



APPENDIX

S

# ECONOMIC ASSESSMENT



**Snowy 2.0**  
**Exploratory Works**  
**Economic Assessment**

*Prepared for*

**EMM**

*By*



**Gillespie Economics**

Email: [gillecon@bigpond.net.au](mailto:gillecon@bigpond.net.au)

Web: [gillespieeconomics.com](http://gillespieeconomics.com)

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## EXECUTIVE SUMMARY

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme).

The purpose of the Exploratory Works for Snowy 2.0 is primarily to gain a greater understanding of the conditions at the proposed location of the power station, approximately 850 metres (m) below ground level. Understanding factors such as rock conditions (such as stress conditions) and ground temperature is essential to inform decisions about the precise location of the power station cavern and confirm the cavern construction methods.

This Economic Assessment supports the EIS for the Exploratory Works. It documents two types of economic assessment:

- a cost benefit analysis (CBA) which is the primary way that economists evaluate the net benefits of projects and policies, provide economic justification for a project and address the public interest; and
- an assessment of the economic effects in the locality, using input-output analysis.

The Exploratory Works are a subcomponent of Snowy 2.0 and hence are associated with some of the potential cost and benefits of the overall Project. A summary of the potential costs and benefits of the Exploratory Works is provided in Table ES1.

Total costs including capital costs, compensation costs and environmental, social and cultural costs that were able to be valued, are estimated at \$280M (\$277M to NSW). The benefits of the Exploratory Works are unquantified but would need to be valued at greater than \$280M (\$277M) for the benefits of the Project to outweigh the costs.

Snowy 2.0, and the Exploratory Works, will be located in the Snowy Monaro Regional local government area (LGA) and the Snowy Valleys LGA. Economic activity for the region from the Exploratory Works is associated with spending that is captured by the region rather than leaking outside the region to other economies. Expenditure from the Exploratory Works that can potentially be captured by the region within which it is located arise from:

- non-labour inputs; and
- expenditure of wages by labour.

Most economic activity in the region will be associated with the expenditure of wages by labour. The economic impact of the additional wage expenditure in the regional economy is estimated at:

- \$2.92M in annual direct and indirect regional output;
- \$1.72M in annual direct and indirect value-added;
- \$0.65M in annual direct and indirect income; and
- 14 direct and indirect jobs.

Hence the direct jobs (23 sourced from the local region and 7 jobs to people who migrate into the region) and indirect jobs (from wage expenditures) (14) to residents in the local economy is estimated at 44. These annual impacts would persist for almost three years.

**Table ES1: Costs and Benefits of Exploratory Works to Australia and NSW (present value @ 7%)**

<b>Costs</b>	<b>\$</b>	<b>Benefits</b>	<b>\$</b>
<b>Market Impacts</b>			
Exploratory Works Construction	\$274M	Reduced direct construction costs of Snowy 2.0	Unquantified
		Reduced delays of Snowy 2.0	Unquantified
		Avoiding investment in a potentially technically infeasible project	Unquantified
		More accurate costing and business case of Snowy 2.0	Unquantified
<b>Total Market Cost</b>	<b>\$274M</b>	<b>Total Market Benefit</b>	<b>Unquantified</b>
<b>Environmental, Social and Cultural Impacts</b>			
Groundwater impacts	No substantive impacts. \$280,000 of WALs required		
Surface water	No material impacts after mitigation and management. \$240,000 of WALs required.		
Terrestrial ecology	Clearing of 95 ha and non-significant impacts on five threatened species. Compensation to be provided - included in discounted capital costs above.		
Aquatic ecology	Minor area of key fish habitat disturbed. Non-significant impact to threatened fish species, localised and temporary. No material impacts.		
Construction noise	Minor temporary moderate exceedance at 1 receptor under adverse weather conditions. No material impacts.		
Construction vibration	No exceedance at human receptors. Some potential impacts on heritage items.		
Road traffic noise	No exceedances of noise criteria.		
Air quality	No exceedances of air quality criteria.		
Greenhouse gas generation	\$2,100 (\$670)		
Traffic	No impact on performance level of roads. Occasional delays when moving oversized equipment.		
Aboriginal heritage	21 Aboriginal stone artifact sites disturbed.		
Historic heritage	57 historic heritage sites directly impacted. 6 of these listed and of local significance. \$3.6M (\$1.2M) Compensation payment proposed.		
Recreation	Up to \$1.7M impact.		
<b>Total Environmental, Social and Cultural Costs</b>	<b>\$5.9M (\$3.4M)</b>		
<b>TOTAL COSTS</b>	<b>\$280 (\$277M)</b>	<b>TOTAL BENEFITS</b>	<b>Unquantified</b>

\* Impacts are initially valued from an Australian perspective. Where a different value occurs at a NSW level this is provided in brackets. Otherwise the Australian value is also relevant from a NSW perspective.

# 1 Introduction

## 1.1 The project

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme). This would be achieved by establishing a new underground hydro-electric power station that would increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 megawatts (MW) generating capacity, and providing approximately 350,000 megawatt hours (MWh) of storage available to the National Electricity Market (NEM) at any one time, which is critical to ensuring system security as Australia transitions to a decarbonised NEM. Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and hydro-electric power station.

Snowy 2.0 has been declared to be State significant infrastructure and critical State significant infrastructure (CSSI) by the NSW Minister for Planning under the provisions of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and is defined in Clause 9 of Schedule 5 of the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). Separate applications and environmental impact statements (EIS) for different phases of Snowy 2.0 are being submitted under Part 5, Division 5.2 of the EP&A Act. This technical assessment has been prepared to support an EIS for Exploratory Works to undertake investigative works to gather important technical and environmental information for the main Snowy 2.0 project. The main project will be subject of a separate application and EIS next year.

The purpose of Exploratory Works for Snowy 2.0 is primarily to gain a greater understanding of the conditions at the proposed location of the power station, approximately 850 metres (m) below ground level. Understanding factors such as rock conditions (such as stress conditions) and ground temperature is essential to inform decisions about the precise location of the power station cavern and confirm the cavern construction methods.

Exploratory Works comprises:

- an exploratory tunnel to the site of the underground power station for Snowy 2.0;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- a portal construction pad for the exploratory tunnel;
- an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades providing access and haulage routes during Exploratory Works;
- barge access infrastructure, to enable access and transport by barge on Talbingo reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir;
- services infrastructure such as diesel-generated power, water and communications; and
- post-construction revegetation and rehabilitation, management and monitoring.

## 1.2 Purpose of this report

This Economic Assessment supports the EIS for the Exploratory Works. It documents the economic assessment methods and results, the initiatives built into the project design to avoid and minimise associated impacts, and the mitigation and management measures proposed to address any residual impacts not able to be avoided.

## 1.3 Location of Exploratory Works

Snowy 2.0 and Exploratory Works are within the Australian Alps, in southern NSW. The regional location of Exploratory Works is shown on Figure 1.1. Snowy 2.0 is within both the Snowy Valleys and Snowy Monaro Regional local government areas (LGAs), however Exploratory Works is entirely within the Snowy Valleys LGA. The majority of Snowy 2.0 and Exploratory Works are within Kosciuszko National Park (KNP). The area in which Exploratory Works will be undertaken is referred to herein as the project area, and includes all of the surface and subsurface elements further discussed in Section 2.1.

Exploratory Works is predominantly in the Ravine region of the KNP. This region is between Talbingo Reservoir to the north-west and the Snowy Mountains Highway to the east, which connects Adaminaby and Cooma in the south-east to Talbingo and Tumut to the north-west of the KNP. Talbingo Reservoir is an existing reservoir that forms part of the Snowy Scheme. The reservoir, approximately 50 kilometres (km) north-west of Adaminaby and approximately 30 km east-north-east of Tumbarumba, is popular for recreational activities such as boating, fishing, water skiing and canoeing.

The nearest large towns to Exploratory Works are Cooma and Tumut. Cooma is approximately one hour and forty five minutes drive (95 km) south-east of Lobs Hole. Tumut is approximately half an hour (45 km) north of Talbingo. There are several communities and townships near the project area including Talbingo, Tumbarumba, Batlow, Cabramurra and Adaminaby. Talbingo and Cabramurra were built for the original Snowy Scheme workers and their families. Adaminaby was relocated to alongside the Snowy Mountains Highway from its original location (now known as Old Adaminaby) in 1957 due to the construction of Lake Eucumbene. Talbingo and Adaminaby provide a base for users of the Selwyn Snow Resort in winter. Cabramurra was modernised and rebuilt in the early 1970s and is owned and operated by Snowy Hydro. It is still used to accommodate Snowy Scheme employees and contractors. Properties within Talbingo are now predominantly privately owned. Snowy Hydro now only owns 21 properties within the town.

Other attractions and places of interest in the vicinity of the project area include Selwyn Snow Resort, the Yarrangobilly Caves complex and Kiandra. Kiandra has special significance as the first place in Australia where recreational skiing was undertaken and is also an old gold rush town.

The project area is shown on Figure 1.2 and comprises:

- **Lobs Hole:** Lobs Hole will accommodate the excavated rock emplacement areas, an accommodation camp as well as associated infrastructure, roads and laydown areas close to the portal of the exploratory tunnel and portal construction pad at a site east of the Yarrangobilly River;
- **Talbingo Reservoir:** installation of barge access infrastructure near the existing Talbingo Spillway, at the northern end of the Talbingo Reservoir, and also at Middle Bay, at the southern end of the reservoir, near the Lobs Hole facilities, and installation of a submarine cable from the Tumut 3 power station to Middle Bay, providing communications to the portal construction pad and accommodation camp. A program of subaqueous rock placement is also proposed;



- **Mine Trail Road** will be upgraded and extended to allow the transport of excavated rock from the exploratory tunnel to sites at Lobs Hole that will be used to manage excavated material, as well as for the transport of machinery and construction equipment and for the use of general construction traffic; and
- several sections of **Lobs Hole Ravine Road** will be upgraded in a manner that protects the identified environmental constraints present near the current alignment.

The project is described in more detail in Chapter 2.

## 1.4 Proponent

Snowy Hydro is the proponent for Exploratory Works. Snowy Hydro is an integrated energy business – generating energy, providing price risk management products for wholesale customers and delivering energy to homes and businesses. Snowy Hydro is the fourth largest energy retailer in the NEM and is Australia’s leading provider of peak, renewable energy.

## 1.5 Assessment guidelines and requirements

This Economic Assessment has been carried out in accordance with:

- Secretary’s Environmental Assessment Requirements (SEARs) for Exploratory Works issued on 17 May 2018 and revised on 20 June 2018, as well as relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.
- Clause 7(1)(f) of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* which requires environmental impact statements to provide “the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations...” Note to Clause 7 (1) (f) states that “A cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure.”

To meet the above requirements two types of analysis are generally needed:

- a cost benefit analysis (CBA) which is the primary way that economists evaluate the net benefits of projects and policies, provide economic justification for a project and address the public interest;
- an assessment of the economic effects in the locality, which can be addressed by evaluating:
  - effects relating to local employment;
  - effects relating to non-labour project expenditure; and
  - environmental and social impacts on the local community.<sup>1</sup>

This Economic Assessment has been prepared in accordance with the Secretary’s Environmental Assessment Requirements (SEARs) for Exploratory Works, issued first on 17 May 2018 and revised on 20 June 2018, as well as relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.

The SEARs must be addressed in the EIS. Table 1.1 lists the matters relevant to this assessment and where they are addressed in this report.

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<sup>1</sup> Refer to Attachment 2 for an introduction to economic methods.

**Table 1.1      Relevant matters raised in SEARs**

Requirement	Section addressed
Including an assessment of the social and economic impacts and benefits of the project for the region and the State as a whole, including consideration of any increase in demand for community infrastructure and services.	Chapters 3 and 4

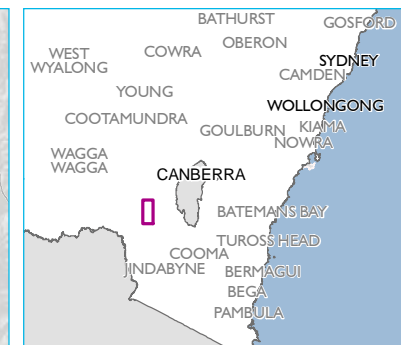
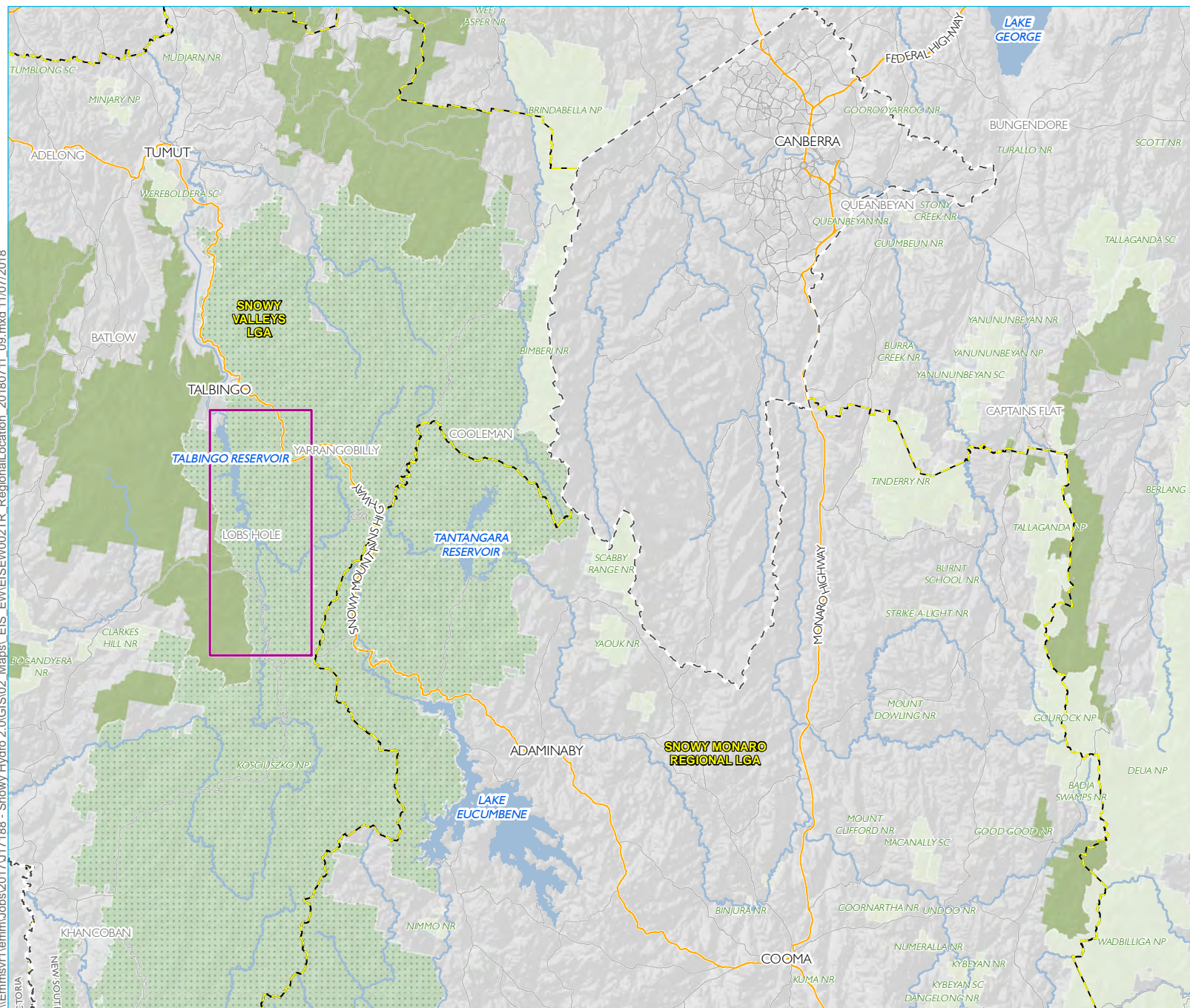
To inform preparation of the SEARs, the Department of Planning and Environment (DPE) invited relevant government agencies to advise on matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs.

#### *1.5.1 Other relevant reports*

This Economic Assessment has been prepared with reference to other technical reports that were prepared as part of the Exploratory Works EIS. The other relevant reports referenced in this Economic Assessment are listed below.

