Snowy 2.0 – Tantangara Surface Depression Rehabilitation Plan

Revision History

Revision	Date	Description	Record of Review (Names)	Approved
3	11/04/2024	Updated following addressing DPIH comments	BC, CB	Chris Buscall - 11/04/2024

Department of Planning, Housing & Infrastructure

Our ref: SSI-9687-PA-176

Emily Martin
Project Manager
PO BOX 332
Cooma, NSW, 2630

12 April 2024

Subject: Snowy 2.0 Main Works (SSI 9687) Tantangara Surface Depression Rehabilitation Plan

Dear Miss Martin

I refer to your submission dated 21 March 2024, requesting approval of the Tantangara Surface Depression Rehabilitation Plan. I also acknowledge your response to the Department's review comments and request for additional information.

As nominee of the Planning Secretary, I approve the Tantangara Surface Depression Rehabilitation Plan (Revision 3, 11 April 2024) under Condition 11A of Schedule 3.

You are reminded that if there are any inconsistencies between the approved document and the conditions of approval, the conditions prevail.

Please make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Ellena Tsanidis on 9228 6214 or at ellena.tsanidis@planning.nsw.gov.au.

Yours sincerely

Anthony Ko
A/Director, Energy Assessments
As nominee of the Planning Secretary

Document Control

Title	Tantangara Surface Depression - Site Specific Rehabilitation Plan		
Document Number	S2-SHL-ENV-PLN-0004		
	Name	**Position**	**Date**
Originator	Ben Croome	Senior Environmental Advisor	07/11/0223
Review	Haofei Zhi	Environmental Scientist	13/12/2023
Approval	Chris Buscall	Environmental Manager	11/04/2024

Revision History			
Revision	**Date**	**Description**	**Record of Review (Names)**
1	22/01/2024	- Draft plan – distributed to NPWS, BCD & EPA.	Ben Croome
2	21/03/2024	- Updated to address BCD comments. - Letter received from EPA 13th Feb confirming no further comments - Updated to address NPWS comments	Ben Croome Chris Buscall
3	11/04/2024	-Updated to address DPIH comments received 9 April 2024	Ben Croome Chris Buscall

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1. Background

At Tantangara, tunnelling via TBM Florence commenced excavation of the head race tunnel (HRT) Adit portal, the TBM then began encountering adverse geological conditions, which can be broadly characterised as unstable sub-surface materials. Following the unstable conditions, a surface depression formed at the surface near the Adit portal outside of the approved project footprint in December 2022. It has a diameter of approximately 8 m and is 5 m deep. It is estimated to have a volume of approximately 635 m3.

To remediate this area appropriately a modification was required to conduct work in this area. As part of the MOD 2 infrastructure approval instrument, a site-specific rehabilitation plan is required. The following conditions of Schedule 3 of the consolidated conditions of approval determined on the 29th of November 2023 are required to be addressed in this plan:

11A Prior to the commencement of surface works for rehabilitation described in MOD2, the Proponent must prepare a Rehabilitation Management Plan for MOD2 to the satisfaction of the Planning Secretary. This plan must:

a) be prepared by a suitably qualified and experienced person in consultation with NPWS, BCD and EPA;
b) be consistent with the Spoil Management Plan;
c) include conceptual and detailed plans for the rehabilitation of the MOD2 disturbance area;
d) describe the measures for MOD 2 to address conditions 10(h) to 10(k) inclusive; and
e) include the screening, testing and validation procedures that would be implemented to assess the suitability of fill material, including a list of the pollutants that would be monitored for within fill material.

11B The proponent must implement the Rehabilitation Management Plan for MOD 2 as approved by the Secretary.

Table 1: Conditions of approval

Condition	Where addressed
10 (h)	Section 4
10 (i)	Section 4, & Section 3 and 10 Appendix E of the Main Works RMP
10 (j)	Sections 4.2 & section 4 Table 4.4 of the Main Works RMP, Appendix B
10 (k)	Section 7 & Section 8.2 & 10.2 Table 2 of the Main Works RMP
11a (a)	Document control
11a (b)	Section 3.2 & 3.4
11a (c)	This plan
11a (d)	Section 4,5 and 7
11a (e)	Appendix A

For project context see Figure 1. The total area to be rehabilitated is approximately 0.63 Ha. Figure 2 provides further context of the site location within the Tantangara construction area:

