



DTM Surfaces Tutorial

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Product

Surpac™ 6.6.1

Last modified: Tuesday, 1 April 2014

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Introduction

Overview

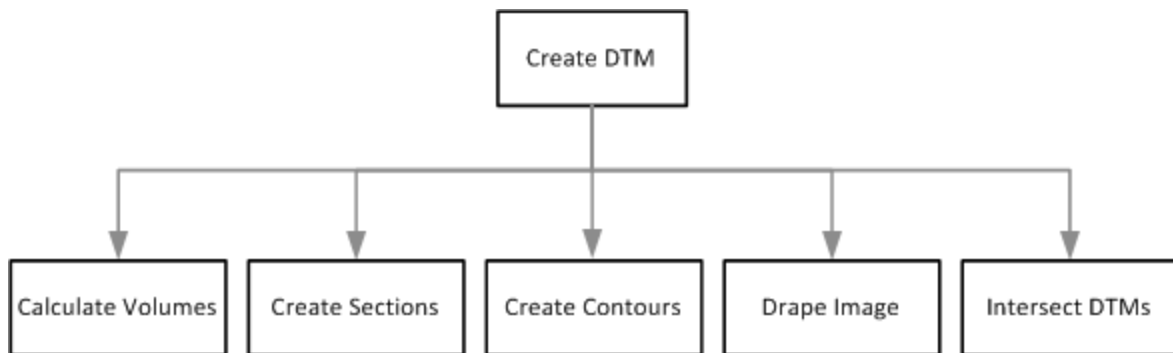
Surface modelling uses triangulation to create two-dimensional models known as digital terrain models (DTMs). This document introduces the theory behind surface modelling processes and provides detailed examples using the surface modelling functions in Surpac. By working through this tutorial, you will gain skills in the construction, use, and modification of DTMs.

Requirements

Before you begin this tutorial, you must have:

- basic knowledge of Surpac
It is recommended that you understand the procedures and concepts from the Introduction tutorial.
- Surpac v6.4, or later, installed on your computer
- the data set accompanying this tutorial

Workflow

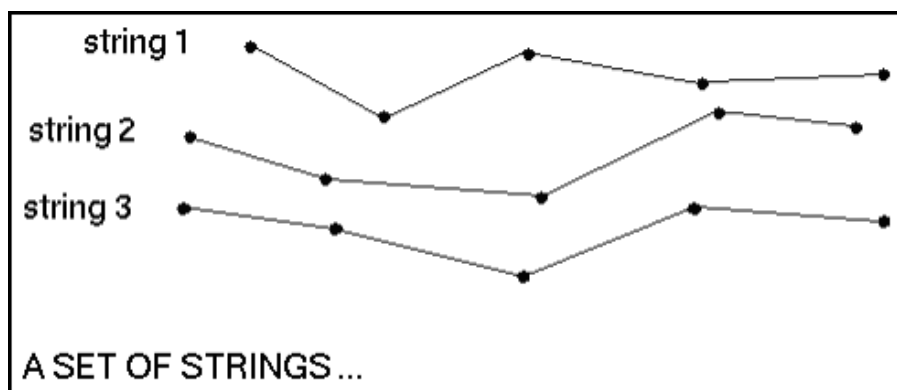


Note: This workflow demonstrates the steps in this tutorial. There are other ways to achieve a result.

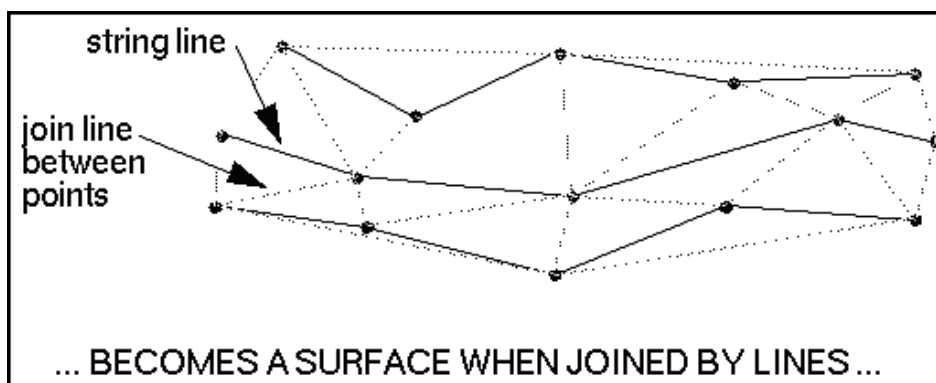
Surface modelling concepts

Strings and DTMs

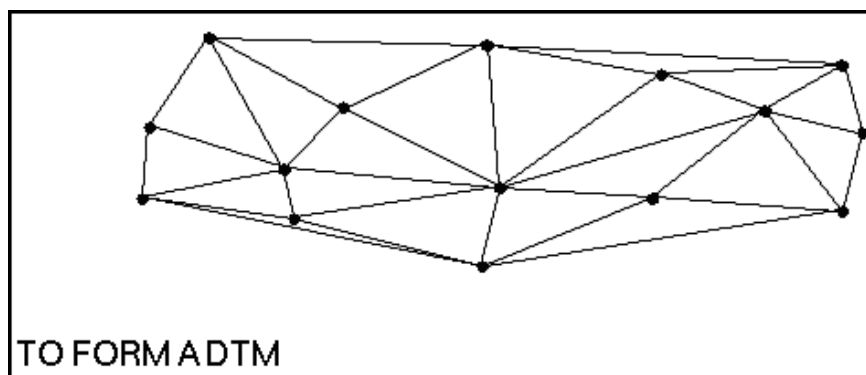
Digital terrain models (DTMs) are created from strings.



Triangles are created between points on the strings.



The result is a set of non-overlapping triangles.



You can use surfaces for such things as 3D visualisation and for calculating volumes. Almost any surface can be modelled as a DTM, including natural topography, lithological contacts, bedrock/overburden contact, or water tables.

DTMs are made of triangles, with each point of each triangle matched to a point in the original string file. As a result, DTM files are not valid without the original string files. To open a DTM file, you must also have access to the original string file of the same name.

DTMs cannot fold back on themselves. That is, a DTM cannot have multiple Z values for a given X, Y coordinate. It is not possible to model overhanging or vertical surfaces with a DTM surface.

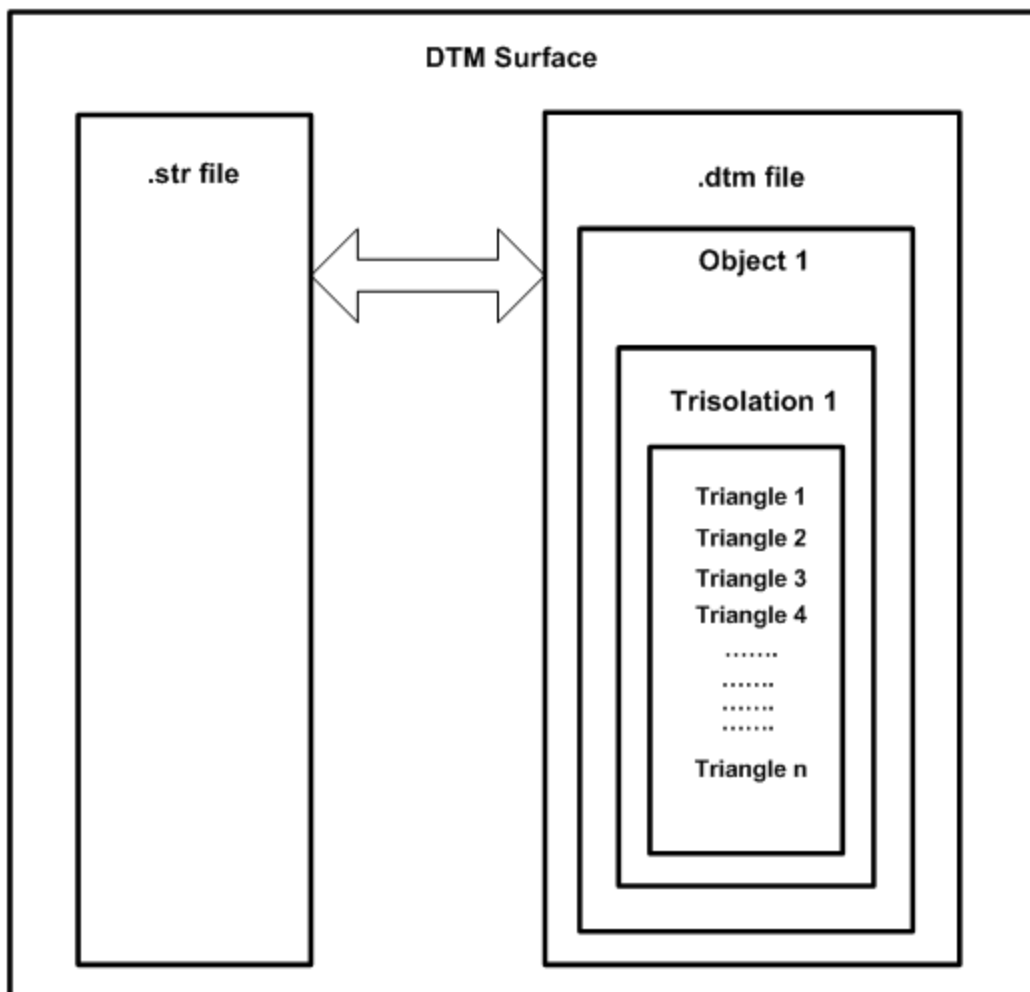
Naming conventions

Surpac assigns numbers to the objects you create by a system similar to that of string and string segment numbers:

- string - object
- segment - trisolation
- point - triangle

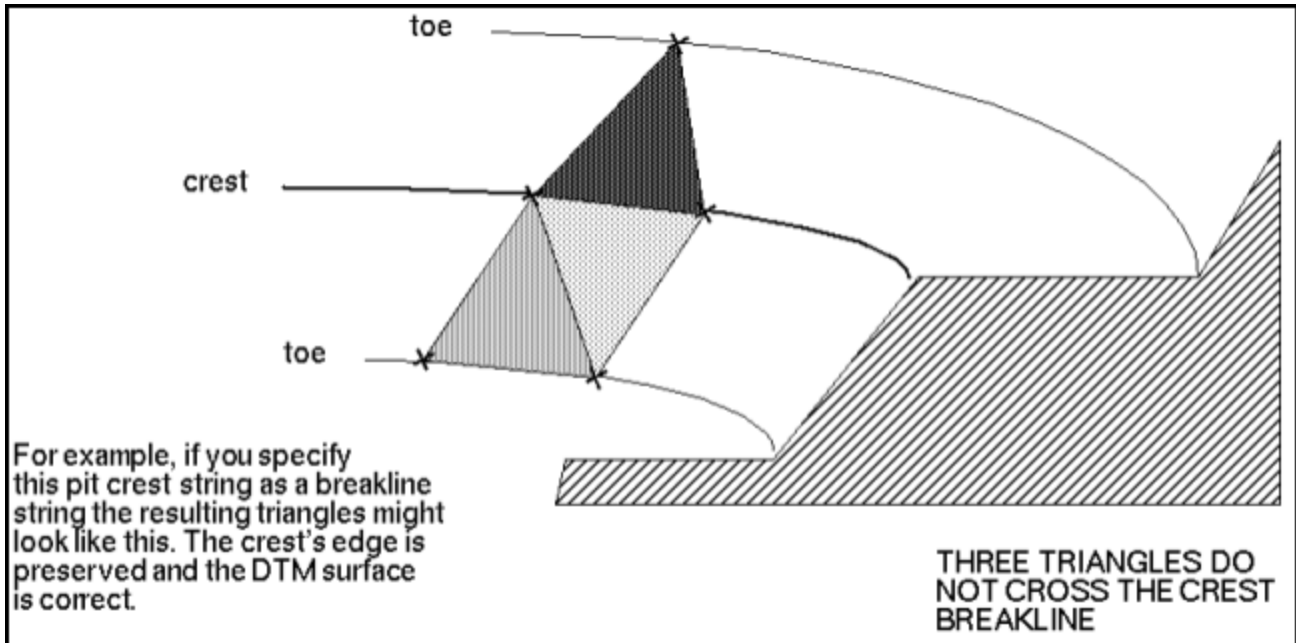
When you define an object, you explicitly assign it both an object number and a trisolation number. The object is then always referred to by this object and trisolation number.

The object number can be any number in the range from 1 to 32000 inclusive. The trisolation number can be any positive integer. However, for some functions the object must be named object 1, trisolation 1.

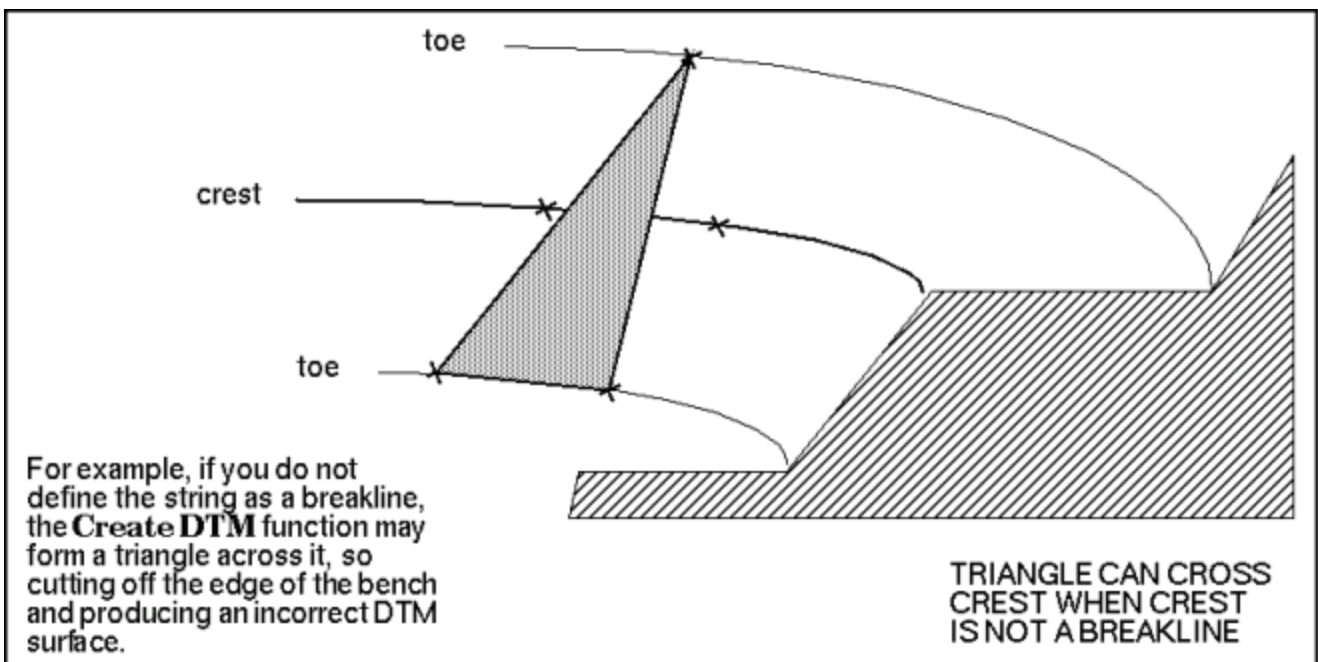


Breaklines and spot heights

Breakline strings are strings that represent linear physical features that you can see in the real world. For example, the crest of a pit, a fault in a geological model, or a contour in a pit.



Spot height strings contain points that represent non-linear or point features. For example, hill peaks, surface low points, gridded points, and borehole collars. The lines connecting the points in the spot height string in **Graphics** do not infer a physical line.

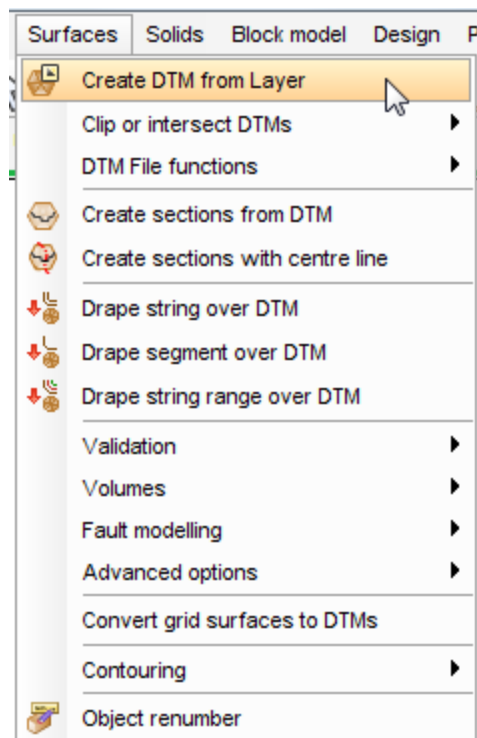


Graphical vs file-based options

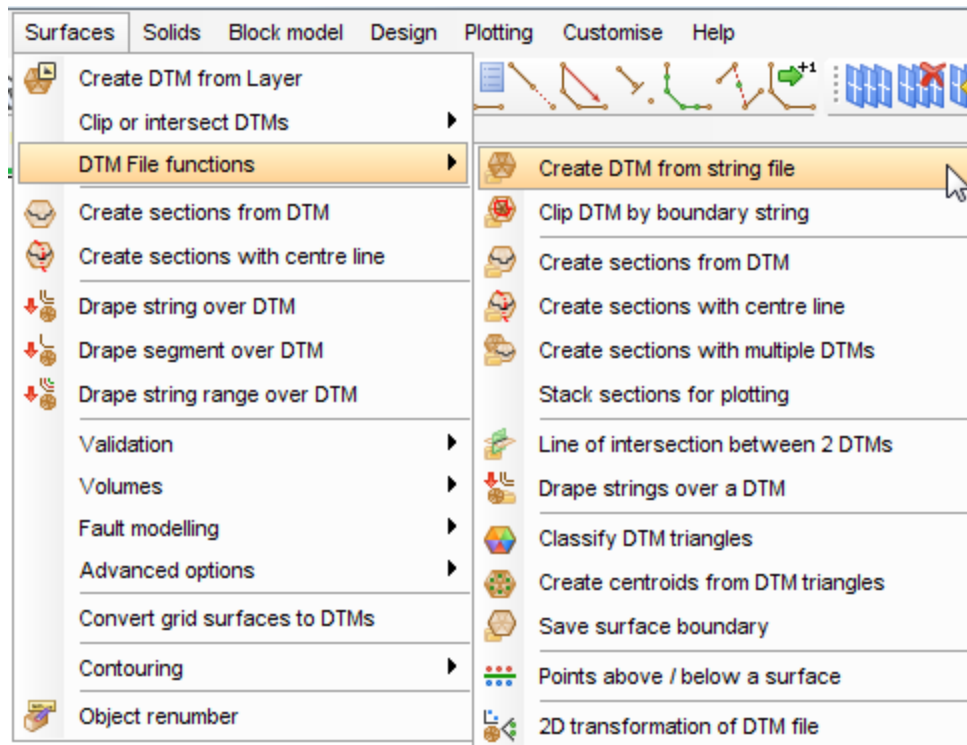
A DTM can be created in two ways to best suit the data you wish to model:

- Graphical DTM operations allow you to view your results immediately. However, for large data files, the processing time can be prohibitive.
- The file-based tools allow you to perform DTM operations directly on the file data, saving both memory usage and creation time.

To create a DTM graphically, you would use the **Create DTM from Layer** function.



To create a DTM using a file-based method, you would use the **Create DTM from string file** function.



Setting up for this tutorial

A work directory is the default directory for saving Surpac files. Files used in this tutorial are stored in the folder `<shared_files>\demo_data\tutorials\dtm_surfaces`.

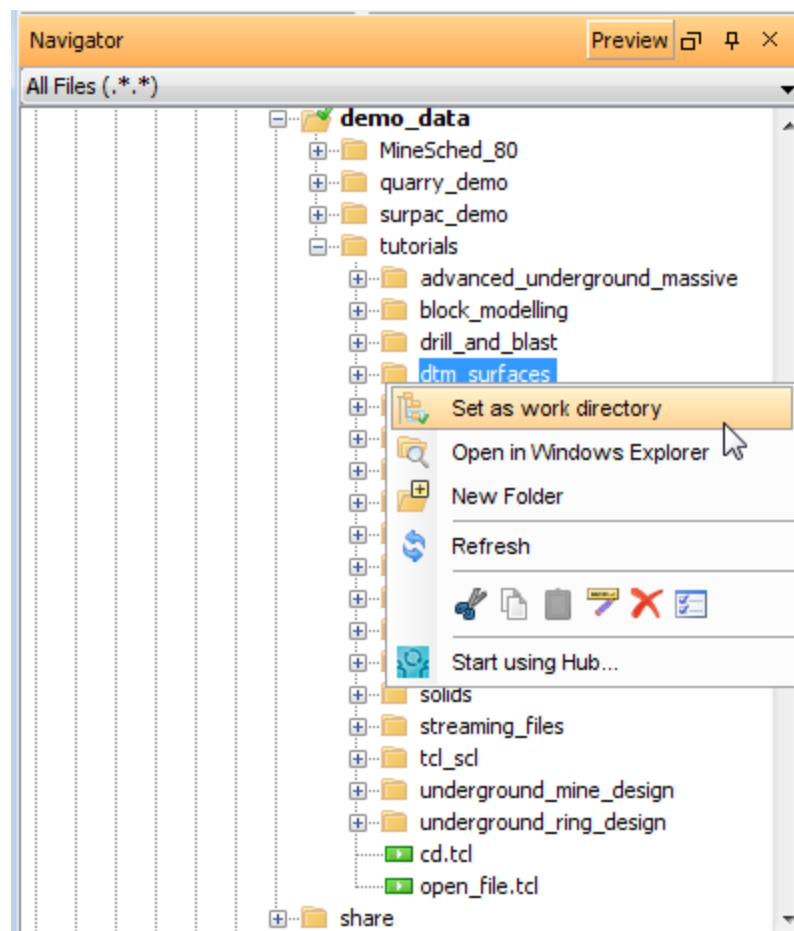
Where `<shared_files>` is the directory in which the Surpac shared files were installed.

In Windows 7, and Windows 8, the default path is

C: \Users\Public\GEOVIA\Surpac\66\demo_data\tutorials\dtm_surfaces.

Task: Set the work directory

1. In the **Navigator**, right-click the **dtm_surfaces** folder.
2. Select **Set as work directory**.



The name of the work directory is displayed in the title bar of the Surpac window.

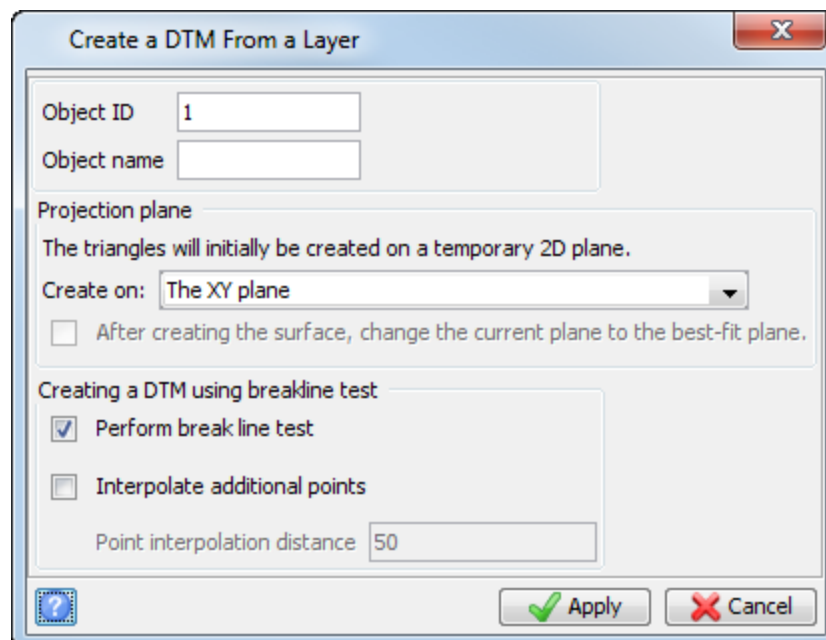
Creating a DTM

Task: Create a DTM – graphics-based method

1. Click **Reset graphics** .
2. Open **topo1.str** in **Graphics**.
topo1 is displayed.



3. Choose **Surfaces > Create DTM from layer**.
4. Enter the information as shown, and click **Apply**.



Create a DTM From a Layer

Object ID

Object name

Projection plane
The triangles will initially be created on a temporary 2D plane.
Create on:


After creating the surface, change the current plane to the best-fit plane.

