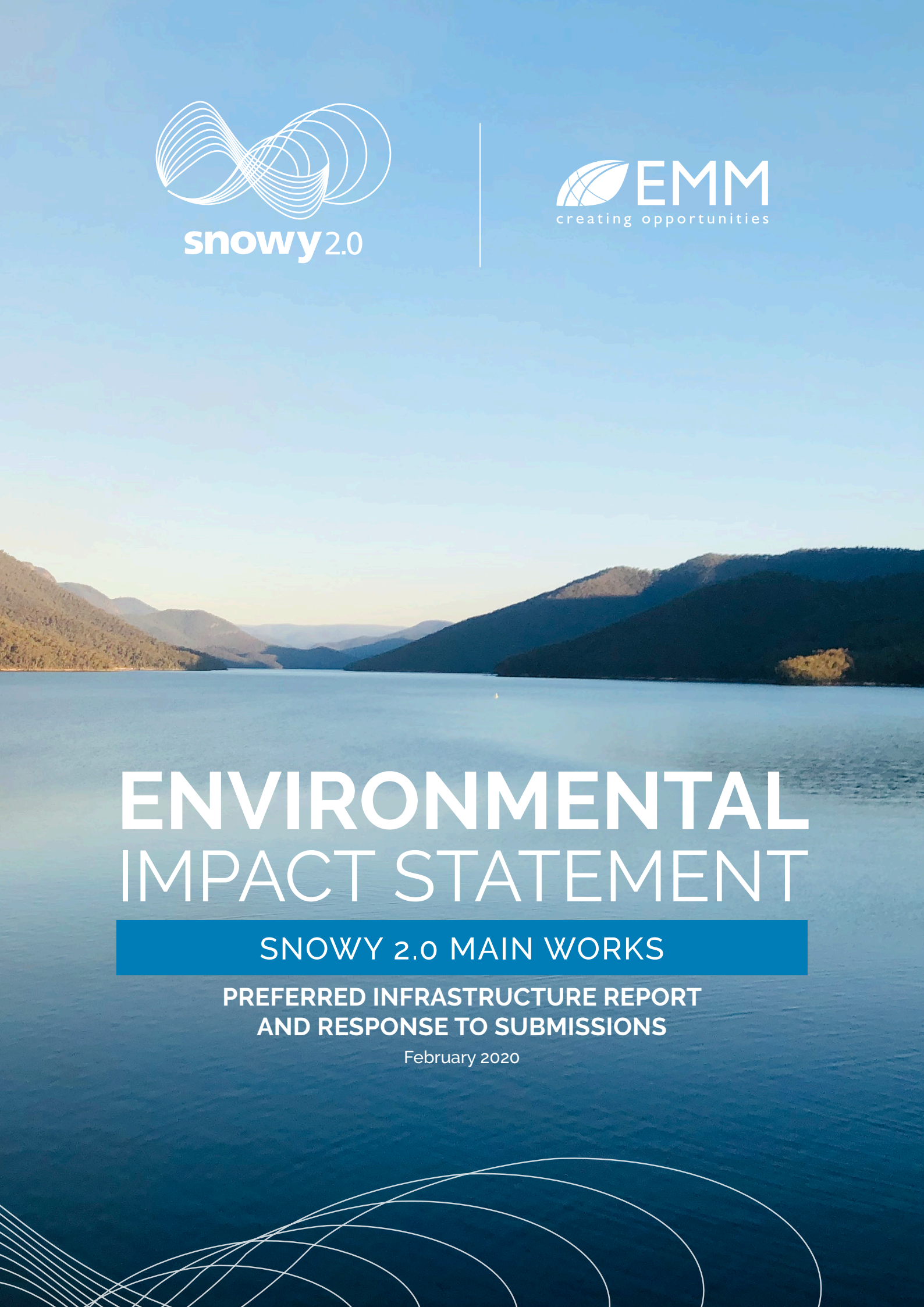

snowy 2.0

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ENVIRONMENTAL IMPACT STATEMENT

SNOWY 2.0 MAIN WORKS

PREFERRED INFRASTRUCTURE REPORT AND RESPONSE TO SUBMISSIONS

February 2020

VOLUME 1

APPENDICES

Main Works Preferred Infrastructure Report and Response to Submissions

Report Number

J17188 RP105

Client

Snowy Hydro Limited

Date

28 February 2020

Version

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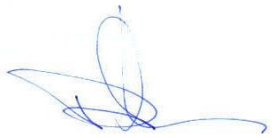
Prepared by	**Approved by**
	
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CHAPTER 1

INTRODUCTION

1 Introduction

1.1 Overview

Snowy Hydro Limited (Snowy Hydro) owns and operates the Snowy Mountains Hydro-electric Scheme (Snowy Scheme), a large and complex water storage and diversion scheme in the Australian Alps within Kosciuszko National Park (KNP) in southern New South Wales (NSW). Snowy Hydro is the proponent for Snowy 2.0, an expansion of the Snowy Scheme that will increase its generation capacity by almost 50%, providing an additional 2,000 megawatts (MW) generating capacity, and making approximately 350,000 megawatt hours (MWh) (175 hours of energy storage) available to the National Electricity Market (NEM).

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

Snowy Hydro acknowledges that on 4 January 2020, bushfire swept through the northern section of KNP, directly impacting parts of the Main Works project area. The bushfires do not change the environmental assessment outcomes described in the Main Works environmental impact statement (EIS), however, at a time of so much devastation, Snowy 2.0's social and economic contribution to the region will be pivotal, as the project is a critical part of the rebuilding efforts across the region.

1.2 Assessment process

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

Snowy 2.0 Main Works (the project) refers to the application for the construction and operation of Snowy 2.0. As a CSSI project, Snowy 2.0 Main Works is subject to Part 5, Division 5.2 of the EP&A Act which requires the preparation of an EIS in accordance with Secretary's Environmental Assessment Requirements (SEARs) and the approval of the NSW Minister for Planning and Public Spaces. In addition to requiring approval from the NSW Minister for Planning and Public Spaces, Snowy 2.0 Main Works has been deemed a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and requires approval from the Commonwealth Minister for the Environment. The Minister for the Environment has accredited the NSW planning process for the assessment of Snowy 2.0 Main Works.

A single EIS was prepared to address the requirements set out by the NSW Department of Planning, Industry and Environment (DPIE) and the Commonwealth Department of the Environment and Energy (DEE). In accordance with the EP&A Act and *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation), the EIS was placed on public exhibition for a period of 42 days, between 26 September 2019 and 6 November 2019. A digital EIS summary (https://www.emmdigital.com.au/Snowy2.0MainWorksSummary) was established to provide the community with the Main Works EIS Summary report and an interactive map of the project.

A total of 201 submissions were received during the public exhibition period, including 30 from special interest groups and 161 individual community submitters. In addition, ten submissions were received from State government agencies and councils. Of the 201 submissions, 5% were in support of the Main Works, 73% objected to the works, and the remaining submissions provided comments (22%). A detailed analysis of matters raised in the submissions is set out in Chapter 2.

1.3 Snowy 2.0 Main Works

1.3.1 Key elements of the exhibited project

The key elements of the exhibited project include permanent infrastructure needed to operate Snowy 2.0 including water intakes, power waterway, underground power station and other important elements. A series of temporary construction elements are needed to support building of this permanent infrastructure. A summary of Snowy 2.0 Main Works as exhibited in the EIS is reproduced in Table 1.1.

Table 1.1 Snowy 2.0 Main Works EIS summary

Project element	Summary of the project
Project area	The project area is the broader region within which Snowy 2.0 will be built and operated, and the extent within which direct impacts from Snowy 2.0 Main Works are anticipated.
Permanent infrastructure	Snowy 2.0 infrastructure to be built and operated for the life of the assets include the: • intake and gate structures and surface buildings at Tantangara and Talbingo reservoirs; • power waterway tunnels primarily comprising the headrace tunnel, headrace surge structure, inclined pressure tunnel, pressure pipelines, tailrace surge tank and tailrace tunnel; • underground power station complex comprising the machine hall, transformer hall, ventilation shaft and minor connecting tunnels; • access tunnels (and tunnel portals) to the underground power station comprising the main access tunnel (MAT) and emergency, cable and ventilation tunnel (ECVT); • fish control structures in proximity to Tantangara Reservoir wall; • establishment of a portal building and helipad at the MAT portal; • communication, water and power supply including the continued use of the Lobs Hole substation; • cable yard adjacent to the ECVT portal to facilitate the connection of Snowy 2.0 to the NEM; and • access roads, permanent bridge structures and barge launch ramps needed for the operation and maintenance of Snowy 2.0 infrastructure.
Temporary infrastructure	Temporary infrastructure required during the construction phase of Snowy 2.0 Main Works are: • construction compounds, laydown, ancillary facilities and helipads; • accommodation camps for construction workforce; • construction portals and adits to facilitate tunnelling activities; • barge launch ramps; • water and wastewater management infrastructure (treatment plants and pipelines); • communication and power supply; and • temporary access roads.
Disturbance area	The disturbance area is the extent of construction works required to build Snowy 2.0. The maximum disturbance area is about 1,680 ha which is approximately 0.25% of the KNP. Most of the disturbance area will be rehabilitated and landformed and other parts will be retained permanently for operation (operational footprint).
Operational footprint	The operational footprint is the area required for permanent infrastructure to operate Snowy 2.0. The maximum operational footprint is about 99 ha which is approximately 0.01% of the KNP.
Tunnelling and excavation method	The primary tunnelling method for the power waterway is by TBM, with portals and adits using drill and blast methods. Excavation for other underground caverns, chambers and shafts will be via combinations of drill and blast, blind sink, or raise bore techniques.

Table 1.1 Snowy 2.0 Main Works EIS summary

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

1.3.2 Key refinements since public exhibition

Snowy Hydro and its appointed engineer, procure and construct (EPC) contractor, Future Generation Joint Venture (FGJV), continue to refine and improve the design for Snowy 2.0 as information is obtained from the geotechnical investigation program and Exploratory Works. In addition, matters raised by agencies and stakeholders during public exhibition of the Main Works EIS has necessitated refinements to key elements of the project. These are described in more detail in Section 3.2, however include:

- Considerable refinement of the disturbance area, which has reduced the overall disturbance area by 62% and therefore improved the project outcomes compared to previously predicted impacts in the EIS. As a consequence of the detailed design not yet being complete (as is normal for a major project at this stage of the process), the new concept of a larger “construction envelope” has been introduced and used in this report. The construction envelope represents the limits of where disturbance may occur during construction of the Main Works. The disturbance area is a smaller indicative corridor inside the construction envelope. As detailed design continues, final siting of the infrastructure (ie the disturbance area) can move within the assessed construction envelope subject to recommended environmental management measures and provided it does not exceed the limits defined by the construction envelope.

- Revised design and methodology for excavated material management. This has resulted in some key improvements including a reduction in the total volumes of excavated rock, improved water quality outcomes, significant improvements to the final landforms of on-land emplacement areas via the use of a geomorphic approach to landform design and rehabilitation, and commitment to remove material generated from Marica to a location outside the KNP which was identified in the EIS as an area to be used for works associated with the Main Works.

- Reduced traffic volumes, which has improved the performance of the local and regional road network compared to previously predicted impacts.

- Refinement of the groundwater model to better represent the inflow mitigation that will occur from the segmental concrete lining of the power waterway. The refinement of the model to reflect this inflow restriction has reduced the quantity of groundwater predicted to flow into the excavated headrace tunnel across the plateau. This has reduced the predicted water table drawdown extents and interactions with bogs and fens, reduced streamflow impacts and reduced the quantity of process water to be discharged to Tantangara Reservoir.

Since the exhibition of the Main Works EIS, DPIE has requested that Snowy Hydro consider alternative options for management of excavated rock.

As a result, a preferred excavated rock management strategy is proposed in this preferred infrastructure report and response to submissions (PIR-RTS). The proposed changes compared to that articulated in the Main Works EIS and the revised design and methodology, are provided in Section 3.2.2 of this report.

An updated project description that consolidates the refinements made to the project since exhibition is provided in Appendix O.

1.3.3 Technical assessments

Where relevant, the refinements to the project listed in Chapter 3 (see Table 3.1) and their residual impacts have been assessed. These technical assessments are provided within this PIR-RTS (refer to Appendices) and information included in responses to submissions (see Chapter 4) where required.

However, the Biodiversity Development Assessment Report (BDAR) and Water Management Report (WMR) provided in Appendix G and J, respectively, comprise revised assessments of the indicative disturbance area within the construction envelope but do not include the preferred excavated rock emplacement areas at Ravine Bay, GF01 and Peninsula (Tantangara).

A preliminary assessment of these emplacement areas has been included in Section 3.2.2 of this document. Both the BDAR and WMR will be updated to include these areas subsequent to the lodgement of this PIR-RTS.

1.4 Purpose of this report

The purpose of the PIR-RTS is to:

- describe refinements made to the project since exhibition of the Main Works EIS, including additional assessment and management measures supporting those refinements;

- describe refinements made to the design and methodology for excavated rock management, including a description of alternative excavated rock management options considered compared to the proposal outlined in the Main Works EIS, as requested by DPIE; and

- assist DPIE and the Minister for Planning and Public Spaces in their assessment of the project.

CHAPTER 2

ANALYSIS OF SUBMISSIONS

2 Analysis of submissions

2.1 Submissions received

The Main Works EIS was placed on exhibition for a period of 42 days between 26 September 2019 and 6 November 2019.

The Main Works EIS was available online at the DPIE NSW Planning Portal (https://www.planningportal.nsw.gov.au/major-projects/project/12891). A digital EIS summary (https://emmdigital.com.au/Snowy2.0MainWorksSummary/index.html) was established to provide the community with the Main Works EIS Summary report and an interactive map of the project. This link was also provided at DPIE NSW Planning Portal for Snowy 2.0 Main Works.

During the exhibition period printed copies of the Main Works EIS documents were provided at the following locations:

- Cooma:
  - Snowy Monaro Regional Council (81 Commissioner Street, Cooma);
  - Snowy Monaro Regional Library (119 Sharp Street, Cooma);
- Talbingo:
  - Talbingo Supermarket (49 Lampe Street, Talbingo); and
- Tumut:
  - Snowy Valleys Council (76 Capper Street, Tumut).

A total of 201 submissions were received by DPIE at the completion of the exhibition period. Submissions were received from government agencies and local council, special interest groups and community members. Each submission is available on the DPIE NSW Planning Portal. A breakdown of the submissions received is provided in Table 2.1. Of the total submissions, 64 were considered form letters.

Table 2.1 Summary of submissions received

Source/type	Object	Support	Comment	Total
Community – individual	130	9	22	161
Special interest group	16	1	13	30
Government agency or local council	-	1	9	10
Total	**146**	**11**	**44**	**201**

2.1.1 Types of submitters

Community members were the majority submitter type (80% of all submissions were made by community members), with a mix of individual submissions and form letters (made available by NSW National Parks Association for community members). Form letters equated to approximately 38% of all community submissions.

The following special interest groups provided submissions:

- National Parks Association of NSW (NPA);
- Tamworth Namoi Branch, National Parks Association of NSW
- National Parks Association of the ACT;
- National Parks Australia Council;
- Colong Foundation for Wilderness;
- Nature Conservation Council;
- Nature Conservation Society of South Australia;
- Friends of Grasslands;
- Australian Wildlife Society;
- Monaro Acclimatisation Society Inc;
- Ryde Gladesville Climate Change Action Group;
- STEP Inc;
- Australian Association of Bush Regenerators;
- Ampcontrol;
- Cochran Horse Treks;
- Illawarra Horse Trail Riders;
- Reynella Rides;
- Centre for Applied Water Science, University of Canberra;
- Snowy River Alliance;
- Upper Murrumbidgee Demonstration Reach;
- Inland Rivers Network;
- Australian Society for Fish Biology;
- Queanbeyan Anglers Club;
- David G Stead Memorial Wild Life Research Foundation of Australia;
- Gippsland Environment Group Inc;
- Australian Brumby Board Inc;
- Snowy Mountains Bush Users Group;
- Friends of Currango;
- Oatley Flora and Fauna Conservation Society; and
- Kosciuszko Huts Association.

The following NSW Government agencies and local councils provided submissions:

- NSW Environment Protection Authority;
- NSW DPIE:
  - Environment, Energy and Science (EES) Group of DPIE;
  - Water and NSW Natural Resource Regulator;
  - Division of Resources and Geoscience;
- NSW Department of Industry;
- NSW Department of Primary Industries Fisheries;
- Heritage Council of NSW;
- NSW Roads and Maritime Services;
- Office of the Commissioner for Sustainability and the Environment;
- ACT Conservator of Flora and Fauna; and
- Snowy Monaro Regional Council.

2.1.2 Location of submitters

The type and location of submitters is presented in Figure 2.1. Local submitters (those within either the Snowy Monaro Regional or Snowy Valleys LGA) comprised about 25% of all submissions. All other submissions were made by community and special interest groups located in all other LGAs, nationally.

Local submitters generally provided comment (43%) or opposed the project (49%), with a small number of submitters providing support (8%).

2.2 Issues raised in submissions

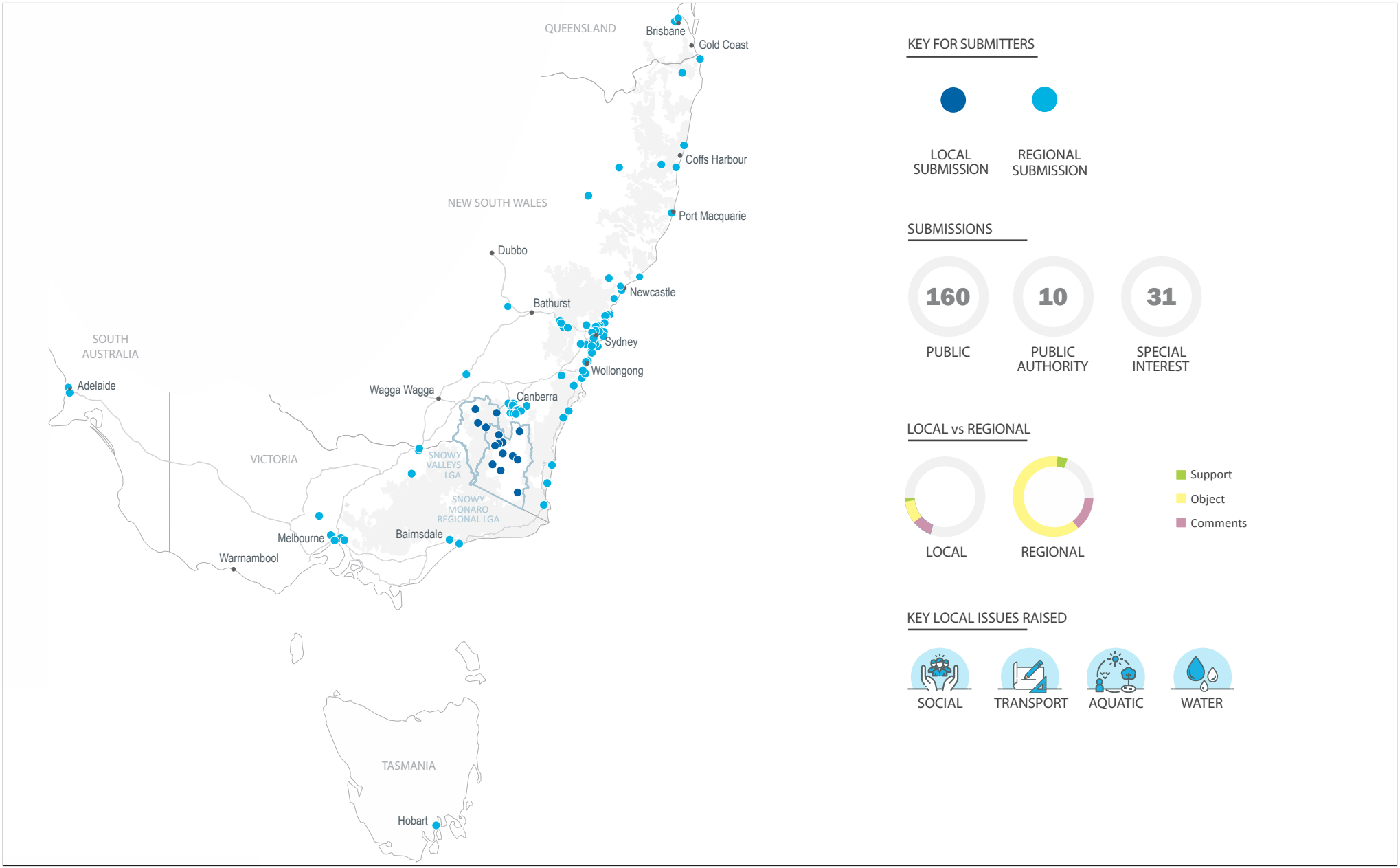
This section provides details of the issues raised in the submissions received.

2.2.1 Response methodology

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

- community and special interest group;
- individual community member; and
- council and State government agencies.

The submissions were reviewed, and the key matters raised in each submission identified. To ensure a structured approach to responding to the submissions, each matter raised was grouped by category and then sub-category. These categories and sub-categories were determined through consideration of key issues and topics raised and with respect to the Draft EIA Guidance Series for *Responding to Submissions* (DPE 2017). The categories and sub-categories identified through the review of key matters are provided in Table 2.2 below.



Map of submitters
Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 2.1

Table 2.2 Themes identified to categorise submissions

Category	Sub-categories / matters raised	
Need and justification of the project (Merits)	• Strategic need and justification (energy market) • Ecologically sustainable development • Options and alternatives	• Impacts to KNP • Cumulative impacts
Project design	• Infrastructure and design • Disturbance footprint • Excavated rock management	• Operations • Rehabilitation • Rock Forest
Environmental assessment and approvals process (Process)	• Approval process and compliance • Level or quality of stakeholder engagement • Adequacy of EIS / assessment documentation	• Biosecurity legislation
Economic	• Economic benefits • Project costs and investment	
Terrestrial ecology	• Adequacy of assessment / survey • Impacts to native vegetation and threatened species • Bogs and fens / GDEs	• Weed and pest management • Monitoring and management • General / ecosystem impacts
Aquatic ecology	• Adequacy of assessment / survey • Fish transfer / biosecurity • Protection of threatened or endangered species	• Fish populations • Monitoring and management • General / ecosystem impacts
Land	• Geodiversity • Contamination • Landforms within KNP	
Water	• Adequacy of assessment / modelling • Site water management • Downstream flows and releases (incl licensing) • Subaqueous placement / reservoir impacts	• Groundwater drawdown impacts • Rivers and streams WQ • Risk to ecosystems • Monitoring and management
Heritage	• Adequacy of assessment / survey • Engagement with Aboriginal groups • Significant places	• Avoidance, mitigation and management
Transport	• Road upgrades and maintenance • Public safety • Traffic movements	
Social	• Business impacts • Accommodation and housing • Public access to KNP recreational areas	• Recreational impacts (incl fishing) • Campgrounds • Closure of Tantangara Road
Amenity	• General amenity impacts • Noise specific impacts • Landscape and visual specific impacts	

Table 2.2 Themes identified to categorise submissions

Category	Sub-categories / matters raised	
Other matters (Other)	• Air quality • Hazards and risk • Waste	• Climate change
Long term management actions (Mitigation)	• Offsets agreement • Committed funding • Construction environmental management	• Research and innovation
Issues beyond the scope of the project (Beyond scope)	• NPWS management (brumbies etc) • Other	

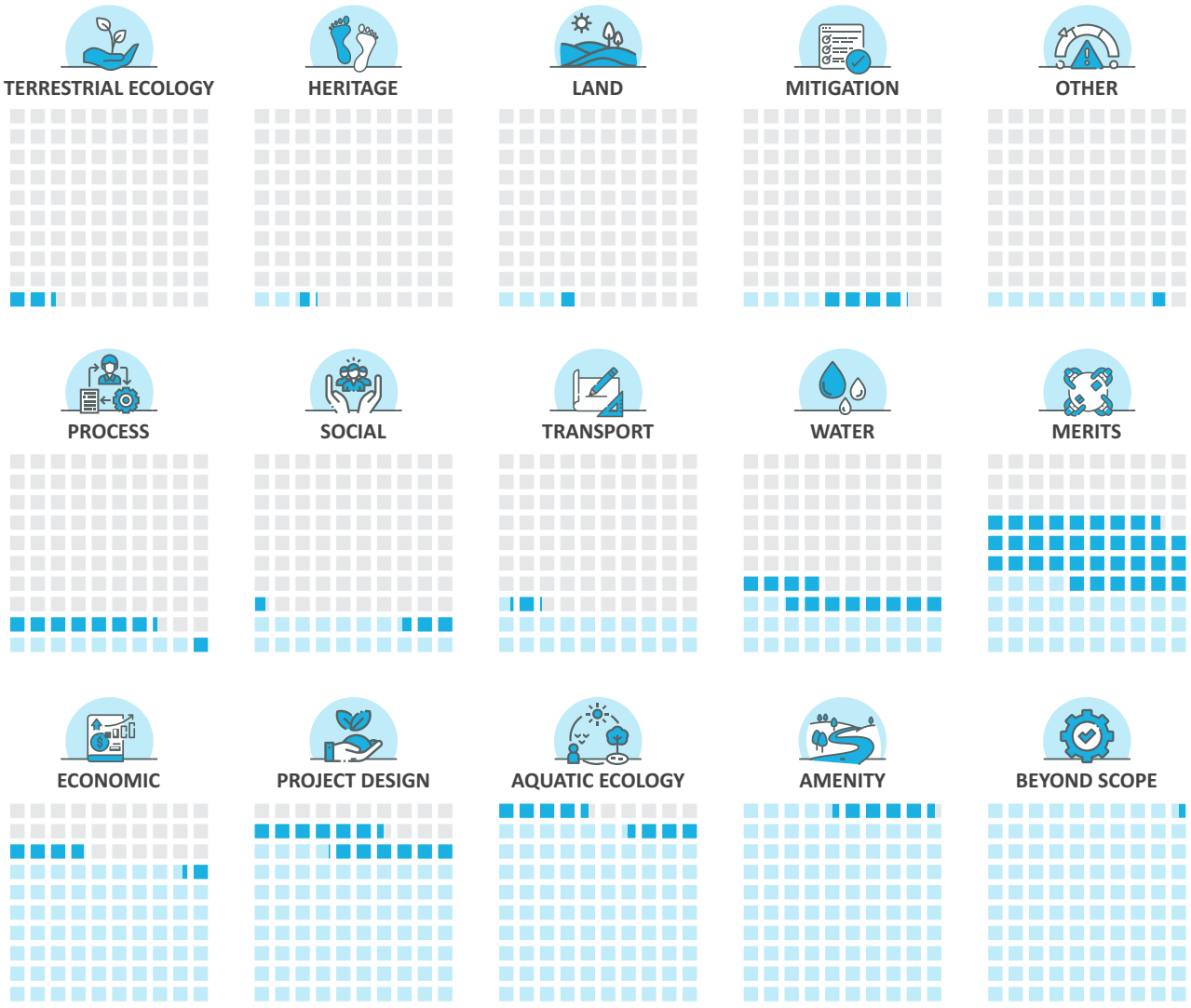
Responses were prepared to each matter, with input from technical specialists who prepared the relevant impact assessment for the EIS. These responses are provided in Chapter 4. The study team was the same team that prepared the EIS.

2.2.2 Summary of matters raised

The frequency of categories raised in the submissions are summarised and shown comparatively in Figure 2.2. The share of overall submissions for each category is shown in dark blue, with an accumulative count shown in light blue.

As can be seen, the key categories for which most submissions provided support, comment or objection were:

- need and justification of the project (merits);
- project design;
- environmental assessment and approvals process (process);
- water;
- aquatic ecology; and
- economics.



Frequency of themes raised in submissions
Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 2.2

Of these categories, the key issues (sub-categories) raised in submission are listed in order of the percentage of submitters raising this issue:

1. impacts to KNP (merits) – raised in 67% of submissions;
2. options and alternatives (merits) – raised in 57% of submissions;
3. strategic need and justification for the project (merits) – raised in 54% of submissions;
4. biosecurity / fish transfer (aquatic) – raised in 50% of submissions;
5. disturbance footprint (project design) – raised in 44% of submissions;
6. project cost and investment (economics) – raised in 44% of submissions;
7. groundwater drawdown impacts (water) – raised in 42% of submissions; and
8. approval process and compliance (process) – raised in 39% of submissions.

Submissions identifying support for the project commented on the benefits of the project in terms of renewable energy to replace reliance on fossil fuels, as well as local business and regional economic opportunities.

The issues raised by community members locally and nationally were generally similar and aligned. However, the differences include:

- Local community expressed greater comparative focus on:
  - biosecurity concerns with fish transfer from Talbingo Reservoir to Tantangara Reservoir;
  - social issues in particular recreational impacts and the closure of Tantangara Road; and
  - traffic and public safety.
- Broader community nationally expressed greater comparative focus on:
  - overall merits of the project with regard to strategic need, project costs and impact to KNP; and
  - groundwater drawdown impacts on ecosystems at the surface.

CHAPTER 3

PREFERRED INFRASTRUCTURE REPORT

3 Preferred infrastructure report

3.1 Overview of actions taken since exhibition

An overview of the key actions taken since exhibition are summarised in Table 3.1. These are further detailed in the following sections of this chapter and in Chapter 4 (Response to submissions). An updated project description that consolidates the design and methodology refinements made to the project since exhibition is provided in Appendix O.

Table 3.1 Overview of key actions taken since exhibition

Area	Design refinements and consultation	Additional impact assessment
Talbingo Reservoir	• Snowy Hydro has investigated a potential alternative excavated rock placement location and activities in response to requests from key government agencies (DPIE, EPA, NPWS). The preferred strategy will lead to improved water quality outcomes compared to the excavated rock placement proposal described in the Main Works EIS. • Talbingo TBM will either be launched via the adit as presented within the MW EIS, or via the Talbingo Intake structure. Launching through the intake would result in a reduction in the length and diameter of the access adit which will still be required for servicing of the TBM.	Water management report – Appendix J BDAR – Appendix G
Lobs Hole	• An additional excavated rock placement location is proposed (GF01), with final landforming as per preferred excavated rock placement strategy. • Improved final landform design for infrastructure pads within Lobs Hole in consultation with NPWS and DPIE. • Optimisation of configuration of tunnels adjacent to underground power station. • Temporary placement of excavated (soil) material for use in final landforming and rehabilitation. • Construction and use of temporary power and additional fuel storage within the disturbance footprint.	BDAR – Appendix G
Lobs Hole Ravine Road	• Refinement of road design and reduced extent of disturbance required.	BDAR – Appendix G
Marica	• Refinement of road design and reduced extent of disturbance required. • Inclusion of a design option that would remove the need for the surge tank structure above ground and instead consist of a surface pond structure to manage flows during operations.	BDAR – Appendix G
Plateau	• Refinement of the groundwater model which has reduced the extent of groundwater drawdown and expressions at surface.	Water modelling report – Appendix I
Tantangara Reservoir	• Snowy Hydro has investigated a potential alternative excavated rock placement location and activities in response to requests from key government agencies (DPIE, EPA, NPWS). • Inclusion of fly camp within the existing disturbance footprint. • Construction and use of temporary power and additional fuel storage within the disturbance footprint. • Adjustment to intake excavation to allow TBM launch during excavation and reduction in length and diameter of access adit into the headrace tunnel to service TBM after launch.	BDAR – Appendix G Water management report – Appendix J
Rock Forest	• Snowy Hydro has investigated potential alternative excavated rock placement activities in response to requests from key government agencies (DPIE, EPA, NPWS). The preferred strategy will involve Marica excavated rock material being transported and placed in a permanent rehabilitated landform site at Rock Forest, compared to placement in Tantangara Reservoir as described in the Main Works EIS.	-

Table 3.1 Overview of key actions taken since exhibition

Area	Design refinements and consultation	Additional impact assessment
Site wide	• Confirmation of traffic numbers on public roads. Additionally, work has continued to progress significant reductions in segment truck movements through the adoption of purpose-built trailers for segment movements.	Traffic and transport assessment – Appendix K

3.2 Refinements to the design of the project

Snowy Hydro and FGJV continue to refine the design for Snowy 2.0 as additional information is obtained from the geotechnical investigation program and Exploratory Works. These refinements are aimed at optimising the performance of the project as well as minimising its impact on the surrounding environment. In addition, issues raised by agencies and stakeholders during public exhibition of the Main Works EIS has also prompted refinements to key elements of the project. These are described in more detail below.

3.2.1 Refinements to project footprint

A key refinement to design since public exhibition of the Main Works EIS is a change to and clarification of the disturbance footprint, previously identified in the Main Works EIS. A summary of the change is described in Table 3.2 below and shown on Figure 3.1 to Figure 3.6. As outlined in Table 3.2 the disturbance area has been indicatively reduced to 640 ha (62%), to better balance the design and its construction requirements, noting that some flexibility will still be required to allow a final design process. Of the revised disturbance area, approximately 92 ha utilises areas already directly impacted by the Exploratory Works. Therefore, the revised disturbance area will result in only 548 ha of additional disturbance.

Of the total area 640 ha to be disturbed by the Main Works, approximately 37 ha of this area is outside the KNP. The expected disturbance area within KNP therefore is approximately 603 ha, (a reduction in area of 58% from the 1,453 ha reported in the Main Works EIS).

The Snowy 2.0 operational footprint has also been reduced from 99 ha to 92 ha.

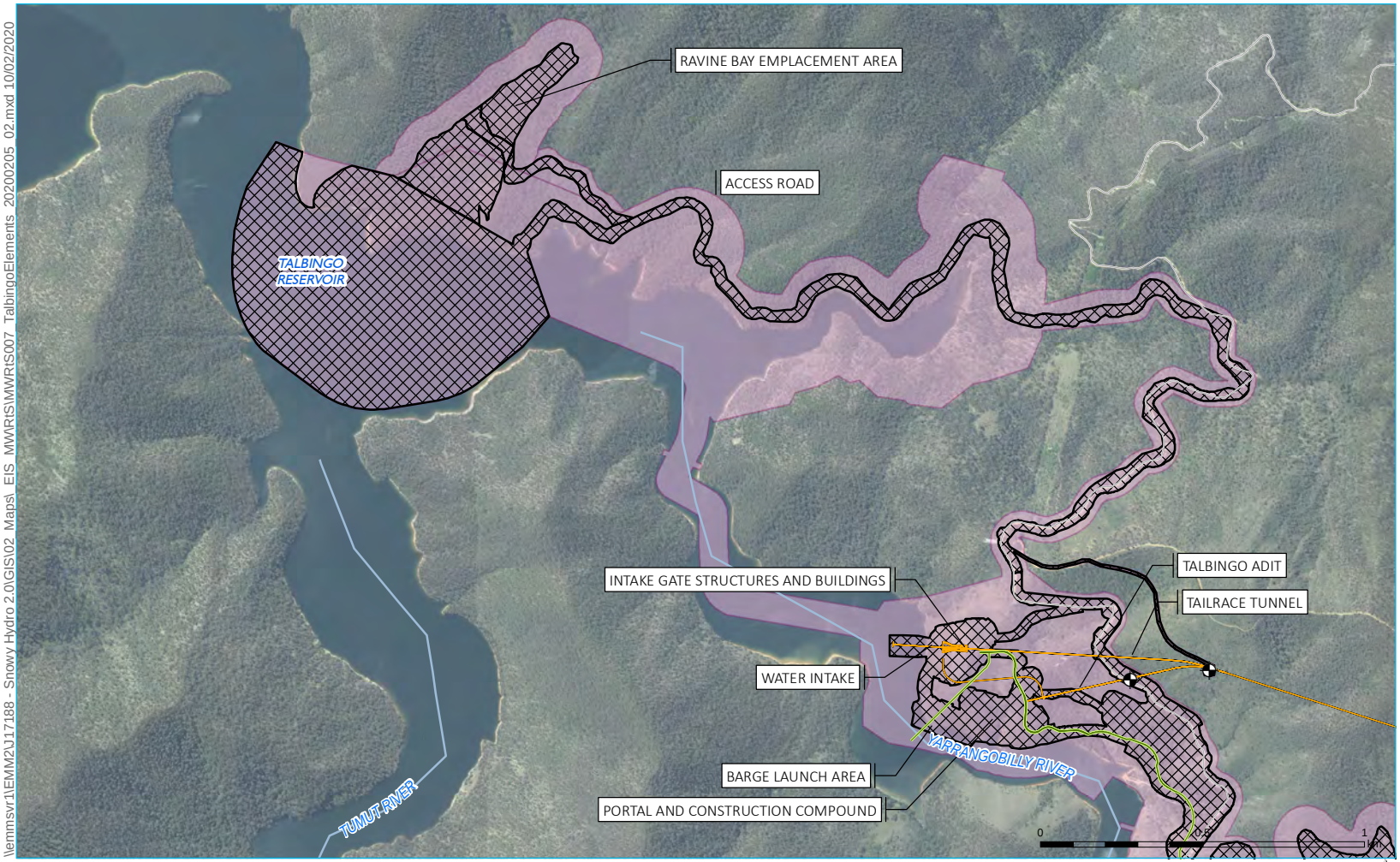
Table 3.2 Disturbance area terminology

Project element	Summary of the project exhibited	Summary of project refinement in PIR-RTS
Project area	The project area is the broader region within which Snowy 2.0 will be built and operated, and the extent within which direct impacts from Snowy 2.0 Main Works are anticipated.	The project area is the broader region within which Snowy 2.0 will be built and operated, and the extent within which direct impacts from Snowy 2.0 Main Works are anticipated. Importantly the project area does not represent a footprint for the construction works, but rather indicates an area that was investigated during environmental assessments.

Table 3.2 Disturbance area terminology

Project element	Summary of the project exhibited	Summary of project refinement in PIR-RTS
Disturbance area	The disturbance area is the extent of construction works required to build Snowy 2.0. The maximum disturbance area is about 1,680 ha which is approximately 0.25% of the KNP. Most of the disturbance area will be rehabilitated and landformed and other parts will be retained permanently for operation (operational footprint).	The disturbance area as described in the PIR-RTS is the indicative corridor inside the larger construction envelope (described below), where construction works required to build Snowy 2.0 can be carried out. The disturbance area has been reduced by 62% to 640 ha, of this only 603 ha of disturbance area is within the KNP which is less than 0.1% of the KNP. The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area. It is proposed that most of the disturbance area will be rehabilitated and landformed at the completion of the project, however other parts will be retained post construction. These components are necessary for the ongoing operation and maintenance of the new power station (operational footprint).
Construction envelope	N/A	In addition to the disturbance area previously described in the Main Works EIS, a new term called the 'construction envelope' has been developed. The construction envelope is the maximum extent within which the disturbance area corridor can move to allow the final siting of infrastructure through the detailed design process. For clarity, the PIR-RTS does not increase the overall area nominated for disturbance in the EIS.

The disturbance area and construction envelope are provided in Figure 3.1 to Figure 3.6 below.



KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Geotechnical investigation
- Indicative disturbance area
- Construction envelope

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

Talbingo Reservoir - project elements

Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 3.1

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

GDA 1994 MGA Zone 55

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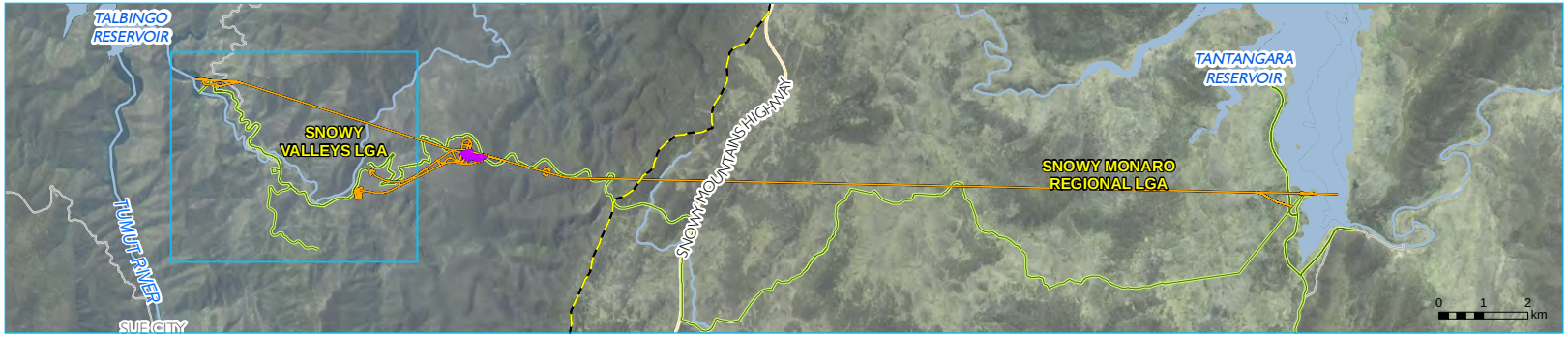

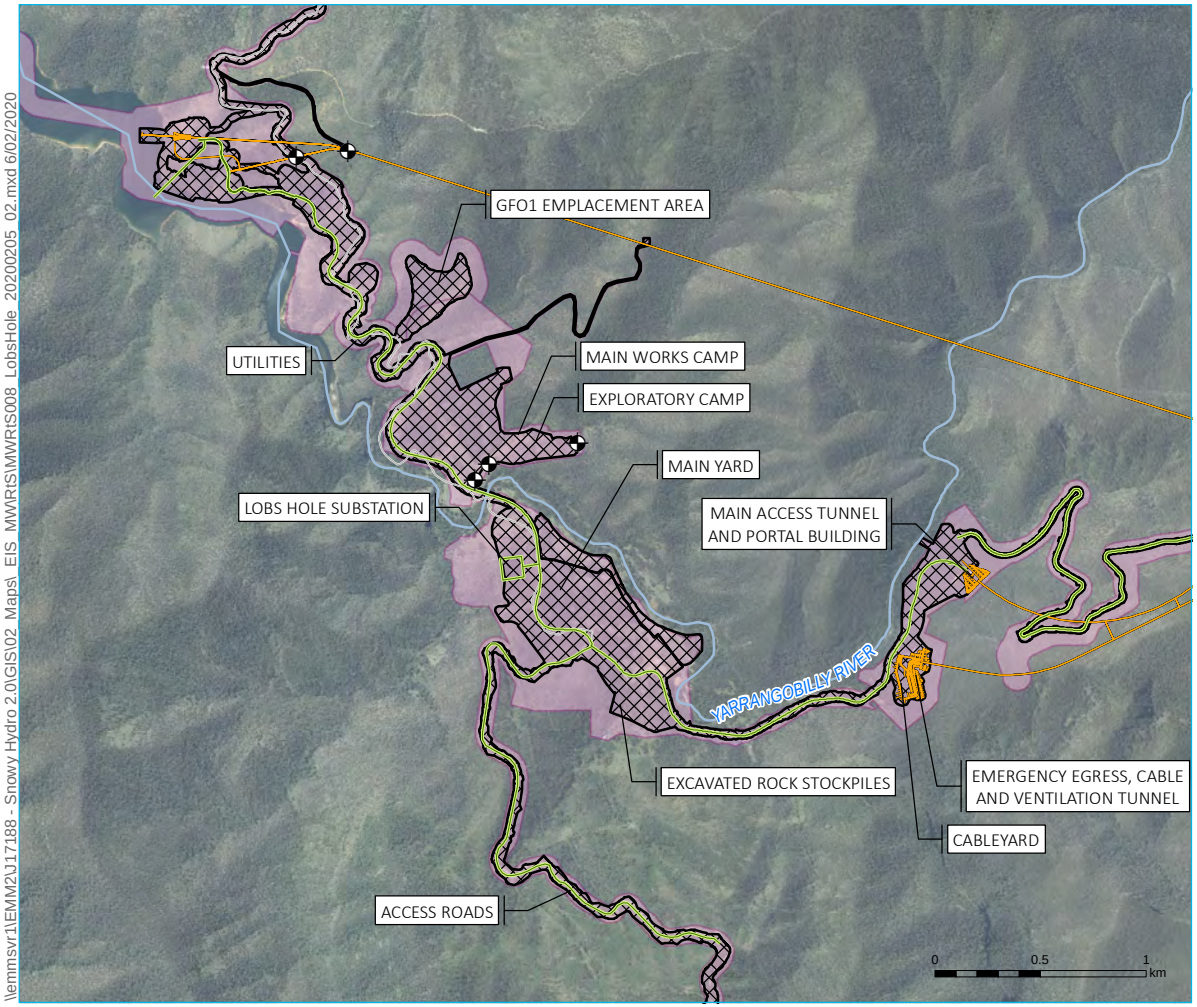

KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Geotechnical investigation
- Indicative disturbance area
- Construction envelope

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

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

GDA 1994 MGA Zone 55

N

Revised disturbance area and construction envelope – Lobs Hole

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 3.2

snowy 2.0

EMM creating opportunities

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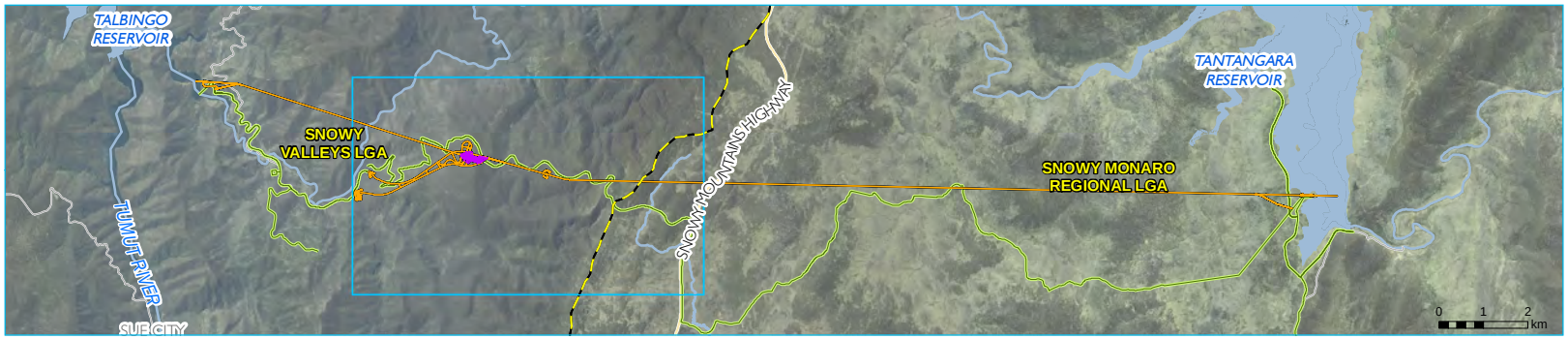

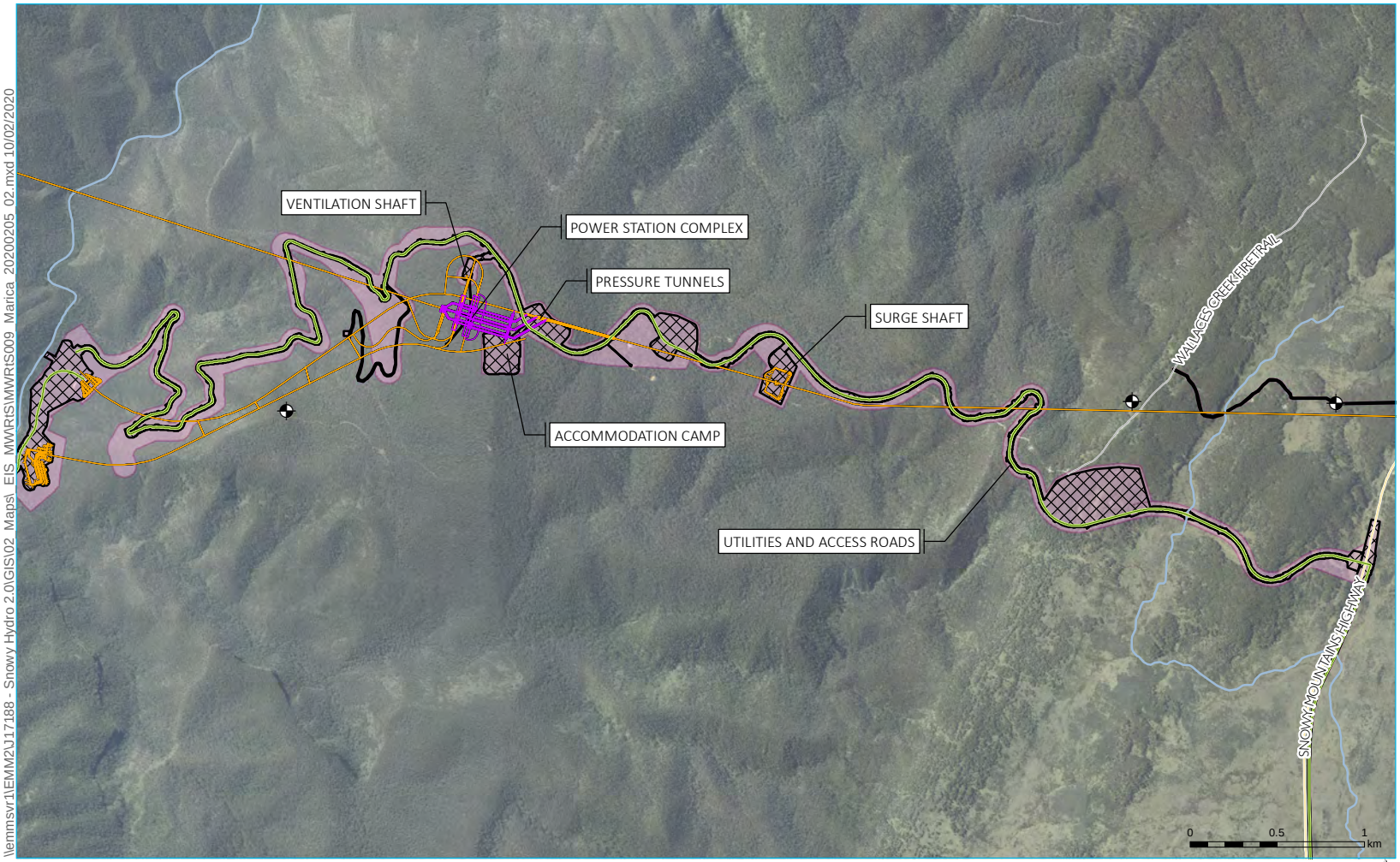

KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Geotechnical investigation
- Indicative disturbance area
- Construction envelope

