



RESPONSE TO SUBMISSIONS

EXPLORATORY WORKS MODIFICATION 1

September 2019

Snowy 2.0 Exploratory Works Modification 1

Response to Submissions Report

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Prepared by



Lawrence Wallis
Senior Environmental
Scientist
2 September 2019



Aaron Bowden
Associate
2 September 2019

Approved by



Duncan Peake
Project Manager
2 September 2019

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CHAPTER

1

INTRODUCTION



1 Introduction

1.1 Snowy 2.0

Snowy Hydro Limited (Snowy Hydro) is pursuing Snowy 2.0 which is a pumped hydro-electric storage and generation project. Snowy 2.0 responds to major and unprecedented challenges faced by the New South Wales (NSW) energy system and broader National Electricity Market (NEM) through rising energy costs, deterioration in energy system security and reliability, and a transition in the generation mix away from coal-fired, dispatchable, base-load power to intermittent renewable wind and solar power. Like the existing Snowy Hydro business, Snowy 2.0 underpins a secure and reliable decarbonisation of the NEM at lowest cost.

Snowy 2.0 involves linking Talbingo and Tantangara reservoirs within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme) and building an underground power station between the two reservoirs. This will increase the current Snowy Scheme generation capacity by almost 50%. The increased quick-start generation and large-scale storage capacity provided by Snowy 2.0 will increase the security and reliability of the NEM. As with most of the existing Snowy Scheme, the majority of Snowy 2.0 is in the Kosciuszko National Park (KNP). Snowy Hydro has been working with NSW National Parks and Wildlife Service (NPWS) since the announcement of Snowy 2.0 to ensure long term management objectives for KNP are considered in project development.

On 7 March 2018 the NSW Minister for Planning declared Snowy 2.0 to be State significant infrastructure and critical State significant infrastructure (CSSI) under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) on the basis that it is critical to the State for environmental, economic or social reasons.

1.2 Exploratory works

Snowy Hydro obtained approval to carry out Exploratory Works for Snowy 2.0 on 7 February 2019. The primary purpose of Exploratory Works is to gain a greater understanding of the rock conditions at the proposed location of the underground power station for Snowy 2.0. An exploratory tunnel is the key element proposed to gain this critical information for design development.

1.3 Purpose of this report

This response to submissions (RtS) report has been prepared in accordance with the draft *Environmental Impact Assessment Guidance Series Responding to Submissions* June 2017 (Department of Planning and Environment 2017). The purpose of the document is to consider and respond to submissions made in relation to the Modification 1 assessment report by various State and local government agencies, special interest groups and the public.

This report also presents details of changes to the Modification 1 proposal since the public exhibition of the assessment report, the findings of additional environmental assessment and any proposed mitigation measures.

1.4 Modification 1

Snowy Hydro Limited is seeking approval for a modification to the Exploratory Works approval (Modification 1). The primary purpose of Modification 1 is to:

- provide additional geotechnical information required for the detailed design of the Snowy 2.0 power station and power waterway;

- provide a reliable long term source of construction power for the duration of Exploratory Works that meets Safe Work Australia's primary and back-up supply requirements while reducing the reliance on diesel generation and associated on-site storage and emissions;
- improve the efficiency of the Exploratory Works construction power;
- optimise the detailed design of construction areas and access roads; and
- improve worker safety during construction.

The Modification 1 assessment report considered the following scope of works:

- borehole drilling and geophysical surveys for further geotechnical investigation of the Snowy 2.0 power station and power waterway at Marica, Talbingo and Tantangara. Geotechnical investigations will involve the following activities:
 - clearing of up to 2.79 hectares (ha) of additional vegetation for access tracks and drilling pads. About 1.33 ha of this vegetation clearing would occur within Smoky Mouse potential habitat. This area of clearing represents less than one percent of the overall Exploratory Works project area;
 - trimming of overhanging dangerous branches on adjacent trees (these trees will not require removal);
 - mulching of the above cleared trees and vegetation;
 - establishment of an additional 1 km of access tracks (4 m wide), including minor earthworks, placement of geofabric (as required) and import of stabilised material;
 - establishment of eight drilling pads and boreholes at top of the cavern area, with an area of 900 m² per pad, including minor earthworks, placement of geofabric (as required) and import of stabilised material (as required);
 - undertaking geophysical surveys near Talbingo and Tantangara reservoirs;
 - establishment of two drilling pads and boreholes at both Tantangara and Talbingo with an area of 900 m² per pad, including approximately 400 m of additional access tracks and minor earthworks (as required);
 - establishment of in-reservoir boreholes including one in Talbingo Reservoir and two in Tantangara Reservoir;
 - drilling of nested vertical boreholes at each of the drilling pads up to a depth of 1,100 m;
 - conversion of selected investigation boreholes into monitoring bores ;
 - undertaking downhole geophysical surveys; and
 - rehabilitation of the drilling pads and access tracks following completion of works.
- ongoing groundwater monitoring using existing boreholes and access tracks within KNP;
- ongoing maintenance and rehabilitation of existing access tracks required for groundwater monitoring and geotechnical investigations within KNP;

- establishment of a construction power connection to the existing transmission line (Line 2) at Lobs Hole for power supply to the Exploratory Works accommodation camp and construction areas. This will provide a reliable and long-term source of construction power that meets Safe Work Australia's back-up power supply requirements and will reduce the reliance on diesel generation and associated on-site storage requirements and emissions. This will include:
 - construction of a 330/33 kilovolt (kV) substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation;
 - geotechnical investigation works to inform the detailed design of the construction power substation;
 - replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height;
 - short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54;
 - 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables;
 - establishment and upgrade of access tracks and roads to the new substation and transmission line structures;
 - installation of a fibre optic communication link into the new substation from the approved communication network; and
 - ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas.
- minor changes to the project boundary identified through detailed design including:
 - revised road upgrade for Lobs Hole/Ravine Road to improve drainage and safety;
 - minor additions to construction areas for design optimisation; and
 - reduction of the project boundary in areas no longer required for construction of Exploratory Works resulting in an overall reduction of the Exploratory Works disturbance footprint.
 - additional minor disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment; and
 - additional disturbance area required for the construction power connection to an existing transmission line at Lobs Hole. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas.
- removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road;

- continued use of existing communications towers within KNP that were previously approved by the National Parks and Wildlife Service (NPWS) under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW *National Parks and Wildlife Act 1974* (NPW Act) and its regulation for the geotechnical investigation program; and
- increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected.

1.5 Changes to design since public exhibition

Following public exhibition of the Modification 1 assessment report, several improvements have been designed and adopted by Snowy Hydro. These improvements include changes to the design and/or management of Exploratory Works and have been developed in response to feedback from government and community stakeholders, as well as the Future Generation Joint Venture contracted to construct Exploratory Works. The key project improvements are summarised as follows:

- revision and clarification of road works in the boulder streams on Lobs Hole Ravine Road;
- additional laydown areas at Talbingo north to improve constructability;
- additional shallow geotechnical drilling for further design information on bridge crossing near Nungar Creek; and
- additional justification for the Lobs Hole substation.

1.6 Approval and engagement process

The Modification 1 Assessment Report and associated technical studies were submitted by Snowy Hydro to the former NSW Department of Planning and Environment (DPE), now known as NSW Department of Planning, Industry and Environment (DPIE), in June 2019 and publicly exhibited by the DPIE in accordance with the EP&A Act between 26 June and 9 July 2019.

Snowy Hydro has adopted a proactive and flexible end-to-end stakeholder engagement strategy for Snowy 2.0, which will be applicable to all phases of Snowy 2.0, including the Exploratory Works. It aims to meet all objectives and the demands of a diverse range of stakeholders with changing needs. The framework is based on the International Association for Public Participation (IAP2) *Public Participation Spectrum, 2014* (the Spectrum).

The proposed modification is not expected to have any impacts on the community beyond those anticipated for the Exploratory Works. The stakeholder engagement for Modification 1 has therefore focused on consultation with key agency stakeholders.

Meetings were held over May and June 2019 with DPIE, NPWS, Commonwealth Department of Environment and Energy (DoEE), NSW Office of Environment and Heritage (OEH), NSW Environment Protection Authority (EPA), NSW Department of Primary Industry (DPI – Fisheries) and TransGrid.

Letters providing scope and assessment of Modification 1 were issued to NSW Roads and Maritime Services (RMS), Department of Industry (Crown Lands & Water Division), Snowy Monaro Regional Council and Snowy Valleys Council. The Rural Fire Service was also contacted in relation to the use of Ravine Road North for secondary emergency egress.

A total of ten submissions were received during the public exhibition period, including two from special interest groups and two individual community submissions. Of the ten submissions, three submissions (33%) objected to the works. In addition, six submissions were received from NSW Government agencies and local councils. A detailed analysis of matters raised in the submissions is set out in Chapter 2.



CHAPTER

2

ANALYSIS OF SUBMISSIONS RECEIVED



2 Analysis of submissions received

2.1 Exhibition details

The Modification 1 assessment report was publicly exhibited from 26 June to 9 July 2019 on the DPIE website. The Modification 1 project page on the DPIE Major Projects Portal is accessible at the following location:

<https://www.planningportal.nsw.gov.au/major-projects/project/13601>

2.2 Submissions summary

Following public exhibition of the Modification 1 assessment report, ten submissions were received by the DPIE. Two submission was received from a special interest groups (Colong Foundation for Wilderness and National Parks Association of NSW) and two were from individual community members. Six submissions were received from NSW government agencies.

A breakdown of the submissions received is provided in Table 2.1.

Table 2.1 Summary of submissions received

Submission category	Object	Support	Comment	Total
Individual community member	2	-	-	2
Special interest group	1	-	1	2
Government	-	-	6	6
Total	3	-	7	10

The following NSW Government agencies provided submissions:

- Department of Premier and Cabinet – Heritage Division;
- Transport for NSW – Maritime Division;
- Transport for NSW – Roads Division;
- Environment Protection Authority – South East Region;
- Department of Planning, Industry and Environment – Lands and Water Division; and
- Department of Planning, Industry and Environment – Biodiversity and Conservation Division.

2.3 Response methodology

All submissions received were collated and categorised based on who they were from, in accordance with the following categories:

- individual community member;
- special interest group; and

- government.

The submissions were reviewed, and the key matters raised in each submission identified. Matters raised in each submission were categorised by theme. The themes identified through the review of key matters were:

- biodiversity;
- geodiversity;
- KNP;
- groundwater;
- surface water;
- traffic and transport;
- visual;
- Aboriginal cultural heritage;
- bushfire; and
- approval process.

Responses were prepared to each matter by Snowy Hydro and EMM, with input from technical specialists who prepared the relevant impact assessment for the EIS. The study team was the same team that prepared the EIS.

2.3.1 Submissions in objection

As noted previously, three submissions objected to Modification 1. This comprised two submissions from individuals and one submission from a special interest group. Frequency of matters raised is provided in Table 2.2.

Matters raised in submissions in objection mainly related to biodiversity impacts and the approval process. Additional matters raised in objecting submissions included geodiversity, bushfire, visual, KNP and waterway impacts.

Table 2.2 Summary of matters raised in objecting submissions

Aspect	Quantity	Percentage (%)
Biodiversity	3	100
Approval process	2	66
Geodiversity	1	33
Bushfire	1	33
Visual	1	33
Kosciuszko National Park	1	33
Waterways	1	33

2.3.2 Government

A summary of the matters raised in submissions from government agencies is provided in Table 2.3.

Table 2.3 Summary of matters raised in government submissions

Aspect	Quantity	Percentage (%)
Historic and natural heritage	2	33
Aboriginal cultural heritage	2	33
Biodiversity	1	17
Traffic and transport	3	50
Regulatory authority	1	17
Erosion and sedimentation	1	17
Groundwater	2	33
Water licencing	1	17
Crown lands	1	17
Geotechnical investigations	1	17
Construction	1	17
Project boundary	1	17
Bushfire	1	17
Tree removal	1	17
Smoky Mouse	1	17

As shown in Table 2.3, matters raised in the government submissions are varied and rarely overlap.

2.3.3 Special interest groups

Two special interest group submission were received. Issues raised included biodiversity visual and waterway impacts, as well as the approval process.

2.3.4 Individual community members

A summary of the matters raised in community submissions is provided in Table 2.4.

Table 2.4 Summary of matters raised in community submissions

Aspect	Quantity	Percentage (%)
Biodiversity	2	100
Approval process	1	50
Geodiversity	1	50
Bushfire	1	50
Visual	1	50
Kosciuszko National Park	1	50

In total two individual community member submissions were received by DPIE following the public exhibition of the Modification 1 assessment report. The matters raised in community submissions are further detailed in Chapter 4.



CHAPTER

3

PROJECT IMPROVEMENTS



3 Project improvements

3.1 Overview of design changes

Following public exhibition of the Modification 1 assessment report, feedback from government and community stakeholders, and the design and construct contractors has been considered and several project improvements have been identified. The proposed project improvements involve design changes for the purposes of:

- further minimising environmental impacts;
- improving the constructability of Exploratory Works; and
- meeting stakeholder expectations for the project.

This section provides details of the proposed minor amendments to the Modification 1 proposal. The key project improvements are:

- revision of the Exploratory Works disturbance footprint to include previously approved vegetation clearance;
- revision and clarification of roadworks in the boulder streams on Lobs Hole Ravine Road;
- additional laydown areas;
- additional geotechnical drilling sites; and
- justification for the Lobs Hole substation.

3.2 Revision of the disturbance footprint

The Modification 1 assessment report proposed to reduce the project disturbance footprint and vegetation clearing in some areas. As detailed in the Modification 1 Assessment Report the proposed reductions in the project disturbance footprint would result in a reduction of the total disturbance footprint to approximately 112 ha and a minor increase in vegetation clearance and biodiversity offsets required for Exploratory Works. Since the Modification 1 exhibition period it has been determined that avoiding areas within the approved disturbance boundary would negatively impact the constructability of the Exploratory Works. Therefore the areas previously identified for reductions in the Exploratory Works boundary will no longer be avoided. This change to the Modification 1 proposal will result in a total of approximately 128 ha disturbance footprint for the Exploratory Works and an increase in the vegetation clearance and biodiversity offsets required for the Exploratory Works. Changes to vegetation clearing and biodiversity offsets required for Modification 1 are assessed and provided in Appendix C.

3.3 Boulder stream road construction

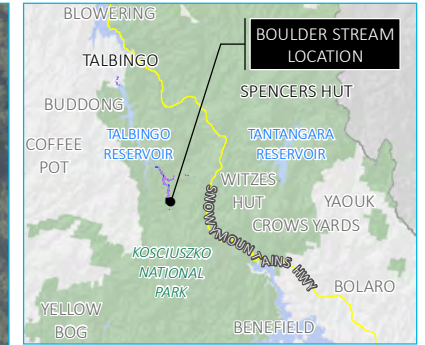
Modification 1 project improvements include an increase of the disturbance area and a change in road design for widening and stabilising the block stream sections of Lobs Hole Ravine Road. This is to reflect additional design development and the identification of a preferred option (known as the wide cut option) for boulder stream road works on Lobs Hole Ravine Road.

Road modifications differ from that proposed originally for these sections, which involved raising the road surface, minor excavation, placement of fill and a retaining wall on the downslope side of the road. Instead it is proposed that road widening will be achieved by excavating on the upslope side of the road into the boulder streams with local stabilisation applied as required using methods with low visual impacts such as wire netting. The additional proposed excavations are larger than what was previously proposed under Modification 1 and reflect additional detailed design for a larger design vehicle (for the installation of the substation) required for the proposed works.

The proposed road design for widening the block stream sections involves excavation on the upslope side of the road with stabilisation achieved by cut and fill to a stable batter slope. Where required, local stabilisation works to maintain block stability and ensure safe use of the road may be undertaken using methods with low visual impacts such as wire netting.

The revised boulder stream works are provided in Figure 3.1 below.

\\lemmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02_Maps\EIS_EW_Mod1\MainReport_rts\G001_RevisedBoulderStreamWorks_20190814_01.mxd 22/08/2019



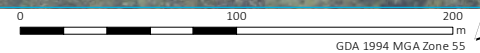
KEY

- EW approved construction footprint
- EW modification construction footprint (additional)
- Excavation extent
- Existing disturbed area
- Boulder stream

Revised boulder stream works
- additional cut

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 3.1

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); DFSI (2017); GA (2015); LPMA (2011)



3.3.1 Geodiversity assessment

A geodiversity assessment report was prepared for the revised boulder stream works by Dr Alexa Troedson, a recognised expert, and is provided in Appendix D. The findings of this report are summarised in this section.

i Impact assessment

The Ravine periglacial block streams are significant geodiversity features within KNP, and roadworks for Snowy 2.0 EW should be designed and managed to minimise impacts to the geodiversity values of the block streams as much as practical. The main risks and sensitivities around these features are impacts on visual amenity, maintenance of landscape integrity, block stability, and future access to the features for viewing and study.

Block streams can form in alpine areas affected by periglacial conditions, where freeze-thaw activity is able to modify the landscape in a significant way. They consist of angular cobbles (6-25 cm diameter) and boulders (>25 cm diameter) that have broken off rock outcrops by frost-shattering and been transported down-slope in association with interstitial ice. Block streams typically occur on steep slopes in shallow depressions in the landscape. In Australia they are relict features formed when the climate was much colder than present, mostly during the peak of the last ice age (last glacial maximum), between around 22 to 16 thousand years ago.

The Ravine block streams are located in the vicinity of Lobs Hole Ravine Road in northern Kosciuszko National Park (KNP), approximately 7 km from the intersection with Link Road to the south. They occur mostly on the steep, eastern, up-slope side of the road, with the lower reaches of several block streams bisected by the road.

While not common, periglacial block deposits have been identified in a number of highland areas of southeastern Australia. These deposits have regional significance based on their contribution to the understanding of climate conditions at the time of their formation during the last glacial period, which peaked at around 20 thousand years ago. The Ravine block streams have additional significance related to their occurrence within a protected area (KNP) and their potential accessibility to the public for the purposes of geological education.

The main impact on the block streams from Modification 1 would be from the additional upslope excavation of the features. The increased excavation would have a negative aesthetic impact on the features that are visible from the existing Lobs Hole Ravine Road. It does, however, represent a small proportion of the overall block stream extents, and the features would remain substantially intact. In all cases the excavation would involve further cut into existing batters adjacent to the road, thereby extending an existing impact. It could be expected that the remaining blocks and underlying substrate in the batter area would form a relatively natural-looking surface, although it may need to be retained with local stabilisation works in some areas to maintain block stability and ensure safe use of the road. The use of wire-netting is preferable to other alternatives, such as shotcrete, which would be more visually intrusive and obscure the view where currently visible.

Despite the increased construction footprint and excavation width, the proposed modification is likely to have some advantages and improvements over the previously approved plan to raise the road surface with filling and to build a retaining structure on the road downslope, which could have a more prominent visual impact. The modified scope would also likely be easier to construct.

ii Conclusion and recommendations

Specific recommendations for minimising potential impacts of Modification 1 on the features are listed below.

1. If not already undertaken, carry out field mapping of block stream extents and morphology within the construction footprint prior to works. Use this data to assist preparation of final design and construction plans which minimise potential impacts on these features and enable management of impacts during construction.
2. Consider the visual impact of the road upgrade in the block stream sections and implement road design that will maintain landscape values.
3. In order to maintain feature integrity in a near-natural state, construction activities should, where practical:
 - a) minimise the extent of excavation into the upslope block streams;
 - b) minimise moving or damaging blocks in areas beyond the excavation zone;
 - c) minimise the use of outside materials onto the block streams (eg soil or fill);
 - d) minimise use of any stabilisation measures that permanently cover the block streams, for example with shotcrete or other construction materials which would preclude their future viewing and study.
4. Road design should incorporate adequate drainage controls to ensure water flow through the upslope block streams are not impeded as this may impact the stability of the features.
5. Erosion and sediment control measures should be implemented during and after construction with the aim to minimise adverse impacts on and around the block streams. Erosion and sediment impacts of the proposed works were assessed in the water impact assessment section of the Modification 1 assessment report.
6. The proposed works should implement controls in accordance with the approved Biodiversity Management Plan to ensure they do not promote the spread of weeds near the boulder streams, and thereby reduce their visibility.
7. Particular care should be taken to avoid impacts on the downslope section of Block Stream B which features well-preserved evidence of ice age block flow in the form of ridges and other low relief surface topography.
8. Undertake visual monitoring of block stream sections during construction to ensure that works are being carried out within design parameters and environmental controls are effective.
9. Where required, local stabilisation works to maintain block stability and ensure safe use of the road may be undertaken using methods with low visual impacts such as wire netting.

If these recommendations are followed, the integrity of the features will be maintained in a reasonably natural state and preserve their geodiversity values for the future, despite the additional impacts of Modification 1.

3.3.2 Other environmental impacts

The proposed changes to the boulder stream works are expected to result in impacts consistent with the impact assessments for heritage, water and traffic provided in the Modification 1 assessment report. The proposed changes would result in some additional impacts to native vegetation clearance and biodiversity offset requirements. These changes to vegetation clearance and biodiversity offset requirements resulting from the proposed boulder works have been assessed and are provided in Appendix C.

3.3.3 Alternatives considered

Alternative options were considered through the development of the proposed boulder stream works. Following detailed design and analysis the preferred option was selected as best meeting the objectives of the Exploratory Works. This section provides a summary of the options analysis undertaken for the Modification 1 boulder stream works.

Following approval of the Exploratory Works EIS three additional options for the boulder stream road works were developed based on detailed design finding that the approved road design in these sections would not enable safe single lane access for the duration of Exploratory Works. Four options were thereby reviewed including the option of continuing with the approved works. The options considered for the boulder stream road works and the outcomes of the options analysis are provided below.

i The approved fill option

This option involved carrying out the approved program of road works in the boulder streams sections. This method involved building a retaining wall on the downslope side of the road and raising the road level with fill. This would result in covering boulders on the upslope side of the road with fill and is shown in Figure 3.2 below.

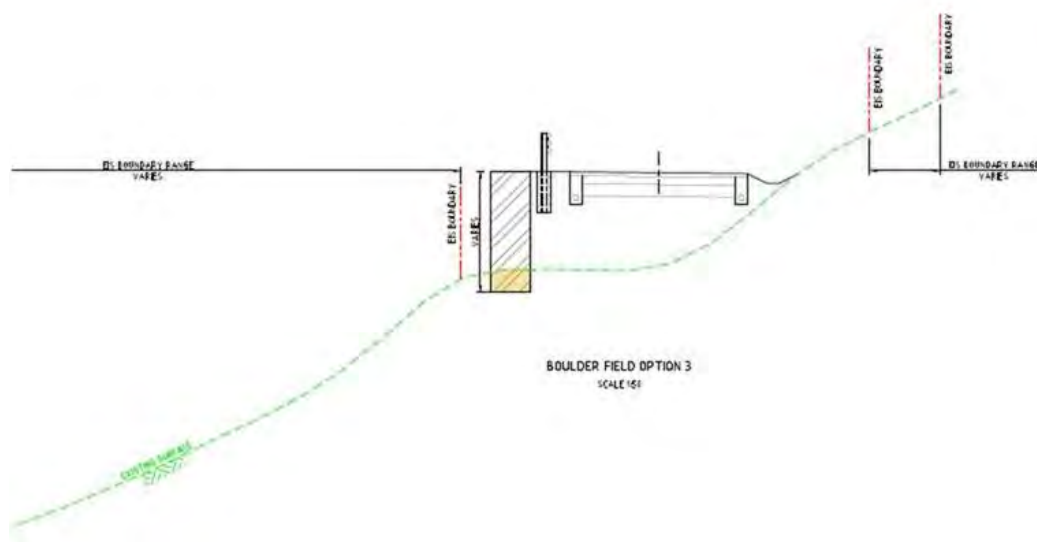


Figure 3.2 Indicative cross-section – approved road works

The approved boulder stream works were considered unsuitable as they do not provide adequate access for the design vehicle required for the Modification 1 proposed works. It was considered that the approved works would restrict access to the full mobilisation of required construction traffic, negatively impact the frequency of daily construction traffic and have a significant impact on the Exploratory Works schedule. The approved boulder stream works were also considered unsuitable as they were likely to require significant management and maintenance throughout Exploratory Works with the proposed road design likely to require additional works for stabilisation, reduction of slope creep and to prevent the slippage of boulders onto the road.

ii Typical cut

The minimal cut option involved cut on the upslope side of the road within the approved Exploratory Works boundary and is shown in Figure 3.3 below.

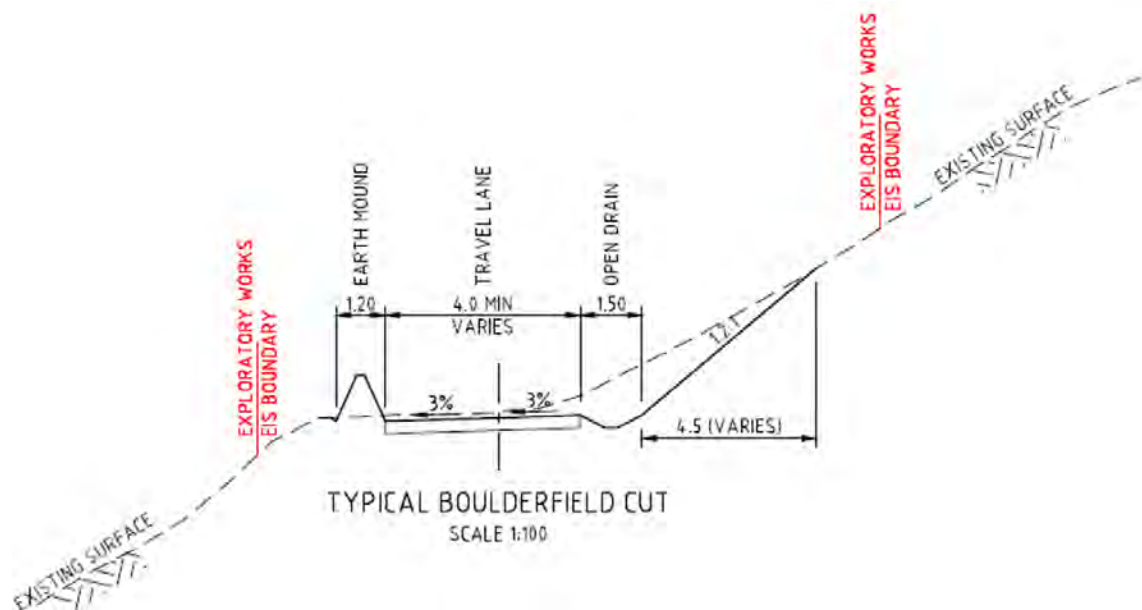


Figure 3.3 Indicative cross-section – minimal cut option

The minimal cut option was considered to be an improvement on the approved fill option as it provided a more efficient road construction method and was less likely to require ongoing maintenance works than the approved fill option. The minimal cut option was, however, considered unsuitable as it would restrict access to the full mobilisation of required Exploratory Works construction vehicles, negatively impact the frequency of daily construction traffic and have a significant impact on the Exploratory Works schedule.

iii Soil nail walls option

The soil nail walls option proposed to undertake road widening mainly by building out over the top of the downslope side of the block streams, with road batters stabilised using soil nail walls. This technique requires drilling a series of closely spaced diagonal holes through the existing road batter face into the blocks and fill underlying the road surface to competent bedrock, and then inserting soil nails up to 12 m in length, which will be bonded within colluvium, residual or rock as appropriate.

Temporary flexible mesh formwork is then installed along the existing batter into which 'no fines' concrete is poured in 300 mm layers, up to the level of the existing road to create a wider road surface. Once all sections of a face are completed the formwork is removed and outside steel reinforcement is put in place using flexible mesh and plates, and tensioned. Finally, the soil nail facing will be covered with shotcrete. An indicative cross-section of the soil nail walls option is provided in Figure 3.4 below.

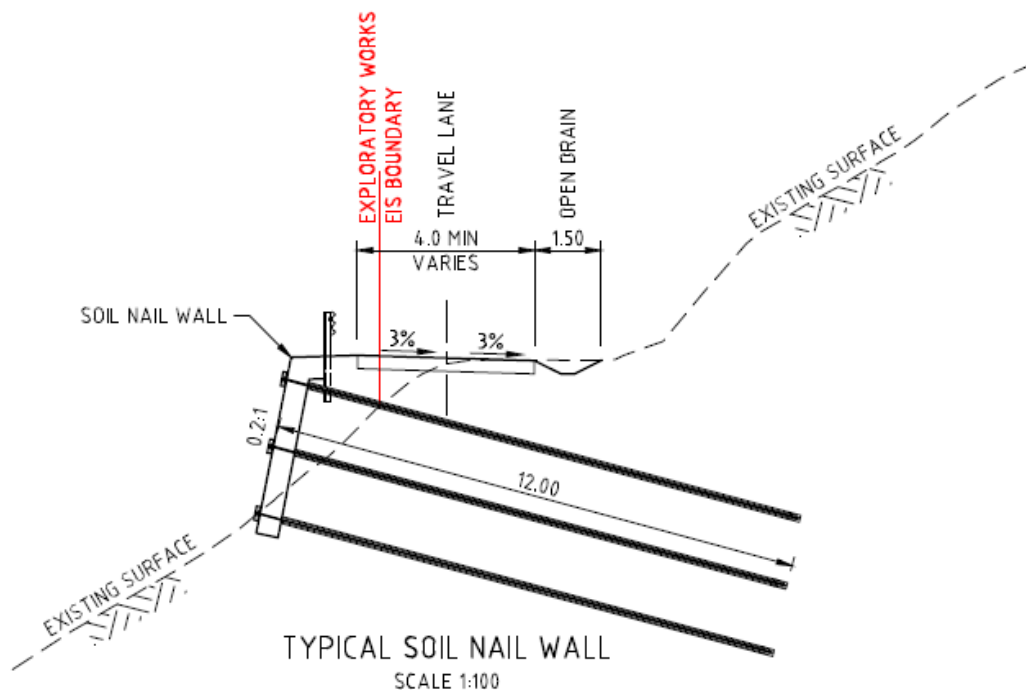


Figure 3.4 Indicative cross-section – soil nail walls option

The soil nail walls option was considered an improvement on the fill option and the minimal cut option as it provides adequate access for the full mobilisation of required Exploratory Works construction traffic. The soil nail walls would also provide a high level of geotechnical stability and minimise the need for ongoing road maintenance. The soil nail walls option was, however, considered unsuitable as it would take a long period of time to construct, and during its construction would restrict access for daily construction traffic resulting in a large impact to the project schedule. The soil nail wall works were also less preferred as they involve permanent covering of boulders on the downslope of the road.

iv Preferred option – wide cut

The wide cut option involves cut on the upslope and extends beyond the approved Exploratory Works disturbance footprint. The wide cut option was developed (and continues to be developed) through detailed design to accommodate transport of the largest required oversize deliveries for Exploratory Works including transformers required for the Lobs Hole substation. An indicative cross-section for the wide cut option is provided in Figure 3.5 below.

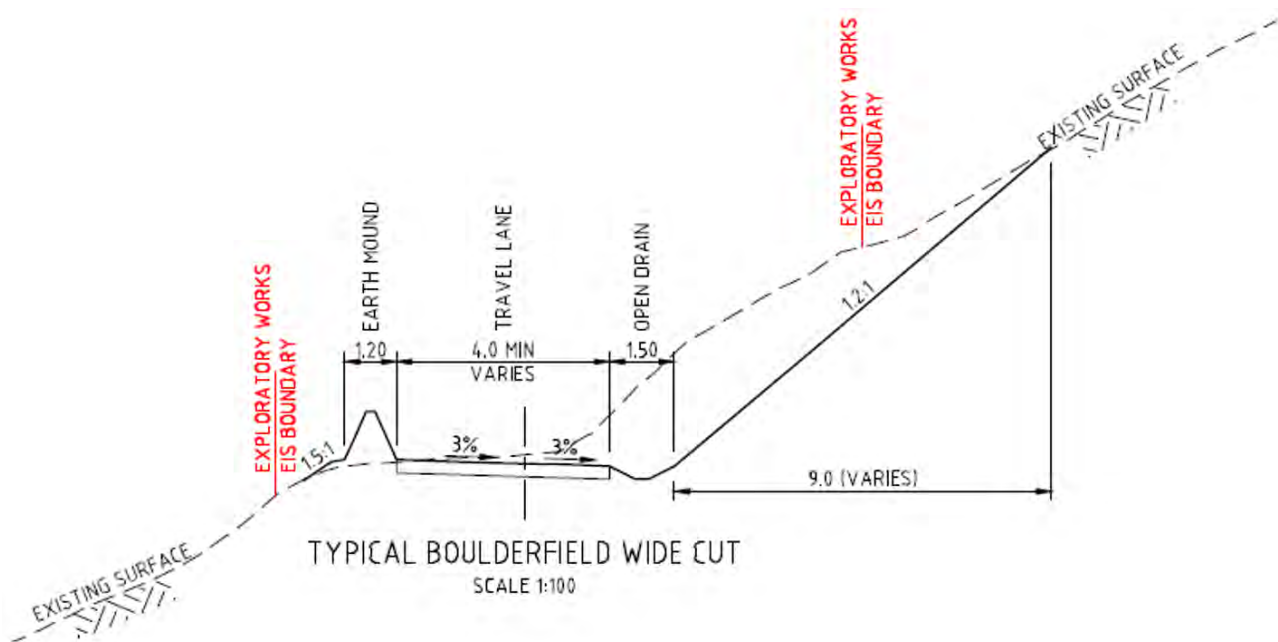


Figure 3.5 Indicative cross-section – wide cut option

The wide cut option was identified as the preferred option for the boulder stream works. This option provides adequate access for all Exploratory Works construction traffic and could be completed safely and efficiently. It was determined that stabilisation of the road and boulder stream could be achieved by establishing batter slopes at a suitable angle of repose and wire mesh used (as required) to secure surface boulders. The use of wire mesh to secure surface boulders will maintain the visibility of the boulder streams and minimise impacts to the geodiversity values of the boulder streams.

3.4 Talbingo north plant and material transfer areas

Additional areas for the transfer of plant and materials are proposed within Modification 1 to improve constructability. Four sites have been proposed for these areas, shown in Figure 3.6. These sites are all on Snowy Hydro owned land and have been sited to assist in installation of communications infrastructure, road works and barge infrastructure works.

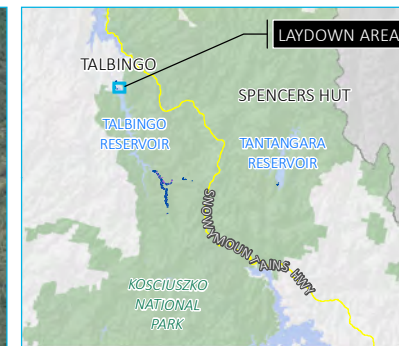
Deliveries and crew mobilisation will be serviced from these areas. The areas will also be used for storage of construction materials and equipment. All areas will be established within existing disturbed land.

3.4.1 Impact assessment

The proposed sites are in previously disturbed and existing hardstand areas at Talbingo north, shown in Figure 3.6. As a result, both access and any works associated with the areas do not require earthworks or vegetation removal. Therefore the proposed areas will have no impact on biodiversity, heritage or water beyond the impacts already approved for Exploratory Works.

Of the four additional areas, two are within areas accessible to the public. The areas at the Talbingo dam wall and Talbingo boat ramp will remain open to the public throughout Exploratory Works. To minimise interactions with the public, temporary construction fencing will be established around all construction areas during works only.

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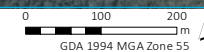


- KEY**
- Orange rectangle: Marine comms laydown (proposed)
 - Purple line: EW EIS approved construction footprint
 - Blue line: EW EIS modification construction footprint (additional)
 - Black line: Local road
 - Dotted line: Vehicular track
 - Blue line: Watercourse / drainage line

Proposed laydown areas at
Talbingo north

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 3.6

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2018); DFSI (2017); GA (2015); LPMA (2011)



The areas near Talbingo dam wall and Talbingo boat ramp will be used for storage and mobilisation only. No operation of construction equipment and machinery will be undertaken within these two areas except as is required for transport and mobilisation. The area at Talbingo Spillway may also be used for the siting of personnel and equipment during road and barge ramp construction. The area near the communications cable route at the north of Talbingo Reservoir will be used during the installation of the communications cable.

All traffic and noise impacts associated with the areas are expected to be consistent with the type and level of impacts already expected for the approved Exploratory Works.

3.5 Geotechnical drilling for Nungar Creek bridge

Additional geotechnical drilling is proposed to enable investigation and detailed design of critical bridge works on Tantangara Road. Two shallow boreholes will be established at the intersection of Nungar Creek and Tantangara Road. The Nungar Creek drill sites are provided in Figure 3.7.

The investigations proposed for the Nungar Creek culvert are planned to ascertain geological condition around the existing Nungar Creek culvert to inform detailed design of bridge works that will provide access to a critical area for the Snowy 2.0 Main Works. Only on-land drilling sites, adjacent to Nungar Creek, will be undertaken. No drilling within the waterway will be undertaken.

Geotechnical investigations will involve the following:

- set-up of the works and equipment storage area within half of the roadway; allowing for one-way traffic movement past the works and equipment storage area;
- drilling two boreholes to a depth of 10 m within two works and equipment storage areas each approximately 70 m². The works and equipment storage area is situated within the existing Tantangara Road alignment; and
- reinstatement of the drilling pads and boreholes following completion of works.

No vegetation removal is required outside of the existing roadway and disturbed area as the works and equipment storage area will remain within the current roadway. Similarly, no access track or pad construction works will be required due to the set-up location. All access will be from the roadway and the existing road surface will be suitable to drill from.

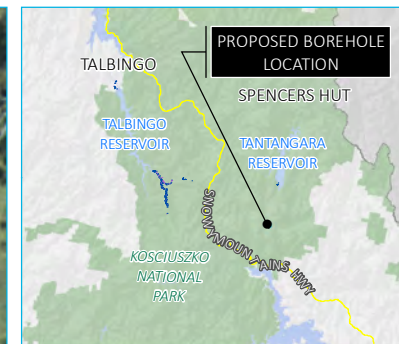
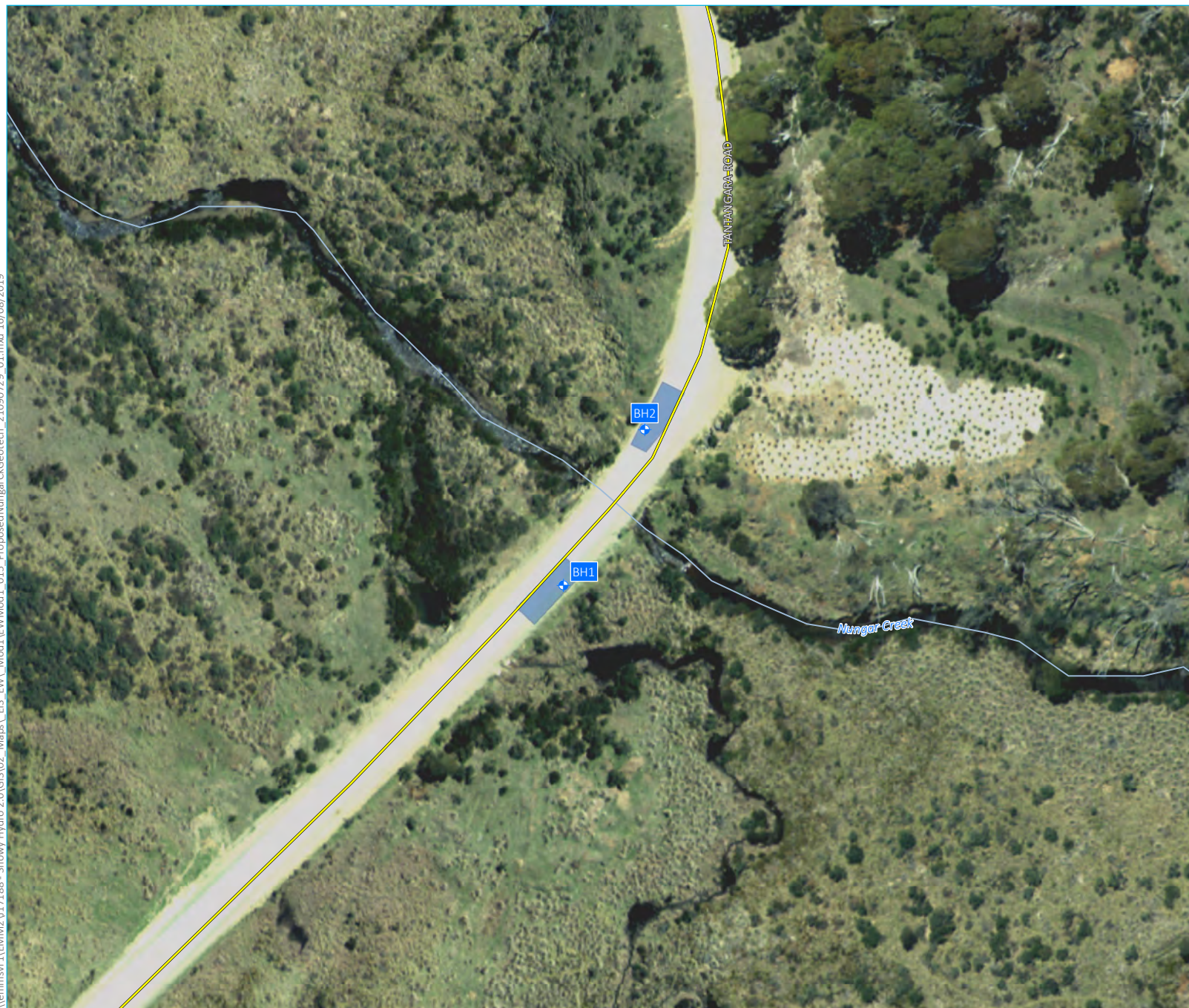
3.5.1 Mobilisation to site

The geotechnical drilling locations will be accessed by the existing Tantangara Road from the Snowy Mountains Highway south of Tantangara Reservoir. The process for mobilising equipment to site will be as follows:

- drill rigs, light vehicles and other support equipment / plant will be driven to the works location on the existing road network; and
- vehicle hygiene checks will be undertaken for all new plant, machinery and vehicles prior to accessing site for the first time.

Tantangara Road is unsealed and is considered suitable for mobilisation of plant and equipment required for geotechnical investigation works access.

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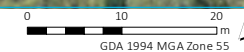
KEY

- Proposed borehole
- Proposed work area
- Main road
- Watercourse / drainage line

Proposed Nungar Creek geotechnical drilling

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 3.7

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); DFSI (2017); GA (2015); LPMA (2011)



3.5.2 Ancillary activities

Ancillary activities associated with the Nungar Creek drilling activities will be consistent with the other geotechnical drilling detailed in the Modification 1 assessment report, which includes the daily mobilisation of site crew (drillers, geotechnical engineer etc) as well as delivery of materials as may be required. Removal of drill core logs (contained in light steel core trays), intermediate bulk containers (IBCs) and other equipment may also be undertaken as required on a daily basis. Deliveries and crew mobilisation will be serviced from works and equipment storage area and adjoined equipment storage area that will be established within the roadway in a linear arrangement as shown in Figure 3.7.

Water supply infrastructure including pumps, tanks and overland piping may also be established within work and equipment storage areas.

All ancillary activities will be undertaken within existing roadway areas and no vegetation clearance or ground disturbance will be required. Materials that are to be delivered, stored and used during the geotechnical investigation will be consistent with the Modification 1 assessment report.

3.5.3 Demobilisation and road reinstatement

Following successful completion of borehole drilling and in situ testing and sampling, the following borehole decommissioning activities will occur:

- decommissioning of all equipment and environmental controls from the boreholes and works and equipment storage area;
- grouting of boreholes and reinstatement of road surface; and
- visual inspection by work crew to ensure that no materials associated with the drilling activities have been left at the drill pads.

The borehole will be decommissioned and grouted at the completion of works and will not be required for ongoing monitoring purposes.

Road reinstatement will extend to where ground disturbance for the borehole was undertaken. Reinstatement of the borehole location within the unsealed, dirt roadway will be undertaken at the commencement of works based on the principle that road safety is maintained and not worsened.

In the event of heavy snowfall whereby the works and equipment storage area may encroach approximately 1 m into the grass adjacent to the roadway without ground disturbance occurring, implementation of strict vehicle hygiene protocol will be followed. This includes washing down of equipment and vehicle wash bays before exiting KNP and cleaning of boots prior to exiting the sites. The weed control measures to be implemented during the activities are based on a significant increase in listed weeds in the KNP Plan of Management (POM).

Following completion of all site activities, a visual inspection of the site by Snowy Hydro and NPWS personnel will be undertaken to ensure that the location of the drilling activities has been reinstated to an acceptable, pre-existing road quality.

3.5.4 Proposed plant, equipment and materials

The plant and equipment for drilling pad construction, site establishment and drilling activities will include the following:

- track mounted drill rig;

- light and medium 4x4 vehicles; and
- rigid truck for transport of equipment and materials

Support vehicles, including light and medium 4x4 vehicles, will be parked in-line with the work and equipment storage area.

As the project involves geotechnical drilling and investigations, materials required for the work will be re-used from site to site, including casing, rods and environmental controls.

Other materials such as cement used for grouting will be brought to site as required or temporarily stored on the site prior to use.

Other materials are expected to include environmental controls such as silt fencing, stakes and geo-fabric products used to mitigate sedimentation and water quality impacts. Flagging, bunting or similar to mark out Nungar Creek as a no go zone.

3.5.5 Drilling resources, timing and hours of operation

It is estimated that geotechnical drilling of both boreholes, mobilisation and demobilisation will take approximately 1–2 weeks subject to weather, commencing as early as Spring 2019 subject to approval. Drilling is proposed to be undertaken during daytime hours only. Approximately four site staff will be involved in drilling activities.

During the drilling activities near Nungar Creek, public access would be restricted at this location.

3.5.6 Impact assessment

i Water

The impacts to water from the proposed drilling are expected to be similar to those anticipate for the other geotechnical drilling works proposed under Modification 1. This section provides assessment and management measures for potential water impacts.

a Establishment of drill pad

As the drill pads can be established within the existing roadway and no ground disturbance or imported pad material is required, drill pad establishment is expected to have negligible erosion and sedimentation and water quality impacts. Any minor impacts would be temporary, lasting only for the duration of the pad establishment and drilling activities. The proposed works will not affect local flood regimes.

Erosion and sediment control measures will be applied to minimise the risk of impacts to Nungar Creek. The following erosion and sediment control principles would be applied.

- minimise ground disturbance as much as possible;
- establish ground cover where possible;
- erosion and sediment controls to be established around the entire work area to reduce sediment loading of site runoff;
- all chemicals and water recirculation tanks to be bunded to 110% capacity of the largest container;
- no ground disturbance works within vegetated areas; and

- no access is permitted to the waterway or the banks of the waterway.

b Drilling of boreholes

The drilling of vertical boreholes involves the operation of heavy machinery, and the production of some solid and liquid waste, both of which have some potential to impact surface water and groundwater on site if no mitigation measures are in place.

The source of water to be used for drilling at all locations is currently under investigation and yet to be confirmed, but will most likely be potable water sourced from a water cart.

Fuel will be brought daily to site as required, presenting a moderate risk to soils, surface water and shallow groundwater contamination if stored incorrectly.

Operation of heavy machinery on site in wet conditions may cause soil disturbance and rutting.

Most waste generated by the proposed activities will be liquid slurry used in drilling, as well as any water encountered whilst drilling. This waste will be stored on site temporarily, before being taken off-site for disposal. Should additional storage be required before waste can be taken off-site, waste will be stored at existing designated laydown areas. Storage of liquid waste on site presents a moderate risk to surface water should spills occur. There will be minimal solid waste generated by the planned activities, as recovered rock cores will be subject to geotechnical assessment.

Domestic waste will be taken off site each day. Amenities will be at existing designated laydown areas elsewhere and therefore do not pose additional impact risks.

Slurry used in geotechnical drilling may enter the groundwater system during drilling, however this material is biodegradable and does not pose a risk of contamination to the groundwater system.

ii Heritage

The potential for ground disturbance associated with the geotechnical drilling to impact Aboriginal and historic heritage items was assessed and is provided in this section.

a Existing environment

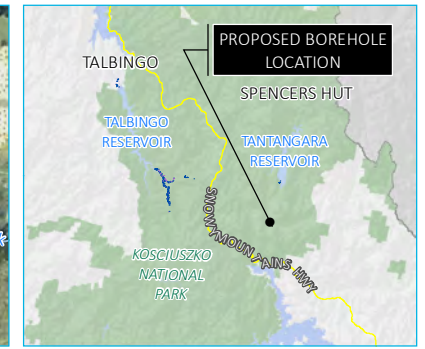
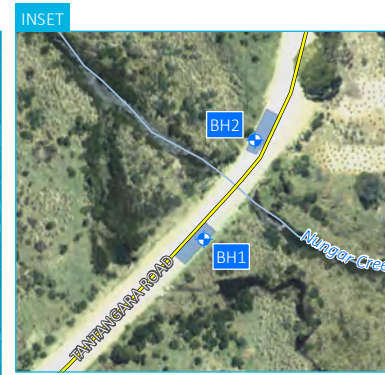
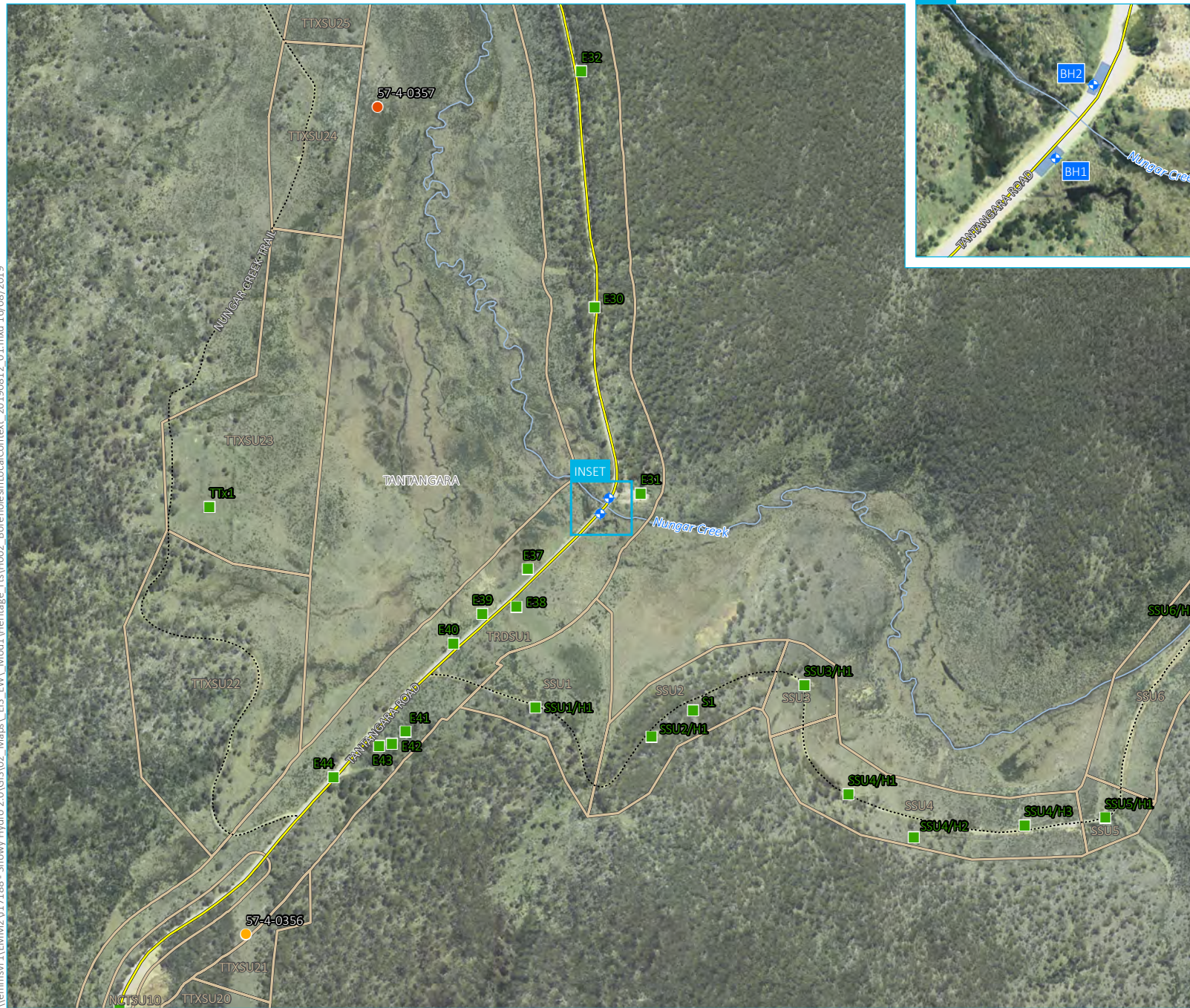
The proposed boreholes are within a crest/simple slope landform and follows an existing vehicle track. The project area was surveyed by NSW Archaeology during the preparation of this report. The survey unit TRdSU1 followed Tantangara Road and the gradient was noted as very gentle to moderate. A total of eight Aboriginal sites were identified within the survey unit which is approximately 14 km long. The sites identified were two isolated artefacts, and four potential artefact deposits (PAD). Historical sites were identified along the transect, in total 38 were noted. The vegetation along the survey unit is woodland and occasionally grassy, above a sedimentary shale demonstrated in cobbles, gravel and shale.

b Register searches

NSW Archaeology completed a search of the Aboriginal Heritage Information System (AHIMS) database on 5 April 2019 which covers the entire Snowy 2.0 Main Works project area, and includes the sites recorded as part of the Exploratory Works and Main Works ACHARs (NSW Archaeology 2018, 2019 in draft).

No AHIMS sites are registered within the disturbance footprint of the proposed boreholes. The closest site is approximately 600 m north-west from the proposed boreholes. The site is AHIMS site number 57-4-0357 and is identified as a PAD, Figure 3.8 demonstrates the AHIMS sites in relation to the proposed boreholes and the survey unit TRdSU1.

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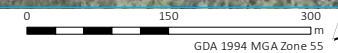


- KEY**
- Main road
 - Vehicular track
 - Watercourse / drainage line
 - ▭ Heritage survey unit
 - ▭ Proposed work area
 - ⊕ Proposed borehole
 - Historic heritage site (NSW Archaeology)
- AHIMS**
- Isolated find
 - PAD

Aboriginal and historic heritage context – Nungar Creek boreholes

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 3.8

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); DFSI (2017); GA (2015); LPMA (2011)



A search was conducted for historical sites in the area. There are no sites within the vicinity of the proposed boreholes. The closest sites identified are part of the NSW Archaeology survey effort, approximately 40 m north east of the proposed boreholes. This site is identified as a former Snowy Mountain Authority laydown area, no constraints have been placed on the site. Table 3.1 provides the search results for historical sites related to the proposed borehole locations.

Table 3.1 **Historical register search for the project area**

Register	Register listing
National Heritage List (NHL)	'Australian Alps National Parks and Reserves' and the 'Snowy Mountains Scheme'
Commonwealth Heritage List (CHL)	Nil
State Heritage Register (SHR)	Nil
Section 170 Registers	Nil
Kosciuszko Huts Association (KHA)	Nil
Tumut Local Environmental Plan 2012 (Schedule 5)*	Nil
Tumbarumba Local Environmental Plan 2010 (Schedule 5)*	Nil

** Snowy Valleys Council Local Government Area (LGA) is still operating with the former Tumbarumba Shire Council and Tumut Shire Council Local Environmental Plans (LEPs) and Development Control Plans (DCPs).*

c Impact assessment

No AHIMS registered sites will be impacted by the proposed activity. The closest registered Aboriginal site is a PAD (AHIMS site number 57-4-0357) and is approximately 600 m north-west from proposed borehole locations. The survey unit covering the proposed borehole locations (TRdSU1) was noted to be of 'low archaeological sensitivity' (NSW Archaeology, 2019 in draft). The survey unit does not contain any landscape features on undisturbed land that are likely to indicate the presence of Aboriginal objects. Additionally, the proposed activity will be within an existing graded vehicle track that has been subject to high disturbance.

It is therefore assessed that there will be no impact on known or previously recorded Aboriginal sites and impacts to unknown Aboriginal objects are unlikely as a result of the proposed activity.

There are no heritage items within the project area listed on the World Heritage List, Commonwealth Heritage List, State Heritage Register, or local government heritage schedules. The 'Australian Alps National Parks and Reserves' and the 'Snowy Mountains Scheme' are two listed places on the National Heritage List. No impacts to national heritage values will occur as a result of the proposed activity due to their minor nature.

d Conclusions and recommendations

No further investigation or assessment is required for the proposed works. Notwithstanding, unexpected finds protocols still apply for the proposed activity.

iii Biodiversity

No vegetation clearing is required as the works and equipment storage area will be entirely within the existing roadway. As such, no access track construction will be required. In the event that heavy snow is present on the road during mobilisation and the snow has not been cleared, the works and equipment storage area may encroach off the roadway up to approximately 1 m in order to maintain adequate access width for passing traffic. This contingency will allow the road to remain open, reducing the impacts on road users. The need for this contingency is considered to be unlikely as the works are planned as early as Spring 2019 subject to approval.

The adjacent vegetation is Plant Community Type (PCT) 1225 Sub-alpine grasslands of valley floors, South Eastern Highlands Bioregion and Australian Alps Bioregion. In the event of heavy snow presence, the equipment storage area will be established to avoid shrubby vegetation and only encroach on grass. No ground disturbance would be required for pad construction in the event of heavy snow presence.

iv Noise and vibration

The potential noise and vibration impacts on Wares Yards campground were assessed in response to submissions raised during the exhibition period. The procedures of the Interim Construction Noise Guideline (ICNG) confirm a noise management level (NML) for passive recreation of $L_{Aeq,15min}$ 60dB(A). A review of the closest track clearing and bore hole location (BH1) confirms a distance separation of approximately 1,500 m to Wares Yards campground.

Source noise levels for geotechnical drilling considered in the noise prediction are presented in Table 3.1.

Table 3.1 Geotechnical drilling – Nungar Creek

Equipment	No.	Lw (each)	Total (Lw)
Tracked drill rig	1	116	116
Truck	1	103	103
Diesel pump(s)	2	96	99
Cumulative Lw			116

Considering all plant operating simultaneously, distance separation and no ground absorption or acoustic shielding from intervening topography confirmed predicted noise level of 45dB(A). The noise prediction confirms compliance with the ICNG noise management level for passive recreation of 60dB(A).

v Traffic and transport

The route for mobilisation and work area access by road vehicles is provided via Tantangara Road from the Snowy Mountains Highway south of Tantangara Reservoir.

Tantangara Road is unsealed and is in good / reasonable condition and considered suitable for mobilisation of plant and equipment required for geotechnical investigation works access. The road can experience occasional heavy snowfall and is not routinely cleared. The area and road alignment is generally flat to undulating with a good gravel road base and well-maintained drainage along the length of the road.

Each works and equipment storage area will be established to leave approximately 3.5 m width of the road for traffic to pass while the works are being undertaken. No road closure will be required. Appropriate slow or stop-go traffic arrangements will be established for the works.

Each works and equipment storage area will be approximately 3.5 m wide and 20 m length, parallel with the road's edge as shown in Figure 3.7.

3.5.7 Conclusion

Drilling will occur either side of Nungar Creek to determine the detailed design and feasibility of a bridge in the area for Snowy 2.0, should it proceed. This will only require shallow geotechnical drilling, approximately 10 m deep. Borehole drilling will occur in existing disturbed areas and no vegetation removal will be required. Environmental impact from the additional geotechnical drilling is likely to be minimal.

3.6 Lobs Hole construction substation

The Lobs Hole construction substation is a key element of Modification 1 that will provide the primary power supply for the Exploratory Works construction phase once it is established and commissioned. Diesel generator sets will be temporarily used for Exploratory Works as both primary and back-up power supply prior to the Lobs Hole substation being established. Once built the substation will take over as the primary supply and diesel generators will be used as back-up.

The Modification 1 assessment report proposed to establish a construction power connection to the existing transmission line (Line 2) at Lobs Hole for power supply to the Exploratory Works accommodation camp, construction and exploratory tunnel areas. This will include:

- Construction of a substation adjacent to Line 2, which forms a 330kV connection between Upper Tumut Switching Station and Yass Substation. This facility will 'step down' the incoming 330kV transmission line to 33 kV sub-transmission for use by the construction site.
- Geotechnical investigation and other survey works to inform the detailed design of the substation.
- Replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height.
- Short overhead 330 kV transmission line connection between the substation and the new Structure 54.
- An outgoing 33 kV feeder connection between the construction substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables.
- Establishment and upgrade of access track and road to the new substation and transmission line structure.
- Installation of a fibre optic communication link into the new substation from the approved communication network.
- Ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas.

The Lobs Hole substation is the preferred option of primary power for the Exploratory Works as it will provide a more reliable and secure source for the duration of Exploratory Works. It will also reduce the management, maintenance and environmental impacts associated with additional diesel generator use. The change to the preferred option for Exploratory Works construction power was made in response to the review of the construction power requirements for Exploratory Works and Safe Work Australia guidelines. This section provides additional information regarding the need and justification for the Lobs Hole construction substation.

3.6.1 Need for Lobs Hole construction substation

The detailed design for Exploratory Works identified a preferred option for the construction power supply involving a connection to the existing 330kV transmission line in Lobs Hole. This preferred option was identified following the construction contractor's review of the construction power requirements for Exploratory Works.

Safe Work Australia *Guide for tunnelling work* (2013) specifies installation of 'back-up power supplies in case of power loss to critical systems like ventilation, pumping, emergency lighting and fire fighting systems'. To ensure the safety of Snowy 2.0 personnel working in the exploratory tunnel, primary and back-up power supply will be used during tunnel construction. The Lobs Hole substation is the preferred option as primary power to best achieve safety of tunnel workers. Initially, diesel generators will be used as both primary and secondary (or 'back-up') power supply, then, once the substation is constructed it will act as the primary supply and diesel generators will be used as the back-up supply.

Construction of the substation will provide a more reliable source of power for the project's essential services. In addition, SHL are negotiating with the network service provider that a portion of the power supplied through the Lobs Hole substation be designated as uninterruptible. The supply of power to loads critical to safety (i.e ventilation, lights, pumps) will be supplied from at least two switch bays (n-1 redundancy) to further ensure the safety of tunnel works.

In addition to the source of power supply, the quantity power has also been increased as the contractor's review of power requirements was found to be substantially higher than what was estimated in the Exploratory Works EIS.

The approved Exploratory Works included approximately 45 kVA capacity provided by diesel generators at the portal construction pad. Through the detailed design process and input from the construction contractor it was determined that up to 8 MW capacity would be required for the Exploratory Works power supply. This increase in required capacity is due to additional construction power demand identified for drill and blast tunnelling activities as well as the operation and management of construction areas and the accommodation camp.

Based on the requirement for increased capacity throughout Exploratory Works options were reviewed for the additional capacity to be provided by both diesel generators and a connection to the existing transmission line at Lobs Hole. Connection of the site to nearby existing 33 kV or 66 kV sub-transmission lines was not considered a feasible option as these are over 15 km away from the worksite and would require significant impact to be connected.

The use of diesel generators alone to provide the additional power supply capacity was considered problematic for the following reasons:

- Supply of diesel to the construction areas is susceptible to adverse conditions where transport site access may occasionally be rendered unsuitable during the winter months.
- Diesel generators are less reliable than power supplied by the grid and require high levels of maintenance.
- The storage of significant volumes of diesel on site would have increased safety, environmental and bushfire risks to construction personnel and equipment.
- The diesel generator option would require combustion of approximately 19 ML of diesel per year and long-term use would lead to increases in particulate and greenhouse gas emissions.
- The large volume of diesel to be delivered to site to meet the revised power demands would require approximately 1,000 total additional heavy vehicle movements.

The establishment of the Lobs Hole construction substation was determined to be the preferred option to meet the requirements for Exploratory Works construction power for the following reasons:

- The construction substation would provide a reliable and long-term power supply for the duration of Exploratory Works that best meets Safe Work Australia's guidelines for primary and back-up power supply for tunnelling.
- The construction substation will be safer to operate and easier to maintain than diesel generators.
- The substation is easily scalable for future use if required. The Lobs Hole substation could provide up to 80 MW of capacity with a similar footprint to what would be required for 8 MW of diesel generators (including fuel storage). This will reduce the need for future upgrades and the potential for duplicated construction works and impacts within the KNP should the Snowy 2.0 Main Works proceed.
- The substation will provide the required construction power capacity without significantly adding to diesel combustion and the project emissions.
- The substation would minimise the volume of diesel requiring transport and storage on-site.
- Should Snowy 2.0 not proceed, the majority of Lobs Hole would be decommissioned and rehabilitated with the substation site included within this phase of work.

The design of the Lobs Hole substation has aimed to minimise and avoid impacts to the surrounding environment. Importantly it has been sited away from ecological sensitivities and the footprint has been greatly reduced through the use of gas-insulated switchgear.

The Lobs Hole substation is the preferred option as the primary construction power supply for the Exploratory Works, with diesel generators to be used in the interim and eventually as the secondary back-up power supply. This combination will provide the most reliable source of power to meet Safe Work Australia guidelines, reduce management and maintenance costs, minimise environmental impacts, and better align the Exploratory Works with potential future upgrades as part of Main Works.

3.6.2 Decommissioning and rehabilitation

The approved diesel generation units would be retained as a secondary power supply in the event of service interruption for the proposed electric substation. Diesel storage tanks will be retained at the portal construction pad as per the approved Exploratory Works.

The proposed power generation infrastructure is subject to the same rehabilitation strategy as all other Exploratory Works infrastructure. The decommissioning of the Lobs Hole substation would follow an approach similar to infrastructure at the portal construction pad including:

- removal of all construction infrastructure;
- re-shaping of batters by site-sourced fill material, with batters at 3H:1V with berms (4 m minimum), between each batter and to reshape to near pre-construction landform;
- rehabilitation of fill and cleared areas through addition of organic matter and revegetation;
- planted swales and sediment basins at the base of slope to assist in ongoing water quality treatment; and
- fencing and tree guards of revegetation areas to protect from grazing fauna.

Should the Snowy 2.0 Main Works not proceed the Lobs Hole substation would be decommissioned and rehabilitated in accordance with the Exploratory Works Rehabilitation Plan and in consultation with NPWS.

Kosciuszko
National Park



Lobs Hole Ravine Road

Wallaces Creek Lookout
2.1km - suitable for 2WD



15km - 4WD recommended, narrow,
winding and rough road

Ravine



No chainsaws



No pets



No firearms



Caution
mine shafts

CHAPTER

4

RESPONSE TO AGENCY AND COUNCIL SUBMISSIONS

4 Response to government submissions

4.1 Overview of government submissions

Responses to the issues raised by the six government agency submissions received during the public exhibition period for the Modification 1 assessment report are provided in the following subsections. Comments from the government agencies are presented verbatim within text boxes, with each respective comment followed directly with a response.

4.2 Department of Premier and Cabinet – Heritage Division

4.2.1 Historic and Natural Heritage Management Plan

The modification proposal does not represent a significant increase in impact to historic heritage or archaeology. The proposed management methods in the assessment are appropriate for the impacts predicted, including archival recording, test and salvage excavation.

Recommendation:

That this modification includes all previous conditions of approval for historic heritage and requires a condition to amend the Historic and National Heritage Management Plan (HNHMP) required by Condition 20 of the approval. This HNHMP should be amended to address the changes of this application as follows:

I. The HNHMP must be updated to include all changes to identified historic heritage and archaeological items affected by modification 1. This includes updating the NHMP to reflect the changes to management requirements proposed from this modification stated in Condition 20.

Snowy Hydro is committed to updating the HNHMP accordingly to reflect Modification 1 changes.

4.3 Transport for NSW – Maritime Division

4.3.1 Waterway Traffic Management Plan

The NSW Maritime Division of RMS will and can advise relevant parties (e.g. contractors engaged to complete the works) on the formulation of a Waterway Traffic Management plan, which may include enacting an 'Exclusion Zone' (which NSW Maritime has the statutory delegation to declare) to ensure the safety of vessel traffic and to establish safe working zone/s.

Snowy Hydro acknowledges the Maritime Division's offer to assist with the preparation of the Waterway Traffic Management Plan. Snowy Hydro will liaise with the Division as relevant to seek advice on the plan preparation and the need for any exclusion or safe working zones.

4.3.2 Marine safety

Any vessel or structure occupying waters must display appropriate shapes and lights in accordance with the *Marine Safety (Domestic Commercial Vessel) National Law Act 2012*. Of particular note is the requirement to display an all-round white whilst at anchor light between the hours of sunset and sunrise.

Snowy Hydro notes this requirement and will comply with the requirements of the *Marine Safety (Domestic Commercial Vessel) National Law Act 2012*.

4.4 Transport for NSW - Roads Division

4.4.1 Access via Coppermine Trail

Access via Coppermine Trail: No details have been provided in the submitted information on the number of vehicles that will be using the access to/from the Snowy Mountains Highway to the 8 newly proposed boreholes that will be accessed via Coppermine Trail. The following details are therefore requested:

- Total maximum daily vehicle movements at this access;
- AM and PM peak hour traffic movements at this access;
- Types of vehicles to utilise the access (e.g. the largest vehicle, movements of class 1 and class 2 heavy vehicles, vehicles exceeding 4.5gvm); and
- Timeframe for use of this access including details on whether this access point will be used only for the duration of the exploratory works or whether it will be used for both the exploratory works and construction of the Snowy 2.0 project.

The Modification 1 application proposes access to geotechnical drilling sites at Marica using the Coppermine Trail from the Snowy Mountains Highway for the duration of Exploratory Works only. The expected traffic volumes for geotechnical drilling works that would use the Coppermine Trail are provided in Table 4.1 below.

Table 4.1 Coppermine Trail daily traffic volumes

Timing	Vehicle types			
	Class 1 vehicle movements (in & out)	Class 2 vehicle movements (in & out)	Class 3 vehicle movements (in & out)	Light vehicles movements (in & out)
Mobilisation				
Sept/Oct 2019 (2 week period)	2 per day	30 per day	10-12 per day	20 per day
Operation				
Oct 2019 – Jan 2020	-	22 per day	-	34 per day
Demobilisation				
Jan/ Feb 2020 (2 week period)	2 per day	10 per day	10-12 per day	20 per day

Peak traffic movements would occur during the mobilisation period and could involve up to 20 light vehicles (LV) and 44 heavy vehicles (HV) in the AM and PM peak hours. The peak construction traffic would only occur for up to two weeks during mobilisation and demobilisation. For the majority of the geotechnical drilling at Marica the AM and PM peak hour traffic would be up to 34 LV and 22 HV.

Access Suitability: No assessment of the adequacy of the existing access to/from Coppermine Trail onto the Snowy Mountains Highway in terms of sight distance, the type of intersection treatment, construction standard, swept paths, etc has been provided. An assessment of the suitability of this access is required. This assessment should detail compliance with the applicable requirements in the Austroads Guide to Road Design and its associated supplements/technical directions. If unable to currently achieve compliance details should be provided on the mitigation measures to be undertaken. Any mitigation measures required/proposed must be contained within the existing legal road reserve boundaries.

The existing intersection visibility (sight distance) is adequate for an 80 km/hr travel speed for the through traffic using the Snowy Mountains Highway in conjunction with the proposed construction access traffic using Coppermine Trail. No additional widening is required for the Snowy Mountains Highway to accommodate the proposed temporary construction traffic access use of the intersection.

Under normal weekday or weekend traffic conditions, the peak hourly through traffic volumes at any time on this section of the Snowy Mountains Highway for either one way or two way traffic, are mostly below 50 vehicles per hour and always below 100 vehicles per hour. This is well below the minimum through traffic level under any of the Austroads Warrant standards for additional turning lanes, so no additional intersection turning lanes are required for the proposed project construction access at this location.

The intersection has been previously utilised by traffic associated with the Snowy 2.0 geotechnical investigation program. The previously approved construction traffic management plan and traffic control plan prepared for this intersection, including the road occupancy license, will be revised and re-submitted to TfNSW (Roads) for approval to accommodate the latest proposed Modification 1 temporary construction access requirements.

4.5 Environment Protection Authority – South East Region

4.5.1 Regulatory authority

The EPA notes that the substation proposed in Lobs Hole will be designed, constructed, owned, operated and maintained by TransGrid. As TransGrid is a public authority, the EPA will be the appropriate regulatory authority as per s.6 of the *Protection of the Environment Operations Act 1997*.

Snowy Hydro acknowledges that the EPA will be the relevant regulatory body in this instance.

4.5.2 Environment Protection Licence

Relating to the proposed Modification 1, the EPA does not intend to alter the current environment protection licence issued to Snowy Hydro Limited for Snowy 2.0 Exploratory Works.

This has been noted by Snowy Hydro.

4.6 Department of Planning, Industry and Environment – Lands and Water Division

4.6.1 Erosion and sedimentation

The proposed surface disturbance activities as part of the modification has the potential to result in erosion and sedimentation, and altered runoff patterns. This could impact downstream watercourses and associated aquatic habitat. This has been identified in the environmental assessment and the proposed mitigating measure concepts are adequate.

Recommendation:

- Disturbance adjacent to the Yarrangobilly River and Wallaces Creek is to be minimised, and rehabilitation measures are implemented to ensure bed and bank stability and the reinstatement of riparian vegetation.
- The proposal to develop an Erosion and Sediment Control Plan and a Rehabilitation Plan to manage potential impacts is supported. It is recommended these plans address the requirements of the *Guidelines for Controlled Activities on Waterfront Land* (NRAR 2018) and the guideline, *Soils and Construction: Managing Urban Stormwater* (Landcom 2004).

Snowy Hydro acknowledges the recommendations and submits that the proposed controls identified in the modification report are considered adequate.

4.6.2 Groundwater

The proposed conversion of boreholes for additional groundwater monitoring is supported. Construction to industry standards and consultation with DPIE Water will be required to ensure the bores are designed appropriately for ongoing monitoring and mitigation of impacts to water sources.

Recommendation:

The proposed groundwater monitoring bores be included in an updated Water Management Plan. It is recommended consultation occur with DPIE Water prior to commencement of drilling to ensure adequate construction design.

Snowy Hydro commits to keeping a register of all new groundwater bores associated with Modification 1.

4.6.3 Water licencing

The proposed sourcing of water from the existing construction water supply will need to ensure the proposed volume is within current licensed entitlements. Where additional water is required, sufficient entitlement will need to be held and additional impact assessment may be required to support this.

Snowy Hydro acknowledges that any additional water take required for the Modification 1 works will be licenced accordingly.

4.6.4 Crown Lands

The proponent should make an application to close and purchase the Crown Road that is located within the proposal area.

Mile Franklin Drive, that is a formed road within the proposal area, should be transferred to Council.

Snowy Hydro would liaise with Councils and DPIE (Crown Lands) to determine the long-term tenure of Crown Lands within the project area during delivery.

4.7 Department of Planning, Industry and Environment – Biodiversity and Conservation Division

4.7.1 Geotechnical investigations

- The description of works (Volume 1 - 3.2.3) identifies that access tracks 1km long and only 4m wide will be required to access all drill pads. It is unlikely that this width will be suitable along those sections of tracks with very steep side slopes such as the access tracks to BH7201 & 7212.
- The description of plant and equipment (Volume 1 – 3.2.11) introduces the use of helicopters for remote drilling operations. The modification identifies that all drilling will be accessed by vehicle.

Recommended action:

- Clarification is provided on the road width along all sections of the tracks to establish access to BH7201 & 7212, and the level of impact is quantified for any sections greater than 4m wide.
- Clarification is provided on how remote drilling operations will be accessed and the use of helicopters. The impact of any changes that lead to increased clearing is to be quantified.

Snowy Hydro notes that access tracks to BH7201 and BH7212 are 12 m wide and are expected to accommodate steep slopes in these areas. The access tracks required to these boreholes were shown in the Modification 1 assessment report figures and assessed in the Modification 1 impact assessment.

Helicopters would not be landing at the site. Materials would be lowered to the drilling sites from the helicopter. No additional vegetation clearing would be required to facilitate the use of helicopter transport.

4.7.2 Groundwater

- The detail identified in Figure 3.6 does not clearly indicate the distinction between vehicle and pedestrian access to sites. Some access identified on the map is not currently used or has been closed and rehabilitated.
- Section 3.2.9 identifies that, “Snowy Hydro proposes to retain the option of installing monitoring equipment in any of the boreholes for ongoing groundwater monitoring purposes. This may occur sometime in the future following the decommissioning activities.”

Recommended action/conditions of approval:

- Clarification on the detail in Figure 3.6 is provided with clear documentation of the requirements for use and maintenance of access tracks in KNP. The impact of any clearing of vegetation along rehabilitated tracks is to be quantified.
- A set time frame for all activities and continuing access to the works is to be provided.
- All rehabilitation is to be incorporated into the Exploratory Work Rehabilitation Plan (yet to be developed) as per Condition of Approval 58.

Snowy Hydro notes that vehicle access to monitoring locations will be carried out using existing and proposed access tracks only. No additional vegetation clearing is required for ongoing monitoring activities other than the access tracks and drill pads proposed under Modification 1. Where rehabilitated tracks are used, access will be on foot only and no clearing of vegetation along rehabilitated tracks will occur. Monitoring access will continue for the duration of Exploratory Works. All rehabilitation of monitoring sites and access tracks will be incorporated into the Exploratory Works Rehabilitation Plan. A summary of site access modes for ongoing monitoring is provided in Figure 4.1.

