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## Chapter 17: Horizontal and Vertical Design

### Introduction

Since there are many different, and acceptable, methods of creating horizontal and vertical geometry using GEOPAK, this chapter will not dictate the exact methods to use. Instead we will describe the different methods that can be used and provide a workflow for a macro that will check the horizontal alignment design for kinks, once completed. This chapter will be in three sections: Horizontal Design, Vertical Design, and Macros.

### Horizontal Design

There are four methods of setting a horizontal alignment: Coordinate Geometry (COGO), Graphical COGO, Horizontal Alignment Generator, and Store Graphics. Any of these methods are acceptable to CFLHD. Each one of these methods has their advantages and disadvantages, although graphical COGO and the horizontal alignment generator are so similar that we will address these tools together. This chapter will describe each of the above listed methods and indicate their advantages and disadvantages. **Regardless of the method used, the final alignment must be drawn into MicroStation using the GEOPAK D&C Manager, with the CFLHD .ddb file.** This will assure that the elements are drawn with the correct symbology, matching the CFLHD standards.

### Coordinate Geometry

Coordinate Geometry can be accessed using Project Manager by selecting the Coordinate Geometry button.

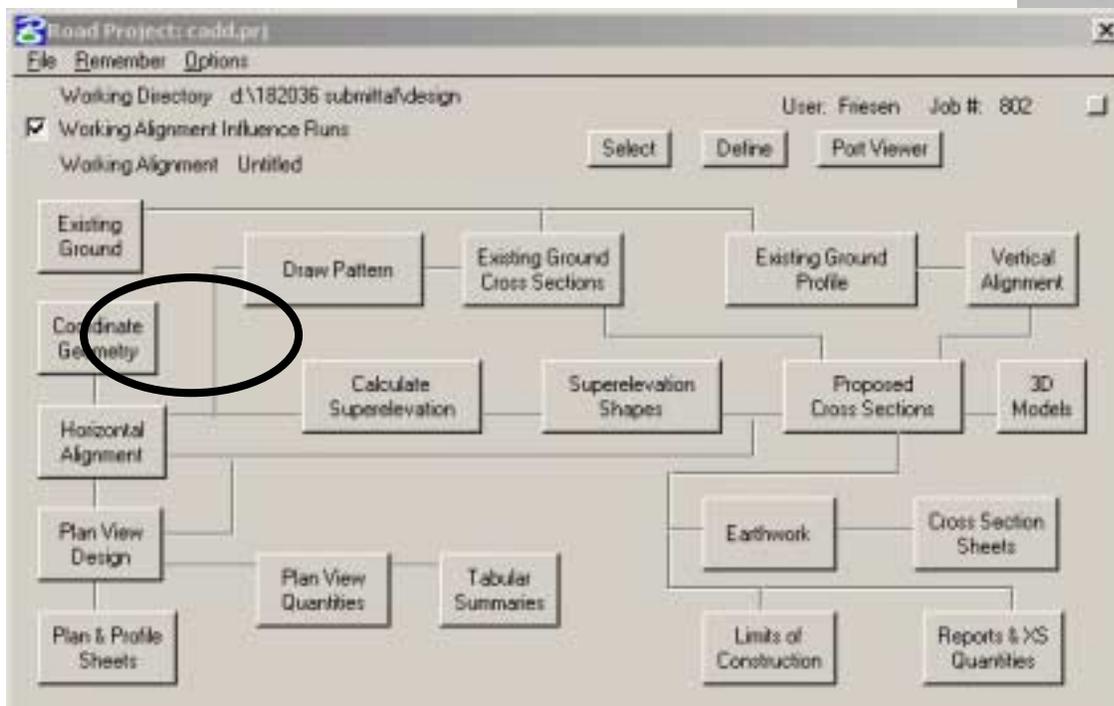


Figure 17-1: Accessing COGO Through Project Manager

You can also select the Coordinate Geometry button on the GEOPAK main dialog box.



