



MODULE USER GUIDE

Mining

Ground measured, ground interpreted, and ground planned: surveys and volumes, drillholes, resource models, mine design and the plan for next period.

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Who this is for Surveyors, geologists, mining engineers and technical services staff, and the supervisors who read the figures they produce.

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Questions Email info@trackapt.co.zw · WhatsApp only (+263) 788-033-775 · Web <https://trackapt.co.zw>

01 What this module is for

This is the technical department. It answers two different kinds of question and keeps them deliberately apart: how much material moved, and what is still in the ground.

The half	What it holds	What it answers
Ground measured	Pickups, Surveys	How much moved, above what level, inside which block — and whether that agrees with what crossed the weighbridge.
Ground interpreted	Drillholes, Wireframes, Block models, Mine designs	What is in the ground, how much sits above each cut-off grade, and what shape the pit, ramp or ring pattern that takes it out has.

The one idea to hold on to

Every record belongs to an item, and the item is what makes two records comparable. A survey is a survey of a dump; a drillhole is drilled *into* a deposit. Cut and fill are only ever offered between surveys that share an item, and a block model is only ever estimated from the holes filed against its own. Get the item wrong and nothing downstream will tell you.

The item sits inside a **Tracker Group**, and the group decides who may see the record. That is the same rule the rest of Trackapt uses, and it is applied here on the way out as well as the way in.

What it does not do

- **It does not keep derived shapes.** Triangulated surfaces, drillhole traces, wireframe skins and pit benches are worked out afresh every time you open them. That is why a wireframe always matches the sections it was drawn from, and why a pit designed to an old geotechnical report goes visibly out of date the moment the slope rules change, instead of quietly staying the old shape.
- **It does not hold unlimited models.** A block model tops out at two million blocks; a hole at 20,000 intervals, 2,000 survey stations and 12 interval tables. Past that the record is refused, with the reason.
- **It does not invent a number to fill a gap.** A block with too few samples is left unestimated rather than counted as barren. A section that found ground on only one surface contributes nothing, and is named. A wireframe that will not close reports *not closed* rather than a plausible volume.

HOW IT BEHAVES

The module is optional and is switched on per account. Until it is, nothing of it appears in the sidebar and none of its endpoints answer. Switching it back off hides it and stops its endpoints — **the data is kept**.

02 Finding your way around

One heading in the sidebar, **Mining**. In the **Modular** view it lists **Workspace** first and then the ten screens below; in the **Professional** view, the default, it opens the workspace, and each of these screens opens in a window over it from the ribbon. Everything in this guide is reached from there.

Sidebar entry	Where it goes	What it is
Surveys	/subscribed/mining	Every survey ever filed, newest first.
Pickups	/subscribed/mining/point-sets	The shots as they came off the instrument.
Drillholes	/subscribed/mining/drillholes	Collars, downhole surveys and interval logs.
Wireframes	/subscribed/mining/wireframes	Interpretations as closed solids.
Block models	/subscribed/mining/block-models	The deposit in blocks, with a grade on each.
Seams	/subscribed/mining/seams	A thin, dipping seam as a grid of floor, thickness and grade.
Mine designs	/subscribed/mining/designs	Pits, haul roads and ramps, and drill rings.
Plans	/subscribed/mining/plans	What a pit will produce next period, and what that costs in waste, metres and blasted tonnes.
Underground	/subscribed/mining/underground	How an underground mine drills, what it drills with and the rock it drills in, and the rounds and rings designed from them.
Blasts	/subscribed/mining/blast	The pattern each bench is drilled and fired to, from the first draft to the muckpile.

WORTH KNOWING

Links made before this module was renamed still work. The old *Survey* and *Geology* addresses redirect to the matching screen here, and a link to one particular survey or hole still lands on that survey or hole rather than dropping you on the register. An address under the module that names no screen lands on the Surveys register rather than on a blank page.

On a phone, a survey, a drillhole, a plan and the designs register each say at the top that they work here and were built for a larger screen. Nothing is withheld; drawing on the plan, the 3D view and estimation are simply easier at a desk.

Who may do what

Reading is open to everybody: a surveyed volume and an assay grade are figures most of a site needs. Writing is split, and the split is deliberate — filing a measurement is a lower bar than publishing an interpretation.

You may	From	Why it sits there
Read anything in the module	Level 1	A volume, a designed bench and a hole's position are things most of a technical department needs.
File or edit a survey, a pickup, a boundary, a survey code	Level 3	A new surface is what every later volume is measured against.

You may	From	Why it sits there
Create or edit a drillhole, wireframe, block model or design	Level 4	These are interpretations the mine plans, budgets and reports against. Whoever may file a pickup is not automatically whoever may change the shape of the orebody.
Create, compute, publish or unpublish a plan; set a parameter's plans by period	Level 4	A plan is an interpretation the mine budgets from, and publishing one writes onto monitored parameters - the same level that may add or remove a group's parameters.
Design, edit or send for approval a blast, a development round or a set of rings	Level 4	The pattern is what the crew drills and loads. Every way into designing one - the register's plus, Design blast, Blast this block, Edit blast - asks for the same level.
Approve or send back a blast	The stage's approvers	Whoever sits at the stage the blast is waiting on, set in the approval chain - not a level of its own.
Remove any record	Level 6	Every figure ever quoted cites a record. Removing one invalidates the citation without invalidating the figure.

TAKE CARE

Clearance is not the whole gate. If you are not whitelisted on the Tracker Group holding an item, its surveys and holes are reported as **not existing** rather than as forbidden. If a colleague can see a record and you cannot, that is the first place to look.

Two coordinate frames, and why

Everything you type and everything you read is on the **mine grid**. Internally a surface is held as offsets from its own local origin, because grid northings are large enough that ordinary arithmetic cannot tell two points a decimetre apart. You will never see a local coordinate.

Areas, drillhole collars and design geometry are stored on the grid instead. A survey's local origin comes from that survey's own extent, so two surveys of one dump can sit in different frames; a boundary or a drillhole database outlives any single survey, so it is kept in the frame everybody shares.

03 The whole module, in order

Every other chapter describes a screen, because that is how you look something up. This one is the road: seven parts, in order, each ending with something the next part needs. Walk it once on a small deposit you already know the answer to, and the rest of this guide becomes reference rather than reading.

Part	You start with	You end with
1. Ground to stand on	A licence and a mine grid	A Tracker Group and an item to file against
2. Exploration	Collar, downhole survey and interval files	A drillhole database that validates clean
3. Interpretation	Holes and section outlines	Closed wireframes, with densities on them
4. Resource	Wireframes and composites	A block model with a defensible grade, and a curve
5. What is worth mining	The model and a survey of the ground	A pit shell filed as a design - or a stope layout
6. The mine as built	The shell	Pit, dumps, roads, ramps, water and stages
7. The plan	A design and today's ground	Published period plans the dashboards judge

Then it loops. The shifts file against the published plan, the surveyor measures what actually moved, the plan is reconciled against the ground and the weighbridge, and next period is planned from ground that is a month newer.

WORTH KNOWING

You do not have to start at part 1. An operation that is already running usually starts at part 7 - plan against the pit as it is - and fills the earlier parts in behind it.

Part 1 - Ground to stand on

Nothing here floats free. Every hole, surface, wireframe, model, design and plan belongs to a **Tracker Group**, and that group's whitelist is who may see it. Most of the second week's confusion - *the model is not in the picker* - is a whitelist rather than a fault.

1. Make the group, and under **Used by** tick the technical work it carries: surveys, geology, designs, plans. The Mining pickers narrow to groups that say they do that job. Left blank means *not yet said* rather than *none*, so the group is offered everywhere with a hint.
2. Make the item - the piece of ground. One pit, one item; not an item per survey. The item is what ties a survey to the survey before it, and what a plan is a plan *of*.
3. Name the mine grid once, so every file that leaves and every file that arrives agrees.

TAKE CARE

Check the easting and the northing before anything else. A collar file mapped the wrong way round loads perfectly, validates cleanly and puts every hole mirrored about the diagonal - which on a north-south orebody looks almost right. The same trap sits on survey import, where the wrong instrument does not fail, it mirrors.

Part 2 - Exploration: getting the holes in

1. If you are collecting the data rather than exporting it, take the **blank** the import screen offers and fill that in.
2. **Import drillholes** takes the three files a database actually is, joined on the hole name: collars, downhole surveys, and one or more interval tables you name. The reader proposes a column mapping from the header row - read the proposal rather than clicking through it.
3. **Assemble** first: it reads the files and shows what they hold without filing anything. Check the extent against where you know the drilling is. **File** then commits the holes against the item.
4. **Validate** the whole register, not a hole. A duplicate hole identifier cannot be seen from inside a single hole, and it silently puts two holes' intervals at one place. Fix at source, import again, validate again.
5. Open one hole and read a **desurveyed** interval against a plan. Depth is measured along the hole: at minus 60 degrees, 100 m down the hole is 50 m away from the collar and 86.6 m below it.
6. Look at the **composites**. Composite by a fixed length to see what an estimate would see; composite by what the ground is to read a contact and the thickness of a band.

Part 3 - Interpretation: wireframes

1. Draw an outline per section, against the holes that pierce it. The skin between them is tied each time the solid is drawn, so what you see is always the shape the sections currently make.
2. Make it **close**. A volume is exact only over a closed boundary; on an open mesh it still returns a number that is plausible, stable and wrong. The register withholds the tonnage and names what is wrong instead.
3. Put a **density** on it, or the volume stands alone.
4. Turn it in 3D against the holes. A solid that closes and is still wrong usually looks wrong here first.

Part 4 - Resource: the block model

1. Define the lattice. The **block height should divide the bench height** you will mine at, or every bench's reserve borrows from the one below; and a model past a million blocks is refused by the pit optimiser rather than part-solved.
2. Fit the variogram **before** you estimate. **Plot what the samples say** draws the experimental variogram with your model over it, using the very curve the estimator will use. A curve above the points smooths the estimate; one below chases noise.
3. **Estimate** - ordinary kriging for a reported resource, inverse distance where you want no assumptions, nearest neighbour as the reference the kriged model is judged against.
4. Read the **curve**. Set the ore fraction and the density deliberately: without an ore fraction every edge block counts whole, and everything scales directly with density.

TAKE CARE

Kriging derives every weight from the nugget and the sill, so a variogram fitted to a different deposit gives weights that look exactly like the right ones. Nothing downstream will tell you. The plot is the only check there is.

Part 5 - What is worth mining

Two things must be true first: the model carries an estimated field, and there is a **survey of the ground**. Blocks above the ground are air, and without a topography the optimiser pays to move the sky above the deposit.

1. Survey the topography if it has never been done - the same import you will run every month from here on. Say which instrument wrote the file, check what the reader understood, code the breaklines, and date it the day the ground looked like this.
2. Consider starting a **running surface** for the pit at the same time. It is the ground as it stands, and it is what a plan reads as of a date.
3. **Optimise a pit** off the block model: what the rock is worth, what it costs to get at, the wall slope from the geotechnical report, a set of prices to run, and the surveyed ground.
4. **Make it a design**. The shell's deepest outline is filed as a pit floor with the bench height, batter angle and berm width you give. That is the handover to part 6.

WORTH KNOWING

Underground the equivalent step is **Lay out stopes**, which reports which stopes pay for themselves and the grade the mill would see. It files nothing on purpose: a stope layout is what a frame and a set of costs imply, and both are read again every time a plan computes. Schedule them by setting a plan's shape to stopes and headings.

Part 6 - The mine as built

The parameters are the record; the geometry is generated. A pit's benches come from its floor outline and its slope rules every time it is opened, so a revised geotechnical report leaves every pit designed to the old one visibly out of date rather than quietly still drawn the old way.

1. Design the **pit** upward and outward from its floor. The result says why it ended: it reached the surface (the normal outcome), it closed on itself (the floor is too narrow for the slope rules), or it hit the bench limit.
2. Put the **water** on it: sump depth and area, and how far beyond the crest the diversion drain runs. A plan reads all three, so the pit is dewatered as designed rather than as remembered.
3. Add **stages** only where a real sequencing decision needs to be seen. **After** is the whole of the ordering; the list order is display only.
4. Design the **waste dumps** now, because part 7 checks whether the waste actually fits in them.
5. Design the **haul roads and ramps**. A haulage process in the plan can read its route straight off one, instead of taking a tonnes-a-month figure on trust.

Part 7 - The plan

This is where the technical work becomes something the mine is run against.

1. Choose the question: to a product target, to capacity, to the best order across the whole horizon, or imported from another package.
2. Point it at the **sources** - the item, the ground and the date it is read as of, the block model and its grade field, and the shape: the pit design from part 6, or slices of a boundary for a first answer.
3. Say what the mine can actually do. Switch off the processes it does not run, and choose where each capacity comes from: declared, varying by period, built up from equipment, demonstrated by a parameter, or worked out from a truck cycle on the real road.
4. Set the **horizon** - a cadence, a start, and up to 24 periods.

5. **Compute**, and read which process **binds**. That is the answer to what is stopping the mine; everything else is slack.
6. Try the alternative as a **scenario** before committing. A scenario is a plan in every other respect, so the one that wins is simply the one that is published.
7. **Publish** each figure onto the monitored parameter it becomes the plan for. Where the group has an approval chain, publishing waits for the desks to sign first.

HOW IT BEHAVES

Publishing is the moment the module stops being a technical department. From then on nothing on the dashboard says *mine plan*: the published figure is simply the **Plan** the dial, the variance and the status use, and the period summary judges the filed readings against it.

And then it loops

- **The shifts file against it.** Nothing changes for the people filling in the form; it is now being judged against the plan.
- **The surveyor measures what moved.** Import the month's survey against the same item and read cut and fill inside the boundary you actually report on. Check the triangulated figure against the grid and end-area methods - the second opinion is the point.
- **Reconcile.** Each figure four ways: planned, surveyed, filed on the parameter, and weighed across the weighbridge. Four columns that disagree are the most useful screen in the module.
- **Re-plan the rest.** Two months into a six-month plan, re-planning keeps the periods already worked and plans the rest afresh from the ground as it stands now.
- **And back to part 2.** Infill drilling goes into the same database, re-estimates the same model, moves the same curve, and the next shell is optimised against a resource that knows more than it did.

A first fortnight

In the order that builds confidence fastest, on ground you already know the answer to.

1. Import one survey of a dump you know, and check the plan against what you remember of the ground.
2. Open the pickup behind it, correct one feature line, and watch the surface follow.
3. Draw a boundary round the block you actually report on, and name it.
4. Import last month's survey of the same item, add it as a layer, and read cut and fill inside that boundary. Check the two methods agree.
5. Reconcile that against the weighbridge, then draw a plan sheet at 1:1000 and print it.
6. Import a small drillhole database and run Validate over it. Fix what it finds at source and import again.
7. Open one hole and read a desurveyed interval against the plan.
8. Draw one wireframe from two or three sections, and confirm it closes.
9. Define a small block model over it, plot the variogram, estimate one field, and read the curve.
10. Optimise a pit out of that model against the survey, and file the shell as a design.
11. Design one waste dump for it.
12. Start a plan against that design and today's ground, compute it to capacity, and see which process binds.

13. Publish its waste onto the parameter the shift form already fills in, and watch the dial change.

The last step is the one to reach. Everything before it is technical work; that is the step where the mine starts being run from it.

04 The workspace

Workspace

Mining (Professional) or Mining > Workspace (Modular)

One picture of the ground with everything filed against it drawn in place - surveys, drillholes, wireframes, block models, mine designs, blasts and underground rounds - and the place a blast is designed, approved, charged, fired and looked back on.

Part	Where	What it is for
The ribbon	Across the top	Every command, in tabs: Home, Survey, Geology, Design, Blast, and a tab named for the active layer.
The Explorer	Down the left	The mines, their workings and every layer of each: to draw, hide, select and colour.
The picture	The middle	Plan, sections and 3D, with the status bar under it.
Properties	Down the right	What the selected layer is and what can be done with it. A form you are working in - a blast design, a pickup, a volume - docks here too, beside the picture.

Under the picture a docked table lists the active layer's records. Registers and records - Surveys, Blasts, one blast - open in windows over the workspace, so the picture stays where you left it. A window can be minimised to the strip along the bottom, and closing one with unsaved work asks first.

The ribbon

A command that cannot be used just now is greyed, and resting the pointer on it mostly says why: no working chosen, nothing to act on, a browser without WebGL, or an access level you do not hold. **Design blast** with no working chosen is greyed without a reason: choose a working in the Explorer first.

Tab	What it holds
Home	The views (Plan view , Section looking north , Section looking east , 3D view , Fit All to View , Snap: vertex or Snap: off); Step section towards me and Step section away , Clip to the slab or Draw everything behind , and Section line ; Measure and Box select ; Refresh layers and Add selected to view ; the panes; Save my workspace , Open saved workspace and Forget saved workspace ; Maximise the workspace , Full screen , Collapse the ribbon (Ctrl+F1) and Preferences...
Survey	Draw every survey and Hide every survey , Import survey , Pick up points , Pick up string , Draw boundary , Measure volume , and the Surveys and Pickups registers.
Geology	Draw drillholes and Hide every drillhole , Draw every wireframe and Hide every wireframe , Check the holes , Plan a hole , Import drillholes , and the Drillholes, Wireframes, Block models and Seams registers.
Design	Digitise a string , Edit string points , Edit outline , Undo and Redo , Save strings as Surpac .str , Save strings as DXF and Save the string as a design , Estimate a grade , Optimise a pit , Lay out stopes , and the Mine designs, Plans and Underground registers.
Blast	Draw every blast and Hide every blast , Design blast , New blast , the Blasts register, and Design a round for underground.

Tab	What it holds
The active layer	Named for what it is - <i>Blast layer</i> , <i>Survey layer</i> : Fit to View , Hide layer or Draw layer , Open record , and that layer's own tools.

WORTH KNOWING

Find a command, at the top of the workspace, finds any command from a few words - *new blast*, *kriging*, *hide table* - and Enter runs the first match.

The Explorer

Mines are listed first, each with its workings under it; a working in no mine is under **Other Workings**. Press a working's row to make it the **active working** - the ribbon, its registers and new work follow it, and it shows an **Active** tag. Its tick opens it and draws its newest survey, or closes it and takes its layers out of the picture. Up to 8 workings can be open at once.

Each working's layers are grouped by kind - Surveys, Drillholes, Wireframes, Block models, Mine designs, Blasts, Underground blasts, Survey boundaries, Pickups, Digitised strings, Section lines and Volumes - and each group counts how many are drawn of how many are listed. Tick a layer to draw it; click its name to select it, so its properties show on the right and its records in the table; drag it onto the picture, or press Enter on it, to draw it and fly to it.

Right-click a row, or long-press it, for its menu:

Item	What it does
Make current surface	Surveys only. Points placed on the working - a pickup, a boundary's corners, a planned hole's collar - take their levels from this survey, on this device. Until you choose, the newest survey is current, and its row says Current . The status bar's Surface: menu does the same, with Use newest .
Edit outline	Designs only: move, add and remove its points on the picture.
Hide / Draw	Stop drawing the layer, or draw it. It stays listed.
Colour and opacity...	Opens under the row, inside the Explorer, so the picture stays in view. The picture changes as you choose; Apply keeps it on this device, Cancel puts it back.
Draw every one / Hide every one	On a group's row.

Explorer as a tree on the Home tab draws the same layers as folders, the way a file browser does. **Explorer as icons** folds it to one button per kind of layer, each counting what is drawn.

The picture

To	With a mouse	On a touch screen
Zoom	The wheel, about the pointer	Pinch
Pan	Middle-drag, or Space and a left-drag; a left-drag with no tool on, in plan or section	One finger in plan or section; two fingers sliding

To	With a mouse	On a touch screen
Turn	A left-drag in 3D; Shift and a left-drag from any view	One finger in 3D; two fingers twisting, or sliding up and down together to tilt
Select	A click; Ctrl and a drag for a box	A tap; with Box select on, a drag
Act on it	Right-click	-

Enter finishes a tool, Backspace takes back its last point, Ctrl+Z and Ctrl+Y undo and redo, and Page Up and Page Down step a section. The status bar reads the grid position under the pointer, *E ... N ... RL ... m*. Sections and 3D need a browser with WebGL; without it the workspace shows a flat plan to read but not draw on.

Right-click something in the picture for what can be done with it there: **Edit blast** on a saved blast, **Blast this block** on a block a blast can be laid in, **Edit hole...** and **Remove hole** on a hole of the blast being designed, **Remove connector** on its tie-up, **Change corners** and **Measure volume inside** on a boundary, **File as survey boundary**, **File as pickup string** and **Design a ramp along this** on a digitised string, **Design a round here** on a heading, and **Plan a hole here** on open ground.

HOW IT BEHAVES

In 3D a survey at 100% opacity is solid: holes, solids and designs below the ground are hidden under it, a design being drawn in a docked form as much as a saved one. Lower the survey's **Opacity - Colour** in Properties, or **Colour and opacity...** on its row - to see through it. In plan a design is always drawn on top.

Designing a blast on the picture

Every way into designing a blast - the register's plus, **Design blast**, **New blast**, **Blast this block** and **Edit blast** - needs access level 4. Below it the register does not show its plus at all; the other commands are greyed and say *Designing a blast needs access level 4*.

1. Choose the working in the Explorer and draw its newest survey.
2. On the **Blast** tab press **Design blast**, or right-click a block in the picture and choose **Blast this block**. **Design a blast** docks beside the picture; a block already selected is taken as the block.
3. Under **The block comes from**, choose a bench of a pit design, a boundary (**Add new boundary** draws one on the picture) or corners you type.
4. Name it, set the day it is **To fire on**, and check the levels and the ground the collars are read off.
5. Under **Burden from** choose how the burden is decided; set the **Hole diameter** (20 to 1000 mm), how **The front row is laid** and the **Layout**; and pick the **Product**, **Primer** and **Detonator** from the mine's Explosives list. The pattern is laid on the picture as you set it.
6. Check the free face and the back line; add, move, edit or remove holes on the picture.
7. Under **Tie-up**, choose how it runs and its firing points, and press **Tie the shot up**.
8. Read what the form found under the tie-up - the holes laid and any warnings - then **Save draft**. The blast is filed with the pit's blasts and opens on the blast screen.

Show holes, **Show tie-up** and **Show outline**, beside **Show muckpile**, hide parts of the design so you can see what lies under them; while the holes are hidden the tools that click on a hole are off. They change only what you see and are all on again next time the form opens. Once the shot is tied up, **Show muckpile** draws the heap it is predicted to leave, and **Muck opacity** sets how see-through it is - 55% to begin with; Apply keeps it on this device.

A saved blast is changed with **Edit blast** - in Properties, or right-click it in the picture: the form docks with it and the picture shows the changes as you make them. A blast awaiting approval, fired or reconciled cannot be edited, and the button says why.

Approving, charging and firing it

Select the blast. Properties gives its **Status** and an **Approval** panel with the actions open to you.

Button	Who sees it	What it does
Send for approval	Everyone, on a designed blast. It works at level 4 on a blast with holes; otherwise a line under it says <i>Sending a blast for approval needs access level 4. or It has no holes to approve yet; draft the pattern in its window.</i>	Sends it to the first stage of its group's chain. A group with no chain approves it at once, and the toast says so.
Approve	The approvers of the stage it waits on	Asks first, then signs that stage. The last stage approves it.
Send back	The same approvers	Asks for a reason and returns it to the designer.
Withdraw	Whoever asked, or the account holder	Takes the request back; the sign-offs so far are dropped and the pattern can be changed again.

Approvers are told when a blast reaches their stage, the person who asked when it is approved or sent back. An approved blast whose pattern is changed returns to Designed, its sign-offs dropped, where its group has a chain - see **From approval to the muckpile**, under Drill and blast.

Open the blast opens it in a window over the workspace, where drilling, loads and the firing are recorded. A load above what the hole holds, or more than a quarter over its design, asks **Check this load** before it is recorded, and a firing cannot be dated on a day that has not come yet. Turn on **Firing** there to watch the shot - see **Watching it fire**.

Afterwards, a tied-up blast shows its predicted muckpile in the picture from **Show muckpile** in Properties, drawn in 3D with its toe outline in plan, at the same **Muck opacity**. The choice is kept for each blast on this device. **Hide every blast** on the Blast tab takes every blast off the picture, in every working you have open; to hide one working's blasts only, use **Hide every one** on its Blasts group in the Explorer.

Underground on the picture

Design a round on the Blast tab, or **Design a round here** on a heading in the picture, docks the round designer: click the heading where the face stands, choose the rock domain and the explosive, and **Save the round**. A plan's **Design rings** on a stope docks the ring designer the same way. Both need level 4; below it they say *Designing a round needs level 4 on this working* and *Designing rings needs level 4 on this working*. Select an underground blast and Properties offers **Open in the round designer** or **Open in the ring designer**, where it is sent for approval, approved or sent back, fired and retired, and **Re-design on the pane**.

Keeping your workspace

The workspace remembers on this device what was up. **Save my workspace** keeps it on the server too, so **Open saved workspace** carries on from another device; it asks first, because it replaces what is up. **Forget saved workspace** removes the saved one after you confirm.

05 Pickups and surveys

A **pickup** is the measurement. A **survey** is one reading of that measurement. Importing a file files both at once, and keeping them apart is what lets you fix a mis-coded crest later without importing anything again.