4.7.3 Construction

- The description of works (Volume 1 page 3) identifies that 33kv feeder connection between the substation and the exploratory works construction power network will be either be via overhead line or underground cable.
- The visual assessment (Volume 1 Section 6.5.5) states that visual impact assessment for the substation will not be done until the Main Works application.

Recommended actions/conditions of approval:

- All feeder power to construction facilities are to be provided via underground cables.
- A visual impacts assessment is to be completed and assessed for the substation as part of this application.
- The current NPWS and TransGrid agreement, “Procedures for the undertaking of Inspection, Maintenance and Emergency Works on TransGrid Network Assets and Associated Infrastructure 2014” is to be referenced for all operational requirements of TransGrid facilities in KNP.

Feeder power connections

Snowy Hydro acknowledges the preference for underground cables for feeder connections to construction areas. Where practical underground cables will be utilised, however, this is unlikely to be the case in all instances. For constructability reasons the feeder cables for Exploratory Works construction power supply will be established using a mix of underground and overhead power lines. The feeder cables to construction areas will be temporary only and, should the Snowy 2.0 Main Works not proceed, will be removed following the completion of Exploratory Works. As the feeder cables will only remain in place through the construction of the project they are not expected to have any long-term impacts on the amenity values of KNP.

Substation visual impacts

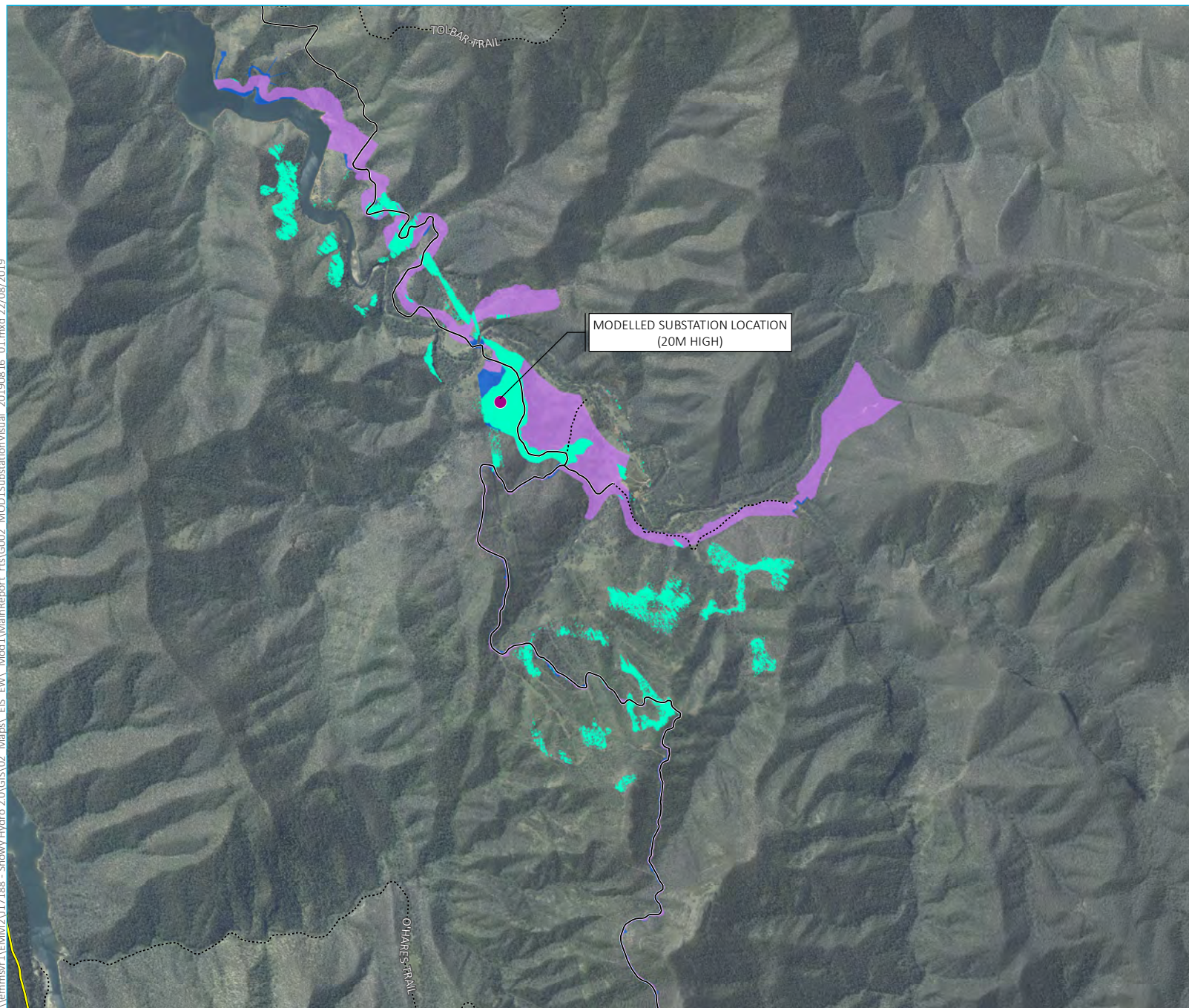
Section 6.5.5 of the Modification 1 Assessment Report states that long term visual impacts of the Lobs Hole substation would be considered in the Main Works application if any infrastructure is proposed to be used for Snowy 2.0 Main Works and maintained permanently within the KNP. The Modification 1 application is for the temporary establishment and use of the Lobs Hole substation throughout the Exploratory Works construction period only. Should the Snowy 2.0 Main Works not proceed, the Lobs Hole substation would be decommissioned and rehabilitated in accordance with the Exploratory Works Rehabilitation Management Plan.

Further visual impact assessment of the Lobs Hole substation during the Exploratory Works construction period is provided in this section.

A viewshed analysis for the proposed Lobs Hole substation has been completed and is provided in Figure 4.2. The viewshed analysis provides predicted locations where the Lobs Hole substation infrastructure will be visible. The tallest piece of infrastructure within the Lobs Hole substation will be approximately 20 m high. This will be the most visible piece of infrastructure in the Lobs Hole construction substation.

The viewshed analysis shows that the substation would be visible from locations closed to the public for the duration of Exploratory Works. It will also be widely visible throughout Lobs Hole and the project area. The majority of visual impacts from the proposed substation would be within the project area only and would not impact any locations accessible to the public during Exploratory Works. This also shows that the Lobs Hole substation will not be visible from any significant viewpoints or recreational areas.

\\lemmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS EWI Mod1\MainReport_rts\G002 MOD1substation\Visual 20190816 01.mxd 22/08/2019



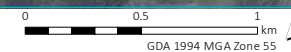
KEY

- Lobs Hole substation location (modelled at 20m above ground level)
- EW approved construction footprint
- EW modification construction footprint (additional)
- Modelled visibility
- Main road
- Local road
- Vehicular

Viewshed analysis of
Lobs Hole substation

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 4.2

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

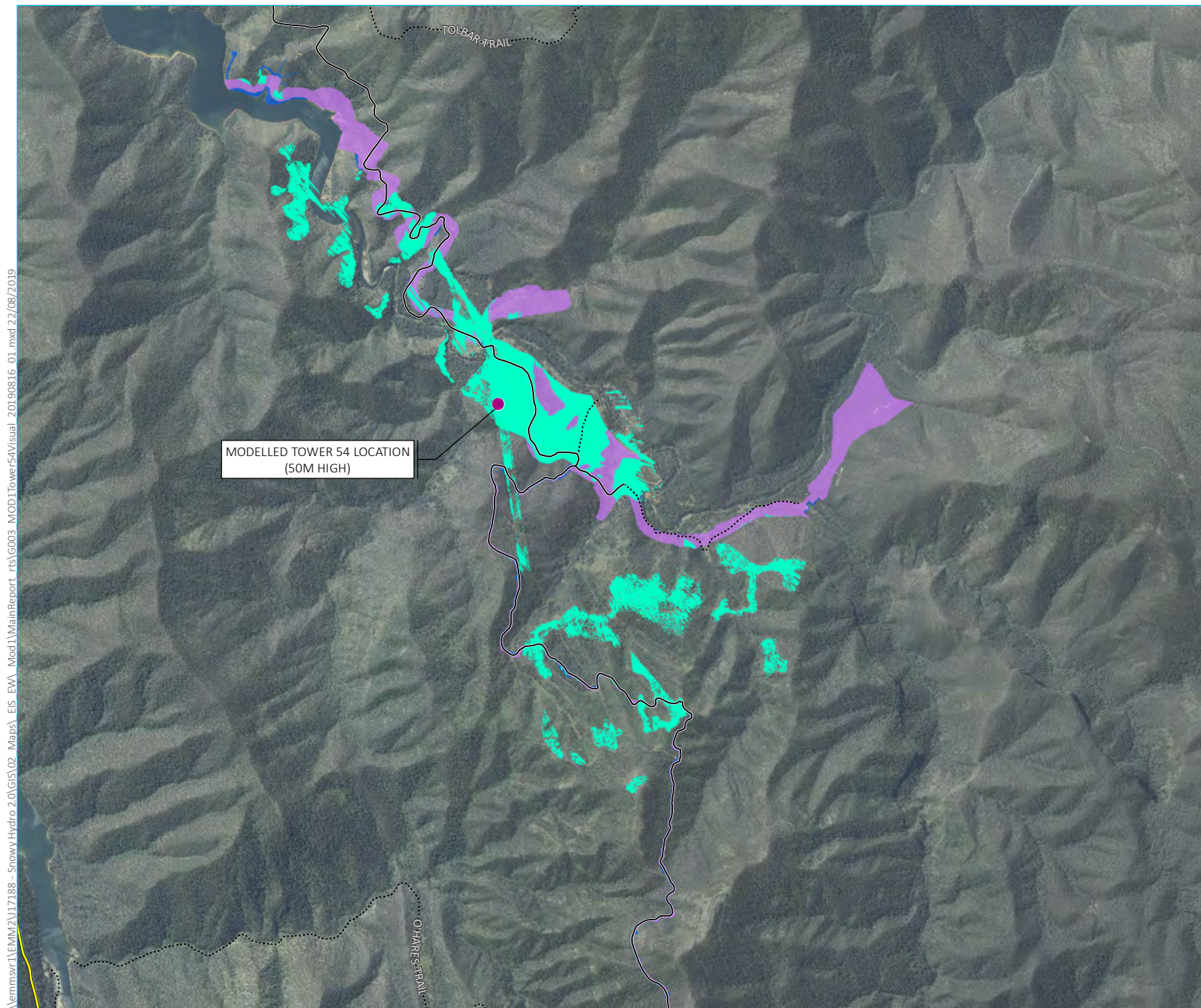


All visual impacts associated with the substation construction are expected to be temporary only. As described in the Modification 1 Assessment Report the substation would be entirely reversible, should the Snowy 2.0 Main Works not proceed, the Lobs Hole substation would be decommissioned and rehabilitated in accordance with the Exploratory Works Rehabilitation Management Plan. As the visual impacts of the proposed substation are expected to impact on no publicly accessible viewpoints during construction and limited to the construction period only the visual impacts of the substation construction will be negligible.

The Structure 54 replacement would be taller than the substation at 50 m height, however, this will be undertaken within the existing transmission line easement and would replace the existing tower structure. The proposed tower replacement would therefore be consistent with the type of existing visible infrastructure in the same location. A viewshed analysis for the transmission tower is provided in Figure 4.3. The transmission tower will be visible from locations within the Exploratory Works project area only and would not be visible from any publicly accessible viewpoints during Exploratory Works.

TransGrid works within KNP

Operational maintenance and emergency works at the Lobs Hole substation will be undertaken in accordance with the Exploratory Works CEMP and the existing NPWS and TransGrid agreement, 'Procedures for the undertaking of Inspection, Maintenance and Emergency Works on TransGrid Network Assets and Associated Infrastructure 2014'. The Lobs Hole substation is proposed for the duration of the Exploratory Works construction.



KEY

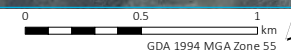
- Tower 54 (modelled at 50m above ground level)
- EW approved construction footprint
- EW modification construction footprint (additional)
- Modelled visibility
- Main road
- Local road
- Vehicular track

MODELLED TOWER 54 LOCATION
(50M HIGH)

Viewshed analysis of Tower 54

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 4.3

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



4.7.4 Project boundary

- Changes to the project boundary do not include all access tracks, laydown areas and communication sites identified in the modification.
- An assessment of impacts has been carried out for road widening at the fossil beds. However, no assessment has been made for similar widening at the streams/boulder screes.

Recommended actions/conditions of approval:

- Changes to the EIS boundary are to incorporate all areas identified in the modification.
- All works are to be incorporated and conducted as per the Exploratory Works Environmental Management Strategy and associated plans.
- All rehabilitation is to be incorporated into the Exploratory Work Rehabilitation Plan (yet to be developed) as per Condition of Approval 58.
- An independent significance, impact and geotechnical engineering assessment is to be undertaken of the proposed works at the stream/boulder screes.
- The mitigation measures identified in the RTS Volume 2 Table 3.2 relating to “no retaining wall” is a condition of approval.
- No impacts beyond those already approved are to occur to the stream/boulder screes and/or site of the Devonian strata fossil beds on Lower Lobs Hole Ravine Road.

Project boundary

The project area including both the scope of works as approved under the Exploratory Works EIS and the proposed Modification 1 scope is mapped in Appendix B.

Should Modification 1 be approved the relevant post approval requirements would be addressed prior to commencement of works.

All rehabilitation of Modification 1 works will be incorporated into the Exploratory Work Rehabilitation Plan as per Condition of Approval 58.

Geodiversity

Boulder stream

Through the response to submissions stage the approach to boulder stream works on Lobs Hole Ravine Road were reviewed and a revised construction method and design were identified. Details of the revised boulder stream works are provided in Section 3.2. A specialist report was also undertaken to determine the impact of the works on the boulder streams and is provided in Appendix D.

Ravine Fossil Beds

As described in the Modification 1 Assessment Report Section 6.5.1, a small amount of additional disturbance is proposed within the Ravine Fossil Beds for road upgrade works on Lobs Hole Ravine Road. The geodiversity assessment undertaken for Modification 1 found that the widening of Lobs Hole Ravine Road in this section will not materially affect the distribution nor abundance of fossils that will be exposed in the new road cuttings. The

proposed road widening will also result in an improvement in site conditions not only in terms of road safety and access but also in access to the fossiliferous layers.

4.7.5 Road access and transport

- Condition 46 of Schedule 3 of SSI 9208 Determination dated 7/2/19 requires preparation of a Traffic Management Plan
- The revised peak hour traffic movements in Table 6.7 indicate a significant increase in traffic movements. While Section 6.4.3 and 8.3.2, “indicates that current conditions of approval relating to traffic are adequate” and “no additional impacts will be experienced by recreational users”. The modification does not address current concerns being expressed by the proponent in relation to the current use and status of Link Road, particularly relating to public interaction and snow and ice impacts. NPWS snow clearing and ice treatment operations have limited capacity and budget to meet additional demand placed on it by this Modification

Recommended action:

- Additional mitigation measures be developed and incorporated into the Traffic Management Plan to address impacts experienced during normal and adverse weather and traffic conditions on KNP roads.

The Modification 1 works would be carried out in accordance with Condition 46 and the associated Exploratory Works Traffic Management Plan. Snowy Hydro acknowledges that existing mitigation measures will adequately manage impacts of traffic generated by the project. Modification 1 traffic assessment found there is significant capacity in the road network to accommodate additional movements.

4.7.6 Heritage

- The Aboriginal and Historic Heritage assessment as outlined in Section 6.2 and shown in Figures 6.3 – 6.6 does not include work associated with BH7201 & 7212 and associated access tracks or geophysical surveys.
- Please note a separate response is to be provided by the Heritage Division of DPC in regard to Heritage Council responsibilities.

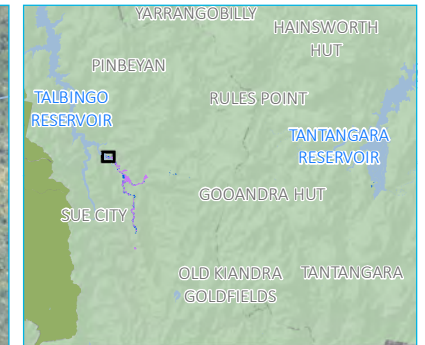
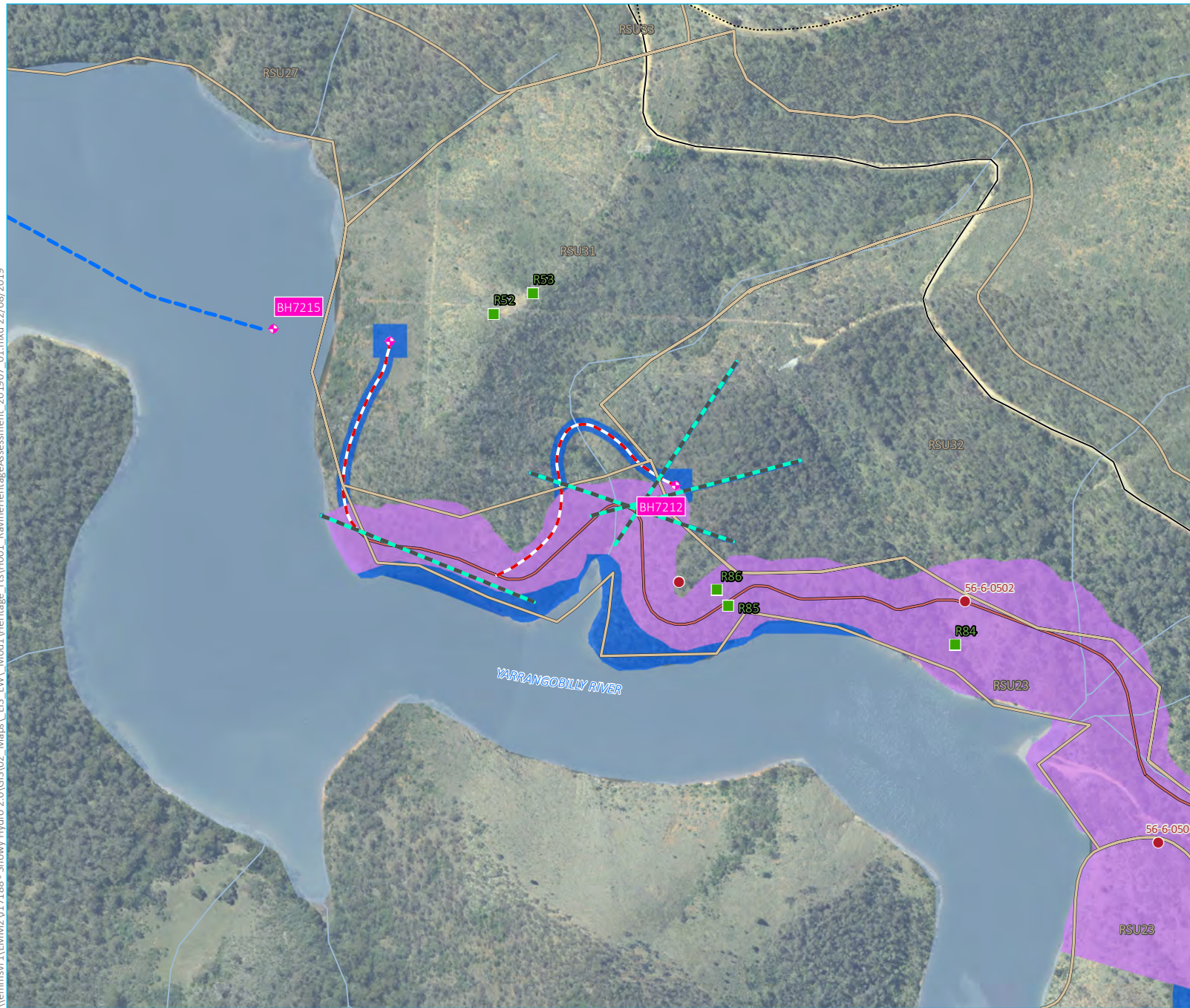
Recommended action:

- Clarification on the assessment undertaken for activity around Talbingo Reservoir associated with BH7201 & 7212 is to be provided.

Snowy Hydro notes that the Aboriginal and historical sites that are potentially affected by the proposed modification footprint are documented in Table 6.4 and shown on Figure 6.3 to Figure 6.6. The works near Talbingo was surveyed within survey units RSU23 and RSU32 but do not have the potential to affect Aboriginal or historical heritage items. As no heritage impacts will be in the vicinity of the works associated with BH7201 and BH7212, they were not included in Table 6.4 and a figure was not prepared.

Notwithstanding the above, the following information provided in Table 4.2 and Figure 4.4 demonstrates that no Aboriginal or historical heritage sites will be impacted by the proposed works relating to BH7201 and BH7212.

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- KEY**
- ◆ Proposed boreholes
 - AHIMS site
 - Historic heritage site
 - Heritage survey unit
 - EW approved construction footprint
 - EW modification construction footprint (additional)
 - Waterbody
 - Proposed geophysics
 - Proposed access track
 - Pre-approved access as part of EW EIS
 - Boat access
 - Local road
 - Vehicular track
 - Watercourse

Heritage assessment - Ravine

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 4.4

Source: EMM (2019); Snowy Hydro (2019); LPI (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011); NSW Archaeology (2019)

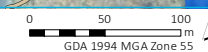


Table 4.2 **Aboriginal or historical heritage sites relating to BH7201 and BH7212**

Survey unit	Modification 1 element within survey unit	Landscape context	Predicted/known artefact density in SU	AHIMS sites within survey unit	Historic sites within survey unit	Impacts from MOD 1 activity
RSU32	Borehole BH 7212 and associated access track MOD 1 disturbance boundary	Moderate to steep simple slopes with gradients ranging from 20° to 32°. The aspect is mainly south westerly. SU dissected by minor drainage lines. Vegetation is scattered shrubs with occasional small Eucalypt becoming very dense in areas. Heavy infestations of blackberry throughout SU. Geology is a mix of conglomerate and meta-sedimentary shales presenting as outcrops, cobble, gravels and high levels of shatter. The SU is very rocky. Tuff and chert occurring naturally as rounded and angular pebbles. Traces of low-quality quartz was observed in the background stone profile, none of which is likely to be artefactual. Soils are skeletal and very gravelly. Erosional context.	Negligible	None within survey unit.	None within survey unit.	No impacts
RSU23	Borehole BH 7201 and associated access track MOD 1 disturbance boundary	Gentle simple slope. Regenerating dry sclerophyll forest. Thickets of blackberry. Erosional context.	Low	56-6-0502 (RSU23/L3) 56-6-0503 (RSU23/L2) 56-6-0506 (RSU23/L1)	R84 (possible old road) R85 (possible old road) R86 (possible old road)	No impacts

4.7.7 Noise and vibration

- The noise and vibration assessment relies on the Exploratory Works EIS. The EIS did not consider works in the Marica area or take into account the impact on adjacent NPWS camp grounds.

Recommended action:

- An assessment is made of possible impacts (noise, vibration) upon Bullocks Hill Camp Ground in KNP.

The procedures of the Interim Construction Noise Guideline (ICNG) confirm a noise management level (NML) for passive recreation of $L_{Aeq,15min}$ 60dB(A).

A review of the closest track clearing and bore hole location (BH5114) confirms a distance separation of 4,800 m to Bullocks Hill campground.

Source noise levels for track clearing and geotechnical drilling considered in the noise prediction are listed in Tables 4.3 and 4.4.

Table 4.3 **Track clearing – Marica area**

Equipment	No.	Lw (each)	Total (Lw)
Excavator	1	105	105
Dozer	1	114	114
Tracked loader	1	106	106
Truck	1	103	103
Chainsaw	1	108	108
Mulcher	1	118	118
Cumulative Lw			120

Table 4.4 **Geotechnical drilling – Marica area**

Equipment	No.	Lw (each)	Total
Tracked drill rig	1	116	116
Truck	1	103	103
Diesel pump/s	2	96	99
Cumulative Lw			116

Assuming all plant operating simultaneously, distance separation and no ground absorption or acoustic shielding from intervening topography, updated modelling confirmed predicted noise levels of <39dB(A) and <35dB(A) respectively. The noise predictions confirm compliance with the ICNG noise management level for passive recreation of 60dB(A).

4.7.8 Bushfire

- Condition 54 of Schedule 3 of SSI 9208 Determination dated 7/2/19 requires preparation of an Emergency Management Plan addressing bushfire risks
- Current bushfire and emergency plans do not address new operational areas, changed landscape and bushfire behaviour. Of particular note, Marica drill sites which only have one access/egress.

Recommended action:

- Current Bushfire and Emergency Management Plans are to be revised to incorporate the additional operational areas as per Condition of Approval 54.

Snowy Hydro commits to updating the Bushfire and Emergency Management Plan accordingly to reflect Modification 1 changes.

4.7.9 Biodiversity

- B&C have reviewed the BDAR to support the modification. The credit calculation has been adjusted to account for areas where the clearing has been reduced. However the calculation is based on a 4m wide road width. Does not appear to account for any cut and fill required on steep slopes. (See Key Issue 1).

Recommended action:

- The road widths and laydown areas in steep areas are to be reconsidered and if it is necessary to widen the roads in sections, then the offsetting requirements are to be recalculated.

Snowy Hydro notes that the access tracks to BH7201 and BH7212 are 12m wide and are expected to accommodate steep slopes in these areas. The access tracks required to these boreholes were shown in the Modification 1 Assessment Report figures and assessed in the impact assessment including biodiversity offset calculations.

4.7.10 Smoky Mouse

- There will be an increase in impact within the Marica area on the Smoky Mouse.
- There is no detail in the Biodiversity Management plan on how the vehicle speed limit will be maintained in the Smoky mouse habitat.

Recommended actions:

- The draft Biodiversity Management Plan is to include extending the existing monitoring program for Smoky Mouse to the Marica area in consultation with B&C Division.
- Detail on how the speed limit will be maintained and enforced in the Smoky Mouse habitat is to be provided.
- The BMP is to include monitoring and recording any fauna road deaths and detail on the adaptive response to any deaths.

Snowy Hydro commits to updating the Biodiversity Management Plan accordingly to reflect the Modification 1 changes.

The proposed night time speed limits within Smoky Mouse habitat at the Marica geotechnical drill sites will be maintained through the use of a project Vehicle Management System (VMS). For improved safety a VMS is used for all Exploratory Works construction vehicles. The VMS enables remote monitoring of vehicles and their speeds and provides notifications to drivers when speed limits are exceeded. It is expected that the VMS will provide adequate control to enforce the night time speed limits within Smoky Mouse habitat.

4.7.11 Tree removal

- The BDAR and offset calculations do not include the 91 trees being cleared on Lobs Hole Road. Some of these trees are large and hollow bearing.

Recommended actions:

- The offset calculation and the credit liability is to be adjusted to include the 91 trees. The financial amount payable in Condition 7 is to be adjusted accordingly.
- The offset strategy is to detail how the loss of hollow bearing trees will be offset on park.
- Clarification on the surveys for arboreal fauna and hollow dependent birds is to be provided including whether the 91 trees were assessed during the appropriate time for breeding habitat.
- Mapping and location of the 91 trees would assist in determining if the trees were surveyed.
- Where feasible, the impact of the removal of hollow bearing trees is to be mitigated by cutting out the section(s) of each removed tree with the large hollows and remounting them on suitable trees.

Snowy Hydro notes that the biodiversity offset requirements for the proposed dangerous tree removal were assessed and are provided in Appendix C.

4.7.12 Aboriginal cultural heritage

- Conditions 11, 12, 13 and 14 of Schedule 3 of SSI 9208 Determination dated 7/2/19 are relevant to the modification.
- Table 6.4 (page 70) and Figure 6.3 (page 77) indicates that additional impacts will also occur to Aboriginal objects in RSU29. This is not discussed under section 6.2.3.ii (page 69).
- The commitment to update the current Aboriginal Heritage Management Plan under section 8.3.1.i (page 113) is noted.

Recommended actions:

- For completeness - section 6.2.3.ii is to be updated to include discussion of impacts to RSU29.
- All operational maps and plans are to be reviewed and updated to ensure the new boundaries of works are consistent with the proposed modification changes, especially those areas where impacts to Aboriginal cultural heritage values are reduced. All older versions of operational maps and plans are to be removed from circulation to ensure there are no inadvertent impacts to Aboriginal cultural heritage values.

Snowy Hydro notes that the proposed modification will introduce additional impacts to RSU29, will result in total destruction for AHIMS site 56-6-0048 (KNP91-63). 56-6-0048 (KNP91-63) is of low archaeological significance and is not recommended for avoidance or mitigation through salvage.

Site 56-6-0540 (Ravine SU29/L1) is 30 m west of the proposed modification footprint and features a hatchet head. This site will be avoided by the proposed modification.

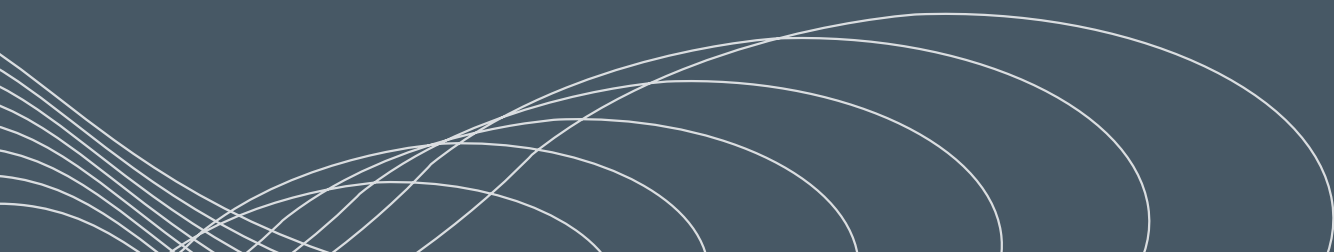
Snowy Hydro commits to updating the Aboriginal Heritage Management Plan accordingly to reflect Modification 1 changes.



CHAPTER

5

RESPONSE TO SPECIAL INTEREST GROUP SUBMISSIONS



5 Response to special interest group submissions

5.1 Overview of special interest group submissions

As discussed in Section 2.3.3, the most commonly raised themes in the special interest group submission included biodiversity, visual and waterway impacts, as well as the approval process. This section summarises special interest group submissions and provides responses. Two special interest group submissions were received from Colong Foundation for Wilderness and the National Parks Association of NSW.

This section summarises the special interest group submission and provides responses.

5.2 Biodiversity

Any consent should decline to allow an additional four hectares of national park destruction (clearing) and a tripling of heavy vehicle movements originally associated with the proposal. Snowy Hydro must work out how to not clear another four hectares and how to reduce vehicle movements back to what was originally proposed.

As described in Section 3.2, Snowy Hydro notes that the proposed Modification 1 will increase the Exploratory Works disturbance footprint from 114 ha to 128 ha. All vegetation clearance undertaken for the Exploratory Works will be offset in accordance with the NSW OEH Biodiversity Offset Scheme. Details of the biodiversity offset requirements for Modification 1 are provided in Appendix C.

The proposed increase to the peak construction traffic volumes was assessed in Section 6.4 of the Modification 1 Assessment Report (EMM 2019). The capacity assessment undertaken for the revised peak construction traffic volumes, found that there is significant additional capacity in the surrounding road network and that the level of service (LoS) outcomes for the primary transport route would remain the same under the revised construction traffic volumes.

Snowy Hydro is committed to maintaining its excellent environmental track record of work within the KNP. This is demonstrated through the high level of engagement achieved with NPWS through the design and planning of Exploratory Works, as well as Modification 1.

The environmental management framework and responsibilities for Exploratory Works within KNP are clearly set out in Chapter 6 of the EIS. Snowy Hydro is committed to ongoing consultation with NPWS regarding Exploratory Works and Snowy 2.0, including the decommissioning and rehabilitation of Exploratory Works and the development of appropriate offsets for unavoidable impacts to biodiversity and recreational users.

The modification does not specify the recompense of environmental offsets.

Snowy Hydro notes that the biodiversity offset requirements for Modification 1 were assessed and provided in Appendix C. A total of 328 ecosystem credits are required for the Exploratory Works Modification 1 disturbance footprint and dangerous tree removal, and 392 species credits arising from Modification 1. These impacts will be offset in accordance with the objective and principles outlined in the biodiversity framework.

5.3 Restoration

The widening of existing tracks and additional new tracks should have been anticipated by the original proposal. Each of the 15 bore holes shall cause significant clearing and compaction of the site. Recovery in a subalpine area of these disturbances will be slow. Each site will be present as a disturbed area in the national park for decades after this temporary drill site use. How does Snowy Hydro propose to reduce the recovery time and further limit the disturbance area at each bore hole site. Where are the detailed site management plans and restoration plans?

Snowy Hydro notes that the Modification 1 works have been designed to avoid and minimise impacts to biodiversity values of the KNP. As described in Section 6.1.2(i)a, the rehabilitation principles listed below will be implemented for rehabilitation of the geotechnical investigation works.

- any cleared vegetation will be stockpiled adjacent to the cleared site and windrowed for use later during rehabilitation work;
- successful rehabilitation is based on the principle of “No Bare Ground” after rehabilitation works have been carried out;
- overburden material will be returned to drilling hole or will be removed from site, and any rock or Geotech material used to establish the pads or access tracks will be removed.
- cover any bare ground with rice straw – 1 bale per 20m², and place windrowed vegetation across rehabilitated area;
- monitor weeds in line with the biodiversity management plan (EMM 2019) and undertake control as required.

The rehabilitation of geotechnical investigation works will be incorporated in the Exploratory Works Rehabilitation Management Plan.

5.4 Waterways

A pristine reach of the Yarrangobilly River should not be further compromised. The riparian buffer must be retained as it stands. Snowy Hydro must be required to work out another way to develop the portal without reduction of the buffer.

The proposed additional disturbance within 50 m of the Yarrangobilly River is associated with bridge construction works at Camp Bridge and Wallaces Creek Bridge. Additional works within the Exploratory Works avoidance area near the Yarrangobilly River have been minimised as far as practicable and are required for placement and operation of equipment and materials during bridge construction. As described in Section 3.5.3 of the Modification 1 Assessment Report the construction activities to be undertaken in the areas adjacent to the two bridges will involve only land-based construction activities with no encroachment on the Yarrangobilly River. Proposed construction activities include:

- clearing of vegetation;
- levelling earthwork, inclusive of fill import as necessary for crane pad construction, stabilisation of equipment parking locations;

- erection of falsework;
- laydown, parking and movement of equipment; and
- placement of sediment controls.

Remediation will occur on site following completion of construction activities.

The water assessment undertaken for Modification 1 found that given the temporary nature of these works, there will be no long-term impacts to water flow and quality. During construction, there will be some risk to water quality due to land clearing and earthworks, as well as increased erosion potential. Erosion and sediment control measures will be implemented to minimise this risk. All impacts to biodiversity associated with these works will be suitably offset.

5.5 Approval process

The test to determine approval for a modification of any development consent in a national park is that it must improve environmental outcomes. This proposed modification to Snowy 2 does not improve environmental outcomes for Kosciuszko National Park.

This proposed major project modification winds back the original protections under the consent for exploratory works within Kosciuszko National Park, our only alpine national park.

Snowy Hydro is committed to maintaining its excellent environmental track record of work within the KNP. This is demonstrated through the high level of engagement achieved with NPWS through the design and planning of Exploratory Works, as well as Modification 1. The proposed modification includes several elements that will improve the environmental outcomes of Exploratory Works including reduced emissions from the changes to the construction power supply.

The environmental management framework and responsibilities for Exploratory Works within KNP are clearly set out in Chapter 6 of the Exploratory Works EIS, approved Environmental Management Strategy and applicable approved management plans. These will continue to apply to any approved modification. Snowy Hydro is committed to ongoing consultation with NPWS regarding Exploratory Works, including the decommissioning and rehabilitation of Exploratory Works and the development of appropriate offsets for predicted impacts to biodiversity and recreational users.

NPA's earlier submission emphasised the scale of potential impacts and the large amount of supporting information provided by the applicant. In that context we requested that the Department extend the submission period to enable community stakeholders sufficient time to prepare comments on the application. We also noted the limited consultation that Snowy Hydro had undertaken and recommended that they consult with a broader range of stakeholders about the proposed modification.

Snowy Hydro notes that the DPIE made the Snowy 2.0 Exploratory Works Modification 1 assessment report available for public comment from 26 June 2019 to 9 July 2019 (15 calendar days). The minimum period (14 days) for modification exhibition periods is mandated in clause 241 of the *Environmental Planning and Assessment Regulation 2000*. The stakeholder engagement undertaken for Modification 1 involved meeting with key government agency stakeholders and is detailed in Chapter 5 of the Modification 1 Assessment Report. Snowy Hydro acknowledges the submission received from the National Parks Association of NSW and has consulted with the Association on the Snowy 2.0 project more broadly.

NPA considers that the additional roadworks described in the application reinforces the inappropriateness of the incremental approach to the public release of information about the total environmental impact of the project. It is recommended that the application should address whether the road and bridge works for the modified Exploratory Works will be extended even further when and if the Main Works proceed, and if so to what total extent.

All construction works and impacts for the Snowy 2.0 Main Works will be addressed by Snowy Hydro in the project application and the Main Works EIS. This will include consideration of cumulative impacts of Main Works and Exploratory Works.

5.6 Project cost and timing

The modification will result in changes to the cost and timing of the Exploratory Works. It is recommended that these changes be disclosed in the application, in particular the construction of the new substation and its connection to the camp and work sites.

Snowy Hydro notes that the estimate of the capital investment value provided in the Exploratory Works EIS is expected to remain valid for the works proposed in Modification 1. Similarly the Exploratory Works schedule is expected to remain consistent with what was documented in the Exploratory Works EIS. The proposed works will enhance the objectives of the Exploratory Works and will improve the constructability and efficiency of the construction works.

5.7 Accommodation

The modification will require accommodation for an additional 70 workers but does not specify where they will be housed and if this requires additional facilities at Lob's Hole

Snowy Hydro notes that the additional workers required for the substation construction will be adequately accommodated by the approved Exploratory Works accommodation camp. This will be achieved by sequencing the construction program to ensure the maximum capacity of 152 beds at the accommodation camp is not exceeded.

5.8 Location of power station

The modification proposed moving the underground power station one kilometre to the west. There is no explanation of the reasons for this change beyond a reference to 'design development'. It is unclear what 'feasible alternatives' were considered (as required by the EP&A Regulations) and whether this change has additional environmental or functional implications for the project. In a recent meeting with NPA, Snowy Hydro indicated that the new location would involve substantial surface structures, which don't appear to be described or assessed in the modification application. It is recommended that the application address the implications for the change of location. For example, declines in pumping efficiency due to the longer distance to Tantangara or a greater visual impact from the higher surge tank.

The Snowy 2.0 power station is not proposed as part of Modification 1. The geotechnical investigation drilling for Modification 1 are proposed to provide additional information on a potential location for a power station cavern. The design development and alternatives considered to the Snowy 2.0 power station would be detailed in the application for the Main Works EIS.

Design details have been provided for the proposed Modification 1 elements including geotechnical drilling, the establishment of a substation at Lobs Hole and other supporting construction activities. Visual impacts from Modification 1 were considered in Section 6.5.5 of the Modification 1 Assessment Report and further in Section 4.7.3 of this report. The visual impact assessment undertaken found that the proposed works will not be visible from any publicly accessible viewpoints during Exploratory Works. As stated in the Exploratory Works EIS the facilities provided during construction of Exploratory Works will be removed and the respective sites rehabilitated, should Snowy 2.0 not proceed.



CHAPTER

6

RESPONSE TO COMMUNITY SUBMISSIONS



6 Response to community submissions

6.1 Overview of community submissions

As discussed in Section 2.3.4, the matters raised in the community submissions were biodiversity, geodiversity, bushfire, Kosciuszko National Park, visual impacts and the approval process.

This section summarises community submissions received and provides Snowy Hydro's responses immediately below. The section is structured to present matters in order of how frequently they were raised by community submissions.

6.2 Biodiversity

6.2.1 Smoky Mouse

Increased impact on Smoky Mouse habitat from the original EIS area has been identified. By staging the approvals process it is unclear how much Smoky Mouse habitat clearance will occur leading into the future.

The staged approvals process for Snowy 2.0 is consistent with NSW planning laws. In NSW, staged applications for SSI projects are common practice and consistent with the requirements for SSI stated in Division 5.2 of the EP&A Act.

Impacts on Smoky Mouse habitat and other sensitive biodiversity values will be fully assessed in accordance with relevant Secretary's environmental assessment requirements for each stage of the project.

6.2.2 Biodiversity credits

Modification 1 attracts a net 96 additional offset credits. This is a 27% increase to 346, which suggests Modification 1 involves a significant increase in impact on the Exploratory Works EIS as previously envisaged.

Project environmental impacts are generally consistent with the approved Exploratory Works. As discussed in Section 3.2, Modification 1 seeks to revise the disturbance footprint to a total 128 ha, increased from the 114 ha already approved. A total of 328 ecosystem credits are required for the Exploratory Works Modification 1 disturbance footprint and dangerous tree removal, and 392 species credits arising from Modification 1. These impacts will be offset in accordance with the objectives and principles outlined in the biodiversity framework. Details of the biodiversity offset requirements are provided in Appendix C. Whilst the biodiversity offset credit calculations have increased, these can be assessed and approved as a modification under Division 5.2 of the EP&A Act.

6.3 Geodiversity

The site visit by Dr Percival included representatives from EMM and Snowy Hydro but excluded NPWS personnel. This has limited NPWS personnel input regarding the proposed changes.

The remainder of excavated material should be provided to NPWS at an appropriate location. This material could be used for distribution to other educational institutions and even distributed/sold by NPWS as "items of curiosity."

Meetings were held with NPWS on 23 May and 8 August 2019, to provide briefings on Modification 1. The following key matters for consideration in Modification 1 were raised in the meeting and during the meeting:

- SHL and EMM presented the proposed scope for Modification 1;
- NPWS requested for the Modification 1 application to include ongoing use of existing access tracks within the KNP and a commitment to rehabilitation;
- NPWS provided input to the design of access tracks;
- NPWS provided feedback on the ongoing use of existing communications towers;
- NPWS expressed a preference for the Lobs Hole substation 33 kV feeder cable to be underground;
- NPWS raised concerns regarding the proposed traffic increases; and
- NPWS requested further information be provided regarding the methods for removal of hazardous trees.

As detailed in Section 6.5.1(i)a of the Modification 1 Assessment Report the widening of Lobs Hole Ravine Road in this section will not materially affect the distribution nor abundance of fossils that will be exposed in the new road cuttings. The proposed road widening will also result in an improvement in site conditions not only in terms of road safety and access but also in access to the fossiliferous layers.

Moreover, fossil bed excavated material has already been provided to a researcher from the Geological Survey of NSW in accordance with the Exploratory Works conditions of consent.

6.4 Bushfire

6.4.1 2003 Canberra bushfires

The EIS recognises the 2003 Canberra bushfires had significant impact at Tantangara but makes no mention of the impact in the Lobs Hole area. The actuality was the whole of the Lobs Hole/Ravine area was significantly impacted.

Snowy Hydro acknowledges the significant bushfire impacts in the Lobs Hole area during the 2003 Canberra bushfires.

6.4.2 Bushfire risk

The potential for uncontrolled fire in this area should be considered high and the ability to respond to it, especially when the construction phase is complete, will be constrained.

While recognising the EIS requires the issue of APZ to be assessed, it should be expected that the fire protection responses will be limited to aerial so a worst-case scenario must be contemplated.

The bushfire risk in Lobs Hole has been considered as part of the Bushfire Management Plan preparation for the Exploratory Works.

6.4.3 Substation

Post project completion, above ground facilities such as the substation would not be immune from significant impact, even with buffer zones. The structure of bunds should anticipate failure and have capacity to contain oils and other contaminants that would be released by failing transformers and/ or circuit breakers

The substation bunds would be designed to Australian Standards and other relevant engineering guidelines, requirements and standards.

6.5 Kosciuszko National Park

A shift of the footprint 1 km to the west, construction of a substation and increasing impact on Smoky Mouse habitat are all additional impacts on Kosciuszko National Park.

Consistent with the principles of ecologically sustainable development, the proposed modification has been designed to avoid and minimise impacts where possible. In the first instance this has included consideration of site suitability based on design and construction needs, existing assets and infrastructure (such as road access), and environmental conditions.

The proposed modification has been informed and refined by the results of field surveys and consultation with key stakeholders, in particular NPWS and OEH. On this basis, a number of significant impacts on biodiversity, heritage, recreation and land use have been avoided and minimised.

6.6 Visual

6.6.1 Underground powerlines

The initial installation of distribution powerlines should require they are installed underground.

Snowy Hydro acknowledges the preference for underground cables for feeder connections to construction areas within KNP. Where practical underground cables will be utilised, however, this is unlikely to be the case in all instances. For constructability reasons the feeder cables for Exploratory Works construction power supply will be established using a mix of underground and overhead power lines. The feeder cables to construction areas will be temporary only and, should the Snowy 2.0 Main Works not proceed, will be removed following the completion of Exploratory Works. As the feeder cables will only remain in place through the construction of the project they are not expected to have any long-term impacts on amenity values of KNP.

6.6.2 Communications infrastructure

Questions around the means of installation of the optic fibre network between the Talbingo intake, the work village, the sub-station and the proposed power station. It seems that this should be installed concurrently with the distribution power lines in an underground manner.

As described in the Exploratory Works EIS Section 2.8.3 the communications cable will be installed as a submarine cable from Tumut 3 power station to Middle Bay in Talbingo Reservoir and then via an underground conduit to the Exploratory Works construction and accommodation areas.

6.7 Approval process

6.7.1 Timing

Dissatisfied with short time frame for public comments.

Snowy Hydro notes that the timeframe for public exhibition is a matter for DPIE. DPIE made the Snowy 2.0 Exploratory Works Modification 1 assessment report available for public comment from 26 June 2019 to 9 July 2019 (15 calendar days). This is in accordance with the requirements of clause 241 of the Environmental Planning and Assessment Regulation 2000, which requires that a modification application be publicly exhibited for at least 14 days.

6.7.2 Staged approvals

Dissatisfied with staged approval process. Only having a footprint for Exploratory Works limits knowledge of the whole project.

The staged approvals process for Snowy 2.0 is consistent with NSW planning laws.

In NSW, staged applications for SSI projects are common practice and consistent with the requirements for SSI stated in Division 5.2 of the EP&A Act.

On 7 March 2018 the NSW Minister for Planning declared Snowy 2.0 to be CSSI and thereby confirmed that a staged SSI application process is an appropriate approvals pathway for Snowy 2.0, if required. As a component of Snowy 2.0, the Exploratory Works is declared to be CSSI for the purposes of the EP&A Act. Therefore, the application for Exploratory Works as a first stage of Snowy 2.0 with later stages of the project to be assessed in separate applications is permissible in accordance with Division 5.2 of the EP&A Act.



CHAPTER

7

UPDATED PROJECT DESCRIPTION



7 Updated project description

This chapter summarises the scope of works, construction activities and method for Modification 1, taking into account the design changes identified in Chapter 3. The final design will be the outcome of the detailed design process. In some cases, detailed design of the infrastructure may vary from the concept design assessed within the assessment report. For example, the actual size, space and specific use of locations within the disturbance footprint may change as part of the detailed design and construction planning. However, the nature of such variations would be generally consistent with the concept design and its environmental outcomes. Any final design will be within the parameters of the impacts assessed in the assessment report, and if not, an additional modification would need to be sought to the Exploratory Works approval.

7.1 Modification 1 elements

Having regard to the design changes identified in Chapter 3, the Modification 1 scope now comprises:

- borehole drilling and geophysical surveys for further geotechnical investigation of the Snowy 2.0 power station and power waterway at Marica, Talbingo and Tantangara. Geotechnical investigations will involve the following activities:
 - clearing of up to 2.79 ha of additional vegetation for access tracks and drilling pads. About 1.33 ha within Smoky Mouse potential habitat. This area of clearing represents less than one percent of the entire Exploratory Works project area;
 - trimming of overhanging dangerous branches on adjacent trees (these trees will not require removal);
 - mulching of trees and vegetation;
 - establishment of an additional 1 km of access tracks (4 m wide), including minor earthworks, placement of geofabric (as required) and import of stabilised material;
 - establishment of eight drilling pads and boreholes at the top of the cavern area, with an area of 900 m² per pad, including minor earthworks, placement of geofabric (as required) and import of stabilised material (as required);
 - undertaking geophysical surveys near Talbingo and Tantangara reservoirs;
 - establishment of two drilling pads and boreholes at both Tantangara and Talbingo with an area of 900 m² per pad, including approximately 400 m of additional access tracks and minor earthworks (as required);
 - establishment of in-reservoir boreholes including one in Talbingo Reservoir and two in Tantangara Reservoir;
 - drilling of additional nested vertical boreholes at each of the drilling pads up to a depth of 1,100 m;
 - conversion of selected investigation boreholes into monitoring bores;
 - undertaking geophysical surveys; and
 - rehabilitation of the drilling pads and access tracks following completion of works.

- ongoing groundwater monitoring using existing boreholes and access tracks within KNP;
- ongoing maintenance and rehabilitation of existing access tracks required for groundwater monitoring and geotechnical investigations within KNP;
- establishment of a construction power connection to the existing transmission line (Line 2) at Lobs Hole for power supply to the Exploratory Works accommodation camp and construction areas. This will provide a reliable and long-term source of construction power and will reduce the reliance on diesel generation and associated on-site storage requirements and emissions. This will include:
 - construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation;
 - geotechnical investigation works to inform the detailed design of the construction power substation;
 - replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height;
 - short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54;
 - 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables;
 - establishment and upgrade of access tracks and roads to the new substation and transmission line structures;
 - installation of a fibre optic communication link into the new substation from the approved communication network; and
 - ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas.
- minor changes to the project boundary identified through detailed design including:
 - additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment;
 - additional disturbance area required for the construction power connection to an existing transmission line at Lobs Hole. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas;
 - revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; and
 - minor additions to construction areas for design optimisation.
- removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road;

- continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW *National Parks and Wildlife Act 1974* (NPW Act) and its regulation for the geotechnical investigation program;
- increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected;
- four additional laydown areas to improve constructability near Talbingo north. The proposed areas will assist with the installation of communications infrastructure, roads works and barge infrastructure works; and
- two additional geotechnical boreholes are required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures near Nungar Creek.

7.2 Geotechnical drilling

Additional geotechnical drilling sites are proposed at the localities of Talbingo, Tantangara and Marica.

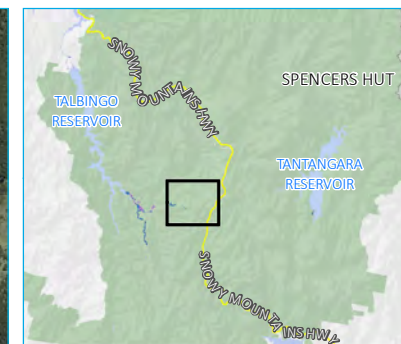
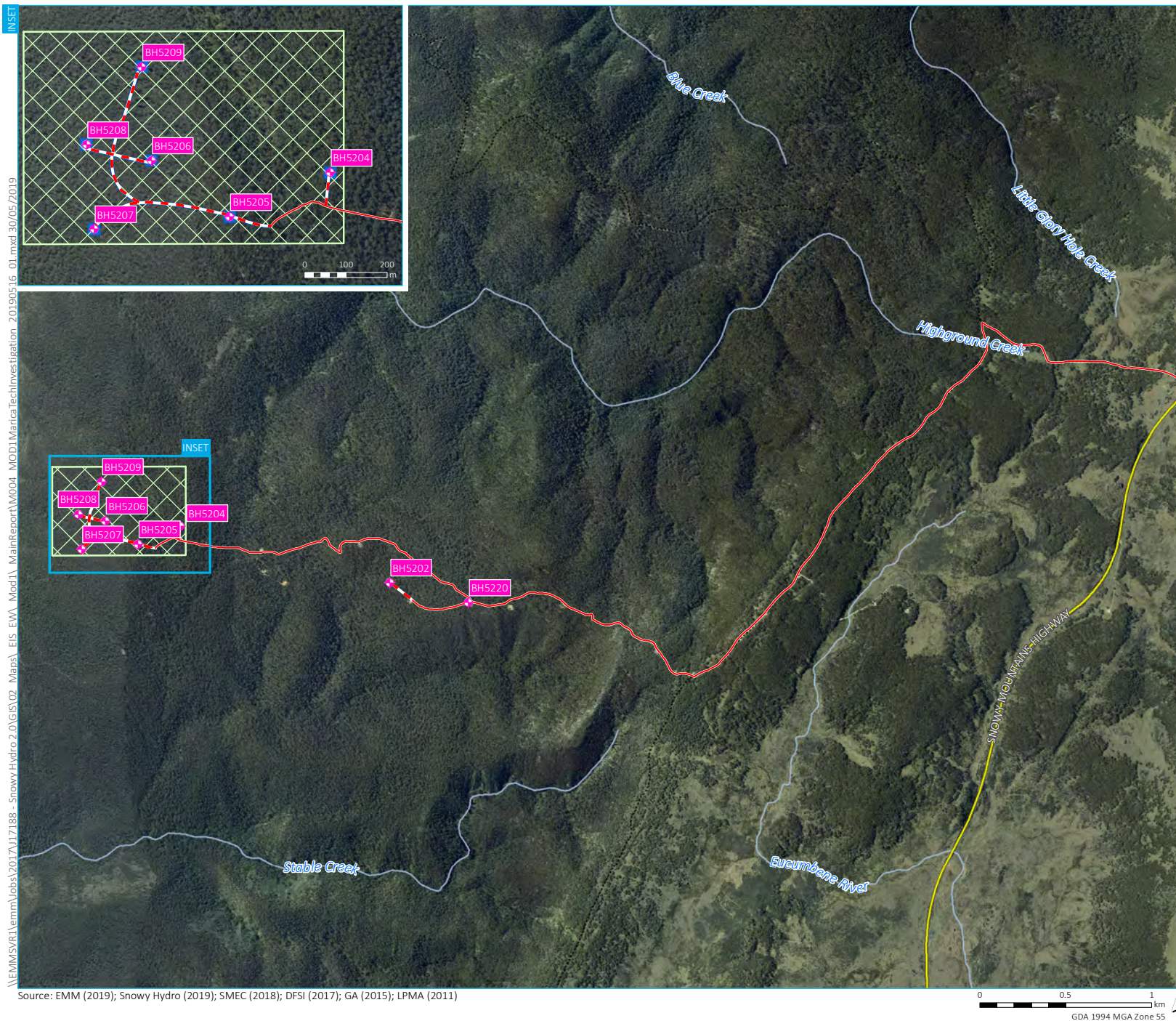
The majority of the drilling sites subject to this modification are in the Marica area of the KNP, above the Snowy 2.0 underground power station and end point of the exploratory works tunnel. BH5202 is near the head race tunnel surge shaft, approximately 1 km east of the other bores in Marica.

The investigations proposed for the Talbingo area are intended to ascertain the geological conditions to inform detailed design, in particular the geological features and defects around the Talbingo Intake and dry portal. One of the drilling sites at Talbingo will be in-reservoir.

The additional investigations in the Tantangara area are intended to ascertain geological conditions to inform design development, in particular the geological features and defects, around the dry portal and associated marine structures. Two of the drilling sites at Tantangara will be in-reservoir.

7.2.1 Borehole details

The locations of the bores are detailed in Figure 7.1, Figure 7.2 and Figure 7.3. The final locations of the drill pads for BH5204-5209 will be within the hatched area shown in Figure 7.1. This area comprises challenging topographical constraints meaning that the final location and orientation of both the access tracks and drill pads must be determined once on site. The final access track locations and drill pad placement will be managed to ensure that the maximum clearing of 2.79 ha of vegetation is maintained.



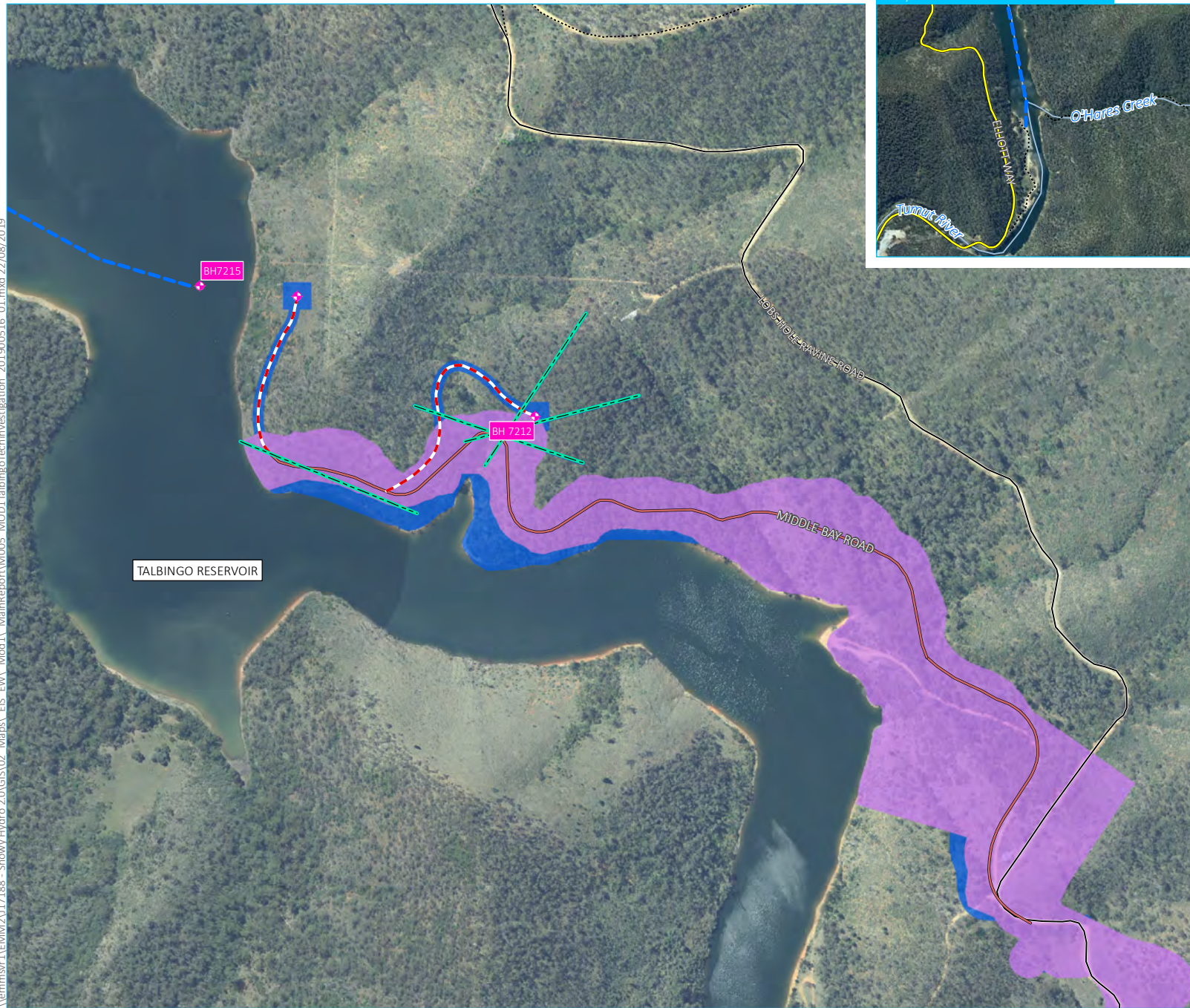
- KEY**
- ◆ Proposed borehole
 - Boreholes requiring on-site adjustment
 - EW EIS modification construction footprint (additional)
 - Existing access track
 - - - Proposed Mod 1 access track
 - Main road
 - Vehicular track
 - Watercourse / drainage line

Marica geotechnical investigation drilling

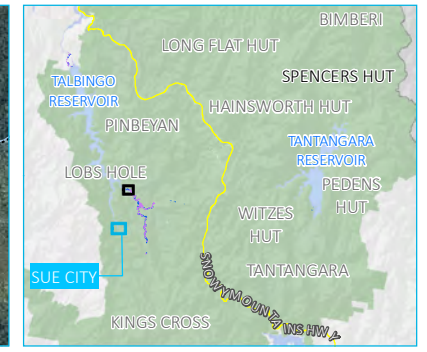
Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.1



\\lemmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS EW Mod 1\ MainReport\MO05 MOD1TalbingoTechInvestigation_201900516_01.mxd 22/08/2019



BOAT/BARGE LAUNCHING AREA - SUE CITY



- KEY
- ◆ Proposed borehole
 - Proposed geophysics
 - - - Proposed access track
 - Approved EW access
 - - - Boat access
 - Main road
 - Local road
 - Vehicular track
 - Watercourse / drainage line
 - EW approved construction footprint
 - EW modification construction footprint (additional)

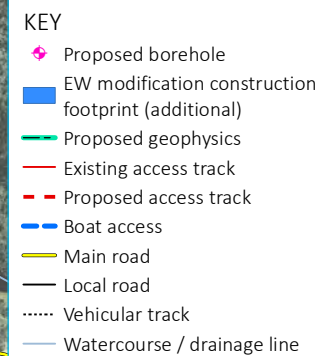
Talbingo geotechnical investigation drilling

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.2

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



0 150 300 m
GDA 1994 MGA Zone 55



Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.3

7.2.2 Mobilisation to site

The geotechnical drilling locations will be accessed by a combination of new access tracks, existing access tracks, boat access via Talbingo and Tantangara reservoir as well as of helicopter access as required. In total 1.8 km of new access tracks will be established to enable access to the proposed geotechnical drilling sites.

The process for mobilising equipment to site will be as follows:

- drill rigs and other large equipment will be transported to the Snowy Mountain Highway lay down area (and Marica Track intersection) where they will be walked or driven into site using existing access tracks that have been previously utilised for Snowy 2.0 Feasibility stage geotechnical investigation activities; and
- vehicle hygiene checks will be undertaken for all new plant, machinery and vehicles prior to accessing site for the first time.

7.2.3 Clearing

Clearing will be required to access 12 of the proposed 15 drilling sites subject to this modification. The other three proposed boreholes are in the Tantangara and Talbingo reservoirs. As detailed in Figure 7.1, there is an existing access track in the Marica area that has previously been used to access and establish drill sites as part of the initial, feasibility stage investigations.

Additional clearing will be required to access and establish the proposed drill sites from this existing track.

The additional clearing will include approximately 0.4 ha of vegetation to establish 1 km of new access tracks and approximately 0.63 ha of vegetation for the drill pads with dimensions of 30 m x 30 m (or equivalent dimensions equating to 900 m²).

The clearing will be undertaken as follows:

- pre-clearance vegetation inspections by ecologists;
- installation of site delineation/webbing, inclusive of sediments control measures along the tracks and around the drill pad sites;
- removal of the trees and upper story vegetation with chainsaws and hand tools and stockpiling of vegetation for rehabilitation activities; and
- removal of the remaining ground vegetation and stumps using a forestry mulcher.

An example of access track clearing completed previously on the existing Marica access track is detailed in Photograph 7.1.



Photograph 7.1 **Example of easement clearing work completed with forestry mulcher on Marica track**

7.2.4 **Access track and drill pad establishment**

Following clearing, the establishment of the access tracks and drill pads will involve:

- where required, installation of swale and/or cut off drains (using skid steer loader or similar) to prevent overland water flow across the track/site and install erosion and sediment controls;
- where required, minor earthworks to level the track or pad to a suitable gradient;
- where required, placement of geofabric and use of compacted imported aggregate material to create a stable track or drill pad. This stabilisation of the ground is of particular importance for the active drilling area within the drilling pads to ensure the stability of the drill rig;
- for the drill pads, placement on site of drill support equipment including water tanks, mud tanks, spill kits, lighting, mobile generator and other equipment as necessary; and
- set up of drill rig and drilling equipment.

The drill pad and surrounding work area will be maintained for the duration of drilling work as required. A drainage sump may also be installed at the lowest point of the site (to capture excess drill fluid) if required.

A typical drill pad layout is shown in Figure 7.4

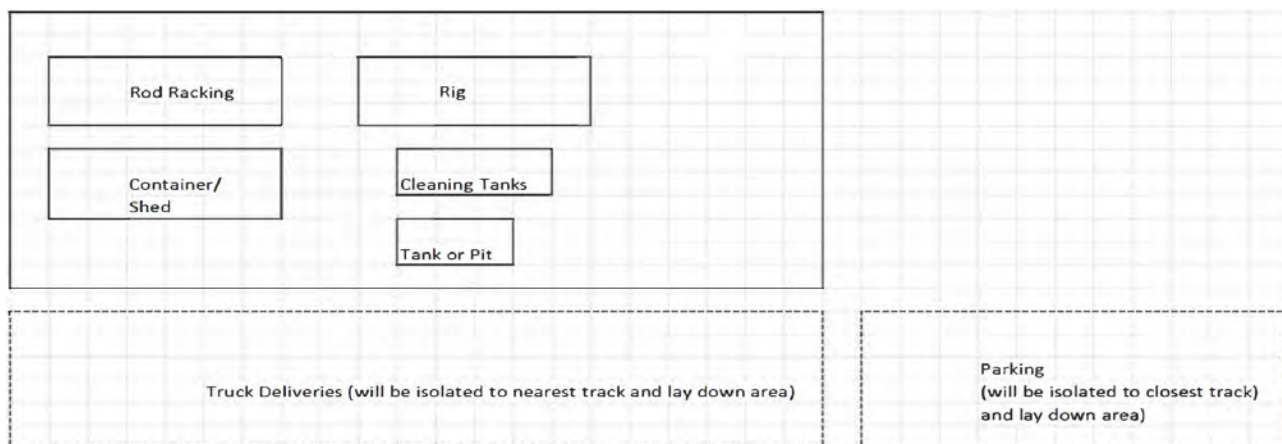


Figure 7.4 Typical drill pad layout

7.2.5 Borehole drilling

Drilling activities, including borehole establishment and in situ testing, will include the following:

- drilling of boreholes using auger and rotary wash bore drilling techniques through soils and weathered rock followed by coring to a maximum depth of approximately 1,100 m, however most Marica boreholes will be to a depth of less than 900 m while intake boreholes will be about 100 m;
- each pad will contain a maximum of two boreholes with the possibility of one being nested for up to four inclusions (directional drilling bores);
- rock core drilling using triple tube diamond coring techniques to the nominated target depth;
- containment of excess drilling fluids and cuttings in re-circulation tanks, excess fluids will be stored in portable containers and disposed of to an EPA licenced facility;
- in situ permeability testing using water pressure tests;
- other downhole testing as required;
- clean water flushing of boreholes upon reaching target depths;
- downhole borehole survey using acoustic televue cameras and instruments;
- survey of the as-built borehole location using GPS or suitable survey techniques;
- install of downhole monitoring instrument, for example vibrating wire piezometers and/or standpipes;
- grout of borehole upon completion of in-situ testing or downhole install; and
- ongoing maintenance of the equipment and site as required.

A typical drill rig is shown in Photograph 7.2. A typical drill rig pad layout and cross section is shown in Figure 7.4 and Figure 7.5.



Photograph 7.2 Typical tracked drill rig

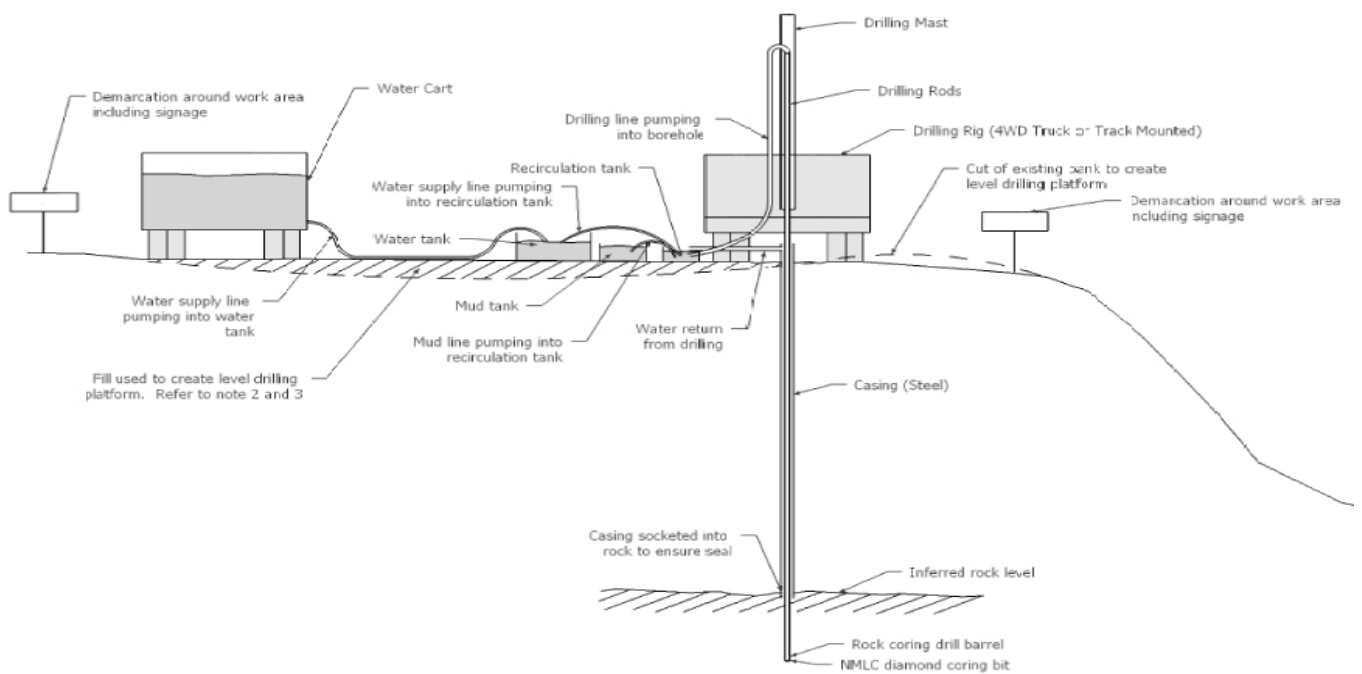


Figure 7.5 Typical drill site set up - cross section

7.2.6 Geophysics surveys

Geophysics surveys were also described in the original Exploratory Works EIS as requiring the establishment of temporary surface equipment that generates seismic energy and receives the resulting reflected/refracted seismic waves along an array of receivers. This seismic data involves establishing straight lines via a cable with geophones installed every 4-8 m and using small charges to generate seismic energy.

The geophysical survey activities were detailed as including the following:

- the geophone cable placed along the survey line with geophones spaced every four metres;
- survey holes established along the survey line every eight metres using a post hole digger or auger;
- small 100 grams charge positioned at the bottom of the holes and then backfilled. A geophysicist will determine the amount of explosives to be used to ensure the minimum possible quantity is used; and
- seismic shots executed one at a time. The shot holes will be inspected by the licensed shot-firer after each shot and filled if necessary.

Additional geophysics survey locations have been nominated by the Snowy 2.0 contractor, to inform detailed design development at Talbingo and Tantangara.

7.2.7 In-reservoir borehole drilling

One drilling site at Talbingo and two drilling sites at Tantangara will be established over water in the reservoirs. Over water drilling activities are to include activities listed below:

- mobilise and secure floating barge to reservoir floor and shoreline using concrete anchors that will be removed at completion of work;
- drill boreholes using auger and rotary wash bore drilling techniques;
- rock core drilling using triple tube diamond coring techniques to the target depth; and
- in-situ testing and surveys including water pressure tests and acoustic surveys.

Access to the in-reservoir drilling site in Talbingo Reservoir will be via barge that will be launched from the existing boat ramp at Sue City and is shown in Figure 7.2. Access to the in-reservoir drilling sites in Tantangara Reservoir will be via barge that will be launched from the existing boat ramp at Tantangara Reservoir and is shown in Figure 7.3.

7.2.8 Ancillary activities

Activities associated with the proposed drilling activities include the daily mobilisation of site crew (drillers, geotechnical engineer etc) as well as delivery of materials as may be required. Removal of drill core logs (contained in light steel core trays), IBCs and other equipment may also be undertaken as required on a daily basis. Deliveries and crew mobilisation will be serviced from the laydown areas that will be established near the proposed drill sites and barge launch areas. All laydown areas will be established within existing disturbed areas and will make use of existing laydown areas and access tracks that were previously used during the feasibility stage geotechnical investigations. Continued use of existing geotechnical investigations infrastructure within KNP is detailed further in Section 7.3.

Water supply infrastructure including pumps, tanks and overland piping may also be established within laydown areas, access tracks and proposed drill sites for borehole drilling water supply.

All ancillary activities will be undertaken within existing disturbed areas and no vegetation clearance or ground disturbance will be required.

The following types of materials are to be delivered, stored and used during the geotechnical investigation program:

- drill rods, casing and equipment;
- IBCs which will be used to store excess drill fluids and cuttings will be stored and then transported from site prior to offsite disposal at an EPA licenced facility;
- light steel core trays to be used for storing rock core samples, once core trays are removed from site, they will be transported to an off-site storage facility;
- fuel supplies for the drilling rig and support equipment to be stored in areas on site;
- drilling water to be stored in IBC and transported to site using water truck from Exploratory Works construction water supply;
- cement used to grout boreholes (to be stored at the laydown area covered under tarpaulins or in a container); and
- other instruments to be installed downhole.

7.2.9 Demobilisation

Following successful completion of borehole drilling and in situ testing and sampling, the following borehole decommissioning activities will occur:

- decommissioning of all equipment and environmental controls from the boreholes and drill pad locations;
- demobilisation of all equipment from site using temporary access tracks; and
- visual inspection by work crew to ensure that no materials associated with the drilling activities have been left at the drill pads.

Snowy Hydro proposes to retain the option of installing monitoring equipment in any of the boreholes for ongoing groundwater monitoring purposes. This may occur sometime in the future following the decommissioning activities.

7.2.10 Rehabilitation

The drill pads will be rehabilitated in accordance with the following principles:

- Successful rehabilitation is based on the principle of “No Bare Ground” after rehabilitation works have been carried out.
- Implementation of strict vehicle hygiene protocol, such as washing down of equipment and vehicle wash bays before entering KNP and cleaning of boots prior to entering the sites. The weed control measures to be implemented during the activities are based on a significant increase in listed weeds in the KNP POM.
- Utilisation of cleared or mulched vegetation in the rehabilitation activities.

The approach to rehabilitation will aim to use existing ecological resources at the sites and to minimise the use of additional materials such as seed, tube stock and mulch. This approach to rehabilitation was used throughout the Feasibility stage geotechnical investigation program and has been undertaken successfully to date. An example of rehabilitation for a drill site within KNP is shown in Photograph 7.3.

Following completion of all site activities, a visual inspection of the site by Snowy Hydro and NPWS personnel will be undertaken to ensure that the location of the drilling activities has been reinstated to an acceptable standard.



Photograph 7.3 **Typical rehabilitated drill site within KNP**

7.2.11 Proposed plant, equipment and materials

The plant and equipment for clearing, access track and drilling pad construction, site establishment and drilling activities will include the following:

- track mounted loader for placement of rock fill materials;
- small excavator;
- forestry mulcher;
- skid steer loader;
- rigid truck and trailer transport for drilling rigs;

- track mounted drill rig;
- light and medium 4x4 vehicles;
- rigid truck for transport of imported fill materials;
- excavator (as required);
- bulldozer (as may be required);
- barge (crane for offloading as required);
- helicopters for remote drilling mobilisation;
- site sheds; and
- site amenities, lighting and facilities/containers (located at the laydown/staging area).

Support vehicles including, light and medium 4x4 vehicles etc will be parked at the laydown/staging area. Additional testing equipment (down hole imaging and camera equipment) will be brought to site via the access tracks and will be removed once no longer in use.

As the project involves geotechnical drilling and investigations, materials required for the work will be re-used from site to site, including casing, rods and environmental controls. Other materials such as cement used for grouting will be brought to site as required or temporarily stored on the site prior to use.

Other materials are expected to include environmental controls such as silt fencing, stakes and geo-fabric products used to mitigate sedimentation and dirty water issues. Flagging, bunting or similar to mark out no go zones will also be used as required.

7.2.12 Drilling resources, timing and hours of operation

It is estimated that subject to obtaining approval, the clearing, access track and drilling pad construction and geotechnical investigation activities will commence in Spring 2019 and be completed over a period of three to four months, with drilling proposed to be undertaken 24 hours per day seven days a week as required.

Approximately four staff will be involved in drilling activities at each borehole site each shift plus up to three full time managers overseeing the investigation works.

Additional personnel may be utilised for access track maintenance and management as required.

7.2.13 Geotechnical drilling for Nungar Creek bridge

Additional shallow geotechnical drilling is also proposed to enable investigation and detailed design of critical bridge works on Tantangara Road. Two shallow boreholes will be established entirely within the existing roadway of Tantangara Road near Nungar Creek. The Nungar Creek drill sites are provided in Figure 3.7 and Section 3.5.

The investigations proposed for the Nungar Creek culvert are planned to ascertain geological condition around the existing Nungar Creek culvert to inform detailed design of bridge works that will provide access to a critical area for the Snowy 2.0 Main Works.

7.3 Ongoing use of existing boreholes and access tracks in the KNP

The proposed modification seeks to authorise the ongoing use of existing boreholes and access tracks within the KNP. A network of boreholes providing geotechnical and groundwater information to inform the design of the project was established in the KNP as part of the Snowy 2.0 geotechnical investigation program and the environmental impact assessment. These works were assessed under Division 5.1 of the EP&A Act with the consent of the NPWS pursuant to clause 23 of the National Parks and Wildlife Regulation 2009. Snowy Hydro proposes to continue to use the existing boreholes and access tracks within the KNP for ongoing groundwater monitoring.