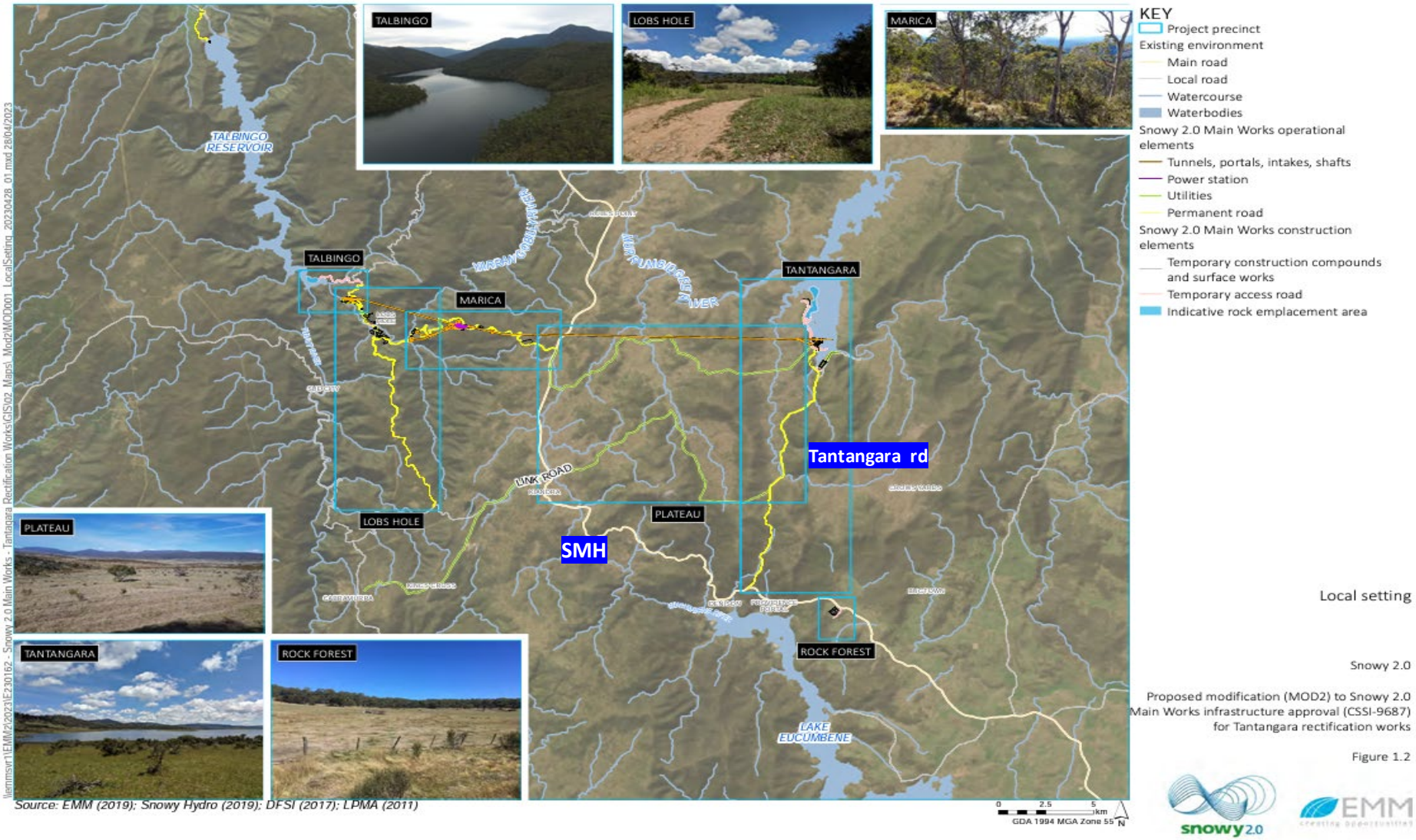


Figure 1: Tantangara regional location

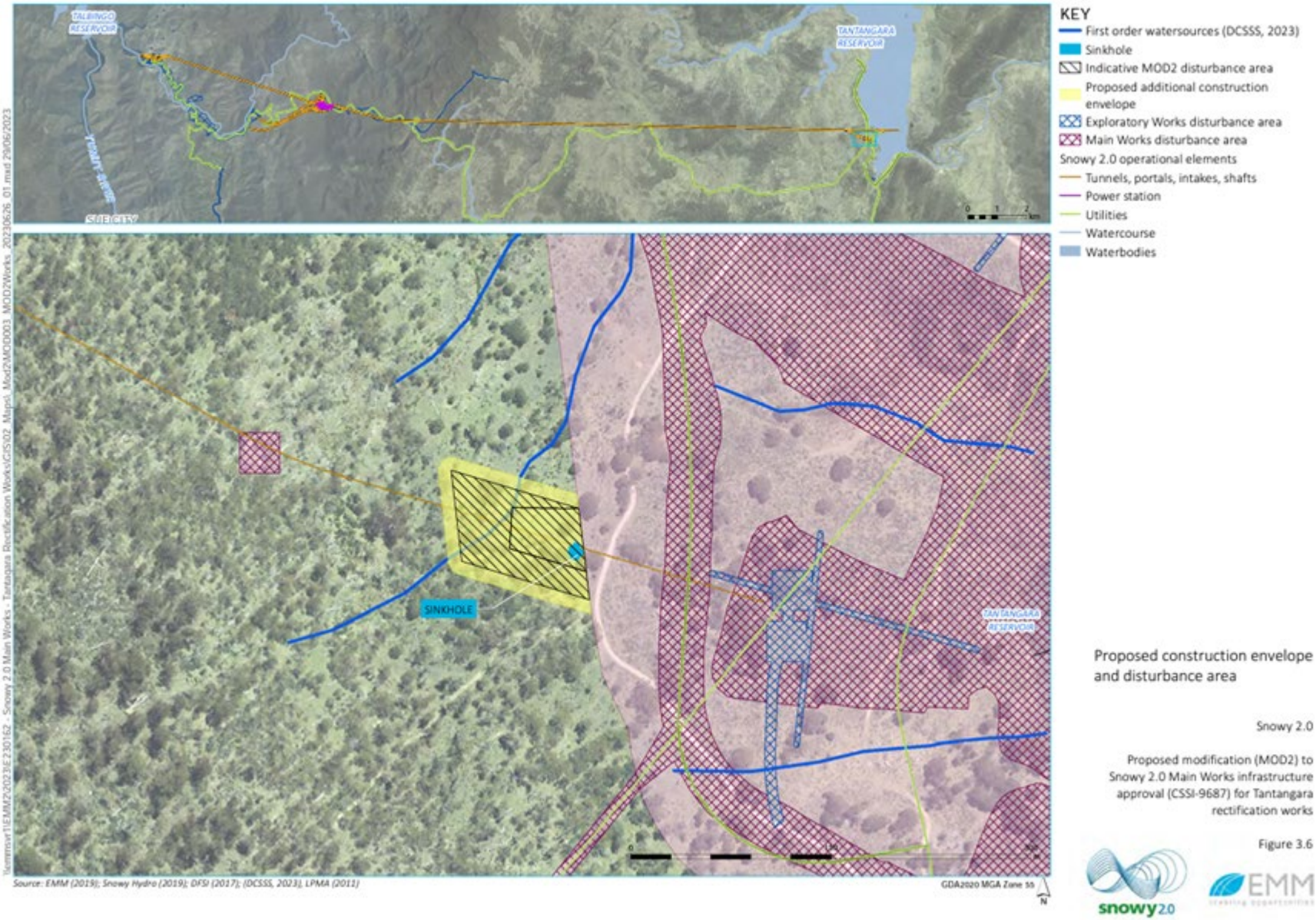


Figure 2: Tantangara surface depression location

Site description

The site currently consists of uncleared Black Sally grassy low woodland and sub-alpine dry grassland (see Figures 3 & 4). The surface depression occurred in the vegetation community mapped as Black Sally, associated habitat of the Alpine She-oak Skin and Broad toothed Rat. Approximately 300m2 has been impacted by the subsidence with the remainder of the MOD2 footprint undisturbed. To conduct the remediation works, vegetation clearing will be required within the MOD2 boundary to facilitate appropriate access around the surface depression to conduct works safely.

Figure 3: Surface current site condition facing West North West

Figure 4: Surface current site condition facing East

Below Figure 5 shows imagery of the area including the construction envelope and Class 1 water way location prior to the surface depression.

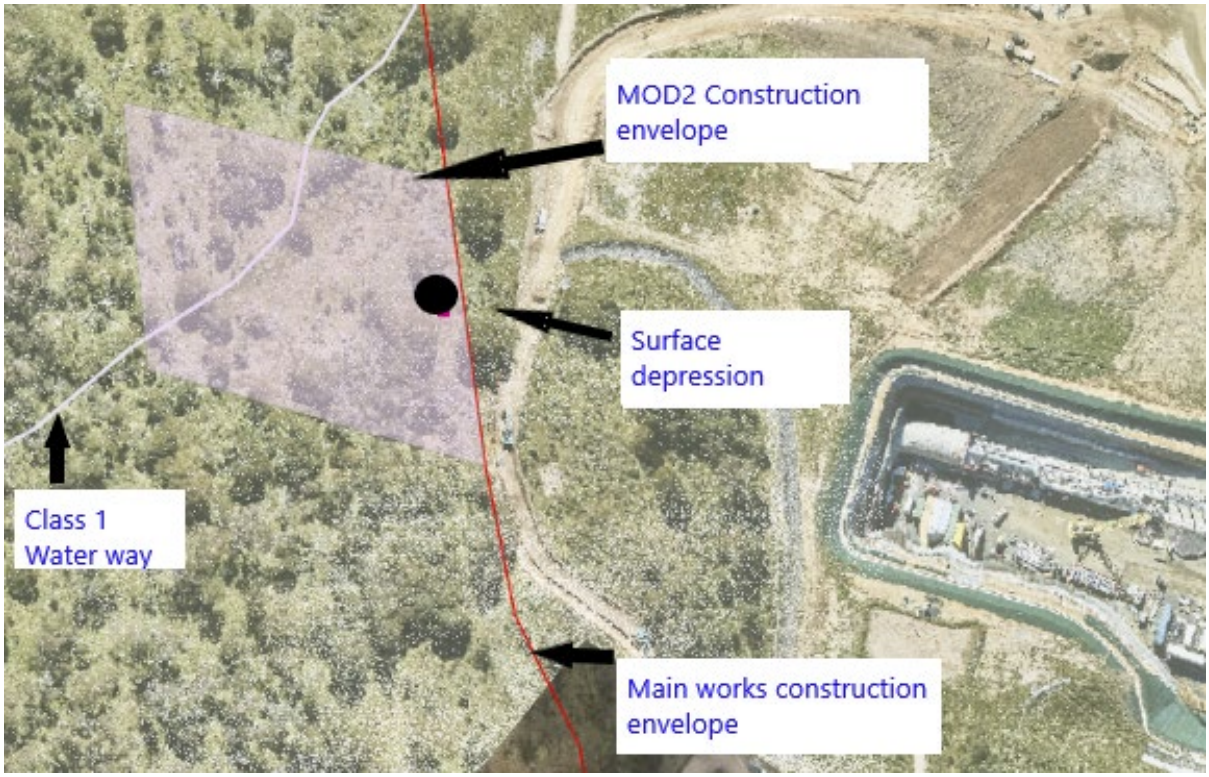


Figure 5: Surface depression location imagery pre subsidence

2. Scope of rehabilitation works

Prior to rehabilitation activities being undertaken, clearing, and grubbing of the area previously shown in Figure 2 is required to provide an appropriate work site surrounding the surface depression. Note the disturbance footprint shown in figure 2 is only indicative with the inner black line showing the proposed extent of the area required for backfilling the surface depression. These works will be carried out under the existing Main Works Biodiversity Management Plan -S2-FGJV-ENV-PLN-0008(I) (Appendix C – Preclearing and clearing procedure)

The works required to be conducted at part of MOD2 are as follows (indicative timeframes are also included pending approval).

Earthworks

April 2024

- Material testing and screening (Appendix A)
- Erosion control (refer section 3.1)
- Landform Reshaping (backfilling surface depression) refer section 3.2
- Surface shaping and drainage (refer section 3.3)
- Topsoil / growth medium placemen (refer section 3.4)Mulch / Hydro mulch and dominant native grass seed applied (if prior to May) (refer section 5.2)

- Access control (refer section 3.5)

Revegetation & short term maintenance

April / May 2024
- Tubestock planting and sowing of drainage line (refer section 4.2)

November 2024-April 2025
- Tubestock planting of priority species identified (refer section 5.3)
- Hydro mulch and dominant native grass seed applied if not applied prior to winter (refer section 5.2)
- Thatching of the site with local dead branches from previous clearing activities

November-April and ongoing seasonally
Quarterly monitoring checks to detect any failed measures (refer section 7)
- Weed treatment and ongoing maintenance (refer section 6.4)

Long term maintenance & Monitoring

November – April 2025 / 2026 and annually
- Supplementary plantings and seeding (refer section 5.4 & 6.3)
- Weed treatment and ongoing maintenance (refer section 6.2)
- Quarterly site checks to monitor performance and detect any failed measures (refer section 7)
- Annual monitoring and reporting (refer section 7)

3. Earthworks

3.1. Erosion and sediment control

An erosion and sediment control plan (ESCP) will be prepared by a Certified Practitioner in Erosion and Sediment Control (CPESC) prior to clearing and grubbing and updated for backfill operations where required. The controls identified in the ESCP will remain in place during shaping and topsoiling of the site. Controls will be then reassessed prior to application of mulch and the plan updated again where required.

On the north-western corner of the proposed disturbance footprint there is first order stream that will not be directly impacted by remediation activities, any flow directed to the drainage line will be managed in accordance with the ESCP as shown in Figure 5 (above). Figure 6 (below) also shows the existing natural flow paths to be reinstated following backfilling of the depression.

