



ENVIRONMENTAL IMPACT STATEMENT

VOLUME 1: MAIN REPORT

September 2019

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Snowy 2.0 Main Works

Environmental Impact Statement

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Client

Snowy Hydro Limited

Date

13 September 2019

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v1 Final

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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.

Certification

For submission of an environmental impact statement under Division 5.2 of Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

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Description of development

The development of an underground pumped hydro power station and ancillary infrastructure

Land to be developed

The land to be developed includes:

- Land within Kosciuszko National Park within Snowy Valleys and Snowy Monaro local government areas;
 - Part of lots 11 and 13 in DP 756682; and
 - Part of road corridor shown in detailed maps and plans.
-

Certification

I certify that the contents of this EIS have been prepared in accordance with Division 5.2 of Part 5 of the EP&A Act, Schedule 2 of the NSW *Environmental Planning and Assessment Regulation 2000* and the NSW Department of Planning, Industry and Environment Secretary's Environmental Assessment Requirements issued for the development on 31 July 2019. To the best of my knowledge, it contains all available information that is relevant to the environmental assessment of the development to which the statement relates. The information contained in this EIS is neither false nor misleading.



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CHAPTER

1

INTRODUCTION



1 Introduction

1.1 Overview

Snowy Hydro Limited (Snowy Hydro) owns and operates the Snowy Mountains Hydro-electric Scheme (Snowy Scheme), a large and complex water storage and diversion scheme in the Australian Alps in southern New South Wales (NSW). In March 2017 Snowy Hydro announced a plan to conduct a Feasibility Study into a possible pumped hydro-electric expansion of the existing Snowy Scheme, called 'Snowy 2.0'. The final investment decision (FID) to proceed with Snowy 2.0 was made by Snowy Hydro's Independent Board of Directors on 12 December 2018 following two years of robust market and economic modelling, extensive due diligence and planning. Shareholder approval was subsequently received from the Australian Government on 26 February 2019.

Snowy 2.0 is the largest committed renewable energy project in Australia and is critical to underpinning system security and reliability as Australia transitions to a decarbonised economy. Snowy 2.0 will increase the pumped hydro-electric capacity of the existing Snowy Scheme by linking Tantangara and Talbingo reservoirs with tunnels and a power station built in between, almost 1 km below the ground.

Snowy 2.0 will increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 megawatts (MW) generating capacity, and making approximately 350,000 megawatt hours (MWh) (175 hours of energy storage) available to the National Electricity Market (NEM). When operational, Snowy 2.0 will provide on-demand energy generation and large-scale energy storage; allowing the water to flow from Tantangara Reservoir into Talbingo Reservoir in the generating mode and pumping water out of Talbingo Reservoir (the lower reservoir) to Tantangara Reservoir (the upper reservoir) in the storage mode. This concept is shown in Figure 1.1.

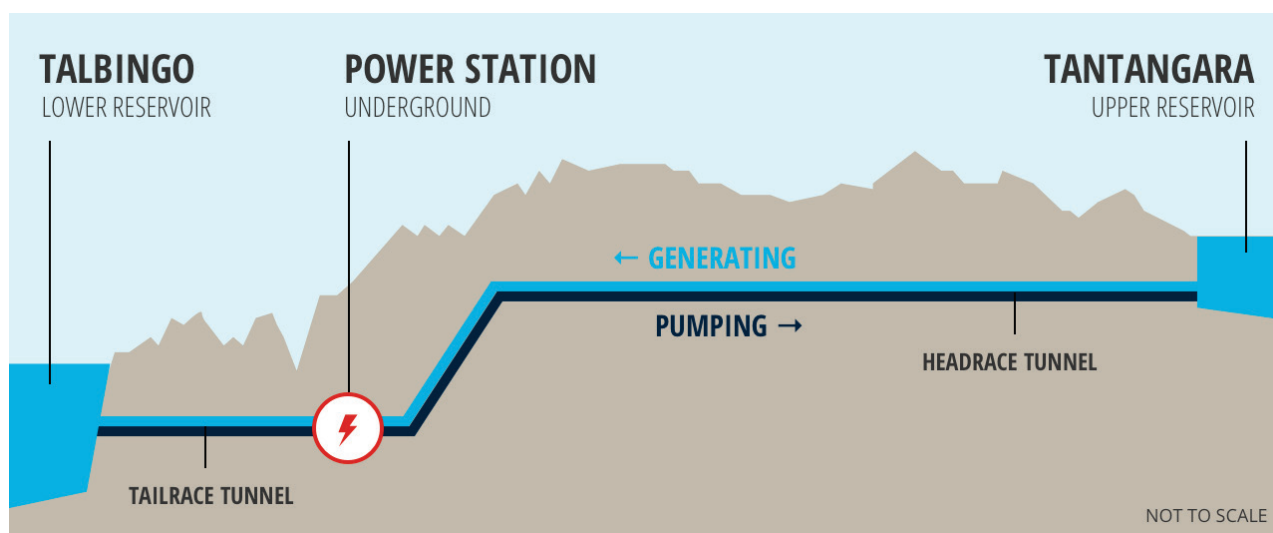


Figure 1.1 Snowy 2.0 pumped hydro concept

Snowy 2.0 will provide large-scale energy storage and quick-start electricity generation at critical times of peak demand when energy supply is constrained and at times when intermittent renewable energy output is low. Pumping water at times of low electricity demand (ie when there is excess supply) means that Snowy 2.0 will have water ready to use for energy generation at times when consumers need it most. Snowy 2.0 will make efficient use of precious water resources to generate electricity without impacting on downstream water users and environmental flows for the Murray-Darling Basin.

Snowy 2.0 has been declared State significant infrastructure (SSI) and critical State significant infrastructure (CSSI) in accordance with the provisions of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The declaration of Snowy 2.0 as a CSSI project acknowledges that the project is critical to the State for environmental, economic or social reasons.

Snowy 2.0 Main Works (the project) refers to the application for the construction and operation of Snowy 2.0. As a CSSI project, Snowy 2.0 Main Works is subject to Part 5, Division 5.2 of the EP&A Act which requires the preparation of an environmental impact statement (EIS) in accordance with Secretary's Environmental Assessment Requirements (SEARs) (Appendix A) and the approval of the NSW Minister for Planning and Public Spaces.

In addition to requiring approval from the NSW Minister for Planning and Public Spaces, Snowy 2.0 Main Works has been deemed a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and requires approval from the Commonwealth Minister for the Environment. The Minister for the Environment has accredited the NSW planning process for the assessment of Snowy 2.0 Main Works. Therefore, a single EIS has been prepared to address the requirements set out by the NSW Department of Planning, Industry and Environment (DPIE) and the Commonwealth Department of the Environment and Energy (DEE).

1.2 The Snowy 2.0 Main Works project

Snowy 2.0 is being developed in two stages. The Exploratory Works which have commenced, includes an exploratory tunnel and portal and other exploratory and construction activities primarily in the Lobs Hole area of Kosciuszko National Park (KNP). The Exploratory Works were approved by the former NSW Minister for Planning on 7 February 2019 as a separate project application to DPIE (SSI 9208).

This EIS addresses the **Snowy 2.0 Main Works**. As the title suggests, this EIS covers the major construction and operational elements of Snowy 2.0. The Snowy 2.0 Main Works is shown on Figure 1.2. The project includes:

- construction of permanent infrastructure needed for the operation of Snowy 2.0, such as the underground power station and access tunnels, water intakes, power waterways, chambers and shafts, new access roads, communications cable, and power and water supply;
- establishment of sites and infrastructure needed during construction, such as temporary access roads, construction adits, construction compounds and accommodation (including water and wastewater services), management and storage of extracted rock material, and construction power supply; and
- the operation of Snowy 2.0.

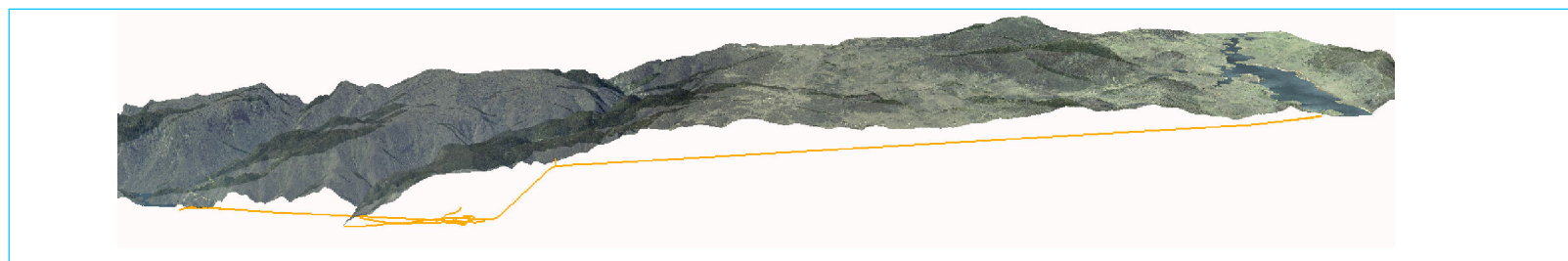
The construction of the project will involve tunnelling and excavation works between Tantangara and Talbingo reservoirs to depths of up to 1 kilometre (km). Surface works will also be required at specific locations during construction. The design and construction of the project will be carried out by Future Generation Joint Venture (FGJV), the contractor appointed by Snowy Hydro. Once construction is complete, Snowy Hydro is responsible for the operation of Snowy 2.0 and its infrastructure.

A detailed description of the construction and operation of the project is provided in Chapter 2, with detailed maps and plans provide at Appendix B.

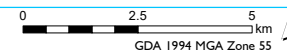
\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS001 Overview 20190828 06.mxd 3/09/2019



- KEY**
- Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Local government area boundary
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Indicative rock emplacement area



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



Snowy 2.0 project elements

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 1.2



1.3 Location and setting

1.3.1 Location

Snowy 2.0 Main Works is in the Australian Alps in southern NSW, about mid-way between Canberra and Albury. Snowy 2.0 Main Works is within both the Snowy Valleys and Snowy Monaro Regional local government areas (LGAs). The area in which Snowy 2.0 will be built and operated is referred to herein as the project area, as shown on Figure 1.3.

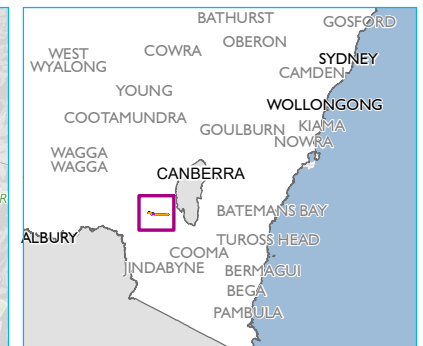
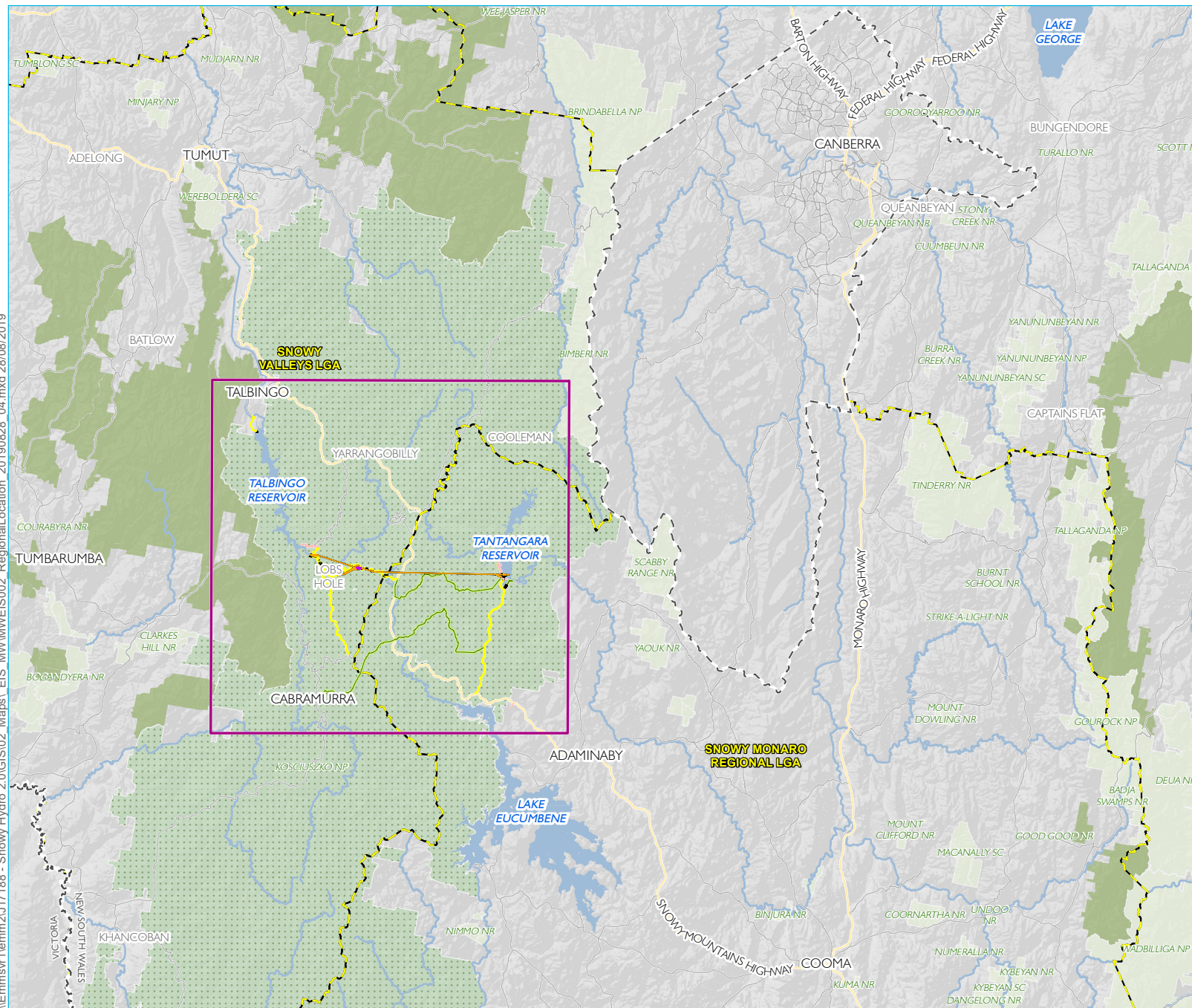
The nearest large towns to the Snowy 2.0 Main Works project area are Cooma and Tumut. Cooma is about 50 km south-east of the project area (or 70 km by road from Providence Portal), and Tumut is about 35 km north-west of the project area (or 45 km by road from Tumut 3 power station). Other nearby towns include Talbingo, Cabramurra, Adaminaby and Tumbarumba. These towns in relation to the project are shown on Figure 1.3.

The pumped hydro-electric scheme elements of Snowy 2.0 Main Works are mostly underground between the southern ends of Talbingo and Tantangara reservoirs, a straight-line distance of 27 km. Key locations for the project are shown on Figure 1.4 and include Talbingo Reservoir, Marica, Lobs Hole, Plateau and Tantangara Reservoir. A site outside the boundaries of KNP (referred to as Rock Forest) will also be used for logistics and staging during construction and is accessed directly from the Snowy Mountains Highway.

1.3.2 Natural and built features

Key features of the project area are shown on Figure 1.4:

- the water bodies of Talbingo and Tantangara reservoirs, covering areas of 19.4 square kilometres (km²) and 21.2 km² respectively, and with gross storages of 921 and 254.1 gigalitres (GL) respectively. The reservoirs provide the water to be utilised in the proposed pumped hydro-electric scheme;
- major watercourses including the Yarrangobilly, Eucumbene and Murrumbidgee rivers and some of their tributaries (such as Nungar, Gooandra and Tantangara creeks); and
- KNP, within which the majority of project elements are located. Within the project area, KNP is characterised by two key zones: upper slopes and inverted treelines in the west of the project area (referred to as the 'ravine') and associated subalpine treeless flats and valleys in the east of the project area (referred to as the 'plateau').



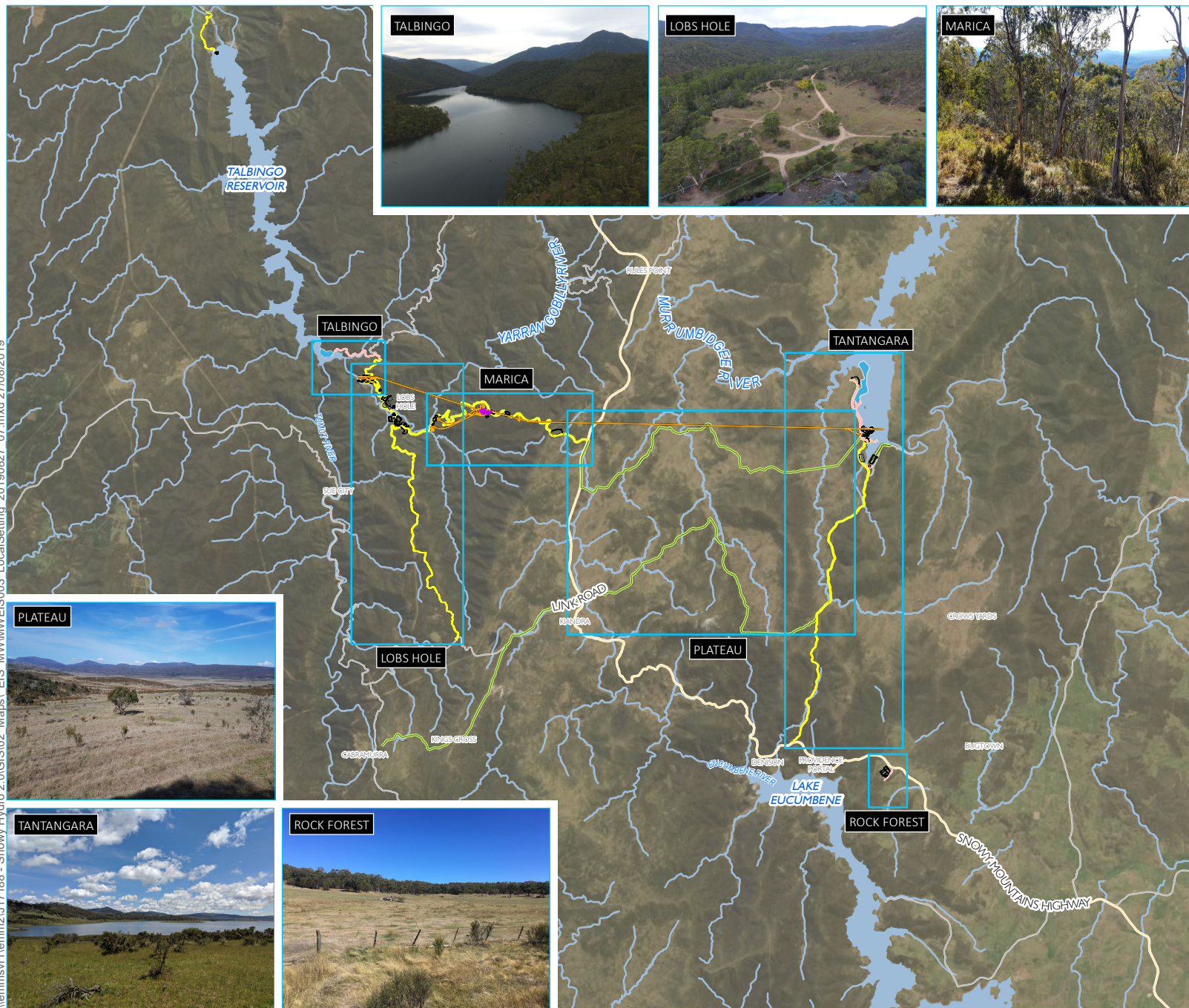
- KEY**
- Project area
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Kosciuszko National Park
 - NPWS reserve
 - State forest
 - Local government area boundary
 - State boundary

Regional setting

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 1.3



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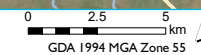
- KEY**
- Project precinct
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Indicative rock emplacement area

Local setting

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 1.4



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



1.4 History and background of the project

1.4.1 The existing Snowy Scheme

i History of development

The Snowy Scheme was designed to collect and store water, divert it through trans-mountain tunnels and power stations and then release it west of the Snowy Mountains into the catchments of the Murray and Murrumbidgee rivers. The Snowy Scheme is the largest engineering project ever undertaken in Australia and is one of the largest and most complex hydro-electric schemes in the world. It took about 100,000 workers around 25 years to build and resulted in many new towns being established. Its construction is seen by many as a defining point in Australia's history, and an important symbol of Australia's identity as an independent, multicultural and resourceful country (Australian Government 2016). A timeline of the development of the Snowy Scheme is provided in Figure 1.5.

ii How the Snowy Scheme works

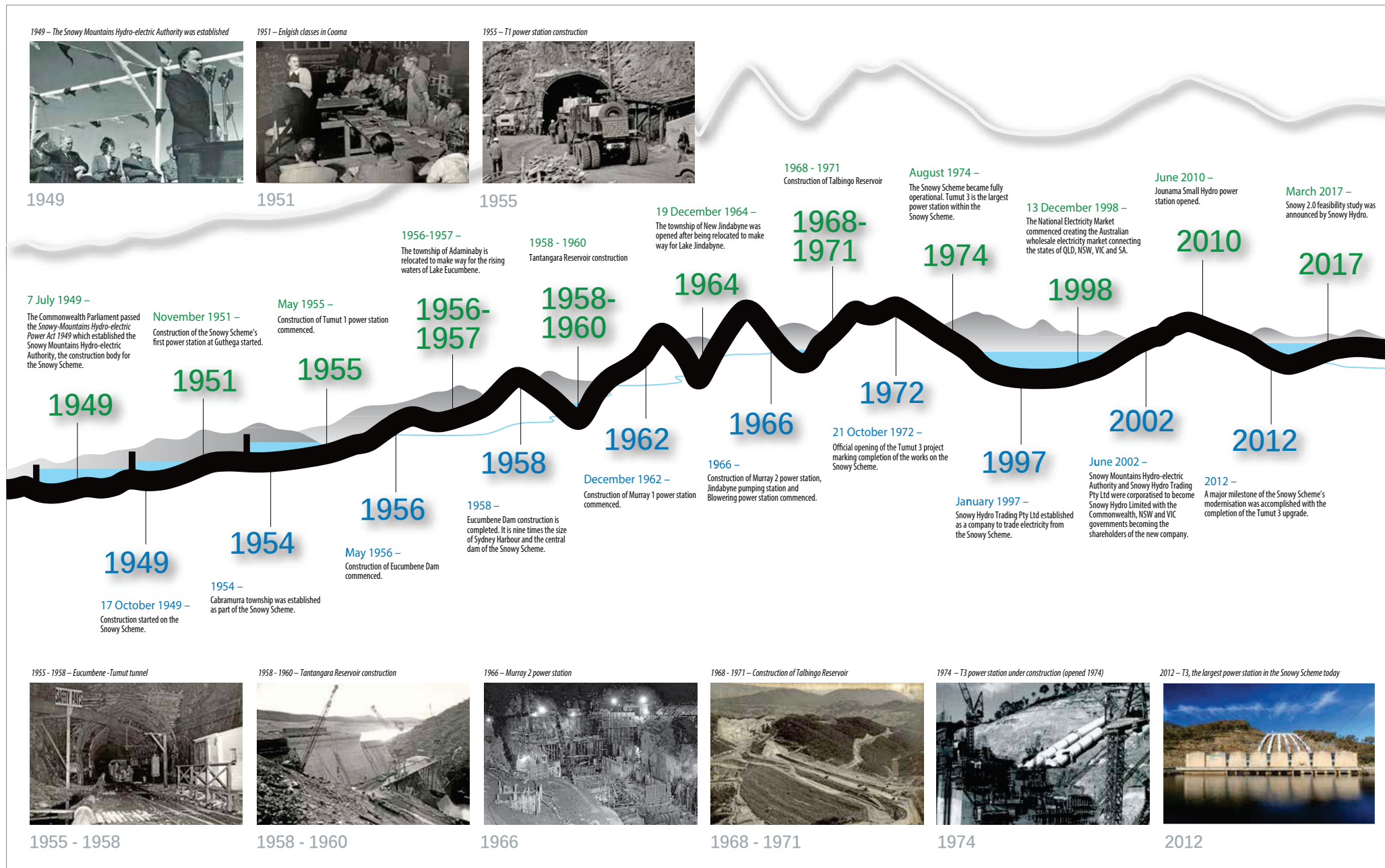
Precipitation in the form of snow and rain falls in the catchment area of the Snowy Scheme. A catchment area is any part of the land where water drains to its lowest part. Water from melting snow and rain is collected and stored behind dams in lakes and reservoirs and then diverted through tunnels and pipelines down to power stations hundreds of metres below.

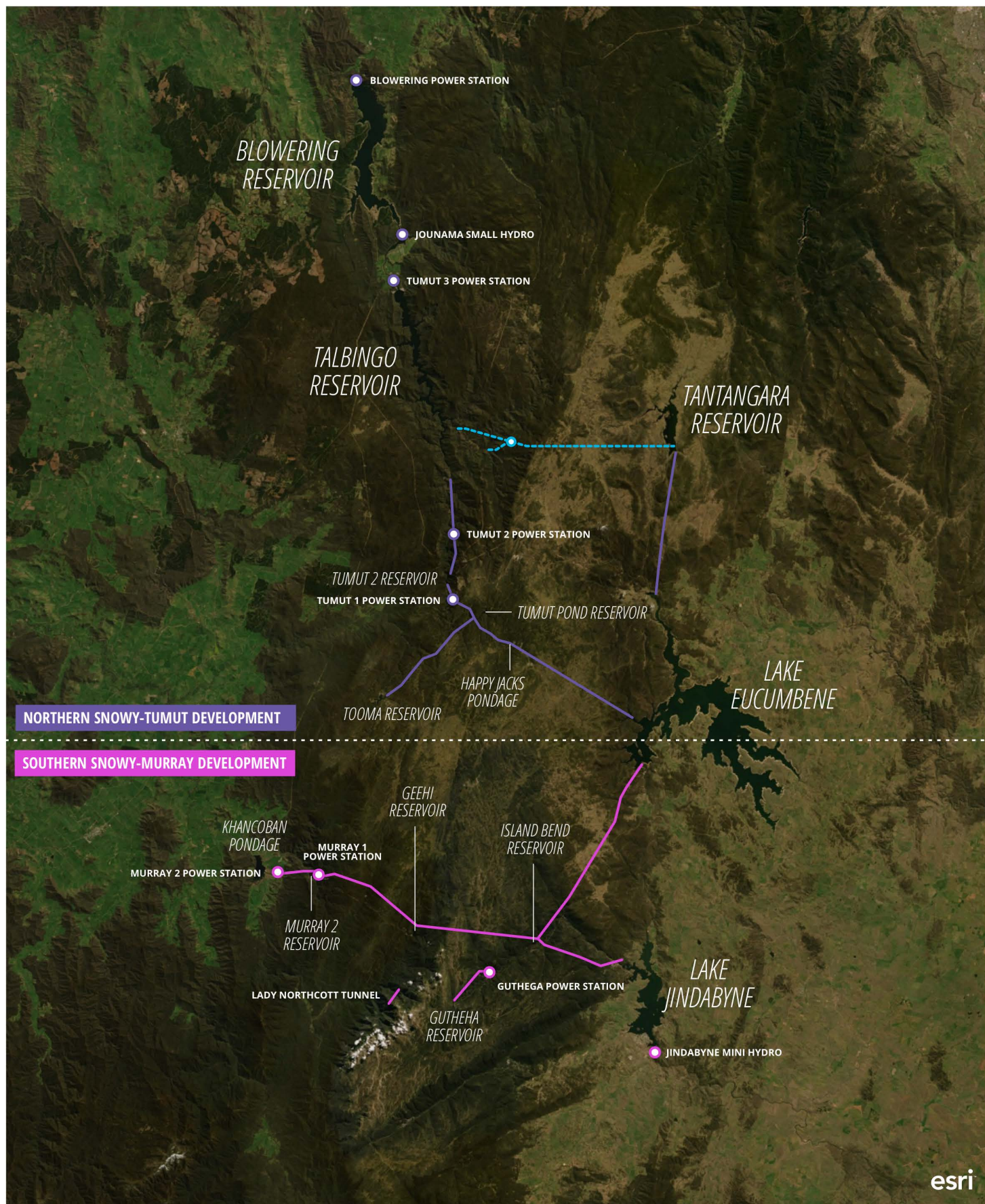
Water is used to drive turbines, turning kinetic energy into mechanical energy. These turbines drive shafts that operate generators. Transformers boost generated voltage to a level that can be economically transmitted over long distances by transmission lines to the towns and cities of eastern mainland Australia. The Snowy Scheme can generate large amounts (around 4,100 MW) of peak-load electricity to meet the daily fluctuating demands for power in the NEM.

Once the water has passed through the turbines in the power stations, it is released into the Murray River and Murrumbidgee River catchments to be used to irrigate farms in the Murray, Murrumbidgee Irrigation Area and Coleambally regions, and for environmental flows. A water licence (known as the Snowy Water Licence) determines the flows and releases to these catchments. Snowy Hydro must deliver the required amount of water to storage outlined in the licence, for flows to be released by the Murray Darling Basin Authority and WaterNSW. This long-term water regulation is designed to counteract the effects of severe drought sequences and raise productivity in the Murray Darling Basin.

iii Snowy Scheme assets

The Snowy Scheme today (shown on Figure 1.6) includes 16 major dams, nine power stations (33 hydro-electric turbines), one pumping station, and 145 km of interconnected tunnels and pipelines and 80 km of aqueducts. It consists of two major developments: the northern Snowy-Tumut Development and the southern Snowy-Murray Development.





Satellite image © Esri, CGIAR | Vicmap, Esri, HERE, Garmin, METI/NASA, USGS | Earthstar Geographics

Figure 1.6 Existing Snowy Mountains Scheme

LOCATIONS ARE APPROXIMATE ONLY

- Power Station in Snowy-Tumut development
- Tunnel in Snowy-Tumut development
- Power Station in Snowy-Murray development
- Tunnel in Snowy-Murray development
- Proposed Power Station in Snowy 2.0
- Proposed tunnel for Snowy 2.0

The Snowy Scheme operates within a catchment of around 5,100 km², most of which is within the KNP. KNP straddles the Great Dividing Range and contains most of Australia's snow and alpine areas. The purpose of the Snowy Scheme was to collect water from these alpine areas and send it to farms and communities in the west. There has been close to 65 years of continuous operation since construction, with sustained water and environmental management allowing the Snowy Scheme's assets to operate within the natural and recreational areas of KNP. The infrastructure of the Snowy Scheme forms part of the tourist attraction to KNP, with many of the Scheme's reservoirs used for recreation as well as the Snowy Hydro operated tourism visitor centres. KNP is discussed further in Chapter 3.

The NSW *Snowy Hydro Corporatisation Act 1997* (SHC Act) provides the legal framework for the Snowy Scheme to operate within the KNP. Part 6, section 37(2) of the SHC Act entitles Snowy Hydro to the grant of a lease, licence, easement or right of way over KNP, for the purposes of the existing Snowy Scheme development. The Snowy Park Lease was granted to Snowy Hydro by the former NSW Minister for Environment in 2002 and has a term of 75 years.

The SHC Act was amended in 2018 and now also entitles Snowy Hydro to the grant of a lease, licence, easement or right of way over KNP, for the purposes of Snowy 2.0. If planning approval is received, Snowy Hydro will be granted a series of licenses and leases by the former NSW Minister for the Environment to enable the construction and operation of Snowy 2.0.

1.4.2 The Snowy 2.0 vision

According to Dunn (SMA 1991), augmentation studies of pumped storage schemes were first considered in 1966 during the design and construction phase of the Snowy Scheme. Further studies concerned with energy reserve capability and mostly of pumped storage schemes were undertaken from 1980 to 1986.

Snowy 2.0 involves linking Tantangara and Talbingo reservoirs. This tunnel link can be seen on a number of historical plans for the Snowy Scheme but was not built at the time due to economic feasibility. At the time cheap coal fired generation was becoming readily available, and at that time, was not limited by potential concerns over greenhouse emissions and climate change.

Snowy 2.0 adopts the vision of connecting Tantangara and Talbingo reservoirs to generate power through a new power station, similar to what was previously envisaged for the original Snowy Scheme. An advantage however of the current vision, Snowy 2.0, is the ability to pump water back to Tantangara Reservoir to be stored for future reuse (ie a closed system) for dispatchable energy generation. The ability for the water to be reused in this way contributes to the strong economic business case of Snowy 2.0. As previously stated, Snowy 2.0 will increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 MW generating capacity, and making approximately 350,000 MWh available to the NEM.

1.4.3 Developing the Snowy 2.0 concept

Since the project was announced in March 2017 Snowy Hydro has undertaken a comprehensive program of project planning, energy market and economic modelling and design development. The project planning and development milestones are provided in Figure 1.7.

Project development flow chart

(Jan 2017 - Dec 2019)

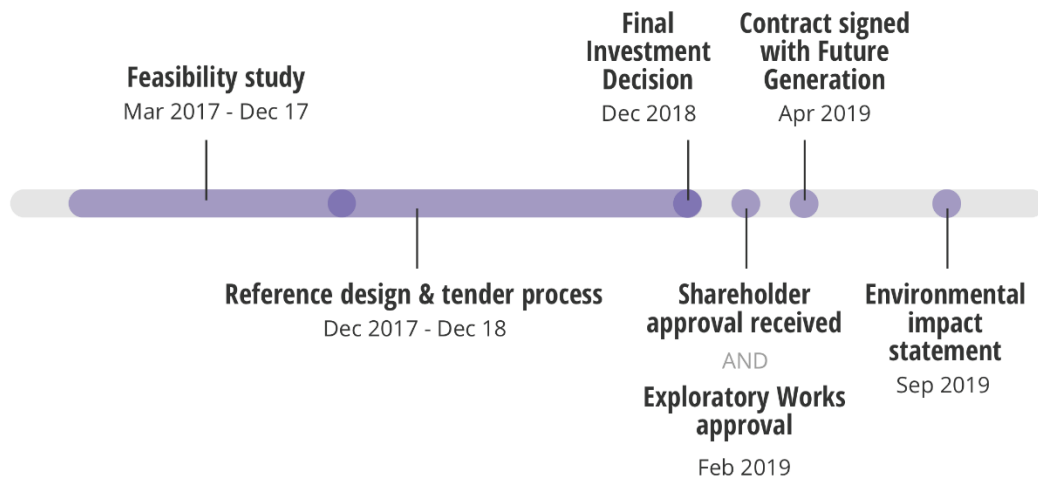


Figure 1.7 Project development flow chart

The first key step of Snowy 2.0 project development was the Feasibility Study which developed the preliminary business case, design, cost estimate, schedule and execution plan. The Feasibility Study, released in December 2017, confirmed that Snowy 2.0 is economic, technically feasible and financeable. The Feasibility Study is available on Snowy Hydro's website.

The next phase of project development was the planning required for the FID. This involved comprehensive and careful planning and assessment of all aspects of the project including: health and safety, the commercial business case, reference design, project execution, consolidated business operability, schedule, cost and contingency, market modelling, revenue sources and portfolio modelling, drivers of revenue, project valuation, scenario analysis, site and ground conditions, environment, project controls, transmission, hydrology, operations readiness, approvals, legal, governance and stakeholder engagement.

The FID was made by Snowy Hydro's Independent Board of Directors on 12 December 2018 with a decision to proceed based on the outcomes of the project planning. The FID documentation (some 1,000 pages) is available on Snowy Hydro's website. Since the FID, a contractor (FGJV) for the detailed design and construction of the project has been appointed by Snowy Hydro, following shareholder approval for Snowy 2.0 from the Australian Government and following approval and commencement of Exploratory Works.

Throughout the project development, comprehensive environmental impact assessment has been carried out by leading experts and identified environmental values of the project area have been considered through careful planning and design. This has involved extensive field surveys to better understand the baseline conditions of the project area as well as environmental specialists working closely with the project design team to avoid, minimise, mitigate and offset environmental impacts.

i Options and alternatives considered

The Snowy 2.0 Main Works has a number of significant and unique benefits that justify its selection over alternative projects to meet the urgent requirements of the NEM for large-scale capability to underpin a stable and secure decarbonisation at lowest cost.

As described more fully in Chapter 3, the NEM is undergoing a paradigm transformation that has been brought about by rapidly decreasing costs of wind and solar (known as variable renewable energy or VRE), significant shifts in energy efficiency, coal power station retirements, increasing coal and gas costs and Australia's participation in global commitments to reduce carbon emissions (ie Paris Agreement).

The NEM urgently needs more on-demand energy and large-scale storage to ensure Australia's secure and stable transition to renewables at lowest cost to consumers.

Independently to Snowy Hydro, the requirement for large-scale storage was identified as a policy priority by the then Prime Minister in an address to the National Press Club on 1 February 2017¹. This has been subsequently confirmed by multiple independent bodies, including the Finkel Review in June 2017² and the Integrated System Plan (ISP) prepared by the Australian Energy Market Operator (AEMO) in December 2018³. It was most recently affirmed by the ISP Insights document published by AEMO in July 2019⁴. The ISP Insights paper confirms that the NEM requires large-scale storage more quickly (by the mid-2020s) and at a greater scale (up to 15 GW of capacity by the early 2040s) than anticipated when Snowy Hydro commenced its Feasibility Study into Snowy 2.0 in March 2017.

The Finkel Review confirmed that the only viable commercial technology to provide large grid-scale storage is pumped hydro-electric storage. The pumped hydro-electric energy storage technology used in Snowy 2.0 would have high full cycle energy efficiency, a long lifespan and significant storage capacity. These benefits are considered to justify the use of pumped hydro energy storage to complement other smaller scale energy storage technologies, such as batteries, which also have a valuable role in the NEM.

As set out in Chapter 3, the independent Marsden Jacob Associates (MJA) study shows that without Snowy 2.0, the market needs would be met by a mix of gas generation and batteries, which would be an order of magnitude more expensive, and would not provide the same benefits as pumped hydro-electric storage.

Other opportunities have been identified in NSW and throughout Australia for hydro-electric storage, notably the atlas of pumped hydro-electric storage released in 2017 (Blakers et al. 2017), however the lead time and planning for such projects is extremely complex. Given the scale of storage that will be required in the NEM, a number of these opportunities are likely to play a role in the future.

Snowy 2.0 Main Works has the following benefits when compared to alternatives in meeting the immediate requirements of the NEM:

- it uses two existing reservoirs (Tantangara and Talbingo) and accordingly does not require inundation of a new area, which is a key environmental impact associated with typical hydro-electric projects;
- the scale of these existing storages, and in particular Tantangara Reservoir, means Snowy 2.0 can provide up to 350,000 MWh of storage, which is significant storage capacity when compared to any alternative;

¹ <https://www.energy.gov.au/sites/default/files/independent-review-future-nem-blueprint-for-the-future-2017.pdf>

² <https://www.energy.gov.au/government-priorities/energy-markets/independent-review-future-security-national-electricity-market>

³ <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Integrated-System-Plan>

⁴ https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2019/ISP-Insights---Building-power-system-resilience-with-pumped-hydro-energy-storage.pdf

- section 37A of the SHC Act, which was introduced by the *Snowy Hydro Corporatisation Amendment (Snowy 2.0) Act 2018*, entitles Snowy Hydro to the grant of a lease for the purpose of the Snowy 2.0 Main Works. Notably, the pumped hydro-electric storage atlas (Blakers et al. 2017) notes that ‘There has been no investigation of land tenure [in respect of the sites]...and no discussions with landowners and managers. Nothing in this list of potential site locations implies any rights for development of these locations’;
- it has been developed to a point that, subject to this approval, it can be delivered by the mid-2020s when storage is required;
- it is between the two largest load centres in the NEM (in NSW and Victoria) and also in proximate to major renewable energy zones in southwestern NSW and northwestern Victoria;
- it will be integrated into the operations of the existing Scheme. Once complete, Snowy 2.0 will be one of nine large generators within the existing Snowy Scheme that operate within an integrated portfolio under the control of Snowy Hydro. Snowy Hydro is uniquely positioned to deliver and operate a project of this magnitude; and
- the Snowy Scheme itself was deliberately in the Australian Alps to capture snow melt, and utilise the existing topography of the landscape. Only by being integrated within the Snowy Scheme can the Snowy 2.0 Main Works leverage these existing capabilities to meet the needs of the NEM, and also provide additional drought proofing for the existing Snowy Scheme.

A comprehensive assessment of options for the augmentation of the Snowy Scheme was documented in the Snowy Mountains Scheme Augmentation Ranking Study (SMA 1991). This involved consideration of 10 conventional hydro power alternatives and four pumped storage alternatives. The options considered are provided in Figure 1.8. This study included consideration of a pumped hydro connection between reservoirs similar to the Snowy 2.0 alignment, called the Yarrangobilly Pumped Storage Scheme. This option was found to be the lowest cost alternative for large scale pumped hydro energy storage of 18 GWh for 10 day capability. This option was not considered economic at the time largely due to the comparative cost of gas turbines. The Yarrangobilly Pumped Storage Scheme was investigated further in 2017 in the Snowy 2.0 Feasibility Study as it was identified that the economic viability of large scale pumped hydro energy storage had improved. It is this scheme which has been developed into Snowy 2.0.

When compared to the other four pumped hydro alternatives in the Ranking Study, the Yarrangobilly Pumped Storage Scheme (ie Snowy 2.0) was clearly superior to the others because:

- The proposed Wandilla and Jagumba Pumped Hydro Schemes would require the construction of new storages; and
- None of the other three options provide the same high head potential linked to the high storage capacity of Snowy 2.0. A detailed comparison of the four schemes is set out in Table 1.1.

Table 1.1 **Ranking Study (SMA 1991) options**

Scheme option	New storages required	Potential storage	Potential head	Tunnelling required
Yarrangobilly	No	238 GL	680 m	~27 km
Wandilla	Yes	6.3 GL	270 m	~1.5 km pressure pipeline
Jagumba	Yes	25.5 GL	680 m	~10 km
Upper Tumut	No	52 GL	610 m	~24 km

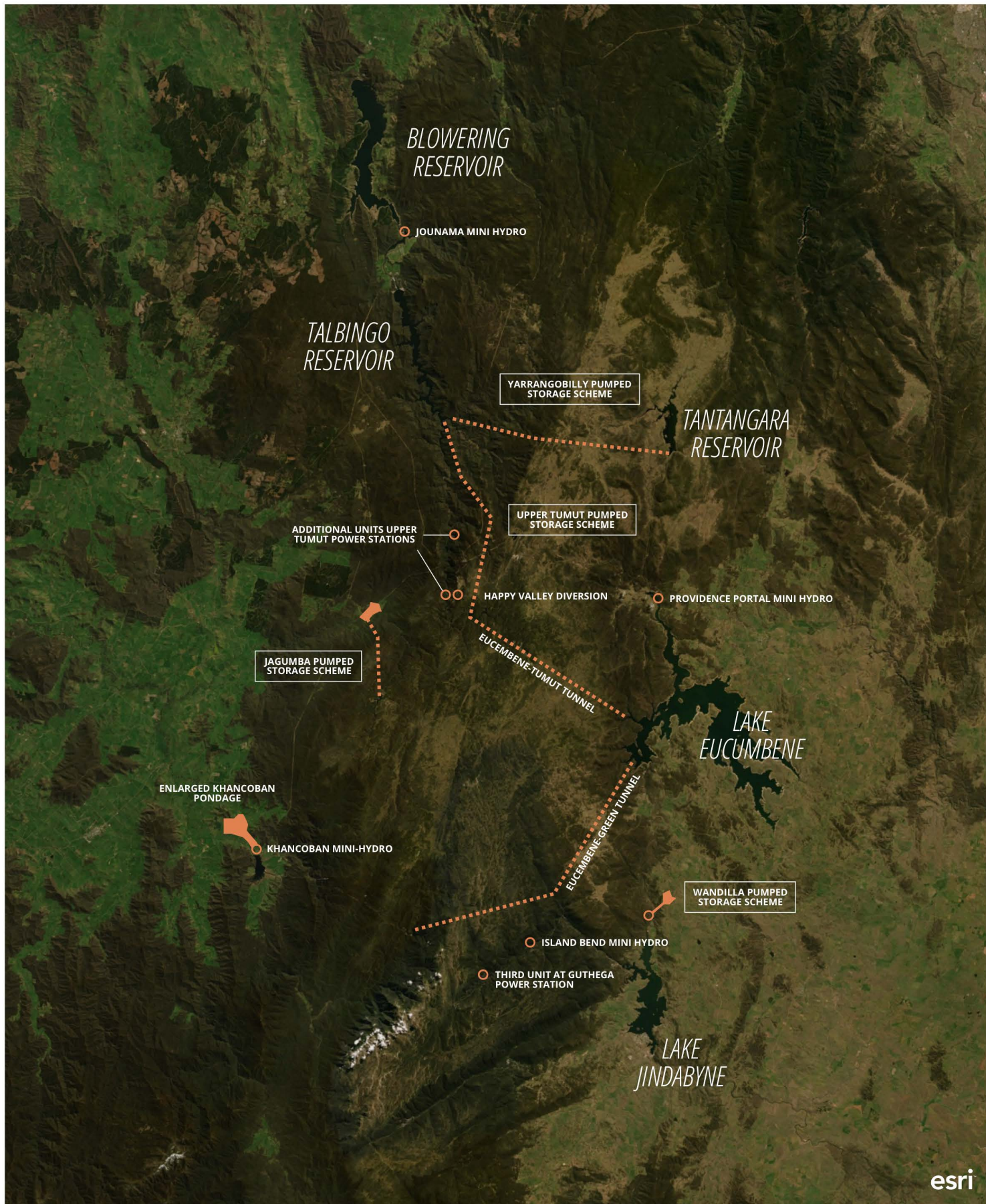
In light of the unique nature of the opportunity offered by the Snowy 2.0 Main Works, Snowy Hydro embarked on a Feasibility Study of the development in March 2017. The progress of that Feasibility Study, and the options within the Snowy 2.0 development are described more fully in Appendix C.

The alternatives within the project have been considered and further developed following the appointment of FGJV. The alternatives considered have arisen with the aim of optimising the former reference design with reference to constructability, environmental, social and economic factors. A detailed description of the options and alternatives considered throughout the design and assessment process for Snowy2.0 is provided at Appendix C. The key aspects of Snowy 2.0 Main Works that have been subject to consideration of options and alternatives are:

- underground infrastructure, primarily the location of the underground power station and the connecting power waterway and access tunnels;
- management options and alternatives for excavated rock, including consideration of alternative placement areas and methods;
- location and extent of surface works, which was subject to an iterative design and environmental assessment process to minimise impacts; and
- design and management measures to be incorporated into the project to minimise environmental impacts.

ii **Design development, consultation and environmental assessment**

Snowy 2.0 Main Works has been developed with underpinning principles to avoid and minimise environmental impacts where possible. These principles were implemented through an iterative design integration and assessment approach (DIAA), supported by consultation with relevant technical advisors, government agencies and other stakeholders. The NSW National Parks and Wildlife Service (NPWS), as land manager of KNP, was consulted throughout design development and as part of the preparation of this EIS.



Satellite image © Esri, CGIAR | Vicmap, Esri, HERE, Garmin, METI/NASA, USGS | Earthstar Geographics

Figure 1.8 Snowy Scheme augmentation options

LOCATIONS ARE APPROXIMATE ONLY

- Proposed Power Station
- Proposed Tunnel
- Proposed Storage

1.5 Related projects

There are three other projects related to Snowy 2.0 Main Works, they are:

- Snowy 2.0 Exploratory Works (SSI - 9208) – a Snowy Hydro project with the former NSW Minister for Planning's approval;
- Snowy 2.0 Transmission Connect Project (SSI - 9717) – a project proposed by TransGrid; and
- Snowy 2.0 Proposed Segment Factory (SSI - 10034) – a project proposed by Snowy Hydro.

Snowy 2.0 Exploratory Works involves the construction of an exploratory tunnel and associated geotechnical investigation activities to inform the final design of Snowy 2.0. Snowy 2.0 Exploratory Works was approved by the former NSW Minister for Planning on 7 February 2019 and works commenced in March 2019. Staged submission and separate approval is appropriate for a project of this magnitude, due to its complexity and funding and procurement processes. Submission of the application and subsequent approval of Exploratory Works ahead of Main Works was critical as it will obtain detailed geological data about the rock types, conditions, ground temperature and stress conditions to inform the detailed design of the underground power station cavern.

While the upgrade works to the wider shared transmission network and connection between Snowy 2.0 and the network form part of the CSSI declaration for Snowy 2.0, they do not form part of Snowy Hydro's application. The Transmission Connection Project, while connecting Snowy 2.0 to the NEM, is part of a broader priority transmission project that will benefit the whole of the NEM as it decarbonises. TransGrid is the proponent for the transmission connection which will be subject to separate application and approval processes. However, cumulative impacts have been considered in this EIS where relevant.

A proposed segment factory at the industrial area of Polo Flat in Cooma is a development that is ancillary to Snowy 2.0 Exploratory Works and Main Works but subject to a separate approval process. This project will provide the concrete segments needed to line the tunnels of Snowy 2.0.

1.6 Purpose of this document

This EIS has been prepared by EMM Consulting Pty Limited (EMM) on behalf of Snowy Hydro to support the CSSI application for approval of Snowy 2.0 Main Works under Part 5, Division 5.2 of the EP&A Act. It has been prepared to the form and contents requirements set out in clauses 6 and 7 of Schedule 2 of the *NSW Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). It has also been prepared with consideration of *Preparing an Environmental Impact Statement Guideline (Draft)* (DPE 2017).

This EIS has also been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued by DPIE on 31 July 2019. The SEARs and where they have been addressed in this EIS are provided in Appendix A. The EIS is supported with input from technical specialists. The EIS study team is provided at the end of this report.



CHAPTER

2

DESCRIPTION OF THE PROJECT



2 Description of the Project

2.1 Introduction

This chapter explains how Snowy 2.0 Main Works will be built over the proposed six year construction period, and how the core elements will be operated and fully integrated into the existing Snowy Scheme. The proposed phases of Snowy 2.0 Main Works comprise construction and operation. The structure of the chapter is therefore as follows:

- Section 2.1 – provides an overview of Snowy 2.0 and how it will function, including an introduction to the principles that enable Snowy 2.0 to be built and to function, the guiding design principles and overview of the construction areas, project elements and access arrangements and the sequencing of the works;
- Section 2.2– provides information relating to the construction of Snowy 2.0 Main Works;
 - Section 2.2.1 – summarises the sequencing of construction activities and outlines the typical methods to be used during construction of Snowy 2.0 Main Works;
 - Section 2.3.2 – describes the construction of permanent infrastructure, mostly underground;
 - Section 2.3.3 – describes the supporting temporary construction sites and infrastructure needed to build permanent elements of Snowy 2.0 Main Works;
 - Section 2.3.4 – describes the temporary and permanent access road requirements;
 - Section 2.3.5 – describes how excavated rock will be managed during construction, including the handling, stockpiling, transport, and placement of rock;
 - Section 2.3.6 – describes how the project area will be accessed during construction, including primary haulage and delivery routes;
 - Section 2.3.7 – describes the construction work requirements, including the workforce and hours of construction;
 - Section 2.3.8 – describes progressive rehabilitation measures to be implemented during construction, and rehabilitation objectives at completion of construction works;
- Section 2.4 – describes the operating regime and maintenance required during the operational phase of Snowy 2.0 Main Works; and
- Section 2.5 – provides a summary of the interactions between Snowy 2.0 Main Works and KNP.

The works described in this chapter form the basis of the environmental impact assessment undertaken.

2.2 Overview of Snowy 2.0 Main Works

2.2.1 Principles of Snowy 2.0

Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the existing Snowy Scheme through a series of new underground tunnels and a hydro-electric power station, to be constructed within an underground cavern. Most of the project's facilities will be underground which minimises the project's long-term footprint and impact on the surface.

Operation of Snowy 2.0 will involve the transfer of water through a series of newly established power waterway tunnels and the underground power station to provide for energy generation, as well as large-scale energy storage that will be available on-demand as quick-start electricity generation at critical times of peak demand including times when intermittent renewable energy output or thermal generation is low. To do this, Snowy 2.0 effectively has two operating modes; energy generating mode and pumping mode (for large-scale energy storage). These are shown and explained in Figure 2.1.

Operating in either generating mode or pumping mode will be facilitated by the Snowy Mountains Control Centre (SMCC) in Snowy Hydro's headquarters at Cooma, via the communication networks between Cooma and Snowy 2.0. Decisions concerning the operational mode, flow rates and flow duration will be made remotely by Snowy Hydro on the basis of the state of the NEM with due regard given to operational and licensing constraints, including the need to maintain downstream supply and environmental flows for the Murray-Darling Basin. As with the current Snowy Hydro generating assets Snowy 2.0 will be remotely operated, so there will be no permanent staff on-site except as required for inspection and maintenance activities. Access to the permanent infrastructure will be provided by upgraded and/or new roads established during the course of construction of Snowy 2.0 Exploratory Works and Main Works.

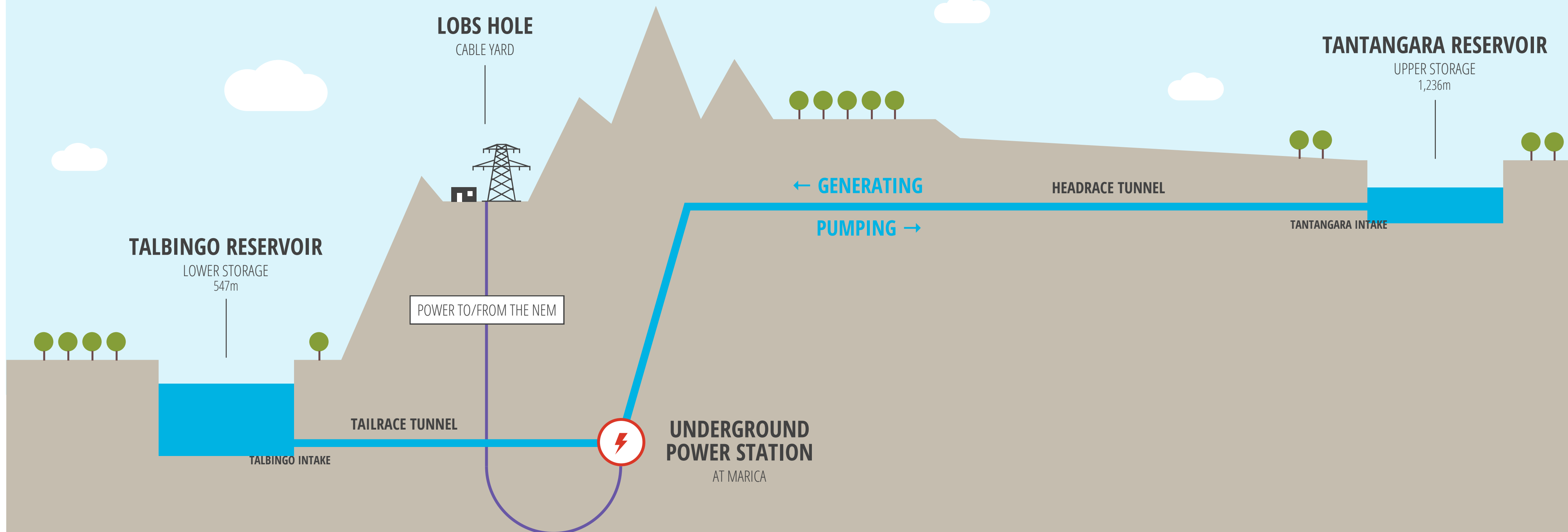
2.2.2 Guiding design principles and approach

Given the complexities of Snowy 2.0 Main Works, its scale and schedule, an iterative and risk-based design and assessment process was adopted in identifying and assessing potential environmental impacts (the DIAA process, as shown in Figure 2.2). This process was undertaken to develop the design and construction methods with the guiding principles of avoiding and minimising environmental impacts where possible and engaging with key stakeholders throughout the process. This EIS has been prepared with consideration of impacts commensurate with the levels of risk identified through the DIAA process.

The challenges for the design team included the need to develop solutions that balance the need for ensuring a safe working environment for the construction of Snowy 2.0 Main Works, including the safe movement of plant, equipment, materials and personnel across the sites, with the need to preserve and protect the values of the KNP and the environmental constraints of the location. Throughout the design process, the objective was to identify and avoid sensitive locations, to minimise the construction footprint and maintain as much of the existing natural environment as is reasonable and feasible.

As previously stated, Snowy Hydro has appointed a contractor for the design and construction of Snowy 2.0. The EIS is based on the design provided by the contractor during the tender process, noting that a detailed design process is now underway.

While project components are generally fixed, there may be some refinements to the physical layout or design of certain components of the project following further investigation and design. Consistent with the DIAA process, the objective for the detailed design process is to optimise the design to meet construction requirements while continuing to minimise environmental impacts.



Operation of Snowy 2.0 will involve the transfer of water through a series of newly established power waterway tunnels and the underground power station to provide for energy generation, as well as large scale energy storage that will be available as quick-start electricity generation at critical times of peak demand.

IN GENERATING MODE:

- The intake structure at Tantangara Reservoir allows water to flow into the headrace tunnel
- Water falls via gravity into the surge tank (the surge tank valves/gate are opened)
- Water flows through pressure tunnels and to the turbines in the machine hall, spinning the turbines and generators to create electricity
- Transformers located in the transformer hall of the underground power station convert the electricity to a higher-voltage current, and is then transmitted via cables to supply the NEM
- Water continues through the tailrace tunnel and is released into Talbingo Reservoir via the Talbingo gate shaft and intake structure

IN PUMPING MODE:

- Energy is sourced from the NEM which is transmitted into the Power station via the same electrical infrastructure used in generating mode
- The turbines in the machine hall, spinning in the reverse direction (as pumps), push the water up the inclined tunnel and through the headrace tunnel to Tantangara Reservoir where it can be stored and used again for energy generation when needed
- Water from Talbingo Reservoir is drawn through the Talbingo intake and the tailrace tunnel toward the turbines

Figure 2.1

Principles of Snowy 2.0 Main Works

Design integration and assessment approach

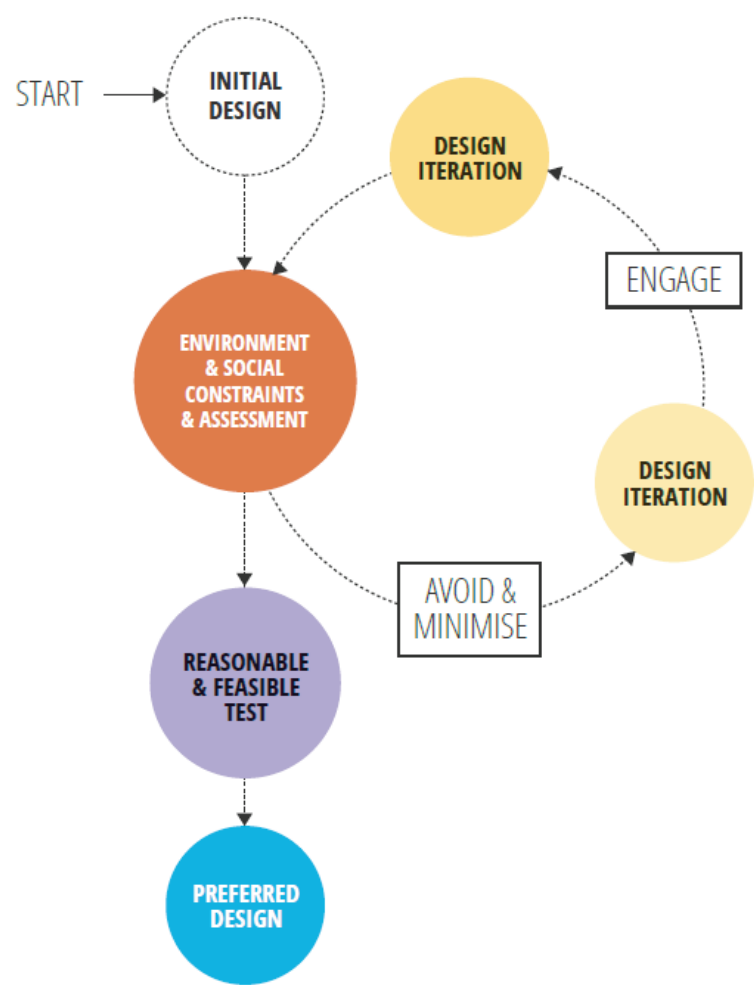


Figure 2.2 Design integration and assessment approach

2.2.3 Snowy 2.0 Main Works

The development of Snowy 2.0 within KNP will result in the creation of permanent infrastructure, mostly underground which is required to operate the project. The design of these infrastructure elements has been integrated into the KNP with careful consideration of its values, as well as maintaining public access to the KNP during construction where safe to do so, and in the long-term once construction has finished.

The following key design elements are proposed as part of Snowy 2.0 Main Works as they are needed for the operation of Snowy 2.0, and are referred to as operational infrastructure:

- an underground pumped hydro-electric power station complex;
- water intake structures at Tantangara and Talbingo reservoirs;
- power waterway tunnels, chambers and shafts;
- access tunnels;
- fish control structures in proximity to Tantangara Reservoir wall;
- new and upgraded roads to allow ongoing access and maintenance; and
- power, water and communication infrastructure, including:
 - a cable yard to facilitate connection between the NEM electricity transmission network and Snowy 2.0;
 - permanent auxiliary power connection;
 - permanent communication cables; and
 - permanent water supply to the underground power station.

Figure 2.3 shows the permanent infrastructure proposed to be built within the KNP as part of Snowy 2.0 Main Works, and Table 2.1 to Table 2.6 provides a summary of the proposed project elements needed to establish this infrastructure.

To build the permanent infrastructure required for Snowy 2.0, several construction elements are needed. The construction elements proposed as part of Snowy 2.0 Main Works include:

- construction compounds, portals, stockpile areas, yards, maintenance and laydown areas to provide areas for plant and equipment, and storage of construction materials, at Talbingo Reservoir, Lobs Hole, Marica, and Tantangara Reservoir;
- access tunnels and adits to support main tunnelling activities and construction of the underground power station complex;
- a construction logistics site at Rock Forest;
- site-based accommodation camps to house the temporary workforce at Lobs Hole, Marica and Tantangara Reservoir;
- road establishment and other access improvements and upgrades to allow access to construction sites;

- management of excavated rock from tunnelling and excavation activities, including:
 - permanent storage of excavated rock within Talbingo and Tantangara reservoirs;
 - temporary and/or permanent on-land storage within the KNP and temporary and/or permanent storage outside of KNP;
- temporary water supply for water required by construction activities;
- temporary water and wastewater treatment facilities where needed to manage the above sites and construction activities;
- continued use of the Lobs Hole substation for construction power if required (note that this component is subject to a modification to the current Exploratory Works for Snowy 2.0 approval; requesting its construction and operation for the Exploratory Works phase of Snowy 2.0); and
- continued access to Talbingo Reservoir by barge (established during Exploratory Works for Snowy 2.0) and establishment of barge access at Tantangara Reservoir for construction of the intake.

Once Snowy 2.0 Main Works are completed, temporary construction elements (such as construction compounds and accommodation camps) will be removed and on-going rehabilitation and revegetation programs implemented.

i Methods

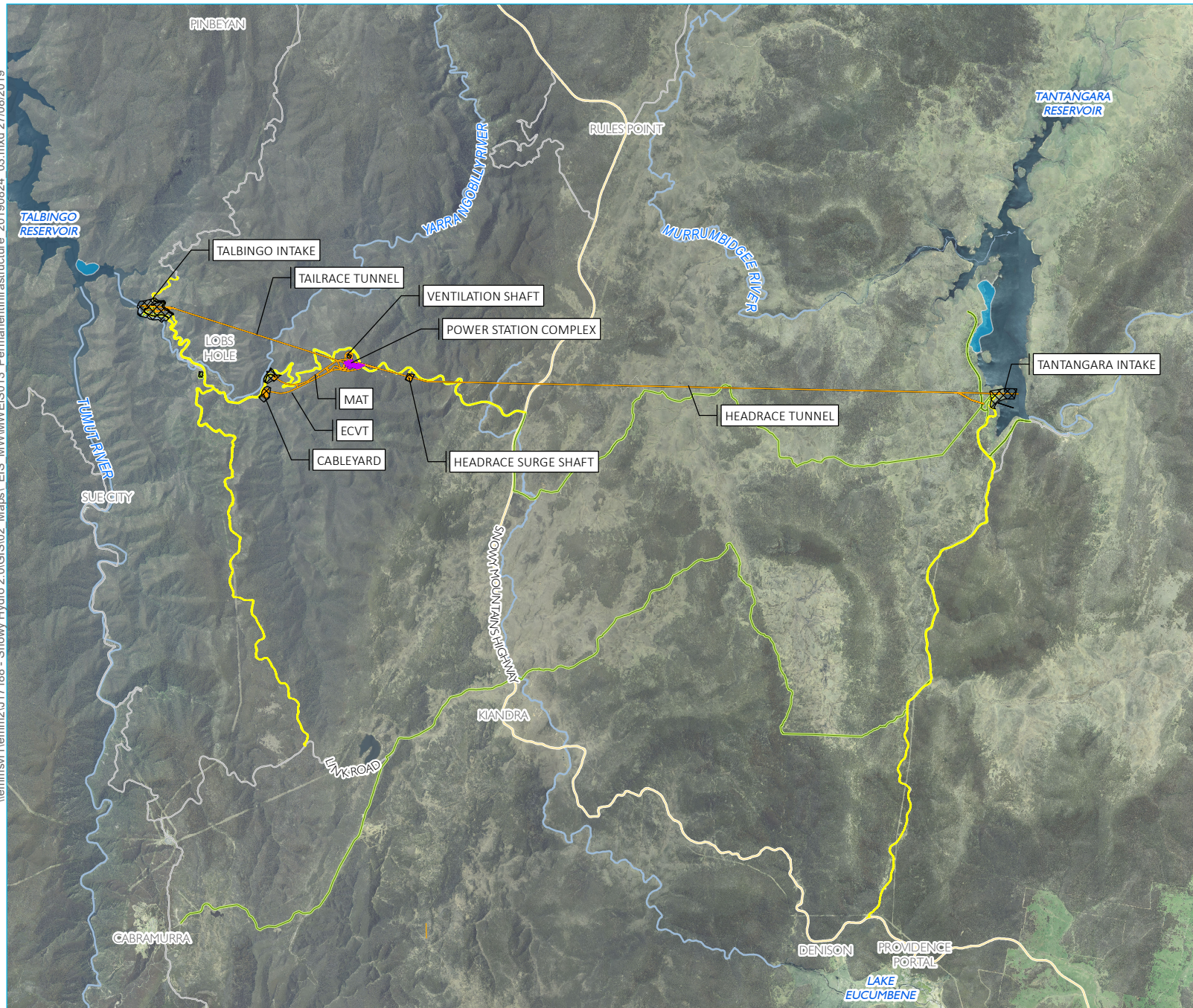
The construction of Snowy 2.0 Main Works requires multiple techniques and methods to achieve safe, efficient and cost-effective delivery. Construction primarily involves temporary surface disturbance works through the creation of construction areas to build infrastructure as well as sites where deep excavation works (primarily utilising tunnel boring machines (TBMs)) can launch from.

The excavation of the underground tunnels and caverns (which will form the power station complex) represent most of the civil construction activities required. Two primary methods of excavation will be used for the underground works: TBM and drill and blast. Figure 2.4 shows the likely locations of where these two primary methods will be used.

Broadly, drill and blast will be initially used to excavate access adits to allow for excavation of the headrace and tailrace tunnels through use of TBM. Drill and blast will also be used for the initial section of the main access tunnel (MAT, approved under Snowy 2.0 Exploratory Works) and emergency egress, cabling and ventilation tunnel (ECVT) until there is competent rock to launch the TBMs to undertake the remainder of the excavation. Drill and blast will be used to excavate the underground caverns and attached small waterway tunnels as well as permanent access and construction adits around the power station complex, as well as to excavate some areas at the surface such as intakes and access roads.

Other methods of excavation proposed during construction include, but are not limited to, open cut (intake construction, road works), and raise bore and blind sink (to excavate shafts and chambers). Further detailed information on construction method is provided in Appendix D.

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- KEY**
- Operational footprint
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Indicative rock emplacement area

Snowy 2.0 Main Works - permanent infrastructure

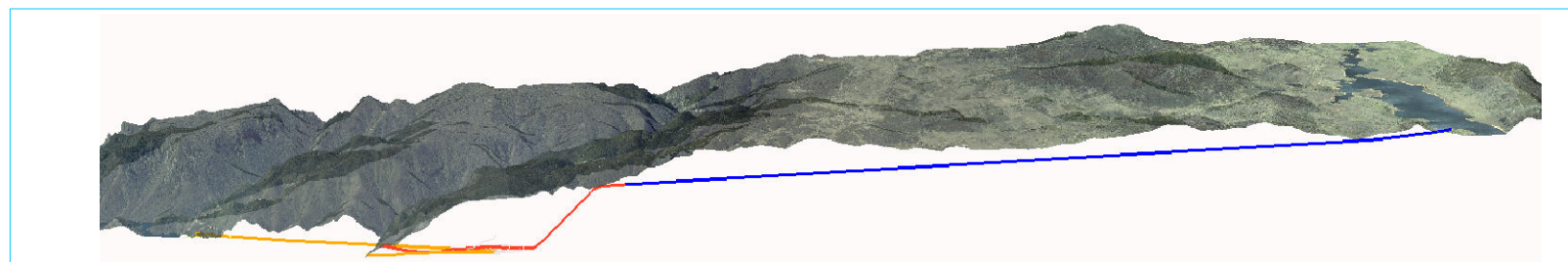
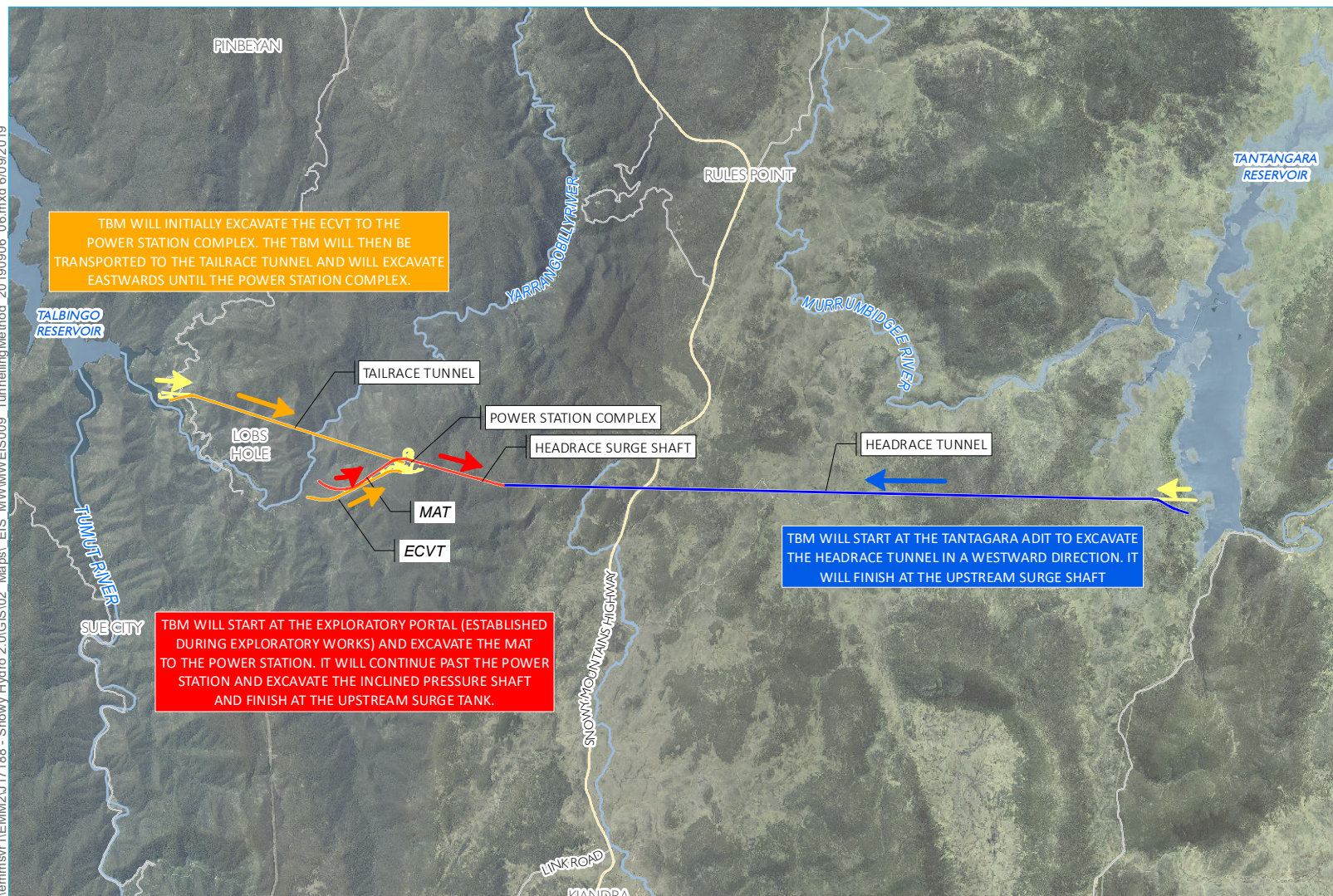
Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.3

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

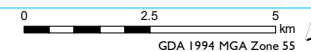
0 2.5 5 km
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Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)



Primary excavation methods – drill and blast and tunnel boring machine

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.4



ii Construction areas

Due to the remoteness of the project area for Snowy 2.0 Main Works, construction sites are generally needed to:

- provide facilities such as concrete batching plants (CBPs), mixing plants and on-site manufacturing;
- store machinery, equipment and materials to be used in construction;
- stockpile material such as aggregate to be used in construction, or stockpile material extracted from tunnelling and road works;
- maintain construction plant and equipment;
- provide access to underground construction sites; and
- provide onsite accommodation for the construction workforce.

For the purposes of this chapter the project area is described by 'construction areas' as shown on Figure 1.4 to account for the nature of the proposed activities and the varying local environmental, amenity and recreational conditions. These geographic areas are:

- Talbingo Reservoir - at an FSL of about 546 m AHD, Talbingo Reservoir will be the lower reservoir for Snowy 2.0 and will include the tailrace tunnel and water intake structure. The site will also be used for temporary construction compounds and other temporary ancillary activities as well as an emplacement area for excavated rock and surplus cut materials;
- Lobs Hole - the area will be used primarily for construction but will also become the main entrance to the power station during operation. Lobs Hole will provide access to the Snowy 2.0 Exploratory Works tunnel, which will be refitted to become the MAT, as well as the location of the ECVT, portal, associated services and accommodation camp;
- Marica - the area will be used primarily for construction purposes including construction of vertical shafts to the underground power station (ventilation shaft) and headrace tunnel (surge shaft), and a small accommodation camp;
- Plateau – the area (predominantly within an existing track) will be used for construction and operation of buried communications and power supply cables to operational infrastructure between Talbingo and Tantangara reservoirs. At depth, the headrace tunnel will be excavated across the plateau;
- Tantangara Reservoir- at a full supply level (FSL) of about 1,229 metres (m) to Australian Height Datum (AHD), Tantangara Reservoir will be the upper reservoir for Snowy 2.0 and include the headrace tunnel and intake structure. The site will also be used for a temporary construction compound, accommodation camp and other temporary ancillary activities as well as an emplacement area for excavated rock and surplus cut materials; and
- Rock Forest – the area comprises private property under lease to Snowy Hydro for use as a logistics site during construction.

Supporting infrastructure will include establishing or upgrading access tracks and roads and electricity connections to construction sites. Each construction site needed for Snowy 2.0 Main Works is shown on Figure 2.6 to Figure 2.11, and further described in Table 2.1 to Table 2.6. These tables provide a summary of the project elements to be built, their purpose, how they are to be built and the access arrangements in the short term (during construction) and long term at completion of construction (during operation).

iii Disturbance footprint

For the purposes of predicting environmental impacts of the project, a disturbance footprint has been defined. The disturbance footprint encompasses the extent of physical disturbance likely to be required to accommodate construction activities and infrastructure needed to build Snowy 2.0 Main Works, based on preliminary designs provided by FGJV. The maximum disturbance area is about 1,680 hectares (ha) which is approximately 0.25% of the KNP. As detailed design progresses, there may be some elements within the boundaries of the disturbance footprint that need to be relocated or optimised. For this purpose, the disturbance footprint described within this EIS may be broader than what will ultimately be impacted.

Progressively and at the end of construction, most of the disturbance footprint will be rehabilitated and returned to its previous use. The exception to this are areas required for permanent operation of Snowy 2.0 which would be retained (referred to as the operational footprint).

iv Timing

Snowy 2.0 Main Works will involve phases of works associated with its construction ensuring an efficient sequencing into operation where it will underpin the secure and reliable decarbonisation of the NEM at lowest cost to consumers. This is shown indicatively in Figure 2.5.

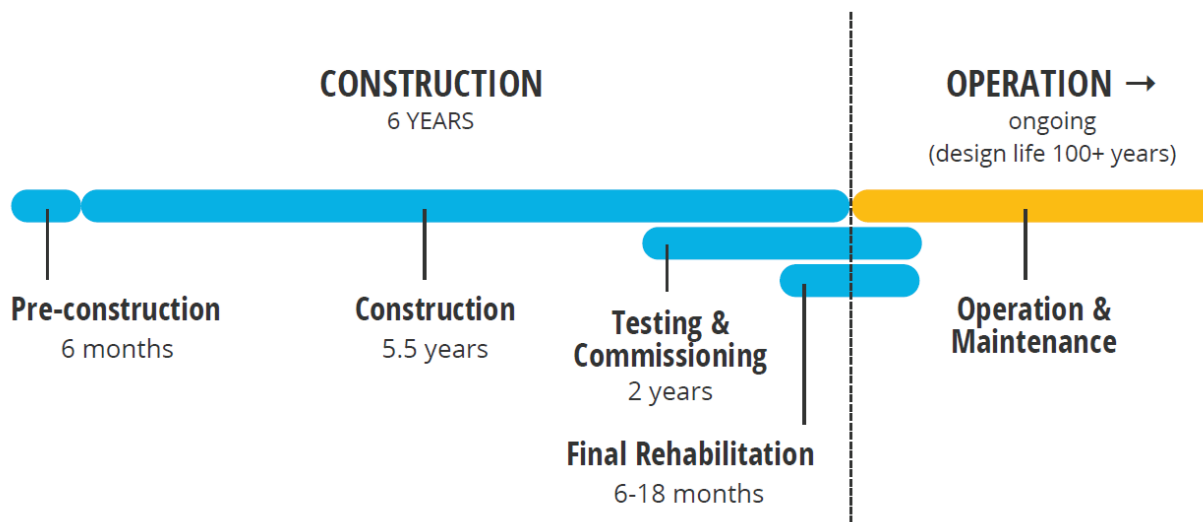


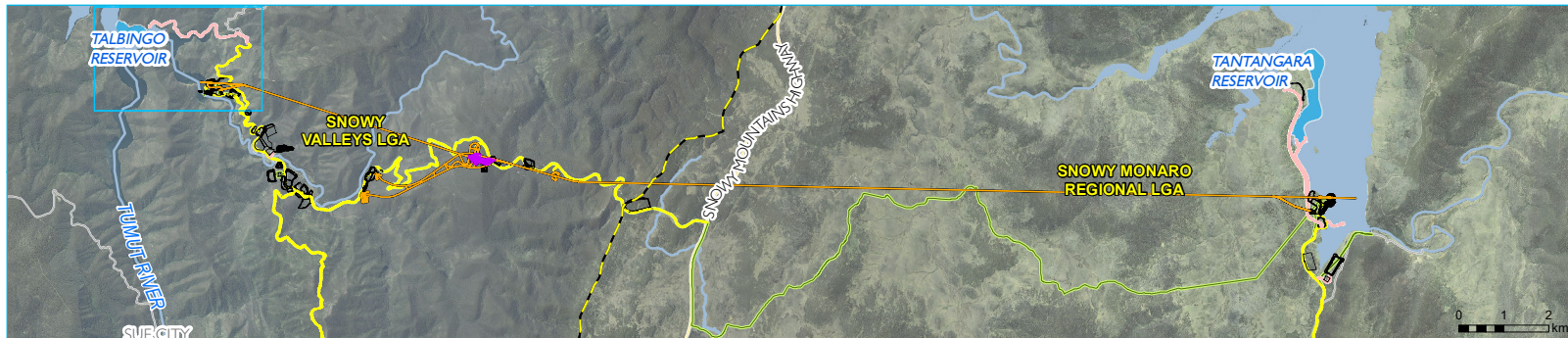
Figure 2.5 Snowy 2.0 Main Works timing and sequencing

Table 2.1 Talbingo Reservoir – project elements, purpose and description

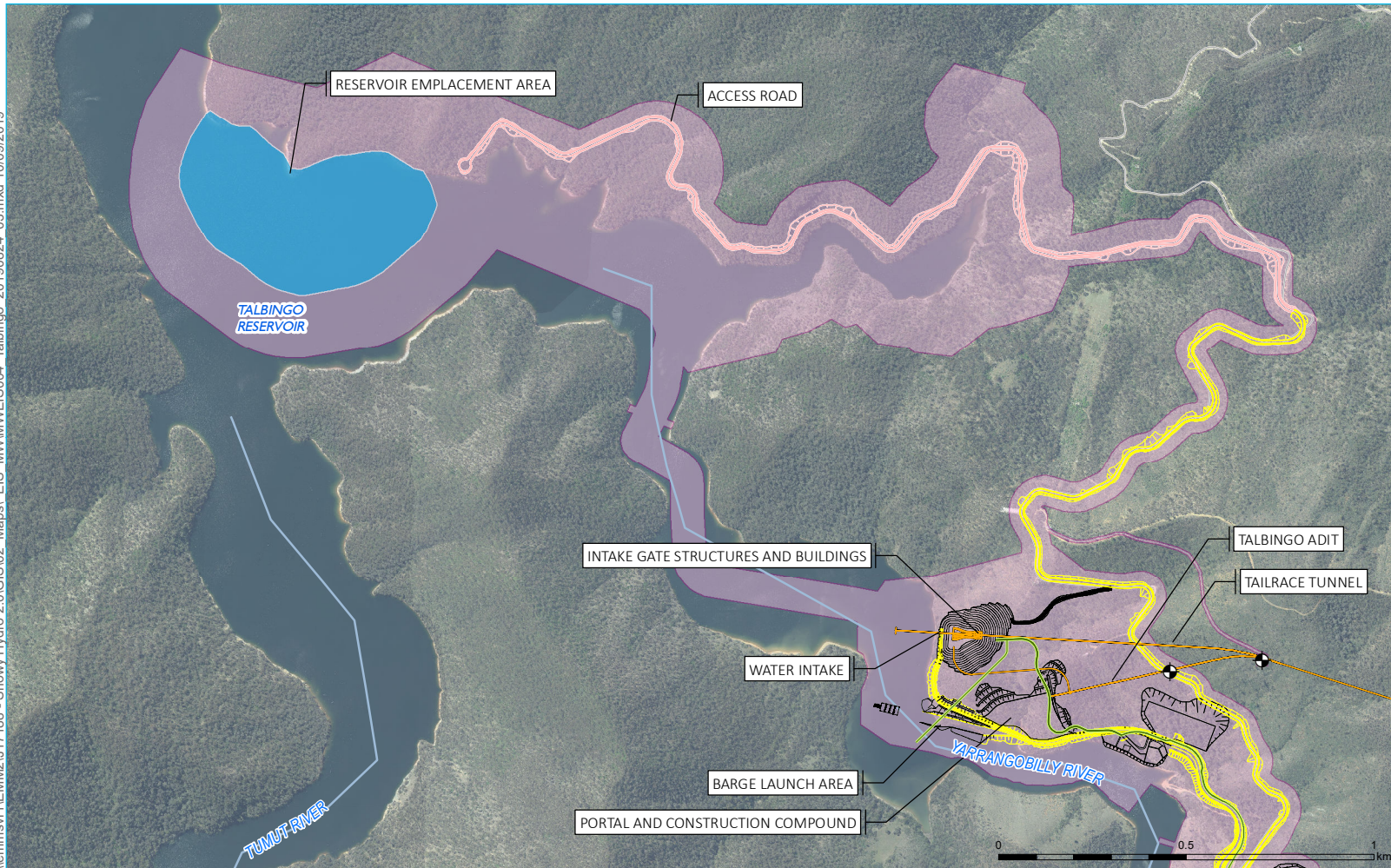
Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Portal and construction compound	Portal and tunnelling associated construction area for TBM launch/support and for removal of excavated material from the tailrace tunnel.	Primary method of drill and blast to create working areas for portals and tunnel access. Construction compounds will require level areas to be created and excess material will be stockpiled and reused where possible.	✓	Construction compound area will be rehabilitated except for hardstand areas remaining at the portal to enable SHL access for maintenance and long-term operations.	SHL access only
Reservoir emplacement areas	Cost-effective and safe management of excess construction materials.	Disposal of excavated material with mobile plant and equipment. Material and armouring will be placed from the edge of the reservoir up to 1 m above FSL to allow for rehabilitation.	✓	Material will be permanent from the shore out into the reservoir down to its bed, however surface water activities on the reservoir will return to pre-construction status. Appropriate signage/navigation hazard warnings will be in place identifying the subaqueous landform.	✓
Access roads and ancillary facilities for emplacement activities	Roads will provide access to the reservoir emplacement area and ancillary facilities.	Roads will be a combination of upgraded existing access roads and new access roads. A new access road will be required to the Talbingo intake structure and to the rock emplacement area.	✓	Existing access roads upgraded to facilitate these activities will be retained permanently. The new access road to Talbingo intake structure will be retained permanently. All other construction only roads will be rehabilitated.	✓
Intake structure	To draw water from the reservoir into the tunnels, and to release water from the tunnels to the reservoir – in pumping and generation modes respectively.	Primary construction method will be drill and blast from shore-based plant and equipment, as well as conventional excavation using earthmoving equipment.	Permanent infrastructure	Cast in-situ concrete structure retained within the reservoir. While the extent is yet to be determined, public access around the intake will need to be restricted for safety reasons.	SHL access only
Intake gate structures (underground) and buildings (at surface)	To isolate the tunnels from the reservoir for maintenance and if required during operation.	Primary construction method will be drill and blast from shore-based plant and equipment. The connection between the intake and reservoir (rock plug) will be removed via water-based equipment, with some underwater blasting and/or dredging, launched from the barge launch area.	Permanent infrastructure	Gate structures within the intake, immediately east of the trashracks and diffuser structure. Access will be restricted to Snowy Hydro.	SHL access only

Table 2.1 Talbingo Reservoir – project elements, purpose and description

Element	Purpose	Temporary use during construction	Permanent/long-term use during operation		
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Tailrace tunnel	<p>During generation mode: to transfer water from the underground power station to Talbingo Reservoir.</p> <p>During pumping mode: to transfer water from Talbingo Reservoir to the underground power station.</p>	<p>Constructed from the Talbingo adit via a TBM heading east towards the power station complex.</p> <p>Excavated material will be transported from the tunnel to Lobs Hole for management or directly to the permanent placement location. The majority of the tunnel will be line with precast concrete segments.</p>	<p>N/A</p> <p>(underground)</p>	<p>Underground and restricted access for Snowy Hydro via the underground power station and Talbingo intake structure for maintenance.</p> <p>The tunnel will be inaccessible to the public.</p>	SHL access only
Talbingo adit	The adit provides access for the TBM to excavate the tailrace tunnel.	<p>Initial excavation will be by drill and blast (from the Talbingo adit to the intake), with the remainder of the tunnel excavation by TBM.</p> <p>The TBM will excavate eastwards to the tailrace surge shaft. This TBM will be the same TBM used for the ECVT tunnel.</p>	<p>✓</p>	The adit will be sealed once excavation of the tailrace tunnel is complete. Rehabilitated land returned to NPWS.	✓
Tailrace surge tank	<p>An underground shaft structure off the tailrace tunnel west of the power station complex at the start of the tailrace tunnel.</p> <p>The shaft will absorb the rise in pressure through the tailrace tunnel during load change conditions in operation.</p>	<p>It will likely be excavated with a blind sink method. Raise boring construction will be utilised initially, with some components constructed by conventional drill and blast practises.</p> <p>Excavated material will be transported from the tunnel to Lobs Hole for management.</p>	<p>N/A</p> <p>(underground)</p>	<p>Underground and restricted access for Snowy Hydro via the underground power station and Talbingo intake structure for maintenance.</p> <p>The tunnel will be inaccessible to the public.</p>	SHL access only
Barge launch area (Exploratory Works)	Boat and barge launching facilities to allow for water access to intakes during construction and for removal of the rock plug, and for assembling and launching of barges.	The launch area will be available for the duration of construction.	Permanent infrastructure	Rehabilitated land returned to NPWS. The launch area will be retained in some form for use during operation for maintenance access. Opportunity for use by NPWS and the public at other times subject to agreement with NPWS.	✓



- KEY**
- Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Local government area boundary
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Geotechnical investigation
 - Indicative rock emplacement area
 - Disturbance area*



Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Talbingo Reservoir - project elements

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.6



Table 2.2 **Lobs Hole – project elements, purpose and description**

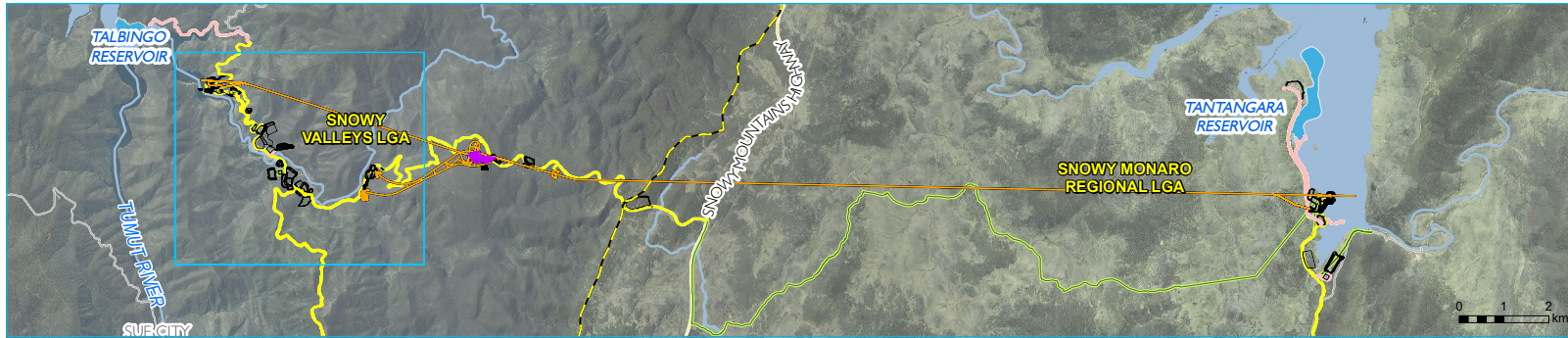
Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Exploratory camp	Approved as part of the Snowy 2.0 Exploratory Works, and provides accommodation for around 150 workers at any one time during construction. Note that approval for an increase to about 250 beds will be sought under a modification to the Exploratory Works approval.	Already constructed as part of Exploratory Works and will be used during construction of Snowy 2.0 Main Works. Rehabilitation will include landforming using excavated rock material.	✓	Rehabilitated land returned to NPWS.	✓
Main Works camp	Provides accommodation for around 1250 workers at any one time during construction.	Constructed using standard techniques. Rehabilitation will include landforming of the site using excavated rock material.	✓	Rehabilitated land returned to NPWS.	✓
On land excavated rock stockpiles and management	Dedicated area to manage excavated rock material in the short and long term. Some of the long term placement will provide improved areas for recreational activities within KNP.	Excavated rock from the tunnels will be placed and compacted with earthmoving plant and equipment. Appropriate batters, drainage and landforming will be carried out to create a safe, non-polluting landform.	✓	Rehabilitated land returned to NPWS. Landform will comprise around 1,000,000 cubic metres (m ³) of excavated rock material used to establish the construction pads and re-shaped to a natural landform commensurate with the surrounding environment.	✓
Main yard	This is the main laydown and construction area for Snowy 2.0 Main Works.	Earth works will be carried out to create stable and flat landforms. Additional materials, in the form of excess cut materials, will be used to create these landforms to enable construction pads to be established and used. Appropriate drainage and erosion and sediment controls will be installed.	✓	Rehabilitated land returned to NPWS.	✓

Table2.2 Lobs Hole – project elements, purpose and description

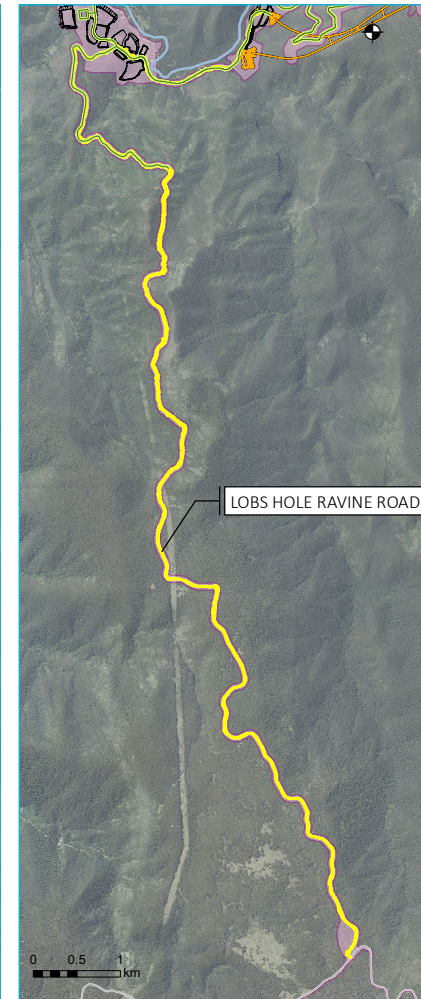
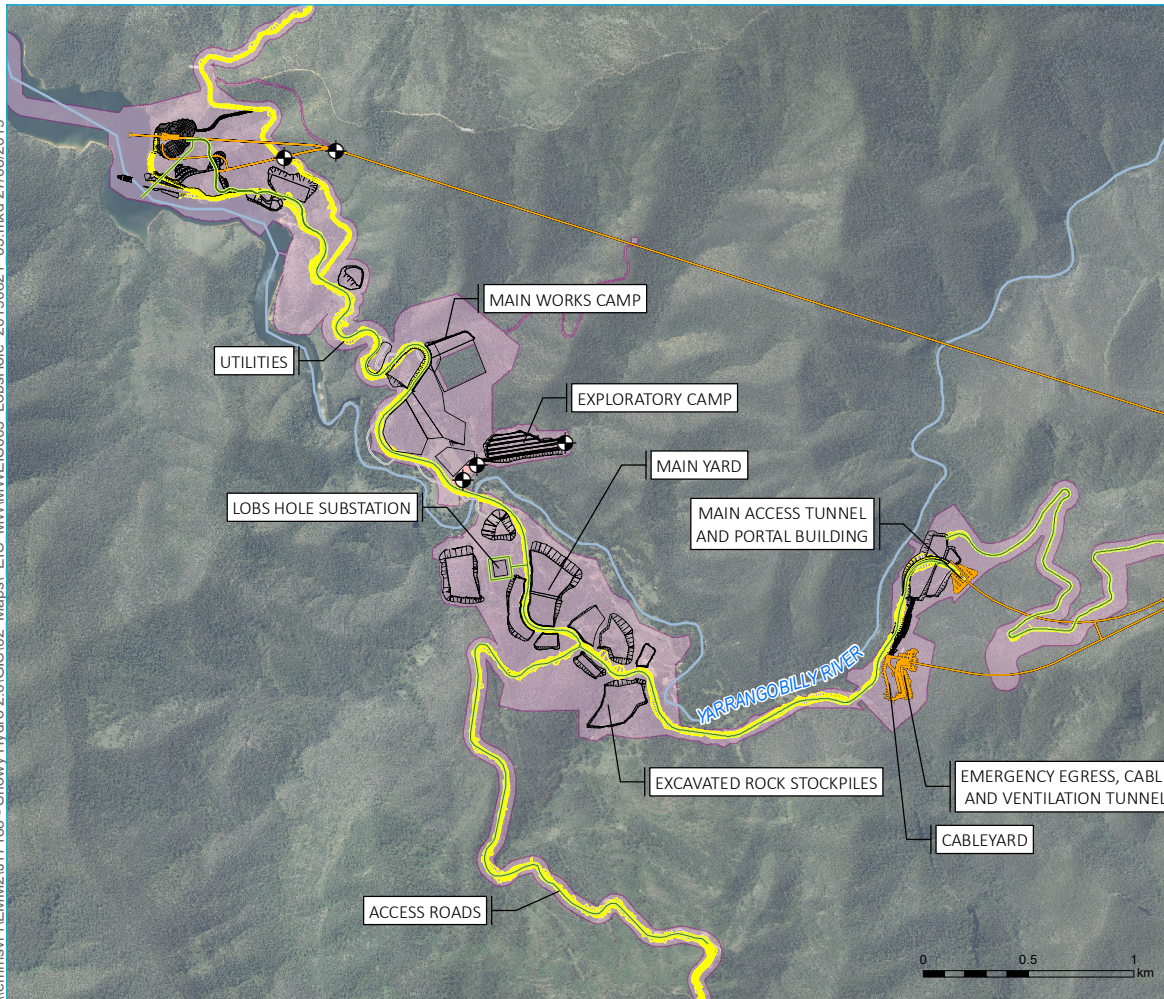
Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
MAT and portal building	The exploratory tunnel approved under Snowy 2.0 Exploratory Works will become the MAT to the underground power station from the surface. It will provide access for staff and equipment during operations and for maintenance of the power station. The portal building and attached facilities accommodate several operational services such as fire protection systems, potable water supply storage and staff facilities.	<p>Already constructed as part of Exploratory Works and will be used during construction of Snowy 2.0 Main Works.</p> <p>The portal building works will be constructed during Snowy 2.0 Main Works and include water treatment facilities.</p>	Permanent infrastructure	Portal will provide access to the power station complex for maintenance and operations. The portal, building and facilities will be retained permanently. Access road will be restricted from Wallaces Creek to MAT portal.	SHL access only
Emergency egress, cable and ventilation tunnel and portal	To provide the route for the high voltage cables to exit from the transformer hall to the above ground cable yard. It also provides a means for emergency evacuation.	This will be excavated by a TBM launching from the ECVT portal. Drill and blast will be carried out for the last section connecting the tunnel to the transformer hall	Permanent infrastructure	The ECVT is parallel to the MAT with its portal adjacent to the MAT portal.	SHL access only
Lobs Hole substation	The primary supply to be used during construction. It will be retained during operations to provide power supply to the power station complex, intake structures and control buildings.	Already constructed as part of Exploratory Works and will be used for construction and operation of Snowy 2.0 Main Works.	Permanent infrastructure	The substation will be fenced and inaccessible to the public.	SHL access only
Cable yard	Connects the power station to the transmission network (NEM).	The construction pad will be levelled, civil and mechanical works to erect and fit-out the gas insulated switchgear (GIS) building and cable yard infrastructure.	Permanent infrastructure	The cable yard will be fenced and inaccessible to the public.	SHL access only

Table2.2 Lobs Hole – project elements, purpose and description

Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Utilities	To provide for the efficient working of construction areas through provision of water and electricity. Discharge of process and waste waters will also be needed.	Wherever possible, electricity and water pipelines will be placed along roads (or adjacent to) and reticulate to the relevant locations within the construction area. Construction methods will comprise a combination of overhead, trenching and underboring, depending on the identified constraints (such as geology and watercourse crossings) or where there are opportunities to minimise disturbance of new areas.	✓	Utilities required for operation will be retained and maintained. Utilities to facilitate construction areas only will be decommissioned and areas rehabilitated. Rehabilitated land returned to NPWS.	✓
Access roads	Roads will provide access to the reservoir emplacement area and ancillary facilities, accommodation camps and MAT and ECVT portals.	Roads will be a combination of upgraded existing access roads and new access roads.	✓	Roads established during construction that are not required for operation will be rehabilitated. Existing access roads upgraded to facilitate these activities will be retained permanently. Lobs Hole Ravine Road and Lobs Hole Road will be publicly accessible, however access on Mines Trail Road east past Wallaces Creek will be restricted to Snowy Hydro and NPWS access only.	✓



- KEY**
- Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Local government area boundary
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Geotechnical investigation
 - Indicative rock emplacement area
 - Disturbance area*



Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Lobs Hole - project elements

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.7



Table 2.3 Marica – project elements, purpose and description

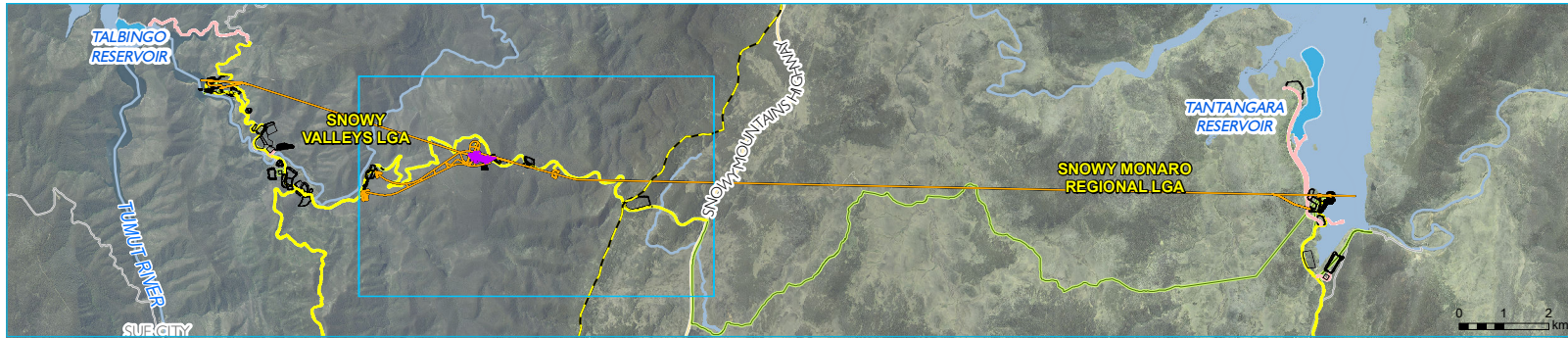
Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated previous use to	Long-term use	Public access
Headrace surge shaft	<p>The shaft ensures safe hydraulic operation of the power station by reducing transient pressures in particular during load change conditions.</p> <p>The upstream surge shaft will absorb sudden rises of pressure on top of the headrace tunnel extension. The shaft is approximately 227 m deep, divided into surge shaft and lower surge riser, and extends to about 15 m above surface level.</p>	<p>A shaft structure constructed from the surface and breaking through to the headrace tunnel, most likely using a blind sink method.</p> <p>A 15 m structure will be visible at the surface.</p> <p>Excavated material will be transported from the shaft to surface at Marica and then to Tantangara for management.</p>	Permanent infrastructure	The shaft structure at the surface will be fenced and inaccessible to the public.	SHL access only
Surge shaft yard	To provide an area to excavate the surge shaft, including storage of equipment, explosives and stockpiles for excavated rock. The area will also allow for site office, first aid and worker facilities.	Construction will involve clearing and levelling of the site, a crane bridge to support blind sinking excavation downward excavation to the headrace tunnel, rock support, concrete works and steel works.	✓	<p>Most of the construction compound area will be rehabilitated, with only the shaft structure remaining at surface.</p> <p>Rehabilitated land returned to NPWS</p>	✓
Pressure tunnels	To transfer water from the headrace tunnel to the power station complex. This includes a single inclined pressure tunnel, branching into three high pressure tunnels and then into six penstock tunnels.	<p>The high pressure tunnels will be constructed using drill and blast.</p> <p>The single-inclined pressure shaft will be excavated by utilising the TBM that excavates the MAT, by continuing past (east) the powerhouse complex and up to the upstream end of the high pressure tunnel manifolds.</p> <p>Excavated material will be transported from the tunnel to Lobs Hole for management.</p>	<p>N/A</p> <p>(underground)</p>	The underground tunnels will be inaccessible to the public.	SHL access only

Table 2.3 **Marica – project elements, purpose and description**

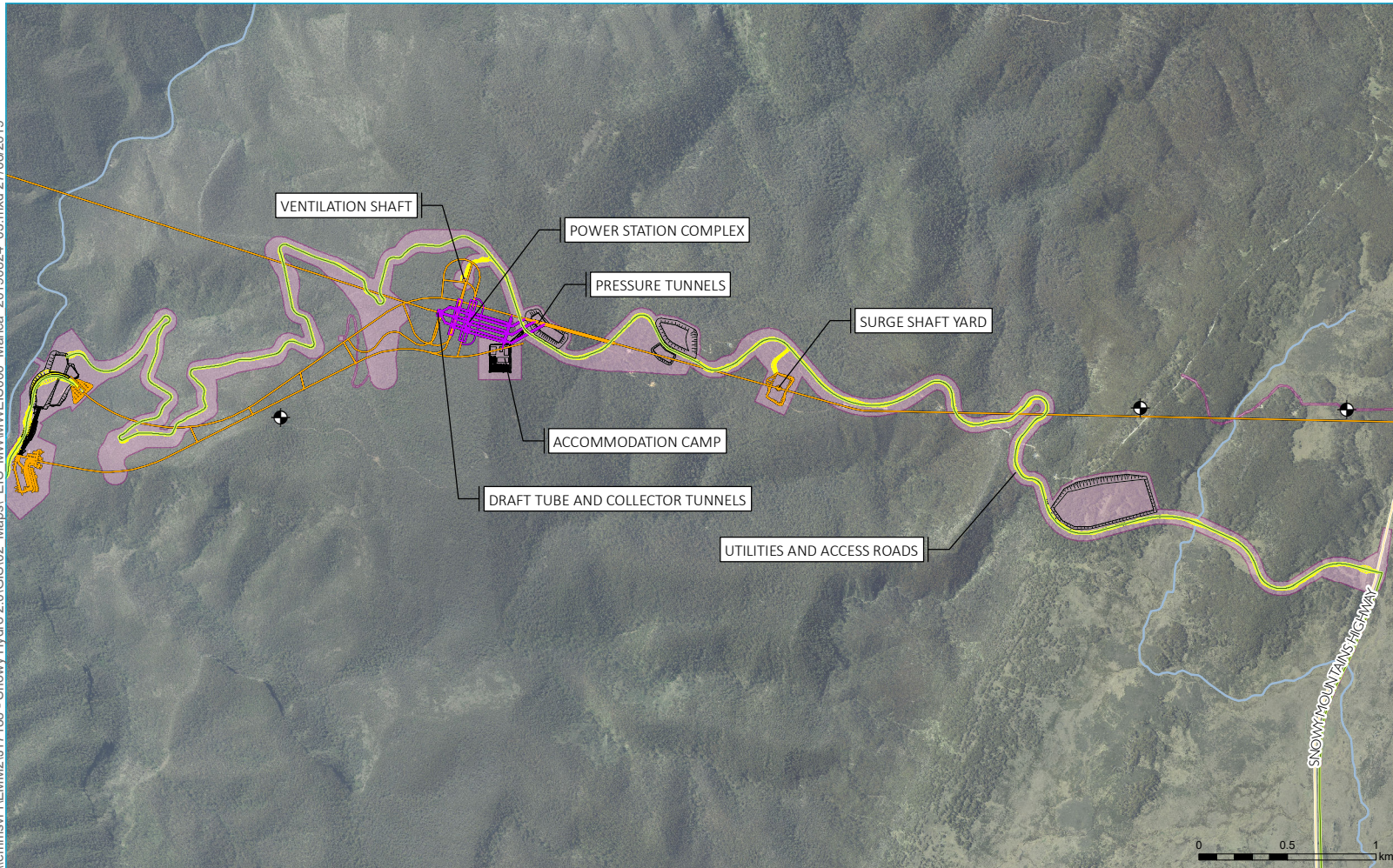
Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Power station complex (including machine hall and transformer hall)	<p>The power station will generate electricity from water transfer and pump water in reverse between Tantangara and Talbingo reservoirs.</p> <p>The machine hall will house the six pump-turbine and motor-generator units. The transformer hall will house the six, three-phase transformers and six draft tube gates.</p>	<p>The complex location will be accessed initially by TBM from the exploratory tunnel. From there, the primary construction method will be drill and blast. The complex will be oriented using the results of the geotechnical drilling carried out following completion of the exploratory tunnel.</p> <p>Excavated material will be transported from the complex to Lobs Hole for management.</p>	N/A (underground)	Underground and accessed from the MAT via the Lobs Hole portal. The power station complex will be inaccessible to the public.	SHL access only
Draft tube and collector tunnels	Underground tunnels to transfer water from the power station draft tube gates to the tailrace surge tank. This includes six draft tube tunnels, converging into three collector tunnels.	These draft tube and collectors tunnels will be constructed via drill and blast method.	N/A (underground)	The underground tunnels will be inaccessible to the public.	SHL access only
Ventilation shaft	To provide ventilation to the underground power station during excavation of the caverns, and during operation if required.	<p>The shaft will likely be constructed by raise bore or blind sink method.</p> <p>It will be accessed by the Marica Trail off the Snowy Mountains Highway.</p>	Permanent infrastructure	The shaft will have a permanent building at the surface about 6 m in height. It will be fenced and inaccessible to the public.	SHL access only
Marica accommodation camp	Provides accommodation for up to 100 workers at any one time during construction.	Constructed during standard techniques. Rehabilitation will include landforming using excavated rock material.	✓	Rehabilitated land returned to NPWS.	✓

