GEM4D DOCUMENTATION

Abandonment Bund (DMP 1997)

User Manual

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Contents

Part 1 — Using the tool ... 4
1. What the tool does ... 4
2. Quick start ... 5
3. Before you run: the inputs ... 5
4. The settings dialog ... 7
4.1 Mesh roles ... 8
4.2 Source sections through the pit shell ... 8
4.3 Projection (unweathered rock) ... 8
4.4 Weathering ... 9
4.5 Output lines ... 9
4.6 Outputs (inserted as Create objects) ... 10
5. Running ... 10
6. The summary box ... 11
7. Checking the answer ... 13
7.1 Look at the fan ... 13
7.2 Refine, twice ... 14
7.3 The analytic check ... 14
Part 2 — How it works ... 14
8. The DMP 1997 rule, in section ... 14
9. From a section to a fan ... 15
10. Many sections: the guideline's Figure 2B ... 16
11. Weathering: the contact kink ... 16
12. From projections to the ZoI limit line ... 17
12.1 The crest reference ... 17
12.2 One point per crest station ... 18
12.3 Cleaning up the limit line ... 18
13. The bund line and the wall ... 19
13.1 The standoff ... 19
13.2 The crest rule ... 19
13.3 The 3D bund wall ... 20
14. How the surfaces are used ... 20
14.1 The Pit mesh ... 20
14.2 The TOPO mesh ... 20
14.3 The BOCO mesh ... 20
14.4 Toe and Crest strings ... 20
14.5 Which way is outward ... 20
15. Assumptions and limitations ... 21
Part 3 — Reference ... 22
16. Messages and troubleshooting ... 22
16.1 Before the dialog opens ... 22

16.2 When you click Calculate 22
16.3 During the run 22
16.4 Results that look wrong 23
17. Glossary 24
Document history ..... **Error! Bookmark not defined.**

> **Results changed in this edition.** Re-run any design made with an earlier build, and compare the limit at the pit corners and along any ramp in the crest. All of the following are fixed: - **Outward corners** (builds before 8 November 2026). The ZoI limit was drawn straight across the outward (convex) corners of a pit, inside the measured daylight positions: on a 100 m square section 50 m below flat ground, 5.7 m inside at 5 m line spacing and 13.4 m at 7 m. The limit now follows the corner arcs (§15, item 6). - **A nearer slice governing** (builds before 9 November). Wherever the deepest slice's lines passed a crest station without landing on it, a nearer slice governed there, so on a steep pit cut at many levels the limit dipped inward: in a test (70° walls, a 95 m reach) by up to 47 m with the smoothing off, and by 10.4 m at the default settings before 8 November. The limit now follows each slice's daylight line (§12.2): within 1.8 m of the exact line in that test with the smoothing off, and 2.5 m at the defaults. - **Smoothing spikes** (builds before 9 November). The smoothing could throw a narrow spike outward from a nearly straight stretch of the limit, twice the smoothing radius long: on a real pit, two 100 m spikes at the defaults (§12.3). - **Different lines from the same data** (builds before 9 November). The sections were cut in a different order on every run, so two runs on the same data could give lines up to 33 m apart. A run on the same data now always gives the same line, and small section loops are judged with a test scaled to their size (§14.1). - **Re-runs and the Simplify tolerance** (builds before 8 November). A re-run pre-ticked the previous run's outputs as TOPO, so it could daylight on the old fan, wall or contact plane (§4.1). The **Simplify tolerance** could bring the bund line up to that distance inside its two clearances: 9.0 m for a 10 m standoff at the default 1 m (§13.2). - **Points filed a station off** (builds before 9 November). Each daylight point went to a crest station counted from the average station length, which drifts where the crest bends: by more than a station on a real pit. At an outward corner the corner's lines could then go to the station beside it, which keeps only one line, and the limit cut the corner arc: 8 m inside in a test. Each point now goes to its nearest station (§12.2); on a real pit the lines moved by up to 2 m, mostly outward. - **A narrow tongue of the crest** (builds of 9 November). Along the sides of a narrow tongue of the crest reference, such as a ramp boxcut drawn into a ticked Crest string, the direction "away from the crest" points back across the pit, and the limit along the tongue was drawn 16 to 25 m inside the true line at the default settings (a tongue 20 m wide and 100 m long, at 60° to 80° to the crest), with the bund line inside the true zone of instability. Such points are now tested along the direction their own projection travelled (§12.1, §12.2): in tests with tongues 40 to 150 m long at 30° to 90°, the limit stayed within 2.4 m of the exact line, apart from the two cases in §15, item 9. On pits without such a tongue nothing changes.

This manual shows you how to draw the zone of instability and the abandonment bund around an open pit with GEM4D, following the Western Australian 1997 guideline, and how to check the answer.

> **Regulatory scope.** This tool implements the *generic* construction of the Western Australian guideline **"Safety Bund Walls Around Abandoned Open Pit Mines"** (1997), referred to in GEM4D as **DMP 1997**. The guideline's generic criteria assume **no major unfavourably oriented geological structures**, sound wall conditions and no nearby public infrastructure. Where any of these does not hold, the guideline requires a **site-specific geotechnical study**. This tool does not replace one, and every summary box says so. Check the current version of the guideline and any conditions attached to your tenement, and have the result reviewed by a competent geotechnical engineer.

How to use this manual

If you want to…	Read
Know what the tool produces	Chapter 1
Get a first result quickly	Chapter 2 — Quick start
Prepare the meshes and fill in the dialog	Chapters 3 and 4
Run it, read the results and check them	Chapters 5–7
Understand the construction behind the answer	Part 2 (Chapters 8–15)
Fix a problem or look up a term	Part 3 (Chapters 16–17)

Part 1 — Using the tool

1. What the tool does

Calc ▸ Abandonment bund (DMP 1997) draws the guideline's construction around an open pit. **Calc** is the Σ button on the scene toolbar; its tooltip starts *Calc:*.

It produces four objects:

1. the **fan surface** — the projection lines that govern the answer, as a surface you can look at and check;
2. the **ZoI limit line** — where those lines meet the natural ground, which is the outer limit of the zone of instability (ZoI);
3. the **bund line** — the ZoI limit moved outward by a standoff, and kept at least a set distance from the pit crest;
4. the **3D bund wall** — a solid wall of your chosen height and base width, with its pit-side toe on the bund line.

The tool slices the pit horizontally at many elevations. From each slice it projects lines outward and upward at the design angle: 45° in fresh rock by default, and optionally a flatter angle through weathered rock. Where a line meets the natural ground, it *daylights*. At each point around the crest, the line that reaches furthest from the crest governs. Part 2 explains the construction.

The results are ordinary GEM4D objects. You can save them to DXF, measure them and hand them on.

Typical questions it answers:

- *Where does the instability zone daylight around a pit whose depth, wall angle and relief all vary?*
- *Which bench actually drives the answer on each side of the pit?*
- *Where does the bund go, and how long is it?*

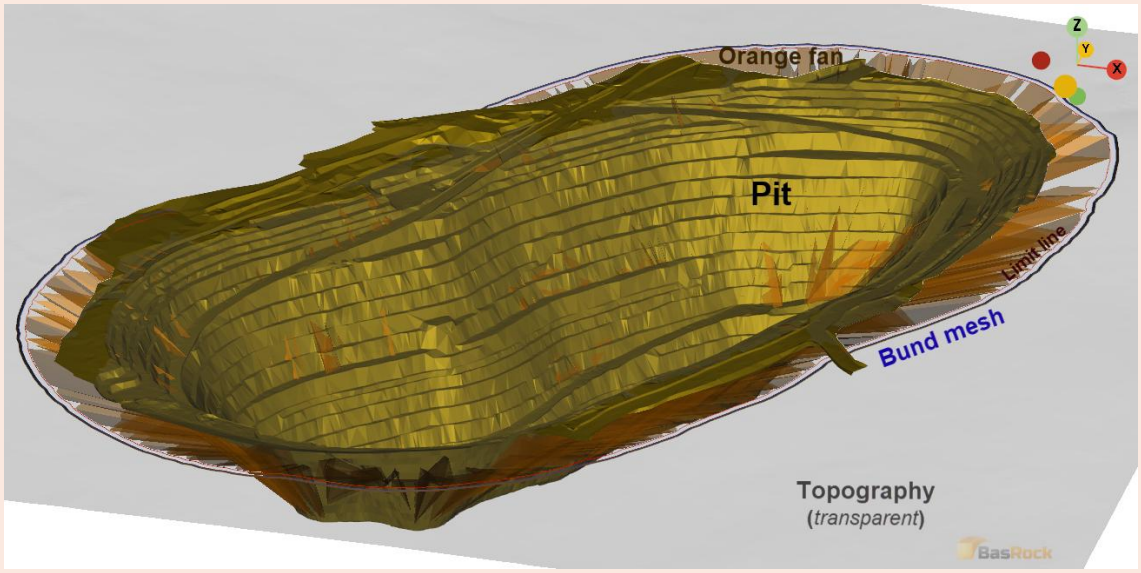


Figure 1 — An as-built pit with the translucent orange fan surface rising outward, breaking the topography along the red ZoI-limit line, with the blue bund mesh 10m further away.

