



Underground Mine Design Tutorial

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Product

Surpac™ 6.6.1

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Introduction

Overview

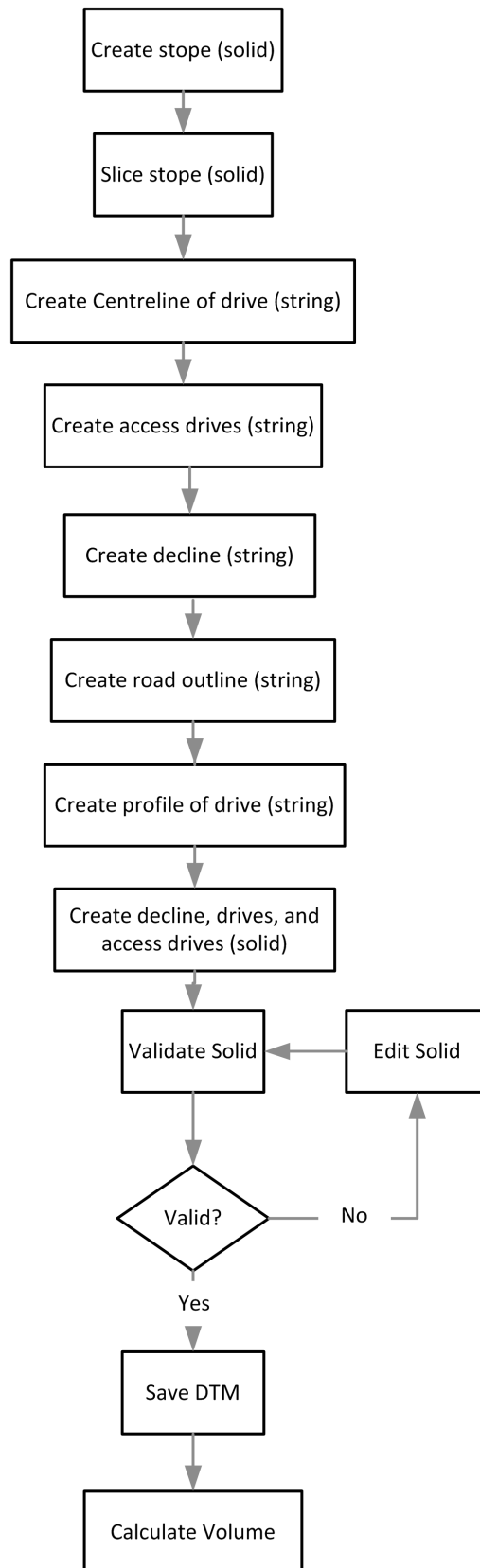
There are many types of designs employed in underground mining. Although there are numerous requirements for each design, Surpac can assist you to create any type of mine design.

Requirements

Before you begin this tutorial, you must have:

- Surpac installed
- basic knowledge of Surpac string files, editing tools, and how to constrain a block model and colour it by attribute
 - ✍ **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.

Underground design concepts

Terminology

- Centreline – a line which represents the centre of a drive. You can use the centreline to create solid models, or outlines for plots that are in plan view.
- Drive – a tunnel, or opening in rock, also known as a drift, or crosscut.
- Stope – a 3-dimensional area (usually ore) which is to be mined out by blasting a series of long holes or ring design holes.

Underground mine design concepts

There are many different scenarios where you might want to create an underground mine design.

In this tutorial, you will use:

- 3D solid models of designed stopes
- strings representing ore outlines at each level where a design is to be created

You will open files containing this data in **Graphics**, and then use various editing and point creation tools to create the underground mine design.

Setting up for this tutorial

Setting 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_mine_design`.

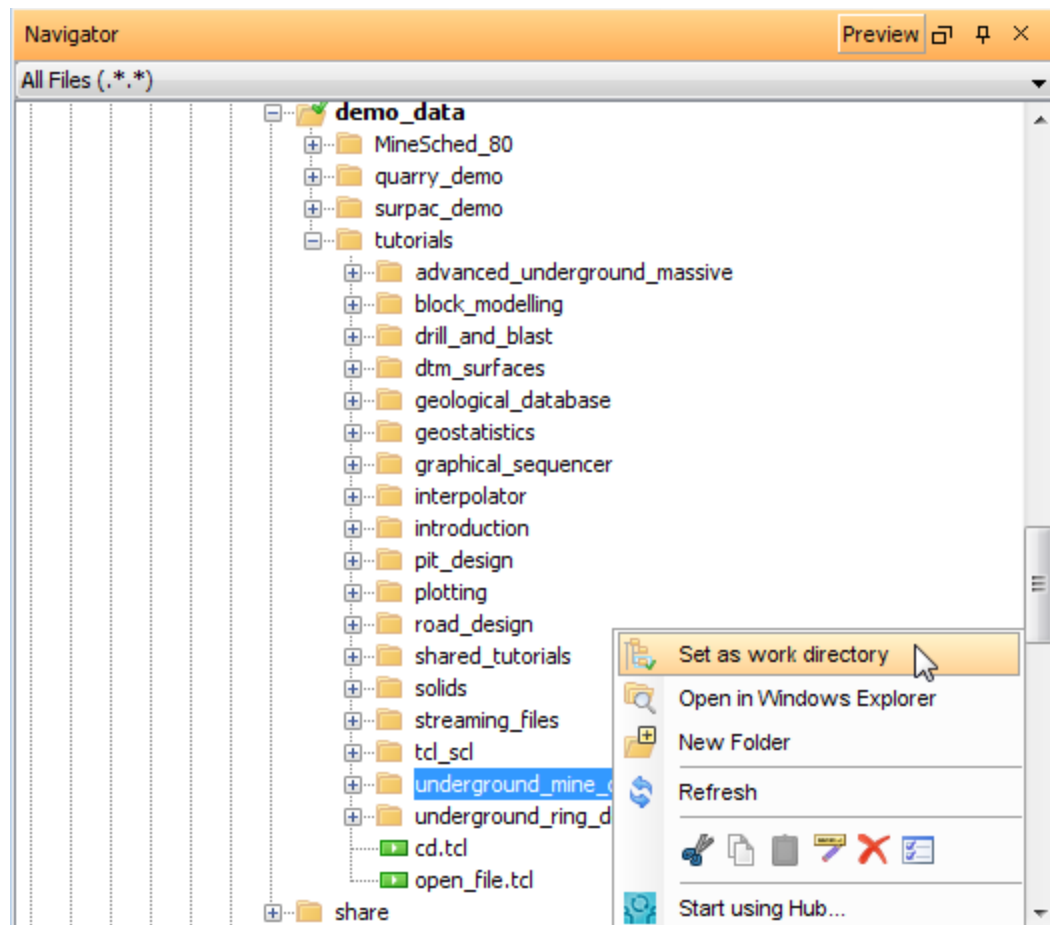
Where `<shared_files>` is the directory in which the Surpac shared files were installed.

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

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

Task: Set the work directory

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



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

Task: Copy planes

You need some planes to complete the stope design tasks.

1. From the `C:\Users\Public\GEOVIA\Surpac\<version>\demo_data\tutorials\underground_mine_design` folder, copy `planes\plan view\ogrndwithcrowns` to the `plan view` folder under your `planes` folder.
By default, your `planes` folder is `C:\Users\Public\GEOVIA\Surpac\<version>\share\planes`.

2. From the **underground_mine_design** folder, copy **planes\vertical sections\stopesPillars**, **planes\vertical sections\bmVert**, and **planes\vertical sections\sd1** to the **vertical sections** folder under your planes folder.

Creating stopes

In this tutorial you will use solids to represent the stopes. In some situations you will have existing solids that conform to the mining constraints, such as the minimum mining width and the angle of the stope. If you do not already have solids that conform to the practical mining constraints, you can use the Stope Design and Stope Slicer features of Surpac to create these solids.

 **Note:** You must have a licence for the Stope Design Tools module to use the Stope Design commands and Stope Slicer.

In Stope design, you digitise polygons on planes and join them together to form a solid. With a shorter distance between polygons, you create more detailed stope solids (and more planes and polygons). The distance that you choose depends on how much detail you require. You also need to make sure that the stope shapes you create are practically mineable. That is, you design the stopes so that your mining equipment can mine the stopes and manoeuvre.

Stope design workflow

This tutorial uses the following workflow.

1. Display the block model (or solid).
2. Start a new stope design project.
3. Choose a plane and digitise a mineable shape around the ore body.
4. Choose another plane and digitise a mineable shape around the ore body.
5. Evaluate the stope polygons that you have digitised.
6. Continue moving from plane to plane, digitising polygons and evaluating stope polygons until you reach the end of the ore body.
7. Create the design object to be used in the Stope Slicer.
8. End the stope design project.

Getting started with stope design

To successfully use stope design you need:

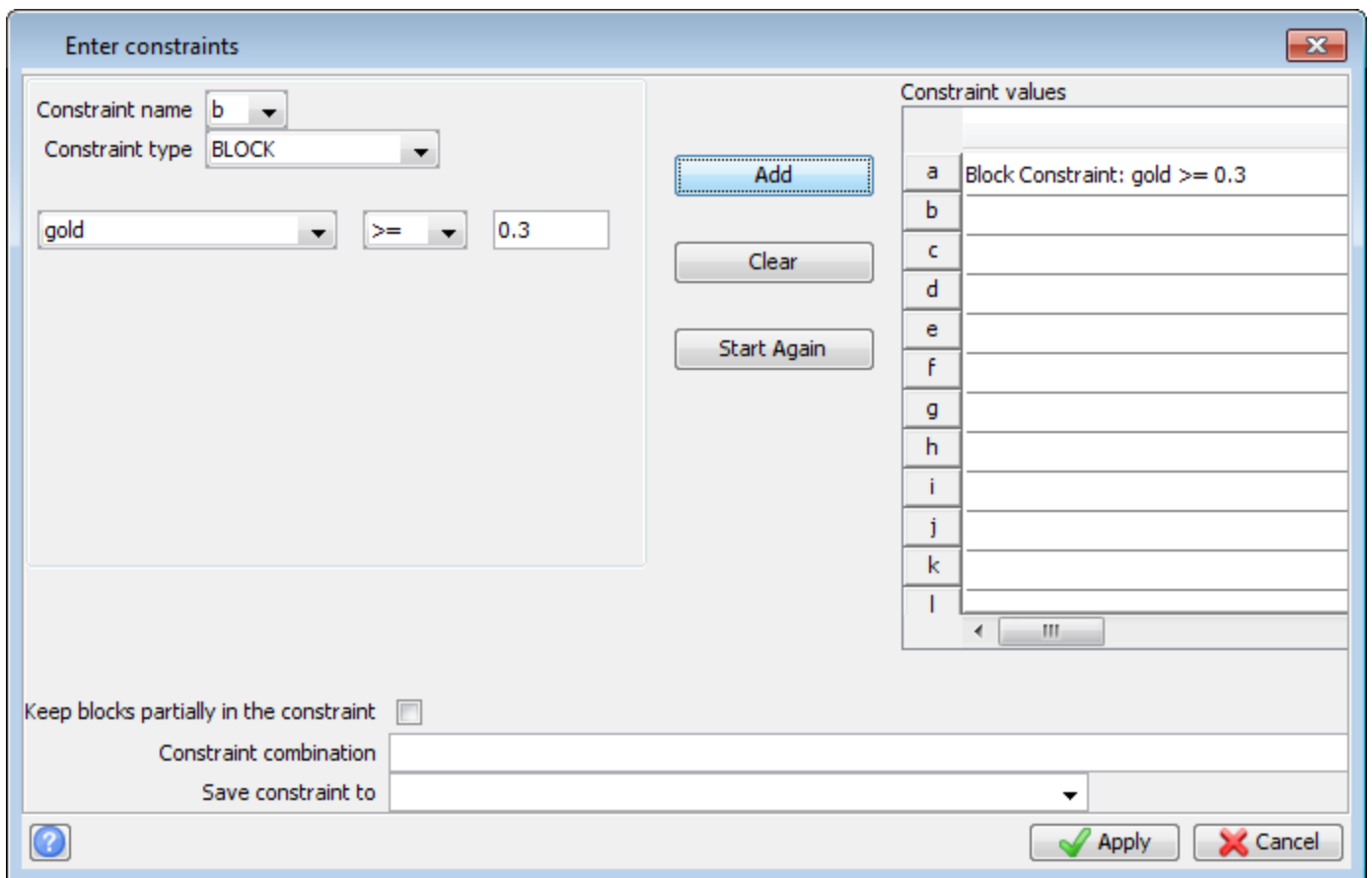
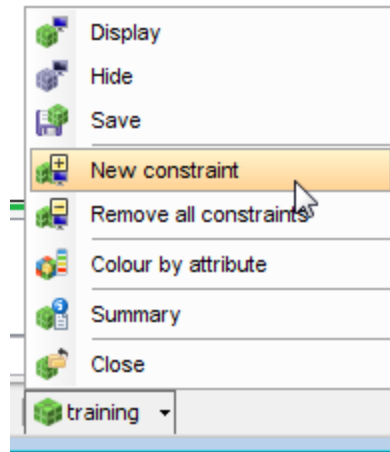
- a block model or solid representing the geological ore body
- planes that intersect the block model or solid
You will create one polygon on each of these planes, and project outwards from the polygon to create the stope.

The **underground_mine_design** data set includes a block model and planes.

Before you start stope design, it is useful to set up your workspace with the toolbars that you will use later.

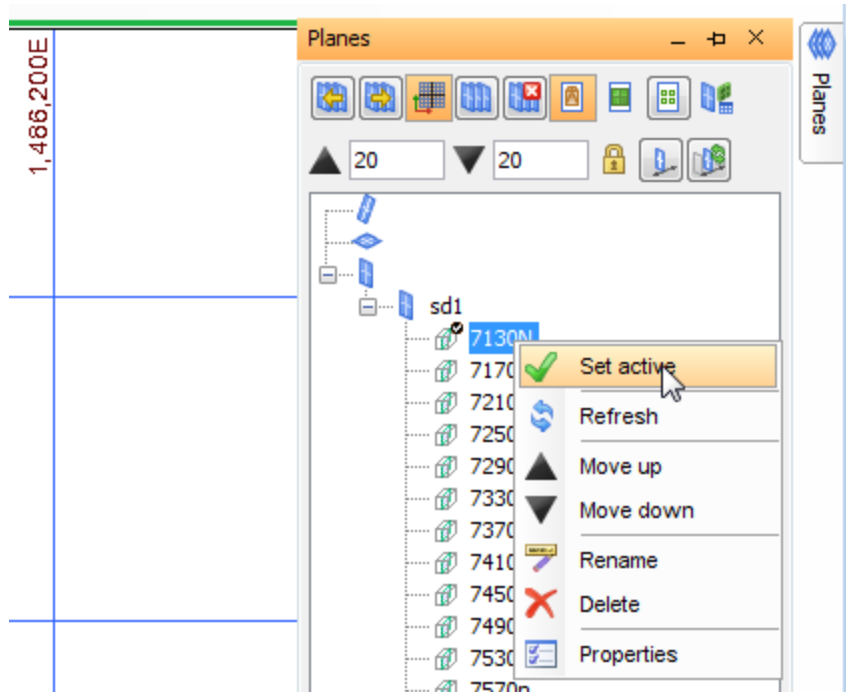
Task: Display block model and set up toolbars

1. Drag **training.mdl** into **Graphics**.
2. Constrain the block model to blocks whose gold grade is 0.3 or greater.

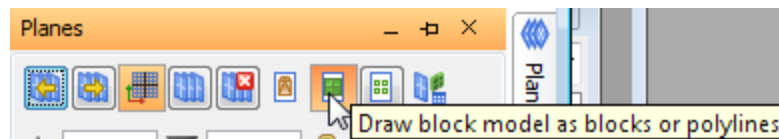


3. Display the block model.
 - 💡 **Tip:** If you cannot see the blocks, select **View > Zoom > All**.
4. Right-click in **Graphics**, and choose **2D Planes mode**.

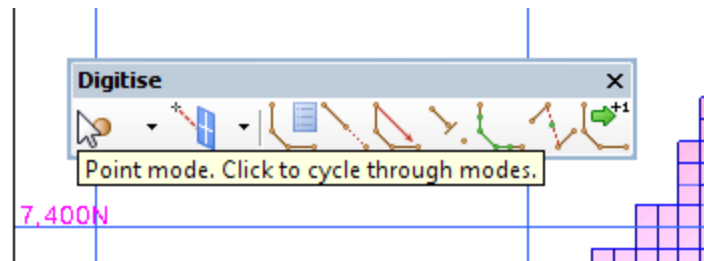
- Expand the **Planes** panel, right-click on plane **sd1\7130N**, and choose **Set active**.



 **Tip:** If the block edges are not visible, click **Draw block model as blocks or polylines** in the **Planes** panel.



- Drag the **Digitise** toolbar to **Graphics** to undock it.

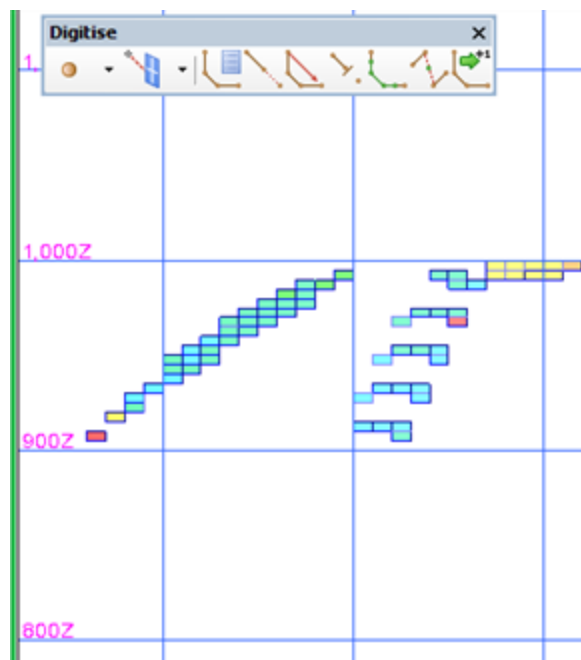
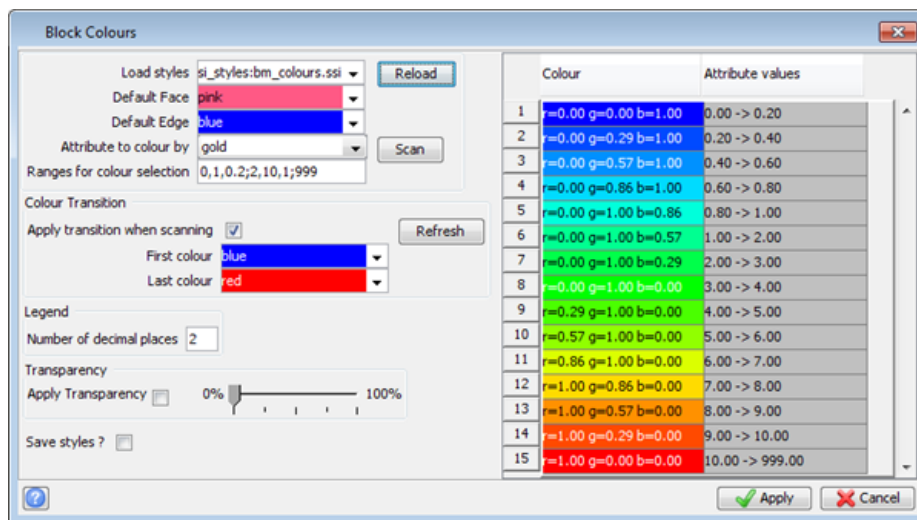
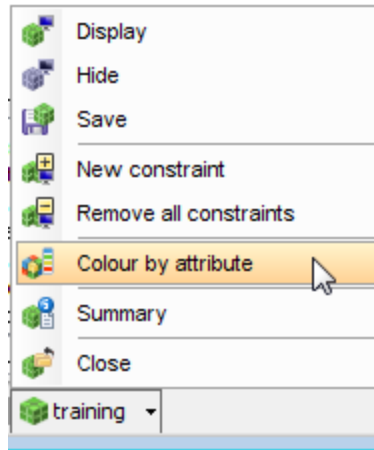


With the **Digitise** toolbar close to the block model, it is easier to create the polygons.

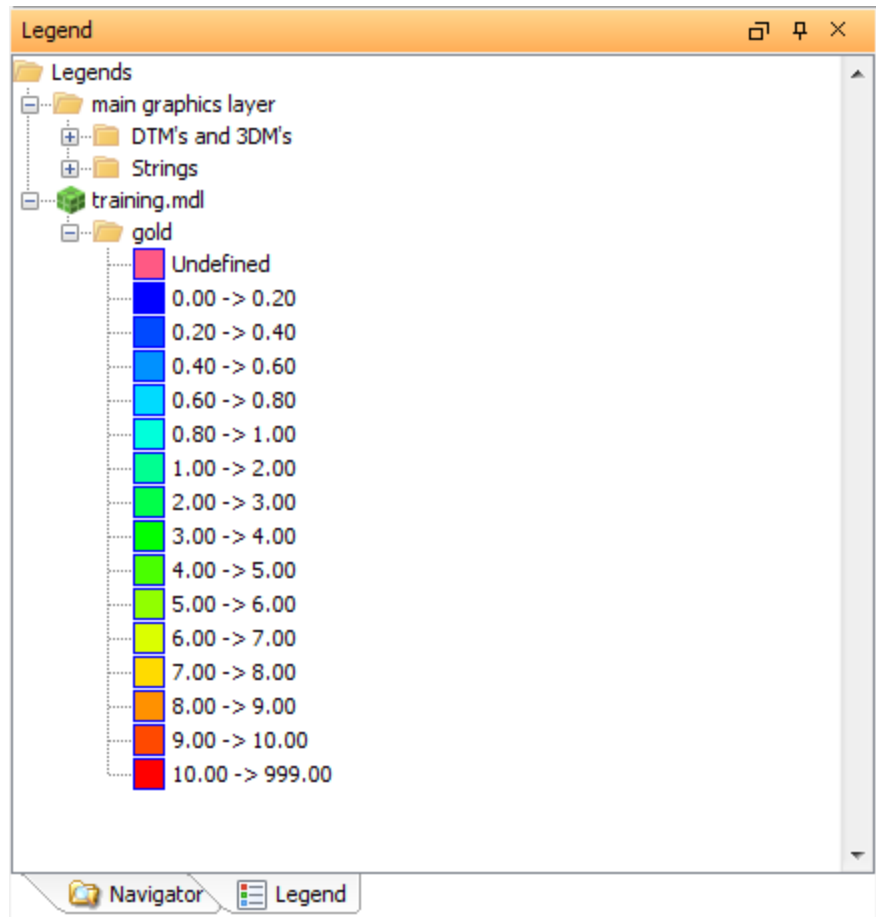
- Right-click in the toolbar area, and choose **Toolbars > Underground Design** to show the **Underground Design** toolbar which includes buttons for the **Stope Design** functions.



- Colour the block model by gold attribute using a **Range for colour selection** of **0,1,0.2;2,10,1;999**.



9. In the Navigator, click the **Legend** tab, and expand the **gold** folder.




You can consider the deposit to be two distinct ore bodies, a larger ore body to the west, and a thinner ore body to the east. In this document, the procedures are written on the assumption that the western ore body will be mined.

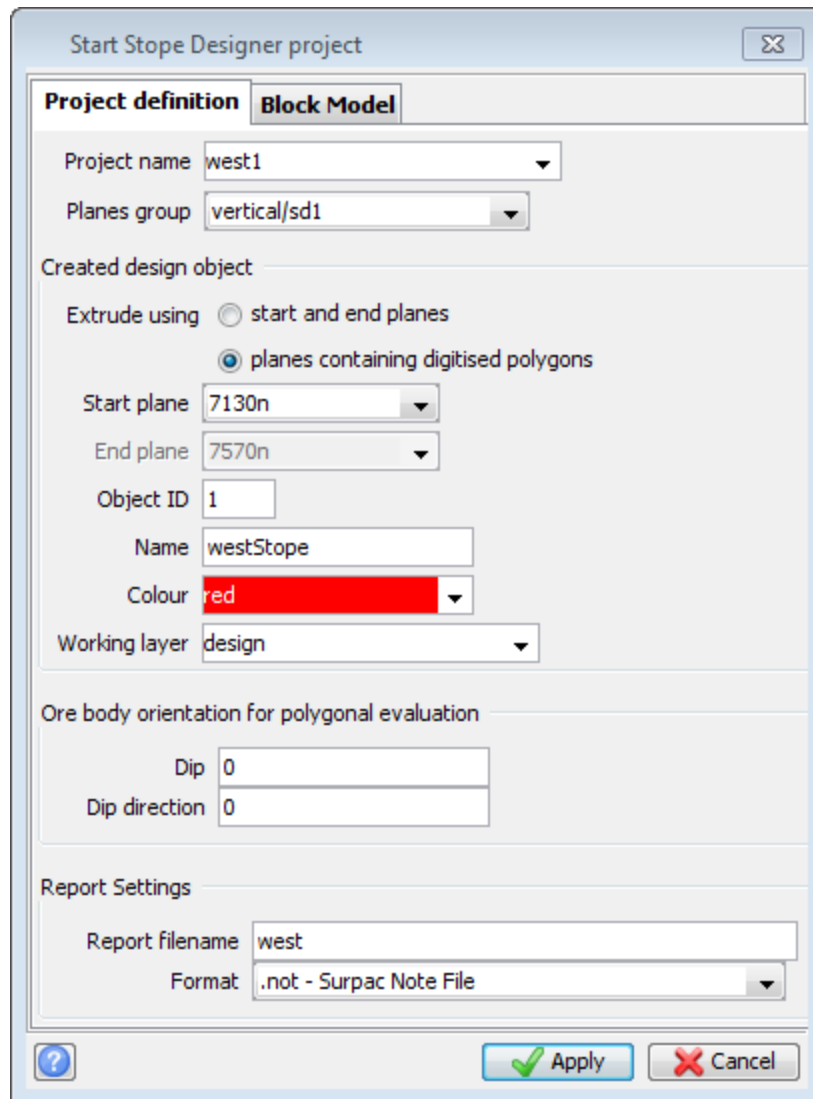
Task: Start stope design project

You can use any of the following methods to run any of the Stope Design commands:

- click a button on the Underground Design toolbar
- type the name of the function into the function chooser
- select the command from the **Design > Stope Design tools** menu

Each step in this document uses one of the previous methods.

1. Click  on the **Underground Design** toolbar.
2. Fill in the following details into the **Project definition** tab of the *Start stope design project* form:
 - **Project name:** west1
 - **Planes group:** vertical\sd1
 - **End plane:** 7570N
 - **Object ID:** 1
 - **Name:** westStope
 - **Report filename:** west



3. Select the **Block Model** tab.

- Fill in the **Block Model** tab as shown below.

Start Stope Designer project

Project definition **Block Model**

Evaluate using block model

Block model **training.mdl**

Block model settings

Specific gravity by attribute value

Value

Use partial percentages

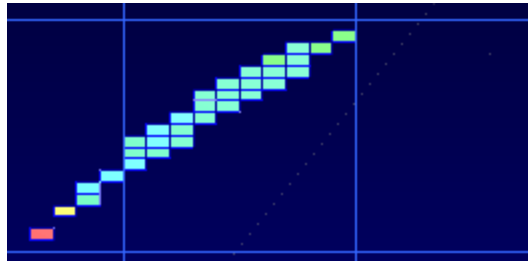
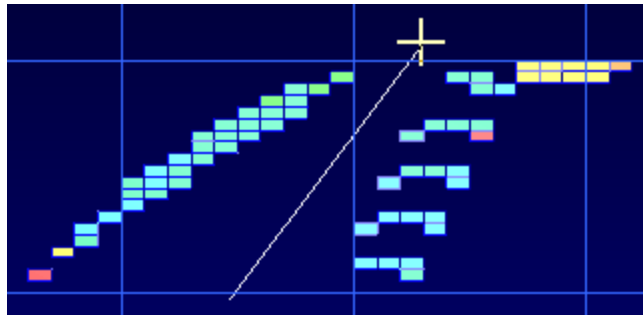
Precision

Ore/rock type attribute for classification

	Attributes	Contained metal factor	Metal units	Replace negatives with
1	gold	1	g	0

- Click **Apply**.
Because you have specified these block model details, the **training.mdl** block model will provide data like gold grade, volume, mass, and contained metal, to the stope design process. By using a **Precision** value of 3, any blocks that are partially inside the solid are sub-blocked into 512 blocks. Only the blocks and sub-blocks, whose centroids are within the stope you are designing, are included in volume calculations.
- If plane 7130N is not the active plane, right-click it in the **Planes panel**, and choose **Set active**.
 Tip: In some situations you might find it useful to use a cutting plane to hide parts of the block model that are outside the area of interest.
- Type CUTTING PLANE in the function chooser, and press ENTER.

- Drag a line from the lower left to the top right to hide the eastern ore body.



- Press ESC to stop defining cutting planes.

Task: Digitise stope outline

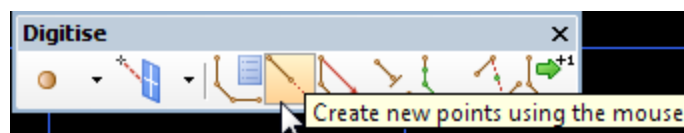
Using the following procedure, you will digitise a string of the stope outline in section view. When you started stope design, the **Working layer** field was set to **design**. This new layer is listed in the **Layer Manager**.

These steps show you a quick way to create a polygon representing the outline of the stope.

- In the **Layer Manager**, make sure the **design** layer is not hidden but is set to visible.

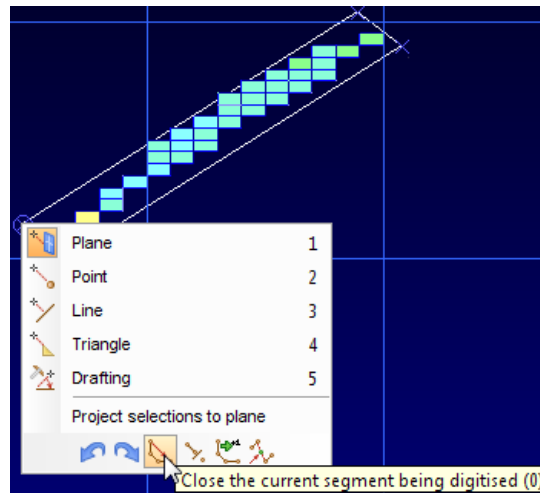


- In the Digitise toolbar, click **Create new points using the mouse**, and digitise points around the block model.



You are viewing the data in section view so a 45 degree line represents a 45 degree stope gradient.

- When you have finished digitising the polygon, right-click, and choose **Close the current segment being digitised**.

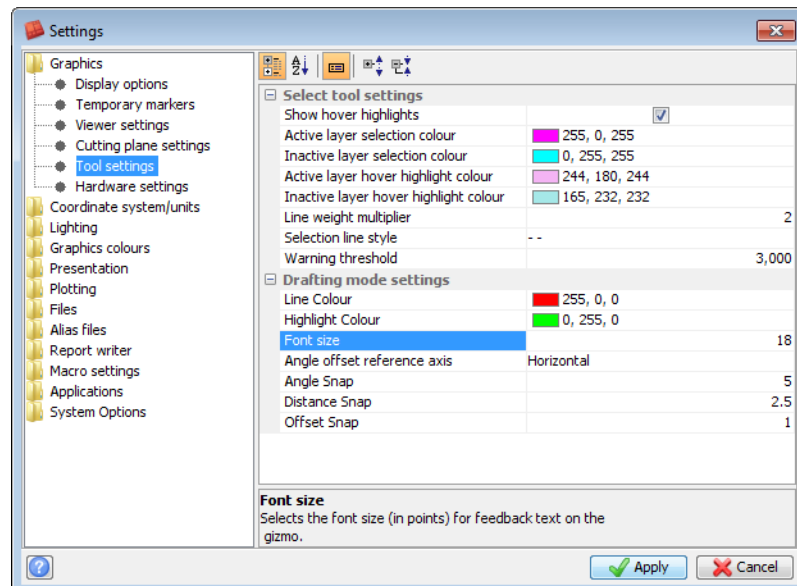


- Press ESC.

Task: Create polygon using Drafting tools

When you create a polygon, you can use the drafting tools to apply more precision in the placement of points and lines.

