



# Underground Ring Design Tutorial

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**Product**

Surpac™ 6.6.1

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# Introduction

## Overview

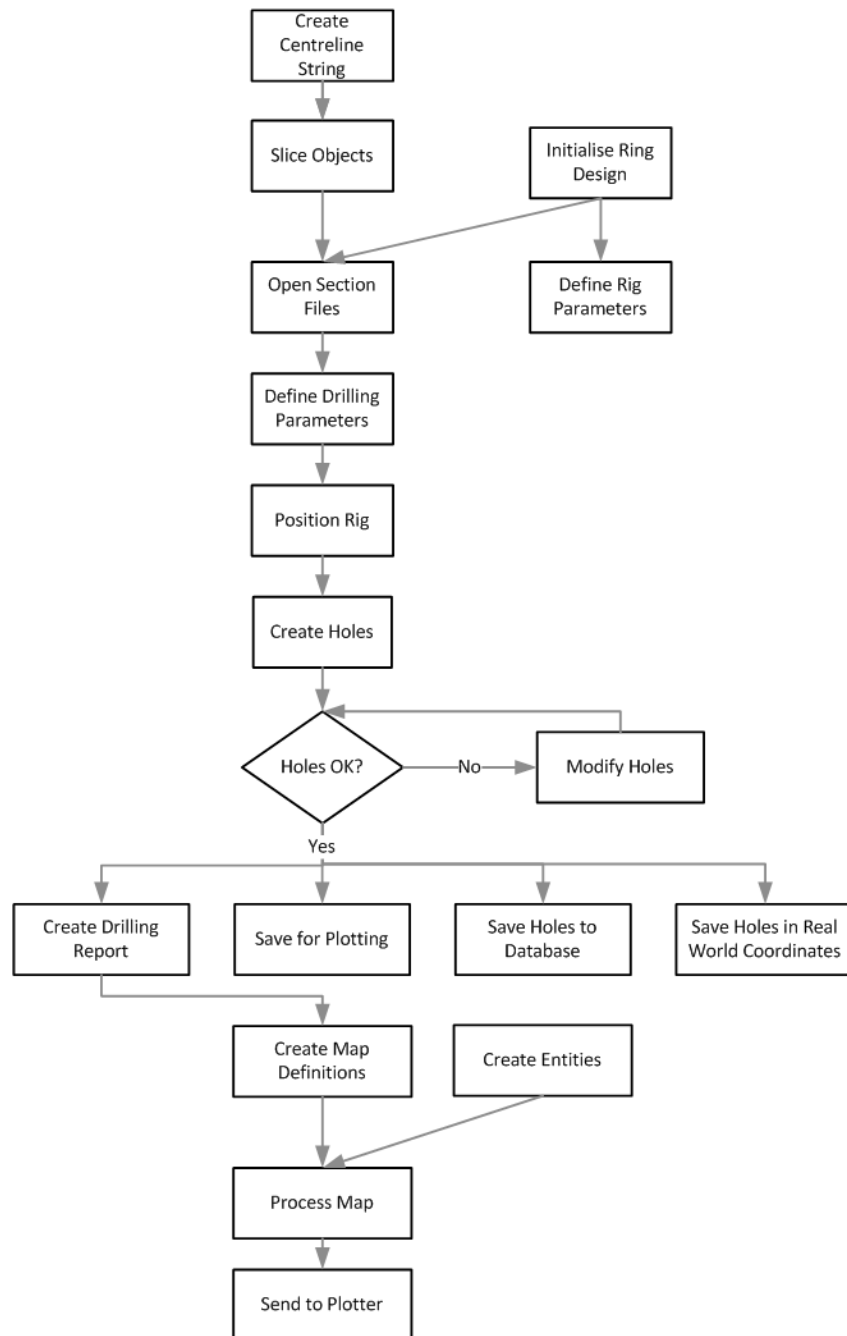
Ring design is the term given to drilling a fan of holes from an underground drive for the purposes of blasting ore. Surpac can help you create and report on any feasible underground ring design.

## Requirements

Prior to proceeding with this tutorial, you will need:

- Surpac installed on your computer
- basic knowledge of Surpac string files and editing tools
  - ✍ **Note:** You can use the relevant sections of the Introduction tutorial to develop your understandings of these tools in Surpac.
- the data set accompanying this tutorial

## Workflow



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

## Ring design concepts

### Terminology

- **Centreline** – A single string segment used in the function **Centreline slice** to create slices from solid models.
- **Real World Coordinates** – The information in a string file is stored with the coordinates representing a plan view of the data. That is, the coordinates represent the mine grid northing, easting, and elevation. Slices of solid objects that you want to use for ring design must be saved in real world coordinates.
- **Section Coordinates** – The information in the string file is not stored in real world coordinates, it is stored as sectional coordinates. That is, the view at right angles to the data. Data created using the ring design function **Save for plot** are saved in section coordinates.
- **Underground Drive** – A tunnel, or opening in the rock, where the drill rig will be positioned.
- **Stope** – A 3-dimensional area (usually ore) which is to be mined out by blasting a series of long holes or ring design holes.

### Prerequisites

In the most common cases, you will need three things to perform ring design:

- 3D solid models of surveyed underground drives
- 3D solid models of designed stopes
- A string segment to be used as a centreline for slicing solid objects

For stopeless designs, such as for roof stability holes and sample holes, you need only a 3D model of the drives and the centreline string. If you have a Surpac block model, you can also slice it at the same time you slice the 3D solid models of drives and stopes. You can also append DTMs representing other features, such as fault surfaces to the drives and stope designs before slicing. After slicing, and before enabling ring design, you can append any other string files (in real world coordinates) to the string files created from slicing.

## Setting up for this tutorial

### Task: Set the work directory

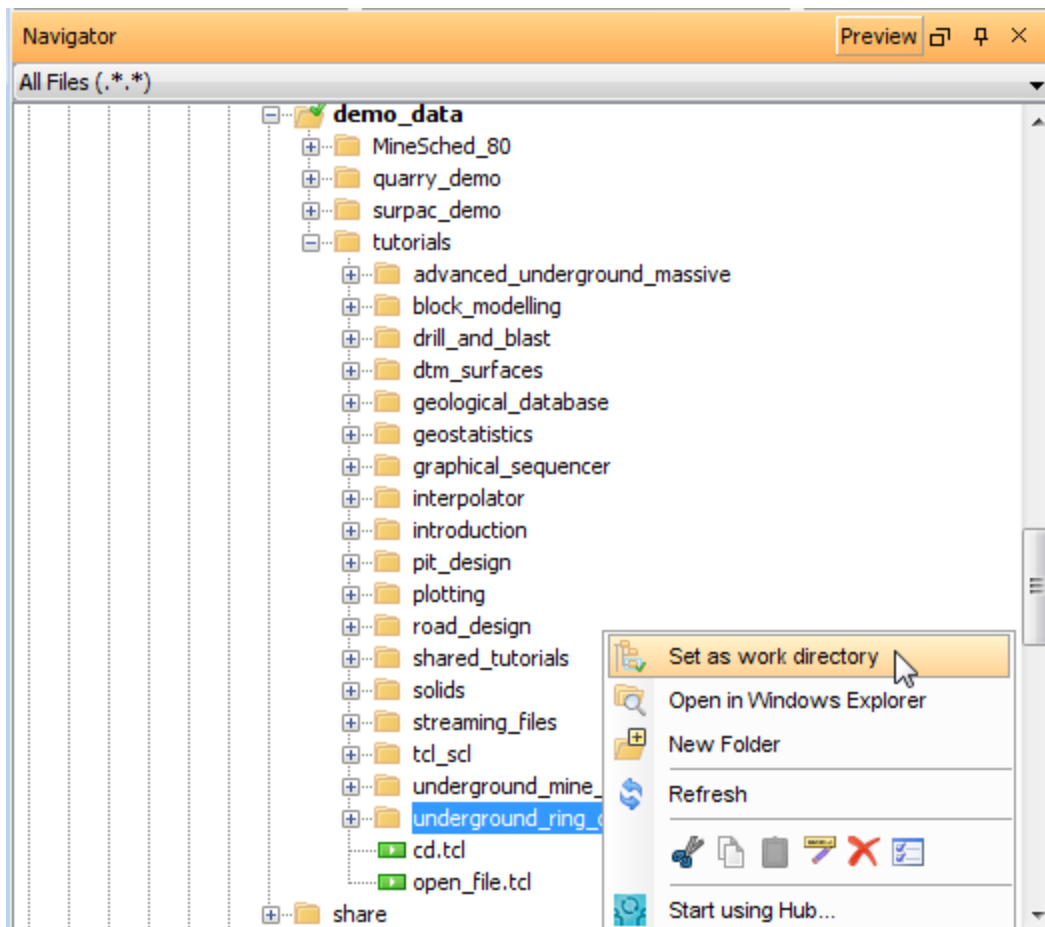
A work directory is the default directory for saving Surpac files. Files used in this tutorial are stored in the folder `<shared_files>\demo_data\tutorials\underground_ring_design`.

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\underground\_ring\_design.

1. In **Navigator**, right-click the `underground_ring_design` folder.
2. From the short-cut menu, select **Set as work directory**.

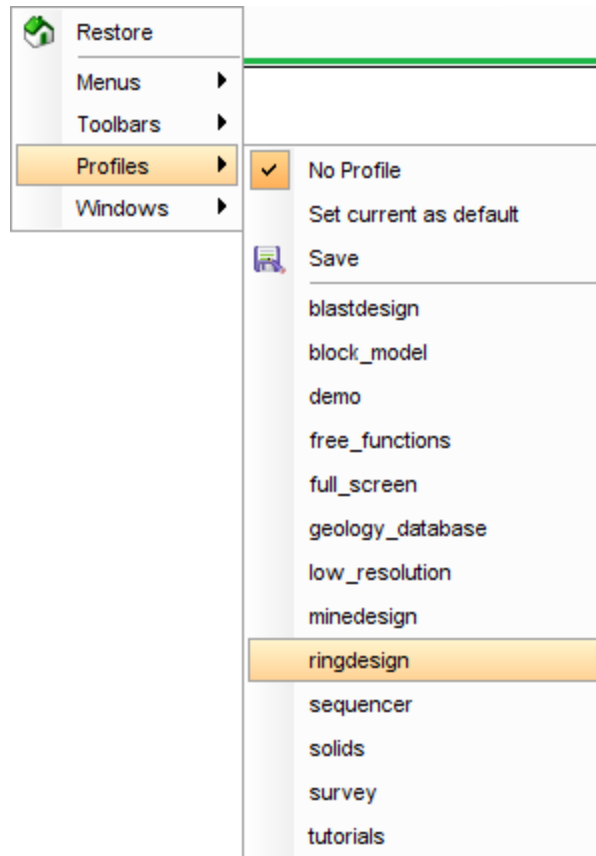


The name of the work directory is displayed in the title bar of the Surpac window.

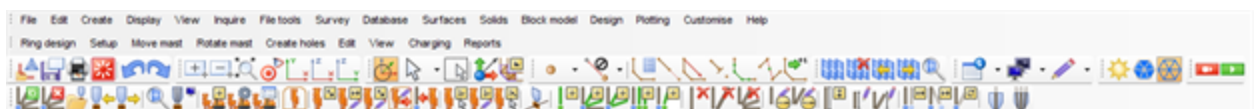
## Display Menubar and Toolbar

### Task: Display Menus and Toolbars

1. Right-click in the area to the right of the menus.
2. Select **Profiles**, and then **ringdesign**.



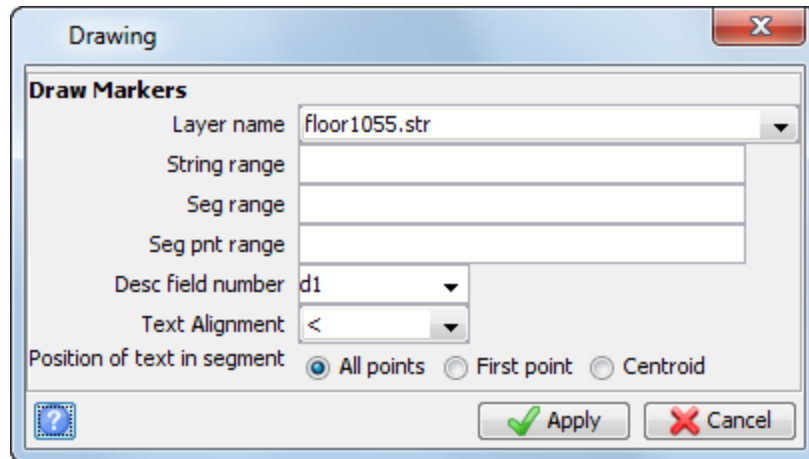
The ring design menubar and toolbar are displayed.



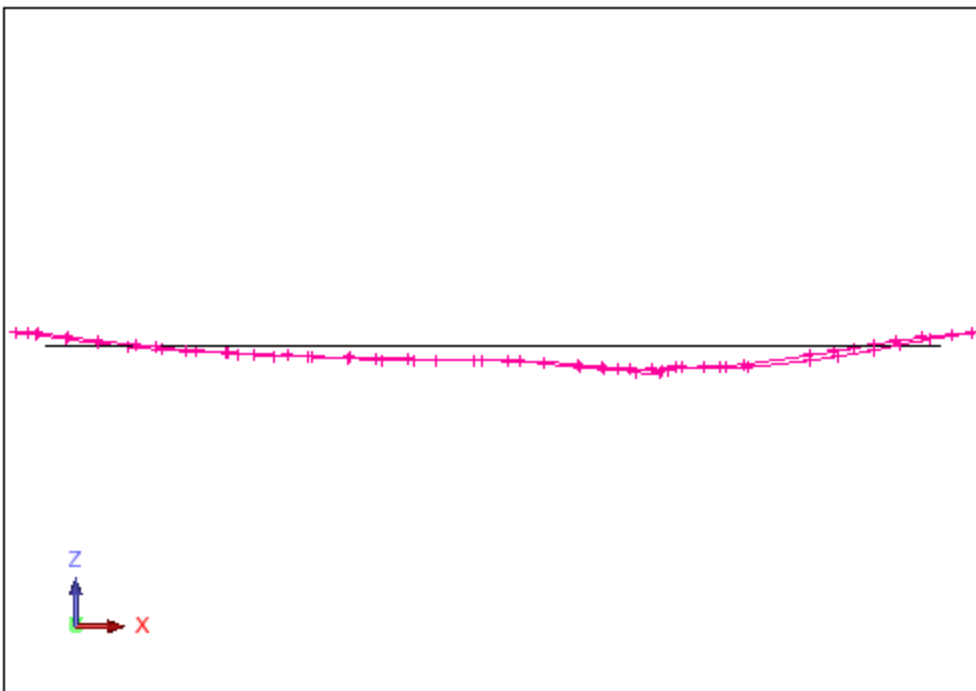
## Creating a centreline

### Task: View the data


1. Open **cl1.str** in **Graphics**.
2. Open **floor1055.str** in **Graphics**.
3. Choose **Display > Point > Markers**.
4. Enter the information as shown, and click **Apply**.

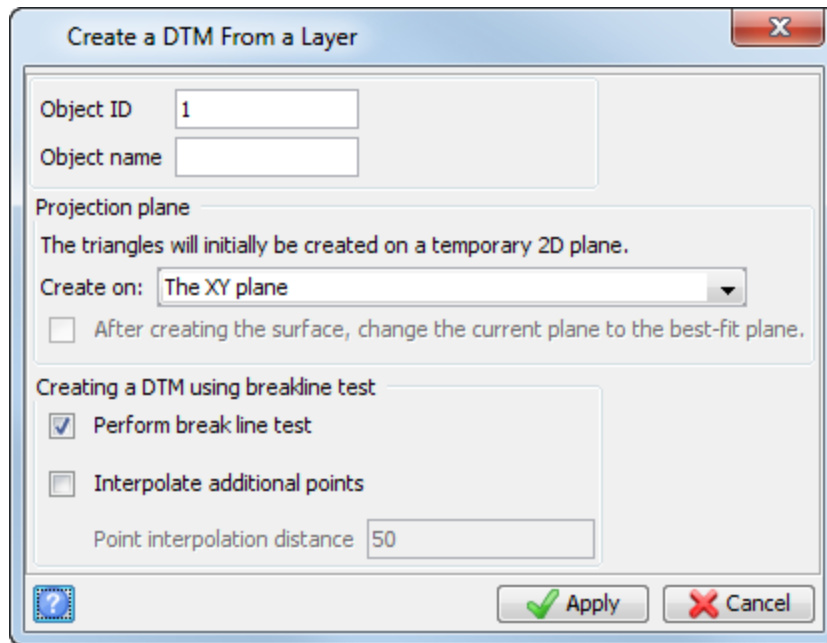


5. Click **Section view** .  
The floor and centreline strings are displayed.

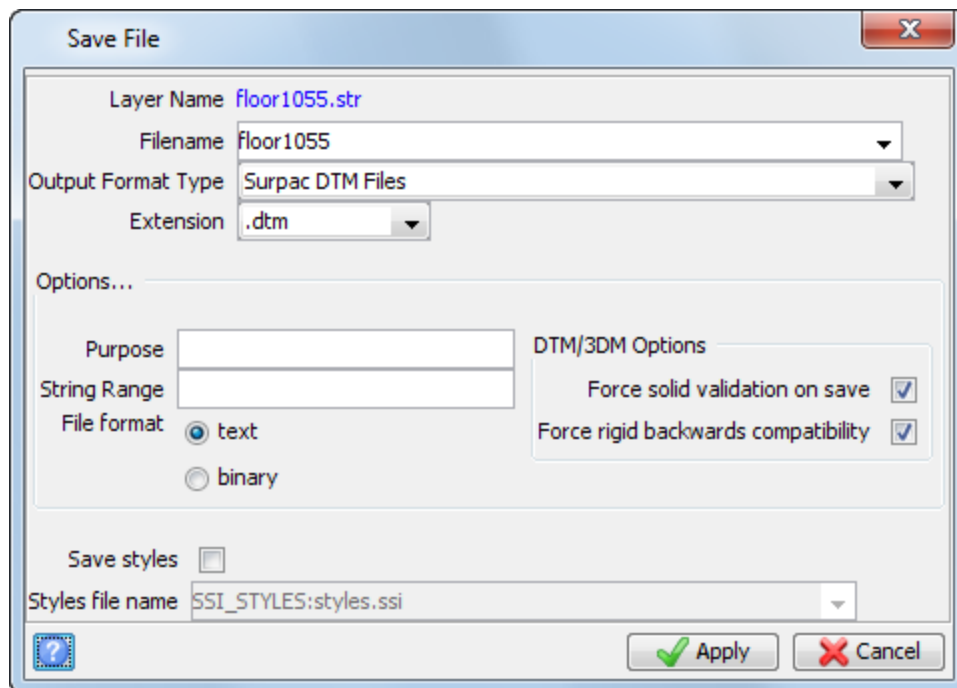


### Task: Create a DTM of a floor string

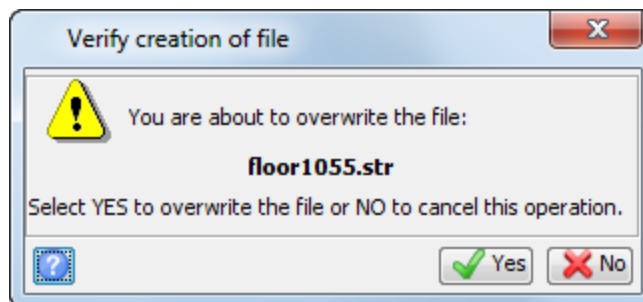
1. Click **Reset graphics** .
2. Open **floor1055.str** in **Graphics**.
3. Choose **Surfaces > Create DTM from layer**.
4. Enter the information as shown, and click **Apply**.