2. Quick start

1. Load the pit surface and the natural topography as **two separate meshes**. The topography must reach well beyond the pit. Turn clipping off.
2. Click **Calc** (Σ) ▸ **Abandonment bund (DMP 1997)**.
3. In the mesh-role table, tick the pit surface in the **Pit** column and the topography in the **TOPO** column. On a first run every visible mesh starts ticked as TOPO; ticking **Pit** on the pit's row clears its TOPO tick.
4. **Sections from / to** follows the pit. Set **every** to about half your bench height.
5. Keep the other defaults: 45°, the suggested line spacing, no weathering, 10 m standoffs and all four outputs ticked. Click **Calculate**.
6. Watch the progress bar in the status bar. **Esc** cancels.
7. A Save dialog asks for a DXF file name for the outputs. Cancelling it discards them.
8. Read the summary box (Chapter 6). Then hide the topography and look at the fan surface (§7.1).
9. Refine and re-run as §7.2 describes: halve the section interval and run again, then halve the line spacing. The ZoI limit should barely move.

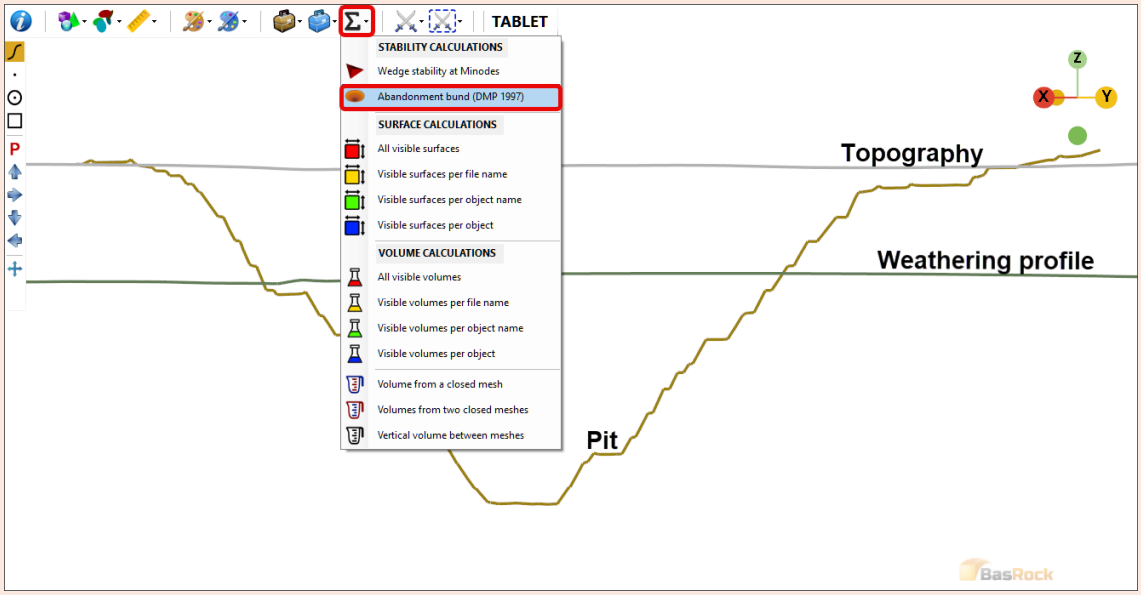


Figure 2 — A section of the scene before a run with the pit, topography, and weathering profile loaded, with the Calc (Σ) drop-down open on "Abandonment bund (DMP 1997)".

3. Before you run: the inputs

Input	Role column	What it is
Pit surface	**Pit**	An as-built or design surface of the excavation. The horizontal slices are cut from it. Required, unless you use a Toe string.
Natural topography	**TOPO**	The ground the projection lines daylight against. Always required. It must extend **well beyond** the expected reach.
Toe string *(optional)*	**Toe**	Any loaded object with polylines, such as a DXF string or a Surpac STR. Used as the source outline instead of slicing the pit.

Input	Role column	What it is
Crest string *(optional)*	**Crest**	A surveyed crest string to measure "furthest from the crest" against. Without one, GEM4D uses the widest slice (§12.1).
Base of weathering *(optional)*	**BOCO**	The modelled contact surface, for mesh-defined weathering (§4.4). A constant contact RL needs no mesh.

Three rules:

- **The pit and the topography must be separate meshes.** The projection lines are cast against the TOPO surface only. A combined as-built used for both would stop every line on the pit wall. The dialog lets each mesh play only one role.
- **A combined as-built is fine as the Pit**, as long as a separate topography is ticked as TOPO. GEM4D drops the terrain contours a combined surface adds to each slice (§14.1).
- **Clipping must be off.** Clipped fragments would misrepresent the pit, so the tool refuses to run in clipping mode.

4. The settings dialog

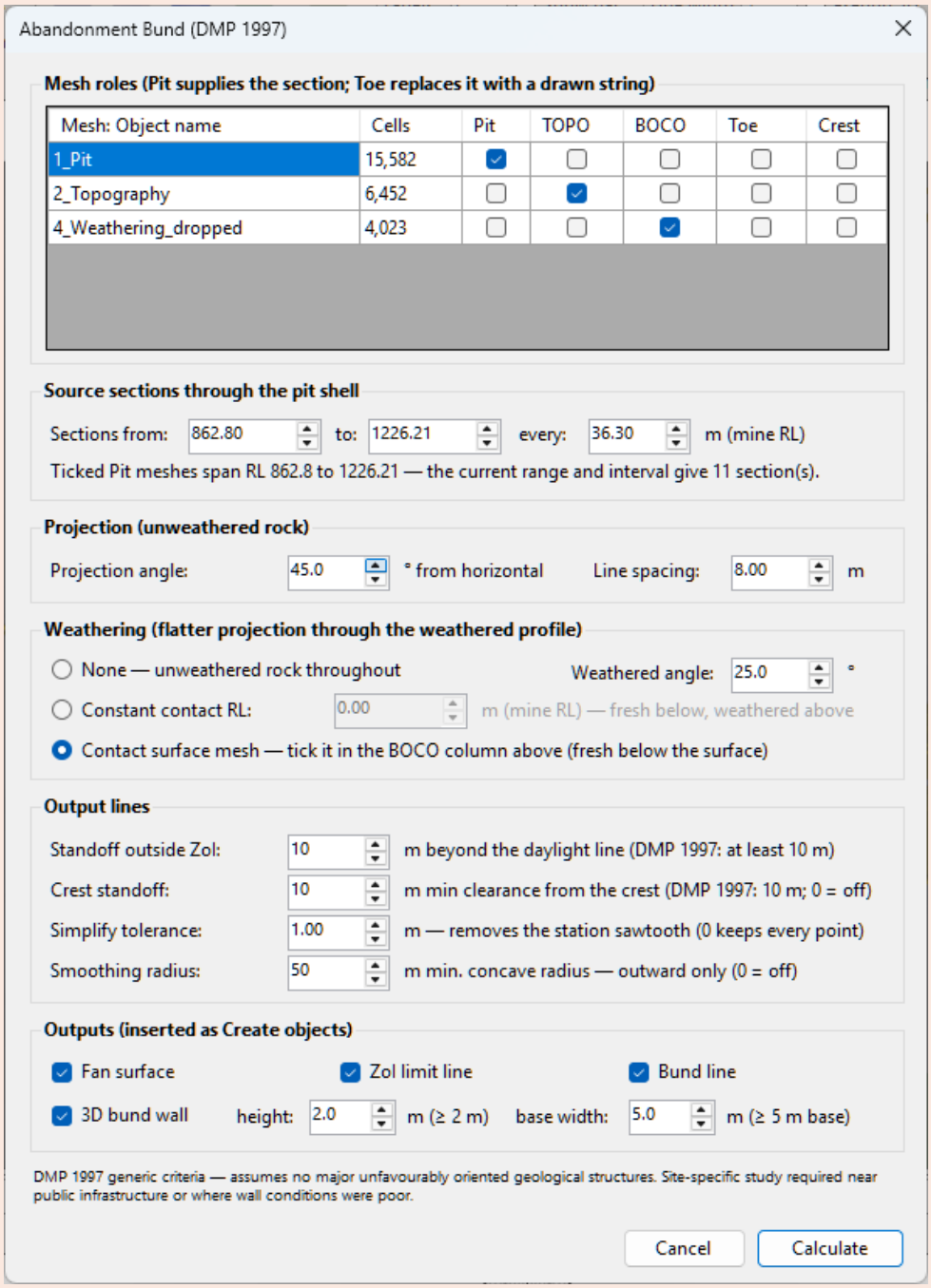


Figure 3 — The Abandonment Bund (DMP 1997) dialog with the mesh-role table populated, a section range and interval entered, and all four output checkboxes ticked.

