and 114.1' for the whole bridge.

8. Calculate the overall **Design Layout Length** for the bridge.

Based on **BM 3.55.3.1-3** (shown below), overall layout length for the bridge is:

$$\Sigma \text{ (CL Bent to CL Bent)} + 2 * (B_e + 3\ ½")$$



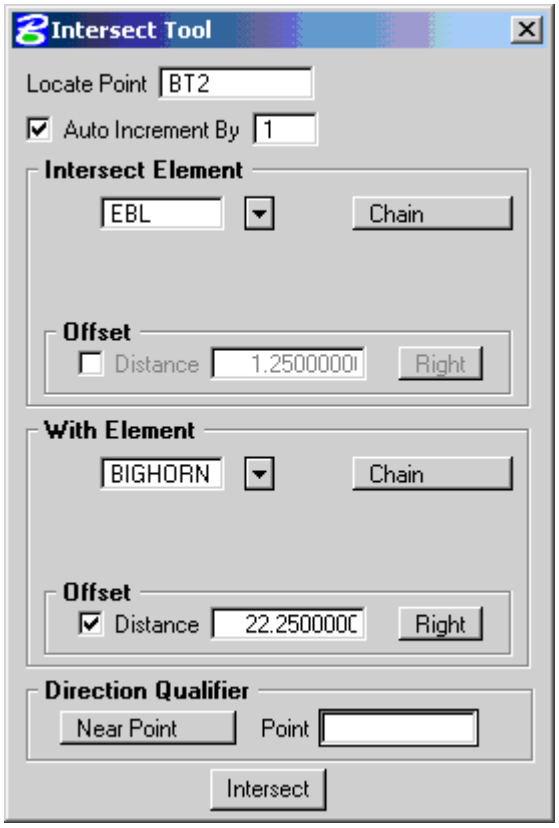
Integral End Bents

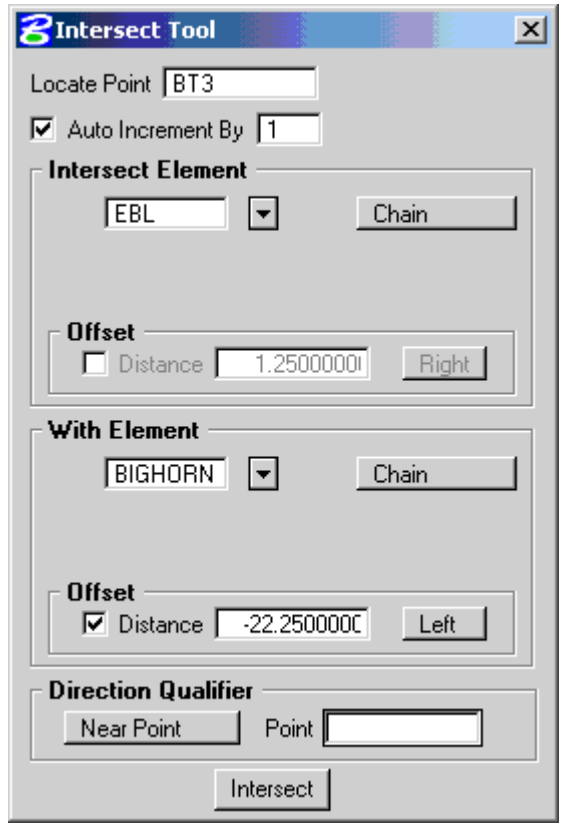
For this bridge B_e = 5 ½" and B_e + 3 ½" = 9" = 0.75'. Thus, the minimum layout length:

for the whole bridge = 114.1' + 2 (0.75' = 114.1' + 1.5' = 115.6' **Use 116'**
from Bent 1 to SK2 = 57.23' + (5 ½ + 3 ½)" = 57.23' + (0.75') = 57.98' **Use 58.0**
from SK2 to Bent 4 = 56.89' + (9)" = 56.89' + 0.75' = 57.64' **Use 58.0**

9. Determine the layout length for each span.

According **BM 2.4.1-2**, the minimum clearance between the front of the curb (offset of 18.5') and Bents 2 and 3 needs to be 2.0'. Assuming a maximum bent width of 3.5', the offset for the centerlines of Bents 2 and 3 from the BigHorn chain needs to be at least 18.5' + 2.0' + 3.5'/2 = 22.25'. Use the intersect tool to **store point BT2 at the intersection of chain EBL & chain BigHorn offset 22.25' to the right** and **store point BT3 at the intersection of chain EBL & chain BigHorn offset 22.25' to the left**. The dialog settings for storing the two points are shown below.





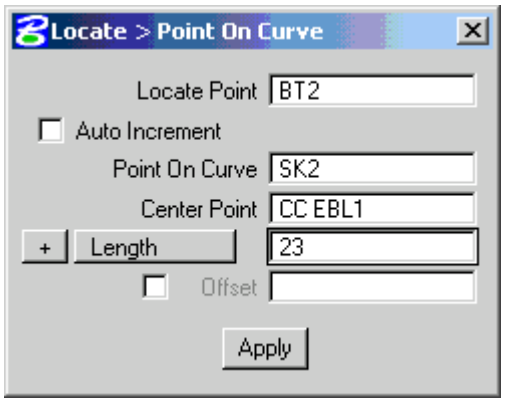
Use the Inverse command to find the distance along chain EBL for points BT2, SK2, and BT3. The results are:

Point	X	Y	Station/Region		Offset	Distance
BT2	1,700,156.6040	999,249.2238	466+06.53	1	0.0000	
						22.6575
SK2	1,700,179.1964	999,247.5093	466+29.19	1	0.0000	
						22.6243
BT3	1,700,201.7685	999,245.9731	466+51.81	1	0.0000	

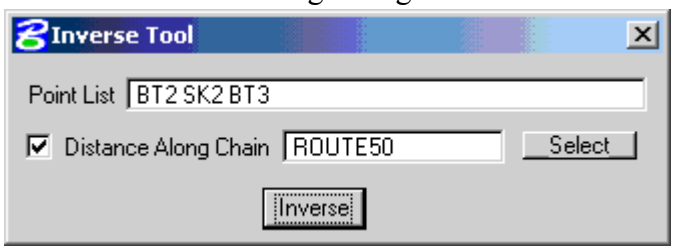
Rounding these values up to the nearest 0.5', use the following **layout lengths: Span 1-2 = 35.0'** (58.0 – 23.0'), **Span 2-3 = 46.0'** (23.0' + 23.0'), and **Span 3-4 = 35.0'** (58.0' – 23.0').

10. Determine the bridge's tie station, which will be at Bent 2.

    Use **Tools > Locate > Point on Curve** to **relocate point BT2 at the centerline of Bent 2 where it crosses chain EBL** using one half of the length of span 2-3 from SK2. The dialog is shown to the right.



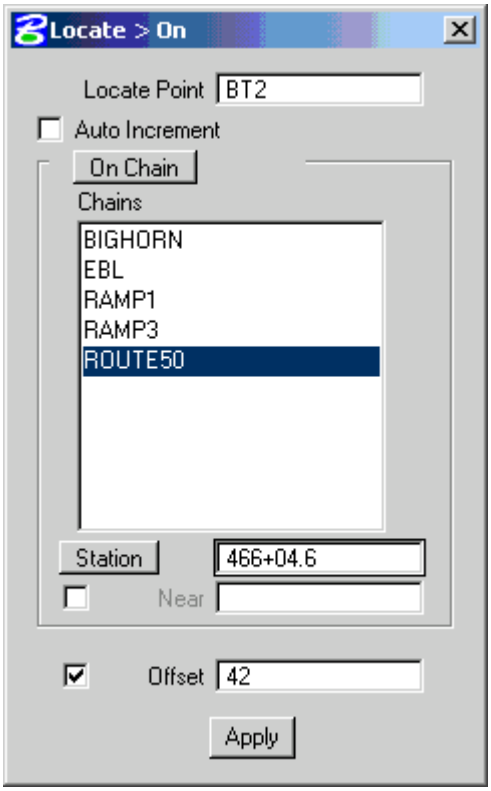
    Use the Inverse tool to find the station and offset of point BT2 relative to chain Route50. Since the inverse tool requires more than one point, some dummy points are included in the following dialog:



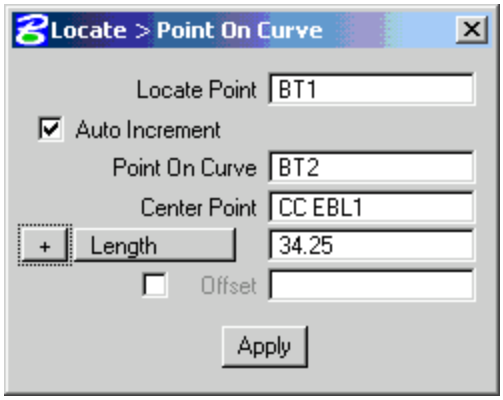
Base on the COGO output information shown below and rounding to the nearest tenth, the **tie station is 466+04.6**.

```
Point        X              Y          Station/Region  Offset  Distance
-----  -------------- -------------- --------------- -------- --------
BT2    1,700,156.2625   999,249.2511    466+04.65  1   42.0000
```

Use Tools > Location > On to restore point BT2 at chain Route50 station 466+04.6 and a 42' offset. The dialog with the proper settings is:

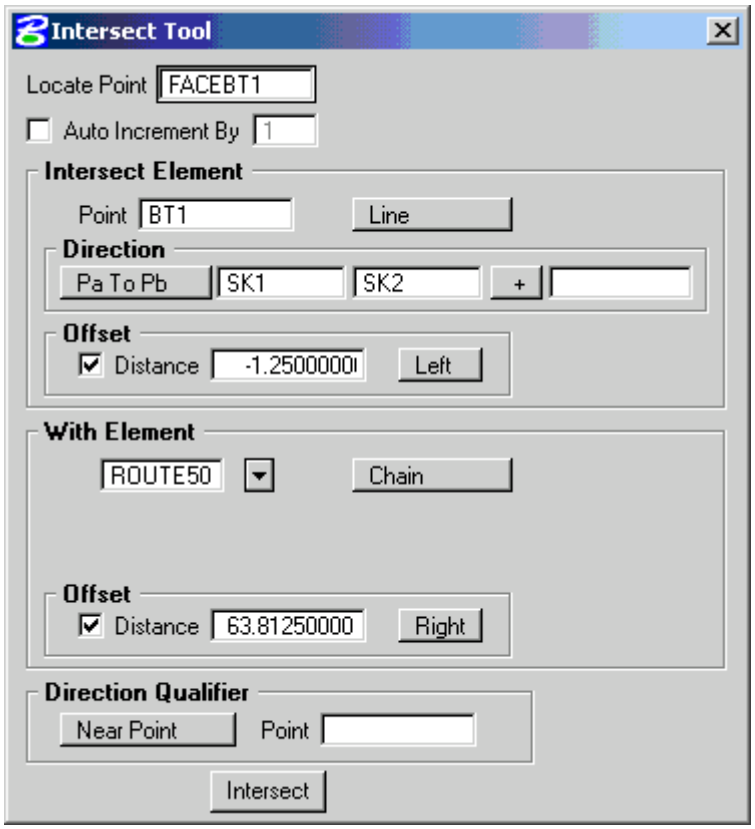


11. The intersection of the centerlines of the other bents with the centerline of the EBL can be located based on point BT2 and the span layout lengths. Use **Tools > Locate > Point on Curve** to **relocate points, BT1, BT3, and BT4 where the centerline for each bent crosses curve EBL1**. The distances along the curve are given in the following table. The dialog for storing point BT1 is shown to the right.



Point	Dist. along EBL1 from tie	Direction
BT1	35' - 0.75' = **34.25'**	+ (clockwise)
BT3	**46.0'**	- (counterclockwise)
BT4	46' + 35' - 0.75' = **80.25'**	- (counterclockwise)

12. Check the location of Bents 1 and 4. To do this, store two points where the front face of each end bent crosses the outside face of the right exterior girders (Route 50 offset 63.8125', as determined in exercise 14-2) and compare the points to EBRT1 and EBRT4. Call the new points FACEBT1 and FACEBT4.



Use **Tools > Intersect** to store the two points. The dialog for storing **EBRT5** is shown to the left. (**Note**: The 1.25' offset accounts for ½ of the beam width.)

Use **Tools > Inverse** to measure the distance along chain Route50 for the following list of points: **FACEBT1 EBRT1 EBRT4 FACEBT4**. If the station values relative to Route 50 are all increasing, the location of the end bents is okay.

Chapter 15

Proposed Cross Sections

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15.1 Objectives

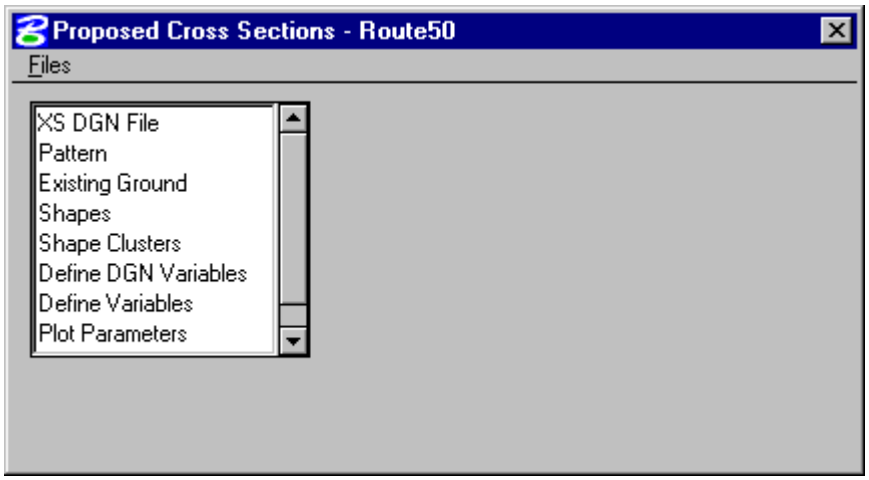
- Use Project Manager to create proposed cross-sections.
- Understand what criteria files are and how Geopak uses them to define proposed cross-sections
- Become familiar with MoDOT's criteria library.

15.2 Accessing

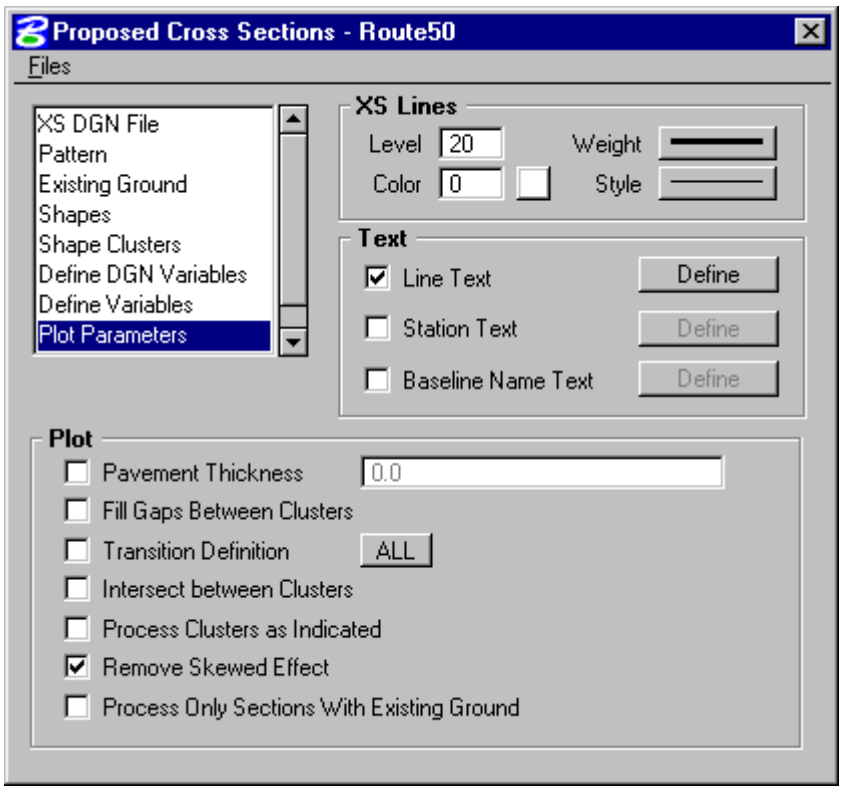
Proposed cross-sections can be accessed from **Project Manager >> Proposed Cross Sections**.

15.3 Dialog

When the **Proposed Cross Sections** button in the Road Project Manager is pressed, the Select Run dialog is displayed. An existing run may be selected or new run may be started. When complete, press the **OK** button, which will close the Select Run dialog and open the proposed cross sections dialog as depicted below.

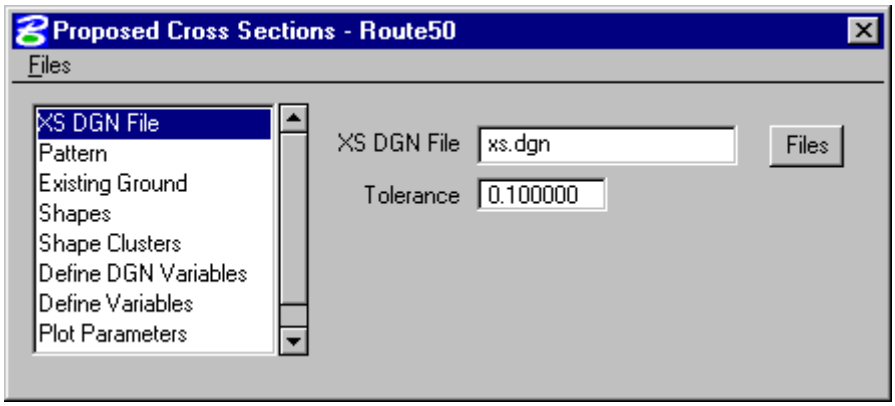


The left side of the dialog contains the list of parameters required to process proposed cross sections. When each parameter is selected, the dialog changes to reflect the requirement of each parameter. For example, when **Plot Parameters** is selected, the dialog changes to reflect the various plot parameters and text as depicted on the next page.



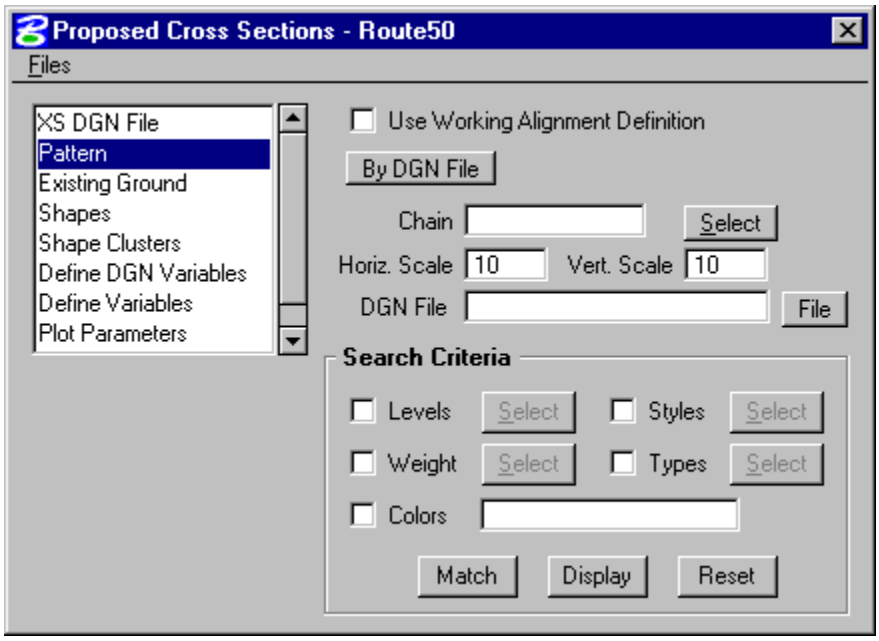
15.3.1 XS DGN File

XS DGN File controls the Microstation file in which the original ground cross-sections are located. The proposed cross section elements will be placed into this file.



15.3.2 Pattern

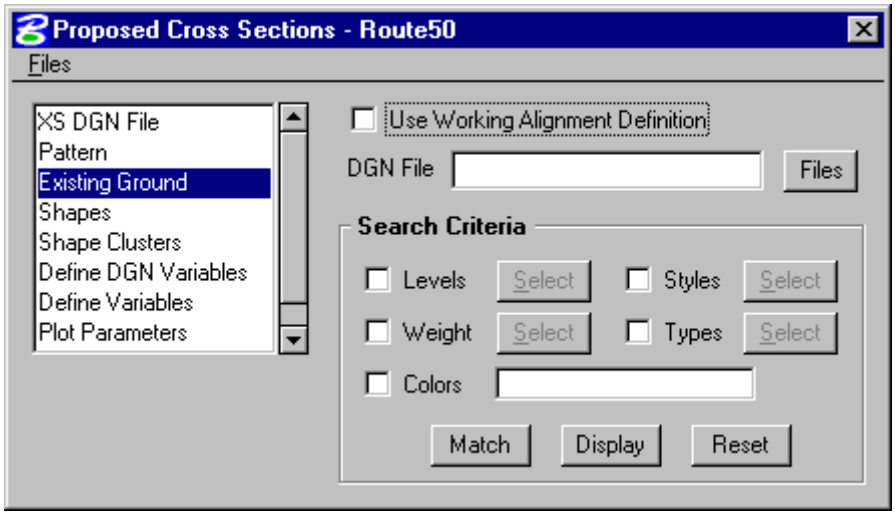
When **Pattern** is selected, the dialog changes to the illustration below. This section contains information on how to find the pattern lines used to create the original ground cross-sections.



Three dialogs (Pattern, Existing Ground, and Shapes) support a toggle to **Use Working Alignment Definition**. For example, in the Pattern dialog above, the toggle is not active; therefore the user must supply all pattern information. However, if the toggle is active when one of these three dialogs is invoked, the data information part of the dialog is ghosted and the required information is utilized from the current working alignment. If the toggle is activated, and the required information is not stored within the current working alignment, an Alert message is displayed. It is recommended to use the working alignment definition when this toggle is available.

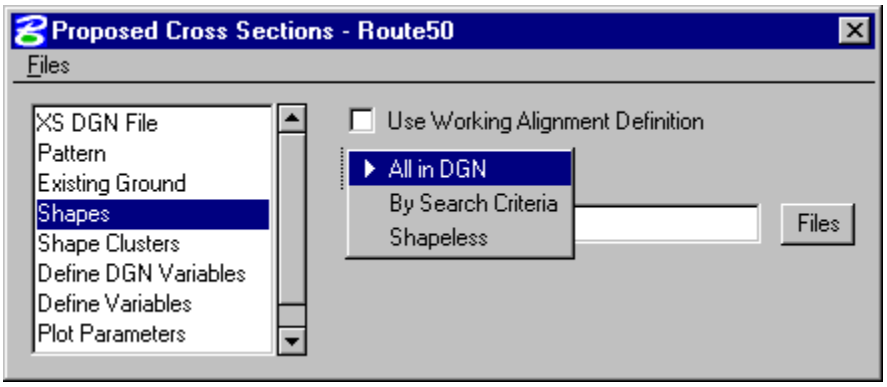
15.3.3 Existing Ground

Existing Ground section contains information to identify the symbology of the existing ground cross-sections. The user toggles on the **Search Criteria** options needed to identify the existing ground, then selects the values for those options. The **Use Working Alignment Definition** toggle is also available.



15.3.4 Shapes

When the **Shapes** parameter is selected, the dialog is displayed as depicted below.



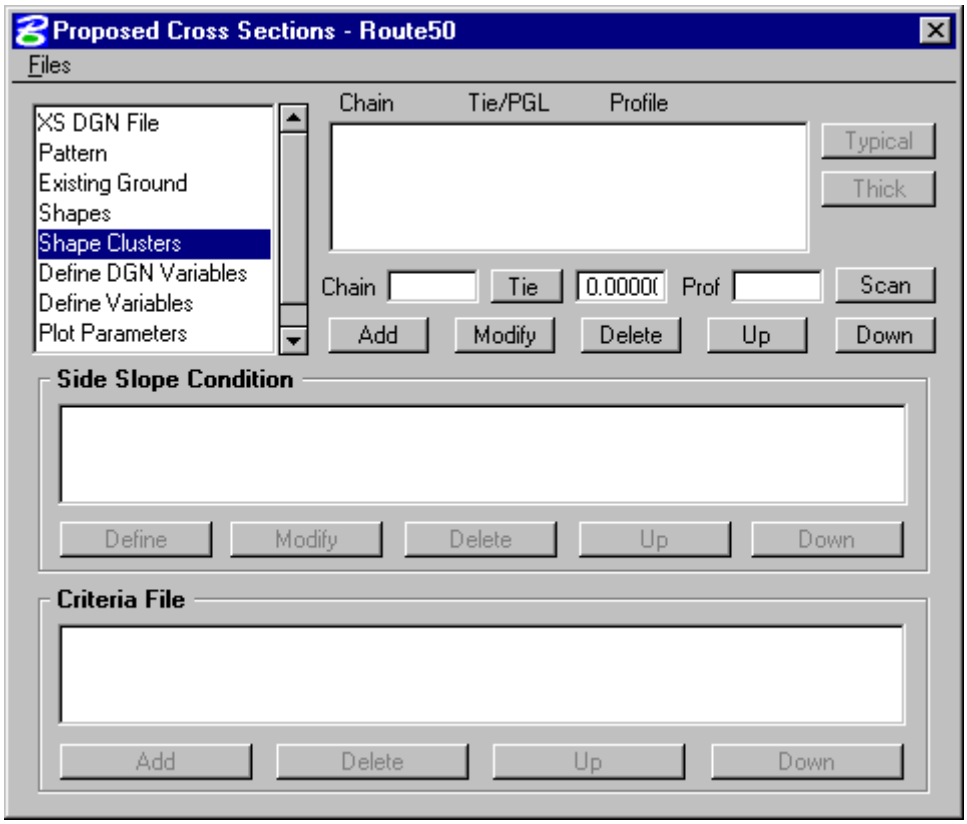
Three options are supported as depicted in the exploded view:

- **All in DGN** - All shapes within the specified file are utilized.
- **By Search Criteria** - Only those shapes that match the specified search parameters are utilized.
- **Shapeless** - No shapes are utilized. In this option, there is no field for a shapes file name or files button.

The **Use Working Alignment** toggle is also available.

15.3.5 Shape Clusters

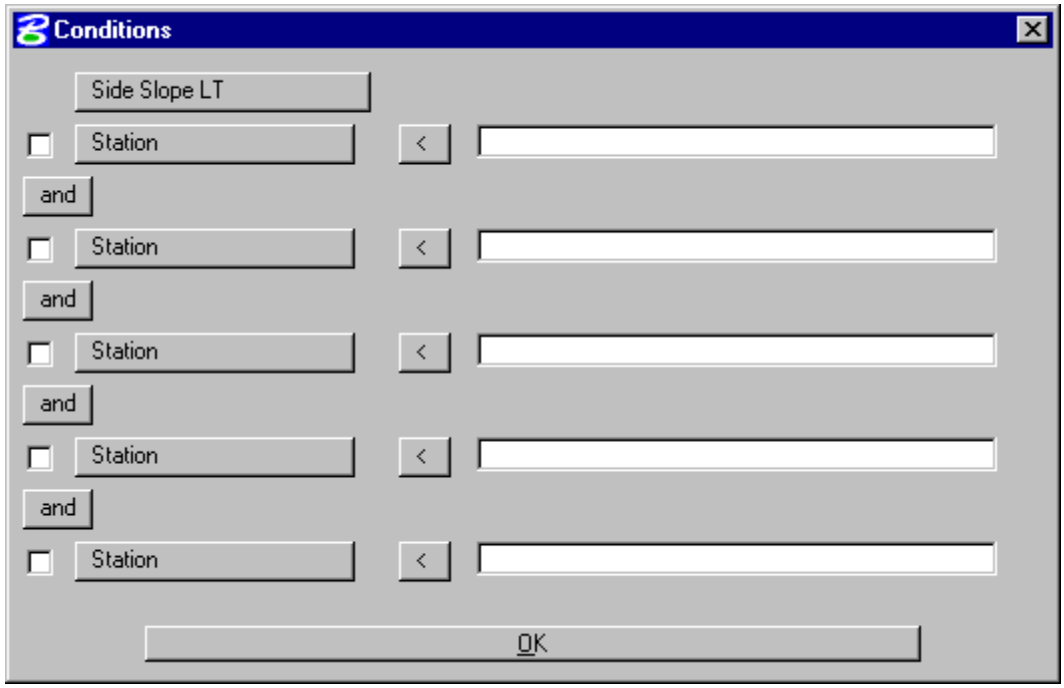
When the **Shape Clusters** parameter is selected, the dialog dynamically changes as depicted below.



The user may **Add, Delete,** or **Modify** any specified shape clusters. When the **Scan** button is pressed, Geopak scans the design file and uses the search criteria specified in the **Shapes** dialog to lists all matching shape clusters. In the case of shapeless criteria, the user must define the cluster by typing in the Chain, Tie/PGL and Prof, then pressing the **Add** button.

SIDE SLOPE CONDITIONS

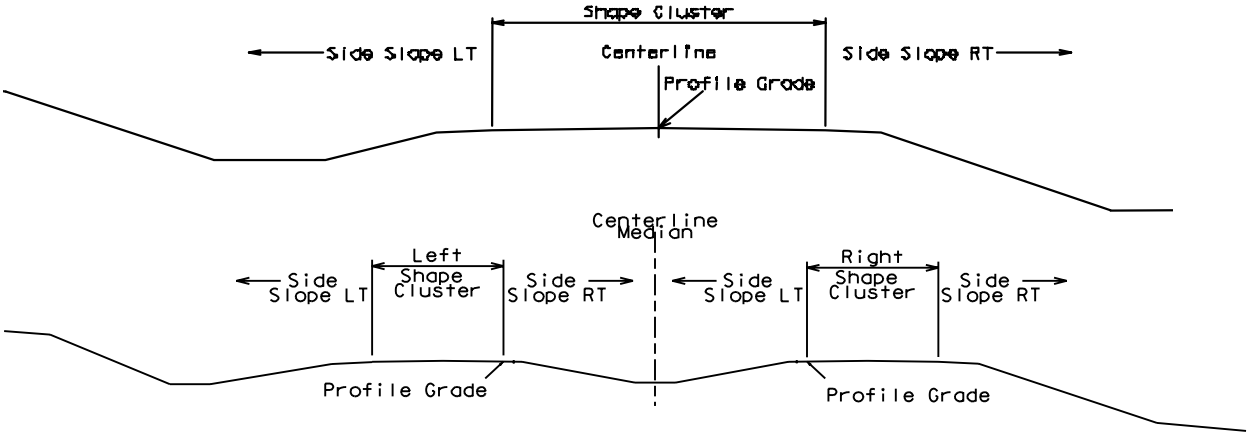
The **Side Slope Conditions** define what happens for each side of the shape cluster, and/or within a specified station range on the specified side of the shape cluster. To define a side slope condition, choose the **Define** button. The dialog box on the next page will open.



The user can choose **Side Slope LT**, **Side Slope RT**, or **Offset Minus/Plus Side Slope LT/RT**.

Certain conditions such as Station > 5+000, or Median Width <= 7.2 can be set up to apply the side slope information if those conditions are met. For example, the side slope condition *Side Slope LT where Station >= 15+00 and Station <= 23+00* would apply the specified criteria files (criteria files are discussed later) to the left side of the shape cluster only between and including stations 15+00 and 23+00.

It is important to remember that the side slope conditions pertain to the left or right side of the shape cluster, not the left or right side of the baseline.



CRITERIA FILE

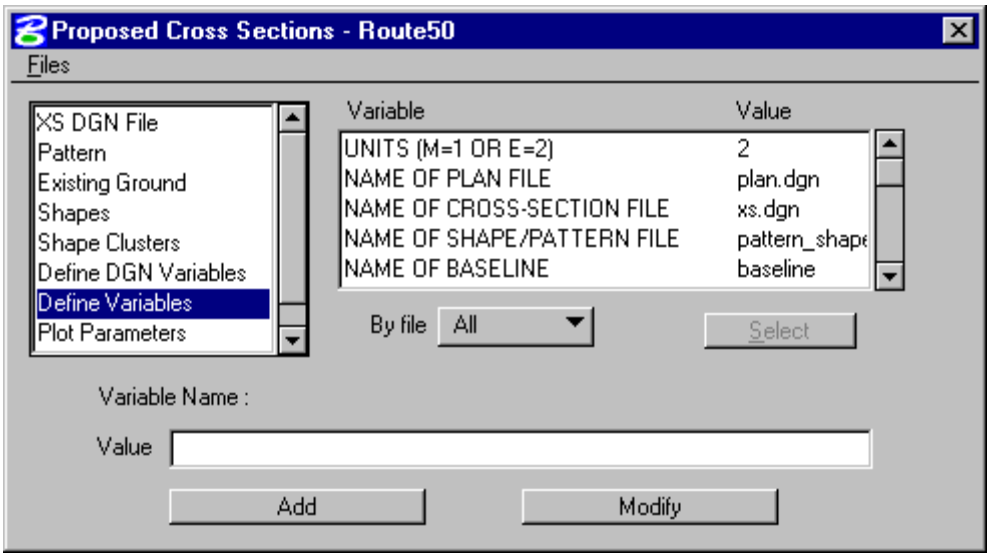
For each **Side Slope Condition** criteria files are added based upon the type of features to be drawn in the cross-sections. Criteria files will be covered in Section 15.4.