- You can keep a day's shots that have not been turned into a surface yet.
- You can build more than one surface from a single day's shots.
- You can **correct a feature line without re-importing the file**. That is the whole of string editing.

HOW IT BEHAVES

Strings live on the pickup, not on the surface. A crest is something the surveyor walked, not something a triangulator decided — so correcting one corrects every survey built from that pickup.

Pickups

Mining > Pickups

The register of shots. Open one to work on its strings: the plan fills the left of the screen, the string list sits on the right.

1. **Pick a string** from the list to highlight it on the plan. Its name is editable in place — write what the feature is: a crest, a toe, a road edge.
2. **Remove a point from a string** by clicking its handle on the plan. The shot itself stays; only the string stops passing through it.
3. **Remove a whole string** with the bin button on its row. The ground will then triangulate straight across it.
4. **Draw a new string** with *Draw a string*: click along the feature, double-click to finish.
5. **Save strings**, or *Revert* to throw the edits away.

TAKE CARE

The shots themselves cannot be edited — they are the measurement. If a shot is wrong the answer is a fresh pickup, not a quietly altered one. Removing a pickup is refused while any survey is still built on it.

If an arrangement of strings will not triangulate — usually a line that doubles back over itself — the plan keeps showing the last arrangement that worked and names the problem. Correct or remove that string and it redraws.

06 Importing a survey

The cloud icon in the header of either register starts an import. One import files the shots as a pickup and builds a surface from them.

Step 1 — say which instrument wrote the file

This matters more than it looks. The differences between instruments are not parse errors: a file read easting-first when it is northing-first gives a mirrored plan and a perfectly plausible volume. Control pegs read as ground stretch the surveyed extent across half a kilometre of untouched land.

Layout	When to choose it
Work it out from the file	The default. Reads a few hundred rows and works out which column holds what — including a record number in front of the point name — then which of the two coordinates is the northing, and says so if it was not confident.
Name, Northing, Easting, Level, Code	The usual total station pickup. Most instruments set up for a survey grid write northing first.
Name, Easting, Northing, Level, Code	Easting first. Common from GPS rovers and CAD exports.
Number, Name, Northing, Easting, Level, Code	A record number in front of the point name, which is how a Hi-Target and several other GNSS rovers write a pickup. Every coordinate sits one column further along than a total station puts it.
Number, Name, Easting, Northing, Level, Code	The same, easting first.
Easting, Northing, Level	A bare point cloud, no names and no codes — a drone or scanner.
Northing, Easting, Level	The same, northing first.
Name, Easting, Northing, Level, String name	Where the fifth column names the feature itself (CREST, TOE) rather than saying it is one. Points sharing a name become one line.

Whichever you choose, the reader lists the columns it settled on with everything else it understood — *Columns read as: 2 name, 3 northing, 4 easting, 5 level, 6 code*. Count along one row of the file and check them. If it reports that no rows read as points at all, the layout does not match the file: nothing was read, so nothing was rejected on its merits.

That picker only appears for point files. Surpac string files (.str), LandXML (.xml) and DXF (.dxf) each state their own column order — including DXF's easting-first, the opposite of the others — so it is hidden rather than offering a choice that would be ignored.

A blank to start from

Beside the file input is a **Template** button. It hands you the file this reader takes — the column names it looks for, with a few rows filled in as an example. Take it, fill it in, or send it to whoever is producing the data, so what comes back is right the first time.

WORTH KNOWING

The survey blank follows the instrument you picked. It is built from whichever layout is selected above it, so changing the instrument changes the blank. That is the point: the layouts differ in which of the first two numbers is the northing, and a blank that showed one layout whatever you chose would teach the very mistake this step exists to prevent.

There is one behind every file input in this module — the three drillhole tables, a boundary, block values, wireframe section outlines, the toe and crest rings of a pit drawn elsewhere, and a plan's schedule. It is worth taking before the first import rather than after the first failure: the readers are forgiving about the order columns arrive in and strict about what has to be there at all, so a file that is nearly right loads without complaint and matches nothing.

Step 2 — check what the reader understood

Before anything is filed you are told how many ground points were found, which feature lines were held as breaklines, how many control shots were set aside, and how many lines were skipped. **Read it.** It is the cheapest check in the module.

Say what each code means

No shipped list can know what your site calls things. BL and CREST are near-universal; PTTN is a drill-hole pattern on one mine and could be anything on the next. So every code in the file is listed with how many points carry it, and you say what it is:

- **Ground** — an ordinary shot, triangulated through.
- **Breakline** — a feature line the surface must not be triangulated across: a bench crest, a stockpile toe, a drain invert, a road edge.
- **Control** — pegs, checks and closes. Never treated as ground.

Answers are remembered against the account, so a code only ever needs saying once — a tick beside one means it was remembered from an earlier import. The label beside it is optional and worth writing: PTTN tells the next surveyor nothing, *PTTN — drill hole pattern* tells them everything.

Numbered codes

Control gets numbered as it is put in — CP1, CP2, TBM3, BASE1 — and the reader takes a numbered code as the code it is numbering, so CP7 comes in as control without you saying anything. It only strips the number where the name left behind is a code it already knows: an invented code that happens to end in a digit is still just that code, and still reads as ground.

Where you have said what a code means, that answer covers its numbered forms too — but only when it moves them towards ground or towards a breakline. Say CP is ground on your site and CP1 to CP8 follow it in as ground. An answer the other way, towards control, holds to the exact code you gave it, so CP1 stays in the ground until you name it. The two mistakes do not cost the same: ground taken for control leaves the surface with nothing on screen to say so, while control left in the ground stands up as a cone somebody queries.

None of this applies to the layout whose fifth column holds the *name of a feature* rather than a code. There the number is how two features are told apart — BM1 and BM2 on a mine are berm 1 and berm 2 far more often than they are two benchmarks — and a name read wrongly there costs the whole line rather than one shot.

A name that could be a mark

On that same layout, a crest the surveyor genuinely called BM cannot be told from a benchmark by its name. The reader does not guess. It asks you about the name — how many shots carry it, and whether it is a control point here or the name of a feature — and the file cannot be brought in until every such name has been answered. Your answer is remembered for this site, so the question is asked once and not again.

Every one of them blocks, with no attempt to sort the dangerous from the harmless, because sorting them would be the same guess the question exists to avoid. It is worth the click. A control network is routinely booked as a dozen marks scattered around the workings under one string name — PEG, CP, STN, TRIG — and read as ground those become one line threaded across the whole site. Measured on a 64-shot floor with a ring of twelve marks 25 m clear of it, the fill against a datum came out 159% over; at 60 m it was 648% over. Nothing else in the import catches that.

Two cases are never asked about, because nothing is at stake in them. A name carried by a single shot has no line to lose. And a run of shots that never moves is repeat observations of one point whatever it is called, so a real BM peg booked at setup stays control even when a crest in the same file shares its name — and it cannot stretch a triangle anywhere, which is the damage the rule exists to prevent.

WORTH KNOWING

Only the codes carrying the most ground are listed. If the dialog reports a very large number of extra ones, the column being read as codes is probably holding *point names* — change the layout above rather than correcting hundreds of codes.

Step 3 — deal with what it flagged

What you may see	What to do about it
This file covers several separate pieces of ground	A day's booking often holds a dump, a pattern, a water point and a reference mark, each hundreds of metres apart. A surface is <i>one</i> of them — choose which, and import the rest as their own surveys. Taken together, the surface stretches across the gaps and reports ground nobody walked.
Some shots sit far from the rest	Strays, set aside by default. Tick <i>Include them anyway</i> only if you know they belong.
Some feature lines will be read as ground	Two lines crossing in plan cannot both fold the ground where they meet, so the weaker claim is released. Every point stays in the surface and no level is invented at the crossing. If the wrong line was released, correct the code meanings above.
Check the plan when it opens	The column order could not be told from the numbers with confidence. Set the layout explicitly, or look at the plan before quoting anything off it.
Some shots stand metres off the ground around them	Each ground shot is compared with the ground immediately around it, and one that disagrees by metres is set aside and listed. A shot <i>above</i> its neighbours is almost always the blunder it looks like — a rod left long, a level typed with two digits the wrong way round. A shot <i>below</i> them is not: a sump, a drain, a void or an over-dug toe reads exactly the same way, and all four are ground you were right to pick up. Look at those on the plan, then <i>Include them anyway</i> if they belong.

What the height check can and cannot see

It finds blunders, not small errors, and the dialog says which in metres for the file in front of you. The comparison is against the ground's own roughness, so on a graded bench it can see an error of a metre or so and on broken ground only a much larger one. An error of a fifth of a metre is invisible to it anywhere, at any setting — that is a limit of the information in the file, not something a threshold can reach.

WORTH KNOWING

Nothing flagged is not a clean bill of health on your levels. Read the figure the dialog gives: it is the smallest error that file could have shown. A piece of ground carrying fewer than twelve shots is not judged on height at all, and the dialog says so rather than leaving you to read silence as a pass.

Step 4 — name it and file it

1. **Survey name** — what it is called in the register. “Waste dump, end of month” beats “survey 14”.
2. **Surveyed on** — the day the ground looked like this, not the day you are filing it.
3. **Tracker Group** — who may see it.
4. **What was surveyed** — the item. This is the field that ties this survey to the ones before it. If the group has no items yet, add the dump or stockpile to the group first.
5. **Notes** — instrument, weather, anything that changes how the figures should be read.

WORTH KNOWING

A pickup walked with no signal still files. An import made with no network is queued on the device — the pickup and the surface it joins or starts, together — and filed the moment the device next sees a connection, whether or not the app is still open. The register reloads rather than opening it, because there is nothing to open yet.

07 Working a survey

Surveys

Mining > Surveys

The register lists every survey with its item, the date it was walked, its point and string counts and its level range. Click a row to open it. Nothing is edited in place beyond the name: a surface records what the ground was on a day, so **a corrected survey is a new one**.

Opening one gives a plan on the left and the figures on the right. The chevron collapses the panel when you want the plan full width.

How the ground is drawn

Control	What it does
Plan / Relief	Plan is the map view. Relief is three-dimensional: drag to turn, scroll to zoom, right-drag to pan.
Heights	Vertical exaggeration, true scale up to 10 ×. A flat dump is unreadable at true scale.
Show	With a comparison set: paint the ground by how far it moved, or draw the material that moved as a solid you can turn.
Contours every	None, 0.5, 1, 2 or 5 m. Contours are drawn on a plain plan; with a comparison set the plan shades by movement instead.
Colour scale	How much movement saturates the colour: read from this survey, or pinned. Pin it to compare two periods on the same scale — otherwise each month recolours itself and two plans side by side mislead.

Measuring inside a boundary

Without one, every volume answers “how much moved everywhere the two surveys overlap”. A mine asks how much came out of a *block*, and expects that to be comparable with the same block last month — which it only is if the boundary is a stored, named thing rather than something redrawn each time.

1. Click **Draw boundary**.
2. Click the plan to place each corner; double-click to close it.
3. Name it. It is kept against the item, so it is there next month.
4. Afterwards choose it under **Measure inside**. Every volume on the page is then measured inside it, and only inside it.

Volume above a level

Type a level and the panel reports the volume above it, the volume below, and the plan area it was measured over. Set it to the floor, the pad, or whatever datum you report to. This is the figure for a stockpile sitting on a known pad.

Change since an earlier survey

Choose an earlier survey of the same item. The headline figures become cut, fill and net, over the area both surveys reached — or over the chosen boundary, if one is set. Two rows below them are what make the figure defensible:

Row	What it is
Same, by 1 m grid	The identical volume worked out a second, independent way — by sampling both surfaces onto a one-metre grid instead of comparing their triangulations.
The two methods differ by	The disagreement between them. A small figure is evidence the volume is real.

TAKE CARE

Above one per cent you are warned, and it usually means one of two things: the two surveys do not cover the same ground, or one of them is missing a feature string the other has. Measuring inside a stored boundary settles the first.

Several surveys on one screen

Under **Surveys on screen**, add any other survey of the same item. The one you opened stays shaded and measured; the others draw as contours in their own colour, and as wireframes in relief — which is how a plan carries several surveys without turning to mud.

- The eye hides and shows a layer.
- The swap icon measures against it — the quickest way to move the comparison from one period to another.
- The cross takes it off the screen.

Adding several earlier surveys at once is how you show a progression: the face at the end of each month, in one picture.

08 A surface that keeps up to date

An imported survey is a picture of one date. A **running surface** is the ground as it stands, kept up to date by every survey imported into it: each pickup replaces the ground it covers and extends the ground it reaches past. Volumes are still taken between two dates - the running surface is simply read as it stood on each.

Starting one

On **Surveys**, the layers icon (or **Start a running surface** on an empty register) opens **Start a running surface**. Choose the Tracker Group and the item it is a surface of, name it, and press **Start it**. It begins empty.

From then on, importing a survey against the same item offers a choice under **This survey**: **Add to** the running surface, or **File as its own survey**. Added shots join the stack in date order, by the **Surveyed on** date you gave them - not the order you imported them - so a backdated pickup slots into its place.

HOW IT BEHAVES

Which pickup wins a piece of ground is decided by its capture date. The newest pickup that covers a spot is the ground there. That is why the date on an import matters more on a running surface than anywhere else in the module.

The stack

On a running surface, **Pickups** on the line above the plan opens **Pickups in this surface**: the stack, newest first, the top one marked **on top**. The number on the button is how many pickups the surface holds. Each row counts its shots four ways:

Tally	Meaning
used	Shots from this pickup that reached the finished surface.
superseded	Shots a later pickup had already covered.
set aside	Shots set aside by an adjustment on this pickup.
lines released	Feature lines read as plain ground because a later pickup took part of the ground they ran over.

A pickup that later surveys cover entirely still counts when the surface is read at an earlier date. The refresh icon rebuilds the surface from its pickups.

In plan view a scrub bar plays the ground forward one pickup at a time, with the date and the count beside it - the quickest way to see a face advance across a quarter.

Refills, and setting ground aside

A pit should come down; a dump should build up. When a pickup moves the ground the other way - a ramp rebuilt inside a pit out of cleared waste, and shot by mistake - the client convention is usually that the **original floor wins**. **Check for refills** on a pickup row finds those places.

1. The first time, say what this ground does between surveys: **Coming down** (a pit, a bench, a borrow area), **Building up** (a dump, a stockpile, a TSF) or **Both** (a live ROM pad). It is remembered for the item.
2. Each flagged region shows its volume, its plan area and the worst height difference inside it.

- Press **Set aside** on a region, and say why - the reason is shown beside every volume the adjustment changes, so write what a client reading the invoice needs to know.

Setting a region aside does two things at once: it suppresses that pickup's shots there **and** its claim on the ground, so the earlier survey wins there again and no hole is left behind. An adjustment is listed under its pickup with a **Lift** button, which gives the pickup its ground back.

TAKE CARE

Check for refills is offered on the pickups of a running surface only. A single-date survey has nothing earlier to fall back to.

Volume by block

Most sites refer to ground by block: *C7, NP-14*. Under **Volume by block** (or **Movement by block** once a comparison is set) every volume measured inside a boundary is attributed to the blocks it came out of - including ground nobody has surveyed, which still gets a name.

Define blocks sets the lattice: the south-west corner of the first block on the mine grid, the block width and height (200 m is usual), a bearing where the lattice runs along strike, and the naming rule - rows lettered and columns numbered, or both numbered, with an optional prefix and padding. The first names are previewed as you type.

Column	Meaning
Cut, Fill	What moved inside this block, m ³ .
Grid net	The same block measured a second time by the grid method, when Check against the grid method is on. Blocks more than 5% apart are worth walking again.
Measured	The plan area actually reached by both surveys, m ² .
Covered	Whether the block was fully or only partly surveyed. A small figure on a partly-covered block means a small survey, not a quiet month.

HOW IT BEHAVES

Moving the blocks saves a **new version** of the lattice rather than replacing it. Figures already reported keep reading on the lattice they were measured against; a change of naming only is a change of name and disturbs nothing. Click a block name in the table to give it the site's own name.

HOW IT BEHAVES

To name a block on the plan itself, right-click it — or, on a phone or tablet, hold a finger on it for half a second. A plain click is left to the plan: it is what pans the drawing and what places boundary corners and measurement points, so the lattice does not answer to it.

09 Sections, and checking a volume by hand

Sections, on the line above the plan, opens a dialog that cuts the ground across a line you draw and works the volume out the traditional way: the area of cut and fill on each section, averaged with the next and multiplied by the distance between them.

HOW IT BEHAVES

End-area is the method a client's engineer checks by hand, and it is the right one on anything long and narrow — a road, a ramp, a trench. On a wide pit or dump the surface-to-surface figure above is better, and a disagreement there is expected rather than alarming.

1. **Draw an alignment** — the line the work runs along. Sections are cut at right angles to it. The dialog steps aside while you click where the work starts, then where it ends, and double-click to finish; it opens again with the line in place.
2. **Section every** 5 to 50 m. Closer sections measure the ground more faithfully and take longer to cut.
3. **Reaching out** 10 to 100 m each side. Wide enough to cross the whole of the work, or the volume misses its edges.
4. **Sampled every** — how closely each section is sampled across its own length. A metre suits pit and road work.
5. **Cut** the sections.

You get a table of chainage against cut and fill area, with the volume totalled at the foot. Click any row to see that section's profile drawn beside the table, both surfaces on it.

- **The two methods are compared for you**, and the disagreement stated. Large on a road or a trench means the sections are too far apart.
- **Sections that contributed nothing are counted and named** — a run that dropped them quietly would report a smaller volume that looks exactly like a correct one.
- **If not one section found ground on both surfaces**, the alignment is outside the surveyed area, or the sections are too short to reach it.

WORTH KNOWING

Closing the dialog keeps the run, so you can look at the plan and come back to the same table. If the survey, the comparison, the level or the alignment has changed in the meantime, your settings are kept and the sections need cutting again.

10 Against the weighbridge

Once a comparison is set, this panel puts what the survey says came out, in tonnes, against what actually crossed the weighbridge over the same days.

It catches what neither figure catches alone. **A surveyed cut with no tonnes behind it is material that went somewhere unrecorded; tonnes with no cut behind them are loads that were never dug.**

1. **Bulk density** — tonnes per cubic metre. The only bridge between a volume and a mass, and the one thing a survey cannot measure. Broken rock in a truck is near 1.6, solid rock near 2.6, loose sand near 1.4.
2. **Weighbridge records mass in** — kilograms, tonnes or pounds. The weighbridge stores a bare number and declares no unit, so you state it here, where a wrong answer is visible.
3. **Tonnes weighed** — shown only where the weighbridge module is not on this account. Type the total off the tickets; the comparison works the same either way.

You then get the surveyed cut in tonnes, the weighed tonnes over the same days, the variance in tonnes and per cent, and the loads broken down by product.

TAKE CARE

If the two are more than ten times apart, that is a **unit**, not a shortfall. Check what the weighbridge records mass in before anybody goes looking for missing loads.

11 Getting a survey off the screen

A plan at a stated scale

The map icon draws a proper plan: a drawing at a stated scale on a stated sheet, with its own title block. The difference between this and the screen is that **a length measured off this sheet with a rule is a length on the ground** — which is what lets a plan be marked up, handed to a shift boss and filed against the month.

Setting	Choices
Paper	A4, A3, A2, A1
Orientation	Landscape or portrait
Scale	1:200 through 1:10000, round numbers only. At 1:1000 a millimetre is a metre and the sheet can be read with a rule and no arithmetic; a plan at 1:1373 fits the paper better and can be read by nobody.
Contour interval	As on screen
Note	Free text, printed in the title block

HOW IT BEHAVES

The sheet prints at true paper size with no margin, so nothing is shrunk to fit. A plan rescaled by five per cent to clear a margin is still labelled 1:1000 and is no longer at 1:1000 — and nothing on it would say so.

Handing it to another package

Format	Use it for
LandXML (.xml)	The format every survey package reads. The default.
Surpac string file (.str)	Where the receiving site works in Surpac.
DXF (.dxf)	A drawing for CAD: shots and feature lines, with levels.
LandXML, as triangles	The triangulation as built here, with its faces, for a package that wants this surface rather than its own re-triangulation - a scheduler reading a topography. Named <i>triangles</i> so the two are never confused.
DXF, as triangles	One 3D face per triangle on the layer SURVEY-TIN.

All are written on the mine grid. Where the account has named its grid under Integrations, the LandXML says which grid it is on.

The export bar

Every screen in this module that shows meaningful data carries the same actions in the same order: reading-mode preview, Excel, PDF, print (hidden on a phone) and, where it makes sense, share. The bar disappears when there is nothing to export — an empty letterheaded page reads as a claim that the figure is zero.

12 Drillholes

Drillholes

Mining > Drillholes

Every hole drilled on the property: where it started, which way it went, and what came out of it. The wireframes are drawn against these and the block model is estimated from them, so it is worth checking the database over before trusting a figure taken from it.

Importing a database

Three files joined on hole name. Choose them, check the reader has understood which column is which, *Read*, and only then *File*.

File	Needed	Columns you map
Collars	Yes	Hole name, easting, northing, level, total depth, and optionally dip and azimuth. Unset, holes are taken as vertical.
Downhole surveys	No	Hole name, depth, dip, azimuth. Without it a hole holds its collar attitude all the way down — right for a short hole, optimistic for a long one.
Intervals	No	A table name (assay, lithology, recovery), hole name, from, to. Every other column is read as a logged value.

- **Check easting against northing.** The wrong way round loads perfectly and mirrors every hole about the diagonal.
- **Dips are negative downward** throughout the module, and azimuths are degrees clockwise from grid north.
- **Whether an interval column is a number was decided by looking at its values, not its name.** A sample identifier is a label, not a grade. What was decided is listed before you file.
- **Orphans are dropped, not invented.** Hole names in the survey or interval files with no collar describe metres belonging to no hole; they are named and left out rather than given a collar nobody surveyed.

Checking it over

The tick icon checks every hole for overlapping intervals, depths past the end of the hole and duplicate names, and marks each row with what it found. Until you run it, every row reads *not checked*.

TAKE CARE

An **error** puts grade somewhere the drill never was. Fix those before anything is estimated from these holes.

The database together

Two icons in the header draw every hole in the database at once — not the page on screen, and not the item the import picker points at. Either can be open without the other, and they are read together.

- **In plan**, from the sheet icon. Looking straight down, at the same scale east and north, so a spacing or a gap can be measured off it against the scale bar. A hole is drawn where its downhole survey says it went, so a vertical hole is a dot and an inclined one reaches away from its collar. Point at a hole to read its collar, level, depth and set-up along the bottom; click one to open it. Holes an error was found on are drawn in red once you have run

the check. Each hole is named with its depth and, where it is not drilled straight down, its inclination. **Plan sheet**, above the drawing, puts the same holes on the sheet a survey plan prints on - paper, orientation and scale of your choosing, printed at true size - and says when a scale leaves labels running together.

- **In three dimensions**, from the cube icon. How deep the holes go and where they pass each other underground, which is the one thing a plan cannot show. Drag to turn, scroll to zoom.

The plan is where a mis-keyed coordinate shows up. A collar typed a kilometre out sits on its own in a corner of the drawing; in a three-dimensional view fitted around it, it simply shrinks every other hole to a dot.

One hole

- **The collar, the set-up and the drilled depth**, and the end of hole worked out from the downhole survey. Depths run along the hole, so the bottom is rarely under the collar — the **toe offset** says how far off it is.
- **The downhole survey**. The hole is desurveyed by minimum curvature, following an arc between stations rather than a straight line. Small in a straight hole, large in one that is deviating.
- **The trace in three dimensions**, from the cube icon. A hole that looks straight in a table of dips is visibly bent here.
- **The logged intervals** of whichever table you choose, with the grid position of each interval's midpoint.
- **Composites** beside them, 0.5 m to 5 m. These are the samples an estimate would actually use: raw samples come at whatever length was logged, and an estimator weights a 0.3 m sample the same as a 4 m one unless they are brought to a common length first.

13 Wireframes

Wireframes

Mining > Wireframes

A geological interpretation as a solid shape. Outlines are drawn section by section against the holes that pierce them, and the skin between them is tied into a closed body that can be measured and used to decide which blocks of a model are ore.

1. **New wireframe** from the plus icon.
2. **Name** it, and give it a **kind** in your own words — ore, waste, stope, dump.
3. **Bulk density**, tonnes per cubic metre. It lives on the shape because it is a property of what the shape encloses, not something supplied per report.
4. **Add a section** for each outline, in order along the body. Paste easting, northing and level, one corner per line. **Do not repeat the first corner at the end** — the ring is closed for you.

HOW IT BEHAVES

There is no standard file for “these six corners”, so geometry is pasted in from a plan, a report or an email. Anything unreadable is named by its line number rather than skipped: a boundary quietly one corner short still looks like a boundary, and every volume taken inside it afterwards is wrong over ground nobody notices. The solid is also built and measured in the dialog before it is saved.

A first pass from the drilling

Outlines can be typed or pasted, but on an item that already carries holes the editor offers **Build from drillholes** instead - and that is the honest place to start, rather than pasting coordinates out of another package.