The dialog has six groups, top to bottom: the mesh roles, **Source sections through the pit shell**, **Projection (unweathered rock)**, **Weathering**, **Output lines** and **Outputs (inserted as Create objects)**. A note at the bottom repeats the guideline's scope. **Calculate** runs the tool.

Every setting is remembered for the rest of the session.

4.1 Mesh roles

One row per loaded mesh. The columns are **Mesh: Object name**, **Cells**, then the five roles **Pit**, **TOPO**, **BOCO**, **Toe** and **Crest** (Chapter 3).

- **One role per mesh.** Ticking a role clears any other tick on that row.
- **Several meshes can share a role.** They are pooled into one surface.
- **BOCO drives the weathering option.** Ticking a mesh in BOCO selects **Contact surface mesh** (§4.4). Removing the last BOCO tick sets weathering back to **None**.
- **Ticking a Toe string turns slicing off.** The section-range row greys out, and the fan starts from the string's own polylines, at their own elevations.

Roles are remembered for the session and re-applied by object name the next time you open the dialog. Objects with the same name each take one remembered row, in order. On a first run, every visible mesh starts ticked as TOPO; no other role is pre-ticked. On later runs, any visible object the dialog has not seen before also starts ticked as TOPO, **except the outputs of an earlier run** (`BundFan`, `ZoILimit`, `BundLine`, `BundWall`, `BOCOPlane`), which start unticked: ticked, the new lines would daylight on the old fan, wall or contact plane and pull the ZoI limit inward. They are recognised by name, so an output you renamed starts ticked like any other object; untick it yourself.

4.2 Source sections through the pit shell

Control	Range	Notes
Sections from: / to:	±100 000 m (mine RL)	The elevation range to slice. The top of the range is always cut, whatever the interval leaves over.
every:	0.1–500 m	The vertical interval between slices.
(hint line)	—	*"Ticked Pit meshes span RL … to … — the current range and interval give N section(s)."*

Until you change them, the range follows the ticked Pit meshes from bottom to top, and the interval is a tenth of that span.

Choosing the range and interval:

- **Bottom.** The deepest point of a pit is often a **sump**, not a working level. Starting below it costs nothing: its projection simply loses, or flies off and never lands. To keep it out of the picture, start the range above its lip.
- **Top.** Set it at or near the crest. Without a Crest string, the crest reference is the widest slice (§12.1), which can only be as high as you slice.
- **Interval.** The interval decides which benches are seen. An interval much larger than the bench height can step over the toe that governs. Start at about half the bench height (or a tenth of the wall height), then refine (§7.2). Up to 2 000 sections are allowed. All of them are cut in a single pass over the pit mesh, so a fine interval costs projection lines, not cutting time.

Setting the top equal to the bottom gives exactly one slice. If the range lies entirely outside the ticked Pit meshes, GEM4D asks before going ahead.

4.3 Projection (unweathered rock)

Control	Range	Default	Notes
Projection angle	5–89°	**45°**	Measured from horizontal. The guideline's generic value for **fresh rock**.
Line spacing	0.25–100 m	suggested	How far apart the projection lines sit along each outline.

The suggested spacing is about 1/400 of the plan diagonal of the visible meshes' bounding box, rounded up to the next 0.5 m: a 4 km × 4 km scene gets 14.5 m.

Line spacing sets the resolution of the whole answer twice over. It sets how densely each slice is fanned, and it is also the size of the crest stations that decide which projection governs (§12.2). It is the main cost driver: halving it doubles the lines per slice, and the number of slices multiplies that again. Start with the suggestion, then refine (§7.2).

Above about **500 000** projection lines, GEM4D gives the count and the memory it will need, and asks before starting. Above **2 000 000** it declines and asks you to coarsen the spacing or the interval. Both are guards against a mistyped setting, not limits on how fine the analysis can be.

Outward (convex) corners are always fanned finely, whatever the spacing. The arc across a corner is stepped at most 5° at a time, so a right-angle corner gets 17 lines of its own. The straight pieces on either side add one each at the ends of the arc. An inward corner gets one line along its bisector (§9).

4.4 Weathering

Control	Range	Default	Notes
None — unweathered rock throughout	—	selected	The single-angle construction.
Constant contact RL	±100 000 m (mine RL)	0	One horizontal contact for the whole site. Fresh rock below it, weathered above.
Contact surface mesh	—	—	The base of weathering is the mesh (or meshes) ticked in **BOCO**.
Weathered angle	1–89°	**25°**	The flatter projection angle through the weathered profile. Refused if it is steeper than the projection angle.

The weathered angle is greyed out while **None** is selected, and the RL box is greyed out unless **Constant contact RL** is selected. Chapter 11 describes what the lines do at the contact.

- **Constant contact RL** is the blanket assumption. Use it when the depth of weathering is known only regionally, or to bracket the answer. A contact at or above the highest topography cannot affect any line; the run is made without weathering and the summary says so. A contact below the whole slice range makes every line weathered from the start.
- **While Constant contact RL is selected, a translucent tan plane shows the contact in the scene.** It follows the RL box as you edit it, so you can set the contact against the walls rather than by number. It disappears when you choose another option or close the dialog. A run with a constant contact also inserts the plane, `BOCOPlane`, with the outputs (§4.6).
- **Contact surface mesh** follows your geological model. A projection line whose start point has **no contact surface** vertically above or below it is taken as **fresh rock**, and counted in the summary. GEM4D never assumes weathering where none is modelled. If the count matters, extend the contact model, or use a constant RL as the conservative blanket case.
- **The weathered angle extends the reach a long way.** At 25°, a line moves about 2.1 m outward for every metre it climbs, against 1 m at 45°. Expect the ZoI limit to move out wherever weathered ground overlies the walls.

4.5 Output lines

Control	Range	Default	What it does
Standoff outside ZoI	0–200 m	**10 m**	Distance from the ZoI limit to the bund's pit-side toe (DMP: at least 10 m). At 0, the bund line is drawn on the ZoI limit itself, still subject to the crest standoff.

Control	Range	Default	What it does
Crest standoff	0–200 m	**10 m**	The guideline's second rule: the bund "in any case" at least this far, in plan, from the pit crest. 0 turns the rule off (§13.2).
Simplify tolerance	0–20 m	**1 m**	Removes the small sawtooth from both lines without moving them more than this distance, in either direction, so the ZoI limit can move towards the pit by up to this much. The bund line keeps its two clearances: they are enforced again after simplifying (§13.2). 0 keeps every point (§12.3).
Smoothing radius	0–200 m	**50 m**	The smallest concave radius the ZoI limit may have. Smoothing only ever moves the line outward. 0 turns it off, and the limit then joins every station (§12.3).

4.6 Outputs (inserted as Create objects)

All four are ticked by default. Untick what you do not need.

Checkbox	Object name	What it is
Fan surface	`BundFan`	A translucent orange surface swept by the **governing** lines only, one sheet per continuous stretch of crest they govern. It carries the raw daylight positions. **Tick it every time you check an answer.**
ZoI limit line	`ZoILimit`	A red closed ring on the governing daylight positions, lifted 0.3 m so it shows above the topography. One DXF polyline per ring.
Bund line	`BundLine`	A blue closed ring at the standoff beyond the ZoI limit, draped on the topography and lifted the same 0.3 m. One DXF polyline per ring.
3D bund wall	`BundWall`	A brown solid wall with a triangular cross-section, its pit-side toe on the bund line (§13.3). One object for all rings.

The wall row has two boxes: **height** (0.5–20 m, default 2 m, labelled *m (≥ 2 m)*) and **base width** (1–50 m, default 5 m, labelled *m (≥ 5 m base)*). The labels show the guideline's minimums. The boxes are greyed out unless **3D bund wall** is ticked. A base narrower than twice the height gives side slopes steeper than 45°, steeper than dumped fill can stand. GEM4D asks before building such a wall rather than refusing it, because a keyed or reinforced bund is your decision.

The wall follows the bund alignment even when **Bund line** is unticked, so the crest rule still applies to it.

A run with **Constant contact RL** weathering also inserts the contact plane, `BOCOPlane` (§4.4). It has no checkbox of its own.