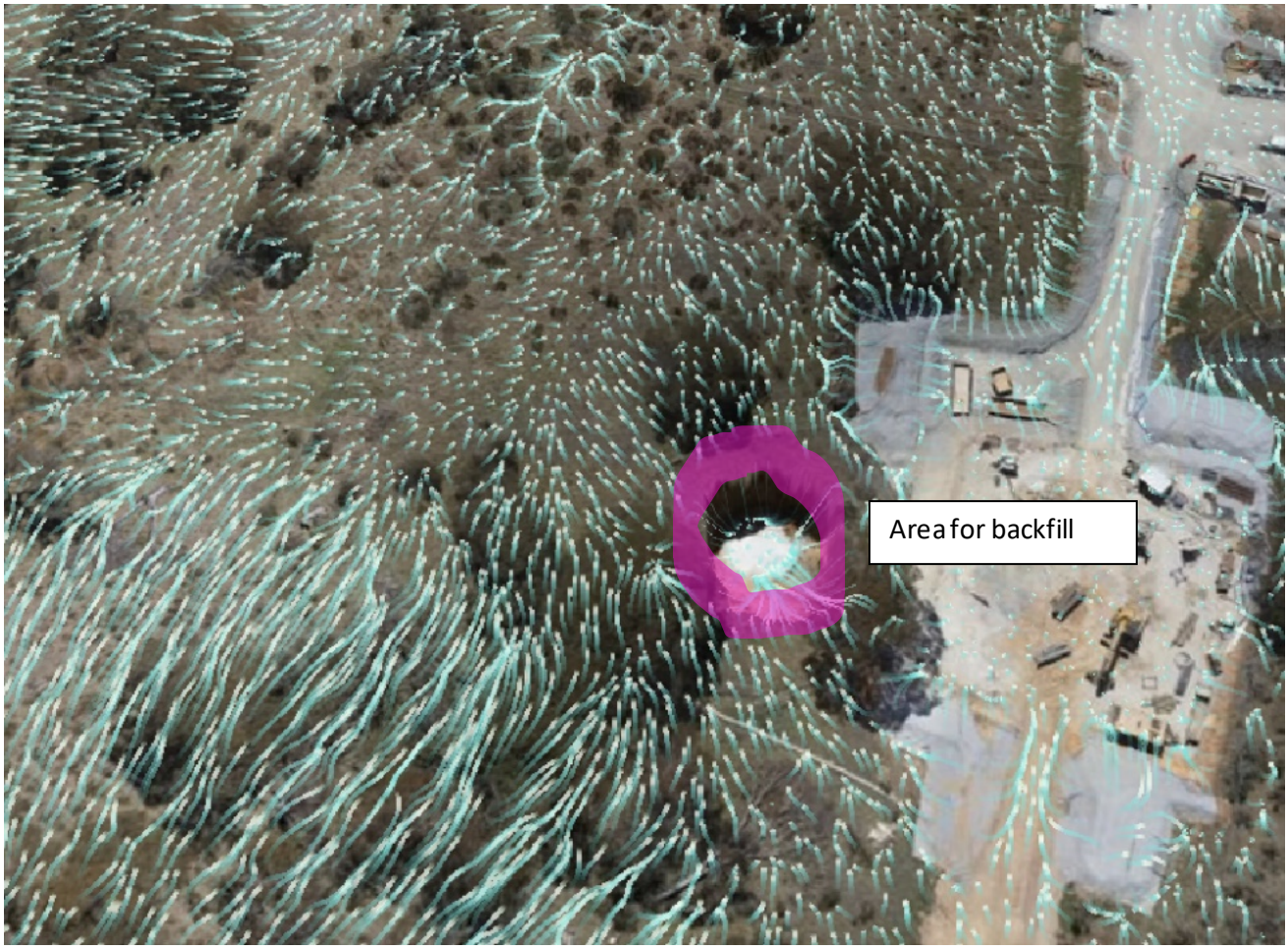


Figure 6: Local surface water flow path and area to be backfilled

3.2. Landform reshaping and backfill

The natural surface water flow of the area highlighted in Figure 6 (above) is to be restored to pre subsidence conditions by completing the following process outlined in MOD 2:

1. Filling the lower half of the surface depression with a stabilised granular material (flowable fill), using a cement binder. The stabilised fill will be placed to approximately 3 to 4 m below surface level (BSL). - The granular materials will be processed from local sources won onsite, and predominantly be 40 millimetres (mm) minus crushed rock. - The stabilised fill will be pumped into the existing depression utilising a concrete pump, considered to be self-compacting, and once cured, will provide a robust media that will not be subjected to any subsidence from future influences.
2. Filling the upper half (near surface) of the surface depression with a general fill as defined by the project's earthworks specification. The general fill will be compacted to 95% standard maximum dry density, using conventional earthworks techniques.

Excavated site material will be beneficially used for backfilling in accordance with section 6.2.2 of the Spoil Management Plan (SMP). Additionally fill material must also meet the requirements detailed in Appendix A – Material screening testing and validation procedure of this document.

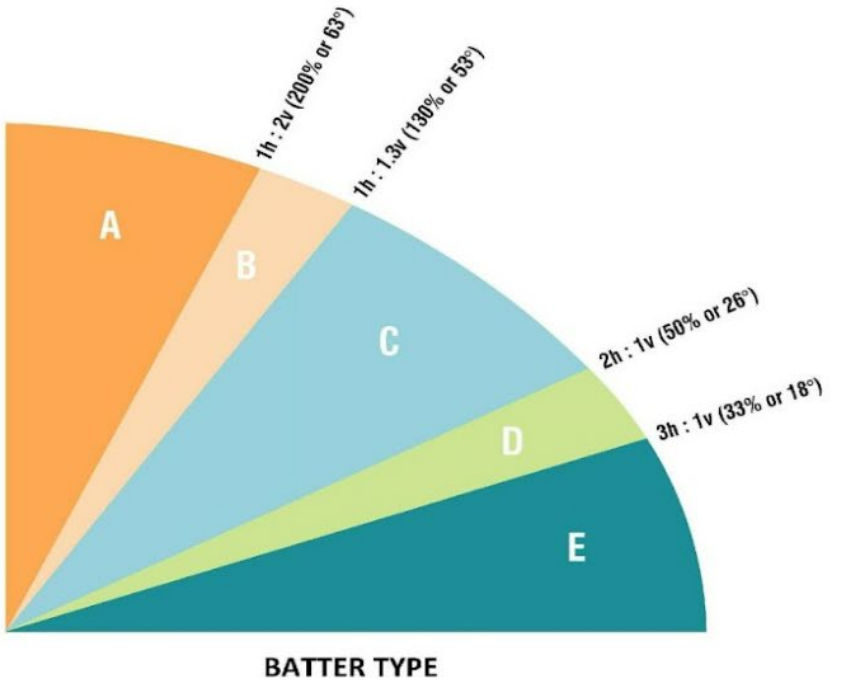
3. The surface materials (i.e., upper 0.3 m) will consist of a growth medium, comprising topsoil/subsoils not yet stripped and some which are currently from existing project areas that have been cleared and stripped, to make up the deficit resulting from the surface depression.

The gradient of the surrounding land is less than 4h:1v. Stabilisation will be undertaken in accordance with Batter Type E shown in Figure 8 on the following page.

3.3. Surface shaping and drainage

Following backfill activities the natural contours will be re-established across the disturbance area as shown below in Figure 7 . Figure 6 further illustrates the natural surface flow through the disturbance area and how this ties into the backfilled area shown in figure 7. If for any reason disturbance of the first order drainage line is required, it will have jute mesh applied after topsoiling and be planted out at a rate of 4 plants per metre. Slope breaks in the form of coir logs will also be installed. The drainage line is not in the planned disturbance area.

Figure 7: Final landform cross section



Snowy 2.0 Revegetation Decision Making Tool			
Batter Type	**Temporary Revegetation Options ***	**Permanent Revegetation**	**Permanent Revegetation Description**
A	N/A	Structural reinforcement	Reinforcement measures may include terramesh, gabion walls, shotcreting, rock bolting and soil nails
B	N/A	Geo mesh and grassing	Geo mat is required to provide rock dowels to retain soil containing grass seed
C	• Soil binder	Jute mesh + planting & hydromulching	Jute mesh is required to hold soil while vegetation is established
D	• Soil binder • Hydromulching	Planting & hydromulching	Tubestock planting density (1 plant / 2m²) with hydromulch applied to the remainder of the area
E	• Direct seeding • Mulched timber • Soil binder • Hydroseeding • Hydromulching • Straw mulching	Planting & hydromulching Direct seeding	Tubestock planting density (1 plant / 2m²) with hydromulch applied to the remainder of the area
**temporary revegetation method depends on temporal span and / or proximity to sensitive receptors*			

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Revegetation Decision Making Tool

FIGURE 13

Figure 8: Vegetation decision making tool

3.4. Topsoil/growth medium amendment and placement

Topsoil will be directly re-applied over the site at the depth it was stripped (between ~100 mm depth) with another 200 mm of subsoil applied. Topsoil and subsoil will be sourced from stripping of the area prior to remediation activities and from local Snowy 2.0 stockpiles if required. The surface will be left rough with ripping on the contour undertaken to a depth of approximately 300mm.

3.5. Access control

A wire fence will be established to prevent unauthorised access by both humans and horses. The indicative location of the fencing to be installed around the perimeter of the site is shown in blue in Figure 9, final position will be determined by the clearing extent. A gate will be installed on the eastern side to facilitate access from the current Tantangara main works site.

4. Revegetation

The site will be vegetated using a combination of tube stock planting and direct seeding to ensure ground cover and Community structure/species composition is comparable to reference vegetation communities as required by Table 4.4 of the Main Works RMP. The Plant Community Types (PCTs) within the construction envelope are outlined in Table 2 (PCT composition) and Figure 9 (PCT map of disturbance footprint).