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

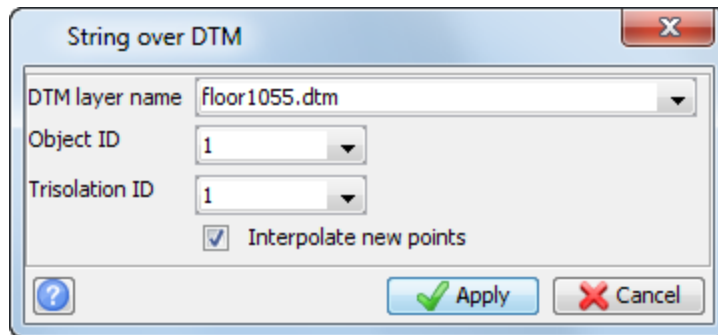



7. Click **Yes**.



**Task: Drape a centreline string over the DTM of the floor**

1. Click **Reset graphics** .
2. Open **floor1055.dtm** in **Graphics**.
3. Open **cl1.str** in **Graphics**.
4. Click Section view .
5. Choose **Surfaces > Drape string over DTM**.
6. Follow the prompt at the bottom of the screen to click the centreline string.
7. Enter the information as shown, and click **Apply**.

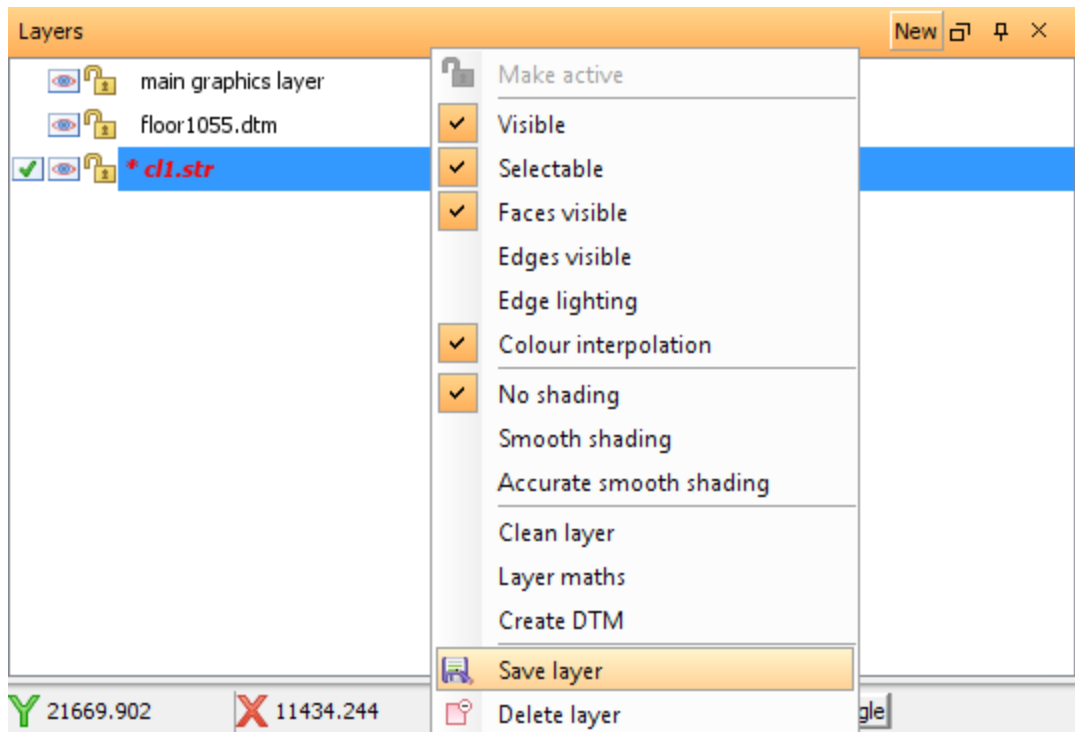


 **Note:** You must select **Interpolate New points** to create new points on the centreline wherever it crosses a triangle edge.

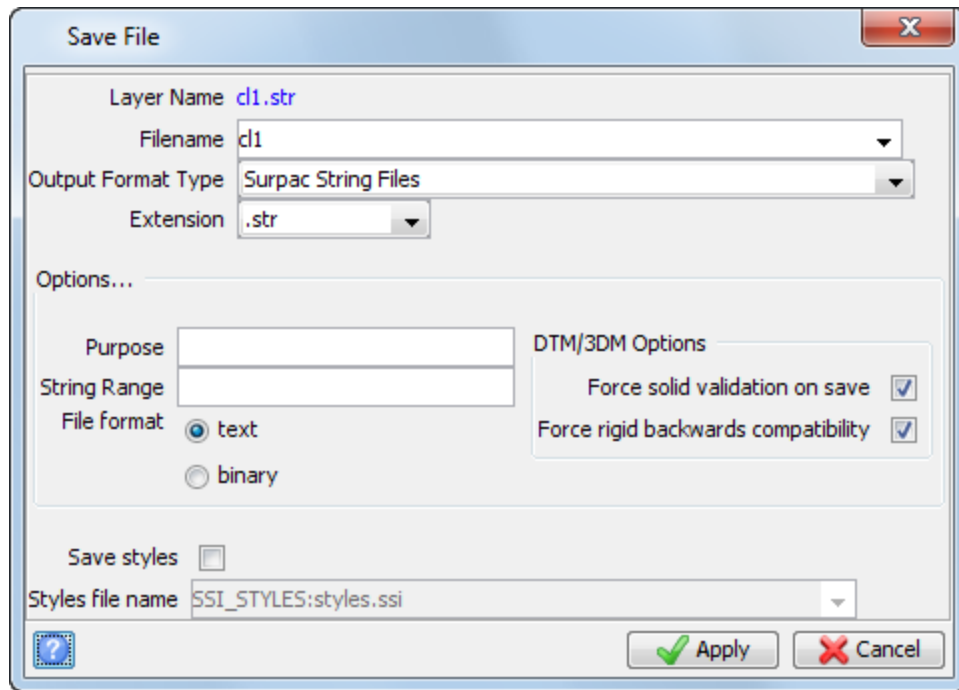
If you did not select **Interpolate new points**, you would get an output file with only the two end points.

You will see the string draped to match the contours of the DTM surface.

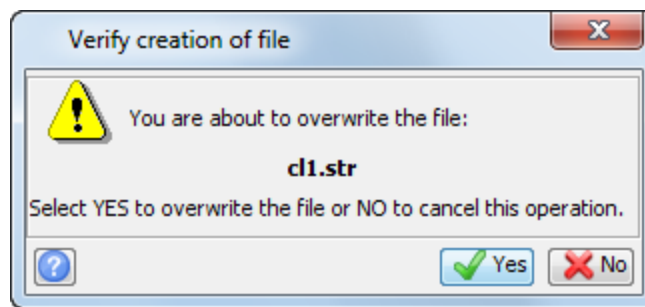
8. In the Layers pane, right-click **cl1.str**.
9. Choose **Save layer**.




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

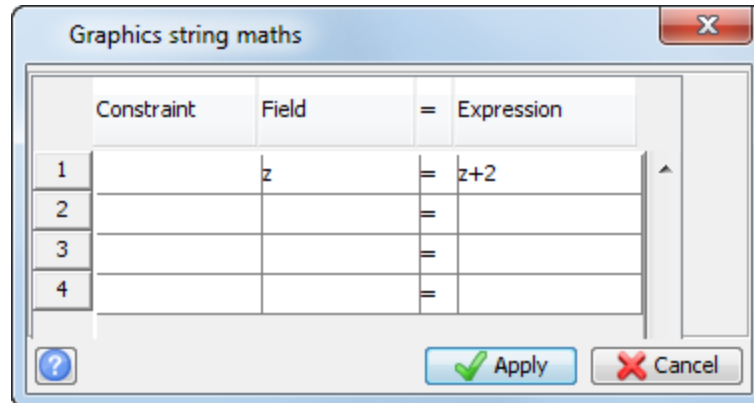


11. Click **Yes**.



**Task: Raise the centreline string above the floor**

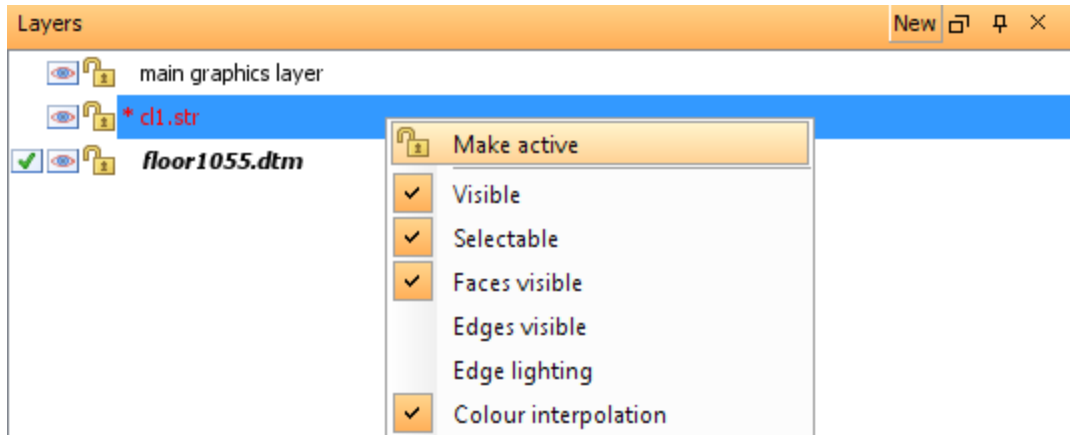
1. Click **Reset graphics** .
2. Open **cl1.str** in **Graphics**.
3. Choose **Edit > String > Maths**.
4. Enter the information as shown below, and click **Apply**.



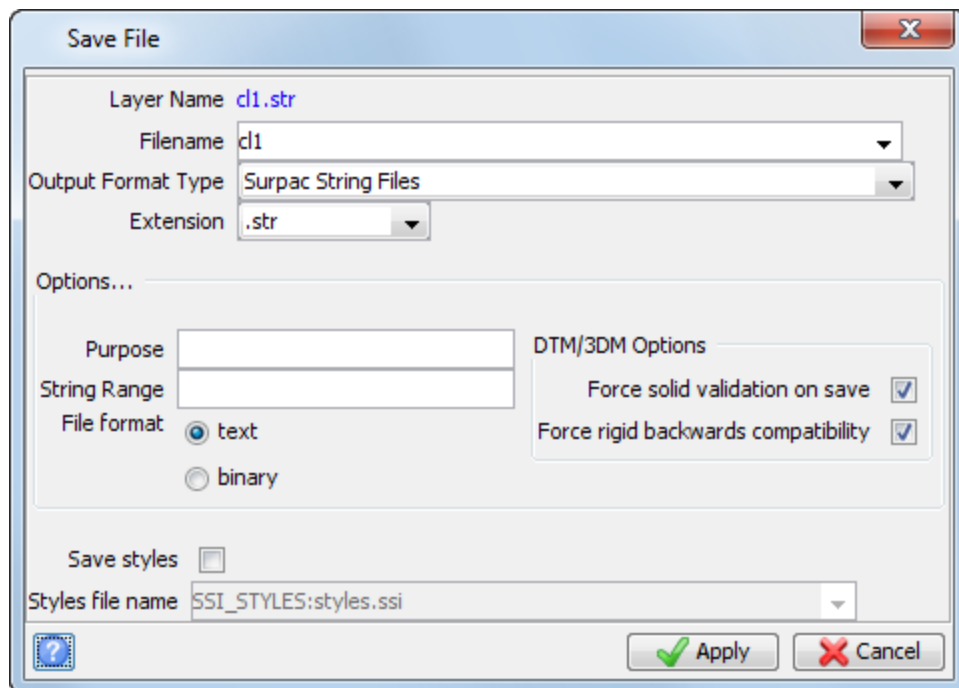
5. Click the string.
6. Press **ESC**.  
The centreline has been raised 2 metres vertically.
7. Open **floor1055.dtm** in **Graphics**.  
The centreline string is displayed 2 metres above the floor.



8. In the Layers pane, right-click **cl1.str**, and choose **Make active**.




9. Choose **File > Save > string/DTM**.
10. Enter the information as shown, and click **Apply**.

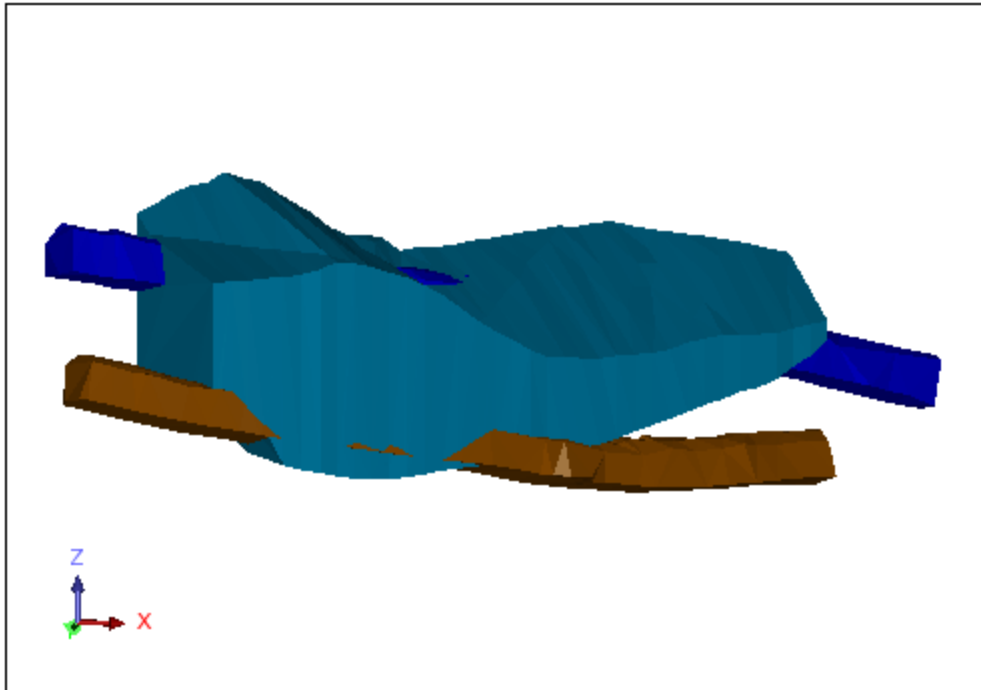


**Note:** To see all of the steps performed in this chapter, run **01\_create\_centrelines.tcl**. You need to click **Apply** on any forms presented.