Creating a DTM using breakline test

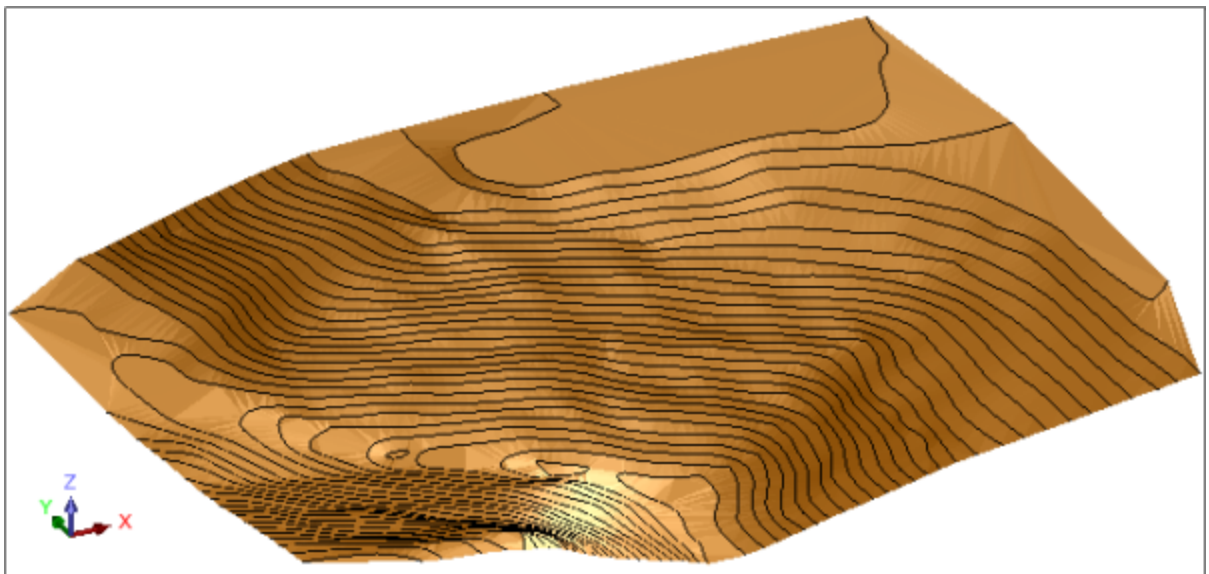
Perform break line test

Interpolate additional points

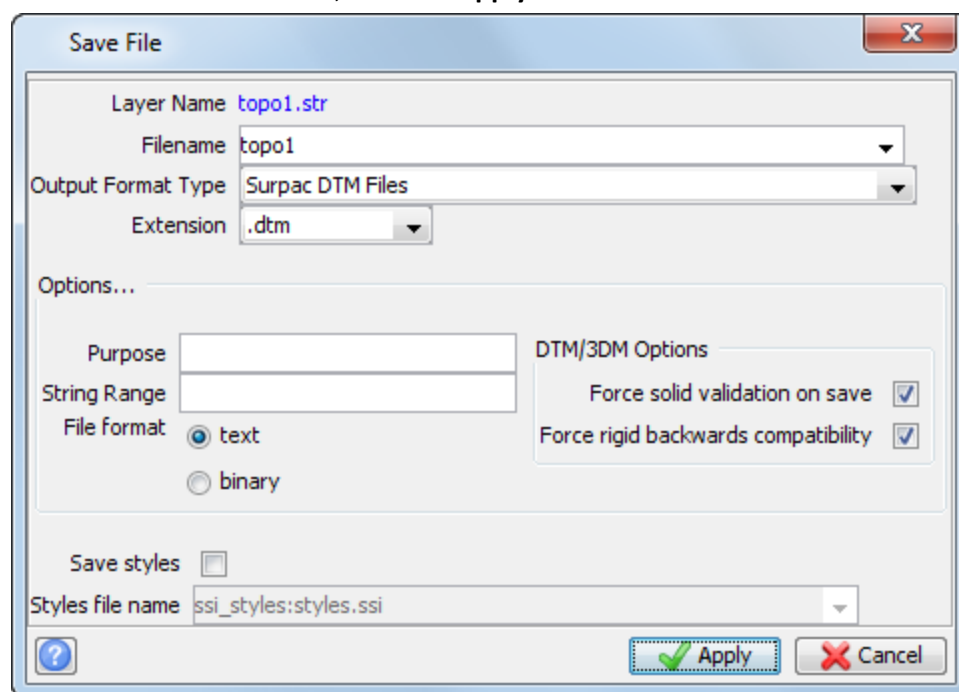
Point interpolation distance




The DTM surface is displayed.

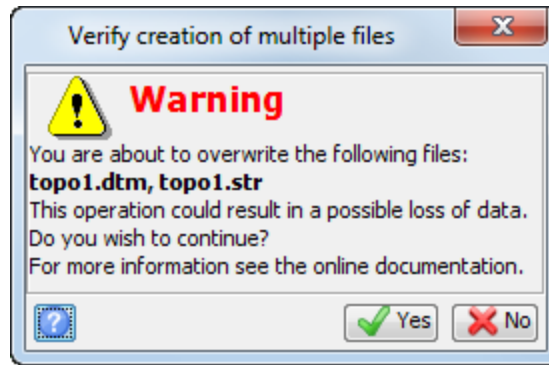



5. Choose **File > Save > String/DTM**.
6. Enter the information as shown, and click **Apply**.



 **Note:** Because the string file exists, you are asked if you want to replace it.

7. Click **Yes**.



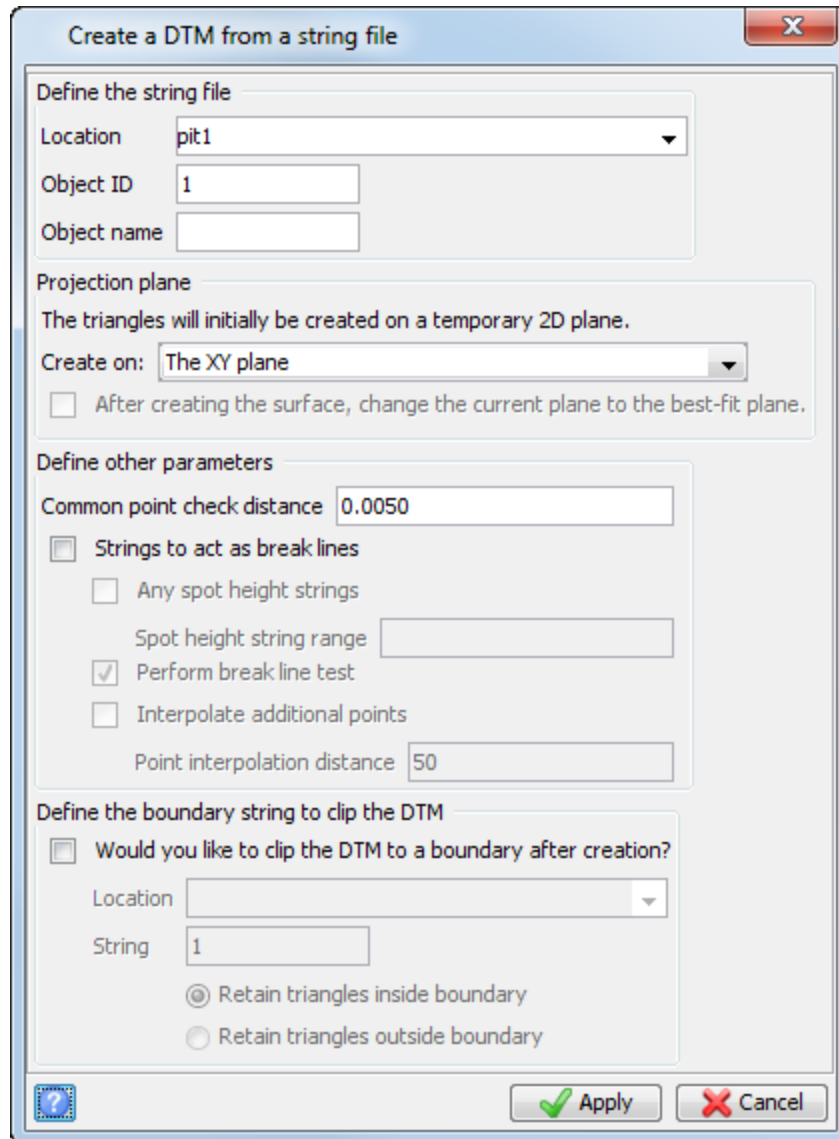
 **Note:** To see all of the steps performed in this task, run `_01a_create_DTM_from_layer.tcl`. You need to click **Apply** on any forms presented.

Task: Create a DTM – file-based method

In addition to demonstrating how to create a DTM using a file-based method, this task demonstrates the effect of using strings as breaklines.

1. Click **Reset graphics** .
2. Choose **Surfaces > DTM File functions > Create DTM from string file**.

3. Enter the information as shown, and click **Apply**.



Note: The **Strings to act as break lines** check box is *not* selected.

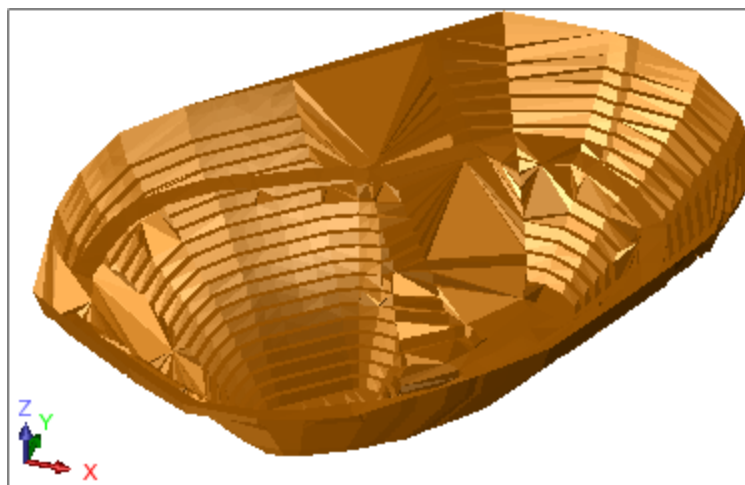
DTM information is displayed in the **message window**.

Triangles formed = 3670
DTM created successfully. Details in .LOG file

The DTM report log opens in your default text editor.

```
-----  
DTM FORMATION                                01-Mar-11  
-----  
  
DTM formed from      : pit1.str  
DTM File             : pit1.dtm  
Object ID            : 1  
Number of Triangles  : 3670  
Maximum/Minimum E   : 1995.046 / 1424.116  
Maximum/Minimum N   : 7659.763 / 7036.983  
Maximum/Minimum Z   : 255.561 / 45.561  
Strings to act as breaklines : N  
Common point check distance : 0.005
```

4. Close the log file.
5. Open **pit1.dtm** in **Graphics**.



Note: There are triangles in the DTM that are created across strings. This result is *not* desired.

6. Choose **Surfaces > DTM File functions > Create DTM from string file**.

7. Enter the information as shown, and click **Apply**.

Create a DTM from a string file

Define the string file

Location: pit1

Object ID: 1

Object name:

Projection plane

The triangles will initially be created on a temporary 2D plane.

Create on: The XY plane

After creating the surface, change the current plane to the best-fit plane.

Define other parameters

Common point check distance: 0.0050

Strings to act as break lines

Any spot height strings

Spot height string range:

Perform break line test

Interpolate additional points

Point interpolation distance: 50

Define the boundary string to clip the DTM

Would you like to clip the DTM to a boundary after creation?

Location:

String: 1

Retain triangles inside boundary

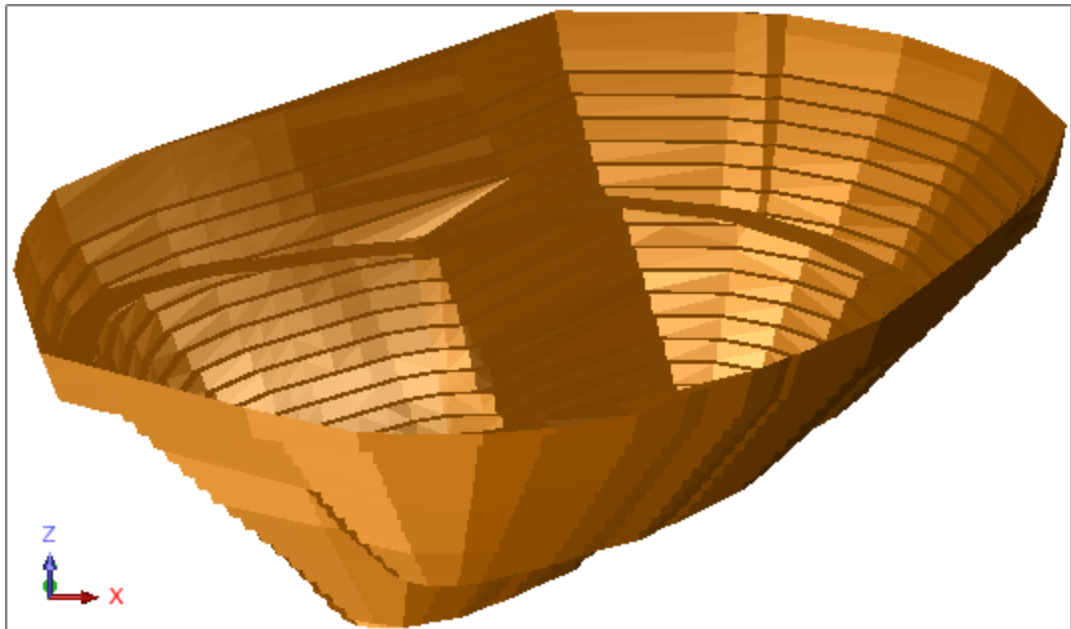
Retain triangles outside boundary


Note: The **Strings to act as break lines** check box is selected.

The DTM is created and the log file opens in your default text editor.

8. Close the log file.

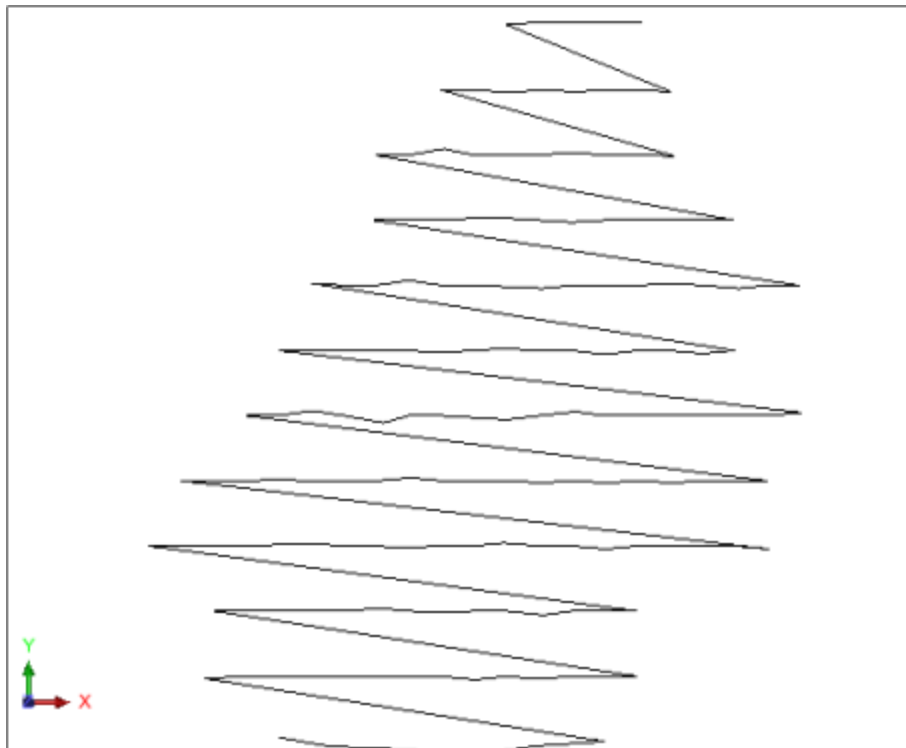
9. Open **pit1.dtm** in **Graphics**.




 **Note:** To see all of the steps performed in this task, run `_01b_create_DTM_from_string_file.tcl`. You need to click **Apply** on any forms presented.

Task: Create a DTM from spot height data

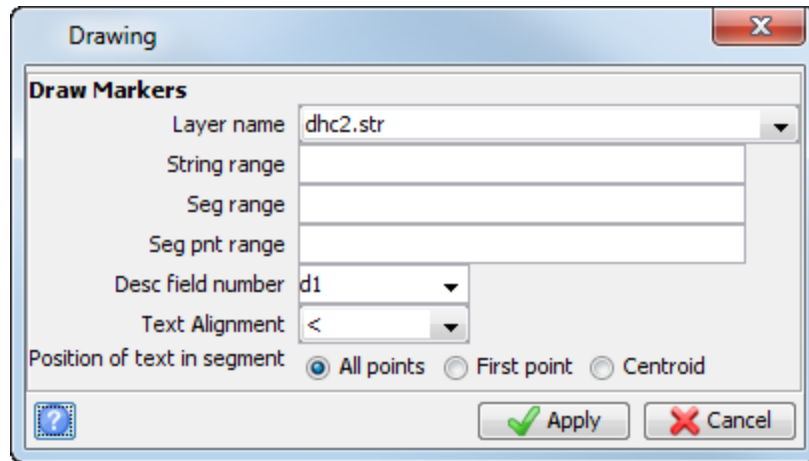
1. Click **Reset graphics** .
2. Open **dhc2.str** in **Graphics**.



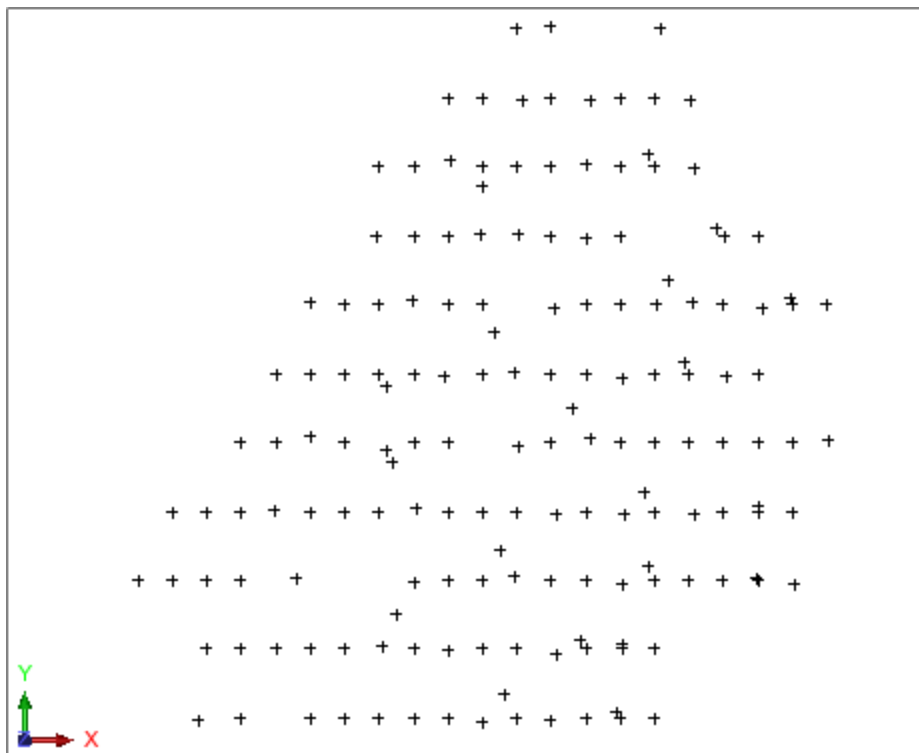
 **Note:** This file is a survey of drillhole collars before mining and can be used to model the natural surface. The file consists of one spot height string.

3. Choose **Display > Hide everything**.

4. Choose **Display > Point > Markers**.
5. Enter the information as shown, and click **Apply**.

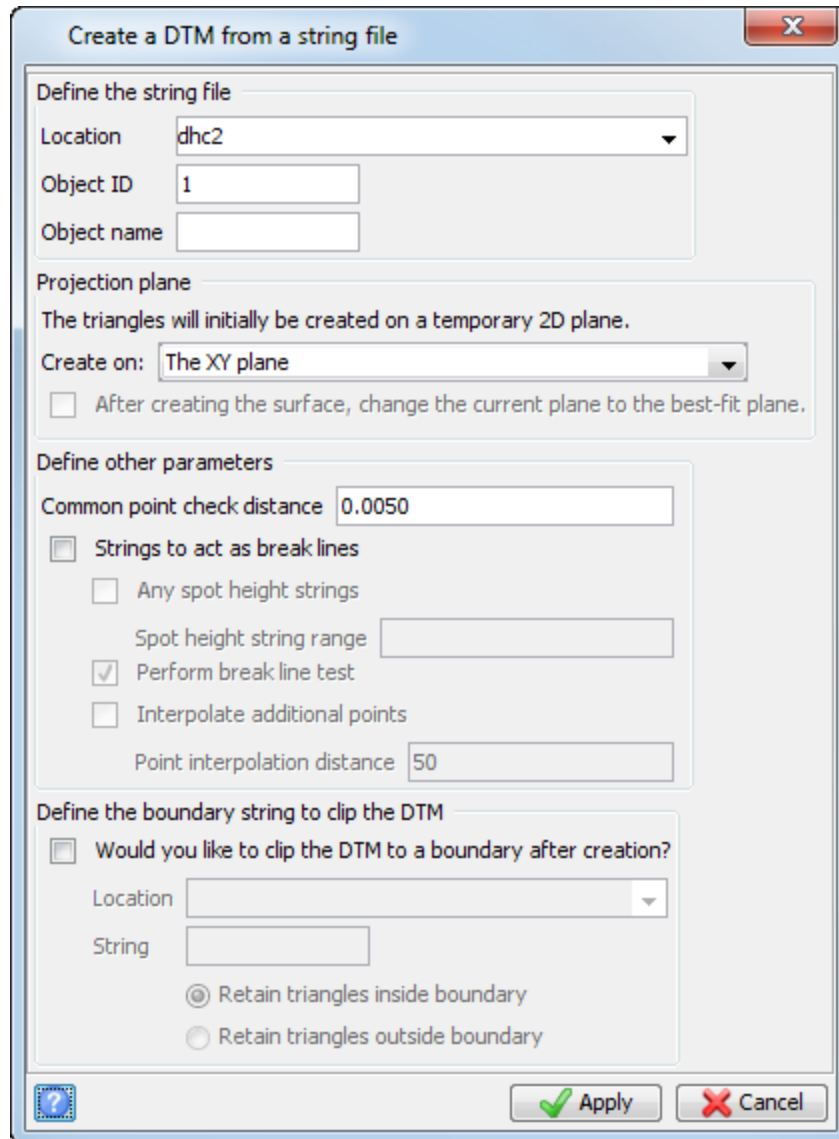


The string is displayed as markers.