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

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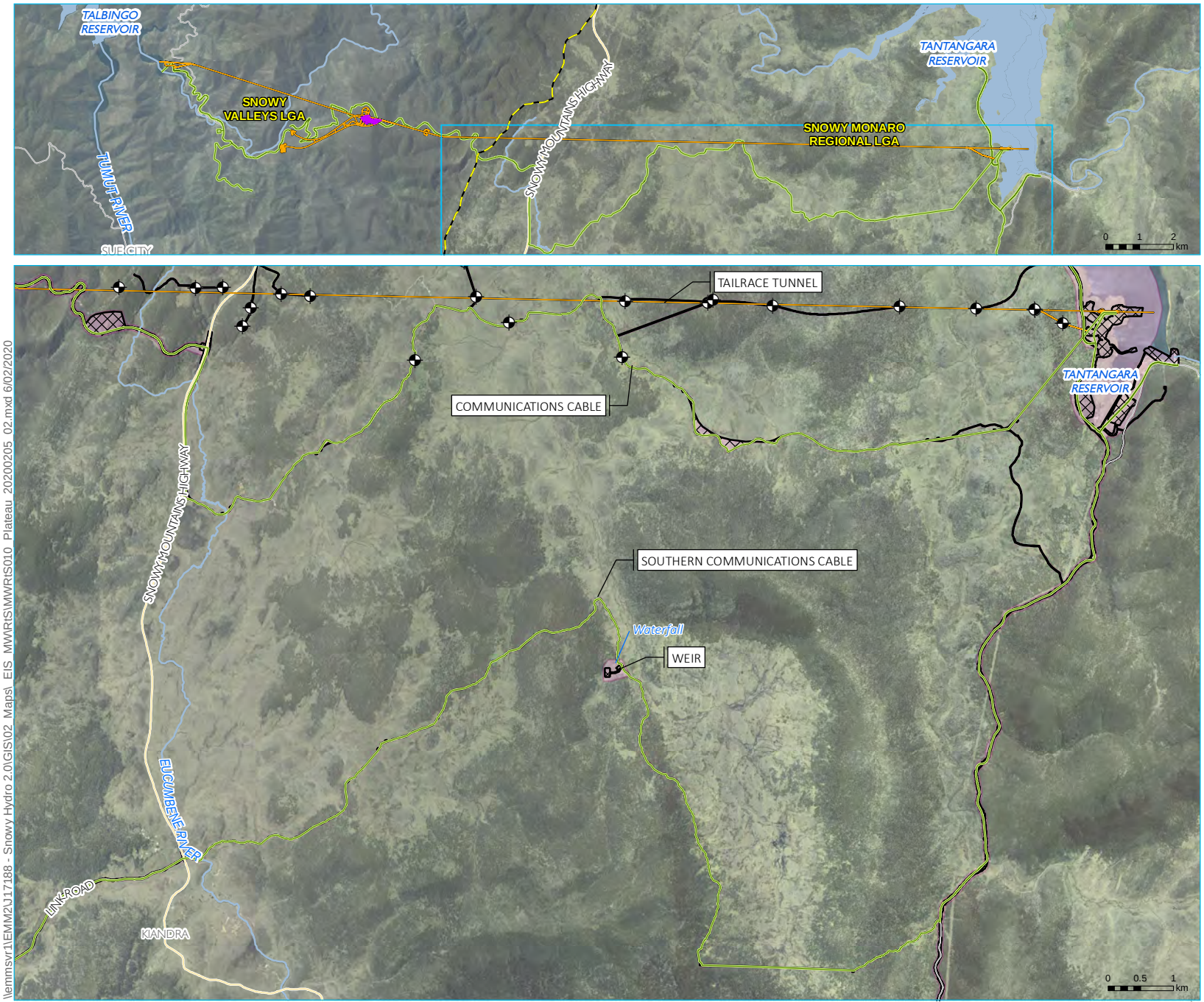
Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

Marica - project elements

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 3.3



KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Geotechnical investigation
- Indicative disturbance area
- Construction envelope

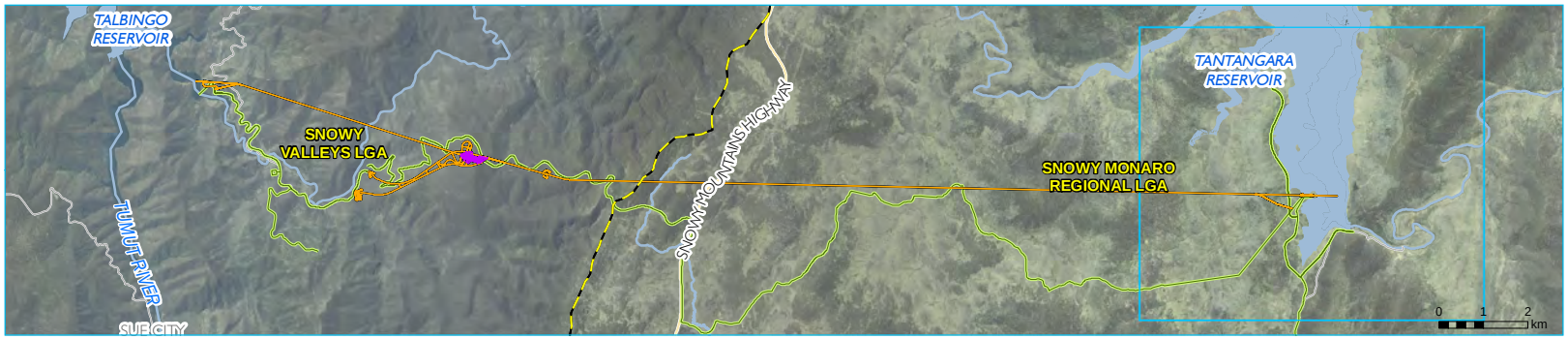
The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

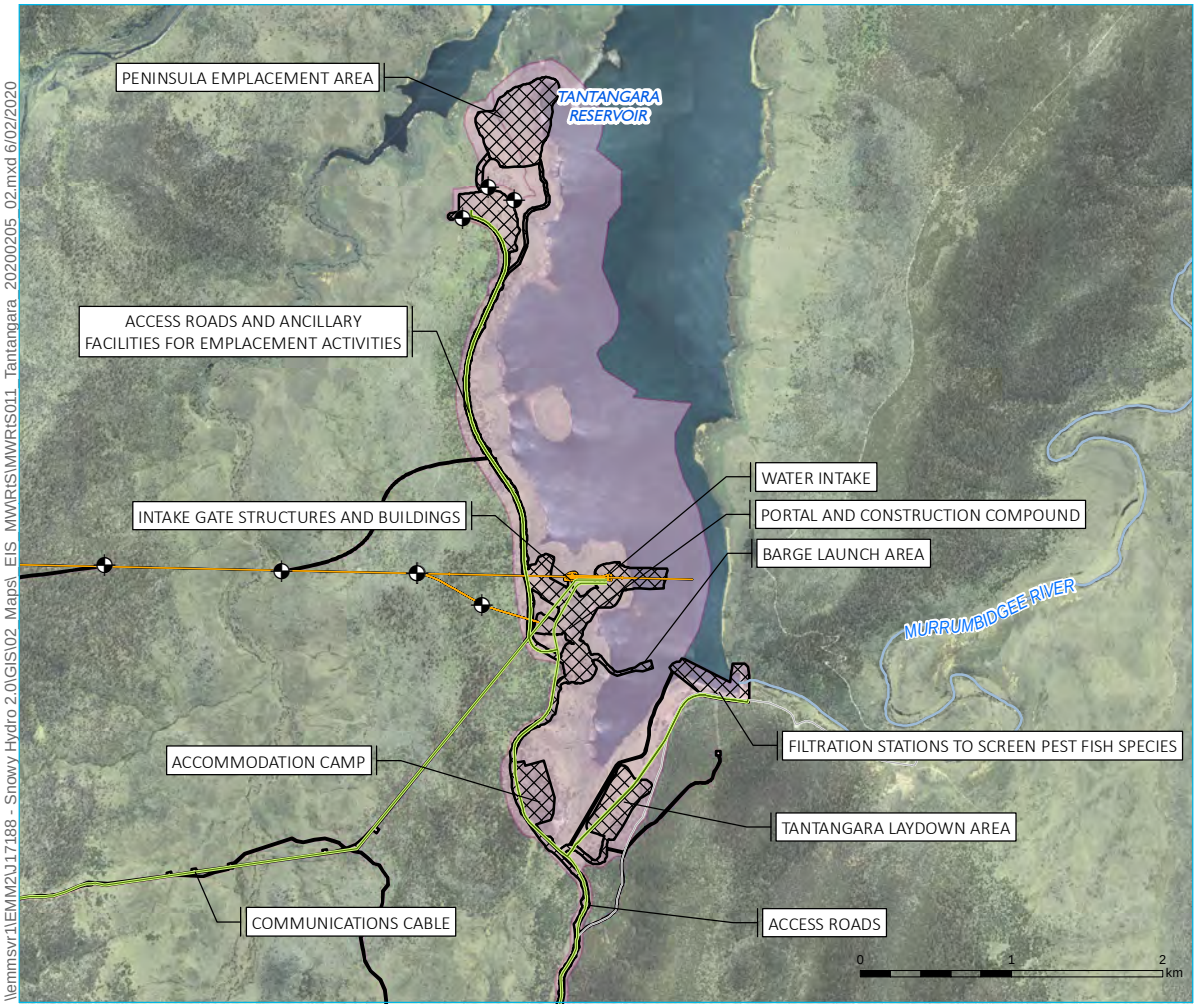
Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

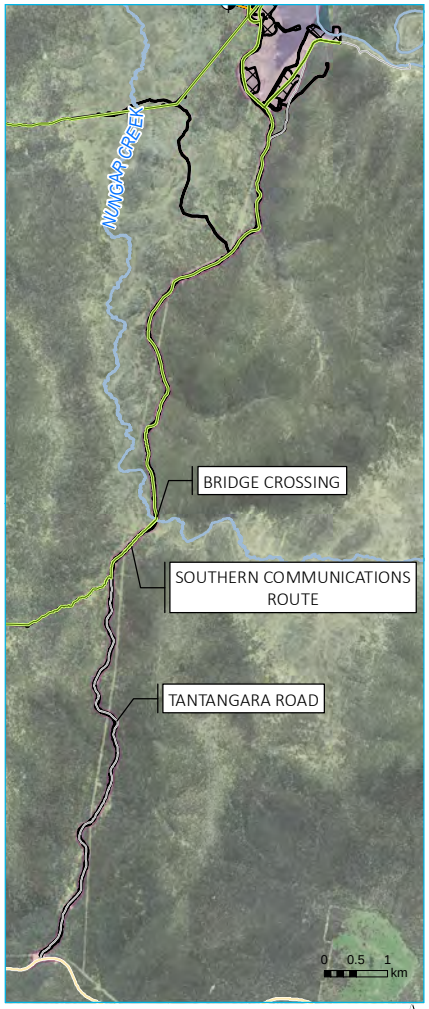
\\emmsvr1\EMM2\117188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWRtS\MWRtS010 Plateau 20200205 02.mxd 6/02/2020

Revised disturbance area and construction envelope – Plateau

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 3.4







KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Geotechnical investigation
- Indicative disturbance area
- Construction envelope

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

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

GDA 1994 MGA Zone 55

N

Revised disturbance area and construction envelope – Tantangara

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 3.5

snowy 2.0

EMM creating opportunities

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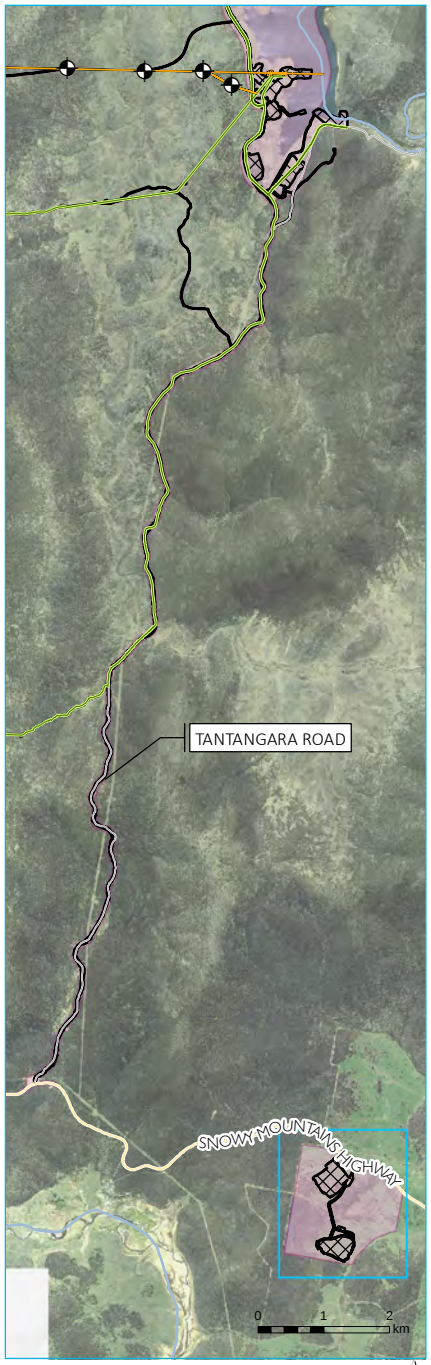


KEY

Existing environment

- Main road
- Local road
- Watercourse

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Utilities
- Geotechnical investigation
- Indicative disturbance area
- Construction envelope

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

\\emmsvr1\EMM2\117188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWRtS\MWRtS012 RockForest 20200205 02.mxd 6/02/2020

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

GDA 1994 MGA Zone 55

N

Revised disturbance area and construction envelope – Rock Forest

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 3.6

The reduction in disturbance area is summarised by zone in Table 3.3 below.

Table 3.3 Summary of disturbance area reduction by zone

Zone	MW EIS disturbance area (ha)	MW PIR-RTS disturbance area (ha)	% change
Total	1,678	640	-62%
Within KNP			
Lobs Hole Ravine Road	125	62	-50%
Lobs Hole	232	139	-40%
Marica	169	67	-60%
Plateau	99	92	-7%
Talbingo Reservoir	169	83	-51%
Tantangara Reservoir	659	161	-76%
Total within KNP	1,453	603	-58%
Outside KNP			
Rock Forest	226	37	-84%

3.2.2 Excavated rock management

i Preferred excavated rock management strategy

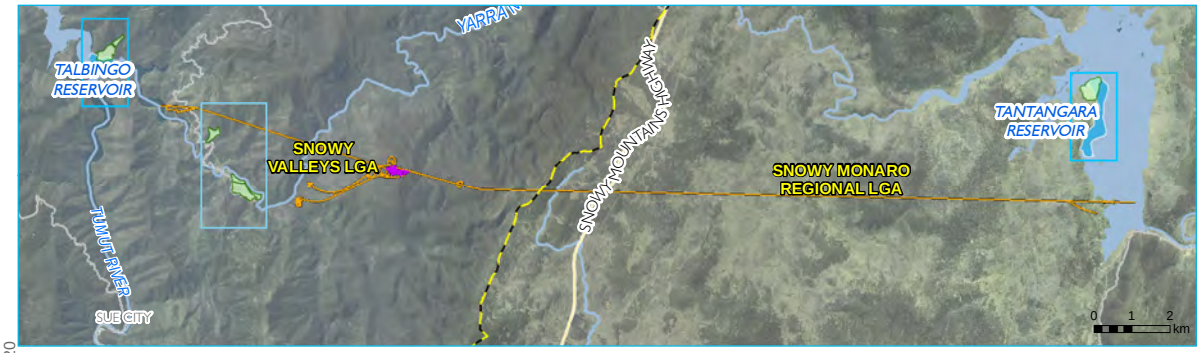
a Overview

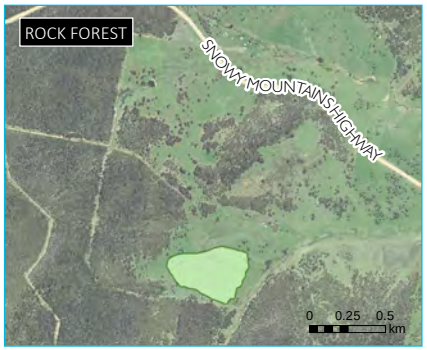
In response to public and agency submissions, Snowy Hydro has considered alternative options for management of excavated rock. As a result, Snowy Hydro proposes an alternative excavated rock management option compared to that articulated in the Main Works EIS.

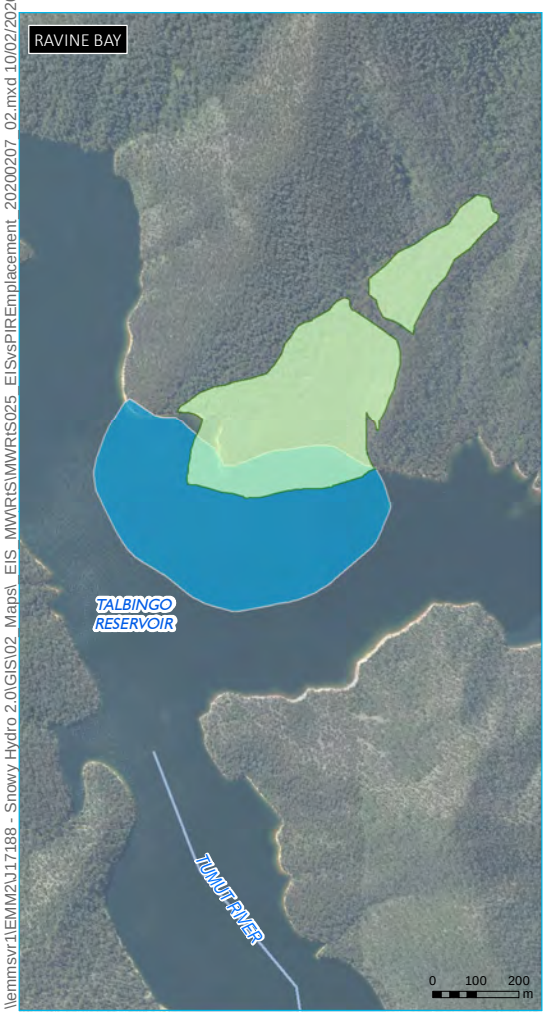
Consistent with the strategy proposed in the EIS, the preferred excavated rock management strategy presented in this report continues to comprise a 'hybrid' solution within three zones (Talbingo, Marica and Tantangara) whereby excavated material is:

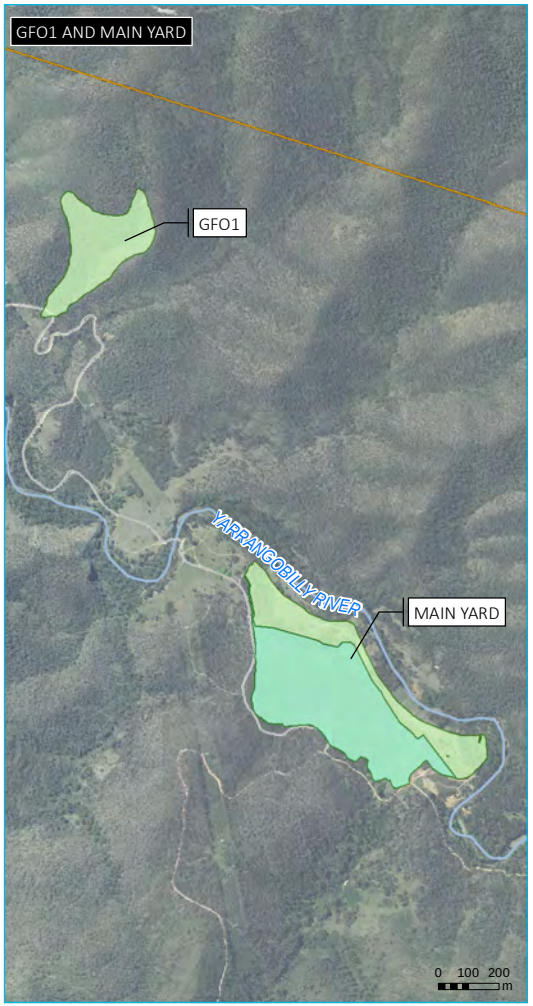
- beneficially re-used where possible, including for embankments, construction pads, operational pads and structures and in road works;
- placed within Talbingo and Tantangara reservoirs;
- applied to land within the KNP and subject to landforming and rehabilitation; and
- potential for application to land outside the KNP, subject to identification and assessment of identified locations.

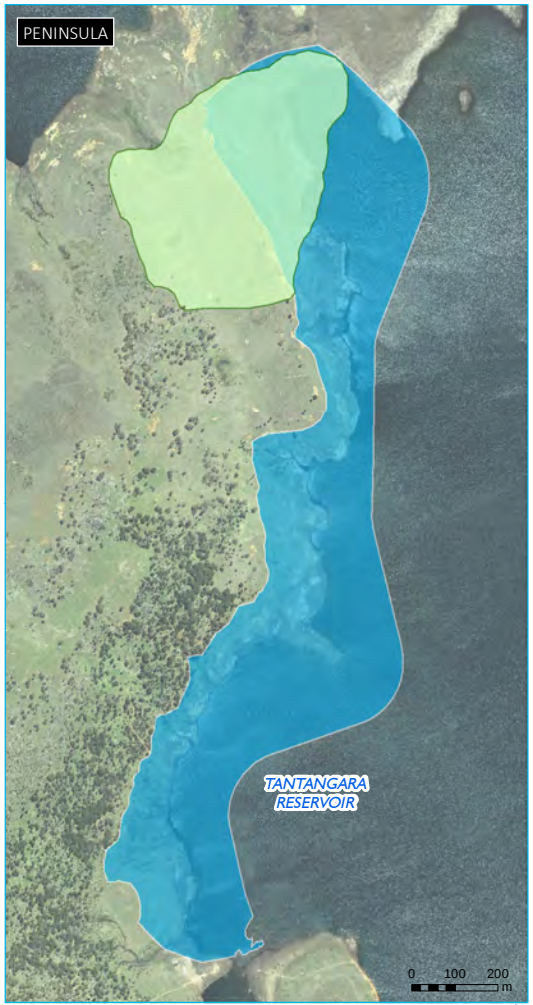
Table 3.4 below provides a comparison of the preferred excavated rock management strategy now proposed by Snowy Hydro against the methods proposed in the EIS with Figure 3.7 identifying the relevant locations.











KEY

PIR-RTS indicative emplacement area

EIS indicative emplacement area

Existing environment

Main road

Local road

Watercourse

Waterbodies

Local government area boundary

Snowy 2.0 Main Works operational elements

Tunnels, portals, intakes, shafts

Power station

\\emmsvr1\EMM2\117188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWRtS\MWRtS025 EISvsPIREmplacement 20200207 02.mxd 10/02/2020

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

GDA 1994 MGA Zone 55

N

Revised excavated rock emplacement areas

Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 3.7

snowy 2.0

EMM creating opportunities

Table 3.4 Comparison of preferred excavated rock management strategy against strategy within EIS

Item	EIS	Preferred excavated rock management strategy
Talbingo zone		
Source of excavated material	The bulk of the excavated material comes from the construction of the underground power station and associated construction tunnels, the tailrace tunnel, the Talbingo intake structure and the establishment of new access roads or the upgrades of existing access roads.	No change.
Method proposed	Combination of land application in KNP and in-reservoir placement.	Combination of land application in KNP and in-reservoir placement but with design optimisation resulting in: • reduction in overall volume of material placed within Talbingo Reservoir; • improved water quality outcomes as only drill and blast (D&B) material is placed within the active storage of Talbingo Reservoir; and • geomorphic landform design.
Locations	Ravine Bay and Main Yard.	Ravine Bay, Main Yard and GF01. GF01 avoids sensitive flora and fauna, is outside of Lobs Hole (envisaged to be a recreational zone post construction subject to ongoing engagement with NPWS), has a lower disturbance footprint, is close to existing roads and had a small upstream catchment.
Marica zone		
Source of excavated material	Excavated rock and material generated from mobilisation and establishment activities and construction of permanent assets including Marica Road, Marica West Road and headrace tunnel surge shaft.	No change.
Method proposed	In-reservoir placement.	Land application outside KNP, with geomorphic landform design.
Location	Tantangara Reservoir.	Rock Forest.
Tantangara zone		
Source of excavated material	Excavated rock material is primarily from the Tantangara intake structure and headrace tunnel.	No change.
Method proposed	In-reservoir placement.	In-reservoir placement and shaped landform but with design optimisation resulting in: • improved water quality outcomes as only D&B is placed below full supply level (FSL), with TBM material above FSL; and • geomorphic landform design.
Locations	Tantangara Reservoir.	Tantangara Reservoir – proposed 'Peninsula' emplacement area to the north of the location proposed in the EIS.

The refinements made to the strategy seek to improve overall environmental outcomes (particularly water quality and outcomes for recreational users) by:

- Adopting an improved compaction factor for on-land excavated rock placement which results in a reduction in overall excavated rock volumes across the Project.
- Reducing the total volume of materials within the active storages for Talbingo and Tantangara reservoirs.
- Changing the design of the rock placement within Talbingo Reservoir and below FSL at Tantangara Reservoir, so that only D&B material (and not TBM material) is used to establish the pads below FSL. D&B contains a considerable amount of less fines than TBM which greatly improves water quality outcomes.
- Refining the design for on-land application and rehabilitation by applying geomorphic landform design principles and methodology (see Section 3.2.2ii). The final rehabilitated landforms will blend and integrate into the surrounding environment to create natural-looking and stable slopes, in balance with the localised environmental conditions.
- Refining the locations for on-land application and shaped landforms, which remain within the project area identified in the EIS and remain generally consistent with the construction envelope and indicative 'disturbance area'. The locations proposed for disposal of excavated rock are broadly consistent with the sites nominated in the EIS at Talbingo Reservoir, Tantangara Reservoir and Lobs Hole. Although on-land storage is now proposed within the KNP at GF01 and outside of the KNP at Rock Forest, the EIS expressly contemplated temporary and/or permanent on-land storage within the KNP and outside of the KNP.

ii Design optimisation process

Excavated rock management has been the subject of ongoing discussions between Snowy Hydro, FGJV and relevant government agencies since the submission of the Main Works EIS, and following receipt of public and agency submissions. Agencies requested Snowy Hydro and FGJV explore alternative excavated rock management options to consider during the assessment process.

Significant effort has been carried out by engineering teams and environmental specialists into further identifying, and then assessing reasonable and feasible options for excavated rock management. A summary of these design optimisation processes is presented in the following table.

Table 3.5 Design optimisation process to improve outcomes

Design optimisation factors	Description of work carried out	Outcome
Compaction factors	One of the key optimisations is the development of an improved compaction factor for on-land excavated rock placement – reductions in compaction factor translates into less excavated rock material requiring management. As presented in the Main Works EIS, a conservative compaction factor of 1.5 was presented. As the design has progressed, an improved compaction factor of 1.16 has been developed for the design of all on-land material emplacement. The concept behind the transition of excavated rock volume from in-situ, to the final compacted volume can be seen in Figure 3.8. Notwithstanding the above, for the Ravine Bay D&B pad below FSL a ratio of 1.5 has still been adopted. The adoption of the updated compaction factor has resulted in a reduction in overall excavated rock material volumes across the project. Indicative compacted volumes for the Talbingo, Marica and Tantangara zones have been calculated and displayed in Table 3.6 below.	Reduction in materials requiring management Reduction in size of area needed for emplacement

Table 3.6 Excavated material volumes across zones

Talbingo zone (including reservoir and Lobs Hole)	Indicative volume (m^3)	Marica zone	Indicative volume (m^3)	Tantangara zone	Indicative volume (m^3)
Total cut volume	7,150,000	Total cut volume	650,000	Total cut volume	3,300,000
Permanent works (*roads, ECVT and MAT, etc*)	1,100,000	Permanent works *(roads etc)*	200,000	Permanent works *(roads etc)*	340,000
Construction pads (*main yard, MW camp, TRT adit etc*)	1,950,000	Construction pads	40,000	Construction pads *(camp, portal etc)*	120,000
Residual volume	4,100,000	Residual volume	410,000	Residual volume	2,900,000
GF01	1,050,000				
Ravine Bay	3,100,000				
(below FSL)	(1,800,000)				
(above FSL)	(1,300,000)				

It is expected that the final excavated rock volumes will be further optimised during the detailed design stages, as further geotechnical information becomes available.

Table 3.5 Design optimisation process to improve outcomes

Design optimisation factors	Description of work carried out	Outcome
Emplacement methods within reservoirs	A key matter raised in submissions concerned water quality impacts in Talbingo Reservoir due to the proposed method for edge placement of excavated material at Ravine Bay. In order to address this concern, the design of the rock emplacement within the reservoir was revisited with the primary objective to minimise water quality impacts as far as reasonably practicable. The underwater pad has undergone significant redesign, resulting in greatly improved water quality outcomes. The updated designs avoid placement of the finer TBM material below FSL (or within the active storage) of the Talbingo and Tantangara Reservoirs, using only D&B material to establish the pads below this level. Further, the total volume of material within the active storages for both Tantangara and Talbingo reservoirs has reduced. At Talbingo Reservoir, the D&B material will be placed into the water to construct the pad, however at Tantangara Reservoir, where water levels within the active storage area can be managed through operation of existing Snowy Scheme, the placement of materials and development of the landform will be carried out in dry conditions as the water level will be kept below the emplacement area. The updated lower placement rates, reduced volumes and reduced fines content has been assessed and re-modelled to reflect the updated inputs, with the results demonstrating greatly improved water quality outcome results than those presented in the EIS. In the Main Works EIS, modelled results for expected total suspended solids (TSS) at surface due to excavated material emplacement into Talbingo Reservoir indicated maximum levels of around 16 mg/L at the Talbingo Dam wall. The updated model results incorporating the optimised placement methodology and design indicate maximum TSS levels of around 2.5 mg/L at the same location. Modelled results for surface TSS levels approximately 1 km from the placement location (Location 9) predicted in the Main Works EIS show peak levels of around 32 mg/L. This value has been reduced maximum surface TSS levels to around 5 mg/L due to the optimised placement methodology. Time series charts for the modelled surface TSS levels for locations 1 and 9 using the preferred placement method within Talbingo Reservoir are shown in Figure 3.9–Figure 3.11 and show comparison to the Main Works EIS.	Improved water quality outcomes compared to original method proposed in the EIS

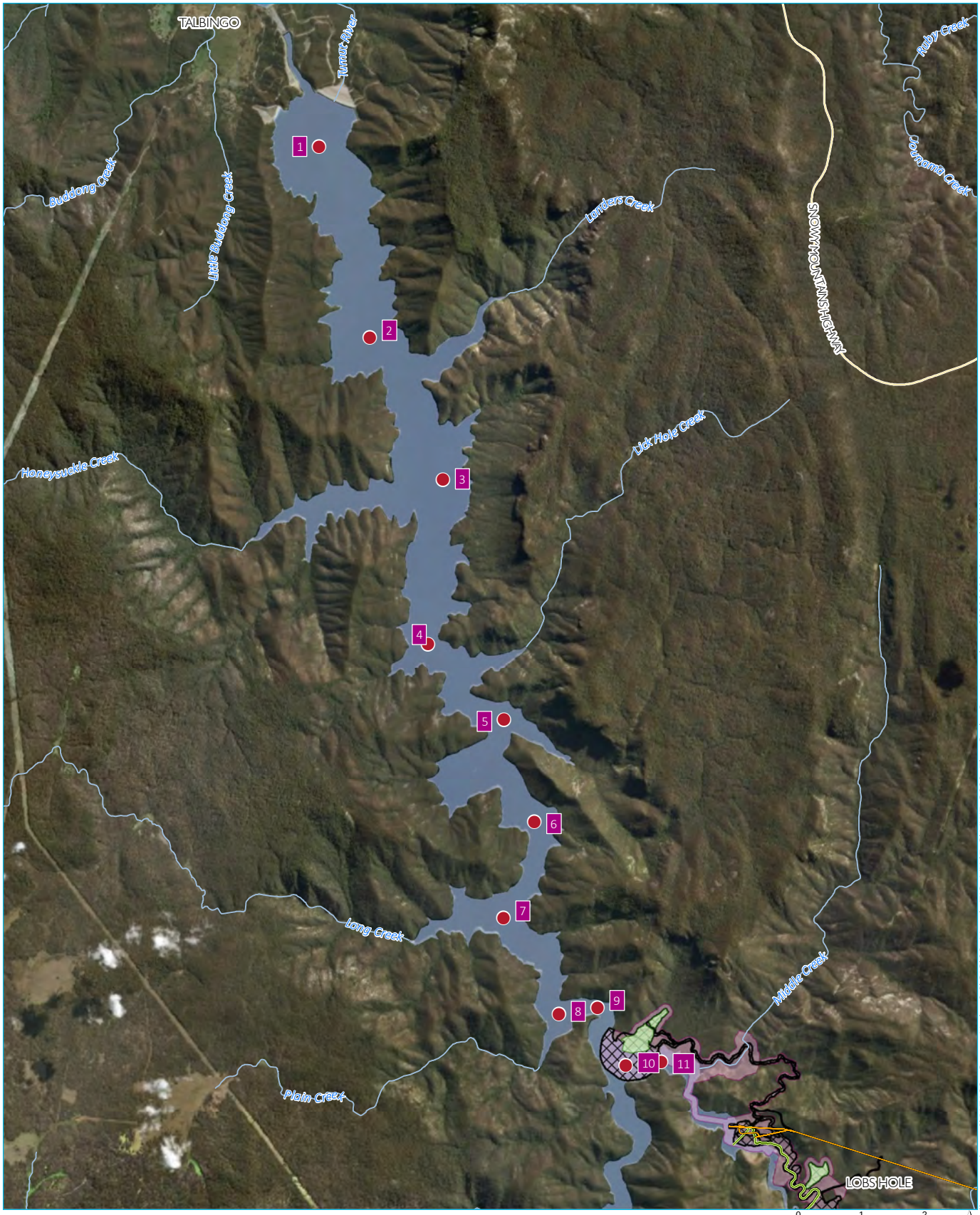
Table 3.5 Design optimisation process to improve outcomes

Design optimisation factors	Description of work carried out	Outcome
Landform design	Another key improvement since the submission of the Main Work EIS is the adoption of a geomorphic approach to landform design and rehabilitation. Feedback from relevant government agencies required further work to improve the methodology and design of the proposed landforms within KNP. To address this issue, significant engineering and environmental specialist resources were used to investigate, and then a suitable geomorphic approach that could be applied to all on-land excavated rock management land rehabilitation was adopted. As such, all final landforms constructed of excavated material will adopt the "geomorphic landform" design principles and methodology. This geomorphic method is a fluvial geomorphic method aimed at developing stable, free draining and non-polluting landform designs. The fundamental basis of the design is to create a landform that mimics and expands on the functions of the natural landscape that would have naturally evolved over time. The result is a stable hydrological equilibrium that occurs naturally. Basically, it expands on drainage networks using a reference landform to extend the design of the new landform. The Geomorphic landform method shares some common design considerations as a conventional geomorphic landform design. It is an empirical method that uses geomorphically mature local reference landforms. The inputs of the method depend on the characteristics of stable natural landforms in the local environment. This analogue provides the basis for the landform design. The application of geomorphic landform design to the emplacement areas within KNP allows the final rehabilitated landforms to blend and integrate into the surrounding environment to create natural-looking and stable slopes, in balance with the localised environmental conditions. The geomorphic landform design procedure builds a drainage network using a reference landform approach. With this procedure, a reference watershed must be identified and characterized. Typically, the reference watershed is the location where the geomorphic design is going to be implemented to properly mimic the pre-disturbed topography. The information that is necessary to inform successful design includes the main channel slope and landform profile shape, drainage density and area, and channel characteristics (Toy and Chuse 2005; Eckels and Bugosh 2010). Given that reducing visual impact to the existing environment is one of the key considerations for the management and placement of excavated rock for the project, the geomorphic landform method is suitable as an appropriate landform design approach for on-land excavated rock placement in order to create a natural-looking, stable, permanent, non-polluting landform. In terms of constructability using this design approach, it is anticipated that building up the excavated rock emplacements in accordance with the geomorphic landform design criteria will be carried out using a bottom-up process combined with conventional earthwork methods. The majority of the micro-relief and landforming through a drainage network applies to the outer slope layer which might be up to 10 m in thickness. This would typically be carried out towards the end of the emplacement activities.	Reduced amenity impacts and complementary with surrounding landscape

KEY

1.0 Compaction factor

Revised compaction factors
Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 3.8



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

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KEY

- Time series output location

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Utilities
- Emplacement area
- Disturbance area
- Construction envelope

Existing environment

- Main road
- Perennial watercourse
- Scheme storage

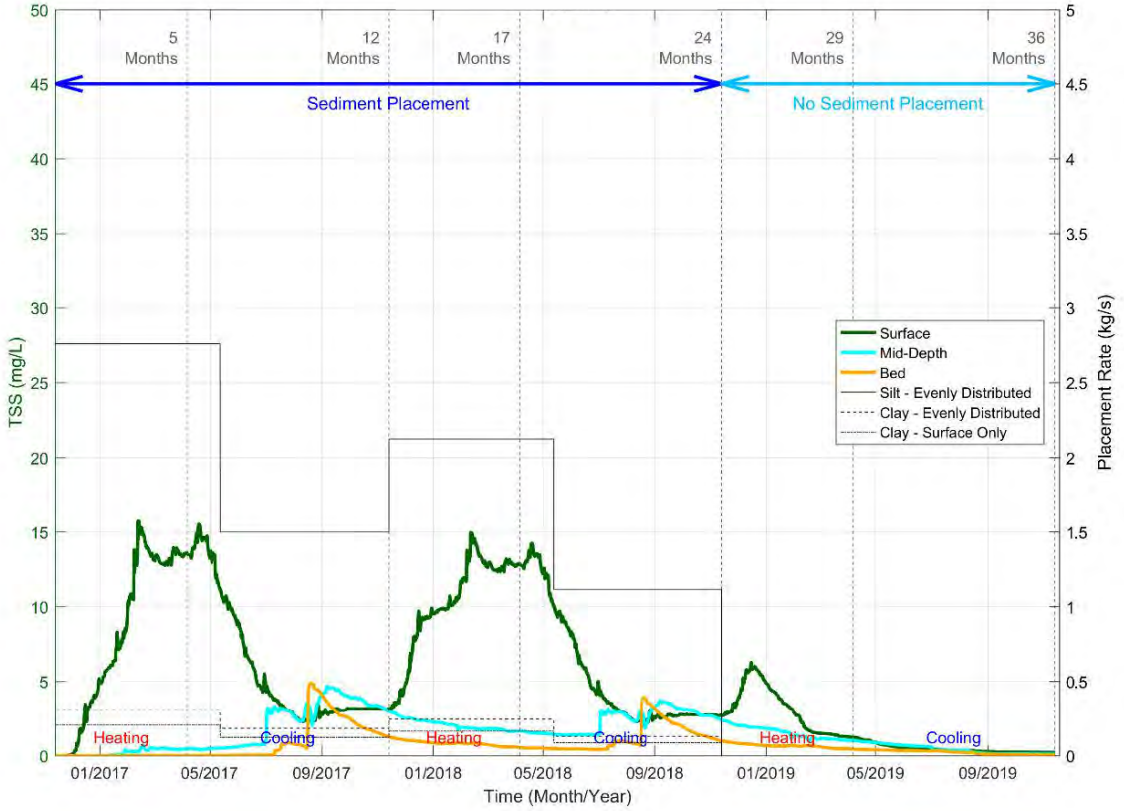
Time series output locations

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 3.9

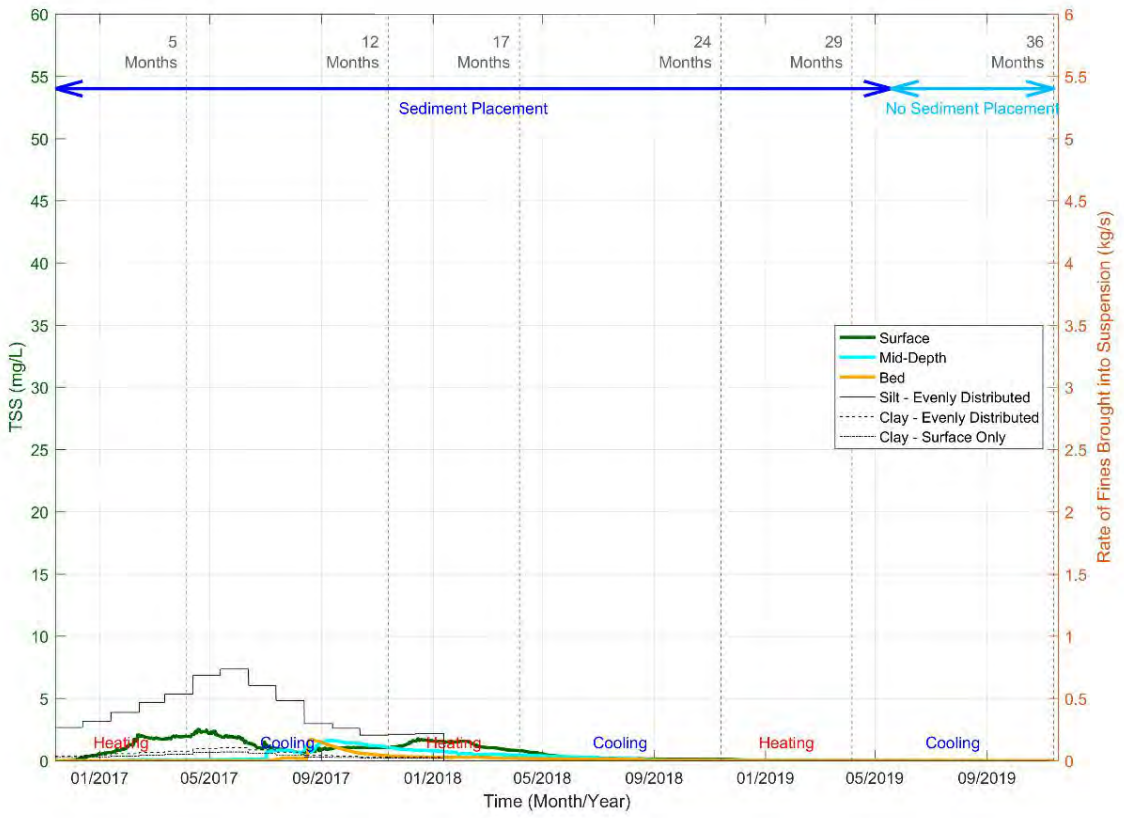
snowy2.0

EMM
creating opportunities

TSS AT LOCATION 1 – EIS METHOD



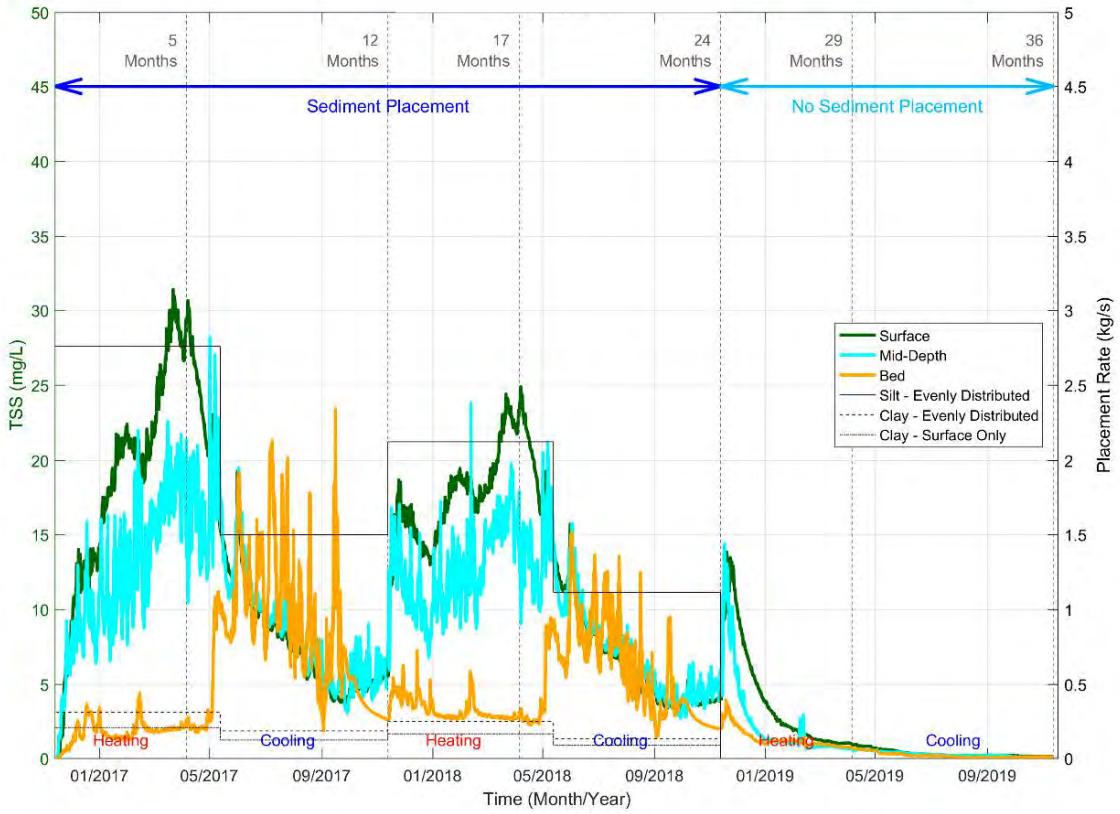
TSS AT LOCATION 1 – PREFERRED METHOD



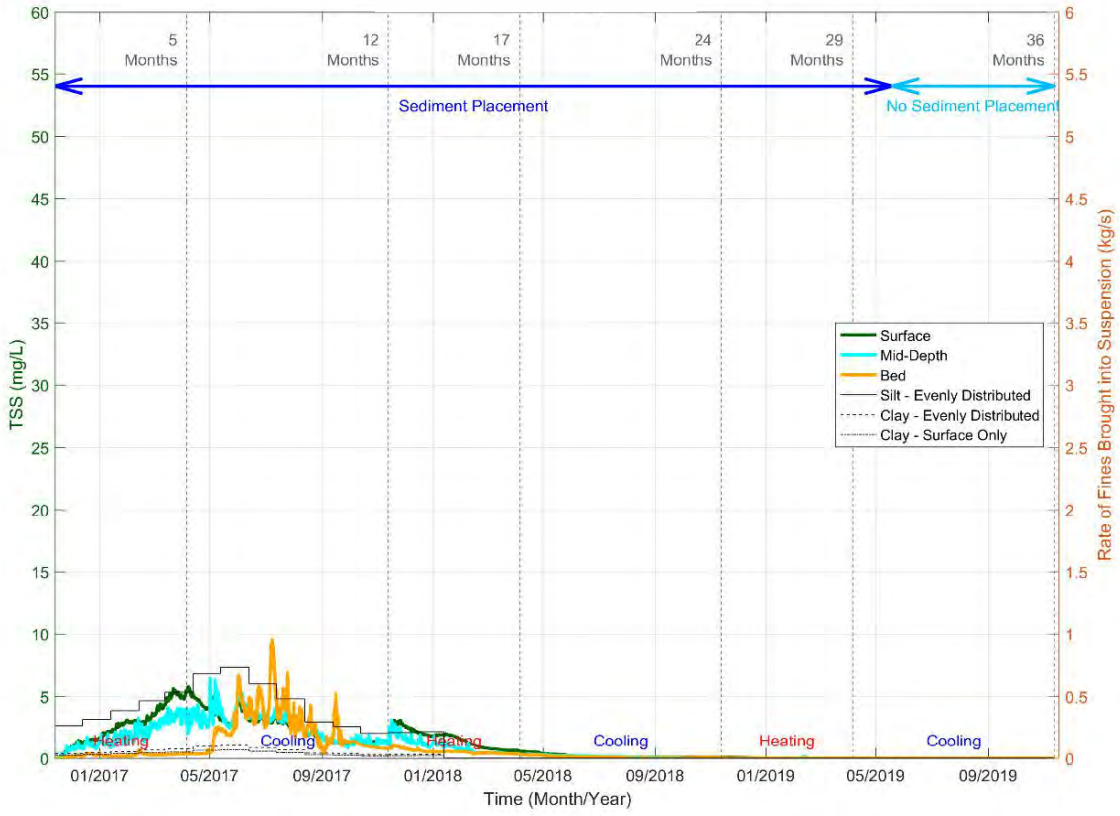
*Source: Royal HaskoningDHV

Talbingo modelled TSS at output location 1
Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 3.10

TSS AT LOCATION 9 – EIS METHOD



TSS AT LOCATION 9 – PREFERRED METHOD



*Source: Royal HaskoningDHV

Talbingo modelled TSS at output location 9
Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 3.11

iii High level options considered

With consideration of the design optimisation process, four concept design options for excavated rock management were investigated for the Main Works, principally for the Talbingo and Tantangara zones, and the feasibility of each option assessed. Table 3.7 below provides a summary of these options and their outcomes.