15.3.6 Define DGN Variables

The **Define DGN Variables** option allows the user to define how to locate Microstation elements used by the criteria files. **Define DGN Variables** can be determined from the element symbology, or from the symbology and attributes assigned in the D&C Manager database. MoDOT users do not need to define the DGN Variables. These are defined within the criteria files.

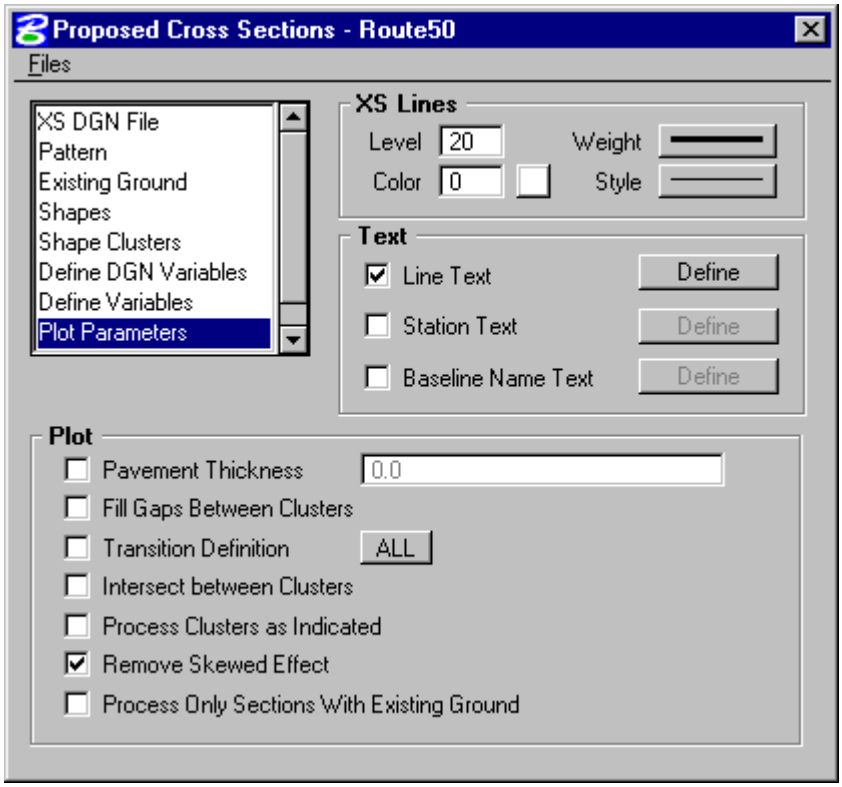
15.3.7 Define Variables

Define Variables are variables that allow the user to enter job specific values for certain variables. (I.e. pavement thickness, ditch width, backslope, etc.) The user can select the variable from the list, then enter the value and select the **Modify** button. The variables displayed will depend on the criteria files specified in the **Shape Clusters** section.



15.3.8 Plot Parameters

Plot Parameters allow the user to determine how the data from the superelevation shapes are going to appear. **XS Lines** determine the symbology of the pavement surface. **Text** plots various pieces of text relating to the cross-section. **Plot** allows the user to control different aspects relating to the cross-sections and criteria files.



Pavement Thickness will plot a depth of pavement below the pavement surface. MoDOT users should leave this value at 0.0. The pvmt_layers.x criteria file should be used to draw the depth of pavement.

Fill Gaps Between Clusters will draw a line between two shape clusters if the criteria does not fill between them.

Transition Definition defines the use of superelevation parabolic transitions. MoDOT users should use the ALL option.

Intersect Between Clusters will extend or trim elements in a median to create a finished, clean appearance.

Process Clusters as Indicated will force the criteria to process the clusters as they are listed in the **Shape Clusters** dialog. If this option is turned off, the clusters will be processed left to right.

Remove Skew Effect will force Geopak to correct itself back to the pattern line if a skewed element is encountered in the processing of the criteria files.

Process Only Sections With Existing Ground will process the proposed cross sections for only those cross section cells that have existing ground drawn.

15.3.9 Drainage

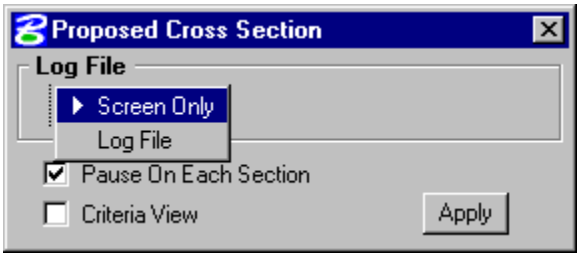
The **Drainage** section allows the user to draw the drainage components into the cross sections. The drainage .dgn file, and the drainage project database must be specified.

15.3.10 File Menu

Under **Files**, the options are **Run, Save Settings, Export...** and **Exit.** To process the cross-sections, press the **Run** button, which invokes the Process Cross Section dialog. **Save Settings** simply saves the current settings to the run, and can be recalled at a later time. When the **File > Export** option is selected, the user may save the dialog information in an ASCII input file for subsequent processing. The **File > Exit** option enables the user to exit the **Proposed Cross Sections** dialog box. The software also prompts the user with an **Alert** box if the settings should be saved before exiting. Pressing the **Yes** button will save the current dialog settings, **No** will not save the settings, but both buttons will exit to the **Project Manager**.

15.3.11 Process Cross Sections

When **File >> Run** is chosen, the dialog to the right appears.



The output can be displayed on the screen only, or written to a log file and displayed to the screen. The **Pause On Each Section** option allows the user to view each section as it is drawn. **Criteria View** displays each step in the criteria file. This is primarily for debugging purposes.

15.4 Criteria Files

One of the most powerful and flexible features of GEOPAK is the use of criteria in generating proposed cross-sections. Within criteria, design conditions can be evaluated and complicated design decisions executed in response to these design conditions. The flexibility of criteria allows the designer to make the design as basic or as complex as the project requires. Numerous baselines can interrelate as ditches and medians are drawn between roadways and ramps. Sophisticated drainage details can also be drawn with criteria. The list is endless.

Cross-section criteria are used to draw cross-section features outside of the mosaic of superelevation shapes typically representing pavement. Operationally, the software constructs

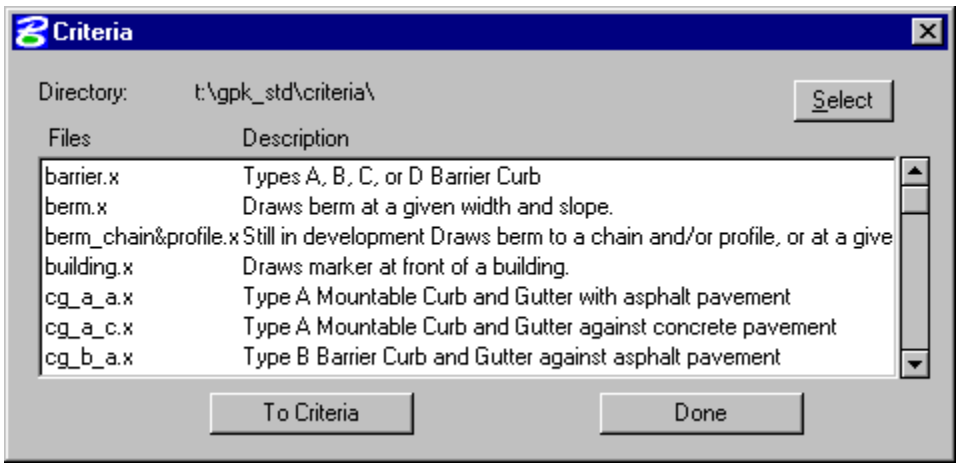
the cross-section features derived from the mosaic of shapes first. Then, the software constructs the remaining portions of the cross-section through the application of criteria emanating out from the outer edges of the mosaic of shapes.

MoDOT users will not need to know how to write criteria. A criteria library has been established, and continues to be expanded. As users encounter situations that require a new criteria file, they should contact the CADD Support Center to have that criteria file written. This will allow standardization within the criteria files, and allow the criteria library to grow so others can use these same files.

Note: Criteria files written or modified outside of the CADD Support Center, and criteria writing **WILL NOT BE SUPPORTED**.

15.4.1 MoDOT's Criteria Library

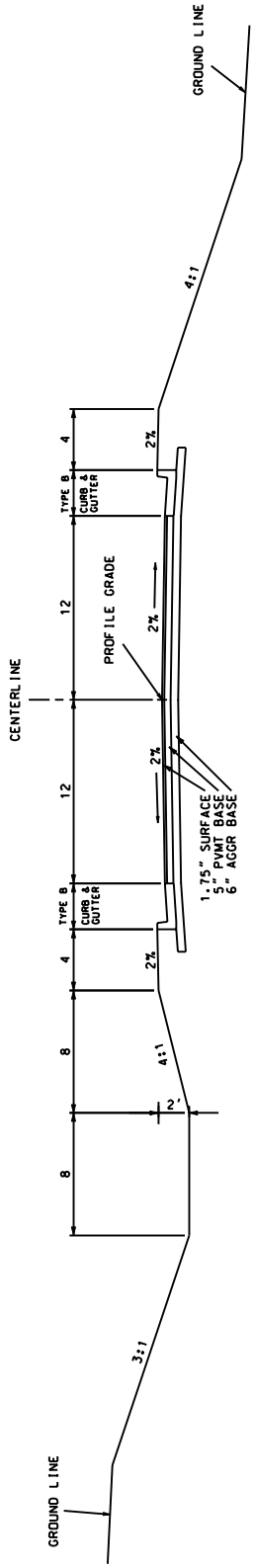
MoDOT's criteria library is located in the directory t:\gpk_std\criteria. Within the **Shape Clusters** section of the **Proposed Cross Section** dialog, the user can choose the **Add** button in the **Criteria File** portion of the dialog box. The following dialog will appear.



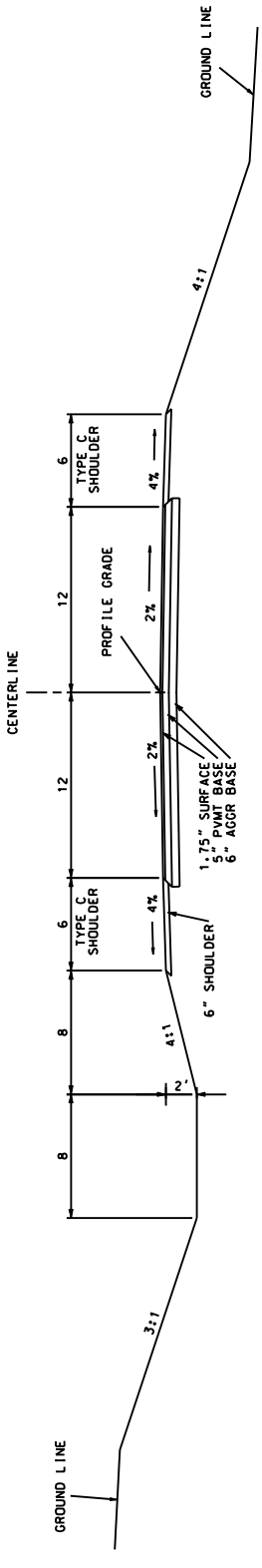
The user simply selects the criteria file to be included, and then clicks the **To Criteria** button. The criteria files must be listed in the order they are to be processed. Once they are selected, they can be re-arranged within the **Proposed Cross Sections** dialog box. (Other methods are being looked at for accessing criteria files.)

With each run, the **Setup.x** criteria file must be chosen as the first criteria file in each side slope condition. This file allows the user to choose the plotting scale and the files that are being used for the plan, shape, and cross-section information. This data is required for other criteria files.

The criteria files will have a short description to help identify what they will do. The criteria file name will also give a basic idea of what the criteria file is. For example, cg_b_c.x will draw a type B curb and gutter and cap the edge of pavement as concrete (vertical line). The file cg_b_a.x will draw a type B curb and gutter and cap the edge of pavement as asphalt (on a 1:1 slope). Help documents will be available on the intranet for further information on the files in the criteria library.



TYPICAL SECTION ROAD 1
STA. 0+00 TO STA. 25+30.18



TYPICAL SECTION ROAD 1
STA. 25+30.18 TO STA. 35+10.01

Side Slope Left and Right Where Station <25+30.18
setup.x
pvmt_layers.x
cg_b_a.x
berm.x
sideslope.x

Side Slope Left and Right Where Station >= 25+30.18
setup.x
pvmt_layers.x
shldr_c_a.x
sideslope.x

"UNITS (M=1 OR E=2)" 2
"NAME OF PLAN FILE" road1_plan_j2p0200.dgn
"NAME OF CROSS-SECTION FILE" road1_xs_j2p0200.dgn
"NAME OF SHAPE/PATTERN FILE" road1_pattern_shape_j2p0200.dgn
"NAME OF BASELINE" road1
"PLOTTING SCALE" 10
"PLOT PGL ELEVATION YES = 1 NO = 0" 1
"PAVEMENT LAYER 1 THICKNESS (MM OR IN)" 1.75
"PAVEMENT LAYER 2 THICKNESS (MM OR IN)" 5
"PAVEMENT LAYER 3 THICKNESS (MM OR IN)" 0.0
"PAVEMENT LAYER 4 THICKNESS (MM OR IN)" 0.0
"PAVEMENT LAYER 5 THICKNESS (MM OR IN)" 0.0
"PAVEMENT LAYER 6 THICKNESS (MM OR IN)" 0.0
"AGGREGATE LAYER 1 THICKNESS (MM OR IN)" 6
"AGGREGATE LAYER 2 THICKNESS (MM OR IN)" 0.0
"AGGREGATE LAYER 3 THICKNESS (MM OR IN)" 0.0
"AGGREGATE LAYER 4 THICKNESS (MM OR IN)" 0.0
"ROCK FILL BASE THICKNESS (M OR FT)" 0.0
"UNDERGRADING THICKNESS (M OR FT)" 0.0
"OVERBREAK THICKNESS (M OR FT)" 0.0
"SHOULDER SLOPE (%)" 4.0
"SHOULDER THICKNESS (MM OR IN)" 6
"BERM WIDTH (M OR FT)" 4
"BERM SLOPE (%)" 2.0
"LEFT BERM WIDTH PROFILE" bermwdth
"RIGHT BERM WIDTH PROFILE" bermwdth
"FILL SLOPE 1 (1:X OR X:1)" 4
"FILL SLOPE 2 (1:X OR X:1)" 2
"FILL SLOPE 1 WIDTH (M OR FT)" 8
"DITCH FORESLOPE (1:X OR X:1)" 4
"DITCH BACK SLOPE (1:X OR X:1)" 3
"DITCH DEPTH (M OR FT)" 2
"DITCH WIDTH (M OR FT)" 8
"DITCH PROFILE FORESLOPE 2 (1:X OR X:1)" 4
"LEFT DITCH PROFILE" ditchlt
"RIGHT DITCH PROFILE" ditchrt

Exercise 15-1

This begins a series of exercises that will demonstrate another method for determining bridge length, which will by using cross-sections. The proposed cross sections for Route50 are draw in this group exercie. Later exercises will use these and other cross sections to create a proposed TIN and determine the bridge length from this surface model.

1. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\xs_50_j5p0100.dgn**.

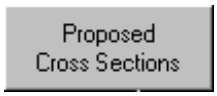
2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**.

   Enter the as user **userc**.

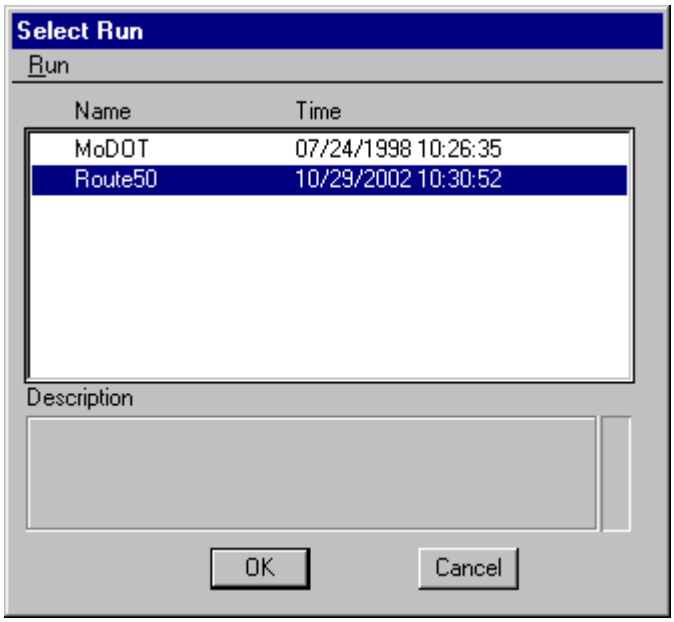
   Go into **Road**.

3. Select the **Route50** working alignment.

4. Choose **Proposed Cross Sections** from the **Project Manager** dialog.



   Copy the **MoDOT** run to **Route50**, and open the **Route50** run.



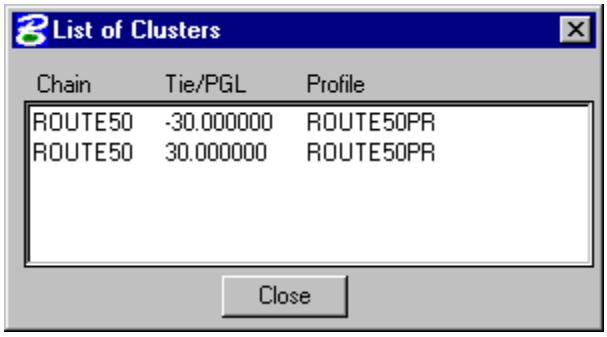
5. Be sure the following items are set in the given sections of the dialog:

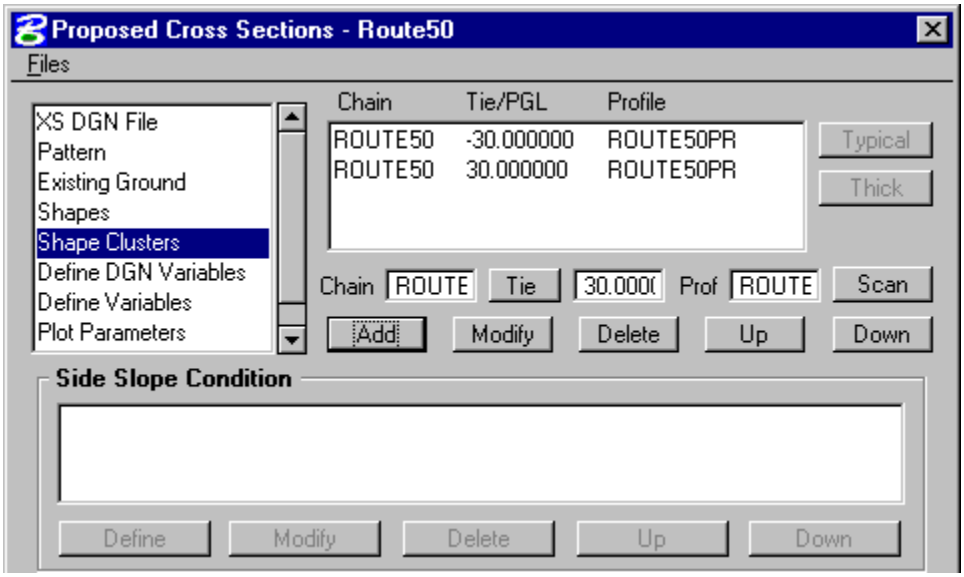
XS DGN File:	**xs_50_j2p0200.dgn**
Pattern:	**Use Working Alignment Definition**
Existing Ground:	**Use Working Alignment Definition**
Shapes:	**Use Working Alignment Definition**

6. In the **Shape Clusters** section of the dialog, choose the **Scan** button. Add the two shape clusters in the following order:

Chain	Tie	Profile
ROUTE50	**-30**	**ROUTE50PR**
ROUTE50	**30**	**ROUTE50PR**

The clusters are added by highlighting a cluster in the top dialog shown below and clicking on **Add** in the Proposed Cross Sections dialog, which is depicted in the bottom figure. When you are finished adding the Shape Clusters, close the **List of Cluster** dialog by clicking on **Close** at the bottom of the dialog. Leave the **Proposed Cross Sections – Route50** dialog open. Information will be added to it in the next step.





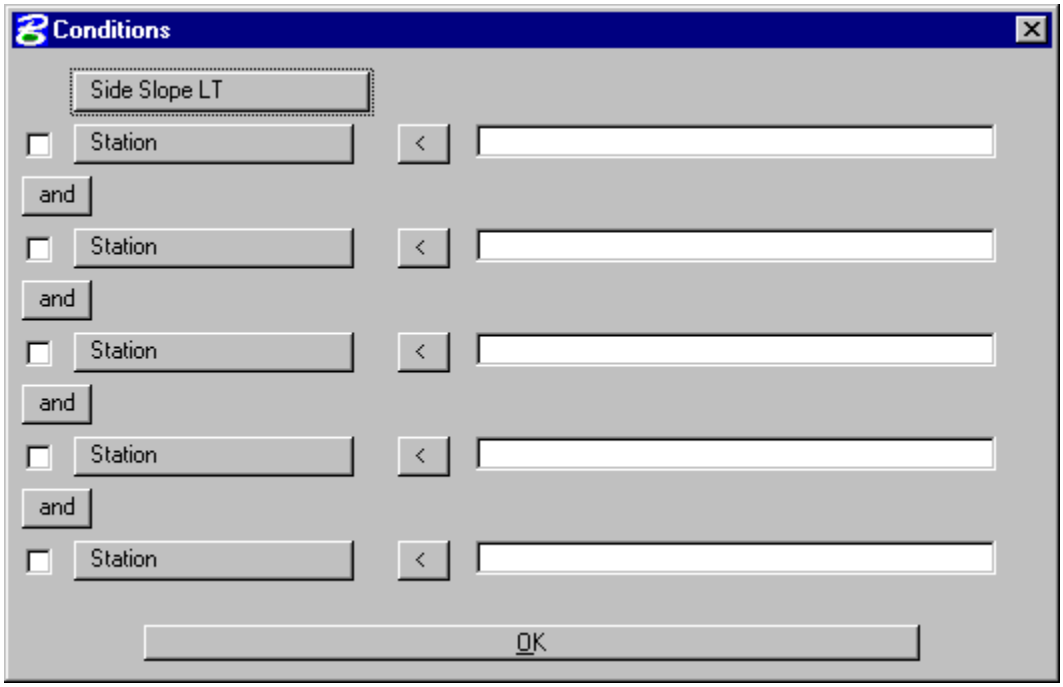
7. For each shape cluster, **add** the given side **Slope Conditions** and **Criteria Files**. (See the attached typical section for details.)

Chain	Tie	Profile
ROUTE50	**-30**	**ROUTE50PR**
Side Slope:	LT	
Criteria Files:		setup.x
		pvmt_layers.x
		shldr_a_c.x
		sideslope.x
Side Slope:	RT	
Criteria Files:		setup.x
		pvmt_layers.x
		shldr_a1_c.x
		median_ditch.x

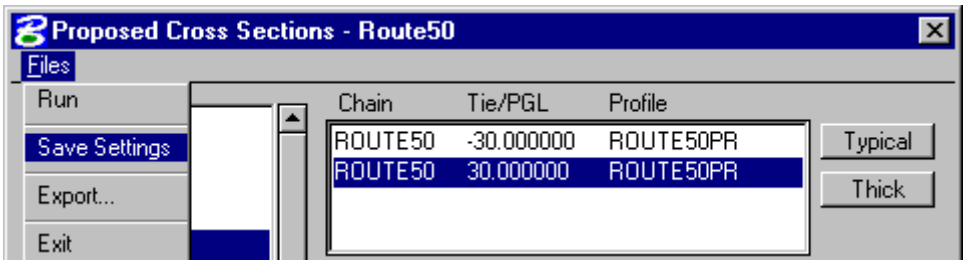
Chain	Tie	Profile
ROUTE50	**30**	**ROUTE50PR**
Side Slope:	LT	
Criteria Files:		setup.x
		pvmt_layers.x
		shldr_a1_c.x
		median_ditch.x
Side Slope:	RT	
Criteria Files:		setup.x
		pvmt_layers.x
		shldr_a_c.x
		sideslope.x

To add the **Side Slope Conditions**, highlight a shape cluster, and click on the **Define** button under that section of the Proposed Cross Section dialog.

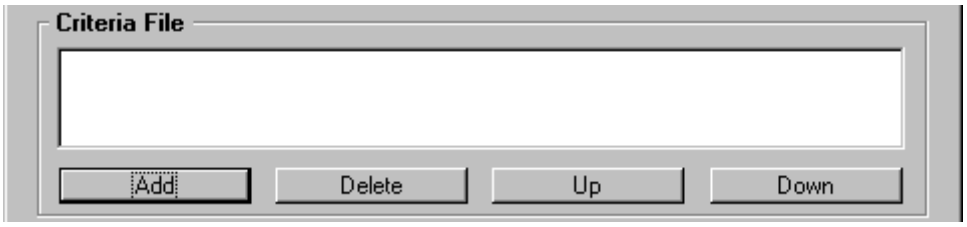
This will bring up the following dialog, which lets you define each condition. Once the condition is set, click OK in the dialog to add it to the list of Side Slope Conditions.



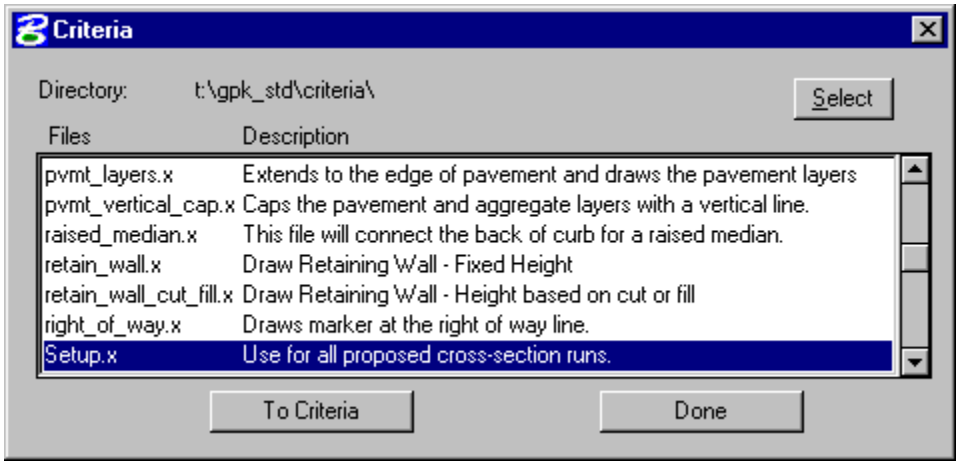
Once the Side Slope Conditions are defined, save the Proposed Cross Sections settings by going to **Files > Save Settings**, as shown in the following figure.



Add the Criteria Files to each condition by highlighting one of the conditions and clicking on the **Add** button at the bottom of the **Criteria File** list.



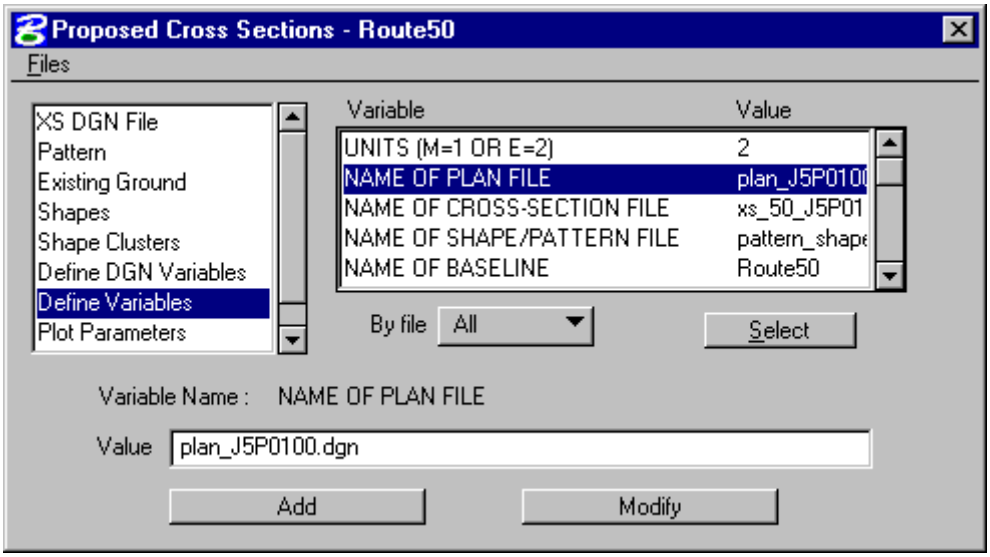
This brings up the **Criteria** dialog shown below. Criteria files are added to the highlighted side slope condition by selecting a criteria file of the list and clicking on **To Criteria**.



Select the **Setup.x** criteria file, as shown above, and add it to the selected condition by clicking on **To Criteria.** Since this file is used in all conditions, highlight the other condition for the shape cluster and clicking on **To Criteria**. Do the same thing for the other shape cluster. Add **pvmt_layers.x** (which is the top file shown in the above figure) to all conditions and clusters. Add the criteria files shldr_a_c.x, shldr_a1_c.x, sideslope.x, and median_ditch.x to the appropriate side slope conditions.

Once all of the files have been added, click on **Done** to close the Criteria dialog and save the Proposed Cross Section run by going to **Files > Save Settings**.

8. Switch to the Define Variables section of Proposed Cross Sections, as shown below:



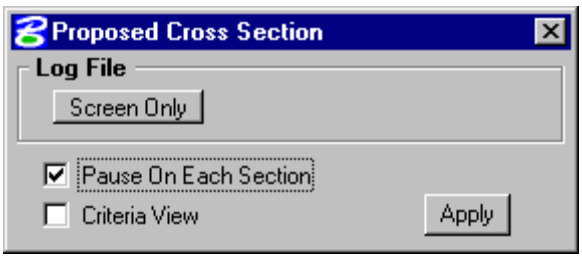
Set the following variable values.

NAME OF PLAN FILE.....plan_J5P0100.dgn
NAME OF CROSS-SECTION FILE .....xs_50_J5P0100.dgn
NAME OF SHAPE/PATTERN FILE .....pattern_shape_J5P0100.dgn
NAME OF BASELINE Route50
PAVEMENT LAYER 1 THICKNESS (MM OR IN).....10
AGGREGATE LAYER 1 THICKNESS (MM OR IN) 4

Leave the remaining variables set to the defaults.

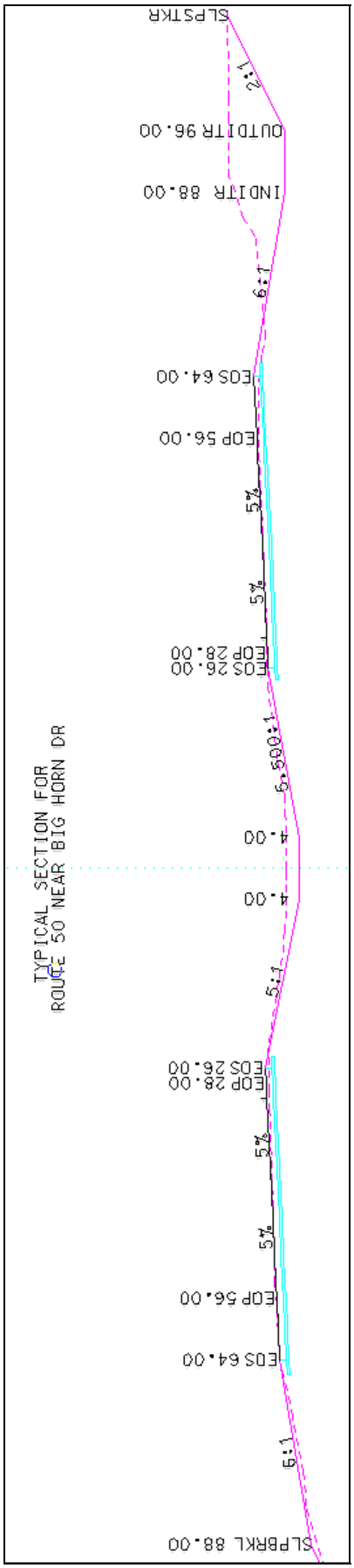
9. Save the settings for the run.

10. Run the proposed cross-sections (**Files > Run**). The following dialog will appear:



Set the **Log File** to **Screen Only**.

Turn on **Pause on Each Section**.