- Aboriginal cultural heritage assessment (NSW Archaeology 2018) – Appendix O of the EIS
- Air quality and greenhouse gas impact assessment (Jacobs 2018) – Appendix U of the EIS
- Aquatic ecology assessment (Cardno 2018) – Appendix G of the EIS
- Biodiversity development assessment (EMM 2018) – Appendix F of the EIS
- Groundwater assessment (EMM 2018) – Appendix N of the EIS
- Historic cultural heritage assessment (NSW Archaeology 2018) – Appendix P of the EIS
- Noise and vibration impact assessment (EMM 2018) – Appendix T of the EIS
- Recreational user impact assessment (TRC 2018) – Appendix C of the SIA within the EIS
- Social assessment (EMM 2018) – Appendix R of the EIS
- Surface water assessment (EMM 2018) – Appendix M of the EIS
- Traffic and Transport assessment (SCT 2018) – Appendix Q of the EIS

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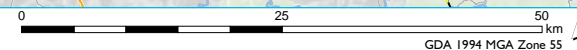


- KEY**
- Exploratory Works project area
  - Main road
  - Local road
  - Watercourse
  - Waterbodies
  - Kosciuszko National Park
  - NPWS reserve
  - State forest
  - Local government area boundary
  - State boundary

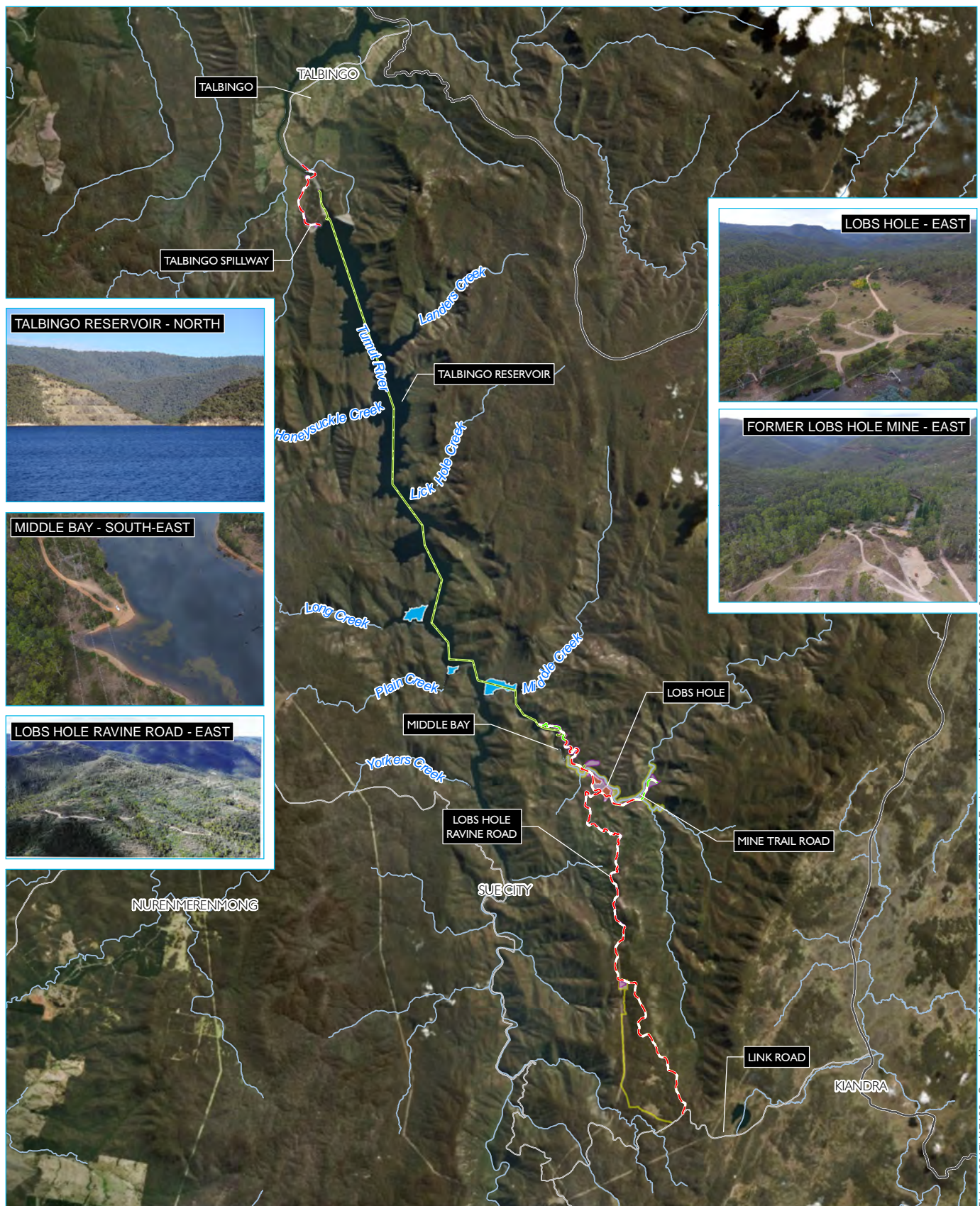
Regional location of Snowy 2.0 and Exploratory Works

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 1.1

Source: EMM (2018); Snowy Hydro (2018); DFSI (2017); LPMA (2011)







Source: EMM (2018); Snowy Hydro (2018); SMEC (2018); Robert Bird (2018); DFSI (2017); LPMA (2011)

#### KEY

- Access road upgrade
- Access road extension
- Communications cable
- Main road
- Local road
- Major watercourse
- On land rock management
- Subaqueous excavated rock placement
- Disturbance footprint
- Avoidance footprint

0 1 2 km  
GDA 1994 MGA Zone 55  
N

Exploratory Works project area

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 1.1

## **2 Project description**

### **2.1 Overview**

Exploratory Works comprises construction associated with geotechnical exploration for the underground power station for Snowy 2.0. The Exploratory Works elements are shown on Figure 2.1 and involve:

- establishment of an exploratory tunnel to the site of the underground power station for Snowy 2.0;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- establishment of a portal construction pad for the exploratory tunnel;
- establishment of an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades providing access and haulage routes during Exploratory Works;
- establishment of barge access infrastructure, to enable access and transport by barge on Talbingo reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir;
- establishment of services infrastructure such as diesel-generated power, water and communications; and
- post-construction revegetation and rehabilitation, management and monitoring.

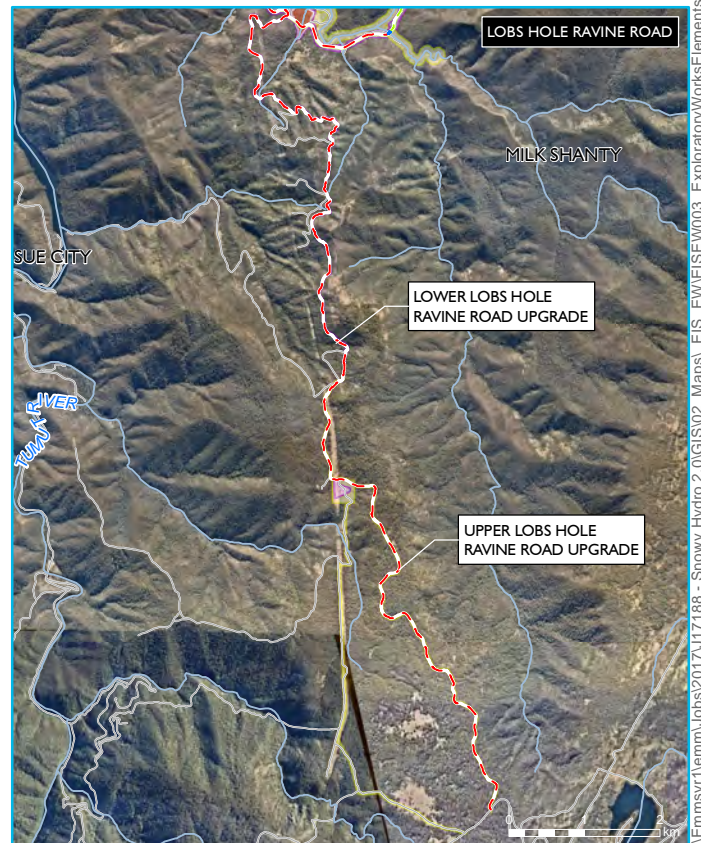
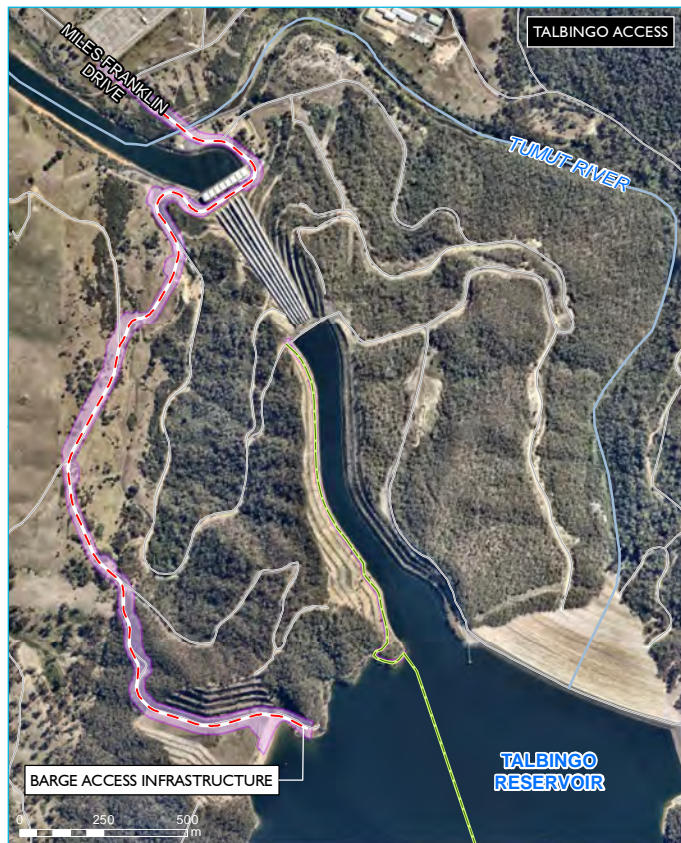
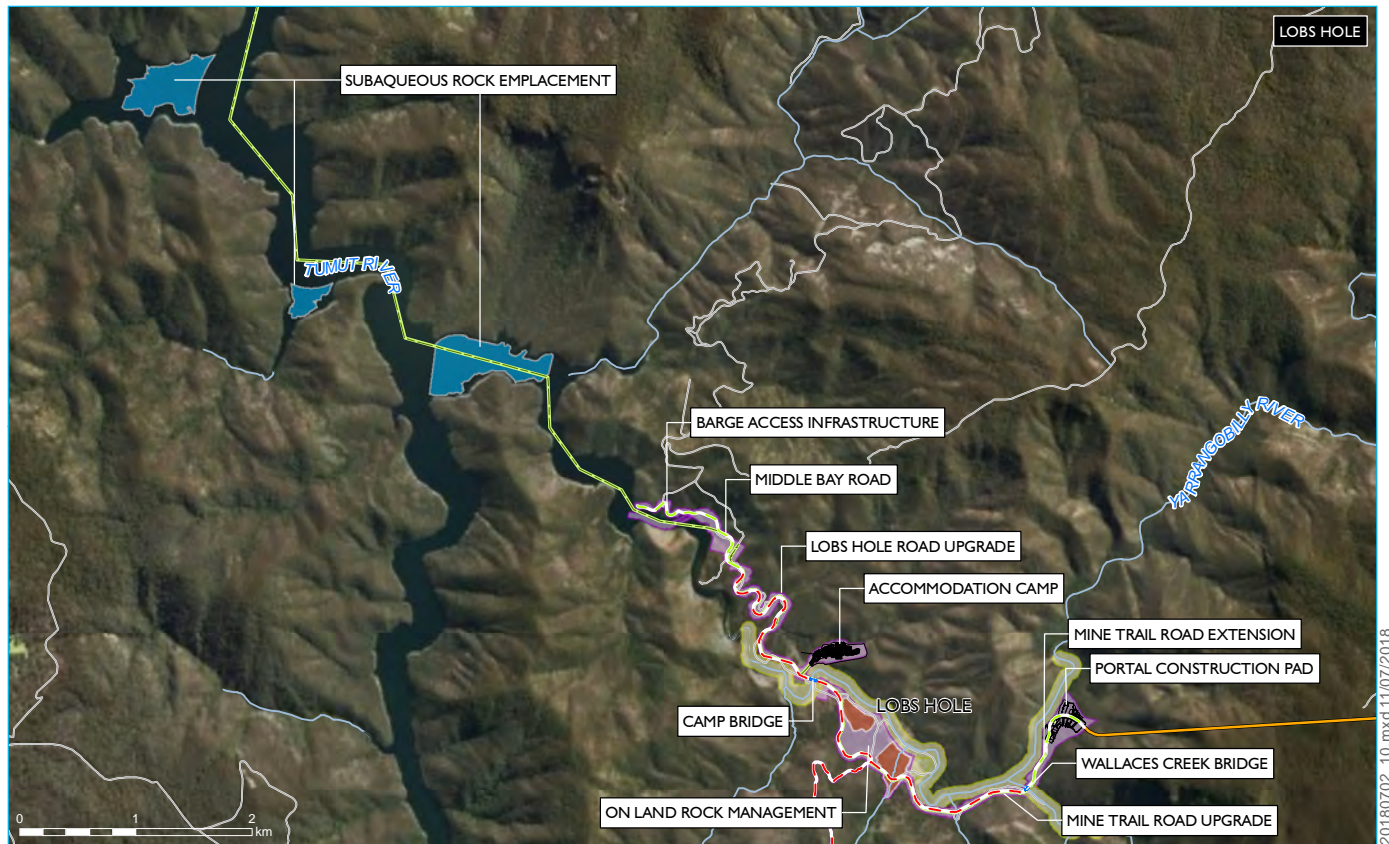
### **2.2 Exploratory tunnel**

An exploratory tunnel of approximately 3.1 km is proposed to provide early access to the location of the largest cavern for the underground power station. This will enable exploratory drilling and help optimise the location of the cavern which, in turn, will optimise the design of Snowy 2.0.

The exploratory tunnel is proposed in the north-east section of Lobs Hole and will extend in an east-west direction with the portal construction pad to be outside the western end of the tunnel at a site east of the Yarrangobilly River, as shown on Figure 2.2.

The location of the proposed exploratory tunnel and portal construction pad is shown in Figure 2.2. The exploratory tunnel will be excavated by drill and blast methods and have an 8 x 8 m D-Shaped cross section, as shown on Figure 2.3.





Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017); LPMA (2011)

GDA 1994 MGA Zone 55

## KEY

- |  |                                    |
|--|------------------------------------|
| — Exploratory tunnel   | — Local road or track              |
| - - Access road upgrade  | — Watercourse                      |
| - - Access road extension  | ■ On land rock management          |
| — Permanent bridge   | ■ Subaqueous rock emplacement area |
| — Portal construction pad and accommodation camp conceptual layout | ■ Disturbance footprint            |
| — Communications cable   | ■ Avoidance footprint              |

## Exploratory Works elements

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 2.1



The drill and blast excavation process will be repeated cyclically throughout the tunnelling works, involving:

- marking up and drilling blast holes in a predetermined pattern in the working face of the tunnel;
- loading the blast holes with explosives, attaching detonators and connecting the holes into a blast sequence, and detonating the blast;
- ventilating the tunnel to remove blast fumes and dust;
- removing blasted rock;
- scaling and wash down of the tunnel roof and walls to remove loosened pieces of rock;
- geological mapping of the exposed rock faces and classification of the conditions to determine suitable ground support systems for installation;
- installing ground support; and
- advancing construction ventilation ducting and other utilities including power, water, compressed air and communications.

The exploratory tunnel will be shotcrete-lined with permanent anchor support, and incorporate a groundwater management system. The exploratory tunnel shape and dimensions are designed to allow two-lane traffic for the removal of excavated material, along with additional space for ventilation and drainage of groundwater inflows. Groundwater intersected during tunnelling will be contained and transferred to the portal for treatment and management. Areas identified during forward probing with the potential for high groundwater flows may require management through a detailed grouting program or similar.

The tunnel portal will be established at the western end of the exploratory tunnel and provide access and utilities to the exploratory tunnel during construction. The portal will house power, communications, ventilation and water infrastructure. The portal will also provide a safe and stable entrance to the exploratory tunnel.

It is anticipated that the exploratory tunnel will be adapted for multiple functions during construction of the subsequent stages of the Snowy 2.0 project. The exploratory tunnel will also eventually be utilized to form the main access tunnel (MAT) to the underground power station during the operational phase of Snowy 2.0, should it proceed.



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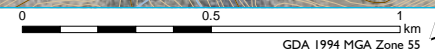


- KEY**
- - - Access road upgrade
  - - - Access road extension
  - Portal construction pad conceptual layout
  - Exploratory tunnel
  - Permanent bridge
  - Communications cable and water services pipeline location
  - Watercourse
  - Contour (10m)
  - Contour (100m)
  - Disturbance footprint
  - Avoidance footprint

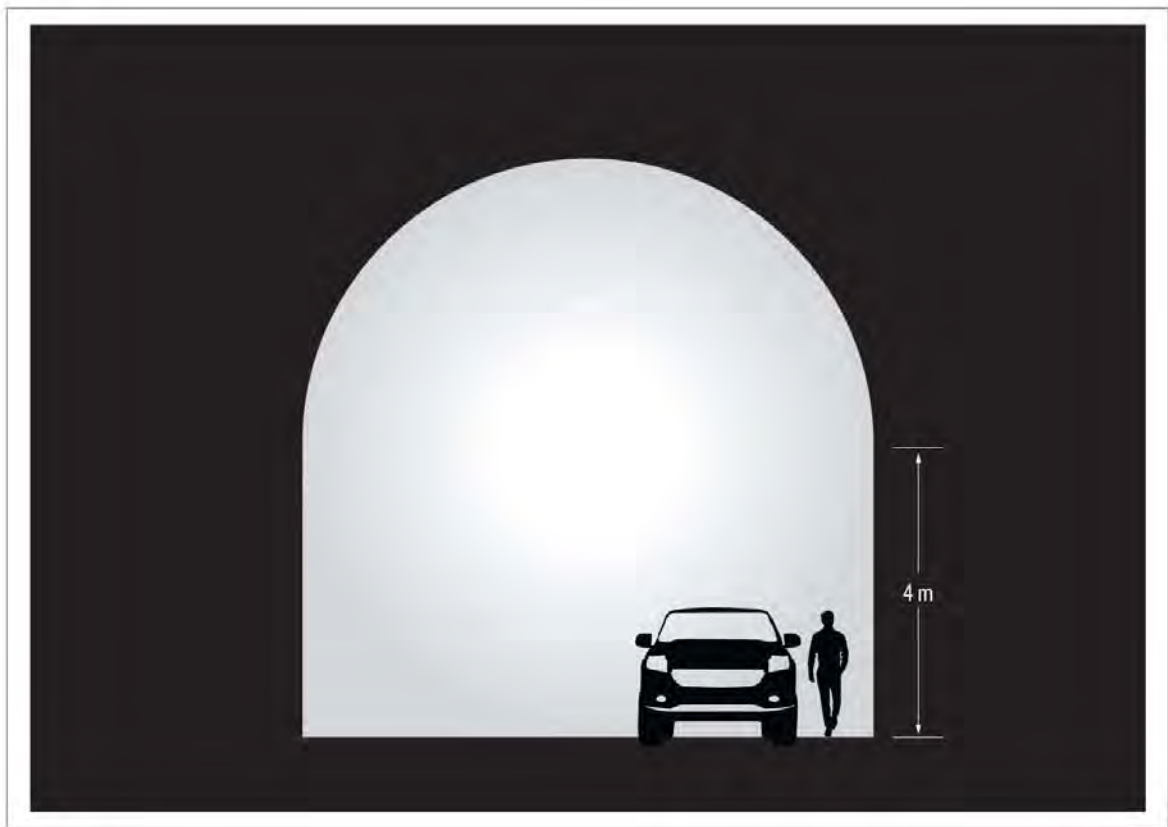
Exploratory tunnel location

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 2.2

Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); Robert Bird (2018); SMEC (2018); DFSI (2017)