Table 2.3 **Marica – project elements, purpose and description**

Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated previous use	Long-term use	Public access
Utilities	To provide for the efficient working of construction areas through provision of water and electricity. Discharge of process and waste waters will also be needed.	<p>Wherever possible, electricity and water pipelines will be placed in roads (or adjacent to) and reticulate to the relevant locations within the construction area. Construction methods will comprise a combination of overhead, trenching and underboring, depending on the constraints identified (such as geology and watercourse crossings) or where there are opportunities to minimise disturbance of new areas.</p> <p>Options to source water locally (eg via groundwater supply wells) or transported to site (eg water carts) will be investigated during detailed design.</p>	✓	<p>Utilities to facilitate construction areas will be decommissioned and areas rehabilitated.</p> <p>Rehabilitated land returned to NPWS.</p>	✓
Access roads	To provide for safe access for materials, equipment and workforce during the construction period.	<p>A new intersection with Snowy Mountains Highway will be built, enabling access directly to the existing Marica Trail. From the intersection to the surge tank, the road will be gravel and two lanes. A new track (single lane) will be created extending Marica Trail down to the MAT portal to provide an alternate access to Lobs Hole.</p> <p>Roads and tracks will be built using standard construction techniques.</p>	Permanent infrastructure	From its intersection with the Snowy Mountains Highway, Marica Trail will be retained permanently for use during operation by Snowy Hydro and NPWS.	SHL access only



- KEY**
- Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Local government area boundary
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Geotechnical investigation
 - Indicative rock emplacement area
 - Disturbance area*



Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Marica - project elements

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.8



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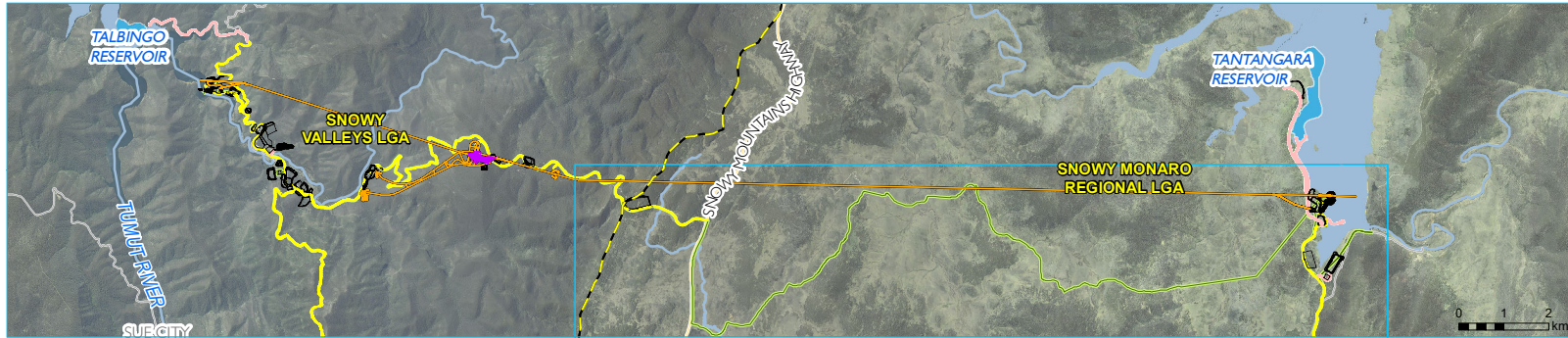
Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

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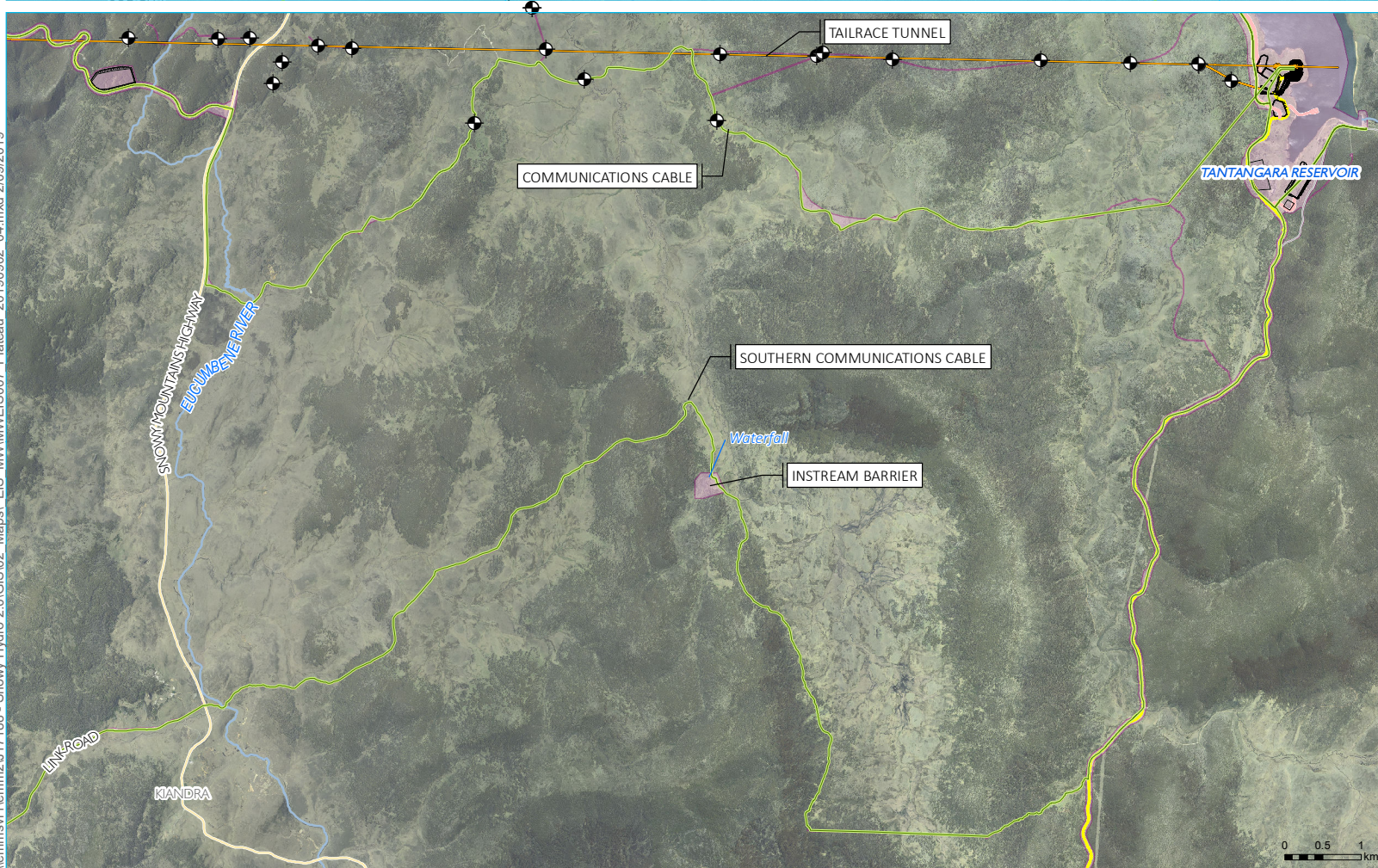


Table 2.4 Plateau- project elements, purpose and description

Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Headrace tunnel	<p>During generation mode: to transfer water from Tantangara Reservoir to the underground power station.</p> <p>During pumping mode: to transfer water from the underground power station to Tantangara Reservoir.</p>	<p>Constructed via a TBM launched from Tantangara adit heading westwards to the surge shaft at Marica.</p> <p>Excavated material will be transported from the tunnel to Tantangara for management.</p>	<p>N/A</p> <p>(underground)</p>	<p>During generation mode: to transfer water from the Tantangara intake to the underground power station.</p> <p>During pumping mode: to transfer water from the underground power station to Tantangara Reservoir.</p> <p>Underground and restricted access for Snowy Hydro via the surge tank and Tantangara intake structure for maintenance.</p> <p>The tunnel will inaccessible to the public.</p>	SHL access only
Communications cable	To provide secure and redundant communications between Talbingo intake, power station and Tantangara intake and the main control centre in Cooma.	<p>Two communications cables will be installed. One will be within sections of the Snowy Mountains Highway and Gooandra track corridors between the power station and Tantangara Reservoir.</p> <p>A more southern route will also be built. This route is mainly within the Snowy Mountains Highway and Tantangara Road corridors.</p> <p>These cables will be laid in a trench with some sections also underbored or bridged where suitable. Temporary passing bays enabling vehicles to safely manoeuvre and pass will be established where required.</p>	✓	<p>It will provide a communication system that connects the Snowy 2.0 assets for operations.</p> <p>The cable will be buried and the existing KNP tracks and public roads will be accessible the public.</p>	✓
Instream barrier	To prevent the potential upstream migration of Climbing galaxias	A structure will be built on Tantangara Creek. The construction method will be determined as part of the detailed design process.	Permanent structure	Rehabilitated land returned to NPWS.	✓



- KEY**
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- Main road
 - Local road
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 - Waterbodies
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 - Power station
 - Utilities
 - Permanent road
- Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
 - Temporary access road
 - Geotechnical investigation
 - Indicative rock emplacement area
 - Disturbance area*



Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Plateau - project elements

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.9



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

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Table 2.5 **Tantangara Reservoir – project elements, purpose and description**

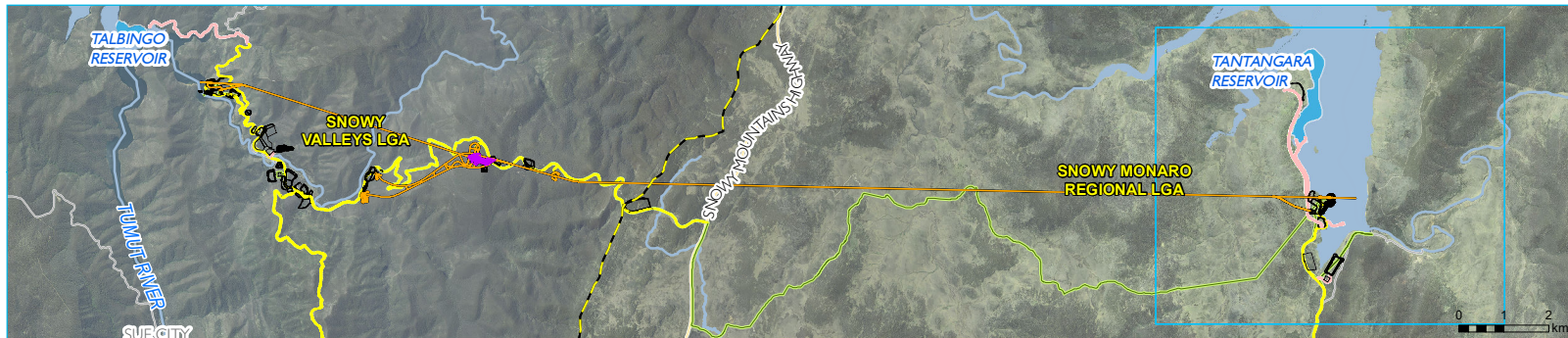
Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Portal and construction compound	Portal and tunnelling associated construction area or TBM support and for removal of excavated material from the tailrace tunnel.	The portal will be excavated using drill and blast techniques. Excavated material will be transported to Tantangara for management. The compound will be created using earthworks to create stable and flat areas for use.	✓	Construction compound area will be rehabilitated with small hard-standing areas remaining at the portal to enable Snowy Hydro access for maintenance and long-term operations.	SHL access only
Tantangara adit	To provide access for a TBM into the headrace tunnel.	One TBM will be launched from the Tantangara construction adit.	✓	The adit will be appropriately capped and closed off preventing access.	SHL access only
Tantangara laydown area	An area for laydown and maintenance of construction plant, equipment and materials storage.	Earthworks will be carried out to create stable and flat areas for use. Appropriate drainage and erosion and sediment controls will be installed.	✓	Rehabilitated land returned to NPWS.	✓
Reservoir emplacement areas	Excavated rock will be emplaced at this location as a cost-effective solution with minimal long-term environmental impacts.	Disposal of excavated material with mobile plant and equipment between FSL and MOL. The final height of the emplacement area will be above FSL level to allow for rehabilitation for use as a recreational area.	✓	Material will be permanently placed within the reservoir. This area will be accessible to the public, however may be inundated more often than existing Snowy Scheme operations. Appropriate signage/navigation hazard warnings will be in place identifying the subaqueous landform.	✓
Access roads and ancillary facilities for emplacement activities	Roads will provide access to the reservoir emplacement area and ancillary facilities.	Roads will be a combination of upgraded existing access roads and new access roads. New access road to the Tantangara intake structure will be permanent. Other access roads will be temporary and rehabilitated. Improvements to the intersection at Tantangara Road and Snowy Mountains Highway will be built to facilitate access for construction traffic. A bridge over Nungar Creek on Tantangara Road will be built.	✓	Existing access roads upgraded to facilitate these activities will be retained permanently. New access road to the Tantangara intake structure will be restricted to SHL access only. Rehabilitated land returned to NPWS.	✓

Table 2.5 Tantangara Reservoir – project elements, purpose and description

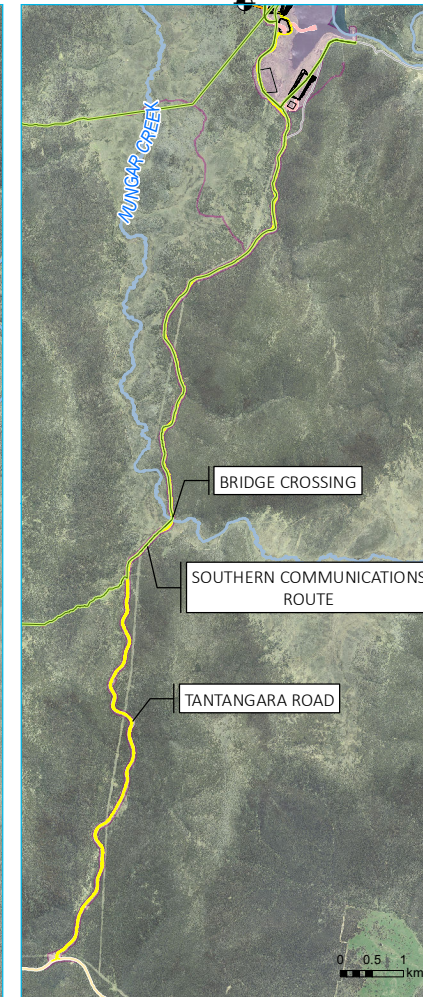
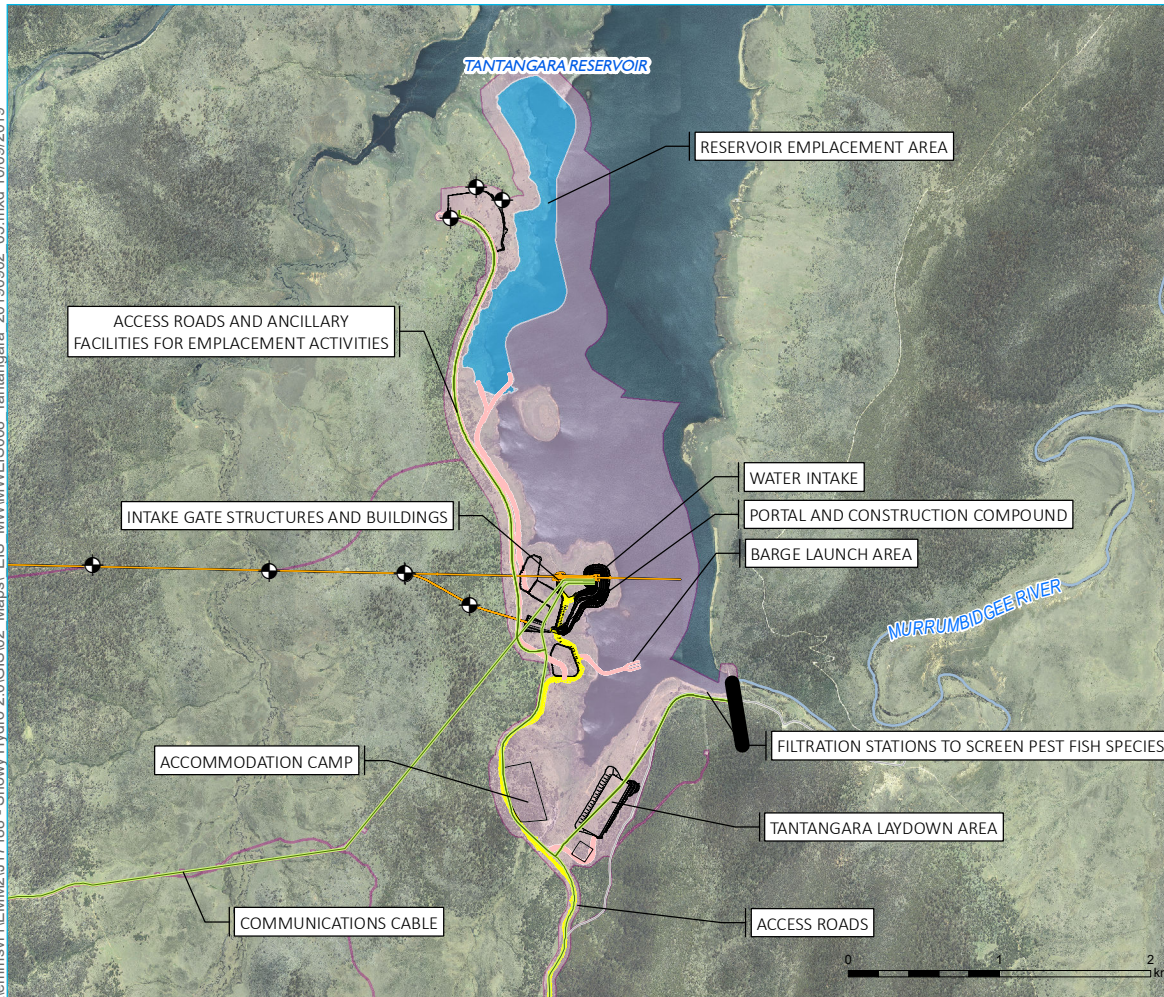
Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Intake structure	To draw water from the reservoir into the tunnels, and to release water from the tunnels to the reservoir – in both generation and pumping modes.	Primary construction method will be drill and blast from shore-based plant and equipment.	Permanent infrastructure	Intake structure retained within the reservoir. A floating boom across the end of the approach channel will be placed to restrict public access for safety reasons.	SHL access only
Intake gate structures (underground) and buildings (at surface)	To isolate the tunnels from the reservoir for maintenance and if required during operation.	Primary construction method will be drill and blast from shore-based plant and equipment. The connection between the intake and reservoir (rock plug) will be removed via water-based equipment, launched from the barge launch area.	Permanent infrastructure	Gate structures within the intake, approximately 250 m west of the trashracks and diffuser structure. Access will be restricted to use by Snowy Hydro.	SHL access only
Barge launch area	Boat and barge launching facilities to allow for water access to intakes during construction and for removal of the rock plug, and for assembling and launching of barges.	The launch area will be available for the duration of construction.	Permanent infrastructure	Rehabilitated land returned to NPWS. The launch area will be retained in some form for use during operation for maintenance access. Opportunity for use by NPWS and the public at other times subject to agreement with NPWS.	✓
Tantangara accommodation camp	Provides accommodation for around 500 people to facilitate construction of the headrace tunnel, intake and excavated rock emplacement.	Earthworks will be carried out to create stable and flat areas for use. Appropriate drainage and erosion and sediment controls will be installed.	✓	Rehabilitated land returned to NPWS.	✓
Utilities	To provide for the efficient working of construction areas through provision of water and electricity. Discharge of process and waste waters will also be needed.	Wherever possible, electricity and water pipelines will be placed in roads (or adjacent to) and reticulate to the relevant locations within the construction area. Construction methods will comprise a combination of overhead, trenching and underboring, depending on the identified constraints (such as geology and watercourse crossings) or where there are opportunities to minimise disturbance of new areas.	✓	Utilities to facilitate construction areas will be decommissioned and areas rehabilitated. Rehabilitated land returned to NPWS.	✓

Table 2.5 **Tantangara Reservoir – project elements, purpose and description**

Element	Purpose	Temporary use during construction		Permanent/long-term use during operation	
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Fish control structures	To limit the potential range expansion of any fish species of concern that may be potentially transferred to Tantangara Reservoir as a result of the project.	A filtration station/s to screen pest fish species from being discharged through the Murrumbidgee-Eucumbene Tunnel will be installed upstream of Tantangara Reservoir wall.	Permanent infrastructure	Permanent infrastructure to be maintained by Snowy Hydro.	SHL access only



- KEY**
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Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Tantangara Reservoir - project elements

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.10



Table 2.6 **Rock Forest – project elements, purpose and description**

Element	Purpose	Temporary use during construction	Permanent/long-term use during operation		
		Method summary	Rehabilitated to previous use	Long-term use	Public access
Logistics yard	Laydown, stockpile and staging area for materials and heavy vehicles. This is a private landholding under lease to Snowy Hydro.	Earthworks will be carried out to create stable and flat areas for use. Appropriate drainage and erosion and sediment controls will be installed.	✓	Rehabilitated landform returned to landowner.	N/A
Access	Provide safe access to and from the logistics yard via the Snowy Mountains Highway.	A new intersection from the Snowy Mountains Highway will be built.	✓	The access will be able to be used by the landowner.	N/A

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



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- KEY**
- Existing environment
 - Main road
 - Local road
 - Watercourse
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Geotechnical investigation
 - Disturbance area*

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Rock Forest - project elements

Snowy 2.0
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Main Works
Figure 2.11



2.2.4 Summary of project elements

A summary of the key elements that form Snowy 2.0 Main Works is provided in Table 2.7.

Table 2.7 Snowy 2.0 Main Works summary

Project element	Summary of the project
Project area	The project area is the broader region within which Snowy 2.0 will be built and operated, and the extent within which direct impacts from Snowy 2.0 Main Works are anticipated.
Permanent infrastructure	<p>Snowy 2.0 infrastructure to be built and operated for the life of the assets include the:</p> <ul style="list-style-type: none"> • intake and gate structures and surface buildings at Tantangara and Talbingo reservoirs; • power waterway tunnels primarily comprising the headrace tunnel, headrace surge structure, inclined pressure tunnel, pressure pipelines, tailrace surge tank and tailrace tunnel; • underground power station complex comprising the machine hall, transformer hall, ventilation shaft and minor connecting tunnels; • access tunnels (and tunnel portals) to the underground power station comprising the MAT and ECVT; • fish control structures in proximity to Tantangara Reservoir wall; • establishment of a portal building and helipad at the MAT portal; • communication, water and power supply including the continued use of the Lobs Hole substation; • cable yard adjacent to the ECVT portal to facilitate the connection of Snowy 2.0 to the NEM; and • access roads, permanent bridge structures and barge launch ramps needed for the operation and maintenance of Snowy 2.0 infrastructure.
Temporary infrastructure	<p>Temporary infrastructure required during the construction phase of Snowy 2.0 Main Works are:</p> <ul style="list-style-type: none"> • construction compounds, laydown, ancillary facilities and helipads; • accommodation camps for construction workforce; • construction portals and adits to facilitate tunnelling activities; • barge launch ramps; • water and wastewater management infrastructure (treatment plants and pipelines); • communication and power supply; and • temporary access roads.
Disturbance area	The disturbance area is the extent of construction works required to build Snowy 2.0. The maximum disturbance area is about 1,680 ha which is approximately 0.25% of the KNP. Most of the disturbance area will be rehabilitated and landformed and other parts will be retained permanently for operation (operational footprint).
Operational footprint	The operational footprint is the area required for permanent infrastructure to operate Snowy 2.0. The maximum operational footprint is about 99 ha which is approximately 0.01% of the KNP.
Tunnelling and excavation method	The primary tunnelling method for the power waterway is by TBM, with portals and adits using drill and blast methods. Excavation for other underground caverns, chambers and shafts will be via combinations of drill and blast, blind sink, or raise bore techniques.
Excavated rock management	Excavated rock will be generated as a result of tunnelling activities and earthworks. The material produced through these activities will be stockpiled and either reused by the contractor (or NPWS), placed permanently within Tantangara or Talbingo reservoirs, used in final land forming and rehabilitation of construction pads in Lobs Hole, or transported offsite.

Table 2.8 Snowy 2.0 Main Works summary

Project element	Summary of the project
Construction water and wastewater management	<p>Water supply for construction will be from the two existing reservoirs (Talbingo and Tantangara) and reticulated via buried pipelines (along access roads). Raw water will be treated as necessary wherever potable water is required (eg at accommodation camps).</p> <p>Water to be discharged (comprising process water, wastewater and stormwater) will be treated before discharge to the two existing reservoirs (Talbingo and Tantangara) as follows:</p> <p>treated process water will be reused onsite where possible to reduce the amount of discharge to reservoirs, however excess treated water will be discharged to the reservoirs;</p> <p>collected sewage will be treated at sewage treatment plants to meet the specified discharge limits before discharge and/or disposal; and</p> <p>stormwater will be captured and reused as much as possible.</p>
Rehabilitation	<p>Rehabilitation of areas disturbed during construction including reshaping to natural appearing landforms or returning to pre-disturbance condition, as agreed with NPWS and determined by the Rehabilitation Strategy (see Appendix F). This includes construction areas at Lobs Hole which comprise surplus cut materials. Areas to be used by Snowy Hydro in the long-term may be re-shaped and rehabilitated to maintain access and operational capabilities (eg intakes and portal entrances)</p>
Construction workforce	<p>The construction workforce for the project is expected to peak at around 2,000 personnel.</p>
Operational life	<p>The operational life of the project is estimated to be 100 years.</p>
Operational workforce	<p>The operational workforce is expected to be 8-16 staff, with fluctuations of additional workforce required during major maintenance activities.</p>
Hours of operation	<p>Construction of Snowy 2.0 will be 24/7 and 365 days per year.</p> <p>Operation of Snowy 2.0 will be 24/7 and 365 days per year.</p>
Capital investment value	<p>Estimated to be \$4.6 billion.</p>

2.3 Construction of Snowy 2.0 Main Works

2.3.1 Construction phases and activities

The construction of Snowy 2.0 Main Works has different and overlapping phases during the approximate six year period. This is shown in Figure 2.12, with each of the different phases described in the following sections.

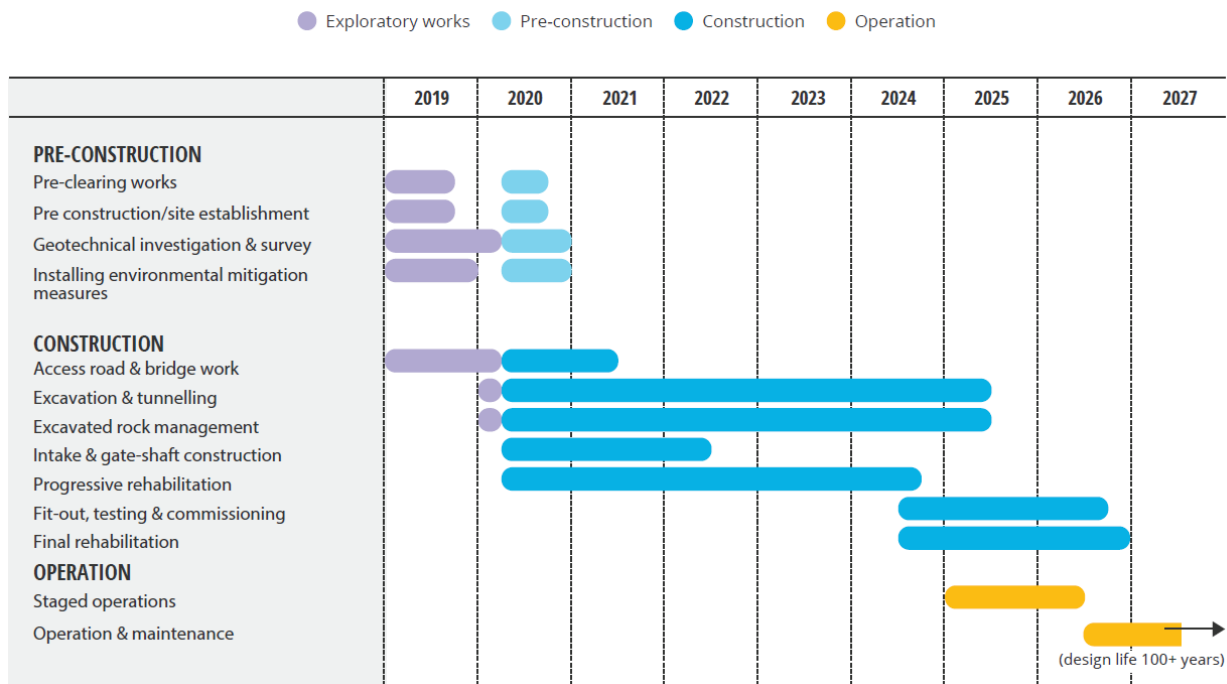


Figure 2.12 Indicative construction sequencing

i Pre-construction works

Pre-construction works will follow well-established practices with the following indicative steps carried out:

- prior to the commencement of work, all sites will be surveyed and clearly marked;
- site fencing will be erected to provide security and safety;
- erection of a temporary site compound at each site to support pre-construction activities;
- erosion and sediment control measures will be installed on site. This includes mitigation around stockpile areas. Topsoil and general fill material will be stockpiled in clearly separated areas;
- trees and shrubs will be cleared only within the demarcated disturbance boundary (clearing works includes removing tree stumps and roots up to 600 millimetres (mm) below ground);
- hazardous tree assessment of trees that are outside the disturbance boundary but within close proximity, and removal of any trees deemed to be hazardous or at-risk to ensure the safety of workers; and
- expansion of the initial site compound to provide facilities for the main construction activities.

Table 2.9 provides a summary of the activities to be carried out during the pre-construction phase of the works.

Table 2.9 Overview of pre-construction activities and methods

Component/stage	Construction area	Typical activities
Site establishment	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Site boundary delineation and establishment of survey control network Clearing and grubbing Hazardous tree assessment within and adjacent to disturbance boundary and removal/trimming of hazardous trees as per assessment recommendations Drainage and environmental controls Earthworks and levelling Establish construction ancillary facilities and access Construct water and wastewater treatment facilities Continued use of construction power substation
Construction – geotechnical investigation and survey	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Clearing and levelling of drill pads including temporary access tracks and support infrastructure such as water supply and waste management systems Drilling and in situ testing and characterisation
Archaeological and heritage salvage and test excavations	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Carry out archaeological and heritage surveys of project area as required Record sites as required Salvage items as required and carry out reporting as documented in Aboriginal Cultural Heritage Assessment (ACHA) and Historic Heritage Assessment
Pre-clearance surveys	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Carry out ecological surveys in accordance with requirements of the Biodiversity Development Assessment Report (BDAR) and relevant species
Building and road dilapidation studies	<ul style="list-style-type: none"> Lobs Hole Tantangara Relevant public roads 	<ul style="list-style-type: none"> Identify buildings and/or roads to be subject to dilapidation studies Carry out dilapidation surveys and report Execute relevant recommendations of dilapidation studies
Environmental management, monitoring and mitigation	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Establish committed environmental management, monitoring and management measures
Groundwater monitoring bores	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Clearing and levelling of drill pads including temporary access tracks and support infrastructure such as water supply and waste management systems Drilling and bore establishment Rehabilitation of drill pad with access maintained

Management plans will be prepared as required by the conditions of approval and submitted to the relevant authority.

ii Construction and progressive rehabilitation

A detailed schedule will be prepared for the construction of Snowy 2.0 Main Works. It is anticipated the schedule will further detail the sequencing of construction and is expected to include the following discrete but overlapping activities:

Construction works: Once relevant designs are completed and approved, construction works will commence. The timing of the construction works is shown in Figure 2.12.

- Construction activities will occur concurrently at several sites across the project area.

- Progressive revegetation and rehabilitation, management and monitoring: Rehabilitation will be carried out progressively during the construction works where practicable. All non-permanent infrastructure will be decommissioned, and the disturbance area rehabilitated in accordance with a rehabilitation plan.

Table 2.10 Overview of construction activities and sequencing

Component/stage	Construction area	Typical activities
Construction - access road and bridge work	<ul style="list-style-type: none"> • All 	<ul style="list-style-type: none"> • Site preparation of all roads (new or upgraded), including: <ul style="list-style-type: none"> – Clearing boundary is surveyed and pegged out – Removal/trimming of any hazardous trees following pre-construction survey if required as per assessment recommendations – Any pre-clearing activities are completed, such as facilitating the egress of fauna – Erosion and sediment control measures will be installed prior to works commencing, or as early as practicable • Construct retaining walls where needed • Excavate road level • Lay road base, pavement and drainage • Construct bridges and culverts • Install road furniture such as signs and safety barriers
Construction - excavation and tunnelling	<ul style="list-style-type: none"> • Talbingo Reservoir • Lobs Hole • Marica • Tantangara Reservoir 	<ul style="list-style-type: none"> • Construct portals and adits • Mobilisation and site setup of TBMs (where required) • Excavate power waterways, power station cavern, and associated tunnel infrastructure • Install ground support where required • Receipt and use of precast segments for tunnels where required • Excavated rock management and haulage
Construction - excavated rock management	<ul style="list-style-type: none"> • Talbingo Reservoir • Lobs Hole • Marica • Tantangara Reservoir 	<ul style="list-style-type: none"> • Transport of excavated rock from tunnels, adits, portals and surge shaft to stockpile areas • Testing of excavated rock for suitability of placement (where required) • Transport to and filling of placement areas within the reservoirs and on-land placement for construction pads and/or permanent landforming
Construction - intake and gate shaft construction	<ul style="list-style-type: none"> • Talbingo Reservoir • Tantangara Reservoir 	<ul style="list-style-type: none"> • Clearing and grubbing • Cut excavation and benching to required depth, retaining a temporary rock plug to allow dry works zone • Install permanent rock anchors where required • Concrete works • Removal of rock plug
Construction – progressive rehabilitation	<ul style="list-style-type: none"> • All 	<ul style="list-style-type: none"> • Collection and storage of indigenous/native seed and alpine sods • Progressive rehabilitation comprising: <ul style="list-style-type: none"> – Stabilisation of slopes and preparation of sites for revegetation – Mitigation of sediment runoff – Hydroseeding/hydro mulching/planting of slopes – Decommissioning of infrastructure by removal of all temporary facilities – Reinstatement of topsoil and seeding and planting of vegetation – Protection of revegetation and weed management

iii Testing and commissioning

Commissioning activities will be carried out over approximately a two-year period and will involve:

- operation and testing of all plant in both generating and pumping modes, at all required power output and input ranges for operations;
- the associated transfer of water between Tantangara and Talbingo reservoirs at various reservoir levels; and
- the testing of operating and protection systems for the plant and equipment.

Table 2.11 Overview of testing and commissioning activities and methods

Component/stage	Construction area	Typical activities
Commissioning - fit-out, testing and commissioning	<ul style="list-style-type: none"> • Talbingo Reservoir • Lobs Hole • Marica • Tantangara Reservoir 	<ul style="list-style-type: none"> • For all permanent structures: <ul style="list-style-type: none"> – Concrete works – Install electrical and mechanical – Test and commission plant equipment

iv Final rehabilitation

Most disturbed areas, not retained for operations, will be returned to land uses generally consistent with their pre-disturbance use, subject to ongoing consultation with NPWS. Snowy Hydro will liaise closely with NPWS to determine the extent of decommissioning of temporary construction facilities and rehabilitation activities to be carried out during and following the construction of Snowy 2.0 of Main Works.

This approach will be taken to ensure that decommissioning allows for integration with future planned recreational uses of these areas and to maintain the values of KNP and be consistent with the KNP Plan of Management (PoM) (NPWS 2006). An overview of final rehabilitation activities and methods is provided in Table 2.12. Further engagement with NPWS will be carried out to understand the opportunities to allow for recreational uses where appropriate and practical to do so within the rehabilitation activities implemented post-construction. This is discussed further in Section 2.3.8.

Table 2.12 Overview of final rehabilitation activities and methods

Component/stage	Construction area	Typical activities
Completion of rehabilitation	<ul style="list-style-type: none"> • All 	<ul style="list-style-type: none"> • Detailed completion criteria, performance measures and associated indicators will be used to demonstrate success of rehabilitation. These include: <ul style="list-style-type: none"> – Phase 1: Active – Phase 2: Decommissioning – Phase 3 – Landform establishment – Phase 4 – Growth medium development – Phase 5 – Ecosystem and Land use establishment – Phase 6 – Ecosystem and Land use development – Phase 7 – Rehabilitation complete
Rehabilitation monitoring	<ul style="list-style-type: none"> • All 	<ul style="list-style-type: none"> • Ongoing monitoring will be carried out as required using analogue/references sites for a comparison of the development and success of rehabilitation

2.3.2 Permanent infrastructure

i Intake structures and gate shafts

Intake structures are required at the Tantangara and Talbingo reservoirs to convey water in and out of the power waterway and ultimately to and from the Snowy 2.0 power station. Both intake structures are designed to operate in either generating or pumping mode with minimum head losses and optimised to reduce impacts on the environmental setting of the structures within KNP where possible. Each intake will comprise:

- a permanently submerged approach channel; and
- an integrated gate tower and diffuser structure.

The construction of intake structures will be divided into two stages. Firstly, the intake structures will be constructed on-land by excavating the intake pit, creating a natural rock plug to prevent reservoir water flowing into the tunnel and flooding the underground works. The rock plug will be removed in the second stage once the permanent approach channel has been excavated and all underground and tunnelling works are completed. Detailed description of the construction process for each intake is provided in Appendix D, with a snapshot provided in Figure 2.13 and Figure 2.14.

ii Power waterway tunnels, chambers and shafts

The main power waterway comprises the headrace tunnel and the tailrace tunnel. However, there are several other underground tunnels, chambers and shafts that enable the transfer of water between the two reservoirs and through the underground power station. Most of the power waterway infrastructure will be established underground, with access to the surface provided via several access tunnels and portals.

For the headrace and tailrace tunnels in particular, two single shielded TBMs will be utilised (refer to Figure 2.4). A dual mode TBM will be used to excavate the headrace tunnel, capable of operating as a single shield TBM or operating in slurry mode to manage naturally occurring asbestos (NOA) material expected along the way. The choice of the shielded TBM has been driven by safety considerations during construction and a higher rate of advance. When compared with drill and blast, shielded TBM excavation provides almost no exposure of workers to an unsupported rock mass.

The TBMs will be fully equipped to perform the excavation, ventilation, lining, removal of excavated material. Geotechnical drilling or 'probing' as well as seismic reflection and geo-electrical surveys will also be conducted ahead of the TBMs to identify potentially critical areas with poor rock conditions, high fracturing or the presence of an aquifer. Application, where required, of pre-grouting and secondary grouting from the TBM to prevent excessive leakage and aquifer drainage during tunnel construction, as well as to consolidate the rock mass and reduce the risk of jamming the TBM, will be undertaken.

iii Power station complex

Central to the operation of Snowy 2.0 is the underground power station, at a site to be optimised as a result of the further geotechnical investigations to be undertaken as part of Exploratory Works. While the location of the power station is the subject of further refinement as a result of the underground geotechnical drilling program (as described in the Exploratory Works EIS), the design and features of the power station are predominantly fixed.

The power station comprises two main caverns; the machine hall and the transformer hall. The machine hall will house six 340 MW pump-turbine generating units and associated plant facilities required for operating the power station. The transformer hall will house the power station's six transformers, power transmission equipment and the draft tube valves. The two caverns will be connected through Isolated Phase Busduct (IPB) galleries, which contain electrical equipment needed between the generating units and transformers.

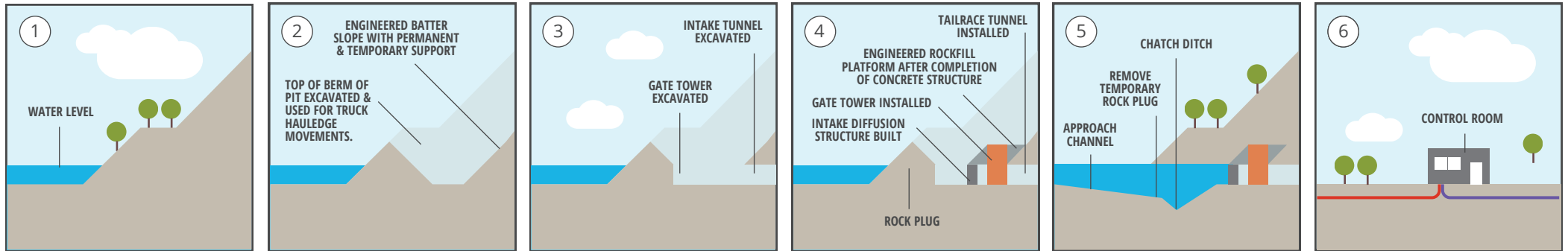
The cavern complex is deep underground and will be accessible from the MAT and from the ECVT (described in the next section). The construction methods for the key components of the underground power station are shown in Table 2.13. The drill and blast method has been considered most suitable for the deep underground excavation works involving short length and changing geometries.

Table 2.13 Snowy 2.0 power station complex summary

Primary component	Description/location	Construction method	Approximate size
Machine hall	Houses the six turbines	Drill and blast	About 240 m long, 34 m wide and 55 m high
Transformer hall	Houses the six transformers	Drill and blast	About 204 m long, 20 m wide and 34 m high
IPB galleries	Houses electrical equipment between generating units and transformers	Drill and blast	About 50 m long, 10 m wide, and 16 m high
Ventilation shaft and air intake structure	From the power station to the surface. The shaft and air intake structure (at the surface) will provide air to the cavern during construction and operation of the power station	Raise bore or blind sink	About 4 m in diameter below surface and about 680 m in height from the power station to the surface Air intake structure at the surface is 7.5 m long, 7.5 m wide and about 6 m high

Figure 2.13 Construction method – Talbingo Intake

NOT TO SCALE



TEMPORARY WORKS AND PRECONSTRUCTION ACTIVITIES

Temporary works and significant pre-construction activities to prepare for commencement of the main works include installation of:

- Setting out of the construction battery limits
- Temporary erosion and sediment control measures
- Clearing and grubbing within the battery limit
- Temporary bench access road from the Quarry Trail
- Security fence, entrance gate and safety signs around the construction and stockpile area battery limit
- Temporary stormwater drainage channel for work area and stockpile area.

EXCAVATION OF THE INTAKE

Future Gen will construct this intake using the open cut method. Drilling, blasting and mass excavation will be carried out to reach the bottom of the intake structure with design batter slope for corresponding rock materials.

As the excavation progress downwards, permanent rock anchors will be installed to stabilise the cut surface depending on the rock materials found on site.

A temporary pit will be fitted with a pump to remove any possible surface water and rain water that accumulates during construction.

EXCAVATION OF THE GATE SHAFT

To gain access at the bottom area of the Intake Structure, Future Gen will excavate an additional tunnel from the Tailrace Adit tunnel. This tunnel will then be connected to the benching platform via a shaft done in Raise Boring method.

The remaining excavation from the FSL level will be carried out from the surface, with spoil mucking through the shaft and out of the access tunnel. Figure 2 shows the sequence of excavation and how to gain access in to the invert level of intake structure.

INSTALLATION OF INTAKE INFRASTRUCTURE & CONCRETE WORKS

The unique design at Talbingo intake requires the gate tower to be constructed as a freestanding tower from ground up. Once the concrete works of each lift of the intake structure have been completed and obtained sufficient design strength, backfilling works will commence to form the ground for construction of the next lift of the gate tower. Suitable site-won materials or materials improved with a mix of other materials and compacted to earthworks specification will be used for backfilling. A concrete face wall will be designed and constructed parallel to the mouth of intake opening to retain the base of this backfill work. The estimated backfill volume is 110,000m³.

The finished, backfilled batter slope will be rehabilitated with landscaping features as detailed in the contract landscaping reference design drawings.

Significant concrete works are required to construct both intake structures, specifically the diffusion structure and gate shaft.

The exposed portion of the diffusion structure will be constructed using conventional reinforced concrete, which will commence once excavation reaches the intake invert levels.

REMOVAL OF ROCK PLUG

The rock plug will be removed from the front of the intake structure. Due to the large volume of rock to be excavated and discarded, various excavation options are being considered.

The rock plugs will be removed using a combination of the following construction methods:

- Drill and blast to remove a portion of the rock plugs (to be confirmed with during the project execution phase) from the dry side in the excavated pit area. The amount of rock excavation to be completed to remove the plugs at Tantangara intake site is significant however, the majority may be able to be removed by blasting during dry conditions while the reservoir water level is low.
- Underwater blasting to break down the remaining rock material in the plug and remove by dredging machine or barge-mounted excavator.
- Long-arm excavator on a barge to remove bigger boulders, which are then crushed into smaller sizes before being transported to the dumping site, if required.

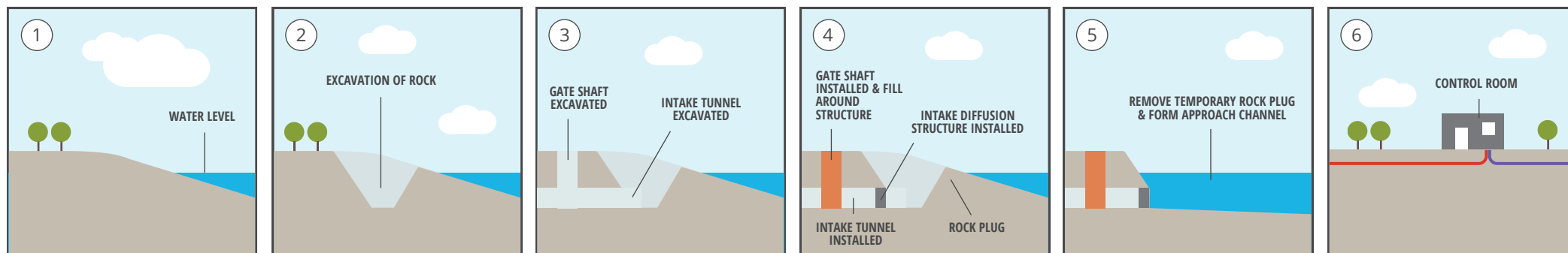
CONTROL ROOM/ CABLES & CONDUITS

The control room will house all equipment such as the hydro mechanical components, hoist, control instrumentation, sensors, DC Systems, transformers, switchboards and emergency diesel generator.

This building will be pre-fabricated with all components fitted and tested in factory before transporting it to site for connection, testing and commissioning. The trenches will be formed for laying the cables and conduits.

Figure 2.14 Construction method – Tintangara Intake

NOT TO SCALE



TEMPORARY WORKS & PRECONSTRUCTION ACTIVITIES

Temporary works and significant pre-construction activities to prepare for commencement of the main works include installation of:

- Setting out of the construction battery limits
- Temporary erosion and sediment control measures
- Clearing and grubbing within the battery limit
- Temporary bench access road from the Quarry Trail
- Security fence, entrance gate and safety signs around the construction and stockpile area battery limit
- Temporary stormwater drainage channel for work area and stockpile area.

EXCAVATION OF THE INTAKE

The intake pit excavation incorporates an open-cut trench into the various excavation levels as the works progress down below the natural surface level.

There will be drilling, blasting and mass excavation to be carried out to reach to the bottom of the intake structure.

As the excavation progress downwards, permanent rock anchors will be installed to stabilise the cut surface.

The temporary pit will be fitted with a pump to remove any water that accumulates during construction.

EXCAVATION OF THE GATE SHAFT

The shaft for the gate tower will be bored at the highest ground along the wet tunnel alignment, approximately 200m away from the intake mouth and will be completely hidden underground. Therefore, the intake transition piece will be connected to the gate tower transition piece with a stretch of wet tunnel.

The gate tower in Tintangara intake will be formed by a blind sink shaft boring method and the gate tower will be constructed from the bottom up with concrete filling in the void between the tower and shaft.

INSTALLATION OF INTAKE INFRASTRUCTURE & CONCRETE WORKS

Significant concrete works are required to construct both intake structures, specifically the diffusion structure and gate shaft.

The exposed portion of the diffusion structure will be constructed using conventional reinforced concrete, which will commence once excavation reaches the intake invert levels.

The diffusion structure at the opening of the Tintangara intake site will be open excavated from the top down and the concrete works will be constructed from the bottom up. Once completed concrete works, it shall be backfilled with local site-won material, which will be crushed to a consistent size to meet design backfill requirements.

REMOVAL OF ROCK PLUG

The rock plug will be removed from the front of the intake structure. Due to the large volume of rock to be excavated and discarded, various excavation options are being considered.

The rock plugs will be removed using a combination of the following construction methods:

- Drill and blast to remove a portion of the rock plugs from the dry side in the excavated pit area.
- Underwater blasting to break down the remaining rock material in the plug and remove by dredging machine or barge-mounted excavator.
- Long-arm excavator on a barge to remove bigger boulders, which are then crushed into smaller sizes before being transported to the disposal area.
- Personnel will use of depth silt curtain around the dredging and underwater blasting work zone during the construction phase to contain water pollution away from the rest of the reservoir.

CONTROL ROOM, CABLES AND CONDUITS

The control room will house all equipment such as the hydromechanical components, hoist, control instrumentation, sensors, DC Systems, transformers, switchboards and emergency diesel generator.

This building will be pre-fabricated with all components fitted and tested in factory before transporting it to site for connection, testing and commissioning.

The trenches will be formed for laying the cables and conduits.

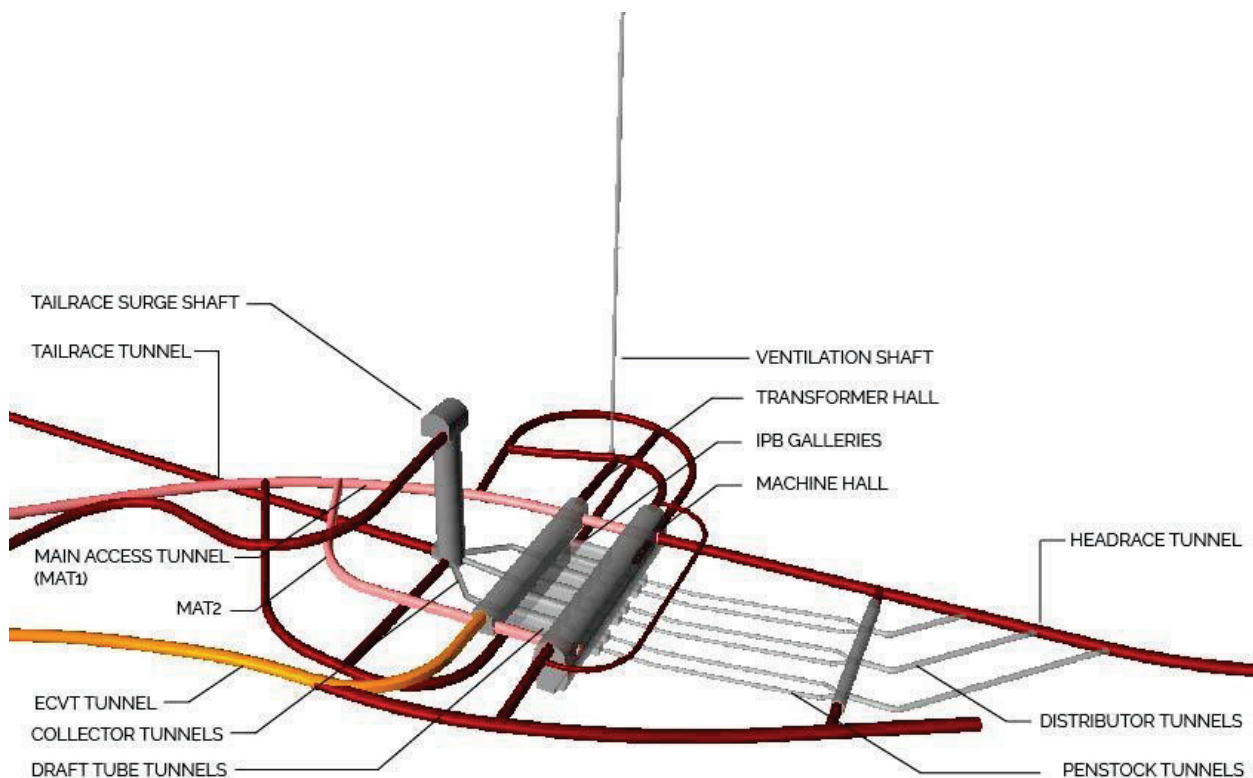


Figure 2.15 Powerhouse complex indicative general layout (3D)

iv Power station main access tunnel and the ECVT

Access tunnels are needed to provide efficient and safe access to permanent infrastructure. Access tunnels are considered to be permanent tunnels, which may also be used during construction of operational infrastructure.

All access tunnels will have portals and surface infrastructure established to facilitate entry. Portal positions for the permanent tunnels have been defined based on the topography, geological environment and spatial dimensions of the tunnel. Tunnels requiring surface infrastructure (ie portals) are the MAT and ECVT (adjacent to the MAT).

The MAT is the Exploratory Works tunnel, refitted and redesigned, as required, to provide the permanent main entry to the underground power station, power waterway tunnels, chambers and shafts.

iii Substations and power connection

One substation is required to provide permanent power to Snowy 2.0, at Lobs Hole. This substation will be built for use as part of Snowy 2.0 Exploratory Works (approval currently being sought under Modification 1) with a capacity of 80 megavolt amps (MVA). It will continue to be used for Snowy 2.0 Main Works, however requires the establishment of additional power supply cables to provide power to the work sites, in particular to power the TBMs via the MAT, ECVT, Talbingo and Tantangara portals, as well as construction and accommodation camps at Talbingo, Marica and Tantangara. The supporting high voltage cable route therefore follows access roads to these locations (refer to utilities alignment shown on Figure 2.6 to Figure 2.11).

The cables will be overhead or underground (buried in a trench) from Lobs Hole to Marica and then on to Tantangara, along existing or proposed access roads. The cable trenches will be excavated to the required depth and in some areas direct drilled (such as for crossing sensitive environments such as watercourses). Bedding sand will be laid, and the conduit placed. Trenches will be backfilled and compacted with the excavated material.

The Lobs Hole substation will become a permanent feature of Snowy 2.0, with power to be reticulated to the power station and other operational facilities at Lobs Hole including the Talbingo intake control buildings and gates.

v Communication system

In addition to communications and construction power links established for Snowy 2.0 Exploratory Works, communications infrastructure will be established for Snowy 2.0 Main Works. The links will connect infrastructure at Tantangara and Talbingo reservoirs to the existing communications system at the Tumut 3 power station (via the submarine communications cable in Talbingo Reservoir established during Exploratory Works) and to Snowy Hydro's communications infrastructure at Cabramurra. This system will include fibre-optic cables, and will serve all fixed construction communication needs, as well as providing the permanent communication network. Buried fibre-optic cable will connect the Talbingo intake, the underground power station, headrace tunnel surge shaft and Tantangara intake.

The fibre-optic cable will be buried in conduits generally within access roads and established tracks. This involves excavating a trench, laying the conduits, pulling the cables through, and backfilling and restoring the surface. Communication pits will be required along the route to join lengths of cable. Watercourse crossings will be carried out in a manner that minimises environmental impacts where possible, and may include some trenching of ephemeral creeks (during dry periods only), bridging of creeks, temporary creek diversion and burying conduits below watercourse beds and some horizontal drilling or underbore methods, to minimise impacts to the watercourse and adjacent riparian zone. Horizontal drilling methods will also be considered to minimise impacts to other sensitive areas where possible.

vi Secondary containment controls

An instream barrier is proposed to prevent the potential upstream migration of Climbing galaxias (*Galaxias brevipinnus*), a native but translocated species, into the habitat of the critically endangered Stocky galaxias (*Galaxias tantangara*). The Climbing galaxias has the potential ability to climb out of the water up moist to wet vertical surfaces. While the potential transfer of this species between reservoirs is considered possible to unlikely, detailed scientific investigations have not been able to categorically rule out this potential upstream migration of Climbing galaxias through the power waterways connecting the two reservoirs.

Currently, Climbing galaxias have not yet been recorded in Tantangara Reservoir, however the pumping mode of Snowy 2.0 has the potential to transfer the species from Talbingo Reservoir as individuals have been detected in the hydrologically connected Yarrangobilly River. The upper reaches of Tantangara Creek contains habitat for the critically endangered Stocky galaxias (*Galaxias tantangara*). The existing waterfall is a barrier to other non-indigenous species such as Trout, however there is the potential risk this natural barrier may not be as effective for the Climbing galaxias. The construction of this instream barrier in the upper reaches of Tantangara Creek is a secondary control to avoid its potential upstream migration and establishment and resultant potential impact upon Stocky galaxias.

Concept designs have been developed for a section of Tantangara Creek about 15 km upstream of the reservoir, above an existing waterfall just upstream of the Alpine Creek Firetrail. An indicative area is shown in Figure 2.9.

In addition, a filtration station/s to screen pest fish species from being discharged through the Murrumbidgee-Eucumbene Tunnel from Tantangara Reservoir is proposed. Detailed scientific investigations have not been able to categorically rule out potential transfer of pest species through the tunnels connecting the two reservoirs. Given the residual risk of potential transfer, it is proposed to avoid the potential secondary transfer of any pest fish species that may establish in Tantangara Reservoir as a result of Snowy 2.0.

Concept designs have been developed that would aim to prevent the potential transfer of all life stages of pest fish through the River Outlet Works of Tantangara Reservoir to the Upper Murrumbidgee River and through the Murrumbidgee-Eucumbene tunnel to Lake Eucumbene. This control is designed to limit the potential range expansion of any fish species of concern that may be potentially transferred to Tantangara Reservoir as a result of the project. The location of the station will be upstream of the existing reservoir wall, near the intake of the Murrumbidgee-Eucumbene tunnel within the disturbance footprint indicated in Figure 2.10.

2.3.3 Supporting construction sites and infrastructure

i Construction portals, tunnels and adits

Numerous construction adits are needed to provide access and facilitate the construction of the power station complex, tailrace tunnel and headrace tunnel. The adits will be excavated and accessed from portals established at Tantangara and Talbingo reservoirs, as well as the MAT and ECVT portals.

A level site area (a construction pad) is needed for launching TBMs from the portals. Therefore, construction of these sites will involve clearing and levelling of the site (which may include placement of surplus cut materials at Lobs Hole), with hardstand areas established. The portals and adits will be excavated using drill and blast techniques, with rock support and concrete works as needed. These areas are shown in Figure 2.16.

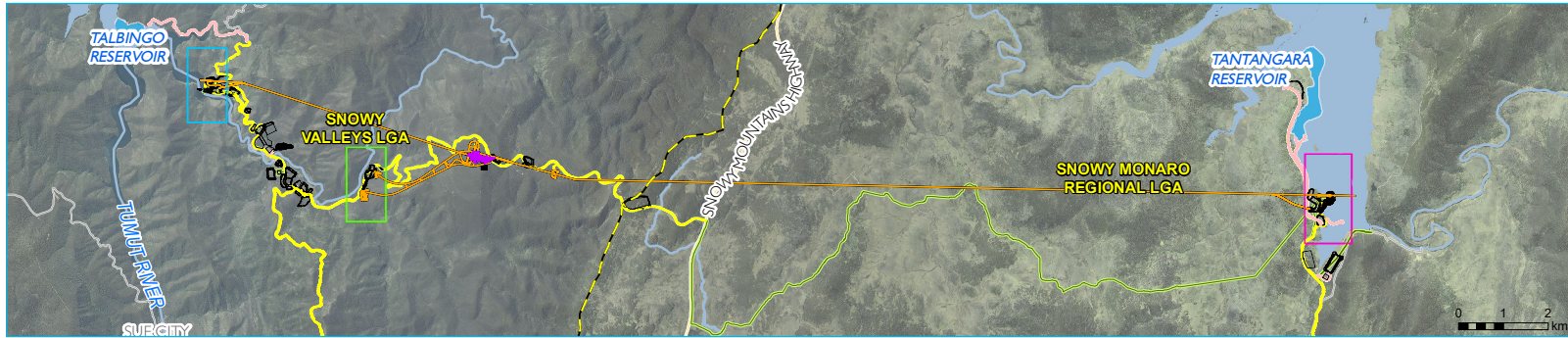
ii Primary construction compounds and laydown areas

Within each of the construction areas, temporary construction compounds will be required (as previously listed in Table 2.1 to Table 2.6) to provide construction support facilities, such as CBPs, water and wastewater treatment facilities, material storage, material testing and laboratory facilities, lay down areas, stockpiles and hardstand areas. Construction will require the areas to be cleared of vegetation and earthworks involving cut and fill to ensure a level site area. Once these areas are no longer required for the construction of Snowy 2.0, they will be rehabilitated in line with the requirements of the Rehabilitation Strategy (see Appendix F).

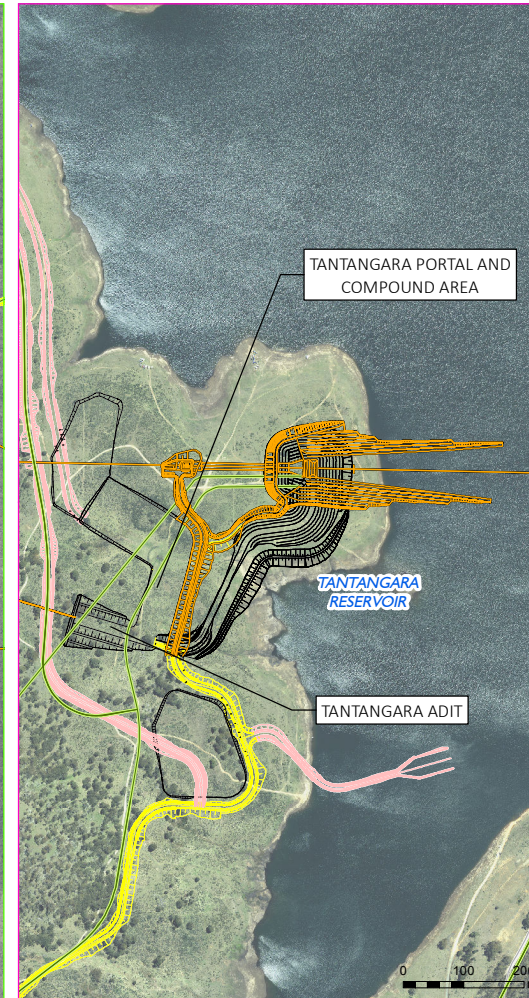
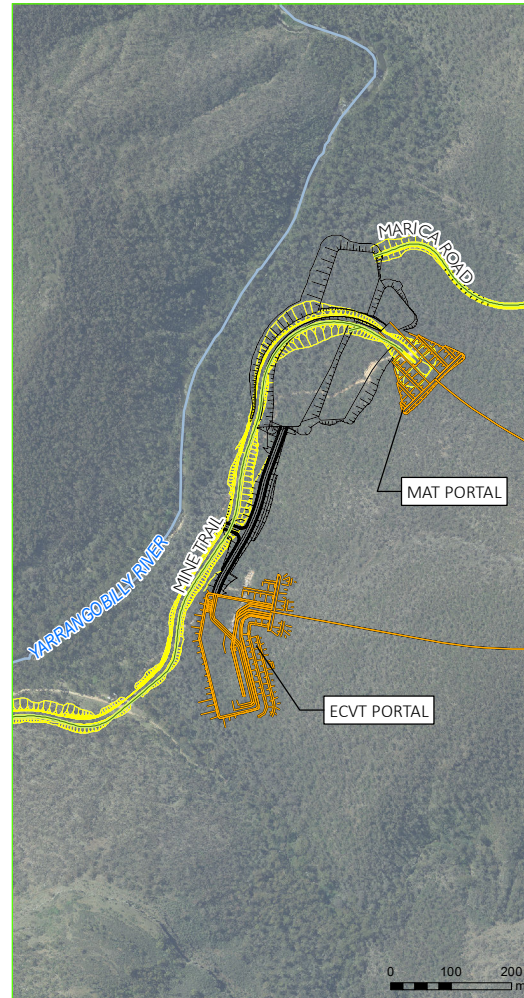
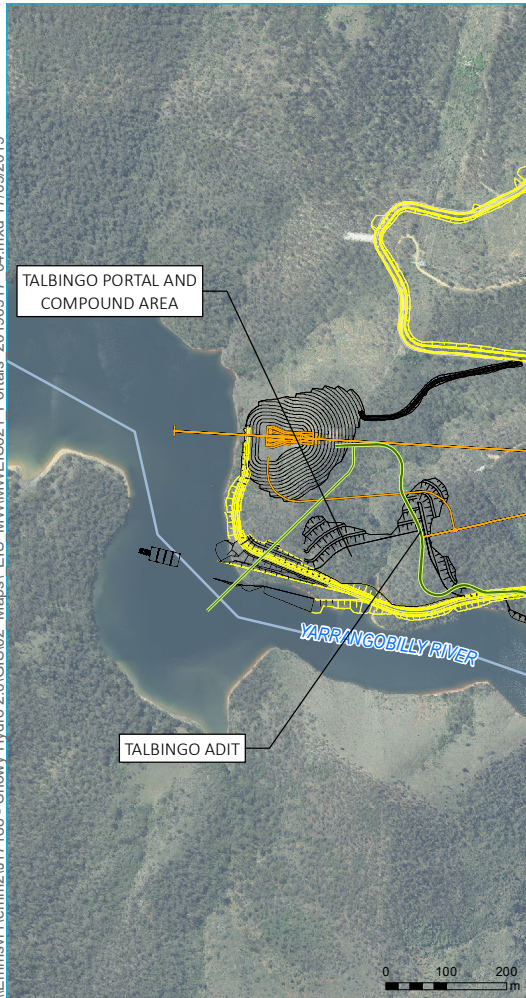
Compound areas associated with portals for the TBMs will contain the necessary facilities to support TBM operation. This includes storage of power plant, site offices, medical facilities, warehouse and workshops, TBM parts and tools storage, grouting system, water storage and storage of segments.

The Main Yard (Lobs Hole) will be the largest construction compound, providing most of the ancillary construction facilities and areas for laydown. It is likely to include ancillary construction facilities, warehouses, maintenance sheds, first aid buildings, medical facilities, helipad, explosive storage magazine, stockpiles (aggregate, and other materials), truck and vehicle parking, workshops and stores, offices, site worker facilities, site laboratory for testing of materials including concrete, aggregate, excavated rock and water quality, wood carpentry workshop and a steel fabrication yard.

Rock Forest, outside KNP, will be used as a storage and staging/logistics area for the delivery of materials to site. During adverse weather or unsafe conditions, the site would be used to hold deliveries and staff for a short timeframe. Facilities likely to be established at the site include storage yards (for segments and other goods), turn around and parking yard for trailer/trucks and portable toilet facilities.



- KEY**
- Existing environment
- Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Local government area boundary
- Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
- Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
 - Temporary access road
 - Indicative rock emplacement area



Portals to underground works

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.16



iii Ancillary construction facilities

Several supporting facilities are required to support construction activities within the construction areas. These are provided in Table 2.14.

Table 2.14 Ancillary construction facilities

Item	Description
CBPs	To ensure supply of concrete products (eg for grout), particularly during critical, large scale pours.
Crushing plants	To receive excavated material directly from the intakes and other sources such as cuts from road works.
Laydown areas	To host temporary installation such as machinery, formwork and oversize deliveries, as well as use for storage, equipment maintenance or work areas. Laydown areas will be provided at each of the main construction yards, providing space to store all plant, equipment and materials required for all construction activities.
Stockpile areas	To support both excavated rock from tunnelling and clearing activities, as well as aggregate and other building materials imported for construction.
Accommodation camps	To provide on-site accommodation for workers to deliver Snowy 2.0 Main Works. Snowy 2.0 Main Works will also utilise existing accommodation at Snowy Hydro's Cabramurra township where possible.
Helipads	Helipads will be near each accommodation camp where medical facilities are based, to provide emergency egress.
Water supply infrastructure	<p>Raw water will be primarily sourced from Talbingo and Tantangara reservoirs for use in concrete mixing and supply to CBPs, tunnelling activities and supply to TBM (TBM cooling) and drill and blast sites as well as dust suppression and firefighting supply.</p> <p>Potable water will require the commissioning of water treatment plants within construction areas. Potable water will be reticulated to facilities in each accommodation camp site (ie Lobs Hole, Marica and Tantangara) via a reticulated system or via truck mounted water bowser.</p>
Wastewater	<p>A separate collection and treatment system is proposed to manage the tunnel seepage and construction wastewater (referred to as process water). The treated seepage water will be prioritised for reuse to supply construction demands. Treated water will be reused onsite where possible to reduce the amount of discharge to reservoirs, however excess treated water will be discharged to the reservoirs.</p> <p>Sewage will be generated at accommodation camps from showers, kitchens, laundries and toilet facilities. Collected sewage will be treated at sewage treatment plants to meet the specified discharge limits before effluent is discharged.</p> <p>To minimise raw water intake and runoff, stormwater will be captured and reused as much as possible. Sedimentation basins and stormwater diversions would be installed as part of erosion and sediment control measures. Higher order erosion and sediment controls such as clean and dirty water separation and minimisation of disturbed areas will significantly reduce the quantity and improve the quality of sediment-laden water required to be treated. Any stormwater to be treated and released to the surrounding environment would need to meet specific water quality criteria before being discharged.</p>

2.3.4 Temporary and permanent access roads

i Construction access

Access works are required to:

- provide for the transport of excavated material between the tunnel portals and the excavated rock emplacement areas;
- accommodate the transport of oversized loads as required; and
- facilitate the safe movement of plant, equipment, materials and construction workers into and out of construction sites.

Construction of Snowy 2.0 Main Works will require use of existing roads and tracks within KNP, some of which will need to be restricted from the public for the entire construction period for safety reasons. Once construction has finished, Snowy Hydro will either return the existing road to a standard agreed to with NPWS or rehabilitate constructed roads and return access to NPWS and the public. Some new roads will be constructed to provide access to permanent infrastructure with these roads maintained in the long term and some public access restrictions signposted.

The primary access roads to the construction areas are listed below.

- Talbingo Reservoir and Lobs Hole – accessed by Lobs Hole Ravine Road;
- Marica – accessed by Marica Trail;
- Plateau – accessed by Gooandra Trail;
- Tantangara Reservoir – accessed by Tantangara Road; and
- Rock Forest – accessed by Snowy Mountains Highway.

Road conditions will be impacted by the heavily loaded construction traffic and the climatic conditions of the region, including snow, rain, heat and dry weather. To adequately maintain safe access and use of roads through to completion, maintenance crews will be employed, undertaking maintenance activities such as using snow ploughs and blowers, grade, patch, fill pot holes, water and re-mark roads as necessary.

Section 2.5 of this chapter provides a summary of works required for these roads and the access arrangements for both the construction period and long-term once construction has finished.

ii Road works

Snowy Hydro has been liaising with NSW Roads and Maritime Services (RMS) to understand the existing program of works within the region to be carried out during the planned construction of Snowy 2.0 Main Works and the requirements of the project. Road works required for the Snowy 2.0 Main Works are as follows:

- widening of the intersection with Snowy Mountains Highway and Tantangara Road – to allow safe passage for light and heavy vehicles through this intersection;
- new intersection with Snowy Mountains Highway and the Marica Trail – to allow direct access to construction areas for project-related traffic;

- new access from Rock Forest with Snowy Mountains Highway – to allow ingress and egress from the Rock Forest property to the Snowy Mountains Highway for light and heavy vehicles; and
- widening of the intersection with Link Road and Lobs Hole Ravine Road - to allow direct access to construction areas for project-related traffic.

2.3.5 Management of excavated rock

i Management strategy

The strategy for the management of excavated rock will aim to maximise beneficial reuse of materials for construction activities. Beneficial re-use of excavated material may include use for road base, pad establishment, selected fill and tunnel backfill and rock armour as part of site establishment for construction areas. Excess excavated material that cannot be re-used during construction will be placed within Talbingo and Tantangara reservoirs. During the construction phase, surplus cut materials used to establish construction pads within Lobs Hole may be used to assist with landforming and rehabilitation.

This section provides an overview of the proposed strategy for excavated material management including the methods proposed for placement within the reservoirs.

ii Sources of excavated rock

Approximately 9 million m³ (unbulked) of excavated material will be generated by Snowy 2.0 Main Works. Excavated material will be generated by the activities listed below:

- intake construction at both reservoirs;
- tunnelling for power waterways, access tunnels and adits;
- excavation of underground caverns, chambers and shafts;
- road establishment and upgrades; and
- site establishment for construction areas and accommodation camps.

The management of excavated material generation and disposal has been divided into two management systems based on the east (Tantangara) and west (Talbingo) sides of the Snowy 2.0 Main Works project area. Excavation work at Marica will be managed by the Tantangara management system. This is shown in Figure 2.17. The predicted excavated material is categorised according to the main methods of tunnel excavation, TBM and drill and blast.

iii Re-use of excavated material

Several sections along road alignments and construction sites will have large cut and fill quantities. It is also considered much of this material will be suitable for reuse as embankment material. Suitable material will be crushed and screened on site as necessary at stockpile locations, minimising the need to import material and reducing road traffic. Material reuse is expected for:

- compound and camp locations to level the site as part of construction (construction pads);
- fill at the MAT, ECVT, Talbingo and Tantangara portal (permanent operational pads and structures); and
- road works in the project area.

Estimated reuse volumes are shown in Table 2.15.

Table 2.15 Estimated excavated material volumes reused or permanently placed

Management area	Total estimate	In-reservoir placement	Re-used for permanent operational structures (eg roads and operational pads and portals)	Retained as shaped final landform
Talbingo	4,974,784 m ³	2,834,212 m ³	1,140,573 m ³	1,000,000 m ³
Tantangara	3,627,419 m ³	2,800,677 m ³	826,742 m ³	Not applicable

iv In-reservoir placement

Excavated material not used for beneficial re-use will be permanently emplaced within Talbingo and Tantangara reservoirs. Emplacement areas have been identified in both reservoirs. It is expected that approximately 2.8 million m³ will be emplaced within each reservoir. Placement of excavated material will be carried out 24 hours a day, seven days a week and 365 days a year.

Emplacement within Talbingo Reservoir is proposed from the bed of the reservoir to just above FSL (approximately 0.3% of the total storage). Emplacement within Tantangara Reservoir is proposed within the active storage (approximately 1.1% of the storage) of the reservoir from the MOL to just above FSL.

The final elevation of the emplacement areas will be above FSL to allow for permanent rehabilitation of the landform. This is to prevent inundation of the emplacement area when the reservoir is at capacity. Further engagement with NPWS will be carried out regarding the end use of these areas, such as recreational areas.

a Transport and placement within Talbingo Reservoir

Placement of excavated rock within Talbingo Reservoir involves placing materials from the northern edge of Ravine Bay into the Talbingo Reservoir by conventional earth-moving plant, such as trucks and excavators, and installing a rock armour layer formed by large size excavated rock on the emplacement slope batter by barges.

A new access road will be constructed from Lobs Hole Ravine Road North along the shoreline of Ravine Bay for about 5.8 km. This access road will be used to transport materials suitable for placement within Ravine Bay.

Ravine Bay placement activities will commence with the installation of a silt curtain to reduce turbidity within the reservoir during placement activities. Rock armouring materials will be placed on the outer areas of emplacement area to provide a barrier for the finer materials (sourced from TBM excavated rock) to be placed in the area to the shore. The rock armouring will encapsulate the finer materials and prevent them from entering the reservoir. These activities will progress in a westerly direction over an anticipated three year placement program and fill the Ravine Bay placement area. This is shown in Figure 2.18.

A nominal 1 m layer of rock armouring will be placed above MOL to protect the slope of submerged emplacement area. The placement area will be rehabilitated to about 1 m above FSL to allow for revegetation. Figure 2.19 and Figure 2.20 provide an indicative rehabilitated landform at the Ravine Bay placement area. The future use, including recreational, of this area will be subject to ongoing engagement with NPWS.

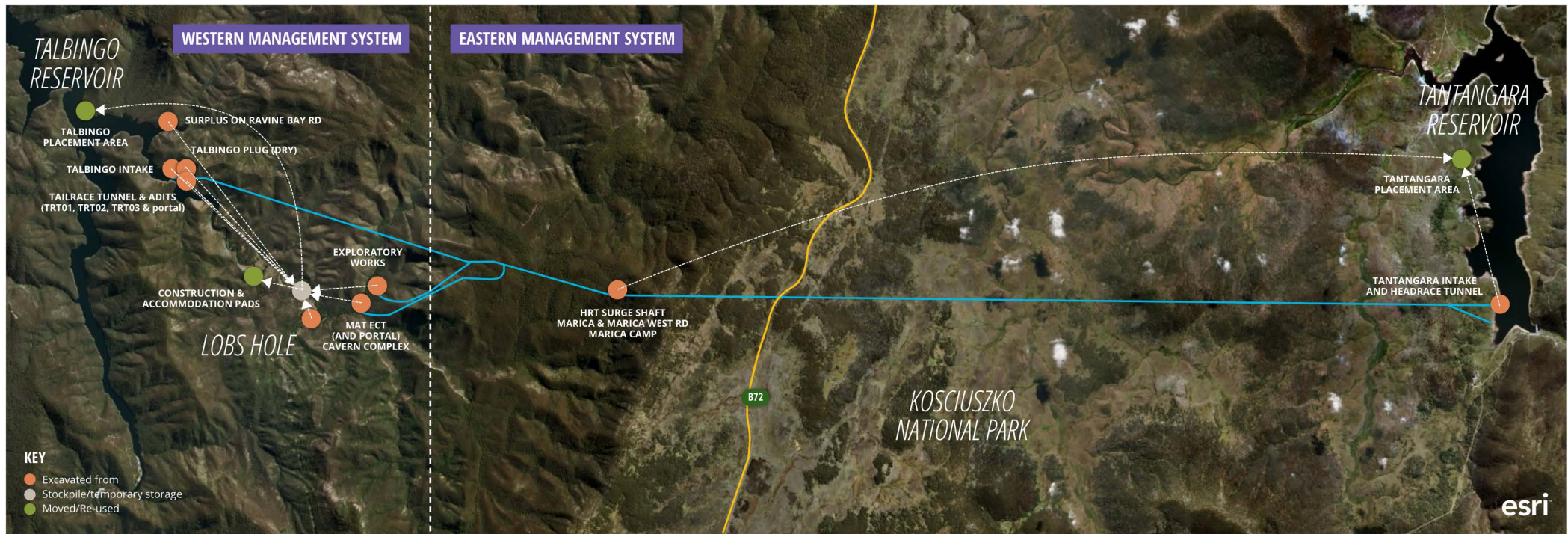


Figure 2.17 Excavated materials management systems

Satellite image © Esri, CGIAR | Vicmap, Esri, HERE, Garmin, METI/NASA, USGS | Earthstar Geographics

ALL FIGURES IN M3 (UNBULKED)
LOCATIONS ARE APPROXIMATE ONLY

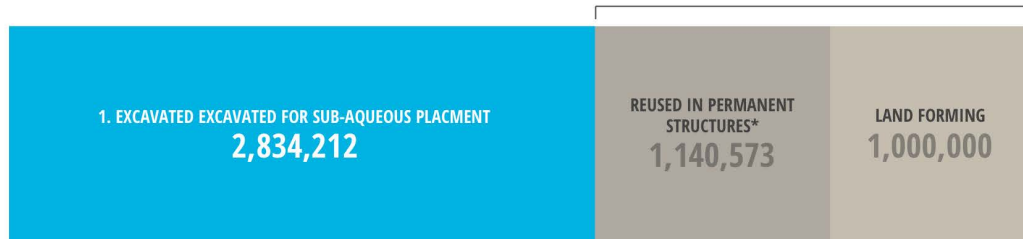


WESTERN MANAGEMENT SYSTEM TALBINGO SCHEME

TOTAL VOLUME GENERATED:

4,974,784

AMOUNT OF MATERIAL REUSED: 2,140,573



* e.g. roads and operational pads - MAT, ECVT etc

EASTERN MANAGEMENT SYSTEM TANTANGARA SCHEME

TOTAL VOLUME GENERATED:

3,627,419

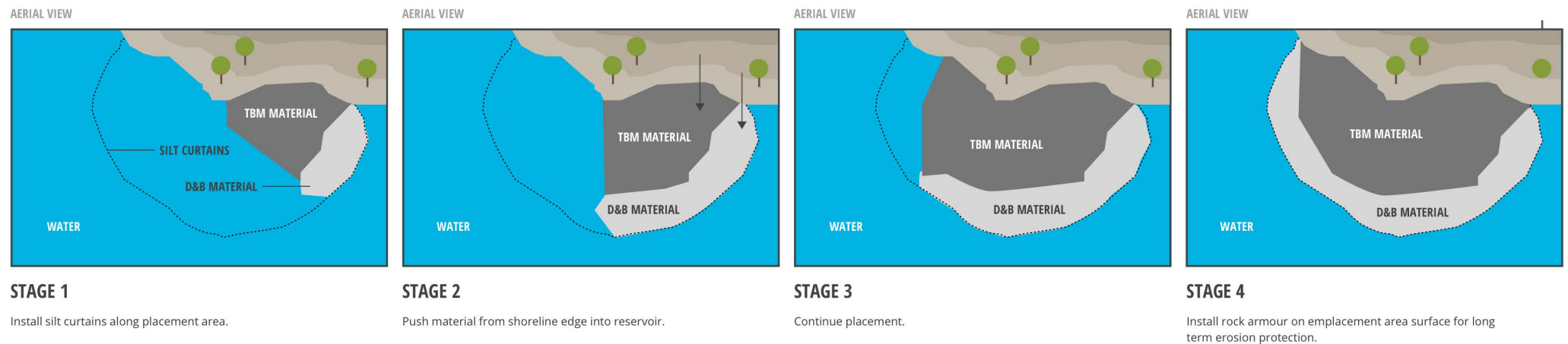




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Figure 2.18 Placement of material at Talbingo Reservoir

● Tunnel boring machine (TBM) material ● Drill & blast (D&B) material





Artist impression: Existing full supply level



Artist impression: Rehabilitated full supply level

Figure 2.19 Talbingo – Ravine Bay placement area rehabilitation (aerial view)



Artist impression: Existing full supply level



Artist impression: Rehabilitated full supply level

Figure 2.20 Talbingo – Ravine Bay placement area rehabilitation (water view)

b **Transport and placement within Tantangara Reservoir**

Placement of materials within Tantangara Reservoir utilises an area within the active storage of the reservoir, between MOL and FSL. During the placement of materials, Snowy Hydro is able to manage the water levels within the reservoir through existing approved operating practices for the Snowy Scheme. This will provide for efficient conditions for effective placement within the reservoir using conventional earth-moving equipment and techniques.

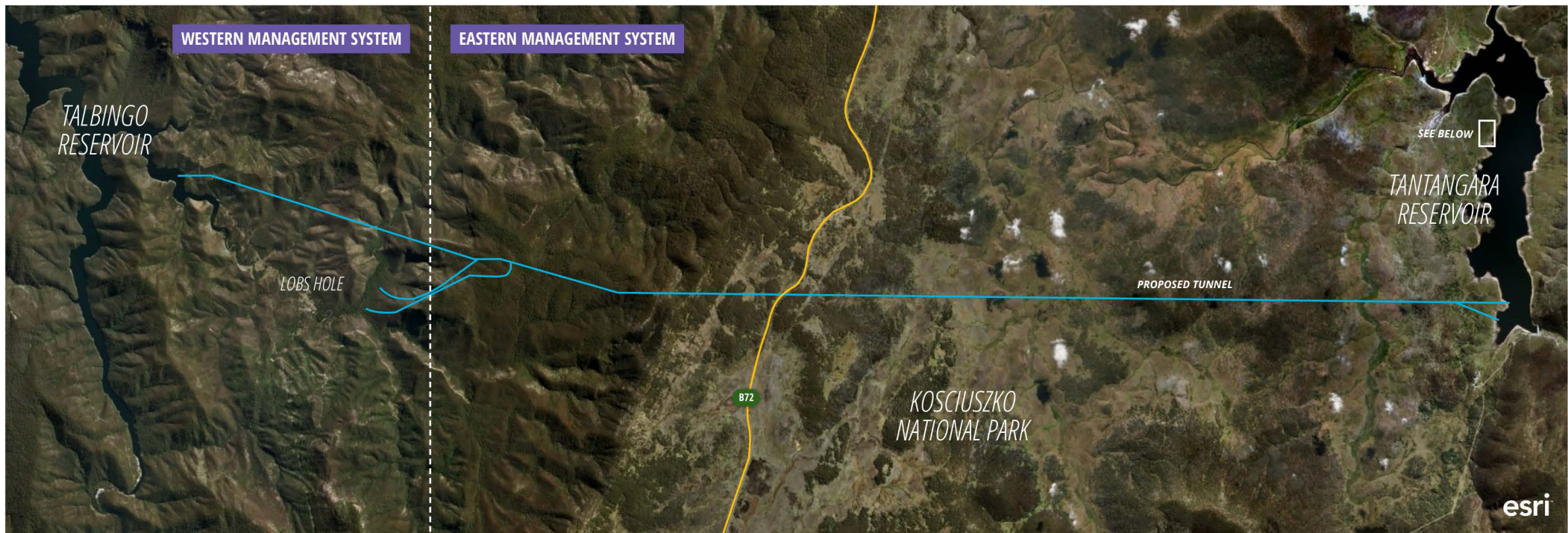
Like the Ravine Bay placement, appropriate erosion and sediment control measures, such as temporary diversion drains will be installed prior to the commencement of placement activities. As placement activities will be carried out on land (albeit within active storage of the reservoir), materials will be placed in cells to minimise potential for impacts. Finer materials will be placed within the cells whilst the batters of these cells will be covered by larger sized materials. As a cell is nearing completion, the next cell is prepared to commence receiving materials. The placement area is progressively filled over an anticipated three year placement program. This is shown in Figure 2.21.

To reduce the potential of finer materials leaching from the cells, a geotextile layer will be installed on the emplacement surfaces in the cell establishment phase. During placement activities, water will be managed in the work areas through temporary diversion drains taking water into sediment control ponds where the water will be reused where possible. Given the potential for rising water levels during placement activities at Tantangara Reservoir, a trigger action response plan (TARP) will be developed to manage these activities.

A nominal 1 m thick rock armour will be installed for protection of the placement surface as it will be submerged for periods of time given the variation in water levels between MOL and FSL, similar to the currently approved practices of Snowy Hydro. The placement area will be rehabilitated to about 1 m above FSL to allow for revegetation. Figure 2.22 provides an indicative rehabilitated landform at the Tantangara Reservoir placement area. The future use, including recreational, of this area will be subject to ongoing engagement with NPWS.

v **On-land placement and rehabilitation**

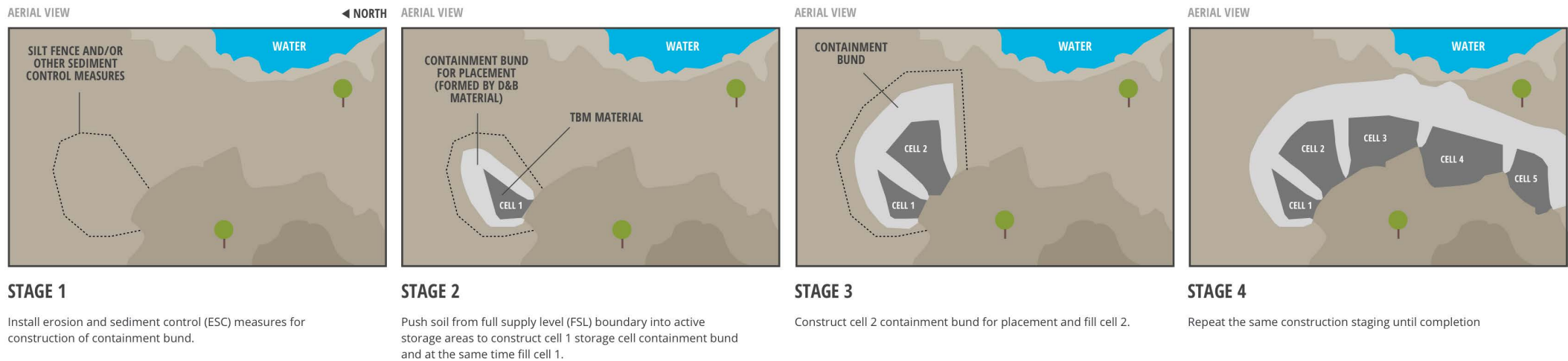
The continued use of the Main Yard at Lobs Hole requires considerable materials in the form of surplus cut to create safe and stable areas for construction. Following completion of construction activities for Snowy 2.0 Main Works, these surplus materials and areas will be landformed, reshaped and rehabilitated to their pre-construction condition. The Lobs Hole area is a remote area of KNP and is used by recreational users for these values. Snowy Hydro will continue to engage with NPWS regarding the opportunities for future recreational use of these areas at Lobs Hole.



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Figure 2.21 Placement of material at Tantangara Reservoir

● Tunnel boring machine (TBM) material ● Drill & blast (D&B) material





Artist impression: Full supply level



Artist impression: Full supply level optimised for recreational use

Figure 2.22 Tintangara placement area rehabilitation (aerial view)

2.3.6 Traffic and transport requirements

i Traffic generating activities and volumes

Throughout the construction period there will be several traffic generating activities, including:

- deliveries of materials, plant and equipment to and from site, including materials such as aggregate and cement as well as delivery of segments;
- transport of personnel to designated airports;
- busing of personnel to and from shifts on site;
- servicing of accommodation camps (eg waste collection, food delivery, etc); and
- haulage of excavated rock and materials from surface works and tunnelling activities.

The regular types and volumes of vehicles estimated over the life of the construction works will range from semi-trailers delivering concrete and segments for the tunnels, truck and dogs bringing in road-base and other construction materials, agitators for the concrete pours to smaller vehicles such as mini-busses and coaches for the workforce and light vehicles for internal movements by personnel. These movements will occur on both the external and internal site road network.

In June 2019, Snowy Hydro lodged an application seeking planning approval from the NSW Minister for Planning and Public Spaces for an ancillary facility to Snowy 2.0, being a segment factory in Polo Flat (SSI-10034). Should the factory be approved and constructed, segments would be manufactured and delivered to site from Polo Flat.

ii Transport routes

The bulk of the deliveries and transport requirements for Snowy 2.0 Main Works are expected to approach the project from the east, travelling through Cooma, due to likely availability and source of materials required for the construction of Snowy 2.0 Main Works. Roads from the east are predominantly established designated transport routes. The primary transport routes for delivery of materials and equipment to site are shown on Figure 2.23, and comprise:

- route to Talbingo Reservoir and Lobs Hole:
 - main access: Snowy Mountains Highway > Link Road > Lobs Hole Ravine Road; and
 - alternative access/egress: Snowy Mountains Highway > Marica Trail > Marica Road West > Lobs Hole Road;
- route to Marica:
 - Snowy Mountains Highway > Marica Trail > Marica Road West;
- route to Tantangara Reservoir:
 - Snowy Mountains Highway > Tantangara Road > Quarry Trail.

Transport routes outside of the ones described above and shown in Figure 2.23 will also be used, but are likely to be used for minor supplies of materials or services. These include approaching the project from the west (using Elliot Way) or from the north (using Snowy Mountains Highway).

iii Marine access

Barge launch facilities on Talbingo will have already been established during Snowy 2.0 Exploratory Works for the placement of the submarine communications cable, and will continue to be used for Snowy 2.0 Main Works for construction works associated with the Talbingo intake structure. Snowy 2.0 Main Works will require the establishment of launch facilities on Tantangara Reservoir to enable these similar works (removal of the intake plug).

iv Movement of personnel and shifts

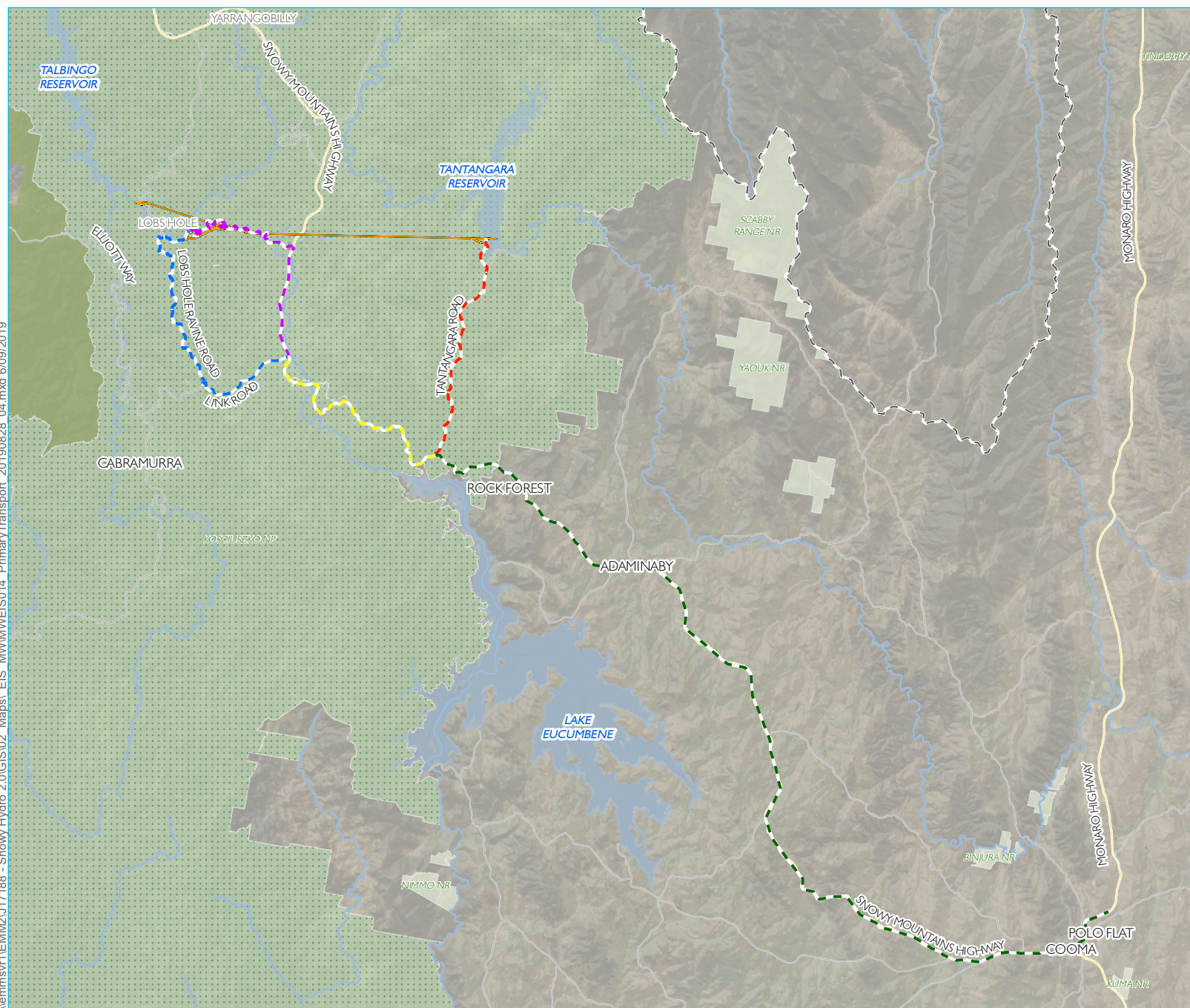
Personnel working on the project will generally not be permitted to drive to the camps, in order to reduce the volume of traffic on the roads and reduce travel time and improve safety outcomes for the workforce. This also has the benefit of reducing parking requirements at the accommodation camps. They will be transported from designated towns and airports to the accommodation camps by project-supplied buses.

When on site, buses will collect workers and transport them between accommodation camps to various worksites before and after shifts. Bus pick-up and drop-off points will be marked at accommodation camps and at worksites, along with safe pedestrian routes. Sufficient buses will be allocated to each camp to ferry the workforce back and forth at the start and end of each shift. Exceptions will apply for superintendents and engineers or for personnel who require flexibility of movement as a result of the nature of their role.

The site roster for personnel will be developed as part of FGJV's human resources and recruitment initiatives. However, it is expected to be 20 days on, 10 days off, with two shifts of 12 hours each, or similar arrangement.

The use of Lobs Hole Ravine Road North for an alternative light vehicle access to Lobs Hole, which is currently part of a proposed modification to the Snowy 2.0 Exploratory Works approval, will be continued under Snowy 2.0 Main Works.

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KEY

Primary transport route

- All site access from Cooma to KNP and Rock Forest
- Route to Tantangara Reservoir
- Route to Talbingo Reservoir and Lobs Hole
- Route to Marica and Lobs Hole
- Route to Marica, and alternative access to Lobs Hole

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station

Existing environment

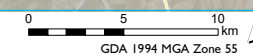
- Main road
- Local road
- Watercourse
- Waterbodies
- Kosciuszko National Park
- NPWS reserve
- State forest
- State boundary

Primary transport routes

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.23



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



2.3.7 Workforce requirements

i Workforce

The workforce is expected to reach about 2,000 workers at peak construction, based on current labour requirements forecast by the contractor. The indicative distribution of the workforce over the construction program is shown below in Figure 2.24.

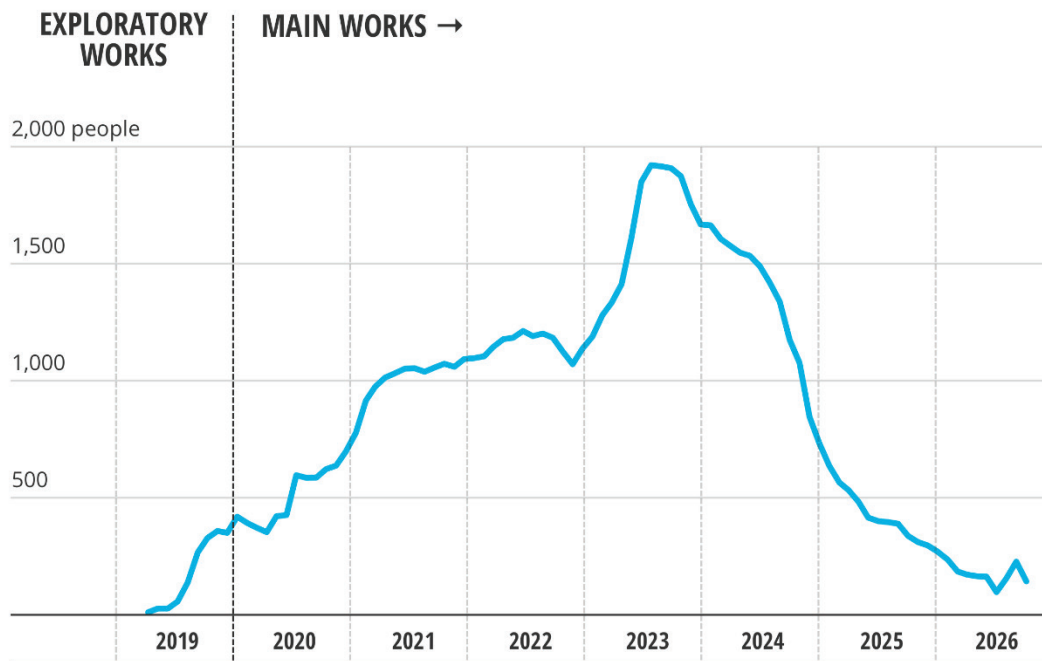


Figure 2.24 Indicative workforce histogram

The segment factory (subject to a separate application) is likely to require a workforce of about 125 people during its operation. The construction workforce for the Transmission Connection Project (subject to a separate application) is likely to require an average workforce of about 75 people.

ii Construction hours

Construction works will be undertaken 24 hours a day, seven days a week and 365 days a year. This includes all activities needed to support tunnelling and construction (eg segment production and receipt, use of batching plants and mixer trucks, and haulage of excavated material), as well as operation of accommodation camps.

2.3.8 Progressive rehabilitation

Snowy Hydro has established key principles to restore disturbed land within KNP following disturbance from the project. These include:

- preserve KNP's natural assets and values;
- agree on future land use and consider long-term site management;
- establish processes prior to construction works to engage organic matter to be used in revegetation and ongoing rehabilitation during the construction works phase;
- establish appropriate treatments for minimisation of runoff into waterways;
- protect existing native fauna and their habitats;
- rehabilitate disturbed areas to their pre-existing or improved state at completion of construction activities in consultation with NPWS; and
- minimise visual impact of construction works from significant public viewpoints.

Rehabilitation will be carried out in several phases through the construction period to achieve the desired outcome for KNP and also for Rock Forest which is outside KNP. Activities during (or prior to) construction to enhance rehabilitation will be performed, such as salvaging habitat resources and native seed collection. Other progressive rehabilitation techniques will be carried out including temporary stabilisation of batters and construction of appropriate erosion and sediment control devices, collection of seeds, sods or cuttings from appropriate plant community types (PCTs) for use in final rehabilitation.

A Rehabilitation Strategy for Snowy 2.0 Main Works has been prepared and is provided in Appendix F. This document provides information on the objectives and desired outcomes for rehabilitation activities from Snowy 2.0 Main Works.

2.4 Operation of Snowy 2.0

2.4.1 Scheme operation and reservoir management

The existing Snowy Scheme reservoir operating principles essentially aim to deliver the following:

- continue meeting the drought proofing objective of the Snowy Scheme through the required water releases for downstream water users, including the environment, of the Murray and Murrumbidgee valleys, and complying with the Snowy Water Licence;
- minimise spill from the Snowy Scheme; and
- maximise value through utilising the scheme's flexibility.

These will not change during the operation of Snowy 2.0.

Following the commencement of the operation of Snowy 2.0, both Tantangara and Talbingo reservoirs will have increased operational functions. Tantangara Reservoir will have the additional operational functions of acting as a head storage for generation from the Snowy 2.0 power station and also acting as a storage for water pumped up from Talbingo Reservoir. Talbingo Reservoir will have the additional operational function of acting as a tail storage from Snowy 2.0 generation.

Due to these additional operational functions proposed for Tantangara and Talbingo reservoirs, the short and longer term water levels in both reservoirs, as well as the rates of water level rise and fall, are expected to experience some degree of change compared to the historical operations. However:

- the water levels in both reservoirs will remain within the MOL and FSL approved for the existing Snowy Scheme;
- there will be no more water in the Snowy-Tumut Development as a whole. The flexible storage of that water across the storages within the Snowy-Tumut Development below FSL is currently approved under the EP&A Act (by virtue of the deeming provisions within the SHC Act); and
- no additional land will be affected by virtue of the inundation of the reservoirs through Snowy 2.0 operations. Water storages will continue to be held wholly within the footprint of the existing FSLs.

The factors for change and the degree of noticeability of change are detailed further in the following sections.

The inundation of land below the FSL and the variability in storage levels has existed within the existing Snowy Scheme since the scheme was implemented and is deemed to have been approved under the EP&A Act. This will continue under Snowy 2.0. The deemed approval is explained in more detail in Chapter 4.

2.4.2 Water storages and their continued use under Snowy 2.0

i Tantangara Reservoir

Tantangara Reservoir currently has the following operational functions within the Snowy Scheme:

- collects inflows from the Murrumbidgee River and the Goodradigbee River Aqueduct;
- provides a means for storage and diversion of water to Lake Eucumbene via the Murrumbidgee-Eucumbene Tunnel; and
- provides environmental releases through the Tantangara Dam river outlet gates to the Murrumbidgee River.

Tantangara Reservoir is a straight concrete gravity dam with active storage of 238.8 GL and gross storage of 254.1 GL, meaning the active storage (ie the amount of water available for use in the Snowy Scheme) is approximately 93.9% of the gross storage. Tantangara Reservoir has a MOL of 1,205.83 m AHD and FSL of 1,228.69 m AHD, an operating range of 22.86 m.

Due to the bathymetry of Tantangara Reservoir (which can be visualised as a cone – wide at the top and narrow at the bottom), the maximum rate of change in water levels is dependent on the water level, meaning that for the same volume of water flowing into or out of Tantangara Reservoir, the maximum rate of change in water level is more rapid when the reservoir is emptier (ie near MOL) compared to when it is at FSL.

ii Talbingo Reservoir

Talbingo Reservoir currently has the following operational functions:

- collects releases from Tumut 2 power station;
- collects inflows from the Yarrangobilly and Tumut rivers;
- acts as head storage for water pumped up from Jounama Pondage; and
- acts as head storage for generation at Tumut 3 power station.

Due to its historic relationship to both the upstream Tumut 2 power station and downstream Tumut 3 power station, Talbingo Reservoir has had more operational functions than Tantangara Reservoir in the current Snowy Scheme.

The bathymetry and storage characteristics of Talbingo Reservoir are different from Tantangara Reservoir. Talbingo Reservoir has a rated MOL of 534.35 m AHD, an FSL of 543.19 m AHD, an operating range of 8.84 m. The historic, long term average level for Talbingo Reservoir is 541.47 m AHD, which is just under the FSL.

Talbingo Reservoir has an active storage of 160 GL and a gross storage of 921 GL, meaning the active storage is approximately 17.3% of the gross storage. The active storage, or operating range, is a small range of levels near the top of the reservoir, and as a result, throughout its rated operating range, Talbingo Reservoir levels have a largely linear relationship with flows, and therefore unlike Tantangara Reservoir, the maximum rate of change in water level is less dependent on where the water level is relative to MOL and FSL.

iii Continued water storage variability as part of Snowy 2.0

Under the current approved operations of the existing Snowy Scheme, the levels within the various reservoirs are subject to significant variability over both the short and long terms due to the interplay of a number of factors relating to the design and construction of reservoirs, the environmental releases required by the Snowy Water Licence as well as variations of annual flows into the existing scheme.

In operating the Snowy 2.0 power station, Snowy Hydro will move water directly (in both directions) between Tantangara and Talbingo reservoirs (rather than in only one direction via Lake Eucumbene, Tumut Pond and Tumut 2 Pondage), and as a consequence will store water at different locations in the Snowy-Tumut Development. For example, more water is likely to be held for longer (whilst still meeting existing obligations) in Tantangara than was previously diverted from Tantangara Reservoir to Lake Eucumbene.

However, there will be no more water in the Snowy-Tumut Development as a whole, and the flexible storage of that water across the storages within the Snowy-Tumut Development below FSL is currently part of the approved operation of the existing Snowy Scheme.

As a result of the operation of Snowy 2.0, the water level in Tantangara Reservoir will be more variable than historically. Notwithstanding this, operations will not affect release obligations under the Snowy Water Licence, nor will it involve any change to the currently imposed FSLs. No additional land will be affected by virtue of the inundation of the reservoirs through Snowy 2.0 operations. Water storages will continue to be held wholly within the footprint of the existing FSLs.

Accordingly, no further impact assessment of any variations in storage levels in the Snowy-Tumut Development below FSL has been carried out for the purposes of this EIS.

2.4.3 Scheme infrastructure and maintenance

i Infrastructure servicing

The operation of Snowy 2.0 infrastructure requires ongoing servicing by power, communications and water. These requirements will be met by retaining select utility infrastructure established during construction, such as buried power and communication cables, as well as relevant water treatment plants and pipelines. A summary of infrastructure services provided during operation is provided in Table 2.16.