TYPICAL SECTION FOR
ROUTE 50 NEAR BIG HORN DR
SLPBRKL 88.00
6:1
EOS 64.00
EOP 56.00
5%
5%
EOP 28.00
EOS 26.00
5:1
4.00
4.00
6.50:1
EOS 26.00
EOP 28.00
5%
5%
EOP 56.00
EOS 64.00
6:1
INDITR 88.00
OUTDITR 96.00
2:1
SLPSTKR

Chapter 16

Port Viewer

16.1 Objectives 16-1
16.2 Definitions 16-1
16.3 Accessing 16-2
16.4 Dialog 16-2

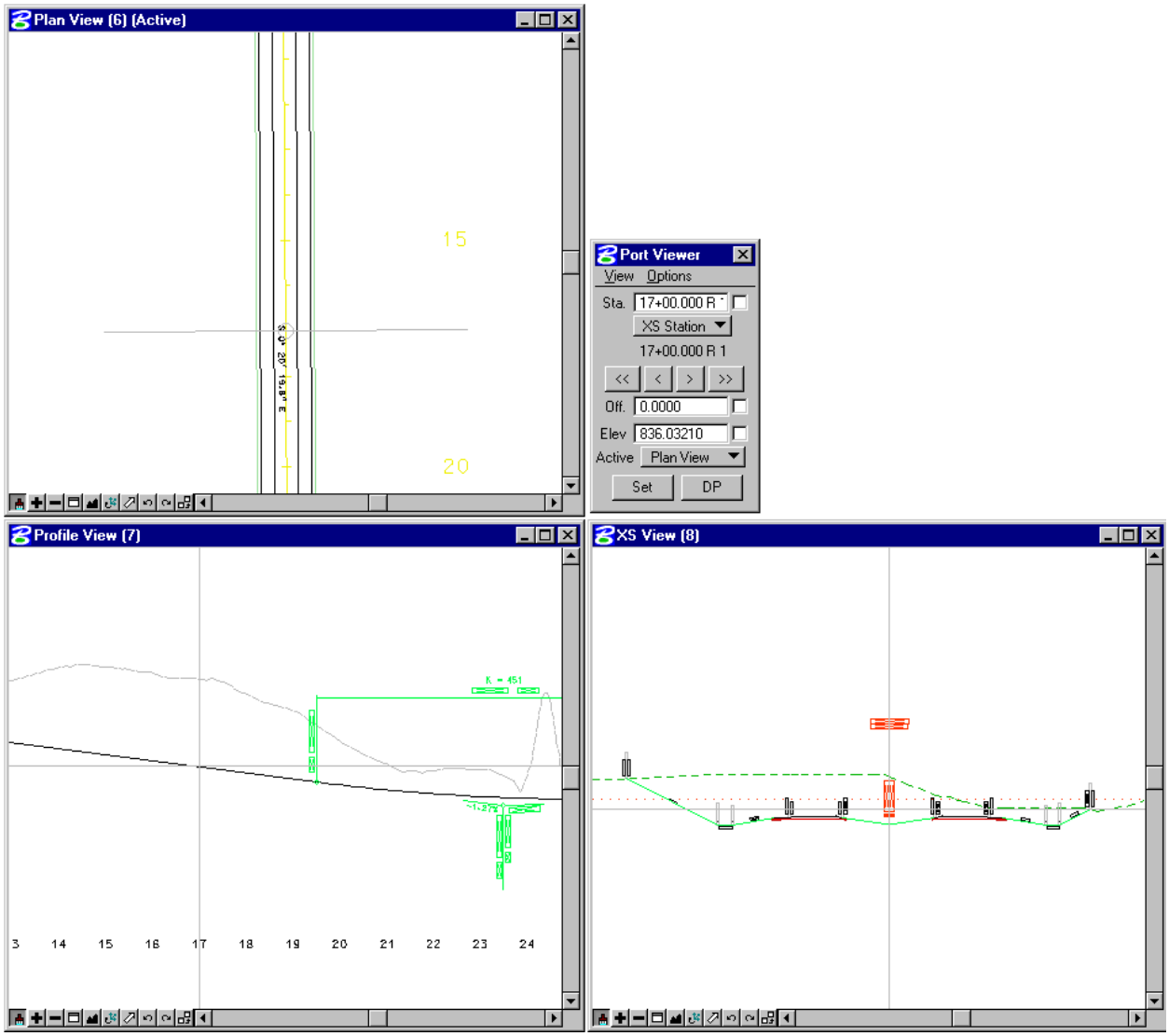
16.1 Objectives

- Learn how to use Geopak's **Port Viewer** utility.

16.2 Definitions

The **Port Viewer** is a tool that enables the user to view and manipulate all three major aspects of a road design simultaneously, even though they are located in different files. These include:

- Plan
- Profile
- Cross-sections

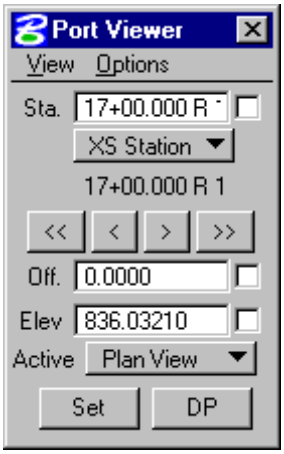


16.3 Accessing

Prior to starting the **Port Viewer** the working alignment must be set up to include the plan view drawing file, centerline chain, profile view file, profile name and location, and cross-section view file.

To access the **Port Viewer,** choose the **Port Viewer** button from the **Project Manager** dialog.

16.4 Dialog



The **Port Viewer** dialog box allows the user to manipulate the views several different ways.

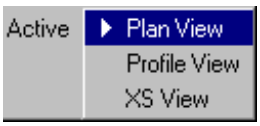
The user is able to key-in the **Station** they want to view. The cross hairs in the plan and profile views will move to the keyed-in station, and the section view will display the cross-section nearest that station.

The navigation buttons allow the user to navigate station by station (< or >), or to the beginning (<<) or ending (>>) station.

The **Offset** option will control the location of the circle in the plan view and the vertical cross hair in the cross-section view.

The **Elevation** option will control the location of the horizontal cross hairs in the profile and cross-section views.

If the Portview TIN is defined in the **Working Alignment** definition, the DTM view can be substituted for the cross-section view. The DTM view will cut a section at the location of the cross hairs in the plan view.

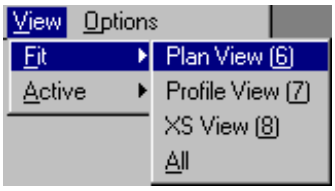


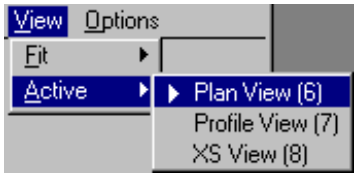
The **Active View** chooses the view to change the current file. Any Microstation drawing commands will be executed in the **Active View**. If the user wants to draw something in the cross sections, they should switch the **Active View** to XS View.

Selecting the **Set** button allows the user to move the cursor to a view and move the cross hairs. As the user moves the cursor along the view, the other two views will be updated according to the placement of the cursor in the current view.

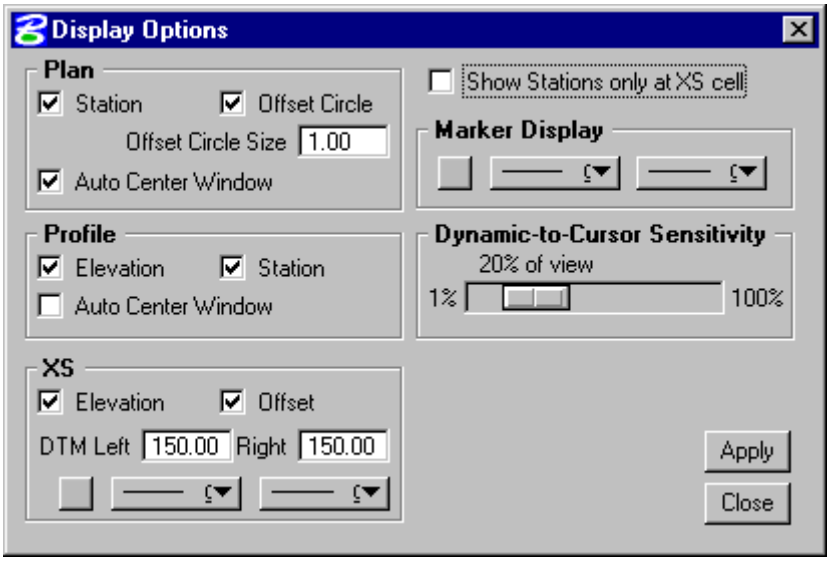
The **DP** button allows the user to issue a data point for a Microstation command. For example, if the user wanted to draw a line at the given station and offset listed in the **Port Viewer** dialog, they would select the line tool, and press the **DP** button. This would begin drawing a line at the given station and offset.

The **View** menu at the top of the dialog box allows the user to fit one or all of the views, or to select the **Active View**.





The **Options** menu controls which cross hairs to display, as well as the symbology of the DTM section view.



Chapter 17

Earthwork

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17.3 Accessing 17-1
17.4 Dialog 17-1
17.4.1 XS DGN File 17-2
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17.4.10 Process Cross Sections 17-8

17.1 Objectives

- Learn the procedures for calculating earthwork quantities with GEOPAK
- Learn how to use Project Manager to set up and process an earthwork run.

17.2 Definitions

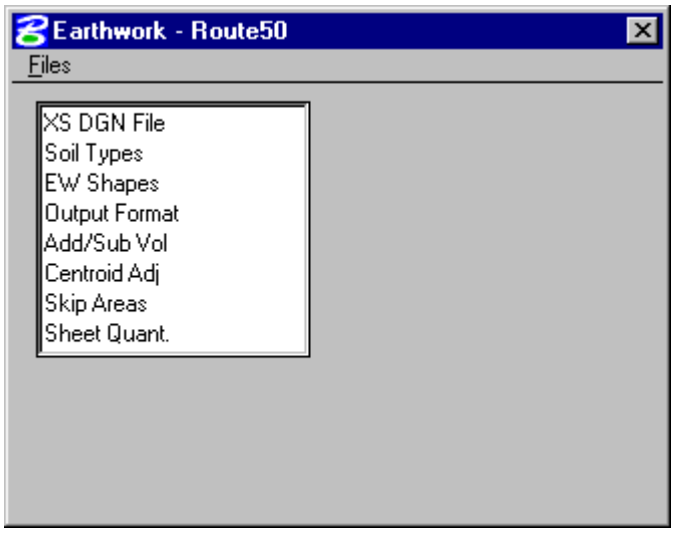
GEOPAK forms **earthwork shapes** in a design cross section .dgn file to represent the end areas used to calculate volumes. These shapes are created when the designer processes an earthwork run in which the existing ground, finished grade, base, etc. are identified by level, color, weight and type. For complete information, see the *GEOPAK Manual* or online help.

17.3 Accessing

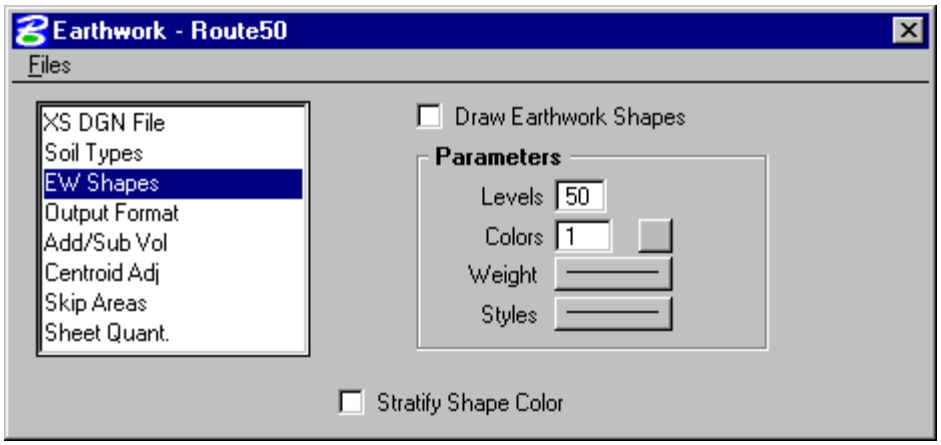
To access the necessary dialogs needed to create and process an earthwork run, select **Project Manager >> Earthwork**.

17.4 Dialog

Once the Earthwork run is chosen, the following dialog box appears.

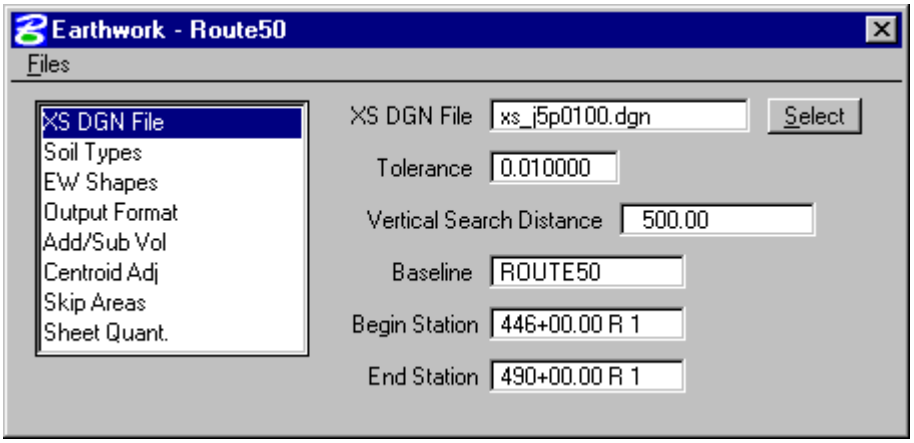


The left side of the dialog contains the list of parameters required to compute earthwork. When each parameter is selected, the dialog changes the keyin fields to reflect the selection. For example, when **EW Shapes** is selected, the dialog changes as illustrated below.



17.4.1 XS DGN File

In **XS DGN File** the user can specify the file name in which to find the cross-sections.



Tolerance specifies the maximum distances between two elements to be considered as adjoining.

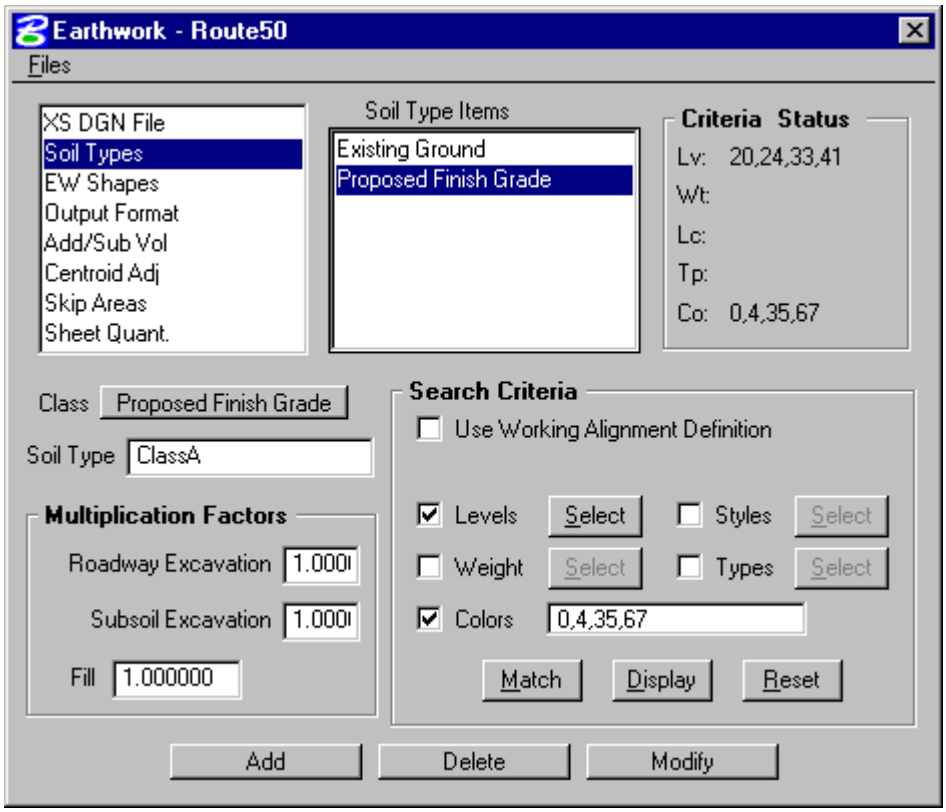
Vertical Search Distance specifies the distance above and below the cross-section to look for elements pertaining to that cross-section. **(DO NOT CHANGE!)**

Baseline specifies the Geopak COGO chain the cross-sections are based from.

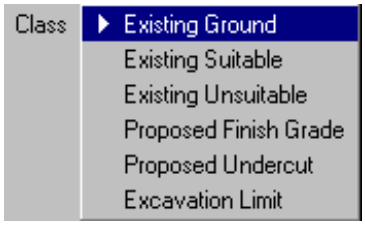
Begin/End Station specifies the beginning and ending stations to perform the earthwork calculations.

17.4.2 Soil Types

The **Soil Types** dialog requires the user to define the symbology and shrinkage/swell factors to be used in defining each soil type.



The user must first select the **Class** of the soil type. The classifications are as follows.



Existing Ground – identifies the surface of the existing ground. This classification is required to calculate earthwork.

Existing Suitable – identifies material that is to be removed, but can be used for fill material. (I.e. rock)

Existing Unsuitable – identifies material that is to be removed, but cannot be used for fill material. (I.e. shale, muck, pavement, etc.)

Proposed Finish Grade – identifies the surface of the proposed roadway. This classification is required to calculate earthwork.

Proposed Undercut – identifies proposed layers that are not part of the finish grade. This soil type is not the material being removed, but what the area will be backfilled with. (I.e. rock blanket)

Excavation Limit –identifies the location to stop removing the existing suitable or unsuitable material. Excavation limits can also be used to separate the areas of earthwork calculations for staged construction, multiple roadway cross sections, etc.

Once the **Classification** is chosen, a **Soil Type**, the element symbology of the material, and the shrinkage/swell factors need to be entered. A **Classification**, except **Existing Ground**, can be listed multiple times. The **Soil Type** determines how the cut and fill are calculated. For example, a user creates an earthwork run with a classification of Existing Ground with a soil type of Existing, classification of Proposed Finish Grade with a soil type of Suitable_Grading, and a classification of Proposed Undercut with a soil type of Pavement. The output from the run would look as follows.

Station	Material Name	End Areas (square feet)	Unadjusted Volumes (cubic yards)	Adjusted Volumes (cubic yards)	Mult Factor	Mass Ordinate
449+00.00	SUITABLE_GRADING					
	Excavation	0.00	0	0	1.00	
	Fill	132.61	439	439	1.00	2887
	PAVEMENT					
	Excavation	0.00	0	0	1.00	
	Fill	315.81	960	0	0.00	2887
	EXISTING					
	Excavation	278.57	855	855	1.00	
	Fill	0.00	0	0	1.00	3541

In the same example, if both classifications of Existing Ground and Proposed Finish Grade had the soil type of Suitable_Grading, then the output would look as follows.

Station	Material Name	End Areas (square meters)	Unadjusted Volumes (cubic meters)	Adjusted Volumes (cubic meters)	Mult Factor	Mass Ordinate
449+00.00	SUITABLE_GRADING					
	Excavation	278.57	855	855	1.00	
	Fill	132.61	439	439	1.00	3541
	PAVEMENT					
	Excavation	0.00	0	0	1.00	
	Fill	315.81	960	0	0.00	3541

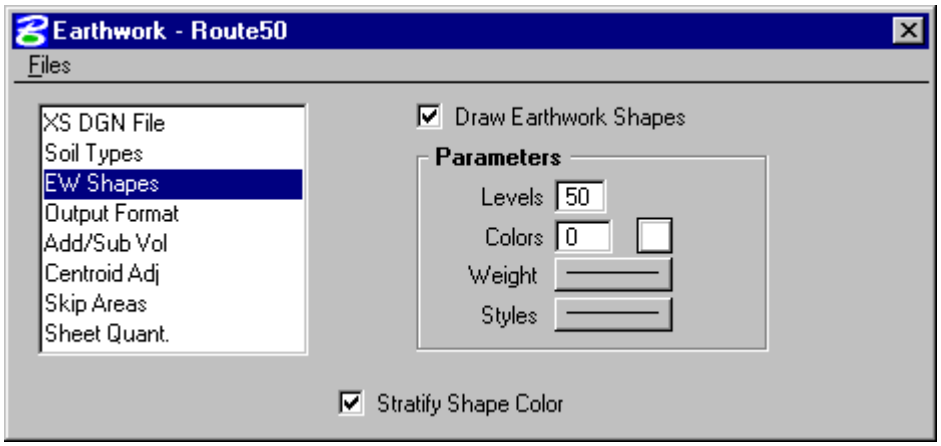
As can be seen from the above examples, when the soil types for the Existing Ground and Proposed Finish Grade classifications were named differently, both soil types appeared in the output. When the soil types for the Existing Ground and Proposed Finish Grade classifications were named the same, the quantities for each classification were combined into one soil type. By paying close attention to the soil types, the user can specify exactly where a specific soil type should be placed.

Once the **Classification** and **Soil Type** are chosen, the user can select the **Element Symbology** to define that particular **Soil Type** and the **Multiplication Factors** for the **Soil Type**. The **Match** button can be used to select the **Element Symbology**. Once the **Match** button is selected, the user can select the elements in the Microstation view. The symbology of that element will be added to the list of symbologies to be used to define the **Soil Type**.

After the user selects the soil type symbologies, the **Add** button needs to be selected to add this soil type to the **Soil Type Items** list. The items in this list can be modified or deleted by selecting the soil type item, making the changes, then selecting the **Modify** or **Delete** buttons.

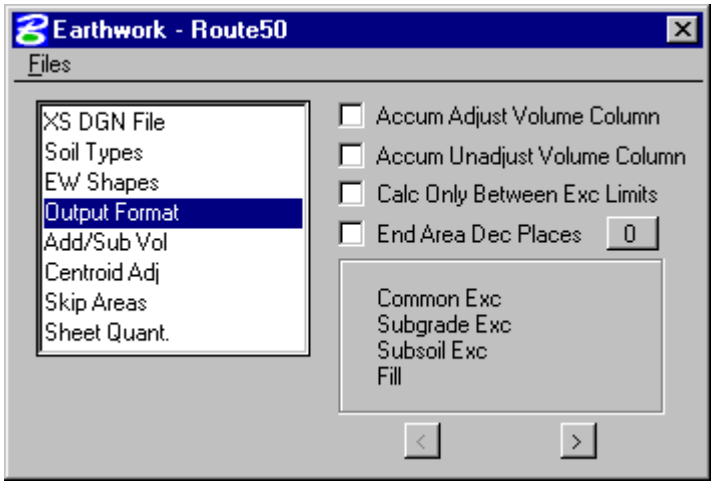
17.4.3 EW Shapes

EW Shapes allows the earthwork shapes to be drawn and specifies the symbology to draw them with. The colors of the earthwork shapes can be stratified, so that each soil type is a different color.



17.4.4 Output Format

Output Format allows the user to specify which items to show in the earthwork report. As the <> buttons are pressed, the Common Excavation, Subgrade Excavation, and Subsoil Excavation are combined into a single quantity.



Common Excavation volumes are not backfilled with an earthwork material. This includes the excavation required for cut sections as well as for pavement thickness, shoulder thickness, etc.

Subgrade excavation volumes are backfilled with an earthwork material.

Subsoil excavation - excavation required to remove unsuitable material down to the bottom of the proposed template.

Accum Adjust Volume Column will add a column to the earthwork quantities report to show the accumulated adjusted volume. This provides a running total for the adjusted volumes.

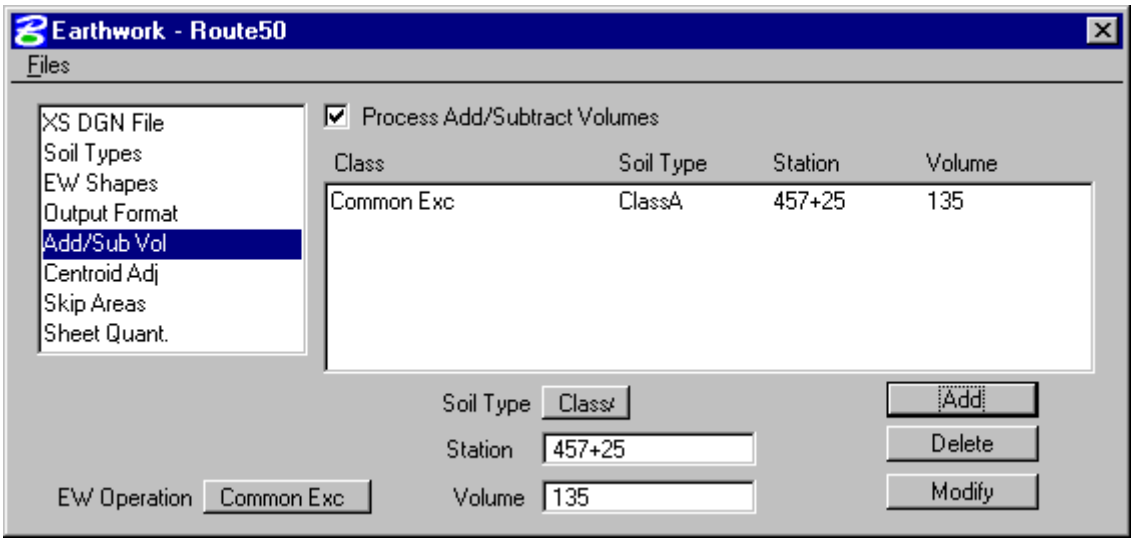
Accum Unadjust Volume Column will add a column to the earthwork quantities report to show the accumulated unadjusted volume. This provides a running total for the unadjusted volumes.

Calc Only Between Exc Limits will calculate the earthwork only between the excavation limit lines as specified in the **Soil Types** section. This can be used to calculate earthwork quantities for staged construction, individual roadbeds in a multiple roadbed section, etc.

End Area Dec Places sets the number of decimal places to display in the earthwork quantities report.

17.4.5 Add/Sub Vol

Add/Sub Volumes allows the user to enter positive or negative add volumes. The user can specify whether to add excavation or fill, the soil type, the station, and the volume to be added.

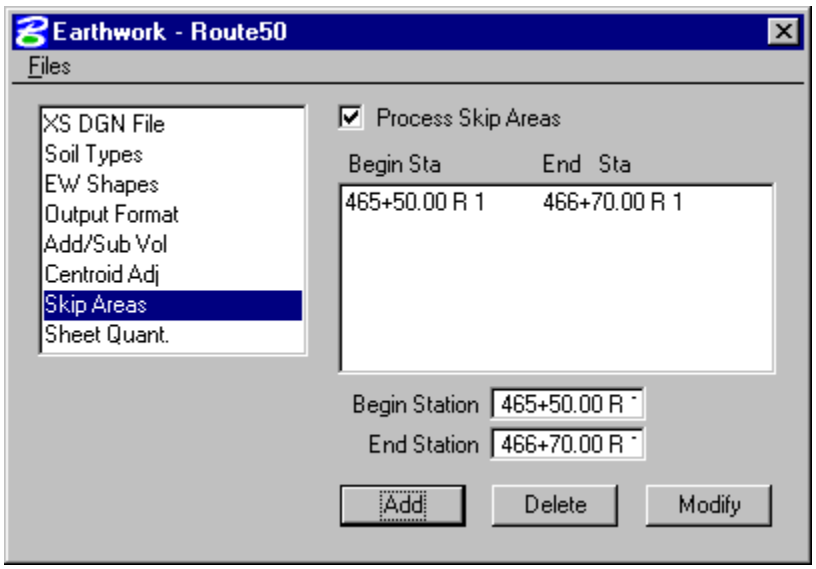


17.4.6 Centroid Adj

Centroid Adjustment allows the user to use the measurement between the centroids of the endarea as the distance between sections instead of the centerline distance. MoDOT does not use the **Centroid Adjustment** method of calculating endarea volumes except in areas where there are extremely deep cuts or high fills.

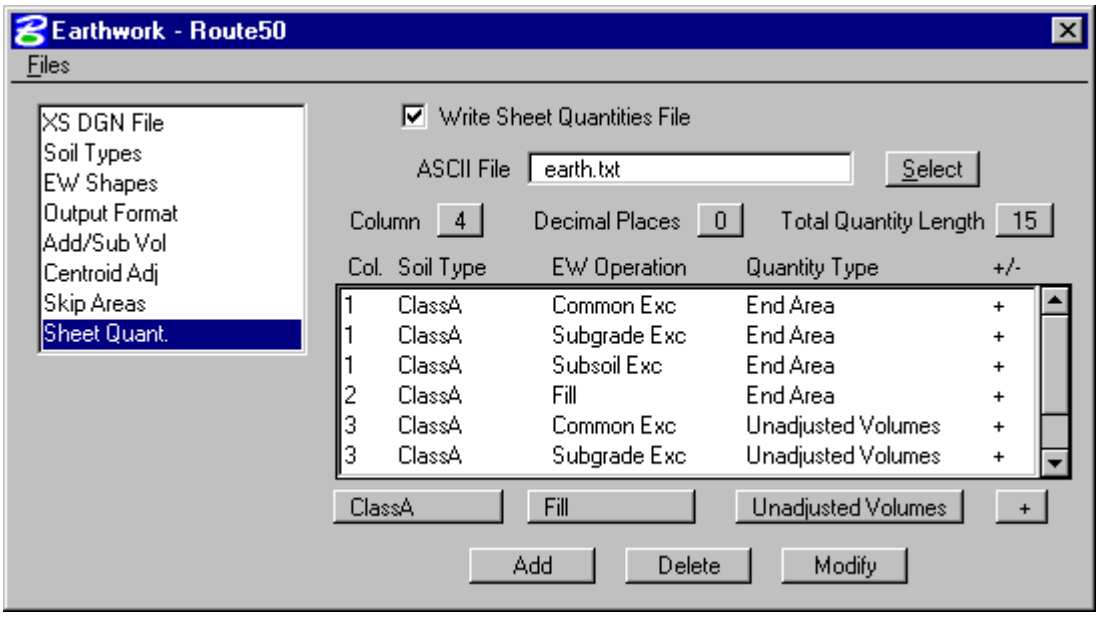
17.4.7 Skip Areas

Skip Areas allows a user to specify an area (i.e. bridge exception) in which to not calculate earthwork volumes. The user needs to specify the **Begin Station** and **End Station** of the **Skip Area**.



17.4.8 Sheet Quant.

Sheet Quantities allows a user to write an earthwork quantity file to be used when plotting the cross-section sheets.



The name of the ASCII file can be chosen or entered. The user then selects the columns in which to place the quantity, the number of decimal places, the total column width, the soil type, the earthwork operation, and the type of quantity.

For MoDOT, the cross section sheets are set up to plot the information in the proper location on the cross section sheets, the quantities should be set up as follows.

Column	Soil Type	EW Operation	Quantity Type	+/-
1	ClassA	Common Exc	Endarea	+
1	ClassA	Subgrade Exc	Endarea	+
1	ClassA	Subsoil Exc	Endarea	+
2	ClassA	Fill	Endarea	+
3	ClassA	Common Exc	Unadjusted Volumes	+
3	ClassA	Subgrade Exc	Unadjusted Volumes	+
3	ClassA	Subsoil Exc	Unadjusted Volumes	+
4	ClassA	Fill	Unadjusted Volumes	+

If Class C quantities are being shown on the cross section sheets, the following columns should be added.

Column	Soil Type	EW Operation	Quantity Type	+/-
5	ClassC	Common Exc	Endarea	+
5	ClassC	Subgrade Exc	Endarea	+
5	ClassC	Subsoil Exc	Endarea	+
6	ClassC	Common Exc	Unadjusted Volumes	+
6	ClassC	Subgrade Exc	Unadjusted Volumes	+
6	ClassC	Subsoil Exc	Unadjusted Volumes	+

This information is written to the ASCII file, and can be used to plot the quantities on the cross-section sheets. The process of plotting this data on the cross section sheets is covered in more detail in Chapter 14.

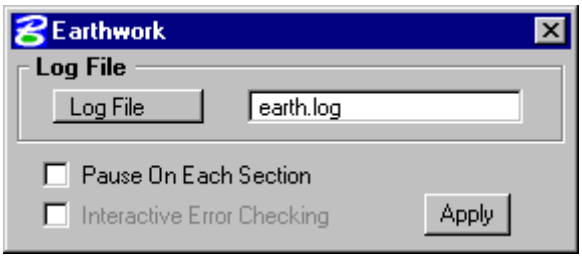
17.4.9 File Menu

From the **Files** menu, the **Run** option will process all parameters that have been set in the **Earthwork** dialog box. The **Save Settings** option will save all information in the **Earthwork** dialog box. The **Export** option will allow the user to save the parameters in the **Earthwork** dialog box as an ASCII input file. The **Exit** option will exit the **Earthwork** dialog box.

17.4.10 Process Cross Sections

After all necessary information has been entered the user has two options. The preferred method of running the earthwork is to select the **Run** option. The following dialog box will appear and the user may proceed by entering a log file name, choosing the **Pause On Each Section** option

and then selecting the **Apply** button. The second method is to export the information as an ASCII input file, then use the **Process Cross Sections** tool.



When processing the earthwork quantities, a .log file should be created. This ASCII file will contain the earthwork quantities that the user will use to evaluate the earthwork.

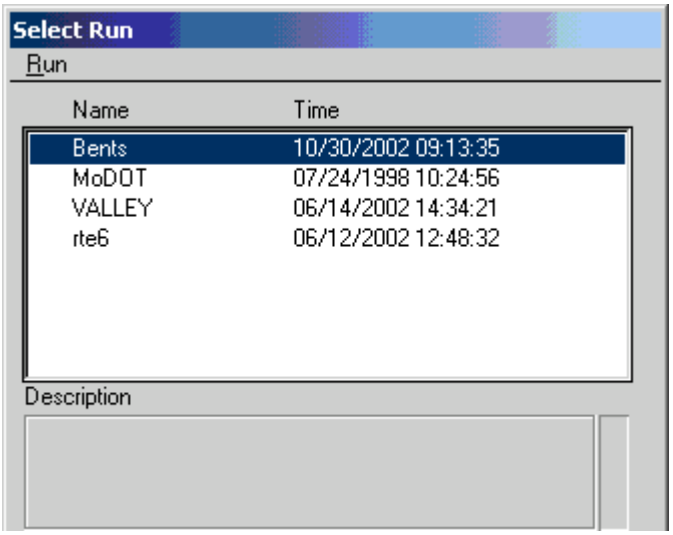
Exercise 17-1

This group exercise calculates the Class 1 and Class 2 excavation for Bents 3 & 4 of one of the Route 6 bridges. The bents are spread footings on rock.