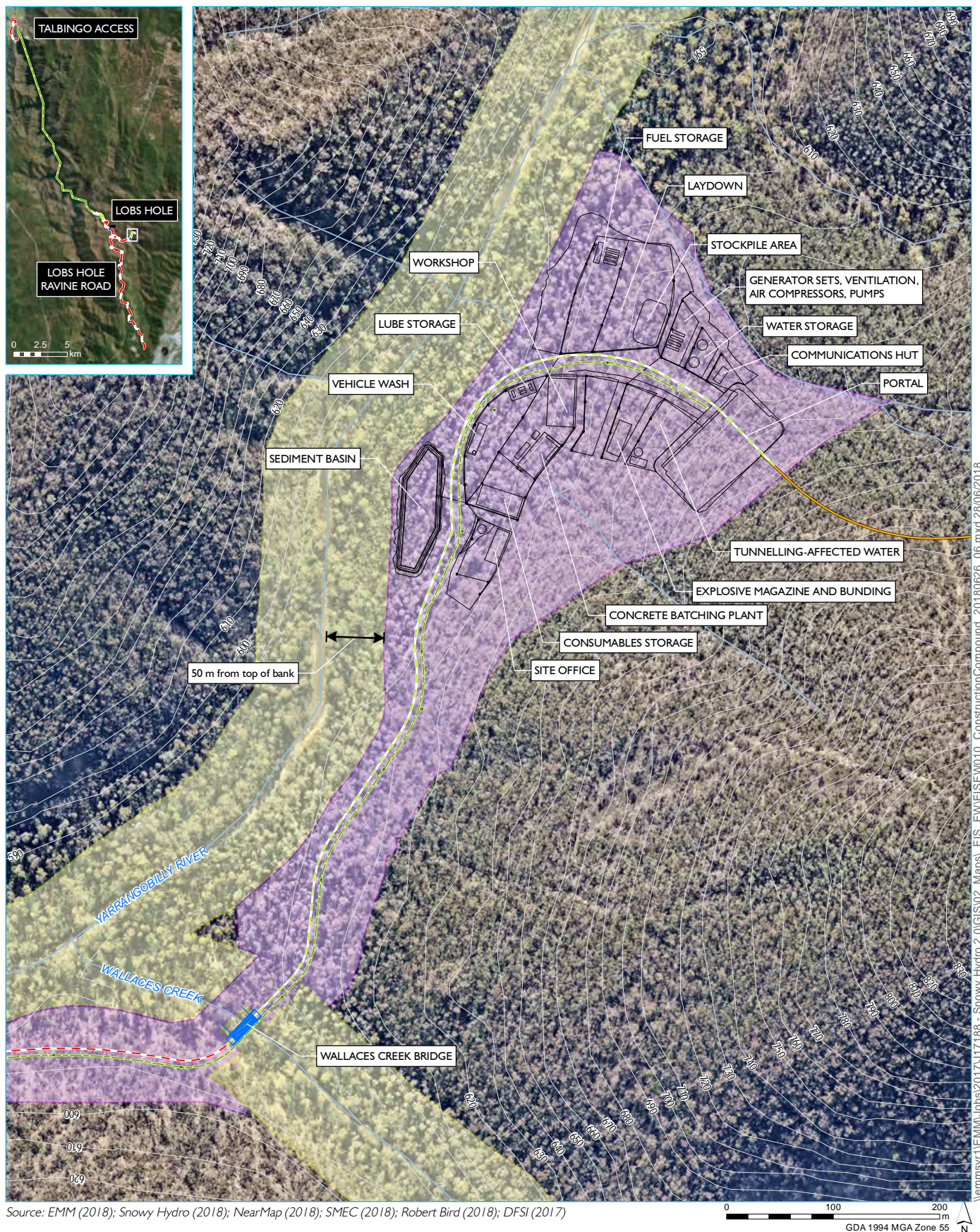
**Figure 2.3**      **Exploratory tunnel indicative cross section**

### **2.3 Portal construction pad**

A portal construction pad for the exploratory tunnel will provide a secure area for construction activities. Infrastructure at the portal construction pad, shown in Figure 2.4, will primarily support tunnelling activities and include a concrete batching plant and associated stockpiles, site offices, maintenance workshops, construction support infrastructure, car parking, equipment laydown areas. Stockpile areas will allow for around two to three months supply of concrete aggregate and sand for the concrete batching plant to ensure that the construction schedule for the proposed access road works do not interfere with the exploratory tunnel excavation schedule. A temporary excavated rock stockpile area is also required to stockpile material excavated during tunnel construction prior to its transfer to the larger excavated material emplacement areas.

The portal construction pad will be at the western end of the exploratory tunnel. The portal construction pad will be excavated to provide a level construction area with a near vertical face for the construction of the portal and tunnelling. The area required for the portal construction pad is approximately 100,000 m<sup>2</sup>.





## KEY

- |   |                         |
|---|-------------------------|
| — Permanent bridge                          | — Watercourse           |
| — Access road upgrade                       | — Contour (10m)         |
| — Access road extension                     | — Disturbance footprint |
| — Portal construction pad conceptual layout | — Avoidance footprint   |
| — Exploratory tunnel                        |                         |
| — Communications cable                      |                         |

Conceptual layout – portal  
construction pad

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 2.4





## 2.4 Excavated rock management

It is estimated that approximately 750,000 m<sup>3</sup> of bulked materials will be excavated, mostly from the exploratory tunnel and portal construction pad with additional quantities from road upgrade works. Subject to geochemical testing of the rock material, excavated rock will be placed either on land or subaqueously within Talbingo Reservoir.

### 2.4.1 On land placement

Excavated materials will be placed in one of two rock emplacement areas at Lobs Hole as shown on Figure 2.5.

The strategy for excavated rock management is for excavated material to be emplaced at two areas with the final placement of excavated material to be determined at a later date.

Consultation with NPWS throughout the design process has identified an opportunity for the eastern emplacement area to form a permanent landform that enables greater recreational use of Lobs Hole following the completion of Snowy 2.0's construction. It is envisaged that the excavated rock emplacement area will provide, in the long-term, a relatively flat final landform suitable for camping and basic recreational facilities to be confirmed in consultation with NPWS.

The eastern emplacement area has a capacity of up to 600,000 m<sup>3</sup> of material. It will be approximately 25 m maximum depth and will be benched down to the northern edge of the emplacement which is setback 50 m from the Yarrangobilly River.

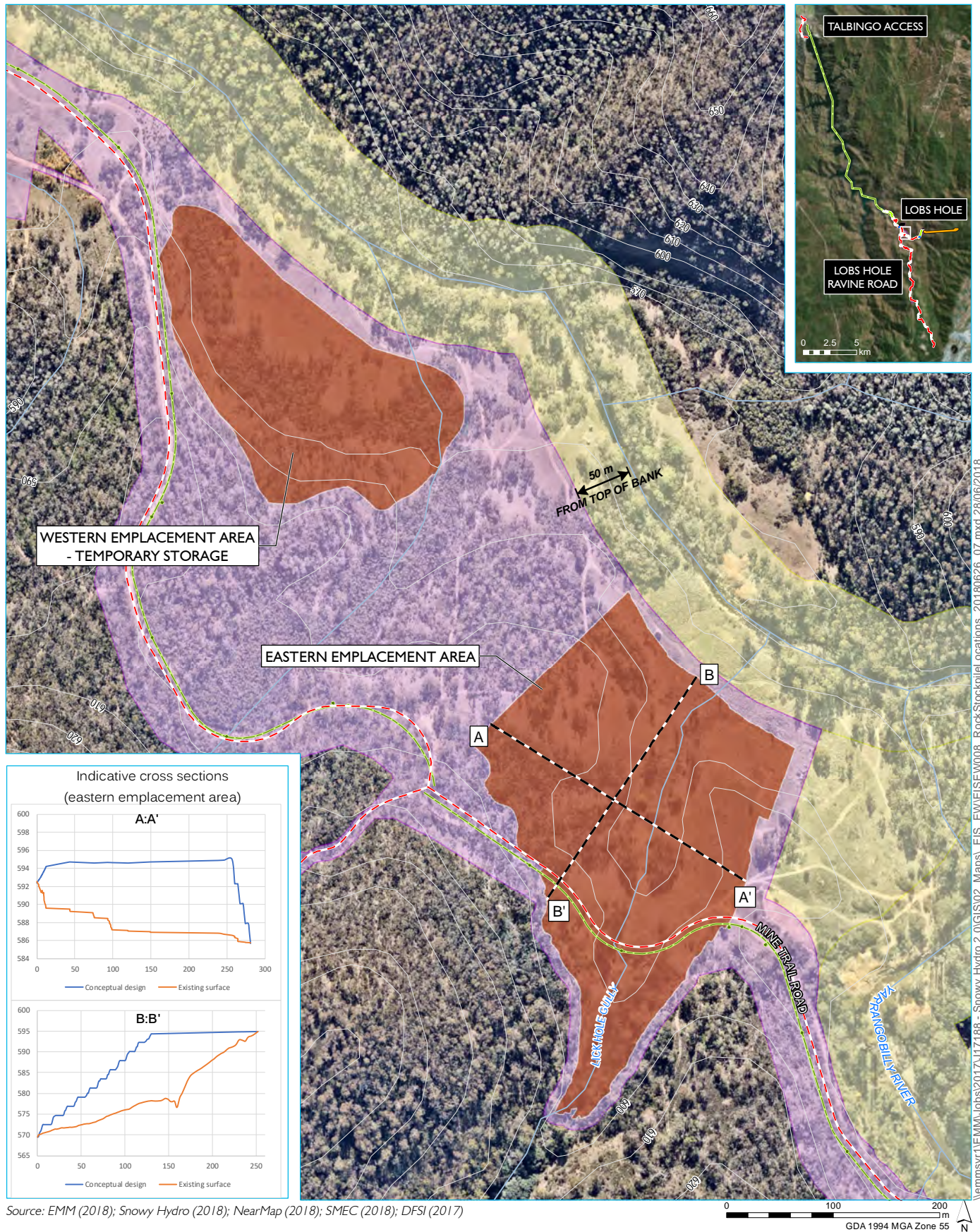
The western emplacement area will be used to store excavated material should it not be able to be placed within the eastern emplacement area. It is envisaged this emplacement area will be used to store excavated materials suitable for re-use within the construction of Exploratory Works or for use by NPWS in KNP maintenance activities. All remaining material placed in this emplacement area will be removed following the completion of Exploratory Works.

The guiding principles for the design, construction method and management of emplacement areas undertaken for Exploratory Works have been as follows:

- reducing potential for acid rock drainage from the excavated rock emplacement area entering the Yarrangobilly River or forming groundwater recharge;
- avoid known environmental constraints; and
- manage existing surface water flows from Lick Hole Gully.

The design and management of the emplacement areas have not yet been finalised due to the need for further investigations to determine the likely geochemical characteristics of the excavated material. Following further investigation and prior to construction of Exploratory Works a management plan will be prepared and implemented.





## KEY

- Cross-section
- - - Access road upgrade
- Communications cable and water services pipeline location
- Watercourse
- Contour (10m)
- On land rock management
- Disturbance footprint
- Avoidance footprint

Conceptual layout – excavated material emplacement areas

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 2.5





#### *2.4.2 Subaqueous placement*

An initial program for the placement of excavated rock within Talbingo Reservoir also forms part of Exploratory Works. The program will be implemented in an appropriate section of Talbingo Reservoir in accordance with a detailed management plan based on an engineering method informed through the materials' geochemistry and reservoir's characteristics. The purpose of the program is to confirm the suitability of the emplacement method for future excavated rock material from the construction of Snowy 2.0, should it proceed.

The rock for subaqueous placement will be taken from the excavated rock emplacement areas as described above. Testing of the rock would be conducted during excavation to assess geochemical properties. Any rock assessed as unsuitable for subaqueous placement based on the prior geochemical and leachability testing would be separately stockpiled and not used in the program. Suitable (ie non-reactive material) would be transported and loaded to barge, for placement at the deposition area. Suitable placement locations have been identified for Exploratory Works and are shown indicatively on Figure 2.6.

All placement within the reservoir would occur within silt curtains and would be subject to a detailed monitoring regime including survey monitoring of pre-placement and post-placement bathymetry, water quality monitoring during placement, and monitoring of aquatic ecology and the recolonisation of benthic species and fish species to the placement area following the placement program. The management, mitigation and monitoring measures would be refined following the ongoing investigations.

### **2.5 Accommodation camp**

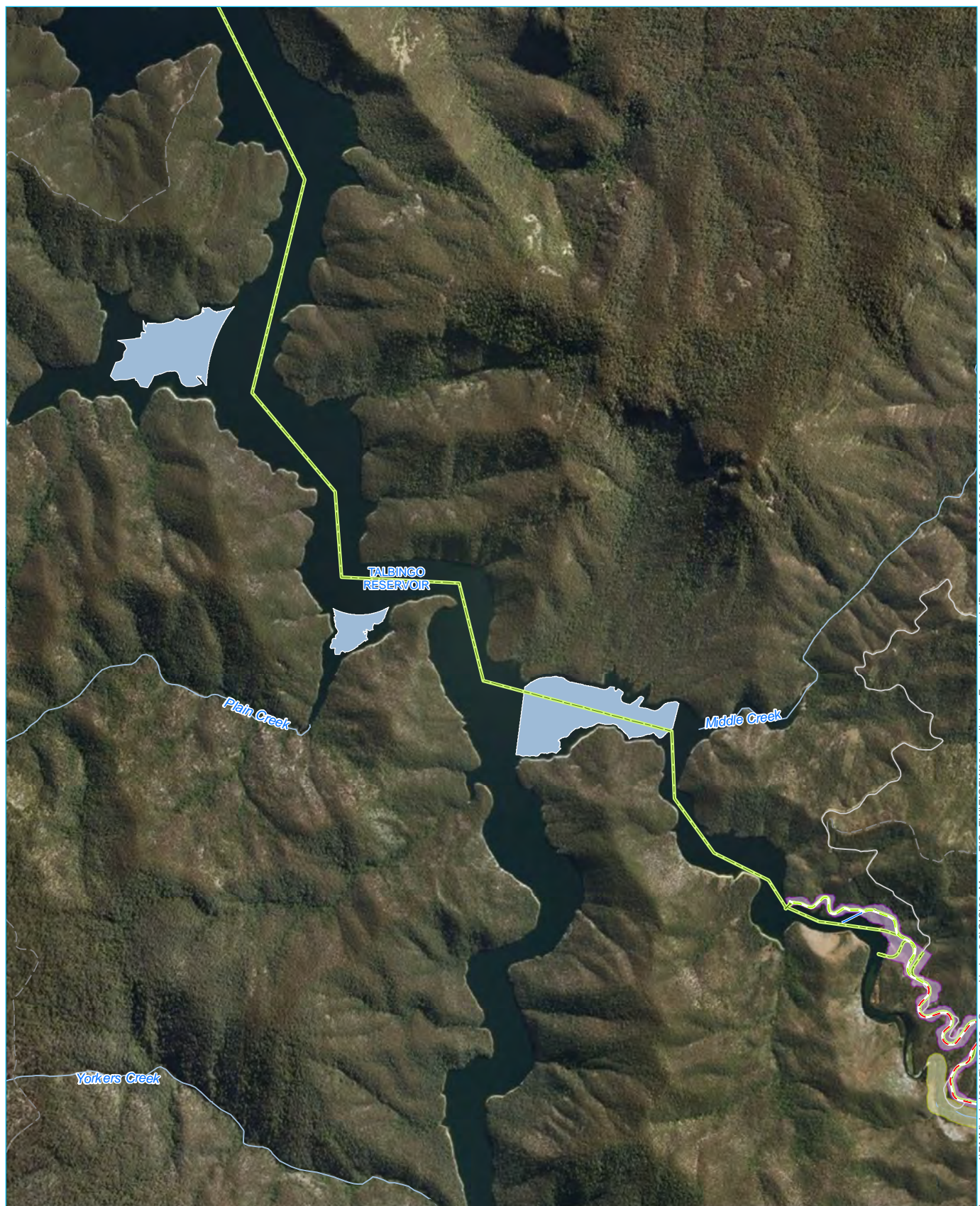
An accommodation camp is proposed to provide accommodation and supporting services for workers in close proximity to the exploratory tunnel. The accommodation camp layout is shown on Figure 2.7 and includes ensuite rooms surrounding central facilities including a kitchen, tavern, gym, admin office, laundry, maintenance building, sewage and water treatment plants and parking that will service the Exploratory Works workforce. The accommodation camp access road will connect to the north side of Lobs Hole Road at Lobs Hole. The conceptual layout of the accommodation camp is shown on Figure 2.7.

### **2.6 Road and access provisions**

Existing road and access will need to be upgraded to a suitable standard to:

- provide for the transport of excavated rock material between the exploratory tunnel 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 staff to the portal construction pad.

Given the topographic constraints of the area, the standard of the existing roads and the environmental values associated with KNP, the option of barging larger and oversized loads to the site is available. This is discussed further at Section 2.7.