The existing access tracks and boreholes required for groundwater monitoring will be used throughout the Exploratory Works. The proposed modification seeks to streamline the planning approvals for continued use of the existing access tracks and boreholes used for groundwater monitoring by including them as part of the Exploratory Works project. The decommissioning and rehabilitation of the existing access tracks and boreholes required for groundwater monitoring will be managed in the same way as the Exploratory Works. Snowy Hydro also proposes to continue regular maintenance and snow clearing of existing access tracks within the KNP. The ongoing maintenance and snow clearing are outlined in the below section.

7.3.1 Road maintenance, snow clearing and ancillary activities

i Road maintenance

Regular maintenance will be undertaken on the existing access roads to maintain suitable access to existing boreholes. All maintenance works will be carried out within the existing roadway. No additional ground disturbance or vegetation clearing will occur outside the existing disturbed area and newly formed tracks. Maintenance works will include:

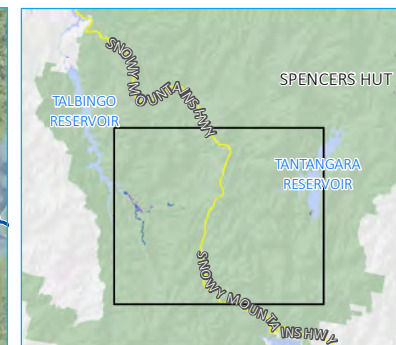
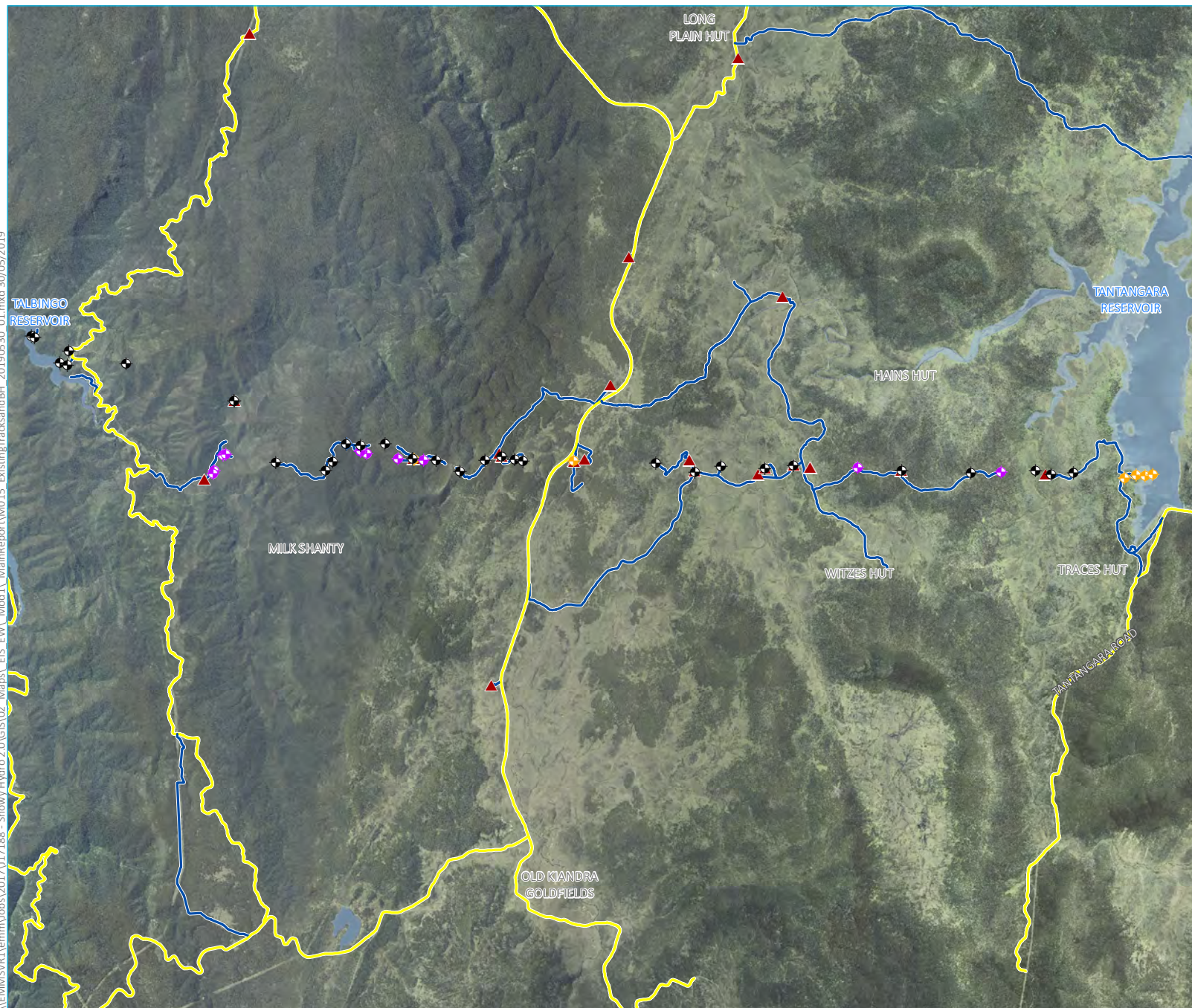
- restoring road profile (longitudinal, crossfall/crown) and surface as required, ensuring proper runoff;
- clearing and reforming blocked table, mitre or catch drains to ensure proper drainage;
- removing roadside vegetation impeding on driver visibility or passing opportunities within the existing roadway. No vegetation clearing will occur outside the existing disturbed area;
- clearing existing culverts if required;
- installation of temporary erosion/sedimentation controls if required to drains or outfalls; and
- temporary removal and restoration of roll-over/dish drains if required to facilitate long vehicle movements (generally to be restored on the same day).

ii Safety

Minor works to improve the safety of existing access tracks within the KNP will be carried out as required. This will include:

- appropriate signage and traffic management;
- installation or replacement of guideposts; and
- removing vegetation that has fallen on (or is otherwise obstructing) the roadway.

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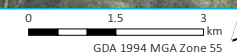
KEY

- ◆ Completed R4 borehole
- ◆ Completed S1 borehole
- ◆ Completed T1 borehole
- ◆ Completed SMEC borehole
- ▲ Monitoring piezometer
- Existing road
- Existing track

Continued use of existing access tracks and boreholes within the KNP

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.6

Source: EMM (2019); Snowy Hydro (2019); LPI (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



iii Snow clearing

To maintain access to existing boreholes and access tracks snow clearing will be carried out as required on the roads, tracks and other areas as and when affected by snow. This will be carried out through use of a bladed vehicle to clear snow off road surface to allow safe vehicle access.

7.4 Lobs Hole substation - construction power connection

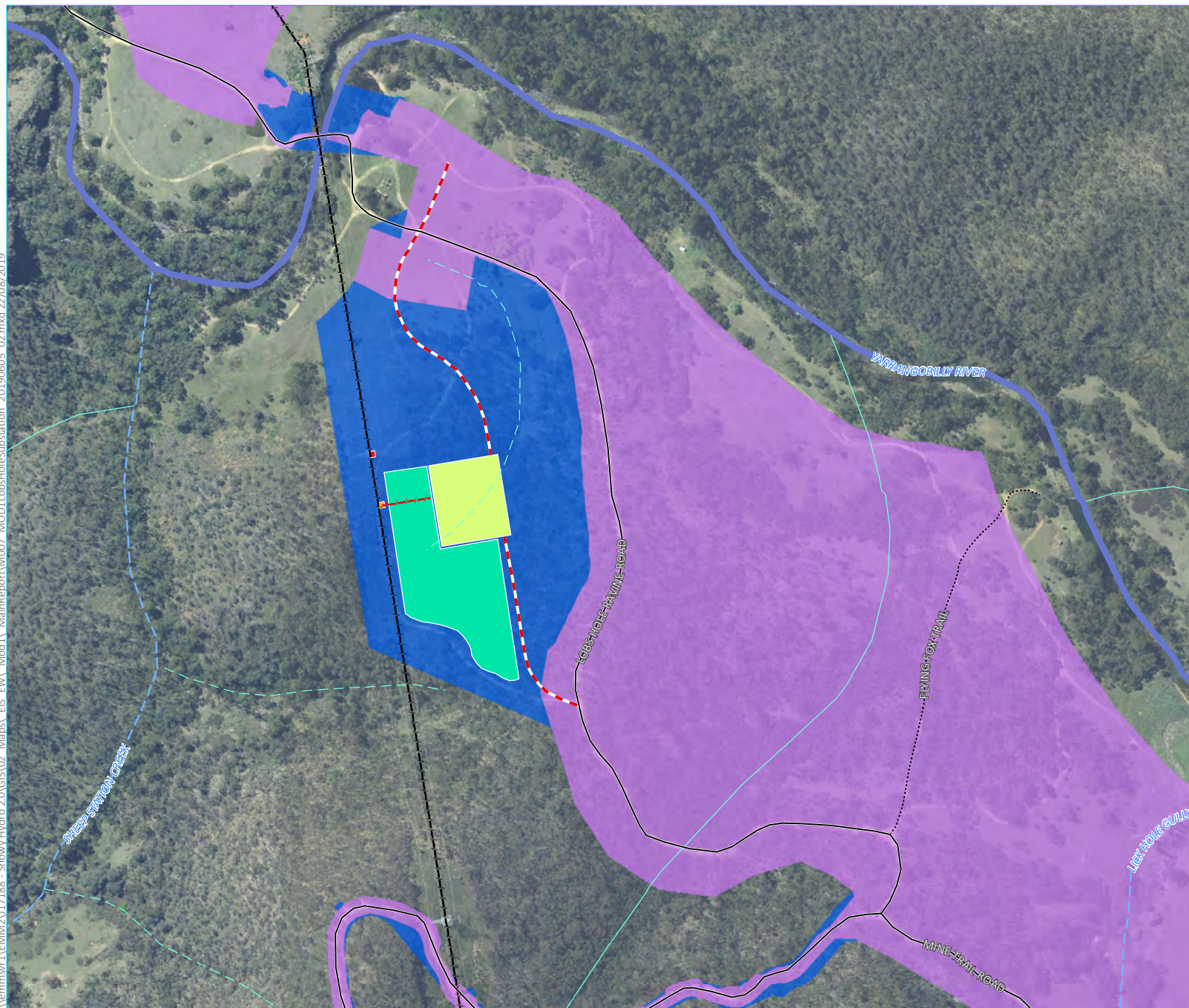
7.4.1 Overview

The Lobs Hole substation is proposed to provide electricity to power Exploratory Works rather than the approved diesel generator sets. The Exploratory Works construction power supply will be provided by a connection to the existing TransGrid transmission line at Lobs Hole once it is established. Diesel generator sets will continue to be used for Exploratory Works construction power supply prior to the Lobs Hole substation being established. The proposed construction power connection will supply construction power to the Exploratory Works including activities at the accommodation camp, the exploratory tunnel and construction portal pad. A connection to TransGrid's existing transmission line is preferred as, once established, it will reduce the need for diesel generators during Exploratory Works.

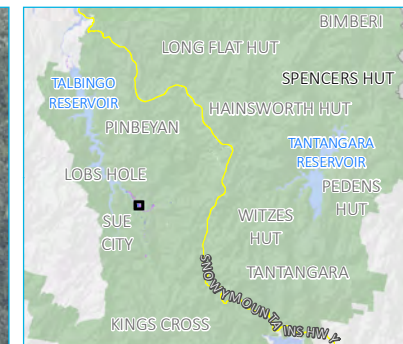
The project requires the construction of a 330/33 kV substation at Lobs Hole and is shown in Figure 7.7. The Lobs Hole substation will abut the easement of the 330 kV 'Line 2' connection between the Upper Tumut Switching Station and the Yass Substation. The close proximity to Line 2 will enable an approximate 100 m slack span connection between the proposed substation and Line 2. An existing transmission tower (Structure 54) will also be replaced as part of the Lobs Hole substation works. This will involve decommissioning the existing tower and establishing a new steel lattice structure within the existing transmission easement. The Lobs Hole substation will be linked to the easement.

The Lobs Hole substation may also be used for subsequent phases of Snowy 2.0 including the Main Works. Should Snowy 2.0 proceed, the Lobs Hole substation will remain in place subject to the design and approval of the Main Works. Should Snowy 2.0 not proceed, the Lobs Hole substation will be decommissioned and rehabilitated in consultation with NPWS, ensuring the values of KNP are maintained.

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Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Transmission line connection
- Existing transmission line 2
- EW approved construction footprint
- EW modification construction footprint (additional)
- Indicative laydown area
- Proposed substation
- Existing transmission support - Structure 54
- Replacement transmission support - Structure 54
- Proposed substation access road
- Local road
- Vehicular track
- Strahler stream order
 - 1st order
 - 2nd order
 - 3rd order
 - 7th order

Lobs Hole substation indicative layout

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.7



7.4.2 Design details

i Substation

The Lobs Hole substation will comprise a level benched area by which all high voltage and ancillary substation equipment and buildings will be located. This includes the following:

- up to two 330/33 kV ester oil transformers;
- two auxiliary transformers to provide low voltage supplies;
- 330 kV gas insulated switch bays connecting the two new transformers to the existing network (Line 2);
- 33 kV switch bays to facilitate connection of the load;
- onsite buildings to accommodate the 330 kV gas insulated switchgear, 33 kV metal clad gas insulated switchgear, substation controls, secondary systems equipment and amenities;
- oil containment system (including bunding and containment tank(s); and
- gantry and lightning masts.

Other features of the substation include:

- reinforced concrete footings to provide structural support for key substation equipment such as transformers, transmission gantries and other outdoor equipment; and
- provision of banded transformer compounds incorporating a flame trap and drainage point in the event of an emergency. These compounds will be designed to drain to a reinforced concrete spill oil tank.

The total area of disturbance proposed for construction of the substation includes the substation footprint, a new access road to the substation, ancillary construction and laydown areas as well as a cleared buffer area around the substation known as an asset protection zone (APZ) which remains cleared following completion of construction.

The total area of disturbance is therefore expected to be approximately 7 ha including the substation footprint of approximately 85 m by 85 m and the 25 to 35 m APZ buffer. Micro siting of the preferred location will be required to ensure the site is suitable to orientate the Lobs Hole substation to facilitate the efficient connection to Line 2.

ii Transmission lines and structures

The substation will be connected to the existing transmission Line 2 at Lobs Hole by an overhead wire span of approximately 100 m. The existing transmission Structure 54 will be replaced with a new steel lattice structure approximately 50 m in height. This will include construction pad and laydown areas close to the Structure 54.

The 33kV construction power supply from the Lobs Hole substation to the Exploratory Works construction areas (including the accommodation camp and portal construction pad) will be reticulated by either overhead or underground cabling. All construction power cabling will be installed within the approved Exploratory Works disturbance footprint.

iii Ancillary facilities

a Safety and security

TransGrid have technical compliance standards required for all substation fencing requirements. This is identified as a 3 m high stainless-steel palisade or chain mesh security fence on all boundaries of the substation and topped with barbed or razor wire.

Additional security measures to be implemented across and around the substation will include:

- security cameras within the switchyard;
- safety and public information signage on both the substation and surrounding transmission line towers to ensure public safety; and
- an APZ extending approximately 25 to 35 m from the substation boundary which will be cleared of vegetation and routinely maintained to minimise bushfire risk.

b Lighting

Lighting installation will comply with TransGrid standard design requirements including in positions that minimise light spill outside the substation boundaries.

c Access and parking

New access roads will be designed to allow access to the Lobs Hole substation.

Permanent access to the substation is required firstly for construction of the substation and associated construction power infrastructure and later to provide access for routine inspection and maintenance of assets. The access driveway will be a designed in to allow access for employees undertaking maintenance operations and will also be suitable to allow longer vehicles as required (such as equipment replacement).

An indicative road alignment for primary access to the Lobs Hole substation is provided in Figure 7.7. Other temporary access roads may be required throughout construction of the substation and other construction power supply infrastructure and will be established within the disturbance footprint as required.

The final layout of access roads will be established as part of the detailed design process.

Given the limited operational requirements for the substation, it is unlikely that any formal or dedicated parking facilities will be provided within the substation. However, sufficient cleared areas within the site, on hardstand areas, will be available for any vehicles that visit the substation during operation (such as for routine maintenance or inspections).

d Stormwater and drainage

As construction required a hardstand for the establishment of the substation a stormwater catchment system will be incorporated into design to ensure no contaminated runoff leaves the site. Additionally, oil containment will be incorporated into hardstand design, including bunded transformer compounds to contain any spills or asset failures.

The substation will have a stormwater system and an oil containment system installed as part of the project. The on-site stormwater drainage system will be established during the construction works, allowing stormwater flows from the site to be diverted appropriately away from the switchyard. The stormwater and drainage system will be developed during detailed design, however it is expected to include a series of surface drains which will interconnect with a grid of stormwater pits within the substation site. Appropriate controls will also be installed to ensure sediments, oils and chemicals are controlled and not released from site.

e Landscaping

Landscaping of the substation site is proposed to be limited to typically landscaped grassland extending approximately 25-35 m out from the substation security fence, with this area comprising the APZ.

The easement containing the overhead wire span between Structure 54 and the Lobs Hole substation will also be maintained with ongoing vegetation management as required.

f Utility connections

It is not anticipated that utilities such as water and sewage will be available on the substation site, the substation site will be connected to a rainwater tank is proposed for the collection of rainwater. The substation amenities will be provided for with installation of a pump out septic system. Electricity will be supplied via an auxiliary transformer for low voltage requirements with a backup diesel generator.

iv Construction methods

At the commencement of construction, the main activities which will be undertaken include:

- installation of temporary fencing and security measures as well as any necessary construction environmental management measures such as sedimentation controls;
- confirmation of all utility services and any affected services which will be relocated or required to be made safe to allow construction to proceed;
- clearing and removal of topsoil and vegetation. Excavated topsoil excavated will be stockpiled on site for later use;
- minor earthworks to establish the site amenities. These earthworks will include:
 - cut and fill to establish a level area for the site facilities and temporary storage areas; and
 - trenching to install services (power, water and communications).
- establishment of primary access road; and
- establishment of site office(s) and any other temporary buildings, compounds, carparks and facilities.

i Geotechnical investigations

Further survey of ground conditions is required to inform detailed design of the substation. A program of geotechnical investigations including geophysical survey, excavation of test pits, and borehole drilling, within the revised substation disturbance footprint will be undertaken.

v Plant and equipment

An indicative list of construction plant and equipment likely to be required for the substation construction is provided below in Table 7.1. Not all the equipment identified below will be required for all phases of the proposed construction of the substation and associated transmission lines.

Table 7.1 **Indicative construction equipment**

Air compressors	Drilling machines	Piling rig/s
Backhoes	Dumper trucks	Pneumatic jackhammers
Bob cats	Elevated working platforms	Rigid tippers
Bulldozers	Excavators (various sizes)	10-15 tonne rollers
Concrete agitators	Flatbed Hiab trucks	12-15 tonne rollers
Concrete pumps	Drilling machines	Semi-trailers
Cranes (various sizes up to approximately 200 tonnes)	Forestry harvesters	Tilt tray trucks
Crawler crane with grab attachments	Generators	Trenchers
Crushers	Graders	Transport trucks

vi **Excavation**

Excavation works will be carried out at the substation site to provide a level surface, establish the access roads and create the required trenches for drainage, earthing, and electrical conduits within the site. Excavation works will be carried out using excavators, dozers and crushing plant. Furthermore, depending on the underlying geology, blasting may be required to facilitate the break-up of rock, should it be present.

Some spoil from the excavation may be reused on site for filling and compaction (including benching areas of the site where required). Where excavated material is determined not to be appropriate for re-use on site, it may be necessary to import additional material to site to make up any identified deficit. Where this is required, this will be sourced from suitable local quarries.

vii **Waste**

Anticipated waste streams may include metal offcuts and materials from transmission structures and substation components, vegetation debris, excess spoil including soil and rock, concrete, packaging materials, putrescible wastes and oils and lubricants from construction plant and equipment.

All waste generated during construction will be reused if appropriate, or removed, transported and disposed from the site in accordance with the Waste Classification Guidelines (EPA, 2014), *Protection of the Environment Operations Act 1997* and Protection of the Environment Operations (Waste) Regulation 2005.

viii **Traffic**

Construction vehicle movements will comprise vehicles transporting equipment, waste, materials and spoil, as well as workers' vehicles. Heavy vehicle movements will occur during the main civil construction works associated with the construction of the new substation and for the transport of large plant and equipment to construct the transmission connection. The revised average and peak daily heavy vehicle movements expected during the Lobs Hole substation construction are outlined in Table 7.2.

Table 7.2 **Estimated vehicle movements during substation construction**

Vehicles	Movement Type	Estimated one-way movements
Light vehicles	Indicative daily movements (typical day)	30
	Maximum daily movements (critical peak/peak construction period)	40
Heavy vehicles	Indicative daily movements (typical day)	30
	Maximum daily movements (critical peak/peak construction period)	75

The traffic generated during substation construction is expected to increase the overall traffic volumes during Exploratory Works.

ix Workforce

The substation and transmission infrastructure construction require additional dedicated personnel. During construction, a maximum of 70 additional workers will be required with the average workforce anticipated to be around 35 workers. Post construction there will be no full-time presence at the Lobs Hole substation during operation.

During construction, personnel working on the substation and transmission infrastructure will be housed in the approved Lobs Hole accommodation camp.

x Construction hours

Consistent with the other Exploratory Works approval construction hours for substation establishment will occur within the KNP seven days a week and 24 hours per day. Access to Lobs Hole Ravine Road will generally only occur from 7 am to 6 pm.

Outside of the KNP the works will be undertaken during recommended standard hours for construction. These are:

- Monday to Saturday 7:00 am to 6:00 pm; and
- no works on Sundays or Public Holidays.

Work outside standard hours (outside of the KNP) will only include the following:

- transmission line cutover and commissioning;
- substation assembly (oil filling of the transformer) and commissioning;
- the delivery of materials outside standard hours requested by police or other authorities for safety reasons;
- emergency work to avoid the loss of lives and/or property; and
- work timed to coincide with planned system outages.

7.4.3 Commissioning and operation

i Commissioning

Once all high voltage and low voltage testing is completed, the electrical protection systems have been set and all quality assurance documentation has been completed, commissioning will proceed. The key activities involved in the main commissioning process includes:

- transmission line cut in and connection to the electrical network;
- protection, control, and metering checks;
- high voltage equipment operation and energisation; and
- electromagnetic fields (EMF) testing.

ii Operation

The Lobs Hole substation and associated transmission lines will be inspected by field staff on a regular basis, with other operational activities occurring in the event of an emergency (as required). Likely maintenance activities include:

- regular inspection and maintenance of electrical equipment;
- general building, APZ and landscaping maintenance;
- fire detection system inspection and maintenance; and
- stormwater maintenance.

Routine inspection and maintenance of the substation and transmission infrastructure will be required for the duration of operation; including:

- regular inspection and maintenance of the transmission tower;
- regular inspection and conditions assessment of high voltage plant and equipment within the substation including footings and structural supports; and
- vegetation removal required to maintain appropriate clearances between ground vegetation and transmission lines.

It is expected that only light vehicles and small to medium plant need to access the new substation site and the transmission line easement for these activities. The substation will not accommodate full-time staff or contractors, and the regular collection of waste is not required. Any waste generated during operation of the substation will be minimal and disposed of as required.

7.5 Project boundary changes

The Exploratory Works boundary has been reviewed as part of detailed design and several changes have been identified. Modifications to the project boundary are required to reflect detailed design carried out by the construction contractor and optimise the design and constructability of Exploratory Works. The following changes to the project boundary are required:

- increases in disturbance area of Lobs Hole Ravine Road to improve access, drainage and safety;
- increase in disturbance area of Middle Bay Road to improve drainage and safety and optimise constructability;
- additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability for the crossings; and
- minor additions to construction areas for design optimisation.

In total the proposed modification will result in a net 14 ha increase to the Exploratory Works disturbance footprint. The approved Exploratory Works disturbance footprint is approximately 114 ha and following Modification 1 the Exploratory Works disturbance footprint will be approximately 128 ha.

The change in the overall footprint comprises 14.4 ha of additional disturbance. Changes to the project boundary are shown in Figures 7.8a to Figure 7.8c.

7.5.1 Lobs Hole Ravine Road boundary changes

An amendment to the Lobs Hole Ravine Road upgrade and its construction footprint is proposed. The purpose of this amendment is to improve access, drainage and the safety of the proposed road upgrades. The revised road upgrade includes some areas where additional ground disturbance is required, and other sections where the design has been refined and disturbance area reduced. Rock stabilisation may also be undertaken along the Lobs Hole Ravine Road boundary as required for safety. The Lobs Hole Ravine Road upgrades include a revised approach to upgrades in the boulder stream sections of the road. Where boulder streams are present the road widening will be carried out predominantly through cut on the upslope side of the road. In these sections localised stabilisation may be undertaken using methods and materials with low visual impacts. The Lobs Hole Ravine Road disturbance area changes are provided in Figure 7.8a to Figure 7.8c.

7.5.2 Middle Bay Road boundary changes

An addition to the road boundary of Middle Bay Road is proposed. A section of the disturbance area required for Middle Bay Road will be extended to the Talbingo Reservoir full supply level (FSL) to improve the constructability of this road section. This road boundary addition is shown in Figure 7.8a to Figure 7.8c.

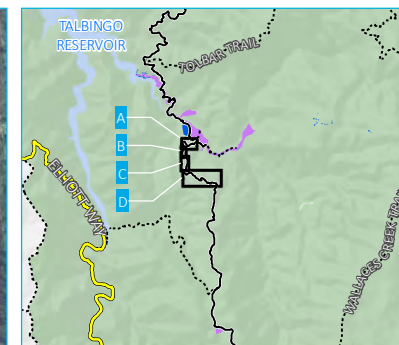
SECTION A



SECTION B



SECTION C



KEY

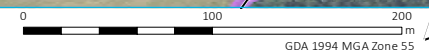
- Local road
- Watercourse / drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Fossil area

SECTION D



Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

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Lobs Hole Ravine Road
boundary changes - 1

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.8a



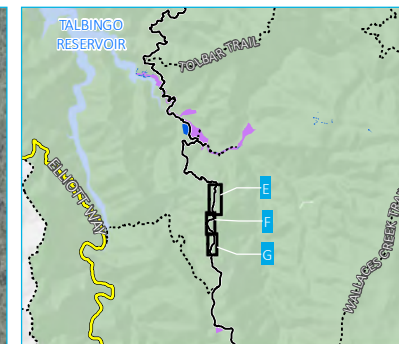
SECTION E



SECTION F



SECTION G



KEY

- Local road
- Watercourse / drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Fossil area

Lobs Hole Ravine Road
boundary changes - 2

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.8b



Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

GDA 1994 MGA Zone 55



7.5.3 Bridge construction

Some additional disturbance area is required adjacent to Camp Bridge and Wallaces Creek Bridge. This is required to improve the constructability of the crossings. The construction activities to be undertaken in the areas adjacent to the two bridges will involve only land-based construction activities with no encroachment on the Yarrangobilly River. Proposed construction activities include:

- clearing of vegetation;
- levelling earthwork, inclusive of fill import as necessary for crane pad construction, stabilisation of equipment parking locations;
- erection of falsework;
- laydown, parking and movement of equipment;
- placement of sediment controls; and
- remediation will occur on site following completion of construction activities.

The construction areas are provided in Figure 7.9.

7.5.4 Minor boundary additions and reductions

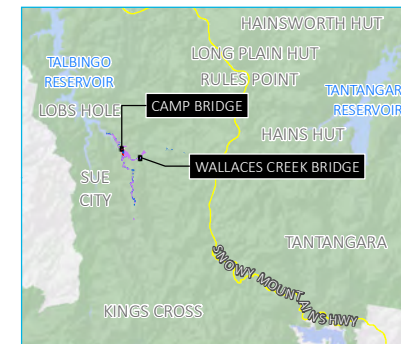
Some minor additions are also proposed to other Exploratory Works construction areas including the portal construction pad, Middle Bay Road, Mine Trail Road and Talbingo Spillway. These changes are proposed to reflect detailed road design undertaken by the construction contractor to optimise the constructability of the Exploratory Works. The additional areas required in these sections are minor in nature.

7.6 Dangerous tree removal

As part of the Exploratory Works pre-construction safety checks a tree risk assessment of trees adjacent to the site access roads, Lobs Hole Ravine Road and Mine Trail Road was carried out. The assessment ascertained the risk of failure for trees affecting the safety of construction workers and road users, evaluate the health and condition of identified trees, as well as any significant defects, and provide management/mitigation options to reduce risks associated with identified trees. The assessment was undertaken by Tree Survey Pty Ltd who utilised a quantified tree risk assessment (QTRA) to assess the trees identified as at risk within the project boundary using the following components of risk:

- **Target:** The persons, property, or asset at risk and the likelihood of that target being present/impacted in the event of partial or whole tree failure.
- **Size:** The size of the tree or branch most likely to impact the target. The size of the failure determines the likely force exerted upon impact.
- **Probability:** The likelihood of a failure occurring within the assessment period (1 year) based on the structure and condition of the tree.

\\lemmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02_Maps\EIS_EW_Mod1\MainReport\MO111_MOD1BridgeConstruction_20190520_01.mxd 22/08/2019



- KEY**
- EW approved construction footprint
 - EW modification construction footprint (additional)
 - Watercourse / drainage line
 - Proposed substation access road

Bridge construction
boundary changes

Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.9

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100
m
GDA 1994 MGA Zone 55



Trees were identified and characterised using risk matrices. A total of 91 trees were identified that pose a risk to construction workers and road users:

- a total of 29 trees were identified as requiring removal within 3 months;
 - one tree, Tree 57, is recommended for the removal of dead branches (greater than 150 mm in diameter) that overhang the access road;
 - remaining trees are recommended for complete removal;
- a total of 62 trees were identified as requiring removal within 6 months;
 - two trees, Tree 16 and 53, are recommended for the removal of dead branches (greater than 150mm in diameter) that overhang the access road; and
 - remaining trees are recommended for complete removal.

A total of 88 trees are likely to require complete removal.

Wherever feasible, trees will be delimbed to reduce safety risks, reduced in height by at least 50% and retained in-situ as habitat trees. This will be determined on a case-by-case basis, with the priority being safety of construction workers and road users. Where this is not feasible, due to safety risks etc., complete removal will be required.

Trees will be removed in a manner which avoids and minimises impacts to adjacent vegetation. Wherever feasible, trees will be removed using sectional dismantling of the tree, with upper limbs removed using tree climbers and elevated work platforms, and gently lowered to the ground or felled onto the road. The trunk will be removed using a tree harvester. This removal method will minimise impacts to adjacent vegetation and threatened species habitat. The removal of any hollow-bearing limbs will be undertaken in accordance with the pre-clearance and clearing procedures outlined in the Exploratory Works Biodiversity Management Plan, as updated, including staged clearing.

All hollow-bearing limbs and sections of trunk will be retained adjacent to the works area (but outside the disturbance boundary wherever possible) as habitat. These limbs and trunk sections should be gently placed into these areas, minimising vegetation disturbance.

7.7 Communication towers

Two temporary communications towers were previously established within KNP as part of the project geotechnical investigation program. These works were assessed under Division 5.1 of the EP&A Act with the consent of the Park Authority pursuant to clause 23 of the National Parks and Wildlife Regulation 2009. Under the original approval the temporary communications towers were planned to be removed at the conclusion of the geotechnical investigation program. To carry out the Exploratory Works safely and efficiently adequate communications capabilities are required throughout the Exploratory Works project area. The existing temporary communications towers are accordingly proposed to remain in place during Exploratory Works to provide adequate communications capabilities within the Exploratory Works project area. The communications towers are provided in Figure 7.10.

7.8 Geomatic survey

Geomatic survey is proposed to inform detailed design. Survey will involve installing concrete posts within existing disturbed areas including geotechnical investigation sites and Exploratory Works construction areas. This will involve minor excavation to a depth of up to 2 m using a hand auger or vehicle mounted drill rig. Access for the survey works will utilise the Exploratory Works access roads as well as other access tracks previously established within the KNP. Unmanned drones will also be used and will be operated within the KNP in accordance with NPWS policies. No vegetation clearance is required for the proposed survey.

7.9 Excavated material management

Excess excavated material will be generated during construction of the Lobs Hole substation and access road establishment and upgrades. The additional excavated material generated by the proposed works is expected to be relatively minor and will be disposed of in accordance with the excavated material management program described in the approved Exploratory Works EIS.

Subject to geochemical testing of excavated rock material, excavated rock will either be re-used, placed on land or placed subaqueously within Talbingo Reservoir. The proposed on land and subaqueous placement areas are described in detail in Section 2.5 of the Exploratory Works EIS. A flow chart showing the proposed process for excavated rock management is provided in Figure 7.11.

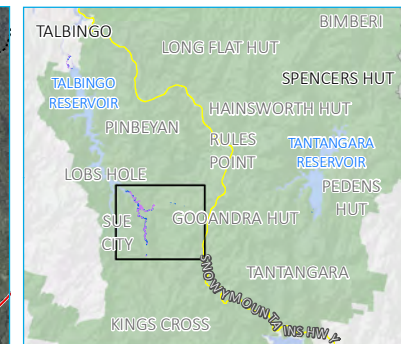
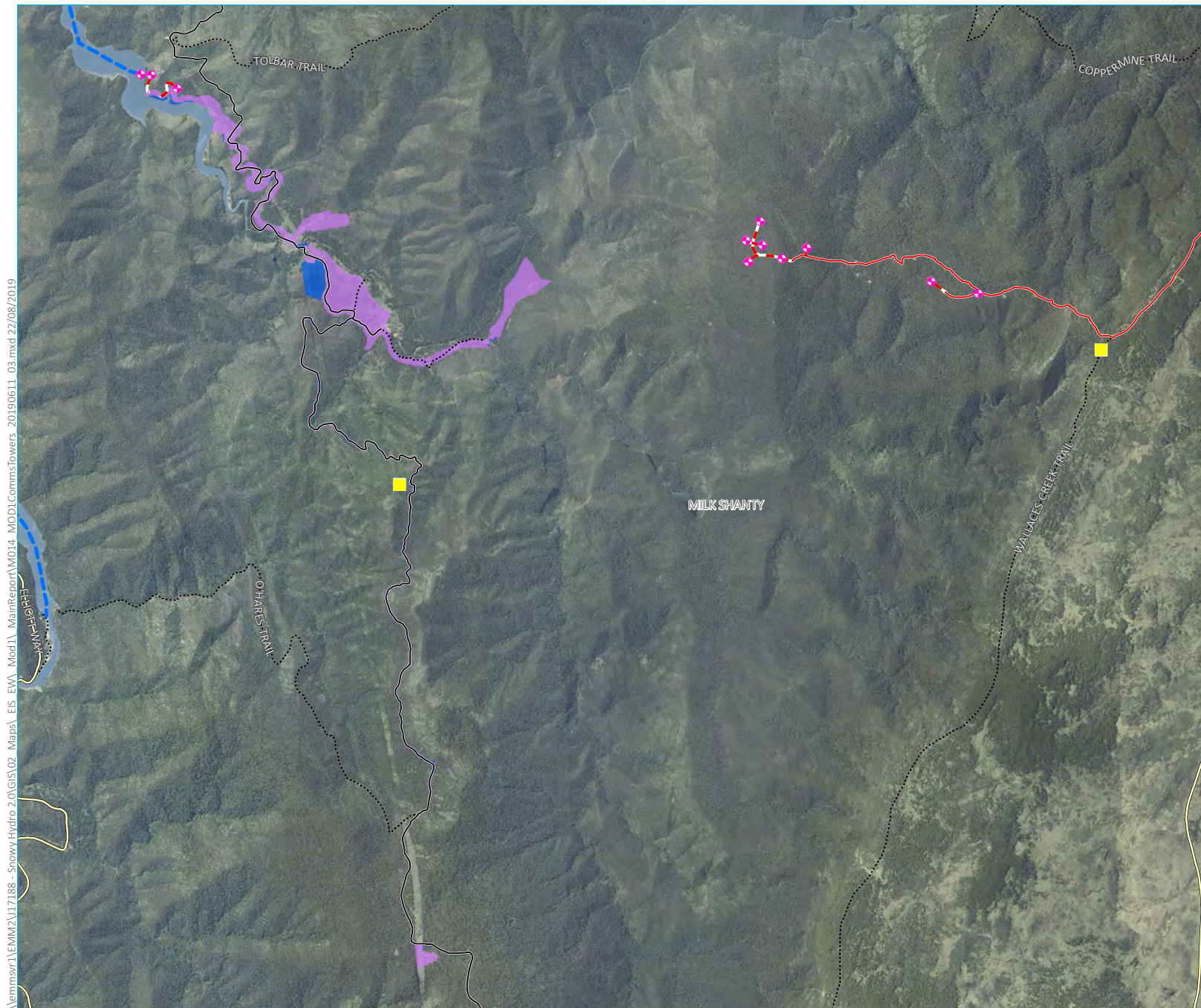
7.9.1 Talbingo North plant and material transfer areas

Four additional plant and material transfer areas are proposed to improve constructability of communications infrastructure, road works and barge infrastructure works. Four sites have been proposed for these areas and are provided in Figure 3.6. These laydown areas are all sited on Snowy Hydro owned land within existing disturbed areas.

7.10 Decommissioning

As described in the Exploratory Works EIS, the project involves construction works associated with further investigations to gather technical and environmental information for Snowy 2.0. Should Snowy 2.0 not proceed following the commencement or completion of Exploratory Works, elements constructed will be decommissioned and disturbed areas rehabilitated. Given works are within KNP, Snow Hydro will liaise closely with NPWS to determine the extent of decommissioning and types of rehabilitation to be undertaken. This approach will be taken to ensure that decommissioning allows for integration with future planned recreational use of these areas and to maintain the values of KNP.

These activities will be documented in a Decommissioning Plan, prepared in consultation with NPWS, and be implemented should Snowy 2.0 not proceed.



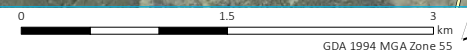
- KEY**
- Existing temporary communications towers
 - Proposed borehole
 - Existing access track
 - Proposed access track
 - Boat access
 - Main road
 - Local road
 - Vehicular track
 - EW approved construction footprint
 - EW modification construction footprint (additional)

Existing communications towers

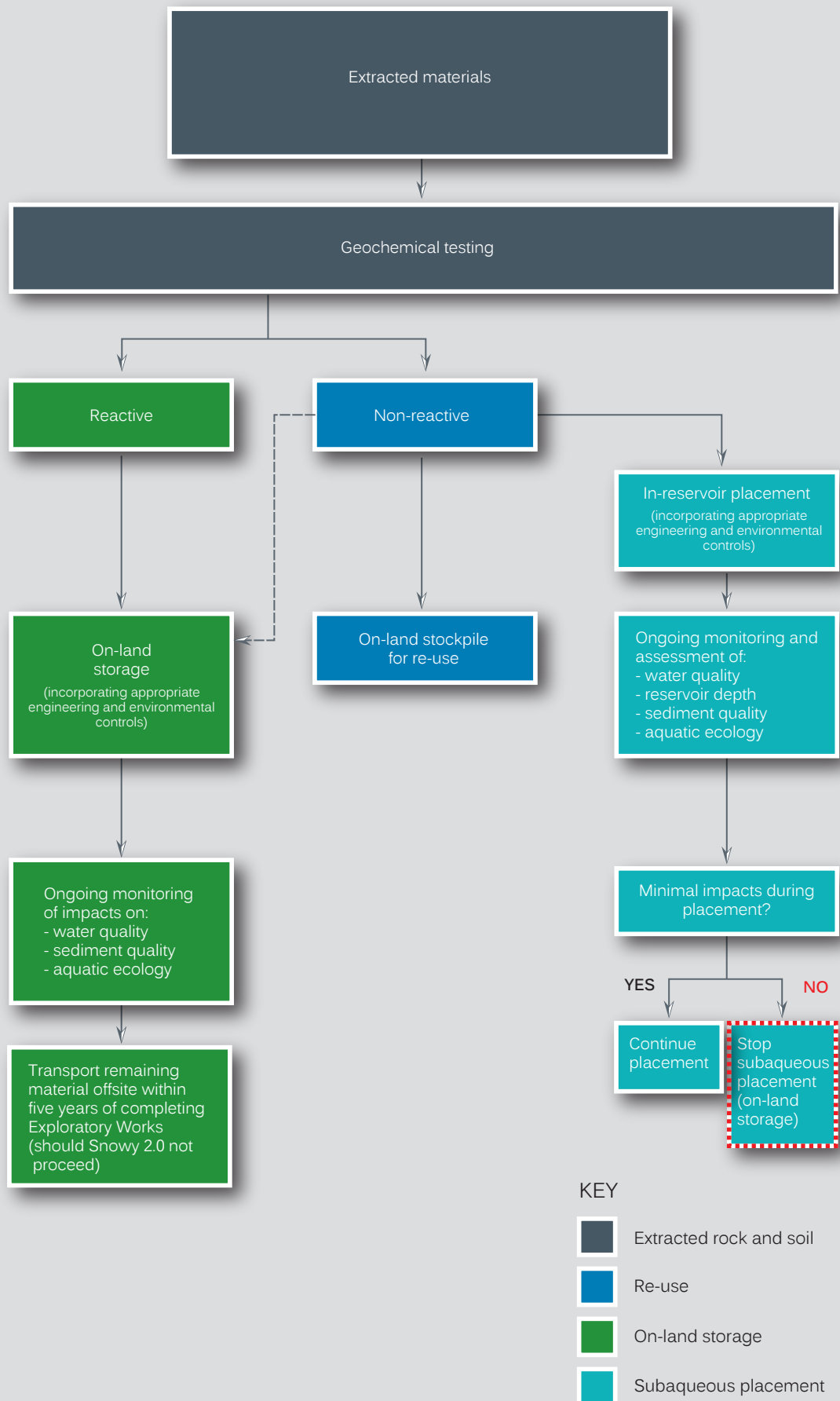
Snowy 2.0
Exploratory Works EIS
Modification 1
Figure 7.10



Source: EMM (2019); Snowy Hydro (2019); LPI (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



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Excavated rock management flow chart



CHAPTER

8

UPDATED MITIGATION MEASURES



8 Updated mitigation measures

Following public exhibition of the Modification 1 assessment report, revisions to the mitigation measures included in the assessment report have been identified. Mitigation measures have been revised in order to further minimise environmental impacts, improve the constructability of the Modification 1 Works and meet the expectations and requirements of stakeholders. A complete and comprehensive list of updated mitigation measures is provided in Table 8.1 below.

Table 8.1 **Revised environmental management measures**

No.	Impact	Environmental management measures	Revised environmental management measures
Biodiversity			
M1.1	Dangerous tree removal	The following controls will be implemented during dangerous tree removal: - Wherever feasible, trees will be delimbed to reduce safety risks, reduced in height by at least 50% and retained in-situ as habitat trees. This will be determined on a case-by-case basis, with the priority being safety of construction workers and road users. Where this is not feasible, due to safety risks etc. complete removal will be required. - Trees will be removed in a manner which avoids and minimises impacts to adjacent vegetation. Wherever feasible, trees will be removed using sectional dismantling of the tree, with upper limbs removed using tree climbers and elevated work platforms, and gently lowered to the ground or felled onto the road. The trunk will be removed using a tree harvester. This removal method will minimise impacts to adjacent vegetation and threatened species habitat. The removal of any hollow-bearing limbs will be undertaken in accordance with the pre-clearance and clearing procedures outlined in the Exploratory Works Biodiversity Management Plan, as updated, including staged clearing. All hollow-bearing limbs and sections of trunk will be retained adjacent to the works area (but outside the disturbance boundary wherever possible) as habitat. These limbs and trunk sections should be gently placed into these areas, minimising vegetation disturbance.	No change
M1.2	Smoky Mouse	The existing Smoky Mouse monitoring program will be extended to include the Marica area.	No change
M1.3	Fauna strike	Restrictions on vehicle movements in the Marica area limited to speeds of 20 km/h between dusk and dawn.	No change
Heritage			
M1.4	Aboriginal heritage	The Aboriginal heritage management plan (AHMP) will be updated to account for the additional areas assessed for the proposed modification.	No change
M1.5	Historical heritage	The historical heritage management plan (HHMP) will be updated to account for the additional areas assessed for the proposed modification.	No change

Table 8.1 **Revised environmental management measures**

No.	Impact	Environmental management measures	Revised environmental management measures
Groundwater			
M1.6	Borehole drilling	During borehole drilling slurries used will be of appropriate grade and composition such that it poses no threat to groundwater quality should it infiltrate intersected aquifers.	No change
M1.7	Lobs Hole substation	During construction of the Lobs Hole substation contractors should assess groundwater conditions as a precaution during excavation. If water is encountered, excavation should cease pending further advice and site-based assessment of conditions.	No change
Surface water			
M1.8	Clean water	Where practicable, all clean water will be diverted around or through sites using cross-path drains or other similar measures to limit impact to existing flow regimes.	No change
M1.9	Regrading	Drill sites that have been modified to allow for vehicle access will be regraded to natural lay of the land as part of the site rehabilitation.	No change
M1.10	Refuelling	A refuelling protocol will be developed for in-reservoir borehole drilling and will be included in the Construction Environment Management Plan (CEMP).	No change
Erosion and sediment control			
M1.11	Erosion and sedimentation	Erosion and Sediment Control Plans will be prepared for all proposed construction sites and drilling pads. These plans will consider local soil characteristics, clean water management and site-specific measures to suit the proposed construction methods.	No change

Table 8.1 **Revised environmental management measures**

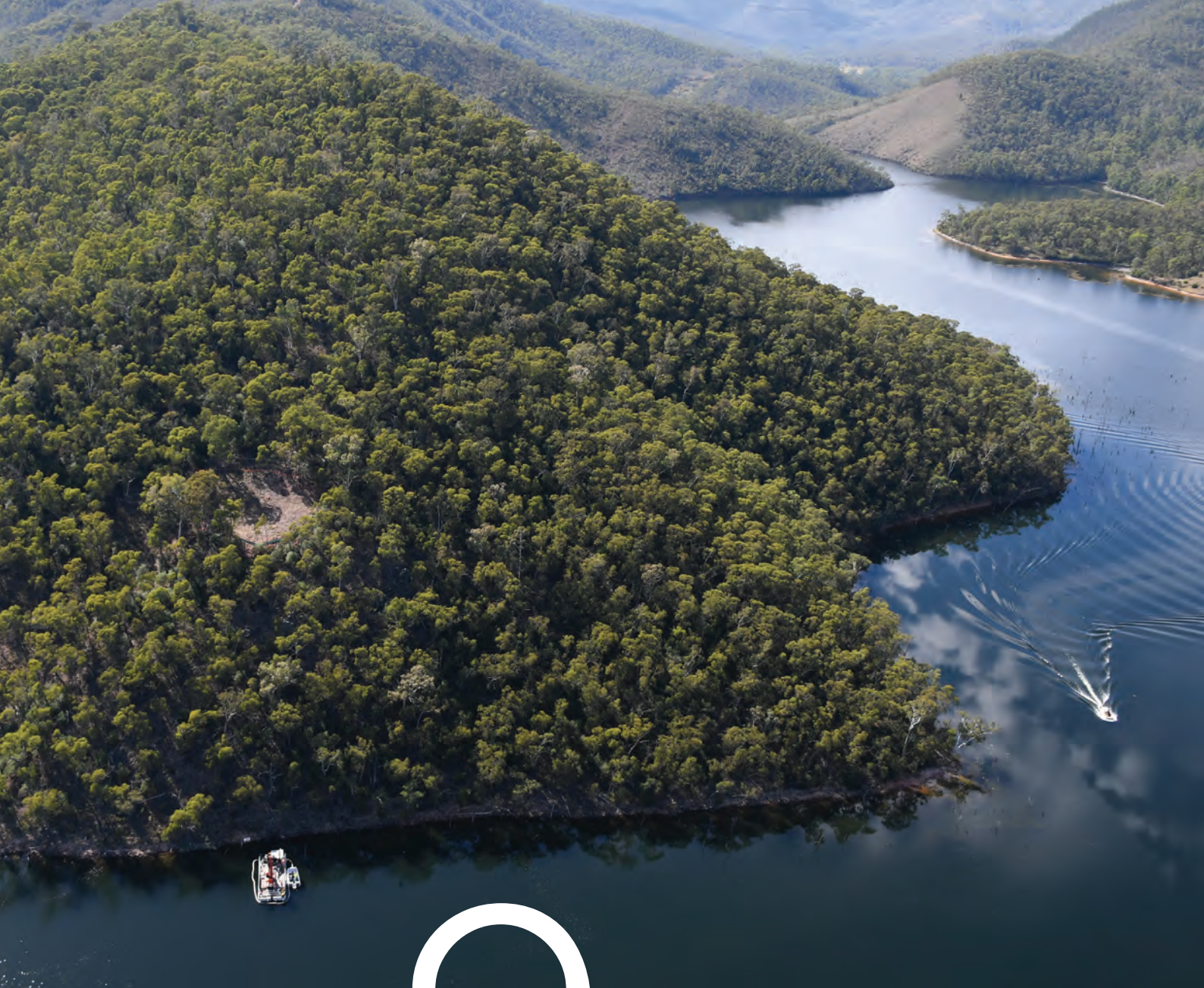
No.	Impact	Environmental management measures	Revised environmental management measures
Hazardous material			
M1.12	Spills	The CEMP will be updated to address spills and leaks of hazardous materials associated with the proposed modification elements including geotechnical investigation drilling. The following controls will be included as part of this update: • All fuel and hazardous substances used in drilling will be stored in designated areas of the drill pad. Hazardous chemicals will be stored in accordance with relevant standards, including AS 1940:2004. • Designated fuel storage areas will be bunded to mitigate risk of contamination to surface water and soils should spills occur. Refuelling will also be carried out in the designated, bunded area. • Equipment should be appropriately maintained to ensure there are no leaks. • Spill kits will be available on site to contain contamination should any spills outside these bunded areas occur. If used, waste from the spill kits will be disposed of appropriately. • The safety data sheets of all hazardous chemicals required for drilling activities will be made available on site. All waste produced during drilling will be stored on site in above ground containers, and when required will be taken off-site by vehicles. All waste will be disposed of off-site to an EPA licensed facility.	Geotechnical investigation drilling will be undertaken in accordance with the surface water management plan. The following mitigation measures are included in the existing surface water management plan: • All fuel and hazardous substances used in drilling will be stored in designated areas of the drill pad. Hazardous chemicals will be stored in accordance with relevant standards, including AS 1940:2004. • Designated fuel storage areas will be bunded to mitigate risk of contamination to surface water and soils should spills occur. Refuelling will also be carried out in the designated, bunded area. • Equipment should be appropriately maintained to ensure there are no leaks. • Spill kits will be available on site to contain contamination should any spills outside these bunded areas occur. If used, waste from the spill kits will be disposed of appropriately. • The safety data sheets of all hazardous chemicals required for drilling activities will be made available on site. All waste produced during drilling will be stored on site in above ground containers, and when required will be taken off-site by vehicles. All waste will be disposed of off-site to an EPA licensed facility.
Flooding			
M1.13	Flooding	Protocols will be developed for the proposed modification elements for use and storage of plant, equipment and materials in flood prone areas commensurate with the frequency of inundation.	No change
Geodiversity			
M1.14	Block streams		Carry out field mapping of block stream extents and morphology within the construction footprint prior to works. Use this data to assist preparation of final design and construction plans which minimise potential impacts on these features and enable management of impacts during construction.

Table 8.1 **Revised environmental management measures**

No.	Impact	Environmental management measures	Revised environmental management measures
M1.15	Block streams		Consider visual amenity in the final road design and aim, where possible, to avoid the use of construction methods and materials that detract from the landscape values of the block streams and their surrounds.
M1.16	Block streams		In order to maintain feature integrity in a near-natural state, construction activities should, where practical: • minimise the extent of excavation into the upslope block streams; • minimise moving or damaging blocks in areas beyond the excavation zone; • minimise the use of outside materials onto the block streams (e.g. soil or fill); • minimise use of any stabilisation measures that permanently cover the block streams, for example with shotcrete or other construction materials which would preclude their future viewing and study.
M1.17	Block streams		Road design will incorporate adequate drainage controls to ensure water flow through the upslope block streams are not impeded as this may impact local stability of the features.
M1.18	Block streams		Erosion and sediment control measures will be implemented during and after construction with the aim to minimise adverse impacts on and around the block streams.
M1.19	Block streams		The proposed works should implement controls in accordance with the Biodiversity Management Plan to ensure they do not promote the spread of weeds near the boulder streams, and thereby reduce their visibility.
M1.20	Block streams		Care will be taken to minimise impacts on the downslope section of Block Stream B which features well-preserved evidence of ice age block flow in the form of ridges and other low relief surface topography.

Table 8.1 **Revised environmental management measures**

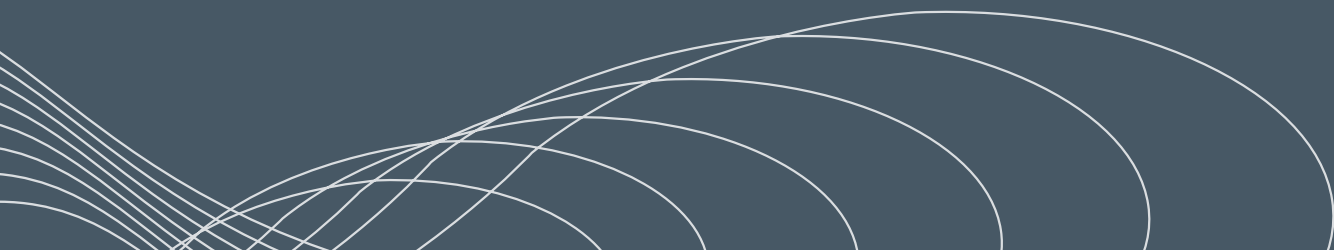
No.	Impact	Environmental management measures	Revised environmental management measures
Traffic			
M1.21	Coppermine Trail intersection		The construction traffic management plan and traffic control plan, including the road occupancy license, for the Coppermine Trail/Snowy Mountains Highway intersection will be revised and updated to accommodate the latest proposed Modification 1 temporary construction access requirements.



CHAPTER

9

EVALUATION AND CONCLUSION



9 Evaluation and conclusion

This chapter presents the overall impacts and benefits of the Modification 1 works, having regard to strategic need, environmental, social and economic impacts and considers the response to project changes and additional assessments undertaken in the response to submissions.

9.1 Need for the modification

Since the Exploratory Works EIS was developed, Future Generation Joint Venture (FGJV) has been engaged by Snowy Hydro as the construction contractor and a period of design development has led to a shift in the location of the proposed power station approximately one kilometre west along the tunnel alignment. This shift in the power station location will cause a change in alignment and reduction in length of the exploratory tunnel, which will now also finish approximately one kilometre west of the location detailed in the Exploratory Works EIS.

The proposed modification reflects project changes and requirements identified by the construction contractor.

Modification 1 will enhance the outcomes of Exploratory Works. The proposed modification will contribute to the aims of Exploratory Works by providing the following benefits:

- provide additional geotechnical information required for the detailed design of Snowy 2.0;
- provide a more reliable power source and reduce the management, maintenance and environmental impacts associated with additional diesel generation;
- optimise the detailed design of construction areas and access roads; and
- improve worker safety during construction.

9.2 Summary of environmental impacts

Impacts to the biophysical environment are likely to arise in two ways; via direct impacts from clearing of vegetation and ground disturbance, and via indirect impacts (eg water runoff, noise and light) to adjacent areas during construction activities. Following the avoidance and minimisation measures adopted through design, the main impacts concluded for the proposed modification are described and assessed as follows.

9.2.1 Biophysical environment

i Conservation

Conservation values include biodiversity and heritage, which contribute to the overall values of KNP.

The heritage assessment found that the proposed modification will have only minimal impacts on known Aboriginal or historic heritage items. The potential impacts to Aboriginal and historic heritage are able to be adequately managed using the revised mitigation measures provided in Table 8.1. The Exploratory Works AHMP and HHMP will be updated to include the revised mitigations.

The biodiversity assessment found that the project area contains habitat for native and threatened flora and fauna including the Slender Greenhood, Gang-gang Cockatoo, Eastern Pygmy-possum, Booroolong Frog, Smoky Mouse and Alpine Tree Frog. Residual impacts to biodiversity are considered to be one of the most important issues to be managed during Exploratory Works.

The impacts on Smoky Mouse habitat is potentially the most serious and therefore impacts from design and construction along identified habitat on Lobs Hole Ravine Road and Marica have been minimised. The minor loss of native vegetation and impacts to threatened species will require offsets in accordance with legislation, and implementation of a biodiversity offset strategy will be determined in consultation with NPWS and DPIE (Biodiversity and Conservation).

ii Land

The proposed modification has been designed with consideration to impacts on landform and soil characteristics, including geodiversity features. The disturbance footprint has been reduced as far as practical to avoid and minimise disturbance to landforms and soils. The modification road upgrades will impact on five boulder streams on Lobs Hole Ravine Road. As described in Section 3.2 the road upgrade works have been designed to ensure geotechnical stability whilst also minimising the impacts on the geodiversity values of the boulder streams. Very minor disturbance will occur to the Ravine Beds fossil area and is expected to have negligible impacts to the significance of the feature. No other geodiversity features will be impacted and the proposed encroachment on these areas are very minor. Additional mitigations have been identified for the boulder stream works and are detailed in Table 8.1. The implementation of these measures are expected to provide adequate protection and the geodiversity values of these features will not be affected.

iii Water

The proposed modification will have only minimal impacts on water. The potential issues include erosion and sedimentation impacts from construction sites, surface water quality impacts associated with in-reservoir drilling, impacts to groundwater quality associated with geotechnical drilling and contamination from hazardous materials associated with geotechnical drilling and construction of proposed infrastructure. These impacts will be minimised through the continued use of design and control measures that are in place for the Exploratory Works.

9.2.2 Social and economic

Impacts to social values are primarily connected to the amenity and conservation values of KNP as part of recreational uses. Social and economic impacts are also associated with the influx of workforce and contribution to local business and housing. The main impacts concluded for the proposed modification are described and assessed as follows.

i Amenity and public safety

The construction associated with the proposed modification will have potential to cause noise and vibration impacts, impacts to local air quality and visual amenity. However, due to the isolated and remote location of the works the proposed modification is expected to have no perceptible amenity impacts on any identified sensitive receivers.

Other public safety risks are bushfire and electromagnetic fields from the proposed Lobs Hole substation. These risks will be mitigated through design of the Lobs Hole substation and other assets to include appropriate bushfire and electromagnetic fields protection standards.

ii Recreation

No additional impacts to recreational users are expected due to the proposed modification.

iii Economic factors

Up to 70 additional workers will be employed during the construction of the Lobs Hole substation. The additional workforce required for the proposed modification will be housed in the Exploratory Works accommodation camp when they are rostered-on. Similar to the existing approved Exploratory Works workforce some employees will be sourced from the local labour force, but most will FIFO and/or DIDO.

The proposed modification is expected to have no measurable impacts on the capacity of community services and infrastructure. This is based on the negligible population changes predicted for the total Exploratory Works workforce and the existing service and infrastructure capacity of service level providers within the local area.

The economic impacts of the proposed modification are expected to be largely consistent with the economic impacts predicted in the Exploratory Works EIS (EMM 2018a).

9.3 Snowy Hydro's commitment

Snowy Hydro is committed to maintaining its excellent environmental track record of work within the KNP. The environmental management framework that will govern the avoidance, minimisation and management of impacts during the Exploratory Works has been set out to ensure responsibilities and accountabilities for environmental performance are clear (see Chapter 6 of the Exploratory Works EIS).

Snowy Hydro's consultation with key stakeholders and the community is ongoing. Working together with NPWS is fundamental to achieving long term management objectives, and has been important in the development of Exploratory Works. Snowy Hydro has set out in its commitments, the ability for the Exploratory Works to be reversible (ie decommissioned and suitably rehabilitated) should unacceptable impacts occur or if Snowy 2.0 does not proceed. Snowy Hydro has also been working with NPWS to develop appropriate offsets for biodiversity and recreational uses, for predicted impacts.

9.4 Conclusion

The proposed modification will contribute to achieving the objectives of the Exploratory Works and is essential to the final design of Snowy 2.0.

The proposed modification has been designed to avoid and minimise impacts where possible. The residual impacts have been identified and assessed. The key impacts of the proposed modification are associated with direct and indirect impacts from vegetation clearance and ground disturbance, such as loss of native habitat for threatened species, impacts to known geodiversity features and potential for impacts to water quality from construction activities.

The proposed modification will provide several benefits that contribute to the objectives of the Exploratory Works. These include providing additional geotechnical information required to finalise the design of Snowy 2.0, improving the efficiency of the construction power supply, optimising the design of several construction areas and roads and improving safety during construction.

The proposed modification is considered to be justified and in the public interest because:

- it seeks to promote the management and conservation of resources, while also permitting appropriate development to occur which is in line with the objects of the EP&A Act;
- Snowy 2.0 will provide long term reliable energy, environmental and economic benefits;
- it is a necessary precursor to finalising the detailed design for Snowy 2.0. The geotechnical investigation drilling is required to understand the geotechnical conditions of the site for the proposed underground power station, the power waterway and access;

- the design of the proposed modification has been an iterative design and environmental assessment process to ensure impacts have been avoided and minimised as much as possible;
- the environmental impact assessment has identified that residual impacts can be appropriately managed and in consultation with NPWS and DPIE (Biodiversity and Conservation);
- consultation with NPWS, DPIE (Biodiversity and Conservation) and other key stakeholders has been undertaken to ensure appropriate management objectives are identified for the proposed works; and
- Snowy Hydro has committed to the long-term environmental management and rehabilitation of impacted sites, including removal, decommissioning and rehabilitation, should Snowy 2.0 not proceed.

Glossary

Term	Meaning
Access road upgrade	Upgrade works (realignment, widening or no widening) of existing access roads
Access road extension	A new access road that is an extension of an existing access road
Accommodation camp	Area used for temporary housing and facilities for construction personnel
Avoidance footprint	Exploratory Works areas excluded from clearing and ground disturbance due to sensitive environmental constraints
Barge access infrastructure	A ramp and associated facilities to allow the loading and unloading of barge(s) on Talbingo Reservoir
Base-load	Represents the minimum continuous level of energy demand in a grid system
Camp Bridge	The permanent bridge structure across Yarrangobilly River
Communications cable	Fibre optic communications cable in Talbingo Reservoir
Disturbance footprint	The area subject to clearing and ground disturbance
Exploratory tunnel	A 3.1 km tunnel to the cavern of the proposed Machine Hall for the purposes of understanding geotechnical and underground conditions
Exploratory Works	A program of exploratory works for Snowy 2.0, as more fully described in the EIS for Application No. SSI 9208 and approved by the Minister on 7 February 2019 subject of this EIS and as described in Section 2
Firming generation/capacity	Energy available within the network to respond to demand when other energy sources, such as intermittent renewables are not operating (due to low wind or low sunlight)
Hydro-electric	Generation of electricity using flowing water (typically from a reservoir held behind a dam or barrage) to drive a turbine which powers a generator
Kosciuszko National Park	A National Park protected under the NSW <i>National Parks and Wildlife Act 1974</i> and managed by NSW National Parks and Wildlife Service. It covers an area of 673,543 hectares and forms part of Australia's only Alpine area
Lobs Hole	A former settlement location within Kosciuszko National Park, and primary location of Exploratory Works
Lobs Hole Mine	The site of a former copper mine circa 1908, located at Lobs Hole
Lobs Hole Road	The road at Lobs Hole, not the main access down to Lobs Hole
Lobs Hole Ravine Road	The main access road to Lobs Hole
Lower Lobs Hole Ravine Road	The section of Lobs Hole Ravine Road from Link Road to where it crosses the transmission easement
Middle Bay barge ramp	Location of barge access infrastructure at the southern end of Talbingo Reservoir
Middle Bay Road	The access road from the accommodation camp to the Middle Bay barge ramp. An extension to Middle Bay Road is proposed as part of Exploratory Works
Miles Franklin Drive	Existing road leading to Spillway Road, for access to the Talbingo barge ramp
Mine Trail Road	The access road from the intersection with Lower Lobs Hole Ravine Road and the portal construction pad. An extension to Mine Trail Road is proposed as part of Exploratory Works
On land rock emplacement area	The locations for rock emplacement at Lobs Hole being the western emplacement area and the eastern emplacement area
Permanent bridge	The permanent bridge crossings comprising Wallace Creek Bridge and Camp Bridge
Portal	Location of surface connection with the exploratory tunnel
Portal construction pad	Area used for construction for the exploratory tunnel and portal, including ancillary facilities, laydown and storage, and environmental controls
Power station	An industrial facility for the generation of electric power

Term	Meaning
Project area	The area required to access and build project infrastructure, including surface and tunnel components of the project
Snowy 2.0	A pumped hydro-electric expansion of the Snowy Scheme that will link the two existing reservoirs of Tantangara and Talbingo through underground tunnels, and include a new underground power station with pumping capabilities
Spillway Road	The access road to Talbingo barge ramp
Talbingo barge ramp	Location of barge access infrastructure at the northern end of Talbingo Reservoir
Talbingo Spillway	Structure used to provide the controlled release of flows from Talbingo Dam into the reservoir
Temporary bridge	A temporary structure or causeway across a watercourse to allow construction of permanent bridges
Tumut 2 power station	Underground power station south of Talbingo Reservoir
Tumut 3 power station	Power station at the northern end of Talbingo Reservoir
Upper Lobs Hole Ravine Road	The section of Lobs Hole Ravine Road from where it crosses the transmission easement to Lobs Hole
Wallaces Creek Bridge	The permanent bridge structure across Wallaces Creek
Water services pipeline	Utility pipeline for Exploratory Works providing water supply and wastewater discharge between accommodation camp, portal construction pad and Talbingo Reservoir

References

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- 2019a, Snowy 2.0 Exploratory Works: Modification 1 to Infrastructure Approval SSI 9208, prepared for Snowy Hydro Limited.

NSW Archaeology 2018, Exploratory Works Aboriginal Cultural Heritage Assessment Report, prepared for Snowy Hydro Limited.

- 2019 Main Works Aboriginal Cultural Heritage Assessment Report (in draft), prepared for Snowy Hydro Limited.