6. Choose **Surfaces > DTM File functions > Create DTM from string file**.

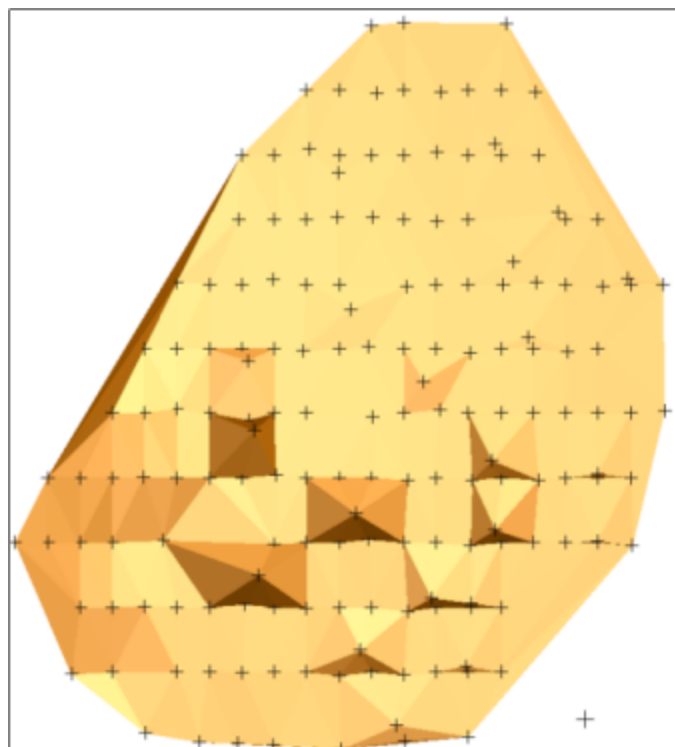
7. Enter the information as shown, and click **Apply**.



The DTM is created and the report log opens in your default text editor.

```
-----  
DTM FORMATION  
-----  
  
DTM formed from      : dhc2.str  
DTM File             : dhc2.dtm  
Object ID            : 1  
Number of Triangles  : 321  
Maximum/Minimum E   : 2732.643 / 2119.432  
Maximum/Minimum N   : 7330.425 / 6643.354  
Maximum/Minimum Z   : 1099.168 / 1045.343  
Strings to act as breaklines : N  
Common point check distance : 0.005
```


8. Close the log file.
9. Open **dhc2.dtm** in **Graphics**.
The DTM is displayed with markers.

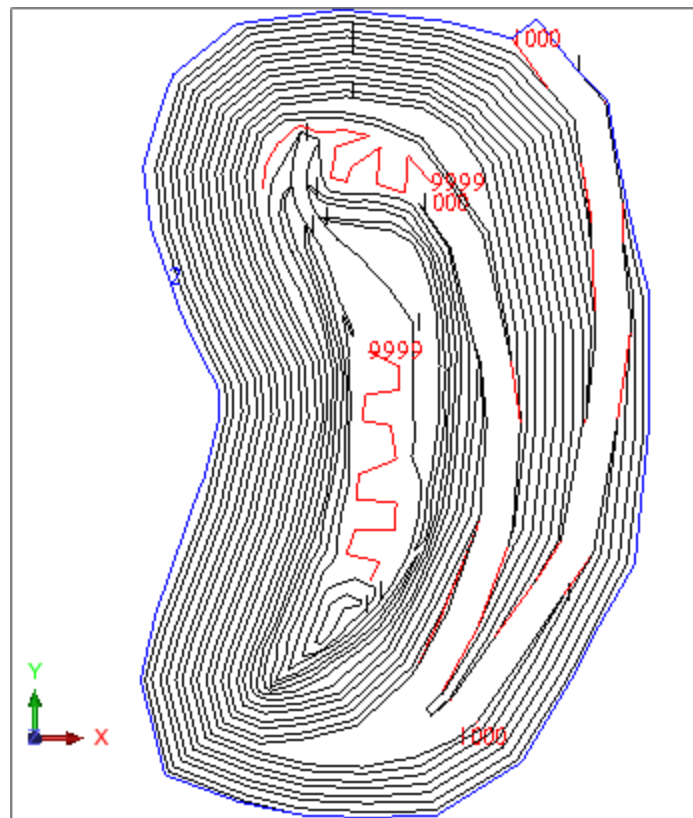
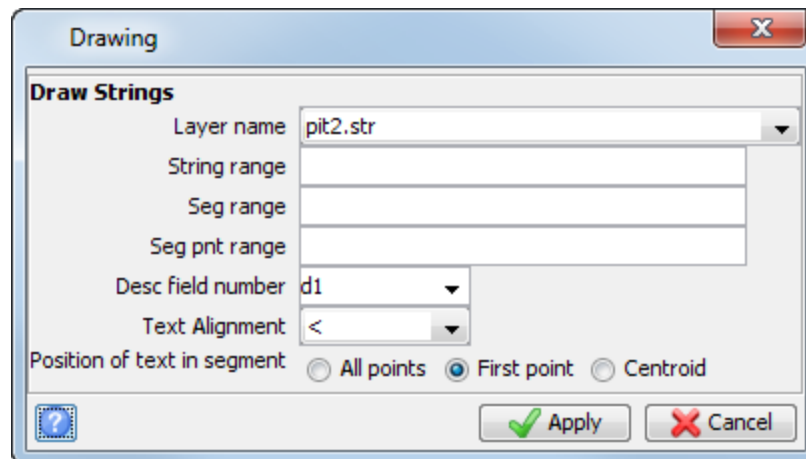



Notes:

- The default display view of a DTM is without markers.
- To see all of the steps performed in this task, run **_01c_create_dtm_from_spot_height_data.tcl**. You need to click **Apply** on any forms presented.

Task: Create a DTM using breaklines and spot heights

1. Click **Reset graphics** .
2. Open **pit2.str** in **Graphics**.
3. Choose **Display > Strings > With string numbers**.
4. Enter the information as shown, and click **Apply**.



 **Note:** You can see that string 9999 is a spot height string.

5. Choose **Surfaces > DTM File functions > Create DTM from string file**.

6. Enter the information as shown, and click **Apply**.

Create a DTM from a string file

Define the string file

Location: pit2

Object ID: 1

Object name:

Projection plane

The triangles will initially be created on a temporary 2D plane.

Create on: The XY plane

After creating the surface, change the current plane to the best-fit plane.

Define other parameters

Common point check distance: 0.0050

Strings to act as break lines

Any spot height strings

Spot height string range: 9999

Perform break line test

Interpolate additional points

Point interpolation distance: 50

Define the boundary string to clip the DTM

Would you like to clip the DTM to a boundary after creation?

Location:

String:

Retain triangles inside boundary

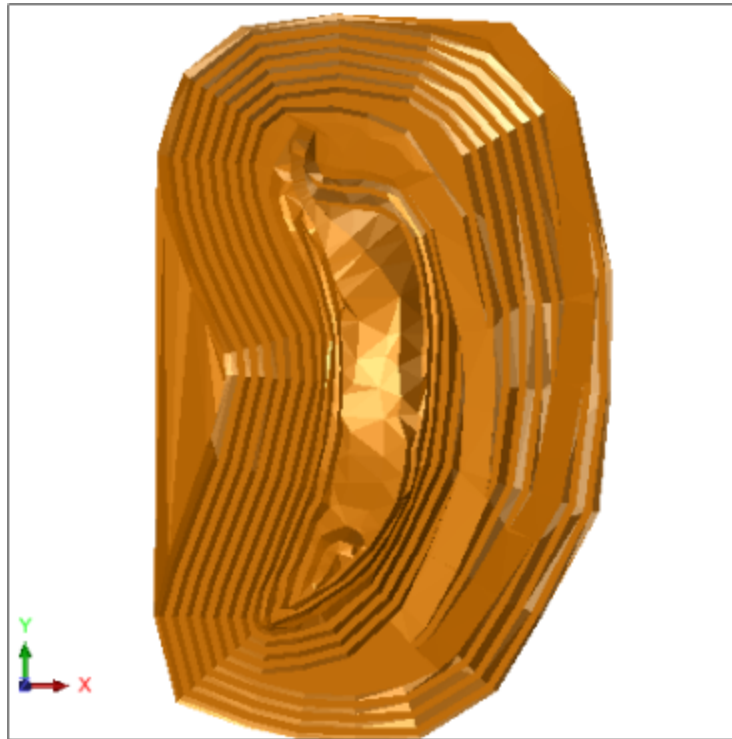
Retain triangles outside boundary

Reset graphics

Apply Cancel

7. Click **Reset graphics**.
8. Open **pit2.dtm** in **Graphics**.

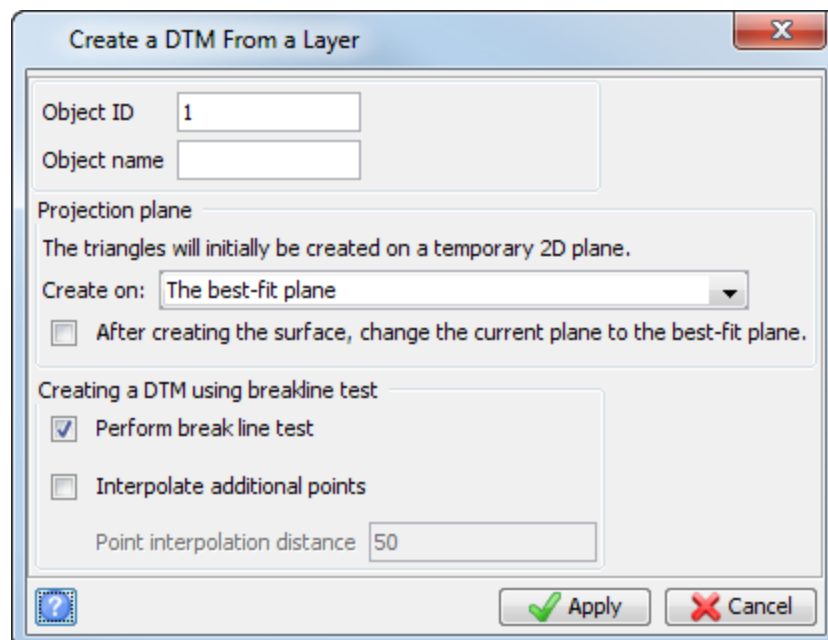
The pit is displayed in plan view.



Note: To see all of the steps performed in this task, run `_01d_create_dtm_using_breaklines_and_spot_heights.tcl`. You need to click **Apply** on any forms presented.

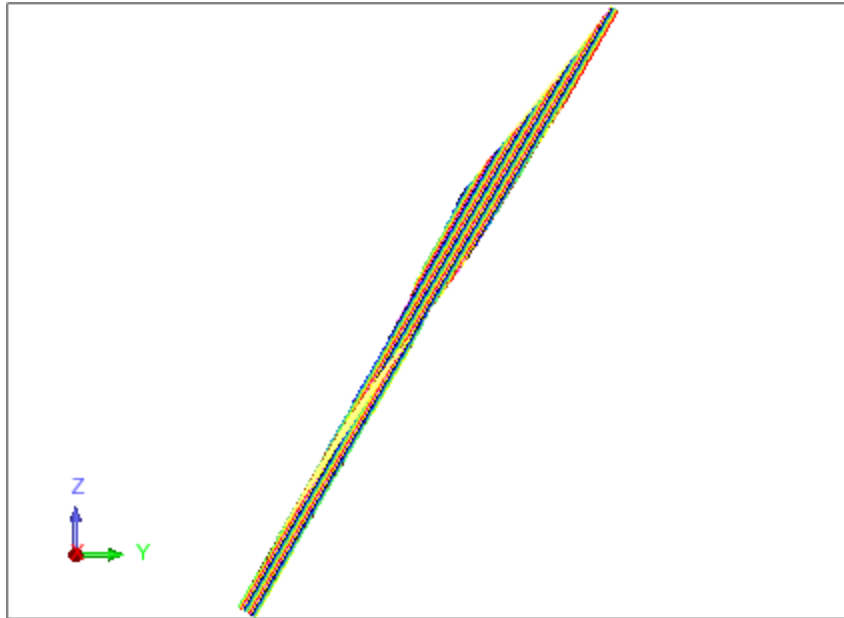
Task: Create a DTM on the plane of best-fit

1. Click **Reset graphics**.
2. Open `topo2.str`.
3. Choose **Surfaces > Create DTM from Layer**.



4. Enter the information as shown, and click **Apply**.
5. Click **Long section view**.

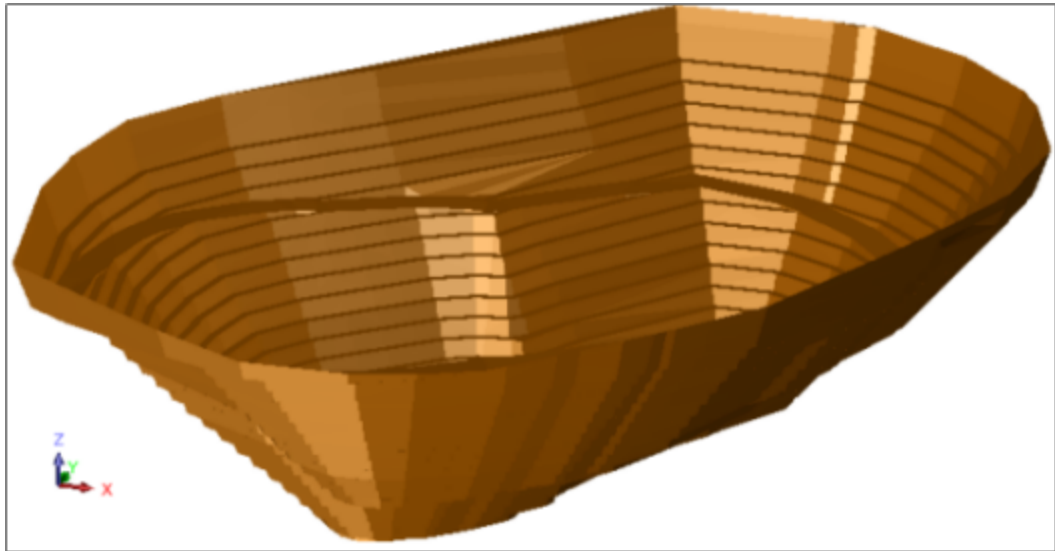
6. The DTM has been created on the best-fit plane for the data.



Viewing DTMs

Task: Colour a DTM by elevation

1. Click **Reset graphics** .
2. Open **pit1.dtm** in **Graphics**, and rotate it.
An oblique view of the pit is displayed.



3. Choose **Display > Surface or solid with colour banding**.

4. Enter the information as shown, and click **Apply**.

Surface or solid colour banding

Draw Shells

Display Properties

Layer name: pit1.dtm

Object Range: _____

Trisol Range: _____

Triangle Range: _____

Field to colour by: Z

Banding Type

none

bands of specified size

set number of bands

range for bands

using algebraic expressions

Set colour range

Size of bands: 50

Band Range: 0,300,20

Starting colour: Blue

Ending colour: Red

Number of colours: 5

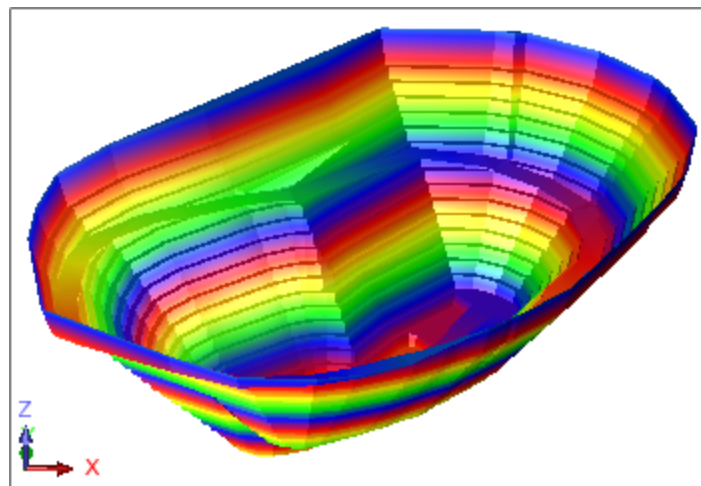
Reset colour range

Colour

1	blue
2	green
3	yellow
4	red
5	
6	
7	

Apply Cancel

The coloured pit is displayed.

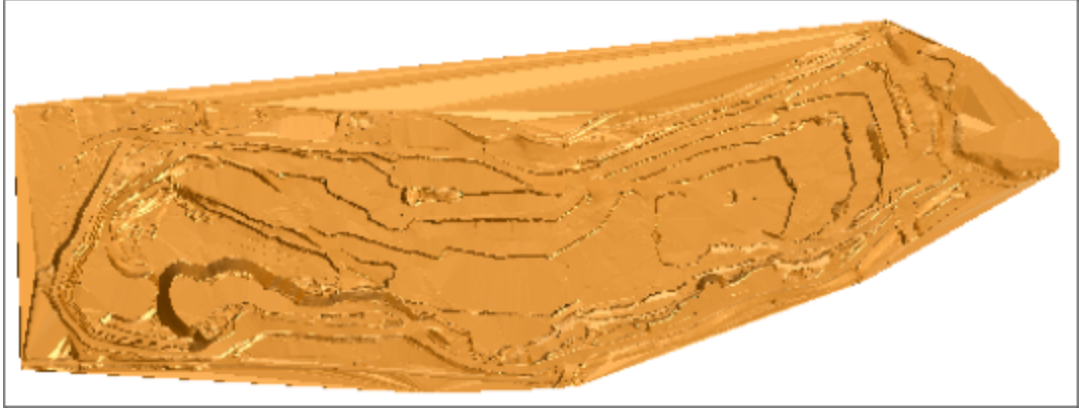


Note: To see all of the steps performed in this task, run `_02_colour_dtm_by_elevation.tcl`. You need to click **Apply** on any forms presented.

Task: Perform graphical animation

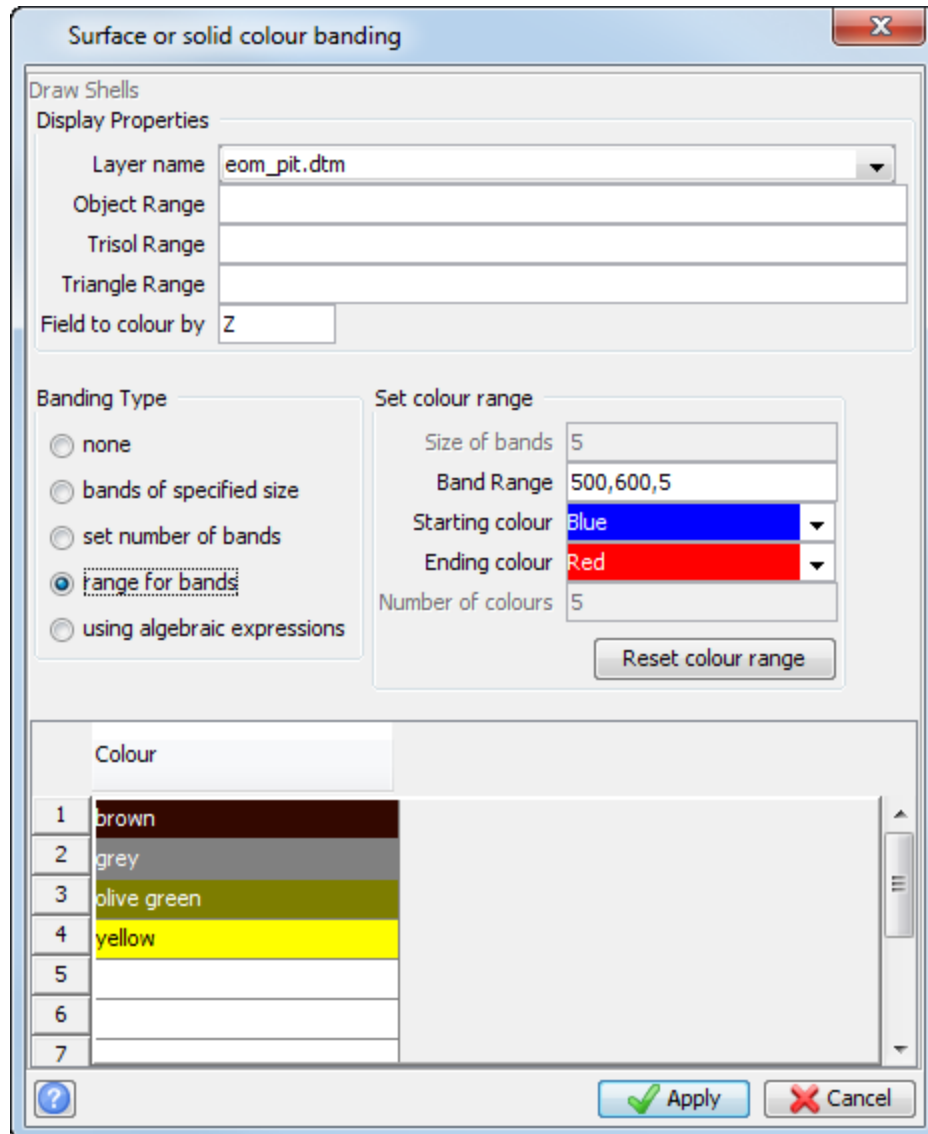
In this task, you will digitise a string to follow and use the **View along string** function to fly in the direction of the string.

1. Click **Reset graphics** .
2. Open **eom_pit.dtm** in **Graphics**.




3. Choose **Display > Surface or solid with colour banding**.

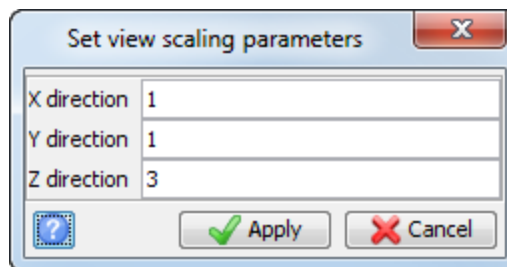
4. Enter the information as shown, and click **Apply**.



5. Choose **View > Data view options > View scale factors**.

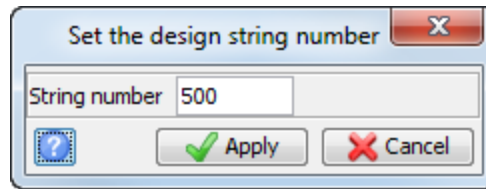
 **Tip:** To give a more realistic view, increase the Z scale by a factor of 3.

6. Enter the information as shown, and click **Apply**.



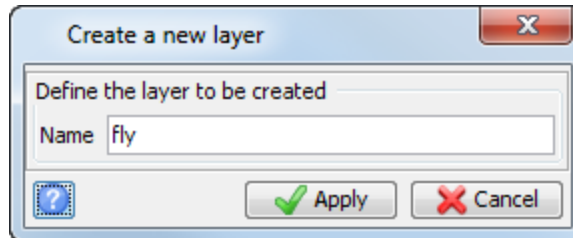
7. On the Status bar, click the **design string button** .

8. Set the **Design string number** to 500, and click **Apply**.

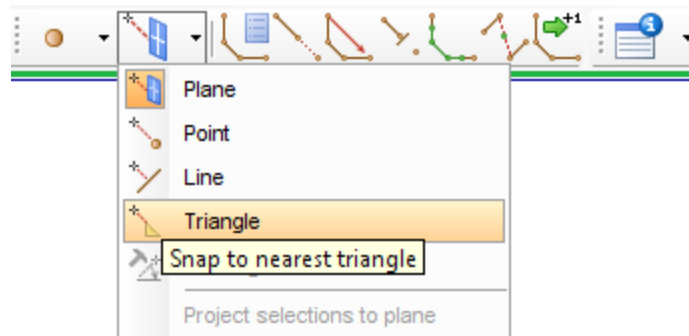



Next you will create a layer for the design string.