Figure 17-2: Accessing COGO Through Road Tools Icon

Either method will bring up the following Coordinate Geometry start up dialog box:

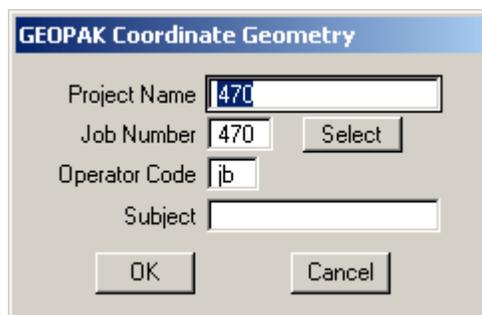


Figure 17-3: COGO Settings



If you are using Project Manager, the appropriate information should already be in the correct fields. Otherwise, the Job Number and Operator code will have to be entered. Project Name and Subject are optional fields. Press the OK button to bring up the Coordinate Geometry window.

You can create the horizontal geometry by typing commands in at the COGO command line, by creating an input file with a sequence of COGO commands and loading it into COGO, or by using the dialog box driven Store Curve From Tangents, Locate Traverse, etc., tools that are accessed from the COGO pull down menus to generate the commands. If you use the input file method, remember that the COGO input file name can only be 8 characters long, must have the job number as the last three digits in the name, and the extension has to have an "i"+ the operator code. (i.e. XXXXX470.ijb), where the i stands for input file.

#### Advantages.

- This method allows the user to have more precise control over tangent bearings, control point coordinates, etc., than with Store Graphics, if done properly.
- The user can set visualization on to view progress of design.

#### Disadvantages.

- Commands for the command line and input file methods are difficult to memorize
- Small adjustments are hard to make
- Process is time consuming

#### Uses.

- Reviewing both horizontal and vertical alignments
- Creating output of alignments for printing
- Tweaking alignments that were created using store graphics, or any of the other methods.
- Storing as-built centerline chain and profiles, especially those for which there are only hard copy paper plans.

### Graphical COGO / Horizontal Alignment Generator Overview

Graphical COGO and the Horizontal Alignment Generator, allow the user to create coordinate geometry elements, much the same as the original COGO tools, but with a much more graphic and user-friendly

process. Graphical COGO and the Horizontal Alignment Generator can be accessed by selecting:

