GEMCOM becomes GEOVIA

Surpac 6.3

Pit Design

3DEXPERIENCE

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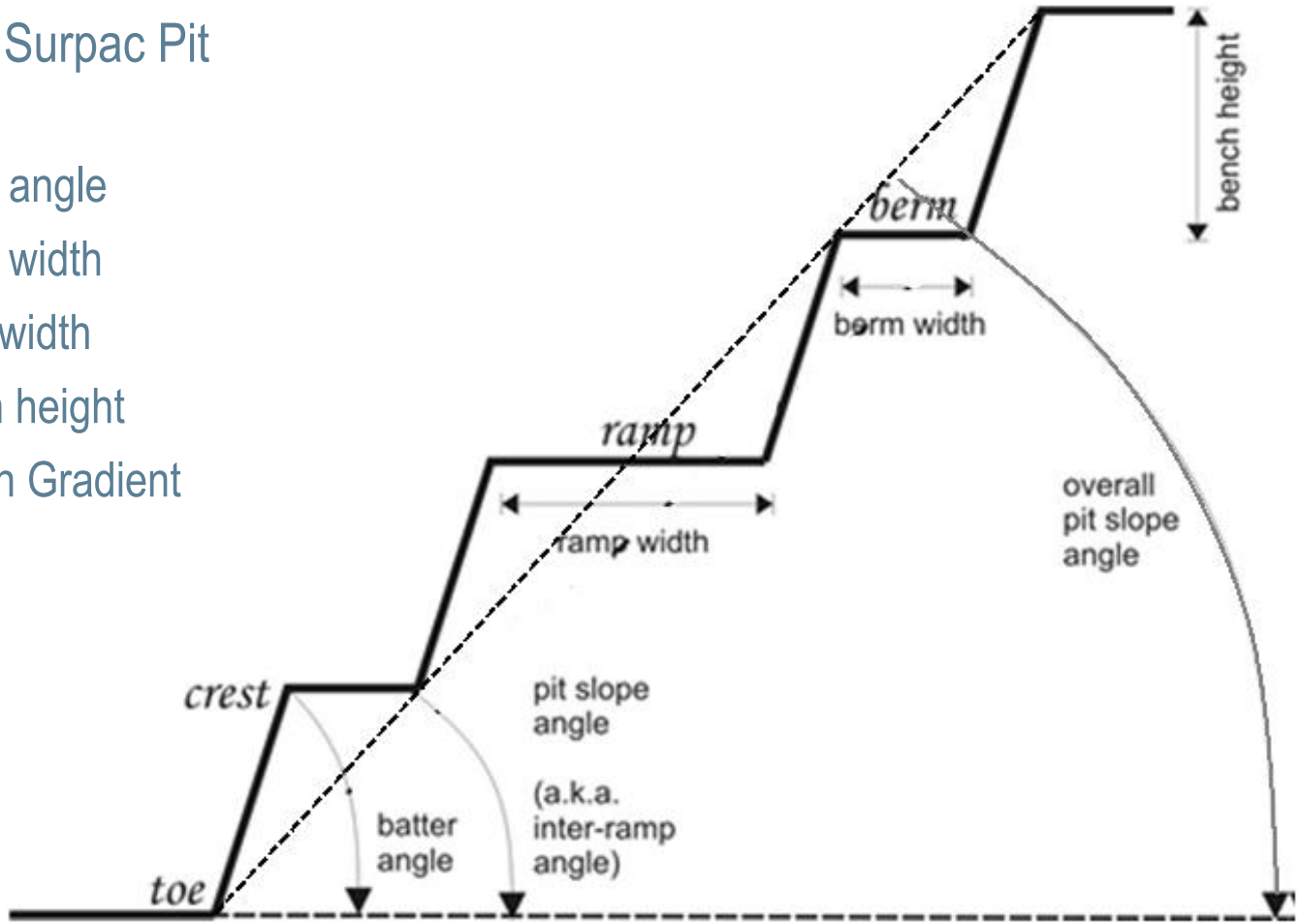
Pit Design Tools

- Direct editing of the design enables modification of the geometry to capture additional material
- Choice of technique for specifying wall slopes and bench widths
- Design parameters may be changed at any point in the design, giving great flexibility in design as the pit evolves

Pit Design – 2D Visualization

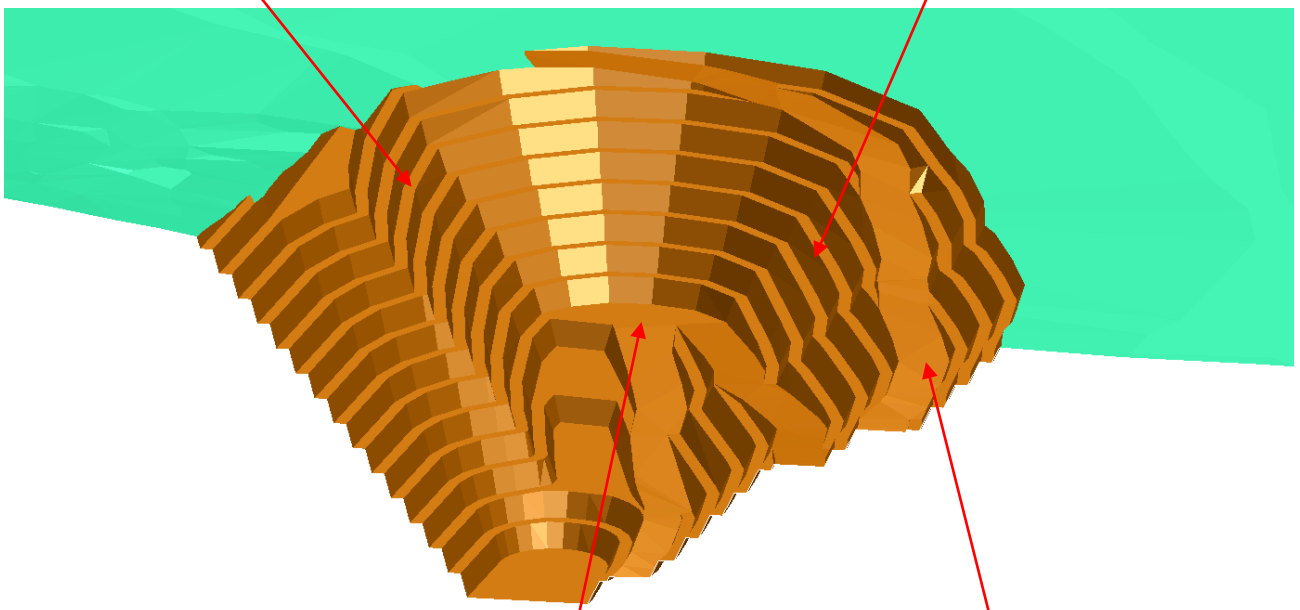
- Inputs to Surpac Pit Design:
  - Batter angle
  - Ramp width
  - Berm width
  - Bench height
  - Design Gradient



Pit Design – 3D Visualization

Benches and Berms from design parameters

Slope angles based on geotechnical parameters



Switchbacks

Road design to set gradients

Calculate accurate extraction volumes and grades from the pit design

Mine Design and Editing Toolbar

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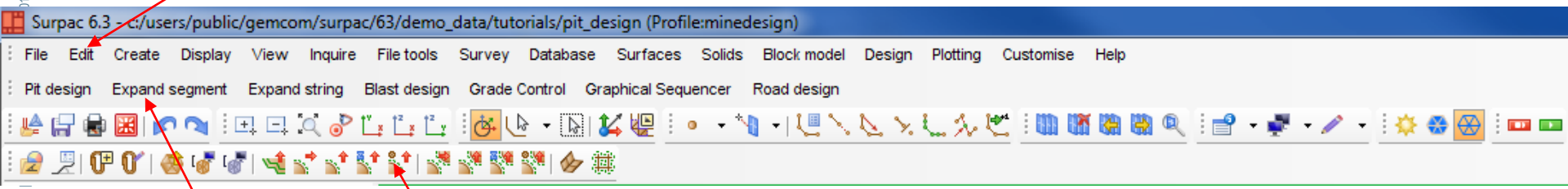
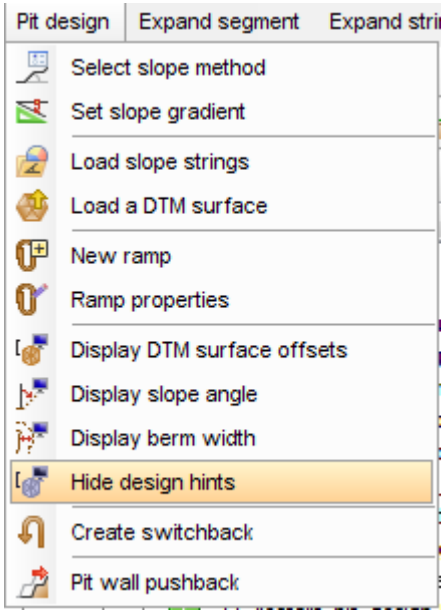


Pit Design Menus

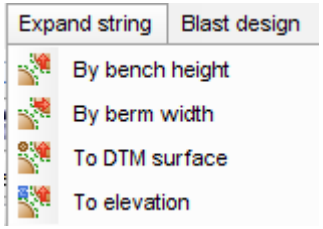
Pit Design Icons

Pit Design Tools/Menus

- Pit Design Parameters:



- Create benches and berms:

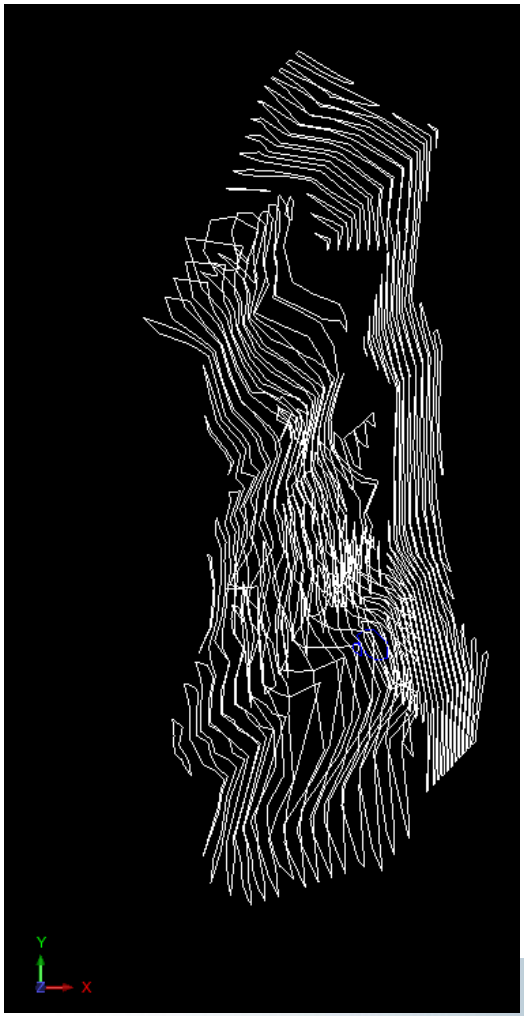


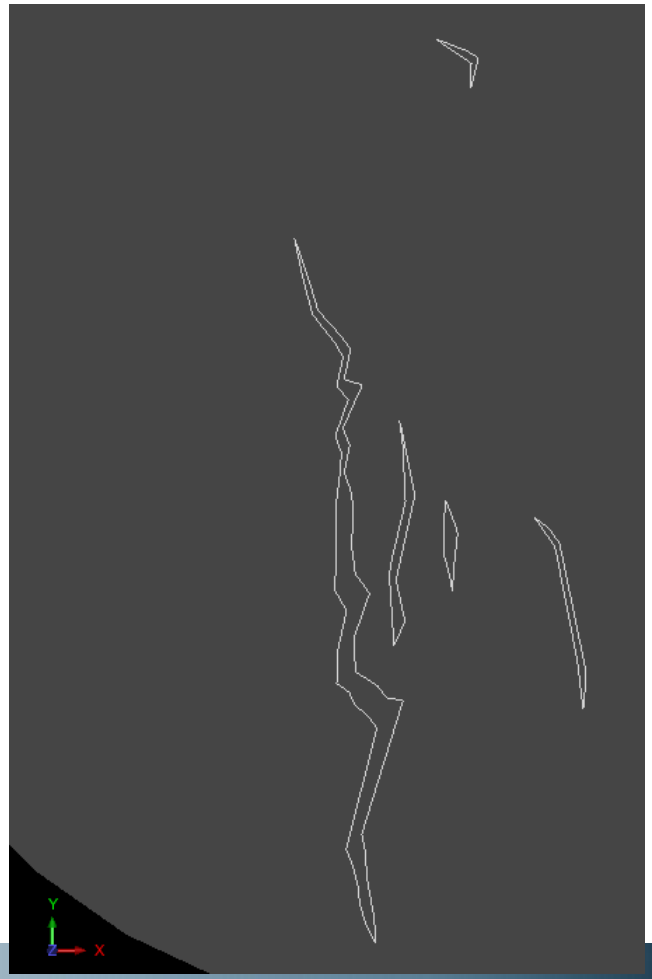
Pit Design Data Preparation

- Data can be obtained from various sources and in different formats:
  - Geology outlines
  - Outlines from Whittle
  - Constrained block models
  - Natural Surface data
  - Geotechnical design constraints
  - Mining fleet design constraints

