

Line Of Sight Investigations

One of the most important safety issues to check in any intersection design is the line of sight for motorists. Even on the most simple side road intersection, the ability of the driver on the side road to be able to see any approaching traffic to determine whether it is safe to enter or cross the main roadway is critical. Areas along the approach to the intersection and across the corners should be clear of obstructions that might block the driver's view of approaching traffic.

In this document we will describe two methods for checking the line of sight at intersections using Geopak. The first method can be done during development of the proposed roadways by plotting the line of sight on the roadway cross sections. The second method uses the final proposed surface and can be used to do a final check on line of sight clearance.

Determining the Line of Sight

The first step in determining the line of sight is to decide on the type of sight triangle involved and thereby the intersection sight distance (ISD).

Specified areas along the approach to the intersection and across the corners which should be clear of obstructions that might block the driver's view of approaching traffic are known as clear sight triangles. The dimensions of the legs of the sight triangles depend on the design vehicle, design speed of the major roadway, traffic control at the intersection and the time required for the proposed vehicle movement. They can be influenced by the grade of the intersecting roadway, width of the major roadway and the skew of the intersection.

The intersection sight distance represents the length along the roadway legs of the clear sight triangles. The line of sight required is the line forming the third side of the sight triangle which connects to the roadway legs.

Refer to the T.D.O.T. Design Division standard roadway drawings RD01-SD-1 through RD01-SD-7 and to AASHTO's Geometric Design of Highways and Streets (2004 edition), Intersection Sight Distance, pages 650-677 for more information. There you will find intersection sight distance tables based on the determining conditions for the desired clear sight triangle as well as guidance on vehicle driver locations. These will be required to establish a horizontal and vertical alignment to represent the proposed line of sight.

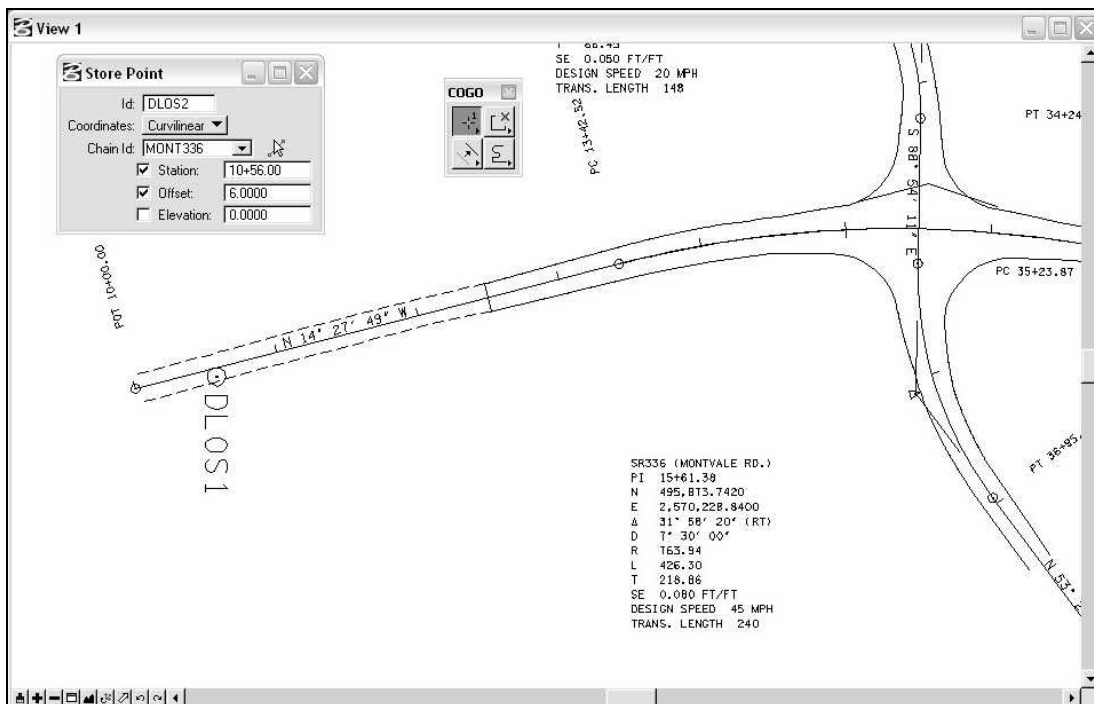
Plotting Line of Sight on Cross Sections

In order to plot a line of sight location on our cross sections we must first store a horizontal and vertical alignment to represent it and then we can use the proposed cross section tool to plot it on our roadway cross sections to check for obstructions.

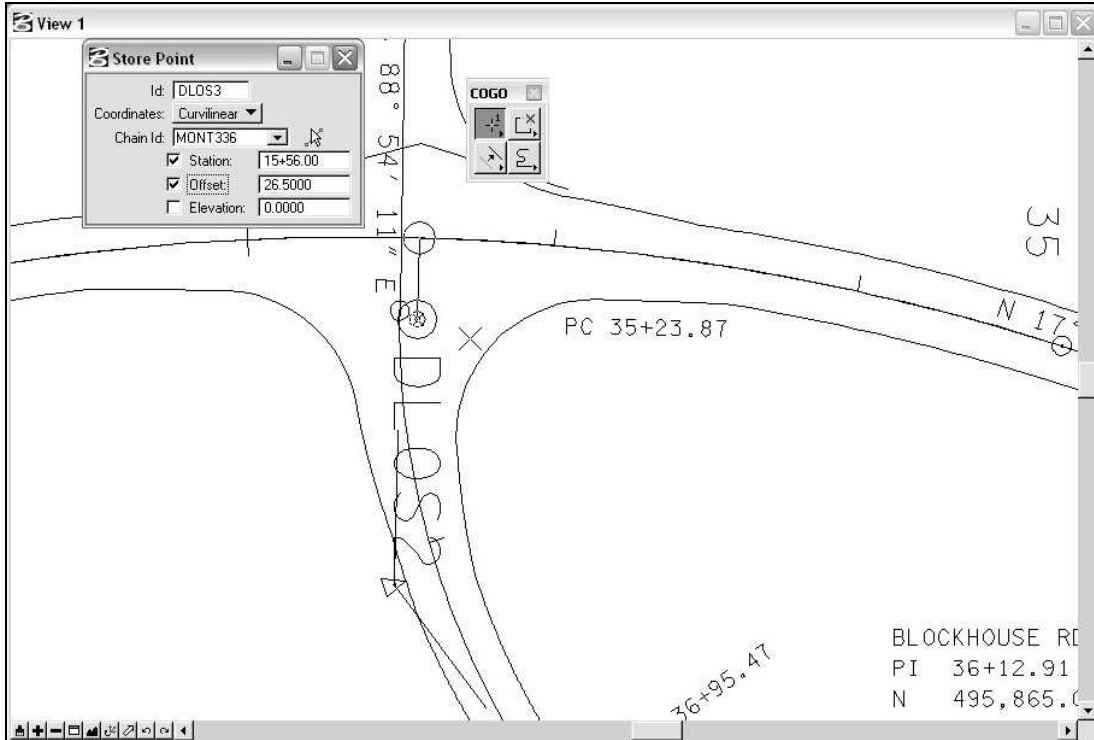
In the example we will use to illustrate these steps, we have a passenger car performing a left turn from a stop condition on the side road and the major road has a design speed of 45 MPH. From T.D.O.T. Design Division standard roadway drawing RD01-SD-3, we have determined that a 500' intersection sight distance is required. The major roadway is a 2 lane roadway, the side road's grade is less than 3% and the intersection skew is 90 degrees so no further adjustment is needed.