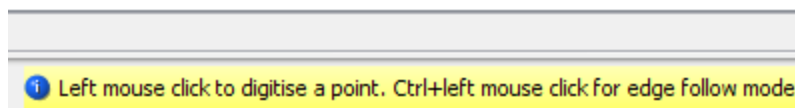
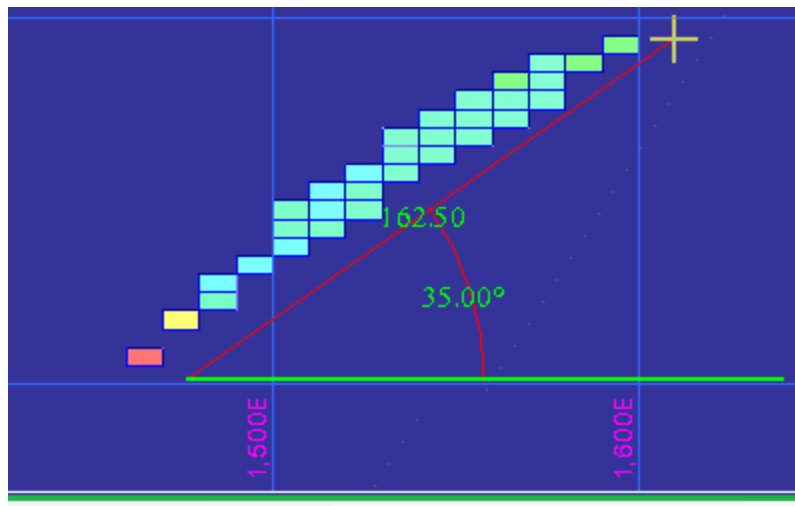
- Choose **Edit > Segment > Delete**, and click on the polygon you created in the previous task.
- Select **Customise > Default Preferences**.
- Under **Graphics > Tool settings**, enter the following, and click **Apply**.
 - Font size.** 18
 - Angle offset reference axis.** Horizontal
 - Angle snap.** 5
 - Distance Snap.** 2.5



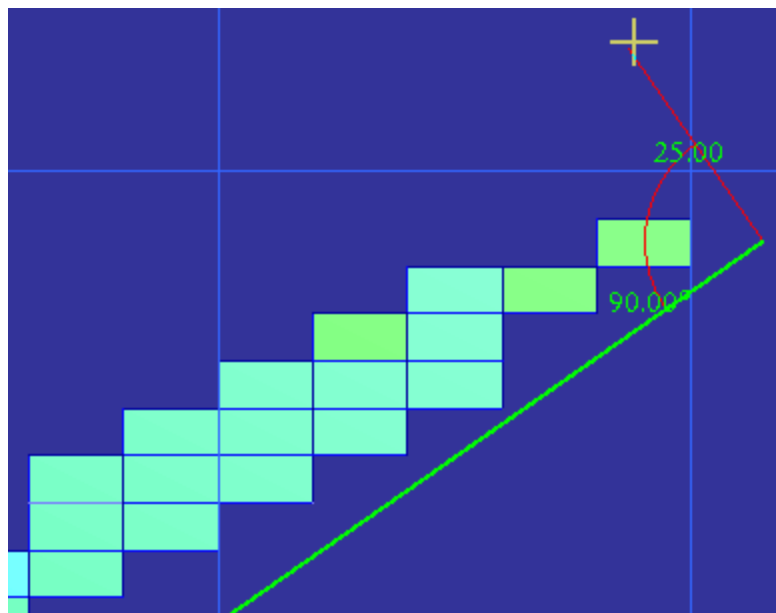
- Click the **Create new points** icon on the **Digitise** toolbar.



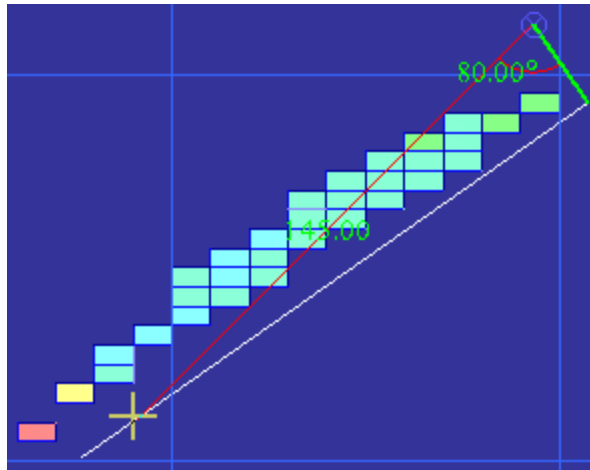
- Digitise a point below the blocks and press 5 to activate drafting mode. As you move the mouse you can see the distance to the next point and the angle to it. Because of the settings you entered, you can create the next point at any number of degrees that is a multiple of 5. This feature can help you enforce a minimum stope angle.



- Digitise another point at the top right of the blocks at 35 degrees from the first point.
- Digitise another point at 90 degrees from the last point, and a distance of 25.

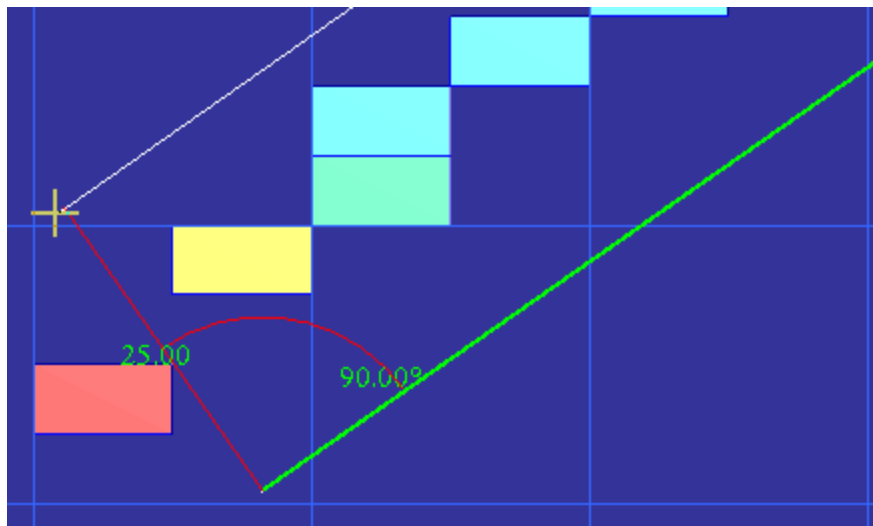


- Press CTRL and click on the long line under the blocks to activate Edge Follow mode.

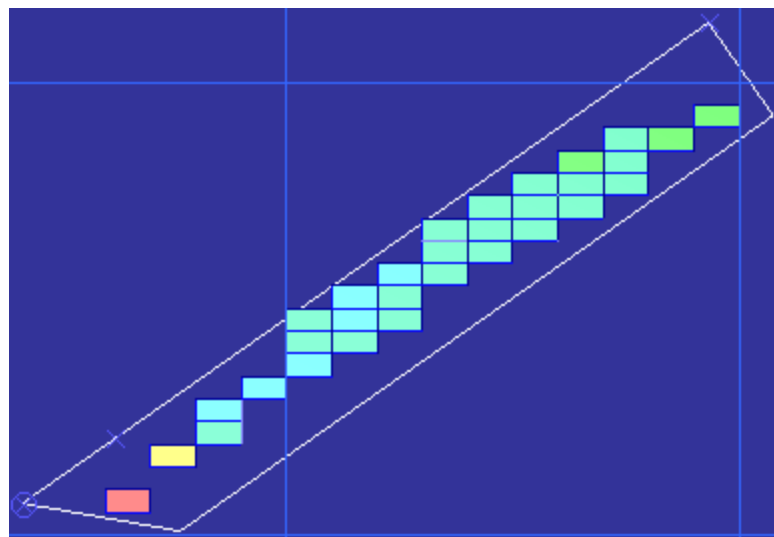
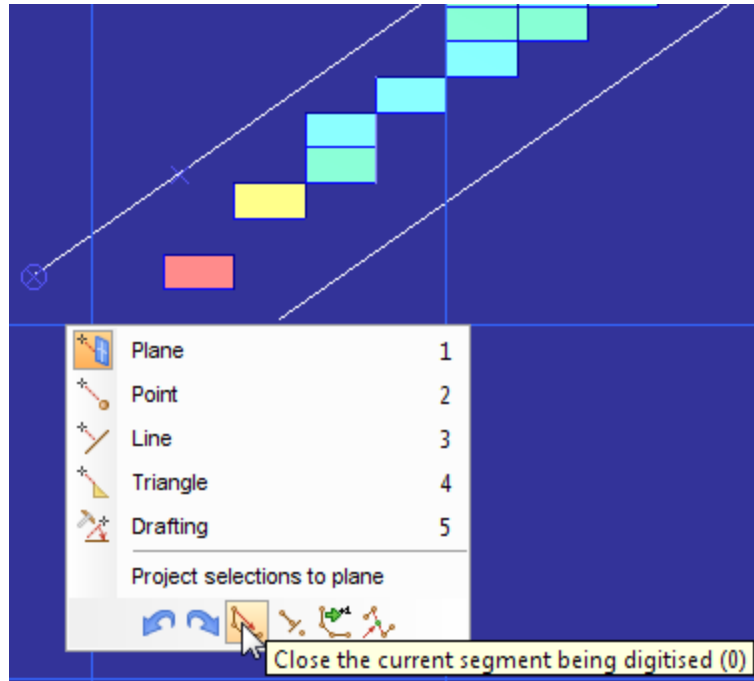


You can use Edge Follow mode to ensure that a line is parallel to another line.

- Digitise a point that is 90 degrees from the lowest point in this polygon, and a distance of 25 from that point.



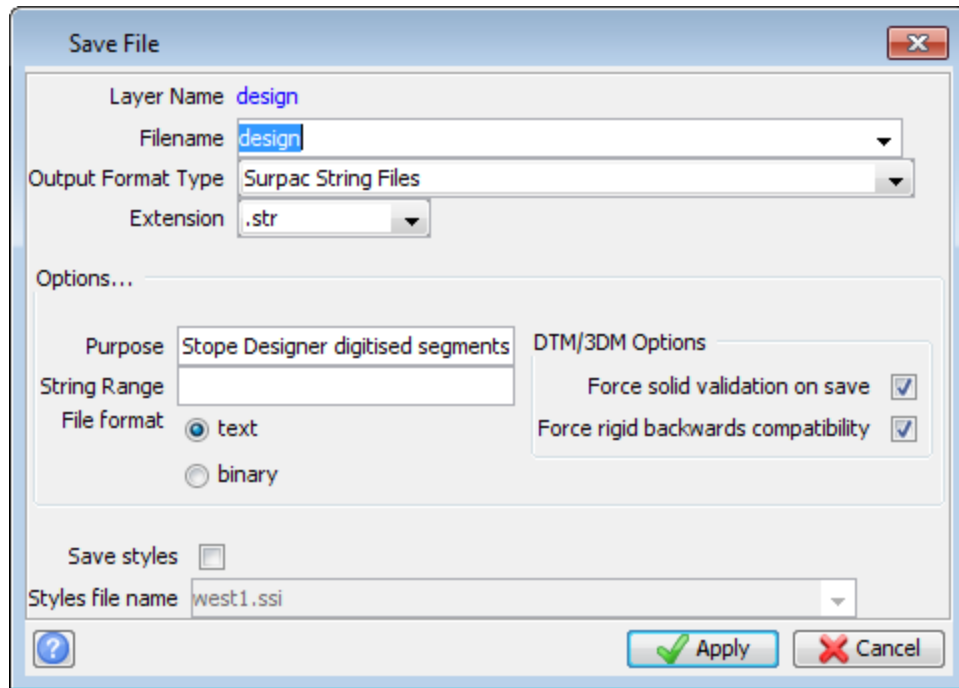
10. Digitise another point, and then close the segment.



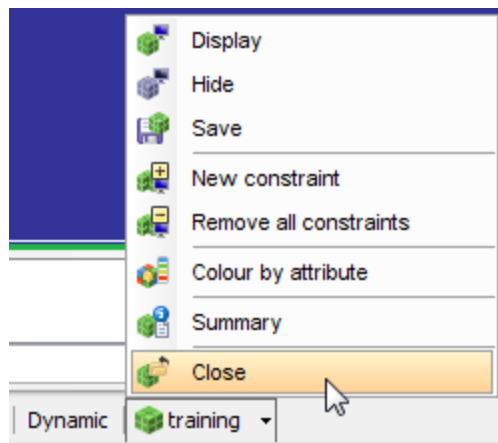
Task: Save and edit a stope design project

When you save a stope design project (**.sdproj** file), you also save a **.swa** file that records details like the files that are open, and any block model constraints or colouring that you have applied. When you reopen the **.sdproj** file, the **.swa** file is also opened.

1. Click the **Save** icon  on the **Underground Design** toolbar to save the stope design project.
2. Click **Apply** in the *Save File* form.

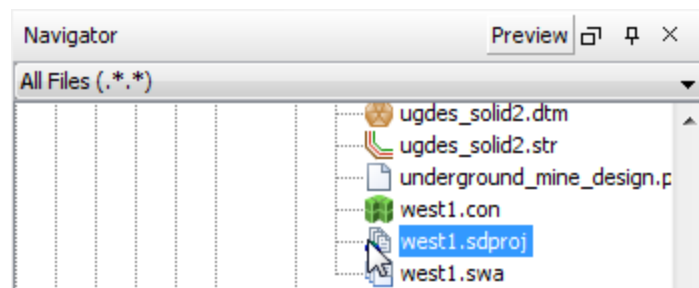


3. Click the **End Stope Design** icon  on the **Underground Design** toolbar.
4. Reset **Graphics** and close the **Training** block model.




When you reset Graphics, the default, dynamic plane is activated. If you display any files, the data is not constrained to a particular plane and you have a 3D view of the data.

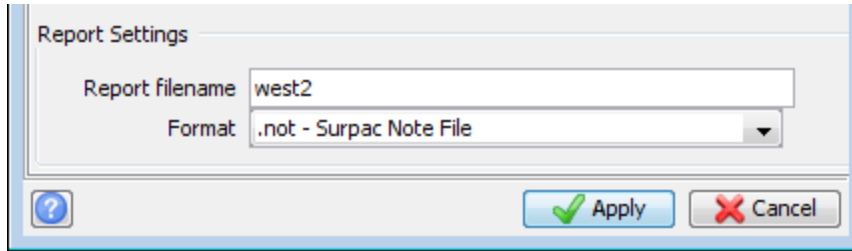
5. Drag **west1.sdproj** from the **Navigator** to **Graphics**.



The stope design project, and the **west1.swa** file are opened. The **sd1\7130n** plane is activated.


You can modify any of the stope design settings at any time. With this data set, the final plane, **7570n**, contains only one block that is within the constraint, so you will set **End plane** to the previous plane, **7530n**.

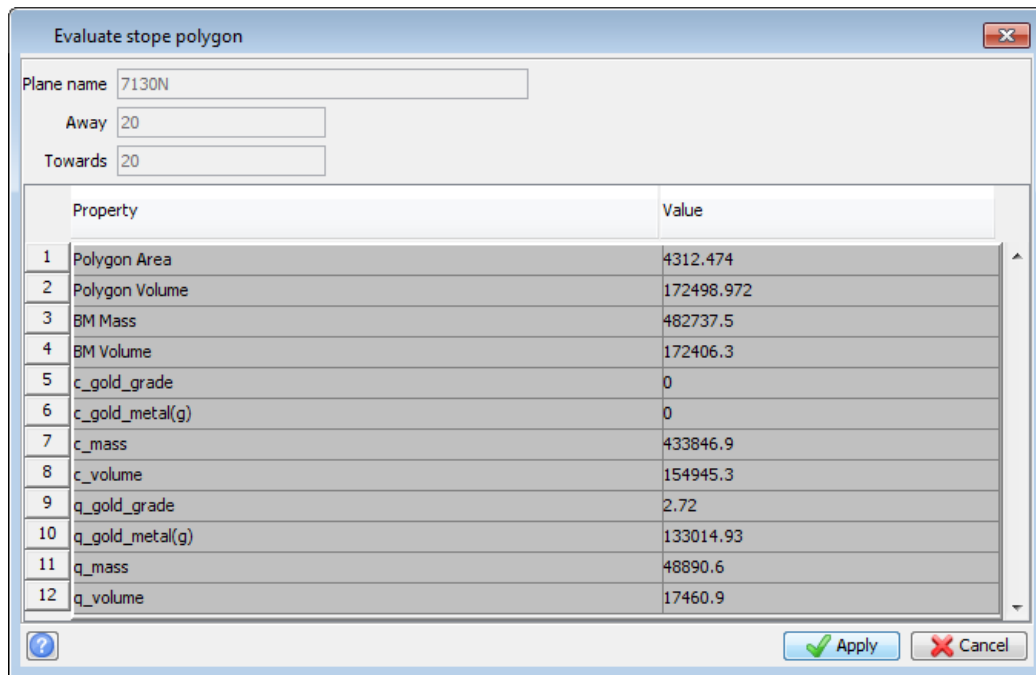
6. Click the **Modify Stope Design** icon  on the **Underground Design** toolbar.
7. Change **Report filename** to west2, and click **Apply**.




Task: Evaluate stope polygon

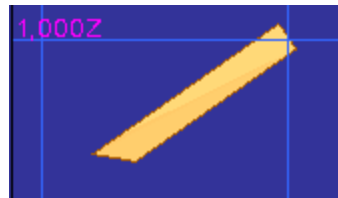
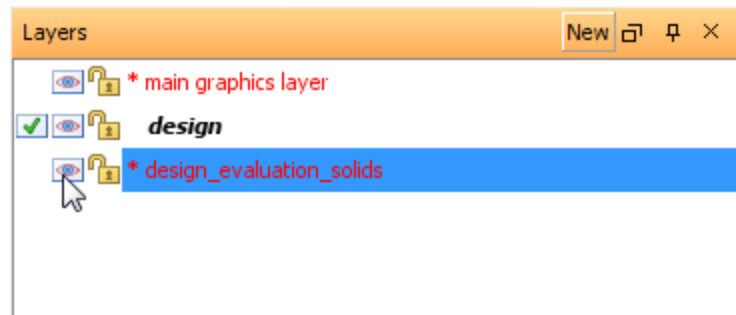
When you have a polygon of the proposed stope, you can create a temporary solid from it to represent a part of the stope.


1. On the **Underground Design** toolbar, click the **Query block model**  button. This button runs the EVALUATE STOPE POLYGON function which reports on grade, metal, mass, and volume within each rock type. In this section of the ore body there are two rock types: c (country rock) and q (quartz porphyry).

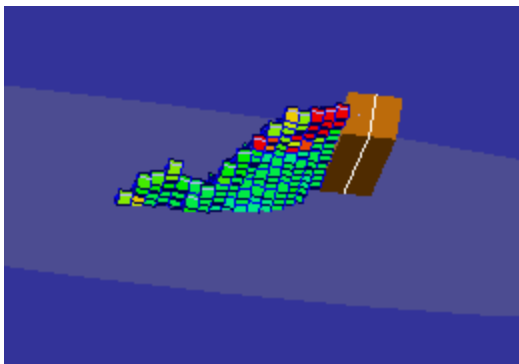


2. Click **Apply**.
A temporary solid is created, in the **design_evaluation_solids** layer in **Graphics**. This solid is projected to the edges of the plane.
 **Note:** Because the **Dip** and **Dip direction** that you entered are both 0, the projection is perpendicular to the plane.

- In the **Layer manager**, show the **design_evaluation_solids** layer.




- Right-click in **Graphics**, and choose **3D Planes mode**.
- In the **Planes** panel, click **Set large projections**  to show the data outside the plane that is currently active.
- Rotate the view.



The temporary solid is approximate. It is useful for highlighting locations where you might adjust the points of the polygon to include more ore or to exclude more waste.

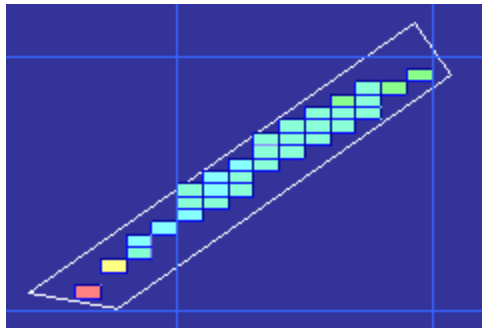
Task: Move points

At any time you can make adjustments to the polygons and recreate the temporary solid (and the final solid) quickly.

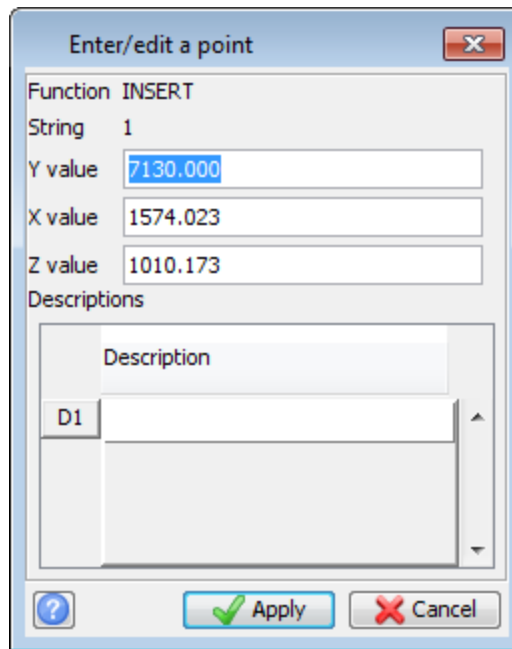
 **Note:** The **Move** tool works on the active plane, even if it is an oblique plane.

- Right-click in **Graphics**, and choose **2D planes mode**.
- Hide the **design_evaluation_solids** layer.

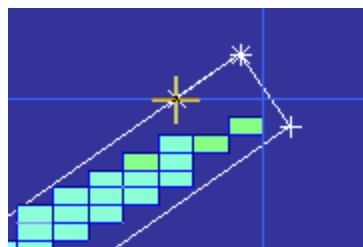
3. If the blocks are not displayed, choose **Draw triangulations as triangles or polylines** in the **Planes** panel.



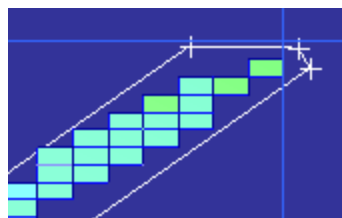
4. Select **Create > Points > Insert after an existing point**, and click **Apply** in the **Edit/Enter a point** form.




5. Create a point near the top of the polygon on the left.



6. Press ESC to finish adding points.
7. Select **Edit > Point > Move**.
8. Drag the point at the top to the right and down.



9. Press ESC.

10. On the **Underground Design** toolbar, click the **Query block model**  button.




Evaluate stope polygon

Plane name:

Away:

Towards:

	Property	Value
1	Polygon Area	4073.152
2	Polygon Volume	162926.097
3	BM Mass	456225.0
4	BM Volume	162937.5
5	c_gold_grade	0
6	c_gold_metal(g)	0
7	c_mass	407356.3
8	c_volume	145484.4
9	q_gold_grade	2.72
10	q_gold_metal(g)	132968.82
11	q_mass	48868.8
12	q_volume	17453.1

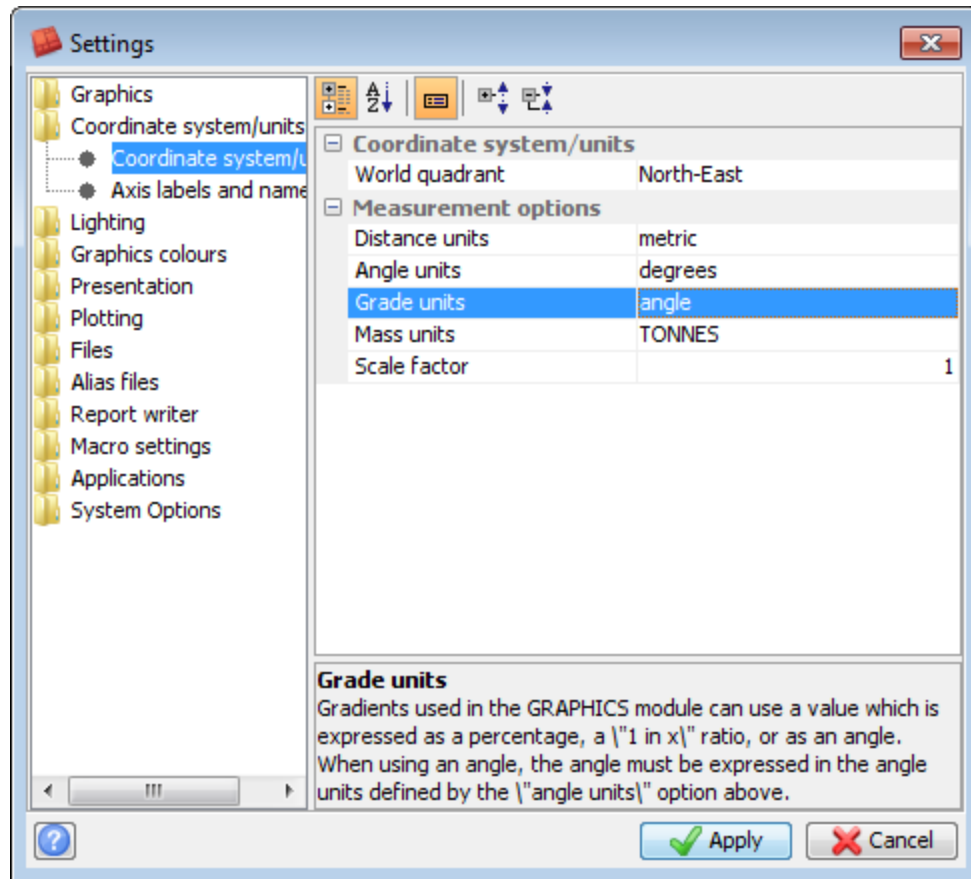
11. Click **Apply**.

The *Evaluate stope polygon* form shows the same gold grade in the quartz as before but less mass and volume, in particular less mass and volume of country rock.

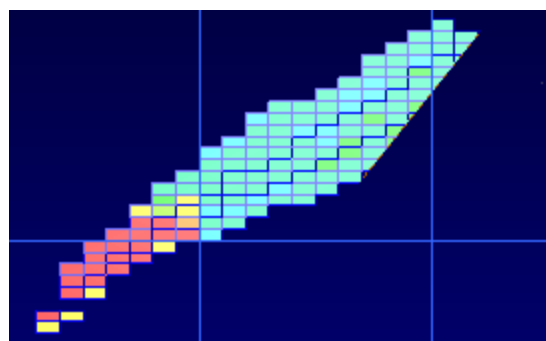
Task: Create and evaluate subsequent polygons

After you have created and evaluated the first polygon, you can activate each of the other planes, and create a polygon on each plane.

1. Select **Customise > Default preferences**.
2. Under **Coordinate system/units**, set **Grade units** to **angle**, and click **Apply**.



3. Press F12 to activate the next plane.

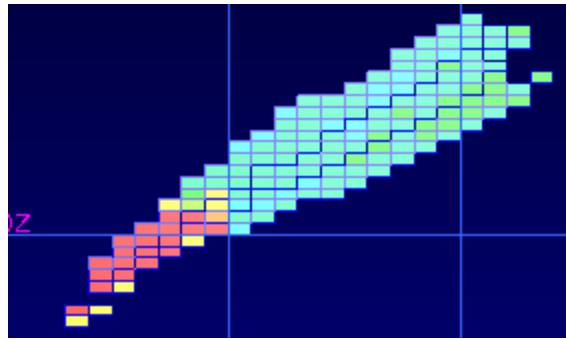


The cutting plane you previously defined is now cutting into the ore blocks in this plane. You can remove the cutting plane by running CUTTING PLANE REMOVE.

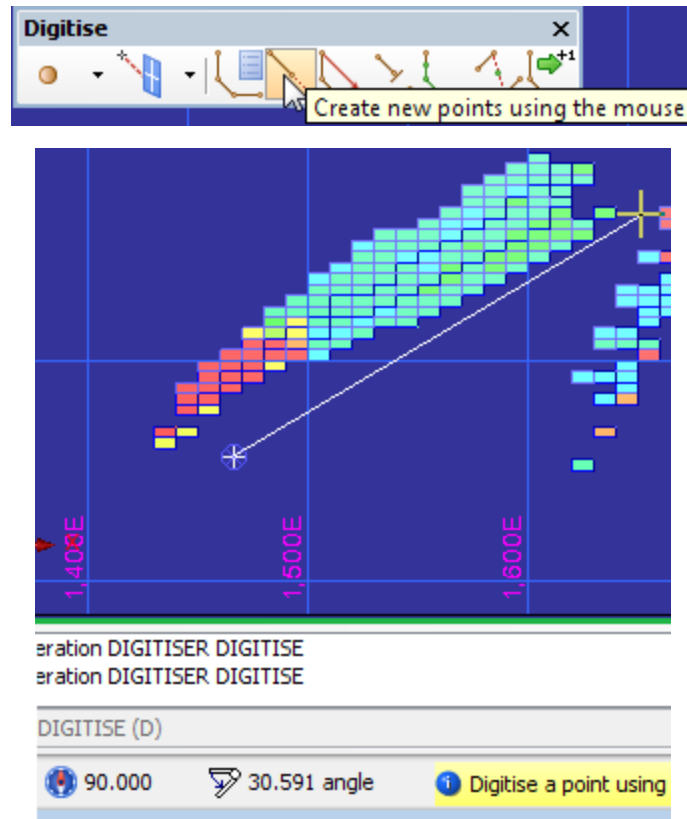
Note: You cannot run DELETE CUTTING PLANES unless you exit stope design. Run CUTTING PLANE REMOVE instead.

Tip: If a solid is obscuring your view, click **Draw triangulations as triangles or polylines** to hide it.

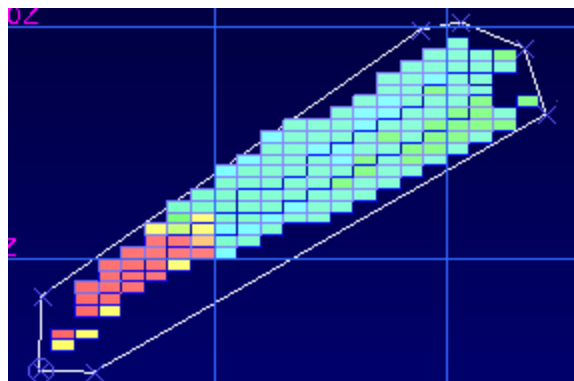
- In the function chooser, type CUTTING PLANE REMOVE, and press ENTER.




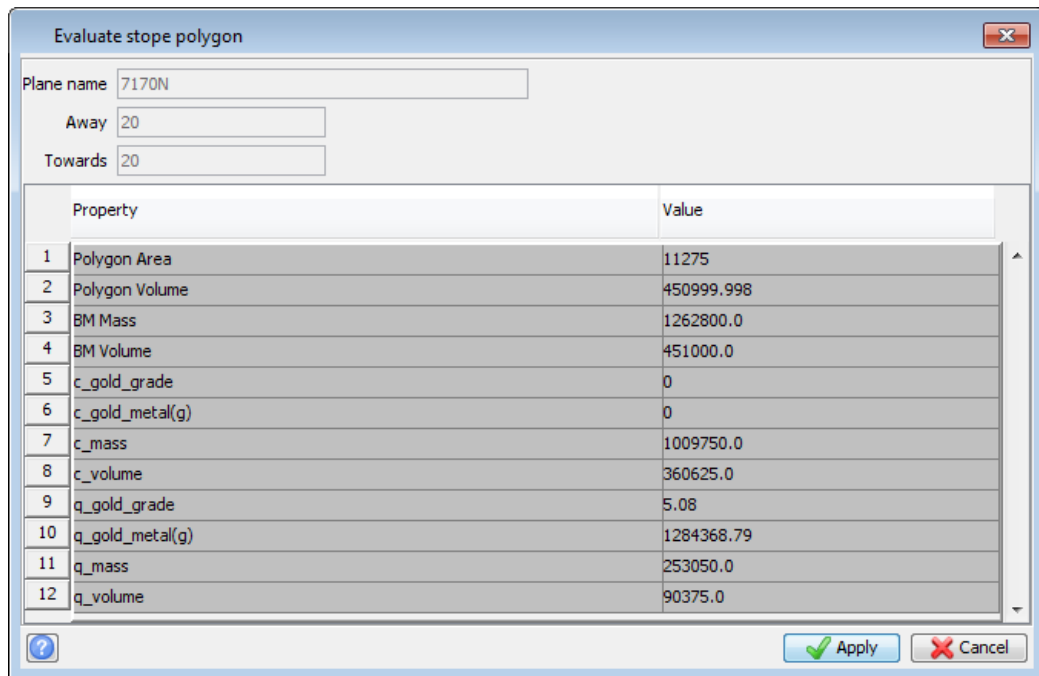
- Start a new segment, digitise a polygon around the ore body, and press ESC.



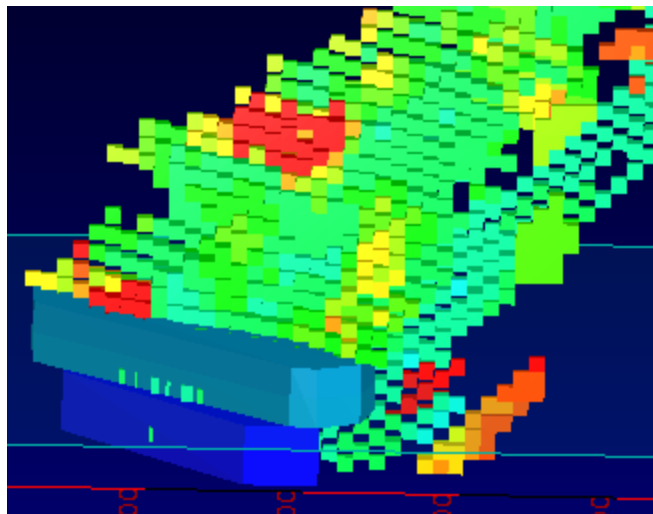
The **Status bar** displays the gradient from the last point you digitised to the pointer position. The gradient is displayed as an angle because you selected angle for the grade units in the *Settings* form. Viewing the grade units as angles is an alternative to using Drafting mode to ensure you honour a particular slope angle.



- On the **Underground Design** toolbar, click the **Query block model**  button, and click **Apply**.