5. Running

After you click **Calculate**:

1. The progress bar in the status bar fills as GEM4D cuts the sections, fans them, prepares the topography for ray-casting, projects the lines, selects the governing ones and builds the bund. The phase names go to `GEM4D_diag.log`.
2. **Esc** cancels at any time. Nothing is created (*"Abandonment bund calculation cancelled — nothing was created."*).
3. A Save dialog asks for a DXF file name. All ticked outputs go into that one file. Cancelling the dialog discards them (*"Saving was cancelled and the created objects deleted"*).
4. The summary box opens (Chapter 6).

6. The summary box

The summary box opens after every run, headed *Abandonment bund construction complete.* It lists only counts and lengths; the full detail of each run goes to `GEM4D_diag.log`. The lines below appear in the order the box shows them. A line in *italics* appears only when it applies.

Line	Meaning
Source:	The sections that cut the pit, their range and interval (or *drawn outline* for a Toe string), the total outline length and the line spacing.
Section loops ignored: N open fragment(s), M topographic high(s)	Loops cut from the Pit mesh that are not excavation (§14.1). A large M means the Pit mesh covers a lot of ground beyond the crest. That is harmless; it tells you the mesh is a combined as-built.
N small section loop(s) kept as excavation: the pit probe could not tell a hollow from a knoll there	Loops on which the test of §14.1 found no two-thirds majority; they are kept, the safe choice. Check the fan where the limit bulges round a small feature. A loop beside which the Pit mesh is missing, such as a section just below the edge of a mesh that ends at the crest, is kept without this line.
Measured from the …	The crest reference used: the *widest section ring (RL …)*, the *ticked crest string*, or, in a Toe-string run with no Crest ticked, the *drawn outline (no Crest ticked)*. A reported RL far below your range top means the higher slices never form complete rings, usually on a pit in sloping terrain. Consider a surveyed crest string (§12.1).
Daylight: N of M lines (K trimmed on the medial axis)	How many projection lines met the ground. Trimmed lines are normal wherever an outline has inward corners (Chapter 9).
Governing: N station(s) drawn from X of Y section(s), reaching A to B m out	How much of the crest got an answer, how many slices contributed one, and the range of horizontal reach. If X is 1, one slice governs everywhere; if X is most of Y, the interval is earning its keep. *; K of them on a section's daylight line between two of its lines, where its fan passed the station without one* follows when K stations took a point between two of a slice's lines rather than a line's own daylight point (§12.2).
Zol limit: L m in R closed ring(s)	The total length of the Zol limit. One ring per crest loop; a single pit gives one.
No line reached the ground — nothing daylighted, so there is no limit line.	Replaces the three lines above when no projection met the topography. The topography does not reach the fan, or TOPO is ticked on the wrong mesh.
Smoothed at a R m minimum concave radius — outward only, deepest sealed notch X m	The smoothing (§12.3) ran at radius R. X is the deepest notch it sealed: the furthest any measured point now lies *inside* the smoothed line. A ring the smoothing could not process is left as measured and counted.
Bund line: L m at S m beyond the limit	The bund-line length and the standoff used. Shown when **Bund line** is ticked.
Wall toe alignment: L m at S m beyond the limit (Bund line output not ticked)	Shown instead of the bund-line line when the wall is ticked but the bund line is not. The alignment is still computed, so the crest rule still applies.

Line	Meaning
Crest rule: …	Shown whenever the bund line or the wall is ticked. Either *N bund point(s) pushed out to the C m crest clearance (K added on the arcs)*; or *the bund line already clears the crest by C m everywhere*; or *OFF (crest standoff 0)*, so a disabled rule is never mistaken for a passed one. *N could not reach clearance* flags ground that cannot hold a compliant bund (§13.2). With the bund line unticked, the line speaks of the *wall toe*. The counts are taken before the line is simplified (§13.2).
Bund wall: H m high on a W m base, pit-side toe on the bund line	The wall was built with these dimensions. A bracketed count of wall points that *had no ground beneath them* means the base ran past the edge of the topography; those points kept the nearest landed elevation. If it reads ***not built — the half-base-width offset swallowed every bund ring***, the rings are smaller than the wall base.
N projection(s) daylighted INSIDE the crest and were discarded	These lines rose through the ground surface while still over the excavation, so they undermine nothing beyond the crest. Expected, often in large numbers, when the topography spans the pit opening, as a regional DTM does. Only lines that clear the crest can govern.
Interpolated across N station(s) with no daylight point of the outermost line, longest run X m	The ring is closed by a straight line where no point of the outermost daylight line was found (§12.2). A short run is housekeeping. A long one is a stretch where the answer is not measured, and is worth a look.
Clean-up: N crest loop(s) ignored …; M self-crossing(s) removed; K bund point(s) had no ground beneath them and took a neighbour's elevation	Three counts on one line: crest loops dropped for not enclosing the pit, folds untangled from the rings, and bund points with no topography beneath them. The line appears only when one of the counts is not zero.
Warning: untangling removed more than a tenth of N ring(s)	The crest reference is probably not a clean pit outline, so the stations are ordered badly. Check the fan and the section range top, and consider a surveyed crest string.
Note: the crest-enclosure check matched no loop … all crest candidates were kept	Expected on a **single-slice or Toe-string run**, where the crest reference *is* the source outline. Nothing is wrong.
N of M lines never met the ground	Expected: these are the projections arrested inside the pit (Chapter 10). Act only if it is *most* of them, which means the topography does not reach far enough.
Note: the outward side of N open outline(s) was taken from their own direction	No Pit mesh was ticked to probe against (§14.5). Check that the fan points the way you expect.
Weathering: N of the M daylighted line(s) kink at the contact; K met the ground in weathered material	How much weathering changed the answer. If both counts are 0, the contact never mattered.
N line(s) started outside the contact surface's coverage and were taken as fresh rock	Contact-mesh weathering only (§4.4). Extend the contact model if the count matters.
N line(s) hit the 8-kink guard	The contact surface runs along those lines, so they crossed it more than eight times. From the eighth kink on they keep their material. Rare; look at the fan crease there if it matters.

Line	Meaning
Objects created: N.	How many output objects were inserted. Instead it reads *Objects: cancelled at the save dialog — nothing inserted* if you cancelled the save, or *Objects: none created (nothing to draw from these sections)* when there was nothing to draw.
Projection angle: …	The angle used, *from horizontal (unweathered rock throughout)*; with weathering, *Projection angles: … in fresh rock, … in the weathered profile, kinked at* the contact RL or the contact surface. If a constant contact lay at or above the highest ground, a note says the weathered angle never engaged.
Note: DMP 1997 generic criteria assume …	The guideline's scope, repeated on every run.

7. Checking the answer

7.1 Look at the fan

Hide the topography and view the fan surface obliquely. In one look you can confirm that:

- it rises **outward**, away from the pit, everywhere;
- corners fan smoothly instead of leaving wedges;
- the line origins step from bench to bench where the governing slice changes. That stepping *is* the guideline's Figure 2B behaviour (Chapter 10), made visible.

Then show the topography again. The fan disappears into the ground, and the red ZoI limit line marks exactly where it breaks through.

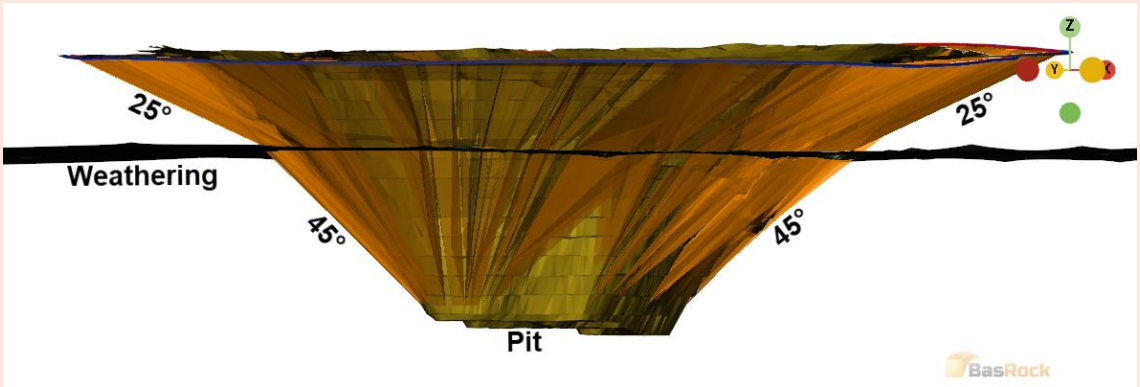


Figure 4 — The governing fan surface with the topography hidden, showing the line origins stepping between benches around the pit.