1. **Store points on both ends of the line of sight and then store a chain.** Since we can specify our locations by station and offset we recommend using the Graphical COGO Store Point tool. Go to **Applications > Geopak Road > Geometry > Graphical Coordinate Geometry**. Set the Store Point tool Coordinates mode to **Curvilinear**.

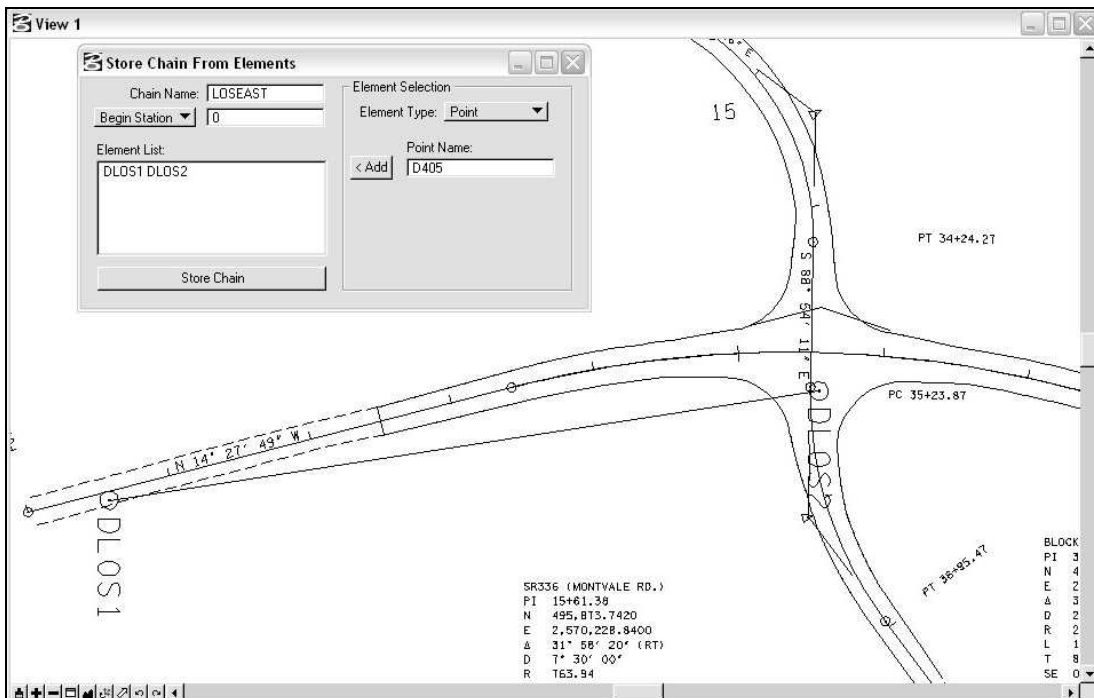
Our intersection station is at 15+50 and our stopped vehicle is positioned on the side road 6 feet beyond that station. If we subtract the intersection sight distance of 500' from 15+56, that puts our approach vehicle at station 10+56 with an offset of 6' to position it in the middle of the 12' travel lane.



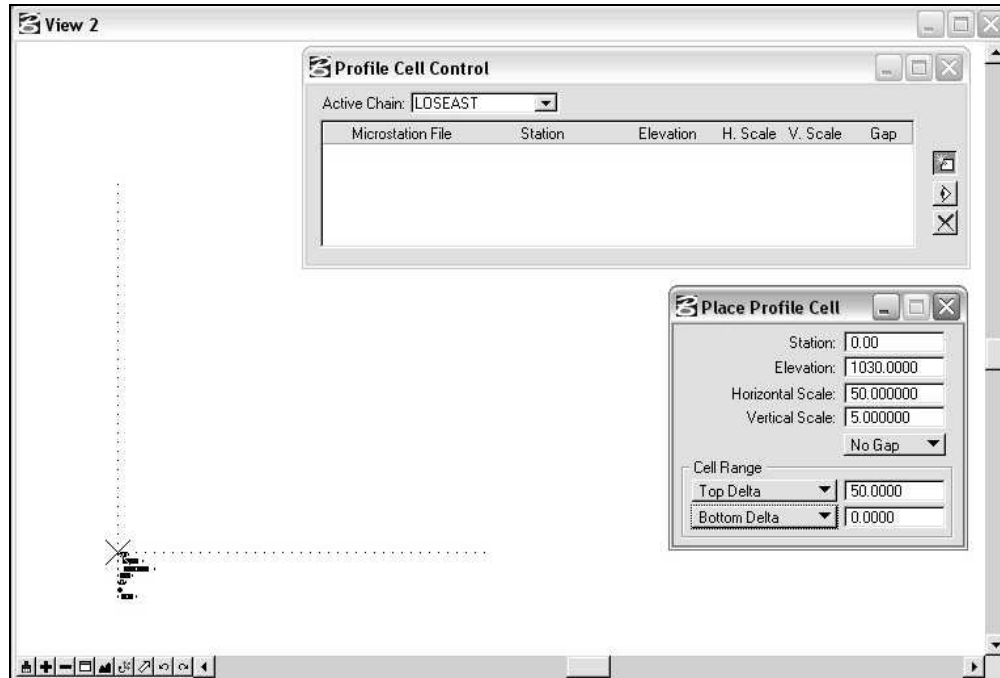
To locate our stopped vehicle in the side road travel lane, we add 6' to the intersection station to position the point in the center of his lane. For the offset we will use the suggested value of 14.5' from the edge of the major road travel lane, so $12' + 14.5'$ equals a 26.5' offset. This point could be located off of the side road chain as well.