Source: EMM (2018); Snowy Hydro (2018); ESRI (2018); SMEC (2018); DFSI (2018); GA (2017); LPMA (2011)

#### KEY

- - Access road upgrade
- - Access road extension
- - Communications cable and water services pipeline location
- - Subaqueous rock emplacement
- - Major watercourse
- - Local road
- - Track
- - Middle Bay barge access
- - Disturbance footprint
- - Avoidance footprint

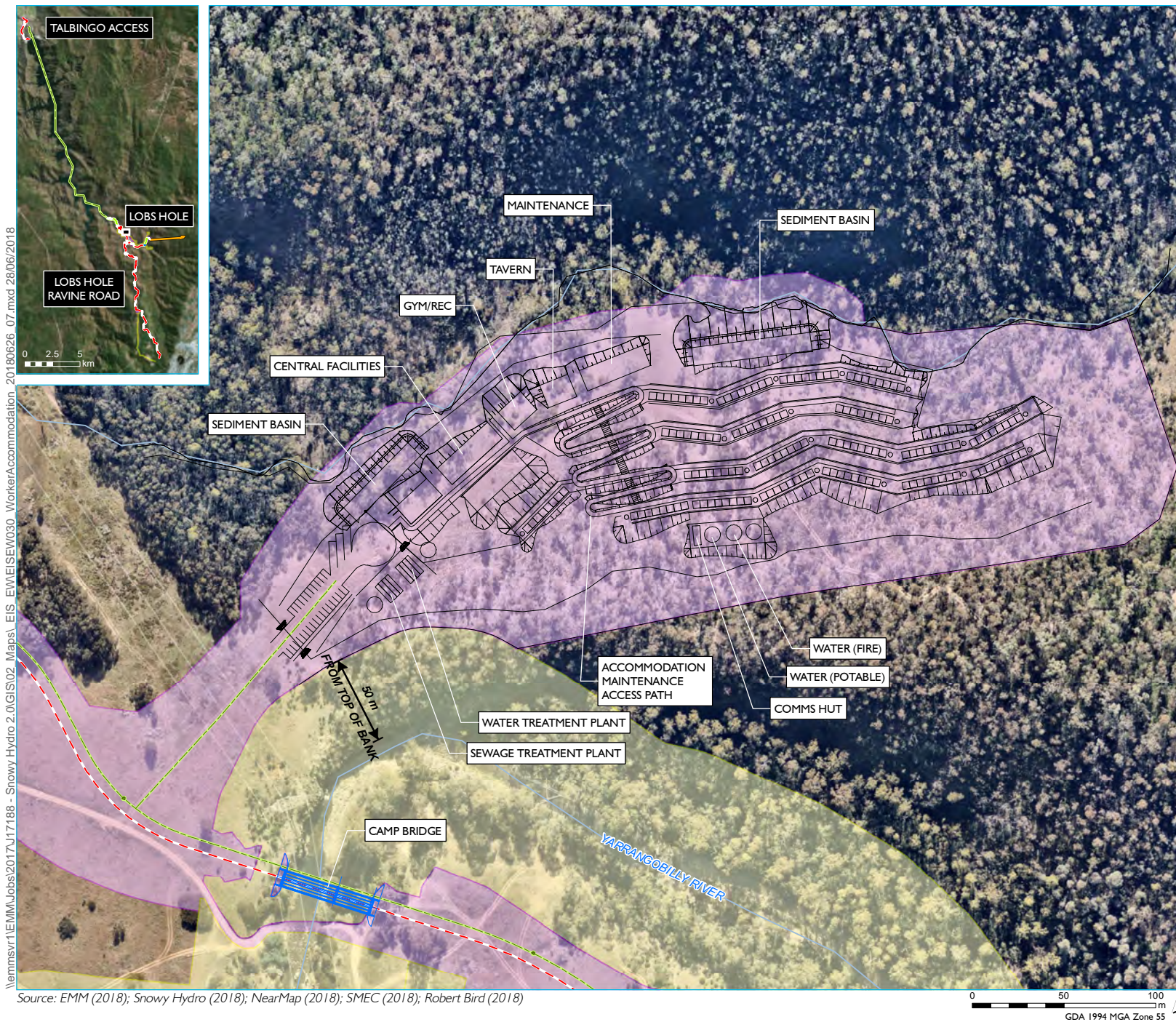
Subaqueous excavated rock placement

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 2.6



\\emmsvr1\EMM\Jobs\2017\17188 - Snowy Hydro 2.0\GIS02\_Maps\EIS\_EW\SEW034\_IndicativeExcavatedMaterialPlacement\_20180613\_05.mxd 28/06/2018





# KEY

- Access road upgrade
- Permanent bridge
- Accommodation camp conceptual layout
- Communications cable and water services pipeline location
- Watercourse
- Disturbance footprint
- Avoidance footprint

Conceptual layout – accommodation camp

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 2.7

Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018)



### 2.6.1 Access road works

The access road upgrades will be designed based on access for a truck and dog trailer. The proposed road works are shown in Figure 2.8 and described in Table 2.1. It is expected that the majority of materials and equipment will travel along the Snowy Mountains Highway, Link Road and Lobs Hole Ravine Road, with some required to travel on Miles Franklin Drive via Talbingo to Talbingo Dam Wall and be transferred via a barge to site. The primary haul routes for construction material on site are provided in Figure 2.9. Where existing roads are replaced by new access roads or road upgrades, the existing roads will be removed and rehabilitated in line with the rehabilitation strategy for Exploratory Works.

**Table 2.1 Access road works summary**

Roadwork area	Overview
Upper Lobs Hole Ravine Road upgrade	Minor upgrades to 7.5 km section of existing road. Only single lane access will be provided. No cut and fill earthworks or vegetation clearing will be undertaken.
Lower Lobs Hole Ravine Road upgrade	Upgrades to 6 km section of existing road involving cut and fill earthworks in some sections. Only single lane access will be provided.
Lobs Hole Road upgrade	Upgrade to 7.3 km section of existing road providing two-way access.
Mine Trail Road upgrade	Upgrade to 2.2 km section of existing track to two-way access.
Mine Trail Road extension	Establishment of a new two-way road providing access to the exploratory tunnel portal.
Middle Bay Road	Establishment of a new two-way road to the proposed Middle Bay barge ramp.
Spillway Road	Upgrade of a 3 km section of existing road to provide two-way access to the proposed Spillway barge ramp.

While no cut and fill earthworks or vegetation clearing is proposed along Upper Lobs Hole Ravine Road, a laydown area is proposed within and adjacent to the existing transmission line easement. This area will be used to store materials required for the road works to the lower section of Lobs Hole Ravine Road.

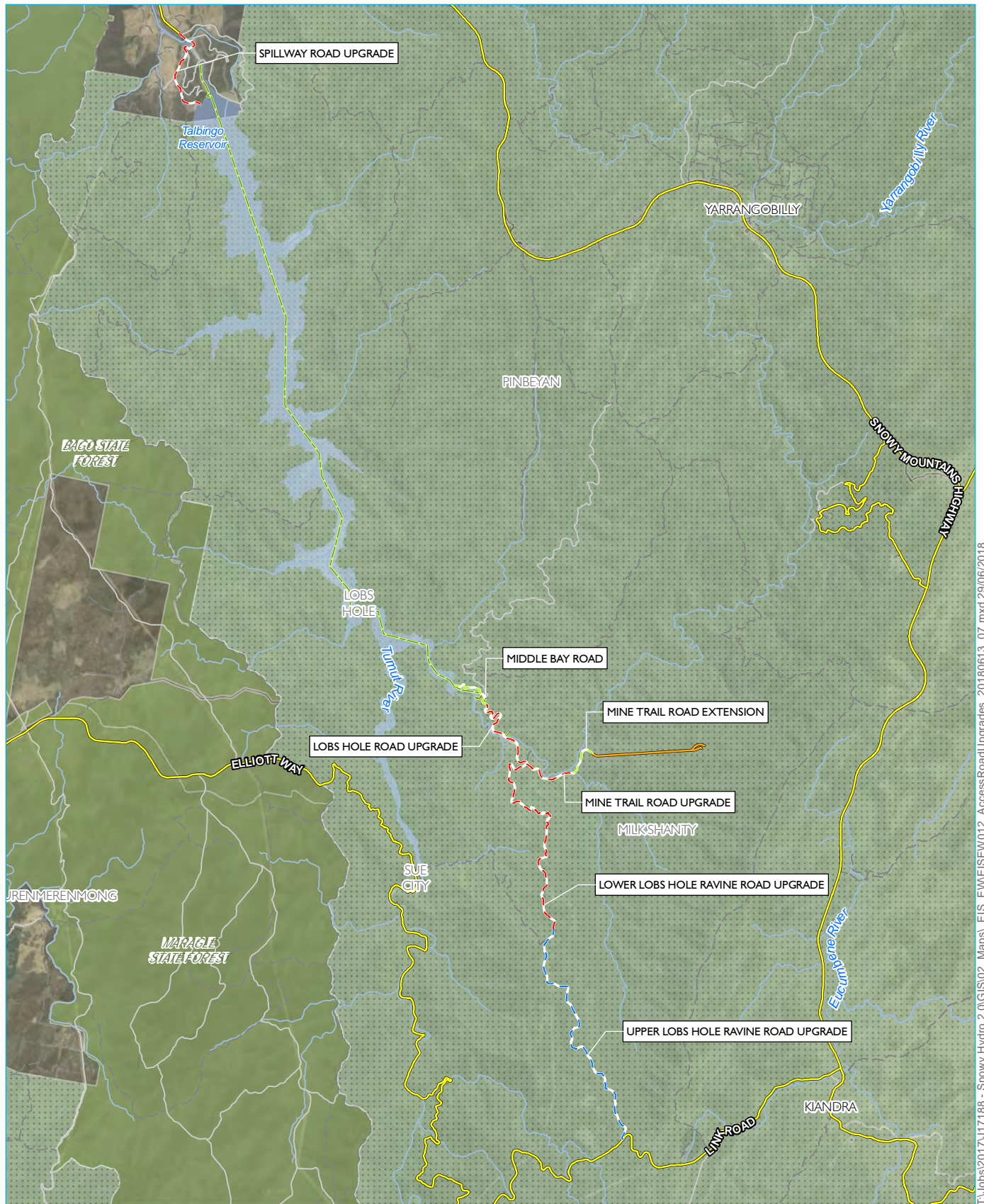
### 2.6.2 Watercourse crossings

Bridge construction will be required at two locations as described in Table 2.2. The locations of these bridge works are shown in Figure 2.9.

**Table 2.2 Watercourse crossing summary**

Bridge works area	Overview
Camp bridge	An existing crossing on Yarrangobilly River will be used as a temporary crossing while a new permanent bridge is built as part of Lobs Hole Road upgrade. The existing crossing will require the crossing level to be raised with rocks to facilitate vehicle passage. The rocks used to raise the crossing level will be removed and the crossing no longer used once the permanent bridge has been constructed. The new bridge (Camp Bridge) will be a permanent crossing and used for both Exploratory Works and Snowy 2.0 main works, should it proceed.
Wallaces Creek bridge	Establishment of a new permanent bridge at Wallaces Creek as part of the Mine Trail Road extension. Establishment of this bridge will require an initial temporary pre-fabricated 'Bailey bridge' to be constructed, which will be removed before the end of Exploratory Works.





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

## KEY

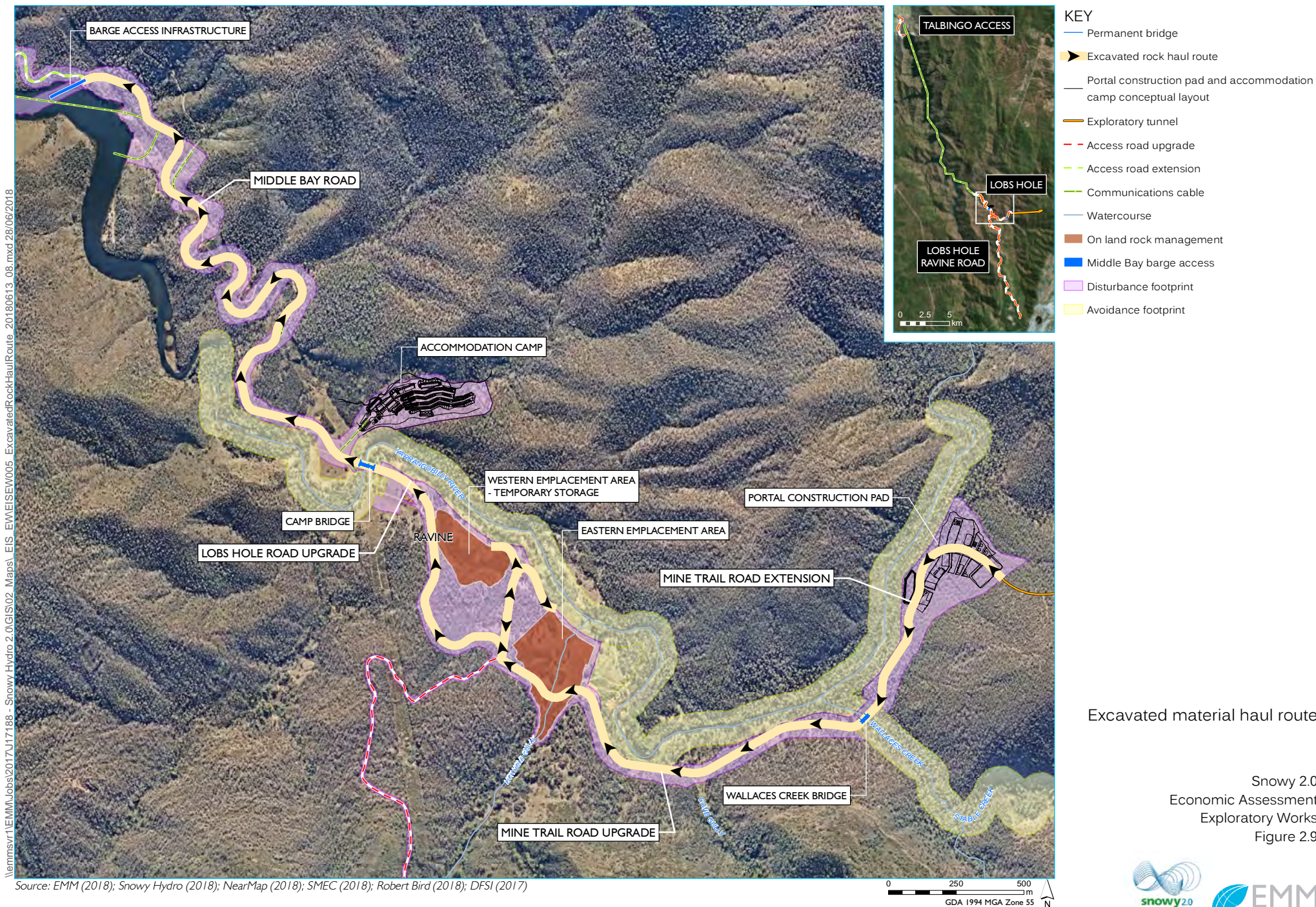
- |  |  |
|--|--|
| <span style="color: blue;">—</span> Access road upgrade - without widening                     | <span style="color: grey;">—</span> Local road   |
| <span style="color: red;">—</span> Access road upgrade - with widening                         | <span style="color: grey;">- -</span> Vehicular track  |
| <span style="color: green;">—</span> Access road extension                                     | <span style="color: blue;">—</span> Perennial watercourse  |
| <span style="color: orange;">—</span> Exploratory tunnel                                       | <span style="color: blue;">■</span> Scheme storage   |
| <span style="color: green;">—</span> Communications cable and water services pipeline location | <span style="background-color: #d3d3d3; border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span> Kosciuszko National Park |
| <span style="color: yellow;">—</span> Main road  | <span style="background-color: #808000; border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span> State forest             |

## Access road upgrades and establishment

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 2.8









The design for permanent bridges at both crossings will consist of steel girders with a composite deck. This is the most common type of permanent bridge constructed in and around the existing Snowy Scheme. Lightweight steel girders are easy to transport and will therefore allow for efficiencies in the construction schedule and permit the use of smaller-scale lifting equipment at the construction site.

## **2.7 Barge access infrastructure**

To provide an alternative to road access, a barge option is proposed, not only for bulky and heavy equipments but for materials and also in case of emergency. During Exploratory Works, barges will be loaded at the northern barge ramp (Talbingo barge ramp), travel about 18 km along Talbingo Reservoir and be unloaded at the southern barge ramp (Middle Bay barge ramp) before returning to the north. Some loads may also be transported in the reverse direction.