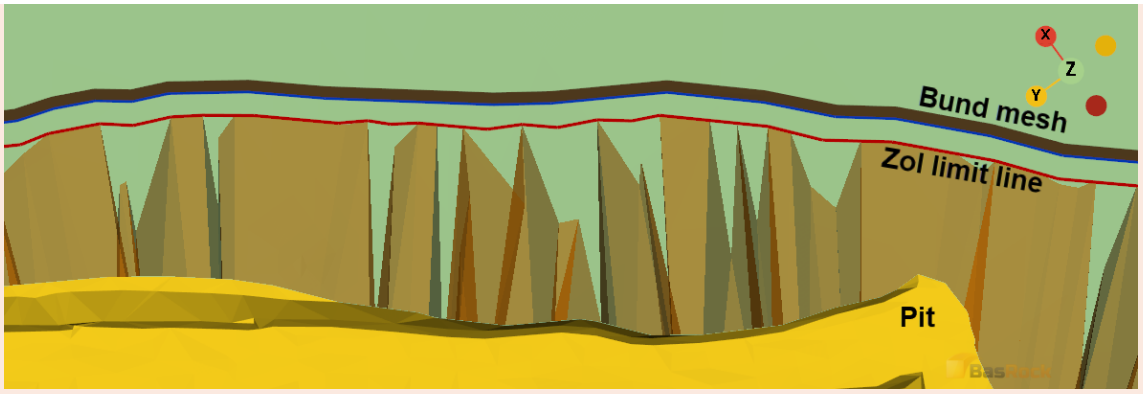


Figure 5 — A plan view with the ZoI limit line and the bund line together, showing the constant standoff band between them. The red (ZoI) and blue (bund) lines are 10m apart, and the bund mesh built start at the blue bund line.

7.2 Refine, twice

Run once at the suggested spacing and your interval. Then:

1. **Halve the section interval**, run again and confirm the ZoI limit barely moves. If it jumps, the interval was stepping over the governing bench.
2. **Halve the line spacing**, run again and confirm the same.
3. Refine whichever one moved until the line is stable.

The previous run's outputs start unticked in the **TOPO** column (§4.1); leave them so.

7.3 The analytic check

Worth doing once, so that you trust the tool:

1. Build a simple pit with a flat floor at a known RL: conical (a circular floor) or pyramidal (a square floor).
2. Load a **flat** topography a known height h above that floor.
3. Slice at the floor only (bottom = top = floor RL), angle **45°**, **Simplify tolerance** 0.

The ZoI limit must sit h metres out from the floor outline, all the way round, and h metres above it (the `ZoILimit` object is drawn 0.3 m higher, §4.6). Round each corner of a square floor it follows an arc of radius h about the corner, to within one 5° chord: $h \times (1 - \cos 2.5°)$, 0.05 m at h = 50 m. Where a corner falls between two line-spacing samples, the slice cuts it off by up to 0.35 × the spacing, and the limit there lies that much inside (§15, item 6). At 60° the limit must sit $h / \tan 60° = 0.577\,h$ out.

With weathering: add a constant contact RL a known height w above the floor ($0 < w < h$) and a weathered angle of 25°. The limit must now sit exactly $w + (h - w) / \tan 25°$ out: the 45° rise to the contact, then the flatter climb. The fan shows a clean crease at the contact elevation, all the way round. Put the contact below the floor and the answer becomes $h / \tan 25°$. Put it above the topography and it returns to h.

GEM4D's automated tests check the same cases.

Part 2 — How it works

8. The DMP 1997 rule, in section

Draw a section through the pit. From the toe of the wall, project a line upward and outward at **45°** through unweathered rock, the guideline's generic value. Where that line meets the natural surface is

the outer limit of the ground that could be undermined as the abandoned walls ravel and regress. The bund's pit-side toe stands at least **10 m** beyond that point, and at least 10 m from the crest. The bund itself is at least **2 m** high and **5 m** wide at the base.

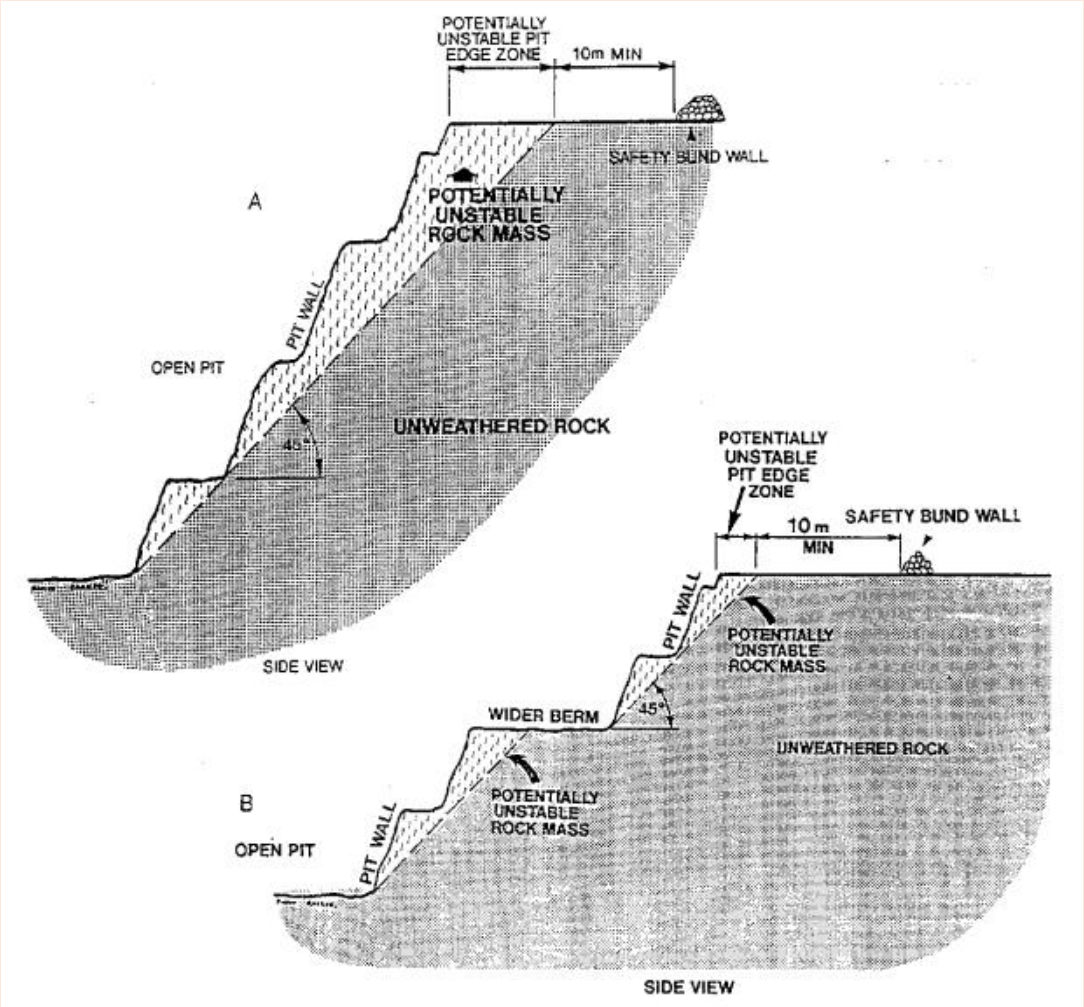


Figure 6 — Pit wall excavated entirely in unweathered rock. [DEMIRS, 1997]

9. From a section to a fan

A pit is not one section. GEM4D takes the closed outline the pit makes at a chosen elevation and repeats the section construction **all the way around it**. Every straight piece of the outline sends out lines tilted outward, away from the void, at right angles to the piece. Together those lines form a surface: the **fan**.

Doing it this way, rather than on a handful of hand-picked sections, has two benefits:

- the answer is **continuous** around the pit, with no interpolation between sections and no missed re-entrant;
- the answer is **visible**. The fan is a real mesh. If it points the wrong way, or stops somewhere odd, you see it at once.

Corners. A fan of lines at right angles to the outline does not obviously know what to do at a corner. GEM4D does not guess; the answer follows from what the fan is. Its elevation at any point in plan is

> **fan elevation = slice elevation + tan(angle) × (horizontal distance to the outline)**

That gives a single value everywhere outside the outline, with three consequences:

Where	What you get	Why
Along a straight piece	The tilted plane you would draw by hand.	The nearest point of the outline is straight across.
At an **outward (convex) corner**	A **cone around the corner**: the fan opens out in an arc.	For a range of directions, the corner point itself is the nearest part of the outline.
At an **inward (reflex) corner**	The two sheets **stop on the line that bisects the corner**.	Each point is claimed by the nearer piece. The two sheets reach the bisector at the same height, so they meet exactly, with no gap and no crossing.

