Volumes and Slope Area

11.1   Overview

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Feature / Function	Compute volumes between two models or a model and plane, and generate an optional ASCII report.
Tools	
DTM Menu Bar	Analysis > Volumes

The Volumes Tool computes volumes between TIN models and planes. The quantities are displayed in the dialog, and can be optionally written into an ASCII file. Eight volume analyses are supported in the GEOPAK DTM operation to compute cut and fill volumes. These include:

- Prismoidal Surface To Plane - prismoidal volume between a single triangulated model and a horizontal plane at a specified elevation.
- Prismoidal Surface to Surface - prismoidal volume between two triangulation models.
- Prismoidal Surface Balance - volume between two gridded triangulation models producing simply a cut and fill totals.
- Gridded Surface To Plane - volume between a single gridded triangulated model and a horizontal plane at a specified elevation.
- Gridded Surface to Surface - volume between two gridded triangulation models.
- Gridded Surface Balance - prismoidal volume between two TIN models producing simply a cut and fill totals.
- Elevation Differences - Surface to Plane - a variety of grid generation, Isopach contour drawing, and cut/fill latticing between a lattice surface and a horizontal plane.
- Elevation Differences - Surface to Surface - a variety of grid generation, Isopach contour drawing, and cut/fill latticing between two TIN models.
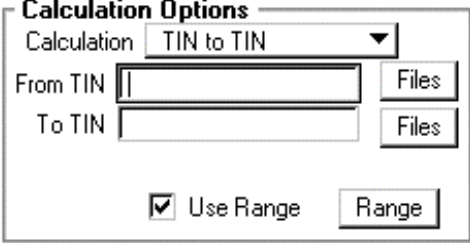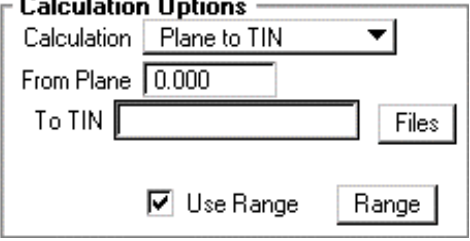
Each of these options will be discussed in subsequent subsections.

For each volume option, the area about which volume calculations are performed is defined by a MicroStation shape or complex shape element (Select mode). An alternative method of defining the area about which volume calculations are performed is by interactively defining the area (Place mode). Both Select and Place mode operations will be discussed for each volume calculation option. In addition, depth ranges may also be utilized for each Lattice or TIN Volume option, however, they are not supported for the Lattice Patch functions.

When the Volumes tool is selected, the dialog depicted below is displayed.
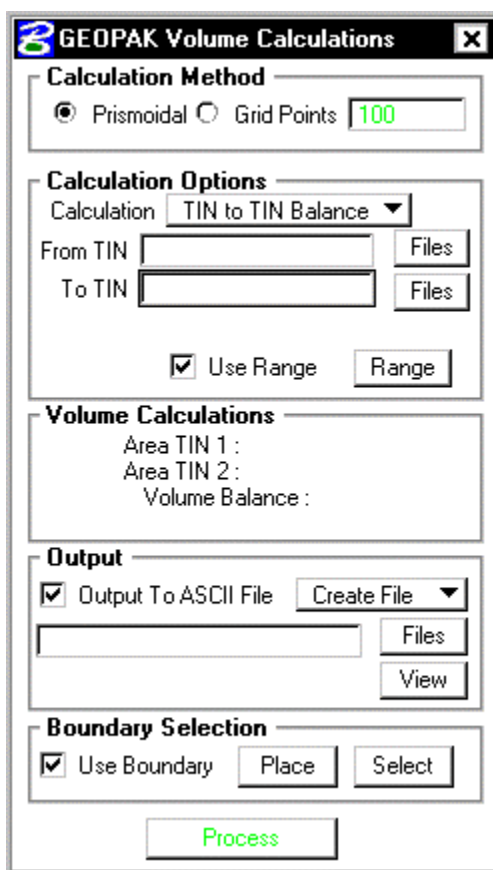
Calculation Method:	Activate one of the two methods to determine the method of calculation. Prismoidal utilizes the triangulation models, while the Grid Points utilizes lattice models created "on the fly."
Prismoidal	When activated, triangulated models are utilized to compute the prismoidal volume.
Grid Points	When activated, the Site Modeler utilizes the user-specified number of **Grid Points** to create a lattice, then computes lattice volumes.
Calculation and	This group box specifies which TIN files or planes are to be utilized

Site Elements	for volume calculations. As the Calculation type is selected, the From and To fields directly below dynamically change to reflect the selection.
Calculation	A TIN file and a horizontal Plane (defined by specified elevation) can be utilized for volume calculations. When **TIN to TIN** is selected, the fields directly below are **From TIN** and **To TIN**, as depicted below. This configuration would be common for determining the project volumes, i.e., from existing ground terrain to the proposed surface.

When **Plane to TIN** is selected, the fields directly below are **From Plane** and **To TIN**. In this case, a keyin field for the elevation is provided. This example is common for determining volumes between existing ground and the proposed pond.