**Applications>GEOPAK ROAD>Geometry>Graphical Coordinate Geometry, or**

**Applications>GEOPAK ROAD>Geometry>Layout Horizontal Alignments**

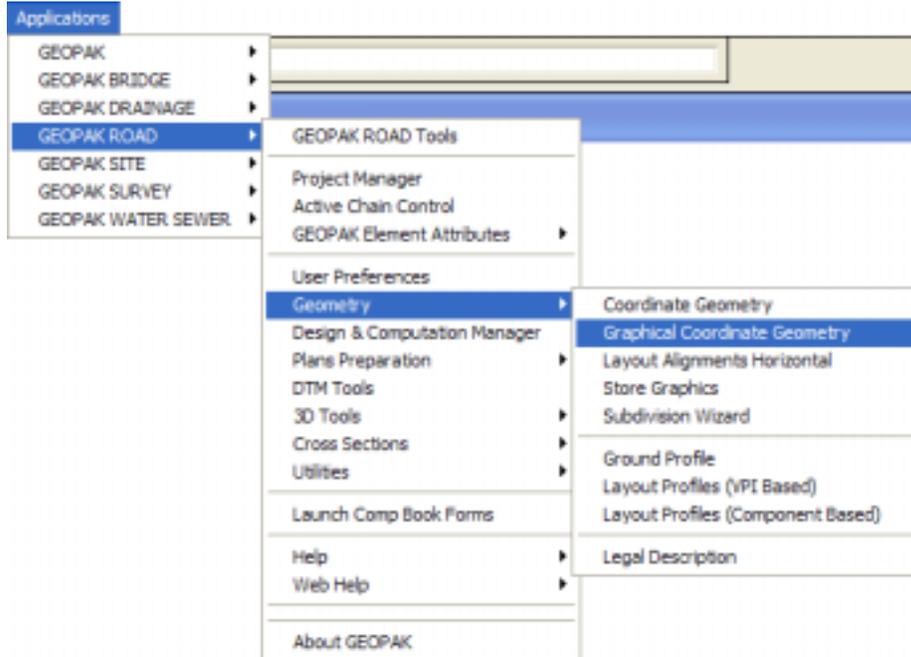


Figure 17-4: Accessing Horizontal Alignment Generator and Graphical COGO

Or by selecting the icons from the main GEOPAK Road tool box.



Figure 17-5: Horizontal Alignment Generator and Graphical COGO Icons

When using either of these tools, the original COGO window must be active. If the COGO window is not active when the tool is selected the following dialog box is displayed.

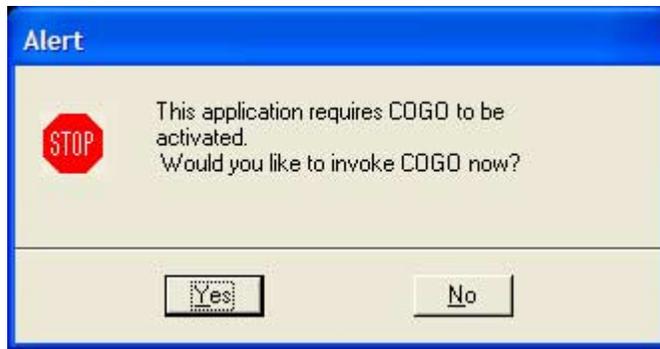


Figure 17-6: COGO Alert

Selecting **Yes**, will then activate the desired tool.

The Horizontal Alignment Generator can also be accessed using Project Manager by clicking on the Horizontal Alignment button on the flow chart and selecting Graphical Element Based geometry. Graphical COGO cannot be accessed directly from Project Manager

### Graphical COGO

The Graphical COGO tool frame, shown below contains tools for creating COGO elements such as lines, points, curves, modifying COGO elements, manipulating elements, and grouping elements.



Figure 17-7: Graphical COGO Tool Frame

From the main Graphical COGO tool frame, additional tools may be accessed from each of the four main tool boxes.

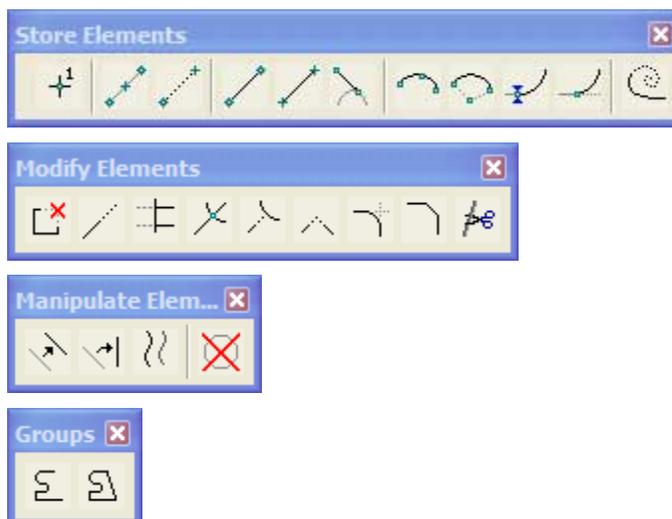


Figure 17-8: Graphical COGO Tools



The Graphical COGO tools shown above, and those in the Horizontal Alignment Generator, look and act the same as many MicroStation tools. However, these tools are not relying on the accuracy of MicroStation graphics, but rather the much more accurate GEOPAK coordinate geometry engine.

### Horizontal Alignment Generator

When selecting the Horizontal Alignment Generator the first time, the following dialog box is displayed.