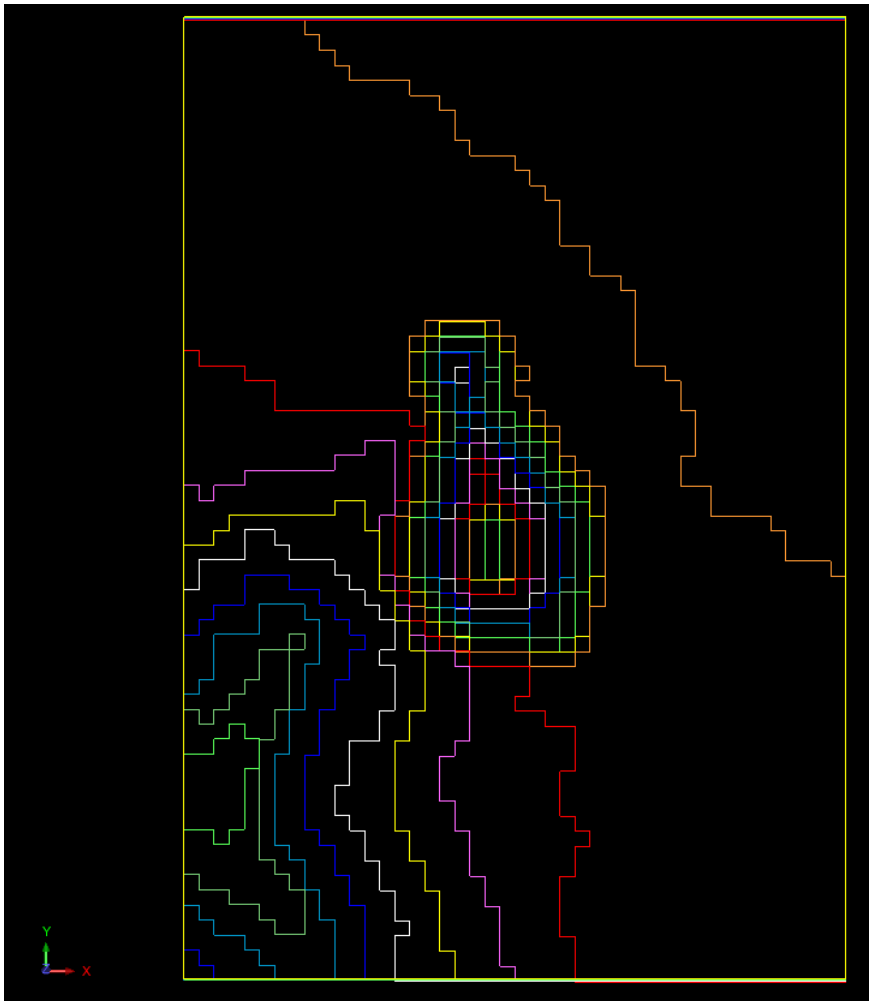
Pit Design Data Preparation

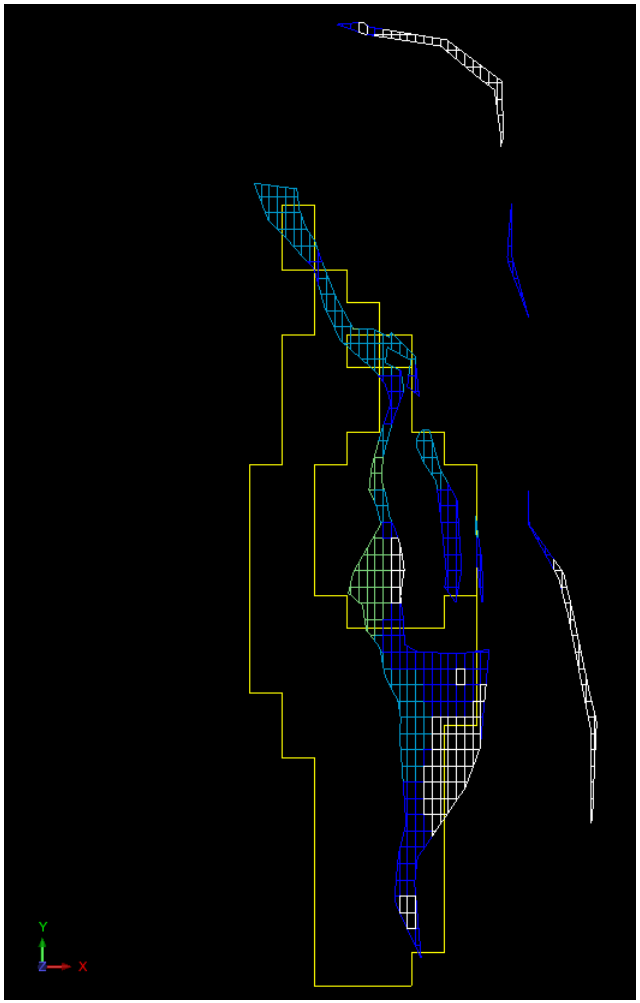
- Geological outlines:





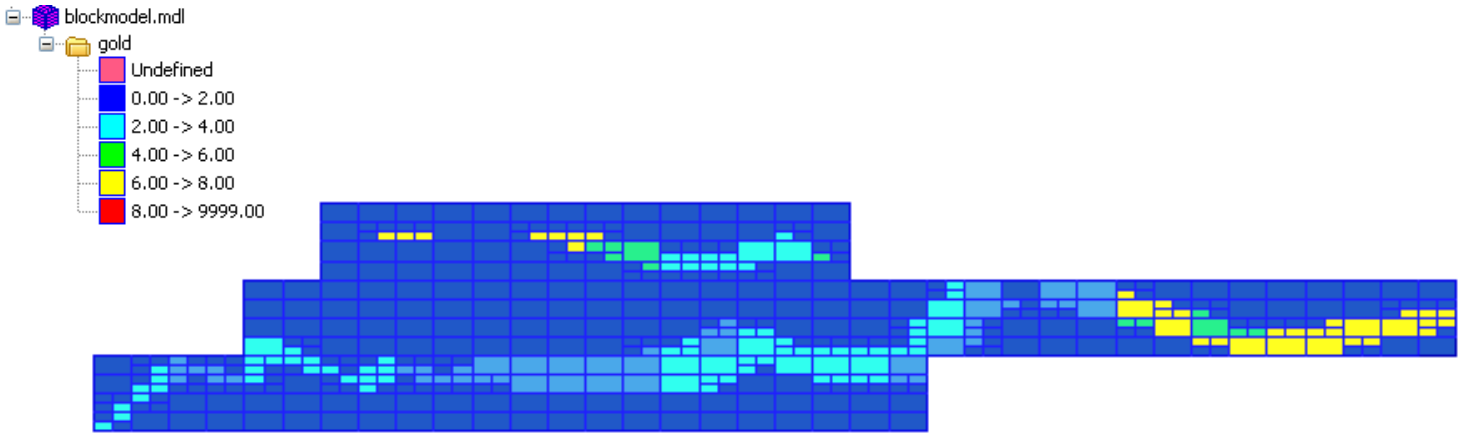
Pit Design Data Preparation





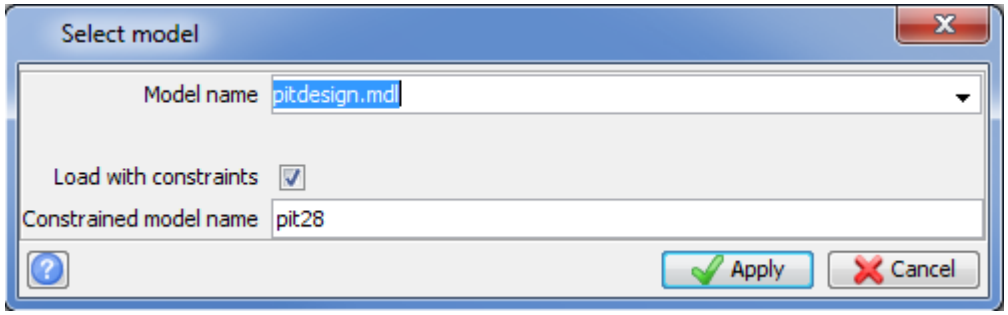
Pit Design Data Preparation

- Constrained block models:
  - This is the Surpac training block model at 890m elevation, showing high contests of gold at the intended pit floor.



Assignment 1: Load a constrained block model

- Profiles> Block model. Open pitdesign.mdl, as shown, apply.

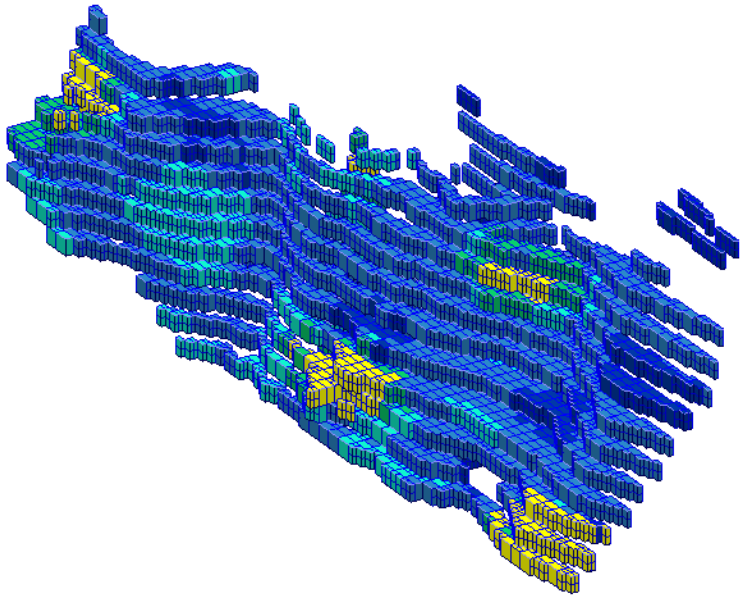


- Then in the 'Block Model Load' window, tick the box, to load all blocks for this attribute. Apply.
- Then in the 'Enter Constraint' window add a constraint to constrain values inside pit28.con.
- Display block model.
- Colour model by attribute, gold, refresh, make sure model insn't transparent. Apply.

Assignment 1: Continued...

- If you want to see the ore that pit28.con defines, select block model>constraints>new graphical constraint. Create a block constraint of gold >0.

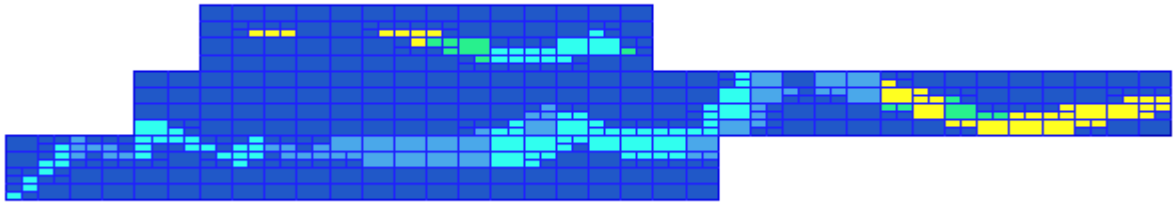
  Does your constrained model look like this:



- Now remove last graphical Constraint.

Assignment 1: Continued...

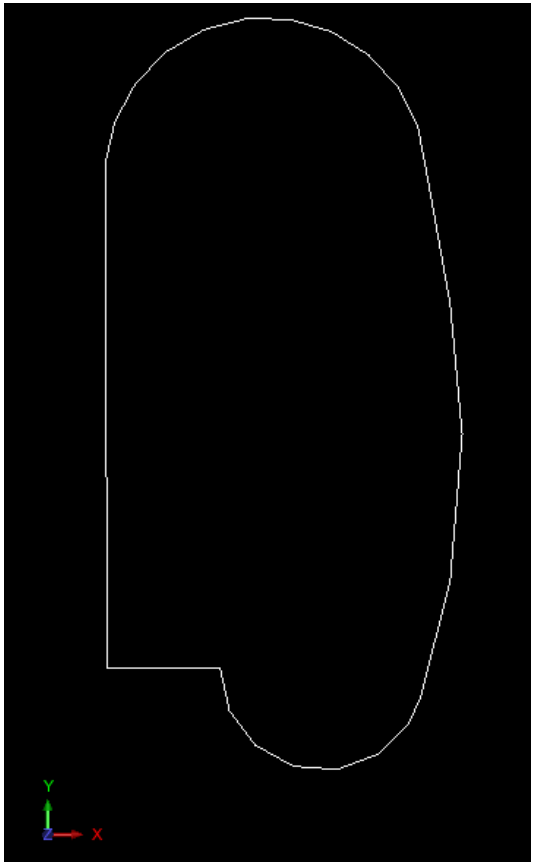
- New graphical constraint> constrain type = z plane at 890 below, Add. Does the block model look like this?