Safe Work Australia 2013, *Guide for tunnelling work*, Australian Government, Canberra, ACT



APPENDIX

A

SUBMISSION REGISTER



A.1 Submissions register

Ref#	Category	Objection	Name	Role	Company/agency	Address
1	Government	No	Rebecca Newell	Senior Historical Archaeology Officer	Heritage Division Department of Premier and Cabinet	Locked Bag 5020 PARRAMATTA NSW 2124
2	Government	No	Deon Voyer	Manager Operations South	Maritime Division Transport for NSW	91 Foreshore Road PORT KEMBLA NSW 2505
3	Government	No	Ellie Dean	Officer	South East Region Environment Protection Authority	PO Box 622 QUEANBEYAN NSW 2620
4	SIG	Objection	Keith Muir	Director	Colong Foundation for Wilderness	Suite 201, Level 2 332 Pitt Street SYDNEY NSW 2000
5	Community	Objection	Gary Bilton	—	—	49 Grove Street TALBINGO NSW 2720
6	Government	No	Elizabeth Rogers	Manager Assessments	Division of Water Department of Planning, Industry and Environment	Level 49, 19 Martin Place SYDNEY NSW 2000
7	Community	Objection	George Thomas	—	—	—
8	Government	No	Mike Saxon/ Alison Treweek	Director, South East Branch	DPIE (Environment and Heritage) & NPWS	Level 3, 11 Farrar Place QUEANBEYAN NSW 2620
9	Government	No	Chris Millet/ Andrew Lissenden	Manager Land Use, Southern Region	Roads and Maritime Services	—
10	SIG	No	Gary Dunnet	Executive Officer	National Parks Association of NSW	PO Box 528, Pyrmont NSW 2009

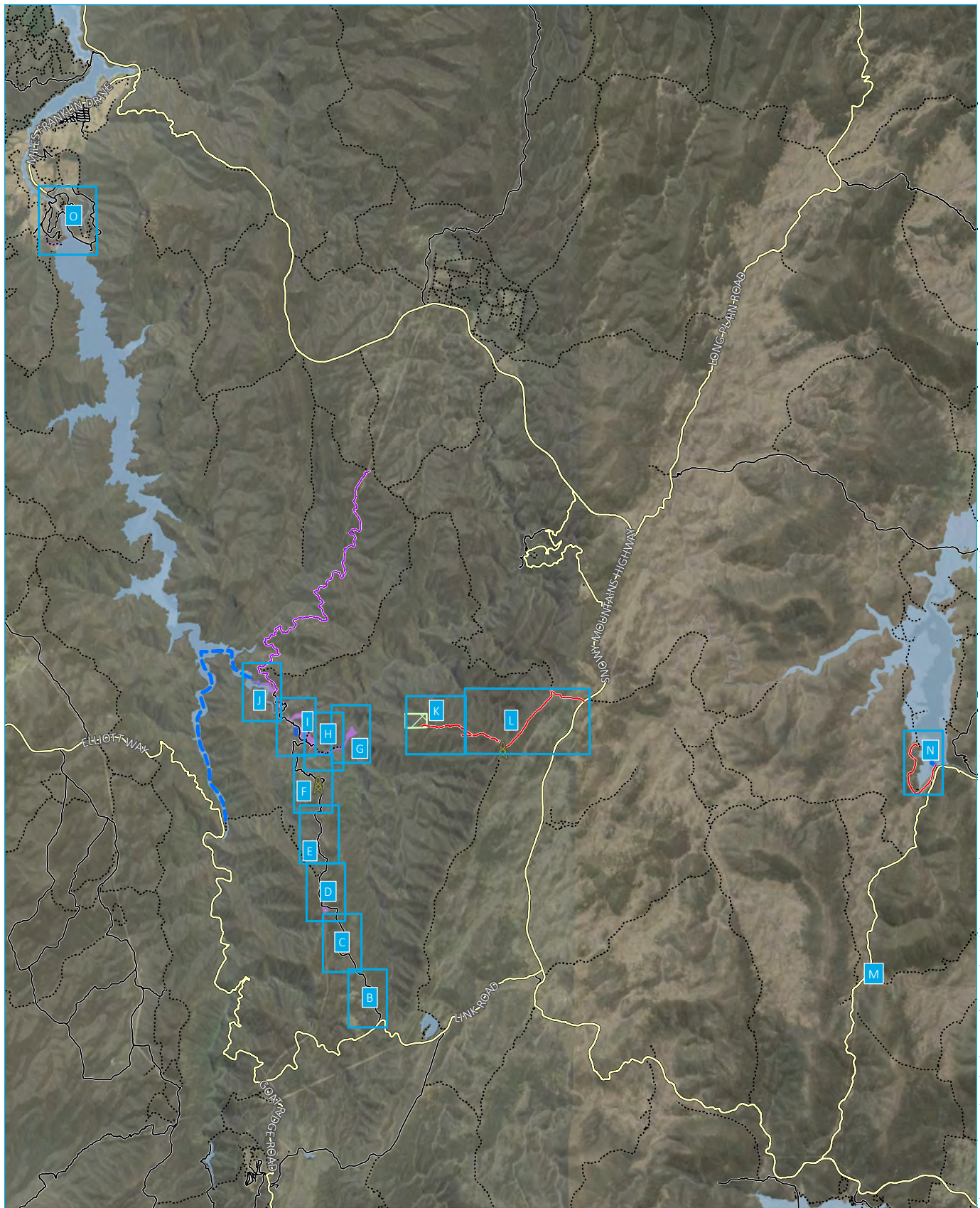


A P P E N D I X

B

PROJECT BOUNDARY





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Proposed temporary communications upgrade location
- Existing access track
- Boat access
- Main road
- Local road
- Vehicular track
- Map index
- EW approved construction footprint
- EW modification construction footprint (additional)
- Boreholes requiring on-site adjustment
- Lobs Hole Ravine Road north - emergency evacuation
- Waterbody

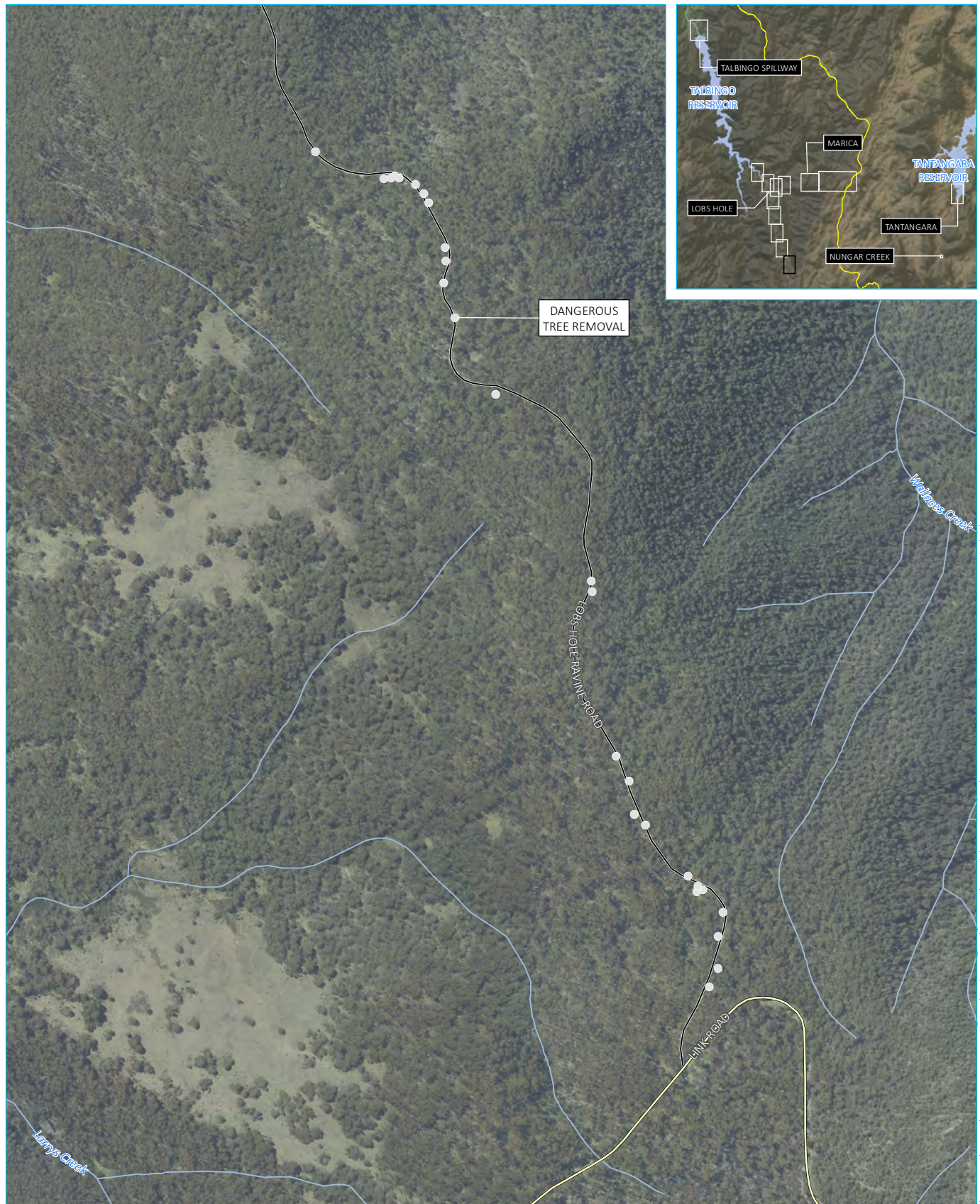
0 5 10 km
GDA 1994 MGA Zone 55

Exploratory Works project boundary - overview

Snowy 2.0
Exploratory Works EIS
Modification 1
1 a



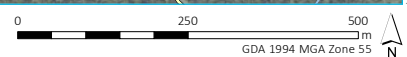
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- Main road
- Local road
- Watercourse/drainage line



Exploratory Works project boundary
- Lobs Hole Ravine Road (Upper) 1

Snowy 2.0
Exploratory Works EIS
Modification 1
1 b





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

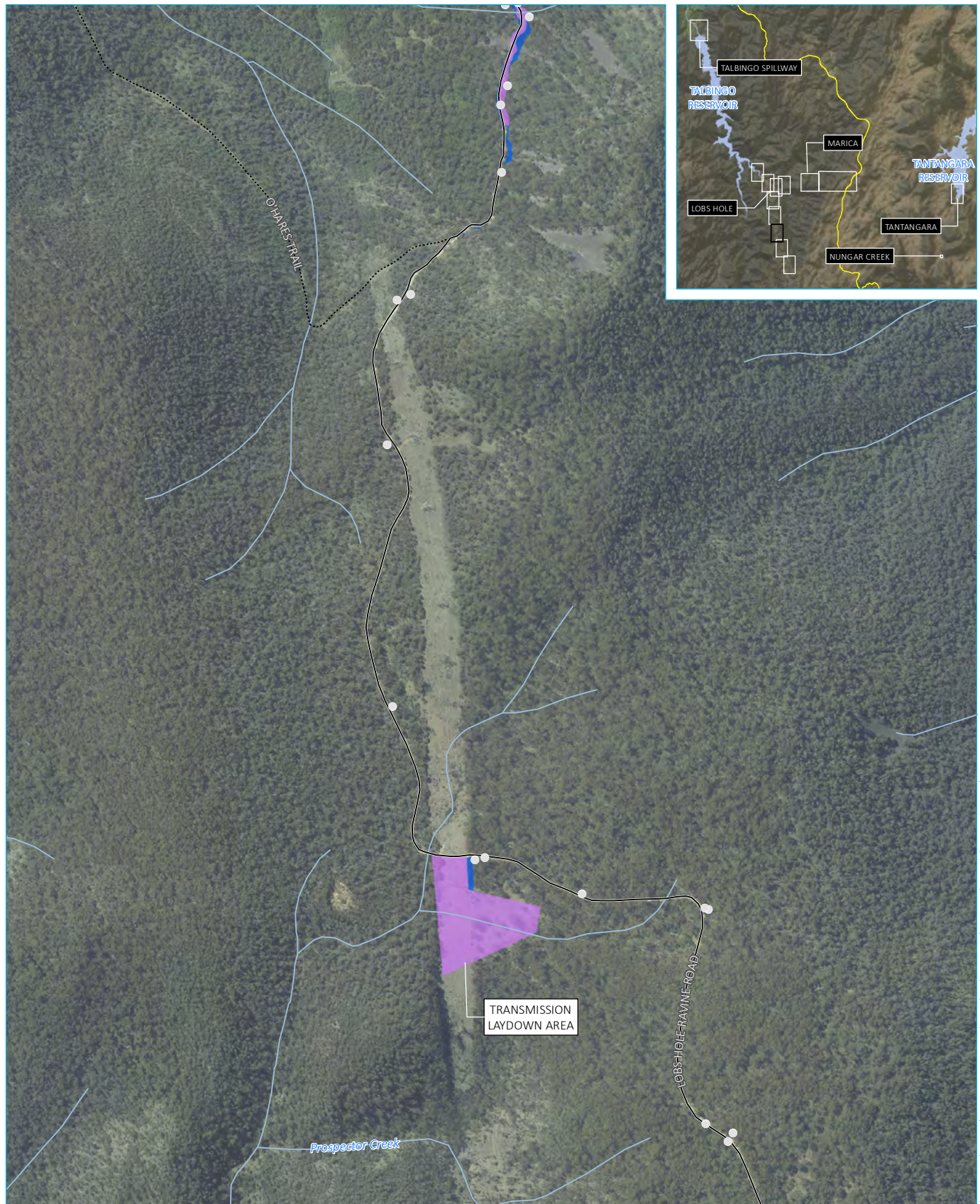
- Dangerous tree
- Local road
- Watercourse/drainage line
- EW approved construction footprint

0 250 500
m
GDA 1994 MGA Zone 55

Exploratory Works project boundary
- Lobs Hole Ravine Road (Upper) 2

Snowy 2.0
Exploratory Works EIS
Modification 1
1 c





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

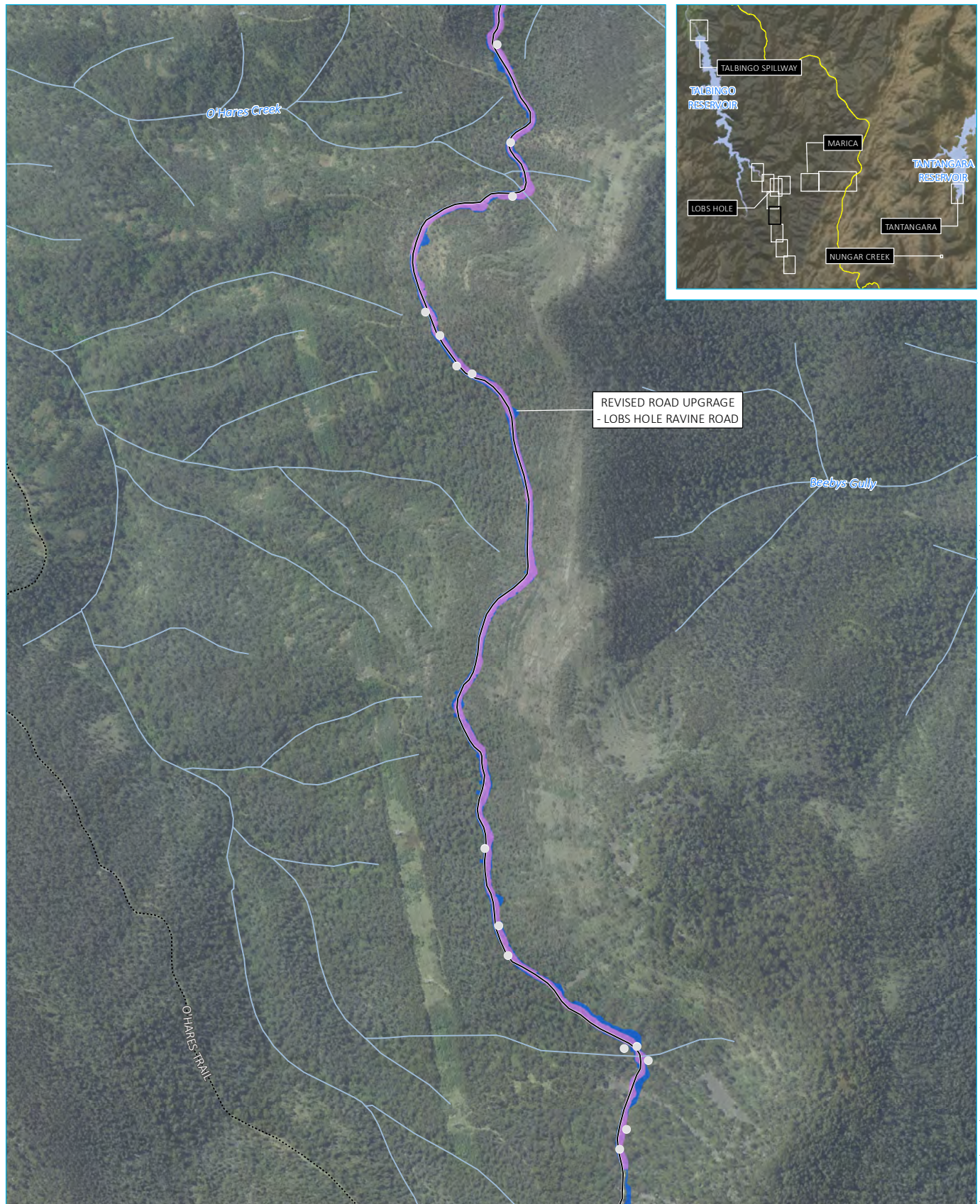
- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)

0 250 500
m
GDA 1994 MGA Zone 55

Exploratory Works project boundary
- Lobs Hole Ravine Road (Upper) 3

Snowy 2.0
Exploratory Works EIS
Modification 1
1 d

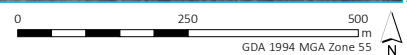




Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)

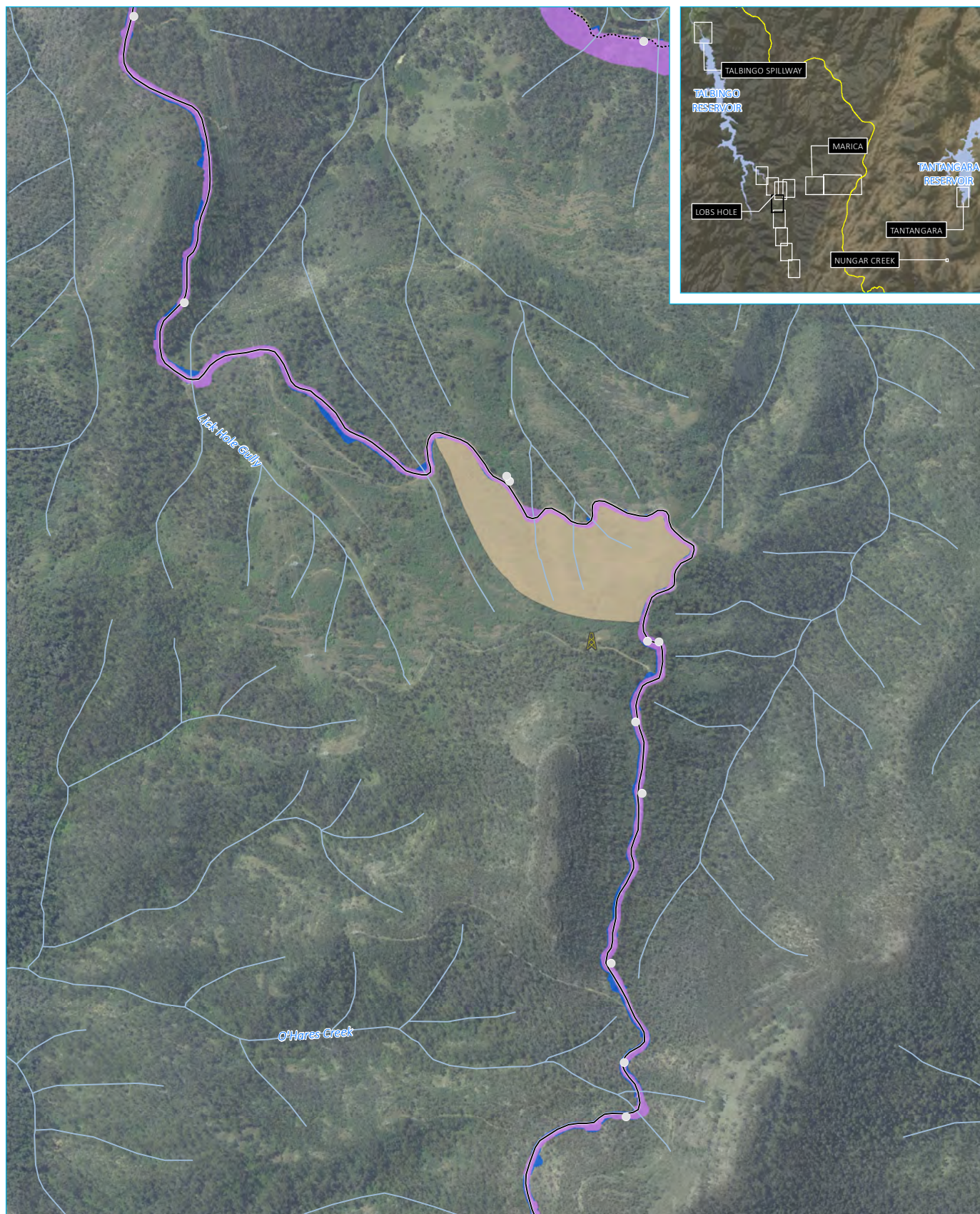


Exploratory Works project boundary
- Lobs Hole Ravine Road (Lower) 1

Snowy 2.0
Exploratory Works EIS
Modification 1
1 e



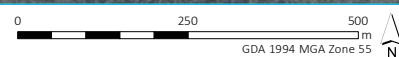
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- ▲ Proposed temporary communications upgrade location
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Fossil area

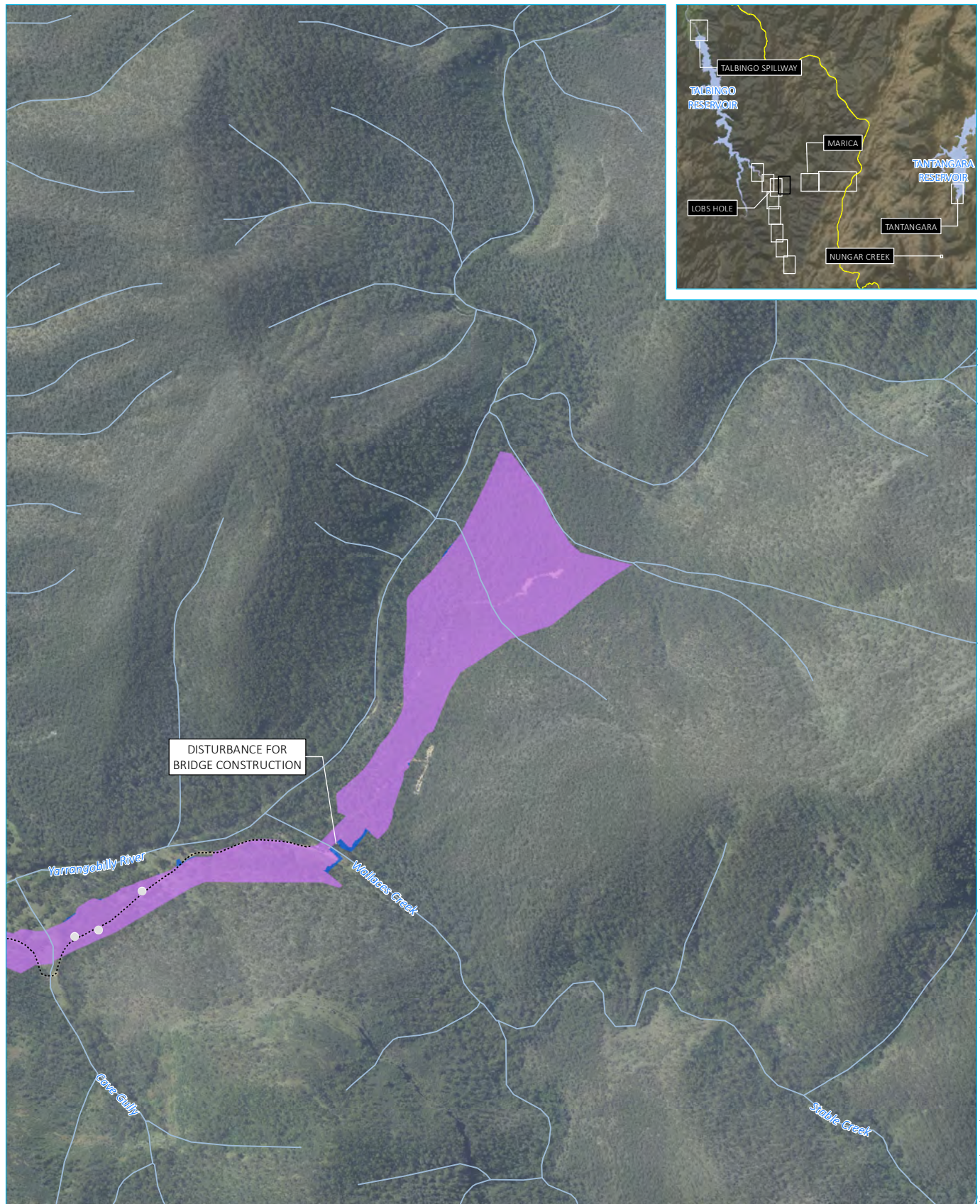


Exploratory Works project boundary
- Lobs Hole Ravine Road (Lower) 2

Snowy 2.0
Exploratory Works EIS
Modification 1
1 f



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

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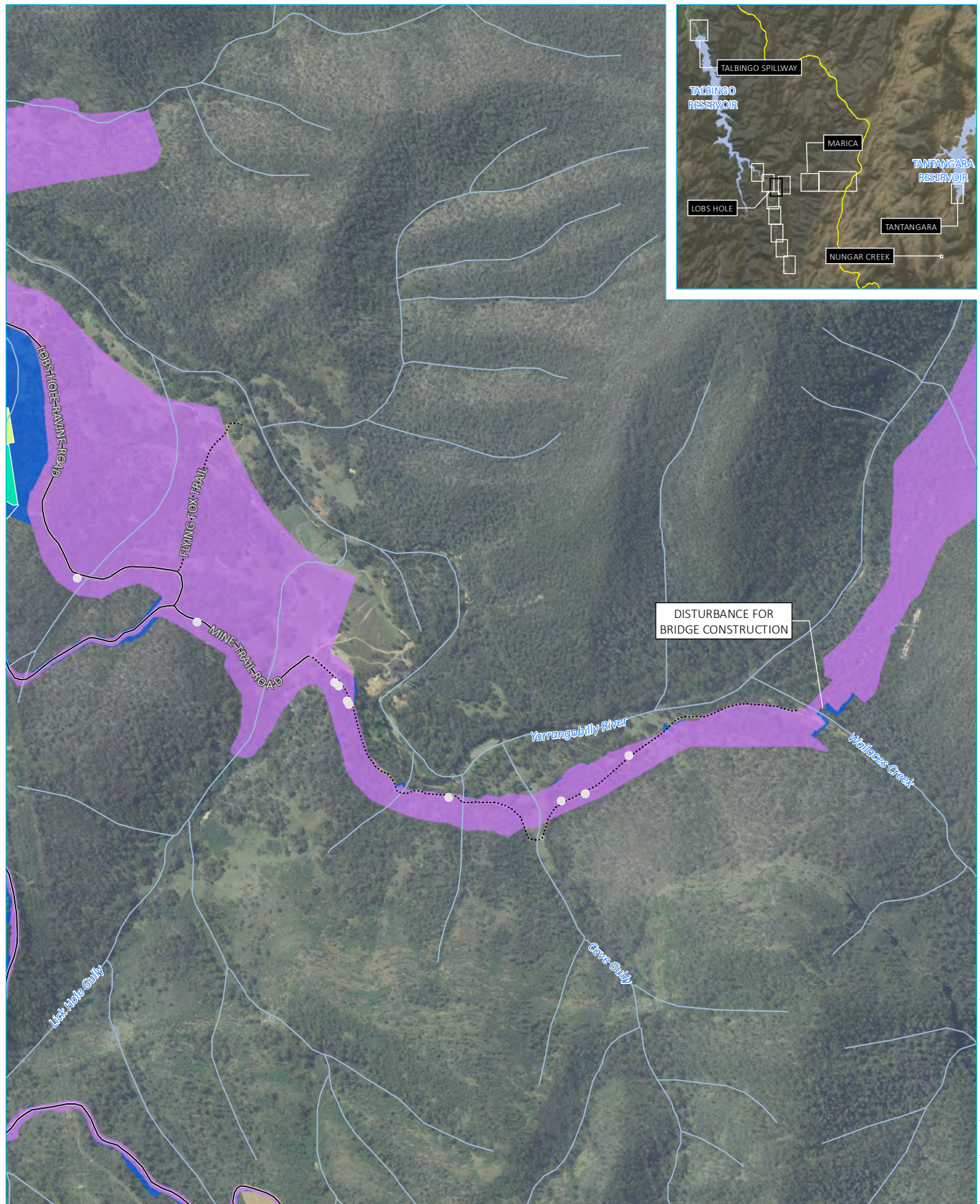
- Dangerous tree
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)

0 250 500
m
GDA 1994 MGA Zone 55

Exploratory Works project boundary
- Mine Trail Road 1

Snowy 2.0
Exploratory Works EIS
Modification 1
1 g





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

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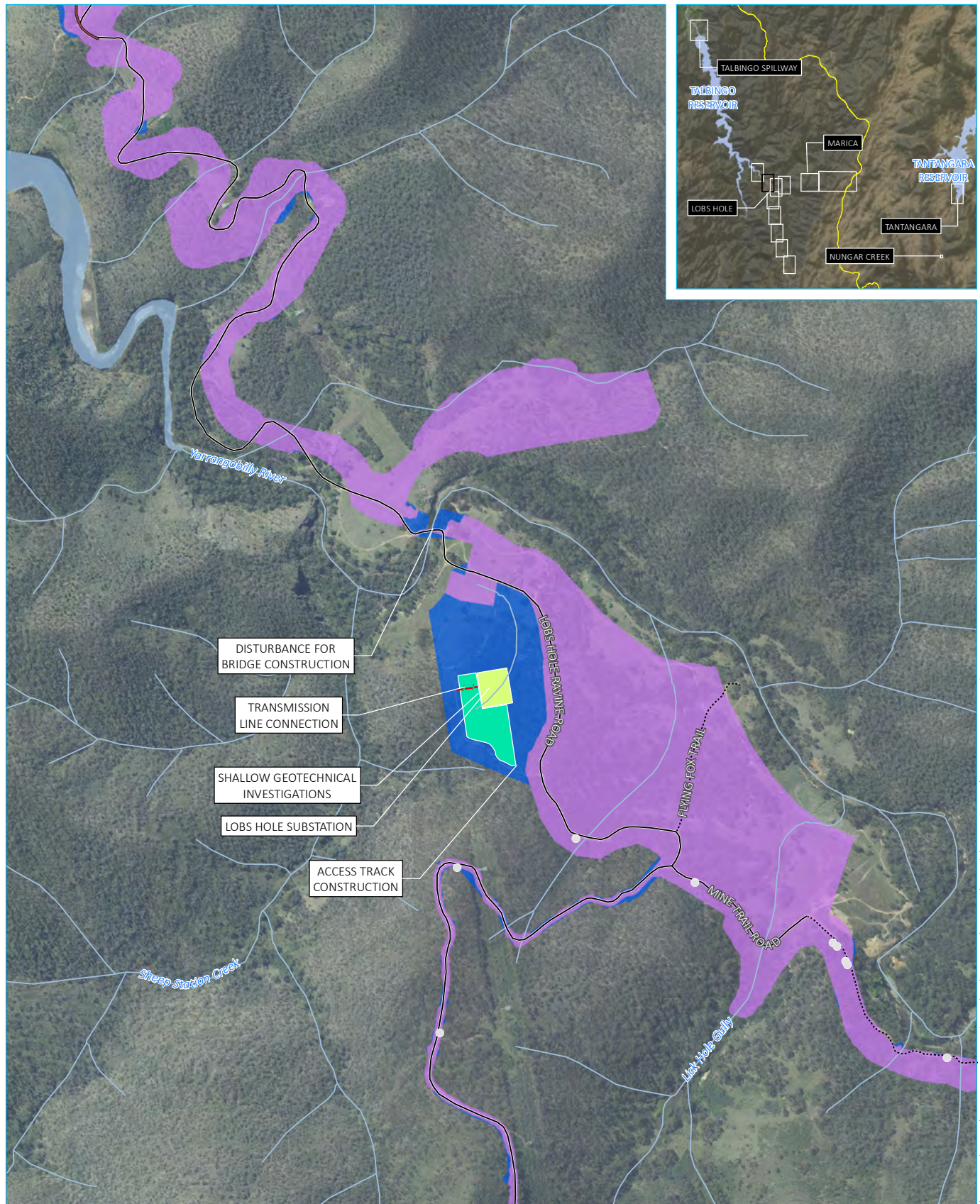
- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Indicative laydown area
- Proposed substation
- Fossil area

0 250 500
m
GDA 1994 MGA Zone 55

Exploratory Works project boundary
- Mine Trail Road 2

Snowy 2.0
Exploratory Works EIS
Modification 1
1 h



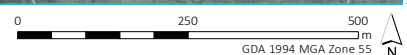


Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- Approved EW access
- Transmission line connection
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)

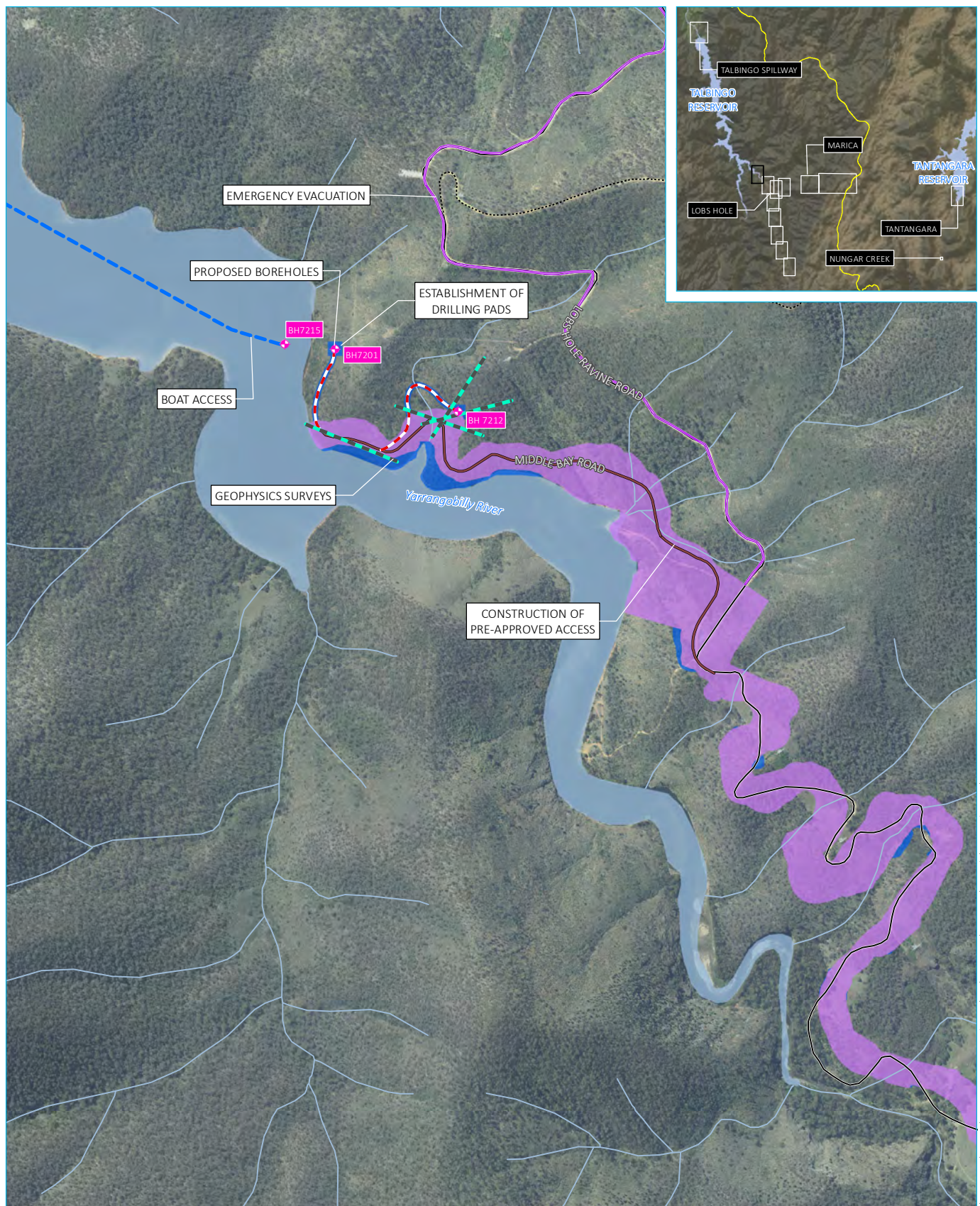
- Indicative laydown area
- Proposed substation
- Waterbody



Exploratory Works project boundary - Lobs Hole

Snowy 2.0
Exploratory Works EIS
Modification 1
1 i





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

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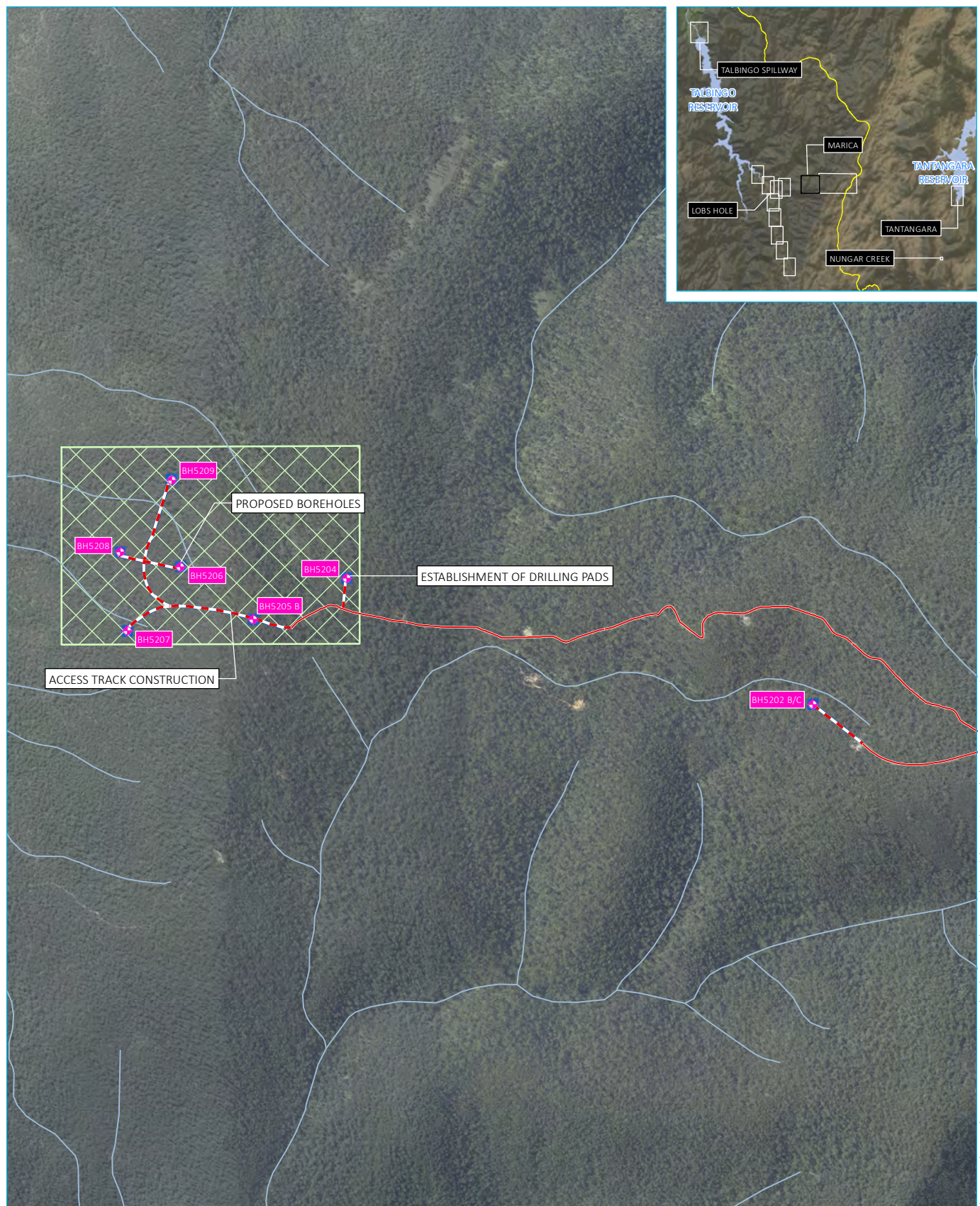
- ◆ Proposed borehole
- Proposed geophysics
- Proposed access track
- Approved EW access
- Boat access
- Local road
- ⋯ Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Lobs Hole Ravine Road north - emergency evacuation
- Waterbody

0 250 500
m
GDA 1994 MGA Zone 55

Exploratory Works project boundary
- Lobs Hole Ravine Road

Snowy 2.0
Exploratory Works EIS
Modification 1
1 j





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

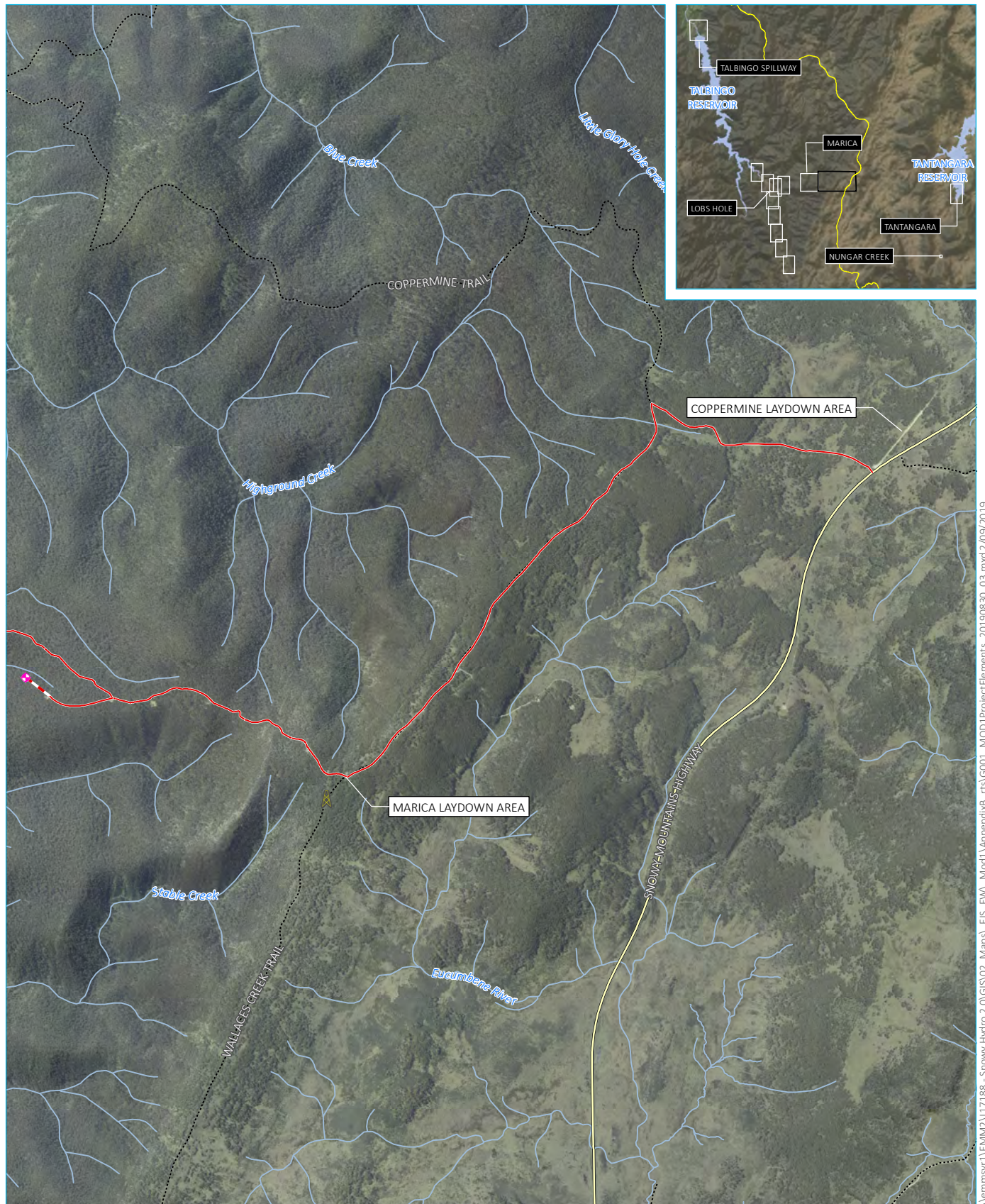
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- Existing access track
- - Proposed access track
- Watercourse/drainage line
- EW modification construction footprint (additional)
- Boreholes requiring on-site adjustment

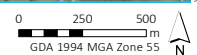
Exploratory Works project boundary
- Marica 1

Snowy 2.0
Exploratory Works EIS
Modification 1
1 k





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

-  Proposed borehole
-  Proposed temporary communications upgrade location
-  Existing access track
-  Proposed access track
-  Main road
-  Vehicular track
-  Watercourse/drainage line
-  EW modification construction footprint (additional)

Exploratory Works project boundary
- Marica 2

Snowy 2.0
Exploratory Works EIS
Modification 1
11

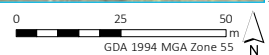




Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Proposed borehole
- Main road
- Watercourse/drainage line
- Proposed work area

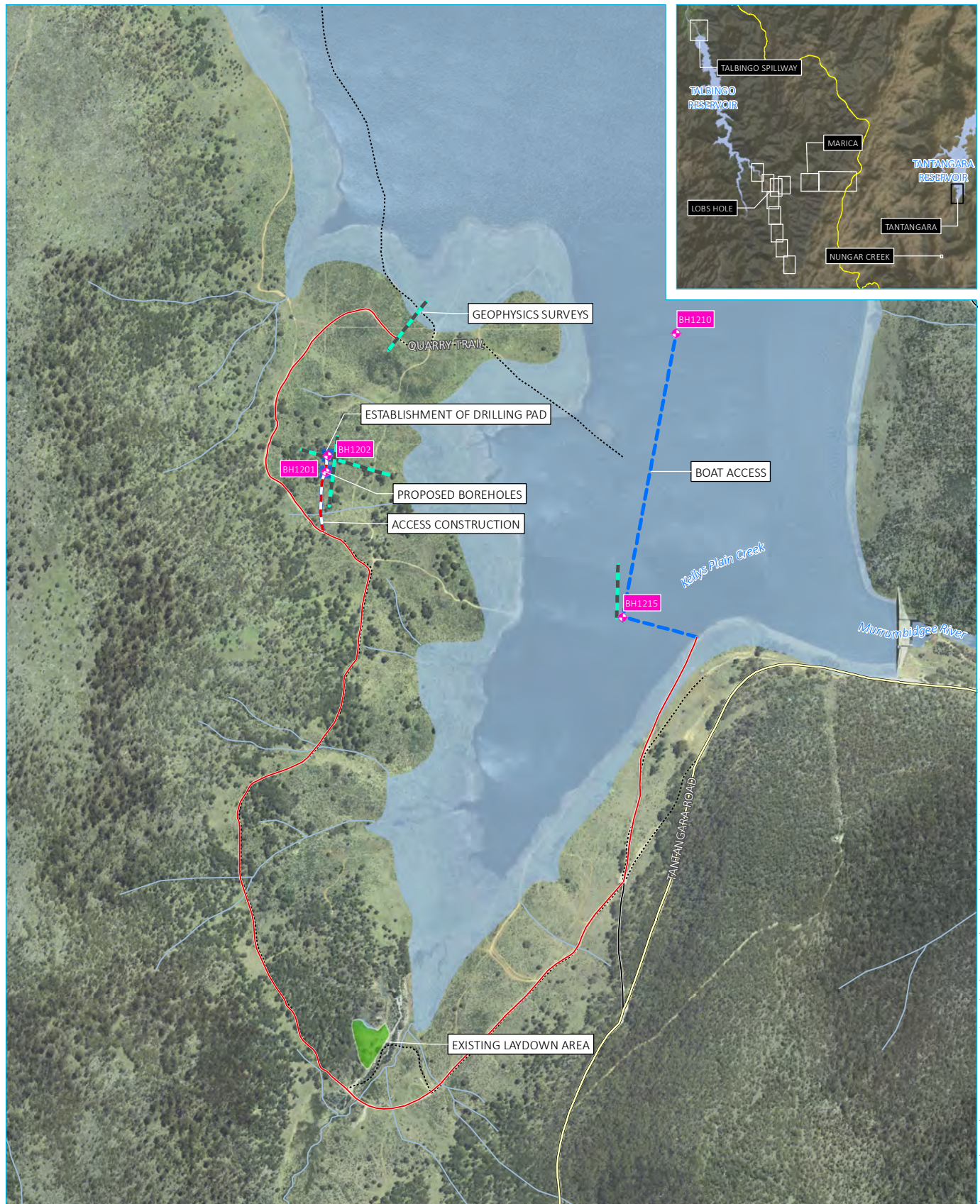


Exploratory Works project boundary
- Nungar Creek

Snowy 2.0
Exploratory Works EIS
Modification 1
1 m



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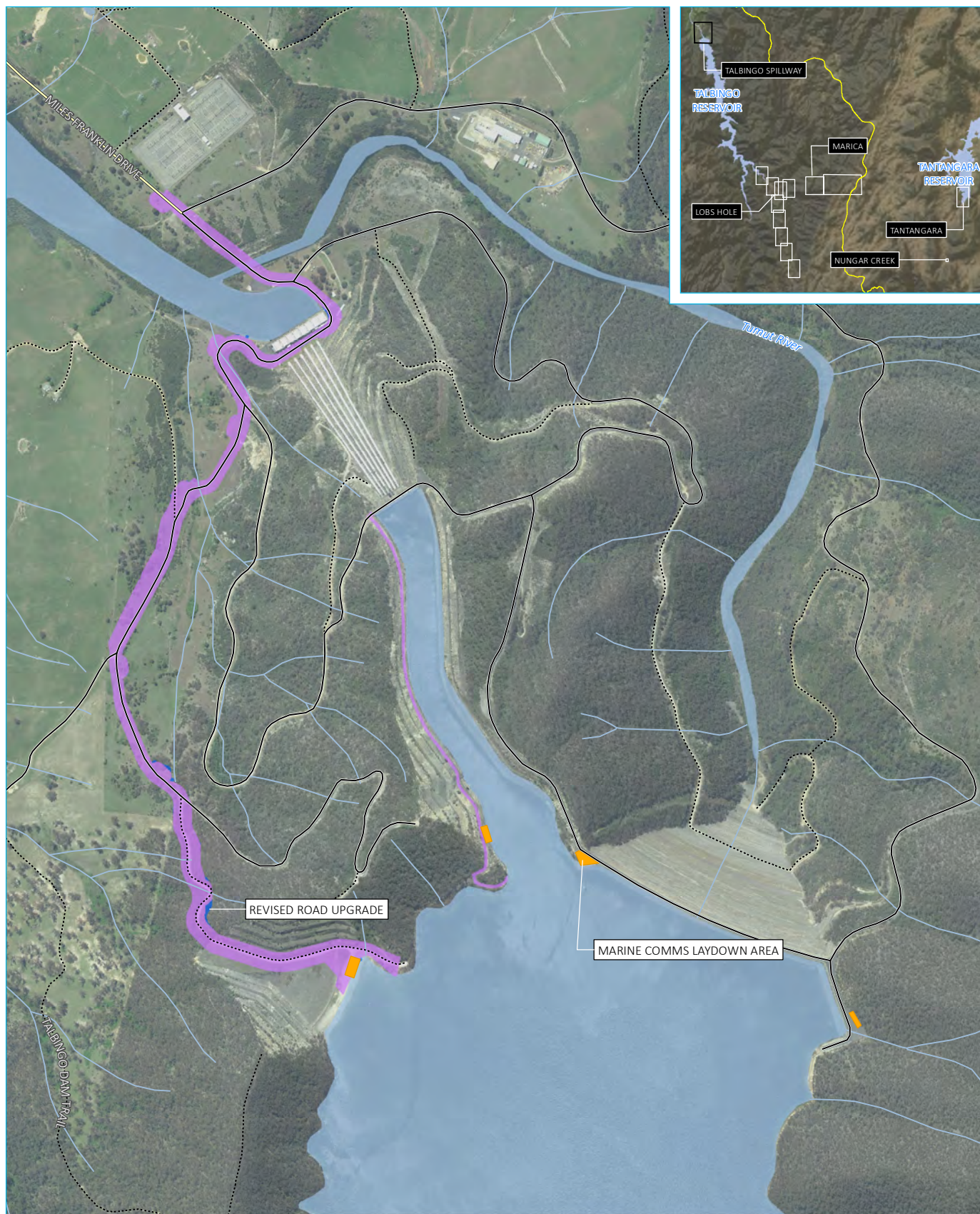
- Proposed borehole
- Proposed geophysics
- Existing access track
- - Proposed access track
- Boat access
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- EW modification construction footprint (additional)
- Existing laydown area
- Waterbody

0 250 500 m
GDA 1994 MGA Zone 55

Exploratory Works project boundary
- Tantangara Reservoir

Snowy 2.0
Exploratory Works EIS
Modification 1
1 n





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Marine comms laydown (proposed)
- Waterbody



Exploratory Works project boundary
- Talbingo spillway

Snowy 2.0
Exploratory Works EIS
Modification 1
10





A P P E N D I X

C

BIODIVERSITY OFFSET REPORT



Biodiversity Offset Report – Modification 1 Response to Submissions

Prepared for Snowy Hydro Limited
September 2019

EMM Sydney
Ground floor, 20 Chandos Street
St Leonards NSW 2065

T 02 9493 9500
E info@emmconsulting.com.au

www.emmconsulting.com.au

Biodiversity Offset Report – Modification 1

Response to Submissions

Report Number

J17188 RP#1

Client

Snowy Hydro Limited

Date

2 September 2019

Version

v2 Draft

Prepared by



Cassandra Kottaras

Ecology

2 September 2019

Approved by



Nathan Garvey

Associate Director

2 September 2019

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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1 Submissions received

EMM received comments for Modification 1 to the Snowy Hydro 2.0 Exploratory Works on 19 July 2019 from Biodiversity and Conservation Division (BCD) of the Department of Planning, Industry and Environment (DPIE) and the NSW National Parks and Wildlife Service (NPWS). Key issues around biodiversity values, Smoky Mouse and the removal of dangerous trees are provided in Table 1.1, along with a response to each issue.

Table 1.1 **Response to submissions**

Submission	Response
Biodiversity BDC have reviewed the BDAR to support the modification. The credit calculation has been adjusted to account for areas where the clearing has been reduced. However, the calculation is based on a 4m wide road width. Does not appear to account for any cut and fill required on steep slopes. (See Key Issue 1). <i>Recommended action:</i> The road widths and laydown areas in steep areas are to be reconsidered and if it is necessary to widen the roads in sections, then the offsetting requirements are to be recalculated.	The access tracks required to these boreholes were shown in the Modification 1 Assessment Report figures and assessed in the impact assessment including biodiversity offset calculations. Access tracks to BH7201 and BH7212 are 12m wide and are expected to accommodate cut and fill requirements through steep slopes in these areas. No reconsideration is required.
Smoky Mouse There will be an increase in impact within the Marica area on the Smoky mouse. There is no detail in the Biodiversity Management plan on how the vehicle speed limit will be maintained in the Smoky mouse habitat. <i>Recommended actions:</i> The draft Biodiversity Management Plan is to include extending the existing monitoring program for Smoky Mouse to the Marica area in consultation with B&C Division. Detail on how the speed limit will be maintained and enforced in the Smoky mouse habitat is to be provided. The BMP is to include monitoring and recording any fauna road deaths and detail on the adaptive response to any deaths.	Table 7.1 of the Biodiversity Development Assessment Report for Modification 1 states there will be a restriction on vehicle movements in the Marica area, with speeds limited to 20 km/h between dusk and dawn. The proposed night-time speed limits within Smoky Mouse habitat at the Marica geotechnical drill sites will be maintained through the use of a project In-vehicle Management System (IVMS). For improved safety an IVMS is used for all Exploratory Works construction vehicles. The IVMS enables remote monitoring of vehicles and their speeds and provides notifications to drivers when speed limits are exceeded. Specific limits can be set for specific roads and tracks, including access borehole tracks in the Marica area. It is expected that the IVMS will provide adequate control to enforce the night time speed limits within Smoky Mouse habitat. The existing Smoky Mouse monitoring program within the Biodiversity Management Plan (BMP, EMM 2019a) will be extended to include the Marica area (as per Section 7.2.1, EMM 2019b). The BMP will also include monitoring and recording of any fauna road deaths and details on the adaptive response to any deaths.

Table 1.1 Response to submissions

Submission	Response
Dangerous tree removal The BDAR and offset calculations do not include the 91 trees being cleared on Lobs Hole Road. Some of these trees are large and hollow bearing. <i>Recommended actions:</i> The offset calculation and the credit liability is to be adjusted to include the 91 trees. The financial amount payable in Condition 7 is to be adjusted accordingly. The offset strategy is to detail how the loss of hollow bearing trees will be offset on park. Clarification on the surveys for arboreal fauna and hollow dependent birds is to be provided including whether the 91 trees were assessed during the appropriate time for breeding habitat. Mapping and location of the 91 trees would assist in determining if the trees were surveyed. Where feasible, the impact of the removal of hollow bearing trees is to be mitigated by cutting out the section(s) of each removed tree with the large hollows and remounting them on suitable trees.	Each of the 91 trees have been mapped within the project area and associated vegetation zone, see Figure 3.1. Extensive and comprehensive biodiversity surveys have been undertaken for Snowy 2.0 between August 2017 and August 2019. This has included targeted arboreal mammal and hollow-dependent bird surveys along Lobs Hole Ravine Road. Surveys were undertaken during appropriate seasons, to meet the key life cycle requirements for candidate species (see EMM 2018). Further surveys have been completed between submission of the Exploratory Works BDAR (EMM 2018) and Modification 1. A summary of these surveys has been provided below in Section 3.2.1. Survey effort within these areas is provided in Figure 3.2. The 91 trees to be cleared along Lobs Hole Ravine Road will be offset through calculation of vegetation integrity scores of the treeless zones, as set out in Section 3. Offsets required for the dangerous tree removal have been addressed in Section 3.3.A credit report is provided in Appendix E. Hollow bearing trees removed during vegetation clearing will be retained for use during rehabilitation works.

2 Updated disturbance footprint

Following public exhibition of the Modification 1 assessment report, feedback from government and community stakeholders, and design and construct contractors has been considered. Several project improvements have been identified and incorporated within the Modification 1 RTS. The key project improvements are:

- revision of the Exploratory Works disturbance footprint to include previously approved vegetation clearance;
- revision and clarification of road works in the boulder streams on Lobs Hole Ravine Road;
- additional laydown areas;
- additional geotechnical drilling sites; and
- justification for the Lobs Hole substation.

Further details for each of these project elements have been addressed in Section 3 of the Response to Submissions Report.

This section provides details of the proposed changes to the Modification 1 proposal and revised vegetation calculations for the additional areas.

2.1 Native vegetation

2.1.1 Methods

Please refer to Section 5.2.1 and Section 5.2.2 in EMM (2019b) for detailed methodology of vegetation mapping, habitat assessment and vegetation integrity assessment.

2.1.2 Results

i Plant community types

Site investigations, including determination of plant community types (PCTs) using the methods described in Section 5.2.1 in EMM (2019b), identified the presence of 13 PCTs within the disturbance footprint. The additional disturbance areas arising from changes to the project boundary will result in additional impacts to 0.29 ha of native vegetation across two PCTs (PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment and PCT 643 – Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion).

The PCT, vegetation formation and vegetation class within Modification 1, including the original Modification 1 disturbance footprint and additional areas, are provided in Table 2.1.

Table 2.1 Plant community types mapped within the Modification 1 disturbance footprint

Plant community type	Vegetation formation	Vegetation class	Original area (ha) of disturbance footprint	Additional area (ha) of disturbance footprint	Total area (ha) of disturbance footprint
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Dry Sclerophyll Forest (Shrubby sub-formation)	Southern Tableland Dry Sclerophyll Forests	0.11	0.00	0.11
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Wet Sclerophyll Forests (Grassy sub-formation)	Southern Tableland Wet Sclerophyll Forests	1.67	0.25	1.92
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Upper Riverina Dry Sclerophyll Forests	1.61	0.00	1.61
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 Bioregion	Grassy Woodlands	Southern Tableland Grassy Woodlands	0.31	0.00	0.31
PCT 311 – Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Upper Riverina Dry Sclerophyll Forests	0.09	0.00	0.09
PCT 643 – Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	Alpine Complex	Alpine Heaths	0.01	0.05	0.06
PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	Southern Tableland Dry Sclerophyll Forests	6.62	0.00	6.62
PCT 953 – Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	Southern Tableland Dry Sclerophyll Forests	1.09	0.00	1.09
PCT 999 – Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	Southern Tableland Dry Sclerophyll Forests	0.64	0.00	0.64
PCT 1191 – Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion	Grassy Woodlands	Subalpine Woodlands	0.47	0.00	0.47
PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Grassy Woodlands	Subalpine Woodlands	0.61	0.00	0.61

Table 2.1 Plant community types mapped within the Modification 1 disturbance footprint

Plant community type	Vegetation formation	Vegetation class	Original area (ha) of disturbance footprint	Additional area (ha) of disturbance footprint	Total area (ha) of disturbance footprint
PCT 1224 – Sub alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	Grasslands	Temperate Montane Grasslands	0.15	0.00	0.15
PCT 1225 – Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	Grasslands	Temperate Montane Grasslands	<0.01 ¹	0.00	<0.01
TOTAL			13.38	0.30	13.68

Notes: 1. The area of impact for this PCT is below 0.01 ha and is not discussed further below.

ii Vegetation zones

Each of the 13 PCTs identified within the revised disturbance footprint was stratified into vegetation zones based on broad condition state. This process identified 29 vegetation zones within the revised disturbance footprint, with two vegetation zones within the additional areas, as outlined in Table 2.2.

Table 2.2 Vegetation zones mapped within the Modification 1 disturbance footprint

Plant community type	Condition	Original area (ha) of disturbance footprint	Additional area (ha) of disturbance footprint	Total area (ha) of disturbance footprint
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Low	<0.01	0.00	<0.01
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Medium	0.01	0.00	0.01
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	High	0.10	0.00	0.10
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Derived grassland	<0.01	0.00	<0.01
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Poor	0.01	0.00	0.01
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Other	0.07	0.00	0.07

Table 2.2 **Vegetation zones mapped within the Modification 1 disturbance footprint**

Plant community type	Condition	Original area (ha) of disturbance footprint	Additional area (ha) of disturbance footprint	Total area (ha) of disturbance footprint
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Medium	0.33	0.00	0.33
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	High	1.26	0.25	1.51
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Low	0.95	0.00	0.95
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Derived Grassland	0.32	0.00	0.32
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Poor	0.01	0.00	0.01
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Other	0.29	0.00	0.29
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Medium	0.01	0.00	0.01
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	High	0.03	0.00	0.03
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 Bioregion	Other	0.31	0.00	0.31
PCT 311 – Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Derived grassland	<0.01	0.00	<0.01
PCT 311 – Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	High	0.09	0.00	0.09

Table 2.2 **Vegetation zones mapped within the Modification 1 disturbance footprint**

Plant community type	Condition	Original area (ha) of disturbance footprint	Additional area (ha) of disturbance footprint	Total area (ha) of disturbance footprint
PCT 643 – Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	Low	0.01	0.05	0.06
PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Derived grassland	1.70	0.00	1.70
PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Medium	<0.01	0.00	<0.01
PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	High	4.92	0.00	4.92
PCT 953 – Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion	High	1.09	0.00	1.09
PCT 999 – Norton’s Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Derived grassland	0.06	0.00	0.06
PCT 999 – Norton’s Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	High	0.58	0.00	0.58
PCT 1191 – Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion	High	0.47	0.00	0.47
PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Derived grassland	<0.01	0.00	<0.01
PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	High	0.61	0.00	0.61
PCT 1224 – Sub alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	High	0.15	0.00	0.15
PCT 1225 – Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	Low	<0.01	0.00	<0.01
TOTAL		13.38	0.29	13.67

Notes: Vegetation zones with an area less than 0.01 ha were not inputted into the BAM calculator.

iii **Vegetation integrity score**

The vegetation integrity score for each vegetation zone is provided in Table 2.3.

Table 2.3 **Vegetation integrity scores for all vegetation zones within Modification 1 disturbance boundary**

Plant community type	Condition	Vegetation integrity score
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Medium	71.9
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	High	55.3
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Poor	71.7
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Other	59.8
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Medium	56
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	High	49
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Low	21.2
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Derived Grassland	64
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Poor	26.6
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Other	68.3
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Medium	65.9
PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	High	70.9
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 Bioregion	Other	40.2
PCT 311 – Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	High	60.9
PCT 643 – Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	Low	13
PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Derived grassland	46.2

Table 2.3 **Vegetation integrity scores for all vegetation zones within Modification 1 disturbance boundary**

Plant community type	Condition	Vegetation integrity score
PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	High	64.3
PCT 953 – Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion	High	75.7
PCT 999 – Norton’s Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Derived grassland	38.3
PCT 999 – Norton’s Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	High	63.6
PCT 1191 – Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion	High	47.2
PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	High	95.7
PCT 1224 – Sub alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	High	36.2

2.2 Impacts requiring offsets

2.2.1 Impacts on native vegetation

A summary of ecosystem credits required for all vegetation zones, including changes in vegetation integrity score, are provided in Table 2.4. A total of 313 ecosystem credits are required to offset the residual impacts to 13.62 ha of native vegetation within the disturbance boundary of the Exploratory Works Modification 1. A credit report is provided in Appendix E.

Table 2.4 **Summary of ecosystem credits required for impacts to all vegetation zones for Modification 1**

Vegetation zone number	PCT	Vegetation zone name	Area	Vegetation integrity score	Future vegetation integrity score	Change in vegetation integrity score	Credits required
1	PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	296_High	0.10	55.3	0	-55.3	2
2	PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	296_Medium	0.01	71.9	0	-71.9	1
3	PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	300_High	1.51	49	0	-49	28
5	PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	300_Medium	0.33	56	0	-56	7
7	PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	300_Other	0.07	59.8	0	-59.8	2
9	PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	300_Poor	0.01	71.7	0	-71.7	1
10	PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	302_DNG	0.32	64	0	-64	9
11	PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	302_High	0.03	70.9	0	-70.9	1
12	PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	302_Low	0.95	21.2	0	-21.2	9

Table 2.4 **Summary of ecosystem credits required for impacts to all vegetation zones for Modification 1**

Vegetation zone number	PCT	Vegetation zone name	Area	Vegetation integrity score	Future vegetation integrity score	Change in vegetation integrity score	Credits required
13	PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	302_Medium	0.01	65.9	0	-65.9	1
14	PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	302_Other	0.29	68.3	0	-68.3	9
15	PCT 302 – Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	302_Poor	0.01	26.6	0	-26.6	1
16	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 Bioregion	303_Other	0.31	40.2	0	-40.2	8
17	PCT 311 – Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	311_High	0.09	60.9	0	-60.9	2
18	PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	729_DNG	1.70	46.2	0	-46.2	29
19	PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	729_High	4.92	64.3	0	-64.3	119
20	PCT 999 – Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	999_High	0.58	63.6	0	-75.7	14
21	PCT 999 – Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	999_DNG	0.06	38.3	0	-38.3	1

Table 2.4 **Summary of ecosystem credits required for impacts to all vegetation zones for Modification 1**

Vegetation zone number	PCT	Vegetation zone name	Area	Vegetation integrity score	Future vegetation integrity score	Change in vegetation integrity score	Credits required
22	PCT 1191 – Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion	1191_High	0.47	47.2	0	-47.2	14
23	PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	1196_High	0.61	95.7	0	-95.7	22
25	PCT 1224 – Sub alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion	1224_High	0.15	36.2	0	-36.2	2
26	PCT 953 – Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion	953_High	1.09	75.7	0	-75.7	31

2.2.2 Impacts on threatened species

A summary of the species credits required for all vegetation zones occupied by threatened species credit species, including changes in vegetation integrity score, are provided in Table 2.5. A total of 392 species credits are required to offset the residual impacts to 10.83 ha of threatened species credit species habitat of Modification 1. A credit report is provided in Appendix E.

Table 2.5 **Summary of threatened species credits required for Modification 1**

Species	Vegetation zone name	Area (ha)/individual (HL)	Habitat condition	Future habitat condition	Loss of habitat condition	Candidate SAIL	Species credits
Eastern Pygmy-possum	296_High	0.1	55.3	0.0	-55.3	No	3
Eastern Pygmy-possum	300_High	1.51	49	0.0	-49	No	37
Eastern Pygmy-possum	300_Medium	0.33	56	0.0	-56	No	9
Eastern Pygmy-possum	300_Other	0.07	59.8	0.0	-59.8	No	2
Eastern Pygmy-possum	302_High	0.03	70.9	0.0	-70.9	No	1
Eastern Pygmy-possum	302_Other	0.29	68.3	0.0	-68.3	No	10
Eastern Pygmy-possum	311_High	0.09	60.9	0.0	-60.9	No	3
Eastern Pygmy-possum	729_High	4.92	64.3	0.0	-64.3	No	158
Eastern Pygmy-possum	999_High	0.58	63.6	0.0	-63.6	No	18
Eastern Pygmy-possum	1196_High	0.61	95.7	0.0	-95.7	No	29
Booroolong Frog	300_High	0.03	49	0.0	-49	No	1
Booroolong Frog	302_High	0.03	70.9	0.0	-70.9	No	1
Booroolong Frog	302_Low	0.16	21.2	0.0	-21.2	No	2
Booroolong Frog	302_Other	0.21	68.3	0.0	-68.3	No	7
Booroolong Frog	729_High	0.02	64.3	0.0	-64.3	No	1
Smoky Mouse	729_High	0.1	64.3	0.0	-64.3	Yes	5
Smoky Mouse	953_High	0.87	75.7	0.0	-75.7	Yes	49
Smoky Mouse	1196_High	0.6	95.7	0.0	-95.7	Yes	43
Slender Greenhood	1196_High	0.28	95.7	0.0	-95.7	No	13 ¹

Notes: 1. At the time of preparation of this BDAR, the credit calculator appeared to be incorrectly calculating credits for some species. Credits required have been updated based on Equation 2 of the BAM (OEH 2017a).

2.3 Impacts not requiring offsets

One vegetation zone was found to be in degraded condition. In line with the requirements of Section 10.3 of the BAM (OEH 2017) impacts to the vegetation zones (Table 2.6) and threatened species credit species (Table 2.7) do not require offsets.

Additional areas not requiring assessment in accordance with Section 10.4 of the BAM (OEH 2017) include:

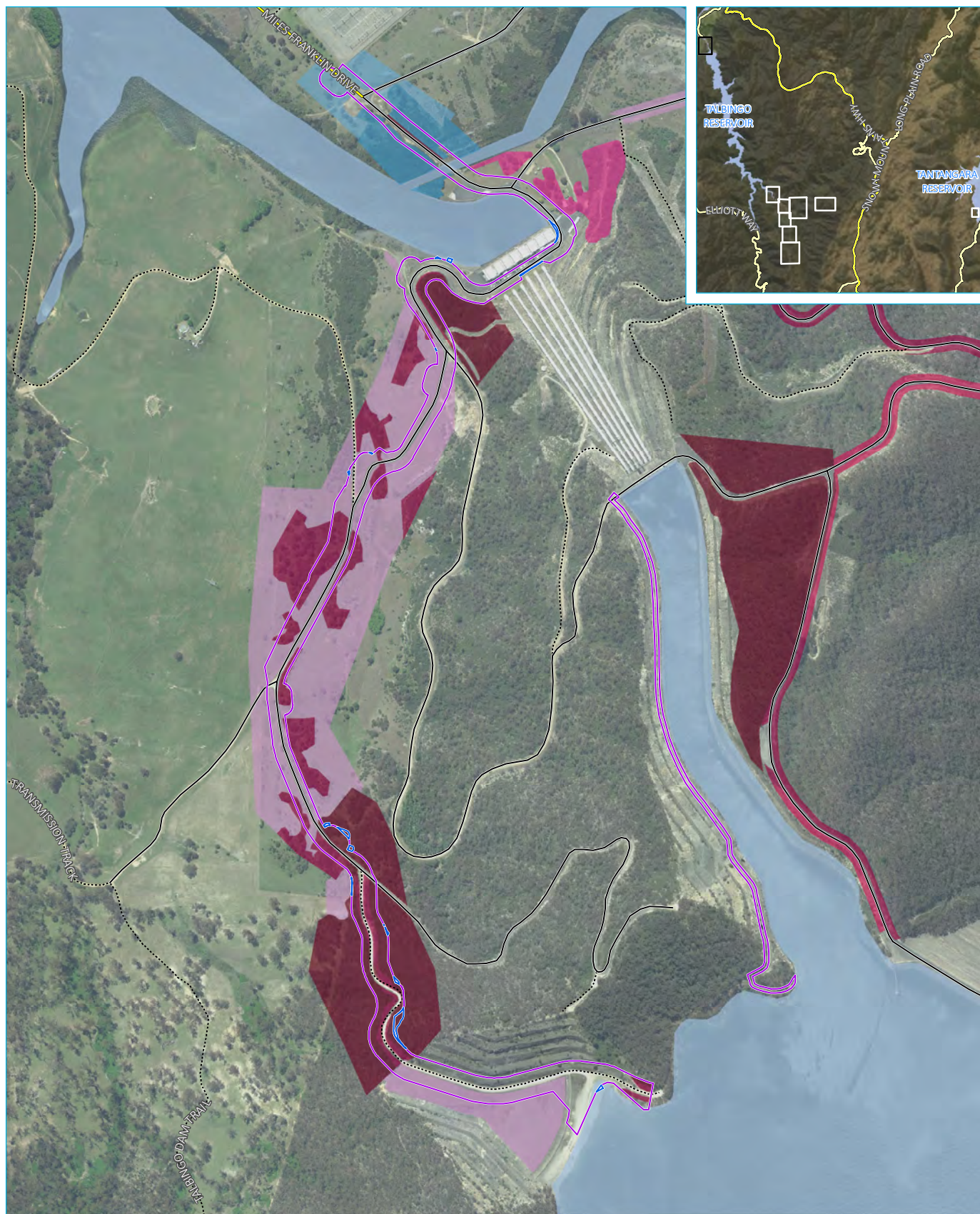
- existing roads;
- cleared and highly disturbed land; and
- watercourses.

Table 2.6 Summary of impacts not requiring offsets – native vegetation

Vegetation zone number	PCT	Vegetation zone name	Area	Vegetation integrity score	Future vegetation integrity score	Change in vegetation integrity score	Credits required
18	PCT 643 – Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	643_Low	0.1	13	0	-13	0

Table 2.7 Summary of impacts not requiring offsets – threatened species

Species	Vegetation zone name	Area (ha)/individual (HL)	Habitat condition	Future habitat condition	Loss of habitat condition	Candidate SAIL	Species credits
Gang-gang Cockatoo	296_High	0.01	55.3	0.0	-55.3	No	0
Eastern Pygmy-possum	296_Medium	0.01	71.9	0.0	-71.9	No	0
Eastern Pygmy-possum	300_Poor	0.01	71.7	0.0	-71.7	No	0
Eastern Pygmy-possum	302_Medium	0.01	65.9	0.0	-65.9	No	0
Eastern Pygmy-possum	302_Poor	0.01	26.6	0.0	-26.6	No	0
Alpine Tree Frog	303_Other	0.01	40.2	0.0	-40.2	No	0
Alpine Tree Frog	1224_High	0.02	36.2	0.0	-36.2	No	0



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

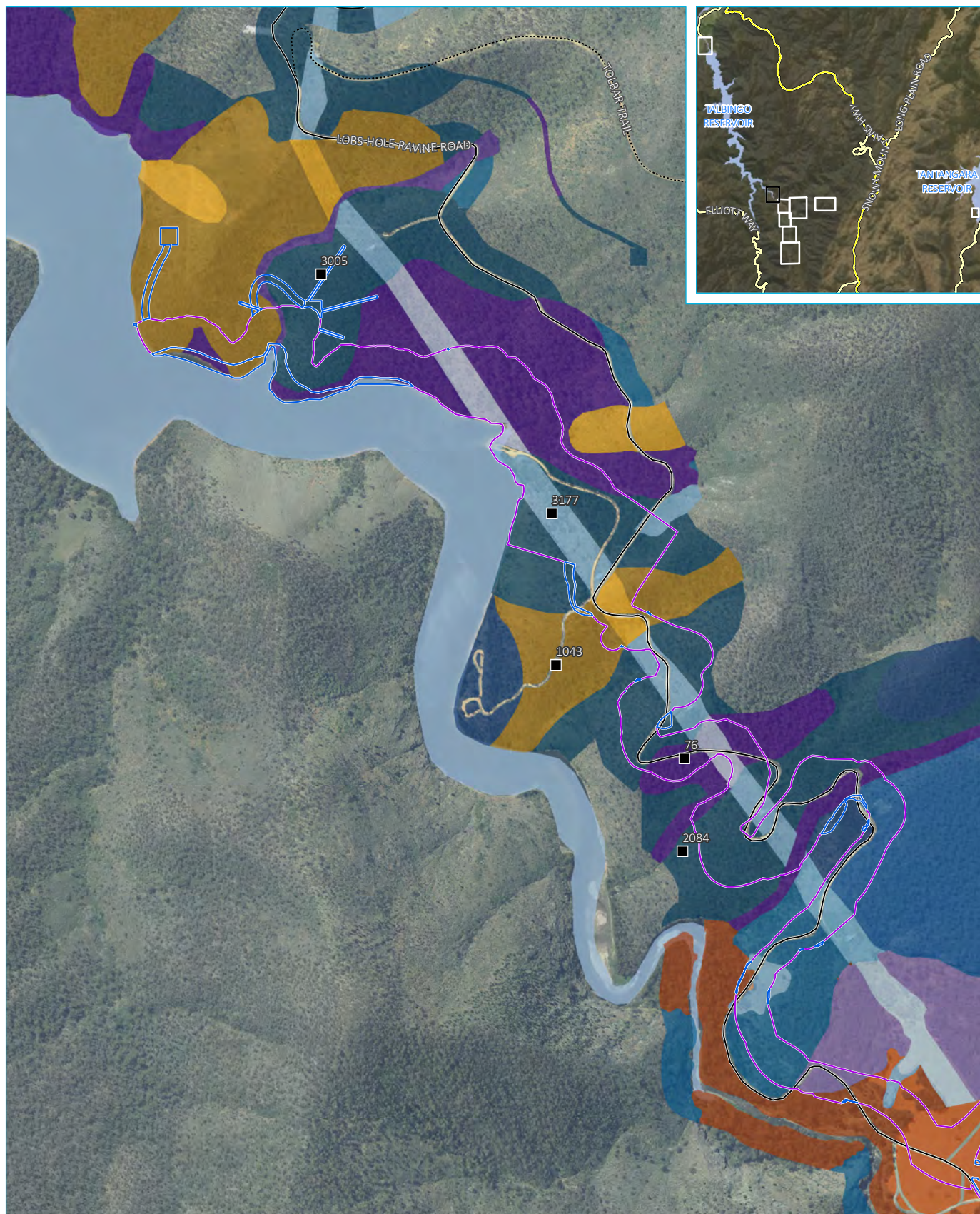
— Main road	■ Poor
— Local road	■ Other
..... Vehicular track	■ Derived grassland
□ EW approved construction footprint (additional)	PCT 650
□ EW approved construction footprint	■ Medium
■ Waterbody	■ Derived grassland
PCT 311	
■ High	
■ Medium	
■ Low	

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

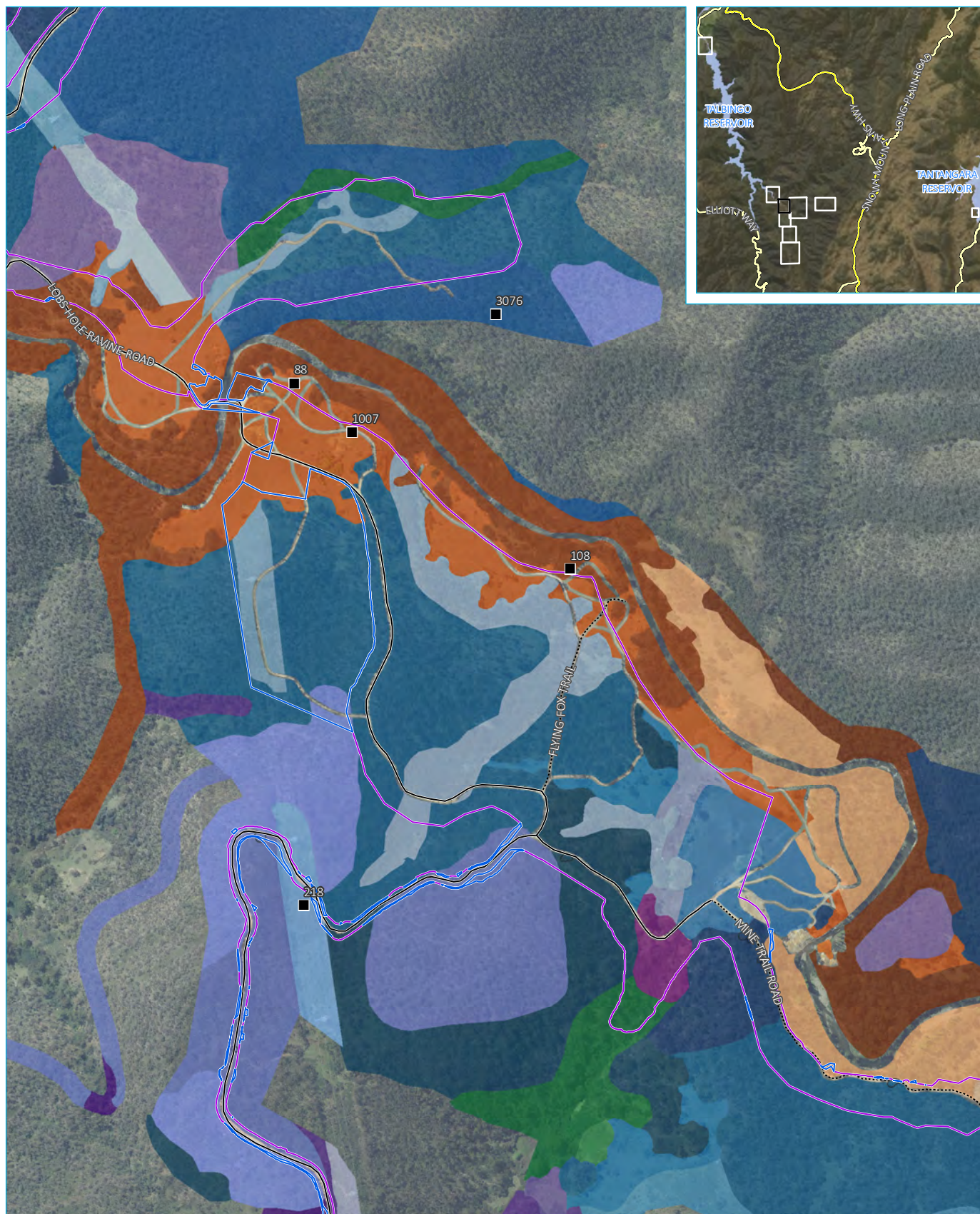
■ Plot location	PCT 296	Medium	Derived grassland
— Local road	High	Low	
..... Vehicular track	Medium	Other	
EW approved construction footprint (additional)	Derived grassland		
EW approved construction footprint	PCT 300	High	
Waterbody	High	Medium	
PCT 285	Medium	Derived grassland	
Medium	Derived grassland	PCT 1191	
Derived grassland	PCT 302	High	
	High	Medium	

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

Snowy 2.0
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Plot location
- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- PCT 299
 - Medium
 - Low
- PCT 285
 - High
 - Medium
 - Low

- Poor
- Derived grassland
- PCT 296
 - High
 - High - tree
 - Medium
 - Low
 - Poor
 - Derived grassland
- PCT 300
 - High
 - Medium

- Low
- Derived grassland
- PCT 302
 - High
 - Medium
 - Low
 - Poor
 - Other
 - Derived grassland
- PCT 729
 - High
 - High - tree

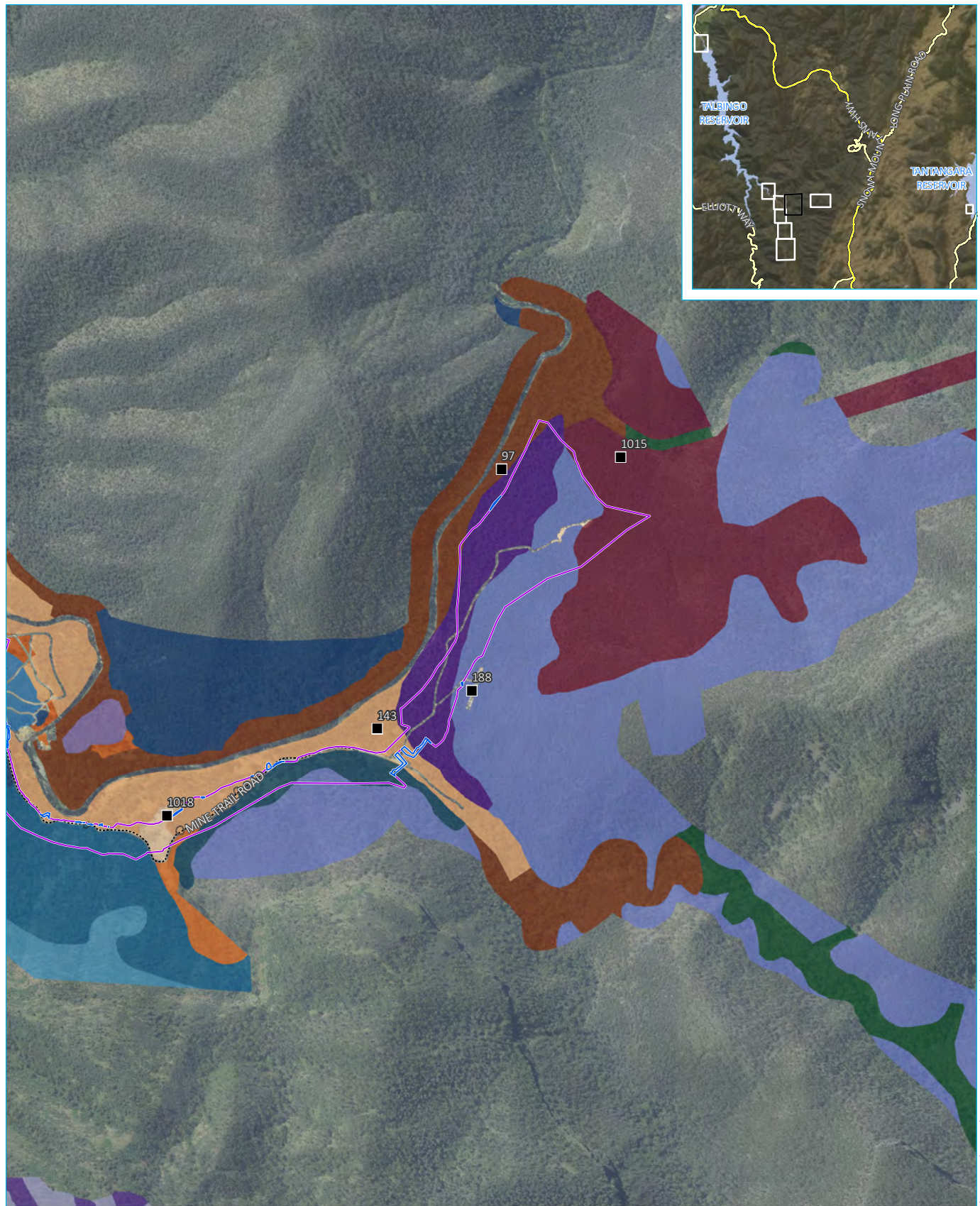
- Medium
- Medium - tree
- Low
- Poor
- Derived grassland
- PCT 999
 - High
 - High - tree
 - Medium
 - Derived grassland