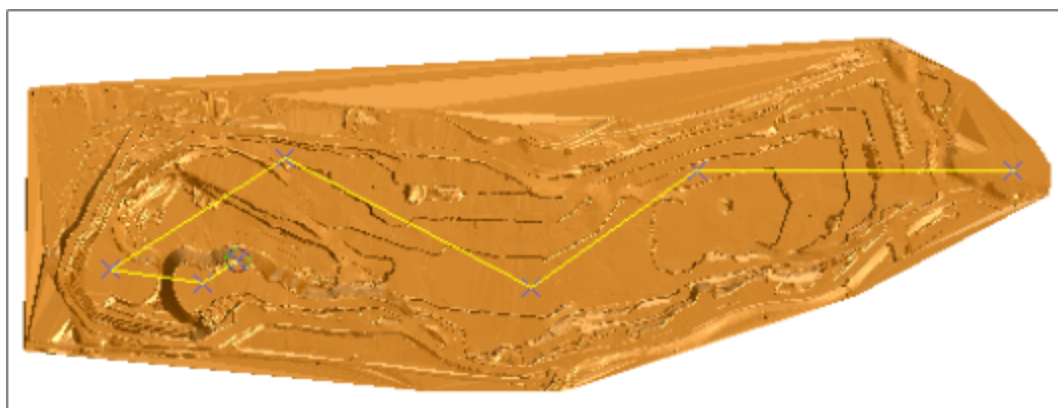
9. In the **Layers Pane**, click **New**.
10. Type **fly** as the name of the new layer, and click **Apply**.



11. Click **Snap Mode**, and select **Triangle**.

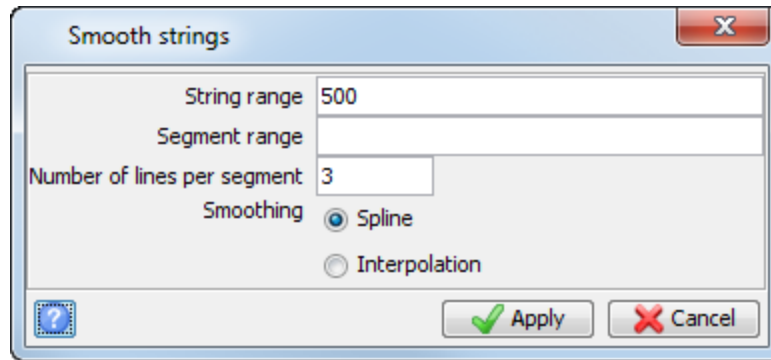


12. Click  **Digitiser Digitise**.
13. Click points for the flight path.
The flight path in the pit is displayed.

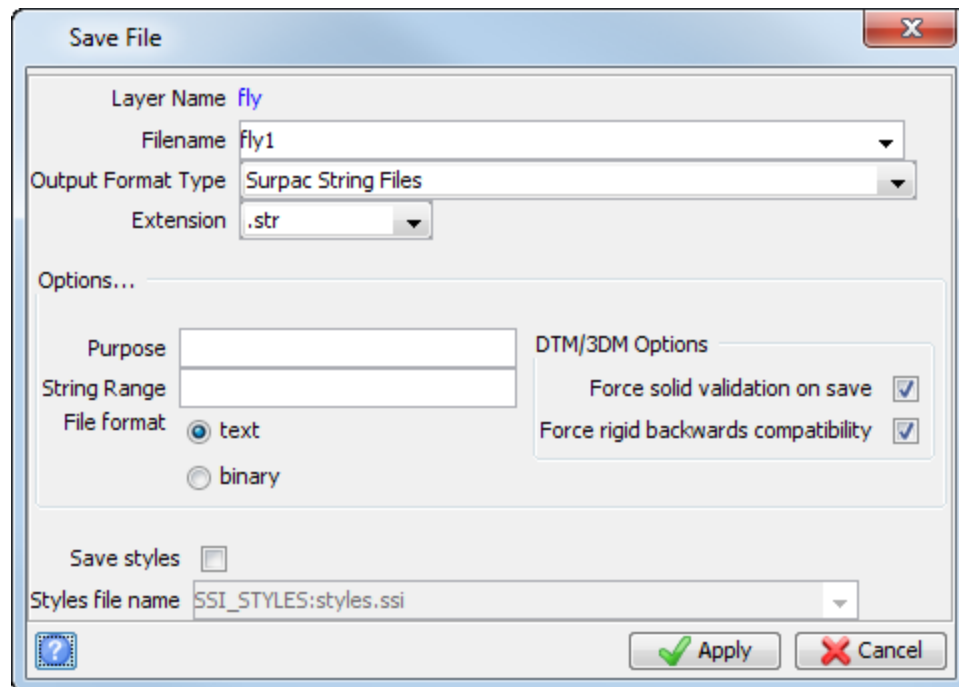


14. Press ESC.
15. Choose **Edit > String > Smooth**.

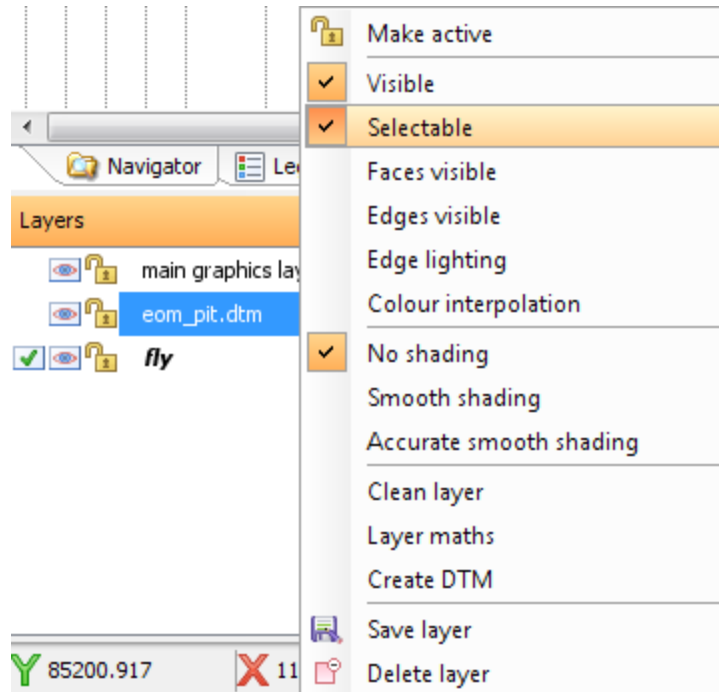
16. Enter the information as shown, and click **Apply**.




17. Save this string as **fly1.str**.

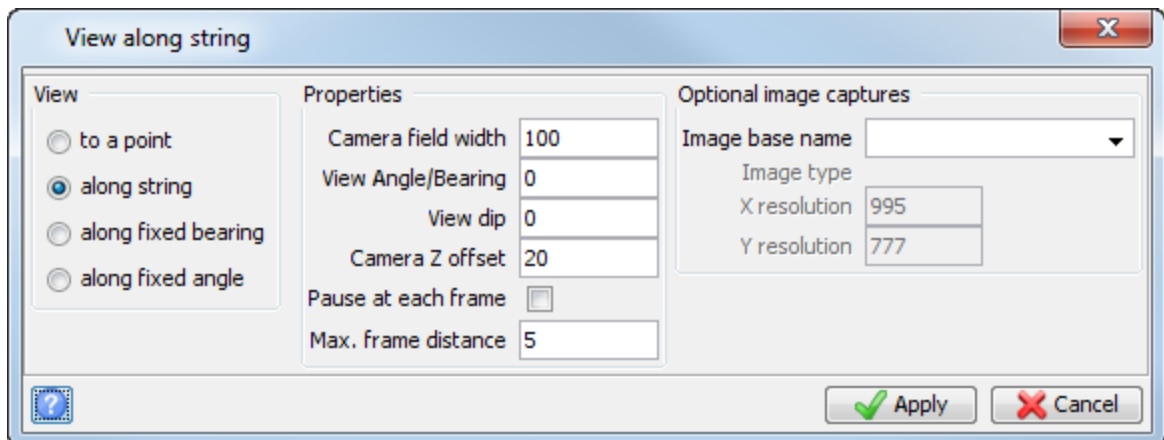


18. In the **Layers** pane, right-click the **eom_pit.dtm** layer, and click **Selectable**.



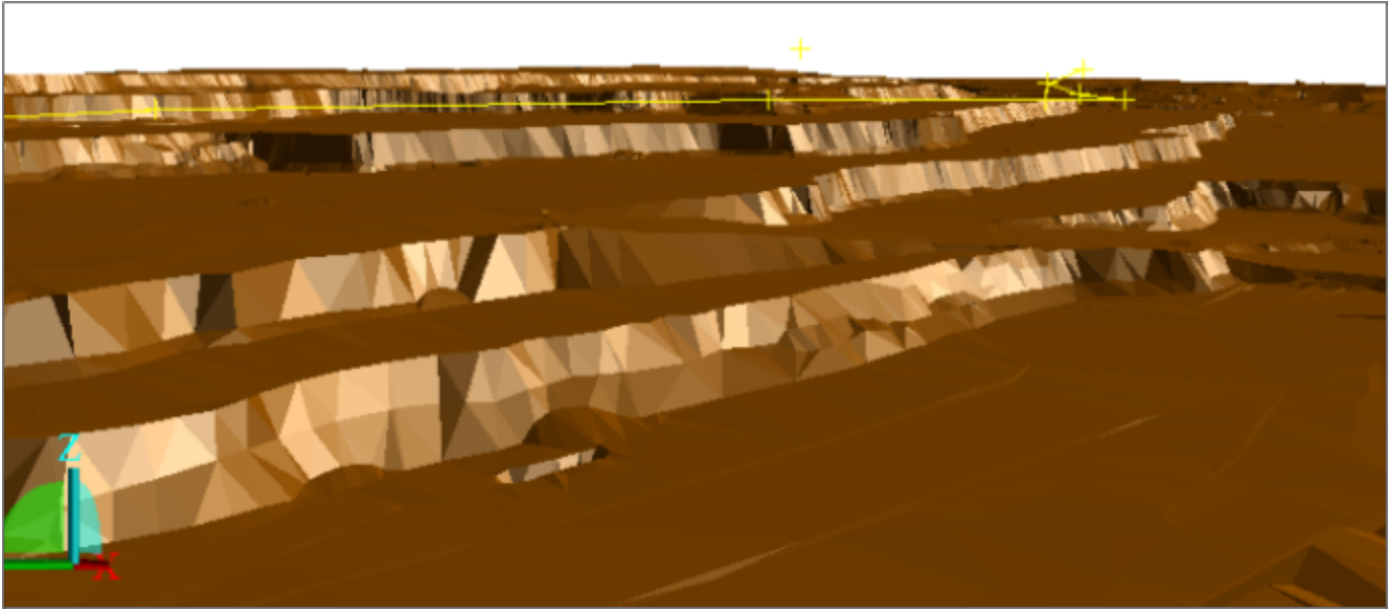
 **Note:** After you click **Selectable**, the padlock becomes closed to indicate that the layer is no longer selectable. This ensures that when you start the animation, only the string is selected and not the DTM.

19. Choose **View > Data view options > View along a string**.
 20. Enter the information as shown, and click **Apply**.




21. Click any point on string 500 to start the animation.

The inside of the pit is displayed.



Note: To see all of the steps performed in this task, run `_03a_fly_through.tcl`. You need to click **Apply** on any forms presented.

Task: Save images of a graphical animation

1. Click **Zoom All** .
2. Choose **View > Data view options > View along string**.
3. Enter the information as shown, and click **Apply**.

Note: This process produces many output files so the **Max. frame distance** has been changed to capture an image every 20 metres.


4. To start the animation, click any point on string 500.

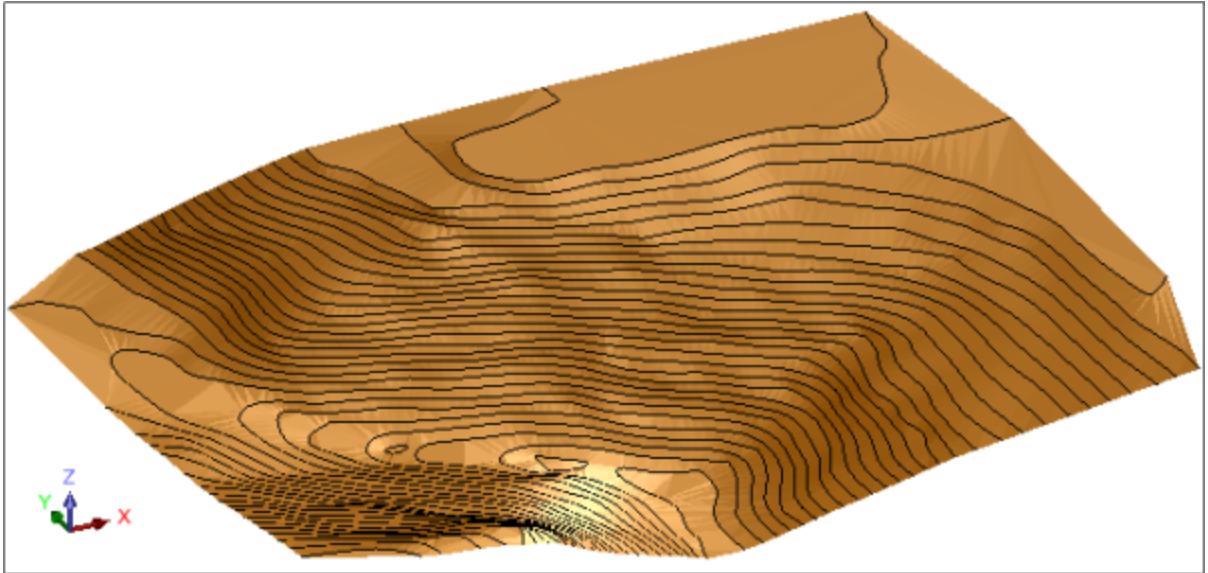
Notes:

- You can use the output files (`fly001.gif`, `fly002.gif...`) to create an animated gif file using other software.
- To see all of the steps performed in this task, run `_03b_fly_through_save_images.tcl`. You need to click **Apply** on any forms presented.

Transforming a DTM

Task: Transform a DTM to a different coordinate system

1. Click **Reset graphics** .
2. Open **topo1.dtm** in **Graphics**.
topo1 is displayed.



3. Open **pit2.dtm** in **Graphics**.
4. Click **Zoom to extents**.
Both the DTM surfaces are displayed.



5. Choose **File tools > Transformations > 2D Transformation of DTM file**.

6. Enter the information as shown, and click **Apply**.

This creates a new dtm called **transformed_pit**.

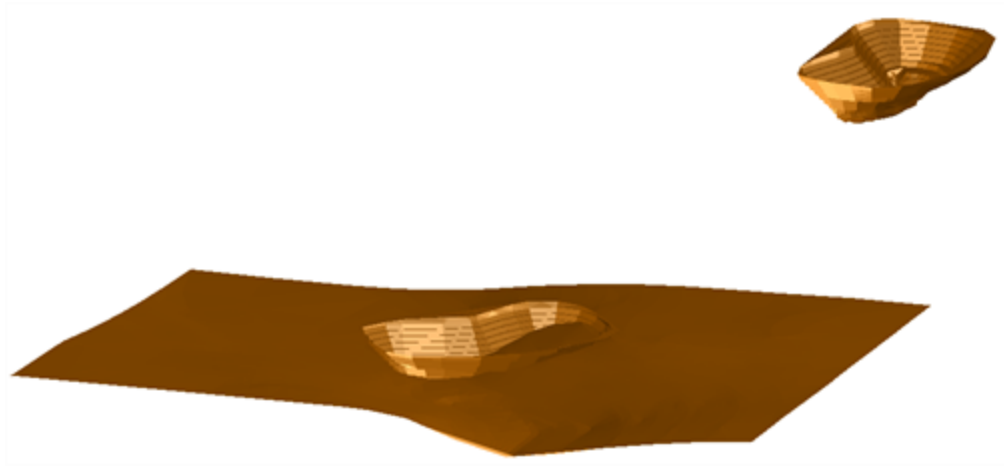
- **Old points** are the coordinates in the old system. **New points** are the coordinates of the same two points in the new system.
 - A Z correction of -800 is applied to move the pit 800 metres lower.
7. Verify that the transformation parameters are correct on the *Verify transformation parameters* form.


Scale	0.999999838
Rotation	45.0000
Shift Y	413.474
Shift X	-891.119

If the grids are plane metric grids, the scale factor should be 1.0. Any variation represents an error. In the example, there is an error of 5 mm in 10 m.

Note: By default, the rotation is displayed in DDD.MMSS format. **Shift Y** is the difference between Y1 (old) and Y1 (new) as entered on the *Transform Coordinates of Triangles (2d)* form. **Shift X** is the difference between X1 (old) and X1 (new). In other words, the shifts are the difference in Nothing and Easting between the coordinates of the first point in the two systems.

8. Select the **Accept these adjustments** check box, and click **Apply**.

9. Open **transformed_pit2.dtm**.

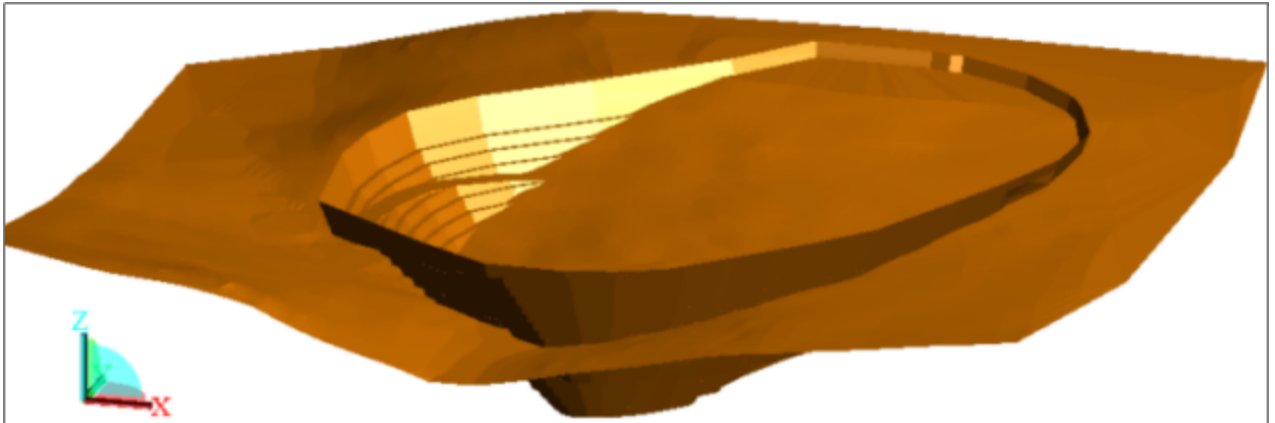
 **Note:** To see all of the steps performed in this task, run **_04_transform_DTM.tcl**. You need to click **Apply** on any forms presented.

DTM volume calculations

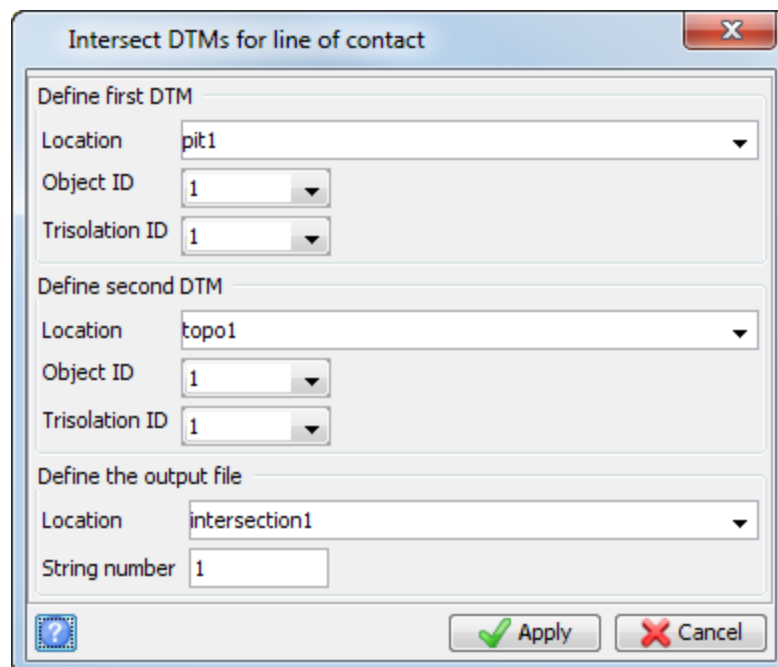
Task: Create a boundary string using the file-based method

In this case, you will display the DTMs only for clarity.

1. Click **Reset graphics** .
2. Open **pit1.dtm** and **topo1.dtm** in **Graphics**.
The pit with topography is displayed.

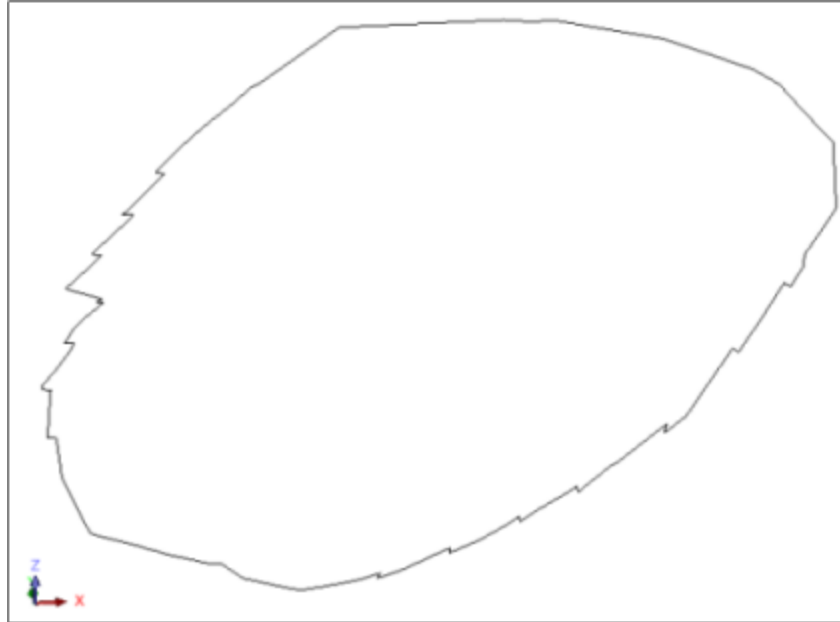



3. Choose **Surfaces > DTM File functions > Line of intersection between 2 DTMs**.
4. Enter the information as shown, and click **Apply**.



5. Open **intersection1.str**.


- Click **Faces Off** . The boundary string is displayed.

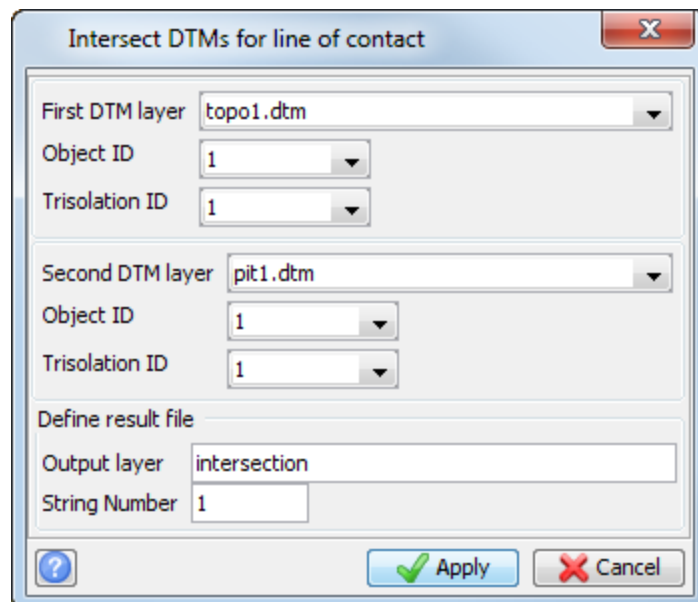



 **Note:** To see all of the steps performed in this task run `_04a_create_boundary_string_file_based.tcl`. You need to click **Apply** on any forms presented.