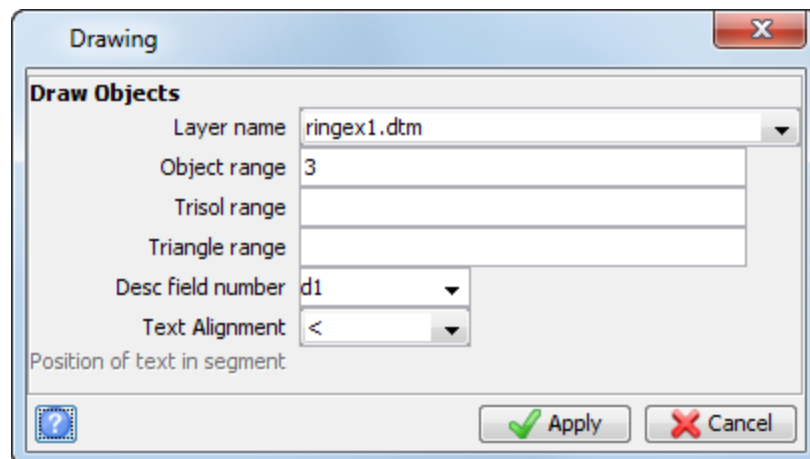
## Slicing objects

### Task: View the data

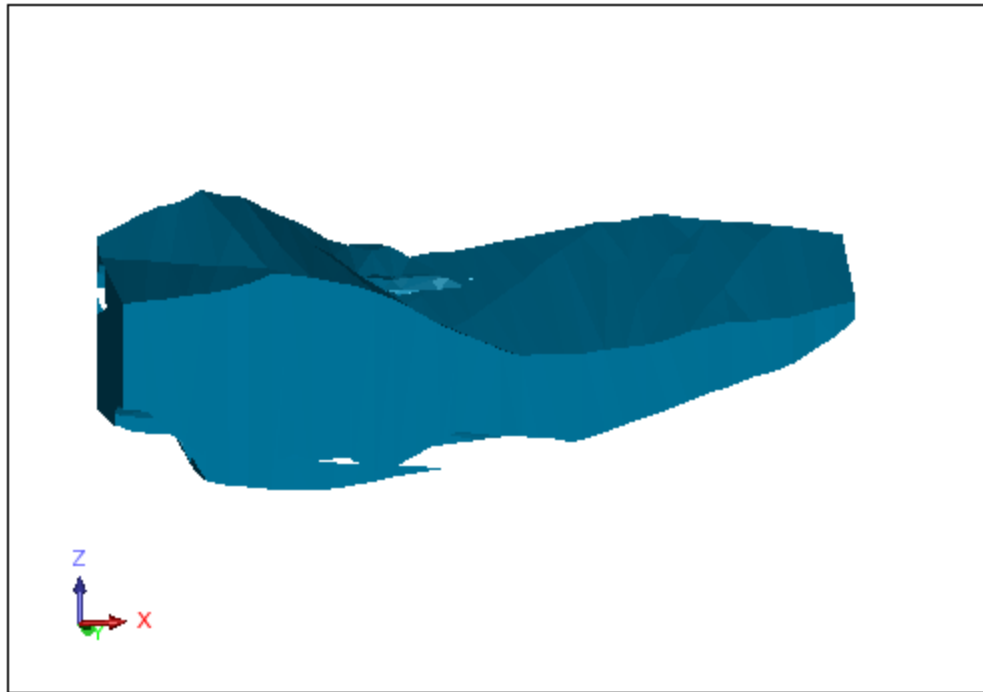
1. Click **Reset graphics** .
2. Open **ringex1.dtm** in **Graphics**.
3. Rotate the data to get an idea of the shape of the solids models.



4. Choose **Display > Hide everything**.
5. Choose **Display > Surface or Solid**.
6. Enter the information as shown, and click **Apply**.

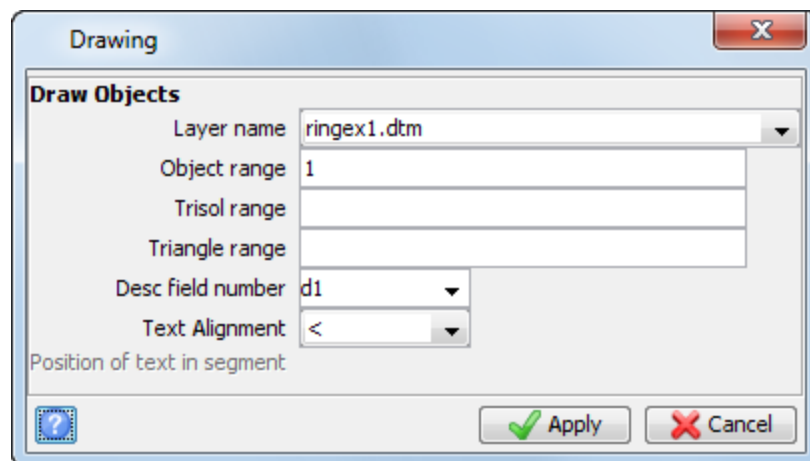


Object 3 is displayed.

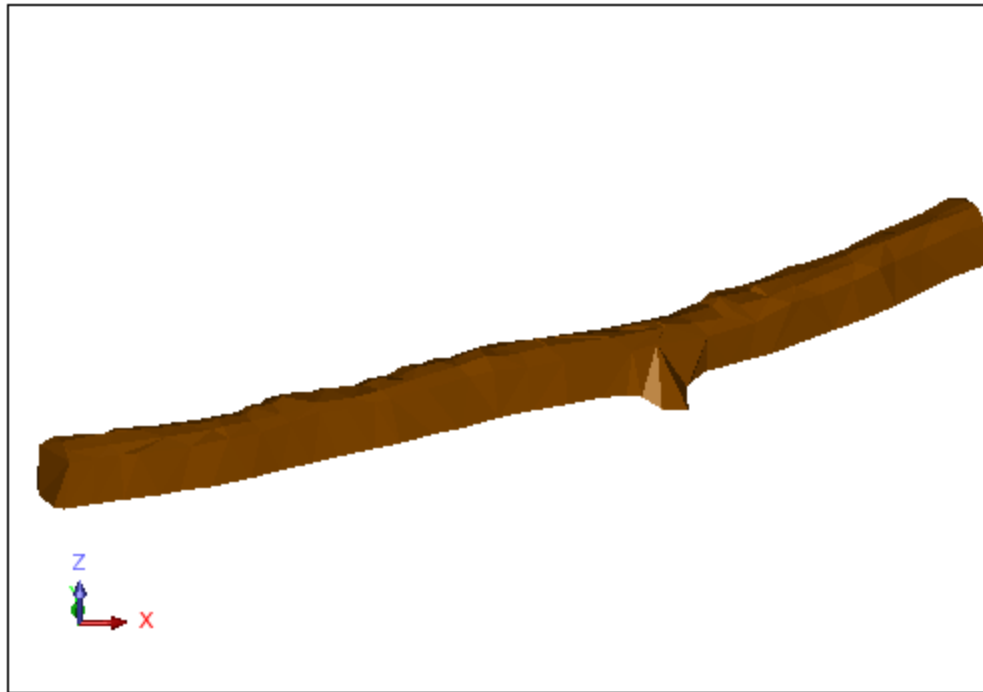


📌 **Note:** Object 3 represents the ore zone. It contains holes where the drives pass through it.

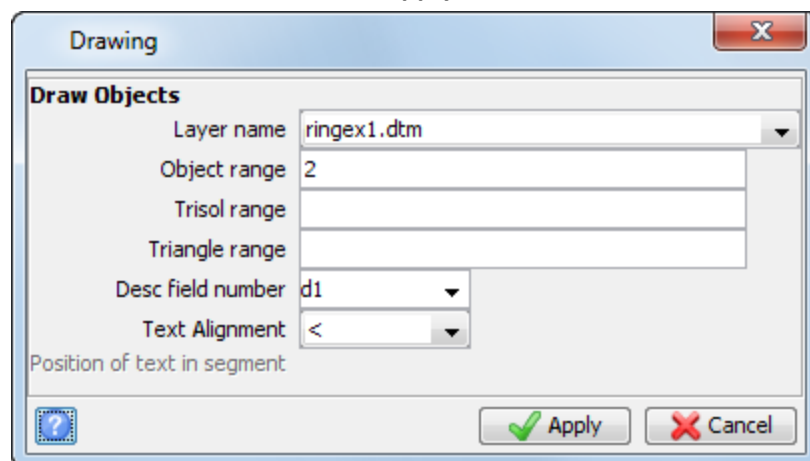
7. Choose **Display > Hide everything**.
8. Choose **Display > Surface or Solid**.
9. Enter the information as shown, and click **Apply**.



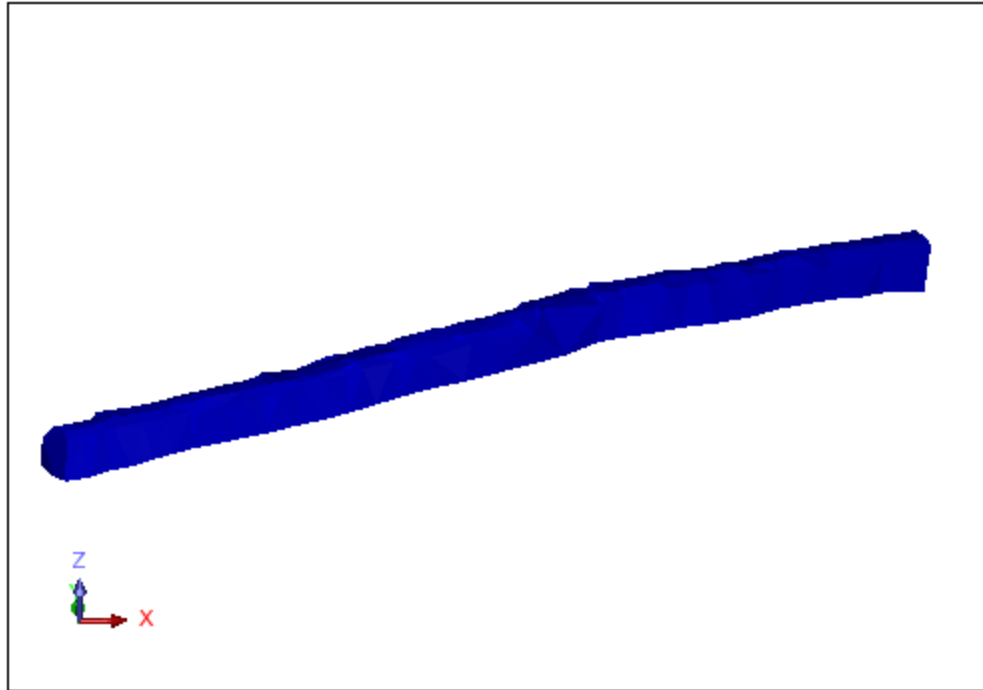
Object 1 is displayed.



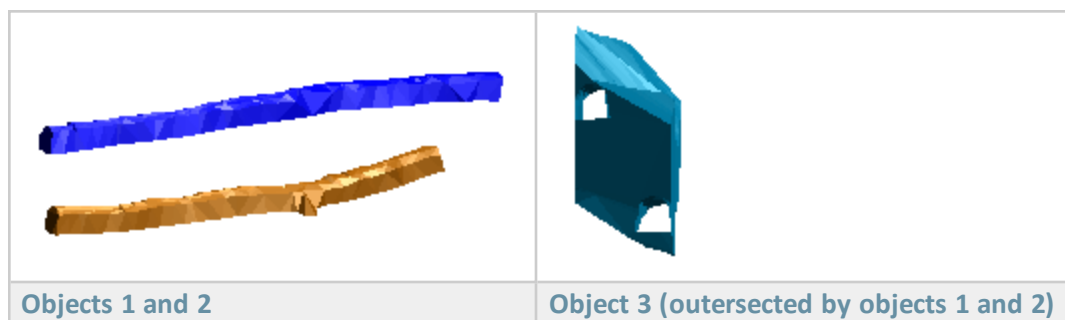
10. Choose **Display > Hide everything**.
11. Choose **Display > Surface or Solid**.
12. Enter the information as shown, and click **Apply**.



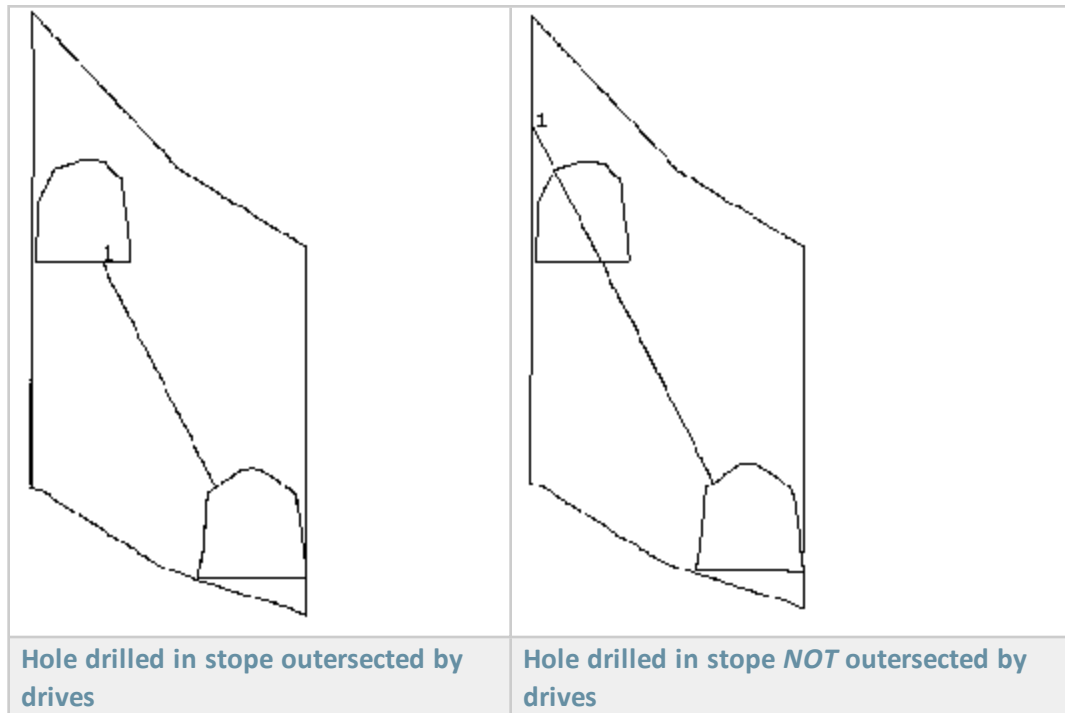
Object 2 is displayed.




Objects 1 and 2 are the drives, created from survey data. Object 3 was created by outersecting the solid of the ore zone by the solid of the drives.

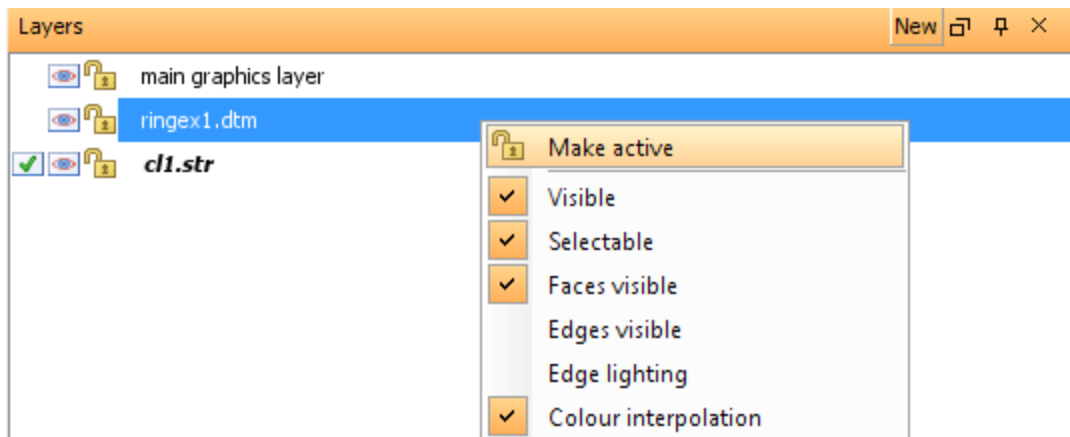



📌 **Note:** It is a good idea to use outersected solids for creating ring design slices, since the toe (or end) of the hole will be located at the point where the hole intersects the stope. As shown below, if the 3D solid of the stope is not outersected by the drives, you might not achieve the desired result.



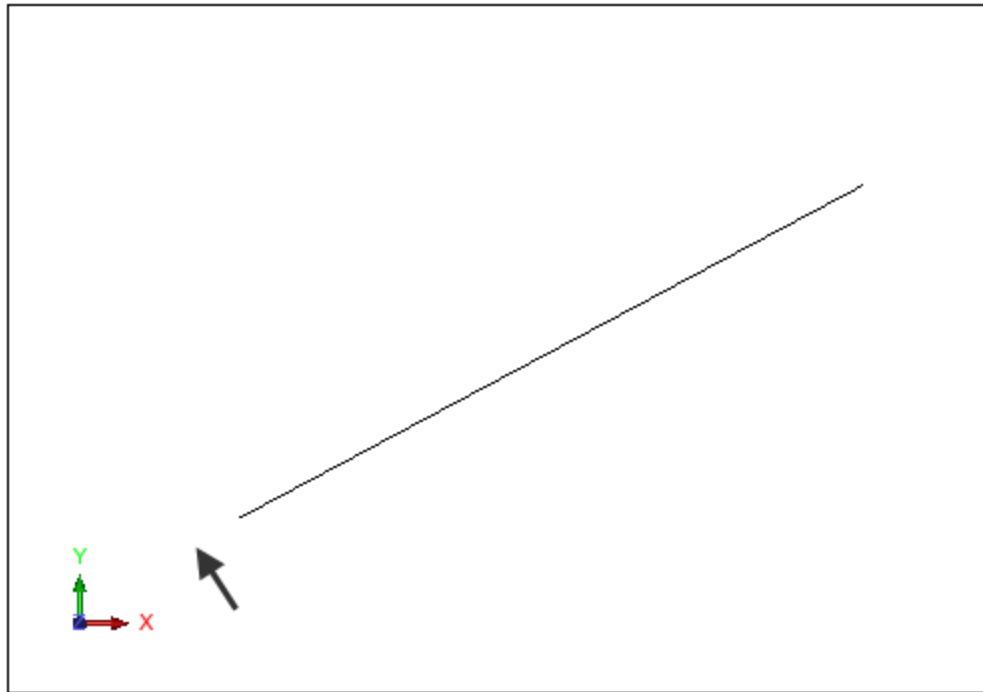
### Task: Slice the solid

1. Click **Reset graphics** .
2. Open **ringex1.dtm** in **Graphics**.
3. Open **cl1.str** in **Graphics**.
4. In the Layers pane, right-click **ringex1.dtm**, and select **Make active**.



5. Choose **View > Surface view options > Hide triangle faces**.
6. Click **Zoom all** .
 

You will use the southwest endpoint of **cl1.str** as the point from which to create the first ring. In this example, the rig will start from the southwest end of the stope and work toward the northeast, numbering the rings 1,2,3,through 50.
7. Choose **Solids > Solids tools > Section using centre line**.
8. Click a point below and to the left of the southwest end of the centreline, as shown.



Surpac will choose the nearest location on the line.