Table 3.7 High level conceptual options considered

Option	Description	Talbingo zone	Tantangara zone
Deep in reservoir placement	Transportation and placement of all excavated rock within Talbingo and Tantangara reservoirs, below the minimum operating level (MOL) of each via the use of barges.	To achieve acceptable water quality outcomes within the reservoir, the placement rate of this method would be slower than the rate of excavated material being generated. This would mean additional on-land areas would be required to temporarily stockpile the material, therefore resulting in a larger disturbance area for the project. Several key construction risks were identified for this emplacement method, including: • risk to the overall schedule due to events such as poor weather (high winds and fog) limiting barge movements; • the fluctuating water levels at Talbingo Reservoir creating challenges for loading and unloading; • mechanical failure of barge or plant that are not easily fixed or replaced; • the method requires significant plant-to-plant movements which would increase safety risks (loading material from land to water poses a high level of risk). • the method would require closure of the majority of the lower end of Talbingo Reservoir to enable 24/7 movement of barges to maintain the rate of placement required to keep pace with material generation. As identified in the EIS for Exploratory Works, this would impact on recreational users of the reservoir, particularly users near the dam wall; • increased length of closure of Talbingo spillway and upgrades to Spillway Road to enable mobilisation of required barge infrastructure; and • least favourable commercial result for the project with the cost of the methodology being unfeasible.	The placement of material within Tantangara Reservoir below the MOL is not feasible based on several factors outlined below: • Insufficient capacity to place all the material below MOL due to the shallow nature of Tantangara Reservoir, therefore limiting the placement area to the southern end of the reservoir only. • The ability to move and operate the barges on the reservoir is limited by the need to maintain enough draught below MOL for the barges to move across the reservoir, as well as the 500 m buffer zone required around the Tantangara Reservoir dam wall and Snowy 2.0 intake structure. • Risk of low inflows into Tantangara Reservoir, impacting the ability to operate the barges across the reservoir. The result is that there is insufficient capacity for the barge disposal method of deep placement, and a construction risk that was unacceptable for the project.

Table 3.7 High level conceptual options considered

Option	Description	Talbingo zone	Tantangara zone
Out of KNP	Transportation and haulage of all excavated rock from the site of excavation, to locations outside the KNP for on-land placement (eg Rock Forest).	Like the deep placement option, the option for the removal of all excavated rock out of KNP was investigated, and it was concluded that this method would not be feasible, nor reasonable for the following reasons: • The number of truck movements required to move the volume of excavated material would be excessive, with an average of an additional 194 heavy vehicle movements a day, with peaks of up to 400 additional one-way vehicle movements per day from Talbingo to an area out-of-the park (double these numbers for a return trip to site). • The number of heavy vehicle movements would result in significant impacts on recreational users and visitors to KNP for an extended duration of time (minimum four years). This is likely to represent an unacceptable public safety risk to road users if this option were to be implemented.	Like the deep placement option, the option for the removal of all excavated rock out of KNP was investigated, and it was concluded that this method would not be feasible, nor reasonable for the following reasons: • The number of truck movements required to move the volume of excavated material would be extremely excessive, with on average around 124 heavy vehicle movements a day, with peaks of up to 198 movements, one-way from Tantangara Reservoir to an area to a location out-of-the park (double these numbers for a return trip to site). • The number of heavy vehicle movements would result in significant impact on recreational users and visitors to KNP, for an extended duration of time, most likely for a minimum of four years. This is likely to represent an unacceptable public safety risk to road users if this option were to be implemented.
Land and water	A hybrid option that considers placement of material on edges of the Talbingo and Tantangara reservoirs, via the creation of underwater pads below FSL of the reservoir, with geomorphic landforms developed on the land above FSL and rehabilitated.	Option adopted as preferred option in combination with All to land.	Option adopted as preferred option.

Table 3.7 High level conceptual options considered

Option	Description	Talbingo zone	Tantangara zone
All to land	On-land placement of material within the KNP, geomorphically landformed and rehabilitated.	Option adopted as preferred option in combination with Land and water.	An all-to-land excavated rock management method within KNP was also investigated for the Tantangara zone. This method would involve the development of a geomorphic landform design on-land and rehabilitation, close to the Tantangara Reservoir on its western foreshore. This method and location is feasible as it has a high material placement volume per area of land ratio which achieves high compaction rates and would remove the construction risk of high inflows into Tantangara Reservoir impacting on works. This method would also remove operational in-reservoir water quality risks as all the material is placed on-land above FSL. However, further investigations identified significant constraints with this location and method, primarily related to significantly increasing the disturbance areas of the project in an area of high ecological value within KNP that has not been currently disturbed. Therefore, this alternative was not considered acceptable.

a Details of preferred strategy

This section details the preferred excavated rock management strategy within each of the three zones: Talbingo, Marica and Tantangara. A description of the updated design and methodology for excavated rock management is provided for each zone. All volumes described within this report are bulked, meaning the volume of material placed rather than in-situ prior to excavation.

Key drivers

Throughout the development of excavated rock management for Snowy 2.0, Snowy Hydro and FGJV have strongly prioritised the commitment to minimising environmental impacts to KNP and surrounds. Feedback in submissions and extensive agency consultation has also been critical to the development of options since exhibition of the Main Works EIS. The final preferred strategy for the management of excavated rock has been identified with a focus on the following key environmental drivers and having regard to the matters raised in public and agency submissions:

- optimisation of the placement methodology with a strong consideration and focus on reducing both direct, and indirect, impacts to terrestrial and aquatic ecology within KNP;
- ensuring that impacts to the visual and social amenity of KNP are minimised as far as reasonably practicable; and
- commitment to undertake effective and progressive rehabilitation and stable, non-polluting landforms that aid in maintaining long term ecological functions and processes and/or provide areas for future recreation activities.

In addition to the key environmental drivers mentioned above, there are a number of other key factors that have driven the preferred strategy. These include:

- minimising the distance between the source of excavated materials, and the final placement location where possible, resulting in:
    - improved construction efficiency by reducing time to transport and place materials;
    - minimisation of traffic impacts to the external public road network;
    - minimisation of safety risks to the public and project workforce by reducing exposure to heavy vehicle movements;
    - minimisation of social and recreational impacts to users of KNP outside of the project area during construction; and
    - a reduction in transport and haulage costs.
- optimising scheduling by minimising double-handling by placing excavated material in final landform locations, which will:
    - reduce the required lay down and material storage areas, therefore reducing the overall required disturbance area; and
    - improve the cost-efficiency of excavated rock management.
- optimisation of the design including:

- ensuring cut and fill balances are balanced or as close as possible to minimise the excess excavated rock that requires management;

- minimising disturbance areas and vegetation clearing within the KNP. Similar considerations were also applied to land outside KNP; and

- optimising the reuse of materials in permanent structures (eg roads, portals, pads, gabions, and access tracks).

Talbingo zone

The bulk of the excavated rock material comes from the construction of the underground power station and associated construction tunnels, the tailrace tunnel, the Talbingo intake structure, and the establishment of new access roads or the upgrades of existing access roads. For the excavated rock management in this zone, all high-level concept options were considered, with numerous assessments completed to determine the feasibility of each. Consultation with key government agencies (DPIE, NPWS and EPA) was also undertaken and feedback taken on board to refine options.

For Talbingo excavated rock, it was determined that a combination of all-to-land and land and water options would be required, predominately due to consideration of environmental impacts, scheduling constraints, constructability and method required to build the final landforms. The locations of the emplacement areas are Ravine Bay, GF01 and Main Yard (Lobs Hole).

i) Ravine Bay

As presented in the Main Works EIS, Ravine Bay was identified as a suitable location for the management of excavated rock. Ravine Bay is shown in Figure 3.12. Significant work has gone into the design, scheduling and construction method at this location, particularly to address key concerns regarding water quality outcomes, biodiversity impacts, and impacts to park users. An indicative visualisation and conceptual design using the geomorphic landform method is shown in Figure 3.13.

The key improvements to the Ravine Bay placement area include:

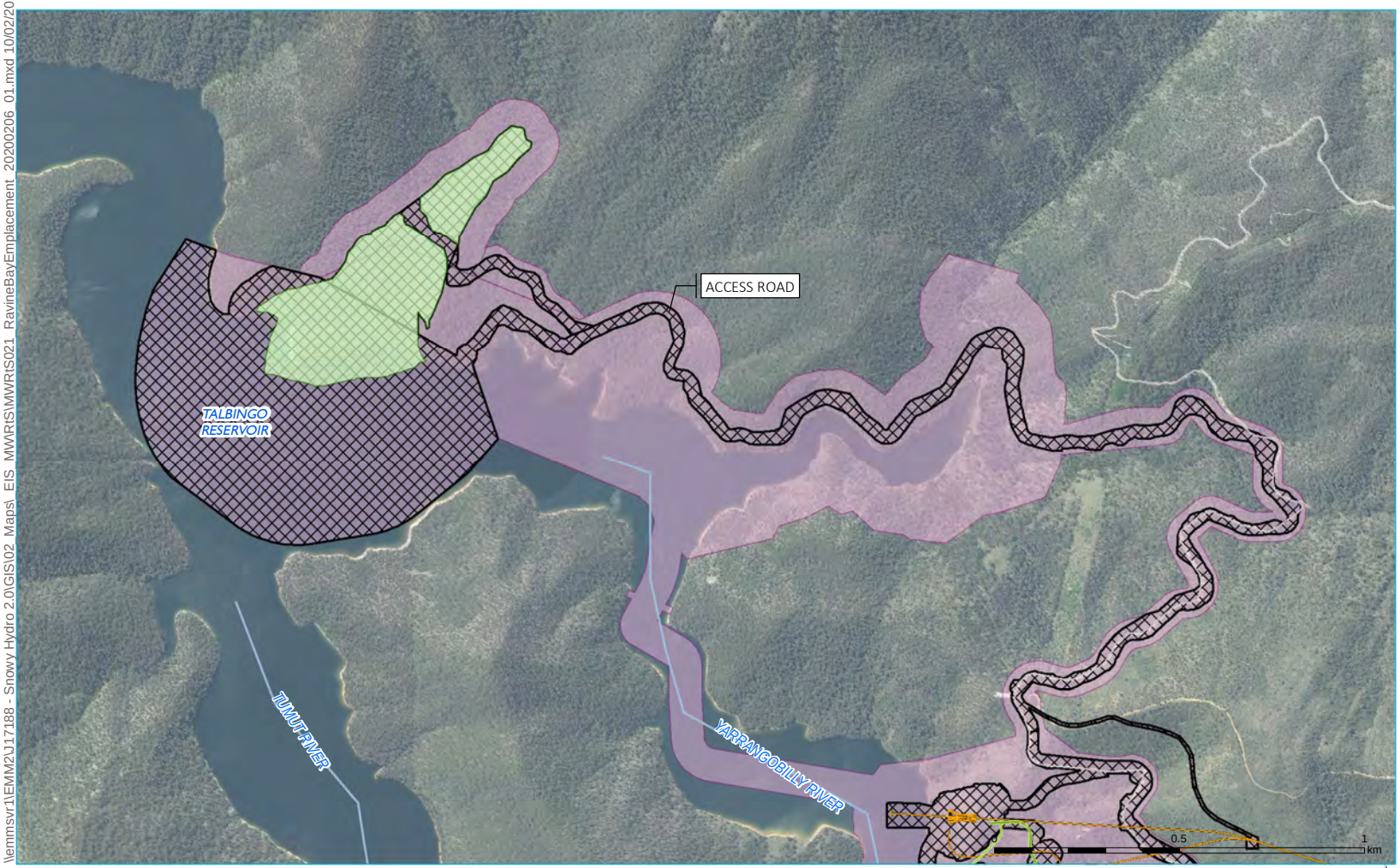
- Design optimisation that ensures that only D&B material is placed below FSL.

- Significant reduction in the overall volume of material placed into the reservoir, and in turn, a reduction in the footprint of material within the reservoir. This is the result of design and method optimisation.

- Improved amenity through the adoption of the geomorphic landform approach to ensure that the final landform integrates into the existing topography around the landform, minimising impacts to park users in the long term.

The design of the Ravine Bay rock emplacement is comprised of an underwater pad constructed using D&B material from the reservoir bed up to FSL. The capacity of the underwater D&B pad design would be approximately 1.8 million m^3 of excavated material.

On top of the D&B pad, and on existing land above FSL, placement of predominately finer TBM material will occur using the geomorphic landform method. The capacity of the design above the FSL is approximately 2.7 million m^3.



KEY

- Emplacement area

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Disturbance area
- Construction envelope

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

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

GDA 1994 MGA Zone 55

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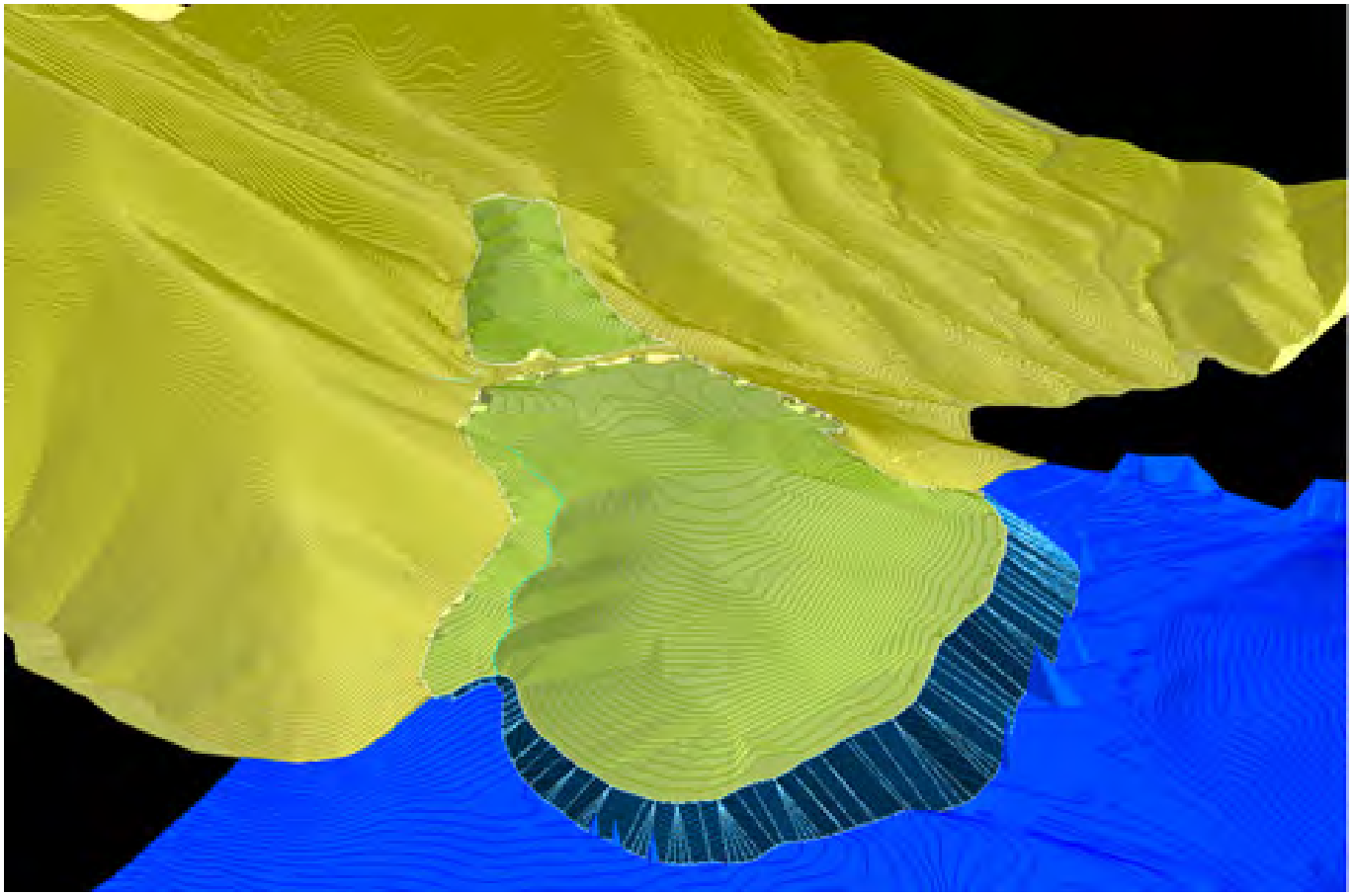
Location of Ravine Bay emplacement area

Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 3.12



Ravine Bay emplacement area visualisation and conceptual geomorphic design
Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 3.13

Additionally, Ravine Bay has sufficient capacity to manage the expected volumes of residual material from the proposed Transgrid Shallow Connection works. If TransGrid's separate application for these works is approved, a strategy and location for the disposal of excavated rock, primarily from road construction and transmission tower pad construction occurring in parallel with the Snowy 2.0 Main Works, is anticipated to be required. Based on initial geotechnical assessments, there may also be a volume of naturally occurring material (NOA) material that is required to be managed. Ravine Bay has sufficient capacity to accommodate this material which will be placed and managed as per to be NOA management methodology outlined below.

ii) GF01

GF01 is an all-to-land location between the Main Yard (Lobs Hole) and Ravine Bay. During the analysis of the options for the Talbingo excavated material emplacement to improve water quality outcomes within the reservoir, it was identified that the scheduling and production of material would not allow for all material to be accommodated at Ravine Bay, so a separate on-land location was required. The location of GF01 is shown in Figure 3.14.

In order to establish access to the Ravine Bay site, an access road must be constructed before placement in that location can begin. Construction of this access road results in a volume of material that needs to be placed elsewhere, as well as any other excess material that is generated during the construction of other access roads.

An options analysis for all-to-land options was completed and 13 locations were assessed and ranked. It was concluded that GF01 would the most suitable location as it:

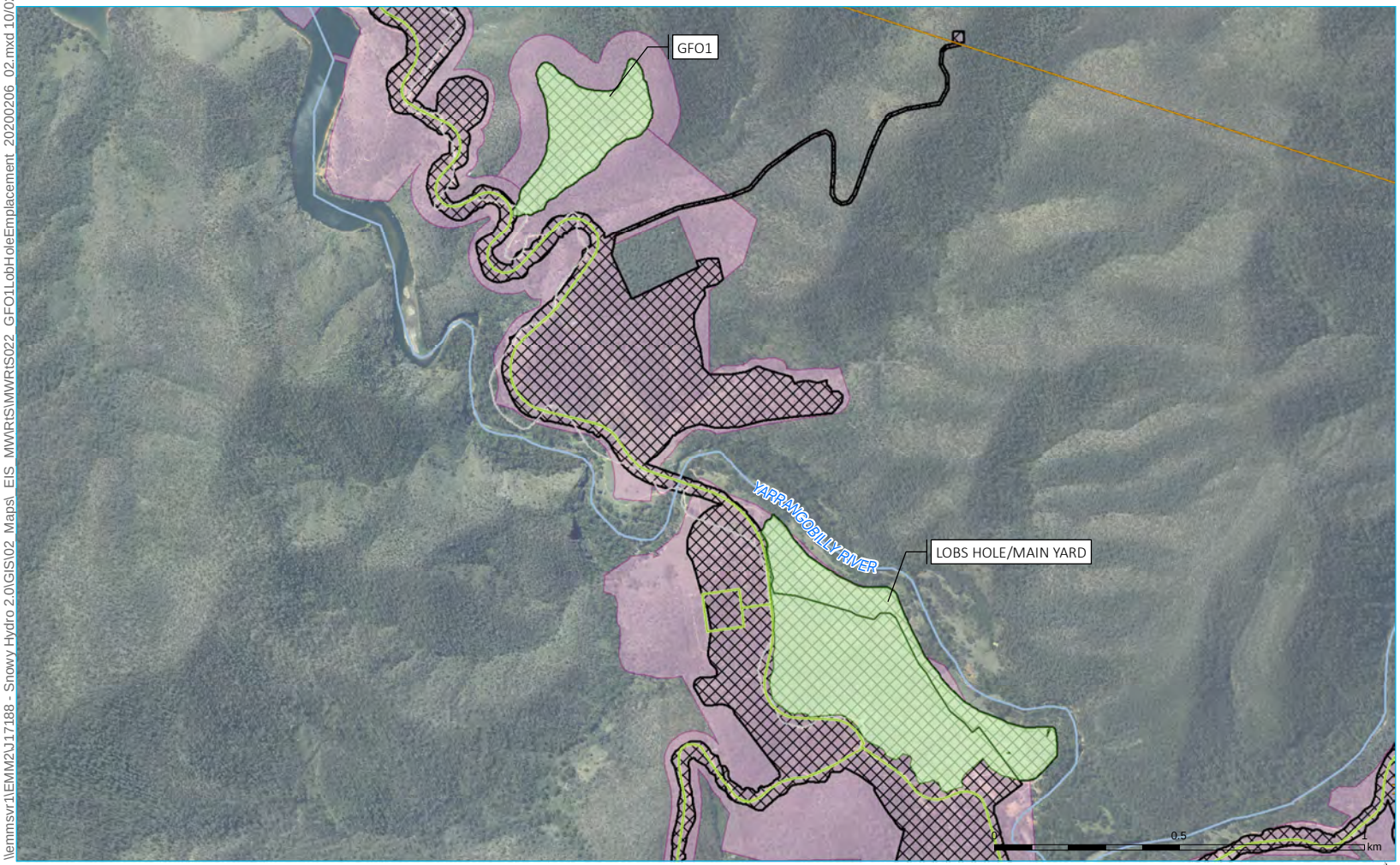
- avoids sensitive flora and fauna;
- avoids long-term recreational impacts at Lobs Hole;
- has one of the highest ratio of material capacity-to-area (resulting in a smaller disturbance footprint);
- is close to existing internal project roads; and
- has a small upstream catchment meaning less water to manage during emplacement.

The concept geomorphic excavated material design for GF01 has a capacity to accommodate approximately 1 million m^3 of excavated rock. The concept geomorphic landform methodology along with an aerial photo of the GF01 location can be seen in Figure 3.15. A short access road would be required to be constructed from Lobs Hole Road to access the site at GF01.

iii) Main Yard

During the construction phase of the Main Works, construction pads are required to house workshops, sheds, machinery, offices and other project related infrastructure. In order to get level platforms on which the necessary infrastructure can be constructed, excavated material will be emplaced and compacted into pads within Lobs Hole. The Main Yard (Lobs Hole) area is shown in Figure 3.14.

At the completion of construction, the Main Yard construction pads will be shaped using a geomorphic landform method and then rehabilitated. It is envisaged that in consultation with NPWS, the final landform would be developed and optimised to facilitate recreational use in Lobs Hole area.



KEY

- Emplacement area

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Disturbance area
- Construction envelope

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

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

GDA 1994 MGA Zone 55

N

GF01 and Lobs Hole/Main Yard emplacement areas

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 3.14

snowy 2.0

EMM creating opportunities

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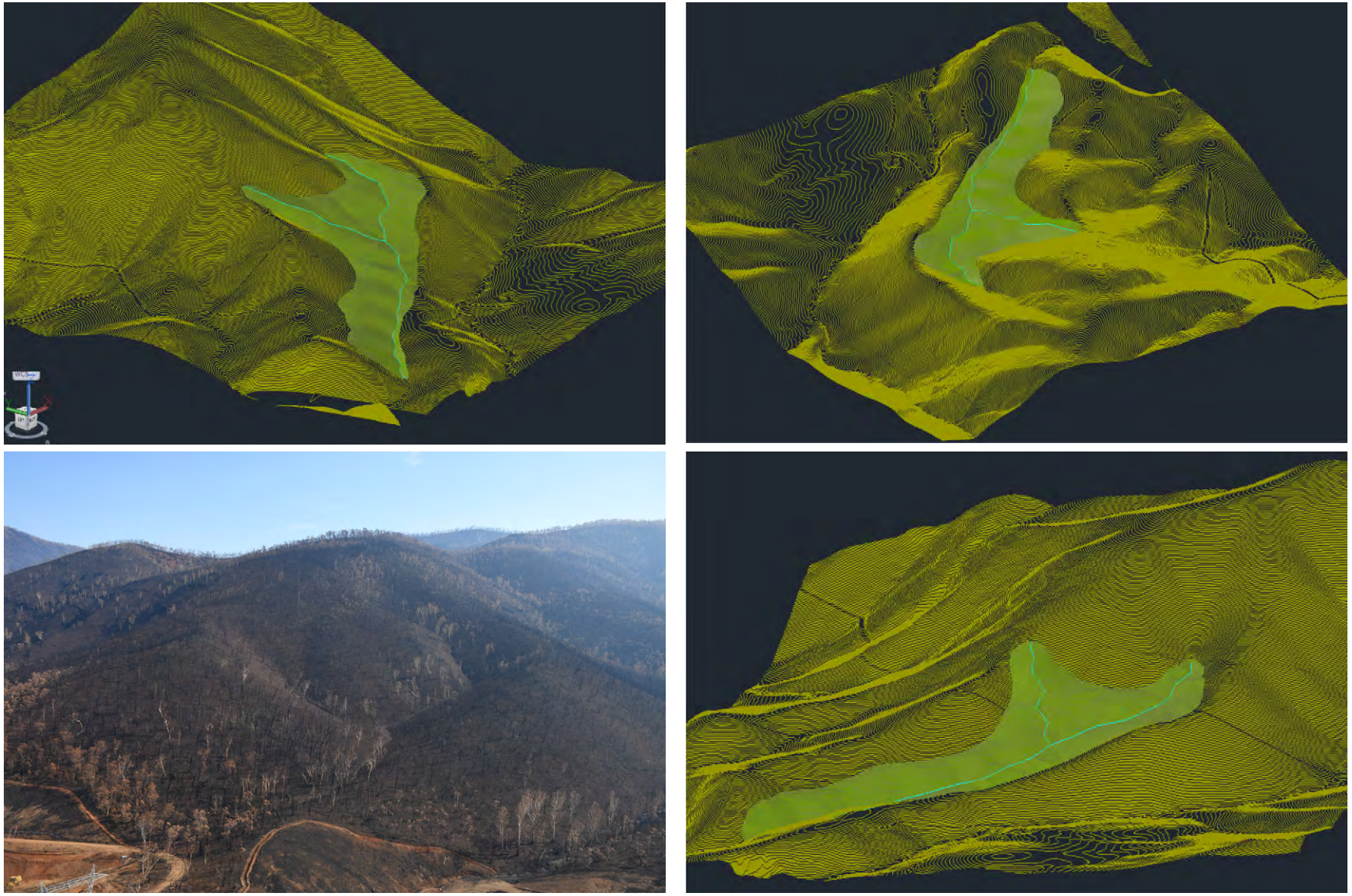


GF01 emplacement area (aerial view) and conceptual geomorphic designs

Construction method

The three locations of the Talbingo zone excavated rock emplacement (Ravine Bay, GF01 and Main Yard) are intrinsically linked. Without all three of these locations, the overall construction sequencing and methodology of the Main Works is not possible.

The Main Works EIS envisaged that all material (D&B and TBM) from within the Talbingo zone could be placed within the reservoir at Ravine Bay. The Main Works EIS indicated that temporary water quality outcomes were significantly above background levels, before returning to background levels within a few months of emplacement. In response to feedback from government agencies to improve these water quality outcomes, further investigations regarding amendments and alternatives for emplacement construction methods were carried out.

As a result of these investigations and to minimise adverse water quality outcomes, it is now proposed that only D&B material will be placed below FSL to construct the pad. The determining factor therefore of how much material could be placed in a geomorphic designed landform at Ravine Bay became the availability and quantity of D&B materials to establish the pad ahead of TBM material being generated (and requiring storage) in the Talbingo zone.

An important construction sequencing factor is that D&B material is primarily excavated from the underground construction adits around the power station complex and the excavation of the underground cavern itself, which are activities subsequent to TBM tunnelling commencing for Main Works, therefore this D&B material is not immediately available for use at Ravine Bay.

Figure 3.16 to Figure 3.19 present histograms which show the quantities and scheduling of the types of material generated from the Talbingo zone. An explanation of these figures follows subsequently.

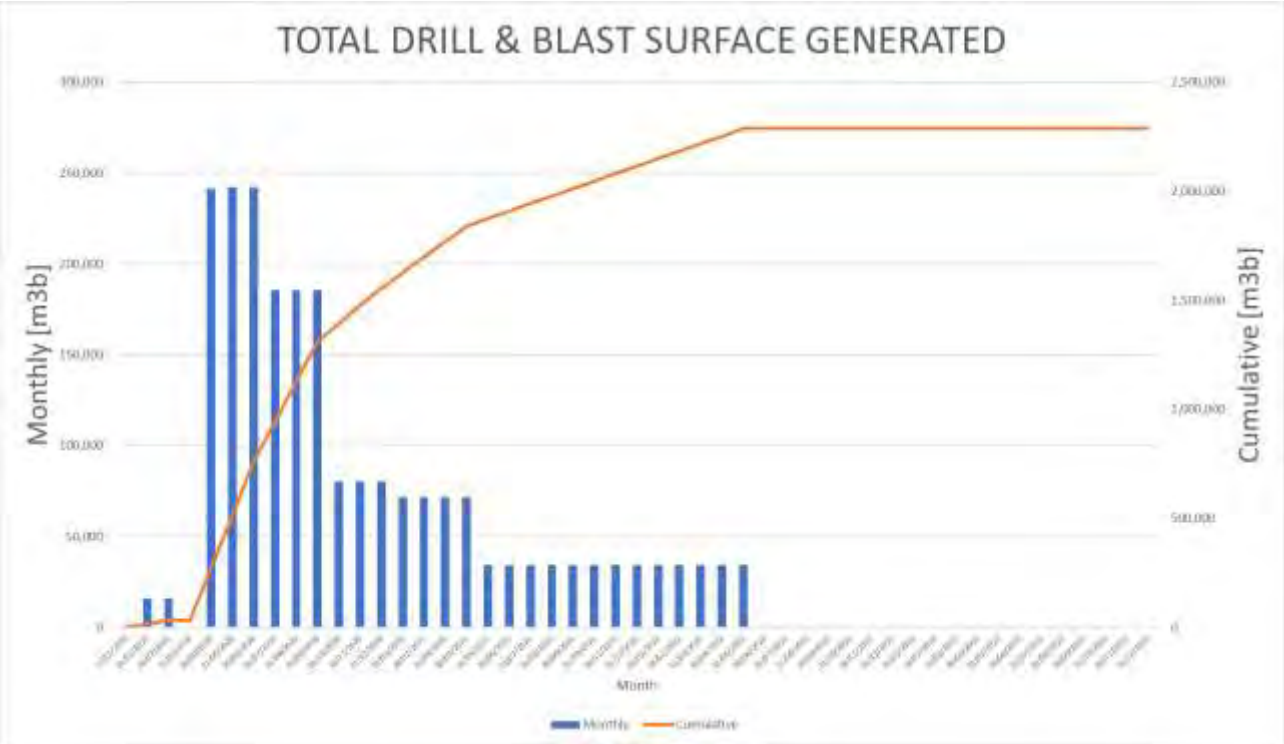


Figure 3.16 Total D&B excavated from surface works

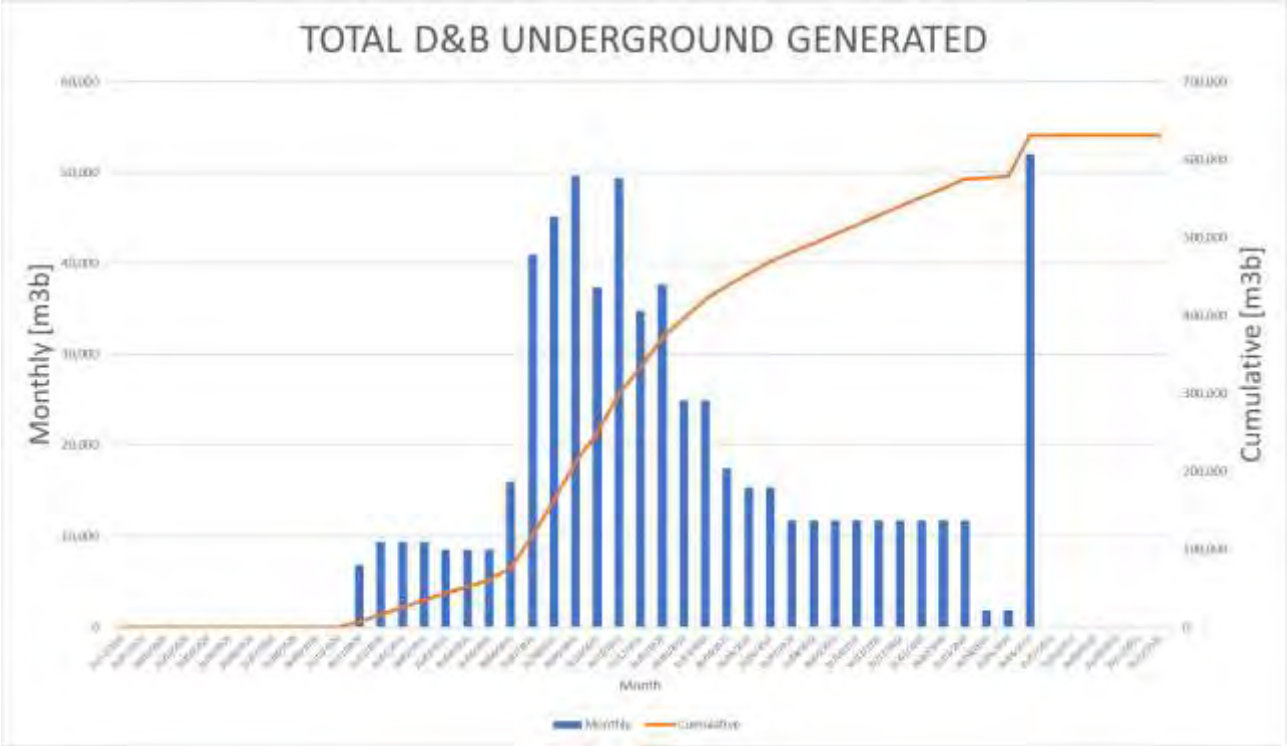


Figure 3.17 **Total D&B excavated from underground works**

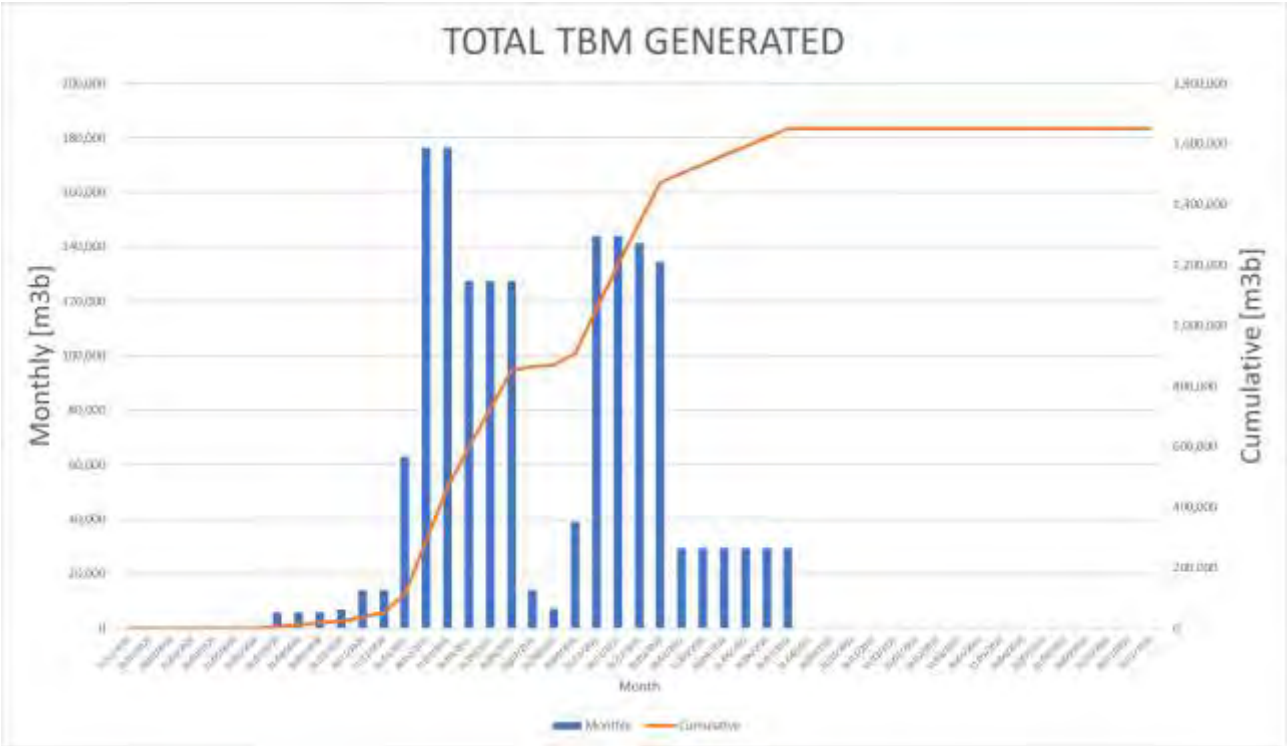


Figure 3.18 **Total TBM excavated from underground works**

Figure 3.19 Overall monthly excavation rate by area

As previously mentioned, there are inter-relationships between the three locations at Talbingo to implement the excavated rock management strategy. The sequence below illustrates the sequencing of activities and these inter-relationships for excavated materials management. Note that the dates expressed are indicative only and are based on the current project schedule and a nominal commencement of works in April 2020 based on the current construction schedule with FGJV.

- April 2020

    1. At the commencement of Main Works, the excavated material from surface activities(as outlined in Figure 3.16) as well as early tunnelling activities will be transported to Lobs Hole to construct the Main Yard. There is an urgency to complete the construction of these infrastructure pads due to their importance for logistically supporting the construction of the project.

    2. At the same time as the Main Yard is being constructed, the construction of the access road to Ravine Bay commences.

    3. Additional material that cannot be placed within the Main Yard will start to be placed at GF01.

- October 2020

    4. Once Ravine Bay Road is constructed, placement of material can commence at Ravine Bay. D&B material from excavation associated with the underground power station will be used to build the pad below FSL, whilst TBM material will be placed above FSL.

    5. There is only very limited capacity for TBM material to be placed on-land at Ravine Bay prior to the D&B pad being constructed within the reservoir. As such, as the D&B material is excavated and the

underwater pad enlarges and above FSL, more TBM material can be placed here, removing the need for further placement at GF01.

- June 2021

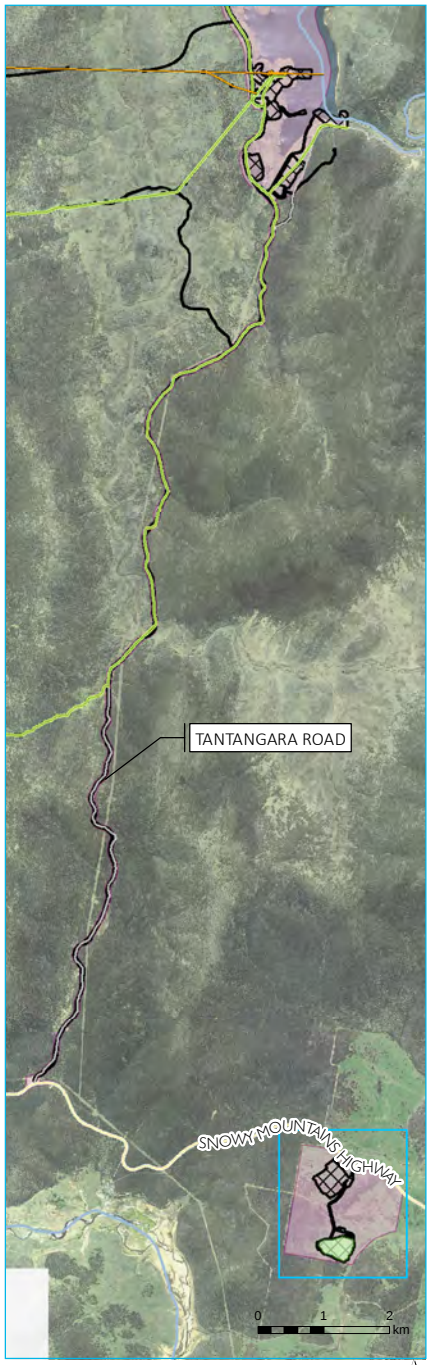
6. When both the Main Yard and GF01 have reached capacity, all the remainder of material is placed at Ravine Bay.

Marica zone

For the Marica zone, excavated rock and material will be generated during mobilisation and establishment activities as well as the construction of permanent assets required for Snowy 2.0. Activities generating excavated material in this area include establishment of Marica access road, construction of part of Marica West track, headrace tunnel surge shaft and any other excavation conducted in this area. Figure 3.3 provides an outline of the disturbance area and permanent assets required in the Marica zone.

Excavated rock generated from the Marica zone is now proposed to be transported to Rock Forest which is outside KNP. Once placed at Rock Forest, the excavated rock will be geomorphically landformed, and then rehabilitated consistent with the other on-land emplacements. The Rock Forest emplacement area location is provided in Figure 3.20 below.

The overall volume of excavated material to be handled at Marica is approximately 400,000 m^3. There is also sufficient capacity for the total volume of the Marica material to be included within the Tantangara 'Peninsula' emplacement area (see section below), which is also considered a feasible, but not preferred, option for emplacement of this material.



KEY

Emplacement area

Existing environment

Main road

Local road

Watercourse

Snowy 2.0 Main Works operational elements

Tunnels, portals, intakes, shafts

Utilities

Disturbance area

Construction envelope

The disturbance area is the extent of construction works required to build Snowy 2.0. The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that there will be some minor amendments to the disturbance area.

Rock Forest emplacement area

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 3.20

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

GDA 1994 MGA Zone 55

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Tantangara zone

Excavated rock material generated in this zone is primarily from the Tantangara intake structure and the headrace tunnel. All high-level concept options were considered, with numerous assessments completed to determine the feasibility of each.

Construction method

Figure 3.21 presents a histogram which shows the quantities and scheduling of the types of material generated from the Tantangara zone:

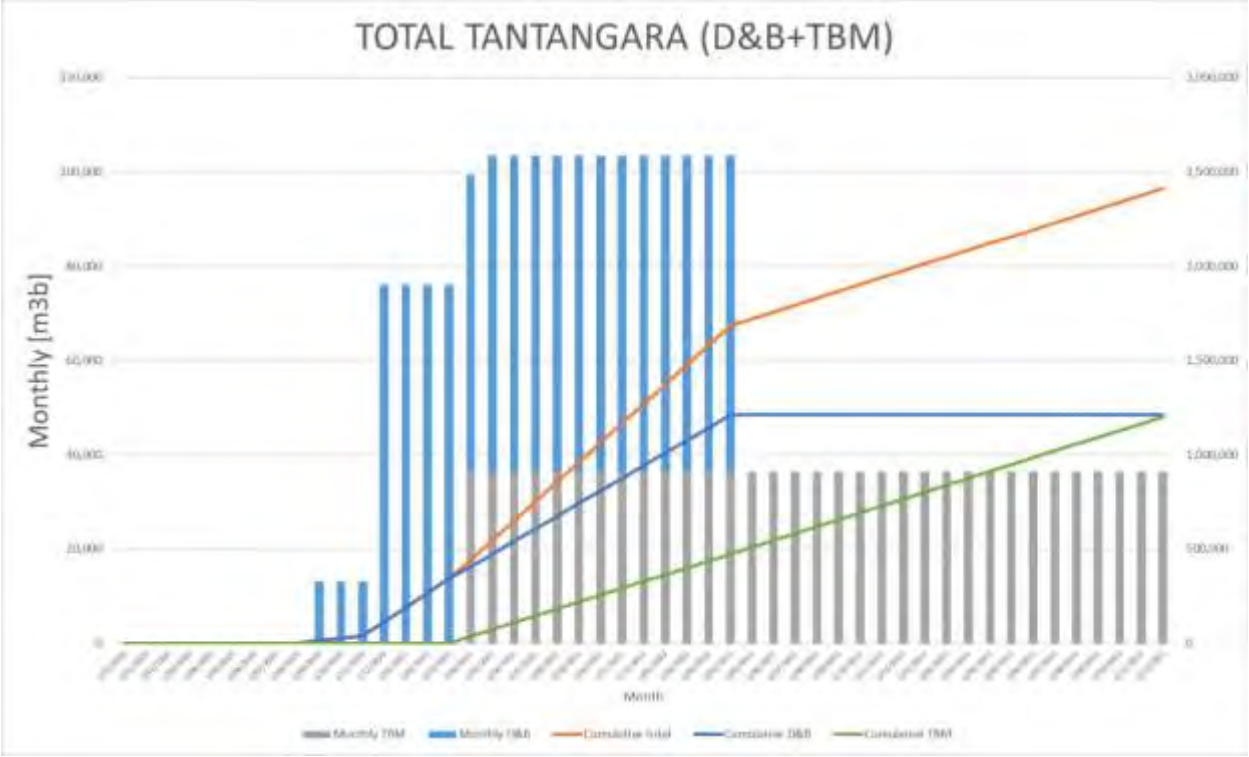


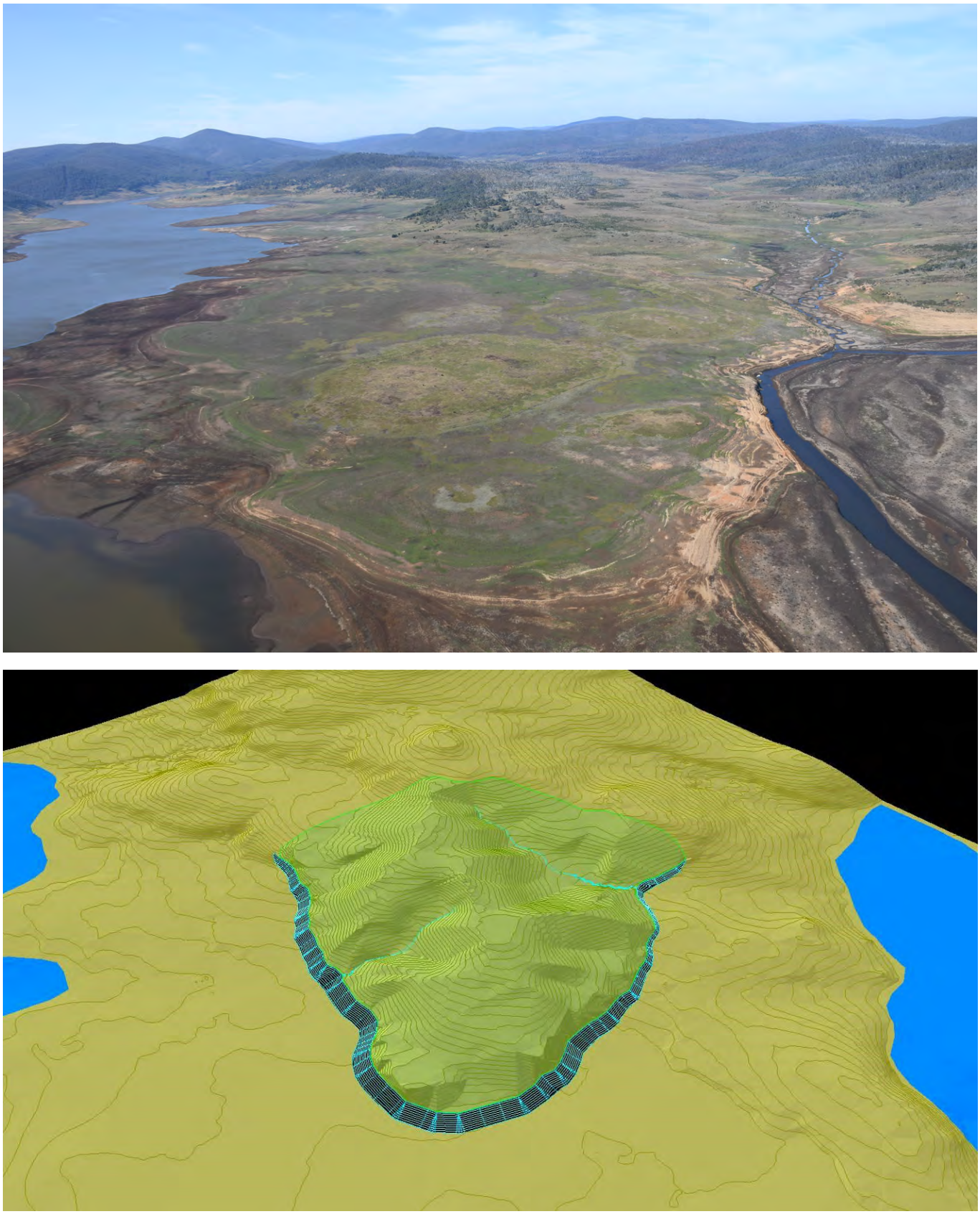
Figure 3.21 Expected total monthly excavation of D&B and TBM material from across the Tantangara Zone

The proposed location for the Tantangara 'Peninsula' excavated rock placement area is north of the location proposed in the Main Works EIS. Approximately 60% of the emplacement location footprint is below FSL.

Figure 3.22 provides a photo of the proposed location along with a conceptual geomorphic landform design. Figure 3.23 provides the location of the Peninsula emplacement area.

The proposed location would involve constructing a geomorphic landform method connecting to the existing ridgeline that runs along the western shoreline of Tantangara Reservoir. Similar to Ravine Bay at Talbingo, D&B material would be placed below FSL, with a capacity for approximately 1 million m^3, whilst the TBM material would be placed above FSL allowing for an additional 1.9 million m^3.

All emplacement activities would be constructed above water levels as Snowy Hydro is able to manage the operational water levels within Tantangara Reservoir through operation of the existing Snowy Scheme. The following figure outlines the proposed design, and how it would integrate with the existing ridge.