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

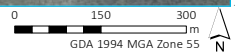
Snowy 2.0
Modification 1 Response to Submissions
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



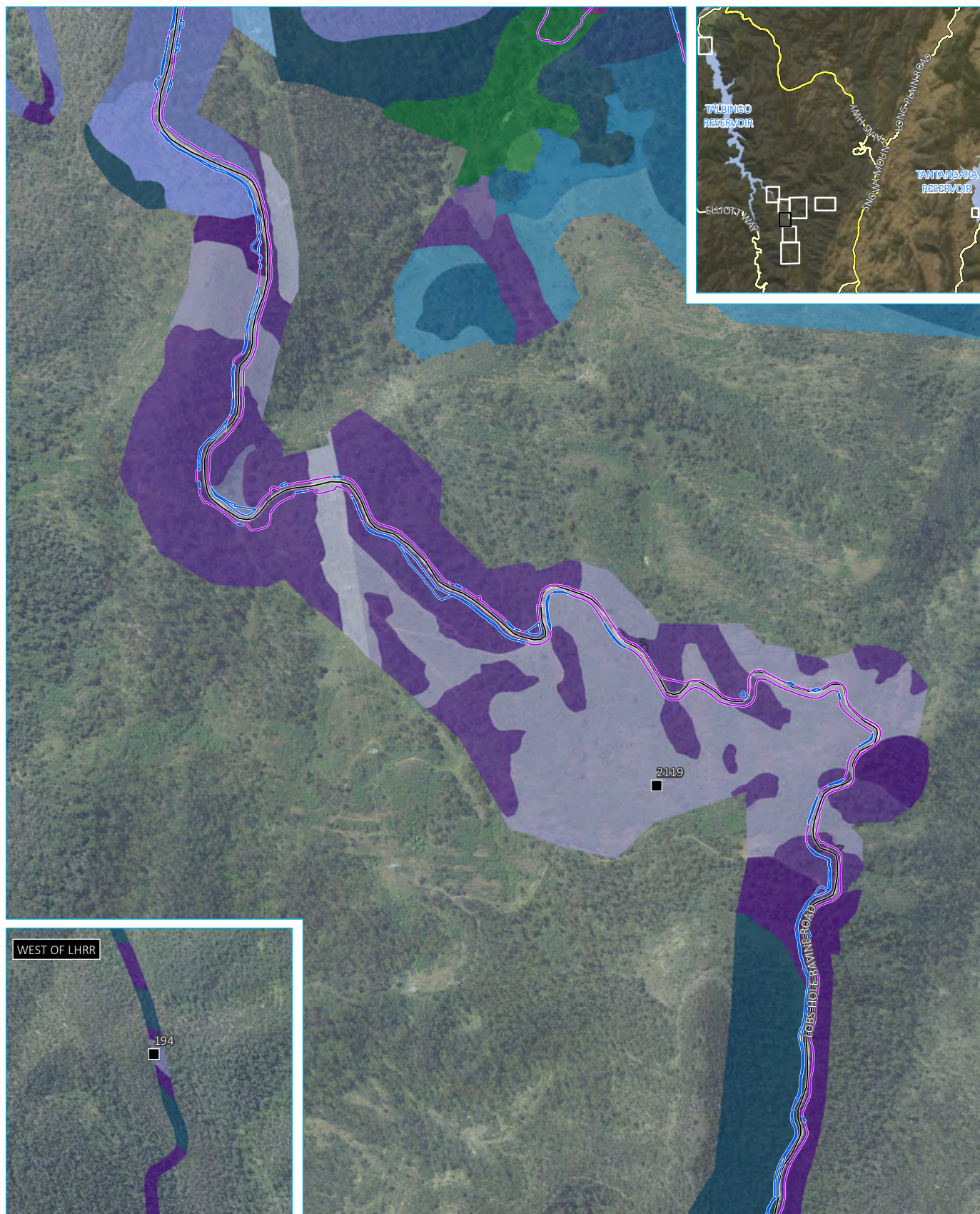
KEY

■ Plot location	PCT 300	Derived grassland
..... Vehicular track	High	PCT 311
EW approved construction footprint (additional)	Medium	High
EW approved construction footprint	Other	PCT 729
PCT 299	PCT 302	High
High	High	Medium
PCT 285	Low	Medium - tree
Medium	Poor	Poor
PCT 296	Poor - tree	PCT 999
High	Other	High
Low	Other - tree	

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

Snowy 2.0
Modification 1 Response to Submissions
2.1 d





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Plot location
- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint

- PCT 299
- Medium
 - Low
- PCT 285
- High

- PCT 296
- High
- PCT 300
- High
 - High - tree
 - Medium
 - Medium - tree
 - Low
 - Poor
 - Other
 - Derived grassland

- PCT 302
- High
 - Poor
 - Other
 - Other - tree
 - Derived grassland
- PCT 729
- High
 - Medium
 - Medium - tree
 - Low

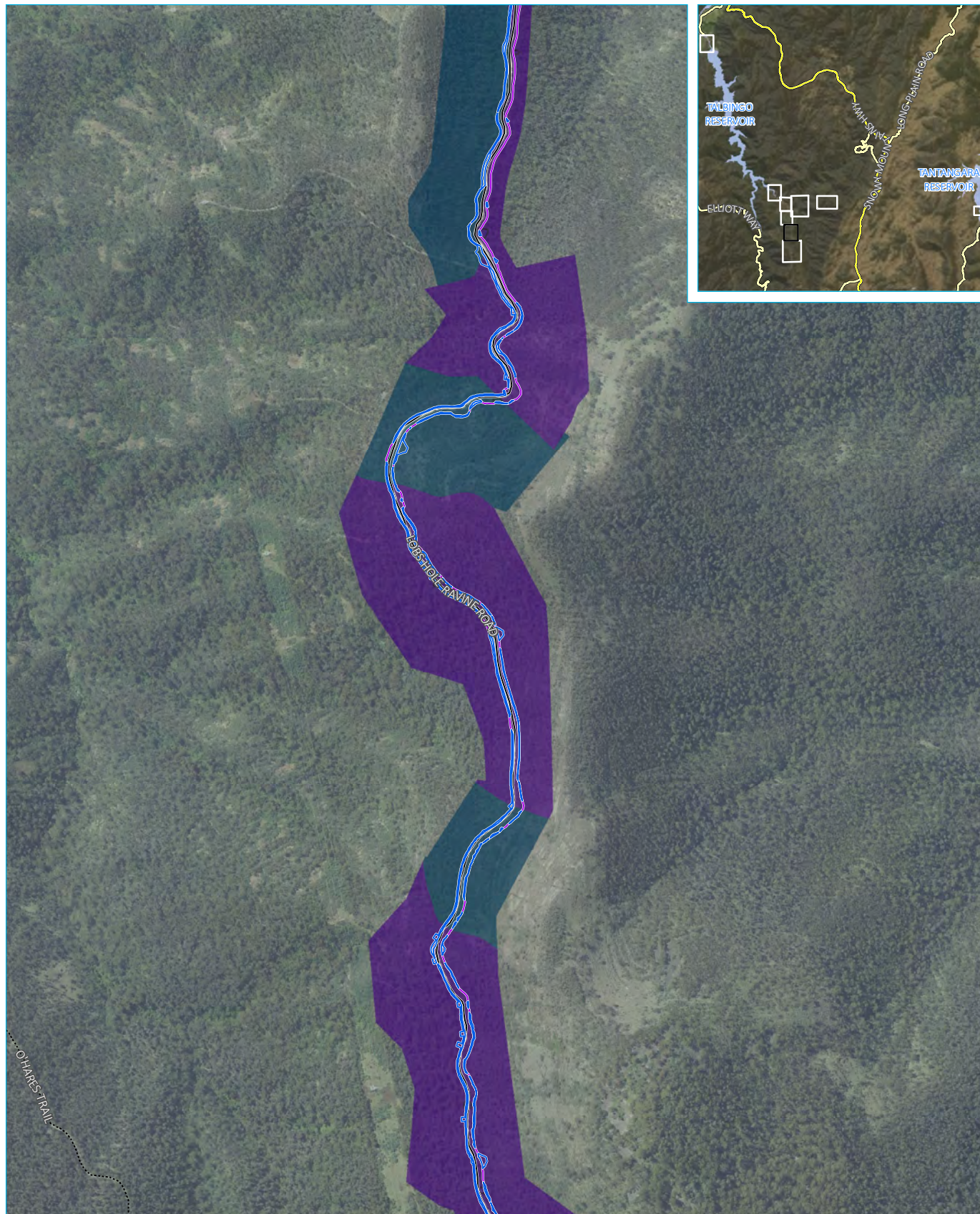
- Poor
- PCT 999
- High
 - High - tree
 - Medium
 - Derived grassland

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

Snowy 2.0
Modification 1 Response to Submissions
2.1 e



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- PCT 300
 - High
 - High - tree
- PCT 729
 - High
 - High - tree

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

Snowy 2.0
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

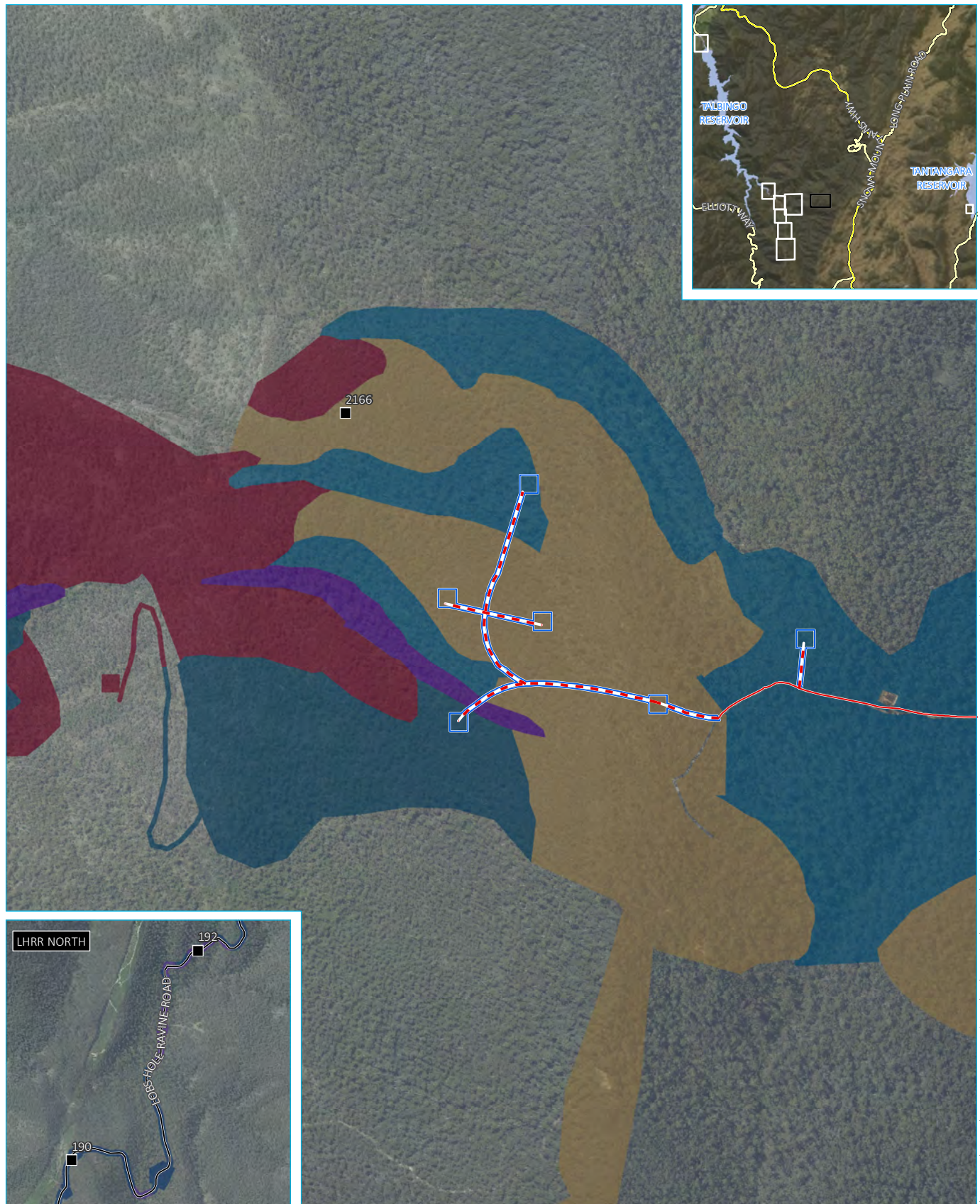
■ Plot location	PCT 303	PCT 1196
— Local road	High	High
..... Vehicular track	PCT 637	High - tree
EW approved construction footprint (additional)	High	Medium
EW approved construction footprint	PCT 643	Derived grassland
PCT 296	Low	
High	PCT 953	
Medium	High	
PCT 300	High - tree	
High	Derived grassland	
High - tree		

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

Snowy 2.0
Modification 1 Response to Submissions
2.1 g



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Plot location
- Existing access track
- - - Proposed access track
- EW approved construction footprint (additional)
- PCT 300
- PCT 311
- PCT 729
- PCT 953
- High
- PCT 1196
- High

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

Snowy 2.0
Modification 1 Response to Submissions
2.1 h





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Plot location
- Vehicular track
- Existing access track
- - - Proposed access track
- EW approved construction footprint (additional)
- EW approved construction footprint
- Waterbody

- PCT 303
- High
- PCT 637
- High
- PCT 1196
- High
- PCT 1224
- High

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GDA 1994 MGA Zone 55

Plant Community Type and
vegetation zone mapping within
the additional Modification 1 areas

Snowy 2.0
Modification 1 Response to Submissions
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3 Dangerous tree removal

3.1 Native vegetation

3.1.1 Methods

Each of the 91 dangerous trees were mapped, including tree canopy using the following data:

- waypoints of tree locations;
- a canopy height model developed using Light Detection and Ranging (LiDAR) data and hi-resolution aerial imagery;
- photographs of each tree to be removed; and
- tree attributes provided by Tree Survey Pty Ltd (Tree Survey 2018).

Tree canopies were drawn around visible canopies using the canopy height model and were stratified into vegetation zones based on condition state of the PCT the trees were mapped within (Table 3.1).

Table 3.1 Definitions used in delineation of dangerous tree vegetation zones

Condition class	Description
High_tree	Largely intact with all stratum present and minimal disturbance
Medium_tree	Some elements or stratum missing or immature, but minimal disturbance
Other_tree	Regeneration is occurring due to previous human impacts, such as clearing or fire, but minimal to moderate disturbance to other stratum.

Vegetation within the disturbance boundary, including dangerous trees, were re-calculated. Additional PCTs, vegetation zones and areas (ha) are addressed below (Section 3.1.2).

For the purposes of the BAM assessment, it was assumed all trees within the zone were removed. Future vegetation integrity scores were calculated by setting the composition and structure scores for the tree growth form to zero and leaving scores for all other growth forms with the current score. Functional scores for large trees and stem size class were set to zero; all other function scores were not modified.

3.1.2 Results

i Plant community types and vegetation zones

Site investigations, including determination of vegetation communities using the methods described in Section 3.1.1, identified dangerous trees were mapped within five PCTs. Each of these PCTs were stratified into vegetation zones based on broad condition state. This process identified eight vegetation zones, as outlined in Table 3.2.

Table 3.2 Plant community types and vegetation zones mapped within dangerous tree areas

Plant community type	Condition	Area (ha)
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Other_tree	0.02
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Medium_tree	0.01
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	High_tree	0.10
PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Medium_tree	<0.01
PCT 729 – Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	High_tree	<0.01
PCT 953 – Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion	High_tree	0.02
PCT 999 – Norton’s Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	High_tree	<0.01
PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	High_tree	0.98
TOTAL		1.13

Notes: Vegetation zones with an area less than 0.01 ha were not inputted into the BAM calculator.

ii Vegetation integrity score

The vegetation integrity score for each vegetation zone is provided in Table 3.3. Dangerous tree vegetation zones were calculated with a vegetation integrity score loss. These have been assessed further in Table 3.7.

Table 3.3 Vegetation integrity scores for all vegetation zones within dangerous tree areas

Plant community type	Condition	Current vegetation integrity score	Future vegetation integrity score
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Other_tree	59.8	38.7
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Medium_tree	56	31.2
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	High_tree	49	28.7
PCT 953 – Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion	High_tree	75.7	45.9

Table 3.3 **Vegetation integrity scores for all vegetation zones within dangerous tree areas**

Plant community type	Condition	Current vegetation integrity score	Future vegetation integrity score
PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	High_tree	95.7	64.6



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

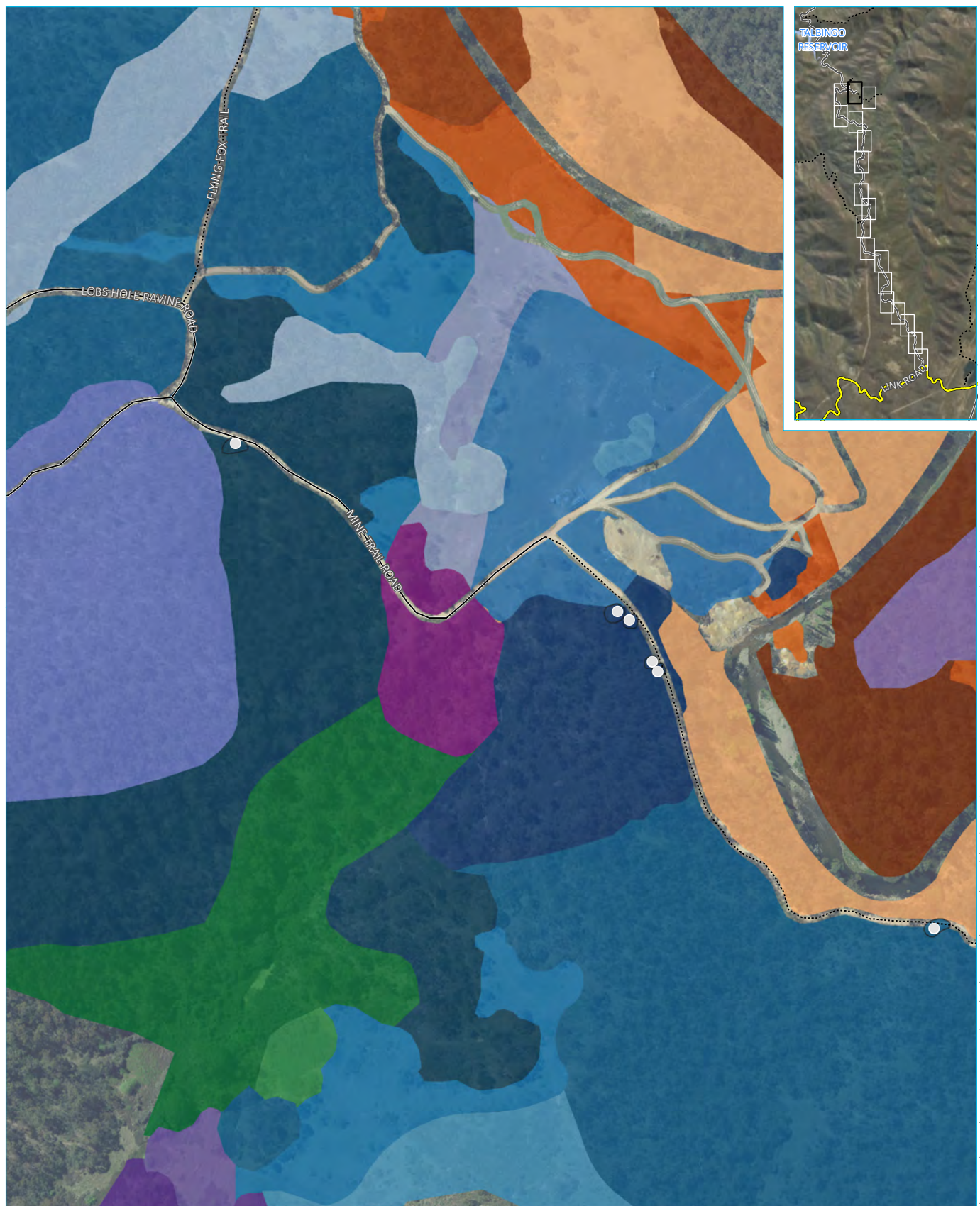
KEY

● Dangerous trees	Poor	PCT 999
..... Vehicular track	Poor - tree	High
PCT 285	Other	
Medium	Other - tree	
PCT 296	Derived grassland	
High	PCT 729	
Low	High	
PCT 302	Medium	
High	Medium - tree	
Low	Poor	

Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
Ecology RTS
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

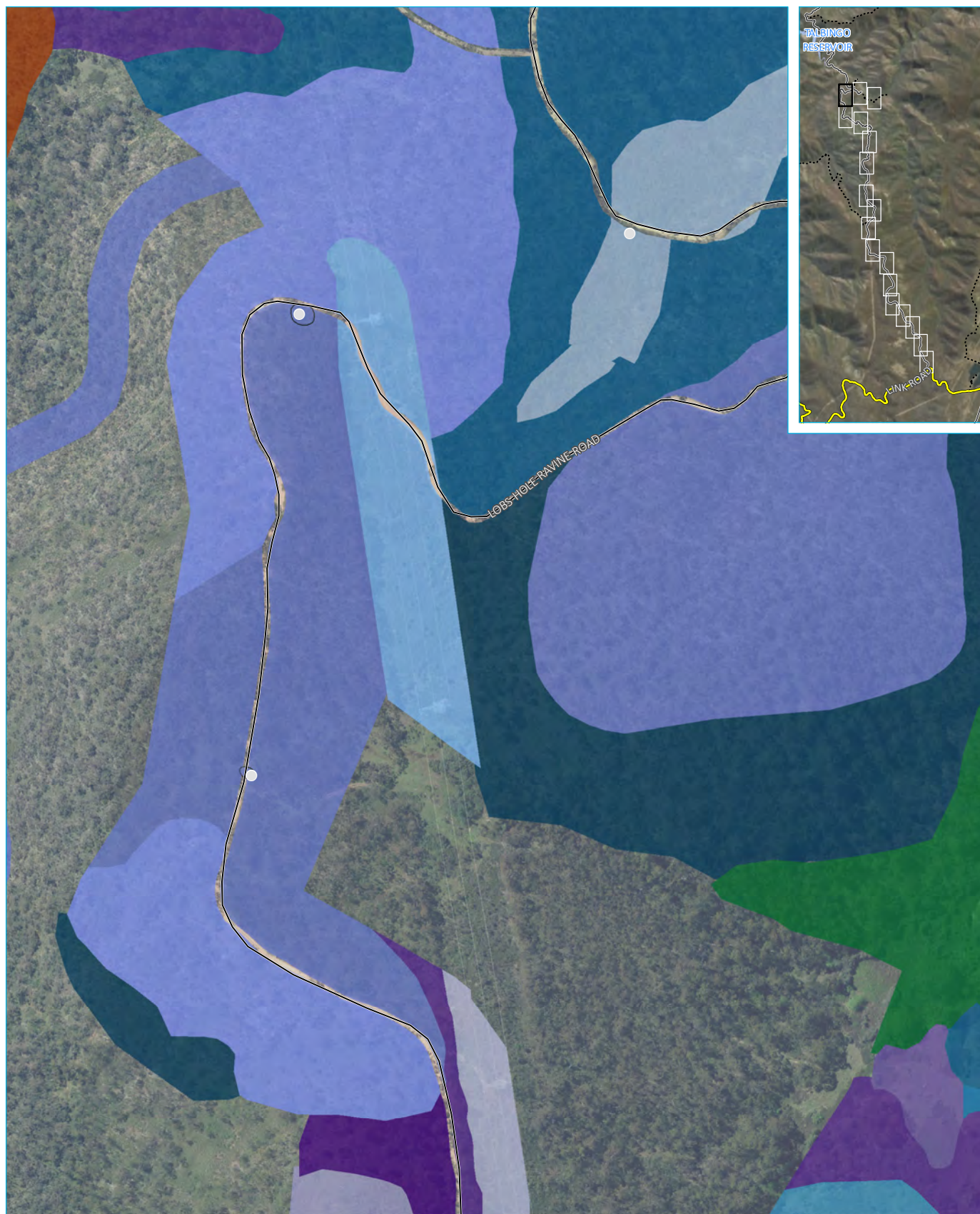
● Dangerous trees	■ Poor	PCT 302	■ Medium - tree
— Local road	PCT 296	■ High	■ Low
..... Vehicular track	■ High	■ Medium	■ Poor
PCT 299	■ High - tree	■ Low	PCT 999
■ Medium	■ Low	■ Poor	■ High
■ Low	■ Poor	■ Other	
PCT 285	PCT 300	PCT 729	
■ High	■ Medium	■ High	
■ Medium	■ Low	■ High - tree	
■ Low		■ Medium	

Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
Ecology RTS
Modification 1
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

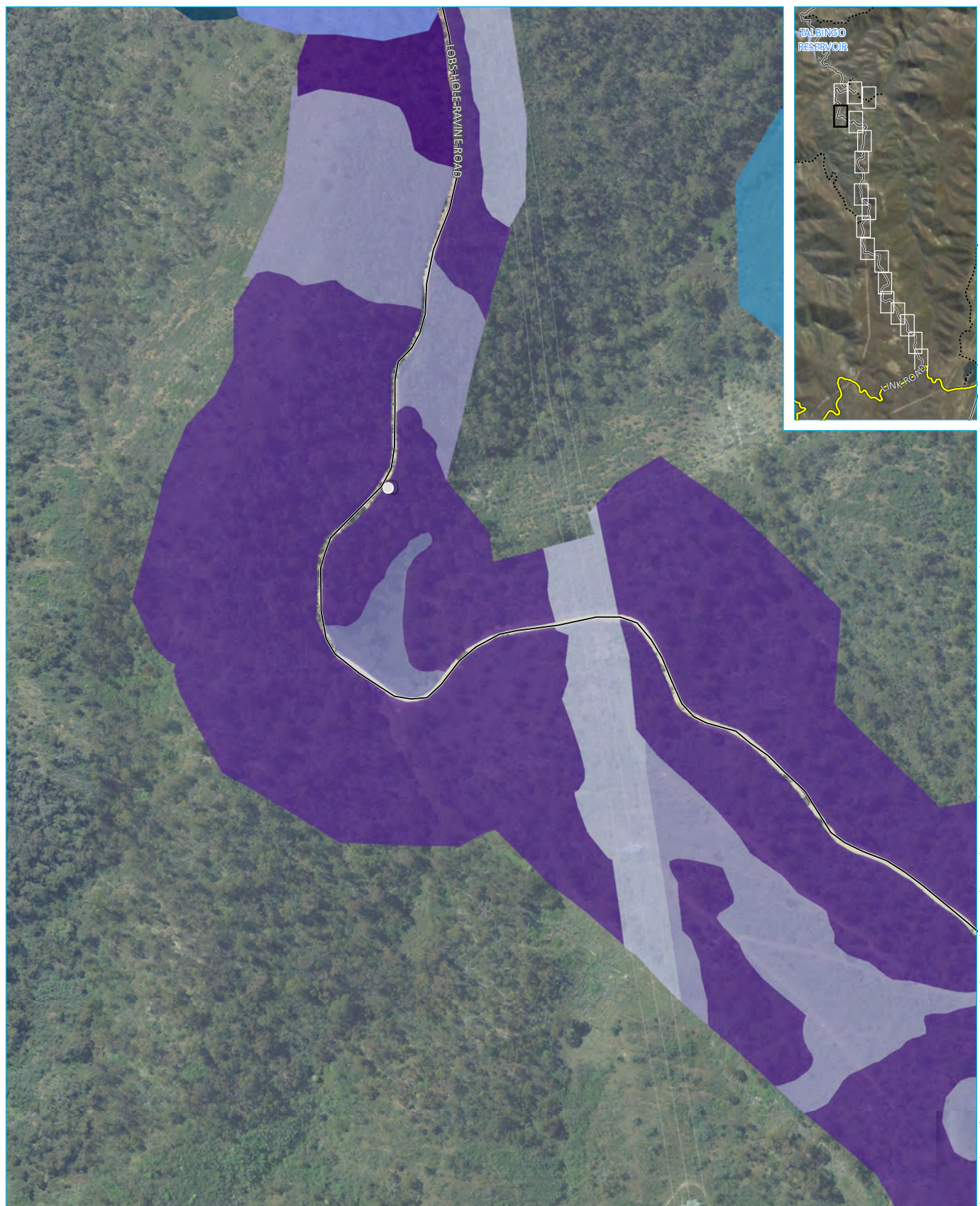
KEY

● Dangerous trees	Medium	Low
— Local road	Low	Poor
..... Vehicular track	Other	PCT 999
PCT 299	Derived grassland	High
Medium	PCT 302	High - tree
Low	Medium	Medium
PCT 285	PCT 729	Derived grassland
Poor	High	
PCT 300	High - tree	
High	Medium	

Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 c





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

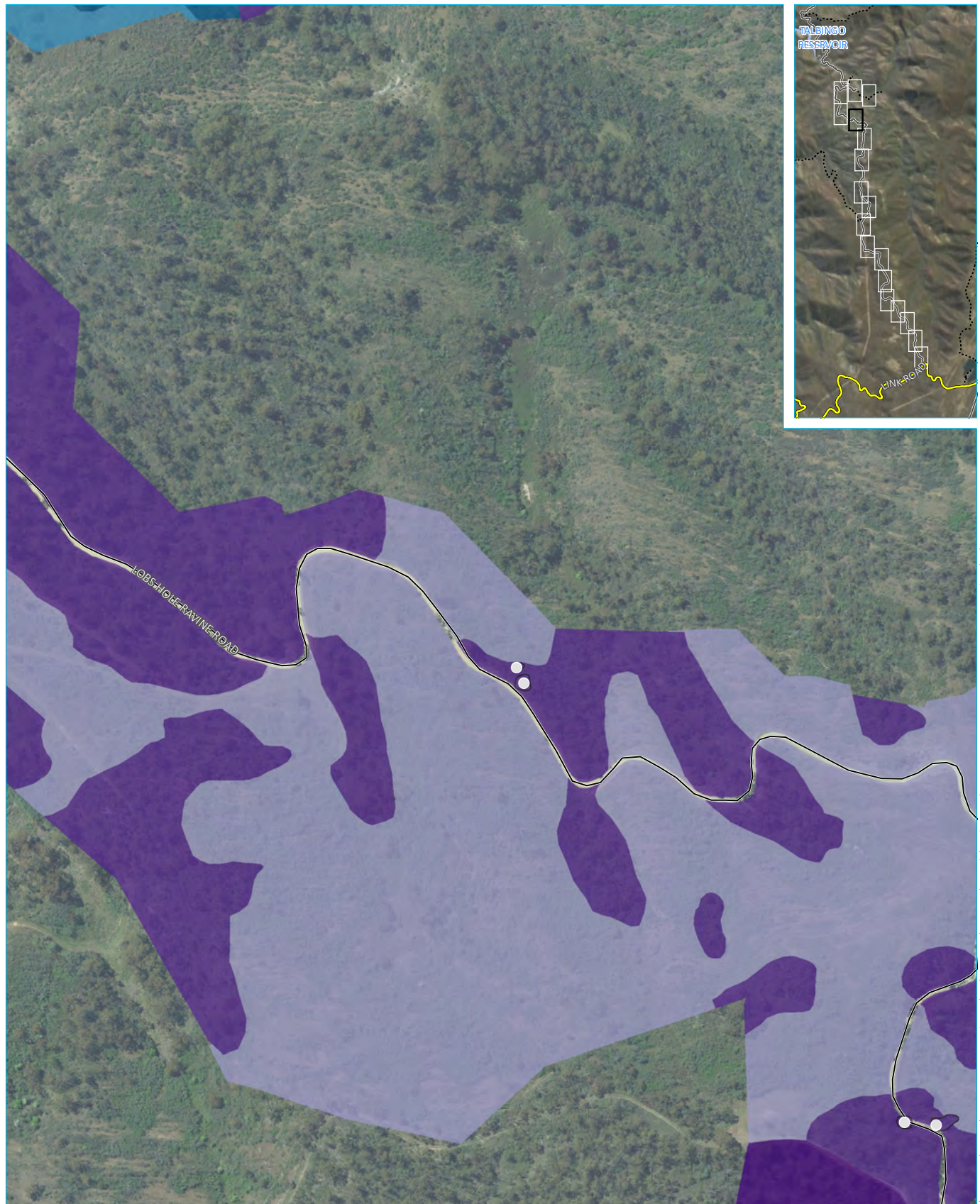
● Dangerous trees	PCT 729
— Local road	■ High
PCT 300	■ Medium
■ High	■ Low
■ Medium	■ Poor
■ Medium - tree	PCT 999
■ Low	■ Medium
■ Poor	
■ Other	
■ Derived grassland	

Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

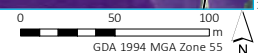
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Modification 1
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Dangerous trees
- Local road
- PCT 300
 - High
 - Medium
 - Medium - tree
 - Other
- PCT 729
 - Medium
 - Poor

Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

Snowy 2.0
Ecology RTS
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3.1 e





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous trees
- Local road
- PCT 300
 - High
 - High - tree
 - Medium
 - Medium - tree
 - Other
- PCT 729
 - High

Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

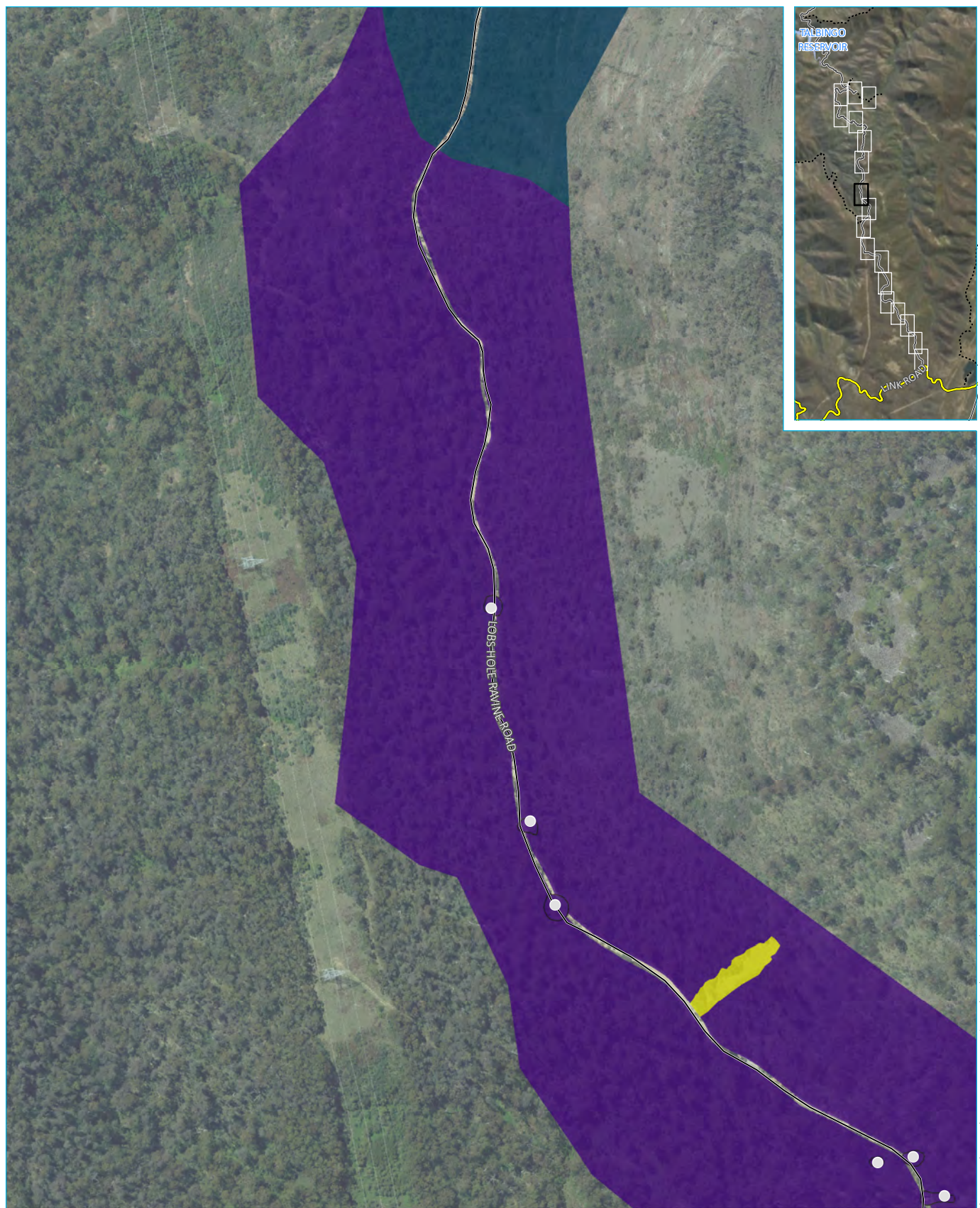
- Dangerous trees
- Local road
- PCT 300
 - High
 - High - tree
- PCT 729
 - High
 - High - tree

Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
Ecology RTS
Modification 1
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

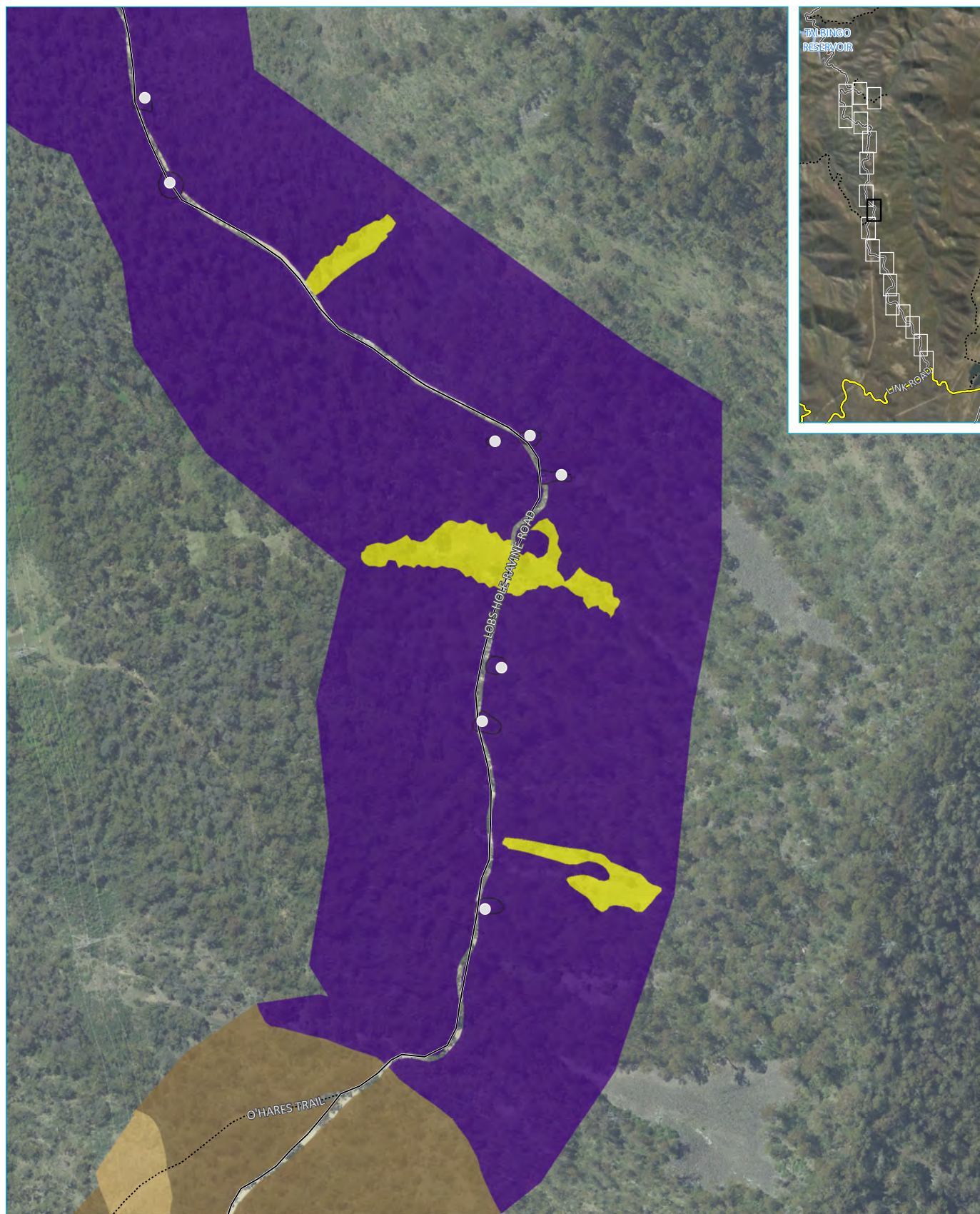
KEY

- Dangerous trees
- Local road
- PCT 300
- High
- High - tree
- PCT 643
- Low
- PCT 729
- High

Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 h





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous trees
- Local road
- Vehicular track
- PCT 300
- High
- High - tree
- PCT 643
- Low
- PCT 953
- High
- Derived grassland

Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 i



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

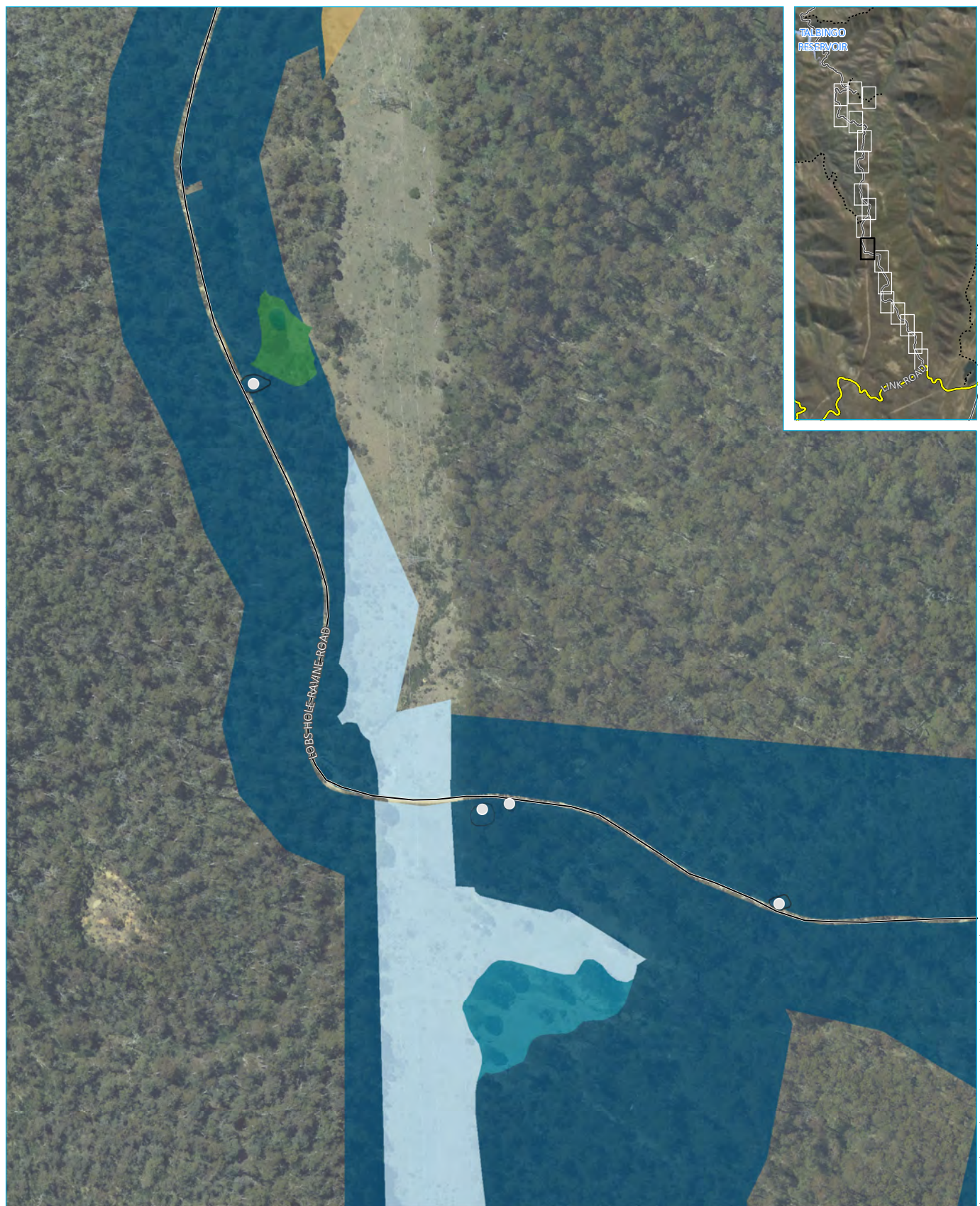
- Dangerous trees
- Local road
- Vehicular track
- PCT 300
- High
- High - tree
- PCT 643
- Low
- PCT 953
- High
- High - tree
- Derived grassland
- PCT 1196
- High
- High - tree
- Derived grassland

Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
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Modification 1
3.1 j



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous trees
- Local road
- PCT 303
- High
- PCT 637
- High
- PCT 953
- High
- Derived grassland
- PCT 1196
- High
- High - tree
- Medium
- Derived grassland

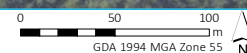
Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 k





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Dangerous trees
- Local road
- PCT 1196
- High
- High - tree

Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

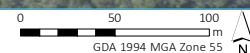
Snowy 2.0
Ecology RTS
Modification 1
3.1 I



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Dangerous trees
- Local road
- PCT 1196
- High
- High - tree
- PCT 1224
- High

Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

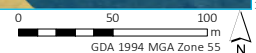
Snowy 2.0
Ecology RTS
Modification 1
3.1 m



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



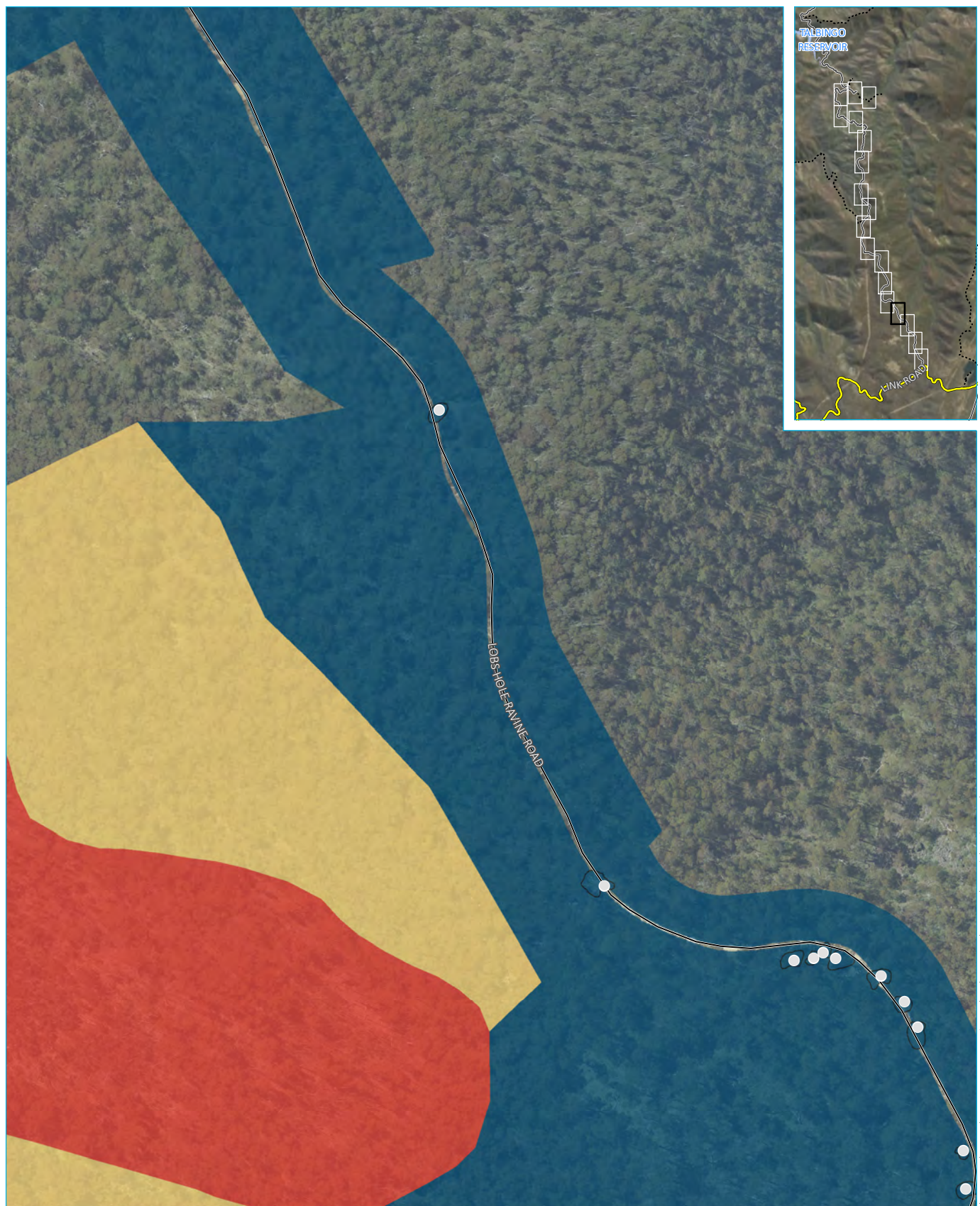
KEY

- Dangerous trees
- Local road
- PCT 639
- High
- PCT 638
- High
- PCT 1196
- High
- High - tree

Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 n





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

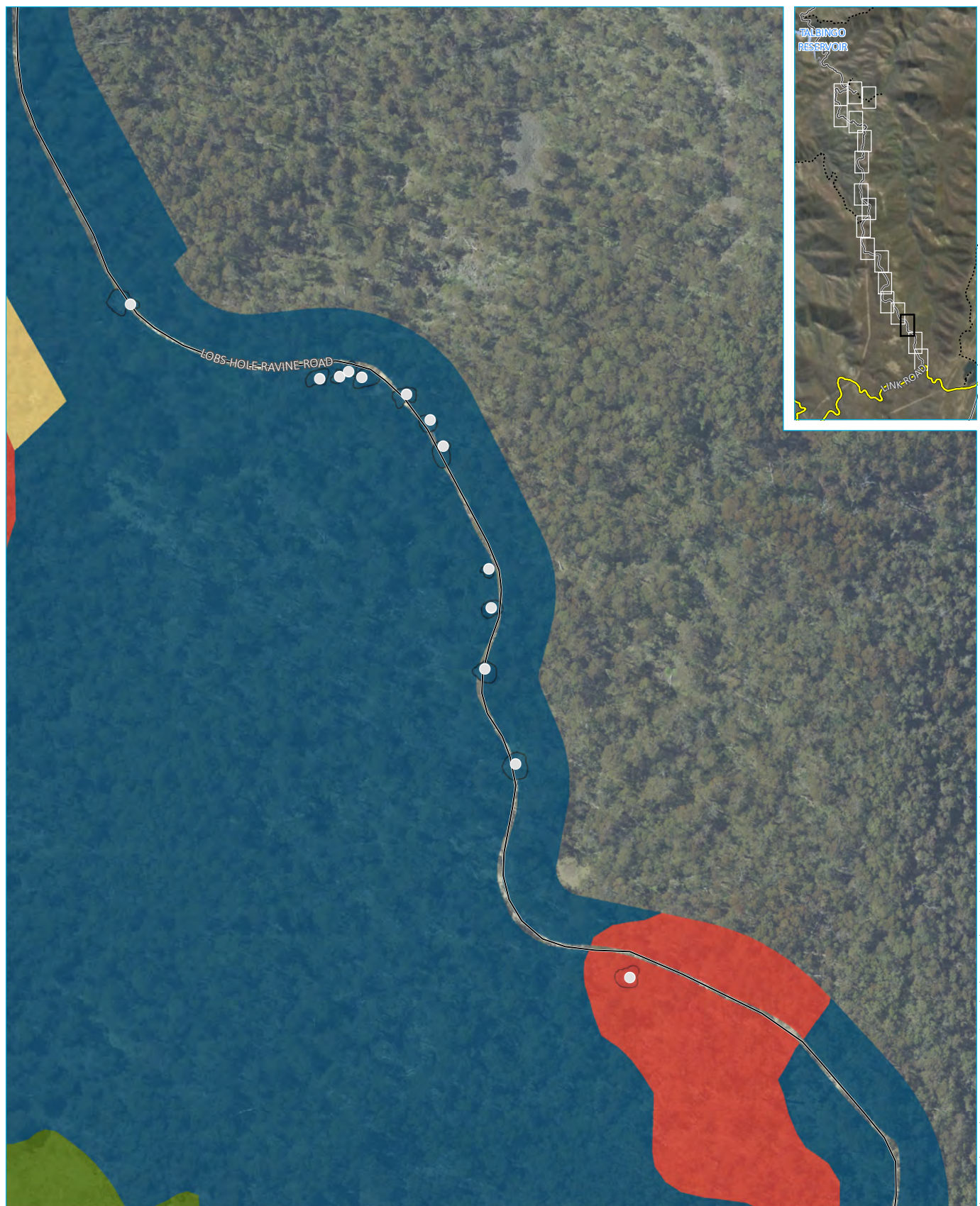
- Dangerous trees
- Local road
- PCT 639
- High
- PCT 638
- High
- PCT 1196
- High
- High - tree

Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 o



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous trees
- Local road
- PCT 639
- PCT 638
- PCT 1196
- High
- High - tree
- High
- High - tree
- PCT 1224
- High

Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 p



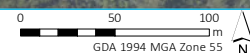
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous trees
- Local road
- PCT 639
- High
- PCT 638
- High
- High - tree
- PCT 1196
- High
- High - tree



Dangerous tree locations, Plant Community Type and vegetation zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 q



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous trees
- Main road
- Local road
- PCT 638
- High
- High - tree
- PCT 1196
- High

Dangerous tree locations, Plant
Community Type and vegetation
zone mapping

Snowy 2.0
Ecology RTS
Modification 1
3.1 r



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3.2 Threatened species assessment, including for dangerous tree removal

3.2.1 Targeted fauna survey methods

Targeted fauna surveys were conducted within the survey area for Snowy 2.0 in accordance with various NSW (DECC 2004) and Commonwealth (DSEWPac 2010, 2011) guidelines. This section provides a summary of surveys undertaken within Lobs Hole Ravine, including the dangerous trees.

i Diurnal birds

Bird surveys for diurnal birds were undertaken for five species listed under the BC Act and three additional migratory species listed under the EPBC Act. Targeted bird species included:

- Gang-gang Cockatoo (breeding habitat)
- breeding habitat for birds of prey, including:
 - Little Eagle;
 - Square-tailed Kite; and
 - White-bellied Sea-eagle.
- Latham's Snipe;
- Rufous Fantail; and
- Satin Flycatcher.

Bird survey methods and survey effort are outlined in Table 3.4.

Table 3.4 Methods and survey effort – diurnal birds

Method	Survey description	Survey effort
Transects and area searches	• Land based areas searches and transects. • Surveyors walked transect (access tracks) or area searches within a 1-3 ha area (other areas). • All calls and habitat features were investigated. • Birds observed or heard were recorded.	DEC (2004) has not resolved bird survey requirements. DSEWPac (2010a) was reviewed and sympatric species survey efforts indicated a requirement for 10 hours over 5 days (2 hours per day) for sites less than 50 ha. No survey effort for larger sites is provided. A total of 29 bird surveys have been completed with a total of 67 people hours within the survey area between December 2017 and April 2019.
Targeted nest searches	Observers travelled across available habitat, seeking out habitat features including nest trees and hollows. Suitable nests or breeding hollows were marked and watched to determine if they are being used by the target species.	DEC (2004) has not resolved nest search requirements. DSEWPac (2010a) was reviewed and sympatric species survey efforts indicated 8 hours over 4 days (2 hours per day) for sites less than 50 ha. Completed survey effort is outlined above within transects and area searches.

ii Nocturnal birds

Bird surveys for nocturnal birds were undertaken to identify breeding habitat for three forest owl species listed under the BC Act. Targeted bird species include:

- Barking Owl;
- Powerful Owl; and
- Masked Owl

Although breeding habitat is restricted within the modification project area, surveys were undertaken across all breeding and foraging habitat to determine if forest owls were active within the survey area. If found to be active surveys would focus on identifying breeding locations, if present. Nocturnal bird survey methods and survey effort are outlined in Table 3.5.

Table 3.5 Methods and survey effort – nocturnal birds

Method	Survey description	Survey effort
Call playback and spotlighting	DEC (2004) recommends call playback and spotlighting are undertaken to target these owl species. • Commence surveys with a 10-15 minute listening period. This will target the male and female calling back and forth to one another and is useful in identifying nesting trees. • This will be followed by spotlighting for 10 minutes in the immediate vicinity. • Call playback is then undertaken with the call of each target species played intermittently for a 5 minutes period followed by a 10 minute listening period. • Following call playback a further 10 minutes of spotlighting is undertaken. If forest owls were found to be present within the survey area, surveys would try to identify nesting sites by listening to roosting males calling to nesting females on dusk. Females calls would be triangulated and nest searches undertaken in identified areas over several nights.	DEC (2004) recommends at least 5 visits for the Powerful Owl and Barking Owl, 6 visits for the Sooty Owl and 8 visits for the Masked Owl. Sites should be separated by 1 km. Surveys have been completed at 24 sites within the survey area, with eight-night visits. Surveys were undertaken within May 2018 and June 2019.

iii Arboreal mammals

Arboreal mammal surveys were undertaken within the survey area to target four arboreal species listed under the EPBC Act and/or BC Act. Targeted arboreal mammal species include:

- Koala;
- Squirrel Glider;
- Brush-tailed Phascogale; and
- Greater Glider.

Arboreal mammal methods and survey effort is outlined in Table 3.6.

Table 3.6 Methods and survey effort – arboreal mammals

Method	Survey description	Survey effort
Trapping	Ten Elliot B or cage traps were placed at 2-4 m above the ground, 50 m apart in two parallel lines separated by 50 m: • Traps were baited with a mixture of peanut butter, rolled oats and honey. • A mixture of water and honey was sprayed on each tree trunk. • Traps were checked early in the morning and closed for the day. • Traps were re-opened and rebaited in the late afternoon. • Animals were temporarily marked to allow mark-recapture data to be collected. • Trapping was undertaken in conjunction with terrestrial mammal trapping where suitable habitat occurs.	DEC (2004) requires 24 trap nights over 3-4 consecutive days per 50 ha of stratification unit. Surveys were undertaken between December 2017 and April 2019 at 19 survey sites within the survey area, equating to 760 trap nights.
Spotlighting	DSEWPaC (2011) recommends two parallel 200 m transects per 5 ha site. No survey effort for larger sites is specified. In line with DSE (2011) and DEC (2004), a survey effort of two parallel 2,000 m transects per 100 ha site (half the survey effort, but over a larger area) was deemed suitable in consultation with OEH. Surveys included: • 2,000 m transects were undertaken by 2 observers (4,000 m total transect), with 25 m between transects. • Observers moved at a speed of 10 m per minute (ie 200 minutes for a 2,000 m transect). • All animals observed were recorded, including the distance of the animals from the observer.	DSEWPaC (2011) recommends two parallel transects per 5 ha site, while DEC (2004) recommends 2 transects per 200 ha of stratification unit. Given the size of the survey area and the fact that no species specific guidelines are available for the Greater Glider a survey effort of two 2,000 m transects per 100 ha stratification unit, repeated on two separate occasions, was deemed appropriate based on DSE (2011) and DEC (2004). Surveys were undertaken between December 2017 and June 2019, with 39 transects (2,000 m minimum distance) completed within the survey area, totalling 224,840m in length. Some transects were less than 2,000 m as they were sited in infrastructure areas where a 2,000m transect was not appropriate.

Table 3.6 **Methods and survey effort – arboreal mammals**

Method	Survey description	Survey effort
Regularised Grid Based (RGB) Spot Assessment Technique (SAT) (Koala)	The RGB SAT method requires application of a uniform assessment method across a broad area. A 350 m x 350 m grid was applied to the survey area to identify survey locations. At each grid point, the SAT (Phillips and Callaghan 2011) was undertaken, as follows: • Centre tree was located and marked with flagging tape. • The 29 nearest trees to the centre tree were also identified and marked. • Koala faecal pellets were searched for beneath each of the 30 trees within a distance of 100 cm. Initial inspections were checked in undisturbed ground surface, followed by a more thorough inspection involving disturbance of leaf litter and ground cover (if no faecal pellets were initially detected). • An average of approximately two person minutes per tree should be dedicated to the faecal pellet search. Activity levels can be interpreted using Table 2 from Phillips and Callaghan (2011).	Grid points located below 800 m and in proximity to and surrounding the survey area were included for survey. A total of 51 grid locations have been surveyed within the survey area.
Songmeters (Koala)	Following recent use of acoustic recorders to document calling by male Koalas (Law et al. 2018) Songmeters were deployed during the breeding season to record males bellowing: • Songmeters were set to record between dusk and dawn • Songmeters were deployed at sites separated by at least 3 km, over a mix of landscape positions (ridge, valley, gully and flat). • Songmeters were deployed at each site for a minimum of 7 nights. • Songmeter data was analysed by Dr Brad Law of the NSW Department of Primary Industry.	No survey effort has been determined for the use of Songmeters. Three Songmeters were placed out within the survey area for 62 nights.



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- ▲ Owl survey
- Koala Spot Assessment Technique (SAT)
- Watercourse/drainage line
- Vehicular track
- Fauna survey transect
- Bird survey
- Spotlighting

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 a





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

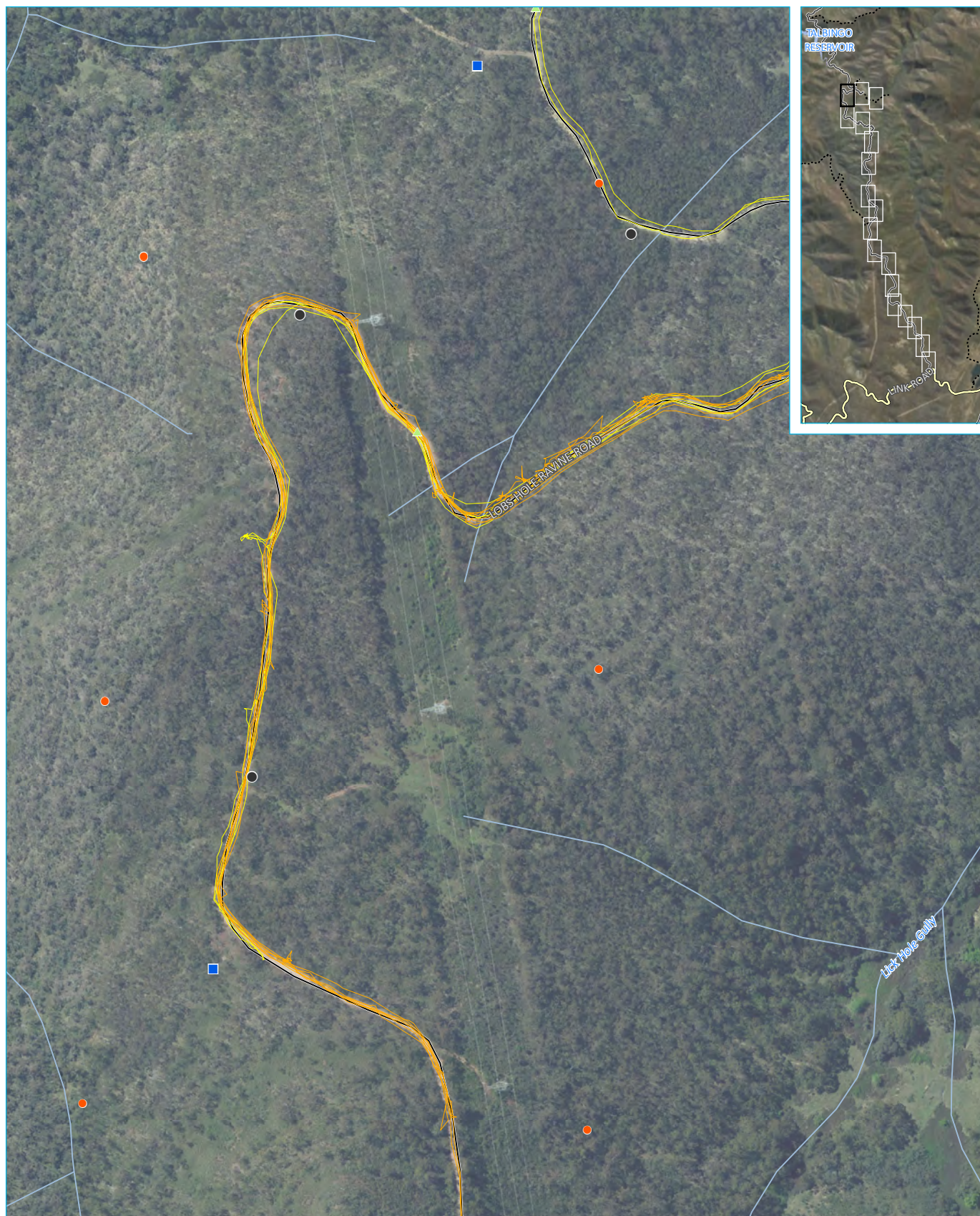
KEY

- Dangerous tree
- ▲ Owl survey
- Koala Spot Assessment Technique (SAT)
- Arboreal trapping
- Watercourse/drainage line
- Local road
- Vehicular track
- Fauna survey transect
- Bird survey
- Spotlighting

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 b





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100
m
GDA 1994 MGA Zone 55

KEY

- Dangerous tree
- ▲ Owl survey
- Koala Spot Assessment Technique (SAT)
- Arboreal trapping
- Watercourse/drainage line
- Local road
- Vehicular track
- Fauna survey transect
- Bird survey
- Spotlighting

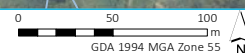
Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 c





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Dangerous tree
- ▲ Owl survey
- Koala Spot Assessment Technique (SAT)
- Watercourse/drainage line
- Local road
- Fauna survey transect
- Bird survey

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 d





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- ▲ Owl survey
- Koala Spot Assessment Technique (SAT)
- Watercourse/drainage line
- Local road
- Fauna survey transect
- Bird survey

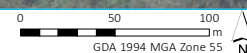
Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 e





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Dangerous tree
- ▲ Owl survey
- Koala Spot Assessment Technique (SAT)
- Watercourse/drainage line
- Local road
- Fauna survey transect
- Spotlighting

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 f





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

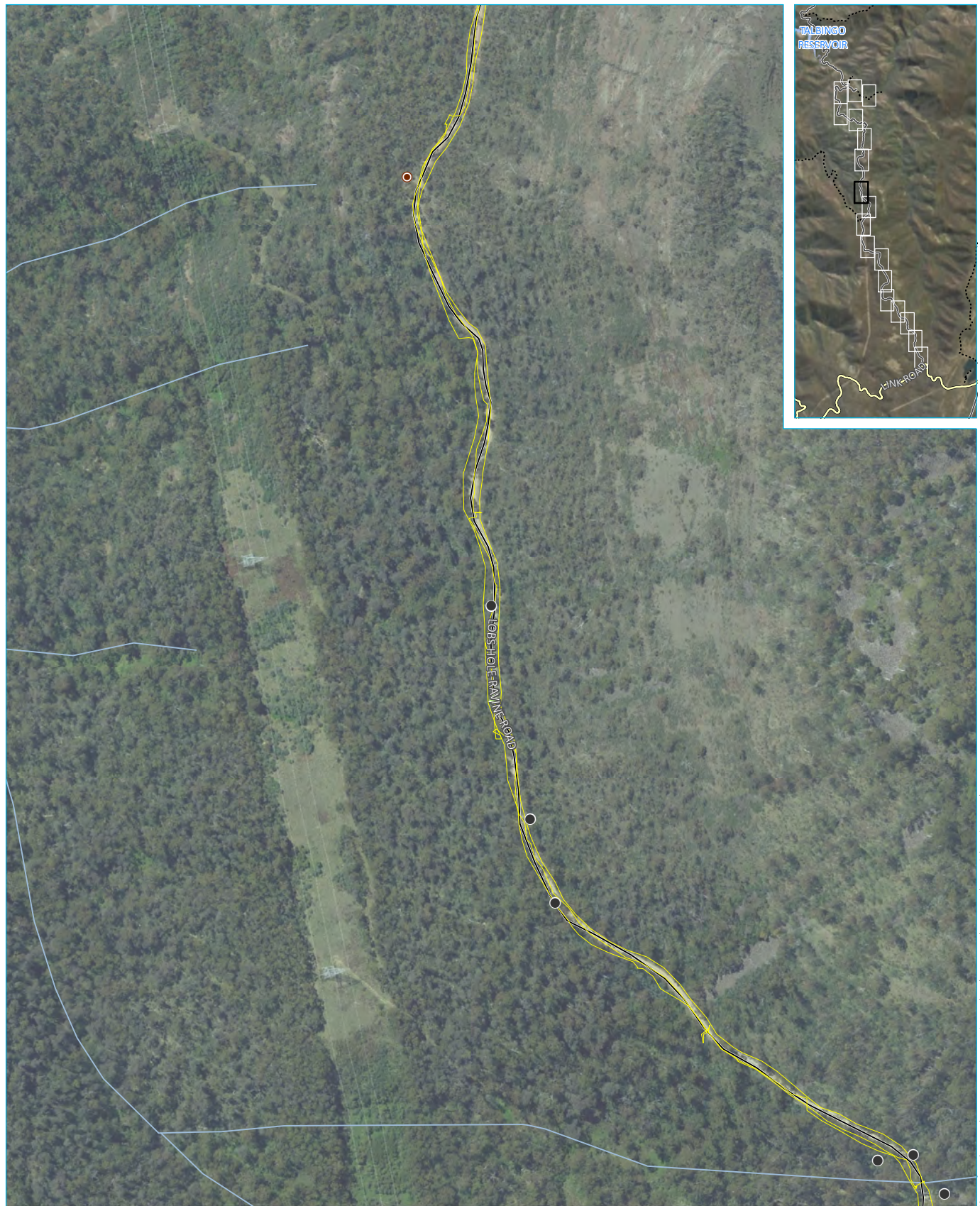
KEY

- Dangerous tree
- ▲ Owl survey
- Arboreal trapping
- Watercourse/drainage line
- Local road
- Fauna survey transect
- Spotlighting

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 g





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100
m
GDA 1994 MGA Zone 55

KEY

- Dangerous tree
- ▲ Owl survey
- Koala songmeter
- Watercourse/drainage line
- Local road
- Fauna survey transect
- Spotlighting

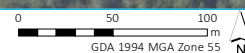
Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 h





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Dangerous tree
- ▲ Owl survey
- Watercourse/drainage line
- Local road
- Vehicular track
- Fauna survey transect
- Bird survey
- Spotlighting

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 i



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- | | |
|-----------------------------|-----------------------|
| ● Dangerous tree | Fauna survey transect |
| ▲ Owl survey | — Bird survey |
| ■ Arboreal trapping | — Spotlighting |
| — Watercourse/drainage line | |
| — Local road | |
| Vehicular track | |

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 j



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

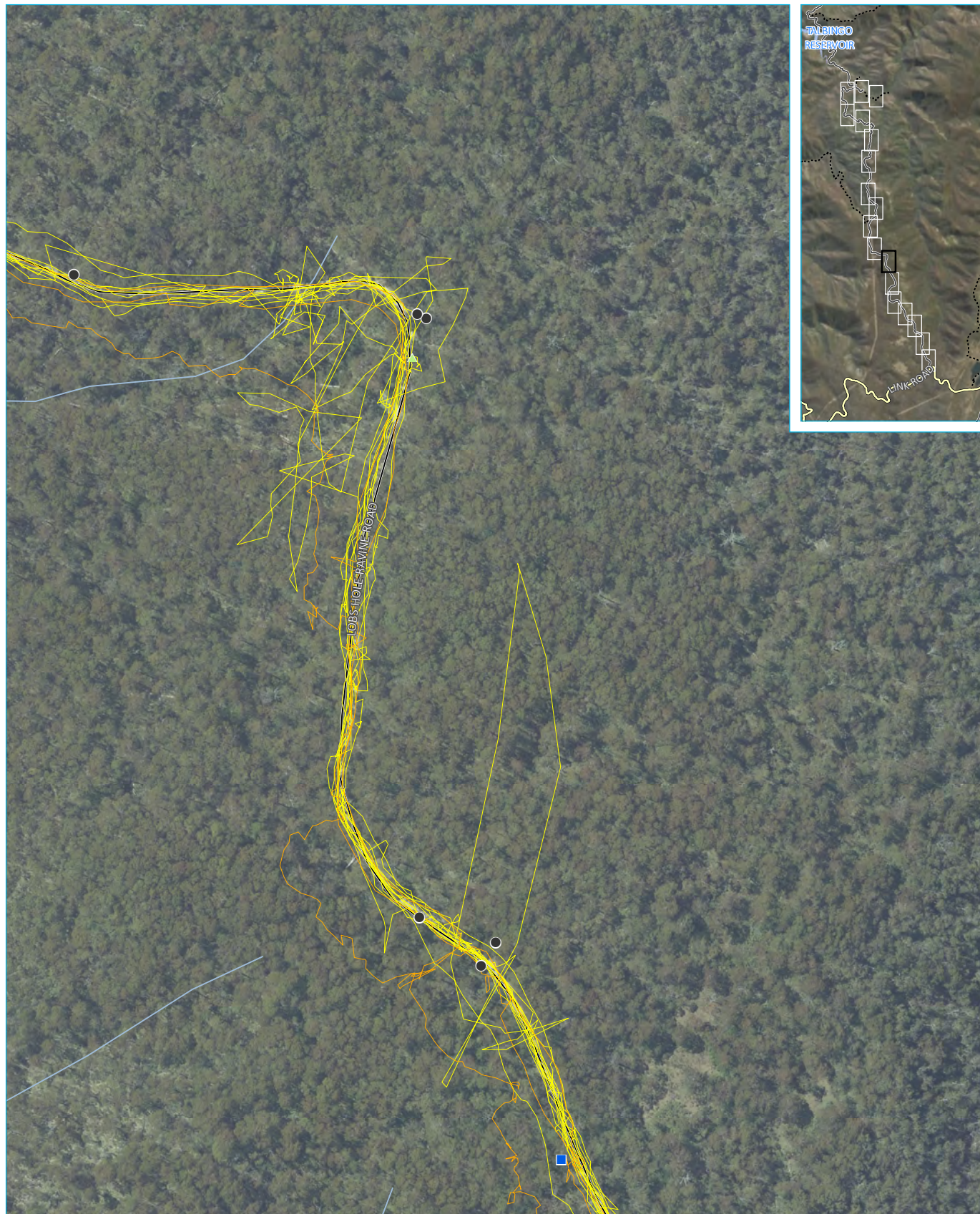
KEY

- Dangerous tree
- ▲ Owl survey
- Watercourse/drainage line
- Local road
- Fauna survey transect
- Bird survey
- Spotlighting

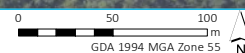
Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 k





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- | | |
|-----------------------------|-----------------------|
| ● Dangerous tree | Fauna survey transect |
| ▲ Owl survey | — Bird survey |
| ■ Arboreal trapping | — Spotlighting |
| — Watercourse/drainage line | |
| — Local road | |

Fauna survey locations

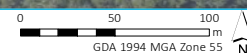
Snowy 2.0
Ecology RTS
Modification 1
3.2 I



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- | | |
|-----------------------------|-----------------------|
| ● Dangerous tree | Fauna survey transect |
| ▲ Owl survey | — Bird survey |
| ■ Arboreal trapping | — Spotlighting |
| — Watercourse/drainage line | |
| — Local road | |

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 m



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- ▲ Owl survey
- Watercourse/drainage line
- Local road
- Fauna survey transect
- Bird survey
- Spotlighting

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 n





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- ▲ Owl survey
- Koala songmeter
- Arboreal trapping
- Watercourse/drainage line
- Local road
- Fauna survey transect
- Bird survey
- Spotlighting

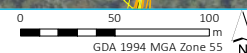
Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 0





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- | | |
|-----------------------------|-----------------------|
| ● Dangerous tree | Fauna survey transect |
| ▲ Owl survey | — Bird survey |
| ■ Arboreal trapping | — Spotlighting |
| — Watercourse/drainage line | |
| — Local road | |

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 p



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

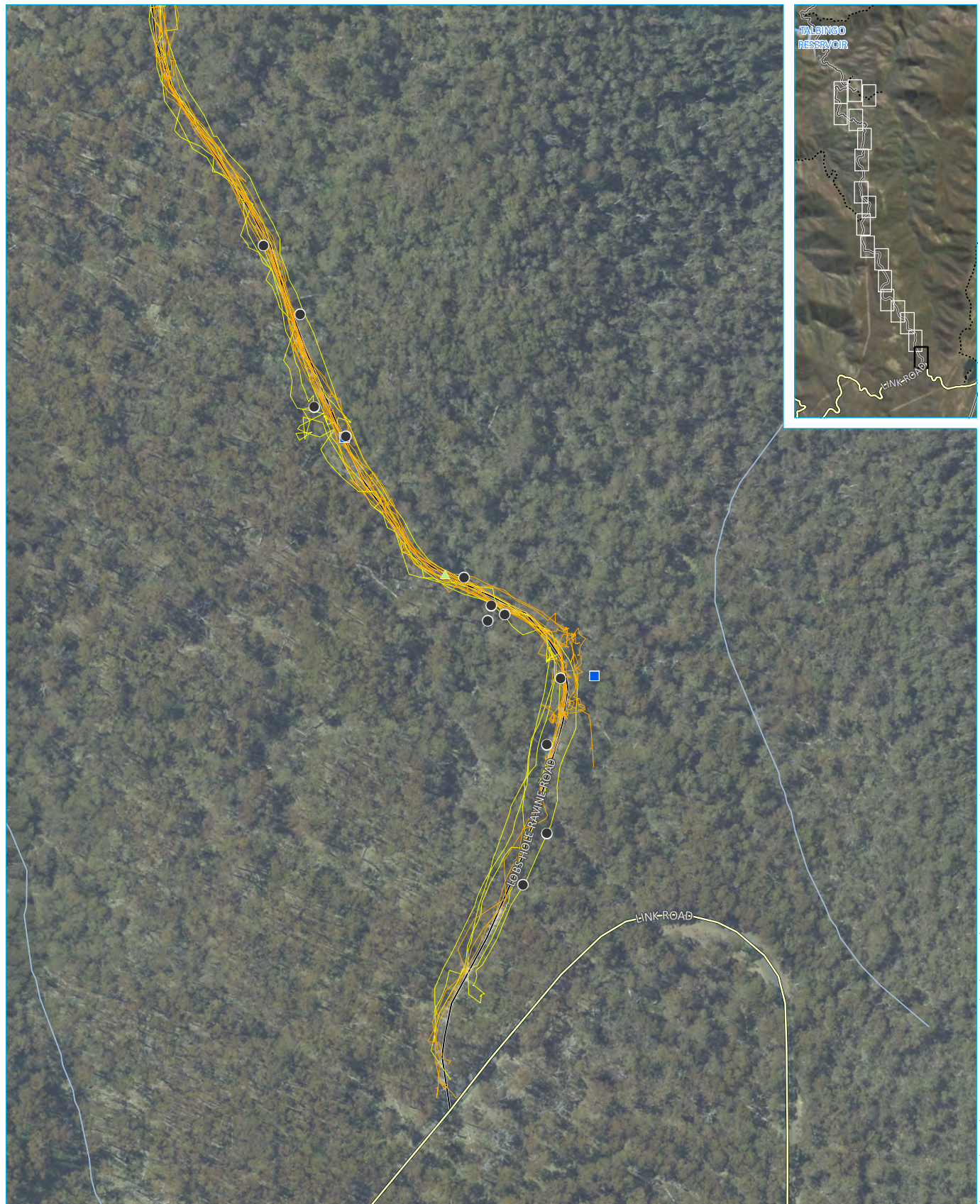
- | | |
|-----------------------------|-----------------------|
| ● Dangerous tree | Fauna survey transect |
| ▲ Owl survey | — Bird survey |
| — Watercourse/drainage line | — Spotlighting |
| — Local road | |

Fauna survey locations

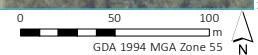
Snowy 2.0
Ecology RTS
Modification 1
3.2 q



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- | | |
|-----------------------------|-----------------------|
| ● Dangerous tree | Fauna survey transect |
| ▲ Owl survey | — Bird survey |
| ■ Arboreal trapping | — Spotlighting |
| — Watercourse/drainage line | |
| — Main road | |
| — Local road | |

Fauna survey locations

Snowy 2.0
Ecology RTS
Modification 1
3.2 r



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3.2.2 Targeted fauna survey results

Ten threatened fauna species have been recorded within or adjacent to the dangerous trees (Figure 3.3):

- seven threatened bird species:
 - Diamond Firetail (ecosystem credit species);
 - Dusky Woodswallow (ecosystem credit species);
 - Flame Robin (ecosystem credit species);
 - Gang-gang Cockatoo;
 - Masked Owl;
 - Olive Whistler (ecosystem credit species);
 - Scarlet Robin (ecosystem credit species);
- two threatened mammal species:
 - Eastern Pygmy-possum;
 - Smoky Mouse; and
- one threatened amphibian species:
 - Booroolong Frog.

i Diurnal birds

One target species, the Gang-gang Cockatoo, was recorded foraging within adjacent vegetation to the dangerous trees. The species was not recorded breeding or observing hollows within any dangerous trees identified for removal. Therefore, considering the species was recorded as an ecosystem credit species, no species polygon was developed for the Gang-gang Cockatoo.