9. Click the other endpoint of the centreline by positioning the cursor northeast of the northeast endpoint of the line.
10. Enter the information as shown, and click **Apply**.

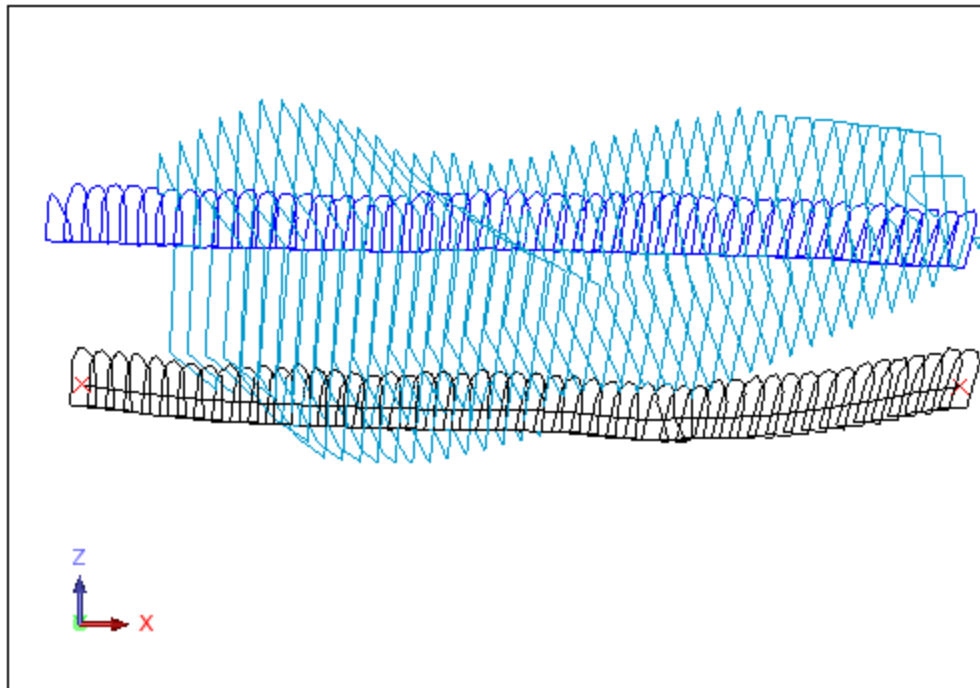
**Slice information** X

Spacing	<input type="text" value="2"/>		<input type="button" value="Calculate no. of Slices"/>
Number	<input type="text" value="50"/>		<input type="button" value="Calculate Spacing"/>
First slice dip	<input type="text" value="90"/>	degrees	
Last slice dip	<input type="text" value="70"/>	degrees	
Slice dip angles	<input checked="" type="radio"/> absolute <input type="radio"/> relative		

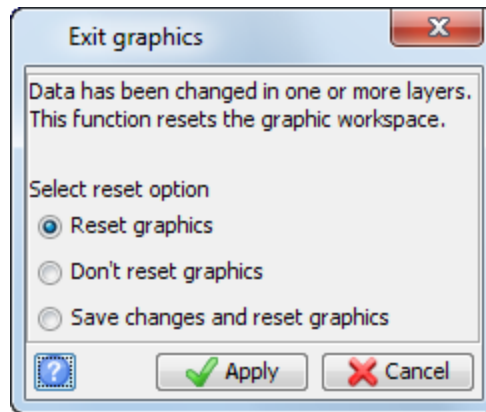
The slices for any portion of the centre line segment that is vertical will only be created in the XY plane regardless of the dip values entered for the slices. The dip is effectively locked at 90 degrees for any slices in a vertical centre line.

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

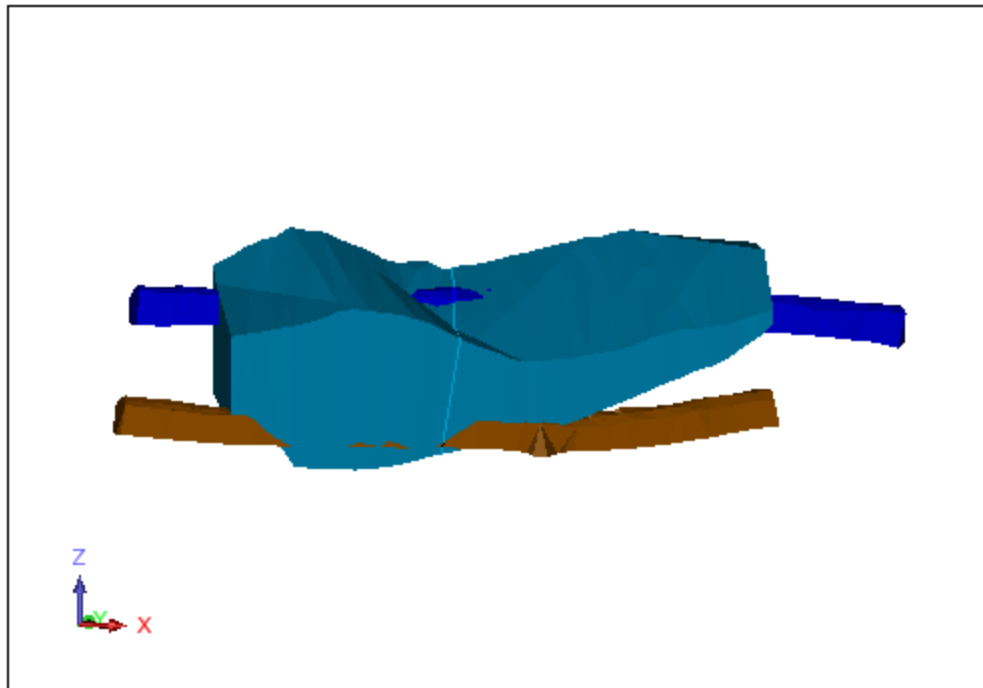
12. Click **Section view** .  
The sections are displayed.




13. Choose **Reset graphics** , and click **Apply**.



14. Open **1055sec25.str** in **Graphics**.
15. Open **ringex1.dtm** in **Graphics**.
16. Rotate the data to verify that the section has been created correctly.  
The solids section is displayed.

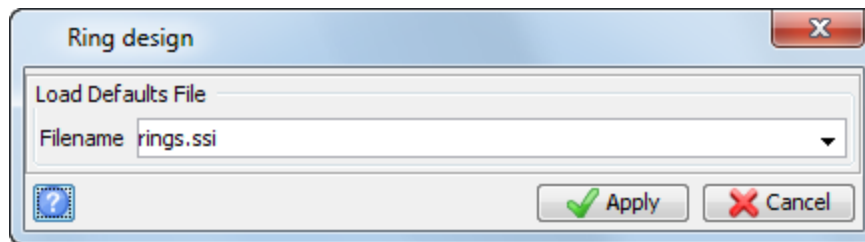


 **Note:** To see all of the steps performed in this chapter, run **02\_slice\_objects.tcl**. You need to click **Apply** on any forms presented.


## Setting up the rig

### Task: Perform rig setup

1. Click **Reset graphics** .
2. Choose **Ring design > Start ring design**.
3. Enter the information as shown, and click **Apply**.



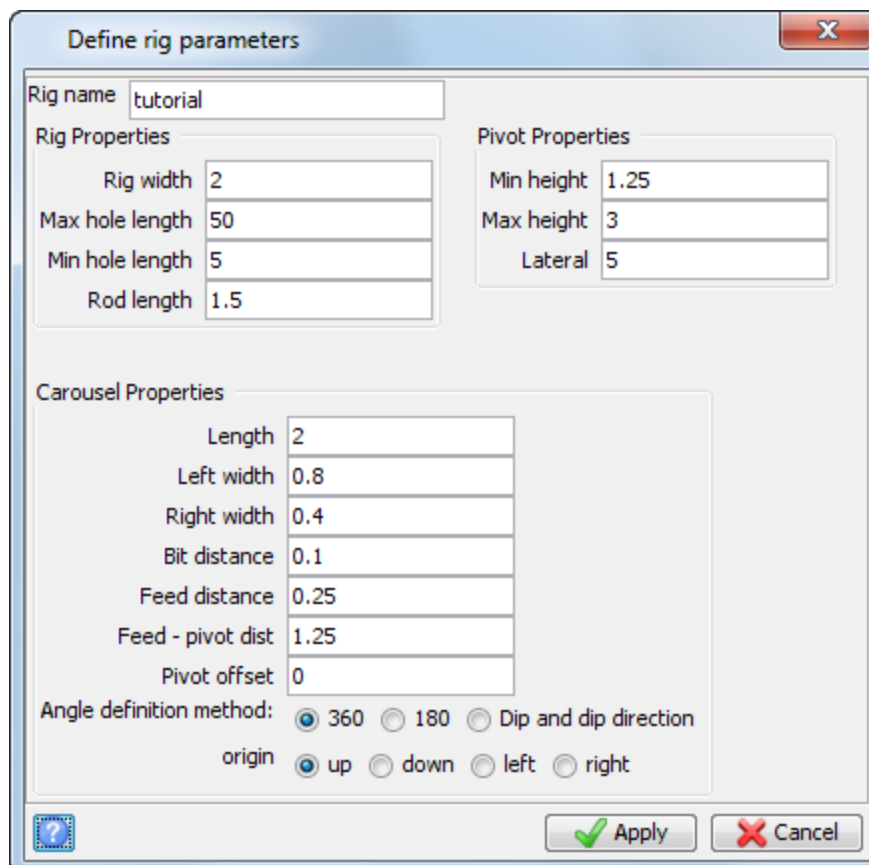
The 'Ring design' dialog box has a title bar with a close button (X). Below the title bar is a section labeled 'Load Defaults File' containing a text field with the value 'rings.ssi' and a dropdown arrow. At the bottom of the dialog are three buttons: a help button (question mark in a square), an 'Apply' button with a green checkmark, and a 'Cancel' button with a red X.

 **Note:** The default value of `ssi_etc:rings.ssi` would read values from a file in the `ssi_etc:` directory. In this example, you will store the data in a file named **rings.ssi** in the local data directory.

In the Status bar, the name of the default rig is displayed. If you are using ring design for the first time, **OLD DEFAULT RIG** is displayed.

 OLD DEFAULT RIG

4. Choose **Setup > New rig**.
5. Enter the information as shown, and click **Apply**.



The 'Define rig parameters' dialog box has a title bar with a close button (X). It contains several sections of input fields:

- Rig name:** A text field containing 'tutorial'.
- Rig Properties:** A table with four rows:
 

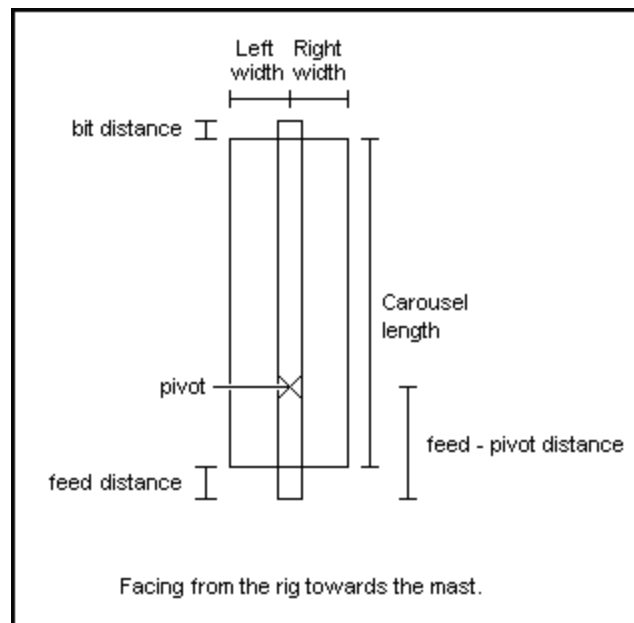
Rig width	2
Max hole length	50
Min hole length	5
Rod length	1.5
- Pivot Properties:** A table with three rows:
 

Min height	1.25
Max height	3
Lateral	5
- Carousel Properties:** A table with seven rows:
 

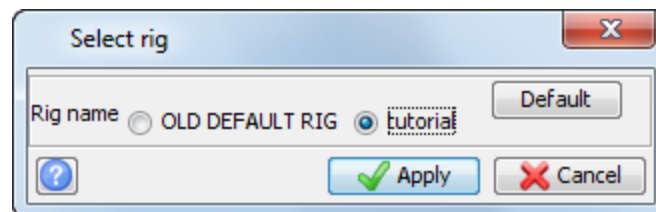
Length	2
Left width	0.8
Right width	0.4
Bit distance	0.1
Feed distance	0.25
Feed - pivot dist	1.25
Pivot offset	0
- Angle definition method:** A group of radio buttons with labels:
  - 360
  - 180
  - Dip and dip direction
- origin:** A group of radio buttons with labels:
  - up
  - down
  - left
  - right

At the bottom of the dialog are three buttons: a help button (question mark in a square), an 'Apply' button with a green checkmark, and a 'Cancel' button with a red X.

The diagram below shows how the parameters entered in the previous form relate to the rig you are creating.

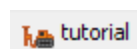


6. Choose **Setup > Select rig**.
7. Click **tutorial**, and then click **Default**.



The **tutorial** rig is set as the default rig the next time you invoke ring design.

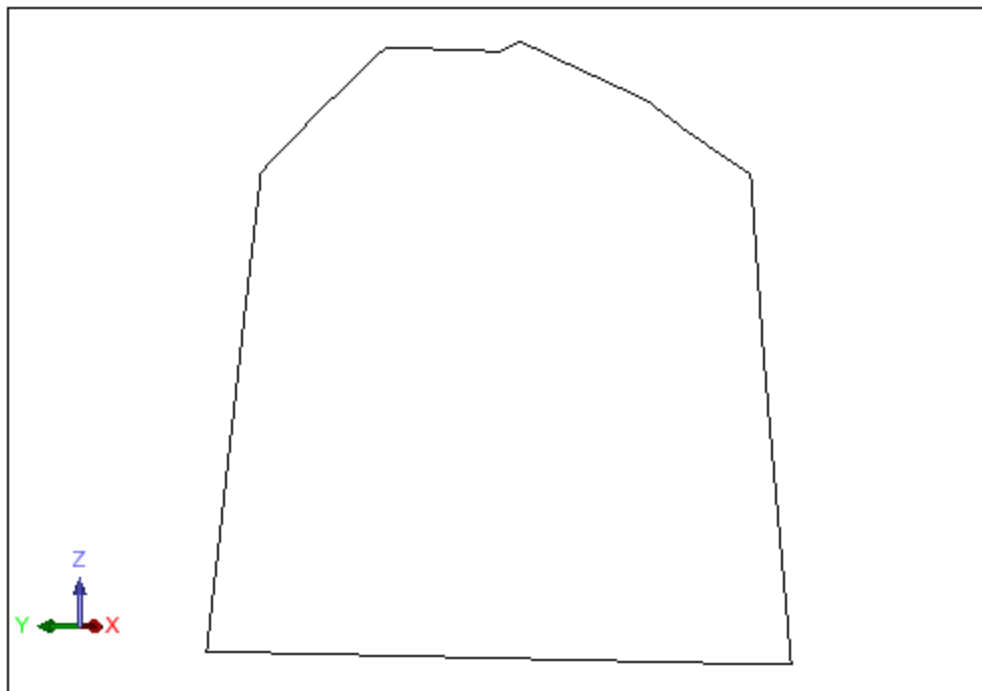
8. Click **Apply**.
- The rig name **tutorial** is displayed in the Status bar.





### Task: Set drilling parameters




1. Choose **Ring design > Open section files of stopes and openings.**
2. Enter the information as shown, and click **Apply.**

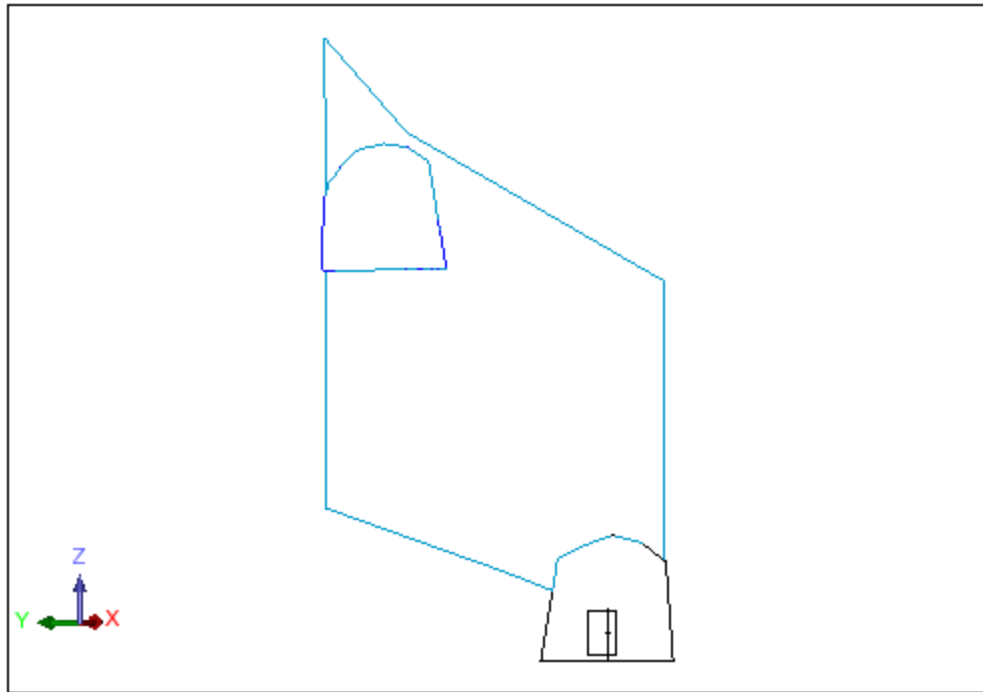
The first section is displayed.