- Once you have this, you have successfully loaded a constrained block model. If you drag in bas880.str you can see the pit floor shape used resulting from this block model.
- Reset graphics.

Where to start?

- First step in defining a pit is to design a starting string. You will copy and transform this string throughout your design.



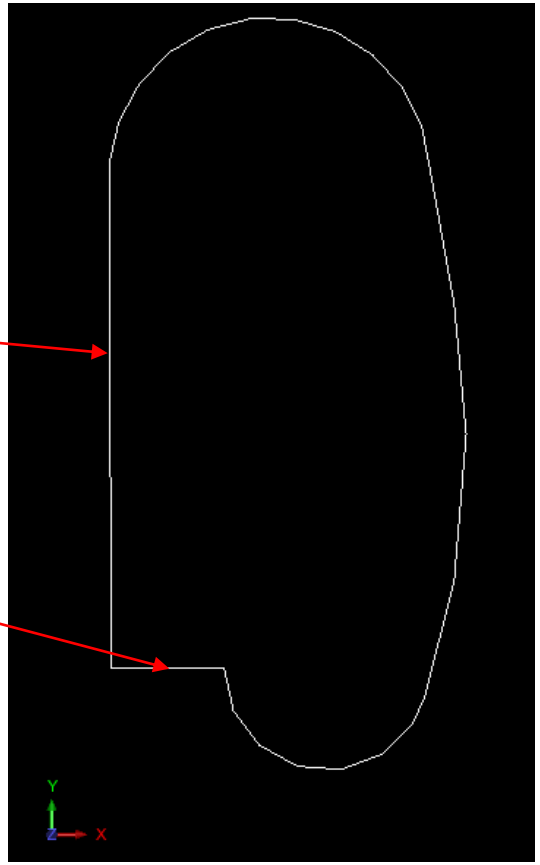
- Starting string could be on:
  - The top of the pit
    - Usually when you are constrained to some physical boundary
    - Pit would be designed from the top down
  - The bottom of the pit
    - Pit would be designed from the bottom up
    - Better for adapting to geological constraints
  - Has to be a closed polygon
- An example has been included in “bas880.str”.
- This is for a bottom-up design.

Assignment 2: Open starting string and setting slope of pit

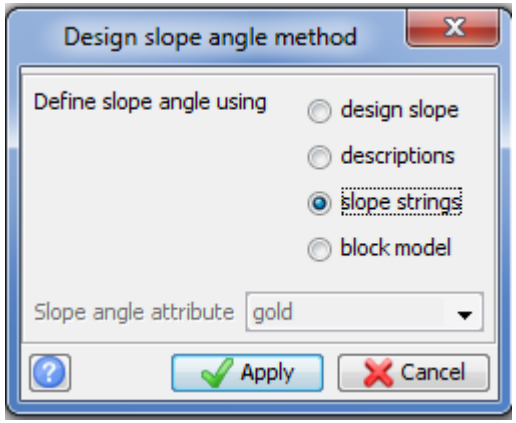
- Load the minedesign profile.
- Drag bas880.str into the graphics.
- Design> pit design> set slope gradient.
- Choose a realistic gradient.

This line will represent the toe of the bottom bench.

This area will form the start of the ramp.



Define a Sloping Method



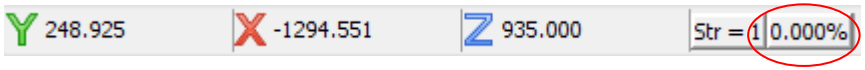
- Define a sloping method:

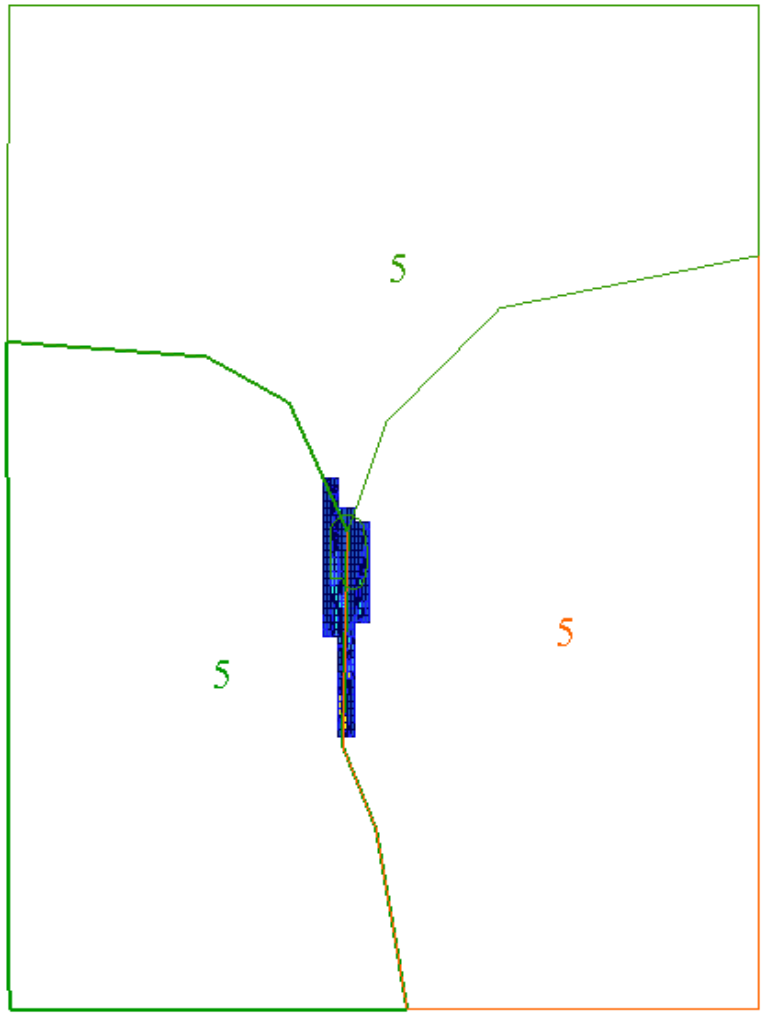
(Design > pit design > select slope method).

  - Design slope:
    - User inputs the value for the slope method.
    - This value is constant for the entire perimeter of the pit and can be changed at any time between benches by the user.
    - It can be entered as an angle, percentage or ratio.
  - Descriptions:
    - This method reads the slope angle directly from the starting string.
    - The slope angle is stored in D1 field and the berm width in the D2 field.
    - Angles must be stored in decimal degrees and they are copied to the expended pit string as the pit is being constructed.
  - Slope strings:
    - A file containing closed polygons is loaded into memory.
    - These polygons have slope angle stored in D1 field and any points from the pit outline string that fall within the polygon will be assigned a slope from these polygons.
  - Block model reads from an attribute in the connected block model.

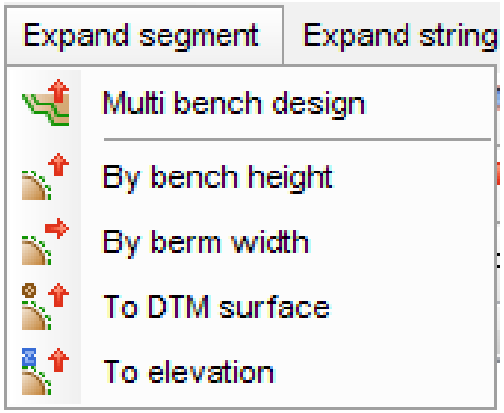
Defining a Slope Angle from a String

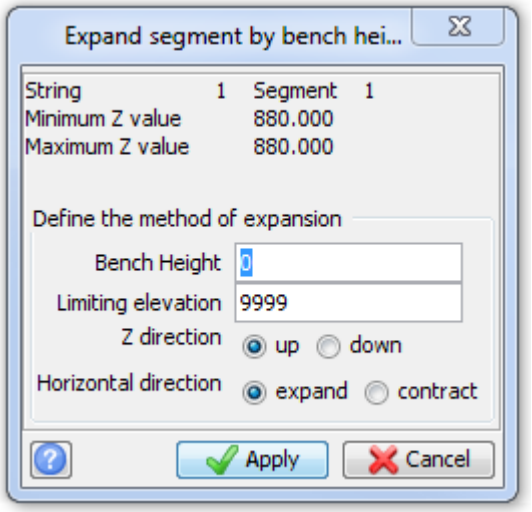
- You can use a string file with closed polygons containing slope angles in their d fields.
- The slope angle will automatically be read from this d field.
- If you would like to design your pit using this method, use the string slo1.str. Edit the d fields to define the slope angles you would like to use.
- If you would like to manually enter the slope string, select the icon below.

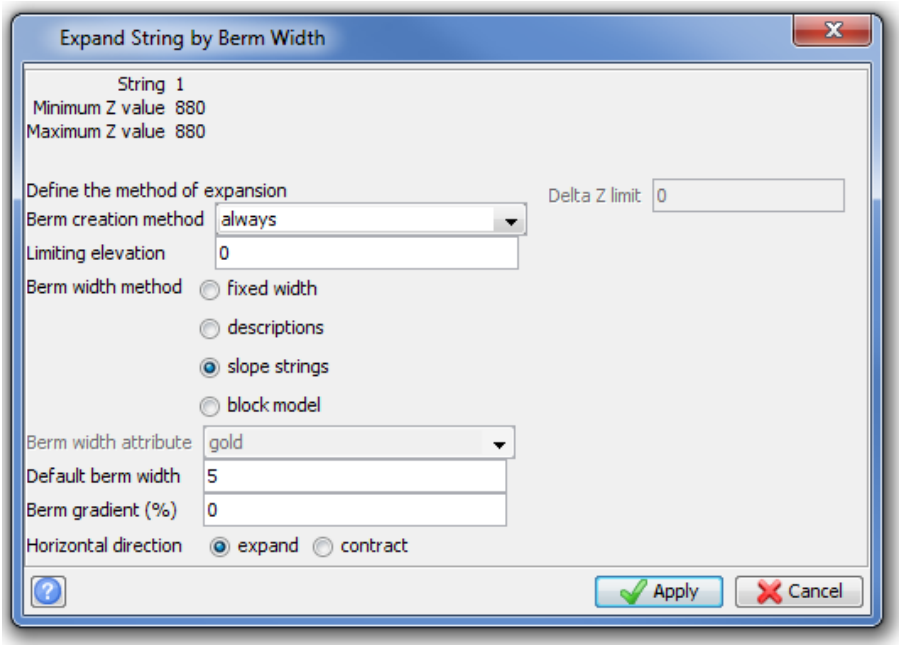




Creating Crest and Toes



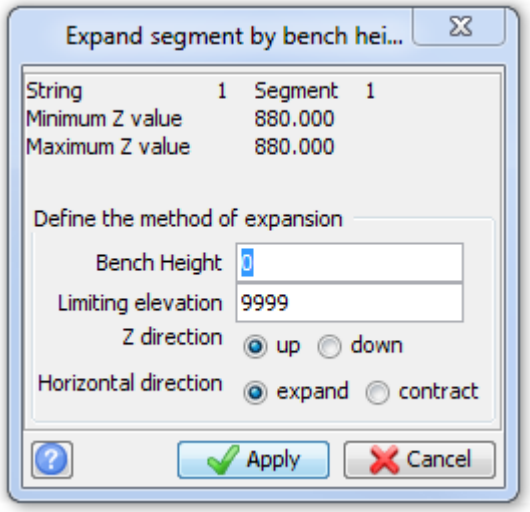




Creating Crest and Toes

- The expand string function will perform the task for all segments of the selected string while the expand segment function will operate only on the selected segment
- Both options will work on open or closed segments

- Expand by bench height:



Creating Crest and Toes

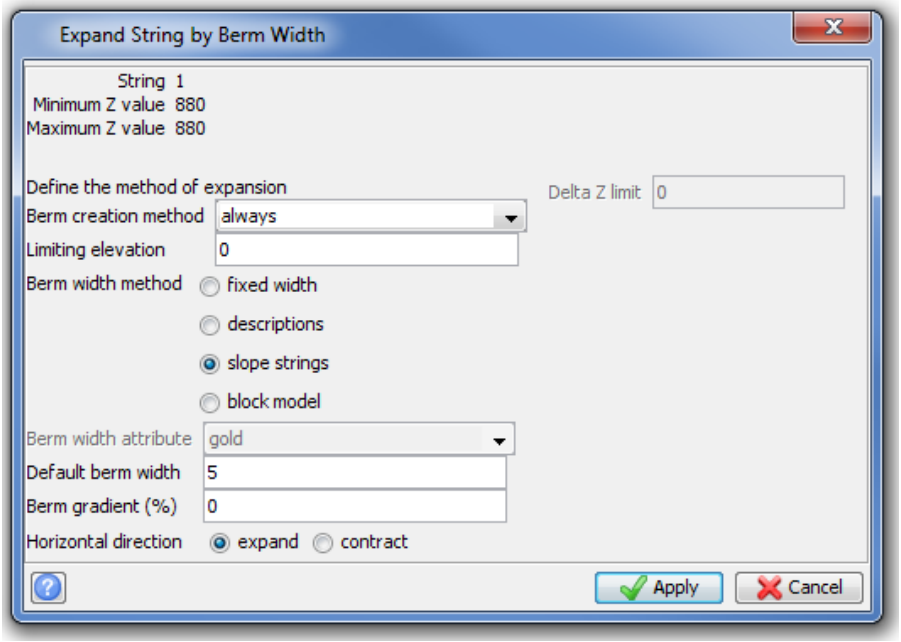
- Bench height:
  - This is the bench height which will be used to modify the position of the points on the selected segment.
  - If the Z direction is up then the bench height is added to the Z value of the points on the selected segment to give the new elevations.
  - If the Z direction is down then the bench height is subtracted from the Z value of the points to give the new elevation.
  - The bench height is always a positive value.
- Limiting elevation:
  - Used to restrict the elevations of the points on the new segment.
  - If, when the bench height is added (or subtracted from) the elevations of the points, the limiting elevation is exceeded (in the defined Z direction), the new bench height is restricted to prevent the limiting elevation from being exceeded.