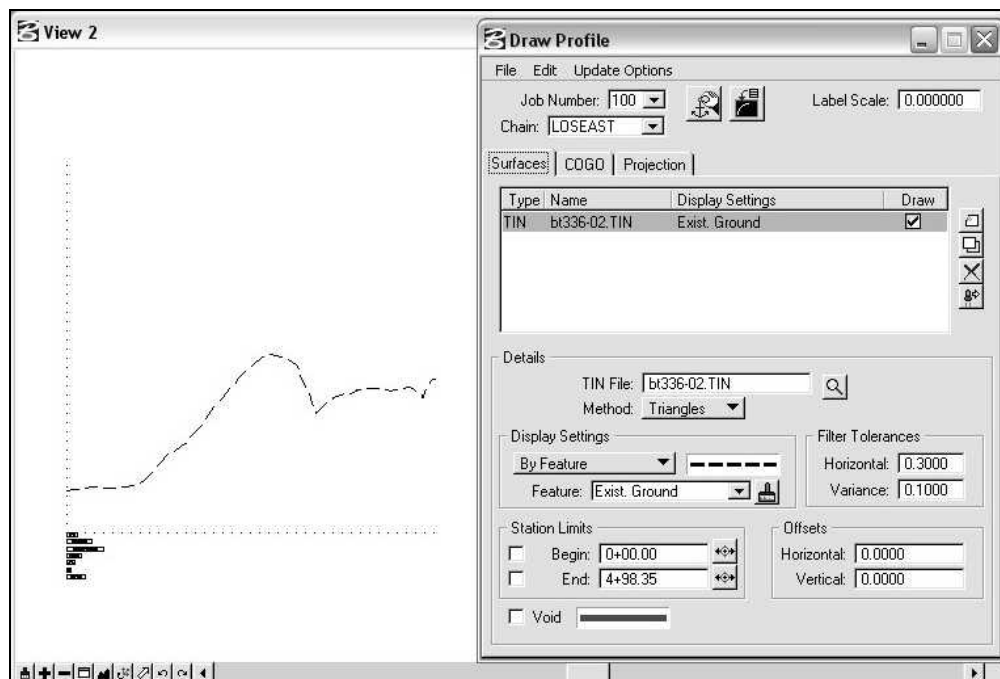
Finally we can store the two points as a chain.



2. Display an existing ground profile of your line of sight chain. Go to **Applications > Geopak Road > Plans Preparation > Draw Profiles**. Click on the **Profile Cell Control** icon on the Draw Profile dialog and place a new profile cell for the line of sight chain.



Under the **Surfaces** tab on Draw Profile dialog set the project's existing TIN surface file and symbology for the ground line (D&C Item can be used as shown). Click the **Add** icon on the right to add the TIN to the surface list area and draw the ground line.

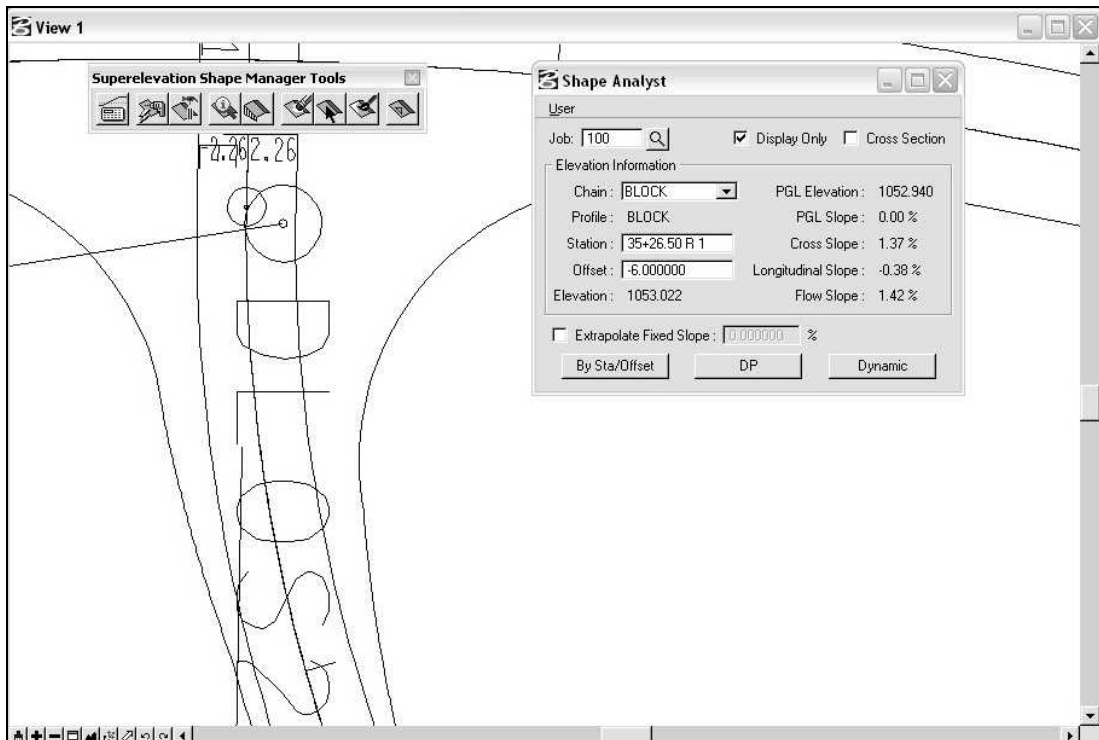


3. **Store a proposed profile for the line of sight.** Since our design vehicle is a passenger car, the suggested driver's eye level is 3.5 feet above the ground on both ends of the line of sight.

Our first point on the mainline roadway occurs prior to the start of the new proposed roadway which begins at 12+50 so we can simply set a point 3.5' above the existing ground line on the profile.