Barge access infrastructure will comprise two dedicated barge ramps at Middle Bay and Talbingo Spillway, with a slope of approximately 1 vertical to 10 horizontal (1V: 10H) at each location. A navigation channel is also required adjacent to the Middle Bay barge ramp. Construction will involve:

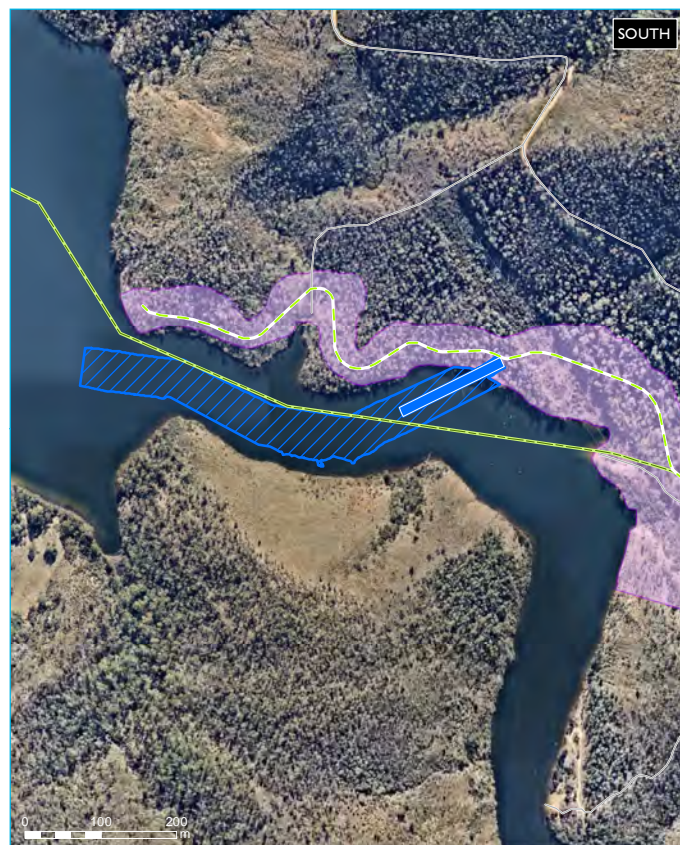
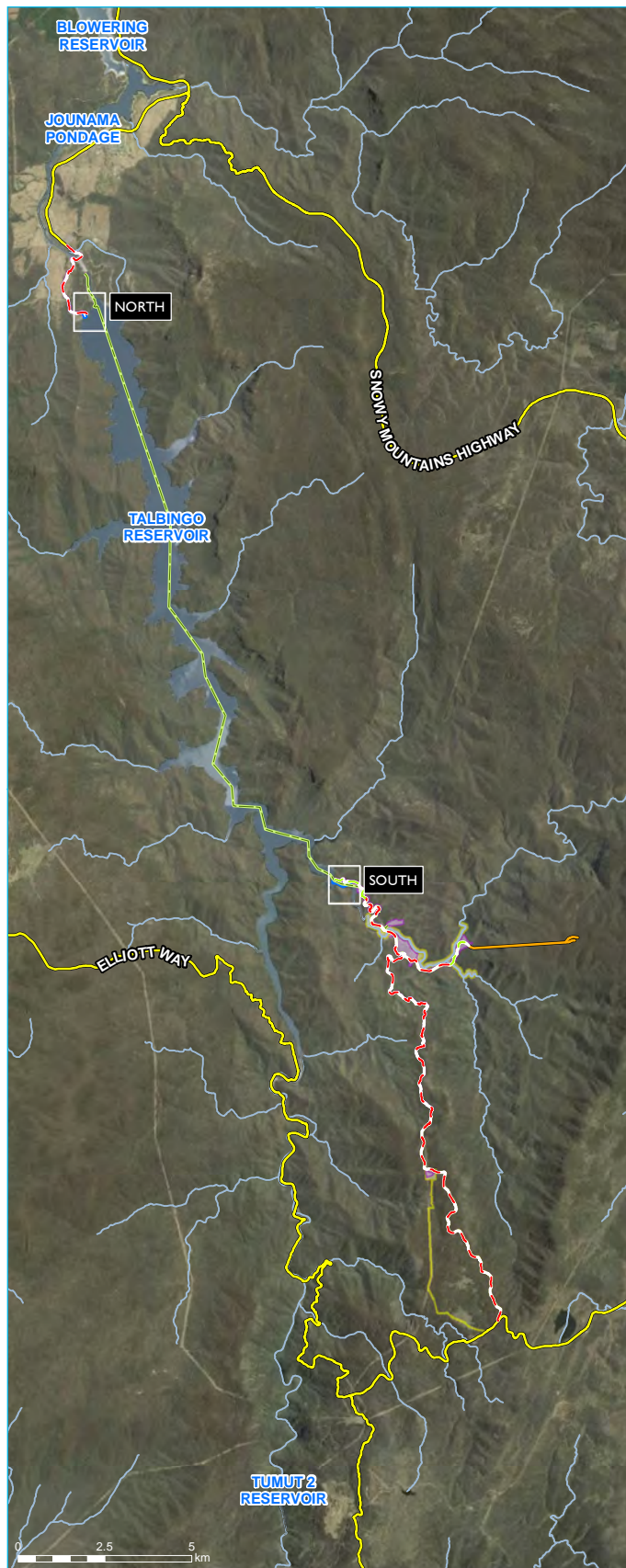
- geophysical and geotechnical investigation of the barge access area to inform detailed design;
- site establishment and excavation of barge access area;
- installation of precast concrete panels at the ramp location;
- installation of bollards for mooring lines;
- removal of trees and debris to establish a navigation channel allowing barge access; and
- minor dredging to allow barge access at the reservoir minimum operating level.

To facilitate construction, laydown areas are proposed adjacent to the Middle Bay barge ramp and adjacent to the water inlet pipeline. Laydown will also be used within the footprint of the Talbingo barge ramp.

Dredged material will be placed as part of the subaqueous placement program or within one of the designated on land rock emplacement areas. The infrastructure proposed for the Talbingo Spillway barge ramp and Middle Bay barge ramp is provided in Figure 2.10.

## **2.8 Services and infrastructure**

Exploratory Works will require additional power and communication infrastructure. Water services are also needed and include a water services pipeline and water and waste water (sewage) treatment facilities. A summary of services required is provided at Table 2.3.



Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); DFSI (2017); LPMA (2011)

GDA 1994 MGA Zone 55

#### KEY

- |                           |   |
|---------------------------|---|
| — Exploratory tunnel      | — Perennial watercourse                   |
| - - Access road upgrade   | ■ Middle Bay barge access                 |
| - - Access road extension | ▨ Disturbance area - barge infrastructure |
| - - Communications cable  | ■ Disturbance footprint                   |
| — Main road               | ■ Avoidance footprint                     |
| — Local road or track     |   |

Barge access locations

Snowy 2.0  
Economic Assessment  
Exploratory Works  
Figure 2.10



**Table 2.3 Summary of services and infrastructure**

Services infrastructure	Description
Power	Power will be provided at the portal construction pad and accommodation camp by diesel generators, with fuel storage provided at the portal construction pad.
Communication	Communication will be provided via fibre optic link. The fibre optic service has been designed to incorporate a submarine cable from Tumut 3 power station across Talbingo Reservoir to Middle Bay, and then via a buried conduit within the access roads to the accommodation camp and the portal construction pad.
Water and waste water (sewage)	<p>A water services pipeline is proposed for the supply and discharge of water for Exploratory Works which will pump water between Talbingo Reservoir and the exploratory tunnel portal, portal construction pad and accommodation camp.</p> <p>A package water treatment plant is proposed at the accommodation camp to provide potable water to the accommodation camp and portal construction pad facilities and will be treated to a standard that complies with the Australian Drinking Water Guidelines. The accommodation camp water supply will be pumped via the water pipeline from Talbingo Reservoir at Middle Bay.</p> <p>A package waste water (sewage) treatment plant (STP) is proposed at the accommodation camp for the Exploratory Works waste water. The STP will produce effluent quality comparable to standard for inland treatment facilities in the region (eg Cabramurra). Following treatment waste water will be discharged to Talbingo reservoir via the water services pipeline connecting the accommodation camp to Talbingo Reservoir.</p> <p>Waste water from the exploratory tunnel and concrete batching plant will be either re-used on site or sent to the waste water treatment plant for treatment prior to discharge.</p>

## 2.9 Construction and schedule

### 2.9.1 Geotechnical investigation

To assist the design development for the portal construction pad, accommodation camp, Middle Bay Road, Spillway Road, and Lobs Hole Ravine Road, further survey of ground conditions is required. A program of geotechnical investigations including geophysical survey, construction of test pits, and borehole drilling within the disturbance footprint, will be undertaken as part of construction activities. Excavation of test pits in areas where information on relatively shallow subsurface profiles is required, or where bulk sampling is required for laboratory testing. Borehole drilling is required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures.

### 2.9.2 Construction activities

A disturbance footprint has been identified for Exploratory Works. The extent of the disturbance footprint is shown on Figure 2.1 and shows the area required for construction, including the buildings and structures, portal construction pad, road widenings and bridges, laydown areas, and rock emplacement areas. Typical construction activities that will occur within the footprint are summarised in Table 2.4.



**Table 2.4 Construction activities**

Activity	Typical method
Geophysical and geotechnical investigation	<p>Geophysical surveys will generally involve:</p> <ul style="list-style-type: none"> <li>• laying a geophone cable at the required location and establishing seismic holes;</li> <li>• blasting of explosives within seismic holes; and</li> <li>• in-reservoir geophysics surveys will use an air gun as the seismic source.</li> </ul> <p>Geotechnical surveys will generally involve:</p> <ul style="list-style-type: none"> <li>• establishing a drill pad including clearing and setup of environmental controls where required;</li> <li>• drilling a borehole to required depth using a tracked or truck mounted drill rig; and</li> <li>• installing piezometers where required for future monitoring program.</li> </ul> <p>Geophysical and geotechnical investigation within Talbingo Reservoir will be carried out using barges and subject to environmental controls.</p>
Site establishment for portal construction pad, accommodation camp, rock placement areas and laydown areas	<p>Site establishment will generally involve:</p> <ul style="list-style-type: none"> <li>• identifying and flagging areas that are to be avoided during the Exploratory Works period;</li> <li>• clearing of vegetation within the disturbance footprint, typically using chainsaws, bulldozers and excavators;</li> <li>• civil earthworks to create a stable and level area suitable for establishment. This will involve a cut and fill approach where required to minimise the requirement for imported material;</li> <li>• installing site drainage, soil erosion and other permanent environmental controls where required;</li> <li>• surface finishing, compacting only existing material where possible, or importing additional material. Where suitable, this material will be sourced locally (eg from upgrade works to Lobs Hole Ravine Road); and</li> <li>• set up and commissioning of supporting infrastructure, including survey marks.</li> </ul>
Road works	<p>Upgrades of existing tracks (no widening) will generally involve:</p> <ul style="list-style-type: none"> <li>• identifying and flagging areas that are to be avoided during the Exploratory Works period; and</li> <li>• removing high points, infilling scours, levelling of rutting, and compacting surfaces.</li> </ul> <p>Extension or widening of existing tracks will generally involve:</p> <ul style="list-style-type: none"> <li>• identifying and flagging areas that are to be avoided during the Exploratory Works period;</li> <li>• installing site drainage, soil erosion and other permanent environmental controls where required;</li> <li>• clearing and earthworks within the disturbance footprint; and</li> <li>• placing road pavement material on the roadway.</li> </ul>
Bridge works	<p>Establishment of permanent bridges will generally involve:</p> <ul style="list-style-type: none"> <li>• installing erosion and sedimentation controls around watercourses and installing scour protection as required;</li> <li>• establishing temporary diversions within the watercourse where required, including work to maintain fish passage;</li> <li>• establishing temporary bridges to facilitate permanent bridge construction;</li> <li>• constructing permanent bridges including piling, establishment of abutments and piers; and</li> <li>• removal and rehabilitation of temporary bridges and diversions.</li> </ul>

**Table 2.4 Construction activities**

Activity	Typical method
Barge access works	Establishment of barge access infrastructure will generally involve: <ul style="list-style-type: none"> <li>• installing sediment controls;</li> <li>• excavating and dredging of barge ramp area and navigation channel;</li> <li>• installing precast concrete planks and bollards; and</li> <li>• set up and commissioning of supporting infrastructure.</li> </ul>
Exploratory tunnel construction	The drill and blast excavation process will be repeated cyclically throughout the tunnelling works, involving: <ul style="list-style-type: none"> <li>• marking up and drilling blast holes in a predetermined pattern in the working face of the tunnel;</li> <li>• loading the blast holes with explosives, attaching detonators and connecting the holes into a blast sequence, and detonating the blast;</li> <li>• ventilating the tunnel to remove blast fumes and dust;</li> <li>• removing blasted rock;</li> <li>• scaling and wash down of the tunnel roof and walls to remove loosened pieces of rock;</li> <li>• geological mapping of the exposed rock faces and classification of the conditions to determine suitable ground support systems for installation;</li> <li>• installing ground support; and</li> <li>• advancing construction ventilation ducting and other utilities including power, water, compressed air and communications.</li> </ul>

### 2.9.3 Ancillary construction areas

Ancillary facilities and laydown areas have been identified within the conceptual layout for the portal construction pad and accommodation camp. A number of other indicative construction and laydown areas have also been identified to support Exploratory Works. A summary of these sites are:

- Upper Lobs Hole Ravine Road laydown area;
- rock emplacement area laydown, storage and ancillary uses;
- barge access infrastructure laydown areas at Talbingo and Middle Bay; and
- other minor laydown areas as needed during site establishment of watercourse crossings.

All laydown areas are within the disturbance footprint identified for Exploratory Works.

In addition, an area near Camp Bridge has been identified to be used for a plant nursery and organic stockpile area.

### 2.9.4 Construction workforce requirements

#### i Staffing levels

It is currently expected that workforce for Exploratory Works will be approximately 200 people in total at peak construction. Workers are anticipated to work a 'swing' shift, for example two weeks on and one week off. These workers will be accommodated within the accommodation camp at Lobs Hole when rostered on.

The majority of the workforce will work on a fly-in fly-out and drive-in drive-out basis. It is expected that the majority of workers will fly in and out of either Cooma Airport or Canberra Airport and then travel to site via bus.

During construction of the accommodation camp, workers will be accommodated at Cabramurra. Some workers may also be accommodated at Snowy Hydro existing accommodation units at Talbingo during construction of the Talbingo barge ramp. No accommodation will be required outside of Cabramurra, the construction accommodation camp or Talbingo for the Exploratory Works workforce.

## ii Hours of operation

It is expected that construction of the exploratory tunnel and haulage of rock material between the tunnel and excavated rock stockpile locations at Lobs Hole will be 24 hours a day, seven days a week for the duration of the tunnel drilling and blasting operation. Other construction activities, including the establishment works, road and infrastructure works, will normally work a 12 hour day, seven days a week.

The transport of materials along the haul route from Snowy Mountains Highway, Link Road and Upper Lobs Hole Ravine Road will only occur during day time hours (except during emergency), to avoid impacts to threatened species (Smoky Mouse). Transport by barge will be 24 hours a day, seven days a week.

### 2.9.5 Timing and staging

Exploratory Works are expected to take about 34 months, with the exploratory tunnel expected to be completed by late 2021.

It is expected that the construction works will be completed largely in parallel. However, road and access works are expected to be completed within the first six months from commencement. The proposed staging of construction activities are highlighted in Table 2.5.

**Table 2.5 Indicative staging of construction**

Construction works	2018	2019	2020	2021
Access roads				
Portal construction pad				
Accommodation camp				
Services infrastructure				
Barge access infrastructure				
Tunnelling				
Excavated rock management				

### 2.10 Site rehabilitation

All Exploratory Works align with components of the main works for Snowy 2.0. However, should Snowy 2.0 not be approved or not progress, the project area will need to be rehabilitated, and project elements decommissioned in consultation with NPWS. Anticipated rehabilitation activities are summarised in Table 2.6.



**Table 2.6      Planned Exploratory Works rehabilitation activities**

<b>Exploratory Works element</b>	<b>Indicative rehabilitation activities</b>
Exploratory tunnel	Tunnel to remain open, and allowed to flood in lower portion provided groundwater impacts are negated.
Exploratory tunnel portal area	Permanent portal facade to be constructed, portal to be sealed from entry.
Portal construction pad and associated infrastructure	To be demobilised and all infrastructure removed. Site to be revegetated and returned to “original state”.
Excavated rock emplacement areas	Emplaced excavated rock in the western emplacement area to be removed offsite and area to be revegetated and returned to “original state”. The eastern emplacement area could remain in-situ and the landform rehabilitated as agreed with NPWS.
Accommodation camp	To be demobilised and all infrastructure removed. Site to be revegetated and returned to “original state”.
Road access works	No remediation required as works are to be designed to be permanent.
Barge access infrastructure	No remediation works required as wharf and loading ramps are designed as permanent. Wharf can be removed if desired.
Services and infrastructure	To be demobilised and all infrastructure removed. Site to be revegetated and returned to “original state”.

### **Decommissioning**

Should Snowy 2.0 not proceed following the commencement or completion of Exploratory Works, elements constructed are able to be decommissioned and areas rehabilitated. Given works are within KNP, Snow Hydro will liaise closely with NPWS to determine the extent of decommissioning and types of rehabilitation to be undertaken. This approach will be taken to ensure that decommissioning allows for integration with future planned recreational use of these areas and to maintain the values of KNP.

### **Key aspects relevant to the Economic Assessment**

Any element of the Project that has financial implications or may impact the wellbeing of individuals and the community is relevant to the CBA of the Project. This includes the results of all the technical assessments related environmental, social and cultural impacts.

Employment and expenditure associated with the Project is relevant to the assessment of impact in the locality.

### 3 Cost Benefit Analysis Considerations of the Exploratory Works

#### 3.1 Introduction

The Exploratory Works are a subcomponent of Snowy 2.0 that aim to help gain a greater understanding of the underground conditions at the proposed location of the power station cavern and so aid in the design of Snowy 2.0. It is only with the aid of this information that more accurate estimates can be made of the capital costs of Snowy 2.0 and a CBA of the overall Project can be undertaken. Consequently, this section focuses on a broad consideration of the costs and benefits of the Exploratory Works subcomponent of the larger project only.