Use Range	Pressing the **Use Range** button invokes the dialog depicted below. Note the button is only unghosted when the toggle is active. If the toggle is active and no ranges are defined, the **Process** button remains ghosted.
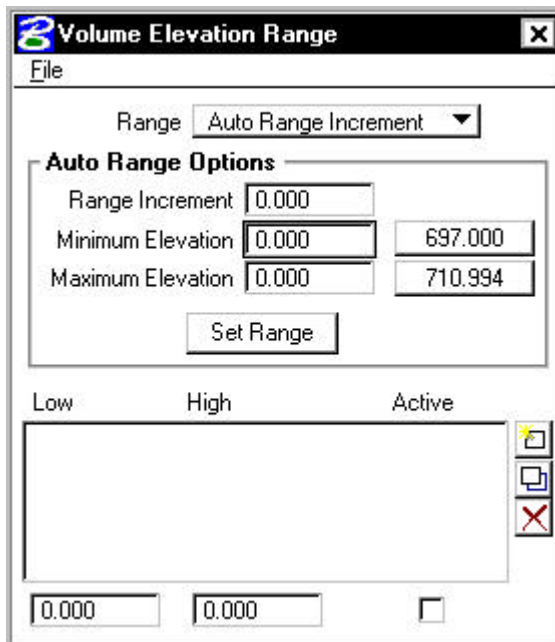
The center of the dialog contains the list box, with edit fields directly below. Options are supported (button to the right of the list box) to **Add**, **Modify**, and **Delete** ranges. When the **Active** toggle is activated, the selected range is utilized for computations. A range can be activated or deactivated at any time during the processing by highlighting the desired line and changing the **Active** toggle. In this manner, the user has complete control over which ranges are computed at any one time.

To add a single range, simply key in the desired values, set the Active toggle, and press the **Add** button. The created line is added to the list box. To modify a line, highlight the desired line. The current values are displayed in the edit fields. Change the desired field, then press the **Modify** button. GEOPAK updates the list box. To delete a line, highlight the line and press the **Delete** button. The line is removed from the list box. An unlimited number of ranges is supported. When more than five ranges are specified, the scroll bar and arrows on the right side of the dialog are automatically invoked for easy scanning.

The top of the dialog supports automatic creation of ranges. Two options are supported:

- **Auto Number of Ranges** - the number of ranges is specified, along with the Minimum and Maximum elevations (or slopes or aspects). GEOPAK divides the elevation into the specified number of ranges.

- **Auto Range Increment** - the range increment is specified, along with the Minimum and Maximum elevations. GEOPAK divides the elevation into as many
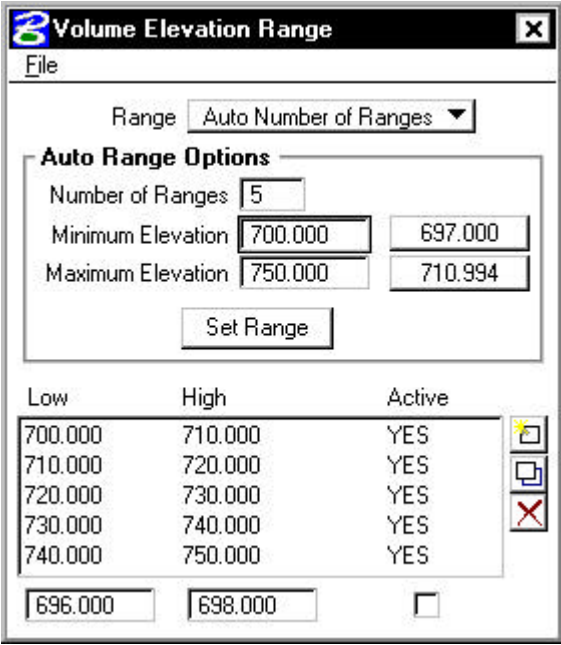
ranges as necessary at the specified increment.

For example, set the Range option to **Auto Range Increment**. Then set the **Range Increment** to 5, and the Minimum and Maximum elevations to 700 and 750 respectively. To populate the list box with the specified ranges, press the **Set Range** button. The resultant dialog is depicted below. Note the buttons to the right of the Elevations are the Min /Max values for the current TIN Model. They are displayed only when TIN file names are specified within the main dialog. To utilize them in populating the fields, simply press the appropriated button.
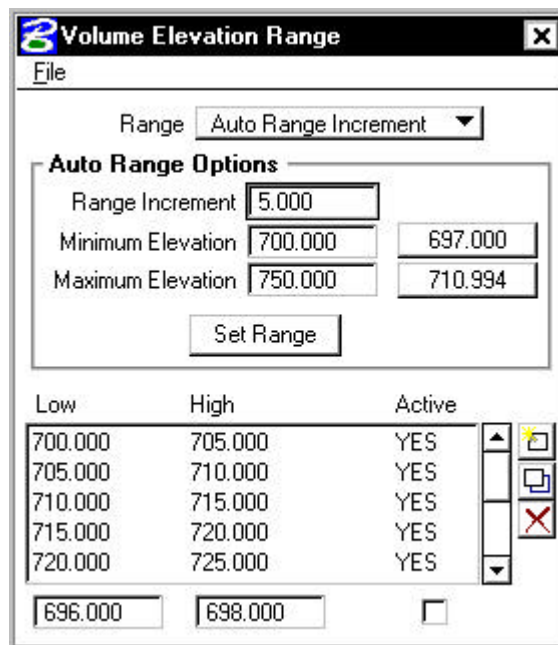
The **Range Increment** is added to the **Minimum Elevation** as many times as possible until the **Maximum Elevation** is attained. Note there are numerous ranges, however, each range is five master units (per our dialog specification.) All **Active** toggles are defaulted on.

Now, change the Range to **Auto Number of Ranges**, and set the **Number of Ranges** to five. Leaving the **Minimum** and **Maximum Elevations** the same as the last example, press the **Set Range** button. The resultant dialog is depicted below.

In this case, GEOPAK computed the elevation difference, divided by the number of ranges, and computed the **Low** and **High** for each range. Note, there are only five ranges (the number specified in the dialog) in the list box, each 10 master units in range. All **Active** toggles are defaulted on.

To utilize the specified ranges for subsequent sessions, several File functions are supported: **Save**, **Save As**, and **Open**.