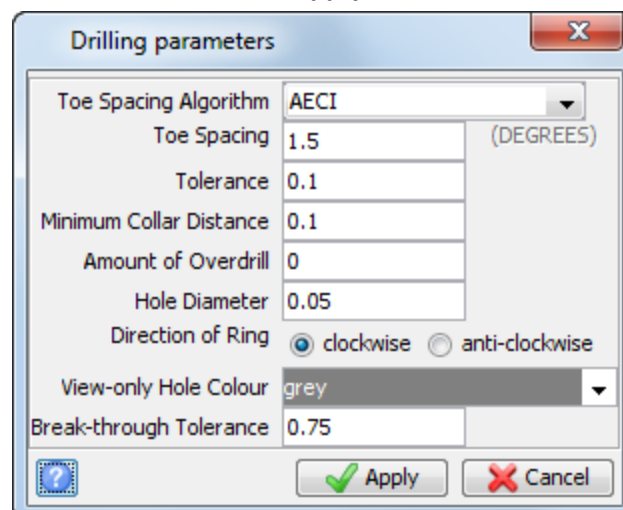
3. Click **Next section**  until you get to section 9.
  -  **Note:** The information on the Status bar changes each time you click **Next section.**

 tutorial  9  3.19895  151.946

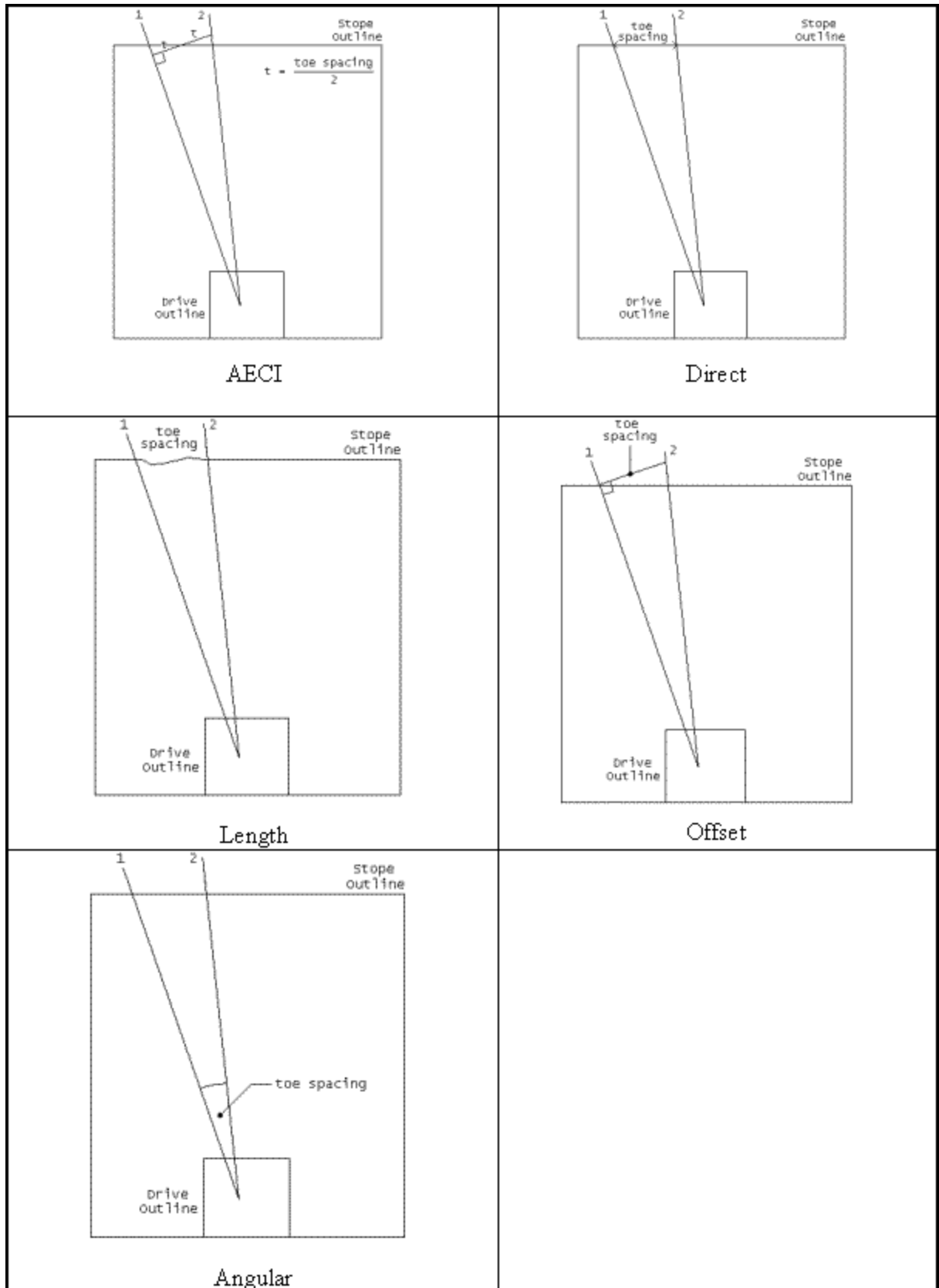
-  **Note:** When using **Next section**  and **Previous section** , the view presented in **Graphics** will always be perpendicular to each section.
4. Choose **Setup > Rig position.**
  5. Click near the lower drive, then near the stope.  
The rig is positioned in the lower drive as displayed.



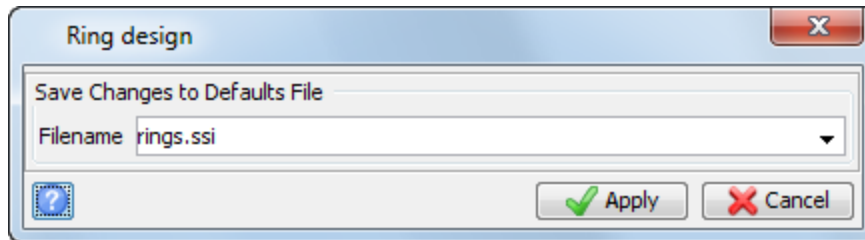
6. Choose **Setup > Drilling parameters**.
7. Enter the information as shown, and click **Apply**.




Diagrams representing the **Toe spacing** algorithms are displayed below. The toe spacing is a unit of measure (metres or feet) for all algorithms except for angular. When the angular toe spacing algorithm is selected, the toe spacing is in defined in degrees.




8. Choose **Ring design > Save ring design settings**.
9. Enter the information as shown, and click **Apply**.



 **Note:** To see all of the steps performed in this chapter, run **03\_setup.tcl**. You need to click **Apply** on any forms presented.

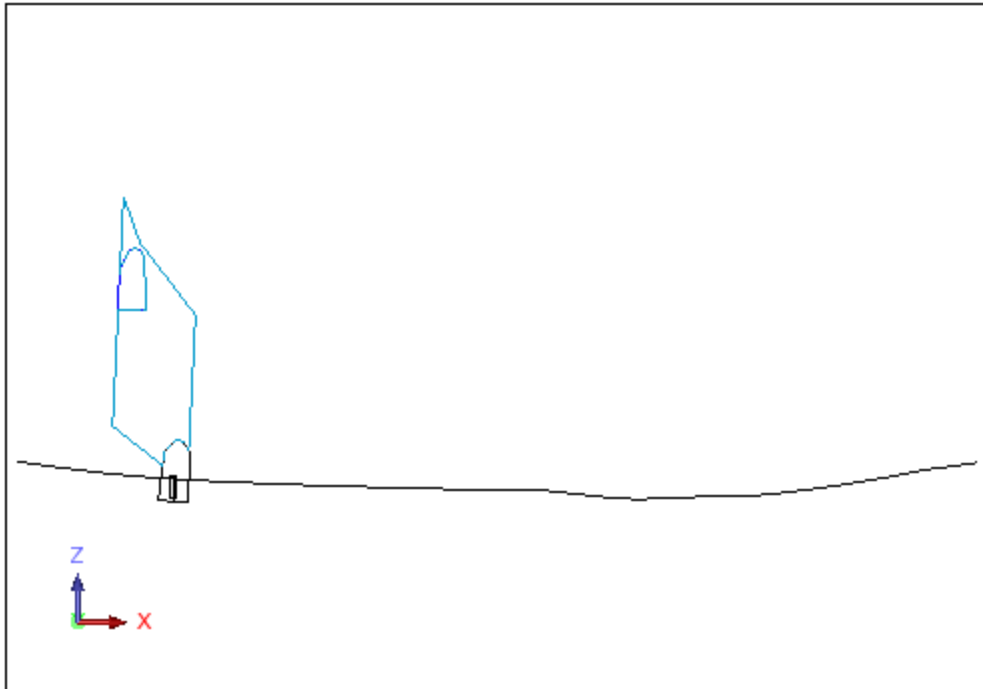
## Moving the mast

### Task: Use a centreline string as a reference line

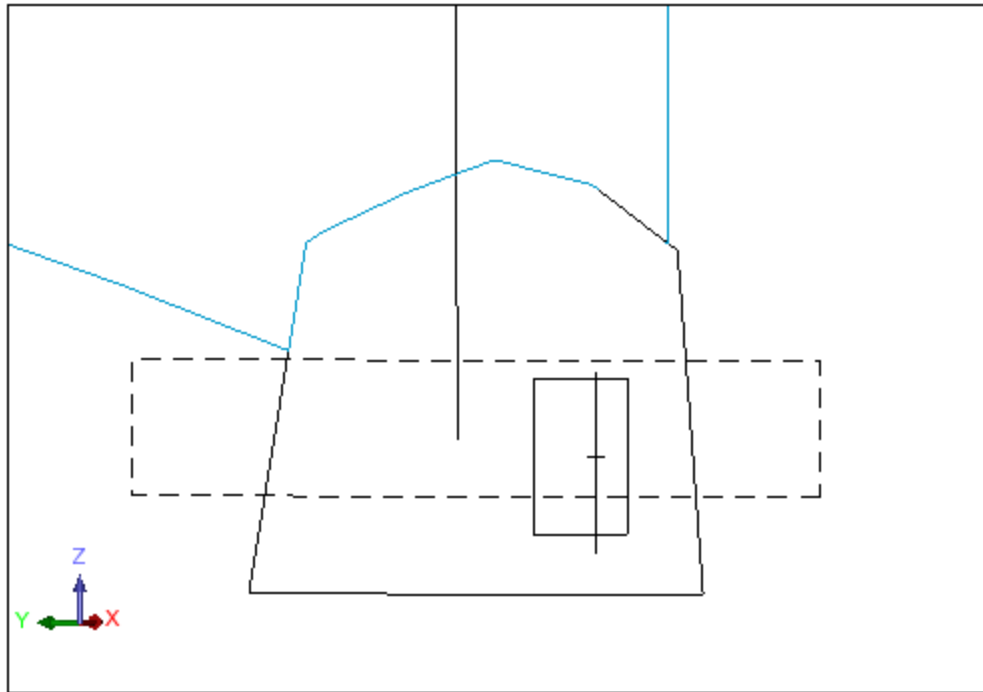
 **Note:** To perform the steps in this task, you must have either:

- completed the previous task **Setting up the rig**
- run macro **03\_setup.tcl**

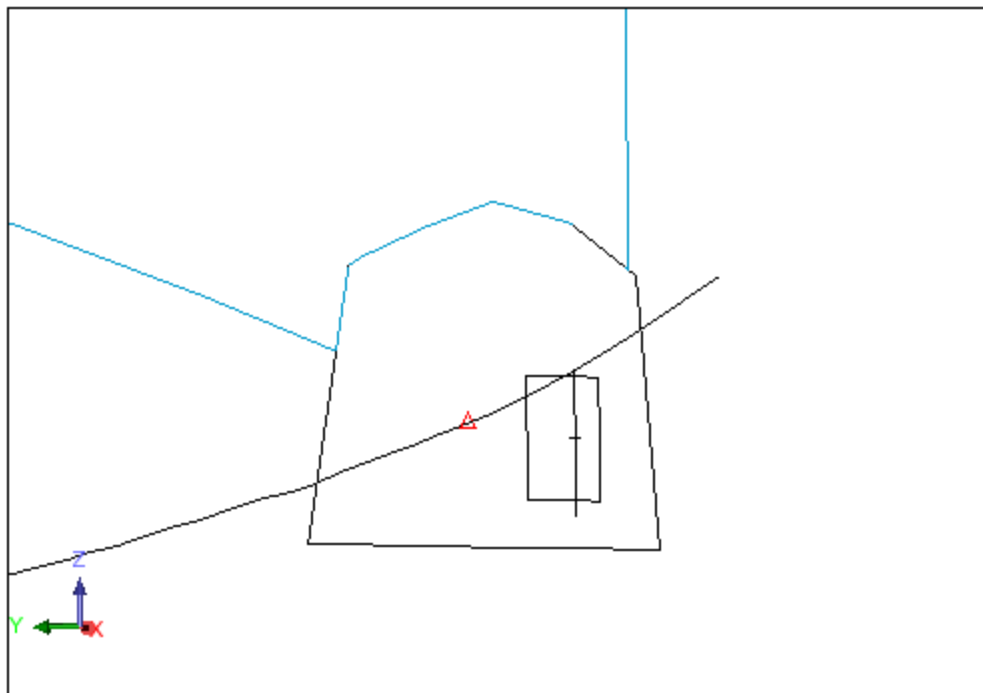
1. Open **cl1.str** in **Graphics**.



2. Choose **View > Zoom to extent of current section**.
3. Zoom in on the drive where the rig is positioned.
4. Choose **Move mast > By graphics**.
5. Practice moving the mast by clicking and dragging it around in **Graphics**.
6. Press **ESC**.



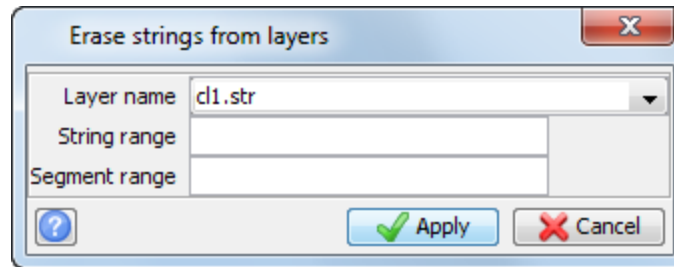
7. Choose **Setup > Select reference line for offsets**.
8. Click the centreline string.
9. Click and drag the cursor in **Graphics** to view the data as shown.



After selecting the reference centreline, the point where the centreline intersects the plane of the section is marked with a small red triangle. A reference distance and direction is now stored for every hole drilled on this section.

10. Choose **View > Zoom to extent of current section** to return to a view perpendicular to this section.

11. Choose **Display > Hide strings > In a layer**.
12. Enter the information as shown, and click **Apply**.

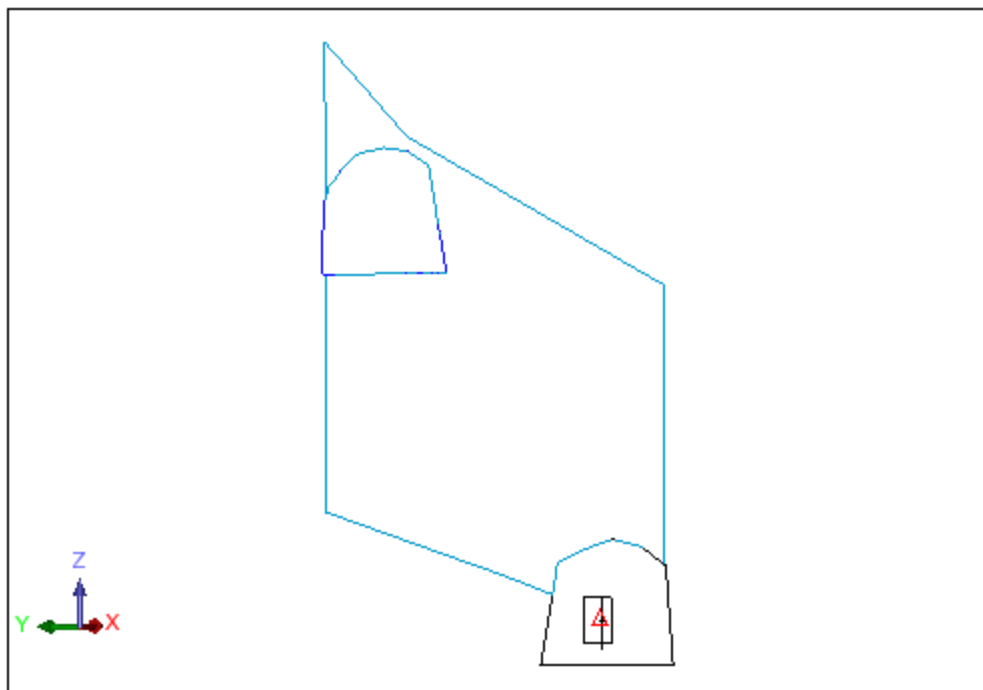


### Task: Move and rotate the mast

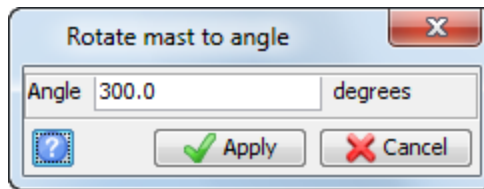
1. Choose **Move mast > By coordinates**.
2. Enter the information as shown, and click **Apply**.