#### 3.2 Potential costs and benefits of Snowy 2.0

To evaluate the costs and benefits of the Exploratory Works it is useful to place them in the context of the potential overall costs and benefits of the Snowy 2.0 Project. Table 3.1 provides a summary of potential costs and benefit categories of the full Snowy 2.0 Project

**Table 3.1 Potential economic benefits and costs of Snowy 2.0**

Category	Costs	Benefits
Market benefits	Capital and operating costs of Snowy 2.0, including transmission costs	<ul style="list-style-type: none"><li>• Savings in generator fuel and operating costs</li><li>• More orderly use of thermal generation</li><li>• Reduced capital for dispatchable capacity</li><li>• Increased generation inertia and greater system reliability</li><li>• Availability of spinning generation for the provision of spinning reserve</li><li>• Option value and flexibility</li><li>• Extend life of other existing generators through more stable operations</li><li>• Efficient use of existing hydro-power generation resources</li></ul>
Potential environmental, social and cultural impacts	<ul style="list-style-type: none"><li>• Surface and groundwater impacts</li><li>• Terrestrial and aquatic ecology impacts</li><li>• Noise and vibration impacts</li><li>• Air quality impacts</li><li>• Greenhouse gas emissions</li><li>• Traffic and transport impacts</li><li>• Aboriginal heritage impacts</li><li>• Historic heritage impacts</li><li>• Recreation impacts</li><li>• Visual amenity impacts</li></ul>	<ul style="list-style-type: none"><li>• Reduction in greenhouse gas emissions in energy market</li></ul>

The potential market benefits of Snowy 2.0 are discussed in detail in MJA (2017) *NEM Outlook and Snowy 2.0*.

#### 3.3 Market costs and benefits of the Exploratory Works

The Exploratory Works are a subcomponent of Snowy 2.0 and hence are associated with some of the potential cost and benefits of the Project, that are identified in Table 3.1.

In particular, the Exploratory Works are associated with some of the Snowy 2.0 capital costs (\$325M undiscounted) and some of the environmental, social and cultural impacts. These potential environmental, social and cultural impacts of the Exploratory Works are assessed in the EIS and discussed below in economic terms.

The potential market benefits identified for Snowy 2.0 do not arise from the Exploratory Works. It is only Snowy 2.0 together with transmission that provides these benefits.

However, in economic efficiency terms the Exploratory Works play an important role in the design of Snowy 2.0 in particular the appropriate location for the underground power station. Economic benefits of undertaking the Exploratory Works relate to:

- reduced direct construction costs. The Exploratory Works will enable a greater understanding of the conditions at the proposed location of the power station, approximately 850 metres (m) below ground level. Understanding factors such as rock conditions, ground temperature and stress conditions is essential to confirm the suitability of the site for the underground power station and help optimize the location of the cavern and finalise the design of Snowy 2.0. This optimisation process will avoid inappropriate location and design, and the additional costs associated with this.
- reduced delays. Launching into the full project development without Exploratory Works may lead to delays in the project as unforeseen conditions arise during construction. Delays during construction would have direct costs in terms of idle labour and capital resources while design issues are resolved. Delays in project construction would also delay the flow of market benefits identified by MJA. Any delay in benefits is an economic cost.
- avoiding substantial investment in a technically infeasible project with the associated impacts. The Exploratory Works will confirm the technical feasibility of Snowy 2.0 and ensure that more substantial investment, with associated environmental impacts, is not erroneously made.
- enable more accurate costing of Snowy 2.0 and hence more accurate assessment of the businesses case and CBA of the Project.

To achieve these benefits of the Exploratory Works some environment, social and cultural impacts will be incurred. These are the subject of the EIS. The main potential impacts of the Exploratory Works, and their economic dimensions are as follows.

### **3.4 Environmental, social and cultural impacts**

#### *3.4.1 Introduction*

Potential environmental, social and cultural impacts identified in the technical assessments and summarised in the EIS are only economic costs to the extent that they affect individual and community well-being. Individual and community well-being can be impacted if people's use of a resource is affected or if there are impacts to people's non-use values that they hold for a resource. If the potential impacts do not occur, are immaterial in magnitude, or are mitigated, compensated or offset (e.g. costs are borne by the proponent rather than others in the community) to the extent where community wellbeing is insignificantly affected, then no environmental, social or cultural economic costs should be included in the Project Economic Assessment apart from the mitigation, compensation or offsetting costs.

Each of the main potential environmental, social and cultural impacts is considered below from an economic perspective.

### 3.4.2 Groundwater

Groundwater impacts can potentially have economic consequences for groundwater users, groundwater dependent ecosystems and waterway health relying on groundwater flows.

Groundwater modelling predicts localised water table drawdown in the vicinity of the tunnel alignment, primarily around the portal where the exploratory tunnel intercepts shallow geological material that is more permeable than the deeper rock in which the majority of the tunnel will be excavated. However, there are no groundwater users in the area of localised impacts and hence no users of groundwater will be impacted.

No drawdown impact is predicted at the one high priority groundwater dependent ecosystems identified, the Yarrangobilly Caves. Potentially groundwater dependent ecosystems are considered to have opportunistic dependency on groundwater. Where water table drawdown is predicted to occur, the ecosystems are expected to be able to adapt and, therefore, influence would be minimal.

Only minor impacts to baseflow to the Yarrangobilly River and associated tributaries are expected, with the base case and maximum plausible impact scenarios predicting baseflow reductions of 0.14% (4 ML/yr) and 0.18% (14 ML/yr) respectively arising from the excavation of the exploratory tunnel. Losses are predicted to increase post construction until a new equilibrium is reached for which the steady state model predicts losses of 0.67% (19 ML/yr) and 2.29% (178 ML/yr) respectively for the base case and maximum plausible impact scenarios.

Groundwater licences from the Murray Darling Basin Lachlan Fold Belt groundwater source would be required to be held. There is an opportunity cost to SHL of holding these Water Access Licences (WALs) which is reflected in their market value. Conservatively assuming a market value of \$800/ML, and the need to hold 400 ML of WALs, there would be an economic opportunity cost of \$320,000. Assuming that these would not be required until 2019 the discounted cost is estimated at \$280,000 (present value at 7% discount rate).

### 3.4.3 Surface Water

Surface water impacts can potentially have economic consequences for users of surface water and surface water ecosystems.

The surface water access licence (WAL) volumes that Snowy Hydro needs to acquire for Exploratory Works are recommended to be 272 ML/yr to cater for the maximum plausible extraction from Talbingo Reservoir, as described. WALs should be acquired from the Department of Industry (DoI) Water under the *Water Sharing Plan for Murrumbidgee unregulated and alluvial water sources (2012): Upper Tumut Water Source*. Existing WALs in the Upper Tumut Water Source are limited to 205 ML/yr, which are currently allocated to existing users. Snowy Hydro will consult with DoI Water to establish the most appropriate means to acquire the required WALs. The value of these WALs in the market reflects their economic value and acquisition means that SHL bears the cost. The market value of the required WALs is uncertain due to the thinness of the market and absence of trading. However, assuming a value of \$1,000/ML, the total cost to the Project would be \$272,000. Assuming that these would not be required until 2019 the discounted cost is estimated at \$240,000 (present value at 7% discount rate).

Potential impacts to the surface water environment are due to ground disturbance, construction activities, and water management. Potential impacts include:

- water quality impacts associated with sediment-laden runoff (including fine or dispersive sediments) from construction areas, unsealed access roads, rock emplacement areas,

accommodation camp and portal construction pad into Yarrangobilly River, Wallaces Creek and other local waterways;

- contamination of stormwater runoff due to construction activities (including accidental spills) resulting in downstream impacts if not appropriately captured and managed;
- changes to flow regime from new infrastructure primarily bridges, the accommodation camp, and rock emplacement areas; and
- increased runoff volumes due to failure of road embankments, water management systems and other infrastructure during flood events;
- increased erosion of landforms and waterways associated with uncontrolled runoff and changes to flow regimes;
- uncontrolled discharge of process water into the stormwater system due to inadequate system design or stormwater ingress into the process water system;
- receiving water impacts due to discharge of process water or extraction of water;
- water quality impacts associated with the discharge of process and waste water to Talbingo Reservoir; and
- potential for acid rock drainage (ARD) seeping from rock emplacement areas into the Yarrangobilly River.

A suite of mitigation and management measures will be implemented to minimise impacts to surface water and receiving watercourses. The cost of these is included in the capital costs of the Project. With implementation of the proposed mitigation and management measures there will be no material impacts on community well-being.

#### *3.4.4 Terrestrial Ecology*

Impacts to threatened species habitat and native vegetation (including those vegetation communities requiring offsets) include clearing of 95 ha of native vegetation, comprising impacts to 70.64 ha of threatened species habitat for five species credit species, Gang-gang Cockatoo, Eastern Pygmy-possum, Booroolong Frog, Smoky Mouse and Masked Owl. However, impacts to these species are not expected to be significant.

Notwithstanding, impacted vegetation and associated fauna is likely to have nonuse values to the community that can potentially be estimated using non-market valuation methods. These impacts remain unquantified.

However, SHL is proposing to compensate NPWS for, among other things, the following predicted impacts of Exploratory Works on the KNP:

- biodiversity - offsets required as a result of predicted impacts to biodiversity in accordance with the Biodiversity Conservation Act; and
- biodiversity premium - additional compensation for the predicted impacts to biodiversity recognising that the impacts will occur within a national park with unique environmental values.

To the extent that the compensation payment is used to achieve community values that are at least equivalent to the values lost from clearing, there will be no net loss in community economic values and the cost of ensuring this is borne by SHL. This cost to SHL is included in the discounted capital costs of the Project.

### *3.4.5 Aquatic Ecology*

The community may hold nonuse values for key fish habitat (KFH) and threatened fish species.

The Exploratory Works would result in disturbance to KFH from to barge access infrastructure and associated dredging. However, the areas of disturbance would be a small proportion of the entire Talbingo reservoir. There is unlikely to be any net loss of this habitat and associated impacts to species, including threatened species that use this habitat. Impacts are likely to be minimal in extent and temporary.

If threatened species are present in the reservoir, construction and dredging works may result in disturbances to the due to reduced water quality and noise. However, these would be localised and temporary and both potentially present threatened species would be able to actively avoid disturbed areas. Consequently, no substantial or ongoing impacts to threatened species of KFH are expected and economic impacts are likely to be minimal.

### *3.4.6 Noise and Vibration*

Noise and vibration can potentially impact community wellbeing via direct effects on sensitive receptors including dwellings, infrastructure and Aboriginal and historic heritage. Government guidelines establish noise and vibration criteria to minimise impacts.

Construction noise - Assessment results indicate that construction noise levels satisfy noise management levels (NMLs) at all assessment locations with the exception of R2 where a 2 dB and 5 dB (moderate) exceedance is predicted for the out of hours period during calm and adverse weather conditions, respectively. The predicted exceedance at location R2 is generated by Spillway Road construction activities (near Talbingo). Road construction for this activity is scheduled to occur for six weeks. The time spent in this zone and therefore the duration of noise levels above the NMLs will therefore be less.

Construction vibration - All assessment locations are well outside of the safe working distances for human response.

Road traffic noise - Nearest residential assessment locations potentially affected by project related traffic are located on Miles Franklin Drive, Talbingo and Snowy Mountains Highway to the east of the project area. Road traffic noise levels are predicted to satisfy relevant road traffic noise criteria.

Blasting - An offset distance that would satisfy the vibration criteria is provided in the Noise and Vibration Impact Assessment for vibration sensitive receivers. Several vibration assessment locations (heritage items) fall within the required offset distances.

Based on the technical assessments moderate construction noise impacts may occur at R2 for a short period (in the order of 6 weeks), depending on weather conditions. The economic consequence of a short term reduction in amenity is likely to be small, but remains unquantified. Other impacts meet government criteria and hence are unlikely to be material from an economic perspective. The exception is heritage impacts from blasting which are considered below.

### *3.4.7 Air Quality*

Air quality impacts arise from the generation of dust emissions in the form of particulate matter. These can affect community well-being via the potential for harmful effects on human health well as amenity impacts from the settling of course dust on surfaces and materials.

Air quality criteria, relating to total suspended particles (TSP), PM10 and PM2.5, have been developed that take into consideration the existing background dust levels in an area, as well as the dust levels that will arise from a project. These criteria are set at levels to protect against health effects and nuisance dust effects (Department of Environment and Conservation 2005).

The main air quality impact for the Exploratory Works is airborne particulate matter (i.e. dust) from the handling and transport of excavated material. The CALPUFF computer-based air dispersion model was used to predict ground-level concentrations and deposition levels due to the identified emission sources, and the model predictions have been compared with relevant air quality criteria. The model predictions showed that PM10, PM2.5, TSP and deposited dust levels would not exceed relevant air quality criteria at the nearest sensitive receptor (that is, the accommodation camp). It is concluded that the Exploratory Works can achieve acceptable air quality outcomes for the nearest sensitive receptor (the accommodation camp) but it is recommended that monitoring is carried out prior to and during the Exploratory Works. Consequently, there will be no material residual air quality impacts on community well-being.

#### *3.4.8 Greenhouse Gas Generation*

Greenhouse gas emissions can impact community well-being to the extent that they cause environmental, social and economic impacts.

The Project will generate GHG emissions from :

- Diesel combustion – plant and equipment (stationary and mobile), light vehicles, transport of diesel fuel to site, transport of construction material to site
- Use of explosives
- Vegetation removal
- Construction materials

The total GHG emissions predicted for Exploratory Works are:

- Scope 1 – 40,278 tCO<sub>2</sub>e
- Scope 2 – n/a
- Scope 3 – 65,313 tCO<sub>2</sub>e

Scope 3 emissions are other indirect emissions that are a consequence of the Project but not controlled by SML. The GHG Protocol identifies that the reporting of scope 3 emissions can therefore result in double counting of emissions (WRI/WBCSD 2004). Consequently, these would not normally be attributed to the Project.

To place an economic value on CO<sub>2</sub>-e emissions, a shadow price of CO<sub>2</sub>-e is required. Assuming a social cost of carbon emissions of \$21/t<sup>2</sup> the discounted greenhouse gas emission cost for scope 1 emissions is \$0.7M. This is a global damage cost of carbon (i.e. the cost of carbon emissions to the population of the whole world).

The focus of CBA is typically national or State. In the absence of any studies that have focused on the social damage cost of carbon emissions to Australian or NSW residents, some means of apportioning global damage costs borne by these populations is required. For the purpose of this assessment this

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<sup>2</sup> The average of the Forecast European Union Emission Allowance Units price, the Australian Treasury Clean Energy Future Policy Scenario and the US EPA Social Cost of Carbon in 2020.

has been undertaken using Australia's share of the global population (around 0.3%) and NSW's share of the Australian population (32%).

On this basis the discounted cost of greenhouse gas emissions from the Project to Australia and NSW is estimated at \$2,100 and \$670, (present value), respectively.

#### *3.4.9 Traffic*

Road transport impacts can arise from pavement damage where heavy vehicles need to use local roads that are not designed for heavy vehicle use. Congestion and accident costs can also occur where the road network is at capacity or road features such as pavement/shoulder width and intersections are inadequately designed for the additional traffic.

Heavy vehicle use will largely be confined to arterial roads where pavement damage costs are embedded into operating costs. With regard to network impacts, Snowy Mountains Highway is expected to remain at the existing performance level of service A.

Link Road is expected to remain at the existing performance level of service C throughout Exploratory Works. Construction vehicle movements along Miles Franklin Drive will only be undertaken to deliver oversized equipment and materials. This is expected to be an occasional occurrence that will not impact the operational performance of the road.

Consequently, the economic consequences of road transportation associated with the Project is expected to be minimal.

Lobs Hole Ravine Road and roads within Lobs Hole will be closed to the public for the duration of Exploratory Works. This will have impacts for recreation which are discussed below.

#### *3.4.10 Aboriginal Heritage*

Any impacts on Aboriginal heritage sites may impact the well-being of the Aboriginal community. However, monetisation of these impacts is problematic and so these impacts are best left to consideration as part of the preparation of the Aboriginal Heritage Management Plan. Impacts on Aboriginal heritage sites have been shown in some instances to reduce the well-being of the broader community (Gillespie Economic 2009a, 2009b, 2010) while in other instances the impact on the community's well-being has been mixed (Windle and Rolfe 2003).

Twenty one Aboriginal object (mainly stone artefact) locales within nine Survey Units would be disturbed by the Exploratory Works;

- seven which occur in Survey Units 6 and 10 of moderate to high local significance;
- three in Survey Unit 3 of low to moderate local significance; and
- 12 in Survey Units 4, 13, 16, 23, 24 and 25 of low local significance.

These have been historically disturbed with most Aboriginal object locales already impacted and not considered to be of sufficient significance to warrant avoidance measures. None include the types of Aboriginal heritage valued in the studies referred to above. However, a number of management strategies are proposed.

For the purpose of this analysis, the impacts on Aboriginal heritage remains unquantified but their economic value is likely to be minimal.



### 3.4.11 Historic Heritage

Historic heritage can have both use and nonuse values to the community.

The Project will directly impact 57 items of historic heritage, of which six are listed as locally significant, and the remaining items have not been assigned a level of significance. The majority of identified items are assessed to be of insufficient value to warrant any sort of formal heritage listing. None of the recorded heritage items are assessed to be of potential state significance.

No specific non-market valuation study has been undertaken in relation to the five heritage items assessed as being of local heritage significance that will directly impacted by the Project. However, Allens Consulting Pty Ltd (2005), found that respondent utility is increased by an increase in the number of heritage places on heritage lists that are protected — average household willingness to pay across Australia for the protection of additional places on heritage lists from loss was estimated to be \$5.53 per person (household) each year for every 1,000 places protected. Indexing this value to 2018 and aggregating it to 79% of the Australian and NSW households (as reflected by the survey response rate) and converting to a present value using a 7% discount rate gives a non-use economic value of \$600,000 per place for the Australian population and \$195,000 per place for the NSW population<sup>3</sup>. The impacts of the directly impacted listed heritage items are therefore estimated at \$3.6M (present value) for the Australian population and \$1.2M (present value) for the NSW population.

A range of mitigation and management measures are proposed in relation to the heritage items that may be directly and indirectly impacted by the Project and these costs are included in the capital costs of the Project. In addition, SHL will compensate NPWS for impacts of Exploratory Works on the KNP, including in relation to heritage impacts. To the extent that the compensation payment is used to achieve community values that are at least equivalent to the values lost, there will be no net loss in community economic values and the cost of ensuring this is borne by SHL. This cost to SHL is included in the discounted capital costs of the Project.