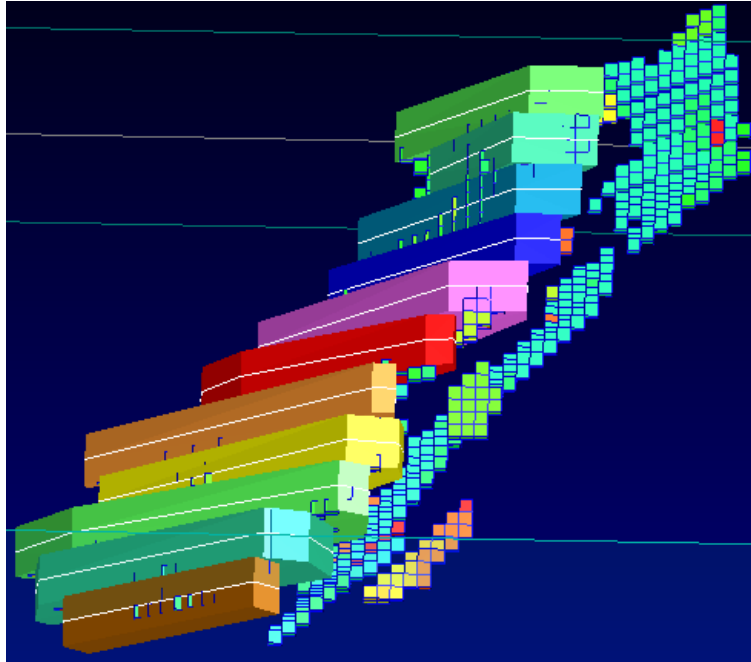
- Right-click in **Graphics**, and choose **3D Planes mode**.
 - Show the **design_evaluation_solids** layer.
 - Click **Set Large Projections** in the **Planes** panel.
- Graphics** shows the new working stope design in context. You can rotate the view to see how the stope design is progressing.



You might decide to increase or decrease the size of this part of the stope. To do so, you can edit the stope polygon and then evaluate it again.

- Right-click in **Graphics**, and choose **2D Planes mode**.
- Hide the **design_evaluation_solids** layer.
- In the **Planes** panel, click **Revert to plane corridor**.

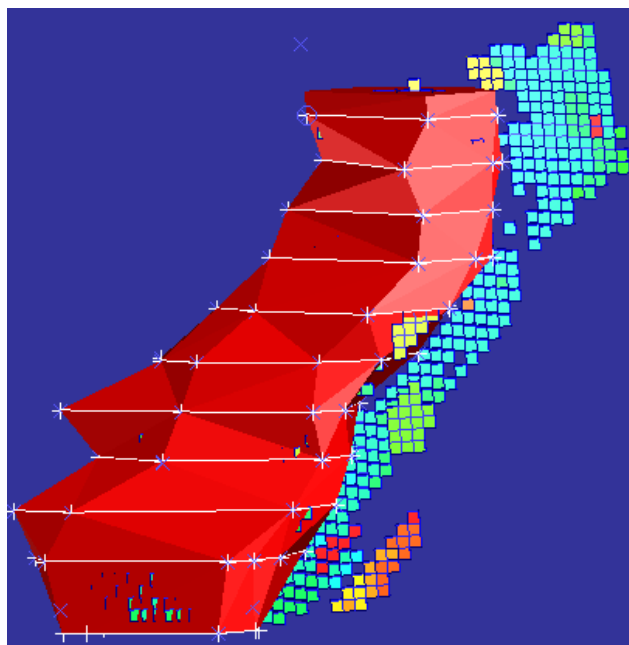
- For each remaining plane up to 7530n, activate the plane, digitise a polygon, and evaluate the ore body.



Task: Create design object

After you have created polygons on each part of the stope, you can create a final solid from it to represent the stope.

- Right-click in **Graphics**, and select **3D planes mode**.
- In the **Planes** panel, click **Set large projections**.
- Select **Design > Stope Design tools > Create design object**.
- Hide the **design_evaluation_solids** layer.



- A report is also created that shows details of the new stope.

Stope Designer Created Object

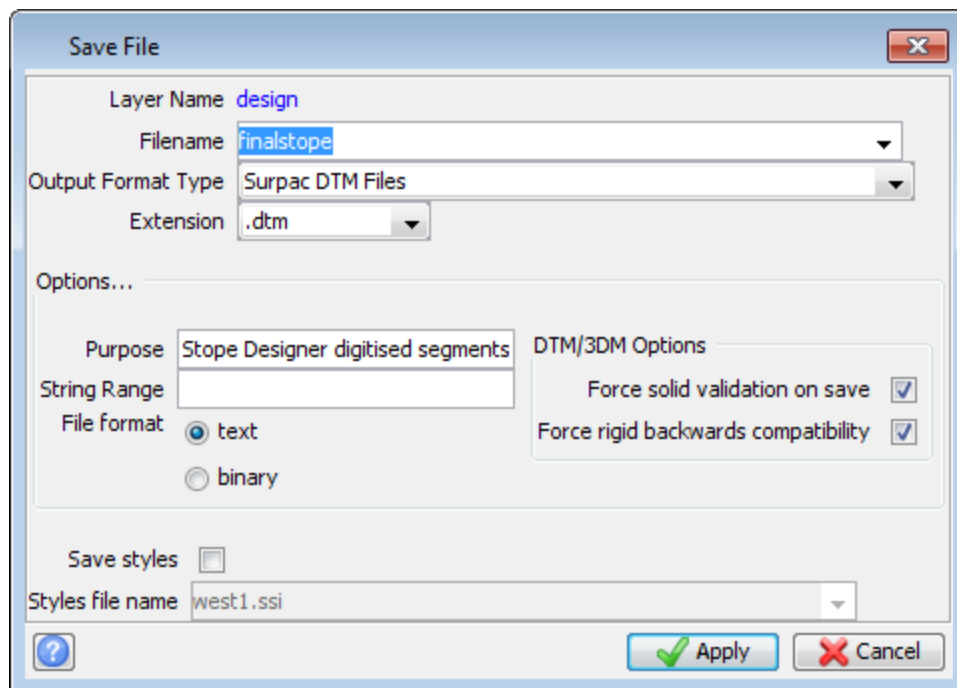
Design Object properties

Property	Value
Object	1
Trisolation	4 (westStope)
Validated	true
Status	solid
Volume	4771245
Surface area	259184
X Minimum	1408.841
X Maximum	1843.445
Y Minimum	7110.000
Y Maximum	7550.000
Z Minimum	831.164
Z Maximum	1001.902

Block Model properties

Property	Value
BM Mass	13359355.1
BM Volume	4771198.2
c_gold_grade	0
c_gold_metal(g)	0
c_mass	10639174.2
c_volume	3799705.1
q_gold_grade	3.82
q_gold_metal(g)	10232194.81
q_mass	2678216.4
q_volume	956505.9
s_gold_grade	5.38
s_gold_metal(g)	225793.48
s_mass	41964.5
s_volume	14987.3

- Select **Design > Stope Design tools > Save Stope Designer project**.
- Save the **design** layer as **finalStope**.



The new stope design object is saved as finalstope. In addition, the **.sdproj** file is saved, and also a **.swa** file that records the location of all data and your view of it.

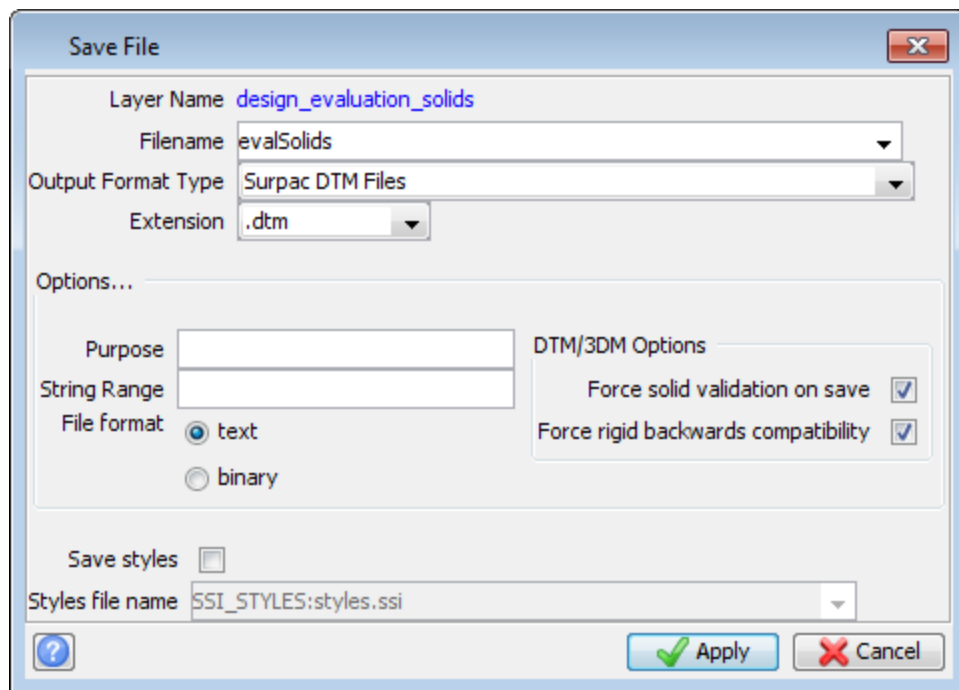
Caution: If you have already created the design object, and later want to move a point in a polygon, and then recreate the design object, you must first delete the following objects:

- the final solid that stope design previously created
- any new segments at each end of the solid

You cannot create the new object without deleting the end segments. If you do not delete the existing solid, stope design will merge the existing solid with the new solid, to create a new solid that is likely to be invalid.

Tip: Use DRAW LINES to see the segments, and use SEGMENT DELETE to delete them. Use OBJECT DELETE to delete the solid.

8. Save the evaluation solids as **evalSolids**.

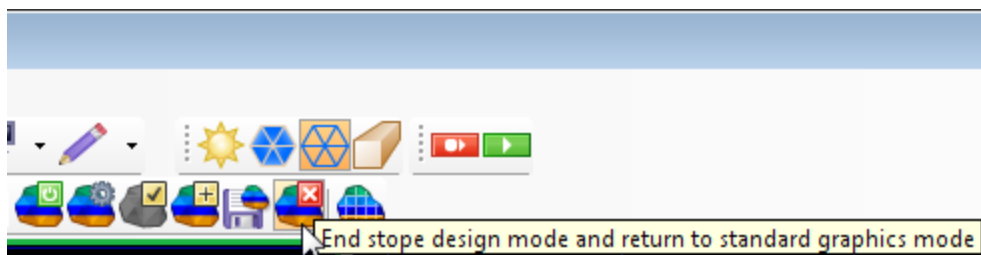


The polygons and the temporary solids are stored as evalSolids.

Task: End stope design

You can use this function to save your stope design project and close it.

1. Click the **End Stope Design** button on the **Underground Design** toolbar.



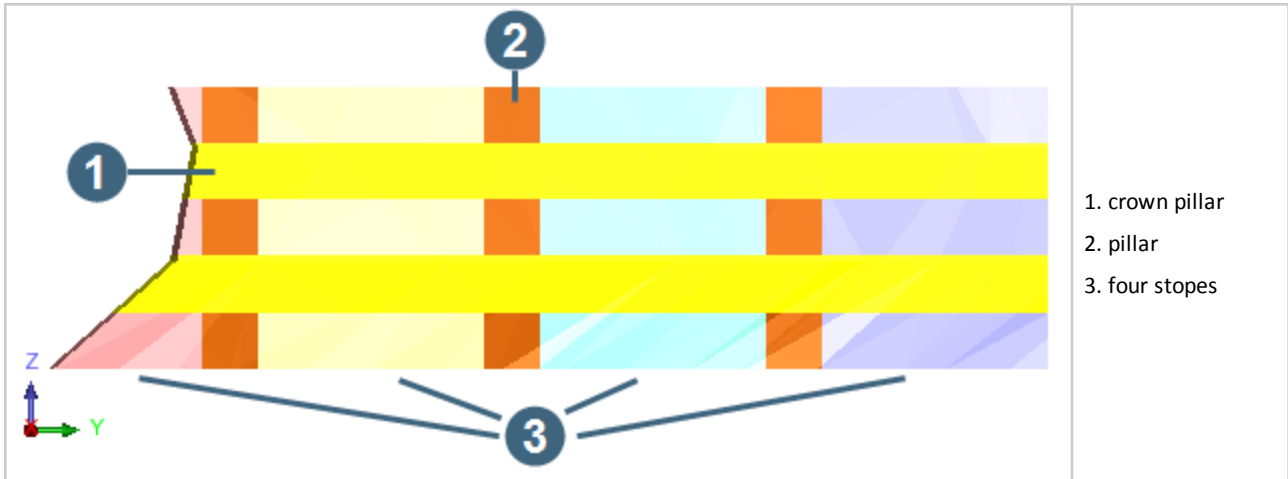
Stope Slicer

Stope Slicer takes a valid solid and cuts it into levels (horizontal) or stopes (vertical), (or both levels and stopes).

As well as specifying the solid you want to slice, you can specify solids you do not want to slice. For example, you can exclude development workings and tunnels that intersect the mining solid.


You can slice levels by elevation or by using planes. You can create crown pillars between the levels.

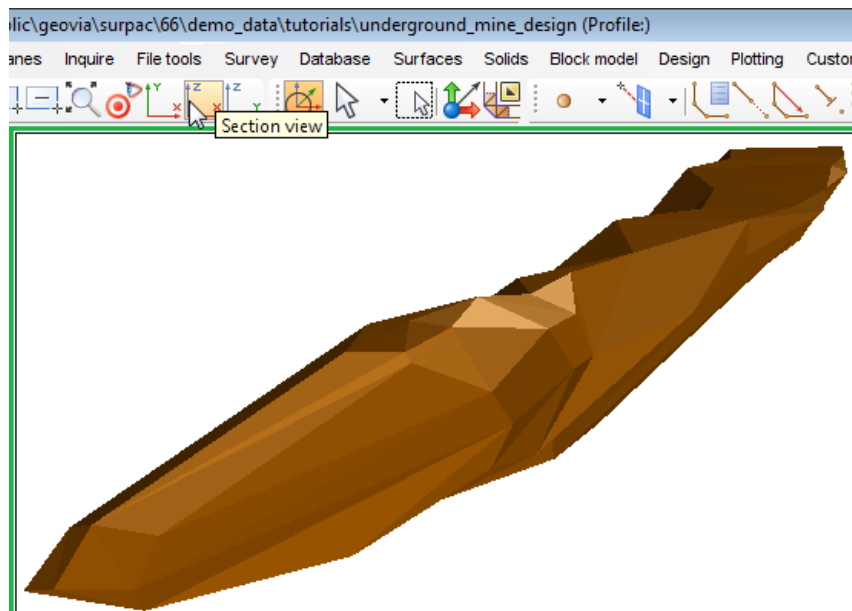
In this tutorial, you will use several different solids to experiment with the different slicing methods.




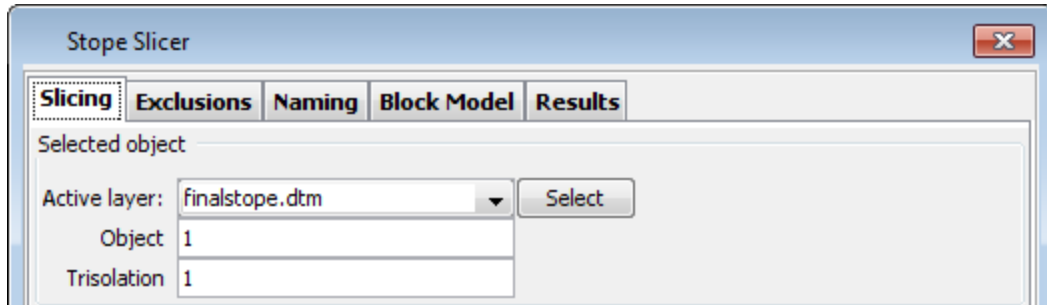
Task: Slice by elevation

To get familiar with the basics of Stope Slicer, you will perform a simple task, slicing a solid by elevation.

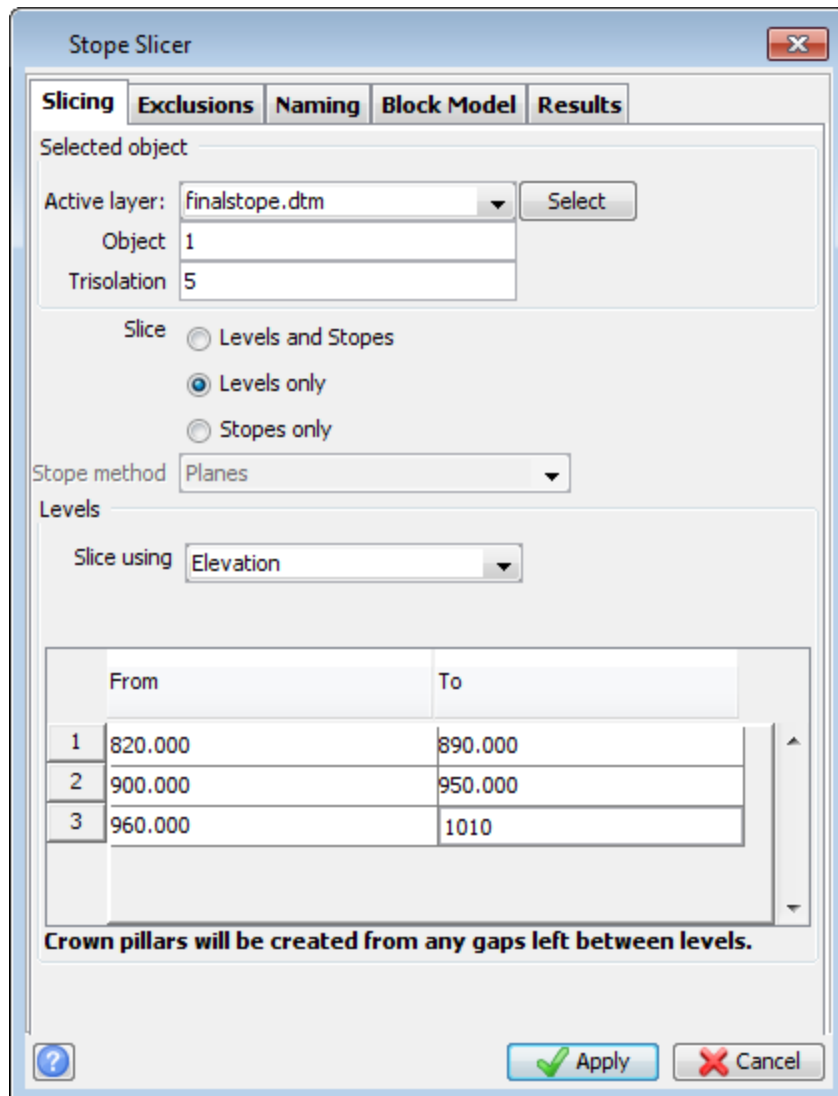
1. Click **Reset Graphics**.
2. Close any block model that is open.
3. Drag **finalstope.dtm** into **Graphics**.
 - 📌 **Note:** If you have not created **finalstope.dtm**, use the **finalstopeZ.dtm** that is supplied with the data set.
4. Click **Section view**  on the **Navigate** toolbar.



5. If the **Underground Design** toolbar is not already displayed, right-click in the toolbar area, and choose **Toolbars > Underground Design** to show the **Underground Design** toolbar.
6. Click  on the **Underground Design** toolbar to start the Stope Slicer.
7. On the **Slicing** tab, click **Select**, and click on the ore body in **Graphics**.



8. In the **Slice** section, select **Levels only**.
9. In the **Slice using** section, select **Elevation**.
You can also slice levels using planes, if you have created the planes already.
10. In the 'From To' table, enter **From: 820, To: 890, From: 900, To: 950, and From: 960, To: 1010**.



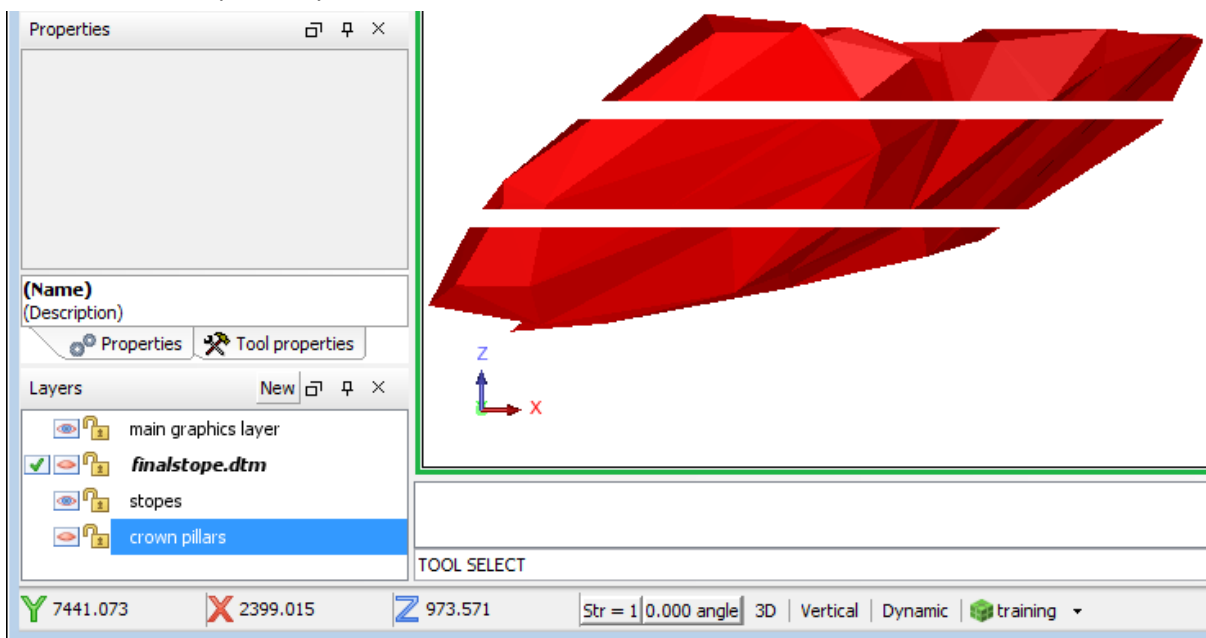
11. Click **Apply**.



The ore body is sliced into three stopes with two crown pillars in between. By default, crown pillars are displayed in yellow.

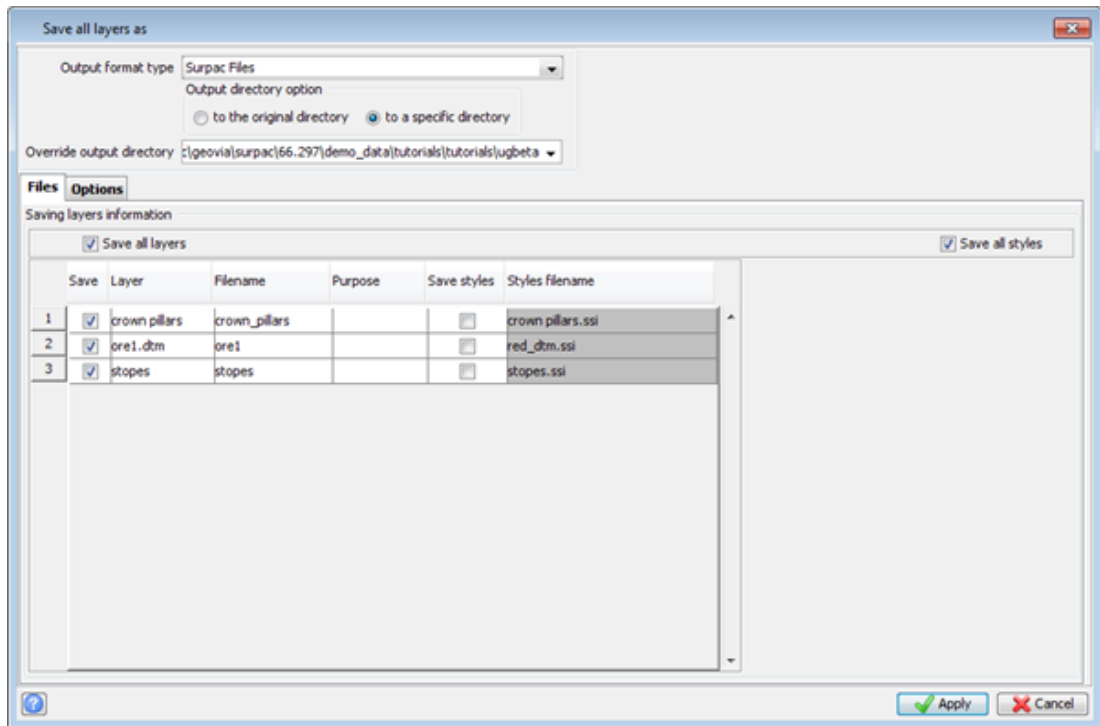
In the **Layer Manager**, you can see two new layers, one for the stopes, and one for the crown pillars. In this example there are no (vertical) pillars, but there are (horizontal) crown pillars.

12. Click the crown pillars layers to make it invisible.

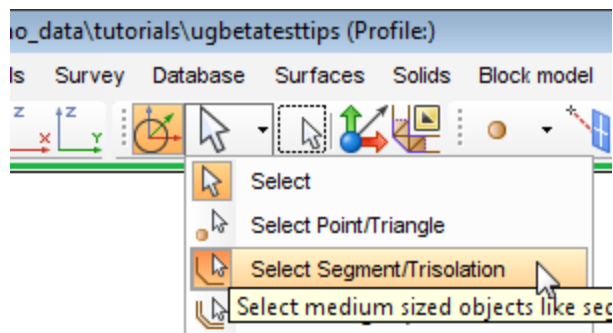


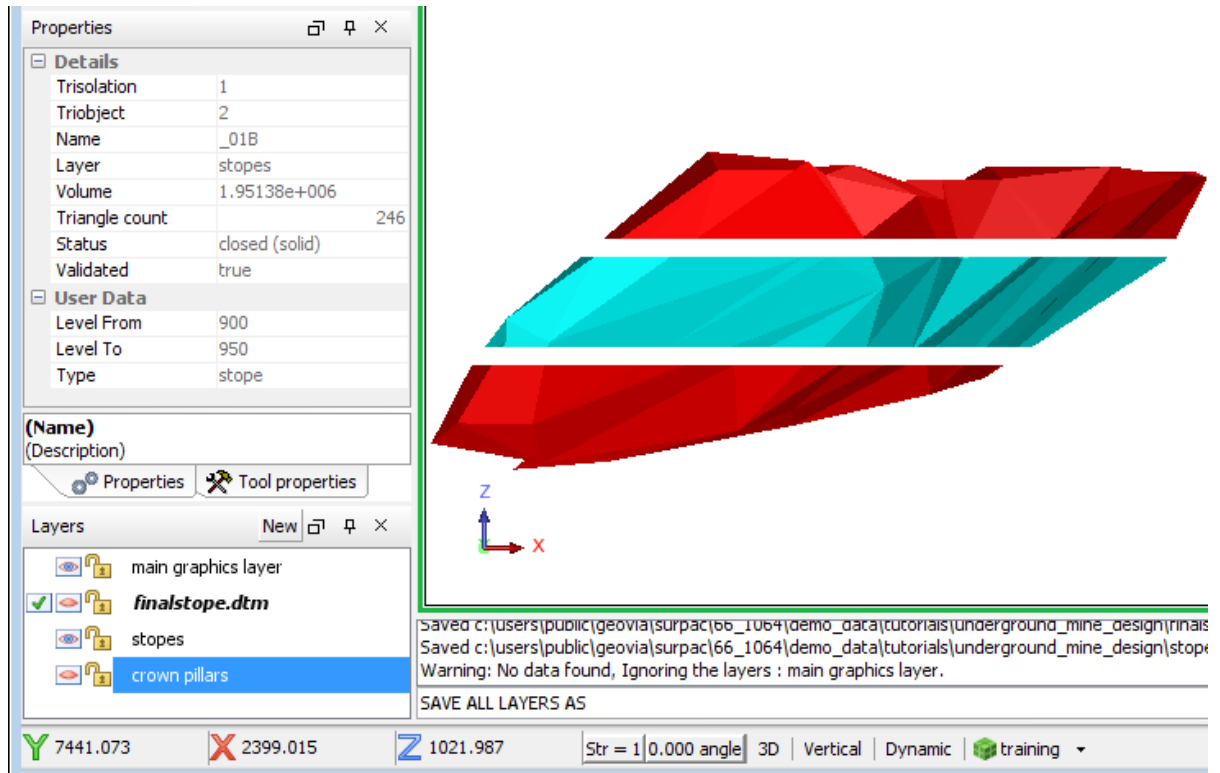
The stopes layer and the crown pillars are not yet saved. You do not create files for the stopes and for the crown pillars until you save the layers in which they are temporarily stored.

13. In the function chooser, type **SAVE ALL LAYERS AS**.



14. Click **Apply**.
 ⚠ **Note:** To make sure that the stopes are always displayed with the same colour (red in this example) you must select the **Save all styles** check box.
15. On the **Tools** toolbar, click the **Select** tool, and choose **Select Segment\Trisolation**.



16. Select one of the stopes in **Graphics**.

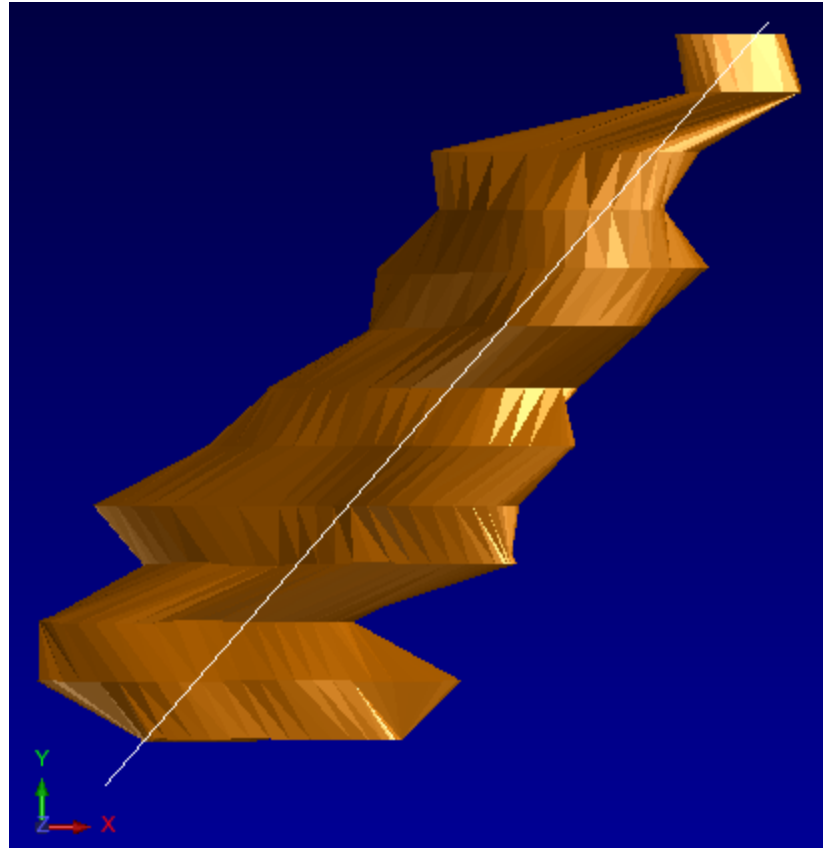
The **Properties** pane displays some details of the stope.

Task: Slice by stopes

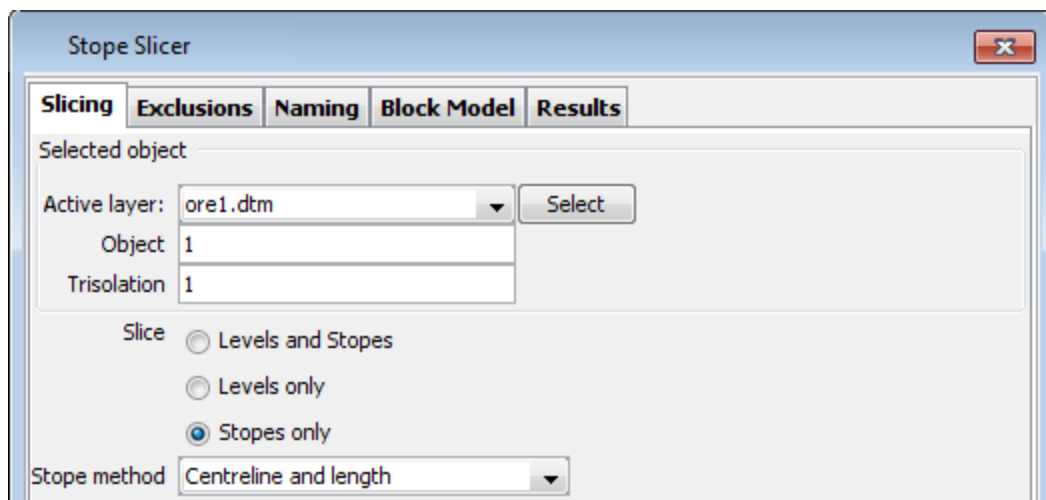
This procedure shows you how you can slice a solid vertically to create stopes. You can use planes or a centreline to define the stopes. This example uses a centreline.

1. Click **Reset Graphics**.
2. Open **middle.str**.
3. Open **ore1.dtm** in **Graphics**.

The ore body is displayed in plan view. The elevation of the centreline is greater than the elevation of the ore. The centreline does not need to be draped over the ore body.



4. In the function chooser, type STOPE SLICER, and press ENTER.
5. Click **Select**, and select the ore body.
6. For the **Slice** option, select **Stopes only**.
7. For the **Stope method**, select **Centreline and length**.