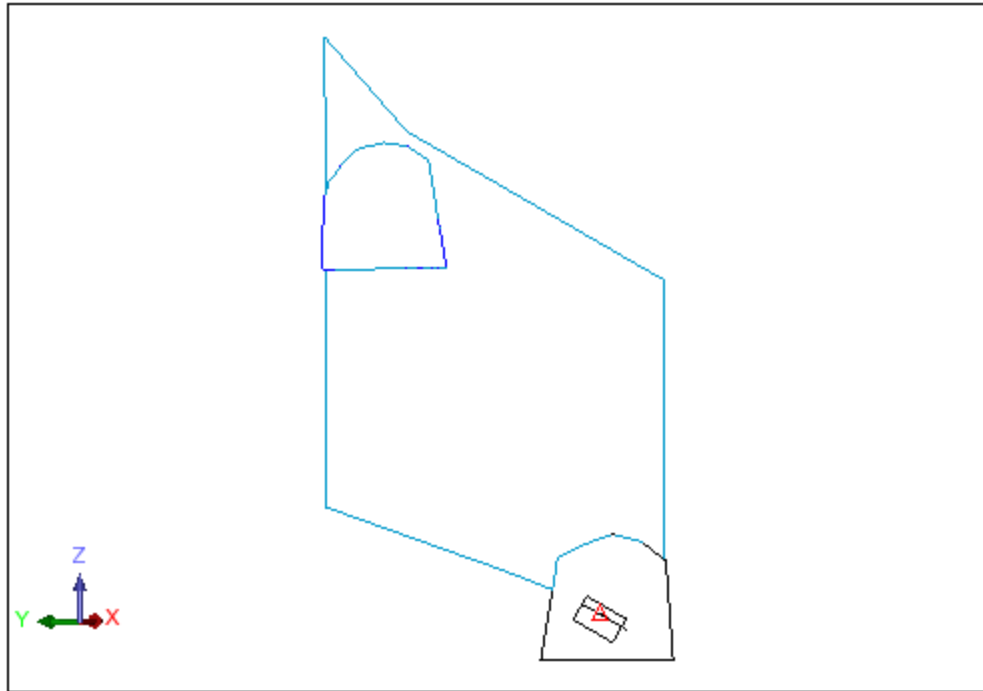
The mast is moved so that its pivot point is on the centreline. By selecting a reference line, you have set up a coordinate system within the plane of the section that has an origin at the point where the centreline pierces the section. This coordinate system is used only for positioning the rig, and for reporting the rig pivot point position relative to the centreline.



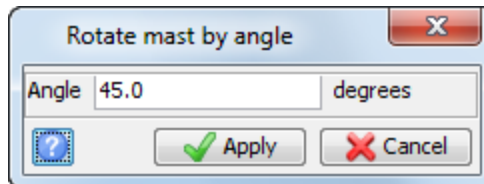
3. Choose **Rotate mast > To angle**.
4. Enter the information as shown, and click **Apply**.



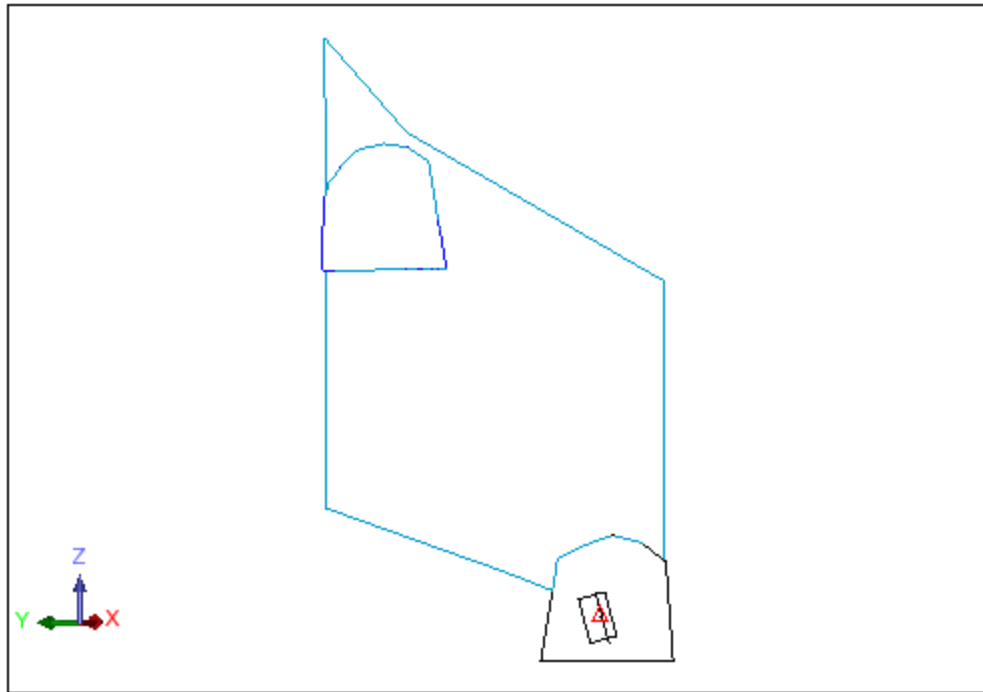
The mast is rotated to an angle of 300 degrees.



5. Choose **Rotate mast > By angle**.
6. Enter the information as shown, and click **Apply**.



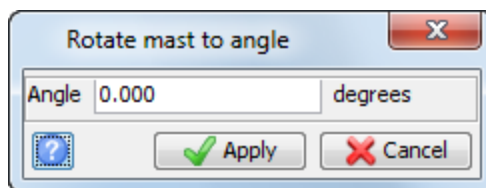
The mast is rotated clockwise from its current orientation by 45 degrees.



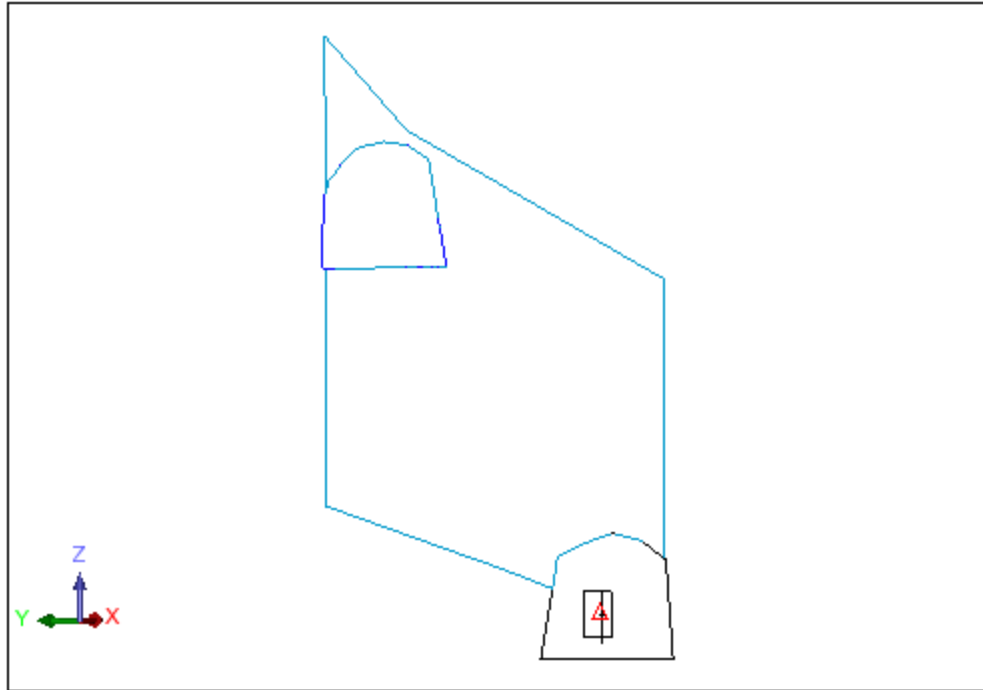
7. Choose **Rotate mast > By graphics**.
8. Click and drag in **Graphics** to move the mast around, then release to leave the mast in a new location.
9. Press **ESC**.
10. Choose **Rotate mast > To point**.
11. Click a point in **Graphics**.
12. Choose **Move mast > By coordinates**.
13. Enter the information as shown and click **Apply**.



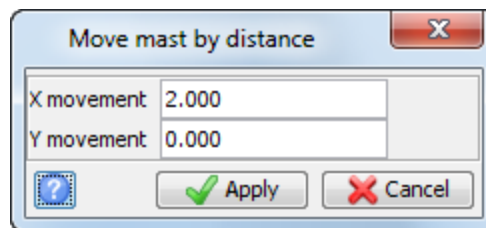
14. Choose **Rotate mast > To angle**.
15. Enter the information as shown, and click **Apply**.



The mast is moved to the centreline.



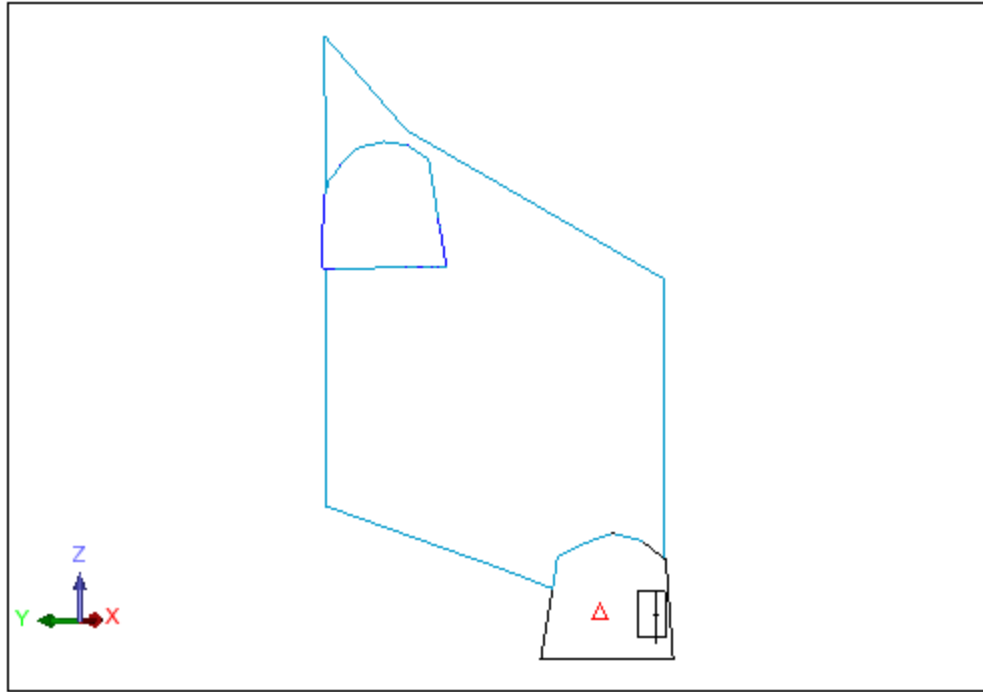
16. Choose **Move mast > By distance**.
17. Enter the information as shown, and click **Apply**.




18. Choose **Move mast > From wall**.
19. Enter the information as shown, and click **Apply**.




The mast is displayed in the following orientation.




 **Note:** The distance shown will change when you select the left or right radio button. This is the horizontal distance in the plane of the section, from the pivot point to the point on the wall.

Leave the mast in this position for use in the next section, **Creating and reporting holes**.

 **Note:** To see all of the steps performed in this chapter, run **04\_move\_mast.tcl**. You need to click **Apply** on any forms presented.

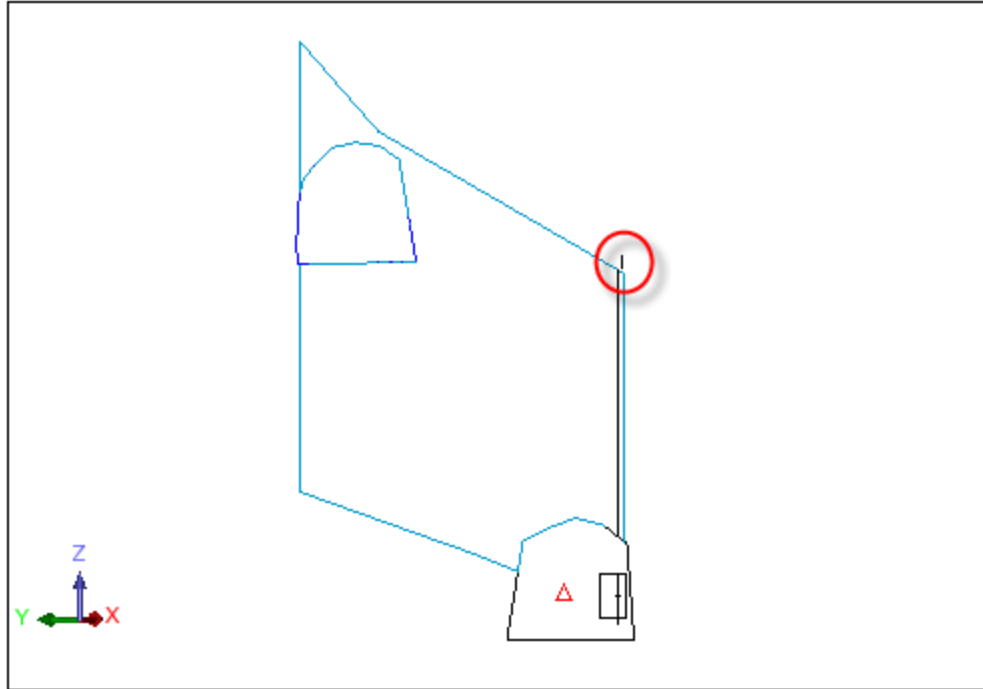
## Creating and reporting holes

### Task: Create and edit holes

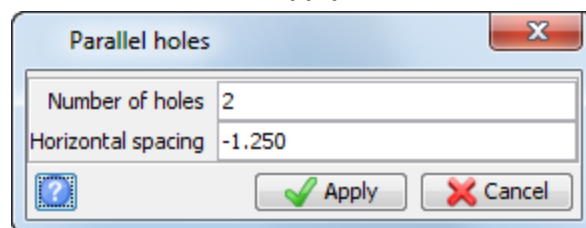
 **Note:** To perform the steps in this task, you must have either:

- completed the previous task **Moving the mast**
- run macro **04\_move\_mast.tcl**

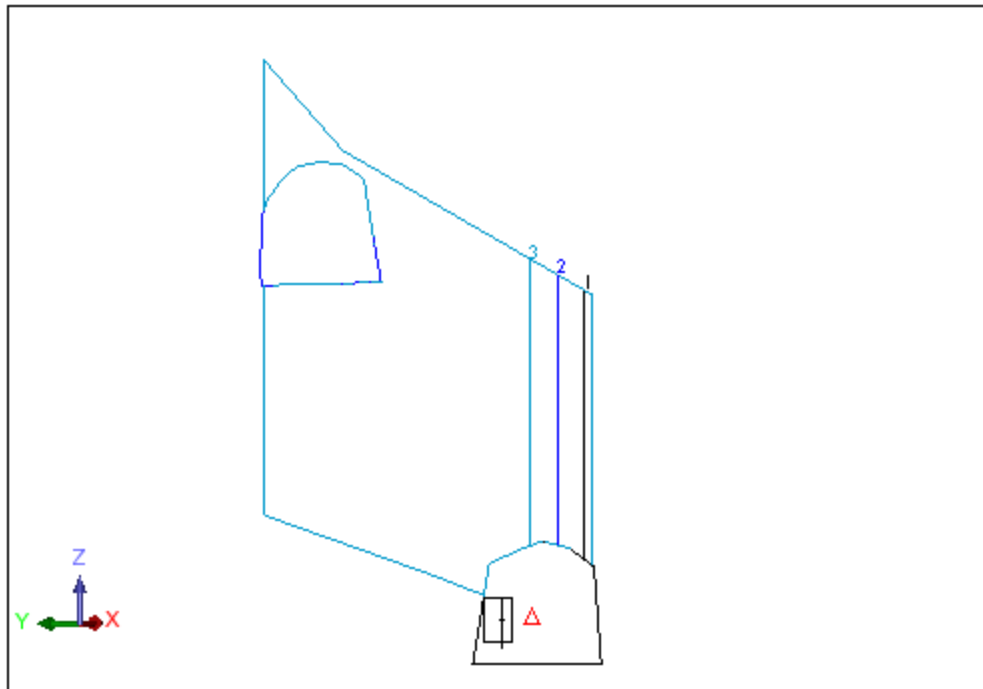
1. Choose **Create holes > At current mast orientation**.
2. Choose **View > Hole IDs** four times, until you see the number "1" for the second time. The hole is displayed.



3. Choose **Create holes > Parallel to an existing hole**.
4. Click **hole number 1**.
5. Enter the information as shown, and click **Apply**.



Three holes are displayed.



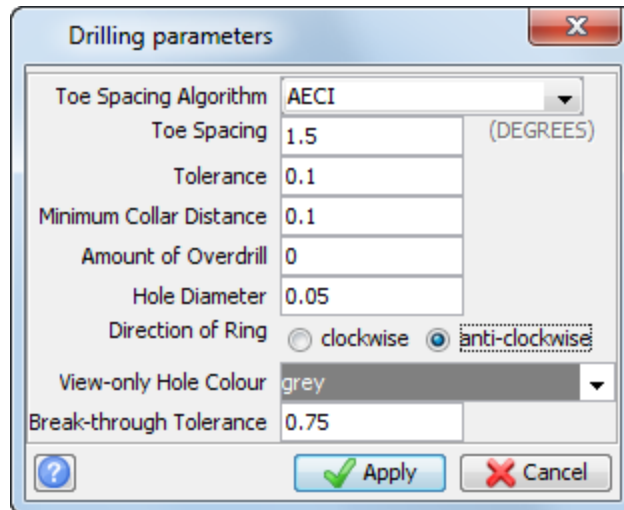
Assume that after looking at this result, you decide that you would rather drill hole number 3 and all remaining holes with the rig at the centreline point.

6. Choose **Edit > Delete one hole**.
7. Click **hole number 3**.  
Hole number 3 is removed.
8. Choose **Move mast > By coordinates**.
9. Enter the information as shown, and click **Apply**.