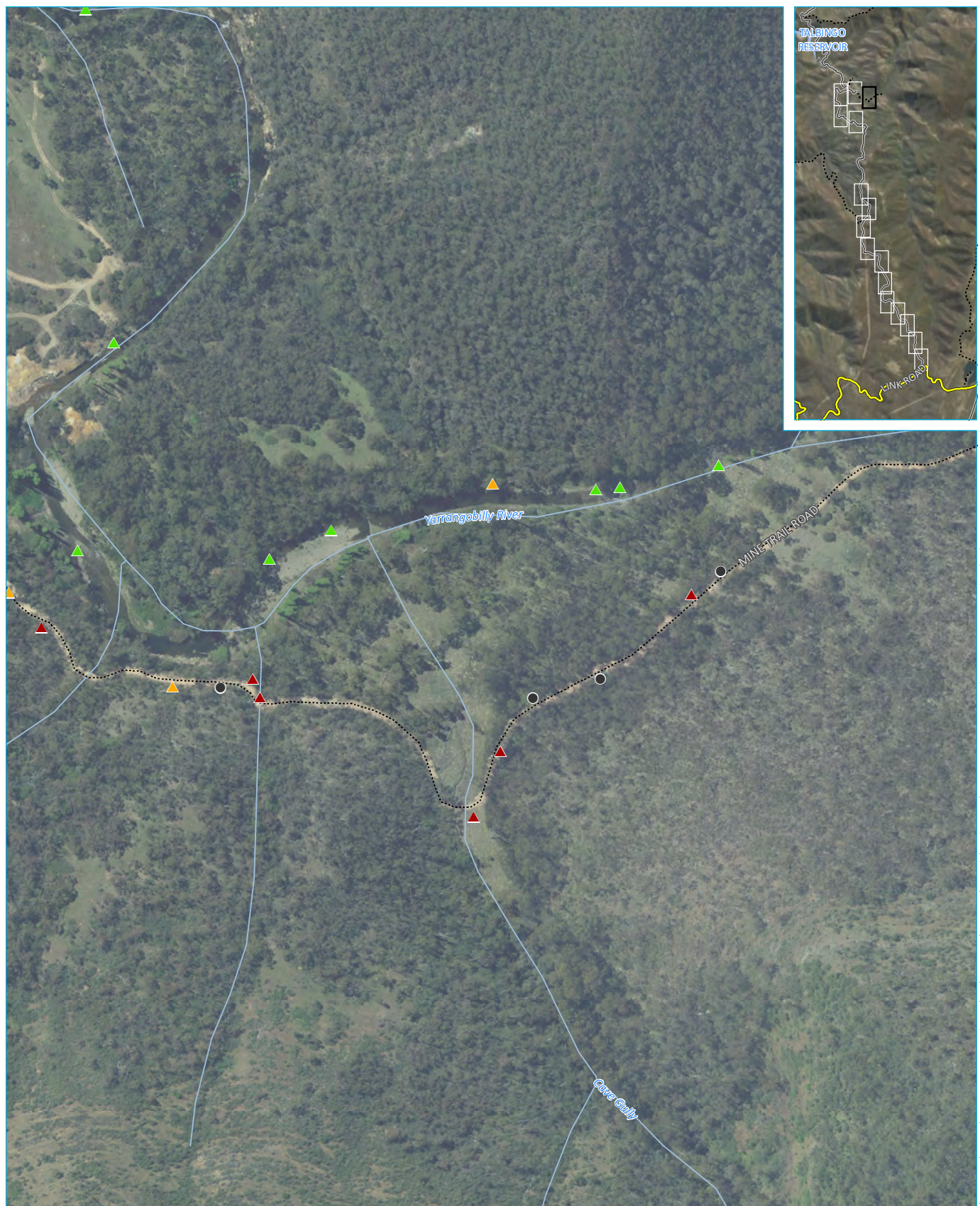
ii Nocturnal birds

One target species, the Masked Owl, was recorded within vegetation adjacent to the dangerous trees. This record was from the species being “called in” as a result of call playback. However, no nesting birds were identified during targeted surveys. Therefore, considering the species was only recorded as an ecosystem credit species, no species polygon was developed for the Masked Owl.

iii Arboreal mammals

No threatened arboreal mammals were recorded during targeted surveys.

Although there is some potential for these species to occur in low densities and/or utilise the dangerous trees on occasion, these species are not considered present for the purposes of this assessment. The Koala is rare in the KNP and was not observed during targeted surveys; therefore, it is considered unlikely to occur for the purposes of this assessment.



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

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m
GDA 1994 MGA Zone 55
N

KEY

..... Vehicular track
— Watercourse/drainage line

● Dangerous trees

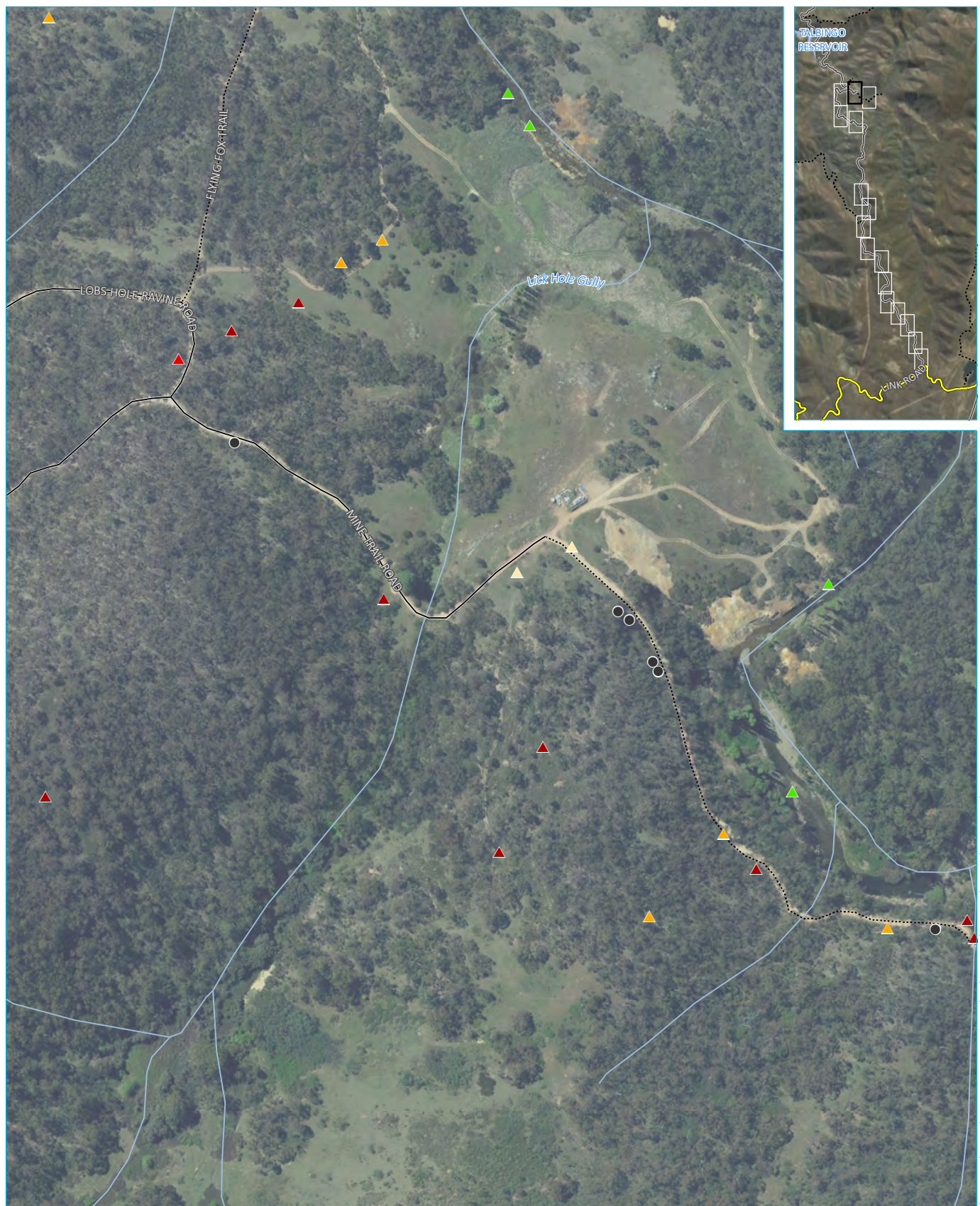
Threatened fauna

▲ Booroolong Frog
▲ Dusky Woodswallow
▲ Gang-gang Cockatoo

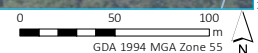
Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 a





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Local road
- Vehicular track
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
- ▲ Booroolong Frog
- ▲ Diamond Firetail
- ▲ Dusky Woodswallow
- ▲ Flame Robin
- ▲ Gang-gang Cockatoo

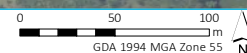
Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 b





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



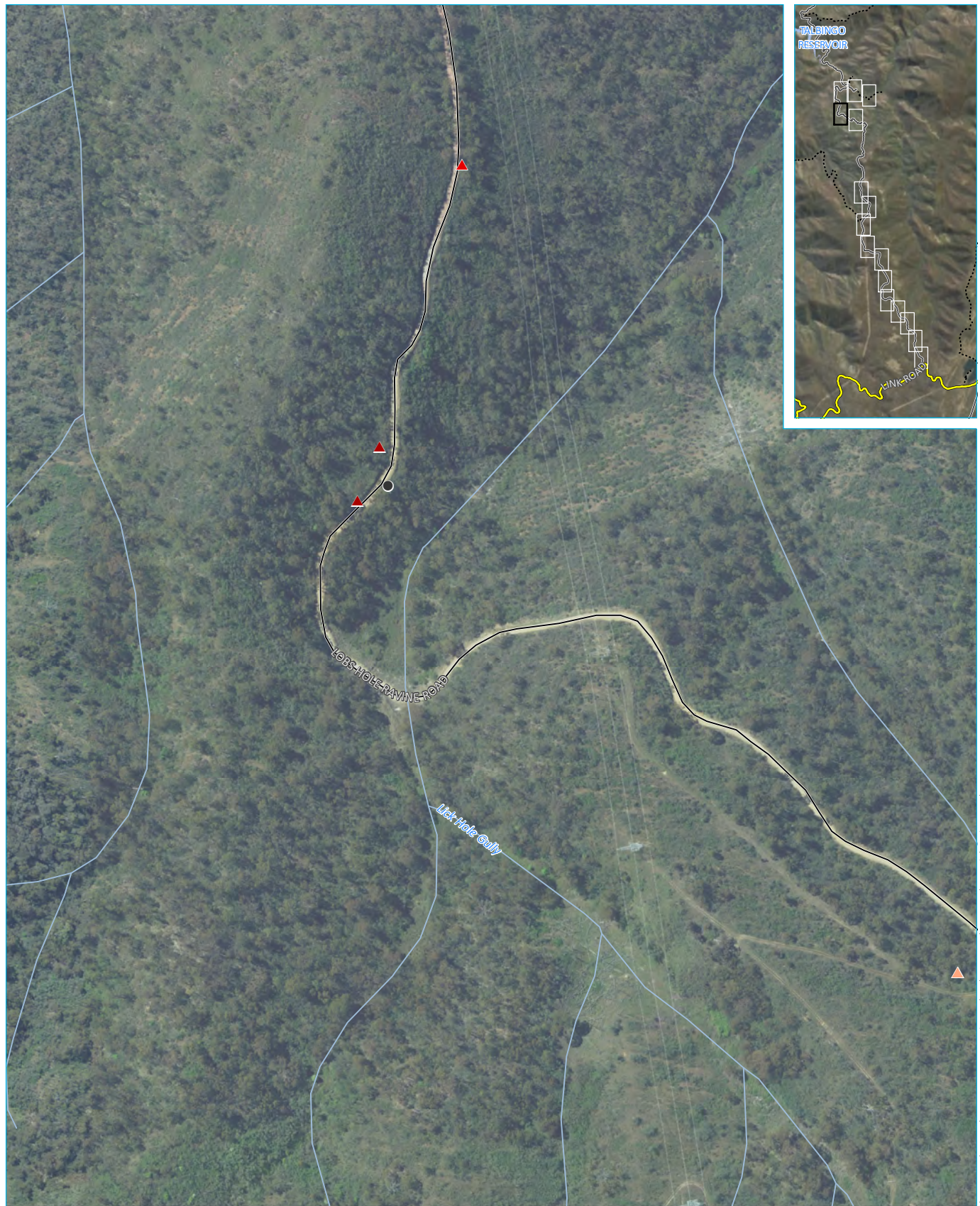
KEY

- Local road
- Vehicular track
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
- ▲ Dusky Woodswallow
- ▲ Flame Robin
- ▲ Gang-gang Cockatoo
- ▲ Scarlet Robin

Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 c





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Local road
- Watercourse/drainage line
- Dangerous trees

Threatened fauna

- ▲ Eastern Pygmy-possum
- ▲ Flame Robin
- ▲ Gang-gang Cockatoo

Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 d





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Local road
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
- ▲ Eastern Pygmy-possum

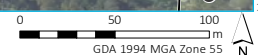
Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 e





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Local road
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
- ▲ Dusky Woodswallow
- ▲ Gang-gang Cockatoo

Fauna survey results

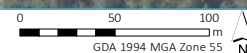
Snowy 2.0
Ecology RTS
Modification 1
3.3 f



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Local road
- Vehicular track
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
- ▲ Gang-gang Cockatoo
- ▲ Smoky Mouse

Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 g



\\emmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02_Maps\LEIS_EW_Mod1\Ecology_rts\G003_FaunaSurveyResults_20190729_01.mxd 19/08/2019



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

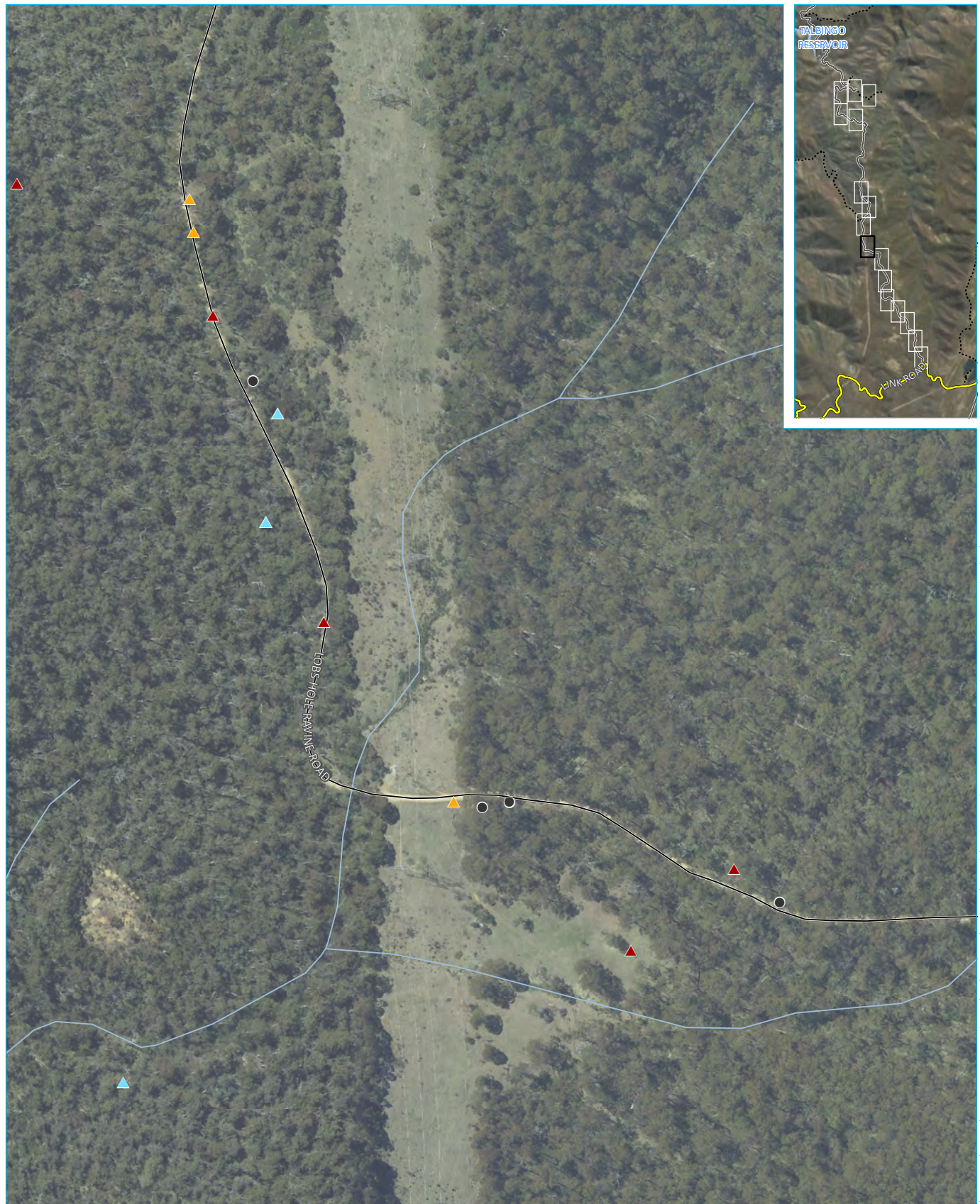
- Local road
- Vehicular track
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
- ▲ Dusky Woodswallow
- ▲ Eastern Pygmy-possum
- ▲ Gang-gang Cockatoo
- ▲ Smoky Mouse

0 50 100
m
GDA 1994 MGA Zone 55

Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 h





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Local road
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
 - ▲ Dusky Woodswallow
 - ▲ Gang-gang Cockatoo
 - ▲ Smoky Mouse

0 50 100
m
GDA 1994 MGA Zone 55
N

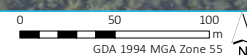
Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 i





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Local road
- Watercourse/drainage line
- Dangerous trees

Threatened fauna

- ▲ Eastern Pygmy-possum
- ▲ Flame Robin
- ▲ Gang-gang Cockatoo
- ▲ Olive Whistler
- ▲ Smoky Mouse

Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 j





KEY

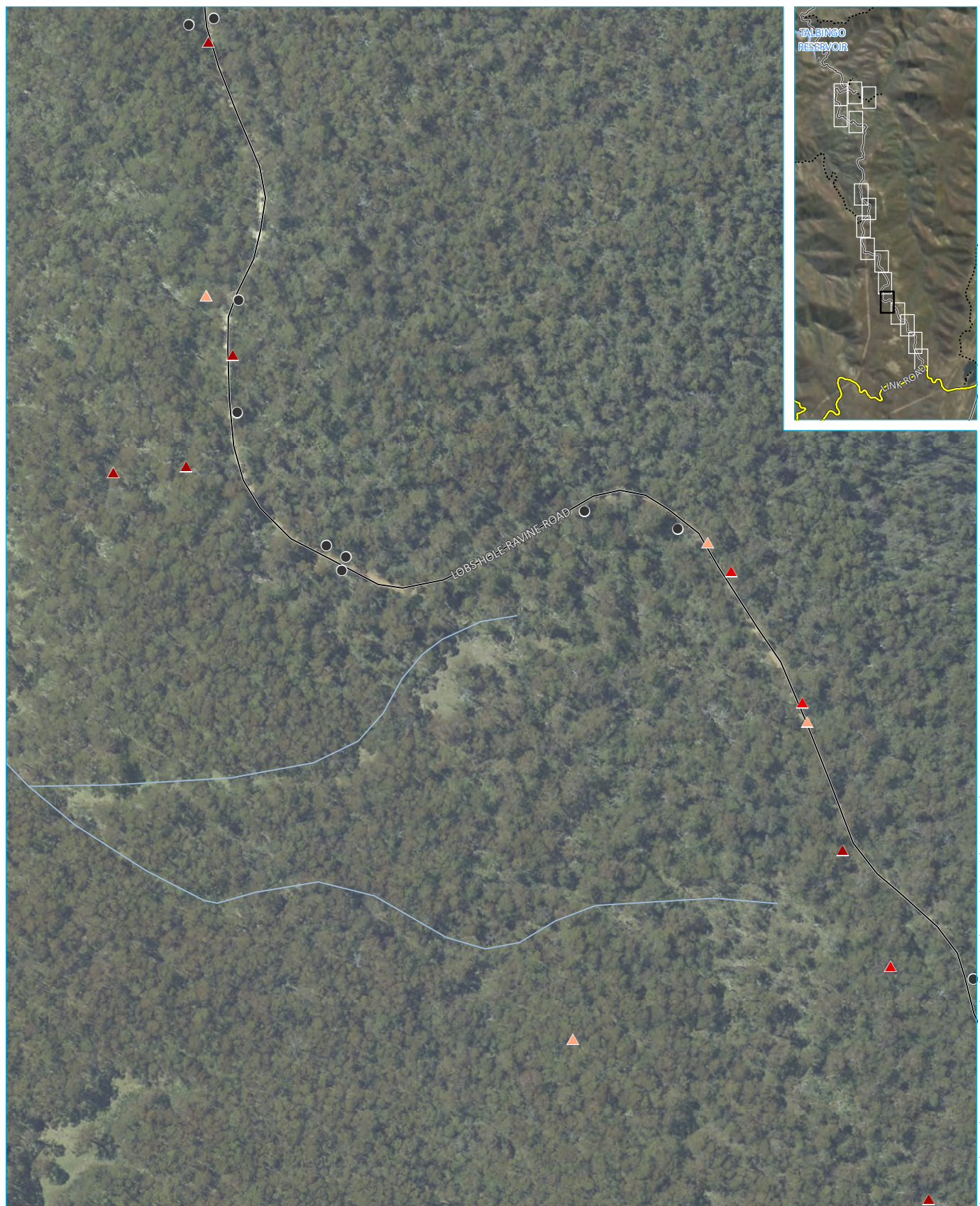
- Local road
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
 - ▲ Flame Robin
 - ▲ Gang-gang Cockatoo
 - ▲ Smoky Mouse

Fauna survey results

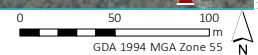
Snowy 2.0
Ecology RTS
Modification 1
3.3 k



\\emmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02_Maps\EIS_EW_Mod1\Ecology_rts\G003_FaunaSurveyResults_20190729_01.mxd 19/08/2019



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Local road
- Watercourse/drainage line
- Dangerous trees

Threatened fauna

- ▲ Eastern Pygmy-possum
- ▲ Flame Robin
- ▲ Gang-gang Cockatoo

Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 I



\\emmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02_Maps\EIS_EW_Mod1\Ecology_rts\G003_FaunaSurveyResults_20190729_01.mxd 19/08/2019



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Local road
- Watercourse/drainage line
- Dangerous trees

Threatened fauna

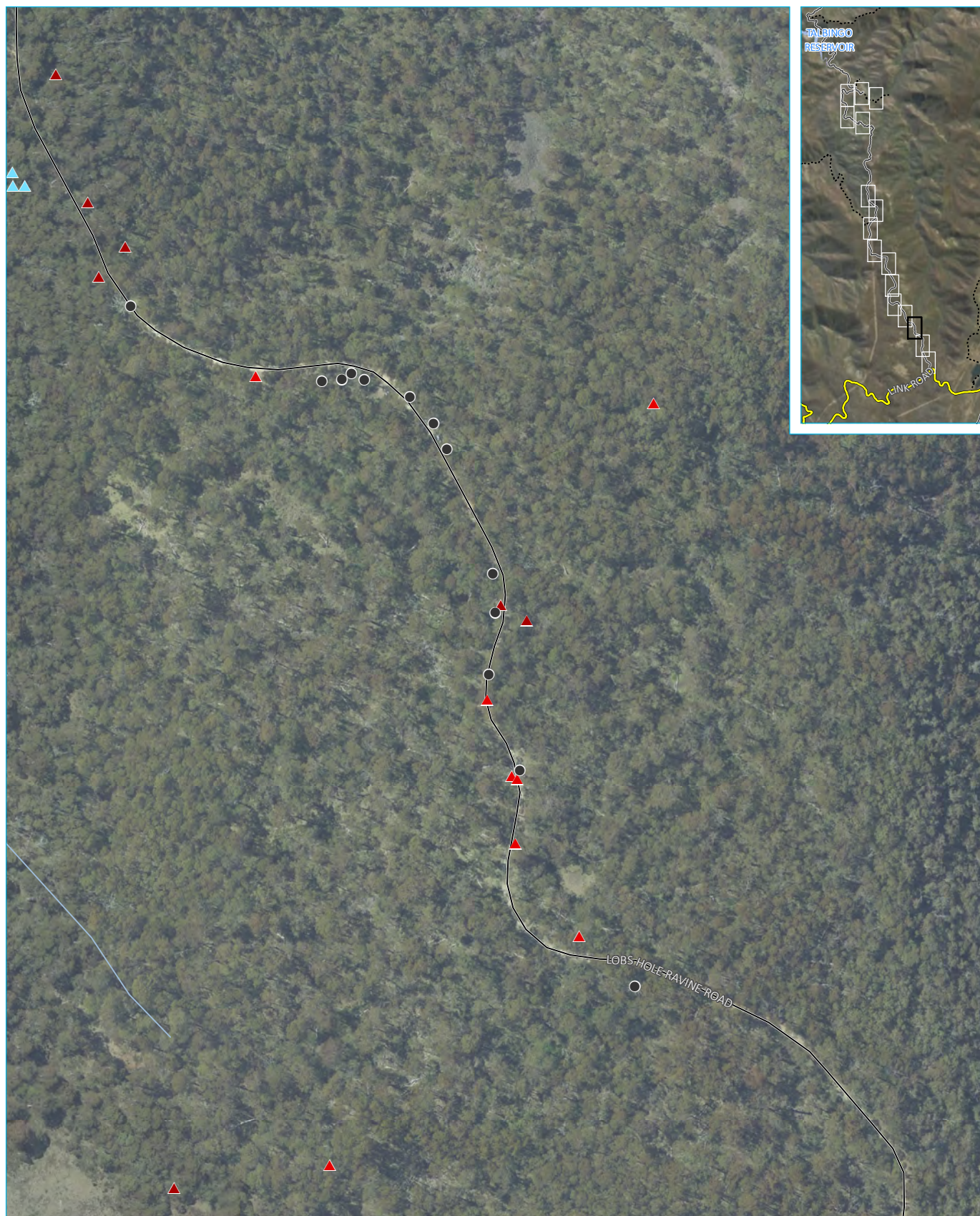
- ▲ Eastern Pygmy-possum
- ▲ Flame Robin
- ▲ Gang-gang Cockatoo
- ▲ Smoky Mouse

0 50 100
m
GDA 1994 MGA Zone 55

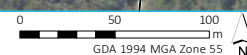
Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 m





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Local road
- Watercourse/drainage line
- Dangerous trees

Threatened fauna

- ▲ Flame Robin
- ▲ Gang-gang Cockatoo
- ▲ Smoky Mouse

Fauna survey results

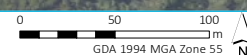
Snowy 2.0
Ecology RTS
Modification 1
3.3 n



\\emmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02_Maps\EIS_EW_Mod1\Ecology_rts\G003_FaunaSurveyResults_20190729_01.mxd 19/08/2019



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Local road
- Watercourse/drainage line
- Dangerous trees

Threatened fauna

- ▲ Eastern Pygmy-possum
- ▲ Flame Robin
- ▲ Gang-gang Cockatoo

Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 o



\\emmsvr1\EMM2\17188 - Snowy Hydro 2.0\GIS\02_Maps\EIS_EW_Mod1\Ecology_rts\G003_FaunaSurveyResults_20190729_01.mxd 19/08/2019



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100
m
GDA 1994 MGA Zone 55

KEY

- Main road
- Local road
- Watercourse/drainage line
- Dangerous trees
- Threatened fauna
- ▲ Flame Robin
- ▲ Gang-gang Cockatoo
- ▲ Masked Owl
- ▲ Smoky Mouse

Fauna survey results

Snowy 2.0
Ecology RTS
Modification 1
3.3 p



3.3 Impacts requiring offsets

A summary of ecosystem credits required for all vegetation zones associated with the dangerous trees, including changes in vegetation integrity score, are provided in Table 3.7. A total of 15 ecosystem credits are required to offset the residual impacts to 1.13 ha of native vegetation arising from the removal of dangerous trees within the Exploratory Works Modification 1. A credit report is provided in Appendix E.

Table 3.7 **Summary of ecosystem credits required for impacts to dangerous trees within Modification 1**

Vegetation zone number	PCT	Vegetation zone name	Area	Vegetation integrity score	Future vegetation integrity score	Change in vegetation integrity score	Credits required
4	PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	300_High_tree	0.10	49	28.7	-20.3	1
6	PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	300_Medium_tree	0.01	56	31.2	-24.8	1
8	PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	300_Other_tree	0.02	59.8	38.7	-21.2	1
27	PCT 953 – Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion	953_High_tree	0.02	75.7	45.9	-29.8	1
24	PCT 1196 – Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	1196_High_tree	0.98	95.7	64.6	-31.1	11

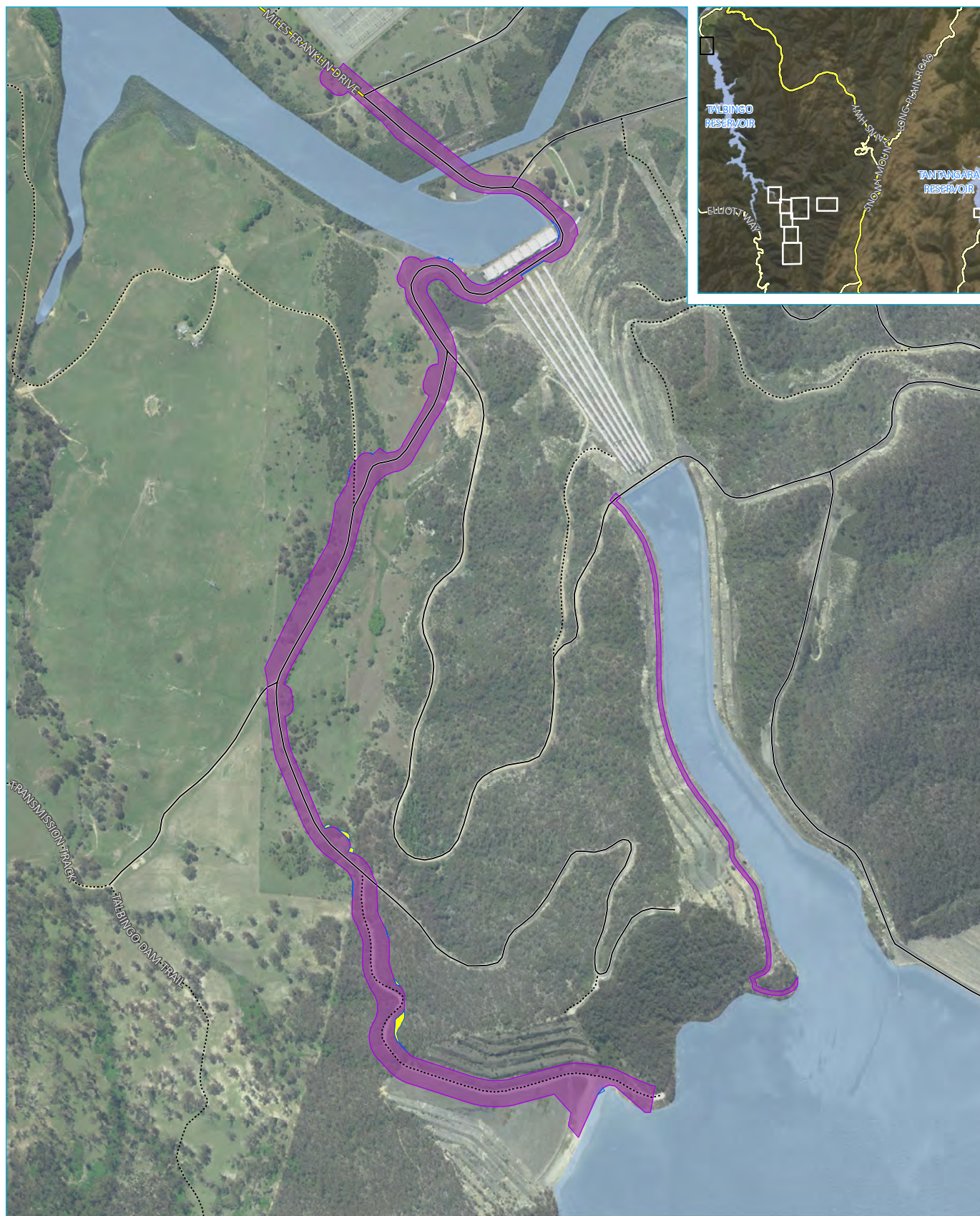
4 Conclusion

As a result of response to submissions including additional offsets for the removal of dangerous trees, and changes to the Modification 1 boundary additional offsets will be required as well as the increase of removal of native vegetation and impacts to threatened species habitat. Residual impacts following the amendments within this RTS include:

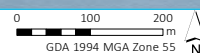
- clearing of 13.68 ha of native vegetation;
- impacts to 10.91 ha of threatened species habitat for five species credit species; and
- removal of 91 dangerous trees.

Threatened species survey identified 10 fauna species recorded adjacent to the dangerous trees. However, no species credit species were identified utilising the dangerous trees to be removed.

A total of 328 ecosystem credits are required for the Exploratory Works Modification 1 disturbance footprint and dangerous tree removal, and 392 species credits arising from Modification 1. These impacts will be offset in accordance with the objective and principles outlined in the biodiversity framework.



Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



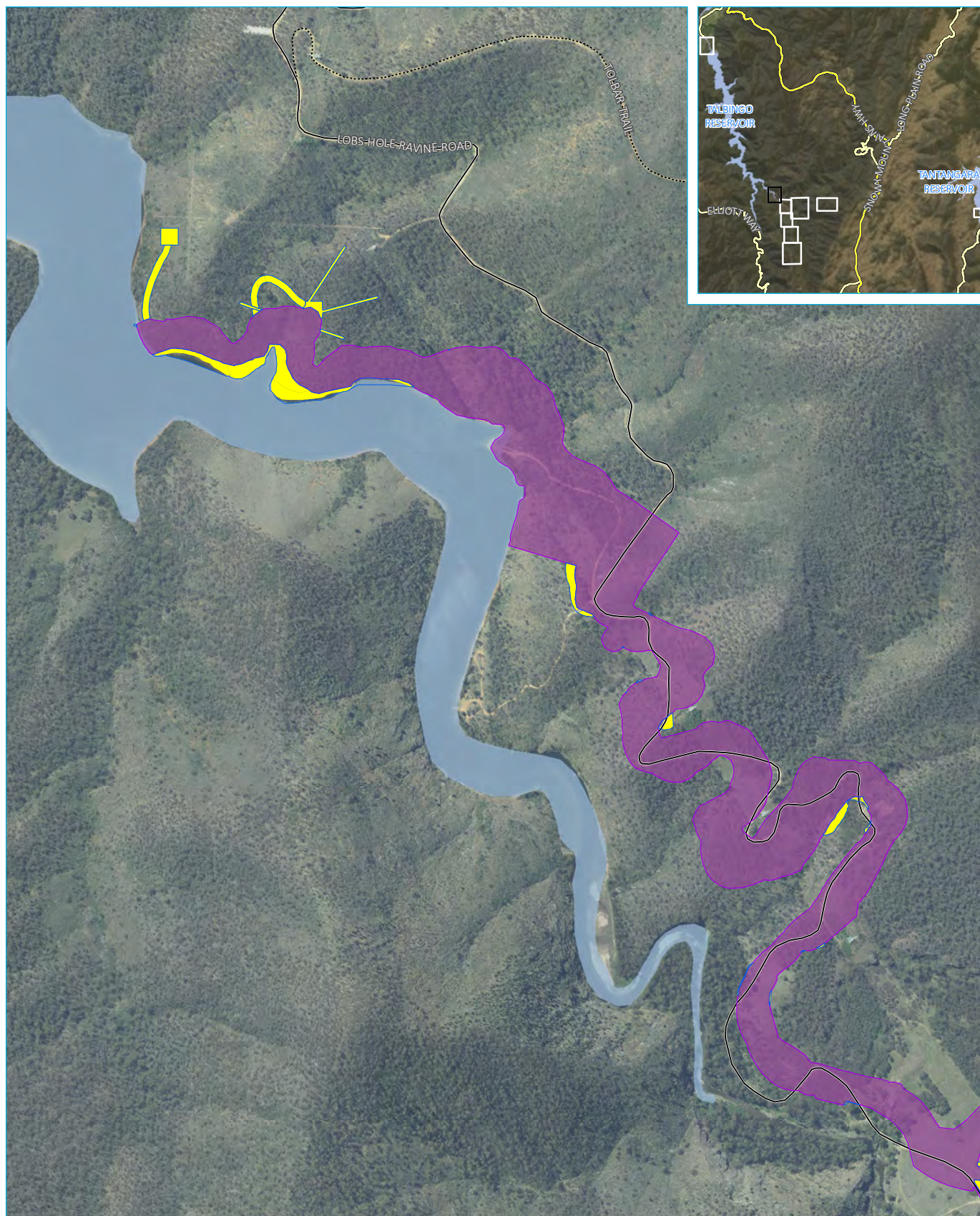
KEY

- Main road
- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- Waterbody
- Impacts requiring offsets
- Areas not requiring assessment

Impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment

Snowy 2.0
Modification 1 Response to Submissions
4.1 a





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

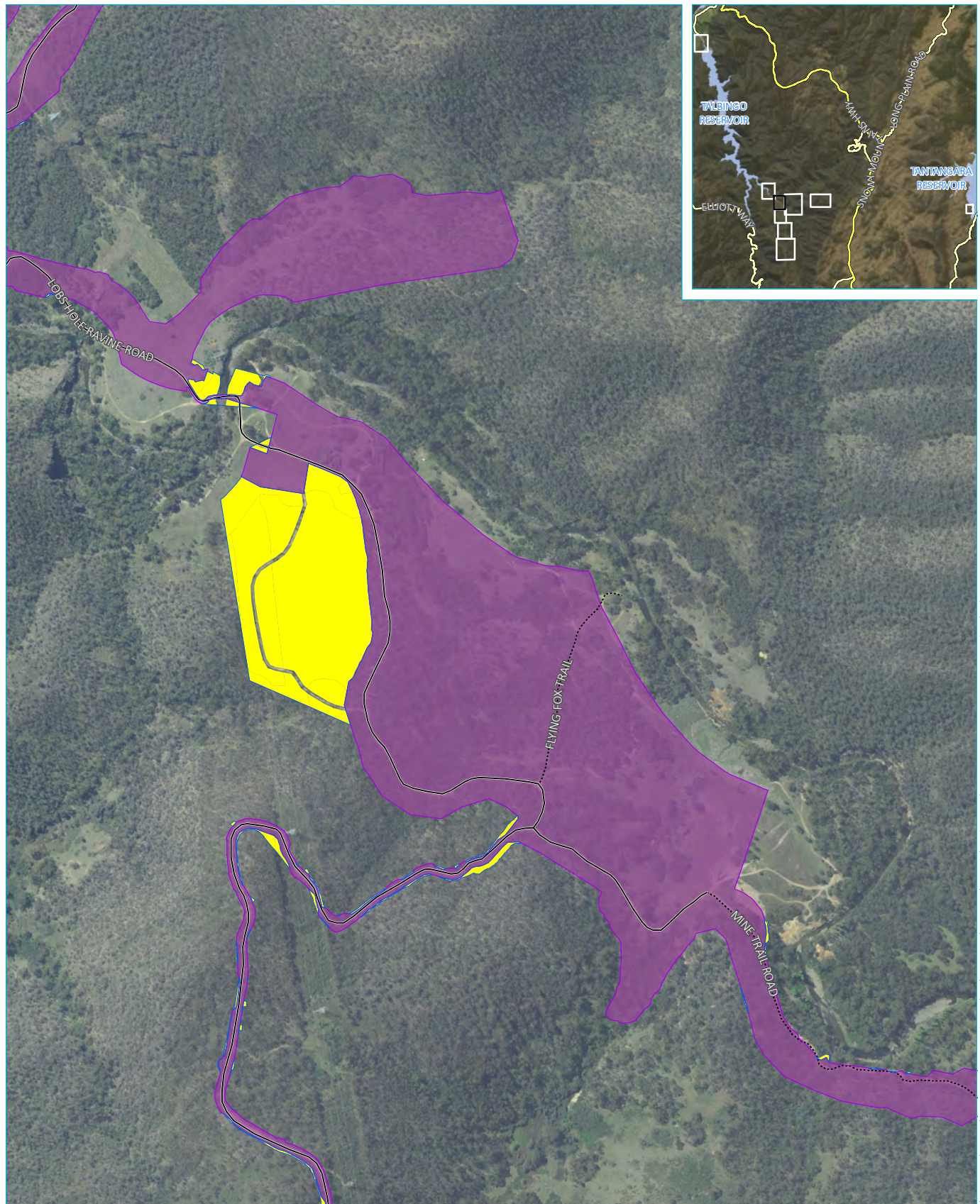
- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- Waterbody
- Impacts requiring offsets
- Areas not requiring assessment

Impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment

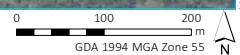
Snowy 2.0
Modification 1 Response to Submissions
4.1 b



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)



KEY

- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- Impacts requiring offsets
- Areas not requiring assessment

Impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment

Snowy 2.0
Modification 1 Response to Submissions
4.1 c





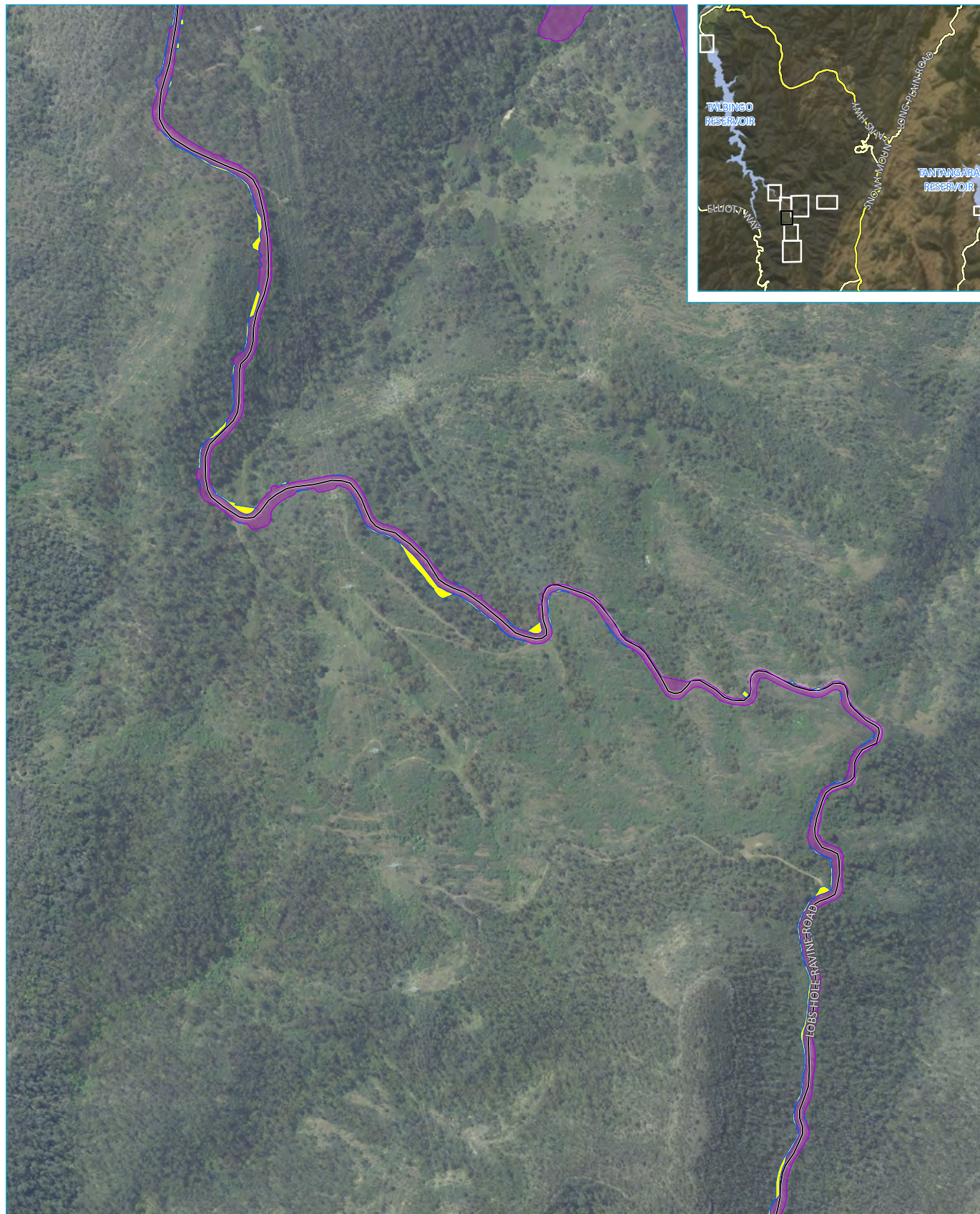
KEY

- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- Impacts requiring offsets
- Areas not requiring assessment

Impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment

Snowy 2.0
Modification 1 Response to Submissions
4.1 d





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

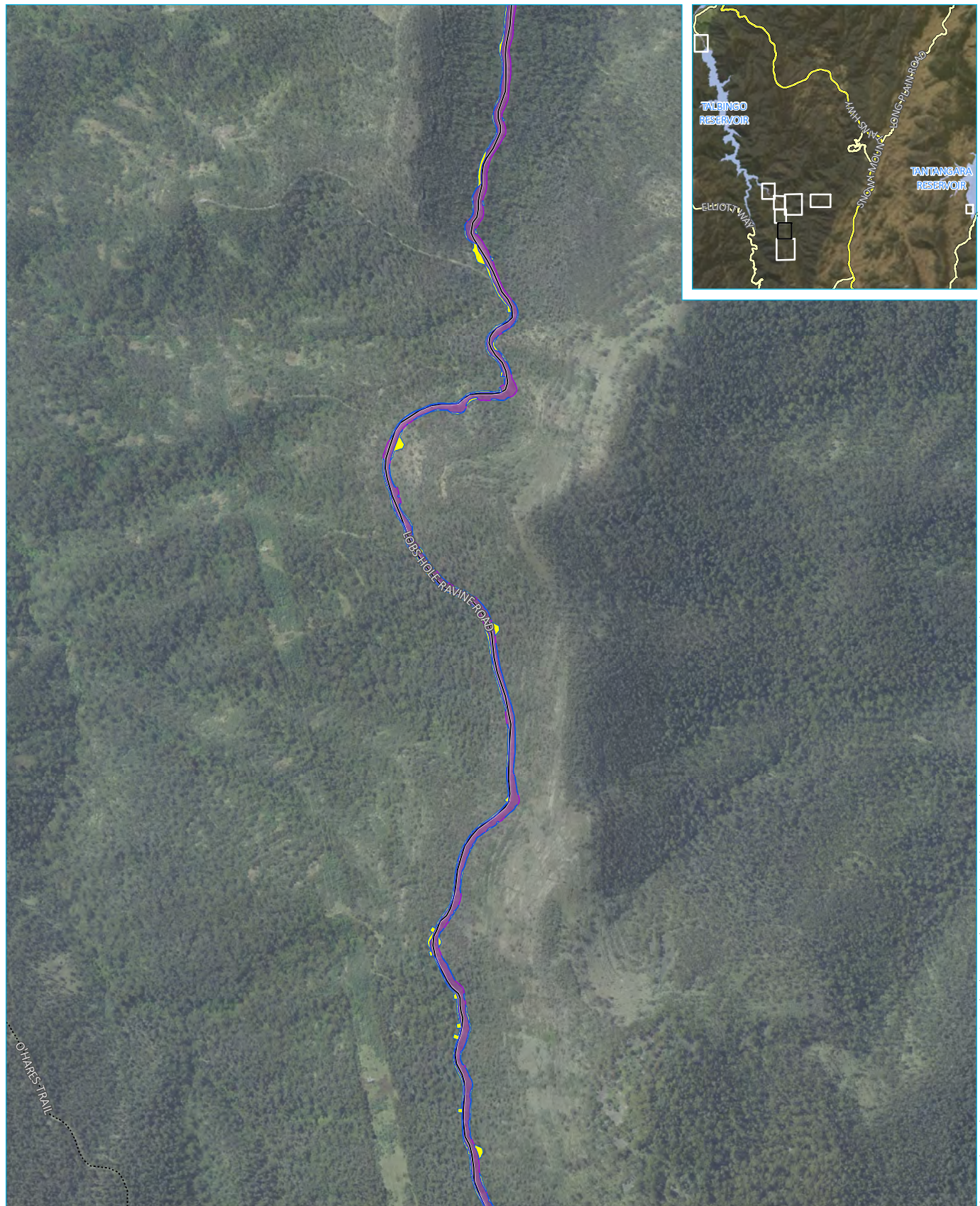
KEY

- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- Impacts requiring offsets
- Areas not requiring assessment

Impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment

Snowy 2.0
Modification 1 Response to Submissions
4.1 e





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- Impacts requiring offsets
- Areas not requiring assessment

Impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment

Snowy 2.0
Modification 1 Response to Submissions
4.1 f



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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

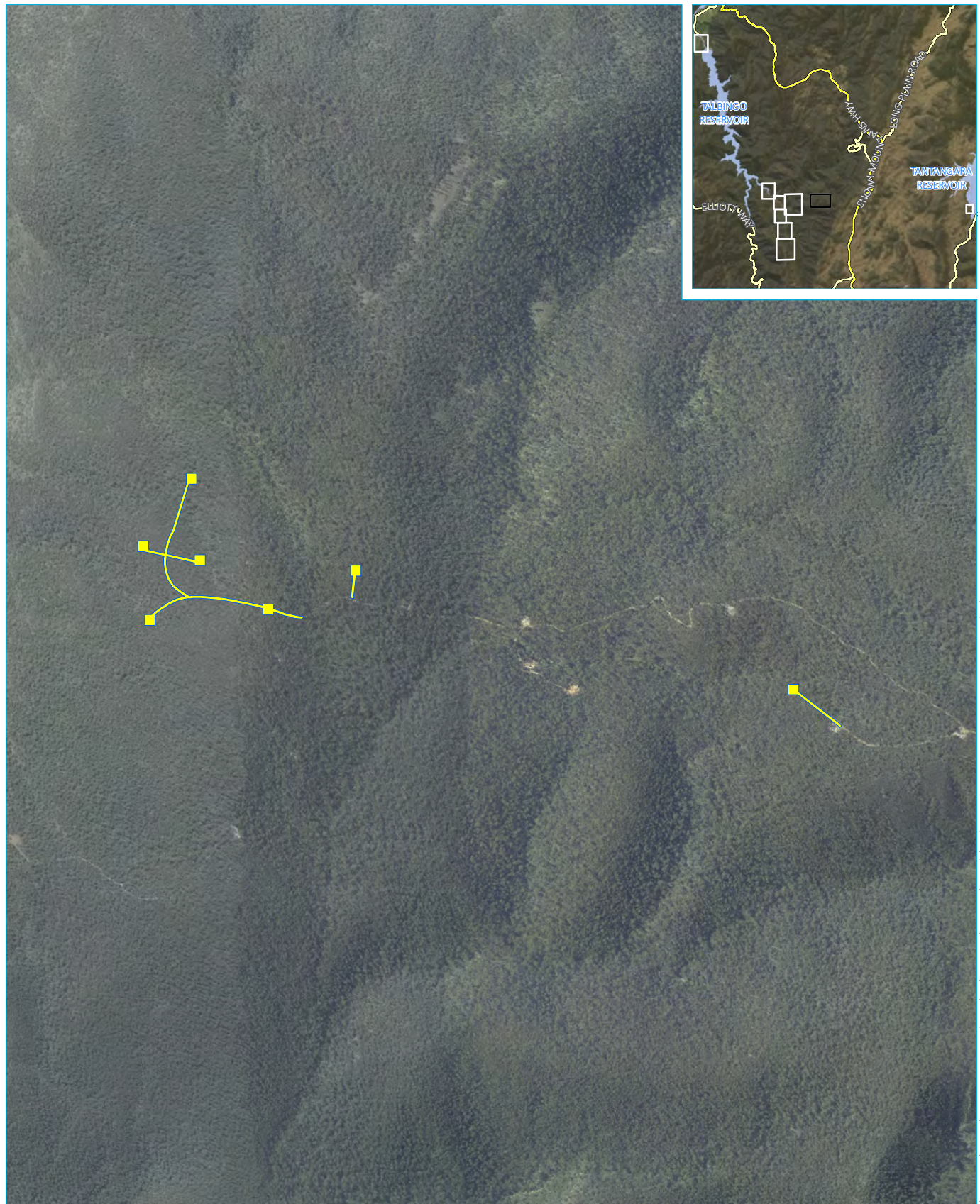
KEY

- Local road
- Vehicular track
- EW approved construction footprint (additional)
- EW approved construction footprint
- Impacts requiring offsets
- Impacts not requiring offsets
- Areas not requiring assessment

Impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment

Snowy 2.0
Modification 1 Response to Submissions
4.1 g





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- EW approved construction footprint (additional)
- Impacts requiring offsets

0 100 200
m
GDA 1994 MGA Zone 55

Impacts requiring offsets, impacts
not requiring offsets and areas not
requiring assessment

Snowy 2.0
Modification 1 Response to Submissions
4.1 h





Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Vehicular track
- EW approved construction footprint (additional)
- Waterbody
- Impacts requiring offsets

Impacts requiring offsets, impacts not requiring offsets and areas not requiring assessment

Snowy 2.0
Modification 1 Response to Submissions
4.1 i



References

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DSE 2011. Survey Standards: Greater Glider, *Petauroides volans*. Department of Sustainability and Environment, Melbourne.

DSEWPac 2010. Survey Guidelines for Australia's Threatened Birds. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPac 2011. Survey Guidelines for Australia's Threatened Mammals. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

EMM 2018. Biodiversity Development Assessment Report, Exploratory Works for Snowy 2.0. Report prepared for Snowy Hydro Ltd by EMM Consulting Pty Ltd, St Leonards, NSW.

EMM 2019a. Exploratory Works Biodiversity Management Plan, Snowy 2.0. Report prepared for Snowy Hydro Ltd by EMM Consulting Pty Ltd, St Leonards, NSW.

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Law B, Brassi T, Gonsalves L, Rose P, Truskinger A & McConville A 2018. Passive acoustics and sound recognition provide new insights on status and resilience of an iconic endangered marsupial (koala *Phascolarctos cinereus*) to timber harvesting. *Plos One* 13(10):e0205075.

Phillips S and Callaghan J 2011, The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas *Phascolarctos cinereus*. *Australian Zoologist* 35 (3): 774-780.

Appendix A

Vegetation integrity assessment - datasheets

BAM Site – Field Survey Form

Plot ID:	76	Date:	10-01-18	Survey Name:	Lobbs Hole Ravine Road north	Recorders:	SD
Zone:	55	Easting:	625307.5339	Plot dimensions:	20m x 50m	Midline bearing:	160
Datum:	GDA94	Northing:	6039766.938	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	300: Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment				Confidence:	Low	Photo #:
Vegetation Class:	Southern Tableland Wet Sclerophyll Forests				EEC:	No	Confidence:
							High

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	13
	Grasses etc.:	10
	Forbs:	18
	Ferns:	0
	Other:	3
Sum of Cover of native vascular plants by growth form group	Trees:	30.7
	Shrubs:	21.2
	Grasses etc.:	6.3
	Forbs:	9.3
	Ferns:	0
	Other:	0.3
High Threat Weed cover:		0.2

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	1	0	0
30 – 49 cm:	1	0	1
20 – 29 cm:	0	0	0
10 – 19 cm:	0	0	0
5 – 9 cm:	0	0	0
< 5 cm:	0	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	28		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	30	20	60	60	40	0	0	1	20	10	80	70	90	50	70	1	0	0	0	0
Average of the 5 subplots:	42					6.2					72					0.2				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)	Sedimentary rock (unidentified)	Soil Surface Texture	Sandy clay loam	Soil Colour	Brown	Soil Depth	Medium
Lithology (B)							
Slope	20	Aspect	160	Site Drainage	Moderate	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Severe	greater than 10yo	Regrowth
Cultivation (inc. pasture):			
Soil erosion:	Moderate	greater than 10yo	
Firewood / CWD removal:			
Grazing (identify native/stock):	Light	greater than 10yo	
Fire damage:			
Storm damage:			
Weediness:	Light	3 to 10 yo	Blackberry
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if "top 3"; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobbs Hole Ravine Road north					
	Date:	10-01-18	Plot ID:	76	Recorders:	SD

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus robertsonii</i>	30	100		N	
Shrub (SG)	<i>Acacia pravissima</i>	15	100		N	
Other (OG)	<i>Clematis aristata</i>	0.1	20		N	
Grass & grasslike	<i>Lomandra bracteata</i>	0.5	40		N	
Other (OG)	<i>Glycine microphylla</i>	0.1	10		N	
Shrub (SG)	<i>Pimelea linifolia</i>	0.2	40		N	
Forb (FG)	<i>Hydrocotyle laxiflora</i>	1	1		N	
Shrub (SG)	<i>Pimelea curviflora</i>	0.1	10		N	
	<i>Rubus anglocandicans</i>	1	1		E	
Grass & grasslike	<i>Microlaena stipoides</i>	4	1000		N	
Forb (FG)	<i>Arthropodium milleflorum</i>	0.1	10		N	
Shrub (SG)	<i>Cassinia arcuata</i>	0.5	5		N	
Forb (FG)	<i>Lagenophora stipitata</i>	4	1000		N	
Forb (FG)	<i>Dianella revoluta</i>	0.1	5		N	
Shrub (SG)	<i>Banksia canei</i>	1	5		N	
Shrub (SG)	<i>Olearia myrsinoides</i>	2	500		N	
	<i>Hypericum perforatum</i>	0.1	10		HTE	
Shrub (SG)	<i>Acacia obliquinervia</i>	0.5	10		N	
	<i>Plantago lanceolata</i>	0.1	10		E	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	1	20		N	
Tree (TG)	<i>Eucalyptus dives</i>	0.2	5		N	
	<i>Centaurium erythraea</i>	0.1	10		E	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	0.1	10		N	
Forb (FG)	<i>Geranium solanderi</i>	0.1	10		N	
Forb (FG)	<i>Boronia nana</i> var. <i>hyssopifolia</i>	0.1	5		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.1	10		N	
Grass & grasslike	<i>Anthosachne scabra</i>	0.2	50		N	
Forb (FG)	<i>Viola betonicifolia</i>	0.1	10		N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	0.5	100		N	
Forb (FG)	<i>Wahlenbergia stricta</i>	0.1	10		N	
Shrub (SG)	<i>Leucopogon fletcheri</i> subsp. <i>brevisepalus</i>	0.1	1		N	
Grass & grasslike	<i>Echinopogon ovatus</i>	0.5	100		N	
Forb (FG)	<i>Stylidium graminifolium</i>	0.1	10		N	
Shrub (SG)	<i>Bursaria spinosa</i>	0.5	5		N	
Forb (FG)	<i>Asperula scoparia</i>	1	300		N	
Shrub (SG)	<i>Gompholobium huegelii</i>	0.1	1		N	
Forb (FG)	<i>Dichondra repens</i>	0.5	100		N	
Forb (FG)	<i>Hypericum gramineum</i>	0.1	20		N	
Forb (FG)	<i>Cymbonotus lawsonianus</i>	0.1	10		N	
Forb (FG)	<i>Euchiton japonicus</i>	0.1	20		N	
Other (OG)	<i>Glycine clandestina</i>	0.1	10		N	
Forb (FG)	<i>Stellaria pungens</i>	0.2	30		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>hirtella</i>	0.1	1		N	
Forb (FG)	<i>Galium gaudichaudii</i>	1	20		N	
Grass & grasslike	<i>Luzula densiflora</i>	0.2	40		N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	0.1	1		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>sieberiana</i>	0.5	30		N	

Tree (TG)	<i>Eucalyptus rubida</i>	0.5	7		N	
Grass & grasslike	<i>Carex appressa</i>	0.1	1		N	
	<i>Rosa rubiginosa</i>	0.1	1		HTE	
Forb (FG)	<i>Acaena novae-zelandiae</i>	0.1	5		N	
Grass & grasslike	<i>Austrostipa mollis</i>	0.1	5		N	

BAM Site – Field Survey Form

Plot ID:	88	Date:	22-11-17	Survey Name:	Lobs Hole Ravine	Recorders:	SW, SW	
Zone:	55	Easting:	625982.396	Plot dimensions:	20m x 50m	Midline bearing:	204	
Datum:	GDA94	Northing:	6039028.785	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:		
Plant Community Type:	302: Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion				Confidence:	Medium	Photo #:	
Vegetation Class:	Upper Riverina Dry Sclerophyll Forests				EEC:	No	Confidence:	High

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	0
	Shrubs:	0
	Grasses etc.:	3
	Forbs:	3
	Ferns:	0
	Other:	1
Sum of Cover of native vascular plants by growth form group	Trees:	0
	Shrubs:	0
	Grasses etc.:	62.1
	Forbs:	0.3
	Ferns:	0
	Other:	0.1
High Threat Weed cover:		21.1

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	0	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	0		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	10	25	5	5	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average of the 5 subplots:	13					0					0					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Valley flat	Lf Pattern (A)	Alluvial plain	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Loam	Soil Colour	Brown	Soil Depth	At least 100mm
Lithology (B)							
Slope		Aspect	SSW	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Severe	less than 3yo	Historic clearing, area used for camping, regular slashing may occur to accommodate camping.
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:	Light	less than 3yo	Majority or area cleared except for small patch of vegetation which may experience loss of fallen timber for car
Grazing (identify native/stock):			No evidence
Fire damage:			No evidence
Storm damage:			No evidence
Weediness:	Severe	less than 3yo	High number of exotic species
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine					
	Date:	22-11-17	Plot ID:	88	Recorders:	SW, SW

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Grass & grasslike	<i>Themeda triandra</i>	60	1000		N	
	<i>Hypericum perforatum</i>	10	300		HTE	
	<i>Bromus molliformis</i>	5	200		E	
Other (OG)	<i>Convolvulus angustissimus</i>	0.1	3		N	
	<i>Hypochaeris radicata</i>	3	300		E	
	<i>Taraxacum officinale</i>	0.2	20		E	
	<i>Lysimachia arvensis</i>	0.1	20		E	
	<i>Vulpia bromoides</i>	20	1000		E	
	<i>Briza minor</i>	0.1	20		E	
	<i>Potentilla recta</i>	0.1	20		E	
	<i>Acetosella vulgaris</i>	1	200		HTE	
	<i>Agrostis capillaris</i>	10	500		HTE	
	<i>Rubus fruticosus</i> sp. agg.	0.1	5		HTE	
Grass & grasslike	<i>Carex breviculmis</i>	0.1	5		N	
Grass & grasslike	<i>Carex appressa</i>	2	20		N	
	<i>Cirsium vulgare</i>	0.1	5		E	
	<i>Sonchus oleraceus</i>	0.1	10		E	
	<i>Verbascum virgatum</i>	0.1	2		E	
Forb (FG)	<i>Cymbonotus preissianus</i>	0.1	2		N	
Forb (FG)	<i>Oxalis perennans</i>	0.1	10		N	
Forb (FG)	<i>Veronica subtilis</i>	0.1	10		N	
	<i>Aira elegantissima</i>	0.5	500		E	

BAM Site – Field Survey Form

Plot ID:	97	Date:	12-12-17	Survey Name:	Lobs Hole Ravine	Recorders:	AM, SW
Zone:	55	Easting:	627960.6244	Plot dimensions:	20m x 50m	Midline bearing:	20
Datum:	GDA94	Northing:	6038787.024	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	302: Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion				Confidence:	Low	Photo #:
Vegetation Class:	Upper Riverina Dry Sclerophyll Forests				EEC:	No	Confidence:
						Low	

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	2
	Shrubs:	14
	Grasses etc.:	8
	Forbs:	4
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	30
	Shrubs:	43.6
	Grasses etc.:	14.6
	Forbs:	0.4
	Ferns:	0
	Other:	0
High Threat Weed cover:		75.5

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	1	0	1
50 – 79 cm:	1	0	1
30 – 49 cm:	1	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	0	1	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	65		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	90	85	85	95	95	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average of the 5 subplots:	90					0.4					0					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Other	Lf Pattern (A)	Alluvial plain	Microrelief	
		Lf Element (B)	River flat	Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Loam	Soil Colour	Dark brown	Soil Depth	At least 100mm
Lithology (B)							
Slope		Aspect	North	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Light	greater than 10yo	
Storm damage:			No evidence
Weediness:	Severe	less than 3yo	Blackberry infestation 80% of plot
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine						
		Date:	12-12-17	Plot ID:	97	Recorders:	AM, SW

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus viminalis</i>	10	8		N	
Tree (TG)	<i>Eucalyptus robertsonii</i>	20	6		N	
Shrub (SG)	<i>Acacia pravissima</i>	30	50		N	
Shrub (SG)	<i>Bursaria spinosa</i>	2	7		N	
Shrub (SG)	<i>Prostanthera lasianthos</i> variant 'typical'	0.5	3		N	
Grass & grasslike	<i>Poa helmsii</i>	10	70		N	
Shrub (SG)	<i>Cassinia aculeata</i>	2	10		N	
Shrub (SG)	<i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i>	5	20		N	
Grass & grasslike	<i>Poa labillardierei</i> var. <i>labillardierei</i>	3	50		N	
Shrub (SG)	<i>Pomaderris aspera</i>	1	4		N	
Forb (FG)	<i>Asperula scoparia</i>	0.1	30		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	0.1	10		N	
Shrub (SG)	<i>Pomaderris angustifolia</i>	1	8		N	
Grass & grasslike	<i>Carex breviculmis</i>	0.1	10		N	
Grass & grasslike	<i>Dichelachne inaequiglumis</i>	1	100		N	
Forb (FG)	<i>Geranium solanderi</i> var. <i>solanderi</i>	0.1	20		N	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	0.2	20		N	
Shrub (SG)	<i>Gynatrix pulchella</i>	0.2	5		N	
Shrub (SG)	<i>Lomatia myricoides</i>	1	2		N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	0.1	20		N	
Shrub (SG)	<i>Olearia phlogopappa</i>	0.2	3		N	
Forb (FG)	<i>Oxalis perennans</i>	0.1	10		N	
Grass & grasslike	<i>Rytidosperma penicillatum</i>	0.1	10		N	
Grass & grasslike	<i>Carex lynx</i>	0.2	5		N	
Shrub (SG)	<i>Pimelea pauciflora</i>	0.2	2		N	
	<i>Rosa rubiginosa</i>	0.5	5		HTE	
Shrub (SG)	<i>Grevillea rosmarinifolia</i> subsp. <i>rosmarinifolia</i>	0.2	1		N	
Grass & grasslike	<i>Carex inversa</i>	0.1	10		N	
	<i>Rubus fruticosus</i> sp. <i>agg.</i>	75	1000		HTE	
Shrub (SG)	<i>Pomaderris subcapitata</i>	0.1	2		N	

BAM Site – Field Survey Form

Plot ID:	108	Date:	23-11-17	Survey Name:	Lobs Hole Ravine	Recorders:	AM, SW	
Zone:	55	Easting:	626424.2617	Plot dimensions:	20m x 50m	Midline bearing:	308	
Datum:	GDA94	Northing:	6038732.062	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:		
Plant Community Type:	302: Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion				Confidence:	High	Photo #:	
Vegetation Class:	Upper Riverina Dry Sclerophyll Forests				EEC:	No	Confidence:	High

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	6
	Grasses etc.:	6
	Forbs:	5
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	43
	Shrubs:	65.6
	Grasses etc.:	21.4
	Forbs:	0.6
	Ferns:	0
	Other:	0
High Threat Weed cover:		7.2

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	1	0	1
50 – 79 cm:	0	0	0
30 – 49 cm:	1	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	1	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	23		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	95	100	70	60	20	0	0	2	0	0	0	0	5	0	0	0	0	10	0	0
Average of the 5 subplots:	69					0.4					1					2				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Valley flat	Lf Pattern (A)	Alluvial plain	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Loam	Soil Colour	Brown	Soil Depth	At least 100mm
Lithology (B)							
Slope		Aspect	SSE	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:	Light		Evidence of small trees cut felled
Grazing (identify native/stock):			No evidence
Fire damage:			No evidence
Storm damage:			No evidence
Weediness:	Moderate	less than 3yo	Exotic species present
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine						
		Date:	23-11-17	Plot ID:	108	Recorders:	AM, SW

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus camphora</i> subsp. <i>humeana</i>	3	2		N	
Tree (TG)	<i>Eucalyptus viminalis</i>	20	10		N	
Tree (TG)	<i>Eucalyptus stellulata</i>	20	20		N	
Shrub (SG)	<i>Acacia pravissima</i>	35	50		N	
Grass & grasslike	<i>Themeda triandra</i>	20	200		N	
	<i>Hypochaeris radicata</i>	0.2	20		E	
	<i>Hypericum perforatum</i>	0.8	50		HTE	
	<i>Plantago lanceolata</i>	0.2	20		E	
	<i>Rosa rubiginosa</i>	2	20		HTE	
	<i>Rubus fruticosus</i> sp. agg.	2	10		HTE	
Shrub (SG)	<i>Rubus parvifolius</i>	10	50		N	
Forb (FG)	<i>Asperula conferta</i>	0.1	20		N	
Forb (FG)	<i>Acaena agnipila</i>	0.1	20		N	
Grass & grasslike	<i>Juncus sarophorus</i>	0.1	1		N	
Grass & grasslike	<i>Poa helmsii</i>	1	20		N	
Shrub (SG)	<i>Cassinia aculeata</i>	5	10		N	
Shrub (SG)	<i>Grevillea rosmarinifolia</i>	15	20		N	
	<i>Bromus sterilis</i>	30	1000		E	
	<i>Poa pratensis</i>	5	100		E	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	0.1	5		N	
	<i>Vulpia bromoides</i>	3	100		E	
	<i>Veronica arvensis</i>	0.1	20		E	
	<i>Centaureum erythraea</i>	0.2	50		E	
Forb (FG)	<i>Dichondra repens</i>	0.2	100		N	
Forb (FG)	<i>Geranium solanderi</i>	0.1	20		N	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	0.1	1		N	
Grass & grasslike	<i>Carex appressa</i>	0.1	5		N	
	<i>Bromus diandrus</i>	2	50		HTE	
	<i>Cirsium vulgare</i>	0.2	10		E	
Forb (FG)	<i>Acaena novae-zelandiae</i>	0.1	20		N	
	<i>Cerastium glomeratum</i>	0.1	10		E	
	<i>Briza minor</i>	0.1	10		E	
	<i>Potentilla recta</i>	0.1	1		E	
Shrub (SG)	<i>Acacia siculiformis</i>	0.5	1		N	
Grass & grasslike	<i>Poa sieberiana</i>	0.1	10		N	
	<i>Crataegus monogyna</i>	0.2	2		HTE	
	<i>Crataegus monogyna</i>	0.2	2		HTE	
	<i>Veronica peregrina</i>	0.1	10		E	
	<i>Myosotis discolor</i>	0.1	10		E	

BAM Site – Field Survey Form

Plot ID:	143	Date:	22-11-17	Survey Name:	Lobs Hole Ravine adjusted location for 143	Recorders:	ED, LH
Zone:	55	Easting:	627654.339	Plot dimensions:	20m x 50m	Midline bearing:	20
Datum:	GDA94	Northing:	6038148.986	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	302: Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion				Confidence:	Low	Photo #:
Vegetation Class:	Upper Riverina Dry Sclerophyll Forests				EEC:	Yes	Confidence:
						Low	

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	2
	Shrubs:	13
	Grasses etc.:	5
	Forbs:	7
	Ferns:	1
	Other:	1
Sum of Cover of native vascular plants by growth form group	Trees:	35
	Shrubs:	132.7
	Grasses etc.:	20.5
	Forbs:	0.8
	Ferns:	0.6
	Other:	0.1
High Threat Weed cover:		16.3

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	1	0	0
30 – 49 cm:	1	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	12		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	40	25	80	80	25	0	0	0	0	0	2	0	0	0	0	0	0	0	0	25
Average of the 5 subplots:	50					0					0.4					5				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Valley flat	Lf Pattern (A)	Alluvial plain	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Fine loam	Soil Colour	Dark brown	Soil Depth	Deep
Lithology (B)							
Slope	Flat	Aspect		Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Light	greater than 10yo	Previous clearing
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			
Grazing (identify native/stock):			
Fire damage:			
Storm damage:			
Weediness:	Moderate	greater than 10yo	Blackberry
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine adjusted location for 143						
		Date:	22-11-17	Plot ID:	143	Recorders:	ED, LH