You give it	What it is
Table, Field, Cut-off	Which interval table the cut-off reads (usually assay), the field it applies to, and the value at or above which an interval is ore. A missing assay is never treated as barren
Section bearing	The direction sections are stacked along - normally the strike, so each section looks across the body
Section spacing	Distance between sections. Usually the drill spacing
Minimum half-width	A section with one intercept is a line, and a line lofts into nothing. It is given this width rather than dropped, because dropping it silently shortens the body at exactly the ends where the drilling is thinnest

Build the sections reads every hole whole, takes the intervals above the cut-off, cuts them into sections along the bearing and puts a **convex hull round the intercepts on each one**. What comes back **replaces** the section boxes and is then edited by hand - which is the point.

TAKE CARE

This is a shape to edit, never a shape to report. Interpretation is the only step in the chain that is a judgement rather than a calculation: a geologist draws an orebody using structure, logging and everything they know about the deposit, none of which is in the assay table. A hull per section cannot be concave, so a crescent lens comes back as the block containing it and the barren middle is counted as ore; it bridges two shoots on one section into one body; it knows nothing about structure, so a fault offset between sections is lofted straight through; and it stops at the outermost hole, so a body open along strike is closed off at the drilling. All four make the solid larger in the middle and smaller at the ends, which is the wrong direction for a resource.

So it never runs silently. It reports how many sections it drew, from how many intercepts in how many holes, and how many metres of ore - then the warnings in full: the hull caveat every time, how many sections were widened rather than dropped, any gap between sections too large to tie together, and how many holes carry nothing above the cut-off, since those are what bound the body.

Measuring, and closure

The cube icon in the header rebuilds every solid from its own outlines and measures it. The register then shows volume, and tonnes where a density is set. The cube on a row draws that solid — the skin is tied from the outlines each time rather than stored, so what you see is always the shape the sections currently make.

TAKE CARE

A wireframe that is not closed has no meaningful volume. The theorem that measures a body is exact over a closed boundary and returns a plausible, wrong number over an open one — so an open body reports *not closed*, with the faults listed, rather than a figure. An uncapped end is the usual cause.

14 Block models and grade

Block models

Mining > Block models

The deposit divided into boxes with a grade on every one. What gets read off it is the grade-tonnage curve: how much ore there is above each cut-off and at what grade — the figure the reserve, the schedule and the cut-off decision are all read from.

Defining the lattice

1. **Origin** — easting, northing and level of the **corner of the first block, not its centre**. That is what every file format writes and what a geologist reads off a plan. A model built half a block out is wrong everywhere without looking wrong anywhere.
2. **Bearing** — of the model's own x-axis. A model is usually built along the strike of the deposit rather than along grid north, so a block's long axis follows the ore.
3. **Block size** east, north and up. The vertical is normally the bench height.
4. **Block counts** along each axis, up to two million blocks in total.

Taking the model to another package

File	What it carries
Download as CSV	One row per estimated block: centroid on the mine grid, the lattice indices ix, iy and iz, the block's dimensions and volume, and every estimated field. What Surpac, Datamine and Vulcan import and what a consultant asks for. The screen says how many blocks it wrote.
Every block as CSV	The whole lattice, estimated or not, with a blank where nothing has been said. For a scheduler that will cut the model against its own solids and needs to know where the air is. Read its blanks as blanks, never as zero.
Definition as JSON	The lattice alone: origin, bearing, block size, counts, the attribute names, the model's reference elsewhere and the account's grid - so the far end rebuilds the lattice exactly rather than inferring it from the centroids.

Reference elsewhere, on the model's editor, is the name the model goes by in the other package - a Vulcan model name, a NOVA solid id. It rides along in every file as a *model_ref* column and in the definition, so both sides can be sure they mean the same model.

Estimating a grade

With a model chosen, the activity icon opens the estimator. The compositing length, the search shape and the method all change the reported tonnage, so all three are on the form rather than defaulted out of sight.

What to estimate

Field	What it decides
Interval table, Field	Which log the grade is in, and which assayed field is being estimated.
Composite to	The common sample length. Without it, finely-sampled ground is over-weighted.

Field	What it decides
Weight by density	Composite by mass rather than by length where density varies. A metre of massive sulphide carries more metal than a metre of the shale beside it.
Write into	The attribute on the model the estimate is written to.
Only inside	Estimate only the ground inside a wireframe. Much faster, and the difference between a resource and a box of numbers — grades outside the orebody are grades somebody has to remember not to report.

Method

Method	What it is
Ordinary kriging	Weights derived from a fitted variogram, and a variance with them. The standard for a reported resource.
Inverse distance	Weights by one over distance to a power. No assumptions, defensible to anybody, and knows nothing about how the deposit behaves. Power 2 is usual; 3 is common in erratic gold.
Nearest neighbour	The closest sample and nothing else. Never smooths, so it is the reference a kriged model is judged <i>against</i> rather than a block value.

Where to look

Grades run continuously along strike for hundreds of metres and across it for tens. A search that treats distance as plain distance mixes samples from the far side of the ore into a block on this side, so the search is an ellipsoid oriented to the geology.

Setting	What it is
Along strike, across strike, through the ore	The ellipsoid's three axes in metres. The third is normally the shortest.
Azimuth, dip	Bearing of the long axis clockwise from north, and its inclination, negative downward.
Fewest samples	Below this the block is left unestimated rather than guessed at .
Most samples	Above this the nearest are kept.
Most per hole	Stops one densely-sampled hole supplying the whole search and becoming the estimate. Zero removes the cap.

How grades behave (kriging only)

The variogram says how quickly grades stop resembling each other with distance, and kriging derives its weights from it — so it is the part worth checking against the experimental variogram before trusting a result. Its ranges come from the search ellipsoid above.

- **Shape.** Spherical reaches its sill exactly at the range and suits most deposits.
- **Nugget.** Variance at zero distance: sampling error and true short-scale variability. A high nugget is the strongest reason a kriged estimate comes out smoothed, and **setting it to zero because the fit looks nicer overstates how well the deposit is known**.

- **Sill.** How much variance the structure accounts for above the nugget.

Reading the run

Run estimates without saving, and reports samples used, blocks estimated of blocks attempted, blocks left empty, and samples per block. *Save* writes the values onto the model with a record of how they were arrived at; if the attribute already exists, saving replaces every value in it and you are told so first.

TAKE CARE

Not one block found enough samples is almost never a search slightly too small — it usually means the holes and the model are not over the same ground, or the grade field is empty. **A large share coming back with nothing** means a search too far from the drilling: widen it before the figure is used.

HOW IT BEHAVES

Estimated grades are the one derived thing this module stores. Re-running an estimate takes minutes rather than milliseconds, and a resource is a figure that gets reported — it must not silently change between two readings of the same record.

Reading the curve

Back on the register, choose the model and say which field carries the grade. The rest decides how tonnage is counted:

Control	What it does
Ore fraction	How much of each block is ore. Without it every block counts whole, which overstates the tonnage on every block at the edge of the orebody .
Density	A field where density varies block to block, otherwise one figure for the model. Everything on the curve scales directly with it.
Cut-offs	The grades to report at, separated by commas.

You then get tonnes, grade and contained metal at each cut-off. **Average grade is weighted by tonnes, not by block count**, and a block with no estimate is left out rather than counted as barren.

How the grades were arrived at lists, per field, the method, the date of the run and how many blocks it estimated and left alone. A grade nobody can state the provenance of is a grade nobody can defend in a technical report.

The cube icon draws every estimated block above a cut-off you set, coloured with grade. Blocks with no estimate are not drawn — they are not barren, they are unspoken about.

Laying stopes out of the model

The underground twin of the pit optimiser, and it answers the same kind of question one step earlier than a plan does. A plan says *when* the stopes are mined and what that costs. **Lay out stopes** says which stopes there are at all, and how the answer moves when the frame or the price moves. Run it at several prices to find out whether the layout is robust or one bad quarter from being a different mine.

Give it what the rock is worth - the grade field, density, plant recovery, product price, and what a tonne costs to mine and to treat underground - and the shape a stope may be: which axis follows the ore, the sublevel interval and panel length, the narrowest and widest stope across strike, the wall slough and its grade, and the mining recovery.

It reports how many stopes pay for themselves out of the panels examined, the tonnes fed and how much of that is slough, **the grade the mill sees**, and what the layout is worth before development - then a row per stope. The whole thing leaves through the standard take-away actions.

HOW IT BEHAVES

A stope is built from whole model blocks, so a 25 m sublevel on 10 m blocks is laid out at 30 m and a 3 m minimum width at 10 m. Both are reported rather than silently honoured: a layout quietly built to a different frame from the one asked for is worse than one that argues.

TAKE CARE

It files nothing, deliberately. A pit optimiser produces a shell, and a shell is a design you can file and plan against. A stope layout is what a frame and a set of costs *imply*, and both live on the plan, where they are read again every time it computes. To schedule these stopes, open a plan for the item and set its shape to Stopes and headings.

Optimising a pit out of the model

The trending icon on **Block models** opens **Optimise a pit**: which blocks are worth mining once the waste above each one is paid for, and therefore what shape the pit is. It is offered once the model carries at least one estimated field.

Under	You give it
What the rock is worth	The grade field, the price per unit of grade, recovery, and the selling cost per unit - refining, freight and royalty, taken off the price because it scales with metal rather than rock.
What it costs to get at	Density, mining cost per tonne (paid on every tonne, ore and waste), processing cost per tonne (paid on ore only - a block that cannot pay it is mined as waste, which is where the cut-off comes from), and the wall slope from the geotechnical report.
Prices to run	Fractions of the price above, <i>0.4, 0.6, 0.8, 1.0</i> by default. Each gives a pit; the small ones sit inside the big ones, and that nesting is the order to mine in.
Surveyed ground	Blocks above the ground are air. Without a survey the optimiser pays to move the sky above the deposit.

The ultimate pit reports value, ore tonnes, stripping ratio and the floor level, then one row per price. Under **Make it a design**, give it a name, bench height, batter angle and berm width and press **Create pit design**: the outline of the shell's deepest level is filed as a pit floor under Mine designs, ready to run against the survey.

TAKE CARE

A slope built out of whole blocks is quantised by the block size and can only ever steepen a wall. The dialog says what slope the pit actually stands at; if the blocks are too coarse for the wall asked for, it says how narrow they would need to be. Blocks with no estimate are mined and paid for as waste, never treated.

15 Seams

Seams

Mining > Seams

A thin, dipping seam - a Great Dyke chromitite of 25 to 30 cm, a coal seam, a reef - modelled the way it lies: as a grid in plan, each cell carrying the level of the seam's floor, its true thickness and its grade.

A block model cannot see a thin seam. A 0.3 m seam is 6 percent of a 5 m block, and blocks thin enough to hold it are far more than a model may carry. Everything that matters about a seam - how thick, how rich, how deep its floor lies - is in its own plane, so it is modelled as a grid instead.

Modelling a seam

Choose the item, then **Model a seam**. It reads the item's drillholes and asks how the seam is recognised down them.

Field	What it is
Recognise by	Code - the seam logged as, say, LG6 in a lithology table - or Cut-off, every interval at or above a grade. A code is better wherever the seam was logged: a cut-off also picks up disseminated chromite above it.
Table, code field, codes	Where the seam is logged, and the codes that mean it.
Grade table, grade field	Where its grade is. Weighted over the seam's own two contacts, so the assays need not share the log's boundaries.
Join gap	Seam intervals closer than this down the hole are one crossing - a parting thin enough to mine with it.
Cell size	The grid's cells. A quarter of the drill spacing is usual.
Seam density	The seam's own, t/m ³ - chromitite is nearer 4 than 2.7.
Dip, dip direction	Typed only where the holes cannot say; otherwise fitted through the crossings.
Estimator	Nearest, inverse distance or kriging, as for a block model.

Preview shows each hole's crossing - its contacts, true thickness and grade - the holes that never crossed the seam, the dip it was read at, and what the grid holds: cells, plan and true area, tonnes, mean thickness and grade.

Save files it; **Estimate again** re-runs a filed seam and replaces its grid whole.

HOW IT BEHAVES

A hole not square to the seam reads it long - a vertical hole through a seam dipping 15 degrees reads it 3.5 percent long - so every crossing is corrected to the thickness square to the seam. The grade is estimated through the accumulation, grade times thickness, and a cell's grade is its accumulation over its thickness: 0.3 m at 40 percent beside 0.6 m at 10 percent averages to 20, not 25.

TAKE CARE

With no limit drawn, the seam stops at the outermost hole that crossed it. A faulted seam is modelled one fault block at a time.

Laying a seam out

Lay out panels and **Lay out strips** preview what the seam holds as panels between levels underground, or as strips from the outcrop, at a frame and a price - the seam's twin of Lay out stopes. Strips need the ground, which their overburden is read from. They file nothing: a layout is scheduled by a plan whose shape is Seam panels or Seam strips (see A thin seam: panels and strips, in the Plans chapter). A seam a plan reads cannot be deleted; the refusal names the plans.

16 Mine designs

Mine designs

Mining > Mine designs

Pits, waste dumps, haul roads and ramps, and underground drill rings. What is stored is the parameters; the shape is worked out from them each time the design is opened.

HOW IT BEHAVES

That is why a revised geotechnical report makes every pit designed to the old one **visibly** out of date rather than quietly still drawn the old way. The four kinds share nothing but a name and an item; a design filed under the wrong kind can be changed, but only with the new kind's parameters typed beside it.

A pit

Designed upward from its floor outline against the slope rules the geotechnical report allows: floor level, bench height, batter angle (the face itself, typically 55 to 80 degrees, not the overall slope), berm width, and where to stop.

Running it gives benches with toe level, crest level and crest area, the volume to the top crest, and — the number worth reading — **the overall slope those parameters actually produce**. That is the angle a geotechnical report constrains, and the one nobody can read off bench height, batter and berm by eye. A floor too narrow for its slope produces no benches at all, and says so.

A pit drawn in another package

A pit designed elsewhere arrives as its strings: a closed ring per toe and per crest, each at its level, as a Surpac string file or a DXF. On the pit's editor, under **As drawn elsewhere**, read the file in and the pit **is** those benches. The slope rules above describe it - the floor outline follows the lowest toe and the bench height the lowest bench - but they are never run; the 3D view, the export and every plan for the pit take exactly the benches that were drawn.

Strings named TOE and CREST are read by name and paired by level. Unnamed rings are read by their level and size: of two rings at one level, the smaller is the crest of the bench below and the larger the toe of the bench above. The editor says how many benches it read and from which level to which; a file with fewer than a toe and a crest is refused and the reason shown. **Back to the rules** drops the drawn benches, after asking.

HOW IT BEHAVES

A drawn pit is stored; a designed pit is not. This is the one place a pit's geometry is kept rather than generated, because it was decided elsewhere and nothing here can regenerate it. Re-import when the other package revises it. **Reference elsewhere**, near the top of every design, block model and wireframe, is the name the record goes by in that package, and rides along in every file it leaves in.

Water in the pit

Three more numbers under **Water** say where the water goes, and are generated the way the benches are. **Sump depth** and **Sump area** dig the sump: a box below the floor at its centre where the water collects and the pumps stand, holding depth times area. A sump larger than the floor is taken as the whole floor, and the design says so. **Diversion drain** is how far beyond the top crest the cut-off drain runs; ground beyond it sheds away, and the strip between the crest and the drain still drains in, with its area reported.

Both are drawn in the 3D view - the sump as a box below the floor, the drain strip as a band at the crest - and reported under Water beside the benches. A plan for the pit reads the sump and the strip from here where the planner leaves them blank, so the pit is dewatered as it was designed, not as somebody remembered it. Leave all three blank for a design with no water on it. Where the water table is, and how much the pit takes from it, is typed on the plan, not the design.

Stages, for the optimiser

A pit design with nothing more is mined bench by bench, top-down, exactly as drawn - which is everything a plan in **to a product target** or **to capacity** mode needs. A **stage** is for the case the schedule optimiser is built to use and top-down cannot: a pushback or a cutback the mine genuinely wants taken before or after another part of the same pit, recorded on the design itself rather than left for a planner to remember.

A stage is drawn the way everything in this dialog is drawn - an **Outline** typed or pasted in, plan only, one corner per line. Its level is ignored, exactly as the pit's own floor outline's is, because a stage's levels are its own **From level** and **To level** fields instead. **Label** is what a planner calls it. **After** names the other stages that must be finished first - leave it empty and the stage may start whenever the optimiser likes; name one or more and it waits on them. The order stages are listed in is only display order: what actually holds a stage back is what it names under After, never where it sits in the list.

A pit that names none is unaffected — *No stages. The pit is mined bench by bench* is what an empty list says, and that stays true until one is added. Add a stage only where a real sequencing decision needs to be seen and acted on, not as a matter of course.

TAKE CARE

Two problems stop a save outright, named rather than left for the server to refuse blind: a loop of After references that names no order at all, and two stages that cross the same bench levels and overlap in plan — the same ground claimed by both.

A waste dump

The pit turned inside out. A dump is designed **upward and inward from its footprint** - the toe outline at the ground - lift by lift: lift height, face angle (the material's angle of repose, about 35 to 38 degrees for blasted waste, or flatter where the stability report asks), berm width between one lift's crest and the next lift's toe, the most lifts, and where the lowest toe sits. Leave the base level empty and the dump stands on the lowest surveyed ground inside its footprint; give it a top level and no crest passes it.

Running it gives the lifts with toe and crest levels and crest area, what each lift **holds** and what the dump holds to that lift, the overall slope the rules produce, and the capacity of the whole dump. **The capacity is measured, not assumed**: it is the space between the designed top and the ground the design names, inside the footprint, worked out piece by piece against the survey - so on a hillside the uphill side of a lift holds nothing, which a spreadsheet frustum would count. On flat ground it is exactly the frustum arithmetic a planner does on paper.

WORTH KNOWING

The footprint need not be typed. Where the area has already been set out in Survey as a **boundary** - which is usually how a dump allocation is agreed - pick it under **Take a surveyed boundary** and its corners become the footprint. Boundaries are stored on the mine grid, the same frame a design is stored in, so nothing is converted and nothing is retyped. The same control fills a pit floor. It is not offered for a road's centreline: a boundary carries no levels. Drawing on the plan and pasting coordinates both still work.

WORTH KNOWING

A dump's capacity is in *placed* cubic metres. Rock swells when it is blasted - a tonne at 2.7 t/m³ is about 0.48 loose m³ on the truck - so a plan turns its waste tonnes into loose cubic metres through the pit's swell factor before it asks whether they fit.

A dump has to be worked

A stack of lifts is a shape. Two more things make it a dump the mine can use, and without them the drawing is wrong in a way no capacity figure would show.

The top is where the trucks tip. Stepping inward lift after lift closes the outline to a point, and nothing tips on an apex - a rear-dump truck has to reverse to the edge, tip, and turn round. **Least top width** is the room that takes, about 40 m for a rear-dump fleet and more for the largest trucks, and the design stands at the last lift whose crest is still that wide, giving *Top* as the reason it stopped. The top's width and area are reported beside the lifts.

HOW IT BEHAVES

It is a width, not an area. A top of 4,000 m² that is 300 m long and 13 m wide is a road, not a pad. What is reported is the widest strip that fits inside the top outline, which is what decides whether a truck can turn.

The trucks have to get up there. Give the dump a **ramp width** and a **ramp grade** and the design spirals a haul road up the outside of the faces, climbing each lift at that grade and crossing each berm still climbing, so it arrives at every lift's toe exactly at that lift's level. Every crest it passes is a **landing** - the level tipped at while that lift is being built. The report gives its length, the grade it achieves, how many times it goes round the dump and the levels it lands on; the 3D view draws it; and it leaves with the design on its own layers and as a body.

What the ramp says	What to do
So much of it stands beyond the toe and must be built out	Widen the berm to the figure named, or allow for the extra fill. The ramp is laid on the faces the lift rules produced; it never moves the dump.
It would cross itself climbing one lift	The dump is not far enough round for that climb. A lift's rise divided by the grade is the running it needs - a 10 m lift at 8 per cent is 125 m. Flatten the grade, lower the lift, or widen the footprint. Laps across different lifts are ordinary.
The top is narrower than the ramp arriving on it	Raise the least top width, or narrow the ramp.

WORTH KNOWING

Leave all three empty and the dump is shaped exactly as it always was - a dump filed before these existed is unchanged. The design does say, in its message, when the top has closed to something nothing can tip on: the capacity is not wrong, the shape is unworkable. A plan reads the same least top width, so the space it believes it has is the space the design actually leaves.

A road or ramp

A centreline with a grade on it: carriageway width, crossfall, shoulder, safety berm, start level, grade per cent, station interval, and the steepest grade allowed. Running it gives stations with chainage, design level, bearing and grade.

WORTH KNOWING

If the design exceeds the grade limit you are told the centreline length that *would* be needed — which is the answer the question was really asking.

An underground heading

A heading is a road with a roof. A **decline** gets between levels, a **drive** runs along one, a **crosscut** reaches across to the ore, and an **ore drive** is driven in the ore itself so its rock is fed rather than tipped. Each is designed along a centreline exactly as a haul ramp is - stations cut at an interval, each carrying the profile swept onto it - and the difference is that the excavation is a tube, not a surface.

Field	What it is
What it is	Decline, drive, crosscut or ore drive. It decides whether the rock it breaks is tipped or fed.
Width and height	The hole the machine cuts, metres. A twin-boom jumbo drive is 5 to 6 m wide.
Arch rise	How far the back rises above the springline. Zero is a flat back, which is what a jumbo cuts in competent ground.
Start level and grade	Where the floor sits at the first point, and the per cent it climbs. A decline falls, so its grade is negative.
Steepest allowed	The steepest the equipment will drive. Exceeding it is reported, not refused - the remedy is a decision.

Running it gives the stations a survey crew sets out from, the **metres driven** - which is what development is priced by - the fall from end to end, the face area the profile cuts, and the rock it breaks, which has to be hauled out and tipped like any other. A heading told to arrive at a level its centreline is too short for says how much centreline that level actually needs.

WORTH KNOWING

Underground, everything is priced and scheduled per metre advanced. A plan that knows how far a decline is knows when the level below it can be mined, which is the whole of underground scheduling.

Drill rings

A fan of holes drilled out to the ore boundary: burden between rings along the drive, target toe spacing, standoff from the boundary, and the shortest hole worth drilling. **The fan is laid out by walking the ore boundary at the toe spacing and aiming a hole at each point**, so the toes are evenly spread rather than the angles — which is what breaks the rock evenly.

You get ring count, hole count and total drilled metres, and for the selected ring every hole with its dip, azimuth and length. Dips are negative downward, the same convention a drillhole uses, **so a designed hole and a surveyed one can be compared directly**.

Taking a design to another package

An open design leaves as a Surpac string file or a DXF drawing, on the mine grid, each kind of line on its own layer: a pit as every bench's toe and crest on PIT-TOE and PIT-CREST, a road as its centreline and both edges, drill rings as one line per hole. And, for a scheduling package that takes mining blocks rather than strings, **as bodies**: LandXML surfaces with their faces, or a DXF with one layer per body.

Design	Bodies
Pit	PIT SURFACE, then one closed solid per bench (BENCH 3 1020.0-1030.0) and, where the design carries stages, each stage's cut through each bench (STAGE A BENCH 3).
Waste dump	DUMP SURFACE, then one closed solid per lift.
Road or ramp	ROAD SURFACE - the running surface as a strip.

Generated, like the design: revise the slope rules and the next export is a different pit.

17 Plans

Plans

Mining > Plans

A plan says what a pit will produce over one or more periods, read from the ground as it was surveyed and the deposit as it was modelled: which benches, how much waste before the ore, how many drilled metres and blasted tonnes, and which of the mine's capacities binds first. Its figures are then **published onto monitored parameters**, where the dashboards and period summaries already judge readings against a plan.

Two questions, and every plan asks one of them of each period: **we need this much product - what has to move?**, or **we can move this much - what does that buy?** The register lists every plan with its item, period, mode and status; the figures shown are the first period's. The plus icon starts a blank plan, which is saved the first time you press Save or Compute.

HOW IT BEHAVES

A plan is not an optimiser. It takes the pit as designed and walks it top-down, bench by bench, until the target is reached or a capacity runs out. The answer is one a planner can check by hand. It never moves a pit wall.

Sources

Field	What to choose
Item	The pit. Its surveys, models, designs and boundaries are what the pickers below offer.
Swell factor	Loose cubic metres each bank cubic metre of the pit's rock becomes once blasted and tipped - about 1.3 for blasted waste. It turns waste tonnes into the volume the dumps must hold; blank leaves the waste out of the dump balance.
Ground, and Ground as of	The surveyed ground the reserve is read against, and the date it is read as of. A running surface is read as it stood on that date. Everything mined before the date is above the surface and drops out on its own - which is what keeps the reserve current.
Block model	The deposit in blocks. Its grade attribute decides ore and product.
Shape	A pit design: the design's benches are read, each daylighting where its crest reaches the ground. Slices of a boundary: a column sliced from the highest ground inside the outline down to the floor level, in benches of the height you give - no batter, no berm; a first answer, not a design.
Grade field, Grade unit	Which attribute is the grade, and what one unit of it means per tonne of ore: g/t makes grams, cphat makes carats at 0.01 per tonne, percent is read as kilograms, or name the product and its factor yourself.
Ore is decided by	A cut-off grade - a block at or above it is wholly ore - or an ore-fraction field , which is what flagging a model against an orebody solid writes.
Recovery	Product is in situ times recovery, not plant output.
Density	One figure for every block, or a model attribute.

Field	What to choose
Unestimated blocks	Waste - the rock still has to move - or excluded . A block with no grade is never ore either way. are

TAKE CARE

The model's block height should divide the bench height, or each bench's reserve borrows from the one below. The result says so when it happens; it does not refuse.