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Volume Calculations	This display field contains the **Cut Volume**, **Fill Volume**, **Balance**, and **Area**. Units are determined by the Site User Preferences (not Site Modeler preferences.) In English projects, units are cubic and square yards, while metric projects are cubic and square meters.
Output	An optional output can be generated, placing the results in an ASCII file.
Output to ASCII File	When activated, the results are placed in the specified ASCII file
Files	Name of ASCII file to be created or appended. In lieu of typing, pressing the **Files** button invokes the Create ASCII Output File dialog, wherein the desired file may be selected.
Create File Append File	Setting the option to **Create File** creates a new file, while setting the option to **Append File** adds the results of the current processing to the bottom of the previously created file.
View	Pressing this button invokes the MDL editor, and automatically loads the output report.
Boundary Selection	Volume calculations can be performed in a user-defined area, rather than the entire model, utilizing information within this group box.
Use Boundary	When activated, the Site Modeler utilizes a user-defined boundary, rather than computing volumes for the entire model.

Place	Pressing this button enables the user to subsequently identify data points within the model. To close the boundary, place the last data point within the circle at the initial point of the boundary.
Select	Pressing this button enables the user to identify a previously defined closed element, wherein volume calculations can be computed.
Process	Commences the volume calculations. Note this button is ghosted until sufficient data has been incorporated within the dialog.

11.1.1 Volumes Calculation Example

In this first example, the total project volume is calculated. The dialog is depicted below.
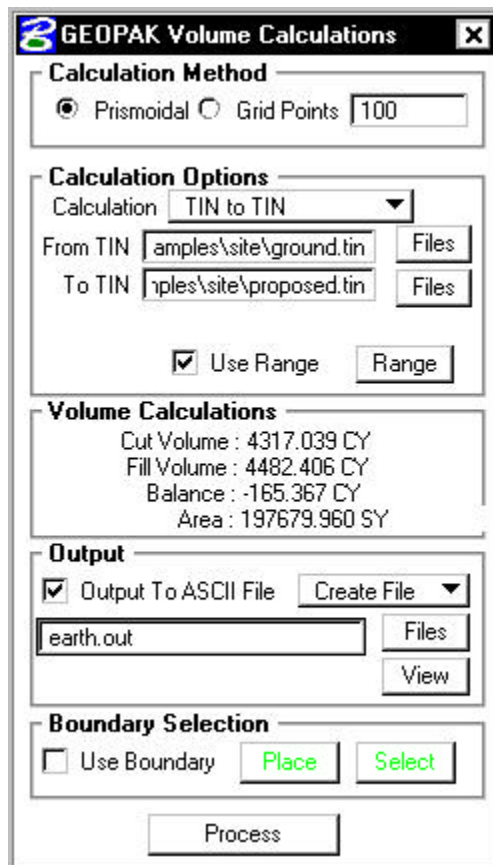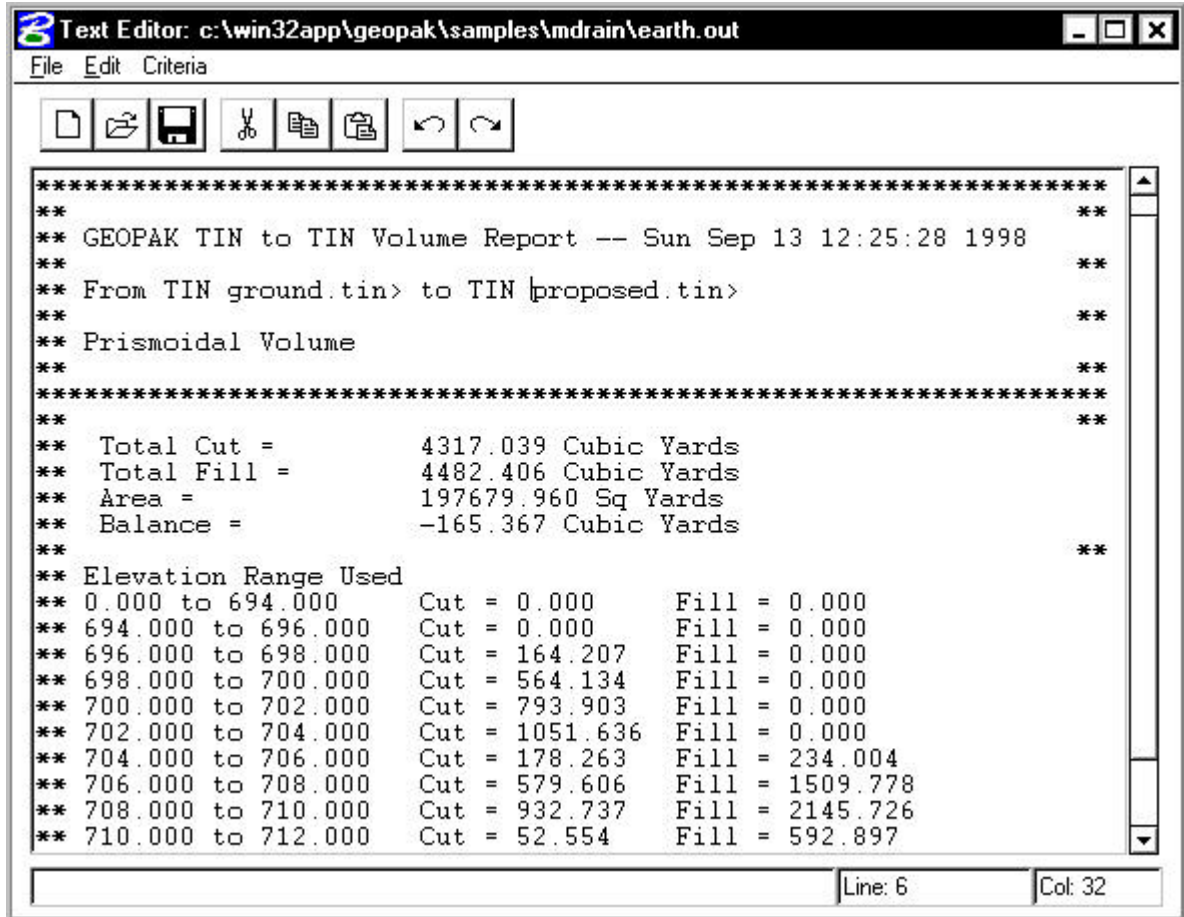
The example utilizes the prismoidal option and calculates **From TIN**, ground **To TIN**, Proposed. Ranges have been defined as depicted in the graphic below.
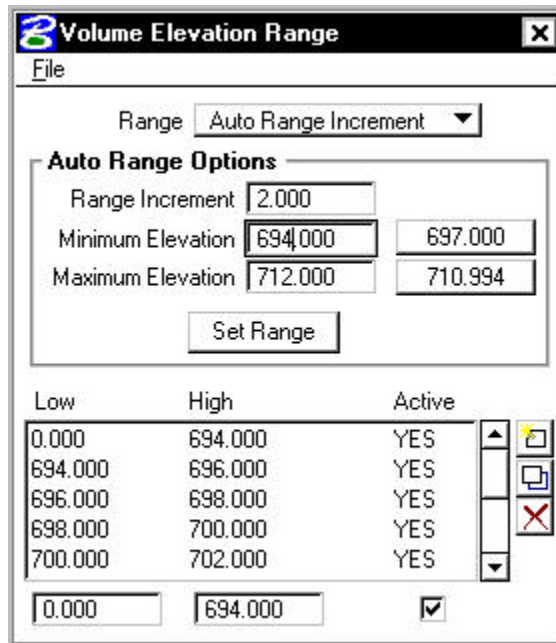