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Shrub (SG)	<i>Acacia pravissima</i>	60	200		N	
Shrub (SG)	<i>Pomaderris aspera</i>	45	10		N	
Grass & grasslike	<i>Poa helmsii</i>	20	200		N	
	<i>Rosa rubiginosa</i>	0.7	5		HTE	
	<i>Rubus fruticosus</i> sp. agg.	15	100		HTE	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	4	20		N	
Shrub (SG)	<i>Cassinia longifolia</i>	15	40		N	
Tree (TG)	<i>Eucalyptus stellulata</i>	10	15		N	
Forb (FG)	<i>Geranium solanderi</i>	0.2	10		N	
Shrub (SG)	<i>Cassinia aculeata</i>	5	10		N	
	<i>Hypericum perforatum</i>	0.2	30		HTE	
Shrub (SG)	<i>Banksia spinulosa</i> var. <i>collina</i>	0.5	1		N	
	<i>Bromus diandrus</i>	0.4	20		HTE	
Forb (FG)	<i>Oxalis perennans</i>	0.1	5		N	
Shrub (SG)	<i>Leucopogon gelidus</i>	0.2	5		N	
Grass & grasslike	<i>Carex appressa</i>	0.1	1		N	
Grass & grasslike	<i>Poa sieberiana</i>	0.2	10		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.2	4		N	
Fern (EG)	<i>Pteridium esculentum</i>	0.6	10		N	
Shrub (SG)	<i>Dillwynia prostrata</i>	0.1	6		N	
Forb (FG)	<i>Asperula conferta</i>	0.1	10		N	
Grass & grasslike	<i>Lomandra micrantha</i> subsp. <i>tuberculata</i>	0.1	1		N	
Shrub (SG)	<i>Bursaria spinosa</i>	1	5		N	
Shrub (SG)	<i>Gynatrix pulchella</i>	1	5		N	
Other (OG)	<i>Glycine tabacina</i>	0.1	1		N	
Forb (FG)	<i>Poranthera microphylla</i>	0.1	3		N	
Forb (FG)	<i>Hydrocotyle laxiflora</i>	0.1	2		N	
Forb (FG)	<i>Asperula scoparia</i>	0.1	10		N	
Shrub (SG)	<i>Exocarpos strictus</i>	0.6	3		N	
Forb (FG)	<i>Dichondra repens</i>	0.1	2		N	
Grass & grasslike	<i>Carex breviculmis</i>	0.1	1		N	
Tree (TG)	<i>Eucalyptus viminalis</i>	25			N	
	<i>Malus</i> spp.	0.1	1		E	
Shrub (SG)	<i>Rubus parvifolius</i>	0.1	5		N	
	<i>Vulpia bromoides</i>	0.1	10		E	

BAM Site – Field Survey Form

Plot ID:	164	Date:	23-11-17	Survey Name:	Tantangara Dam south intake	Recorders:	ED, LH
Zone:	55	Easting:	649062.6036	Plot dimensions:	20m x 50m	Midline bearing:	117
Datum:	GDA94	Northing:	6037390.662	IBRA region:	Australian Alps (Snowy Mountains)	Zone ID:	
Plant Community Type:	1224: Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion				Confidence:	Medium	Photo #:
Vegetation Class:	Temperate Montane Grasslands				EEC:	Yes	Confidence:
							Low

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	1
	Shrubs:	3
	Grasses etc.:	8
	Forbs:	5
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	2
	Shrubs:	27.2
	Grasses etc.:	23.5
	Forbs:	2.1
	Ferns:	0
	Other:	0
High Threat Weed cover:		0.7

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	0		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	5	10	10	15	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average of the 5 subplots:	9					0					0					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Fine loam	Soil Colour	Dark brown	Soil Depth	Moderate
Lithology (B)							
Slope		Aspect		Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No
Cultivation (inc. pasture):			No
Soil erosion:			No
Firewood / CWD removal:			
Grazing (identify native/stock):	Moderate	greater than 10yo	Horses and rabbits present. trampling is severe changing nsture and structure of landscape
Fire damage:			No
Storm damage:			No
Weediness:	Moderate	greater than 10yo	
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Tantangara Dam south intake					
	Date:	23-11-17	Plot ID:	164	Recorders:	ED, LH

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus stellulata</i>	2	2		N	
Grass & grasslike	<i>Themeda triandra</i>	0.2	20		N	
Shrub (SG)	<i>Hakea microcarpa</i>	25	200		N	
Shrub (SG)	<i>Epacris breviflora</i>	2	20		N	
Grass & grasslike	<i>Juncus sarophorus</i>	4	50		N	
Forb (FG)	<i>Senecio gunnii</i>	0.5	40		N	
Forb (FG)	<i>Gonocarpus montanus</i>	0.1	20		N	
Forb (FG)	<i>Hydrocotyle laxiflora</i>	0.2	80		N	
	<i>Cirsium spp.</i>	0.1	3		E	
Forb (FG)	<i>Acaena novae-zelandiae</i>	1	40		N	
Forb (FG)	<i>Epilobium gunnianum</i>	0.3	50		N	
	<i>Holcus lanatus</i>	30	500		E	
	<i>Acetosella vulgaris</i>	0.7	10		HTE	
Grass & grasslike	<i>Carex breviculmis</i>	0.1	4		N	
Grass & grasslike	<i>Luzula flaccida</i>	0.1	5		N	
	<i>Hypochaeris radicata</i>	0.1	6		E	
Grass & grasslike	<i>Poa labillardierei</i> var. <i>labillardierei</i>	5	100		N	
	<i>Anthoxanthum odoratum</i>	40	1000		E	
Grass & grasslike	<i>Poa sieberiana</i>	10	300		N	
Grass & grasslike	<i>Empodisma minus</i>	4	80		N	
Shrub (SG)	<i>Epacris microphylla</i>	0.2	10		N	
Grass & grasslike	<i>Carex inversa</i>	0.1	5		N	

BAM Site – Field Survey Form

Plot ID:	173	Date:	20-11-17	Survey Name:	Lobs Hole Ravine Track	Recorders:	ED, LH	
Zone:	55	Easting:	627162.9974	Plot dimensions:	20m x 50m	Midline bearing:	84	
Datum:	GDA94	Northing:	6033833.665	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:		
Plant Community Type:	643: Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion				Confidence:	High	Photo #:	
Vegetation Class:	Alpine Heaths				EEC:	Yes	Confidence:	Low

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	4
	Grasses etc.:	0
	Forbs:	2
	Ferns:	1
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	4
	Shrubs:	8.2
	Grasses etc.:	0
	Forbs:	0.2
	Ferns:	1
	Other:	0
High Threat Weed cover:		0.1

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	0	0	0
5 – 9 cm:	0	1	0
< 5 cm:	0	1	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	17		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	10	75	5	10	10	0	0	0	0	0	15	0	0	0	0	75	25	85	90	90
Average of the 5 subplots:	22					0					3					73				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)	Basalt	Soil Surface Texture	Volcanic boulderfield	Soil Colour		Soil Depth	
Lithology (B)							
Slope	Steep	Aspect		Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			
Cultivation (inc. pasture):			
Soil erosion:			
Firewood / CWD removal:			
Grazing (identify native/stock):			
Fire damage:	Light	greater than 10yo	Charred logs
Storm damage:			
Weediness:			
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if "top 3"; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine Track					
	Date:	20-11-17	Plot ID:	173	Recorders:	ED, LH

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Fern (EG)	<i>Pteridium esculentum</i>	1	25		N	
Forb (FG)	<i>Stellaria pungens</i>	0.1	5		N	
	<i>Rubus fruticosus</i> sp. agg.	0.1	2		HTE	
Shrub (SG)	<i>Indigofera australis</i>	0.2	3		N	
Shrub (SG)	<i>Bedfordia arborescens</i>	2	2	Yes	N	
Shrub (SG)	<i>Cassinia longifolia</i>	5	10		N	
Tree (TG)	<i>Acacia melanoxylon</i>	1	3		N	
Tree (TG)	<i>Acacia dealbata</i> subsp. <i>subalpina</i>	2	5		N	
Tree (TG)	<i>Eucalyptus viminalis</i>	1	1		N	
	<i>Galium aparine</i>	0.1	2	Yes	E	
Forb (FG)	<i>Geranium solanderi</i> var. <i>solanderi</i>	0.1	3		N	
Shrub (SG)	<i>Polyscias sambucifolia</i> subsp. <i>leptophylla</i>	1	1		N	

BAM Site – Field Survey Form

Plot ID:	188	Date:	13-12-17	Survey Name:	Lobs Hole Ravine	Recorders:	AM, SW
Zone:	55	Easting:	627887.1793	Plot dimensions:	20m x 50m	Midline bearing:	190
Datum:	GDA94	Northing:	6038242.868	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	999: Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion				Confidence:	Low	Photo #:
Vegetation Class:	Southern Tableland Dry Sclerophyll Forests				EEC:	No	Confidence:
						Low	

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	1
	Shrubs:	13
	Grasses etc.:	4
	Forbs:	5
	Ferns:	0
	Other:	1
Sum of Cover of native vascular plants by growth form group	Trees:	35
	Shrubs:	119
	Grasses etc.:	10.2
	Forbs:	1.4
	Ferns:	0
	Other:	0.2
High Threat Weed cover:		0

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	1	0	3
20 – 29 cm:	1	0	1
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	48		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	80	60	85	90	80	0	15	0	0	0	0	10	0	0	0	5	1	1	0	10
Average of the 5 subplots:	79					3					2					3.4				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Loam clay	Soil Colour	Brown	Soil Depth	Skeletal to shallow
Lithology (B)							
Slope		Aspect	Western	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Light	greater than 10yo	
Storm damage:			No evidence
Weediness:			No evidence
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if "top 3"; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine					
	Date:	13-12-17	Plot ID:	188	Recorders:	AM, SW

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus dives</i>	35	20		N	
Shrub (SG)	<i>Banksia canei</i>	60	200		N	
Shrub (SG)	<i>Acacia buxifolia</i> subsp. <i>buxifolia</i>	0.2	3		N	
Other (OG)	<i>Cassytha pubescens</i>	0.2	5		N	
Shrub (SG)	<i>Tetratheca bauerifolia</i>	2	100		N	
Forb (FG)	<i>Gonocarpus teucrioides</i>	1	200		N	
Forb (FG)	<i>Hovea heterophylla</i>	0.1	10		N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	5	50		N	
Shrub (SG)	<i>Leucopogon attenuatus</i>	30	500		N	
Shrub (SG)	<i>Leucopogon virgatus</i>	1	30		N	
Forb (FG)	<i>Boronia nana</i> var. <i>hyssopifolia</i>	0.1	20		N	
Shrub (SG)	<i>Podolobium procumbens</i>	3	50		N	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	5	30		N	
Shrub (SG)	<i>Monotoca scoparia</i>	0.5	10		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>sieberiana</i>	5	100		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	0.1	10		N	
Shrub (SG)	<i>Dillwynia phyllicoides</i>	10	100		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.2	10		N	
Forb (FG)	<i>Stylidium graminifolium</i>	0.1	10		N	
Grass & grasslike	<i>Rytidosperma pallidum</i>	5	50		N	
Shrub (SG)	<i>Calytrix tetragona</i>	2	20		N	
Forb (FG)	<i>Dianella revoluta</i> var. <i>revoluta</i>	0.1	3		N	
Shrub (SG)	<i>Daviesia ulicifolia</i>	0.1	2		N	
Grass & grasslike	<i>Lomandra multiflora</i> subsp. <i>Multiflora</i>	0.1	5		N	

BAM Site – Field Survey Form

Plot ID:	190	Date:	09-01-18	Survey Name:	Lobs Hole Ravine Road north	Recorders:	SD	
Zone:	55	Easting:	627370.4074	Plot dimensions:	20m x 50m	Midline bearing:	300	
Datum:	GDA94	Northing:	6044577.778	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:		
Plant Community Type:	296: Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion				Confidence:	High	Photo #:	
Vegetation Class:	Southern Tableland Dry Sclerophyll Forests				EEC:	No	Confidence:	High

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	11
	Grasses etc.:	5
	Forbs:	6
	Ferns:	1
	Other:	2
Sum of Cover of native vascular plants by growth form group	Trees:	20
	Shrubs:	29.3
	Grasses etc.:	2.5
	Forbs:	0.9
	Ferns:	0.1
	Other:	0.6
High Threat Weed cover:		0

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	1	0	2
30 – 49 cm:	0	0	0
20 – 29 cm:	0	0	0
10 – 19 cm:	0	0	0
5 – 9 cm:	0	0	0
< 5 cm:	0	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	4490		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	90	80	80	95	95	0	2	5	5	0	10	10	30	30	15	15	1	10	1	10
Average of the 5 subplots:	88					2.4					19					7.4				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)	Sedimentary rock (unidentified)	Soil Surface Texture	Sandy loam	Soil Colour	Brown	Soil Depth	Shallow
Lithology (B)							
Slope	30	Aspect	North-west	Site Drainage	Good	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Moderate	greater than 10yo	
Cultivation (inc. pasture):			
Soil erosion:	Moderate	greater than 10yo	
Firewood / CWD removal:			
Grazing (identify native/stock):			
Fire damage:	Light	3 to 10 yo	
Storm damage:			
Weediness:			
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine Road north					
	Date:	09-01-18	Plot ID:	190	Recorders:	SD

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus mannifera</i> subsp. <i>mannifera</i>	7	5		N	
Tree (TG)	<i>Eucalyptus dives</i>	3	5		N	
Tree (TG)	<i>Eucalyptus macrorhyncha</i>	10	10		N	
Shrub (SG)	<i>Acacia obliquinervia</i>	10	100		N	
Shrub (SG)	<i>Dillwynia phyllioides</i>	15	200		N	
Other (OG)	<i>Cassytha glabella</i>	0.5	20		N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	1	30		N	
Forb (FG)	<i>Dianella revoluta</i>	0.1	10		N	
Forb (FG)	<i>Poranthera</i> spp.	0.2	30		N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	0.2	30		N	
Forb (FG)	<i>Asperula</i> spp.	0.2	30		N	
Grass & grasslike	<i>Lomandra bracteata</i>	0.1	20		N	
Shrub (SG)	<i>Cassinia longifolia</i>	0.7	20		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.5	20		N	
Forb (FG)	<i>Senecio quadridentatus</i>	0.1	1		N	
Grass & grasslike	<i>Rytidosperma pallidum</i>	2	100		N	
Shrub (SG)	<i>Tetradlea bauerifolia</i>	1	200		N	
Shrub (SG)	<i>Persoonia chamaepeuce</i>	0.2	30		N	
Other (OG)	<i>Hardenbergia violacea</i>	0.1	10		N	
Shrub (SG)	<i>Exocarpos strictus</i>	0.1	2		N	
Shrub (SG)	<i>Banksia canei</i>	0.5	2		N	
Grass & grasslike	<i>Poa</i> spp.	0.2	20		N	
Grass & grasslike	<i>Austrostipa scabra</i>	0.1	10		N	
Shrub (SG)	<i>Pimelea linifolia</i>	0.1	10		N	
Shrub (SG)	<i>Leucopogon fletcheri</i> subsp. <i>brevisepalus</i>	0.2	10		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	0.1	5		N	
Forb (FG)	<i>Stylidium graminifolium</i>	0.1	5		N	
Fern (EG)	<i>Asplenium flabellifolium</i>	0.1	5		N	

BAM Site – Field Survey Form

Plot ID:	192	Date:	09-01-18	Survey Name:	Lobbs Hole Ravine Road north	Recorders:	SD
Zone:	55	Easting:	627958.7871	Plot dimensions:	20m x 50m	Midline bearing:	160
Datum:	GDA94	Northing:	6045556.519	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	300: Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment				Confidence:	High	Photo #:
Vegetation Class:	Southern Tableland Wet Sclerophyll Forests				EEC:	No	Confidence:
							High

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	13
	Grasses etc.:	5
	Forbs:	12
	Ferns:	0
	Other:	3
Sum of Cover of native vascular plants by growth form group	Trees:	25.5
	Shrubs:	38.8
	Grasses etc.:	16.5
	Forbs:	2.4
	Ferns:	0
	Other:	0.4
High Threat Weed cover:		0

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	1	0	0
50 – 79 cm:	3	0	5
30 – 49 cm:	0	0	0
20 – 29 cm:	0	0	0
10 – 19 cm:	0	0	0
5 – 9 cm:	0	0	0
< 5 cm:	0	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	30		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	100	100	60	80	95	0	0	50	25	1	10	10	20	15	20	0	0	0	95	0
Average of the 5 subplots:	87					15.2					15					19				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)	Sedimentary rock (unidentified)	Soil Surface Texture	Clay	Soil Colour	Brown	Soil Depth	Medium
Lithology (B)							
Slope	30	Aspect	South-east	Site Drainage	Medium	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Moderate	greater than 10yo	
Cultivation (inc. pasture):			
Soil erosion:	Light	greater than 10yo	
Firewood / CWD removal:			
Grazing (identify native/stock):			
Fire damage:	Light	3 to 10 yo	
Storm damage:			
Weediness:			
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobbs Hole Ravine Road north					
	Date:	09-01-18	Plot ID:	192	Recorders:	SD

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus robertsonii</i>	20	10		N	
Tree (TG)	<i>Eucalyptus mannifera</i> subsp. <i>mannifera</i>	5	5		N	
Shrub (SG)	<i>Daviesia latifolia</i>	20	500		N	
Shrub (SG)	<i>Grevillea rosmarinifolia</i>	2	50		N	
Shrub (SG)	<i>Leucopogon fletcheri</i> subsp. <i>brevisepalus</i>	5	200		N	
Shrub (SG)	<i>Cassinia aculeata</i>	5	10		N	
Shrub (SG)	<i>Platylobium montanum</i>	2	100		N	
Tree (TG)	<i>Acacia melanoxylon</i>	0.5	5		N	
Shrub (SG)	<i>Olearia phlogopappa</i>	0.8	30		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	0.3	20		N	
Shrub (SG)	<i>Persoonia chamaepeuce</i>	2	80		N	
Forb (FG)	<i>Asperula scoparia</i>	0.5	50		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>sieberiana</i>	5	500		N	
Forb (FG)	<i>Geranium solanderi</i>	0.1	10		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	0.2	30		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>cyanophylla</i>	10	1000		N	
Forb (FG)	<i>Podolepis jaceoides</i>	0.3	100		N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	0.2	40		N	
Forb (FG)	<i>Stackhousia monogyna</i>	0.1	1		N	
Forb (FG)	<i>Stellaria pungens</i>	0.2	20		N	
Shrub (SG)	<i>Banksia canei</i>	0.5	8		N	
Forb (FG)	<i>Ranunculus lappaceus</i>	0.2	20		N	
Shrub (SG)	<i>Acacia pravissima</i>	0.1	5		N	
	<i>Centaurium erythraea</i>	0.1	10		E	
Forb (FG)	<i>Galium binifolium</i>	0.2	30		N	
Forb (FG)	<i>Poranthera microphylla</i>	0.2	30		N	
Other (OG)	<i>Clematis aristata</i>	0.1	10		N	
Other (OG)	<i>Glycine tabacina</i>	0.2	30		N	
Shrub (SG)	<i>Coprosma quadrifida</i>	0.1	1		N	
Other (OG)	<i>Glycine microphylla</i>	0.1	10		N	
Forb (FG)	<i>Veronica derwentiana</i> subsp. <i>derwentiana</i>	0.2	5		N	
Shrub (SG)	<i>Exocarpos strictus</i>	0.2	1		N	
Grass & grasslike	<i>Lomandra longifolia</i>	1	20		N	
Shrub (SG)	<i>Cassinia longifolia</i>	1	20		N	
Shrub (SG)	<i>Coprosma hirtella</i>	0.1	1		N	
Forb (FG)	<i>Viola betonicifolia</i>	0.1	20		N	
Forb (FG)	<i>Viola hederacea</i>	0.1	1		N	

BAM Site – Field Survey Form

Plot ID:	194	Date:	12-12-17	Survey Name:	O'Hares Creek Trail	Recorders:	SW, AM
Zone:	55	Easting:	625172.182	Plot dimensions:	20m x 50m	Midline bearing:	180
Datum:	GDA94	Northing:	6036523.662	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	300: Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment				Confidence:	Low	Photo #:
Vegetation Class:	Southern Tableland Wet Sclerophyll Forests				EEC:	No	Confidence:
						Low	

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	5
	Shrubs:	16
	Grasses etc.:	12
	Forbs:	21
	Ferns:	1
	Other:	3
Sum of Cover of native vascular plants by growth form group	Trees:	48.3
	Shrubs:	53.4
	Grasses etc.:	27.2
	Forbs:	3.6
	Ferns:	25
	Other:	0.4
High Threat Weed cover:		7.1

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	1	0	3
30 – 49 cm:	1	0	1
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	0	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	111		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	95	80	90	90	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average of the 5 subplots:	83					0					0					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Loamy clay	Soil Colour	Brown	Soil Depth	At least 100mm
Lithology (B)							
Slope	15°	Aspect	ESE	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:	Light	less than 3yo	Some feral pig damage
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Light	greater than 10yo	
Storm damage:			No evidence
Weediness:	Light	less than 3yo	Exotic forbs
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if "top 3"; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	O'Hares Creek Trail						
		Date:	12-12-17	Plot ID:	194	Recorders:	SW, AM

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus viminalis</i>	20	5		N	
Tree (TG)	<i>Eucalyptus robertsonii</i> subsp. <i>robertsonii</i>	20	7		N	
Tree (TG)	<i>Eucalyptus dives</i>	7	3		N	
Shrub (SG)	<i>Cassinia longifolia</i>	5	20		N	
Shrub (SG)	<i>Platylabium formosum</i> subsp. <i>formosum</i>	10	100		N	
Forb (FG)	<i>Cymbonotus preissianus</i>	0.1	5		N	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	25	70		N	
Fern (EG)	<i>Pteridium esculentum</i>	25	200		N	
Shrub (SG)	<i>Exocarpos strictus</i>	1	5		N	
Grass & grasslike	<i>Anthosachne scabra</i>	5	300		N	
Grass & grasslike	<i>Lomandra longifolia</i>	2	20		N	
Grass & grasslike	<i>Poa tenera</i>	2	100		N	
Forb (FG)	<i>Stellaria pungens</i>	0.2	50		N	
Forb (FG)	<i>Viola betonicifolia</i>	0.1	30		N	
Shrub (SG)	<i>Banksia canei</i>	0.5	8		N	
Forb (FG)	<i>Plantago varia</i>	1	100		N	
Grass & grasslike	<i>Dichelachne rara</i>	5	500		N	
Other (OG)	<i>Glycine clandestina</i>	0.1	50		N	
Forb (FG)	<i>Wahlenbergia stricta</i> subsp. <i>stricta</i>	0.1	20		N	
Forb (FG)	<i>Picris angustifolia</i> subsp. <i>merxmulleri</i>	0.2	50		N	
Forb (FG)	<i>Hydrocotyle laxiflora</i>	0.2	100		N	
Forb (FG)	<i>Hovea heterophylla</i>	0.1	10		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>hirtella</i>	10	100		N	
	<i>Rosa rubiginosa</i>	0.1	2		HTE	
Other (OG)	<i>Hardenbergia violacea</i>	0.2	20		N	
Other (OG)	<i>Cassytha pubescens</i>	0.1	5		N	
Shrub (SG)	<i>Pimelea linifolia</i> subsp. <i>linifolia</i>	0.3	20		N	
Forb (FG)	<i>Geranium solanderi</i> var. <i>solanderi</i>	0.2	50		N	
	<i>Taraxacum officinale</i>	0.1	5		E	
Forb (FG)	<i>Senecio quadridentatus</i>	0.1	20		N	
Forb (FG)	<i>Poranthera microphylla</i>	0.1	20		N	
Forb (FG)	<i>Gonocarpus teucrioides</i>	0.2	200		N	
	<i>Hypochaeris radicata</i>	0.1	20		E	
Shrub (SG)	<i>Bursaria spinosa</i>	0.3	4		N	
Tree (TG)	<i>Acacia melanoxylon</i>	1	2		N	
Shrub (SG)	<i>Tetradlea bauerifolia</i>	10	500		N	
Forb (FG)	<i>Microtis unifolia</i>	0.1	5		N	
	<i>Hypericum perforatum</i>	2	100		HTE	
Forb (FG)	<i>Pimelea curviflora</i> var. <i>sericea</i>	0.1	20		N	
Forb (FG)	<i>Stylidium graminifolium</i>	0.1	20		N	
	<i>Rubus fruticosus</i> sp. <i>agg.</i>	5	30		HTE	
Shrub (SG)	<i>Gompholobium huegelii</i>	0.2	10		N	
Shrub (SG)	<i>Pimelea pauciflora</i>	0.1	2		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.1	5		N	
Shrub (SG)	<i>Acacia pravissima</i>	0.2	1		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	0.2	20		N	
Forb (FG)	<i>Dianella revoluta</i> var. <i>revoluta</i>	0.1	5		N	

Grass & grasslike	<i>Rytidosperma penicillatum</i>	2	100		N	
Forb (FG)	<i>Oxalis perennans</i>	0.1	10		N	
Forb (FG)	<i>Chrysocephalum semipapposum</i>	0.2	40		N	
	<i>Centaurium erythraea</i>	0.1	20		E	
Grass & grasslike	<i>Luzula flaccida</i>	0.1	20		N	
Tree (TG)	<i>Acacia dealbata</i> subsp. <i>subalpina</i>	0.3	3		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>sieberiana</i>	0.5	50		N	
Shrub (SG)	<i>Leucopogon virgatus</i>	0.1	5		N	
Forb (FG)	<i>Acaena novae-zelandiae</i>	0.1	30		N	
Shrub (SG)	<i>Acrotriche serrulata</i>	0.1	2		N	
Shrub (SG)	<i>Leucopogon attenuatus</i>	0.1	3		N	
Forb (FG)	<i>Senecio gunnii</i>	0.1	10		N	
Shrub (SG)	<i>Cassinia aculeata</i> subsp. <i>aculeata</i>	0.4	2		N	
Forb (FG)	<i>Dichondra repens</i>	0.1	50		N	
Grass & grasslike	<i>Echinopogon ovatus</i>	0.1	10		N	
Grass & grasslike	<i>Lachnagrostis filiformis</i>	0.2	20		N	
Grass & grasslike	<i>Lomandra multiflora</i> subsp. <i>Multiflora</i>	0.1	10		N	

BAM Site – Field Survey Form

Plot ID:	201	Date:	29-11-17	Survey Name:	Port Phillip Trail Tantangara North	Recorders:	SW, SZD	
Zone:	55	Easting:	643221.7613	Plot dimensions:	20m x 50m	Midline bearing:	148	
Datum:	GDA94	Northing:	6048793.201	IBRA region:	Australian Alps (Snowy Mountains)	Zone ID:		
Plant Community Type:	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				Confidence:	Low	Photo #:	
Vegetation Class:	Southern Tableland Grassy Woodlands				EEC:	Yes	Confidence:	High

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	1
	Shrubs:	2
	Grasses etc.:	5
	Forbs:	20
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	2
	Shrubs:	0.5
	Grasses etc.:	53.6
	Forbs:	2.5
	Ferns:	0
	Other:	0
High Threat Weed cover:		0.1

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	0	0	0
10 – 19 cm:	0	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	0		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	5	10	15	20	15	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Average of the 5 subplots:	13					0.4					0					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Footslope	Lf Pattern (A)	Low hills	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)	Shale	Soil Surface Texture	Clay loam	Soil Colour	Light brown	Soil Depth	shallow
Lithology (B)							
Slope	0.05	Aspect	NNW	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):	Light	less than 3yo	Brumbie and rabbits
Fire damage:	Severe	less than 3yo	
Storm damage:			No evidence
Weediness:	Light	less than 3yo	Pasture weeds
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Port Phillip Trail Tantangara North					
	Date:	29-11-17	Plot ID:	201	Recorders:	SW, SZD

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus stellulata</i>	2	7		N	
Shrub (SG)	<i>Hakea microcarpa</i>	0.3	1		N	
Forb (FG)	<i>Ranunculus lappaceus</i>	0.1	50		N	
Forb (FG)	<i>Diuris behrii</i>	0.1	30		N	
Forb (FG)	<i>Scleranthus biflorus</i>	0.2	50		N	
Forb (FG)	<i>Cymbonotus lawsonianus</i>	0.2	50		N	
Forb (FG)	<i>Veronica subtilis</i>	0.1	20		N	
Forb (FG)	<i>Craspedia costiniana</i>	0.3	100		N	
Forb (FG)	<i>Acaena ovina</i>	0.1	20		N	
Forb (FG)	<i>Epilobium gunnianum</i>	0.1	20		N	
Forb (FG)	<i>Rhodanthe anthemoides</i>	0.1	20		N	
Forb (FG)	<i>Leptorhynchus squamatus</i>	0.1	10		N	
Forb (FG)	<i>Senecio pinnatifolius</i> var. <i>alpinus</i>	0.1	5		N	
Grass & grasslike	<i>Poa costiniana</i>	0.5	50		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>sieberiana</i>	50	1000		N	
Forb (FG)	<i>Coronidium scorpioides</i>	0.2	50		N	
Shrub (SG)	<i>Pultenaea fasciculata</i>	0.2	50		N	
Forb (FG)	<i>Stylidium graminifolium</i>	0.1	10		N	
Forb (FG)	<i>Asperula scoparia</i>	0.1	30		N	
Grass & grasslike	<i>Themeda triandra</i>	2	200		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>cyanophylla</i>	1	50		N	
Forb (FG)	<i>Oreomyrrhis</i> spp.	0.1	2		N	
Forb (FG)	<i>Pterostylis cynocephala</i>	0.1	3		N	
	<i>Acetosella vulgaris</i>	0.1	10		HTE	
Forb (FG)	<i>Viola betonicifolia</i>	0.1	5		N	
Forb (FG)	<i>Geranium antrorsum</i>	0.1	5		N	
Forb (FG)	<i>Euphrasia collina</i> subsp. <i>diversicolor</i>	0.1	10		N	
	<i>Taraxacum officinale</i>	0.1	5		E	
Grass & grasslike	<i>Carex breviculmis</i>	0.1	10		N	
Forb (FG)	<i>Erigeron bellidioides</i>	0.1	20		N	

BAM Site – Field Survey Form

Plot ID:	218	Date:	12-12-17	Survey Name:	Access Roads	Recorders:	SD, EL
Zone:	55	Easting:	625998.1173	Plot dimensions:	20m x 50m	Midline bearing:	318
Datum:	GDA94	Northing:	6038194.426	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	999: Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion				Confidence:	High	Photo #:
Vegetation Class:	Southern Tableland Dry Sclerophyll Forests				EEC:		Confidence:

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	2
	Shrubs:	14
	Grasses etc.:	5
	Forbs:	9
	Ferns:	1
	Other:	1
Sum of Cover of native vascular plants by growth form group	Trees:	0.2
	Shrubs:	85.6
	Grasses etc.:	3.6
	Forbs:	3.3
	Ferns:	0.2
	Other:	1
High Threat Weed cover:		0.5

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	0	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	0		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	40	10	10	10	30	25	25	35	10	15	0	0	0	20	4	10	10	4	4	4
Average of the 5 subplots:	20					22					4.8					6.4				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)		Lf Pattern (A)	Hills	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Silty clay	Soil Colour	Red	Soil Depth	Shallow
Lithology (B)							
Slope	20	Aspect	ENE	Site Drainage	Good	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Severe	greater than 10yo	Historical. Single age class no old trees in adjacent community.
Cultivation (inc. pasture):			No evidence
Soil erosion:	Moderate	3 to 10 yo	Associated with removal of overstorey and also access road adjacent.
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):	Light		Native and exotic herbivores
Fire damage:	Light	3 to 10 yo	Burnt logs
Storm damage:			No evidence
Weediness:	Light	less than 3yo	Roadside weeds
Other:	Moderate	3 to 10 yo	Clearing associated with power line corridor.

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Access Roads						
		Date:	12-12-17	Plot ID:	218	Recorders:	SD, EL

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Shrub (SG)	<i>Acacia buxifolia</i>	1	20		N	
Shrub (SG)	<i>Calytrix tetragona</i>	70	1000		N	
Shrub (SG)	<i>Leucopogon attenuatus</i>	1	30		N	
Shrub (SG)	<i>Acacia pravissima</i>	2	20		N	
Shrub (SG)	<i>Banksia canei</i>	0.1	3		N	
Other (OG)	<i>Cassytha glabella</i>	1	50		N	
	<i>Hypericum perforatum</i>	0.5	30		HTE	
Tree (TG)	<i>Eucalyptus nortonii</i>	0.1	1		N	
Grass & grasslike	<i>Rytidosperma caespitosum</i>	1	200		N	
Forb (FG)	<i>Stylidium graminifolium</i>	0.5	100		N	
	<i>Rubus anglocandicans</i>	0.5	10		E	
Tree (TG)	<i>Eucalyptus dives</i>	0.1	1		N	
Shrub (SG)	<i>Cassinia longifolia</i>	0.5	5		N	
	<i>Centaurium erythraea</i>	0.5	100		E	
Shrub (SG)	<i>Brachyloma daphnoides</i>	5	100		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	2	50		N	
Grass & grasslike	<i>Poa</i> spp.	0.2	20		N	
Forb (FG)	<i>Hypericum gramineum</i>	0.2	30		N	
Grass & grasslike	<i>Anthosachne scabra</i>	0.2	30		N	
Forb (FG)	<i>Oxalis perennans</i>	0.1	10		N	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	3	30		N	
	<i>Conyza canadensis</i> var. <i>canadensis</i>	0.1	2		E	
Forb (FG)	<i>Hydrocotyle laxiflora</i>	1	200		N	
Forb (FG)	<i>Euchiton sphaericus</i>	0.1	10		N	
Forb (FG)	<i>Acaena novae-zelandiae</i>	0.1	5		N	
	<i>Aira elegantissima</i>	0.2	50		E	
Shrub (SG)	<i>Monotoca scoparia</i>	0.5	2		N	
Grass & grasslike	<i>Lomandra bracteata</i>	0.2	20		N	
Shrub (SG)	<i>Pimelea linifolia</i>	0.1	10		N	
Forb (FG)	<i>Gonocarpus teucrioides</i>	0.2	20		N	
Fern (EG)	<i>Cheilanthes sieberi</i>	0.2	20		N	
Shrub (SG)	<i>Bursaria spinosa</i>	2	10		N	
Forb (FG)	<i>Dianella revoluta</i>	1	30		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.2	10		N	
Forb (FG)	<i>Microtis unifolia</i>	0.1	1		N	
Shrub (SG)	<i>Podolobium alpestre</i>	0.1	2		N	
	<i>Hypochaeris radicata</i>	0.1	2		E	
Shrub (SG)	<i>Pimelea glauca</i>	0.1	1		N	

BAM Site – Field Survey Form

Plot ID:	1007	Date:	16-03-18	Survey Name:	X7	Recorders:	JA, ACM
Zone:	55	Easting:	626074.9424	Plot dimensions:	20m x 20m	Midline bearing:	182
Datum:	GDA94	Northing:	6038950.364	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	302: Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion				Confidence:		Photo #:
Vegetation Class:	Upper Riverina Dry Sclerophyll Forests				EEC:	Yes	Confidence:

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	1
	Shrubs:	4
	Grasses etc.:	6
	Forbs:	0
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	1
	Shrubs:	81.3
	Grasses etc.:	5.4
	Forbs:	0
	Ferns:	0
	Other:	0
High Threat Weed cover:		10.1

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	5	0	0
10 – 19 cm:	9	0	0
5 – 9 cm:	2	0	0
< 5 cm:	0	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	2		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	95	60	85	90	100	5	30	15	10	0	0	15	5	0	0	0	0	0	0	0
Average of the 5 subplots:	86					12					4					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Valley flat	Lf Pattern (A)	Plain	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)	Clay	Soil Surface Texture	Smooth soil covered by grass	Soil Colour	Orange-brown	Soil Depth	Shallow -moderate
Lithology (B)							
Slope	Slight upslope along midline (5°)	Aspect	182°S	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Severe	greater than 10yo	Adjacent to unsealed track and remains of building
Cultivation (inc. pasture):			
Soil erosion:			
Firewood / CWD removal:			
Grazing (identify native/stock):			
Fire damage:			
Storm damage:			
Weediness:	Severe	greater than 10yo	
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	X7					
			Date:	16-03-18	Plot ID:	1007
			Recorders:		JA, ACM	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus camphora</i>	1	6		N	
Shrub (SG)	<i>Acacia pravissima</i>	80	1000		N	
Shrub (SG)	<i>Bursaria spinosa</i>	1	3		N	
	<i>Rosa rubiginosa</i>	0.1	2		HTE	
	<i>Rubus fruticosus</i> sp. agg.	6	12		HTE	
	<i>Hypericum perforatum</i>	4	200		HTE	
Grass & grasslike	<i>Carex inomitata</i>	1	21		N	
	<i>Centaureum erythraea</i>	0.1	50		E	
Grass & grasslike	<i>Rytidosperma penicillatum</i>	0.1	5		N	
Grass & grasslike	<i>Dichelachne</i> spp.	0.1	15		N	
Grass & grasslike	<i>Carex breviculmis</i>	0.1	50		N	
Grass & grasslike	<i>Lomandra</i> spp.	0.1	15		N	
Grass & grasslike	<i>Themeda triandra</i>	4	300		N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	0.1	1		N	
Shrub (SG)	<i>Grevillea rosmarinifolia</i>	0.2	1		N	

BAM Site – Field Survey Form

Plot ID:	1015	Date:	15-03-18	Survey Name:	Lobs Hole Ravine	Recorders:	AM, CK
Zone:	55	Easting:	628253.5021	Plot dimensions:	20m x 50m	Midline bearing:	105
Datum:	GDA94	Northing:	6038816.712	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	311: Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion				Confidence:	High	Photo #:
Vegetation Class:	Upper Riverina Dry Sclerophyll Forests				EEC:	No	Confidence:
						High	

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	15
	Grasses etc.:	6
	Forbs:	3
	Ferns:	0
	Other:	4
Sum of Cover of native vascular plants by growth form group	Trees:	32
	Shrubs:	94.3
	Grasses etc.:	9.2
	Forbs:	0.4
	Ferns:	0
	Other:	0.4
High Threat Weed cover:		0

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	1	0	0
30 – 49 cm:	10	0	0
20 – 29 cm:	1	0	1
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	31		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	95	90	90	95	65	1	2	5	1	30	0	0	0	0	0	1	0	0	0	0
Average of the 5 subplots:	87					7.8					0					0.2				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Silty clay	Soil Colour	Light brown	Soil Depth	
Lithology (B)							
Slope	5	Aspect	NE	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Moderate	greater than 10yo	
Storm damage:			No evidence
Weediness:			no weeds
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine					
	Date:	15-03-18	Plot ID:	1015	Recorders:	AM, CK

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus dives</i>	15	10		N	
Tree (TG)	<i>Eucalyptus nortonii</i>	7	5		N	
Tree (TG)	<i>Eucalyptus macrorhyncha</i>	10	8		N	
Shrub (SG)	<i>Banksia canei</i>	30	200		N	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	35	200		N	
Shrub (SG)	<i>Platylobium formosum</i>	22	80		N	
Shrub (SG)	<i>Pomaderris subcapitata</i>	0.5	10		N	
Shrub (SG)	<i>Podolobium procumbens</i>	1	30		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	2	100		N	
Other (OG)	<i>Hardenbergia violacea</i>	0.1	5		N	
Forb (FG)	<i>Dianella revoluta</i> var. <i>revoluta</i>	0.2	30		N	
Grass & grasslike	<i>Dichelachne rara</i>	0.1	10		N	
Grass & grasslike	<i>Rytidosperma pallidum</i>	1	30		N	
Shrub (SG)	<i>Tetradlea bauerifolia</i>	1	50		N	
Grass & grasslike	<i>Lomandra longifolia</i>	1	20		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.2	10		N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	0.1	20		N	
Other (OG)	<i>Billardiera scandens</i>	0.1	5		N	
Shrub (SG)	<i>Persoonia chamaepeuce</i>	0.1	5		N	
Forb (FG)	<i>Hovea heterophylla</i>	0.1	10		N	
Shrub (SG)	<i>Monotoca scoparia</i>	0.3	5		N	
Shrub (SG)	<i>Leucopogon virgatus</i>	0.1	10		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>hirtella</i>	5	100		N	
Shrub (SG)	<i>Acacia pravissima</i>	3	20		N	
Shrub (SG)	<i>Cassinia longifolia</i>	0.5	5		N	
Shrub (SG)	<i>Choretrum pauciflorum</i>	0.2	3		N	
Shrub (SG)	<i>Leucopogon attenuatus</i>	0.2	5		N	
Shrub (SG)	<i>Correa lawrenceana</i> var. <i>rosea</i>	0.2	5		N	
Grass & grasslike	<i>Lepidosperma laterale</i>	0.1	2		N	
Other (OG)	<i>Cassytha pubescens</i>	0.1	10		N	
Other (OG)	<i>Glycine clandestina</i>	0.1	3		N	

BAM Site – Field Survey Form

Plot ID:	1018	Date:	20-03-18	Survey Name:	Lobs Hole	Recorders:	AM, CK
Zone:	55	Easting:	627137.3172	Plot dimensions:	20m x 50m	Midline bearing:	330
Datum:	GDA94	Northing:	6037934.516	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	302: Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion				Confidence:	High	Photo #:
Vegetation Class:	Upper Riverina Dry Sclerophyll Forests				EEC:	No	Confidence:
						High	

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	8
	Grasses etc.:	7
	Forbs:	1
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	47
	Shrubs:	6.2
	Grasses etc.:	61.4
	Forbs:	0.1
	Ferns:	0
	Other:	0
High Threat Weed cover:		25.5

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	1	0	0
30 – 49 cm:	1	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	54		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	93	85	70	80	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average of the 5 subplots:	79.6					0					0					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Valley flat	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Clay loam	Soil Colour		Soil Depth	
Lithology (B)							
Slope	2	Aspect	NW	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Moderate	greater than 10yo	Historical clearing
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Light	greater than 10yo	
Storm damage:			No evidence
Weediness:	Moderate		
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole						
		Date:	20-03-18	Plot ID:	1018	Recorders:	AM, CK

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus viminalis</i>	35	20		N	
Tree (TG)	<i>Acacia dealbata</i>	4	8		N	
Shrub (SG)	<i>Acacia pravissima</i>	3	10		N	
Tree (TG)	<i>Acacia melanoxylon</i>	8	6		N	
Shrub (SG)	<i>Cassinia longifolia</i>	1	3		N	
Shrub (SG)	<i>Gynatrix pulchella</i>	0.1	1		N	
Grass & grasslike	<i>Poa helmsii</i>	60	500		N	
	<i>Rubus fruticosus</i> sp. agg.	25	100		HTE	
Shrub (SG)	<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>	0.1	2		N	
Grass & grasslike	<i>Dichelachne inaequiglumis</i>	0.2	50		N	
Shrub (SG)	<i>Exocarpos strictus</i>	0.2	3		N	
	<i>Cirsium vulgare</i>	0.2	30		E	
	<i>Centaureum erythraea</i>	0.1	20		E	
	<i>Hypericum perforatum</i>	0.2	20		HTE	
	<i>Rosa rubiginosa</i>	0.3	10		HTE	
Forb (FG)	<i>Geranium solanderi</i> var. <i>solanderi</i>	0.1	30		N	
Shrub (SG)	<i>Rubus parvifolius</i>	0.5	50		N	
Grass & grasslike	<i>Rytidosperma penicillatum</i>	0.1	30		N	
Grass & grasslike	<i>Anthosachne scabra</i>	0.2	50		N	
Shrub (SG)	<i>Melicytus dentatus</i>	0.5	2		N	
	<i>Asparagus officinalis</i>	0.3	3		E	
	<i>Hypericum androsaemum</i>	0.1	3		E	
Grass & grasslike	<i>Lachnagrostis filiformis</i>	0.5	50		N	
Shrub (SG)	<i>Cassinia aculeata</i>	0.8	2		N	
Grass & grasslike	<i>Microlaena stipoides</i> var. <i>stipoides</i>	0.1	10		N	
Grass & grasslike	<i>Carex inomitata</i>	0.3	30		N	

BAM Site – Field Survey Form

Plot ID:	1019	Date:	16-03-18	Survey Name:	Lobs Hole Ravine	Recorders:	AM, CK
Zone:	55	Easting:	627362.9423	Plot dimensions:	20m x 50m	Midline bearing:	281
Datum:	GDA94	Northing:	6032066.195	IBRA region:	Australian Alps (Snowy Mountains)	Zone ID:	
Plant Community Type:	1196: Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion				Confidence:	High	Photo #:
Vegetation Class:	Subalpine Woodlands				EEC:	No	Confidence:
						High	

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	10
	Grasses etc.:	5
	Forbs:	19
	Ferns:	0
	Other:	2
Sum of Cover of native vascular plants by growth form group	Trees:	65
	Shrubs:	13.4
	Grasses etc.:	62.7
	Forbs:	27.1
	Ferns:	0
	Other:	1.2
High Threat Weed cover:		0

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	2	0	1
50 – 79 cm:	3	0	2
30 – 49 cm:	1	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	48		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	65	75	85	85	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average of the 5 subplots:	76					0					0					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Loam	Soil Colour		Soil Depth	
Lithology (B)							
Slope	3	Aspect	W	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Light	greater than 10yo	
Storm damage:			No evidence
Weediness:	Light		
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine					
	Date:	16-03-18	Plot ID:	1019	Recorders:	AM, CK

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus dalrympleana</i>	10	4		N	
Tree (TG)	<i>Eucalyptus pauciflora</i>	40	40		N	
Tree (TG)	<i>Acacia dealbata</i> subsp. <i>subalpina</i>	15	30		N	
Shrub (SG)	<i>Acacia obliquinervia</i>	3	20		N	
Shrub (SG)	<i>Cassinia aculeata</i>	3	10		N	
Shrub (SG)	<i>Lomatia myricoides</i>	3	10		N	
Shrub (SG)	<i>Platylobium formosum</i>	2	80		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>sieberiana</i>	60	1000		N	
Shrub (SG)	<i>Acacia praevisissima</i>	1	8		N	
Forb (FG)	<i>Asperula scoparia</i>	20	10000		N	
Other (OG)	<i>Glycine clandestina</i>	1	500		N	
Forb (FG)	<i>Geranium potentilloides</i>	0.1	50		N	
Other (OG)	<i>Clematis aristata</i>	0.2	100		N	
	<i>Dactylis glomerata</i>	0.5	30		E	
Forb (FG)	<i>Arthropodium milleflorum</i>	0.2	50		N	
Grass & grasslike	<i>Dichelachne hirtella</i>	0.2	100		N	
Forb (FG)	<i>Wahlenbergia stricta</i> subsp. <i>stricta</i>	0.1	50		N	
Forb (FG)	<i>Lobelia gibbosa</i>	0.1	10		N	
Forb (FG)	<i>Ranunculus lappaceus</i>	0.1	20		N	
Forb (FG)	<i>Coronidium monticola</i>	0.2	50		N	
Forb (FG)	<i>Acaena novae-zelandiae</i>	5	1000		N	
Forb (FG)	<i>Veronica calycina</i>	0.2	50		N	
Forb (FG)	<i>Picris angustifolia</i>	0.1	20		N	
	<i>Trifolium repens</i>	0.1	20		E	
Grass & grasslike	<i>Anthosachne scabra</i>	0.3	50		N	
Grass & grasslike	<i>Lomandra longifolia</i>	2	50		N	
Forb (FG)	<i>Stackhousia monogyna</i>	0.1	5		N	
Shrub (SG)	<i>Olearia erubescens</i>	0.1	2		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	0.2	30		N	
Forb (FG)	<i>Brachyscome spathulata</i>	0.1	30		N	
Forb (FG)	<i>Cullen microcephalum</i>	0.1	3		N	
Shrub (SG)	<i>Daviesia ulicifolia</i>	0.7	20		N	
Forb (FG)	<i>Viola betonicifolia</i>	0.1	100		N	
Forb (FG)	<i>Stellaria pungens</i>	0.2	200		N	
Shrub (SG)	<i>Coprosma hirtella</i>	0.3	10		N	
Forb (FG)	<i>Epilobium billardierianum</i> subsp. <i>Cinereum</i>	0.1	10		N	
Forb (FG)	<i>Senecio gunnii</i>	0.1	5		N	
Shrub (SG)	<i>Pimelea curviflora</i>	0.1	2		N	
Forb (FG)	<i>Dianella tasmanica</i>	0.1	5		N	
Forb (FG)	<i>Bulbine bulbosa</i>	0.1	20		N	
Shrub (SG)	<i>Leucopogon gelidus</i>	0.2	5		N	

BAM Site – Field Survey Form

Plot ID:	1043	Date:	15-03-18	Survey Name:	Talbingo	Recorders:	AMu, AMo	
Zone:	55	Easting:	625081.4636	Plot dimensions:	20m x 50m	Midline bearing:	59	
Datum:	GDA94	Northing:	6039931.079	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:		
Plant Community Type:	1191: Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion				Confidence:	Medium	Photo #:	
Vegetation Class:	Subalpine Woodlands				EEC:	No	Confidence:	Medium

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	2
	Shrubs:	7
	Grasses etc.:	8
	Forbs:	10
	Ferns:	0
	Other:	1
Sum of Cover of native vascular plants by growth form group	Trees:	21
	Shrubs:	54.3
	Grasses etc.:	11.8
	Forbs:	1
	Ferns:	0
	Other:	0.1
High Threat Weed cover:		3.1

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	3	0	0
20 – 29 cm:	4	0	0
10 – 19 cm:	8	0	0
5 – 9 cm:	1	0	0
< 5 cm:	0	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	7		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	95	25	60	5	70	5	2	40	2	15	5	99	5	95	20	0	0	0	0	0
Average of the 5 subplots:	51					12.8					44.8					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Silty clay	Soil Colour	Light brown	Soil Depth	
Lithology (B)							
Slope	5-10 degrees	Aspect	North-east	Site Drainage		Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Severe	greater than 10yo	Relatively young regenerating trees
Cultivation (inc. pasture):			No evidence
Soil erosion:	Light	less than 3yo	Small areas of bare soil
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):	Light		
Fire damage:	Light	greater than 10yo	
Storm damage:			No evidence
Weediness:	Moderate		Exotic grasses and forbs
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Talbingo					
	Date:	15-03-18	Plot ID:	1043	Recorders:	AMu, AMo

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus rubida</i>	6	10		N	
Tree (TG)	<i>Eucalyptus pauciflora</i>	15	20		N	
Shrub (SG)	<i>Acacia pravissima</i>	50	100		N	
Shrub (SG)	<i>Cryptandra amara</i>	1	20		N	
Shrub (SG)	<i>Exocarpos strictus</i>	2	10		N	
Grass & grasslike	<i>Rytidosperma penicillatum</i>	5	500		N	
Shrub (SG)	<i>Gompholobium huegelii</i>	0.5	10		N	
	<i>Hypericum perforatum</i>	3	300		HTE	
	<i>Trifolium arvense</i>	0.1	50		E	
Forb (FG)	<i>Veronica calycina</i>	0.1	50		N	
	<i>Petrorhagia nanteuillii</i>	0.1	50		E	
	<i>Centaurium erythraea</i>	0.1	100		E	
Grass & grasslike	<i>Carex breviculmis</i>	0.2	50		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.2	30		N	
	<i>Aira elegantissima</i>	1	1000		E	
Grass & grasslike	<i>Dichelachne rara</i>	0.3	100		N	
Forb (FG)	<i>Acaena ovina</i>	0.1	30		N	
Grass & grasslike	<i>Anthosachne scabra</i>	0.5	200		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>cyanophylla</i>	5	500		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	0.2	40		N	
Forb (FG)	<i>Stellaria pungens</i>	0.1	100		N	
Forb (FG)	<i>Senecio quadridentatus</i>	0.1	5		N	
Forb (FG)	<i>Hypericum gramineum</i>	0.1	30		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>hirtella</i>	0.5	50		N	
Forb (FG)	<i>Dichondra repens</i>	0.1	100		N	
Forb (FG)	<i>Daucus glochidiatus</i>	0.1	10		N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	0.1	10		N	
Forb (FG)	<i>Euchiton japonicus</i>	0.1	5		N	
Other (OG)	<i>Glycine clandestina</i>	0.1	3		N	
Shrub (SG)	<i>Grevillea arenaria</i> subsp. <i>canescens</i>	0.4	5		N	
Grass & grasslike	<i>Luzula flaccida</i>	0.1	20		N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	0.2	5		N	
Forb (FG)	<i>Stylidium graminifolium</i>	0.1	2		N	
	<i>Vulpia bromoides</i>	5	1000		E	
	<i>Rosa rubiginosa</i>	0.1	1		HTE	

BAM Site – Field Survey Form

Plot ID:	2084	Date:	31-01-19	Survey Name:	Lobs Hole Ravine	Recorders:	SW, KM
Zone:	55	Easting:	625304.0394	Plot dimensions:	20m x 50m	Midline bearing:	155
Datum:	GDA94	Northing:	6039603.223	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	729: Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion				Confidence:	High	Photo #:
Vegetation Class:	Southern Tableland Dry Sclerophyll Forests				EEC:	No	Confidence:
							Medium

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	8
	Grasses etc.:	8
	Forbs:	2
	Ferns:	1
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	50
	Shrubs:	146
	Grasses etc.:	24
	Forbs:	3
	Ferns:	1
	Other:	0
High Threat Weed cover:		5

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	2	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	0	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	111		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	25	15	5	20	70	10	10	10	5	5	15	1	1	1	0	5	2	3	3	1
Average of the 5 subplots:	27					8					3.6					2.8				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Low hills	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Medium grained	Soil Colour	Dark orange-brown	Soil Depth	At least 30cm
Lithology (B)							
Slope	10	Aspect	W	Site Drainage	Good drainage	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Moderate	3 to 10 yo	Eucalyptus trunks show old burn marks, some conifers completely burnt
Storm damage:	Light	less than 3yo	Broken Eucalyptus branch, high winds recorded during previous two days
Weediness:	Moderate	less than 3yo	St Johns Wort present in plot
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine						
		Date:	31-01-19	Plot ID:	2084	Recorders:	SW, KM

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus rubida</i>	20	4		N	
Tree (TG)	<i>Eucalyptus dives</i>	25	8		N	
Shrub (SG)	<i>Bursaria spinosa</i>	2	3		N	
Shrub (SG)	<i>Grevillea arenaria</i> subsp. <i>canescens</i>	30	60		N	
Shrub (SG)	<i>Calytrix tetragona</i>	40	100		N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	10	20		N	
Grass & grasslike	<i>Themeda triandra</i>	5	50		N	
	<i>Hypericum perforatum</i>	5	100		HTE	
Grass & grasslike	<i>Lomandra filiformis</i>	4	150		N	
Grass & grasslike	<i>Dichelachne micrantha</i>	4	50		N	
Forb (FG)	<i>Oxalis perennans</i>	1	10		N	
	<i>Centaurium erythraea</i>	1	20		E	
Shrub (SG)	<i>Tetratheca thymifolia</i>	1	30		N	
Grass & grasslike	<i>Poa sieberiana</i>	1	50		N	
Grass & grasslike	<i>Lomandra longifolia</i>	5	10		N	
Shrub (SG)	<i>Dillwynia sericea</i>	1	15		N	
Grass & grasslike	<i>Carex appressa</i>	1	5		N	
Grass & grasslike	<i>Rytidosperma</i> spp.	2	50		N	
Grass & grasslike	<i>Dichelachne hirtella</i>	2	10		N	
Fern (EG)	<i>Cheilanthes sieberi</i>	1	30		N	
Forb (FG)	<i>Galium gaudichaudii</i>	2	30		N	
	<i>Trifolium arvense</i>	1	1		E	
Shrub (SG)	<i>Leucopogon attenuatus</i>	60	1000		N	
Tree (TG)	<i>Eucalyptus mannifera</i>	5	1		N	
Shrub (SG)	<i>Acacia saliciformis</i>	2	1		N	

BAM Site – Field Survey Form

Plot ID:	2119	Date:	31-01-19	Survey Name:	Lower Lobs Hole Ravine Road	Recorders:	SW, KM
Zone:	55	Easting:	626681.907	Plot dimensions:	20m x 50m	Midline bearing:	350
Datum:	GDA94	Northing:	6036779.516	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	300: Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment				Confidence:	High	Photo #:
Vegetation Class:	Southern Tableland Wet Sclerophyll Forests				EEC:	No	Confidence:
						Medium	

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	2
	Shrubs:	3
	Grasses etc.:	6
	Forbs:	8
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	65
	Shrubs:	41
	Grasses etc.:	107
	Forbs:	16
	Ferns:	0
	Other:	0
High Threat Weed cover:		15

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	1	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	0	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	0	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	3		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	2	80	15	20	10	1	2	20	10	0	0	1	1	0	0	0	1	2	3	0
Average of the 5 subplots:	25.4					6.6					0.4					1.2				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Hills	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)	Alluvial loams and clays	Soil Surface Texture	Fine grained	Soil Colour	Pale light brown	Soil Depth	At least 50cm
Lithology (B)							
Slope	30	Aspect	N	Site Drainage	Good drainage	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Moderate	greater than 10yo	Some burnt trunks
Storm damage:			No evidence
Weediness:	Severe	less than 3yo	St Johns Wort and Blackberry present within plot
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lower Lobs Hole Ravine Road						
		Date:	31-01-19	Plot ID:	2119	Recorders:	SW, KM

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus viminalis</i>	10	5		N	
Tree (TG)	<i>Acacia dealbata</i> subsp. <i>dealbata</i>	55	60		N	
Shrub (SG)	<i>Exocarpos strictus</i>	35	100		N	
	<i>Rubus anglocandicans</i>	25	30		E	
	<i>Rosa rubiginosa</i>	10	15		HTE	
Shrub (SG)	<i>Pultenaea fasciculata</i>	5	50		N	
Forb (FG)	<i>Chrysocephalum semipapposum</i>	2	200		N	
	<i>Hypericum perforatum</i>	5	500		HTE	
Grass & grasslike	<i>Rytidosperma erianthum</i>	60	3000		N	
Forb (FG)	<i>Wahlenbergia communis</i>	2	100		N	
Forb (FG)	<i>Picris angustifolia</i>	1	20		N	
Grass & grasslike	<i>Dichelachne rara</i>	30	1000		N	
	<i>Verbascum virgatum</i>	1	30		E	
Forb (FG)	<i>Geranium solanderi</i>	5	100		N	
	<i>Tragopogon dubius</i>	3	10		E	
	<i>Centaureum erythraea</i>	4	100		E	
Forb (FG)	<i>Oxalis</i> spp.	1	200		N	
	<i>Trifolium arvense</i>	5	50		E	
	<i>Conyza</i> spp.	2	10		E	
	<i>Petrorhagia nanteuilii</i>	1	20		E	
Grass & grasslike	<i>Themeda triandra</i>	4	100		N	
Forb (FG)	<i>Oxalis perennans</i>	2	200		N	
Forb (FG)	<i>Acaena ovina</i>	2	50		N	
Grass & grasslike	<i>Microlaena stipoides</i>	5	300		N	
Forb (FG)	<i>Galium gaudichaudii</i>	1	50		N	
Grass & grasslike	<i>Panicum effusum</i>	3	100		N	
Shrub (SG)	<i>Cassinia aculeata</i>	1	1		N	
Grass & grasslike	<i>Poa induta</i>	5	20		N	

BAM Site – Field Survey Form

Plot ID:	2166	Date:	15-11-18	Survey Name:	Marica Firetrail	Recorders:	JS, SW	
Zone:	55	Easting:	630057.8919	Plot dimensions:	20m x 50m	Midline bearing:	196	
Datum:	GDA94	Northing:	6039371.587	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:		
Plant Community Type:	953: Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion				Confidence:	Medium	Photo #:	
Vegetation Class:	Southern Tableland Dry Sclerophyll Forests				EEC:	No	Confidence:	Medium

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	17
	Grasses etc.:	6
	Forbs:	12
	Ferns:	0
	Other:	2
Sum of Cover of native vascular plants by growth form group	Trees:	19.2
	Shrubs:	18.1
	Grasses etc.:	7.1
	Forbs:	1.9
	Ferns:	0
	Other:	0.5
High Threat Weed cover:		0

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	1	0	1
50 – 79 cm:	2	0	2
30 – 49 cm:	8	0	0
20 – 29 cm:	1	0	1
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	66		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	90	80	95	90	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average of the 5 subplots:	88					0					0					0				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Mountains	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Loam	Soil Colour	Brown	Soil Depth	At least 50mm
Lithology (B)							
Slope	20	Aspect	WNW	Site Drainage	Good	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Light	greater than 10yo	
Storm damage:			No evidence
Weediness:			No evidence
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if "top 3"; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Marica Firetrail						
		Date:	15-11-18	Plot ID:	2166	Recorders:	JS, SW

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus dives</i>	15	30		N	
Tree (TG)	<i>Eucalyptus macrorhyncha</i>	4	7		N	
Shrub (SG)	<i>Daviesia latifolia</i>	8	500		N	
Shrub (SG)	<i>Platylobium formosum</i>	1	100		N	
Shrub (SG)	<i>Leucopogon fletcheri</i> subsp. <i>brevisepalus</i>	5	500		N	
Shrub (SG)	<i>Monotoca scoparia</i>	1	50		N	
Grass & grasslike	<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	0.4	100		N	
Grass & grasslike	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	0.4	500		N	
Forb (FG)	<i>Dianella revoluta</i>	0.3	100		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>sieberiana</i>	3	500		N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>cyanophylla</i>	3	500		N	
Shrub (SG)	<i>Pimelea linifolia</i> subsp. <i>linifolia</i>	0.2	20		N	
Shrub (SG)	<i>Persoonia chamaepeuce</i>	0.1	5		N	
Other (OG)	<i>Cassytha pubescens</i>	0.4	100		N	
Shrub (SG)	<i>Tetradlea bauerifolia</i>	0.5	500		N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	0.5	500		N	
Forb (FG)	<i>Stylidium graminifolium</i>	0.2	50		N	
Shrub (SG)	<i>Leucopogon virgatus</i>	0.7	100		N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	0.3	50		N	
Forb (FG)	<i>Brachyscome aculeata</i>	0.1	20		N	
Forb (FG)	<i>Craspedia jamesii</i>	0.1	7		N	
Forb (FG)	<i>Calochilus robertsonii</i>	0.1	1		N	
Other (OG)	<i>Hardenbergia violacea</i>	0.1	1		N	
Forb (FG)	<i>Hovea heterophylla</i>	0.1	4		N	
Shrub (SG)	<i>Omphacomeria acerba</i>	0.1	7		N	
Forb (FG)	<i>Pterostylis longifolia</i>	0.1	3		N	
Shrub (SG)	<i>Astrotricha ledifolia</i>	0.1	4		N	
Shrub (SG)	<i>Daviesia ulicifolia</i> subsp. <i>ruscifolia</i>	0.1	1		N	
Grass & grasslike	<i>Rytidosperma pallidum</i>	0.2	20		N	
Shrub (SG)	<i>Grevillea neurophylla</i>	0.2	20		N	
Forb (FG)	<i>Stackhousia monogyna</i>	0.1	5		N	
Grass & grasslike	<i>Lomandra longifolia</i>	0.1	20		N	
Forb (FG)	<i>Senecio gunnii</i>	0.1	1		N	
Shrub (SG)	<i>Acacia falciformis</i>	0.3	10		N	
Tree (TG)	<i>Eucalyptus dalrympleana</i> subsp. <i>dalrympleana</i>	0.2	2		N	
Forb (FG)	<i>Caladenia congesta</i>	0.1	3		N	
Shrub (SG)	<i>Dillwynia phylloides</i>	0.2	1		N	
Forb (FG)	<i>Thelymitra pauciflora</i>	0.1	1		N	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	0.2	7		N	
Shrub (SG)	<i>Acrotriche serrulata</i>	0.1	2		N	

BAM Site – Field Survey Form

Plot ID:	3005	Date:	03-02-19	Survey Name:	Lobs Hole Ravine	Recorders:	SW, KM	
Zone:	55	Easting:	624666.8469	Plot dimensions:	20m x 50m	Midline bearing:	125	
Datum:	GDA94	Northing:	6040619.943	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:		
Plant Community Type:	729: Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion				Confidence:	High	Photo #:	
Vegetation Class:	Southern Tableland Dry Sclerophyll Forests				EEC:	No	Confidence:	Medium

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	2
	Shrubs:	13
	Grasses etc.:	2
	Forbs:	3
	Ferns:	0
	Other:	1
Sum of Cover of native vascular plants by growth form group	Trees:	58
	Shrubs:	182
	Grasses etc.:	40
	Forbs:	6
	Ferns:	0
	Other:	4
High Threat Weed cover:		0

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	1	0	0
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	6		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	30	25	25	20	60	3	3	5	2	1	1	0	1	1	1	0	0	0	5	2
Average of the 5 subplots:	32					2.8					0.8					1.4				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Hills	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Medium-course grained	Soil Colour	Deep brown-mauve	Soil Depth	At least 30cm
Lithology (B)							
Slope	40	Aspect	S	Site Drainage	Good drainage	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):			No evidence
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Light	greater than 10yo	Some burnt trunks and stumps
Storm damage:	Moderate	less than 3yo	At least 2 fallen Eucalytus trees
Weediness:			No evidence
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine					
			Date:	03-02-19	Plot ID:	3005
			Recorders:		SW, KM	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus dives</i>	55	30	No	N	
Tree (TG)	<i>Eucalyptus mannifera</i>	3	1	No	N	
Shrub (SG)	<i>Leucopogon attenuatus</i>	80	1000	No	N	
Shrub (SG)	<i>Leucopogon virgatus</i>	20	200	No	N	
Shrub (SG)	<i>Grevillea arenaria</i> subsp. <i>Canescens</i>	10	10	No	N	
Shrub (SG)	<i>Kunzea muelleri</i>	40	1000	No	N	
Grass & grasslike	<i>Poa sieberiana</i>	20	500	No	N	
Shrub (SG)	<i>Dodonaea viscosa</i> subsp. <i>Angustissima</i>	5	50	No	N	
Shrub (SG)	<i>Epacris celata</i>	5	100	No	N	
Shrub (SG)	<i>Tetradlea thymifolia</i>	2	200	No	N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	2	200	No	N	
Shrub (SG)	<i>Pimelea linifolia</i> subsp. <i>linifolia</i>	3	50	No	N	
Shrub (SG)	<i>Acacia pravissima</i>	5	10	No	N	
Shrub (SG)	<i>Hibbertia obtusifolia</i>	5	20	No	N	
Grass & grasslike	<i>Poa sieberiana</i> var. <i>cyanophylla</i>	20	300	No	N	
Other (OG)	<i>Cassytha pubescens</i>	4	10	No	N	
Forb (FG)	<i>Stellaria pungens</i>	1	20	No	N	
Forb (FG)	<i>Stylidium graminifolium</i>	3	20	No	N	
Shrub (SG)	<i>Acacia gunnii</i>	3	10	No	N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	3	30	No	N	
Shrub (SG)	<i>Bursaria spinosa</i>	1	1	No	N	

BAM Site – Field Survey Form

Plot ID:	3076	Date:	05-02-19	Survey Name:	Lobs Hole Ravine	Recorders:	SW, KM
Zone:	55	Easting:	626305.6539	Plot dimensions:	20m x 50m	Midline bearing:	250
Datum:	GDA94	Northing:	6039139.16	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	296: Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion				Confidence:	High	Photo #:
Vegetation Class:	Southern Tableland Dry Sclerophyll Forests				EEC:	No	Confidence:
							Medium

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	16
	Grasses etc.:	5
	Forbs:	5
	Ferns:	0
	Other:	2
Sum of Cover of native vascular plants by growth form group	Trees:	54
	Shrubs:	184
	Grasses etc.:	41
	Forbs:	8
	Ferns:	0
	Other:	7
High Threat Weed cover:		0

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	5	0	0
20 – 29 cm:	1	0	1
10 – 19 cm:	1	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	22		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	85	90	90	85	80	5	5	10	5	5	1	0	2	1	2	0	0	0	1	0
Average of the 5 subplots:	86					6					1.2					0.2				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Footslope	Lf Pattern (A)	Low hills	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)		Soil Surface Texture	Medium-fine grained	Soil Colour	Dark orange-brown	Soil Depth	At least 30cm
Lithology (B)							
Slope	<5	Aspect	275	Site Drainage	Moderate drainage	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Moderate	less than 3yo	Plot adjacent to road
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):			No evidence
Fire damage:	Moderate	greater than 10yo	Some trees have burn marks from trunk to crown
Storm damage:	Severe	3 to 10 yo	At least 7 fallen Eucalyptus or Banksia, most leaves browned off
Weediness:			No evidence
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine						
		Date:	05-02-19	Plot ID:	3076	Recorders:	SW, KM

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus dives</i>	40	12	No	N	
Tree (TG)	<i>Eucalyptus mannifera</i>	10	3	No	N	
Shrub (SG)	<i>Acacia pravissima</i>	20	50	No	N	
Shrub (SG)	<i>Epacris celata</i>	15	50	No	N	
Shrub (SG)	<i>Acacia saliciformis</i>	10	20	No	N	
Shrub (SG)	<i>Daviesia ulicifolia</i>	10	50	No	N	
Shrub (SG)	<i>Banksia canei</i>	60	200	No	N	
Grass & grasslike	<i>Lomandra longifolia</i>	10	50	No	N	
	<i>Polypogon spp.</i>	10	50	No	E	
Shrub (SG)	<i>Hibbertia linearis</i>	5	100	No	N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	1	200	No	N	
Forb (FG)	<i>Stellaria pungens</i>	4	100	No	N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	10	50	No	N	
Grass & grasslike	<i>Lomandra filiformis</i>	5	50	No	N	
Grass & grasslike	<i>Poa spp.</i>	20	200	No	N	
Shrub (SG)	<i>Acacia gunnii</i>	1	20	No	N	
Shrub (SG)	<i>Tetradlea thymifolia</i>	1	300	No	N	
Grass & grasslike	<i>Carex appressa</i>	1	10	No	N	
Tree (TG)	<i>Acacia dealbata</i>	4	5	No	N	
Grass & grasslike	<i>Entolasia stricta</i>	5	20	No	N	
Shrub (SG)	<i>Leucopogon ericoides</i>	3	50	No	N	
Shrub (SG)	<i>Leucopogon virgatus</i>	3	40	No	N	
Forb (FG)	<i>Brachyscome decipiens</i>	1	1	No	N	
Shrub (SG)	<i>Pimelea linifolia</i>	5	50	No	N	
Shrub (SG)	<i>Mirbelia oxylobioides</i>	31	100	No	N	
Other (OG)	<i>Cassytha spp.</i>	5	20	No	N	
Forb (FG)	<i>Senecio quadridentatus</i>	1	1	No	N	
Shrub (SG)	<i>Exocarpos strictus</i>	5	10	No	N	
Other (OG)	<i>Billardiera scandens</i>	2	1	No	N	
Forb (FG)	<i>Boronia nana</i> var. <i>hyssopifolia</i>	1	1	No	N	
Shrub (SG)	<i>Monotoca scoparia</i>	3	20	No	N	
Shrub (SG)	<i>Hovea montana</i>	2	10	No	N	

BAM Site – Field Survey Form

Plot ID:	3177	Date:	04-02-19	Survey Name:	Lobs Hole Ravine	Recorders:	SW, KM
Zone:	55	Easting:	625074.1738	Plot dimensions:	20m x 50m	Midline bearing:	318
Datum:	GDA94	Northing:	6040197.698	IBRA region:	South Eastern Highlands (Bondo)	Zone ID:	
Plant Community Type:	729: Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion				Confidence:	High	Photo #:
Vegetation Class:	Southern Tableland Dry Sclerophyll Forests				EEC:	No	Confidence:
				Medium			

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	3
	Shrubs:	7
	Grasses etc.:	7
	Forbs:	7
	Ferns:	0
	Other:	1
Sum of Cover of native vascular plants by growth form group	Trees:	13
	Shrubs:	181
	Grasses etc.:	95
	Forbs:	22
	Ferns:	0
	Other:	1
High Threat Weed cover:		3

BAM Attribute (1000 m2 plot) DBH			
DBH	Stem count (euc)	Stem count (non-euc)	Stems with Hollows
80 + cm:	0	0	0
50 – 79 cm:	0	0	0
30 – 49 cm:	0	0	0
20 – 29 cm:	0	0	0
10 – 19 cm:	0	0	0
5 – 9 cm:	1	0	0
< 5 cm:	1	0	0
Length of logs (m) (≥10 cm diameter, >50 cm in length)	0		

Counts apply when the number of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree stems must be living. For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)					Bare ground cover (%)					Cryptogam cover (%)					Rock cover (%)				
Subplot score (% in each):	10	10	5	20	20	3	0	25	10	25	5	0	0	5	0	0	0	0	5	3
Average of the 5 subplots:	13					12.6					2					1.6				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography + site features that may help in determining PCT and Management Zone (optional)

Morphological Type		Lf Element (A)	Hillslope	Lf Pattern (A)	Low hills	Microrelief	
		Lf Element (B)		Lf Pattern (B)			
Lithology (A)	Alluvial loams and clays	Soil Surface Texture	Medium-fine grained	Soil Colour	Dark brown	Soil Depth	At least 30cm
Lithology (B)							
Slope	20	Aspect	NW	Site Drainage	Good drainage	Distance to nearest water & type	

Plot Disturbance	Severity code	Age code	Observational evidence
Clearing (inc. logging):	Severe	3 to 10 yo	Derived grassland under power easement. Close to boatramp in Lobs Hole, extensive clearing in surrounding area
Cultivation (inc. pasture):			No evidence
Soil erosion:			No evidence
Firewood / CWD removal:			No evidence
Grazing (identify native/stock):	Light	less than 3yo	Rabbit scats present
Fire damage:	Light	3 to 10 yo	Some burnt logs present
Storm damage:			No evidence
Weediness:	Severe	less than 3yo	Blackberry, St Johns Wort and Centorium erthyum present in plot
Other:			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if "top 3"; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
 Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
 Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Survey Name:	Lobs Hole Ravine					
	Date:	04-02-19	Plot ID:	3177	Recorders:	SW, KM

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	Cover	Abund	Voucher	N, E or HTE	Stratum
Tree (TG)	<i>Eucalyptus rubida</i>	10	5	No	N	
Shrub (SG)	<i>Bursaria spinosa</i>	40	30	No	N	
Shrub (SG)	<i>Acacia pravissima</i>	50	100	No	N	
Tree (TG)	<i>Callitris endlicheri</i>	1	1	No	N	
Shrub (SG)	<i>Bossiaea foliosa</i>	70	300	No	N	
Grass & grasslike	<i>Themeda triandra</i>	50	2000	No	N	
Shrub (SG)	<i>Brachyloma daphnoides</i>	10	50	No	N	
Shrub (SG)	<i>Pimelea linifolia</i>	5	200	No	N	
Forb (FG)	<i>Pimelea curviflora</i> var. <i>sericea</i>	2	50	No	N	
	<i>Hypericum perforatum</i>	1	200	No	HTE	
Grass & grasslike	<i>Carex appressa</i>	5	20	No	N	
Other (OG)	<i>Glycine clandestina</i>	1	1	No	N	
Grass & grasslike	<i>Rytidosperma</i> spp.	2	50	No	N	
Forb (FG)	<i>Gonocarpus tetragynus</i>	2	200	No	N	
Forb (FG)	<i>Ranunculus lappaceus</i>	3	50	No	N	
	<i>Centaurium erythraea</i>	10	200	No	E	
Grass & grasslike	<i>Dichelachne rara</i>	10	200	No	N	
	<i>Taraxacum officinale</i>	1	1	No	E	
Forb (FG)	<i>Oxalis perennans</i>	5	100	No	N	
Grass & grasslike	<i>Anthosachne scabra</i>	1	20	No	N	
Shrub (SG)	<i>Tetradlea thymifolia</i>	1	20	No	N	
	<i>Rosa rubiginosa</i>	2	1	No	HTE	
	<i>Rubus anglocandicans</i>	20	50	No	E	
Grass & grasslike	<i>Poa sieberiana</i>	25	500	No	N	
Forb (FG)	<i>Acaena ovina</i>	5	200	No	N	
Grass & grasslike	<i>Lomandra multiflora</i> subsp. <i>Multiflora</i>	2	10	No	N	
Tree (TG)	<i>Eucalyptus robertsonii</i>	2	1	No	N	
Forb (FG)	<i>Chrysocephalum semipapposum</i>	1	50	No	N	
Forb (FG)	<i>Ranunculus collinus</i>	4	20	No	N	
	<i>Centaurium erythraea</i>	3	50	No	E	
Shrub (SG)	<i>Exocarpos strictus</i>	5	5	No	N	