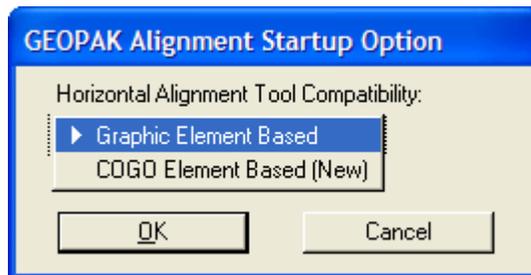


Figure 17-9: Horizontal Alignment Generator Startup Options

From this dialog box, the user is prompted to select either, Graphic Element Based, or COGO Element Based (New). For this manual we will only be concerned with the COGO element based tools, as these are the newest, most user-friendly tools.

Once selected, the following dialog box is displayed.



Figure 17-10: Horizontal Alignment Generator Menu

The file pull-down menu allows the user to set preferences for how newly created elements will be displayed, how to name elements, and which geometry tables to use as a default. The Design Tables menu allows the user to view the settings for the current default design tables. The tools menu activates the COGO tools that will be used to create geometry elements. Selecting **Tools>Main** accesses the following tool frame.

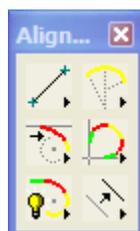


Figure 17-11: Horizontal Alignment Generator Tool Frame

From the main tool frame, shown above, additional tools may be accessed from each of the six main tool box icons.

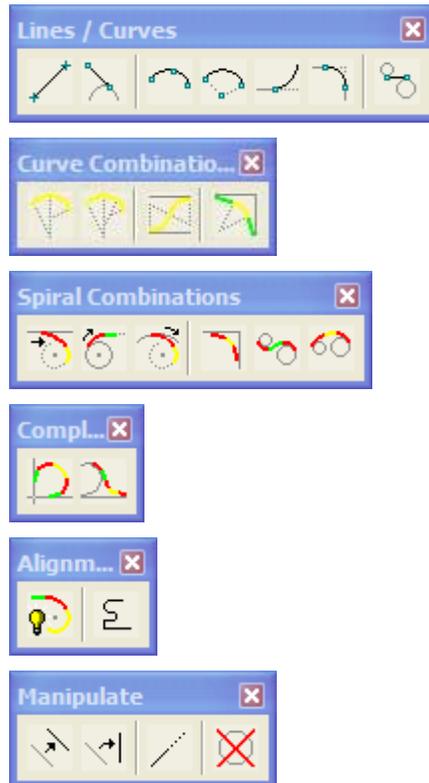


Figure 17-12: Horizontal Alignment Generator Tools

Each of the tool boxes shown above, as well as the tools from Graphical COGO, may be used together to create any combination of geometry, from the simplest to the most complex.

#### Advantages

- Using these tools to set a horizontal alignment, if done properly, is just as accurate as traditional command line COGO.
- The user does not have to remember syntax of COGO commands.

#### Disadvantages

- The Graphical COGO and Horizontal Alignment Generator tools can be complicated.
- the process is slower than using store graphics, as detailed below.



## Uses

- When the geometry is known, as the input of As-Built alignments.
- When the user wants to give exact bearings and distances.

## Store Graphics

The store Graphics procedure is the simplest and quickest method to create a horizontal alignment. The user can use standard MicroStation draw utilities to layout the alignment then use the Store Graphics tool to store the alignment into COGO. In one sense, the Store Graphics is the “least accurate” of the methods that can be used to create horizontal alignments because it relies on the limited precision of the MicroStation elements to determine the geometry of the alignment. Store Graphics will make slight adjustments to the graphical element locations as required to force each element in the chain to be exactly tangent to the immediately preceding element and the immediately following element. These adjustments are always minor (e.g. the coordinates of a curve’s PC and/or PT may be adjusted a few millimeters to force the curve to match the tangents exactly) but they do occur and the user has no control over them. So in this sense, Store Graphics is “less accurate” than the other methods. However, if the graphical elements were drawn correctly then the chain that gets stored into the gpk file is exactly as “accurate” as a chain stored using any of the other methods.