Creating Crest and Toes

- Z direction:
  - The Z direction is used to determine whether the bench height is added to, or subtracted from, the elevations of the points on the selected segment.
  - Options:
    - Up
    - Down
- Horizontal direction:
  - The selected segment may be either expanded or contracted to create the new segment.
  - Options:
    - Expand
    - Contract

Creating Crest and Toes

- Expand by berm width:



- This function will expand (or contract) a selected segment by a fixed berm width

Creating Crest and Toes

- Berm creation method:
  - When creating a berm, you can choose to have a berm of required width along the full length of the selected string or only where the difference in elevation from each point on the selected string to a target elevation or DTM meets some criteria
  - Options:

Berm creation method	Description
always	A berm of the required width is created at each point on the segment
delta z to elevation >=	A berm of the required width is only created at a point if the absolute value of the difference in elevation from the point to the target elevation is greater than or equal to the delta z limit value.
delta z up to elevation >=	A berm of the required width is only created at a point if the point is presently below the target elevation and if the difference in elevation from the point to the target elevation is greater than or equal to the delta z limit value.
delta z down to elevation >=	A berm of the required width is only created at a point if the point is presently above the target elevation and if the difference in elevation from the point to the target elevation is greater than or equal to the delta z limit value.
delta z to elevation <=	A berm of the required width is only created at a point if the absolute value of the difference in elevation from the point to the target elevation is less than or equal to the delta z limit value.
delta z up to elevation <=	A berm of the required width is only created at a point if the point is presently below the target elevation and if the difference in elevation from the point to the target elevation is less than or equal to the delta z limit value.

Creating Crest and Toes

- Berm creation methods:
  - Options:

delta z down to elevation <=	A berm of the required width is only created at a point if the point is presently above the target elevation and if the difference in elevation from the point to the target elevation is less than or equal to the delta z limit value.
delta z to dtm >=	A berm of the required width is only created at a point if the absolute value of the difference in elevation from the point to the DTM surface is greater than or equal to the delta z limit value.
delta z up to dtm >=	A berm of the required width is only created at a point if the point is presently below the DTM surface and if the difference in elevation from the point to the DTM surface is greater than or equal to the delta z limit value.
delta z down to dtm >=	A berm of the required width is only created at a point if the point is presently above the DTM surface and if the difference in elevation from the point to the DTM surface is greater than or equal to the delta z limit value.
delta z to dtm <=	A berm of the required width is only created at a point if the absolute value of the difference in elevation from the point to DTM surface is less than or equal to the delta z limit value.
delta z up to dtm <=	A berm of the required width is only created at a point if the point is presently below the DTM surface and if the difference in elevation from the point to the DTM surface is less than or equal to the delta z limit value.
delta z down to dtm <=	A berm of the required width is only created at a point if the point is presently above the DTM surface and if the difference in elevation from the point to the DTM surface is less than or equal to the delta z limit value.

- Delta Z limit:
  - If you wish to create the berm dependent upon some difference in elevation to a traget elevation or DTM surface, then you must enter the delta z limit value here which will be used to determine if the berm is created or not

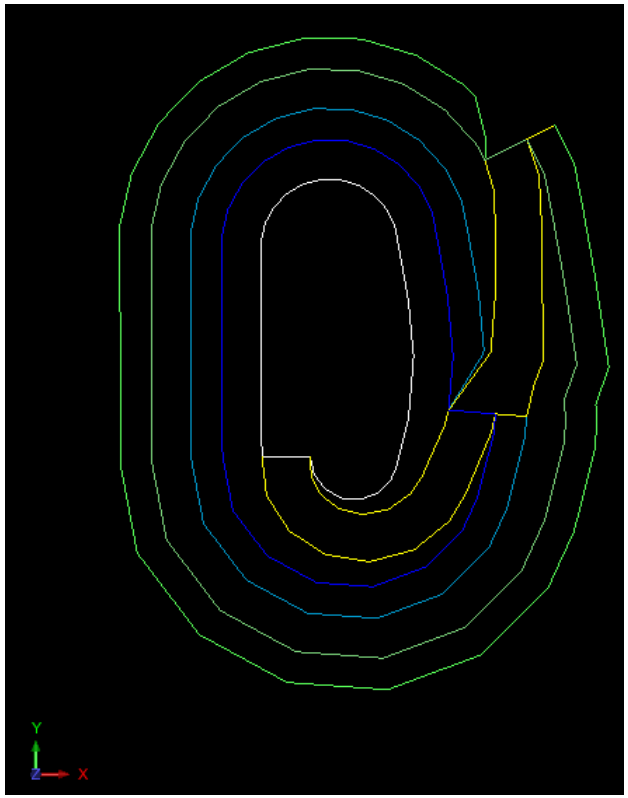
Creating Crest and Toes

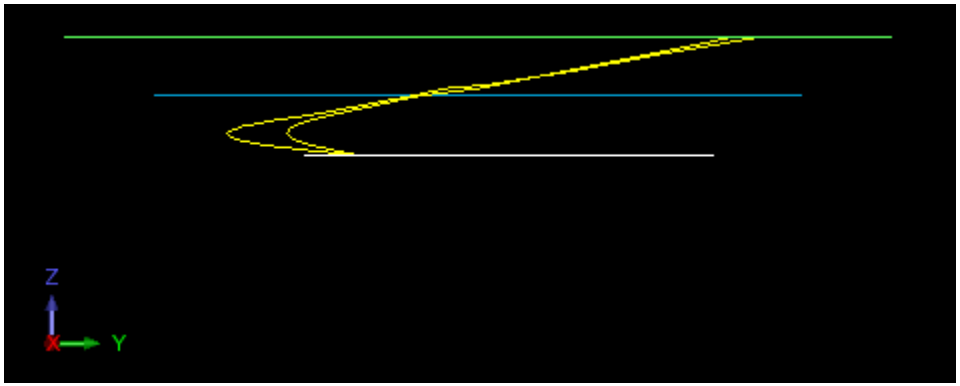
- Limiting elevation:
  - If you wish to create a berm dependent upon some difference in elevation to a target elevation then you must enter the limiting elevation which will be used if you have chosen to use a target elevation as the controlling feature for conditional berm creation.
- Berm width method:
  - This determines the method which will be used to obtain the berm width so that the segment is expended in the required manner.
  - Fixed width:
    - To use a fixed berm width for all points in the segment.
    - The default berm width is the value which is used if this method is chosen.
  - Descriptions:
    - To use the value stored in the D2 field of each point in the selected segment as the berm width.
  - Slope strings:
    - The strings from the slope string layer are used to define the required berm widths.

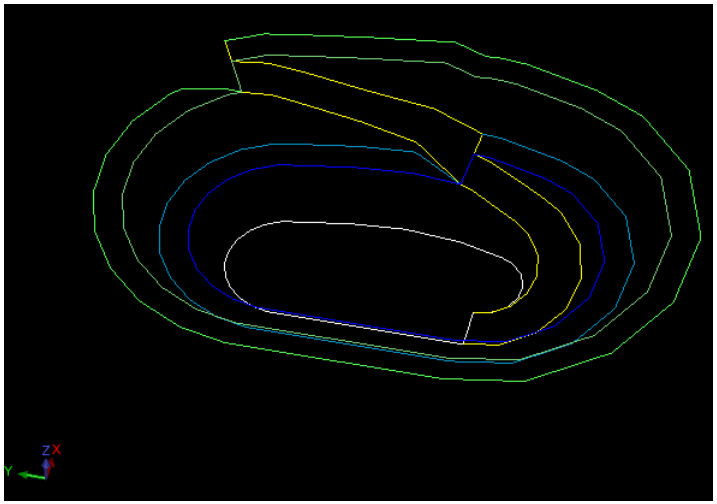
Creating Crest and Toes

- Default berm width:
  - This is the berm width which will be used if the berm width method being used is fixed width or if the berm width is otherwise undefined.
  - Should always be a positive value.
- Berm gradient (%):
  - A crossfall gradient may be used to ensure appropriate drainage of hte berm.
  - The gradient is expressed as a percentage with a positive value causing an increase in elevation from the selected segment to the new segment and a negative value causing a decrease from the selected segment to the new segment
- Horizontal direction:
  - The selected segment may be either expended or contracted to create the new segment.