Task: Create a boundary string using the graphics-based method

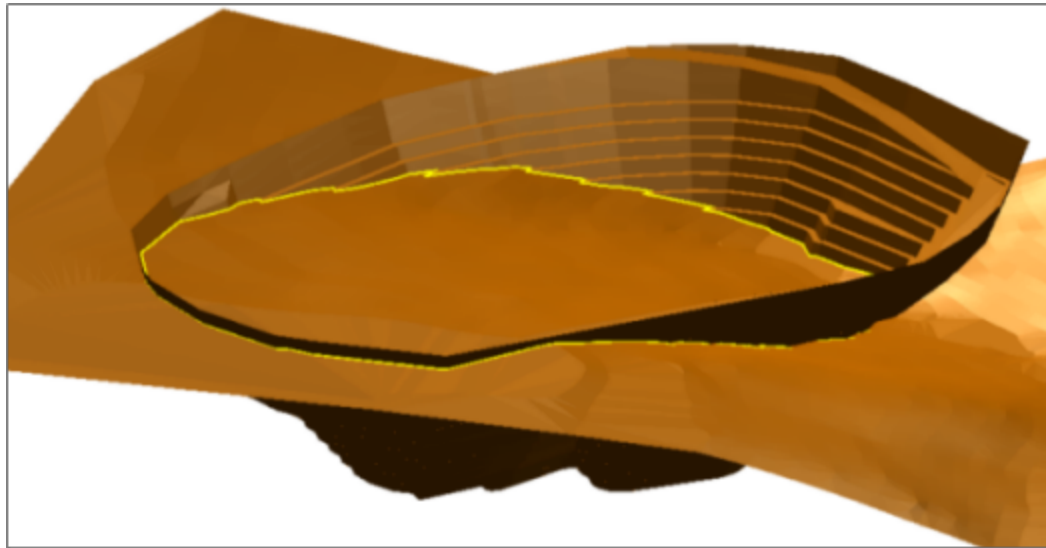
In this case, the DTMs **must** be displayed in **Graphics** because the function uses graphics layers to determine its input and output.


- Click **Reset graphics** .
- Open `topo1.dtm` and `pit1.dtm` in **Graphics**.
- Choose **Surfaces > Clip or intersect DTMs > Line of intersection between DTMs**.
- Enter the information as shown, and click **Apply**.



 **Note:** In the graphics-based method, you must save the string in the intersection layer to a string file if you want to use it for further processing.


The pit intersection line is displayed.




 **Note:** To see all of the steps performed in this task, run `_04b_create_boundary_string_graphics_based.tcl`. You need to click **Apply** on any forms presented.

Calculate the volume between two DTMs

Task: Calculate cut and fill volumes

 **Note:** In order to perform this task, the file `intersection1.str` must exist. If it does not exist, run macro `_04a_create_boundary_string_file_based.tcl`.

1. Click **Reset graphics** .
2. Choose **Surfaces > Volumes > Cut and fill between DTMs**.
3. Enter the information as shown, and click **Apply**.

DTM cut and fill volumes ✕

<p>Define the first DTM</p> <p>Location: <input type="text" value="topo1"/></p> <p>Object ID: <input type="text" value="1"/></p> <p>Trisolation ID: <input type="text" value="1"/></p> <p>Define the second DTM</p> <p>Location: <input type="text" value="pit1"/></p> <p>Object ID: <input type="text" value="1"/></p> <p>Trisolation ID: <input type="text" value="1"/></p> <p>Define the volume boundary string</p> <p>Location: <input type="text" value="intersection1"/></p> <p>Boundary string: <input type="text" value="1"/></p>	<p>Define the file for the cut and fill boundary</p> <p>Location: <input type="text" value="cfill_volume"/></p> <p>ID number: <input type="text" value="1"/></p> <p>Fill string: <input type="text" value="2"/></p> <p>Cut string: <input type="text" value="3"/></p> <p>Boundary string: <input type="text" value="1"/></p> <p>Define reporting options</p> <p>Decimals: <input type="text" value="2"/></p> <p>Density: <input type="text" value="2.000"/></p> <p>Report format: <input type="text" value=".not"/></p> <p><input checked="" type="checkbox"/> Detailed report</p> <p><input checked="" type="checkbox"/> Report by elevation</p> <p>Range: <input type="text" value="40,260,10"/></p>
--	--

The DTM cut and fill report opens in your default text editor.

DTM CUT AND FILL VOLUME REPORT

```


First DTM: topol.dtm
Second DTM: pit1.dtm
Upper DTM object ID: 1
Upper DTM trisolation ID: 1
Lower DTM object ID: 1
Lower DTM trisolation ID: 1

Boundary file: intersection1.str
Boundary string: 1
Number of segments: 1
Density: 2.000
Elevation range: 40,260,10

DTM Extents
-----
X Minimum X Maximum Y Minimum Y Maximum Z Minimum Z Maximum
Topol.dtm 600.000 2100.000 6999.891 8000.000 158.000 250.000
Pit1.dtm 1424.116 1995.046 7036.983 7659.763 45.561 255.561

Volumes
-----
Cut Vol  Cut Area  Fill Vol  Fill Area  Nett Vol  Nett Tonnage  Common Area
12808357.26 182470.43 0.00 0.38 -12808357.26 -25616714.52 0.00

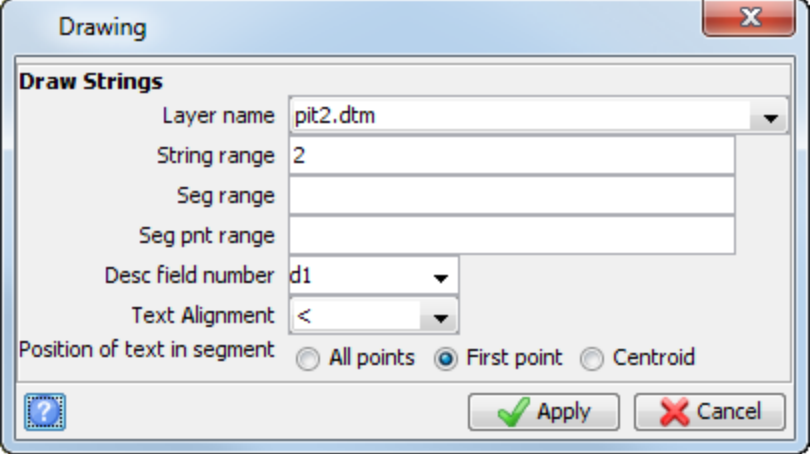
Total Volumes By Elevation
-----
From To Cut Vol Avg. Cut Area Fill Vol Avg. Fill Area Nett Vol Nett Tonnage Common Area Cum Cut Vol Cum Fill Vol
Cum Nett Vol Cum Nett Tonnage
-----
40.0 50.0 21064.27 2106.43 0.00 0.00 -21064.27 -42128.54 0.00 21064.27 0.00
-21064.27 -42128.54
50.0 60.0 72141.14 7214.11 0.00 0.00 -72141.14 -144282.27 0.00 93205.41 0.00
-93205.41 -186410.82
60.0 70.0 124036.02 12403.60 0.00 0.00 -124036.02 -248072.04 0.00 217241.43 0.00
-217241.43 -434482.86
70.0 80.0 198816.10 19881.61 0.00 0.00 -198816.10 -397632.19 0.00 416057.53 0.00
-416057.53 -832115.05
80.0 90.0 292340.87 29234.09 0.00 0.00 -292340.87 -584681.74 0.00 708398.39 0.00
-708398.39 -1416796.79
90.0 100.0 391116.16 39111.62 0.00 0.00 -391116.16 -782232.33 0.00 1099514.56 0.00
-1099514.56 -2199029.12
100.0 110.0 490252.08 49025.21 0.00 0.00 -490252.08 -980504.16 0.00 1589766.64 0.00
-1589766.64 -3179533.28
110.0 120.0 599929.58 59992.96 0.00 0.00 -599929.58 -1199859.15 0.00 2189696.22 0.00
-2189696.22 -4379392.43
120.0 130.0 718478.07 71847.81 0.00 0.00 -718478.07 -1436956.15 0.00 2908174.29 0.00
-2908174.29 -5816348.58
130.0 140.0 838382.14 83838.21 0.00 0.00 -838382.14 -1676764.28 0.00 3746556.43 0.00
-3746556.43 -7493112.86
140.0 150.0 963199.74 96319.97 0.00 0.00 -963199.74 -1926399.48 0.00 4709756.17 0.00
-4709756.17 -9419512.34
150.0 160.0 1089504.79 108950.48 0.00 0.00 -1089504.79 -2179009.58 0.00 5799260.96 0.00
-5799260.96 -11598521.92
160.0 170.0 1107446.54 110744.65 0.00 0.00 -1107446.54 -2214893.09 0.00 6906707.50 0.00
-6906707.50 -13813415.00
170.0 180.0 1067956.57 106795.66 0.00 0.00 -1067956.57 -2135913.15 0.00 7974664.08 0.00
-7974664.08 -15949328.15
180.0 190.0 1046641.35 104664.13 0.00 0.00 -1046641.35 -2093282.69 0.00 9021305.42 0.00
-9021305.42 -18042610.85
190.0 200.0 999180.69 99918.07 0.00 0.00 -999180.69 -1998361.38 0.00 10020486.11 0.00
-10020486.11 -20040972.22
200.0 210.0 900886.34 90088.63 0.00 0.00 -900886.34 -1801772.69 0.00 10921372.45 0.00
-10921372.45 -21842744.91
210.0 220.0 784620.81 78462.08 0.00 0.00 -784620.81 -1569241.62 0.00 11705993.27 0.00
-11705993.27 -23411986.53
220.0 230.0 640071.65 64007.17 0.00 0.00 -640071.65 -1280143.30 0.00 12346064.92 0.00
-12346064.92 -24692129.83
230.0 240.0 383659.90 38365.99 0.00 0.00 -383659.90 -767319.79 0.00 12729724.81 0.00
-12729724.81 -25459449.62
240.0 250.0 76410.63 7641.06 0.00 0.00 -76410.63 -152821.26 0.00 12806135.44 0.00
-12806135.44 -25612270.88
250.0 260.0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 12806135.44 0.00
-12806135.44 -25612270.88
Total 12,806,135.44 0.00 -12,806,135.44 -25,612,270.88
    
```

 **Note:** To see all of the steps performed in this task, run `_05a_cut_and_fill_volumes.tcl`. You need to click **Apply** on any forms presented.

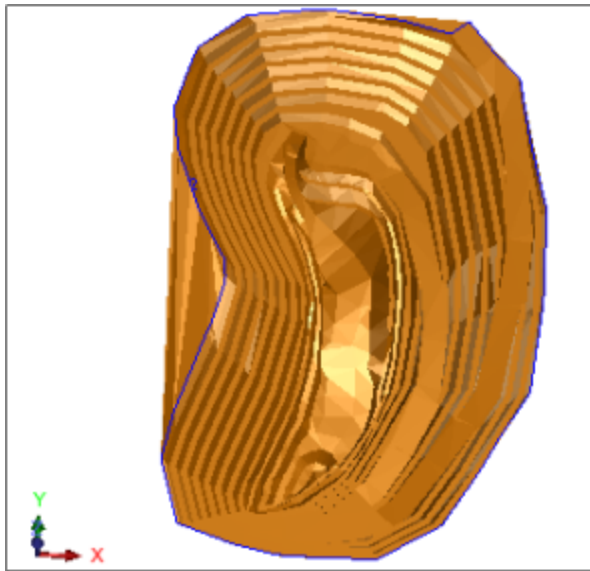
Task: Net volume between DTMs


1. Open `pit2.dtm` in **Graphics**.
2. Choose **Display > Strings > With string numbers**.

3. Enter the information as shown, and click **Apply**.



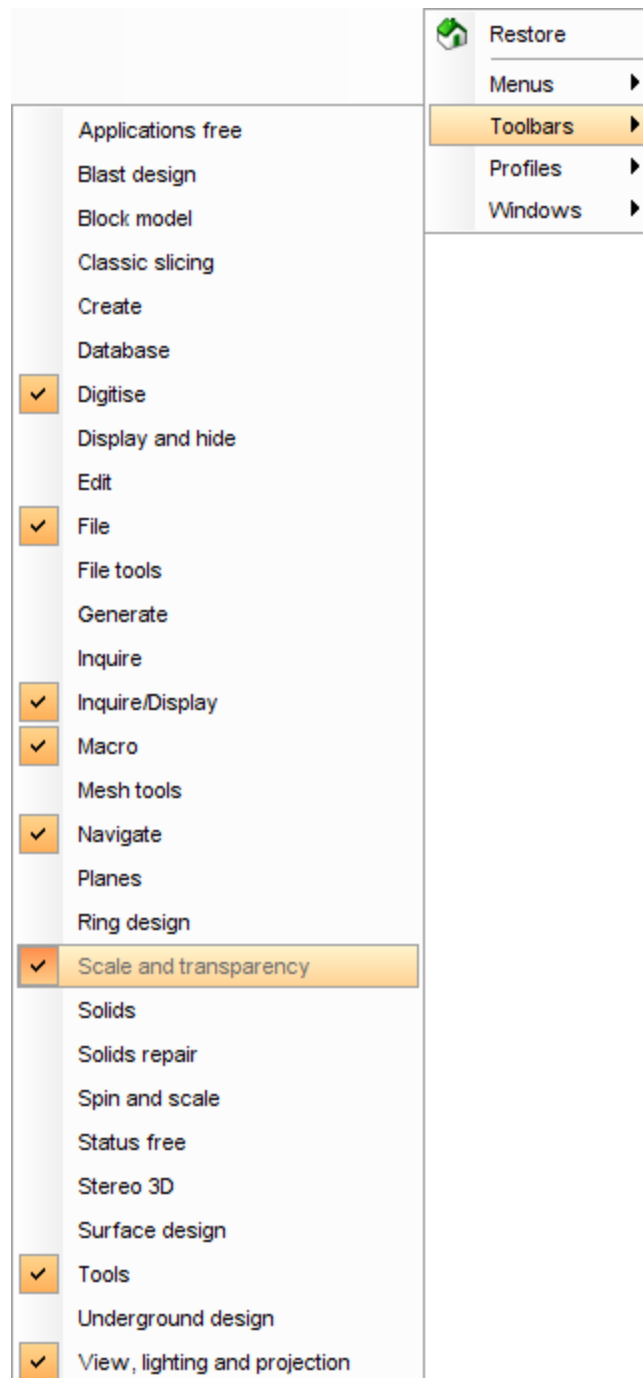
The plan view of the pit is displayed.



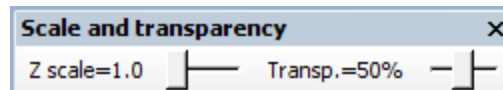
 **Note:** String 2 of **pit2.str** is used as the boundary string for the volume calculation.

4. Open **dhc2.dtm** in **Graphics**.

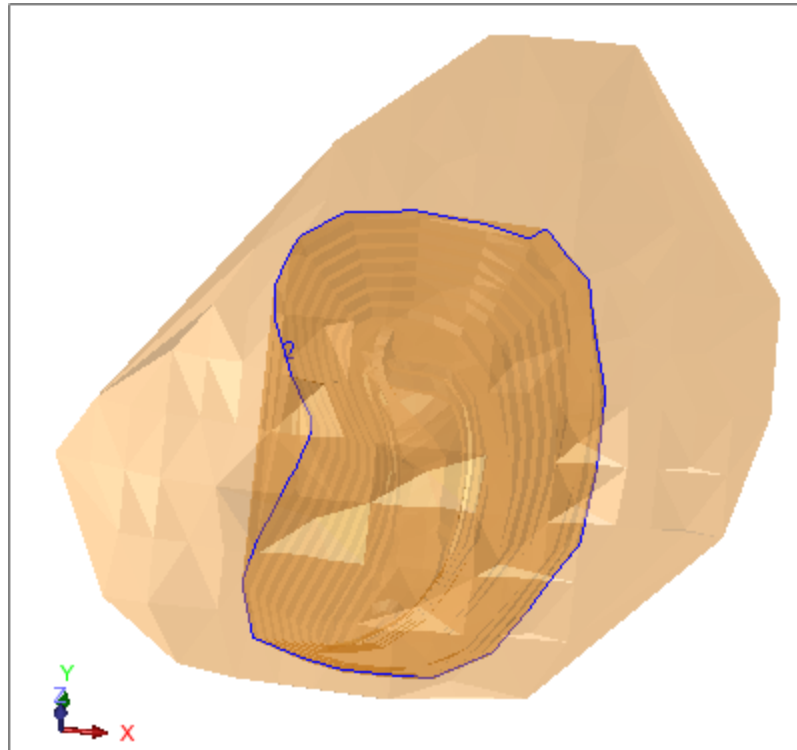
5. Right-click in the area next to the menu titles, select **Toolbars**, and click **Scale and transparency**.



6. Drag the transparency slider to set the transparency of triangles to 50%.



The DTM displayed is transparent.



7. Choose **Surfaces > Volumes > Net volume between DTMs**.
8. Enter the information as shown, and click **Apply**.

Surface to surface DTM volumes

Number of DTMs for volume An upper surface DTM only
 Upper and lower DTM surfaces

Define first DTM with object and trisolation

Location:

Object ID:

Trisolation ID:

Define second DTM with object and trisolation

Location:

Object ID:

Trisolation ID:

Define the boundary string

Use a boundary string

Location:

String number:

Quality parameters for volume calculations

Do not use any quality parameters
 Use 1 quality parameter
 Use 2 quality parameters

Define reporting parameters

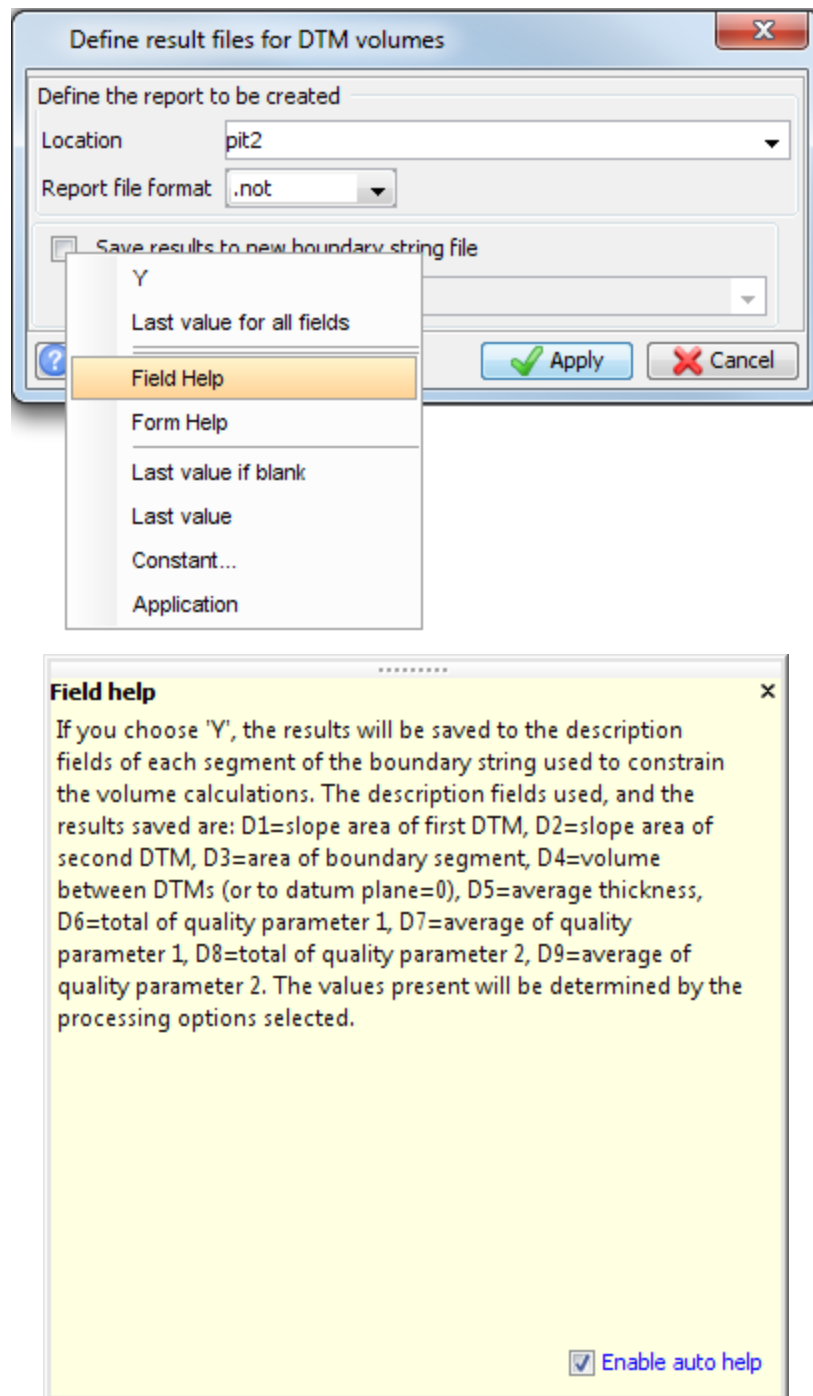
Decimals:


Density:

Detailed report
 Report by elevation

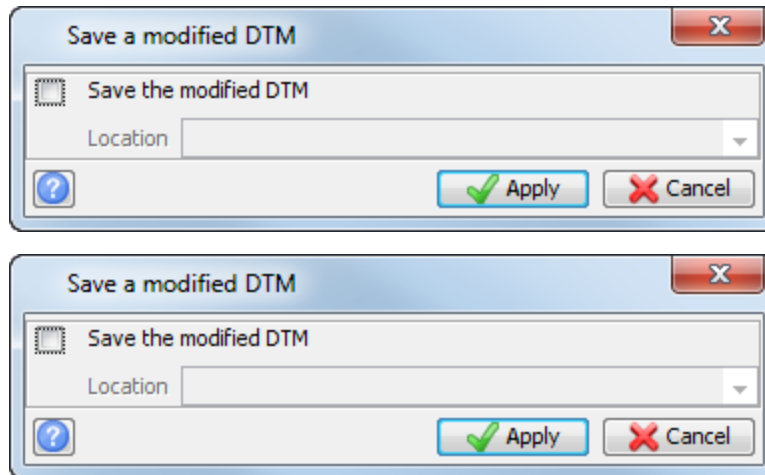
Range:

9. Click, then right-click the **Save results to new boundary string file** check box as shown, and select **Field Help**.



10. Close **Field help**.
 11. Select the **Save results to new boundary string file** check box, and type "bdyres2" in the **Location** field.
 12. Click **Apply**.
Next you are prompted to save the triangles from each DTM that the boundary string clips.
-  **Note:** It is not necessary to save the modified DTMs.