The optional report is also being utilized. The total quantities are displayed in the center of the dialog, while the **View** button is pressed in order to open the text editor and view the sub-totals, as depicted below.

```
Text Editor: c:\win32app\geopak\samples\mdrain\earth.out        _ □ ×
File  Edit  Criteria

┌──┐┌──┐┌──┐  ┌──┐┌──┐┌──┐  ┌──┐┌──┐
│ D││ ☞││ 🖫│  │ ✂││ 🖹││ 🖺│  │ ↺││ ↻│
└──┘└──┘└──┘  └──┘└──┘└──┘  └──┘└──┘

***************************************************************
**                                                          **
** GEOPAK TIN to TIN Volume Report -- Sun Sep 13 12:25:28 1998
**                                                          **
** From TIN ground.tin> to TIN proposed.tin>
**                                                          **
** Prismoidal Volume
**                                                          **
***************************************************************
**                                                          **
**   Total Cut =          4317.039 Cubic Yards
**   Total Fill =         4482.406 Cubic Yards
**   Area =               197679.960 Sq Yards
**   Balance =            -165.367 Cubic Yards
**                                                          **
** Elevation Range Used
** 0.000 to 694.000      Cut = 0.000      Fill = 0.000
** 694.000 to 696.000    Cut = 0.000      Fill = 0.000
** 696.000 to 698.000    Cut = 164.207    Fill = 0.000
** 698.000 to 700.000    Cut = 564.134    Fill = 0.000
** 700.000 to 702.000    Cut = 793.903    Fill = 0.000
** 702.000 to 704.000    Cut = 1051.636   Fill = 0.000
** 704.000 to 706.000    Cut = 178.263    Fill = 234.004
** 706.000 to 708.000    Cut = 579.606    Fill = 1509.778
** 708.000 to 710.000    Cut = 932.737    Fill = 2145.726
** 710.000 to 712.000    Cut = 52.554     Fill = 592.897

                                          Line: 6      Col: 32
```

The second example is **From Plane** (elevation 704.00) **To TIN** (Pond). In this case, the elevation is above the pond. The **Grid Points** option is utilized, and therefore, the toggle is active and 10000 points has been keyed in the appropriate field. No depth ranges are required, so the **Use Range** toggle is not active. As we only want total cut / fill volumes, no report is required. Therefore, the **Output to ASCII File** toggle is not active. The dialog, including quantities, is depicted below.
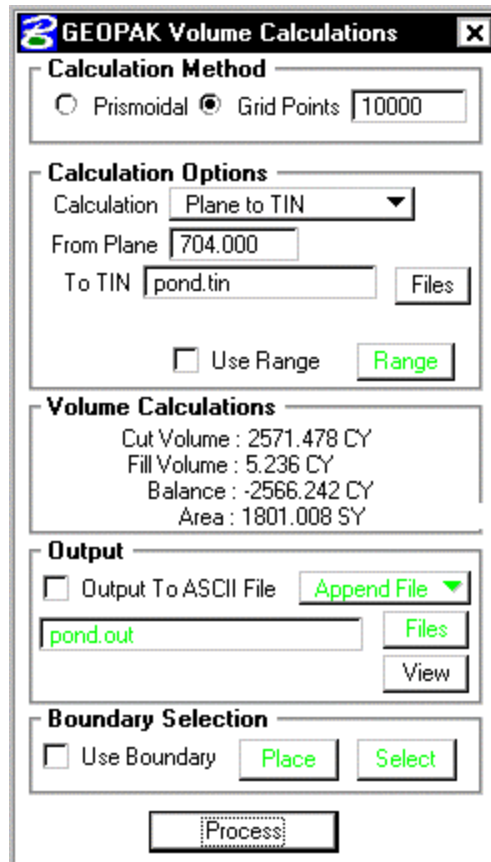
11.2   Elevation Differences