Table 2: PCT composition of construction envelope

PCT	HA
303 – Black Sally grassy low woodland in valleys in the upper slopes sub-region of the NSW South Western Slopes Bioregion and western South Eastern Highlands Bioregion. (Yellow in Figure 9) Area to be rehabilitated 0.04 Ha	0.55
1224 – Sub-alpine dry grasslands and heathlands of valley slopes, southern South-eastern Highlands Bioregion and Australian Alps Bioregion. (Lavender in Figure 9) – Nil area to be disturbed as part of remediation	0.08

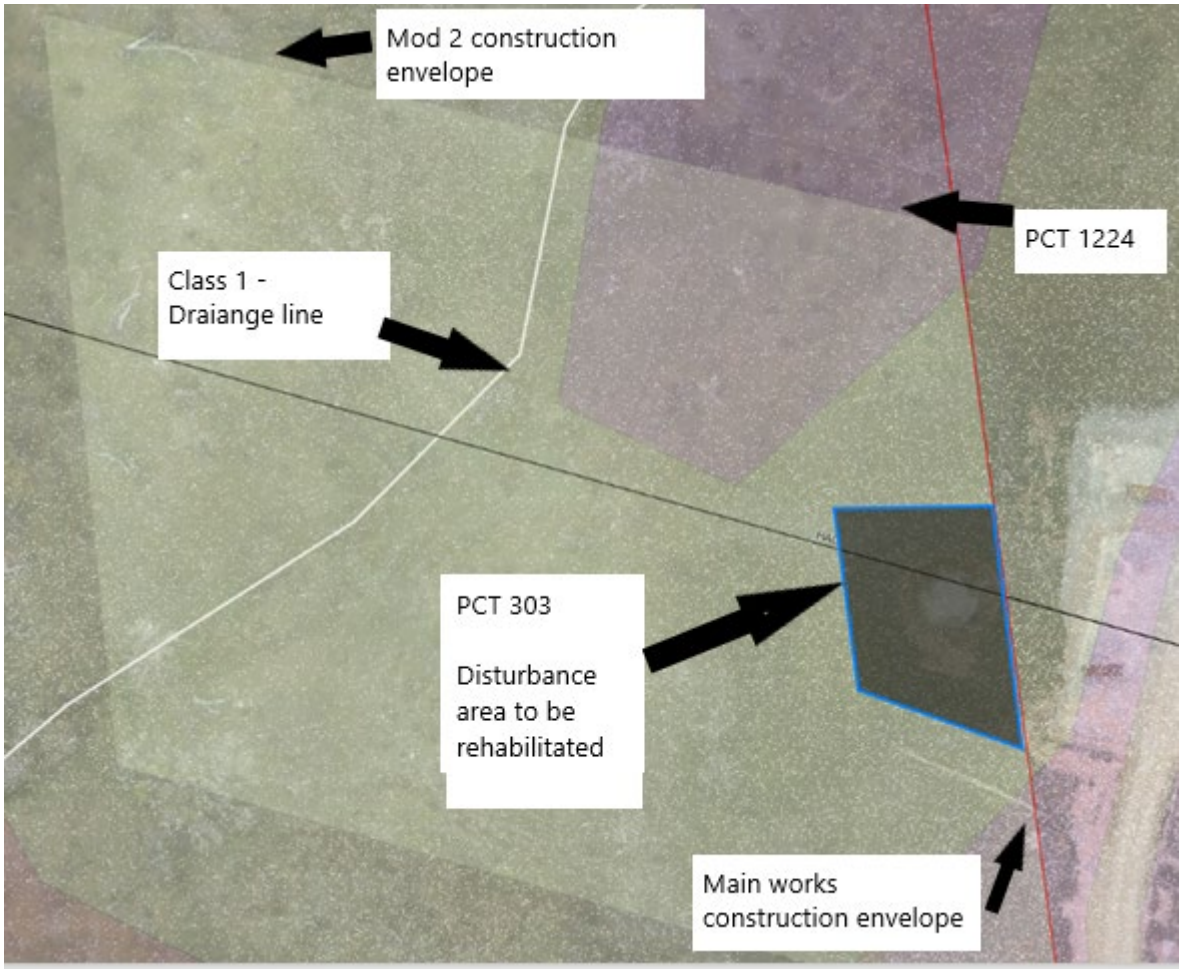


Figure 9: PCT map of disturbance footprint

The primary risk for the revegetating of the site will be competition from weeds and the restrictions on planting and seeding due to the cold winter climate. Contingencies have therefore been allowed for regarding sowing and planting times and application of mulch cover over the winter period. These challenges have shaped the sequence outlined in Table 3 Revegetation timing.

Table 3: Revegetation timing

Sequence	Task	Timing
0	- Weed control - Clearing and grubbing - ESCP implementation	March - April 2024
1	- Remediation, backfilling and landforming	April 2024
2	- Topsoil application - Mulching (direct seeding of natives if before May) - Drainage line stabilisation - tubestock planting / direct seeding (not expected to be required)	April – May 2024
3	- Weed control (ongoing seasonally)	2024 / 2025 (November – April)

Sequence	Task	Timing
4	- Revegetation (direct seeding of natives) pending weed load and timing of remediation completion - Thatching	2024/2025 (November – April)
5	- Priority tubestock planting	2024/2025 (November – April)
6	- Supplementary tube stock	2025 / 2026 (November – April)

4.1. Species use and type

The list of species to be used for initial planting and seeding are provided in section 4.2. **Appendix J PCT Target Species List** of the Main Works Rehabilitation Management Plan details a broader species list for the PCTs that will be used with the final composition of the planting design, to be prepared following establishment of an interquartile range for the relevant PCTs determined by the ecological monitoring results from the monitoring program outlined in section 8 of the Main Works RMP. This plan will be updated following approval of the Main Works RMP to ensure consistency.

Until the interquartile range is established revegetation will be guided by the floristics from the BDAR, local reference sites and surrounding vegetation detailed in the following section.

4.2. Planting and seeding specification

Tube stock will be randomly planted at a density initially guided by the floristics from local reference sites and surrounding vegetation detailed in Table 4. Following establishment of an interquartile range for the relevant PCTs, supplementary planting will be undertaken if required to achieve the specific benchmarks of native plant species composition outlined in Table 4.4 Rehabilitation completion criteria for the Snowy 2.0 Main Works - Main Works RMP.

Table 4: Priority tube stock species planting density by PCT

PCT	Priority Species	Number for site
303	Black Sally (Eucalyptus stellulata)	12
303	Snowy gum (Eucalyptus pauciflora)	8
303	Hakea (Hakea microcarpa)	40
303	Acrothamnus hookeri (Mountain beard heath)	10

PCT	Priority Species	Number for site
1224	Acrothamnus hookeri (Mountain beard heath)	8
1224	Pimelia linifolia	2

Below Table 5 gives a seeding rate for native ground covers used for initial groundcover as part of mulching.

Table 5: Direct seeding rates for PCT

PCT	Priority Species	Kg/ per ha -
303	Anthosachne scabra	0.5
303	Microlaena stipoides	0.5
303	Poa labillardierei	0.5
303	Poa sieberiana	1.5
303	Rytidosperma caespitosum	1
303	Themeda Triandra	1
1224	Anthosachne scabra	5
1224	Microlaena stipoides	0.5
1224	Poa ensiformis	0.25
1224	Poa labillardierei	0.5
1224	Poa sieberiana	3
1224	Rytidosperma caespitosum	1

Table 6 lists the species to be used for the stabilisation of the drainage line if disturbed. Note some of the species may be planted of tubestock instead of sown.

Table 6: Drainage line species list

Botanical Name	Common Name	Notes
Anthosachne scabra	Wheat Grass	Sow on batters.
Bulbine bulbosa	Chocolate Lily	Sow on batters.
*Carex appressa	Saw Sedge	Plant in riparian area.
*Carex Gaudichaudiana	Fen Sedge	Plant in riparian area
*Poa costiniana	Horny Grass	Sow in riparian area.
Poa ensiformis	Sword Tussock Grass	Sow on batters.
*Poa labillardierei	Tall Tussock Grass	Plan tin riparian area
Poa sieberiana	Grey Tussock Grass	Sow on batters.
Senecio gunnii	Gunns Senecio	Sow on batters.

Direct Seeding – sowing rate of 2g per m2 for a mix of the species below

** To be planted as tubestock at a rate of 4 per m2*

It is not anticipated that planting of the drainage line will be required

4.3. Water requirements

Planting will occur during times where soil moisture content is present. Due to access constraints watering will be limited to watering phase 4 to 6 weeks after planting and if drought conditions occur (no rainfall in 2 months).

5. Resource specification

5.1. Compost / topsoil

Compost will only be used in planting holes for tube stock. One litre of compost per planting hole will be used.

Site won topsoil will be applied over the site at 100 mm depth. Topsoil will be sourced from the disturbance footprint and other local stockpiles located on site consistent with appendix B of the Spoil management plan.

(An ITP for topsoil application ITP will be developed and utilised).

5.2. Mulch

Mulch selection will be guided by 6.3.1.5 & 6.3.5.4 of the Main Works RMP.

If available, site won mulch is to be utilised at a rate ~100mm following topsoil placement. Alternatively weed free straw mulch with a tackifier will be utilised if hydromulching and seeding cannot be undertaken prior to the colder months (an ITP for hydromulching will be prepared with final products and application rates approved through the ITP review process).

5.3. Tube stock

Tubestock will be supplied by SHL as part of the tubestock propagation program grown from seed collected as part of the Snowy 2.0 seed collection program or from local nurseries that support revegetation in KNP.

5.4. Seed

Native seed will be sown as part of a hydromulch mix after treatment of weeds and tubestock planting of shrubs and trees. Seed will be sourced from the Snowy 2.0 seed collection program.

5.5. Fencing/tree guards

The site will be fenced with wire fencing and will be maintained to prevent damage from large grazing animals.

5.6. Fertilisers

A small handful of slow-release organic fertiliser will be added to all planting holes in the planting process. No fertiliser will be used for direct seeding or near drainage lines

5.7. Signage and safety

“No unauthorised access” rehabilitation signage with a Snowy 2.0 logo will be erected following completion of backfilling and fencing with relevant site-specific information provided.

6. Post rehabilitation

Both a short term and long term maintenance program will be implemented to ensure the site trends to towards the final land use. This maintenance program will begin within 3 weeks after the rehabilitation work has been completed and continue until handover to NPWS.

6.1. Final land use

The area will be reverted to native vegetation consistent with the plant community types described in section 4 and section 3 of the Main Works Biodiversity Management Plan.