The same rule handles a narrow neck between two arms of an outline, with no special case. The line that stops at a bisector is reported as *trimmed on the medial axis* in the summary. Every inward corner also sends one line straight up its bisector, so that a smoothly curving inward stretch of wall is sampled too.

Within one slice, the daylight line therefore cannot cross itself. Folds can still appear once the slices are combined into one ring; §12.3 explains how they are removed.

Slices never trim each other. The bench above sits only a berm-width outside the bench below. If the slices competed geometrically, every line from the lower bench would be cut off after half a berm. Each slice is an independent construction, and the selection in Chapter 10 decides between them.

10. Many sections: the guideline's Figure 2B

Project 45° from the very bottom of a pit whose overall wall is *flatter* than 45°, or that has a wide berm, and the line leaves the rock and passes into the void. That projection is **arrested**: it daylights on the pit face itself, and the ground beyond the pit is not undermined by that toe at all. The real driver is the toe of a face **higher up**.

The guideline covers this case in its Figure 2B. GEM4D generalises it: it slices the pit at many elevations, fans every slice, and at each place around the pit keeps the projection that reaches furthest out.

The arrested projections need no special detection. Every line is cast against the **topography only**. A line that leaves the excavation into the void keeps climbing, never comes down and never offers a candidate. The upper slice wins by default.

11. Weathering: the contact kink

Weathered rock does not stand at 45°. The guideline projects at the fresh-rock angle only **below the base of weathering**. Above the contact, the projection continues at a **flatter angle**; GEM4D defaults to 25°. So the section line **kinks where it crosses the contact**, and the zone of instability reaches further out wherever weathered ground overlies the pit.

GEM4D draws exactly that, line by line:

- A line rises at the fresh angle until it crosses the contact, then continues at the weathered angle until it daylights.
- A line that starts in weathered ground (a slice above the contact) rises at the weathered angle from the start.
- A line that daylights before reaching the contact never kinks.

- If an undulating contact surface crosses a line more than once, the line kinks at every crossing, steepening back to the fresh angle where it re-enters fresh rock.

With a contact surface mesh, each line's starting material comes from a vertical probe: above the contact is weathered, below is fresh. The line then kinks at its **exact** crossings with the surface, with no gridding in between.

Weathering bends the lines only vertically. Everything that works in plan is unchanged: the corner trimming, the slice competition, the crest stations, the rings and the smoothing. On the fan surface the kink shows as a visible **crease**, so the two-angle construction stays inspectable. Every governing line is still the section an engineer would draw by hand through that point of the pit.

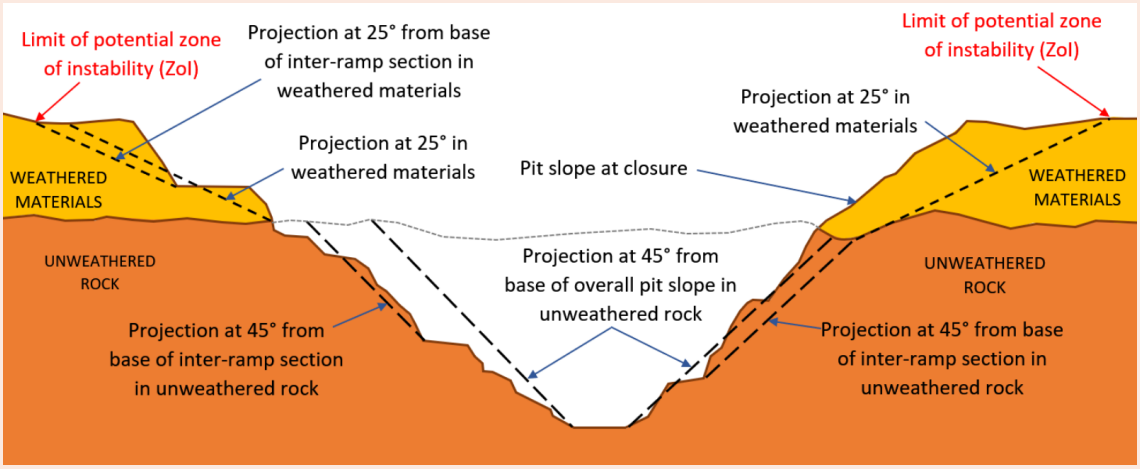


Figure 7 — Sectional view through the final pit showing the projected position of the potentially unstable edge zone (zone of instability – ZoI) surrounding the pit at surface. [De Bruyn et al, 2019]

12. From projections to the ZoI limit line

12.1 The crest reference

"Furthest from the crest" needs a crest. If you tick a **Crest** string, GEM4D uses it; that also lets you measure against a crest above or outside your slice range.

A ramp boxcut, or another narrow tongue of the excavation, in a Crest string. "Away from the crest" is measured at right angles to the crest, and along the sides of a narrow tongue that direction points back across the pit. There GEM4D tests a point along the direction its own projection travelled instead (§12.2). This needs a closed Crest string: along an open one the points keep the test from the crest, so close the string, or untick it so that the widest slice is the crest. In tests with tongues 40 to 150 m long at 30° to 90° to the crest, in the Crest string only or also cut by the slices, the limit stayed within 2.4 m of the exact line with the smoothing off and at the default settings, apart from the two cases in §15, item 9 (a long tongue lying low over the crest, and a thin spike towards the pit with the smoothing off). Look at the fan and the limit along such a tongue (§7.1).

Otherwise the crest reference is the slice whose rings enclose the **largest plan area**. A pit widens towards the rim, so the widest ring is the highest *complete* outline. The summary reports the RL it came from.

It is deliberately **not** the topmost slice. On a pit in sloping terrain, the slices just below the high side of the rim are only fragments, because on the low side the outline has already opened into the hillside. A fragment used as the crest would crowd the daylight points onto a few stations and draw the limit as chords across the pit.

The crest is used to measure "furthest", to discard lines that daylight inside it, to order the stations and find the outward corners (§12.2), to decide which way the bund standoff pushes, and to measure the crest standoff (§13.2). It never positions a point of the ZoI limit. It does not enter the projection either, and so the crest rule works with **no surveyed crest at all**: the widest slice comes from the same pit mesh as everything else.

A crest loop is used only if it holds the pit, that is, if it encloses or runs along a source outline. Other loops are dropped and counted on the summary's *Clean-up* line.

12.2 One point per crest station

GEM4D divides the crest into **stations**, one per line spacing. Every daylight point is assigned to the station of its nearest point on the crest, and at each station the projection that reaches **furthest from the crest** governs.

- A line that daylights **inside** the crest has risen through the ground while still over the excavation. It is arrested and discarded, and counted in the summary.
- **Each slice's daylight line.** A slice's daylight points, joined in the order its fan makes them, form its daylight line. A slice's fan lines are 5° apart round a corner, 8 m apart at a 95 m reach, so its line can pass a station without one of its own lines landing there. That station then also gets the point of the slice's line between its two neighbouring lines. Without it, a nearer slice's projection governed there and the limit dipped to it, by tens of metres on a steep pit cut at many levels.
- **The outermost line.** A daylight point is set aside when it lies inside a daylight line of the same crest, of any slice, its own included: that line lies further out along the point's own direction from the crest, and the direction leaves the line's zone there, before it reaches the crest again. The line of a second pit, of the far side of a bay that the point faces, or of the far arm of the pit beyond the bay, does not count. Where the crest nearest a point lies *ahead* of it, as along the sides of a narrow tongue of the crest (§12.1), its direction from the crest points back across the pit, and the point is tested along the direction its own projection travelled instead. *Furthest from the crest* alone compares points at different places along the crest: near a corner, a nearer slice's point a few metres along the wall can be further from the crest and still lie inside the deepest slice's line. A small closed slice ring away from the pit, such as a sump, keeps only its outer half.
- Each station contributes one point to the ZoI limit: the **measured** daylight position of its governing line, or the point of a slice's line between two of its lines. At an outward (convex) corner of a closed crest, the station instead keeps every point left there, in order round the corner, so the limit follows the arc (§15, item 6). Either way the limit comes out as one closed ring per crest loop, and fragments, gaps and forks cannot occur.
- A station where no point is left is filled on the straight line between the nearest stations that did, in plan and in elevation, so that the ring closes. Over a long run that line neither follows the crest nor lies on the ground, and on an outward-curving stretch it cuts inside where the limit would be. The summary reports how many stations were filled and the longest run.