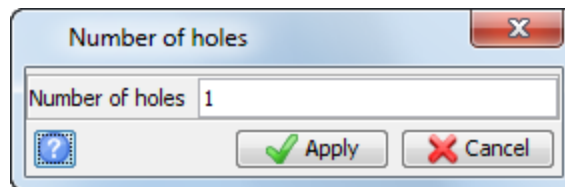


10. Choose **Setup > Drilling Parameters**.

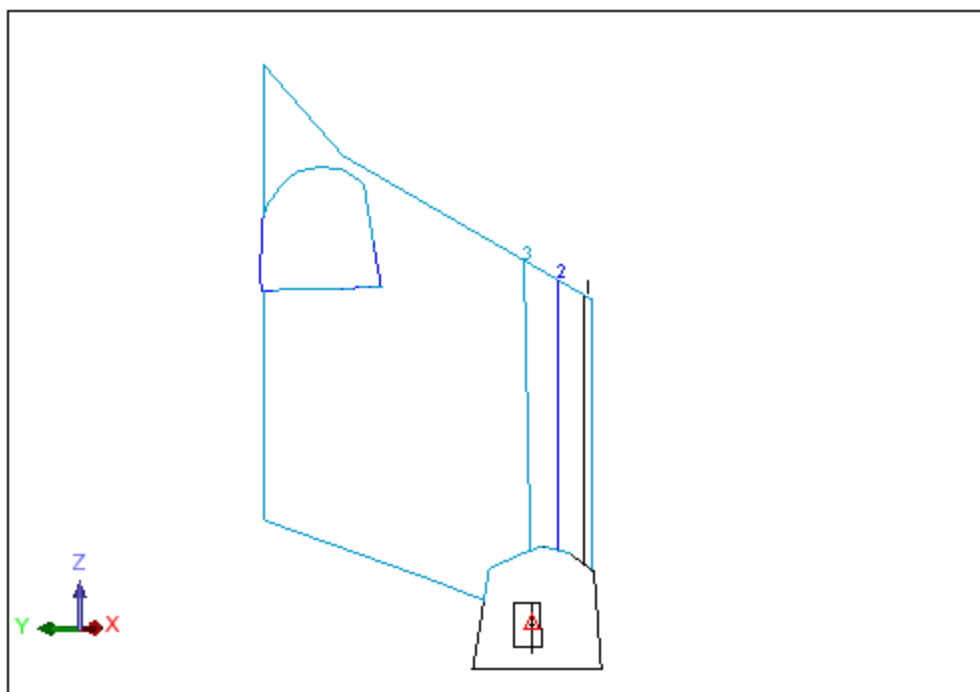
- Enter the information as shown, and click **Apply**.



- Choose **Create holes > Offset from existing hole**.
- Click **hole number 2**.
- Enter the information as shown, and click **Apply**.

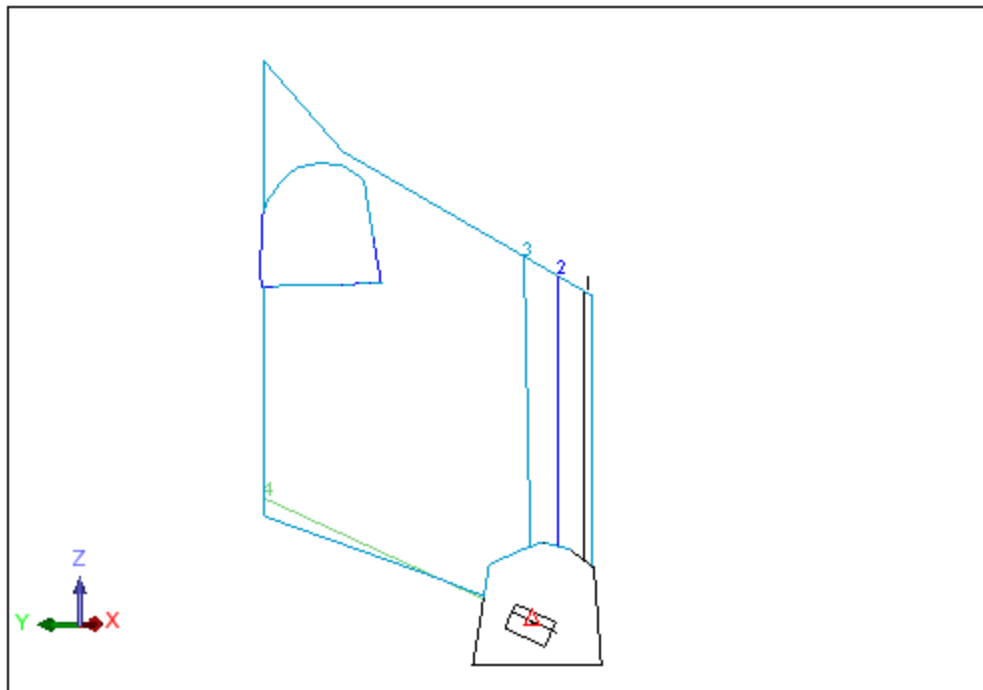


Hole number 3 is created to the left of hole number 2, using the AECI algorithm, and a toe spacing distance of 1.5.

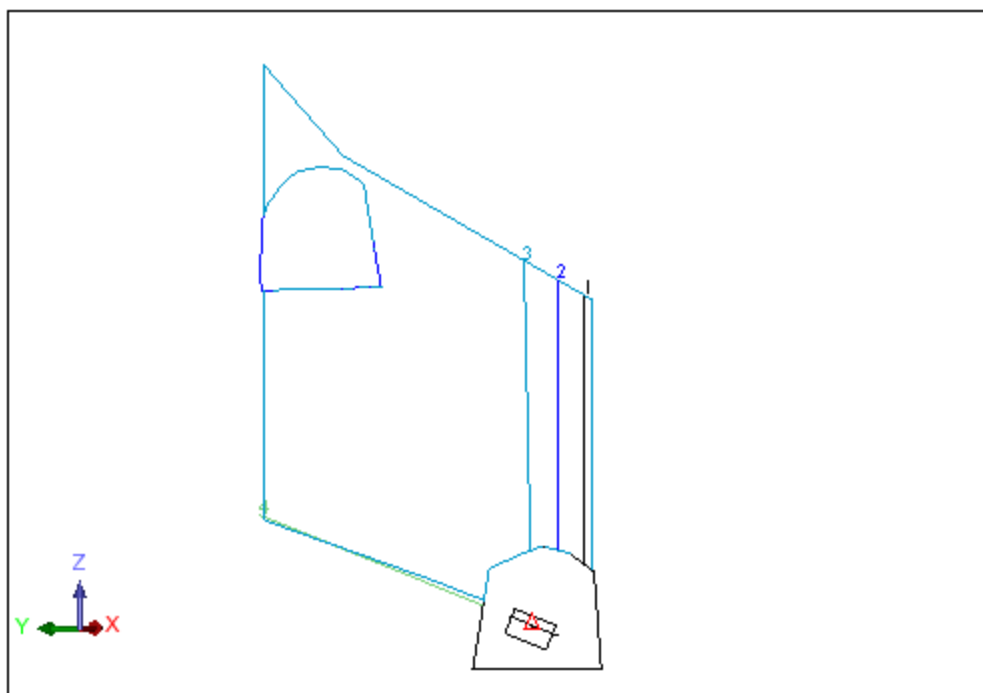


- Choose **Create holes > At selected location**.

16. Click a location on the left stope wall to create a hole similar to that shown in the following.

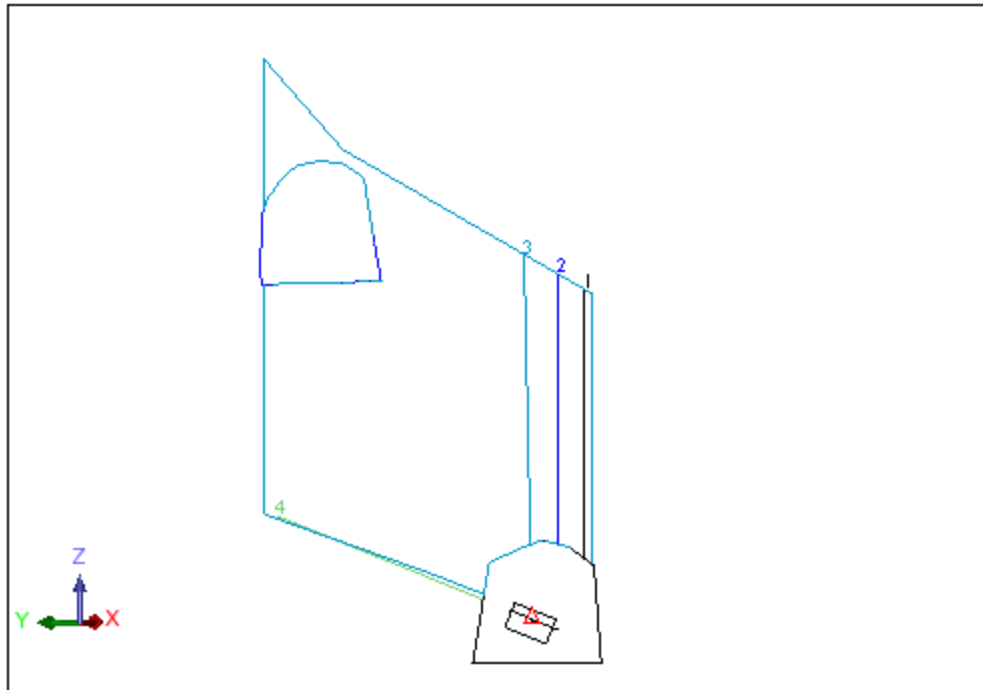


17. Choose **Edit > Rotate hole**.
18. Click hole **4**, then release to select hole number 4.
19. Click hole **4** again and drag it to the lower stope limit, or footwall as displayed.



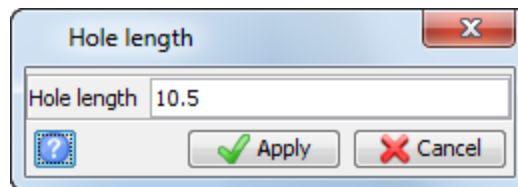
20. Choose **Edit > Edit hole length graphically**.

- At the prompt, click and drag the toe, or end of the hole, to the new position.

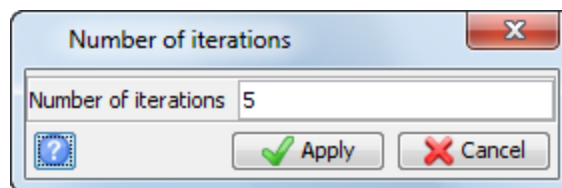


When you release the mouse, the length of the hole will be reset to that position. This function is not an exact means of setting a hole length.

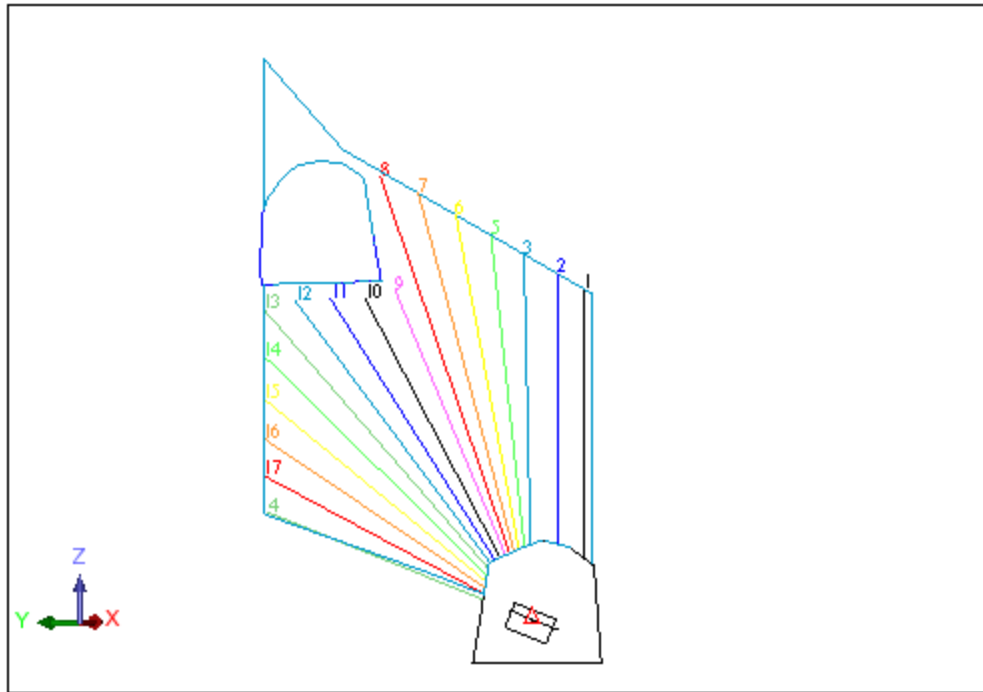
- Choose **Edit > Set length of one hole**.
- Click **hole number 4**.
- Enter the information as shown, and click **Apply**.



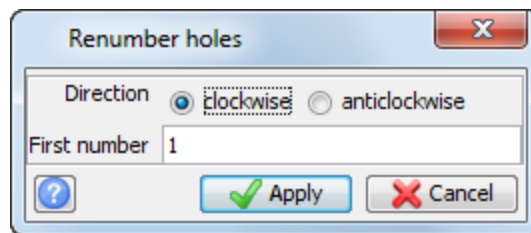
- Press **ESC**.
- Choose **Create holes > Between two holes**.
- Click **hole 3**, and then **hole 4**.
- Enter the information as shown, and click **Apply**.



The holes will be created between holes 3 and 4. Notice that several holes which came near, or would have intersected the upper drive, were shortened. When holes would normally terminate at a surveyed opening, they are shortened by the break-through tolerance value. In this case, the tolerance was set to 0.75m on the *Drilling Parameters* form.

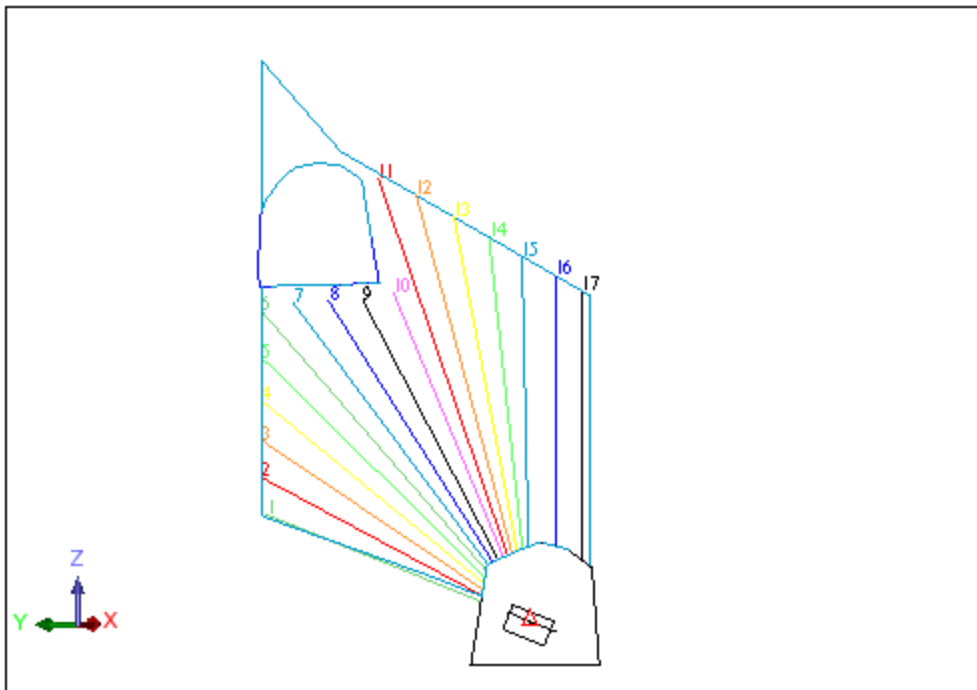


29. Choose **Edit > Renumber holes**.
30. Enter the information as shown, and click **Apply**.



31. Click hole **4**.

The holes are renumbered clockwise from 1 upwards, starting at the footwall.



### Task: Save holes

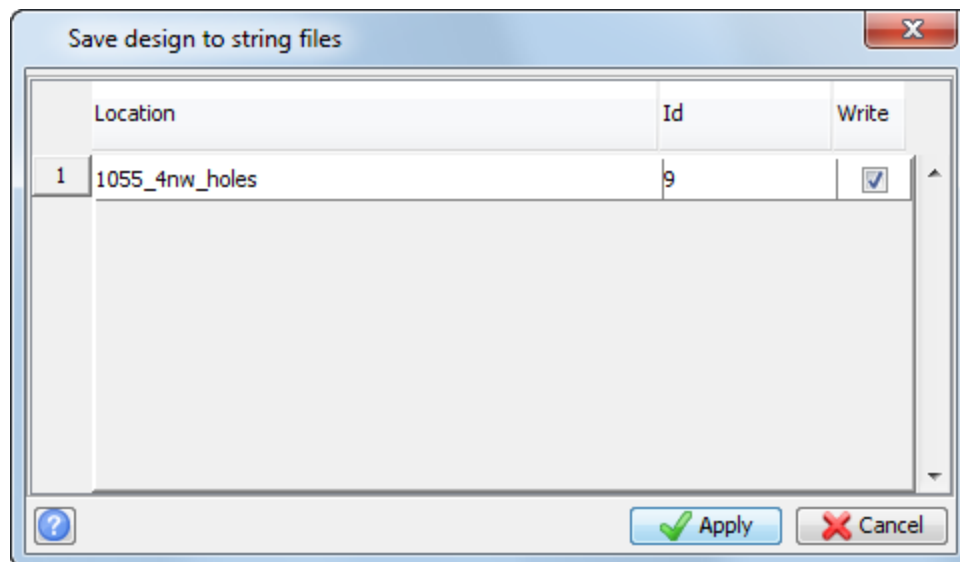
1. Choose **Ring design > Save holes**.
2. Enter the information as shown, and click **Apply**.

The screenshot shows a dialog box titled "Current position information" with a close button (X) in the top right corner. It contains two text input fields: "Stope" with the value "4NW" and "Drive" with the value "1055". Below the fields are three buttons: a help button (question mark in a blue square), an "Apply" button with a green checkmark, and a "Cancel" button with a red X.