This command cannot be accessed using Project Manager, but can be accessed the following two ways. From the GEOPAK pull down menus select, **Applications>GEOPAK ROAD>Geometry>Store Graphics**, or select using the icon shown below.

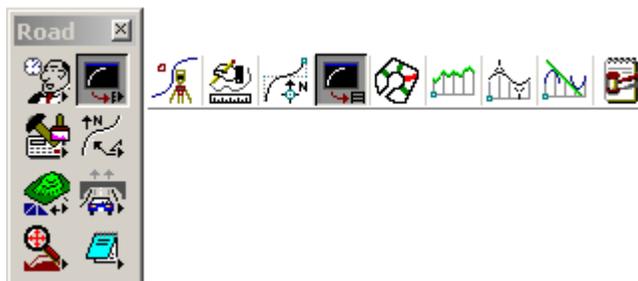


Figure 17-13: Store Graphics Icon

## Advantages

- Use simple MicroStation commands to layout alignment, adjustments to alignment are quick, and, the only point numbers used are on the alignment (usually just the first and last).



## Disadvantages

- Not as accurate as COGO. Store Graphics makes minor adjustments to the as-drawn elements in order to get them to tie together mathematically.
- Cannot draw spirals using MicroStation commands. If spirals are needed, you must use Horizontal Alignment Generator to create that element, then you may continue using MicroStation commands.

## Uses

- For long alignments with many elements.

## Vertical Design

There are two tools used to set proposed vertical alignments, and both are acceptable to CFLHD. The VPI based Vertical Alignment Generator has been used by engineers and designers since the early days of GEOPAK. This tool, although having been around for years, is still a user-friendly, accurate method for creating and storing vertical alignments. The second method is the Component Based Vertical Alignment Generator. This tool is much newer than the VPI based tool, and has yet to be fully utilized by most GEOPAK users. Both these methods are just as accurate and depending on your preference, as easy to use. Regardless of the method you use for creating proposed vertical alignments, there is only one process for creating the existing ground profile.

CFLHD's preferred method for cutting existing ground profiles is Intersection mode.

After completion of the existing and proposed profiles, they must be drawn into MicroStation using the GEOPAK D&C Manager, with the CFLHD **.ddb** file. This will assure that they will be placed with the correct symbology.

## Macro

Once you set your horizontal alignment, you should run the **Chkbear.bas** macro. This macro checks the horizontal alignment chain for misaligned consecutive elements (i.e. "kinks" in the chain) by comparing the ahead and back bearings of all the elements (tangents, spirals, and curves) that make up the chain. Consultants will need to get the **chkbear.bas** and **chkbear.ba** files from CFLHD and put them into their default macro directory (probably **\\Bentley\Workspace\System\macros**).



This macro requires a COGO description output file of the chain you want to check. Workflow 1 will describe the process of running the macro.

## Workflow 1: Running the Chkbear.bas macro

1. *Open the COGO dialog box.*
2. *Use the Describe/List/Print Chain button on the menu line, or from the COGO menus select Element>Chain>Describe/List/Print.*



Figure 17-14: Describe Chain Icon

3. *The following dialog box appears.*

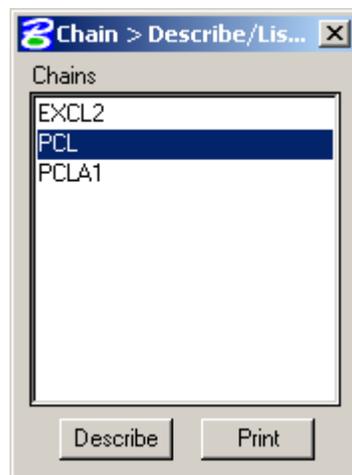


Figure 17-15: Select Chain

*Highlight the chain you want to test and pick Describe.*

4. *The Chain description is written into the COGO output window. Create the output file of the chain description by picking File > Output.*