6.2. Short term maintenance

Short-term maintenance activities (3 weeks to 6 months) will be guided by the quarterly inspection and monitoring program and may include activities such as:

- Sediment and erosion control (cleaning out of silt etc)
- Additional mulching
- Weed control
- Replacement of tree guards

If a prolonged dry period occurs after the planting, additional watering will be required 4 to 6 weeks after sowing. Watering is best done with a mobile water cart.

6.3. Long term maintenance

It is envisaged long term maintenance activities (+6 months ongoing) such as erosion control and replanting will be undertaken, and these activities will be guided by the inspection and monitoring program. Maintenance will be guided by monitoring described in section 7 of this plan and the trigger action response plan outlined in Table 10.2 of the Main Works RMP.

6.4. Weed control

All weed species will be sprayed at the appropriate time with the appropriate herbicide. Weeds that are close to newly germinated seedlings will be weeded by hand. Spraying to be conducted prior to stripping of topsoil.

Annual weed monitoring will be scheduled with weed control programs occurring on a biannual basis as per the Biodiversity Management Plan Appendix F (Weed, Pest, and Pathogen Management Plan section 5.1.2.1 – Chemical Weed Control. Weeds identified at the site and in the surrounding area include:

- Anthoxanthum_odoratum (sweet vernal grass)
- Dactylis glomerata (cocks' foot)
- Hypochaeris radicata (cats' ear)
- Acetosella vulgaris (sheeps sorrel
- Agrostis capillaris (common bent grass)
- Leucanthemum vulgare (Ox eye daisy)
- Holcus lanatus (Yorkshire fog)

- Taraxacum officinale (common dandylion)

6.5. Fertiliser augmentation

A small handful of slow-release phosphorus organic fertiliser will be added to all planting holes in the planting process. Once native species have germinated and begun to grow, additional slow-release organic fertiliser may be used in the maintenance process to augment the growth of the sown species. No fertiliser will be used for direct seeding or near drainage lines.

6.6. Re-mulching

To be undertaken if required for seedlings planted in the revegetation process until they are sufficiently grown to provide their own biomass. Hydro mulching of areas that are showing signs of erosion to be utilised where appropriate.

7. Rehabilitation monitoring

Monitoring will be undertaken to provide information on the success of the rehabilitation regarding tubestock growth and mortality, seed germination and establishment, weed invasion, erosion, natural recruitment, and disturbance from grazing animals.

Quarterly Observational monitoring

Quarterly observation checks of rehabilitation sites to be undertaken (4 times per year). A checklist will be used to evaluate performance and detect any failures and will generate maintenance programs and further rehabilitation works (if measures are failing). This checklist will include the measures linked to the TARPs outlined in section 10.2 of the Main Works RMP. See Appendix C for template or the below link to a digital checklist that will form the basis for the quarterly observational monitoring:

Quarterly Observational Monitoring Form

Photo points will be established as part of the quarterly monitoring.

Annual monitoring

Annual monitoring will occur as described in Table 7 below and in accordance with section 8.2 of RMP:

Table 7: Annual rehab monitoring – Unmanned Aerial Vehicle (UAV)

Monitoring parameter	Description
PCT variation	**(1 digital 20m x 20 quadrat per Ha)** 5 PCT characteristic species and weeds with species added over time
Weeds	Weed abundance and species
Native species	species composition, cover, structure, and health
Bare ground	% Area and location
Erosion	Depth, width, length, change over time
Habitat features	Logs and rock
Pest species	Track and individual at time of survey
Human Disturbance	Wheel tracks, waste
Legacy Items	Infrastructure for removal

Three yearly monitoring

Ecological recovery will be measured every 3 years during the same monitoring period as the reference sites. This monitoring will consist of on the ground assessment of species, composition and abundance as described in table 8 below:

Table 8: PCT ecological monitoring – on ground monitoring

Method number	Monitoring method
1	Permanent, full floristic plots (i.e., 20x20m; cover and abundance estimate for all species present). Sites will have a GPS point recorded and 2 permanent corner posts for plots. Data to be collected is: full scientific name, estimated % foliage cover. If less than 1% cover then decimals to be used (0.1, 0.2, 0.3…). Estimated abundance of each species to be recorded from 1 to 10, 10 to 100 with intervals of 10 and 100 to 1000 in intervals of 100 and so on. Species type, i.e., native, exotic, or high threat exotic to be recorded. Threatened species will be recorded per plot.
2	Permanent 50m midline transect located through the middle of the 20m x20m plot. A way point recorded at 0m and 50m and posts used to mark the points..
3	Measurement of all trees for Diameter at Breast Height (DBH) per plot.
4	Recording of all hollow bearing trees per plot.
5	Habitat resources (coarse woody debris, ponds, rocks) per plot. Type and size of coarse woody debris to be recorded.
6	Evidence of vertebrate pests and native species (scats, digging, chewing) per plot to be recorded.

Method number	Monitoring method
7	Soil surface characteristics will be recorded along the 50m line transect at 5m intervals. Characteristics recorded will be: Native vascular plant (living), Exotic vascular plant (living), Litter (type, depth, and origin), Cryptograms, Logs (standing or dead), Rock, Water, Bare ground
8	Soil characteristics - field tests - pH, EC, texture (Samples taken in accordance with steps 1-6 of Section 5.4.1 of Biodiversity Conservation Trust Ecological Monitoring Module Operational Manual | February 2022)
9	Soil characteristics - Laboratory tests - Nitrogen, Total Carbon, Available Phosphorus, pH, EC (Samples taken in accordance with steps 1-6 of Section 5.4.1 of Biodiversity Conservation Trust Ecological Monitoring Module Operational Manual | February 2022)

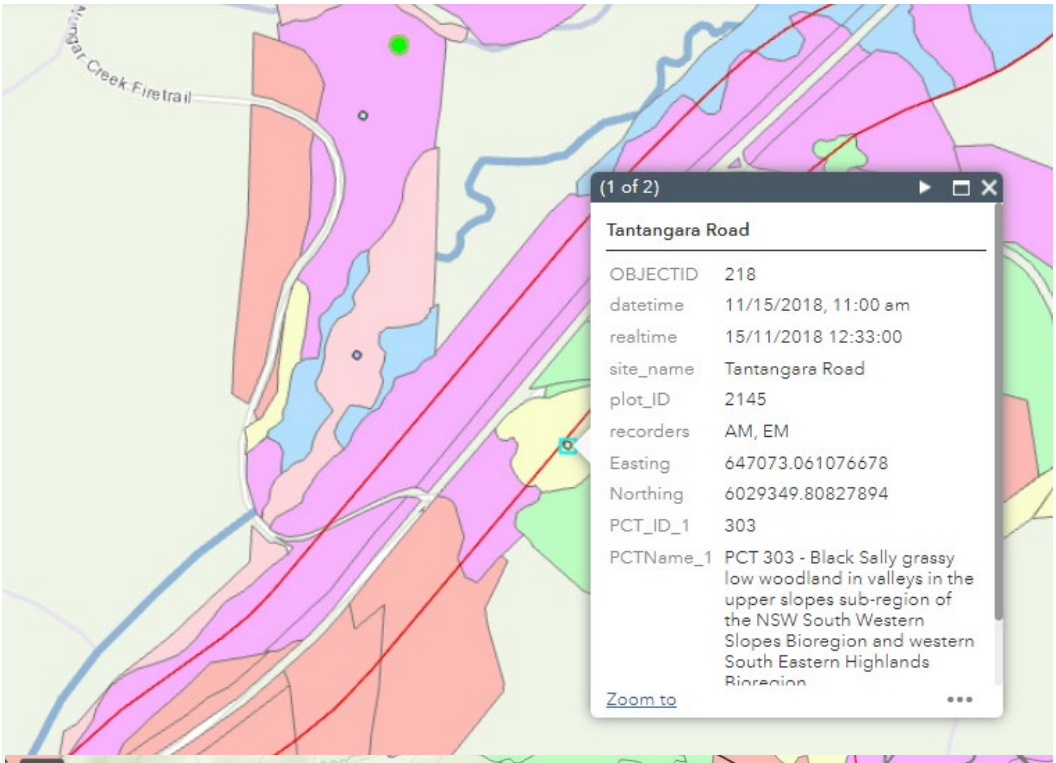
Reporting will be undertaken as per section 8.3 of the Main Works Rehabilitation Management Plan. This requires an annual public report and a separate annual report to NPWS and BCS.

7.1. Local reference sites

Until set metrics are confirmed following implementation of the monitoring program the following sites will be used to track progress vegetation cover and abundance. Table 9 below details the reference site plot number and location relevant to the plant community types recorded at this specific site.