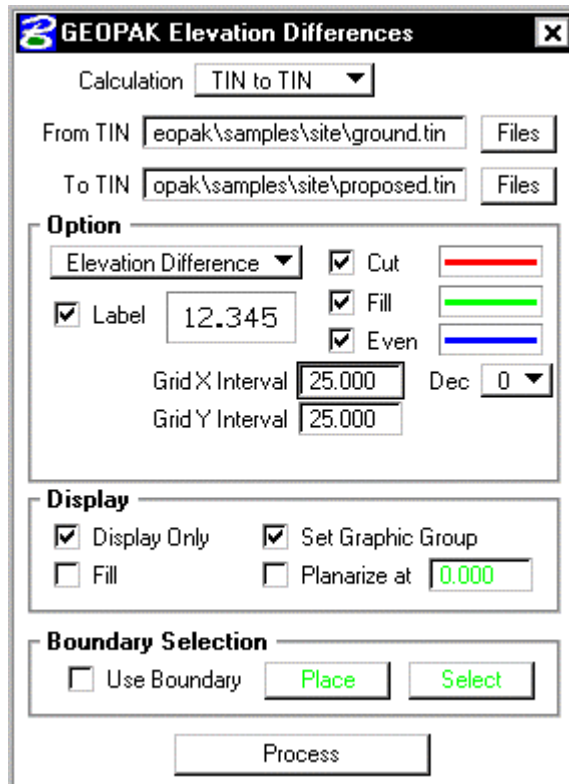| Feature / Function	Generate grids, or contours of elevation differences
Tools	
Menu Bar Application	Analysis > Elevation Differences

The Elevation Difference tool supports a variety of grid generation, Isopach contour drawing, and cut/fill latticing. The three tools are:

- Elevation Difference - draws the grid of cut / fill elevations, i.e., the cut or fill depth between the two specified TIN files at each grid point. In a 3D design file, when in a front or side view, the grid displays T's. The T's represent the cut or fill values. The vertical part of the T is the vertical length of the cut or fill and the bar of the T is the text value of the cut or fill. The bar of the T is placed on the surface of the From TIN. Therefore, in a
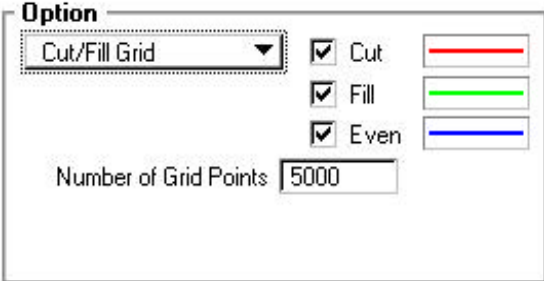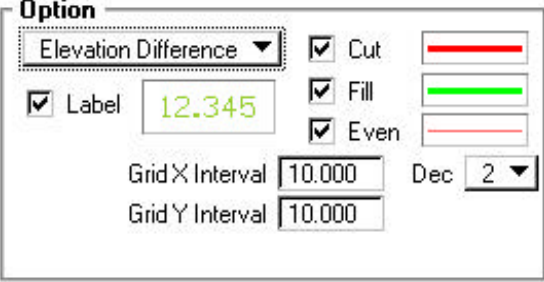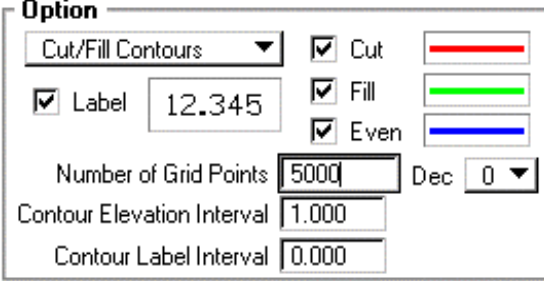
cut situation, a normal T is placed, while in a fill situation the T is inverted.

- Cut / Fill Grid - a lattice with a user-defined number of points determining the density with different element symbology for cut and fill. The lattice can be wireframe or filled color.

- Cut / Fill Contours (Isopach) - which are simply contours of the cut and fill depths. A fill of two feet is a positive two contour, while a cut depth of six would be a negative contour. A zero contour would be where the surface and plane intersect.

When invoked, the dialog depicted below is displayed.

Calculation	**TIN Models** and a horizontal **Plane** (defined by specified elevation) can be utilized for elevation differences. When **TIN to TIN** is selected, the fields directly below are **From TIN** and **To TIN**, as depicted below. This configuration would be common for determining the project elevation differences, i.e., from existing ground terrain to the proposed surface.

|	
	Calculation TIN to TIN ▼ From TIN eopak\samples\site\ground.tin Files To TIN opak\samples\site\proposed.tin Files
Option	The **Cut / Fill Grid** option requires the number of grid points, then calculates the grid interval based on the area encompassed by the TIN, Plane or Boundary area. **Option** Cut/Fill Grid ▼ ☑ Cut ────── ☑ Fill ────── ☑ Even ────── Number of Grid Points 5000 The **Elevation Difference** option requires the grid interval to determine the gridded text placement. **Option** Elevation Difference ▼ ☑ Cut ────── ☑ Label 12.345 ☑ Fill ────── ☑ Even ────── Grid X Interval 10.000 Dec 2 ▼ Grid Y Interval 10.000 The **Cut / Fill Contours** option requires the number of grid points in order to lattice the models, then draws Isopach (cut / fill) contours of the latticed model. User-defined parameters include **Contour Elevation Interval** (elevation difference between successive contours), and **Contour Label Interval**. If the **Label** toggle is active, and the **Contour Label Interval** is zero, a single label is placed midpoint on each contour. **Option** Cut/Fill Contours ▼ ☑ Cut ────── ☑ Label 12.345 ☑ Fill ────── ☑ Even ────── Number of Grid Points 5000 Dec 0 ▼ Contour Elevation Interval 1.000 Contour Label Interval 0.000
Display Only	When activated, the elevation differences are not drawn into the