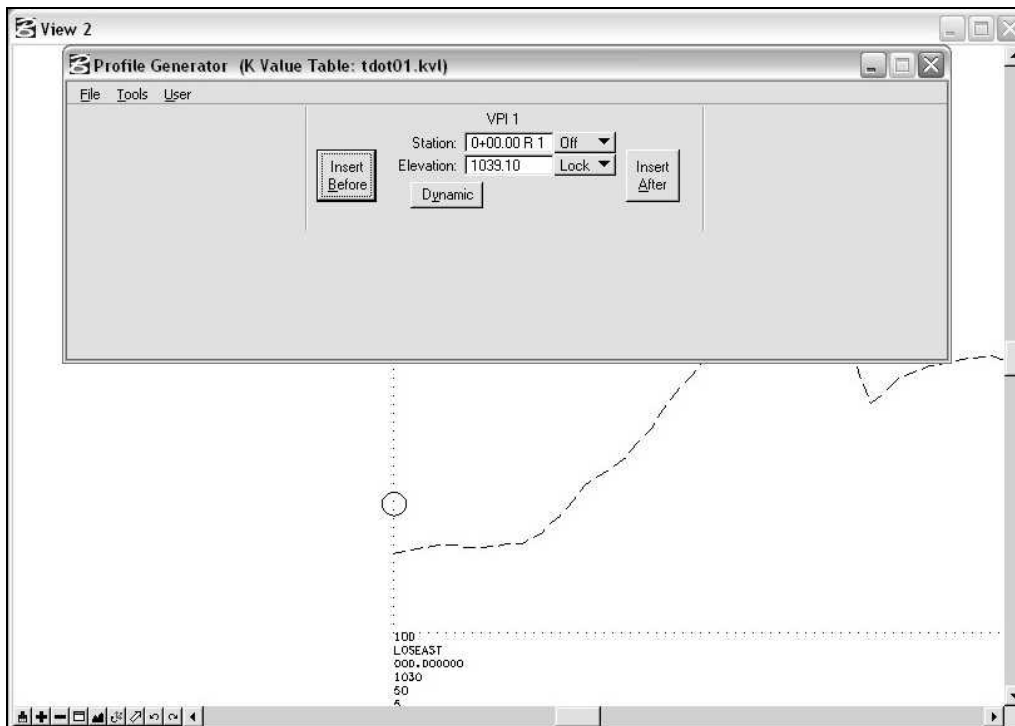
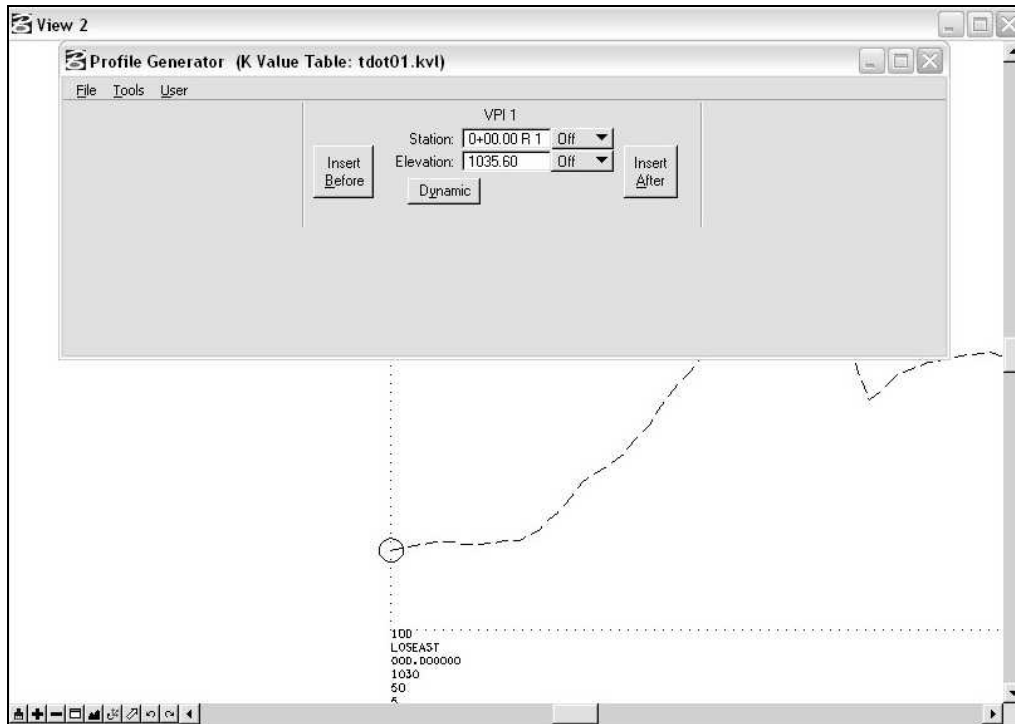
The other point on the side road occurs within the proposed roadway area. We can use the Shape Analyst tool to find the elevation in the middle of the proposed traffic lane. Go to **Applications > Geopak Road > Cross Sections > Superelevation Shape Manager Tools** and click on the **Shape Analyst** icon (4th from left)

In the Shape Analyst dialog set the side road chain name, click the **DP** button and snap & data point on the line of sight COGO point. To this elevation we will need to add the 3.5 feet ($1052.94 + 3.5 = 1056.44$).



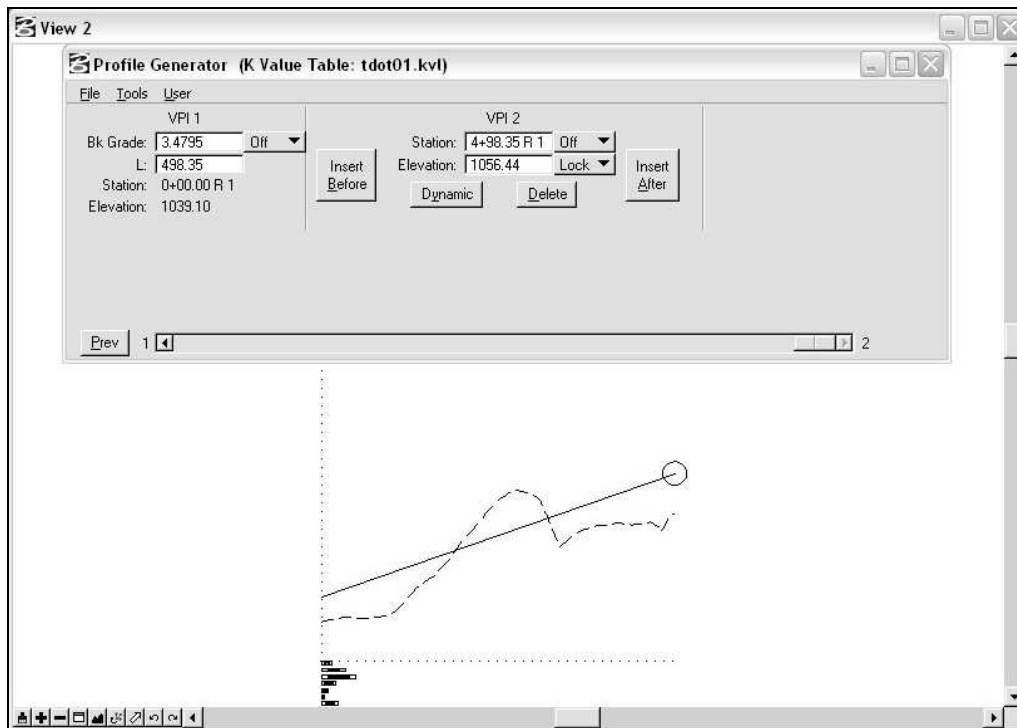
We have the elevations we need so we can store the line of sight profile. From the Road Project workflow dialog click on **Vertical Alignment**.

Identify the Geopak Profile cell set up in step 2. Our first point out on the mainline roadway is in an existing area so initially, using **Dynamic**, set the first VPI at the ground and then adjust the resulting elevation by the 3.5' driver's eye level height.