Tantangara Peninsula emplacement area (aerial view) and conceptual geomorphic designs

KEY

- Emplacement area

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Disturbance area
- Construction envelope

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

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

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Tantangara Peninsula emplacement area

Snowy 2.0
Preferred infrastructure report and response to submissions
Main Works
Figure 3.23

In addition to the proposed method for managing the encapsulation of NOA as presented in the Main Works EIS, it is also proposed to include emplacement of this material at the Tantangara Peninsula site to allow for management and handling of this material immediately after excavation. Both methods of encapsulation, the first being within the emplacement area and the second being storing and managing separately on land and then transporting to within the construction adit to the headrace tunnel following its construction are proposed. Section 4.4.4i of this document provides a description of how these materials will be managed safely. The same method of placement and handling would also apply to any NOA material required to be placed at Ravine Bay in the Talbingo Zone.

As stated in the EIS, this volume is expected to be approximately 150,000 m^3 which is based on current geotechnical information. Figure 3.24 below provides a conceptual design of how the material will be managed and encapsulated within an emplacement area. It will be placed above FSL as well as in areas where there is enough depth of cover (ie excavated rock materials) to ensure sufficient final capping.

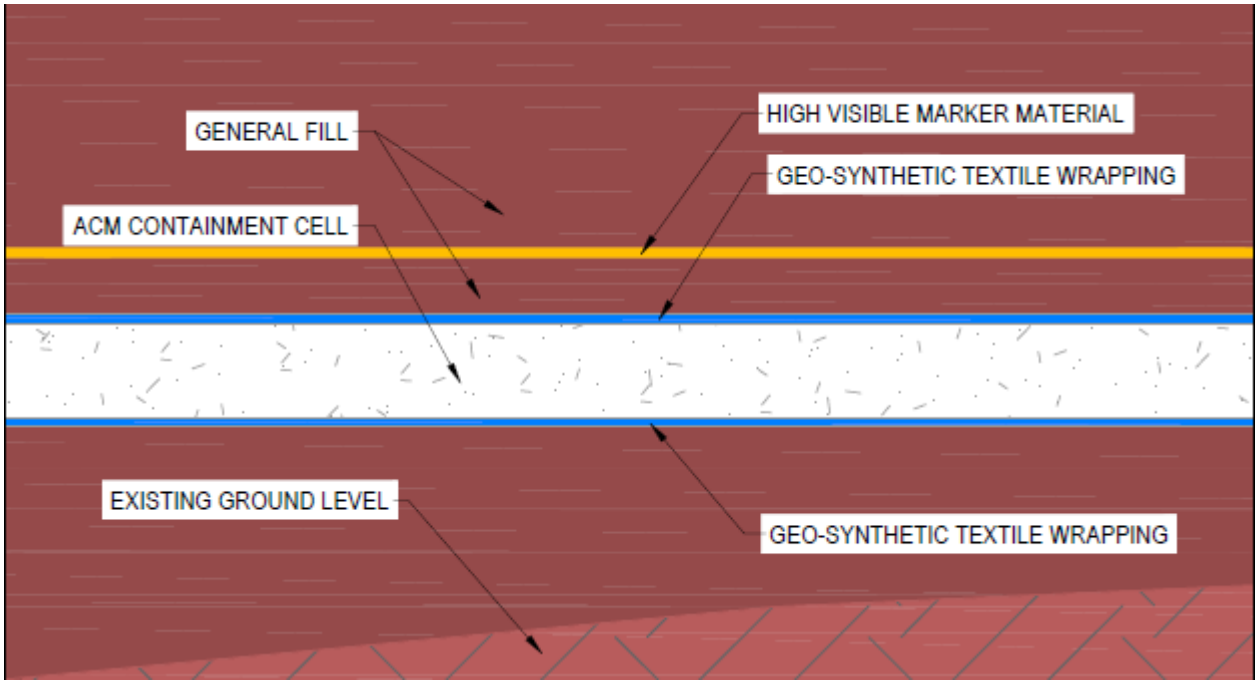


Figure 3.24 Conceptual design for NOA encapsulation within Tantangara Peninsula emplacement area

iv Preliminary assessment of preferred excavated rock management strategy

Technical assessments within the EIS comprised information that related to the proposed emplacement areas. The emplacement area footprints at Rock Forest and Lobs Hole were addressed in their entirety and are not discussed any further within this section.

The below sections provide preliminary assessments for the proposed emplacement areas of Ravine Bay, GF01 and Tantangara Peninsula, where relevant.

a Biodiversity values

Biodiversity values of the emplacement areas are well understood. The below sections provide a summary of these values. As previously discussed in Chapter 1, the BDAR provided in Appendix G does not contain a complete assessment of the proposed emplacement areas. An updated BDAR will be prepared prior to approval to include these emplacement areas.

Ravine Bay

The southern half of the Ravine Bay south emplacement area extent has been assessed as part of the BDAR. Within this area, targeted fauna surveys were completed for diurnal birds, arboreal mammals and small terrestrial mammals. Species recorded within and adjacent to the disturbance area include Dusky Woodswallow, Eastern Pygmy-possum, Gang-gang Cockatoo and White-bellied Sea-Eagle.

Candidate species credit species recorded within and adjacent to the disturbance area include the White-bellied Sea-Eagle (breeding habitat), Eastern Pygmy-possum and Gang-gang Cockatoo. However, the Gang-gang Cockatoo was not recorded nesting within the disturbance area. Additional surveys for candidate species credit species such as diurnal birds and arboreal species have not been completed in the northern section of the emplacement area.

The Ravine Bay emplacement area was assessed in the aquatic ecology assessment provided in the Main Works EIS. The area of direct impact has been reduced to 3 ha with no additional areas outside the locations assessed in the aquatic ecology assessment. The proposed placement of coarse D&B material in a 3 ha area of Ravine Bay would provide habitat complexity due to the addition of different sized bed material into the benthic environment. Hard surfaces such as rocks / boulders provide habitat complexity that is attractive to trout cod (NSW DPI 2006) and Murray crayfish. The introduction of rock material to Ravine Bay is therefore expected to contribute to habitat complexity and benefit these aquatic species, particularly if the natural abundance of rocky habitat is currently limited.

To help mitigate risks to aquatic biota from changes in water quality during excavated material placement in the reservoir, a Trigger Action and Response Plan (TARP) will be in place with real time continuous physicochemical water monitoring at buoys immediately adjacent to the rock emplacement area and in locations further away. Trigger action responses will depend on the extent of water quality impacts and will be developed in consultation with relevant agencies (refer to Section 4.4.1 for further information).

GF01

GF01 has not previously been assessed within the BDAR. However, targeted flora surveys were completed adjacent to the disturbance footprint, recording *Caladenia montana*. Targeted flora and fauna surveys have not been completed within the GF01 emplacement area extent. However, adjacent survey plots provide for likely species to occur. Species credit species with potential to occur include Gang-gang Cockatoo (breeding habitat), *Caladenia montana* and *Pomaderris cotoneaster*. Additionally, the Eastern Pygmy-possum will be impacted by GF01, with the species associated with PCTs (plant community types) recorded within the disturbance area.

Tantangara Peninsula

The Peninsula emplacement area has not previously been assessed within the BDAR. Targeted flora species with potential to occur within the disturbance area include Mauve Burr-daisy (*Calotis glandulosa*), Max Mueller's Burr-daisy (*Calotis pubsecens*), Raleigh Sedge (*Carex raleighii*), Leafy Anchor Plant (*Discaria nitida*), Clover Glycine (*Glycine latrobeana*), *Prasophyllum innubum*, Kiandra Leek Orchid (*Prasophyllum retroflexum*), Blue-tongued Greenhood (*Pterostylis oreophila*) and Monaro Golden Daisy (*Rutidosis leiolepis*). Targeted fauna species which will be impacted by the Peninsular emplacement area are the Broad-toothed Rat and Alpine She-oak Skink; these species are associated with PCTs recorded within the disturbance footprint. Additionally, one threatened ecological community (TEC), Alpine Sphagnum Bogs and Associate Fens, has the potential to occur within the Peninsula emplacement area.

A preliminary assessment of impacts to aquatic ecology found the proposed Peninsula emplacement area similar to the area and method presented in the Main Works EIS, although the footprint may be slightly adjusted along the shore. Most of the material will be placed above MOL using dry placement techniques and therefore, with the adoption of appropriate sediment control measures, impacts to water quality are likely to be low. No sensitive aquatic habitats are known from the proposed footprint.

b Water management

On-land emplacement is part of the proposed strategy for the management of excavated rock material from tunnelling operations. The locations and proposed designs of the excavated rock stockpiles is key to ensuring that water management risks are adequately considered. Key water management risks include:

- discharge of runoff laden with either coarse sediment or fine and/or dispersive material that will not readily settle under gravity in receiving waters;
- other changes to water chemistry associated with water contact with contaminated material; and
- erosion due to inadequate drainage design, construction or rehabilitation.

As previously discussed, geomorphic landform design is a fluvial geomorphic method that aims to create a landform that mimics the functions of the natural landscape that would have naturally evolved over time.

The characteristics of material produced by tunnelling are expected to vary and some contaminated material may be encountered, including potentially acid forming (PAF) and NOA. Following the design of the on-land emplacement areas, the following mitigation and management principles are proposed:

- characterisation of excavated material and identification of contaminated soils (NOA / PAF material);
- construction of the on-land emplacement areas in stages, including clearing, grubbing and topsoil retention, benching of existing landforms where required, placement of material in cells or layers, trimming slope batters to reflect the geomorphic landform design method and rehabilitation;

  Note construction staging will consider risk assessment and where appropriate, demarcation and management of NOA and PAF material within the emplacement.
- preparation of progressive Erosion and Sediment Control Plans (ESCPs) for each on-land emplacement area to reflect construction staging, including:
  - applying clean water management controls where possible;
  - directing stormwater from emplacement or disturbed areas to temporary controls;
  - consideration and application of appropriate practical temporary stabilisation methods.
- revegetation and stabilisation in accordance with the rehabilitation strategy.

c Amenity and recreational users

The amenity and park user impacts from the preferred excavated rock management strategy are largely consistent with those assessed in the EIS.

At Talbingo, the proposed emplacement areas are generally consistent with those previously assessed within the EIS. The EIS concluded that views of Ravine Bay from water-based receptors nearby would be adversely affected during construction. Lobs Hole would have limited visibility during construction given restricted access to the public and impacts would be negligible.

During operations, assessed impacts to views of Ravine Bay and Lobs Hole land-based emplacements were largely dependent on the shaping of the landform and its ability to complement the surrounding landscape. The implementation of geomorphic landform design methods for these emplacement areas and rehabilitation of the landforms is considered to result in improved amenity outcomes than previously predicted for these areas. The

inclusion of GF01, in proximity to both Ravine Bay and Lobs Hole, within the strategy is consistent with these conclusions.

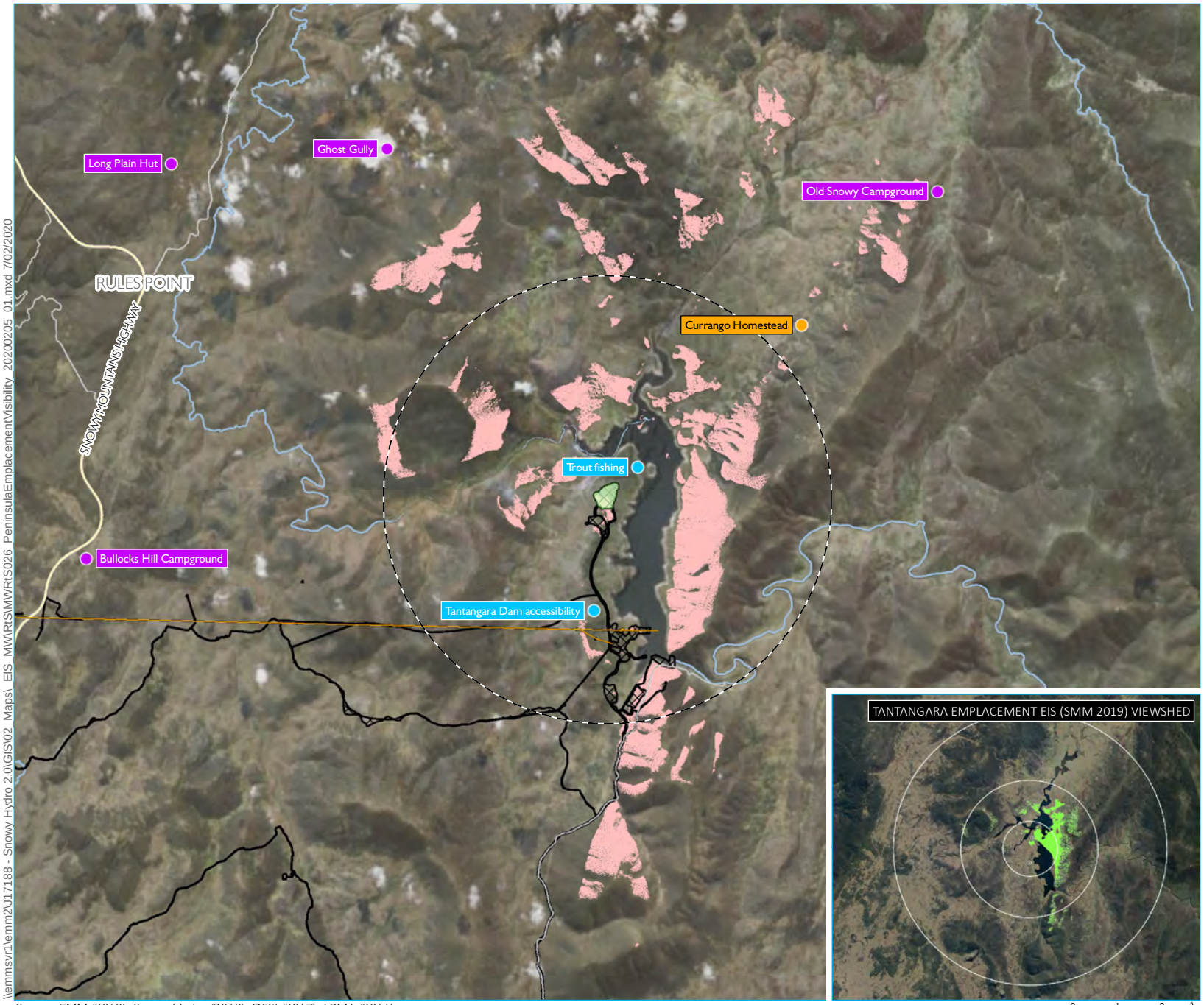
At Tantangara, the proposed Peninsula emplacement area is north of the area assessed in the EIS. The location of Peninsula emplacement area and the resultant amenity impacts for both water-based and land-based receptors during construction are generally consistent to the overall conclusions presented in the EIS. The EIS assessed emplacement area was highly visible to both water-based and land-based users proximate to the reservoir. Views during construction would be adversely affected. Receptors that were either close or had unobstructed views were more sensitive to the visual impact with receptors further away or experiencing intermittent views less sensitive to the change in amenity.

During operations, visibility of the emplacement area assessed within the EIS was considered between moderate and high, largely dependent on the distance and nature of the view to the landform. The Peninsula emplacement area is consistent with these conclusions with views more prominent to those receptors in the north of the reservoir than those in the south, such as the dam wall.

Figure 3.25 provides a comparison of the viewshed (or zone of theoretical visibility) for the emplacement area assessed in the EIS (see inset) and the proposed Peninsula emplacement area. This figure demonstrates that both emplacement areas have high visibility given they are on the edge of the reservoir. Similar to Ravine Bay and GF01, the implementation of geomorphic landform design methods for these emplacement areas and rehabilitation of the landforms is considered to improve previously predicted amenity outcomes for these areas.

The EIS assessed construction impacts to Rock Forest and considered amenity impacts negligible due to the temporary nature of the disruption. The proposed emplacement area at Rock Forest will introduce a change to the landscape during operations which may be visible to some isolated receptors, predominantly south of the emplacement area. Due to the intervening topography between the emplacement area and the receptors, it is expected these views may be limited. It is noted that some of these receptors may experience some intermittent noise from these emplacement activities, which were not previously assessed within the EIS.

The proposed changes to the location of the emplacement areas previously assessed does not change the outcomes for recreational users. As outlined in Section 4.4.8, the recreational offset package has been further developed in consultation with NPWS in the period since exhibition and includes measures to enhance the recreational values of areas that have been impacted by the Main Works.



KEY

- Peninsula emplacement area
- Modelled visibility of the Peninsula emplacement area
- 5km buffer

Recreational use areas

- Camping - horses permitted
- Fishing and boating
- Place of interest

Existing environment

- Main road
- Local road
- Watercourse

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Utilities
- Disturbance area

The disturbance area is an estimation of the area required for construction works based on the current level of project design. Detailed design is still required to be completed, therefore it is expected that the precise location of the disturbance area may move within the broader construction envelope and consequently there will be some further refinements to the disturbance area.

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

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Tantangara emplacement viewshed analysis

Snowy 2.0
Preferred infrastructure report
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Main Works
Figure 3.25

d Heritage

NSW Archaeology completed a desktop Aboriginal and historic heritage assessment for the emplacement areas (NSW Archaeology 2020) which is provided in Appendix M. The proposed Talbingo excavated rock emplacement areas GF01 and Ravine Bay, and Tantangara Peninsula are partially within previously assessed archaeological survey units. All previously assessed areas have had appropriate impact assessment and management measures ascribed which is presented in Snowy 2.0 Main Works ACHA (NSW Archaeology 2019).

Additional desktop assessment was completed for the emplacement area boundaries that extend beyond the existing heritage survey units and each of these areas were attributed new survey unit areas (RSU38b, RSU40b, and TSU14b). At Tantangara, survey unit TSU14b was considered to have potential for high Aboriginal artefact incidence and NSW Archaeology recommended field survey, possibly followed by salvage excavation, if warranted. NSW Archaeology recommended for these measures to be included in the proposed Heritage Management Plan for Snowy 2.0 Main Works.

At Ravine Bay and GF01, survey units RSU38b and SUR40b were assessed to have low Aboriginal artefact incidence whereby NSW Archaeology recommended no unmitigated impacts and no further assessment.

No impacts to historic heritage items are anticipated at any of the additional survey units and no further investigation was recommended in relation to historic heritage.

e Traffic and transport

Traffic associated with the preferred emplacement strategy is largely within the project site and subject to the internal road network. The exception is the transportation of excavated rock generated at Marica.

The Main Works EIS assessed the transportation of this materials to Tantangara via the Snowy Mountains Highway. The preferred emplacement strategy transports this excavated rock from Marica to Rock Forest via the Snowy Mountains Highway. This haulage route is another approximately 6.1 km east of the intersection of Tantangara Road and the Snowy Mountains Highway before using the proposed access intersection into the Rock Forest property.

A traffic and transport assessment of this amendment was carried out and concluded that there were no adverse impacts to the performance of the road network or at the access intersection with the Rock Forest property. Further information is provided in Appendix K.

v Detailed design for the emplacement areas

The preferred excavated material strategy presented has been developed to a satisfactory conceptual level in consultation with key agencies to enable assessment and determination of the project. Work has already commenced on the detailed design process and to develop construction method statements for execution. These activities require further detailed investigations to inform these design and constructability details.

Key activities to be carried out during the detailed design process include the following.

- Soils and erosion characterisation and assessment
    - Identification of the likely material to be used on the outer surface of each feature (topsoil etc) and its integration with the detailed Rehabilitation Management Plan.
    - This work will involve an initial erosion and sediment assessment.
    - Once site access is established, samples of the material will be obtained to verify the initial soils and erosions assessments.

- Landform assessment
    - Detailed assessment of the non-alluvial analogues (ie overall gradients steeper than what is stable on natural alluvial landforms in the local area).
- Constructability development
    - Detailed method statements require development in order to demonstrate how the geomorphic landforms will be constructed (eg the use of staging and benches to develop the landform in steeper environments).
- Geomorphic methodology design
    - Refinement and further development of the design using design software (eg Civil 3D, Natural Regrade/Carlson Civils or other suitable software).

Snowy Hydro will ensure these activities will be carried out consistent with management plans where required.

3.2.3 Change to tunnelling methods and staging

i TBM staging

Progress on the detailed design of the project made since the exhibition of the Main Works EIS requires some minor revisions to the proposed tunnelling methods and staging.

The TBM drive for the ECVT tunnel (TBM 2) now continues past the power station complex and constructs the single inclined pressure shaft. The MAT TBM (TBM 1) commencing as part of EW stops at the power station complex and is removed. TBM 1 will initially excavate the MAT, continue past the power station complex and complete the North Access to the Bifurcation Chamber. This TBM will then be disassembled, removed and transported to the tailrace tunnel entrance. TBM 1 will then excavate the tailrace tunnel eastwards until the power station complex. This TBM will then be removed via the ECVT.

TBM 2 will be launched at the ECVT portal shortly after TBM 1. TBM 2 will excavate the ECVT, continue past the power station complex, excavate the inclined pressure shaft and pass the headrace surge shaft. The TBM will stop prior to the predicted naturally occurring asbestos (NOA) material within the headrace tunnel.

TBM 3 will start at the Tantangara Adit to excavate the headrace tunnel in a westward direction. This TBM can operate in slurry mode to manage the NOA material expected along the way. TBM 2 and 3 will be disassembled and removed via the tunnels that have been constructed eg the inclined pressure shaft and the headrace tunnel respectively, or via the headrace surge shaft. There has been discussion about an alternative location to launch TBM 3, possibly down the intake gate shaft, however an alternative design has not been submitted during preliminary design.

This tunnelling program differs slightly from the tunnelling program proposed in the Main Works EIS which assumed that TBM 1 was to excavate the MAT, through the power station complex, and then continue through to excavate the headrace tunnel, concluding at the headrace surge shaft. Therefore, TBM 2 was to excavate the ECVT and conclude at the power station complex. This construction method and sequence was altered as described above to separate the construction of the pressure tunnels and penstock tunnels around the power station complex from the inclined pressure shaft construction. If TBM 1 excavated past the power station and continued on through the inclined pressure shaft and headrace tunnel, any construction in the power station complex could impact the works in the headrace tunnel or vice versa.

Now that TBM 2 excavates the headrace tunnel, the progress of TBM 2 and the power station complex is segregated. This reduces construction schedule and improves the safety of the operation by separating these critical works. If TBM 1 excavated past the power station and continued on through the inclined pressure shaft and headrace tunnel, any construction in the power station complex could impact the works in the headrace tunnel or vice versa.

ii TBM launch location

An option has been identified to launch TBMs from the Talbingo and Tantangara intakes respectively. The TBMs will either be launched via the Talbingo and Tantangara adit as presented within the Main Works EIS, or via the Talbingo intake structure. Launching through the intake would result in a reduction in the length and diameter of the access adit which will still be required for servicing of the TBM.

iii Power station excavation methods

The initial power station complex construction method was to be drill and blast, however, as the preliminary design has progressed, an alternative construction method option is proposed. An option for the power station complex is the use of machinery called a Surface Miner. The benefit of this excavation method is lowering air, dust and noise pollution in the cavern, resulting in the ability to allow other works to continue simultaneously. However, the application of a Surface Miner is determined by the geotechnical properties of the area being excavated, and needs further investigation during design and construction phases.

3.2.4 Change to surge shaft design

An alternative option for the surge shaft at Marica is proposed. In the design presented in the Main Works EIS, the headrace surge shaft extended 15 m above surface level. However, since the exhibition of the Main Works EIS an alternative option for the surge shaft design has been identified. In this option the headrace surge shaft incorporated a surface surge pond in the design, where the surge pond is capable of holding the required amount of water during an extreme hydraulic event during operations. The surge pond and surrounding Snowy Hydro assets will be fenced and inaccessible to the public.

Figure 3.26 3D view of alternative surge shaft design

Originally, it was proposed that the blind sink method was to be used for the headrace and tailrace surge shaft construction. However, preliminary design proposes a combination of raise boring and drill and blast construction methods, where the excavated material would fall into the tunnel, and be continuously removed. These construction methods are still in development through the detailed design phase.

3.2.5 Revision of construction traffic volumes

Since the public exhibition period, clarification of the predicted traffic volume data has identified a significant reduction in the predicted traffic movements. The final traffic volumes show a peak of approximately 410 (205 in each direction) truck movements per day through Cooma for Snowy 2.0, noting the average number of trucks is lower through the project. The EIS for the Main Works, and its supporting traffic and transport impact assessment (TIA), were based on predicted operational project-generated traffic volumes that are double those now proposed.

The volumes are different to what was modelled in the traffic and transport assessment which was 820 daily two-way heavy vehicle movements (ie 410 one-way movements). The change was the result of how the data provided by FGJV was interpreted with respect to the definition of 'one-way movements'. Accordingly, predicted operational project-related traffic volumes would now be half of those contained within the EIS and the detailed traffic and transport assessments.

For example, the Main Works EIS and TIA assessed traffic impacts of a peak of 402 one-way (or 804 two-way) daily operational heavy vehicle movements on the Link Road between Kings Cross Road and Snowy Mountains Highway. This would now be a peak of 201 one-way (or 402 two-way) daily operational heavy vehicle movements. The predicted average and peak daily light and heavy vehicle one-way movements during the operations of the Main Works are consistent with what was presented in the EIS and is provided in Table 3.8 and Table 3.9 below.

Table 3.8 Predicted daily traffic volumes by road section – KNP

Road	Location	Baseline traffic (Non-winter)		Main Works only		Main Works + Polo Flat	
		LV	HV	LV	HV	LV	HV
Link Road	Between Kings Cross Road and Snowy Mountains Highway	316	44	150	224	150	402
Link Road	West of Lobs Hole Ravine Road	206	22	48	44	48	44
Snowy Mountains Highway	North of Link Road (Garden Gully Creek)	436	79	42	146	42	148
Snowy Mountains Highway	North of Yarrangobilly Caves intersection	385	70	24	64	24	64

Notes: All volumes provided are two-way movements

Table 3.9 Predicted daily traffic volumes by road section – Cooma

Road	Location	Baseline traffic	(Non-winter)	Main Works	only	Main Works+	Polo Flat
		LV	HV	LV	HV	LV	HV
Snowy Mountains Highway	West of Cooma	3,499	477	98	252	124	410
Snowy Mountains Highway	Old SMEC Offices	4,261	586	98	252	194	410
Snowy Mountains Highway	Cooma	4,888	1,509	94	252	264	390
Monaro Highway	South of Cooma	1,524	971	36	82	50	78
Monaro Highway	East of Polo Flat	4,198	683	48	176	74	270
Polo Flat Road	Polo Flat North	1,036	806	26	82	196	252
Polo Flat Road	Polo Flat South	1,102	1,067	42	82	308	78

Notes: All volumes provided are two-way movements

A revised assessment of intersection capacity has been prepared accordingly and is presented in Section 3.4.4.

3.2.6 Revised segment transport vehicles

In addition to the above, FGJV is in the process of applying to use Performance-Based Standards (PBS) vehicles to transport segments between the segment factory and construction sites for Snowy 2.0. These vehicles include three articulated trailers which would hold three times the number of segments compared to a regular semi-trailer (ie nine segments compared to three) and as such would reduce the number of heavy vehicle movements transferring segments by about 66%.

The design of the PBS vehicles (see Figure 3.27) is currently under assessment by the National Heavy Vehicle Regulator. It is anticipated that a decision on the use of the PBS vehicles will be made in quarter 1, 2020. If approved by the regulator, FGJV anticipate that the PBS vehicles would transport all segments to the construction sites for Snowy 2.0, including Main Works. Notwithstanding this, other heavy vehicles may be required for materials and segment transport during the initial construction of the segment factory.

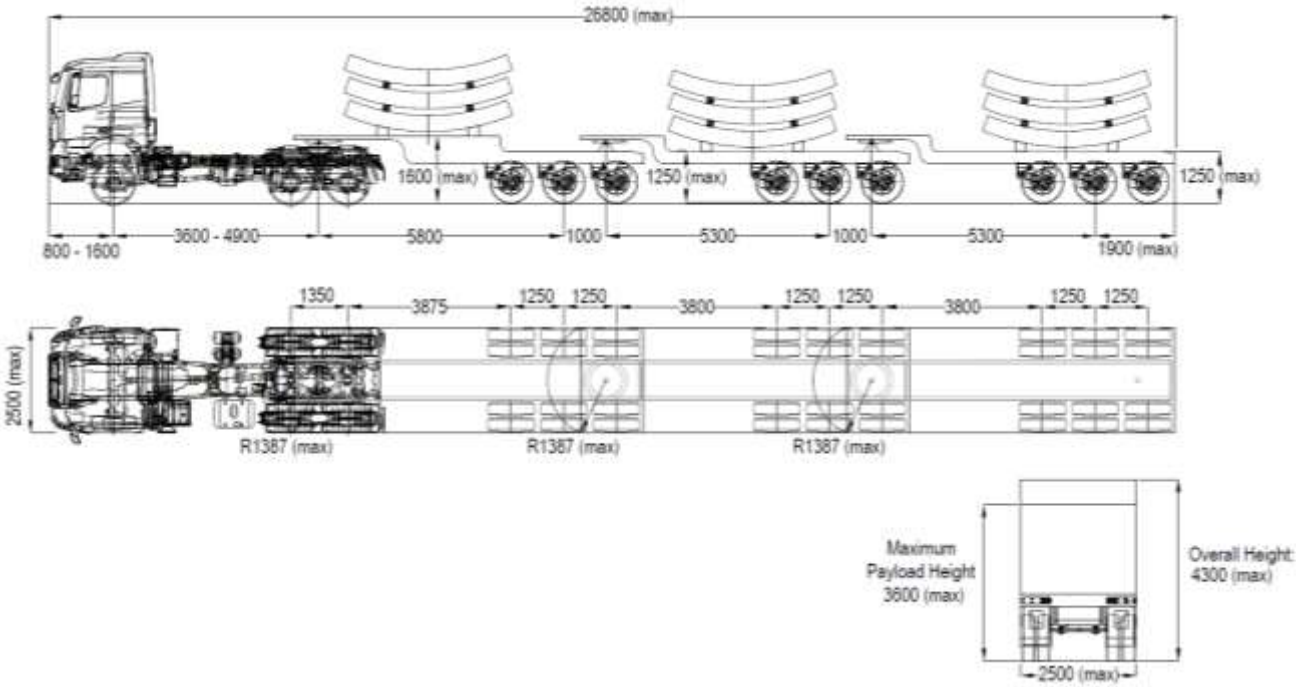


Figure 3.27 Design of proposed PBS vehicles

3.2.7 Road and intersection upgrades

i Proposed road upgrades

Snowy Hydro has been working with Transport for NSW (TfNSW) in relation to the external road and intersection upgrades required for the Snowy 2.0 project generally, including for the Main Works. The work being undertaken with TfNSW on external road and intersection upgrades is to address the recommendations from both the traffic and transport assessment and the road safety audit (RSA).

Upgrades to the external road network that will be undertaken by Snowy Hydro are detailed in Table 3.10 below. These road upgrades have been included in the revised disturbance area and assessed for potential impacts to biodiversity, heritage and water.

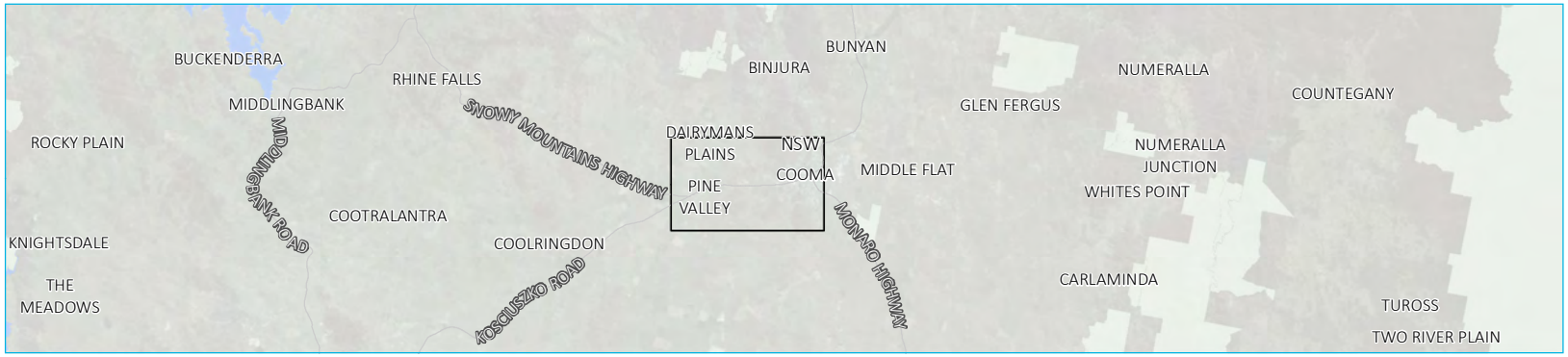
Table 3.10 Intersection upgrades to be carried out as part of the Main Works

Major road location	Intersection side road	Proposed road upgrades
Snowy Mountains Highway	Bombala Street Roundabout	The roundabout of Snowy Mountains Highway and Bombala Street will remain in its current state. Large over size over mass loads (OSOM), such as TBM and transformer transportation may require minor temporary alterations. The proposed alterations are as follows: • installation of a traffic signal on Bombala Street with traffic sensor on Monaro Highway on the eastern side of Cooma Creek bridge to minimise queuing on Monaro Highway; • roundabout infill and adjustment of road signage and kerbs to allow transport of OSOM vehicle movement; • trimming of overhanging vegetation; and • minor traffic signage and replacement.

Table 3.10 Intersection upgrades to be carried out as part of the Main Works

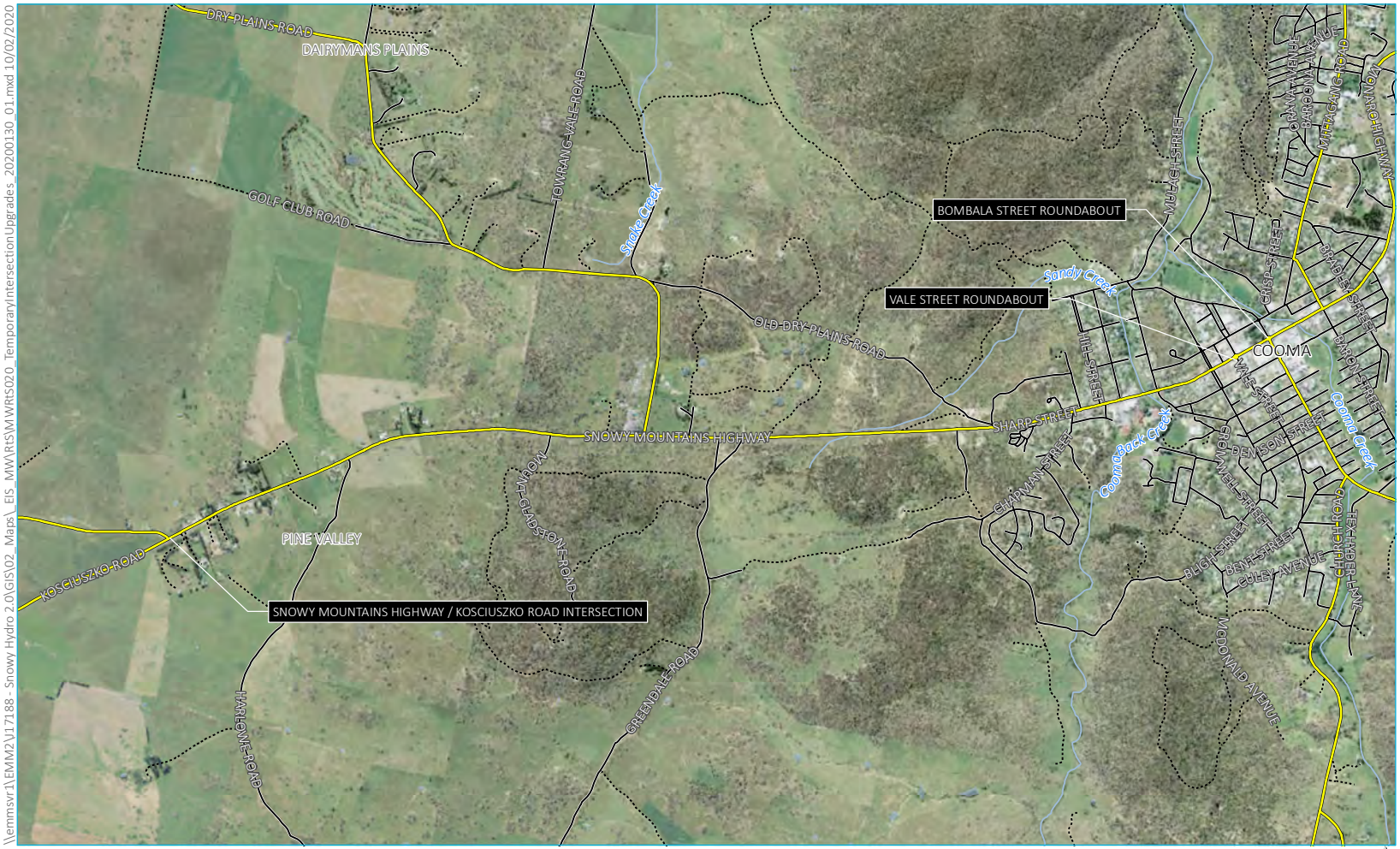
Major road location	Intersection side road	Proposed road upgrades
Snowy Mountains Highway	Vale Street Roundabout	The roundabout of Snowy Mountains Highway and Vale Street will remain in its current state. Due to OSOM vehicles, the following temporary measures will be required: • roundabout infill and adjustment of road signage and kerbs to allow transport of OSOM vehicle movement; • trimming of overhanging vegetation; and • minor traffic signage and replacement.
Snowy Mountains Highway	"Rock Forest"	A new intersection is required to allow access into the Rock Forest property. The following works are proposed: • pavement widening; and • Basic Right (BAR) Turn Treatment plus Auxiliary Left (AUL) Turn Treatment.
Snowy Mountains Highway	Marica Road	A new intersection is required for a new stretch of road to join Marica Road with Snowy Mountains Highway. Within the existing road corridor the following works are required: • road widening and embankment works; and • Basic Right (BAR) Turn Treatment plus Auxiliary Left (AUL) Turn Treatment.
Link Road	Lobs Hole Ravine Road	Intersection improvements are required to improve geometry on Ravine Road and improve safety. The improvements include: • sealing of Lobs Hole Ravine Road at intersection with Link Road; • grading and alignment of Lobs Hole Ravine Road to tie into Link Road; and • potential use of vehicle activated signage.
Snowy Mountains Highway between Sawyer Hut and Link Road		Two areas of minor cutback of existing embankment are required on the Snowy Mountains Highway. These areas of minor earthworks are required to enable the safe transport of the largest OSOM movement required for the Main Works. The cutback would not involve any widening of the road pavement and would be carried out entirely within the existing road reserve.

The locations of intersection upgrades within the project area are shown in Figure 3.1 to Figure 3.6. The locations of intersections requiring temporary measures are provided in Figure 3.28. The location for embankment cut-back on Snowy Mountains Highway between Sawyer Hut and Link Road is provided in Figure 3.29.



KEY

- Main road
- Local road
- Vehicular track
- Watercourse / drainage line
- Waterbody



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

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GDA 1994 MGA Zone 55

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Existing intersections requiring temporary measures

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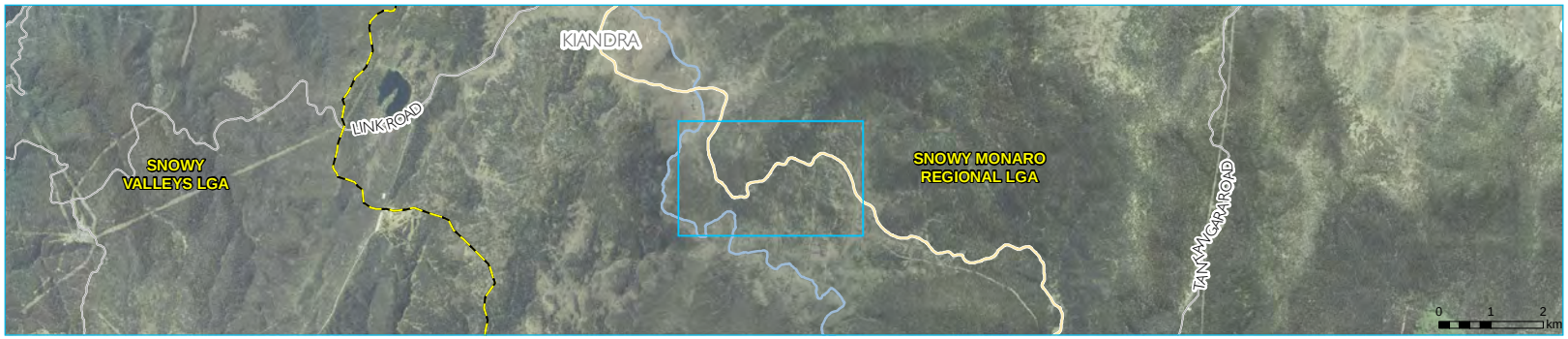
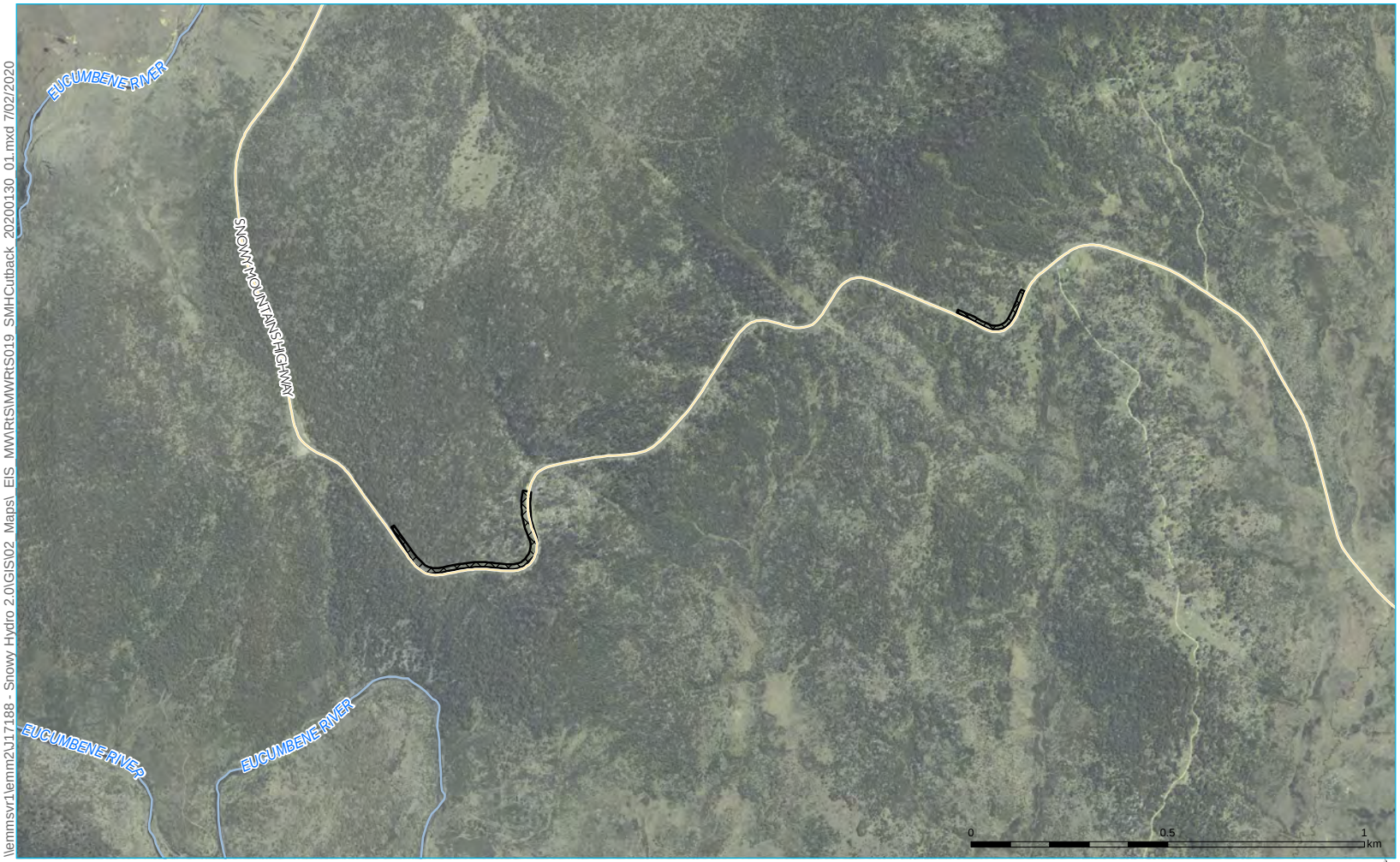
Figure 3.28

snowy 2.0

EMM creating opportunities





KEY

Existing environment

- Main road
- Local road
- Watercourse
- Local government area boundary
- Disturbance area - embankment cut back required on Snowy Mountains Highway

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

GDA 1994 MGA Zone 55

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Snowy Mountains Highway between Sawyer Hut and Link Road – embankment cut back

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Main Works
Figure 3.29

ii Road upgrades to be carried out by TfNSW

Several of the external road and intersection upgrades are proposed to be separately undertaken and managed by TfNSW due to the broader benefits to the Snowy Mountains region as a result of the upgrades. Table 3.11 below lists the various intersections that are in-principle agreed to be undertaken and managed by TfNSW. It is envisaged that TfNSW would undertake the upgrade works in the first half of 2020.

TfNSW will be managing its own approvals to undertake these road and intersection upgrades under Part 5 of the EP&A Act. Accordingly, while these upgrades will be utilised by traffic generated by construction activities associated with Snowy 2.0, including the Main Works they do not form part of the applications for Snowy 2.0.

Table 3.11 Intersection upgrades agreed with TfNSW

Major road location	Intersection side road	Intersection upgrades agreed with TfNSW
Snowy Mountains Highway	Tantangara Road	Due to increased traffic numbers using Snowy Mountains Highway and Tantangara Road, the following upgrades are proposed • Channelised Right (CHR) Turn Auxiliary Left Turn (AUL) Treatment; and • potential vehicle activated sign for intersection.
Snowy Mountains Highway	Kosciusko Road	Minor works are required to improve the turn path for heavy vehicles. The works will incorporate: • shoulder widening to be conducted to improve the current turn path for heavy vehicles; and • potential realignment of centre island to improve access / turn path.
Snowy Mountains Highway	Link Road	The intersection of Link Road and Snowy Mountains Highway will have the following improvements: • pavement markings and vehicle activated sign for intersection; and • movement of signage on Link Road. No additional pavement widening proposed
Monaro Highway	Yallakool / Polo Flat Road	This intersection has been flagged by SMRC and RMS as needing improvements external to impacts of Snowy 2.0. The works involved include • conversion of Monaro Highway / Polo Flat Road intersection into a roundabout; and • improvement to turning lanes and intersection at Yallakool Rd and Monaro Highway T intersection.
Monaro Highway	Sales Yard Road	Some improvements are required to improve safety of the intersection. The following improvements are to be constructed: • minor shoulder strengthening; and • Basic Right (BAR)Turn Treatment and vehicle activated sign for slow moving southbound vehicles.

In order to mitigate against potential travel delays to road users and improve road safety, Snowy Hydro has been working in consultation with TfNSW to develop an arrangement consisting of several turn out bays placed in strategic locations along the Snowy Mountains Highway.

It is anticipated that approximately four slow vehicle turn-out bays will be constructed on the northbound route, and two new turnout bays constructed on the southbound route along the highway. The specific locations of these will be determined by TfNSW to ensure that they are effective in mitigating the impacts of project traffic on public users. These turn-out bays will be managed by TfNSW, including approvals and construction. It is expected that these works will be completed by the start of the winter months of 2020.

Snowy Hydro has conducted extensive community engagement about Snowy 2.0 since mid-2017, to raise awareness about the project and its benefits and impacts, and to seek feedback from the community. Snowy

Hydro has established effective communications channels including online, social media, publications and face-to face interactions to meaningfully engage with stakeholder groups and the wider community. Community engagement, updated communication materials and consultation will continue throughout the life of the project.

A Snowy 2.0 communications working group has been established, with representation from Snowy Hydro, the project's principal contractor FGJV, TfNSW, local governments (SMRC and Snowy Valleys Council), the NSW Police, NPWS, Destination NSW, and DPIE.

A major focus for the group is coordinating effective and broad-reaching communications around Snowy Mountains road safety, increased traffic in the region and roadworks (either scheduled upgrades or works occurring as a result of Snowy 2.0). A communications strategy has been drafted and aims to:

- share road safety information to help improve safety among road users;
- advise the public of roadworks and encourage journey planning;
- raise awareness about extra heavy vehicles present on Snowy Mountains roads during construction;
- influence driver behaviour during interactions with roadworks or heavy vehicles; and
- educate the community about the need for, and benefits of, roadworks supporting the Snowy 2.0 project.

Snowy Hydro, FGJV and members of the working group will share important information about Snowy 2.0 and work together to coordinate messaging. Communications will be delivered via a wide range of tools and channels (including networks established by key stakeholders) to maximise the reach and audience.

Tools include videos, variable message signs, other signage, works notifications, print and electronic newsletters, written materials, radio advertising, etc. Channels include traditional and social media, websites, apps such as Live Traffic, stakeholder networks, Snowy Mountains region business networks, community information sessions etc.

3.2.8 Use of temporary power and fuel storage

It is proposed to provide temporary construction power using diesel generator sets at Tantangara accommodation camp and portal as well as at the Lobs Hole main yard. This will allow for works to commence in each of the locations before the permanent power supply is made available and will ensure construction program proceeds without any delay.

The following types of plant and equipment will be required for temporary power at the Tantangara camp and portal and the Lobs Hole main yard:

- several 1 MVA diesel generators sets;
- switch gear;
- transformers; and
- 60,000L diesel tanks.

In addition ancillary fuel storage is proposed at the Lobs Hole main yard with a capacity of approximately eight 40,000 L tanks. The storage area would be appropriately designed in accordance with Australian Standard 1940:2017 and appropriate bunding, storage and handling in accordance with the relevant Australian Standards.