Appendix B

Vegetation integrity assessment – plot data

Table B.1 **Vegetation integrity plot data**

plot	zone	easting	northing	bearing	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to9	funTreeStem10to19	funTreeStem20to29	funTreeStem30to49	funTreeStem50to79	funTreeRegen	funHighThreatExotic
190	55	627370	6044578	300	3	11	5	6	1	2	20.0	29.3	2.5	0.9	0.1	0.6	1	2	88.0	4490.0	0	0	0	0	1	0	0.0
3076	55	626306	6039139	250	3	16	5	5	0	2	54.0	184.0	41.0	8.0	0.0	7.0	0	1	86.0	22.0	1	1	1	1	0	1	0.0
76	55	625308	6039767	160	3	13	10	18	0	3	30.7	21.2	6.3	9.3	0.0	0.3	0	1	42.0	28.0	0	0	0	1	1	0	0.2
76	55	625308	6039767	160	3	13	10	18	0	3	30.7	21.2	6.3	9.3	0.0	0.3	0	1	42.0	28.0	0	0	0	1	1	0	0.2
192	55	627959	6045557	160	3	13	5	12	0	3	25.5	38.8	16.5	2.4	0.0	0.4	1	5	87.0	30.0	0	0	0	0	1	0	0.0
192	55	627959	6045557	160	3	13	5	12	0	3	25.5	38.8	16.5	2.4	0.0	0.4	1	5	87.0	30.0	0	0	0	0	1	0	0.0
2119	55	626682	6036780	350	2	3	6	8	0	0	65.0	41.0	107.0	16.0	0.0	0.0	1	0	25.4	3.0	0	1	0	0	0	1	15.0
2119	55	626682	6036780	350	2	3	6	8	0	0	65.0	41.0	107.0	16.0	0.0	0.0	1	0	25.4	3.0	0	1	0	0	0	1	15.0
194	55	625172	6036524	180	5	16	12	21	1	3	48.3	53.4	27.2	3.6	25.0	0.4	0	4	83.0	111.0	1	1	1	1	1	0	7.1
1018	55	627137	6037935	330	3	8	7	1	0	0	47.0	6.2	61.4	0.1	0.0	0.0	1	0	79.6	54.0	1	1	1	1	1	1	25.5
97	55	627961	6038787	20	2	14	8	4	0	0	30.0	43.6	14.6	0.4	0.0	0.0	2	2	90.0	65.0	1	1	1	1	1	1	75.5
88	55	625982	6039029	204	0	0	3	3	0	1	0.0	0.0	62.1	0.3	0.0	0.1	0	0	13.0	0.0	1	1	0	0	0	1	21.1
108	55	626424	6038732	308	3	6	6	5	0	0	43.0	65.6	21.4	0.6	0.0	0.0	1	1	69.0	23.0	1	1	1	1	0	1	7.2
143	55	627654	6038149	20	2	13	5	7	1	1	35.0	132.7	20.5	0.8	0.6	0.1	1	0	50.0	12.0	1	1	1	1	1	1	16.3
1007	55	626075	6038950	182	1	4	6	0	0	0	1.0	81.3	5.4	0.0	0.0	0.0	0	0	86.0	2.0	1	1	1	0	0	0	10.1
201	55	643222	6048793	148	1	2	5	20	0	0	2.0	0.5	53.6	2.5	0.0	0.0	0	0	13.0	0.0	1	0	0	0	0	1	0.1
1015	55	628254	6038817	105	3	15	6	3	0	4	32.0	94.3	9.2	0.4	0.0	0.4	1	1	87.0	31.0	1	1	1	1	1	1	0.0
173	55	627163	6033834	84	3	4	0	2	1	0	4.0	8.2	0.0	0.2	1.0	0.0	0	0	22.0	17.0	1	0	1	0	0	1	0.1

Table B.1 **Vegetation integrity plot data**

plot	zone	easting	northing	bearing	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to9	funTreeStem10to19	funTreeStem20to29	funTreeStem30to49	funTreeStem50to79	funTreeRegen	funHighThreatExotic
3177	55	625074	6040198	318	3	7	7	7	0	1	13.0	181.0	95.0	22.0	0.0	1.0	0	0	13.0	0.0	1	0	0	0	0	1	3.0
2084	55	625304	6039603	155	3	8	8	2	1	0	50.0	146.0	24.0	3.0	1.0	0.0	0	0	27.0	111.0	1	1	1	1	0	0	5.0
3005	55	624667	6040620	125	2	13	2	3	0	1	58.0	182.0	40.0	6.0	0.0	4.0	0	0	32.0	6.0	1	1	1	0	0	1	0.0
188	55	627887	6038243	190	1	13	4	5	0	1	35.0	119.0	10.2	1.4	0.0	0.2	0	4	79.0	48.0	1	1	1	1	0	1	0.0
218	55	625998	6038194	318	2	14	5	9	1	1	0.2	85.6	3.6	3.3	0.2	1.0	0	0	20.0	0.0	1	1	0	0	0	1	0.5
1043	55	625081	6039931	59	2	7	8	10	0	1	21.0	54.3	11.8	1.0	0.0	0.1	0	0	51.0	7.0	1	1	1	1	0	0	3.1
1019	55	627363	6032066	281	3	10	5	19	0	2	65.0	13.4	62.7	27.1	0.0	1.2	5	3	76.0	48.0	1	1	1	1	1	1	0.0
1019	55	627363	6032066	281	3	10	5	19	0	2	65.0	13.4	62.7	27.1	0.0	1.2	5	3	76.0	48.0	1	1	1	1	1	1	0.0
164	55	649063	6037391	117	1	3	8	5	0	0	2.0	27.2	23.5	2.1	0.0	0.0	0	0	9.0	0.0	1	1	1	0	0	1	0.7
2166	55	630058	6039372	196	3	17	6	12	0	2	19.2	18.1	7.1	1.9	0.0	0.5	3	4	88.0	66.0	1	1	1	1	1	1	0.0
2166	55	630058	6039372	196	3	17	6	12	0	2	19.2	18.1	7.1	1.9	0.0	0.5	3	4	88.0	66.0	1	1	1	1	1	1	0.0

Appendix C

Fauna survey effort summary

Table C.1 **Fauna survey effort**

Survey type	Site name	Location	Surveyors	Start date	End date	Start time	End time	Total effort
Bird surveys	Lobs Hole Ravine		LH	05-12-17	05-12-17	9:40	10:40	1:00
Bird surveys	Lobs Hole Ravine		GM	05-12-17	05-12-17	9:50	10:50	1:00
Bird surveys	Wallace Creek		GM & LH	05-12-17	05-12-17	12:15	13:15	1:00
Bird surveys	Lobs Hole		DJ & AR	21-01-18	21-01-18	14:40	15:40	1:00
Bird surveys	Lobs Hole		DJ & AR	21-01-18	21-01-18	16:40	17:40	1:00
Bird surveys	Lobs Hole Ravine		GM & CK	07-02-18	07-02-18	7:25	8:25	1:00
Bird surveys	Lobs Hole Ravine		GM & CK	07-02-18	07-02-18	9:45	10:45	1:00
Bird surveys	Talbingo	BS1	GD & DK	16-10-18	16-10-18	8:08	9:08	1:00
Bird surveys	Talbingo	BS2	GD & DK	16-10-18	16-10-18	9:36	10:37	1:01
Bird surveys	Talbingo	BS3	GD & DK	16-10-18	16-10-18	10:48	11:48	1:00
Bird surveys	Talbingo	BS4	GD & DK	16-10-18	16-10-18	12:44	13:44	1:00
Bird surveys	Talbingo	BS5	GD & DK	16-10-18	16-10-18	13:52	14:52	1:00
Bird surveys	Lobs Hole Ravine rd	BS13	CK, BR	04-11-18	04-11-18	13:16	14:20	1:04
Bird surveys	Lobs Hole Ravine rd	BS14	BR, CK, JB	05-11-18	05-11-18	10:45	13:39	2:54
Bird surveys	Lobs Hole Ravine rd	BS10	JB, DJ	29-11-18	29-11-18	10:55	11:40	0:45
Bird surveys	Lobs Hole Ravine rd	BS11	JB, DJ	29-11-18	29-11-18	8:26	9:30	1:04
Bird surveys	Lobs Hole Ravine rd	BS12	JB, DJ	29-11-18	29-11-18	9:40	10:29	0:49
Bird surveys	Lobs Hole Ravine rd	BS13	JB, DJ	29-11-18	29-11-18	14:11	15:34	1:23
Bird surveys	Lobs Hole Ravine rd	BS11	EL, AR	15-01-19	15-01-19	17:40	19:00	1:20
Bird surveys	Lobs Hole Ravine rd	BS12	AS, BR	15-01-19	15-01-19	17:45	18:45	1:00
Bird surveys	Lobs Hole Ravine rd	BS9	EL, AR	16-01-19	16-01-19	12:18	13:20	1:02
Bird surveys	Lobs Hole Ravine rd	BS10	AS, BR	16-01-19	16-01-19	12:30	13:45	1:15
Bird surveys	Lobs Hole Ravine rd	BS13	BR, AS	16-01-19	16-01-19	9:07	11:07	2:00
Bird surveys	Lobs Hole Ravine rd	BS14	EL, AR	16-01-19	16-01-19	9:21	11:25	2:04

Table C.1 **Fauna survey effort**

Survey type	Site name	Location	Surveyors	Start date	End date	Start time	End time	Total effort
Bird surveys	Lobs Hole Ravine rd	BS14	CK, IC	20-01-19	20-01-19	14:20	15:40	1:20
Bird surveys	Lobs Hole Ravine rd	BS11	JW, GS	05-02-19	05-02-19	17:01	17:37	0:36
Bird surveys	Lobs Hole Ravine rd	BS12	JW, GS	05-02-19	05-02-19	16:11	16:55	0:44
Bird surveys	Lobs Hole Ravine rd	BS10	JB, DF	14-02-19	14-02-19	13:52	14:52	1:00
Bird surveys	Lobs Hole Ravine rd	BS27	CW, DK	12-04-19	12-04-19	10:50	11:50	1:00
Owl surveys	Lobs Hole Ravine	LHRR1	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR2	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR3	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR4	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR5	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR6	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR7	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR8	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR9	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR10	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR11	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR12	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR13	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR14	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR15	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR16	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR17	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR18	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR19	JB & DK	07-05-18	20-06-19			8

Table C.1 **Fauna survey effort**

Survey type	Site name	Location	Surveyors	Start date	End date	Start time	End time	Total effort
Owl surveys	Lobs Hole Ravine	LHRR20	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR21	JB & DK	07-05-18	20-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR22	JB & DK	16-06-19	26-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR23	JB & DK	16-06-19	26-06-19			8
Owl surveys	Lobs Hole Ravine	LHRR24	JB & DK	16-06-19	26-06-19			8
Arboreal trapping	Lobs Hole Ravine	TA02	GM & LH	04-12-17	08-12-17			4
Arboreal trapping	Lobs Hole	TAT01	NG & ED	12-12-17	16-12-17			4
Arboreal trapping	Talbingo Reservoir (south of boat ramp)	TAT02	SW, DJ & KS	17-03-18	22-03-18			4
Arboreal trapping	Lobs Hole Ravine Road	TAT06	NG & ED	12-12-17	16-12-17			4
Arboreal trapping	Yarrangobilly River	TAT08	SW, DJ & KS	17-03-18	22-03-18			4
Arboreal trapping	Link Rd	TAT09	SW, DJ & KS	17-03-18	22-03-18			4
Arboreal trapping	Lobs Hole Ravine rd	TT-10	CK, GM	14-10-18	18-10-18			4
Arboreal trapping	Lobs Hole Ravine rd	TT-11	CK, GM	14-10-18	18-10-18			4
Arboreal trapping	Lobs Hole Ravine rd	TT-12	CK, GM	14-10-18	18-10-18			4
Arboreal trapping	Lobs Hole Ravine rd	TT-5	DJ, KS	12-10-18	16-10-18			4
Arboreal trapping	Lobs Hole Ravine rd	TT-6	DJ, KS	12-10-18	16-10-18			4
Arboreal trapping	Lobs Hole Ravine rd	TT-7	DJ, KS	12-10-18	16-10-18			4
Arboreal trapping	Lobs Hole Ravine rd	TT-8	DJ, KS	12-10-18	16-10-18			4
Arboreal trapping	Lobs Hole Ravine rd	TT-9	JB, AS	16-03-19	20-03-19			4
Arboreal trapping	Talbingo Intake	TAT07	SW, DJ & KS	17-03-18	22-03-18			4
Arboreal trapping	Lobs Hole Ravine, Wallaces creek	TT-53	DK, CW	09-04-19	13-04-19			4
Arboreal trapping	Lobs Hole Ravine	TT-55	DK, CW	09-04-19	13-04-19			4

Table C.1 Fauna survey effort

Survey type	Site name	Location	Surveyors	Start date	End date	Start time	End time	Total effort
Arboreal trapping	Lobs Hole Ravine	TT-57	DK, CW	09-04-19	13-04-19			4
Arboreal trapping	Lobs Hole Ravine	TT-58	DK, CW	10-04-19	14-04-19			4
Spotlighting	Wallace Creek		GM & LH	13-12-17	13-12-17	21:00	23:00	2:00
Spotlighting	Yarrangobilly River		GM & LH	13-12-17	14-12-17	23:50	1:50	2:00
Spotlighting	Lobs Hole Ravine		GM & LH	14-12-17	14-12-17	2:30	4:30	2:00
Spotlighting	Lobs Hole Ravine		GM & LH	25-01-18	25-01-18	0:45	1:45	1:00
Spotlighting	Lobs Hole Ravine		AR & DL	27-01-18	27-01-18	1:45	2:30	0:45
Spotlighting	Lobs Hole Ravine		AR & DL	28-01-18	28-01-18	1:05	2:05	1:00
Spotlighting	Lobs Hole Ravine		AR & ACM	29-01-18	29-01-18	21:00	22:30	1:30
Spotlighting	Lobs Hole Ravine		AR & ACM	29-01-18	30-01-18	22:55	0:05	1:10
Spotlighting	Lobs Hole Ravine		AR & ACM	30-01-18	30-01-18	0:40	1:55	1:15
Spotlighting	Lobs Hole Ravine		GM & CK	08-02-18	08-02-18	21:00	22:00	1:00
Spotlighting	Wallace Creek		SW & DJ	19-03-18	20-03-18	23:28	1:00	1:32
Spotlighting	Proposed campsite		SW & DJ	20-03-18	20-03-18	2:30	3:30	1:00
Spotlighting	Proposed campsite		SW & DJ	20-03-18	20-03-18	3:45	4:05	0:20
Spotlighting	Lobs Hole Ravine		SW & KS	23-03-18	24-03-18	23:30	1:00	1:30
Spotlighting	Lobs Hole Ravine		SW & KS	23-03-18	23-03-18	22:00	23:00	1:00
Spotlighting	Lobs Hole Ravine rd	SL-13	EL, BR	08-11-18	08-11-18	20:33	21:53	1:20
Spotlighting	Yarrangobilly River	SL-10	JB, JW	15-12-18	16-12-18	23:21	0:22	1:01
Spotlighting	Yarrangobilly River	SL-10	JB, JW	16-12-18	16-12-18	21:55	0:14	2:19
Spotlighting	Mines trail	SL-12	JB, JW	16-12-18	16-12-18	0:20	0:58	0:38
Spotlighting	Mines trail	SL-12	JB, JW	17-12-18	17-12-18	0:20	0:58	0:38
Spotlighting	Yarrangobilly River	SL-10	JB, JW	18-12-18	18-12-18	20:55	21:46	0:51
Spotlighting	Lobs Hole Ravine rd	SL-11	JB, JW	20-12-18	20-12-18	21:12	22:02	0:50

Table C.1 Fauna survey effort

Survey type	Site name	Location	Surveyors	Start date	End date	Start time	End time	Total effort
Spotlighting	Mines trail	SL-12	JB, JW	09-01-19	09-01-19	1:02	1:42	0:40
Spotlighting	Lobs Hole Ravine rd	SL-11	JB, JW	10-01-19	10-01-19	0:44	1:26	0:42
Spotlighting	Lobs Hole Ravine rd	SL-11	JB, JW	11-01-19	11-01-19	0:11	1:30	1:19
Spotlighting	Lobs Hole Ravine rd	SL-13	JB, DF	10-02-19	10-02-19	21:53	23:25	1:32
Spotlighting	Lobs Hole Ravine rd	SL-14	JB, JD	10-02-19	11-02-19	23:27	0:39	1:12
Spotlighting	Lobs Hole Ravine rd	SL-13	AR, EL	20-02-19	21-02-19	22:40	0:20	1:40
Spotlighting	Lobs Hole Ravine rd	SL-14	AR, EL	20-02-19	20-02-19	0:20	2:35	2:15
Spotlighting	Lobs Hole Ravine rd	SL-14	JB, DK	15-05-19	15-05-19	17:40	19:59	2:19
Spotlighting	Lobs Hole Ravine rd	SL-30	JB, DK	15-05-19	15-05-19	23:14	23:57	0:43
Spotlighting	Lobs Hole Ravine rd	SL-31	JB, DK	15-05-19	15-05-19	21:16	21:56	0:40
Spotlighting	Lobs Hole Ravine rd	SL-32	JB, DK	15-05-19	15-05-19	20:32	20:55	0:23
Spotlighting	Lobs Hole Ravine rd	SL-30	JB, DK	17-06-19	17-06-19	18:18	18:56	0:38
Spotlighting	Lobs Hole Ravine rd	SL-31	JB, DK	17-06-19	17-06-19	20:52	21:13	0:21
Spotlighting	Lobs Hole Ravine rd	SL-32	JB, DK	17-06-19	17-06-19	19:01	19:29	0:28
Spotlighting	Lobs Hole Ravine rd	SL-30	JB, DK	19-06-19	19-06-19	21:36	22:17	0:41
Spotlighting	Lobs Hole Ravine rd	SL-31	JB, DK	19-06-19	19-06-19	18:33	19:13	0:40
Spotlighting	Lobs Hole Ravine rd	SL-32	JB, DK	19-06-19	19-06-19	20:48	21:26	0:38
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW10	CW & DK	02-05-18	02-05-18	Upper Lob's Hole Ravine rd	EW10	CW & DK
Koala SAT surveys	Lobs Hole Ravine rd	EW100	CK & PF	16-05-18	16-05-18	Lobs Hole Ravine rd	EW100	CK & PF
Koala SAT surveys	Lobs Hole Ravine rd	EW102	CK & PF	15-05-18	15-05-18	Lobs Hole Ravine rd	EW102	CK & PF
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW12	CW & DK	02-05-18	02-05-18	Upper Lob's Hole Ravine rd	EW12	CW & DK
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW130	DK & CW	03-05-18	03-05-18	Upper Lob's Hole Ravine rd	EW130	DK & CW

Table C.1 Fauna survey effort

Survey type	Site name	Location	Surveyors	Start date	End date	Start time	End time	Total effort
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW132	DK & CW	03-05-18	03-05-18	Upper Lob's Hole Ravine rd	EW132	DK & CW
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW136	DK & CW	03-05-18	03-05-18	Upper Lob's Hole Ravine rd	EW136	DK & CW
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW139	DK & CW	03-05-18	03-05-18	Upper Lob's Hole Ravine rd	EW139	DK & CW
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW15	CW & DK	02-05-18	02-05-18	Upper Lob's Hole Ravine rd	EW15	CW & DK
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW16	CW & DK	01-05-18	01-05-18	Upper Lob's Hole Ravine rd	EW16	CW & DK
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW17	CW & DK	01-05-18	01-05-18	Upper Lob's Hole Ravine rd	EW17	CW & DK
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW18	CW & DK	01-05-18	01-05-18	Upper Lob's Hole Ravine rd	EW18	CW & DK
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW21	CW & DK	01-05-18	01-05-18	Upper Lob's Hole Ravine rd	EW21	CW & DK
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW22	CW & DK	01-05-18	01-05-18	Upper Lob's Hole Ravine rd	EW22	CW & DK
Koala SAT surveys	Yarrangobilly River	EW41	CK & PF	18-05-18	18-05-18	Yarrangobilly River	EW41	CK & PF
Koala SAT surveys	Yarrangobilly River	EW42	CK & PF	17-05-18	17-05-18	Yarrangobilly River	EW42	CK & PF
Koala SAT surveys	Yarrangobilly River	EW43	CK & PF	17-05-18	17-05-18	Yarrangobilly River	EW43	CK & PF
Koala SAT surveys	Yarrangobilly River	EW45	CK & PF	17-05-18	17-05-18	Yarrangobilly River	EW45	CK & PF
Koala SAT surveys	Yarrangobilly River	EW46	CK & PF	18-05-18	18-05-18	Yarrangobilly River	EW46	CK & PF
Koala SAT surveys	Yarrangobilly River	EW48	CK & PF	17-05-18	17-05-18	Yarrangobilly River	EW48	CK & PF
Koala SAT surveys	Lobs Hole Ravine rd	EW49	CK & PF	17-05-18	17-05-18	Lobs Hole Ravine rd	EW49	CK & PF
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW5	CW & DK	03-05-18	03-05-18	Upper Lob's Hole Ravine rd	EW5	CW & DK

Table C.1 Fauna survey effort

Survey type	Site name	Location	Surveyors	Start date	End date	Start time	End time	Total effort
Koala SAT surveys	Lobs Hole Ravine rd	EW50	CK & PF	17-05-18	17-05-18	Lobs Hole Ravine rd	EW50	CK & PF
Koala SAT surveys	Construction camp	EW51	DK & CW	04-05-18	04-05-18	Construction camp	EW51	DK & CW
Koala SAT surveys	Construction camp	EW52	DK & CW	04-05-18	04-05-18	Construction camp	EW52	DK & CW
Koala SAT surveys	Construction camp	EW53	DK & CW	05-05-18	05-05-18	Construction camp	EW53	DK & CW
Koala SAT surveys	Construction camp	EW54	DK & CW	05-05-18	05-05-18	Construction camp	EW54	DK & CW
Koala SAT surveys	Lobs Hole Ravine rd	EW56	CK & PF	17-05-18	17-05-18	Lobs Hole Ravine rd	EW56	CK & PF
Koala SAT surveys	Construction camp	EW57	DK & CW	04-05-18	04-05-18	Construction camp	EW57	DK & CW
Koala SAT surveys	Construction camp	EW58	DK & CW	05-05-18	05-05-18	Construction camp	EW58	DK & CW
Koala SAT surveys	Construction camp	EW59	DK & CW	05-05-18	05-05-18	Construction camp	EW59	DK & CW
Koala SAT surveys	Construction camp	EW62	DK & CW	04-05-18	04-05-18	Construction camp	EW62	DK & CW
Koala SAT surveys	Construction camp	EW63	DK & CW	05-05-18	05-05-18	Construction camp	EW63	DK & CW
Koala SAT surveys	Construction camp	EW64	DK & CW	06-05-18	06-05-18	Construction camp	EW64	DK & CW
Koala SAT surveys	Construction camp	EW69A	DK & CW	06-05-18	06-05-18	Construction camp	EW69A	DK & CW
Koala SAT surveys	Lobs Hole Ravine rd	EW69B	CK & PF	16-05-18	16-05-18	Lobs Hole Ravine rd	EW69B	CK & PF
Koala SAT surveys	Construction camp	EW70	DK & CW	06-05-18	06-05-18	Construction camp	EW70	DK & CW
Koala SAT surveys	Construction camp	EW71A	DK & CW	06-05-18	06-05-18	Construction camp	EW71A	DK & CW
Koala SAT surveys	Lobs Hole Ravine rd	EW71B	CK & PF	16-05-18	16-05-18	Lobs Hole Ravine rd	EW71B	CK & PF
Koala SAT surveys	Construction camp	EW72	DK & CW	06-05-18	06-05-18	Construction camp	EW72	DK & CW
Koala SAT surveys	Construction camp	EW77A	DK & CW	06-05-18	06-05-18	Construction camp	EW77A	DK & CW
Koala SAT surveys	Lobs Hole Ravine rd	EW77B	CK & PF	16-05-18	16-05-18	Lobs Hole Ravine rd	EW77B	CK & PF
Koala SAT surveys	Lobs Hole Ravine rd	EW78	CK & PF	17-05-18	17-05-18	Lobs Hole Ravine rd	EW78	CK & PF
Koala SAT surveys	Upper Lob's Hole Ravine rd	EW8	CW & DK	03-05-18	03-05-18	Upper Lob's Hole Ravine rd	EW8	CW & DK
Koala SAT surveys	Lobs Hole Ravine rd	EW86	CK & PF	16-05-18	16-05-18	Lobs Hole Ravine rd	EW86	CK & PF

Table C.1 **Fauna survey effort**

Survey type	Site name	Location	Surveyors	Start date	End date	Start time	End time	Total effort
Koala SAT surveys	Lobs Hole Ravine rd	EW87	CK & PF	16-05-18	16-05-18	Lobs Hole Ravine rd	EW87	CK & PF
Koala SAT surveys	Lobs Hole Ravine rd	EW94	CK & PF	15-05-18	15-05-18	Lobs Hole Ravine rd	EW94	CK & PF
Koala SAT surveys	Lobs Hole Ravine rd	EW95	CK & PF	17-05-18	17-05-18	Lobs Hole Ravine rd	EW95	CK & PF
Koala SAT surveys	Lobs Hole Ravine rd	EW97	CK & PF	15-05-18	15-05-18	Lobs Hole Ravine rd	EW97	CK & PF
Koala SAT surveys	Lobs Hole Ravine rd	EW98	CK & PF	15-05-18	15-05-18	Lobs Hole Ravine rd	EW98	CK & PF
Koala SAT surveys	Lobs Hole Ravine rd	EW99	CK & PF	15-05-18	15-05-18	Lobs Hole Ravine rd	EW99	CK & PF
Koala Songmeters	Lobs Hole Ravine rd	KSM2	DJ, KS	16-10-18	17-12-18			62
Koala Songmeters	Lobs Hole Ravine rd	KSM3	DJ, KS	16-10-18	17-12-18			62
Koala Songmeters	Wallaces creek trail	KSM4	DJ, KS	16-10-18	17-12-18			62

Appendix D

Targeted survey weather conditions

Table D.1 Targeted survey weather conditions

Date	Min Temp (oC)	Max Temp (oC)	Rain (mm)	Max wind direction	Max wind speed (km/hr)
05-12-17	4.7	10.6	22.6	ESE	70
12-12-17	12.2	21.8	0	NW	37
13-12-17	14.7	23.8	0	W	50
14-12-17	17.1	21.9	0	NW	57
15-12-17	12.9	20.6	1.4	W	41
16-12-17	13.6	21.9	0	WNW	35
21-01-18	20.1	27	0	NNE	48
25-01-18	15.5	21.8	0.8	NNW	30
27-01-18	15.2	22	0	E	46
28-01-18	14.8	24.9	0	ENE	39
30-01-18	17	18.6	0	WNW	46
07-02-18	13.1	24.2	0	WNW	39
08-02-18	16.8	26.5	0	E	43
23-03-18	14.2	23.3	0	WNW	31
24-03-18	8.5	15	0	NNW	39
06-05-18	3.1	11	0	SSW	30
07-05-18	5.2	11.3	0	WNW	52
08-05-18	5.8	12.4	0	WSW	31
09-05-18	5.6	10.2	0	NW	41
10-05-18	2.3	2.4	1	W	72
16-05-18	-0.3	7.3	0	ESE	50
12-10-18	0.2	10.3	0	ESE	76
13-10-18	1.4	14.4	0	ESE	65
14-10-18	5.5	14.2	0	NE	54
15-10-18	5.8	17.2	0	NE	52
16-10-18	7.3	19.1	0	NE	52
17-10-18	8.7	11.9	5.2	NW	41
18-10-18	7.6	13.3	14.8	NW	50
19-10-18	7.1	17.2	0	NNW	31
20-10-18	9.4	15.6	0	WNW	74
21-10-18	1.4	12.6	1.2	ESE	33
22-10-18	6.5	16.3	0	W	31
23-10-18	8.8	19.3	0	WNW	59
24-10-18	3.4	15.5	0	ESE	43
25-10-18	3.2	14.4	0	E	35
26-10-18	5.3	15.1	0	WSW	35
27-10-18	7.9	15	0	W	65

Table D.1 Targeted survey weather conditions

Date	Min Temp (oC)	Max Temp (oC)	Rain (mm)	Max wind direction	Max wind speed (km/hr)
28-10-18	1.5	15.7	0	WNW	26
29-10-18	7.4	17.3	0	WSW	30
30-10-18	7.4	17.5	0	W	43
31-10-18	10.1	20.5	0	SW	48
01-11-18	13.1	24.3	0	NNW	61
02-11-18	14.9	20.8	0	NNW	83
03-11-18	5.3	14.5	1.8	W	67
04-11-18	5.6	17.2	0	WSW	39
05-11-18	9.8	15.9	0	NNW	52
06-11-18	11.5	12.9	8	WNW	70
07-11-18	9.4	9.7	66.2	WNW	65
08-11-18	-1.3	8.5	10.6	W	35
09-11-18	1.3	9.9	0	WNW	39
10-11-18	4.1	13.8	0	W	37
11-11-18	7.7	17	0	ESE	35
12-11-18	8.6	19.4	0	W	31
13-11-18	13.5	16.9	0	N	39
14-11-18	9.8	14	8.4	NNW	50
15-11-18	9.9	16.7	16.6	ESE	54
16-11-18	2.7	15.4	0	ESE	46
17-11-18	5.6	14.8	0	ESE	63
18-11-18	3.6	17.5	0	ESE	65
19-11-18	6.3	17.8	0	E	30
20-11-18	10.8	18.3	0	N	57
21-11-18	10.8	12	24.2	W	63
22-11-18	-0.4	2.5	34	W	91
23-11-18	-0.1	4.2	33.2	WNW	70
24-11-18	1.2	8.6	61.4	SW	46
25-11-18	3	11.3	3	WSW	37
26-11-18	3.7	15.5	0	ESE	50
27-11-18	6.1	15.7	0	ENE	35
28-11-18	7.6	10.6	1	ESE	76
29-11-18	4.8	14.3	0.2	ESE	63
30-11-18	6.7	16	0.6	WNW	50
01-12-18	8.7	19.7	0	WNW	44
02-12-18	11.2	11.3	0.2	WNW	76
03-12-18	2.4	11.7	9	W	70

Table D.1 Targeted survey weather conditions

Date	Min Temp (oC)	Max Temp (oC)	Rain (mm)	Max wind direction	Max wind speed (km/hr)
04-12-18	4.3	18	0	ESE	48
05-12-18	6.8	19	0	E	43
06-12-18	9.6	21.2	0	WNW	35
07-12-18	14.2	23.3	0	WNW	31
08-12-18	15.6	23.5	0	SE	54
09-12-18	15.9	21.2	0	ESE	43
10-12-18	9.8	20.5	13.2	ESE	43
11-12-18	10.3	20.3	0	NE	41
12-12-18	11.3	20.8	0	NE	37
13-12-18	11.3	16.4	16	ENE	74
14-12-18	9.6	17.8	20.2	E	56
15-12-18	10.9	17.1	8.8	NE	54
16-12-18	10.9	15.1	0	N	37
17-12-18	10.3	20	0.4	NW	39
20-12-18	14.4	22.9	0	E	41
09-01-19	11.5	20.8	19.8	W	59
10-01-19	9.3	21.9	0	E	46
11-01-19	12.2	21.2	0	SW	57
15-01-19	20.3	30.6	0	ESE	44
16-01-19	20.8	32.3	0	ESE	63
20-01-19	14.1	26.1	0	ESE	57
05-02-19	13.3	18.8	18.6		
10-02-19	2.9	16.2	2.8	SW	39
11-02-19	7.1	18.7	0	W	50
20-02-19	7.1	20.2	0	ESE	35
21-02-19	8.6	21.5	0	ESE	54
16-03-19	8.5	18.2	0	ESE	74
17-03-19	9.9	16.8	0	ESE	74
18-03-19	8.7	15.5	0.2	SE	67
19-03-19	11.3	19.2	0.2	ESE	43
20-03-19	11.8	19.8	7.6	ESE	41
12-04-19	6.1	13.5	0	WNW	33
15-05-19	4.9	11.8	0	N	17
16-06-19	0.9	6.5	0	ESE	39
17-06-19	-0.4	7.8	0	ESE	50
18-06-19	1.6	4.6	0	WNW	56
19-06-19	-3	2.5	2.4	NNW	20

Table D.1 Targeted survey weather conditions

Date	Min Temp (oC)	Max Temp (oC)	Rain (mm)	Max wind direction	Max wind speed (km/hr)
20-06-19	-3.5	2.6	0	N	31
21-06-19	-4.7	2.9	0	SE	50
22-06-19	-3.3	3.8	0	SE	57
23-06-19	-2.6	2.6	0	ESE	70
24-06-19	-2	6.6	0	ESE	70
25-06-19	-0.4	8.9	0	ESE	46
26-06-19	1.2	9.7	0	ESE	33

Appendix E

Credit Report

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00015116/BAAS17037/19/00015118	Snowy Hydro - MOD1 Dangerous trees	04/07/2019
Assessor Name	Report Created	BAM Data version *
Nathan Garvey	23/08/2019	12
Assessor Number	BAM Case Status	Date Finalised
BAAS17037	Open	To be finalised
Assessment Revision	Assessment Type	
0	Major Projects	

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAI	Ecosystem credits
Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion								
18	643_Low	13.0	0.1	0.25	Moderate Sensitivity to Potential Gain	1.25		0
							Subtotal	0

BAM Credit Summary Report

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								
16	303_Other	40.2	0.3	0.25	High Sensitivity to Potential Gain	2.50		8
							Subtotal	8
Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion								
1	296_High	55.3	0.1	0.25	High Sensitivity to Potential Gain	1.50		2
2	296_Medium	71.9	0.0	0.25	High Sensitivity to Potential Gain	1.50		1
							Subtotal	3
Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion								
19	729_DNG	46.2	1.7	0.25	High Sensitivity to Potential Gain	1.50		29
20	729_High	64.3	4.9	0.25	High Sensitivity to Potential Gain	1.50		119
							Subtotal	148
Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion								
27	953_High	75.7	1.1	0.25	High Sensitivity to Potential Gain	1.50		31
28	953_High_tree	29.8	0.0	0.25	High Sensitivity to Potential Gain	1.50		1
							Subtotal	32
Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion								
21	999_High	63.6	0.6	0.25	High Sensitivity to Potential Gain	1.50		14
22	999_DNG	38.3	0.1	0.25	High Sensitivity to Potential Gain	1.50		1

BAM Credit Summary Report

						Subtotal	15
Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion							
17	311_High	60.9	0.1	0.25	High Sensitivity to Potential Gain	1.50	2
						Subtotal	2
Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment							
3	300_High	49.0	1.5	0.25	High Sensitivity to Potential Gain	1.50	28
4	300_High_tree	20.3	0.1	0.25	High Sensitivity to Potential Gain	1.50	1
5	300_Medium	56.0	0.3	0.25	High Sensitivity to Potential Gain	1.50	7
6	300_Medium_tree	24.8	0.0	0.25	High Sensitivity to Potential Gain	1.50	1
7	300_Other	59.8	0.1	0.25	High Sensitivity to Potential Gain	1.50	2
8	300_Other_tree	21.2	0.0	0.25	High Sensitivity to Potential Gain	1.50	1
9	300_Poor	71.7	0.0	0.25	High Sensitivity to Potential Gain	1.50	1
						Subtotal	41
Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion							
10	302_DNG	64.0	0.3	0.25	High Sensitivity to Potential Gain	1.75	9
11	302_High	70.9	0.0	0.25	High Sensitivity to Potential Gain	1.75	1
12	302_Low	21.2	1.0	0.25	High Sensitivity to Potential Gain	1.75	9
13	302_Medium	65.9	0.0	0.25	High Sensitivity to Potential Gain	1.75	1
14	302_Other	68.3	0.3	0.25	High Sensitivity to Potential Gain	1.75	9

BAM Credit Summary Report

15	302_Poor	26.6	0.0	0.25	High Sensitivity to Potential Gain	1.75		1
							Subtotal	30
Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion								
23	1191_High	47.2	0.5	0.25	High Sensitivity to Potential Gain	2.50		14
							Subtotal	14
Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion								
24	1196_High	95.7	0.6	0.25	High Sensitivity to Potential Gain	1.50		22
25	1196_High_tree	31.1	1.0	0.25	High Sensitivity to Potential Gain	1.50		11
							Subtotal	33
Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion								
26	1224_High	36.2	0.2	0.25	High Sensitivity to Potential Gain	1.50		2
							Subtotal	2
							Total	328

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAI	Species credits
<i>Callocephalon fimbriatum</i> / Gang-gang Cockatoo (Fauna)						
296_High	55.3	0.01	0.25	2	N/A	0
					Subtotal	0
<i>Cercartetus nanus</i> / Eastern Pygmy-possum (Fauna)						
296_High	55.3	0.1	0.25	2	False	3

BAM Credit Summary Report

296_Medium	71.9	0.01	0.25	2	False	0
300_High	49.0	1.51	0.25	2	False	37
300_Medium	56.0	0.33	0.25	2	False	9
300_Other	59.8	0.07	0.25	2	False	2
300_Poor	71.7	0.01	0.25	2	False	0
302_High	70.9	0.03	0.25	2	False	1
302_Medium	65.9	0.01	0.25	2	False	0
302_Other	68.3	0.29	0.25	2	False	10
302_Poor	26.6	0.01	0.25	2	False	0
311_High	60.9	0.09	0.25	2	False	3
729_High	64.3	4.92	0.25	2	False	158
999_High	63.6	0.58	0.25	2	False	18
1196_High	95.7	0.61	0.25	2	False	29
Subtotal						270
<i>Litoria booroolongensis / Booroolong Frog (Fauna)</i>						
300_High	49.0	0.03	0.25	2	False	1
302_High	70.9	0.03	0.25	2	False	1
302_Low	21.2	0.16	0.25	2	False	2
302_Other	68.3	0.21	0.25	2	False	7
729_High	64.3	0.02	0.25	2	False	1
Subtotal						12

BAM Credit Summary Report

<i>Litoria verreauxii alpina / Alpine Tree Frog (Fauna)</i>							
303_Other	40.2	0.01	0.25	2	False		0
1224_High	36.2	0.02	0.25	2	False		0
					Subtotal		0
<i>Pseudomys fumeus / Smoky Mouse (Fauna)</i>							
729_High	64.3	0.1	0.25	3	True		5
953_High	75.7	0.87	0.25	3	True		49
1196_High	95.7	0.6	0.25	3	True		43
					Subtotal		97
<i>Pterostylis foliata / Slender Greenhood (Flora)</i>							
1196_High	N/A	1	0.25	1	N/A		0
					Subtotal		0



A P P E N D I X

D

GEODIVERSITY ASSESSMENTS OF SIGNIFICANCE



ASSESSMENT OF POTENTIAL IMPACTS TO THE RAVINE BLOCK STREAMS FROM EXPLORATORY WORKS MODIFICATION 1, SNOWY 2.0

Prepared by Dr. Alexa Troedson, Consultant Geologist

Final submitted 2 September 2019

1. PURPOSE AND SCOPE OF THIS REPORT

The purpose of this report is to assess potential impacts on the geodiversity values of the Ravine periglacial block streams as a result of proposed modifications to the Exploratory Works (EW) for Snowy 2.0, hereafter described as Modification 1. Modification 1 includes a proposal to undertake additional road widening on the block stream sections of Lobs Hole Ravine Road. This report presents an analysis of the potential impacts of Modification 1 on the block streams and recommendations for managing any impacts so as to minimise any damage and provide benefits to the geodiversity values of the features. A summary of previous geodiversity assessments of the site, observations from a site visit and a map of Ravine area block stream extents are provided for context.

2. PREVIOUS ASSESSMENTS OF THE FEATURES

Previous assessment of the blocks streams was provided for the EW Environmental Impact Statement (EIS) and comprised a geodiversity report prepared by EMM, dated 13 July 2018, and additional assessment provided by Dr Bradley Opdyke in September 2018. Together these reports provide a description of the block streams, outline their geodiversity values and significance, describe the potential impacts of the EW on the features, and provide guidance for the management and amelioration of these impacts, as summarised below.

2.1 Overview of the Ravine block streams

Block streams can form in alpine areas affected by periglacial conditions, where freeze-thaw activity is able to modify the landscape in a significant way. They consist of angular cobbles (6-25 cm diameter) and boulders (>25 cm diameter) that have broken off rock outcrops by frost-shattering, and been transported down-slope in association with interstitial ice. Block streams typically occur on steep slopes in shallow depressions in the landscape. In Australia they are relict features formed when the climate was much colder than present, mostly during the peak of the last ice age (last glacial maximum), between around 22 to 16 thousand years ago.

The Ravine block streams are located in the vicinity of Lobs Hole Ravine Road in northern Kosciuszko National Park (KNP), approximately 7 km from the intersection with Link Road to the south. They occur mostly on the steep, eastern, up-slope side of the road, with the lower reaches of several block streams bisected by the road.

The block streams are distributed in around six zones which are elongate parallel to the steep slope on which they lie. The zones vary in size but are typically 20 m to 40 m across and 100 m to 200 m long. The blocks are composed of dark grey, hard, fine-grained basalt inferred to have been sourced from outcrops of Cenozoic basalt occurring on the ridge-top to the east. The blocks have a typical size range of 20-50 cm.

The block streams are striking landforms, readily viewed from Lobs Hole Ravine Road in a number of locations. They stand out clearly from surrounding thickly forested slopes, being largely unvegetated.

Current impacts on the block streams are confined to the areas where the road bisects the block streams. At these sites, sections of the block streams have been excavated on the upslope side of the road and filling placed below that on the block streams to build up a level road surface. The road dates originally from the late 19th century and is currently a single-lane unpaved road.

2.2 Geodiversity significance of the block streams

Geodiversity is defined as the natural range of geological, geomorphological and soil features, assemblage, systems and processes (Commonwealth of Australia 2002). Guidelines for geodiversity preservation and management within KNP are provided in the KNP Plan of Management 2006 (PoM) and KNP Geodiversity Action Plan 2012-2017 (KGAP). The PoM specifies periglacial features as significant geodiversity features that occur within the park, and periglacial block streams are listed in Schedule 1 of that plan which defines 'Significant Natural and Cultural Features'. The KGAP outlines issues and conservation strategies associated with specific geodiversity features including the Ravine block streams. The block streams are subject to condition assessments every three years in accordance with the KNP Geodiversity Monitoring Program which was initiated in response to issues raised in the KGAP. In summary, the Ravine block streams are seen as significant geodiversity features within KNP.

While not common, periglacial block deposits have been identified in a number of highland areas of southeastern Australia (Slee & Schulmeister 2015). These deposits have regional significance based on their contribution to the understanding of climate conditions at the time of their formation during the last glacial period, which peaked at around 20 thousand years ago. The Ravine block streams have additional significance related to their occurrence within a protected area (KNP) and their potential accessibility to the public for the purposes of geological education.

2.3 Impact of Exploratory Works

In the original approved plan for the Exploratory Works, impacts on the block streams relate to minor widening of Lobs Hole Ravine Road to enable access to Lobs Hole for EW construction traffic. The impact on the block streams was described as being limited to three locations where the features have been bisected previously by Lobs Hole Ravine Road. The works are described as including a road upgrade to allow single lane access for construction traffic, and geophysical and geotechnical investigation within the existing road width (EMM 2018).

The previously proposed road design, as described in Opdyke (2018), involved building a retaining wall on the downslope side anchored into the existing road surface for stabilisation, and building up the road surface vertically enabling slight widening of the road (approximately 2 metres). Impacts on the block streams would include some encroachment on the upslope side, mainly through filling, but disturbance downslope into the block streams would be avoided.

Opdyke (2018) noted that the very angular nature of the rock boulders and cobbles of which the block streams are comprised enables them to interlock and resist movement, even on steep slopes.

He surmised that, as a result, if road works are undertaken carefully and did not cut too deeply, block stream stability should not be compromised.

2.4 Recommendations for management of impacts from Exploratory Works

The prior reports outline a number of recommendations for managing impacts of the Exploratory Works on the block streams in order to minimise or avoid damage to the features, and provide future benefits, as listed below.

1. Minimise earthworks where possible.
2. Implement environmental management measures to control erosion and runoff during and after construction.
3. In the case that upslope sections of the block streams require stabilisation, that open mesh wire fencing is used so that the deposits remain visible for the purposes of public and scientific interpretation. Building a solid wall or spraying concrete on the upslope side should be avoided.
4. Additional covering of the deposits on the downslope side should be avoided where practical.
5. Digging the road deeper into the block streams should be avoided where practical.
6. In relation to design and construction of drainage, consideration should be given to the extremely porous and permeable nature of the block streams and their likely locations overlying minor depressions in the landscape, in particular to ensure build up of water does not occur on the upslope side of the road during heavy rain.
7. Ensure road widening is only done to the width needed to accommodate safe single lane access for construction vehicles.
8. Monitor the effectiveness of environmental controls during construction.
9. Provide signage in a nearby suitably widened area explaining the nature and significance of the periglacial block streams.

The reports conclude that the road could be widened and strengthened with only minor additional impacts to the block streams and associated landscape if the above recommendations are followed, and that these works potentially provide an opportunity to enhance the value of the site within KNP and provide a public education benefit if subsequently developed as a geoheritage site.

3. SITE VISIT, MAPPING AND OBSERVATIONS

3.1 Site visit

A site visit was undertaken by the author on 30 May 2019 facilitated by EMM and Snowy Hydro Pty Ltd. Conditions were snowy, but generally this did not hinder visibility of the features. The purpose of the site visit was to make observations of block stream characteristics, extent and condition, and enable visualisation of potential impacts of the proposed road works on the features. Field activities included examination of features in the vicinity of the road, note taking, recording of waypoints at observation sites using a hand-held GPS unit, and photography. These activities were confined largely to roadside areas where the features could be examined most easily and future impacts are likely to be greatest.

3.2 Block stream mapping

Figure 1 shows a map of inferred block stream extents. This map is modified from an earlier version which was based on aerial image interpretation and vegetation mapping and used in the previous geodiversity reports. Changes include recognition of additional block streams and expanded extents of some previously mapped block streams, and were based on additional remote interpretation of aerial and DEM imagery, ground-truthing of approximate locations of some road/block stream intersections during the site visit, and field mapping by SMEC geologists. It is possible that some limited additional areas of block stream remain undetected, in particular where vegetation obscures remote interpretation. The mapped boundaries along the road corridor are inferred from the DEM and coincide with the base of the existing road batter on the downslope side and the road surface edge on the upslope.

Five block streams, labelled A to E, are intersected by the road (Figure 1). One additional block stream, labelled B2, appears to terminate just upslope of the road. The inferred extent of ridge-capping basalt from which the blocks were sourced is also shown in Figure 1.

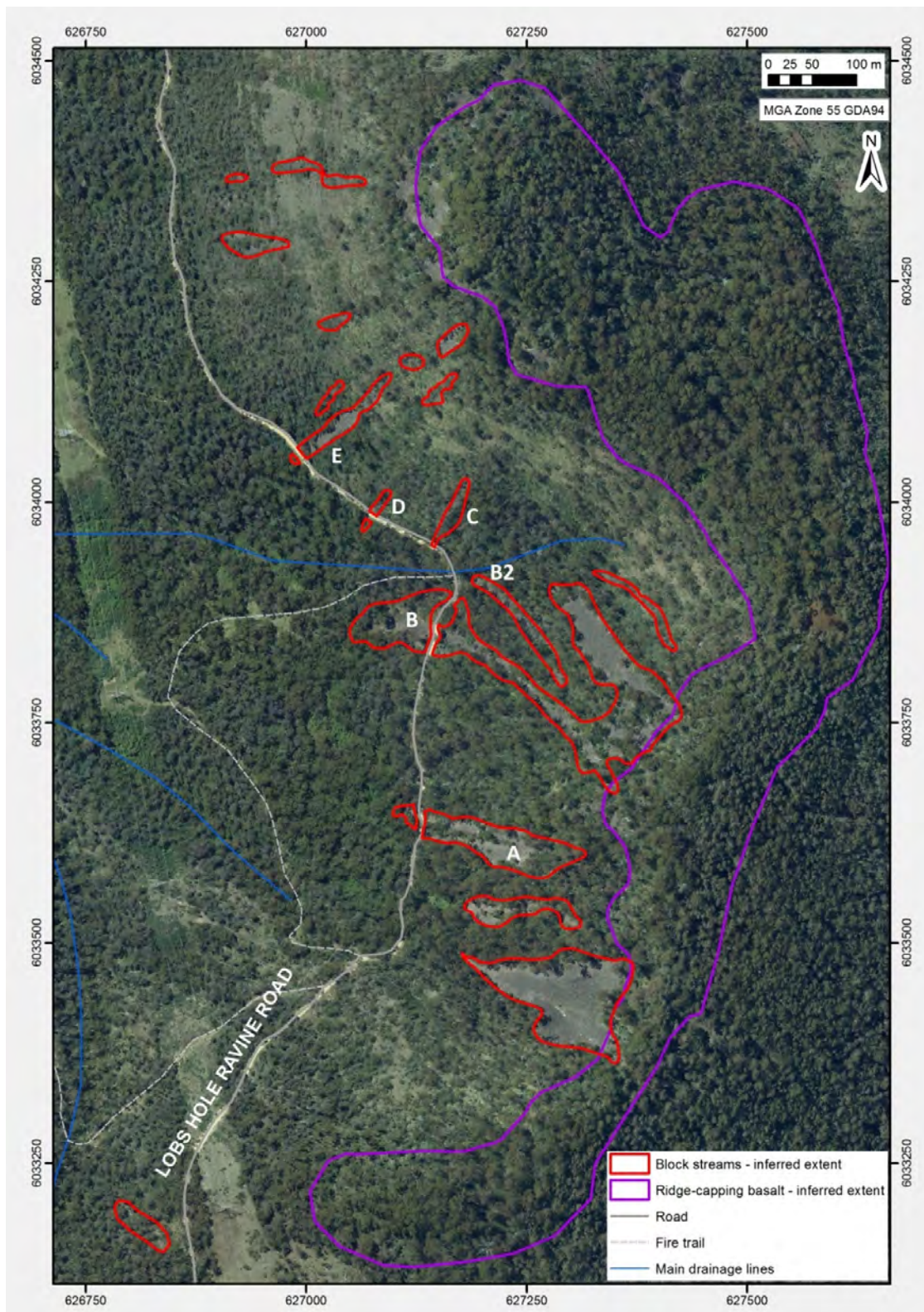


Figure 1. Aerial image showing inferred extents of periglacial block streams adjacent to Lobs Hole Ravine Road. Five block streams, labelled A to E, are intersected by the road. Block stream B2 appears to stop just short of the road. The approximate extent of ridge-capping basalt from which the blocks were sourced is also shown.

3.3 Field observations

Key field observations are listed below and field photos are provided at the end of this report.

1. As documented previously, the deposits comprise interlocking basalt blocks in the cobble to boulder size range, which are mainly sub-angular to sub-rounded.
2. Where they are unvegetated the block streams are very striking features (e.g. Photo 1), clearly visible in aerial imagery. There are, however, other areas of block stream which are vegetated, particularly around the edges of the features, making the full extent of the deposits hard to determine precisely from aerial imagery.
3. Block Streams D and E may extend further downslope of the road beyond what is mapped in Figure 1. These sites are very steep and hard to access with thick vegetation cover obscuring the view downslope below the road (e.g. Photo 2). In contrast, Block streams A and B have substantial unvegetated expanses below the road, with a shallower gradient.
4. On the upslope side of the road, Block Stream B is not continuous but has two parts separated by a small ridge of block-free colluvium and/or residuum.
5. The mapped block stream extents are confined to areas of matrix-free blocks (i.e. boulders and cobbles with no interstitial finer-grained material). Basalt blocks buried in the upper soil profile to a variable depth, but in places exceeding 1 m deep, were observed in some road cuttings both underlying matrix-free blocks and adjacent to some block stream edges where surficial matrix-free blocks are absent (Photos 3 & 4). The buried blocks may represent a lower layer of the block stream structure, or (less likely) may be older colluvial slope deposits. It is unclear whether matrix-free blocks are invariably underlain by such deposits as it is only possible to observe the substrate underlying the block streams in a few localities where there are existing road cuttings; however, such deposits have been reported to underlie block streams elsewhere in KNP (Caine & Jennings 1968).
6. Block sizes are quite variable, ranging from around 0.08 m to greater than 1 m in diameter, but are typically in the 0.2-0.5 m range. Some very large blocks (>0.8 m) were observed in places, but only at the surface (e.g. Photo 5). Where the subsurface was visible no size sorting of blocks was noted.
7. Block stream thickness can be hard to estimate accurately due to uncertainty around depth to the underlying substrate. Where block stream bases could be observed at road cuttings or intersections the features are typically 1-2 m thick, as previously estimated by Barrows et al. (2004); however, a range in thickness was observed from around 0.2-0.5 m (one layer of boulders) at block stream edges, to greater than 4 m in the central part of Block Stream B.
8. All five of the block streams bisected by Lobs Hole Ravine Road occupy shallow gullies at the road intersection. The gullies occupied by Block Streams C, D and E may be no more

than 1.5-2 m deep centrally, while those occupied by Block Streams A and B appear deeper (perhaps up to 4-6 m).

9. Vegetation around the block is largely eucalypt forest with a variable understory of smaller trees and shrubs. It seems likely that where block stream deposits are relatively thick, vegetation is absent to sparse, with vegetation colonising areas of block stream where the deposits are relatively thin or interstitial soil occurs close to the surface.
10. The assumed source for the blocks is a Miocene basalt deposit capping the ridge to the east of Lobs Hole Ravine Road. The inferred extent of this deposit, based largely on interpretation of remotely sensed data, is shown in Figure 1. On the regional geology map Cenozoic basalt is not shown to extend this far north along this ridge (Colquhoun et al. 2018), but discontinuous basalt is shown on unpublished Snowy Mountains Authority maps produced in the 1950s (e.g. Drawing B1, reproduced in SMEC (2018)).
11. In places, low relief curved ridges perpendicular to the slope and other surface micro-topography are visible on the block streams. From the road, these are best observed on lower Block Stream B (Photo 6). Such features are characteristic of periglacial block streams (Wilson 2007), and have been described previously from the Ravine block streams and attributed to block flow (Barrows et al. 2004). The preservation of such features, which likely date from the time of deposition of the features during the last glacial period (ice age) between 22 to 17 thousand years ago (Barrows et al. 2004), suggests that the block streams are inherently stable features.
12. Current impacts on the block streams are confined to the existing road corridor in the five areas where it bisects the features. As noted previously, Lobs Hole Ravine Road is currently an unpaved single lane road with a simple cut and fill construction. Typical impacts on the block streams are illustrated in Photos 7 and 8, and can be summarised as follows:
 - a) On the upslope side of the road, block stream deposits have been excavated, in some cases into the underlying substrate, in places forming road cuts up to ~ 2m high;
 - b) Filling has been placed on top of block stream deposits below the excavated areas to build up a level road surface with a down-slope batter angle ranging from ~26° to 44°.

4. IMPACT ASSESSMENT OF PROPOSED MODIFICATIONS

4.1 Proposed modifications to Exploratory Works

Modification 1 includes revisions to the road design and additions to the construction footprint from that approved previously for the EW. It is understood that the proposed modifications are required to accommodate an increase in the maximum vehicle size and load width requiring passage along Lobs Hole Ravine Road during the EW.

The proposed road design for widening the block stream sections involves excavation on the upslope side of the road with stabilisation achieved by cut and fill to a stable batter slope (Figure 2). Where required, local stabilisation works may be undertaken using methods with low visual impacts such as wire netting. Additional elements of the design include an open drain on the upslope edge of the road and an earth mound on the downslope edge of the road, as indicated in Figure 2. It is understood that the earth mound is a temporary safety barrier to be installed during construction prior to installation of permanent guardrails and may be stabilised with grass seed or polymer spray. The road surface would have a crossfall into the cut side to capture water and control runoff. This design differs from that proposed originally for the block stream sections which involved raising the road surface and building a retaining structure on the downslope side of the road.

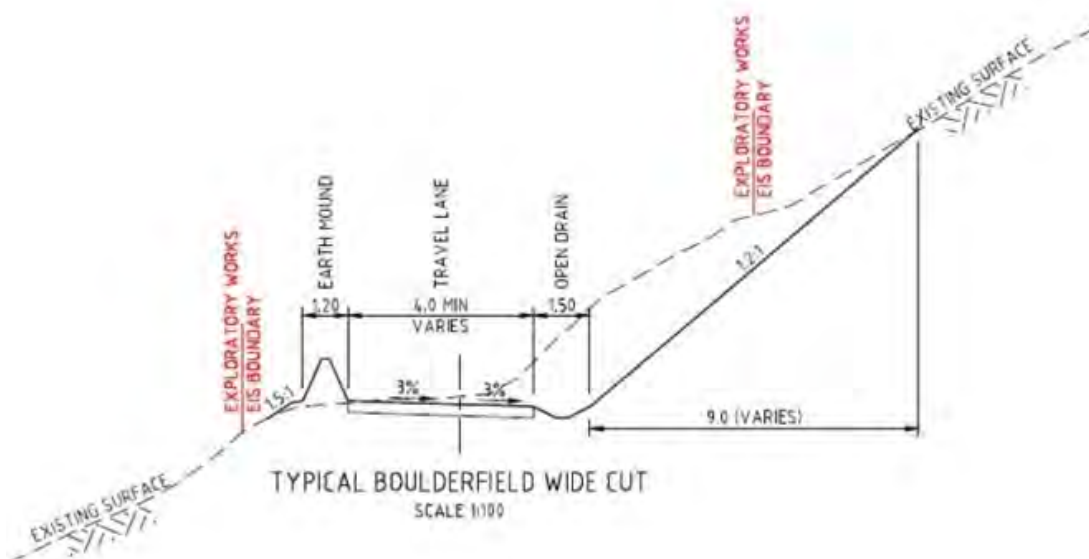


Figure 2. Proposed road design for the block streams sections. (Source: Snowy Hydro Ltd)

Figure 3 shows the previously approved construction footprint in purple and the additional footprint required in blue. The additions are mostly on the upslope and extend through the block stream areas and some adjacent road sections. On the downslope side, additions are minor and lie almost wholly outside the block stream extents.

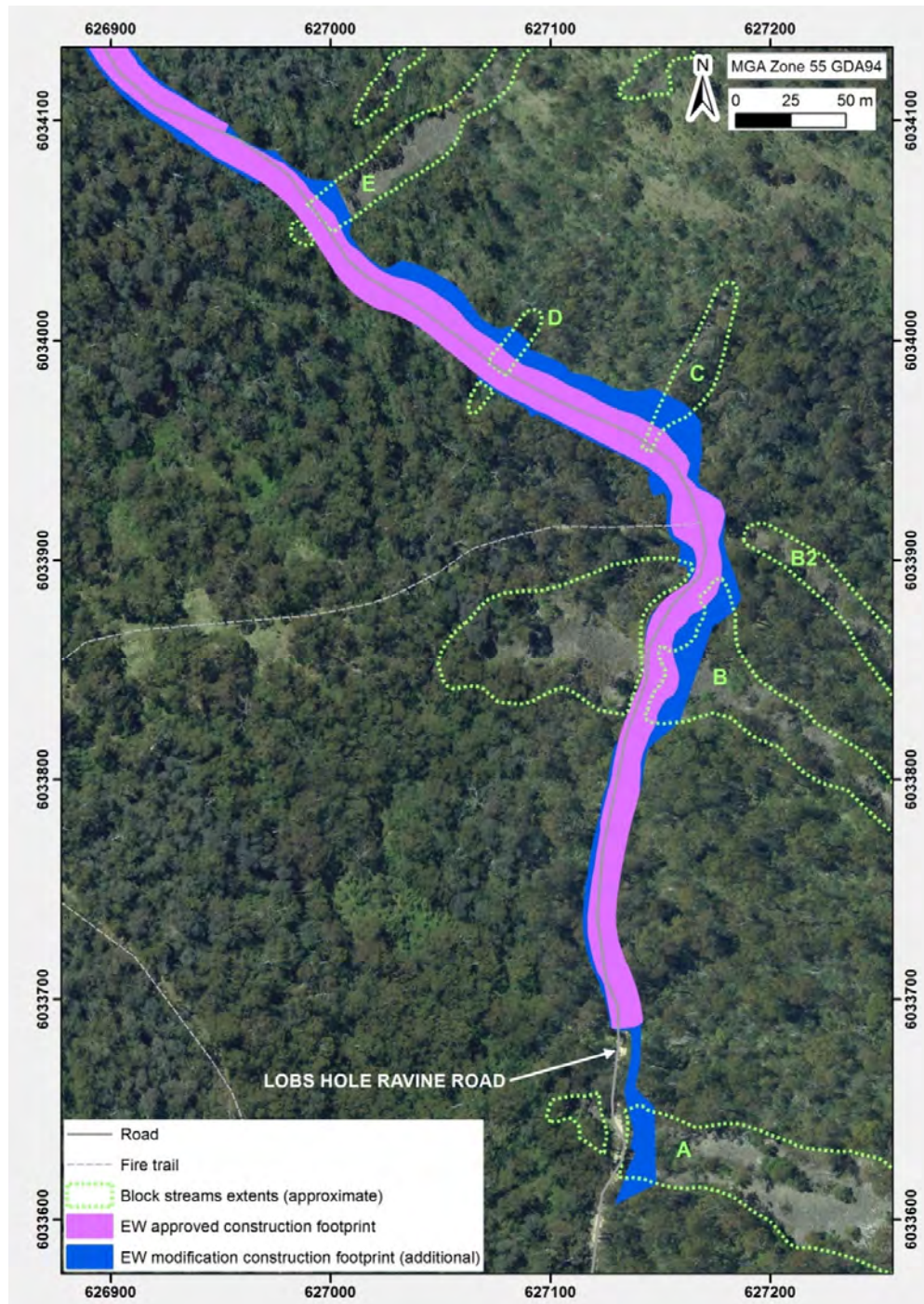


Figure 3. Aerial view of the Ravine block streams showing the approved EW construction footprint and proposed Modification 1 additions to that footprint along Lobs Hole Ravine Road.

Figures 4, 5 and 6 provide a closer view of the proposed construction footprint and an indication of the road design through the various block streams. The orange lines of the road design drawing show the extent to which excavation would occur. In the area beyond that but within the modified construction footprint, local stabilisation with wire netting or similar may be undertaken to secure boulders and there may also be impacts during construction, for example, the area may be used for stationing of equipment and materials.

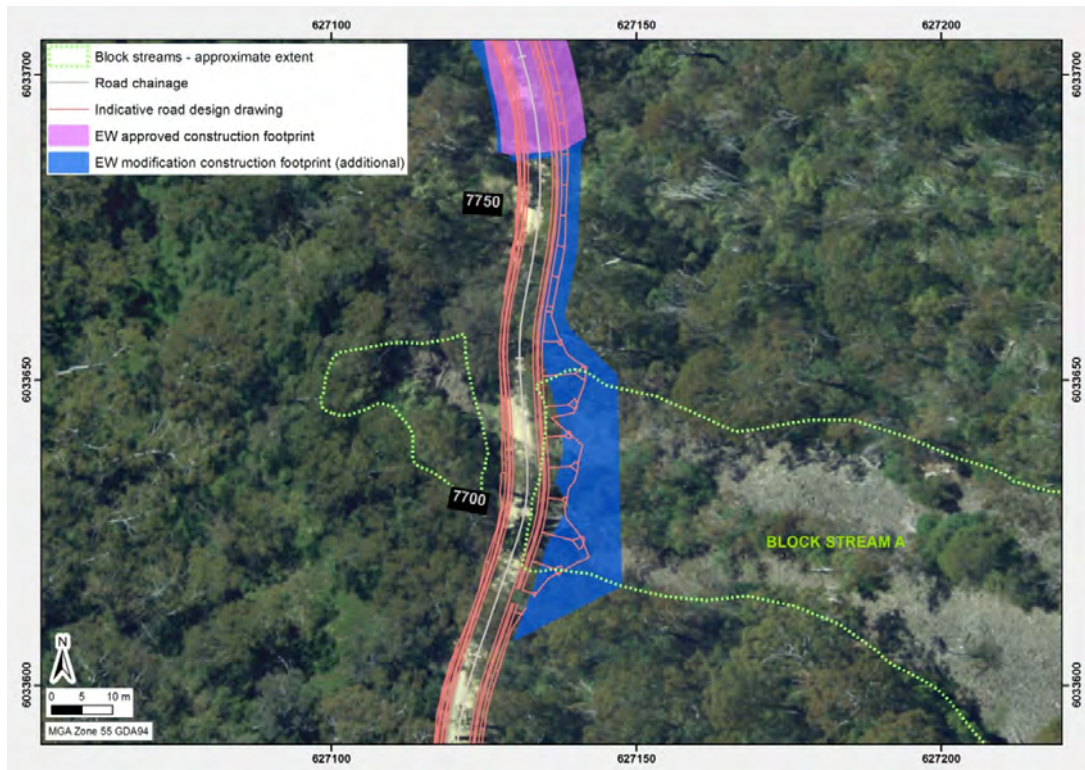


Figure 4. Aerial view of Block Stream A, at Lobs Hole Ravine Road, showing the extent of the proposed additional construction footprint and the indicative road design drawing for this section.

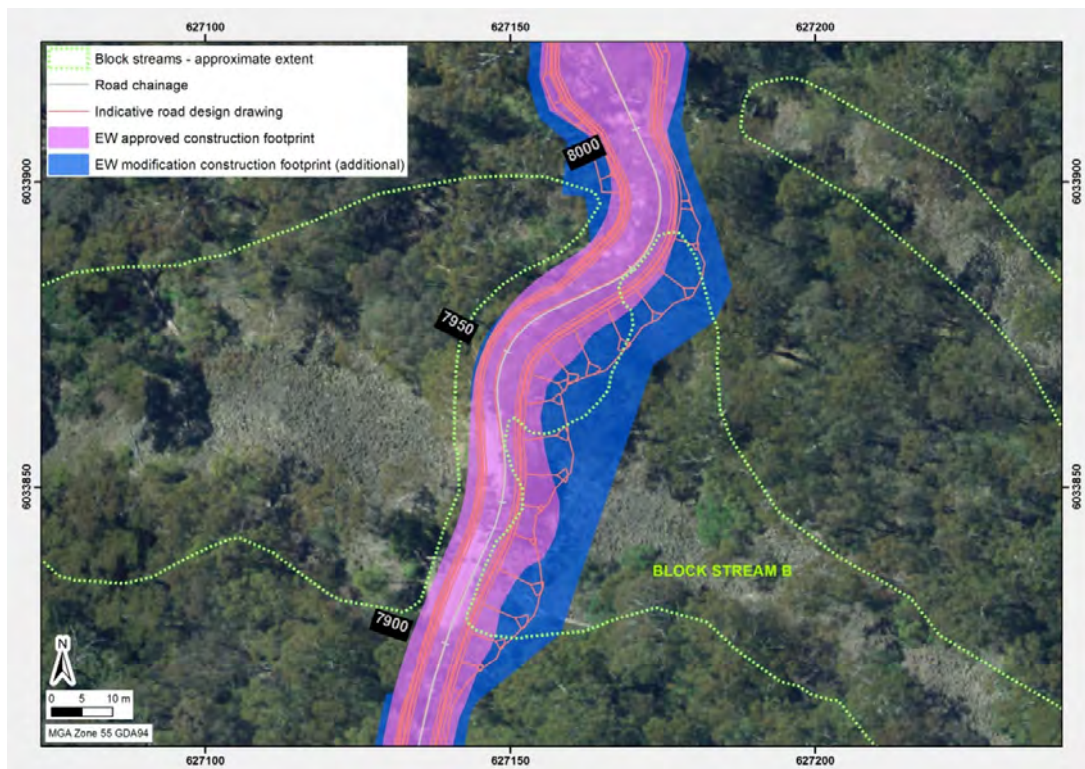


Figure 5. Aerial view of Block Stream B, at Lobs Hole Ravine Road, showing the extent of the proposed additional construction footprint and the indicative road design drawing for this section.

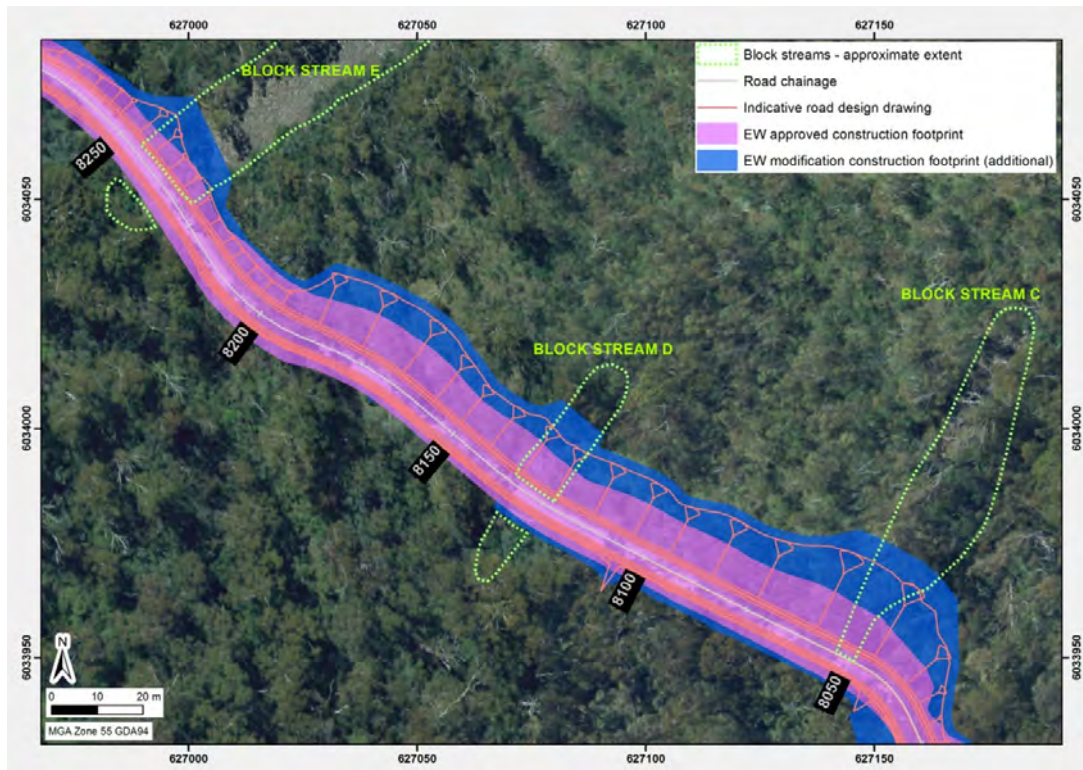


Figure 6. Aerial view of Block Streams C, D and E, at Lobs Hole Ravine Road, showing the extent of the proposed additional construction footprint and the indicative road design drawing for this section.

Table 1 provides estimates of maximum upslope impacts widths for each of the five block streams bisected by the road. Compared to the approved construction footprint, the maximum additional upslope width of the modified footprint ranges between around 10 to 15 m through the block stream sections. The proposed width of upslope excavation within this area ranges from around 5 to 10 metres. Drawings provided to the author indicate that the maximum thickness of excavation in the block stream sections would range from around 1.6 m to 3.1 m at the base of the batter slope, tapering upslope at a typical 1.2:1 slope to the extent of excavation (see Figure 2).

Block Stream ID	Additional construction footprint (m)	Additional excavation beyond approved footprint (m)
A	13.6	6.8
B	15.4	6.1
C	15.3	10.2
D	10.1	4.8
E	10.6	5.4

Table 1. Estimates of maximum upslope impact widths for individual block streams.

4.2 Potential impacts of proposed Exploratory Works modifications on the features

The main impact on the block streams from Modification 1 would be from the additional upslope excavation of the features. The increased excavation would undoubtedly have a negative aesthetic impact on the features. It does, however, represent a small proportion of the overall block stream extents (see Figures 1 and 2), and the features would remain substantially intact. In all cases the excavation would involve further cut into existing batters adjacent to the road, thereby extending an existing impact. It could be expected that the remaining blocks and underlying substrate in the batter area would form a relatively natural-looking surface, although it may need to be retained with local stabilisation works in some areas to maintain block stability and ensure safe use of the road. The use of wire-netting is preferable to other alternatives, such as shotcrete, which would be more unsightly and would cover up the blocks from view.

Despite the increased construction footprint and excavation width, the proposed modification may have some advantages over the previously approved plan to raise the road surface with filling and build a retaining structure on the road downslope, which could have a more prominent visual impact.

There do not appear to be any impacts on the block streams downslope of the existing road from Modification 1.

4.3 Potential opportunities

Opdyke (2018) indicated that a potential benefit of Snowy 2.0 relates to future development of the Ravine block streams for geoheritage tourism, which is also foreshadowed in the KNP Geodiversity Action Plan (OEH 2012). Widening and upgrade of Lobs Hole Ravine Road would help facilitate this benefit, but public access and any associated tourism infrastructure such as a parking bay and signage would likely need to wait until after construction work on Snowy 2.0 is completed. Any road design considerations that would enable this opportunity to be realised might be more appropriately addressed during Snowy 2.0 Main Works. Should the Snowy 2.0 Main Works not proceed, opportunities to enhance the geotourism potential of the Ravine block streams should be considered as part of the Exploratory Works Rehabilitation Plan.

Aspects of periglacial block stream formation and structure remain poorly understood and are hard to study due to the nature of the features. The creation of fresh road cuts through the Ravine block streams and their substrate may provide new information on the nature of these features which would be of interest to scientific specialists, if the cuts are left exposed to view post-construction. Such studies would be greatly enhanced if the data generated and acquired during Snowy 2.0 (e.g. geotechnical reports, and remote sensing data) was shared with suitably interested scientific researchers. Findings from such a study would contribute to the scientific and educational value and significance of the features.

5. RECOMMENDATIONS

As ascertained previously, the Ravine periglacial block streams are significant geodiversity features within KNP, and roadworks for Snowy 2.0 EW should be designed and managed to minimise impacts to the geodiversity values of the block streams as much as practical (EMM 2018; Opdyke 2018). The main risks and sensitivities around these features are impacts on visual amenity, maintenance of landscape integrity, block stability, and future access to the features for viewing and study. Specific recommendations for minimising potential impacts of Modification 1 on the features are listed below.

1. If not already undertaken, carry out field mapping of block stream extents and morphology within the construction footprint prior to works. Use this data to assist preparation of final design and construction plans which minimise potential impacts on these features and enable management of impacts during construction.
2. Consider visual amenity in the final road design and aim, where possible, to avoid the use of construction methods and materials that detract from the landscape values of the block streams and their surrounds.
3. In order to maintain feature integrity in a near-natural state, construction activities should, where practical:
 - minimise the extent of excavation into the upslope block streams;
 - minimise moving or damaging blocks in areas beyond the excavation zone;
 - minimise the placement of outside materials onto the block streams (e.g. soil or fill);
 - minimise use of any stabilisation measures that permanently cover the block streams, for example with shotcrete or other construction materials, which would preclude their future viewing and study.
4. Road design should incorporate adequate drainage controls to ensure water flow through the upslope block streams is not impeded as this may impact local stability of the features.
5. Sediment and erosion control measures should be implemented during and after construction with the aim to minimise adverse impacts on and around the block streams. Sediment and erosion impacts of the proposed works were assessed in the water impact assessment section of the Modification 1 assessment report.
6. The proposed works should implement controls in accordance with the Biodiversity Management Plan to ensure they do not promote the spread of weeds near the boulder streams, and thereby reduce their visibility.
7. Particular care should be taken to avoid impacts on the downslope section of Block Stream B which features well-preserved evidence of ice age block flow in the form of ridges and other low relief surface topography.
8. Undertake monitoring of block stream sections during construction to ensure that works are being carried out within design parameters and environmental controls are effective.

If these recommendations are followed, it should be possible to maintain the integrity of the features in a reasonably natural state and preserve their geodiversity values for the future, despite the additional impacts of Modification 1.

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SITE PHOTOS



Photo 1. Block Stream E immediately upslope of Lobs Hole Ravine Road showing a typical view of unvegetated matrix-free blocks up the main axis of the block stream.



Photo 2. The view immediately below Lobs Hole Ravine Rd at Block Stream E. Some boulders are visible at the base of the road batter but thick vegetation obscures the view beyond that point, and the downslope extent of the block stream is uncertain.



Photo 3. Road cut at the northern edge of Block Stream E, upslope of Lobs Hole Ravine Road. In the foreground, basalt blocks are embedded in soil. Matrix-free surface blocks occupy a shallow gully beyond that to the right; pink streamers mark the roadside extent of surface blocks.



Photo 4. A layer of basalt blocks within the upper soil profile adjacent to the southern edge of Block Stream B, where matrix-free surface blocks are absent. The camera case is 14 cm long.



Photo 5. Block sizes are mainly in the 0.2-0.5 m diameter range but a few are much larger including this elongate boulder around 1.2 m long at the surface of Block Stream A on the upslope side of Lobs Hole Ravine Road.



Photo 6. Block Stream B immediately downslope of Lobs Hole Ravine Road. Low relief surface topography on the block stream is subtly delineated by variations in snow cover, and includes across-slope ridges. These features were probably formed by block flow at the time of deposition, ~22-17 thousand years ago.



Photos 7 & 8. Block Stream B where it is bisected by Lobs Hole Ravine Road showing an example of current impacts of the road on the block streams. On the upslope side the block stream and in places the underlying substrate, have been excavated. Fill has been placed on the block stream below the cutting to create a level road surface with a steep batter sloping down to the lower section of the block stream.

DR ALEXA TROEDSON: AUTHOR BIOGRAPHY

Dr Alexa Troedson is a geologist with expertise in sedimentology, stratigraphy, geological and geomorphic mapping of Cenozoic deposits, palaeoenvironmental interpretation, and Geographic Information Systems (GIS). She has worked for government agencies in Australia and the UK, for a geotechnical and environmental engineering consultancy based in Sydney, and most recently as a self-employed consultant. Her qualifications include a Bachelor of Science Honours degree (First Class) majoring in geology and a PhD in sedimentology, both from the University of Sydney. She has also undertaken environmental law, management and GIS subjects at Macquarie University, gaining distinctions. She has experience interpreting Cenozoic deposits from a range of environments including specific experience in glacial deposits gained from research on Antarctic glacial rocks; she was first author on two papers published in international scientific journals on this work (see below). More recent work has included studies and mapping of Cenozoic deposits in NSW. Some publications associated with these projects are also listed below.

Selected publications:

Troedson A.L. & Smellie J.L. 2002. The Polonez Cove Formation of King George Island, Antarctica: stratigraphy, facies and implications for mid-Cenozoic cryosphere development. *Sedimentology* 49, 277-301

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OFFICE LOCATIONS

SYDNEY

Ground floor, 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE

Level 1, 146 Hunter Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE

Level 10, 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

ADELAIDE

Level 1, 70 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE

187 Coventry Street
South Melbourne VIC 3205

PERTH

PO Box 8155
Fremantle WA 6160

CANBERRA

PO Box 9148
Deakin ACT 2600