For our second location on the side road, click **Insert After** and keyin the ending station and the elevation we derived using the Shape Analyst tool.

From the profile we can already see that we may have a sight clearance problem due to the existing ground between the 2 vehicle locations.



Finally save the line of sight profile and exit the Profile Generator tool.



4. **Plot existing cross sections off the mainline chain, if it has not already been done.**
In most cases you would already have cross sections for the mainline roadway but if you are just investigating existing conditions at the intersection you will need to cut cross sections before going to the next step.
5. **Set up a proposed cross section run to plot the line of sight location on the cross sections.** Set the mainline as the active working alignment. From the Road Project workflow dialog click on **Proposed Cross Sections** and create a new run. Make the following settings for the run.

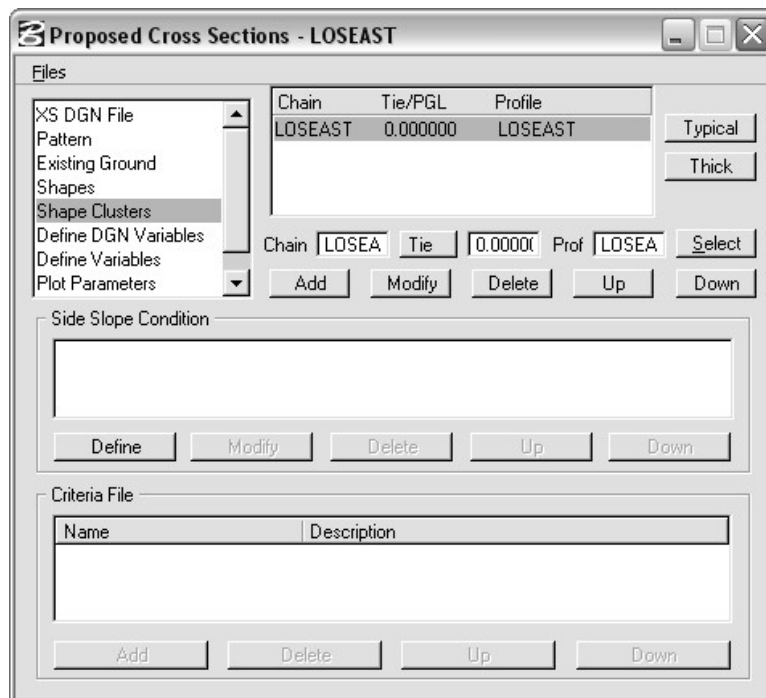
XS DGN File: Use defaults from the working alignment.

Pattern: Click on Use Working Alignment Definition

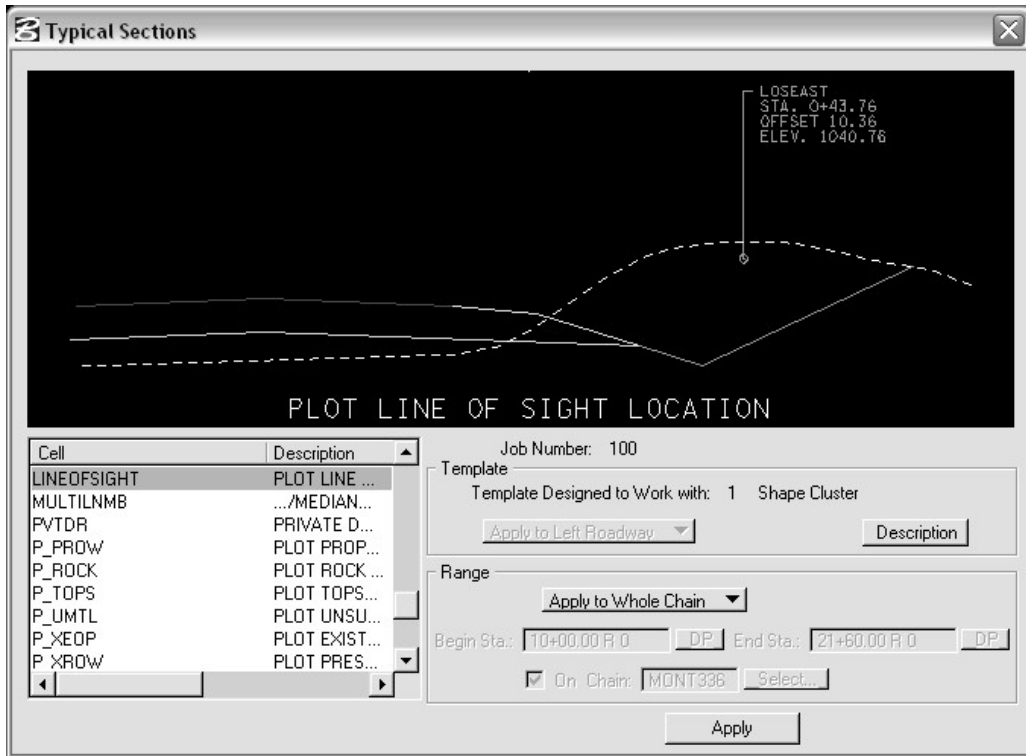
Existing Ground: Click on Use Working Alignment Definition

Shapes: Set to Shapeless.

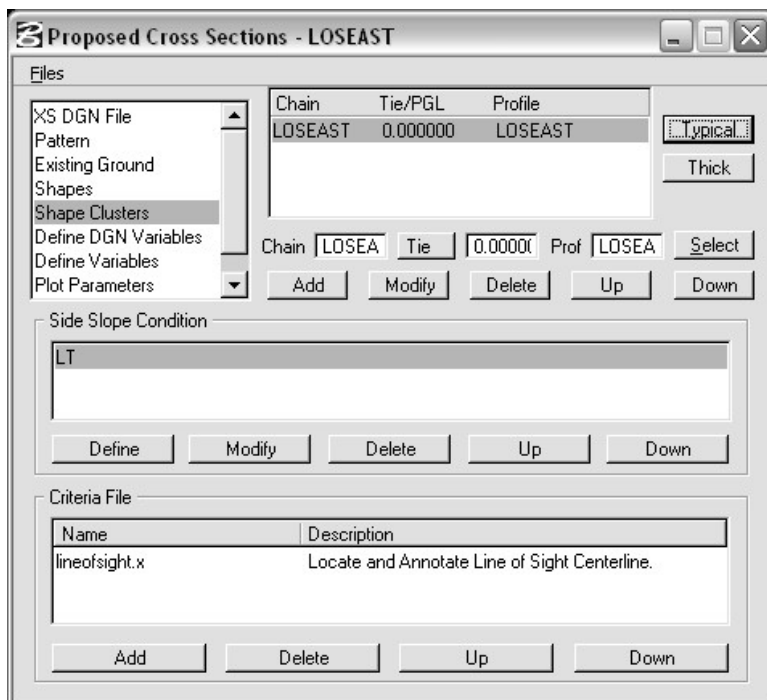
Shape Clusters: Click **Select**, and set the chain and profile of your line of sight that was stored in steps 1 and 3. Then hit **Add**.