12.3 Cleaning up the limit line

Three steps tidy each ring, in this order:

1. **Untangling.** Combining slices can leave a small fold in a ring. GEM4D removes the enclosed loop and counts it on the *Clean-up* line. It also takes out any stretch where the ring runs straight back along itself, as it can where a narrow tongue of the crest files the points of one straight piece of a daylight line out of order. Such a stretch encloses nothing, but both the smoothing and the bund standoff would read its reversed part as facing the pit and push it inward.
2. **Smoothing** (the **Smoothing radius**). GEM4D rolls a disc of this radius around the *outside* of the ring and keeps the boundary the disc can touch. Inward notches narrower than twice the radius are sealed by smooth arcs. The line only ever moves **outward**, gaining margin and never giving any up. Wherever the line was already smoother than the radius it stays exactly where it was,

and outward reaches, which are measured projections, are kept. Physically, the radius is the smallest concave radius an earthworks alignment can follow anyway. The summary reports the deepest notch that was sealed. A smoothed ring that does not contain every point of the ring as measured is not used: that ring is left as measured and counted in the summary. With the smoothing off, the limit joins every station; in a test (a square pit cut every 10 m, a 95 m reach, 60° and 70° walls) it lay within 1.8 m of the exact line, the slice's own resampling (§15, item 6).

3. **Simplifying** (the **Simplify tolerance**). Because "furthest wins" is decided separately at each station, a corner projection reaching a metre further than its neighbours pulls out a small tooth. Douglas–Peucker simplification removes these teeth while guaranteeing that the line never moves more than the tolerance from the measured one. It also cuts the number of vertices substantially, which keeps the DXF light. At 0, every station is kept.

Every point on the finished ZoI limit lies on a slice's daylight line, a measured daylight position or a point between two of them, apart from interpolated stations and the arcs added by smoothing. The clean-up decides which points are used and in what order. The fan surface keeps every raw daylight position for audit.

13. The bund line and the wall

13.1 The standoff

The bund line is the cleaned ZoI limit offset outward by the **Standoff outside ZoI**, with rounded arcs at outward corners. It inherits the smoothing of the limit line. It is then untangled and simplified like the limit, and draped on the topography. A bund point with no topography beneath it takes a neighbour's elevation, so that the ring still closes, and is counted on the *Clean-up* line.

13.2 The crest rule

The guideline also requires the bund to be "in any case" at least 10 m, in plan, from the pit crest. This matters where the projection construction produces the least: walls flatter than the projection angle arrest every line inside the pit, and a shallow pit daylights just past the crest. In both cases the ZoI limit hugs, or never leaves, the crest.

Wherever the bund line comes nearer than the **Crest standoff** to the crest reference, or strays inside it, that stretch is pushed straight out from the crest to exactly the clearance. Points are added around crest corners so that the line between pushed points cannot dip back inside. Everything already clear is left where the projection put it.

Both clearances (the standoff outside the ZoI and the crest standoff) are applied before the line is simplified, and again after it, on the simplified line: the standoff against the drawn ZoI limit, the crest rule against the crest. Where simplifying cut across a corner, the corner's arc points are put back. The finished bund line therefore clears both by the set distance to within about 1 cm, whatever the **Simplify tolerance** (§12.3).

- **The ZoI limit line is never moved.** It is the measured answer; only the bund line is subject to the rule.
- **With the default 10 m standoff outside the ZoI, the rule only engages on those starved stretches.** Wherever the zone encloses the crest, 10 m beyond the zone is already 10 m beyond the crest.
- **Some ground cannot hold a compliant bund**, for example a corridor between two crest loops narrower than twice the clearance. The summary then reports *could not reach clearance* rather than pretending. Those stretches need an engineering decision, not a longer offset.

13.3 The 3D bund wall

The bund line is the wall's pit-side toe, not its centre. Both standoffs are clearances to the bund's **nearest part**, its inner toe. A wall centred on the line would quietly give back half a base width of every clearance. So the wall's centre-line is the bund line offset **outward** by half the base width, with the same rounded corners, and the inner edge of the base runs along the bund line. The outer toe therefore reaches the standoff **plus one base width** beyond the ZoI limit. The bund line in your DXF *is* the edge of the earthworks.

How the wall is built. At every point of the centre-line the wall has three edges: the **crest of the wall** at the local ground elevation plus the wall height, and the two **base edges** at half the base width on either side, each seated at **its own** ground elevation. The wall therefore follows undulating topography instead of floating or digging in. Ground elevations come from vertical ray-casts against the TOPO surface. Corners are mitred and limited at sharp turns so that the wall cannot flare out. Closed rings join seamlessly, open ends are capped, and the underside is closed, so the wall is a solid and reports a volume in CAD.

14. How the surfaces are used

14.1 The Pit mesh

The Pit meshes are pooled and cut by a horizontal plane at each section elevation. The cut segments are joined into ordered outlines, always in the same order, and each closed outline starts at its westernmost point, so a run on the same data always gives the same answer.

Not every loop a section cuts is pit. A combined as-built that extends past the crest, as most survey pickups do, also yields contours of the surrounding ground at high sections: ridges, knolls and lines running off the edge of the survey. GEM4D keeps a section loop only when it is **closed** and the excavation rises towards its **outside**, which is what a contour of a depression does and a contour of a high does not. The summary counts both kinds of dropped loop.

The test looks at the Pit mesh to either side of the loop at 32 points or more round it, at most one line spacing away and, for a small loop, no further than halfway to its centre. At least two thirds of the points must agree. A loop on which they disagree is kept as excavation and counted on the summary. A loop beside which the Pit mesh is missing at most of the points, such as a section just below the edge of a mesh that ends at the crest, is kept without a note. A small hollow kept by the rim adds a bulge to the limit round it: check the fan there.

14.2 The TOPO mesh

The TOPO meshes are pooled into one surface for ray-casting. Each projection line takes its **first** intersection with it as its daylight point. Nothing else is ever daylighted against.

14.3 The BOCO mesh

With mesh-defined weathering, the BOCO meshes are pooled into their own ray-casting surface (Chapter 11).

14.4 Toe and Crest strings

The object's line segments are joined into ordered polylines and used as they are, at their own elevations.

14.5 Which way is outward

A **closed** outline is fanned away from its own interior; its winding settles that exactly.

The **pit probe** looks at the pit surface a short step to either side of the outline and takes the side where the pit is **higher**, because the pit rises towards the crest. Many samples along the outline vote, and the majority decides. The probe has two jobs: it sets aside section loops that are not excavation (§14.1), and it picks the outward side of an **open** Toe string, which has no interior. Where an open string has no Pit mesh beneath it to probe, its own direction is used, and the summary says so.

15. Assumptions and limitations

1. **Generic criteria only.** The guideline's angles assume no major unfavourably oriented structures, sound walls and no nearby public infrastructure. Adverse structure, poor ground or a sensitive receptor requires a site-specific study.
2. **Geometry only.** No groundwater, rock-mass strength, seismicity, time dependence or dynamic loading. The construction is a geometric projection rule, as the guideline intends.
3. **Two materials at most.** Fresh rock and one weathered profile with one flatter angle. A layered profile, such as transported cover over saprolite over saprock with an angle each, is not modelled. To bracket it, use the flattest applicable angle and the shallowest applicable contact.
4. **The interval sets which benches are seen.** A toe that falls between two slices cannot govern. Refine the interval until the answer stops moving (§7.2).
5. **Ground rising steeply beyond the crest.** An arrested projection normally never lands. If the topography beyond the crest rises *more steeply than the projection angle*, the ground can climb to meet such a line, which then lands further out than it deserves. The error is conservative. With weathering on, the relevant angle is the **weathered** one (25° by default), which makes this more common than at 45°.
6. **Corners and the line spacing.** The answer is resolved at one point per line spacing along the crest. Round an outward (convex) corner of a closed crest, the limit follows the arc of the corner fans to within one 5° chord (§12.2), with any number of slices. What is left is the slice's own resampling: a sharp corner of a section that falls between two line-spacing samples is cut off by up to 0.35 × the line spacing, and the limit round it is measured from that cut, inside the true limit (2.3 m at 7 m spacing on a 100 m square section 50 m below flat ground). Where a section has sharp corners, use a finer line spacing. An open crest (an open Crest or Toe string) keeps one line per station, so its outward corners are still cut across, inside the daylight positions. Where the crest bends away from the limit, several neighbouring stations can put their points close together and the next one far along; the limit is joined straight between them and can cut inside a gentle outward bulge of the daylight line by a few metres (at most 2.6 m on a real pit at 8 m line spacing). The bund line's standoff lies beyond it.
7. **First hit wins.** Each line takes its first intersection with the topography; overhanging ground is not modelled.
8. **The crest rule is only as good as the crest reference.** The clearance is measured against the ticked crest string or the widest slice. If your section range stops well below the true crest, the clearance is measured from that lower outline. Set the range top at the crest, or tick a surveyed crest string.
9. **A narrow tongue of the crest.** Along the sides of a narrow tongue of a closed crest reference, such as a ramp boxcut, points are tested along the direction their own projection travelled (§12.2). Two things remain. Where a long tongue lies low over the crest, the limit can lie a few metres inside the true line where the deepest slice's line comes out from under the tongue, because each station keeps one point (item 6): 4.8 m and 3.9 m in a test with a tongue 150 m long at 30° and 45° to the crest. And with the smoothing off, where the slices also cut a ramp boxcut, the limit can show a thin spike towards the pit, up to about 40 m long in the tests: a stray point inside the zone whose test directions both run back over the pit. Such a spike encloses nothing, the bund line is not affected, and any smoothing removes it. Keep the smoothing on, and look at the fan and the limit along a tongue.