Processes, and where a capacity comes from

A process is anything the pit runs that is linear in ore and waste tonnes. A new plan starts with eight, in the order the ground is worked: **Pre-stripping** (clearing virgin ground - trees, levelling), **Topsoil removal** (to the topsoil dump, kept for rehabilitating the rock dumps later, whether by load-and-haul, by dozer or both), **Waste drilling**, **Waste blasting**, **Waste haulage** (to the waste dumps), **Ore drilling**, **Ore blasting** and **Ore haulage** (to the plant or a stockpile). **Add process** adds any other - plant feed, crusher hours, truck cycles.

Pre-stripping and topsoil removal start with no demand, because the plan reads ore and waste tonnes: type what a tonne of waste asks of each - the share of the stripping that is topsoil, say - or switch them off once the ground is cleared. A drill takes tonnes per drilled metre instead of two factors, and says which rock it **Drills** - waste, ore or both - so the two drills read their own tonnes; the plan's drilled and blasted figures are the pairs added together.

WORTH KNOWING

Every process card folds to one line on its chevron, and folds by itself when you switch the process off. Switch off a process the mine does not run: it then places no demand and never binds. Switching it on opens the card again. This device remembers how you left things: a card you folded opens folded next time, a preset you switched off comes up switched off on your next new plan, and a new plan opens in the grade unit you chose last. A saved plan keeps its own switches and unit; another computer starts from the presets.

Each process may carry a capacity per period, and **Capacity from** is the planner's choice, process by process:

Capacity from	What you give it
Declared - one figure	The figure. <i>A million tonnes a month.</i> Right for a planner working from a contract, a budget or long experience.
Built up from equipment	A list of units - a name, a count, a rate per hour, and the machine's own item where it is on a register - with shifts per day, hours per shift, availability and utilisation. Capacity is the units' combined rate times hours per shift times shifts per day times the period's calendar days times availability times utilisation. Type the units in one at a time with Add unit , or take a whole fleet at once with Add from a fleet (below). Make loading and hauling two processes when you want to see which of them is short. Where the account holds the Maintenance module, Read availability from maintenance replaces the typed availability with what was measured for the machines named on the build-up over the same length of time before the plan starts.
Demonstrated by a parameter	A monitored parameter that already records what this process does - the tonnes moved per shift filed on a form - a look-back in periods, and whether to take the mean, the best period or the 80th percentile. Fetch actuals shows the series before you commit to it.

Capacity from	What you give it
Declared - varying by period	Tick Varies by period on a declared capacity and type a figure per period, or paste a column from a spreadsheet. A period left blank takes the single figure. <i>Three trucks in March, five from April.</i>
From a truck cycle	The trucks, the road and the shifts, worked the way a haulage engineer works them - see Haulage from the road, below.

WORTH KNOWING

The demonstrated source is what keeps a plan honest. A fleet build-up that promises double what the same fleet did last quarter is visible as such: switch the process between the two and watch the walk stop in a different place.

Adding units from a fleet

A dump-truck fleet is usually already set up in Trackapt - a Tracker Group with one item per truck - so a build-up should not mean retyping every registration. On a process whose capacity is **Built up from equipment, Add from a fleet** sits beside **Add unit**, in the header of the Units list and again after the last unit.

1. Press **Add from a fleet**. The **Add units from a fleet** window opens with a **Fleet** picker. Only fleets marked as **Equipment** are offered.
2. Choose the fleet - *Dump Trucks, Excavators* - and its machines are listed with a tick each. **Select all** ticks every machine not already on the build-up; a machine already there shows ticked and greyed, marked *already added*, so the fleet's full roster still reads.
3. Press **Add**. One unit is added per ticked machine, named after it, with its **Machine** set, a count of 1 and a rate per hour of 0. Fill in the rates before computing; count, rate and machine stay editable.

HOW IT BEHAVES

Only a fleet marked as Equipment can hold a machine. The tick is on the fleet's Tracker Group when it is created - *Equipment: select if this group is of equipment, machinery or vehicles* - and cannot be changed afterwards. The same rule governs the fleet register and the maintenance assets, so a fleet that holds trucks in one module holds them in all three. If the picker is empty it says so: *No fleet is marked as Equipment yet. Tick Equipment when you create it - it cannot be changed afterwards.* A unit typed by hand that names a machine outside such a fleet is refused on save.

Haulage from the road

A haulage process costed **from a truck cycle** works its capacity out from the trucks and the road rather than taking a tonnes-a-month figure on trust. Pick a truck class from the presets - a 40 t articulated, a 90 t, 140 t or 220 t rigid - or type one: its payload, and its speed in km/h at each total resistance, loaded and empty. Total resistance is grade plus rolling resistance, so a 10 per cent ramp on a 3 per cent road reads at 13 per cent loaded going up and minus 7 coming down. Several classes may share a cycle; each contributes its own trips.

The route is segments of length and grade, with a rolling resistance per segment or one for the road. **Read from a road design** fills the segments from a filed haul road or ramp, and *Driven out of the pit* flips the grades so the loaded leg climbs. Add the loading and dumping time and the shifts, hours, availability and utilisation a fleet build-up already takes, and the card previews the cycle - *a cycle of 24.6 minutes over 2,100 m each way, 182 tonnes per truck hour* - and the capacity follows.

The result then reports, per period, the **trips**, the **truck hours** and, where the class states litres an hour, the **diesel** and the **CO2** that moving the period's rock costs. Truck hours and diesel can be published as figures of their own.

WORTH KNOWING

A fleet build-up says what the fleet could do; a truck cycle says what the road lets it do. The same ten trucks give a different capacity on a 2 km flat haul and a 5 km ramp at 10 per cent. Where the haul will lengthen as the pit deepens, cost the haulage from the road and vary the fleet by period.

Mode and horizon

Setting	Meaning
To a product target	Benchmarks are taken top-down until the target per period is reached, the last one pro rata. Capacities are advisory and are marked where exceeded.
To capacity	Benchmarks are taken until a process runs out of capacity. The process that stops the walk is named on the result.
To the best order	Every period is planned together, in whichever order gets the most out of the objective you name — see Optimising the schedule, below.
As imported	The schedule was decided in another package and read in against this plan's reserve. Nothing here chooses a benchmark; every figure is read off exactly what the file said - see Working with a scheduling package, below.
Cadence, Starts, Periods	How long each period is (daily to annual), the first day, and how many consecutive periods, up to 24. Each continues where the last stopped, with every capacity refilled. The screen tells you how many calendar days the first period has - that is what a fleet build-up is multiplied by.

Optimising the schedule

The third mode, **to the best order**, does not walk the periods one at a time. It plans the whole horizon together and decides, for every period, how much of it to take — not necessarily top benchmark first in every one — so as to get the most out of whatever you tell it to make the most of. The other two modes ask a fixed question of each period in turn; this one is free to hold a period back if that leaves a better order over the whole horizon.

What to make the most of

Optimise for	What it is	Pick it when
Product	The most product over the whole horizon.	The plain question: the most metal, carats or tonnes of product, full stop.
Value	The most money, at the price and costs below, added up over the horizon.	Product from different periods is worth the same to you, but not every tonne of it is — grade or cost varies enough that money, not tonnes, is the real target.
Net present value	The most money, weighted toward sooner — product taken next month is worth more than the same product next year.	The timing of the cash matters as much as the total — the question a mine schedule proper is usually judged against.

Value and net present value both need the economics that turn tonnes into money: **price** per unit of product, **mining cost** per tonne — paid on every tonne, ore and waste alike — **processing cost** per ore tonne, and an optional **selling cost** per unit of product: refining, freight, royalty — left empty where there is none.

Net present value needs one figure more: the **discount rate**, the annual rate money is discounted at — 0.08 for eight per cent a year — converted to the plan's own cadence when it is computed. **There is no default.** It is a business decision, not a guess, and Compute is refused without one.

Holding every period to the target

Left off, the optimiser is free to mine nothing in a period if that gives the better order overall — a real answer, but not always the one a planner can present. The **Must reach the target each period** toggle pins a floor under every period instead: on, the optimiser must reach the target given beside it in each one, or it reports why it cannot and the capacity schedule runs in its place — so a plan reader is never handed silence instead of a reason. The toggle is saved with the plan, on or off, so reopening it later shows the same choice you left it on.

Reading an optimised result

The Result card carries two things the other modes do not. The **objective value** is what was actually made the most of, over the whole horizon, stated in whatever the objective is in — product, or money. And, behind a details toggle, the **shadow prices**: what one more unit of a process's capacity, in a given period, would have been worth to the objective — the figure that says which period's trucks or drills are the ones actually worth adding to.

Neither is stored. Both belong to the run just computed, and reopening an already-optimised plan does not bring them back — press Compute again to see them.

Several pits, one plant

A mine with two pits in different states - one still stripping, one in production - and one plant asks a question a single-pit plan cannot: which pit to attack, for how much, and for how long, to get the most out of the plant. A plan to the best order can hold more than one pit.

Under the first pit's sources, **Other pits** lists the rest. **Add pit** opens a card with the same fields as the first pit: item, ground and the date it is read as of, block model, shape, grade, ore rule, density and recovery. Every pit produces the plan's product; a pit may be estimated in a different grade unit, but what it makes is what the first pit makes. An item already on the plan is not offered again.

Each process then gains **Applies to**. Every *pit* is a shared capacity - the plant, or a fleet that moves between pits. *One pit only* is that pit's own, such as its excavator; other pits' rock places no demand on it. The optimiser reads each pit's reserve on its own, with its own stages, and schedules them together. Nothing forces one pit to wait for another; the shared capacities are what tie them, and what let the optimiser choose between them.

The result names the pit on every bench, adds a **By pit** table beside the totals, and carries the split into every export. **Publish** offers each figure twice over: the plan total, and each pit's own share, offered that pit's own group's parameters, so each pit's dashboard carries its own target.

TAKE CARE

Only a plan to the best order can hold more than one pit. A target or capacity plan takes the top bench first through one list, and would finish the first pit before touching the next. Switching a multi-pit plan to either mode says so, and the plan will not save until the mode is switched back or the other pits are removed.

Blending, opening a pit, and the longer haul

- **Feed grade band**, on the Objective card: the ore fed to the plant in every period must average inside it, measured as recovered product per ore tonne so it reads the same across pits estimated in different grade units. Leave either end blank. The capacity schedule keeps the band as well, so the band alone never leaves the optimiser without an answer; only a band together with a target it cannot reach can, and the result then says so.
- **Cost of opening each pit**, for a value or net present value objective: a one-off cost charged if the schedule mines anything at all from the pit - the box cut, the haul road. The optimiser then decides whether each pit is worth opening within this horizon, and the result says which pits it opened and which it left closed. On a single-pit plan it answers whether the pit is worth touching at all.
- **Haul factor by pit**, on a process that serves every pit: how much more of it a tonne from each further pit demands than a tonne from the first - 1.4 for a haul forty percent longer. Leave at 1 where the pits are alike.

The plant's minimum, the stockpile, free-dig and stage openings

Minimum plant feed is the least ore the plant must be fed in every period, in tonnes - a floor in tonnes rather than in product. Blank asks nothing; a minimum the reserve cannot feed is reported, and the capacity schedule runs instead.

Turn on **There is a stockpile between the pits and the plant** and say what is on it at the start, its grade in product per ore tonne, what reclaiming a tonne costs, and the most it may hold. Then mark the plant, under Processes, as **Fed from the stockpile**: its demand is read on ore fed - mined, less what went on the pile, plus what came off it. The optimiser may dig ahead in a good month and feed the pile in a lean one. Everything that crosses the pile is taken at the grade you declared, so the arithmetic stays exact, and the result shows what went on, what came off, what is left, and what the plant was fed. With a stockpile, Publish offers Ore fed, Product fed, Stockpiled and Reclaimed as figures of their own.

Under Sources, a **Free-dig attribute** of the block model - any value above zero means the block needs no blasting - and, under Processes, **Skips free-dig rock** on the blast and the drilling before it: those tonnes are still mined and moved, they simply place no demand on the processes that skip them. Where a pit's design has stages, each stage may carry its own **opening cost** beside the pit's; pits and stages together may carry twelve. And a demonstrated capacity's **Fleet since then** multiplies the look-back - 1.2 for six trucks where it ran five - for a fleet that has changed.

Qualities, blending and several piles

A plant is rarely bound by one grade alone. Under Sources, **Qualities** names up to eight more attributes of the block model the plan should carry - sulphur, silica, iron, moisture - each read into the reserve as a tonnes-weighted mean over the unit's ore.

- **Feed quality bands**. Beside the feed grade band, each quality can carry a minimum and a maximum the plant will accept, averaged over what it is fed in the period. To the best order the bands bind, and the optimiser blends the pits, the piles and the periods to hold them; on the walks and on an imported schedule a band is judged and a breach reported - *Sulphur of the feed averages 2.1, above the band's 1.5*.
- **A recovery curve**. Recovery need not be one figure. Type it against grade - 0.5 at 0.5 g/t, 0.85 at 1.5 g/t, 0.92 at 3 g/t - and every block's product is taken at the recovery its own grade reads off the curve, so a low-grade bench yields what it will yield rather than what the average says.
- **Several stockpiles**. Tick **Several piles, by grade** and up to six piles are listed, each with its own grade, its qualities, what is on it, what it may hold, and the grade band it accepts - a high-grade pile and a marginal pile. Rock off a bench may go onto any pile whose band accepts its grade; the optimiser decides which, and when to reclaim from which, and the result shows every pile's movements.

Compute, and reading the result

Compute saves the plan, loads the sources, reads the reserve bench by bench and schedules the horizon. It runs in the background; the screen stays usable. The **Result** card then shows, per period:

- The benches taken, top-down, with the fraction of each, the blocks, how many were air or unestimated, ore and waste tonnes, grade and product - and a total row.
- Every enabled process's demand against its capacity and where the capacity came from, the **binding** one marked, and any exceeded one in red.
- The stripping ratio, the ground-as-of date, when it was computed, and the warnings - a target out of reach, a reserve exhausted, a bench whose height the blocks do not divide.
- On a haulage process costed from a truck cycle: the trips, the truck hours, the diesel and the CO2. Where the plan carries qualities: what the feed averaged on each, against its band.

HOW IT BEHAVES

The last bench of a period is a fraction of a **uniform** bench. On a bench that is waste on the west and ore on the east, the split is an estimate by exactly that much. The export bar on the card takes the whole horizon into a document.

On a plan to the best order the result also carries the objective value over the horizon, which pits and stages were opened, and what an extra unit of each capacity would have been worth this period - stored with the result now, so reopening the plan shows them. Each bench row has a **Pin** column: type a fraction, 0 to 1, to fix how much of that bench the period takes, then press Compute again. The optimiser solves around what you pinned and says so - the best schedule around it, not the best schedule. A pin no schedule can honour is reported, and the capacity schedule runs instead.

Publishing the plan

Publish lists the plan's figures - ore, waste, total rock, product, drilled, blasted and any custom process - and against each, **Publish onto**: the monitored parameter that figure becomes the plan for. Pick the one the readings for it are filed on; leave a figure as **Not published** to write nothing for it. One period plan is written per figure per period.

From then on nothing on the dashboard says *mine plan*. The published figure simply becomes the **Plan** number the dial, the variance and the red or green status use for that period, and the period summary over the form's submissions judges the filed readings against it. A published plan is locked; **Unpublish** withdraws the period plans it wrote and makes it editable again. A dashboard already open on the pit's parameters picks the new plan up on its own, the way it does a broadcast.

TAKE CARE

Publishing onto a parameter that already has a plan period covering the same days is refused, naming the parameter. Move that period or unpublish the plan that wrote it. A parameter takes one figure.

TAKE CARE

Figures left part-written. Publishing marks the plan published and then writes a figure for every period; unpublishing marks it and then takes them off. If the server stops part-way, the plan reads as published with some periods missing a figure, and the mine reads a missing figure as zero tonnes planned. The plan cannot say which of the two stopped, so its page says in red that **this plan's figures were left part-written on its parameters**, and the Plans register shows **Publish cut short** in its Status column, which can be filtered on.

Unpublish the plan, then publish it again: unpublishing takes off whatever figures are there, and publishing again writes them all. Re-plan is not offered until then. For up to half a minute, while a sound publish may still be writing, the plan reads **Publishing** instead, and the page and the register look again by themselves.

Approval before publishing

Publishing is a commitment the mine budgets against, so it can be made to wait for a sign-off. On the Plans register, **Approval of plans** - level 6, admin or the account holder - sets a chain of desks for a Tracker Group: stage one, stage two and so on, each naming the members or clearance levels who may sign there and whether the account holder may too. Stage two opens only once stage one has signed. Nobody signs twice: someone who signed an earlier stage is turned away from a later one, so no one person clears the whole chain - unless that later stage has **Earlier signer may sign on**, for a small mine where one person holds both desks. A group with no chain publishes straight away.

With a chain, **Publish** checks everything a publish checks and then parks the plan as **Awaiting approval**, naming the desk it is waiting on. Nothing is on the parameters yet, and the plan is locked. An approver at that stage sees **Approve** and **Decline** on the plan: approving signs it on to the next desk, and the last approval writes the figures; declining sends the plan back to its planner as a draft with the reason shown on it. Whoever asked, or the account holder, may **Withdraw** the request.

Nobody has to keep the register open to notice. When a plan reaches a desk, every approver at that stage is told on their subscribed devices, the way a form awaiting their signature tells them; when it is sent back or published, the planner who asked is told, with the reason where there is one. On the register a plan waiting on *you* reads **Awaiting your approval**, the header counts how many are, and **Show - Awaiting my approval** narrows the register to those. An approver with no signal can still decide: Approve and Decline queue on the device and go up the moment it next has a connection.

When a plan's figures are written, the plan records which pickups made the ground as of its date, pit by pit. A published plan lists them under *Published from these pickups*, and if a pickup is later re-dated, added under that date or taken out - or an adjustment made or undone - the plan says so in a warning above its figures. The figures stand as published; a re-plan reads the ground as it is now.

Re-planning part-way through

A plan is computed from the ground as it stood on one date. Two months into a twelve-month plan the pit has not gone the way the plan said, and the ten months left need planning again - but the months already worked were judged against the plan as it was, and unpublishing the whole plan to replace its tail would take that record with it.

Re-plan on a published plan opens a new plan over the rest of the horizon. **From** is one of this plan's own period boundaries, the first on or after today offered by default - a period is never split. **Periods** is offered as what this plan has left, and **Name** as this plan's name with the day appended.

1. Add the latest survey pickup to the pit's running surface.
2. On the published plan, press **Re-plan**, pick the period to start from, and press **Re-plan** again. The new plan opens as a draft with everything copied.

3. Move its **Ground as of** date to the pickup. Benches the pit has actually taken are gone from the reserve; benches it has not are still there, whatever the old plan expected.
4. Adjust what has changed - the fleet, a capacity, the target - then **Compute** and **Publish**.

HOW IT BEHAVES

Publishing the new plan is where the old one changes: its periods from the new plan's first day on are removed and replaced, its earlier periods stay exactly as published, and it is marked **Closed** - readable, exportable and reconcilable, but never edited or unpublished again. Unpublishing the new plan afterwards removes only its own periods; the old plan stays closed, because what was cut is gone. The dialog says so before you commit.

The budget against the latest plan

A twelve-month budget re-planned every month is twelve plans, each closed by the next, and each plan's page shows only its own periods. The **chain** action - on any plan that has been re-planned, or is a re-plan - shows the whole chain as one thing. Every plan is named across the top, oldest first, the closed ones greyed.

Over the horizon gives each figure three ways, summed over every period any plan in the chain covers: what the budget said, what the latest plan says, and what was filed - with latest less budget and filed less latest. **Period by period** gives the same for each period, naming the plan the latest figure came from. The budget is the first plan of the chain; the latest is the last plan to have planned that period; the filed figure is what was recorded on the parameter that plan published the figure onto. Nothing here is stored, and the export bar takes it away.

Reconciling at period end

Reconcile on a published or closed plan shows each figure of each period four ways: what the plan said, what the surveyed ground lost between the start and the end of the period, what was filed on the parameter the figure was published onto - with the difference - and what crossed the weighbridge over the period, on the total tonnes alone, since a weighbridge sees loads and not ore from waste. The surveyed column needs a running surface that can be read as of two dates and is filled for the tonnes figures only. The weighbridge stores a bare number, so you state what it records in and the weighed column is read in tonnes; where the account holds no weighbridge the column is empty and the dialog says so. Nothing here is stored; it is read from the survey, the readings and the tickets each time, and the export bar takes all four columns away together.

Underground: stopes and headings

A third shape, beside a pit design and slices of a boundary. Choose **Stopes and headings** and the plan stops being about benches altogether.

Open pit asks how far down it pays to dig, and the answer is one shell. Underground asks which pieces of the orebody are worth the drives that reach them, and the answer is a set of separate stopes with the rock between them left standing. The plan works that out from a **frame** - what shape a stope is allowed to be - and what mining one costs.

Field	What it is
Sublevel interval	How tall one stope is: the distance between sublevels, and what a longhole rig drills in one go.
Panel length	How long one stope is along strike.
Narrowest and widest stope	What the equipment can mine and what the ground will stand, across strike.

Field	What it is
Wall slough (ELOS)	How far each wall sloughs in, metres. That rock is barren and still gets hauled and treated.
Mining recovery	The fraction of a designed stope actually recovered - pillars left standing, ore lost in the drawpoint.
Price and the two costs	What decides how far across strike each stope is taken. This is the optimisation, not a report.

HOW IT BEHAVES

The level height and the panel length are the method. **The width is the variable one, and choosing it is the optimisation:** for every panel the plan takes the run of rock across strike worth the most, between the narrowest and the widest allowed. Every admissible width is examined, so no better one exists.

TAKE CARE

Everything mucked from a stope is fed. Nothing is sorted underground, so the waste caught between the ore goes to the mill with it - which is why the width is a real decision, and why a minimum width forced on a narrow orebody shows up as a lower grade rather than as more metal.

Under **The development that reaches them**, tick the headings designed for this item **in the order they are driven**. Each follows the one before it, and every stope follows the last of them, so a level is reached before it is mined. A heading is a unit like a stope: it breaks rock that has to be hauled, it uses the same capacities, and on an ore drive it produces as well.

HOW IT BEHAVES

By the end of any period, no more of a stope has been taken than of the development that reaches it. What that does not say is that the drive must be *finished* first: two thirds of a decline permits two thirds of the stope below it, because the schedule is solved in fractions. Where it must be all-or-nothing, **pin** the heading to the period it is driven in and every stope behind it waits.

The order the sublevels are worked is bottom-up by default, so a stope is filled before the one above it is taken and the fill becomes the next floor. Stopes are stacked by panel, so only stopes in the same panel wait for each other.

TAKE CARE

An underground plan cannot be walked to a target or to capacity. Those walks take benches top-down, and underground has no top-down: a stope waits on the heading that reaches it, not on the ground above it. Plan it to the best order, or read a schedule in as imported.

Each heading is drilled and loaded as its round is. Where a development round has been designed for a heading in **Underground**, the plan charges the heading's drill and explosives processes at that round's own drilled metres and kilograms per tonne; stopes keep the typed rates. Of several rounds, an approved one is taken before one not yet approved: the one approved last, or else the one filed last, never a retired one. A save or a firing does not count, so a new round supersedes the last on the next compute. A saved plan charges each stope at the rings drafted from it the same way. Rates are scaled to the plan's rock density where the round's differs. The *Drill and blast* card lists each heading and its round after a compute. The card and the first period's notes name any heading with no round, or with a round that charges nothing, which keeps the typed rates. A plan reads up to 2,000 rounds

a mine, and the card says when a mine has more.

Everything else in this chapter then applies unchanged - capacities, blending bands, stockpiles, haulage from the road, the dump balance and publishing - because the units are units.

A thin seam: panels and strips

A chromitite seam on the Great Dyke is a sheet, not a lump: 25 to 30 cm thick, coming to surface along strike and dipping gently into the ground. A block model cannot see it, a pit designed from a flat floor does not fit it, and a stope laid out across strike between sublevels is nearly all waste. So a seam is modelled on its own in **Seams** (see Modelling a seam, in the geology chapter) and planned with one of two shapes of its own: **Seam panels**, mined underground between levels and reached by inclines, and **Seam strips from the outcrop**, taken down dip until a strip stops paying for its waste.

Choose either and the plan names a **Seam** instead of a block model. The grade field, the ore rule, the density rule, free-dig, the qualities and the recovery curve all read a block model, so they go; the seam carries its own floor, thickness, grade and density. The grade unit and the recovery stay: a chromitite graded in percent makes tonnes of oxide at 0.01 per tonne.

Seam panels

Field	What it is
Panel length	How long one panel is along strike.
Level interval	The vertical distance between levels. At 15 degrees a 10 m interval is about 39 m of seam down dip.
Stoping height	The least height broken square to the seam - what people and machines work in. Where the seam is thinner the rest is wall rock, fed with it.
Extraction	The share of a panel mined; the rest stands as pillars. Square 6 m pillars at 12 m centres leave a quarter, so 0.75.
Mining recovery	Of what is broken, the share that reaches the plant.
Crown pillar	Rock left over the seam near surface. Where the seam is also stripped from its outcrop, set it to the open cut's depth.
Price, costs, wall rock density	What decides which panels are worth mining.