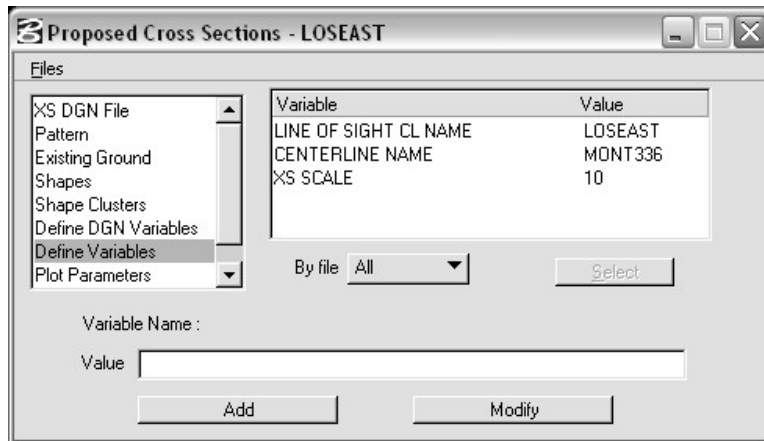
Highlight the cluster and click the **Typical** button. In the **Typical Sections** dialog, scroll and select the typical named LINEOFSIGHT. Set to **Apply to Whole Chain** and click **Apply**.



The Side Slope Condition and Criteria File are added to Shape Clusters.



Define Variables: Set the name of your line of sight chain for the LINE OF SIGHT CL NAME variable and the name of your mainline chain for the CENTERLINE NAME variable. Adjust XS SCALE as needed.

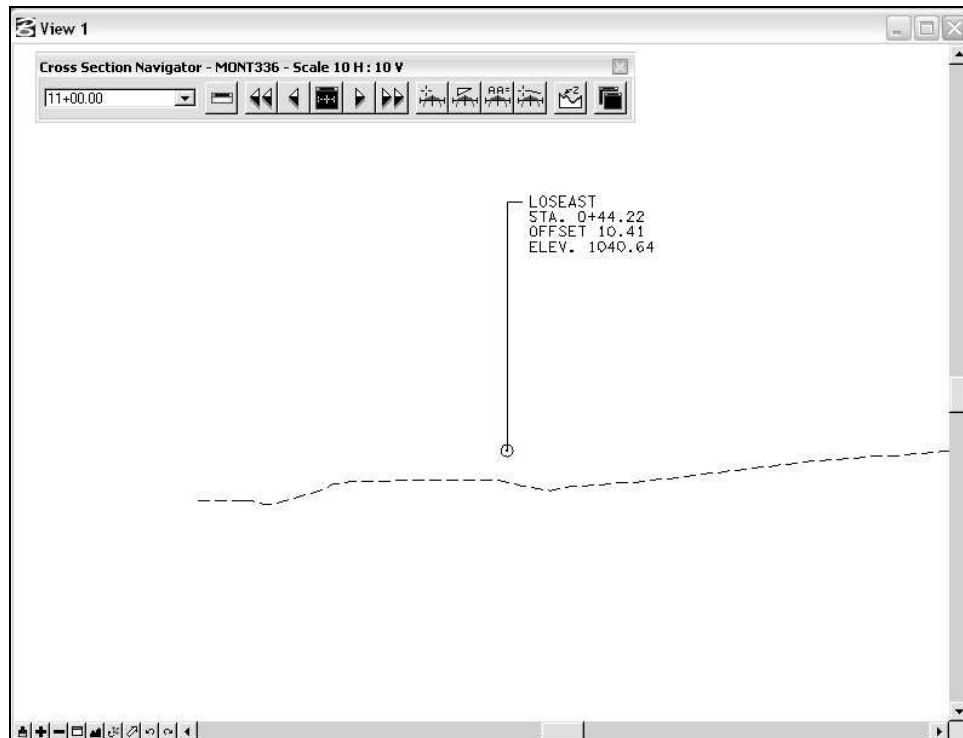


Plot Parameters: Turn off all options.

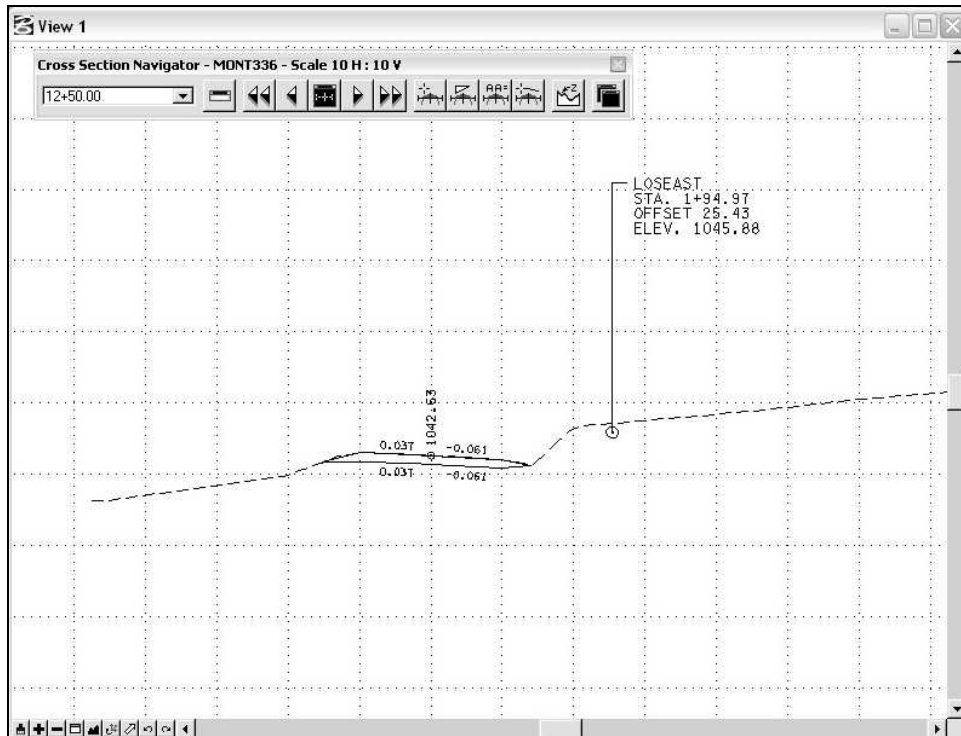
Now that all of the settings are completed, you can plot the line of sight on the cross sections. In the Proposed Cross Sections dialog go to **File > Run**.