|	MicroStation file, and disappear when any view or update command is issued.
Fill	Only applicable in the cut / fill grid, this toggle when active fills the grid solid color, rather than wire frame. Note the Fill View Attribute must also be active.
Set Graphic Group	When activated, all themes within a single processing are placed in a single graphic group for easy manipulation and deletion.
Planarize at Elevation	When activated, all elevation difference data is drawn at the specified elevation, rather than the elevation of the TIN model. This is applicable only in a 3D design file.
Boundary Selection	Elevation differences can be performed in a user-defined area, rather than the entire model, utilizing information within this group box.
Use Boundary	When activated, the Site Modeler utilizes a user-defined boundary, rather than displaying elevation differences for the entire model.
Place	Pressing this button enables the user to subsequently identify data points within the model. To close the boundary, place the last data point within the circle at the initial point of the boundary.
Select	Pressing this button enables the user to identify a previously defined closed element, wherein elevation differences can be displayed.
Process	Commences the elevation difference calculations. Note this button is ghosted until sufficient data has been incorporated within the dialog.

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11.2.1 Elevation Differences Examples

The first example is utilizing the **Elevation Difference** option as depicted in the dialog below. The Grid Intervals are set to 25 master units.

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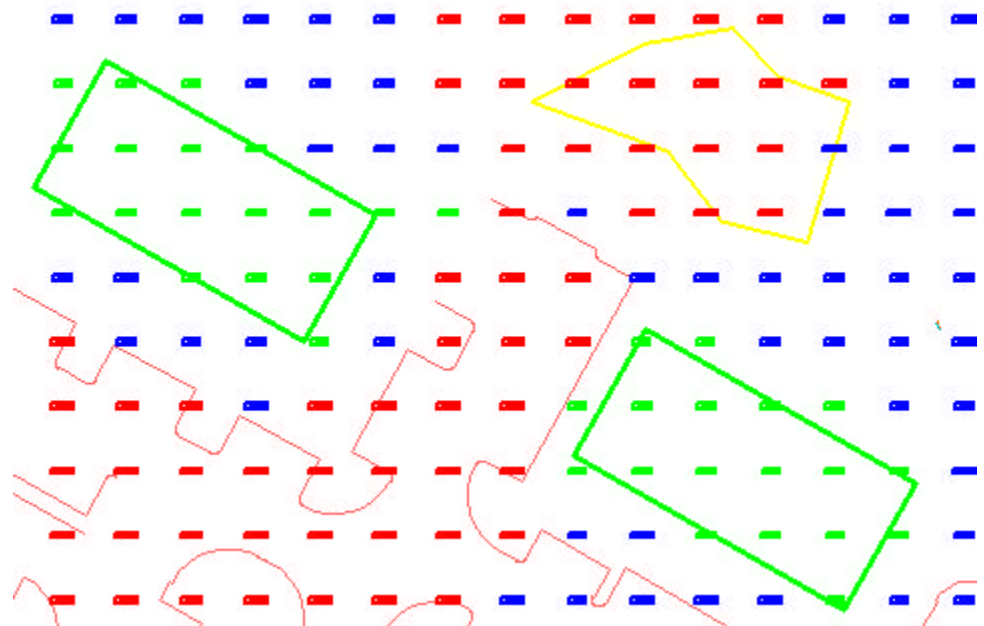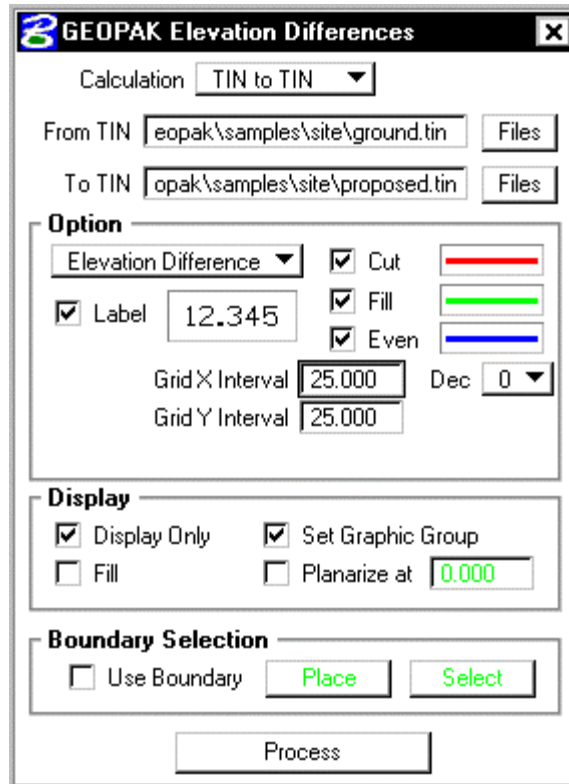
A detail of one area is illustrated below.
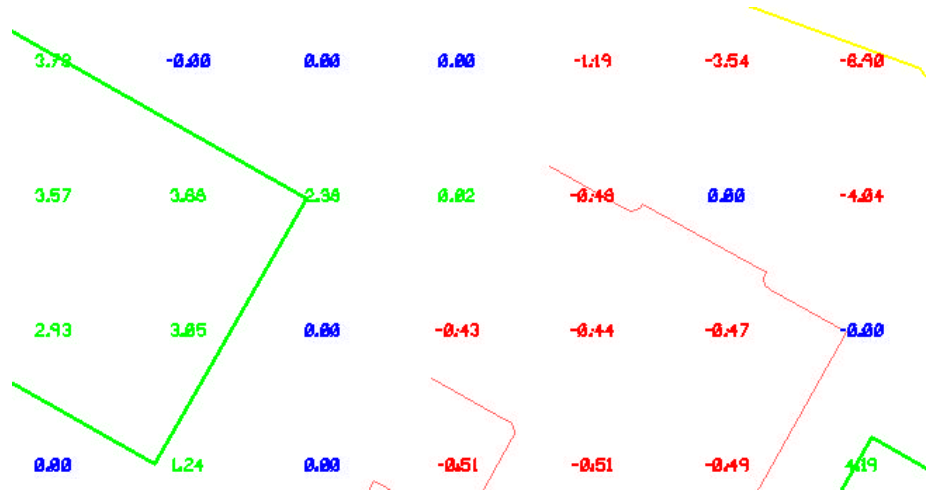
The graphic below illustrates the screen if a side view is depicted (3D design file only).
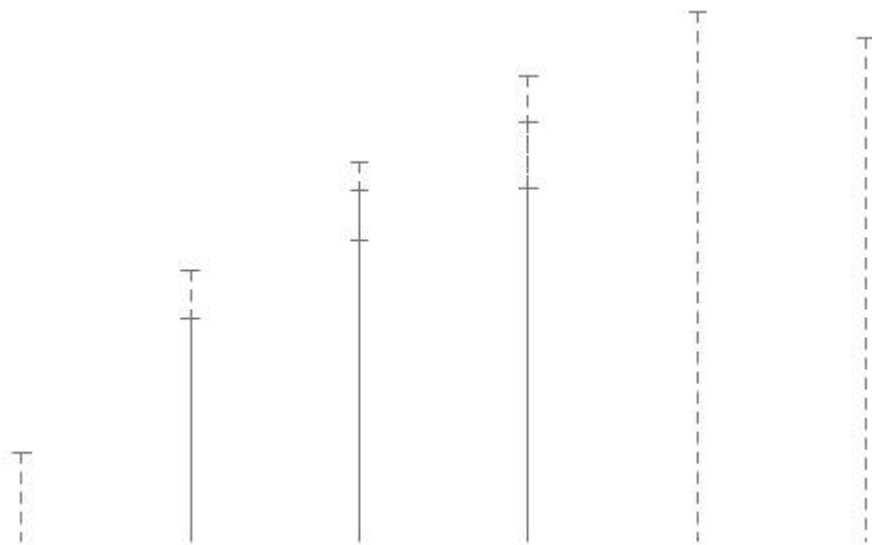
The T's represent the cut or fill values. The vertical part of the T is the vertical length of the cut or fill and the bar of the T is the text value of the cut or fill. The bar of the T is placed on the surface of the primary TIN. Therefore, in a cut situation, a normal T is placed, while in a fill situation the T is inverted.