Table 9: Local reference site (BDAR)

PCT	Reference site	Condition
303	2145	High
1224	2023	High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(1 of 2)
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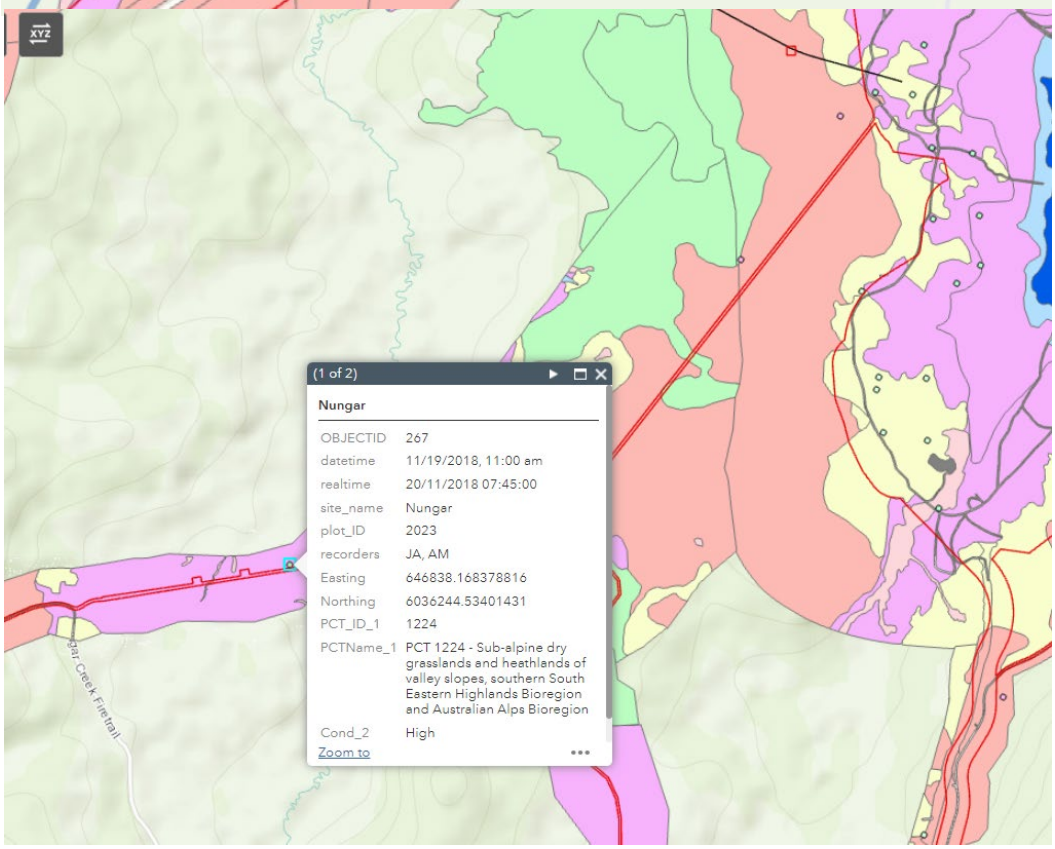
plot_ID 2145
recorders AM, EM
Easting 647073.061076678
Northing 6029349.80827894
PCT_ID_1 303
PCTName_1 PCT 303 - Black Sally grassy low woodland in valleys in the upper slopes sub-region of the NSW South Western Slopes Bioregion and western South Eastern Highlands
Zoom to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Northing 6036244.53401431
PCT_ID_1 1224
PCTName_1 PCT 1224 - Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion
Cond_2 High
Zoom to

Appendix A - Material screening testing and validation procedure

Background

Appendix A describes the material screening, testing, and validation that will be implemented to assess the suitability of fill material for placement in the surface depression and includes a list of the pollutants that will be monitored to ensure this rehabilitation work does not cause harm to human health or the environment.

As part of the MOD 2 infrastructure approval instrument this rehabilitation site is considered a Snowy 2.0 site. The material used at this rehabilitation site will be in accordance with the guidelines made or approved under the *Contaminated Land Management Act 1997*, will not cause pollution under the *Protection of the Environment Operations Act 1997*, and will be subject to engineering requirements described in section 3.2.

Suitability of fill material

The chemical suitability of fill material for this surface depression (Figure 2 in report) will be determined in accordance with the National Environment Protection (Assessment of Site Contamination) Measure (National Environment Protection Council, 1999) and the NSW Environment Protection Authority resource recovery framework.

Proposed fill material

The fill material for this rehabilitation work will primarily be sourced from the already excavated material from the Snowy 2.0 Tantangara site, including:

1. Virgin Excavated Natural Material (VENM)

Where material can be confirmed not to contain sulfidic ores or naturally occurred asbestos (NOA), and excavation methods preclude the use of residual chemicals (e.g. use of excavator rather than drill and blast), this material may be classified as VENM and be reused on this rehabilitation work.

For instance, gate shaft excavated material may be classified as VENM where drill and blast have not been utilised for this excavation purposes.

2. Excavated Natural Material (ENM)

In accordance with Resource Recovery Order under Part 9, Clause 93 of the Protection of the Protection of the Environment Operations (Waste) Regulation 2014 and Exemption Order, ENM can be reused.

Where material cannot be classified as VENM, the material may be classified as ENM if the material has been excavated from the ground, contains at least 98% (by weight) natural material, and does not contain sulfidic ores or NOA.

For instance, the drill and blast, tunnel boring machine excavated material may be classified as ENM.

3. Suitable material from the site

If the chemical concentrations for on-site spoil material are above the absolute maximum concentration under the ENM Resource Recovery Order, the concentrations will be assessed with the adopted Ecological Investigation Levels (EILs) and Health Investigation Levels (HILs) outlined in Schedule B(1) of NEPM (1999) to ensure this material would not cause harm to human health or the environment.

Based on the current and future land use of the site, the following criteria are proposed to assess the suitability of the fill material:

- Ecological investigation levels for areas of ecological significance (EILs A)
- Health investigation levels for recreational (HILs C)

Screening testing

It is noted that approximately 635 m3 of material will be required to complete the rehabilitation work.

The current material characterisation on site will be used as the initial screening testing to select the suitable fill material, the following analytes are included in the current routine tests:

Analytes	**unit**
Acidity (as CaCO3)	mg/kg
Conductivity (1:5 aqueous extract at 25 °C as rec.)	uS/cm
Nitrate-N	mg/kg
Nitrite-N	mg/kg
NOx-N	mg/kg
pH (1:5 Aqueous extract at 25 °C as rec.)	pH units
Total Carbon	%
Total Inorganic Carbon	%
Total Kjeldahl Nitrogen	mg/kg
Total Nitrogen	mg/kg
Total Sulfur (%) by LECO	%
Total Alkalinity (as CaCO3)	mg/kg
Extraneous Material	
<2mm Fraction	g
>2mm Fraction	g
Analysed Material	%
Extraneous Material	%
Chromium Suite NASSG (Excluding ANC)	
CRS Suite - Liming Rate - NASSG (Excluding ANC)	kg CaCO3/t, mol H+/t
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	% S
pH-KCL (NLM-3.1)	pH Units
Titratable Actual Acidity (NLM-3.2)	mol H+/t, % pyrite S
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)	mol H+/t, % S
Sulfur - KCl Extractable	% S
HCl Extractable Sulfur	% S
Net Acid soluble sulfur	% S, mol H+/t
Acid Neutralising Capacity	% CaCO3, mol H+/t, % S
CRS Suite - Net Acidity – NASSG (including ANC)	% S, mol H+/t
CRS Suite - Liming Rate - NASSG (Including ANC)	kg CaCO3/t

Net Acid Production Potential (by CRS)	
Acid Production Potential (by CRS)	kgH2SO4/t
Chromium Reducible Sulfur (s-SCr)	% S
Net Acid Production Potential (NAPP) by CRS	kgH2SO4/t
Net Acid Generation	
Net Acid Generation: NAG (initial to pH 4.5)	kgH2SO4/t
Net Acid Generation: NAG (pH 4.5 - pH 7.0)*	kgH2SO4/t
pH After Oxidation (pH NAG)	pH Units
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	
TRH C6-C9	mg/kg
TRH C10-C14	mg/kg
TRH C15-C28	mg/kg
TRH C29-C36	mg/kg
TRH C10-C36 (Total)	mg/kg
BTEX	
Benzene	mg/kg
Toluene	mg/kg
Ethylbenzene	mg/kg
m&p-Xylenes	mg/kg
o-Xylene	mg/kg
Xylenes - Total	mg/kg
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	
Naphthalene	mg/kg
TRH C6-C10 less BTEX (F1)	mg/kg
TRH C6-C10	mg/kg
TRH >C10-C16 less Naphthalene (F2)	mg/kg
TRH >C10-C16	mg/kg
TRH >C16-C34	mg/kg
TRH >C34-C40	mg/kg
TRH >C10-C40 (total)	mg/kg
Polycyclic Aromatic Hydrocarbons	
Benzo(a)pyrene	mg/kg
Acenaphthene	mg/kg
Acenaphthylene	mg/kg
Anthracene	mg/kg
Benz(a)anthracene	mg/kg
Benzo(a)pyrene	mg/kg
Benzo(b&j)fluoranthene	mg/kg
Benzo(g.h.i)perylene	mg/kg
Benzo(k)fluoranthene	mg/kg
Chrysene	mg/kg
Dibenz(a.h)anthracene	mg/kg
Fluoranthene	mg/kg
Fluorene	mg/kg
Indeno(1.2.3-cd)pyrene	mg/kg
Naphthalene	mg/kg
Phenanthrene	mg/kg
Pyrene	mg/kg
Total PAH	mg/kg
Metals M8	
Arsenic	mg/kg

Cadmium	mg/kg
Chromium	mg/kg
Copper	mg/kg
Lead	mg/kg
Mercury	mg/kg
Nickel	mg/kg
Zinc	mg/kg
Foreign Materials – ENM	
Foreign Materials – Type I	%
Foreign Materials – Type II	%
Foreign Material - Type III	%
ASLP	
Nitrate -N	mg/L
Nitrite -N	mg/L
NOx-N	mg/L
Total Kjeldahl Nitrogen	mg/L
Total Nitrogen	mg/L

After the initial assessment of the proposed material, the selected suitable material will be placed into a designated stockpile away from any other potential pollutant sources to undertake the validation testing prior to use in the rehabilitation work.

Validation testing

The stockpiled proposed fill material will have validation testing undertaken to ensure the material is suitable for the rehabilitation work. In accordance with Table 4 in Sampling Design Part 1 – Application (NSW EPA, 2022), a minimum of 12 samples are required for the initial assessment of a stockpiles between 200 – 300 m^3. Final quantities required for backfill must be established prior to undertaking sampling to confirm that the minimum sample numbers will be achieved in accordance with the aforementioned standard.

The systematic grid sampling pattern will be followed to take the validation samples (Figure 10). The quantity of material in the stockpile in cubic meters will be measured by survey methods such as drone.