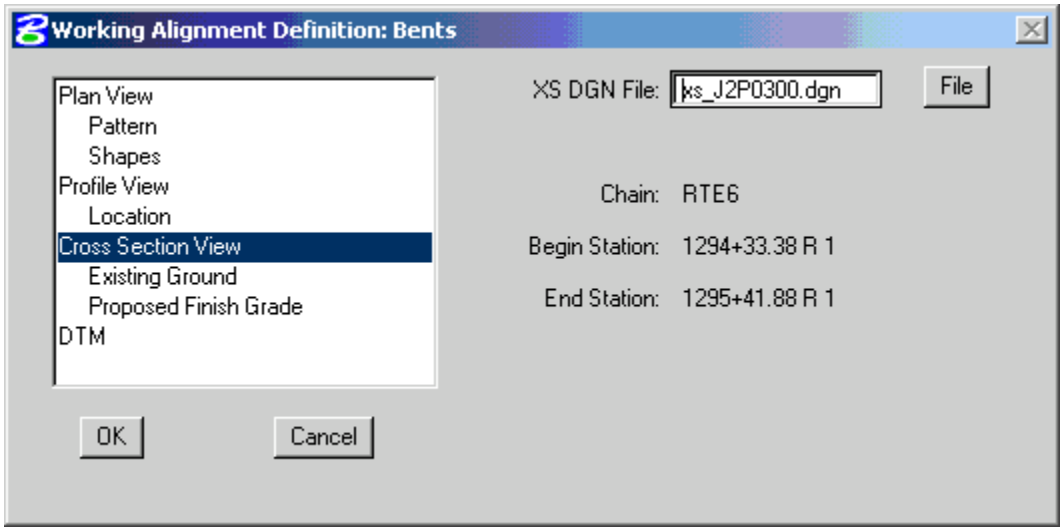
1. Open the MicroStation file **t:\br-proj\a_geopak\d2\j2p0300\data\xs_j2p0300.dgn**.

2. Open the project **t:\br-proj\a_geopak\d2\j2p0300\project\j2p0300.prj**.
   Enter the project as user **userc** and go into **Road**.

3. Copy the **Rte6** working alignment to **Bents** and enter that working alignment.



4. Set the XS DGN File in the Working Alignment Definition (Under Cross Section View) to: **xs_j2p0300.dgn**, as shown in the following figure.



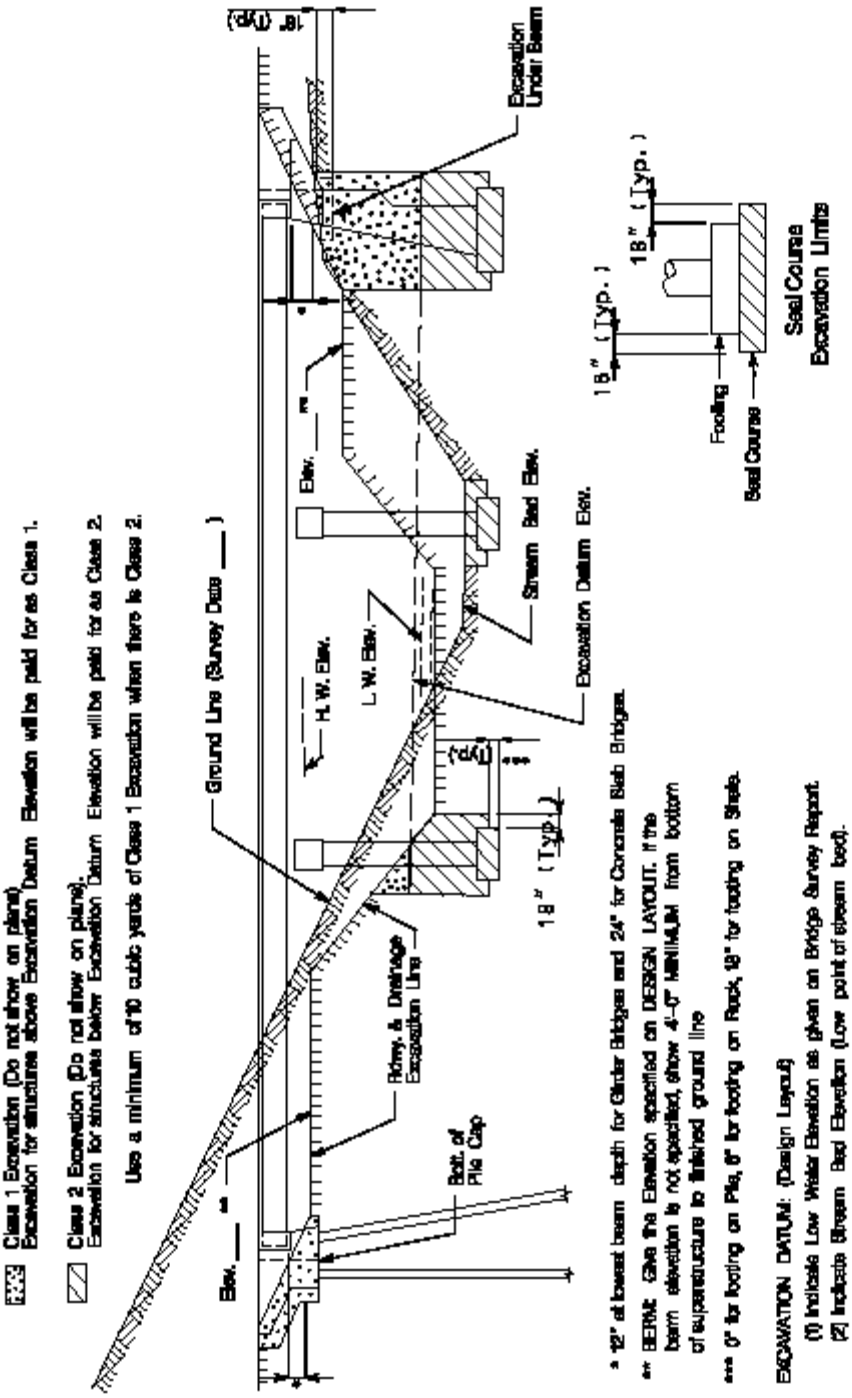
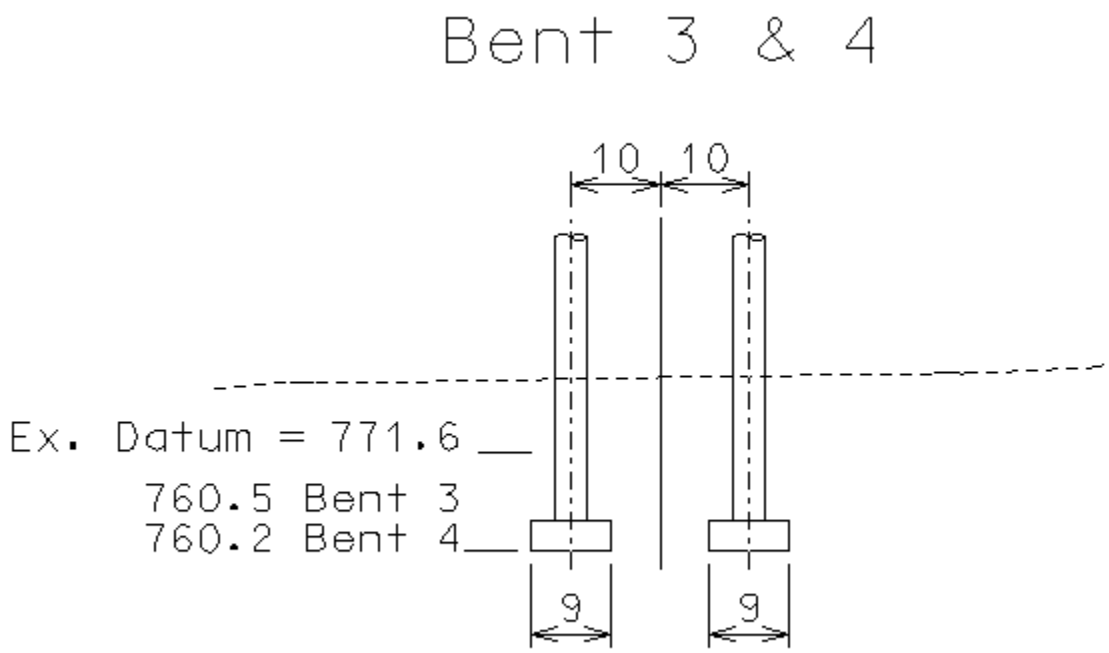


Figure 2.5.2 - 6 Excavation Limits: Stream Crossings (Typical)

5. The figure from the Bridge Manual on the previous page shows the Class 1 & 2 excavation for footings in a streambed. As noted there, Class 1 excavation covers all material above the excavation datum, and Class 2 is for all excavation below the datum. Also, since the bents have footings on rock, the *** dimension in the figure is 6" (0.5').

   The following figure shows a typical cross section for Bents 3 & 4. The spacing and size of the square footings is the same for both bents, as is the excavation datum. Only the elevation at the bottom of the footings varies from one bent to the next.



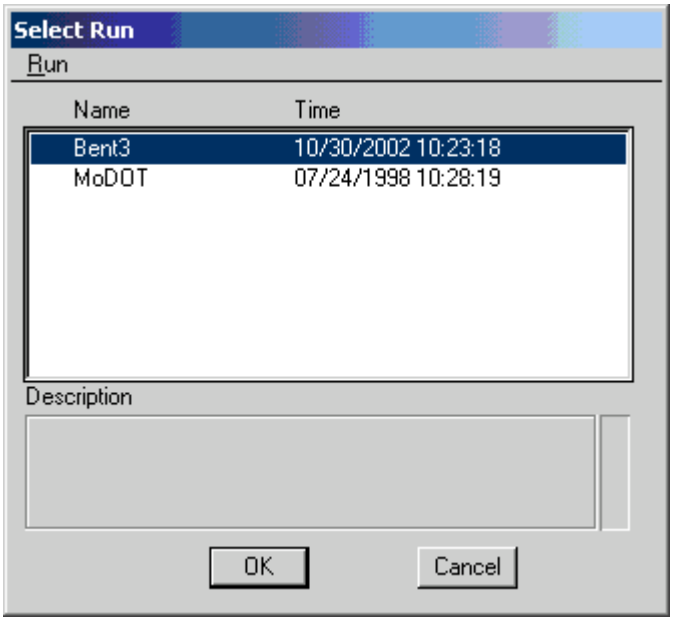
   Based on these figures, excavation will extend out from the footings on all sides by 1.5' (18") and stop 0.5' above the bottom of the footing in this extended area. Directly under the footings, the excavation goes to the bottom of footing elevation. Cross sections starting 1.5' before each footing and ending 1.5' after the end of each one have already been created in the MicroStation file. The sections for Bent 3 go from Sta. 1294+33.375 thru Sta. 1294+45.375, while the sections for Bent 4 go from 1295+31.375 thru 1243+43.375.

   Cross sections of the footings have been added to each of the cross sections at the correct elevation. Only the bottom of footing line has been added for the sections before and after the footing The excavation limits have also been added using a line drawn on level 60 using color 22. This limit line stops 6" above the bottom of footing at Stations 1294+33.375, 1294+34.855, 1294+43.905, & 1294+45.375 for Bent 3 and Stations 1295+31.375, 1295+32.855, 1295+41.905, & 1295+43.375 for Bent 4. The limit traces the bottom of the footing at all of the other sections.

   The excavation datum has been draw in all cross sections at elevation 771.6 using a line on level 57 and color 0. The earthwork run will be set up using these drawn elements plus the existing ground line on level 57 and color 90.

6. Choose **Earthwork** from the **Road Project** dialog.

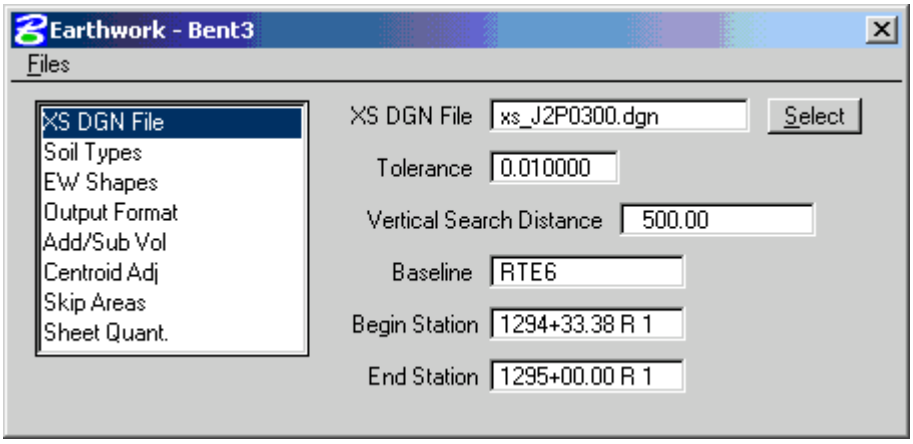
Copy the **MoDOT** run to **Bent3**, and enter the run.



7. In the **XS DGN File** section of the **Earthwork** dialog, set the following items:

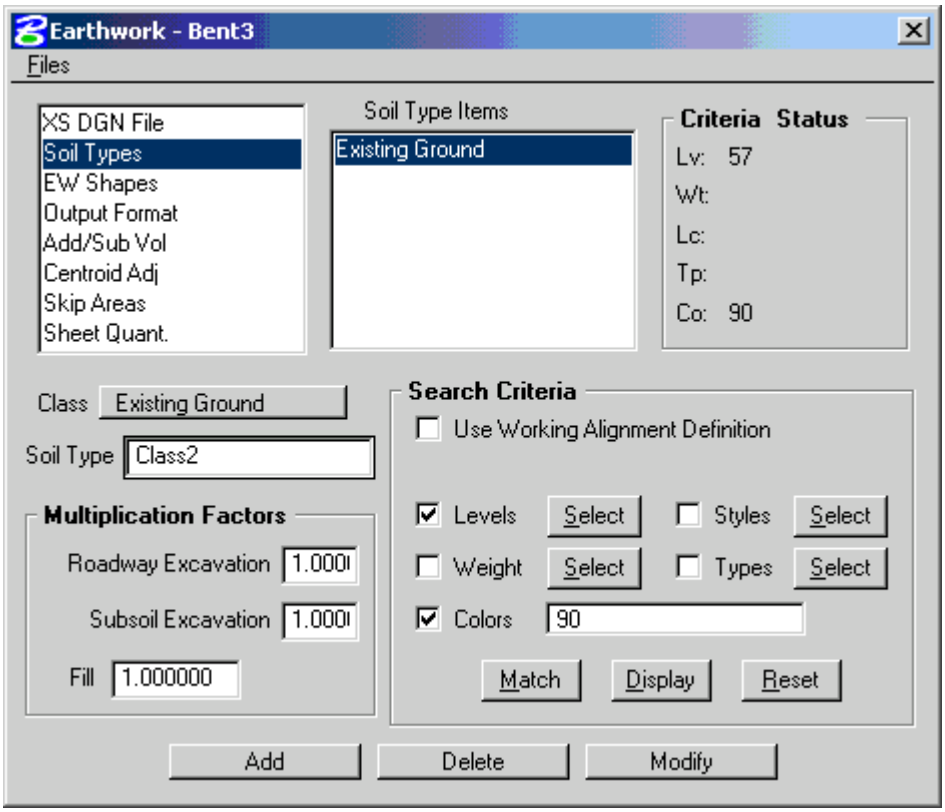
Begin Station **First Cross Section Station**
End Station **1295+00 R 1**

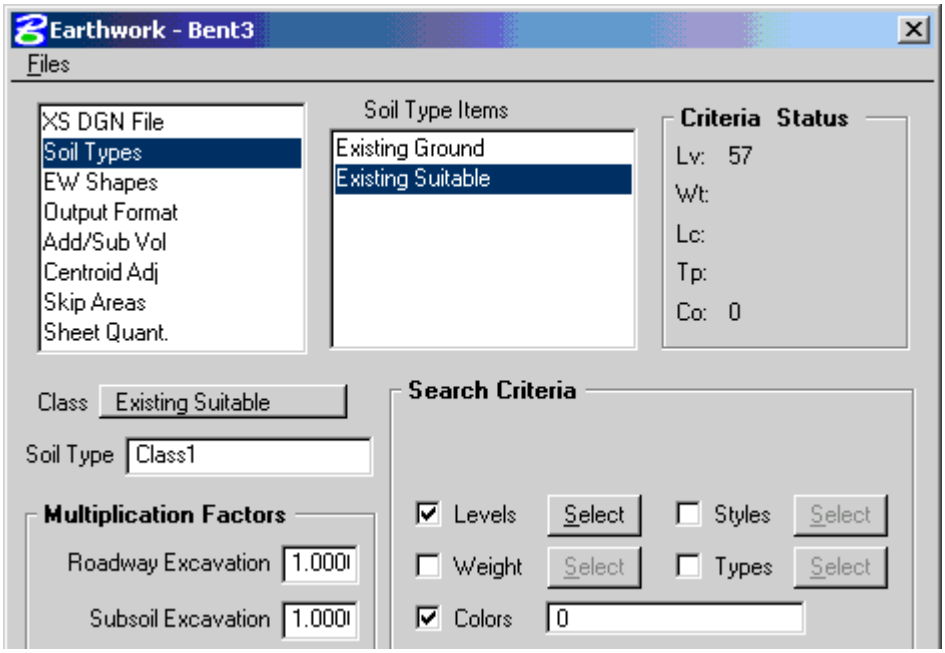
The **XS DGN File** and **Baseline** have already been set by the Working Alignment Definition. The rest of the values are defaults, which do not need to be modified.

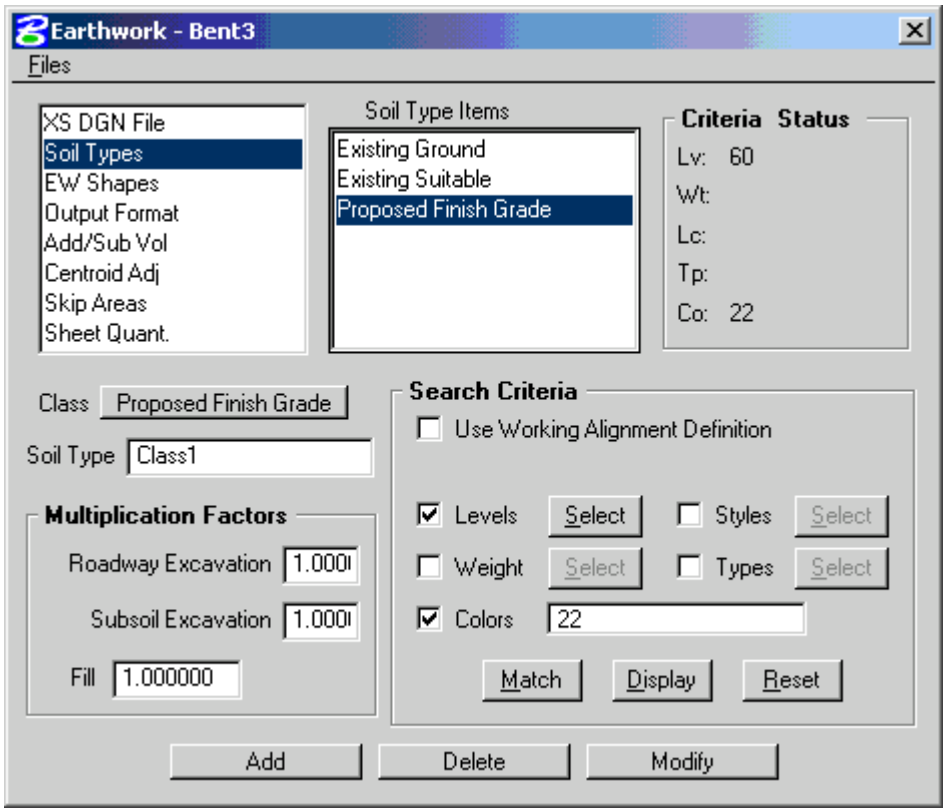


8. In the **Soil Types** section, created the following **Soil Type Items**:

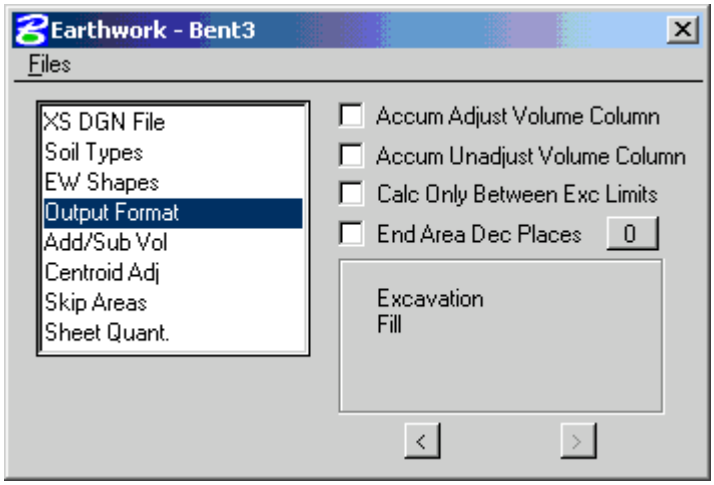
Class	Soil Type	Level	Colors
Existing Ground	**Class2**	**57**	**90**
Existing Suitable	**Class1**	**57**	**0**
Proposed Finish Grade	**Class1**	**60**	**22**







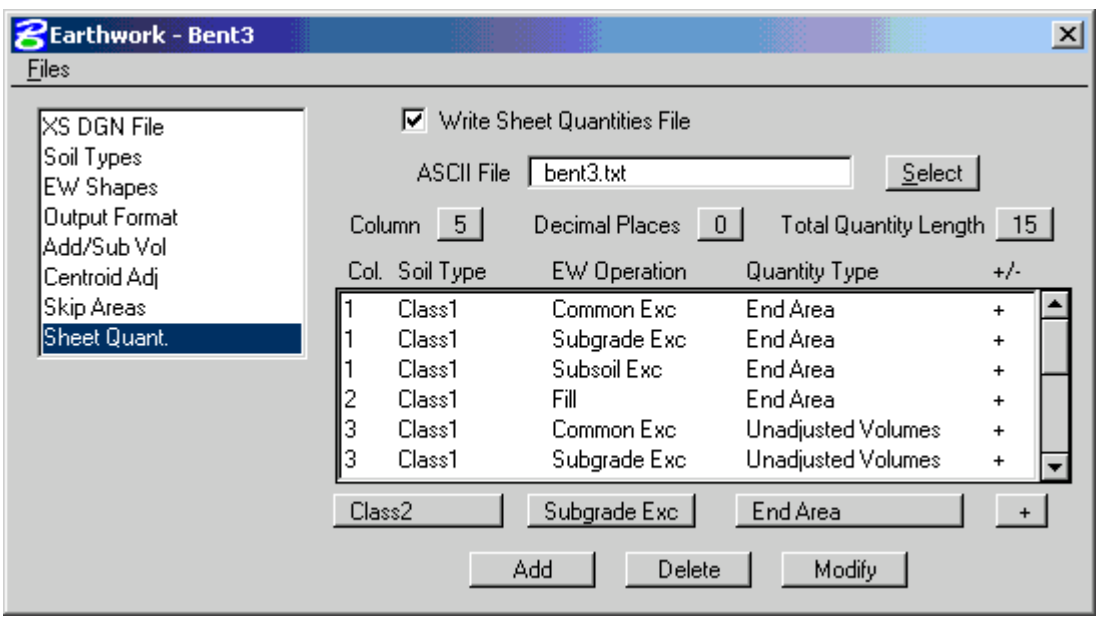
9. Switch to the **Output Format** section of Earthwork and set the format to **Excavation** and **Fill** only, as shown below:



10. In the **Sheet Quant.** Section, toggle on the **Write Sheet Quantities File**.

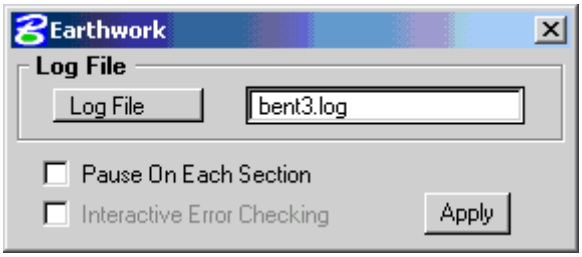
ASCII file: **bent3.txt**
Decimal Places: **0**
Total Quantity Length **15**

Col.	Soil Type	EW Operation	Quantity Type	+/-
1	Class1	Common Exec	End Area	+
1	Class1	Subgrade Exec	End Area	+
1	Class1	Subsoil Exec	End Area	+
2	Class1	Fill	End Area	+
3	Class1	Common Exec	Unadjusted Volumes	+
3	Class1	Subgrade Exec	Unadjusted Volumes	+
3	Class1	Subsoil Exec	Unadjusted Volumes	+
4	Class1	Fill	Unadjusted Volumes	+
5	Class2	Common Exec	End Area	+
5	Class2	Subgrade Exec	End Area	+
5	Class2	Subsoil Exec	End Area	+
6	Class2	Common Exec	Unadjusted Volumes	+
6	Class2	Subgrade Exec	Unadjusted Volumes	+
6	Class2	Subsoil Exec	Unadjusted Volumes	+



11. Save the settings for the run (**Files > Save Settings**).

12. Run the earthwork run (**Files > Run**). The following dialog will appear:

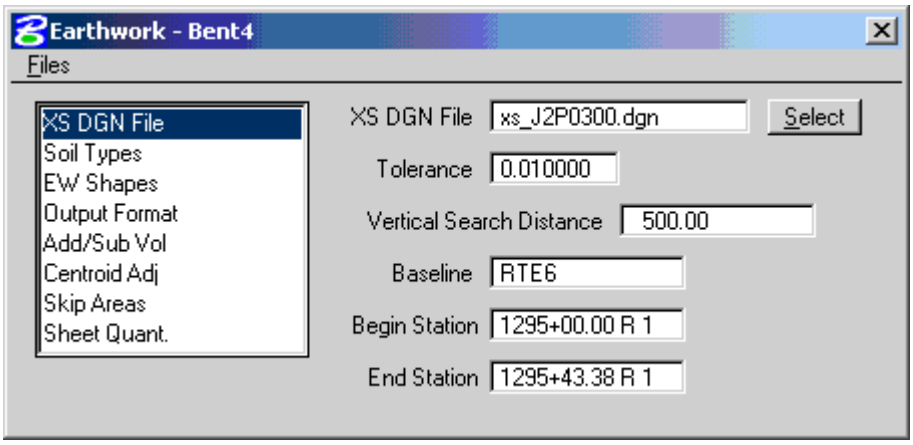


Set the **Log File** to **bent3.log**.

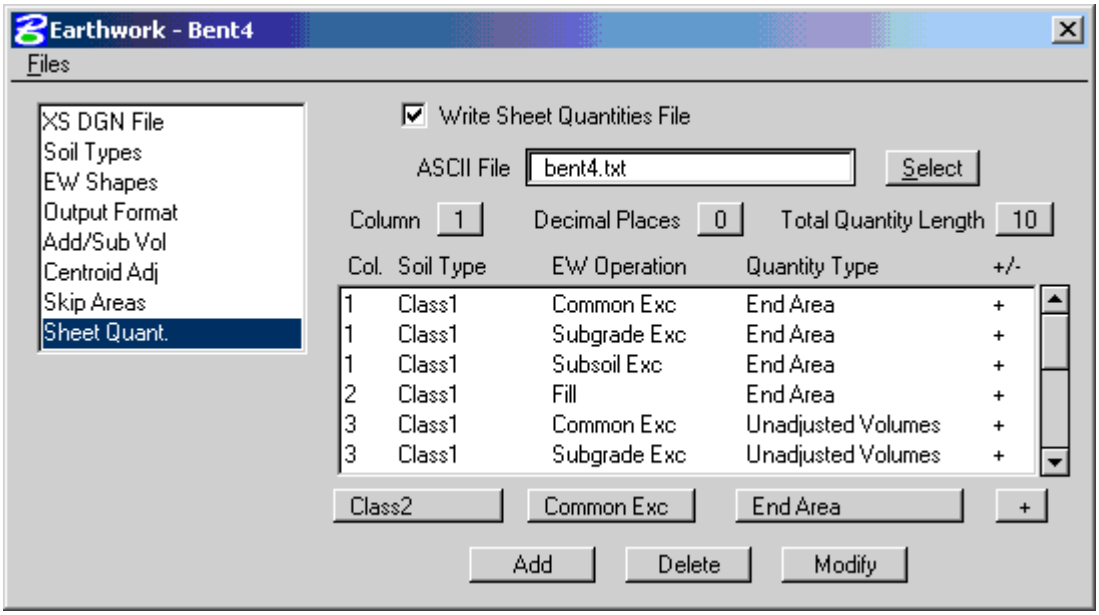
13. Repeat the process for Bent 4, by going back into Earthwork. This time however, copy the **Bent3** run and name it **Bent4**. Go into the new run. By copying the Bent3 run, everything is already set except for the station range and the name of the Sheet Quantity file.

14. Under XS DGN File, change the station range to the following:

Begin Station **1295+00 R 1**
End Station **Last Cross Section Station**

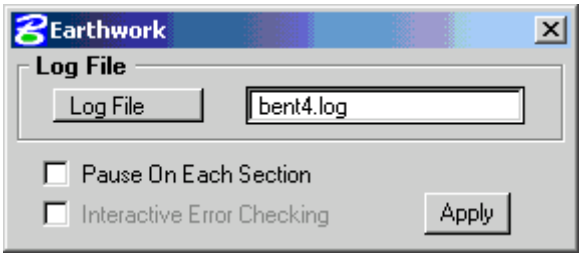


15. In the **Sheet Quant**. section, name the file **bent4.txt**.



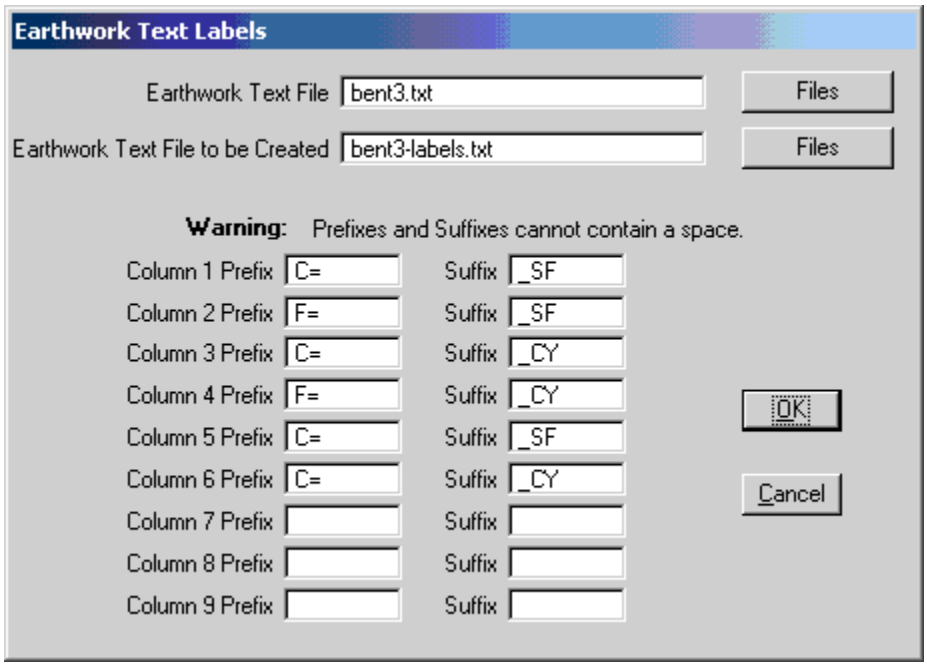
16. Save the settings for the run (**Files > Save Settings**).

17. Run the earthwork run (**Files > Run**). The following dialog will appear:

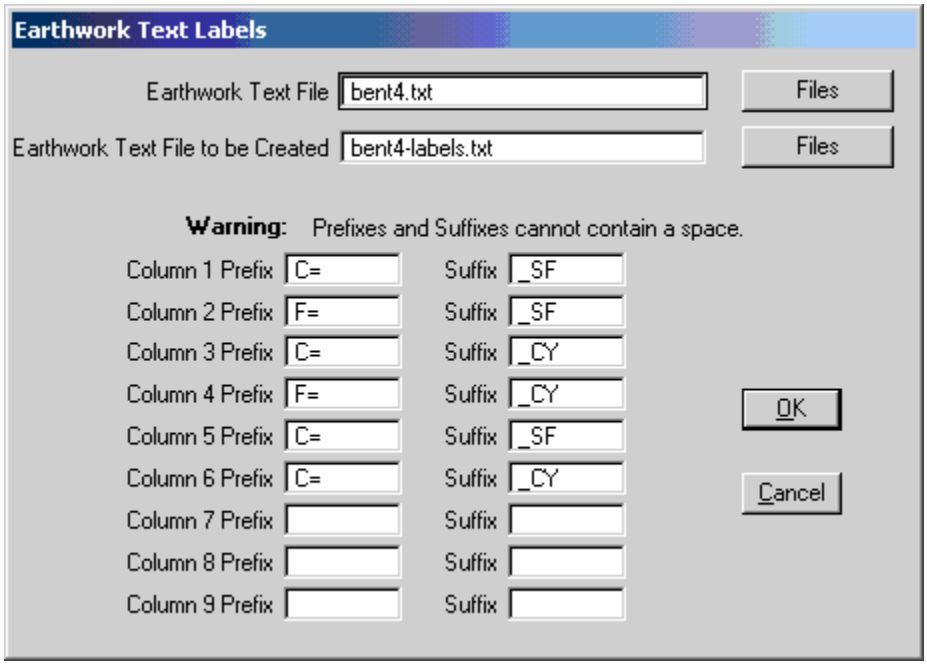


Set the **Log File** to **bent4.log**.