TAKE CARE

On a thin seam the stoping height is the grade. A 0.3 m seam at 40 percent stoped at 1 m sends 0.7 m of barren wall rock to the mill with it, and the mill sees about 15.5 percent. That is the price of a thin seam, not a fault in the layout.

Tick **The inclines that reach them** in the order they are driven; each follows the one before it and every panel follows the last. The levels are worked top-down by default. Like stopes, panels wait on their access, so a panel plan is planned to the best order or read in as imported, and the plan refuses the target and capacity walks.

Seam strips from the outcrop

Field	What it is
Strip width	How wide one strip is down dip, in plan, counted from where the seam leaves the ground in each cut.
Cut length	How long one cut is along strike - the unit the schedule takes.
Least digging thickness	The least height a bucket digs square to the seam. On a 25 cm seam it still takes this much, and the floor rock beyond the seam is fed with it.
Seam left behind, floor dug with it	Seam lost when it is exposed, and floor rock that comes with it, as thicknesses.
Most strip ratio	The most waste a strip may carry for every tonne it feeds. Blank: a strip is taken while it pays.
Final highwall	The angle the last strip's wall is left at. Default 70 degrees.
Cast the overburden into the strip before	Each strip's overburden goes into the void beside it and asks nothing of the dumps. The box cut still goes to the dump.

HOW IT BEHAVES

Down each cut the strips are taken while each pays for its own overburden **and for the extra highwall it adds**, and the first that does not ends the cut. The wedge behind the final wall is stripped with the last strip. A strip plan can be walked to a target or to capacity: the walk takes the shallowest strips first, which is the order they are dug in wherever the seam keeps dipping the one way.

WORTH KNOWING

One seam can be mined from the outcrop and then underground, as two plans on the same seam: a strip plan for the open cut, and a panel plan whose crown pillar is the open cut's depth.

Waste dumps, and whether the waste fits

Waste has to go somewhere. The **Waste dumps** card lists the dumps the plan tips into, **in tipping order** - the first fills first, then the next, and the arrows change the order. Each names the dump item, its dump design, and what is already in it: a figure typed, or **measured off a survey** of the dump as it stands, read as of a date. A compaction factor says what each loose cubic metre tipped settles to; the runoff coefficient and the toe pond are for the rain.

Compute designs each dump against its ground, measures what it holds, turns every period's waste into loose cubic metres through the swell factor, and tips them into the dumps in order. The result shows, per period, the loose waste, what each dump took, what is in it at the end and the space left, with a **full** mark on the period a dump fills. In **To capacity** the dumps' space is a capacity like any other and **binds**: the walk stops when they are full and names *Waste dump space*. In **To a product target** the target is taken anyway and the period whose waste has nowhere to go says so, in red, with the volume. In **To the best order** the space is one limit over the whole horizon and the optimiser will not plan more waste than the dumps hold.

HOW IT BEHAVES

The space is a stock, not a rate: what one period uses of it, the next does not have. The demand table shows the space left over the horizon under the Waste dump space row. A dump whose footprint overlaps the pit's crest is reported, with the shared area.

Water: rain and groundwater

Switch **Plan for water** on. Type the site's mean rainfall by month and the storm the pit is designed for - the 1-in-10-year 24-hour depth, say - and, for each pit, its runoff coefficient (about 0.9 for bare rock and haul roads; the catchment is the design's opening), any outside ground that still drains in once the diversion drains have taken their share, the sump, the pumping rate of all the pumps together, their hours a day and availability. A dump sheds about half of what falls on it.

Groundwater goes on the same block. Give the pit a **steady inflow** in cubic metres an hour - seepage and springs, as the hydrogeology report puts them - and, where the pit goes below the water table, the **water table** as a level with a rate **per metre below** it. Every period reads how far the floor it has reached sits below the table and takes that many metres' worth, all day, rain or no rain; a floor above the table takes none of it. Leave all three blank for a pit above the table.

Leave the **sump** blank and the plan reads the sump the pit's design carries; leave the **outside catchment** blank and it reads the strip inside the design's diversion drain. The placeholder under each field says which it will use. A typed figure always wins, and a sump typed as zero means none.

Every period then shows, for the pit and each dump, the runoff - rainfall times area times coefficient - and the groundwater the period took, against what the pumps clear in the period's days and the pumping hours the two together take; and the storm, with the groundwater that keeps coming while it falls, against the sump and what the pumps move meanwhile, the excess, and how deep it floods the floor of the lowest bench the period has reached. A period whose inflow outruns the pumps is marked in red, and the warning says by how much; groundwater with no pumps to move it is marked the same way, because it is a pit filling up.

TAKE CARE

Water never stops a plan. It is worked around by pumping, by the sump, or by mining the low benches in a drier month; the plan's job is to name the month and the figure before it arrives. Evaporation is ignored, which makes every figure conservative; the groundwater is what you typed, so a pit whose inflow was never measured reads as dry below the table until somebody measures it.

Plans by period, on any parameter

Publishing writes rows into a facility every parameter has, whether or not the Mining module is licensed. On a Tracker Group's parameter, and in the form builder's field editor where a field is linked to a parameter, **Plan by period** sits under the single plan figure: a cadence, a start date, the derived end, and the figure for the whole period. **Add period** starts the next row where the last one ends. A reading in a period is judged against that period's figure; any day no period covers falls back to the plan above.

*Rows set by a mine plan appear here marked **Set by a mine plan** and are changed from the plan, not here. A reading-goal parameter has nothing to hit and carries no plan.*

A worked example: the Daily Tracker

A site files a **Daily Tracker** form every shift. Its Trucks section repeats one row per item of the HAULAGE TRUCKS group, with a computed **Tonnage** of loads times truck factor, and the Summary totals tonnage across the fleet. Because the section is linked to the group, every truck's Tonnage is stored as a reading on that group's Tonnage parameter.

1. Start a plan for the pit. Ground: the running surface, as of the first of the month. Block model and pit design: the current ones. Grade in cpht, ore by cut-off, density one figure.

2. On **Waste haulage**, set Capacity from to **Demonstrated by a parameter**, pick the trucks' Tonnage, look back three months, taken as the mean, and press **Fetch actuals**.
3. Mode: **To capacity**. Cadence monthly, starting on the first, one period. Press **Compute**.
4. Read the result: the benches the month takes, the carats that buys, and whether waste haulage or something else binds.
5. Press **Publish** and put **Waste** onto the trucks' Tonnage parameter. The dashboard dial for Tonnage now carries the month's target, and every shift's Daily Tracker is judged against it.
6. At month end, press **Reconcile**: planned waste, the survey's cut times density, and the tonnage the shifts filed, side by side.

18 Drill and blast

Blasts

Mining > Blasts

A blast is a block of a bench, the holes drilled into it, and what each hole is loaded with. Trackapt drafts the holes from a handful of rules, drills every one to the grade from the ground it actually stands on, and works out the explosives from the holes as they stand.

WORTH KNOWING

Nothing is set in stone. The drafted pattern is a starting point. Move a hole round a boulder, drop one on soft ground, add filler holes where the face is ragged, bring in the pattern the surveyor marked out, record what the crew really loaded. Every figure follows the holes you end up with.

Designing a blast

The pattern has the page to itself. What the blast is set up from sits in seven tiles along the top - **The block**, **Ground and rock**, **Pattern rules**, **Timing and checks**, **Top of ore**, **Tie-up** and **Front row** - each saying what is set, with a warning stripe where something needs you. A tile opens its section as a window; what you change applies as you type, so closing it loses nothing.

The tiles sit under a **The set-up** heading that folds. It stays open while there is no pattern, and folds away once one is drawn so the picture comes first; folded, it still counts what needs attention. Open or fold it yourself and that choice stands while you stay on the page. The checks and the front row, with its table, are never folded away.

1. Open **Blasts** and press the plus.
2. Under **The block**, choose the **pit**, then where the block comes from: a bench of a pit design, one of the pit's boundaries, or corners you type. A new boundary is drawn in the Mining workspace, under **Design blast**.
3. Under **Ground and rock**, pick the **surface** the collars are read off. The levels are then read off it for you - pick **which bench this shot takes**, or type the floor and crest yourself.
4. Once per pit, under **The block**, set the **Pit bench height** and **Bench reference RL** and press **Save for the pit**. Ground spanning more than one planned bench is then offered bench by bench, each drilled to the floor of the one below, top first - ground rising above the top level without a flat is offered too - with **All benches together** beside them for one deep blast. A span up to a fifth taller than planned is still one bench. The mine plan shares the height; a blast can work on its own under **Pattern rules**.
5. Under **Pattern rules**, set the hole diameter, the product and the rock, and how the burden is decided.
6. Press **Draft the pattern**.

Burden from	What it does
From the hole and the rock	Konya and Walter's rule from the diameter and the two densities. The usual starting point.
To a powder factor	Type the kilograms per cubic metre this rock is blasted at; the burden that gives it is found.
To a fragment size	Type the mean fragment wanted and the rock factor; the burden that gives it is found.
As I type it	Type the burden and spacing yourself.

The **rock factor** says how hard the ground is to break: about 6 for weak rock, 12 for hard. Type it under **Rock factor** in **Pattern rules**, or have each hole read its own from a block model. A design with none is worked on an **assumed 9**, a medium-hard rock, so the mean fragment is never simply missing, and the Mean fragment line says so: *on rock factor 9 (assumed - set the design's own)*. A design's or a hole's own rock factor always wins; designing **to a fragment size** still needs one typed; and an assumed fragment size is never saved with the blast.

Where no fragment size can be predicted at all, the Mean fragment line says why in place of the figure, first reason that applies:

- *charge the holes to predict it*: nothing is charged. Draft the pattern, or check the product and that the stemming leaves a column to charge.
- *no rock under the charge to work a powder factor on*: the holes are charged but the block holds no rock between its crest and floor. Check the outline, the floor and crest levels, and that the ground under the block is surveyed.
- *the design's rock factor and some holes' own are 0 or less — type one above 0 in Pattern rules, then re-draft the pattern on it*: both of the two below at once. Type one above 0 under **Rock factor** and draft the pattern again.
- *a rock factor of 0 or less predicts nothing — type one above 0 in Pattern rules*: the design's own rock factor is 0 or less and the holes read it. Type a rock factor above 0 under **Rock factor** in **Pattern rules**, or clear the field to work on the assumed 9.
- *the holes were drafted on a rock factor of 0 or less — re-draft the pattern on one above 0 in Pattern rules*: each hole keeps the rock factor it was drafted on. Type one above 0 under **Rock factor** and draft the pattern again.
- *the product's strength (RWS) is 0 or less — set one above 0 under Explosives*: the holes have a rock factor, but the product's **Strength (ANFO = 100)** is 0 or less.

The reason is judged from the rock factor each charged hole actually reads: its own where it carries one, the design's where it does not. A design's rock factor of 0 is only named where a hole falls back on it. A cleared **Rock factor** field is no rock factor, never a 0.

Where only some charged holes read a rock factor of 0 or less, they are **left out** of the rock factor the fragment size is worked on rather than averaged in, which would predict the rock breaking finer than it will; their charge still counts. The Mean fragment line says so under the figure: *worked without 3 of 40 charged holes — their rock factor is 0 or less*, and the charge sheet carries the count as **Charged holes left out of the rock factor (0 or less)**. Type a rock factor above 0 and re-draft the pattern to bring them back in.

A charged hole with no rock factor of its own, where Pattern rules has none either, is left out too, with its own reason: *worked without 4 of 40 charged holes — they have no rock factor of their own and Pattern rules has none*. Both kinds at once read *worked without 7 of 40 charged holes — 3 on a rock factor of 0 or less, 4 with none of their own and none in Pattern rules*, and the charge sheet gives them their own row, **Charged holes left out of the rock factor (none of their own, none in Pattern rules)**. Typing a rock factor in Pattern rules brings these back at once, with no re-draft.

A fragment size worked without some holes is still saved with the blast, with the Mean fragment line's words saved beside it among the blast's warnings: *Mean fragment worked without 3 of 40 charged holes — their rock factor is 0 or less*.

Rows are laid one burden apart from the **free face** — the open side the rock is thrown towards, found on the surveyed ground: an edge where the ground falls to half the bench within two burdens of the outline, half the bench measured from the bench's own crest and floor. Where the face's crest stands out past the outline the rows are laid from the crest, and past a burden the pattern card offers to **extend the blast to the face** so the rock between is drilled. Where the outline runs down the batter, the crest stands inside it and the rows are laid from the crest, so the front row keeps a full burden. A block with no face within reach is a **box cut**, drafted along the edge with the lowest

ground beyond it and fired as a V from the centre. Under **Front row, Pick the edges myself** sets the face by hand where the survey does not show it; each edge's **View** opens the plan, where clicking beside an edge ticks or clears it. A firing point is picked the same way, by clicking its hole on the plan.

The levels a boundary stands at

A boundary drawn on a pit survey does not need its levels typed: the ground under it already stands at them. Once a surveyed **surface** is set, the ground inside the block - and out to 30 m around it - is read for the levels it holds, and every pair of them is offered as a bench of its own, because a bench is taken from one level down to the next below it.

- **RL 1100 to RL 1090 - 10.0 m - 4,210 m²**: the crest, the floor, the bench height, and how much of the block stands at or above that crest. The bench standing on most of the block is taken for you.
- Where the block sits wholly on one flat, the level its face drops to is read off the ground just outside it, and the bench says so: *floor beside the block*.
- A floor that is not flat - humped and hollowed over a metre or more, with no one level holding enough of it - is offered down to its **lower edge**, so nearly every hole on it stays in play. **Where its floor is taken** switches to **Its mean**, and the page says beside the choice how much of the block each leaves out of play: holes on ground already at or below the floor design to nothing. A saved blast keeps the choice. Ground that lies on one plane - a ramp, or a floor graded to an even fall of a metre or more - is read as a slope, not a floor: type that floor, or drill it to a grade surface.
- **Expect small benches**, off by default, looks for thin benches - a capping over the ore, a thin ore bench on the basement. Where the ground steps between well-defined flat platforms less than a bench apart, the page asks whether they are separate small benches or one floor that is not flat, and takes no bench until you answer. Separate, the thin bench between them is offered like any other; haphazard heights, ramps and graded floors are not asked about, and until you answer the levels are exactly what they would be with the switch off. Platforms under half a metre apart, or too narrow for the survey's sampling, are not found; a flat-bottomed sump may be asked about. Changing the outline asks again.
- **Levels I type** - or simply typing in **Floor RL** or **Crest RL** - settles them yourself, and the page stops offering its own.

Whoever set them, the levels are checked against the same ground. Four things cannot be drilled on it and are said on the page itself, with the real bench offered beside them:

What it says	What it means
There is nothing here to drill	The floor is at or above the ground across the block: that bench has already been taken, or a digit slipped.
The bench above this one has not been taken yet	The crest is below all of the ground, so the holes would collar under standing rock.
More than one bench	The floor is further below the ground than one bench. Take them one at a time.
The crest must be above the floor	A bench is drilled from its crest down to its floor. Refused on save as well.

Everything else is a warning, because each of them is sometimes what was meant: part of the block already dug out, rock still standing above the crest, a crest above every collar, a floor at no level the survey holds, a floor above the lower edge of a floor that is not flat (with how much of the block that leaves out of play), or a bench height that disagrees with the ground. A block with no surveyed ground is checked for one thing only - the crest against its

own floor, which needs no survey - and Save is held until that is right.

How long each hole is

A hole's length is never typed. It runs from the surveyed ground at its collar down to the grade under its toe, plus the sub-drill, and along its lean: $\text{length} = (\text{collar RL} - \text{grade RL} + \text{sub-drill}) / \cos(\text{lean})$. A hole on a high spot is longer and holds more, which is what keeps the floor flat. The grade is the floor RL, or a designed grade surface for a ramp or a drainage fall. The holes table and the charge sheet give each hole's lean and toe RL.

A rig drills from the top of the bench, so the collar is always the surveyed ground itself and a drafted hole is only laid where a rig can stand. It is left out where the lie of the ground across the rig's footing is steeper than 20 degrees both across 2.5 m and across the pattern's own footing (0.6 of the burden, at least 1.5 m) - so a rough top is never taken for the face, and a small pattern keeps its first row - where it is more than 30 percent of the bench height (at least 1 m) under the crest, or where it stands more than half a bench over it (the bench above). A hole added by hand there is kept, with a warning saying why. A smaller pattern collars nearer the crest: on a 2:1 face about 0.7 m back at a 2 m burden and 1.15 m at 4 m; behind a vertical wall 1.5 m and 2.4 m. If every hole would be left out, Draft leaves the pattern as it was and says why. The rock is measured from the same ground, so the powder factor holds; charged holes kept on the bench above are warned about, because the rock there is measured from the crest and the powder factor reads high. Recharging an older blast reads the ground again, so its collars move onto it.

In three dimensions

The pattern card switches between **Plan**, **3D** and **Pictorial**. The same three buttons also sit inside the picture, beside its legend, so you can change view without scrolling back up - and a picture taken full screen stays full screen. The eye at the picture's top-right corner takes the legend and those buttons off the picture when they cover the holes you are looking at, and brings them back on the next click; the choice is kept as you switch between Plan, 3D and Pictorial. The expand control beside it fills the screen. In 3D each hole is a rod - grey stemming, orange charge, blue where wet - standing in the blast's **surveyed ground**, so the real ground profile shows: the crest, the face, any toe left in front. Beneath it are the **grade** and, where there is ore, the **top of the ore**. Each collar sits on the surveyed ground where its hole is drilled. Click a layer in the legend to switch it off and see the holes inside it, or **Drill holes** to take the holes out and look at the ground on its own - the camera stays put, so switching them back on shows where each one stands.

Rest the pointer on a hole in **Plan** and its name, position, depth and inclination are written along the bottom of the drawing. A hole with something wrong also shows a tooltip beside its collar saying what: its warning, and what the front row found for it - a hard toe, no free face at the toe, too little rock in front of the charge - and why a fix could bring it no further forward. A sound hole shows no tooltip. A hole with an **error** is drawn red: it cannot fire as designed - nothing to charge, a collar past the final wall, a wet hole loaded with a product water spoils, a hard toe, no free face at the toe or too little rock in front of the charge, or the gap a removed hole leaves beside it. A hole with only a **warning** is drawn amber: an unsurveyed collar at the nominal crest, a stand-off note, why a fix could bring it no further forward. The legend says *Has an error* and *Has a warning*, each only when a hole on the plan has one.

Hide ... with warnings, beside the view buttons, takes every hole that carries a warning or an error - its own, what the front row found for it, or a gap beside a removed hole - off the plan, the 3D pictures and the plan sheet. Nothing is removed from the blast; the holes table still lists them.

Pictorial shows what a person standing on the bench would see: the surveyed ground, solid, with a collar where each hole is marked out, and nothing below the surface. It is the same picture as 3D drawn another way, so switching keeps where you turned and zoomed to.

The 3D picture draws ground only where the survey walked; ground the surveyor never picked up shows as a gap, the same rule the volume engine uses. A ramp, the far side of a highwall or a sump the pickup did not reach is a hole in the picture, not a fault in it. The ground is cut to a straight edge 20 m round the block, and further out where a berm or island card's window takes in ground beyond the block.

How the holes are named

A designed hole is named for where it stands: the row as a letter from the free face back - **A** the front row, **B** the row behind it, and past the twenty-sixth row **AA**, the way a spreadsheet letters its columns - then its number along the row. A1, A7, B12. The rows that are not the pattern's take a three-letter token, so nothing reads as a row: BUF-01 a buffer hole, TRM-01 a trim hole, ISL1-01 a hole covering the first island, FIL-01 a filler you add, and SUR-A1 a collar brought in from a pickup that no design hole stood at. An easer is named after the front hole it stands behind with an E - A4E, and A4E2 should a second come off the same hole. A blast drafted before this naming keeps the names it already carries - R1-01, B-01, F1, S1-01, and easers R1-04E, R1-04E2 - for the whole of its life, through a re-draft, a pickup and a filler added at the face, because its charge sheet, its change log and the tags on the ground are already written that way. The two are never mixed on one blast.

The plan sheet

In **Plan** each hole is named with its depth and, where it is not drilled straight down, its inclination. **Plan sheet** draws the pattern on the same sheet a survey plan prints on - the paper, orientation and scale you choose, the four corner blocks, printed at true size - with every hole marked and named over the block and the ground's contours. It starts at the smallest scale that holds the holes; where a scale leaves labels running together or a hole off the sheet, it says so and names a larger scale.

The front row

A real face leans back, bellies out, and keeps a toe. So Trackapt reads the rock in front of every hole next to the face off the surveyed ground: the **toe burden**, just above the grade, and the **least burden in front of the charge**. Too much at the toe is a hard toe; too little in front of the charge is flyrock.

Flagged when	Unless you set it
The toe carries more than the burden by more than	20 %
The charge has less of the burden in front of it than	70 %
No face in reach - no open face within four burdens of the toe	always

No face in reach means the ground in front stands as high as the toe - muck left from the last blast, a ramp, or ground not taken down to grade. No lean, move or easer gives that toe anywhere to break to, so the draft cannot fix it and the finding does not pretend it can: clear the face in front before firing, or check the face picked for the blast. The Front row card's table and the export read *no face in reach* for such a hole.

The two are read separately, and not always the same way: the toe the way the hole breaks, the charge the way its cover is thinnest, since flyrock goes to the nearest open ground. Each finding says which way it was read, so one hole can be flagged for both - too much rock at its toe and too little halfway up, from a face that kept its toe and bellies, or a step beside the hole that stops short of the floor. That is not a contradiction. Where the thin cover is on the side the toe breaks to, bringing the hole forward would thin it further and moving it back would add to the toe, so the findings say not to: stem the hole down past the thin level, and handle the toe with a toe hole or a heavier bottom charge. **Fix the front row** does the same: it never brings such a hole forward, leans it only as far as the cover does not thin, and says the collar was not brought forward because the charge's cover would thin.

Fix the front row leans each hard-toe hole towards the face, up to the most lean (30 degrees unless you set it), then brings it forward as far as the rig can still stand on the top of the bench and the charge keeps its burden - never onto the face - and names any toe that still needs a toe hole or a heavier bottom charge. Where a bund, a hump or the crest's edge stopped the collar, it says the hole could not come further forward because a rig cannot stand there - so a rough top leaves more toes for the blaster. Where the top falls away towards the crest, the collar comes down as it is brought forward, and the top of the charge with it; once the charge would not rise above the toe, it says the hole could not come further forward because the charge would not rise above the toe there, and that toe too needs a toe hole or a heavier bottom charge. A hard-toe hole already leaned the most the rules allow is not told to lean further: it is told to come forward, or to take a toe hole or a heavier bottom charge. A drilled hole is never touched; a hole the surveyor marked out is only leaned. Every draft is fixed this way as it is drafted, by default; under the **Front row** tile it can be set to only flag the hard toes. The front row is whichever holes have nothing ahead of them and the ground falling away in front, so where rows on the face or on a bund along the crest were left out, the row behind is judged and fixed. One hole left out of a row, off a hump or out of free-dig rock, does not make the hole behind it a front hole; a strip of two or more, or a whole row of free-dig rock, does.

An easer row and a bottom charge

A front hole leaned to the face puts its toe out towards it, so the row behind, drilled plumb a burden back, has that much more rock at its toe. Leaning every row to match leaves a slanting wall behind the blast - a toe the next cut makes for itself. Under the **Front row** tile a new blast's front row is laid, unless the mine chooses one hole a spacing apart instead, as **a leaned front row with an easer row behind it**: between each two front holes where either is leaned, an easer named after the first with an E (A4E) stands half a spacing across and set back half a burden, in a row of its own. The leaned holes take the toe at the face; the easers break what they leave; the rows behind stay plumb. A row of its own matters on the bench: every row is then a row of one angle, so the crew can tell the front row from the easer row by eye and tie each up for what it is. Holes of two angles alternating along one line of collars are one row to look at, and a surface connector tied to the wrong one is a hole fired with nothing broken in front of it.

Only the holes that need it lean: a front hole leans only as far as its own toe asks, and no easer goes between two front holes where neither neighbour was leaned or brought forward for its toe, so on easy ground an easer row adds nothing. No easer is added either where it would stand too close to another hole - one placed by hand included - or where no rig can stand. Wherever a leaned front hole is left with no easer behind it - skipped for any of those reasons, or deleted by hand - the pattern card says so, naming the pair, the extra rock the row behind then carries at its toe (up to the bench height times the tangent of the lean), and the hole standing in the easer's place where one does: *expect a hard toe there*. Two charges that close would fire as one, so the easer is not forced in; move or take out the hole in the way and draft again. A hole brought forward plumb is not read here: where it was laid is not kept once the draft is saved. A blast drafted before 19 September 2026 that never said how its front row is laid was laid hole by hole; its holes are left where they are, and where a front hole was leaned for its toe the pattern card says that drafting it again lays the easer row (choose one hole a spacing apart to keep it as it is). A blast drafted with the earlier paired layout, a plumb hole in the front row between two leaned ones, is told: *Drafted with the old paired layout: the easers are still in the front row. Draft again to move them into a row of their own*. Nothing is re-laid until you draft, and once a blast is drilled, charged, tied up, sent for approval or fired the note only says how it was laid.