8. Click **Select centreline**.
9. In **Stope length**, type 40.

10. In **Pillar length**, type 10.

Centreline

Select centreline

Layer	String	Segment
1 middle	1	1

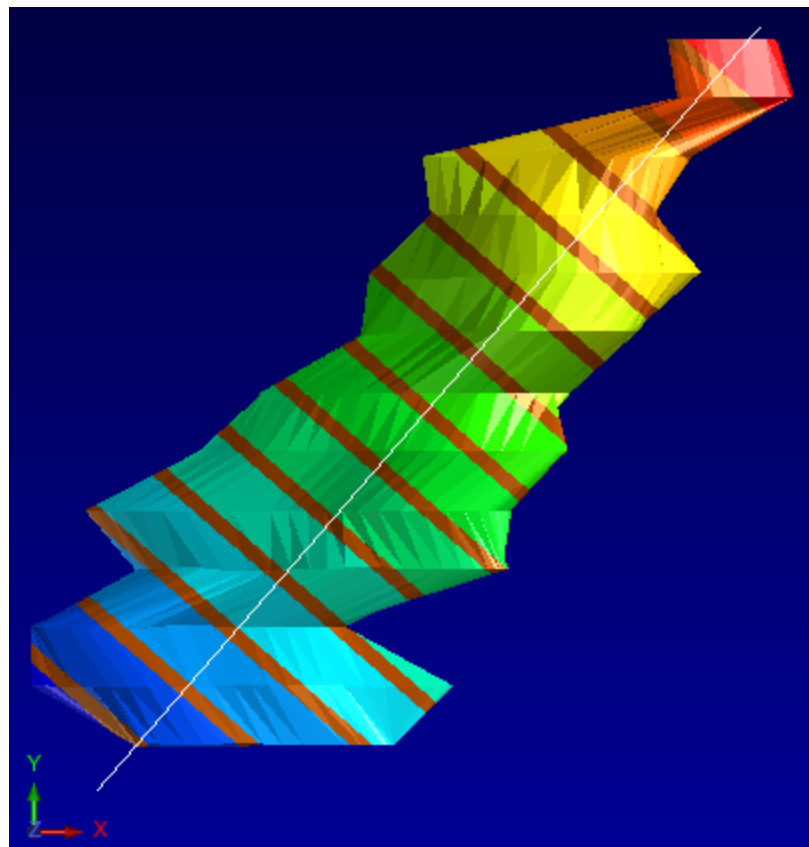
Stopes

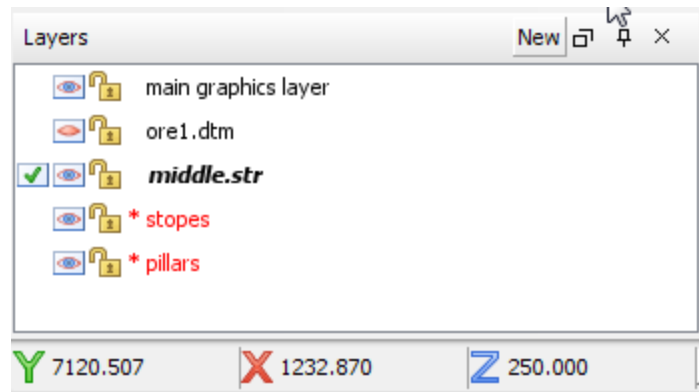
Stope length 40

Pillar length 10

11. Click **Apply**.

The ore body is sliced, and the **Layer Manager** shows two new layers: one for the stopes and one for the pillars.

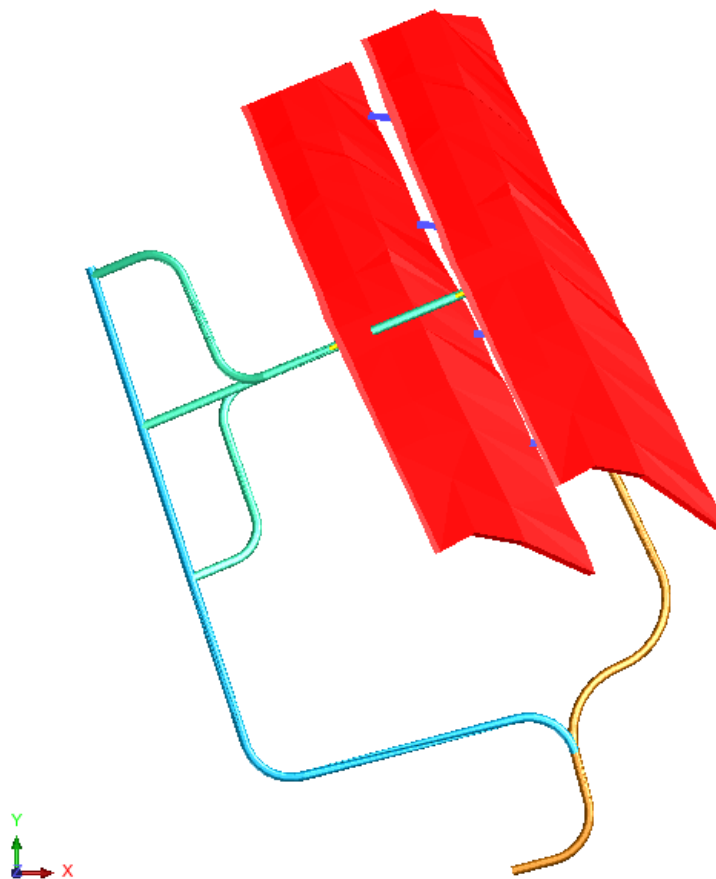




Task: Define exclusions in stope slicing

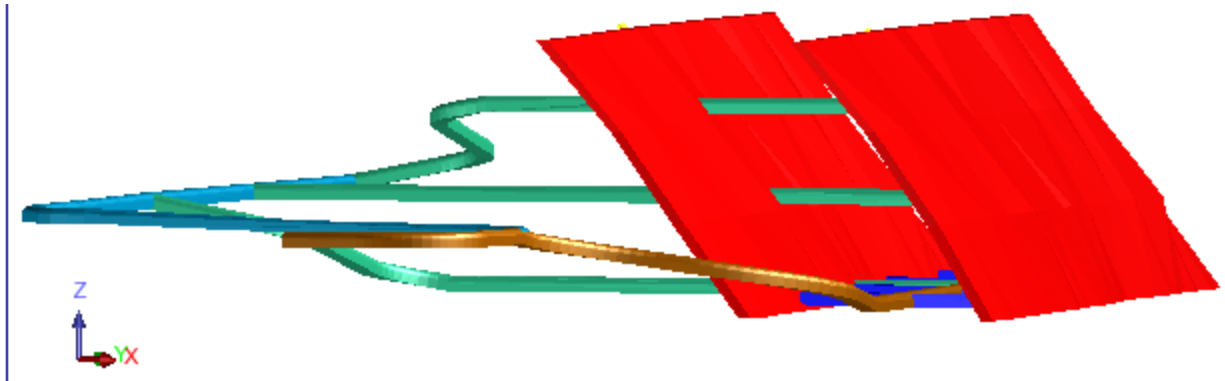
You can exclude a valid solid from a stope when you slice so that the volume of the excluded solid is not included in the stopes (or pillars or crown pillars) that you create. This is useful when you have drives, or existing workings, that are already modelled as solids.

1. Click **Reset Graphics**.
2. Open **ugdesAlt.dtm**.
3. Open **stopesAlt.dtm**.

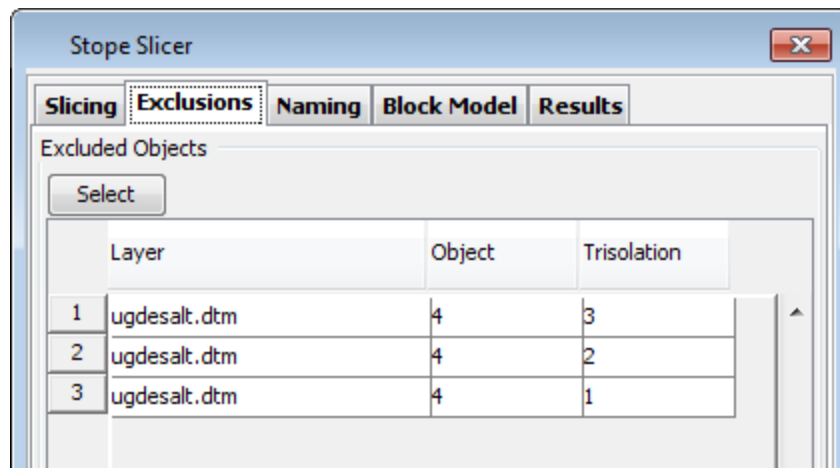


4. Click the **Section view** icon  on the **Navigate** toolbar to view the data in section view.

- Rotate the image so you can see the three drives.



- Type STOPE SLICER in the **Function Chooser**, and press ENTER.
- Select the **Exclusions** tab.
- Click **Select**, and, in **Graphics**, select one of the three blue-green drives.
- Select the other two blue-green drives in the same way, and press ESC.

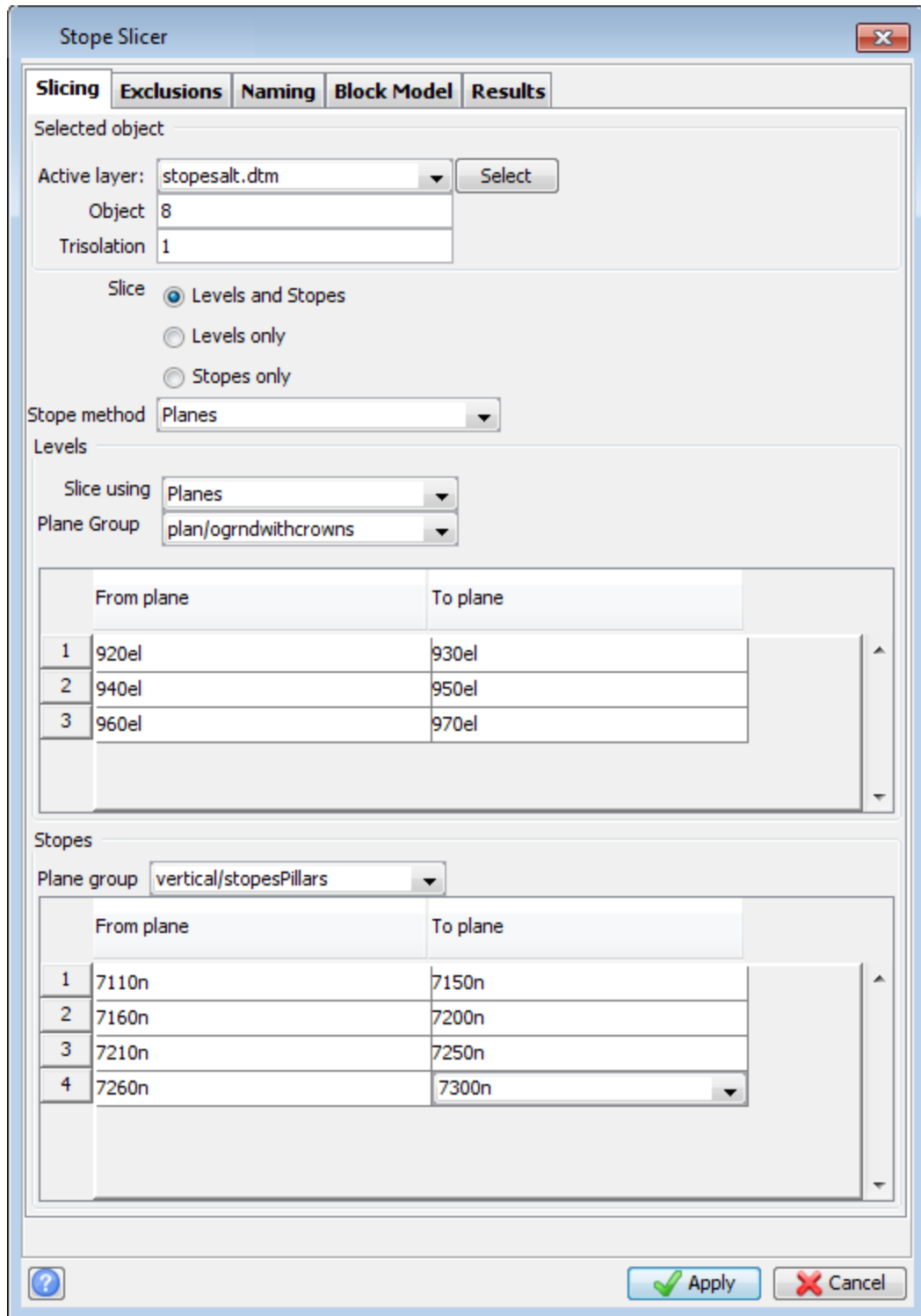


You have specified to exclude the three drives.

- Select the **Slicing** tab.
- Click **Select**, and select the stope on the left.
- Select **Levels and Stopes**.
- For the **Stope method**, select *Planes*.

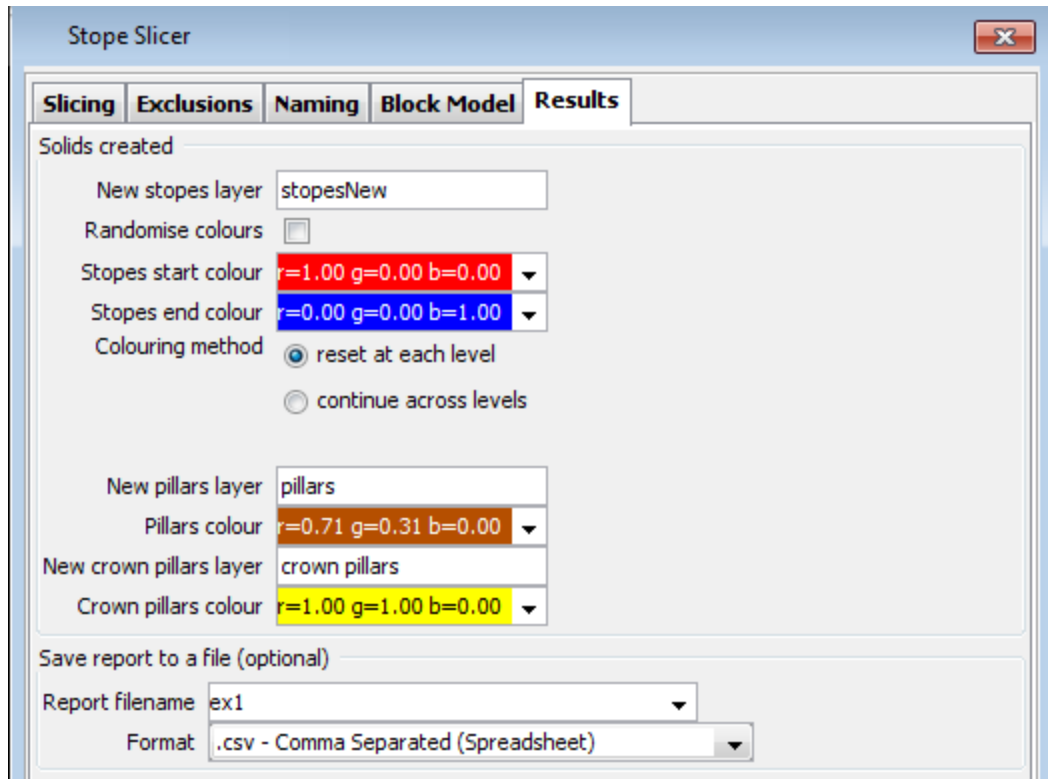
📌 **Note:** If *Planes* is not listed in the **Stope method** list, you do not have any horizontal planes available. You can copy the planes supplied with this data set to your planes folder, and then right-click in the **Planes** panel, and click **Refresh**. The default planes folder is **C:\Users\Public\GEOVIA\Surpac\<version>\share\planes**.
- For **Slice using**, select *Planes*.

- Fill in the 'From plane To plane' tables, and the **Stopes** section, as shown.

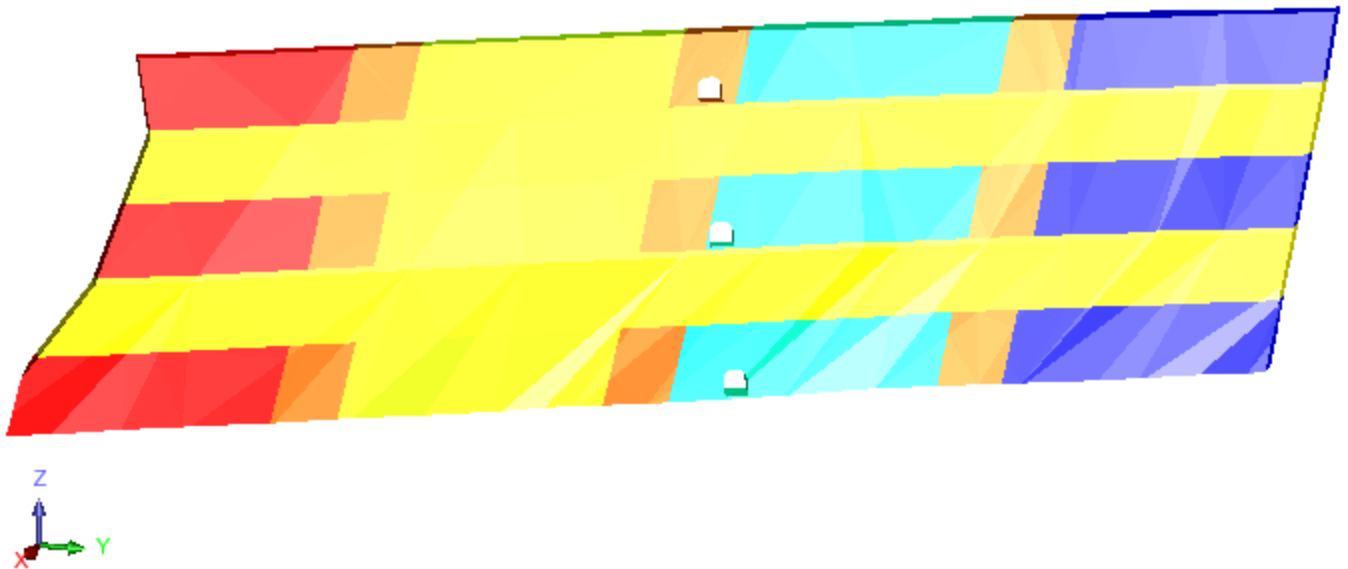


- Click the **Results** tab.
- In the **New stopes layer** field, type `stopesNew`.

18. In the **Output Report File Name** field, type ex1.



19. Click **Apply**.



The solids that are created have holes where the drives were.

20. Right-click on **ex1.csv** in the Navigator, and choose **Open**.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Object ID	Trisolation ID	Name	Type	Level plane group	Level From	Level To	Stope plane group	Stope From	Stope To	Object Volume	
2	1	1	01A	stope	Plan/ogrndwithcrowns	920El	930El	Vertical/stopesPillars	7110N	7150N	1752.4	
3	2	1	01B	stope	Plan/ogrndwithcrowns	920El	930El	Vertical/stopesPillars	7160N	7200N	1877.7	
4	1	1	01B_pillar	pillar	Plan/ogrndwithcrowns	920El	930El	Vertical/stopesPillars	7150N	7160N	486.2	
5	3	1	01C	stope	Plan/ogrndwithcrowns	920El	930El	Vertical/stopesPillars	7210N	7250N	1617.4	
6	2	1	01C_pillar	pillar	Plan/ogrndwithcrowns	920El	930El	Vertical/stopesPillars	7200N	7210N	508.3	
7	4	1	01D	stope	Plan/ogrndwithcrowns	920El	930El	Vertical/stopesPillars	7260N	7300N	1335.2	
8	3	1	01D_pillar	pillar	Plan/ogrndwithcrowns	920El	930El	Vertical/stopesPillars	7250N	7260N	331.6	
9	5	1	01E	stope	Plan/ogrndwithcrowns	940El	950El	Vertical/stopesPillars	7110N	7150N	965.4	
10	1	1	01E_crownpillar	crownpillar	Plan/ogrndwithcrowns	930El	940El	Vertical/stopesPillars	7110N	7150N	1218.7	
11	6	1	01F	stope	Plan/ogrndwithcrowns	940El	950El	Vertical/stopesPillars	7160N	7200N	1083.6	
12	4	1	01F_pillar	pillar	Plan/ogrndwithcrowns	940El	950El	Vertical/stopesPillars	7150N	7160N	302.7	
13	2	1	01F_crownpillar	crownpillar	Plan/ogrndwithcrowns	930El	940El	Vertical/stopesPillars	7160N	7200N	1324	
14	3	1	01F_pillar_crownpillar	pillar_crownpillar	Plan/ogrndwithcrowns	930El	940El	Vertical/stopesPillars	7150N	7160N	341.5	
15	7	1	01G	stope	Plan/ogrndwithcrowns	940El	950El	Vertical/stopesPillars	7210N	7250N	1277.9	
16	5	1	01G_pillar	pillar	Plan/ogrndwithcrowns	940El	950El	Vertical/stopesPillars	7200N	7210N	304.9	
17	4	1	01G_crownpillar	crownpillar	Plan/ogrndwithcrowns	930El	940El	Vertical/stopesPillars	7210N	7250N	1442.4	
18	5	1	01G_pillar_crownpillar	pillar_crownpillar	Plan/ogrndwithcrowns	930El	940El	Vertical/stopesPillars	7200N	7210N	326.5	
19	8	1	01H	stope	Plan/ogrndwithcrowns	940El	950El	Vertical/stopesPillars	7260N	7300N	1362.8	
20	6	1	01H_pillar	pillar	Plan/ogrndwithcrowns	940El	950El	Vertical/stopesPillars	7250N	7260N	379.8	

The report shows you the volume of each stope, pillar, and crown pillar.

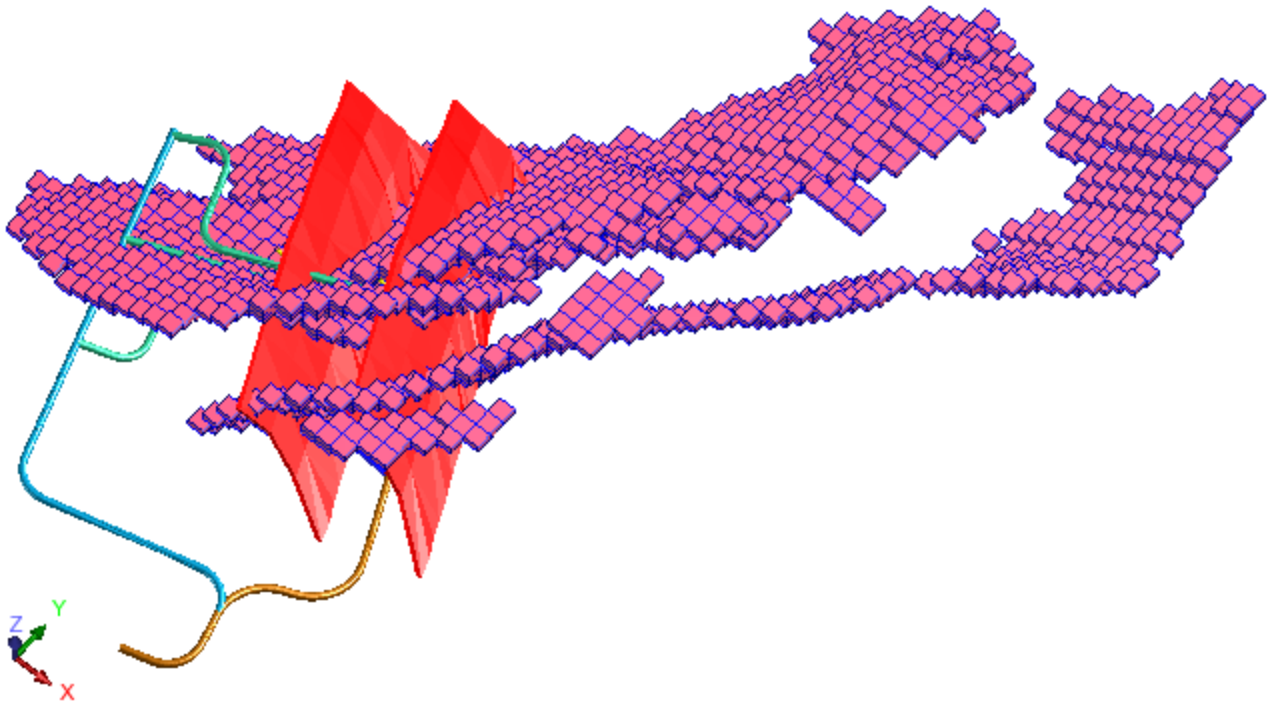
Task: Slice to a target tonnage

You can slice the stopes so that the stopes are as close as possible to a specific volume or tonnage. If you have a block model in the same location as the solid you are slicing, you can create a report that shows the tonnage and the mass of your resource in each stope.

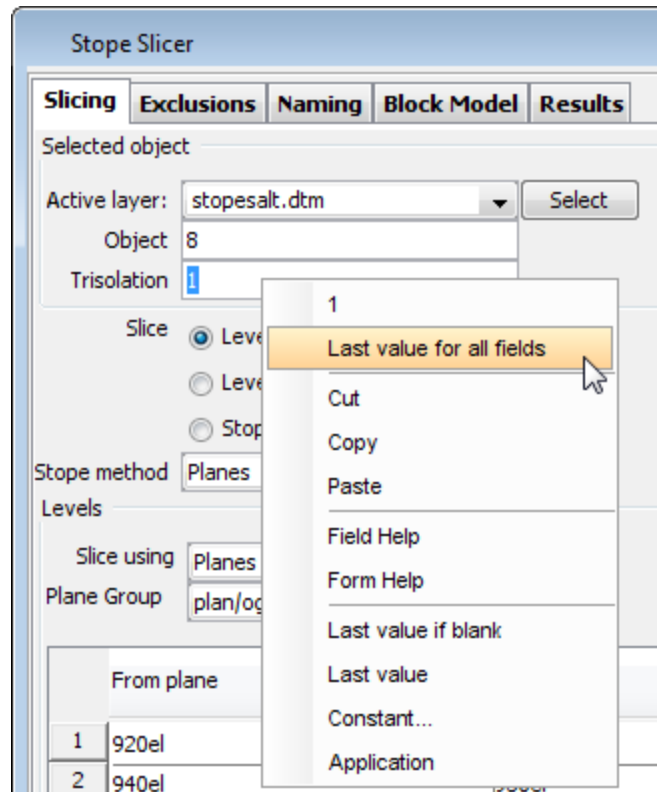
1. Click **Reset Graphics**.
2. Open **stopesAlt.dtm**.
3. Open **ugdesAlt.dtm**.
4. Drag **training.mdl** into **Graphics**.

In this data set, the solids have been placed in the same location as this block model. The values of each of the attributes in the block model have not been modified. Therefore the grade values are unrealistic. However, the data is sufficient to demonstrate how the STOPE SLICER function works.

- To confirm that the block model is in the same location as the solids, display the block model, and apply a constraint to display gold > 0.3.



- Hide the block model again, so it is easier to work with the solids.
- Run STOPE SLICER.
- Right-click in the **Trisolation** field, and choose **Last Value for all Fields**.



Note: This step is effective only if you have just completed Task: Define exclusions in stope slicing.

9. For the **Stope method**, select Start, plane, length and target.
10. Fill in the **Stopes** section of the form as follows.

The screenshot shows the 'Stope Slicer' dialog box with the following settings:

- Selected object:** Active layer: stopesalt.dtm, Object: 8, Trisolation: 1
- Slice:** Levels and Stopes (selected)
- Stope method:** Start plane, length and target
- Levels:** Slice using: Planes, Plane Group: plan/ogrndwithcrowns
- Table:**

	From plane	To plane
1	920el	930el
2	940el	950el
3	960el	970el
- Stopes:** Plane group: vertical/bmVert, Start at plane: 7100v, Stope length: 10, Pillar length: 10, Target: Tonnage (selected), Target value: 500

You have specified that STOPE SLICER will try to create stopes that are 10 units in width, but that if the tonnage (volume * density) of any stope is less than 500, that stope is increased in width by another 10 units. The new stope tonnage is then calculated and if it still does not meet the target of 500 tonnes the width is increased by another 10 units. This process repeats until every stope meets the target of 500 tonnes.

11. Select the **Block Model** tab.
12. Fill in the form as follows.

Stope slicer

Slicing **Exclusions** **Naming** **Block Model** **Results**

Evaluate using block model

Block model **training.mdl**

Block model settings

Specific gravity by attribute
 value

Value

Use partial percentages

Precision

Ore/rock type attribute for classification

	Attributes	Contained metal factor	Metal units	Replace negatives with
1	gold	1	g	0

You have specified that the density of each block in the block model is 1.2. Blocks that are partially inside the solid are sub-blocked into 8, and those blocks are divided into 8 again. Those blocks and sub-blocks whose centroids are within the solid, are included in the stope slicing report. The report will show gold grade, ore/rock type, and contained metal for gold.

Tip: Alternatively, you could use the *sg* attribute in the block model instead of a constant density value.

13. Select the **Results** tab, and, in **Report Filename**, type **ex2**.
14. Click **Apply**.

15. Select a trisolation to see properties for the slice, including more detailed information, such as gold grade and contained metal.

16. Open **ex2.csv**.

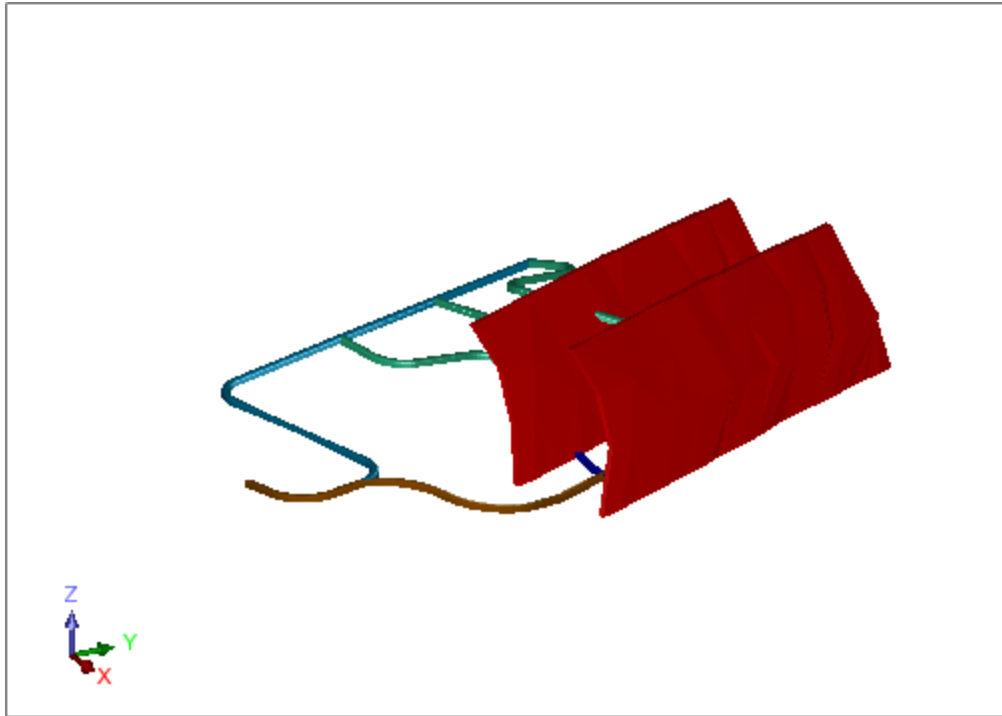
K	L	M	N	O	P	Q	R	S
Object Volume	Object Mass	BM Mass	BM Volume	b_gold_grade	b_gold_metal(g)	b_mass	b_volume	c_gold_grade
858.9	1030.7	1096.9	914.1	0	0	0	0	0
451.2	541.4	543.8	453.1	0	0	0	0	0
442.3	530.8	581.3	484.4	0	0	0	0	0
486.2	583.4	618.8	515.6	0	0	0	0	0
487.5	585	600	500	1.23	322.88	262.5	218.8	0
529.9	635.9	637.5	531.3	1.23	357.47	290.6	242.2	0
477.6	573.1	581.3	484.4	0	0	0	0	0
382.7	459.3	459.4	382.8	0	0	0	0	0
508.3	610	600	500	0	0	0	0	0
479.9	575.9	600	500	0	0	0	0	0
423	507.5	515.6	429.7	0	0	0	0	0
364.7	437.6	450	375	0	0	0	0	0
681.4	817.7	825	687.5	0	0	0	0	0
374.9	449.9	450	375	0	0	0	0	0
681.4	817.7	815.6	679.7	0	0	0	0	0
278.9	334.7	346.9	289.1	0	0	0	0	0

For each stope, pillar, and crown pillar, the report shows gold grade and mass by rock type. There are two rock types in the block model: o and r.