Use **Cross Section Navigator** to check the line of sight locations. The circle at the end of the leader line is the line of sight.

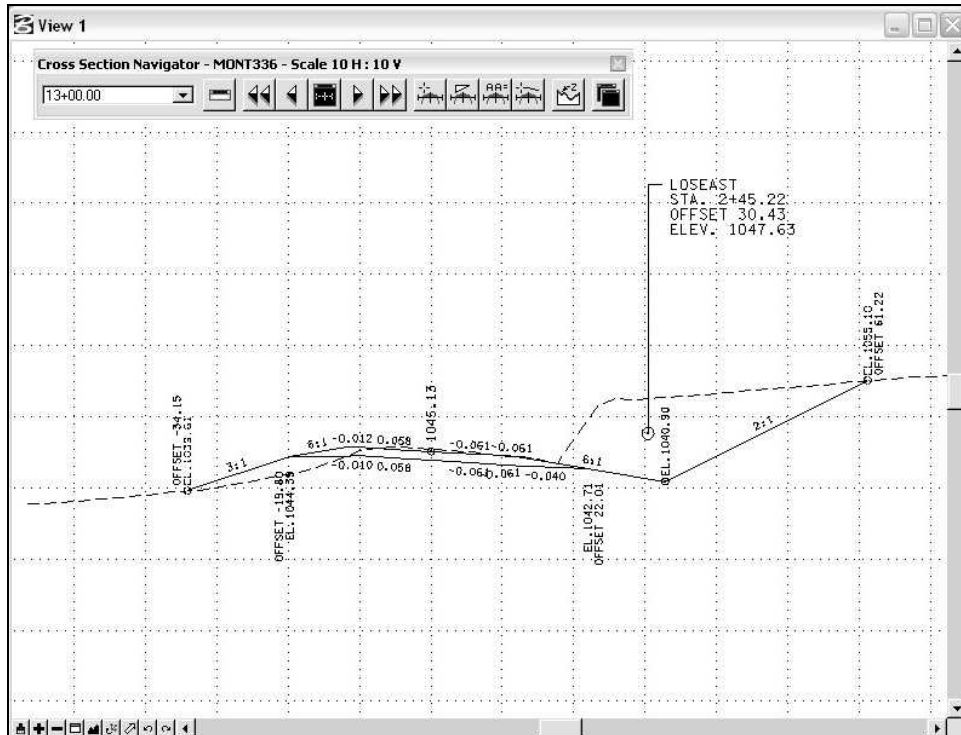
In our example, near the beginning of the line of sight on the mainline roadway



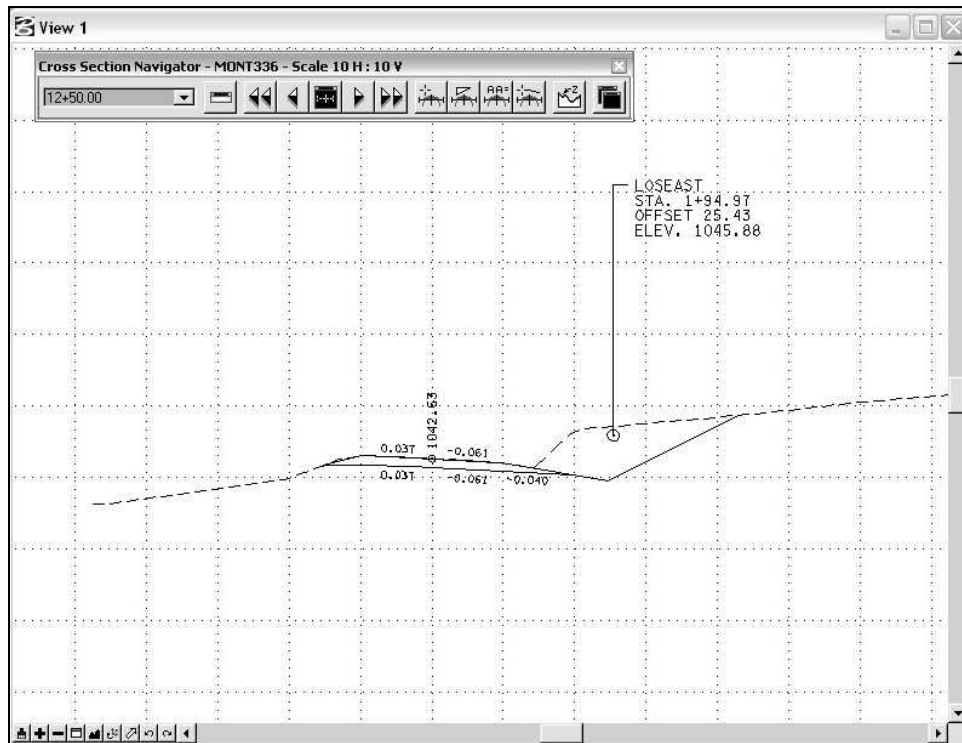
At the start of our proposed mainline roadway notice that the line of sight is blocked by the hill along the right side of the roadway.



Beyond the proposed beginning at 12+50, the proposed cut ditch will open up the line of sight.



In our example the only problem area was at the beginning of the proposed roadway. By laying the slopes back or by transitioning the ditch in sooner as shown below we can open up the line of sight.

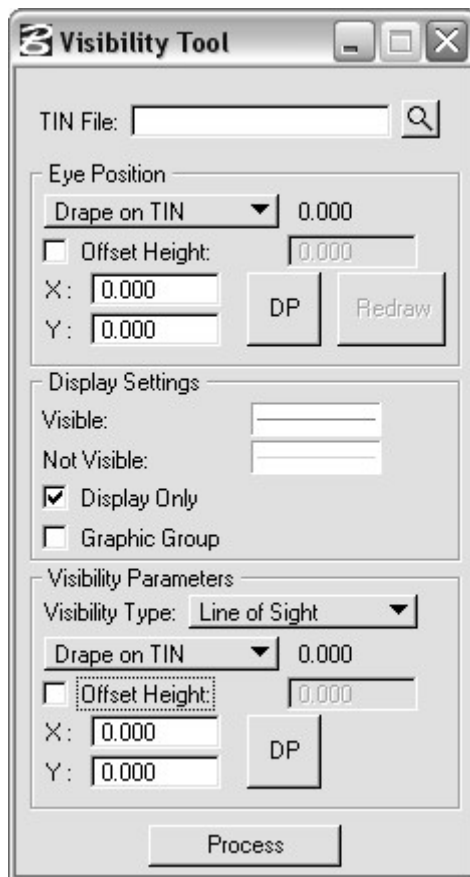
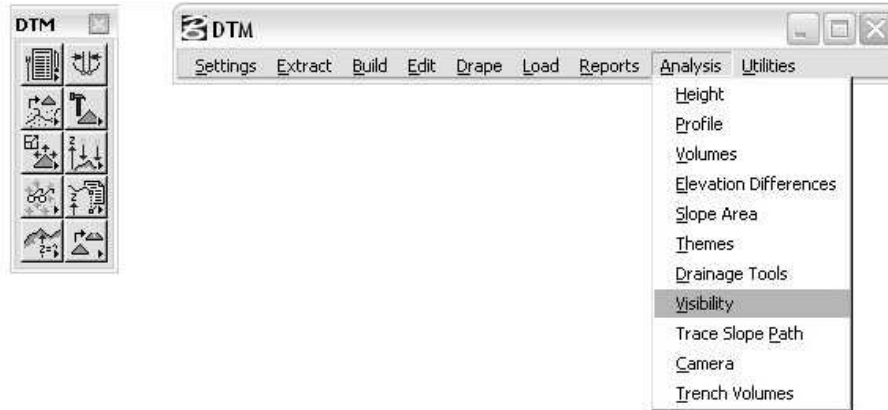