13. Leave the next two forms blank, and click **Apply** on both.



The DTM surfaces report log **pit2.not** opens in your default text editor.

```

VOLUME BETWEEN DTM SURFACES

Upper surface: dhc2.dtm
Upper surface object ID: 1
Upper surface trisolation ID: 1
Lower surface: pit2.dtm
Lower surface object ID: 1
Lower surface trisolation ID: 1

Boundary file: pit2.str
Boundary string: 2
Number of segments: 1
Density: 2
Elevation range: 940,1070,10

Segment Number 1 of 1
Density: 2.000
Surface to surface volume: 5943396.06
Nett Tonnage: 11886792.12
Boundary string horizontal area check: 116184.86
Total surface area: 301400.90
DTM Summary

```

	Upper Surface	Lower Surface
Purpose	Drill hole collars	
Dtm File	dhc2.dtm	pit2.dtm
Number OF Data Points	174	915
Number OF Triangles	241	1791
Z Datum	940.00	940.00
Z Min	1048.94	944.37
Z Max	1075.60	1062.01
Volume To Datum	13374476.54	7431080.49
Surface Area OF Dtm Triangles	118468.94	182931.96
Horizontal Area	116184.86	116184.86
Segment Number	1	1

```

Warning: The elevation range does not encompass the Z extents.
Total Volumes By Elevation

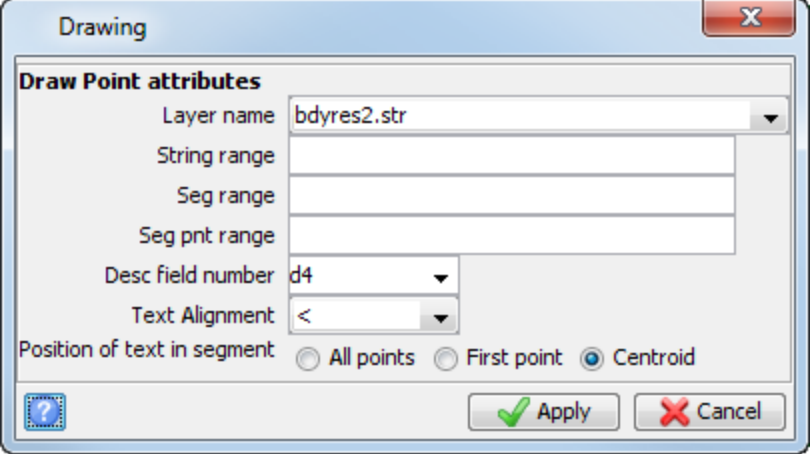
```

From	To	Volume	Avg. Horizontal Area	Surface Area	Cumulative Volume
940.0	950.0	3598.70	359.87	2669.77	3598.70
950.0	960.0	106830.78	10683.08	15015.11	110429.48
960.0	970.0	166551.95	16655.19	8729.95	276981.43
970.0	980.0	217579.31	21757.93	11391.76	494560.74
980.0	990.0	327430.40	32743.04	17527.21	821991.14
990.0	1000.0	440430.96	44043.10	17877.31	1262422.10
1000.0	1010.0	550959.80	55095.98	17972.70	1813381.90
1010.0	1020.0	690190.97	69019.10	21263.73	2503572.87
1020.0	1030.0	817564.61	81756.46	20501.00	3321137.48
1030.0	1040.0	952142.43	95214.24	21612.00	4273279.91
1040.0	1050.0	1087760.20	108776.02	25797.22	5361040.11
1050.0	1060.0	538089.47	53808.95	108565.11	5899129.58
1060.0	1070.0	42889.78	4288.98	11507.09	5942019.36
Total		5,942,019.36			

Page 1 of 1

14. Close **pit2.not**.
15. Click **Reset graphics** .
16. Open **bdyres2.str** in **Graphics**.
17. Choose **Display > Point > Attributes**.

18. Enter the information as shown, and click **Apply**.

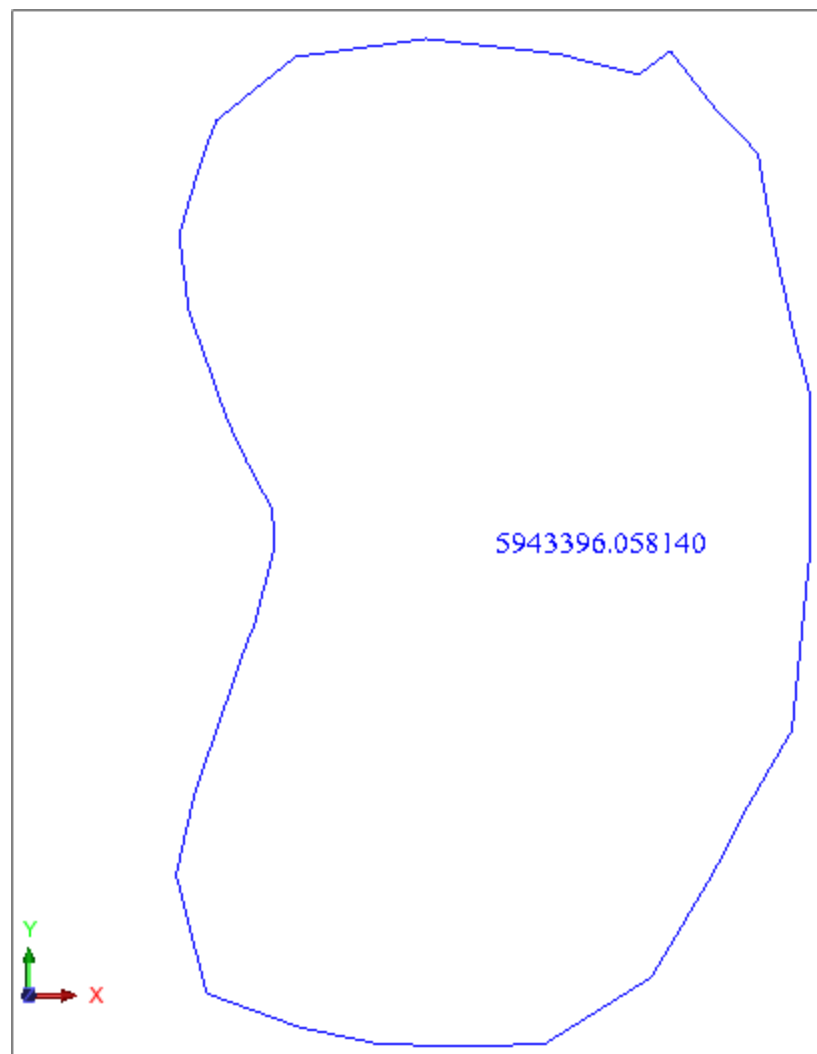


The image shows a 'Drawing' dialog box with the following settings:

- Layer name: bdyres2.str
- String range: (empty)
- Seg range: (empty)
- Seg pnt range: (empty)
- Desc field number: d4
- Text Alignment: <
- Position of text in segment: All points First point Centroid

Buttons: ? (help), Apply (green checkmark), Cancel (red X).


The boundary string is displayed.

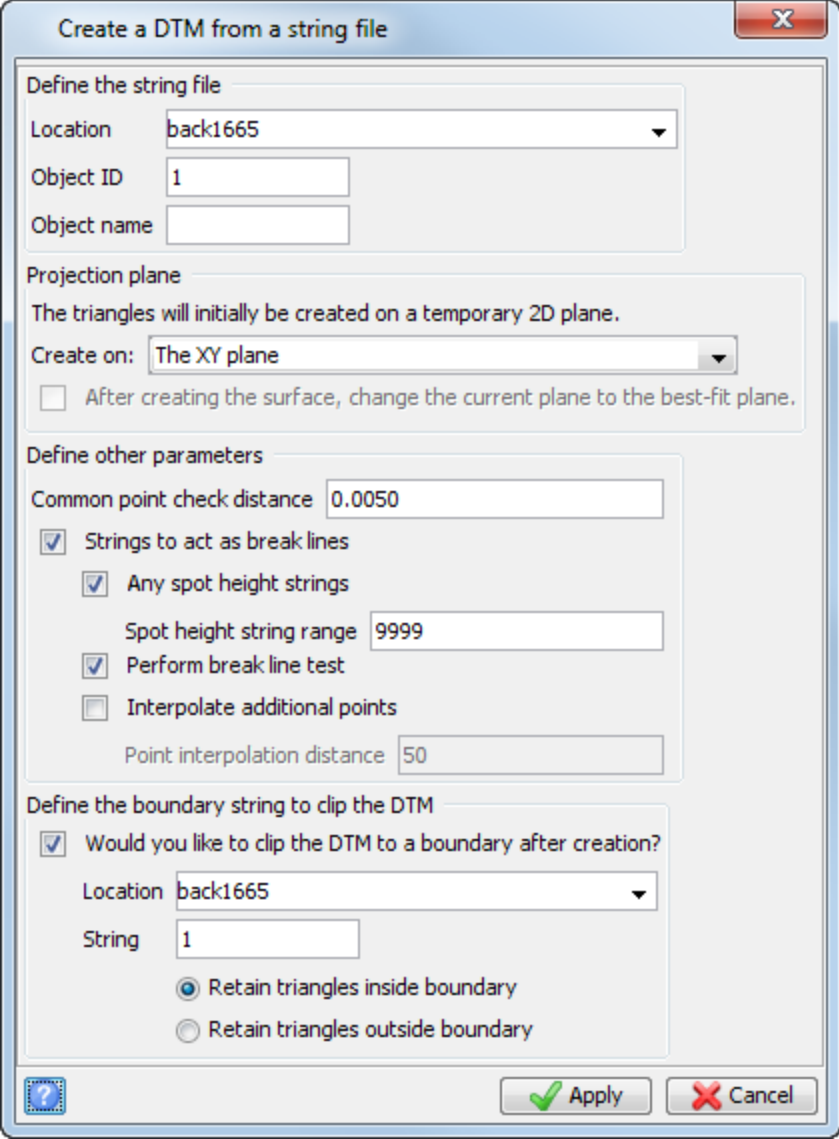



Note: To see all of the steps performed in this task, run `_05b_net_volumes_between_dtms.tcl`. You need to click **Apply** on any forms presented.

Clipping a DTM

Task: Clip a DTM – file-based method

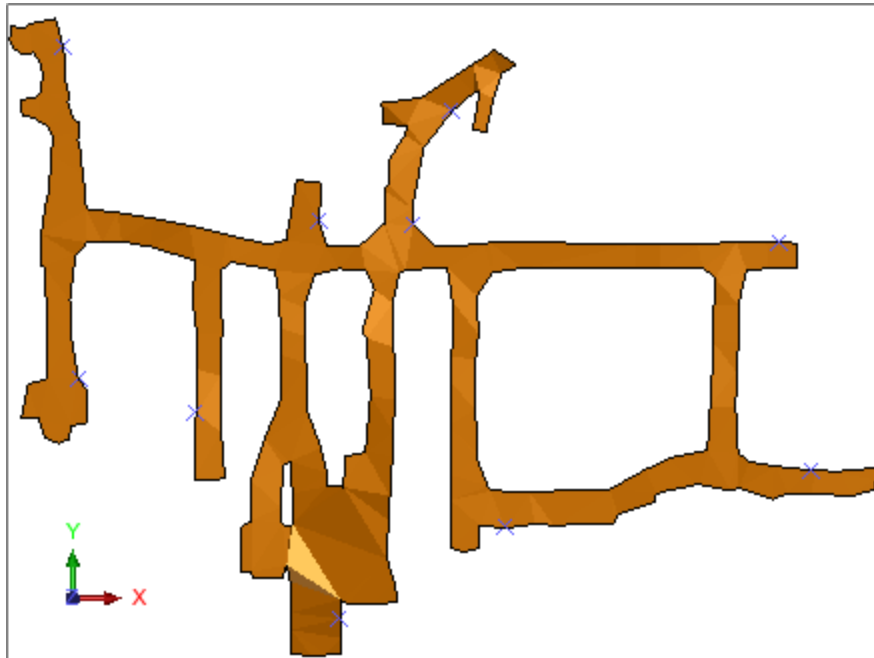
1. Click **Reset graphics** .
2. Choose **Surfaces > DTM File functions > Create DTM from string file**.
3. Enter the information as shown, and click **Apply**.



 **Note:** In this case, you are using the same string to clip the DTM as was used to define the boundary of the DTM. Because the operation is performed directly on the input files, there is no need to save the DTM file manually.

4. Close the log file generated in the previous step.
5. Open **back1665.dtm** in **Graphics**.

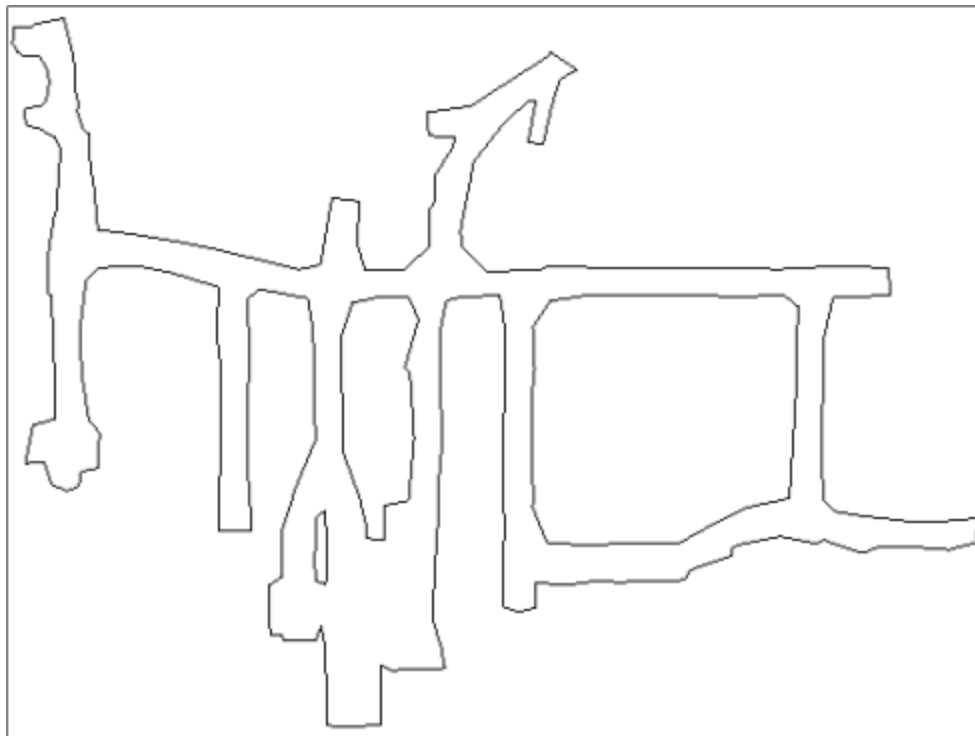
The clipped DTM is displayed.



Note: To see all of the steps performed in this task, run `_06a_clip_dtm_file_based.tcl`. You need to click **Apply** on any forms presented.

Task: Clip a DTM – graphics-based method

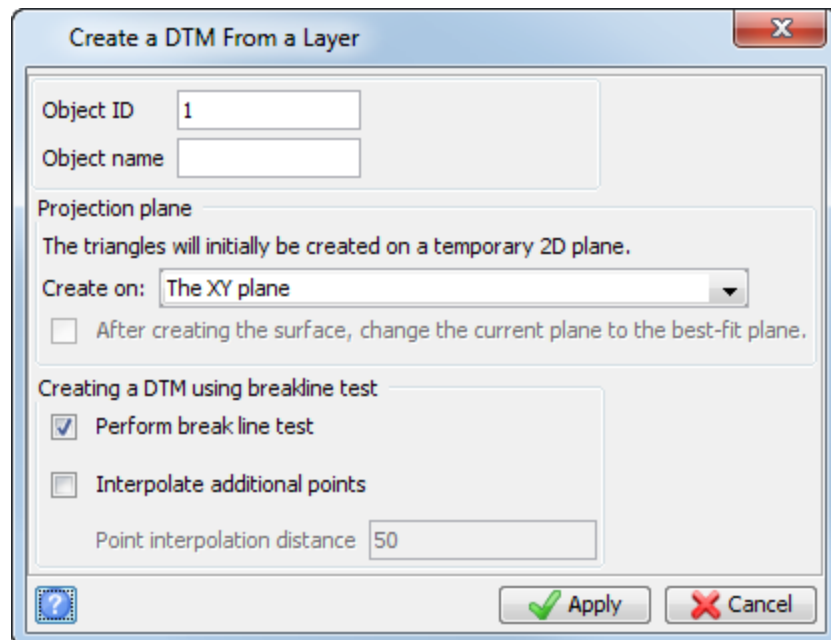
1. Click **Reset graphics** .
2. Open `lev1665.str` in **Graphics**.



3. Choose **Inquire > Segment properties** and select each segment.

Note: The pillars are all anti-clockwise and the drives are all clockwise.

4. Choose **Surfaces > Create DTM from layer**.
5. Enter the information as shown, and click **Apply**.



Object ID

Object name

Projection plane

The triangles will initially be created on a temporary 2D plane.

Create on:

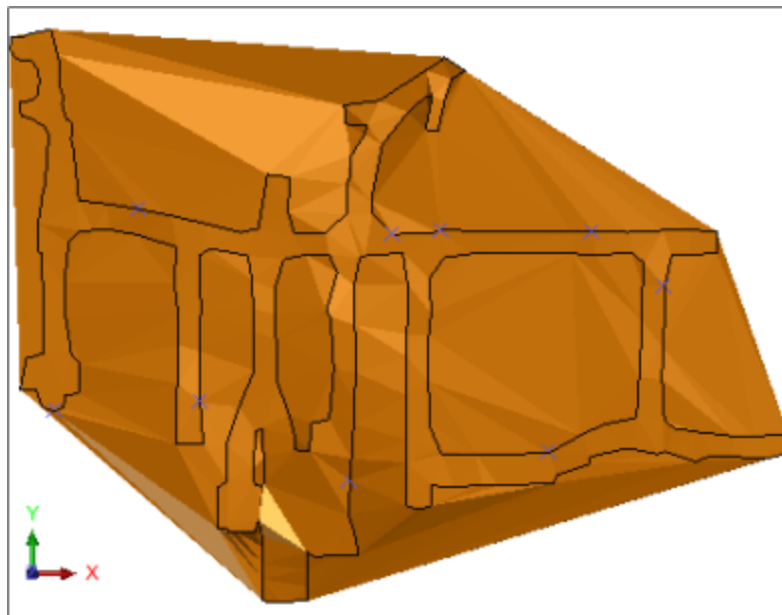
After creating the surface, change the current plane to the best-fit plane.

Creating a DTM using breakline test

Perform break line test

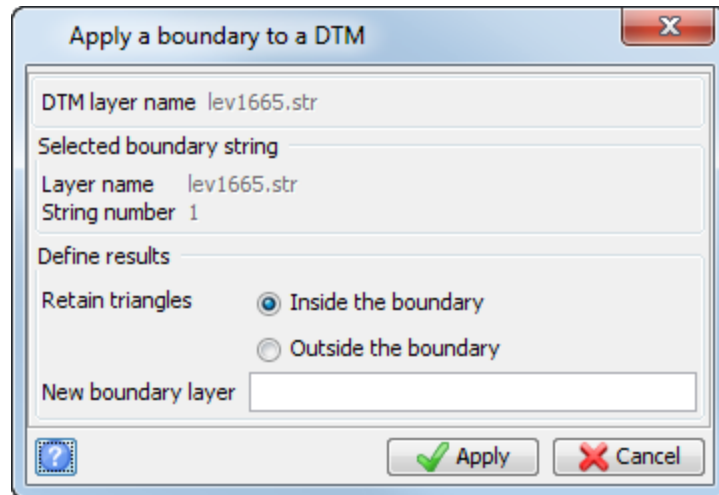
Interpolate additional points

Point interpolation distance

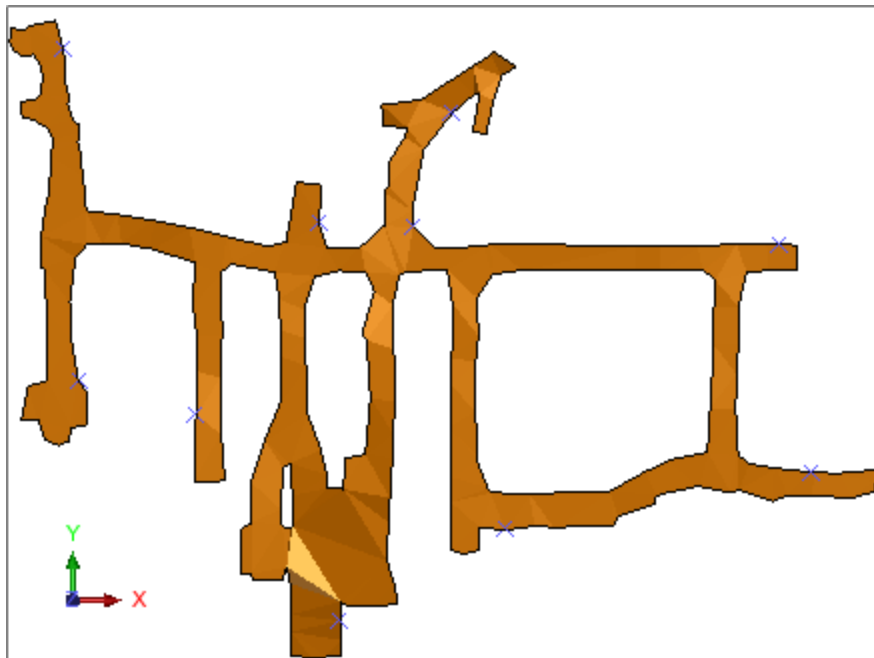


6. Choose **Surfaces > Clip or intersect DTMs > Clip DTM with string**.
7. Select any point on the string.


8. Enter the information as shown, and click **Apply**.



9. Save as **lev1665.dtm**.




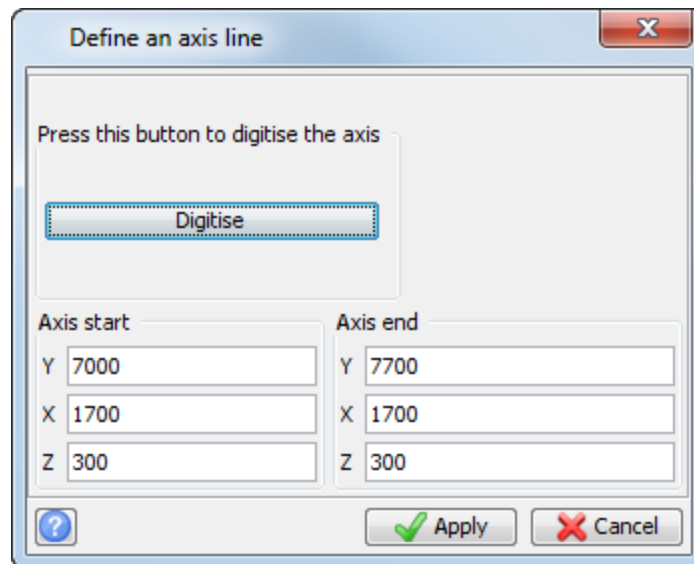
This is one way of beginning to create a 3D model of these underground workings.

 **Note:** To see all of the steps performed in this task, run `_06b_clip_dtm_graphics_based.tcl`. You need to click **Apply** on any forms presented.

Sectioning a DTM

Task: Create a DTM section axis line

1. Click **Reset graphics** .
2. Open **pit1.dtm** in **Graphics**.
3. Choose **Create > Section axis by coordinates**.
4. Enter the information as shown, and click **Apply**.



Define an axis line

Press this button to digitise the axis

Digitise

Axis start

Y 7000

X 1700

Z 300

Axis end

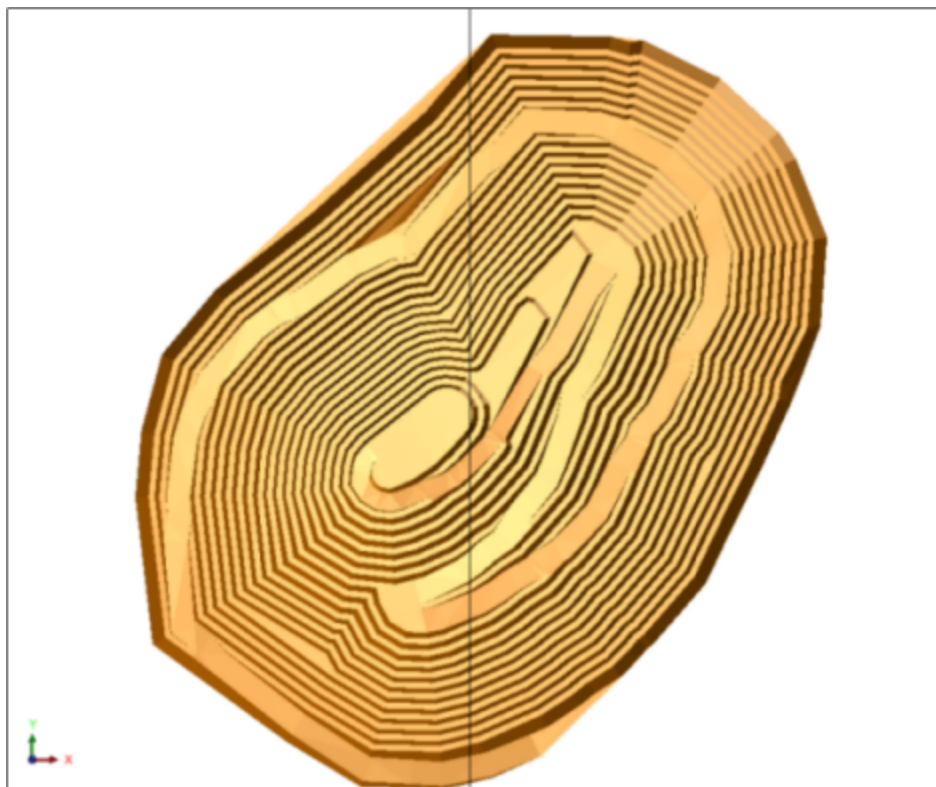
Y 7700

X 1700


Z 300

Apply Cancel


The pit with axis line is displayed.