### 3.4.12 Recreation

The Exploratory Works will impact recreation at the:

- Lobs Hole Ravine area; and
- Talbingo Reservoir.

Lobs Hole Ravine area is used for camping with annual visitation of up to 2,500 people i.e. a very small proportion of the total 2.2 million domestic visitors to KNP. During the Exploratory Works, road access to Lobs Hole Ravine will be closed to the public and remains so for the duration of the Project. Survey results indicate that during the Exploratory Works some users will choose to relocate to other places in KNP, with others going outside the park.

Following the Exploratory Works completion, the upgraded access road is likely to lead to an increase in usage of the site, change the visitor experience and alter the visitor mix. With improved access, some upgrade of visitor facilities will be required, either following Exploratory Works should Snowy 2.0 not proceed past these works; or after Snowy 2.0.

Studies have found that nonmarket recreation has values to visitors. Mules et al (2005) found an average value (consumer surplus) attributable to recreation in the Australian Alps between \$280 and

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<sup>3</sup> It is recognised that there may be a distance decay relationship where households located closer to the impacted heritage items have higher values than those located further away. However, the study referred to for benefit transfer values did not investigate this issue.

\$860 per visitor, per annum. However, these values are likely to be less applicable to remote camping recreation and more likely reflect skiing recreation. Notwithstanding, if it assumed that the lower bound figure is applicable to recreation at Lobs Ravine then the annual economic values of visitation are in the order of \$700,000. If people choose to relocate to other places during the Exploratory Works then only part of these recreation values will be lost during the Exploratory Works. However, if people choose to forego this recreation all together than all these values would be lost. Assuming the latter, the upper bound recreation impact of the exploratory works, assuming a life of 3 years, commencing in 2019, would be \$1.7M, present value (7% discount rate).

Impacts after the Exploratory Works on the Lobs Hole Ravine are likely to be mixed, with improved access and increased usage resulting in increases in economic value and displacement of economic values for those who prefer the previous level of access. However, overall it is likely to result in an increase in economic values. This impact remains unquantified.

Talbingo Reservoir is used for water skiing, paddle boarding, canoeing, swimming, swimming. The area around the spillway is also used by trail bike riders. There is no data available on recreational usage of the reservoir.

The Exploratory Works will involve the provision of a ramp for barge facilities on the spillway of the Talbingo Dam and at Middle Wharf. This will have some minor impact on users of Talbingo Reservoir for the period of the Works. The impacts at Talbingo Reservoir can be mitigated by providing access to the southern part of the spillway, relocating the existing swimming enclosure from the northern part of the spillway to the southern part, limiting access restrictions to the spillway and reservoir during times of peak usage, and ensuring that users of the reservoir are aware of the timing of the operation of the barge. The net impacts are likely to be minor and remain unquantified in this analysis.

It should be noted that SHL will compensate NPWS for impacts of Exploratory Works on the KNP, including in relation to recreation impacts. This cost to SHL is included in the discounted capital costs of the Project.

### *3.3.12 Visual Impacts*

Lobs Hole is within a steeply incised ravine, along the western fringe of the Long Plains fault escarpment. The visibility of the indicative infrastructure points at Lobs Hole is contained to the immediate working areas which will be closed to the public during construction. Effective rehabilitation of the site post-construction will ensure that these impacts remain minimal once the area is made available to the general public.

Works at Talbingo barge ramp and Spillway Road upgrades are likely to be intermittently visible from some locations in the vicinity.

Visual impacts remain unquantified but are likely to be minimal.

## **3.5 Summary of Results**

Based on the above assessment the economic costs and benefit of the Exploratory Works to Australia are summarised in Table 3.2.

Total costs including capital costs, compensation costs and environmental, social and cultural costs that were able to be valued, are estimated at \$280M (\$277M to NSW). The benefits of the Exploratory Works are unquantified but would be need to be valued at greater than \$280M (\$277M) for the benefits of the Project to outweigh the costs.

**Table 3.2 Costs and benefits of Exploratory Works to Australia and NSW (present value @ 7%)**

Costs	\$	Benefits	\$
<b>Market Impacts</b>			
Exploratory Works Construction	\$274M	Reduced direct construction costs of Snowy 2.0.	Unquantified
		Reduced delays of Snowy 2.0	Unquantified
		Avoiding investment in a potentially technically infeasible project.	Unquantified
		More accurate costing and business case of Snowy 2.0.	Unquantified
<b>Total Market Cost</b>	<b>\$274M</b>	<b>Total Market Benefit</b>	<b>Unquantified</b>
<b>Environmental, Social and Cultural Impacts</b>			
Groundwater impacts	No substantive impacts. \$280,000 of WALs required		
Surface water	No material impacts after mitigation and management. \$240,000 of WALs required.		
Terrestrial ecology	Clearing of 95 ha and non-significant impacts on five threatened species. Compensation to be provided - included in discounted capital costs above.		
Aquatic ecology	Minor area of key fish habitat disturbed. Non-significant impact to threatened fish species, localised and temporary. No material impacts.		
Construction noise	Minor temporary moderate exceedance at 1 receptor under adverse weather conditions. No material impacts.		
Construction vibration	No exceedance at human receptors. Some potential impacts on heritage items.		
Road traffic noise	No exceedances of noise criteria.		
Air quality	No exceedances of air quality criteria.		
Greenhouse gas generation	\$2,100 (\$670)		
Traffic	No impact on performance level of roads. Occasional delays when moving oversized equipment.		
Aboriginal heritage	21 Aboriginal stone artifact sites disturbed.		
Historic heritage	57 historic heritage sites directly impacted. 6 of these listed and of local significance. \$3.6M (\$1.2M) Compensation payment proposed.		
Recreation	Up to \$1.7M impact.		
<b>Total Environmental, Social and Cultural Costs</b>	<b>\$5.9M (\$3.4M)</b>		
<b>TOTAL COSTS</b>	<b>\$280M (\$277M)</b>	<b>TOTAL BENEFITS</b>	<b>Unquantified</b>

\* Impacts are initially valued from an Australian perspective. Where a different value occurs at a NSW level this is provided in brackets. Otherwise the Australian value is also relevant from a NSW perspective.

## 4 Impacts on the Regional Economy

### 4.1 Introduction

Snowy 2.0 will be located in the Snowy Monaro Regional local government area (LGA) and the Snowy Valleys LGA.

### 4.2 Characterisation of the region

Snowy Monaro Regional LGA comprises an area of 15,162 square kilometres (5,854 sq mi) and occupies the higher slopes of the eastern side of the Great Dividing Range between the Australian Capital Territory to the north and the state boundary with Victoria to the south. Towns<sup>44</sup> in the Snowy Monaro Regional LGA include :

- Cooma (6,379);
- Jindabyne (1,771);
- Bombala (1,197);
- Berridale (957);
- Adaminaby (210); and
- Nimmitabel (230).

The Snowy Valleys LGA comprises an area of 8,960 square kilometres (3,460 sq mi) and covers the western side of the southern-most portion of the Great Dividing Range and foothills in New South Wales. Large sections of the local government area are contained within national parks. The main towns of the LGA are:

- Tumut (6,154);
- Tumbarumba (1,484);
- Batlow (1,021); and
- Adelong (829).

An indication of the health of an economy can be gained from population changes. This theory of regional economic growth suggests that places that are able to attract population immigration create increased demand for goods and services and thus more jobs. This growth leads to increasing local multiplier effects, scale economies and an increase in the rate of innovation and capital availability (Sorensen, 1990). Conversely, population losses can contribute to a 'vicious cycle' of decline whereby reduced populations results in closure of services, which in turn makes it difficult to attract new populations (Sorensen 1990).

Trends in regional economies of NSW as a result of globalization and associated structural adjustment include:

- loss of significant industries such as abattoirs and timber mills from many rural areas;
- increased mechanisation of agriculture and aggregation of properties, resulting in loss of employment opportunities in this industry;
- growth of regional centres, at the expense of smaller towns;

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<sup>44</sup> Populations are in brackets.

- preference of Australians for coastal living, particularly for retirement; and
- preference of many of today's fastest growing industries for locating in large cities (Collits 2000).

The result is that there has been declining population in many rural LGAs that are located in non-coastal areas in NSW. There has also been a decline in the population of smaller towns even in regions where the population has been growing.

Against this backdrop, it is evident that the population of the Snowy Valleys LGA has been relatively static since 2006 while the Snowy Monaro Regional LGA has grown slightly. The total region has grown at a rate of 2.4% since 2006, less than that for NSW as a whole (14.2% between 2006 and 2016) and less than that for regional NSW.

**Table 4.1 Population growth**

	2006	2011	2016	Growth 2006 - 2016	Growth 2011 - 2016	Growth Rate 2006 - 2016
Snowy Valleys	14,335	14,292	14395	-0.3%	0.7%	0.4%
Snowy Monaro Regional	19,452	19,689	20216	1.2%	2.7%	3.9%
<b>Total Region</b>	<b>33,787</b>	<b>33,981</b>	<b>34,611</b>	<b>0.6%</b>	<b>1.9%</b>	<b>2.4%</b>
<b>New South Wales</b>	<b>6,549,177</b>	<b>6,917,658</b>	<b>7,480,228</b>	<b>5.6%</b>	<b>8.1%</b>	<b>14.2%</b>

Source: ABS Census of Population and Housing, Place of Usual Residence

The NSW Department of Planning and Environment's (DPE) population forecasts for the two LGAs are given in Table 4.2. This suggests declining population in the region post 2026. With small population growth in the region between 2016 and 2026 being driven by small population growth in the Snowy Monaro LGA.

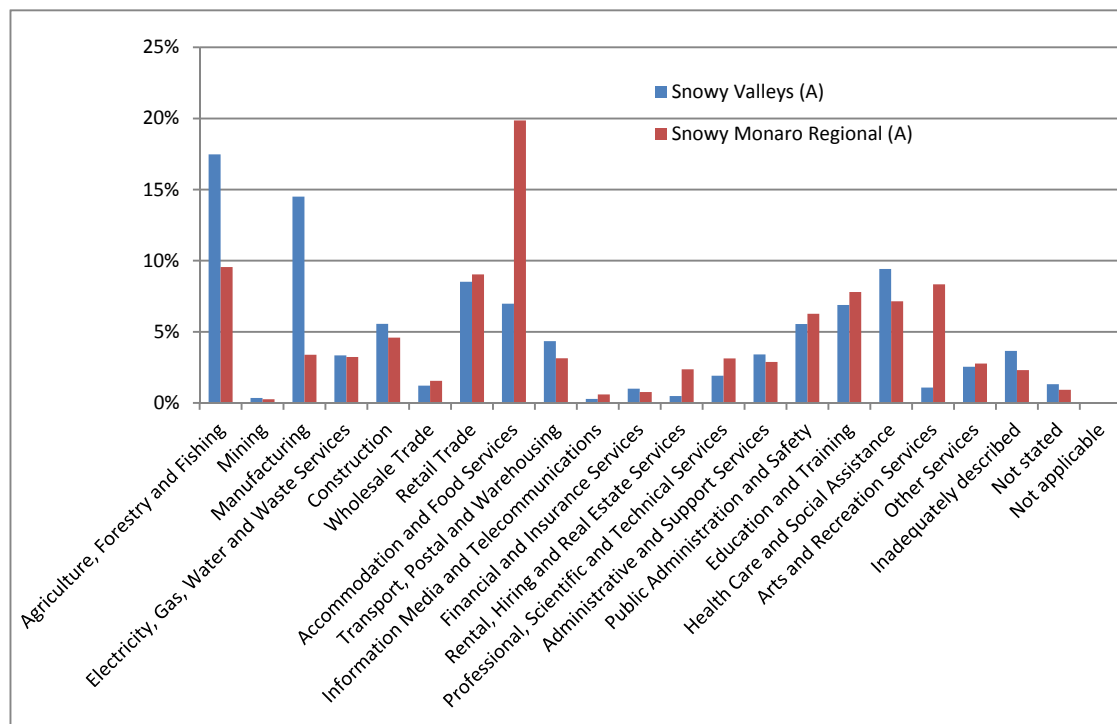
**Table 4.2 Population growth rate projections**

	2016 to 2021	2021 to 2026	2026 to 2031	2031 to 2036
Snowy Monaro	1.7%	1.2%	0.7%	0.2%
Snowy Valleys	-1.4%	-1.7%	-2.5%	-2.9%
<b>Total Region</b>	<b>0.4%</b>	<b>0.0%</b>	<b>-0.6%</b>	<b>-1.0%</b>

An indication of the nature of the economies can be gained by examining place of work employment by industry data for each of the LGAs - refer to Figure 4.1.

This indicates the significance of agriculture, forestry and fishing sector (predominantly beef cattle farming, sheep farming, fruit growing, forestry and logging), and manufacturing sector (timber and paper production manufacturing) to the Snowy Valleys LGA and the significance of accommodation and food services and retail trade sectors (reflecting the importance of tourism) and agriculture forestry and fishing (sheep and beef cattle farming) to the Snowy Monaro Regional LGA.

**Figure 4.1 Place of work employment by industry**



Source: ABS Census of Population and Housing, Place of Work.

## 4.3 Regional impacts

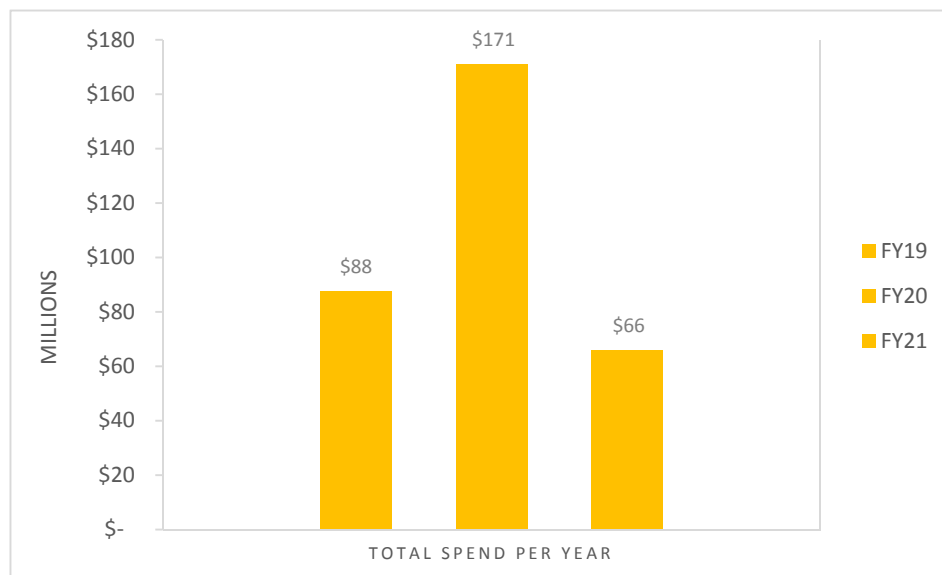
### 4.3.1 Introduction

The CBA in Section 3 is concerned with whether the incremental benefits of a project exceed the incremental costs, and therefore whether the community would, in aggregate, be better off 'with' the project compared to 'without' it. In contrast, the focus of the regional Economic Assessment is to assess the economic activity that a project will bring to a local economy.

The proposed Exploratory Works are estimated to cost \$325M (undiscounted) over a three year period - refer to Figure 4.2. Economic activity is associated with spending that is captured by the region rather than leaking outside the region to other economies. Expenditure from the Exploratory Works that can potentially be captured by the region within which it is located arise from:

- non-labour inputs; and
- expenditure of wages by labour.

**Figure 4.2** Capital costs of exploratory works over time



#### 4.3.2 Non-labour inputs

Non-labour inputs to Exploratory Works would include, but not be limited to, excavation and earthworks, buildings and sheds, reinforced concrete pipes, plant and equipment, concrete manufacturing, haulage and engineering services. These types of inputs are mainly from specialty manufacturing sectors, the heavy and civil engineering construction sector, road transport sector and from the professional, scientific and technical services sector. These types of sectors are poorly represented in the regional economy. Furthermore, the Exploratory Works will be undertaken by a large suitably qualified and experienced contracting company. The companies that undertake these types of developments frequently centralise their purchasing activities in capital cities, including overseas; tend to have an existing suite of suppliers that they have worked with before; and also often impose strict prequalification requirements which small to medium sized regional businesses find difficult and expensive to meet. Consequently, there is 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.

#### 4.3.3 Labour inputs

The project will require labour for:

- the initial construction of the accommodation camp - up to 10 months;
- construction of the Exploratory Works - 34 months; and
- operation of the accommodation camp - 34 months.

The impact of the provision of employment in the region arises from:

- the additional wages spent in the region; and
- the ability of the regional economy to produce and provide the goods and services demanded by households.

The level of additional wages that are spent in the region depends initially on how labour is sourced, which in turn depends on the location of labour that has the skills required for the Exploratory Works.

The labour for the Exploratory Works may potentially be sourced from:

- the local region either from:
  - the unemployment pool; or
  - workers from other industries;
- outside the region with labour:
  - moving into the region to live during the employment period; or
  - commuting from outside the region e.g. Fly-in-fly-out (FIFO) and Drive-in-drive-out (DIDO).

Whether local labour is sourced from the unemployment pool or from other industries within the region, it can increase the level of wages in the region. The existence of job chain<sup>5</sup> effects means that whether employment is filled directly from the unemployment pool or from workers in other industries, the additional wages that accrue to the region approximates the difference between the wages in the new job and unemployment benefits. To the extent that the job chain effects is only partial, the additional wages in the region will be less than this. However, to the extent that the job chain effects reaches all the way to new participants in the labour force, the additional wages in the region will be greater than this.

Where labour is sourced from outside the region and migrates into the region to live, the additional wages in the region is equivalent to the full wages of the job.

The impact of commuting workers depends on the extent to which they spend money in the regional economy. However, generally commuting workers will repatriate most of their wages back to their home region. Therefore, a commuting workforce will invariably have a large leakage of wage and salary income away from the region in which they are working.