An easer fires half way from the later of the two holes it stands between to the row behind it - the later of the two, because it stands behind both and the ground in front of it is opened by both, and half of that window rather than half a row delay, because an easer is a row of its own between two rows and must leave the row behind as much time as it took - rounded up to the whole millisecond, or with shock tube the nearest surface connector not less than that. It takes no place of its own along the row, so the front row keeps pace with the rows behind it. It leans too, half as far as the row in front: set back and left plumb it would carry half a burden at its collar and far more at its

toe, so its toe is put half way between the front row's and the pattern's, leaving the rock it must break the same depth in front of it and behind it. An easer row only adds holes beside front holes leaned or brought forward for their toe, never on a hole placed by hand, so drafts must be fixing the front row. **Fix the front row** and a reset to the rules both leave an easer at its own lean. Its toe is never flagged - judged against the face the blast started with it reads as a hard toe every time, and the face it really fires to is the one the leaned holes make - but the cover over its charge is. The set-back can be changed for the blast; half a burden is what its lean is worked to.

Choose a denser **bottom charge product** and every front hole is loaded with it at the bottom, where the burden is heaviest, with the pattern's product above it, under a longer stemming - heavy at the toe, not the whole length. By default the bottom charge is 1.3 burdens long and the stemming one burden, never shorter than the pattern's: Langefors and Kihlstrom's bench-blast proportions. Both can be changed for the blast, and the tile shows what they come to in metres. An easer is charged for the burden an easer has: its bottom charge is worked over its set-back rather than the pattern's burden, since a bottom charge is sized to the rock it has to lift. Stemming goes the other way. A hole standing less than a burden from the face it fires to carries thin rock over the top of its charge, and that is where flyrock leaves a bench, so its stemming is lengthened in proportion - up to the blast's longest stemming, 1.5 burdens by default - to put the top of the charge back under cover. An easer asks for twice the stemming and is held to the cap; a front hole brought forward for its toe, or one on a crest that has back-broken, is lengthened by what it lost. A hole with a full burden in front of it is not changed, and no stemming is ever shortened. The bottom charge is its own product in the totals, on the charge sheet and on the magazine - as designed and as loaded: recording loads as designed keeps it apart, and a loaded kg typed for a hole keeps its bottom charge - and the holes table and the charge sheet show it hole by hole. The charge sheet gives each hole its charge length and total charge; its column length and column charge - the column above the bottom charge, that is the total less the bottom charge, in metres and in kilograms - and the bottom product, its kg and its length. When the blast is fired, a product with no magazine item, or not under Explosives (or renamed there since the blast was drafted), is named in what was not filed.

The heavier front throws further. The checks work Richards and Moore's range for the front row as it is loaded and show it as **Front row flyrock**; where it throws further, the warnings say the front row is charged heavy and how far to clear the blast. Each hole is read over the burden it actually has, so where the worst is an easer the warning says how far that hole stands from the face it fires to, and the figure is not read as the front row's. With an easer row they also ask you to check how far the easers stand from the holes around them - across to the leaned holes in front, and back to the row behind - against your explosive supplier's least distance between charged holes, and name any hole beside an easer too close for its delay - less than 8 ms for each metre between the two, or the pattern's own hole delay per metre of spacing where that is less - and any pair firing less than 8 ms apart, which the ground takes as one charge. Whatever the front row, the checks name any hole that fires with or before the hole ahead of it towards the face: with nothing broken in front of it, it chokes, craters and throws. Each hole is judged against the earliest-firing hole of the nearest row of charged holes ahead of it, whichever row that is numbered, so the rows behind are compared with the row in front of them too; whether that lead is long enough for the burden is not judged. Where nothing is charged ahead of a hole, the warnings name it as not judged - check its delay by eye - and a blast with no front to judge from says relief was not judged. Wall and island holes are not judged. A box cut fires from the centre out, so the warnings say once that its relief was not judged: check by eye that every hole fires after the hole that opens ground for it. A blast with no ground survey is not a box cut: it is judged from its numbered rows, row 1 at the front. Your statutory exclusion zone always governs.

Thin-cover flyrock is the same range again for the front hole with the least rock in front of its charge, read off the surveyed ground rather than the design burden - the bottom charge's kilograms a metre where the thin rock is in front of it. The blast is cleared to the furthest of the three - the pattern's, the front row's and this one - and a warning says so when this one sets it. A charge with under 0.1 m of rock in front of it stands in the open: no clearance can be worked for it, the checks and the charge sheet say so, and the hole must be stemmed down, moved back or left uncharged before firing.

Fly-rock or a hard toe

Places to protect are kept in one register under **Pattern rules**. Each has a name and its mine-grid position, and either or both of:

- a **vibration limit** (mm/s), from 0.1 to 1000 - leave it blank for a place that only needs keeping fly-rock off, such as a workshop or a haul road. A limit outside that range is refused, whether or not the place is protected from fly-rock;
- **Protect from fly-rock** - ticked by default. Untick it for a place that only needs its vibration kept down. A place with neither is refused.

The checks show the predicted vibration at each place with a limit, against that limit; and for each place protected from fly-rock, how far it stands from the nearest charge - the line from a hole's collar to its toe, since a leaned front hole throws from near its toe - in red, with a warning, when that is inside the fly-rock clearance. A place with no East and North is **not known**: its vibration is never read as 0 mm/s or as a pass - the Checks card, the warnings and the charge sheet say *not known* and count it as failed until both are given - and a fly-rock place with no position is taken as inside the clearance, never measured from the grid's origin.

A draft fixes a hard toe by leaning the hole and bringing it forward, and bringing it forward thins the rock in front of its charge. Where the register has **no place protected from fly-rock** in reach, the draft goes on fixing the toe until half a burden is left in front of the charge - the cover an easer is laid under by design - rather than stopping at the 70 % the front row is judged by: some fly-rock is better than a toe left standing. The thin cover is still named on the front row, a draft stems it deeper where it can, and the clearance widens to cover what is left (thin-cover flyrock, above). Where a protected place **is** in reach, the draft leaves only as little cover as keeps its throw - Richards and Moore's face burst, safety factor in, for the densest product a front hole can carry (the pattern's, the wet holes' and the front row's bottom charge) - short of the nearest one, and never less than the 70 % it is judged by. The distance is measured from the outline less how far a fixed front hole's charge can stand past it - its lean down the hole at the most the rules allow, and a burden more - so it errs on the safe side. Adding, moving, ticking or removing a place works this out again before the next draft.

A front hole leaned for its toe and left between the two covers is named as **traded for the toe**, never told to move back, which would give the toe up again. Setting your own **least in front of the charge** under Front row takes this out of the draft's hands: it then fixes to exactly that.

Berms

A **berm** is the catch ledge left on a pit wall where one bench steps back from the next, and it stays, even a temporary one on a body mined along its dip. The page finds berms on the surveyed ground - a flat about the pit's berm width, no wider than half as much again, standing at least a fifth of a bench above the blast's crest (with no crest level set, none is looked for), with the wall falling at least a fifth of a bench (2 m on a 10 m bench) along one side and rising as much along the other - and drafts no hole on one, nor behind its crest: ground joined to the berm and no more than 1 m below it (0.4 of its height over the crest at most) is its ragged ledge and the wall behind, and a hole there would cast the berm into the blast. The card counts the positions on the ledge itself - its ragged edge, no higher than the berm and that margin, not those up the batter or on the benches above, which no pattern drills - and the window shades all of that ground. That ground and the berm itself are left out of the rock's volume, so the powder factor is the charge over the rock it is fired into, and the card says how many square metres were left out. A card on the pattern says it is **left as a berm**, and the eye on the card opens the pattern as a window with that berm's ground shaded blue-green and the ground behind its crest violet, so you can see which flat is meant; the card's width is the berm's alone, not the violet wall behind it. The window opens in the view the pattern card shows and has its own **Plan**, **3D** and **Pictorial** buttons inside the picture; the berm stays shaded in all three. The hole positions it kept off are pale rings on a dark rim, so they stand out on brown ground, on the shading and on either

theme. Ground at the level being blasted - a narrow top, a haul road, a platform you said is a small bench of its own - is never a berm, however rough. A berm that **sags along its length** and comes back up is still one berm: with the berm standing either side of the dip, the two stretches within a step of each other, the dip at least half a metre below them and the ledge's own step in front of it, the dip is the berm's. One card, one answer, and no hole in the dip; a ramp cut down through a berm joins the same way, so the road down belongs to the berm. Not joined: a berm that dips and stays down (two cards), berms stacked one above another, and the top of the bench standing high between two ends of a ledge - it has no step under it, and it is drafted. Ground below this blast's crest is never a berm. An answer given on a berm that now reads joined is kept only where the joined berm stands where the answered one did, so check its card. An island or strip running up to a berm is named on its card: only what stands on the berm's own step is left with it, and the rest - a mound on the top beside it too - is reached. The ground alone cannot tell a berm from a platform of this bench, so each berm card asks: **Leave it - it is a berm**, as it is until you say, or **Drill it - it is production ground**, which drafts its hole positions. Set the **Pit berm width** under The block (10 m unless you say), or **Berm width** under Pattern rules for one blast: 0 looks for none, otherwise 2 to 100 m. Older blasts show their berms when reopened, and nothing on them moves. Take a berm only once the benches above it are taken: start at the top bench and work down, or open a new cut along strike from the outcrop.

A block from a boundary or typed corners can name a pit design under **Final wall from**: no hole is drafted past the toe of the design's bench the floor lies on. That errs on the side of the wall - at a floor between two design benches up to a batter run and a berm is left unblasted against it.

The crest of the bench below

A block's outline can run past the top of this bench onto the top of the next bench down - along the foot of a wall, or where a bay of the pit wraps round. The ground there is a **lip**: at or a little under the crest you are blasting, the wall rising close behind it, and in front of it the ground falling away toward a lower bench. That lip is the top of the bench below, and a hole drilled on it is on the wrong bench - it belongs to the shot that takes the bench below, working down from the top. So the pattern leaves a designed hole off it and counts it. This is read off the surveyed ground, not the outline: round each point the steepest fall and the steepest rise are looked for, out to about a burden and a half, and the ground close underfoot must read flat - a lip, not a plain graded bench that merely tilts through the point. The point is the crest of the bench below when the ground falls at least a berm's step and **keeps falling** toward a lower bench - reaching this blast's floor, or dropping another step below where it had got to - set opposite a rise of the same step behind it that **stays up**, a wall climbing to the bench above. A mound of muck, a windrow or a boulder pile behind the front row rises and comes back down to the bench top, so it is no wall, and that front row is drilled. The old rule asked the wall in front to fall all the way to this floor; now a lip that sits high above the floor but plainly stands on the next bench down is caught too. An ordinary front row, with the bench top flat behind it, is drilled as always; a berm stands above this crest, not under it; the rim of the pit has the ground falling away behind, not rising. A **firm** lip - a flat lip, a full step down in front and up behind, the wall the steepest thing behind it, standing up across its width, and surveyed well past it - is left off outright, counted on its own card, and shaded green; a hole you put there yourself is kept, with a warning. A **marginal** lip - the wall behind battered or short, rising but not a full step, or only a narrow bund or a short pickup to show it - is less certain, so a hole is left standing on it and you are asked, as on a berm: **Leave it off - the bench below**, or **Drill it - this bench** (neither, until you say, leaves the hole on). It is shaded in a paler jade to set it apart from a firm crest, with its own card, count and RL range. Your answer is kept by each collar, so a fresh draft holds it while the ground stays; resurvey the lip away and the question goes with it. **What it takes** lists the crest of the bench below on its own card - how many holes were left off and the RL range of the ground - and the eye on the card opens the pattern as a window with that ground shaded, the left-off positions marked on it, in Plan, 3D and Pictorial; the checks name it too.

Wall control

Beside a final wall or the toe of a berm, the pattern's full charge would break back into rock that has to stay. So no hole stands within the **stand-off** of a wall (half a burden, 2 m at a 4 m burden): the pattern's positions there are left out. Out to the end of the **keep-out band** (half a burden and 0.8 of one more, 5.2 m at a 4 m burden) the pattern's own holes stay where they are and carry the **buffer charge** - 60 % of the column, the rest stemmed - leaning away from the wall at the pattern's own angle: charged lighter, not removed. A **buffer row** is laid on the stand-off line only in place of the pattern's holes left out inside the stand-off, never within 0.8 of a spacing of another hole along the wall; where the pattern left no hole out, no row is laid. A **trim row** can be added right against the wall in the same places - small 89 mm holes 15 diameters apart, no sub-drill, loaded in two decks. Where the stand-off left ground the pattern reached and no hole now reaches, a buffer hole is added there. The rows and those holes never carry more explosive than the holes they replace, so there is never more explosive, more holes than the row's own, or holes closer than 0.8 of a burden near a wall than the pattern alone would have, and a hole leaned in under an island from beside a wall carries the buffer charge too. Where no buffer hole stands along a wall that needs one, the pattern's hole nearest that stretch of wall carries the buffer charge instead - never one off to the side or farther out than the keep-out band and half a spacing - and a stretch no such hole stands beside is said. Ground at or above the crest all the way out past the final wall is a wall: that is what a final wall at a pit limit is, the rock beyond it unmined and level with the bench top or higher. Only ground that falls away more than a fifth of a bench below the crest (at least a metre) within a burden and a half of the wall is a free face - even with the crest a few metres past the wall, or a face that starts at the wall itself - and a windrow that rises then falls is a free face too. Where no hole can be designed, a hump no rig stands on say, the draft warns how many places are left and names the holes nearest them. The charges count in the totals, the powder factor, the most per delay, flyrock, vibration and the magazine like any hole's. A card on the pattern names the walls in reach and the rows along them, and warns of a hole with a full charge inside the keep-out band or a wall with no buffer row beside it.

Set the buffer row, its charge and the trim row once for the pit under The block, beside the pit's benches, or for one blast under Pattern rules - **Wall control**, where the burden, spacing, stand-off and trim diameter can also be changed. The final wall comes from **Final wall from** on a boundary or drawn block; on any block the berms' toes count. Rows are laid when the pattern is drafted: an older blast shows its walls and warnings when reopened, and nothing on it moves.

Where mining goes next

Once a blast is on the pit's floor - the pit design's lowest toe, or the lowest bench the ground offers - and only berms are left on the walls beside it, a card says mining goes on from the top: widen the pit bench by bench down, each bench leaving its berm for the one below. Where the ground runs along strike - the area at least two and a half times as long as it is wide, or the pit's own **Strike bearing**, with the ground rising at least a bench towards one end - it also says a new cut along strike opens from the outcrop at that end. **Start at the top bench** opens a new blast on the pit at its top bench; nothing is saved or drafted until you do.

Islands in the pattern

Where a draft leaves holes out because a rig cannot stand there - a hump over the crest, a mound too steep, a hollow above the floor - and holes stand all round that patch, its rock would stay behind as a toe. The page calls it an **island** and addresses it by default: holes are collared on the nearest ground a rig can stand on and leaned back into it where they need to be, no further than the most lean and no nearer another hole than 1 m or three tenths of the burden, named I1-01, I1-02 and so on. One leaned under a hollow is stemmed longer so its charge is never less covered than the pattern's stemming. They reach under an island only: the part of a hump above the crest is not drilled.

A **strip** is the same patch reaching the edge of the pattern instead: the holes left out along a step between two terraces, say, with holes along both sides of it and ground below it that never comes down to the floor - it settles on a terrace or in a hollow. Its rock has nowhere to go either, so the page treats a strip exactly as an island, and its

card calls it a strip. It needs holes along both sides: a run left out at the edge with holes along one side only - the back row against the face of the bench above, a row along a bund at the side - is the edge of the pattern and is left as it is, and so is one hole left out on its own at the edge. Nothing against the final wall is taken for an island or a strip: that rock is for the wall's own holes, and no hole is added past the wall. Where the ground below does come down to the floor, the holes beside it are checked as front holes towards that open ground instead, and - where the draft fixes the front row, as it does unless the Front row tile says otherwise - leaned towards it.

That cover is kept: a shorter stemming typed on an island hole is lengthened back and the page says so, and a hole whose charge no stemming can keep covered carries a warning to take it out or treat the ground over it first. A stemming typed before the ground has loaded is measured when it arrives, and a stand-off over the ore says when it leaves an island hole a longer stemming.

A card on the pattern says what was found, how much of the island the holes reach, and - where they cannot reach all of it - why: out of a rig's reach (doze it down or level it), or under ground too thin to cover a charge (fill it or level it). On a large block the card says it is working that out while the page opens. Choose **Address it**, or **Leave it - it is meant** for a ramp or a bund, which takes the added holes out. The answer is saved with the blast; a drilled hole stays whatever it is.

Waste over ore: the stand-off

Where a waste bench sits on ore, say under **Top of ore** where the ore is - a surface of its top, or the block model at or above a cut-off - and the **stand-off**: the waste each hole leaves over it. Every hole is then stopped the stand-off above the first ore its line meets, and charged from what is left. Trackapt asks for the stand-off rather than assume one: until it is given, holes that reach the ore are only flagged, and the checks ask how far above the ore the holes should stop.

What it takes, and the checks

The page shows burden and spacing, the holes, the metres drilled, the kilograms by product, primers and detonators, the rock in the block, the **powder factor** in kg/m³ and kg/t, and the **drill yield** — tonnes broken per metre drilled. Beneath it: the predicted mean fragment, the most explosive that goes off within 8 ms, the flyrock clearance, and each place to protect - its vibration against its limit, and its distance against the flyrock clearance (see **Fly-rock or a hard toe**).

Those are worked from the hole delay and the row delay in the design, which is a rule about the pattern rather than a statement about any hole. Cut-offs, relief off the real firing times, and what the delays' own scatter does to the charge in one window need the shot tied up first - see **Tying the shot up**.

TAKE CARE

These are predictions from published rules. They become your own only once you enter your site's constants and reconcile your own blasts. Your statutory exclusion zone and your own monitoring always govern.

Adjusting the pattern

- **Add a hole** — a filler or a spare. Type where it is; leave any figure blank to use the pattern's.
- **Place a hole**, beside Draft the pattern, points at the plan instead: the pointer takes a crosshair and a click on the ground opens Add a hole with the collar where you clicked. A click near a position the pattern laid that no hole stands at takes that position exactly - within three-tenths of the smaller of burden and spacing - so a filler put back in a gap stands where the pattern wanted it; a click on open ground stands where it fell, and clicking a hole still opens that hole.

- **Click a hole**, in the table, on the plan or in the front row, to move it, give it its own stemming, lean or product, set its firing time, record the load, or mark it abandoned.
- **Remove** takes a hole out of the pattern after you confirm. A drilled hole is better marked abandoned: it stays on the record, out of every total. The gap it leaves is measured: where ground the hole was to break is out of every other hole's reach - the pattern's own cover, the reach wall control fills to - the checks card names the two row neighbours now carrying it, how far apart they stand, and the point to add a hole at; both neighbours carry the warning in the holes table and on the plan, and **Add a hole here** on the warning opens Add a hole there. A blast opened with a hole already missing says the same without a click; a berm left undrilled, a wall's stand-off or an island is no gap, and a front hole the front-row fix brought forward still stands for its position. Gaps are only judged for a pattern that still follows the layout: where fewer than four in five of the laid positions have a hole, the checks card says the pattern no longer follows the rules laid on this block and gaps are not judged - re-draft the pattern or check it by eye.
- **Two holes standing too close** are measured too, the reverse of a gap. Two holes closer than half the smaller of burden and spacing share one burden between two full charges: twice the powder factor the design chose, which over-breaks behind the face, throws off the collar and can cut off one hole with the other. It is judged at the collar and at the toe, since holes that stand clear at the surface can converge below. The checks name the pair, with **Open ...** to move the hole, lean it off its neighbour or take it out; both holes carry the warning in the holes table and on the plan, in amber, because both still fire. A wall row and the holes added to reach an island keep their own spacing against the pattern - both are drilled tight on purpose - but a hole you place by hand is judged against them like any other: a filler half a metre from a trim hole puts a full production charge inside the buffer zone against the final wall.
- **Pattern from survey** turns a pickup's shots into the holes. **As drilled from survey** matches the collars picked up after drilling to the holes they were drilled for. Where the pickup also walked the crest or the floor, choose the pattern's code (PTTN, say) under **Shots coded** and only those shots are read. The codes chosen are offered again next time. A pickup filed before codes were kept has none to choose by: import the file again.

Tying the shot up

A hole delay and a row delay typed against the pattern are enough to charge the blast. They are not enough to say when any one hole fires. On a shock tube shot the signal starts at one collar and runs from there - connector to connector across the bench, and down each hole's own downline - so a hole's time is the shortest path the signal can take to reach its collar plus whatever holds it back in the hole. Two holes a row apart can be half a second apart or go off together, depending which way the tie runs.

Open the **Tie-up** tile. Until the pattern is drafted it says so, and it says so too where the Explosives catalogue holds no surface connector to tie with.

Field	What to choose
How it runs	Echelon - diagonally across the pattern, so every hole breaks at an angle to the face. It is the usual bench tie, and a shot not yet tied up opens on it. Row by row - each row end to end, the row behind following it, square to the face. V from the centre - each row opening from its middle to both ends, for a cut with no face of its own.
Started at	The hole the lead-in reaches. Left to the app it starts at the end of the front row, where there is a free face, so every hole after the first breaks towards ground already moved.
Downline in each hole	What holds each hole back behind the signal that passed its collar, 400 to 500 ms as a rule. Without one a hole fires the moment the signal arrives, and every connector clipped beside it is cut. A shot not yet tied up opens on the stocked downline nearest 500 ms.

Field	What to choose
Lead-in	What starts the shot from the firing point. A shot not yet tied up opens on the stocked lead-in nearest 0 ms, so the shot begins the instant it is fired.
Tie each row twice	A second way into each row, so cutting one connector does not take the row with it.

Tie the shot up draws the network: a surface connector between each pair of holes, taken from the catalogue as the nearest delay to the hole-to-hole and row-to-row milliseconds under **Timing and checks**, a downline in every charged hole, and the lead-in at the starting point. Tie it up again after any change to the pattern. **Untie** puts the blast back to firing off the two delays in its design, and asks first.

WORTH KNOWING

The app drafts it; the blaster owns it. The starting point, the shape, the downline and the lead-in are all yours to set, and any hole given a firing time by hand keeps it - the table marks it *timed by hand* and the network is worked round it.

Editing the tie-up by hand

Every connector is listed under **Connectors** in the Tie-up window: the hole it is clipped at, the hole it fires, the product, its delay, and whether it was tied by hand. Pick one to change its product - the delay changes with it, and nothing is asked - or **Remove** it. Removing asks first, names both holes and the delay, and says which holes nothing would then reach.

Add a connector takes the hole the signal comes from, then the hole it fires, and a surface connector from the catalogue. The app suggests the one nearest the hole-to-hole delay for two holes of one row, the row-to-row delay between rows, and for an easer the delay the draft itself would give it; the blaster's pick stands. A hole cannot be tied to itself, nor a pair tied twice the same way, and an abandoned hole or one not in the blast is refused. On the firing picture, tap a connector to pick it, or press the add-connector button and tap the two holes - it works the same on a phone.

Every edit is checked at once: cut-offs, holes nothing reaches, one connector carrying the shot, relief, the heaviest 8 ms and the firing times. An edit that leaves a charged hole unreached is allowed - the check shows it as the error it is. A hole a hand-tied connector reaches is marked *tied by hand* in the table.

Tie it up again over hand edits asks first. **Keep your changes** lays them over the new draft; **Start clean** takes the draft alone. A change naming a hole that has since gone or been abandoned cannot be kept, and the notice names it. A fired blast's tie-up is a record and cannot be edited.

WORTH KNOWING

An abandoned, uncharged hole still stands in the bench. Its connectors are left out when the blast is saved, and the notice says which. If the chain ran through it, the blaster must tie across it, and the *holes nothing reaches* check will show them where.

An easer is tied off the holes it stands between, not along their row. The draft chains the front row without it, then clips each easer off the later of its two leaned holes with the connector that lands it far enough after that hole not to dead-press it, and far enough ahead of the hole behind it - of those, the one nearest half its window. On a 3.0 x 3.5 m pattern, holes 25 ms and rows 65 ms apart and the easer set back 1.5 m, that is at least 16.4 ms after and 10.7 ms before: a 17 ms connector. Where nothing the mine holds fits, the easer is still tied, with the nearest, and the draft says why. The table and the firing picture both mark an easer as one.

Tied up, the tile says how long the shot takes, the heaviest 8 ms (and, where the delays carry a scatter figure, what the worst run in twenty puts in one window - the figure to hold a vibration limit against), the burden and spacing the **timing** makes of the pattern, and the relief this rock wants in milliseconds per metre of burden. Rock breaks towards whatever was open when it fired, not square to the row it was drilled in, so a 3.0 x 3.5 m pattern tied in echelon can work as 2.4 x 4.4 m - which is how a blaster buys fragmentation without moving a drill. Below them, every hole with the moment the signal reaches it and the moment it goes off.

The delays a shot is tied with

A tie-up is made of products, and the products are the mine's. Under **Explosives** on the Blasts register, a product of kind **Detonator** says what it does in the tie-up - starter or lead-in, surface connector, in-hole downline, or no delay at all - and carries its delay off the data sheet, its scatter as a percentage of that delay (a share, not milliseconds, because a long delay scatters wider than a short one; usually 1 to 3), and for the bench its colour and the supplier's series.