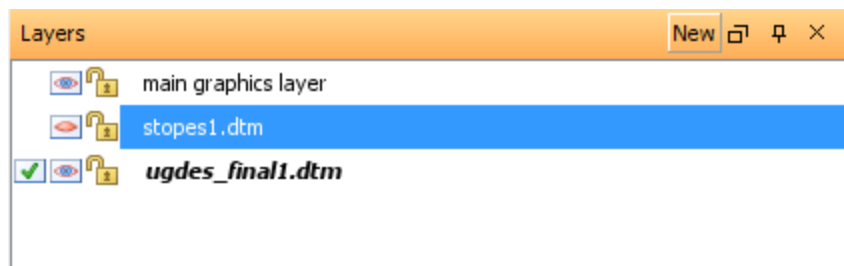
Creating a centreline design

Task: View the data

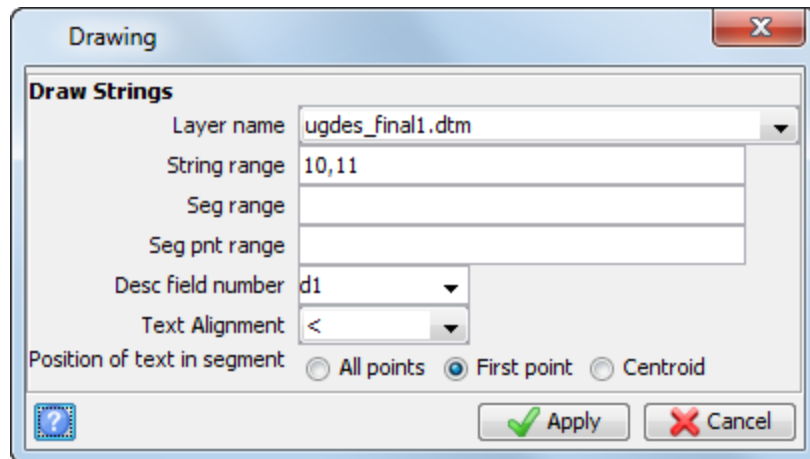
1. Open **stopes1.dtm** in **Graphics**.
2. This file represents two parallel ore zones.
3. Open **ugdes_final1.dtm** in **Graphics**.



4. Click the eye icon in the **Layer Manager** for **stopes.dtm** to hide the stopes layer.

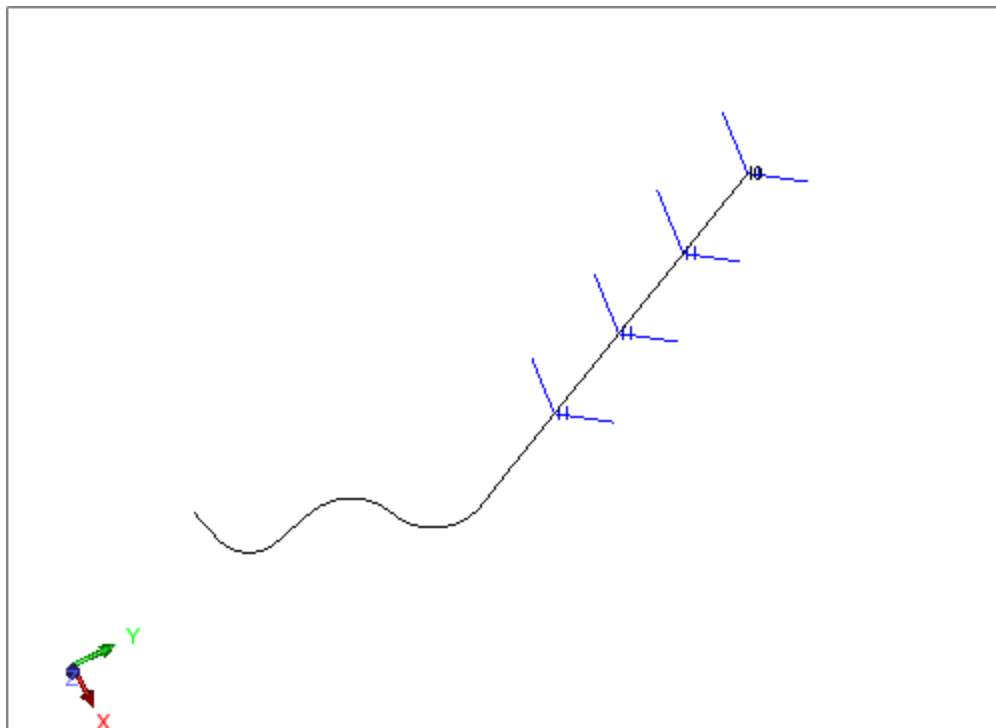


5. Choose **View > Surface view options > Hide triangle faces** to hide the drives.
6. Choose **Display > Strings > With string numbers**.
7. Enter the information as shown, and click **Apply**.





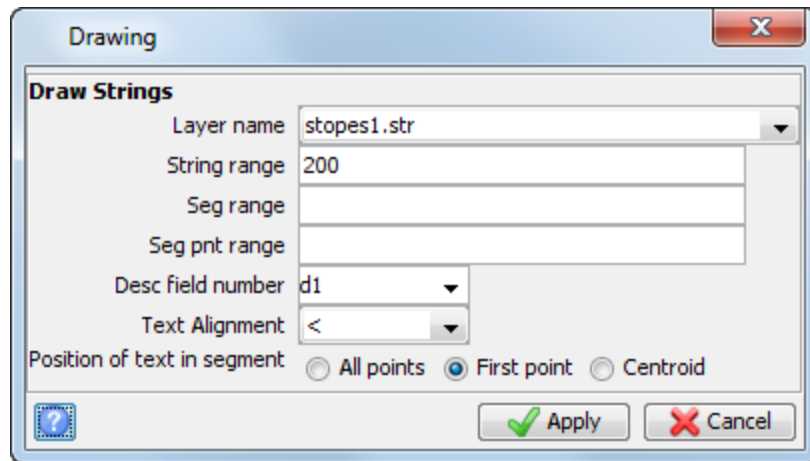
Strings 10 and 11 represent the centreline string numbers in the final design.

The centreline string is displayed.

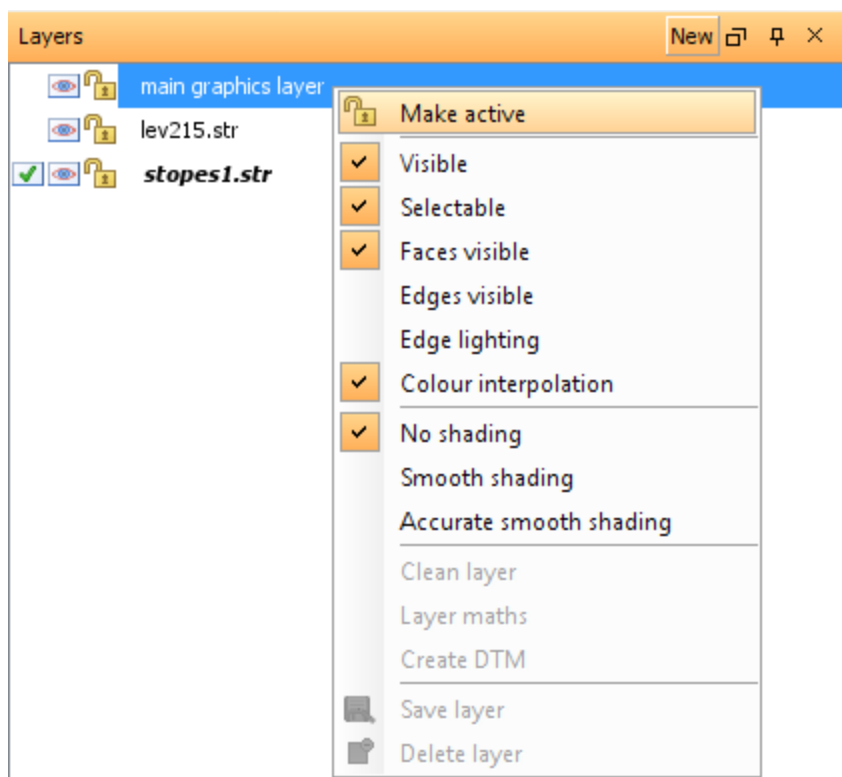


Task: Create a centreline between ore zones

1. Click **Reset graphics** .
2. Open **lev215.str** in **Graphics**.
3. Open **stopes1.str** in **Graphics**.
4. Spin the data around to get an idea of how the strings are formed in 3D space.
5. Choose **Display > Strings > With string numbers**, leave the fields blank and click **Apply** to display all strings with numbers.
6. Choose **Inquire > Point properties**, and click several different segments.
 -  **Note:** The string numbers correspond with the Z value of the strings.
7. Choose **Display > Hide everything**.
8. Choose **Display > Strings > With string numbers**.
9. Enter the information as shown, and click **Apply**.



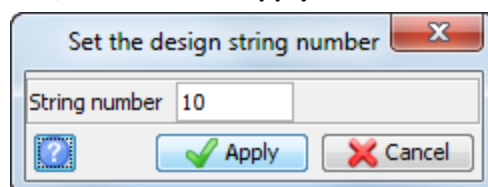
10. In the Layer Manager, right-click **main graphics layer** and choose **Make active**.



The **main graphics layer** currently does not contain any data.

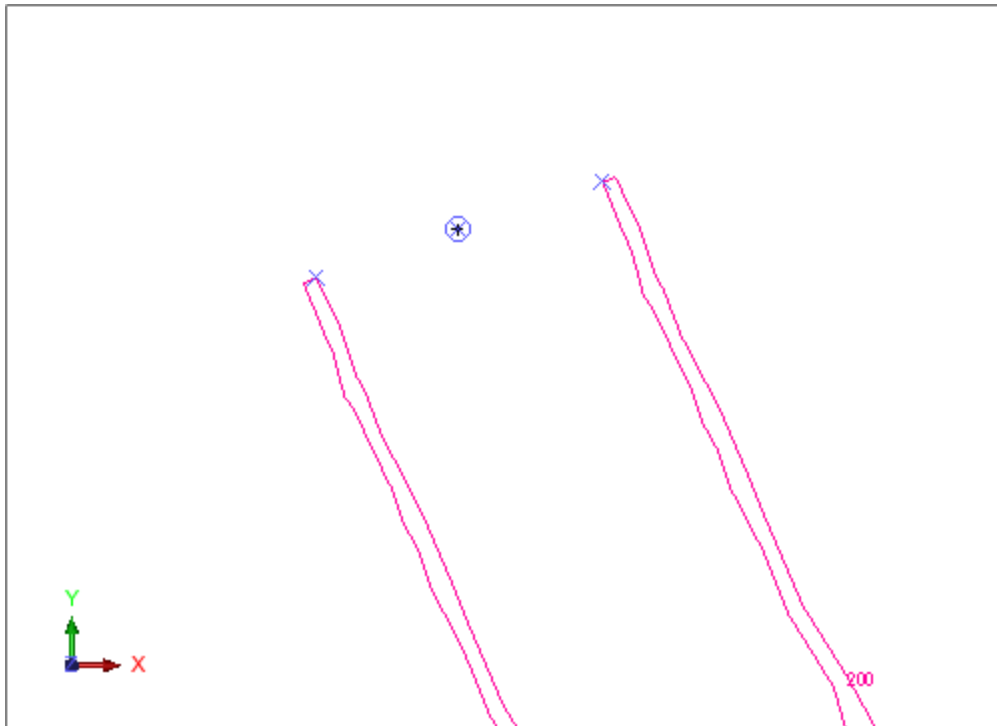
As shown in the final design previously, the string used to create the main drive between the two ore zones is string 10.

11. Click the **Design string number** button **Str = 1** on the Status bar.
12. Enter the information as shown, and then click **Apply**.

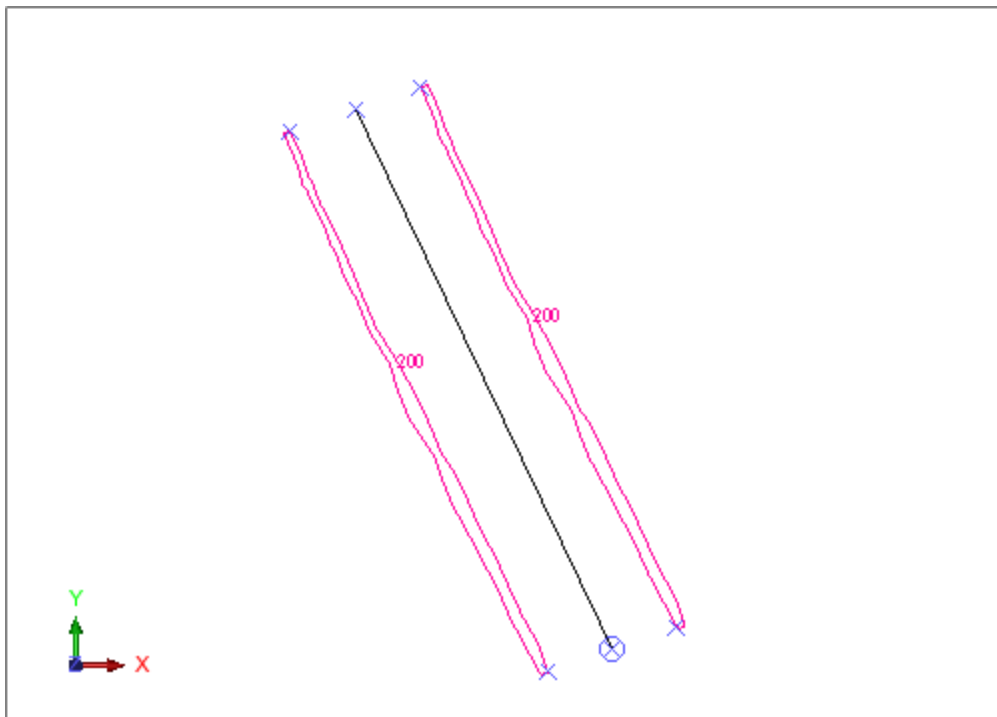


13. Choose **Create > Digitise > New midpoint**.

14. Click two points on the north end of the ore zones to create a point midway between the two selected points, as displayed.



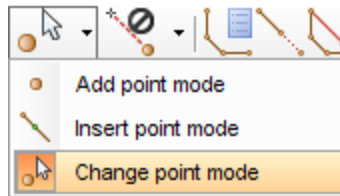
15. Click two points on the south end of the ore zones to create another point midway between the two selected points, as displayed.



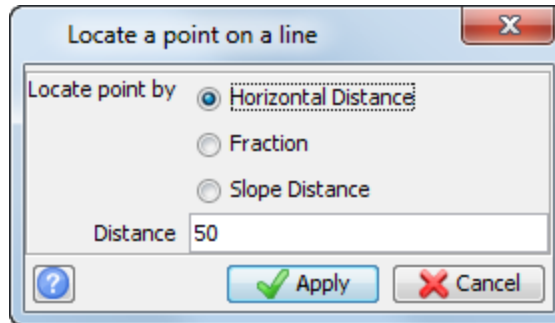
16. Press **ESC**.

The Z value of the created points will be equal to the average of the Z values of the two selected points. In this case, where the Z value of both points is 200, the Z value of the new points will also be 200.

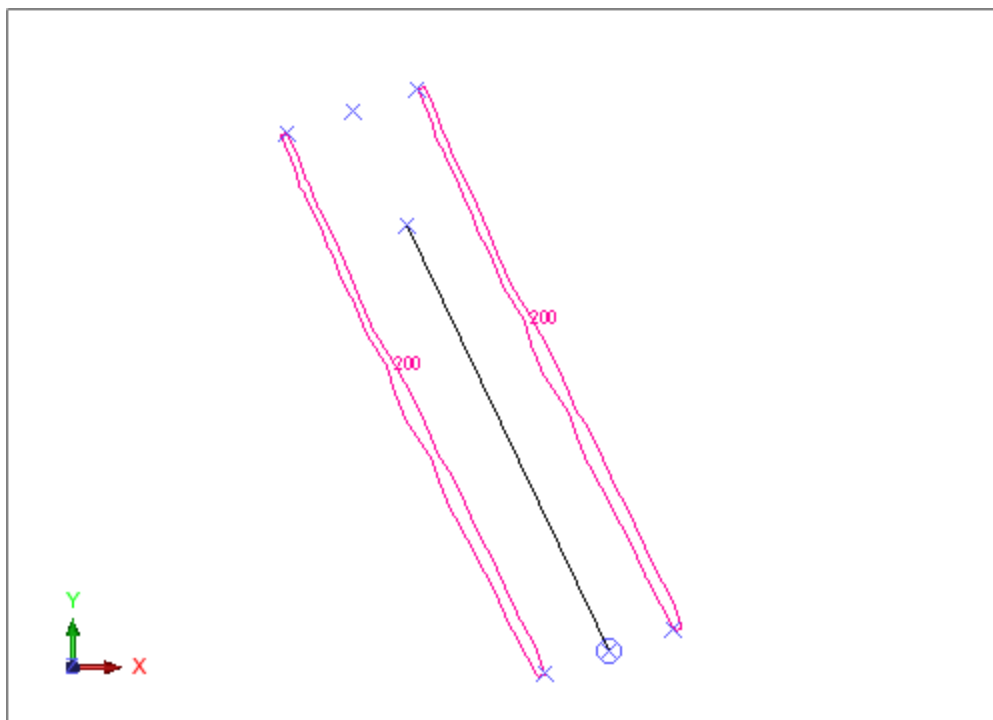
- Click the point mode drop down, and select **Change point mode**.



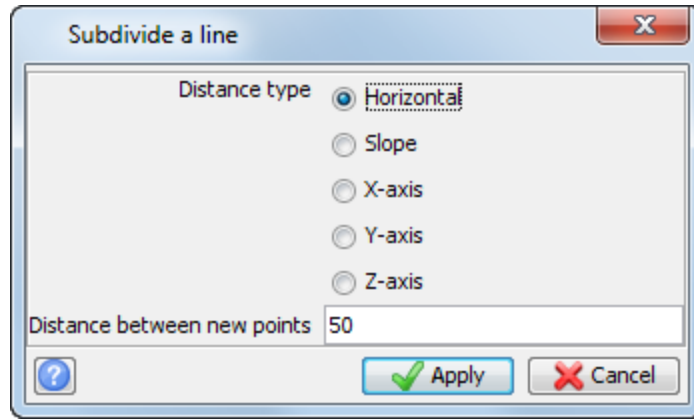
- Choose **Create > Points > On line between any points**.
- Click the first point created in string 10 (that is, the point to be moved), and then click the second point created in string 10.
- Enter the information as shown, and then click **Apply**.



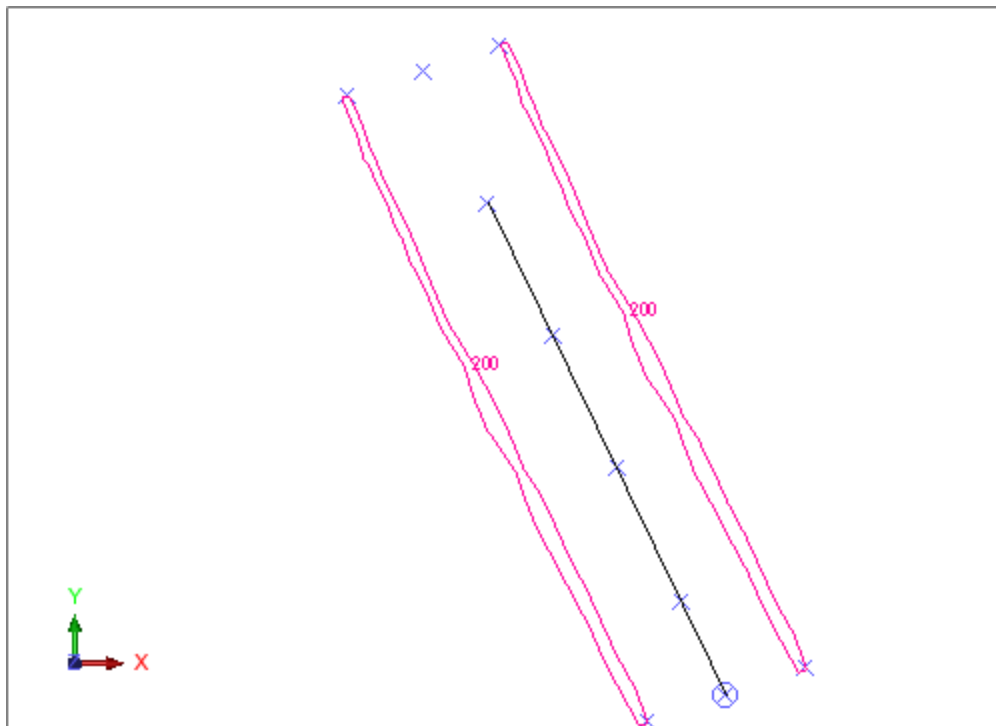
The point will be moved 50 metres as displayed.



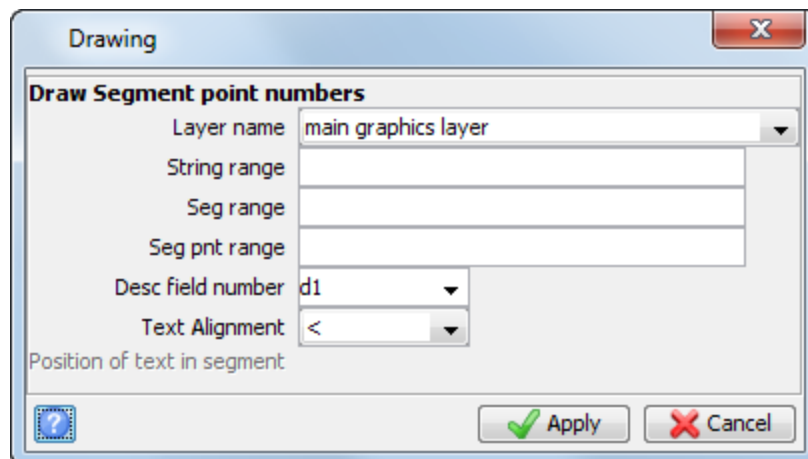
- Press **ESC**.
- Choose **Create > Points > Insert point mode**.
- Choose **Create > Points > Multiple points by subdividing**.
- Click the northern end of string 10, then the southern end of string 10.
- Enter the following information, and click **Apply**.



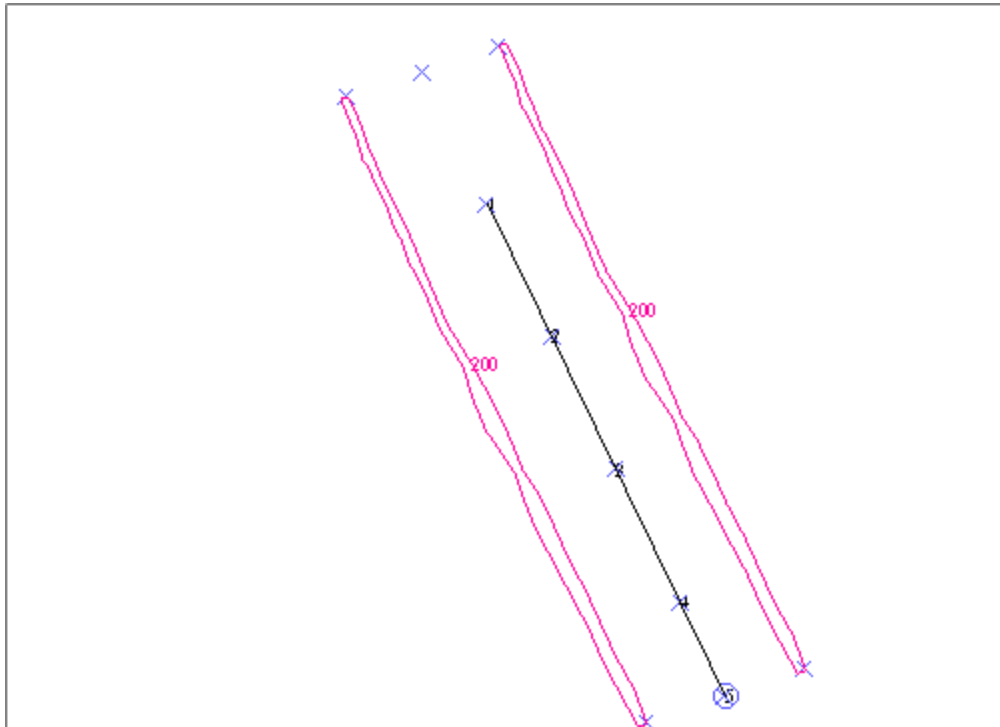
The centre string is displayed.



26. Press **ESC**.
27. Choose **Display > Point > Numbers**.
28. Enter the information as shown, and click **Apply**.



The points inserted along the centreline are displayed.



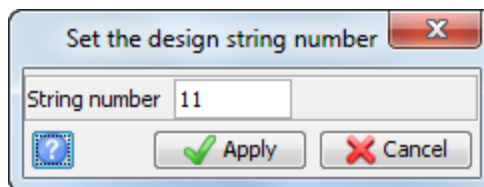
These points will be the starting points for the access drives to the ore zones.

29. Save the centreline string to the file **ugdes1.str**.

Note: To see all of the steps performed in this section, run **_01_create_centreline_between_ore_zones.tcl**. You need to click **Apply** on any forms presented.

Task: Create access drives to the ore zones

1. Click the **Design string** button on the Status bar.
2. Enter the information as shown, and click **Apply**.



3. Choose **Create > Points > Add point mode**.
4. Choose **Create > Points > By angle**.
5. Click point 2, then point 1.

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

Locate point by angle, distance and design grade

Gradient and angle

Units angle percentage "1 in x" ratio

Gradient 0

Angle 0.0000

Distance

Along slope horizontal

Distance 0

Angle in various units of measurement

Angle units degrees

angle 0

percentage 0

ratio 1 in 100000000

Apply Cancel

7. Without cancelling the previous function, click point 2, and then click point 1.
8. Enter the information as shown, and then click **Apply**.

Locate point by angle, distance and design grade

Gradient and angle

Units angle percentage "1 in x" ratio

Gradient 0

Angle 120.0000

Distance

Along slope horizontal

Distance 50

Angle in various units of measurement

Angle units degrees

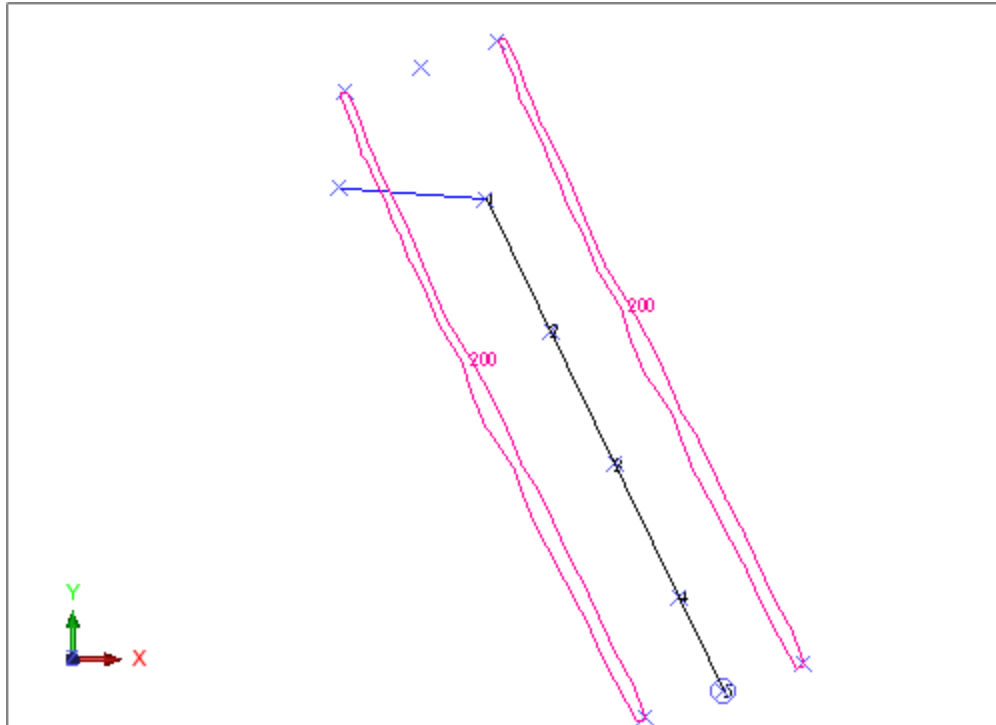
angle 0

percentage 0

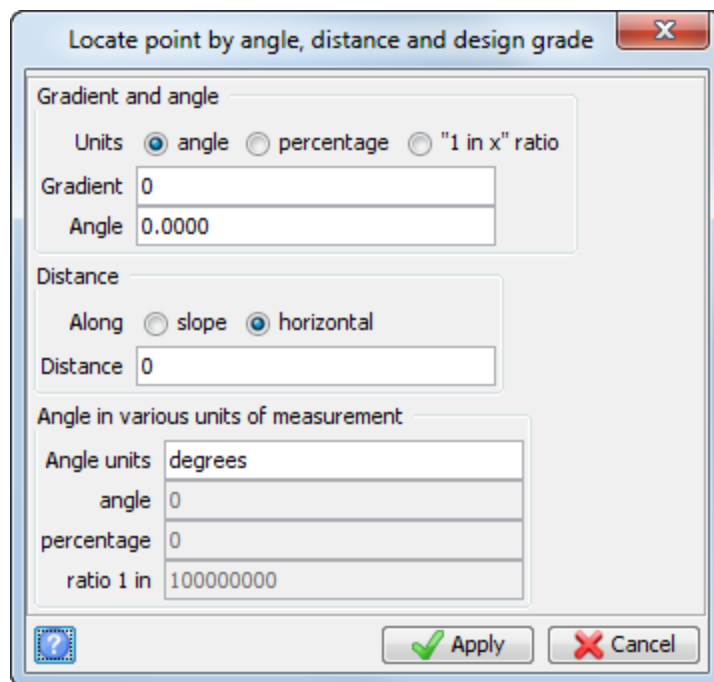
ratio 1 in 100000000

Apply Cancel

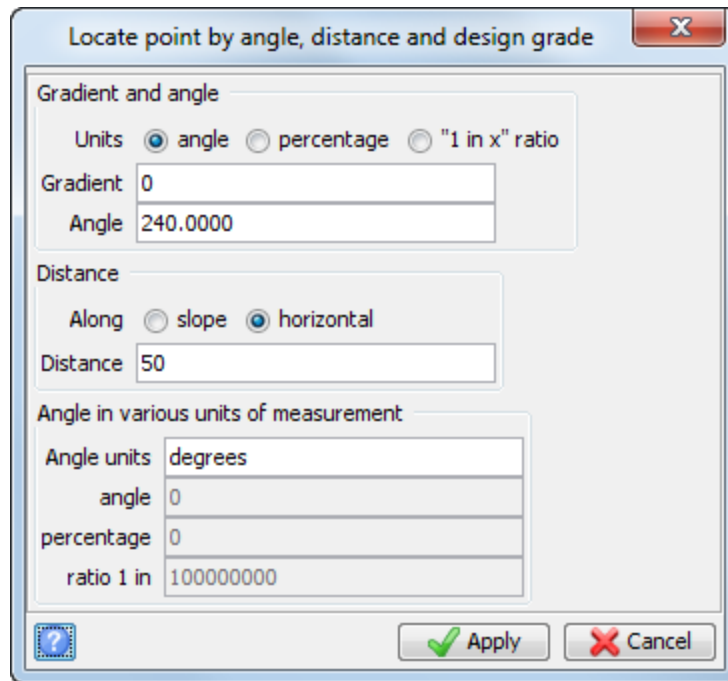
This creates a new segment of string 11 that will extend beyond the western ore zone as shown.



9. Choose **Create > New segment**.
10. Choose **Create > Points > By angle**.
11. Click point 2, then point 1 again.
12. Enter the information as shown, and click **Apply**.

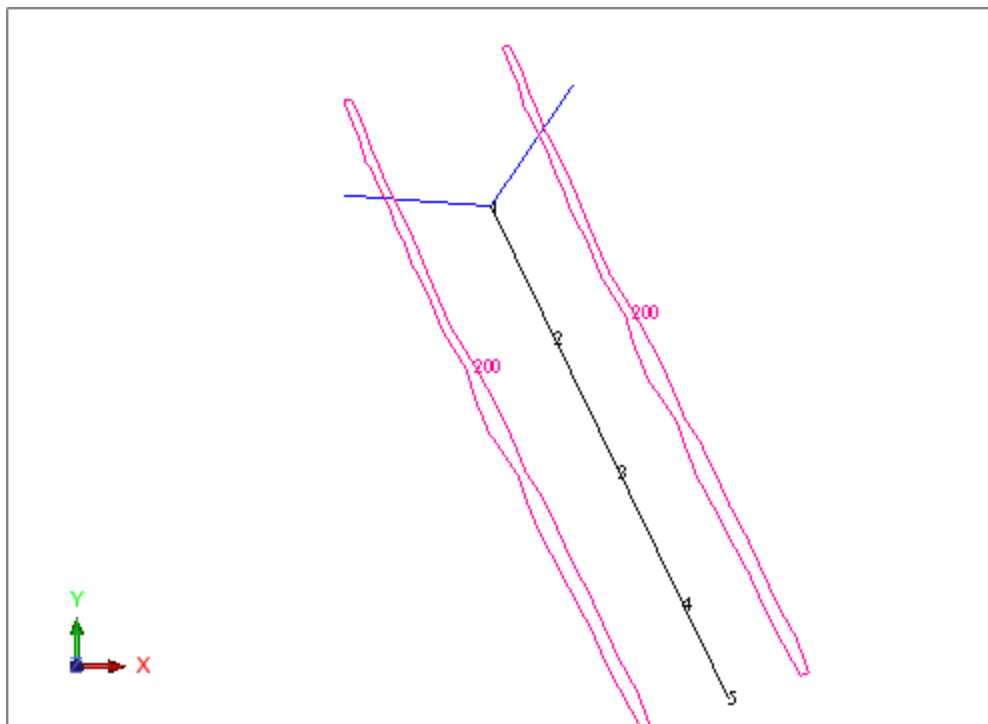


13. Without cancelling the previous function, again click point 2, then point 1.
14. Enter the information as shown, and click **Apply**.