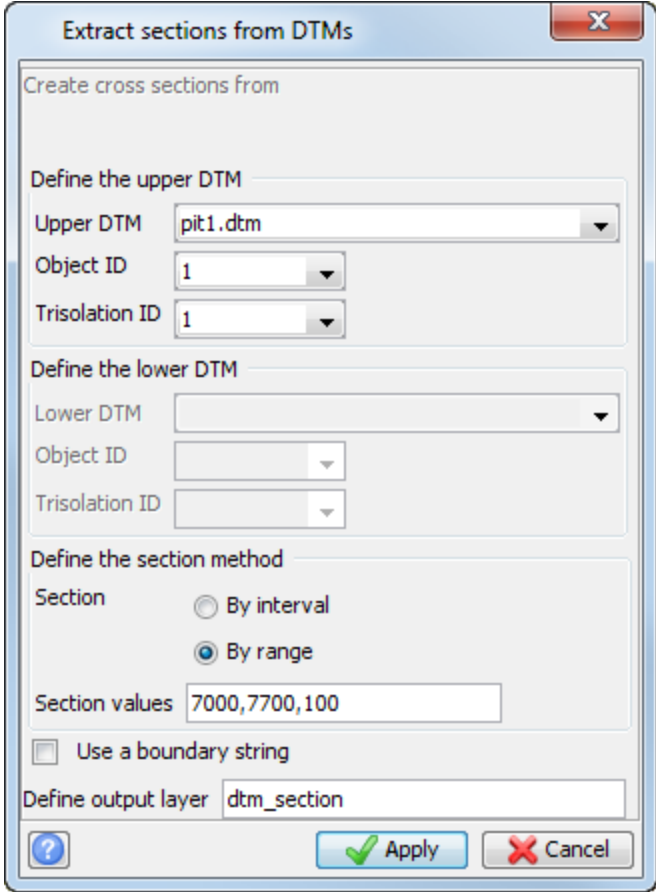


5. Save **pit1.dtm**.

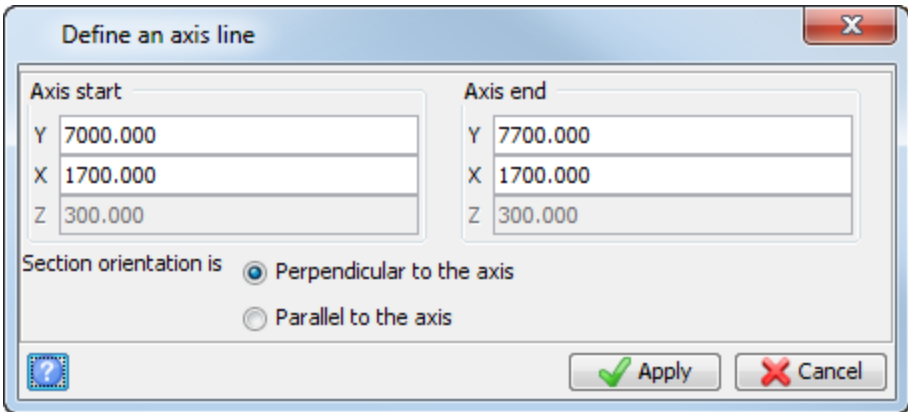
 **Note:** To see all of the steps performed in this task, run `_07a_create_section_axis_line.tcl`. You need to click **Apply** on any forms presented.


Task: Create DTM sections

1. Click **Reset graphics** .
2. Open **pit1.dtm** in **Graphics**.
3. Choose **Display > Section axis line**.
4. Choose **Surfaces > Create sections from DTM**.
5. Enter the information as shown, and click **Apply**.

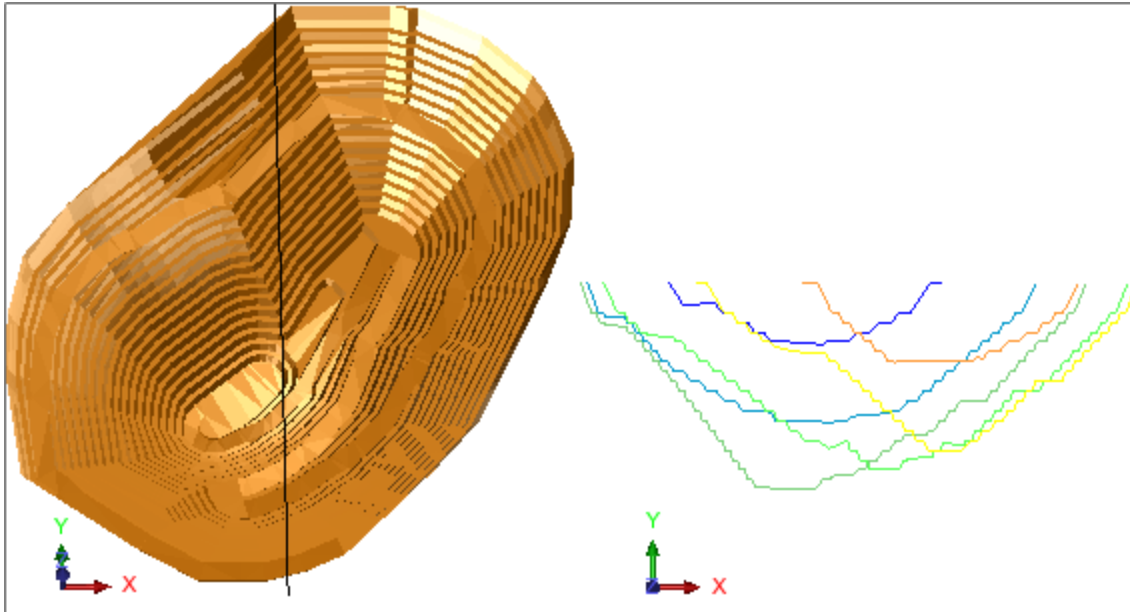


6. Enter the information as shown, and click **Apply**.



 **Note:** The first section is extracted from the axis start. Sections are not extracted past the axis end point.


The axis line is displayed on the left. The resulting section coordinates are displayed on the right.

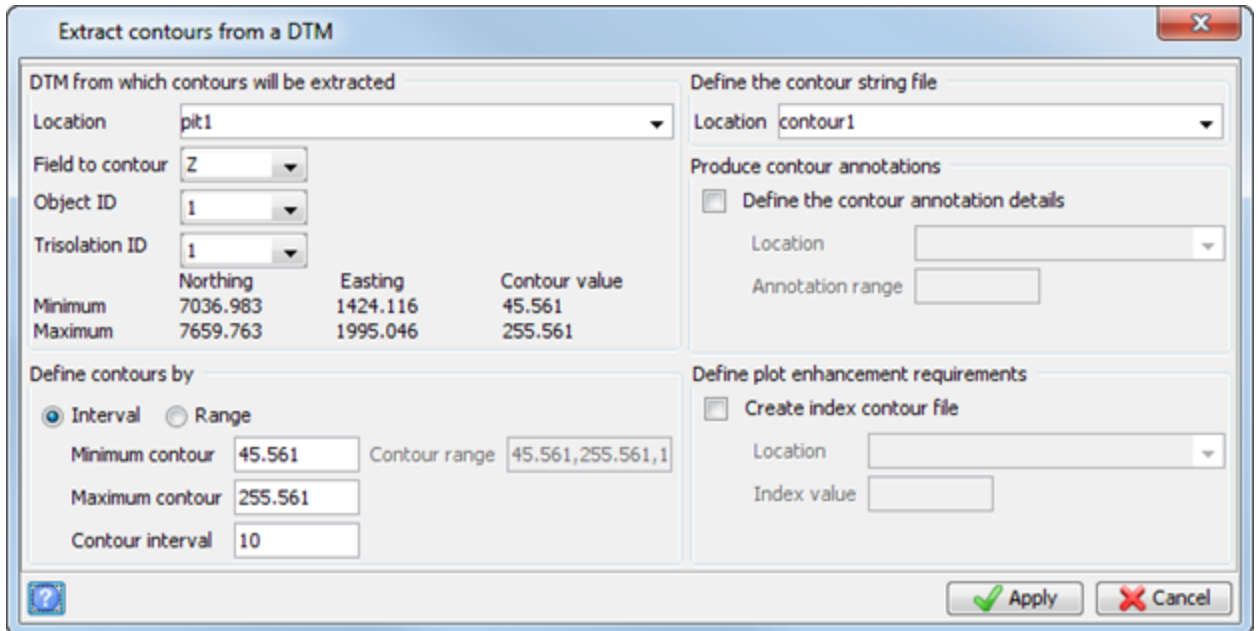


Note: To see all of the steps performed in this task, run `_07b_sectioning_pit.tcl`. You need to click **Apply** on any forms presented.

Creating contours

Task: Create DTM contours – file-based

1. Click **Reset graphics** .
2. Choose **Surfaces > Contouring > Contour DTM file**.
3. Enter the information as shown, and click **Apply**.



Extract contours from a DTM

DTM from which contours will be extracted

Location: pit1

Field to contour: Z

Object ID: 1

Trisolation ID: 1

	Northing	Easting	Contour value
Minimum	7036.983	1424.116	45.561
Maximum	7659.763	1995.046	255.561

Define contours by

Interval Range

Minimum contour: 45.561

Maximum contour: 255.561

Contour interval: 10

Contour range: 45.561,255.561,1

Define the contour string file

Location: contour1

Produce contour annotations

Define the contour annotation details

Location: []

Annotation range: []

Define plot enhancement requirements

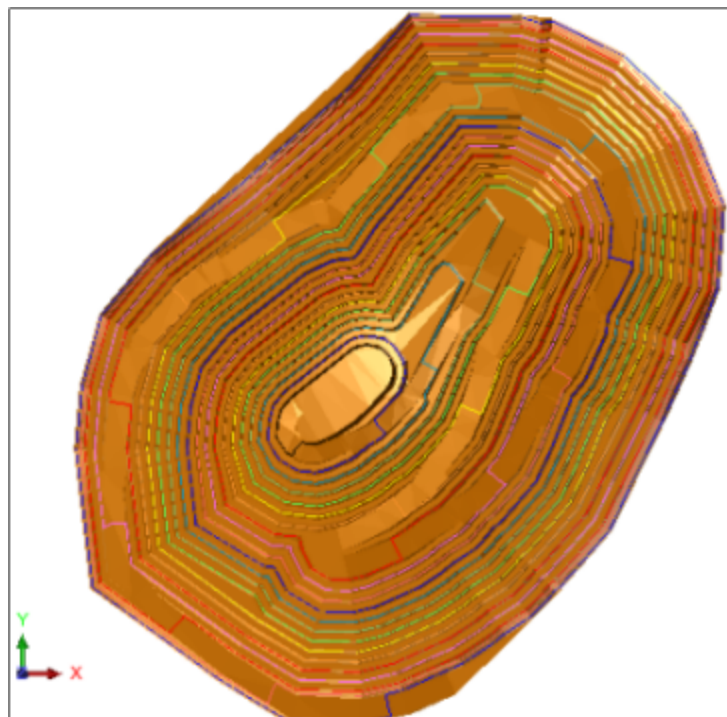
Create index contour file


Location: []

Index value: []


Apply Cancel

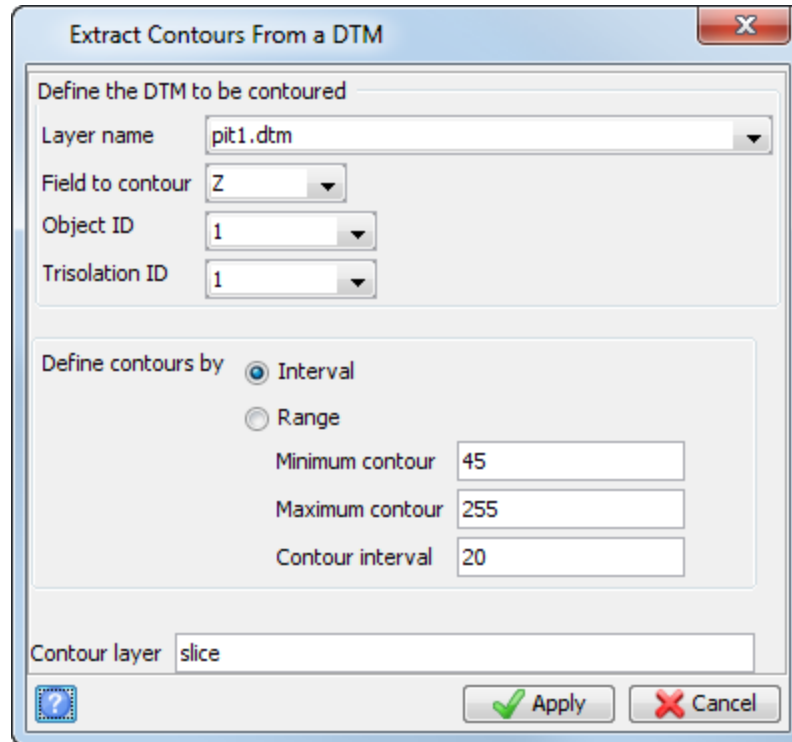
4. Open **pit1.dtm** in **Graphics**.
 5. Open **contour1.str** in **Graphics**.
- The plan view of the pit is displayed.



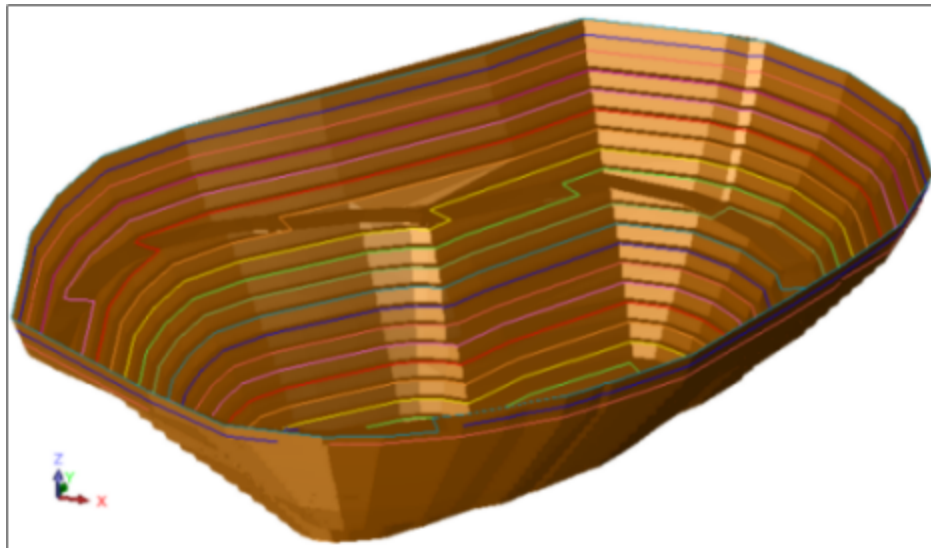
 **Note:** To see all of the steps performed in this task, run **08a_create_dtm_contours_file_based.tcl**. You need to click **Apply** on any forms presented.

Task: Create DTM contours – graphics-based

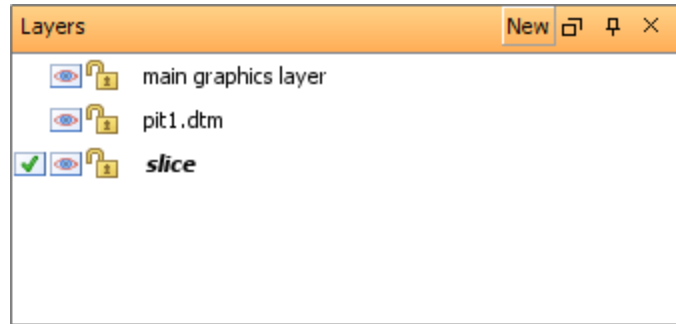
1. Click **Reset graphics** .
2. Open **pit1.dtm** in **Graphics**.
3. Choose **Surfaces > Contouring > Contour DTM in layer**.
4. Enter the information as shown, and click **Apply**.



The pit and contours are displayed.



5. Make **slice** the active layer.

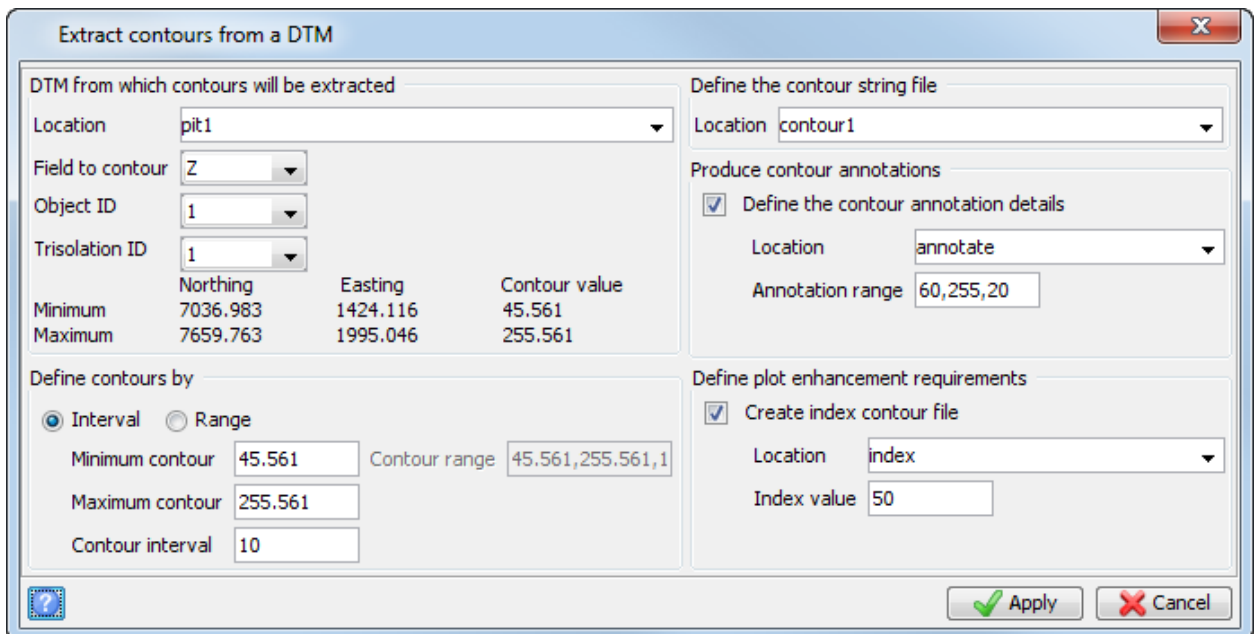


6. Save the data to **pitcon5.str**.

Note: To see all of the steps performed in this task, run **07c_section_pit_by_elevation.tcl**. You need to click **Apply** on any forms presented.

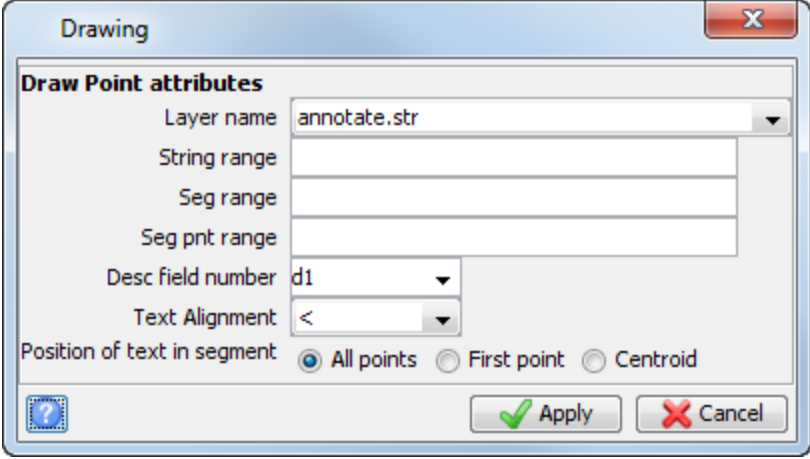
Task: Create index contour file with annotations

1. Click **Reset graphics** .
2. Choose **Surfaces > Contouring > Contour DTM file**.
3. Enter the information as shown, and click **Apply**.



4. Open **annotate.str** in **Graphics**.
5. Choose **Display > Hide everything**.
6. Choose **Display > Point > Attributes**.

7. Enter the information as shown, and click **Apply**.

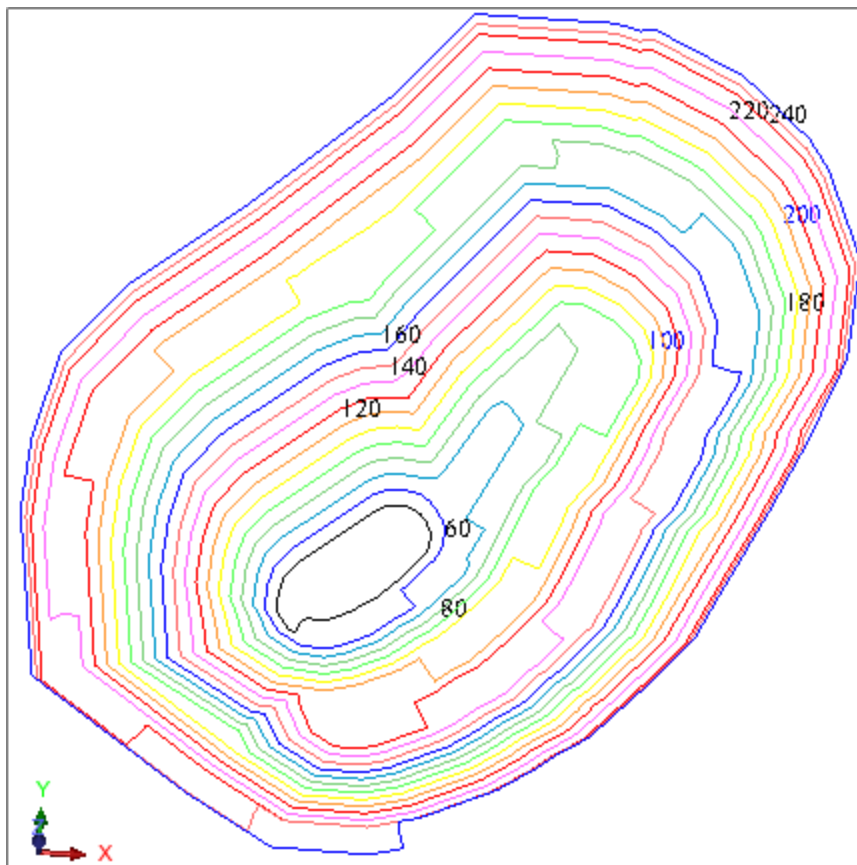


The 'Drawing' dialog box is shown with the following settings:

- Layer name: `annotate.str`
- String range: (empty)
- Seg range: (empty)
- Seg pnt range: (empty)
- Desc field number: `d1`
- Text Alignment: `<`
- Position of text in segment: All points First point Centroid

Buttons: **Apply** (green checkmark) and **Cancel** (red X).


8. Open `index1.str` in **Graphics**.
 9. Open `contour1.str` in **Graphics**.
- The pit contour with annotations is displayed.