Creating Crest and Toes

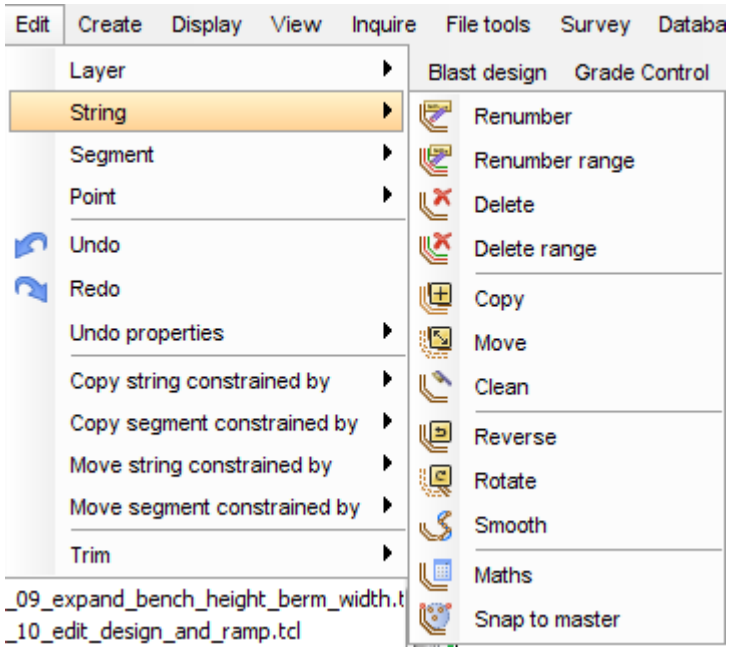


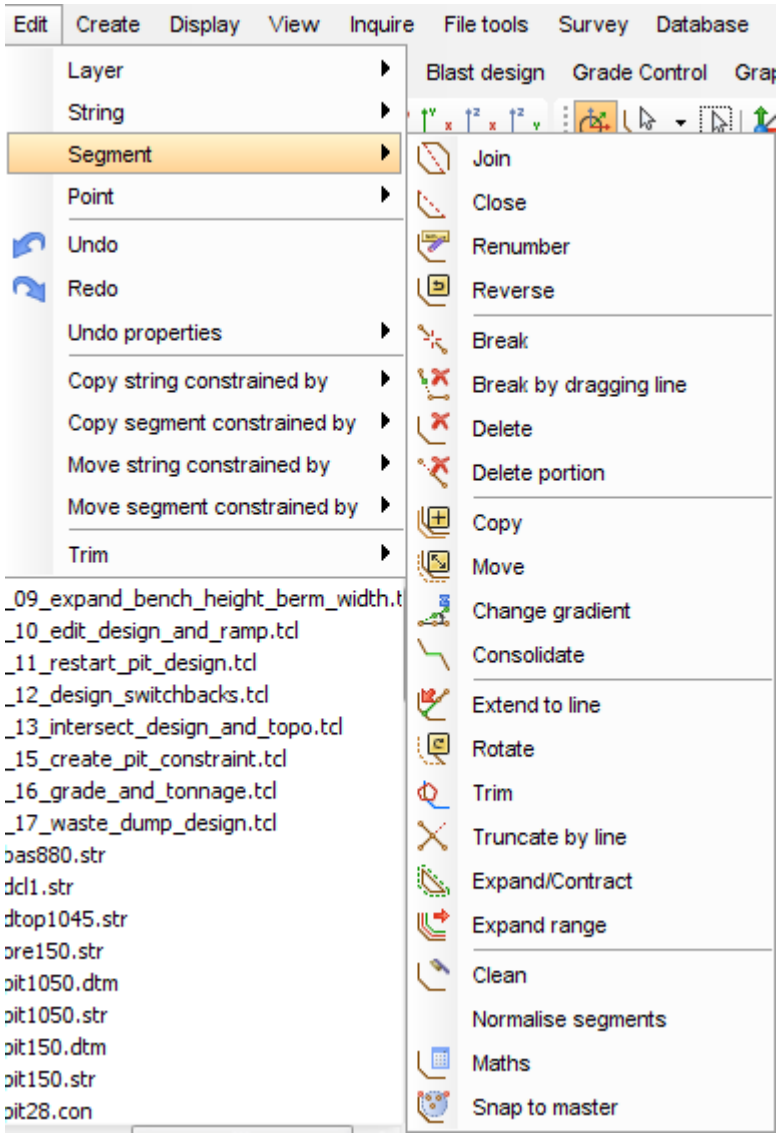




Pit Design Editing Functions

- To adjust the pit to your own needs

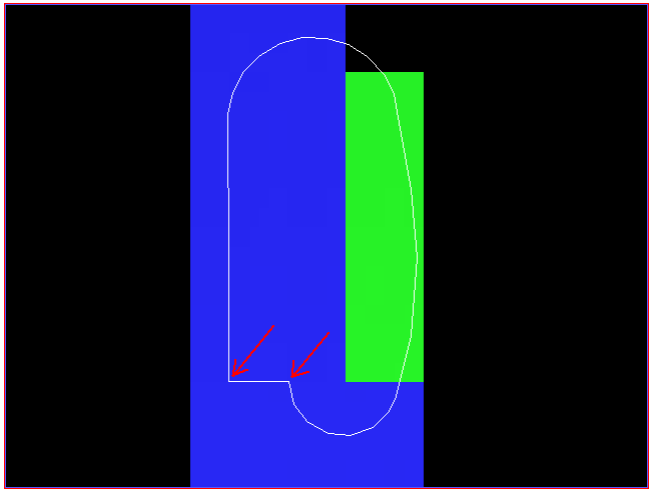




Define a Ramp

- Define a ramp:
  - Pit design> New ramp

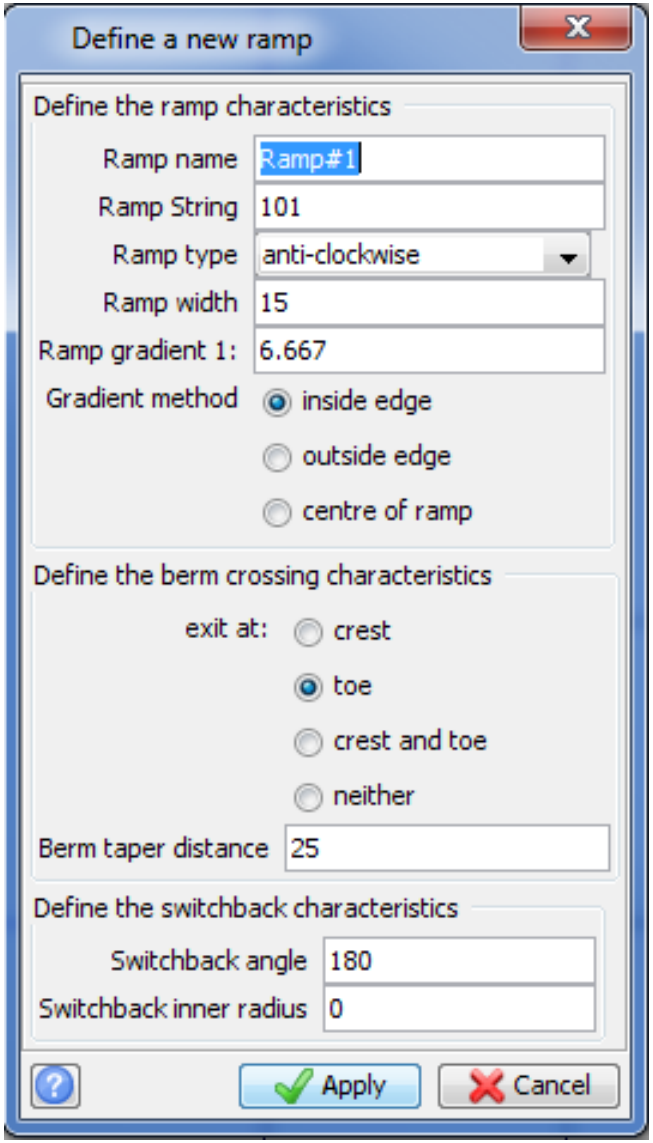
- First you need to select two ramp points
- !The geometry of these points is important as they define the initial width of the ramp
- !Ramp points must also be adjacent with no other points between them



Define a Ramp

- Once two points have been selected, the new window will pop-up

- Ramp name:
  - You may have multiple ramps in the pit and this name is to help you manage the individual ramp characteristics you may change later on



Define a Ramp

- Ramp string:
  - You may specify the string number for the ramp edges.
  - Both sides of the ramp will have this string number, with distinct segments used to represent each side of the ramp.
- Ramp type:
  - Clockwise
  - Anti-clockwise
  - All Cut

  - Clockwise: this is a circular ramp that will be generated in a clockwise fashion around the segment as it is expanded or contracted from one level to the next.
  - Anti-Clockwise: this is a circular ramp that will be generated in an anticlockwise fashion around the segment as it is expanded or contracted from one level to the next.

Define a Ramp

- Ramp Type:
  - All Cut: this is a ramp which will be created as an all cut ramp or as an all fill ramps.
    - a further requirement for this kind of a ramp is to select a pre-designed segment that defines the path that the ramp must follow as the design progresses from one level to the next.
    - The elevation of the alignment segment has no influence on the elecations of the points that represent the ramp as it is created. The elevation of the points on the ramp are determined as the design progresses from one level to the next using the ramp grade and starting elevation.
- Ramp Width:
  - This field has default value, rounded to the nearest unit of the distance between the selected points.
  - This may prove a useful aid in ensuring that the correct points have been selected.
  - By entering a width greater than the width of the two ramp points, Surpac will widen the ramp to the new width from one level to the next.
  - Original points are not altered.

Define a Ramp

- Ramp Gradient:
  - The gradient is defined as a ratio, therefore entering a value of 10 will produce a ramp with a gradient of 1 in 10, or 10%.

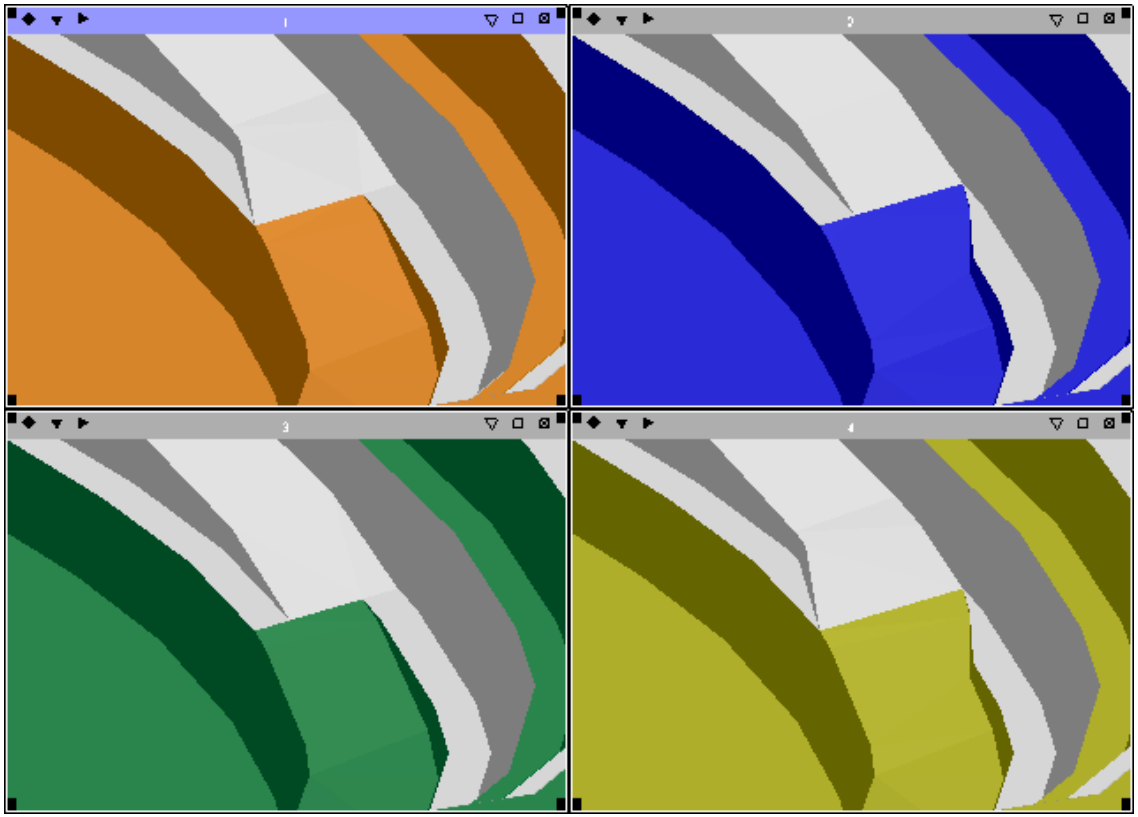
- Gradient Method:
  - Inside edge
  - Outside edge
  - Centre of ramp

  - Inside edge: the ramp gradient is calculated along the inside edge of any curves in the ramp.
  - Outside edge: the ramp gradient is calculated along the outside edge of any curves in the ramp.
  - Centre of the ramp: this ramp gradient is calculated along the centre of the ramp.

Define a Ramp

- Berm Crossing Method:
  - Determines the berm characteristics where the ramp crosses the berm.
  - Valid choices:

exit at toe



exit at crest

exit crest and toe

no berm exit

Define a Ramp

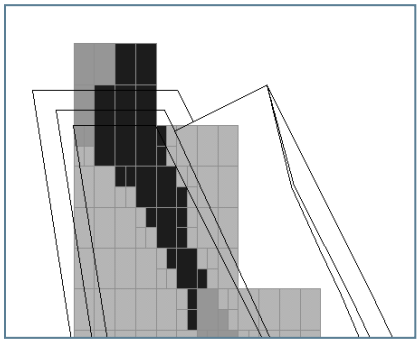
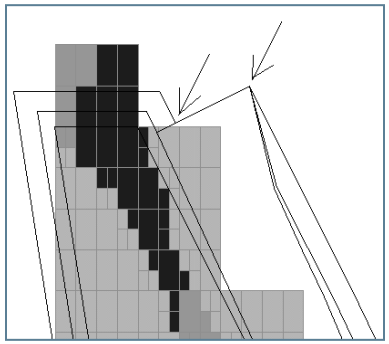
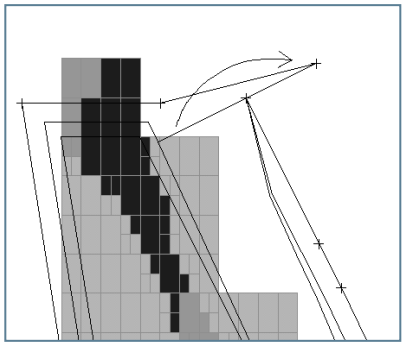
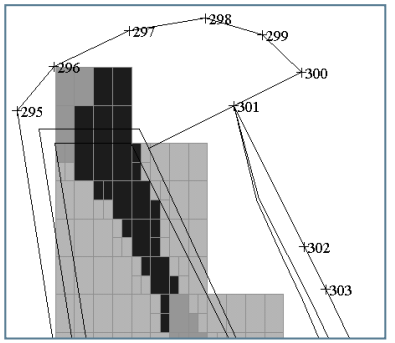
- Berm Taper Distance:
  - Distance along the ramp from the ramp crossing point that the berm starts to the taper

Assignment 3: Crest and Toes

- Using base string bas880.str
- Use the functions described to create start the pit (only do approximately six levels, bench height 10, berm width 5).
  - Remember to add ramps as you go upwards.
  - Remember alternate between expanding segements for berms and for benches.