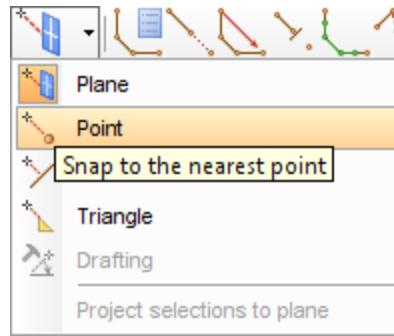


You now have two segments of string 11 representing the centreline of ore access drives left and right off the main drive.

15. Choose **Display > Hide temporary markers**.

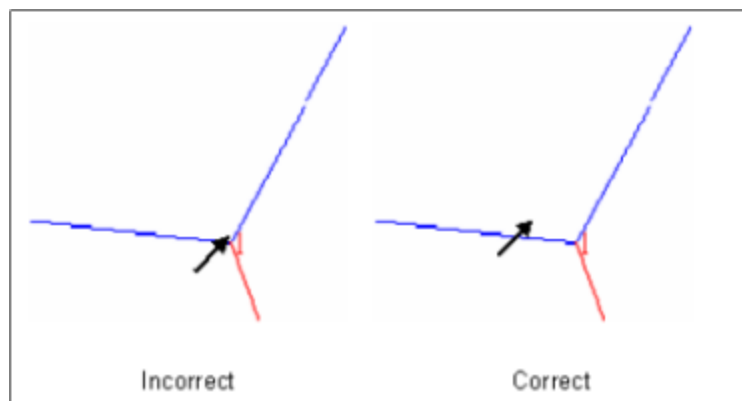


- Click the **Snap mode** drop-down and select **Point**.

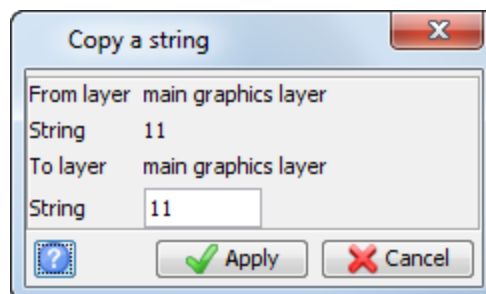


- Choose **Edit > String > Copy**.
- Click **string 11** near point 1 on string 11, drag to point 2 on string 10, then release.

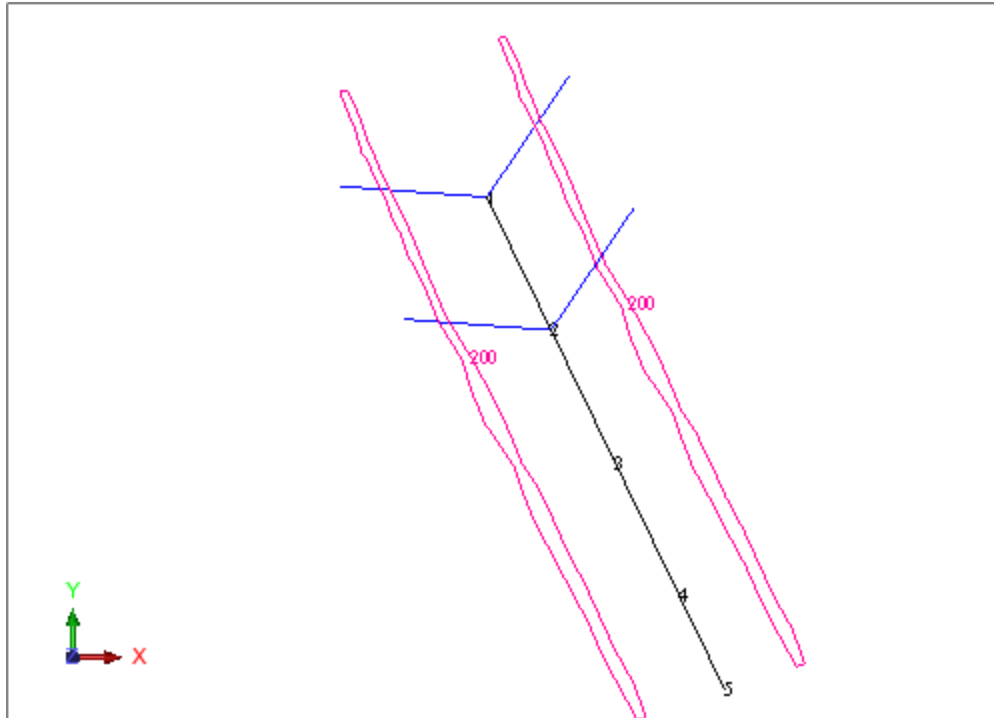
Note: In order to correctly select a string or segment in Surpac, do *NOT* select a point common to two or more strings. In this case, in order to select string 11, you would not want to position the cursor right on top of point 1, because this point is common to string 10 and string 11, and you could not be certain exactly which string you select.



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

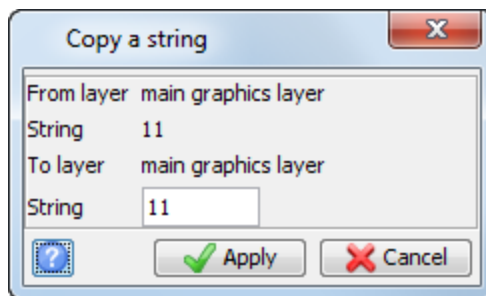


A copy of both segments of string 11 is created at point 2.

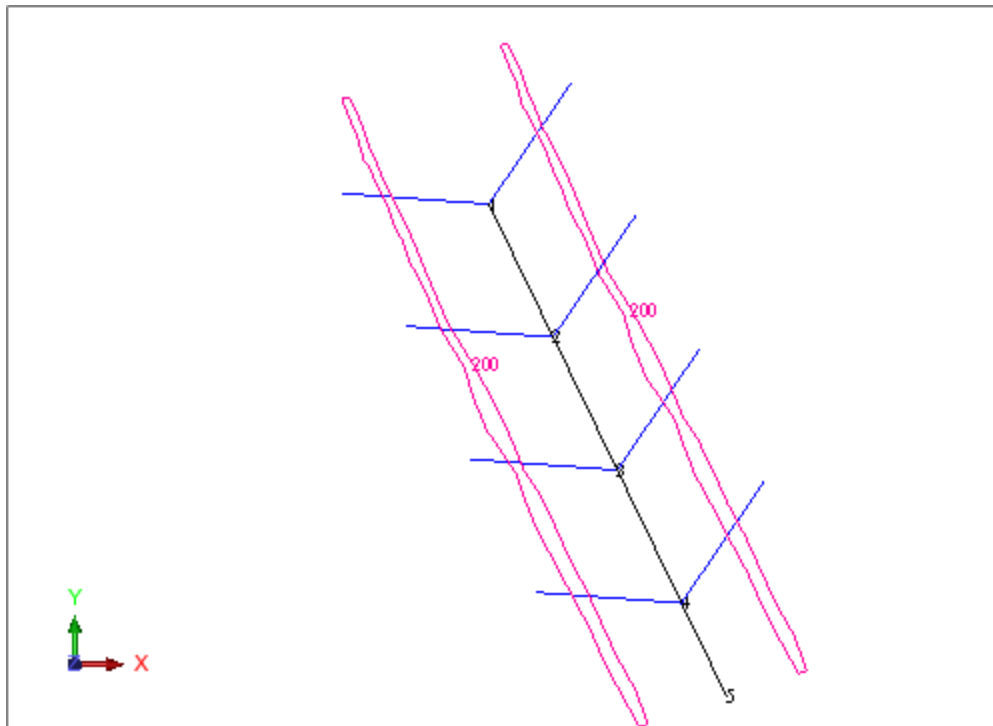



Note: There are two additional points on string 10 (point 3 and point 4) where you need access drives. You can continue using the **String Copy** function to create drives for these points.

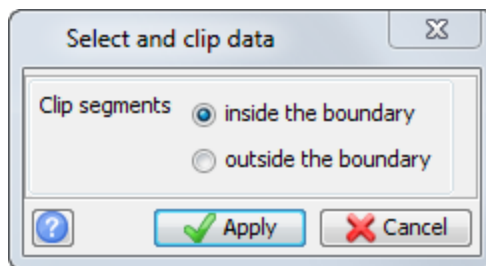
20. Click near point 1 of string 11 again, drag to point 3 on string 10, and release.
21. Enter the information as shown, and click **Apply**.



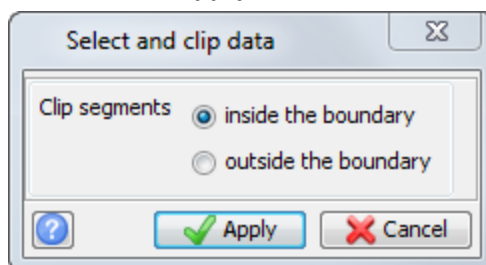
22. Press **ESC**.
The eight access drives are displayed.



23. Click **Plan view** .
24. Choose **Edit > Trim > Clip by selected segment**.
25. Enter the information as shown, and click **Apply**.

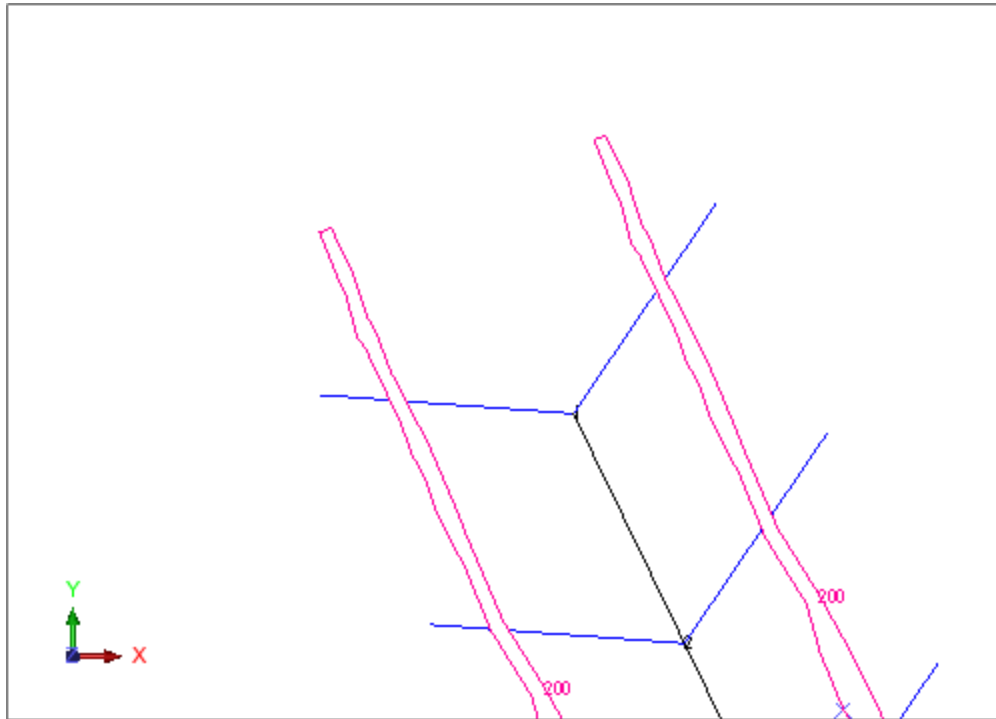


26. Click one segment of string 200.
27. Enter the information as shown, and click **Apply**.

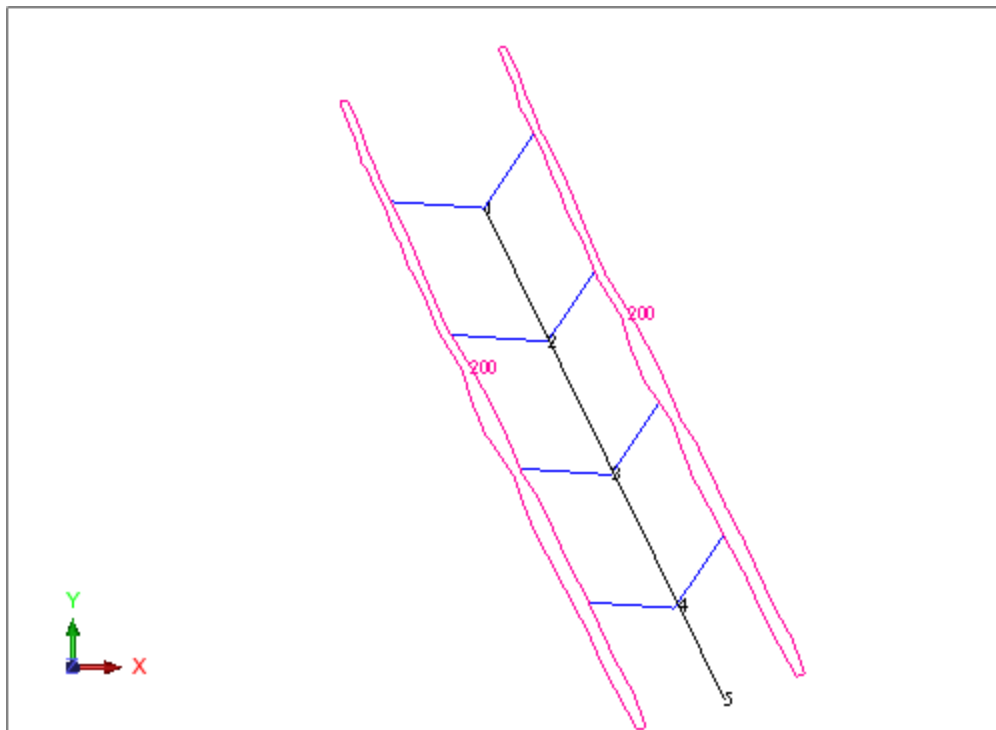


28. Click the other segment of string 200.
29. When the form appears again, click **Cancel**.

You will see all portions of segments inside both ore zones removed.



30. Choose **Edit > Segment > Delete**
31. Click the portion of each segment extended beyond the ore zones.
32. Press **ESC**.
33. Choose **Display > Hide temporary markers**.
The drives are displayed.

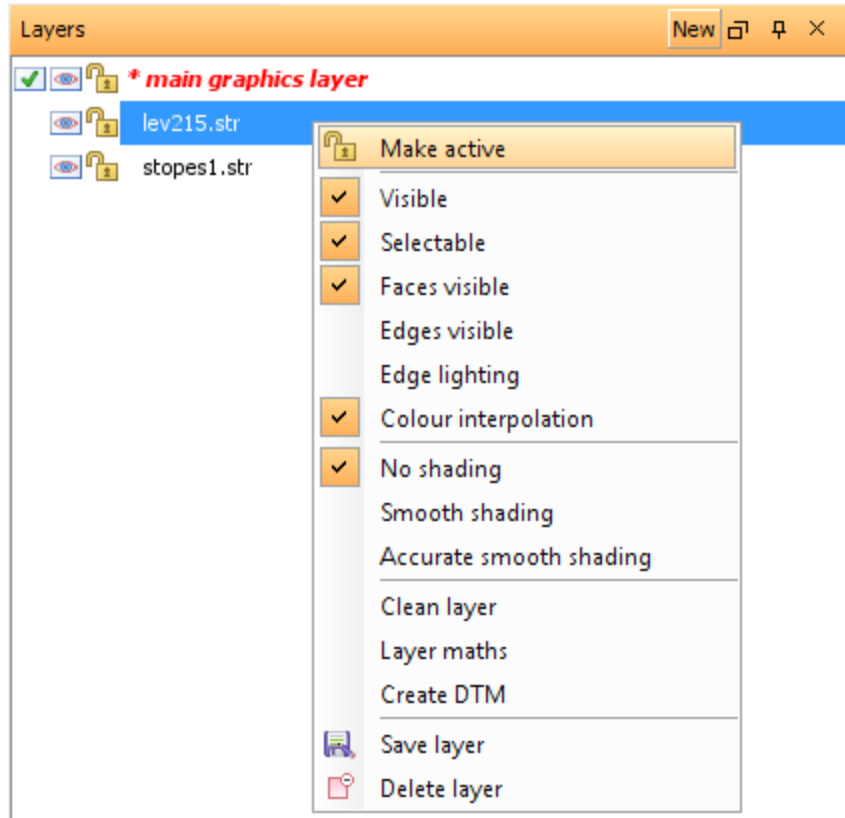


34. Save as **ugdes1.str**, overwriting the previous contents.

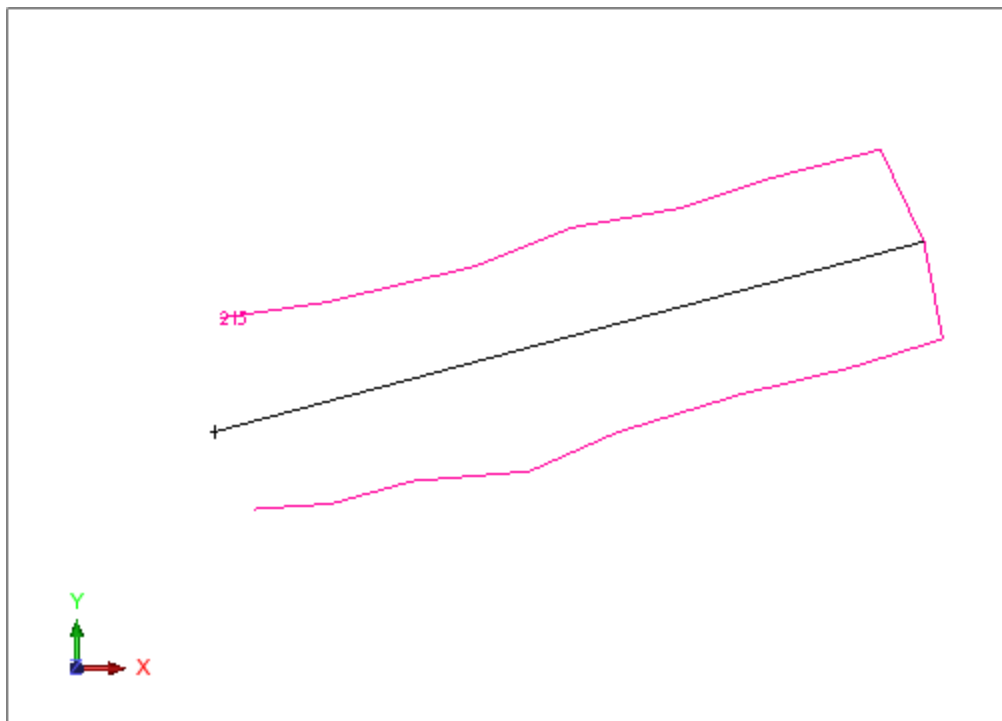
Note: To see all of the steps performed in this section, run `_02_create_access_drives_to_ore_zones.tcl`. You need to click **Apply** on any forms presented.

Task: Create the main decline

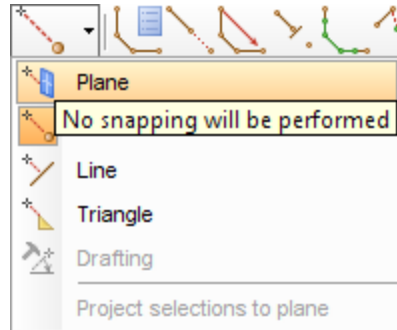
1. In the Layers pane, right-click **lev215.str** and choose **Make active**.



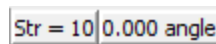
2. Choose **Display > Strings > With string numbers** and click **Apply** on the form, to display all strings in the layer.



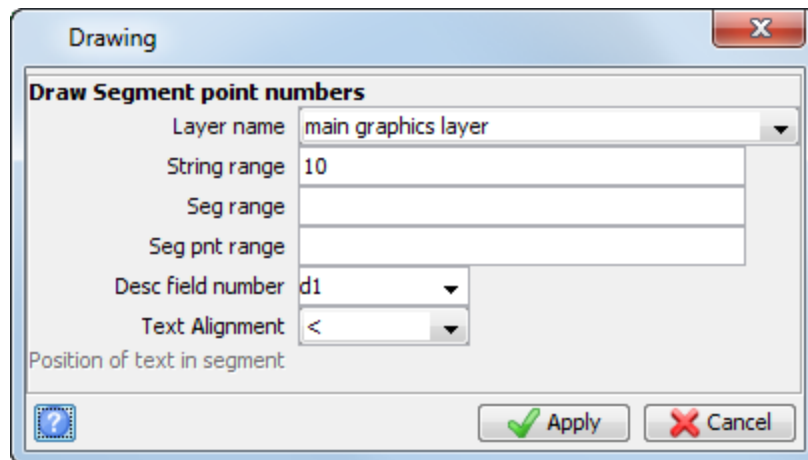
3. Choose **Inquire > Point properties** to determine the elevation of the two points.
4. Choose **Inquire > Bearing and Distance between two points**.
5. Click the end of string 1, then the beginning of string 1.
6. Press **ESC**.
7. Zoom out to see the access drives then zoom in to get a good view of points 4 and 5.
8. Choose **Inquire > Bearing and Distance between two points**.
9. Click point 5, then point 4 on string 10 in **ugdes1.str**.
10. Press **ESC**.
11. In the Layers pane, right-click **main graphics layer**, and choose **Make active**.
12. Choose **Create > Points > Add points mode**.
13. Click the **Snap mode** drop-down and choose **Plane**.



14. Use the **Design string** and **Design gradient** buttons on the Status bar to set the string to 10, and the grade to zero percent.

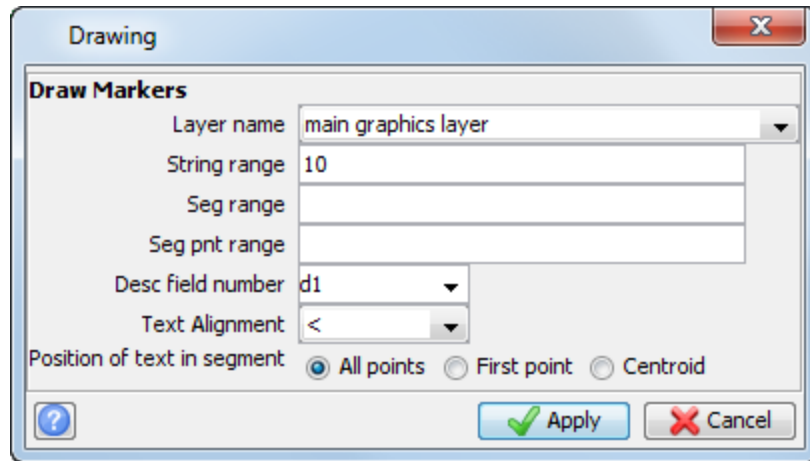


15. Choose **Display > Point > Numbers**.
16. Enter the information as shown, and click **Apply**.

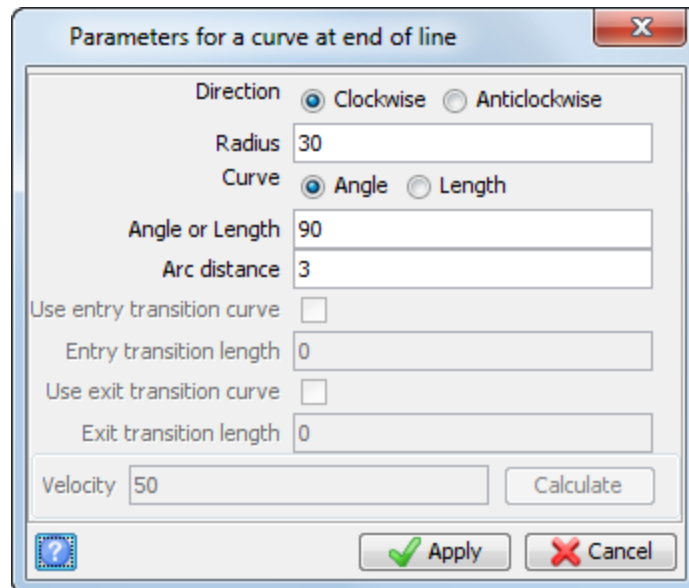


17. Choose **Display > Point > Markers**.

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

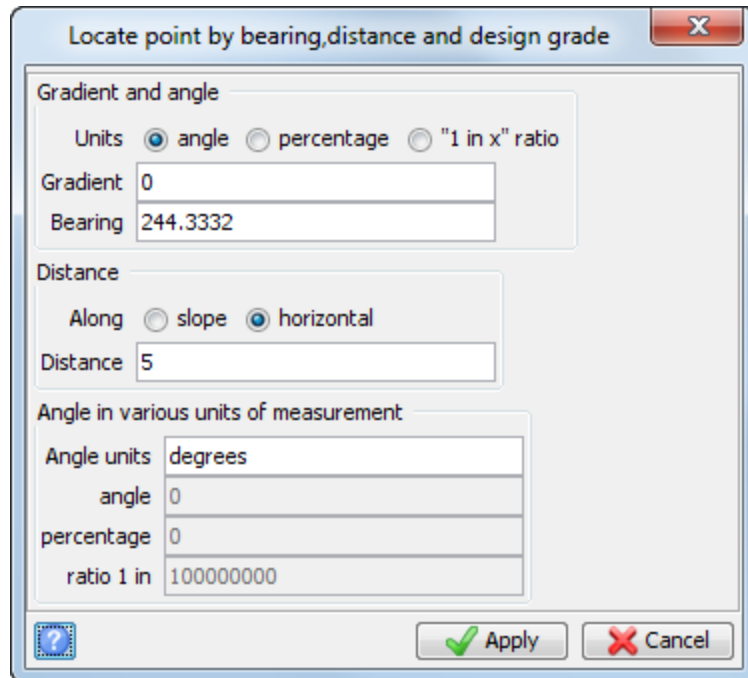


19. Choose **Create > Curve at segment end**.
20. Click point 4, then point 5.
21. Enter the data as shown, and click **Apply**.

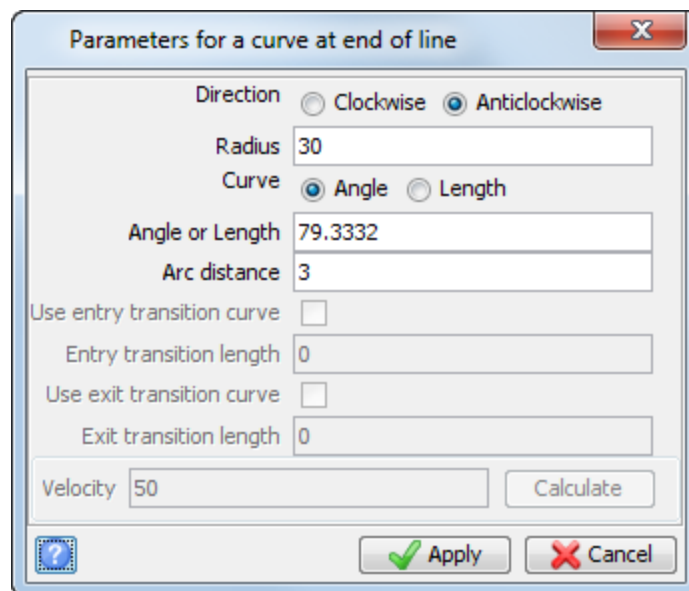


22. Press **ESC**.
23. Zoom in so that you can see the points clearly.
24. Choose **Edit > Segment > Join**.
25. Zoom in so that you can see the points clearly.
26. Click point 5, then point 7.
27. Press **ESC**.
Because the bearing of the main drive between the ore zones was 334.3332, you will construct the 5 metre straight section at a bearing 90 degrees less than that. That is, at 244.3332.
28. Choose **Create > Points > By bearing**.
29. Click the end of the newly created curve.

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



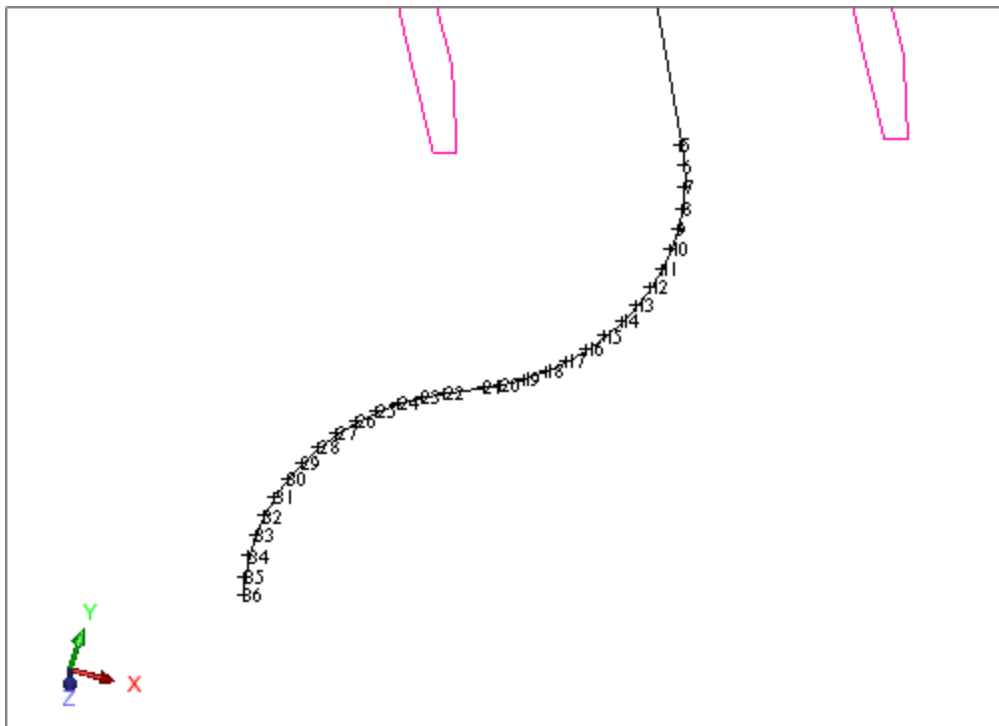
31. Choose **Create > Curve at segment end**.
32. Click point 21, then point 22.
33. Enter the information as shown, and click **Apply**.



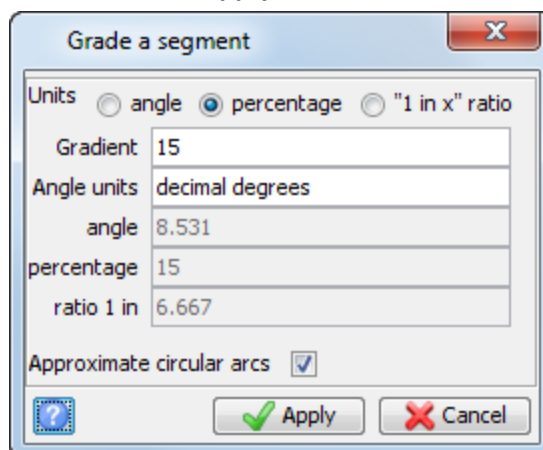
Note: The direction of the curve is anticlockwise.

34. Press **ESC**.
35. Choose **Display > Hide temporary markers**.

The curve is displayed.

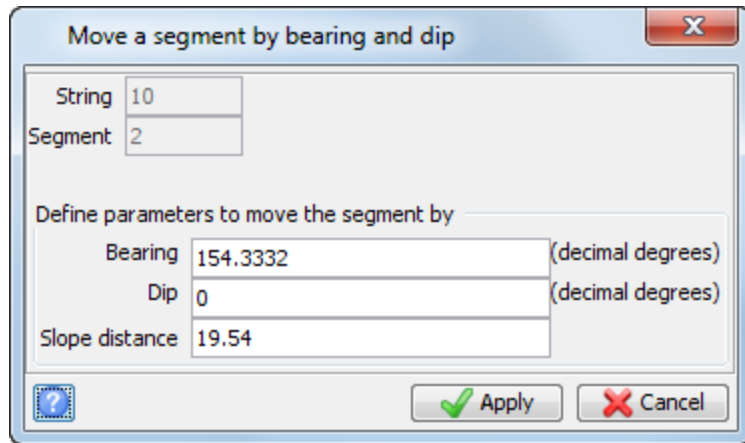


36. Choose **Edit > Segment > Change gradient.**
37. Click point 5, then point 36.
38. Enter the following information, and click **Apply.**

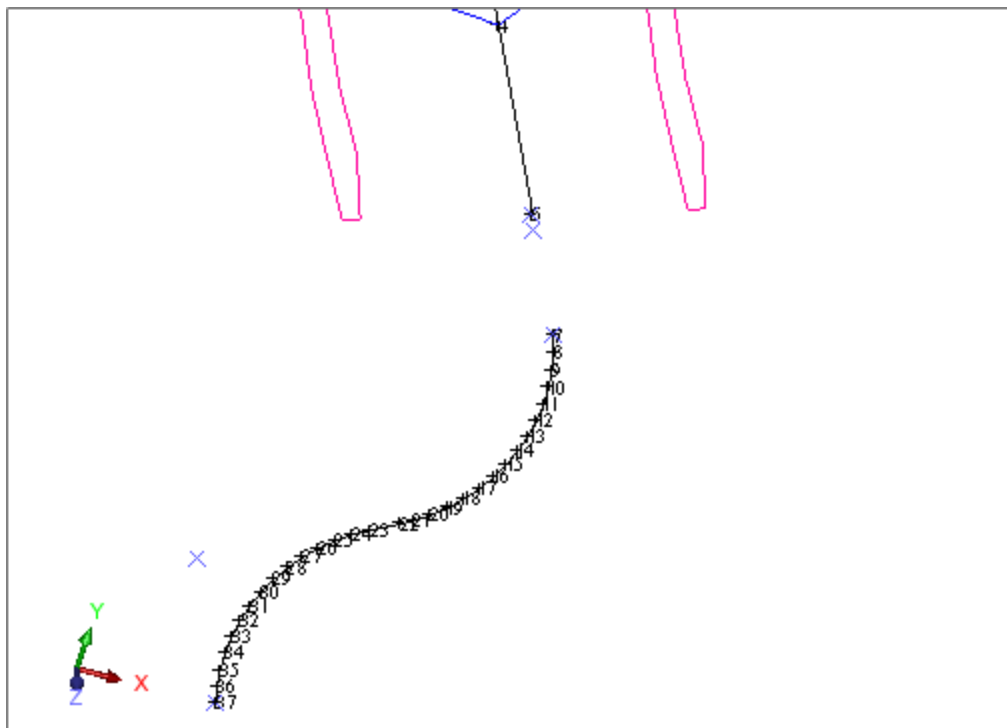


39. Choose **Inquire > Point properties.**
40. Click point 36.
41. Choose **Edit > Segment > Break.**
42. Click the segment between points 5 and 6.
43. Choose **Edit > Move segment constrained by > Bearing and distance.**
44. Click the segment with the two curves.