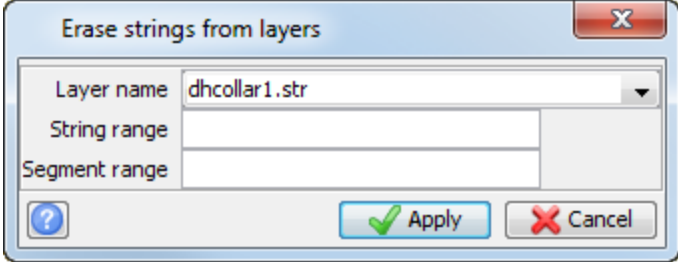


Note: To see all of the steps performed in this task, run `_08b_create_index_contour_file_with_annotations.tcl`. You need to click **Apply** on any forms presented.

Draping a string over a DTM

Task: Drape a spot height string over a DTM

1. Click **Reset graphics** .
2. Open **topo1.dtm** in **Graphics**.
3. Open **dhcollar1.str** in **Graphics**.
4. Choose **Display > Hide strings > In a layer**.
5. Enter the information as shown, and click **Apply**.



Erase strings from layers

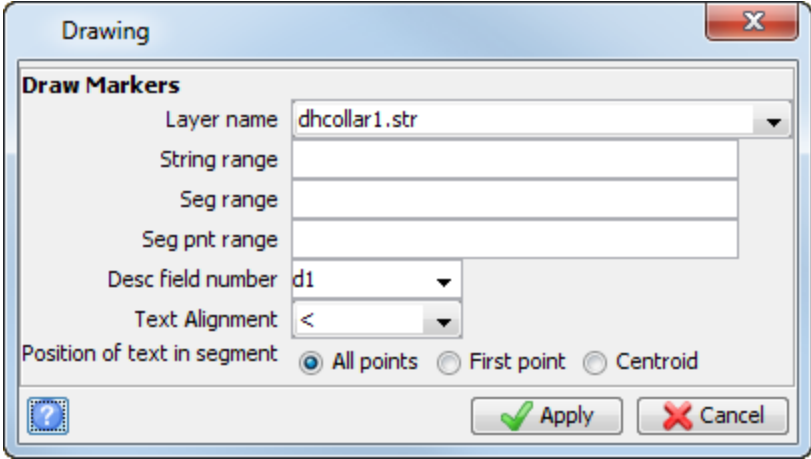
Layer name: dhcollar1.str

String range: [Empty]

Segment range: [Empty]

Buttons: [Help], [Apply], [Cancel]

6. Choose **Display > Point > Markers**.
7. Enter the information as shown, and click **Apply**.



Drawing

Draw Markers

Layer name: dhcollar1.str

String range: [Empty]

Seg range: [Empty]

Seg pnt range: [Empty]

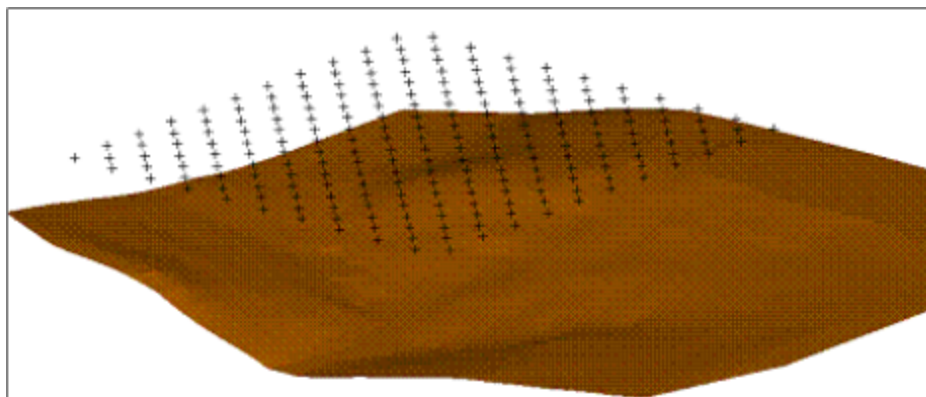
Desc field number: d1

Text Alignment: <

Position of text in segment: All points First point Centroid

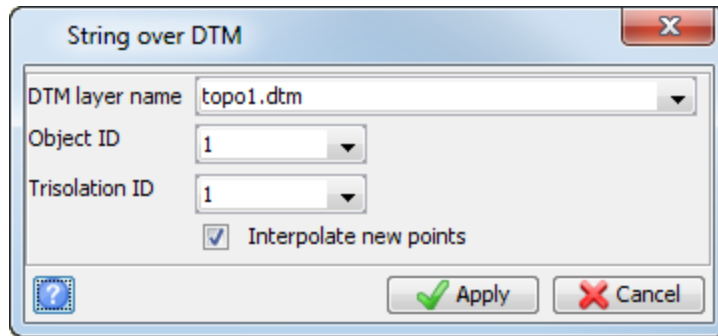
Buttons: [Help], [Apply], [Cancel]

8. Press and hold down the mouse button to rotate the view of the drillhole collars as shown. By rotating the image, you can select the markers and *not* the DTM.

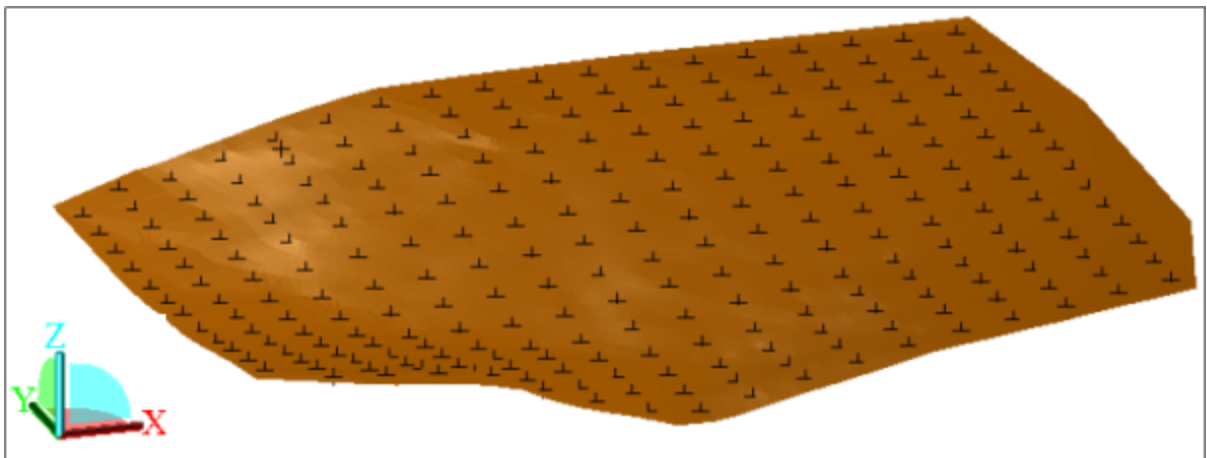


9. Choose **Surfaces > Drape string over DTM**.
10. Click one of the markers to select the string to drape over the DTM.

11. Enter the information as shown, and click **Apply**.





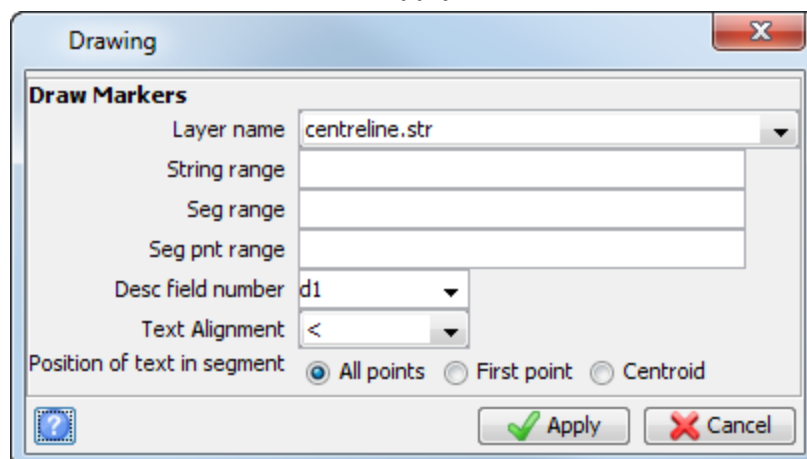
The DTM is displayed with draped markers.

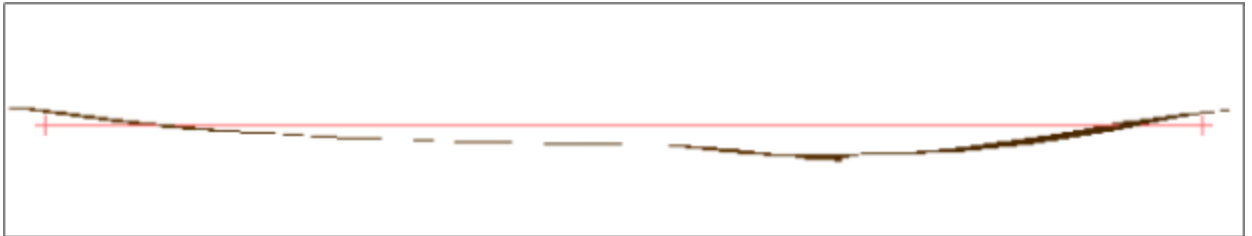


Note: To see all of the steps performed in this task, run `_09a_draping_a_spot_height_string_over_a_dtm.tcl`. You need to click **Apply** on any forms presented.

Task: Drape a non-spot height string over a DTM

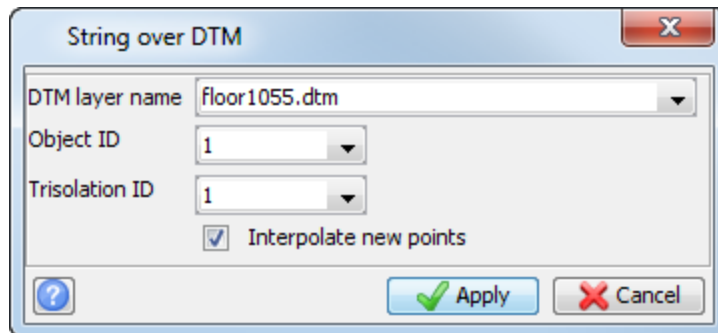
1. Click **Reset graphics** .
2. Open `floor1055.dtm` in **Graphics**.
3. Open `centreline.str` in **Graphics**.
4. Click **Section view** .
5. Choose **Display > Point > Markers**.
6. Enter the information as shown, and click **Apply**.





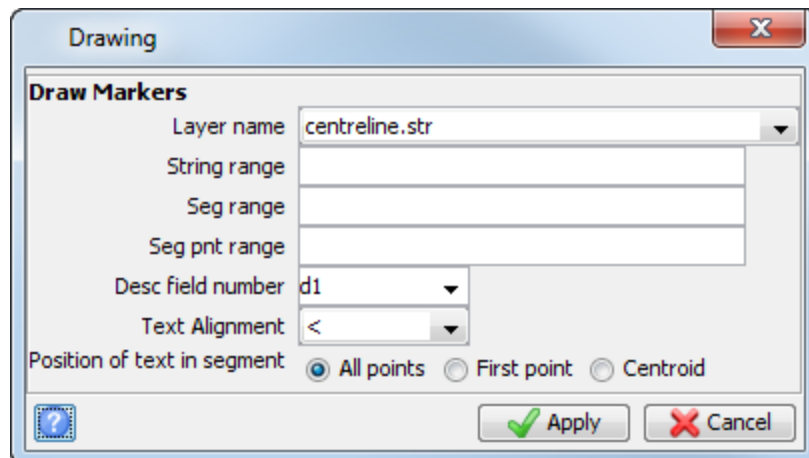
Note: The **centreline.str** only contains two points.

7. Choose **Surfaces > Drape string over DTM**.
8. Click the centreline string.
9. Enter the information as shown, and click **Apply**.

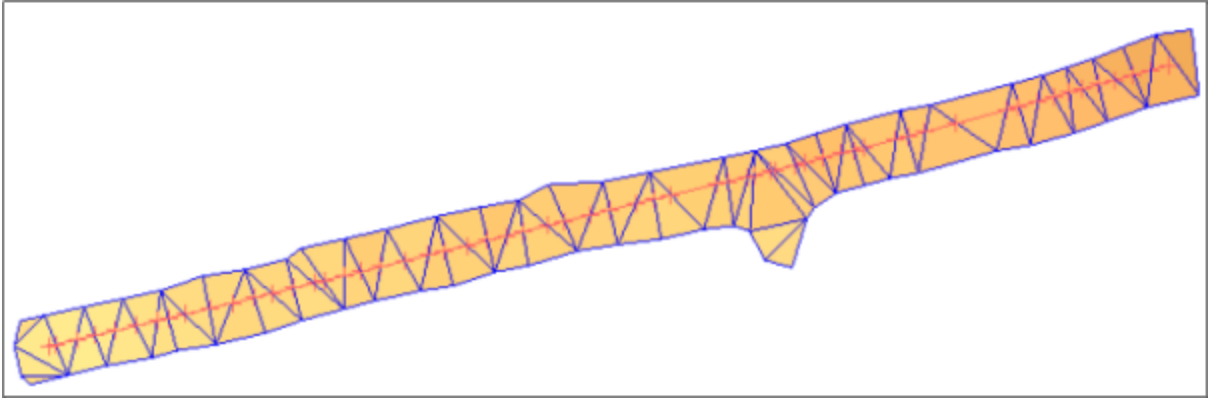



Note: The option to **Interpolate new points** is selected to create new points where the string crosses a triangle edge.

10. Choose **Display > Point > Markers**.
11. Enter the information as shown, and click **Apply**.




12. Click **Plan view** , and then click **Edges on**  to display the DTM triangle edges.

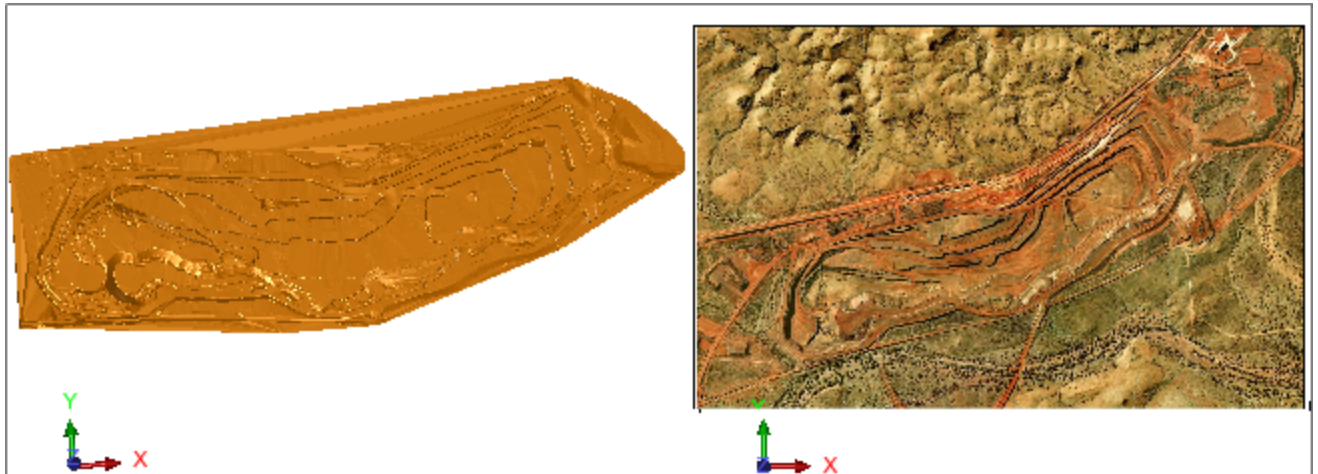


 **Note:** The points have been created at the intersection of the string and DTM triangle edges.


13. Save the string as **centreline_draped.str**.

 **Note:** To see all of the steps performed in this task, run **_09b_draping_a_non_spot_height_string_over_a_dtm.tcl**. You need to click **Apply** on any forms presented.

The DTM is displayed first, then the image to drape over the DTM.



6. Follow the prompts at the bottom of the screen to select a series of registration points, first in the image, and then in the DTM.

 **Tip:** Try to pick points that represent features easily recognisable on both the image and the DTM. Also, pick enough points to cover most of your area of interest.

7. When sufficient registration points have been defined (a minimum of three points), press ESC to display the coordinates of your registration points.

Image and Real World coordinates for registration points					
	X Image	Y Image	X Data	Y Data	Z Data
1	330	223	11967.602	85548.531	555.883
2	1178	570	13690.507	85708.631	533.872
3	761	557	12749.126	86019.935	567.735

8. Click **Apply**.
The pit with image drape is displayed.






Tip: To give a more realistic view, increase the z scale by a factor of 3.

9. Choose **View > Data view options > View scale factors**.
10. Enter the information as shown, and click **Apply**.

Set view scaling parameters	
X direction	1
Y direction	1
Z direction	3


Buttons: ? Apply Cancel

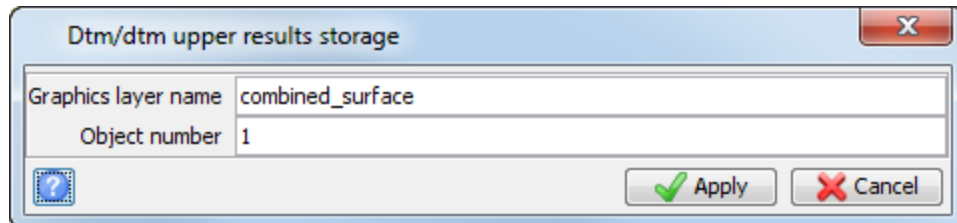
11. Rotate the image to see the full effects of the rescaled image drape.


 **Note:** To see all of the steps performed in this task, run `_10_image_drape.tcl`. You need to click **Apply** on any forms presented.


DTM/DTM intersections

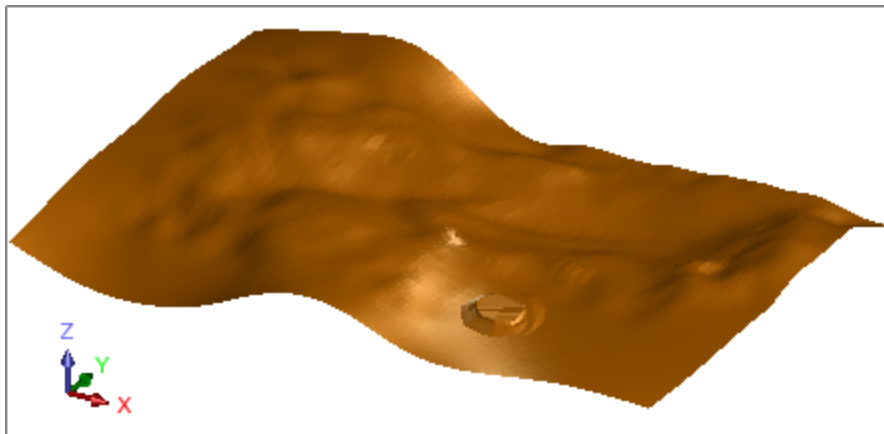
Task: Create an upper triangles surface of two DTMs

1. Click **Reset graphics** .
2. Open **dump1.dtm** in **Graphics**.
3. Open **topo_dump1.dtm** in **Graphics**.
4. Choose **Surfaces > Clip or intersect DTMs > Upper triangles of 2 DTMs**.
5. Enter the information as shown, and click **Apply**.




-  **Note:** The layer name cannot be the same as any of the current layers.
6. Follow the prompts highlighted on the Status bar.

 **Note:** The image will be displayed in a different colour until the calculation function is deselected.
 7. Press ESC.
The DTM is displayed.



8. Save the file as **upper_surface.dtm**.

 **Note:** To see all of the steps performed in this task, run `_11a_upper_triangles_of_2_dtms.tcl`. You need to click **Apply** on any forms presented.

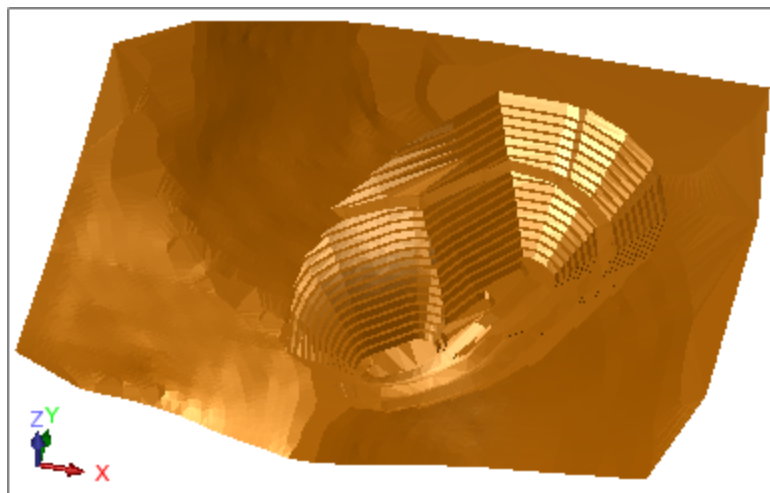
Task: Create a lower triangles surface of two DTMs

1. Click **Reset graphics** .
2. Open **topo1.dtm** in **Graphics**.
3. Open **pit1.dtm** in **Graphics**.
4. Choose **Surfaces > Clip or intersect DTMs > Lower triangles of 2 DTMs**.

5. Enter the information as shown, and click **Apply**.

Dtm/dtm upper results storage	
Graphics layer name	combined_surface
Object number	1
<input type="button" value="Apply"/> <input type="button" value="Cancel"/>	

6. Follow the prompts highlighted on the Status bar.
 - ✔ **Note:** The image will be displayed in a different colour while the function is running.
7. Press ESC.
The DTM with pit is displayed.



8. Save the file as **lower_surface.dtm**.

✔ **Note:** To see all of the steps performed in this task, run `_11b_lower_triangles_of_2DTMs.tcl`. You need to click **Apply** on any forms presented.

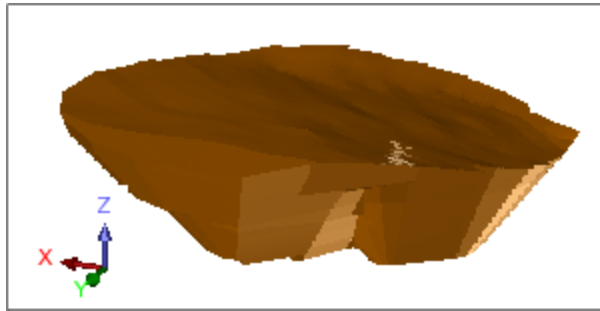
Task: Create solid by intersecting two DTMs

1. Click **Reset graphics** .
2. Open **topo1.dtm** in **Graphics**.
3. Open **pit1.dtm** in **Graphics**.
4. Choose **Surfaces > Clip or intersect DTMs > Create solid by intersecting 2 DTMs**.
5. Enter the information as shown, and click **Apply**.

Dtm/dtm intersect results storage	
Graphics layer name	layer_intersect
Object number	1
<input type="button" value="Apply"/> <input type="button" value="Cancel"/>	

- ✔ **Note:** The layer name **cannot** be the same as any of the current layers.
6. Follow the prompts highlighted on the Status bar.
 - ✔ **Note:** You **must** select the upper DTM (topography) first, followed by the lower DTM (pit). The image will be displayed in a different colour until the calculation function is deselected.

7. Press ESC.
The solid from the DTM intersection is displayed.



8. Save the file as **pit_solid.dtm**.
9. Choose **Solids > Solids tools > Report volume of solids**.
10. Enter the information as shown, and click **Apply**.

The solids object report log opens in your default text editor.

```
SOLID MODELLING OBJECT REPORT
Layer Name: layer_intersect

Object: 1
Trisolation: 1
Validated = true
Status = solid

Trisolation Extents
X Minimum: 1510.797 X Maximum: 1988.576
Y Minimum: 7122.451 Y Maximum: 7655.154
Z Minimum: 45.561 Z Maximum: 243.000
Surface area: 481570
Volume : 12603221
```

Note: To see all of the steps performed in this task, run **_11c_create_solid_intersecting_2_dtms.tcl**. You need to click **Apply** on any forms presented.