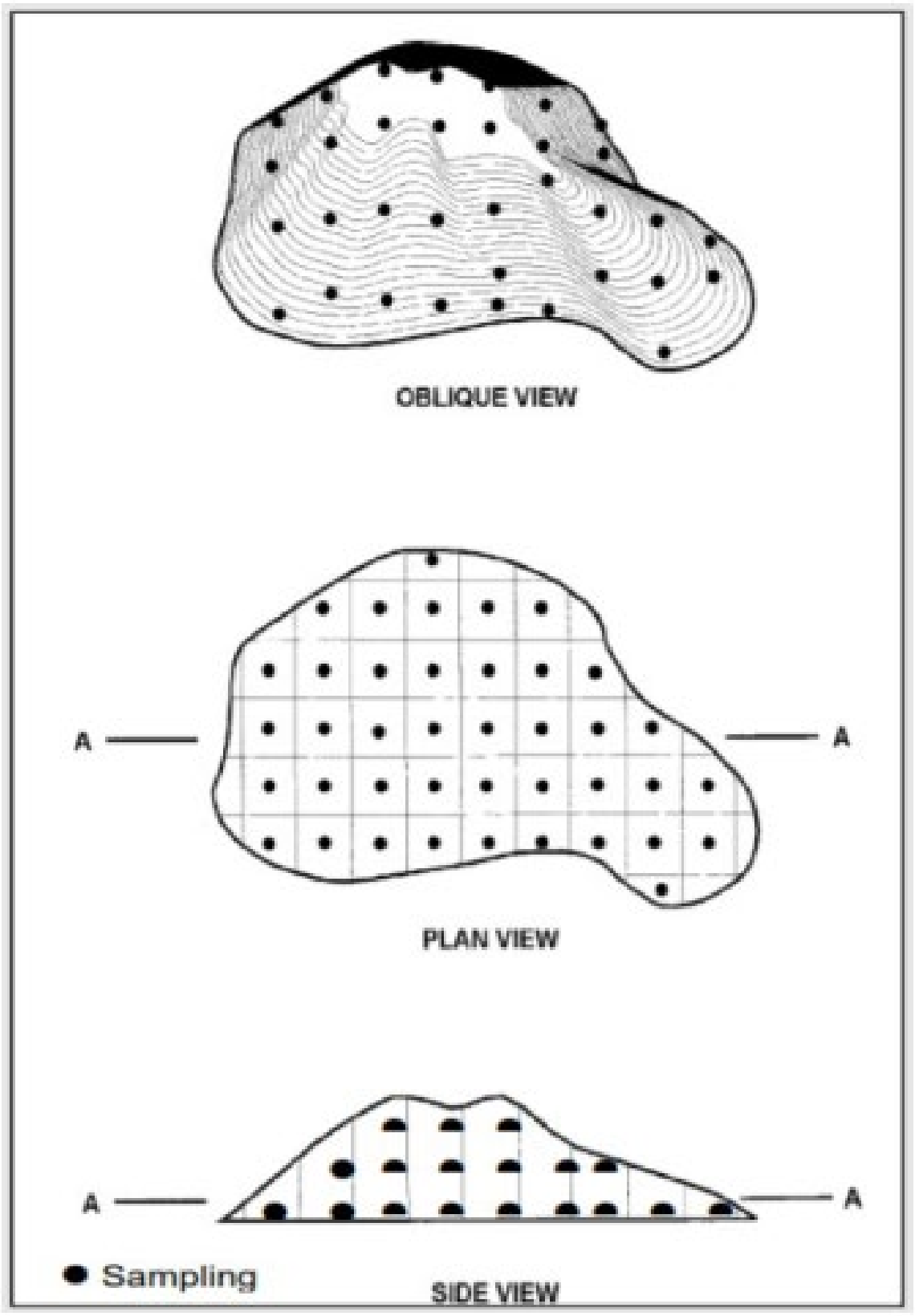

Figure 10: Stockpile sample pattern

The samples will be collected by a suitably qualified person. Samples will be transported to a NATA laboratory under the chain of custody. The following analytes will be analysed in the NATA laboratory to ensure the material is suitable for the rehabilitation work:

Analytes	**unit**
Conductivity (1:5 aqueous extract at 25 °C as rec.)	uS/cm
Nitrate-N	mg/kg
Nitrite-N	mg/kg
NOx-N	mg/kg
pH (1:5 Aqueous extract at 25 °C as rec.)	pH units
Total Carbon	%
Total Inorganic Carbon	%
Total Kjeldahl Nitrogen	mg/kg
Total Nitrogen	mg/kg
Total Sulfur (%) by LECO	%
Total Alkalinity (as CaCO3)	mg/kg
Chromium Suite NASSG (Excluding ANC)	
CRS Suite - Liming Rate - NASSG (Excluding ANC)	kg CaCO3/t, mol H+/t
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	% S
pH-KCL (NLM-3.1)	pH Units
Titratable Actual Acidity (NLM-3.2)	mol H+/t, % pyrite S
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)	mol H+/t, % S
Sulfur - KCl Extractable	% S
HCl Extractable Sulfur	% S
Net Acid soluble sulfur	% S, mol H+/t
Acid Neutralising Capacity	% CaCO3, mol H+/t, % S
CRS Suite - Net Acidity – NASSG (including ANC)	% S, mol H+/t
CRS Suite - Liming Rate - NASSG (Including ANC)	kg CaCO3/t
Net Acid Production Potential (by CRS)	
Acid Production Potential (by CRS)	kgH2SO4/t
Chromium Reducible Sulfur (s-SCr)	% S
Net Acid Production Potential (NAPP) by CRS	kgH2SO4/t
Net Acid Generation	
Net Acid Generation: NAG (initial to pH 4.5)	kgH2SO4/t
Net Acid Generation: NAG (pH 4.5 - pH 7.0)*	kgH2SO4/t
pH After Oxidation (pH NAG)	pH Units
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	
TRH C6-C9	mg/kg
TRH C10-C14	mg/kg
TRH C15-C28	mg/kg
TRH C29-C36	mg/kg
TRH C10-C36 (Total)	mg/kg
BTEX	
Benzene	mg/kg
Toluene	mg/kg
Ethylbenzene	mg/kg
m&p-Xylenes	mg/kg
o-Xylene	mg/kg
Xylenes - Total	mg/kg
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	

Naphthalene	mg/kg
TRH C6-C10 less BTEX (F1)	mg/kg
TRH C6-C10	mg/kg
TRH >C10-C16 less Naphthalene (F2)	mg/kg
TRH >C10-C16	mg/kg
TRH >C16-C34	mg/kg
TRH >C34-C40	mg/kg
TRH >C10-C40 (total)	mg/kg
Polycyclic Aromatic Hydrocarbons	
Benzo(a)pyrene	mg/kg
Acenaphthene	mg/kg
Acenaphthylene	mg/kg
Anthracene	mg/kg
Benz(a)anthracene	mg/kg
Benzo(a)pyrene	mg/kg
Benzo(b&j)fluoranthene	mg/kg
Benzo(g.h.i)perylene	mg/kg
Benzo(k)fluoranthene	mg/kg
Chrysene	mg/kg
Dibenz(a.h)anthracene	mg/kg
Fluoranthene	mg/kg
Fluorene	mg/kg
Indeno(1.2.3-cd)pyrene	mg/kg
Naphthalene	mg/kg
Phenanthrene	mg/kg
Pyrene	mg/kg
Total PAH	mg/kg
Metals M8	
Arsenic	mg/kg
Cadmium	mg/kg
Chromium	mg/kg
Copper	mg/kg
Lead	mg/kg
Mercury	mg/kg
Nickel	mg/kg
Zinc	mg/kg
Foreign Materials – ENM	
Foreign Materials – Type I	%
Foreign Materials – Type II	%
Foreign Material - Type III	%

Data quality assurance (QA) and quality control (QC) procedures shall be performed in the validation process to demonstrate data quality.

Reporting

The suitably qualified person shall prepare a report regarding the validation sampling method and the result of laboratory analysis to demonstrate the statistical confidence level achieved and a statement that the material is suitable for this remediation work based on analysis against the

appropriate EILs and HILs . This report is to be provided to SHL prior to undertaking backfilling through the project document control system. The report will also be made available to NPWS.

Appendix B – Tantangara Surface Depression Completion Criteria - PCT 303

Table 10: PCT 303 Completion Criteria

<table>
<tr><th>Rehab Objective / Characteristic</th><th>Indicator</th><th>Benchmark for Indicator</th><th>Measure (note inter measures taken from BDAR plot 2145 field sheets)</th></tr>
<tr>
<td>The vegetation composition of the rehabilitation is recognisable as the target vegetation community contained within the BioNet Vegetation Classification and which was present on site prior to the project's temporary disturbance.</td>
<td>All native vascular plant species are monitored to species level from fixed 0.04 ha monitoring plots in accordance with table 8</td>
<td>(a) Native plant species composition is characteristic of the target PCT based on suitable analysis against a reference data set
(b) The target PCT composition score is within or greater than the inter-quartile range of local reference site values for the assigned PCT.</td>
<td>Rehabilitation monitoring reports

Final Independent ecological reports that validate rehabilitation completion criteria have been met

BDAR Data – Field sheet extract

<table>
<tr><td rowspan="6">Count of Native Richness</td><td>Trees:</td><td>2</td></tr>
<tr><td>Shrubs:</td><td>5</td></tr>
<tr><td>Grasses etc.:</td><td>3</td></tr>
<tr><td>Forbs:</td><td>14</td></tr>
<tr><td>Ferns:</td><td>0</td></tr>
<tr><td>Other:</td><td>0</td></tr>
</table>