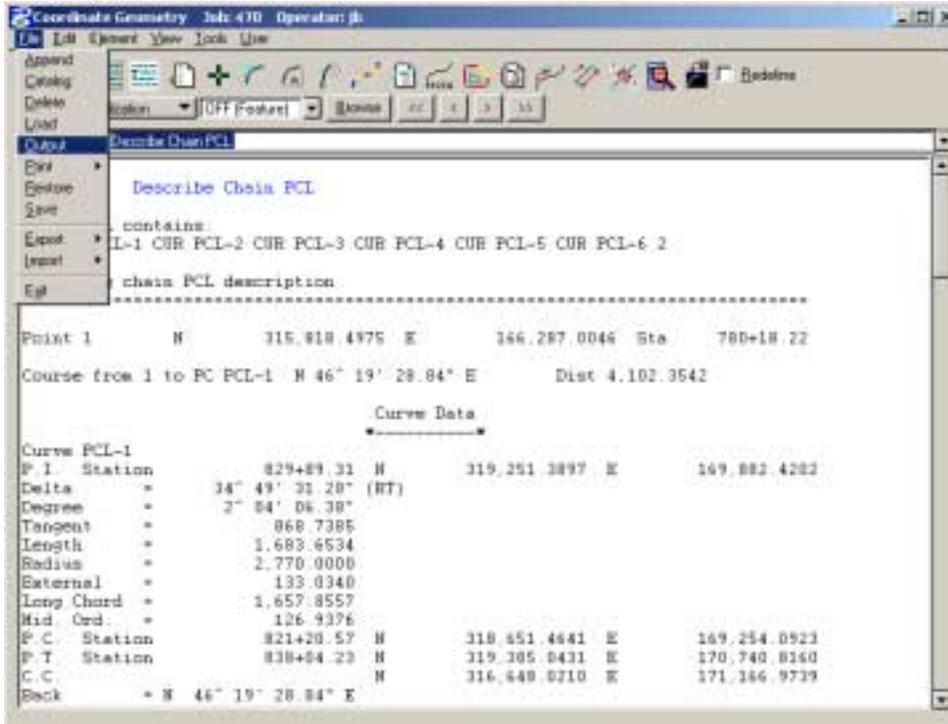


Figure 17-16: COGO Output

5. The following dialog box will appear.

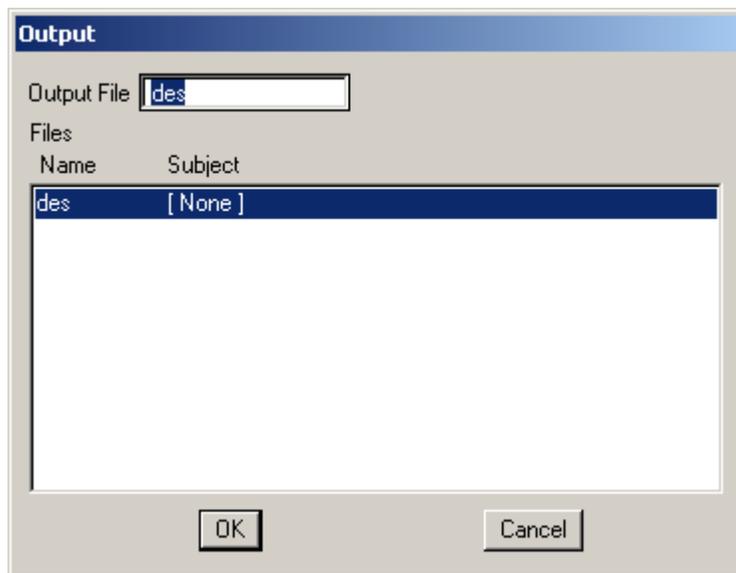


Figure 17-17: Select Output File Name

Type in up to five characters for the filename. GEOPAK will add the job number to the end to form the root and add an extension of .oXX where XX is the operator code, and the o stands for output file, to form the final output file name. Pick OK.