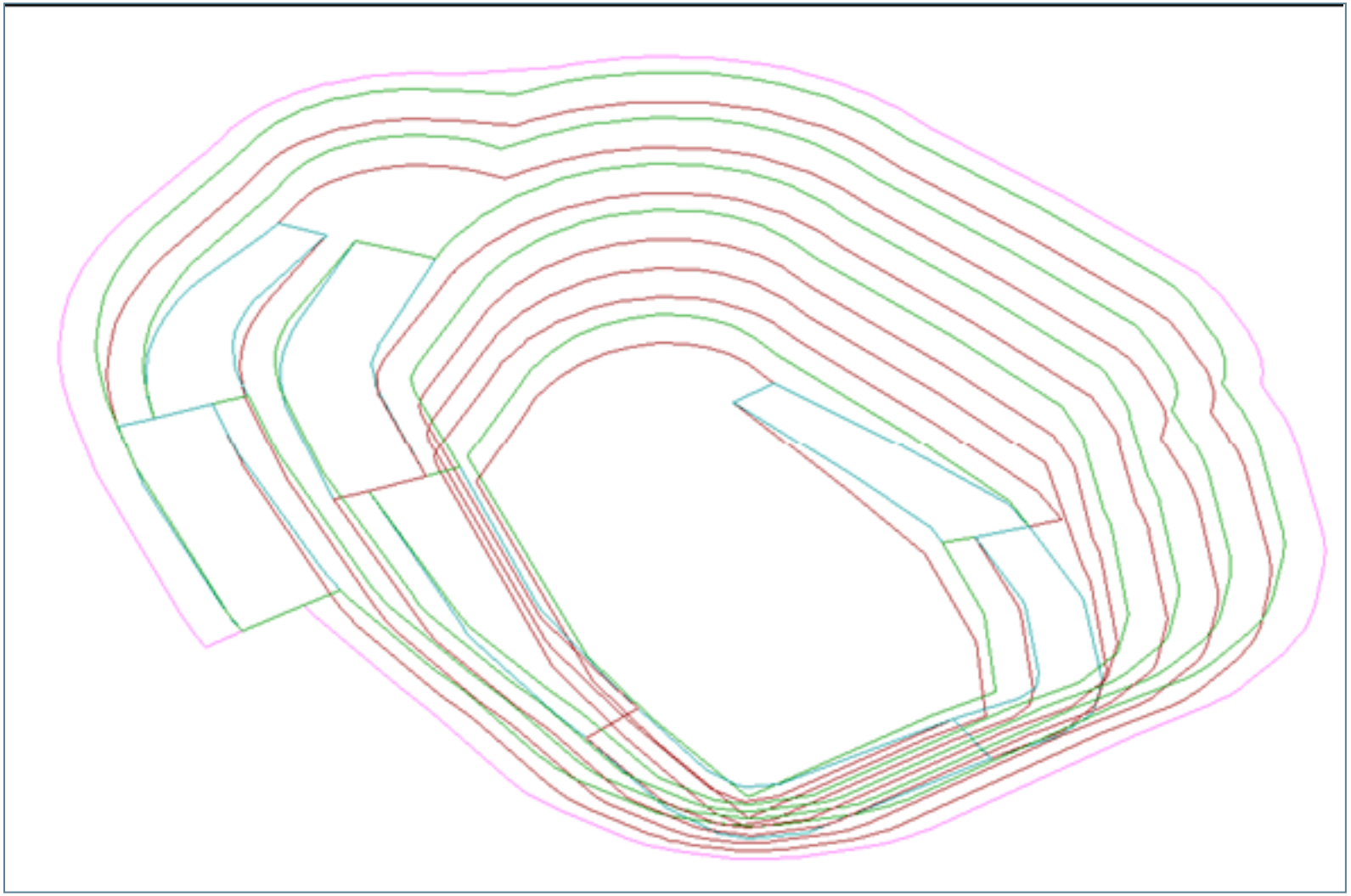
Designing a Switchbacks

- Switchbacks are turning points that enable a ramp to stay in the same part of the pit (the same wall, effectively).

- Modify the toe string to design the switchback
  - Create a circle at the centre of the corner, with radius matching your road width.
  - Remember to use edit>string>move to move it to match the radius of the circle you created.

Designing a Switchbacks



Assignment 4: Switchbacks

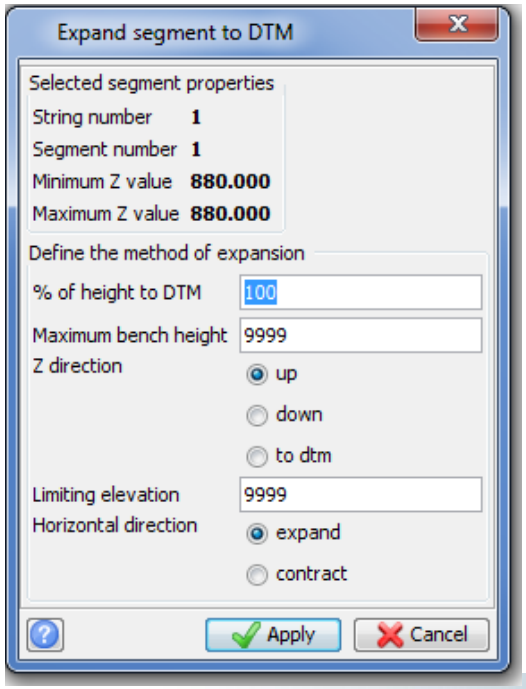
- Now add at least one switchback.
- Ask if you are unsure what to do.
- Continue with bench and berm additions unitil the rim of the pit is just beneath the topography z = 990.

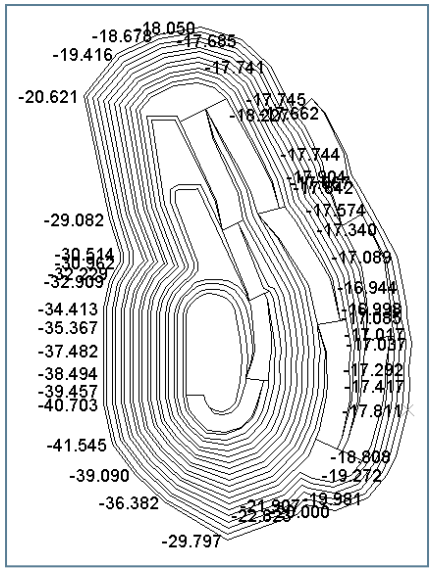
Additional Tools

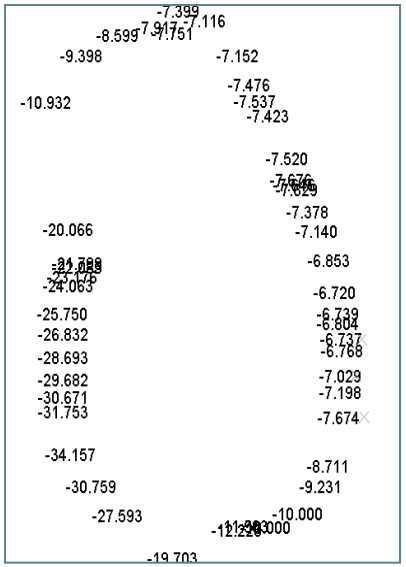
- Pit design directly to the DTM surface:
  - Very powerful option when working with layered deposits where benches are designed up to the top or bottom of seams, or when designing a put up to the land surface
- When a design is heavily influenced by surface features, the starting design can easily be fitted to the land surface and the pit designed from top to bottom
- Conditional berm generation: berms may be generated based on the distance to a DTM surface or elevation
- Optional bern generation at any level to accommodate double benching

Pit Design to Surface

- Once we know that the surface is less than 10m vertically away from the natural surface, we will want to expand the string to the DTM
  - This allows us to expand up to the intersection of topography and optionally allows us to res.trict this height if needed

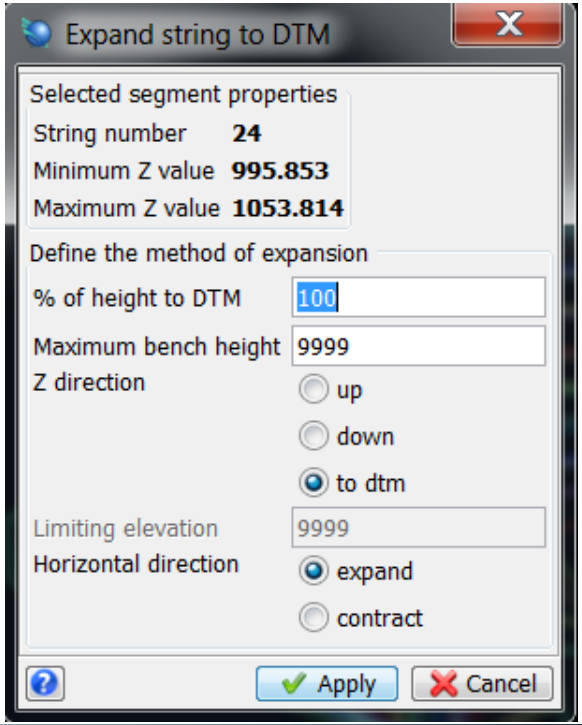






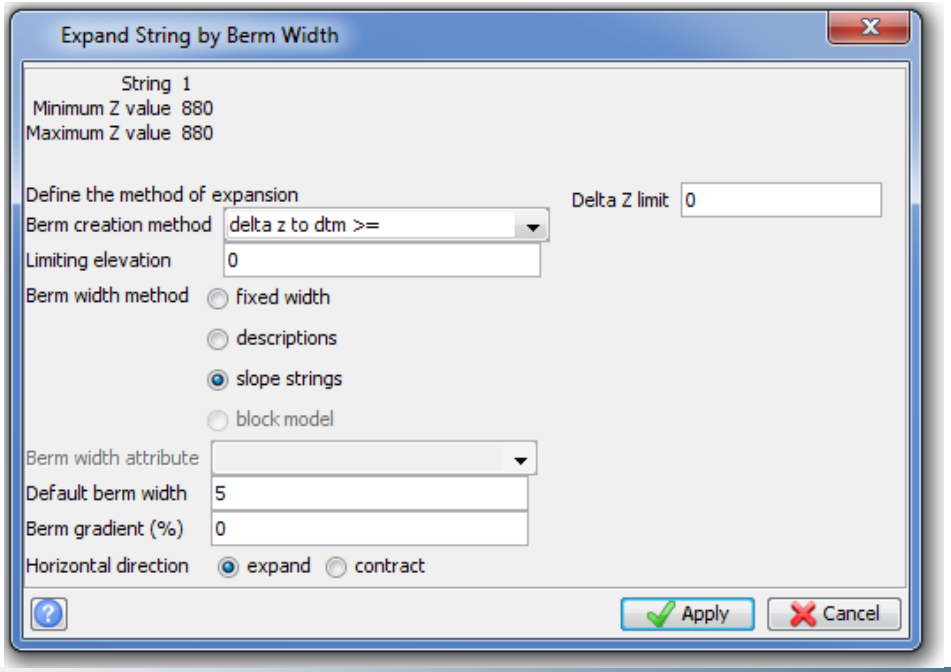
Assignment 5: Expand string to dtm

- Now we will expand the string to the dtm.
- Remember you change the gradient of your pit at any stage during the pit design, usually this will be determined by geological constraints.
- Expand string > to DTM surface
  - If prompted, use pit design>load dtm
- Apply



Pit Design to Surface

- Allows for automatically terminated design along the sides as they meet the surface and create conditional berms dependent on the distance to the surface
- Selecting the Delta z to DTM allows you to create a 5m berm where the distance to the dtm is greated than 5m

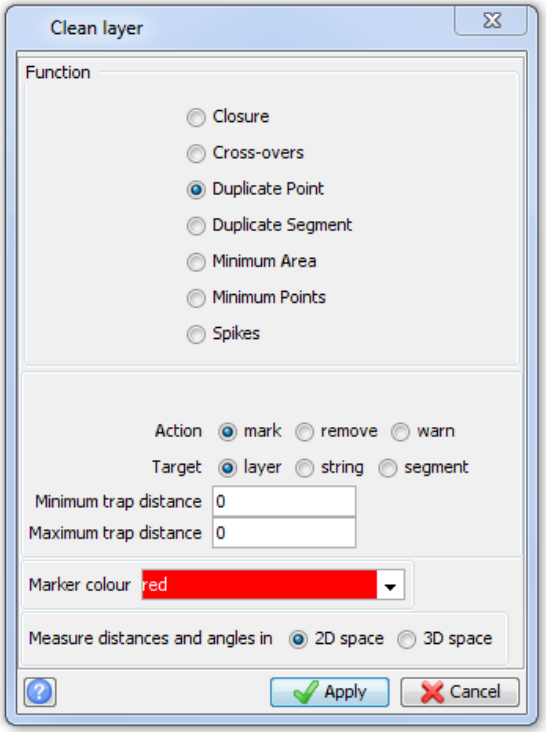


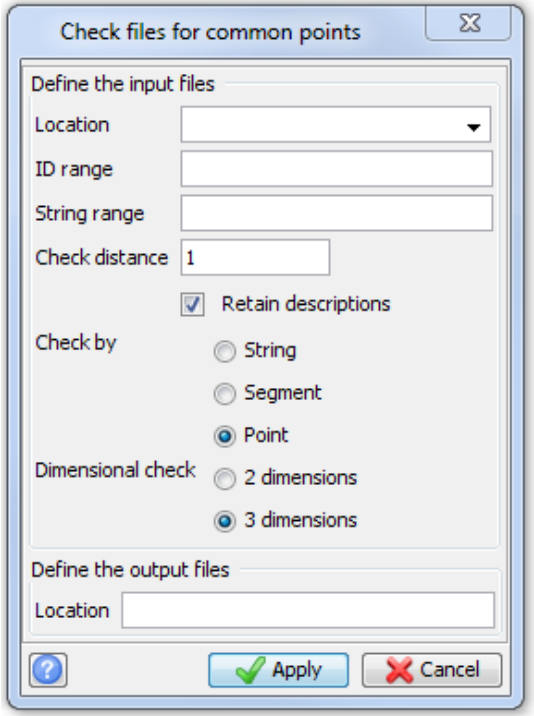
String Cleaning

- During the design phase, use the clean functions to check the design before creating a digital terrain model (DTM)
- Breakline strings are those strings which represent physical features, ie. Crest of a pit. If a string file has been formed correctly, then no breakline strings will cross over other breaklines strings, unless two strings cross at a common point.
- If an error message is received indicating breaklines detected, these strings must be edited. A DTM cannot be formed with breakline intersections