The lightning bolt at the top of that window adds the shock-tube delays in common use in one press: a starter, surface connectors at 9, 17, 25, 33, 42, 65, 67, 100, 109 and 176 ms, and downlines at 400, 425, 450, 475 and 500 ms. They arrive marked as figures in common use across the industry rather than your supplier's, and the note goes the moment you change one. Anything your supplier makes that is not on that list is added like any other product.

What the checks make of it

- **Cut-offs** - a connector whose signal has not passed before a hole beside it moves the ground. The line is cut there and everything behind it never fires. Ground is taken to move 10 ms after a hole goes off, deliberately the pessimistic end of what is published. A connector through with little to spare is said too.
- **Relief** - a hole that fires with, or before, the hole ahead of it towards the face, judged off the tie-up's own times rather than the two delays in the design. Holes it could not judge are named.
- **Holes nothing reaches** - a hole the signal never gets to, which would be left charged and unfired.
- **One connector carrying the shot** - eight or more charged holes reached only through a single connector. Cut it and all of them stay charged; tie a second way in.
- **The timing against the rock** - row to row and hole to hole, in milliseconds per metre, against what this rock wants.
- **The charge in one window** - where scatter in the delays puts appreciably more in one 8 ms window than the nominal timing does.

TAKE CARE

A tie-up check is a prediction about a signal running across ground that is already moving. It uses your delays where you have typed them and typical figures where you have not. Your statutory exclusion zone, your own monitoring and the blaster on the bench always govern.

Watching it fire

Watch it fire, on the Tie-up window, plays the shot on the pattern; so does the **Firing** switch beside **Plan**, **3D** and **Pictorial** once the shot is tied up. Firing is not a fourth picture: with the switch on, each of the three plays the shot, and the shot waits at 0 ms for Play. While the switch is on, Plan is the firing plan; turning the switch off shows the blast standing still. On a phone the switch shows without its word.

With Firing on	What it plays
Plan	Every hole coloured by when it goes off, the signal running along each connector, a hole flashing as it detonates, and an arrow the way each hole's rock leaves. Cut connectors are drawn cut and holes nothing reaches are left hollow. Underneath: the moment, how many holes have gone, the kilograms gone, and the kilograms inside the last 8 ms.
3D	Holes fire as tied, rock flies as the muckpile model throws it, craters open and the predicted heap forms.
Pictorial	The shot as a person standing off the bench would see it: the ground solid, the rock thrown, the dust, and the heap it leaves.

Under each picture: **Play** and **Pause**, **Back to the start**, **Go to the end of the shot** (the last hole on the plan, the settled heap in 3D and Pictorial), a scrubber to drag to any moment, and the speed - **Very slow** (a fortieth of real time), **Slow** (a tenth, where it starts) or **Real time**, about two seconds. In 3D and Pictorial the clock shows the moment in milliseconds: the holes fire in a few hundred and the rock flies for seconds, so Slow shows the firing and Real time the flight. There the key gains **Connectors**, **Hole states** and **Flyrock (predicted)**, each pressed to hide or show what it draws; the dust button shows or hides the tumble, dust and fume (illustration, shown to begin with); the palette button draws the muck in a colour of its own or in the ground's shade (the shade to begin with); and the question mark opens **The shot, played**, which says what is illustration.

Recording a video. The record button beside the controls saves the shot as a video: a 3 s countdown, the shot at the speed chosen, then 3 s of the settled shot. It saves itself at the end; pressed while it reads **REC**, it stops and saves the video as it stands. In 3D it records from where you have turned the camera, and the clip says it is predicted from the design model, not a recording of the blast. Switching picture while recording throws the recording away, and a browser that cannot record video does not show the button.

The shot is played as it would run. A hole behind a connector that moving ground cuts never fires in the picture either, and pointing at it says which connector - the same holes the muckpile card says never fire. Once the blast is fired, the misfires named on the firing are the holes left hollow.

The muckpile it is predicted to leave

On **3D** and **Pictorial**, the **Muckpile (predicted)** line in the picture's key draws the heap the blast should leave. It is offered once the shot is tied up. With the blast standing still it starts switched off: press the line to have it drawn, and again to take it off. With **Firing** on, the heap is what the shot builds, so its line comes on by itself and goes off again when you leave firing mode. Each hole's rock is thrown the way its timing sends it, as far as its charge per metre of burden carries it, landed on the surveyed ground, swollen and slumped to the angle of repose; rows behind the front throw less, because there is more broken rock in the way. The figures say the loose volume and the solid it came from, the swell between them, how far the rock is thrown on average and at the furthest, how high the heap stands, and how much lands beyond the face. A shot that is not tied up has no firing times to throw it by, so no heap - and no crater - is predicted for it; tie it up and the heap is drawn the way its timing sends it.

The heap is drawn as broken rock, not a smooth mound. The rock lying on it is drawn at its true size, from the fragmentation this design is predicted to give, coarsest first - so a design that breaks coarse shows its boulders, and one that breaks fine reads as a gravel pile. Where each rock lies on the heap is illustration; the sizes and the heap are the model's. A design with no rock factor of its own is drawn on an assumed 9; with no fragmentation figure at all, the heap is drawn bare rather than with rock of a made-up size.

The heap thins into an **apron**, not a scatter of little heaps. A hole's charge column is thrown in six slices, and each is laid over the ground it lands across - along the throw, from where the next shorter slice lands to where the next further one does; across it, the width the hole broke - so the slices add up to one heap thinning steadily out to the furthest throw, with no ridge across it. The furthest slice's rock is shared over where the others land, so nothing is

drawn beyond the furthest throw the figures state, and the shot played in 3D lays the rock the same way as it lands. Where the apron is thinner than half a metre it is drawn as **single rocks lying on the ground**, from the coarse end of the same sizes, as many as the volume there makes. **Flyrock** is drawn the same way, but in red: one rock at the coarse end of the sizes off each front-row hole, and three round each collar the muckpile says craters, landing on the ground at its range. Its key line, **Flyrock (predicted)**, shows only while a shot is played and switches it off without stopping the shot. The volumes and the throw are the model's; laying the rock out puts the heap's highest point a little lower than landing each slice on one spot would, and the height figure says the lower one.

TAKE CARE

What those distances are worth. A line under the figures says whether they are calibrated. Until the mine has surveyed muckpiles of its own they are drawn with typical constants: the shape, and the way it changes when you move the start or retie the shot, are worth reading; the distances are not measurements.

What each hole's rock does. Under the figures, every hole whose rock does anything but throw cleanly to the face is named, marked **Warning** where a blaster should act on it and **Note** where it is only worth knowing. A hole with no face within its charge's reach **craters through the collar**: the rock breaks out upwards and leaves a hollow, which is drawn below the ground in 3D and Pictorial and given its width and depth. Rock that breaks with nowhere to go **heaves in place** - it swells where it stands and lifts the ground, and is never drawn as thrown. A charge that reaches neither a face nor the collar **breaks nothing at the surface**. The rest are a toe left at the floor, a bench left part standing under a short charge, and a crest beyond the charge's reach, which is only a note.

This is why a charge far too small for its hole no longer draws a tidy heap. Half a metre of charge under nine and a half metres of stemming cannot reach the surface at all: nothing is thrown, what breaks heaves where it stands, and the bench above is left standing. Below those lines, **what the figures take as given** lists the assumptions the shot rests on - that rock broken in place swells by the free swell because its rock domain states no confined bulking of its own, say, or that stemming is judged on its length alone.

When the shot does not go as designed. The heap is not only drawn for a perfect shot. Where something fails, the card lists it under **What does not go as designed**, in the blast's own hole names - a run along a row as a range, such as C4-C7 - and 3D and Pictorial draw the rock that does not break in its own slate colour, **Rock left standing (predicted)**, apart from the loose muck. It switches off from its own line of the key.

- **Holes that never fire.** Before the blast is fired, a tied-up shot is run the way the tie-up would run it: where a hole's moving ground cuts a surface connector before its signal has passed, every hole behind it with no other way in never fires - *C4-C7 never fire (the connector from C3 to C4 is cut by the ground B4 moves): 1,240 m³ left standing*. A hole nothing ties in is said the same way. Their rock stands where it stood, unbroken and unswollen, and the loose volume drops by exactly that much.
- **Once the blast is fired**, what did not go is what was recorded, not what was predicted. On **Record the firing**, name the holes that misfired under **Which holes misfired** where you know them; the heap leaves their rock standing. Misfires counted but not named are said on the card and drawn as fired: the app never guesses which holes they were.
- **A toe the bottom charge cannot break.** Each front hole's toe is judged against the most its bottom charge can break - Langefors and Kihlström's maximum burden, from the hole's diameter, its charge per metre at the bottom, the product's strength, its lean and the pattern's spacing - with the rock in front read off the surveyed face along the hole's own lean and laid line. Where there is more than the charge can break, the excess stays as a hump at the floor, up to where the face comes back within reach, and less rock is thrown in front of it. An easer is not judged this way: it breaks to the ground its leaned partners open. A toe that cannot be judged is said on the card, never left out.

- **A hole with no open ground when it fires.** A tied-up shot knows when each hole goes. A hole behind the front breaks to the nearest ground already open at that moment; where that is further than its burden it throws less, and where nothing open is within what its charge can break its rock **heaves** - it swells where it stood and is not thrown. A hole behind one that never fired is confined the same way.
- **Rock cannot fly through rock.** Thrown rock that meets rock left standing stops against it and piles there, and the card says how much.

On a shot that is not tied up there are no firing times, so relief - whether the holes fired before a hole behind the front had emptied the ground beside its charge - cannot be judged. The card says so under **What does not go as designed** even when the list is empty, so an empty list is never read as a clean bill on the one question nobody looked at. Tie the shot up and it is worked out in full.

The toe judgement uses the **Rock constant c** under **Ground and rock** - how much explosive it takes to break a cubic metre of this rock. Left empty it is 0.4 kg/m³, Langefors' figure for most hard crystalline rock; weak ground takes less, massive ground more. Like every figure on the card, what fails is indicative until the mine has calibrated its muckpiles: read it as where to look, not as a survey.

From approval to the muckpile

Stage	What moves it on
Designed	Send for approval. A group with no chain approves at once.
Awaiting approval	The chain's desks sign in order, or send it back.
Approved	Mark drilled — or reopen the design before anything is drilled.
Drilled	Mark charged, after recording any load that differs.
Charged	Record the firing: the day, the shotfirer, misfires - and which holes misfired, where known.
Fired	Reconcile: the rock surveyed, the dig rate, the fragment size, and - where the mine surveys its heaps - the muckpile.

Holes can be changed at every stage until the blast is fired, except while it awaits approval: the pattern is held as it was sent, and **Withdraw** frees it. After approval every save writes a line in the blast's change log. An **approved** blast whose pattern changes - holes added, removed or moved, a charge, the design rules or the tie-up - goes back for approval where its group has an approval chain: **Why the pattern changed** must be filled in before Save, the page says *Saving sends it back for approval*, and the blast returns to **Designed** with its sign-offs dropped, to be sent again from the first stage. A group with no chain asks nobody, so the blast stays approved and the change is logged. Changes to a **Drilled** or **Charged** blast are field records: they are logged only. Linked to a magazine item under **Explosives**, a product's kilograms come off the magazine when the blast is fired. Reconciling gives back the rock factor your ground behaved as, for the next design.

What the muck survey found is the second half of reconciling, and it is optional in the fullest sense: most mines survey no muckpile at all, the blast reconciles perfectly well without it, and leaving every field blank changes nothing. Where a mine does fly or walk its heaps, type the loose volume, the solid it came from, the furthest throw and how high it stood, and the dialog shows what this one blast says the swell and the throw constant would be, beside what the prediction was made with. What was predicted is saved with the survey exactly as it was predicted, so a fit worked out later cannot quietly rewrite the evidence it was fitted from - and saving the survey again on a shot with nothing predicted now, one fired without a tie-up in the app, keeps the prediction saved with it before.

What the crater survey found is how a mine measures the rock itself. Where a blast broke out through its collars - a confined shot, a hole that vented, or a crater test fired on purpose - survey the hollow and type its depth, its diameter, the rock it lost where that was measured, and how far the ground rose around it, over which hole and on which day. A crater is the plainest measurement a blast gives of how far a charge breaks: with no face to go to, the charge breaks out up through its collar as far as it reaches and no further. Set against the crater predicted for it, that gives this rock's own **rock constant**, and the rise of the ground gives how much the rock bulks when it is broken with nowhere to go. Both are fitted per rock domain, because how hard rock is to break is a property of the rock and not of the mine. A survey that found nothing broke through is worth filing as 0 and 0: that counts as evidence too.

As soon as that survey is whole the dialog reads it back and says what **this crater** implies: the rock constant it gives, and how far its charge actually reached against the reach the design was drawn at. A crater bigger than the one predicted is rock that breaks more easily than it was taken to be, so it reads a lower constant; a smaller one reads a higher. Where it can read nothing it says which - no crater was predicted for that hole, the hole is not in the design, the survey found no crater at all, or a figure in it is one the page would not send. Your rock's own constant is worked from five or more surveyed blasts in the same rock, under **From your own blasts** on that rock domain, where it comes with the spread it was fitted over.

TAKE CARE

One shot is not a calibration. That comparison is shown, and nothing else happens to it - saving it applies nothing to any design. A muckpile is one reading of ground that varies enormously from blast to blast. It takes five surveyed blasts before the figures become the mine's own, and even then they are shown with the spread they were fitted over, the odd shot named and set aside rather than averaged away, and the blasts, benches and period they came from written beside them.

The firing is recorded first and the magazine filed second, product by product, so a fired blast says how its filing went - under **Magazine** on its page and in the **Magazine** column of the Blasts register, which can be filtered on. **Filed**: every product came off. **Partly filed**: some did. **Not filed**: none did, and kilograms are owed. **Nothing to file**: filing was switched off, or no product fired is linked to a magazine item. For a partly filed or not filed blast the page lists, in amber, a sentence per product that was not filed - no magazine item, an item no longer under Explosives or renamed, a magazine that no longer keeps the figure the product is filed onto, no access to the magazine, or a reading for that day typed or corrected by hand - with the kilograms to **add to the magazine by hand**. **Filing cut short** means the firing was recorded but its filing never finished: check the magazine's reading for the firing day first, and add only what is missing.

Two more words appear in that column, and neither means kilograms are owed. **Filing unconfirmed** is a filing started moments ago and not marked finished - a blast does not keep when its filing started, so one still running cannot be told from one cut short; reload in a minute, and if it then reads **Filing cut short**, treat it as that. **Not recorded** is a blast fired before blasts kept how their filing went, with nothing shown as taken off the magazine: filing may simply not have been asked for. It is deliberately not worded like a failure, so that filtering the register for **Not filed** finds only the blasts somebody has to put right.

Two people can act on one blast in the same moment. Where a colleague got there first you are told **Someone else changed this blast a moment ago**, and nothing of yours is written: reload it, and do it again if it still applies. Two approvers signing one desk together both sign. One press of Approve is one decision at one desk: where the blast moves to the next desk while your approval is on its way, you are told either that **your approval was recorded** at the desk it was made at, or that the desk **was completed by another approver** and yours was not needed. Open the blast again to approve at the next desk.

Approve and **Send back** are held to the request that was on your screen. Where the blaster withdrew it, changed the holes and asked again while you were still reading, you get the same **Someone else changed this blast** and nothing is signed or sent back: reload, read the holes as they are now, and decide again. A page left open since before an update of Trackapt is covered once it has been reloaded.

From a plan

On a plan's **Drill and blast** card, **Design from the pattern** charges the drill and explosives processes from each bench's own pattern instead of one typed rate — in every mode, the optimiser's included. Once computed, **Draft this period's blasts** files the period's blasts under Blasts, cut from each bench's share, ready to adjust and approve.

19 Underground drill and blast

Every underground design is worked out from what the mine records: how it drills, what it drills with, and the rock it drills in. No mine's habits are built in, and a figure a design needs but the mine has not given is asked for rather than guessed.

How the mine is drilled

Open **Underground** and choose the mine. Nothing is designed until both questions are answered — there is no default.

Question	Choices	What it decides
Development	Mechanised (jumbo) or Conventional (handheld)	Whether rounds are designed for a jumbo or a handheld drill
Stoping	Mechanised (long-hole / bord) or Conventional (handheld face)	Whether a stope is designed as long-hole rings or a handheld face

Under **Drilling machines**, leave a figure blank to use the typical machine's, or type the mine's own bit, reamer, steel, deviation and collaring error. A design marks every figure it used as typical or stated.

Rock domains

A rock domain is a kind of ground in the mine. **Add rock domain**, then record the figures you have, each with where it came from: measured, block model, typical, calibrated or stated. A figure is *stated* until you pick another source. A development round needs the **rock constant** (about 0.4 kg/m³ in most hard rock) and the **density**; calibrate the constant from the mine's own firings.

From your own blasts. Open a domain that already exists and the dialog reads the blasts fired in that rock and shows what they say its constants are: the rock constant from the craters surveyed, the confined bulking from how far the ground rose around one, and the swell from the muckpile surveys. Each carries the range the blasts gave, how far they wander either side of it, how many blasts are behind it, and what the figure was before. **Accept into this draft** fills a figure in and marks it *calibrated* - nothing is saved until you press Save, and nothing is ever applied on its own.

Under five surveyed blasts in one domain the figures are still shown, so you can watch a fit settle as the shots accumulate, but none can be accepted: one crater is one shot in one piece of ground. Every blast the fit could not use is named with its reason - no rock domain on the blast, nothing surveyed, no prediction to measure a survey against, the surveyed hole missing from the design, a crater that reads back to no reach, or a figure outside anything rock does - and where the mine has more reconciled blasts than one read returns, the panel says how many of how many it read. How fast rock leaves the face is shown where the muck surveys fit it, but never offered as a rock figure: it belongs to the muckpile, not to the rock.

Designing a development round

1. On Underground, press **Design a development round**.
2. Choose the **Heading** from Mine designs and type the **Chainage** the face stands at.
3. Choose the **Rock domain** the face is in and the **Explosive**.
4. Read the round drawn on the face, its figures and its holes.
5. **Save the round**, then **Send for approval**.

The round is Holmberg's four-section burn cut (López Jimeno et al., 1995): the depth from the relief holes, the drilling error taken off every burden, four cut sections, then easers, walls and lifters, and a smooth-blasted back. Type your own hole depth, relief holes, look-out or stocked charges and the round is redesigned around them; what you typed is filed beside what was worked out.

Each shift's firing

Log a firing on an approved round records the shift, the pull, the holes drilled, misfires and, optionally, the measured width and height. The explosives are the design's scaled by the holes drilled, and come off the magazine; the log's **Magazine** column says whether each firing was filed, partly filed or not filed, and what was not is listed under the log with the kilograms to add by hand. **Retire** the round when the heading moves on; a fired round cannot be removed. Rounds are listed in **Blasts** beside the benches. A mine plan of stopes and headings charges each heading at its own round's drilled metres and kilograms per tonne.

Designing a stope's rings

1. Compute a saved plan of stopes and headings. Under **Planned to fire in the selected period**, press **Design rings** beside a stope, or **Open the rings** where it has some.
2. Name the rings, and choose the **Rock domain**, the **Explosive** and whether they are drilled up from the floor or down from the back.
3. Type the mine's own **Holmberg–Persson K** and **alpha**.
4. Read the rings, their holes and each hole's uncharged collar.
5. **Save the rings**, **Send for approval**, then mark them drilled and charged. **Fire** records the day, the shotfirer and any misfires, once.

Designed or approved rings are designed again from today's figures when reopened, and the page says if that changes them. Approved rings that change go back for approval. Drilled, charged, fired or retired rings are shown and exported exactly as filed. Rings are retired while designed, approved or drilled; charged rings are fired, or made safe under the mine's misfire and recovery procedure, never retired. A stope has one set of rings still to fire per plan.

The burden is Langefors' at a toe spacing of 1.25 burdens, less the drilling deviation (López Jimeno et al., 1995), with Myers et al. (1990) shown beside it. Each collar is the longer of Onederra & Chitombo's (2007) collar sequence and what the hole's damage zone needs; a sequence collar is shortened, with a warning, to keep ten charge diameters, and never less than 0.5 m, charged. Holes are collared where they leave the drive, and their metres are metres in rock. The drive is a filed development design within 3 m of the drilling level with at least half its length inside the stope, cut at the stope's walls; the rings say when it covers under 90% of the stope. With none, the long axis is assumed and the rings say so. A plan charges a stope all the metres and kilograms of its rings still to fire, each period the share of the stope it mines; rings already fired are spent and left out, and the period table shows each heading's rounds to fire and each stope's share of its rings. Handheld stope faces are not yet designed from the rock.

20 Working with a scheduling package

A scheduling package - Deswik NOVA, MineSched, Minemax, a consultant's own tool - takes a reserve in and gives a schedule back. A plan speaks both: it can be handed over to be scheduled elsewhere, and the answer read back in and published here, where the dashboards already judge it. Trackapt is not a scheduler of NOVA's depth, and NOVA is not a survey, reconciliation and reporting system; each does its half.

What crosses, and in which direction

Out of Trackapt	Into Trackapt
The reserve as CSV - one row per bench, or per stage's cut through a bench, per pit, with tonnes, grade, product and every quality	A schedule as CSV - one row per unit per period, with the fraction taken or the tonnes
The schedule and the demands as CSV, and the whole plan as JSON	A pit as drawn - its toe and crest rings, as strings
A pit, a dump or a road as bodies; a survey as triangles	Everything that always read in: surveys, drillholes, boundaries
A block model as every block, with its definition	

HOW IT BEHAVES

The **unit** is the join. Every reserve row carries a unit - *pit/bench/stage* as one string - and a row that comes back is matched to the reserve by that identity, never by position. Carry the unit column through the other package unchanged and the match is exact whatever it did to the bench numbers.

A schedule decided elsewhere

1. **Compute** the plan once, in any mode, so it has a reserve. The reserve is pinned with the result: the file the scheduler was sent and the plan that later reads its answer are the same reserve.
2. Under **Export**, download **Reserve as CSV** and hand it over - or hand over the pit as bodies, the block model as every block with its definition and the topography as triangles, and let the scheduler cut its own.
3. When the schedule comes back as CSV, press **Import a schedule** under Import - where **Schedule template** beside it hands you a blank in the shape this plan reads, to send with the reserve. The dialog reads the file, says how many rows matched the reserve and which did not and why, and what the file gives - fractions, tonnes or both. Note where it came from.
4. **Take it.** The plan's mode becomes **As imported**, the takes are its pins, and Compute runs at once: every period's tonnes, grade, product, demands, truck hours, feed qualities and dump balance are read off exactly the fractions the file said.
5. **Publish**, as any plan is published. The figures reach the parameters the dashboards judge, and a webhook, if one is registered, tells the other side that they did.

Capacities are still judged and an exceeded one is still red. A bench taken after the one below it is reported as *the imported order runs against the pit's own* and kept as imported; a row asking for more of a unit than is left takes what is left and says so. Columns are found by heading, and the reader tolerates the names schedulers use: pit or

pit_name; bench, bench_no or bench_index; stage, pushback or cutback; period, or a from date resolved against the plan's own periods; and fraction (0 to 1, or a percentage) or tonnes.

Scenarios

New scenario, under Plan, makes a draft copy of the plan kept beside it rather than in the register at large: the same sources, processes and horizon, ready for one thing to be changed - a second excavator, a lower cut-off, the schedule the consultant sent. The register names the plan each scenario is a scenario of. **Compare scenarios**, under View, lays the original and every scenario side by side, each figure summed over the horizon and then period by period, with a dash where a scenario has not been computed. A scenario is a plan in every other respect; the one that wins is the one that is published.

The exchange API, tokens and webhooks

Everything above is also available to a program, so a scheduler can pull the reserve and push the schedule without anyone downloading files. The account holder or a Level 6 user opens **Integrations** on the plans register and:

1. **Makes a token**, named for the package it is for, with a read scope or read and write. The secret is shown **once**, when it is made; only its prefix is kept on screen afterwards.
2. Hands the secret to the other side, which sends it as *Authorization: Bearer tk_...* on every call.
3. **Revokes it** when the integration ends. A revoked token is refused at once; the register keeps its name and when it was last used.

Call	Returns
GET /plans	The plan register
GET /plans/:id	The plan as one document - the same JSON as Whole plan
GET /plans/:id/reserve.csv, schedule.csv, demands.csv	The three files
POST /plans/:id/schedule	Files a schedule: the CSV as text, or JSON with a csv field. The plan becomes an imported plan, not yet computed. Needs the write scope.
GET /block-models/:id.csv, /definition.json	The model as CSV (all=true for every block), and its lattice
GET /surfaces/:id.xml	A survey as LandXML, on the named grid
GET /designs/:id	A design with its generated geometry and its bodies

All under /api/exchange/v1. The files a program pulls and the files a person downloads are the same bytes.

Beside the tokens, a **webhook** address can be registered to be told when a plan is published or unpublished: each event is posted as JSON - the event, when, and the plan's id, name and status - signed with an HMAC under the hook's own secret in X-Trackapt-Signature. Verify the signature over the raw body before trusting it. A hook can be paused, and is removed after asking.

Two small fields keep the two sides honest. **Reference elsewhere** on a block model, a wireframe or a design is the name the far end knows it by, and rides along in every file the record leaves in. **The mine grid**, named once under Integrations - its name, its EPSG code where it has one, and its datum - is written into every LandXML the module produces and into the block-model definition. Nothing is re-projected; Trackapt works on the mine grid and says which one it is.