6. *GEOPAK will put the file in the working directory, or the COGO output directory if it is defined. The next step is to run the macro. Pick Utilities > Macros from the MicroStation pull-down menus.*



Figure 17-18: Macro Pull-down Menu

*The macro dialog box will come up.*

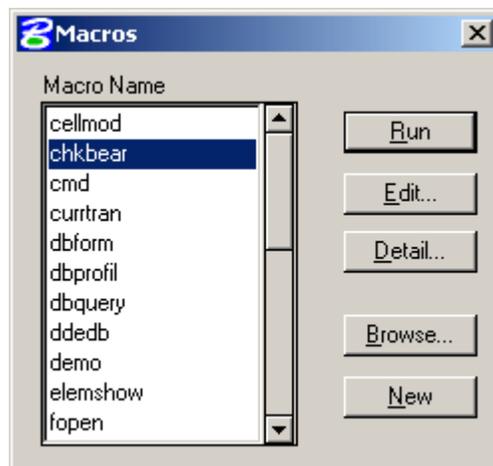


Figure 17-19: Macro Dialog Box

7. *Highlight the chkbear macro name and pick run.*

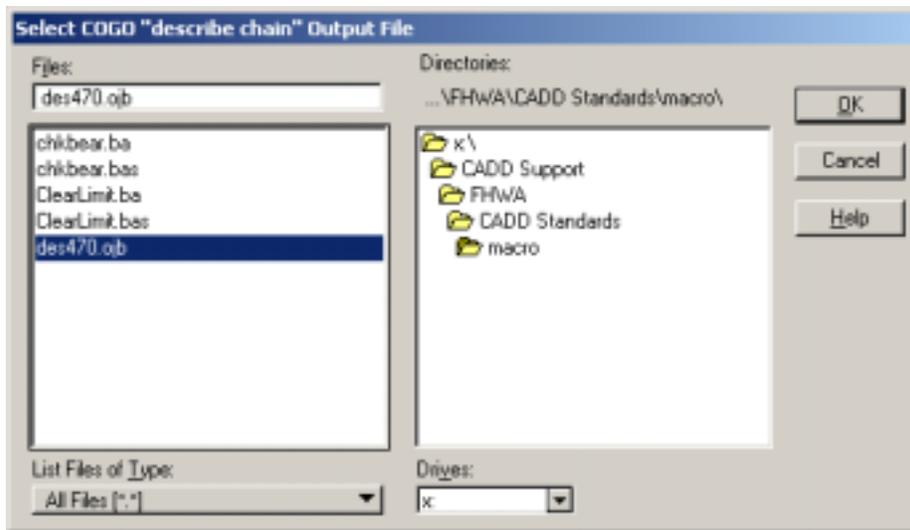


Figure 17-20: Select Output File

8. *Highlight the output file you created and select OK. The Check Bearings dialog shown below will pop up.*



Figure 17-21: Check Bearings Settings

9. *In the dialog, select the tolerance value the macro will use to decide how misaligned consecutive elements must be before they are reported as being misaligned. This macro defaults to 1 Second. Change to 0.1 Second and pick OK.*



```
BASIC Editor: D:\Wilson\chkbear.err
File Edit Run

***** ERROR LOG FOR MICROSTATION MACRO CHKBEAR *
Date: 1-22-2004 Time: 8:54:43
COGO describe chain File: x:\CADD Support\FHWA\C
Chain: PCL
Bearing Mismatch Tolerance: 0.10 Second

No mismatched bearing errors were found.

Look in file CHKBEAR.LOG for a complete list of
back and ahead bearings for all elements in this

Line: 1 Col: 1
```

Figure 17-22: Basic Editor

*If the alignment is good, then you will get the above output. If not, it will tell you where there is a problem.*

- 10. If there is a problem, go back to COGO, Store Graphics, or the Horizontal Alignment generator to fix it and repeat steps 1 through 9.*