Table 2.16 Permanent infrastructure servicing requirements during operation

Servicing requirement	Purpose	Source/infrastructure provided
Electrical supply	To provide ongoing power for MAT and ECVT tunnel services (such as lighting, ventilation, groundwater pumps and surge shaft), control buildings (intake gates, MAT and cable yard) and raw water pumping infrastructure.	Permanent electrical supply will continue to be provided from Lobs Hole substation.
Communication supply	To provide communications between power station and access tunnels (MAT and ECVT), MAT control building, cable yard and control building, intake gates and control buildings.	Communication to be provided via cables installed during construction.
Raw water supply	To provide water for fire fighting at the power station, MAT and portal and the ECVT, and water source for treatment to potable standard.	Raw water will be sourced from Talbingo Reservoir via buried pipelines and water inlet established during construction.
Potable water supply	To provide potable water to the MAT portal building and the underground power station for staff facilities.	Water treatment plant at the MAT portal (established during Snowy 2.0 Exploratory Works). The plant receives water from the raw water supply system.

ii Maintenance requirements

Maintenance activities required for Snowy 2.0 will be integrated with the maintenance of the existing Snowy Scheme. Maintenance activities that will be required include:

- maintenance of equipment and systems within the power station complex, intake structures, gates and control buildings;
- maintenance of access roads (vegetation clearing, pavement works, snow clearing);
- dewatering the headrace and tailrace tunnel (estimated once every 15 to 50 years, or as required); and
- maintenance of electricity and communications infrastructure (cables, cable yard, cable tunnel).

iii Permanent access for operation and maintenance

Permanent access to Snowy 2.0 infrastructure is required. During operation, a number of service roads established during construction will be used to access surface infrastructure including the power station's ventilation shaft, the water intake structures, and the headrace tunnel surge shaft. Permanent access tunnels (the MAT and ECVT) will be used to enter and exit the power station. For some roads, permanent access by Snowy Hydro will require restricted public access arrangements. These arrangements are described in Section 2.5.

2.5 Interactions with Kosciuszko National Park

2.5.1 Final rehabilitation of disturbed areas within KNP

i Final land uses

The Rehabilitation Strategy developed for Snowy 2.0 has developed final land use domains characterised by similar final land use objectives. Each final land use domain will require site-specific decommissioning and rehabilitation methods. Table 2.17 provides a summary of the final land use domains with these shown on Figure 2.26 to Figure 2.31.

Table 2.17 Final land use domains

Domain	Description
Retained infrastructure	<ul style="list-style-type: none">• Water intake structures at Talbingo and Tantangara reservoirs.• Permanent access tunnel portals and associated infrastructure including the MAT and ECVT.• Ventilation shaft and headrace tunnel surge shaft at Marica.• Transmission cableyard at the ECVT portal.• Lobs Hole substation and associated power and communication cables between operational infrastructure.
Roads	New access roads or those which are upgraded, widened and sealed will be retained with agreement from NPWS. These roads will remain open to the public post-construction and will enable access to locations previously accessible by four-wheel drive.
Recreation sites	It is intended, and agreed with NPWS, that Lobs Hole and Tantangara areas will be retained as remote campsites.
Native vegetation	Areas will be revegetated and returned to a native vegetation final land use. The species used for each area will be commensurate with that present prior to disturbance as per the PCTs mapped for the area. Areas to be rehabilitated to native vegetation will include rehabilitated access roads.
Water management	The Talbingo and Tantangara reservoirs will remain as water storages that will continue to allow fishing and boating. Appropriate safety exclusion zones will be put in place in the vicinity of the intake structures.

ii Landform design

Final landform design and planning has been carried out to identify opportunities for the reuse of excavated material in rehabilitation and in construction of final landforms which complement the surrounding landscape of KNP and provide recreational opportunities for users of KNP where appropriate. Reuse of excavated material in the final landform will be subject to geochemical testing to confirm it is suitable to remain in situ. Any unsuitable materials will be remediated and removed from the areas to be rehabilitated. An example of potential landforming activities at Lobs Hole is presented in Figure 2.25.

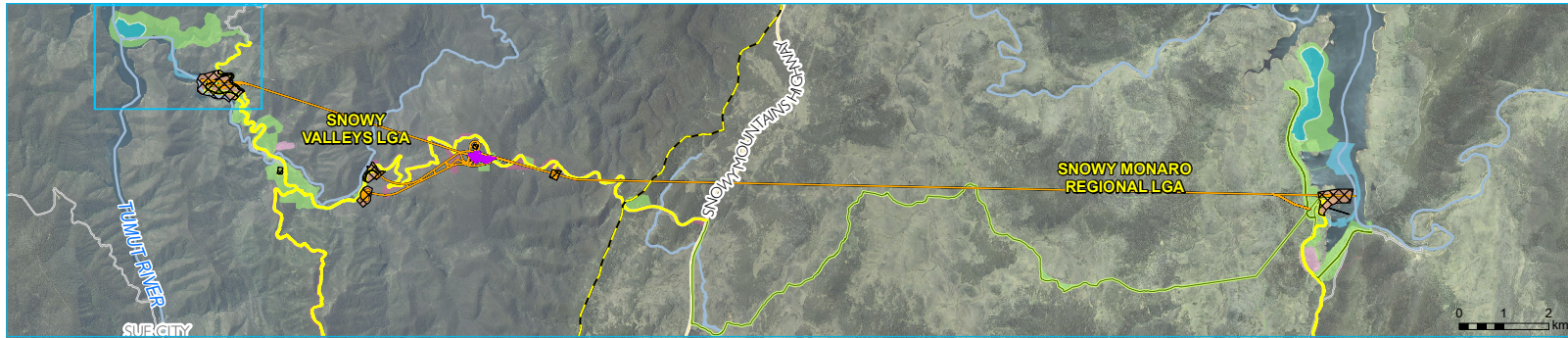


Artist impression: Possible rehabilitation optimised for recreational use

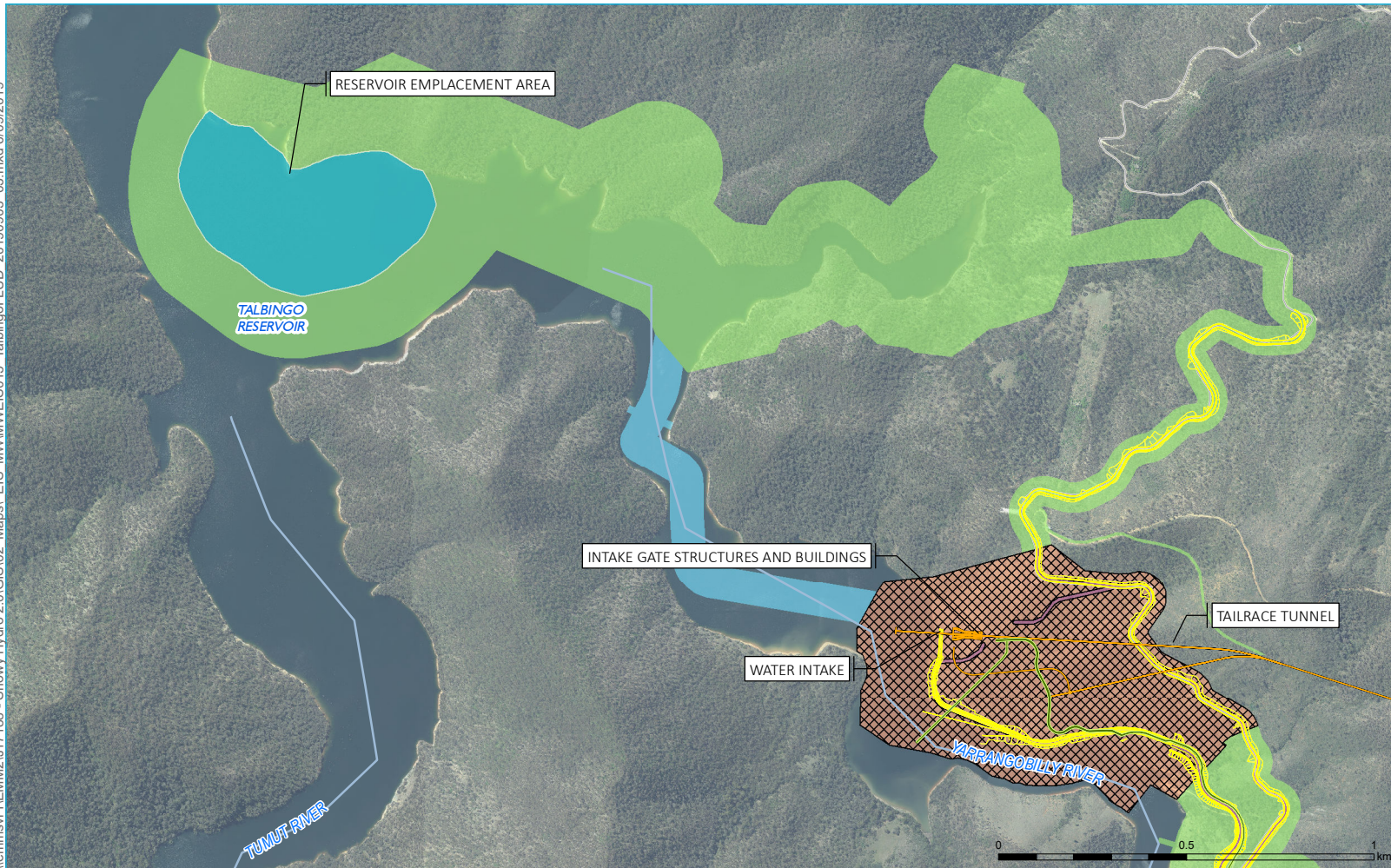


Artist impression: Profile of indicative re-shaping and landforming optimised for recreational use

Figure 2.25 Indicative rehabilitated landform of the Lobs Hole area post construction of Snowy 2.0 Main Works



- KEY**
- Operational footprint
 - Final land use domain
 - A - Retained infrastructure
 - B - Upgraded roads
 - C - Recreation sites
 - D - Native vegetation
 - E - Water management
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Local government area boundary
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Indicative rock emplacement area



Talbingo Reservoir - final land use domains

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.26

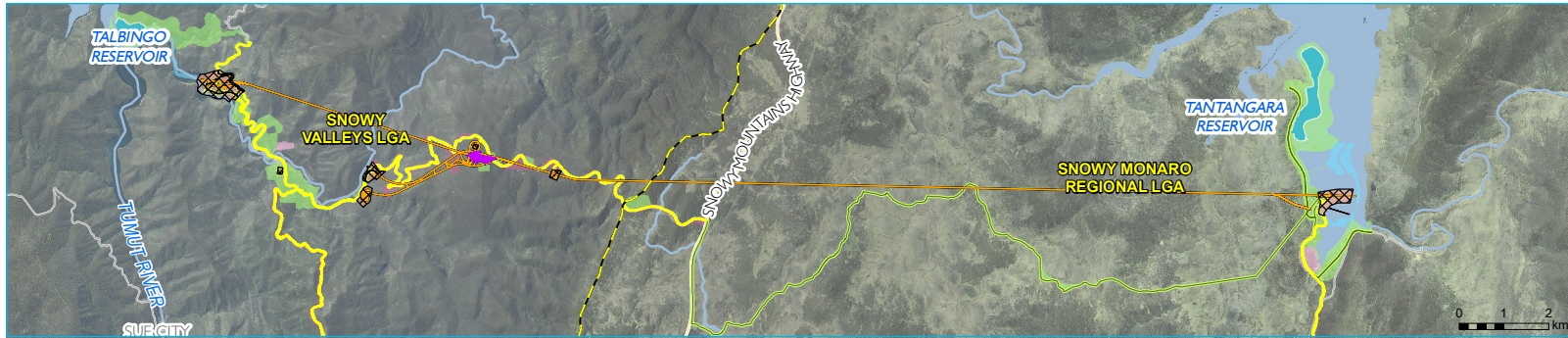


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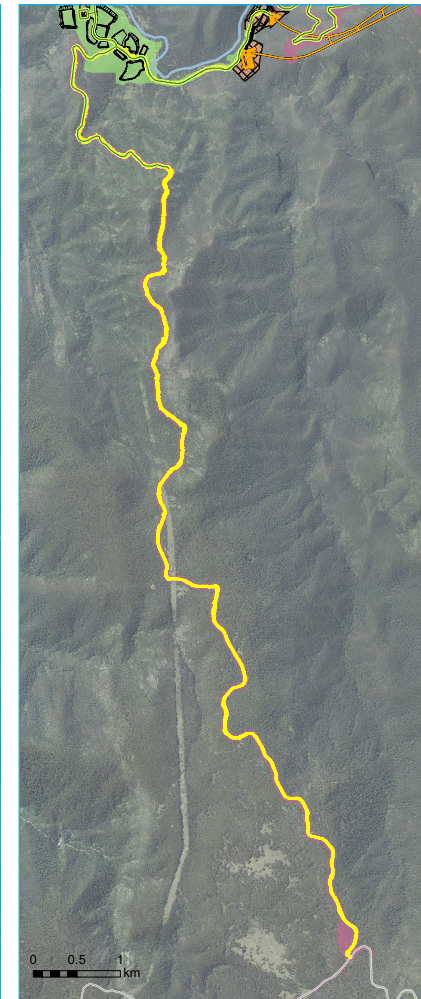
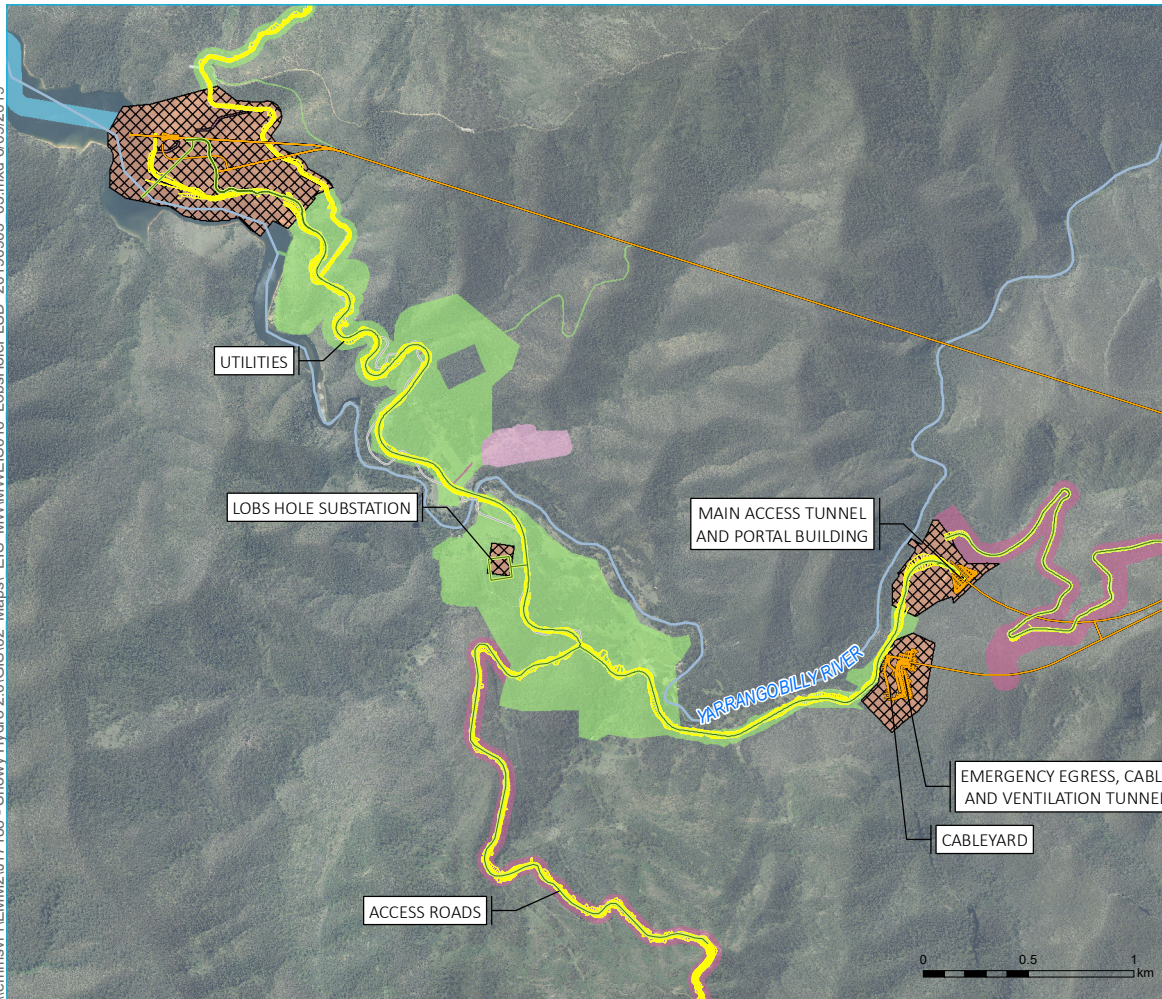
Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011); SLR (2019)

GDA 1994 MGA Zone 55





- KEY**
- Operational footprint
- Final land use domain
- A - Retained infrastructure
 - B - Upgraded roads
 - C - Recreation sites
 - D - Native vegetation
 - E - Water management
- Existing environment
- Main road
 - Local road
 - Watercourse
 - Waterbodies
- Local government area boundary
- Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Indicative rock emplacement area



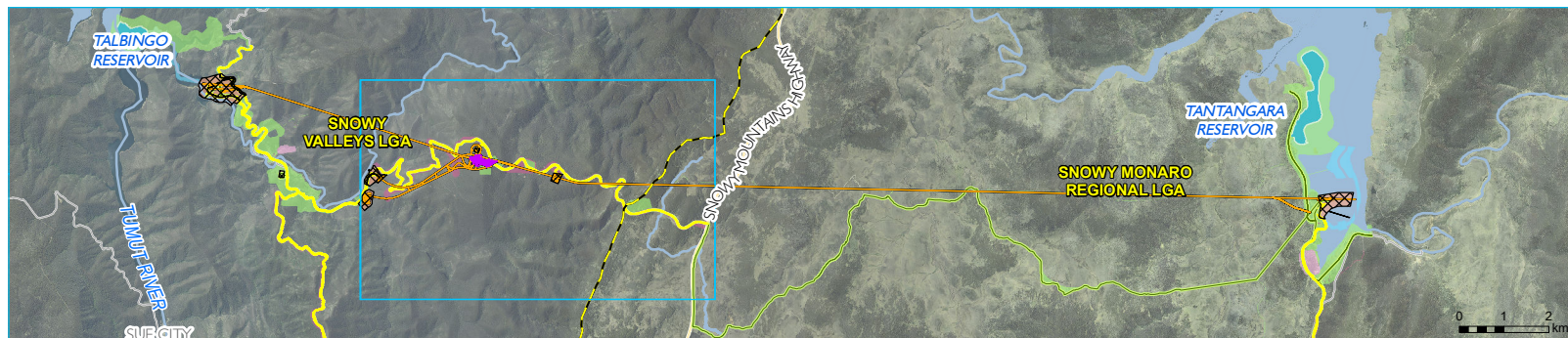
Lobs Hole - final land use domains

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.27

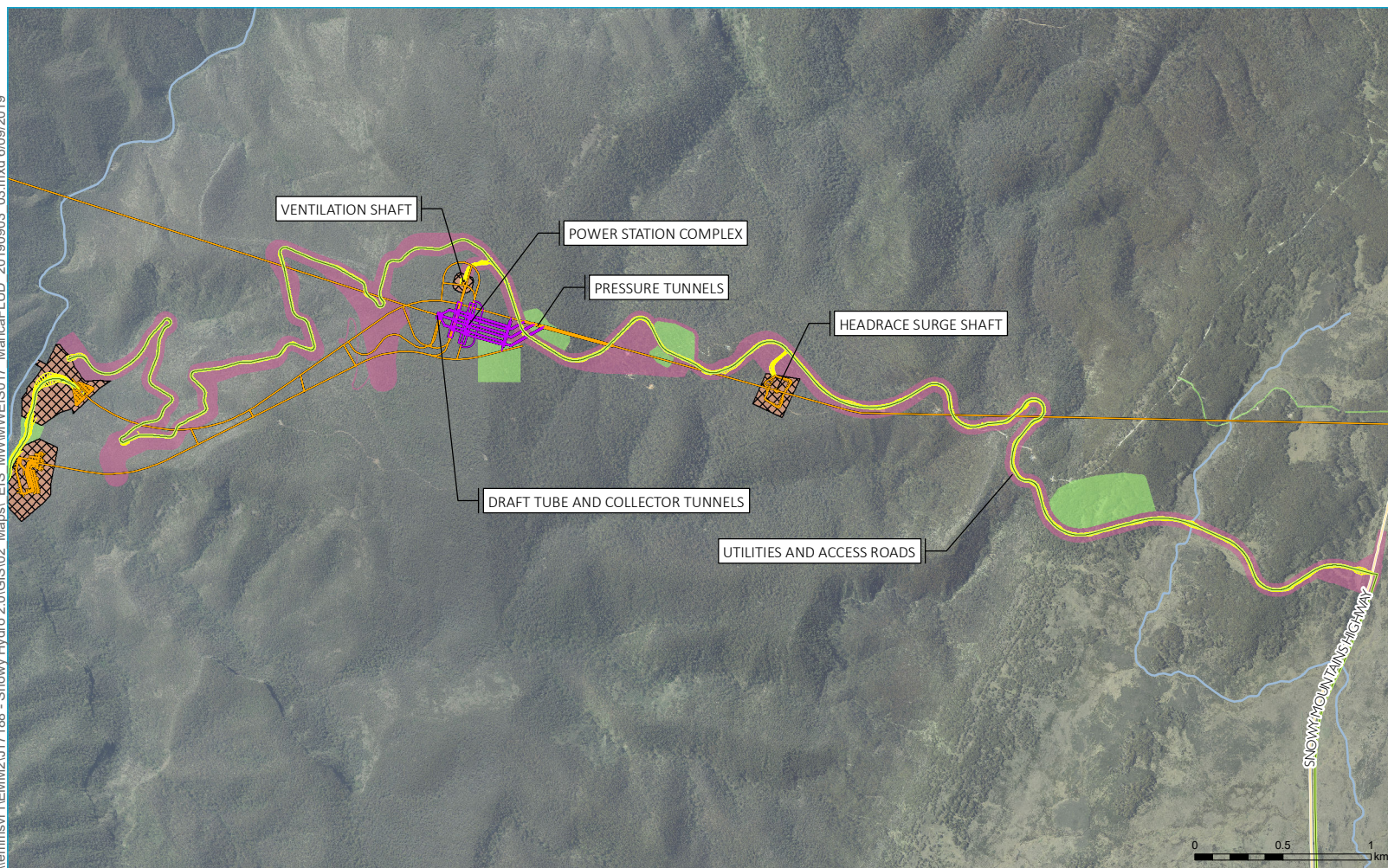
Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011); SLR (2019)

GDA 1994 MGA Zone 55





- KEY**
- Operational footprint
 - Final land use domain
 - A - Retained infrastructure
 - B - Upgraded roads
 - C - Recreation sites
 - D - Native vegetation
 - E - Water management
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Local government area boundary
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Indicative rock emplacement area



Marica - final land use domains

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.28

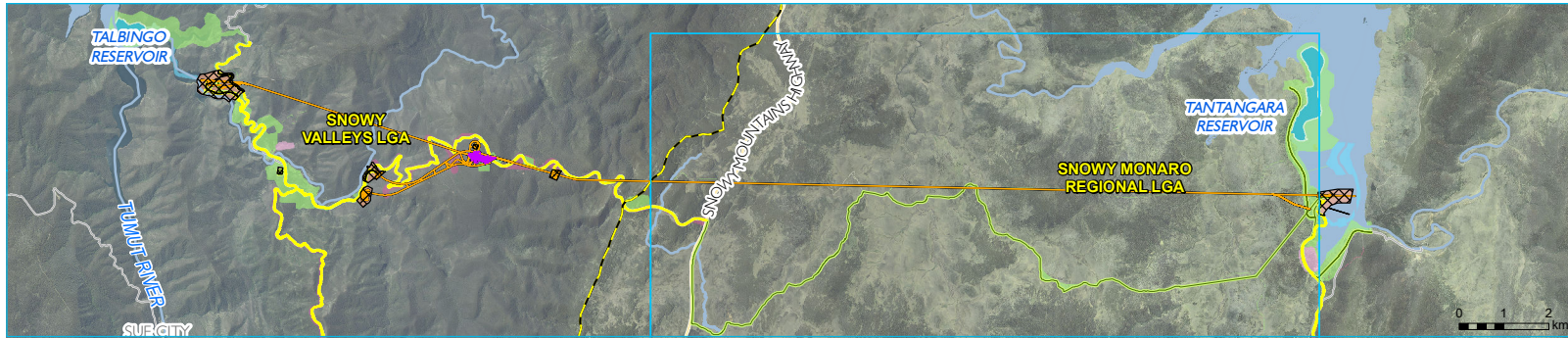


Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011); SLR (2019)

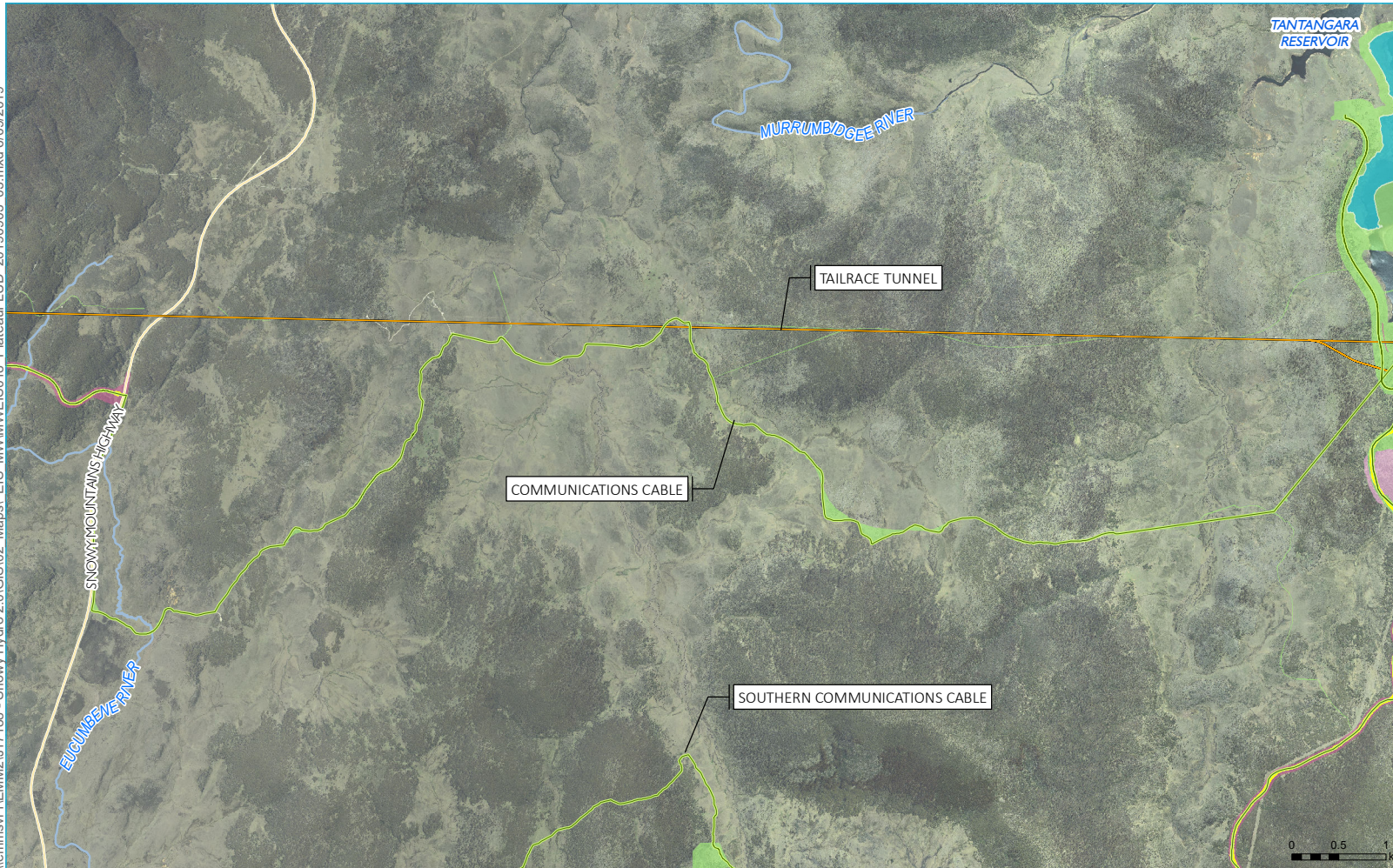
GDA 1994 MGA Zone 55



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- KEY**
- Operational footprint
 - Final land use domain
 - A - Retained infrastructure
 - B - Upgraded roads
 - C - Recreation sites
 - D - Native vegetation
 - E - Water management
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Local government area boundary
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Indicative rock emplacement area



Plateau - final land use domains

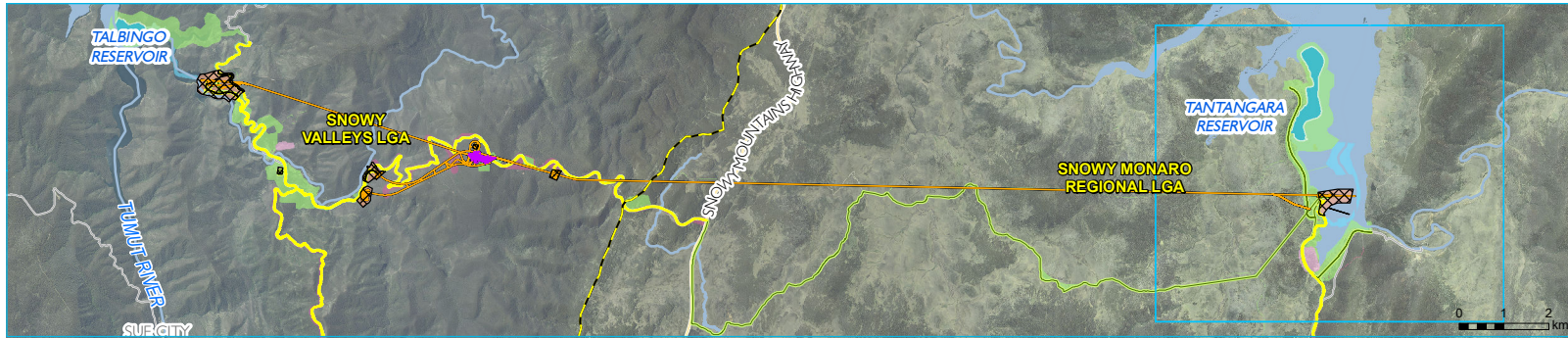
Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.29

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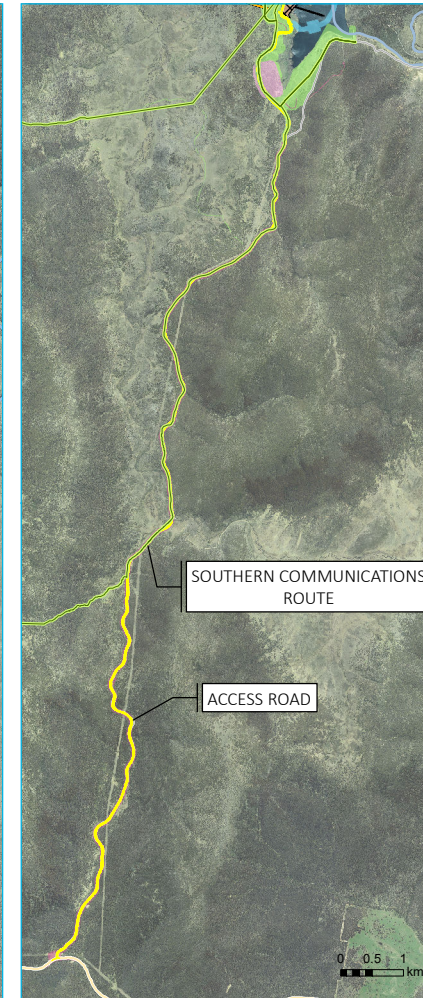
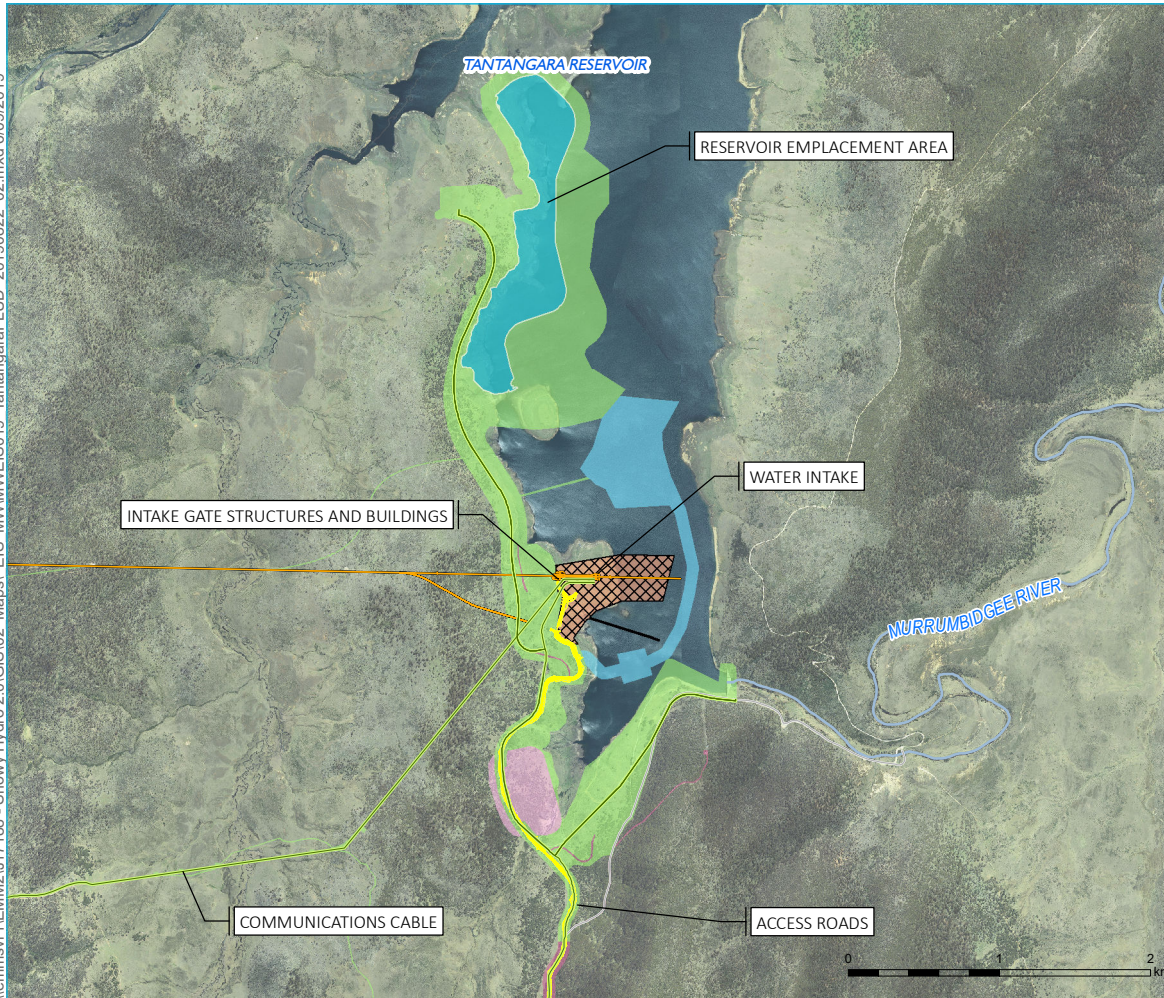
Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011); SLR (2019)

GDA 1994 MGA Zone 55





- KEY**
- Operational footprint
 - Final land use domain
 - A - Retained infrastructure
 - B - Upgraded roads
 - C - Recreation sites
 - D - Native vegetation
 - E - Water management
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Local government area boundary
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Indicative rock emplacement area



Tantangara Reservoir - final land use domains

Snowy 2.0
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Figure 2.30



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Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011); SLR (2019)

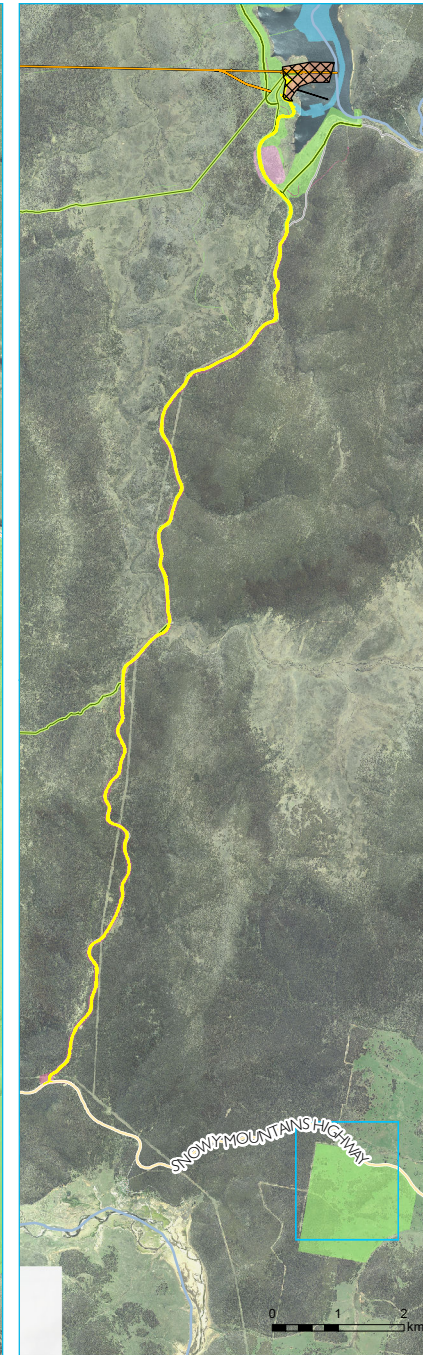
GDA 1994 MGA Zone 55



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



- KEY**
- Operational footprint
 - Final land use domain
 - A - Retained infrastructure
 - B - Upgraded roads
 - C - Recreation sites
 - D - Native vegetation
 - E - Water management
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Utilities
 - Permanent road

Rock Forest - construction areas, purpose and description

Snowy 2.0
Environmental Impact Statement
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Figure 2.31



GDA 1994 MGA Zone 55

iii Completion criteria

Following completion of construction of Snowy 2.0 Main Works, rehabilitation of disturbed areas will continue and be measured against established completion criteria as outlined in the Rehabilitation Strategy. Completion criteria are objective target levels or values assigned to a variety of indicators (eg slope, species diversity, groundcover) which can be measured against to demonstrate progress and the ultimate success of rehabilitation. As such, they provide a useful and defined end point at which time rehabilitation can be deemed successful.

Indicative completion criteria, performance measures and associated indicators have been developed for Snowy 2.0 Main Works by rehabilitation specialists with experience in alpine environments and are provided in the Rehabilitation Strategy in Appendix F. These criteria have been developed for each phase of the rehabilitation so that the rehabilitation success can be quantitatively tracked throughout the life of the project. The performance measures and associated indicators will be designed to provide an appropriate benchmark or guide against which to assess the management of project lands and the resulting improvements.

iv Recreational areas

Snowy Hydro will liaise closely with NPWS to determine the final end land use and the extent of decommissioning of temporary construction facilities and rehabilitation activities to be undertaken following the construction of Snowy 2.0 Main Works. This approach will be taken to ensure that decommissioning allows for integration with future planned recreational uses of these areas and to maintain the values of KNP and be consistent with the KNP PoM (NPWS 2006).

Following Snowy 2.0 Main Works, the Talbingo and Tantangara reservoirs will continue to be used for boating and fishing, however safety exclusion zones will be put in place in the vicinity of the intakes. The extent of safety exclusion zones is unknown at this stage and will be determined during the detailed design. Remote camping areas will be retained in the Lobs Hole and Tantangara areas for recreational use. These areas will either be retained or they will be recreated during rehabilitation if they are disturbed during construction activities. Following the construction of Snowy 2.0, temporary construction pads, accommodation camps, rock emplacements and some access roads, will be rehabilitated to land uses generally consistent with their pre-construction use, subject to ongoing consultation with NPWS.

Detailed design will follow the principles and concepts in this strategy to achieve stable non-polluting landforms and recreational areas consistent with the final land use domains.

2.5.2 Public access and recreational activities

i Water access

During construction of Snowy 2.0, public access to some areas of Talbingo and Tantangara reservoirs will be restricted. In Talbingo Reservoir, areas near the construction of the intake and excavated rock emplacement, including the Yarrangobilly Arm will be restricted from the public for safety reasons. Public access will be maintained in all other areas of the reservoir. Public access will also be restricted in areas near the construction of the intake and excavated rock emplacement for safety reasons.

Boat access at Tantangara Reservoir is from a public boat launching area in the south of the reservoir, accessed from Tantangara Road. However, this area will be closed to the public during construction. The barge launch area to be constructed for Snowy 2.0 Main Works will be retained and, subject to consultation with NPWS, available for public use. Boats are also currently free launched by recreational users in northern areas of Tantangara Reservoir, subject to operating water levels. It is anticipated that boat launching from these areas will continue to be available to the public during construction of Snowy 2.0 Main Works.

The operation of Snowy 2.0, either through generating or pumping mode, will result in higher velocities of water and conditions generally in the vicinity of the intakes in Talbingo and Tantangara reservoir. Public safety exclusion zones will be implemented near the intakes which will be identified by markers and/or signage.

Post-construction of Snowy 2.0 Main Works, public boat access will be maintained at both Talbingo Reservoir (at the public boat ramp in the northern end of the reservoir and at Sue City to the south) and Tantangara Reservoir (at the southern end).

ii Road access

To facilitate construction, some new roads will be constructed and existing tracks will be upgraded to provide permanent access to the new facilities such as Tantangara and Talbingo intake structures and the underground power station complex.

During construction, some existing roads will need to be closed to the public for safety reasons. During construction, Tantangara Road will be closed while it is upgraded and when any high risk activities are being undertaken (eg transport of oversized equipment and heavy periods of activity). Access along Tantangara Road will be maintained at other times with measures in place (such as vehicle escort and traffic controls) to achieve the required level of safety.

Once Snowy 2.0 is commissioned, some roads may need to remain restricted or closed to public access. Table 2.18 and Figure 2.32 and Figure 2.33 provide a summary of public access during the construction of Snowy 2.0 Main Works and once it has been finished.

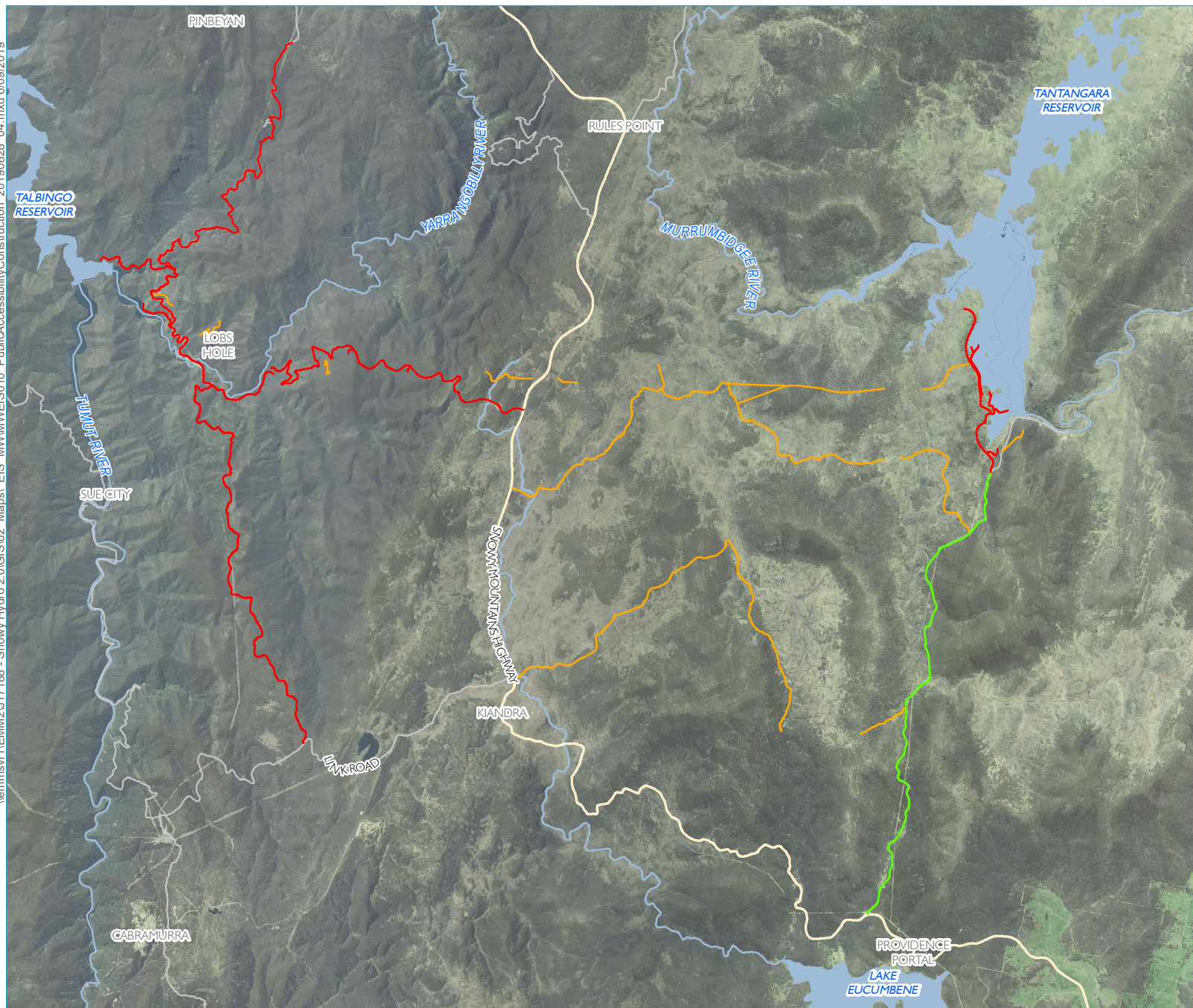
Table 2.18 KNP road infrastructure changes and access arrangements summary

Road name	Project use	Current condition	Construction upgrade	Public access during construction	Final condition	Long term public access (post-construction)
Lobs Hole Ravine Road (south)	Provide suitable and permanent access to the main construction area (Lobs Hole) and the portals to access the power station complex	Single lane, gravel track	Dual lane, gravel road with new alignment	SHL access only	Dual lane, sealed road	✓
Mines Trail Road	Provide suitable and permanent access to the portals and power station complex	Dual lane, gravel road and bridge over Wallaces Creek to access MAT portal (as approved under Snowy 2.0 Exploratory Works)	No further upgrade	SHL access only	Dual lane, sealed road	✓ (SHL only for MAT and ECVT access)
Lobs Hole Road	Provide suitable and permanent access to the main construction area (Lobs Hole)	Dual lane, gravel road and bridge over Yarrangobilly Road (as approved under Snowy 2.0 Exploratory Works)	No further upgrade	SHL access only	Dual lane, gravel road	✓
Lobs Hole Ravine Road (north)	Provide suitable and permanent secondary access and emergency egress from main construction area (Lobs Hole)	Single lane, 4WD track	Single lane, 4WD track with minor work to providing turning areas at some locations	✓ (first 5 km)	Single lane, 4WD track	✓
Marica Trail/Marica Trail west	Provide suitable and permanent access to headrace surge structure and ventilation shaft building	Dead end, single lane, 4WD track	Single lane, gravel road extended to Mines Trail Road at MAT portal	SHL access only	Dual lane, gravel road	✓ (SHL only section between MAT and surge)
Wharf Road/ Pipeline Road	Provides suitable and permanent access - to Talbingo intake, gate structure and wharf	-	New road, dual lane, gravel road	SHL access only	Dual lane, gravel road	SHL access only
Talbingo Excavated Rock Emplacement Access Road	Provides suitable access to the excavated rock emplacement area	-	Dual lane, gravel road	SHL access only	Rehabilitated	NA

Table 2.17 KNP road infrastructure changes and access arrangements summary

Road name	Project use	Current condition	Construction upgrade	Public access during construction	Final condition	Long term public access (post-construction)
Tantangara Road	Provide suitable access to the construction area at Tantangara	Single lane, gravel road	Dual lane, gravel road	✓ (limited, facilitated access)	Dual lane, gravel road	✓
Tantangara Camp Road	Provide suitable access to the construction area, excavated rock emplacement area and accommodation camp at Tantangara	Undefined 4WD tracks	Dual lane, gravel road	SHL access only	Rehabilitated	NA
Tantangara Excavated Rock Emplacement Access Road	Provide suitable access to excavated rock emplacement area	Undefined 4WD tracks	Dual lane, gravel road	SHL access only	Rehabilitated	NA
Quarry Trail	Provide suitable and permanent access to Tantangara intake	Single lane, gravel track	Dual lane, gravel road	SHL access only	Dual lane, gravel road	✓ (SHL only access to intake)
Gooandra/Bullock/Tantangara Dam fire trails	Provide suitable access for installation of communications cables	Single lane, gravel track	Single lane, gravel track with some minor works to allow for passing bays	SHL access only	Single lane, gravel track	✓
Link Road	Provide suitable and permanent access to the main construction area (Lobs Hole)	Dual lane, sealed	Dual lane, sealed with widening to 6 m in some areas	✓	Dual lane, sealed road	✓
Snowy Mountains Highway	Provide suitable and permanent access to all construction areas	Dual lane, sealed	No work anticipated as part of Snowy 2.0 Main Works	✓	Dual lane, sealed road	✓

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- KEY**
- Restricted access
 - No access during construction
 - Temporary/short-term closure during construction
 - Facilitated access during construction
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies

Public accessibility during construction

Snowy 2.0
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Figure 2.32

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

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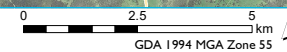
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- KEY**
- Restricted access post-construction
 - Access tracks rehabilitated on project completion
 - Full access reinstated
 - Partial access - no public access to infrastructure areas
 - No public access
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies

Public accessibility during operations

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



Snowy 2.0
Environmental Impact Statement
Main Works
Figure 2.33





CHAPTER

3

STRATEGIC CONTEXT



3 Strategic Context

The strategic context of Snowy 2.0 relates to its critical significance for the NEM, key State and Commonwealth government plans and policies, and economic, social and environmental trends driving change in the energy market. It is also important to understand the context in which the project will be constructed and operate, Kosciuszko National Park - an alpine national park with environmental and social values.

During the Feasibility Study for Snowy 2.0 and in the lead up to its FID, MJA carried out independent market modelling to understand upcoming trends and the future NEM in which Snowy 2.0 will operate. The findings of these studies confirm the strategic justification and need for Snowy 2.0 to provide large-scale storage that facilitates firming and reliability to the NEM, as the NEM decarbonises over the next few decades.

While the MJA modelling in the lead up to FID in late 2018 is still very relevant and underpins the strong economic case for the project -since this time, the energy market has evolved and changed much more quickly than originally anticipated even just a year ago. The likelihood of coal-fired generators closing earlier than previously anticipated is increasing (Aurora Energy Research 2019) and concurrently, the rapid uptake of intermittent renewables due to favourable economics is changing the energy market landscape. For example, investment in large-scale renewable energy projects doubled in 2018 compared to a previous record-breaking 2017, increasing from \$10 billion to \$20 billion (Clean Energy Council 2019).

The strategic context of Snowy 2.0 is summarised in this chapter, with further information also provided at Appendix H.

3.1 A changing energy system and market

3.1.1 National electricity market

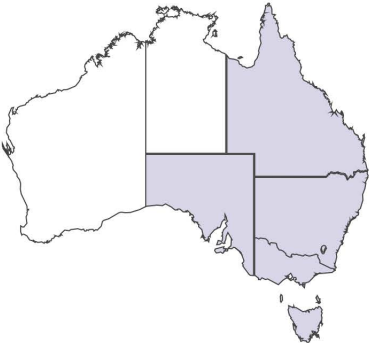
The NEM involves the wholesale generation of electricity from coal, gas and renewable sources that is transported via high voltage transmission lines from generators to local distributors. From the distributors, it is converted to low voltage electricity and delivered to almost 10 million homes and businesses across the Australian eastern and south eastern seaboard. The NEM delivers around 80% of all electricity consumption in Australia.

The NEM operates on one of the world's longest interconnected power systems and connects five regional market jurisdictions – Queensland, NSW (including the Australian Capital Territory), Victoria, South Australia, and Tasmania (as shown in Figure 3.1). The NEM has over 300 registered industry participants which include market generators, transmission network service providers, distribution network service providers and market customers.

The NEM is a wholesale commodity exchange for electricity across the five regional markets. As electricity cannot currently be stored easily, the NEM works as a 'pool', or spot market, where power supply and demand across all jurisdictions is matched instantaneously in real time through a centrally coordinated dispatch process.

The spot market is managed by a set of procedures that is managed on a five minute basis by AEMO, where generators offer to supply the market with specified amounts of electricity and AEMO decides which generators will be deployed to produce electricity, with typically the cheapest generator put into operation first. NEM operation is designed to meet electricity demand (or consumption) in the most cost-efficient way.

The NEM and how it works



There are over **300** registered participants such as generators, retailers & distributors in the NEM

● States/Territories that form the NEM

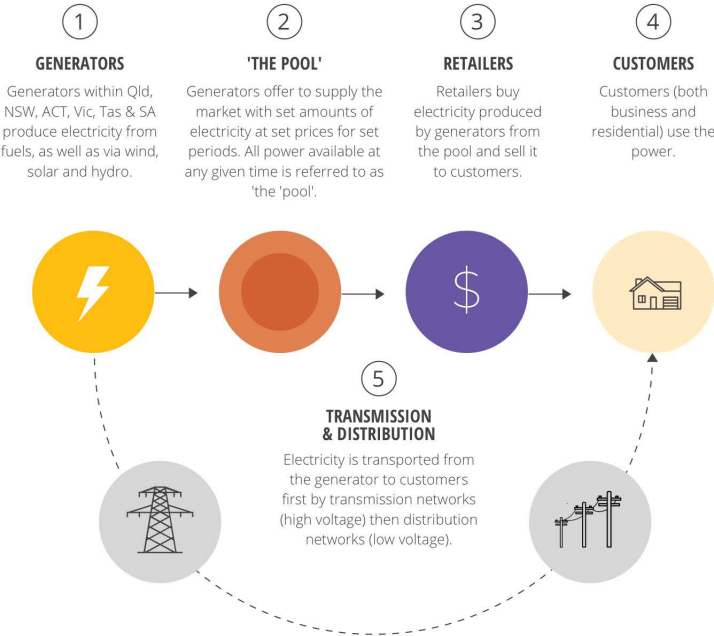


Figure 3.1 National Electricity Market

3.1.2 Planning policies driving change and regulation

The NSW energy system (and broader NEM) is facing several challenges through rising energy costs, deterioration in energy system security and reliability, and a transition in the generation mix away from coal-fired, dispatchable, baseload power to renewable wind and solar power characterised by intermittency. These challenges create a need for more energy storage within NSW and the NEM.

This energy transition towards renewables is driven by rapidly decreasing costs of wind and solar technologies as well as legislation and several strategic plans and policies set out by the Australian Government and States in the interconnected NEM.

Planning policies driving change and regulation in the NEM



WORLDWIDE

- The *Paris Agreement*: a global agreement signed by the Australian Government that sets in place a durable and dynamic framework for all countries to take climate action from 2020

AUSTRALIA

- *Commonwealth Renewable Energy (Electricity) Act 2000* and Australian Renewable Energy Target scheme: to encourage additional generation of electricity from renewable sources, to reduce emissions of greenhouse gases in the electricity sector and to ensure that renewable energy sources are ecologically sustainable

NSW

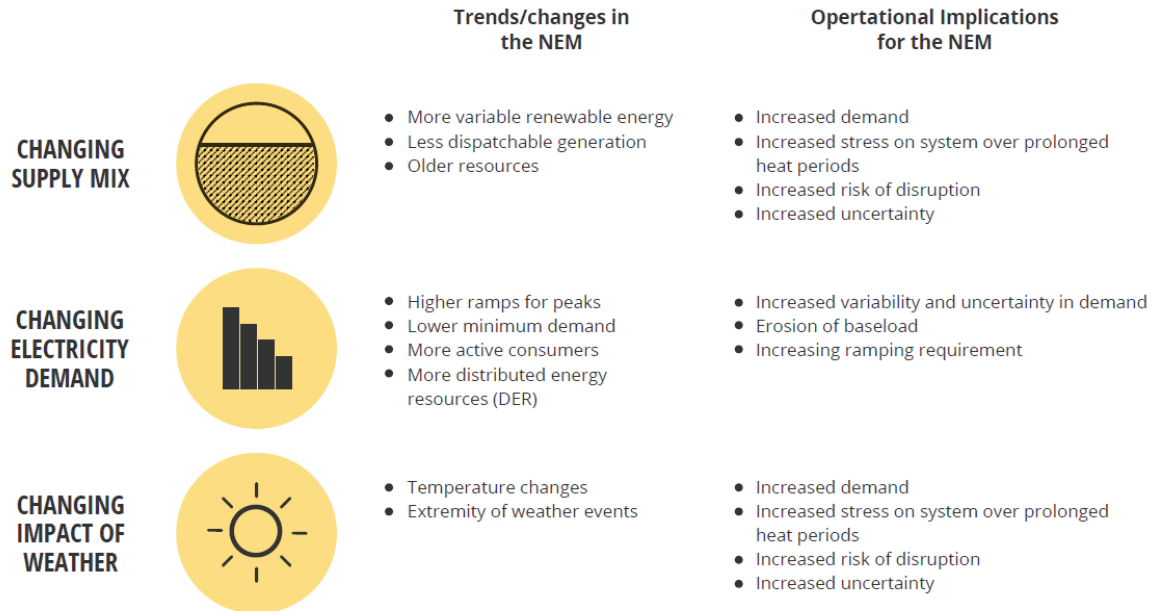
- *NSW Renewable Action Plan*: positions NSW to increase the use of energy from renewable sources at least cost to the energy customer and with maximum benefits to NSW.
- *NSW Climate Change Policy Framework*: aims to achieve net-zero emissions by 2050.
- *NSW Energy Security Taskforce*: Energy Zones were proposed to help unlock the pipeline of generation projects, support more competition in the energy market and help deliver low-cost energy for NSW consumers.
- *NSW Emerging Energy Program*: to support the transition in NSW to a clean energy system as coal-fired power plants are retired.

Figure 3.2 Relevant planning policies and regulation

3.1.3 Technological, economic and social trends

Currently, coal-powered generation accounts for approximately 77% of the annual generation of electricity within the NEM, with gas (9%), water (8%) and wind (5%) contributing the majority of the remainder. Solar and other generators (including biomass generators) currently account for approximately 1% of generation within the NEM (<https://www.aemo.com.au/>). Key system changes and operational challenges for the NEM are shown in Figure 3.3.

Key system changes in the NEM



Source: AEMO

Figure 3.3 Key system changes and operational challenges

As with many electricity markets around the world, the NEM is undergoing a paradigm transformation that has been brought about by significant shifts in energy efficiency, rapidly decreasing costs of wind and solar generation (known as variable renewable energy or VRE), coal power station retirements, increasing coal and gas costs and Australia's participation in global commitments to reduce carbon emissions (ie Paris Agreement).

Amongst the participants of the NEM, NSW is likely to have one of the greatest requirements for energy replacement and capacity, as several coal-fired power plants are confirmed to be retired. As the likelihood of new coal-fired power stations is considered to be low, much of the replacement of coal-powered generation will be from renewable sources and to a lesser extent gas. Figure 3.4 shows the projected evolution of the generation mix in the NEM to 2040, demonstrating both the increase in forecast generating capacity within the NEM and the shift from coal to renewable energy.

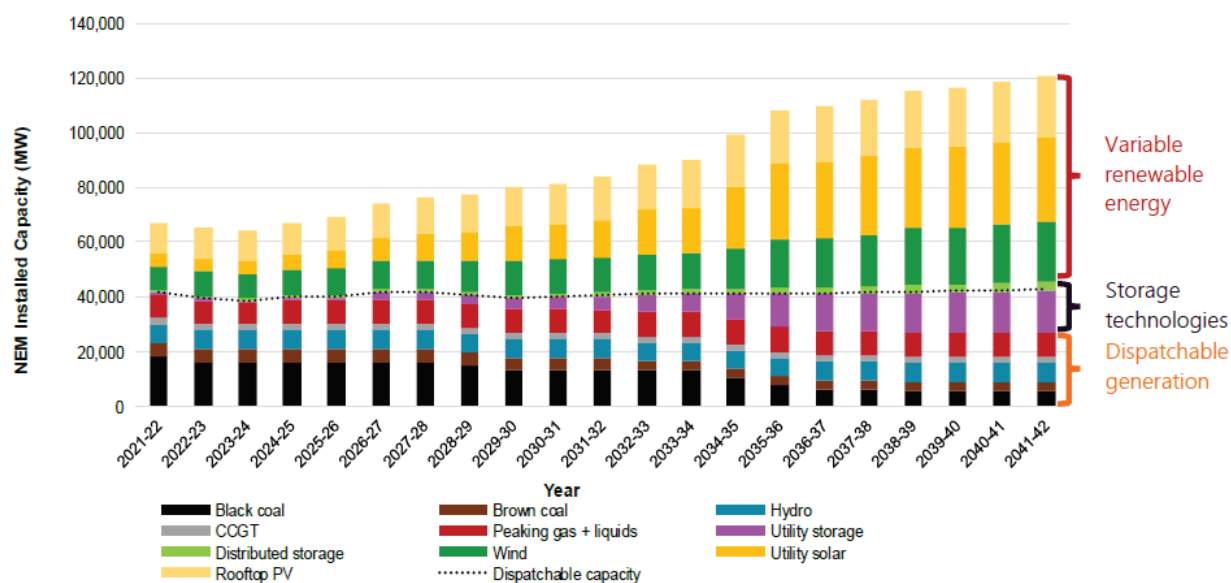


Figure 3.4 Forecast NEM generation capacity (AEMO 2019)

3.1.4 Security, reliability and resilience

In the NEM, changes in technology, costs, policy and customer preferences are occurring at a rapid rate. As energy generation needs to balance with customer demand in real time, the integration of intermittent generation will require increased peaking generation and energy storage solutions to provide a sufficiently fast response capacity and to ‘time shift’ non-dispatchable renewable generation to those periods when it is needed. The requirements for the NEM include storage that can provide energy for consecutive days (MJA 2018a).

While VRE provide energy during model conditions, the challenge for these sources are during prolonged wind and/or solar droughts when they would not operate. Energy storage helps build power system resilience to weather events (including wind, solar, and hydro droughts) by storing surplus renewable generation for use at times when these resources are scarce and allowing more constant operation of less flexible existing generation. This, in turn, creates a more dispatchable and reliable power system, while helping to keep prices down for consumers. This concept is shown in Figure 3.5.

Note: The demand for power varies by season and location.

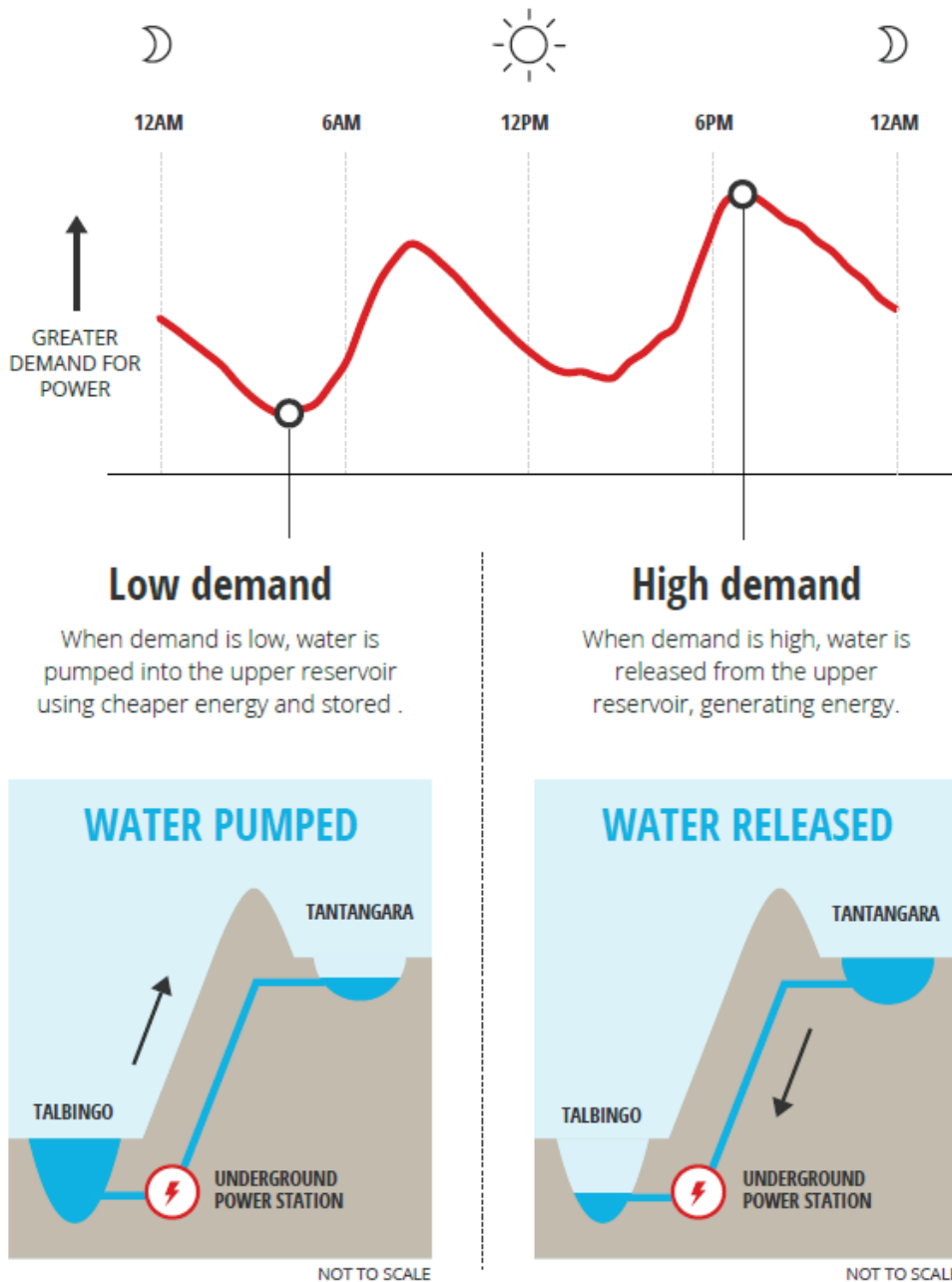


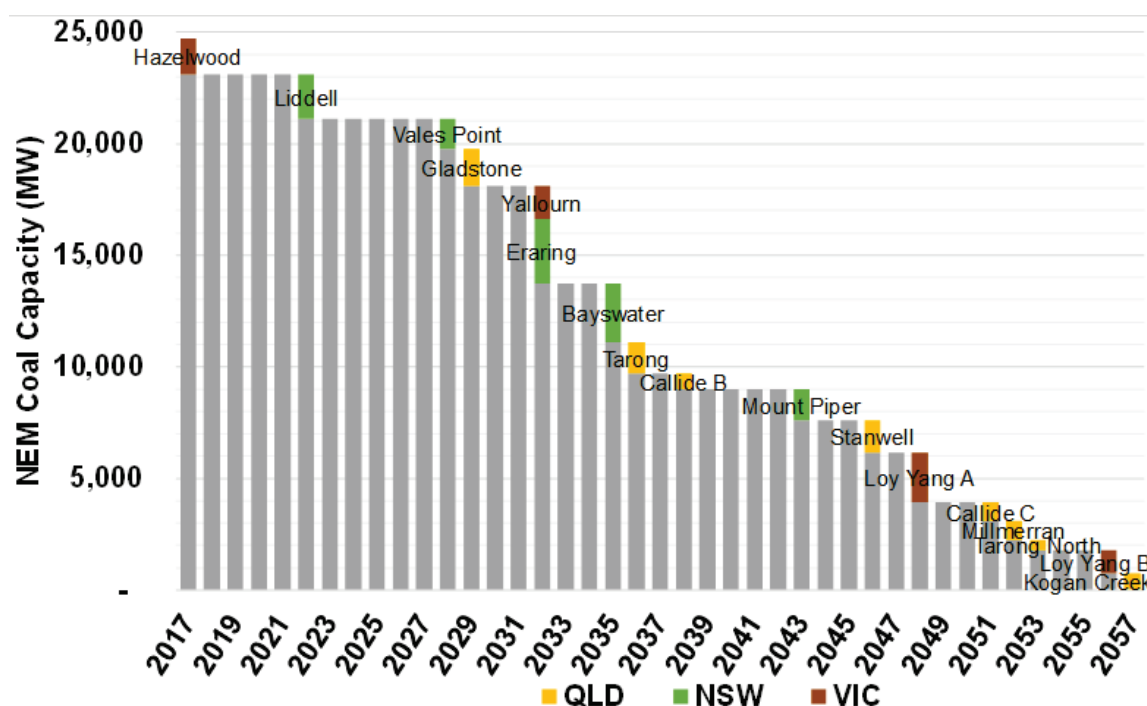
Figure 3.5 Snowy 2.0 operational phases responding to daily power demand

A large pumped hydro system such as Snowy 2.0 (with approximately 350,000 MWh of energy storage) can provide significant energy storage capable of delivering large-scale generation within minutes in times when VRE and / or other generation output is low.

3.2 Need and benefits of Snowy 2.0

As Australia decarbonises, Snowy 2.0 is required to support an orderly transition, prevent blackouts and put downward pressure on energy prices. Snowy 2.0 provides new dispatchable energy generation with large-scale storage to provide secure and reliable energy to the NEM at the lowest cost, which ultimately benefits consumers.

Snowy 2.0 will play a crucial role in providing long term storage and dispatchable generation that can fill and firm the energy void left from the exit of fossil fuel generation. As recognised by the NSW Government in its submission to AEMO (NSW Government 2018), the expected retirement of ageing coal-fired power stations over the next 10 to 15 years combined with increasing demand for energy at peak times will put pressure on the future energy system and require development of replacement firming energy capacity and dispatchable generation. Figure 3.6 shows the current assumptions regarding the closure of these coal-fired generators, with NSW, one of the NEM regions with the greatest scale of age-driven retirements (AEMO 2018). However, as previously discussed, the market has continued to change at a fast pace with an increasing risk that coal-fired generating assets retiring earlier than previously anticipated, placing further pressure on the need to develop replacement firming capacity and dispatchable generation.



Source: MJA S2.0 FID Modelling; technical life basis

Figure 3.6 NEM coal-fired power station operating life (AEMO 2018)

3.2.1 Need for Snowy 2.0 in the NEM

An independent study was carried out by MJA on the operation of Snowy 2.0 in the NEM. The study involved modelling of the NEM with and without Snowy 2.0 for a number of future market scenarios. A detailed account of the methodology and the findings of the study are documented in a detailed report (MJA 2018).

The study included the modelling of the NEM over the period 2018/19 to 2074/75. Further, the modelling was required to properly represent the hourly/daily/weekly/seasonal variations that are fundamental to the operation of generators in the NEM. For each scenario modelled, the impact on the NEM was determined by considering a case where Snowy 2.0 is developed and where Snowy 2.0 is not developed.

As previously discussed, the MJA modelling, whilst carried out in 2017 and 2018, is still very relevant – however, the energy market is evolving and changing much more quickly than originally anticipated even just a year ago. The likelihood of coal-fired generators closing earlier than previously anticipated is increasing (Aurora Energy Research 2019) and concurrently, the rapid uptake of intermittent renewables due to favourable economics is changing the energy market landscape, further underpinning the need for Snowy 2.0.

i The NEM without Snowy 2.0

In the absence of Snowy 2.0, the study concluded the replacement of coal power stations with VRE, gas generation and storage would result in:

- using VRE to replace the lost energy production from the closed coal generators;
- using dispatchable generation (most notably gas) to fill in the gaps when VRE is not generating; and
- using battery storage to capture excess VRE generation that would spill and using it when needed.

Batteries will have a role to play in the future of NEM, but within this scenario, the economics and limited hours of batteries mean that they can only capture part of the variation in VRE and, on their own, do not provide sufficiently for firm capacity. The outlook of this case is that even with the projected reduced costs of batteries, the level of storage required means that more expensive gas generation will be required for firm capacity and to address the majority of the variations in VRE output.

ii The NEM with Snowy 2.0

The MJA study concluded that Snowy 2.0 would influence the operation of and asset mix that replaces the closing coal power stations as follows:

- Significantly more VRE output would be captured thereby improving the economics of VRE entry. Additional VRE generation would be developed. The diversity of VRE output means that Snowy 2.0 would provide for significantly more than 2,000 MW of additional VRE to enter.
- The firm capacity provided by Snowy 2.0 would provide for about 2,000 MW less of more expensive gas generation to be developed.
- Less battery storage would also be needed, although the reduction in battery storage would reduce as battery costs become lower late in the study period.

The net result of Snowy 2.0 being developed is improved market efficiency, more reliable market operation, and lower emissions at the lowest cost.

iii Need for the project

Snowy 2.0 is a critical project for the NEM as it moves to a low-emissions future. As the transition to renewables accelerates, reliable supply cannot be achieved without large-scale energy storage. Snowy 2.0 is the least cost option to build large-scale storage and is centrally located between the NEM's two biggest load centres, Sydney and Melbourne.

In recognition of the need to manage the transition and future energy mix in the NEM, Snowy 2.0 was declared CSSI by the former NSW Minister for Planning under the NSW EP&A Act in March 2018. When announcing the CSSI declaration, the Minister stated that Snowy 2.0 was 'essential for the future security of our energy system, the economy and our environment' with project declared as critical for the energy security and reliability needs of NSW. The declaration signifies the critical role that Snowy 2.0, together with the upgrades to the NSW transmission network, will play in providing reliable energy and large-scale storage to NSW as it transitions to a low emissions economy.

Snowy 2.0 would build on the Snowy Scheme's existing capabilities and meet the needs of the market and consumers by providing fast-start, clean energy generation to address supply volatility, as well as fast-start capability and large-scale storage to address the intermittency issues associated with renewables. Snowy 2.0's 350,000 MWh or 175 hours of energy storage is enough to underpin the stability and reliability of the NEM especially during prolonged weather events, such as wind or solar 'droughts'.

3.2.2 Key benefits of Snowy 2.0

Snowy 2.0 is the largest committed renewable energy project in Australia. By expanding the current Snowy Scheme's renewable energy capacity by almost 50%, the NEM will be served with an additional 2,000 MW generating capacity. In terms of the future energy market, the key benefits of Snowy 2.0 are summarised as follows:

- Snowy 2.0 makes a significant contribution to the continued decarbonisation of the economy;
- Snowy 2.0 provides large-scale energy storages at the least cost to allow more flexibility to respond to seasonal variability when compared to other VRE and batteries;
- Snowy 2.0 will improve the overall efficiency of the NEM by absorbing and storing excess energy from the system at times of excess demand (through pumping) and generate at the critical times of peak times;
- Snowy 2.0, being a closed system, can move water between reservoirs and not rely on natural inflows that may vary seasonally, offering valuable seasonal storage and insurance against drought risk;
- Snowy 2.0 will have the capability to run for over seven days continuously before it needs to be 'recharged'. By comparison, small and large-scale batteries have limited storage (typically one to four hours) and their already high prices increase significantly when used for more than one charge/discharge cycle per day; and
- Snowy 2.0 has a 100 year design life and will operate for generations to come.

The following sections provide further detail on the benefits of Snowy 2.0 within the NEM.

i Supports trilemma of issues of reliability, price and emissions reduction

On a NEM wide basis the above relationships would provide for Snowy 2.0 to directly and substantially contribute to the trilemma issues of reliability (firm capacity), price (least-cost new entry solution), and emissions reduction (optimises VRE storage over time) as the existing fleet of coal-fired generators closes and replacement firm capacity and energy production is required. Lithium ion technology is economically marginal as the reliability (up to 4 hours only) and price (along the learning curve) are not sufficiently profitable in the short to medium term.

ii Avoids excess supply

Snowy 2.0 would utilise otherwise unused low-cost generation (unused coal and VRE) and provide dispatchable and firm capacity that can operate for days if required, with the effect that the NEM would operate more efficiently and with lower emissions.

iii Emissions reduction

Before the closure of NSW Eraring power station, the lowest cost option for reducing emissions is replacing coal generation with VRE generation, together with the level of firming required (with most firming being available from the existing dispatchable generation).

Once Eraring power station and other coal-fired generators close, increasing levels of VRE would require increasing amounts of new firming assets, with economics having this increasingly composed of gas generation. This limits the level of emissions reduction to about a 65% level of abatement (compared to the 2005 level).

A constraint on emissions when coal plant has substantially closed would involve VRE with substantial storage and a reduced reliance on gas generation. The value of large storage is magnified under such conditions.

iv Green energy economy supported by Snowy 2.0

As shown in Figure 3.7, Snowy 2.0, the least-cost economic entrant, displaces both gas (grey bar) and battery (green bar) new entry requirements. In addition, it economically supports wind (black bar) and solar (yellow bar) new entry by converting intermittent dispatchable energy into firm energy using its unique storage and capacity value capabilities.

Snowy 2.0 provides support and firming for VRE generation. It results in about 3,000 MW of additional VRE generation and a reduction of about 2,000 MW of gas generation (mainly combined gas cycle turbine (CCGT)). Snowy 2.0 results in a reduction of about 1,000 MW of Lithium ion batteries in the initial years of Snowy 2.0 operation, with this reduction diminishing due to the additional VRE that enters in the medium term.

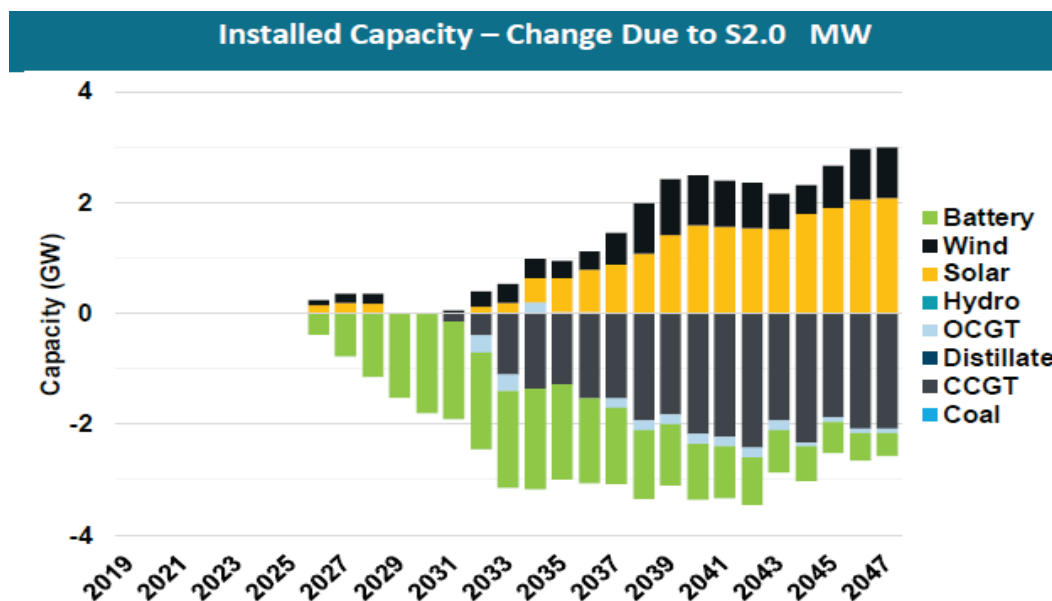


Figure 3.7 MJA modelling – installed capacity changes due to Snowy 2.0 over time

The chart in Figure 3.8, is largely consistent with the ISP (AEMO 2018) decarbonisation prediction shows the benefits Snowy 2.0's unique capabilities can provide to enable the transition to a reliable green energy economy. There is very significant coal-fired generation capacity out to 2047. It is replaced with wind and solar energy, battery value (from Lithium ion and Snowy 2.0) as well as capacity / value from open cycle gas turbines (OCGT) and CCGT.

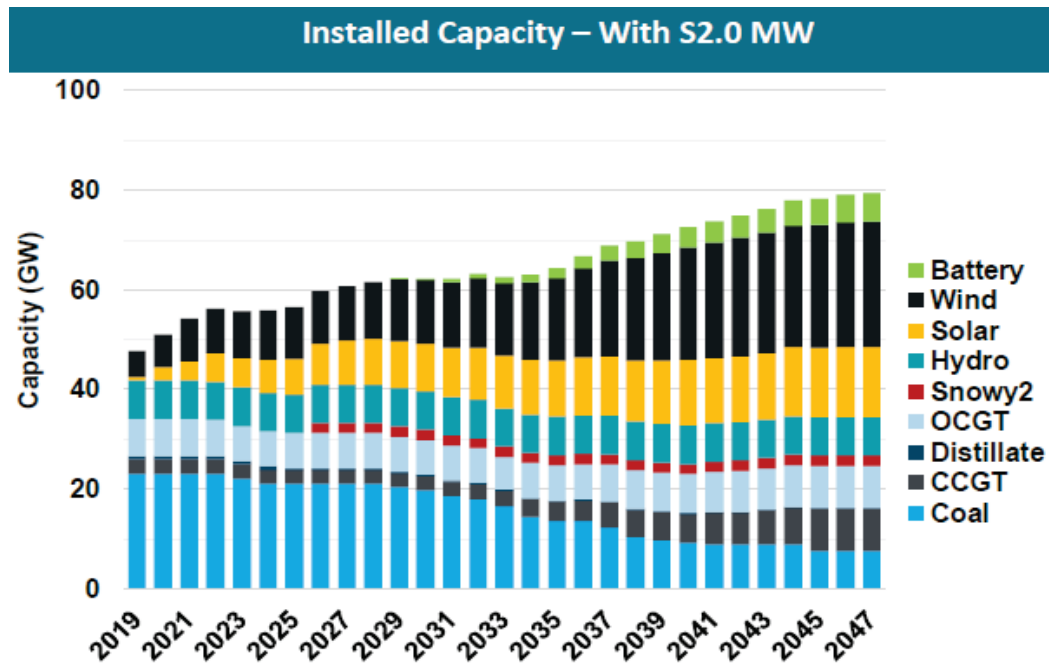


Figure 3.8 MJA modelling – installed capacity due to Snowy 2.0 over time

v Supply side options and costs considered in MJA modelling

Lithium ion battery and gas plants were both considered the two possible next best alternatives to Snowy 2.0's capabilities. The full list of generator options considered in the MJA modelling were as follow:

- high efficiency low emission coal plant;
- gas plant – CCGT;
- gas plant – OCGT;
- gas plant – reciprocating;
- solar generation; and
- wind generation.

The main storage providers in the NEM that were considered in the modelling were as follows:

- Large scale pumped hydro schemes. There were only two:
 - Snowy 2.0 which includes the potential further development of Snowy 3.0;

- Battery of the Nation – Basslink II plus potential developments to the hydro systems in Tasmania. This is supported by the Australian and Tasmanian governments and has economics that requires Riverlink to be developed (which is near being financially committed) and increased VRE development. Battery of the Nation was not costed and has unknown economics;
- Lithium Ion Batteries. Batteries were the principal storage technology developed in the AEMO ISP modelling, and possibly are the most direct competitor to pumped hydro storage in the NEM. However, on the current cost curves, batteries with storage hours of over 4 hours will not be economic from spot price revenues until past 2040;
- Small scale pumped hydro schemes. The geography of Australia limits the number of sizeable and economic sites. Two that were considered included:
 - Kidston in northern Queensland (200 MW and 8 hours of storage); and
 - Cultana in South Australia (up to 250 MW). The Kidston project was assumed to be developed in the MJA modelling.

vi [Lithium ion battery as the next best alternative](#)

Not all value that a battery or storage can provide will be translated into a corresponding revenue stream. For example, reducing the costs of coal-fired generator ramping does not appear as a revenue stream.

However, the potential value and revenue streams for batteries that can be modelled and the approach to this assessment of the respective revenue streams includes:

- spot price arbitrage;
- risk value through sustainable operation (associated with storage availability); and
- risk value through the sale (or avoided purchase) of 5-minute cap response products.

The first two of the above increase in value through increased energy in storage.

Another economic factor has been noted:

- batteries can be developed in conjunction with a solar / wind facility. This can have a battery charge directly from the solar plant and discharge when economic. This can have benefits to transmission use of system charges. (if applicable).

The following Lithium ion battery cost curve shown in Figure 3.9 was employed across time on best available, current information on wholesale battery costs.

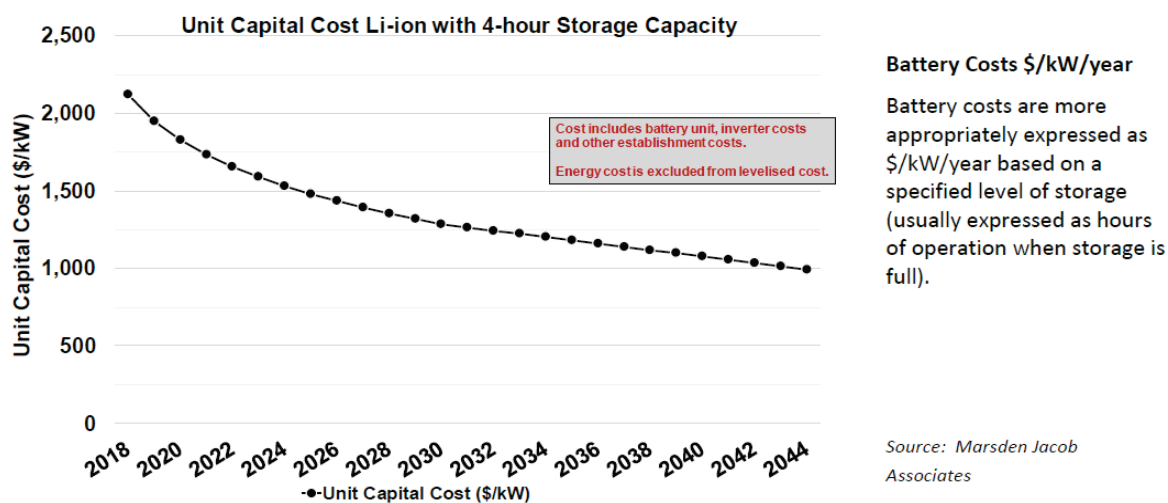


Figure 3.9 MJA modelling – Lithium ion learning cost curve

The development of battery storage is complex. The issue with battery storage is that battery storage (with limited hours of storage) is and will likely continue to enter despite batteries currently not being economic and an outlook (based on the forward cost curves) that batteries will not be economic until past 2040 (for storage with hours of storage over about four hours).

On the basis that batteries will be required to support VRE entry, the analysis concluded batteries will likely enter through the following means:

- limited storage with a solar or wind generator to smooth the VRE profile;
- government-sponsored for reliability and security;
- by regulation. This would require VRE enter to be with a battery for daily smoothing (such as to address minimum load issues) and security post 2030. This would be influenced by other storage such as Snowy 2.0.

The economics of batteries would require very high arbitrage revenues and it is unlikely that there would be a surplus of battery storage competing for VRE charging energy. Consequently, gas generation would form an important component of firming and price setting.

vii OCGT and CCGT gas as the next best alternative

OCGT and CCGT gas generation will likely be needed to provide the firm capacity shortage resulting from the closure of coal plant and the limited expected battery development. MJA economic modelling shows that gas generation is the next best alternative under most scenarios rather than Lithium Ion battery technology due to the latter's constrained energy duration.

viii Summary of key benefits

Snowy 2.0 would result in benefits distributed to the wholesale market, retailers, and consumers. The scale and centralised location of Snowy 2.0 in the NEM enables the system stability, energy reliability and firming capability benefits to be enjoyed by all segments of the NEM as summarised in Figure 3.10.

Key benefits of Snowy 2.0 in the NEM



Source: Snowy Hydro Limited (2019)

Figure 3.10 Benefits of Snowy 2.0 by market segment

3.2.3 Support for Snowy 2.0

There is strong support for Snowy 2.0 in the community. As part of the stakeholder engagement and community consultation formal surveys were undertaken. Responses identified the areas considered most important by the community, they include:

- the reliability of the electricity network;
- lower energy prices;
- increasing and expanding sources of reliable, renewable energy and minimising reliance on traditional fossil fuels (cleaner energy);
- minimising potential environmental impacts of Snowy 2.0 construction ; and
- the economic benefits of Snowy 2.0 for the local communities.

Snowy Hydro's Independent Board of Directors made its FID on 12 December 2018 to proceed with Snowy 2.0, again confirming the project is economic, technically feasible and financeable. As the sole shareholder, the Australian Government provided shareholder approval for Snowy Hydro to proceed with Snowy 2.0 and committed up to \$1.38 billion by way of an equity injection in Snowy Hydro.

3.3 Land use context

3.3.1 Snowy 2.0 and Kosciuszko National Park

The KNP PoM (NPWS 2006) recognises the Snowy Scheme with various references including to the Park Zoning provisions. The Park Zoning covers the whole of the KNP and is intended to:

- protect the values of the park, as set out in the PoM under the categories of Natural Values, Cultural Values and Recreational Values;
- optimise opportunities for a wide range of recreational activities and visitor experiences; and
- minimise land use conflict between participants in different recreational activities, and between visitors, management operations and other authorised users.

The KNP PoM incorporates the Snowy Management Plan. Both plans will be reviewed and amended as required under a transitional program explained in detail in Chapter 4. Chapter 4 also explains the current arrangements for Snowy Hydro's existing and ongoing occupation and use of land within KNP.

One site is beyond the boundaries of KNP and on land zoned for rural uses (RU1 Primary Production) under the *Snowy River Local Environmental Plan 2013*. The Rock Forest site has been secured by Snowy Hydro under a private lease agreement with the landowner.

3.3.2 Elements of the site that could be impacted

The existing environment of the project area has been generally summarised in Table 3.1. Each of the key features are further described in the relevant section in Chapter 6 of this EIS, including how they might be impacted by the project. The project interacts with a number of environmental and social values of the project area which include:

- landscape and natural heritage values of KNP, including its management by NPWS and use by the public;
- terrestrial and aquatic biodiversity, including endangered and critically endangered species identified throughout the project area;
- surface and groundwater features and their interaction, including groundwater levels and overlying watercourses and respective water quality of these resources;
- Aboriginal cultural heritage values and sites and historic heritage items; and
- recreational uses of Lobs Hole, Talbingo and Tantangara reservoirs.

Snowy 2.0 Main Works through its design has considered the interactions with these environmental and social values and where possible sought to avoid and minimise impacts. This principle of avoidance through design is detailed further in Chapter 6.

Table 3.1 **Snowy 2.0 site and surrounds – key features requiring consideration**

Attributes	Talbingo Reservoir	Lobs Hole	Marica	Plateau	Tantangara Reservoir	Rock Forest
Natural environment						
Geology	<p>The Ravine area is within a geologic domain referred to as the Tumut Block which extends west of the Long Plain Fault (LPF) (Figure 6.3) to the east of Talbingo Reservoir. The area is dominated by Silurian to Devonian sedimentary and igneous rocks. The Silurian Ravine Beds, composed of stratified altered siltstone, sandstone and limestone, provide the structural framework and topographic control for this area.</p> <p>The Ravine Beds are overlain in areas, typically along the escarpment, by younger volcanic rock (Boraig Group and Byron Range Group) deposited in the Devonian during a period of explosive felsic volcanism.</p>			<p>The plateau area is within a geologic domain referred to as the Tantangara Block which extends from the Tantangara Fault (TF) in the east to the LPF in the west.</p> <p>The geological units within the plateau area generally grade from youngest to oldest in an east to west direction, reflecting the compression and tilt placed on the structural block. Igneous intrusions within the plateau area include the Ordovician Shaw Hill Gabbro, Devonian Boggy Plain Suite and Tertiary basalt.</p>		<p>The Rock Forest area is also within the Tantangara Block. The area, which is largely characterised by the steeply dipping metasediments of the Ordovician Bolton Beds and Kiandra Beds, has been significantly intruded by Devonian undifferentiated granites.</p>
Hydrogeology	<p>In the Ravine area, groundwater levels are monitored in the Ravine Beds and the Boraig Group. Groundwater levels within the Ravine area are influenced by the steep relief that exists across the area. Groundwater levels generally mirror the topography. Groundwater levels within the Ravine Beds vary from approximately 1325 m AHD in the topographically elevated terrain adjacent to the LPF towards the east; to approximately 545 m AHD in the topographically lower terrain adjacent to Talbingo Reservoir towards the west. Overall, groundwater levels indicate that groundwater flow within the Ravine Beds is towards the west from the direction of the LPF.</p>			<p>In the plateau area, groundwater levels are monitored in the Tertiary basalt, Gooandra Volcanics, Tantangara Formation, Temperance Formation, Boraig Group, Kelly Plains Volcanics, Boggy Plains Suite and within several bog and fen areas.</p>		<p>N/A</p>

Table 3.1 **Snowy 2.0 site and surrounds – key features requiring consideration**

Attributes	Talbingo Reservoir	Lobs Hole	Marica	Plateau	Tantangara Reservoir	Rock Forest
Natural environment						
Watercourses	Watercourses	Tumut River, Middle Creek.	Yarrangobilly River, Wallaces Creek, Lick Hole Gully, Sheep Station Creek.	Eucumbene River, Murrumbidgee River, Tantangara Creek, Gooandra Creek and unnamed tributaries, Nungar Creek, Kellys Plain Creek, Boggy Plain Creek.	Eucumbene River, Murrumbidgee River, Tantangara Creek, Gooandra Creek and unnamed tributaries, Nungar Creek, Kellys Plain Creek, Boggy Plain Creek.	Camerons Creek, unnamed watercourse.
Biodiversity	Aquatic habitat comprises submerged trees and the reservoir is considered habitat for Murray Crayfish (threatened species).	Areas of habitat for threatened species such as Booroolong Frog (recorded and mapped Yarrangobilly River) and Smoky Mouse (recorded and mapped along Lobs Hole Ravine Road).	Areas of habitat for threatened species such as Smoky Mouse (recorded and mapped along Marica Trail), and threatened flora species also recorded.	Bogs and Fens endangered ecological community are located throughout the Plateau area, and threatened flora and herpetofauna species also recorded.	Threatened flora species recorded adjacent to Tantangara Reservoir and Tantangara Road.	Rock Forest is located just outside of the KNP, consisting of predominantly derived grasslands as a result of historical clearing and grazing.
Natural and cultural heritage	Historic Ravine Cemetery near Lobs Hole.	The historic Washington Hotel at Lobs Hole and geodiversity features (periglacial boulder stream and Devonian fossils) along Lobs Hole Ravine Road.	Historic heritage features associated with pastoralism, mining and the Snowy Scheme.	Historic heritage features associated with pastoralism, mining and the Snowy Scheme.	Aboriginal cultural heritage rock shelter near Tantangara Reservoir and geodiversity features (Kellys Plain Volcanics) including a former quarry and an outcrop of agglomeratic porphyry.	Historic heritage items relating to mining, agriculture and pastoralism.

Table 3.1 **Snowy 2.0 site and surrounds – key features requiring consideration**

Attributes	Talbingo Reservoir	Lobs Hole	Marica	Plateau	Tantangara Reservoir	Rock Forest
Built environment						
Reservoirs	Talbingo Reservoir is a large storage dam (921 GL total, or 239 GL active storage) that operates between 534 m AHD and 543 m AHD. The reservoir is about 25 km long and has a surface area of approximately 19.4 km ² (at spillway crest).	N/A	N/A	N/A	Tantangara Reservoir is a storage dam (254 GL total, or 240 GL active storage) that operates between 1,206 m AHD and 1,229 m AHD. It is about 14 km long and has a surface area of approximately 21.2 km ² (at FSL).	N/A
Social infrastructure	No townships or existing social infrastructure present.	No townships or existing social infrastructure present. Former township of Lobs Hole.	No townships or existing social infrastructure present.	No townships or existing social infrastructure present.	No townships or existing social infrastructure present.	No townships or existing social infrastructure present.
Transport infrastructure	N/A	Lobs Hole Ravine Road, Lobs Hole Road, Mine Trail Road.	Marica Trail, Marica West Road, Snowy Mountains Highway.	Snowy Mountains Highway, Gooandra Track.	Snowy Mountains Highway, Tantangara Road, Quarry Trail, Pocket Saddle Road.	Snowy Mountains Highway.
Utility infrastructure	330 kV transmission easement.	330 kV transmission easement.	N/A	330 kV transmission easement.	11 kV transmission easement, 33 kV substation, Tantangara Dam.	N/A
Recreational features	O'Hares boat ramp, informal boat ramp at Middle Bay, boating, water sports, fishing.	Camping at Lobs Hole.	N/A	Camping at Bullocks Hill and 3 Mile Dam and Mt Selwyn ski resort.	Camping on reservoir foreshore, fishing, boating, water sports, horse riding trails, Wares Yard, Currango Homestead.	N/A
Historic heritage	Snowy Scheme.	Washington Hotel, Ravine Cemetery.	N/A	Kiandra courthouse.	Snowy Scheme.	N/A

3.3.3 Offsets strategy

In considering the residual impacts of the Snowy 2.0 project, it is critical to place them in context. A fundamental objective of the project is to provide a large scale storage facility to enable the decarbonisation of the nation's energy system in order to achieve meaningful progress in emissions reductions as a key mitigant of climate change. The project's location within the largest alpine area within NSW gives particular merit to this mission given the potential long term impacts on many of the snow dependent species and communities of the local region.

Further, the configuration of the project takes advantage of existing reservoir infrastructure and is constructed almost entirely underground in order to minimise the surface impacts of the works. It is, however, acknowledged that the sensitive nature of the location of the works with KNP requires careful consideration to ensure the project retains a net beneficial contribution to the environment.

The key principles of the strategy are to ensure that an outcomes based program of management actions is developed to ensure that the residual impacts to key values of KNP, which include terrestrial and aquatic biodiversity, with a particular focus on threatened species and communities, and recreational uses in and around the Project area are proportionately offset.

Actions and outcomes to be achieved will be aligned with the Project's understanding of the key stakeholders objectives for impacted values, and Policies and programs such as Caring for our Australian Alps Catchments (Worboys and Good 2011) and the NSW Save our Species (SOS) Program. In particular Snowy Hydro will work with NPWS, DPIE (formerly OEH), DPI Fisheries and local stakeholders to further develop a suite of fully funded conservation and recreational management projects specifically for the improvement of KNP.

Once agreed, this offsets strategy will be implemented to fulfil Snowy Hydro's obligations under NSW *Biodiversity Conservation Act 2016* (BC Act) and EPBC Act. The key areas to be covered by the strategy are set out in Table 3.2, and further details provided in the Offset Strategy in Appendix M.3.

Specific details for the scope and implementation of the suite of proposed actions and measures will be developed further and agreed in consultation with key stakeholders, including DPIE and DEE.

The offsets strategy is expected to be implemented over time and deliver significant benefits for the natural values of the KNP and the people who use it.

3.3.4 Other developments

As previously described in Section 1.4, in addition to the Snowy 2.0 Main Works, Snowy 2.0 also comprises the Snowy 2.0 Exploratory Works, Snowy 2.0 Transmission Connection Project, and proposed segment factory at Polo Flat. This EIS considers the interactions with these projects, using publicly available information to assess potential impacts.

These projects will overlap construction schedule and location, primarily in the Lobs Hole area. Key issues requiring consideration include:

- traffic and transport, as these projects will share the external road network, in particular Snowy Mountains Highway;
- impacts to KNP values, in particular biodiversity and heritage; and
- social and amenity, as workforce enter the region and may influence local towns.

Table 3.2 Potential actions for residual impacts

Key values	Potential actions
Terrestrial biodiversity	<p>Key focus species</p> <ul style="list-style-type: none"> • Clover Glycine • Kiandra Leek Orchid • Eastern Pygmy-possum • Smoky Mouse • Booroolong Frog • Alpine Tree Frog • Alpine She-oak Skink <p>Key focus communities:</p> <ul style="list-style-type: none"> • Bogs and Fens <p>Management actions:</p> <ul style="list-style-type: none"> • Targeted research and monitoring actions to better understand species distribution, abundance and key threats, e.g. systematic camera surveys across KNP and surrounding National Parks and State Forests to document the distribution of Smoky Mouse, or annual systematic surveys of suitable habitat for Clover Glycine to determine the area and extent of populations, the number, size and structure of populations in KNP. • Habitat restoration works for threatened species and communities, eg restoration and dry open Eucalypt forests and woodland. • Management of key threats in particular for predators and invasive competitors eg, weed control programs across KNP etc. • Establishment of SOS sites to ensure good, targeted management of threats for key species and communities.
Aquatic ecology	<ul style="list-style-type: none"> • Targeted research and monitoring actions to better understand species distribution, abundance and key threats. • Support for local / regional insurance population programs of Macquarie perch. • Habitat protection and enhancement activities for threatened species' with a focus on Murray crayfish and Stocky galaxias.
Recreation	<ul style="list-style-type: none"> • With stakeholders, develop a program for stocking of large fish (rainbow trout) in Tantangara Reservoir. • Upgrade camping facilities on the Tantangara Reservoir foreshore and Lobs Hole and integrate with the new assets. • Upgrade/ refurbish facilities that have been directly impacted as a consequence of Snowy 2.0.

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

STATUTORY FRAMEWORK

4 Statutory Framework

4.1 Overview

4.1.1 Snowy 2.0

Snowy Hydro is a company incorporated under the Commonwealth *Corporations Act 2001*, with an independent board of directors and all shareholding held by the Australian Government.

The existing Snowy Scheme is able to operate within land that is reserved as a national park under the provisions of the SHC Act. Snowy Hydro has rights to access and operate the existing Snowy Scheme within the KNP in accordance with the Snowy Park Lease granted by the NSW Minister for the Environment, and the Snowy Management Plan. Snowy Hydro also operates the Snowy Scheme under a water licence administered by DPIE that allows for water collection, storage, diversion and release in order to generate electricity (the Snowy Water Licence).

On 26 October 2017, Snowy Hydro and TransGrid requested that the then NSW Minister for Planning declare Snowy 2.0 and associated transmission upgrade works to be CSSI to which Part 5, Division 5.2 of the EP&A Act applies. On 7 March 2018 the Minister declared 'Snowy 2.0 and Transmission Project' to be CSSI with the declaration coming into effect on 9 March 2018.

As stated in Chapter 1, while the upgrade works to the wider shared transmission network and connection between Snowy 2.0 and the network form part of the CSSI declaration for Snowy 2.0 and the Transmission Project, they do not form part of Snowy Hydro's application. TransGrid is the proponent for the transmission connection which will be subject to separate application and approval processes. However, cumulative impacts have been considered in this EIS where relevant.

i Exploratory Works for Snowy 2.0

Snowy 2.0 is being developed in stages. The first stage, Snowy 2.0 Exploratory Works (SSI 9208), includes an exploratory tunnel and portal and other exploratory and construction activities primarily in the Lobs Hole area of KNP. Approval for Exploratory Works was granted by the then NSW Minister for Planning on 7 February 2019. Construction works commenced in March 2019. Submission of the application and subsequent approval of Exploratory Works ahead of Main Works was critical as it will obtain detailed geological data about the rock types, conditions, ground temperature and stress conditions to inform the detailed design of the underground power station cavern.

The Exploratory Works were referred to the Commonwealth Minister for the Environment under the EPBC Act (Reference 2018/8217) and were determined on 10 July 2018 not to be a controlled action.

An application to modify the Exploratory Works approval to include additional geotechnical drilling and a construction power connection to the existing TransGrid 330 kV line 2 at Lobs Hole (Modification 1) was submitted to DPIE in June 2019 and publicly exhibited between 26 June and 9 July 2019. A response to submissions report was subsequently submitted to DPIE in September 2019 and a determination for Modification 1 is expected in 2019. A second modification to the Exploratory Works that involves changing the tunnelling method for the exploratory tunnel from drill and blast to TBM (Modification 2) is expected to be submitted to DPIE in October 2019.

ii Snowy 2.0 Main Works

The second stage is Snowy 2.0 Main Works (SSI 9687), which includes the full construction and operation of Snowy 2.0. On 15 October 2018, Snowy Hydro submitted to the former Department of Planning and Environment a PEA (also known as a scoping report) for Snowy 2.0 Main Works. It was prepared in accordance with the *draft Environmental Impact Assessment Guidance Series* (June 2017) prepared by DPIE to request and inform the content of the SEARs for Main Works. The project that was described in the PEA was largely a description of the reference design prepared by SMEC on behalf of Snowy Hydro for the purpose of specifying Snowy Hydro's functional and performance requirements for tenders for the detailed design and construction of Snowy 2.0.

In January 2019, Snowy Hydro identified a preferred construction contractor, FGJV, to develop the final design and carry out construction of Snowy 2.0. The contract was formally awarded in April 2019. On 20 June 2019, Snowy Hydro submitted to the former Department of Planning and Environment an amended PEA (in the form of an amended scoping report) to reflect relevant design solutions the contractor was developing for the final design of Snowy 2.0 Main Works. On 31 July 2019 Snowy Hydro was provided with the SEARs for Snowy 2.0 Main Works.

On 30 October 2018, Snowy Hydro submitted a referral to the Commonwealth Minister for the Environment for a proposed action under the EPBC Act for Snowy 2.0 Main Works (EPBC 2018/8322). This referral considered impacts to matters of national environmental significance (MNES) and the environment generally and detailed that Snowy 2.0 Main Works would potentially have a significant impact on MNES, including national heritage places, listed threatened species and ecological communities and listed migratory species. The referral also identified, on a precautionary basis, that Snowy 2.0 Main Works would potentially have a significant impact on the environment, as defined under the EPBC Act.

Due to the potential impacts of Snowy 2.0 Main Works on MNES and the environment, an accredited assessment process was sought under section 87(4) of the EPBC Act, where the Commonwealth accredits the assessment process under Division 5.2 of the EP&A Act. On 5 December 2018, the Assistant Secretary of the DEE provided notification of its referral decision and designated proponent, determining that the Snowy 2.0 Main Works action was a controlled action and is to be assessed by accredited assessment process under Part 5, Division 5.2 of the EP&A Act.

As part of the accredited assessment process, DEE's assessment requirements have been included in the SEARs.

iii Segment factory

The tunnels for Snowy 2.0 Main Works, including the exploratory tunnel for Exploratory Works, would be excavated in part, using TBMs and would be lined using precast concrete tunnel segments. These segments are proposed to be constructed at a factory (the proposed segment factory) on the eastern side of Polo Flat, an industrial estate east of Cooma. The segments would be transported to the construction areas of Snowy 2.0.

In June 2019, Snowy Hydro submitted a Scoping Report to DPIE for the proposed segment factory (SSI-10034). SEARs were issued to Snowy Hydro on 31 July 2019.

The proposed segment factory was referred to the Commonwealth Minister for the Environment under the EPBC Act (Reference 2019/8481) and was determined on 13 August 2019 not to be a controlled action.

Snowy Hydro is preparing the EIS for the proposed segment factory in accordance with the SEARs. Notwithstanding this, potential impacts of the proposed segment factory have been considered in this EIS so that cumulative impacts of the project have been identified and considered.

4.1.2 Transmission connection

Works are required to connect Snowy 2.0 with the existing high voltage transmission network which is owned and managed by TransGrid (the Snowy 2.0 Transmission Connection Project). Principally these works include the construction of:

- a substation to the west of Talbingo Reservoir outside of KNP near an existing transmission line; and
- two transmission lines connecting Snowy 2.0 with the substation.

In November 2018, TransGrid submitted to the former Department of Planning and Environment a PEA (in the form of a scoping report) for the Snowy 2.0 Transmission Connection Project (SSI 9717). SEARs were issued to TransGrid on 4 February 2019.

In February 2019, TransGrid submitted a referral to the Commonwealth Minister for the Environment for its proposed action under the EPBC Act for the Snowy 2.0 Transmission Connection Project (EPBC 2018/8363). This referral considered impacts to matters of MNES and concluded that the Snowy 2.0 Transmission Connection Project would potentially have a significant impact on MNES, including national heritage places, listed threatened species and ecological communities and listed migratory species.

Due to the potential impacts of the Snowy 2.0 Transmission Connection Project on MNES, an accredited assessment process was sought under section 87(4) of the EPBC Act, where the Commonwealth accredits the assessment process under Part 5, Division 5.2 of the EP&A Act. On 5 April 2019, the Acting Assistant Secretary of the DEE provided notification of its referral decision and designated proponent, determining that the Snowy 2.0 Transmission Connection Project was a controlled action and is to be assessed by accredited assessment process under Part 5, Division 5.2 of the EP&A Act.