All temporary construction power infrastructure will be sited entirely within the Main Works disturbance area and require no additional vegetation clearing or ground disturbance.

It is expected that the duration of temporary construction power use would be approximately 3-6 months and may be retained as an emergency backup.

i Traffic

It is expected that additional traffic associated with the increased fuel storage would result in an additional two deliveries per day. This would result in no significant increase to the predicted traffic impacts during construction.

ii Air quality

Particulate and NO_x emissions associated with diesel generators on-site have been included in the Main Works air quality impact assessment. Annexure D, Section D.2 of the air quality assessment prepared for the Main Works EIS provides details of the way in which diesel combustion was assessed for the project. Total site and project diesel use (including generators) were considered. This value was used to derive a maximum 12-month diesel-use period and diesel emissions were apportioned across the site according to activity. This approach is considered conservative in terms of generator emissions as it occurs one year into the project operations when permanent power supply is expected to be available.

3.2.9 Temporary first stage accommodation at Tantangara

It is proposed to establish a temporary 'fly camp' at Tantangara during the first phase on construction. The first stage accommodation camp would be established within the proposed Tantangara accommodation camp footprint and will house approximately 30-40 workers. This will enable workers to stay on-site and construct the remainder of the camp. This will provide improved productivity for the workforce due to reduced travel times.

The Tantangara fly camp will have separate tanks for waste water and potable water systems. All supplies and water, both potable and waste water, will be trucked in and out of the fly camp until Main Works treatment plants are installed and operational.

3.2.10 Post-approval vegetation removal and management

Experience with the implementation of Exploratory Works to date has highlighted the need on rare occasions, for a process to assess and manage critical vegetation removal that is outside the approved boundary, as part of the project's post-approval environmental management. Given the proximity of large forested areas to the project construction areas and access roads, it is expected that instances of individual trees posing safety risks will continue to arise throughout the construction period. This safety risk has been heightened/significantly increased given the damage and impacts of the bushfires in the KNP.

The sensitivity of the surrounding environment to Main Works is acknowledged and therefore, it is proposed that a protocol for post-approval vegetation removal is developed as part of the biodiversity management plan to provide for a safe working environment. This protocol will apply to critical vegetation removal only, where:

- vegetation removal is critical and unavoidable;
- the impacts of the vegetation removal are not considered to be significant; and
- the use of the post-approval protocol is agreed by Environment, Energy and Science – Biodiversity and Conservation Division (BCD) of the NSW Government.

3.3 Exploratory Works

Snowy 2.0 Exploratory Works (SSI - 9208) involves the construction of an exploratory tunnel and associated geotechnical investigation activities to inform the final design of Snowy 2.0. Snowy 2.0 Exploratory Works was approved by the former NSW Minister for Planning on 7 February 2019 and works commenced in March 2019. Staged submission and separate approval is appropriate for a project of this magnitude, due to its complexity and funding and procurement processes. Submission of the application and subsequent approval of Exploratory Works ahead of Main Works was critical as it will obtain detailed geological data about the rock types, conditions, ground temperature and stress conditions to inform the detailed design of the underground power station cavern.

As the Exploratory Works will be carried out alongside and coordinated with the Main Works it is intended that the facilities and activities established as part of Exploratory Works will be utilised throughout the construction of and inclusive of the Main Works. This includes maintenance and use of access roads, infrastructure and geotechnical investigations established or used as part of the Exploratory Works. Following the completion of Main Works areas associated with both Exploratory Works and Main Works will be decommissioned and rehabilitated in accordance with the Main Works rehabilitation strategy.

3.4 Further stakeholder engagement

3.4.1 Agency consultation

During and post the public exhibition phase, engagement activities with stakeholders have been ongoing with the main purpose of discussing initial comments on the EIS and providing clarifications where required. Details of key engagements with government and other stakeholders are outlined in Table 3.12.

Table 3.12 Engagement during and post EIS exhibition phase

Stakeholder	Date	Engagement activity	Purpose	Key outcomes
Aboriginal Parties	26/9/19	Iris White	Project update/ link stakeholder to Contractor	
	4/10/19	Rhonda Casey	Project update/ link stakeholder to Contractor	
Local Fishing Groups representative	9/10/19	Face to face meeting	Discuss recreational fishing offsets opportunities	
BCD/ DoEE	18/10/19	On site meeting	BDAR and threatened species assessment. Update on reduction to disturbance footprint	Agreement on methodology for BDAR assessment
Joint agency meeting	31/10/19		Biosecurity	
DPIE/ DPI – Fisheries/Biosecurity	6/11/19		Biosecurity – Details on Snowy Hydro investigations to prevent, eliminate and minimise biosecurity risks from the operation of Snowy 2.0	Snowy Hydro to provide further technical information to agencies to support application for exemption and PIR-RTS

Table 3.12 Engagement during and post EIS exhibition phase

Stakeholder	Date	Engagement activity	Purpose	Key outcomes
DPIE/ NPWS	7/11/19		Discussion around potential alternative excavated rock management options and road upgrades	
NPWS	8/11/19	Regional Parks Advisory Committee	Project update	
	weekly	Liaison meetings	Update on Main Works activities	
	5/12/19	Meeting	Bushfire management plan	Discussion around bushfire strategy
Joint agency meeting	14/11/19	Communications working group meeting	Plan, coordinate and maximise communications around key issues such as traffic and transport	Range of actions to follow up
EPA	12/11/19		Seek clarification of EPA submission and update on progress	
DoEE	15/11/19	Treatment of Offsets	Update DoEE on EIS matters	
DPI - Fisheries and community representatives	20/11/19	Snowy Lakes Working Group	Update on EIS with focus on fish/ biosecurity	
Joint agency meeting	20/11/19	Regional Coordination group, Snowy region, meeting	Project update, issues identification, reporting and planning	Agency actions to follow up in areas including emergency management, transport, housing, DPC coordination.
TfNSW, Police, NPWS, SMRC	20/11/19	Traffic and Transport Liaison Group meeting	Project traffic management including logistics planning and revision of existing traffic arrangements.	Initial information meeting
EPA	27/11/19	Water	Discussion of EIS water matters	
	04/02/20	Excavated rock management	Update on the excavated rock management strategy as outlined in this document	Snowy Hydro to document this strategy as preferred alternative method for excavated rock management
DPI - Biosecurity	16/12/19		Presentation of further information requested from agencies	

Table 3.12 Engagement during and post EIS exhibition phase

Stakeholder	Date	Engagement activity	Purpose	Key outcomes
Joint agency meeting	3/12/19	State Coordination Group meeting	agency collaboration	Further inter-agency collaboration to progress actions
DPIE/NPWS	10/12/19	Excavated rock management	Discussion of potential alternative excavated rock management options	Snowy Hydro to continue exploring options for improved in-reservoir and on land disposal as alternatives to strategy presented in Main Works EIS.
	30/01/20	Excavated rock management	Update on the excavated rock management strategy as outlined in this document	Snowy Hydro to present this strategy to EPA for feedback
Business	15/10/19	Tumbarumba	Project update and link to employment and business opportunities	30 attendees
	16/10/19	Tumut	Project update and link to employment and business opportunities	60 attendees
	17/10/19	Cooma	Project update and link to employment and business opportunities	120 attendees
	21/11/19	Queanbeyan	Project update and link to employment and business opportunities	100 attendees
	11/12/19	Young	Project update and link to employment and business opportunities	35 attendees
	28/1/20	Albury	Project update and link to employment and business opportunities	
	29/1/20	Wagga Wagga	Project update and link to employment and business opportunities	

i Groundwater modelling peer review

One of the key activities undertaken following the exhibition of the EIS was the refinement of the regional groundwater model to better represent the inflow mitigation that will occur as part of Snowy 2.0 and reflect less conservative predicted impacts. The refinement of the model and design of the scenarios to reflect this inflow restriction was undertaken in consultation with a government nominated independent modelling peer reviewer.

A number of meetings were held between Snowy Hydro and the peer reviewer in December 2019 and January 2020 and on 14 January 2020, the peer reviewer provided confirmation of the adequacy of the revised scenario design and proposed model outputs.

A subsequent meeting was held on 29 January 2020, where the model outputs and revised inflow and water table drawdown results were presented, and the final scenario chosen for impact assessment agreed with the peer reviewer.

3.4.2 Community engagement

Snowy Hydro's strong stakeholder engagement focus, established in the local community for many decades, has been built on and maintained throughout the Snowy 2.0 project. Snowy Hydro and FGJV have continued providing information and seeking feedback from stakeholders since EIS exhibition, as part of the commitment to ongoing, meaningful engagement with the community and the strengthening of stakeholder relationships.

A number of targeted community information sessions were carried out during and post exhibition of the EIS.

Snowy Hydro and FGJV, along with the Industry Capability Network (ICN) NSW, presented workshops to the community and business owners in Tumbarumba, Tumut and Cooma in October, Queanbeyan in November and Young in December 2019. More than 335 people attended these workshops. ICN, a national business procurement network, has been contracted to match suppliers with Snowy 2.0 sub-contracting and supply packages. Snowy Hydro provided attendees with a project update and information about the EIS, submissions and the approval process. Further workshops were being held in Albury and Wagga on 28 and 29 January 2020.

Snowy Hydro has also met twice with the Cooma Chamber of Commerce and has begun planning for a further round of community information sessions in Snowy Mountains towns during February and March.

Snowy Hydro and FGJV met with community stakeholders in Talbingo on 27 November 2019 for discussions around upcoming work in the area and provided information about the EIS and planning approval process.

3.5 Further assessment of the impacts of the project

The refinements to the project outlined in Section 3.2 have resulted in improved outcomes for the environment including reduced vegetation clearing, groundwater drawdown impacts and predicted traffic volumes. Some minor additional assessments have been carried out to demonstrate these outcomes. A brief description of these assessments is provided in the sections below.

3.5.1 Biodiversity

A revised BDAR has been prepared to assess the refinements to the design of the project described in Section 3.2. In particular, the BDAR assesses the impact of the reduced disturbance footprint and provides a mitigation and offset approach that responds to the use of a construction envelope. The revised BDAR is provided in Appendix G and found that the reduced disturbance area will result in significant reductions in overall impacts to native vegetation and threatened species habitat. It is expected that the Main Works project will result in 640 ha of disturbance, a 62% reduction in overall impacts from the impacts predicted in the Main Works BDAR (EMM 2019). This reduction in impacts will result in a concurrent reduction in the offsets required for the project.

As previously discussed, the BDAR in Appendix G will be updated to include the proposed emplacement areas described in Section 3.2.2.

3.5.2 Heritage

During the PIR-RTS phase, NSW Archaeology completed additional archaeological survey and assessment of potential Snowy 2.0 Main Works impact areas that were committed to in the Snowy 2.0 Main Works Aboriginal Cultural Heritage Assessment Report (ACHAR). This comprised archaeological Survey Unit (SU) CCSU20 (at Rock Forest) and NCTSU37 (at proposed Fish Weir at Alpine Creek Trail) (refer Table 171 and Table 172 of the ACHAR) (NSW Archaeology 2019a).

The additional assessment is provided at Appendix M. The additional surveys identified no Aboriginal heritage objects or sensitivity at either Rock Forest or Nungar Creek (NCTSU37). One historic item was identified at Rock Forest which was a cast iron pipe with little to no heritage value. One historic feature was identified at Nungar Creek (NCTSU37) which is an extensive area of alluvial gold workings consisting of tailing mounds, modified and relic creek channels and water races situated in and adjacent to a tributary creek of Boggy Plains. Through detailed design, impacts to the feature will be avoided if practicable, however, if impacts are unavoidable, a comprehensive archival recording is proposed in order to mitigate impacts.

3.5.3 Water

The project refinements described in Chapter 3 have required some revisions to the water assessment. These revisions included the following key activities and outcomes:

- further detailed inputs to more closely represent the permeability characteristics of the tunnel lining were processed through the groundwater model. These modelled outputs showed:
  - significant reductions in groundwater inflows into the excavated headrace tunnel;
  - significant reductions in drawdown of shallow aquifers and expressions at surface for groundwater dependent ecosystems such as bogs and fens; and
  - significant reductions in process water discharges to Tantangara Reservoir.
- Reductions in the disturbance area by some 62% means that significantly less water requires management through the water management system.

The approaches to these assessments were discussed with the relevant government agencies (ie EPA and DPI-Water) and the DPIE-appointed groundwater peer reviewer. Consultation with these stakeholders was described in Section 3.4.1.

3.5.4 Transport

The traffic and transport assessment was revised based on the revised traffic volumes discussed in Section 3.2.6 and is provided in Appendix K. The reduction in traffic volumes is predicted to reduce impacts to intersections across the project transport route. A revised summary of the intersection capacity assessment is provided in Table 3.13 below.

Table 3.13 Future intersection performance summary

Intersection	Performance (LoS)		
	Existing	Main Works	Main Works + Polo Flat
Link Road / Lobs Hole Ravine Road	A	A	A
Snowy Mountains Highway / Link Road	A	A	A
Snowy Mountains Highway / Tantangara Road	A	A	A
Snowy Mountains Highway / Marica Access	-	A	A
Snowy Mountains Highway / Rock Forest Access	-	A	A
Snowy Mountains Highway / Kosciuszko Road	B	B	B
Snowy Mountains Highway / Vale Street	A	A	A

Table 3.13 Future intersection performance summary

Intersection	Performance (LoS)		
	Existing	Main Works	Main Works + Polo Flat
Monaro Highway (Snowy Mountains Highway) / Bombala Street	B	B	B
Monaro Highway / Yallakool Road	A	A	A
Monaro Highway / Polo Flat Road (north end)	A	B	B
Monaro Highway / Saleyards Road (south of Polo Flat Road)	A	A	A

Snowy Hydro is continuing to engage with roads authorities (SMRC and TfNSW) to determine the most appropriate measures to address traffic performance issues. Road upgrades and management measures proposed to mitigate the project's transport impacts are detailed in Section 3.2.7 of this report.

3.5.5 Amenity

The amenity values of the project area are reflective of its location within and adjacent to a national park setting.

The refinements to the project outlined in Section 3.2 have resulted in generally improved outcomes for the environment, including the amenity of the project area within KNP. In particular, reduced vegetation clearing, improved streamflows (due to reduced groundwater impacts), and lower traffic volumes than expected in the EIS, have resulted in overall improvements to amenity, compared with the previously assessed impacts.

Additionally, in some locations (see below) amenity has been improved through reductions to the visual impacts of excavated material placement. This is due to a combination of (a) adjustments to placement location and (b) the proposed fluvial geomorphic landform design and placement methodology. The Geomorphic landform design approach attempts to design landforms in a steady-state condition, considering long-term climatic conditions, soil types, slopes, and vegetation types (Toy and Chuse 2005; Bugosh 2009).

It is important to note in the context of amenity, that the geomorphic landform method aims to mirror the existing landforms both functionally and visually by tying the new landform into the existing landscape. The main advantages of the excavated rock placement based on geomorphic design, especially on-land excavated rock placement, would be that the landforms will be integrated with the surrounding environment to create natural-looking and stable slopes, in sympathy with localised environmental conditions.

Assessment of impacts to amenity was carried out for the Main Works EIS. The conclusion of this assessment was that the principle impacts to amenity were during construction (such as noise from traffic) and the permanent built structures (such as intakes and portals).

> "However, opportunities to provide recreational facilities as part of the permanent rehabilitation of these sites is proposed to be determined in consultation with NPWS, which may mitigate the magnitude of predicted impacts during operation".

Together with the geomorphic landform design methodology, mitigation through rehabilitation and realisation of potential recreational opportunities have been enhanced through the refinement process.

Consequently, it is considered there is no overall change to the significance of impacts amenity, and in some places, there will be improvements.

CHAPTER 4

RESPONSE TO SUBMISSIONS

4 Response to submissions

4.1 Need and justification (merits) of the project

4.1.1 Strategic need for the project

Submissions challenged the strategic need for a pumped hydro project within KNP. Key concerns include:

- the project will provide minimal contribution to renewable energy and the benefits of the project within the National Electricity Market are overstated in the EIS;
- Snowy 2.0 will be a net consumer of electricity in the short term (including coal-fired electricity), not a generator, and result in significant net losses via pumping and transmission;
- the practical capacity of the project is less than 350 GWh;
- the volume of Tantangara Reservoir's active storage cannot be contained within Talbingo Reservoir, thereby necessitating releases into Jounama and Blowering and losing effective storage to other parts of the Snowy Scheme; and
- Snowy 2.0 is not a true closed system due to requirements for downstream releases.

Snowy Hydro reaffirms its stated position in the EIS that Snowy 2.0 is critical to ensuring an orderly transition to a low carbon emissions economy, is in the public interest (including lowering energy costs for consumers), and should proceed.

i Contribution to renewable energy

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

Figure 4.1 shows the projected evolution of the generation mix in the NEM to the early 2040s, demonstrating both the increase in forecast generating capacity and the shift from coal to VRE.

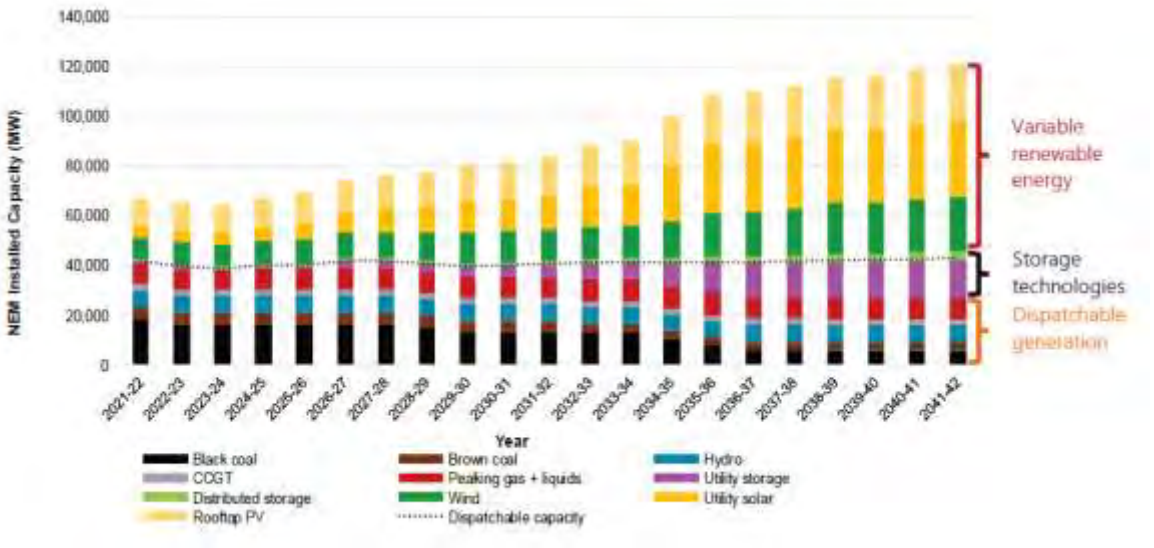


Figure 4.1 Forecast NEM generation capacity (AEMO 2019)

The increasing penetration of VRE is in the public interest; wind and solar produce zero emissions and are the cheapest form of incremental generation, supporting lower consumer prices. However, as recognised by the 'Finkel Review', it also poses significant risks for the electricity grid, since a certain amount of dispatchable capacity is required to maintain system security and reliability (that is, an ability to generate on-demand, when VRE is unavailable).

In their Draft 2020 Integrated System Plan (Draft ISP), the Australian Energy Market Operator (AEMO) forecast that Australia will need to invest in a further 30,000 - 47,000 MW of new, large-scale VRE to replace retiring plants and meet peak demand, and that this will in turn require the support of up to 21,000 MW of new dispatchable capacity, and up to 15,000 MW of storage capacity. Without alternatives, gas-fired power stations would be required to provide much or all of this firming capacity, but such gas-fired power plant cannot provide storage, resulting in an increased carbon footprint, higher consumer costs and a wastage of surplus renewable energy. The NEM modelling conducted by independent expert Marsden Jacob Associates (MJA) evidenced that Snowy 2.0 is the cheapest option for the NEM to gain access to both the necessary firm capacity and large-scale storage within a single project.

Batteries, on a $/MWh storage basis, are at least 60 times more expensive than Snowy 2.0, will be replaced many times within Snowy 2.0's lifetime (a 100-year design life) and are small scale in the context of storing bulk energy in the NEM. Matching the storage of Snowy 2.0 would necessitate 2,700 South Australia big batteries.

Gas plants provide MW of capacity but cannot provide storage.

Snowy 2.0 provides both capacity and storage, and thereby underpins cheaper NEM prices by capping price peaks and bringing new wind and solar into the system by providing 'firming'. As well as responding to the NEM's requirement for price-period (5 minute) to intra-day firming, Snowy 2.0's large-scale capacity and world class technology enables the plant to respond to the NEM's requirement for 'deep storage' that must deal with seasonal and longer climatic cycles (expected and unexpected).

The impact that Snowy 2.0 will have on the level of VRE generation within the NEM is shown in Figure 4.2 below. According to MJA's modelling, the development of Snowy 2.0 results in approximately 3 GW or additional VRE generation and a reduction in approximately 2 GW of gas generation (mainly Closed Cycle Gas Turbine (CCGT) stations). Additionally, Snowy 2.0 results in a reduction of approximately 1 GW of higher-cost batteries in the initial years of Snowy 2.0 operation. However, this reduction diminishes over the forecast period due to additional VRE entering and the need for storage above and beyond that provided by Snowy 2.0.

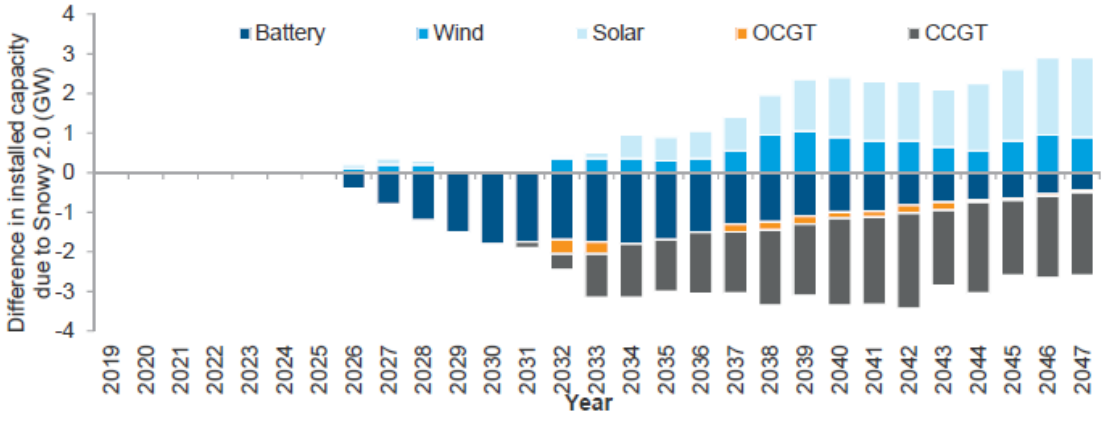


Figure 4.2 Impact of Snowy 2.0 on generation and storage in the NEM (MJA 2018)

For the reasons above, Snowy 2.0 has a significant and beneficial role to play in the future NEM. However, it should be noted that the NEM will require a huge amount of dispatchable generation and storage (according to AEMO, the NEM will need the equivalent of eight times Snowy 2.0) and Snowy 2.0 is just one of the mix of projects and storage options required.

ii Snowy 2.0 cycle efficiency and transmission losses

Cycle efficiency

The Round Trip Efficiency (RTE) of Snowy 2.0 (or any pumped storage, including Tumut 3 Power Station (T3)) refers to the ratio of the energy generated from a quantity of water to the energy required to pump that quantity of water.

Pumped storage RTE = generated energy / pumping energy

This RTE depends on factors such as the level of generation / pumping compared to maximum generation / pumping, water level in the upper reservoir, etc. For a hydro power station with multiple generators and pumps, it would also depend on how generation and pumping is shared across the generator and pump units.

Snowy 2.0 has a RTE of approximately 72-79%, depending on how many units are running. It averages about 76% at commissioning. This means that Snowy 2.0 will require approximately 1.3 times as much energy to pump the water than it will create when it generates.

Despite being a net consumer of energy, Snowy 2.0 benefits the market by providing for increased market stability and efficiency. Snowy 2.0 will utilise otherwise unused low-cost generation (surplus coal and VRE) and provide dispatchable and firm capacity that can operate for days if required, with the effect that the NEM will operate more efficiently and with lower emissions. In the absence of this less VRE would be built and when powered by VRE, the project's carbon emissions are zero.

Transmission losses

All generating assets have transmission losses; the quantity of those losses depends on the asset's location in the electricity network and the transmission infrastructure that supports it.

Whilst quantifying the transmission loss factors for Snowy 2.0 is not yet possible, there are strong indications that the loss factors will be the same, if not better, than Snowy Hydro's current hydro generation assets for the following reasons:

- The proposed new transmission infrastructure supports low loss factors.
- Humelink - The Project Assessment Draft Report (PADR) jointly prepared by TransGrid and AEMO (August 2019) recommends 3 new 550 kV lines to minimise loss factors; and
- Victoria to NSW Interconnector West (VNI West) - The Project Specification Consultation Report (PSCR) jointed prepared by TransGrid and AEMO (December 2019) includes 550 kV options that will support low loss factors.
- Snowy 2.0 generation / pumping will be non-concurrent with the renewable assets utilising the same transmission infrastructure (ie Snowy 2.0 will be pumping when the renewable assets are generating). This will reduce transmission losses for Snowy 2.0 because the project won't be competing for capacity on the transmission infrastructure.

iii Capabilities of Snowy 2.0 and its place in the Scheme

Snowy 2.0 will add 2,000 MW and 350,000 MWh of pumped hydro storage. The 2,000 MW of capacity, and the 350,000 MWh stored in Tantangara Reservoir, individually and together constitute the two key capabilities of Snowy 2.0. 2,000 MW of reliable, on-call capacity backs several of Snowy 2.0's revenue sources, including the $300/MWh cap contracts that have been a mainstay of Snowy Hydro's role in the market since the beginning of the NEM. Submissions have claimed that Snowy 2.0 will not be able to generate the full 350,000 MWh due to downstream hydraulic constraints in Talbingo, Jounama and Blowering dams. This is incorrect for the following reasons:

- Because it has a much higher elevation, Snowy 2.0 passes through water at a much lower rate when operating at full capacity than T3. In fact, one third of T3, that is 2 of the 6 units, is able to pass all the water that Snowy 2.0 passes when generating at its full 2,000 MW capacity. Given this simple fact, Snowy 2.0's ability to generate at full capacity at 2,000 MW for 175 hours will never be constrained by the operating level of Talbingo Dam because Snowy Hydro is able to pass water out of Talbingo Dam much more quickly than it flows into it.

- Talbingo Dam level does not operate at close to full. The 'active storage' of Talbingo Dam is only the top 9 m of a dam that is up to 140 m deep in places. This 9 m constitutes the 160 GL of 'active storage'. Accordingly, if the water level in Talbingo is only 4 m below FSL, and appears close to full, its active storage is actually half-empty.

- The active storage in Talbingo is also augmented by the 30 GL active storage in Jounama (from which Snowy Hydro can also pump water), which means there is 190 GL of active storage in the lower dams, which is 80% of the 240 GL storage of Tantangara. So as a closed cycle system, Snowy 2.0 can operate at 80% of its full capacity.

- However, of course, Snowy 2.0 is not a fully closed system, and one of the significant advantages of adding Snowy 2.0 to the existing Snowy Scheme is that Tantangara and Talbingo dams both operate as part of an integrated portfolio of 16 dams, with water capable of being stored in multiple places throughout the Scheme. In particular, both are connected to Lake Eucumbene, which has 4,400 GL of storage capacity. There are in fact three ways to recharge Tantangara Dam: natural inflows, which average 294 GL/annum; water passed into Talbingo from Snowy 2.0 and then pumped back up (190 GL); and water passed into Talbingo from Eucumbene through the existing Tumut 1 and Tumut 2 power stations. Accordingly, there is no question that Tantangara can be fully recharged.

The following water flow diagram (Figure 4.3) illustrates the relationships between Snowy 2.0 and Snowy Hydro's existing assets.

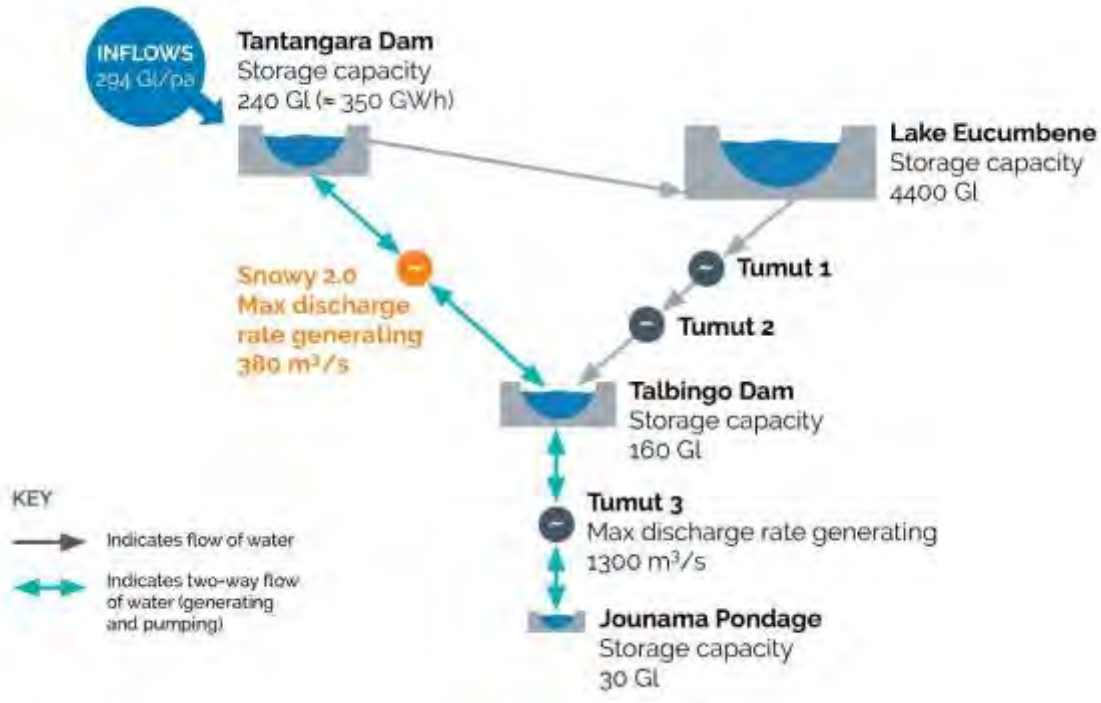


Figure 4.3 Waterflow diagram (Snowy Hydro)

4.1.2 Project cost and funding

Submissions queried the overall cost of the project and means of funding; comments included:

- Snowy 2.0 is not economic as originally proposed, with the cost estimate for the project having increased from $2.1 billion to $5.1 billion, with further increases expected;
- Snowy Hydro is Commonwealth owned and funding will ultimately be borne by taxpayers; and
- transmission costs should be included in the cost estimate reported for Snowy 2.0.

i Increased cost of the project

Snowy 2.0's capital costs have not increased. The first time costs were modelled for the project was the 2017 Feasibility Study and the capital cost of Snowy 2.0 remains consistent with that estimate. Submissions that use a rough pre-feasibility study estimate figure, quoted by the then Prime Minister when announcing that ARENA was funding a feasibility study into Snowy 2.0 are misleading; the detailed analysis of the feasibility study had not yet been undertaken.

Following that announcement, Snowy Hydro undertook the feasibility study and published the outcomes of that study (along with thousands of pages of supporting material) in December 2017. Any assessment of the ongoing performance of the project should be made against the publicly available feasibility study, which included a cost estimate of $3.8-4.5 billion. This estimate is in December 2017 dollars so it is not inclusive of escalation.

The Engineer, Procure and Construct (EPC) contract signed in April 2019 is wholly consistent with the feasibility study. The $5.1 billion contract for civil and electro-mechanical works is a lump-sum EPC contract price. The key fact is that it is expressed in nominal dollars from 2019 to the commissioning of Snowy 2.0. It therefore includes 100% of all inflation-related cost escalation for the project. It also includes the contractor contingency, foreign exchange exposure, and "interface risk", which relates to the cost of managing multiple contractors working on the same project.

Snowy Hydro continues to progress the project, with consistent dollar figures at every milestone. Any claim to the contrary is false.

ii Funding the project

The financing mechanism for Snowy 2.0 is typical for investments of this type, being made up of free cash flow, external debt finance and shareholder equity.

Snowy Hydro has recently completed a successful, highly competitive debt-raising process. The outcome of that process was that Snowy Hydro has been overwhelmingly supported and the debt funding requirement oversubscribed. The project has been fully funded up front, with zero financing risk during construction.

The Federal Government will inject equity in future years during the construction period; up to $1.38 billion in total. This will appear in the Company's balance sheet as shareholder capital. This is an investment, not a subsidy. Snowy Hydro will continue to pay dividends to the Federal Government during the construction period of Snowy 2.0 and thereafter. The increased dividends flowing from Snowy 2.0 are the return on the equity invested.

iii Consideration of transmission costs

The cost of updates to the transmission networks owned and operated by the Transmission Network Service Providers (TNSPs) cannot be included in the project's costs, as the transmission lines to be upgraded or built are part of the NEM's shared transmission network and are not owned or controlled by Snowy Hydro, nor for the sole benefit of Snowy Hydro or the project.

Upgrades to the transmission networks must be prioritised independently of the project to support the NEM. Most of Australia's existing transmission network was built decades ago, and designed principally to transmit the output of now ageing coal-fired power stations.

With the gradual retirement of these assets, new transmission routes will be needed to connect new, geographically-dispersed generation, renewable energy zones and strategic storage projects across the NEM. The project is just one of many new power stations that will require upgrades to the transmission network.

AEMO is responsible for forecasting and planning national transmission system requirements. In 2018, AEMO released its inaugural ISP, which is designed to identify transmission system developments needed to meet future NEM requirements. The ISP supports strategic storage initiatives such as the project, which it recognises is required to 'firm up' the rapidly-growing renewable developments in NSW and Victoria, and indirectly, South Australia. The ISP also proposed upgrades to the shared transmission network that will facilitate the large volume of renewable energy generation and storage projects currently in planning phase or already under construction. Upgrades to the transmission network are critical to ensure energy security in the future and will bring new generation and competition into the market, including the project, and put downward pressure on prices for the benefit of consumers.

These upgrades included two projects HumeLink and VNI West (previously known as "KerangLink"), which each provide a range of benefits (which include increased interconnection, integration of Renewable Energy Zones, and access to grid scale storage) including providing access to the generation and storage capacity of the project. In December 2019, AEMO released a draft of the 2020 ISP, which re-confirmed that both projects were required to meet the wider needs of the NEM, and in fact accentuated their importance by designating both HumeLink and VNI West as two of the six priority "Actionable ISP Projects" requiring urgent investment to maximise benefits, and bringing forward their timing to 2024-25 and 2026-27 respectively.

There is a long-standing regulatory framework in place to determine funding of these upgrades. As with any other generator, Snowy Hydro does not own or operate the shared network. For this reason, the costs associated with upgrading the shared transmission network (so-called deep augmentation works) have not been, and cannot be, included in the project costs.

Transmission network investments are undertaken by TNSPs, subject to the NER, and will only be undertaken if their market benefit exceeds their cost.

Both HumeLink and VNI West are currently being pursued by the respective TNSPs (TransGrid and AEMO) through the Regulatory Investment Test for Transmission process (RIT-T). On 10 January 2020, TransGrid released the Project Assessment Draft Report (PADR) for HumeLink, which is the second step of the RIT-T, which confirms that HumeLink will provide significant market benefits with or without Snowy 2.0. In December 2019, AEMO released the Project Specification Consultation Report (PCSR) for VNI West, which is the first step of the RIT-T, which confirmed that VNI West will deliver market benefits that extend well beyond Snowy 2.0 including "improved access to low-cost fuel resources, more efficient sharing of generation between regions, reduced need for firming capacity investment, and improved supply reliability as ageing thermal plant withdraws from the market".

4.1.3 Consideration of options and alternatives

Comments raised in submissions sought more information on alternatives to Snowy 2.0, including:

- Analysis of other feasible alternatives in accordance with the Environmental Planning and Assessment Act Regulation 2000, including consideration of other energy generation and storage projects;
- Evaluation of alternatives and sites for the project with less environmental impacts and better economics, both within and outside KNP. It was suggested that the pumped hydro options report cited in the EIS is dated and more recent studies identifying potential pumped hydro sites in south east Australia have been dismissed by Snowy Hydro without adequate justification; and
- Assessment of alternatives within the project for disposal of excavated rock from tunnelling activities;

i Alternative energy generation and storage

The NEM needs dispatchable generation and large-scale storage, at the lowest cost and in the most effective location between major load centres. According to AEMO, the NEM will need the equivalent of eight times Snowy 2.0 which is the most cost effective option to meet that need, compared to;

- Batteries, on a $/MWh storage basis, are at least 60 times more expensive than Snowy 2.0, will be replaced many times within Snowy 2.0's lifetime (a 100-year design life) and are small scale in the context of storing bulk energy in the NEM. Matching the storage of Snowy 2.0 would necessitate 2,700 South Australia big batteries.

- Gas plants provide MW of capacity, but cannot provide storage.

- Snowy 2.0 provides both capacity and storage, and thereby underpins cheaper NEM prices by capping price peaks and bringing new wind and solar into the system by providing 'firming'.

The strength of the NEM in the past has been its diversity of generating sources. To maximise competition and minimise consumer costs, future NEM developments should include all economic generating sources. In an optimal NEM, the balance between coal, gas, wind, solar, hydro and other sources is determined by effective competition. Snowy Hydro agrees with AEMO's assessment that the NEM requires greater storage capacity than Snowy 2.0 can provide:

- Large-scale batteries have a role in the NEM (frequency control for example) however based on evidence provided on our website they suffer from prohibitive cost to provide the same products and service that Snowy 2.0 provides. There is no evidence provided that batteries will ever be economic.

ii Alternative pumped hydro projects and locations

There are no alternative projects or locations which can feasibly replicate the benefits of Snowy 2.0. In a number of important ways, this project and its particular benefits are the product of its location and environment. Most

importantly, Snowy 2.0 relies on its alpine geography for inflows into its reservoirs. The purity of these water resources distinguishes the project from saltwater hydro projects which are being considered in coastal locations. As with the existing Snowy Scheme, water passing through Snowy 2.0 generation assets will have negligible turbidity, enhancing efficiency and lowering capital and maintenance costs. This means that the energy and storage services offered by Snowy 2.0 can be provided at a lower cost than other potential pumped-hydro projects.

Self-evidently, Snowy 2.0 is an expansion of the existing Scheme, so it cannot be built anywhere else. Snowy 2.0 takes advantage of two existing reservoirs and has proposed most infrastructure to be underground to avoid permanent impacts to the park. There are also no other potential projects which provide the scale of storage offered by Snowy 2.0. As discussed in section 4.1.1, this level of storage will be critical to managing energy security given the increasing penetration of VRE. Finally, from an energy market perspective, the project is strategically located between the two major load centres of the NEM - Sydney and Melbourne.

iii Alternative disposal of excavated rock

Throughout the development of the Snowy 2.0 Main Works, numerous options and alternatives have been investigated with respect to the management of the excavated material. Some of the key considerations that have influenced the final excavated material design, management and methodology have included:

- Minimising impacts to the environment through:
    - optimising of the methodology to reduce impacts to terrestrial and aquatic ecology;
    - reducing visual impacts to KNP where possible; and
    - undertaking effective rehabilitation and landforming to maintain long term ecological processes.
- Optimisation of material handling resulting in:
    - a reduced laydown and storage footprint in KNP required for material storage; and
    - a reduction in a overall construction schedule;
- Reusing materials through the optimisation of the design to:
    - reduce the total volume of excavated material that requires disposal.

Options for the disposal of excavated rock that have been investigated and exhausted have included:

- on-land outside of KNP;
- deep placement in both the Talbingo and Tantangara reservoirs;
- on-land within Project area; and
- in-reservoir edge placement.

Further information regarding potential alternative excavated rock management options to that articulated in the Main Works EIS is provided in Section 3.2.2 of this report.

4.1.4 Impacts to Kosciuszko National Park

Comments raised in submissions were not supportive of the project's location within KNP. Key issues raised included:

- describing KNP as a sensitive and vulnerable sub-alpine environment with potential for further stresses to be caused by the extent and scale of permanent disturbance proposed by Snowy 2.0;
- inconsistent with the National Park designation and the values for which it has been listed for conservation and protection under the National Parks and Wildlife Act 1979 and the supporting KNP Plan of Management; and
- the need to protect and conserve sensitive ecosystems and habitats, avoiding and minimising impacts through transparent evaluation of options and alternatives.

The existing Snowy Scheme has been operating responsibly for decades in KNP and the Commonwealth Authority that built the original Snowy Scheme encouraged the creation and expansion of KNP in its early years. The KNP Plan of Management (KNP PoM) specifically recognises the existence of the Snowy Scheme and provides for its continuation. To ensure the environmental values of KNP are protected and maintained, the Snowy Scheme operates in accordance with a Plan of Management developed for the Scheme. Should the relevant planning approval be granted for Snowy 2.0, the plans of management will be updated as required, to include Snowy 2.0 operations.

As noted in chapter 4 of the EIS, the *Snowy Hydro Corporatisation Act 1997* (NSW) (SHC Act) enables a lease to be granted by the NSW Minister for the Environment, for the purposes of the existing Snowy Scheme. Importantly, s41(5) of the SHC Act provides that development that is for a purpose for which a lease has been granted under the Act, is taken to be authorised under the *National Parks and Wildlife Act 1974* (NSW) (NPW Act). In November 2018, noting the importance of Snowy 2.0 to NSW's energy security and underpinning the transition to a modern decarbonised energy system, [1]amendments to the SHC Act were passed by the NSW Parliament to enable a lease to be granted for Snowy 2.0, subject to approval being granted under the EP&A Act. Under the legislation, the Minister for the Environment can consider the objects of the NPW Act, the management principles for national parks and other matters when negotiating any lease and deciding what conditions to impose.

Snowy Hydro recognises the sensitive environment in which Snowy 2.0 and its existing Snowy Scheme assets are located. Snowy 2.0 is sited to take advantage of two key existing Snowy Scheme dams, Talbingo and Tantangara reservoirs, so the location for Snowy 2.0 and the Main Works construction and operational infrastructure within the park is unavoidable. Utilising the two existing reservoirs and locating most infrastructure underground avoids large permanent impacts to the park. It is also strategically located to provide unparalleled large scale storage capability to the two major load centres of the NEM - Sydney and Melbourne. Responses to options and alternatives considered is provided in Section 4.2.3.

Since the inception of the project, the aim of the design has been to avoid and minimise environmental impacts as much as possible and much of the design refinement has been to continually reduce the project's footprint. This process is ongoing following the exhibition of the EIS. While there will continue to be a need for permanent footprint for operational infrastructure, as discussed in Section 3.2.1, the disturbance footprint needed for construction has been further refined and significantly reduced by 62% from 1,680 ha to 640 ha. As detailed design continues, Snowy Hydro and its contractor will continue to look for ways to minimise the disturbance area, wherever possible. A revised BDAR and revised water management report have been completed based on the reduced disturbance footprint (provided at Appendix G and Appendix J, respectively), and further describes the predicted impacts to natural ecosystems.

The EIS contains detailed descriptions of the environment and values of KNP and the numerous environmental technical studies undertaken for Snowy 2.0 have significantly contributed to better understanding these values. The substantial work undertaken to better understand the existing environment within the project area is critical

[1] The Hon. Don Harwin, *Second Reading Speech, Snowy Hydro Corporatisation Amendment (Snowy 2.0) Bill 2018*, 24 October 2018, https://www.parliament.nsw.gov.au/Hansard/Pages/HansardResult.aspx#/docid/'HANSARD-1820781676-77854'

to the avoidance and minimisation of impacts that has been achieved through the project's iterative design and assessment process. This was recognised by EES in its submission, which stated the assessment has undertaken:

> …a significant amount of biodiversity survey across the project area in consultation with agency staff. This work has resulted in significant additions to our knowledge of biodiversity values in the northern section of KNP. DPIE also acknowledge that this has influenced Snowy Hydro's design of certain project elements to avoid impacts to areas of high biodiversity value.

Since the inception of the project, the aim of the design has been to avoid and minimise environmental impacts as much as possible and much of the design refinement has been to continually reduce the project's footprint. This process is ongoing following the exhibition of the EIS. While there will continue to be a need for permanent footprint for operational infrastructure, as discussed in Section 3.2.1, the disturbance footprint needed for construction has been further refined and significantly reduced by 62% from 1,680 ha to 640 ha. As detailed design continues, Snowy Hydro and its contractor will continue to look for ways to minimise the disturbance area, wherever possible. A revised BDAR and revised water management report have been completed based on the reduced disturbance footprint (provided at Appendix G and Appendix J respectively), and further describes the predicted impacts to natural ecosystems.

An assessment of Snowy 2.0 on the listed values of the Australian Alps (of which KNP is a part) was carried out as part of the heritage assessment in the EIS. These values are commensurate with those in the KNP PoM, consisting of natural, cultural and recreational values. Further, individual values were considered in each relevant technical assessment prepared with the EIS, in particular:

- Natural heritage
    a) Rocks and landforms; karst areas; soils; were considered in the geodiversity and soil and land assessments, respectively;
    b) Rivers and lakes; ecosystem processes were considered in the water assessment;
    c) Native plants and animals were considered in the biodiversity and aquatic ecology assessments; and
    d) Wilderness; aesthetic were considered in the landscape character and visual impact assessment;
- Cultural heritage
    a) Aboriginal heritage values were considered as part of the Aboriginal cultural heritage assessment;
    b) Pastoralism; huts; mining; water harvesting were considered as part of the historic heritage assessment; and
    c) Scientific research; conservation were considered as part of the water, aquatic ecology and biodiversity assessments; and
- Tourism and recreation; considered as part of the social impact assessment and recreational user assessment.

Utilitarian functions are also described as values in the KNP PoM, which includes the existing Snowy Scheme.

Due to the nature of the project and clearing required, impacts to small parts of KNP and some of its habitats is unavoidable. However, through ongoing refinements to the design the project has further minimised the construction footprint and maintained as much of the existing natural environment as is reasonable and feasible. This is consistent with the broader biodiversity mitigation process to avoid, minimise and offset. Where impacts

are unavoidable they will be offset in accordance with the revised Offset strategy (provided in Appendix L) to achieve long-term conservation outcomes in the park, in line with the values and mitigation strategies outlines in the KNP PoM and as determined in consultation with NPWS. The offsets strategy is expected to be implemented over time and to deliver significant benefits for the natural values of the KNP and the people who use it.

Conservation actions developed in consultation with species experts from relevant government agencies and stakeholders and listed in the Offset strategy for consideration include:

- establish a program to restore and regenerate dry open eucalypt forest and woodland within KNP, improving connectivity and water yield;
- undertake an expanded weed control program across the park to improve vegetation condition and habitat for threatened species;
- develop and implement a program to improve watercourses within the park, restoring alpine watercourses, recovering habitat for threatened species and improving water yield;
- establish a program to reduce the distribution and abundance of feral predators across the park;
- specific conservation actions for key species including smoky mouse, booroolong frog, alpine tree frog and clover glycine; and
- further information regarding the proposed Offset strategy is provided in Section 4.5.2 and Appendix L.

4.1.5 Cumulative impacts

Comments raised in submissions were made regarding staged assessment and cumulative impacts of the project, primarily:

- a staged assessment process does not allow adequate consideration of the cumulative impact of the project as a whole, namely Snowy 2.0 (Exploratory Works, Segment Factory, Main Works) and its Transmission Connection;
- exacerbating environmental impacts within KNP already experienced as a result of Snowy 1; and
- cumulative environmental impacts with the broader, existing Snowy Scheme and downstream catchments.

i Staged assessment process

Snowy Hydro has followed the well-established and robust regulatory process for the approval of Snowy 2.0 every step of the way. This includes the declaration of the project by the NSW Planning Minister as “critical State significant infrastructure” (CSSI) under the EP&A Act; the detailed assessment required for CSSI projects under that Act, importantly including public exhibition of EISs for Snowy 2.0; referrals to the DoEE for decisions to be made under the EPBC Act; and extensive consultation with the community and key stakeholders over the past two years.

The NSW and Commonwealth environment and planning systems allow for multiple major project applications to be submitted and assessed. Within this, cumulative impacts of projects are to be addressed where relevant. The EIS process for any major project of this size will take a number of years to complete in order for the appropriate design and environmental surveys, modelling and assessments to be undertaken with rigour and in line with best practice.

The staged delivery of CSSI projects is not unique to Snowy 2.0 and has been applied in other projects in NSW, namely the WestConnex, and Sydney Metro projects. While these projects are within urban areas, they share similarities to Snowy 2.0 in that they are both complex engineering and tunnelling infrastructure within a constrained environment.

The staging strategy for Snowy 2.0 was first outlined in the 2017 Feasibility Study which is available on Snowy Hydro's website, as well as the business case (or Financial Investment Decision). The timing for the various component projects is illustrated in Figure 4.4 below.