To complete this line of sight investigation for the passenger car performing a left turn from a stop condition on the side road you would now need to check the line of sight for an approaching vehicle from the other direction on the mainline roadway. Simply repeat the steps just illustrated for this alternate approaching vehicle location.

When investigating line of sight conditions, all aspects of engineering must be considered before deciding on a course of action. The suggested correction shown previously may not be feasible due to economic or other reasons.

Checking Line of Sight with a TIN Surface

The **Visibility Tool** utilizes a TIN surface. Based on a user-defined point of origin, it visually displays lines of sight between two specified points. To access this tool go to **Applications > Geopak Road > DTM Tools**. In DTM tools go to **Analysis > Visibility**.



Fields within the dialog are described below for investigating a line of sight. If the specified parameters cannot be met, a **Point Not Visible** message is displayed. For example, if the eye position elevation is below the surface, this can occur.

TIN File : GEOPAK binary TIN file. Selecting the **File** button invokes a File Manager wherein the desired TIN may be selected.

Eye Position

Drape on TIN or User Supplied: Defines the point of origin. The user can manually type in the elevation for the **User Supplied** option. The other option is to select a point within the TIN surface and GEOPAK determines the elevation by draping the point on the TIN. When the **Drape on TIN** option is utilized, the elevation is displayed to the right of the option.

Offset Height: When the toggle is activated, the eye position is adjusted by the specified **Offset Height** from the defined **Eye Position**.

X, Y DP: The user may manually type in the X, Y coordinates of the point of origin or click **DP** and place a data point to define the origin. GEOPAK displays the coordinates of the selected point. A display circle is visualized, utilizing the MicroStation active element symbology.

Display Settings

Visible or Not Visible: Defines the element symbology to draw the visible and non visible lines.

Display Only: When activated, the visible and non-visible elements are not drawn in the design file, but merely displayed. Therefore, any execution of a screen refresh or view control command will remove the elements from the screen.

Graphic Group: When active, all elements placed within the single click of **Process** form a graphic group for easy manipulation and deletion.

Visibility Parameters.

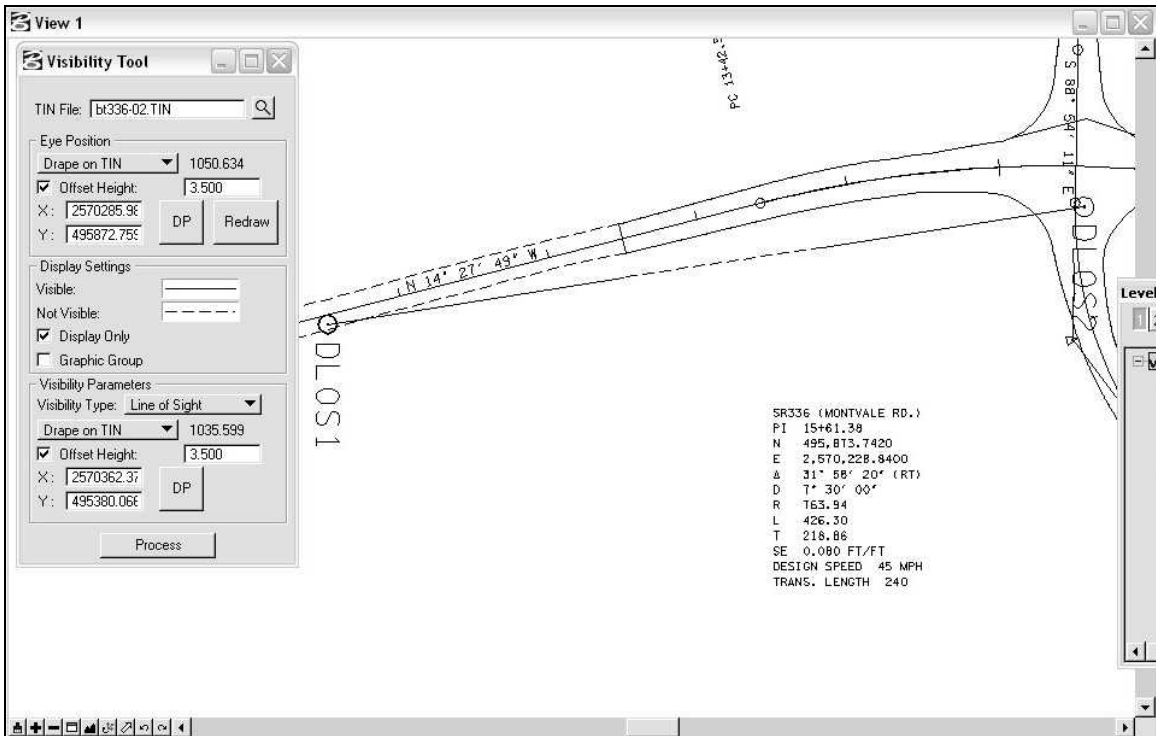
Visibility Type: Line of Sight, Given the point of origin and the point to sight, this tool displays a line between the two points of varying symbology, depending whether it is visible or not visible.

Drape on TIN or User Supplied: Defines the elevation of the point to sight. Works the same as the controls for Eye Position.

Offset Height: Defines the offset height of the point to sight. Works the same as the controls for Eye Position.

X, Y DP: Defines the X,Y location of the point to sight. Works the same as the controls for Eye Position.

Shown below is a use of the tool on the example project described previously in this document. For this case the existing TIN surface was utilized. Notice the dashed area along the line of sight indicating an area of blocked visibility.



For this case the final proposed TIN surface was utilized. Notice that the area of blocked visibility has been eliminated.