As stated above, as part of the accredited assessment process, DEE's assessment requirements for the Snowy 2.0 Transmission Connection Project have been included in the SEARs.

TransGrid will prepare the EIS for the Snowy 2.0 Transmission Connection Project in accordance with the SEARs. Notwithstanding this, potential impacts of the Snowy 2.0 Transmission Connection Project, as identified by TransGrid, have been considered in this EIS so that cumulative impacts of the projects have been identified and considered.

4.2 Snowy Hydro

The former Commonwealth Snowy Mountains Hydro-electric Authority was corporatised under the NSW SHC Act (and corresponding legislation passed in Victoria and by the Commonwealth) as Snowy Hydro Limited on 28 June 2002. Snowy Hydro is now fully owned by the Commonwealth following the acquisition of all remaining shares by the Commonwealth from the States of NSW and Victoria in July 2018.

In addition to providing for the corporatisation of Snowy Hydro Limited, the SHC Act implemented a range of measures to transition the operations of the Snowy Scheme as regulated under NSW environmental laws and other regulatory requirements for the first time. As part of this transition Snowy Hydro was entitled to be granted the Snowy Water Licence and the Snowy Park Lease to enable the continued operation of the existing Snowy Scheme and in addition its operations were recognised as having the necessary approvals and consent for the purposes of the EP&A Act and as authorised under the NSW *National Parks and Wildlife Act 1974* (NPW Act).

4.2.1 Snowy Park Lease

Part 6, section 37(2) of the SHC Act entitled Snowy Hydro to the grant of a lease, licence, easement or right of way over KNP, for the purposes of the existing Snowy Scheme. The Snowy Park Lease was granted to Snowy Hydro by the former NSW Minister for Environment in 2002 and has a term of 75 years. The lease covers land where infrastructure associated with the existing Snowy Scheme has been constructed. Section 41(5) of the SHC Act provides that development that is for a purpose for which a lease has been granted under Part 6 of the Act, is taken to be authorised under the NPW Act.

4.2.2 Amending legislation to authorise Snowy 2.0

The NSW *Snowy Hydro Corporatisation Amendment (Snowy 2.0) Act 2018* (the SHC Amendment Act) was passed by the NSW Parliament in November 2018. The SHC Amendment Act authorised further leases and other tenures to be granted over the KNP to facilitate the construction and ongoing operation of Snowy 2.0 including the supporting electricity transmission upgrades.

Section 37A(2) of the SHC Act entitles Snowy Hydro to the grant of a lease, licence, easement or right of way over the KNP, for the purposes of and in connection with, Snowy 2.0 and confers similar entitlements for the transmission assets. Snowy Hydro entered into an Agreement for Lease (AFL) with the NSW Minister for the Environment on 18 December 2018 in respect of Snowy 2.0. Subject to the terms of the AFL, Snowy Hydro (and its contractors) will be granted rights to access the areas required for construction under Works Access Licences and Construction Leases. On practical completion of construction of Snowy 2.0 Main Works, Snowy Hydro will be granted an Operational Lease to allow the ongoing operation of Snowy 2.0. This operational lease will expire at the same time as the Snowy Park Lease issued in 2002. Snowy Hydro must satisfy a number of conditions precedent before it will be granted rights to access and use KNP, including that Snowy 2.0 Main Works must obtain CSSI approval.

Section 38(1) of the SHC Act, provides that a plan of management may deal with the activities of Snowy Hydro within the KNP and impose obligations on the company to comply with the plan of management. This compliance obligation is supported by Part 4 of the *NSW National Parks and Wildlife Regulation 2009* (NPW Regulation). The SHC Amendment Act also provided for a transitional period for the KNP PoM and the Snowy Management Plans to be revised to reflect Snowy 2.0. Clause 7 of Schedule 4 to the SHC Act provides a period of three years from when first planning approval is granted for any part of the Snowy 2.0 project, for the KNP PoM to be amended for the purposes of including the Snowy 2.0 project. A further period until 1 January 2024 is then allowed for the Snowy Management Plan to be updated. During that transitional period, section 81(4) of the NPW Act does not operate to prohibit operations being undertaken in relation to the Snowy 2.0 project that are not in accordance with those plans.

4.2.3 Snowy Water Licence

The Snowy Water Licence is a special purpose statutory approval issued under Part 5 of the SHC Act. It embodies the operating and accounting principles of the Snowy Scheme. The Snowy Water Licence confers several rights and obligations on Snowy Hydro for the collection of all water from the rivers, streams and lakes within the Snowy Water Catchment. Snowy Hydro has the right to divert, store and use that water to generate electricity and for purposes that are incidental or related to the generation of electricity, and the obligation to release that water from storage.

4.2.4 Deemed planning approvals for existing Snowy scheme

Part 7 of the SHC Act approved the existing Snowy Scheme development as at the date of corporatisation (28 June 2002) under former Parts 4 and 5 of the EP&A Act. Section 41(2) of the SHC Act provides:

A determining authority is not required to comply with Part 5 of the EPA Act for the purposes of granting an initial approval. However, the determining authority is, for the purposes of any Act or law, taken to have complied with Part 5 of the EPA Act in granting the initial approval (but only to the extent that the determining authority would but for this Act have been required to comply with that Part).

Section 41(3) of the SHC Act provides:

For the purposes of the application of any Act or law to an activity that is part of the existing Scheme development but that is not the subject of an approval granted by a determining authority or of a development consent, the activity is taken to have been commenced and previously carried out in accordance with Part 5 of the EPA Act.

Section 41(4) of the SHC Act further provides:

This subsection applies to any development that is part of the existing Scheme development and that, on the corporatisation date, cannot be carried out without development consent. On that date, the Snowy Hydro Company is taken to have been granted that development consent in accordance with Part 4 of the EPA Act by the relevant consent authority under that Part

These deemed arrangements applied to the existing scheme as at the date of corporatisation. Any proposed changes since that time have been developed in accordance with applicable legislation.

4.3 Kosciuszko National Park

The existing Snowy Scheme and assets have long been part of the KNP landscape and are a key feature in park recreation and visitation. The KNP is reserved as a national park under Part 4, Division 3 of the NPW Act. NSW national parks are the responsibility of the NPWS which is a part of DPIE.

KNP contains unique sub-alpine values and declared wilderness areas and is listed on the Australian National Heritage List. All activities on reserved land must be consistent with the objects and purpose of the NPW Act. Consideration of Main Works against the objects and purpose of the NPW Act is provided in Appendix H.

All activities within KNP must be consistent with the KNP PoM, prepared in accordance with Part 5 of the NPW Act. Various references are made to the existence and continued operation of the Snowy Scheme throughout the KNP PoM, including within park zoning provisions and Chapter 12. The PoM also incorporates the Snowy Management Plan to more specifically deal with the operations of the existing Snowy Scheme within KNP.

As such, should approval be granted for the Main Works, the Snowy Management Plan will be reviewed and updated to incorporate management obligations with respect to the Snowy 2.0 project in accordance with the timetable imposed by the SHC Amendment Act.

4.4 NSW planning approval process

4.4.1 Permissibility of Snowy 2.0 Main Works

The EP&A Act and EP&A Regulation form the statutory framework for environmental assessment and planning approval in NSW. Implementation of the EP&A Act is the responsibility of the Minister for Planning and Public Spaces, statutory authorities and local councils.

As explained in more detail in Section 4.2, the existing Snowy Scheme operates under deemed planning approvals conferred by Part 7 of the SHC Act. Snowy 2.0 is an augmentation to the existing Snowy Scheme, beyond the scope of Snowy Hydro operations currently authorised by the SHC Act. Assessment of those impacts of Snowy 2.0 which have not previously been approved, and approval of Snowy 2.0 Main Works under the EP&A Act are, therefore, required prior to commencing.

Section 5.13 enables the Minister for Planning and Public Spaces to declare SSI to be CSSI if 'it is of a category that, in the opinion of the Minister, is essential for the State for economic, environmental or social reasons'. On 26 October 2017 Snowy Hydro requested that the former NSW Minister for Planning declare Snowy 2.0 to be CSSI. On 7 March 2018 the former NSW Minister for Planning declared Snowy 2.0 and the Transmission Project to be CSSI.

This declaration came into effect on 9 March 2018 and is included in Clause 9 of Schedule 5 of the SRD SEPP, as follows.

9 Snowy 2.0 and Transmission Project

- (1) The Snowy 2.0 and Transmission Project is a proposed program of works for the expansion of the generating capacity of the Snowy Mountains Hydroelectric Scheme and for associated upgrades and additions to the electricity transmission network. The object of this clause is to declare development for the purposes of the Snowy 2.0 and Transmission Project that is set out in this clause to be State significant infrastructure and critical State significant infrastructure.
- (2) This clause applies to development on land in any of the following local government areas:
 - (a) Cootamundra-Gundagai Regional,
 - (b) Goulburn Mulwaree,
 - (c) Snowy Monaro Regional,
 - (d) Snowy Valleys,
 - (e) Upper Lachlan Shire,
 - (f) Yass Valley.
- (3) **Snowy 2.0**

Development for the purpose of pumped hydro and generation works to be known as Snowy 2.0 on land between Tantangara Reservoir and Talbingo Reservoir that involves:

- (a) the carrying out of exploratory geotechnical works or engineering investigations, and
- (b) the construction and operation of an underground hydroelectric power and pump station capable of supplying approximately 2,000 megawatts of hydroelectric power, and
- (c) the construction of water and access tunnels, surge tank and intake and outlet structures at and between the two reservoirs.

(4) Transmission works

Development that involves:

- (a) the construction and operation of new electricity transmission lines and an electricity substation to the west of the Talbingo Reservoir to connect Snowy 2.0 to the existing electricity transmission network at Nurenmerenmong, east of Tumbarumba, and

- (b) the construction and operation of new electricity transmission lines between the new substation at Nurenmerenmong and an existing substation at Bannaby, north of Marulan, and
 - (c) the construction and operation of new transmission lines between an existing substation at Khancoban and a location on the NSW-Victorian border generally south-west of Khancoban, and
 - (d) the augmentation of the existing substation at Bannaby.
- (5) The development referred to in this clause does not include:
- (a) the carrying out of surveys, sampling, environmental investigations, geotechnical borehole drilling, test drilling, test excavations, or other tests or investigations, for the purposes of feasibility assessment and the preliminary design of the Snowy 2.0 and Transmission Project, or
 - (b) the carrying out of works to upgrade or modify electricity transmission lines, works within existing switchyards, and the installation of communications infrastructure.

(6) Ancillary development

Development that is ancillary to any other development in this clause, including the carrying out of works to upgrade or construct access roads, utilities infrastructure, construction accommodation, construction compounds and construction power supply.

Snowy 2.0 Main Works is development of the kind specified in Schedule 5, clause 9, subclause (3) and (6) of the SRD SEPP. Clause 16 of the SRD SEPP states that development specified in Schedule 5 of the SRD SEPP:

- (a) may be carried out without development consent under Part 4 of the EP&A Act; and
- (b) is declared to be SSI for the purposes of the EP&A Act if it is not otherwise so declared; and
- (c) is declared to be CSSI for the purposes of the EP&A Act.

Accordingly, Snowy 2.0 (including Snowy 2.0 Main Works) has been declared to be SSI and CSSI and may be carried out without obtaining development consent under Part 4 of the EP&A Act. Therefore, the project requires assessment and approval under Part 5, Division 5.2 of the EP&A Act.

As previously stated, the Transmission Connection Project and proposed segment factory are being considered under separate applications and EISs under Part 5, Division 5.2 of the EP&A Act. Notwithstanding this, potential impacts of the Transmission Connection Project and the proposed segment factory have been identified within this EIS so that potential cumulative impacts of Snowy 2.0 can be considered.

The Transmission Connection Project is for the connection of Snowy 2.0 with the shared transmission network. As the CSSI declaration indicates, the deep augmentation of the shared transmission network is for the broader NEM, and not just Snowy 2.0.

The Minister for Planning and Public Spaces is the determining authority for Snowy 2.0 Main Works, the proposed segment factory and the Snowy 2.0 Transmission Connection Project given their status as CSSI. Whilst section 2.4 of the EP&A Act allows the Minister to delegate his function of determining an application for approval under Part 4 or Part 5 of the EP&A Act, section 2.4(3)(b) prevents this for the determination of an approval for CSSI.

4.4.2 Environmental Planning and Assessment Regulation 2000

The EP&A Regulation was made under the EP&A Act and provides details of the requirements set out in the Act. Requirements of the EP&A Regulation relevant to Snowy 2.0 Main Works include how the EIS is to be prepared and how the application is to be notified.

An EIS for SSI and CSSI is to be prepared in accordance with Part 3 of Schedule 2 of the EP&A Regulation (as per Section 5.16 of the EP&A Act). The requirements for preparation of an EIS are set out in clause 6 and 7 of Schedule 2 of the EP&A Regulation. A summary of these requirements and where they are addressed in the EIS is provided in Table 4.1.

Table 4.1 Schedule 2 requirements for an EIS

Requirement	Where contained in the EIS
Clause 6 - Form of environmental impact statement	
(a) the name, address and professional qualifications of the person(s) by whom the statement is prepared,	Certification page at the front of this EIS
(b) the name and address of the responsible person (the applicant),	Certification page at the front of this EIS
(c) the address of the land: (i) in respect of which the development application is to be made, or (ii) on which the activity or infrastructure to which the statement relates is to be carried out,	Certification page at the front of this EIS
(d) a description of the development, activity or infrastructure to which the statement relates,	Chapter 2
(e) an assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Schedule,	Certification page at the front of this EIS and the technical papers within the EIS
(f) a declaration by the person by whom the statement is prepared to the effect that: (i) the statement has been prepared in accordance with this Schedule, and (ii) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and (iii) that the information contained in the statement is neither false nor misleading.	Certification page at the front of this EIS
Clause 7 - Content of environmental impact statement	
(a) a summary of the EIS,	Executive summary
(b) a statement of the objectives of the development, activity or infrastructure,	Chapter 1 and Chapter 2
(c) an analysis of feasible alternatives to the carrying out the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure,	Chapter 1 and Chapter 3
(d) an analysis of the development, activity or infrastructure, including:	
(i) a full description of the development, activity or infrastructure, and	Chapter 2
(ii) a general description of the environment likely to be affected by the development, activity or infrastructure, and	Chapter 6
(iii) the likely impact on the environment of the development, activity or infrastructure, and	Chapter 6
(iv) a full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure, and	Chapter 6 and Appendix G
(v) a list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out,	Section 4.4

Table 4.1 Schedule 2 requirements for an EIS

Requirement	Where contained in the EIS
(e) a compilation (in a single section of the EIS) of the measures referred to in item (d)(iv),	Appendix G
(f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development.	Chapter 7

Landowners consent is not required for a CSSI application under clause 193(1) of the EP&A Regulation. However, under clause 193(4), the proponent is required to give notice of the application or request:

- (a) by written notice to the owner of the land before, or no later than 14 days after, the application or request is made, or
- (b) by advertisement published in a newspaper circulating in the area in which the infrastructure is to be carried out:
 - (i) in the case of an infrastructure application—at least 14 days before the environmental impact statement that relates to the infrastructure is placed on public exhibition,

An advertisement will be published in local papers in accordance with clause 193(4)(b) of the EP&A Regulation. Notwithstanding this, while landowners consent is not required for a CSSI application, Snowy Hydro has been in regular consultation with all stakeholders in the project area, including landowners.

4.4.3 Other regulatory requirements

Although EPIs do not apply to SSI or CSSI by virtue of section 5.22(2) of the EP&A Act, consideration of the instruments that would have applied to the Snowy 2.0 Main Works project area is also given.

It is also worth noting that, whilst in close proximity to the Mount Selwyn Alpine Resort, the Snowy 2.0 Main Works are outside of the application area for the *State Environmental Planning Policy (Kosciuszko National Park – Alpine Resorts) 2007*.

4.4.4 Summary of approvals required for the project

A summary of the licences, approvals and permits that are likely to be required for the project is provided in Table 4.2.

Table 4.2 Required licences, approvals and permits summary

Legislation	Authorisation	Consent of approval authority
EP&A Act	CSSI approval for Snowy 2.0 Main Works	NSW Minister for Planning and Public Spaces
	Construction certificate required for construction of relevant structures in the surface infrastructure area	Snowy Valleys Council (SVC) and/or Snowy Monaro Regional Council (SMRC) or private certifier
	Occupation certificate required prior to use of certain buildings in the surface infrastructure area	SVC and/or SMRC or private certifier
SHC Act	<i>Grant of Construction Lease and Licences in accordance with the Deed of Agreement for Lease</i>	NSW Minister for Energy and Environment

Table 4.2 Required licences, approvals and permits summary

Legislation	Authorisation	Consent of approval authority
<i>NSW Protection of the Environment Operations Act 1997</i> (POEO Act)	Environment protection licence (EPL) for the following premises based scheduled activities: <ul style="list-style-type: none"> • scheduled development work to enable electricity generation • sewage treatment plant and water treatment plants • disposal of excavated rock • chemical storage 	NSW Environment Protection Authority (EPA)
<i>NSW Roads Act 1993</i>	Section 138 permits for works involving a public road	SVC, SMRC, NPWS and RMS
<i>NSW Water Management Act 2000</i> (WM Act)	Water access licences	DPIE
<i>NSW Water Act 1912</i>	Licensing of monitoring bores	DPIE
<i>NSW Local Government Act 1993</i> (LG Act)	Approval for carrying out sewerage work	EPA
<i>NSW Work Health and Safety Act 2011</i>	Licensing of dangerous goods	NSW WorkCover Authority
<i>NSW Biosecurity Act 2015</i>	Exemption required under s402 of the Act from compliance with the mandatory measures for relevant listed aquatic pests and diseases	DPIE

Under sections 5.23 and 5.24 of the EP&A Act, certain separate approvals and licenses would not be required for Snowy 2.0 Main Works or would be required to be issued consistent with any planning approval granted.

4.4.5 Consistency with State and regional policies

The provisions of EPIs, including SEPPs, do not apply to SSI by virtue of section 5.22(2) of the EP&A Act. Nevertheless, the SEPPs that would have otherwise applied to Snowy 2.0 in the absence of section 5.22(2) of the EP&A Act are detailed in Table 4.3, together with an assessment of the consistency of Snowy 2.0 Main Works with those policies.

Table 4.3 Consideration of relevant State policies and plans

Policy/plan	Relevant project elements	Consistency of Snowy 2.0 Main Works
<i>State Environmental Planning Policy No. 33 – Hazardous and Offensive Development</i> (SEPP 33)	Storage and transport of dangerous goods.	Consideration of DPIE's guideline <i>Applying SEPP 33</i> (2011) and, if required, preparation of a Preliminary Hazard Assessment (PHA) has been carried out and is provided in Appendix U.
<i>State Environmental Planning Policy No. 44 – Koala Habitat Protection</i> (SEPP 44)	Clearance of potential Koala habitat.	A biodiversity assessment including surveys for Koalas to determine whether Koala habitat would be impacted is provided in Appendix M.1 of this EIS.
<i>State Environmental Planning Policy No. 55 – Remediation of Land</i> (SEPP 55)	Historic mining and agricultural activities have potential for land contamination.	A contamination assessment is provided in Appendix N.1 of this EIS.

4.5 Commonwealth approvals

4.5.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the primary piece of Commonwealth legislation that governs the protection of the environment.

Relevantly, under the Commonwealth EPBC Act:

- a person is prohibited from taking an action that has, will have or is likely to have a significant impact on certain aspects of the environment (being MNES); and
 - the Commonwealth or a Commonwealth agency must not take inside or outside the Australian jurisdiction an action that has, will have or is likely to have a significant impact on the environment inside or outside the Australian jurisdiction;
- without the Commonwealth Minister for the Environment having given approval under the EPBC Act or decided that approval is not needed.

Snowy Hydro became a 'Commonwealth agency' only for the purposes of the EPBC Act on 2 July 2018, following the acquisition of all remaining shares by the Commonwealth from the States of NSW and Victoria.

Under the EPBC Act, a person proposing to take an action may refer the proposal to the Commonwealth Minister for a decision as to:

- whether approval is needed to take the action; and
- how to assess the impacts of the action to be able to make an informed decision whether or not to approve the action.

As previously noted, Snowy 2.0 Main Works action is a controlled action and will be assessed by accredited assessment process under Part 5, Division 5.2 of the EP&A Act.

The proposed action was described in the referral decision notice as follows:

To construct and operate the Snowy 2.0 project in the Snowy Mountains, NSW, to increase the pumped hydro-electric capacity within the existing Snowy Hydro Scheme, including construction of a pipeline between Tantangara reservoir and Talbingo reservoir and an underground power station [See EPBC Act referral 2018/8322].

The referral decision notice also confirmed the relevant controlling provisions under the EPBC Act relevant to Snowy 2.0 Main Works:

- National Heritage places (sections 15B and 15C);
- Listed threatened species and communities (sections 18 and 18A);
- Listed migratory species (sections 20 and 20A); and
- Commonwealth action (section 28).

Potential impacts to National Heritage places are addressed in Section 6.6 and Appendix P.2. Potential impacts to listed threatened species and communities, and migratory species are addressed in Section Figure 6.3 and

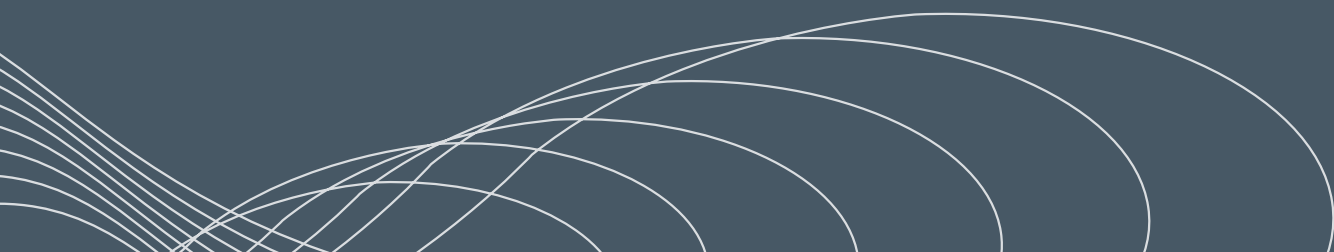
Appendix M.1. Potential impacts of the Commonwealth action on the environment generally are considered throughout this EIS.



CHAPTER

5

ENGAGEMENT



5 Engagement

5.1 Overview of engagement activities

Over many decades Snowy Hydro has lived, worked and invested in the communities it operates in. The company is a sponsor and supporter of community groups, events and activities. Snowy Hydro's high level of local activity, transparent, timely and regular interaction with stakeholder groups, and participation on emergency management groups, ensures the community and stakeholders have ample regular opportunities to engage with the business.

Snowy Hydro has established stakeholder goodwill and a reputation as a trusted and respected corporate and community 'citizen'. This has been reflected in the high results in previous community perception research and is the sentiment felt and expressed during engagement activities.

At the very start of the project Snowy Hydro identified key stakeholders, many with already established and strong relationships. This has meant that engagement this time around for the Snowy 2.0 Main Works EIS is the continuation of a conversation that builds on the Exploratory Works consultation. Snowy Hydro's engagement approach is two-way with Snowy Hydro sharing information and then listening to and taking onboard stakeholder feedback. This EIS addresses how stakeholder feedback has been considered and incorporated into the project plans and activities.

Snowy Hydro's engagement approach is open and transparent, with public and community events open to everyone to attend, including the media. To share information about Snowy 2.0, educate and consult with stakeholders Snowy Hydro utilise multiple communications channels, a suite of hardcopy and digital information materials and attend a wide range of forums and meetings.

To address the needs of special interest and industry groups, information is tailored to focus on the areas that matter the most to them and address specific issues. For example, engagement and discussions with Business Chambers tend to focus more on sub-contracting and local business opportunities, whereas meeting with bush-user groups are more tailored towards addressing the potential impacts to recreational use of the KNP.

The level of engagement reflects the needs of each stakeholder group and their proximity and relationship to the project. The most intensive engagement is with groups closest to the sites impacted and with stakeholder groups whose input and involvement with the project is critical, for instance the NPWS, emergency service agencies and regulators.

On the whole the feedback received from the community and industry groups on Snowy 2.0 has been positive. A range of potential impacts on the local community and industry groups, both positive and negative, by Main Works were identified early by Snowy Hydro based on existing relationships with stakeholder groups, and stakeholder engagement undertaken as part of Exploratory Works. Broadly, these were:

- impacts and opportunities on local employment and businesses;
- impacts and benefits to towns and localities in the region;
- impacts and benefits to services in the region;
- impacts and opportunities on recreation and tourism;
- impacts and benefits on roads; and
- impacts on environment and heritage.

As engagement has progressed through Main Works, Snowy Hydro has continued to seek feedback on key issues which is explored further in this chapter. Snowy Hydro has also used engagement around the EIS as an opportunity to ensure local business owners and locals are informed of how they can connect to procurement, contracting and employment opportunities as they arise on the project.

5.1.1 Engagement objectives

Snowy Hydro has a proactive and flexible stakeholder engagement strategy for Snowy 2.0, which is applicable to all phases of Snowy 2.0, including Main Works. It aims to meet the needs of a diverse range of stakeholders who have different levels of involvement in the project and a wide range of interests.

The strategy has been designed to maintain our social licence and support for the project and deliver the following objectives:

- maintain and build stakeholder and community confidence and trust in Snowy Hydro with open, transparent and timely engagement;
- create awareness of Snowy 2.0, what the project will involve, potential impacts on stakeholders and the role the project will play in the NEM among key stakeholder groups;
- retain and build stakeholder support for Snowy 2.0 and encourage positive collaboration between Snowy Hydro and stakeholders;
- build strategic relationships and work in partnership with key stakeholders to ensure the matters impacting Snowy 2.0 can be mitigated or managed;
- identify, listen to and manage emerging issues through effective two-way engagement;
- ensure communication and project information is up-to-date and communicated in a clear and transparent way; and
- be customisable, flexible, and dynamic to ensure engagement strategies meet the needs of stakeholders.

Like Snowy 2.0 Exploratory Works, the specific objectives of stakeholder engagement for Snowy 2.0 Main Works are to ensure identified stakeholders have a sufficient understanding of:

- its scope of Main Works;
- how Main Works may affect them;
- how engagement contributes to the overall approval process for Snowy 2.0 Main Works;
- how they can participate in the approval process and be informed, consulted and provide feedback;
- collect qualitative and quantitative data, evidence and insights for scoping the EIS, in ways that maximise diversity and representativeness;
- understand the interests that stakeholders have in Snowy 2.0 Main Works, and how potential impacts are predicted to be experienced from their perspective;
- consider the views of stakeholders in a meaningful way and using these insights to inform project planning, mitigation and enhancement measures, and monitoring and management frameworks; and
- respect people's privacy, allowing them to communicate their views anonymously if they desire.

Additionally, the stakeholder engagement strategy is aligned to DPIE's community participation objectives, which were developed by DPIE to ensure community participation is inclusive, easy to access, relevant, timely and meaningful.

5.1.2 Stakeholder engagement framework

To ensure all objectives are addressed, Snowy Hydro has developed an end-to-end framework for stakeholder engagement outlined in Figure 5.1. The framework is based on the International Association for Public Participation (IAP2)'s Public Participation Spectrum, 2014 (the Spectrum).

The framework has and will be applied throughout the lifespan of Snowy 2.0, with the ability to adapt as Snowy 2.0 progresses (including transitioning between Exploratory Works and Main Works) and as/when stakeholder requirements change, while remaining consistent with the overarching objectives.

The key phases are summarised below and in Figure 5.1:

1. identify - identification of stakeholders and impacts;
2. design and prepare - definition of desired level of engagement (to inform, consult, involve, or collaborate), and the development of corresponding stakeholder engagement tools and methods;
3. engage - commence stakeholder engagement in line with the level identified in the previous phase, and implement relevant methods;
4. provide feedback - create mechanisms for timely two-way feedback on stakeholder needs and concerns; and
5. review - implement a continuous improvement loop to assess the adequacy and effectiveness of engagement, and where required, change the nature of engagement.

1. Identify

Four key stakeholder groups that require engagement have been identified:

- government
- local community
- local industry groups
- media

A range of potential impacts both positive and negative, by Main Works were identified:

- impacts and opportunities on local employment, businesses, recreation, and tourism
- impacts and benefits to towns, localities and services in the region, and roads
- impacts on the environment and heritage

2. Design and prepare

Four levels of engagement were assigned to each stakeholder group; they include:

1. **Inform** – create awareness amongst stakeholders and communicate progress
2. **Consult** – proactively seek feedback through formal and informal mechanisms, mitigate potential concerns and establish dialogue
3. **Involve** – in cases where feedback is provided on direct impacts, consider feedback when designing relevant activities
4. **Collaborate** – actively seek and incorporate stakeholder input into the design and implementation

3. Engage

The following engagement activities have been undertaken by Snowy Hydro:

- Community consultations in local townships
- The undertaking of surveys
- The provision of information materials through digital channels and in hardcopy
- Regular updates to the company website about the project
- Snowy Hydro's quarterly newsletter
- Ongoing consultation with NPWS, DP&E, local councils (Snowy Valleys & Snowy Monaro Regional Council)
- Ongoing consultation with key stakeholders such as Aboriginal groups, fishing and recreational groups
- Briefings and engagement with local communities and community stakeholders obtained through existing relationships with the community; and
- Briefings and engagement with industry groups
- Media engagement
- Utilising the Snowy Hydro Discovery Centre and Visitor Centres
- Presentations at conferences
- Focus groups

A range of permanent engagement channels have been established for Snowy 2.0 to seek input from stakeholders and to support stakeholder engagement on an ongoing basis

A range of tools continue to be used to support communication and engagement for Snowy 2.0 and Main Works, including: publications and information materials, community consultation sessions, presentations, meetings, workshops, media releases, articles, interviews, website updates, Snowy Hydro, FGJV and KNP shop fronts, and surveys

5. Review

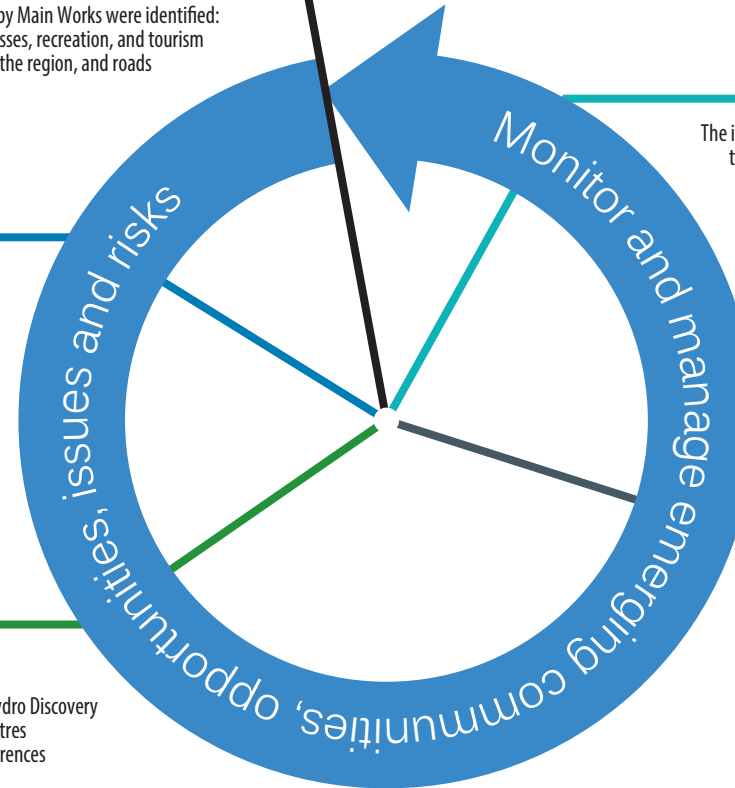
The intent of this phase is to implement a continuous improvement loop to assess the adequacy and effectiveness of engagement, and where required, change the nature of engagement

- Snowy Hydro has undertaken the following activities:
- research into better practice in community engagement
 - validation and testing with key internal stakeholders

4. Feedback

Purpose is to capture feedback during stakeholder engagement and to identify issues by the stakeholders to address throughout Snowy 2.0

Opportunities for future feedback will include the exhibition period for the Main Works EIS



5.1.3 Identified stakeholders – who was engaged

Snowy Hydro identified four key stakeholder groups, being governments, local community, local industry groups and media.

5.1.4 Engagement activities and tools – how and when engagement occurred

i Engagement tools

A range of tools continue to be used to support communication and engagement for Snowy 2.0 Main Works, including:

- publications and information materials;
- community consultation sessions (open to the public);
- stakeholder presentations with audience questions and answers (Q&As);
- meetings, workshops and formal working groups (State and Federal government, SVC and SMRC);
- traditional media (media releases, articles and interviews);
- print and radio advertising
- Snowy Hydro, FGJV and KNP shopfronts - sharing and distributing information;
- Snowy 2.0 project website updates;
- social media;
- surveys; and
- Snowy Hydro staff responding to enquiries and the Snowy Hydro Discovery and Visitor Centres.

Additionally, a range of permanent channels have been established for Snowy 2.0 to seek input from stakeholders and to support stakeholder engagement on an ongoing basis. These channels include:

- Snowy Hydro website (www.snowyhydro.com.au/our-scheme/snowy20/), provides background information, maps, videos, information on approvals, frequently asked questions, and details on how to enquire about the project;
- FGJV website (www.futuregenerationjv.com.au) and site office in Cooma (as of August 2019) to help facilitate stakeholder engagement;
- a dedicated project email address (snowy2.0@snowyhydro.com.au) to facilitate project feedback and comments; and
- a dedicated project freecall number for feedback, questions and complaints.

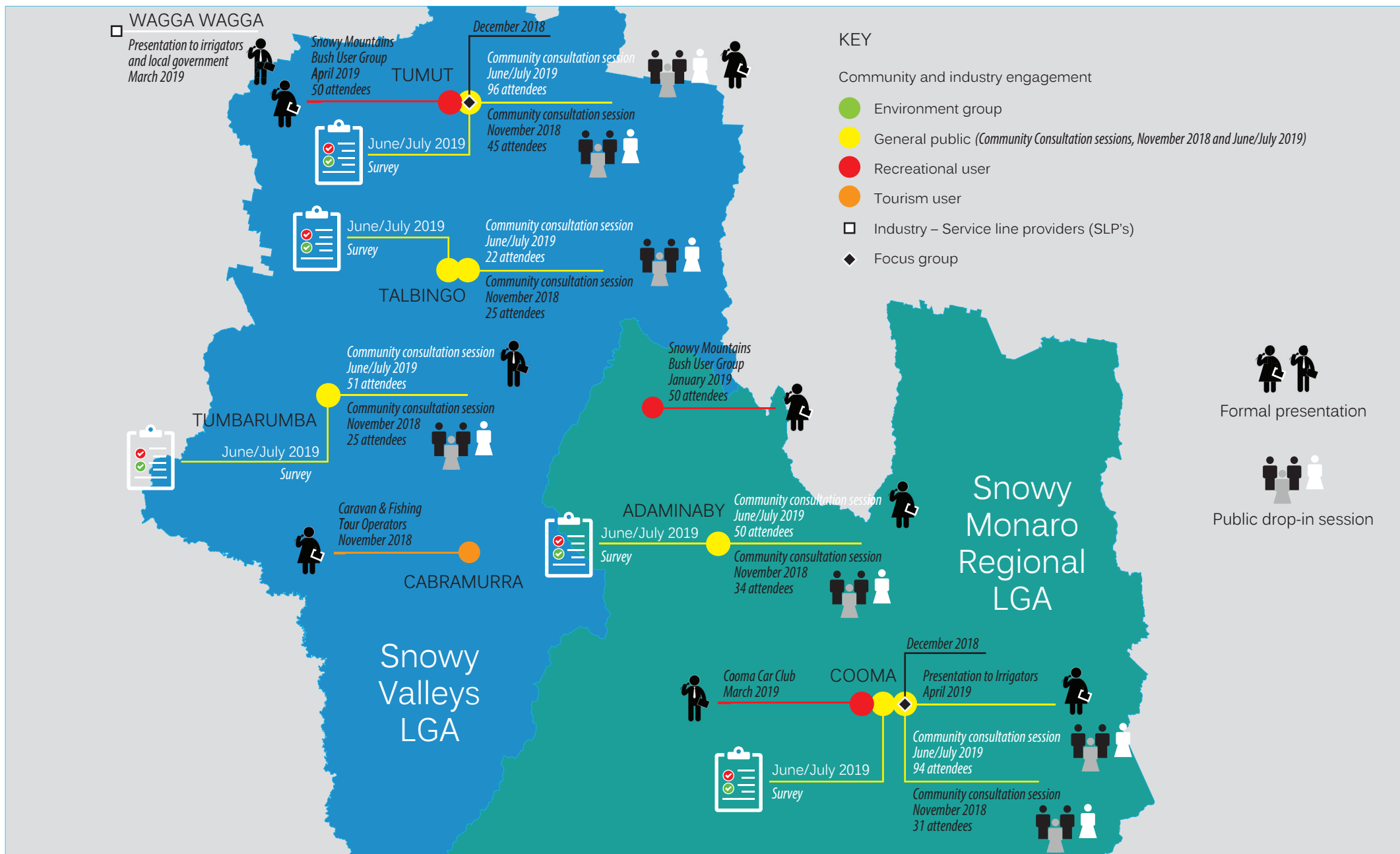
ii Engagement activities

Engagement on Snowy 2.0 commenced in early 2017 as soon as the project was announced and has been regular and ongoing. As the design for Snowy 2.0 developed and the need for Exploratory Works became apparent, stakeholder engagement activities evolved to inform stakeholders about Exploratory Works, as well as the broader Snowy 2.0. Engagement on Exploratory Works was generally undertaken between November 2017 and the end of October 2018. Engagement since the start of November 2018 has largely focused on Snowy 2.0 Main Works.

Further details regarding engagement with the identified stakeholder groups are provided in Appendix I. A summary of engagement activities undertaken by, or on behalf of, Snowy Hydro are below and are also reflected in Figure 5.2 and Figure 5.3:

- community consultations in local townships and discussed the project with over 800 community members;
 - November 2017 – community drop-in sessions held in Adaminaby, Cooma, Talbingo and Tumut;
 - April to June 2018 – community briefings held in Adaminaby, Cooma, Corryong, Jindabyne, Talbingo, Tumbarumba, and Tumut;
 - November 2018 – community drop-in sessions held in Adaminaby, Cooma, Talbingo, Tumbarumba, and Tumut; and
 - June/July 2019 - community briefings and drop-in sessions held in Cooma, Adaminaby, Tumbarumba, Talbingo and Tumut.
- the undertaking of surveys;
 - November 2017 to May 2018 – open online survey (also available in hard copy);
 - December 2018 – telephone survey of a representative sample of residents by target gender, age groups and postcodes in the local area;
 - December 2018 – online surveys completed by a register of interested people on a Snowy Hydro contact list and visiting patrons of the Snowy Hydro Discovery Centre in Cooma;
 - June/July 2019 – open online survey (also available in hard copy through the Snowy Hydro newsletter and at community briefing sessions); and
 - Additional surveys to supplement the Social Impact Assessment and the Recreational User Impact Assessment were also conducted and are discussed further in Appendix X and Appendix Y respectively;
- The provision of information materials through digital channels and in hardcopy including
 - community information booklets;
 - booklet one in November 2017;
 - booklet two in January 2018;
 - booklet three in April 2018;

- booklet four in December 2018; and
- booklet five in May 2019.
- information available on the Snowy Hydro website and social media channels;
- Snowy Hydro's quarterly community newsletter which is delivered by mailbox drop and provides project updates to communities in the Snowy Valleys and Snowy Monaro Regional LGAs;
- focus groups held in Cooma and Tumut in December 2018 with a representative sample of local residents;
- ongoing consultation and site visits with State and Commonwealth government agencies and local councils (SVC and SMRC), outlined further in Figure 5.3;
- ongoing consultation with key stakeholders such as Aboriginal groups, recreational, and fishing groups;
- briefings and engagement with local communities and community stakeholders obtained through existing relationships with the community;
- briefings and engagement with local industry groups, environment groups, and business chambers, including:
 - National Parks Association;
 - Talbingo Process Association;
 - Snowy Mountains Bush User Group;
 - Snowy Mountains Local Business Chambers of Commerce;
- media engagement through media releases, editorial content, events and responding to media enquiries;
- utilising the Snowy Hydro Discovery Centre and visitor centres to share information about the project and showcase display materials; and
- presentations at conferences and events relevant to stakeholders.



iii Engagement with government agencies

The NPWS have been the principal NSW agency engaged through the process of developing the Snowy 2.0 Main Works EIS. This has involved over 10 formal and numerous informal briefings and workshops with representatives from KNP over the last 12 months.

The former OEH (now DPIE) has been engaged comprehensively regarding biodiversity and heritage issues since February 2019. In the first instance ensuring that biodiversity and heritage survey methodology and targets were identified with the best available knowledge in collaboration with OEH was the priority. Thereafter, OEH has been updated on both ecological and heritage findings as surveys progressed and feedback incorporated as work progressed.

There have been at least five workshop/meetings between the project design team and RMS, with a site visit for the RMS team led by Snowy Hydro to help further the understanding of the level of upgrade and maintenance work required, as well as the existing issues that are present with the project region. Engagement with RMS has been very positive throughout the entire consultation process. Both Snowy Hydro and RMS have been working together to achieve the best outcome for the project, whilst taking into account the existing road requirements of the region and ensuring all parties such as local council are equally engaged. Both the Snowy Hydro and RMS teams have been actively sharing information such as model data and proposed designs in order to ensure all issues are raised and that an agreeable solution can be found.

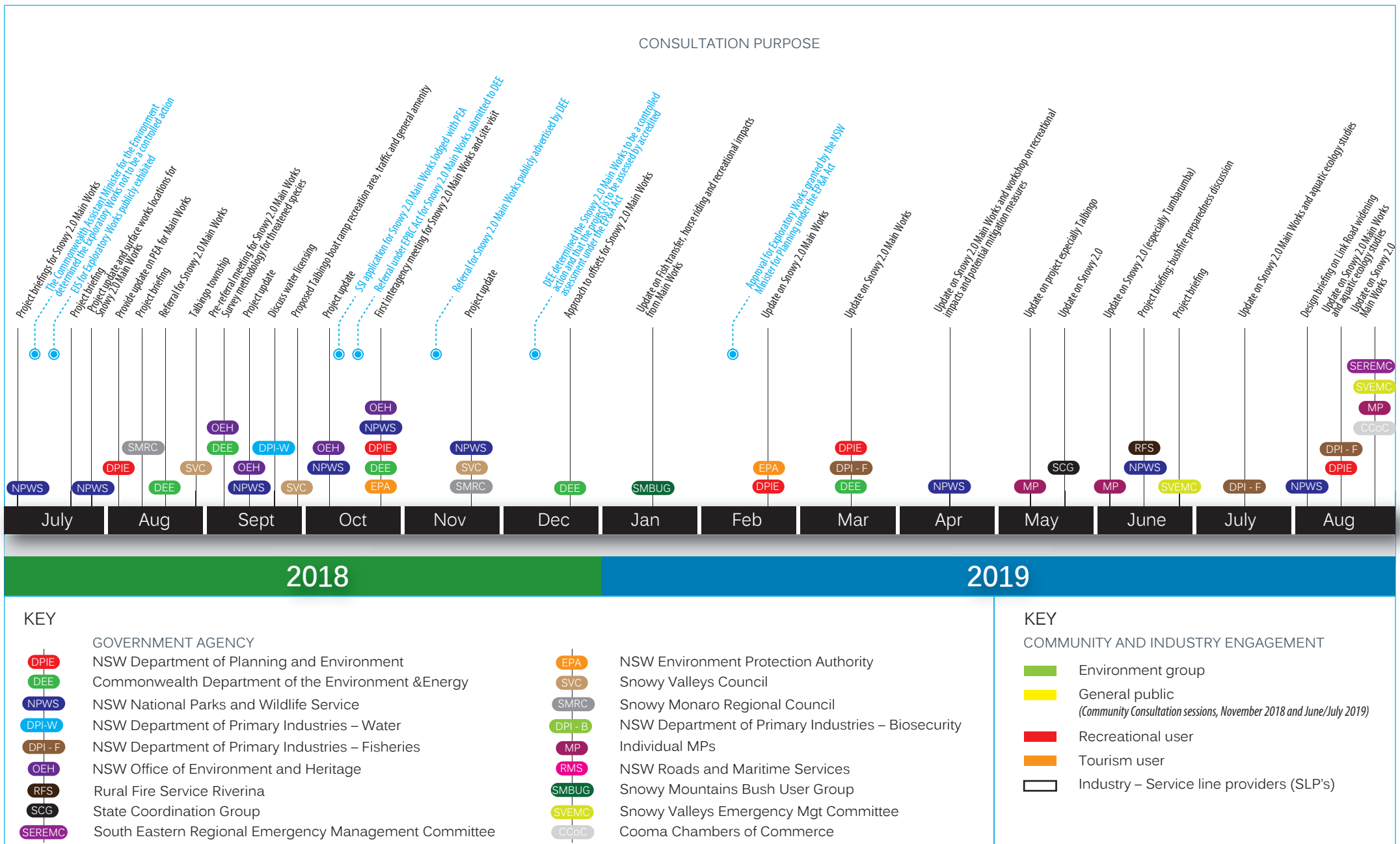
The EPA has been engaged on the Snowy 2.0 Main Works since February 2019 and has involved briefings and workshops with regional officers of the EPA and head office technical assessment teams.

Engagement with DPI Fisheries and Biosecurity during Main Works EIS development have involved face to face briefings and workshops with representatives on at least five occasions and followed on from numerous meetings through the development of the Exploratory Works EIS.

To date Snowy Hydro have met with local representatives of both the Cooma Monaro and Riverina Rural Fire Service (RFS) units on several occasions, in addition to providing regular project updates at the Snowy Monaro and Snowy Valleys Local Emergency Management Committees. RFS representatives have attended for several site familiarisation visits to Project locations and have been extensively consulted in the development of the Project Bushfire Management plans and Emergency Management Plans. Prior to the commencement of the bushfire season each year, Snowy Hydro will attend the local bushfire management committees to obtain the latest information regarding the bushfire outlook.

Throughout the preparation of the technical studies, Snowy Hydro has met with DEE on a regular basis to provide updates on project design, technical study outcomes, principally on ecological and heritage MNES and approval pathway matters (refer to Chapter 4) under the EPBC Act.

Figure 5.3 provides a summary of the engagement undertaken with key government agencies (related predominantly to Snowy 2.0 Main Works). For a full list of government engagement activities please refer to Table 3.1 in Appendix I. Figure 5.3 also contains key dates in the approval process for Snowy 2.0 to provide context to the consultation with the agencies.



5.2 Key issues raised and how they have been addressed

5.2.1 Local community, local industry and special interest groups

Feedback from the community on Snowy 2.0 has been positive. Some of the issues identified and raised by these stakeholders are specific to a geographic location or an individual. Other issues that are raised at community events (which are all open to anyone to attend) are raised by someone on behalf of a local community group and reflect a special interest group's view. Key matters raised include:

- general interest in business opportunities and work with Snowy 2.0;
- traffic around Cooma and potential disruptions to the main street from trucks;
- the concern that there will be accommodation shortages when workers come into towns, especially in winter, which will impact on ski tourism;
- closures of specific roads, for example Tantangara Road; and
- impacts to recreational fishing spots from partial reservoir closures or restrictions at Talbingo and Tantangara Reservoirs.

Additionally, the most recent survey results undertaken in June and July 2019 indicates that these interests are still very important to the community, with the top four themes identified by the community as the most important being (in order of importance);

1. Economic, employment and business opportunities;
2. Energy reliability;
3. Renewable / greener energy; and
4. Environmental impacts.

Snowy Hydro has specifically engaged with a range of special interest groups. It's also important to note that many of these groups' views are also captured through engagement with the local community and the public information sessions held. Key matters raised by these groups include:

- environment impacts to the KNP;
- impacts to recreational activities including fishing and horse riding in the KNP;
- potential for fish transfer;
- excavated rock placement in the Tantangara Reservoir;
- road closures and increased traffic during construction; and
- opportunities for local businesses to get work on Snowy 2.0.

5.2.2 Government agencies

As discussed in Section 5.1.4 engagement with government agencies during the Snowy 2.0 Main Works EIS development has been in concurrence with Exploratory Works and Snowy 2.0 in general and remains a priority to Snowy Hydro. Primary matters raised during these engagement sessions include:

- potential impacts of the proposed works on the amenity and recreational facilities in KNP;
- potential impacts to local water quality during construction;
- potential impacts on reservoir water quality from the excavated material placement;
- impacts on native aquatic species and recreation as a result of potential pest fish transfer between Talbingo and Tantangara and related impacts (such as potential transfer of pathogens);
- potential impacts to threatened species as a result of excavated material placement in Talbingo; and
- traffic impacts across the project and on the main haul routes to site.

These matters are outlined in further detail in Table 5.1.

5.2.3 Summary of matters raised

Table 5.1 provides a summary of the matters raised through the engagement carried out by Snowy Hydro for Snowy 2.0 Main Works.

Table 5.1 **Key issues raised during the preparation of the EIS**

Theme	Key issue raised	How has the issue been addressed	Where addressed in this EIS
Strategic context	<ul style="list-style-type: none"> • Renewable energy • The transitioning NEM • Energy prices • Viability of project/cost of pumping • Concerns that alternative sites for pumped-hydro were not considered • Economic viability • impact of the transmission corridor • Staging of the approval process 	<p>This EIS has provided a detailed options report (refer to Appendix C) which provides information on the alternatives to Snowy 2.0. A key reference document is 1991 study carried out by Snowy Mountains Scheme which considered the Yarrangobilly Pumped Storage Scheme, a precursor to Snowy 2.0.</p> <p>With the NEM continuing to evolve and at a rapid pace, Snowy 2.0 be a significant contributor to the continued decarbonisation of the NEM. The EIS provides further contextual information (Appendix H).</p> <p>Each technical study has considered the cumulative impacts of the Snowy 2.0 Transmission Connection Project where relevant to do so. Snowy Hydro and TransGrid have been working together during the design development to maximise an efficient and optimised integration of the two projects.</p> <p>Community consultation activities for Snowy 2.0 Main Works have included materials providing information on the Snowy 2.0 Transmission Connection Project with some TransGrid personnel available at some sessions.</p>	Chapter 3 of the EIS

Table 5.1 **Key issues raised during the preparation of the EIS**

Theme	Key issue raised	How has the issue been addressed	Where addressed in this EIS
KNP	<ul style="list-style-type: none"> • Environment impacts to the KNP and potential long-term damage • Long term impacts on the KNP of 2.0 operations 	<p>Through the design process significant effort has been put into mitigating impacts to amenity, natural and cultural values of the KNP by:</p> <ul style="list-style-type: none"> • minimising physical disturbance areas as much as possible; • using existing and limiting new access points; and • committing to land-forming and rehabilitation programs. <p>Concerns about long term impacts to KNP will be addressed through the program of rehabilitation and land forming impacted areas.</p> <p>It has also been agreed with KNP that a recreation plan be developed collaboratively, that identifies any permanently affected recreation facilities requiring relocation, or new or augmented visitor facilities.</p> <p>Lastly, the long term tenure arrangements for operation of Snowy 2.0 within KNP, will contain provisions for maintenance of areas, roads and other assets to ensure costs are apportioned and borne by the appropriate party.</p> <p>Where these measures have not fully avoided or minimised impacts, offsets are proposed that will see management actions implemented, that achieve direct recreation and conservation outcomes within KNP, proportionate with the impacts.</p>	Chapter 6 of the EIS

Table 5.1 Key issues raised during the preparation of the EIS

Theme	Key issue raised	How has the issue been addressed	Where addressed in this EIS
Biodiversity	<ul style="list-style-type: none"> • Impacts on native aquatic species and recreation as a result of potential pest fish (Redfin) transfer between Talbingo and Tantangara reservoirs, and further impacts from distribution upstream and downstream • Impacts on recreational fish (trout) as a result of potential Redfin transfer • Potential transfer of pathogens and in particular the EHN virus through the power waterway • Transfer of invasive weed species from vehicle movement • Concerns for wildlife on the roads and increased roadkill; • Potential impacts to threatened species (Murray crayfish) as a result of excavated material placement in Talbingo Reservoir • Potential impacts to threatened species and communities • Where impacts to threatened species and communities cannot be avoided, developing a strategy for offsets 	<p>The project has committed to fish barrier controls on the Eucumbene - Murrumbidgee tunnel and on the Tantangara dam wall and upstream on Tantangara Creek</p> <p>The project has committed to augmenting the recreational fishing resource through stocking of larger trout in Tantangara Reservoir that can survive predation from Redfin, should the pest species be transferred.</p> <p>The aquatic ecology assessment (Appendix M.2) considers the risks of the EHN virus. There is no history of outbreaks in Talbingo Reservoir. The assessment also found that the number of outbreaks and virulence of them, has been in decline and there has been no outbreak detected since 2011. The potential for use of UV to mitigate this risk is being assessed and discussions with DPI about the value of installing this is ongoing.</p> <p>The direct impacts to Murray crayfish from placement of excavated material is being mitigated through reductions in the overall placement area, pre-clearance surveys, and translocation. Where these do not adequately mitigate the impacts to Murray crayfish, offsets will be necessary and proportionate with the impacts.</p>	Section 6.4 of the EIS

Table 5.1 Key issues raised during the preparation of the EIS

Theme	Key issue raised	How has the issue been addressed	Where addressed in this EIS
Heritage	<ul style="list-style-type: none"> Potential impacts to Aboriginal cultural heritage 	<p>Snowy Hydro has committed to the avoidance of Ravine cemetery and Washington Hotel at Lobs Hole, the main construction area. Further, Importantly a highly significant Aboriginal heritage rock shelter was identified during the project investigations and has been avoided.</p> <p>Through the Aboriginal cultural heritage assessment process, Snowy Hydro has regularly engaged with RAPs and OEH regularly regarding the heritage investigations, findings and management measures. These matters are addressed in the Aboriginal Cultural Heritage Assessment (Appendix P.1).</p> <p>Should Snowy 2.0 Main Works be approved, management plans addressing potential impacts to Aboriginal heritage will be prepared and implemented.</p>	Sections 6.7 and 6.8 of the EIS
Water	<ul style="list-style-type: none"> Impact of subaqueous placement of excavated rock (turbidity and water quality) Fluctuation of dam levels on Talbingo and Tantangara reservoirs Closure of the Talbingo spillway Interest from irrigators about water quality and of downstream water releases or flows will be impacted Eucumbene lake operators concerned that water will be held in Tantangara and not released into Eucumbene or Providence Portal Potential impacts to local water quality from surface water runoff from disturbed construction areas Potential impacts to local water quality from process tunnel and wastewater from accommodation and other construction facilities 	<p>For surface water runoff, a range of cultural, physical design and administrative measures are proposed, including:</p> <ul style="list-style-type: none"> establishing a strong culture of pollution prevention and providing access to a highly experienced and skilled pollution control expertise; focusing prevention of pollution through design (eg clean water diversion), site selection and source controls; minimising disturbance and the amount of time disturbed areas are exposed and closing site prior to weather events that could result in runoff; monitoring and responding rapidly to any potential pollution causing event and taking corrective action; and ensuring that discharges meet the water quality objectives for process and wastewater. 	Section 6.2 of the EIS

Table 5.1 **Key issues raised during the preparation of the EIS**

Theme	Key issue raised	How has the issue been addressed	Where addressed in this EIS
Traffic and transport	<ul style="list-style-type: none"> Existing road utilisation and known issues within the road network for the Project Traffic modelling and the comparison between existing baseline and average and peak project loading Impact of construction traffic on main and local roads Transport of large equipment and project routes The ability to use Port Phillip Track as an alternative to Tantangara Road and the seasonal access Truck parking and places to stop aren't available in some of the towns like Adaminaby Review and discussions on concept designs for road intersection across the Project site and on the main haul routes to site Safety concerns with trucks on the roads and accidents Managing and scheduling Project required works with RMS existing planned maintenance and works Local road upgrades Closure of roads due to construction 	<p>Snowy Hydro has engaged with road authorities, SMRC, NPWS and RMS, regarding proposed measures to provide for adequate road safety and network performance during the construction period.</p> <p>There have been several workshop/meetings between the Snowy Hydro, SMRC, NPWS and RMS, with a site visit for the RMS team led by Snowy Hydro to help further the understanding of the level of upgrade and maintenance work required, as well as the existing issues present with the region's road network.</p> <p>The teams have been actively sharing information such as model data and proposed designs in order to ensure that appropriate solutions are implemented.</p> <p>A Traffic and Transport Assessment (Appendix Q) has been prepared and Snowy Hydro will continue to engage with RMS and other key road agencies.</p>	Section 6.9 of the EIS

Table 5.1 **Key issues raised during the preparation of the EIS**

Theme	Key issue raised	How has the issue been addressed	Where addressed in this EIS
Social and economic	<p>Local employment and business opportunities</p> <ul style="list-style-type: none"> • Opportunities for businesses and individuals to participate (including opportunities for apprenticeships) • Access to packages for small operators/businesses • Process for business pre-qualification, project readiness and job applications • Seeking support for the Chambers to assist business get ready and prequalified for work on the project • Concerns from local business owners about losing their existing staff to the project workforce • Training opportunities • Impact on existing local workforce/employee availability 	Ongoing engagement with local businesses and Business chambers will assist in ensuring they are aware of business opportunities and contracts available on Snowy 2.0.	Section 6.13, Section 6.14, and Appendix X of this EIS

Table 5.1 Key issues raised during the preparation of the EIS

Theme	Key issue raised	How has the issue been addressed	Where addressed in this EIS
	Recreation and tourism <ul style="list-style-type: none"> • Access to Talbingo and Tantangara reservoirs, lobs hole • Impacts to recreational activities ie fishing and tourism • Concerns that Lobs Hole won't be the same quiet campsite post-project (access will be opened up with improved road access to the site) • Impacts of the proposed works on the amenity and visitor facilities of KNP and recreational users who value this • Impacts of the proposed works on the natural and cultural heritage values of KNP • Long term impacts on the KNP of 2.0 operations • Tourism operators and towns worried about the perception that the region is 'closed' or impacted by construction and traffic and it could deter visitors to the region • Horse riders - access to recreation sites • Tourism benefits from off-shift workers recreating locally • Desire for some of the funding from the environmental offsets to be invested in improved recreational amenities • Impacts on accommodation shortages, especially in winter which will impact on ski tourism 	<p>Engagement with community and stakeholders has been a key part of avoidance and minimisation of impacts throughout the design process. Keeping the community informed of project developments and predicted impacts enables the community to prepare for and predict how the project might result in some changes to recreation in some sections of KNP. In addition to community and stakeholder engagement, the following avoidance and minimisation measures have been considered and adopted for the project:</p> <ul style="list-style-type: none"> • maintaining some level of access on Tantangara Road; • providing future recreational opportunities through consultation with NPWS; and • incorporating relevant road works to improve safety and access to KNP in the long term. <p>The recreational user assessment involved the collection of qualitative and quantitative data on the use and visitation of KNP, including field (visitor) surveys, email surveys, and visitor counts, as well as consultation with NPWS.</p>	<p>Section 6.13, Section 6.14, and Appendix X of this EIS</p>

Table 5.1 Key issues raised during the preparation of the EIS

Theme	Key issue raised	How has the issue been addressed	Where addressed in this EIS
	Impacts or benefits to towns in the region <ul style="list-style-type: none"> • Benefits for economies of local towns • Impacts for towns (eg Talbingo, Tumut) not perceived as central to the project • Benefits of families of workers moving to towns • Local towns are seeking ways to market their region to workers on their swing off days • Concerns from land holders about difficulty crossing live-stock on the Snowy Mountains Highway • Impacts on services such as health and schools, tertiary education facilities and childcare • Short and long-term housing availability 	<p>In addition to the extensive engagement already undertaken by Snowy Hydro during the preparation of this EIS, a series of targeted social impact-specific engagement activities was undertaken to address issues raised by the community on the impacts or benefits to communities of local towns in the region. These activities utilised a variety of techniques including focus groups, surveys and in-depth interviews with service level providers.</p> <p>Planning is already underway regarding mitigating potential impacts to short and long-term housing availability. Snowy Hydro are pursuing the provision of accommodation for project workers at a site in Cooma (called Pacific Hills) that could provide 120 short term accommodation rooms and 30 long term accommodation cabins. It also allows for potential expansion. This accommodation would support the accommodation needs of the different project components of Snowy 2.0. This process is subject to a separate development application to SMRC.</p>	Section 6.13, Section 6.14, and Appendix X of this EIS
	Workforce <ul style="list-style-type: none"> • Duration of swings and facilities in the accommodation camps • Where will the workers come from and how will they be mobilised? • Transport to site and FIFO <p>What will happen to construction camps and sites after the project is finished?</p>	<p>Snowy Hydro views the Exploratory Works phase of Snowy 2.0 as a unique opportunity to anticipate degrees of workforce population and movements and potential impacts on the local community. Preparing for and adequately monitoring the degree of population change that arises will be the main way of managing social impacts when the Main Works phase of the Project commences.</p> <p>Depending on the population change scenario that eventuates, appropriate interventions can then be designed by Snowy Hydro that are proportionate to the scale of change being experienced.</p>	Section 6.13, Section 6.14, and Appendix X of this EIS
Emergency services	<ul style="list-style-type: none"> • potential lack police resources -escort vehicles • Lack of single communication network 	Prior to the commencement of the bushfire season each year, Snowy Hydro will attend the local bushfire management committees to obtain the latest information regarding the bushfire outlook.	Section 6.11

5.3 Proposed approach to community engagement if the project is approved

Community and Stakeholder Management Plans (CSMP) have been developed for Snowy 2.0 that provide a framework for the management of community and stakeholder relations and communication related to the project. This plan will be a fluid document that will be updated every year and reviewed regularly following Snowy 2.0 engagement activities. These CSMPs will continue to be updated and implemented should Snowy 2.0 Main Works be approved. These plans will be supported by other plans and procedures as needed to manage engagement with the community during construction.

The proposed approach to community engagement if the project is approved, is to focus on providing engagement activities that provide up to date project information to those likely to be affected during construction and also allow the community to communicate concerns with the project.

A summary of the key engagement activities proposed if the project is approved is provided in Table 5.2, with further detail provided at Appendix I. Table 5.2 also outlines the implementation of the DPIE community participation objectives in relation to the engagement activities.

Table 5.2 Engagement activities during construction

Engagement activities	Description	DPIE community participation objectives to be implemented
Construction management communication	<p>A Snowy 2.0 Main Works Communication Action Plan will be developed three months prior to construction to plan for all upcoming construction activities including traffic and transport movements that may impact the local community and travelling public. This action plan will be a working document and updated regularly as the project progresses.</p> <p>Additionally, some indicative tools and engagement activities that may be used to communicate construction activities during Main Works include:</p> <ul style="list-style-type: none"> • Targeted communication: <ul style="list-style-type: none"> – briefings for local councils and emergency services, meetings/briefings with key stakeholders such as directly impacted residents, business owners and the wider community; – construction disruption letters to affected properties and construction notification emails to key stakeholders; – construction information sessions for the community; • Mass-distribution communication: <ul style="list-style-type: none"> – community consultation sessions; – community announcements/road work alerts; – community and media events at project milestones; – public display materials; – Snowy Hydro Discovery Centre; – project fact sheets and traffic management communications supporting collateral; – e-newsletters, freecall 1800 information line which operated 24/7; and – project website and social media accounts, email addresses for feedback and enquiries. <p>A Crisis Communication Procedure has been developed to ensure an effective and appropriate response to any incident on site.</p>	<ul style="list-style-type: none"> • Open and inclusive • Easy to access • Relevant • Timely • Meaningful

Table 5.3 Engagement activities during construction

Engagement activities	Description	DPIE community participation objectives to be implemented
Traffic and Transport Communication Working Group	<p>A Snowy 2.0 Traffic and Transport Communication Working Group has been established including communication representatives from Snowy Hydro, Future Generation Joint Venture, NSW Police, Transport NSW, Destination Southern NSW, Snowy Monaro Regional Council and Snowy Valleys Council. The group will continue throughout Main Works.</p> <p>The purpose of this group is to share resources and communication tools to ensure all communication channels and resources are utilised to inform the local community and general public of the project's traffic and transport activity and likely impacts.</p>	<ul style="list-style-type: none"> • Open and inclusive • Easy to access • Relevant • Timely
Complaints handling	<p>A Complaint Management and Dispute Resolution Procedure has been developed for Snowy 2.0 with an overview of the process and procedures established to manage complaints and disputes. Regular reporting will also occur from within the project in relation to complaints raised, outcomes and process changes arising from such complaints.</p> <p>A register of community inquiries will be maintained through the Snowy 2.0 stakeholder management software and updated as inquiries or complaints are received and resolved. All complaints and actions will be published on the project webpage.</p>	<ul style="list-style-type: none"> • Open and inclusive • Easy to access • Timely • Meaningful
Online communications	<p>During Exploratory Works, communication has been developed to educate and prepare the community for the likely impacts of construction activity, especially during Main Works. Some communication channels for the project have already been established such as www.futuregenerationjv.com.au and www.snowyhydro.com.au/our-scheme/snowy20/.</p>	<ul style="list-style-type: none"> • Open and inclusive • Easy to access • Relevant • Timely • Meaningful
Snowy 2.0 information centre	<p>A Snowy 2.0 information centre/project office is being established to provide a one-stop shop for the local community. Due to the isolated nature of the site location and camp accommodation this information centre/project office will be positioned prominently and will be easily accessible within Cooma.</p> <p>A community suggestion box will also be included for the community to offer feedback and suggestions for improvement.</p> <p>The information centre/project office is planned to include interactive displays, photographic installations and a project construction video. Project staff will be available to answer community questions when required.</p>	<ul style="list-style-type: none"> • Open and inclusive • Easy to access
Media	<p>Media briefings, especially to local media throughout the project's life cycle, will form the cornerstone of a media strategy to deliver key information to the public. To disseminate key project messages into the public domain and to ensure that media are armed with information relating to this project, a series of media briefings will be held throughout the project construction. Other activities to support this strategy may include:</p> <ul style="list-style-type: none"> • Construction updates in local community newspapers/newsletters; • Onsite media visits; • Inclusion of construction updates in existing project communication materials; and • Production of a promotional video for the lifecycle of the project 	<ul style="list-style-type: none"> • Open and inclusive • Easy to access • Relevant • Timely



CHAPTER

6

ASSESSMENT OF IMPACTS





CHAPTER 6.1

OVERVIEW

6 Assessment of impacts

6.1 Overview

This chapter provides a summary of the environmental, social and economic impacts of the Snowy 2.0 Main Works. Impacts have been assessed with technical specialist reports prepared where appropriate. Specialist technical reports are provided as appendices to this EIS with the key impacts, outcomes and mitigation measures summarised in this section. Mitigation measures have been identified to minimise, avoid and manage predicted impacts. A consolidated list of all mitigation measures contained in this EIS is provided in Appendix G.



CHAPTER 6.2

WATER

6.2 Water

The water assessment (Appendix J) supports the EIS for Snowy 2.0 Main Works. Appendix J consists of an overarching water assessment and a number of technical annexures that present detailed information on the existing water environment, monitoring and available data, groundwater and surface water modelling undertaken for the project, flood risk assessments, water management measures and predicted residual impacts.

The water assessment and technical annexures provide further information for all matters presented in this chapter. The water assessment concludes that although local effects will occur as a result of the project, the regional effects on the catchment surface water flows, catchment water quality and regional groundwater resources are insignificant.

6.2.1 Existing environment

i Setting and terrain

The project is in the Australian Alps in southern NSW, generally between Talbingo and Tantangara reservoirs, which are part of the existing Snowy Scheme. With the exclusion of Rock Forest, the landform of the Snowy 2.0 Main Works project area can be described as two distinctive terrains; an incised ravine and a plateau.

The ravine extends from Talbingo Reservoir in the west to the Snowy Mountains Highway in the east. The ravine is characterised by deep gorges and steep sloping ridges, the product of incision from river flow, historic glaciation and structural movement. The project areas of Talbingo Reservoir, Lobs Hole and Marica are all within the ravine.

The plateau extends from the Snowy Mountains Highway in the west to Tantangara Reservoir in the east. The plateau is typical of elevated alpine environments, dominated by low energy streams, gently rolling hills and mostly flat floodplains.

ii Climate

The general project area has an alpine climate that is characterised by cool summers and cold, damp, and snowy winters. The highest and most consistent rainfall generally occurs in winter to early spring, with mean annual rainfall generally increasing with elevation. Data from existing rainfall gauges indicate that median rainfall ranges from around 920 mm/year in the lower areas of the ravine to around 1,350 mm/year in the headwater catchments, with the spatial variation in median rainfall generally reflecting the variation in topography across the project area.

Summer and autumn are generally drier and experience greater variation in monthly rainfall depths. Summer rainfall is typically of higher intensity and of shorter duration than winter rainfall.

From late autumn to early spring, rainfall is generally of lower intensity, but more persistent, and at higher elevations can occur within the project area, falling as snow. Snow is therefore expected to occur during winter across elevated areas of the plateau, whilst generally not expected to occur regularly in the lower elevation areas within the ravine.

The temperature records from gauges within the vicinity of the project area show a correlation of higher mean monthly temperatures at lower altitudes (ie Talbingo Reservoir and Lobs Hole) and lower mean monthly temperatures at higher altitudes (ie plateau and Rock Forest).

The alpine climate across the project area is an important consideration for water impact mechanisms and water management aspects of Snowy 2.0 Main Works.

iii Watercourses and water quality

Watercourses vary according to soil type, geology, topology, elevation, climate and range from small ephemeral watercourses to regional rivers with perennial flow regimes. All water courses are defined as receiving baseflow from groundwater (gaining streams). The key watercourses and the baseline water quality and flood characteristics are described below for the ravine, plateau and Rock Forest, as well as the baseline water quality for Talbingo and Tantangara reservoirs.

The NSW Water Quality and River Flow Objectives (DECCW 2006) provides Water Quality Objectives (WQO) consistent with ANZECC/ARMCANZ (2000) water quality guidelines for the protection of the aquatic environment. The WQOs are 'primarily aimed at maintaining and improving water quality, for the purposes of supporting aquatic ecosystems, recreation and where applicable water supply and the production of aquatic foods suitable for consumption and aquaculture activities' (DECCW 2006). Different WQOs apply to rivers and reservoirs and these are referenced within the following sections.

a Ravine

Within the ravine, the Yarrangobilly River is the major regional watercourse that flows into Talbingo Reservoir, downstream of Lobs Hole. Its catchment has an area of 271 km² that is wholly within the KNP. The Yarrangobilly River has a number of tributaries within the ravine, including Wallaces Creek, Stable Creek, Sheep Station Creek and Highground Creek. The key watercourses in the ravine are shown in Figure 6.1. Stream flows in the Yarrangobilly River and its major tributaries are continuous all year round during normal rainfall conditions. The majority of annual stream flow occurs in late winter and early spring, which is typical for rivers in the Australian Alps.

At Lobs Hole the Yarrangobilly River emerges from a deeply incised gorge and follows a relatively narrow floodplain through to Talbingo Reservoir. In flood, flows along the Yarrangobilly River through Lobs Hole are predominantly confined to the main river channel and immediate overbank areas for floods up to about the 5% annual exceedance probability (AEP) event, with more extensive inundation of the floodplain occurring for larger events.

Baseline water quality monitoring was undertaken in the ravine between February 2018 and May 2019, predominantly during dry weather conditions, with wet weather monitoring events also undertaken in March and May 2019. Baseline water quality characteristics for watercourses within the ravine can generally be described as follows:

- Yarrangobilly River and Wallaces Creek have similar water quality during dry weather conditions. Key characteristics include:
 - pH ranges between 6.2 to 8.5, with occasional lower and upper bound exceedances;
 - low concentrations of suspended solids and low turbidity;
 - carbonate and salinity vary seasonally, with higher levels occurring in summer/autumn; and
 - aluminium concentrations in the Yarrangobilly River exceed WQO values frequently in winter/spring and occasionally in summer/autumn and copper concentrations in Wallaces Creek occasionally exceed WQO values.
- The water quality during dry weather conditions in minor watercourses in Lobs Hole is generally poorer than larger watercourses, with elevated suspended sediment, nutrients and some metals (aluminium and copper).

- Receiving water quality during wet weather conditions (informed by data from wet weather events with moderate rainfall) is generally poorer relative to baseflow conditions with higher turbidity, lower pH, higher nutrients and potential for non-trivial concentrations of some metals such as aluminium and copper.

b Plateau

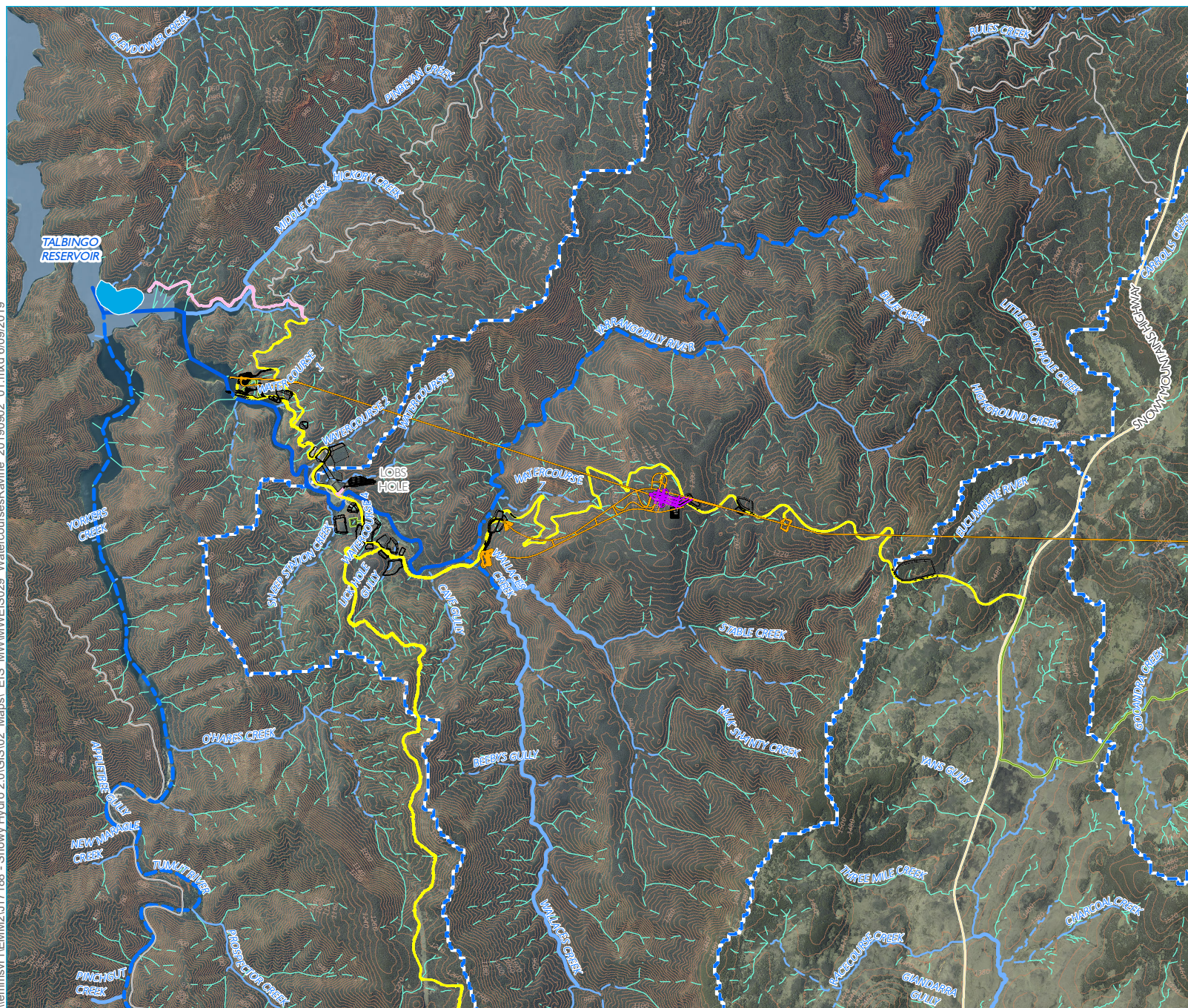
The plateau is within the upper reaches of the Murrumbidgee and Eucumbene River catchments, wholly within KNP. The headwaters of the Eucumbene River are in the western plateau, and the river flows in a southerly direction to Lake Eucumbene. The Murrumbidgee River flows from north of the plateau in a south easterly direction into Tantangara Reservoir.

A number of perennial waterways are present across the plateau, that either flow north into the Murrumbidgee River or directly into Tantangara Reservoir, including Gooandra Creek, Tantangara Creek, Nungar Creek and Kellys Plain Creek. The key watercourses across the plateau are shown in Figure 6.2.

Baseline water quality monitoring was undertaken between February 2018 and August 2019 in the Murrumbidgee and Eucumbene rivers, Tantangara, Gooandra, Nungar and Kellys Plain creeks and other minor watercourses. Water quality characteristics for watercourses across the plateau are described as follows:

- The Murrumbidgee and Eucumbene rivers, Tantangara, Gooandra, Nungar and Kellys Plain creeks have similar water quality during dry weather conditions, key characteristics include:
 - pH that generally ranges between 6.2 and 8.5, with occasional lower and upper bound exceedances;
 - carbonate and salinity vary seasonally, with higher levels occurring in summer/autumn;
 - low concentrations of suspended solids and low turbidity;
 - oxidised nitrogen concentrations exceed WQO values frequently in summer/autumn and occasionally in winter/spring; and
 - aluminium concentrations exceed the WQO value on a frequent basis. Copper, iron and zinc concentrations exceed WQO values on an occasional basis.
- The water quality of minor watercourses in the vicinity of the proposed surface works near Tantangara Reservoir is generally poorer than larger watercourses, with elevated suspended sediment, nutrients and some metals (aluminium and iron).
- The water quality during wet weather conditions is poorly understood. It is expected that concentrations of suspended sediment and some metals may be higher during these events than during dry weather concentrations.

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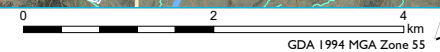


- KEY**
- Catchment area
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Indicative rock emplacement area
 - Existing environment
 - Main road
 - Local road
 - 20m contour
 - Waterbodies
 - Strahler stream order
 - 0
 - 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7

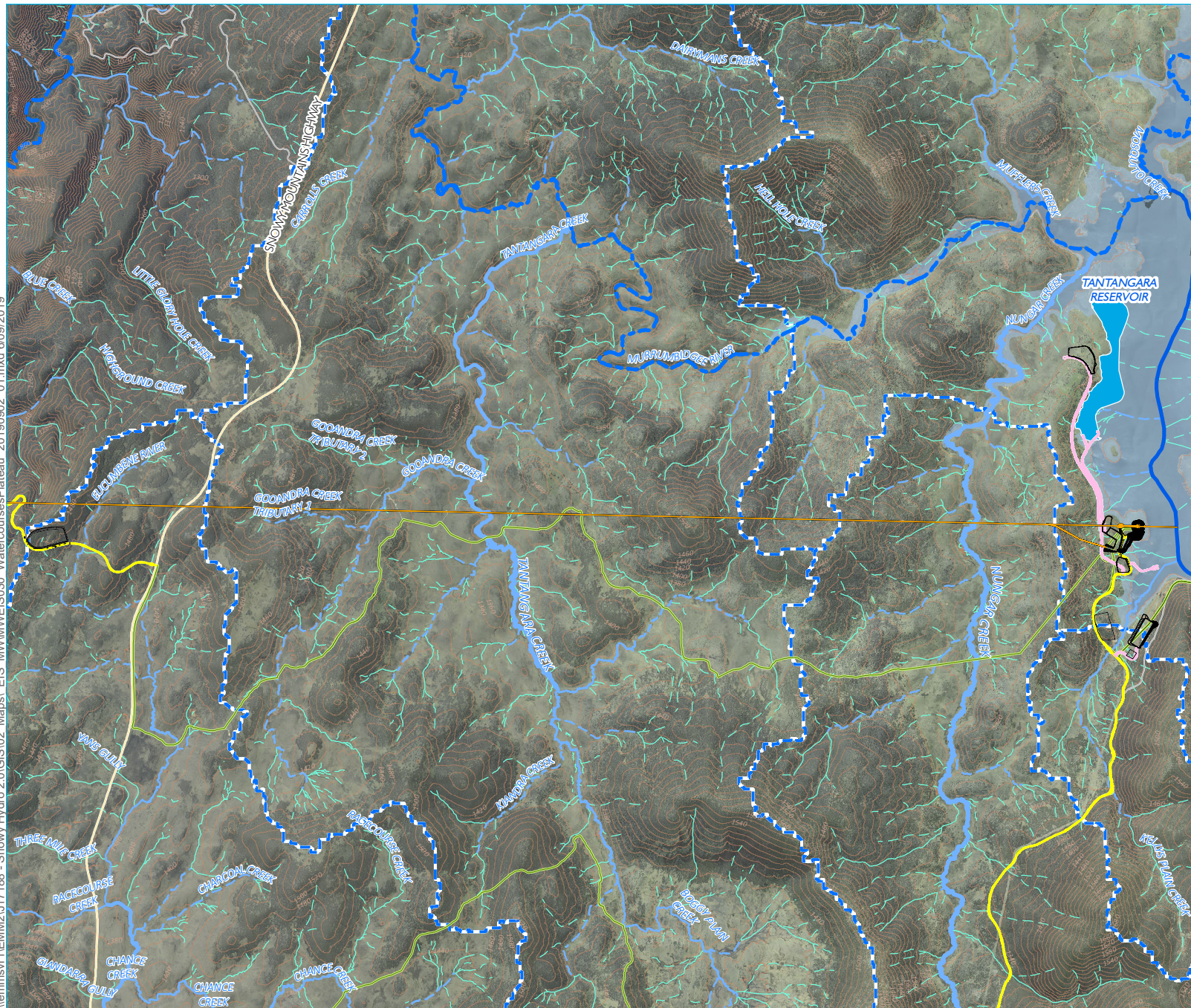
Watercourses - Ravine

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.1

Source: EMM (2019); Snowy Hydro (2019); FGJV (2019); DFSI (2017); LPMA (2011)



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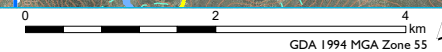


- KEY**
- Catchment area
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Indicative rock emplacement area
 - Existing environment
 - Main road
 - Local road
 - 20m contour
 - Waterbodies
 - Strahler stream order
 - 0
 - 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7

Watercourses - Plateau

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.2

Source: EMM (2019); Snowy Hydro (2019); FGJV (2019); DFSI (2017); LPMA (2011)



c **Rock Forest**

Rock Forest is in the headwaters of the Goorudee Rivulet catchment, outside of KNP and is nearby to two watercourses, being Camerons Creek and an unnamed 3rd order watercourse. The watercourses at Rock Forest are shown in Figure 6.3.

Five water quality samples were collected from Camerons Creek between February and May 2019. Some samples were collected from a standing pool due to a lack of streamflow. The water quality is characterised as having a neutral pH, low salinity and moderate turbidity. Ammonia, oxidised and total nitrogen, total phosphorus, aluminium and iron exceeded WQO values in at least four of out five samples. Copper occasionally exceeded the WQO values.

The locations, existing flow regimes and water quality of watercourses that traverse the project area are important considerations for direct potential surface works impacts and groundwater drawdown impact mechanisms from Snowy 2.0 Main Works.



- KEY**
- Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Existing environment
- Main road
 - Local road
 - 20 m contour
 - Waterbodies
- Strahler stream order
- 0
 - 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7

Watercourses - Rock Forest

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.3



\\lemmsvr1\EMM2\U17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS031 WatercoursesRockForest 20190902 01.mxd 6/09/2019

LAKE
EUCUMBENE

Source: EMM (2019); Snowy Hydro (2019); FGJV (2019); DFSI (2017); LPMA (2011)

0 0.5 1 km
GDA 1994 MGA Zone 55

iv Reservoir water quality

A description of Talbingo and Tantangara reservoirs, including details of the existing storages and typical operational characteristics, is contained in Section 2.4.2.

Water quality monitoring was undertaken between February 2018 and May 2019 in both Talbingo and Tantangara reservoirs. Baseline water quality characteristics in both reservoirs is generally similar and is described as follows:

- pH was similar in both reservoirs - between 6.3 and 8.2, with occasional lower and upper bound exceedances;
- electrical conductivity is low in both reservoirs, generally within or below the default guideline value range, but is approximately 30% lower in Tantangara Reservoir;
- the turbidity is low in both reservoirs, at the lower end of the default guideline value range, but is marginally higher in Tantangara Reservoir than in Talbingo Reservoir;
- the dissolved oxygen concentration (measured as percent saturation) is higher in Talbingo Reservoir than in Tantangara Reservoir but is generally within the default guideline value range;
- the nutrient concentrations (total nitrogen, oxidised nitrogen, ammonia and total phosphorus) were generally low in both reservoirs, but some nutrient concentrations exceeded the default guideline values;
- metal concentrations were generally low in both reservoirs, with the following potential exceptions which would need to be confirmed by further monitoring:
 - in Talbingo Reservoir, copper and zinc concentrations frequently exceeded WQO values in summer/autumn and occasionally in winter/spring;
 - in Talbingo Reservoir, chromium (total) and lead concentrations occasionally exceeded WQO values in summer/autumn;
 - in Tantangara Reservoir, aluminium concentrations frequently exceeded WQO values and copper, iron and zinc frequently exceeded WQO values during summer/autumn; and
 - in Tantangara Reservoir, chromium (total), cobalt and lead occasionally exceeded WQO values during summer/autumn.
- very limited data are available regarding reservoir water quality during and following wet weather conditions. There is potential for elevated turbidity, nutrients and some metals to occur near watercourse inflow locations for several weeks following a substantial runoff event.

The locations, existing functions and water quality in Talbingo and Tantangara reservoirs are important considerations for direct potential surface works impact mechanisms from Snowy 2.0 Main Works, including excavated rock emplacement.

v Geology and hydrogeology

The project area is within the south-eastern portion of the Lachlan Fold Belt (LFB) of NSW. The geology between Talbingo and Tantangara reservoirs is structurally deformed with numerous folds and several major faults associated with the north-south trending Long Plain Fault (LPF) zone.

The project intercepts two major structural blocks, which form the two distinct geological terrains; being the Tumut Block in the west (the ravine), and the Tantangara Block in the east (the plateau). The ravine and plateau are separated by an escarpment caused by movement on the LPF.

Within the Tumut Block, the key geological formations include Boraig Group, Byron Range Group, Ravine Beds and Yarrangobilly Limestone. Within the Tantangara Block, the key geological formations include Tertiary Basalt, Kellys Plain Volcanics, Boggy Plain Suite, Peppercorn Formation, Tantangara Formation, Temperance Formation, Shaw Hill Gabro and the Gooandra Volcanics. The key geological formations of the ravine and plateau are shown in Figure 6.4.

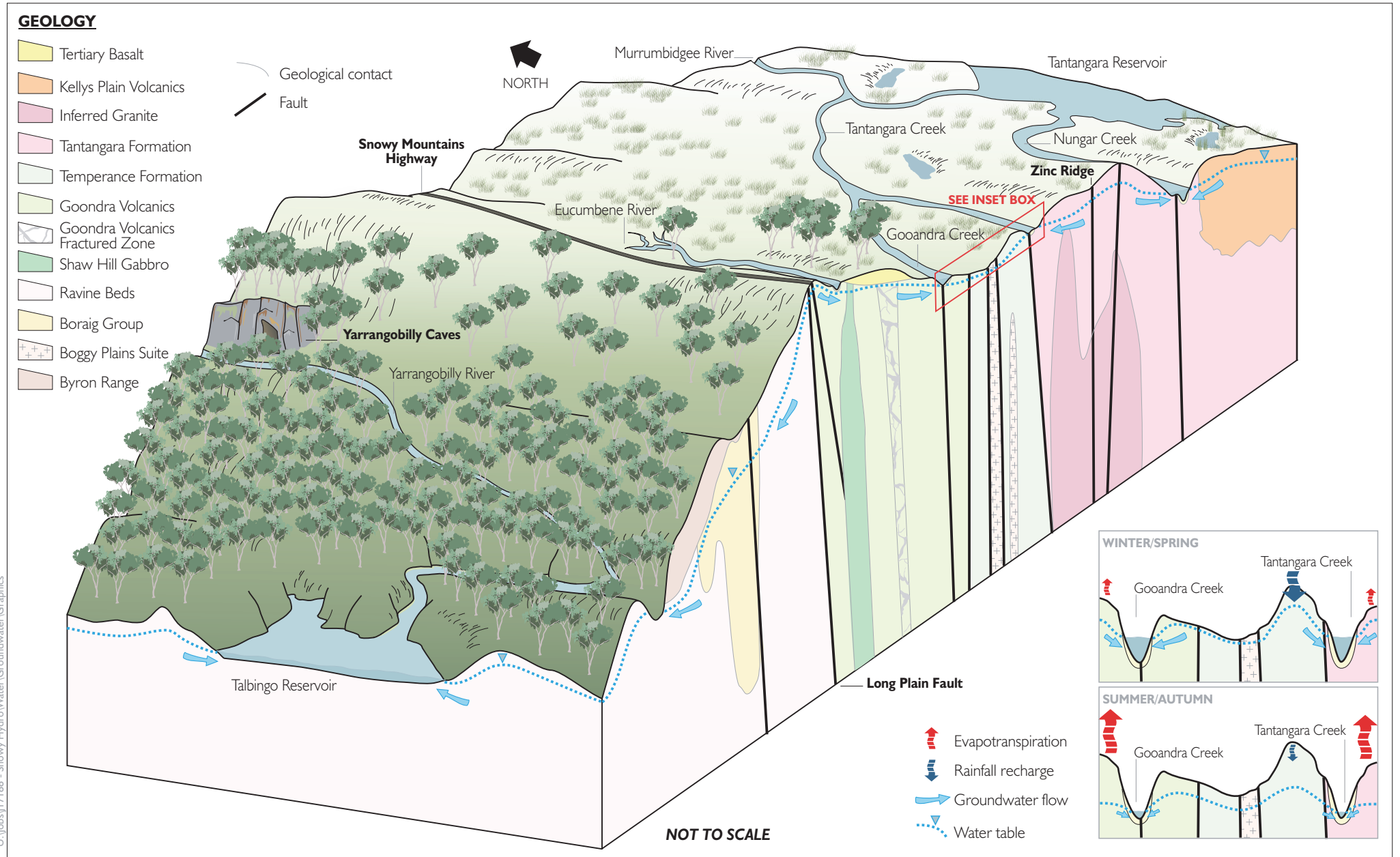
Hydrogeology across the project area has been informed by a groundwater monitoring network, designed specifically to investigate the hydrogeological conditions of the project area, and developed in consultation with DPIE Water, NRAR and WaterNSW.

The hydrogeological units of the project are:

- alluvium, colluvium and weathered rock: these shallow units are generally recharged by moderate to high rainfall, flooding for alluvial areas and snow melt;
- shallow weathered fractured rock: these units have low to moderate permeability and are recharged by moderate to high rainfall and snow melt (occurring when soil moisture conditions are exceeded); and
- deep fractured rock: recharged by infiltration of rainfall migrating from shallow groundwater systems. Permeability is generally lowest in the central section of the plateau and higher in the east and western areas of the plateau. There is downward flow of groundwater in recharge areas and upward flow in discharge areas.

Hydrogeological characterisation within the project can be summarised as follows and represented in Figure 6.4:

- groundwater levels generally are a muted version of the topography. Measurements from the groundwater monitoring network vary from approximately 1,470 m AHD in the topographically elevated terrain adjacent to the LPF, to approximately 570 m AHD in the topographically lower terrain near Lobs Hole. Groundwater levels may fall outside of this measured range in areas of higher relief and in some of the lower drainage lines, such as the interface between the Yarrangobilly River and Talbingo Reservoir where levels are likely at or close to surface levels of about 545 m AHD;
- groundwater levels within the ravine do not typically show an obvious response to rainfall or flow events within the Yarrangobilly River, indicating there is not a strong connection between the surface and the regional groundwater system;
- groundwater levels on the plateau within the Gooandra Volcanics, Tertiary basalt, Tantangara Formation, Temperance Formation, Boraig Group, Kellys Plain Volcanics and Boggy Plain Suite generally show a moderate to strong response to rainfall events, indicating a moderate to strong connection between surface and the regional groundwater system;
- vertical groundwater flow within the Ravine Beds is downwards, with groundwater in the upper horizons of the unit recharging the deeper horizons;
- vertical groundwater flow within the Gooandra Volcanics, Tantangara Formation and Temperance Formation is variable and complex with the direction of vertical flow (ie upwards versus downwards) varying with location and depth within these groundwater systems;



- watertables oscillate between wet winter/spring recharge periods and dry summer periods when there is negligible recharge; and
- differences between water levels within the Tertiary basalt and underlying Gooandra Volcanics suggests that the Tertiary basalt is a perched groundwater system.

The geology and hydrogeology of the regional project have been carefully considered and conservative assumptions have been made to consider potential worst-case scenarios for understanding and predicting impacts to the regional groundwater system. In reality, such averaged conditions are unlikely to occur throughout, and the typical nature of fractured rock groundwater systems means that highly localised conditions are expected to exist.

vi High priority GDEs

There are no identified High Priority GDEs within the project area. The Yarrangobilly Caves is the only High Priority GDE listed within the Water Sharing Plan (WSP) for the LFB Murray Darling Basin (MDB) Fractured Rock groundwater source within the groundwater model domain. The Yarrangobilly Caves are approximately 5 km north of the nearest infrastructure feature of Snowy 2.0 Main Works and are shown conceptually on Figure 6.4. Modelling demonstrates that there are no predicted impacts to any High Priority GDE's (including the Yarrangobilly Caves) as a result of Snowy 2.0 Main Works.

vii Soils

The complex geology has resulted in a diverse soil landscape. Soils vary significantly across the bioregions in relation to altitude, temperature and rainfall. The soils and land assessment (Appendix N.2) describes soils within the project area as likely to have low to moderate erodibility, with some localised areas of highly erodible and dispersive soils.

Due to timing and approval limitations for disturbance activities within KNP only limited, targeted soil sampling in Lobs Hole was able to be carried out for the assessment. From this data, as well as available disturbed area runoff samples also from Lobs Hole, the runoff water quality from existing disturbed areas is characterised as being mildly acidic and having elevated turbidity and concentrations of suspended solids and nutrients, indicating that poor water quality may be expected from some soils disturbed by construction activities.

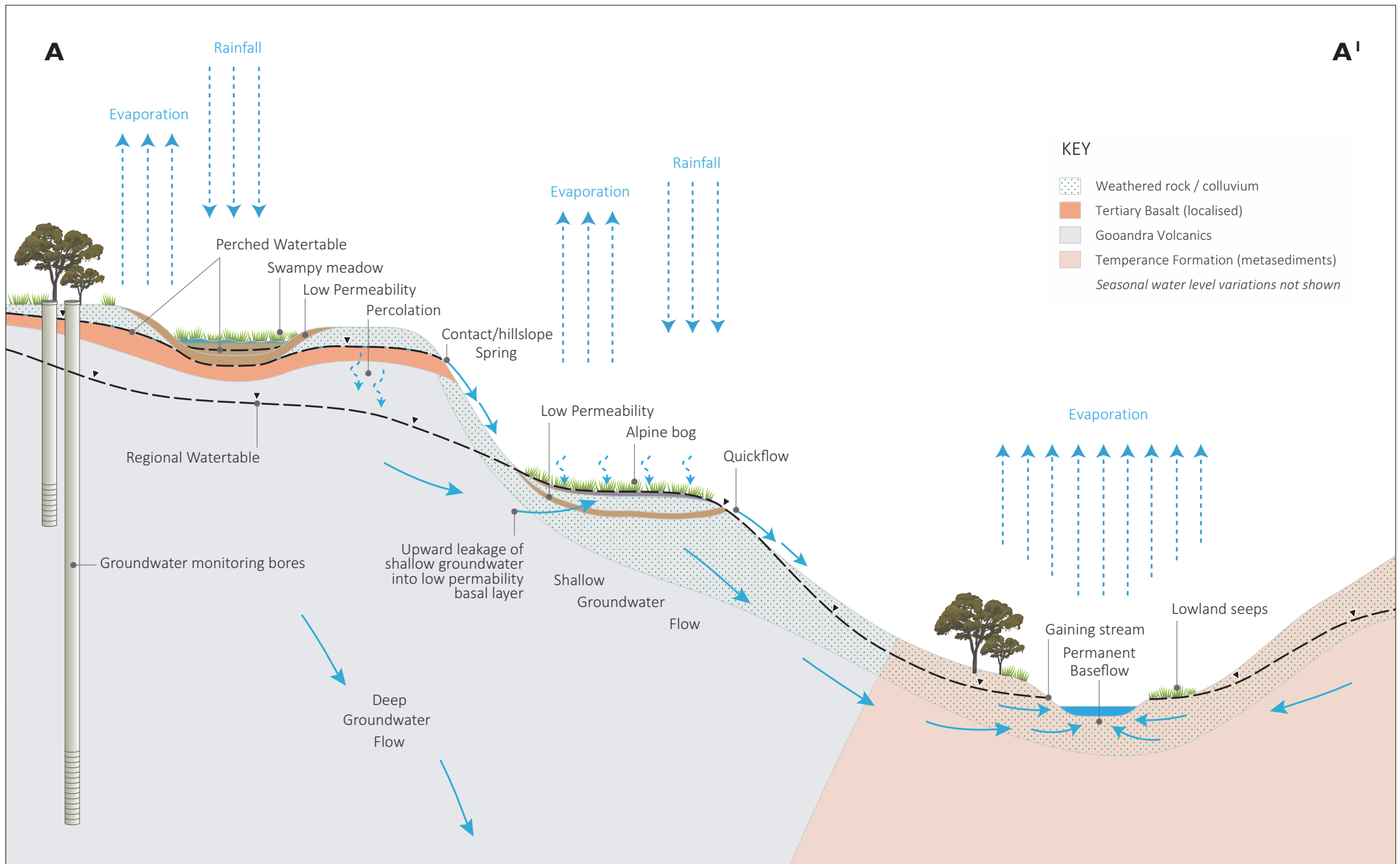
Rock Forest is on the lower to mid-slopes of gently undulating to undulating rises of sandstone and the soils are likely to be Kandosols and Dermosols that have moderately deep gradational profiles of clay loam over light clays.

The soils of the project area are important considerations for the construction of surface infrastructure, the proposed management approach and the assessment of residual water quality risks.

viii Conceptual model

The information presented in the preceding sections provided the basis for the development of the conceptual hydrogeological model of the project area. The conceptual model provides the basis for the numerical model design and communicates how the groundwater and surface water systems work and interact and the manner in which water becomes available for ecosystems. The conceptual model presents the current understanding of the key processes of the hydrogeological system including the influence of stressors and assists in the understanding of possible future changes that may occur due to Snowy 2.0 Main Works.

Streams in the area are all strongly gaining systems (ie streams that receive groundwater baseflow into them continually throughout the year). A diagram conceptualising groundwater occurrence and flow on the plateau is presented in Figure 6.5.



6.2.2 Community and stakeholder views

All key regulators have been consulted throughout project development. A summary of the key points raised by these stakeholders relevant to the water assessment and/or potential water related impacts from the construction or operation of the project is provided below.

- NSW EPA
 - water management framework – ensuring that the assessment of water impacts is consistent with the statutory framework; and
 - water quality – potential changes to existing receiving water quality parameters caused by surface disturbance, excavated rock management and the management of captured surface or groundwater.
- DPIE Water
 - groundwater numerical modelling – ensuring that modelling and reporting included suitable information and justification for programs, processes and data, including permeability and conductance values, evapotranspiration, assessment of climate change and uncertainty analysis.
 - groundwater drawdown and baseflow reduction - potential resultant impacts to GDEs and streams;
 - excavated rock emplacement;
 - impacts to waterfront land; and
 - water take / licensing – ensuring licence requirements (by water source) are assessed as per the NSW Aquifer Interference Policy (AIP) - ie for direct tunnel inflow, and indirect take from overlying systems.
- OEH and NPWS
 - ensuring a suitable baseline assessment of groundwater dependent stygofauna is undertaken as part of the Snowy 2.0 Main Works EIS.

6.2.3 Avoidance and minimisation through design

The project has responded to the key existing environment water risks and stakeholder concerns identified in the preceding sections. The following are the key project refinements made to avoid or minimise potential water impacts from Snowy 2.0 Main Works.

- the majority of groundwater inflow during tunnel construction is expected to occur via discrete and local fractures and fissures – mitigation and management of these discrete intervals will occur during construction. This reduction of groundwater inflow will be required to enable safe tunnel construction and this is anticipated to reduce actual tunnel inflows to below modelled predictions, which are based on a conservative approach of simulating an unlined tunnel construction design;
- the process and wastewater systems have been designed to ensure that water is treated to reasonable and feasible standards prior to discharge to reservoirs;

- the process and wastewater systems have been designed to discharge treated water to Talbingo and Tantangara reservoirs to avoid discharge to any sensitive creeks or rivers within the ravine or plateau;
- the majority of the project surface elements have been designed to be greater than 40 m from waterways to minimise disturbance of riparian zones and associated ecological impacts;
- the location and design of temporary and permanent surface elements avoids flood prone land (ie. land susceptible to flooding by the probable maximum flood (PMF)) where possible, or otherwise attempts to minimise exposure to flooding to reduce residual flood impacts and risks;
- the Talbingo Reservoir excavated rock emplacement will encapsulate finer TBM material with coarser drill and blast material, will include a geotextile layer, and will then be armoured with rocks with a diameter greater than 200 mm to minimise the loss of fines from the placement; and
- the Tantangara Reservoir excavated rock emplacement will be constructed as a series of cells that encapsulate TBM material within drill and blast material that would be constructed above the reservoir water level using standard 'dry' earthmoving equipment and techniques.

6.2.4 Predicted impacts

The key aspects of Snowy 2.0 Main Works that present a risk of impact to water resources, water users and sensitive receiving environments include:

- underground excavations that intercept groundwater;
- construction and use of site infrastructure;
- on-site water management and discharge;
- in reservoir works; and
- excavated rock placement.

The key impacts are described below by impact mechanism, and where appropriate by area, within the ravine, plateau, Rock Forest and Talbingo and Tantangara reservoirs as applicable. The key water-related impact mechanisms are:

- impacts to groundwater quantity, including levels and flow;
- impacts to surface water quantity, including flows and availability;
- impacts to surface water quality (excluding reservoirs);
- impacts to reservoir water quality; and
- impacts to flooding regimes.

i Impacts to groundwater quantity, including levels and flow

For the purposes of modelling groundwater, a conservative approach of simulating all excavations as fully drained (during construction) and unlined was adopted. The majority of the intercepted geological units have very low hydraulic conductivity values, and hence are predicted to contribute minimal relative inflow. However, the hydraulic properties for the Gooandra Volcanics and the Kellys Plain Volcanics are two orders of magnitude higher than adjacent geological units in the area.

The model predictions are considered conservative due to the design scenario assumptions (unlined and unmitigated) and the adoption of conservative hydraulic parameters (as per field measurements). Therefore, it is considered that the predicted inflow (and subsequent impacts) will be lower than predicted due to mitigation and management measures committed to during construction (ie pre-grouting and segmental lining).

Groundwater flow into the tunnel is expected to occur primarily as a function of secondary porosity (ie via fractures and along bedding planes). The groundwater model assumes significant connection between the tunnel and the watertable in the Gooandra Volcanics and the Kellys Plains Volcanics. However, it is expected that although parts of this unit will behave like this (ie along fault zones with enhanced permeability), the entire unit may not, and other sections of the geological unit will be much less permeable. Modelling has therefore adopted conservative hydraulic parameters due to the limited hydraulic testing undertaken throughout the unit. With additional field testing, there is potential for the modelled hydraulic parameters to be constrained, potentially reflecting a more realistic fractured rock environment.

The model cannot simulate individual fractures because the locations and conductivity of individual fractures are not known until the tunnel intersects them. Because the exact locations and extent of inflow mitigation strategies are not yet known the groundwater modelling adopted a conservative approach of simulating all excavations as non-mitigated/controlled. Attempts to 'constrain' the model to simulate unknown geological occurrences or design elements are not in-line with the Australian Groundwater Modelling Guidelines (a core requirement of NSW Governments AIP for groundwater modelling) and have therefore not been undertaken. The modelling results are therefore conservative for two reasons:

- modelling does not consider actual design, management or mitigating activities. In reality during construction the discrete fractures that yield excess water will be grouted and will reduce the actual overall tunnel inflow volume; and
- hydraulic parameters within the numerical model for the Gooandra Volcanics and the Kellys Plain Volcanics are conservative and assumes significant connection to the water table based on limited pumping test data. However, in reality the entire unit is unlikely to behave like this, with some parts expected to be much less permeable.

Therefore, the model predictions of tunnel inflow, baseflow reduction and water table drawdown are likely to be over estimating project impacts. The results of this conservative model approach need to be considered within this overall context to accurately assess the project on its true merits for impacts to water resources.

The combination of hydraulic head measurements, baseflow calculations and hydraulic property testing were used to inform calibration of the model in both steady state and transient modes. Calibration achieved a scaled root mean square statistic of 3.6% for the steady state model, and 3.9% for the transient model, which are good results.

To meet the objectives regarding both the project and environmental impacts, two predictive scenarios were produced during numerical modelling:

- a transient simulation: which considers excavation sequencing and climatic seasonality; and

- a steady state simulation: used to predict operational long term steady state impacts under a long term constant average climate.

a Ravine and plateau

Groundwater is expected to enter underground excavations during construction. Higher inflows are expected in the geological formations with higher vertical connectivity, primarily the Gooandra Volcanics and Kellys Plain Volcanics.

During operation, the tunnel will become a throughflow system, and will continue to draw water into it (eg primarily act as a 'sink'), with a very minor volume of groundwater re-entering the groundwater system. The tunnel inflow will be at a reduced rate compared to the peak inflows during construction.

The numerical groundwater model predicts that total inflow to excavations is expected to increase throughout the construction period as tunnelling progresses, with a peak at 160 L/s (5 GL/year) in the final year of construction. The gradual increase in construction inflows is a function of the excavation sequencing approach (ie more excavated areas are available for water to drain into). Once the tunnel becomes operational it will be fully saturated with water, and the overlying geology will begin to re-pressurise (and overlying groundwater levels will begin to recover). This recovery of overlying pressures and levels will not go back to 'pre-project' levels but will re-establish as a new (lower level) equilibrium. The steady state model simulates the long-term operational inflow and overlying groundwater levels.

Tunnel inflows will therefore taper following construction as the tunnel floods and enters the operational stage. Inflow during operations is predicted to reduce to approximately 85 L/s (2.7 GL/year).

The groundwater inflow to underground excavations during construction and operation is predicted to create depressurisation and drawdown of the watertable. Spatially, groundwater drawdown is predicted across the plateau; near the Tantangara adit in the east (Kellys Plain Volcanics), and from Gooandra Creek west to the LPF (Gooandra Volcanics). The spatial extent and level of predicted groundwater drawdown in both a steady state and operational scenario (ie worst case drawdown extents) are shown in Figure 6.6. It should be noted that the impact predictions are indicative and conservative, due to the model simulating unmitigated design (ie fully unlined tunnel without consideration of construction management) and the adoption of potentially conservative hydraulic parameters for the Gooandra Volcanics and the Kellys Plain Volcanics.

Figure 6.6 shows that watertable drawdown is predicted to be in excess of 50 m directly above the tunnel alignment in areas of high vertical hydraulic conductivity (Gooandra Volcanics). At a distance of approximately 2 km either side of the tunnel alignment the drawdown reduces to 0.5 m in the western plateau.