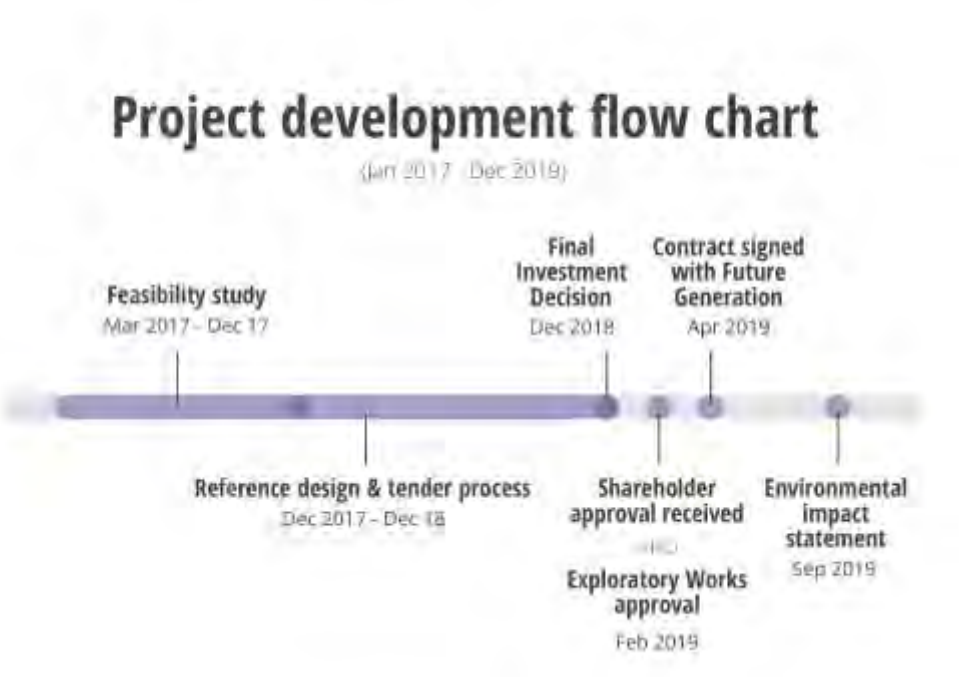


Figure 4.4 Project development flow chart

Factors considered in the staging of Snowy 2.0 included:

- need for exploratory activities to reduce uncertainty in the construction and commissioning of the project;
- ensuring a beneficial procurement and delivery strategy;
- funding requirements; and
- NEM considerations.

Network connection and transmission augmentation works will be carried out by a Transmission Network Service Provider (TNSP) in NSW and Victoria and so the TNSP will be responsible for obtaining the approvals to construct and operate that infrastructure. As such, details of the required approvals and environmental impact assessment for the network connection and transmission augmentation works are not covered by Snowy Hydro's application(s). Snowy Hydro is collaborating closely with both the TNSP and NSW, Victorian and Commonwealth approval authorities throughout this process.

In accordance with the SEARS, the Snowy 2.0 Main Works EIS included the strategic context of the project having regard to any other existing, approved or proposed projects that could result in cumulative impacts of the project (see Section 4.1.1 of the Main Works EIS). The projects considered were:

- Snowy 2.0 Exploratory Works;
- Snowy 2.0 Segment Factory; and
- Snowy 2.0 Transmission Connection Project.

While these projects are subject to their own commercial processes, environmental assessment and approvals, they have been considered in the Main Works EIS to the extent possible using information publicly available at the time or sought directly from the respective proponent.

The Transmission Connection Project is proposed by TransGrid. The EIS being prepared by TransGrid was not available at the time of preparation of the Snowy 2.0 Main Works EIS. However, as a key stakeholder, TransGrid has been consulted throughout the planning and delivery of Snowy 2.0.

Technical studies included consideration of cumulative impacts where possible with available information including:

- Traffic and transport assessment – consideration of traffic movements inclusive of estimated traffic from concurrent projects:
    - information relating to estimated traffic movements were provided by TransGrid and considered within the assessment. The contribution of traffic from the Transmission Connection Project was minimal; and
    - the assessment was carried out assuming the segment factory would be operational at the time construction of Main Works started, and therefore all traffic numbers considered in the assessment were included.
- Landscape character and visual impact assessment – consideration of short term and long term changes to visual amenity due to the combination of projects during operation, in particular where infrastructure proposed as part of the Transmission Connection Project interfaces with Snowy 2.0 Main Works.
- Water assessment – consideration of the cumulative groundwater drawdown, baseflow reduction and surface water quality impacts of the project combined with existing works (ie Exploratory Works).
- Biodiversity assessment – assessment of cumulative impacts to native vegetation and threatened species from the Main Works, the Exploratory Works and the Segment Factory. Suitable information on the clearing requirements for the Transmission Connection Project was not available at the time, however Snowy Hydro has provided TransGrid with all relevant survey data to inform the cumulative assessment to be carried out for the Transmission Connection EIS.
- Heritage assessment and statement of heritage impact – consideration of impacts to historic heritage complexes and thematic groups providing consideration of cumulative impacts arising from the Main Works and Exploratory Works. Suitable information on the clearing requirements for the Transmission Connection Project was not available at the time, however Snowy Hydro has provided TransGrid with all relevant survey data to inform the cumulative assessment to be carried out for the Transmission Connection EIS.
- Social impact assessment – consideration of cumulative social impacts of the project combined with Exploratory Works, the Segment Factory and the TransGrid Transmission Connection project including impacts to: economic stimulus and employment opportunities, population change and housing affordability, pressure on local infrastructure, tourism, local workforce and the visual and scenic qualities of the KNP.

ii Exacerbating environmental impacts to KNP

Snowy Hydro recognises the sensitive environment in which Snowy 2.0 and its existing Snowy Scheme assets are located. The Snowy Scheme has been operating in the KNP for decades and Snowy 2.0 is an expansion of the existing Scheme that will operate as part of an integrated system and it utilises existing dams as such it cannot be

built anywhere else. Throughout the project, an aim of the design has been to avoid and minimise environmental impacts as much as possible. This includes using the previously disturbed area of Lobs Hole as the primary construction site, and designing stable landforms that can be reshaped and rehabilitated successfully into the landscape.

Following the Snowy Mountains rehabilitation program, a better understanding and more successful methods for rehabilitation of alpine vegetation communities have been determined and rehabilitation improved over many years since the original Scheme was built. The Rehabilitation Strategy developed for Snowy 2.0 builds on this demonstrated experience to ensure that newly disturbed areas will be successfully revegetated and maintained in the long term.

iii Cumulative environmental and downstream impacts

As detailed in Section 4.2.4 of the Main Works EIS the existing Snowy Scheme has deemed planning approval in accordance with the EP&A Act. The proposed location of Snowy 2.0 within the existing Snowy Scheme provides numerous benefits including the availability of an existing robust environmental management framework that is implemented for the existing Snowy Scheme. As discussed in Section 4.3 of the Main Works EIS the KNP PoM incorporates the Snowy Management Plan to specifically deal with the operations of the existing Snowy Scheme within KNP. Should approval be granted for the Main Works, the Snowy Management Plan will be reviewed and updated to incorporate management obligations with respect to the Snowy 2.0 project in accordance with the timetable imposed by the SHC Amendment Act.

There are no other proposed changes or construction works to the existing Snowy Scheme that would create cumulative impacts with the Main Works.

As discussed in Section 2.4 of the Main Works EIS, if the Main Works is approved, the Snowy Scheme will continue to meet the drought proofing objective of the Snowy Scheme through the required water releases for downstream water users, including the environment, of the Murray and Murrumbidgee valleys, and complying with the Snowy Water Licence.

Impacts of the Main Works on water, aquatic ecology and terrestrial ecology were thoroughly assessed in the respective sections of the Main Works EIS and supporting technical reports.

4.1.6 Ecologically sustainable development

Comments raised in submissions called for the project to be rejected as it is not considered ecologically sustainable development.

Snowy Hydro acknowledges that its environmental assessment of Snowy 2.0 must address the principles of ecologically sustainable development (ESD) as those principles are expressed and applied by the EP&A Act. In particular, one of the objects of the EP&A Act is:

"To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment."

Snowy Hydro considers that its extensive environmental assessment with significant input from technical and scientific experts has fully addressed these matters.

The EP&A Act adopts the definition of ESD found in the *Protection of the Environment Administration Act 1991.* Section 6(2) of that Act states that ESD requires the effective integration of economic and environmental consideration in the decision-making process and that ESD be achieved through the implementation of the following principles and programs:

- the precautionary principle;

- inter-generational equity;
- conservation of biological diversity and ecological integrity; and
- improved valuation, pricing and incentive mechanisms.

The Main Works EIS has considered the above principles and programs, and further consideration is provided below. Precautionary principle

The precautionary principle holds that where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

In the application of the precautionary principle, public and private decisions should be guided by:

- careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and
- an assessment of the risk-weighted consequences of various options.

Snowy 2.0 Main Works has been designed to avoid and minimise serious or irreversible damage to the environment where possible. As discussed in Section 2.2.2 of the Main Works EIS, an iterative and risk-based design and assessment process was adopted in identifying and assessing potential environmental impacts and opportunities to avoid and minimise impacts throughout the project design. Small residual impacts have been assessed and documented in the Main Works EIS.

Snowy Hydro recognises the unique environment in which the Snowy Scheme is located, KNP, and is committed to ensuring it enables long-term improvements to the environmental and recreational values.

Technical and scientific assessments have been completed as part of the Main Works EIS to identify the potential impacts of the project and outline measures to prevent long-term environmental degradation. These technical assessments describe those areas where lack of full scientific certainty exist and, in these cases, the precautionary principle has been appropriately applied. As an example:

- Groundwater impacts outlined in the Main Works EIS were conservative, with a precautionary approach applied through the modelling scenario adopted for the assessment. This scenario was an unlined, free draining power waterway which resulted in a worse-case extent of groundwater drawdown impact. The power waterway will be grouted in areas of high inflow and therefore this worse-case extent is considered unlikely to eventuate. While evidence of the precautionary principle being applied, this overly conservative approach has overstated potential impacts to be mitigated and offset which would otherwise not need to be determined. The groundwater modelling for the project has been reviewed to ensure a more realistic scenario is presented and assessed, allowing offsets to be more responsively determined. Further detail on revised groundwater modelling results are presented in Section 4.4.1 and Appendix I.
- Biodiversity surveys were carried out across the disturbance area. At the time of the Main Works EIS public exhibition period, surveys were ongoing. The assessment included in the EIS therefore utilised the precautionary principle and assumed presence for a number of threatened species and/or communities, resulting in a conservative impact assessment approach presented in the BDAR. Since the Main Works EIS was placed on exhibition, further surveys have been carried out to fill previous gaps in survey effort and provide more certainty on potential impacts. Further detail on the activities carried out since exhibition of the Main Works EIS is provided at section 4.4.2 and Appendix G. A similar approach was carried out for the heritage assessment, with further detail provided at section 4.4.5 and Appendix M.
- Transfer of aquatic pest species from Talbingo to Tantangara – research was carried out by technical experts to assess the risk of transfer as well as investigate a range of containment and mitigation measures.

The Main Works EIS concluded that while the risk of transfer is low, these detailed scientific investigations have not been able to categorically rule out this potential risk. As such and assuming that transfer may eventuate, reasonable and feasible mitigation measures have been committed to by Snowy Hydro. Further detail and justification of the mitigation measures selected is provided in Section 4.4.3 and Appendix H.

- There was some limitation placed on the ability to conduct intrusive investigations as part of the Main Works EIS in relation to the soil and land and contamination assessments. As a precautionary approach, desktop studies informed the likelihood for contaminated land and potential risks identified have been recommended for further investigation should the project be approved, and throughout the construction period.

- Other technical assessments also included a level of conservatism, in particular where assessments were guided by the design (noting that a detailed design process was underway but not completed at the time of preparing the assessments). Assumptions were made to inform the assessments and these were qualified in the subsequent mitigation measures and recommendations of each assessment.

Snowy Hydro has engaged qualified experts in their field to carry out scientific investigations for key aspects of the project as well as consulted with species experts from relevant government departments to develop conservation actions for KNP. As outlined in Appendix C suitable safeguards and management measures will be implemented to manage and reduce impacts identified in assessments.

Snowy Hydro has, and will, continue to consult extensively with NPWS to achieve an offset strategy that will deliver real and long-term conservation outcomes for the park.

i Inter-generational equity

Inter-generational equity is the concept that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

Snowy 2.0 is the largest committed renewable energy project in Australia and will underpin the nation's secure and stable transition to a low carbon emissions future at the lowest cost for consumers. The Snowy 2.0 Main Works would provide the following benefits to future generations:

- more efficient dispatch of electricity to major load centres and less emission generation when compared to traditional electricity generating plants powered by fossil fuels;

- increase the generation capacity of the Snowy Scheme by almost 50% providing an additional 2,000 MW generating capacity, and make approximately 350 GWh of storage available to the NEM at any one time to provide firming to zero-emissions forms of VRE such as wind and solar;

- increased storage lifespan, longer lifespan for storage, and cheaper full life cycle cost when compared to current lithium-ion storage batteries; and

- improved security and reliability of electricity supply when compared to the intermittency of primary renewable energy sources (such as wind and solar).

Construction of the Snowy Scheme was a nation building project for the time. Construction of Snowy 2.0, an expansion of the Scheme, will have a positive outcome overall when balanced with the strategic need for the project in the energy market and the long term conservation outcomes to be delivered in KNP by the Offsets Strategy.

The strategic planning studies summarised in Chapter 3 of the Main Works EIS have identified a strong need and justification for Snowy 2.0 and this is further expanded in Section 4.1.1 of this PIR-RTS.

ii Conservation of biological diversity and ecological integrity

This principle holds that conservation of biological diversity and ecological integrity should be a fundamental consideration.

Conservation of biodiversity and the wider environment was a fundamental consideration in the design of Snowy 2.0 Main Works with avoidance and minimisation measures implemented wherever possible. As described in section 2.2.2 of the Main Works EIS, an iterative and risk-based design and assessment process was adopted in identifying and assessing potential environmental impacts (the DIAA process). This process was undertaken to develop the design and construction methods with the guiding principles of avoiding and minimising environmental impacts where possible and engaging with key stakeholders throughout the process. This process continued beyond the preparation of the Main Works EIS, with further design refinements and environmental assessment being undertaken as part of the PIR-RTS. Consistent with the DIAA process, the detailed design continues to be optimised to meet construction requirements while continuing to minimise environmental impacts. A key outcome is the reduction in the disturbance area required to build Snowy 2.0.

The use of land previously disturbed has been maximised and the use of undisturbed land minimised. Nonetheless there will be land and waters impacted that contain habitat for native and threatened fauna. Mitigation and management measures have been recommended to ensure conservation of biodiversity though specific limitations to design and construction, requirements for offsets in accordance with legislation, and implementation of an offset strategy and threatened species monitoring plans.

iii Improved valuation, pricing and incentive mechanisms

This principle holds that environmental factors should be included in the valuation of assets and services, such as.:

(i) polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The development of Snowy 2.0 would improve the reliability and security of the NEM, with lower costs and greenhouse gas emissions than other energy generation alternatives. Further, Snowy 2.0 would increase generation competition in the NEM at the peak times, exerting downward pressure on peak energy prices, providing economic benefits to the consumer.

In addition, the Commonwealth Government's 1992 *National Strategy for Ecologically Sustainable Development* defines ESD as:

> using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life now, and in the future, can be increased.

Snowy 2.0 Main Works is being developed to enhance existing community resources and would provide for an increased quality of life now, and in the future.

Snowy 2.0 Main Works has the potential to impact ecological processes in the following ways; via direct impacts from clearing of vegetation and ground disturbance, and via indirect impacts (eg sedimentation of waters, noise and light, and the introduction of weeds and pests) during construction activities, and potentially through the

introduction of weeds and pests during the commissioning and operational phases. In recognition of these, the design of the Snowy 2.0 Main Works adopted avoidance and minimisation measures. Residual impacts have been assessed and documented in the EIS.

iv Summary

Following the announcement of Snowy 2.0 by former Prime Minister Malcom Turnbull, the decision to proceed with Snowy 2.0 was made only once several undertakings had been completed including completion of the Feasibility Study in December 2017, independent market modelling and Final Investment Decision in December 2018.

Following two years of extensive work and analysis Snowy Hydro has in its decision-making processes considered both long-term and short-term environmental, economic, social and equitable considerations. These are outlined in the business case available at Snowy Hydro's website https://www.snowyhydro.com.au, and included consideration of:

- environmental studies were initially carried out to inform the 2017 Feasibility Study and remain ongoing. These studies included a series of assessments and field surveys and investigations to establish the current environmental baseline conditions and determine the likely short-term and long-term environmental impacts. Together with a design integration and assessment approach, Snowy Hydro's project team has worked together in identifying strategies to avoid, minimise or offset these impacts in the short and long-term. Technical environmental assessments were completed for each of the Snowy 2.0 project applications to support the respective EIS'. These studies describe how the project's design has been amended to respond to survey and assessments results, in particular with regard to biodiversity and heritage;

- social considerations through extensive community and stakeholder engagement both locally and more broadly with key interest groups. In addition, social impact studies were completed for each of the Snowy 2.0 project applications to support the respective EIS'; and

- economic studies including modelling numerous scenarios including short-medium term and long-term. Studies were done as part of the 2017 Feasibility Study and revised for the business case (or Final Investment Decision). Economic assessments were also completed for each of the Snowy 2.0 project applications to support the respective EIS'.

Snowy 2.0 Main Works is considered consistent with the principles of ESD.

4.2 Project design

4.2.1 Infrastructure and design

Several submissions raised matters for consideration that related to siting of infrastructure or its design and construction method, including:

- application of relevant guidelines for design of surface infrastructure on waterfront land;
- design and location of invasive fish barriers to ensure their effectiveness;
- design and construction methods for powerlines and communications cables;
- design of the project access roads;
- the excavated rock emplacement methods and equipment;
- the generation capacity of the power station; and
- the geotechnical stability of the power waterway.

One submission raised concerns regarding the potential for delays to the construction schedule.

As described in Section 4.2.3 above the design of the Main Works has considered a range of options and alternatives for various aspects of the project. Responses to each of the matters raised regarding infrastructure and design are provided in this section.

i Infrastructure on waterfront land

The NRAR Guidelines for controlled activities on waterfront land states that waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 m of the highest bank of river, lake or estuary. It recommends these types of areas have a 40 m vegetated riparian zone (VRZ) be kept undisturbed at a development site.

For Snowy 2.0, the majority of the project surface elements have been designed to be greater than 40 m from waterways to minimise the disturbance of riparian zones and associated ecological impacts. Where project surface elements do encroach this 40 m VRZ, the guideline states that so long as the average width of the VRZ can be achieved over the length of the water course within the development site, this can be authorised. Consequently, the design of the project is consistent with the NRAR Guidelines.

ii Fish barriers

As discussed in Section 4.3.4 below, Snowy Hydro reaffirms its view that the controls proposed in the Main Works EIS are the most reasonably practicable solution to manage potential risks and impacts associated with the potential transfer of pest fish in the operation of Snowy 2.0. Additional detailed information has separately been provided to DPIE and DPI Fisheries for assessment and determination, in response to the request for additional information dated 15 January 2020 (Appendix N).

iii Powerline and communications cable

As outlined in Section 2.2.3 of the Main Works EIS, two communications cables will be installed as part of the project. One will be within sections of the Snowy Mountains Highway and Gooandra track corridors between the power station and Tantangara Reservoir. A more southern route will also be built that will connect to Cabramurra (Upper Tumut Switchyard). This route is mainly within the Snowy Mountains Highway and Tantangara Road corridors. These cables will be laid in a trench with some sections also underbored or bridged where suitable.

As also described in this section, for construction power, cables will be constructed using either overhead powerlines, or will be buried cable will be installed along roads (or adjacent to) and reticulate to the relevant locations within the construction area. Permanent power will also be buried cable. Construction methods may comprise a combination of trenching and underboring, depending on the identified constraints (such as geology and watercourse crossings) or where there are opportunities to minimise disturbance of new areas.

A substation is required to provide power to the construction of Snowy 2.0 at Lobs Hole. This substation is proposed to be built as part of the Exploratory Works with a capacity of 80 MVA, subject to the approval of Modification 2 for Exploratory Works. If approved, it will continue to be used for Snowy 2.0 Main Works, however requires the establishment of further power supply cables to provide power to the work sites and TBM at Tantangara, as well as Talbingo, in particular to power the TBMs via the MAT, ECVT, Talbingo and Tantangara portals. The supporting high voltage cable route therefore follows access roads to these locations.

The cables will be either overhead or buried from Lobs Hole to Marica and then buried via trench to Tantangara, within existing or proposed access roads, generally along the same alignment as the communication system cable discussed below. The cable trenches will be established to the required depth and in some areas direct drilled (such as for crossing sensitive environments such as watercourses). Bedding sand will be laid, and the conduit placed. Trenches will be backfilled and compacted with the excavated material.

In addition to construction power established for construction works, communications infrastructure will be established as part of the Snowy 2.0 construction and will connect infrastructure at Tantangara and Talbingo reservoirs to the existing communications system at the Tumut 3 power station (via the submarine communications cable in Talbingo Reservoir established during Exploratory Works) and to Snowy Hydro's communications infrastructure at Cabramurra. This system will include optic fibre cables, and will serve all fixed construction communication needs, as well as providing the permanent communication supply. This will involve a buried conduit linking the Talbingo intake, the underground power station, headrace valve chamber, headrace tunnel surge shaft and the Tantangara intake.

The cable will be buried in conduits within access roads, which involves excavating a trench, laying the conduits, pulling the cables through, and backfilling and restoring the surface. Where cables are to be laid in conduits beneath gravel roads, communication pits will be required along the route to provide access for maintenance. Watercourse crossings will be carried out in a manner that minimises environmental impacts where possible, and may include:

- trenching of ephemeral creeks during dry periods only;
- temporary creek diversion and burying conduits below watercourse beds; or
- horizontal drilling or underbore methods, to minimise impacts to the watercourse and adjacent riparian zone.

Horizontal drilling methods will also be considered to minimise impacts to other sensitive areas where possible, as identified in the EIS.

iv Access roads

As outlined in Section 2.2.2 of the Main Works EIS an iterative and risk based process was implemented throughout the project design to develop the design and construction methods with the guiding principles of avoiding and minimising environmental impacts where possible and engaging with key stakeholders throughout the process. Accordingly the project access roads were sited and designed with an aim to balance the need to provide safe movement of plant, equipment, materials and personnel across the sites, with the need to preserve and protect the values of the KNP and the environmental constraints of the location. Further information is provided in Section 4.3.2 below regarding additional reductions in the construction footprint (including access roads) that have been achieved since the exhibition period.

With specific mention to the Marica West, this access road is required during construction to provide access and power supply/ communication requirements to the project. The Marica West access road is further required during operations as a permanent maintenance road due to the routing of power and communication cables beneath the road. Through the design development process, this road has been reduced to a single lane road from the Access Tunnel Portal through to the spur road servicing the Ventilation Shaft, resulting in a reduced disturbance area for the construction of this access road.

v Excavated rock emplacement

Excavated rock management has been the subject of ongoing discussions between Snowy Hydro and relevant government agencies since the submission of the Main Works EIS, and following receipt of public and agency submissions. Agencies have requested Snowy Hydro explore alternative excavated rock management options for DPIE to consider during the assessment process. A summary of these potential alternative design options are presented in Section 3.2.2 of this report.

vi Generation capacity of the power station

The generation capacity of the power station was a matter considered during the Feasibility Study stage of the project. The proposed generating capacity is considered to optimise the benefits provided by Snowy 2.0 as outlined in Chapter 3 of the Main Works EIS and discussed further in Section 4.2.1 above.

vii Geotechnical stability of the power waterway

The geotechnical conditions for the power waterway and underground power station have been extensively studied through the geotechnical investigation program completed for the Feasibility Study. The Exploratory Works, which are currently underway, will provide additional valuable information regarding the underground conditions at the power station cavern and the power waterway. Further geotechnical investigations are also proposed as part of the Main Works application. The ultimate design of the power station and power waterway will include suitable safety in design measures to minimise risks of geotechnical stability and will be informed by previous, ongoing and future geotechnical investigations.

Further to the above, the proposed support systems for the underground structures are designed to provide robustness and flexibility to adapt to the full range of foreseeable ground conditions. In combination with this, planning for the implementation of auxiliary construction measures has also been undertaken to allow for credible geotechnical risks scenarios eventuating. As is standard practice within the tunnelling industry, the actual encountered ground conditions and the performance of the installed support systems will be continually assessed and monitored during construction to ensure that the design assumptions remain valid and the appropriate measures are implemented.

viii Construction schedule

Snowy Hydro has engaged FGJV to deliver the Snowy 2.0 project, a Tier 1 joint venture contractor whose partners have considerable experience in the design, construction and delivery of comparable large infrastructure projects. Snowy Hydro are confident that the contractor and the Snowy Hydro delivery team are capable of managing the construction program as presented in the Main Works EIS to the extent that it is within their control.

In developing the construction methodology and construction program for the project, the aim has been to minimise the period of construction whilst maintaining an acceptable and manageable amenity for surrounding receivers. The linear nature of the project has enabled a methodology which allows for construction activities to occur on multiple work fronts. This, along with numerous other mitigation measures presented in the EIS are designed to minimise the period of construction and therefore associated impacts on surrounding receivers.

4.2.2 Disturbance footprint

Comments raised in submissions were made regarding the disturbance area, primarily:

- the extent of disturbance is understated in the EIS;
- the disturbance area will be larger than reported in the EIS;
- the extent of impacts to the KNP will extend throughout the project area and will not be limited to the disturbance area;
- area of disturbance is significant and unacceptable.

i Disturbance area assessed in the EIS

As reported in the Main Works EIS, the physical disturbance for the Snowy 2.0 Project is limited to the Main Works disturbance area which is approximately 1,680 ha (or 16.8 km^2). This figure equates to approximately 0.25% of KNP. It should be noted that significant refinement of the disturbance area has been carried out and is presented within this PIR-RTS report. The total area to be disturbed from the Snowy 2.0 Project is 640 ha which is

a 63% reduction from what was reported in the Main Works EIS. Of the revised disturbance area, approximately 37 ha of this area outside the KNP. The expected disturbance area within KNP therefore is approximately 603 ha which is less than 0.1% of KNP.

The disturbance area is an estimation of the area required for construction works based on the current level of project design. It is important to note that a significant portion of this disturbance area utilises areas that have been previous disturbed. Areas such as Lobs Hole (where the bulk of the surface disturbance is expected) is the site of an old mining town.

Several submissions received raised concerns based on an incorrect understanding of the disturbance area assessed in the Main Works EIS. Several submissions were not clear on the difference between the 'project area' with the 'disturbance area' and were concerned that the entire project area would be subject to construction activities. As outlined in Section 2.2.4 of the Main Works EIS the project area was defined as:

> the broader region within which Snowy 2.0 will be built and operated, and the extent within which direct impacts from Snowy 2.0 Main Works are anticipated.

The project area was defined in the Main Works EIS to provide an area in which environmental assessment would be undertaken to understand the impacts of the proposed works.

The "disturbance area" provided in the Main Works EIS is a much more accurate representation of the project footprint and was defined in Section 2.2.4 of the Main Works EIS as:

> the extent of construction works required to build Snowy 2.0. The maximum disturbance area is about 1,680 ha which is approximately 0.25% of the KNP. Most of the disturbance area will be rehabilitated and landformed and other parts will be retained permanently for operation (operational footprint).

The disturbance area provided in the Main Works EIS is the maximum extent of construction activities proposed for the Main Works. No ground disturbance of vegetation removal would occur outside of the proposed disturbance area. As noted above, significant refinement to the disturbance boundary has occurred since the exhibition of the Main Works EIS. Should the Main Works be approved, the disturbance area would become the project boundary and would be enforceable under the conditions of consent.

ii Refinements to the disturbance area post-exhibition

Since the submission of the Main Works EIS, significant work has gone into refining a more realistic value for the expected disturbance area. Due to the development of the design, and as part of ongoing environmental assessment post Main Works EIS submission, the expected disturbance area has been reduced. As outlined in Section 3.2.1 of this report the terminology used to define the project footprint has also been revised to reflect the refinement of the disturbance area.

The updated disturbance area is approximately 640 ha, a 62% reduction of the disturbance area that was assessed in the Main Works EIS. It is important to note that of the 640 ha disturbance area, approximately 37 ha of this area is outside the KNP.

The expected disturbance area within KNP therefore is approximately 603 ha, (a reduction in area of 58% from the 1,453 ha reported in the Main Works EIS).

iii Disturbance outside construction area

The extent of expected impacts beyond the construction footprint have be rigorously assessed throughout the EIS process and associated studies with the areas of influence defined in those studies.

Appropriate offsets for the biodiversity impacts of the project footprint will be agreed with BCD and DPIE as outlined in the Offset Strategy provided in Appendix L.

4.2.3 Excavated rock management

Several submissions raised matters regarding the management of excavated rock, primarily:

- Some submissions indicated that total volumes to be excavated are unclear, with clarification required on the bulked and unbulked volumes. Several submissions state that 14 million m^3 excavated rock would require management and disposal.
- Concerns about the general environmental impacts to KNP of on-land excavated rock placement.
- Contamination risks associated with on-land excavated rock placement including management of asbestos containing material and potential acid forming material.
- Terrestrial ecology impacts of on-land excavated rock placement.
- Visual impacts of excavated rock placement.
- Reduced storage capacity of Talbingo and Tantangara Reservoirs due to in-reservoir excavated rock placement.
- Water quality impacts to Talbingo and Tantangara Reservoirs due to in-reservoir excavated rock placement.
- Downstream water quality impacts due to in-reservoir excavated rock placement.
- Aquatic ecology impacts of in-reservoir excavated rock placement.
- Operational impacts of in-reservoir excavated rock placement.
- Options for excavated rock placement outside of KNP including beneficial re-use.

Excavated rock management has been the subject of ongoing discussions between Snowy Hydro and relevant government agencies since the submission of the Main Works EIS. Agencies have requested Snowy Hydro explore alternative excavated rock management options for DPIE to consider during the assessment process. A summary of these potential alternative design options and the preferred strategy are presented in Section 3.2.2 of this report.

4.2.4 Operations

Several submissions raised matters relating to the operational phase of the project, including:

- Increased fluctuation of the reservoir levels due to operation of the project and resultant movements at the shoreline.
- Changes to downstream water releases and how outlet rivers are managed due to operation of the project, impacting irrigators and others.
- Ongoing maintenance requirements for the operational infrastructure, suggesting potential for pipeline failure may occur due to pressure in the power waterway.
- Operational limitations due to the reservoir capacities (and changes to capacity), eg if Talbingo is full how can any flow from Tantangara be allowed to generate electricity.

i Increased fluctuation of reservoir levels

Following the commencement of the operation of Snowy 2.0, both Tantangara and Talbingo reservoirs will have increased operational functions. However, the water levels in both reservoirs will remain within their existing MOL (minimum operating level) and FSL (full supply level).

Tantangara Reservoir will have the additional operational function of acting as a head storage for generation from the Snowy 2.0 power station and also acting as a storage for water pumped up from Talbingo Reservoir. Talbingo Reservoir will have the additional function of acting as a tail storage from Snowy 2.0 generation.

Due to these additional operational functions, the short and long term water levels in these reservoirs, as well as the rates of water level rise and fall, are expected to experience some degree of change compared with the historical operations. While it is desirable to accurately predict what these reservoir level changes and rates of water level rise and fall will be, only broad conclusions can be drawn, as this will depend on the transfer regime. The transfer regime will vary widely depending on Snowy Hydro operational decisions and planning within the highly competitive NEM. However, regardless of this variability, it is important to note that:

- the water levels in both reservoirs will remain within the MOL (minimum operating level) and the FLS (full supply level) approved for the existing Snowy Scheme;
- the flexible storage of the water in the Snowy-Tumut Development below FSL currently has the benefit of a "deemed" approval under the EP&A Act (by virtue of the express deeming provisions within the SHC Act); and
- no additional land will be affected by virtue of the inundation of the reservoirs through Snowy 2.0 operations. Water storages will continue to be held wholly within the footprint of the existing FSLs.

The variability in storage levels within the existing Snowy Scheme has existed since the scheme was implemented, and is approved under the EP&A Act. This will continue under Snowy 2.0.

In terms of recreational use of Tantangara Reservoir, it is known from the Recreational Users Impact Assessment that the foreshores of Tantangara Reservoir are a popular part of KNP. The area is used for fishing, camping, swimming and relaxing, although there are no designated camping areas or facilities (toilets or water supply). During the operations phase of Snowy 2.0, the water level in Tantangara Reservoir will remain variable with regular rising and falling of water and water storages will continue to be held wholly within the footprint of the existing FSL. Currently, many people camp below the FSL. The Master Plan for Camping and Day Use proposed for the park will need to address any safety measures that may be required in response to this issue of rising and falling water levels and more formalised arrangements for camping around Tantangara may need to be implemented.

ii Changes to downstream water releases

There will be no changes to the Snowy Water Licence release obligations as a result of Snowy 2.0 and therefore no changes to downstream water releases and therefore no impacts to users or the NSW government operated irrigation storages downstream of the Snowy Scheme.

iii Ongoing maintenance requirements for the operational infrastructure

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

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

iv Operational limitations due to the reservoir capacities

As the net elevation difference between Tantangara and Talbingo reservoirs is substantially higher than that of Talbingo and Jounama reservoirs, Snowy 2.0 power station would pass through water at a much lower flowrate when operating at full capacity than Tumut 3 power station (T3). In fact, one third of T3, that is 2 of the 6 units, is able to pass all the water that Snowy 2.0 passes when generating at its full 2,000 MW capacity. Given this simple

fact, Snowy 2.0's ability to generate at full capacity at 2,000 MW for 175 hours will never be constrained by the operating level of Talbingo Dam because Snowy Hydro is able to pass water out of Talbingo Dam much more quickly than it flows into it.

Talbingo Dam level does not frequently operate at close to full. The active storage of Talbingo Dam is only the top 9 m of a dam that is up to 140 m deep in places. This 9 m gives the 160 GL of active storage. Accordingly, if the water level in Talbingo is only 4 m below FSL, and appears close to full, its active storage is actually close to half-empty.

The active storage in Talbingo is also augmented by the 30 GL active storage in Jounama (from which Snowy Hydro can also pump water), which means there is 190 GL of active storage in the lower dams, which is 80% of the 240 GL storage of Tantangara; so as a closed cycle system, Snowy 2.0 can operate at 80% of its full capacity.

However, of course, Snowy 2.0 will not operate in isolation, and one of the significant advantages of adding Snowy 2.0 to the existing Snowy Scheme is that Tantangara and Talbingo dams both operate as part of an integrated portfolio of 16 dams, with water capable of being stored in multiple places throughout the Scheme. In particular, both are connected to Eucumbene Dam, which has 4,400 GL of storage capacity. There are in fact three ways to recharge Tantangara Dam: natural inflows, which average 294 GL/annum; water passed into Talbingo from Snowy 2.0 and then pumped back up (190 GL); and water passed into Talbingo from Eucumbene through the existing Tumut 1 and Tumut 2 Power Stations and then pumped back up. Accordingly, there is no question that Tantangara can be fully recharged.

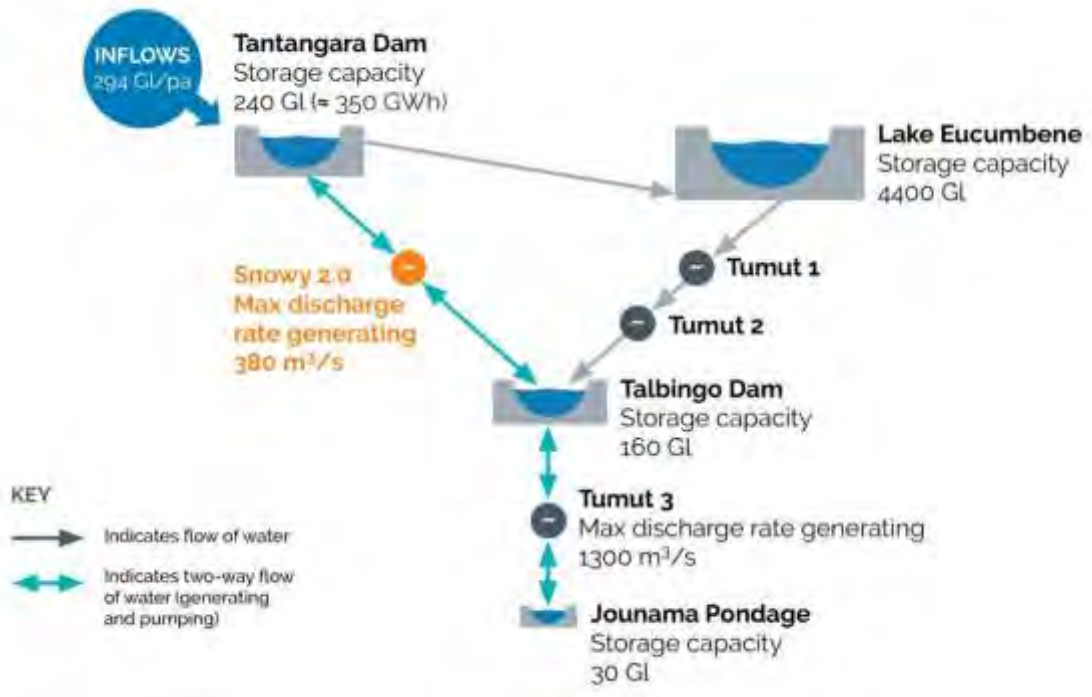


Figure 4.5 Reservoir capacities diagram

4.2.5 Rehabilitation

Submissions were received regarding rehabilitation. Matters raised included:

- The efficacy of the proposed rehabilitation, with suggestions the proposed rehabilitation will not fully restore the qualities and values impacted.
- Comments on the level of rehabilitation proposed and lack of commitment to restore the landscape to its previous state.
- Restoration of historical Snowy Scheme sites.

i Rehabilitation objective

The principal objective of rehabilitation works undertaken will be to leave a positive legacy that enables the project to co-exist within KNP and maintain its values.

The project will involve the necessary clearance of native vegetation within the KNP which includes:

- land cleared to accommodate temporary project infrastructure but not required for long-term scheme operation;
- land cleared to facilitate the on-land placement of excess TBM materials, proposed for emplacement as geomorphic landform design methodology complementary to surrounding topography;
- land created (land reclamation) through emplacement of drill and blast (D&B) waste rock into Talbingo and Tantangara reservoirs, integrated with landforms; and
- other locations of on-land disposal of waste rock and TBM excavated rock with placed material used as construction pads, prior to re-shaping and rehabilitation.

As stated in the Main Works EIS, all areas disturbed by the project not required for operational purposes will be returned to land uses generally consistent with their pre-disturbance use, subject to ongoing consultation with NPWS. The following surface infrastructure areas will be required and retained for the operation of Snowy 2.0:

- water intake structures and gate houses at the Tantangara and Talbingo reservoirs;
- permanent access tunnel portals and associated infrastructure including the MAT and ECVT;
- ventilation shaft and head race tunnel surge shaft at Marica;
- permanent access roads;
- Tantangara and Talbingo barge launch areas;
- transmission cableyard at the ECVT portal; and
- Lobs Hole substation.

At Lobs Hole, temporary construction areas will be rehabilitated to native vegetation or an agreed recreational user capability as determined in consultation with NPWS. Detailed design will follow the principles and concepts to achieve non-polluting landforms and recreational areas which will be outlined in a Recreational User Strategy to be developed post-approval.

ii Framework for development of completion criteria

The Main Works EIS outlined a comprehensive framework through which rehabilitation methods, criteria and implementation techniques will be developed, carried out and monitored to ensure the stated objectives and outcomes are met. This framework will be in place to safeguard the desired rehabilitation outcomes during and post-construction activities.

Completion criteria are objective target levels or values assigned to a variety of indicators which can be measured against to demonstrate progress and the ultimate success of rehabilitation. As such, they provide a defined end point at which time rehabilitation can be deemed successful. These completion criteria will be developed in the preparation of the Rehabilitation Management Plan post-approval.

To ensure the required levels of efficacy of rehabilitation are achieved, a Rehabilitation Quality Assurance Process (RQAP) will be developed and implemented throughout the project. This plan will include details of inspections, monitoring and record keeping which will be required to ensure that:

- rehabilitation is being implemented in accordance with the nominated methodologies in the Rehabilitation Management Plan; and
- identified risks to rehabilitation are being adequately addressed at each phase of rehabilitation.

Further, a dedicated monitoring system is critical to assessing the effectiveness of the rehabilitation implementation measures as well to identify the need for corrective actions as soon as required. This monitoring will be conducted as required by the approval conditions by independent, suitably skilled and qualified persons at locations which will be representative of the range of conditions on the rehabilitated areas.

These plans will be supported by a Trigger Action Response Plan (TARP) which will identify management actions and contingency strategies to implement in the event of unexpected impacts to rehabilitation, or where rehabilitation outcomes are not achieved in an acceptable timeframe.

iii Key considerations for rehabilitation detailed design

Rehabilitation within alpine areas presents some challenges which need careful consideration when carrying out the detailed design of rehabilitation techniques. Some of these key considerations have been informed by the rehabilitation activities carried out by NPWS on the historic Snowy Scheme rehabilitation sites. These considerations include:

- Climate – differences between lower altitude areas such as Talbingo and Lobs Hole compared to the higher altitudes of the Plateau and Tantangara.
- Topography – the slope variability of the undulating landforms to be rehabilitated.
- Soils – varying nature of the physical, chemical and microbiological properties of the soils which will guide the selection and use of alternative growth media should they be needed.
- Excavated materials for landforming – geotechnical and geomorphological stability of excavated materials to understand erodibility and erosivity.
- Native vegetation – aspect of the landforms and accounting for micro-climates to support vegetation establishment, particularly in the Plateau and Tantangara.

- Weeds – topsoils from weed infested areas should be avoided with targeted weed control programs carried out where practical prior to vegetation clearance and excavated rock emplacement to reduce for weed infestation.

- Fauna activity – fencing and feral animal controls programs within the rehabilitation areas may be required to protect soils and vegetation.

- Fire – establishing native vegetation has a low tolerance to fire, analogous to natural vegetation communities in the early stages of re-growth after fire.

In addition, the success of rehabilitation will also be informed by targeted erosion and landform evolution modelling, combined with revegetation establishment trials, are strongly recommended in order to identify key risks and constraints, and required controls.

iv Historic Snowy Scheme rehabilitation sites

As discussed in Section 4.1.5, the Snowy Mountains rehabilitation program operated for more than a decade from 2003, implemented by NPWS in partnership with Snowy Hydro. Snowy Hydro provided $32 million towards the program, which restored lush bushlands, carried out major earthworks, removed hazardous materials, and cultivated native plants with a 90 per cent survival rate.

Following the Snowy Mountains rehabilitation program, a better understanding and more successful methods for rehabilitation of alpine vegetation communities have been determined and rehabilitation improved over many years since the original Scheme was built. The Rehabilitation Strategy developed for Snowy 2.0 builds on this demonstrated experience to ensure that newly disturbed areas will be successfully revegetated and maintained in the long term.

4.2.6 Rock Forest

One submission raised matters regarding the design of the Rock Forest site. In particular the submission recommended consideration of terrestrial biodiversity, riparian land and wetlands sensitivities identified in the Local Environmental Plan (LEP) maps.

The Rock Forest site includes some areas identified as “Biodiversity” in the Snowy River LEP (2013). A comprehensive BDAR was completed for the proposed works and provided in Appendix M.1 of the Main Works EIS. This assessment outlined how impacts to biodiversity values were minimised through the project design including the Rock Forest site. The assessment and measures outlined in the BDAR are expected to provide suitable management for the biodiversity values identified in the Snowy River LEP mapping.

The Rock Forest site includes some areas identified as watercourses under the Snowy River LEP (2013). A comprehensive assessment of impacts to water was prepared and provided in Section 6.2 of the Main Works EIS which included consideration of impacts to watercourses at the Rock Forest site. The assessment and measures outlined in the Main Works EIS are expected to provide suitable management for the watercourse values identified in the Snowy River LEP mapping.

The Rock Forest site includes some areas identified as wetland under the Snowy River LEP (2013). The BDAR provided in Appendix M.1 of the Main Works EIS included a comprehensive assessment of the project impacts to ecosystems as well as suitable mitigation measures and offsets for the impacts identified. The assessment and measures outlined in this report are expected to provide suitable management for the wetland values identified in the Snowy River LEP mapping.

4.3 Environmental assessment and approvals processes

4.3.1 Approvals process and compliance

Several submissions raised matters regarding the approvals process. Matters raised include:

- Approval pathway and process:
  - The planning approval pathway was raised in several submissions. With some submissions raising concerns regarding the planning approval pathway as flawed and arguing that the CSSI status of the project resulted in an inadequate planning approval process. Some submissions argued that the Main Works application is not able to satisfy relevant legislative requirements for planning approval.
  - Concerns that works have already commenced prior to assessment of the EIS, and that piecemeal approvals are not appropriate for a project of this scale.
  - The process for providing consent and setting conditions of approval.
  - The suitability and integrity of the determining authority.
- EIS documentation and exhibition:
  - The quantity of documentation provided in the EIS made it difficult for the public to adequately review the key issues.
  - The adequacy of the public exhibition including the exhibition period, availability of EIS documents and process for public submissions.
  - That the EIS does not adequately consider relevant legislation regarding impacts to biodiversity.
  - One submission argued that the environmental management plans should be completed prior to the assessment of the EIS.
  - Concern that the EIS did not consider the management objectives of the KNP Plan of Management (PoM).
- Submissions raised concerns regarding the procurement process. In particular that environmental assessment and planning approvals would be sought after a contract had been signed for the project construction.

Snowy Hydro has complied with all applicable environmental assessment and approvals processes under the EP&A Act, as set out below. The staged process adopted for the applications and approvals is appropriate for a project of the magnitude and complexity of Snowy 2.0. It is not uncommon for large-scale infrastructure projects to be the subject of separate applications under the EP&A Act. Examples of infrastructure and development the subject of separate applications include WestConnex, Parramatta Light Rail and Barangaroo.

Section 4.4 of the Main Works EIS details the relevant environmental assessment and approvals process at the state level for Main Works pursuant to the EP&A Act.

As Snowy 2.0 has been declared to be critical State significant infrastructure, the environmental assessment and approvals process is prescribed by Part 5, Division 5.2 of the EP&A Act. The requirements of Part 5, Division 5.2 of the EP&A Act have been complied with as follows for the Main Works:

- Snowy Hydro Limited submitted a Scoping Study to the Secretary of Planning in October 2018 requesting that Secretary's Environmental Assessment Requirements (SEARs) be issued with respect to Snowy 2.0 Main Works (s5.15, EP&A Act);

- in June 2019, due to proposed design changes, Snowy Hydro lodged with the Planning Secretary an updated Scoping Study for the Snowy 2.0 Main Works;

- the Planning Secretary issued environmental assessment requirements in respect of the proposed infrastructure on 31 July 2019, requiring that an environmental impact statement be prepared. In preparing the environmental assessment requirements, the Planning Secretary consulted with relevant public authorities and had regard to the need for the requirements to assess key issues raised by the public authorities (s5.16, EP&A Act);

- Snowy Hydro submitted to the Planning Secretary on September 2019 the environmental impact statement which addressed the environmental assessment requirements in the form prescribed by the Regulations (s5.17, EP&A Act); and

- the Secretary placed the Main Works EIS on public exhibition for a period of 42 days (s5.17 and S5.28, EP&A Act)

The public submissions received by the Planning Secretary during the period of public exhibition of the Main Works EIS have raised a number of matters regarding the environmental assessment and approvals process. Responses to these matters are provided below.

i Separate planning applications for projects related to Snowy 2.0 Main Works

Section 1.5 of the Main Works EIS identifies that there are three other projects related to Snowy 2.0 Main Works, being:

- Snowy 2.0 Exploratory Works (SSI-9208) – a project proposed by Snowy Hydro which has been approved;

- Snowy 2.0 Transmission Connection Project (SSI-9717) – a project proposed by TransGrid; and

- Snowy 2.0 Segment Factory (SSI-10034) – a project proposed by Snowy Hydro which is currently being assessed by the Planning Secretary.

As identified in the Main Works EIS, the above projects do not form part of the application for Main Works. Separate applications and approvals are appropriate for a project of the magnitude of Snowy 2.0.

In relation to the Transmission Connection Project, it is necessary for that project to be separate to the Main Works application by virtue of section 5.15(1) of the EP&A Act which provides that only the proponent may apply for the approval of the Minister to carry out critical State significant infrastructure. 'Proponent' is defined in section 5.11 of the EP&A Act to mean *"the person proposing to carry out development comprising all or any part of the infrastructure, and includes any person certified by the Planning Secretary to be the proponent"*.

Snowy Hydro is not proposing to carry out the Transmission Connection Project because the existing high voltage transmission network to which Snowy 2.0 will connect is owned and managed by TransGrid, and the Transmission Connection Project (while connecting Snowy 2.0 to the NEM) is part of a broader priority transmission project that will benefit the whole of the NEM as it decarbonises. Accordingly, Snowy Hydro cannot be the proponent for those works.

Although TransGrid as the proponent of the Transmission Connection Project has lodged a separate application seeking approval of those works, the EIS lodged by Snowy Hydro for Main Works considers the cumulative impacts of the Transmission Connection Project.

The separation of Snowy Hydro's Exploratory Works application from its Main Works application is appropriate in circumstances where the Exploratory Works were required to be undertaken in advance of Main Works to ascertain the feasibility and to inform the detailed design of the proposed underground power station cavern having regard to geological data about rock types, conditions, ground temperature and stress conditions.

The separation of Snowy Hydro's Main Works application from its Segment Factory application is also appropriate in circumstances where the locations of those works are separated in distance and not connected geographically. In any event, the EIS for Main Works confirms that the potential impacts of the proposed segment factory have been considered and cumulative impacts identified and considered, and the EIS for the segment factory is currently being assessed by the Planning Secretary.

ii Status of works in KNP

The submission of the Snowy River Alliance raises concern that Snowy Hydro has "commenced construction works in the Ravine and signed the major works contractor before the major works has been given approval."

The works undertaken to date in KNP on behalf of Snowy Hydro are works authorised by the Exploratory Works approval, and are not works the subject of the Main Works application still being assessed by the Planning Secretary.