18. Open D&C Manager, and use the Earthwork Text File Labels 3PC Tool to set up the cross section sheet labels as shown below:



19. Repeat the last step for Bent 4:



Chapter 18

Cross Section Sheets

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18.2 Accessing 18-1
18.3 Dialog 18-2
18.3.1 XS DGN 18-2
18.3.2 Earthwork Quantities 18-3
18.3.3 Sheet DGN File 18-4
18.3.4 Add Elevations 18-4
18.3.5 Files Menu 18-5
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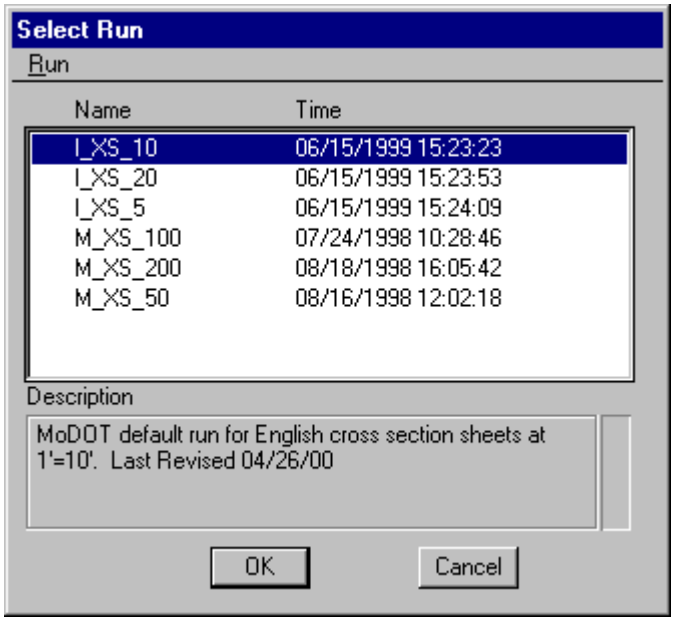
18.1 Objectives

- Learn the procedures for laying out cross-section sheets.

18.2 Accessing

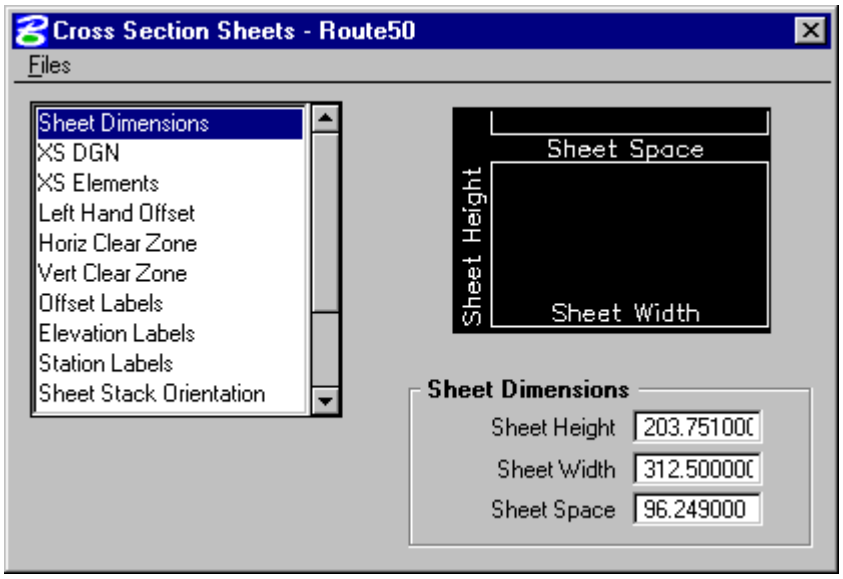
Prior to beginning the cross-section sheet layout process, the user will need to create a cross-section sheet file. There are six seed files the user can choose from when setting up the cross-section sheet file: i_xs_shts_5.dgn, i_xs_shts_10.dgn, i_xs_shts_20.dgn, m_xs_shts_100.dgn, m_xs_shts_200.dgn, and m_xs_shts_50.dgn. The user should choose the seed file that represents the scale the cross-sections will be plotted at.

To access the necessary dialogs needed to process the cross-section sheet layout, select **Project Manager >> Cross Section Sheets**. The run should be chosen according to the scale that the cross-sections will be plotted at.



Once the run is chosen, the dialog box shown below appears.

18.3 Dialog

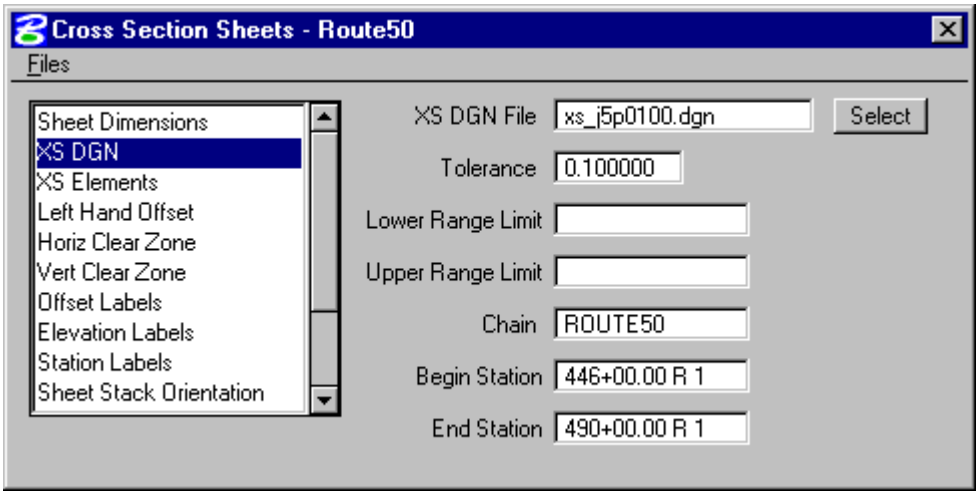


The left side of the dialog contains the list of parameters required to draw the cross section sheets. When each parameter is selected, the dialog changes the key-in fields to reflect the selection.

Most of the parameters should be left alone. They are setup by the CADD Support Center, and are correct for the given scales. Listed below are the items the user will need to change.

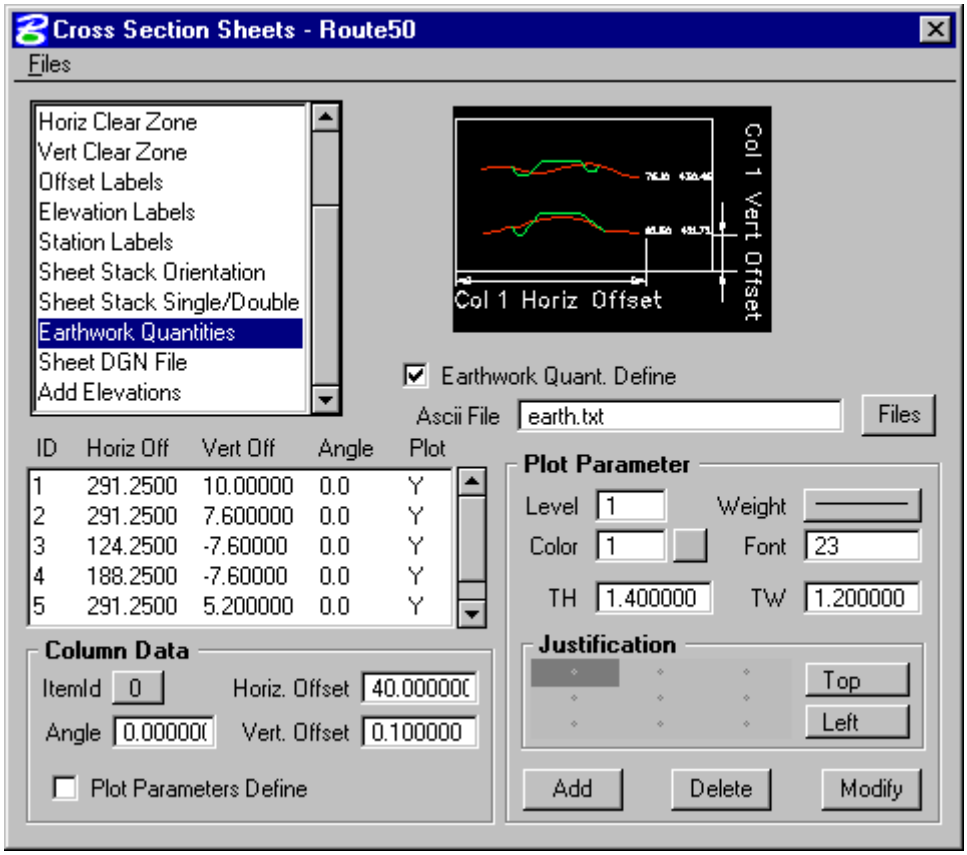
18.3.1 XS DGN

XS DGN defines the file in which the cross-sections are located, the baseline chain, and the station limits.



18.3.2 Earthwork Quantities

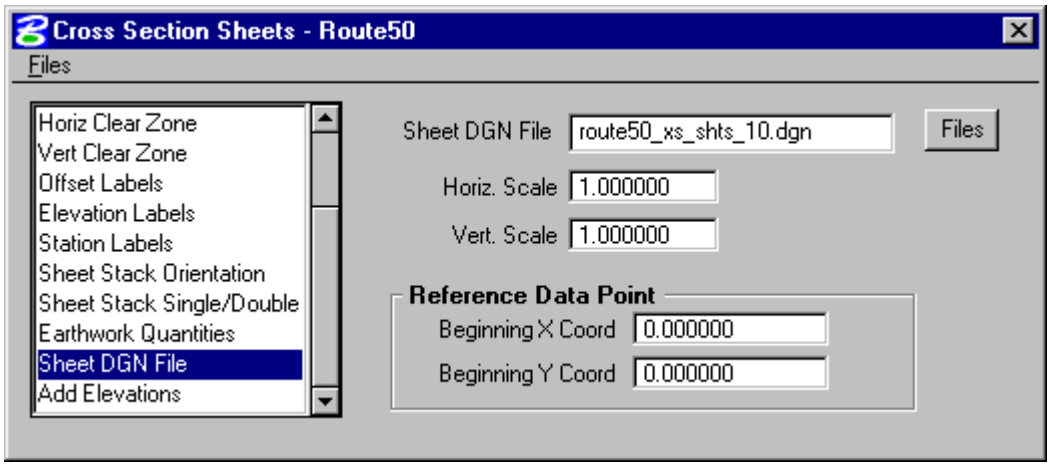
Earthwork Quantities allows the user define the ASCII file that contains the earthwork quantity information, as well as toggle on/off the plotting of the earthwork quantities. If the **Sheet Quantities** portion of the earthwork run was not changed, the user should not change anything else in this dialog.



18.3.3 Sheet DGN File

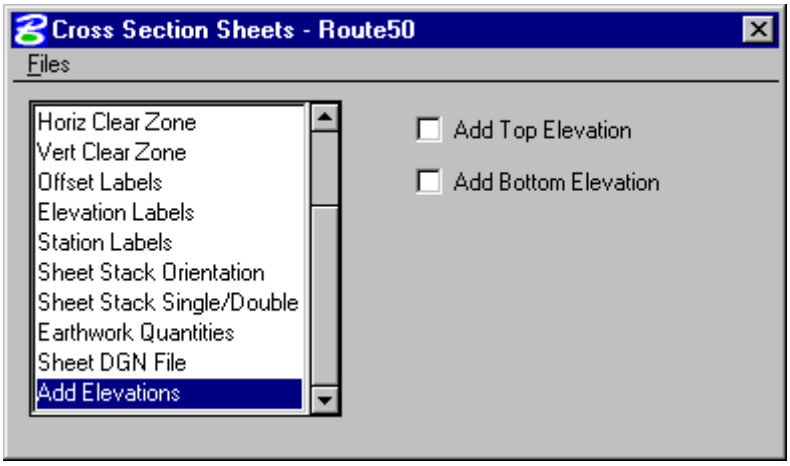
The **Sheet DGN File** specifies which file the cross-section sheets will be placed in. (Currently, the path to the Sheet DGN File including the file name is limited to 40 characters. By using the working directory, the user can specify only the file name in the Sheet DGN File field to increase the length of the file name.)

The Horizontal and Vertical Scales should be left at 1.0 regardless of what scale is being plotted. The Reference Data Point coordinate should be left at 0, 0.

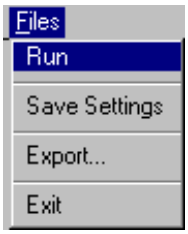


18.3.4 Add Elevations

Using the toggles **Add Top Elevation** and **Add Bottom Elevation** located in the **Add Elevations** section, the user can plot the elevation above and/or below the cross section elements.



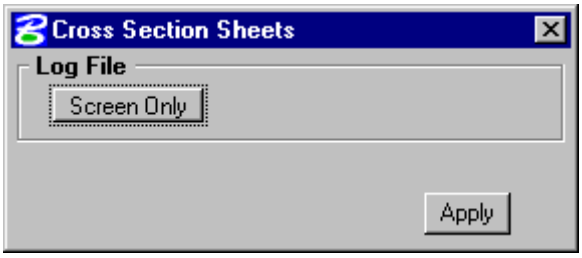
18.3.5 Files Menu



From the **Files** menu, the **Run** option will process all parameters that have been set in the **Cross Section Sheets** dialog box. The **Save Settings** option will save all information in the **Cross Sections Sheets** dialog box. The **Export** option will allow the user to save the parameters in the **Cross Section Sheets** dialog box as an ASCII input file. The **Exit** option will exit the **Cross Sections Sheets** dialog box.

18.3.6 Process Cross Sections

Once the dialog box is complete, the user can select **File >> Run** and the following dialog box will appear.



The user can display the results to the screen only, or write them to a log file. Once the **Apply** button is selected, the cross-sections will be plotted in sheet format.

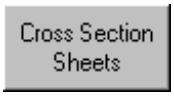
Exercise 18-1

1. Open the MicroStation file **t:\br-proj\a_geopak\d2\j2p0300\data\xs_j2p0300.dgn**.

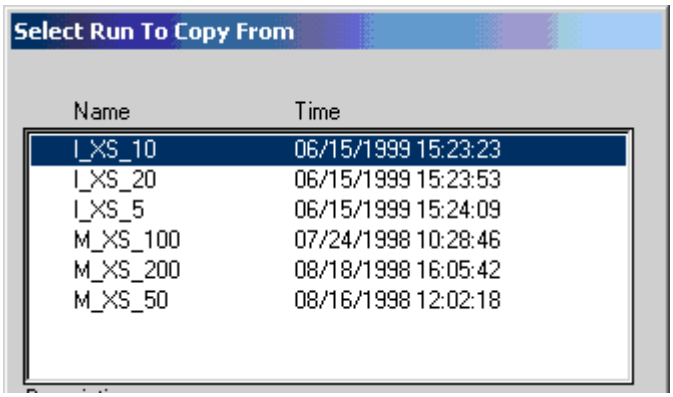
2. Open the project **t:\br-proj\a_geopak\d2\j2p0300\project\j2p0300.prj**.
   Enter the project as user **userc** and go into **Road**.

3. Select the **Bents** working alignment.

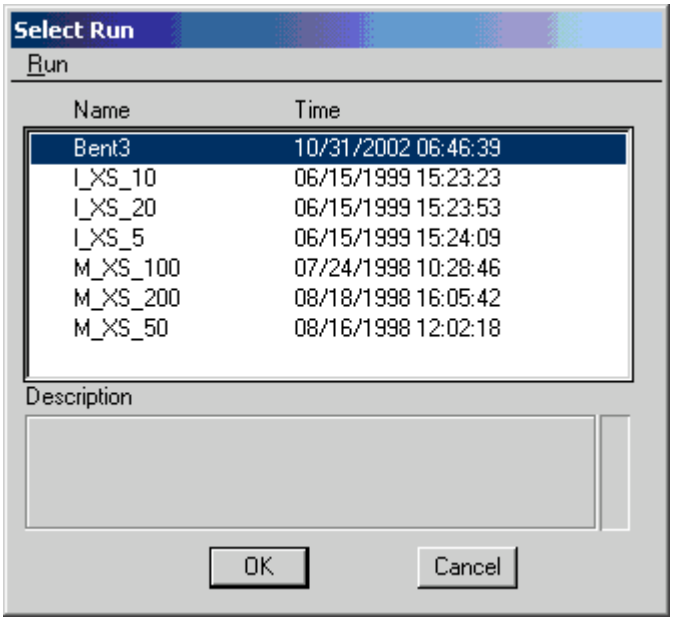
4. Choose **Cross Section Sheets** from the **Project Manager** dialog.



Copy the **I_XS_10** run to **Bent3**.



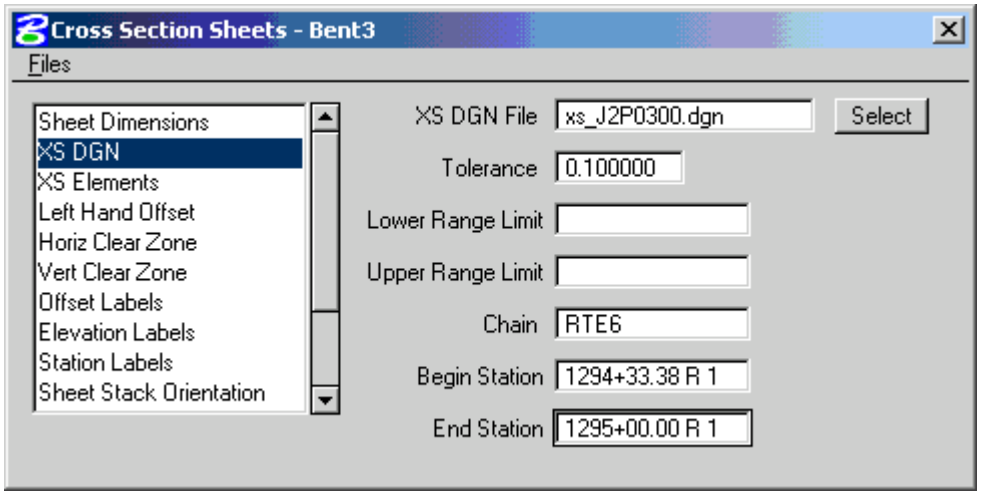
Open the **Bent3** run.



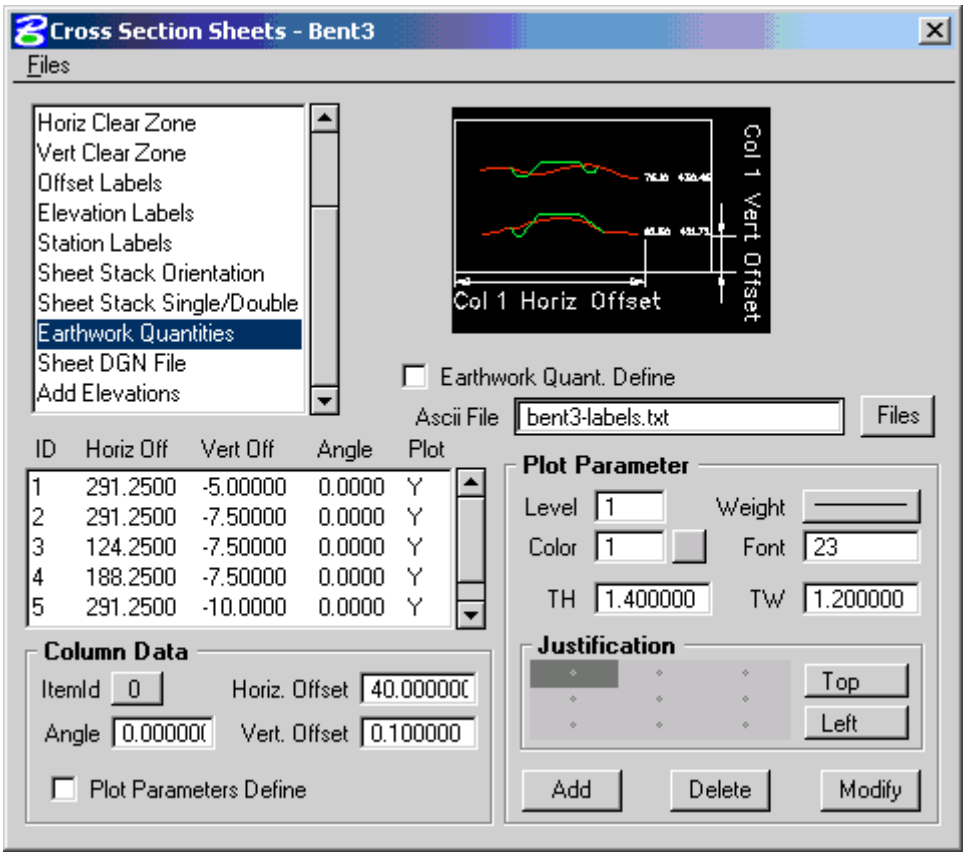
5. Create a new MicroStation file. Name the file **xs_bent3_sheets.dgn**, and put the file in the directory **t:\ br-proj\a_geopak\d2\j2p0300\data** \. Use the seed file **t:\standard\wsmod\design\seed-i\i_xs_shts_10.dgn**.

6. Be sure the following items are set in the **XS DGN File** section of the dialog:

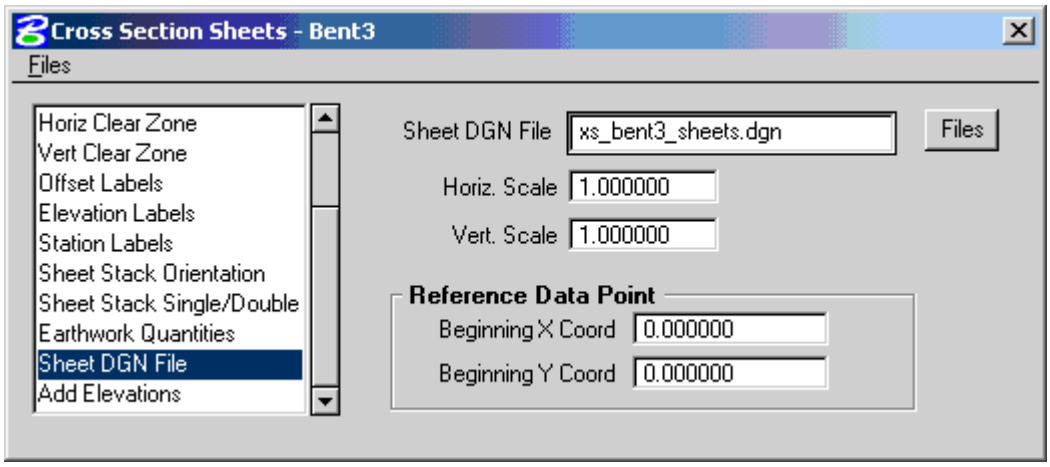
XS DGN File	**xs_j2p0300.dgn**
Chain	**RTE6**
Begin Station	**First Cross Section Station**
End Station	**1295+00 R 1**



7. In the **Earthwork Quantities** section, turn on the **Earthwork Quant. Define** option, and choose the ASCII file of **bent .txt**.



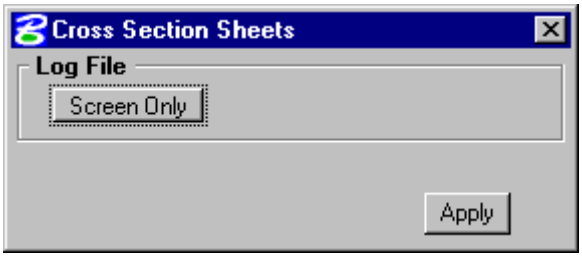
8. Select the **Sheet DGN File** to be the file **xs_bent3_sheets.dgn** created in step 5:



9. Save the settings for the run (**Files > Save Settings**).

10. Run the proposed cross-sections.

    Set the **Log File** to **Screen Only**.



11. Repeat the process for Bent 4, by going back into Cross Section Sheets. This time however, copy the **Bent3** run and name it **Bent4**. Go into the new run. By copying the Bent3 run, everything is already set except for the station range and the name of the files. Use names relevant to Bent 4. The earthwork quantities file is **bent4-labels.txt**, for instance.

Chapter 19

XS Reports & Limits of Construction

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19.1 Objectives

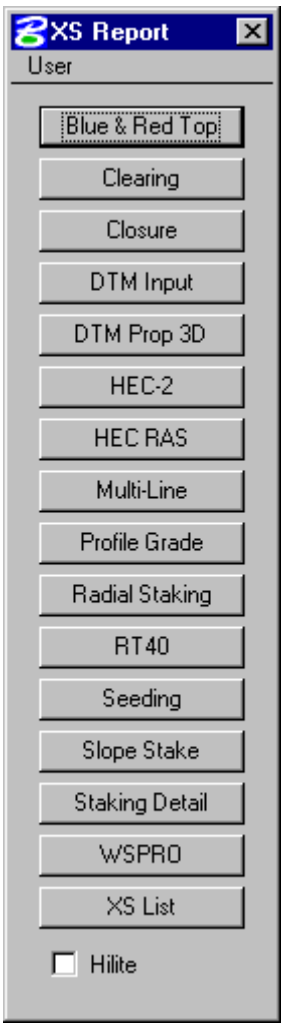
- Create various cross section reports:
  - for plan use (design elements and quantities)
  - as input for other programs and/or applications of GEOPAK
  - for construction layouts
- Create and plot construction limits in the plan view.

19.2 XS Reports Definitions

The GEOPAK Cross Section Report Utility can extract up to sixteen different reports from original and design cross-sections. For each report generated, the user must set the parameters of the existing and/or design cross sections. GEOPAK also provides an option to make custom headers for each of the reports via the **User** pull down menu.

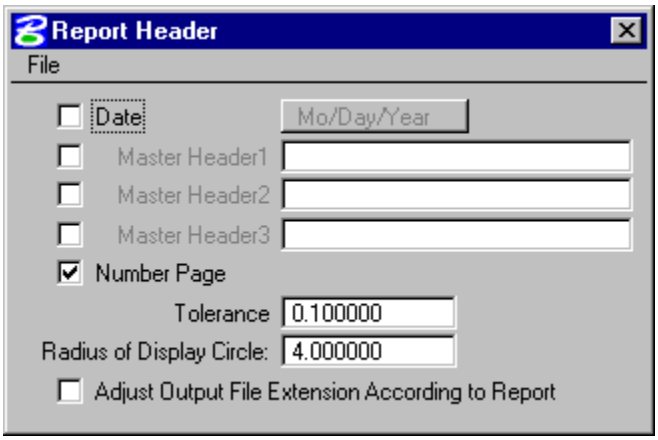
19.3 XS Reports Accessing

To access the **XS Report** select **Project Manager >> Reports & XS Quantities**.



19.4 XS Reports Dialog

From the **XS Report** dialog box select **User >> Preferences**; a **Report Header** dialog box will appear with all options ghosted out. To activate the individual fields simply toggle on the box next to the desired field. Once you have completed the dialog box, the information will be saved as an **.hdr** file. This allows for the creation of a separate header for each type of report. The tolerance field determines the maximum gap allowed between cross section elements.



19.5 Reports

Blue and Red Top

Based on the dialog box settings, GEOPAK determines the offset and elevation of a slope and its breakpoints. **Blue** refers to the top of pavement and **Red** is the top of subgrade. The user must determine this by indicating the level, color, weight and style for each surface.

Clearing

The **Clearing Report** is useful for obtaining clearing and grubbing quantities. For each station, GEOPAK will list the clearing distance on each side of the chain and the width of any exception. You can obtain the results in meters squared and/or hectares. Toggle boxes for Cut Slope Rounding, Additional Clearing in Cut and Fill, and Minimum Clearing Width are provided for increased control over the output.

GEOPAK can also generate quantity sub-totals based on the value specified in **Sub Every**.

To use the **Except Width** option, you must have an existing ASCII file that includes the Beginning and Ending Station and Exception Width.

Once everything is set, you can output the information to an ASCII file

Closure

The **Closure Report** provides information on the intersection point between the user defined proposed finish grade and existing ground. In addition to the ASCII report, the designer may instruct GEOPAK to close any gap either by drawing a vertical line between the endpoint of the proposed finish element and the existing ground or extending the slope of the last proposed element to intersect existing ground. The procedure will not extend existing ground. The **Closure Report** can be accessed within any Microstation cross section file by selecting Closure from the main XS Reports dialog

DTM Input

This process generates XYZ coordinates from cross section elements and places this information into an ASCII file for use in Geopak's DTM package. To use this dialog box simply enter the .gpk job number, chain name and station range. GEOPAK will read the cross section elements based on level, weight, color and style.

DTM Proposed 3D

This report is similar to DTM Input except that you can set both original and proposed cross sections at the same time. This report also differs in that it makes breaklines across the cross sections. This report is mainly useful when making 3-D cross sections for modeling purposes.

HEC-2

This process reads cross section elements and formats the information in an ASCII text file suitable for use in the HEC-2 hydraulic program.

HEC RAS

This process reads cross section elements and formats the information in an ASCII text file suitable for use in the HEC RAS hydraulic program.

Multi-Line

This report is useful in creating cross-sections for staged construction. Begin by entering the job number, chain name and station limits. Primary cross section element parameters must be completed before secondary element parameters. This is important due to the order in which GEOPAK reads the information. Once all the parameters have been entered, the new cross sections may be drawn to the design file or you may choose the display only option. An ASCII text file will be generated.

Profile Grade

The **Profile Grade Repor**t is one of the most versatile reports available. It prints existing ground and design grade elevations and low point elevations for each cross section. Additionally, this report has the ability to create horizontal and vertical alignments along the low points and store them directly into the .gpk. Horizontal alignments created from this report will start with station 0+000 and have no curves.

Radial Staking

The **Radial Staking Report** is a specialized report created for the U.S. Federal Highway Administration (FHWA).

RT 40

The **RT 40 Report** produces RDS based RT40 data. To use this dialog box simply fill in the job chain name, stationing range and the parameters of the cross section elements you wish to use.

Seeding

Other than the usual entries, the user must enter the parameters of the elements to be seeded.

This dialog box includes slope and subtotal options as well as a way to limit the number of segments read (**By-Pass Segments**). The user may also establish additional seeding specifications (**Additional Distance**).

Once all of the settings are complete, the report is written to an ASCII output file for use in plan quantities.

Slope Stake

The **Slope Stake Report** is a special format report developed for the FHWA. This report generates offsets, elevations and superelevation information for each cross section. To generate this report fill in the usual cross section parameters plus Subgrade and Hub Staking information. When complete, push Apply and the report is written into an ASCII file.

Staking Detail

The **Staking Detail Report** determines the tie down point between the proposed finished grade and the existing ground. GEOPAK will list the right and left offset, elevation, slope of the finish grade and superelevation rate for each cross section. To create this report, fill in the project information and desired cross section elements' parameters. Once complete, you have the choice between two formats, a FHWA ASCII report or a Montana DOT report (includes ditch elevations).

WSPRO

This report takes the cross section elements and turns them into an ASCII file in the WSPRO format for use as input in the WSPRO hydraulic analysis program.

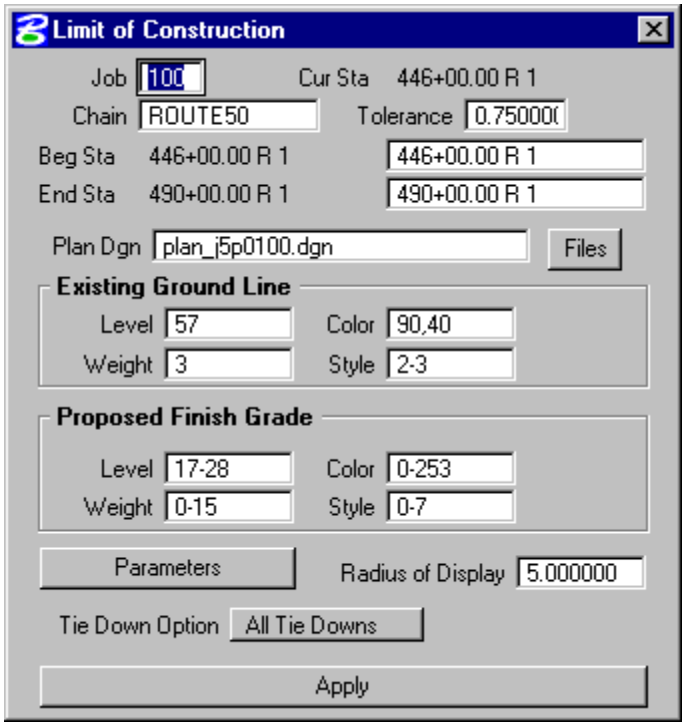
XS List

This report creates a listing of elevations and offsets for each cross section element according to user defined parameters. You have the option of creating either an original cross section list or a design cross section list. These reports are very similar to RDS cross section lists.

Note: For more information on the various reports and the dialogs, see the Geopak manual or the online help.