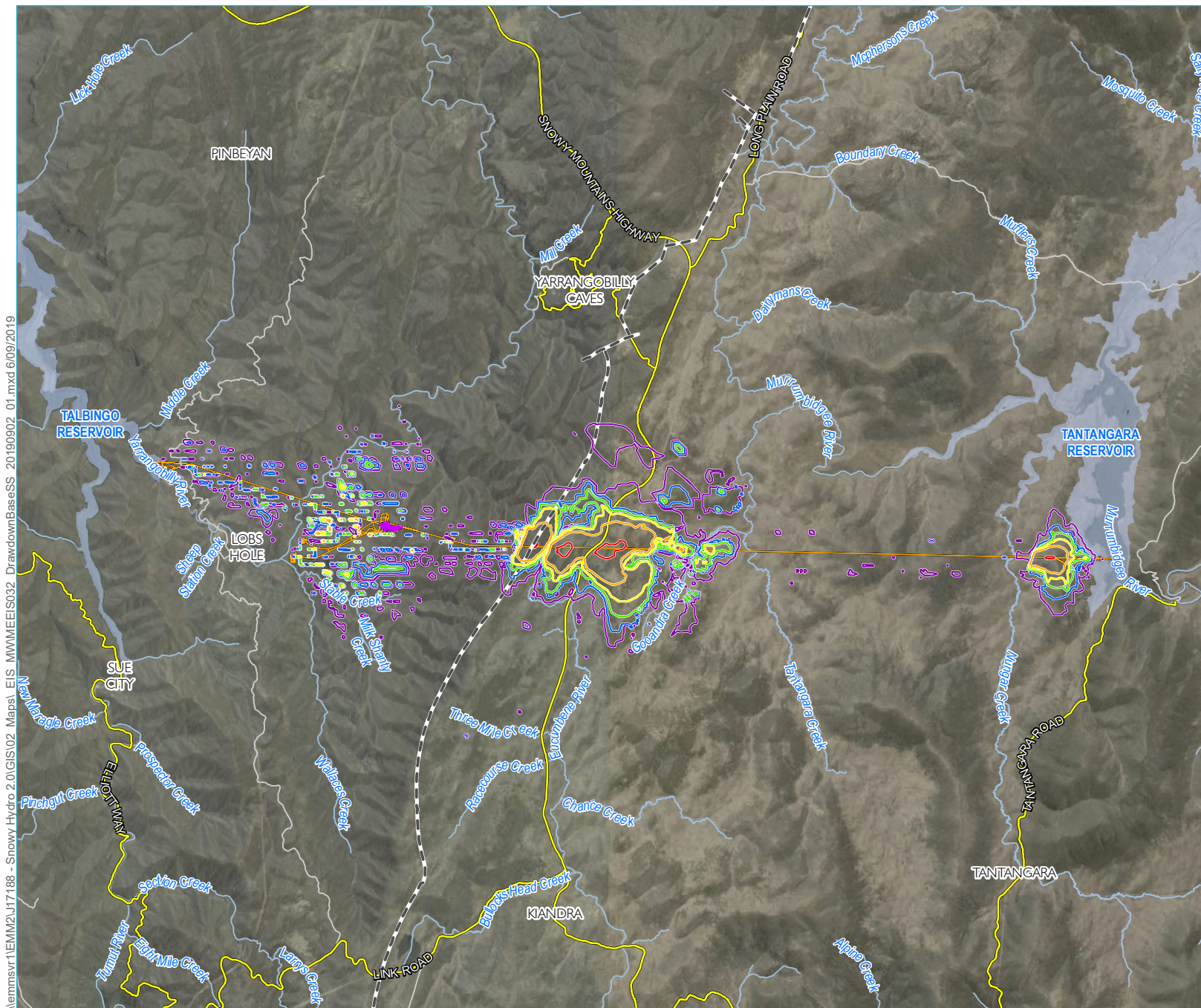
Figure 6.6 also shows that predicted drawdown in the ravine (where geological formations have low vertical connectivity) is localised with no significant cones of depression.

Due to the environmental and ecological significance of the Yarrangobilly Caves, detailed investigations were undertaken that included water level and quality monitoring programs (including detailed isotopic investigations) with a focus on understanding surface water-groundwater interaction. The groundwater model domain was also extended to ensure the Yarrangobilly Caves were included in numerical model predictions.

As shown in Figure 6.6, the predicted 0.5 m drawdown contour remains several kilometres away from the Yarrangobilly Caves. The numerical model therefore demonstrates that there are no predicted impacts to any High Priority GDE's (including the Yarrangobilly Caves) as a result of Snowy 2.0 Main Works.

b Rock Forest

There will be no underground or significant excavations at Rock Forest that would impact groundwater quantity, levels or flow during Snowy 2.0 Main Works and therefore no groundwater impacts are predicted.



- KEY**
- Modelled drawdown (m)
- 0.5
 - 2
 - 5
 - 10
 - 20
 - 50
- Long Plain Fault
- Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
 - Power station
- Existing environment
- Main road
 - Local road
 - Perennial watercourse
 - Scheme storage

Predicted steady state drawdown

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.6



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

0 2.5 5 km
GDA 1994 MGA Zone 55

ii Impacts to surface water quantity, including flows and water availability

Streamflow regime changes were estimated using a catchments model, which was developed in parallel to the numerical groundwater model. The volumetric impacts to surface water systems are largely a result of decreased groundwater levels which decrease the available groundwater baseflow to streams.

Reduction to available baseflow is considered a localised impact, as:

- it is limited to those sections of watercourses directly overlying the water table drawdown areas;
- watercourses remain gaining (ie groundwater baseflow reduces, but even impacted streams continue to receive groundwater baseflow (Figure 6.7)); and
- local lateral inflow to watercourses is a major component of stream flow, which continues to occur outside of the drawdown area (Figure 6.8).

The predicted baseflow effects are based on the numerical groundwater model predictions of inflow. Proposed localised mitigation and management of tunnel inflows during construction will reduce tunnel inflows and therefore are likely to reduce the level and extent of baseflow impact to impacted streams.

In addition, as additional field data becomes available the adoption of potentially less conservative hydraulic parameters for sections of the Gooandra Volcanics and the Kellys Plain Volcanics can be adopted which may reduce predicted impacts to baseflow further.

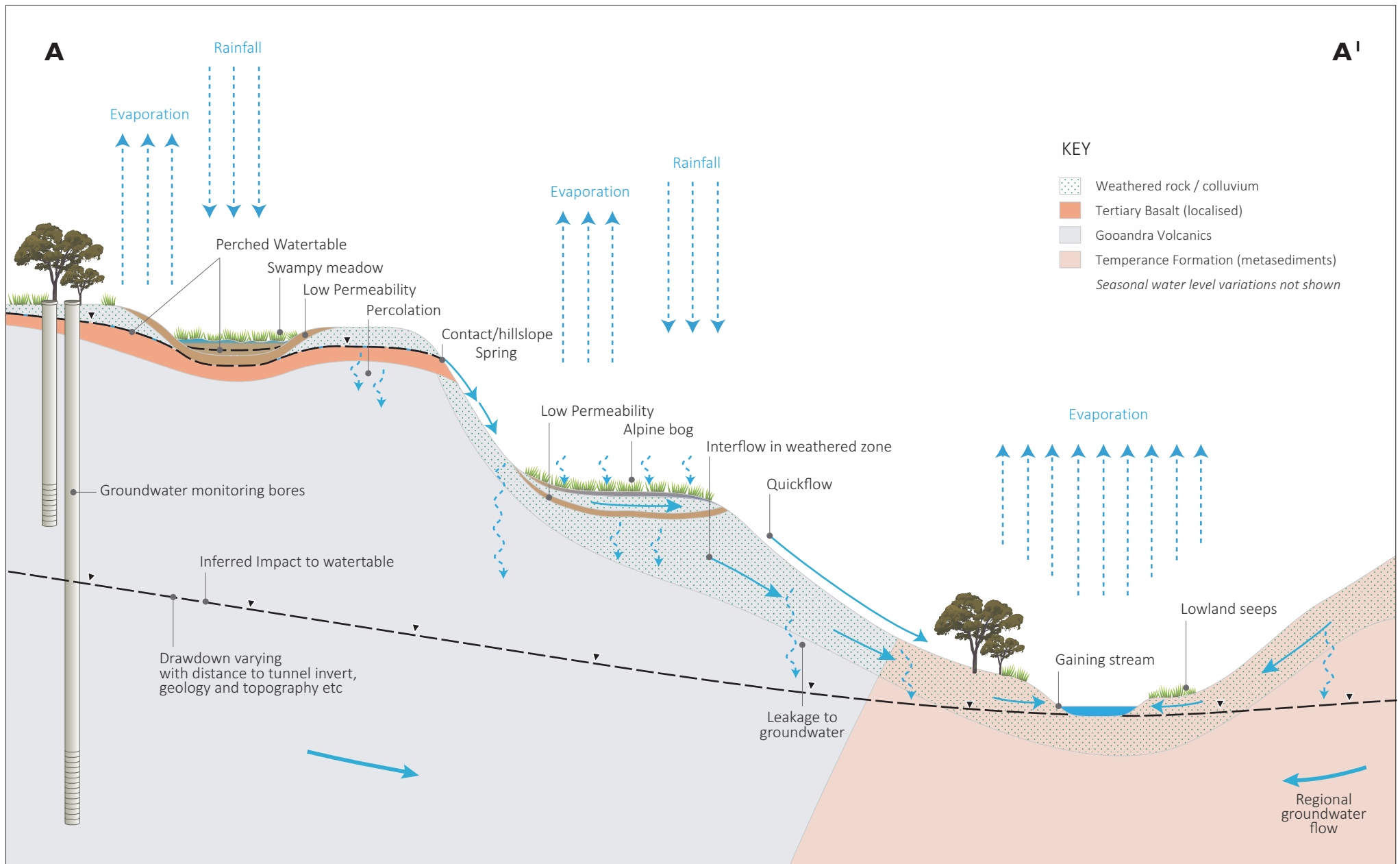
a Modelled impacts during construction

The groundwater model predicted that impacts to creek and river baseflow would develop over time, with the greatest impacts to baseflow predicted to occur post-construction. During construction the groundwater model predicted that:

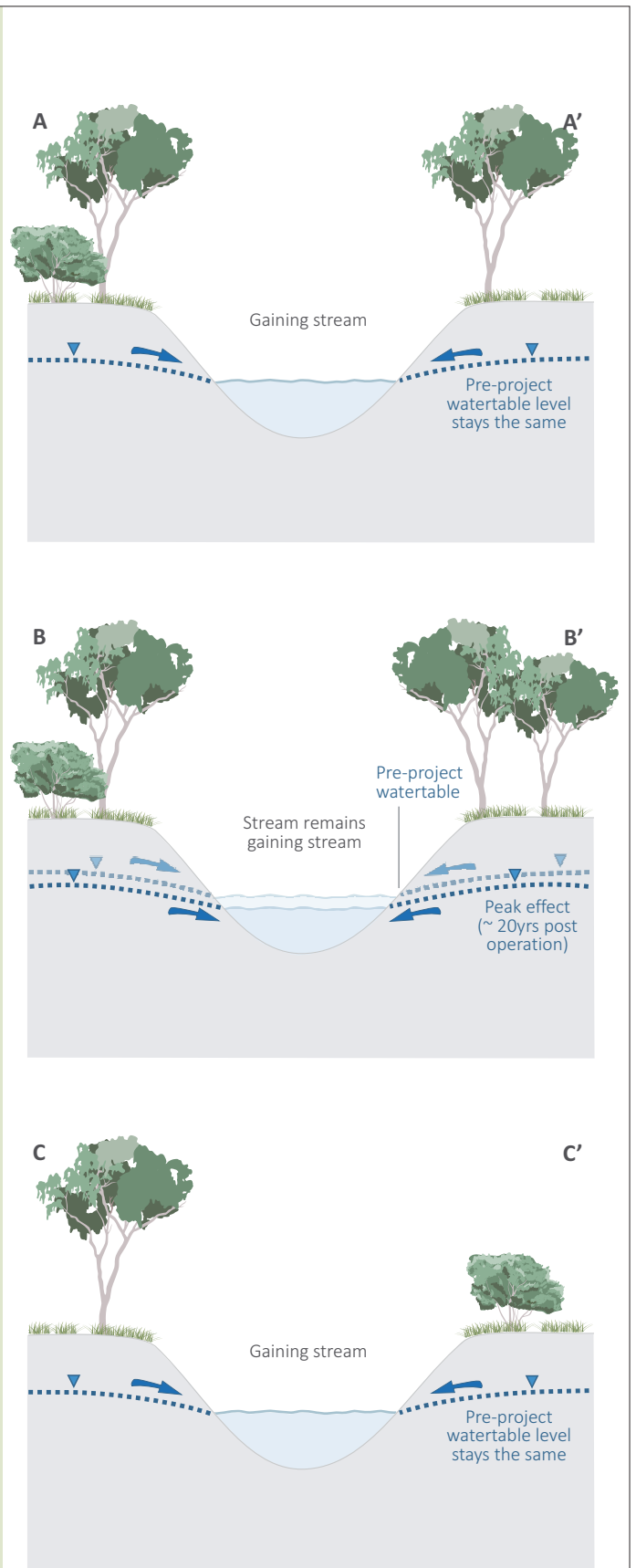
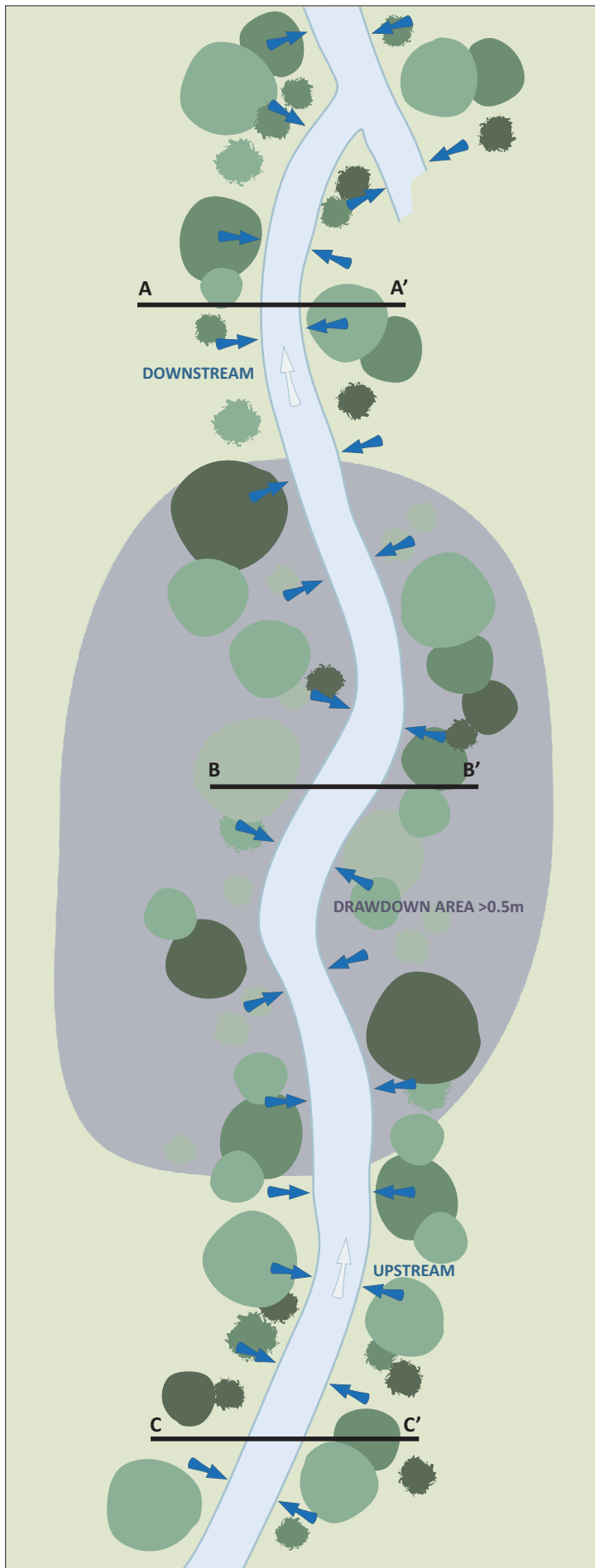
- baseflow to Gooandra Creek may decline by up to 20%, beginning in year 4 of construction. This is expected to cause no discernible changes to streamflow through winter months, however during the March – April period in the final two years of construction, available groundwater for baseflow may reduce and potentially cause flows within the Gooandra Creek catchment to cease under dry climatic conditions; and
- during construction baseflow to the upper reaches of the Eucumbene Creek may decline by up to 5%, beginning in year 5 of construction. This is not expected to cause discernible changes to streamflow during the construction period.

Immediately downstream of the localised area of impact, the percentage impact reduces significantly during construction, offset by contributions at creek and river confluences, and more information is provided on this in the next section.

As discussed earlier, the unmitigated modelled approach to construction and operations does not reflect the approach proposed for construction management (ie excludes pre-grouting and segmental lining) and as such, predicted localised impacts to baseflow are expected to reduce. The regional effects on the catchment surface water flows are considered insignificant.



Conceptual understanding of potential drawdown impacts on gaining streams – plateau



NOT TO SCALE –
CONCEPTUAL SCHEMATIC

b Modelled impacts during operation

Modelling results indicate a lag between maximum tunnel inflow and maximum baseflow impacts occurring; with peak impacts expected to occur following completion of the construction phase (ie in the operational phase of the project).

Baseflow impacts to Gooandra Creek

- within the localised area of impact, the long-term baseflow is conservatively predicted to decline by 28.8% in Gooandra Creek (again noting that the modelled predictions are based on an unmitigated scenario); and
- immediately downstream of the impact area, where the Gooandra Creek catchment and adjoining catchments enter the Tantangara Reservoir, the percentage impact of baseflow reduction is predicted to be 0.7% and as such, is considered insignificant at a broader regional scale.

Baseflow impacts to Eucumbene River

- within the localised area of impact, the long-term baseflow is conservatively predicted to decline by 12.5% in the upper reaches; and
- immediately downstream of the impact area, just upstream of where the river enters the Eucumbene Reservoir, the percentage impact of the baseflow reduction is only 0.6% and considered insignificant at a broader regional scale.

The groundwater model predicts that each creek would continue to receive baseflow discharge; no creek sub-catchment was predicted to change from 'gaining' to 'losing' during long term operations. Subsequently, it is expected that impacts will be limited to baseflow reductions (ie no streamflow losses), and the quickflow component of streamflow (surface runoff in response to rainfall) will not be affected by groundwater drawdown.

Freshes and floods are important for stream health and are primarily driven by quickflow response to heavy rain. The frequency of freshes and floods is not predicted to be affected by the predicted changes to baseflow.

The water licencing requirement for the changes to baseflow is to attribute it to the water source from which it derives (as per the AIP). Due to the streams remaining gaining (even under peak impact), the source of water is therefore groundwater and it is proposed to be licenced as such.

Streamflow impacts

Streamflow impacts were predicted to be directly experienced at sites immediately downstream of the impacted headwater sub-catchments in Gooandra Creek and the Eucumbene River (Figure 6.6). This is particularly the case in dry climatic conditions and during summer and autumn, when groundwater baseflows provide the majority of total flow. The streamflow impacts due to reduced available groundwater for baseflow immediately lessen in the river reaches immediately downstream of these sites, because they receive flow from unaffected catchment areas and from unaffected lateral baseflow that is not impacted by the project (Figure 6.8).

Proposed localised mitigation and management of tunnel inflows during construction (ie pre-grouting and segmental lining) will reduce tunnel inflows and are therefore likely to reduce the level of baseflow impact to these streams.

River flow objectives, as defined by the NSW Government for the management of environmental flows and set out aspects of flow considered to be critical for the protection or restoration of river health, ecology and biodiversity, were utilised to define high flows, low flows and very low flows. In addition to these flow categories, a 'no flow' category was also assessed such that zero flow was assumed to occur for modelled flows less than 0.1 ML/day.

Using these flow categories, the percentage of modelled days within each flow category under the construction phase and under the operating phase of Snowy 2.0 Main Works were calculated for the impacted surface water reporting sites in Gooandra Creek and Eucumbene River.

The model predicts the following impacts to streamflow regimes during the operational phase of Snowy 2.0 Main Works:

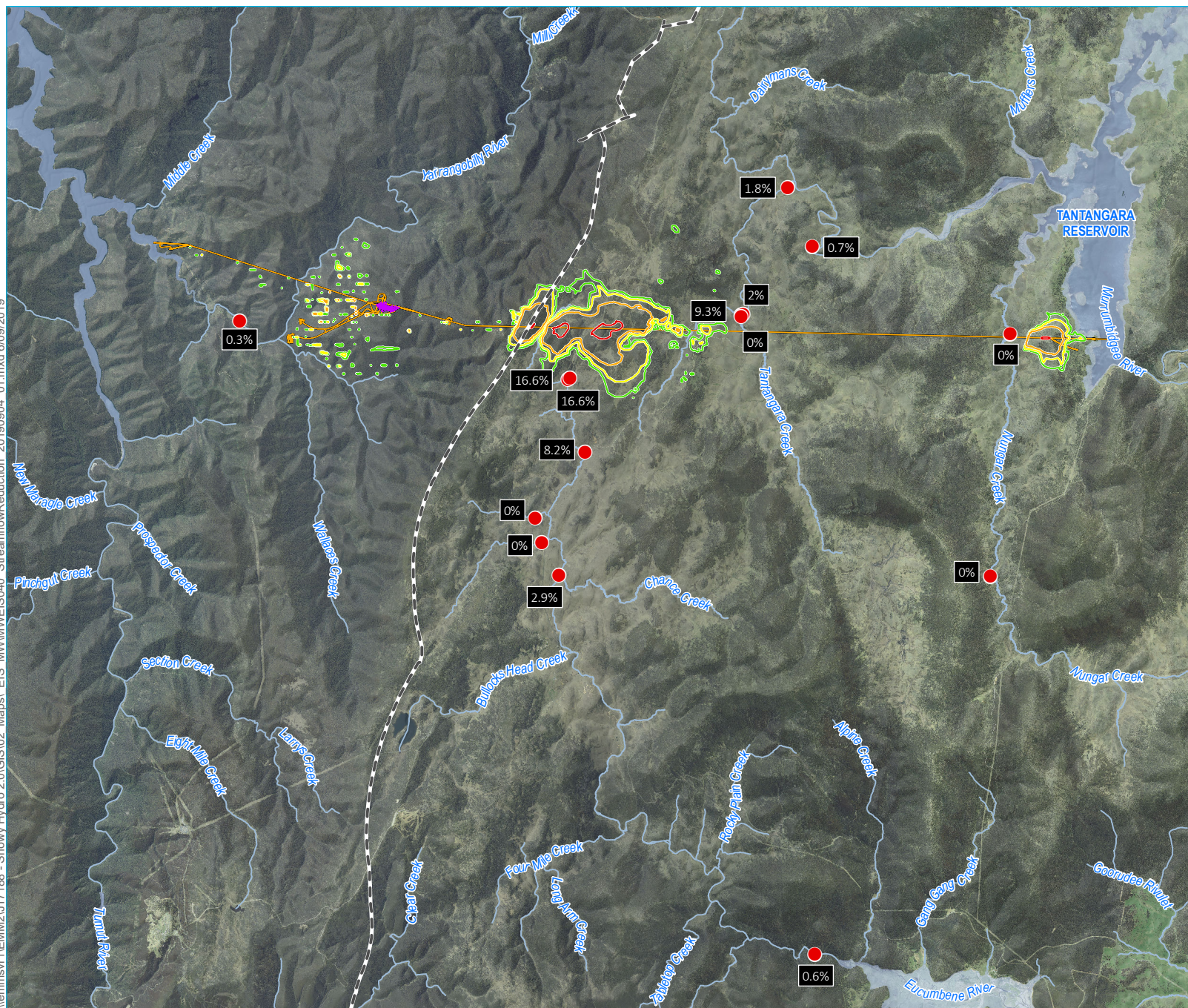
- Gooandra Creek is likely to change from a perennial streamflow regime to ephemeral (days with 'no flow' increase from 0% to 9%);
- in Gooandra Creek, days with no flows and very low flows increase, particularly in summer and autumn and the number of days with low, medium and high flows decrease correspondingly;
- flows from the unaffected Tantangara Creek catchment area would alleviate impacts in the river reaches downstream of Gooandra Creek ; and
- the streamflow regime in the headwaters of the Eucumbene River could change from perennial to ephemeral (days with 'no flow' increase from 0% to approximately 20-25%), however this impact does not continue downstream, as flows from the catchment area unaffected by the project alleviate the impact.

iii [Impacts to surface water quality \(excluding excavated rock emplacement\)](#)

The key water cycle interfaces, showing the locations of the key aspects of the water management system relative to key construction phase project areas and activities are provided in Figure 6.10.

Surface water quality impacts have the potential to occur to both watercourses and to reservoirs.

\\lemmsvr1\EMM2\U17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS M\MMWE\IS040 StreamflowReduction 20190904 01.mxd 6/09/2019

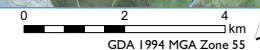


- KEY**
- Reporting points
 - Modelled drawdown (m)
 - 5
 - 10
 - 20
 - 50
 - Long Plain Fault
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Perennial watercourse
 - Scheme storage

Long term total streamflow reduction

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Figure 6.9

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



a Impacts to watercourses

It is proposed to discharge all treated process and wastewater directly to Talbingo and Tantangara reservoirs, hence stormwater discharges are considered the only discharge mechanism that could impact watercourses. A residual water quality impact assessment was undertaken factoring in all construction activities, discharge characteristics, area, locations and duration of disturbance.

This assessment indicated that there is potential for measurable changes in water quality to occur during construction and that changes will most likely occur for several days during and shortly after wet weather conditions. Only minor changes are predicted during operations.

Factoring all of the above, the potential for changes from stormwater discharge is considered proportionally greater:

- during the initial 1.5 years of construction when the greatest area of disturbance and poorest water quality will occur due to surface construction activities;
- in watercourses that have small catchment areas relative to the disturbance within the catchment; and
- in summer and autumn during moderate rainfall conditions, when discharges from the stormwater system may occur but there is insufficient rainfall to generate runoff from the broader catchment.

The potential for changes from stormwater discharge is considered proportionally lower:

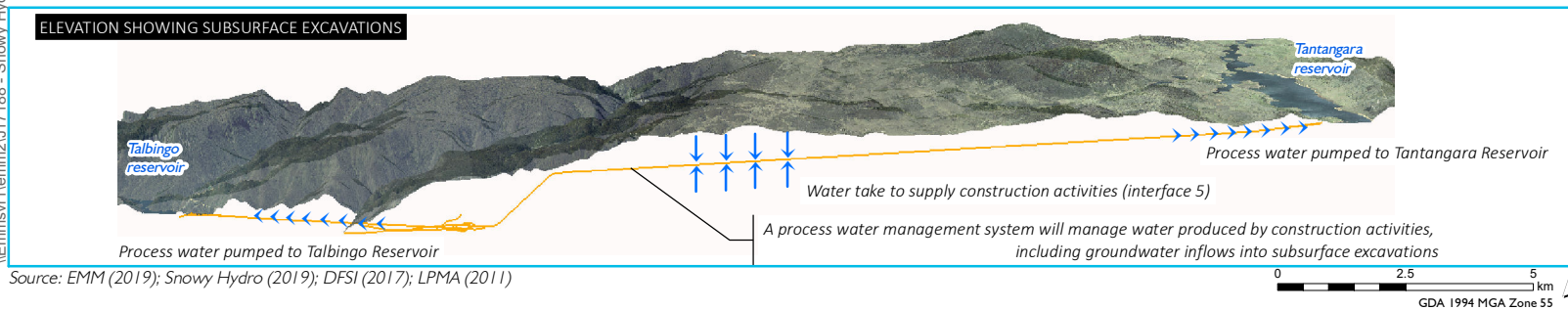
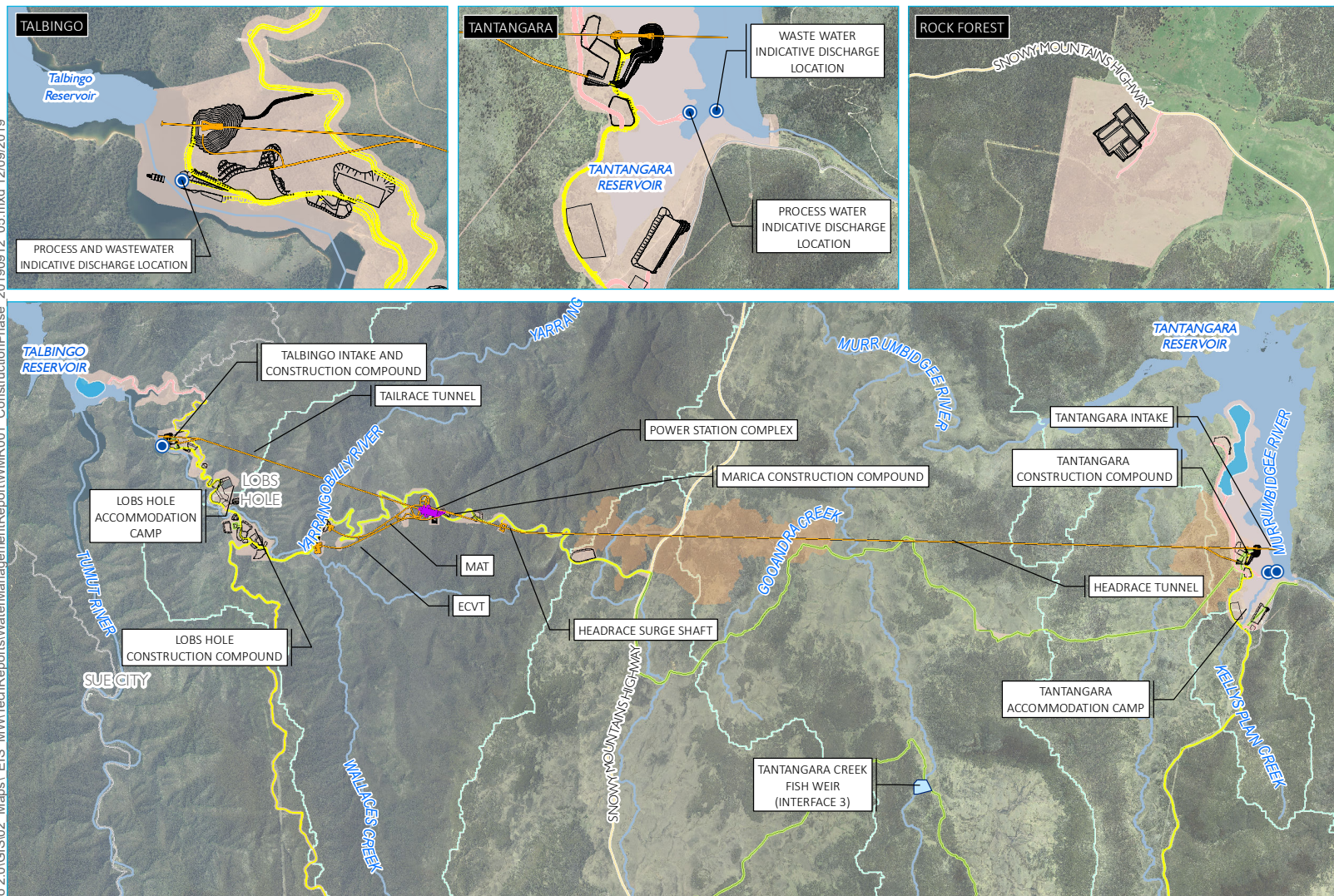
- following the initial 1.5 years of construction when disturbance due to construction of surface infrastructure is complete;
- in watercourses that have large catchment areas relative to disturbance within the catchment;
- in winter and spring when streamflow is seasonally high; and
- in summer and autumn during significant rainfall events that result in high streamflow.

b Impacts to reservoir water quality during construction (excluding excavated rock emplacement)

The following impact mechanisms (not related to excavated rock emplacement) have potential to change reservoir water quality during construction:

- stormwater discharges into watercourses that flow into reservoirs;
- controlled discharges of treated wastewater and process water directly to reservoirs; and
- underwater removal of the intake rock plug and channel excavation resulting in the formation of turbid plumes in the reservoir.

The predicted impacts of these activities and mechanisms are described in the following sections.



Water cycle interfaces - construction phase

Snowy 2.0
Environmental Impact statement
Main Works
Figure 6.10



Stormwater discharges and controlled process and wastewater discharges

There is potential for measurable changes in reservoir water quality to occur during construction. The greatest increase in nutrient loads entering the reservoirs is expected to occur during the initial construction period due to stormwater discharges from areas disturbed by construction activities.

Changes to salinity levels may occur due to the discharges of treated process water and wastewater that have salinity levels that are higher than ambient levels in the reservoirs. Changes to water quality are most likely to occur near discharge locations.

Intake structure - rock plug removal and channel excavation

The methodology for the construction of the intake structures for both reservoirs is outlined in section 2.3. While the primary construction method will be drill and blast from shore-based plant and equipment in dry conditions, the key activity with the potential to impact on reservoir water quality will be the removal of the connection between the intake and reservoir (rock plug). This plug will be removed via water-based equipment, with some underwater blasting and/or dredging.

The impacts of rock plug removal and channel excavation in Talbingo Reservoir will be dependent on the methods used and the duration of these activities. The water quality impacts from the removal of the plugs have not been quantified for either reservoir, however in Talbingo, given that the volume of plug material to be removed will be small (approximately 2-3%) compared to the volume of excavated material placed in the Ravine Bay, with the implementation of appropriate management measures, the impacts of rock plug removal and channel excavation on water quality are expected to be small in comparison.

c Impacts to reservoir water quality during commissioning and operation (excluding excavated rock emplacement)

The following impact mechanisms (not related to excavated rock emplacement) have the potential to change reservoir water quality during commissioning and operation:

- bed sediment disturbance; and
- mixing of water between the reservoirs.

The predicted impacts of these mechanisms are described below.

Bed sediment disturbance during commissioning and operation

In Talbingo Reservoir, both the fine settled material from the construction phase and the existing reservoir sediments in Middle Bay, downstream of the intake works, and over large areas of Ravine Bay, would be expected to be disturbed by generation and pumping flows. Rock sized greater than 200 mm will be placed on the upper slope of the Ravine Bay emplacement as armouring and will not be disturbed by these flows and, if the drill and blast material on the lower part of the slope is greater than 8 mm, it is also predicted not to be disturbed.

In Tantangara Reservoir, the existing reservoir sediments within the intake channel and areas directly offshore and adjacent (mostly to the north) would be expected to be disturbed by generation and pumping flows. The Tantangara Reservoir excavated rock emplacement will be well to the north of the intake structure and will not be intersected by generation and pumping flows to any material extent.

Mixing of water between the reservoirs during operation

The construction and commissioning impacts described above will cease at the end of these phases or gradually decrease over time. Over the long-term (years to decades), the primary impact on water quality in the reservoirs will be changes due to the mixing of the water between the reservoirs.

These changes may not be deleterious but will result in a new dynamic equilibrium being established in both reservoirs and most likely with a larger change in the water quality of Tintangara Reservoir than in Talbingo Reservoir. This is because Tintangara Reservoir does not currently receive water from Talbingo Reservoir, and as its total volume is smaller and so transferred water will make up a larger portion of the total volume.

While it is desirable to accurately predict what these changes will be, only broad conclusions can be drawn as the water quality in each of the reservoirs will depend on the transfer regime and the transfer regime will vary widely depending on Snowy Hydro operational decisions and planning within the highly competitive NEM. All of these many factors will continuously vary, such that it is not possible to predict the transfer of water between the reservoirs or the resulting change in water quality in the reservoirs during the operation of Snowy 2.0. Further, there are such a large range of independent factors that the scenarios that combine various states for each factor are effectively limitless.

However, some general predictions may be made regarding potential changes to water quality from the mixing of water between the reservoirs during operation:

- water levels have varied widely in the reservoirs will continue to vary widely;
- as the Tintangara Reservoir active storage is approximately 93.9% of the gross storage (ie the maximum volume of water that may be transferred between the reservoirs), the potential for water temperature change is higher in Tintangara Reservoir than in Talbingo Reservoir where active storage is approximately 17.3% of the gross storage but that these changes cannot be predicted in the absence of an accurately forecast of water transfers; and
- based on 2018–2019 water quality monitoring and default guideline values, mixing of the reservoir waters during operations is unlikely to significantly impact pH, electrical conductivity, turbidity, dissolved oxygen concentration (except as a result of temperature changes); nutrients and metals (with the exception of aluminium and copper where a few measured concentrations indicated that the concentrations may be different between the reservoirs and which requires further monitoring).

iv Impacts to reservoir water quality from excavated rock emplacement

The key mechanisms with the potential to impact reservoir water quality from excavated rock emplacement are:

- release of suspended solids during construction of the Ravine Bay excavated rock emplacement in Talbingo Reservoir and changes to the reservoir water quality due to interactions between the water and suspended sediment (excavated rock particles) during construction;
- runoff from the parts of the excavated rock emplacements that are above water during intense rainfall resulting in erosion and sedimentation during construction and operations;
- wave erosion of the emplacement outer surfaces during construction and operations; and
- water infiltration into the excavated rock emplacements from: upslope runoff (Tintangara Reservoir only), rainfall, and water movement into submerged parts of the emplacements leading to seepage from the emplacement or directly into reservoir water during construction and operations.

The predicted impacts of these mechanisms are described below.

a Release of suspended solids during construction of the Ravine Bay excavated rock emplacement

The Ravine Bay excavated rock emplacement will expand from the shore as excavated rock is placed over the advancing face into the reservoir. The excavated rock will travel down the submerged slope of the emplacement until it reaches the bottom or comes to rest on the slope. As the material travels down the slope, fine sediments will be released into the water column. These suspended sediments will form a turbid plume that will then disperse.

As the turbid water moves away from the area where it was generated, the turbidity in the reservoir surface water will be minimised by a silt curtain surrounding the emplacement area. The silt curtain will not extend to the bed of the reservoir, so currents will carry some of the suspended sediment beyond the silt curtain into the body of the reservoir.

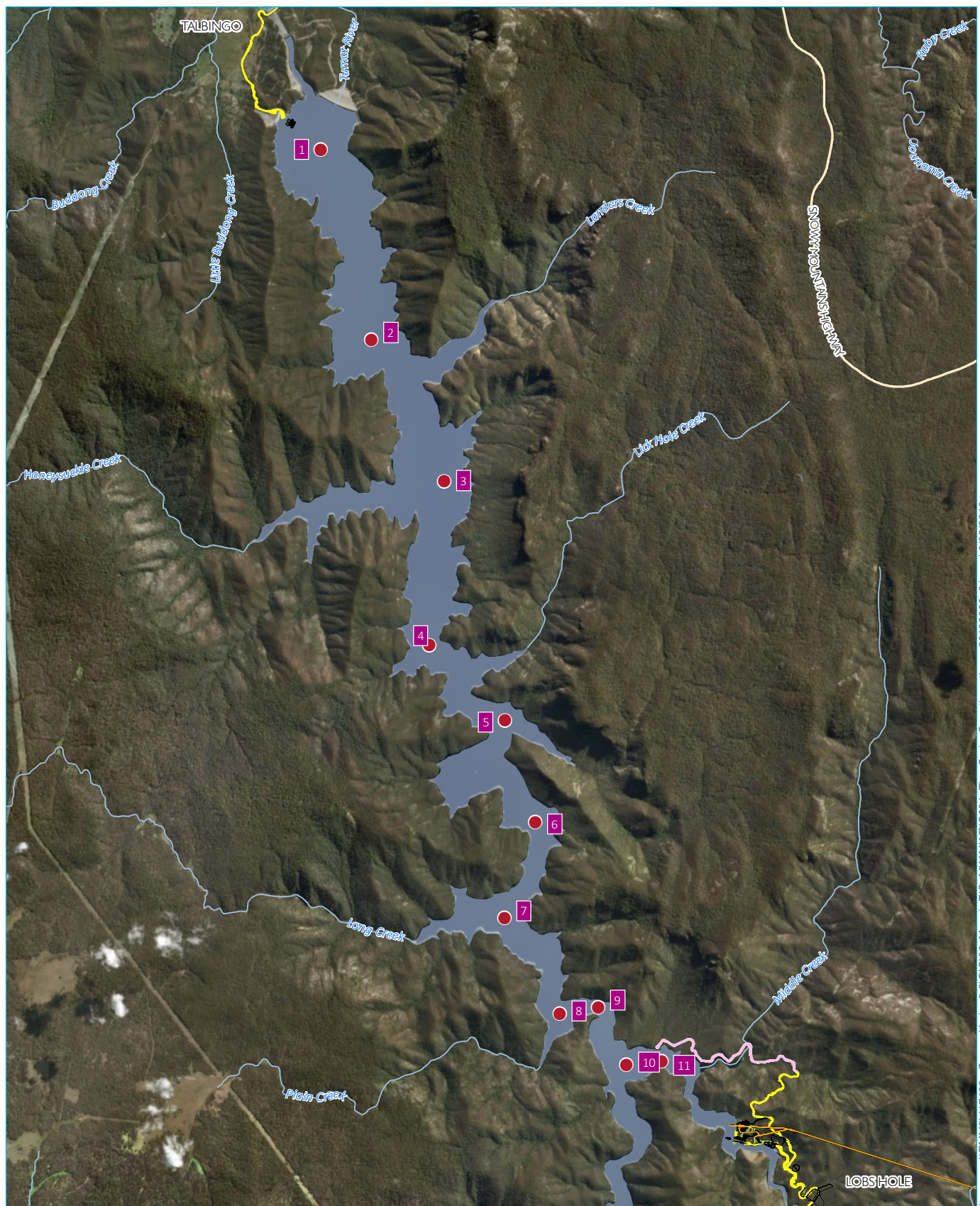
Suspended sediment will interact with the reservoir water with the key stressors of potential concern (SOPC) and contaminants of potential concern (COPC) being TSS/turbidity; pH; electrical conductivity; and aluminium. The primary stressor of concern, TSS/turbidity, is discussed below, as is aluminium, as a mixing zone is proposed.

TSS/turbidity

The Ravine Bay emplacement will take about 2 years to construct. The maximum predicted TSS concentrations across the reservoir were modelled over the placement period and the following year (ie for 3 years in total). The locations of the modelling results in Talbingo Reservoir are shown in Figure 6.11.

The maximum TSS concentration within the silt curtains surrounding the placement area is predicted to be high, up to 2,700 mg/L. The TSS concentrations at the surface at locations 1, 4, 9 and 11 are compared to baseline TSS concentrations, baseline turbidity and ANZECC/ARMCANZ (2000) default guideline values in Table 6.1.

It is predicted that TSS concentrations will be highest close to the Ravine Bay placement area and will decrease moving north along the reservoir, with the annual median surface TSS concentration decreasing from 18 mg/L in the Yarrangobilly Arm to 6 mg/L adjacent to the dam wall.



Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011); RHDHV (2019)

KEY

- | | |
|--|-------------------------|
| ● Time series output location | Existing environment |
| Snowy 2.0 Main Works operational elements | — Main road |
| — Tunnels, portals, intakes, shafts | — Perennial watercourse |
| — Utilities | ■ Scheme storage |
| — Permanent road | |
| Snowy 2.0 Main Works construction elements | |
| — Temporary construction compounds and surface works | |
| — Temporary access road | |

Time series output locations

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.11



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Table 6.1 Predicted TSS concentrations and turbidity during placement at representative reservoir locations

Location		Predicted TSS concentration (mg/L)			Predicted turbidity (NTU) ⁴		
		Annual	Warming ¹	Cooling ¹	Annual	Warming	Cooling
Talbingo Reservoir background level (2018–2019)		<1–6 mg/L ²			1–5 NTU ⁵		
Default guideline value		– ³			1–20 NTU ⁶		
11 Yarrangobilly Arm, approximately 500 m of placement area	Median	18	43	9	39	61	28
	Maximum	80	80	70	83	83	78
9 Approximately 1 km north of placement area	Median	7	18	7	24	39	24
	Maximum	31	31	25	52	52	46
4 Adjacent Lick Hole Creek, approx. half-way along the reservoir	Median	8	15	5	26	36	20
	Maximum	26	26	22	47	47	43
1 Adjacent the dam wall	Median	6	10	3	22	29	<20
	Maximum	16	16	14	37	37	34

Notes: 1. Warming period: 13 November to 4 May (summer), Cooling period: 5 May to 12 November. Assumes placement starts on 5 May and continues for 2 years.
2. Based on discrete water quality samples collected from Talbingo Reservoir (2018–2019). Increases to background TSS concentrations are presented.
3. There is no default ANZECC/ARMCANZ (2000) TSS guideline value.
4. Assuming turbidity = $9.0649 \times \text{TSS}^{0.506}$ for Ravine Beds (EIS Appendix L, The excavated rock placement assessment summary (RHDHV 2019)).
5. Time-series results from moorings in Talbingo Reservoir (2018–2019), 1st-percentile to 99th-percentile.
6. Default turbidity guideline value for freshwater lakes and reservoirs in South-Eastern Australia (ANZECC/ARMCANZ 2000).

The reservoir water column becomes stratified (warmer surface waters overlying cooler deep water) as the reservoir warms from early November to early May. This stratification can trap suspended sediments in the surface layer, increasing surface TSS concentrations. Whereas in the longer cooling period from early May to early November, suspended sediments are generally mixed through the water column. For example, the median surface TSS in the Yarrangobilly Arm is predicted to be 43 mg/L for the five warming months and 9 mg/L for the seven cooling months and the median surface TSS adjacent to the dam wall is predicted to be 10 mg/L for the warming months and 3 mg/L for the cooling months.

The maximum surface TSS concentrations are predicted to peak in the second half of the warming period and rapidly decrease as the reservoir cools but will remain above the very low background TSS concentrations in the reservoir.

The TSS concentrations have been modelled. However, there is no default ANZECC/ARMCANZ (2000) TSS guideline value. Instead TSS concentrations have been converted to turbidity values to allow comparison to the default ANZECC/ARMCANZ (2000) turbidity guideline values for freshwater lakes and reservoirs in South-Eastern Australia (1–20 NTU). The relationship between TSS concentration and turbidity for excavated rock particles suspended in reservoir water has been determined as part of the settling tests in reservoir water (EIS Appendix L, The excavated rock placement assessment summary (RHDHV 2019)).

The TSS concentration (in mg/L) and turbidity (in NTU) are similar when the TSS concentration is greater than 50 mg/L. For example, Ravine Bed sediment remaining suspended in reservoir water at 50 mg/L has a turbidity of 66 NTU. However, low TSS concentrations result in comparatively high turbidity values due to the very fine suspended clay-sized particles. For example, Ravine Bed sediment suspended in reservoir water at 10 mg/L would have a turbidity of about 29 NTU. This relationship is not well characterised below about 5 mg/L/20 NTU (ie the upper default guideline value). Based on the derived relationship for Ravine Bed sediment, it is predicted that the turbidity will exceed the default guideline throughout the reservoir.

Surface TSS concentrations and turbidity will return to close to background levels within approximately 8 months of the completion of the Ravine Bay excavated rock emplacement.

Sediment deposition

The vast majority of excavated rock discharged in the Talbingo placement area will travel down the slope of the emplacement and deposit within the emplacement footprint. However, some of the suspended sediment dispersed in the reservoir will settle to the bed of the reservoir.

Current sediment deposition rates have been estimated based on the examination of sediment cores collected from Talbingo Reservoir. Current annual sediment deposition rates in parts of the Yarrangobilly Arm have been estimated to be 5–15 mm/year, while it is estimated that very little sediment deposition (<1 mm/year) currently occurs in the rest of the reservoir.

During construction, it is predicted that sediment deposition rates will be:

- highest (above 150 mm/year) closest to the placement location;
- 7–45 mm/year in the southern half of the reservoir; and
- 2–15 mm/year in the northern half of the reservoir; and
- higher in shallow parts of the reservoir (ie reservoir edges) than in the deeper parts.

Sediment discharged from the reservoir

The predicted TSS concentration at Location 1 is representative of the TSS concentration that will be discharged from the reservoir via the T3 Power Station. This indicates that water with an annual median TSS concentration of 6 mg/L, with a maximum up to 16 mg/L, will be discharged at times via the T3 Power Station during the 2-year construction period. It is predicted that a total of 16,021 tonnes of suspended sediment will be discharged from Talbingo Reservoir in total, representing about 0.21% of placed material.

Aluminium

Mixing excavated rock particles in reservoir water is predicted to result in aluminium concentrations that exceed baseline and default guideline values close to the emplacement area.

Analysis of aluminium concentrations predicted from excavated rock placement in Talbingo Reservoir found that the default trigger value for slightly to moderately disturbed ecosystems (55 µg/L) may not be met immediately outside of the silt curtain around the placement area, but is estimated to be met 500 m from the silt curtain. Therefore, a mixing zone 500 m from the silt curtain would be required to meet the default guideline value for aluminium.

b **Runoff from the parts of the excavated rock emplacements that are above water**

There is expected to be runoff from parts of the excavated rock emplacement areas that are above the reservoir water levels, both at Tantangara Reservoir and to a lesser extent Talbingo Reservoir, where the majority of the excavated rock will be placed.

The armouring of the excavated rock emplacement at both Talbingo and Tantangara reservoirs will minimise surface erosion during intense rainfall for areas above the reservoir water level and will also minimise the potential for waves to scour the excavated rock, so that the emplacements will behave similarly to the existing parts of the reservoir shores that are covered by rocks.

v **Impacts to flooding regimes**

The key flood impact mechanisms that were considered are associated with:

- locating temporary and/or permanent surface infrastructure on flood prone land (ie land susceptible to flooding by the PMF), including instream works and works on the adjacent floodplain;
- placement of excavated material in Talbingo and Tantangara reservoirs, which may reduce the volume of reservoir storage available during flood events; and
- operation of permanent infrastructure for power generation and pumped storage, which may also reduce the volume of reservoir storage available during flood events.

The key outcomes of the flood risk assessment were as follows.

a **Ravine**

Temporary and permanent surface infrastructure will unavoidably need to be constructed on flood prone land in the ravine area, particularly around Lobs Hole. This includes temporary infrastructure and construction support sites (eg associated with construction phase works, such as the accommodation camp and main yard) and permanent infrastructure (eg infrastructure associated with ongoing operation, such as roads, bridges and tunnel portal sites and buildings).

Flood modelling was undertaken to predict changes to existing flooding characteristics along the Yarrangobilly River in Lobs Hole as a result of proposed construction phase works. Whilst the spatial extent and magnitude of impacts is extensive throughout Lobs Hole, in particular for floods of 1% AEP and above, these impacts are not anticipated to impact on existing infrastructure or other areas of significance, and the design of temporary works can accommodate the changed flooding characteristics.

Several sites, including the accommodation camp, will be established predominantly above PMF levels so they can function as flood refuges for the construction workforce.

Flooding impacts in Lobs Hole are anticipated to be reduced during the operational phase, relative to the construction phase, as a result of rehabilitation works and associated permanent landform changes.

No significant change to flooding characteristics for Talbingo Reservoir is anticipated as the volume of excavated material to be placed within the reservoir is very small in comparison to the existing storage volume.

b Plateau

Proposed temporary surface infrastructure in the vicinity of Kellys Plain Creek (eg accommodation camp and stockpile area), largely avoids flood prone land and therefore will not impact on existing flooding characteristics. Minor increases to peak flood levels along Kellys Plain Creek are expected to occur from the proposed upgraded road crossing of this watercourse, however these impacts would be localised and are not anticipated to impact on infrastructure or other areas of significance.

No significant change to flooding characteristics for Tantangara Reservoir is anticipated as the volume of excavated material to be placed within the reservoir is small in comparison to the existing storage volume.

c Rock Forest

This site will be used only during construction of the project and proposed temporary surface infrastructure largely avoids flood prone land and therefore will not impact on existing flooding characteristics.

6.2.5 Mitigation measures

Proposed mitigation measures to reduce or mitigate impacts of the construction and operational activities of Snowy 2.0 Main Works on water resources and receivers are provided in Table 6.2.

Table 6.2 Mitigation measures for water impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
General	WM01	<p>A Water Management Plan will be developed for Snowy 2.0 Main Works that includes:</p> <ul style="list-style-type: none">• proposed mitigation and management measures for all construction water management categories;• spill management and response;• a surface and groundwater monitoring program;• water quality trigger levels;• reporting requirements;• corrective actions;• contingencies; and• responsibilities for all management measures. <p>The WMP will be prepared in consultation with DPIE, EPA, WaterNSW and key local stakeholders, and would consider concerns raised during the exhibition and approvals process for the project.</p>	Construction	Contractor
General	WM02	<p>A water monitoring program will be developed as part of the water management plan to monitor quality and quantity impacts to surface water, groundwater and reservoirs.</p> <p>The water monitoring program will incorporate and update the existing monitoring network and detail monitoring frequencies and water quality constituents.</p>	Construction and operation	Contractor
Water quality impacts from stormwater runoff	WM03	<p>Where practical, clean water will be diverted around or through construction areas. Runoff from clean water areas that cannot be diverted will be accounted for in the design of water management systems.</p>	Construction	Contractor

Table 6.2 Mitigation measures for water impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Water quality impacts from stormwater runoff	WM04	An Erosion and Sediment Control Plan (ESCP) will be prepared for each construction area that will include relevant information presented in the water management report (Annexure D to water assessment)	Construction	Contractor
Water quality impacts from stormwater runoff	WM05	A suitably qualified erosion and sediment control professional(s) will be engaged to: <ul style="list-style-type: none"> • oversee the development of ESCPs; • inspect and audit controls; • train relevant staff; and • progressively improve methods and standards as required. 	Construction	Contractor
Groundwater modelling	WM06	The groundwater model developed for Snowy 2.0 Main Works will be validated and, if necessary, recalibrated to new groundwater monitoring data as the monitoring record increases throughout construction. It is recommended that assessment of the monitoring record and groundwater affecting activities, along with model updates, be undertaken at least annually throughout construction and into operation until it is evident that the update frequency can be reduced.	Construction and operation	Contractor Snowy Hydro
Groundwater inflow / drawdown	WM07	Where discrete high flow features are intercepted, pre-grouting and secondary grouting from the TBM may be undertaken to enable tunnel construction.	Construction	Contractor
Water supply	WM08	A water supply system will be established to supply water for potable water use and construction activities. The system will most likely source water from regional groundwater resources, but may also source water from either Tantangara or Talbingo Reservoirs provided licences are available. Extraction from watercourses will be avoided. The most suitable extraction locations and water sources will be established during detailed design	Construction	Contractor Snowy Hydro
Reservoir water quality (wastewater management)	WM09	A wastewater management system will be established to manage effluent from construction compounds and accommodation camps. All wastewater will be treated to meet the water quality specifications provided in the water management report (Annexure D to water assessment) and will be discharged to reservoirs. Wastewater discharges to watercourses will be avoided.	Construction	Contractor
Reservoir water quality (process water management)	WM10	A process water management system will be established to manage water from subsurface excavations and large surface excavations during construction; and to supply water to construction activities. All surplus process water will be treated to meet the water quality specifications provided in the water management report (Annexure D to water assessment) and will be discharged to reservoirs. Process water discharges to watercourses will be avoided.	Construction	Contractor

Table 6.2 Mitigation measures for water impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Changes to reservoir water quality due to plug removal within the reservoirs	WM11	The specifications and locations of the proposed environmental measures will be determined as part of detailed design, including the installation of silt curtains. They will be designed such that water quality criteria is agreed with the regulators, with the application of a mixing zone if required.	Construction	Contractor
Reservoir bed sediments are disturbed by commissioning water flows	WM12	Investigations to minimise the disturbance of bed sediments due to water flows during commissioning will be undertaken as part of detailed design. Potential measures to minimise the disturbance of bed sediments include: <ul style="list-style-type: none"> • investigate mitigated design measures; • dredging sediments from the potential disturbance zones and placing them in another part of the reservoir; and/or • armouring the sediments in the potential disturbance zones. These options are currently being assessed.	Construction	Contractor Snowy Hydro
Flooding	WM13	Further consideration of flooding conditions and impacts, including flood modelling where necessary, will be undertaken to support future detailed design of both temporary and permanent works.	Construction Operation	Contractor Snowy Hydro
Flooding	WM14	Flood emergency response plans will be developed for both construction and operational phases	Construction Operation	Contractor Snowy Hydro

6.2.6 Summary and conclusion

Construction and operational activities associated with Snowy 2.0 Main Works have potential to impact on surface and groundwater levels and quantities, surface water quality (including watercourses and reservoirs) and to flooding regimes.

There is potential for measurable changes to surface water quality to occur in watercourses during the construction phase of the project, generally during the initial 18 months when the greatest area of disturbance and poorest water quality will occur due to surface construction activities. Measures will be implemented by the contractor to minimise impacts.

The water quality in Talbingo Reservoir will be also be impacted during the construction of the Ravine Bay excavated rock emplacement over two years, primarily as a result of increased turbidity, but is predicted to return to baseline levels over the following 8 months.

Mitigation measures will be implemented in the form of grouting to minimise groundwater inflows to subsurface excavations, which will reduce impacts to groundwater drawdown and in turn reduce baseflow and streamflow impacts to Gooandra Creek and Eucumbene River. No High Priority GDEs (including the Yarrangobilly Caves) will be impacted as a result of Snowy 2.0 Main Works.

While local effects will likely occur as a result of the project, the regional effects on the catchment surface water flows, catchment water quality and regional groundwater resources are insignificant.



CHAPTER 6.3

TERRESTRIAL ECOLOGY

6.3 Terrestrial ecology

Biodiversity relates to the variety of plants and animals and the environment in which they inhabit. KNP, in which the Snowy 2.0 Main Works are proposed, is recognised for its unique biodiversity values, incorporating Australia's only alpine area, the Australian Alps along with the South-East Highlands. Altitude, temperature and rainfall (snowfall) influence the types of vegetation communities, species and their species habitat present within the Australian Alps bioregion. There are four main physiographic elements to the bioregion, these being alpine, sub-alpine, montane and tableland areas. Due to the high-altitude environment KNP supports a rich and unique assemblage of cold-climate specialist species that have evolved unique physiological characteristics, enabling them to survive in an environment subject to extreme climate variation.

A comprehensive biodiversity assessment has been completed by EMM and provides:

- an assessment of the biodiversity values present, including Commonwealth and State listed threatened species, terrestrial and groundwater-dependent ecosystems, and Commonwealth listed migratory species;
- an assessment and quantification of impacts of the project on identified biodiversity values and recommendations to avoid, minimise and mitigate these impacts; and
- an outline of the strategy proposed to offset the residual impacts of the project on these ecosystems and species, focussing on enhancing the biodiversity values of the KNP in the medium to long term.

The detailed assessment (and supporting methodology) is documented in the Biodiversity Development Assessment Report (BDAR) prepared in accordance with the *Biodiversity Assessment Method* (BAM) (OEH 2017a) and provided at Appendix M.1. The BDAR is also supported by an Offset Strategy which has been prepared to enhance the values of the KNP (Appendix M.3). This Offset Strategy contains, in part, a strategy to offset biodiversity in line with the NSW Biodiversity Offsets Scheme (BOS). As the project has been declared a controlled action under the EPBC Act, the BDAR also addresses the relevant MNES and is summarised in this chapter.

6.3.1 Existing environment

KNP is largely vegetated across its extent and covers a variety of climatic regions which support several distinct ecosystems. The extent of vegetation across KNP provides a high degree of connectivity. Biodiversity values of KNP are linked to its unique landscapes, native vegetation and ecological communities, and flora and fauna.

i Landscapes

Landscape and topography changes across the project area, with the steeper terrain of the Lobs Hole area evident compared to the high plains of the Plateau and Tantangara.

The various watercourses provide suitable connectivity for aquatic and semi-aquatic species (such as fish and amphibians) and species which use linear features (such as birds and bats) to navigate. The wooded area supports connective features for terrestrials and arboreal mammals, birds, reptiles etc. The previously disturbed areas within Lobs Hole containing open grassland and paddock trees are considered less suitable for the movement of mammals, in particular those that require vegetation cover to avoid predation.

Geodiversity features are located within the project area and contribute to landscape values, namely the block streams and Devonian outcrops along Lobs Hole Ravine Road. These geodiversity features have been identified and assessed in separate geodiversity assessments provided with the EIS (refer to Appendix O.1 and O.2).

ii Native vegetation and threatened ecological communities

Field surveys have confirmed the presence of 22 plant community types (PCTs) within the disturbance footprint which are described in Table 5.2 of the BDAR (Appendix M.1) and illustrated in Figure 6.12. The area was found to support a high diversity of communities and a total of 1,053 ha of native vegetation communities were confirmed in the disturbance footprint, with the three dominant communities consisting of:

- PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion (348.14 ha);
- PCT 1224 – Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion (133.84 ha); and
- PCT 644 – Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion (116.22 ha).

One threatened ecological community (TEC) listed under the BC Act and EPBC Act has been confirmed in the project area, primarily across the Plateau and Tantangara areas as shown in Figure 6.12. The Alpine Sphagnum Bogs and Associated Fens ecological community is listed as endangered under the EPBC Act while the Montane peatlands and swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions is listed as endangered under the BC Act. This community occurs across alpine, sub-alpine and montane landscapes and is generally found in permanently wet areas and situated on slopes and valley floors where soils are waterlogged.

iii Fauna Habitats

Fauna habitat features relevant to the project include:

- habitat trees including large hollow-bearing trees;
- flowering shrubs and feed tree species;
- waterways; and
- ground litter and logs.

The habitat assessment identified that areas where disturbance has been limited such as upper section of Lobs Hole Ravine Road and Marica, fauna habitat features are abundant. In areas subject to disturbance, such as clearing and human activity, fauna habitat features are limited such as the disturbed areas of Lobs Hole and in Talbingo Reservoir.

iv Threatened species

Results of targeted surveys have confirmed the presence of six threatened flora species listed under the BC Act, with two also listed under the EPBC Act within the disturbance footprint (Table 6.3, Figure 6.13).

Table 6.3 Flora species recorded within and adjacent to the disturbance footprint

Species name	Common name	EPBC Act ¹	BC Act ²	Talbingo	Lobs Hole	Marica	Plateau	Tantangara	Rock Forest
<i>Calotis glandulosa</i>	Mauve Burr-daisy	VU	V				✓	✓	
<i>Carex raleighii</i>	Raleigh Sedge		E1				✓	✓	
<i>Discaria nitida</i>	Leafy Anchor Plant		V			✓	✓	✓	
<i>Glycine latrobeana</i>	Clover Glycine	VU	E4A				✓	✓	
<i>Prasophyllum retroflexum</i>	Kiandra Leek Orchid		V				✓	✓	
<i>Pterostylis foliata</i>	Slender Greenhood		V			✓			

1. EPBC Act categories: VU- Vulnerable; EN- Endangered

2. BC Act categories: V- Vulnerable; E1- Endangered; E4A- Critically endangered

There were no threatened flora species recorded in the Lobs Hole, Talbingo Reservoir areas or at Rock Forest.

Twenty-one threatened fauna species listed under the BC Act have been recorded within and adjacent to the disturbance footprint, with six of these species also listed under the EPBC Act (**Error! Reference source not found.** and Figure 6.14).

Table 6.4 Fauna species recorded within and adjacent to the disturbance footprint

Species name	Common name	EPBC Act ¹	BC Act ²	Talbingo	Lobs Hole	Marica	Plateau	Tantangara	Rock Forest
Ecosystem credit species									
<i>Artamus cyanopterus</i>	Dusky Woodswallow		V	✓	✓	✓	✓	✓	✓
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper		V		✓				
<i>Daphoenositta chrysoptera</i>	Varied Sittella		V		✓	✓		✓	
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	EN	V			✓			
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle		V		✓	✓	✓	✓	
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle		V	✓	✓			✓	
<i>Lophoictinia isura</i>	Square-tailed Kite		V				✓		
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat		V	✓	✓	✓	✓	✓	
<i>Pachycephala olivacea</i>	Olive Whistler		V		✓				
<i>Petroica boodang</i>	Scarlet Robin		V		✓	✓	✓	✓	✓
<i>Petroica phoenicea</i>	Flame Robin		V		✓	✓	✓	✓	✓
<i>Stagonopleura guttata</i>	Diamond Firetail		V		✓				

Species credit species

Species name	Common name	EPBC Act ¹	BC Act ²	Talbingo	Lobs Hole	Marica	Plateau	Tantangara	Rock Forest
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo		V	✓	✓	✓	✓	✓	✓

Table 6.5 Fauna species recorded within and adjacent to the disturbance footprint

Species name	Common name	EPBC Act ¹	BC Act ²	Talbingo	Lobs Hole	Marica	Plateau	Tantangara	Rock Forest
<i>Cercartetus nanus</i>	Eastern Pygmy-possum		V		✓	✓			
<i>Cyclodomorphus praealtus</i>	Alpine She-oak Skink	EN	E1			✓	✓	✓	
<i>Hieraaetus morphnoides</i>	Little Eagle		V				✓		
<i>Litoria booroolongensis</i>	Booroolong Frog	EN	E1		✓	✓			
<i>Litoria verreauxii alpina</i>	Alpine Tree Frog	VU	E1				✓	✓	
<i>Mastacomys fuscus</i>	Broad-toothed Rat	VU	V			✓	✓	✓	
<i>Pseudomys fumeus</i>	Smoky Mouse	EN	E4A		✓	✓			
<i>Tyto novahollandiae</i>	Masked Owl		V		✓				

1. EPBC Act categories: VU- Vulnerable; EN- Endangered

2. BC Act categories: V- Vulnerable; E1- Endangered; E4A- Critically endangered

The ravine (Talbingo Reservoir, Lobs Hole and Marica areas) contain very limited threatened flora and instead have a number of threatened bird and mammal species, including the Eastern Pygmy-possum and Smoky Mouse (Photograph 6.1) which were recorded within habitat zones along Lobs Hole Ravine Road and at Marica. The Booroolong Frog (Photograph 6.2) was also recorded within habitat along the Yarrangobilly River at Lobs Hole.



Photograph 6.1 Smoky Mouse recorded in Marica during field survey



Photograph 6.2 Booroolong Frog recorded along Yarrangobilly River during field survey

The plateau (Plateau and Tantangara Reservoir) contain abundant records of threatened flora and include threatened herpetofauna species along watercourses and across the plateau including Alpine Tree Frog and Alpine She-oak Skink (Photograph 6.3).

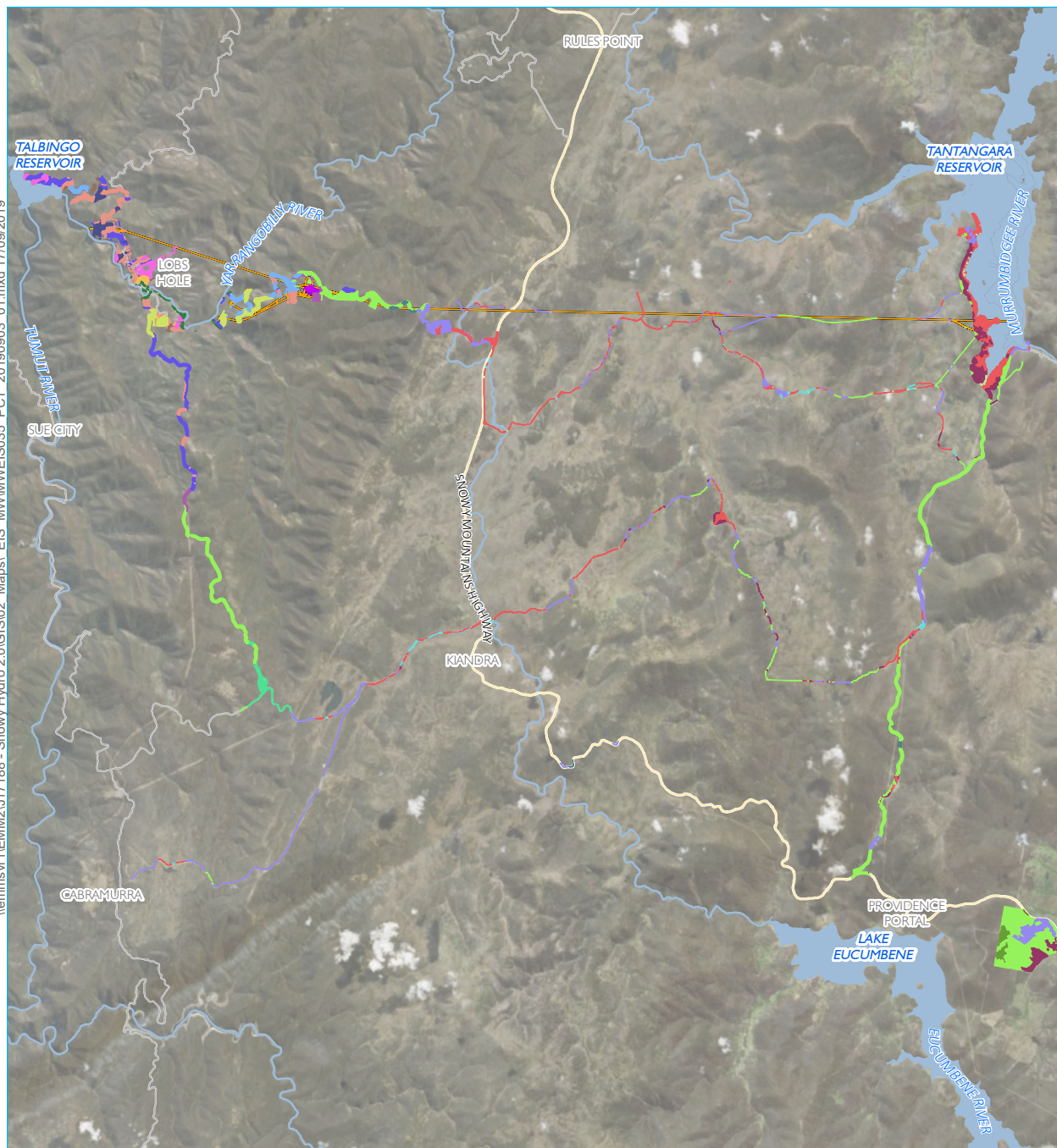


Photograph 6.3 Alpine She-oak Skink recorded on the Plateau during field survey

New records of Clover glycine (Photograph 6.4) were recorded near Tantangara, which previously only had a very limited extent within KNP.



Photograph 6.4 Clover Glycine recorded near Tantangara during field survey



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

KEY

Plant community type

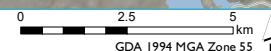
- PCT 1191 - Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion
- PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 1224 - Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 1225 - Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 285 - Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion
- PCT 296 - Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion
- PCT 299 - Riparian Ribbon Gum - Robertsons Peppermint - Apple Box riverine very tall open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion
- 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
- 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
- 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
- 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
- PCT 637* - Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 638 - Alpine Ash - Mountain Gum moist shrubby tall open forest of montane areas, southern South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 639 - Alpine Ash - Snow Gum shrubby tall open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion
- PCT 644 - Alpine Snow Gum - Snow Gum shrubby woodland at intermediate altitudes in northern Kosciuszko NP, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 679 - Black Sallee - Snow Gum low woodland of montane valleys, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion
- PCT 765 - Carex - Juncus sedgeland/wet grassland of the South Eastern Highlands Bioregion
- PCT 952 - Mountain Gum - Narrow-leaved Peppermint - Snow Gum dry shrubby open forest on undulating tablelands, southern South Eastern Highlands Bioregion
- PCT 953 - Mountain Gum - Snow Gum - Broad-leaved Peppermint shrubby open forest of montane ranges, South Eastern Highlands Bioregion and Australian Alps Bioregion
- PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion

* PCT 637 - Alpine bogs and fens (TEC)

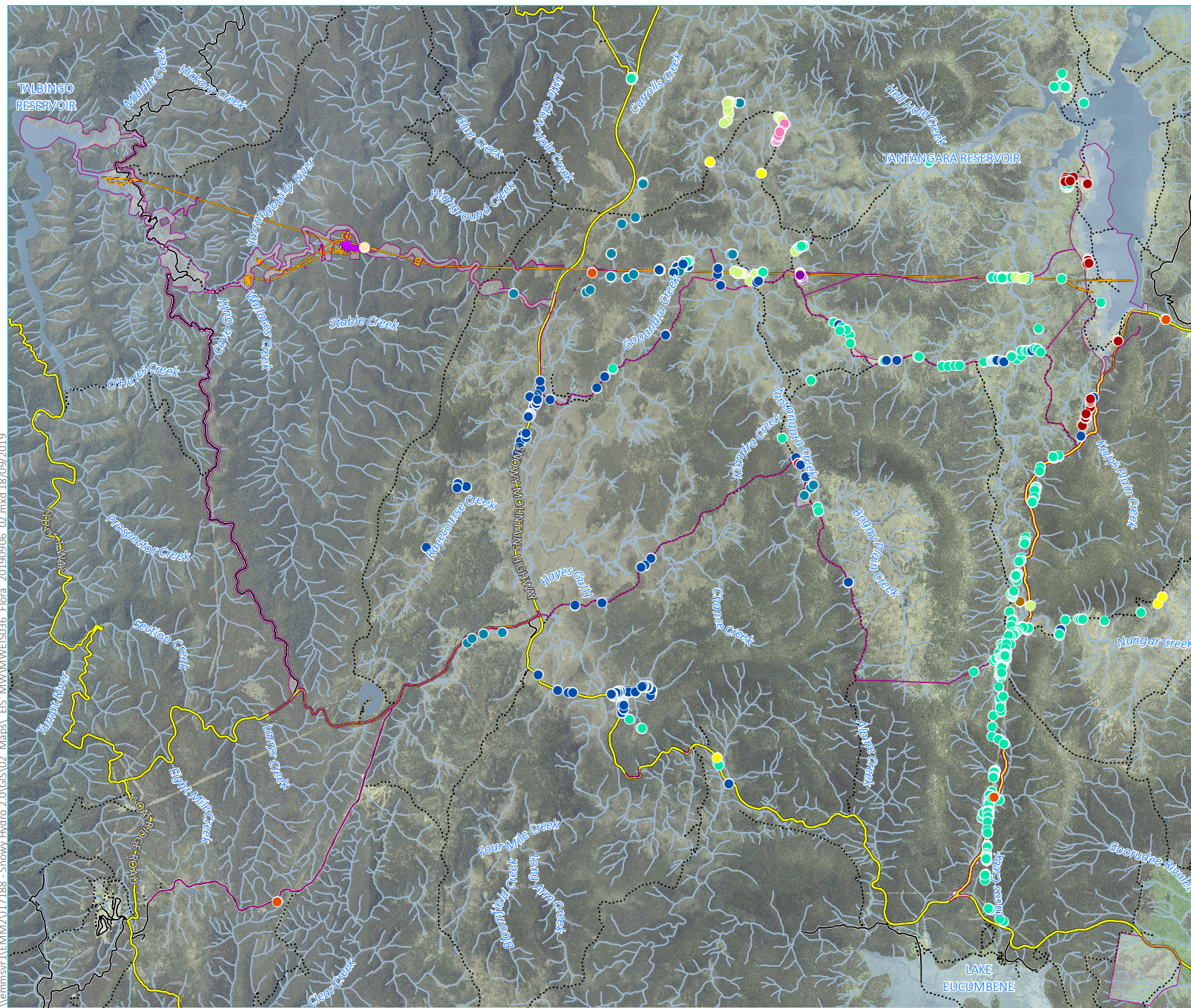
PCTs within the disturbance footprint



Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.12



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KEY

Disturbance area*

Threatened flora

- Clover Glycine
- Kiandra Leek Orchid
- Leafy Anchor Plant
- Mauve Burr-daisy
- Max Mueller's Burr-daisy
- Monaro Golden Daisy
- Raleigh Sedge
- Slender Greenhood
- *Pterostylis alpina*
- *Thelymitra alpicola*
- *Prasophyllum innubum*

Snowy 2.0 Main Works operational elements

Tunnels, portals, intakes, shafts

Power station

Existing environment

Main road

Local road

Vehicular track

Watercourse / drainage line

Waterbody

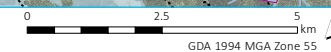
Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Threatened flora results

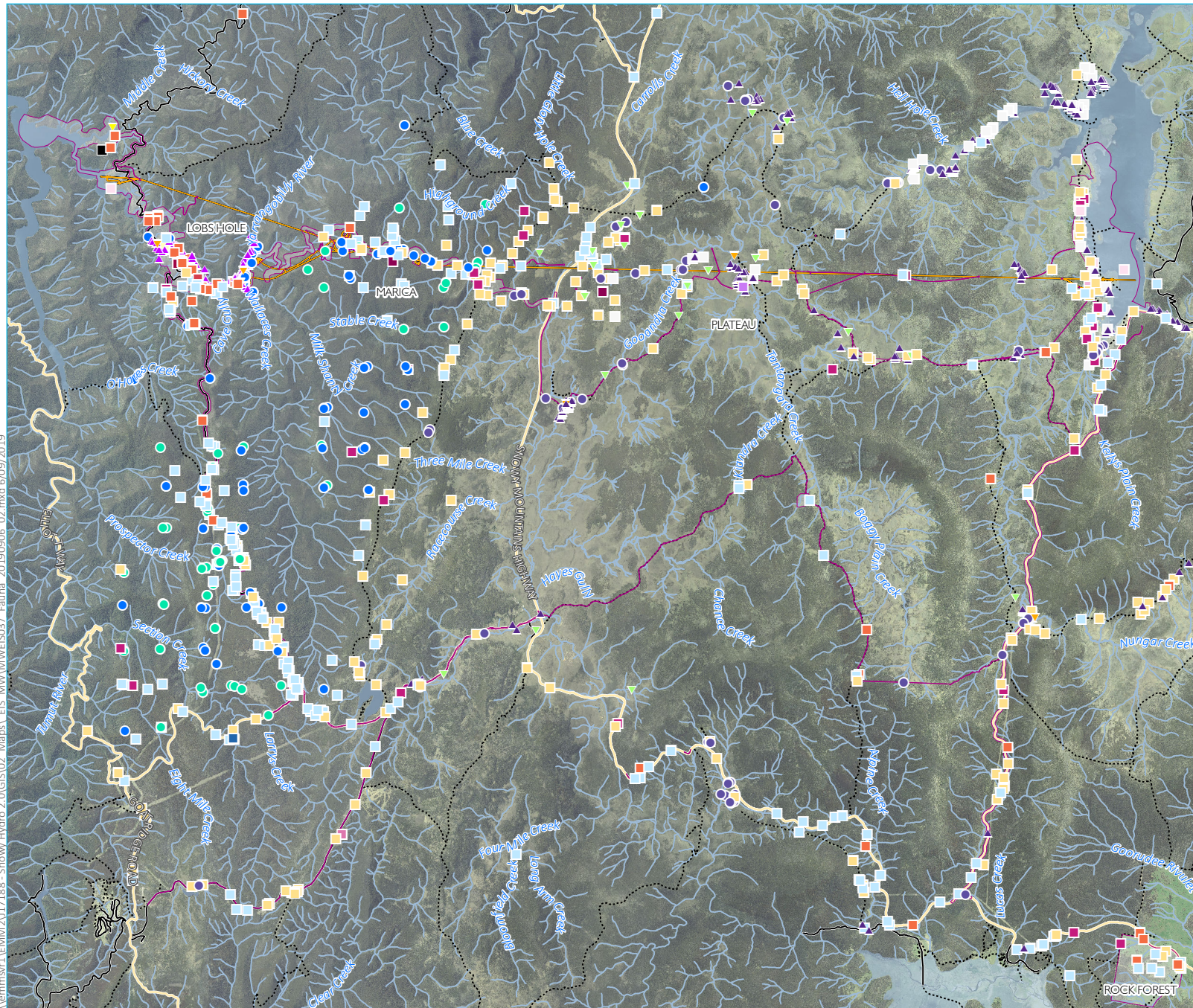
Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.13



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



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KEY

Disturbance area*

Birds

- Rainbow Bee-eater
- Flame Robin
- Gang-gang Cockatoo
- Olive Whistler
- Glossy Black-Cockatoo
- Pink Robin
- Masked Owl
- Diamond Firetail
- Latham's Snipe
- Scarlet Robin
- Dusky Woodswallow
- Square-tailed Kite
- Varied Sittella
- Little Eagle
- Brown Treecreeper
- Satin Flycatcher^
- White-bellied Sea-Eagle

Mammals

- Eastern Bentwing-bat
- Smoky Mouse
- Eastern False Pipistrelle
- Eastern Pygmy-possum
- Spotted-tailed Quoll
- Broad-toothed Rat

Reptiles and amphibians

- Alpine She-oak Skink
- Alpine Tree Frog
- Booroolong Frog

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts

Power station

- Power station

Existing environment

- Main road
- Local road
- Vehicular track
- Watercourse / drainage line
- Waterbody
- ^ - migratory species

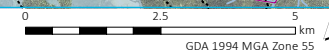
Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Threatened fauna results

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.14



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



v Groundwater dependent ecosystems

As terrestrial vegetation communities are composed of a range of vegetation types, with a range of rooting depths and strategies, there is a relationship between groundwater depth and the types and composition of the vegetation that can access it (Serov 2013). Analysis of the distribution of PCTs in relation to the simulated regional groundwater levels carried out for the project indicated several PCTs are strongly associated with shallow groundwater.

Ground dependent ecosystems (GDEs) were classified into three categories according to their increasing dependence on groundwater:

- non-dependent;
- facultative:
 - opportunistic;
 - proportional;
 - highly dependent; and
- entirely dependent/obligate.

The plant communities identified as having varying degrees of groundwater dependence within the project area are listed in Table 6.6 and shown on Figure 6.15. All other communities were considered non-dependent on groundwater. As can be seen, the majority of entirely/obligate dependent ecosystems occur across the high plains of the Plateau and Tantangara.

Table 6.6 Groundwater dependent ecosystems

Groundwater dependence	Mapped plant community type (PCT)
Entirely/obligate dependence on groundwater	<ul style="list-style-type: none"> • PCT 637 - Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion; • PCT 765 - Carex - Juncus sedgeland/wet grassland of the South Eastern Highlands Bioregion; and • PCT 1225 - Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion.
Facultative proportional dependence on groundwater	<ul style="list-style-type: none"> • PCT 285 - Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion; • PCT 299 - Riparian Ribbon Gum - Robertsons Peppermint - Apple Box riverine very tall open forest of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion; and • 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.
Facultative – opportunistic dependence on groundwater	<ul style="list-style-type: none"> • 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; • 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; and • PCT 679 - Black Sallee - Snow Gum low woodland of montane valleys, South Eastern Highlands Bioregion and Australian Alps Bioregion.

GDEs within the survey area are deemed to have high ecological value, based on their occurrence with KNP, good water quality and quantity parameters, and aquifer structure given limited disturbance, patch size criteria given high levels of connectivity, and delivery of ecosystem services.

6.3.2 Community and stakeholder views

The community generally support the project and recognise that there will be impacts to biodiversity within KNP. Notwithstanding this, the community also recognised that there is a need to avoid and minimise these impacts, in particular to threatened flora and fauna species. Stakeholder engagement with key government stakeholders, including DPIE and DEE, and species experts and accountable officers within these departments, was undertaken to:

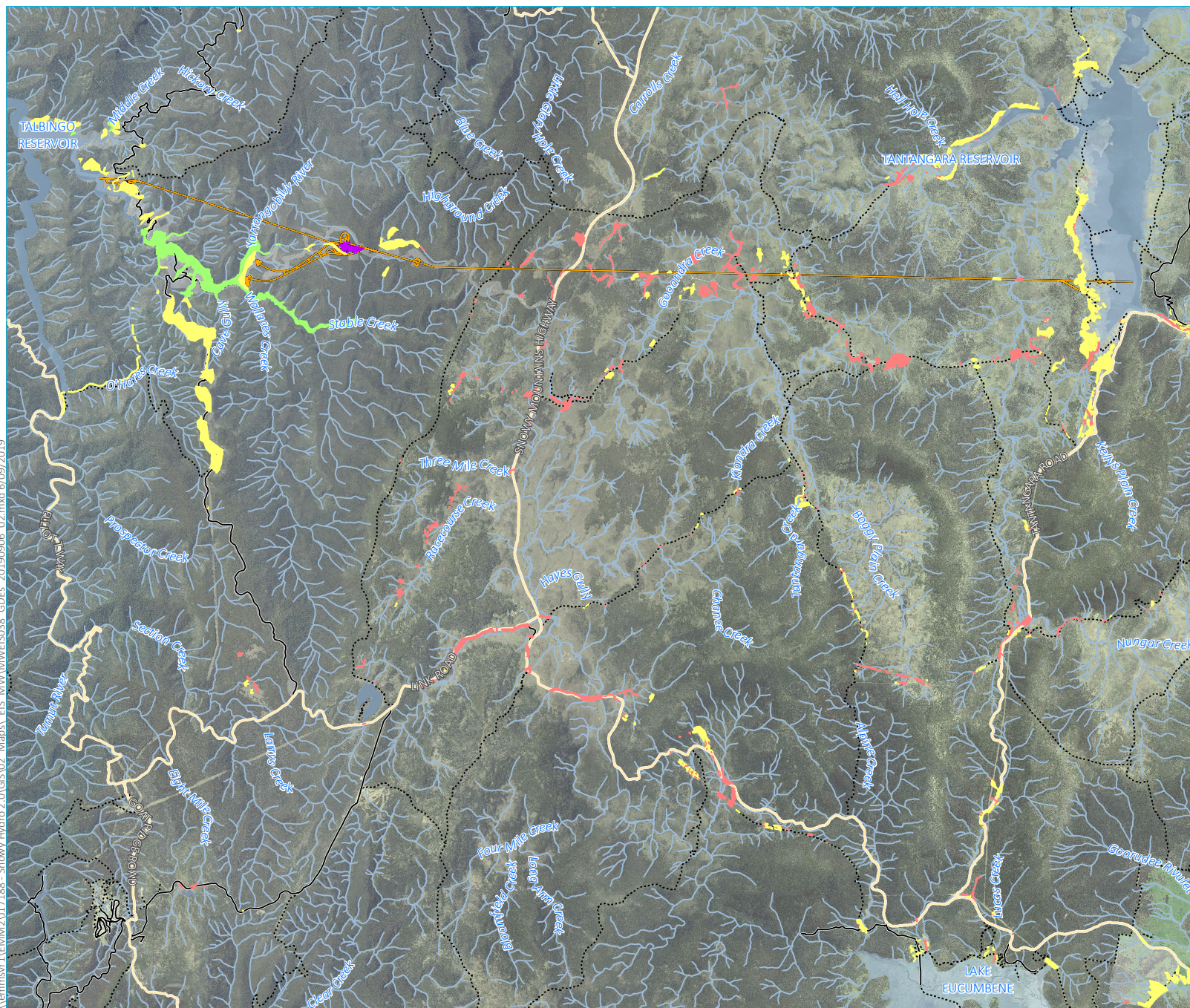
- inform the identification of biodiversity values and biodiversity survey methods; and
- seek input and discuss measures proposed to avoid, minimise and mitigate impacts.

6.3.3 Avoidance and minimisation through design

A key focus of project design has been to avoid and minimise impacts to biodiversity values, identified during the field surveys, as a result of surface infrastructure. In recognition of the location of the Snowy 2.0 project in the KNP, and associated biodiversity and other values of the park, the project has undergone significant steps to avoid, minimise and mitigate impacts through the DIAA process. Examples of measures undertaken to avoid, minimise and mitigate impacts that have arisen during the process are outlined below, with more detail provided in the BDAR (Appendix M.1) and Options Report (Appendix C):

- Placement of excavated rock – many of the options considered required much larger disturbance to identified biodiversity values. The current proposed option for disposal of excavated rock has resulted in a significant reduction in predicted impacts;
- Access roads – the design of these access roads has attempted to limit disturbance as far as practicable, largely through the use of the existing road network, resulting in upgrades to existing roads rather than construction of new roads and reducing the overall extent of disturbance required;
- Surface infrastructure – early designs for the project included a number of ancillary facilities to be located over the sensitive plateau area. Due to identified biodiversity constraints the project was refined, with only the communication cables to be located in this area. All other project elements have been removed and associated impacts will be avoided as much as possible; and
- Significant measures were put in place to avoid impacts to Clover Glycine when a large population was recorded along a proposed Tantangara East Road to access private property along the eastern edge of KNP. Surveys of this option identified significant biodiversity values along this proposed route, including a population of over 600 Clover Glycine, representing approximately 65% of the known population of the species in NSW. The removal of this option has resulted in a substantial and significant reduction in impacts to Clover Glycine.

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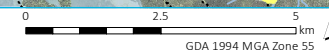


- KEY**
- Groundwater dependent ecosystems
 - Entirely/obligate dependence
 - Facultative - proportional
 - Facultative - opportunistic
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Existing environment
 - Main road
 - Local road
 - Vehicular track
 - Watercourse / drainage line
 - Waterbody

Groundwater dependent ecosystems

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.15

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



Since the initial identification of the Smoky Mouse along Lobs Hole Ravine Road (as well as a number of other threatened species), a number of options for the widening of Lobs Hole Ravine Road have been considered by the design team to avoid and minimise clearing in this area. Large-scale regional surveys undertaken for the Smoky Mouse recorded a significant regional population of the Smoky Mouse extending from Coppermine Firetrail in the north to Link Road in the south, and from Wallaces Creek Firetrail in the east to near Goat Ridge Road in the west. These regional surveys placed the original finding of Smoky Mouse on Lobs Hole Ravine Road in a broader regional context. This has negated much of the benefit of alternative options to widening of Lobs Hole Ravine Road. Consideration was given to fencing off Lobs Hole Ravine Road in order to minimise impacts to fauna species such as Smoky Mouse and the Eastern Pygmy-possum, with provision of under-road crossing points via culvert. Concerns were raised that this measure may result in significant fragmentation and loss of connectivity, and thus alternative measures have been proposed (see Section 6.3.5).

6.3.4 Predicted impacts

The current design for many elements of Snowy 2.0 Main Works has included a disturbance area that is much larger than is required to construct the project. Therefore, the current disturbance footprint is likely to significantly overestimate the impacts arising from the project, and currently represents the maximum extent where construction works will be carried out.

The detailed design for the project is ongoing. In recognition of the biodiversity values of KNP, and the unique native species and communities that it supports, the disturbance area will be minimised as much as possible during detailed design as part of the continuing DIAA process.

The main direct impacts of the project will be associated with impacts arising from the clearing works for construction of the project. Potential direct impacts that could arise include:

- clearing of areas of significant native vegetation;
- clearing of high-quality threatened species habitat;
- clearing of TECs; and
- disturbance of river/creek beds and banks.

Indirect impacts that could occur include:

- drawdown of groundwater, resulting in impacts to GDEs;
- increased noise, vibration and dust levels resulting in disturbance of fauna species, and consequent abandonment of habitat, or changes in behaviour (including breeding behaviour);
- lighting for night works, resulting in disturbance to fauna species and changes in occupancy or behaviour;
- increase in weeds and pathogens, resulting in degradation of retained native vegetation and habitat; and
- increase in predatory and pest animal species, resulting in increased predation and competition and a consequent reduction in populations.

Based on the biodiversity assessments that have been completed to identify the presence of Commonwealth and State listed communities and species, and after avoidance and mitigation measures are implemented, the residual impacts to biodiversity will be primarily associated with the loss of native vegetation communities and fauna species habitats. Alpine Bogs and Fens are a TEC and GDE located across the Plateau and predicted impacts have also been estimated based on current groundwater modelling for the project.

i Native vegetation and threatened ecological communities

The disturbance footprint covers an area of 1,680 ha. As a worst-case prediction, it is anticipated there will be a total loss of 1,053 ha of native vegetation including 4.09 ha of TECs and 992 ha of habitat for fourteen threatened species. A detailed breakdown of specific PCTs to be cleared is provided in the BDAR (Appendix M.1).

As a result of the measures to avoid and minimise impacts, particularly removal of large sections of the project area across the Plateau, there has been a significant reduction in impacts to Alpine Sphagnum Bogs and Associated Fens (the only TEC occurring within the disturbance footprint). Snowy 2.0 Main Works will result in a residual impact to 4.09 ha of the community, representing 0.04% of the national extent of the community. A further 17.51 ha is mapped within the groundwater drawdown area and may be subject to impacts arising from changes in hydrology. The scale and extent of these impacts are unknown and will be subject to ongoing monitoring.

ii Threatened species and their habitat

Removal of native vegetation and threatened species habitat has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. Habitat loss is expected for several threatened species, summarised as follows:

- 2.01 ha of habitat for Clover Glycine;
- 1.67 ha of habitat for the Kiandra Leek Orchid;
- 17 individuals of the Leafy Anchor Plant;
- 16.55 ha of habitat for the Mauve Burr-daisy;
- 0.38 ha of habitat for the Raleigh Sedge;
- 0.18 ha of habitat for the Slender Greenhood;
- 0.04 ha of habitat for *Thelymitra alpicola*;
- 5.42 ha of breeding habitat for the Gang-gang Cockatoo;
- 30.23 ha of habitat for the Broad-toothed rat;
- 552.94 ha of habitat for the Eastern Pygmy-possum;
- 174.39 ha of habitat for the Smoky Mouse;
- 9.85 ha of habitat for the Booroolong Frog;
- 48.87 ha of habitat for the Alpine Tree Frog; and
- 133.83 ha of habitat for the Alpine She-oak Skink.

Further discussion on key species subject to greatest impact include:

- Clover Glycine - Twenty-six individuals will be impacted by the project, in the Tantangara area. This represents 2.9% of the location population of the species recorded during surveys undertaken for Snowy 2.0, and approximately 0.4% of the estimated national population (Carter and Sutter 2010), including records from Snowy 2.0 surveys;
- Kiandra Leek Orchid - direct impacts on 1.67 habitat for the Kiandra Leek Orchid;
- Mauve Burr-daisy - the Mauve Burr-daisy was found to be ubiquitous throughout KNP, often growing on the margins of disturbed areas such as management tracks and firetrails. This has meant that measures to avoid and minimise impacts are challenging. The Snowy 2.0 Main Works project is expected to impact 3,686 individuals. This represents less than 17% of the national population of the species;
- Raleigh Sedge - direct impacts on 0.38 ha of habitat for the Raleigh Sedge; and
- Smoky Mouse - Regional surveys have contributed a significant amount of knowledge on the distribution of this species in northern KNP. These surveys recorded the species over a large area of suitable habitat. It is estimated that Snowy 2.0 Main Works will result in impacts to 174.39 ha of habitat for the species, representing less than 3% of the estimated available habitat in the region. There is also potential for indirect impacts from fragmentation, fauna vehicle collisions, weeds and pathogens and increased predation to further impact this species if unmitigated.

Two migratory species listed under the EPBC Act (Satin Flycatcher and Latham's Snipe) were recorded within or adjacent to the disturbance footprint and will have habitat impacted as a result of the project.

iii Groundwater dependent ecosystems

Groundwater-dependent riparian vegetation is predicted to be at moderate risk of predicted impact, as the GDE will experience some drawdown, but some level of baseflow is expected to be maintained to large areas and the community will only experience minor changes in species composition.

PCTs 1225 and 637 are considered to be at high risk of predicted impact given the level of drawdown, the entirely/obligate dependence of these communities on groundwater and possible changes in species composition. However, these impacts will occur to a small portion of these communities at a local, NSW and national scale.

It is worth noting that these predicted impacts are considered an unrealistic, worst-case scenario given the groundwater model was not able to consider the effectiveness of pre-grouting the tunnel, which will be implemented during construction. This is likely to considerably reduce the drawdown arising from the project; however, the degree of reduction is unknown.

6.3.5 Mitigation measures

Direct impacts will need to be offset in accordance with the BC Act and the total credits and strategy to be implemented is discussed in Appendix M.3. Mitigation measures recommended to manage indirect impacts of the project to biodiversity are provided in Table 6.7.

Table 6.7 Mitigation measures for terrestrial ecology impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Fauna strike to Smoky Mouse and Eastern Pygmy possum	ECO1	<p>Management measures to mitigate the potential impacts of fauna strike are currently being considered. These measures include:</p> <ul style="list-style-type: none"> reduced speed limit along Lobs Hole Ravine Road and Marica Trail at night, when fauna species are likely to be most active; fencing of these roads to prevent access to the road surface; and construction of fauna underpasses. <p>The adopted measures will be agreed in consultation with DPIE.</p>	Construction	Contractor
Spread of weeds	ECO2	A weed and pathogen monitoring program will be implemented, with a weed control program to be implemented if weeds are identified along road verges. This will include wash-down stations will be constructed at a suitable location, with wash down for weeds as well as <i>P.cimmamomi</i> .	Construction	Contractor
Impacts to GDEs	ECO3	A GDE monitoring program will be implemented to ensure actual impacts are within prediction. If actual impacts are greater than predicted, adaptive management will be implemented.	Construction	Contractor
Removal of native vegetation and threatened species habitat	ECO4	<p>A Biodiversity Management Plan will be prepared and implemented during construction. It will include the following measures:</p> <ul style="list-style-type: none"> establishment of exclusion zones around retained vegetation, including fencing and signage; pre-clearing surveys conducted prior to clearing, including translocation of fauna into areas of retained vegetation; vegetation clearing undertaken in accordance with the two-stage process; mulching and stockpiling of cleared native vegetation for use during rehabilitation; retention of hollows logs and limbs for placement within retained vegetation and reuse during rehabilitation; regional surveys for the Smoky Mouse to demonstrate presence of a significant regional population; collection of native seeds and alpine sod for propagation; and establishment of native plant nursery and propagation of endemic native species for use in rehabilitation works. 	Construction	Contractor
	ECO5	A threatened species monitoring program will be designed and implemented to ensure impacts arising from clearing are within prediction.	Construction	Contractor
Increase in predatory and pest species	ECO6	A pest and predator monitoring program will be designed and implemented to ensure Main Works does not result in a significant increase in numbers of pest and predatory species and impacts to threatened species remain within prediction.	Construction	Contractor

6.3.6 Summary and conclusion

A key focus of project design has been to avoid and minimise impacts to biodiversity values identified during the field surveys as a result of surface infrastructure. In recognition of the location of the Snowy 2.0 project in the KNP, and associated biodiversity and other values of the park, the project has undergone significant steps to avoid, minimise and mitigate impacts through the DIAA process.

The disturbance footprint for Snowy 2.0 Main Works covers an area of 1,680 ha. As a worst-case prediction, it is anticipated there will be a total loss of 1,053 ha of native vegetation including 4.09 ha of TECs and 992 ha of habitat for fourteen threatened species. Removal of native vegetation and threatened species habitat has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. Habitat loss is expected for several threatened species.

Residual impacts will be offset. Further detail regarding offset credits and approach to delivering the biodiversity offsets for the project are summarised in Section 8.4 of the BDAR (Appendix M.1) and Offset Strategy (Appendix M.3).



CHAPTER 6.4
AQUATIC
ECOLOGY

6.4 Aquatic ecology

Construction and operational aspects of Snowy 2.0 have potential to impact aquatic ecology in local catchments upstream and downstream of Talbingo and Tantangara reservoirs, and within the reservoirs.

A comprehensive aquatic ecology assessment has been completed by Cardno (2019b – Appendix M.2) and provides:

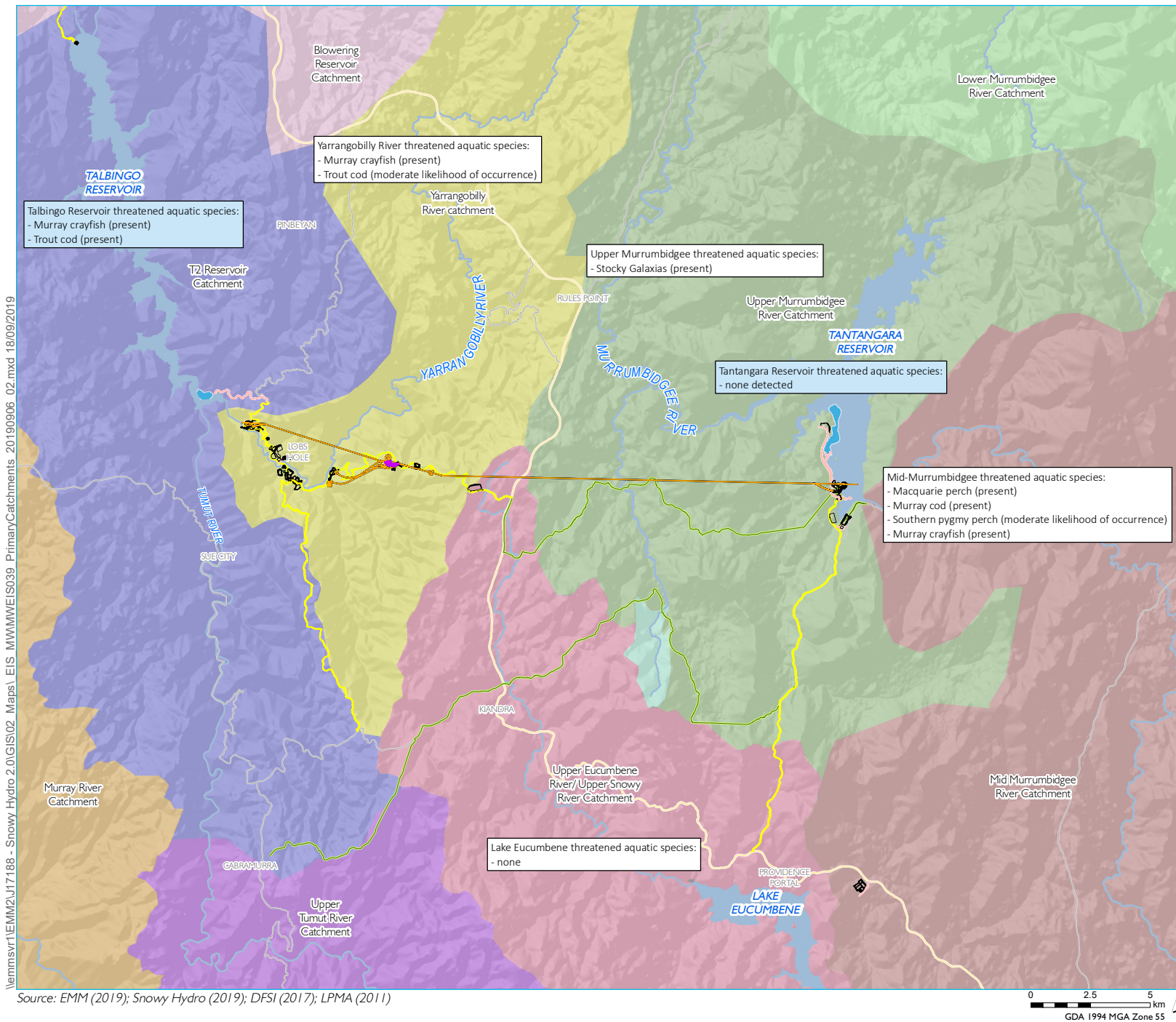
- an assessment of the biodiversity values present including Commonwealth and State listed threatened aquatic species;
- an assessment and quantification of impacts of the project on identified aquatic ecology values; and
- outlines the strategy proposed to offset the residual impacts of the project on these aquatic ecosystems and species.

The assessment incorporates findings from various technical studies undertaken to characterise the aquatic ecology associated with Tantangara and Talbingo reservoirs and associated catchments. A number of scientific investigations and technical studies have been carried out to inform this assessment of impacts to aquatic ecology.

6.4.1 Existing environment

Snowy 2.0 is within the Snowy-Tumut Development which provides for the diversion off the Eucumbene, the Upper Murrumbidgee and the Tooma rivers at Blowering Reservoir. This development currently provides an existing one-way transfer of water Tantangara Reservoir to Talbingo Reservoir via Lake Eucumbene and a series of tunnels and power stations through the Upper Tumut catchment into Talbingo Reservoir and the lower Tumut River. The Snowy-Murray Development involves the diversion of the Snowy River by a tunnel system to the Geehi River and then to the Swampy Plain River via a series of tunnels and power stations.

Key catchments relevant to potential impacts are Talbingo Reservoir, Yarrangobilly River, Lake Eucumbene and Mid-Murrumbidgee River which are shown in Figure 6.16. Table 6.8 and Table 6.9 provide an overview of aquatic information for the key catchments and two reservoirs, respectively.



KEY

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road
- Indicative rock emplacement area

Primary catchments

- Blowering Reservoir catchment
- Lower Murrumbidgee River catchment
- Mid Murrumbidgee River catchment
- Murray River catchment
- Yarrangobilly River catchment
- T2 Reservoir catchment
- Upper Eucumbene River/ Upper Snowy River catchment
- Upper Murrumbidgee River catchment
- Upper Tantangara Creek catchment
- Upper Tumut River catchment

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies

Primary catchments and threatened aquatic species

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.16



Table 6.8 Key catchment features

Feature	Yarrangobilly River	Lake Eucumbene	Upper Murrumbidgee River	Mid-Murrumbidgee
General description and watercourses	Headwaters of the Yarrangobilly River lie approximately 22 km east of Talbingo. The river flows predominantly southwest and south, passing beneath the Snowy Mountains Highway before combining with Wallaces Creek and turning north-west into the Tumut River and into Talbingo Reservoir.	Encompasses the whole of Lake Eucumbene, the Eucumbene River and several small tributaries (including Bullocks Head Creek, Chance Creek, Racecourse Creek, Three Mile Creek and Gang Gang Creek) and is bound by the Lake Eucumbene dam wall in the south western section of Lake Eucumbene. The primary watercourse is the upstream section of the Eucumbene River which runs for approximately 37 km south from its source in the plateau region of the study area before reaching Lake Eucumbene.	Extends from the upper alpine areas of KNP with the Murrumbidgee River flowing into the northern end of Tantangara Reservoir and exiting at the southeast corner via the Tantangara Reservoir dam wall. Major tributaries include Nungar Creek, Tantangara Creek, Gooandra Creek and Mufflers Creek west of the reservoir, Mosquito Creek in the north and Kellys Plain Creek in the south. Major watercourses in the west of the catchment are generally perennial and flow through alpine environments with a mixture of native and non-native sedges, grasses and shrubs. Tantangara Creek and Gooandra Creek are narrower and shallower than the Murrumbidgee River and flow over a mixture of cobble, pebble and gravel substratum with some boulders, bedrock and deeper pool sections. Nungar Creek has a similar morphology to Tantangara Creek and with a greater proportion of gravel and sand substratum.	Extends from below Tantangara Reservoir dam wall to the ACT/NSW border. The primary watercourses in this catchment include the Murrumbidgee River and the Numeralla River. The Murrumbidgee River is approximately 190 km to the ACT border and the Numerella River is approximately 110 km. Below the Tantangara Reservoir dam wall, the catchment to Yaouk (13 km south-east) is undisturbed grassland and grassy woodland. Downstream from Yaouk the catchment is heavily cleared until the Binjura Nature Reserve in the southern part of the catchment where the channel becomes deeply incised and surrounded by undisturbed native sclerophyll forest.
Aquatic values	The Yarrangobilly River is relatively undisturbed, is considered of high ecological value (EMM 2018) and has no natural or artificial barriers to fish passage in the sections of Yarrangobilly River and Wallaces Creek surveyed by Cardno (2019b).	The upper reaches of the Eucumbene River meander through the KNP with pools, riffles and cobbles and boulder habitat. The surrounds generally comprise open and closed woodland or alpine tundra.	Areas of shallow riffles and deeper pools with widths of up to 10 m. Native aquatic vegetation (<i>Potamogeton tricarinatus</i> and <i>Myriophyllum</i> sp.) is present in isolated patches in Tantangara and Gooandra Creeks, the Murrumbidgee River and most of the smaller tributaries. Large rocks and gravel beds are also present.	Areas of riffles and deep pools with large rocks, wood debris and native aquatic plants support a diverse fish community.