Given the status of Snowy 2.0 as critical State significant infrastructure, Snowy Hydro has endeavoured to streamline project delivery including identifying a design and construct contractor. As the approval authority for Main Works, the Minister for Planning has the discretion under the EP&A Act to refuse or approve the project and to impose such conditions on an approval as the Minister may consider appropriate. In making a determination, the Minister is not constrained in any way by the separate design and construct tender process.

In the event that the terms of any approval granted by the Minister for Main Works was inconsistent with the project design proposed by the contractor, the Minister's decision and the conditions of approval will prevail.

Works will not commence under the contract with respect to Main Works until required approvals have been obtained.

iii Adequacy of public exhibition

The submission of the National Parks Australia Council raised concern that the exhibition period of the Main Works EIS was too short to allow adequate assessment of the project.

The Main Works EIS was publicly exhibited for a period of six weeks from 25 September 2019 to 6 November 2019. Further information regarding consultation activities undertaken since the submissions of the Main Works EIS are provided in Section 3.3 of this report. The Planning Secretary (totally independently of Snowy Hydro) is responsible for determining the timing and duration of public exhibition for environmental impact statements under the EP&A Act.

The period of public exhibition provided by the Planning Secretary for the Main Works EIS was longer than the statutory minimum of 28 days and is commensurate with other large infrastructure projects, such as WestConnex.

Although a large quantity of material was lodged as part of the EIS given the nature and scale of Main Works, the EIS sought to make the information as accessible as possible by including summaries of key issues and assessment of impacts https://emmdigital.com.au/Snowy2.0MainWorksSummary/index.html available online.

iv Planning approvals pathway

As noted above, Snowy 2.0 has been declared to be critical State significant infrastructure and is therefore subject to the assessment and approval requirements within Part 5, Division 5.2 of the EP&A Act.

A number of public submissions identified that Main Works will not meet the requirements of section 4.15 of the EP&A Act. Part 4 (which includes section 4.15) of the EP&A Act does not apply to critical State significant infrastructure and therefore does not apply to assessment of Snowy 2.0 (s5.22, EP&A Act). The Minister's decision in relation to critical State significant infrastructure must be made on the basis of the Planning Secretary's report required by section 5.18 of the EP&A Act.

Submissions by the National Parks Australia Council and National Parks Association of NSW also raise concern that the Main Works EIS did not include an analysis of any feasible alternatives to the carrying out of the infrastructure contrary to the requirements of the Regulation.

The Main Works EIS included in both Section 1.4.3 and in Volume 2 Appendix C a detailed assessment of project development options and alternatives. Section 1.4.3 of the Main Works EIS identifies that other opportunities have been identified in NSW and throughout Australia for hydro-electric storage, notably the atlas of pumped hydro-electric storage released in 2017 (Blakers et al. 2017), however the lead time and planning for such projects is extremely complex. Given the scale of storage that will be required in the NEM, a number of these opportunities are likely to play a role in the future. Key benefits of Main Works when compared to alternatives in meeting the immediate requirements of the NEM were identified in the Main Works EIS to be:

- it uses two existing reservoirs (Tantangara and Talbingo) and accordingly does not require inundation of a new area, which is a key environmental impact associated with typical hydro-electric projects;
- the scale of these existing storages, and in particular Tantangara Reservoir, means Snowy 2.0 can provide up to 350,000 MWh of storage, which is significant storage capacity when compared with any alternative;
- section 37A of the SHC Act entitles Snowy Hydro to the grant of a lease for the purpose of the Snowy 2.0 Main Works. The pumped hydro-electric storage atlas (Blakers et al. 2017) notes that "there has been no investigation of land tenure [in respect of the sites]…and no discussions with landowners and managers. Nothing in this list of potential site locations implies any rights for development of these locations";
- it has been developed to a point that, subject to obtaining all required approvals, it can be delivered by the mid-2020s when storage is required;
- it is between the two largest load centres in the NEM (Sydney and Melbourne) and also is proximate to major renewable energy zones in southwestern NSW and north-western Victoria;
- it will be integrated into the operations of the existing Snowy Scheme. Once complete, Snowy 2.0 will be one of nine large generators within the existing Snowy Scheme that operate within an integrated portfolio under the control of Snowy Hydro. Snowy Hydro is uniquely positioned to deliver and operate a project of this magnitude; and
- the Snowy Scheme itself was deliberately located in the Australian Alps to capture snow melt, and utilise the existing topography of the landscape. Only by being integrated within the Snowy Scheme can the Snowy 2.0 Main Works leverage these existing capabilities to meet the needs of the NEM, and also provide additional drought proofing for the existing Snowy Scheme.

A comprehensive assessment of options for the augmentation of the Snowy Scheme was documented in the Snowy Mountains Scheme Augmentation Ranking Study (SMA 1991). This involved consideration of 10 conventional hydro power alternatives and four pumped storage alternatives as detailed in the Main Works EIS.

v Management objectives within the KNP

Public submissions raised a concern that the Main Works EIS did not consider the management objectives of the KNP Plan of Management.

Section 38(1) of the SHC Act provides that a plan of management may deal with the activities of Snowy Hydro within the KNP and impose obligations on the company to comply with the Plan of Management. This compliance obligation is supported by Part 4 of the *National Parks and Wildlife Regulation 2009* (NSW). The SHC Amendment Act also provided for a transitional period for the Plan of Management and the Snowy Management Plans to be revised to reflect Snowy 2.0. Clause 7 of Schedule 4 to the SHC Act provides a period of 3 years from when the first planning approval is granted for any part of the Snowy 2.0 Project, for the KNP Plan of Management to be amended for the purposes of including the Snowy 2.0 Project. A further period until 1 January 2024 is then allowed for the Snowy Management Plan to be updated. During that transitional period, section 81(4) of the NPW

Act does not operate to prohibit operations being undertaken in relation to the Snowy 2.0 Project that are not in accordance with those plans.

vi Preparation of management plans

One submission also suggested that the environmental management plans should be completed prior to the assessment of the EIS.

Given the nature and scale of the Main Works, it is appropriate that fine-grain management detail be the subject of management plans required as conditions of any approval granted to Main Works. The management plans must meet certain outcomes specified in the conditions of any approval and will be subject to separate approval by the Planning Secretary.

If the Planning Secretary grants approval to Main Works, future engagement with community groups will be undertaken through forums or other such events to focus on key environmental management issues of concern to those relevant communities.

4.3.2 Level or quality of stakeholder engagement

Submissions included comments regarding stakeholder engagement. Matters raised include:

- Level of stakeholder engagement with local business.
- Level of stakeholder engagement with the local community.
- Inadequate public notification of the public exhibition period.

i Stakeholder engagement with local business

Snowy Hydro has conducted extensive community and business engagement about Snowy 2.0 since mid-2017, to raise awareness about the project and its benefits and impacts, and to seek feedback from the local community. This engagement is ongoing.

General information has been provided to local businesses in relation to potential Snowy 2.0 involvement prior to the principal contractor, FGJV, being appointed in April 2019. FGJV is managing all subcontracting requirements and workforce employment for Snowy 2.0.

Engagement activities with local businesses have included:

- presentations and Q&As, along with multiple face-to-face meetings, with chambers of commerce throughout the Snowy Mountains region;
- one-on-one meetings with individual business owners - pre-arranged and drop-ins. Opportunities for further meetings have been offered to business owners;
- community consultation sessions have attracted a significant number of local business owners and following the appointment of FGJV, sessions have included information and advice about how business owners and job-seekers can connect with the project;
- consultation sessions specifically with businesses have also been held in relation to the associated Snowy 2.0 segment factory proposal for Polo Flat, Cooma;
- a Snowy 2.0 business directory was established and widely publicised in 2018 so that business owners could register their interest in becoming involved in the project. This information has been shared with FGJV and all businesses on the register have been contacted directly;

- FGJV has engaged the Industry Capability Network (ICN) to manage the tendering and supplier process and has co-hosted information sessions with Snowy Mountains businesses in Tumut, Cooma and other regional locations. There are now more than 700 suppliers - many of them local - registered with FGJV on the ICN website. Registration on the ICN website is free; and

- under instruction from Snowy Hydro, Snowy 2.0 tendering contractors and subcontractors have contacted and delivered information to a wide range of Snowy Mountains businesses about potential project participation.

ii Stakeholder engagement with local community

Snowy Hydro has conducted extensive community engagement about Snowy 2.0 since mid-2017, to raise awareness about the project and its benefits and impacts, and to seek feedback from the local community. As a major local employer and supporter of Snowy Mountains communities for decades, meaningful two-way engagement with the community has been a priority for Snowy Hydro since the project's inception.

Snowy 2.0 community engagement activities have included:

- four rounds of community consultation have been held in towns throughout the Snowy Mountains (Cooma, Adaminaby, Talbingo, Tumut, Tumbarumba, Jindabyne). These sessions have been conducted during the daytime, evening and on weekends, with either an informal drop-in format, or a formal presentation followed by Q&As. Printed information, hand-outs and banners have been available at each of the sessions. Further community and business consultation sessions have been held in relation to the associated Snowy 2.0 segment factory proposal for Polo Flat;

- project staff have conducted multiple face-to-face meetings with key individual stakeholders including local business owners and tourism operators. Opportunities for further meetings have been offered to business owners. Multiple meetings have also been held with community stakeholder groups such as recreational user groups, chambers of commerce, Tourism Snowy Mountains, progress associations, indigenous groups, etc.;

- multiple face-to-face meetings, briefings and site visits with Snowy Monaro and Snowy Valleys local government representatives;

- collaboration between Snowy Hydro and stakeholder networks has enabled information to be circulated widely in the local area;

- a number of feedback surveys (written, telephone and online) have been conducted;

- extensive information has been made available to the community via channels including the Snowy Hydro website, through local traditional media and social media, e-newsletters, printed materials such as information booklets, community newsletters, fact sheets, and displays, plus project videos and imagery. The Snowy Hydro Discovery Centre and other Snowy Hydro-owned and run visitor centres have also provided printed and video information, along with verbal information from staff; and

- there is a freecall 1800 Snowy 2.0 community information phone line and dedicated project email address for project enquiries.

Community engagement, updated communication materials and consultation, including with individuals and business owners, will continue throughout the life of the project.

iii Public exhibition period

Since 2017 Snowy Hydro has provided information about the EIS process including the public exhibition period and opportunity for community submissions on its website, in community project information booklets and printed timelines and verbally at community consultation events, meetings and presentations. Updates in relation to the Main Works EIS lodgement timing have been provided verbally by project staff and via the printed timeline at community consultation events, and also verbally at stakeholder meetings, presentations etc.

As discussed in Chapter 2 the Main Works EIS was placed on exhibition for a period of 42 days between 26 September 2019 and 6 November 2019. The Snowy 2.0 Main Works EIS was made publicly available with hard copies provided at exhibition locations and electronically via DPIE and Snowy Hydro websites.

4.3.3 Adequacy of EIS/Assessment documentation

Submissions raise matters regarding the adequacy of the EIS and supporting technical reports, including:

- Concerns that the quantity of documentation provided in the EIS was difficult for the public to review and understand the key issues.
- Concerns about the adequacy of the EIS assessment of environmental impacts in general. Some submissions argued that the EIS technical reports identified significant impacts that were not adequately described in the Executive Summary.
- Lack of primary scientific research provided with the EIS regarding the assessment of options for fish screening to mitigate fish or pathogen transfer between the reservoirs.
- Some submissions argued that it was inappropriate for Snowy Hydro to be responsible for preparing the EIS and technical assessments.
- One submission suggested that sustainability has not been considered and called for the determining authority to consider the United Nations Sustainable Development Goals.

The primary purpose of an EIS is to help the community, public authorities and the decision-maker to understand the likely consequences of a project and make informed submissions or decisions. The information to be provided in an EIS is set out the Planning Secretary's Environmental Assessment Requirements (SEARs). The SEARs for Snowy 2.0 Main Works were issued on 31 July 2019 and an EIS was prepared to respond to the key issues and requirements identified.

The Snowy 2.0 Main Works EIS was prepared in line with legislative requirements set out in the EP&A Act and EP&A Regulation, with guidance on its format, structure and length provided by the *Draft Environmental Impact Assessment Guidance Series, Preparing an Environmental Impact Statement* (DPE 2017).

The Main Works EIS contained a Main Report which identified and addressed all the key impacts and issues and summarised technical assessments provided as appendices to the EIS. This approach allows readers to gain an understanding of the environmental assessment that has been undertaken and access supporting technical assessments which are very detailed documents and can be overwhelming in quantity. It is difficult to reduce the quantity of some of these documents due to the scientific and technical nature of the studies and their reporting requirements. However, the detailed assessments are available for the community to review if they would like to understand more about a specific key issue.

A condensed, standalone summary of the EIS was also provided to allow the community to get an understanding of the project without having to read the whole EIS. A digital version of this summary was also provided online and distributed via Snowy Hydro and DPIE website. This was prepared to allow the community a brief appreciation of the project and the key issues. References were also provided to the relevant sections of the EIS with the capacity for more detailed information.

Copies of the Main Works EIS were provided in accessible formats. The Snowy 2.0 Main Works EIS was made publicly available:

- hard copies provided at exhibition locations;

- electronically via DPIE website; and
- electronically via Snowy Hydro website.

Electronic files were provided in formats suitable for acceptance on the DPIE website. It is noted that some submitters in remote local area had issues downloading larger file sizes from online sources. This is not a matter for Snowy Hydro, however Snowy Hydro provided accessible Universal Serial Bus (USB) drives to some individuals where specifically requested.

The minimum exhibition period required by legislation is 28 days (four weeks). The Snowy 2.0 Main Works EIS was publicly exhibited between 26 September 2019 and 6 November 2019, a total of 42 days (six weeks). The public exhibition period is set by DPIE.

Snowy Hydro is the proponent for Snowy 2.0 Main Works. Snowy Hydro was supported by a team of qualified professionals to provide a balanced assessment of environmental impacts in accordance with legislative requirements, supported by subject matter experts and specialists in their field.

The Main Works EIS included the preparation of a large number of comprehensive technical studies (contained in appendices to the Main Works EIS). These technical studies were prepared in accordance with the key issues identified in the SEARs which included requirements issued by key government regulatory agencies as well as industry standards and guidelines. It is noted that some primary research studies supporting the main aquatic ecology assessment were made publicly available shortly following the publication of the Main Works EIS.

4.3.4 Biosecurity legislation

Some submissions raised matters regarding NSW biosecurity legislation. These submissions argue that the proposed impacts to invasive fish species and pathogens due to water transfer between the reservoirs is prohibited under the NSW biosecurity legislation. One submission also raised concerns that DPIE Fisheries had not commented on the proposed works permissibility under the Fisheries Management Act and Biosecurity Act.

A number of public submissions raise concerns in relation to the potential for certain pest fish species and diseases to be transferred between reservoirs and catchments as a consequence of the transfer of water between Talbingo Reservoir and Tantangara Reservoir as proposed by Main Works. Those submissions have requested that further detail be provided in relation to the control measure options that were explored, the reasons why certain control measures have not been pursued, and the efficacy of the proposed secondary control measures (including how these measures will protect the stocky galaxias).

Responses to these matters are provided below.

i Overview of legislative regime

Biosecurity is regulated under NSW biosecurity legislation.

The primary objective of the Biosecurity Act and Biosecurity Regulation is to provide a framework for the prevention, elimination and minimisation of biosecurity risks, including by providing a framework for risk-based decision-making in relation to biosecurity.

Snowy Hydro has a general duty under the Biosecurity Act to ensure that, so far as is reasonably practicable, any biosecurity risk arising from its operation of Snowy 2.0 is prevented, eliminated or minimised. Section 21 of the Biosecurity Act provides that if it is not reasonably practicable to prevent or eliminate the biosecurity risk, then there is a duty to minimise the biosecurity risk so far as is reasonably practicable. “Reasonably practicable” is defined in Section 16 of the Biosecurity Act as:

in relation to the prevention, elimination or minimisation of a biosecurity risk, means that which is, or was at a particular time, reasonably able to be done, taking into account and weighing up all relevant matters including:

(a) the biosecurity risk concerned, and

(b) the degree of biosecurity impact that arises, or might arise, from the biosecurity risk, and

(c) what the person concerned knows, or ought reasonably to know, about the biosecurity risk and the ways of preventing, eliminating or minimising the risk, and

(d) the availability and suitability of ways to prevent, eliminate or minimise the biosecurity risk, and

(e) the cost associated with available ways of preventing, eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

In addition, Snowy Hydro is subject to the mandatory measures which apply to redfin and EHNV under clause 18 of the Biosecurity Regulation. The mandatory measures prohibit the possession, control, sale or purchase, moving or releasing of redfin and EHNV including their movement or release.

Snowy Hydro expects that the operation of the Snowy 2.0 project, specifically the transfer of water between Talbingo Reservoir and Tantangara Reservoir during station operation, may pose a biosecurity risk and/or may not comply with the mandatory measures by virtue of the potential transfer of a variety of biota, including:

- Redfin, which have been observed in Talbingo Reservoir;
- Climbing galaxias, which have not been observed in Talbingo Reservoir but have been observed in the Yarrangobilly River which feeds Talbingo Reservoir;
- Eastern gambusia, which have been observed in Talbingo Reservoir; and
- EHNV, which has not been observed in Talbingo Reservoir but Redfin are the primary host.

Studies commissioned by Snowy Hydro and undertaken by fisheries scientists at Charles Sturt University (CSU) indicate that it is likely that some life stages of redfin and other fish may become entrained and survive transport through the pipeline from Talbingo Reservoir to Tantangara Reservoir (Ning et al., 2019). Whether these fish will actually be entrained into the intake and survive transfer between Talbingo Reservoir and Tantangara Reservoir cannot be known with certainty until the Snowy 2.0 project becomes operational. However, Ning et al. (2019) indicate that it is reasonable for Snowy Hydro to assume that the operation of the Snowy 2.0 project, specifically the transfer of water between Talbingo and Tantangara Reservoirs, may pose a biosecurity risk.

Acknowledgement of the potential biosecurity risk posed by the operation of Snowy 2.0 has led Snowy Hydro, in conjunction with scientific experts from THA Aquatic (2019), to exhaustively review the available options to prevent, eliminate or minimise the potential biosecurity risk associated with the operation of Snowy 2.0 since the project's inception. This review has included an assessment of all known technologies to prevent or minimise rates of pest fish entrainment into the Talbingo intake of Snowy 2.0, options to minimise the scale of the potential biosecurity impact arising from Snowy 2.0 by limiting the area (ie the number of catchments) where it may occur and investigations into elimination of the source redfin population. Investigations regarding the potential to prevent or minimise the spread of EHNV have also been undertaken.

As detailed below, the review concluded that it is not reasonably practicable for Snowy Hydro to prevent or eliminate the potential biosecurity risk having regard to the matters set out in s16 of the Biosecurity Act and given the absence of suitable mitigation measures that could reasonably be incorporated into the design of Snowy 2.0

to completely prevent the potential transfer of redfin, other pest fish and/or EHNV between the two reservoirs. Importantly however, there are mitigation measures proposed in the Main Works EIS which will:

- minimise entrainment as a result of the depth of the intake and the construction of an approach channel which will remove vegetation and complex habitat from the intake; and

- limit the potential range expansion of pest species from salmonid-dominated Tantangara Reservoir into other catchments. These mitigation measures include installing fish barriers on the outlets to Tantangara Reservoir and in the Upper Tantangara Creek catchment at an estimated cost of A$30 million. Screening these outlets using the best available technology in screening systems is expected to significantly reduce the likelihood of pest fish being able to access these areas and therefore minimise the spatial extent of the potential biosecurity risk of Snowy 2.0.

These measures represent the most reasonably practical way of minimising the risk to significant aquatic species associated with the operation of Snowy 2.0.

ii What is the potential biosecurity impact and risk?

Pest fish are known to occur in and around Talbingo Reservoir. It is possible that the operation of Snowy 2.0 may entrain and transfer individuals of these species through the proposed pipeline and pumped hydroelectric station into Tantangara Reservoir.

The likelihood of Tantangara Reservoir and connected tributaries being favourable for redfin and eastern gambusia population establishment is somewhat uncertain. This is primarily due to the outcomes of modelling showing that habitat suitability of streams and waterbodies within the Upper Murrumbidgee catchment was largely unsuitable or marginal (less than 20% chance of survival) for redfin (Baumgartner et al., 2017), the presence of minimal aquatic vegetation and other complex habitat and the large operating range of the reservoir (Cardno, 2019).

A biosecurity impact related to the operation of Snowy 2.0 will only occur if the following series of events occur:

1. Pest fish occur in the vicinity of and are entrained into, the Talbingo intake; and

2. A proportion of these fish survive the effects of extreme pressure, high shear stress and avoid being fatally struck by the turbine blades during transport through the Snowy 2.0 tunnels and station; and

3. Sufficient numbers of these fish are transferred and survive such that breeding in Tantangara Reservoir is possible; and

4. Conditions in Tantangara Reservoir prove favourable for breeding success leading to population establishment; and

5. The population numbers increase to such an extent over such an area that an adverse effect on the economy, the environment or the community occurs.

Whether this series of events will occur cannot be known with certainty until Snowy 2.0 becomes operational. Should this risk eventuate in Tantangara Reservoir, there may be impacts to native fish and/or recreationally important salmonids. A key point is that the aquatic environment of Tantangara Reservoir and the catchment upstream (with the exception of the Tantangara Creek headwaters) are dominated by introduced salmonids and there are no known threatened fish species or Endangered Ecological Communities (EEC's) present within Tantangara Reservoir or immediately upstream (Cardno 2019).

There are however, threatened species known to occur further upstream in the headwaters of Tantangara Creek (Stocky galaxias), downstream in the Mid-Murrumbidgee River below Tantangara Dam (Macquarie Perch, Trout Cod and Murray Cod) and the catchment of Lake Eucumbene forms part of the Snowy River EEC (Cardno 2019). As such, the severity of the potential biosecurity impact arising from the potential inadvertent transfer of pest species is different within Tantangara Reservoir, where no threatened species are known to occur and where the aquatic ecology is heavily modified by salmonids, compared to locations outside of Tantangara Reservoir which include areas of habitat for threatened species.

Any consideration of the potential biosecurity impact and risk at locations outside of Tantangara Reservoir must also take into account the fact that threatened species in these areas are currently subject to multiple existing threatening processes, irrespective of Snowy 2.0. If approved and once operational, the risk of Snowy 2.0 contributing any further biosecurity impacts to these species outside of Tantangara Reservoir, is very low due to the mitigation outlined in the Main Works EIS and below.

As such, the residual risk of a biosecurity impact occurring to threatened species due to the operation of Snowy 2.0 is very low. Should this risk eventuate, as a result of a failure of the controls proposed for Snowy 2.0, there are a number of actions the State has already identified that could be evaluated to assist with building resilience of threatened species in the catchments upstream and downstream of Tantangara Reservoir.

iii Investigations to achieve obligations

Acknowledgement of the potential biosecurity risk has led Snowy Hydro, in conjunction with scientific experts from THA Aquatic (2019), to exhaustively review the available options to prevent, eliminate or minimise the potential biosecurity risk over the past two years. These are summarised below.

a Prevent

Given that Ning et al. (2019) indicate that all life stages of fish, including eggs and larvae, may be susceptible to entrainment and could survive transfer, the only options considered technically possible to prevent the movement of the smallest life stages of the pest species through the Snowy 2.0 intakes are very fine mesh screens and electrical euthanasia.

After investigating the various technologies, the review concluded that there are no reasonably practicable mitigation measures available that could be incorporated into the design of Snowy 2.0 to fully prevent the biosecurity risk associated with the potential transfer of redfin, other pest fish and/or EHNV between the two reservoirs. This is due to:

- the potential risk that additional complex works pose to the reliability of the Snowy 2.0 station;
- the increased environmental impacts associated with the larger disturbance footprint due to significant volumes of additional blasting and dredging in the reservoirs with consequent impacts at excavated material placement locations;
- human safety and significant non-target species mortality for electrical barriers;
- the very high cost of construction, estimated at $619M for fine mesh screens (SWIFF 0.5 mm aperture) and $535M for electrical deterrence;
- significant ongoing operational costs and maintenance requirements; and
- uncertain efficacy in light of the unprecedented application of the technologies at this scale.

iv Eliminate

The only way to eliminate the risk of pest fish transfer associated with the operation of Snowy 2.0 would be to remove the source populations of redfin and other pest fish from within Talbingo Reservoir. Potential options for removal include:

- physical removal (ie fishing, netting);
- harvest regimes (ie intentional over-fishing of target species or modification of angling regulations);
- chemical treatments such as antimycin or rotenone;
- biological control (eg introduction of predators, competitors, sterilization or targeted pathological reactions);
- environmental (eg lowering water level);
- other (eg explosives); or
- a combination of the above methods (Rytwinski et al. 2019).

Although these methods have been reported to successfully eradicate non-native species, there are few documented studies from large and complex environments like Talbingo Reservoir. Typically, eradications have been most frequently successful when applied in small, shallow, sparsely vegetated, easily accessible, and closed lentic systems (Closs, et al. 2003; Rayner and Creese, 2006). Eradication attempts have been identified as most likely to fail due to one or a combination of the following factors:

- ineffective capture techniques (eg size-specific efficiencies);
- habitat complexity (eg areas of refuge and plant density);
- large water-body size;
- the degree of site enclosure (ie open versus closed water bodies);
- species-specific factors (eg size and habitat preferences); and
- physical water properties (eg water chemistry, temperature, and water depth) (Rayner and Creese, 2006; Rytwinski et al. 2019).

Unfortunately, many of these factors are key issues for a potential redfin and other pest fish eradication program at Talbingo Reservoir. The large area (1,943 ha at FSL) and depth (up to 140 m) of Talbingo Reservoir, coupled with the habitat complexity including standing timber and a high density of aquatic vegetation (Elodea) (Zukowski, 2019), the linkages to the Yarrangobilly River and Jounama Pondage (where water can be pumped via the Tumut 3 power station) where redfin are also known to occur (Cardno 2019) and the known redfin utilisation of habitats of up to 50 m depth (Thorpe 1977; Imbrock et al. 1996) means that there would be a low probability of complete success for all possible options. An unsuccessful eradication attempt where some redfin are left or are able to recolonise also has the potential to lead to high juvenile redfin recruitment due presumably to the loss of larger cannibalistic adults (Closs et al. 2003) which could actually increase the number of redfin in the reservoir that would be susceptible to entrainment.

Efforts to control redfin using physical removal, harvesting, chemical treatment and/or explosives would be hampered by the inability to drain Talbingo by more than 14 m below MOL, ie even if the reservoir was drained as

far as possible (rendering Tumut 3 power station out of service), sections of the reservoir would still be over 110 m deep.

Chemicals such as rotenone are known to impact aquatic macroinvertebrates as well as fish (Lintermans and Raadik 2003). Although decapods are considered less susceptible than other types of invertebrates (Dalu et al. 2015), the presence of Murray crayfish (listed as vulnerable under the NSW FMA 1994) (Zukowski 2019) as well as a stocked population of trout cod (listed as endangered under the NSW FMA 1994) (Cardno 2019) within Talbingo Reservoir makes the use of rotenone or other non-selective chemicals or explosives undesirable. There are also no biological controls (other than EHN virus) known to be selective for redfin or other pest fish present in Talbingo.

As a result of these factors, the elimination of redfin and other pest fish populations in Talbingo reservoir to eliminate the biosecurity risk of pest fish transfer is not reasonably practicable.

v Minimise

When considering how Snowy Hydro could minimise the potential biosecurity risk posed by Snowy 2.0, consideration was given to measures that could potentially reduce the number of fish transferred to Tantangara Reservoir (Entrainment Reduction) and measures that could reduce the scale of biosecurity impact i.e. minimise the area over which pest fish could potentially establish and cause an impact (Secondary Controls).

There are inherent features of the existing design that will act to minimise fish entrainment at the Talbingo intake such as the depth of the top of intake and the construction of an approach channel (which will remove vegetation and complex habitat from around the intake). Additional options to further minimise the rate of entrainment and transfer of fish are considered unlikely to reduce the numbers of fish potentially transferred down to a level that would materially reduce the risk of redfin population establishment in Tantangara Reservoir and a consequent biosecurity impact. The ability of populations of redfin to establish from introductions of as little as 11 individuals (Harris 2013) and the potentially high rates of larvae and juvenile entrainment, mean that measures to further reduce the number of adult fish susceptible to entrainment are unlikely to materially reduce the likelihood of sufficient numbers of fish being transferred such that breeding is not technically possible.

Considering the low likelihood of efficacy in minimising the scale of the potential biosecurity impact, the costs of all potential options to minimise fish entrainment are disproportionately high. These options would also increase the disturbance footprint of construction works, including within Talbingo Reservoir which is habitat to Murray crayfish, listed as vulnerable under the *Fisheries Management Act 1994.* These options are not considered reasonable either alone or in combination due to the low likelihood of any material reduction in the risk of environmental harm or a biosecurity impact.

In comparison, the mitigation measures proposed in the Main Works EIS provide an effective means of minimising the potential biosecurity impact that could occur by limiting the potential range expansion of pest species from Tantangara Reservoir into other catchments to the greatest extent practicable.

The proposed mitigation measures include installing fish barriers on the outlets to Tantangara Reservoir and in the Upper Tantangara Creek catchment at an estimated cost of A$30 million. Screening these outlets using the best available technology in screening systems is expected to significantly reduce the likelihood of pest fish being able to access these areas and therefore minimise the spatial extent of the potential biosecurity risk of Snowy 2.0. These measures represent the most reasonably practical way of minimising the risk to significant aquatic species associated with the operation of Snowy 2.0. As noted within the Main Works EIS, Snowy Hydro has high confidence in being able to avoid spill from Tantangara Dam.

By undertaking these measures, as discussed above, the risk to any threatened species and EECs is dramatically reduced as are any potential impacts to recreationally important salmonid populations in Lake Eucumbene and connected catchments. Snowy Hydro has committed to offsetting the residual potential impact to recreational fishing that may occur in the Tantangara reservoir catchment.

Snowy Hydro considers that the measures proposed within the Main Works EIS meet the requirements of the general duty under the Biosecurity Act and also, in light of the critical significance of the Snowy 2.0 project to NSW and the broader NEM, provides sufficient justification for the Secretary to grant an exemption from both the general duty and the mandatory measures pursuant to section 402 of the Biosecurity Act, and to issue a permit or exemption pursuant to s216 of the *Fisheries Management Act 1994*.

4.4 Environmental, social or economic impacts

4.4.1 Water

i Structure of revised water assessment

Due to key project refinements to the groundwater modelling approach, as well as a number of key submissions, parts of the Water Assessment as presented in the EIS have been updated. Table 4.1 provides the overarching structure of the EIS Water Assessment and Annexures, and details which sections have been revised as part of the PIR-RTS.

Table 4.1 Summary of changes to the water assessment

Water Assessment Section	Change from EIS?	Where is updated information provided in the PIR-RTS?	Notes
Part A – Project context	Partial. • Only the project description (Section 2) has been amended. • All other sections remain valid.	The current project description is detailed in Section 3.2 of the PIR-RTS	
Part B – Impact Assessment	Partial. • Section 9 (Assessment Approach) remains valid • Sections 10 (Groundwater flow assessment) and 11 (Surface water flow assessment) are superseded • Section 12 (Water quality assessment) Sections 12.1, 12.2 and 12.7 remain valid Sections 12.3 (Reservoir water quality), 12.4 (Stormwater and controlled discharges), 12.5 (Surface water quality), 12.6 (Wastewater) are superseded • Section 13 (Impact summary and risk assessment) remains valid.	• Revised groundwater and surface water flow assessments are provided in the revised Modelling report (PIR-RTS Appendix I) and revised WMR (PIR-RTS Appendix J) and summarised in Section 4.4.1 of the PIR-RTS • Revised reservoir water quality information is provided in Section 4.4.1(ii) of the PIR-RTS • Revised stormwater, controlled discharge, surface water and wastewater information is provided in the revised WMR (PIR-RTS Appendix J) and Sections 4.4.1(iv) of the PIR-RTS.	With respect to Section 13 (Impact summary and risk assessment), while the revised modelling has shown a reduction in groundwater inflows and surface impacts, the broad conclusions of the assessed risks remain valid and the EIS outcome has not changed
Part C – Licensing, mitigation and management	• Section 14 (Water licenses) – the licensing context remains valid however the water take has been revised downwards based on the revised groundwater modelling • Section 15 (Management measures and residual impacts) remains valid • Section 16 – AIP Assessment framework remains valid	The revised water take and licensing summary is provided in Section 4.4.1(v) of the PIR-RTS	(Note - some minor refinements to higher level water management measures WM01 – WM14 are provided in Appendix C of the PIR-RTS)

Table 4.1 Summary of changes to the water assessment

Water Assessment Section	Change from EIS?	Where is updated information provided in the PIR-RTS?	Notes
Annexure A – Water characterisation report (WCR)	No	N/A	No changes to the WCR, however monitoring programs are still in place and data continues to be collected
Annexure B – Modelling report	Yes	Yes – refer PIR-RTS Appendix I for revised Modelling report	
Annexure C – Flood risk assessment	No	N/A	Design continues to progress, however the key impacts and risks identified in the EIS FRA are still valid and no updates are required for the PIR-RTS
Annexure D – Water management report (WMR)	Yes	Yes – refer PIR-RTS Appendix J for revised WMR	

ii Reservoir related water quality impacts and releases

Comments raised in submissions relating reservoir water quality impacts from excavated rock placement, in reservoir works and impacts to environmental releases, included:

- the EIS only provides limited information about the placement methodology of excavated material into the reservoir but does not provide any assessment of potential water quality impacts or potential mitigation measures;
- uncertainty in the modelling parameters for predicting water quality impacts within the reservoir;
- no modelling carried out for Tantangara Reservoir;
- recommendations and management measures identified in Appendix L of the EIS have not been adopted in the list of mitigation measures proposed for the project;
- impacts to reservoir water characteristics due to placement of excavated rock, including elevated turbidity and release of pollutants from suspended solids; and duration of suspended silts and sediment within the reservoirs;
- bank erosion and water quality impacts from more rapid fluctuations in reservoir levels;
- the rise and fall (wetting and drying) of reservoir water impacting spoil placement and release of pollutants;
- the EIS does not assess the cumulative water quality impacts of construction stage activities, including those of rock emplacement, dredging, and stormwater, treated wastewater, process water and groundwater discharges;
- resuspension associated with commissioning and operation stage transfers;
- possible impacts on Snowy Hydro's ability to meet environmental flows and releases into downstream catchments, as well as potential changes to water quality of these releases as a result of sedimentation caused by placement of excavated rock within the reservoir;
- the EIS does not characterise existing water quality or assess potential impacts on waterways downstream of Tantangara and Talbingo reservoirs.

a Revised rock emplacement construction and water quality impacts

Talbingo Reservoir

The construction of the excavated rock emplacement in Ravine Bay as described in the EIS, predicted the potential to impact water quality, primary through elevated TSS concentrations and turbidity along the length of Talbingo Reservoir. For example, a median TSS concentration of 6 mg/L and a maximum TSS concentration of 16 mg/L was predicted in reservoir surface water adjacent to the dam wall (EIS Table 6.1); and a median turbidity of 22 NTU and a maximum turbidity of 37 NTU was predicted at the same location.

These water quality impacts were predicted to increase moving towards Ravine Bay. These predicted impacts were primary as a result of the release of fine (<63 µm) sediment particles, and particularly clay-sized (<4 µm) particles. The sediment transport modelling and laboratory test work predicted that clay-sized particles will remain suspended in the water column for long periods, exacerbating their impacts on water quality. It was predicted that the default ANZECC/ARMCANZ (2000) turbidity guideline for freshwater lakes and reservoirs in South-eastern Australia (1–20 NTU) would be exceeded throughout the reservoir at times during construction.

As described in Section 3.2.2 of this PIR-RTS, the proposed excavated rock placement locations, designs and construction methods presented in the EIS have been substantially revised following feedback from submissions and key agencies. The proposed alternative will substantially reduce the mass of fine material released into the Talbingo Reservoir water column during construction, in particular:

- the total volume of excavated rock placed below FSL will be substantially reduced - reducing the total mass of fine materials that could be released into the water column during placement;
- only D&B material will be placed below FSL, with all TBM placed above FSL. As there will be higher concentrations of fine (and clay-sized) particles in TBM material than in D&B material (see Table 4.2), this will further reduce the mass of fine material released into the water column during placement; and

- there is the potential to restrict the placement of D&B material in the reservoir to winter months which will further reduce turbidity/TSS in the surface layers of the reservoir.

Table 4.2 Predicted fine and clay-sized material in excavated material

Material source	Percentage of material <63 µm	Percentage of material <4 µm
Tunnel boring machine (TBM)	6.0	0.7
Drill and blast (D&B)	2.0	0.3

The reduction in the mass of sediment released into the water column will materially reduce TSS concentrations and turbidity in the reservoir. Depending on the option selected, the changes to the emplacement design could reduce the maximum TSS concentration increase at the dam wall (all depths) to <4 mg/L which is similar to the measured maximum concentration in the reservoir and that a maximum increase in surface water TSS of 10 mg/L would be achieved within 7 km of Ravine Bay.

While the EIS identified that TSS and turbidity were the primary stressors of potential concern (SOPC), the following other SOPC and contaminants of potential concern (COPC) were identified: pH, conductivity and aluminium as a result of the interaction of suspended sediment with reservoir water. These sediment-water interactions would be greatest for clay-sized particles due to their high surface area, long residence times in the water column and potential surface reactivity. These interactions were assessed by CSIRO through laboratory test work (elutriate tests) (see EIS Appendix L, Annexure C (CSIRO 2019a)) and a follow-up desktop assessment of potential aluminium concentrations (see EIS Appendix L, Annexure E (CSIRO 2019b)).

The EIS found that a 500-m-wide mixing zone was required outside of the silt curtain surrounding the emplacement area to before the default ANZECC/ARMCANZ (2000) guideline value would be met. The substantial reduction in fine sediment released would be expected to substantially reduce the aluminium released into the water column from the sediment and reduce changes to water pH and conductivity as a result of sediment-water interactions. This will reduce the width of the mixing zone or remove it entirely.

There will also be a corresponding decrease in the volume of fugitive sediment deposited on the bed of the reservoir.

Tantangara Reservoir

The excavated rock emplacement at Tantangara Reservoir described in the EIS would be constructed between MOL and FSL using standard 'dry' earthmoving methods with downslope sediment controls. Therefore, no direct release of sediments into Tantangara Reservoir water column that could impact water quality during construction was predicted. This remains the case, with the emplacement now proposed to be constructed between MOL and FSL for D&B material, with the TBM material above FSL.

Water quality impacts to Tantangara Reservoir during construction of the excavated rock emplacement are not predicted.

b Dredging, channel excavation and underwater blasting

The construction of the Talbingo and Tantangara intakes was detailed in the EIS Figures 2.13 and 2.14 respectively, and are described as follows:

- drill and blast to remove a portion of the rock plugs (to be confirmed with during the project execution phase) from the dry side in the excavated pit area. The amount of rock excavation to be completed to remove the plugs at Tantangara intake site is significant however, the majority may be able to be removed by blasting during dry conditions while the reservoir water level is low;

- underwater blasting to break down the remaining rock material in the plug and remove by dredging machine or barge-mounted excavator; and
- long-arm excavator on a barge to remove bigger boulders, which are then crushed into smaller sizes before being transported to the dumping site, if required.

These methods have been refined for the PIR-RTS and details of the refined in-reservoir intake construction are provided in Table 4.3.

Table 4.3 In-reservoir intake construction

Aspect	Talbingo Reservoir intake	Tantangara Reservoir intake	Tantangara Reservoir barge ramp
Maximum design depth	514 m AHD	1,184 m AHD	To be determined.
Maximum water depth to base of in-reservoir excavation	29 m (at FSL) 20 m (at MOL)	45 m (at FSL) 22 m (at MOL)	To be determined.
Extraction methods	The area requiring underwater extraction and the water depth during extraction will be minimised by keeping the water level in the reservoir as low as practicable during in-reservoir excavation of the intake channel. The majority of material will be extracted by a barge-mounted crawler crane with a grab. A barge-mounted long-arm excavator may be used to extract material from shallower depths. Large boulders extracted following drill and blast may be crushed prior to transport to the disposal location.		
	The intake location (Middle Bay) has shallow sediment overlying bed rock. The majority of excavated material will require drill and blast with extraction by a barge-mounted crawler crane with a grab.	The intake location has three distinct layers: • unconsolidated sediment (alluvium); • weathered rock; and • competent rock. These materials generally will be extracted with a barge-mounted crawler crane with a grab. Competent rock will need drill and blast prior to extraction.	Extraction using a barge-mounted crawler crane with a grab or a barge-mounted long-arm excavator.
Estimated material volume	Net volume (in situ) below FSL: ~70,000 m^3. Gross volume (allowing for bulking): ~115,000 m^3.	Sediment: • net volume below FSL: ~65,000 m^3 • gross volume: ~65,000 m^3 Weathered rock: • net volume below FSL: ~52,000 m^3 • gross volume: ~61,000 m^3 Competent rock: • net volume below FSL: ~393,000 m^3 • gross volume: ~644,000 m^3	To be determined.

Table 4.3 In-reservoir intake construction

Aspect	Talbingo Reservoir intake	Tantangara Reservoir intake	Tantangara Reservoir barge ramp
Blasting	Drill and blast is expected to require: • two drill towers; • use of package explosives; • 4–5 m deep lifts; • drill spacing on a ~2 m by 2.1 m grid; and • maximum instantaneous charge: 27 kg.		
Number of blast holes	~4,000	~25,000	To be determined.
Dredge spoil disposal	It is preferred that material extracted from beneath the water level is disposed to an area of the reservoir bed that has previously been identified as being disturbed. Otherwise, material will be transported by barge to land, and transported overland for disposal with the TBM material within appropriate excavated rock placements.		
Channel stabilisation	The base of the channel will be bed rock.	Rip rap will be installed on any soft sediment in the base of the channel.	Not applicable.
Environmental management	Silt curtains, with an approximate 2-m-drop, will be deployed around the dredging plant and on-water transport. The locations of these curtains will be subject to detailed design by a dredge specialist to ensure that they do not restrict barge manoeuvrability. Water quality monitoring buoys will be deployed to record real-time turbidity. Environmental monitoring and trigger action response management plans will be prepared based on detailed design methodology and included in the Dredge Management Plan prepared as part of post approvals in consultation with the relevant environmental agencies. Measures for management responses may include staging and timing of activities based on reservoir levels and weather dependent activities.		
Construction period	~24 weeks	~ 91 weeks	To be determined.

The potential water quality impacts from the extraction of sediment on rock during the construction of the intakes will be largely dependent on the construction and environmental management methods employed, and the physical and chemical characteristics of the material to be removed.

Water quality – Talbingo

Sediments from across Talbingo Reservoir are soft and muddy in texture with a dominance of particles in the coarse silt fraction. The Talbingo Reservoir intake will be constructed in Middle Bay. The Exploratory Works EIS proposed dredging of a channel in the same area.

The potential water quality impacts were assessed in detail in RHDHV (2018) (Appendix C of Appendix L of the Exploratory Works EIS). This assessment included the analysis of total metal concentrations in 11 samples from Middle Bay (see EIS Appendix L Figure 3.4a). This found that the concentrations of copper and nickel exceeded the *National Assessment Guidelines for Dredging* (Australian Government 2009) screening levels. (The screening and maximum levels provided in these guidelines are the same as those in ANZG (2018) with the exception of the maximum level for silver which is marginally different). As copper and nickel exceeded the screening levels, elutriate tests and dilute acid extractions were performed on selected samples. These found that a total dilution of 1:25 (sediment:water) was required to meet all ANZECC (2000) (and therefore ANZG(2018)) default guideline values.

These results are applicable to the Middle Bay sediment that will be extracted during construction of the Talbingo intake. That is, default water quality guideline values are predicted to be achieved within a 1:25 dilution. This is likely to be achieved within the silt curtain(s) that will surround the extraction area. Underlying rock that is extracted following blasting will be far coarser than existing bed sediment and any impact that its extraction has on water quality is expected to be less than that of impacts from the extraction of soft sediment.

Potential turbidity impacts will be managed through the use of siltation curtains and turbidity monitoring (see Table 4.3)

Water quality - Tantangara

The chemical characteristics of 22 sediment samples collected across Tantangara Reservoir are presented in EIS Appendix J, Annexure A, Attachment F, *Sediment Data*. Sediments from across the reservoir are soft and muddy in texture with a dominance of particles in the coarse silt fraction. The concentrations of potential organic contaminants were below laboratory detection limits. Therefore, metal concentrations are the primary consideration for the assessment of the potential impacts of dredging on water quality.

The total metal concentrations for which there are ANZG (2018) default guideline values are presented in Table 4.4.

Table 4.4 Tantangara Reservoir – sediment metal concentrations

Metal/metalloid	Concentration (mg/L)		
	Default guideline value[1]	**Default guideline value – high[1]**	**Tantangara Reservoir**
Arsenic	20	70	<2–9.1
Cadmium	1.5	10	<0.4
Chromium	80	370	17–37
Copper	65	270	13–29
Lead	50	220	14–31
Mercury	0.15	1	<0.1
Nickel	21	52	9.5–20
Silver	1	4	<0.2
Zinc	200	410	45–110

ANZG (2018) default guideline values for toxicants in sediment.

All metals concentrations in Tantangara Reservoir sediments were below the ANZG (2018) default guideline values (Table 4.4), indicating that there is a low risk of unacceptable impacts occurring from dredging. Therefore, further assessment, such as elutriate tests or dilute acid extractable metals, is not required.

Potential turbidity impacts will be managed through the use of siltation curtains and turbidity monitoring (see Table 4.3).

c Reservoir fluctuations

Section 4.2.4 (i) of the PIR-RTS provides a response to the more rapid increase in reservoir fluctuation levels. In summary, while the rates of water level rise and fall are expected to experience some degree of change compared with the historic operations, only broad conclusions can be drawn to what the change will be, as the transfer

regime will vary widely depending on Snowy Hydro operational decisions and planning within the highly competitive NEM.

Notwithstanding the above, the water levels in both reservoirs will remain within the MOL and the FSL approved for the existing Snowy Scheme and no additional land will be affected by virtue of the inundation of the reservoirs through Snowy 2.0 operations. Bank erosion from fluctuations and wave erosion on areas not subject to excavated rock emplacement is not predicted to change from that currently experienced and approved.

With regards to modified bank areas created by the emplacement of excavated rock below FSL, potential water quality issues will be managed by:

- placing only the coarser D&B material below FSL in the Ravine Bay and Tantangara (Peninsula) emplacements;
- armouring the slopes of the emplacements below (and immediately above) FSL;
- the use of a geotextile filter layer at the Tantangara (Peninsula) excavated rock emplacement area;
- appropriately designing and rehabilitating the exposed portions of the emplacements; and
- potentially the selective placement of material sorted by particle size within the outer layers of the emplacements to form a filter to prevent the release of fine particles from within the emplacement.

In relation to potential reservoir water quality impacts during construction, preventing the release of fine materials will minimise any potential long-term turbidity generated by the emplacements. Further, it will minimise the potential interaction of sediment particles with reservoir water and therefore the potential impacts of SOPC/COPC on water quality.

d Environmental flows and downstream water quality

With regards to environmental flows, and as detailed in Section 4.2.4 (ii), there will be no changes to the Snowy Water Licence release obligations as a result of Snowy 2.0 and therefore no changes to downstream water releases nor impacts to users or the NSW government operated irrigation storages downstream of the Snowy Scheme.

Characterisation of existing water quality and flow regimes downstream of Tantangara and Talbingo reservoirs has not been undertaken on the basis that there will is no material water quality impact predicted to these watercourses. The basis for this is:

- the revised method of excavated rock emplacement in Talbingo reservoir shows a reduction in the predicted turbidity at the dam wall to <4 mg/L (Section 3.2.2);
- there is no predicted construction water quality impacts from excavated rock emplacement at Tantangara (Peninsula) - Section 4.4.1(ii);
- the combined process and wastewater discharge quantity has been significantly reduced from that presented in the EIS and a mixing zone analysis indicates that the mixing zone is predicted to be small (ie in the order of 10's of metres); and
- potential turbidity impacts from dredging, channel excavation and underwater blasting will be managed through the use of siltation curtains and turbidity monitoring.

iii Groundwater inflow, drawdown and surface hydrology impacts

Comments raised in submissions relating to impacts associated with groundwater drawdown from tunnelling activities, included:

- concerns that drawdown that could dry up creeks or alter the stream flow regime, resulting in risk to ecosystems and recreational activities;
- the loss of baseflow in rivers and creeks with specific concern for Upper Tantangara Creek, a known habitat for Stocky galaxias;
- groundwater inflow during operation and potential water quality impacts; and
- concerns for reduced inflow into the reservoirs and hence water releases.

a Groundwater modelling

The groundwater modelling presented in the EIS was based on an unlined, unmitigated (ie no grouting) tunnelling scenario. This was done to provide a very worst case prediction of potential impacts.

Since the Main Works EIS, refinement of the inputs into the regional groundwater model have been undertaken to better represent a more realistic worst case outcome. These refinements have focussed on representing the predicted permeability characteristics of the concrete lining (ie how much groundwater inflow is expected through the concrete lining) and better estimating the likely groundwater inflows in the first 15 m of tunnel construction (termed the 'face' of the TBM) prior to segmental lining being installed.