See table 11 for species composition.</td>
</tr>
</table>

<table>
<tr><th>Rehab Objective / Characteristic</th><th>Indicator</th><th>Benchmark for Indicator</th><th>Measure (note inter measures taken from BDAR plot 2145 field sheets)</th></tr>
<tr>
<td>The vegetation structure of the rehabilitation is recognisable as, or shows a substantial trend towards, a PCT contained within the BioNet Vegetation Classification and which was present on site prior to the project's temporary disturbance</td>
<td>The cover, abundance and height range of all native vascular plant species are monitored from fixed 0.04 ha monitoring plots in accordance with Table 8</td>
<td>Cover, abundance, and height range of native plant growth forms are characteristic of the target PCTs and within or greater than the inter-quartile range of local reference site values for the assigned PCT.</td>
<td>Rehabilitation monitoring reports

Final Independent ecological reports that validate rehabilitation completion criteria have been met

BDAR Data – Field sheet extract

<table>
<tr><td rowspan="5">Sum of Cover of native vascular plants by growth form group</td><td>Trees:</td><td>30</td></tr>
<tr><td>Shrubs:</td><td>15.5</td></tr>
<tr><td>Grasses etc.:</td><td>47.1</td></tr>
<tr><td>Forbs:</td><td>1.8</td></tr>
<tr><td>Ferns:</td><td>0</td></tr>
<tr><td colspan="2">Other:</td><td>0</td></tr>
<tr><td colspan="2">High Threat Weed cover:</td><td>1.1</td></tr>
</table>

See table 11 for species cover and abundance of growth forms

Height range to be included after first round of monitoring as described in table 8</td>
</tr>
</table>

<table>
<tr><th>Rehab Objective / Characteristic</th><th>Indicator</th><th>Benchmark for Indicator</th><th>Measure (note inter measures taken from BDAR plot 2145 field sheets)</th></tr>
<tr><td>Levels of ecosystem function have been established that demonstrate the rehabilitation is self-sustainable or shows a substantial trend towards a self-sustaining state.</td><td>Growth medium, covering both subsoil and topsoil properties, and soil processes are monitored using methods specified in table 8</td><td>Growth medium, including topsoil, is suitable for target PCTs establishment, and indicators of nutrient cycling are suitable for sustaining the target PCTs.

All priority attributes of nutrient cycling, soil processes and both subsoil and topsoil properties should be within or greater than the interquartile range of local reference site values for the assigned PCT.

Attributes include; depth of leaf litter, cryptograms Total Carbon and total Nitrogen</td><td>BDAR Data – Field sheet extract

<table>
<tr><td>BAM Attribute (1 x 1 m plots)</td><td colspan="5">Litter cover (%)</td></tr>
<tr><td>Subplot score (% in each):</td><td>80</td><td>70</td><td>60</td><td>75</td><td>80</td></tr>
<tr><td>Average of the 5 subplots:</td><td colspan="5">73</td></tr>
</table>

<table>
<tr><td>BAM Attribute (1 x 1 m plots)</td><td colspan="5">Cryptogam cover (%)</td></tr>
<tr><td>Subplot score (% in each):</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Average of the 5 subplots:</td><td colspan="5">0</td></tr>
</table>

Measure to be updated after first round of monitoring as majority of nutrient cycling processes not were not captured at time of BDAR Rehabilitation monitoring reports

Final Independent ecological reports that validate rehabilitation completion criteria have been met</td></tr>
<tr><td></td><td>All species are monitored for establishment of second-generation juveniles /immatures and capacity for recruitment from fixed 0.04 ha monitoring plots in accordance with Table 8</td><td>Rehabilitation vegetation communities are maturing, and natural recruitment is occurring for species within each growth form at rates within or greater than the interquartile range of local reference site values for the assigned PCT.</td><td>Measure to be updated after first round of monitoring as it was not captured at time of BDAR</td></tr>
</table>

<table>
<tr><th>Rehab Objective / Characteristic</th><th>Indicator</th><th>Benchmark for Indicator</th><th>Measure (note inter measures taken from BDAR plot 2145 field sheets)</th></tr>
<tr><td></td><td>Number and ground cover of weed species are monitored from fixed 0.04 ha monitoring plots in accordance with table 8 and input from annual UAV monitoring outlined in table 7</td><td>The number and ground cover of weed species is comparable to, or less than, the interquartile range of local reference site values for the assigned PCT.
Monitoring program to feed into annual weed control program</td><td>Less than 31 % cover was identified as non-native in the BDAR see table 11 for abundance of individual species

Measure to be updated after first round of monitoring described in table 8</td></tr>
<tr><td></td><td>Presence/absence of some fauna habitat features (e.g. flowering plant, decorticating bark, stags with hollows and/or nest boxes) and quantitative assessment of other features (e.g. leaf litter cover, bare ground, wood debris) are monitored from fixed 0.04 ha monitoring plots in accordance with table 8</td><td>Fauna habitat features and resources (food and shelter characteristics) within the rehabilitation vegetation communities are present and within or greater than the interquartile range of local reference site values for the assigned PCT.</td><td>BDAR Data – Field sheet extract
<table>
<tr><th colspan="4">BAM Attribute (1000 m2 plot) DBH</th></tr>
<tr><th>DBH</th><th>Stem count (euc)</th><th>Stem count (non-euc)</th><th>Stems with Hollows</th></tr>
<tr><td>80 + cm:</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>50 – 79 cm:</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>30 – 49 cm:</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>20 – 29 cm:</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>10 – 19 cm:</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>5 – 9 cm:</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>< 5 cm:</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>Length of logs (m) (≥10 cm diameter, >50 cm in length)</td><td colspan="3">10</td></tr>
</table>
<table>
<tr><th>BAM Attribute (1 x 1 m plots)</th><th colspan="5">Rock cover (%)</th></tr>
<tr><td>Subplot score (% in each):</td><td>10</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Average of the 5 subplots:</td><td colspan="5">2</td></tr>
</table>
Rehabilitation monitoring reports

Final Independent ecological reports that validate rehabilitation completion criteria have been met

Measure to be updated after first round of monitoring described in table 8</td></tr>
</table>

Table 11: Species cover and abundance Plot 2145 - BDAR

	Growth form	Cover%:	Abundance:
Eucalyptus_stellulata	Tree	25	6
Eucalyptus_pauciflora	Tree	5	4
Hakea_microcarpa	Shrub	10	50
Dillwynia_prostrata	Shrub	5	100
Poa_sieberiana_var_sieberiana	Tussock Grass	45	500
Anthoxanthum_odoratum	Introduced	25	1000
Dactylis_glomerata	Introduced	5	200
Geranium_antrorsum	Forb	0.1	30
Elymus_scaber	Tussock Grass	0.1	20
Senecio_gunnii	Forb	0.1	20
Scleranthus_biflorus	Forb	0.1	30
Microseris_lanceolata	Forb	0.1	10
Poranthera_microphylla	Forb	0.2	200
Asperula_scoparia	Forb	0.2	200
Brachyscome_decipiens	Forb	0.1	10
Acrothamnus hookeri	Heath shrub	0.1	3
Aciphylla simplicifolia	Forb	0.1	5
Olearia_sp	Shrub	0.1	20
Acaena_ovina	Forb	0.2	200
Hypochaeris_radicata	Introduced	0.1	30
Acaena_novae-zelandiae	Forb	0.2	100
Ranunculus_graniticola	Forb	0.1	20
Themeda_triandra	Tussock Grass	2	80
Acetosella_vulgaris	Introduced	0.1	100

Persoonia_chamaepeuce	Shrub	0.3	5
Stellaria_pungens	Forb	0.1	20
Viola_betonicifolia	Forb	0.1	30
Agrostis_capillaris	Introduced	1	40
Podolepis_laciniata	Forb	0.1	30

*Non natives

Appendix C – Quarterly Observational Monitoring Form

Quarterly Rehabilitation Inspection (Feb 2024)

Form completed for each rehabilitation area and submitted to rehab manager - Photos required for each question

* Indicates required question

Date *

Date

dd/mm/yyyy

Person completing inspection

Your answer

Site *

Your answer

Photo monitoring points established

- ○ Yes
- ○ No - Action required
- ○ Other: _____

Landform Stability / Erosion

- ○ No erosion present
- ○ Minor surface erosion less than growth medium depth
- ○ Minor erosion less than 300 mm - Action required
- ○ Major erosion more than 300 mm - Immediate action required
- ○ Sediment not controlled leaving area - Immediate action required
- ○ Other: _____

Bare Ground / Ground Cover (excluding rocks and logs)

- ○ No bare ground
- ○ Bare ground - less than 5%
- ○ Minimal bare ground - less than 15% - Monitor
- ○ Bare patches - Between 15 and 30% - Action required
- ○ Bare patches - over 30% - Action required

Vegetation Health

- ○ Minimal mortality / sickness observed - Less than 5%
- ○ Mortality / sickness 5 - 20% - Action required
- ○ Mortality / sickness more than 20% - Action required
- ○ Minimal germination following direct seeding - Action required

Weeds

- ○ No weeds presents
- ○ Individuals weeds present - Action required
- ○ Weed infestation present - Action required
- ○ Colonising weeds of area present - Action required

Pests

- ○ No evidence of pest species observed
- ○ Presence observed minimal impact
- ○ Pest species causing damage to rehabilitation - Action required
- ○ Other: _____

Hydrological Integrity and function of bogs and fens

- ○ No issue
- ○ Incision forming - Action required
- ○ Drying of bog identified - Action required
- ○ NA

Human interference

- ○ Wheel tracks
- ○ Litter

Site Signage

- ☐ Yes
- ☐ No - Action required

Site Access

- ○ Site accessible for monitoring
- ○ Monitoring access requires action
- ○ Access control not in place - Action required
- ○ Access control in place
- ○ Other: _____

Other Comments

Your answer

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