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

The screenshot shows a dialog box titled "Ring name" with a close button (X) in the top right corner. It contains a text input field labeled "Ring" with the value "9". Below the field are three buttons: a help button (question mark in a blue square), an "Apply" button with a green checkmark, and a "Cancel" button with a red X.

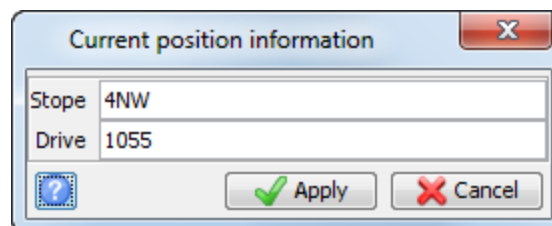
4. Enter the information as shown, and click **Apply**.



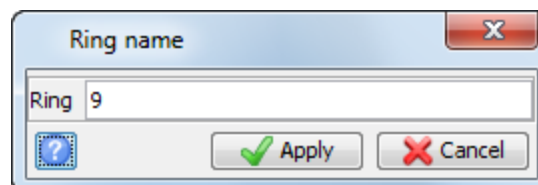
The string file **1055\_4nw\_holes9.str** is created in the working directory.

### Task: Report holes

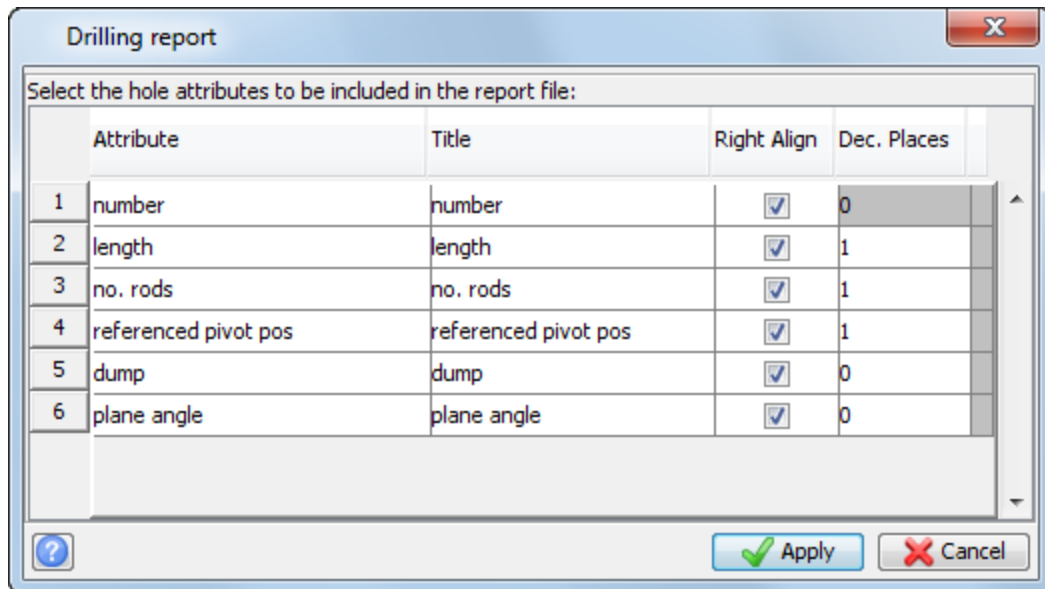
1. Choose **Reports > Drilling report**.
2. Enter the information as shown, and click **Apply**.



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

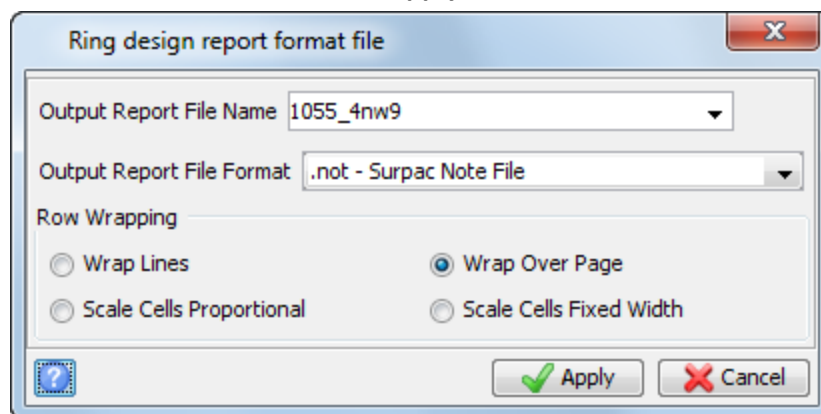


4. Enter the information as shown, and click **Apply**.



**Note:** To add rows to the table, right click in the blank area beneath the table, and select **Add**. You can then select the fields from a drop down list.

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



The drilling report is written to the file **1055\_4nw9.not**. If you double-click this file in the Navigator it opens in your default text editor.

Ring Design drilling report:

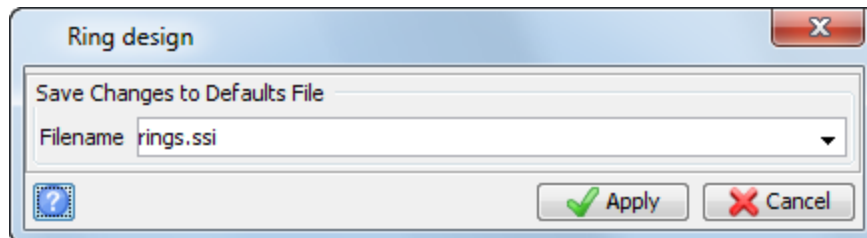
Ring: 9

Number	Length	No. Rods	Referenced Pivot Pos	Dump	Plane Angle
1	10.5	7.0	0.0	3	292
2	11.3	7.5	0.0	3	298
3	12.1	8.1	0.0	3	304
4	13.0	8.7	0.0	3	309
5	14.2	9.4	0.0	3	314
6	15.5	10.4	0.0	3	319
7	14.9	9.9	0.0	3	323
8	14.0	9.3	0.0	3	328
9	13.3	8.8	0.0	3	332
10	13.0	8.7	0.0	3	337
11	18.1	12.0	0.0	3	341
12	16.8	11.2	0.0	3	345
13	15.4	10.3	0.0	3	349
14	14.2	9.5	0.0	3	354
15	13.2	8.8	0.0	3	359
16	12.3	8.2	1.15	3	0
17	12.2	8.1	2.45	3	0
	233.9				

Page 1 of 1

**Task: Save default values**

1. Choose **Ring design > Save ring design settings**.
2. Enter the information as shown, and click **Apply**.



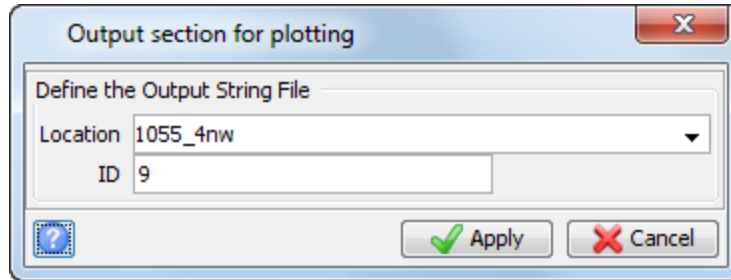
**Note:** In practice, you would usually want to use the default file of **ssi\_etc:rings.ssi**. You are saving **rings.ssi** in the local directory for training purposes only.

**Note:** To see all of the steps performed in this chapter, run **05a\_create\_holes.tcl** and **05b\_report\_holes.tcl**. You need to click **Apply** on any forms presented in each of these macros.

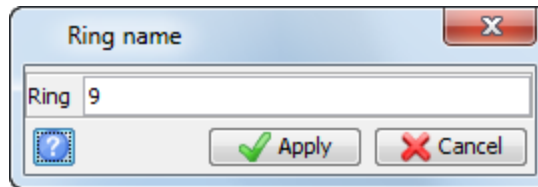
# Plotting

## Task: Save holes for plotting

1. Choose **Ring design > Save holes and sections for plotting**.
2. Enter the information as shown, and click **Apply**.



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



The file **1055\_4nw9.str** is saved to the work directory.

String files saved with **Save holes and sections for plotting** contain:

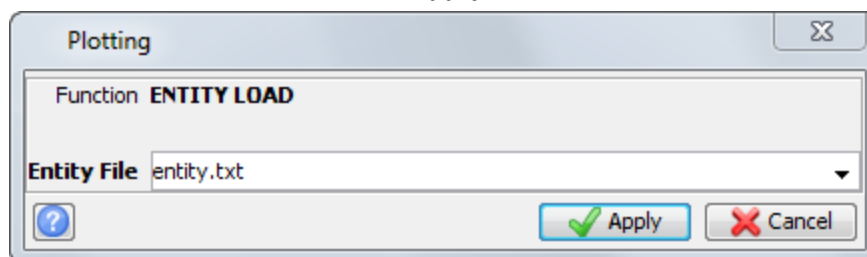
Data	String Numbers
Drill Holes	1,999
Drives	Drive string number + 1000
Stopes	Stope string number + 2000
Rig Pivot Points	32000

The following string numbers are used in plotting. In this example, **1055\_4nw9.str** will contain:

Data	String Numbers
Drill Holes	1,17
Drives	1001, 1002
Stopes	2003
Rig Pivot Points	32000

## Task: Create a plot

1. Choose **Plotting > Entity > Import**.
2. Enter the information as shown, and click **Apply**.

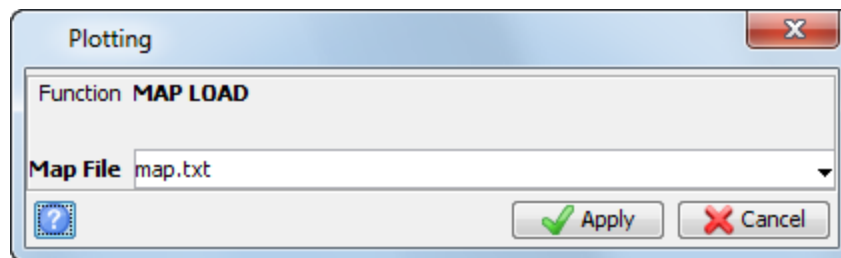


The results of the function will be written to the file **entity\_load.log**.

Entity load log is displayed in your default text editor.

```
Entity load log
=====
Loaded _RIG PIVOT
Loaded _RING BLAST HOLE
Loaded _RING HOLE
Loaded _RING NOTE
```

3. Close the log file.
4. Choose **Plotting > Map > Import**.
5. Enter the information as shown, and click **Apply**.

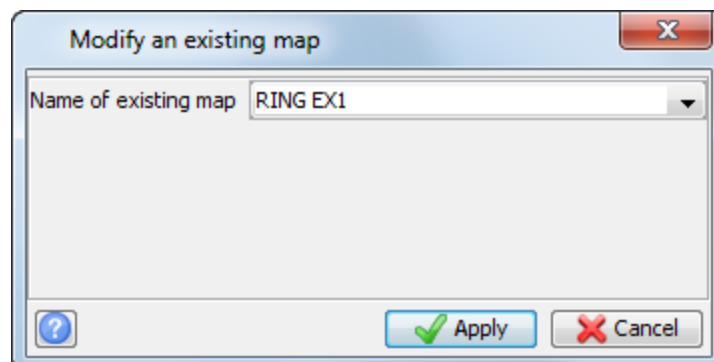


The results of the function is written to the file **map\_load.log**.

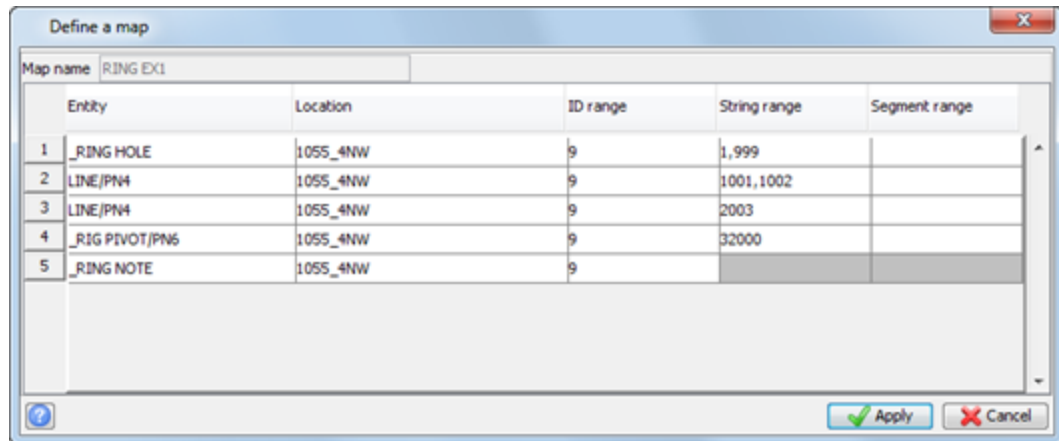
Map load log is displayed in your default text editor.

```
Map load log
=====
Loaded RING BLAST EX1
Loaded RING EX1
```

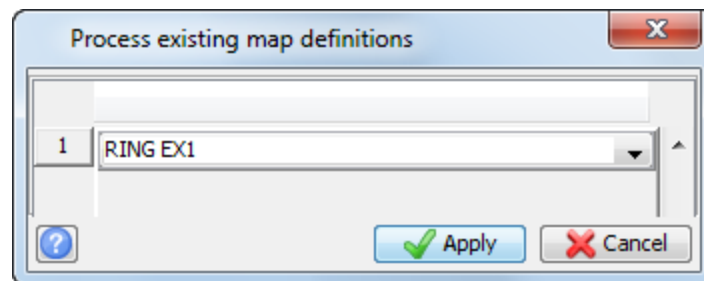
6. Close the log file.
7. Choose **Plotting > Map > Edit**.
8. Enter the information as shown, and click **Apply**.



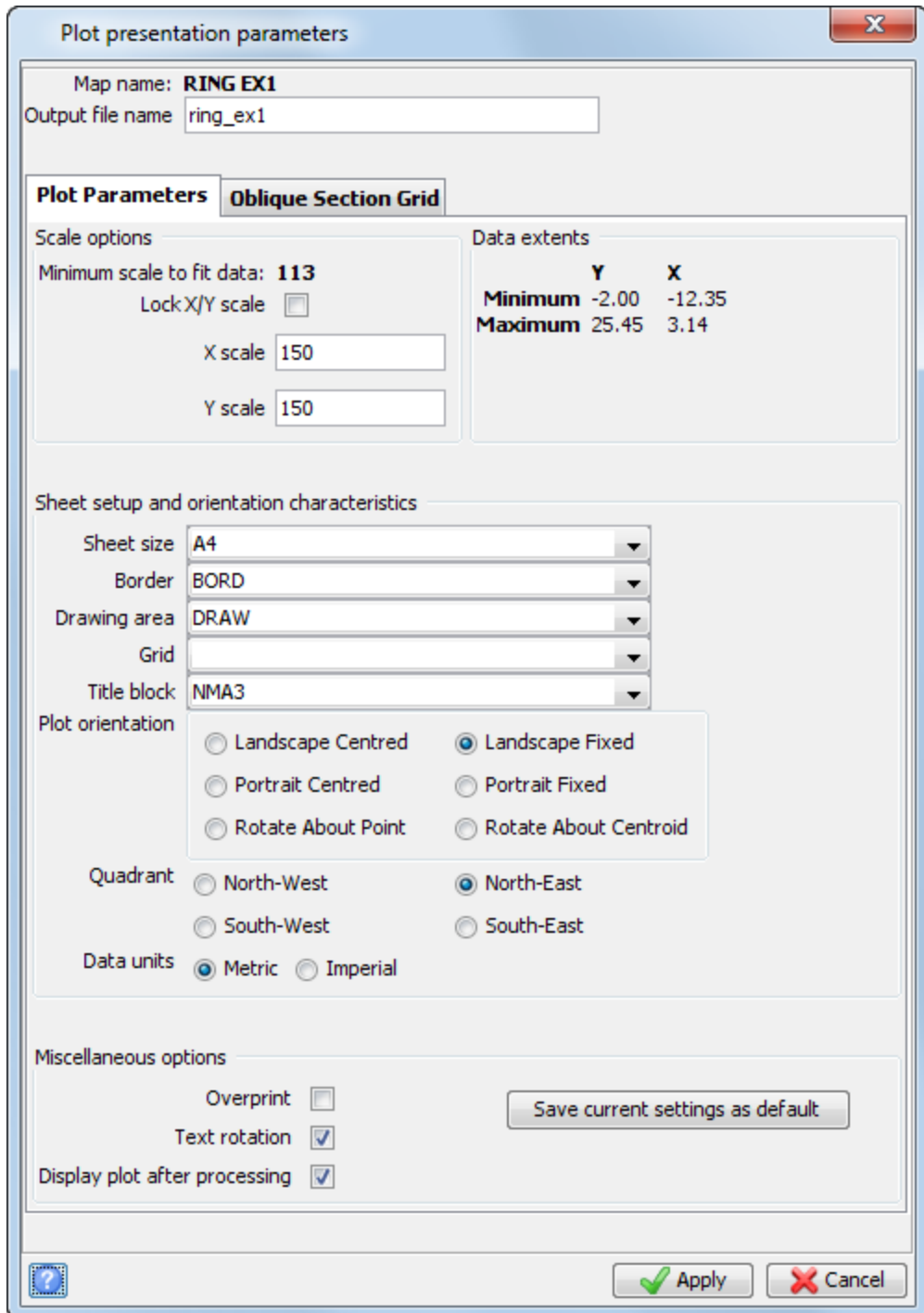
9. View the contents of the map you are processing (ringex1), and then click **Apply**.



10. Choose **Plotting > Process > Map**.  
11. Enter the information as shown, and click **Apply**.



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



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