String Cleaning

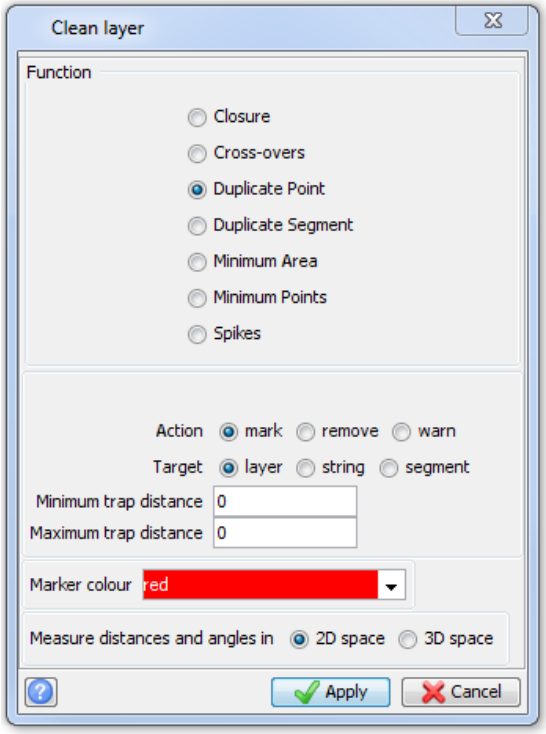
- To locate errors graphically use:
  - Cleaning function (edit>layer or edit>segment)
  - Check for common points function (file tools)
  - Always mark rather than remove, because spike removal will delete your ramps!





Assignment 6: Clean layer and save

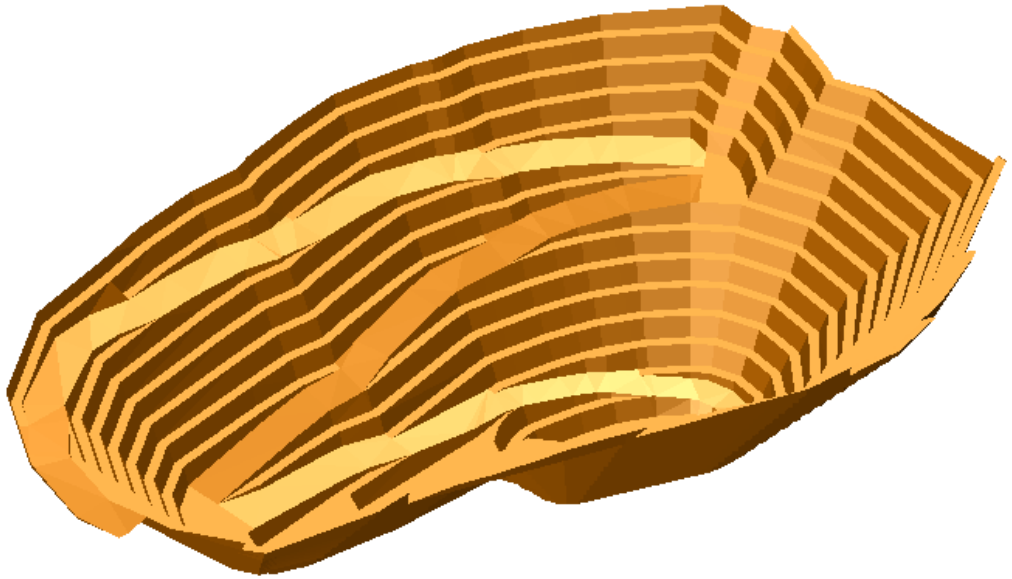
- Edit > layer > clean; Apply



- Select File > Save > string / DTM
- Save as 'pitdesign3.str'

Assignment 7: Create DTM

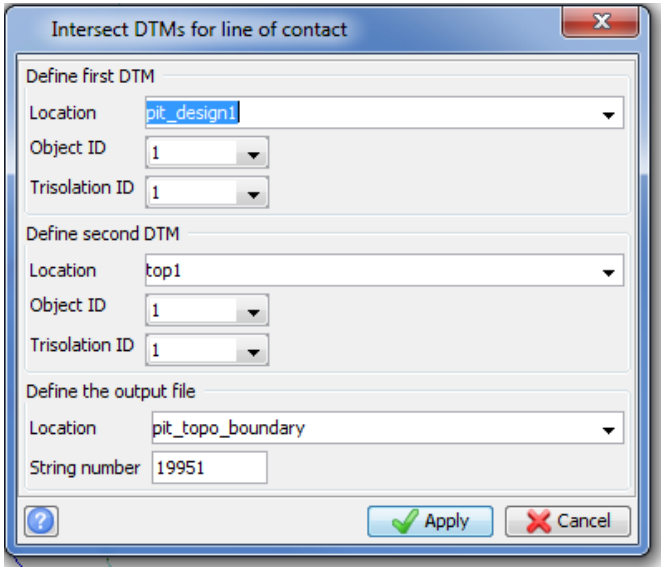
- Surfaces > create DTM from layer; Apply



- Save, File > Save; pitdesign3.dtm

Assignment 8: Updating the Topography

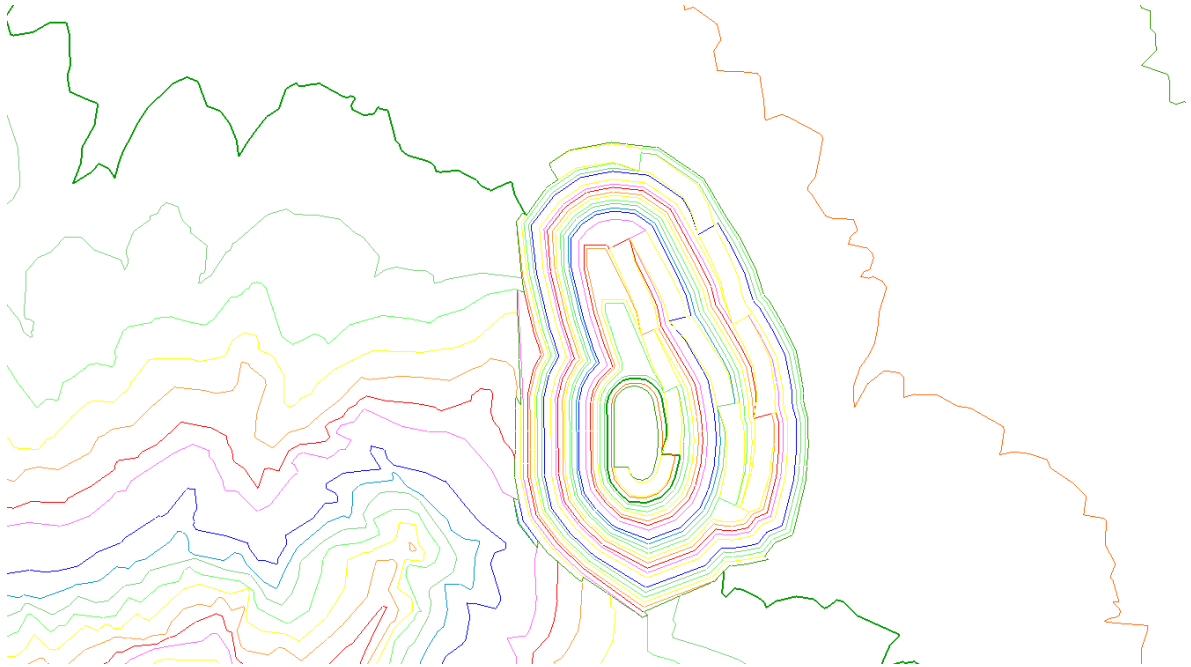
- To append the pit design to topography you will need to remove the parts that cover the pit design.
- First create a boundary string using surfaces>DTM file functions>line of intersection between 2 DTMs.



- Select edit>trim>clip by selected segment and clip the strings inside the boundary string.

Assignment 8: Continued...

- Now do the same for the pit design string file.

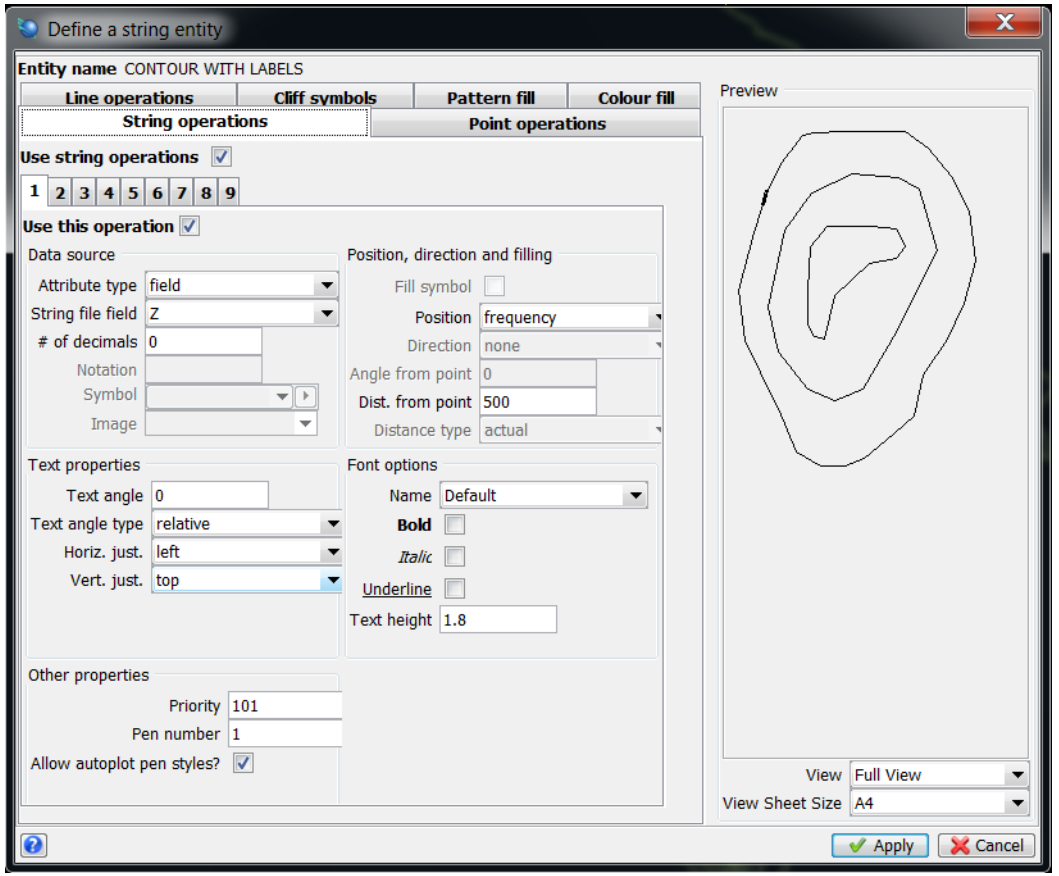


- Now you can append the pit design string into the updated topography and create a surface from them if you wish.
- Save the string file as pit_and_topo.str.