19.6 Accessing Limits of Construction

To access the **Limits of Construction** dialog, go to **Project Manager >> Limits of Construction**. After the run is chosen, the following dialog opens.

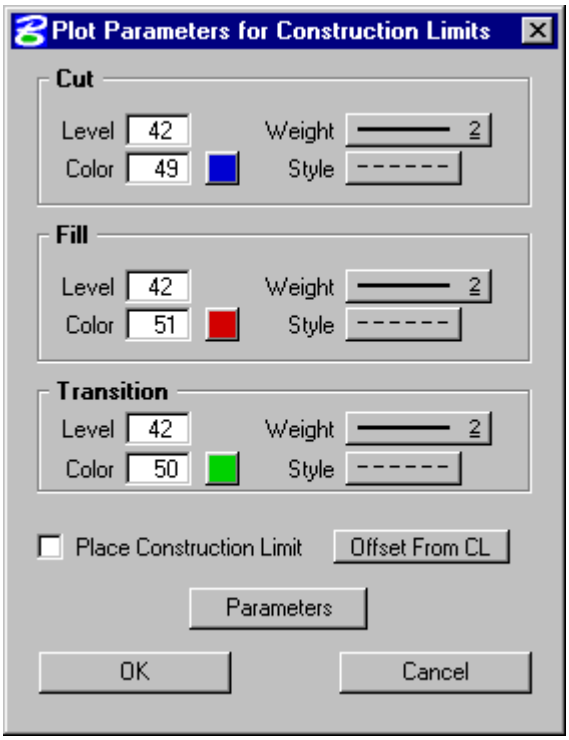


19.7 Processing Limits of Construction

The user can specify the .gpk job number, the centerline, and the file containing the plan view information. The **Working Alignment** should fill the **Existing Ground** and the **Proposed Finish Grade** sections.

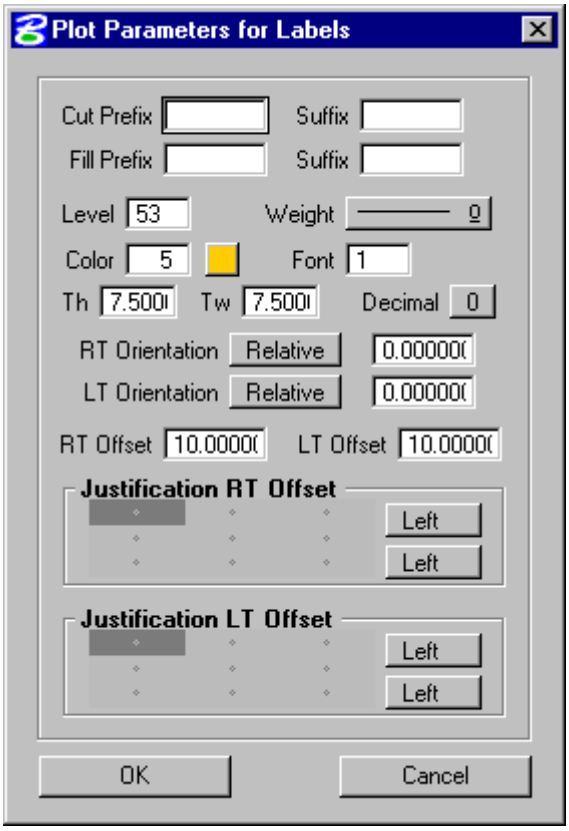
The **Parameters** button opens the dialog box below. The symbology for the cut, fill, and transition construction limits can be set in this dialog.

The **Place Construction Limit** toggle allows the user to place various text strings along the construction limits. Selecting the Parameters button, and making the desired changes in the dialog box shown below will set the symbology for these text strings.



The **Radius of Display** field is the size of the display circle when Geopak is scanning the cross-sections. The last option in the main **Limits of Construction** dialog is the **Tie Down Option**. There are two **Tie Down Options**. If the **All Tie Down** option is set, all tie downs within a section are plotted. (I.e. wide medians, outer roadways, ramps, etc. may have tie downs in between the limits of the main roadway, and the outer roadway or ramp.) If the **Outer Tie Down** option is selected, then only the outmost tie downs are plotted.

Once the **Apply** button is chosen, the limits of construction and the optional text are drawn into the plan view file.



Exercise 19-1

1. Open the MicroStation file:
   t:\br-proj\a_geopak\d2\j2p0300\data\pattern_shape_j2p0300.dgn.
   The yellow lines on level 22 will be used as pattern lines for cross sections for hydraulic analysis. A GEOPAK XS Report will be created, which can be imported into HEC RAS.

2. Open the project **t:\br-proj\a_geopak\d2\j2p0300\project\j2p0300.prj**.
   Enter the project as user **userc** and go into **Road**.

3. Copy the J2P0300 working alignment to **Water** and enter that working alignment.

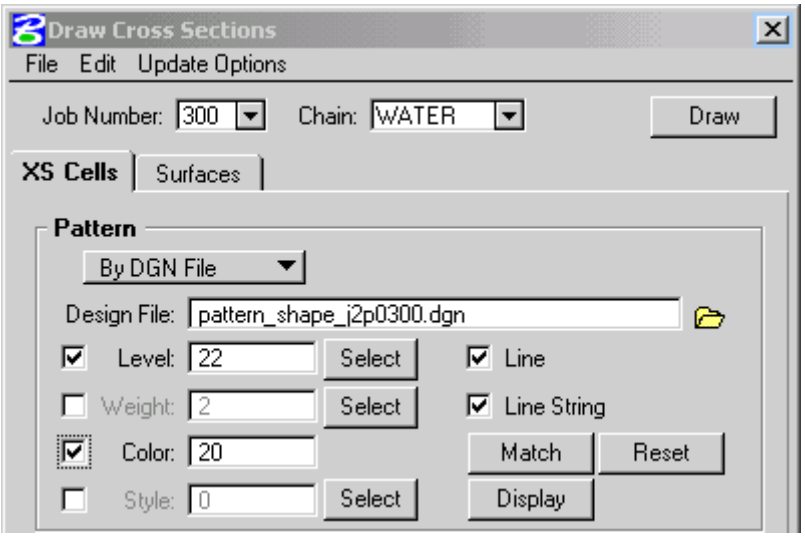
4. Enter the Working Alignment Definition for **Water** and change the following:

Section	Item	Value
Plan View	**Chain:**	**WATER**
Pattern	**Design File:**	**pattern_shape_j2p0300.dgn**
	Levels	**22**
	Weights	**2**
	Colors	**20**

5. Open the MicroStation file **t:\br-proj\a_geopak\d2\j2p0300\data\xs_water_j2p0300.dgn**.

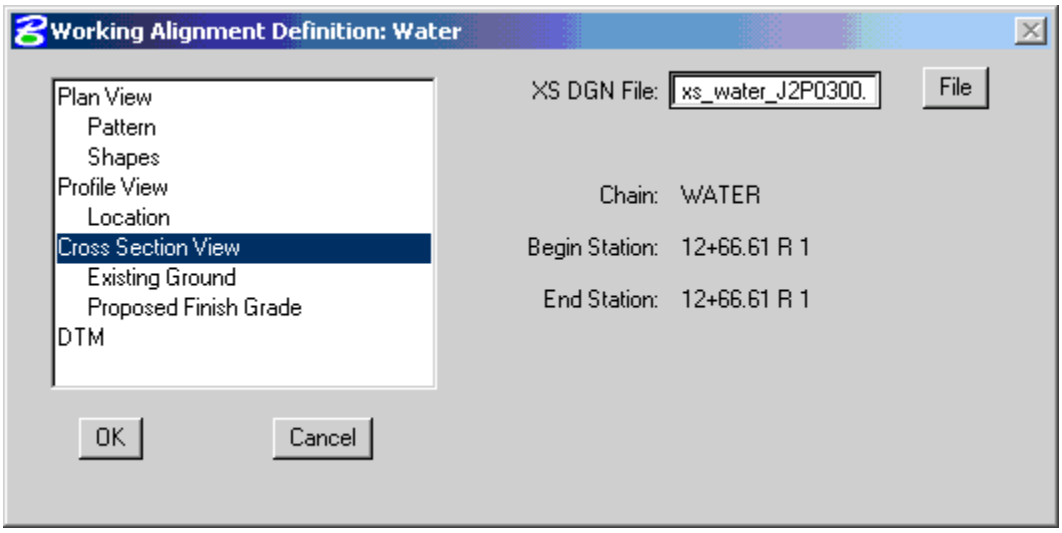
6. Choose **Existing Ground Cross Sections** from the **Project Manager** dialog.

   Copy the **MoDOT** run to **Water** and enter that run. Set the **XS Cells tab** as shown below and have the **J2P0300.TIN** as the only one listed under the **Surfaces tab**.



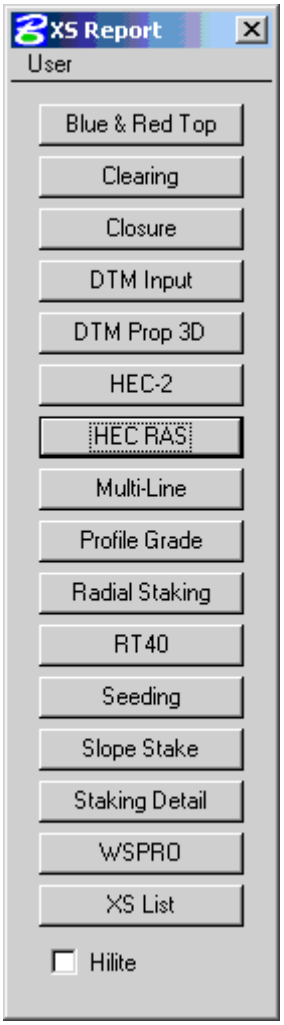
   Select **Draw** to draw the cross section and **Save** the MicroStation file.

7. Set **xs_water_j2p0300.dgn** as the **XS DGN** in the Cross Section View section of the Water **Working Alignment Definition** as shown below.

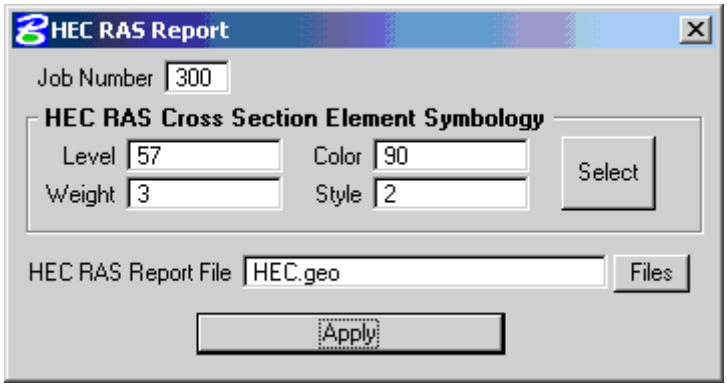


8. Choose **Reports and XS Quantities** from the **Project Manager** dialog.

This will bring up the XS Report dialog shown to the right. Select the **HEC RAS** report.



The dialog shown below will appear. Enter the information as shown:



Select **Apply** to generate the report.

The report will be written to the working directory. Open the report in Ultra Edit. It is:

t:\br-proj\a_geopak\d2\j2p0300\data\HEC.geo.

To import the data into HEC RAS, start the HEC RAS project and go to **Edit > Geometric Data…** in HEC RAS. In the Geometric Data dialog, go to **File > Import Geometry Data > GIS Format…** and load the HEC.geo report.

Exercise 19-2

This is the second in a series of exercise that will demonstrate using cross-sections to determine bridge length. The group exercise makes use of the proposed cross-sections for Route50 that were drawn in Exercise 15-1. In this exercise, a XS Report is used to create a new TIN, which will serve as the surface model for other cross-sections.

1. Open the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\xs_50_j5p0100.dgn**.

2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**.

   Enter the as user **userc**.

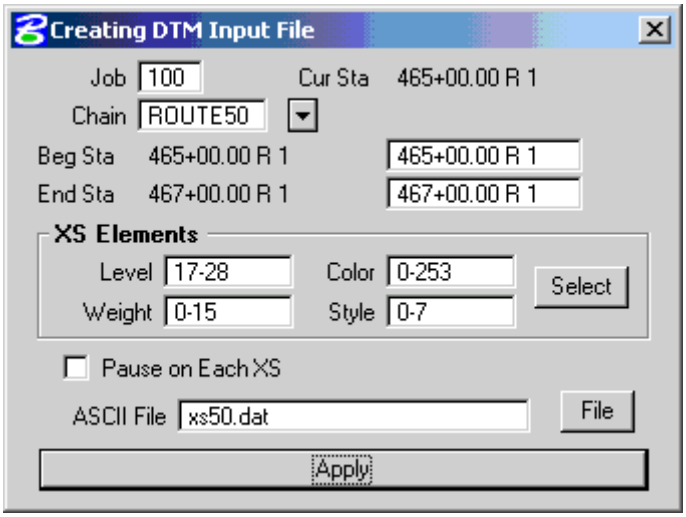
   Go into **Road**.

3. Select the **Route50** working alignment.

4. Choose **Reports and XS Quantities** from the **Project Manager** dialog.

   Select the **DTM Input** report.

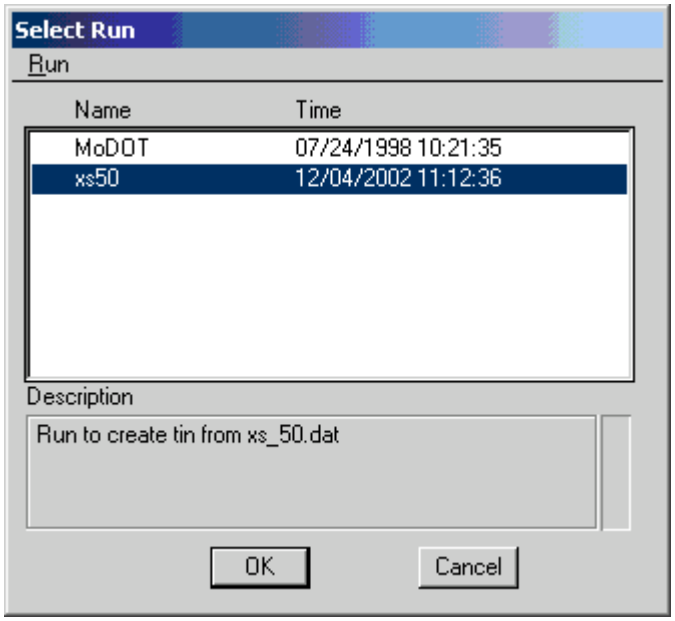
   The dialog shown below will appear. Enter the information as shown:

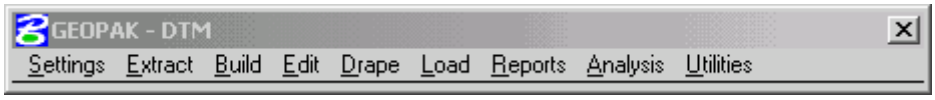
   Once the information is entered, click on **Apply**. Close the Reports and XS Quantities dialog when the Create DTM Input File process is completed.

5. Choose **Existing Ground** from the **Project Manager** dialog.

Copy the **MoDOT** run to **xs50**, and open the **xs50** run.

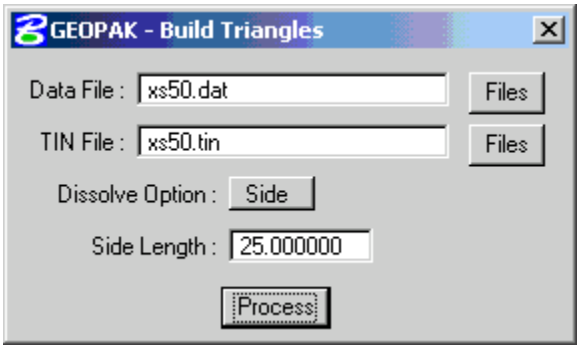


From the DTM menu, shown below, select **Build > Triangles**.



When the following dialog appears, populate it as shown below:

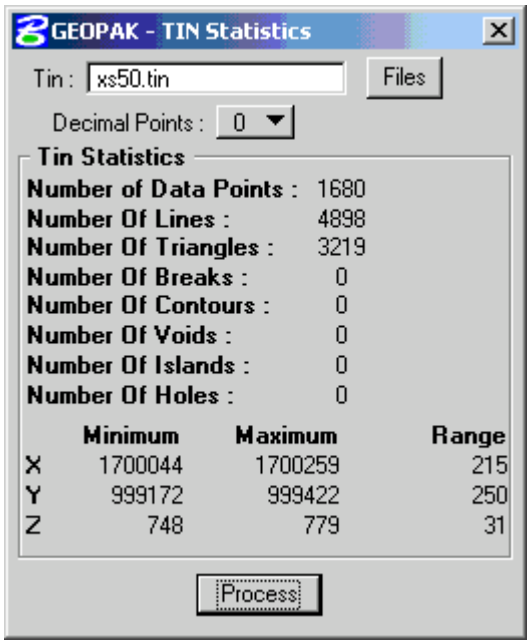
Data File:	**xs50.dat**
TIN File:	**xs50.tin**
Dissolve Option:	**Side**
Side Length:	**25**



When the "Build Triangles Complete" appears in the MicroStation Status Bar, close the Build Triangles dialog. Say YES, when asked if you want to save the settings.

6. Select **Reports > Triangle Statistics** from the DTM menu.

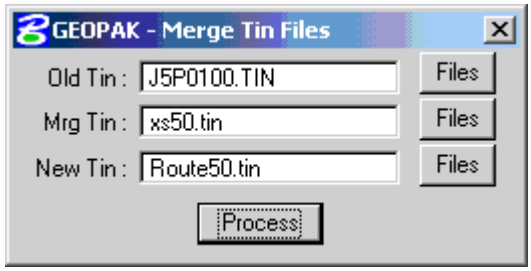
   When the following dialog appears, load the file **xs50.tin** and Process the report. Compare your results to those shown below.



7. Select **Build > Merge TINs** from the DTM menu.

   When the following dialog appears, populate it as shown below:

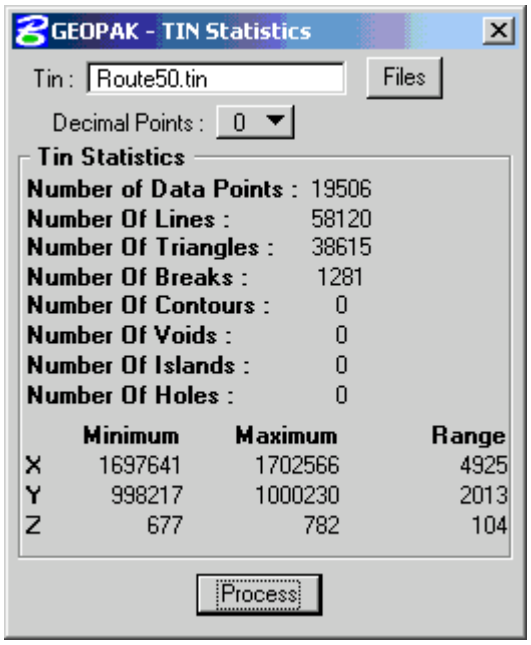
Old Tin:	**J5P0100.TIN**
Mrg Tin:	**xs50.tin**
New Tin:	**Route50.tin**



   Once the dialog is set, click on **Process**. When the "Build Merge Complete" appears in the MicroStation Status Bar, close the Merge Tin Files dialog.

8. Select **Reports > Triangle Statistics** from the DTM menu.

   When the following dialog appears, load the file **Route50.tin** and Process the report. Compare your results to those shown below.



   If you wish you may open either topo_J5P0100.dgn (2D file) or dtm_J5P0100.dgn (2D file) and view either of the tins created in this exercise. The Route50.tin will serve as the existing ground tin for Exercise 19-3.

   Exit the DTM tools.

Exercise 19-3

This continues a series of exercise that demonstrate a method for determining bridge length using cross-sections. The previous exercised in the series are 15-1 and 19-2.

1. Open the MicroStation file:
   t:\br-proj\a_geopak\d5\j5p0100\data\pattern_shape_j5p0100.dgn.

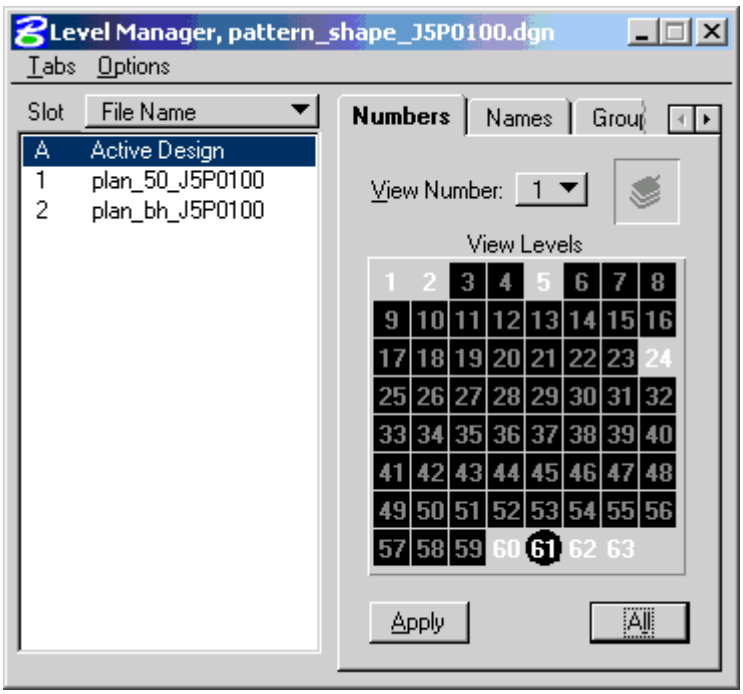
2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**.

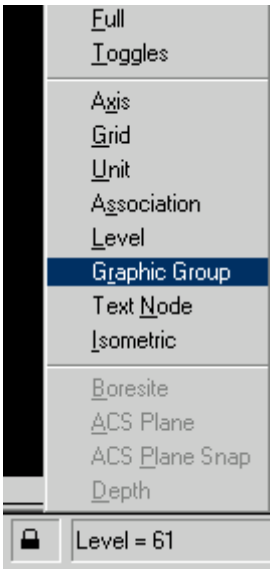
   Enter the as user **userc**.

   Go into **Road**.

   Select the **Route50** Working Alignment.

3. Open level manager and turn on level 61 and turn off levels 1-2, 5, 24, 60, and 62-63 as shown in the dialog in the following figure on the left.

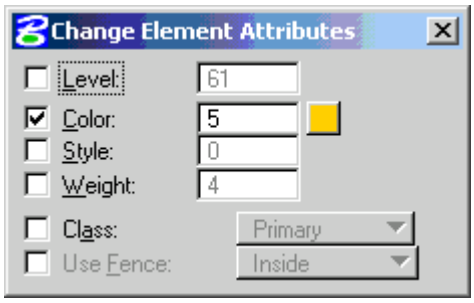




   Do a MicroStation Fit View. All that should be visible are the pattern lines for Route 50.

   Go to the pad lock in the MicroStation status bar and make sure that the Graphic Group lock is deactivated, as shown above in the figure on the right.

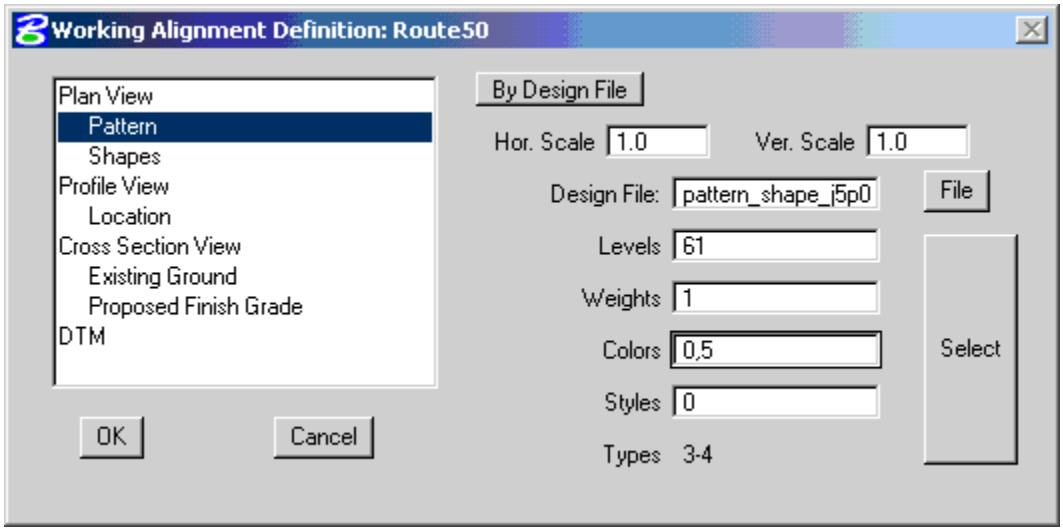
4. Use the MicroStation **Change Element Attribute** tool to change the color of the **first** and the **last** pattern line to Color **5**.



This will enable the next set of cross sections to ignore those two pattern lines. The remaining color 0 pattern lines will be used as part of a working alignment called 50Clear, which while using the same chain as Route50, will use a profile 4.25' below Route50PR. Just as a new tin was create from the Route50 cross sections to represent the surface of the highway, 50Clear cross sections will be used to create a tin representing the maximum height of the fill slopes under the bridge. The shorter range of pattern lines is being used to show a clear drop between the two surfaces.

Save the changes to the MicroStation file.

5. Since the pattern lines for the Route50 working alignment have been modified, enter the **Route50 Working Alignment Definition**, highlight **Pattern**, and add color **5** to the list of **Colors**, as shown below.



Click **OK** to save the changes to the alignment definition.

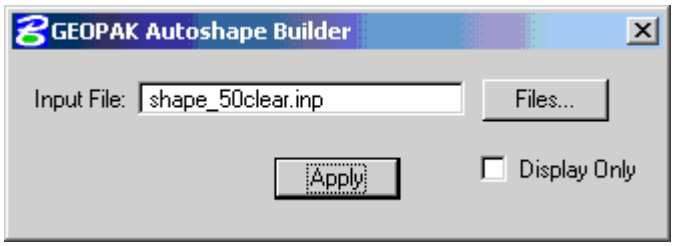
6. Use the GEOPAK **Autoshape Builder** tool to plot the shapes for 50Clear.

To open the Autoshape Builder, **expand the Cross Sections toolbox**, which is the icon in the lower left hand corner of the Road Tools, shown to the right and **select the fourth icon from the right**, which is the raised icon shown below.

This will display the Superelevation Shape Manger Tools dialog depicted below. **Select the Autoshape Builder**, which is the second tool, as highlighted in the figure/

Click on the **Files…** button in the Autoshape Builder and select **shape_50clear.inp**.

Press **Apply** to plot the shapes.

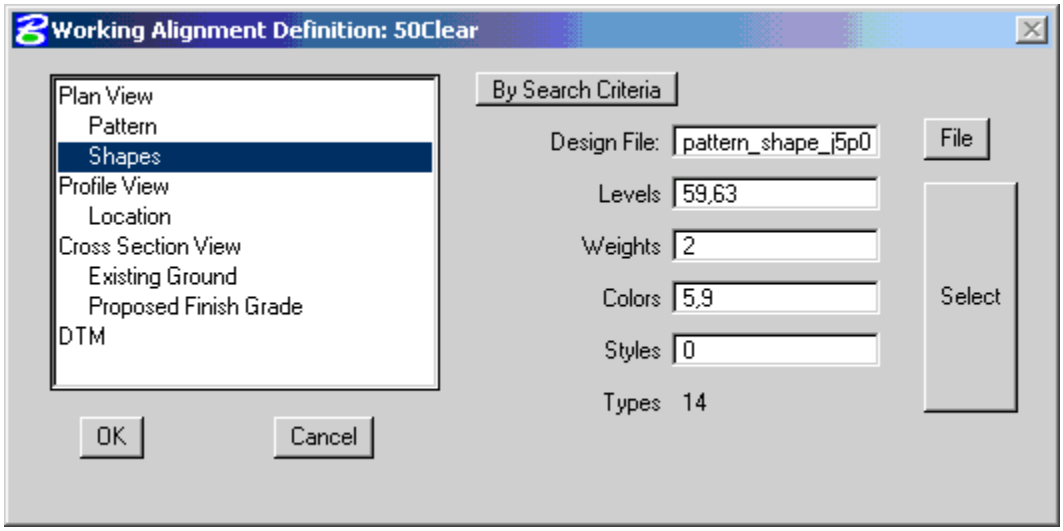


Save the changes to the MicroStation file. **Close** the **Autoshape Builder** and related toolboxes.

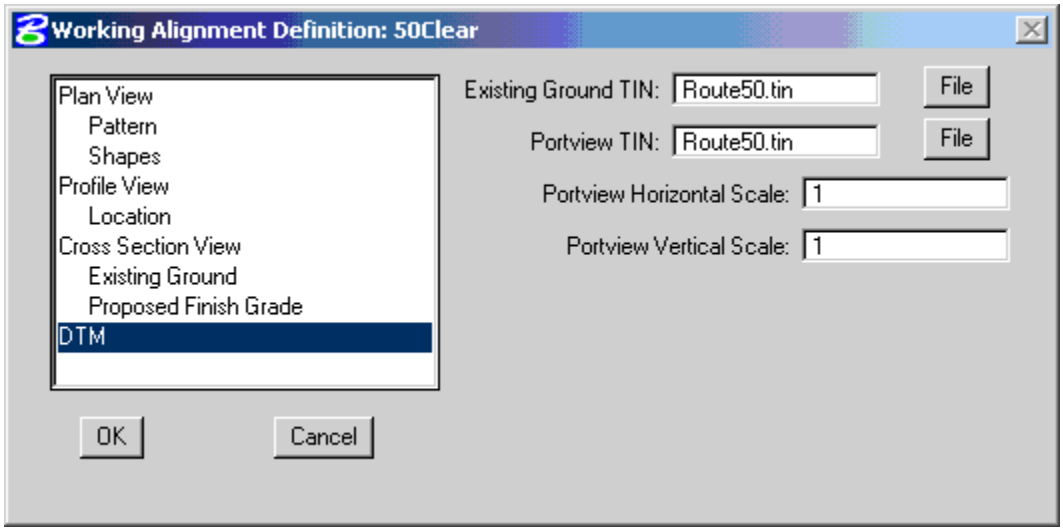
7. **Select** the **50Clear** working alignment.

8. Enter the working alignment definition for **50Clear**.

   Go to the **Shapes** section and change **Colors** to **5,9** as depicted below.



   Switch to the **DTM** section and change the **Existing Ground TIN** and the **Portview TIN** to **t:\br-proj\a_geopak\d5\j5p0100\data\Route50.tin** as shown in the following dialog. This TIN reflects the new driving surface for Route 50 and will be used for 50Clear existing and proposed cross sections.



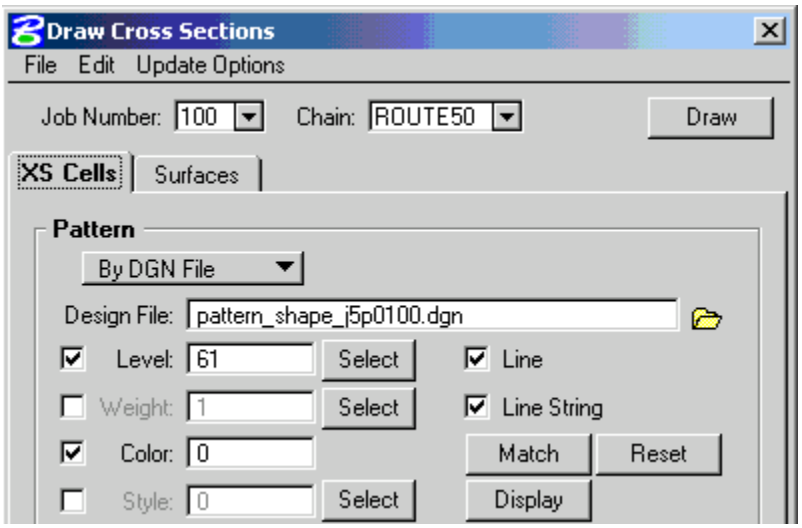
   Click **OK** to save the changes to the alignment definition.

9. **Open** the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\xs_j5p0100.dgn**. Save it as **t:\br-proj\a_geopak\d5\j5p0100\data\xs_50clear_j5p0100.dgn**.

10. Choose **Existing Ground Cross Sections** from the **Project Manager** dialog.

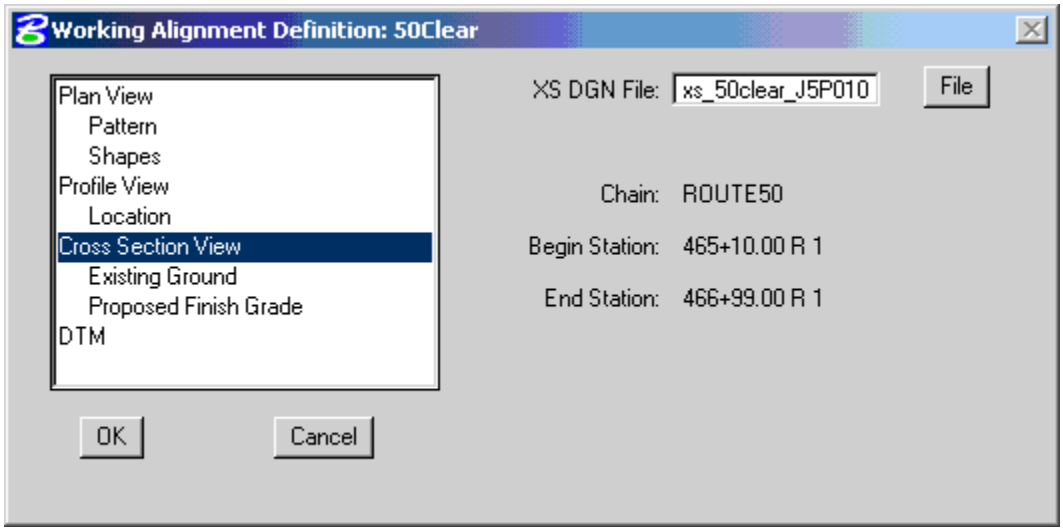
Copy the **MoDOT** run to **50Clear** and enter the **50Clear** run.