Table 6.7 **Key catchment features**

Feature	Yarrangobilly River	Lake Eucumbene	Upper Murrumbidgee River	Mid-Murrumbidgee
Key fish habitat (KFH)	Yarrangobilly River and Wallaces Creek support type 1 – Highly Sensitive KFH due to the presence of large rocks, large wood debris (in Yarrangobilly River) and the provision of habitat for a threatened species (Murray crayfish) in both watercourses. Lick Hole Creek and Sheep Station Creek are ephemeral tributaries of Wallaces Creek with limited instream habitat (type 3 – minimally sensitive KFH).	Eucumbene River and its main tributaries provide type 1 KFH, due the presence of native aquatic plants and / or their association with the EEC listing for the Snowy River, which includes these watercourses and provides endangered status to all associated species.	The Murrumbidgee River, Tantangara Creek (and tributary TCA1/2), Gooandra Creek, Nungar Creek, Bally Creek and Ghost Gully provide type 1 – highly sensitive KFH, due to the presence of native aquatic plants and large rocks; they are also Class 1 waterways due to their perennial flow. The remaining watercourses including Mufflers Creek and Kellys Plain Creek provide type 2 – moderately sensitive KFH, and the pools associated with Gooandra Creek, Tantangara Creek and Nungar Creek are type 3 KFH.	The Murrumbidgee River downstream of Tantangara dam wall provides type 1 – highly sensitive KFH due to the presence of large rocks, wood debris, native aquatic plants and the threatened Macquarie perch (<i>Macquaria australasica</i>), at least as far downstream as Yaouk Bridge.
Species – threatened	Murray crayfish (present) and trout cod (moderate likelihood of occurrence).	Snowy River endangered ecological community.	Stocky galaxias (present) – upper Tantangara Creek only.	Macquarie perch (present), trout cod (present), Murray cod (present), southern pygmy perch (moderate likelihood of occurrence) and Murray crayfish (present).
Species – native	Two-spined blackfish (present), mountain galaxias (present), climbing galaxias (present), flathead gudgeon (moderate likelihood of occurrence), common yabby (moderate likelihood of occurrence) and unidentified spiny crayfish (present).	Climbing galaxias (present), flathead gudgeon (present), common yabby (present) and Reiks crayfish (present).	Mountain galaxias (present), common yabby (present) and Reiks crayfish (present).	Golden perch (present), two-spined blackfish (present), Australian smelt (present), flathead gudgeon (present), carp gudgeon (present), common yabby (present), Reiks crayfish (present), freshwater prawn (present) and freshwater glass shrimp (present).
Species – non-native	Redfin perch (present), rainbow trout (present) and brown trout (present).	Eastern gambusia (present), wild goldfish (present), oriental weatherloach (present), rainbow trout (present), brown trout (present) and brook trout (present).	Cypriniforme OTU2 (moderate likelihood of occurrence), rainbow trout (present) and brown trout (present).	Eastern gambusia (present), wild goldfish (present), carp (present), oriental weatherloach (present), rainbow trout (present) and brown trout (present).

Table 6.9 **Key reservoir features**

Feature	Talbingo	Tantangara
Water flow	Receives water from natural catchment inflows, with the Tumut River, Yarrangobilly River and several smaller creeks contributing to the catchment inflow. Water discharged from T3 can also be pumped back into the reservoir from Jounama Pondage immediately downstream of Talbingo Reservoir. Once water is released from Jounama Pondage, it enters Blowering Reservoir where it is released by WaterNSW.	The Reservoir impounds the headwaters of the Murrumbidgee River for diversion through the Murrumbidgee-Eucumbene Tunnel into Lake Eucumbene for storage. Water from the Goodradigbee River, a downstream tributary of the Murrumbidgee River, is also collected within the reservoir via the Goodradigbee River Aqueduct.
Sediments	Soft and muddy, fine textured predominantly consisting of coarse silts (RHDHV 2018). Sediment metal concentrations are below the interim sediment quality guidelines (ISQG) low values (ANZECC/ARMCANZ 2000) except for copper and nickel which are naturally high and unlikely to be bioavailable (RHDHV 2018). Sedimentation rates are approximately 2 mm per year except at Middle Bay (15 mm per year) where sediment loads from the Yarrangobilly River deposit.	Soft and muddy, fine textured predominately consisting of coarse silt with small varying fractions of clay (Cardno 2019b). Heavy metal concentrations were within ISQG guideline values at all sites sampled. Sedimentation rates are up to 3 mm per year.
Aquatic habitat	Soft sediment habitats predominate throughout the reservoir, and submerged timber is abundant. Beds of aquatic macrophytes occur in the shallower margins of the reservoir, particularly within the lower Yarrangobilly River and Middle Creek areas where large dense beds of the introduced water weed <i>Elodea canadensis</i> form thick mats to around 5 m water depth (Cardno 2019b). Macrophytes are seasonal, generally being present during the warmer months of the year. Types of habitat include unvegetated soft sediment, aquatic macrophytes (<i>Elodea</i>), submerged timber, rocky rubble and open water.	Soft sediment predominates and drowned grasses and tussocks are present at the confluence of Nungar Creek and the Murrumbidgee River within the reservoir. Areas of large boulders and emergent bedrock are present throughout the reservoir, which likely provide habitat for invertebrates and fish (Cardno 2019b). One small patch of <i>Elodea</i> was reported in shallow water on the eastern shore. Types of habitat include unvegetated soft sediment, drowned grass tussocks and shrubs, rocky rubble, rock boulders and emergent bedrock and open water.
Benthic invertebrates	Oligochaete worms were numerically abundant in benthic samples, accounting for 81% and 79% of all individuals collected from the reservoir in March 2018 and January 2019, respectively. Other prominent benthic taxa included chironomids (insects) and nematode worms (Cardno 2019b).	Oligochaete worms, chironomids (non-biting midges) and nematode worms accounted for over 95 % of the benthic invertebrates sampled. Number of taxa sampled generally low within Tantangara Reservoir for both surveys, with fewer than four taxa recorded at most locations sampled. No clear pattern of spatial variability.
Phytoplankton	Phytoplankton assemblages within Talbingo Reservoir comprise chlorophytes (45%), cyanophytes (38%) and bacillariophytes (15%) and less than 2% of other taxa (Cardno 2019b). Seasonal variation in phytoplankton assemblages is apparent, although there is very little spatial difference throughout the reservoir.	Chlorophytes (44%), cyanophytes (19%) and bacillariophytes (30%) and less than 8% of other taxa (Cardno 2019b). No strong seasonal variation in phytoplankton.
Key fish habitat	Type 1 KFH due to the known presence of Murray crayfish.	Type 2 KFH (moderately sensitive fish habitat). No threatened or protected species have been reported.
Species – threatened	Murray crayfish (present) and trout cod (present).	None detected.

Table 6.8 **Key reservoir features**

Feature	Talbingo	Tantangara
Species – native	Two-spined blackfish (present), mountain galaxias (present), climbing galaxias (moderate likelihood of occurrence), flathead gudgeons (present), common yabby (present).	Mountain galaxias (present), common yabby (present), Reiks crayfish (present).
Species – non-native	Redfin perch (present), eastern gambusia (present), rainbow trout (present), brown trout (present), wild goldfish (present).	Rainbow trout (present) and brown trout (present).
Macrophytes	The introduced weed <i>Elodea</i> is widespread.	Elodea is present in low abundance
Pathogens	EHNv is known to occur in the wider Murrumbidgee catchment but has not been recorded in the Reservoir or upstream catchment	EHNv is known to occur in the wider Murrumbidgee catchment but has not been recorded in the Reservoir or upstream catchment

6.4.2 Community and stakeholder views

Community and stakeholder views were considered through the development of the project, with these views obtained through community consultation and government agency meetings including DPI-Fisheries.

Key matters raised through the period of engagement with DPI Fisheries were potential impacts on:

- native aquatic species and recreation as a result of potential pest fish (Redfin perch) transfer between Tantangara and Talbingo reservoirs, and further impacts from distribution upstream and downstream, if not contained;
- recreational fish (trout) as a result of potential Redfin perch transfer into Tantangara reservoir;
- transfer of pathogens, especially the EHNW through the power waterway;
- threatened species (Murray crayfish) as a result of excavated rock material placement in Talbingo Reservoir.

Targeted community consultation was carried out for the purpose of the social and recreational user assessments for the EIS (Appendix X.2), to determine the current level of understanding of the project and its potential impacts, and possible measures or opportunities that would be considered suitable by the community to mitigate or offset those impacts. The aquatic values identified by recreational users generally included fishing at Lobs Hole and Tantangara Reservoir.

6.4.3 Avoidance and minimisation through design

In response to key matters raised by stakeholders regarding the potential transfer/movement of fish between the reservoirs, Snowy Hydro carried out detailed design investigations for fish barrier controls.

The approach included investigations of the feasibility and effectiveness of controls that could be incorporated at the intake structures in Tantangara and Talbingo reservoirs (primary controls) to prevent live fish transfer to Tantangara Reservoir. However, due to the complex nature of the proposed structures and their operation, no feasible primary control measures were identified to prevent the transfer of fish, larvae and/or eggs between the reservoirs. Consequently, the objective of the barrier control measures is to contain any fish potentially transferred and restrict them to within Tantangara Reservoir and out of any catchments known to contain threatened species.

These investigations identified secondary design controls which form part of Snowy 2.0 Main Works. These are:

- In Tantangara Creek just upstream of the waterfall upstream of Alpine Creek Trail. This barrier is designed to prevent movement of Climbing galaxias into the 4 km upstream section of Tantangara Creek where stocky galaxias are found;
- At Tantangara Reservoir dam wall. This barrier is designed to prevent transfer via the existing environmental release from Tantangara Reservoir to the Mid and Lower Murrumbidgee River catchments; and
- At the entrance to the Murrumbidgee-Eucumbene tunnel that transfers water from Tantangara Reservoir to Lake Eucumbene. This barrier has been designed to prevent fish transfer from Tantangara Reservoir to the Snowy River, Upper Tumut River and Murray River catchments.

These barriers are a result of considerable volumes of research and design development initiated by Snowy Hydro aimed to eliminate the potential risk to pre-existing fish populations and other components of aquatic ecology at risk from fish transfer.

6.4.4 Predicted impacts

Potential direct and indirect impacts to habitat, water resources and biota would be broadly managed via the CEMP and specific sub-plans. Any disturbed habitat would be appropriately rehabilitated and/or offset as required. Impacts of surface works would primarily be controlled via the methodologies outlined in the Erosion and Sediment Control Plan (ESCP) but will be supported by other sub-plans including:

- Biodiversity Management Plan;
- Aquatic Habitat Management Plan;
- Water Management Plan; and
- Rehabilitation Plan.

The subsequent sections of this section describe the key matters associated with the interactions between the construction and operation of Snowy 2.0 Main Works and aquatic ecology. Detailed information is provided within the aquatic ecology study provided in Appendix M.2.

i Removal/modification of aquatic habitat and associated biota

Altering the aquatic environment through removal and/or modification of habitat can affect the number and type of aquatic species living in an area. Each species has an environmental preference with respect to water quality, water flows, substrate type and the presence of predators, competitors and food. Snowy 2.0 Main Works activities have potential to alter aquatic habitats with a summary of these impacts provided in Table 6.10.

Table 6.10 Removal/modification of aquatic habitat and associated biota

Activity	Impact assessment	Residual risk ¹
Construction of surface infrastructure and utilities	<p>Where possible, an exclusion buffer will be applied for road construction either side of a river except where bridges or other crossing structures are required. Habitat loss / modification would be minor due to the small footprint of waterway crossing sites compared with extensive similar riparian and instream habitat along the Eucumbene River, Nungar Creek, Kellys Plain Creek and Talbingo Reservoir.</p> <p>Temporarily disturbed riparian vegetation will be rehabilitated in accordance with the rehabilitation strategy. Cables will be underbored where they cross third order perennial waterways with Type 1 KFH with appropriate erosion and sediment controls, keeping disturbance at all locations short term and highly localised.</p> <p>Wastewater outlets entering creeks and reservoirs would be designed and positioned to minimise the footprint of hard bank engineering and prevent bank scouring and erosion. Quality of discharge will be maintained within licence conditions.</p>	Low
Subaqueous placement of excavated rock in Talbingo Reservoir	<p>Bare soft sediment habitat makes up the largest area of benthic aquatic habitat within the proposed excavated rock placement area of Talbingo Reservoir, and within the entire reservoir. The relatively small area directly impacted is not expected to significantly affect the functioning of soft sediment habitats in the reservoir. Similarly, small areas of fringing rocky habitat within the excavated rock placement area will be lost; although the addition of coarse excavated material should adequately compensate for any losses.</p> <p>Aquatic vegetation in Talbingo Reservoir in the areas of the excavated rock placement is mostly non-native <i>Elodea</i>, and loss of this nuisance species is not considered to be a negative impact. A few individuals of native aquatic species may be lost but would not affect the overall population in the reservoir.</p> <p>Submerged timber is extensive throughout Talbingo Reservoir, including within the vicinity of the proposed excavated rock emplacement area. On a reservoir scale, the loss of submerged timber within the proposed excavated rock placement area is unlikely to cause any long-term impacts on habitat availability.</p>	Low
Dry placement of excavated rock below FSL in Tantangara Reservoir	<p>Bare soft sediment habitat makes up the largest area of benthic aquatic habitat within the proposed placement area of Tantangara Reservoir. Due to the variability of water level that occurs within Tantangara Reservoir, the soft sediment habitat and benthic communities between MOL and FSL experience constant disturbance and the ecological value of benthic environment is diminished compared to areas that are permanently inundated below MOL (Cardno 2019b).</p> <p>No aquatic vegetation was observed. Very few areas of rocky shoreline habitat are present within Tantangara Reservoir, and where present, consist of scattered boulders and smaller rocks amongst the soft sediment (Cardno 2019b). The loss of a small proportion of these habitat types within the reservoir is not considered a significant impact.</p>	Low

Table 6.9 Removal/modification of aquatic habitat and associated biota

Activity	Impact assessment	Residual risk ¹
Construction of intakes and dredging works	<p>The soft sediment habitat in and around the proposed intake is not considered to be unique and once dredging and construction of the intakes are complete, areas within the approach channel will be stabilised with rock capping. There will be a complete loss of soft sediment habitat within the intake footprints and any uncapped areas would be recolonised over time. The loss of a small percentage of total soft sediment habitat within the reservoirs is negligible and is unlikely to have a long-term impact on nutrient cycling or trophic interactions beyond the immediate vicinity of the excavated intake areas.</p> <p>Similarly, a small area of natural rocky habitat along the shore will be lost during construction of the intakes. Although, the total overall area of hard substrate will be increased through stabilisation of the approach channel, which will compensate for any habitat loss.</p> <p>Aquatic vegetation in Talbingo Reservoir in the areas of the intake is mostly non-native <i>Elodea</i>, and removal of this nuisance species is not considered to be a negative impact. Scattered individuals of native aquatic species may be lost but would not affect the overall population in the reservoir. Macrophytes are largely absent from Tantangara Reservoir.</p> <p>Wood debris along the shore of Talbingo Reservoir in the vicinity of the intakes is likely to provide habitat for fish and crayfish species. Following disturbance, associated fish species would move to available habitat nearby. Pre-disturbance surveys of Murray crayfish would be undertaken prior to any habitat removal.</p> <p>Wood debris is largely absent from Tantangara Reservoir; instead there are areas of submerged grass tussocks.</p>	Low
Transfer of water between reservoirs during operations	<p>Available data indicates phytoplankton is more abundant in Tantangara Reservoir than Talbingo Reservoir. Some phytoplankton may die when transferred between reservoirs (due to pressure changes that rupture cells) while others could be expected to survive, resulting in the transfer of viable phytoplankton, including one species implicated in harmful algal blooms that are currently in Tantangara Reservoir that could be transferred to Talbingo Reservoir. Transfer of phytoplankton between Tantangara Reservoir and Talbingo Reservoir would likely result in changes to the phytoplankton assemblages in both reservoirs so that they become more alike. Changes to the phytoplankton assemblage in Talbingo Reservoir have the potential to alter the composition of other components of aquatic life in the reservoir, such as zooplankton communities, although this would not necessarily result in a negative impact.</p> <p>A one-way water linkage currently exists between Tantangara and Talbingo reservoirs via Lake Eucumbene and the upper Tumut River, and therefore plankton exchange between the two reservoirs is already possible. Despite the certainty of new water exchange pathways associated with Snowy 2.0, the consequence of mixing plankton assemblages is deemed to be minor. There are no direct practical methods for mitigating the transfer of phytoplankton between reservoirs or reducing the likelihood of occurrence and residual risk ranking is moderate.</p> <p>Given the abundance of <i>Elodea</i> in Talbingo, transfer of fragments during operation is likely. <i>Elodea</i> is already present in Tantangara and it is not known if this would lead to an increase in abundance of this species.</p>	Low - Moderate

Notes: 1. Residual risk following implementation of management measures.

ii Impacts to aquatic species and their distribution

The natural distribution of aquatic species is determined by environmental conditions and the ability of individuals (or eggs, larvae) to move between areas. Project activities can directly impact species (eg by smothering), can force individuals to flee from distasteful conditions (eg noise) or can restrict the natural movement of individuals between different areas (eg for spawning). New species introduced into areas can also compete with or consume local species. Several activities associated with the construction and operation of Snowy 2.0 could affect the natural distribution and/or movement of aquatic species in the project area. These are summarised in Table 6.11 below.

Table 6.11 Impacts to aquatic species and their distribution

Activity	Impact assessment	Residual risk ¹
Construction of surface infrastructure and utilities	<p><u>Fish passage</u></p> <p>Construction of permanent crossings has potential to temporarily obstruct the passage of fish and mobile macroinvertebrates. This is important for species where migration is required to complete reproductive life cycles and their ability to breed and spawn is restricted.</p> <p>The crossing site at Talbingo Reservoir has potential to provide habitat for several non-threatened native species and threatened Murray crayfish and trout cod. Temporary construction works at this site would therefore require site specific management. Temporary waterway obstructions would be minimised during the upgrade or construction of bridges and culverts. Where practical, waterways will be partially closed using a coffer dam, with works staged to minimise the total disturbance and maintain fish passage. Any flow diversion barriers and instream sediment control barriers would be removed as soon as practicable and rehabilitated.</p> <p>As stated above, cables will be underbored where they cross third perennial order waterways with Type 1 KFH with appropriate erosion and sediment controls, which will keep disturbance at these locations short term and highly localised.</p>	Low
	<p><u>Spread of aquatic weeds and pests</u></p> <p>Heavy plant, vehicles and barges operating in and around waterways during construction of roads, utilities and infrastructure have potential to act as vectors for a range of aquatic weeds and pest fish if not properly managed. The noxious weed <i>Elodea</i> is widespread in Talbingo Reservoir and plant fragments could inadvertently be transferred to other waterways. Similarly, eggs of non-native pest species, such as redfin perch, eastern gambusia and wild goldfish could be transferred between waterways.</p> <p>The risk of Redfin perch spreading from Talbingo Reservoir and its tributaries to Tantangara Reservoir and tributaries where it does not currently occur is of concern. Eastern gambusia and Wild goldfish are also not currently found in Tantangara Reservoir, the Upper Tantangara or Upper Murrumbidgee catchments. The introduction of pests to these catchments could impact on native species.</p> <p>A Weed, Pest and Pathogen Management Plan will be prepared and implemented to minimise and manage the spread of weeds, pest fish and pathogens which will include a description of measures that would be implemented to minimise the spread of weeds and pest via vehicle and plant movements.</p>	Moderate

Table 6.10 **Impacts to aquatic species and their distribution**

Activity	Impact assessment	Residual risk ¹
Subaqueous placement of excavated rock in Talbingo Reservoir	<p>Given the excavated rock emplacement area amounts to a small proportion of Talbingo Reservoir and recovery of benthic communities is expected to occur following the cessation of placement activities, the loss of soft sediment and rocky habitat biota would be temporary and amount to only a minor localised impact.</p> <p>Submerged wood habitat is widespread throughout the reservoir and any direct loss of this habitat within the excavated rock emplacement area likely represents only a small area compared to the broader reservoir. Therefore, any impacts to submerged timber in the excavated rock emplacement area would have a negligible effect on aquatic biota.</p>	Low
Dry placement of excavated rock below FSL in Tantangara Reservoir	<p>Excavated rock placement within Tantangara Reservoir would cause mortality to benthic infauna assemblages residing within sediments directly within the placement area. Given the excavated rock emplacement area amounts to a small proportion of Tantangara Reservoir and recovery of benthic communities is expected to occur following the cessation of placement activities, the loss of soft sediment and rocky habitat biota would be temporary and amount to only a minor localised impact.</p>	Low
Construction of intakes and dredging works	<p><u>Noise and vibration from blasting</u></p> <p>Receptors in the water column of the reservoirs that have potential to be directly affected by underwater noise and vibration associated with blasting include zooplankton, macroinvertebrates (including crustaceans such as crayfish, adult fish (native and non-native), larvae and eggs. Most fish species in Talbingo Reservoir are non-native brown / rainbow trout or pest species (redfin perch) and impacts to these species are not considered as having a direct negative impact.</p> <p>Designated blast limits and other management measures to minimise impacts to aquatic ecology will be outlined in the Blast Management Plan. Pre-disturbance clearance surveys would be undertaken to remove Murray crayfish from outside the affected zone and relocate them.</p>	Low to moderate
	<p><u>Hydraulic entrainment within dredge areas</u></p> <p>Direct entrainment of fish (individuals, larvae and/or eggs) into the dredge head is possible if a suction type dredge is used. Mobile species may be able to actively avoid the suction head. Non-native species are most likely to be entrained given their relative abundance in both reservoirs. Entrainment risk of crayfish is unknown. Pre-disturbance clearance surveys would be undertaken to remove Murray crayfish from outside the effect zone and relocate them.</p>	Low
Tunnel excavation and dewatering	<p>Modelled impacts to groundwater drawdown are presented in the Section 6.2 above. Predicted impacts are mainly restricted to discrete sections of the Gooandra Creek and the upper Eucumbene River. Increased periods of no flow would cause a decrease in available aquatic habitat, and population sizes of aquatic biota could decrease. Trout but no native fish species and only Reik's crayfish were found in Gooandra Creek during recent surveys. Likewise, for the upper Eucumbene catchment. Drawdown in the Yarrangobilly River catchment is predicted to be localised, with minimal changes overall for Yarrangobilly River and Wallaces Creek.</p> <p>The extent of associated impacts to aquatic habitat and biota from drawdown would be relatively minor within the context of each catchment.</p>	Low

Table 6.10 **Impacts to aquatic species and their distribution**

Activity	Impact assessment	Residual risk ¹
Transfer of water between reservoirs during operations	<p><u>Entrainment and transfer of biological material</u></p> <p>During operation, the flow of intake water at the reservoirs could entrain aquatic flora and fauna into the intake. Species drawn into the intake could be transferred alive through the tunnel (and underground power station) or be critically injured or killed during passage through the system.</p> <p>Plankton are not strong swimmers and would offer no resistance to being entrained in water being transferred between reservoirs. Daily abstractions by the intakes would be a small fraction of the total volume of reservoir water.</p> <p>Fish occurring in Talbingo Reservoir include a mixture of native and introduced species although introduced species make up a large proportion of the fish community (Cardno 2019b). Eggs of most of these species are at low risk of entrainment given they are adhesive and laid on submerged objects such as vegetation, logs and rocks or higher up tributaries. Eggs of freshwater crayfish in the reservoir, including the threatened Murray crayfish, are carried by females until they hatch in summer, and are unlikely to be entrained. Some benthic invertebrates release planktonic eggs and larvae which could be entrained into the inter-reservoir water exchange. Given the large volume of Talbingo Reservoir, the amounts of fish and invertebrate eggs entrapped daily by the intakes would likely constitute a negligible fraction of the total number of eggs at any one time in the reservoir.</p> <p>Fish larvae in the vicinity of the intake, would be susceptible to entrainment when the station was operating. Depending upon the species and size of individual, juvenile and adult fish species (including redfin perch and eastern gambusia) could also be entrained.</p>	Low

Table 6.10 **Impacts to aquatic species and their distribution**

Activity	Impact assessment	Residual risk ¹
	<p><u>Transfer of fish between reservoirs</u></p> <p>Ning <i>et al.</i> (2019) were commissioned by Snowy Hydro to investigate the potential survival of various life-history stages of redfin perch and of adult eastern gambusia through the proposed pumped hydro system. This was undertaken via a series of laboratory based experiments and modelling that simulated various aspects and scenarios of pumping from Talbingo to Tantangara reservoirs. This included simulated blade strike, shear stress and pressure changes. In addition to surviving passage through the pipeline and station, the likelihood of redfin perch or gambusia reaching Tantangara is also dependant on them becoming entrained at the intake. This would depend on conditions at the intake, factors related to fish behaviour and swimming speeds and presence of different life-history stages near the intake. Overall, they concluded that based on the results of their experiments and modelling, if entrained into the intake at Talbingo Reservoir, a proportion of redfin perch or eastern gambusia could survive the shear, blade strike and pressure impacts expected to occur within the pumped hydro system (Ning <i>et al.</i> 2019). Whether redfin and gambusia will be entrained into the intake and survive transfer through the completed development in 'real life' cannot be known with certainty until Snowy 2.0 becomes operational. In absence of this, the assessment is based on the experimental results.</p> <p>No data were obtained on survival of other fish species known to be present in Talbingo Reservoir and no studies were undertaken on the likelihood of survival of fish during the transfer of water from Tantangara Reservoir to Talbingo Reservoir in generation mode. Thus, as a precautionary approach Cardno's (2019b) assessment assumed the potential for any species currently present in either reservoir to survive transport through the pumped hydro system.</p> <p>The key ecological concern relating to water transfer is the potential transfer of undesirable species (redfin perch, gambusia, goldfish and climbing galaxias) from Talbingo to Tantangara which is considered likely for redfin perch and possible to unlikely for other species. Research into available options for preventing transfer has determined that no reasonable and feasible options exist for the Snowy 2.0 waterway; however, fish barriers are proposed at the outflows from Tantangara and near the waterfall on Tantangara Creek. These secondary controls form part of Snowy 2.0 Main Works. While the transfer of these species could lead to populations establishing in Tantangara reservoir and some distance upstream with consequent impacts on native fish and salmonids, the installation of barriers will limit the potential range expansion and prevent these fish from entering Lake Eucumbene or the known habitats of any threatened species.</p>	Moderate to high
	<p><u>Transfer of fish diseases between reservoirs</u></p> <p>The potential of Snowy 2.0 Main Works to increase the range of EHNW was assessed by the University of Sydney (Hick <i>et al.</i> 2018). EHNW is a viral pathogen of fish that is of international concern and in Australia has been restricted to the south-east mainland where it has caused sporadic outbreaks of high mortality disease in redfin perch since the 1980s, and low mortality disease in farmed rainbow trout. EHNW is not known to occur in Tantangara or Talbingo reservoirs and was not detected in limited testing undertaken for this project. As redfin perch is considered the host for this disease, there is potential for it already occur or to establish in Talbingo in the future (unrelated to Snowy 2.0).</p> <p>A direct water connection between Talbingo and Tantangara reservoirs increases the risk for expanding the range of EHNW, if EHNW occurs in Talbingo Reservoir or occurs at some point in the future. Without any disease mitigation, there is a high risk of EHNW accessing new locations and impacting susceptible fish populations including native species. The implementation of the fish barriers described in the section above will reduce, but not eliminate the potential for spread of the virus to other locations, should it occur in either of the reservoirs in the future. A monitoring program for EHNW is proposed as part of the project.</p>	Moderate

Notes: 1. Residual risk following implementation of management measures.

iii Changes to water quality

Water quality naturally varies between different water bodies while often fluctuating with season. Water quality is critical for the health of aquatic species and determines which aquatic species can live successfully in each aquatic habitat. Snowy 2.0 Main Works activities that alter the quality (or quantity) of surface water can impact on the health and distribution of aquatic species. These are summarised in Table 6.12.

Table 6.12 Changes to water quality and quantity

Activity	Impact assessment	Residual risk ¹
Surface infrastructure and utilities	<p>Temporary and permanent wastewater discharge outlets would be constructed with appropriate water quality maintained.</p> <p>Except for uncontrolled stormwater discharge, wastewater treatment would comply with the surface water quality guidelines and discharge limits as set out in the relevant management plans. Where possible, process water will be reused for TBM operations, dust suppression and greywater to reduce the flow discharged into reservoirs.</p> <p>Construction of new roads, accommodation camps and construction staging sites may lead to increased diffuse surface run-off. Contaminants such as hydrocarbons and metals may accumulate on road and hardstand surfaces used by heavy plant and equipment and could enter waterways during rainfall events. The increase in area of impervious surfaces is small compared to the entire project area and unlikely to cause widespread changes in surface water quality. Localised effects may be apparent and would be managed using standard stormwater practices. This may vary depending upon location within the project area.</p>	Low
Subaqueous placement of excavated rock in Talbingo Reservoir	<p>Emplacement of excavated rock material within Talbingo Reservoir has the potential to change water quality throughout the reservoir and impact aquatic ecology. Fine materials could stay suspended within the water column before settling out and depositing in areas within and outside of the placement area. Two main impact pathways on water quality exist as a result of the placement of excavated rock materials within Talbingo Reservoir: increased turbidity and sedimentation and increased levels of contaminants entering the water column.</p> <p>Increased turbidity (TSS) and sedimentation will occur in Talbingo Reservoir during placement of excavated rock (Royal Haskoning DHV 2018). Elevated TSS and sedimentation will be greatest at the placement area and will decrease with increasing distance. Silt curtains will be used to help contain suspended sediment to the immediate area around the placement site. Elevated TSS and sedimentation can impact the health of aquatic species.</p> <p>Contamination from excavated rock is not expected since most of the rock will come from underground areas associated with the tunnels and underground power station. Some excavated rock will be PAF so excavated rock will be stockpiled and screened for PAF before being allocated for reuse or placement in the reservoir.</p>	Low to moderate (TSS)
Dry placement of excavated rock below FSL in Tantangara Reservoir	<p>The Tantangara Reservoir excavated rock emplacement will be constructed immediately below FSL – allowing it to be constructed above the reservoir water level using standard ‘dry’ earthmoving equipment and techniques. As such, impacts to water quality are expected to be low. The final excavated rock placement will be at least 1m above FSL to allow for rehabilitation.</p> <p>Contamination from excavated rock is not expected since most of the rock will come from underground areas associated with the tunnels and underground power station.</p>	Low

Table 6.11

Changes to water quality and quantity

Activity	Impact assessment	Residual risk ¹
Construction of intakes and dredging and blasting works	<p>Dredging and blasting will cause an unavoidable and localised increase in suspended sediments. Aquatic species in the vicinity of the dredge will be exposed to turbid water and mobile species will move away to clearer water. Receptors likely to occur within the water column include plankton, fish larvae and adult fish. Based on fish populations known to occur within both reservoirs, mostly non-native species including stocked rainbow trout and brown trout and pest redfin perch (in Talbingo Reservoir) would be affected.</p> <p>Silt curtains deployed around the disturbance area will seek to contain turbid water within close proximity to the dredge. Silt curtains would also help to keep fish away from the high impact areas. Pre-clearance surveys prior to disturbance will be undertaken to minimise the risk of harm to Murray crayfish. Results of testing indicated that sediments, if mobilised would be unlikely to present any risk to the aquatic environment via the release of contaminants such as lead, nickel and zinc (Royal Haskoning DHV 2018).</p>	Low
Tunnel excavation and dewatering	<p>Impaired water quality could occur in watercourses associated with reduced flow from drawdown. Water quality in disconnected pool habitat could be compromised due to potential for elevated temperatures and reduced concentrations of dissolved oxygen particularly during summer. Affected areas would be relatively minor within the context of each catchment.</p>	Low
Transfer of water between reservoirs during operations	<p>The primary impact on water quality in the reservoirs will be changes due to the mixing of the water between the reservoirs. These changes may not be deleterious but will result in a new dynamic equilibrium being established in both reservoirs but most likely with a larger change in the water quality of Tantangara Reservoir as it does not currently receive water from Talbingo Reservoir and its total volume is smaller than Talbingo Reservoir.</p> <p>Only broad conclusions can be drawn because the water quality in each of the reservoirs will depend on the transfer regime and the transfer regime will vary depending on SHL operational decisions. Mixing of the reservoir waters during operations is unlikely to significantly impact pH, electrical conductivity, turbidity, dissolved oxygen concentration (except as a result of temperature changes); nutrients and metals (except for aluminium and copper). The greatest change to reservoir water quality is likely to be in water temperature, particularly in Tantangara Reservoir.</p>	Low

Notes: 1. Residual risk following implementation of management measures.

6.4.5 Mitigation measures

Proposed mitigation measures to reduce or mitigate impacts of the construction and operational activities of Snowy 2.0 Main Works on aquatic ecology are provided in Table 6.13.

Table 6.13 Mitigation measures for aquatic ecology impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Impacts to aquatic habitats	AE01	<p>An Aquatic Habitat Management Plan will be prepared and implemented to guide management of impacts to aquatic habitat. The plan will:</p> <ul style="list-style-type: none"> • be prepared in consultation with NPWS and DPI-Fisheries; • include a description of measures that would be implemented to: <ul style="list-style-type: none"> – protect aquatic habitat outside the approved disturbance areas; – minimise the loss of key aquatic habitat; – minimise the impacts of the development on threatened fauna species; – minimise the impact of the development on fish habitat; – relocate Murray crayfish from the shallower parts of the approved disturbance area in Talbingo Reservoir prior to disturbing these areas – notify DPI-Fisheries of any fish kills; • include a trigger action and response plan for the Murray crayfish, which would be implemented if monitoring shows the development is adversely affecting the species; • include a program to restore and enhance the aquatic habitat of the approved disturbance area expect for the intake and their approach areas as soon as practicable following the completion of development in these areas; • include a program to monitor and report on the effectiveness of these measures. 	Construction	Contractor
	AE02	Bridges or culverts would be designed and constructed in accordance with NSW DPI fish passage requirements for waterway crossings (Fairfull & Witheridge 2003).	Construction	Contractor
	AE03	Construction works within the channel of a permanent waterway with type 1 or 2 key fish habitat would allow some flow to maintain fish passage at all times and be staged to minimise the total disturbance at any given time.	Construction	Contractor
Spread of weeds pest fish and pathogens	AE04	<p>A Weed, Pest and Pathogen Management Plan will be prepared and implemented to minimise and manage the spread of weeds, pest fish and pathogens. The plan will:</p> <ul style="list-style-type: none"> • be prepared in consultation with NPWS and DPI-Fisheries; • include a description of measures that would be implemented to: <ul style="list-style-type: none"> – minimise the spread of weeds and pest via vehicle and plant movements; – remove aquatic macrophytes appropriately where required to do so to enable construction activities; • include a program to monitor and report distribution of pest fish within the project area; • include a surveillance plan for EHNW in key locations within the project area. 	Construction	Contractor

Table 6.12 Mitigation measures for aquatic ecology impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Underwater blasting impacts	AE05	Designated blast limits and other management measures to minimise impacts to aquatic ecology will be outlined in the Blast Management Plan.	Detailed design	Contractor
Controls	AE06	Install the following: <ul style="list-style-type: none"> • fish barrier on Tantangara Creek designed to prevent upstream migration of Climbing galaxias; and • fine mesh screens to prevent transfer of key species through releases from the Tantangara Dam River Outlet Works and the Murrumbidgee – Eucumbene tunnel. 	Construction	Contractor

6.4.6 Summary and conclusion

Construction and operational activities associated with Snowy 2.0 Main Works have potential to impact on aquatic ecology in some waterbodies in the project area. After adoption of mitigation measures to reduce impacts where possible, the residual risk for most activities is classified as low. The exceptions are associated with potentially moderate risks associated with the potential transfer of noxious species (fish and/or fish disease) between Talbingo and Tantangara reservoirs, and into associated catchments. Elevated TSS associated with emplacement of excavated rock in Talbingo Reservoir is also classified as moderate.

The management of risks to aquatic ecology will occur via the mitigation measures listed above and through the development of a range of management plans which will contain measures to construct the proposed development in a way that seeks to minimise negative impacts on the aquatic environment.

In response to the risk of fish transfers, Snowy Hydro has incorporated additional secondary controls into the Snowy 2.0 Main Works to prevent fish passage at the outflows of Tantangara Reservoir at the Tantangara Dam wall and Murrumbidgee-Eucumbene Tunnel and above the waterfall on Tantangara Creek. These measures will limit the potential range expansion of any fish that may be transferred as a result of the project and will prevent these fish from entering the known habitats of any threatened species including the Murrumbidgee River below Tantangara Reservoir and Lake Eucumbene. These controls are a result of considerable volumes of research and design development initiated by Snowy Hydro aimed to eliminate the potential risk to pre-existing fish populations and other components of aquatic ecology at risk from fish transfer.



CHAPTER 6.5 LAND

6.5 Land

6.5.1 Context

Potential impacts of Snowy 2.0 Main Works on soils and land capability, topography, geotechnical stability and geodiversity values have been assessed. The assessment relies on technical and specialists' reports prepared for the project and should be referred to for detailed information, including:

- a Preliminary Site Investigation (PSI) and Soils and Land Assessment (SLA) prepared by EMM and provided at Appendix N.1 and N.2 respectively;
- two specialist reports addressing Cenozoic and Paleozoic geodiversity values of the project area prepared by Dr Alexa Troedson and Dr Ian Percival and provided in Appendix O.1 and O.2; and
- a rehabilitation strategy for the project prepared by SLR and provided in Appendix F.

These technical reports collectively address potential impacts to land from Snowy 2.0 Main Works and are summarised in this section.

An overview of the existing environment as it relates to land is provided in Table 6.14, along with relevant community and stakeholder views and project design considerations relevant to the assessment.

Table 6.14 Context of land for Snowy 2.0 Main Works

Existing environment	<p>The project area is within the south-eastern portion of the Lachlan Fold Belt of NSW. The geology between Talbingo and Tantangara reservoirs is structurally deformed with numerous folds and several major faults associated with the north-south trending LPF Zone. The project intercepts two major structural blocks. These two structural blocks form distinct geological terrains; the dominantly Silurian Tumut Block in the west (the incised ravine, and the dominantly Ordovician Tantangara Block in the east (the Plateau). The terrains are separated by an escarpment caused by movement on the LPF.</p> <p>The soils of the project area reflect the extreme climatic gradient across the ravine and Plateau, and complex geology on which the soils have formed. Climatic conditions have a more dominant role in soil formation across the alpine and subalpine areas of the Plateau compared to the low-lying areas of the ravine.</p> <p>The range of geologies present has led to a wide variety of soils forming across the project area including Kandosols, Tenosols, Rudosols, Dermosols, Chromosols, Vertosols, Ferrosols and Organosols.</p> <p>The Talbingo Reservoir, Lobs Hole and Marica project areas consist of steep valleys and ravines of the Yarrangobilly River and tributaries. The subalpine Plateau that includes the Tantangara Reservoir project area has had a complex geomorphic history resulting in a landscape of disrupted drainage patterns and swampy basin. The Rock Forest site, situated outside the boundary of KNP, is on relatively gentle slopes.</p> <p>There are several recognised geodiversity features within the project area including and most notably periglacial block streams, Devonian fossiliferous rocks and tufa near Lobs Hole. The Yarrangobilly karst area is recognised for exceptional geodiversity values (KNP PoM) and while it is within the project area, it is some 5 km north of the tunnel alignment.</p> <p>Lobs Hole is the main area of potential contamination concern, due to its previous use as a copper mine and existing areas of identified metal contamination primarily associated with historical stockpiles. Some areas in the project area have also been identified as potentially containing NOA.</p>
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Table 6.13 **Context of land for Snowy 2.0 Main Works**

Community and stakeholder views	<p>Community and stakeholder views obtained through the preparation of the EIS highlight the need to address:</p> <ul style="list-style-type: none">• long term stability of soils and land resources;• progressive rehabilitation of land as well as the agreed state of final rehabilitation;• avoidance and minimisation of impacts to geodiversity in KNP, particularly fossil beds and blocks streams; and• NPWS stated a preference for removing all excavated material placed on land from the KNP post-construction. <p>These views have been considered through the development of the Rehabilitation Strategy (Appendix F) and ongoing design development.</p>
Avoidance and minimisation through design	<p>A specifically designed hybrid TBM will be used for tunnelling where there is potential for NOA to be encountered, and management measures for handling of this material at the surface.</p> <p>A geotechnical investigation program was undertaken across the project alignment to optimise the design of underground project elements including tunnels, chambers and shafts. Additional geotechnical investigations will be undertaken as part of the Exploratory Works to further refine the underground design.</p> <p>Geological and geotechnical risks have been considered as part of the geotechnical investigation program and project design and included consideration of potential for ground and sub-surface movement. The design of the proposed underground works has incorporated suitable excavation and primary support schemes and construction techniques.</p> <p>The construction method has been developed based on the known geological in-situ stress and strength conditions.</p>

6.5.2 Predicted impacts

Key impacts of Snowy 2.0 Main Works relating to land include the presence of PAF material, NOA, and other contaminating materials in some limited areas that could be disturbed by tunnelling, excavation and other construction activities. Appropriate management measures and protocols are proposed to minimise contamination risks. These activities are also planned to occur through, or in proximity to, identified geodiversity features.

A key impact of the project is the creation of new landforms. These landforms are directly linked to the excavated material management strategy for Snowy 2.0 Main Works and the Rehabilitation Strategy prepared for the project, which have been previously described in Chapter 2. The Rehabilitation Strategy has been developed to provide guidance on the rehabilitation of disturbed areas, as well as final land use consistent with the KNP PoM. The strategy identifies measures to enhance landforms to remain permanently within KNP at completion of construction, and outlines rehabilitation objectives are met.

i Talbingo Reservoir

The risk of contamination from construction activities at Talbingo Reservoir are considered to be low. There are no known geodiversity sites near the proposed works in this area.

The existing use of Lobs Hole as a remote campground within KNP presents opportunities for the project to enhance recreational values within the KNP. Through the Main Works design process, opportunities to enhance recreational opportunities at Lobs Hole have been identified. Key enhancements to recreation values at Lobs Hole include improving access roads as well as enhancing the geotourism potential of several geodiversity sites.

A conceptual site model for potential contamination impacts at Lobs Hole is provided in Figure 6.17. The main contamination risk at Lobs Hole is associated with disturbance to the existing excavated rock stockpiles associated with the historic Lobs Hole copper mine. There is also risk of contamination impacts from construction of access roads, construction yard and utilities infrastructure with potential to intercept PAF rock at Lobs Hole. Risks of encountering contaminated land during construction in this area will be managed through construction methods and suitable controls.

Geodiversity sites likely to be impacted by Snowy 2.0 Main Works are provided in Figure 6.18. The road upgrades on Lobs Hole Ravine Road will impact on three known geodiversity features; the Ravine block streams, the Ravine tufa and the Devonian fossil beds. The proposed road widening is expected to have some impacts on these geodiversity features with a disturbance footprint of up to 80 m wide.

The proposed road widening works will be refined through the detailed design process to minimise impacts to the Ravine block streams and Devonian fossil beds. Key considerations in finalising the design will be to minimise the removal or permanent covering of these features. Where permanent covering is required for geotechnical stability and road safety construction methods with low visual impacts will be selected where practical.

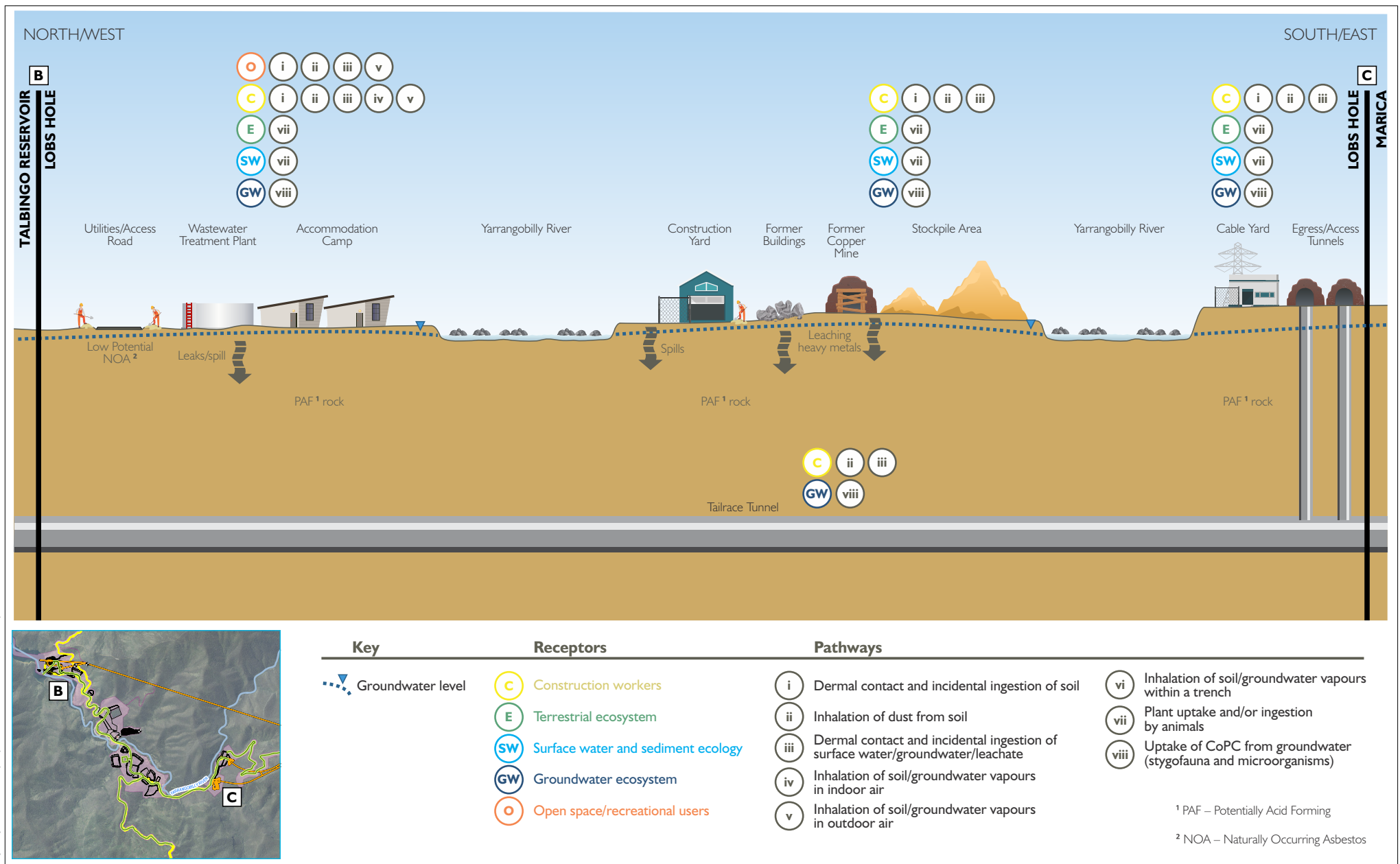
While the proposed works will impact the visible geodiversity features, they will remain largely intact.

Post construction, the access road works adjacent to the block streams and Devonian fossil beds provide an opportunity to enhance the geotourism potential of these features through the establishment of educational signage.

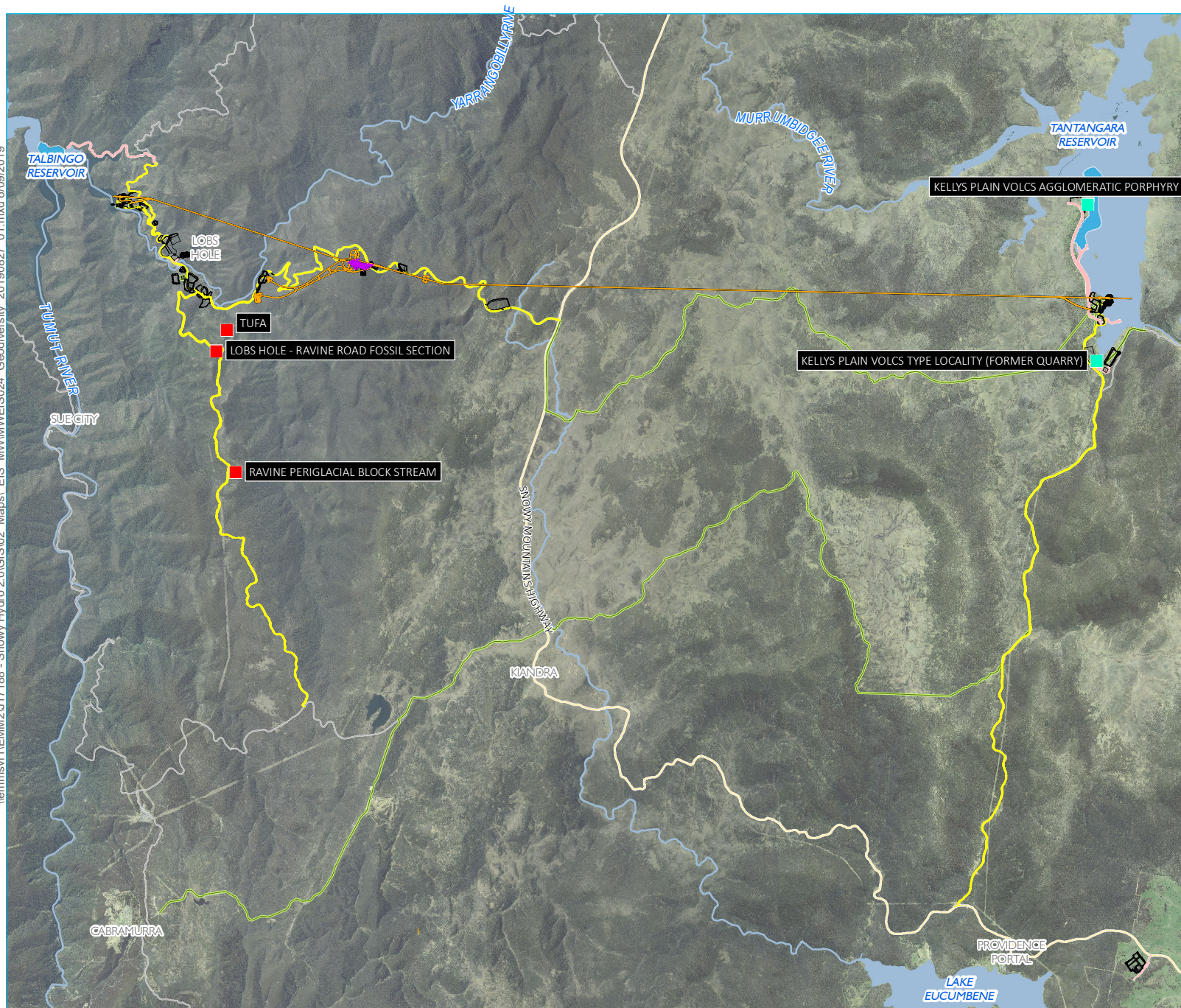
The road upgrades will not impact any of the high value cliff edge tufa within Cave Gully or Lick Hole Gully. Similarly, vibration impacts to tufa deposits outside the existing roadway are expected to be negligible. Three small tufa outcrops within the existing Lobs Hole Ravine Road corridor will be directly impacted by the proposed road upgrades. These impacts are considered to be minor relative to the remaining areas of high value tufa in the vicinity.

Approximately 1,000,000 m³ of excavated material used for temporary construction pads will remain in Lobs Hole following construction. Temporary construction pad areas will be rehabilitated with some areas in Lobs Hole shaped and landformed. Snowy Hydro will continue to engage with NPWS regarding the longer term use and design of Lobs Hole. Detailed design will follow the principles and concepts in the Rehabilitation Strategy provided in Appendix F to achieve stable non-polluting landforms and recreational areas.

Overall, with careful design the proposed works have potential to avoid significant impacts and enhance the geotourism potential of geodiversity sites on Lobs Hole Ravine Road and recreational opportunities within Lobs Hole.



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- KEY**
- Geodiversity sites
- Known site likely to be impacted
 - New sites likely to be impacted
- Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
- Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
 - Temporary access road
 - Indicative rock emplacement area
- Existing environment
- Main road
 - Local road
 - Watercourse
 - Waterbodies

Geodiversity sites likely to be impacted

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.18

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

0 2.5 5 km
GDA 1994 MGA Zone 55



iii Marica

The risk of contamination from construction activities at Marica are considered to be low.

There are no known geodiversity sites near the proposed works in this area. The Yarrangobilly karst area is north of Marica. There is no potential for direct impacts to the Yarrangobilly caves or other geodiversity features of the Yarrangobilly karst area. Indirect impacts to the Yarrangobilly karst area were assessed in the water assessment (Appendix J) and the noise and vibration impact assessment (Appendix R) and no impacts are expected. Permanent infrastructure to remain at Marica includes the Marica Road from the Snowy Mountains Highway (which accesses the MAT and ECVT portals), ventilation shaft and surge shaft yard.

iv Plateau

There is risk of encountering NOA through tunnelling across the Plateau. No known geodiversity sites will be impacted in this area. The communications cable, predominantly buried within the Gooandra Track, will be the only permanent infrastructure proposed in this location. The route will intersect some Alpine humus soils and peat bogs/fens, however these impacts are considered to be minor due to the nature of the trenching and underboring activities and subsequent rehabilitation.

v Tantangara Reservoir

There is medium risk of contamination impacts from construction activities at the Tantangara accommodation camp and utilities near a former quarry site, Traces Knob. Permanent infrastructure to remain in this area includes the Tantangara intake, upgraded Tantangara Road and utilities. The Tantangara camp will be decommissioned and the landform retained for inclusion in a masterplan for recreational use (eg camping) in consultation with NPWS.

Two sites with geodiversity potential may be impacted in this area. These sites are not listed in the KNP PoM or Kosciuszko National Park Geodiversity Action Plan (KGAP) but were identified as having some geological values from a comprehensive review of existing literature and mapping. These sites are part of the Kellys Plains Volcanics formation and are the former quarry site at Traces Knob and an outcrop of agglomeratic porphyry. The agglomeratic porphyry is within the Tantangara Reservoir FSL and has potential to be impacted by excavated rock emplacement. As the feature is within the existing reservoir the site has already been impacted and is frequently unobservable. The further impacts of covering by the excavated rock emplacement are not practical and therefore, considered unavoidable.

The former Traces Knob quarry may be impacted by construction activities for the Tantangara camp and associated utilities. Impacts to the quarry are considered to be reasonable and are consistent with the principles of avoiding and minimising impacts through the use of previously disturbed areas where practical.

vi Rock Forest

The risk of contamination from construction activities at Rock Forest are considered to be low. Also, there are no known geodiversity sites near the proposed works in this area.

6.5.3 Mitigation measures

The mitigation measures to be implemented for impacts to land are provided in Table 6.15.

Table 6.15 Mitigation measures for land impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Rehabilitation	REHAB01	<p>A Rehabilitation Management Plan will be prepared for the new landforms at Tantangara Reservoir, Lobs Hole and Talbingo Reservoir. The plan will:</p> <ul style="list-style-type: none"> include a detailed plan for rehabilitation of the site; include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the sites, and triggering any remedial action (if necessary); describe the measures that would be implemented to: <ul style="list-style-type: none"> comply with the rehabilitation objectives and associated performance and completion criteria; progressively rehabilitate the site; include a program to monitor and report the effectiveness of these measures. 	Construction	Contractor
Creation of new landforms	REHAB02	<p>New landforms will:</p> <ul style="list-style-type: none"> be safe, stable and non-polluting; maximise surface drainage to the natural environment 	Construction	Contractor
Assessment of surface disturbance and excavation areas	CONTAM01	Targeted investigations will be undertaken prior to construction along the surface disturbance areas using a risk-based approach. The results of these targeted investigations will determine the level of management to be implemented.	Pre-construction	Contractor
Assessment of imported Virgin Excavated Natural Material (VENM)	CONTAM02	Prior to the importation of any VENM during construction, the VENM source(s) will be identified and assessed against the definition of VENM in the <i>Waste Classification Guidelines</i> (NSW EPA 2014) and POEO Act. The VENM source(s) will be assessed by an appropriately qualified contaminated land consultant.	Construction	Contractor
Contaminated soil management during construction	CONTAM03	Protocols for the management of contaminated soil during construction will be included in the CEMP.	Construction	Contractor
Excavated rock waste management and transport	CONTAM04	Material which has been assessed as not suitable for reuse on land or for subaqueous disposal or cannot be reused will be classified in accordance with the <i>Waste Classification Guidelines</i> (NSW EPA 2014). The excavated rock would be transported to an appropriate excavated rock disposal area. Approval would be obtained prior to transport and would require an estimate of the likely volume of excavated rock to be disposed.	Construction	Contractor
Asbestos management	CONTAM05	An Asbestos Management Plan (AMP) will be developed for areas and items identified during pre-construction investigations as containing Asbestos Containing Materials ACM (ACM), areas suspected of containing ACM (such as historical buildings) and to address unexpected finds of ACM during construction. Specifically, protocols will be stipulated for separation, monitoring, validation and clearance of asbestos.	Pre-construction	Contractor
Asbestos management	CONTAM06	An Occupational Hygienist (Hygienist) will be on-site for the duration of the excavation works where ACM has been identified from pre-construction or where unexpected finds of ACM are encountered.	Construction	Contractor

Table 6.14 Mitigation measures for land impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
PAF rock	CONTAM07	An Excavated Rock Management Plan would be developed which would include measures identified in the Preliminary Site Investigation – Contamination (Appendix N.1).	Pre-construction	Contractor
Unexpected finds	CONTAM08	An unexpected finds procedure will be included in the CEMP. Workers will be trained to identify potential contamination that may be encountered during construction.	Pre-construction	Contractor
Alpine humus soils and peat bogs/fens	SOIL01	Mitigations will be included in the Rehabilitation Management Plan to minimise impacts to Alpine humus soils and peat bogs/fens.	Construction	Contractor
Loss of soil resource	SOIL02	<p>Preservation of the soil resource including quantity and quality to be managed through the implementation of soil management measures incorporated within the rehabilitation management plan which includes:</p> <ul style="list-style-type: none"> • an inventory of soils to be stripped, including depths and volumes; • a topsoil stripping and stockpiling procedure; • subsoil management measures; and • a soil reinstatement methodology which includes a topsoil application procedure. 	Construction and operation	Contractor
Soil erosion and sedimentation	SOIL03	Site-based Erosion and Sediment Control Plans (ESCPs) will be prepared by a Certified Professional in Erosion and Sediment Control (CPESC) for the construction works with controls addressing the sensitivity and the proximity of the receiving environment and attention will be given to areas where there is an increased risk of erosion, such as, dispersive soils and steep slopes and subalpine landscapes.	Construction	Contractor
Soil capability	SOIL04	<p>The Rehabilitation Management Plan (refer to REHAB01) will be implemented and will include measures to minimise:</p> <ul style="list-style-type: none"> • loss of soil; • loss of organic matter and nutrient decline; • soil structural decline; and • compaction. <p>The plan will include measures for subsoil management.</p>	Construction and operation	Contractor
Geodiversity – Ravine block streams	GEO1	Design principles identified in the Cenozoic Geodiversity Report will be implemented to minimise impacts to the Ravine block streams during detailed design.	Design and construction	Contractor
Geodiversity – Ravine tufa	GEO2	Design principles identified in the Cenozoic Geodiversity Report will be implemented to minimise impacts to the Ravine tufa during detailed design.	Design and construction	Contractor
Geodiversity – Lick Hole Formation fossil locality	GEO3	Final road design will consider incorporating interpretive signage and safe stopping space within the proposed road and disturbance footprint where practical.	Construction	Contractor
Geodiversity – Kellys Plain Volcanics Type Locality	GEO4	During construction, ensure that the former Traces Knob quarry is not in-filled.	Construction and operation	Contractor and Snowy Hydro

Table 6.14 Mitigation measures for land impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Geodiversity – Kellys Plain Volcanics agglomeratic porphyry	GEO5	Identify outcrops of agglomeratic porphyry prior to construction at Tantangara portal. Excavated rock placement should leave some of the best examples of the agglomeratic porphyry uncovered.	Pre-construction, construction and operation	Contractor and Snowy Hydro
Geodiversity	GEO6	A management plan will be prepared that includes measures that minimise impacts to known geodiversity sites and potential undocumented geodiversity sites identified in accordance with the recommendation in the Cenozoic and Paleozoic Geodiversity reports.	Construction	Contractor
Geodiversity	GEO7	Consult with NPWS regarding opportunities to enhance the geotourism potential of impacted geodiversity sites through the development of the masterplan for recreational use.	Operation	Snowy Hydro

6.5.4 Summary and conclusion

Key contamination matters relevant to land identified include contamination risks associated with PAF material at Lobs Hole and NOA materials at the Plateau that may be encountered during excavation works. Appropriate management measures and protocols are proposed to minimise contamination risks.

A Rehabilitation Strategy has been prepared to provide a final and end land use consistent with the KNP PoM. Work methods will implemented management measures to minimise impacts to soils and land capability. The proposed construction works have potential to impact on three known geodiversity sites and two potential newly identified geodiversity sites. Measures will be implemented to minimise impacts, manage and enhance the geodiversity sites identified and it is expected that the geodiversity values of the impacted sites will be maintained.

Impacts to land have been considered through the design of the Snowy 2.0 Main Works and risks and sensitivities for contamination, soils and land capability, rehabilitation and geodiversity were assessed and suitable management measures identified. With the implementation of the proposed management measures it is expected that the project will minimise impacts to land and achieve an end land use consistent with the KNP PoM.



CHAPTER 6.6

NATIONAL
HERITAGE VALUES

6.6 National heritage values

Snowy 2.0 Main Works is within the listed boundaries of two National Heritage places:

- Australian Alps National Parks and Reserves (AANP) – Place ID 05891; and
- the Snowy Mountains Scheme – Place ID 105919.

National Heritage places are protected under the EPBC Act and are deemed MNES under the EPBC Act. An assessment of cultural and heritage impacts of the project including the listed values of the AANP and Snowy Mountains Scheme and the cultural values of KNP is detailed in the heritage assessment and statement of heritage impact (HA&SoHI) (Appendix P.2) and the Aboriginal cultural heritage assessment report (ACHAR). The KNP is not listed as a National Heritage place individually but is one of the 11 National Parks and Reserves that comprise the AANP.

The AANP features both natural and cultural listed values. Impacts to the natural heritage values of the AANP have been assessed based on the results of several specialist studies related to geological, landscape, recreational and ecological values, which have been prepared to support this EIS.

6.6.1 Context

An overview of the heritage values of the AANP, Snowy Mountains Scheme and KNP are provided in Table 6.16, along with relevant community and stakeholder views for each item and project design considerations. The boundaries of these items are shown on Figure 6.19.

Table 6.16 Existing environment relevant to National heritage places

Existing environment	Community and stakeholder views	Avoidance and minimisation through design
<p>Australian Alps National Parks and Reserves</p> <p>The AANP is the mountainous bioregion that extends over NSW, ACT and Victoria. Snowy 2.0 Main Works is wholly within the boundaries of the listed place, except for Rock Forest which directly borders part of the place's eastern boundary (refer Figure 6.19). The AANP has outstanding heritage value to the national because of the place's importance in the course, or pattern, of Australia's nature and cultural history. The AANP is part of a unique Australian mountainous region. Human interaction with the region has been distinctive in its response to the challenges and opportunities present by the unique environment (Commonwealth of Australia Gazette 7 Nov.2008). The AANP listed National Heritage values are presented according to which significance criteria they fulfil. The AANP fulfils the threshold of six criteria which are provided in Table 6.17</p>	<p>SEARs issued by DPIE require the impacts to National Heritage place's official values to be addressed in the EIS. Consideration and assessment of impacts to the KNP geology, ecology, cultural heritage, recreation and landscape that contribute to some of the official values have been addressed in relevant specialist studies. Relevant impacts and issues are summarised in Table 6.17.</p>	<p>The design measures employed to avoid and minimise impacts to geological, ecological cultural heritage, recreational and landscape values have been assessed. Key design considerations to minimise impacts have been through a primarily underground design (minimised surface disturbance footprint) and developing opportunities for the public to explore and appreciate the KNP's significant values.</p>

Table 6.15 Existing environment relevant to National heritage places

Existing environment	Community and stakeholder views	Avoidance and minimisation through design
<u>Snowy Mountains Scheme</u>		
<p>The Snowy Mountains Scheme was constructed between 1949 and 1974. It is the largest public works engineering scheme ever undertaken in Australia. It is nationally significant for its engineering success and as a symbol of Australian achievement (Commonwealth of Australia Gazette 14 October 2016).</p> <p>Snowy 2.0 Main Works is wholly within the boundaries of the listed place, except for Rock Forest which directly borders part of the place's eastern boundary. The Snowy Mountains Scheme listed National Heritage values are presented according to which significance criteria they fulfil. The Snowy Mountains Scheme fulfils the threshold of six criteria which are provided in Table 6.6.</p>	<p>No specific concerns related to the place's official heritage values were raised by community or stakeholders.</p> <p>Snowy Hydro, who manage the legacy of the Snowy Mountains Scheme, is supportive of the project and view it as a means to facilitate the expansion of the original engineering achievement into the current generation.</p>	<p>Not applicable.</p>
<u>Kosciuszko National Park</u>		
<p>The cultural heritage of KNP encompasses many places and themes. It contains a great number of heritage sites, structures and artefacts and innumerable intangible values, some of which are recognised and celebrated nationally, while others are significant to particular groups, communities, families or individuals. The KNP features cultural values related to Aboriginal heritage, pastoralism, huts, mining, water harvesting, scientific research, conservation and recreation.</p> <p>Snowy 2.0 Main Works is wholly within the boundaries of KNP except for Rock Forest.</p> <p>The Aboriginal and historical heritage cultural values affected by the project area primarily addressed in the relevant technical assessments in Appendices P.1 and P.2. respectively.</p>	<p>The historical and Aboriginal cultural heritage assessments included community consultation to gather cultural and historical information about the project area. These are documented in Appendices P.1 and P.2.</p> <p>No specific concerns related to the KNP's conservation or scientific values were identified.</p> <p>Community and stakeholder views relating to recreational values are addressed in Appendix Y.</p>	<p>Measures to avoid historical and Aboriginal cultural heritage items are documented in Appendices P.1 and P.2. These studies detail extensive archaeological survey, and test excavation where relevant, which has resulted in the identification and avoidance of historical and Aboriginal sites where feasible. This includes avoidance of historical items Ravine Cemetery and Washington Hotel at Lobs Hole and an Aboriginal rock shelter at Tantangara Reservoir.</p>

6.6.2 Predicted impacts and mitigation measures

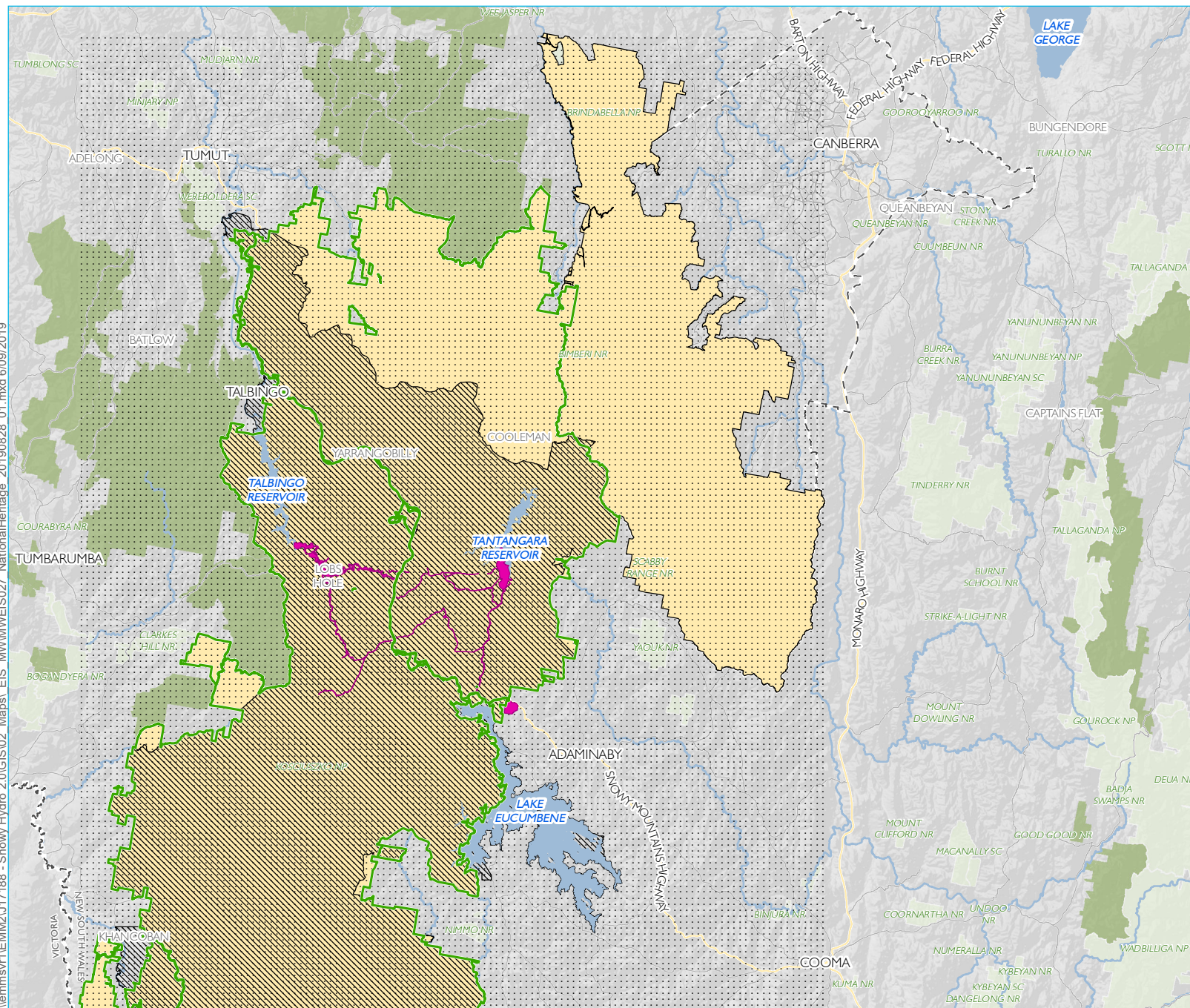
A referral under the EPBC Act for Snowy 2.0 Main Works was submitted to DEE on 21 October 2018. The referral nominated that Snowy 2.0 Main Works had the potential to have a significant impact on the nominated National Heritage places, although the level of impact was not determined at the time of lodgement. Accordingly, DEE determined that the project is a controlled action with a controlling provision including National Heritage places.

The project has several elements that will result in direct impacts within the AANP and Snowy Mountains Scheme National Heritage place boundaries and the non-listed KNP boundaries. A summary of the impact assessment and mitigation measures for the AANP, Snowy Mountains Scheme is provided in Table 6.17 and Table 6.18. A summary of the impact assessment and mitigation measures the non-National Heritage listed cultural values related to the KNP is provided in sections 6.7 and 6.8 and detailed in the ACHAR and HA&SoHI (Appendices P.1 and P.2).

Consideration of cumulative impacts from the approved Exploratory Works and the proposed Snowy 2.0 Transmission Connection project (a separate application by TransGrid, SSI-9717) was made for the AANP, Snowy Mountains Scheme and KNP. Exploratory Works was not determined to have a significant impact on MNES and was therefore not a controlled action. Accordingly, Exploratory Works will be a minor cumulative addition to the impacts of the current project.

The Snowy 2.0 Transmission Connection project is a controlled action with the relevant controlling provisions of National Heritage places, listed threatened species and communities and listed migratory species. However, the Snowy 2.0 Transmission Connection project is considered to represent a minor cumulative addition to the impacts of the current project considering it is relatively lesser in scope of disturbance and geographic extent. Impacts of the Snowy 2.0 Transmission Connection project will be addressed in a separate application and EIS.

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- KEY**
- Kosciuszko National Park boundary
 - Disturbance area*
 - EPBC Act matters of national environmental significance: National Heritage List
 - Place ID: 105891 - Australian Alps National Parks and Reserves
 - Place ID: 105919 - Snowy Mountains Scheme
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - NPWS reserve
 - State forest
 - State boundary

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

National heritage listing boundaries (AANP and Snowy Mountains Scheme) and KNP boundary

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.19

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

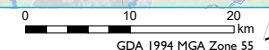


Table 6.17 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
Criterion A Events and processes	
Glacial and periglacial features	
<p>The assemblage of glacial deposits and features in the AANP includes five alpine lakes, thirteen cirques and associated moraines, ice-grooved and polished pavements and erratic boulders. Periglacial features, both fossil and modern, include block streams, permafrost and solifluction deposits. These features are the material expression of the cold-climate, high-altitude history of the AANP, unique in the low-latitude, low-altitude Australian continent. The glacial and periglacial features contribute uniquely to our understanding of the nature of landscape response to climate during the ice ages of the late Quaternary and into the present and therefore has outstanding heritage value to the nation for its importance in the pattern of Australia's natural history (Percival 1985; Galloway 1989; Yeates 2001a; ISC 2004; AALC 2006).</p>	<p>Snowy 2.0 Main Works will impact on five periglacial block streams through roadworks on Lobs Hole Ravine Road in the Ravine area of KNP. Block streams are linear deposits of boulders and cobbles, formed where periglacial conditions have promoted the frost-induced fracture of bedrock outcrops and subsequent en masse down-slope movement of the coarse rock debris under the influence of interstitial ice (Wilson 2007).</p> <p>The Cenozoic geodiversity assessment detailed the significance and potential for impacts to these features (Appendix O.2). This report found that the Ravine block streams have significance for their cultural value due to their potential use in geo-tourism and earth science education. They are part of the story of the ice age heritage of the park, a spectacular example of the effects of periglacial processes, and a prominent testament to late Quaternary climate change. Of additional interest are the visible ridges on the surface of Block Stream B which can be inferred to relate to ice age depositional processes. Intermittent views of the block streams can be obtained at various points on Lobs Hole Ravine Road.</p> <p>These block streams are bisected by the existing Lobs Hole Ravine Road and would be impacted further by project road upgrades. A proposed 80 m wide road corridor has been identified as the maximum extent of impact to the Ravine boulder streams. Snowy 2.0 Main Works are expected to negatively impact the boulder streams through the permanent removal and covering of boulders by the proposed roadworks. The extent of periglacial block streams in this area was mapped as part of the Cenozoic geodiversity assessment which demonstrated that even with the maximum impact occurring a significant extent of boulder streams would remain present in the Ravine area. The Cenozoic geodiversity assessment also identified several additional sites where undocumented periglacial features are likely to occur in the northern section of KNP.</p> <p>To manage the potential impacts to the Ravine block streams several management measures are proposed and are detailed in Section 4.3 of the Cenozoic geodiversity assessment. Measures to be implemented to minimise impacts to the Ravine block streams include selection of construction methods that minimise the road footprint and the visual impacts of the works during detailed design as well as additional field mapping and regular monitoring of block streams during construction. In addition, measures have been identified to enhance the geo-tourism potential of the block streams by providing educational signage and safe stopping space within the proposed road and disturbance footprint where practical.</p>

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
	<p>It is expected that the Ravine block streams will be directly impacted by project road works, but that they will maintain their potential to contribute to our understanding of the nature of landscape response to climate during the ice ages of the late Quaternary. The design of the project road works, and implementation of proposed mitigation measures will ensure that the Ravine block streams maintain and enhance their values as spectacular landscape features that demonstrate glacial and periglacial processes and patterns in Australia's natural history. Therefore, Snowy 2.0 Main Works will not diminish the geoheritage values of the Ravine block streams and with the implementation of the proposed mitigation measures will enhance their geodiversity and geo-tourism potential.</p>
Fossils	
<p>The Mt Howitt fish fossil site demonstrates remarkable fossil species diversity and preserves fish fossils across a wide range of life stages from larvae to mature fish, over tens of millions of years. The site contributes an important narrative about the evolution of fish across a number of different marine and freshwater environments, and the development of features that enabled vertebrates to leave the water to exploit terrestrial environments for the first time. Fossils revealed at the site have outstanding heritage value to the nation for their place in vertebrate evolution during the so-called 'Age of Fish' (Vickers-Rich and Rich 1993; Cook ed. 2007).</p>	<p>Not applicable. This value relates to Mt. Howitt fish fossil site which is not within the project area and will not be affected by Snowy 2.0 Main Works.</p>
Karst	
<p>The Yarrangobilly karst area contains an outstanding collection of surface karst features including gorges, arches, blind valleys, springs and pinnacle fields. It also contains several hundred caves including six show caves with many intricate cave decorations, open for public viewing (ISC 2004). Yarrangobilly has yielded valuable information on the long-term dynamics of landscape formation. The thick flowstone sequences in Jersey Cave span half a million years and provide the longest continuous fire history record from a single site in Australia (DEH 2006b). Yarrangobilly has outstanding value to the nation for its features and karst processes evident in the limestone karst landscape.</p>	<p>The potential for impacts to karst features in the Snowy 2.0 Main Works project area were addressed in the Paleozoic geodiversity report (Appendix O.1). The report found that no features of the Yarrangobilly karst area will be impacted by the project. No direct construction impacts will occur as all construction works are remote from the Yarrangobilly karst area.</p> <p>The Paleozoic geodiversity report also identified that of particular importance to karst sites is the preservation of the existing hydrology regime. As documented in the Snowy 2.0 Main Works water assessment (Appendix J) it is considered highly unlikely that the proposed tunnelling and excavation works would result in any hydrology impacts in the Yarrangobilly karst area.</p> <p>Therefore, the project is not expected to impact on karst features of the Yarrangobilly karst area or their value to the nation for its features and karst processes evident in the limestone karst landscape.</p>

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
<p>Biological heritage</p> <p>The Alps are one of eleven sites recognised in Australia by the IUCN as a major world centre of plant diversity. During the late Quaternary and into the present, the high-altitude, cold-climate environment has provided refuge for species in an increasingly arid climate. Containing most of the contiguous montane to alpine environments in Australia, the AANP supports a rich and unique assemblage of cold-climate specialist species that have evolved unique physiological characteristics, enabling them to survive in an environment subject to extreme climate variation. Outstandingly rich flora taxa in the AANP include the daisies (Asteraceae), willow-herbs (Onagraceae), starworts and cushion-plants (Caryophyllaceae), southern heaths (Epacris), bottlebrushes (Callistemon), orchids (Pterostylis, Prasophyllum and Dipodium) and pimeleas (Thymaelaeaceae). Cold-climate adapted and endemic fauna species include the mountain pygmy-possum (<i>Burramys parvus</i>), the alpine she-oak skink (<i>Cyclodomorphus praealtus</i>), Snowy Mountains rock skink (<i>Egernia guthega</i>), Baw Baw frog (<i>Philoria frosti</i>), southern corroboree frog (<i>Pseudophryne corroboree</i>), and the northern corroboree frog (<i>P. pengillei</i>). Species of a great many invertebrate taxa are endemic to the Alps. These include stoneflies, caddisflies, mayflies, grasshoppers, and earthworms. Many display cold-climate adaptations, such as the mountain grasshopper (<i>Acripeza reticulata</i>), mountain spotted grasshopper (<i>Monistria concinna</i>) and alpine thermocolour grasshopper (<i>Kosciuscola tristis</i>). The Bogong moth undertakes regular migration in Australia and an essential part of its lifecycle occurs within the AANP. The AANP is a vital refuge for alpine and sub-alpine flora and fauna species, with a high level of richness and endemism across a wide range of taxa, and therefore has outstanding value to the nation for encompassing a significant and unique component of Australia's biological heritage (Nankin 1983; Costin 1989; Strahan 1995; Good 1995; Boden and Given 1995; WWF and IUCN 1995; Cogger 1996; Crabb 2003; Good 2003; ISC 2004; DSE 2005; AALC 2005; DEC 2006; McDougall & Walsh 2007, ANHAT 2007).</p>	<p>The relevant species listed under the biological heritage values which were recorded within and adjacent to project area include Alpine She-oak Sink, Mauve Burr-daisy (<i>Calotis glandulosa</i>), Max Mueller's Burr-daisy (<i>Calotis pubescens</i>), <i>Prasophyllum innubum</i>, Kiandra Leek Orchid (<i>Prasophyllum retroflexum</i>), <i>Pterostylis alpina</i> and Slender Greenhood (<i>Pterostylis foliata</i>).</p> <p>Additionally, extensive surveys have resulted in an increased knowledge of the critically endangered Smokey Mouse. The species was only previously recorded three times within KNP. Following remote surveys, the species is now known from 70 locations within KNP. These surveys have significantly expanded the species known distribution within KNP. Providing further information around associated vegetation communities and altitudinal preference.</p> <p>For further detailed assessment on threatened flora and fauna within the KNP, please refer to the biodiversity assessment development report (Appendix M.1).</p> <p>Mitigations for project-related impacts include credit species offsets which will apply to affected species, weed protocols to ensure no introduced species will result from the project, and the prevention of the spread of existing exotic species.</p>

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
<p>Moth feasting</p> <p>The use of an adult insect – the Bogong moth – as the basis for past large-scale annual gatherings of different Aboriginal groups for ceremonies sets the gatherings in the AANP apart from other Aboriginal ceremonial gatherings and has captured the Australian imagination, making it exceptional in Australia (White 2006). Therefore the AANP has outstanding heritage value to the nation because of the importance of Aboriginal social gatherings based on moth feasting in the course, or pattern, of Australia's cultural history</p>	<p>The areas associated with moth feasting are relatively place specific and refer to travel routes, ceremonial places and rock tors that host bogong moths. The Kiandra Plateau would have been traversed by people making their way between important localities such as the Bogong Mountains to the north and Jagungal in the south that were associated with moth feasting and ceremonies (Knight 2009). Moth feasting localities such as rocky tors are, however, generally absent from the project area. The exception is a large rock shelter site at Tantangara which is near to but nevertheless outside the project disturbance footprint.</p> <p>Impacts to the Kiandra Plateau in which travel would have occurred will include road access (most of which currently exists) and the installation of communication cabling within existing road corridors. Such impacts to the landscape can be considered minor and certainly visually insignificant. Impacts would not occur to known moth feasting locales or areas associated with moth feasting ritual activity. Therefore, no moth feasting places, or areas associated with moth feasting will be impacted as a result of the proposed action. The project will not cause a significant impact to the National Heritage values of moth feasting in the AANP. No mitigation is required.</p>
<p>Transhumant grazing</p> <p>The AANP has outstanding heritage value for its association with historic transhumant grazing that commenced in the 1830s. The practice of using alpine high plains to graze stock during the summer months was a significant pastoral activity of the nineteenth and twentieth centuries and was continuously practised for a period of over 150 years; making a considerable contribution to the early pastoral industry of south-east Australia. Transhumant grazing created and sustained a distinctive way of life that is valued as an important part of Australia's pioneering history and culture. Evidence of transhumant grazing includes huts, the former grazing landscapes, stock yards, and stock routes.</p>	<p>All areas in which impacts would occur, including Talbingo, Lobs Hole, Marica, the Plateau and Tantangara were used in the past for transhumant grazing. The evidence of transhumant grazing including huts, stock yards and stock routes occur within the general area of the disturbance area, however, the primary evidence is old stock fences lines, many of which occur within the project disturbance footprint. No huts or stock yards occur within the project disturbance footprint.</p> <p>The impact assessment as presented in the HA&SoHI (Appendix P.2) has determined that impacts to stock fences range from negligible or little in most instances, to moderate in a few.</p> <p>In order to minimize impacts to the official value of transhumant grazing, management and mitigation measures have been proposed as set out in the HA&SoHI (Appendix P.2). These include measures such as minimizing impacts as much as possible, the establishment of no-go zones, archival research and archival recording.</p> <p>Snowy 2.0 Main Works will not cause a significant impact to the National Heritage values of transhumant grazing in the AANP.</p>
<p>Scientific research</p> <p>The AANP has outstanding heritage value for the scientific research that has taken place since the 1830s, demonstrated by the density and continuity of scientific endeavour. Research sites within the AANP include those relating to botanical surveys, soil conservation exclosures, karst research, fauna research, meteorology, fire ecology plots, arboreta and glacial research sites. Space tracking undertaken in the ACT with Honeysuckle Creek Tracking Station having played a significant role in the Apollo 11 moon landing mission.</p>	<p>The additional scientific research that has been completed for the Snowy 2.0 project (Exploratory Works and Main Works) will constitute a positive impact which will be built upon subsequent to project approval. This includes significant ecological findings (eg endangered Smoky Mouse and bogs and fens), additional investigation into geodiversity and its public accessibility and interpretation, and increased evidence of Aboriginal and historical occupation of the KNP.</p>

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
<p>Water harvesting</p> <p>Water harvesting in the AANP has outstanding heritage value to the nation for its contribution to the social and economic development of Australia. Water harvested from headwaters in the AANP contributes to the water needs of Canberra and Melbourne. The Snowy Scheme and the Kiewa Valley Hydro-electric Scheme also contributes to the electricity needs of south-eastern Australia. Both schemes were major post-war reconstruction projects, encouraging migration to Australia and employing over 60,000 displaced persons from post war Europe. Evidence of water harvesting in the AANP for power and irrigation includes the major pondages along with the numerous tunnels, aqueducts, power stations, huts, roads and former settlements, town and work camp sites.</p>	<p>Snowy 2.0 Main Works is based on a water recycling system and accordingly, any potential net loss in the water harvesting scheme is considered negligible. The proposed impacts would have a neutral impact on the water harvesting values of the AANP.</p> <p>In regard to the use of water for the production of electricity, the project rationale is to significantly increase the electricity generating capacity of the Snowy Mountains Scheme.</p> <p>The project will not cause a significant impact to the National Heritage values of water harvesting in the AANP.</p>
<p>Recreation</p> <p>The AANP has outstanding heritage value for the longevity and diversity of its recreational use. Snow sports commenced in Kiandra in 1861 with the establishment of the Kiandra Snowshoe Club and expanded from an ad hoc activity by enthusiasts to a multi-million dollar snow sport and tourism industry characterised by the groomed ski slopes, ski lift infrastructure and substantial village resorts. The chalets supported by government were major features of the expanding activity and were established in scenic locations in the early twentieth century when mountain retreats were highly regarded for good health. These include the Mount Buffalo Chalet, the Yarrangobilly Caves House Precinct, the Chalet at Charlottes Pass, and the former Hotel Kosciuszko and Mount Franklin Chalets.</p>	<p>Potential impacts to recreational values of KNP are documented in TRC Tourism (2019, Appendix Y). The listed recreational sites contributing to the heritage values of AANP will not be impacted by Snowy 2.0 Main Works.</p> <p>The nearest snow sport centre is Selwyn Snowfields, a small ski field on the Kings Cross Road, off Link Road. No direct impacts to the use of this area is expected, however there will be indirect impacts associated with an increase of construction vehicles utilising the Snowy Mountains Highway and Link Road. Recreational uses potentially impacted by the project are limited to sites at Lobs Hole (remote camping, 4WD) and Tantangara (remote camping, fishing, 4WD, horse riding). At the end of construction, public access will be reinstated except where there is a risk to public safety (eg within reservoirs near operational intake structures).</p> <p>Snowy 2.0 Main Works will not impact the National Heritage values of recreation in the AANP.</p>
Criterion B Rarity	
<p>Landscape and topography</p> <p>The high altitudes of the plateaus and peaks in the AANP are prominent in a continent with an average elevation of only 330 m above sea level. The AANP includes most of continental Australia's peaks over 1,700 m and all of those over 1,900 m. These high peaks and plateaus contain the vast majority of alpine and sub-alpine environments in Australia. The AANP experiences extensive snow coverage on a seasonal basis, and its glacial lakes are the only wetlands on the Australian mainland covered by ice sheets in winter. The high-altitude landscape of the AANP has outstanding heritage value to the nation for its topographic heights, uncommon alpine and sub-alpine ecosystems and glacial lakes. (AALC 2005; DEC 2006; Geoscience Australia 2007).</p>	<p>The landscape values of KNP have been assessed in Spackman Mossop Michaels (Appendix S) as relevant to Snowy 2.0 Main Works. The sensitivity of the existing landscape character to change is recognised as high due to its scenic quality, landforms and topography, alpine vegetation, and many other unique characteristics. While the assessment concludes that landscape character impacts are higher during construction, rehabilitation of disturbed areas is expected reduce these impacts during operation.</p> <p>Permanent structures to remain within KNP will be new elements in the landscape. However, these are largely within previously disturbed areas or are consistent with the presence of other infrastructure established during the existing Snowy Mountains Scheme and familiar to visitors of KNP (such as the existing reservoirs and buildings). A number of design measures have been recommended to minimise the visual and landscape impacts of Snowy 2.0 Main Works on KNP.</p>

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
<p>Glacial and periglacial features</p> <p>Continental Australia and its southern territorial islands have experienced periods of historic glaciation, with current snow and ice coverage limited to the highest peaks and altitudes. On mainland Australia, the AANP preserves a concentration of glacial and periglacial features without comparison from the ice ages of the late Quaternary Period. The Kosciuszko Plateau is unique in mainland Australia as the only place irrefutably exhibiting landforms shaped by Late Pleistocene glaciers during a series of glacier advances known as the Late Kosciuszko Glaciation. The active and fossil periglacial landforms of the AANP include block streams and solifluction features (solifluction is the gradual movement of waterlogged soil down a slope, especially where percolation is prevented by a frozen substrate). They are the most striking and extensive in mainland Australia and demonstrate the widespread effects of cold climate in the Quaternary, mild climate in the Holocene and the absence of intensive Pleistocene ice modification of the elevated landscape of the Victorian and ACT Alps. Therefore the AANP has outstanding heritage value to the nation for containing uncommon glacial and periglacial features (Percival 1985; Yeates 2001; Barrows et al. 2001).</p>	<p>The potential impacts and management for glacial and periglacial features are addressed under Criterion A in this table. The project will have minimal effect on the rarity of these values because the Cenozoic geodiversity assessment identified that a significant extent of block streams would remain present in the Ravine area, despite there being impacts proposed to five periglacial block streams (Appendix O.2).</p> <p>The affected uncommon periglacial features will be showcased by providing interpretive signage and safe stopping space within the proposed road and disturbance footprint where practical.</p> <p>This has the potential to enhance the geo-tourism value of the periglacial features.</p>
<p>Fossils</p> <p>The Mt Howitt fish fossil site is globally rare because it preserves a diverse array of fossil fish in uncommon detail at all stages of their lives. It is unique nationally in providing a snapshot of a complete freshwater vertebrate community from the past, and for yielding fossils from all stages of growth of a species, from tiny fish larvae to adult fish, and therefore has outstanding heritage value to the nation because of its preservation of an uncommon aspect of Australia's natural history (Long 2002; Cook ed. 2007).</p>	<p>Not applicable. This value relates to Mt Howitt fish fossil site which is not within the project area and will not be affected by the project disturbance footprint.</p>

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
<p>Alpine and sub-alpine ecosystems</p> <p>The AANP has outstanding heritage significance to the nation for possessing extremely uncommon aspects of Australia's natural history. Alpine and sub-alpine ecosystems are uncommon in the generally arid and warm climate of Australia. The distribution of cold-climate species on the mainland retreated to the higher altitudes of the Alps in the Late Pleistocene as conditions began to warm up. The AANP contains most of the alpine and sub-alpine ecosystems on mainland Australia, supporting flora and fauna species that have evolved to the harsh conditions of the high altitudes. Many of these species are endemic to the Alps and are found nowhere else in Australia. The bog and fen groundwater communities are supported by organic soils and contain exceptional water retention properties. These communities play an integral role in ecosystem function by regulating the slow release of water from saturated peatbeds to the surrounding alpine humus soils, streams and other alpine communities (Good 1995; AALC 2006b).</p>	<p>The BDAR completed for the project assessed the impacts to Alpine and sub-alpine peatlands, damp herbfields and fens which are referred to as 'Alpine Sphagnum Bogs and Associated Fens' (Appendix M.1). Direct impacts to these ecosystems have been largely avoided during the detailed design process by review and redesign of proposed infrastructure and comms line routes. Small areas where comms routes intersect with the ecosystems will be offset in accordance with the biodiversity offset framework outlined in Appendix M.1.</p> <p>As a result of the measures to avoid and minimise impacts, particularly removal of large sections of the project area across the plateau area, there has been a significant reduction in impacts to this community. Snowy 2.0 Main Works will result in a residual impact to 3.94 ha of the community, representing 0.04% of the national extent of the community. A further 17.51 ha is mapped within the groundwater drawdown area and may be subject to impacts arising from changes in hydrology. The scale and extent of these impacts are unknown and will be subject to ongoing monitoring.</p> <p>For further detailed assessment on threatened flora and fauna within the KNP, refer to the BDAR (Appendix M.1).</p>
<p>Eucalypt flora community</p> <p>The AANP provides an outstanding example of the adaptability of a plant genus, the genus <i>Eucalyptus</i>, along a steep topographical transect. The eucalypts dominate the AANP vegetation from the lowlands to as high as the alpine region, where the snow gum (<i>E. pauciflora</i>) defines the treeline. Much of the highest land in Australia occurs within the AANP, which also demonstrates very large topographical variations, which in turn is reflected in the high diversity of eucalypt species replacing each other along the altitudinal and climatic gradient (Costin 1988; Kirkpatrick 1994; ISC 2004; ANHAT 2007).</p>	<p>A key focus of design for Snowy 2.0 Main Works has been to avoid and minimise impacts to biodiversity values, including Eucalypt flora communities. <i>Eucalyptus</i> species provided important habitat and food supply for a variety of threatened fauna species. Where viable, high condition vegetation has been avoided, utilising existing tracks and low condition vegetation where Eucalypts are not present. Areas where <i>Eucalyptus</i> communities were unable to be avoided will be offset in accordance with the biodiversity offset framework as discussed in the BDAR (Appendix M.1).</p> <p>For further detailed assessment on threatened flora and fauna within the KNP, please refer to the BDAR (Appendix M.1).</p>

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
Criterion D Principal characteristics of a class of places	
<p>North-East Kosciuszko Pastoral Landscape</p> <p>The landscape is outstanding for demonstrating the use of mountain resources, namely the summer grasses and herbfields. As a relict landscape of past grazing leases it conveys the principal characteristics of transhumance and permanent pastoralism in a remote environment, these being large areas of open grassy landscapes between timbered ridges and hills, stockman's huts, homestead complexes, stockyards and stock routes. The grasslands with swathes of pioneer shrubs include the Kiandra landscape, Boggy Plain, Nungar Plain, Gulf Plain, Wild Horse Plain, Tantangara Plain, Dairyman's Plain, Currango Plain, Long Plain, Cooleman Plain, Kellys Plain, Blanket Plain, Peppercorn and Pockets Saddle (KHA 2008). Homestead buildings include Cooinbil and Old Currango and the modest homestead complexes of Currango and Coolamine with additional features including exotic plantings, sheds, barns, and workers' accommodation. Former stock routes, now fire trails, include the Port Philip Fire and Murrays Gap Fire Trails. In the former grazing leases are stockman's huts, Bill Jones Hut, Circuits Hut, Gavels Hut, Hains Hut, Hainsworth Hut, Millers Hut, Oldfields Hut, Pedens Hut, Pockets Hut, Townsends Lodge, Gavels Hut, Long Plain Hut, Gooandra Hut, Schofields Hut, and Witzes Hut (KHA 2008), which in their use and re-use of available materials typify a lifestyle and vernacular bush building technology using hand tools. The array of characteristics relate to over a century of alpine grazing.</p>	
<p>The project Plateau and Tantangara Reservoir areas are within the North-East Kosciuszko Pastoral Landscape. Specifically, minor impacts would occur within the Kiandra landscape, Boggy Plain, Nungar Plain, Tantangara Plain and Kellys Plain. The relict landscape is comprised of open grassy landscapes between the timbered ridges and hills and includes huts, homestead complexes stock yards and stock routes occur within the general area of the proposed disturbance footprint, however, the primary evidence is old stock fences lines, many of which occur within the project disturbance footprint. No huts, homesteads or stock yards occur within the project disturbance footprint. Largely, the impacts proposed across pastoral landscapes will be linear; such as road access (existing roads/fire trails) or underground cabling within road corridors, and can be considered to be minor in nature.</p> <p>In order to minimize impacts to the official value of the North-East Kosciuszko Pastoral Landscape, management and mitigation measures have been proposed such as the establishment of no-go zones, archival research and archival recording.</p> <p>The project will not cause a significant impact to the National Heritage values of North-East Kosciuszko Pastoral Landscape in the AANP.</p>	

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
Criterion E Aesthetic characteristics	
Distinctive and valued landscapes	
<p>The AANP is a powerful, spectacular and distinctive landscape highly valued by the Australian community. The mountain vistas, including distinctive range-upon-range panoramas, snow covered crests, slopes and valleys, alpine streams and rivers, natural and artificial lakes, the snow-clad eucalypts and the high plain grasslands, summer alpine wildflowers, forests and natural sounds evoke strong aesthetic responses. Much of the terrain of the AANP is highly valued for its remoteness, and naturalness, including views to and from the region that capture snow clad ranges and mountain silhouettes against clear skies as well as expansive views of natural landscapes from the high points of the Alps.</p> <p>The upper Snowy River and Snowy Gorge, Mount Buffalo, the Kosciuszko Main Range, Lake Tali Karng, Dandongadale Falls the peaks and ridges between and including Mt Cobbler, Mt Howitt and the Bluff, and other high peaks, ridgelines, granite outcrops and escarpments are examples of dramatic awe-inspiring landscapes. Recreational pursuits in these landscapes are enhanced by aesthetic appreciation of their wild and natural quality.</p> <p>Snow-covered eucalypts, huts in mountain settings and mountain landscapes are distinctive Australian images captured by numerous artists and photographers. The mountain landscapes have inspired poets, painters, writers, musicians and film makers.</p>	<p>The project disturbance footprint is not in areas specifically recognized as powerful, spectacular and distinctive landscapes. Many of the notable aesthetic values of the AANP such as mountain vistas, including distinctive range-upon-range panoramas would not be impacted by project. Minor, insignificant or temporary impacts would otherwise occur to aspects of the landscape including snow covered crests, slopes and valleys, alpine streams and rivers, natural and artificial lakes, the snow-clad eucalypts and high plain grasslands and summer alpine wildflowers would. Most of the high plain grasslands and valleys across Plateau will only have minor visual impacts through linear infrastructure.</p> <p>Most of the proposed permanent structures are within previously disturbed areas or are consistent with the presence of other infrastructure established during the existing Snowy Mountains Scheme and familiar to visitors of KNP (such as the existing reservoirs and buildings). Accordingly, such landscapes are not necessarily distinctive as natural and remote landscapes because human modification through damming and infrastructure is clearly visible in key project areas such as Talbingo and Tantangara reservoirs.</p> <p>Lobs Hole represents a cleared and remnant indicator of the previous Ravine Village and Lobs Hole Mining Complex. These historical land uses have resulted in a landscape that is not prized for its natural or remote landscape values.</p>
Criterion G Social value	
<p>The Australian Alps have a special association with the Australian community because of their unique landscapes, the possibility of experiencing remoteness and as the only opportunity for broad-scale snow recreation in Australia. The AANP is widely recognised by Australians as the 'high country' and many community groups have a special association with the AANP for social and cultural reasons.</p>	<p>The social values of KNP have been assessed by TRC Tourism (Appendix Y) through a recreational user assessment, which has included responses to a survey of park users within the areas potentially impacted by Snowy 2.0 Main Works. Lobs Hole and Tantangara are recognised as camping destinations for those that want to experience the remoteness of the area, undertake water-based activities, or have a family connection to the area. While there will be impacts to recreational uses at Lobs Hole and Tantangara, it is proposed to rehabilitate these impacted areas to provide improved recreational facilities. There is opportunity to improve the social values of AANP by proving improved access and facilities at these locations. The rehabilitation and master planning of potential recreational facilities will be determined in consultation with NPWS, to ensure relevant KNP values are maintained.</p>

Table 6.16 Australian Alps National Park impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
Criterion H Significant people	
<p>The Australian Alps have a special association with the Australian community because of their unique landscapes, the possibility of experiencing remoteness and as the only opportunity for broad-scale snow recreation in Australia. The AANP is widely recognised by Australians as the 'high country' and many community groups have a special association with the AANP for social and cultural reasons. Mount Kosciuszko is an iconic feature for all Australians and visited by over 100,000 people each year. It was named by the explorer Paul Edmund Strzelecki after the Polish freedom fighter, General Tadeusz Kosciuszko, in appreciation of freedom and a free people, an association that is highly valued by Australia's Polish community. The pioneering history of the high country is valued as an important part of the construction of the Australian identity featuring in myths, legends and literature. The ballad of The Man from Snowy River epitomises horsemanship undertaken historically in the rugged landscape. The stories, legends and myths of the mountains and mountain lifestyles have been romanticised in books, films, songs, and television series and many such as the Elyne Mitchell's Silver Brumby novels are part of Australia's national identity. The mountain huts of the AANP constructed for grazing, mining and recreation are valued by communities as a physical expression of the cultural history of the region. They have special associations with many groups, such as mountain cattlemen, skiers and bushwalkers but particularly with huts associations that have been maintaining mountain huts and associated vernacular building skills for over 30 years.</p>	<p>The project area is not specifically associated with the life, actions or legacy significant people. Importantly, the project will not impact valued huts that were constructed for grazing, mining and recreation. Therefore, groups that have special associations with huts such as mountain cattlemen, skiers and bushwalkers would not experience loss of social related values.</p>

Table 6.18 Snowy Mountains Scheme impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
Criterion A Events and processes	
The Snowy Mountains Scheme is an unprecedented civil engineering project stimulated by the will of the post-World War II Commonwealth Government to build a strong Australian economy. The Snowy Mountains Scheme was a major impetus in the development of Australia's engineering expertise and industrial relations environment in the post-war period. The Snowy Mountains Scheme employed people from thirty different countries, including approximately 60,000 European Displaced Persons and migrants. The Scheme was hailed as a model of multicultural co-operation and integration and provided the opportunity for thousands of migrants to start a new life after the impacts of the war. The vast workforce that was required to build the Snowy Mountains Scheme required new management practices and the mechanisms implemented by Sir William Hudson permanently changed the nature of industrial relations and workplace conditions in Australia.	The project will not cause an impact to the National Heritage values associated with the engineering expertise and industrial relations environment of the Snowy Mountains Scheme in the post-war period. It will not diminish the significance of the Snowy Mountains Scheme relating to the multicultural co-operation and integration provided to the thousands of migrants to start a new life after the impacts of the war.
Criterion B Rarity	
The Snowy Mountains Scheme is a rare example of an engineering program of enormous complexity and scale.	<p>In the original Snowy Mountains Scheme design, a tunnel and associated power station between Tantangara and Talbingo was proposed. It was never built, and it is this link between the two existing reservoirs that Snowy Hydro now plan to construct as Snowy 2.0 Main Works. Accordingly, the project will serve to complete the scheme and hence amplify the significance of the Snowy Mountains Scheme.</p> <p>The project will not cause an impact to the rarity of the engineering program of enormous complexity and scale which is embodied in the Snowy Mountains Scheme.</p>
Criterion D Principal characteristics of a class of places	
The Snowy Mountains Scheme is an exemplar as a currently operating, intact hydro-electric scheme that is the largest and most complex example of such schemes in Australia. The Snowy Mountains Scheme retains all the characteristics of a complex hydro-electric and irrigation scheme with a very high degree of integrity.	The project will not cause an impact to the example of the Snowy Mountains Scheme as a currently operating, intact hydro-electric scheme that is the largest and most complex example of such schemes in Australia. It will not cause an impact to any aspect of the nature of the complex hydro-electric and irrigation scheme. As a component of the original design, Snowy 2.0 Main Works would serve to further develop the scale and complexity of the existing electric and irrigation scheme.
Criterion F Creative or technical achievement	
The Snowy Mountains Scheme is widely regarded as one of the engineering wonders of the world. The Scheme is a major engineering feat that is recognised for its technical excellence and innovation.	The project will not cause an impact to the status of the Snowy Mountains Scheme as being one of the engineering wonders of the world. It will not cause an impact to the technical excellence and innovation as embodied in the Snowy Scheme. As a component of the original design, Snowy 2.0 Main Works will serve to further develop the engineering significance and technical excellence and innovation that the scheme is recognised for its.

Table 6.17 Snowy Mountains Scheme impact assessment and mitigation

Official values	Impact assessment and proposed management and mitigation
Criterion G Social value	
The Snowy Mountains Scheme is strongly symbolic for large parts of the Australian community and is held in special regard, especially by the thousands of former Snowy workers and their families who lived and worked there.	The project will not cause an impact to the symbology embodied in the Snowy Mountains Scheme to large parts of the Australian community, especially the thousands of former Snowy workers and their families who lived and worked there.
Criterion H Significant people	
The Scheme is significant for the association with Sir William Hudson and Olav Olsen. Hudson, the 'Father of the Snowy', was Commissioner of the Snowy Mountains Authority from 1949 to 1967. Olsen was originally on the Hydro-electric Sub-committee of the Commonwealth-States Technical Committee and was subsequently employed as the Chief Investigating Engineer for the Snowy Mountain Authority.	The project will not cause an impact to the significance of the work of Sir William Hudson and Olav Olsen in relation to the Snowy Mountains Scheme.

6.6.3 Summary and conclusion

Overall Snowy 2.0 Main Works will have a minor impact on AANP values through ground disturbance activities within the project disturbance footprint and permanent and temporary changes to natural and cultural heritage landscape characteristics through constructed project elements. Landscape character impacts are higher during construction, but suitable rehabilitation of disturbed areas will reduce these impacts during operation. Snowy 2.0 Main Works will impact values of the AANP relating to geodiversity, ecology, cultural heritage, landscape character and recreation. However, proposed impacts are within a manageable framework that will be minimised and result in only limited impact on official values, which will be confined to the areas within the project disturbance footprint and vantage points overlooking the affected landscapes.

Positive impacts to the values of the ANNP includes the additional scientific research that has been completed for Snowy 2.0 Main Works and will be built upon subsequent to project approval. This includes significant ecological findings (eg critically endangered Smoky Mouse) and increased evidence of Aboriginal and historical occupation of the KNP. Furthermore, there will be enhanced recreational values through improved recreational access and facilities within the KNP, subject to ongoing consultation with NPWS.

The project is assessed to have a direct positive on the National Heritage values of the Snowy Mountains Scheme through further developing the civil engineering project stated in 1949 and is likely to reignite an interest in the scheme and its symbolism relating to a multicultural, independent and resourceful Australian identity. Overall the project represents an expansion of a major engineering achievement which is a key value of the Snowy Mountains Scheme.



CHAPTER 6.7

**ABORIGINAL
CULTURAL HERITAGE**

6.7 Aboriginal cultural heritage

An assessment of the Aboriginal cultural heritage impacts of Snowy 2.0 Main Works has been completed by NSW Archaeology and provided in the Aboriginal Cultural Heritage Assessment Report (ACHAR) at Appendix P.1. The ACHAR has been conducted in line with the DPIE *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011) and *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (NSW DECCW 2010a). A process of Aboriginal community consultation has been undertaken in accordance with the NSW DPIE *Aboriginal cultural heritage consultation requirements for proponents 2010* (NSW DECCW 2010b).

The ACHAR has involved the following components:

- statutory and non-statutory heritage register searches covering the project area and its surrounds, including the NSW DPIE Aboriginal Heritage Information Management System (AHIMS) database;
- review of the project area's environmental, archaeological and ethno-historical context to develop a predictive model of archaeological site type and distribution across the project area and its surrounds;
- regular and ongoing consultation with the Aboriginal community including the five registered Aboriginal parties (RAPs) for the project and five additional groups that expressed interest in the project as it has developed since Exploratory Works;
- an extensive archaeological field survey across the project disturbance footprint and including some previous iterations of the project design footprint (survey area). The survey was divided into 29 survey areas made up of 404 survey units, defined based on landscape features and predicted archaeology sensitivity; and
- an extensive archaeological test excavation program to characterise the archaeological character of the project area, given that the field survey was often met with low ground visibility for the detection of Aboriginal objects. In total 654 test pits measuring 50 cm by 50 cm have been excavated as part of the Exploratory Works and project excavation programs (163 m²) at Lobs Hole, Gooandra Hill (within Plateau) and Tantangara (Tantangara Road and Tantangara Dam).

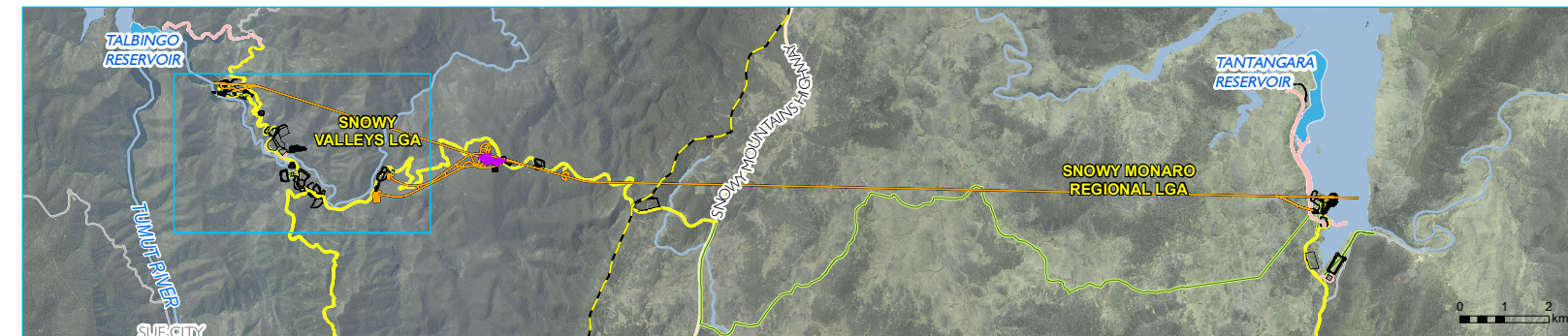
The archaeological field survey and test excavation programs completed for the project were approached as continuation of the programs completed for Exploratory Works, and there was some overlap in project footprints. Due to some recent additions to the project footprint some survey units are yet to be surveyed. Where necessary, un-surveyed areas will be investigated prior to project approval and assigned updated management and mitigation strategies.