Assignment 9: Plotting

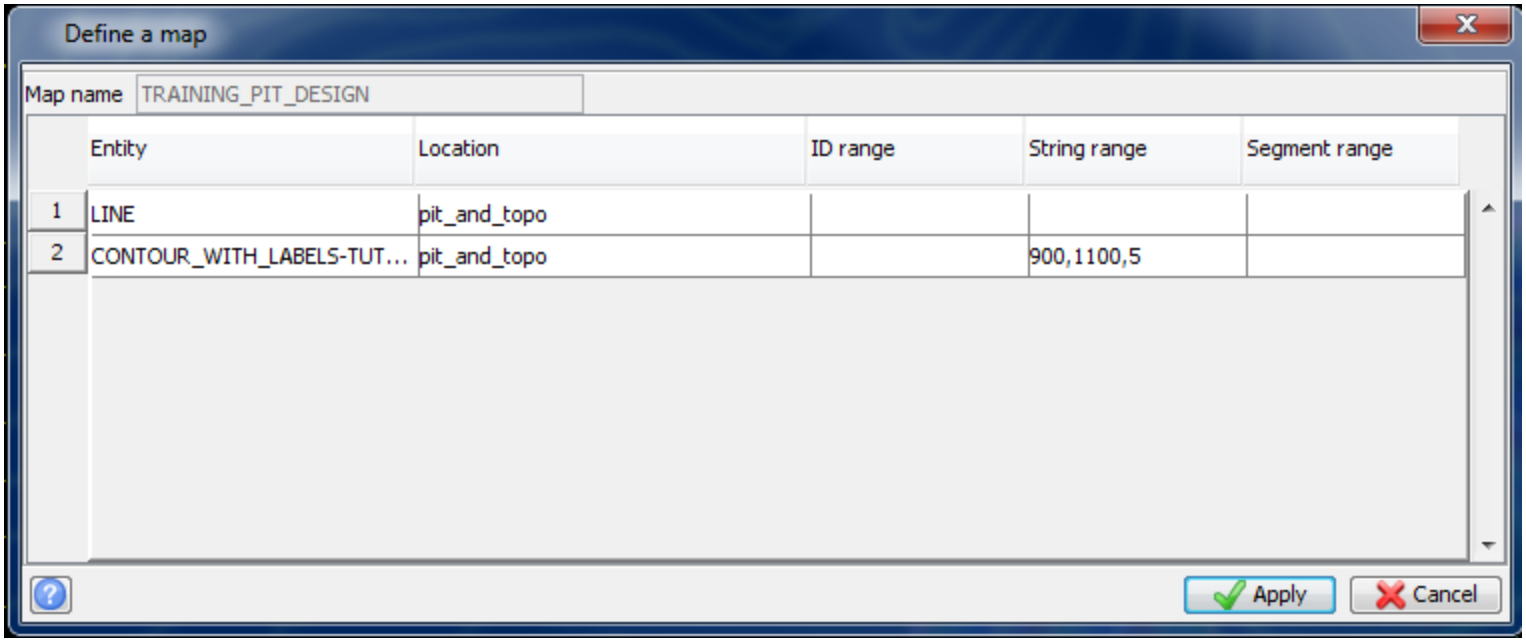
- We will use file based plotting to create a plot of the pit design.

- Select plotting>entity edit and select



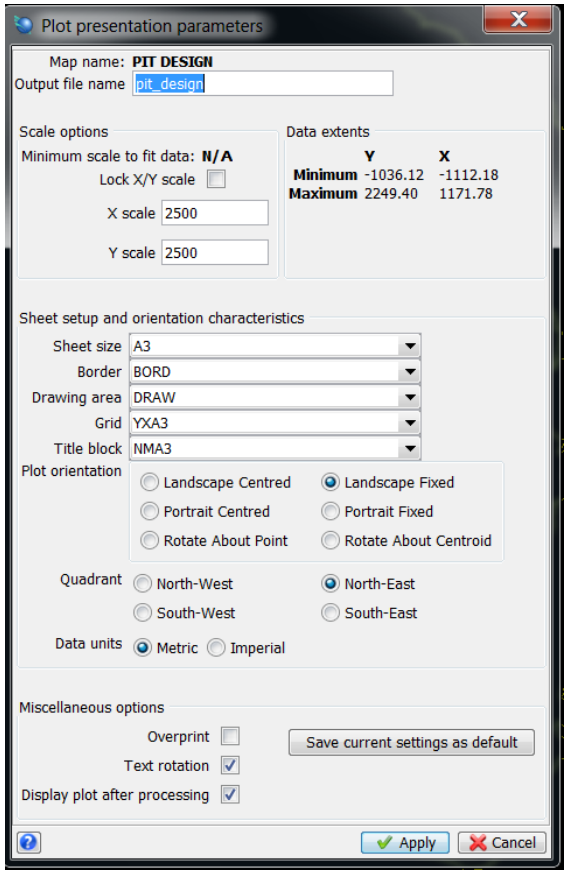
Assignment 9: Continued...

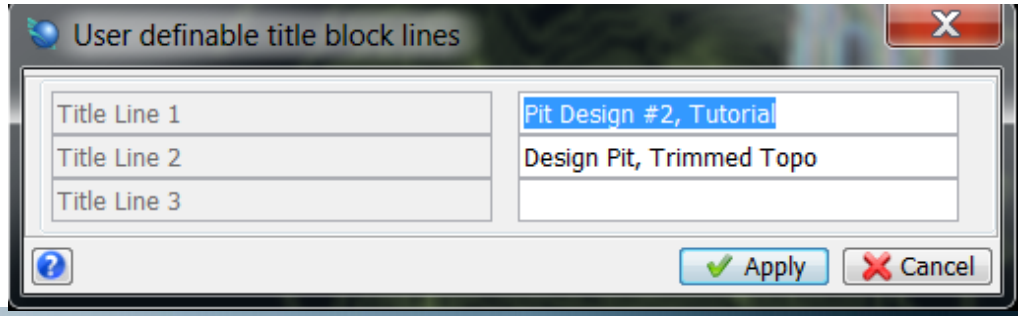
- Plotting > Map > New, name ‘PIT DESIGN’. Apply.
- Then enter information as shown, Apply.



Assignment 8: Continued...

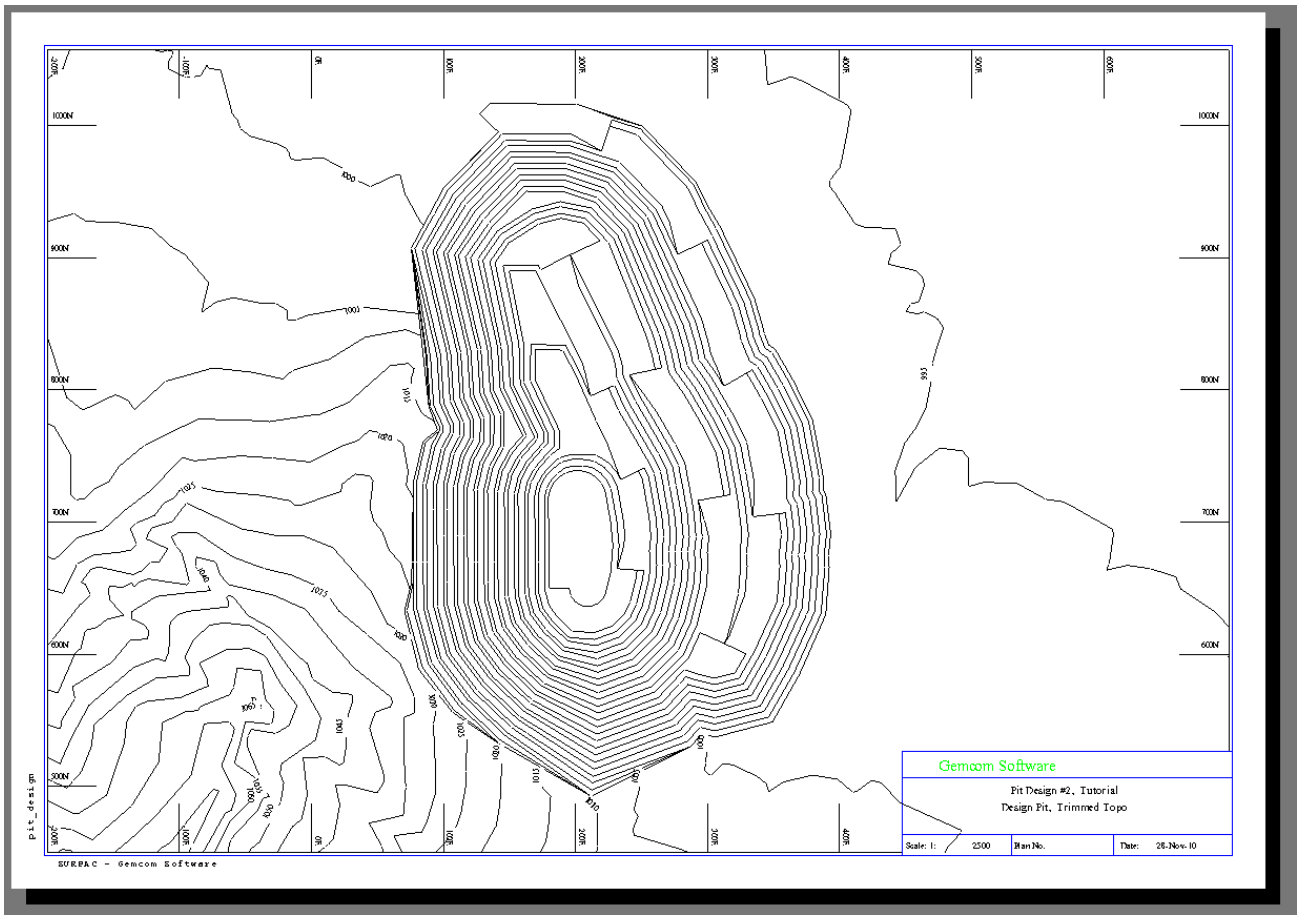
- Plotting > Process>Map, select PIT DEISGN.
- Plot presentation parameters, enter the information as shown, apply.
- User definable title block lines, enter the information as shown, apply.
- Reference Corner: X = -250 Y = 450; Apply.
- Then select apply in the following window.





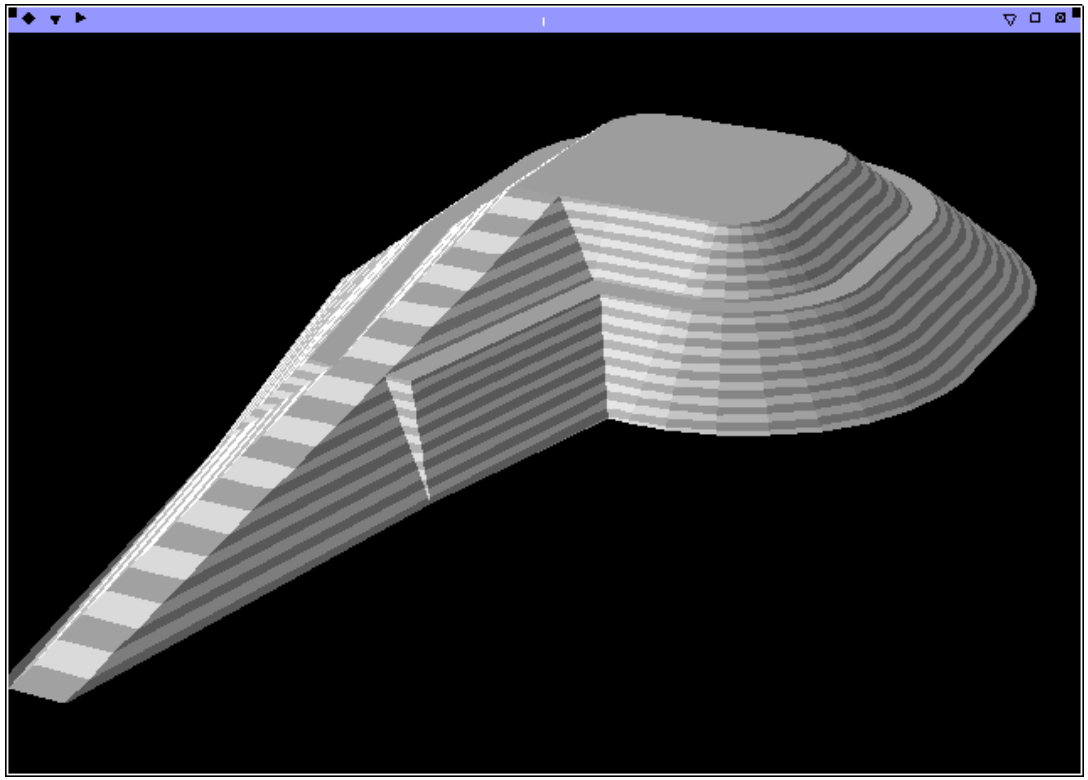
Assignment 9: Continued...

- Does your plot look similar to like this?



Dump Design

- Dump design uses the same functions as pit design.
- In effect, it is a pit design in reverse.



Assignment 10: Dump Design

- Workflow: *An in-depth version is provided in:*
  Tutorials_and_unedited_data>pit_design.pdf (from page 87)
  - Digitize the stockpile outline/footprint
  - Digitize or create a center line for a ramp to follow:
    - Insert point
    - Point by angle
  - Select slope method
  - Set slope gradient
  - New ramp
  - Expand string/segment
    - By elevation
    - By berm width
  - Load a DTM and display offset if required
  - Expan string/segment
    - To DTM surface
  - Create DTM