Not all wages that accrue to labour in a region are spent in a region. The amount of wage spending that is captured by a region will depend on its economic structure and the ability to provide the goods and services demanded by people. Generally the smaller a region the greater the leakage of expenditure to other areas. Even where wages are spent in the region, unless goods are also manufactured in the region only the margins on sales will accrue to the region.

Notwithstanding, any additional local spending creates opportunities for businesses to expand and/or establish within the region so as to service the increased local demand. The opportunities that arise from additional local spending associated with wages are often more available to local regional businesses than are opportunities for providing non-labour inputs to major projects.

#### *4.3.4 Impact estimate*

To estimate the impact of the Exploratory Works on the regional economy the following assumptions were made:

- employment would ramp up over a 10 month period;

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<sup>5</sup> The job chain effect refers to the situation where labour is sourced from other industries in the region making jobs available in those industries which are subsequently filled by people either from the unemployment pool or other industries with the latter making jobs available in that industry, etc.



- once ramped up, there will be up to 201 workers for the Exploratory Works, which includes 20 which would operate the accommodation camp, for a period of 34 months;
- 23 jobs are sourced from the local labour force;
- 7 people migrate into the region with their families to live;
- 24 people stay in the region between swings and spend 25% of their wages in the region;
- remaining workers are FIFO/DID; and
- all FIFO/DIDO wages are repatriated to their home region.

Table 4.3 summarises the additional wages that initially accrue to the region assuming:

- an average wage of \$208,000 (based on the average wage in the Heavy and Civil Engineering Construction sector in the National Input-Output Table);
- Newstart allowance of \$14,000;
- labour sourced locally initially adds the difference between an average wage in the Heavy and Civil Engineering Construction sector and the Newstart allowance;
- labour immigrating into the region initially adds the wage in the Heavy and Civil Engineering Construction sector; and
- those staying the region between swings spend 25% of their wage in the region.

**Table 4.3 Potential additional annual wages accruing to the region**

Category of Labour Contributing Additional Wages to the Region	Employment No.	Additional Wages in Region
Labour sourced locally	23	\$4,461,798
Immigration with family	7	\$1,456,000
Stay in region between Swings	14	\$728,000
<b>Total</b>	<b>44</b>	<b>\$6,645,798</b>

Based on the ABS Household Expenditure Survey, Australia: Summary of Results, 2015–16 for the highest Quintile of Disposable Household Income, 57% of these wages (\$3,812,584) are available for expenditure on goods and services (i.e. after income tax and super etc). Based on the household sector in the input-output table developed for the region using the Generation of Regional Input-Output Tables (GRIT) procedure (refer to Attachment 4), 53% of the expenditure that is available for goods and services (\$2,030,024), would accrue to the regional economy with the remainder leaking outside the region.

Assuming an expenditure profile as per the household sector in the regional input-output table, the economic impact of the additional wage expenditure in the regional economy would be:

- \$2.92M in annual direct and indirect regional output;
- \$1.72M in annual direct and indirect value-added;
- \$0.65M in annual direct and indirect income; and
- 14 direct and indirect jobs.

Hence the direct jobs (23 sourced from the local region and 7 jobs to people who migrate into the region) and indirect jobs (from wage expenditures) (14) to residents in the local economy is estimated at 44.

These annual impacts would persist for almost three years.

**Table 4.4 Direct and indirect impact of additional wage expenditure in the region**

	<b>Direct Effect</b>	<b>Production Induced</b>	<b>Consumption Induced</b>	<b>Total Flow-on</b>	<b>TOTAL IMPACT</b>
<b>OUTPUT (\$M)</b>	2.03	0.46	0.42	0.89	2.92
<i>Type 11A Ratio</i>	<i>1.00</i>	<i>0.23</i>	<i>0.21</i>	<i>0.44</i>	<i>1.44</i>
<b>VALUE-ADDED (\$M)</b>	1.26	0.22	0.25	0.46	1.72
<i>Type 11A Ratio</i>	<i>1.00</i>	<i>0.17</i>	<i>0.20</i>	<i>0.37</i>	<i>1.37</i>
<b>INCOME (\$M)</b>	0.46	0.10	0.09	0.20	0.65
<i>Type 11A Ratio</i>	<i>1.00</i>	<i>0.23</i>	<i>0.21</i>	<i>0.44</i>	<i>1.44</i>
<b>EMPLOYMENT (No.)</b>	10	2	2	4	14
<i>Type 11A Ratio</i>	<i>1.00</i>	<i>0.16</i>	<i>0.20</i>	<i>0.35</i>	<i>1.35</i>

## 5 CONCLUSION

The Exploratory Works are a subcomponent of Snowy 2.0 and hence are associated with some of the potential cost and benefits of the overall Project. In particular, the Exploratory Works are associated with some of the Snowy 2.0 capital costs and some of the environmental, social and cultural impacts. These potential environmental, social and cultural impacts of the Exploratory Works are assessed in the EIS and discussed in this report in economic terms.

The potential market benefits identified for Snowy 2.0 do not arise from the Exploratory Works. It is only Snowy 2.0 together with transmission that provides these benefits. However, in economic efficiency terms the Exploratory Works play an important role in the design of Snowy 2.0 in particular the appropriate location for the underground power station. Economic benefits of undertaking the Exploratory Works relate to:

- reduced direct construction costs;
- reduced delays in construction;
- avoiding substantial investment in a technically infeasible project with the associated impacts; and
- more accurate costing of Snowy 2.0 and hence more accurate assessment of the businesses case and CBA of the Project.

To achieve these benefits of the Exploratory Works some environment, social and cultural impacts will be incurred.

Total costs including capital costs, compensation costs and environmental, social and cultural costs that were able to be valued, are estimated at \$280M (\$277M to NSW). The benefits of the Exploratory Works are unquantified but would be need to be valued at greater than \$280M (\$277M) for the benefits of the Project to outweigh the costs.

Snowy 2.0, and the Exploratory Works, will be located in the Snowy Monaro Regional LGA and the Snowy Valleys LGA. The proposed Exploratory Works are estimated to cost \$325M (undiscounted) over a three year period. Economic activity for the region from the Exploratory Works is associated with spending that is captured by the region rather than leaking outside the region to other economies. Expenditure from the Exploratory Works that can potentially be captured by the region within which it is located arise from:

- non-labour inputs; and
- expenditure of wages by labour.

Most economic activity in the region will be associated with the expenditure of wages by labour. The economic impact of the additional wage expenditure in the regional economy is estimated at:

- \$2.92M in annual direct and indirect regional output;
- \$1.72M in annual direct and indirect value-added;
- \$0.65M in annual direct and indirect income; and
- 14 direct and indirect jobs.

Hence the direct jobs (23 sourced from the local region and 7 jobs to people who migrate into the region) and indirect jobs (from wage expenditures) (14) to residents in the local economy is estimated at 44. These annual impacts would persist for almost three years.

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## ATTACHMENT 1 – LEGISLATIVE CONTEXT FOR ECONOMIC ANALYSIS IN EIA

### Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Regulation

- The basis for economic analysis under the *Environmental Planning and Assessment (EP&A) Act 1979* emanates from:
  - the definition of the term “environment” in the EP&A Act which is broad and includes the social and **economic** environment, as well as the biophysical environment;
  - the “objects” of the EP&A Act which includes “*promoting the social and **economic welfare** of the community*”; and
  - Clause 7(1)(f) of Schedule 2 of the EP&A Regulations which requires environmental assessment to provide “*the reasons **justifying** the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, **economic** and social considerations...*”
- Objects of promoting economic welfare and requirements to justify a project having regard to economic considerations are consistent with the use of CBA. A Note to Clause 7 (1) (f) states that “A cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure.”
- A cost benefit analysis is consistent with the consideration of the public interest, although the limitation of public interest to NSW households requires consideration of the costs and benefits to NSW households, whereas CBA would normally be undertaken at the National level.
- Elements of CBA can provide information on the economic impacts in the locality, although CBA should not be undertaken at the local level. This can be supplemented by other forms of analysis to examine economic impacts in the locality such as the consideration of:
  - effects relating to local employment;
  - effects relating to non-labour project expenditure; and
  - environmental and social impacts on the local community.

### Secretary's Environmental Assessment Requirements

- The Project SEARs include a requirement for:
  - an assessment of the social and economic impacts and benefits of the project for the region and the State as a whole, including consideration of any increase in demand for community infrastructure and services.

### **Other Economic Guidelines**

- In 2015 the NSW Government prepared *Guidelines for the economic assessment of mining and coal seam gas proposals*. This provides an outline of how to undertake a CBA and local effects analysis of mining and coal seam gas proposals but has wider ramifications for other projects.
- NSW Treasury (2017) *NSW Government Guide to Cost Benefit Analysis*, provides guidance for Government agencies on how to undertake CBA of significant spending proposals, including proposed capital works, projects and new programs across all public sector agencies. However, many of the principles have broader application.



## ATTACHMENT 2 – INTRODUCTION TO ECONOMIC METHODS

### Cost Benefit Analysis

- Cost Benefit Analysis (CBA) is the primary way that economists evaluate projects and policies.
- CBA evaluates whether the well-being (**economic welfare**) of the community is in aggregate improved by a project. It does this by comparing the costs and benefits of a project to the community.
- The community whose welfare is included is broadly defined as anyone who bears significant costs and benefits of a project. However, in practice most CBA is undertaken at a national level. CBA at a sub-national level is not recommended however if undertaken at this level should provide decision-makers with estimates of all significant effects, including those to non-residents of the sub-national region.
- It is not possible to justify a project on economic grounds without doing a CBA.

### Economic Activity Analysis

- Economists also often provide information to decision-makers on the **economic activity** that a project will provide to the regional, state or national economy. This is particularly relevant at the regional level since many regions and towns are experiencing long term decline as a result of structural change in the economy. Additional economic activity can help the prosperity of these regions.
- **Direct** economic activity provided by a project can be estimated from financial and labour estimates for a project. Methods that can be used to estimate **direct** and **indirect** economic activity include IO analysis and CGE modelling. Refer to Attachment 3 for a comparison of these methods and their assumptions.
- While economic activity measures from IO analysis and CGE modelling e.g. direct and indirect output, value-added and income, are generally not measures of benefits and costs relevant to a CBA this information can be of interest to decision-makers<sup>6</sup>.

### Economic Analysis and Decision-Making

- CBA and local effects analysis (including IO/CGE analysis) are not mechanised decision-making tools, but rather means of analysis that provide useful information to decision-makers.
- Decision-making is multi-dimensional. CBA is concerned with the single objective of **economic efficiency** (economic welfare) while IO analysis and CGE are concerned with the objective of **economic activity** (growth). They do not address equity and other objectives of government. Decision-makers therefore need to consider the economic efficiency and economic activity

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<sup>6</sup> It should be noted that it is possible to analyse industry benefits and costs within a general equilibrium framework where impacts are of a sufficient scale that they flow through into multiple sectors in the economy. However, for individual projects a partial equilibrium framework is the preferred approach for the estimation of costs and benefits (US EPA (2010) Guidelines for Preparing Economic Analyses, US EPA).

implications of a project, as indicated by CBA and IO/CGE analysis respectively, alongside the performance of a project in meeting other, often conflicting, government goals and objectives.

## ATTACHMENT 3 – INPUT-OUTPUT ANALYSIS AND COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

### Input-Output Analysis

- IO analysis is a cost effective and simple method for estimating the gross market economic activity i.e. financial transactions and employment, in a specified region that is associated with a project.
- IO analysis is the most widely used model for regional impact assessment (West and Jackson 2005).
- IO analysis can be undertaken at the LGA or aggregation of LGAs level.
- IO analysis can provide disaggregation of economic activity impacts across many sectors – 111 sectors based on current National IO tables.
- IO analysis was developed by Wassily Leontief for which he received the Nobel Prize in Economics.
- IO analysis is a static analysis that looks at economic activity impacts in a particular year e.g. a typical year of a projects operation.
- IO analysis has historically been applied at the regional level to assess the economic activity impacts of individual projects.
- IO analysis involves the development of an IO table representing the buying and selling of goods and services in the economy. These fixed average ratios are used to estimate the direct and indirect impacts of a change in expenditure in a region.
- IO analysis identifies the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of a number of indicators of economic activity – output, income, value-added<sup>7</sup> and employment.
- Economic activity measures used in IO are not measures of benefits and costs relevant to a BCA.
- IO analysis does not attempt to examine non-market environmental, social or cultural impacts.
- IO analysis does not depend on the assumption *“that there is a ghost pool of highly skilled yet unemployed people”* in a region as suggested by a Land and Environment Court Judgement.
- The estimation of economic activity impacts in IO analysis are based on a number of simplifying assumptions – most notable is that the regional economy has **access to** sufficient labour and capital resources (from both **inside** and **outside** the region) so that an individual project does not result in any regional price changes e.g. wages in other industries or house rentals, which would lead to contractions (“crowding out”) of economic activity in other sectors in the region.
- For the assessment of the impacts of individual projects on small open regional economies, this is a reasonable assumption.
- Nevertheless, the results of IO modelling can be seen as representing an upper bound for the net economic activity associated with a project.

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<sup>7</sup> Value-added is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output.



## Computable General Equilibrium Modelling

- CGE modelling is an alternative more expensive, complicated but theoretically more sophisticated method for estimating the economic activity associated with a project.
- CGE modelling can be dynamic or comparative static<sup>8</sup> and has historically been applied at the State and National level for determining the potential economic activity associated with the introduction of major government policy changes and investment in large infrastructure projects.
- CGE modelling can also be undertaken at a regional level but normally at no finer scale than the Statistical Subdivision level.
- CGE modelling estimates the additional net (positive and negative) economic activity associated with a project in terms of a number of economic indicators – including value-added and employment – but also real income, government tax revenue and components of value-added.
- Economic activity measures used in CGE modelling are not generally measures of benefits and costs relevant to a BCA, although CGE modelling can also be used to estimate market costs or market benefits, as part of a BCA, where the magnitude of a project will affect a large number of sectors and the effects will be spread more broadly throughout the economy.
- Economic activity impacts can be disaggregated by sector but this is not normally as disaggregated as in IO analysis.
- CGE modelling does not attempt to examine non-market environmental, social or cultural impacts.
- CGE modelling is underpinned by an IO database as well as a system of interdependent behaviour and accounting equations which are based on economic theory (but mostly without econometric backing at the regional level).
- The equations in CGE models ensure that any change in demand in a region, no matter how small, translates into some change in prices and hence there is always some 'crowding out' of other economic activity in the region.
- At the regional level, CGE results can be very sensitive to changes in these behavioural assumptions.
- 'Crowding out' of other economic activities estimated via CGE modelling does not reflect losses of jobs but the shifting of labour resources to higher valued economic activities.

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<sup>8</sup> Comparative static models compare one equilibrium point with another but do not trace the impact path along the way. Dynamic models give year by year impacts of a shock.

## **ATTACHMENT 4 – THE GRIT SYSTEM FOR GENERATING INPUT-OUTPUT TABLES**

The Generation of Regional Input-Output Tables (GRIT) system was designed to:

- combine the benefits of survey based tables (accuracy and understanding of the economic structure) with those of non-survey tables (speed and low cost);
- enable the tables to be compiled from other recently compiled tables;
- allow tables to be constructed for any region for which certain minimum amounts of data were available;
- develop regional tables from national tables using available region-specific data;
- produce tables consistent with the national tables in terms of sector classification and accounting conventions;
- proceed in a number of clearly defined stages; and
- provide for the possibility of ready updates of the tables.

The resultant GRIT procedure has a number of well-defined steps. Of particular significance are those that involve the analyst incorporating region-specific data and information specific to the objectives of the study. The analyst has to be satisfied about the accuracy of the information used for the important sectors; in this case the other mining sector. The method allows the analyst to allocate available research resources to improving the data for those sectors of the economy that are most important for the study.

An important characteristic of GRIT-produced tables relates to their accuracy. In the past, survey-based tables involved gathering data for every cell in the table, thereby building up a table with considerable accuracy. A fundamental principle of the GRIT method is that not all cells in the table are equally important. Some are not important because they are of very small value and, therefore, have no possibility of having a significant effect on the estimates of multipliers and economic impacts. Others are not important because of the lack of linkages that relate to the particular sectors that are being studied. Therefore, the GRIT procedure involves determining those sectors and, in some cases, cells that are of particular significance for the analysis. These represent the main targets for the allocation of research resources in data gathering. For the remainder of the table, the aim is for it to be 'holistically' accurate (Jensen, 1980). This means a generally accurate representation of the economy is provided by the table, but does not guarantee the accuracy of any particular cell. A summary of the steps involved in the GRIT process is shown in Table A4.1 (Powell and Chalmers, 1995).

**Table A4.1**  
**The GRIT Method**

Phase	Step	Action
PHASE I		ADJUSTMENTS TO NATIONAL TABLE
	1	Selection of national input-output table (106-sector table with direct allocation of all imports, in basic values).
	2	Adjustment of national table for updating.
	3	Adjustment for international trade.
PHASE II		ADJUSTMENTS FOR REGIONAL IMPORTS (Steps 4-14 apply to each region for which input-output tables are required)
	4	Calculation of 'non-existent' sectors.
	5	Calculation of remaining imports.
PHASE III		DEFINITION OF REGIONAL SECTORS
	6	Insertion of disaggregated superior data.
	7	Aggregation of sectors.
	8	Insertion of aggregated superior data.
PHASE IV		DERIVATION OF PROTOTYPE TRANSACTIONS TABLES
	9	Derivation of transactions values.
	10	Adjustments to complete the prototype tables.
	11	Derivation of inverses and multipliers for prototype tables.
PHASE V		DERIVATION OF FINAL TRANSACTIONS TABLES
	12	Final superior data insertions and other adjustments.
	13	Derivation of final transactions tables.
	14	Derivation of inverses and multipliers for final tables.

Source: Bayne and West (1988).

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