10. **The wall is a uniform prism.** One height and one base width along the whole alignment, a triangular cross-section, and the height measured above the local centre-line ground. It is a design surface for visualisation, volume take-off and DXF hand-over, not an earthworks design: no compaction, key-in, drainage or material specification.
11. **Bunds only.** Signage, fencing and other abandonment obligations are outside this tool.
12. **No macro recording.** Bund runs cannot yet be recorded and replayed as macros.

Part 3 — Reference

16. Messages and troubleshooting

16.1 Before the dialog opens

Message or symptom	Cause and fix
"This function does not work in clipping mode"	Turn clipping off.
"First load meshes to the scene" (title *Missing information*)	No mesh is loaded. Load the pit and the topography.
"Every mesh is hidden. Show the meshes to use: tick them in the Objects list." (title *Missing information*)	Meshes are loaded but none is visible. Tick the pit and the topography in the Objects list.

16.2 When you click Calculate

Message	Cause and fix
"Tick at least one mesh in the TOPO column …"	No topography is ticked.
"Tick at least one mesh as the Pit source …"	No Pit mesh and no Toe string is ticked. On a first run only TOPO is pre-ticked, deliberately (§4.1).
"The weathered projection angle (…°) is steeper than the fresh-rock angle (…°)."	The weathered profile projects flatter, not steeper. The angles are swapped or mistyped.
"The Contact-mesh weathering option needs a mesh ticked in the BOCO column …"	Tick the contact surface in BOCO, or use a constant contact RL.
"The top of the section range is below the bottom."	The from and to boxes are the wrong way round.
"The section range RL … to … lies outside the ticked Pit meshes … Go ahead anyway?"	The range and the pit do not overlap, so nothing would be cut. Usually a typo in the range (§4.2).
"No outputs are ticked — the calculation would create nothing."	Tick at least one output (§4.6).
"A … m high wall on a … m base has side slopes steeper than 45° … Go ahead anyway?"	The base is narrower than twice the height. Fine for a keyed or reinforced bund; widen the base for dumped fill.

16.3 During the run

Message	Cause and fix
"That range and interval give N sections, past the 2,000 guard."	Increase the interval. The guard catches a mistyped interval; it is not a resolution limit.
"No section between RL … and RL … cut the Pit mesh."	The range lies outside the pit. Compare it with the pit's RL range shown in the dialog.
"… m of source outline at … m line spacing comes to about N projection lines. … Go ahead?"	A heads-up above 500 000 lines, with the memory needed. **Yes** runs it, and **Esc** still cancels.

Message	Cause and fix
"… would need about N projection lines, past the 2,000,000 guard."	Coarsen the line spacing or the section interval.
"The Pit role has no usable mesh geometry." (also *The Ground role…* for TOPO, *The Contact role…* for BOCO) / *"The Ground meshes have no geometry."*	The object ticked for that role is empty. Tick the actual surface. (A line object ticked as Pit gives *No section … cut the Pit mesh* instead.)
"The object ticked in the Toe column holds no polylines …" / *"The object ticked as the Crest holds no polylines …"*	You ticked a surface, not a line object. Untick it to slice the Pit mesh, or to measure against the widest section ring.
"The crest reference holds no usable polyline after resampling …"	The crest string's lines are shorter than one line spacing. Tick a longer crest string, or untick Crest.
"The source outlines are too short to fan."	The sections (or the Toe string) are shorter than one line spacing, or every section loop was set aside as an open fragment or a topographic high (§14.1), for example when the Pit mesh covers only part of the pit, so that no section closes. Reduce the line spacing, or check that the Pit mesh is the one you meant.
"Abandonment bund calculation cancelled — nothing was created."	You pressed Esc.
"Abandonment bund calculation failed: …"	An unexpected error; the text says what failed. Send it, with `GEM4D_diag.log` and `GEM4D_diag.old.log`, to BasRock support.

16.4 Results that look wrong

For what each line of the summary box means, see Chapter 6.

Symptom	Cause and fix
A long interpolated run is reported	Lines ran off the edge of the topography, or every line along that stretch was arrested, so the ring is closed by a straight line there. Extend the topography if it stops short; otherwise check the fan along that stretch.
The fan points the wrong way	An open Toe string with no Pit mesh beneath it to probe (§14.5). Tick the Pit mesh.
The limit line reaches into the pit, or fans appear in odd places	Check the *Section loops ignored* line. A Pit mesh full of terrain contours can still place fans oddly; also check the *Measured from* line and consider a surveyed crest string.
Only 1 of N sections governed	One bench drives the whole pit, which is normal on a uniform wall. Do not coarsen on this evidence alone: unless that bench is the top or the bottom of the range, a coarser interval may step over it.
The limit line moves when the interval or spacing changes	Refine whichever one moved until it is stable (§7.2).
The limit moved inward on a re-run	If an earlier run's outputs were ticked as TOPO — by hand, or because they were renamed (§4.1) — the new lines daylighted on them. Untick them and run again.
A thin spike towards the pit in the limit near a ramp, with the smoothing off	A stray point inside the zone along a narrow tongue of the crest (§15, item 9). It encloses nothing and the bund line is not affected; any smoothing removes it.

Symptom	Cause and fix
The limit lies a few metres inside where it comes out from under a long ramp in the Crest string	One point per station where a long tongue lies low over the crest (§15, items 6 and 9); the smoothing does not reach it. Redraw the Crest string without the tongue, or untick it so that the widest slice is the crest.
The limit line looks smoother than the measured points	That is the simplify tolerance and the smoothing (§12.3). Set both to 0 to see every station, or show the fan, whose rim is the raw daylight line.
Weathering on, but the summary shows 0 kinks	The contact never crosses a line between its start and its daylight point, usually because it lies below the whole pit, so every line is weathered from the start. (A constant contact at or above the highest ground gives no *Weathering* line at all; the *Projection angle* line notes that the weathered angle never engages.)
Many lines *"started outside the contact surface's coverage"*	The contact mesh does not extend under the fan. Those lines ran as fresh rock. Extend the contact model, or use a constant RL.
No bund line, although the ZoI limit exists	**Bund line** was unticked. With the wall ticked, the summary then reports a *Wall toe alignment* instead.
The wall floats or digs in along a stretch	The wall's base ran past the edge of the topography; see the wall-point count on the *Bund wall* line. Extend the topography.
Nothing happens for a long time	Watch the progress bar; **Esc** cancels. A fine interval with a fine spacing is the usual cause.

17. Glossary

Term	Meaning
Arrested projection	A projection line that passes into the void of the pit. Ground it meets over the pit is discarded (§12.2), so it cannot govern, except where the ground beyond the crest rises more steeply than the line (§15, item 5).
BOCO	Base of complete oxidation: the base of the weathered profile, used as the weathering contact. Also the dialog's contact-surface column.
`BOCOPlane`	The constant-RL contact, inserted as a mesh with the outputs of a constant-RL run.
Crest reference	The outline "furthest from the crest" is measured against: a ticked Crest string, or the widest slice (§12.1).
Daylight	The point where a projection line meets the topography.
Daylight line	A slice's daylight points joined in the order its fan makes them (§12.2).
Fan surface	The surface formed by the projection lines from one slice. The output `BundFan` shows the governing lines only.
Governing line	At a crest station, the projection that reaches furthest from the crest, after points that another daylight line lies beyond are set aside (§12.2).
Interval	The vertical distance between slices (**every:**).
Line spacing	The distance between projection lines along an outline, and the size of a crest station.
Medial axis	The line along which two parts of an outline are equally near. Projection lines stop there (*trimmed on the medial axis*).
Mine RL	Elevation in the mine's own coordinate system, as entered in the dialog.

Term	Meaning
Section (slice)	The outline the pit makes at one horizontal elevation.
Standoff	The distance from the ZoI limit to the bund's pit-side toe.
Station	One step of the crest, one line spacing long. Each station contributes one point to the ZoI limit; at an outward corner, one per point left round it (§12.2).
Toe	The base of a pit face. In the dialog, the **Toe** column takes a drawn outline in place of slicing.
TOPO	The natural topography, and the dialog column for it.
ZoI	Zone of instability: the ground that could be undermined as the abandoned walls degrade. Its outer edge is the ZoI limit.