6.7.1 Context

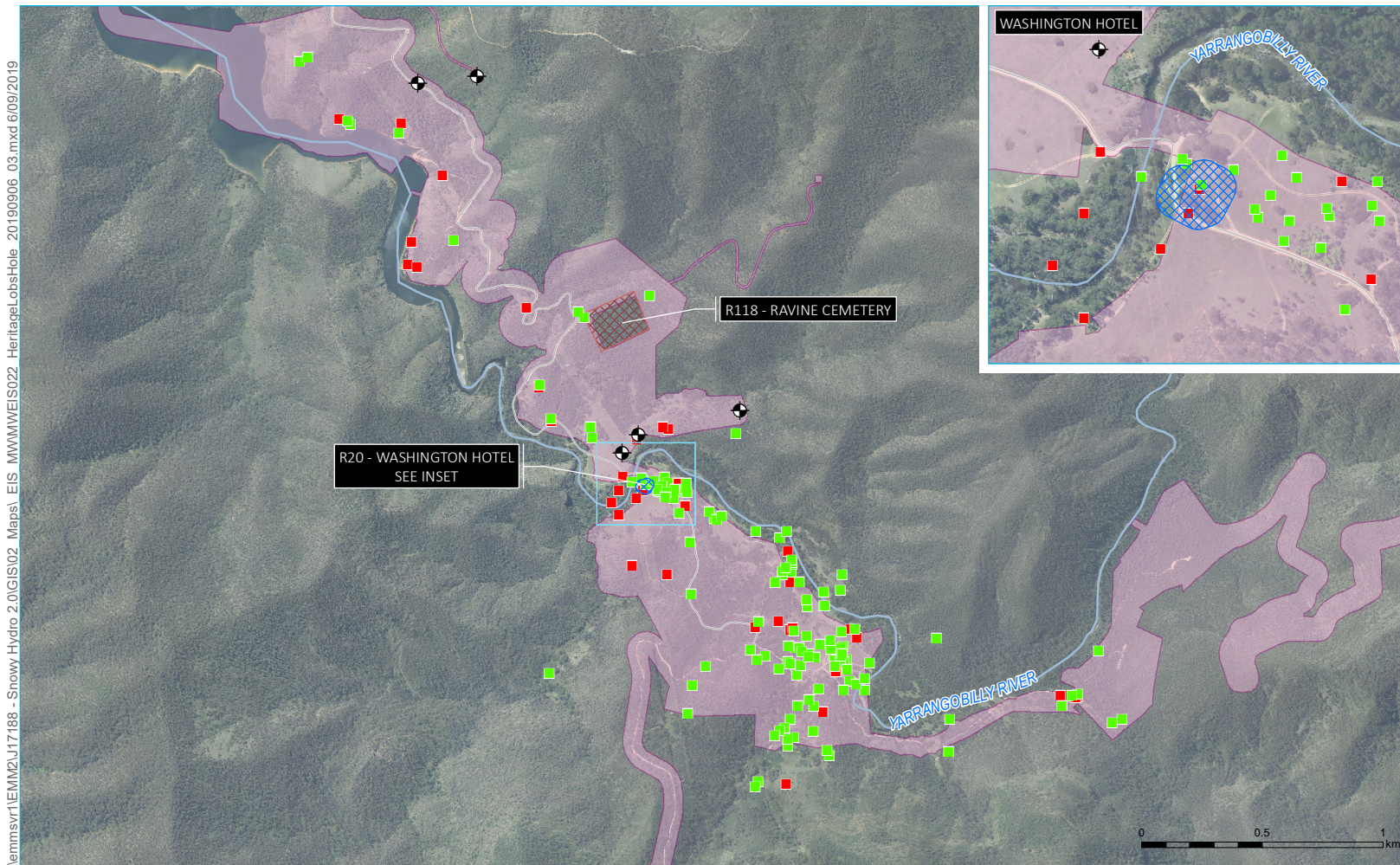
The Aboriginal cultural heritage values related to the project are presented in Table 6.19. Community and stakeholder views are also outlined including how the project design has taken these views into account to avoid or minimise impacts to Aboriginal cultural heritage.

Table 6.19 Existing environment and key issues for Aboriginal heritage

Existing environment	<p>Recent archaeological research has confirmed an Aboriginal presence in the Snowy Mountains since the early Holocene (from around 9,000 years ago) (Aplin et al. 2010, Theden-Ringl 2016).</p> <p>The project area is within the Country of the Wolgalu people (Tindale 1974, Boot 2000). The Snowy Mountains is country to several groups and many Aboriginal people have cultural and spiritual associations that have long histories embodied in objects which can be seen on the ground and other intangible values related to the past and current concerns and aspirations (NSW DEC 2006).</p> <p>Prior to the NSW Archaeology investigation, 29 AHIMS registered Aboriginal sites were present within the project survey area. A total of 306 sites were recorded during the field survey and 3,394 stone artefacts were retrieved from test excavation. This represents a significant increase in the archaeological knowledge of the area. The field survey and test excavation results were used to characterise the archaeological status of the project area and its surrounds.</p> <p>The investigation identified that the areas where Aboriginal sites were identified are generally disturbed by previous use and/or natural geomorphological process. The primary archaeological features across the survey area are Aboriginal stone artefacts and are mostly present in negligible, very low or low density distributions. However, several survey units or micro topographies within survey units have higher artefact densities. At Lobs Hole higher artefact densities were recovered on favourable landforms such as flats and gentle gradient crests adjacent to the Yarrangobilly River and such areas are likely to have been used regularly and reasonably intensively by Aboriginal people.</p> <p>Excavation results at Tantangara indicates widespread Aboriginal use but with highly variable occupation intensity. Although most areas featured low artefact densities, certain benched areas on hill slopes featured higher artefact densities. These areas were at the interface with woodland that occurs at higher elevations (eg TSU4 and TSU15). Such areas are likely to have provided shelter from prevailing weather, frosts and cold air drainage and provided abundant firewood otherwise absent from open grasslands on valley floors. Conversely, areas closer to the Murrumbidgee River featured lower artefact densities which may have been because they were exposed to cold air drainage and winds that would have been a deterrent for occupation. Additional to the stone artefact sites identified, one rock shelter with stone artefacts and potential archaeological deposit was identified 200 m west of the project disturbance footprint at Tantangara Reservoir (site name TSU11/L16) (Figure 6.20).</p> <p>Other areas investigated including Talbingo Reservoir, Marica, Plateau and Rock Forest all featured results consistent with the predictive model for site types, their distribution and predicted artefact densities. The archaeological significance of these areas is accordingly most often negligible/low and infrequently of low/moderate significance. Overall, the most frequently occurring areas of moderate archaeological significance are distributed across favourable landforms at Tantangara Reservoir and Lobs Hole.</p>
Community and stakeholder views	<p>RAP consultation did not identify any specific socio-cultural information to the project area but the identified Aboriginal sites have high cultural value to the local Aboriginal community through the tangible link they provide with their ancestral past.</p> <p>RAPs have been involved in the investigation and decision-making process for matters related to cultural heritage impact assessment and management for the project.</p> <p>NPWS representatives and DPIE regional archaeologists have been consulted over the course of the assessment through on-site and off-site meetings and have supported the investigation approach, methods and mitigation measures. In December 2018, DPIE provided SEARs input requesting for archival and oral history recordings for any items or landscapes with significant Aboriginal heritage values likely to be disturbed or harmed by the project. However, through consultation NSW Archaeology did not identify any specific cultural information of relevance to the project area and therefore no significant Aboriginal heritage items or landscapes are likely to be disturbed or harmed by the project. As such, no oral history or archival recording was completed for the ACHAR.</p>
Avoidance and minimisation through design	<p>The archaeological resource within the project disturbance footprint does not surpass significance thresholds which would act to preclude the proposed impacts. Impact mitigation where warranted is a suitable response to the anticipated project design impacts.</p> <p>Notwithstanding, a 50 m buffer zone from the bank of the Yarrangobilly River was established during the Exploratory Works EIS and has largely continued to be applied to Snowy 2.0 Main Works.</p> <p>The rock shelter site TSU11/L16 is a site of higher significance and research potential. This site was identified early in the investigations phase and the project design was modified to be over 200 m from the project disturbance footprint (Figure 6.21).</p>



- KEY**
- Heritage
- Aboriginal heritage site
 - Historic heritage site
 - ▤ Washington Hotel avoidance area
 - ▤ Ravine cemetery avoidance area
- Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road



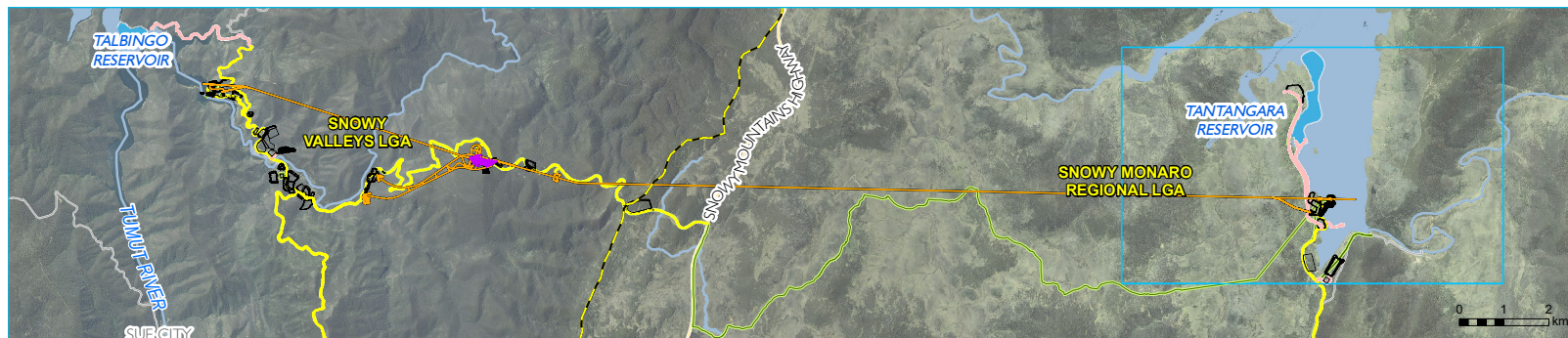
- Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
 - Temporary access road
 - ⬤ Geotechnical investigation
 - ▤ Indicative rock emplacement area
 - ▤ Disturbance area*
- Existing environment
- Main road
 - Local road
 - Watercourse
 - Waterbodies
 - ▤ Local government area boundary

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Key Aboriginal and historical heritage items for avoidance - Lobs Hole

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.20





KEY

Heritage

- Aboriginal heritage site
- Historic heritage site

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road
- ⊕ Geotechnical investigation
- Indicative rock emplacement area
- Disturbance area*

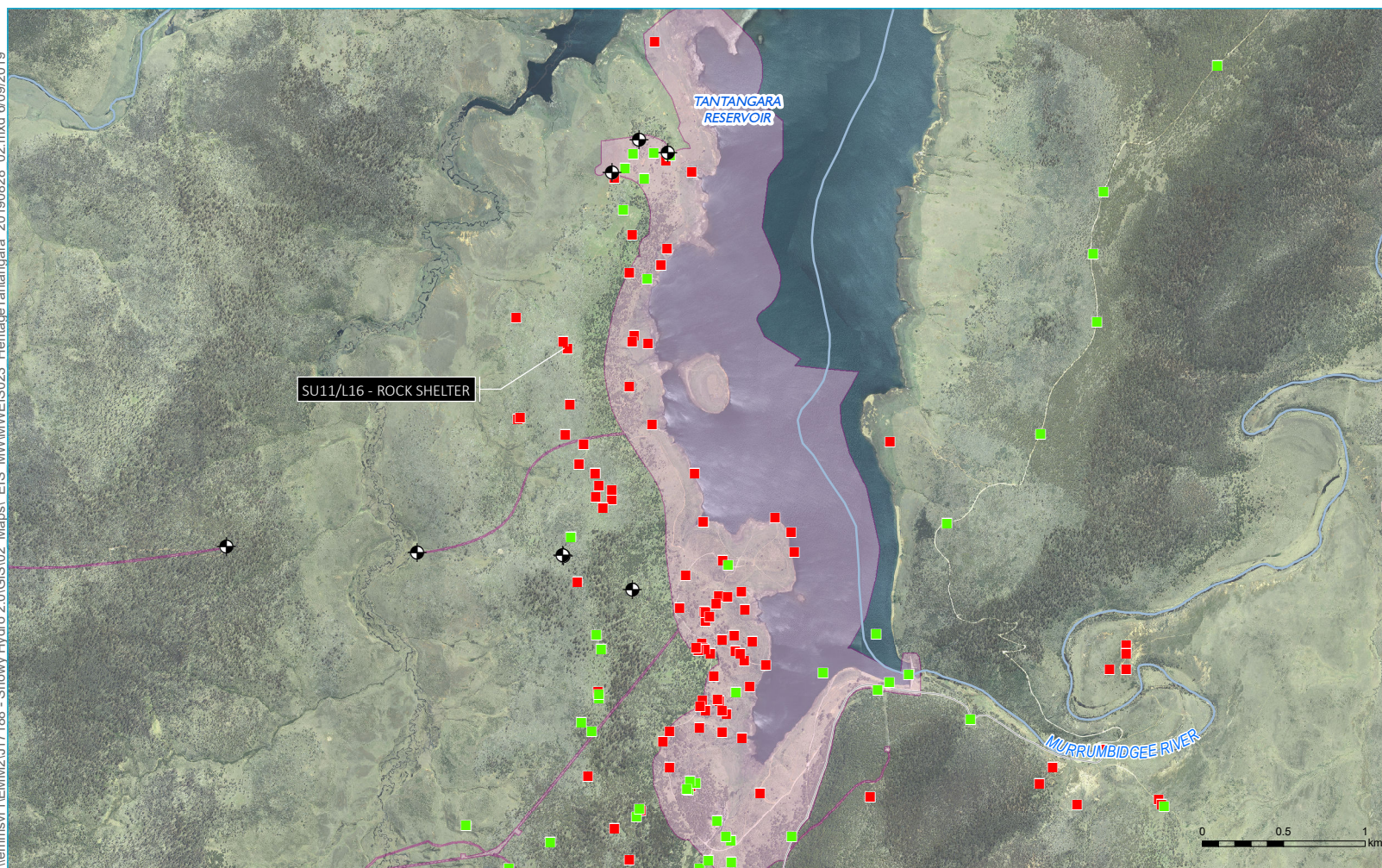
Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Key Aboriginal and historical heritage items for avoidance - Tantangara

Snowy 2.0
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Figure 6.21



\\lemmsvr1\EMM2\U17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS M\MMWEIS023 HeritageTantangara - 20190828 02.mxd 6/09/2019

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

GDA 1994 MGA Zone 55



6.7.2 Predicted impacts

The proposed construction activities within project disturbance footprint will impact Aboriginal sites and objects. No statutory or non-statutory places of Aboriginal cultural significance have been identified within the project disturbance footprint or nearby. The ACHAR addresses impacts to a component of the cultural values of the KNP which covers all Aboriginal objects and places within the KNP (Appendix P.1).

The AHCAR considered the principles of ecologically sustainable development (ESD) in assessing harm to Aboriginal cultural heritage, including consideration of cumulative impacts from the approved Exploratory Works and the proposed Snowy 2.0 Transmission Connection project. Although the project disturbance footprint and Snowy 2.0 Transmission Connection project span across an extensive geographical area, the existing Aboriginal cultural heritage values will generally not be impacted to a significant level because the project is largely linear in nature. Therefore, broad-scale impacts to any one area are limited.

At Lobs Hole, where higher stone artefact densities occur and more concentrated development is proposed, the project disturbance footprint has maintained a 50 m buffer from the Yarrangobilly River where possible. Furthermore, the only rock shelter site near the project disturbance footprint will be avoided (Figure 6.21). Overall, the consideration of ESD and cumulative harm has concluded that further avoidance of impacts is not warranted.

The impact assessment was made considering the level of impact to broader survey units, which sometimes feature none or multiple Aboriginal site locales. The project will not impact the entirety of the survey units within the project disturbance footprint and are therefore considered to be partially impacted (rather than totally impacted). A summary of impacts at each of the construction areas is provided in Table 6.20.

Table 6.20 Predicted impacts to Aboriginal cultural heritage values

Area	Summary of impacts
Talbingo Reservoir	Impacts to the archaeological resource at Talbingo is anticipated to be minor as the area features only survey units of negligible potential and significance. These will be impacted through construction of access roads and adjacent construction areas.
Lobs Hole	Impacts to the archaeological resource at Lobs Hole will not represent a significant addition to the approved impacts for the Exploratory Works project. All survey units of moderate significance will be impacted by Exploratory Works to some extent prior to Snowy 2.0 Main Works impacts. The remaining impacts will be to survey units of negligible to low significance, many of which will be impacted by the Exploratory Works to some extent prior to Snowy 2.0 Main Works impacts.
Marica	Impacts to the archaeological resource at Marica area are anticipated to be minor as the area features survey units generally of negligible or low potential and significance, except for four Aboriginal site locales which may be of low/moderate or moderate significance. Their actual significance values will be established through future salvage excavation if impacts are proposed.
Plateau	<p>Impacts to the archaeological resource across the Plateau area will be minor, considering that project impacts will be primarily linear from communications and electricity cable alignments and construction buffers. Accordingly, only small portions of archaeologically sensitive landforms within relevant survey units will be harmed.</p> <p>There are minor areas of the project disturbance footprint that have not yet been surveyed but are predicted to have negligible archaeological potential negligible significance. These areas will be investigated and assessed prior to project approval.</p>

Table 6.19 Predicted impacts to Aboriginal cultural heritage values

Area	Summary of impacts
Tantangara Reservoir	Impacts to the archaeological resource at Tantangara Reservoir is generally anticipated to be minor. Most of the survey units that will be impacted are of very low to low potential and significance. There are areas with higher artefact densities considered to be of low/moderate (TSU2, TSU3, and TSU14) and moderate (TSU4 and TSU15) significance that will be partially impacted. A substantial archaeological resource will remain to the west of the project disturbance footprint at Tantangara Reservoir, including the rock shelter site TSU11/L16 (Figure 6.21). The noise and vibration impact assessment completed for the project has predicted that the rock shelter is outside the area of potential vibration impact. Notwithstanding, rock shelter monitoring may be employed if work methods or the project disturbance changes.
Rock Forest	<p>Impacts to the archaeological resource at Rock Forest is anticipated to be minor. Most of the survey units that may be impacted are of negligible to low potential and significance.</p> <p>Notably, the actual disturbance footprint at Rock Forest is anticipated to be much smaller than that mapped as it accounts for a broader area from which the proposed logistics yard will be placed within.</p> <p>The southern half of the Rock Forest disturbance footprint has not yet been surveyed but is predicted to have similar values to the areas surveyed. This area will be investigated and assessed if disturbance to this area is expected as determined during detailed design.</p>

6.7.3 Mitigation measures

The mitigation measures presented in Table 6.21 consider the following:

- the significance of the archaeological resource identified through the ACHAR investigation; and
- and the type and scale of impacts proposed by Snowy 2.0 Main Works, the Exploratory Works and the Transmission Connection Project.

Management and mitigation of impacts is proposed according to a tiered approach appropriate for each survey unit, the nature of impacts proposed and their assessed level of significance.

Table 6.21 Summary of mitigation measures for Aboriginal heritage

Impacts/risks	Reference#	Measures	Timing	Responsibility
Impact to known and unknown heritage sites and items	HER01	<p>An Aboriginal Heritage Management Plan (AHMP) will be prepared and implemented to guide the process for management and mitigation of impacts to Aboriginal objects. The AHMP will:</p> <ul style="list-style-type: none"> • be prepared in consultation with RAPs and DPIE; • describe survey units in which impacts are allowable; and • include procedures relating to the conduct of additional archaeological assessment, if required. 	Pre-construction	Contractor

Table 6.20 **Summary of mitigation measures for Aboriginal heritage**

Impacts/risks	Reference#	Measures	Timing	Responsibility
Loss of Aboriginal cultural heritage	HER02	<p>Specific management and mitigation measures are listed for each individual survey unit and Aboriginal object locale in Appendix P.1 and will be included in the AHMP.</p> <p>Management measures to be included in the AHMP are:</p> <ul style="list-style-type: none">• for survey units within the project disturbance footprint which are assessed to be of higher significance values, impact mitigation measures will be implemented. These would comprise salvage in the form of archaeological excavation and archaeological analysis prior to impacts; and• the AHMP is to include measures for the management of any Aboriginal objects that may be found during construction.	Pre-construction	Contractor

6.7.4 **Summary and conclusion**

The ACHAR for the Exploratory Works and Snowy 2.0 Main Works has contributed significantly to our understanding of the archaeological record of the KNP and is evidence of Aboriginal occupation and adaptations to cold climate environments. Although impacts to Aboriginal sites and objects are unavoidable in all instances, mitigation strategies including salvage excavation will aim to recover a representative sample of the areas subject to impact and contribute further to our understanding of Aboriginal occupation. The Aboriginal community will continue to be consulted about the affected Aboriginal cultural heritage values and their management.



CHAPTER 6.8

HISTORICAL HERITAGE

6.8 Historical heritage

An assessment of the impacts of the project on historical heritage items has been completed by NSW Archaeology and provided the HA&SoHI at Appendix P.2. The HA&SoHI used the principles of the *Australia ICOMOS Burra Charter* (Australia ICOMOS 2013a) and its relevant practice notes (Australia ICOMOS 2013b, 2013c, 2017). It also complies with the *Historical Archaeology Code of Practice* (Heritage Council of NSW 2006) and the *NSW Heritage Manual* (1996) and other guidelines published by the NSW Heritage Office (1996, 2001, 2009).

The HA&SoHI has involved the following components:

- a search of relevant statutory and non-statutory heritage registers;
- historical research using primary and secondary sources (including historical maps);
- consultation with the local community to identify historic values and items; and
- an extensive archaeological field survey across the project disturbance footprint and including some previous iterations of the project design footprint (survey area). The survey for historical items was completed in tandem with Aboriginal archaeological field survey.

6.8.1 Context

The historic heritage values related to the project are presented in Table 6.22. Community and stakeholder views are also outlined including how the project design has taken these views into account to avoid or minimise impacts to historic heritage through the DIAA process.

Table 6.22 Existing environment and key issues for historic heritage

Existing environment	<p>The Snowy Mountains has a rich history with the early explorer-settlers in the 1820s, the establishment of pastoralism and summer grazing in the 1830s, the gold rush at Kiandra in 1859-60 and early scientific exploration. Thereafter, throughout the twentieth century the Snowy Scheme was built, scientific research developed further, and tourism and recreation promoted. Other lesser known activities in the high country include timber harvesting and milling, and Eucalyptus oil distilling.</p> <p>Lobs Hole has been used since the early 1800s as a thoroughfare for the movement of stock, prospecting, grazing, horse breeding, settlement, refuge from the winters of Kiandra, horticulture, gardening and agriculture, copper mining (from the 1860s to about 1917) and recreation and processing, recreation. The Marica area is part of the Kiandra plateau which has been used since the early 1800s for summer grazing. From the late 1850s, the area underwent extensive gold mining activity. Tantangara has been used for summer grazing, mining and more recently the construction of the dam and its associated infrastructure. Tantangara is now a popular fishing and camping spot.</p> <p>Statutory and non-statutory heritage search results are shown in the table inset below. The table only refers to listed items that intersect with, are within, or may be affected by the project disturbance footprint. Apart from Rock Forest, the project is entirely within the boundaries of the National Heritage Listed Australian Alps National Parks and Reserves, and Snowy Mountains Scheme. As a result of desktop research, register searches and archaeological survey, a total 550 historic items and potential historic items were recorded as part of the assessment.</p> <p>The 550 items were categorised and assessed of significance according to the cultural heritage complexes and historical themes they contribute to. The historical complex relating to the Ravine Township settlement at Lobs Hole, including Struggle Street, was assessed to be of local heritage significance. Other areas such as Marica and Plateau feature items have local contributory significance to historical themes of mining, pastoralism, transport and Snowy Mountain Authority presence. Historical items at Tantangara include items of local and local contributory significance to pastoralism, mining and the Snowy Mountains Scheme, including survey camps, infrastructure, quarries, the Tantangara Works Centre and Gang Gang Creek Camp. Historical items at Rock Forest include those relating to mining, agriculture and pastoralism and have limited local and local contributory significance.</p>
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Table 6.21

Existing environment and key issues for historic heritage

	Register	Listing type	Register listing
	World Heritage List (WHL)	Statutory	Nil
	National Heritage List (NHL)	Statutory	Australian Alps National Parks and Reserves – Place ID 05891 Snowy Mountains Scheme – Place ID 105919
	Commonwealth Heritage List (CHL)	Statutory	Nil
	State Heritage Register (SHR)	Statutory	Nil
	Section 170 Registers	Statutory	Nil
	<i>Tumut Local Environmental Plan 2012</i> (Schedule 5)	Statutory	Nil
	<i>Cooma-Monaro Local Environmental Plan 2013</i> (Schedule 5)	Statutory	Nil
	National Trust	Non-statutory	Nil
	Register of National Estate (non-statutory)	Non-statutory	Kosciuszko National Park (1981 boundary) Snowy Scheme Lobs Hole Copper Mine Washington Hotel Ruin (Lobs Hole) Kiandra Mining Area
	Kosciuszko Huts Association (KHA)	Non-statutory	A number of pastoral routes and other pastoral items intersect with the project disturbance footprint. However, there are no huts within the project disturbance footprint.
Community and stakeholder views	<p>Local community members were consulted to gather historical information about the project area with aided this historical site investigation.</p> <p>The NSW Heritage Division did not raise any concerns as the project was not identified to be within the vicinity of any previously known heritage items or archaeological sites.</p> <p>NPWS requested that a comprehensive archival history of Lobs Hole be completed as part of the Exploratory Works which has been completed and will continue to be incorporated into the Snowy 2.0 Main Works Project.</p>		
Avoidance and minimisation through design	<p>As a result of refinements and changes to the project disturbance footprint, many of the heritage items of local heritage significance identified during the assessment are now outside impact areas as a result of refinements and changes to the project disturbance footprint.</p> <p>During the initial stages of project design, it was resolved to avoid the two most significance historic heritage items at Lobs Hole/Ravine. This comprises the Washington Hotel rise' ruin structure (site R20) and the cadastral boundary of the Ravine Cemetery (site R118) (Figure 6.20). Furthermore, a previous project design iteration of communication routes and former substation on Plateau was modified to avoid impacts to the State heritage listed Kiandra Courthouse and Chalet and surrounding items with associated significance. Avoidance measures are further is discussed in Section 6.8.3</p>		

6.8.2 Predicted impacts

The construction activities within the disturbance area will impact historical items, landscapes and historical archaeological deposits. The impact assessment for historical items includes consideration of the significant cultural values and features of the KNP relevant to the project, which includes historical items of the Register of the National Estate (Kiandra Mining Area and Lobs Hole Copper Mine), Kosciuszko homestead complexes, huts, ruins and hut sites, physical items of the pastoral era, mining sites and objects, logging sites, Snowy Mountains Scheme sites and scientific research sites. The project impacts to National Heritage place (AANP and Snowy Mountains Scheme) official values are discussed specifically in Section 6.6.2.

The historic items recorded during the assessment are a part of various historical complexes (eg the Lobs Hole complex and the Kiandra mining complex). On their own, many of the elements do not satisfy archaeological significance criteria. However, these combine to make up the historic landscapes which are place of local or greater significance for their historical, technological, social and research values.

The HA&SoHI considered the cumulative impacts from the approved Exploratory Works and the proposed Snowy 2.0 Transmission Connection project. Although the project disturbance footprint and Transmission Connection project span across an extensive geographical area, the existing historical heritage values will generally not be impacted to a significant level because the project is largely linear in nature. Therefore, broad-scale impacts to any one area is limited. Notwithstanding, the cumulative impacts at Lobs Hole from Exploratory Works and the project will involve broad-scale impacts across the historical features that make up the former Ravine village and mining complexes at Lobs Hole. Where possible, the proposed impacts to these complexes were minimised through design by avoiding the Washington Hotel pise' ruin, Ravine Cemetery and mining related sites within a 50 m buffer from the Yarrangobilly River where possible. Overall, the consideration of ESD and cumulative harm has concluded that further avoidance of impacts is not warranted, given their ascribed significance ratings.

Overall, it is anticipated that the project will have a generally low negative effect on the historical heritage significance of the key themes of mining, pastoralism, infrastructure, and the Snowy Mountains Scheme. However, within the project disturbance footprint itself a moderately negative effect would occur both to some individual historic items and, at Lobs Hole and Tantangara Reservoir historic landscape itself. A summary of impacts across the survey areas are shown in Table 6.23. Only items that meet local significance criteria will be impacted by the project. No local or State listed heritage items (LEP or SHR) will be impacted.

Table 6.23 Predicted impacts to historic heritage values

Area	Summary of impacts
Talbingo Reservoir	Impacts to historical heritage items at Talbingo is anticipated to be minor as the area features only some areas of former vehicle track cuttings which have little contributory significance to the landscape.
Lobs Hole	<p>Project impacts to historical heritage complexes of Ravine Township, Greater Ravine Township and Struggle Street at Lobs Hole (local significance). These impacts will result in the loss of features that contribute to the local significance of the complexes. The primary impact additional to Exploratory Works will be of the Struggle Street historic complex.</p> <p>Overall, the impacts to the broader Lobs Hole Ravine will not represent a significant addition to the approved impacts for the Exploratory Works project. There will be additional impacts to the Struggle Street and Lobs Hole mining complex features but none of these items meet the significance threshold to warrant outright conservation. The primary items of significance and archaeological potential will continue to be avoided, being Ravine Cemetery and the Washington Hotel pise' ruin.</p>
Marica	Impacts to historical heritage items at Marica area are anticipated to be negligible as only one historical item (a remnant pastoral fence line) is within the project disturbance footprint which has little local contributory significance to the broader pastoral landscape which does not meet local or State significance criteria.

Table 6.22 Predicted impacts to historic heritage values

Area	Summary of impacts
Plateau	<p>Impacts to historical heritage items across the Plateau area will be minor, considering that project impacts will be primarily linear from communications and electricity cable alignments and construction buffers. Ground disturbance will largely be within existing vehicle tracks, and although project elements traverse locally significant complexes and landscapes such as historic mining complexes at Kiandra and Gooandra which are of local and local contributory significance, there will be only minor impacts to historic items related to mining, pastoralism and transport and limited visual impacts on the pastoral and mining character of the landscape. This type of impact is also limited to the project construction phase, as infrastructure will be buried and areas rehabilitated.</p> <p>There are minor areas of the project disturbance footprint that have not yet been surveyed but are predicted to have negligible archaeological potential negligible significance. These areas will be investigated and assessed prior to project approval.</p>
Tantangara Reservoir	<p>There will be minor impacts to the former Snowy Mountains Authority (SMA) Tantangara Works Centre (est. 1950s) which was built halfway between the Snowy Mountains Highway and Tantangara Reservoir. However, impacts to the Tantangara Works Centre will only be linear from road upgrades but may impact some of the more isolated residential building foundations in the proposed road corridor construction footprint. The main building complexes of Tantangara Works Centre occur to the east and west of the project disturbance footprint.</p> <p>Impacts to historical heritage values at Tantangara Reservoir includes impacts to quarrying, pastoral and SMA historical items and landscapes. The impact of the proposed Tantangara intake and construction compound and associated infrastructure is compared against the Snowy Scheme National Heritage listing as it will occur at a key component of the existing SMA Tantangara Dam and infrastructure. Impacts to the Snowy Scheme listing at Tantangara along with heritage landscape features is discussed further in Section 6.8.1.</p> <p>The overall impacts to pastoral, mining, SMA and transport items will result in impacts to items of local significance and local contributory significance. The overall heritage impacts at Tantangara will be moderate, particularly with regard to impacts at pastoral items and SMA items, and the overall impacts to the broader cultural landscape of the Snowy Mountains will be low.</p>
Rock Forest	<p>Impacts to historical heritage items at Rock Forest is anticipated to be low to negligible. Rock Forest is outside of the National Heritage place listings of the AANP and Snowy Mountains Scheme and also outside of the KNP.</p> <p>It is currently assumed that all of Rock Forest has the potential to be disturbed by construction activities. However, the actual disturbance footprint at Rock Forest is anticipated to be much smaller than that mapped as it accounts for a broader area from which the proposed logistics yard will placed within.</p> <p>Historical items at Rock Forest include those relating to mining, agriculture and pastoralism and have limited local contributory significance. The proposed impacts at Rock Forest would result in direct (physical) impacts to five items of contributory significance only. An old cultivation paddock outside the project disturbance footprint was identified to have local significance for its insights on cultivation practices in the area.</p> <p>The southern half of the Rock Forest disturbance footprint has not yet been surveyed but is predicted to have similar values to the areas surveyed. This area will be investigated and assessed prior to project approval.</p>

6.8.3 Mitigation measures

The mitigation measures presented in Table 6.24 consider the following:

- the significance of the historical heritage values identified in the HA&SoHI investigation; and
- and the type and scale of impacts proposed by the project, the Exploratory Works and the Snowy 2.0 Transmission Connection Project.

Overall, the historical heritage items and landscapes do not surpass significance thresholds which would act to preclude the proposed Snowy 2.0 Main Works impacts. Management and mitigation of impacts is proposed according to a tiered approach appropriate for each complex/item/feature, the nature of impacts proposed and their assessed level of significance.

Table 6.24 Summary of mitigation measures for historic heritage

Impacts/risks	Reference#	Measures
Loss of historic heritage	HER03	Salvage and/or archival recording of potential and known heritage items to be conducted in respect of certain items that warrant that level of impact mitigation.
	HER04	<p>Specific management and mitigation measures are listed for each individual heritage item in Appendix P.2 and will be included in a cultural heritage management plan (CHMP). A series of management recommendations will be presented. In some instances, no impact mitigation is required. For others a range of measures are recommended ranging the establishment of no-zones to ensure the protection of items, salvage of movable heritage to salvage excavation and archival recording.</p> <p>Appropriate avoidance measures will be taken for Washington Hotel (site R20) and Ravine Cemetery (R118).</p> <p>A minimum 20 m project construction avoidance buffer will be applied to the Washington Hotel (site R20) structure.</p> <p>No ground disturbance will occur within the cadastral boundary of Ravine Cemetery as shown on Figure 6.20. Some non-ground invasive vegetation clearance will be required at the western and northern boundaries of the cadastral boundary of Ravine Cemetery (refer to bush fire risk and hazard assessment, Appendix T).</p>

6.8.4 Summary and conclusion

The historical assessments for the Exploratory Works and Snowy 2.0 Main Works project have contributed significantly to our understanding of the archaeological record of the KNP and the range of historical events that have left archaeological traces across the landscape. Although impacts to historical items and landscapes are unavoidable, mitigation strategies including the avoidance of Washington Hotel (site R20) and Ravine Cemetery (R118), and salvage excavation and archival recording where warranted will aim to recover and record contribute further to our understanding of historical occupation and events.



CHAPTER 6.9

TRANSPORT

6.9 Transport

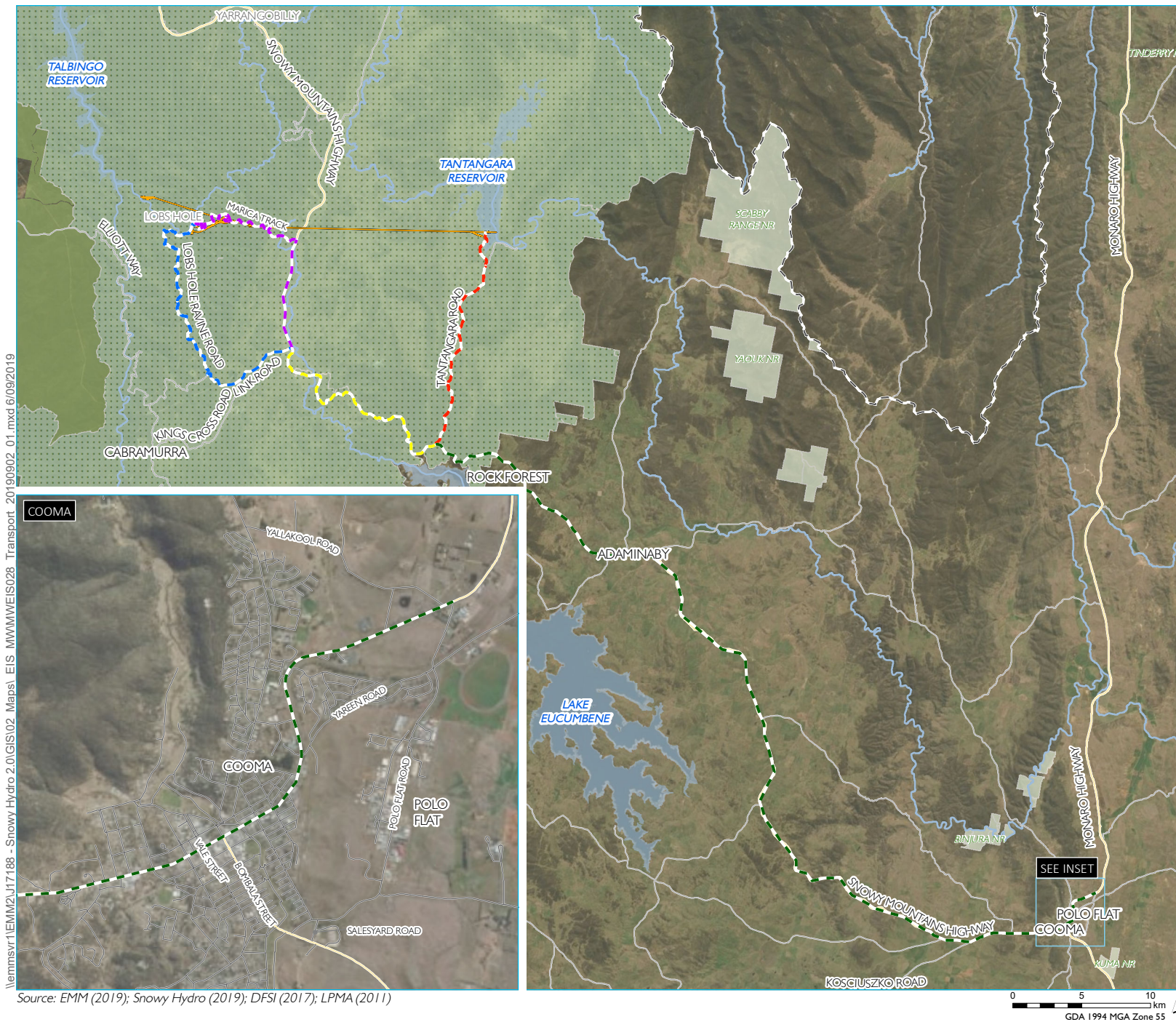
Potential impacts of Snowy 2.0 Main Works on traffic and transport have been assessed. The assessment relies on technical specialist reports prepared for the project and should be referred to for detailed information, including:

- Traffic and Transport Assessment prepared by SCT Consulting and provided in Appendix Q;
- Road Safety Audit prepared by Safe System Solutions and provided in Appendix Q; and
- Navigation Assessment prepared by Royal HaskoningDHV and provided in Appendix W.

These technical reports collectively address potential impacts to traffic and transport from Snowy 2.0 Main Works and are summarised in this section.

6.9.1 Existing environment

The Traffic and Transport Assessment considered a study area encompassing the main transport route and the surrounding regional road network. The predominant mode of transport within the study area is car travel with bus services available in Cooma and Tumut and the nearest train station in Canberra. There are a number of walking and cycling trails within the study area including within the KNP. The KNP and nearby ski resorts mean that the study area attracts an influx of visitors during the snow season resulting in increased traffic volumes. The proposed main transport route and regional road network providing access to the project area are shown in Figure 6.22. Key roads and intersections that will be used by the project construction traffic were identified and are summarised for each of the project areas in the following section.



- KEY**
- Primary transport route
 - All site access from Cooma to KNP and Rock Forest
 - Route to Tantangara Reservoir
 - Route to Talbingo Reservoir and Lobs Hole
 - Route to Marica and Lobs Hole
 - Route to Marica, and alternative access to Lobs Hole
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Kosciuszko National Park
 - NPWS reserve
 - State forest
 - State boundary

Primary transport routes and regional road network

Snowy 2.0
Environmental Impact Statement
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Figure 6.22



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

i Existing road network – KNP

Key roads and intersections within the KNP and predominantly on the Plateau are discussed in this section.

a Snowy Mountains Highway

The Snowy Mountains Highway comprises the majority of the proposed main transport route and is a 333 km long State highway which connects from the Princes Highway north of Bega, via Bemboka to the Monaro Highway south of Nimmitabel, then from the Monaro Highway at Cooma via Adaminaby, Kiandra, Tumut and Adelong to the Hume Highway near Hillas Creek.

Within the KNP, the Snowy Mountains Highway has a two-lane two-way sealed carriageway, generally varying between 6 to 8 m wide. The speed limit varies along the main transport route and is generally 100 km/h on the rural sections with reductions in speed where it passes through residential areas and town centres. In the higher altitude regions, above 1,000 m altitude, where the highway is subject to snow and ice cover over the winter months, distinctive yellow line marking and tall red reflector posts are used for better visibility of the road and vehicles can be required to use snow chains when travelling on these higher sections of the highway, with speed reductions to 80km/hr. The road is an approved B-Double route from Talbingo to Adaminaby and is approved throughout its length within the KNP for 19 m long vehicles.

The Snowy Mountains Highway intersects with Link Road, Miles Franklin Drive and other local roads nearer to the project area. The Snowy Mountains Highway from Cooma to Adaminaby is outside the KNP area and is approximately 50 km long. It runs west from Cooma, then north-west after the intersection with Kosciuszko Road 6 km west of Cooma. It is a two-lane two-way highway with a road width varying from 6.6 to 7.2 m. The speed limit is generally 100 km/h, but it is reduced to 80 km/h when approaching Adaminaby.

The Snowy Mountains Highway passes through the Cooma town centre where the road environment is representative of an urban local road network, with a lower speed environment ranging between 50-60km/hr and roundabouts controlling the major intersections. The physical traits of the road reserve also differ in Cooma, with widened road reserves catering for on-street parking, kerb and guttering, footpaths and street lighting installed at short intervals. During the winter snow season, traffic volumes along Snowy Mountains Highway increases with visitors destined for the ski fields within Kosciuszko National Park. With Cooma serving as the main rest stop for visitors during the snow season, drivers can experience congestion at peak times along the main road of Sharp Street (an extension of Snowy Mountains Highway and Monaro Highway).

The Snowy Mountains Highway also travels north to the north of the project area, passing Talbingo, Adelong and turning north-east after the intersection with Batlow Road to reach Tumut.

North of Link Road the non-winter period the recorded baseline daily traffic volumes are 436 light vehicles (LV) and 79 heavy vehicles (HV). Where the Snowy Mountains Highway passes through Cooma township daily traffic volumes are much higher with traffic counts recording 4,888 LV and 1,509 HV. During the winter peak these volumes are higher again. A traffic count was taken on the Sunday of the Queen's Birthday long weekend 2019 there were 9,311 vehicle movements.

In the period 2013-2017 there were several recorded crashes resulting in injury on Snowy Mountains Highway including 7 West of Bombala Street to Chapman Street, 55 in the township of Cooma, 16 from Cooma to Adaminaby, 30 from Adaminaby to Snowy Monaro LGA boundary, 10 from Snowy Monaro LGA boundary to Talbingo, 4 from Talbingo to Tumut and 45 in the Township of Tumut.

b Link Road

Link Road is a two-way rural road varying from 5.3 to 6.6 m wide between Elliott Way to the west and Snowy Mountains Highway to the east. This road provides connection between the Snowy Mountains Highway and Cabramurra, which is accessible via the Link Road and Goat Ridge Road. It also provides access to the Selwyn Snow Resort during the winter season, which is accessible via Snowy Mountains Highway, the Link Road and Kings Cross Road. The road is approximately 15 km long and is fully sealed. Link Road is an undulating road with numerous bends with lower advisory speed limit signs on approaches. The signposted speed limit is 80 km/h. All intersections on Link Road are basic T-intersections, except for its intersection with Snowy Mountains Highway where an auxiliary right turn (AUR) and auxiliary left turn (AUL) is provided on the major road to allow left and right turning movements to access Link Road. Link Road is not an approved B-Double route.

Baseline daily traffic volumes were recorded between Kings Cross Road and Lobs Hole Ravine Road with 206 LV and 22 HV and between Kings Cross Road and Snowy Mountains Highway with 316 LV and 44 HV. A traffic count was taken on the Sunday of the Queen's Birthday long weekend 2019 there were 1,382 vehicle movements.

Traffic recorded on Link Road by NPWS shows that traffic peak occurred in the month of July with 13,608 vehicles, which is more than double of the average monthly traffic volume (5,935 vehicles) across the year.

c Kings Cross Road

This road, although mostly unsealed, provides a shorter connection between Link Road, near the Selwyn Snow Resort and Cabramurra village, compared to the fully sealed route via Link Road and Goat Ridge Road.

Kings Cross Road is sealed for the initial 3 km of its length between Link Road and the Selwyn Snow Resort. The road is unsealed at about 1 km at the western end near Cabramurra, but nevertheless generally straight and level. It is a two-lane two-way road with a general speed limit of 100 km/h, although lower speed limits apply in the vicinity of the Selwyn Snow Resort. The centre line of the road is not marked. Sealed sections have a width between 5-6 m, while the unsealed section has a width of approximately 7 m. All intersections are of a basic T-form. Kings Cross Road is not an approved B-Double route.

d Key intersections – Plateau

Intersections that will be used by the project construction traffic were identified and assessed. A summary of key intersections on the Plateau is provided in Table 6.25.

Table 6.25 Key intersections – Plateau

Intersection	Description
Link Road / Lobs Hole Ravine Road	The current configuration of Link Road/Lobs Hole Ravine Road intersection is a T-junction. Lobs Hole Ravine Road has an unsealed surface up to the edge of the through traffic lane on Link Road.
Snowy Mountains Highway / Link Road	The current configuration of the Snowy Mountains Highway/Link Road intersection is a T-junction with an auxiliary left-turn (AUL) and a channelised right-turn (CHR) on the major road of Snowy Mountains Highway to allow left and right turning movements to access Link Road.
Snowy Mountains Highway / Tantangara Road	The current configuration of the Snowy Mountains Highway/Tantangara Road intersection is a basic T-junction. There is some additional shoulder width covered with gravels to provide spaces for vehicle turning movements. In addition there is an extremely large shoulder on the inside radius of the Snowy Mountain Highway.

ii Existing road network – Cooma

Key roads and intersections that are predominantly within Cooma are discussed in this section.

a Monaro Highway

The Monaro Highway is a 285 km long north-south highway connecting Canberra and Cooma where it joins the Snowy Mountains Highway. It continues further south, cross the Victoria border and eventually joins the Princes Highway, near Cann River. The Monaro Highway is the major access for most traffic to and from Canberra.

Within the project transport route, Monaro Highway is a two-lane two-way highway with road width varying from 7.4 to 10.3 m. The speed limit is generally between 80 km/h and 100 km/h in the rural area, reducing to 60 km/h on the approaches to Cooma. When entering school zones, speed limit reduces to 40 km/h between 8:00 am to 9:30 am and 2:30 pm to 4:00 pm.

Daily baseline traffic volumes for the non-winter period were recorded south of Cooma with 1,524 LV and 971 HV and east of Polo Flat with 4,198 LV and 683 HV. A traffic count was taken on the Sunday of the Queen's Birthday long weekend 2019 there were 10,953 vehicle movements.

In the period 2013-2017 there were 10 recorded crashes resulting in injury on Monaro Highway East of Bombala Street to Polo Flat Road (north). In the same period there were 4 crashes resulting in injury recorded for Monaro Highway South of Polo Flat Road (south).

b Polo Flat Road

Polo Flat Road is a 4 km long fully sealed road, connecting Monaro Highway to the north and the Snowy Mountain Highway to the south. It runs through the middle of the Polo Flat industrial area. The road width varies from 6 to 8.6 m with speed limit capped at 80 km/h within the industrial area. The centre line of the road is marked.

There is an active railway level crossing approximately 645 m south of Monaro Highway to the north. The railway level crossing is controlled by give way signs. There is a railway bridge on Polo Flat Road with low clearance of 4.1 m. Polo Flat Road is an approved B-Double route.

Baseline daily traffic counts were recorded at Polo Flat North with 1,036 LV and 806 HV and Polo Flat South with 1,102 LV and 1,067 HV.

In the period 2013-2017 there were 4 recorded crashes resulting in injury on Polo Flat Road.

c Salesyard Road

Saleyards Road is a 209 m long fully sealed road, connecting Snowy Mountains Highway to the south and Polo Flat Road to the north. It is a two-lane two-way local road with a road width varying from 10 to 13 m. It provides a bypass route from Monaro Highway to Polo Flat Road for heavy vehicles more than 4.1 m in height. Saleyards Road is an approved B-Double route.

In the period 2013-2017 there were no crashes resulting in injury on Salesyard Road.

d Yareen Road

Yareen Road is a 1.6 km long fully sealed local road, connecting Monaro Highway to the west and Polo Flat Road to the east. There are residential dwellings on both sides of the road. The road width varies from 7.3 to 8.8 m with a speed limit of 60 km/h. There is a non-operational railway level crossing approximately 93 m west of Monaro Highway, which was controlled by flashing lights and stop signs.

Yareen Road is an approved 19 m B-Double route with travel conditions: no travel is permitted between 7:00 am to 9:00 am and 3:00 pm to 5:00 pm on school days.

e Key intersections – Cooma

Intersections that will be used by the project construction traffic were identified and assessed. A summary of key intersections in Cooma is provided in below Table 6.26.

Table 6.26 Key intersections – Cooma

Intersection	Description
Snowy Mountains Highway / Kosciuszko Road	The current configuration of the Snowy Mountains Highway/ Kosciuszko Road intersection is a T-junction with both rural auxiliary left-turn (AUL) and right-turn (AUR) treatments provided along the major road to allow left and right turning movements for cars and trucks to access the minor arm of Snowy Mountains Highway.
Snowy Mountains Highway / Vale Street	The current configuration of the Snowy Mountains Highway/Vale Street intersection is a single lane roundabout with 13 m diameter island. All approaches to the intersection are two-lane two-way roads including Snowy Mountains Highway that runs in an east-west direction as a B-Double route. The intersection is in the Cooma township with large number of angled on-street parking provided on Vale Street and Snowy Mountains Highway to service the local centre.
Monaro Highway (Snowy Mountains Highway) / Bombala Street	The current configuration of Monaro Highway (Snowy Mountains Highway) /Bombala Street intersection is a single lane roundabout with 13 m diameter island. All approaches to the intersection are two-lane two-way roads including Snowy Mountains Highway and Monaro Highway that runs in an east-west direction as a B-Double route. The intersection is in the Cooma township with large number of angled on-street parking provided on all approaches to service the local centre.
Monaro Highway / Yallakool Road	The current configuration of Monaro Highway/ Yallakool Road intersection is a basic T-junction. This intersection is within 100 m of the Polo Flat Road intersection along Monaro Highway.
Monaro Highway / Polo Flat Road (north end)	The current configuration of the Monaro Highway/Polo Flat Road (north end) intersection is a basic T-junction with a rural auxiliary left-turn treatment (AUL) on the major road to allow left turning movements for cars and trucks to access the minor road.
Monaro Highway / Saleyards Road (south of Polo Flat Road)	The current configuration of the Monaro Highway/Saleyards Road intersection is a basic T-junction with a rural basic BAR/BAL treatment (ie parallel widened shoulder) to allow turning movements for cars and trucks.

An intersection warrants review according to Austroads (2017) was carried out for key intersections under existing traffic conditions. Under existing traffic conditions, only two intersections should require channelised right turning lane or auxiliary left turning lanes:

- Monaro Highway / Polo Flat Road (north end); and
- Monaro Highway / Yallakool Road.

An auxiliary left turn lane already exists on the approach to Polo Flat Road, hence a right turn bay may be required to cater for the right turn demand into Polo Flat Road.

iii Roads to be upgraded

The proposed Snowy 2.0 Main Works road upgrades are detailed in Section 2.3.4, key existing roads that will be upgraded and form part of the main internal construction transport route include:

- Lobs Hole Ravine Road;
- Marica Track; and
- Tantangara Road.

These roads are within the Snowy 2.0 Main Works construction area and will be used for construction traffic, noting that limited and facilitated access will be provided along Tantangara Road where determined in consultation with the contractor and where safety requirements can be guaranteed.

6.9.2 Community and stakeholder views

Key stakeholders that were engaged and provided feedback regarding traffic and transport impacts include RMS, NPWS, SMRC, SVC and the community. Key issues raised during the preparation of the EIS relating to traffic and transport impacts are listed below:

- impact of construction traffic on main and local roads
- transport of large equipment;
- local road upgrades; and
- closure of roads due to construction.

6.9.3 Avoidance and minimisation through design

Several measures have been taken through the project design to minimise and avoid impacts to traffic and transport. This section provides a summary of these measures.

i Road safety

A road safety audit of the haulage route in its current condition was carried out for the primary transport route and is provided in Appendix Q.

ii Minimisation of seasonal traffic impacts

The peak construction traffic volumes are predicted to fall outside of the peak winter season between the months of January and February. Baseline traffic counts for the winter ski season has identified peak traffic periods on Friday afternoon and the middle of day on Sunday for some weekends.

iii Internal road network design

All roads that will be upgraded as part of the Snowy 2.0 Main Works construction will be upgraded to facilitate the movement of heavy vehicles. As part of the design, the internal road network will be designed to minimise any delays of construction vehicle operations, including appropriate road widths to safely accommodate heavy vehicle movements. Given the remoteness of these from the external public road network, it is unlikely that the operation of the internal road network would impact the performance of Link Road or Snowy Mountains Highway.

6.9.4 Predicted impacts

Impacts to the capacity, condition, safety and efficiency of the road network were assessed and key issues identified. Key issues identified include the suitability of existing intersections within the KNP and in Cooma township. Traffic and transport impacts were assessed with consideration to other developments in the area including Snowy 2.0 Exploratory Works, Snowy 2.0 Transmission Connection Project, and proposed segment factory at Polo Flat.

Cumulative traffic impacts are expected due to additional traffic volumes that will be generated by the proposed segment factory at Polo Flat. These projects will share the external road network, in particular Snowy Mountains Highway. The assessment of road network impacts has therefore considered a scenario that combines the Snowy 2.0 Main Works and Polo Flat traffic generation. The Snowy 2.0 Transmission Connection Project is expected to utilise a largely different main transport route and is expected to have a peak construction period that does not coincide with the Snowy 2.0 Main Works.

Three scenarios were considered to assess the impacts of the project on the road network:

- 2022 Baseline (No Project);
- 2022 Snowy 2.0 Main Works only; and
- 2022 Snowy 2.0 Main Works and segment factory works proposed at Polo Flat (cumulative impacts).

A summary of predicted impacts is provided in this section.

i Road network impacts – KNP

Impacts to key roads and intersections within the KNP and predominantly on the Plateau are summarised in this section. Impacts associated with the Rock Forest logistics laydown are also addressed in this section due to their proximity to the KNP.

a Construction traffic volume impacts in the KNP

Average and peak daily heavy and light traffic movements were determined for key road sections. A summary of estimated daily traffic generation on the Plateau in the peak month for each scenario is provided in Table 6.27.

Table 6.27 Predicted daily traffic volumes by road section – KNP

Road	Location	Baseline traffic (Non-winter)		Main Works only		Main Works + Polo Flat	
		LV	HV	LV	HV	LV	HV
Link Road	Between Kings Cross Road and Snowy Mountains Highway	316	44	150	224	114	402
Link Road	Between Kings Cross Road and Ravine Road	208	22	48	44	48	44
Snowy Mountains Highway	North of Link Road (Garden Gully Creek)	436	79	42	106	42	108
Snowy Mountains Highway	North of Yarrangobilly Caves intersection	385	70	24	64	24	64

It is forecast that the largest number of HV would be travelling on Link Road (between Kings Cross Road and Snowy Mountains Highway) and Snowy Mountains Highway (between Link Road and Cooma). During the peak month, it is expected up to 410 heavy vehicles (205 in each direction) could be travelling on these sections of Link Road and Snowy Mountains Highway each day, when Mains Works are assessed together with segment factory works proposed at Polo Flat cumulatively. Snowy 2.0 Main Works itself would only be expected to generate up to 250 heavy vehicles per day (125 in each direction) during the peak month along Snowy Mountains Highway.

Due to the locations of the works sites for Snowy 2.0 Main Works, the largest increase of light vehicles is also expected on Link Road and Snowy Mountains Highway. The largest increase of light vehicles is expected to be around 150 (75 in each direction) per day at Link Road (between Kings Cross Road and Snowy Mountains Highway). However, during the Polo Flat Works, up to 308 daily light vehicles (154 in each direction) are expected to be generated.

This level of daily increase of LV and HV movements as a result of Main Works and Polo Flat Works – approximately 550 total vehicles (up to 1,350 Passenger Car Units (PCU) assuming a PCU factor of 2.9 for heavy vehicles) in a day will not have any significant impacts to the mid-block capacity of the study network given the network is currently operating at very low volume / capacity ratios with significant amount of spare capacity.

Predicted impacts to road sections are summarise in Table 6.28.

Table 6.28 Predicted impacts to road sections from construction traffic volumes

Road	Predicted impacts
Link Road	<p>Link Road is expected to have the largest increase in both light and heavy vehicles, especially during the peak month. This level of increase on Link Road is less than the increase of traffic during peak winter days – an increase of approximately 1,000 vehicles per day travelling in both directions.</p> <p>However, the cumulative increase of peak construction traffic as well as winter holidays traffic may cause some localised congestion to occur, especially near the Selwyn Snow Resort.</p> <p>Due to the increase of both light and heavy vehicle traffic along Link Road, the number of incidents could also increase especially where Link Road is below 6 m road-width, where sight-lines are limited and on sections of road with sharp curves. Safety risks could increase due to increased traffic and high percentage of heavy vehicles unless suitable management measures are applied.</p>
Snowy Mountains Highway	<p>Although the Snowy Mountains Highway is the main project traffic route, the traffic volume increase due to the project is less than the normal traffic during peak winter days – an increase of over 5,000 vehicles per day travelling in both directions between Cooma and Kosciuszko Road.</p> <p>Due to the increase of both light and heavy vehicle traffic along Snowy Mountains Highway, the number of incidents could also increase especially where road-widths may be considered inadequate, where sight-lines are limited and on sections of road with sharp curves.</p>

b Impacts to intersections in the KNP

Intersection capacity assessment using SIDRA has been undertaken for all key intersections. The SIDRA modelling confirmed that all key intersections will continue to operate satisfactorily with overall intersection LoS C or better, when considered under non-winter baseline traffic and all scenarios of construction (light and heavy) vehicles traffic. The predicted future intersection performance within KNP is provided in Table 6.29.

Table 6.29 Future intersection performance summary in KNP

Intersection	Performance (LoS)		
	Existing	Main Works	Main Works + Polo Flat
Link Road / Lobs Hole Ravine Road	A	A	A
Snowy Mountains Highway / Link Road	A	A	A
Snowy Mountains Highway / Tantangara Road	A	A	A
Snowy Mountains Highway / Marica Access	-	A	A
Snowy Mountains Highway / Rock Forest Access	-	A	B

The intersection of Snowy Mountains Highway with Link Road does not achieve minimum safe intersection sight distance (SISD) requirements. Given the expected increase of construction traffic at this intersection, mitigation measures such as localised speed reduction on the approaches to this intersection should be considered to mitigate the risks. New construction access intersections will be established for Marica Track and Rock Forest.

ii Road network impacts – Cooma

Impacts to key roads and intersections within Cooma are summarised in this section.

a Construction traffic volume impacts – Cooma

Average and peak daily heavy and light traffic movements were determined for key road sections. A summary of estimated daily traffic generation in Cooma in the peak month for each scenario is provided in Table 6.30.

Table 6.30 Predicted daily traffic volumes by road section – Cooma

Road	Location	Baseline traffic (Non-winter)		Main Works only		Main Works+ Polo Flat	
		LV	HV	LV	HV	LV	HV
Snowy Mountains Highway	West of Cooma	3,499	477	98	252	124	410
Snowy Mountains Highway	SMEC Offices	4,261	586	98	252	194	410
Snowy Mountains Highway	Cooma	4,888	1,509	94	252	264	390
Monaro Highway	South of Cooma	1,524	971	36	82	50	78
Monaro Highway	East of Polo Flat	4,198	683	48	176	74	230
Polo Flat Road	Polo Flat North	1,036	806	26	82	196	252
Polo Flat Road	Polo Flat South	1,102	1,067	42	82	308	78

The combination of baseline traffic (less than 2,000 vehicles per day) and construction traffic (less than 500 vehicles per day) is not expected to cause any capacity issues on Polo Flat Road or Monaro Highway. Polo Flat Road as a local collector road serving the industrial area of Polo Flat is unlikely to be impacted by winter holidays traffic.

b Impacts to key intersections in Cooma

Intersection capacity assessment using SIDRA has been undertaken for a number of critical intersections across the study area. The SIDRA modelling confirmed that all the critical intersections within the study area will continue to operate satisfactorily with overall intersection LoS C or better, when considered under non-winter baseline traffic and all scenarios of construction (light and heavy) vehicles traffic. The predicted future performance for key intersections in Cooma is provided in Table 6.31.

Table 6.31 Future intersection performance summary

Intersection	Performance (LoS)		
	Existing	Main Works	Main Works + Polo Flat
Snowy Mountains Highway / Kosciuszko Road	B	B	B
Snowy Mountains Highway / Vale Street	A	B	B
Monaro Highway (Snowy Mountains Highway) / Bombala Street	B	B	C
Monaro Highway / Yallakool Road	A	A	A
Monaro Highway / Polo Flat Road (north end)	A	B	B
Monaro Highway / Saleyards Road (south of Polo Flat Road)	A	A	A

An intersection warrants review according to Austroads (2017) was completed for the construction traffic scenarios. The following intersections warrant upgrades due to the increased traffic volumes at the intersections:

- Monaro Highway / Yallakool Road;
- Monaro Highway / Polo Flat Road; and
- Monaro Highway / Salesyards Road.

It should be noted that intersections of Monaro Highway / Yallakool Road and Monaro Highway / Polo Flat Road require upgrades even without the construction vehicles, based on the forecast growth of the corridor.

In addition to the upgrades identified based on typical (non-winter) traffic conditions, there may be some upgrades carried out for the existing roundabout intersection of Monaro Highway (Snowy Mountains Highway) / Bombala Street to provide adequate performance during winter peak conditions when considered together with construction traffic. It should be noted this roundabout is expected to fail (ie performs poorly) under existing winter peak traffic conditions (during the peak hours on the weekends of the ski season) regardless of construction traffic. Snowy Hydro is continuing to engage with roads authorities (SMRC, NPWS and RMS) to determine the most appropriate measures to address traffic performance during this peak period.

iii Oversize and over-mass vehicles

A review was undertaken to understand the requirements for the transport of the largest oversize over-mass (OSOM) vehicle required to transport transformers between Port Kembla and the Snowy Mountains Highway at Yarrangobilly. The review has identified a number of critical constraints on the network for the transportation of OSOM items to and from site. These critical constraints have been addressed by including any road widening works required within the Snowy 2.0 Main Works construction footprint including minor widening to two sections of Snowy Mountains Highway between Adaminaby and Link Road. Minor changes to the existing roundabout intersection of Monaro Highway / Vale Street to facilitate some OSOM associated with Exploratory Works are being sought approval for through a modification to the current Exploratory Works approval (Modification 2) expected to be submitted to DPIE in October 2019.

iv Marine transport

The Snowy 2.0 Main Works will involve some marine transport due to the use of barges for construction works on Tantangara and Talbingo reservoirs. A navigation safety assessment was prepared and identified risks associated with the proposed marine transport during construction. The navigation assessment found that some risks may arise from interactions between proposed marine transport and public boating. Management measures will be implemented to minimise these risks including establishing exclusion areas around in-reservoir construction sites and appropriate controls for marine vehicles, equipment and infrastructure.

v Emergency access

Access for emergency vehicles will be unaffected during as there are no plans to close any roads to emergency vehicles. During upgrades of the internal roads, unhindered access will be available and maintained for emergency vehicles at all times. In addition, consultations with emergency service providers would be required as part of the finalisation of the Construction Traffic Management Plan.

vi Public access

As described in Section 2.5.2 there will be some road closures during construction that will impact access to recreational areas within KNP. Proposed public access arrangements during construction and operations are provided in Figure 2.32 and Figure 2.33. An assessment of impacts to recreational users was prepared and is discussed further in Section 6.13. There will be no impact to public transport from the proposed works.

6.9.5 Mitigation measures

Mitigation measures were identified to minimise the identified traffic and transport impacts of the project. Traffic and transport mitigation measures are summarised in Table 6.32.

Table 6.32 Mitigation measures for traffic impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Speed limit reductions	TRA01	<p>At locations where minimum sight distances cannot be achieved, due to the existing road alignments, the posted speed limits adjacent to the intersections will be reduced to satisfy the sight distance requirements and maintain safe manoeuvring conditions for motorists. These intersections and the proposed speeds are:</p> <ul style="list-style-type: none"> • Snowy Mountains Highway/ Tantangara Road – 60 km/hr • Snowy Mountains Highway/ Rock Forest – 80 km/hr • Link Road / Lobs Hole Ravine Road – 60 km/hr • Link Road / Snowy Mountains Highway – 80 km/hr <p>Based on feedback from community consultation speed limit reductions are also being considered for Snowy Mountains Highway through the township of Adaminaby to 60 km/h. Any speed limit changes will be discussed with the relevant roads authority and documented in the construction traffic management plan as required.</p>	Construction	Contractor
Intersection upgrades	TRA02	<p>Based on the consideration of construction activities as well as intersection capacity assessment following intersections will be upgraded:</p> <ul style="list-style-type: none"> • Snowy Mountains Highway / Marica access - establish new construction access (BAR / BAL); and • Snowy Mountains Highway /Rock Forest access - establish new construction access (BAR / BAL). 	Construction	Contractor
OSOM vehicle movements	TRA03	The TMPs will be prepared, submitted and approved by the RMS under permit, prior to the commencement of any deliveries considered 'high risk' OSOM movements in accordance with RMS guidelines.	Construction	Contractor
Road maintenance	TRA04	<p>Road maintenance will be managed through the following measures:</p> <ul style="list-style-type: none"> • a Road Dilapidation Report will be prepared and approved prior to and following Snowy 2.0 Main Works; • routine defect identification and rectification of the internal road network will be managed as part of the project maintenance procedure; and • internal access roads will be designed in accordance with the relevant vehicle loading requirements. 	Construction	Contractor
Traffic control	TRA05	Road works associated with pavement widening, such as those associated with intersection upgrades, that require temporary occupation of traffic lanes or working adjacent to the road, a Traffic Control Plan (TCP) will be prepared identifying the traffic control measures.	Construction	Contractor
Community consultation	TRA06	Affected communities, visitors and emergency services will be notified in advance of any disruptions to traffic and restriction of access to areas of KNP impacted by project activities.	Pre-construction, construction, operations	Snowy Hydro/ Contractor
Construction traffic management	TRA07	A Construction Traffic Management Plan will be prepared and will include guidelines, general requirements and procedures to be used when construction activities have a potential impact on existing traffic arrangements.	Pre-construction	Contractor

Table 6.31 Mitigation measures for traffic impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Marine transport	NAV01	<p>The following measures will be implemented to manage interactions between marine transport and public boating activities during construction:</p> <ul style="list-style-type: none"> • public exclusion zones will be established around all in-reservoir construction areas; • an aquatic license will be obtained from RMS for all in-reservoir construction activities and exclusion zones; • all work vessels will be limited to 4 knots; • all vessels and barges will be fitted with Automatic Identification System and comply with all licensing requirements of Australian Maritime Safety Authority and Roads and Maritime Services including specific requirements for Alpine Waters; • any fixed obstruction such as marker buoys and moorings will comply with Roads and Maritime Services requirements and are adequately lit at night; and • notification signs advising of the works and public closures at: <ul style="list-style-type: none"> – the intersection of Snowy Mountains Highway and Tantangara Road; – the intersection of Snowy Mountains Highway and Long Plain Road; and, – Tantangara Boat Ramp. 	Construction	Contractor

6.9.6 Summary and conclusion

Impacts to the capacity, condition, safety and efficiency of the road network were assessed and key issues identified. Key issues include the suitability of existing intersections within the KNP and in Cooma township.

New intersections will be established for construction access at Snowy Mountains Highway / Marica Track and Snowy Mountains Highway / Rock Forest Access. Upgrades to existing intersections will be undertaken as part of the Polo Flat segment factory application at Monaro Highway/ Yallakool Road, Monaro Highway / Polo Flat Road and Monaro Highway / Salesyard Road. Reduced speed limits are proposed to ensure intersection sight distance requirements are met at the intersection of Snowy Mountains Highway/ Tantangara Road, Snowy Mountains Highway/ Rock Forest and Link Road / Lobs Hole Ravine Road. Construction management protocols will be implemented to manage road maintenance, traffic control and community consultation requirements arising from the project traffic.

The use of navigable waters was also considered in Tantangara and Talbingo reservoirs. Suitable management measures will be implemented to ensure safety of reservoir users around construction areas and project vessels. There will be no access restrictions for emergency management within KNP as a result of the works and Snowy Hydro will consult closely with emergency services. There will be some public access restrictions during construction and operations but careful planning has been undertaken to minimise and mitigate these impacts.

The Snowy 2.0 Main Works will consider traffic and transport impacts as part of the project design and scheduling. Where impacts to traffic and transport are predicted, management measures will be implemented. In the long term the Snowy 2.0 Main Works will provide improved access infrastructure within the project area and wider region.



CHAPTER 6.10

AMENITY

6.10 Amenity

Amenity is a key consideration for the project due to the recognised KNP landscape values and the quiet, rural nature of the surrounding area and its townships. This chapter provides an assessment of the:

- construction, operational and road noise impacts of the project;
- blasting impacts of the project; and
- visual impacts of the project, including lighting impacts and potential impacts on views of the project from key vantage points in KNP.

The assessment of amenity relies on the landscape character and visual impact assessment (Appendix S) and noise and vibration assessment (Appendix R) prepared for the project and should be referred to for further information and detail on the assessment methodology and results.

6.10.1 Existing environment

KNP is an area recognised for its natural and heritage values, as described earlier in this EIS, and provides opportunity for remote experiences within a unique, natural landscape setting. The ambient noise environment is reflective of this uninhabited setting, with background noise levels controlled by natural elements. Industrial infrastructure does occur within areas of KNP proximate to the project area and these include the existing Snowy Scheme, Cabramurra township, electricity transmission lines and associated switchyards as well as evidence of former mining activities.

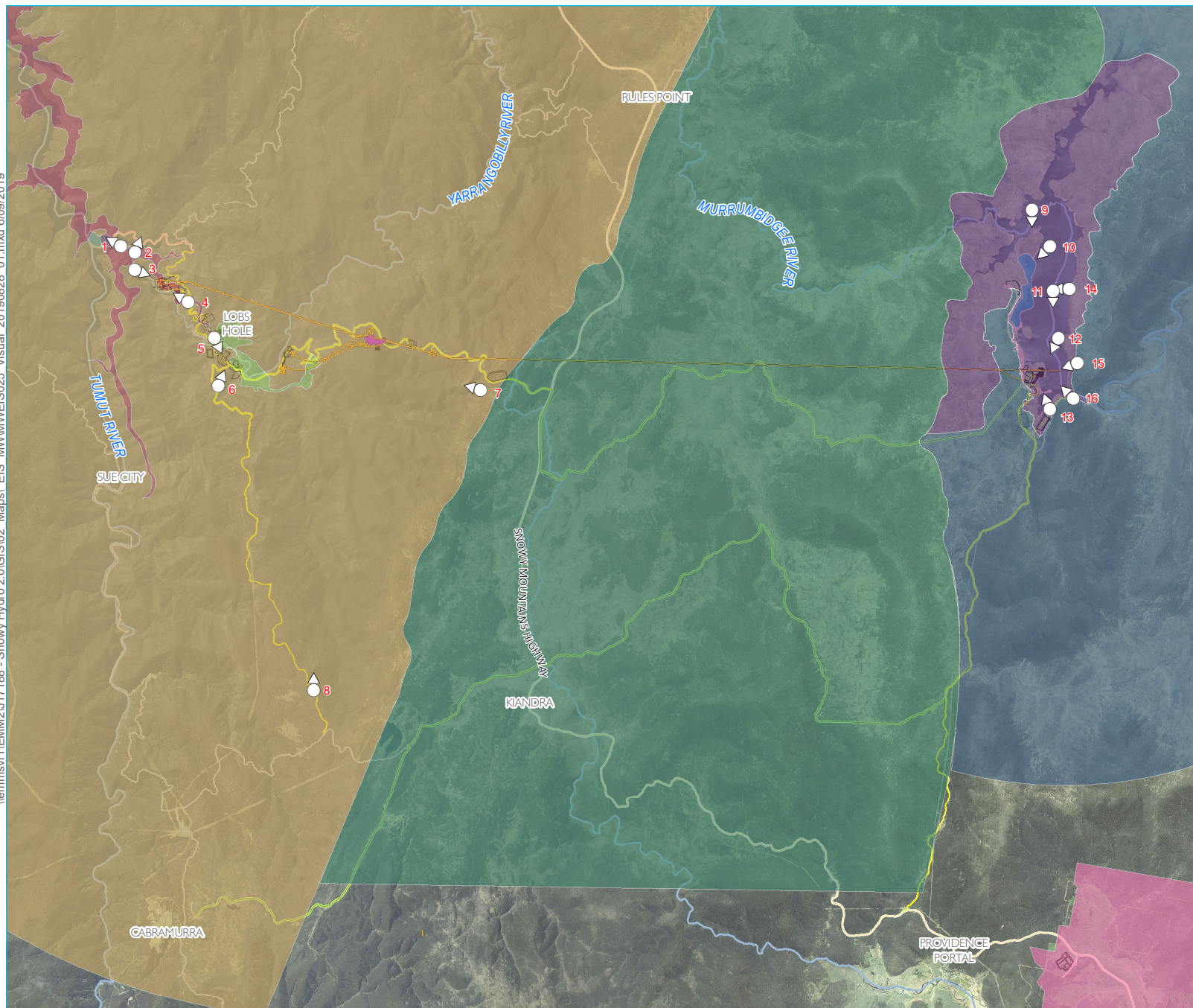
Intrusive noise sources are primarily limited to intermittent traffic along roads and boating activities by recreational users on the reservoirs. Landscape character zones have been derived based on the distinctive environments within the project area, which are shown on Figure 6.23. The road network to be utilised for primary haulage to and from the project is a source for current noise generation and is shown on Figure 6.24, as well as the assessment locations used in the noise assessment.

i Talbingo Reservoir

Talbingo Reservoir is characterised by the artificial lake created by the impounding of the Tumut River and the steep, rugged topography and dense woodland that surrounds it. Typically, vegetation is present all the way to the water's edge, with water quality and clarity high. Submerged trees are visible evidence of the inundation of the valley as part of the reservoir's creation. Noise sources are natural elements, except for minimal human activity associated with recreational pursuits on the reservoir.

In summer, water activities on the reservoir increase and include the use of motorised boats or small vessels such as kayaks or canoes. There are some 4WD fire trails in the surrounding area with views to the reservoir, and an existing transmission line and cleared easement through the woodland associated with the existing Snowy Scheme.

While there is visual evidence of built infrastructure due to the Snowy Scheme (transmission lines and the reservoir itself), there is a perceived naturalness to the reservoir that provides a scenic amenity with limited ability to absorb new built elements into the landscape. As such, the landscape character sensitivity of Talbingo Reservoir is assessed as high.



KEY

△ Viewpoints

Landscape character zone

LCZ 1 Talbingo Reservoir

LCZ 2 Talbingo rugged woodland

LCZ 3 Lobs Hole

LCZ 4 Gooandra Plateau

LCZ 5 Tantangara woodland

LCZ 6 Tantangara Reservoir and foreshore

LCZ 7 Rock Forest

Snowy 2.0 Main Works operational elements

Tunnels, portals, intakes, shafts

Power station

Utilities

Permanent road

Snowy 2.0 Main Works construction elements

Temporary construction compounds and surface works

Temporary access road

Indicative rock emplacement area

Existing environment

Main road

Local road

Watercourse

Landscape character zones and assessment locations

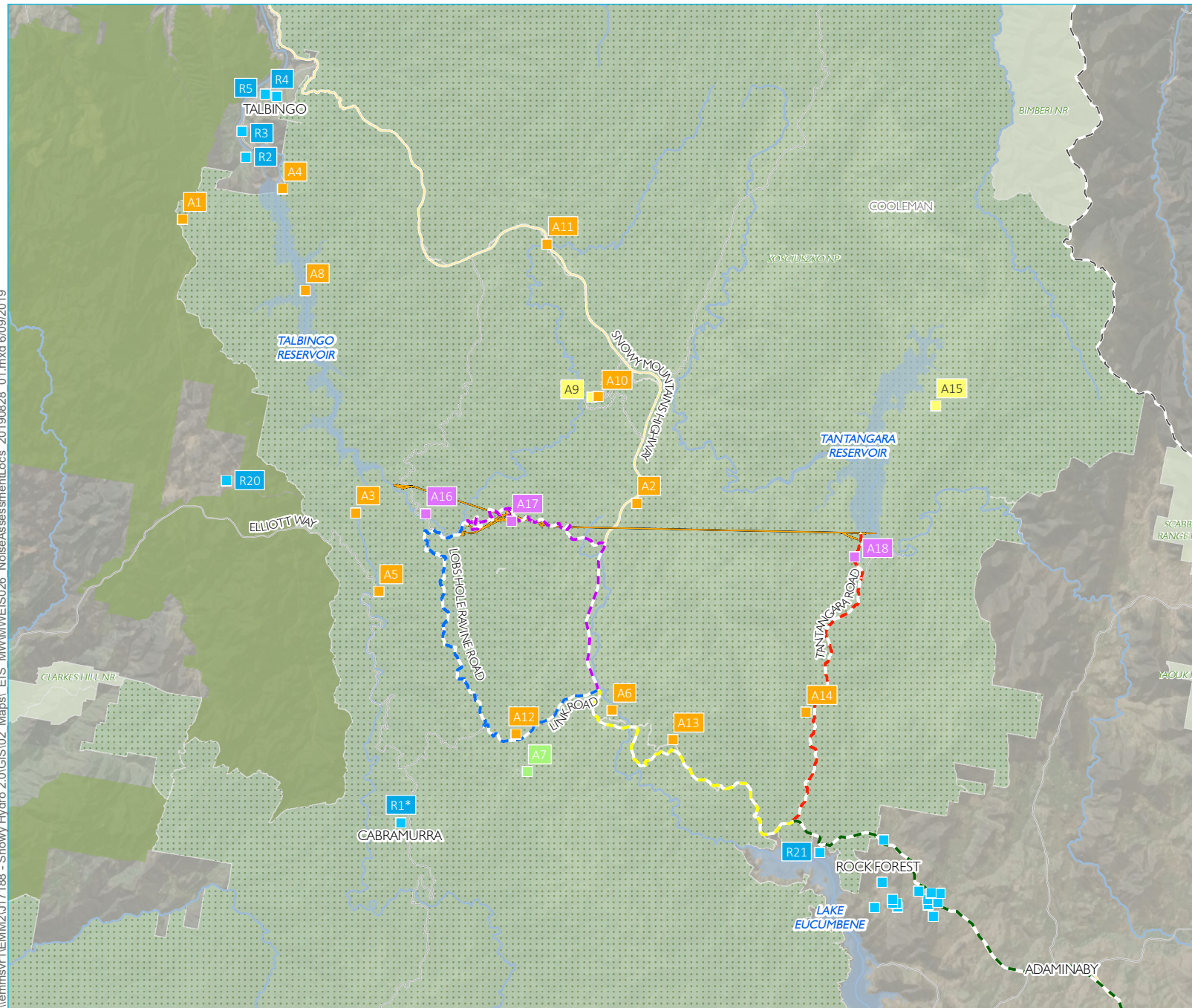
Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.23

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

0 2.5 5 km
GDA 1994 MGA Zone 55



\\lemmsvr1\EMM2\U17188 - Snowy Hydro 2.0\GIS02 Maps\ EIS MWMWEIS026 NoiseAssessmentLocs 20190828 01.mxd 6/09/2019



KEY

Noise assessment location

- Residential
- Commercial
- Passive recreation
- Active recreation
- Project accommodation

Primary transport route

- All site access from Cooma to KNP and Rock Forest
- Route to Tantangara Reservoir
- Route to Talbingo Reservoir and Lobs Hole
- Route to Marica and Lobs Hole
- Route to Marica, and alternative access to Lobs Hole

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Kosciuszko National Park
- NPWS reserve
- State forest
- State boundary

Noise assessment locations

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.24

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

0 5 10 km
GDA 1994 MGA Zone 55



ii Lobs Hole

Lobs Hole is a previously disturbed area which retains remnants of an old settlement where copper mining took place in the late 1800s/early 1900s. Large areas of land were cleared for the township along the Yarrangobilly River. The area is now frequented by visitors wishing to experience the remote nature of the site and its peaceful setting, as well as historical relics such as the Washington Hotel whose building footprint remains as a mud brick remnant. An existing transmission line and cleared easement also traverses the Lobs Hole area. Due to this previous disturbance there is a greater ability to absorb visual change.

iii Marica

Marica is characterised by steep, rugged topography and dense woodland that covers the landforms. The scenic qualities are typical of the Australian bushland aesthetic, and several lookouts have distant views toward Marica. The area is not frequented by visitors, with limited 4WD fire trail access available. Despite the low level of visitors, the largely undisturbed environment results in a high landscape character sensitivity susceptible to visual impacts, and consistent with other parts of KNP, low background noise levels.

iv Plateau

The Plateau represents a geomorphological change within the project area, with a clear visual change in topography and vegetation across the landscape. Visible qualities such as the bogs and fens represent fragile ecosystems that exist in this zone with built form minimal in size and scale but comprising campgrounds (such as Bullocks Hill campground) and unique heritage sites (such as the Kiandra Courthouse and Chalet and the Wolgal Hut). A transmission line easement runs north-south across the landscape, as does the primary road corridor of the Snowy Mountains Highway. The highway presents the primary noise source in this landscape. Due to the presence of infrastructure that supports recreational use, transmission lines and transport movements throughout the zone, the overall landscape character is of moderate sensitivity to change.

v Tantangara Reservoir

Tantangara Reservoir is characterised by a backdrop of undulating woodland that surrounds the grassland of the reservoir foreshore. The area provides spaces for camping accessible by most vehicles, with visitors to the area seeking an isolated experience in a natural setting. While the reservoir is not a natural feature (as evidenced by the dam wall, transmission lines and buildings near the wall), it provides the aesthetic of such. Visitors recreate along the foreshore and on the reservoir, particularly for fishing activities, travel to nearby historic sites such as Currango Homestead, or experience the high plains via horseback. These recreational uses (boating activities and vehicular travel) are the dominant noise sources in this setting.

As the higher of the two reservoirs, Tantangara Reservoir will experience snow during winter. While there is presence of existing infrastructure of the Snowy Scheme it is set amongst clear water and the slow growth alpine vegetation and backdrop to the Snowy Mountains. The landscape character sensitivity is considered to be high.

vi Rock Forest

Rock Forest is characterised by its grazing uses and pockets of vegetation spread throughout the private property. The adjacent Snowy Mountains Highway provides the dominant source of noise, with traffic travelling along the road at the border of the KNP. The sensitivity of the landscape character is moderate, due to the private nature of the site and the transient means in which observers experience the zone.

6.10.2 Community and stakeholder views

Community and stakeholder views relating to amenity have been raised throughout the consultation period to date for Snowy 2.0. The key amenity related matters raised include the need to minimise landscape and visual impacts within KNP, retaining remote recreational opportunities and minimising amenity impacts to park users. This was raised by NPWS, special interest groups and members of the community to ensure the KNP values are preserved.

6.10.3 Avoidance and minimisation through design

A number of avoidance and minimisation measures have been incorporated into the design, either as part of the DIAA process or to respond to community and stakeholder views. These measures include:

- removal of plateau substation, where it would have been a prominent visual feature in the landscape;
- the layout of Rock Forest was reoriented to reduce noise emissions to nearby residences. The proposed use of the site was also reduced in scale resulting in improved amenity outcomes; and
- location, arrangement, design and rehabilitation of intake structures to minimise the visual and aesthetic impact on the natural surrounding environment where possible while meeting all technical requirements.

6.10.4 Predicted impacts

i Overview

The key amenity impacts of the project relate to changes to the landscape and visual impacts associated with the introduction of new infrastructure into the landscape, as well as noise impacts that have the potential to interrupt recreational users of KNP or residences along the key haulage route to construction sites. Impacts to amenity resulting from noise are anticipated to be limited primarily to the construction phase of the project, whereas landscape and visual impacts will be experienced during both construction and operation.

A total of 17 viewpoints were considered representative of key receptors within KNP and surrounds (shown on Figure 6.23), and assessments of each of these are summarised in Table 6.33 and provided in further detail in Appendix S (LCVIA). All viewpoints were representative of 'passive recreation' and the majority of landscape sensitivity is high due to their location within the natural settings provided by KNP. As construction works are 24/7, lighting may be visible from some vantage points during evening and night-time periods (eg views to Marica from Wallaces Creek fire trail), however the number of visitors to these vantage points during these hours is likely to be low. Impacts identified in the table below need to be considered in the context that these areas are not frequently accessed by the public throughout the year.

Table 6.33 Overview of predicted impacts on views of the project from key vantage points within KNP

Viewpoint	Location and representative receptor	Impact during construction	Impact during operation
Talbingo Reservoir			
1	Within Talbingo Reservoir looking north-west towards shoreline. Water-based receptors: Fishers, boaters and swimmers within the reservoir	High – there would be a visible change in water turbidity as well new cleared areas and construction activity along the previously scenic shoreline	Moderate to High – due to the sensitivity of the landscape and visibility of placed rock within the reservoir when water levels are below FSL. However, this impact will occur in a location isolated from the main recreational user areas on Talbingo Reservoir
2	Within Talbingo Reservoir looking north. Water-based receptors only: Fishers, boaters and swimmers within the reservoir	High – clearing for the access road to the placement area will be visible and change the aesthetic of the shoreline	Low – the area will be rehabilitated, and the setting returned to a wooded landscape
3	Within Talbingo Reservoir looking south-east towards shoreline, on the edge of the public exclusion zone. Water-based receptors only: Fishers, boaters and swimmers within the reservoir	High – there would be a substantial change from a largely undisturbed shoreline to one cleared of vegetation	High – the nature and scale of permanent elements in view are contrast to the largely undisturbed woodland setting. However, this impact will occur in a location isolated from the main recreational user areas on Talbingo Reservoir
Lobs Hole			
4	Lobs Hole Ravine Road looking west towards Talbingo Reservoir. Walkers, bike riders, horse riders, vehicles, campers using Lobs Hole Ravine Road	N/A – viewpoint is not publicly accessible during construction	Moderate to High – existing transmission line intersects the view however the alteration of land for the intake would be contrasting to the landscape setting
5	View towards the south, within Lobs Hole. Walkers, bike riders, horse riders, vehicles, campers using Lobs Hole	N/A – viewpoint is not publicly accessible during construction	Moderate to High - the substation in this location is a change to the semi-rural to natural character of this view and surrounding setting
6	Looking north from Lobs Hole Ravine Road along existing transmission line easement. Walkers, Bike riders, Horse Riders, Campers, Vehicles using Lobs Hole Ravine Road	N/A – viewpoint is not publicly accessible during construction	Low to Moderate – only the top of gantries for the substation would be visible and the transient nature of users of the access road
Marica			
7	Looking west from Wallaces Creek Fire Trail towards Talbingo Reservoir. Campers, walkers, bike riders, horse riders	Moderate – visibility of elements would be difficult but possible, and lighting impacts during evening and night time would be possible	Moderate – the visual analysis suggests this location as having some visibility of the surge shaft. However the majority is likely to be screened by the existing vegetation from this viewpoint
8	View north from Wallaces Creek Lookout. Wheel chair accessible lookout. Walkers, campers at Lobs Hole, visitors to the Lookout	N/A – viewpoint is not publicly accessible during construction	Negligible – unlikely to be visible at this distance

Table 6.32 Overview of predicted impacts on views of the project from key vantage points within KNP

Viewpoint	Location and representative receptor	Impact during construction	Impact during operation
Plateau			
N/A	N/A	N/A	N/A
Tantangara Reservoir			
9	Looking south from within Tantangara Reservoir. Water-based receptors: Fishers, boaters and swimmers within the reservoir	High – extensive disturbance to shoreline would be visible during placement of excavated rock	Moderate to High – the intake would only just be visible however a changed shoreline condition would be visible
10	From within Tantangara Reservoir looking southwest. Water-based receptors: Fishers, boaters and swimmers within the reservoir	Moderate to High – extensive disturbance to shoreline would be visible during placement of excavated rock	Moderate to High – the change to landscape from rock placement will contrast with grasses of the shoreline and impact aesthetic value
11	Looking south toward Tantangara Road from within the reservoir. Water-based receptors only: Fishers, boaters and swimmers within the reservoir	Moderate – the view is more distant to intake construction but an abundance of construction activity that would be seen from this location	Moderate – multiple permanent elements would be seen but at a distance which reduces the scale of impact from this location
12	Looking south-west towards proposed Intake location from within Tantangara Reservoir, on edge of public exclusion zone. Water-based receptors only: Fishers, boaters and swimmers within the reservoir	High – due the proximity of the view to construction and obtrusive elements within the landscape setting	Moderate to High – grassy areas will be replaced with permanent structure of the intake that is only partially visible
13	Looking north-west from Tantangara boat ramp into the reservoir. Campers in Tantangara, Walkers, Horse and Bike Riders, 4WD's, Visitors	N/A – viewpoint is only accessible to the public via limited, escorted access by the contractor	High - the view from this location would be altered by the introduction of new permanent infrastructure. The intake would be on the peninsula in the centre of the view and contrast the natural setting
14	Looking west from shoreline towards the excavated rock placement location. Campers in Tantangara, Walkers, Horse and Bike Riders, 4WD's, Visitors	Moderate to High - substantial disturbance and change to the view during construction	Moderate to High – the change in view is influenced by the rock placed on the shoreline
15	Looking west from Pocket Saddle Road into Tantangara Reservoir. Campers in Tantangara, Walkers, Horse and Bike Riders, 4WD's, Visitors	Moderate to High – a high magnitude of change would result from construction activities visible in this view	Moderate to High - the grassed shoreline used by recreational users will be closed to the public, with multiple permanent operational elements atop it
16	Looking north-west into Tantangara Reservoir from the existing dam wall. Campers in Tantangara, Walkers, Horse and Bike Riders, 4WD's, Visitors	Moderate to High - Construction activities would be obtrusive from this angle. Large amounts of clearing and machinery would be noted	Moderate - the existing dam wall is within the view however new permanent operational elements would cause change to the existing landscape seen in the distant outlook

Table 6.32 Overview of predicted impacts on views of the project from key vantage points within KNP

Viewpoint	Location and representative receptor	Impact during construction	Impact during operation
Rock Forest			
17	Rock Forest, looking south from Snowy Mountains Highway. Commuters, workers, tourists predominantly from vehicle, using Snowy Mountains Highway, residents from neighbouring properties	Moderate - the magnitude of change to this observer location is high. However, there exists potential in this location to retain vegetation for screening purposes	N/A – the site will be rehabilitated and not needed during operation

Noise assessment locations considered for the project are widely spread within the project area and include passive and active recreation receptors, residential receptors near Rock Forest (including Providence Portal), and commercial premises. Assessment of predicted noise and vibration impacts at each of these receptors is provided in further detail in Appendix R (NVIA). Assessment of vibration and blasting impacts of the project and changes to road traffic noise levels has also been undertaken. A summary of predicted noise and vibration impacts is provided at Table 6.34.

Table 6.34 Summary of predicted construction (including blasting), operational and road noise impacts of the project

Assessment	Predicted impacts
Construction noise	Construction noise levels satisfy noise management levels (NMLs) at all assessment locations with exception of the nearest receiver (R6) at 6560 Snowy Mountains Highway, Adaminaby where exceedance of 11-14 dB is predicted for the day and out of hours periods during calm and adverse weather conditions, respectively. While noise levels at passive recreation areas satisfy the required NML, noise generated by construction would still be perceptible and clearly audible at these locations.
Sleep disturbance	Predicted noise levels from the project satisfy sleep disturbance screening criteria at all assessment locations with the exception of the nearest receiver (R6) at 6560 Snowy Mountains Highway, Adaminaby where exceedances of 5-6 dB are predicted.
Construction vibration	The nearest residence to construction activity is assessment location R6 which is more than 300 m away from the Rock Forest construction site. This assessment location is beyond the safe working distances for human response considerations. Vibration impacts from construction at residential assessment locations are therefore highly unlikely.
Blasting	<p>All rock structures/transmission lines/and heritage structures in the vicinity of the proposed blasting areas are outside the minimum calculated offset distances. A number of specific sites recorded in the HA&SoHI (EMM 2019) relating to a rock shelter at Tantangara, and exposed cliff-edge tufa deposits identified in Cenozoic Geodiversity Report (Troedson 2019) were identified as high value and worthy of protection. These areas well outside of blast offset zones.</p> <p>Residential receivers surrounding the project are also well outside the blast offset distances required to maintain acceptable emission levels from road construction, portal and early stage tunnel excavation. Therefore, blast impacts on residential receivers are considered highly unlikely.</p>

Table 6.33 Summary of predicted construction (including blasting), operational and road noise impacts of the project

Assessment	Predicted impacts
Road traffic noise	<p>Road traffic noise levels are predicted to increase due to the project in both day and night hours.</p> <p>The increase is most significant on Lobs Hole Ravine Road and Tantangara Road which are within the project area, as the two main access roads to work sites they will experience the greatest level of change in overall traffic volumes. Lobs Hole Ravine Road will be restricted from public access therefore impacts to users in this area is not expected. Tantangara Road will be closed during road construction works and when any high risk activities are being undertaken (eg transport of oversized equipment). Access along Tantangara will be maintained at other times with measures in place (car escort, traffic lights) to achieve the required level of safety. Road traffic noise will satisfy NMLs at Wares Yards along Tantangara Road, however noise will be audible for recreational users of this area.</p> <p>Road traffic noise levels relevant to the township of Adaminaby and properties along Snowy Mountains Highway between Cooma and Link Road will remain within baseline levels of the NSW Road Noise Policy. The predicted increase in construction traffic will result in increases in noise levels up to 7 dB, a perceptible to notable difference in noise level during the day. Louder impacts are anticipated at night with up to 11 dB change in noise level expected. Notwithstanding this increase, baseline levels of the NSW Road Noise Policy are satisfied. As discussed in Section 6.9 reductions in the speed limit on Snowy Mountains Highway through the Adaminaby town centre are also under consideration and would further reduce impacts from road traffic noise.</p> <p>Increases in noise levels are also expected along Link Road. However, limited receptors are along Link Road that would be susceptible to these changes.</p> <p>Road noise level changes in Cooma would not be perceptible during daytime hours, and unlikely to be perceptible during night-time hours.</p> <p>No significant changes to road traffic volumes or noise is expected during operation.</p>
Operational noise	<p>No residential assessment locations are within the vicinity (<1,000 m) of the operational sites associated with Snowy 2.0 Main Works. Noise from the operation of Snowy 2.0 Main Works facilities would be less than L_{Aeq} 30dB(A) at Lobs Hole campground and other camping areas within the vicinity of Talbingo Reservoir and across the Plateau and Tantangara Reservoir.</p>

ii Talbingo Reservoir

Construction works will include the clearance of vegetation to establish construction sites and involve excavation for the Talbingo portal and compound area, the intake and roads to the reservoir emplacement area. The extent of clearing and excavation will be a significant change to a section of the landscape. Placement of excavated rock will also result in temporary elevated levels of turbidity in the water in the area surrounding the emplacement area. However, as construction sites, will be restricted and no public access will be available (including water-based areas surrounding the intake and placement areas), there will be limited views for the duration of the six-year construction period. Upon completion however, public access will be reinstated (with the exception of some areas that will be restricted to ensure public safety) and views of the landscape will include permanent infrastructure that is contrasting to the previously undisturbed natural setting.

The predicted change in landscape is shown visually in the photomontage provided at Figure 6.25, which is representative of water-based users of Talbingo Reservoir. Rehabilitation objectives are set out in the Rehabilitation Strategy (Appendix F) with guidance on different types of revegetation that would better enable integration with the landscape, where possible. However, as seen in the photomontage, the steep batters of the intake limit the extent of stable revegetation that can occur. The visual impact during both construction and operation is high.

While exceedance is not expected at passive recreation receptors during construction, the change in noise environment would be perceptible. During operation however, noise impacts at these receptors is negligible.

iii Marica

There will be no public access to Marica during construction, and limited access during operation as the upgraded Marica trail will be the primary access for Snowy Hydro to access the surge shaft and ventilation shaft. The nearest public viewpoint is from Wallaces Creek Firetrail. Dense vegetation is expected to screen views of the surge shaft and ventilation shaft, therefore negligible visual impacts are expected during both construction and operation. No exceedance of noise levels is predicted however impacts may be audible at nearby recreational sites such as Bullocks Hill campground, during construction.

iv Plateau

No viewpoints were selected within the Plateau as visual elements would be limited to temporary plant and machinery needed during construction for utilities along access roads. During operation, these utilities will be buried and not visible.

v Tantangara Reservoir

Construction works will include the clearance of vegetation to establish construction sites and involve excavation for the Tantangara portal and compound area, the intake and roads to the reservoir emplacement area. The extent of clearing and excavation will be a significant change to the landscape, both temporarily during construction and permanently following completion of the project given public accessibility along the foreshore, the openness of the landscape, and the popularity of the reservoir for recreational boating and fishing activities. Public access will be available from parts of Tantangara Reservoir during construction; therefore impacts are expected during both construction and operation.

A recreation plan is proposed to be prepared in consultation with NPWS to allow for rehabilitation of the foreshore to accommodate more formalised recreational facilities. However, details of likely improvements are yet to be determined.

The predicted change in landscape is shown visually in the photomontage provided at Figure 6.26, which is representative of recreational users accessing Tantangara Reservoir. Rehabilitation objectives are set out in the Rehabilitation Strategy (Appendix F) with guidance on different types of revegetation that would better enable integration with the landscape, where possible.

While exceedance is not expected at passive recreation receptors during construction, the change in noise environment would be perceptible. During operation however, noise impacts at these receptors is negligible.

vi Rock Forest

Construction works at Rock Forest will require the clearing and movement of land to provide level hardstand areas. Trucks will be entering and leaving the site with material storage and would be one of the primary noise sources heard in the surrounding area. While only used during construction, the six year period presents a magnitude of change to its current use, and the noise generating activities are predicted to exceed criteria (day and night) at the nearest residential receiver (to the north-east along Snowy Mountains Highway).



Existing view from water, edge of (indicative) public exclusion zone



During construction – typical operating level



15 year operation – typical operating level

Figure 6.25 Talbingo Reservoir viewpoint assessment – View from water, edge of public exclusion zone



Figure 6.26 Tintangara Reservoir viewpoint assessment – View from Tintangara Road

6.10.5 Mitigation measures

Mitigation measures identified to minimise amenity impacts are provided in Table 6.35.

Table 6.35 Mitigation measures for amenity impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Visual and landscape impacts resulting from permanent placement of excavated material	LCV01	The placement of excavated material in Talbingo, Lobs Hole and Tantangara Reservoir will be rehabilitated as guided by the Rehabilitation Strategy and in consultation with NPWS.	Detailed design	Contractor Snowy Hydro NPWS
Visual and landscape impacts resulting from permanent infrastructure	LCV01	Detailed design is to consider: <ul style="list-style-type: none"> materials and finishes that complement or where possible recede into the surrounding landscape; the use of vegetation to screen project elements and re-vegetation of disturbed areas in line with the Rehabilitation Strategy; and lighting to avoid spill that might affect sensitive areas or receivers. 	Detailed design	Contractor
Construction impacts	NV01	Prepare a construction noise and vibration management plan (CNVMP) that will address noise and vibration management and mitigation options (where required). The CNVMP will include as a minimum: <ul style="list-style-type: none"> identification of nearby residences and sensitive land uses; a description of approved hours of work and what work will be undertaken; a description of what work practices will be applied to minimise construction noise, in particular how construction noise levels will be managed where predicted noise levels above the NMLs have been identified; a description of what work practices will be applied to minimise vibration; a description of the complaints handling process; and a description of monitoring that is required. 	Construction	Contractor
Exceedance of day and night-time criteria at assessment location: R6	NV02	Affected landholders should be consulted prior to and during construction and should be notified of proposed mitigation measures that will be used to manage construction noise levels to below Interim Construction Noise Guideline (EPA 2009) NMLs where practicable.	Pre-construction Construction	Contractor
Vibration impacts in the vicinity of heritage items	NV03	If the safe working distances are encroached vibration monitoring will be carried out at nearby heritage items. If required, the monitoring system will be fitted with an auditory and visual alarm that triggers when vibration levels reach the nominated criteria. This would indicate if and when alternate work practices should be adopted (such as decrease vibratory intensity, alternate equipment selection, or other measure).	Construction	Contractor

Table 6.34 Mitigation measures for amenity impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Blasting in the vicinity of sensitive receptors and heritage items	NV04	<p>A Blasting Management Plan be prepared including specific details to:</p> <ul style="list-style-type: none"> • address the potential for wet drill and blast activities at Talbingo and Tantangara intakes to ensure potential impacts are managed; • allow for blast practices to be reviewed as needed when blasting occurs in the vicinity of significant heritage items; and • allow for blast practices to be reviewed and adapted if complaints are received from residents due to night blasting. 	Construction	Contractor
Operational noise	NV05	<p>The design of operational structures, plant and equipment is to consider:</p> <ul style="list-style-type: none"> • All operational plant and equipment including ventilation, pumps, generators, transformers, variable speed drives or other plant associated with the surface structures of Snowy 2.0 shall be subject to detailed acoustic review prior to final specification. • Design shall be assessed against the requirements of the Noise Policy for Industry (EPA 2017) and consider the amenity criteria for passive recreation. • Building and equipment shall be designed to satisfy the Snowy Hydro design limits of L_{Aeq} 80dB(A) internal. 	Operation	Contractor Snowy Hydro

6.10.6 Summary and conclusion

The amenity values of the project area are reflective of its location within a national park setting. NPWS, special interest groups and members of the community have expressed views on the need to protect KNP and these amenity values, which include conserving the natural landscapes and visual character unique to the Australian Alps. The assessment completed for the project incorporates these views in classifying the sensitivity of the landscape to change, and the magnitude of impacts likely to be experienced.

The assessment concluded that noise and visual impacts are greatest during construction, but as public access will be restricted during construction, these impacts will largely not be experienced. The exception is for properties along Snowy Mountains Highway between Rock Forest and Cooma, where there will be an increase in road traffic noise, and one residential property nearest to Rock Forest that exceeds NMLs and requires mitigation. While noise levels are within NMLs for identified recreational sites within KNP, they will be audible and may affect the amenity of recreational user experience.

The introduction of new permanent elements into the landscape results in a permanent change to the landscape character and visual setting of KNP in the publicly accessible areas of Talbingo Reservoir, Lobs Hole and Tantangara Reservoir. However, opportunities to provide recreational facilities as part of the permanent rehabilitation of these sites is proposed to be determined in consultation with NPWS, which may mitigate the magnitude of predicted impacts during operation.



CHAPTER 6.11

HAZARDS

6.11 Hazards

6.11.1 Context

Potentially hazardous impacts of the project and public safety risks, including bushfire and flooding risks have been assessed. The assessment relies on technical reports prepared for the project and should be referred to for detailed information, including a Hazard Identification and Risk Assessment prepared by Sherpa in line with AS/ISO 31000:2018 Risk Management Guidelines, and a Bushfire Risk and Hazard Assessment (BFRHA) prepared by Eco Logical Australia in line with the NSW Rural Fire Service (RFS) *Planning for Bush Fire Protection Guideline* (PBP) (NSW RFS 2018). These reports are provided at Appendix T and U respectively. A flood assessment has also been completed and provided at Appendix J.

An overview of the existing environment as it relates to hazard is provided in Table 6.36, along with relevant community and stakeholder views and project design considerations relevant to the assessment of these hazards.

Table 6.36 Context of hazards for Snowy 2.0 Main Works

Existing environment	<p>The Snowy 2.0 Main Works sites west of the Snowy Mountains Highway including Talbingo Reservoir, Lobs Hole and Marica occur within the Southern Slopes Fire Weather Area and the Snowy Valleys Bush Fire Management Committee (BFMC) Area. The sites east of the Snowy Mountains Highway including Plateau, Tantangara Reservoir and Rock Forest are within the western extent of the Monaro Alpine Fire Weather Area and the Snowy Monaro BFMC Area.</p> <p>The typical bushfire potential of vegetation within the KNP varies throughout the year, with typical fire risk levels being moderate from September to December, high from January to April and low from May to August. During an average bush fire season, the State Forests to the west of Lobs Hole/Ravine Main Works sites experience 31 very high fire danger days and one total fire ban (Severe fire danger or greater) day per annum (CSIRO 2018). This equates to on average more than two days each week during the summer in which very high or greater fire danger occurs, and at least one total fire ban day (severe or greater fire danger) each fire season.</p> <p>Historically and average of eleven bush fires per year are recorded within the KNP with severe bushfire occurring approximately once every ten years. The most recent severe fire in 2003 burnt approximately 478,000 ha of KNP, including the project area (DECC 2008).</p> <p>One of the key challenges for management of hazards and bushfire for the project is that the Snowy 2.0 Main Works are remotely within the KNP and existing access is constrained by topography and limited existing road infrastructure. The Main Works construction sites are a large distance from the nearest residential or commercial land uses and publicly accessible areas. Access to parts of the project area will be closed to the public for the duration of Main Works to ensure public safety.</p> <p>Watercourses and flood characteristics within the project area are discussed in detail in Section 6.2.</p>
Community and stakeholder views	<p>The RFS and NPWS were consulted regarding secondary access to Lobs Hole. RFS advised that Lobs Hole Ravine Road North is planned to be a strategic fire trail in the Draft Fire Trail and Access Plan.</p> <p>Matters relating to public safety were also raised by the community during consultation, including concern regarding impacts to recreational users within the KNP. These community views have been considered in the recreational user assessment completed for the project (Appendix X.2).</p>
Avoidance and minimisation through design	<p>Bushfire risk assessment was included within the DIAA process for the project with the following changes incorporated:</p> <ul style="list-style-type: none">• re-location of the Tantangara accommodation camp to a downslope location with improved secondary access;• expansion of the disturbance area where required to include adequate Asset Protection Zone (APZ) clearances around all proposed construction areas for bushfire protection; and• identification and design of suitable access routes for access and egress for emergency services, and safe evacuation if required.

6.11.2 Predicted impacts

While bushfires occur naturally in the environment, the project has the potential to exacerbate the risk of bushfire if construction and operation activities are not designed or carried out in a way that minimises this risk. This same principle applies to flooding impacts and requires the project to be designed in a way that minimises risk to public safety. The transport and storage of dangerous goods (which includes flammables, explosives, or other chemicals) is a potentially hazardous impact of the project if not appropriately managed.

The key matters assessed and summarised in Table 6.37 relate to the provision of adequate APZs, the suitability of primary and secondary access and the storage of dangerous goods, and potential flood risks.