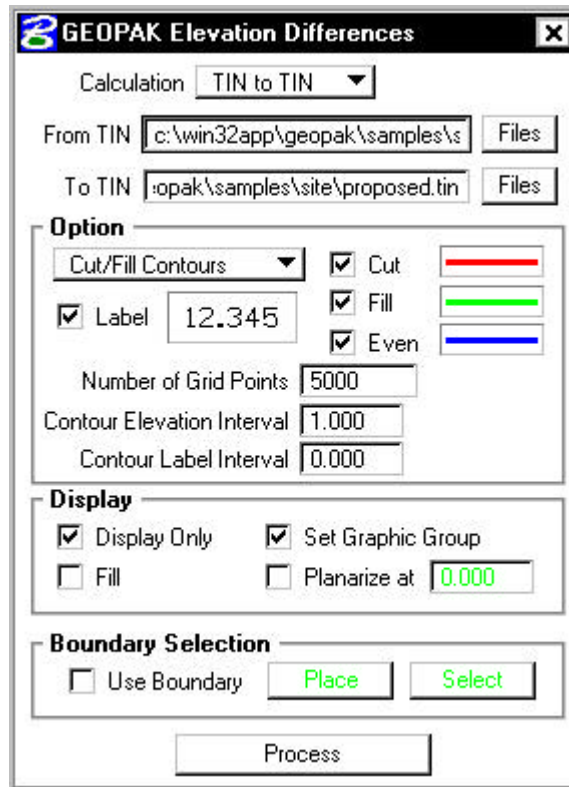The second example is the **Cut / Fill Grid** utilizing the dialog below.
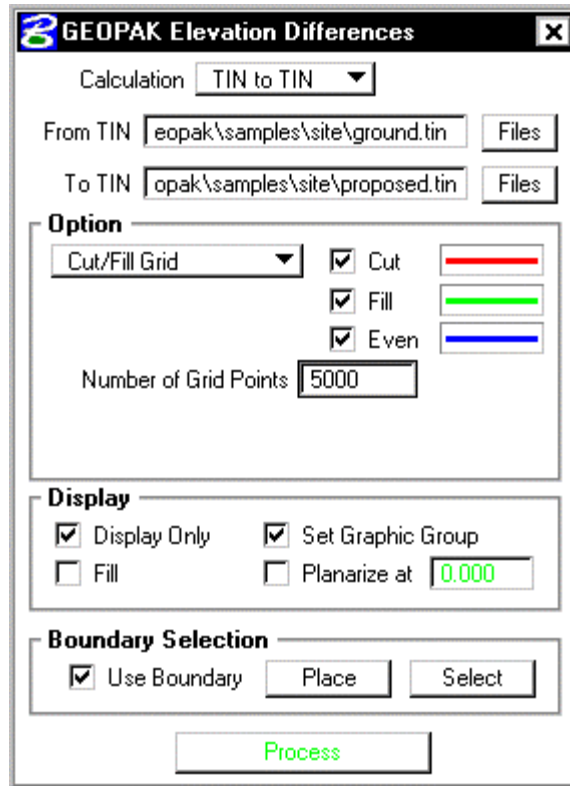
The resultant grid (lattice)is depicted below. Note the change in color for the cut, fill and even. If the Fill toggle is active, the grid is solid color, rather than the individual lattice grids.
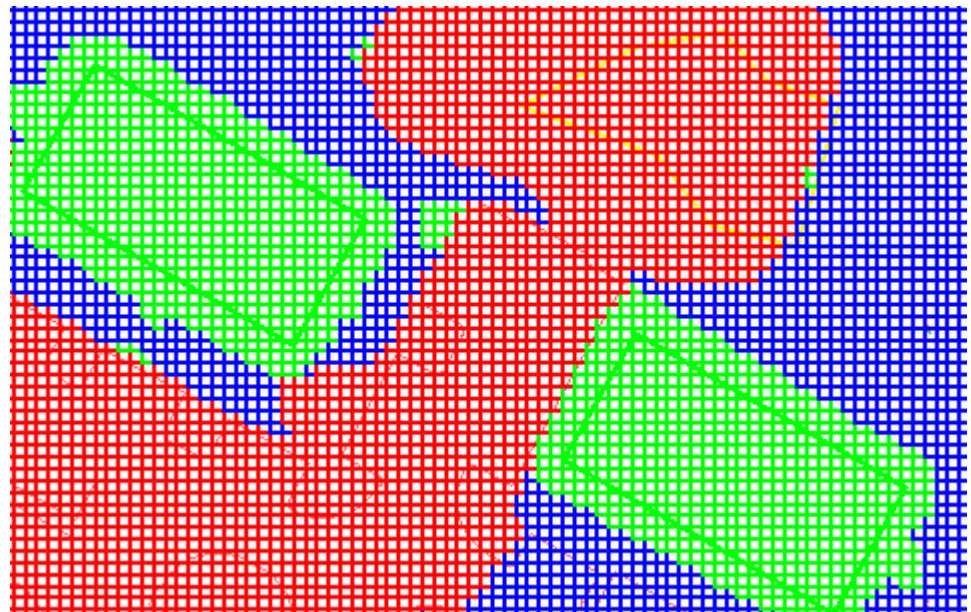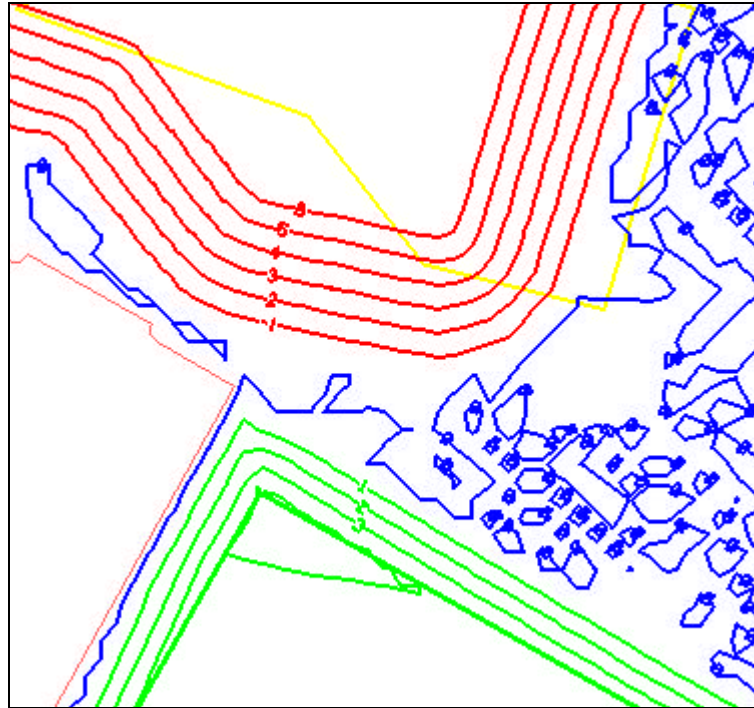
The third example is **Cut / Fill** (Isopach) **Contours**. In the dialog below, 5000 Grid Points are utilized.
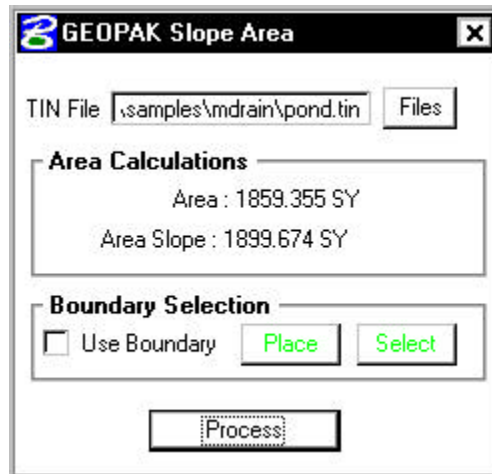

The contours are every even master unit, i.e., every foot or meter. As the **Label** toggle is active and the **Contour Label Interval** is set to zero, each contour is labeled at the midpoint.

11.3 Slope Area

Feature / Function	Displays the horizontal area and actual slope area
Tools	
Menu Bar Application	Analysis > Slope Area

The Slope Area tool displays the horizontal area and actual slope area (area following the terrain of the Model or Object). When invoked, the dialog depicted below is displayed.

TIN File	Select the desired TIN by pressing the Files button.
Area Calculations	Display area of the Area (measured on a horizontal plane) and the Slope Area (measured along the actual model or object).
Boundary Selection	When activated, an enclosed shape or boundary must be identified. To select a previously defined element, press the **Select** button and select the element. To interactively identify the area, press the **Place** button and place data points around the desired area. To close, move the cursor near the initial point within the displayed circle and place the final data point. It is not necessary to tentatively snap to the initial point.
Process	Commences the computation and upon completion, populates the Area Calculations group box.