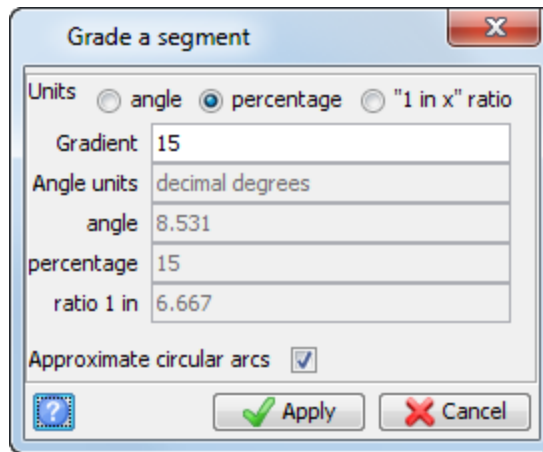
45. Enter the information as shown, and click **Apply**.



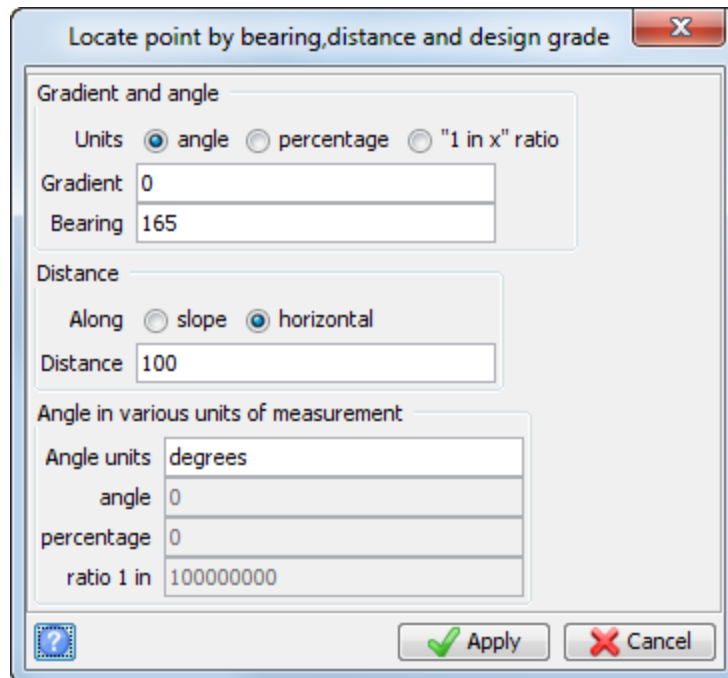
The segment is displayed.



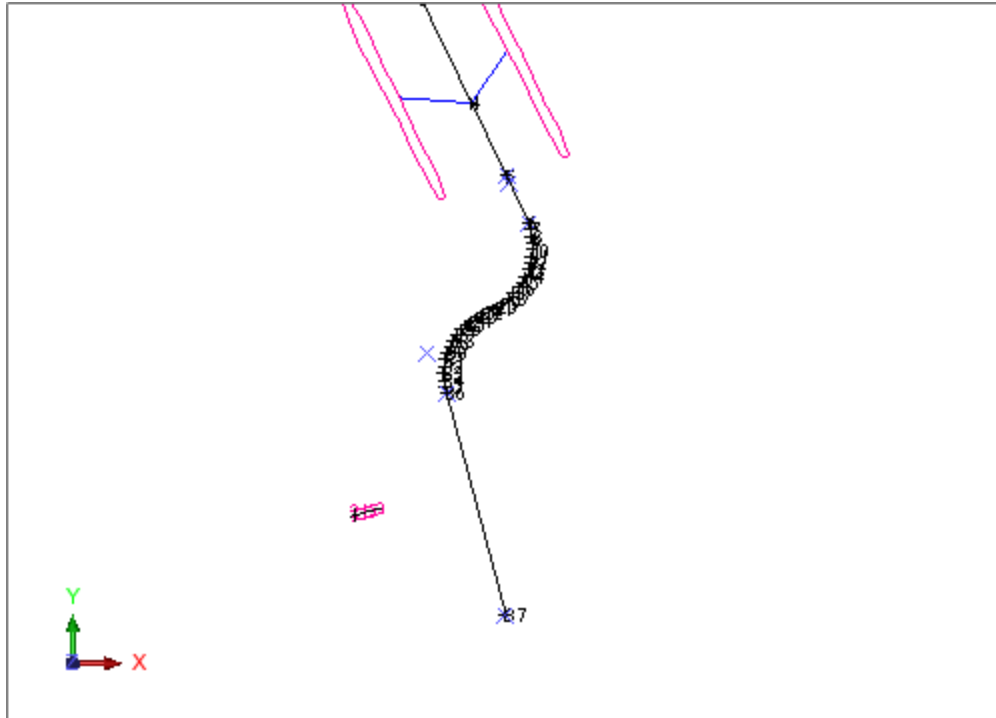
46. Choose **Edit > Segment > Join**.
47. Click the main drive first (at point 5), then click the curves (at point 7).
48. Choose **Edit > Segment > Change gradient**.
49. Click point 5, then click point 36.
50. Enter the information as shown, and click **Apply**.



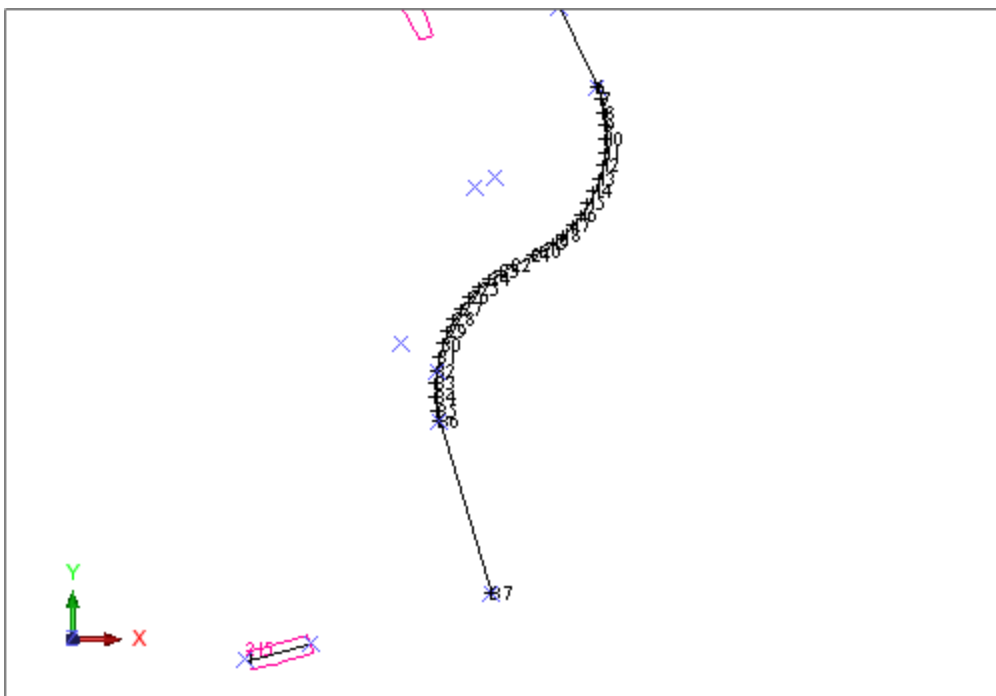
51. Choose **Inquire > Point properties**.
52. Click point 36 (that is, the southern end of curve 2).
53. Choose **Create > Points > By bearing**.
54. Click point 36 (that is, the southern end of curve 2).
55. Enter the information as shown, and click **Apply**.



A new point will now be created much further south as displayed.

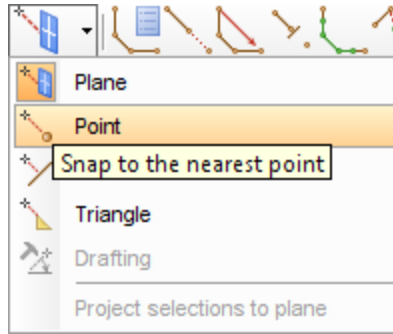


56. Press **ESC**.
57. Choose **Create > Points > Change point mode**.
58. Choose **Create > Points > At intersection of two lines**.
59. Click point 37, then click point 36.
 - 📌 **Note:** It is important to select 37 first, because the first point selected will be moved.
60. Click both of the endpoints of the centreline of **lev215.str** (that is, string 1).
 - 📌 **Note:** You might need to zoom in on **lev215.str** so that you select the correct points. It does not matter which end you select first for this string, point 37 will still be moved to the correct position as shown.



61. Press **ESC**.

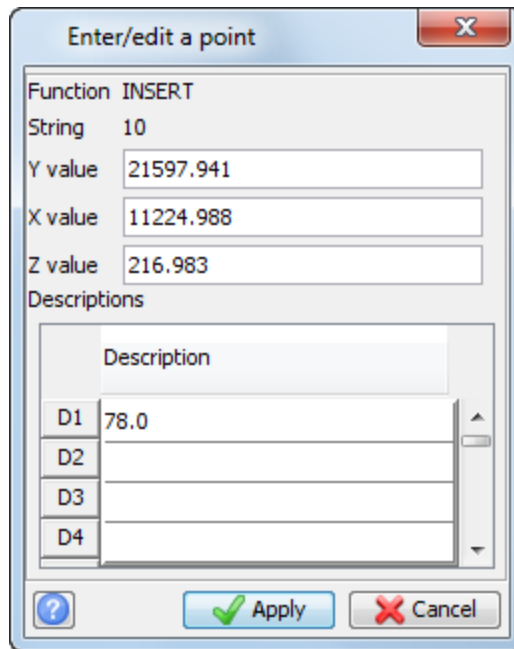
62. Click the **Snap mode** drop-down and choose **Point**.



63. Choose **Create > Points > Insert after an existing point**.

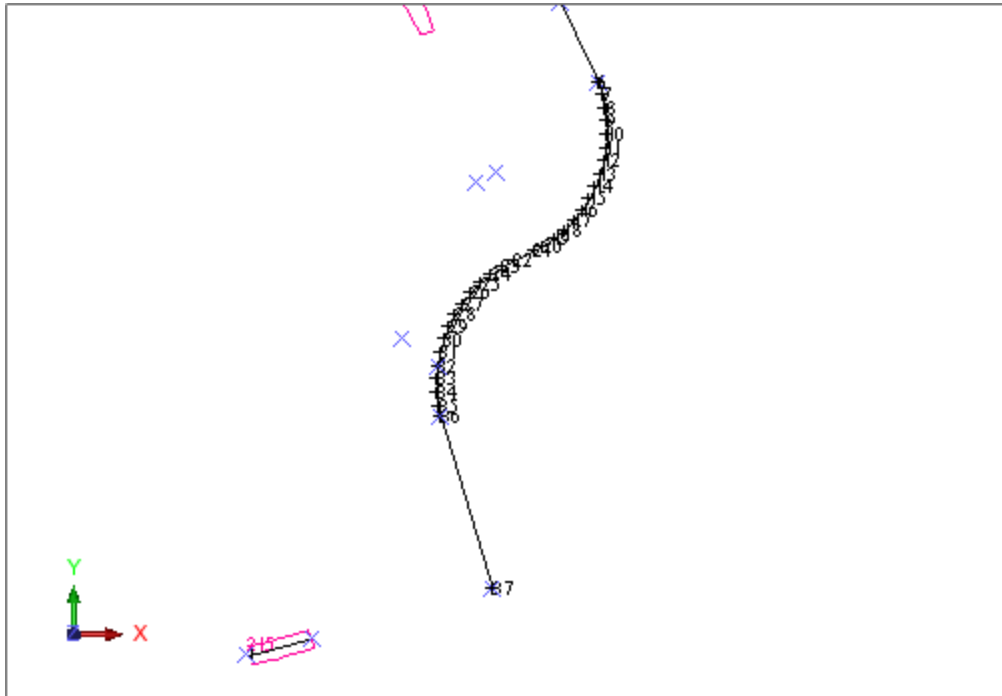
64. Click point 37, and drag it to the Access Point

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

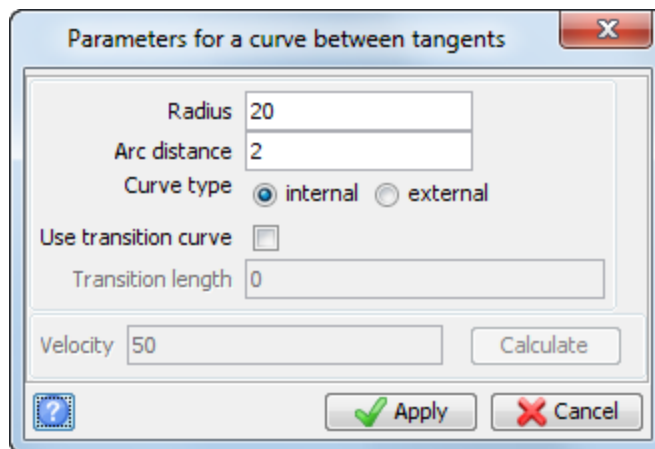


66. Press **ESC**.

The centreline string is displayed.

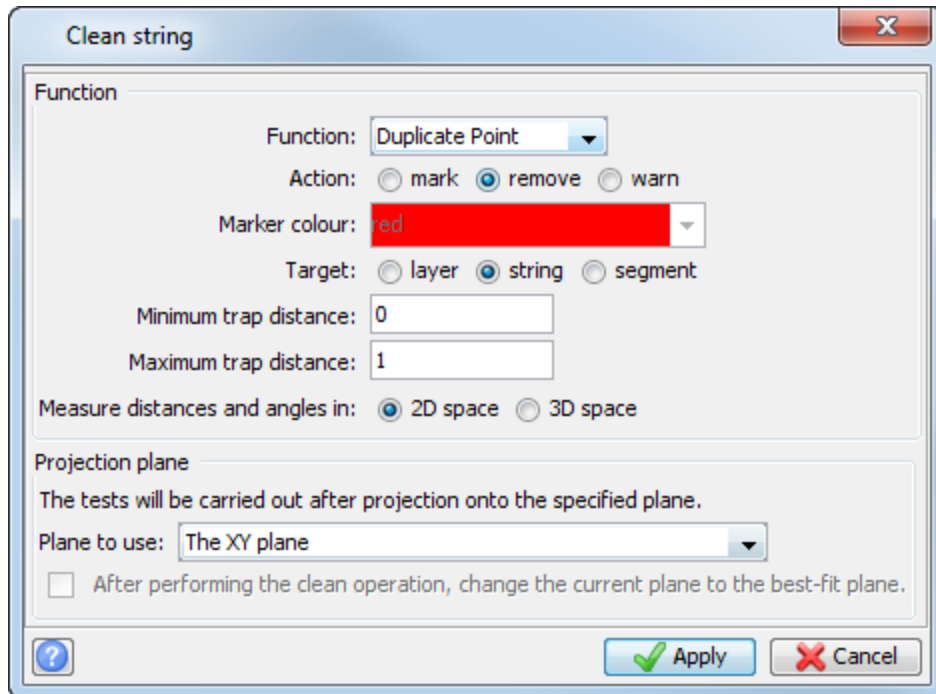


67. Press **ESC**.
68. Choose **Create > Points > Insert point mode**.
69. Choose **Create > Curve from tangents**.
70. Click point 36, then click point 37.
71. Click point 37 again, then click point 38.
72. Enter the information as shown, and click **Apply**.

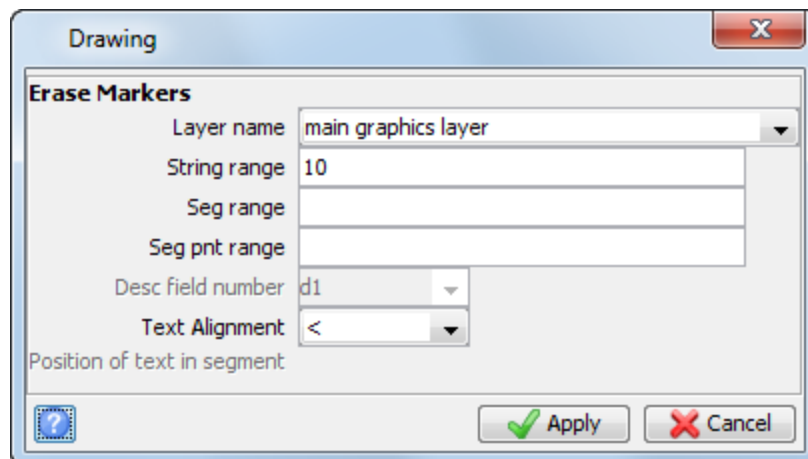


73. Choose **Edit > String > Clean**.

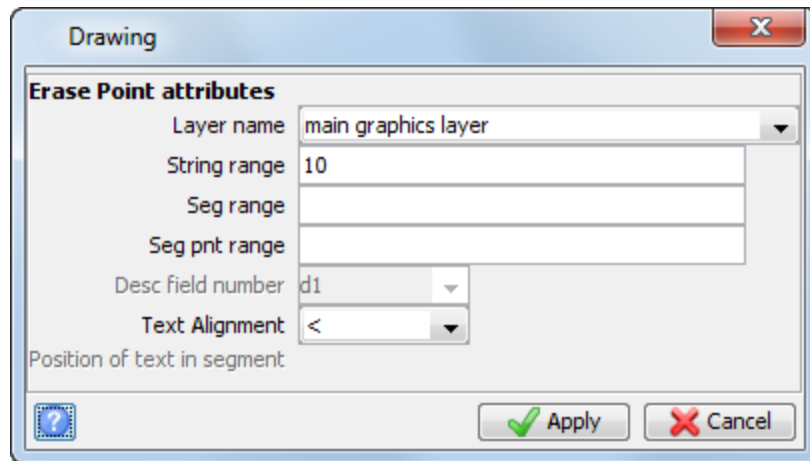
74. Enter the information as shown, and click **Apply**.



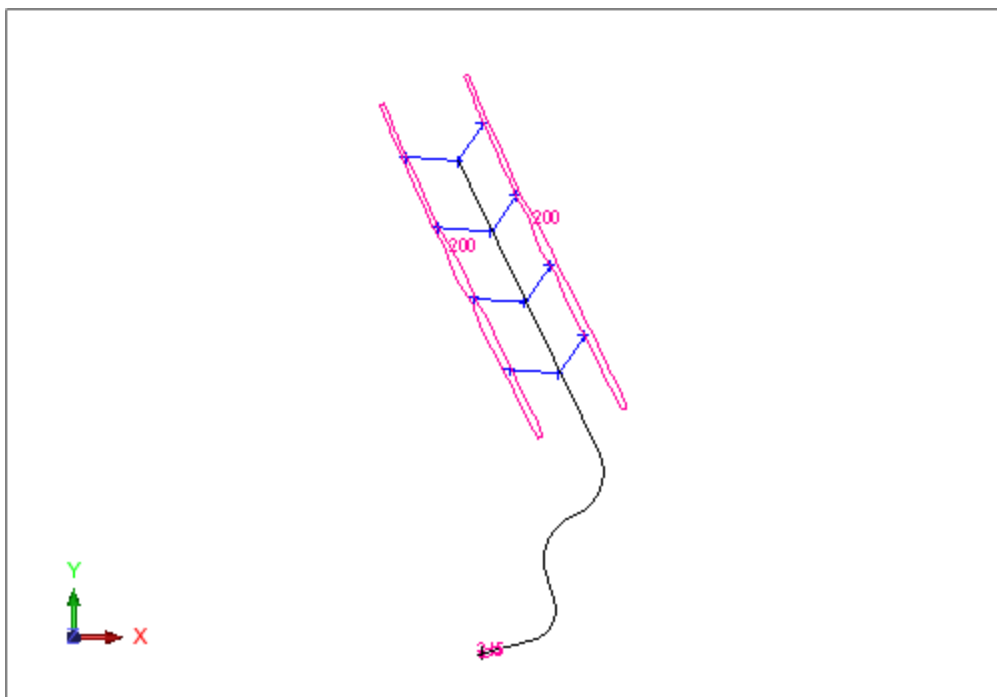
75. Click string 10, the centreline string.
One point is removed from the string.
76. Choose **Display > Hide point > Markers**.
77. Enter the information as shown, and click **Apply**.



78. Choose **Display > Hide point > Attributes**.
79. Enter the information as shown, and click **Apply**.



80. Choose **Display > Hide temporary markers**.
The centre string is displayed.




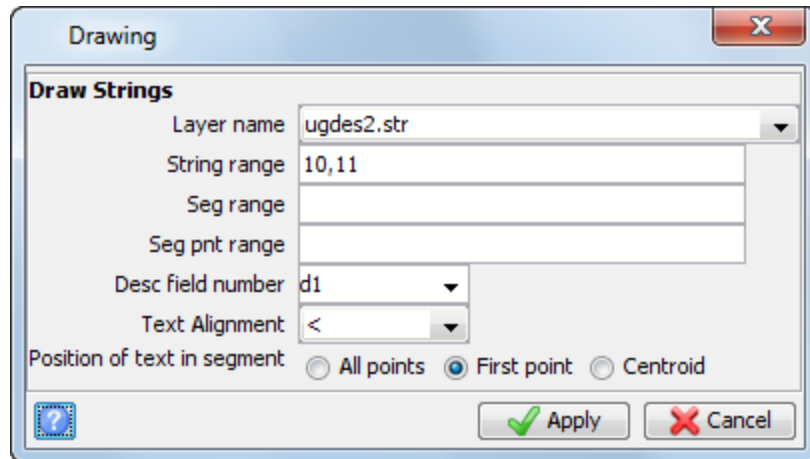
81. Save the file as **ugdes1.str**.


Note: To see all of the steps performed in this section, run **_03_create_main_decline.tcl**. You need to click **Apply** on any forms presented.

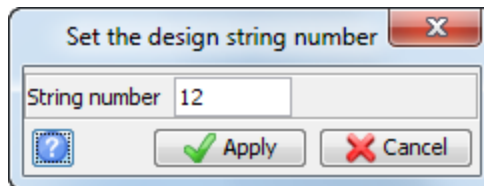
Creating road outlines

Task: Create a road outline of fixed width

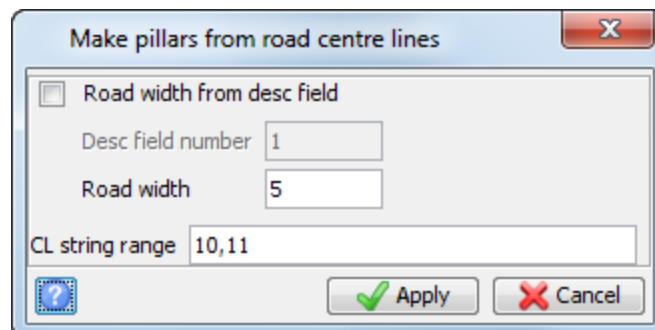
1. Click **Reset graphics** .
2. Open **ugdes2.str** in **Graphics**.
3. Choose **Display > Strings > With string numbers**.
4. Enter the information as shown, and click **Apply**.




5. Click the **Design string number** button  displayed on the Status bar.
6. Enter the information as shown, and click **Apply**.



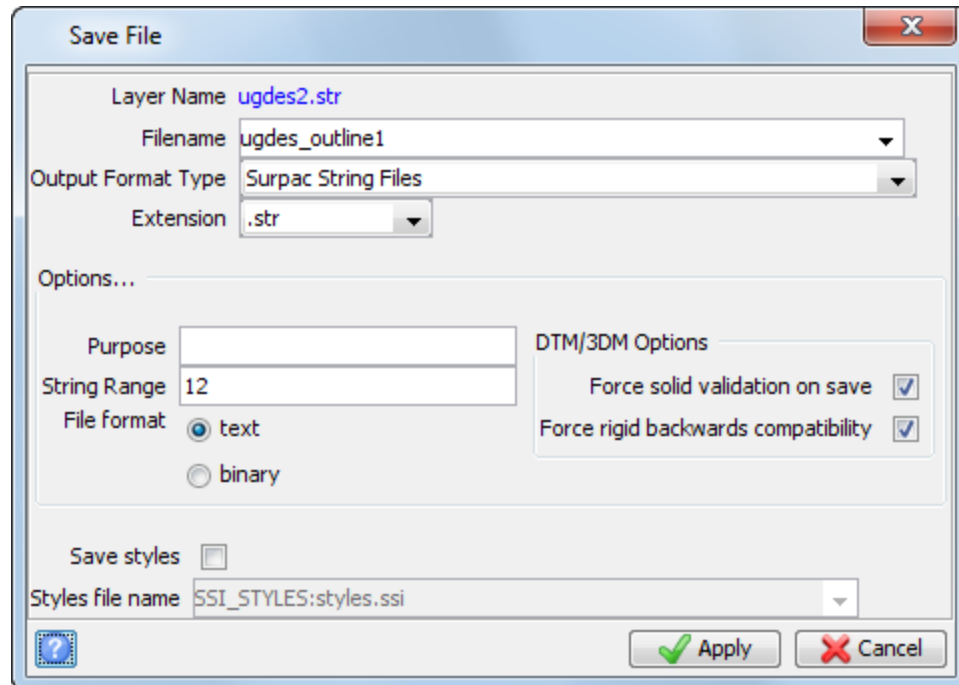
7. Choose **Design > Underground tools > Room & pillar from centrelines**.
8. Enter the information as shown, and click **Apply**.




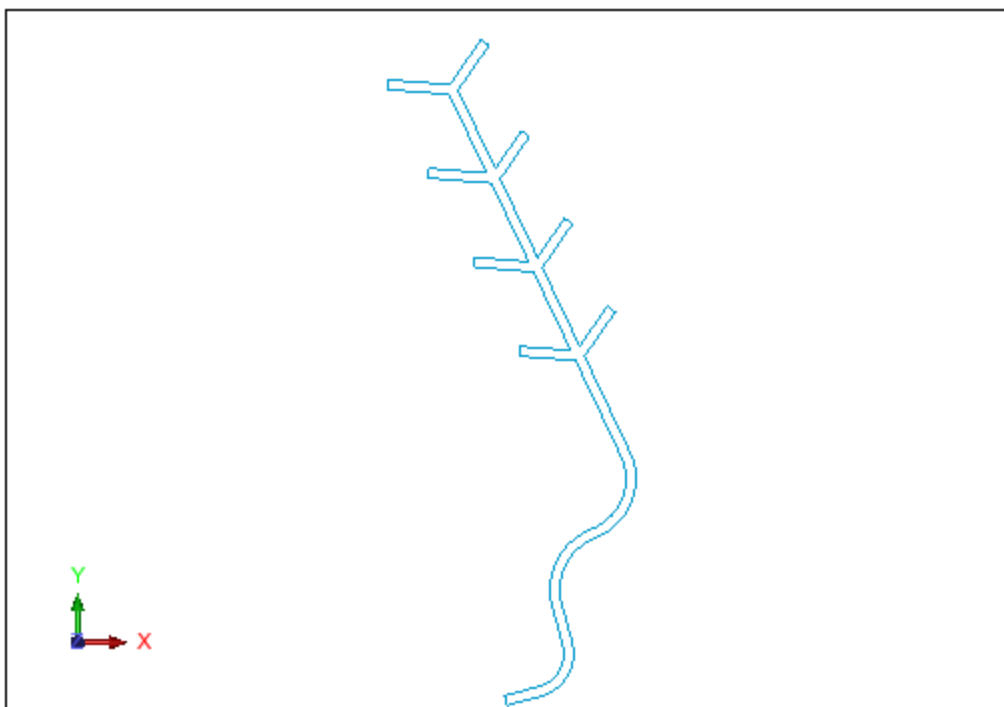
 **Note:** This sets the width of the road to be fixed at 5m for both strings 10 and 11.


9. Choose **File > Save > string/DTM**.

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




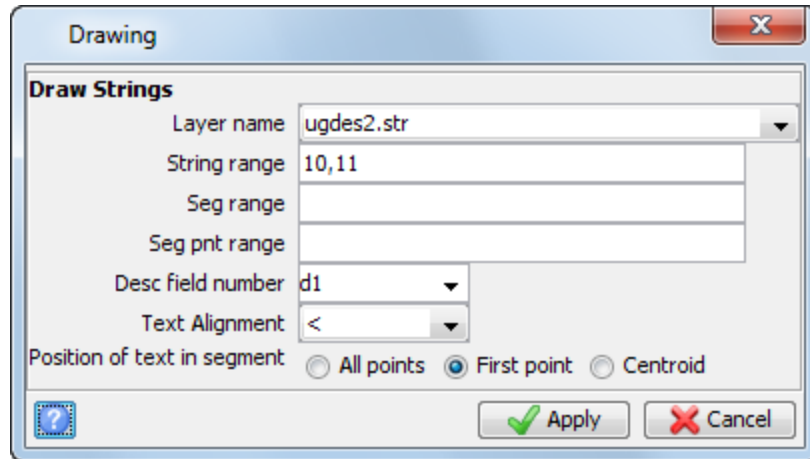
11. Click **Reset graphics** .
12. Open **ugdes_outline1.str** in **Graphics**.
The road outline is displayed.




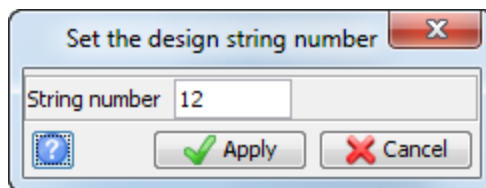
 **Note:** To see all of the steps performed in this section, run **_04a_create_road_outline.tcl**. You need to click **Apply** on any forms presented.

Task: Create a road outline of variable width

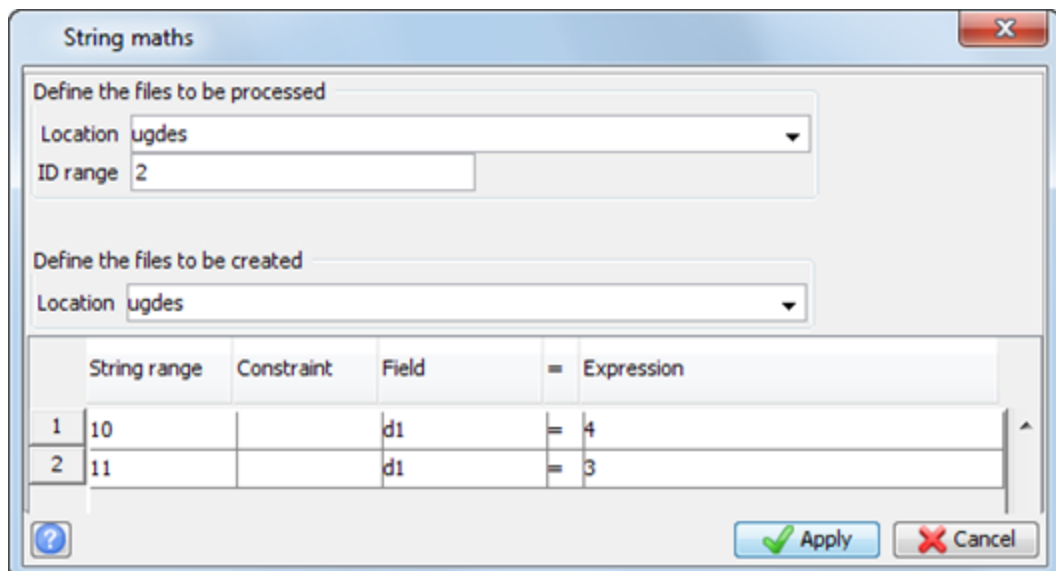
1. Click **Reset graphics** .
2. Open **ugdes2.str** in **Graphics**.
3. Choose **Display > Strings > With string numbers**.
4. Enter the information as shown, and click **Apply**.



5. Click the **Design string number** button  displayed on the Status bar.
6. Enter the information as shown, and click **Apply**.