11. Set the **XS Cells tab** as shown below and have the **Route50.tin** as the only one listed under the **Surfaces tab**.

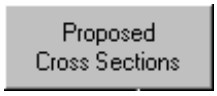


Select **Draw** to draw the existing ground cross section and **Save** the MicroStation file. Exit the run, saving the settings.

12. Reenter the working alignment definition for **50Clear** and change the **XS DGN File** to **t:\br-proj\a_geopak\d5\j5p0100\data\xs_50clear_J5P0100.dgn** in the **Cross Section View** section as shown below. Note that the station range is shorter than that for the Route50 working alignment, which goes from Sta. 465+00 to Sta. 467+00. Click **OK** to save the changes to the alignment definition.



13. Choose **Proposed Cross Sections** from the **Project Manager** dialog.



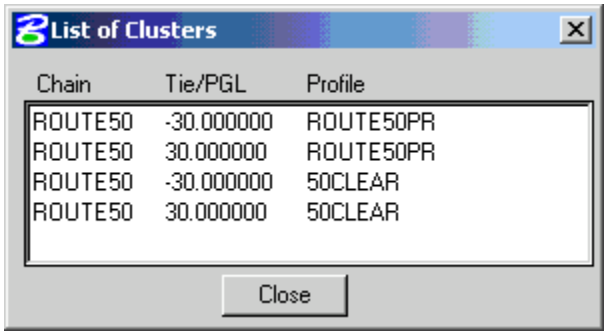
Copy the MoDOT run to **50Clear** and enter the **50Clear** run.

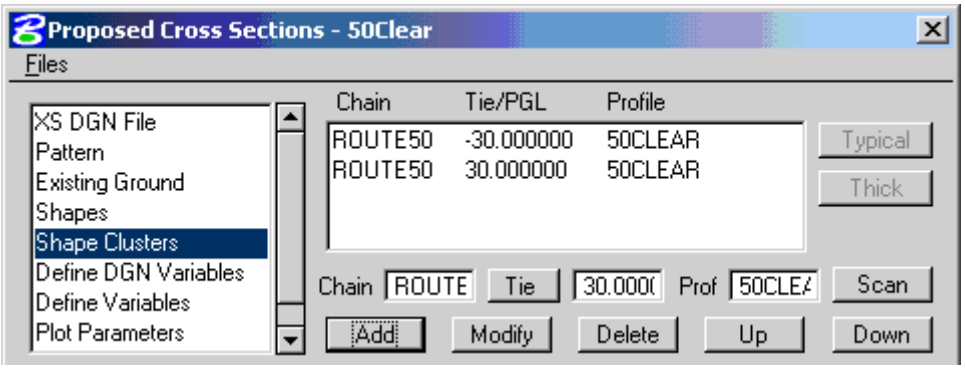
14. Be sure the following items are set in the given sections of the dialog:

XS DGN File:	**xs_50clear_J5P0100.dgn**
Pattern:	**Use Working Alignment Definition**
Existing Ground:	**Use Working Alignment Definition**
Shapes:	**Use Working Alignment Definition**

15. In the **Shape Clusters** section of the dialog add the following shape clusters in the order shown by choosing the **Scan** button, highlighting the desired cluster in the List of Clusters dialog, and clicking on **Add** in the Proposed Cross Sections dialog. Once the clusters have been added, **close** the **List of Clusters**.

Chain	Tie	Profile
ROUTE50	**-30**	**50CLEAR**
ROUTE50	**30**	**50CLEAR**





16. For each shape cluster, **add** the given side **Slope Conditions** and **Criteria Files**. (See the attached typical section for details.)

Chain	Tie	Profile
ROUTE50	**-30**	**50CLEAR**

Side Slope: LT
Criteria Files: setup.x
pvmt_layers.x
shldr_a_c.x
berm_to_prof_or_exgrnd.x

Side Slope: RT
Criteria Files: setup.x
pvmt_layers.x
shldr_a1_c.x
median_ditch.x

Chain	Tie	Profile
ROUTE50	**30**	**50CLEAR**

Side Slope: LT
Criteria Files: setup.x
pvmt_layers.x
shldr_a1_c.x
median_ditch.x

Side Slope: RT
Criteria Files: setup.x
pvmt_layers.x
shldr_a_c.x
berm_to_prof_or_exgrnd.x

Save the Proposed Cross Section run by going to **Files > Save Settings**.

17. Switch to the **Define Variables** section of **Proposed Cross Sections**, as make sure the following are defined:

NAME OF PLAN FILE.....plan_50_J5P0100.dgn
NAME OF CROSS-SECTION FILE .....xs_50clear_J5P0100.dgn
NAME OF SHAPE/PATTERN FILE .....pattern_shape_J5P0100.dgn
NAME OF BASELINE Route50
SHOULDER SLOPE (%).....5
LEFT BERM SLOPE (%) .....-5
RIGHT BERM SLOPE (%).....5
MEDIAN SLOPE (1:X OR X:1) 50
MEDIAN DITCH DEPTH (M OR FT).....0
DITCH BACK SLOPE (1:X OR X:1).....50

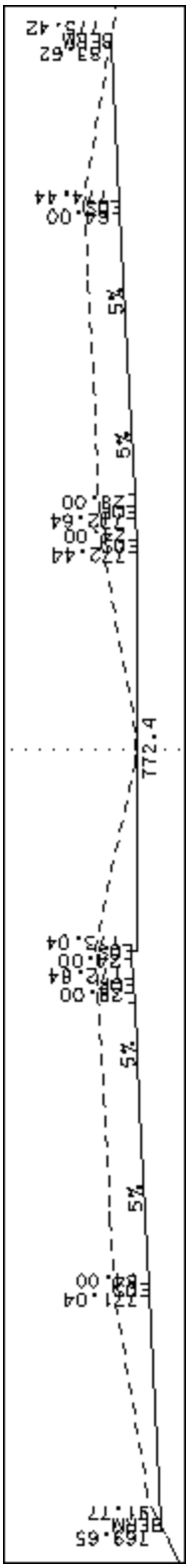
Leave the remaining variables set to the defaults.

18. Save the settings for the run.

19. Run the proposed cross-sections (**Files > Run**).

Set the **Log File** to **Screen Only**.

Turn on **Pause on Each Section**.


169.65
BEGBM
91.77
5%
5%
5%
5%
772.4
BEGBM
175.42
83.62
174.44
64.00

Exercise 19-4

This exercise must be completed after Exercise 19-3 and continues the process of using cross sections to determine bridge length. In this exercise a new TIN is created, which represents the maximum height of the fill slopes.

1. Open the MicroStation file:
   t:\br-proj\a_geopak\d5\j5p0100\data\xs_50Clear_j5p0100.dgn.

2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**.

   Enter the as user **userc**.

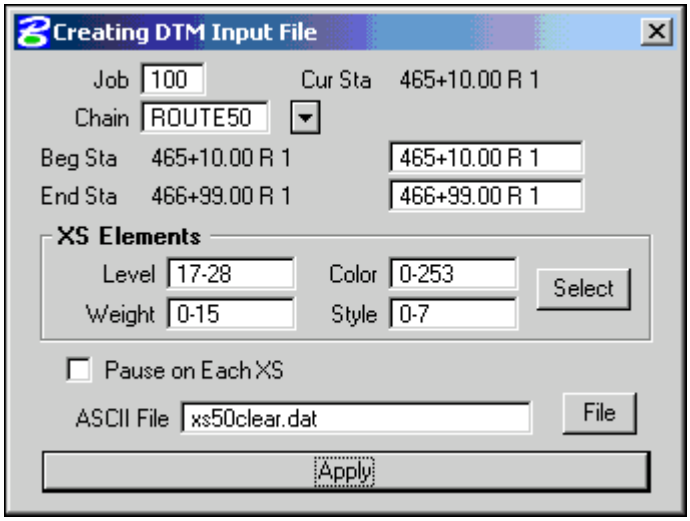
   Go into **Road**.

3. Select the **50Clear** working alignment.

4. Choose **Reports and XS Quantities** from the **Project Manager** dialog.

   Select the **DTM Input** report.

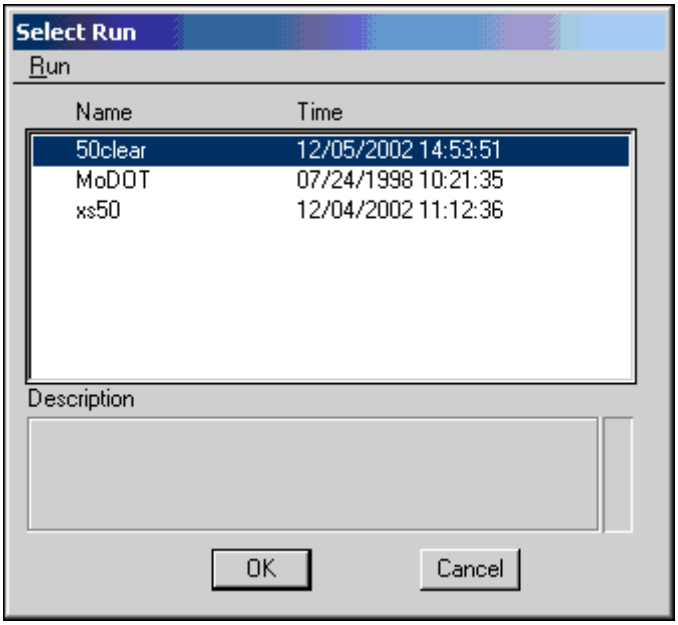
   The dialog shown below will appear. Enter the information as shown:

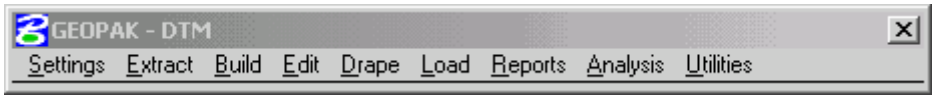
   Once the information is entered, click on **Apply**. Close the Reports and XS Quantities dialog when the Create DTM Input File process is completed.

5. Choose **Existing Ground** from the **Project Manager** dialog.

Copy the **MoDOT** run to **50clear**, and open that run.

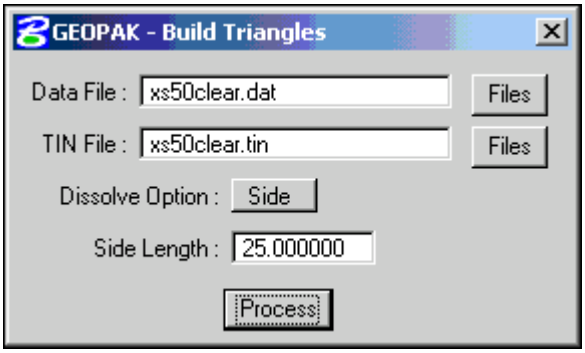


From the DTM menu, shown below, select **Build > Triangles**.



When the following dialog appears, populate it as shown below:

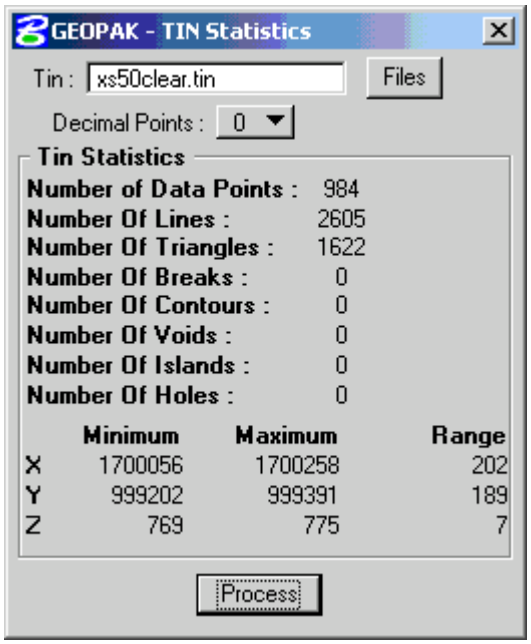
Data File:	**xs50clear.dat**
TIN File:	**xs50clear.tin**
Dissolve Option:	**Side**
Side Length:	**25**



When the "Build Triangles Complete" appears in the MicroStation Status Bar, close the Build Triangles dialog. Say YES, when asked if you want to save the settings.

6. Select **Reports > Triangle Statistics** from the DTM menu.

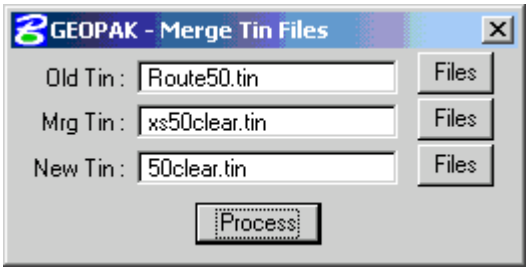
   When the following dialog appears, load the file **xs50clear.tin** and Process the report. Compare your results to those shown below.



7. Select **Build > Merge TINs** from the DTM menu.

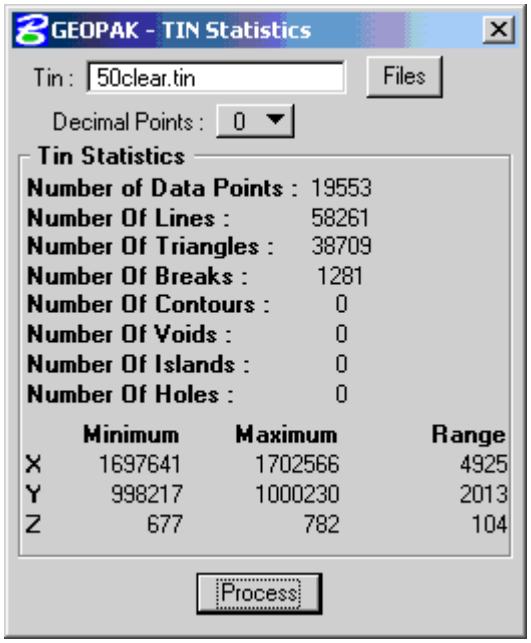
   When the following dialog appears, populate it as shown below:

   Old Tin: **Route50.tin**
   Mrg Tin: **xs50clear.tin**
   New Tin: **50clear.tin**



   Once the dialog is set, click on **Process**. When the "Build Merge Complete" appears in the MicroStation Status Bar, close the Merge Tin Files dialog.

8. Check the statistics for **50clear.tin**. Compare your results to those shown below.

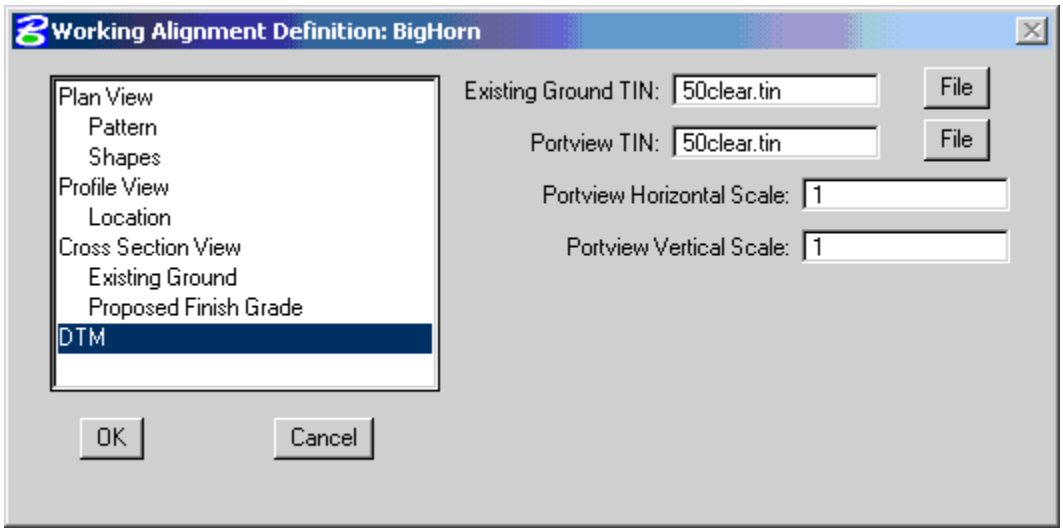


If you wish you may open either topo_J5P0100.dgn (2D file) or dtm_J5P0100.dgn (2D file) and view either of the tins created in this exercise.

Exit the DTM tools.

9. 50clear.tin will be used for cutting cross sections for Big Horn drive. To prepare for that, select the **BigHorn Working Alignment** and click on **Define** in the Road Project dialog.

Go to the **DTM** section of the working alignment definition and select **50clear.tin** for the **Existing Ground TIN** and the **Portview TIN** as shown below.



Click **OK** to save the changes to the working alignment definition.

Exercise 19-5

This continues a series of exercise that demonstrate a method for determining bridge length using cross-sections. The previous exercises in the series are 15-1 and 19-2 through 19-4.

1. Open the MicroStation file:
   t:\br-proj\a_geopak\d5\j5p0100\data\pattern_shape_j5p0100.dgn.

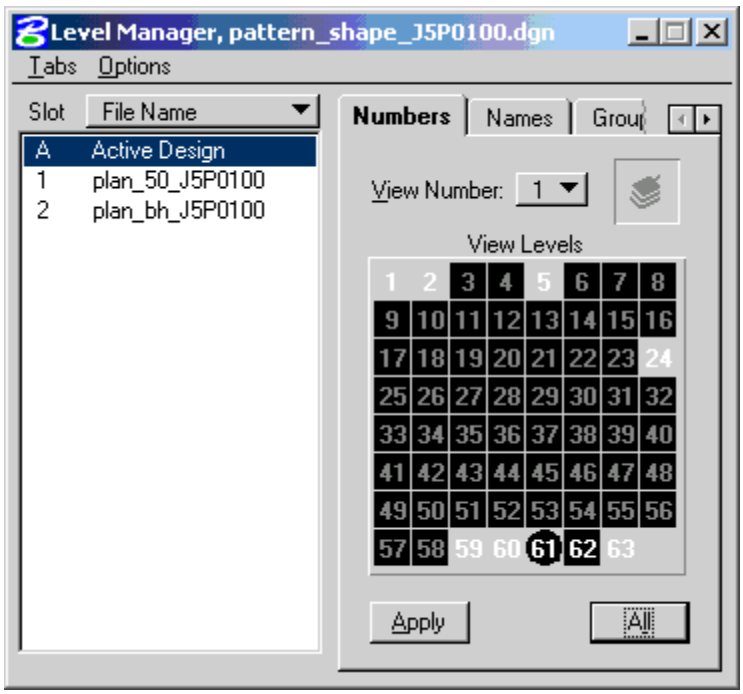
2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**.

   Enter the as user **userc**.

   Go into **Road**.

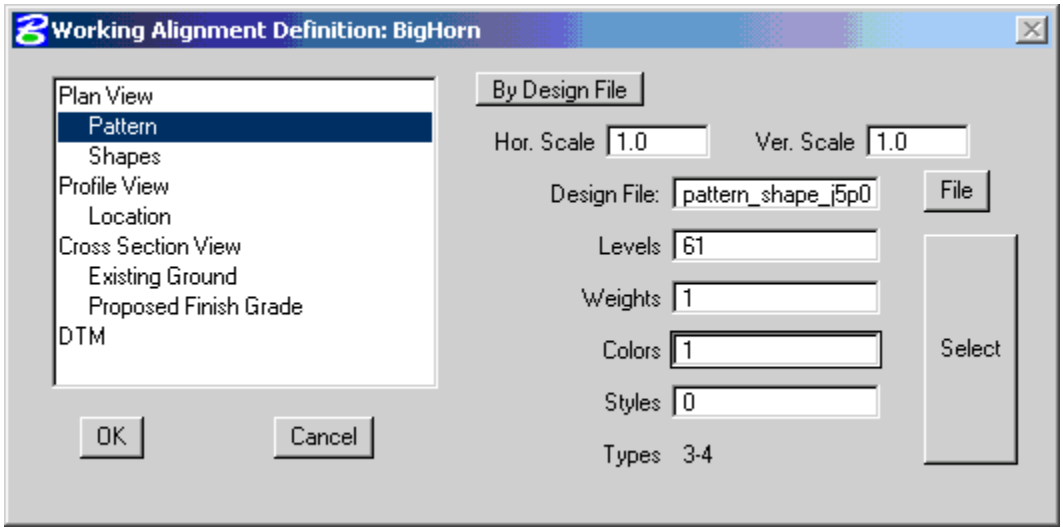
   Select the **BigHorn** Working Alignment.

3. Open level manager and turn on level 62 and turn off levels 1-2, 5, 24, 59-60, and 63 as shown below.



   Do a MicroStation Fit View. All that should be visible are the pattern lines for Route 50 and the BigHorn shapes.

4. Pattern lines need to be drawn for Big Horn Drive. They need to be different from those for Route50. The easiest way to do this is by using a different color. Enter the **BigHorn Working Alignment Definition**, highlight **Pattern**, and change **Colors** to **1**.



Click **OK** to save the changes to the alignment definition.

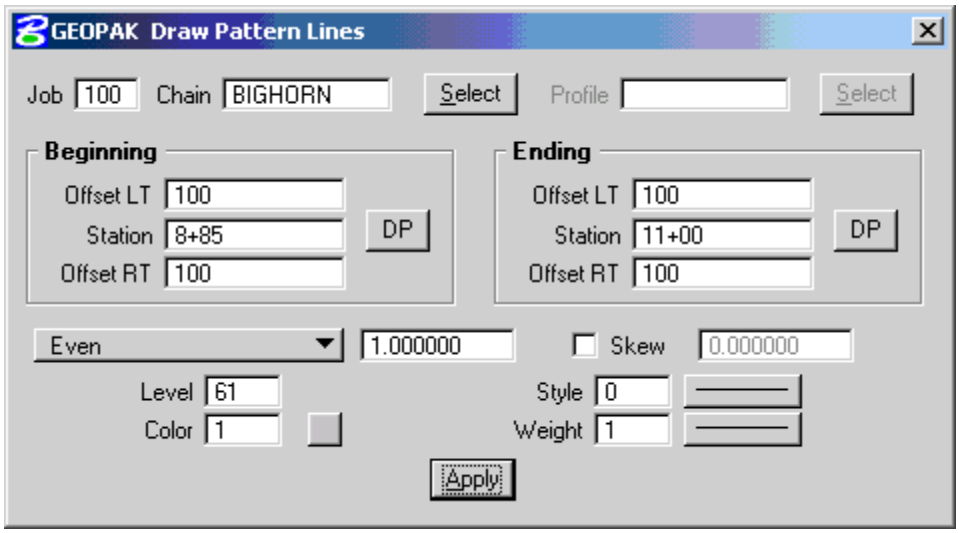
5. Select **Draw Pattern** from the Road Project dialog.

Copy the MoDOT run to **BigHorn** and enter that run. Use the following settings:

Job: **100** Chain: **BIGHORN**

Beginning		Ending	
Offset Lt:	**100**	Offset Rt:	**100**
Station:	**8+85**	Station:	**11+00**
Offset Lt:	**100**	Offset Rt:	**100**

Even: **1**



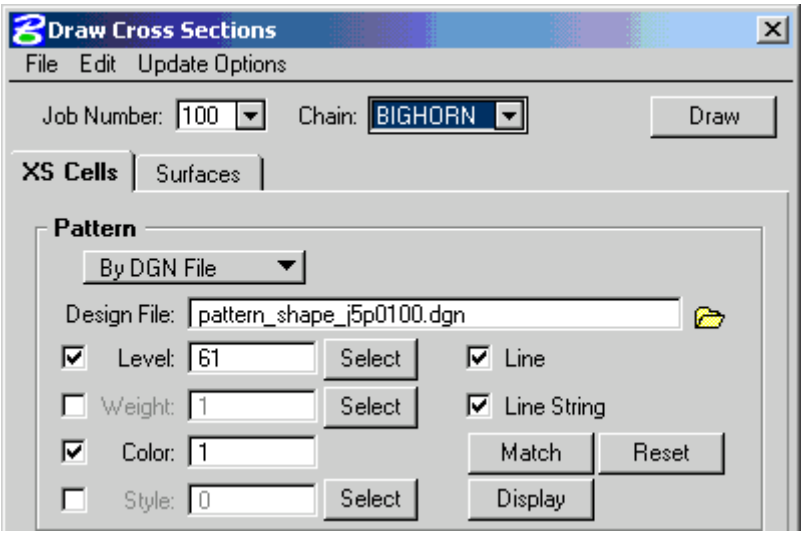
Save the changes to the MicroStation file.

6. **Open** the MicroStation file **t:\br-proj\a_geopak\d5\j5p0100\data\xs_j5p0100.dgn**. Save it as **t:\br-proj\a_geopak\d5\j5p0100\data\xs_bh_j5p0100.dgn**.

7. Choose **Existing Ground Cross Sections** from the **Project Manager** dialog.

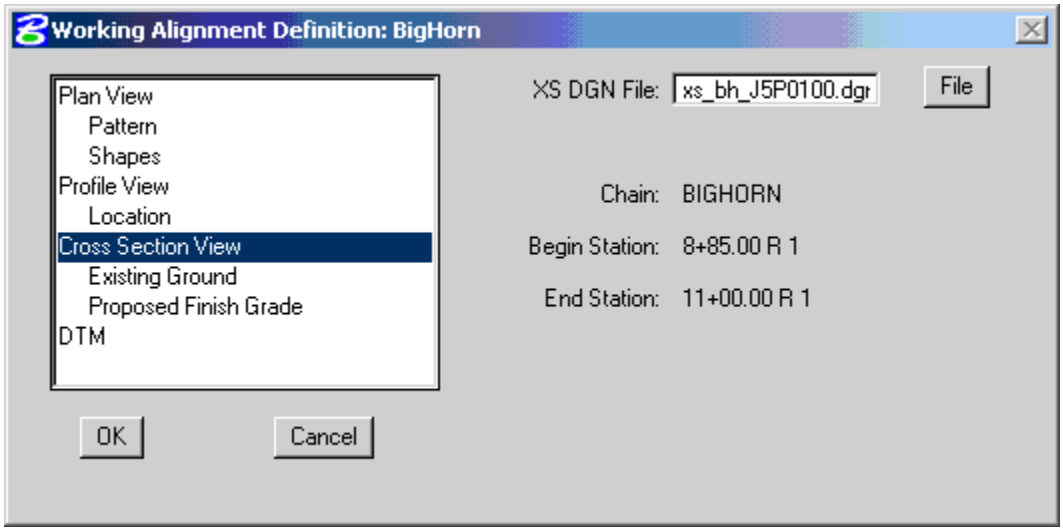
   Copy the **MoDOT** run to **BigHorn** and enter the **BigHorn** run.

8. Set the **XS Cells tab** as shown below and have the **50clear.tin** as the only one listed in the **Surfaces tab**.

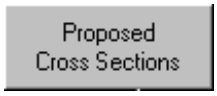


   Select **Draw** to draw the existing ground cross section and **Save** the MicroStation file. Exit the run, saving the settings.

9. Reenter the working alignment definition for **BigHorn** and change the **XS DGN File** to **t:\br-proj\a_geopak\d5\j5p0100\data\xs_bh_J5P0100.dgn** in the **Cross Section View** section as shown below. Click **OK** to save the changes to the alignment definition.



10. Choose **Proposed Cross Sections** from the **Project Manager** dialog.



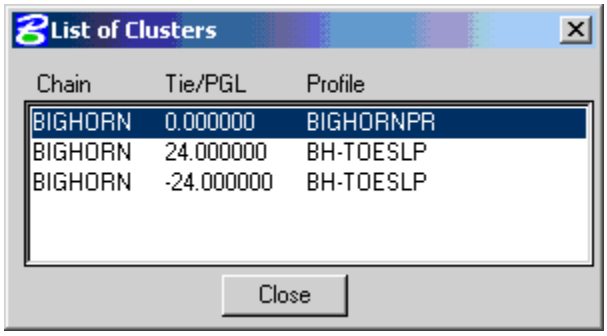
Copy the MoDOT run to **BigHorn** and enter the **BigHorn** run.

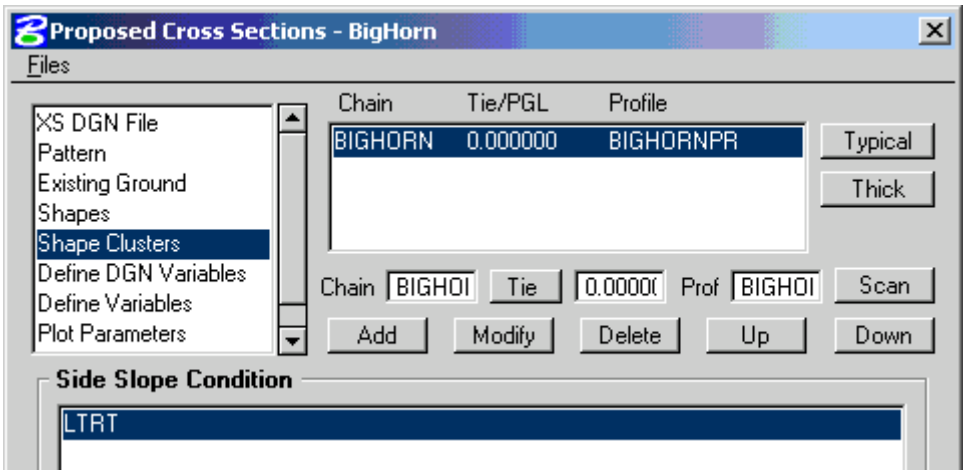
11. Be sure the following items are set in the given sections of the dialog:

XS DGN File:	**xs_bh_J5P0100.dgn**
Pattern:	**Use Working Alignment Definition**
Existing Ground:	**Use Working Alignment Definition**
Shapes:	**Use Working Alignment Definition**

12. In the **Shape Clusters** section of the dialog add the following shape cluster by choosing the **Scan** button, highlighting the desired cluster in the List of Clusters dialog, and clicking on **Add** in the Proposed Cross Sections dialog. **Close** the **List of Clusters**.

Chain	Tie	Profile
BIGHORN	**0**	**BIGHORNPR**





Since the typical section for Big Horn Drive is the same on both sides of the shape cluster, there is only one Side Slope Condition: **LTRT**. Add the listed **Criteria Files**. (See the attached typical section for details.)

Side Slope:	LTRT
Criteria Files:	setup.x
	pvmt_layers.x
	cg_b_a.x
	berm.x
	sideslope.x

Save the Proposed Cross Section run by going to **Files > Save Settings**.

13. Switch to the **Define Variables** section of **Proposed Cross Sections**, as make sure the following are defined:

NAME OF PLAN FILE.....plan_bh_J5P0100.dgn
NAME OF CROSS-SECTION FILE .....xs_bh_J5P0100.dgn
NAME OF SHAPE/PATTERN FILE .....pattern_shape_J5P0100.dgn
NAME OF BASELINE .....BigHorn
PAVEMENT LAYER 1 THICKNESS (MM OR IN).....1.75
PAVEMENT LAYER 2 THICKNESS (MM OR IN).....5.5
AGGREGATE LAYER 1 THICKNESS (MM OR IN) 4
BERM WIDTH (M OR FT) 5
RIGHT BERM SLOPE (%).....3
FILL SLOPE 1 (1:X OR X:1).....2
DITCH FORESLOPE 1 (1:X OR X:1).....2
DITCH DEPTH (M OR FT).....0
DITCH WIDTH (M OR FT).....0

Leave the remaining variables set to the defaults.

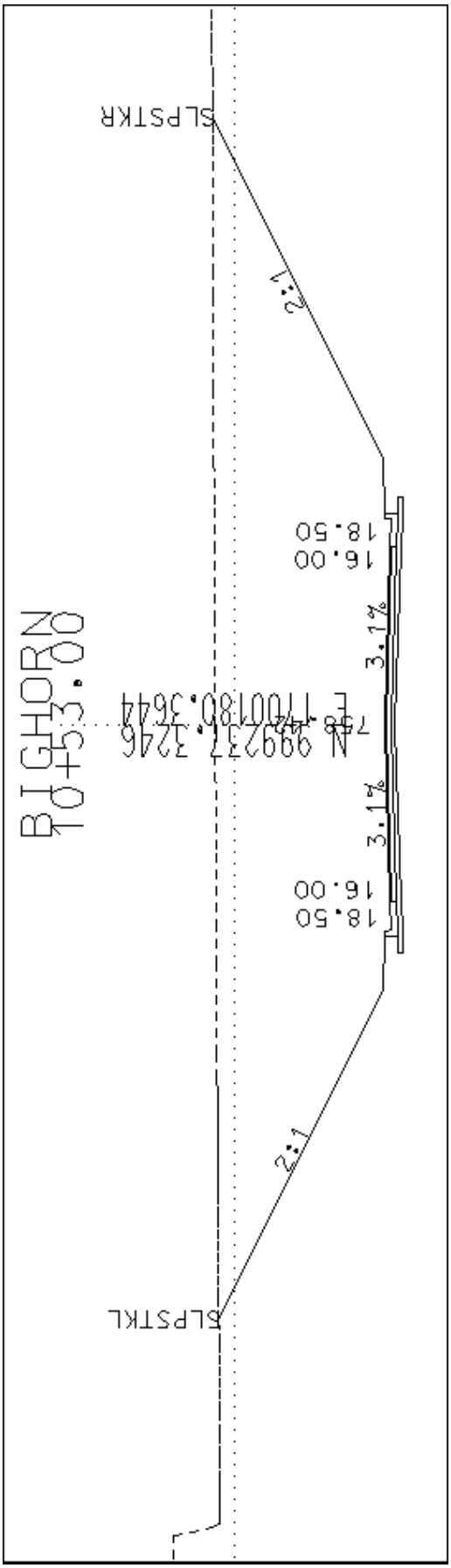
14. Save the settings for the run.