Table 6.37 Summary of impacts – Hazards

APZs	Emergency access and evacuation	Dangerous goods	Flood risks
Talbingo Reservoir			
Assessment of APZs was completed for Talbingo construction yard and the Talbingo intake. All sites were found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29.	<p>Access to sites in this area will be provided as follows:</p> <ul style="list-style-type: none"> Primary Access: South on Lobs Hole Ravine Road to Link Road; Secondary Access: North on Lobs Hole Ravine Road to Snowy Mountains Highway; and Secondary Access (once constructed): Mine Trail Road, Marica Trail West and Marica Trail East to Snowy Mountains Highway. <p>The proposed access will comply with all requirements for primary and secondary access under PBP 2018. The performance criteria for NSW RFS Fire trail standards can be largely achieved by the proposed access. Lobs Hole Ravine Road cannot practically achieve the acceptable solution for turnarounds due to very steep slopes. The performance criteria can be achieved by sign-posting and mapping identified turnaround points.</p> <p>A section of Lobs Hole Ravine Road North between the Blue Creek Trail intersection and Middle Bay cannot practically achieve the acceptable solution for vehicle passing due to very steep side slopes. However, the performance criteria in this section can be achieved by establishing sign-posted passing bays with hold points and radio call-in/out procedures to manage traffic flow in the event of emergency.</p>	The Risk Assessment identified no potentially hazardous activities at the Talbingo Reservoir sites.	No significant change to flooding characteristics for Talbingo Reservoir is anticipated.

Table 6.36 Summary of impacts – Hazards

APZs	Emergency access and evacuation	Dangerous goods	Flood risks
Lobs Hole			
Assessment of APZs was completed for Lobs Hole Camp, Main Yard, ECVT portal and cableyard and the MAT portal. All sites were found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29.	<p>Access to sites in this area will be provided as follows:</p> <ul style="list-style-type: none"> • Primary: South on Lobs Hole Ravine Road to Link Road; • Secondary: North on Lobs Hole Ravine Road to Snowy Mountains Highway; and • Secondary (once constructed): Mine Trail Road, Marica Trail West and Marica Trail East to Snowy Mountains Highway. <p>The proposed access will comply with all requirements for access under PBP 2018. The performance criteria for NSW RFS Fire trail standards can be largely achieved by the proposed access. Lobs Hole Ravine Road cannot practically achieve the acceptable solution for turnarounds due to very steep slopes. However, the performance criteria can be achieved by sign-posting and mapping identified turnaround points.</p> <p>A section of Lobs Hole Ravine Road North between the Blue Creek Trail intersection and Middle Bay cannot practically achieve the acceptable solution for vehicle passing due to very steep side slopes. However, the performance criteria in this section can be achieved by establishing sign-posted passing bays with hold points and radio call-in/out procedures to manage traffic flow in the event of emergency.</p> <p>A bushfire refuge building is required at the Lobs Hole Camp in order to comply with the PBP.</p>	<p>Storage of explosives during construction at the Main Yard, MAT portal and ECVT portal magazine stores were identified as potentially hazardous.</p> <p>The Risk Assessment found that the magazine stores achieve acceptable separation distances to surrounding land uses and the construction accommodation camps.</p>	<p>Temporary and permanent surface infrastructure will unavoidably need to be constructed on flood prone land around Lobs Hole. This includes temporary infrastructure and construction support sites (eg associated with construction phase works, such as the accommodation camp and main yard) and permanent infrastructure (eg infrastructure associated with ongoing operation, such as roads, bridges and tunnel portal sites and buildings).</p> <p>Whilst the spatial extent and magnitude of impacts is extensive throughout Lobs Hole, in particular for floods of 1% AEP and above, these impacts are not anticipated to impact on existing infrastructure or other areas of significance, and the design of temporary works can accommodate the changed flooding characteristics.</p>

Table 6.36 Summary of impacts – Hazards

APZs	Emergency access and evacuation	Dangerous goods	Flood risks
Marica			
Assessment of APZs was completed for the Vent Shaft, Marica Camp and Surge Shaft. All sites were found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29.	<p>Access to sites in this area will be provided as follows:</p> <ul style="list-style-type: none"> • Primary: East on Marica Trail East to Snowy Mountains Highway; • Secondary: North on Lobs Hole Ravine Road to Snowy Mountains Highway; and • Secondary (once constructed): West on Marica Trail West to Mine Trail Road, and south on Lobs Hole Ravine Road to Link Road. <p>The proposed access will comply with all requirements for access under PBP 2018 and achieve all performance criteria and acceptable solution requirements for NSW RFS Fire trail standards.</p> <p>A bushfire refuge building is required at the Marica Camp in order to comply with the PBP.</p>	The Risk Assessment identified no potentially hazardous activities at the Marica sites.	No flooding impacts will occur at Marica
Plateau			
No sites requiring APZs are in this area.	No sites requiring access are in the plateau area.	The Risk Assessment identified no potentially hazardous activities on the Plateau.	Proposed temporary surface infrastructure in the vicinity of Kellys Plain Creek (eg accommodation camp and stockpile area), largely avoids flood prone land and therefore will not impact on existing flooding characteristics. Minor increases to peak flood levels along Kellys Plain Creek are expected to occur from the proposed upgraded road crossing of this watercourse, however these impacts would be localised are not anticipated to impact on infrastructure or other areas of significance.

Table 6.36 Summary of impacts – Hazards

APZs	Emergency access and evacuation	Dangerous goods	Flood risks
Tantangara Reservoir			
Assessment of APZs was completed for Tantangara Intake and Tantangara Camp. All sites were found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29.	<p>Access to sites in this area will be provided as follows:</p> <ul style="list-style-type: none"> • Primary: Quarry Road and south on Tantangara Road to Snowy Mountains Highway; and • Secondary: East on Tantangara Road to Dam wall as an option for refuge. Numerous fire trails east to Yaouk Valley and west (including Port Phillip Trail) to Snowy Mountains Highway. <p>The proposed access will comply with all requirements for access under PBP 2018 and achieve all performance criteria and acceptable solution requirements for NSW RFS Fire trail standards.</p> <p>A bushfire refuge building is required at the Tantangara Camp in order to comply with the PBP.</p>	<p>Storage of explosives during construction at the Tantangara Portal magazine store was identified as potentially hazardous.</p> <p>The Risk Assessment found that the magazine store achieves acceptable separation distances to surrounding land uses and the construction accommodation camps.</p>	No significant change to flooding characteristics for Tantangara Reservoir is anticipated.
Rock Forest			
An assessment of APZs was completed for the Rock Forest logistics hub. It was found to fully comply with the PBP APZ requirements for radiant heat levels, slope and maintenance for a nominated BAL-29.	<p>Primary and secondary: East on Snowy Mountains Highway to Adaminaby, or west to Kiandra.</p> <p>The proposed access will comply with all requirements for access under PBP 2018 and achieve all performance criteria and acceptable solution requirements for NSW RFS Fire trail standards.</p>	The Risk Assessment identified no potentially hazardous activities at Rock Forest.	No flooding impacts are expected at Rock Forest.

6.11.3 Mitigation measures

Mitigation measures required to manage hazard impacts are all associated with the management of bushfire. Management measures for flooding impacts are provided in Section 6.2.5. Mitigation measures for hazard impacts are provided in Table 6.38.

Table 6.38 Mitigation measures for hazards impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
APZs	HAZ 01	APZs are established for all Snowy 2.0 Main Works sites to achieve BAL 29.	Construction and operation	Contractor Snowy Hydro
	HAZ 02	Vegetation is managed within operational APZs in perpetuity.	Construction	Contractor

Table 6.37 Mitigation measures for hazards impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Construction Standards	HAZ 03	All buildings proposed within each development site shall comply with BAL-29 construction standards of Australian Standard AS3959-2018 'Construction of buildings in bush fire-prone areas' or NASH Standard (1.7.14 updated) 'National Standard Steel Framed Construction in Bush fire Areas -2014' as appropriate.	Construction	Contractor
On-site Refuge	HAZ 04	All On-site Refuge buildings will be within the centre of each Snowy 2.0 Main Works Accommodation site, constructed to BAL-29 construction standard, be of appropriate capacity, signposted and mapped.	Construction	Contractor
Access	HAZ 05	Primary and secondary access is maintained, upgraded and/or constructed to comply where possible with performance criteria and/or acceptable solution requirements of PBP 2018 and NSW RFS Fire Trail Standards (NSWRFS 2019). Consultation with the NSW RFS will be undertaken where compliance is constrained.	Construction	Contractor
Water supply	HAZ 06	Water supply requirements for firefighting, including the provision of hydrants and hose reels, is designed, constructed in accordance with the relevant Standards and PBP 2018.	Construction	Contractor
Electricity supply	HAZ 07	Electricity supply and distribution is provided in accordance with the requirements of PBP 2018 and the relevant standards.	Construction	Contractor
Emergency management and response	HAZ 08	A Bushfire Emergency Management Plan is prepared for the project area and includes responsibilities associated with and details of: <ul style="list-style-type: none"> • site specific hazards and risk at each Snowy 2.0 Main Works site; • procedures to maintain bushfire awareness; • bushfire mitigation measures; • fire preparedness actions; • fire response actions including responses to Emergency Alerts issued by emergency services; and • bushfire recovery requirements. 	Pre-construction	Contractor
	HAZ 09	Each main works accommodation camp shall have a full time, onsite Emergency Response Team (ERT), with an appropriate level of training and equipment to respond to potential bushfire and initial structural fire events.	Construction	Contractor

6.11.4 Summary and conclusion

Potentially hazardous activities and public safety risks were assessed in project development and incorporated into the design where possible, to minimise public safety risks. Mitigation measures have been identified to enable the project to achieve compliance with the relevant requirements for bushfire protection (such as establishing APZs, bushfire refuges, and maintaining emergency access and egress routes).

The proposed storage and handling of hazardous chemicals was found to meet the DPIE risk criteria for surrounding land uses and is therefore not 'hazardous' as defined by the SEPP 33.



CHAPTER 6.12
AIR

6.12 Air

An air quality impact assessment (AQIA) has been prepared for the project in general accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016) (the Approved Methods for Modelling), and the air quality impact assessment criteria specified therein. The AQIA is provided at Appendix V and focuses on the potential air quality emissions and associated impacts from Snowy 2.0 Main Works construction activities only, as operation of Snowy 2.0 Main Works will not generate significant air pollution emissions warranting detailed assessment. Detailed information on the methodology can be obtained from the AQIA (Appendix V) however, it generally involved:

- defining meteorological conditions using monitoring data from BoM and project-related stations, in combination with meteorological modelling;
- dispersion modelling using the CALPUFF modelling system, for the 2017 calendar year;
- assessing emissions and ambient concentrations of total suspended particulate matter (TSP), particles smaller than 10 micrometres (μm) in diameter (PM_{10}) and particles smaller than 2.5 μm in diameter ($\text{PM}_{2.5}$) and nitrogen dioxide (NO_2). Dust deposition impacts are also considered; and
- estimating greenhouse gas (GHG) emissions using the methodologies outlined in the National Greenhouse Accounts Factors (NGAF) workbook (DEE 2018).

6.12.1 Context

An overview of existing air quality is provided in Table 6.39, along with relevant community and stakeholder views and project design considerations relevant to the AQIA.

Table 6.39 Context of air quality for Snowy 2.0 Main Works

Existing environment	<p>Background air quality is representative of an area with primarily natural influences, with little daily variation in particulate matter concentration but experiencing seasonal fluctuation. In the absence of significant industrial sources, the primary contributing sources of air pollutant emissions in the project area include:</p> <ul style="list-style-type: none">• dust entrainment due to vehicle movements along unpaved and paved town and rural roads with high silt loadings;• fuel combustion-related emissions from on-road and non-road engines;• wind generated dust from exposed areas within the surrounding region;• seasonal emissions from household wood burning; and• episodic emissions from vegetation fires. <p>More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires.</p>
Community and stakeholder views	<p>No substantial air quality issues were identified during the community consultation process.</p>
Avoidance and minimisation through design	<p>The project design incorporated the following dust mitigation and management measures:</p> <ul style="list-style-type: none">• watering of dozer working areas; and• watering of unpaved project-related roads. <p>Modelling has been completed as part of the DIAA process to identify the level of controls required to achieve relevant criteria at accommodation camps proximate to Lobs Hole Road and Tantangara Road. Adoption of mitigation similar to sealing 1 km each side of the camps to minimise dust impacts to acceptable levels will achieve health-based criteria for the accommodation camp.</p>

6.12.2 Predicted impacts

i Particulate matter and other emissions

In total, 29 assessment locations representative of the nearest sensitive locations to Snowy 2.0 Main Works were considered, although most of these are beyond the identified construction areas of the project. These locations were mainly classified as 'passive recreation' or 'residential'. The passive recreational locations included, for example, Yarrangobilly Caves and the campgrounds at Bullocks Hill, Wares Yards, Rocky Plain and Three Mile Dam.

During construction, emissions will be generated from fugitive sources (eg material handling, processing, movement of equipment, wind erosion) and combustion sources (exhaust emissions from construction equipment). The most important source of emissions for the project is the movement of vehicles across unpaved road surfaces, resulting in elevated dust. The unpaved roads with the largest estimated emissions were Lobs Hole Ravine Road and Tantangara Road and require mitigation to reduce impacts at accommodation camps at Lobs Hole and Tantangara. Mitigation measures have been considered in the emissions estimation and modelling of the project.

Table 6.40 summarises the predicted cumulative impacts at assessment locations. Relatively small exceedances of the 24-hour criterion for PM_{2.5} were predicted at the assessment locations in the Lobs Hole and Tantangara Reservoir areas, however these exceedances were dominated by elevated background concentrations.

Table 6.40 Predicted air quality impacts

Area	Assessment location	Predicted impacts
Talbingo Reservoir	None	None
Lobs Hole	R27: Snowy 2.0 Lobs Hole Accommodation Camp	Two days in the modelled year were predicted to be above the impact assessment criterion for 24-hour PM _{2.5} concentrations ^(a) . The highest and second highest 24-hour PM _{2.5} concentrations were 29.3 µg/m ³ and 25.7 µg/m ³ . Overall, this is considered to be a minor impact.
Marica	R28: Snowy 2.0 Marica Accommodation Camp	Pollutant concentrations below impact assessment criteria.
Plateau	R1: Bullocks Hill campground	Pollutant concentrations below impact assessment criteria.
Tantangara Reservoir	R29: Snowy 2.0 Tantangara Accommodation Camp	One day in the modelled year were predicted to be above the impact assessment criterion for 24-hour PM _{2.5} concentrations. The highest 24-hour PM _{2.5} concentration was 26.8 µg/m ³ . Overall, this is considered to be a minor impact.
Rock Forest	R2: Cabramurra town	Pollutant concentrations well below impact assessment criteria.

Note (a) - The impact assessment criterion for 24-hour PM_{2.5} is 25 µg/m³.

In general, the predicted concentrations at locations outside of the construction areas were below the impact assessment criteria. The main exception to this was assessment location R24 (Wares Yards Campground). Here, there were two predicted exceedances of the 24-hour PM₁₀ criterion (50 µg/m³), with concentrations of 57.2 µg/m³ and 57.1 µg/m³. There were also two exceedances of the 24-hour PM_{2.5} criterion (25 µg/m³), with predicted concentrations of 28.6 µg/m³ and 26.4 µg/m³. In the case of the highest PM₁₀ concentrations, there were similar contributions from the background and the project, whereas for PM_{2.5} the background was the dominant contribution.

The main project contribution at this assessment location was from vehicle movements on unpaved roads. The Wares Yard Campground is within 500 m of Tantangara Road, which was assumed unpaved for purpose of the assessment. The campground will remain open during construction of the project, noting that limited and facilitated access will be provided along Tantangara Road where determined in consultation with the contractor and where safety requirements can be guaranteed.

The predicted cumulative concentrations of TSP and NO₂ were well below the respective air quality criteria at all assessment locations. Similarly, the incremental contribution to dust deposition from Snowy 2.0 Main Works construction activities was below the criterion (2 g/m²/month) at all assessment locations.

ii Greenhouse gas emissions

GHG emissions are defined as 'direct' and 'indirect' emissions. The emission sources included in the GHG assessment for the project are listed in Table 6.41.

Table 6.41 Scope 1, 2 and 3 emission sources

Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect)
<ul style="list-style-type: none"> Fuel combustion (diesel) by onsite plant and equipment Vegetation clearing 	<ul style="list-style-type: none"> Consumption of purchased electricity 	<ul style="list-style-type: none"> Upstream emissions from the extraction, production and transport of diesel Upstream emissions from electricity lost in delivery in the transmission and distribution network Transport of construction materials to site

The estimated GHG emissions for the construction phase of the project were around 150,000 tonnes of CO₂-equivalents per year and 515,000 tonnes of CO₂-equivalents per year during operations.

Annual average total GHG emissions (Scope 1, 2 and 3) generated by the Snowy 2.0 Main Works construction represents approximately 0.12% of total GHG emissions for NSW and 0.03% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

Annual average total GHG emissions (Scope 1, 2 and 3) generated by the Snowy 2.0 Main Works operations represent approximately 0.40% of total GHG emissions for NSW and 0.10% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

6.12.3 Mitigation measures

Table 6.42 shows that mitigation should focus on the control of emissions from unpaved roads close to the Lobs Hole and Tantangara accommodation camps. Review of three kinds of mitigation options for unpaved roads (water suppression, chemical suppression and paving of the unpaved surface) was undertaken, with sealed roads shown to predominantly achieve criteria with a significantly higher emission reduction than the treatment of unpaved roads.

Table 6.42 Mitigation measures for air quality impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Exceedances of air quality criteria for PM ₁₀ and PM _{2.5}	AQ01	Sealed treatment of roads 1 km each side of the Lobs Hole and Tantangara accommodation camps	Pre-construction	Contractor

6.12.4 Summary and conclusion

The AQIA showed that the predicted cumulative concentrations for PM₁₀ and PM_{2.5} were below the impact assessment criteria at most assessment locations. At the Wares Yards Campground, the criteria for 24-hour PM₁₀ and 24-hour PM_{2.5} were both exceeded on two days in an entire year. However, the campground may not be in use at time of Snowy 2.0 Main Works construction. The criterion for 24-hour PM_{2.5} was exceeded on two days at the Lobs Hole accommodation camp and one day at the Tantangara accommodation camp. The background was the dominant contributor to peak PM_{2.5} cumulative concentrations.

The predicted cumulative concentrations of TSP and NO₂ were well below the respective air quality criteria at all assessment locations. Similarly, the incremental contribution from Snowy 2.0 Main Works construction activities to dust deposition was below the criterion (2 g/m²/month) at all assessment locations.

Mitigation should focus on the control of emissions from unpaved roads close to the Lobs Hole and Tantangara accommodation camps.



CHAPTER 6.13

SOCIAL

6.13 Social

Social impacts relate to people and the way they live and move around a geographic area. This chapter provides an overview of the existing social environment of communities living within the area of social influence. It provides an assessment of the project on:

- the locality, including Tumut, Talbingo, Adaminaby and Cooma;
- the demand for infrastructure and services in the Snowy Valleys and Snow Monaro LGAs; and
- users of KNP, including recreational fishing, bushwalking, camping and boating;

A strategy to offset the impacts of the KNP has been developed (Appendix M.3) and includes offset to impacts on recreational users.

The assessment of social impacts relies on the social impact assessment (SIA) and supporting recreational user assessment prepared for the project, provided at Appendix X.1. The SIA was prepared in accordance with relevant and involved the steps highlighted in Figure 6.27. The recreational user study (Appendix X.2) involved the collection of qualitative and quantitative data on the use and visitation of KNP, including field (visitor) surveys, email surveys, and visitor counts, as well as consultation with NPWS.

Steps in the social impact assessment process

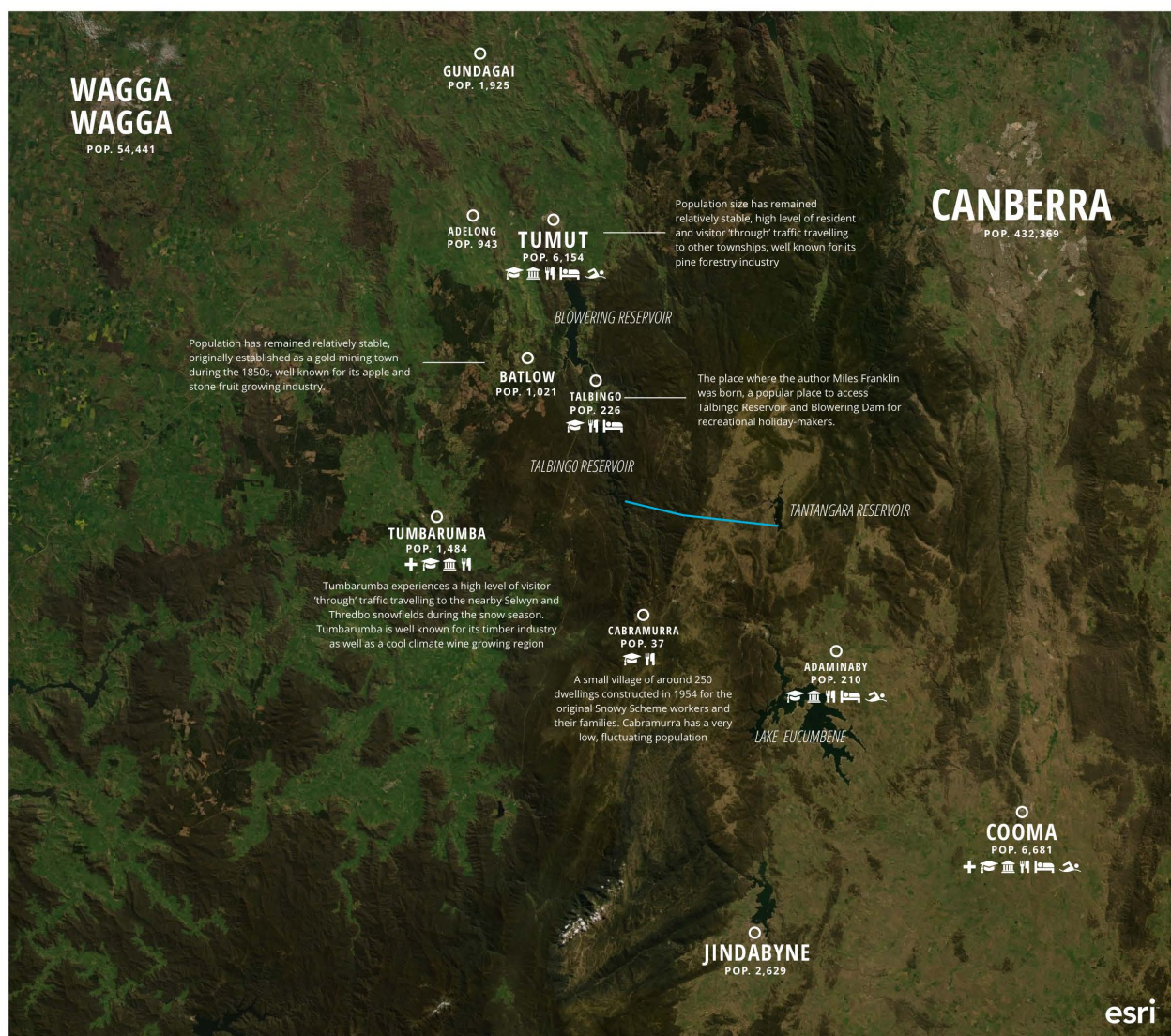


Figure 6.27 Steps in the social impact assessment process

6.13.1 Existing environment

i Social context of communities

The area of social influence for the project is much broader than the project area discussed in other assessments in this EIS. While material environmental impacts will tend to be largely contained within the KNP, social impacts will fundamentally be felt within inhabited areas, namely the worker accommodation camps and nearby villages and townships. The social area of influence for the project extends from Canberra to Cooma to Jindabyne and across to Wagga Wagga. The key place-based communities that fall within the area of social influence are shown on Figure 6.28 and include Cooma, Adaminaby, Jindabyne, Tumbarumba, Talbingo, Batlow, Tumut, Adelong, Gundagai, Wagga Wagga and Canberra.



Satellite image © Esri, CGIAR | Vicmap, Esri, HERE, Garmin, METI/NASA, USGS | Earthstar Geographics

Figure 6.28 Social area of influence & community profile

Adapted from Elton Consulting, 2019

- Proposed Tunnel
- + Hospital
- 🎓 Schools/TAFE
- 🏛️ Museum/Historical
- 🍴 Food/Art/Entertainment
- 🛏️ Accommodation
- 🏊 Pool

NOTE: ALL POPULATIONS FIGURES FROM 2016



ii Recreation and KNP users

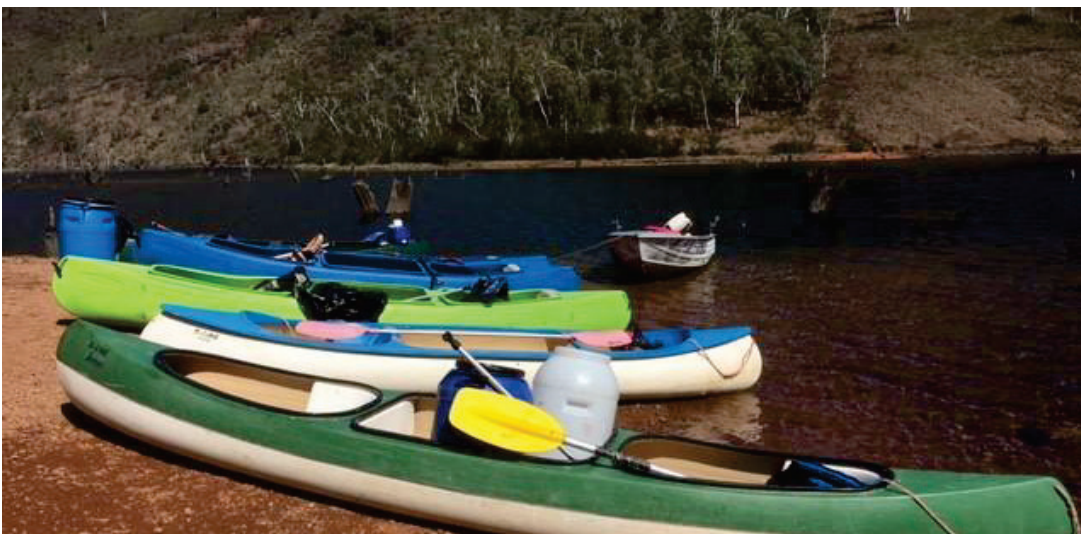
The primary recreational resource in the project area is KNP. The project area is within the northern area of KNP and includes Talbingo Reservoir and the surrounding Lobs Hole area as well Tantangara Reservoir and surrounds. Recreational activities undertaken in the northern area of KNP include drive touring, picnicking, camping, walking, horse riding, cross country skiing, downhill skiing, snowboarding, snow play, cycling, climbing, caving, canoeing and rafting, boating and fishing. Popular sites for recreational activities are shown in Figure 6.29.

Visitation to KNP has increased significantly over the last decade (144% increase since 2008) and is the fourth most visited national park in NSW (almost 3.8 million domestic visitors in 2018). However, there is little visitor data available on visitation to the northern end of KNP, where the project will be built and operated. Visitor counts of the area shows that the busiest periods of visitation to campgrounds within the project area coincided with public holidays and occurred around Christmas, Australia Day and Easter. While campgrounds are busy at these times compared to other times of the year, they are not full.

a Talbingo Reservoir

Talbingo Reservoir is used for a range of water sports and activities. It is a popular fishing spot for trout and some native species, however surveys undertaken for the project indicate that Redfin is the predominant species. Many Talbingo Reservoir users are repeat visitors who have been using the area for many years.

Public access to the reservoir for boats is from either a concrete boat ramp on the western side of the dam wall or the spillway on the eastern side. The reservoir is also accessible from points within KNP including Lobs Hole Ravine campground (see Photograph 6.5) and O'Hares Camping and Rest Area.



Photograph 6.5 Canoes and a boat on Talbingo Reservoir at the Ravine (Source: TRC Tourism 2018)

Some of the visitors to Talbingo Reservoir stay in the township of Talbingo, which is on the shores of Jounama Pondage to the north of the reservoir. For safety reasons however there is no swimming or boating allowed on Jounama Pondage and fishing is allowed from the shore only (due to operational requirements of the Tumut 3 power station). Talbingo Reservoir and nearby Blowering Dam provide recreational opportunities for residents and visitors to Talbingo.

Snowy Hydro has approval to close the spillway as part of the Exploratory Works approval. Closure has not yet been required for Exploratory Works. Should it be closed, Snowy Hydro has committed to upgrade the boat ramp on the opposite side of the reservoir.

b Lobs Hole

Lobs Hole Ravine is a remote campground situated beside the Yarrangobilly River. Campsites are unmarked and there are no facilities (toilets or water supply) provided. Fishing and swimming in the Yarrangobilly River, drive touring and the remote nature of the location are the main appeals of the Lobs Hole Ravine area for visitors. Lobs Hole Ravine was closed to visitors in early February 2019 on commencement of the Snowy 2.0 Exploratory Works, with the commitment to return the land for use as camping and recreation at completion.

c Tantangara Reservoir and surrounds

The area around the foreshores of Tantangara Reservoir is a popular part of the northern part of KNP. It can be accessed at all times of the year via Tantangara Road (which provides access to the southern part of the reservoir) or Long Plain Road and Port Phillip Trail (which provides access to the northern part of the reservoir). Access on Port Phillip Trail is restricted during winter when the road is closed. Tantangara Road and Port Phillip Trail are linked by Pocket Saddle Road on the eastern side of the reservoir.

There are no designated camping areas around the reservoir and no facilities available, and visitors camp in the area of their choice around their vehicles (Photograph 6.6). There is enough space for each group to camp in their own area well away from others regardless of group size.

On the busiest days during the survey period, around sixty vehicles⁵ were parked around the foreshores of Tantangara. Many Tantangara users are repeat visitors who have been using the area for many years. The most popular activities undertaken at the reservoir are fishing, camping, swimming, and relaxing. Fishing is undertaken from the waters' edge, from a boat, by trolling and fly-fishing.

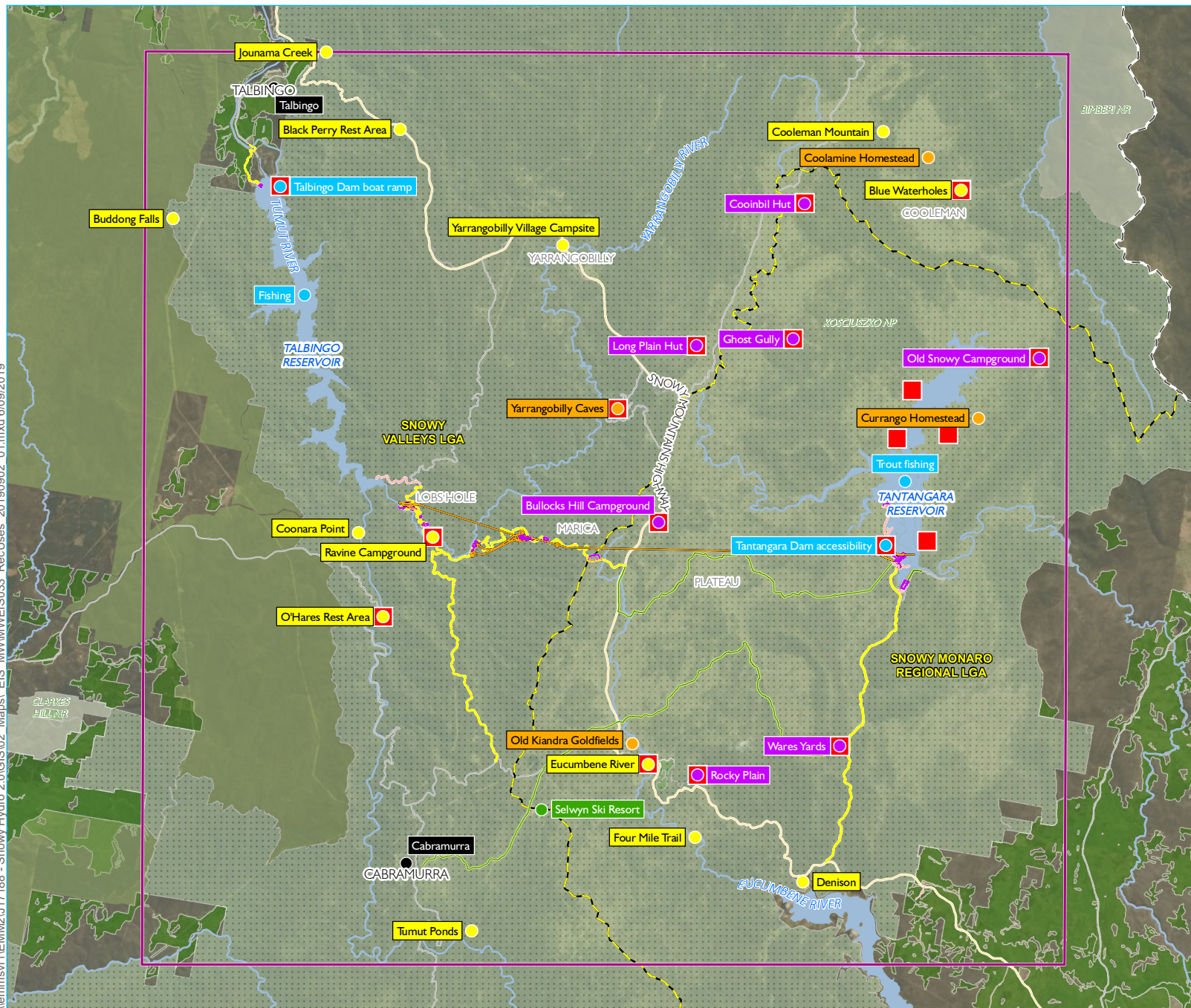
There are also some well used campgrounds to the south and east of the reservoir that allow camping with horses: Wares Yard and Old Snowy Camp situated on Tantangara Road are overnight stops for horse riders including commercial operators offering horse riding tours. The historic Currango Homestead is along the Pockets Saddle Road and is a popular accommodation from which people walk, mountain bike ride, horse ride, drive tour and fish.



Photograph 6.6 Campers along the foreshores of Tantangara Reservoir

⁵ Estimated from TRC visitor counts 2018-19

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- KEY**
- Survey location
 - ▭ Project area
 - Recreational use areas
 - Camping
 - Camping - horses permitted
 - Fishing and boating
 - Place of interest
 - Ski resort
 - Township
 - Snowy 2.0 Main Works operational elements
 - Tunnels, portals, intakes, shafts
 - Power station
 - Utilities
 - Permanent road
 - Snowy 2.0 Main Works construction elements
 - Temporary construction compounds and surface works
 - Temporary access road
 - Existing environment
 - Main road
 - Local road
 - Watercourse
 - Waterbodies
 - Kosciuszko National Park
 - NPWS reserve
 - State forest
 - Grazing
 - Local government area boundary
 - State boundary

Recreational sites relevant to the project area

Snowy 2.0
Environmental Impact Statement
Main Works
Figure 6.29



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



6.13.2 Community and stakeholder views

Community and stakeholder views were considered through the development of the project, with these views obtained through community consultation and government agency meetings (described in Chapter 5). More targeted consultation was carried out for the purpose of the SIA and recreational user study for the EIS, to determine the current level of understanding of the project and its potential impacts, and possible measures or opportunities that would be considered suitable by the community to mitigate or offset those impacts.

i Surveys and consultation carried out for the social impact assessment

Community surveys were carried out in addition to the engagement activities undertaken by Snowy Hydro in order to apply a social impact-specific lens to inform the development of the social impact assessment. The surveys included computer assisted telephone interviews (CATI), op-in online surveys, two community focus groups, and local service provider interviews. The surveys were designed to understand the public's current level of understanding of predicted impacts likely to affect them. The results are shown graphically in Figure 6.30.

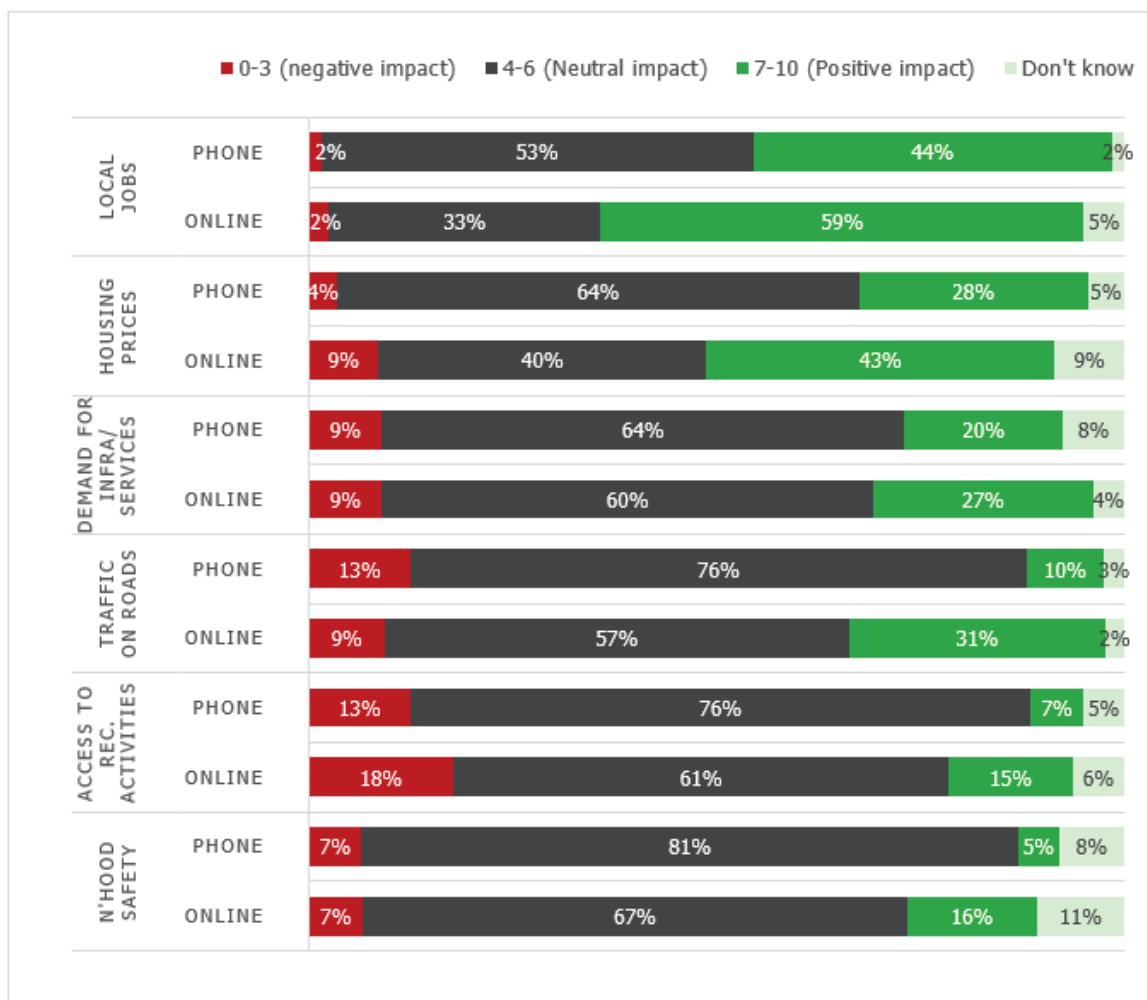


Figure 6.30 Results of SIA surveys (Elton Consulting 2019)

Overall, the majority of respondents believed the social impacts presented to them would lead to neutral impacts for themselves and their families. In addition, more people felt collectively more positive toward the potential social impacts than negatively. Other key observations obtained from the surveys are:

- there was strong preference and expectation for the proponent to source labour from local town (expressed in open-ended responses to surveys);
- house prices were considered the second most positive impact expected to occur as a result of the project; and
- restricted access to recreational activities as a result of construction was thought to be the most negative potential impact from the project, followed by the perception of traffic on roads.

ii Surveys and consultation carried out for the recreational assessment

Qualitative and quantitative data has been collected (by TRC) through face to face and online surveys, with the aim of contributing to the understanding of scale of visitor numbers and to gain insights into the motivations for use and the values of the area for KNP users.

Camping and day use areas likely to be impacted by the project (both directly and indirectly) were surveyed (primarily over weekends or public holidays) between September 2018 and April 2019, building on the previously conducted survey for Exploratory Works phase of the project (which concluded in April 2018). In addition to engagement activities with NPWS by Snowy Hydro, TRC met with NPWS representatives by phone on two occasions during the assessment period to discuss the identified impacts and potential mitigation strategies.

The KNP values identified by recreational users generally included:

- Talbingo - scenery, activities and the unspoiled nature of the site;
- Lobs Hole – fishing, remote camping, bushwalking and family connection to the area; and
- Tantangara – the lack of crowds, quality of fishing and scenery.

Survey results included views on mitigation and management, in particular of Tantangara Road. It has been communicated previously that the closure of this road is uncertain, with NPWS and recreational users stating a preference for maintaining some level of access to Tantangara Reservoir and surrounds via Tantangara Road.

6.13.3 Avoidance and minimisation through design

Engagement with community and stakeholders has been a key part of avoidance and minimisation of impacts throughout the design process. Keeping the community informed of project developments and predicted impacts enables the community to prepare for and predict how the project might cause changes to their way of life. In addition to community and stakeholder engagement, the following avoidance and minimisation measures have been considered and adopted for the project:

- maintaining some level of access on Tantangara Road;
- providing future recreational opportunities through consultation with NPWS; and
- incorporating relevant road works to improve safety and access to KNP in the long term.

Importantly, it is noted that at the commencement of the period of assessment for the EIS, it was considered likely that Tantangara Road would be closed to all traffic for the duration of Snowy 2.0 Main Works. It is now proposed that Tantangara Road will be closed during road upgrade works and when any high-risk activities are being undertaken during Snowy 2.0 Main Works (eg transport of oversized equipment). Access along Tantangara Road will be maintained at other times with measures in place to achieve the required level of safety. This change to the project methodology has significantly mitigated the impact to users of the parts of KNP accessed by Tantangara Road.

6.13.4 Predicted impacts

i Social impacts

The SIA has been completed in line with the relevant SIA guidelines and identifies social impacts according to broad categories. Using this methodology, several social impacts were identified (refer to Appendix X.1 for further detail on all impacts identified). The highest rated positive and negative impacts identified after implementation of mitigation or enhancement responses are:

- benefits arising from increased economic opportunity; and
- reductions in housing availability and decreased housing affordability;

a Benefits arising from increased economic opportunity

Communities are positive about anticipated economic opportunities that can arise from the project, particularly regarding local employment and local procurement. The potential income derived from these economic opportunities will shape other social aspects of people's lives such as their access to health, housing, education and transport. It was identified that if the project can maximise this local content, this is potentially the largest potential social benefit of the project. It is also noted that effective project closure will be required to reduce any potential negative impacts of post-construction workforce and economic decline.

b Reductions in housing availability and decreased housing affordability

It was previously predicted there was sufficient capacity within the local region to accommodate project workers who may choose to relocate to or visit the area as a result of construction for the Exploratory Works phase of Snowy 2.0 (EMM 2018). Due to the extended duration and large-scale nature of construction activity and workforce needed for Snowy 2.0 Main Works, it is predicted that much of this existing capacity is likely to be absorbed. Impacts to the availability and affordability of long-term housing options across the area of social influence are predicted, and likely to be greatest in Cooma.

This social impact arises from both increased demand by project employees that choose to relocate to the local area for the duration of their work contract, as well as indirect employment workforces that will seek to take advantage of ancillary employment opportunities in the area. It is identified that there is minimal ability for the local housing market to adapt to this likely housing 'squeeze', requiring offsetting of impacts, and the likelihood that some existing residents may choose to leave their towns for the duration of construction. It is noted that Snowy Hydro has been investigating options to provide accommodation for workers within Cooma, to minimise risk of housing pressure on the community. As a result, Snowy Hydro propose to provide temporary accommodation at a site in Cooma which was also used to provide accommodation during the construction of the Snowy Scheme. A separate application will be lodged with SMRC for the provision of accommodation on this site.

A small percentage of workers are predicted to take advantage of recreational opportunities during off-shift swings. This is predicted to have a minor impact on the availability and affordability of short-term housing options across the area of social influence, particularly in Jindabyne. However, it is identified that there is reasonable ability for the short-term accommodation market to adapt to this change, as is currently experienced during peak holiday seasons.

ii Recreational user impacts

Recreational impacts are greatest during the construction phase of the project, as several sites within KNP will be closed or restricted in access for an extended period. Once these works are completed and the area rehabilitated however, access will be reinstated and improved. There will be permanent exclusion zones needed around the intakes in both Talbingo and Tantangara reservoirs for public safety, and the extent of these zones are still to be determined. There are a number of opportunities to enhance the recreational value of impacted sites as part of the final rehabilitation of the project. These opportunities are being investigated with NPWS as part of ongoing consultation.

The following aspects of the project are assessed as resulting in impacts to recreational users during construction:

- temporary closure of Tantangara Road;
- exclusion zones on Talbingo and Tantangara Reservoir and restriction of access to these sites;
- increased traffic movements on the road network;
- noise and air quality impacts experienced at passive and active recreation sites and campgrounds; and
- the extension of the period of closure of Lobs Hole Ravine Road and the Lobs Hole Ravine campground.

As a result of prolonged construction impacts and site access restrictions, there is also likely to be an increase in demand placed on other recreational sites in the area and a need for alternative camping sites. A Master Plan for camping and day use across KNP to consider alternative sites was committed during the Exploratory Works and Snowy Hydro will continue this approach for Main Works.

The following aspects of the project are relevant to recreational users during operation:

- potential impacts on the quality of fishing;
- visual impacts of permanent elements in the landscape; and
- increased variable fluctuations in water levels at Tantangara Reservoir.

These are summarised in Table 6.43.

Table 6.43 Summary of recreational user impacts

Impact scenario	Description of impact should scenario occur	Recreational sites impacted	Recommended mitigation or offset to minimise impact
Construction			
Temporary closure of Tantangara Road – for duration of construction or for period of road upgrade works only	<ul style="list-style-type: none"> Loss of access to recreational sites from Tantangara Road, including campgrounds and access to the reservoir for fishing Overlap of closure period with the closure of Long Plain Road and Port Phillip Trail will result in loss of primary and alternative access to Tantangara Reservoir and Currango Homestead Impact to commercial tour operators who will be unable to operate some existing tours 	<ul style="list-style-type: none"> Tantangara Reservoir Wares Yard Currango Homestead 	<ul style="list-style-type: none"> Maintain access along Tantangara Road with measures in place (car escort, traffic lights) other than during periods of high-risk activities Advance communication to stakeholders and visitors Offset strategy developed in consultation with NPWS
Facilitated access along Tantangara Road	<ul style="list-style-type: none"> Access to recreational sites limited to specific times (yet to be determined) 	<ul style="list-style-type: none"> Tantangara Reservoir Wares Yard 	<ul style="list-style-type: none"> Advance communication to stakeholders and visitors Periods of public access to Wares Yard to be developed in consultation with NPWS as part of recreational management plan, and/or development of alternative horse campgrounds in collaboration with NPWS
Exclusion zones on Talbingo and Tantangara Reservoir and restriction of access to these sites	<ul style="list-style-type: none"> Reduced opportunity for fishing and boating, remaining accessible areas may become more crowded 	<ul style="list-style-type: none"> Tantangara Reservoir Talbingo Reservoir 	<ul style="list-style-type: none"> Appropriate recreational offset will be detailed in recreational management plans and will include measures such as: advance communication to stakeholders and visitors when closures are expected, construction of temporary or permanent boat ramps in collaboration with NPWS
Impacts on the quality of fishing in Tantangara Reservoir	<ul style="list-style-type: none"> Potential decline in quality of fishing from foreshore due to changes in water levels, water quality impacts, transfer of Redfin perch possible, also Climbing galaxias and mosquito fish 	<ul style="list-style-type: none"> Tantangara Reservoir 	<ul style="list-style-type: none"> Mitigation measures to manage transfer to fish species are provided in Section 6.4, based on the aquatic ecology assessment for the project (Appendix M.2)

Table 6.42 Summary of recreational user impacts

Impact scenario	Description of impact should scenario occur	Recreational sites impacted	Recommended mitigation or offset to minimise impact
Traffic impacts	<ul style="list-style-type: none"> • Increase in construction traffic • Drive tourists and skiers will experience extended journey times, increased traffic and delays at winter pinch points such as Sawyers Hill, Mt Selwyn and Roaring Meg 	<ul style="list-style-type: none"> • Selwyn Snow Resort • 3 Mile Dam • Other campgrounds along the road haulage route 	<ul style="list-style-type: none"> • Manage traffic to avoid peak times in winter such as mornings and afternoons during ski season
Visual impacts	<ul style="list-style-type: none"> • Visual impacts of construction phase work (accommodation camp, stockpile) and any permanent elements visible from and around publicly accessible parts of the reservoirs • Potential visible turbidity impacts experienced by fishers and boat users on Talbingo Reservoir 	<ul style="list-style-type: none"> • Talbingo Reservoir • Tantangara Reservoir 	<ul style="list-style-type: none"> • N/A
Noise and air quality	<ul style="list-style-type: none"> • Construction noise, while typically below the noise management level (criteria) for recreation sites, will be audible and a perceptible change to amenity • Due to increase in construction traffic along Tantangara Road (unsealed), dust impacts are predicted at Wares Yard 	<ul style="list-style-type: none"> • Tantangara Reservoir • Wares Yard • 3 Mile Dam • Other campgrounds along the road haulage route 	<ul style="list-style-type: none"> • Construction Noise and Vibration management Plan to address noise and vibration management and mitigation options where required • Mitigation measures to impact on horse campground are accounted for in the offset strategy
Extended closure of Lobs Hole Ravine Campground and Middle Bay boat ramp, including access from Lobs Hole Ravine Road and Talbingo Reservoir	<ul style="list-style-type: none"> • Loss of access and use of Lobs Hole Ravine Campground for an extended period • Access via boat or canoe to and from Lobs Hole Ravine will be restricted • Limits opportunities to access water by small craft 	<ul style="list-style-type: none"> • Lobs Hole 	<ul style="list-style-type: none"> • Consistent with commitments made during Exploratory Works, a recreation master plan for camping and day use across KNP to consider alternative sites to develop to consider access to and camping alternative locations elsewhere in the park that offer a similar experience to Lobs Hole • Ensure visitors are aware of alternative options, including alternative locations for camping with access to water • Boat launch to Talbingo Reservoir used during construction to be retained and available for public use at completion of works

Table 6.42 Summary of recreational user impacts

Impact scenario	Description of impact should scenario occur	Recreational sites impacted	Recommended mitigation or offset to minimise impact
Operation			
Exclusion zones on Talbingo and Tantangara Reservoir and restriction of access to these sites	<ul style="list-style-type: none"> Reduced opportunity for fishing and boating, remaining accessible areas may become more crowded 	<ul style="list-style-type: none"> Tantangara Reservoir Talbingo Reservoir 	<ul style="list-style-type: none"> Appropriate recreational offset will be detailed in recreational management plans and will include measures such as: advance communication to stakeholders and visitors when closures are expected, construction of temporary or permanent boat ramps in collaboration with NPWS
Visual impacts	<ul style="list-style-type: none"> Views of the landscape around Talbingo and Tantangara will include permanent infrastructure that is contrasting to the previously undisturbed natural setting Lobs Hole will involve some landforming as part of rehabilitation, which will be consistent with the surrounding area but changed from its current state 	<ul style="list-style-type: none"> Talbingo Reservoir Lobs Hole Tantangara Reservoir 	<ul style="list-style-type: none"> Rehabilitation plan to include vegetation to better enable integration with the landscape

6.13.5 Mitigation measures

A Social Impact Management and Monitoring Plan (SIMMP) has been prepared to identify reasonable and feasible measures the project can implement to minimise and monitor social impacts (and is provided with the social impact assessment at Appendix X.1). The SIMMP includes measures adopted as part of design or operation methodologies to avoid impacts, as well as additional measures recommended to mitigate potential residual impacts.

A recreational users management plan is proposed to minimise impacts to recreational users within KNP, but also to identify offset opportunities to be developed by Snowy Hydro and NPWS.

Measures identified to minimise social and recreational user impacts are provided in Table 6.44.

Table 6.44 Mitigation measures for social and recreational impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
General	SOC1	Refine and implement the SIMMP provided with the EIS	As specified by the SIMMP	Contractor Snowy Hydro
General	SOC2	As part of the Community and Stakeholder Management Plans for Snowy 2.0 Main Works, develop and implement bi-annual liaison with representatives from SVC and SMRC to monitor and report change in indicators relating to: <ul style="list-style-type: none"> • population change • housing availability and affordability • local employment and training rates • incidents of traffic congestion • recreation user visitations • demand for health, education and welfare services • Aboriginal cultural heritage • cumulative impacts of Snowy 2.0 Main Works 	Bi-annual	Contractor SVC SMRC
Recreational user impacts	REC01	A recreational plan is to be prepared for sites impacted by the project and should: <ul style="list-style-type: none"> • be prepared in consultation with NPWS • detail recreational offsets to be provided by the project such as: <ul style="list-style-type: none"> – permanent boat launch areas in Talbingo and Tantangara Reservoirs – Lobs Hole campground • describe measures to be implemented to minimise impacts during construction, including a process for advance communication to stakeholders and visitors when closures are expected 	Pre-construction	Snowy Hydro

6.13.6 Summary and conclusion

Overall, construction of Snowy 2.0 Main Works will generate social change processes within surrounding communities. The characteristics of many social impacts can be both positive and negative, spatially and temporarily dynamic, and experienced by people differently depending on their individual circumstances. People within the area of social influence are considered highly resilient and are informed about how their community may be impacted, positively and negatively. There is an expectation within the community that the project provides economic benefit to the localities within the area of influence. Should these benefits not materialise, a knock-on effect is anticipated. These benefits have been quantified in the economic assessment and are likely to be substantial (see Section 6.14.3).

The key social impacts described relate to economic benefits, but also some negative impacts associated with housing affordability and increased demand for access to community services and infrastructure during the construction phase as a result of the incoming worker population and their families. It is important for the project to monitor social changes relating to these potential impacts and consult with relevant government agencies to provide a collaborative response if needed, to social impacts.

As the project will be built and operated within KNP, recreational users of KNP will also experience social impacts. On balance, these impacts are considered acceptable on the basis that:

- the closure of Tantangara Road has been limited to a period of nine months, which does not fall over the busiest period of January to April and access has been facilitated for the remainder of the construction period;
- most impacts, once mitigation strategies are implemented, will be low;
- some long term impacts will be positive such as improved access and facilities at Lobs Hole and improved access along Tantangara Road; and
- displacement, both temporary and long term, is not expected to occur at high levels and will be to sites that generally have the capacity to absorb some extra visitation.



CHAPTER 6.14

ECONOMICS

6.14 Economics

An economic assessment of Main Works was been prepared by Gillespie Economics Pty Limited (Appendix Y) using two economic methods:

- a computable general equilibrium (CGE) analysis of the project's impact on the National Electricity Market, (NEM), and hence the NSW and Australia economies; and
- an assessment of the economic impact of construction in the local economy, (Snowy Monaro Regional and Snowy Valleys LGAs), using input-output (IO) analysis.

6.14.1 Existing environment

This section provides an overview of the economic characteristics of the region in which Main Works will be constructed and in which Snowy 2.0 will be operated.

The Snowy Monaro Regional and Snowy Valleys LGAs cover an area of 15,162 and 8,960 km², respectively. Snowy Monaro Regional LGA takes in the higher slopes of the eastern side of the Great Dividing Range between the ACT to the north and the state boundary with Victoria to the south, while Snowy Valleys LGA includes the western side of the southern-most portion of the Great Dividing Range and foothills in NSW, with large sections of the LGA contained within national parks.

Three sets of indicators were used to characterise the economies of the region:

- changes in population—provides an indication of the health of an economy;
- place of work employment by industry—gives a broad indication of the nature of economies; and
- those from the regional input-output table—provides more detailed information on the economy.

The population of the Snowy Monaro Regional LGA has grown slightly since 2006 while the Snowy Valleys LGA has been relatively static. The combined population of the LGAs has grown at a rate of 2.4% since 2006, less than the NSW population growth rate of 14.2% between 2006 and 2016, and less than that for regional NSW. Population projections for the combined two LGAs, from DPIE, suggest declining population in the region beyond 2026.

Place of work employment by industry data indicates the significance of the accommodation and food services sector and retail trade sector (reflecting the importance of tourism), and the agriculture, forestry and fishing sector (sheep and beef cattle farming) to the Snowy Monaro Regional LGA. For the Snowy Valleys LGA, significant industry sectors identified are agriculture, forestry and fishing (predominantly beef cattle farming, sheep farming, fruit growing, forestry and logging), and manufacturing (timber and paper production manufacturing).

A 2016-17 IO table developed for the regional economy estimated output at \$8,000 M and value-added at \$2,000 M, comprising \$975 M to households as wages and salaries and \$991 M in other value added. The total employment in the regional economy is 15,416 jobs. A comparison of the economic structure of the regional economy to NSW indicated that the agriculture/forest/fishing, manufacturing, utilities and trade/accommodation sectors in the regional economy are of greater relative importance than they are to the NSW economy, while the mining, and business services sectors are of less relative importance than they are to the NSW economy.

6.14.2 Community and stakeholder views

Engagement on Snowy 2.0 commenced in early 2017 and has been ongoing.

Predominantly feedback and sentiment about Snowy 2.0 has been positive because of perceived economic benefits of the project on the NEM and local region. Business and employment opportunities, local economic benefits and broader energy consumer benefits were highlighted as key positives for most stakeholders, particularly stakeholders in the local region.

Stakeholders recognised the importance of Snowy 2.0 in contributing to the stability of the electricity network as the NEM decarbonises.

There was interest in the proposed workforce arrangements of the project, potential employment opportunities for local people and how local people could position themselves for jobs or contracts with Snowy Hydro or FGJV.

Notwithstanding this, some concerns were expressed that the project may lead to employment competition and become a 'drain' on the local workforce.

6.14.3 Predicted impacts

CGE analysis identified the project's impact to NSW/ACT and other NEM state economies is driven by three key features of the project:

- investment to establish the project, with reduced levels of investment required in the remainder of the NEM;
- reduced fuel cost across the NEM as a result of increased hydroelectric capacity reducing the requirement for fossil fuel generation; and
- a flow-on impact to electricity prices across the NEM.

The CGE analysis estimated the economic impact of Main Works for three economic indicators; gross state product (GSP⁶), gross state income (GSI⁷), and employment. All economic indicators were modelled to increase as a result of the project.

GSP is expected to increase most significantly in the NSW/ACT region, adding \$2,692 M in net present value terms. Once Snowy 2.0 operations begin other NEM states are expected to experience increased economic activity, driven by the combination of ongoing NEM fuel savings and indirect economic activity through trade of goods and services. In aggregate across all NEM states, the project is expected to increase GSP by \$4,176 M in net present value terms.

Gross state income (GSI) is estimated to increase as a result of the project by \$1,608 M in net present value terms in the NSW/ACT modelling region, with an aggregate NEM region impact of \$2,982 M.

Employment is estimated to rise most significantly during the construction period in NSW/ACT region, peaking in 2021/22, during which time other NEM regions experience only small increases or decreases in employment.

Economic impacts to the local economy are associated with spending that is captured by the region rather than leaking outside to other economies. Expenditure from the Main Works project that can potentially be captured by local economy arise from non-labour inputs and expenditure of wages by labour.

⁶ the state equivalent of gross domestic product

⁷ the state equivalent of gross national income

Non-labour inputs to the Main Works project would include, but are not limited to, excavation and earthworks, buildings and sheds, reinforced concrete pipes, plant and equipment, concrete manufacturing, haulage and engineering services. It is assumed that there would be limited scope for the local supply of the major non-labour inputs to the project. Notwithstanding, some small regional businesses may be able to supply some of the minor non-labour inputs to production.

Most economic activity in the region will be associated with the expenditure of wages by labour. The average annual additional wage expenditure in the regional economy across the period to 2026 is estimated to be \$8 M, from jobs where employees are either sourced from the region, migrate to the region with their families, or commute to the region and remain as a visitor when off swing. The economic impact of the average annual additional wage expenditure (\$8 M) in the regional economy would be:

- \$11.60 M in annual direct and indirect regional output;
- \$6.76 M in annual direct and indirect value-added; and
- \$2.58 M in annual direct and indirect income.

Employment is also modelled to increase, with direct local employment engaged in Snowy 2.0 expected to provide additional flow-on positions over the project construction.

6.14.4 Mitigation measures

Table 6.45 Mitigation measures for economic impacts

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Positive local employment	ECON1	Provision of employment opportunities for local workers where they have the necessary skills and experience.	Construction	Snowy Hydro and contractor
Positive local employment	ECON2	Providing and/or collaborating with local education facilities to provide, ongoing training and certification opportunities for local workers to ensure they have the necessary skills to work on the project.	Construction	Contractor
Positive business opportunities	ECON3	Collaborating with SMRC, SVC, economic development organisations, local chambers of commerce and State Government to: <ul style="list-style-type: none"> • inform local businesses of the goods and services required of the project, service provision opportunities and compliance requirements of business to secure contracts; • encourage and provide local businesses on how to meet the requirements of the project for supply contracts; and • develop relevant networks to assist qualified local and regional businesses tender for provision of goods and services to support the project. 	Construction	Contractor

6.14.5 Summary and conclusion

The economic activity impacts of the Main Works have been assessed and are shown to be positive for all regions and economic measures, with key drivers being the direct investment to establish the project, reduced ongoing electricity fuel costs, reduced electricity prices and wage expenditure.

Main Works is predicted to have the greatest impact on the NSW/ACT economy, with GSP modelled to increase by \$2,692 M (net present value terms), GSI by \$1,608 M (net present value terms). Employment is estimated to rise most significantly during the construction period in NSW/ACT region, peaking in 2021/22.

The aggregated economic impact of Main Works across all NEM states is predicted to be an increase in GSP of \$4,176 M (net present value terms) and an increase in GSI of \$2,982 M (net present value terms).

The impact of Snowy 2.0 on the regional economy of the Snowy Monaro Regional and Snowy Valleys LGAs is also predicted to be positive, increasing the average annual additional wage expenditure by \$8 M, and increasing employment of local workers through flow-on effects. Adoption and implementation of the mitigation measures described in Section 6.14.4 would maximise these positive impacts on the regional economy.

Overall, economic benefits of Snowy 2.0 Main Works on the regional economy, NSW and NEM states are predicted to be substantial. These benefits are in addition to the economic benefits of Exploratory Works which are currently being realised, particularly in the regional economy.



CHAPTER

7

EVALUATION AND CONCLUSIONS



7 Evaluation and conclusions

This chapter provides an overall evaluation of the Snowy 2.0 Main Works, with regard to the strategic need for the project and its environmental, social and economic impacts.

7.1 Design development

7.1.1 Principles

Consistent with the principles of ESD, Snowy 2.0 Main Works has been designed to avoid and minimise impacts where possible. These principles were implemented through an iterative approach (known as DIAA), supported by consultation with numerous technical specialists and government agencies. The NPWS, as land manager of KNP, was consulted throughout design development and as part of the preparation of this EIS.

Throughout the design process, the objective was to identify and avoid sensitive locations, to minimise the construction footprint and maintain as much of the existing natural environment as is reasonable and feasible. In the first instance this included environmental conditions and consideration of site suitability based on design and construction needs, existing Snowy Scheme assets (including Talbingo and Tantangara reservoirs) and infrastructure (such as road access).

7.1.2 Design challenges

The challenges for the design team included the need to develop solutions that balance the need to preserve and protect the values of the KNP and the environmental constraints of the location, with the need for ensuring a safe working environment for the construction of Snowy 2.0 Main Works, including the safe movement of plant, equipment, materials and personnel across the sites.

As previously stated, Snowy Hydro has appointed a highly experienced contractor (FGJV) for the design and construction of Snowy 2.0 Main Works. The EIS is based on the design provided by FGJV during the tender process, noting that adjustments to the design may be made with a detailed design process now underway.

Construction sites make use of existing cleared and disturbed areas and access tracks at Lobs Hole, across the Plateau and near Tantangara Reservoir. This has contributed to the ability to avoid and minimise impacts, in particular, impacts that would otherwise be associated with additional new access roads and clearing through undisturbed sites. As far as possible, works have been limited to previously disturbed land in the KNP.

The design principles also provide for the rehabilitation of disturbed areas which will be returned to NPWS and the KNP. Snowy Hydro has been working with NPWS since the announcement of Snowy 2.0 in early 2017. Specific consultation with NPWS on Snowy 2.0 Main Works has been to ensure its development and design avoids and minimises impacts to biodiversity, heritage and recreation and considers their long term objectives for land management in KNP.

The DIAA process developed during the design of Exploratory Works has been carried through Snowy 2.0 Main Works. This process has been described throughout this EIS (see Chapter 2 and 6). Snowy 2.0 Main Works 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 potential significant impacts on biodiversity, heritage, recreation and land use have been avoided and minimised.

7.1.3 Avoidance and minimisation

Implementation of the DIAA process to optimise the design resulted in some significant environmental improvements and outcomes. Primary design improvements include:

- Discounting construction of a power station, and associated access adits, beneath the Plateau rather than Marica. This avoided significant impacts to threatened ecological communities, such as Alpine bogs and fens, and species, such as Alpine she-oak skink.
- Significant reduction in the disturbance footprint for the Marica West track down to Lobs Hole. There were further design improvements in this area through the removal of a construction adit and associated construction area to facilitate these excavations. Together, these improvements have avoided significant impacts to the critically endangered Smoky Mouse.
- Reduction in overall excavated materials due to revised tunnelling layouts and alignments, including removal of adits and relocation of the power station further west minimising the currently approved exploratory tunnel (which would be the MAT if Snowy 2.0 Main Works is approved). This reduced the volumes of materials to be handled and placed within the reservoirs.
- Removal of some construction areas and requirements from the footprint within KNP by choosing to construct a segment factory at Polo Flat in Cooma (subject to a separate application) which significantly reduced traffic volumes for the construction materials for these segments within KNP, and reduced the amount of land required to be cleared in the park by about 32 ha.
- Establish a logistics yard at Rock Forest, just outside the KNP (rather than within the project area), to store materials and manage traffic when required such as during adverse conditions. This improves Snowy Hydro's ability to manage impacts to the road network and improves road user safety during adverse conditions.
- Reuse 1,000,000 m³ of materials to landform and rehabilitate areas at Lobs Hole disturbed from construction, reducing the footprint volumes and timeframe of the Ravine Bay placement which reduces potential water quality impacts to Talbingo Reservoir.
- Reduction in barge infrastructure resulting in avoidance of areas being disturbed and longer term potential for disruption to the Talbingo community.
- Removal of an option to construct a road east of Tantangara Reservoir to a nearby private property, just outside KNP, to place excavated rock materials rather than in the reservoir. This avoided significant impacts to the critically endangered flora, Clover Glycine.
- Reduction in excavated rock emplacement footprint within the reservoirs to focus on a single location within Talbingo Reservoir and within active (and dry during construction) storage at Tantangara Reservoir. This avoids direct impacts to previously proposed emplacement areas.
- Maintenance of the 50 m buffer around the Yarrangobilly River to protect its values and habitat to the endangered Booroolong Frog.
- Reduction of access road works by some 20 km which avoids further environmental impacts through disturbance activities.

- Removal of the need to augment the existing Essential Energy transmission line for power for power to infrastructure at Tantangara Reservoir. This avoids further environmental impacts through disturbance activities.
- Avoidance of the Ravine cemetery within Lobs Hole which preserves the heritage values of this location.

7.2 Strategic context

Snowy 2.0 is the largest committed renewable energy project in Australia. By expanding the current Snowy Scheme's renewable energy capacity by almost 50%, the NEM will be served with an additional 2,000 MW of on-demand generating capacity and large-scale storage. Changes to the NSW and Australian energy system and market are creating a need for large scale energy storage projects such as Snowy 2.0. As with many electricity markets around the world, the NEM is undergoing a paradigm transformation that has been brought about by significant shifts in energy efficiency, rapidly decreasing costs of wind and solar generation (or VRE), coal power station retirements, increasing coal and gas costs and Australia's participation in global commitments to reduce carbon emissions.

While VRE provide energy during model conditions, the challenge for these sources are they are dependent on weather conditions and during prolonged wind and/or solar droughts when they would not operate. Energy storage helps build power system resilience to weather events by storing surplus renewable generation for use at times when these resources are scarce and allowing more constant operation of less flexible existing generation. This, in turn, creates a more dispatchable and reliable power system, while helping to keep prices down for consumers including by maximising use of existing, low-cost, thermal generation assets. A large pumped hydro system such as Snowy 2.0 (with approximately 350,000 MWh of energy storage) can provide significant energy storage capable of delivering large-scale generation within minutes in times when VRE is not operating.

The key benefits of Snowy 2.0 are summarised as follows:

- Snowy 2.0 makes a significant contribution to the continued decarbonisation of the economy;
- Snowy 2.0 provides large-scale energy storages at the least cost to allow more flexibility to respond to seasonal variability when compared to other VRE and batteries;
- Snowy 2.0 will improve the overall efficiency of the NEM by absorbing and storing excess energy from the system at times of excess demand (through pumping) and generate at the critical times of peak times;
- Snowy 2.0, being a closed system, can move water between reservoirs and not rely on natural inflows that may vary seasonally, offering valuable seasonal storage and insurance against drought risk;
- Snowy 2.0 will have the capability to run for over seven days continuously before it needs to be 'recharged'. By comparison, small and large-scale batteries have limited storage (typically one to four hours) and their already high prices increase significantly when used for more than one charge/discharge cycle per day; and
- Snowy 2.0 has a 100 year design life and will operate for generations to come.

Snowy 2.0 would result in benefits distributed to the wholesale market, retailers, and consumers. The scale and centralised location of Snowy 2.0 in the NEM enables the system stability, energy reliability and firming capability benefits to be enjoyed by all segments of the NEM.

Snowy 2.0 has strong support from the community with consultation identifying the public expect the project will create economic opportunities for the region, improve the reliability of the electricity network, lower energy prices and increase and expand sources of reliable, renewable energy to reduce reliance on fossil fuels which will have an overall benefit to the environment.

The development of Snowy 2.0 is consistent with Commonwealth and NSW strategic planning and policy objectives, including the NSW Renewable Energy Action Plan and the Australian Renewable Energy Target.

In recognition of the need to manage the transition and future energy mix in the NEM, Snowy 2.0 was declared CSSI by the former NSW Minister for Planning under the NSW EP&A Act in March 2018. It was declared as critical for the energy security and reliability needs of NSW. At the time of the declaration the Minister stated that that Snowy 2.0 was “essential for the future security of our energy system, the economy and the environment.” The declaration signifies the critical role that Snowy 2.0, together with the upgrades to the NSW transmission network, will play in providing reliable energy and large-scale storage to NSW as it transitions to a low emissions economy.

7.3 Engagement

Snowy Hydro has a proactive, flexible and transparent stakeholder engagement strategy for Snowy 2.0, which is applicable to all phases of Snowy 2.0, including Main Works. It aims to meet the needs of a diverse range of stakeholders who have different levels of involvement in the project and a wide range of interests.

A range of tools and established communication channels continue to be used to support communication and engagement for Snowy 2.0 Main Works. Feedback from the local community, local industry groups and special interest groups on Snowy 2.0 has been mainly positive, with the most recent survey results indicating that matters such as employment, business opportunities, energy reliability, renewable energy and environmental interests are still very important to the community as the project progresses into Snowy 2.0 Main Works.

Engagement with government agencies during the Snowy 2.0 Main Works EIS development was a priority for Snowy Hydro. Primary matters raised during these engagement sessions include potential impacts to local water quality during construction, potential impacts on reservoir water quality from the excavated material placement, impacts on native and threatened species, and traffic impacts across the project.

The proposed approach to community engagement if the project is approved is to focus on providing engagement activities and communication materials that provide up to date project information to those likely to be affected during construction and also allow the community to communicate concerns with the project.

A stakeholder engagement framework has been developed for Snowy 2.0 that provides a structure for the management of stakeholder relations and communication related to the project. The proposed engagement approach is tailored to each stakeholder group, is flexible and will be reviewed regularly following Snowy 2.0 engagement activities. The proposed approach to community engagement if the project is approved, is to focus on providing engagement activities and communication materials that provide up to date project information to those stakeholders likely to be affected during construction. It will also ensure there are opportunities for stakeholders, in particular the community to communicate their concerns with the project.

7.4 Statutory context

Two main approvals are required for Snowy 2.0 Main Works; an approval under the CSSI provisions of the EP&A Act from the NSW Minister for Planning and Public Spaces, and an approval under the EPBC Act from the Commonwealth Minister for the Environment.

The existing Snowy Scheme has been operating successfully in the KNP in accordance with a range of administrative and management arrangements for many years, and similar arrangements would be put in place for Snowy 2.0, if approved.

Snowy Hydro has a number of arrangements with NPWS for the existing Snowy Scheme that have been in place since 2002 when it was corporatized. These arrangements allow Snowy Hydro to occupy and operate the Snowy Scheme within the KNP, and include the Snowy Park Lease, a Roads Maintenance Agreement and the Snowy Management Plan.

Prior to Snowy 2.0 Main Works proceeding, Snowy Hydro would require a new lease for the project from the NSW Minister for the Environment under the NPW Act, and the existing management plans and agreements would need to be updated and revised to incorporate the approved project.

7.5 Long term benefits

As discussed in Section 7.2 above, once operational, Snowy 2.0 will provide numerous benefits to the NEM and energy consumers. Snowy 2.0 will provide broad-scale environmental benefits through its long-term provision of low emission energy and by physically firming and financially supporting VRE coming online. Snowy 2.0 will also improve the drought resilience of the Snowy Scheme and the existing Tantangara and Talbingo reservoirs by providing capability to pump water between the two and reuse available inflows. Snowy 2.0 Main Works will also provide numerous long-term benefits to the local region including within the KNP and the community. The project development has identified several opportunities to provide a legacy of environmental, social and economic benefits through the comprehensive environmental impact assessment process and extensive community consultation.

Snowy Hydro has responsibly and carefully operated the Snowy Scheme in the KNP for more than half a century and will continue to act in an environmentally responsible manner throughout the construction and operation of Snowy 2.0. Some of the key long-term benefits that will be provided by the Snowy 2.0 Main Works to the KNP and local region include improved infrastructure and access, enhanced recreational areas, contributions to scientific research within the KNP, provision of biodiversity offsets and creating economic growth in the region.

While there will be some impacts to recreational uses at Lobs Hole and Tantangara, it is proposed to rehabilitate these impacted areas to provide improved recreational facilities in the long term. There is opportunity to improve the social values of KNP by providing improved access and facilities at these locations post construction. Similarly, several geodiversity sites have been identified where the proposed works provide an opportunity to enhance the geotourism potential of the KNP by providing improved access and educational signage. The rehabilitation and master planning of potential recreational facilities will be determined in consultation with NPWS, to ensure relevant KNP values are maintained. In the long-term improved access infrastructure in KNP and along the project main transport route will provide permanent access infrastructure assets to the community.

The additional scientific research that has been completed for the Snowy 2.0 investigations and EIS will constitute a positive contribution to knowledge about the environmental values of the KNP. This includes significant ecological findings (eg larger population of the endangered Smoky Mouse and mapping of more bogs and fens), additional investigations into the geology and hydrogeology of the KNP, geodiversity sites and their public accessibility and interpretation, and increased evidence of Aboriginal and historical occupation of the KNP.

As detailed in Section 6.14, Snowy 2.0 Main Works will provide economic opportunities for the local region. To date more than 100 local businesses have been part of Snowy 2.0 and more opportunities are expected to follow. The Main Works will provide opportunities for sub-contracting jobs and training associated with the project construction and would provide economic growth to the local region. Community consultation for Snowy 2.0 has shown that the community is highly supportive and expects that Snowy 2.0 will provide lasting benefits for the region. There is also community recognition of the economic benefit that the project has generated with work undertaken since the Feasibility Study.

Snowy Hydro will provide biodiversity offsets for the project impacts to native vegetation, ecological communities and threatened species. Snowy Hydro supports the use of this funding to undertake conservation projects in the local region and recognises the opportunity this provides for improved environmental management within the KNP. It is expected that in consultation with DPIE and NPWS the funding provided for biodiversity offsets for the project will be used to provide lasting environmental benefits for the KNP and NSW.

7.6 Likely or predicted impacts

Potential impacts of the project have been comprehensively assessed and are detailed in Chapter 6. This section provides a summary of the key predicted impacts from the Snowy 2.0 Main Works.

7.6.1 Broader region

Some of the project's predicted impacts are expected to be experienced at a regional level rather than on a site by site basis. These include economic, social and transport impacts that would have a broad area of influence.

The key social impacts relate to economic benefits, but also some potential negative impacts associated with housing affordability and increased demand for access to community services and infrastructure. Social changes relating to these potential impacts and consult with relevant government agencies to provide a collaborative response if needed, to social impacts.

Construction activities within KNP is expected to have some impacts on recreational users of KNP. On balance these impacts are considered acceptable as management measures have been identified to minimise disruptions to recreational activities, displacement is not expected to occur at high levels and will be to sites with capacity to absorb extra visitors and in the long-term impacts to recreation will be positive through improved access and facilities.

Snowy 2.0 Main Works will deliver substantial economic benefits to the local region, NSW and NEM states, with key drivers being the direct investment to establish the project, wage expenditure, reduced ongoing electricity fuel costs, and reduced electricity costs. The greatest effect will be experienced by the NSW/ACT economies with GSP expected to increase by \$2,692 M and additional employment during peak construction.

The aggregated beneficial effect across the remaining NEM participants is predicted to be an increase in GSP of \$4,176 M and an increase in employment. The local economies of Snowy Monaro Regional and Snowy Valleys LGAs will also benefit from Snowy 2.0 Main Works, increasing the average annual additional wage expenditure by \$8 M, and increasing average annual employment through flow-on effects.

The key traffic and transport impacts include the generation of suitability of existing intersections within the KNP and in Cooma township. Two new intersections will be established for construction access from the Snowy Mountains Highway (Marica Track and Rock Forest) with potential improvements carried out within Cooma to address existing peak traffic conditions in the winter period to accommodate Snowy 2.0 Main Works traffic. Further engagement with RMS will be carried out to determine appropriate solutions during these peak periods.

Some temporary reductions in speed limits are proposed to ensure intersection sight distance requirements are met at the intersection of Snowy Mountains Highway/Tantangara Road, Snowy Mountains Highway/Rock Forest access and Link Road/Lobs Hole Ravine Road. Construction management protocols will be implemented to manage road maintenance, traffic control and community consultation requirements arising from the project traffic.

7.6.2 Talbingo Reservoir

Likely impacts to Talbingo Reservoir include water quality and aquatic ecology impacts due to the placement of excavated rock at Ravine Bay. There will also be temporary impacts to visual and recreational values.

Ravine Bay placement will take about two years to complete. The predicted maximum TSS concentrations in surface waters are predicted to exceed the reservoir's baseline concentrations at times. This will occur primarily in summer when the reservoir water column is stratified, trapping suspended solids in the upper layers of the water column. Surface turbidity will return to close to background levels within approximately 8 months of the completion of Ravine Bay placement. Elevated TSS levels from excavated rock placement will result in a moderate aquatic ecology risk which will require monitoring. During placement, it is predicted that increased sediment deposition rates will occur in the reservoir with the deposition rate highest (above 150 mm/year) closest to the placement location, 7–45 mm/year in the southern half of the reservoir, 2–15 mm/year in the northern half of the reservoir and higher in shallow parts of the reservoir (ie reservoir edges) than in the deeper parts.

Alternatives were assessed for further reducing volumes and types of material to be emplaced in Talbingo Reservoir. Adoption of these alternative provides an opportunity to reduce and/or remove the water quality impacts within the reservoir by adopting a land based approach for managing fine materials. Should alternatives be pursued, further detailed engagement with relevant agencies, including NPWS, and an integrated design and assessment approach be carried out with particular consideration needed for water quality, biodiversity, heritage, visual amenity and long-term end use within KNP.

During commissioning of the power station's turbines, fine settled material from the placement activities and some existing reservoir sediments may be disturbed by generation and pumping flows. Rock armouring placed on the upper slope of the Ravine Bay placement will not be disturbed by these flows and, if the drill and blast material diameter on the lower part of the slope is greater than 8 mm, it is also unlikely to be disturbed. Sediment will also be discharged from the reservoir via the T3 Power Station.

Some direct impacts from construction of the intake and dredging works are expected on some aquatic ecology habitat and species, including Murray crayfish. In-reservoir blast management controls will be implemented to minimise blasting impacts to aquatic fauna. Suitable management measures, such as pre-clearance surveys and translocation, will be implemented to avoid and minimise effects to the Murray crayfish.

The extent of clearing and excavation to facilitate construction will be a significant change to a section of the landscape, changing its visual appearance. As stated above, placement of excavated rock will also result in temporary elevated levels of turbidity in the water in the area surrounding the emplacement area. However, there will be limited public views to these areas for the duration of the emplacement period. Upon completion, public access will be reinstated, and views of the landscape will include some permanent infrastructure contrasting to the previously undisturbed natural setting. Revegetation activities will be implemented to improve the infrastructure's integration with the landscape, where possible. There are some likely limitations to some infrastructure components such as the steep batters of the intake where stable revegetation may not be able to successfully establish. In summary, the visual impact during construction is high, but temporary with most construction areas having limited public views.

Snowy 2.0 Main Works will impact on-reservoir recreational users through establishment of exclusion zones around the in-reservoir construction areas as well as the operational intake and will restrict boat access to some areas of the reservoir.

7.6.3 Lobs Hole

Likely impacts to Lobs Hole include stormwater discharges to the Yarrangobilly River from temporary disturbed areas, permanent placement of excavated material, contamination risks, impacts to known geodiversity sites and restricted access to recreational users during construction.

There will be temporary impacts to recreation activities at Lobs Hole as it will be closed for the duration of construction of Snowy 2.0 Main Works. Accordingly, closure from Exploratory Works will be extended for about another six years. The existing use of Lobs Hole as a remote campground within KNP presents opportunities for the project to enhance recreational values within the KNP. Key enhancements to recreation values at Lobs Hole include improving access roads as well as enhancing the geotourism potential of several geodiversity sites. A recreation master plan will be prepared for impacted recreational areas including Lobs Hole.

Approximately 1,000,000 m³ of surplus material will be used to landform and rehabilitate disturbed areas at Lobs Hole following construction. Snowy Hydro will continue to engage with NPWS regarding the longer term use and design of Lobs Hole for recreational purposes. Detailed design will follow the principles and concepts in the Rehabilitation Strategy to achieve stable non-polluting landforms and recreational areas.

There is potential for impacts to water quality of the Yarrangobilly River during the initial establishment phases of construction when the greatest area of disturbance and poorest water quality will occur due to surface construction activities. Suitable erosion and sediment controls will be implemented during construction to minimise this risk.

There are some contamination risks in this area associated with disturbance to the existing excavated rock stockpiles at the former Lobs Hole copper mine as well as potential to intercept PAF rock through site excavations for site establishment. Contamination risks will be minimised through further contamination investigations and suitable controls implemented during construction.

The road upgrades on Lobs Hole Ravine Road will directly impact on three known geodiversity features; the Ravine block streams, the Ravine tufa and the Devonian fossil beds. The road works will be further optimised through the detailed design process to minimise impacts to these geodiversity features. While the proposed works will impact the visible geodiversity features, they will remain largely intact. Post-construction, the access road works adjacent to these geodiversity features provide an opportunity to enhance the geotourism potential of these features through the establishment of educational signage and a suitable stopping area from which to view the features. Snowy Hydro will continue to engage with NPWS regarding these opportunities.

Likely impacts to historical heritage complexes at Lobs Hole include items from the former settlement. Importantly, two prominent heritage features have been avoided, Ravine cemetery and the Washington Hotel.

There will also be some impacts to biodiversity at Lobs Hole with impacts to threatened species including the Smoky Mouse from road upgrades to Lobs Hole Ravine Road. Upgrades to this road are currently being undertaken as part of Exploratory Works. Targeted Smoky Mouse surveys during the design development improved the scientific knowledge of the Smoky Mouse population and distribution in the local area, with records spread over a very large area providing valuable context for the design of an important access road for the project. As such, the population of Smoky Mouse is much larger than previously thought. Notwithstanding, impacts to Smoky Mouse have been minimised where possible whilst ensuring that the project has a safe and reliable access to facilitate the construction and long-term operation of Snowy 2.0.

7.6.4 Marica

As previously mentioned, significant environmental improvements were realised through the DIAA process with the design with surface disturbance greatly reduced.

Likely surface impacts in the Marica area include impacts to threatened fauna and their habitat including the Smoky Mouse. Approximately 174.63 ha of potential Smoky Mouse habitat will be removed. This represents less than 3% of the estimated available habitat in the region based on regional surveys undertaken for the project. However, these impacts will be offset to provide for long-term improvements and conservation outcomes for KNP.

Most construction activities within Marica occur underground through excavation of access tunnels and the cavern. Minimal groundwater impacts are anticipated in Marica due to these activities.

7.6.5 Plateau

Likely impacts to the Plateau area are limited due to the minimal surface infrastructure proposed. Like Marica, impacts at the Plateau area were reduced through the DIAA process.

There will be impacts to about 4 ha of Alpine bogs and fens, and some threatened species including Alpine She-oak skink, Broad-toothed rat and Alpine tree frog, directly affected due to the construction of communications cable. As previously discussed, the route of the communications cable was thoroughly investigated using the DIAA process to avoid and minimise impacts.

Excavation of the power waterway will result in some groundwater drawdown along the tunnel alignment with some 17 ha of Alpine bogs and fens expected to experience a drawdown of greater than 0.5 m. This represents 0.2% of the mapped extent of the community in the Snowy Mountains (OEH 2012b) and 0.15% of the 11,100 ha mapped at a national scale (TSSC 2009). Overall, this is considered to be a low risk to the listed community.

7.6.6 Tantangara Reservoir

Likely impacts to Tantangara Reservoir include aquatic ecology impacts due to transfer of biota between reservoirs during operations as well as construction impacts to visual, recreational and historic heritage values. Snowy Hydro has proposed several management measures to minimise these impacts including the development of fish barrier controls.

During operations there is potential to transfer pest fish species such as Redfin perch, Eastern gambusia and Wild goldfish from Talbingo Reservoir to Tantangara Reservoir via the power waterway. If these species reach Tantangara Reservoir, there is potential that they could establish breeding populations in the reservoir. Breeding populations of these species could negatively impact species already established in the reservoir, including non-native species of trout that support a recreational fishery. If established in the reservoir, the pest species could eventually spread upstream and downstream into the Murrumbidgee River catchment and downstream into Lake Eucumbene and connected reservoirs, unless adequately contained.

Introduction of breeding populations of Redfin perch and/or Eastern gambusia into the mid-Murrumbidgee River catchment and Lake Eucumbene and connected reservoirs below Tantangara Reservoir would inevitably pressure native and threatened species. Non-endemic native species transferred into Tantangara Reservoir could also negatively impact the local species if not contained. For example, if the Climbing galaxias is transferred to Tantangara Reservoir, it could compete with local species, such as the Stocky galaxiid that has a restricted local distribution in the upper reaches of Tantangara Creek.

For these reasons, Snowy Hydro has implemented investigation of using fish barrier controls aimed at preventing the transfer/movement of fish into this key area of habitat should they successfully transfer from Talbingo Reservoir to Tantangara Reservoir. These secondary controls form part of the Snowy 2.0 Main Works project.

Impacts to water quality from excavated rock emplacement are expected to be much less than those in Talbingo Reservoir. This is due to the excavated rock emplacement being constructed predominantly above the water level in Tantangara Reservoir with suitable erosion and sediment control measures in place. The specifications and locations of these measures will be determined as part of detailed design.

During commissioning of the turbines, the existing reservoir sediments within the intake channel and areas directly offshore and adjacent (mostly to the north) may be disturbed by generation and pumping flows. The Tantangara Reservoir excavated rock emplacement will be well to the north of the intake structure and not be intersected by generation and pumping flows to any material extent.

Clearing and excavation activities will change the landscape, both temporarily during construction and permanently following completion of the project given public accessibility along the foreshore, the openness of the landscape, and the popularity of the reservoir for recreational boating and fishing activities. Public access will generally be available from parts of Tantangara Reservoir during construction.

Public access using Tantangara Road will be facilitated through the construction period but may be temporarily restricted or require additional safety measures. Disturbed areas will be rehabilitated with Snowy Hydro continuing to engage with NPWS regarding opportunities to allow for future recreational uses and facilities. Exclusion zones around the construction areas and operational intake will be established including some existing recreational areas on Tantangara foreshore within the active storage of the reservoir.

Some minor impacts to historic heritage values are expected with overall impacts to the broader cultural landscape of the Snowy Mountains considered to be low. Importantly a highly significant Aboriginal heritage rock shelter was identified during the project investigations and has been avoided.

7.6.7 Rock Forest

Negligible environmental impacts are anticipated at Rock Forest, with the key matter related to construction noise received at the nearest residential receiver. Noise generating activities are predicted to exceed criteria (day and night) at one residential receiver to the north-east along Snowy Mountains Highway.

7.7 Public interest

Snowy 2.0 is the largest committed renewable energy project in Australia. It would provide an additional 2,000 MW of dispatchable generating capacity, and make approximately 350,000 MWh (about 175 hours at full power) of storage available to the NEM at any one time. It will provide more flexibility for the NEM to respond to seasonal variability when compared to other VRE and batteries. Most importantly, Snowy 2.0 will make a significant contribution to the continued decarbonisation of the economy.

Stakeholder engagement clearly indicates that Snowy 2.0 has strong support from the community with consultation identifying the public expect the project will contribute to reliability in the electricity network, lower energy prices, increasing and expanding sources of reliable, renewable energy and minimising reliance on fossil fuels, minimising environmental impacts, increased drought-proofing and providing economic benefits to local communities.

The development of Snowy 2.0 is consistent with Commonwealth and NSW strategic planning and policy objectives, including the NSW Renewable Energy Action Plan and the Australian Renewable Energy Target.

Snowy 2.0 was declared CSSI by the former NSW Minister for Planning under the NSW EP&A Act in March 2018. At the time of the declaration the Minister stated that that Snowy 2.0 was “essential for the future security of our energy system, the economy and the environment.” The declaration signifies the critical role that Snowy 2.0, together with the upgrades to the NSW transmission network, will play in providing reliable energy and large-scale storage to NSW as it transitions to a low emissions economy.

Snowy 2.0 Main Works has been designed to avoid and minimise impacts where possible in accordance with the principles of ESD. These principles were implemented through an iterative approach (known as DIAA), supported by consultation with relevant technical advisors and government agencies. The land manager of KNP, the NPWS, was consulted throughout design development and as part of the preparation of this EIS. Throughout the design process, the objective was to identify and avoid sensitive locations, to minimise the construction footprint and maintain as much of the existing natural environment as is reasonable and feasible.

Most impacts from construction are localised and temporary and will generally be experienced for the duration of the six year construction period. These impacts will be managed through the implementation of appropriate environmental controls which will be documented in management plans and publicly reported against for consent and licensing purposes. However, some impacts will be permanent with the introduction of infrastructure into the KNP to operate Snowy 2.0. These permanent impacts will predominantly be changes to the existing natural landscape and its setting, affecting biodiversity, aquatic ecology and recreational users of the disturbed area. To offset these impacts, Snowy Hydro will prepare an offset strategy to deliver actions which provide for long-term improvements and conservation outcomes for KNP.

Snowy 2.0 Main Works will deliver substantial economic benefits to the local region, NSW and NEM states, with key drivers being the direct investment to establish the project, wage expenditure, reduced ongoing electricity fuel costs, and reduced electricity costs. The greatest effect will be experienced by the NSW/ACT economies with GSP expected to increase by \$2,692 M. The aggregated beneficial effect across the remaining NEM participants is predicted to be an increase in GSP of \$4,176 M. The local economies of Snowy Monaro Regional and Snowy Valleys LGAs will also benefit from Snowy 2.0 Main Works, increasing the average annual additional wage expenditure by \$8 M.

Snowy Hydro will continue to consult and engage with the stakeholders as the Snowy 2.0 Main Works progresses through the assessment phase, and if approved, through the construction phase. Snowy Hydro will continue to engagement with government agencies, to refine mitigation measures and develop and enhance long-term recreational values for the KNP. The proposed approach to community engagement is to focus on providing engagement activities and communication materials that provide up to date project information to those likely to be affected during construction and also allow the community to communicate their concerns with the project.

Through the implementation of proposed mitigation, management and offsetting measures, this EIS demonstrates that Snowy 2.0 Main Works could be undertaken without any significant long term impacts on the local environment. As such, Snowy 2.0 is considered to be in the public interest.



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ABBREVIATIONS



Abbreviations

AANP	Australian Alps National Parks and Reserves
ACHA	Aboriginal Cultural Heritage Assessment
ACHAR	Aboriginal Cultural Heritage Assessment Report
ACM	Asbestos Containing Materials
ACT	Australian Capital Territory
AEMO	Australian Energy Market Operator
AEP	Annual exceedance probability
AFL	Agreement for Lease
AHD	Australian height datum
AHIMS	Aboriginal Heritage Management Information System
AHMP	Aboriginal Heritage Management Plan
AIP	NSW Aquifer Interference Policy
AMP	Asbestos management plan
APZ	Asset protection zone
AQIA	Air Quality Impact Assessment
AqHMP	Aquatic Habitat Management Plan
AUR	Auxiliary right turn
AUL	Auxiliary left turn
BAM	Biodiversity assessment method
BDAR	Biodiversity Development Assessment Report
BFMC	Bush Fire Management Committee
BFRHA	Bushfire Risk and Hazard Assessment
BOS	Biodiversity Offset Scheme
CATI	Computer assisted telephone interviews
CBP	Concrete batching plant
CGE	Computable general equilibrium
CHL	Commonwealth Heritage List
CHMP	Cultural Heritage Management Plan
CHR	Channelised right turn

CNVMP	Construction Noise and Vibration Management Plan
CPESC	Certified Professional in Erosion and Sediment Control
CSMP	Community and Stakeholder Management Plan
CSSI	Critical State significant infrastructure
DEE	Commonwealth Department of the Environment and Energy
DIAA	Design integration and assessment approach
DPIE	NSW Department of Planning, Industry and Environment
ECVT	Egress, cabling and ventilation tunnel
EEC	Endangered ecology community
EHNV	Epizootic haematopoietic necrosis virus
EIS	Environmental impact statement
EMM	EMM Consulting Pty Limited
EP&A Act	<i>NSW Environmental Planning and Assessment Act 1979</i>
EP&A Regulation	<i>NSW Environmental Planning and Assessment Regulation 2000</i>
EPA	NSW Environment Protection Authority
EPBC Act	<i>Commonwealth Environment Protection and Biodiversity Conservation Act 1999</i>
EPIs	Environmental planning instruments
EPL	Environment protection licence
ERT	Emergency Response Team
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically sustainable development
FGJV	Future Generation Joint Venture
FIFO	Fly-in fly-out
FSL	Full supply level
FID	Final investment decision
FTE	Full time equivalent
GDE	Groundwater dependent ecosystem
GHG	Greenhouse gas
GIS	Gas insulated switchgear
GL	Gigalitre
GSP	Gross state product
GWh	Gigawatt hour

ha	Hectares
HA&SoHI	Heritage Assessment and Statement of Heritage Impact
HABs	Harmful algal blooms
HV	Heavy vehicle
ICNG	Interim construction noise guideline
IO	Input - output
ISQG	Interim sediment quality guidelines
IPB	Isolated Phase Busduct
KFH	Key fish habitat
KGAP	Kosciuszko National Park Geodiversity Action Plan
KHA	Kosciuszko Huts Association
km	Kilometre
km ²	Square kilometre
KNP	Kosciuszko National Park
KTP	Key threatening processes
LFB	Lachlan Fold Belt
LG Act	<i>Local Government Act 1993</i>
LGA	Local government area
LPF	Long Plain Fault
LV	Light vehicle
m	Metre
M	Million
m ²	Square metre
m ³	Cubic metre
M2	Murray 2 Reservoir Catchment
MAT	Main access tunnel
MJA	Marsden Jacob Associates
mm	Millimetre
MNES	Matters of National Environmental Significance
MOL	Minimum operating level
MVA	Megavolt amps
MW	Megawatt

MWh	Megawatt hour
NEM	National Electricity Market
NGAF	National Greenhouse Accounts Factors
NHL	National Heritage List
NML	Noise management level
NO ₂	Nitrogen dioxide
NOA	Naturally occurring asbestos
NPW Act	<i>NSW National Parks and Wildlife Act 1995</i>
NPW Regulation	<i>NSW National Parks and Wildlife Regulation 2009</i>
NPWS	NSW National Parks and Wildlife Service
NSW	New South Wales
OSOM	Oversize over-mass
PAF	Potentially acid forming
PBP	<i>Planning for Bush Fire Protection Guideline</i>
PCTs	Plant community types
PCU	Passenger Car Units
PHA	Preliminary Hazard Assessment
PM _{2.5}	Particulate matter smaller than 2.5 micrometres in diameter
PM ₁₀	Particulate matter smaller than 10 micrometres in diameter
POEO Act	<i>Protection of the Environment Operations Act 1997</i>
PoM	Plan of Management
PSI	Preliminary Site Investigation
Q&As	Questions and answers
RAPS	Registered Aboriginal Parties
RFS	NSW Rural Fire Service
RMS	NSW Roads and Maritime Services
SEARs	Secretary's environmental assessment requirements
SEPP	State Environmental Planning Policy
SEPP 33	<i>State Environmental Planning Policy No. 33 – Hazardous and Offensive Development</i>
SEPP 44	<i>State Environmental Planning Policy No. 44 – Koala Habitat Protection</i>
SEPP 55	<i>State Environmental Planning Policy No. 55 – Remediation of Land</i>
SHC Act	<i>NSW Snowy Hydro Corporatisation Act 1997</i>

SHR	State Heritage Register
SIMMP	Social Impact management and Monitoring Plan
SISD	Safe intersection sight distance
SMA	Snowy Mountains Authority
SMCC	Snowy Mountains Control Centre
Snowy Scheme	Snowy Mountains Hydro-electric Scheme
Snowy Hydro	Snowy Hydro Limited
SLA	Soils and Land Assessment
SMRC	Snowy Monaro Regional Council
SRD SEPP	<i>State Environmental Planning Policy (State and Regional Development) 2011</i>
SSI	State significant infrastructure
SVC	Snowy Valleys Council
TARP	Trigger action response plan
TCP	Traffic Control Plan
TBM	Tunnel boring machine
TF	Tantangara Fault
TSP	Total suspended particulate matter
VENM	Virgin Excavated Natural Material
WHL	World Heritage List
WM Act	<i>Water Management Act 2000</i>
WQO	Water Quality Objectives
µm	micrometre



GLOSSARY



Glossary

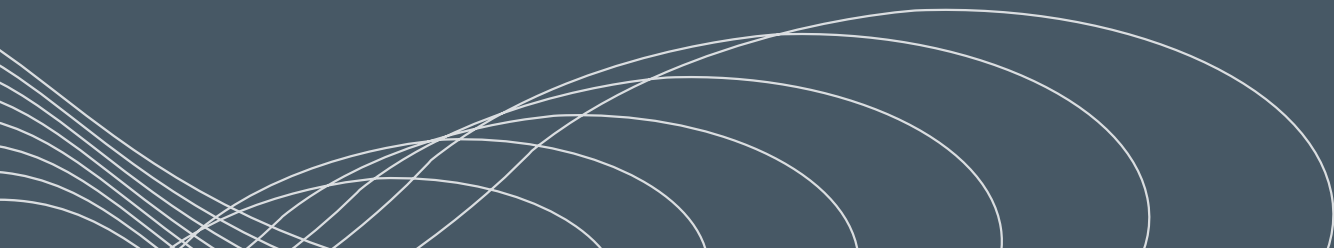
Term	Definition
Accommodation camp	Area used for temporary housing and facilities for construction personnel
Adit	Temporary access tunnel for access to underground construction areas
Ancillary construction facilities	Facilities required to support construction activities such as concrete batching plants, crushing plants, warehouses and laydown, stockpiles
Backfill	Refill an excavated hole with the material dug out of it
Baseflow	The component of streamflow supplied by groundwater discharge. Baseflow is characterised by an exponential decay curve following the cessation of surface runoff.
Bifurcation	Division into two branches
Biodiversity offsets	Management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development (OEH 2017)
Blasting	Rock blasting is the controlled use of explosives and other methods to excavate, break down or remove rock
Blind sink	Excavating a vertical or near-vertical tunnel from the top down, where there is initially no access to the bottom
Boring / shaft boring	Excavating a shaft downwards, usually from the surface
Cable yard	Permanent site for the high voltage transmission connection from the NEM to Snowy 2.0
Capital investment value	All costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment
Communications cable	Fibre optic cable to provide a communications connection
Construction compound	A temporary site used for construction ancillary facilities and laydown
Construction footprint / disturbance area	The area subject to clearing and ground disturbance. The disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design
Contractor	Contractor engaged by Snowy Hydro Limited to construct Snowy 2.0
Detailed design	The phase of the project where the design is refined into drawings, plans, specifications and estimates, suitable for construction
Diffuser	A duct, chamber, or section in which high-velocity flow is converted to low-velocity, high-pressure flow
Drawdown	The lowering of water levels in a surface water or groundwater storage resulting from the loss or take of water from the storage
Drill and blast	The controlled use of explosives to break rock for excavation
ECVT	Emergency egress, cabling and ventilation tunnel
Earthworks	All works involving the loosening, excavating, placing, shaping and compacting of soil or rock
Ecosystem	A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit
Excavated rock	Hard, compacted, or cemented materials that have been removed using blasting or other excavation methods
Exploratory Works	A program of exploratory works for Snowy 2.0, approved by the former NSW Minister for Planning on 7 February 2019 as a separate project application to DPIE (SSI 9208)
Firming 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)

Term	Definition
Full supply level	The normal maximum operating water level of a surface water storage when not affected by floods. This water level corresponds to 100% capacity
Gate shaft	A shaft for the gate tower bored at the highest ground along the wet tunnel alignment, approximately 200 m away from the intake mouth
Generating mode	When water flows from Tantangara Reservoir into Talbingo Reservoir, providing on-demand energy generation
Geodiversity	Geodiversity refers to the variety of the geological and physical elements of nature, such as minerals, rocks, soils, fossils and landforms, and active geological and geomorphological processes
Groundwater dependent ecosystem (GDE)	Natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services.
Headrace surge shaft	A shaft structure constructed from the surface and breaking through to the headrace tunnel, most likely using a blind sink method
Headrace tunnel	The upstream tunnel between Tantangara Reservoir and the underground power station
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
Intake gate	A gate installed at the entrance of the headrace or tailrace tunnels to allow/stop water from entering the tunnels
Karst	Karst is a distinctive topography in which the landscape is largely shaped by the dissolution of carbonate bedrocks (usually limestone, dolomite, or marble)
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
Laydown area	An area for laydown and maintenance of construction plant, equipment and materials storage
Lobs Hole	A remote campsite and former settlement location within Kosciuszko National Park
Lobs Hole camp	Main Works accommodation camp 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
Marica camp	Main Works accommodation camp at Marica
Marica West Track	New access road proposed from the MAT to Marica, above the proposed power station location
Marica Trail	Access road to Marica from the Snowy Mountains Highway
Mine Trail Road	The access road from the intersection with Lower Lobs Hole Ravine Road and the MAT
Minimum operating level	The lowest level to which a reservoir can be drawn down under normal operating conditions and is the lower limit of active storage
National Electricity Market (NEM)	The wholesale exchange of electricity operated by AEMO under the National Electricity Rules (NER). It is the wholesale market for the supply of electricity in all states of Australia except Western Australia and the Northern Territory.
Open cut	Method of excavating a trench from the surface and building the structure within the trench
Portal	Location of surface connection with underground access tunnels
Power station	The 2,000MW underground pumped hydro-electric power station proposed for Snowy 2.0
Project area	The area required to access and build project infrastructure, including surface and tunnel components of the project

Term	Definition
Reference design	Design for Snowy 2.0 prepared by SMEC on behalf of Snowy Hydro, for the purpose of specifying Snowy Hydro's functional and performance requirements for tenders for the detailed design and construction of Snowy 2.0
Residual impact	Those effects that remain following the application of mitigation measures to reduce adverse impacts from the project
Riparian	An area or zone within or along the banks of a stream or adjacent to a watercourse or wetland; relating to a riverbank and its environment, particularly to the vegetation.
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
Snowy 2.0 Transmission Connection Project	Project proposed by TransGrid to connect Snowy 2.0 with the existing high voltage transmission network subject to a separate application
Storage mode	When water is pumped out of Talbingo Reservoir to Tantangara Reservoir, to provide large-scale energy storage
Streamflow	The flow of water in streams, rivers and other channels
Subaqueous	Existing, formed, or taking place under water
Surface water	Water that flows over or is stored on the surface of the earth that includes: (a) water in a watercourse, lake or wetland and (b) any water flowing over or lying on land: (i) after having precipitated naturally or (ii) after having risen to the surface naturally from underground
Surge shaft	A hydraulic structure designed to control pressure and flow fluctuations in the tunnel
Tailrace surge tank	An underground shaft structure off the tailrace tunnel west of the power station complex at the start of the tailrace tunnel
Tailrace tunnel	The downstream tunnel between the underground power station and Talbingo Reservoir
Talbingo intake	Water intake structure to be constructed at Talbingo Reservoir
Talbingo rock emplacement area	Location for permanent rock emplacement within Talbingo Reservoir
Tantangara camp	Main Works accommodation camp at Tantangara
Tantangara rock emplacement area	Location for permanent rock emplacement within Tantangara Reservoir
Transformer	An electromagnetic device used to change the velocity of ac electricity
Transmission	The conveyance of electric energy
Trashrack	A rack or screen of parallel bars installed to prevent debris from entering the turbine
Tumut 2 power station	Underground power station south of Talbingo Reservoir
Tumut 3 power station	Power station at the northern end of Talbingo Reservoir
Turbidity	The measure of the light scattering properties of water and is an indicator of the presence of suspended solids
Turbine	A machine which converts the energy of water to mechanical energy
Variable renewable generation	Intermittent renewable wind and solar energy sources that are non-dispatchable and fluctuating in nature
Water intake	Structures at Talbingo and Tantangara reservoirs used to take water in and out of the headrace and tailrace tunnels



STUDY TEAM



Study Team

Environmental study team

Role	Person	Qualification
Direction and management		
Project Director	Brett McLennan	BTP (Hons)
Project Manager	Duncan Peake	BSc (Hons)
Deputy Project Manager	Alex Frolich	BSc(Marine)
Project Coordinator	Lawrence Wallis	BA, BSc
EIS preparation		
Authors	Alex Frolich	BSc(Marine)
	Mark Trudgett	BSc
	Allan Reid	BTP (Hons), GradDEnv
	Lawrence Wallis	BA, BSc
	Duncan Peake	BSc(Hons)
	Brett McLennan	BTP(Hons)
	Emily McIntosh	BSc, BA
	Ryan Desic	BA (Hons)
	Anthony Knox	BEnv
GIS analysis and spatial solutions	Antony Edenhofner	BSc (Hons)
	Peter Tolley	MSciTech, BBiot (Hons), GradDSIS
	Amy O'Brien	BSc
	Jackie Clifford	BA, MMarScMgt
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	Gayle Bruggemann	
Specialist technical study leads		
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Air quality	Francine Manansala	BA
	Dr Paul Boulter	BSc (Hons), MSc, PhD
	Scott Fishwick	BSc
Aquatic ecology	Dr Paul Goldsworthy	PhD, BSc (Hons)
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	Dr Marcus Lincoln Smith (Cardno)	PhD, MSc, BSc (Hons), BA
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Environmental study team

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Contamination	Kris Rixon (ELA)	BEnvSc
	Peter Hawke (ELA)	BSc, MPhil
	Nina Baulch	BSc
	Anthony Davis	BSc (Hons, DipB
	Lachlan Lewis	BE
	Tavis Kleinig	MSc, BSc (Hons)
Economics	Dr Robert Gillespie (Gillespie Economics)	PhD, MEc, MPlan, BEc, BSc
Flooding Assessment	Nick Bartho	B Eng (Hons)
	Zac Richards (GRC Hydro)	BE (Hons)
	Nathan Cheah (GRC Hydro)	BE, PhD
	Beth Marson (GRC Hydro)	BE, DipEngPrac
	William Tang (GRC Hydro)	BE, ME (Environment)
	Nicola De Paolis	BE, ME (Hydraulics)
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Hazard and Risk	Dr Alexa Troedson	PhD, BSc (Hons)
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	Giles Peach (Sherpa)	CEng, BEng, MIMechE, MIChemE, Professional Process Safety Engineer
	Vahishta Bhasin (Sherpa)	BEng, BSc
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Environmental study team

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