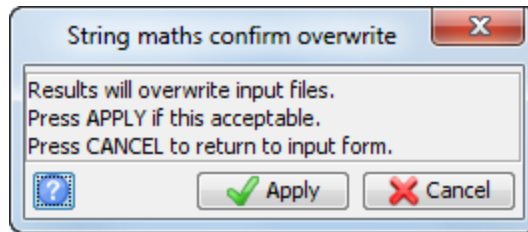


7. Choose **File tools > String maths**.
8. Enter the information as shown, and click **Apply**.

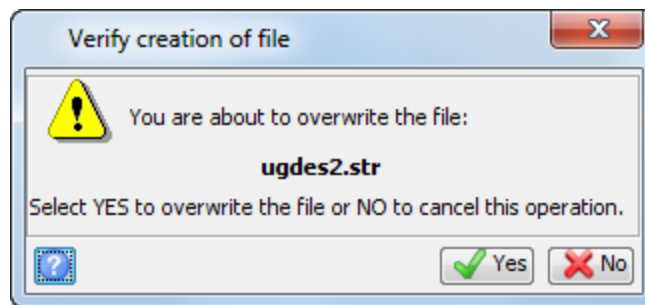


 **Note:** This sets the width of the centreline to be 4m, and the access drives to 3m.

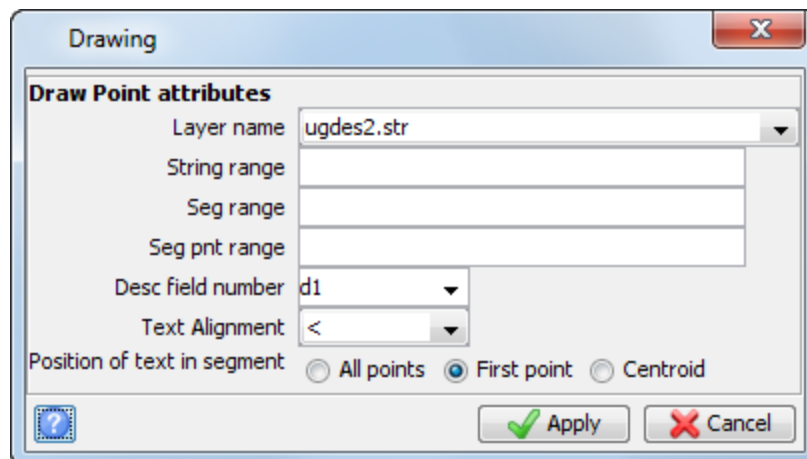
- Click **Apply** to overwrite the file.



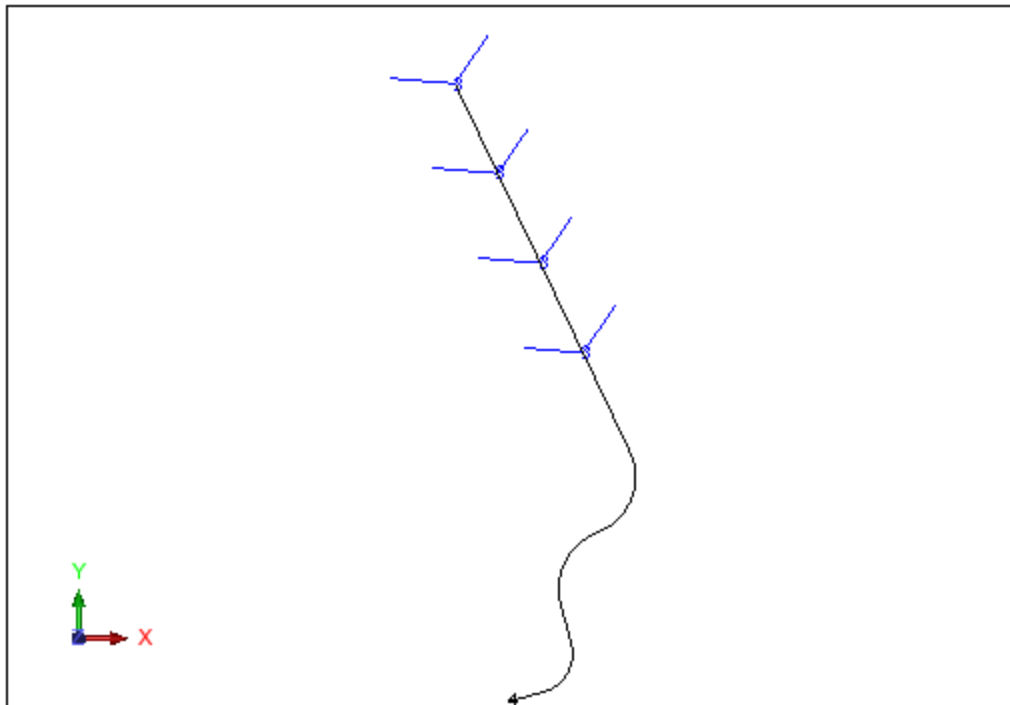
- Click **Yes**.



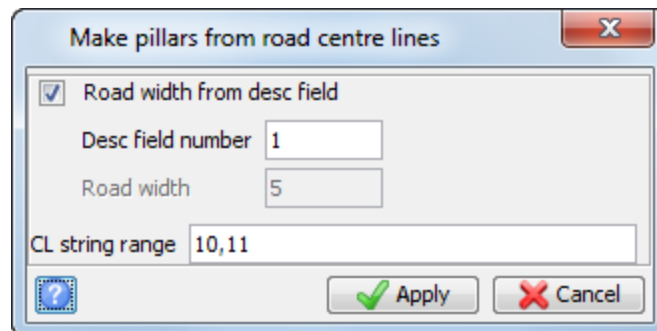
- Choose **Display > Points > Attributes**.
- Enter the information as shown, and click **Apply**.



All drives are displayed.



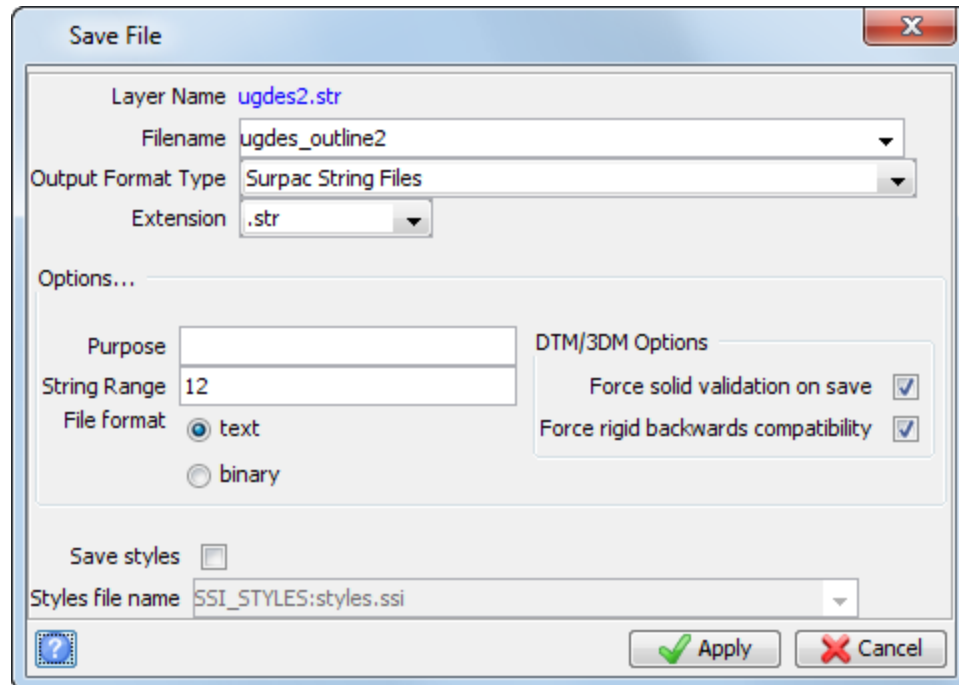
13. Choose **Design > Underground tools > Room & pillar from centrelines**.
14. Enter the information as shown, and click **Apply**.




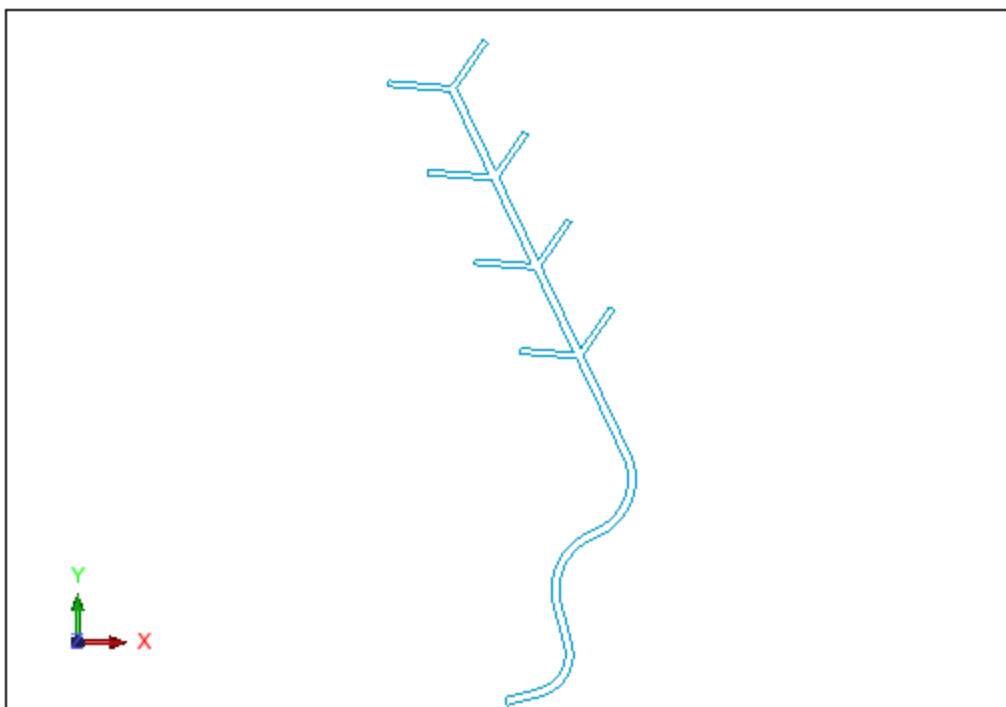
Note: This means that the d1 field is used to determine the width of the road for each string. In this case you have already set d1 to 4m for string 10, and d1 to 3m for string 11.


15. Choose **File > Save > string/DTM**.

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




17. Click **Reset graphics** .
18. Open **ugdes_outline2.str** in **Graphics**.
The road outline is displayed.

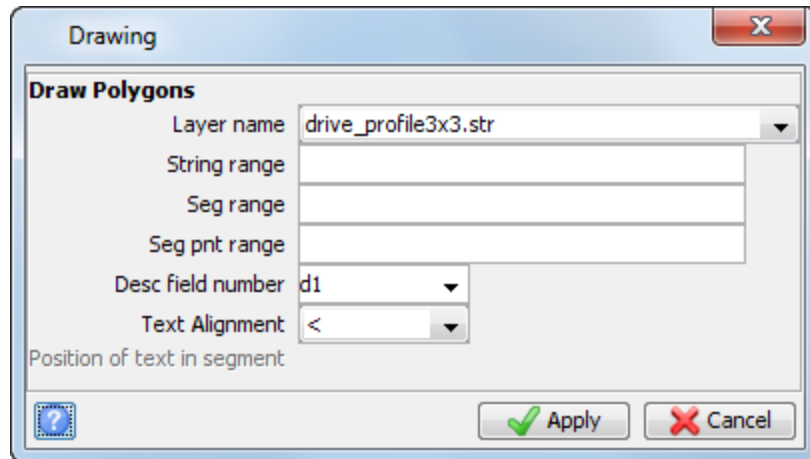


 **Note:** To see all of the steps performed in this section, run **_04b_create_road_outline.tcl**. You need to click **Apply** on any forms presented.

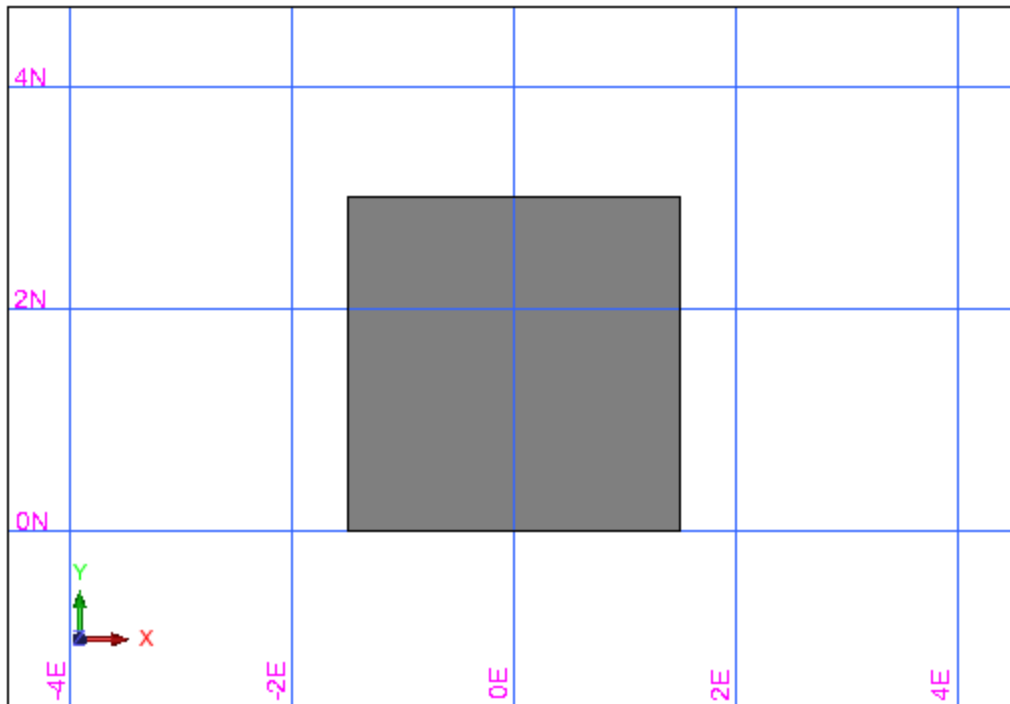
Creating a solid


Task: View profiles

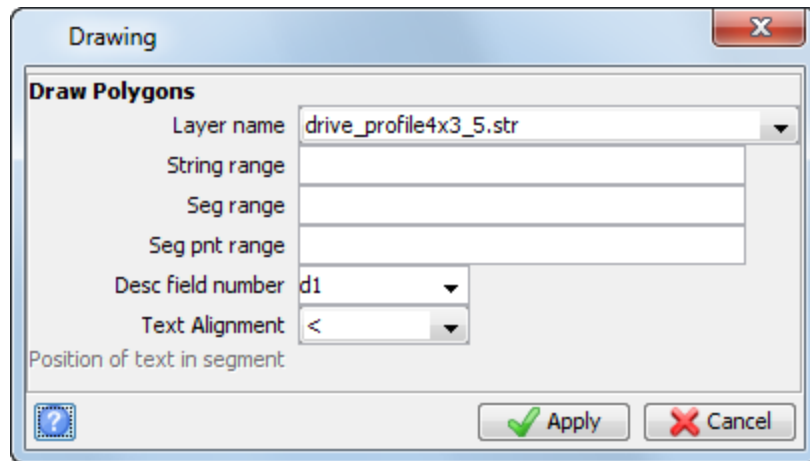
1. Click **Reset graphics** .
2. Open **drive_profile3x3.str** in **Graphics**.
3. Choose **View > Zoom > Out**.
4. Choose **Display > Strings > With colour fill**.
5. Enter the information as shown, and click **Apply**.



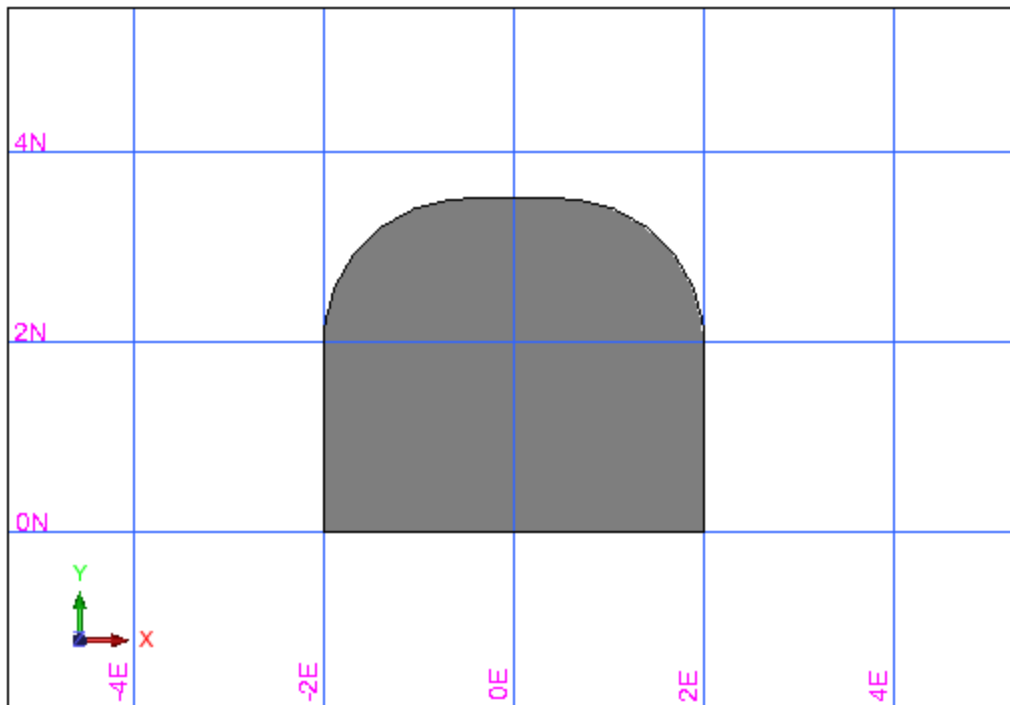
6. Choose **Display > Dynamic 2D grid**.
The profile is displayed.




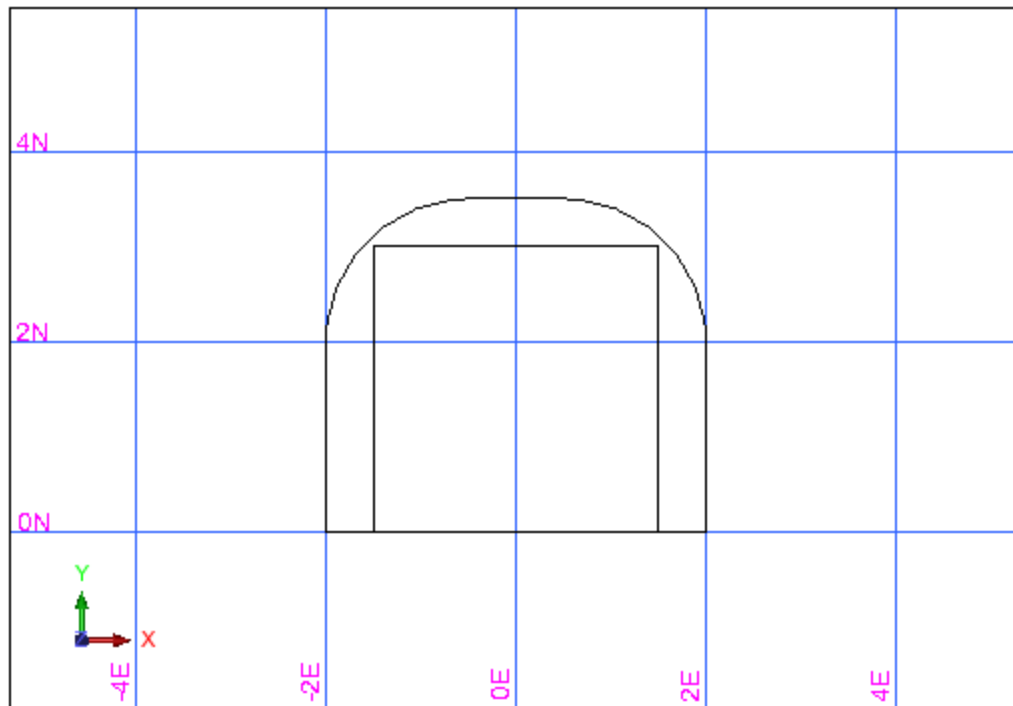
7. Click **Reset graphics** .
8. Open **drive_profile4x3_5.str** in **Graphics**.
9. Choose **View > Zoom > Out**.
10. Choose **Display > Strings > With colour fill**.
11. Enter the information as shown, and click **Apply**.





12. Choose **Display > Dynamic 2D grid**.
The profile is displayed.




13. Click **Reset graphics** .
14. Open **drive_profile3x3.str** in **Graphics**.
15. Open **drive_profile3x4_5.str** in **Graphics**.
16. Choose **View > Zoom > Out**.
17. Choose **Display > Dynamic 2D grid**.
Both profiles are displayed.

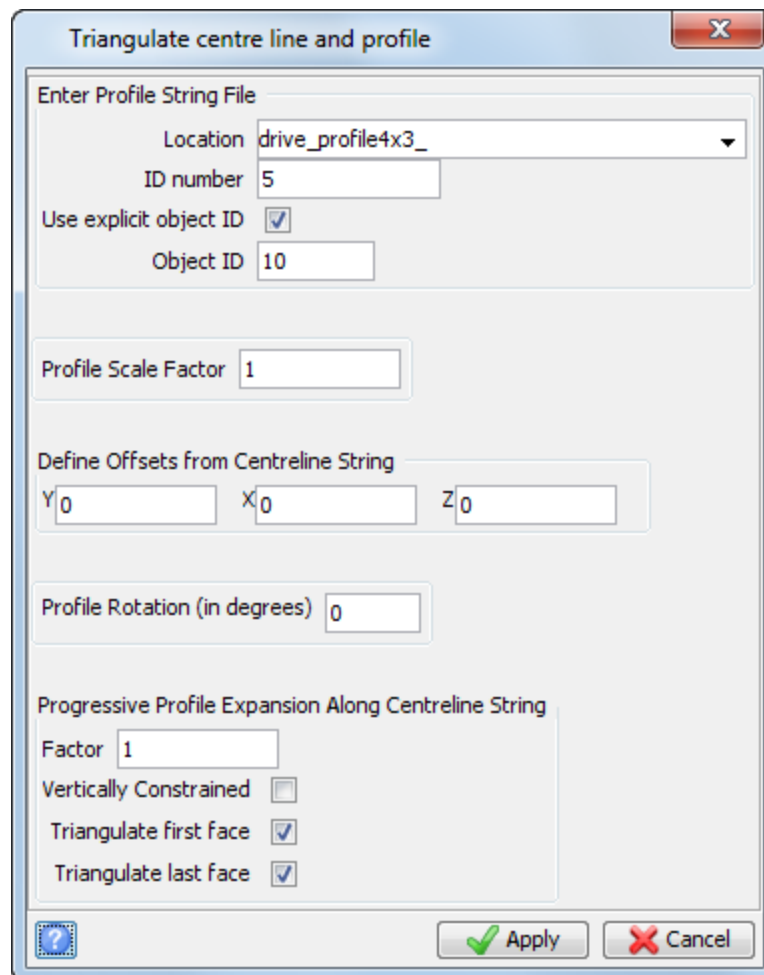


 **Note:** Both of the profiles are centered at point 0,0 on the floor of the profile.

 **Note:** To see all of the steps performed in this task, run `_05a_display_profiles.tcl` . You need to click **Apply** on any forms presented.

Task: Create a solid using triangulate centreline and profile

1. Click **Reset graphics** .
2. Open `ugdes1.str` in **Graphics**.
3. Choose **Design > Underground tools > Triangulate using centre line & profile**.
4. Enter the information as shown, and click **Apply**.



Triangulate centre line and profile

Enter Profile String File

Location drive_profile4x3_

ID number 5

Use explicit object ID

Object ID 10

Profile Scale Factor 1

Define Offsets from Centreline String

Y 0 X 0 Z 0

Profile Rotation (in degrees) 0

Progressive Profile Expansion Along Centreline String

Factor 1

Vertically Constrained

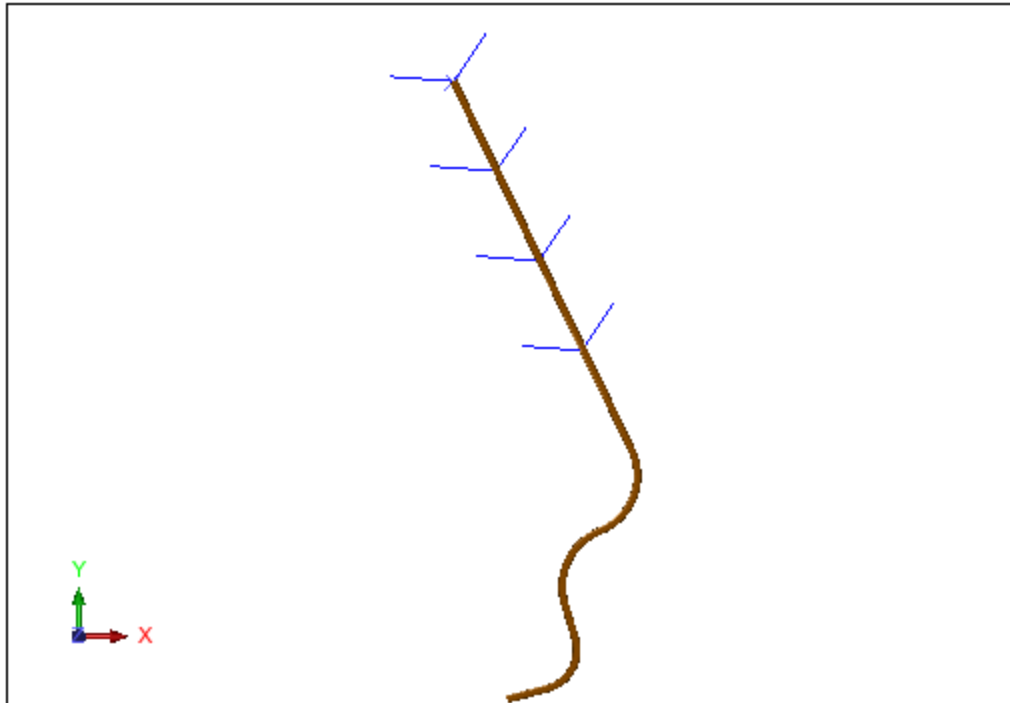
Triangulate first face

Triangulate last face

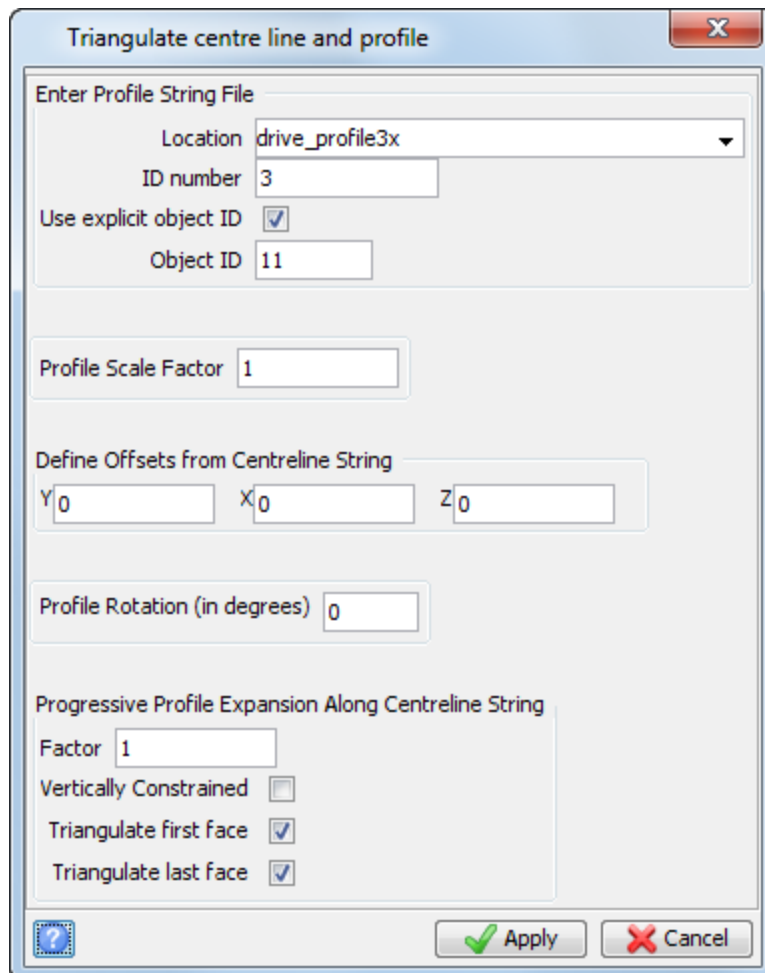
Apply Cancel

5. Click string 10.
This profile is applied to string 10 only, that is, the centreline string.
6. Press **ESC**.

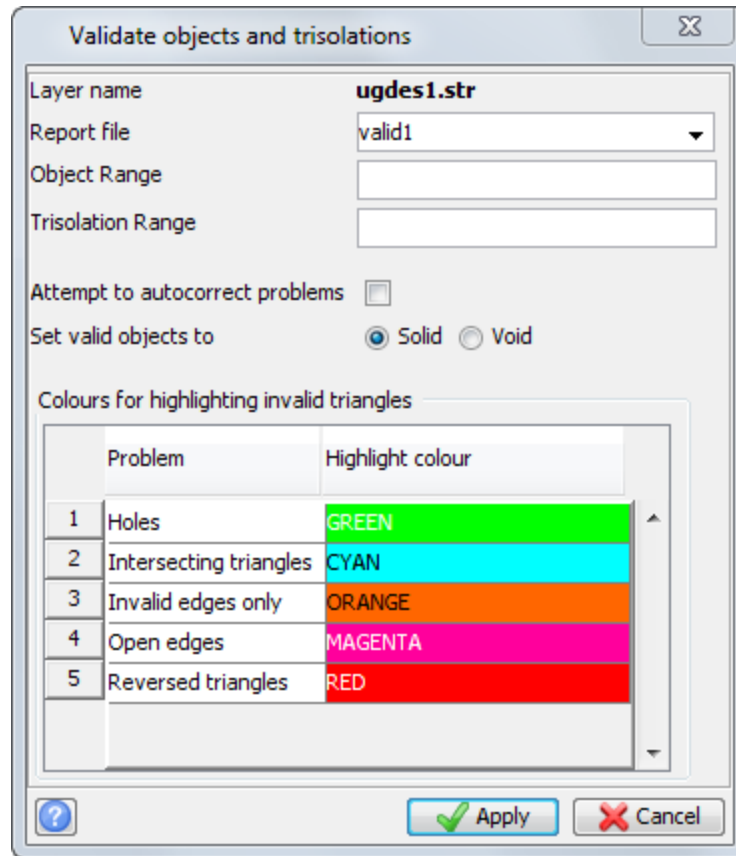
The centreline solid is displayed.



7. Choose **Design > Underground tools > Triangulate using centre line & profile.**
8. Enter the information as shown, and click **Apply**.



9. Click each of the individual segments of string 11.
10. Press **ESC**.
11. Choose **Solids > Validation > Validate object/trisolation**.



12. In the Navigator, double-click **valid1.not**.
The report is opened in your default text editor.

solid validation report

```

Layer:ugdes1.str
object  Trisolation  valid  open/closed  Connected  Duplicate (removed)  Invalid Edges  Intersecting  Reversed
-----
  10      1  valid    closed      Connected          0                0              0            0
  11      1  valid    closed      Connected          0                0              0            0
  11      2  valid    closed      Connected          0                0              0            0
  11      3  valid    closed      Connected          0                0              0            0
  11      4  valid    closed      Connected          0                0              0            0
  11      5  valid    closed      Connected          0                0              0            0
  11      6  valid    closed      Connected          0                0              0            0
  11      7  valid    closed      Connected          0                0              0            0
  11      8  valid    closed      Connected          0                0              0            0
                                     Totals
                                     0                0              0            0
solid validation report                                     1/1
    
```

13. Choose **File > Save > string or DTM**.

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

Note: To see all of the steps performed in this task, run `_05b_triangulate_centrelines.tcl`. You need to click **Apply** on any forms presented.

Task: Calculate volume of underground design

- Choose **Solids > Solids tools > Report volume of solids**.
- Enter the information as shown, and click **Apply**.

- In the Navigator, double-click `ugdes_drive_volume1.not`.

The report is opened in your default text editor.

```

SOLID MODELLING OBJECT REPORT
Layer Name: ugdes1.str

Object: 10
Trisolation: 1
Validated = true
Status = solid

Trisolation Extents
X Minimum: 11196.324 X Maximum: 11292.630
Y Minimum: 21596.009 Y Maximum: 21909.732
Z Minimum: 200.000 Z Maximum: 220.482
Surface area: 5124
Volume : 4837

Object: 11
Trisolation: 1
Validated = true
Status = solid

Trisolation Extents
X Minimum: 11232.261 X Maximum: 11262.672
Y Minimum: 21771.912 Y Maximum: 21777.121
Z Minimum: 200.000 Z Maximum: 203.000
Surface area: 381
Volume : 272

...


Object: 11
Trisolation: 8
Validated = true
Status = solid

Trisolation Extents
X Minimum: 11261.321 X Maximum: 11279.947
Y Minimum: 21772.565 Y Maximum: 21798.006
Z Minimum: 200.000 Z Maximum: 203.000
Surface area: 363
Volume : 258

Totals - Object: 11
Surface area: 3055
Volume : 2183

Totals
Surface area: 8179
Volume : 7020

```

 **Note:** To see all of the steps performed in this task, run `_05c_drive_volume.tcl`. You need to click **Apply** on any forms presented.