15. Run the proposed cross-sections (**Files > Run**).

Set the **Log File** to **Screen Only**.

Turn on **Pause on Each Section**.

Once you see the proposed cross sections is cutting the sections correctly, **toggle off Pause on Each Section** and click **Continue** to cut the rest of the sections without stopping


BIGHORN
10+53.00
N 999237.3246
E 1700180.3644
SLPSTKL
SLPSTKR
2:1
2:1
3.1%
3.1%
18.50
16.00
16.00
18.50

Exercise 19-6

This completes a series of exercise that demonstrate a method for determining bridge length using cross sections. The previous exercises in the series are 15-1 and 19-2 through 19-5.

1. Open the MicroStation file:
   t:\br-proj\a_geopak\d5\j5p0100\data\xs_bh_j5p0100.dgn.

2. Open the project **t:\br-proj\a_geopak\d5\j5p0100\project\j5p0100.prj**.

   Enter the as user **userc**.

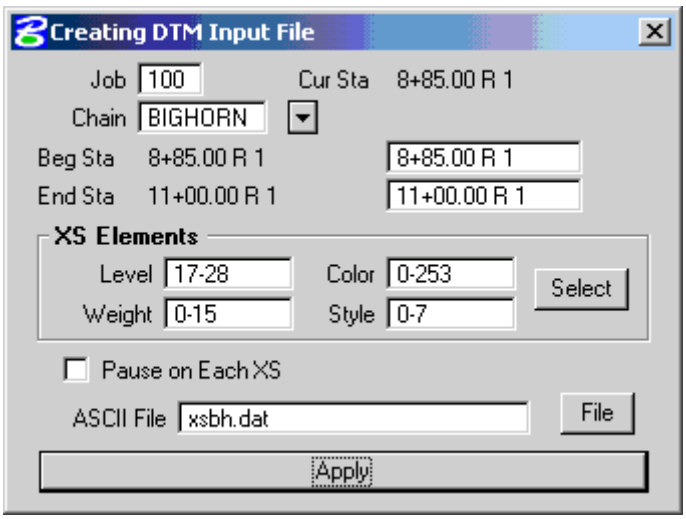
   Go into **Road**.

3. Select the **BigHorn** working alignment.

4. Choose **Reports and XS Quantities** from the **Project Manager** dialog.

   Select the **DTM Input** report.

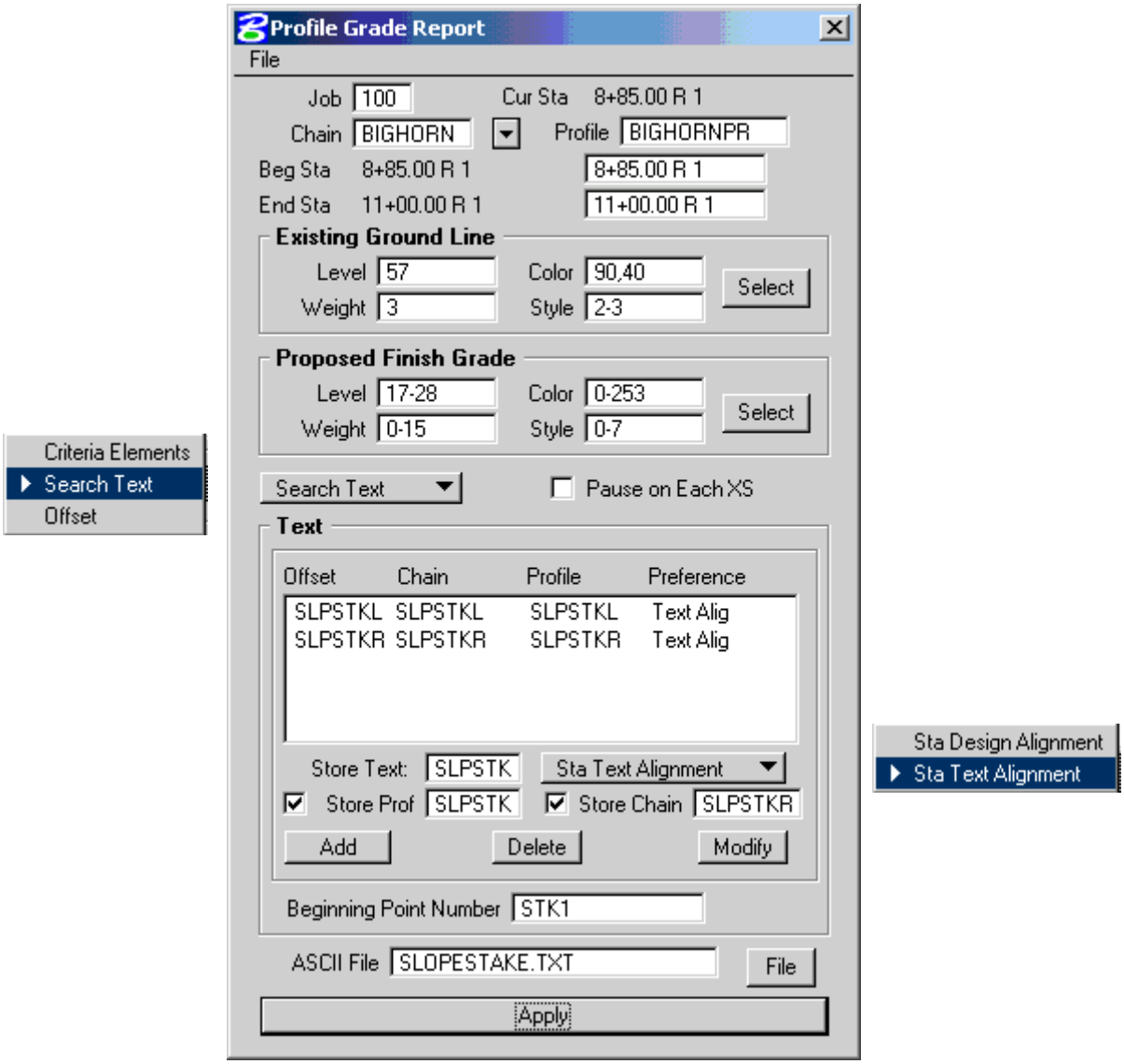
   The dialog shown below will appear. Enter the information as shown:

   Once the information is entered, click on **Apply**.

5. Select the **Profile Grade** report from the **XS Reports** dialog.

The dialog shown below will appear. It can be used to generate a reports from cross sections based on Criteria Elements, Search Text, or an Offset. Use the **Search Text** option. For the Search Text option, the stationing can be related to the alignment chain (Design Alignment) or the location of the text (Text Alignment). Select the **Sta Text Alignment**. Enter the rest of the information as shown:

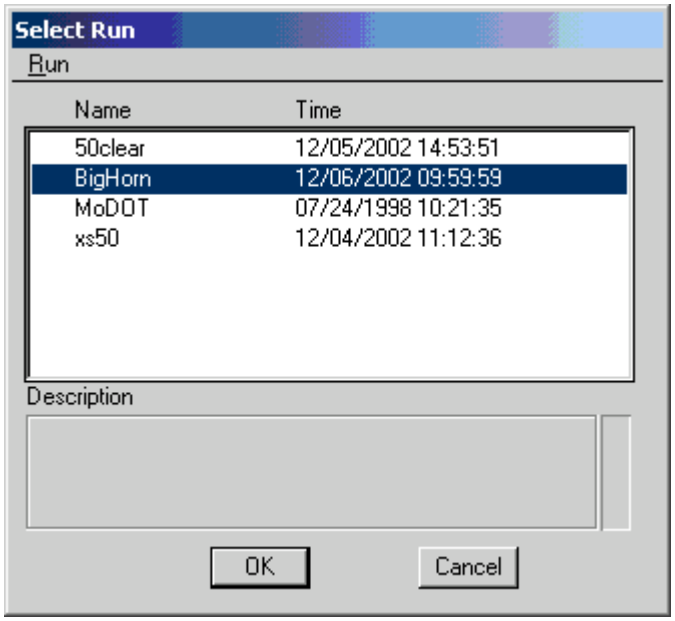


Once the information is entered, click on **Apply**.

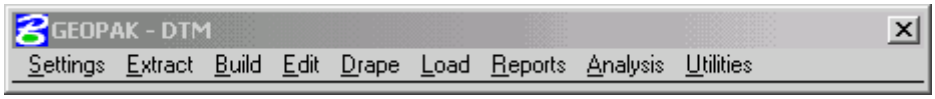
When notified the process is complete, close all the XS Report dialogs. If you wish, you can go into COGO to verify the creation of the chains and the profiles SLPSTKL and SLPSTKR.

6. Choose **Existing Ground** from the **Project Manager** dialog.

Copy the **MoDOT** run to **BigHorn**, and open that run.

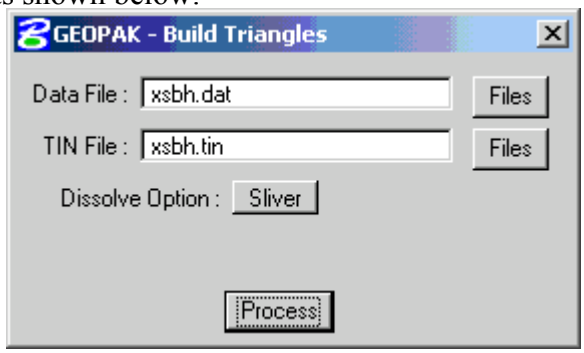


From the DTM menu, shown below, select **Build > Triangles**.



When the following dialog appears, populate it as shown below:

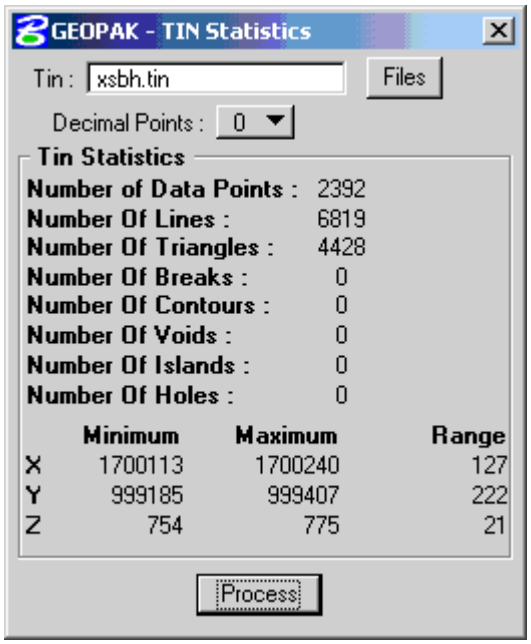
Data File: **xsbh.dat**
TIN File: **xsbh.tin**
Dissolve Option: **Sliver**



When the "Build Triangles Complete" appears in the MicroStation Status Bar, close the Build Triangles dialog. Say YES, when asked if you want to save the settings.

7. Select **Reports > Triangle Statistics** from the DTM menu.

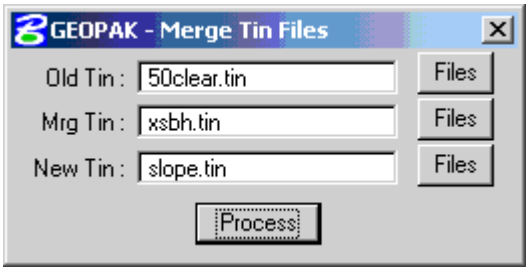
   When the following dialog appears, load the file **xsbh.tin** and Process the report. Compare your results to those shown below.



8. Select **Build > Merge TINs** from the DTM menu.

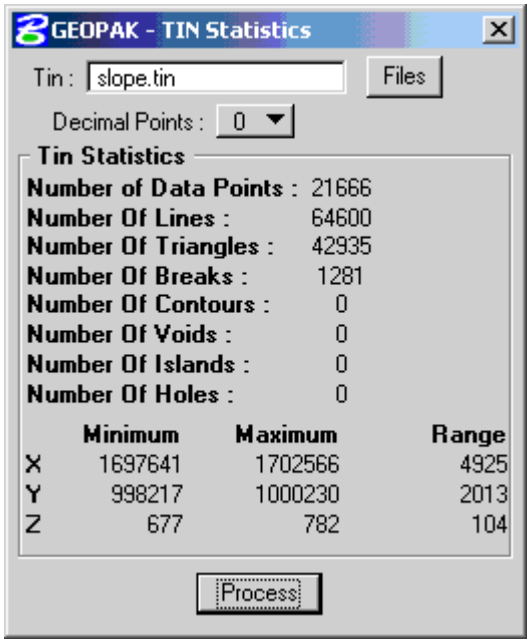
   When the following dialog appears, populate it as shown below:

   Old Tin: **50clear.tin**
   Mrg Tin: **xsbh.tin**
   New Tin: **slope.tin**



   Once the dialog is set, click on **Process**. When the "Build Merge Complete" appears in the MicroStation Status Bar, close the Merge Tin Files dialog.

9. Check the statistics for **slope.tin**. Compare your results to those shown below.

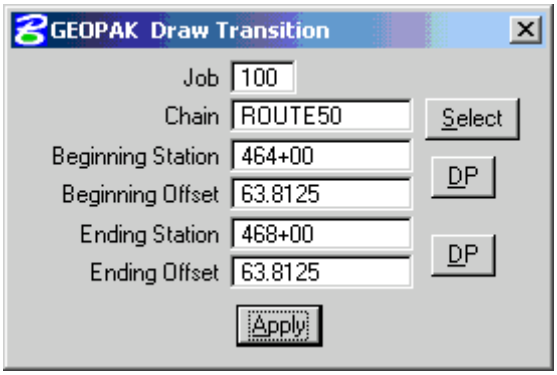


10. Open the MicroStation file:
t:\br-proj\a_geopak\d5\j5p0100\data\topo_j5p0100.dgn.

11. Use the **Draw Transition** tool (the third icon in the Plan View Design tool box) to draw the following lines relative to the **Route 50** chain. They represent the outside face of the exterior girder webs. Use symbology of your choosing.

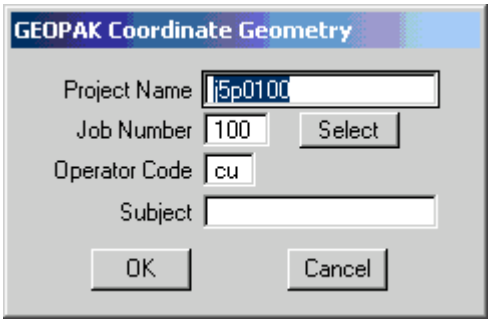
Beginning		Ending	
Station	**Offset**	**Station**	**Offset**
464+00	**24.4375**	**468+00**	**24.4375**
464+00	**63.8125**	**468+00**	**63.8125**

The values for drawing the first line are shown in the figure to the right.



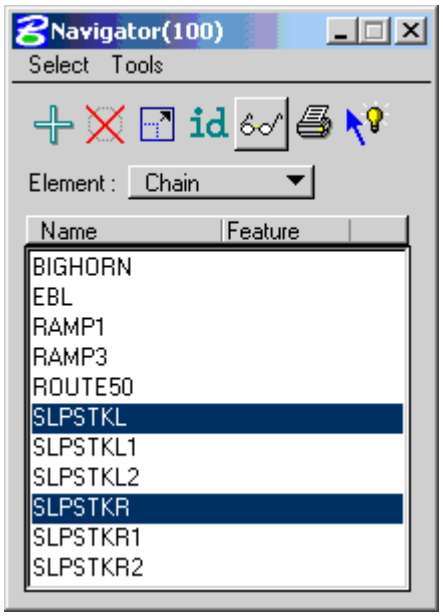
After drawing the drawing the line, close the Draw Transition dialog and do a MicroStation fit view and save the changes to the file.

12. Go into Coordinate Geometry with the following settings.

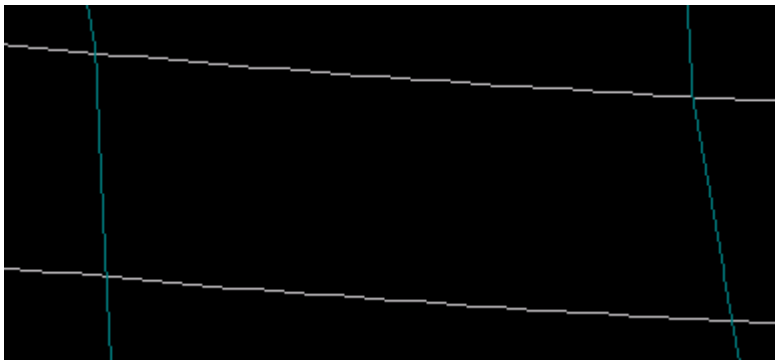


Set the visualization to **Permanent**.

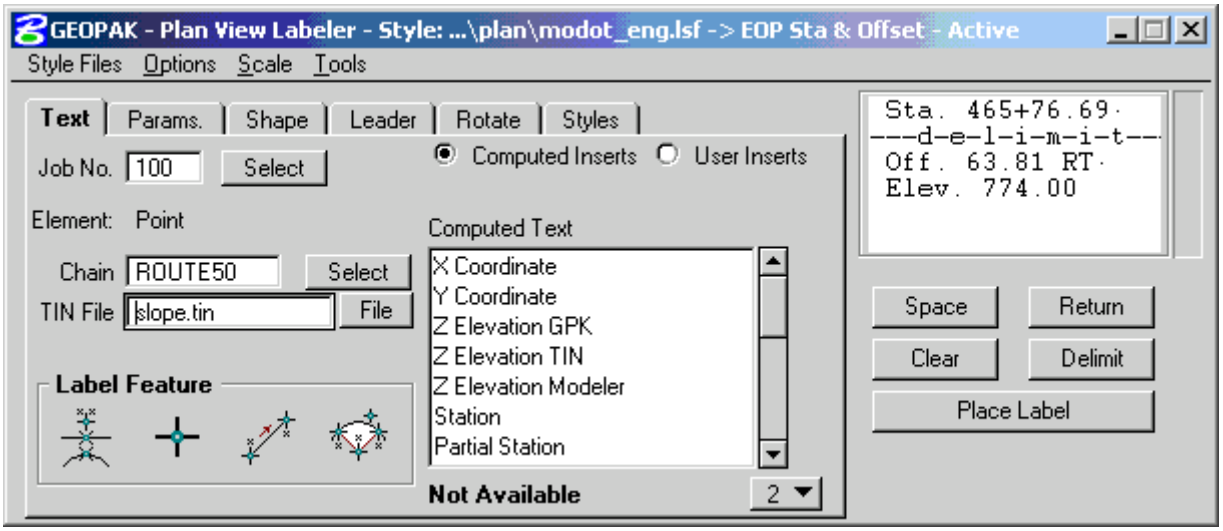
Use the COGO Navigator to **plot** the **chains**: **SLPSTKL** and **SPLSTKR**, as shown in the following figure.



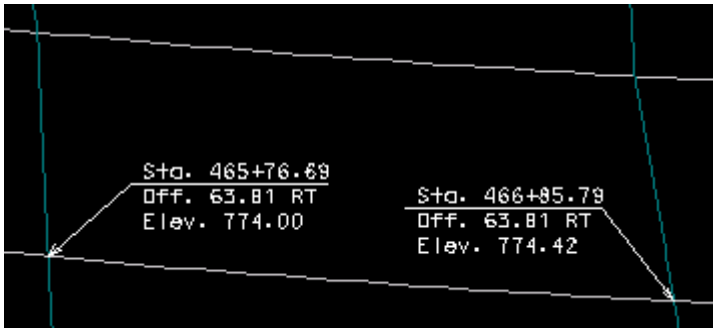
The following screen capture shows the girder lines with the two chains crossing them.



13. Use the Plan View Labeler or any other tool to find the station and elevation where the two changes cross the line with 63.8125' offset. The dialog for using Plan View Labeler is shown below.

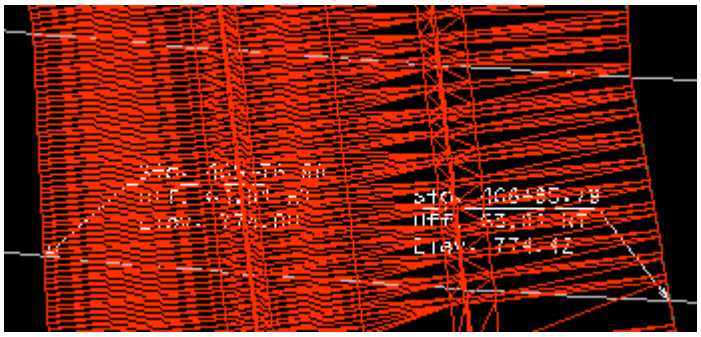


A screen capture showing the label in place is shown in the following figure.



Note that the stations and elevations match the results from in Exercises 14-1 through 14-3. The process for laying out the bents from this point would be the same as was done in Exercise 14-4.

14. To graphically see the results, use Load DTM Features to display xsbh.tin, as shown below.



Chapter 20

3D Modeling

20.1 Objectives 20-1
20.2 Definitions 20-1
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20.4 3D Modeling Tools 20-2
20.5 3D Modeling Process 20-2
20.5.1 3D Alignment 20-3
20.5.2 3D Cross Sections 20-3
20.5.3 Interpolation Between XS 20-4
20.6 Geopak Drive Through 20-5
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20.1 Objectives

- Create 3D cross sections from 2D cross sections
- Interpolate between 3D cross sections to create B-spline surfaces
- Use Drive Through to view the model
- Place pavement markings on the 3D model

20.2 Definitions

Geopak 3D Modeling is a process of deriving three-dimensional cross sections from two-dimensional cross sections and interpolating between the three-dimensional cross sections to create b-spline surfaces that represent the design.

20.3 Prerequisites

Before a 3D model can be extracted from 2D cross sections, there are a few prerequisites that must be met. They are:

- 2D design cross sections
- Plan view graphics
- 3D design file

2D Design Cross Sections

The user should have an existing design file where 2D cross sections are stored. The user will need to know which levels contain the existing ground line and the proposed finished grade.

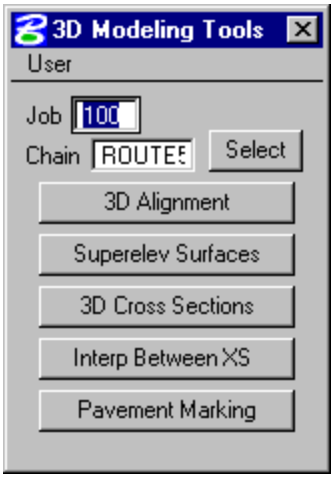
Plan View Graphics

The user must also have another 2D-design file containing plan view graphics. The plan view graphics should include the elements specified in the **Run**. For example, edge of pavement, chains and pavement markings.

3D Design File

A blank 3D-design file must exist to store the 3D cross sections as they are generated. Enter the 3D-design file and attach the 2D-plan file as a reference file. Save the settings of this file with only the Top View displayed.

20.4 3D Modeling Tools



From a 3D-design file, access the 3D modeling tools by selecting **Project Manager >> 3D Models** or by selecting the **3D Models** icon. The dialog box will appear requiring a job number and chain name. This chapter will primarily focus on the **3D Cross Sections, Interp Between XS** and **Pavement Markings** tools. Descriptions of the available 3D modeling tools follow:

3D Alignment - will draw elements into a 3D file, at correct coordinates, using the specified alignment and profile.

Superelevation Surfaces - is used to draw Geopak generated 2D shapes into B-spline surfaces, within a 3D model, following user defined plotting parameters.

3D Cross Sections - will reference your 2D cross section file and create a 3D complex chain to represent the 3D cross sections.

Interp Between XS - interpolates between the 3D cross sections to create B-spline surfaces.

Pavement Markings - will add pavement markings to a 3D model. The pavement-marking tool will scan pavement markings in a 2D file and draw the markings in the 3D file based on user defined parameters.

20.5 3D Modeling Process

1. Plot the 3D alignment, and attach the plan view as a reference file.

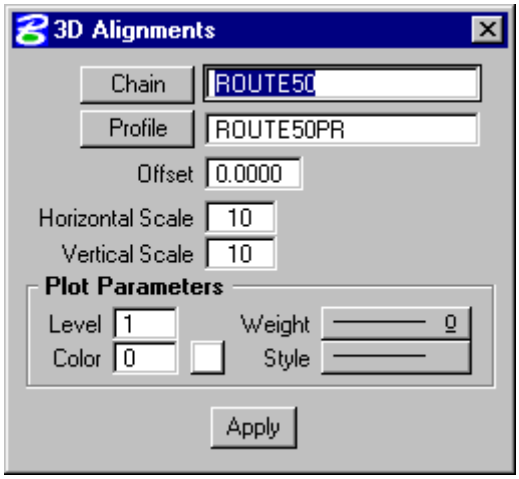
2. Geopak will open the 2D cross section file, scan the cross sections and create a complex line-string based on the cross sections.

2. Geopak then returns to the 3D-design file to draw the 3D cross sections.

3. B-spline surfaces must be created using **Interp Between XS**.

20.5.1 3D Alignment

A 3D alignment must be plotted. This 3D alignment is a representation of the combined chain and profile. An offset from the chain can be specified as well as the horizontal and vertical scales, and the symbology of the 2D alignment.

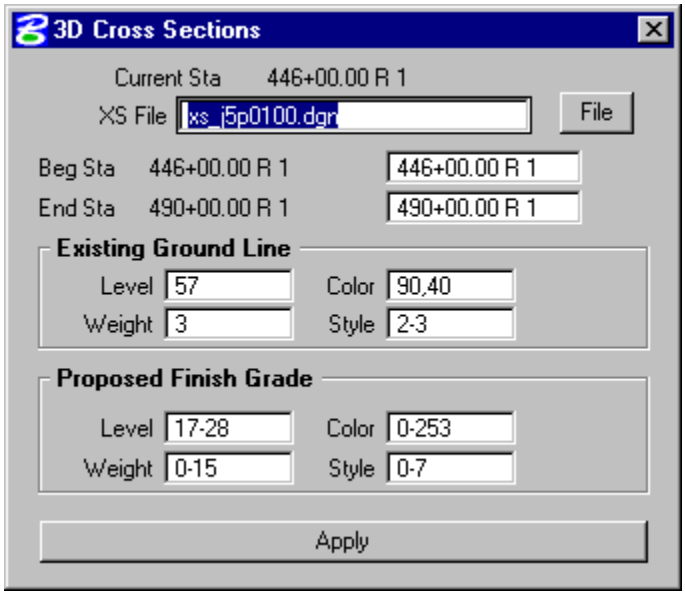


20.5.2 3D Cross Sections

Generate 3D Cross Sections:

- Enter the 2D cross-section file containing design cross-sections; Geopak reads the file to determine the beginning and ending station of the cross-sections. These stations are automatically displayed in the dialog box; however, the user may key in a different range.
- Define the attribute information for Existing Ground Line and Proposed Finished Grade.
- Select **Apply**

Geopak opens the 2D cross-section file and begins creating 3D complex line-strings from each cross-section. Each 2D cross-section will highlight as the line string is formed. This gives the user a brief opportunity to check for errors. When the process is complete, Geopak returns to the 3D file to draw the cross-sections.



A visual inspection of the 3D cross-sections should be performed to verify their integrity. The colors of the 3D-line string should reflect the same colors as shown in the 2D-design cross section. If

an error has occurred, the user should return to the 2D-design cross section file and fix the appropriate cross section(s) using Geopak and/or Microstation. Repeat the 3D cross-section process for any revised cross-sections and review.

20.5.3 Interpolation Between XS

Two **Methods** exist for interpolating cross-sections:

Longitudinal - is used when a 2D-plan view is referenced to the 3D cross-section file. This is the most common method.

Surfaces - should be selected when your plan view reference file is a 3D file.

Beginning Station and Ending Station - values will automatically be displayed when each of their offsets are defined. Offset information must be entered in order and is controlled by successive activation of the **DP** buttons. The user must define the Beginning Station offsets by first issuing a **DP** for the left and right offset locations. The same process is repeated for the End Station box.

Highlight Applied Breaklines - will highlight the breaklines used in interpolation when toggled on.

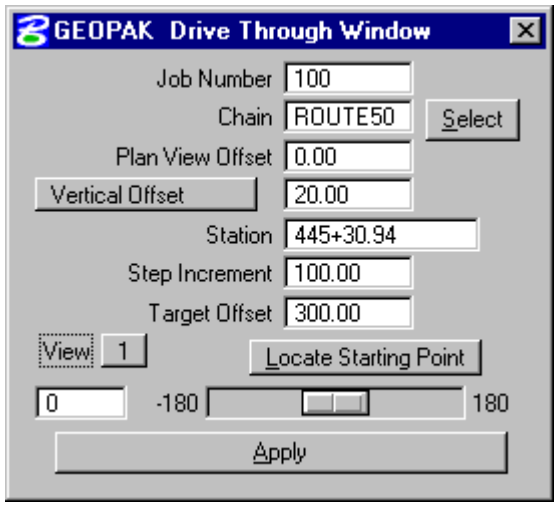
Select the **Draw Surfaces** bar at the bottom of the dialog box to begin the interpolation process. The user is encouraged to process a small range of cross sections until the entire project has been done. When Geopak interpolates 3D cross sections, it projects *like color* to *like color* between cross-sections. All Microstation elements should maintain a consistent color scheme throughout the project. For example, within a 2D file, all ditch slopes should be drawn the same color and roadway lines should also be drawn using one color. If colors do not correspond, you will get a "Color Mismatch" error and the process will terminate. There are two ways to correct this error:

- Check the cross sections for an inconsistent color scheme, correct any errors, then regenerate the necessary cross sections, or

- Activate the **Force Color** toggle; this will allow Geopak to ignore the color of the cross section elements and interpolate using only the specified color.

20.6 Geopak Drive Through

Geopak Drive Through provides the user realistic visualization of 3D surfaces. Select **Applications >> Geopak Road >> 3D Tools >> Drive Through** or choose the **Drive Through** icon.



The user must enter the **Job Number** and a **Chain** name. The drive through will follow this chain or may be offset from the chain by entering a value in the **Plan View Offset** box.

Two options are available to define the distance the driver is from the roadway vertically:

- **Constant Elevation** will place the driver at a fixed elevation, as defined by the user, throughout the drive through process.

- **Vertical Offset** places the driver at a specified distance above the model, meaning the elevation of the view changes with the elevation of the model.

The **Station** value will automatically display the beginning station of the selected chain, but may be changed by user key-in.

Step Increment defines the distance traveled between each camera view.

Target Offset defines how far down the road the viewer is looking (the focal point).

Pressing the **Locate Starting Point** button will find the first station on the alignment where a 3D graphic element is present. This is a convenient way to locate the start of a model.

View indicates the Microstation view to be processed.

Press the **Apply** bar to activate the first camera view. Once the first view is displayed, the user may *pan* the view by moving the slide bar to the desired angle and pressing the Apply button again.

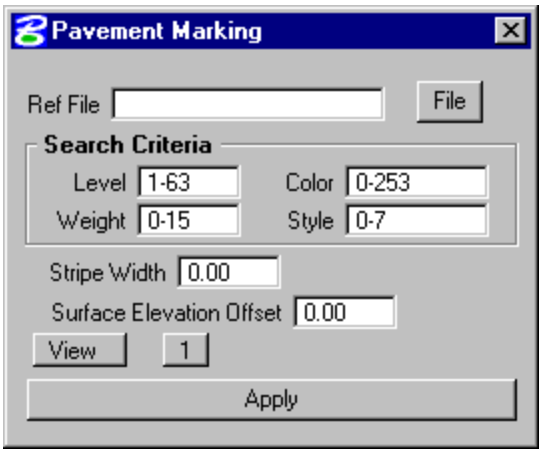
After viewing the model:

- Restore the view by rotating to the top view.

- Access the **Settings >> View Attributes** dialog box from the Microstation command window and toggle **Camera** off (automatically toggled on during drive through process).

20.7 Pavement Markings

This tool places pavement markings in a 3D file by extracting graphic information from the plan view of a 2D file. (Pavement markings created by *copying parallel* a complex element must be dropped before they can be included in a 3D model.)



Enter the name of the 2D graphics file containing pavement markings.

Provide **Search Criteria** by entering the graphic attributes of the pavement markings.

Stripe Width reflects the actual width of the plan view stripe you want to create.

Surface Elevation Offset is the distance from the B-spline surface the stripe shape is drawn. Special attention needs to be applied to this value. If the distance is too low, the stripe may fade into the roadway; if the distance is too high, the stripe may cast a shadow on the road surface when the model is moved to a visualization software package. It is desirable to place the stripe just above the surface. Begin by using a value of 0.10; if adjustments are necessary, use small increments.

Pavement Markings may be applied to an entire view or a fenced area by selecting the appropriate option. If view is chosen, be sure to *fit the view* before processing.