A round trip with Deswik NOVA, in order

1. Name the mine grid under Integrations, and give the block model and the pit design their NOVA references.
2. Send NOVA the pit as bodies, the block model as every block with its definition, and the topography as triangles, if NOVA is to cut its own reserve - or skip all three and send it the plan's reserve CSV, which is the reserve Trackapt read.
3. Let NOVA schedule. Export its schedule as CSV, carrying the unit column or pit, bench and stage, and either the fraction or the tonnes per period.
4. Import a schedule on the plan, or POST it through the API, and Compute: the demands, the truck hours, the qualities of the feed and the dump balance are all read off NOVA's takes.
5. Publish. The figures reach the parameters the dashboards judge, and the webhook tells NOVA's side that they did.

21 Questions people ask about planning

Answered the way they were answered. Each stands on its own; the section it belongs to is where there is more to read.

What is the difference between Professional and Modular?

They are the two ways Mining can open for you, chosen under **Mining view** in the **Appearance** dialog (**Themes** in the header). **Professional**, the default, opens Mining as the workspace: the sidebar has one **Mining** entry, and a register or record opens in a window over the pit rather than on a page of its own. **Modular** lists every Mining screen under **Mining** in the sidebar and opens each register and record on its own screen, landing on **Surveys**; the workspace is still there, as the first entry. The choice is kept in your browser, for you and this account. Modular was called **Casual** until 3 October 2026; a Casual choice opens as Modular.

Why is Design blast greyed out in the workspace?

Designing a blast needs access level 4, by every way into it: Design blast and New blast on the Blast tab, Blast this block and Edit blast in the picture, and the plus on the Blasts register. Below level 4 the commands are greyed, and resting the pointer on one says *Designing a blast needs access level 4.*; the register's plus is not shown at all. Design blast is also greyed in a browser without WebGL, which its tooltip says, and with no working chosen, which it does not: choose a working in the Explorer first. See **The workspace**.

I can't see the blast holes under the ground in 3D. Where are they?

Under the survey. A survey at 100% opacity is solid, so whatever lies below the ground - holes, solids, a design you are drawing - is hidden under it. Select the survey, press **Colour** in Properties (or right-click its row for **Colour and opacity...**) and lower its **Opacity**. While you design a blast, **Show holes**, **Show tie-up** and **Show outline** hide parts of the design itself.

What is a hull?

The smallest shape that contains a set of points with **no dents in it**. Hammer a pin into a board for each point, stretch a rubber band right round the outside, and let go: the band snaps onto the outermost pins and pulls straight between them. That taut outline is the convex hull. *Convex* is the no-dents part - pick any two spots inside the shape and the straight line between them stays inside, so a crescent, a star or a kidney shape cannot be one. On a wireframe section the intercepts above the cut-off are the pins: a hull round them is fast and never leaves ore out, but it cannot bend inward, so a crescent lens comes back as the block that fills the crescent and two separate shoots get one band round both. A geologist's outline curves in where the ore stops; a rubber band cannot.

Are wireframes drawn by hand, or built from the drillholes?

Both, and in that order. On an item that carries drilling, the wireframe editor offers **Build from drillholes**: a table, a field, a cut-off, the section bearing, the section spacing and a minimum half-width, and **Build the sections** puts a convex hull round the intercepts on each section. What comes back replaces the section boxes, and you edit it from there. It is a first pass and it says so every time it runs - a hull cannot be concave, joins two shoots into one body, lofts straight through a fault offset and stops at the outermost hole. Take it to save the afternoon of pasting coordinates, then edit the sections into the shape the geology actually is. See **A first pass from the drilling**, under Wireframes.

In what order do I actually use the module?

Seven parts, each ending with something the next one needs: ground to stand on (a group, an item, the grid), exploration (import, assemble, validate), interpretation (wireframes that close), the resource (a lattice, a variogram, an estimate, a curve), what is worth mining (a survey, then optimise a pit and make it a design), the mine as built

(pit, water, stages, dumps, roads) and the plan (sources, capacities, a horizon, compute, publish). Then it loops. You do not have to start at the first part - an operation already running usually starts at the plan and fills the earlier parts in behind it. **The whole module, in order**, near the front of this guide, is the whole road.

Where do I start if I have never used it?

Backwards from the middle. Import one survey of a dump you already know and check it against the ground you remember; read cut and fill against last month's survey of the same item; reconcile that against the weighbridge. Only then bring the drillholes in. Measuring something you can check by eye first is what makes everything after it believable. **A first fortnight**, at the end of that chapter, is the list.

What does To the best order do?

It is the third way a plan can be scheduled, and the one that runs the optimiser. The other two walk the pit one period at a time, top bench first: **To a product target** takes benches until the period's target is reached, **To capacity** until a process runs out. Both decide period one fully before looking at period two. **To the best order** plans every period together: it works out what fraction of each bench to mine in each period, holding to every capacity and to the rule that nothing is dug from under rock that is still there, and picks the order that gets the most out of what you asked it to maximise - product, value, or net present value. It may leave a bench half-mined for a month, or strip more waste early so later months yield more ore, where the simpler walks never would.

Does Trackapt work with Deswik, or Deswik NOVA?

Yes, in both directions, by file and by API. NOVA schedules a reserve it is given; Trackapt reads the reserve off its own survey, block model and design and hands it over as Reserve as CSV - or hands NOVA the pit as bodies, the block model as every block with its definition and the topography as triangles so NOVA can cut its own. NOVA's schedule comes back as CSV through Import a schedule, or through the exchange API, and the plan becomes an imported plan whose every figure is read off NOVA's takes, then published here. See Working with a scheduling package, above.

What is an imported plan?

A plan whose schedule was decided elsewhere: its takes are exactly what the file said, period by period, and Compute reports what those takes cost - tonnes, grade, product, every demand against its capacity, truck hours, feed qualities, the dump balance - without changing a fraction. A capacity it exceeds is red, a bench taken after the one below it is reported, and a row that asked for more than was left takes what was left and says so.

How do I get a token for the exchange API?

As the account holder or a Level 6 user, open Integrations on the plans register, make a token named for the package, and hand over the secret, which is shown once. It goes in Authorization: Bearer tk_... on every call; read reads, write files a schedule. Revoke it there when the integration ends.

Why does the block model CSV carry ix, iy and iz?

Because a scheduler rebuilds the lattice from them. A centroid says where a block is; the indices say which block it is, so a model that comes back re-blocked or cut against solids lands on the same cells. Columns are found by heading in every reader, so a package that ignores them is unaffected.

Can a plan use a pit that was drawn in another package?

Yes. On the design's editor, under As drawn elsewhere, read in the pit's toe and crest rings as a Surpac string file or a DXF; the pit is then those benches and the slope rules only describe it. A plan for that pit reads exactly the benches that were drawn. Back to the rules drops them, after asking.

How is a capacity from a truck cycle worked out?

From the trucks, the road and the shifts. Each truck class has a payload and its speed against total resistance - grade plus rolling resistance - loaded and empty; the route is segments of length and grade, read off a filed haul road if there is one; add the loading and dumping time and the cycle follows, and the tonnes the fleet can carry round it in the period is the capacity. The result reports the trips, the truck hours and, where the class states litres an hour, the diesel and the CO2.

Can a declared capacity change from one period to the next?

Yes. Tick Varies by period on a declared capacity and type a figure per period, or paste a column from a spreadsheet; a period left blank takes the single figure.

Can the plan blend on more than the grade?

Yes. Under Sources, Qualities names up to eight more attributes of the block model, each carried into the reserve as a tonnes-weighted mean and each able to carry a feed band; to the best order the bands bind, on the walks and an imported schedule a breach is reported. A recovery curve against grade replaces the single recovery, and Several piles gives up to six stockpiles, each with its own grade band.

What is a scenario?

A draft copy of a plan kept beside it, made with New scenario, so one thing can be changed and the two compared side by side with Compare scenarios. A scenario is a plan in every other respect; the one that wins is the one that is published.

Does Trackapt do underground mining?

Yes, for design and planning. Headings are designed in Mine designs - a decline, a drive, a crosscut or an ore drive - and a plan whose shape is Stopes and headings lays the orebody out into stopes, reads the development that reaches them, and schedules the two together against the same capacities a pit plan uses. It does not wrap stope shapes to a rolling orebody, design rings inside a stope, or model ventilation.

Why did my stope grade come out below the block grades?

Two reasons, both deliberate. Everything mucked from a stope is fed to the mill, including the waste caught between the ore, because nothing is sorted underground. And the walls slough: ELOS adds barren rock from both walls to every stope whatever width it was taken at. A layout that ignored either would overstate every grade it reports.

Can a plan mine a stope before the drive that reaches it?

No. By the end of any period, no more of a stope has been taken than of the development it follows. It does allow progress in step - two thirds of a decline permits two thirds of the stope below it - because the schedule is solved in fractions. Pin the heading to its period to make access all-or-nothing.

Can Trackapt plan a thin chrome seam like the ones on the Great Dyke?

Yes. A seam of 25 to 30 cm that outcrops along strike and dips gently into the ground is modelled in Seams from the holes that cross it - its floor, true thickness and grade, cell by cell - and planned as Seam strips from the outcrop, taken down dip until a strip stops paying, or as Seam panels, mined underground between levels behind inclines.

Why is a seam not a block model?

Because blocks cannot see it. A 0.3 m seam is 6 percent of a 5 m block, and blocks thin enough to hold it are far more than a model may carry. Everything that matters about a seam is in its own plane, so it is a grid in plan.

What decides the grade the mill sees from a seam panel?

The stoping height. On a 0.3 m seam stoped at a metre, 0.7 m of wall rock goes to the mill with every square metre of seam, and 40 percent in the seam is about 15.5 percent at the mill. The plan shows it rather than hiding it.

How far down dip do the strips go?

Strip by strip, while each pays for its own overburden and for the extra final wall it adds, and while its waste per tonne fed stays under the most strip ratio where one is set. The first strip that fails ends the cut; the strips beyond it are listed, not taken.

Why will a seam panel plan not run to a target or to capacity?

For the reason stopes will not: panels wait on the incline that reaches them, not on the ground above them. Plan it to the best order or read it in as imported. A strip plan does run to a target or to capacity - its top-down is down dip.

Does the plan allow for groundwater and the water table?

Yes, on the same dewatering block as the rain: a steady inflow in cubic metres an hour, and a water table level with a rate per metre the floor sits below it. Every period reads the floor it has reached against the table and takes that many metres' worth, all day, rain or no rain. The result shows the groundwater beside the runoff, the pumps are judged against the two together, and the storm carries the groundwater that keeps coming while it falls. See Water: rain and groundwater, above.

Does the mine design include water control?

The pit design carries a sump - its depth and plan area, dug below the floor at its centre - and a diversion drain run round the pit a stated distance beyond the top crest. Both are drawn in the 3D view and reported beside the benches, and a plan for the pit reads them where the planner leaves the sump and the outside catchment blank. The water table itself is typed on the plan, not the design. See Water in the pit, under Mine designs.

How does an approver know a plan is waiting on them?

They are told. When a plan reaches a desk, every approver at that stage gets a notification on their subscribed devices, and when it is sent back or published the planner who asked is told, with the reason where there is one. On the Plans register a plan waiting on you reads **Awaiting your approval**, the header counts how many are, and **Show - Awaiting my approval** narrows the register to those. With no signal, Approve and Decline queue on the device and go up when it next has one.

I approved a plan and was told someone else had just changed it. Did my approval count?

Not yet - nothing of yours was written. Two approvers at one desk signing within the same second both sign; you only see *Someone else changed this plan a moment ago. Reload it, then try again.* when the plan moved under you in a way that changes what you were approving: it was declined, withdrawn, or published by the last signature while yours was on its way. Reload the plan. If it is still waiting on you, approve it again; if it has moved on, there is nothing left for you to sign. Tapping Approve twice signs once: the second tap is told you have already approved - or, where your first tap finished that desk, that it was recorded and the plan has moved to the next desk. One tap never signs two desks, even where you are an approver at both: open the plan again to approve at the next one.

You see the same sentence where the planner **withdrew the request, changed the plan and asked again while you were still reading the earlier one.** Your Approve or Decline is held to the request that was on your screen when you pressed it - also when it was queued with no signal and sent hours later - so it is refused rather than signing, or on the last desk publishing, figures you never saw. Reload the plan, read what it says now, and decide again. This needs the page to be up to date: one left open since before an update of Trackapt is only protected once it has been reloaded. A colleague signing while you read is not a change of this kind, and your approval simply joins theirs.

What is a period, and what is the horizon?

A period is one scheduling step of the plan: cadence, start date and count on the plan card define them, so monthly from 1 October with three periods is October, November and December. Each has its own capacities and its own result, and publishing writes one figure per period onto each parameter. The horizon is the periods taken together, first day of the first to last day of the last. In the simpler modes it barely matters; to the best order it is the thing being optimised, since the objective is scored over the whole of it at once.

Two months in, things did not go to plan. Can it be adjusted?

Yes, by re-planning, not by editing. The optimiser always solves fresh from the ground as it stood on the plan's as-of date, so the next survey pickup is what absorbs what actually happened. Add the pickup to the running surface, press **Re-plan** on the published plan, and pick the period to start from. A new plan opens over the rest of the horizon; the old one keeps its first months as history, loses the rest, and is marked closed. The **chain** action shows the budget against the latest plan across every re-plan.

Can it handle several pits, and decide which to attack?

Yes, on a plan to the best order. Add the other pits under the first pit's sources, mark the plant and any shared fleet as processes that serve every pit and each pit's own excavator as one that serves it only, and the optimiser decides which pit to attack, for how much and for how long, to get the most out of the shared capacity. The two simpler modes take one pit: walking top bench first through one list, they would finish the first pit before touching the next.

What is greedy?

The name for how the two simpler modes decide: take the best-looking step right now, top bench first, one period at a time, and never look back or ahead. Fast, easy to check by hand, usually right for a single pit. It cannot lend capacity forward, and with two pits it would finish the first before touching the second - which is what To the best order fixes. The greedy schedule still does three jobs inside the optimiser: the starting point it improves from, the floor its answer must beat, and the fallback when no feasible schedule exists.

What is a band, and what is a lean bench?

A plant runs best on ore of a fairly steady grade, so the **feed grade band** is the range each period's feed must average inside - at least and at most, either left blank - measured as recovered product per tonne of ore so pits in different grade units compare on what a tonne actually yields. A **lean bench** is one whose ore falls below the band's floor on its own; a rich one sits above it. Neither is waste: a lean bench simply has to be mixed with rich ore to be fed. The optimiser blends fractions of several benches to keep every period inside the band; the greedy walk takes of a lean bench only what the surplus the rich ones built can absorb.

Will the waste fit in the dumps?

Add the dumps to the plan in tipping order, each with its dump design and what is already in it, and give the pit a swell factor. Compute turns every period's waste tonnes into loose cubic metres and tips them into the dumps in order; the result shows what each dump took, what is left, and the period it fills. To capacity stops when the dumps are full; to a target says how much has nowhere to go; to the best order never plans more waste than the dumps hold.

What does the plan say about rain?

With Plan for rain water on, every period shows its runoff against what the pumps can clear, and the design storm against the sump and the floor of the lowest bench reached, with the depth it would flood. A period the pumps cannot keep up with is marked in red and the warning says by how much. Rain never stops a plan; it names the month so the low benches can wait for a drier one, or the pumping be added.

What is the back line, and why design from it?

The back line is the back of the blast: the crest of the berm or wall it stands in front of. Laying the pattern from it puts the back row a set distance in front of that line - the edge stand-off unless you type another under **Back row from back line** - and every other row one burden toward the face, so the back of the dig is a clean line that respects the berm. The front row takes what is left: the pattern card shows its burden to the face, and the front-row checks judge it. Holes are still named from the front - row A is the front row. New blasts are designed this way; a blast saved before keeps the face layout it was drafted with. Unless you mark it yourself under **Front row**, the back line is read off the outline: the edges facing away from the free face. See **The back line: designing from the back**, under Drill and blast.

Why does the page refuse an edge I ticked for the back line?

Each edge you tick under **Mark the edges myself** must face away from the free face, within 45 degrees. Tick the free face itself, or a side of the block, and the page leaves the tick showing with the reason under it, lists the line as **Back line (not used)**, and does not take it - laid from it, row A would stand at the back or the side. Clear it and tick the back edges instead.

What does "stands nearer the free face than any hole of row A" mean?

Laid from the back line, the front row takes whatever distance is left to the face, so its burden is seldom the design burden. Where the back line is not parallel to the face, row A can give out part of the way along it and a row behind can run on toward the face. Where a hole of a row behind ends up nearer the face than every hole of row A, the pattern card names it under the front row's figure - for example *1 hole in row B stands nearer the free face than any hole of row A (B1)*. Check the front. Those holes break to the face with less burden than the front row's figure shows. A hole only as near as row A's nearest hole, or farther, is never named, and with the back line parallel to the face nothing is ever warned of.

How do I remove a blast hole from the pattern?

On the blast's **Holes** table, use the row's **Remove** control (the delete action beside *Edit*) and confirm. The hole comes off the pattern and every figure - explosives, powder factor, fragmentation - follows the holes left. The checks then measure the gap: where the ground the hole was to break is out of every other hole's reach, the checks card names the two row neighbours now carrying it, how far apart they stand, and the point to add a hole at, and **Add a hole here** on that warning opens Add a hole there. Save the blast to keep it; after approval the save also writes the removal in the change log, with the reason you type in *Why the pattern changed*. On an approved blast whose group has an approval chain, that save also sends it back for approval. A hole that has already been drilled is better kept: open it and mark it **Abandoned** instead, so it stays on the record but out of every total. Holes cannot be removed while the blast is awaiting approval or once it is fired. See **Adjusting the pattern**, under Drill and blast.

Can I bring in a drilling pattern from the survey?

Yes. File the surveyor's points as a pickup, then use **Pattern from survey** on the blast: each point inside the blast becomes a hole, drilled to the floor from its surveyed height. **As drilled from survey** instead matches the collars picked up after drilling to the holes they were drilled for. If the same pickup also walked the crest or the floor, choose the pattern's code (such as PPTN) under **Shots coded**, and only those shots become holes. A pickup imported before codes were kept has no codes to choose from; import the file again to choose by code.

Why does the blast say two holes stand too close?

Because two holes closer than half the smaller of burden and spacing share one burden between two full charges: the powder factor in that ground is twice what the design chose, which over-breaks behind the face, throws off the collar, and can cut off one hole with the other. The checks measure it at the collar and at the toe - holes that stand clear at the surface can converge below - and name the pair, with **Open ...** to move the hole, lean it off its neighbour or take it out. Both holes carry the warning in the Holes table and in the tooltip on the plan, in amber:

both still fire, so it is advice rather than a fault. A wall row and the holes added to reach an island keep their own spacing against the pattern, since both are drilled tight on purpose - but a hole you place by hand is judged against them like any other, because a filler half a metre from a trim hole puts a full production charge inside the buffer zone against the final wall.

Where did the set-up tiles go?

Once a pattern is drawn they fold away under **The set-up**, so the picture of the pattern comes first. Click the heading to open them again; the heading counts any tile that still needs attention, and your choice stands while you stay on the blast. The checks and the front row are never folded away.

What do the colours on the blast plan mean?

The holes are sandy: the darker dot is the collar, the line the hole projected to plan. A **red** hole has an error - it cannot fire as designed: nothing to charge, a collar past the final wall, a wet hole loaded with a product water spoils, a hard toe, no free face at the toe or too little rock in front of the charge, or the gap left beside it by a removed hole. An **amber** hole has only a warning - something to know while it still fires: an unsurveyed collar, a stand-off note, why a fix could bring it no further forward, or a hole standing too close to its neighbour. Rest the pointer on a hole to read what it is. Blue-green shading is the berm or island a card's eye points at; violet is the ground behind a berm's crest; jade is the crest of the bench below, a paler jade a marginal lip awaiting your answer.

After the blast, what are the red lumps scattered over the ground and the heap?

Predicted **flyrock**: single rocks thrown clear of the heap. One leaves each front-row hole in the way its rock goes (face burst), and three leave the collar of each hole the muckpile says craters. Each lands at the pattern's flyrock range - the figure the flyrock clearance is worked from - on the ground it comes down on, and is never drawn past it. They are sized from the coarse end of the predicted fragmentation and lie where they landed. They are not misfires: a hole that never fires keeps its column. Their key line, **Flyrock (predicted)**, shows while a shot is played in 3D or Pictorial; click it to take them off the picture.

How do I change the view without leaving full screen?

Use the **Plan**, **3D** and **Pictorial** buttons inside the picture, beside its legend. They are the same three as on the pattern card, so you can switch without scrolling back up, and a picture taken full screen stays full screen. Going between 3D and Pictorial also keeps where you turned and zoomed to. On a phone the buttons show their icons only. If the legend and those buttons cover the holes you want to look at, click the eye at the picture's top-right corner to take them off the picture; click it again to bring them back. The choice is kept as you switch between Plan, 3D and Pictorial. The expand control beside the eye fills the screen. See **In three dimensions**, under Drill and blast.

Can I see a berm or island in 3D, not only on the plan?

Yes. The eye on a berm, island or strip card opens the pattern as a window with that ground shaded, in whichever view the pattern card is showing. The window has its own **Plan**, **3D** and **Pictorial** buttons inside the picture, and the ground stays shaded in all three. Switching in the window does not change the pattern card's view.

Why does a berm that looks bigger have a smaller width?

Because the width is the berm's alone - the flat ledge, measured across as its typical width along its length - and the window also shades the ground behind its crest: the rest of its ragged ledge and the wall up to the benches above. That ground is violet, the berm itself blue-green. A low berm with a tall wall behind it can look far larger than a higher, wider berm with nothing shaded behind it, and ground behind two berms is shaded once, behind the lower.

22 If a figure looks wrong

What you are seeing	Where to look
The plan is mirrored, but the volume looks plausible	Easting and northing read the wrong way round on import. Re-import with the layout set explicitly rather than worked out.
A dump appears to cover tens of hectares	Several separate pieces of ground imported as one surface, or control pegs read as ground.
The two volume methods disagree by more than one per cent	The surveys do not cover the same ground, or one is missing a feature string. Measure inside a stored boundary, and compare the string lists on the two pickups.
End-area is far from the surface figure	Expected on a wide body — trust the surface figure. On a road or trench, cut sections closer together and reach further out.
Surveyed and weighed tonnes differ tenfold	A mass unit, not a shortfall.
A wireframe reports 'not closed'	An open end, usually uncapped. Do not quote the volume until it closes.
Most of the block model came back unestimated	Check the origin is the corner of block one and on the same grid as the collars, then widen the search.
A colleague can see a record and you cannot	The Tracker Group whitelist. Ask to be whitelisted on the group holding the item.
The plan will not redraw after editing strings	A string that doubles back on itself cannot be triangulated. The plan keeps the last arrangement that worked and names the problem.
An imported schedule matched none of its rows	Its pit, bench and stage do not name this plan's units. Send the reserve's unit column back through unchanged, or check the bench numbering - the reserve counts benches from 1 at the floor.
An underground plan will not run to a target or to capacity	By design. Those walks take benches top-down and underground has no top-down. Plan it to the best order, or read a schedule in as imported.
A pit or dump stops a bench or two earlier than it used to	An offset narrower than the ring it moves does not fold - it turns through itself and comes back a plausible smaller ring. That is now caught, so a design stops where the ground actually closes. The benches it has lost were never buildable.
A dump holds less than it used to	It was given a least top width, so it stands at the last lift that can be tipped on rather than closing to an apex. The lifts above were never workable.
A dump's ramp goes round and round	Each lift needs its rise divided by the grade in running. A small dump is not far enough round for a flat grade; accept the laps or steepen it within what the trucks pull.
A drawn pit's slope rules do nothing	By design: a pit read in as drawn is those benches, and the rules only describe it. Back to the rules puts them in charge again.
A token stopped working	It was revoked, or its scope is read and the call was a POST. GET /whoami says what a token is and may do.

23 Quick reference

Conventions

Convention	Meaning
Dip	Degrees from horizontal, negative downward.
Azimuth	Degrees clockwise from grid north.
Depth	Measured along the hole, not vertically.
Coordinates	Always the mine grid.
Volumes	Cubic metres. Cut and fill are reported separately, never netted into one figure by default.
Density	Tonnes per cubic metre.
Removing anything	Always asks first, names what is going, and says what else it affects.

What is kept, and what is worked out each time

Kept	Worked out
Surveyed points and breaklines	The triangulated surface
Drillhole collars, surveys and intervals	The desurveyed trace, and composites
Wireframe section outlines	The solid between them, and its volume
Block model lattice, and estimated grades	The grade-tonnage curve
Design parameters	Benches, stations and drill rings
Areas, on the mine grid	Their fit to each survey
The pickups of a running surface, and their adjustments	The surface as of any date
A plan's sources, processes and the result it computed	The reconciliation against the survey and the readings
The reserve a plan was scheduled against, and an imported schedule's takes	Every figure the takes cost: demands, truck hours, feed qualities
A pit's benches as drawn in another package	Nothing - the one design that is kept, not generated

Where to start

The whole module, in order is the road from a drillhole database to a published plan, in seven parts, and it ends with a first fortnight to work through on ground you already know the answer to. Everything between here and there is the detail of one screen at a time.