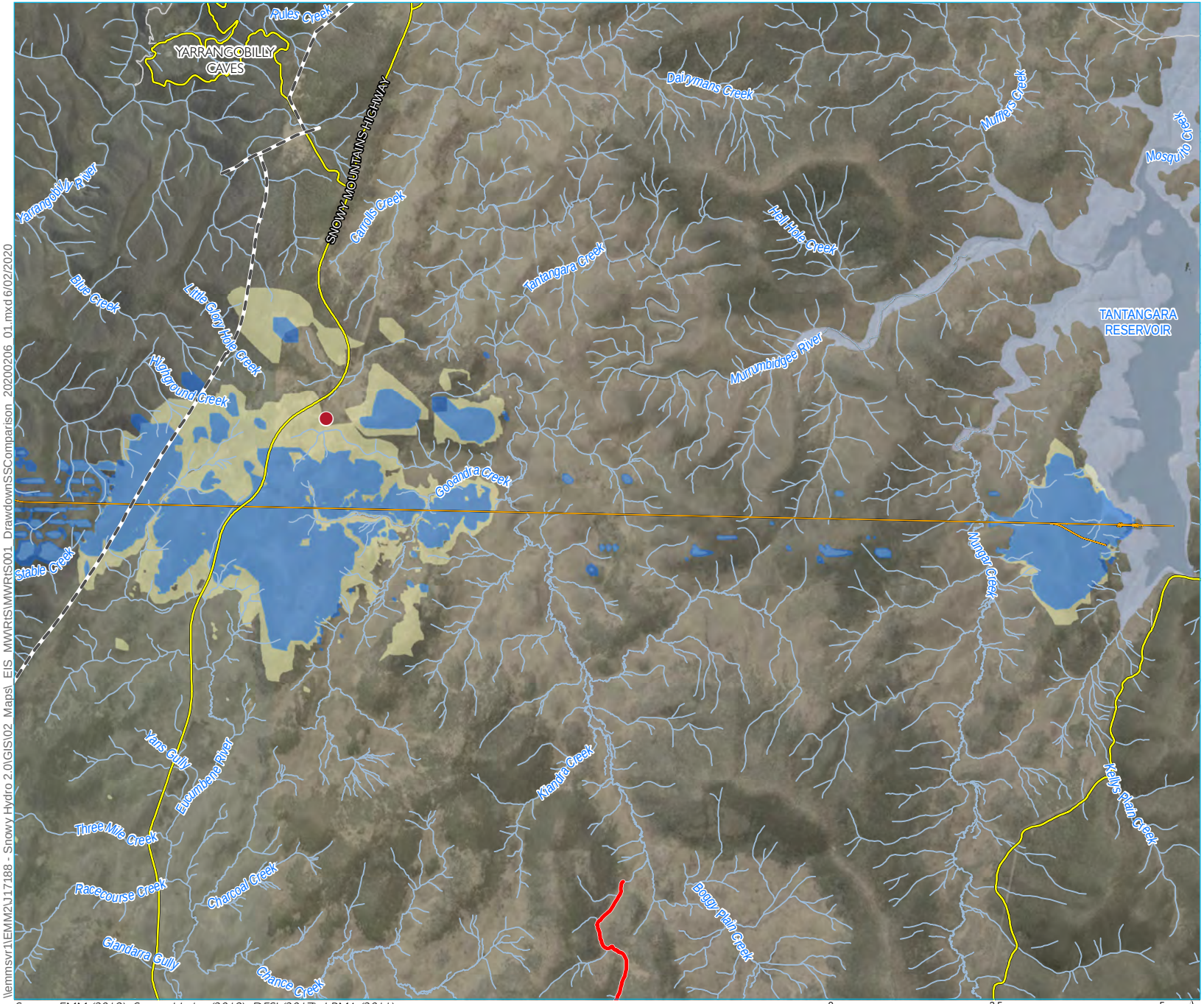
Snowy Hydro can confirm the power waterway elements of the tunnel will be lined with a segmental concrete lining and that that pre and post grouting will be undertaken when predicted (from probe drilling) or measured inflows (post excavation inflow measurements) exceed thresholds. Further information on TBM operation and the grouting process, including management triggers and responses, are included in the revised Modelling Report (PIR-RTS Appendix I).

The representation of the inflow at the face of the TBM, a constrained inflow rate through the segmental lining (as opposed to the unconstrained inflows represented in the EIS), and the subsequent remodelling exercise, has resulted in a predicted reduction to the groundwater inflows, water table drawdown and related impacts at surface.

The revised Modelling Report provides further details on all updated inputs, scenarios modelled and the scenario chosen for the reassessment of predicted impacts. The EIS predicted that total inflows into tunnel excavations during construction would peak at 160 L/s and reduce to approximately 85 L/s during operation. The revised modelling now predicts a peak during construction of 62 L/s and stabilising at 45 L/s during operation.

Focussing on the headrace tunnel where the highest inflows and largest associated water table impacts were predicted, the predicted peak tunnel inflows have reduced from approximately 12,500 kL/day to under 4,000 kL/day. This modelled reduction in groundwater inflow has also reduced the magnitude and extent of groundwater drawdown and associated streamflow impacts. Focussing on the impacts on the plateau, compared to the EIS, there has been a 29% reduction in the area subject to a water table drawdown of up to 0.5 m and 44% reduction in the area subject to a water table drawdown of up to 2 metres.

A comparison showing the reduction in affected area of 0.5 m water table drawdown, from the EIS to the revised modelled scenario, is detailed in Figure 4.6 .



\\emmsvr1\EMM2\117188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWRtS\MWRtS001 DrawdownSSComparison 20200206 01.mxd 6/02/2020

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

Comparison of EIS and PIR-RTS steady state 0.5m water table drawdown

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 4.6

b Streamflow impacts

The reduction in inflows and the magnitude and extent of drawdown has also shown a reduction in predicted streamflow impacts during the operation of Snowy 2.0. The EIS predicted that during operation, Gooandra Creek would change from having a perennial streamflow regime to being ephemeral (ie days with 'no flow' would increase from 0% to 9%). The revised modelling now predicts that the number of days with 'no flow' will increase from 0% to 2%.

Similarly, the EIS predicted the headwaters of the Eucumbene River could change from having a perennial streamflow regime to being ephemeral (days with 'no flow' would increase from 0% to approximately 20-25%). The revised modelling now predicts that the number of days with 'no flow' in the headwaters of the Eucumbene River will increase from 0% to 5-7%.

As detailed in the EIS, the impacts to streamflow are localised and the regional effect of long-term impacts are not significant. The revised long-term streamflow impacts, including the reduced impacts to Gooandra Creek and Eucumbene River described above, are presented in Figure 4.7.

One specific submission was raised regarding potential streamflow reductions to the unnamed tributary to Gooandra Creek that is south of Bullocks Hill campground. While a specific modelling reporting point is not assigned to this tributary, as can be seen on Figure 4.7, the tributary was shown as being within the EIS 0.5m drawdown contour and is now predominantly outside the 0.5 m drawdown contour. Streamflow impacts for this tributary are predicted to be negligible.

A reduction in predicted streamflow impacts has occurred due to the revised groundwater modelling to represent the effect of tunnel lining on inflow restriction. It should still be noted that the modelling still represents an unmitigated tunnel and that grouting, while unable to be accurately represented in the groundwater model, will occur during construction. This will further reduce groundwater inflow, drawdown magnitude and extents and streamflow impacts.

Snowy Hydro can also confirm that there will be no streamflow impacts to upper Tantangara Creek. Tantangara Creek itself will not be subject to direct groundwater drawdown impacts and upper Tantangara Creek (Habitat for Stocky galaxias) is noted to be approximately 6 km upstream of the confluence of Gooandra Creek.

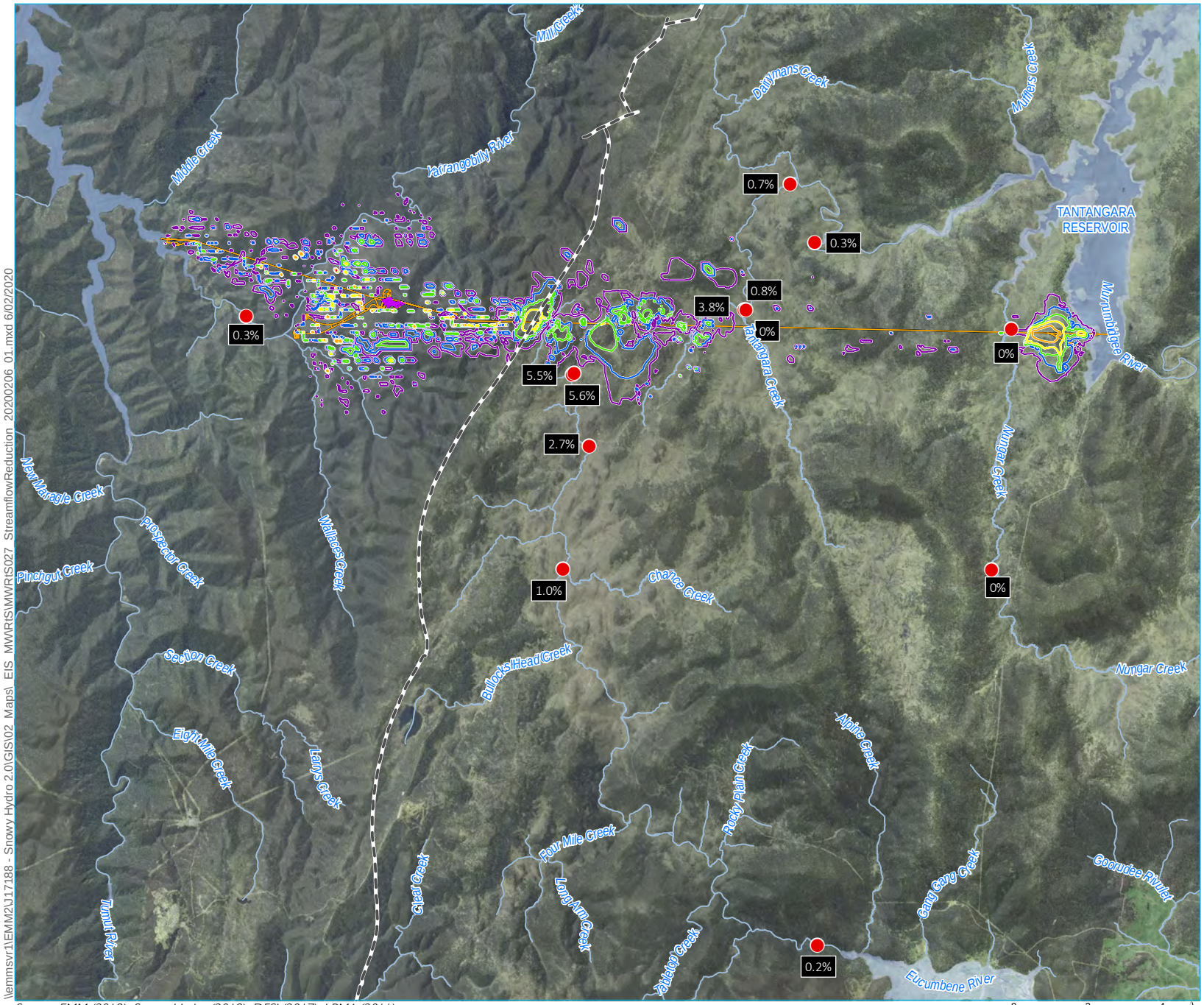
c Surface water quality impacts

There is some potential for a change in water quality in streams within the Gooandra Creek and upper Eucumbene River catchments that are subject to reduced baseflows, including:

- direct impacts due to reductions in baseflow contribution relative to total streamflow; and/or
- indirect impacts via temporary disconnection of pools along impacted streams, and potential impairment of habitat through for example increased water temperature, reduced dissolved oxygen or concentration of nutrients.

Due to the strong seasonality of baseflows on the plateau, direct water quality impacts are unlikely. During winter and spring, total streamflow is dominated by quickflow so that reductions in baseflow contribution will not influence overall water quality. During summer and autumn, streamflow is dominated by baseflow, so that reductions are also not consequential to overall water quality.

Potential indirect impacts to water quality would be limited largely to the operational phase. During construction, baseflow reductions under average climatic conditions are predicted to result in no discernible changes to streamflow year-round. During operations, predicted impacts are highly seasonal and limited to summer and autumn when some stream reaches in the Gooandra Creek and upper Eucumbene River catchments may experience periods of 'no flow'.



KEY

- Reporting points

Modelled drawdown (m)

- 0.5
- 2
- 5
- 10
- 20
- 50
- Long Plain Fault

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Perennial watercourse
- Scheme storage

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

Revised long-term streamflow reduction

Snowy 2.0
Preferred infrastructure report
and response to submissions
Main Works
Figure 4.7

The ecological significance of the altered flow regimes, including the influence of changes to water quality as described above on habitat value, was considered in the aquatic ecology assessment prepared for the EIS (Cardno, 2019), which concluded that the risk to aquatic ecology of impaired water quality in this context was low. As predicted impacts to streamflow regime as presented in this PIR-RTS have now reduced when compared to the EIS, the risk to aquatic ecology has also reduced and remains low.

d Operational groundwater inflow

As detailed in the revised Modelling Report, during operation, water is still predicted to flow into the power waterway and other excavations. The revised modelling report details that the predicted long term peak quantity expected has reduced from approximately 85 L/s as presented in the EIS to approximately 45 L/s. Again, this is a prediction without the grouting as mitigation, and it is noted that grouting will further reduce construction and operational inflows.

No treatment of operational groundwater will occur for inflows into the power waterway, as the inflows will mix directly with the water in the tunnel.

The power waterway will transfer water between Talbingo that has a gross storage of 921 GL (921,000 ML) and Tantangara that has a gross storage of 254 GL (254,000 ML). Both of these reservoirs also receive external inflows via natural flow or in the case of Talbingo via pumping from both T2 and T3 power stations. In addition, at full capacity, the power waterway will hold approximately 2,000 ML of water.

An operational groundwater inflow of 45 L/s equates to 3.9 ML/day, which equates to approximately 0.2% of the full tunnel capacity on any one day. The comparative quantity of groundwater inflows reduces further when comparing tunnel inflows to the capacity in the receiving reservoirs, which will be connected via the power waterway. Using a yearly operational inflow of approximately 1.42 GL/year (45 L/s over one year) into the power waterway, the yearly contribution of groundwater inflow compared to combined reservoir gross storage is approximately 0.1%. Therefore, no operational stage water quality impacts are expected as a result of inflows into the tunnel.

In addition, there will be no change to the quantity of water reaching reservoirs as a result of streamflow losses as water reaches the reservoirs either directly via streamflow or indirectly as groundwater inflows into the power waterway, which would be transferred to the reservoirs during generation or pumping.

The predicted impacts to streamflow and inflows of groundwater into the power waterway from the operation of Snowy 2.0 will therefore not impact the quantity or materially impact the quality of water reaching either Talbingo or Tantangara reservoirs.

iv Site water management and water quality risks

Comments raised in submissions relating to site water management and water quality risks, included:

- lack of detail on specific issues, including:
  - proposed treatment plants and other measures to minimise potential impacts of discharges, including cold climate treatment emergency storage;
  - suitability of wastewater storages including liners;
  - the quality of discharges from each proposed discharge point with reference to the relevant guideline values;
  - demonstration of how each proposed discharge stream will be managed to ensure the NSW Water Quality Objectives (WQOs) will be met by the edge of the near-field mixing zone;
  - the practical measures that will be taken to prevent, control or mitigate pollution including contingencies that will be implemented if WQOs are not met.
- the selection of sediment quality guidelines and recommendations for the modelling and assessment of water impacts;
- stormwater discharges that exceed relevant guideline values could potentially be acutely toxic to aquatic organisms and affect ecosystem health; and
- uncertainty on site water management proposed for temporary excavated rock stockpiles.

a Process and wastewater treatment and storage

A revised Water Management Report has been provided as Appendix J to the PIR-RTS, which provides further details on the design of treatment systems and emergency storage options for process and wastewater. This information is summarised below.

Snowy Hydro can confirm that process water emergency discharges to stormwater basins are not proposed and therefore will not impact on the capacity of stormwater basins or the ability to manage stormwater.

Snowy Hydro can also confirm that after the treatment process, process water will be held in smaller holding tanks and breakout tanks to hold and direct the treated water either for re-use, or discharge to the reservoir when re-use is not possible.

The process water treatment plants will also be designed to minimise the risk of failure, including:

- the plants will be designed to work in stages. Therefore, if a stage of the plant fails, the treatment plant will continue to work in reduced capacity conditions without stopping the entire operation of the treatment plant; and
- treatment plants will have a contingency period during which the plant is able to hold process water. The holding capacity will be dependent on the size of the plant.

Any potential issues with the process water treatment plant will be managed through a combination of the following measures:

- Water minimisation
  - water supply can be reduced by decreasing the volume of process water which requires treatment.
- Emergency water transfer
  - in locations where process water systems are connected, untreated process water could be transferred to nearby operational plant (ie the MAT portal treatment plant can transfer waters to the ECVT treatment plant);

- using in tunnel clean water storage tanks – there will be a number of clean water tanks within the tunnel. In a time of emergency, these tanks could be emptied of clean water and used as the emergency storage for untreated process water;

- discharging back into the tunnel so that the water can be recollected in sumps and treated again once the plant is operational; and

- if the treatment problem is occurring after the process water treatment plant, treated process water can be directed to the mainstream line for reuse in the tunnel boring machines.

Wastewater treatment plants will also be designed to operate in cold weather conditions (-20 degrees Celsius) including the consideration of containerised units, pipe insulation and balancing tanks to keep the water moving and avoid freezing.

With regards to the suitability of wastewater and chemical storages, Snowy Hydro can confirm that all wastewater and chemical storages will be designed and constructed to prevent leaks and seepages, including the installation of liners or other appropriate measures as required.

Mitigation Measure WM01 presented in the EIS commits to a Water Management Plan to be prepared by the contractor and in consultation with agencies, including EPA. This document will detail proposed mitigation and management measures for all construction water management categories, including the management of stored water at accommodation camps, construction pads and for process and wastewater.

b Process and wastewater minimisation

As detailed, refinement of the inputs into the regional groundwater model have been undertaken to better represent a more realistic constrained inflow rate through the segmental lining (as opposed to the unconstrained inflows represented in the EIS). This has resulted in a predicted reduction to the groundwater inflows and the overall amount of process water required to be managed.

Across the headrace tunnel and at the Tantangara process water treatment plant, where most of the inflows were predicted due to the geology of the plateau, the estimated peak inflow quantity has reduced from approximately 12,500 kL/day in the EIS to under 4,000 kL/day in the PIR-RTS. As described further in the revised Modelling Report, grouting will also be used throughout tunnel construction that will further reduce tunnel inflows and the amount of process water required to be managed.

In addition to this predicted reduction in the quantity of process water, Snowy Hydro can confirm that options to reuse all water streams will continue to be investigated and implemented. For example:

- the Contractor will aim to reuse the water from the process water treatments plants in the fire water tanks and the industrial water tank which will be located within the tunnel (if levels require this);

- treated process water may also be reused for tunnelling activities such as dust suppression, washing equipment, soil compaction and wheel wash (if required); and

- the Contractor will also deliver educational campaigns for the workforce to encourage water efficiency.

c Process and wastewater discharge

Snowy Hydro can confirm that there will be two discharge points for all process water and wastewater, and that all process and wastewater will be treated prior to being released. The two discharge points will be combined trunk main discharges to Talbingo and Tantangara reservoirs. The proposed discharge outlet locations parameters are detailed further in the revised Water Management Report (PIR-RTS Appendix J).

A mixing zone assessment has been undertaken and is included as an attachment to the revised Water Management Report (Appendix J). The purpose of the assessment was to determine the near-field dilutions associated with process and wastewater discharges to Tantangara and Talbingo reservoirs and estimate the size of mixing zone required to dilute key analytes (electrical conductivity, total nitrogen and total phosphorus) to ambient water quality targets.

The assessment determined that near-field dilutions are expected to be less for summer conditions when the reservoir is stratified compared to winter conditions when the reservoir is unstratified. However, the mixing zone under both conditions was predicted to be less than 10 m from the outfall location for most of the discharge scenarios modelled, but was found to range between 50 and 100 m for some ambient reservoir conditions. The generally small mixing zone was attributed to the high level of treatment and the small amount of dilution required.

When unstratified near still conditions occur (due to abnormally low ambient current speeds), the number of required dilutions may not be met before the discharge plume reaches the water surface. However, it was noted that such conditions are unlikely to be persistent for more than a week at a time and further mixing would continue to occur as a result of reservoir scale (far-field) mixing processes. Further information is provided in the revised Water Management Report (Appendix J).

d Stormwater

It is noted that the EIS Water Characterisation Report (Annexure A to the EIS Water Assessment) provides detail on the methodology used to characterise the quality of construction stage discharges.

Further information on construction stage stormwater management is included in the revised Water Management Report (PIR-RTS Appendix J). The following additional information is also provided in relation to stormwater management and principles.

- The following design principles will be considered to minimise the potential for discharge from sediment basins:
    - stabilise catchments – many areas such as the accommodation camps and access roads will have an initial earthworks phase, then will be stabilised until the decommissioning phase of the project. This would enable many of the sediment basins to be removed then reinstated (as required) prior to decommissioning. Stabilisation in this interim phase will reduce potential impacts on the receiving environment;
    - increased focus on erosion - additional erosion controls could be installed within the catchments to reduce the amount of sediments that may enter the basins. These could include geotextile materials, mulch / trash covers, hydroseed, hydromulch, natural sealing agents, bitumen, asphalt or concrete to limit the amount of available sediment; and
    - increased focus on sediment controls – additional sediment controls could be installed within the catchments to reduce the amount of sediments that may enter the basins. These can include mulch windrows, timber windrows, vegetated swales with check dams and sediment traps;
- Sediment basins that cannot be installed in space constrained areas or where topography is an issue may have alternative controls including:
    - berms or swale drains placed across the roads to divert water to roadside vegetation or spoon drains;

- check dams will be installed along the length of the spoon drains to reduce velocity, decrease the potential for scour or erosion, and to increase the retention of sediments;

- on extreme slopes, deeper sediment traps or sumps may be able to be installed required. Long term maintenance interests will be considered during the design and construction of dams and sumps;

- as a continuation of proven water management strategies from Exploratory Works, the use of irrigation for stormwater basin management. Factors which will considered when designing the irrigation system will include (but not be limited to) slope, landform, soil characteristics, soil salinity, soil saturated hydraulic conductivity, available soil water holding capacity and whether soil is sodic or non-sodic; and

- sprinkler irrigation systems will likely consist of irrigation mains and laterals, tall risers, and high angle, long throw range sprinkler heads. Sprinkler carts may be employed to increase the potential area available for irrigation. The equipment used will provide high sprinkler uniformity to minimise uneven watering, and will maximise potential evaporation and minimise scouring, erosion and runoff.

e Sediment basin sizing

With regards to sediment basin sizing and relevant submissions made, it is noted that Volume 2C of the Blue Book is applicable to unsealed roads. Volume 2C of the Blue Book does not recommend basins at the 95th or 90th percentile, however recommends that an 85th percentile 5-day rainfall event basin is installed for sensitive environments where disturbance is for 6-12 months. There is no recommendation for more than three years and no recommendation for 90th or 95th percentile basins.

The Blue Book Volume 2D relates to Main Roads and recommends 95th percentile basins for sensitive environments and 90th percentile basins for standard environments where the disturbance is for more than three years. It is noted that the project is not a Main Road construction project.

The Blue Book (Volume 1) recommends that basins are sized to the 85th percentile 5-day rainfall event. The sizing of basins at 85th percentile 5-day rainfall events is therefore in accordance with the Blue Book (Volume 1), and is in accordance with Volume 2D (Main Roads) in those locations with a disturbance duration of less than three years.

Notwithstanding the above, Snowy Hydro can confirm that where space constraints and topography permit, the use of basin of capacity greater than the 85th percentile 5-day rainfall event will be considered.

f Waste rock stockpile management

The potential for contamination from waste rock emplacement was identified in the EIS. Section 4.4.4(i) of the PIR-RTS details the management measures and protocols to minimise contamination risks.

v Monitoring, management and licensing

Comments raised in submissions relating to water monitoring, management measures and water licensing, included:

- characterisation of baseline conditions for groundwater (insufficient timeframe for groundwater samples);
- need for continued groundwater monitoring (in line with approved programme and plan) and commitment to long term monitoring to ensure tunnel grouting of voids is effective;
- uncertainty as to the level of assessment of operation of production bores, having regard to relevant water legislation and policy;
- clarification sought on Snowy Hydro's licensing and allocation for predicted water take.

a Surface water monitoring

A surface water monitoring program will be implemented over the duration of the Main Works, extending on the current program that has been implemented for Exploratory Works as well as ongoing baseline monitoring. The primary objectives of the monitoring program will be to collect sufficient data to:

- continue to monitor baseline conditions (upstream of Main Works);
- identify and quantify water quality impacts (downstream of Main Works);
- enable the effectiveness of water quality controls to be assessed; and
- enable compliance with relevant consent and licence conditions to be assessed.

The monitoring program will include commitments to monitor weather, stream flows, process water quantity and quality, stormwater quality and receiving water quality. It will also identify management triggers and responses to manage potential water quality impacts. It is proposed that further details are developed post-approval during preparation of management plans and in consultation with key stakeholders, consistent with the approach adopted for Exploratory Works.

b Groundwater monitoring and licensing

As detailed in the EIS Water Assessment and Water Characterisation Report (Annexure A to the EIS Water Assessment) the groundwater monitoring network has been completed in stages. Attachment C to the EIS WCR provides the drilling completion reports for the four drilling stages.

The Stage 1 network consisted of 20 groundwater monitoring bores at 11 sites and was completed between January and April 2018 across the extent of the project and data has been continuously collected since that time. There is therefore over 2 years of baseline data for many of these sites. The Stage 2 network extension was completed between May and June 2018, Stages 3 and 4 network extension completed between October 2018 and February 2019.

The EIS and PIR-RTS assessment is based on a model calibration which included data over approximately 16 months (Jan 2018 to May 2019). The frequency and duration of monitoring is considered sufficient to address seasonal fluxes in groundwater levels and quality, having captured monitoring data over two summer periods. While not presented in this PIR-RTS, analysis of the recent data collected (May 2019 to Feb 2020) is very similar and aligns to the initial data collected and used on the EIS and PIR-RTS assessment (Jan 2018 to May 2019). This close alignment of the recent data demonstrates that the 16 months of data utilised is appropriate to accurately represent baseline conditions for the project.

The impact assessment presented in the EIS, and where relevant updated in this RTS, is comprehensive and considers the impact on groundwater and surface water resources from the project activities, which incorporates both tunnel inflow and the operational requirements for potentially additional water supply.

It should be noted that the focus and main water volume is taken by the tunnel inflow, with the additional water supply from bores being an extremely minor volume in comparison to the tunnel inflow volume. The licence share component requirements for additional supply water has been considered in the EIS and the annual volumes are incorporated into the determination of the maximum annual take for water licence purposes that is required by the project.

Snowy Hydro can confirm that their registration of interest for water licence shares in the NSW Government controlled allocation process has been successful. The share volumes applied for are based on the EIS maximum conservative unmitigated and unlined tunnel model scenario and requirements were estimated for two water sources, the Lachlan Fold Belt MDB (other) Groundwater Source and the Lachlan Fold Belt South Coast Groundwater Source.

As detailed, the revised groundwater modelling has reduced the predicted groundwater inflow rates and impacts to streamflow losses. This has resulted in a reduction in the water take and water licensing requirements. A summary of the change in groundwater licensing requirements from the EIS to PIR-RTS is presented in Table 4.5.

Table 4.5 Change in groundwater licensing requirements

	Successful controlled allocation reference number	EIS maximum annual licence required (ML/year)	RTS maximum annual licence required (ML/year)	Total reduction from EIS to RTS (ML/year)
Lachlan Fold Belt (MDB)	ROI3-19-093 (3.375 ML successfully applied for as Snowy Hydro already hold 354 ML)	3,729	2,050	1,679
Lachlan Fold Belt (South Coast)	ROI3-19-092 (1,722 ML successfully applied for)	1,722	511	1,211

Snowy Hydro are now in negotiations with the NSW Government to finalise and secure the required water licence shares for the project based on the RTS maximum annual licence requirement.

4.4.2 Terrestrial ecology

i Adequacy of assessment / survey

Submissions raised matters regarding the adequacy of assessment and survey for terrestrial ecology, including:

- A detailed review of the Biodiversity Development Assessment Report (BDAR) by the Environment, Energy and Science Group of the Department of Planning, Industry and Environment (EES).
- Some submissions argued that the assessment of terrestrial ecology impacts should have considered impacts to areas outside the disturbance footprint identified in the EIS.

Surveys undertaken as a part of the biodiversity assessment for the Main Works EIS were undertaken in accordance with Commonwealth and NSW survey guidelines, including the Biodiversity Assessment Method (BAM, OEH 2017), and met minimum survey standards and effort across the majority of the project area. However, due to the evolving and responsive nature of the project design some surveys initially completed close to design various project elements were located distant from the Main Works project area. Although these survey sites are considered representative of the overall biodiversity values across the Main Works project area, and useful in informing the biodiversity assessment, following consultation with EES additional surveys have been undertaken to close the geographic gaps and undertake additional surveys close to the Main Works project area.

In addition, the inclusion of some areas into the Main Works project area immediately prior to submission of the EIS meant surveys had not been completed in these areas. A commitment was made to undertake additional targeted surveys in these areas prior to the response to submissions.

A revised Biodiversity Development Assessment Report (BDAR) is provided in section 5.6.7. The BDAR outlines the additional surveys undertaken. Overall, the additional surveys significantly address submissions made on the adequacy of surveys. It is noted, however, that the bushfires through this region in January 2020 have resulted in a very small number of surveys being unable to be completed. These incomplete surveys are considered inconsequential to the overall impact assessment, as they were either replicate surveys of areas previously surveyed or surveys closing geographic gaps.

ii Impacts to threatened species

Submissions raised matters regarding the adequacy of assessment and survey for terrestrial ecology, including:

- Construction impacts to threatened flora. Submissions raised concerns regarding impacts to threatened flora including assertions that the proposed impacts are unacceptable.
- Construction impacts to threatened fauna. Submissions raised concerns regarding impacts to threatened fauna including assertions that the proposed impacts are unacceptable.
- Impacts to threatened fauna due to contamination and water quality impacts of the proposed excavated rock placement.
- Several submissions argued that the EIS did not demonstrate sufficient avoidance and minimisation of impacts to threatened species and ecological communities.
- Concerns regarding habitat fragmentation impacts to threatened species.

Notably a detailed review of the BDAR including the assessment of impacts to threatened species was provided in the EES submission. A detailed response to this submission is provided in Appendix E.

Further design of the Main Works project has resulted in significant reductions in overall impacts to threatened species habitat. It is expected that the Main Works project will result in 640 ha of disturbance, a 62% reduction in overall impacts from the impacts predicted in the Main Works BDAR (EMM 2019). A full and complete revised impact assessment is provided in the revised BDAR (Appendix G), which includes revised impact calculations for all threatened species.

The recent fires across KNP have resulted in further consideration of the potential impacts to threatened species, particularly the importance of any refuge areas left unburnt by the fires and the importance of such areas to threatened species recovery. The fires in January 2020 burnt large areas of the Main Works project area, including Talbingo, Lobs Hole Ravine Road and Marica. In these areas, the fire was extensive with no areas left unburnt. As such, the fires have not resulted in any reconsideration of impacts.

Impacts will be offset in accordance with the NSW Biodiversity Offset Scheme through the implementation of biodiversity conservation measures in KNP, ensuring offsets result in benefits to the unique biodiversity values being impacted. A revised and updated Offset Strategy is provided in Appendix L, detailing how offsets will be delivered.

iii Impacts to Bogs and Fens and other groundwater dependent ecosystems

Submissions raised concerns regarding impacts to groundwater dependent ecosystems (GDEs) including bogs and fens. In particular these submissions raised concerns regarding impacts of groundwater drawdown due to tunnelling on GDEs.

The Main Works EIS and BDAR (EMM 2019) assumed that impacts to groundwater dependent ecosystems (GDEs) could occur from an unlined and unmitigated tunnel. This was a worst-case and unrealistic impact scenario. Since this time, additional modelling of groundwater impacts has been undertaken based on a lined but unmitigated tunnel (ie concrete segmental lining but no grouting). This revised modelling has resulted in significant reductions in predicted impacts to GDEs.

A revised assessment of impacts to GDEs is provided in the revised BDAR (Appendix G).

iv General biodiversity and ecosystem impacts

Several submissions raised matters regarding biodiversity impacts in general. Comments received included:

- Impacts to threatened ecological communities (TECs) including alpine bogs and fens. Several submissions raised concerns regarding the rarity and sensitivity of alpine and sub-alpine ecological communities and species.
- Concerns regarding the contribution of vegetation clearing to climate change.
- Several submissions raised concerns regarding the extent of the disturbance footprint. Some submissions questioned the size of the disturbance footprint and whether additional areas of vegetation clearing would be required as part of the Main Works not documented in the EIS. Several submissions asserted that the extent of proposed vegetation clearing was unacceptably large.
- Downstream impacts to biodiversity due to changes in environmental flows and releases downstream.
- The biodiversity offsets required for the proposed works including assertions that offsets should be calculated based on an area larger than the disturbance footprint. Some submissions argued that the biodiversity offsets required were exceedingly high and indicate an unacceptable level of impacts.
- That the proposed works will have cumulative biodiversity impacts within KNP due to existing environmental issues including climate change and invasive species.

Further design of the Main Works project has resulted in significant reductions in overall impacts to native vegetation and threatened species habitat. It is expected that the Main Works project will result in 640 ha of disturbance, a 62% reduction in overall impacts from the impacts predicted in the Main Works BDAR (EMM 2019). This reduction in impacts has resulted in a concurrent reduction in the offsets required for the project.

The design process has strongly considered the significant biodiversity values on KNP, particularly sub-alpine environments, and avoided and minimised impacts wherever possible. Strong and consistent interaction has occurred between project Ecologists, Snowy Hydro and the design team throughout the process. A discussion of these measures is provided in Section 8.2 of the Main Works BDAR (EMM 2019) and reiterated in the revised BDAR (Appendix G).

A full and complete revised impact assessment is provided in the revised BDAR (Appendix G), while a revised Offset Strategy is provided in Appendix L.

v Monitoring and management

Some submissions provided recommendations for measures to be applied to monitor and manage impacts to terrestrial ecology. In particular recommendations were provided regarding management and monitoring of construction traffic impacts to threatened fauna mortality. Notably a detailed review of the BDAR including proposed biodiversity mitigation measures was provided in the EES submission. A detailed response to this submission is provided in Appendix E.

The submissions received regarding monitoring largely focussed on impacts to fauna species as a result of roads and associated potential for mortality. Given the scope and scale of the Main Works project 24 hour operations are required, including traffic on project roads. Prohibitions of night-time traffic is not feasible. As such, other management measures need to be considered. As per the Main Works BDAR, measures to minimise and mitigate impacts are currently being considered, including reduced speed limits, fencing and underpasses.

Monitoring will include monitoring of mortality resulting from fauna vehicle strike along key access roads. Monitoring will be outlined in the Biodiversity Management Plan, to be prepared post-approval.

vi Weed and pest management

Some submissions raised concerns regarding weed and pest management through the project construction. In particular, submissions identified the potential for the project construction to spread weeds and pest species in the KNP as requiring careful management.

The BDAR (EMM 2019) acknowledges the potential for the project to result in introduction of weeds into Kosciuszko National Park, spread of existing weeds (eg Ox-eye Daisy) and increase activity of feral species adjacent to key areas. Several measures to minimise and mitigate these potential impacts are outlined in Section 8.2viic of the EIS BDAR (EMM 2019) and reiterated in the revised BDAR (Appendix G). The focus of ongoing monitoring and management will be on identification and timely management of these impacts during construction and operation of the scheme.

4.4.3 Aquatic ecology

The NSW Department of Primary Industry - Fisheries (DPIF) raised concerns regarding aquatic ecology. Response to DPIF's general comments are included in the following sections, grouped under general headings along with response to the wider community concerns. A detailed response to each concern raised by DPIF, including comments referring to specific sections of the EIS, have been responded to individually in the letter provided in Appendix H.

i Fish transfer

Submissions raised concerns regarding:

- The potential transfer and dispersal of pest species, including redfin perch, eastern gambusia, wild goldfish, Epizootic Haematopoietic Necrosis Virus (EHNV) and *Elodea* weed. Concern was raised that these species would not only be transferred from Talbingo Reservoir into Tantangara Reservoir but also into other downstream environments including the Snowy River, Murrumbidgee River and Murray River catchments. These submissions expressed concern for impacts associated with the transfer of pest species.
- Redfin perch displacing trout populations.
- Redfin perch and potential EHNV impacting the endangered Macquarie perch population in the Murrumbidgee River.
- Climbing galaxias impacting the known population of stocky galaxias in Tantangara Creek.
- The need for additional controls to reduce risks for pest transfer, particularly redfin perch. Submitters provided comment on additional controls including a screen at the inlet at Talbingo Reservoir to provide multiple barriers and redundancy.
- The lack of design detail and information about the fish barrier on Tantangara Creek and fish control structures at Tantangara Reservoir dam. There is insufficient detail to determine whether the barrier will be effective, whether the design has considered a range of scenarios such as flooding events, and what is proposed for its ongoing operation and maintenance.

Most concerns raised in submissions regarding aquatic ecology were focused on issues associated with the potential transfer of pest fish species, predominantly redfin perch (*Perca fluviatilis*) and climbing galaxiids (*Galaxias brevipinnis*) and/or the potential to spread EHNV into the Murrumbidgee River catchment. Common issues raised were concern for not proposing the use of primary controls to prevent fish transfer at the Talbingo intake (and thereby negating the need for secondary controls in Tantangara Reservoir) and the limited level of detail provided for Snowy Hydro's assessment of potential control options. In addition, several submissions included a request for more detailed design information for the proposed secondary controls at Tantangara dam and the galaxiid barrier in Tantangara Creek.

The potential transfer of undesirable fish species and EHNV represents a biosecurity issue. A summary of the assessment of options to prevent, eliminate or minimise the biosecurity risk and consequent environmental and social impacts is provided in Section 4.3.4 of the PIR-RTS.

Following EIS submission, further information on the options considered to prevent or minimise transfer of undesirable fish species has been discussed in meetings with DPIE and DPIF. Snowy Hydro's response to biosecurity issues (Appendix N) provides detail for all the options considered to prevent, eliminate or minimise this risk. Full justification of the approach presented in the Main Works EIS is provided which demonstrates how Snowy Hydro is taking the most reasonably practicable steps to minimise the risk of harm to the environment and recreational fishing from the risk of potential fish transfer. Details are provided for the range of primary and secondary control options assessed including details of estimate costs and likely efficacy.

Mitigation measures proposed in the Main Works EIS and detailed in Appendix N, including installation of best available technology in fish screening on the outlets to Tantangara Reservoir and in the upper Tantangara Creek catchment, are expected to prevent the transfer of fish out of Tantangara Reservoir to other catchments to the greatest extent practicable and therefore represent the most appropriate and reasonably practicable measures to minimise the potential biosecurity risk associated with the operation of Snowy 2.0. By undertaking these measures, the risk to any threatened species and EECs is reduced, as are potential impacts to recreationally important salmonid populations in Lake Eucumbene and connected catchments.

As noted in the Main Works EIS, if redfin perch are transferred to Tantangara Reservoir and become established, impacts to the recreationally important salmonid populations, including potential reductions in abundance or changes to population structure could occur. For this reason, as noted in the Main Works EIS, Snowy Hydro has committed to supporting DPIF and the local community to develop measures to stock Tantangara Reservoir with large salmonids (above the typical fingerling size) which would be better able to avoid competition or predation from any redfin perch in the reservoir. Snowy Hydro anticipates working closely with DPI Fisheries and members of the local fishing community to implement this program in such a way that the positive impacts to the local community and recreational fishing in the region are maximised.

ii Excavated material management

Submissions raised concerns regarding possible aquatic impacts associated with the placement of excavated rock material onto benthic habitat and resulting in changes to water quality, specifically in Talbingo Reservoir where there is habitat for the threatened Murray crayfish.

Another focus for some of the submissions received was on the potential impact of in-reservoir placement of excavated materials on water quality within Talbingo Reservoir and specific impacts on Murray crayfish (*Euastacus armatus*) due to loss of habitat (physical disturbance) and secondary impacts associated with predicted changes to water quality and sedimentation throughout the reservoir. Snowy Hydro has revised the design and methodology for the management of excavated material and the implications of the altered placement footprint and predicted water quality in the reservoir is reported in Section 3.2.2 of the PIR-RTS.

The preferred option for Talbingo Reservoir is placement of the coarser D&B material only in Ravine Bay, with all of the finer grained TBM material to be placed in 1-2 nominated areas on land, including one area directly upslope from the Ravine Bay placement area.

The estimated in-water footprint for the D&B material in Ravine Bay is 3 ha.

The associated impacts to water quality from placement of only D&B material into Ravine Bay have been modelled by Royal Haskoning DHV, with results indicating surface TSS concentrations of 2.5 mg/L at Location 1 (Dam Wall) and 5 mg/L at Location 9 (1 km north of Ravine Bay). These results are lower than the model outputs for the placement option presented in the EIS, which were 16 mg/L and 32 mg/L for Location 1 and Location 9, respectively.

Assuming all shallow water areas within 20m water depth of FSL are representative of potential Murray crayfish habitat in Talbingo Reservoir (a total area of 495 ha), the maximum loss of crayfish habitat due to the in-water placement area is equivalent to 0.6% of the total potential habitat in the reservoir.

Potential cumulative impacts to Murray crayfish habitat in Talbingo Reservoir from construction of the intake (1 ha footprint or 0.2% of total potential habitat) plus the in-water placement of D&B materials (3 ha) equates to an estimated total of 0.8% of available habitat. This small area is not likely to impact the population of Murray crayfish within Talbingo Reservoir, especially considering SHL's proposal to trap and relocate crayfish from the impacted areas prior to construction. DPIF would be consulted during the preparation of the Aquatic Habitat Management Plan including the prescribed process for capture and relocation of Murray crayfish. If preferred by DPIF, individuals could be provided to DPIF for use in captive breeding or relocation programs in other locations.

The revised in-reservoir placement option represents a better environmental option than that presented in the EIS, with a smaller in-water footprint and only placement of the coarser D&B material which reduces the impact on reservoir water quality and has less risk to aquatic ecology throughout the reservoir.

The currently favoured placement option for Tantangara Reservoir is similar to the area and method presented in the EIS, although the footprint may be slightly adjusted along the shore. Most of the material will be placed above MOL using dry placement techniques and therefore, with the adoption of appropriate sediment control measures, impacts to water quality and aquatic habitat are likely to be low.

iii Groundwater drawdown

Submissions raised concerns regarding possible impacts to aquatic biota as a result of changes to stream flows (tunnelling impacts).

A few respondents raised the issue of predicted groundwater drawdown associated with tunnelling, and potential impacts on streamflow dynamics that could affect aquatic ecology. The predicted drawdown reported in the EIS was based on a worst-case scenario of an unlined and unmitigated (no grouting) tunnel. Groundwater remodelling has since been revised (see Section 4.4.1 of the PIR-RTS) and now incorporates groundwater inflow restrictions associated with the use of segmental concrete lining. Segmental lining would reduce inflows and consequent impacts to streamflow from groundwater drawdown.

Progressive grouting of the tunnel during construction also forms part of the proposed tunnelling method and would further reduce the predicted inflows and associated impacts. Unfortunately grouting cannot be modelled on a regional scale and grouting has not been included in the revised modelling scenario. The new results are therefore still conservative.

The new modelling results indicate an overall reduction in areal extent of impacted area and smaller change now apparent for Gooandra Creek and the Eucumbene River (see summary provided in Section 4.4.1 of the PIR-RTS).

In Gooandra Creek, the area with the greatest predicted change is upstream of the confluence with Tantangara Creek (site 3). Modelling at this site indicates only a marginal decrease in annual baseflow (3.6%), mostly apparent in summer (-7.2%) and autumn (-5.9%). Approximately 4.5 km of Gooandra Creek immediately upstream of the confluence with Tantangara creek is expected to be impacted by baseflow reduction due to groundwater drawdown.

Importantly, this potentially impacted area does not overlap with the known distribution of the critically endangered stocky galaxias (*Galaxias tantangara*), which has only been recorded from one locality in the headwaters of Tantangara Creek. The known distribution of this species will not be affected by groundwater drawdown.

Analysis indicates that during the operational phase of the project, Gooandra Creek will change from having a year-round perennial streamflow regime to being occasionally ephemeral, whereby days with ‘no flow’ increase from 0% to 2% (at Site 3) particularly in Summer and Autumn. Medium and high flows continue to predominate in Winter and Spring, and any impacts to flows do not continue downstream since the unaffected flows from Tantangara Creek maintain the normal 0% ‘no flow’ regime (at Sites 5 and 6).

The fish community in Gooandra Creek is dominated by salmonids - rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), with no native fish detected (Cardno 2019). The predicted marginal increase in no-flow (which at 7% in summer equates to about 6 days) is not expected to affect the survival of the creek’s trout population. Also, the upstream spawning run of trout occurs in late Autumn-early Winter which is outside the predicted summer period of highest occurrence of low flows and impacts to trout spawning activity is not expected.

The upstream reaches of the Eucumbene River are predicted to have higher impacts from groundwater drawdown than Gooandra Creek, with predicted impacts greatest in the uppermost 5 km of the river (details provided in Section 4.4.1 of the PIR-RTS). Baseflow discharges could potentially approach zero in the uppermost 1.5 km of the catchment and predicted impacts decrease gradually along the length of the river as unaffected catchments incrementally contribute flow to the river. The highest annual decrease in base flow is predicted to occur in Summer (-10.6%) and Autumn (-8.6%).

The fish community in the upstream reaches of the Eucumbene River is also dominated by non-native species with rainbow trout the only fish detected in the area of predicted impact (Cardno 2019).

The predicted increased frequency of no-flow conditions (which at 11% in summer equates to about 10 days) may temporarily isolate individual fish to deeper pools within the affected reaches for a small number of days each year but is not expected to affect the survival of the local populations in the long term. As indicated above, the predicted highest impact time in summer is outside the trout spawning run and is therefore unlikely to affect the trout population upstream of Lake Eucumbene and subsequent movement of juvenile trout downstream into Lake Eucumbene.

iv Adequacy of assessment

Submissions raised concerns regarding adequacy of the aquatic assessment and survey reported in the EIS, in particular:

- detail and sampling strategy for testing for EHNV.
- laboratory trials of survival of fish to pumping for multiple species including galaxiids.
- lack of assessment on the salmonid species as a result of groundwater losses on Tantangara plain [see *ii*i. Groundwater drawdown].
- investigation of possible transfer and effects of blue green algae in Tantangara Reservoir.
- impacts to galaxiid species referenced in the aquatic ecology assessment.
- impacts to stocky galaxias [see *i. Fish transfer*].
- primary research used to inform the aquatic assessment was not provided for review with the EIS.
- decision not to use primary controls is not adequately justified or demonstrated in the EIS [see *i. Fish transfer*].

a EHNV strategy

Actions associated with an EHNV surveillance program will be described in the associated management plan to be developed in consultation with DPI Fisheries. Actions include design and implementation of surveillance and response plans in the event of an outbreak of EHNV in Talbingo or Tantangara reservoirs.

A Draft EHNV Monitoring Program has been developed (see Appendix A of the Biosecurity document attached as Appendix N). If Snowy 2.0 is approved, a final version of the EHNV program will form part of the Aquatic Habitat Management Plan (AqHMP).

b Fish survival trials

As reported in the EIS, scientists at Charlies Sturt University were commissioned by Snowy Hydro to investigate the potential survival of various life-history stages of redfin perch and of adult eastern gambusia through the proposed pumped hydro system as existing literature was not available to assess this risk (Ning *et al.* 2019; Baumgarter *et al.,* 2017). This was undertaken via a series of laboratory-based experiments and modelling that simulated various aspects and scenarios of pumping from Talbingo to Tantangara reservoirs, including simulated blade strike, shear stress and pressure changes. A desktop study was also undertaken to consider the likelihood of each species and life stage being entrained into the intake at Talbingo. Following a request during the exhibition of the EIS, these studies have been released in full and are available as part of the Main Works EIS.

Whether redfin perch, Gambusia or any other fish present in Talbingo Reservoir will be entrained into the intake and survive transfer through the completed development in 'real life' cannot be known with certainty until Snowy 2.0 becomes operational.

The impact assessment for the EIS in relation to impacts arising from potential pest fish transfer into Tantangara Reservoir and beyond, took a precautionary approach and evaluated the likelihood and consequence of impacts from undesirable fish species on receiving environments assuming that transfer to Tantangara Reservoir of any species present in Talbingo Reservoir could occur. For this reason, it was not considered necessary to include all species and life stages in experimental testing.

c Transfer of blue-green algae

Blue-green algae (Cyanobacteria) are species of phytoplankton that are naturally occurring in water bodies such as inland creeks, rivers and lakes. When conditions are suitable, blue-green algae reproduce in high numbers, causing multicoloured slicks on the water surface known as blooms (Water NSW 2019). Algal blooms are natural but may cause aquatic toxicity and affect species (including humans and stock) which consume water and/or are exposed to toxins during recreational activities in areas contaminated by the bloom. The cause of blooms is unknown although they are typically associated with excess nutrient levels during periods of warm and calm conditions. Once the excess nutrients are consumed by the algae, the bloom 'collapses' and the dead phytoplankton cells dissipate within the water and into the sediments.

No algal blooms have been reported recently in either reservoir although blooms have recently occurred within the catchment of Tantangara Reservoir (ABC 2019) and are frequently reported from throughout the Murray-Darling Catchment. Management of a bloom typically comprises public notification to avoid consumption of water and determining alternative water sources for stock and human consumption during the bloom period, along with water testing to confirm when the bloom is no longer a threat. Blooms are usually left to collapse and naturally disperse, which may take weeks (Water NSW 2019).

As indicated in the aquatic ecology assessment report prepared by Cardno (2019) for the Snowy 2.0 Main EIS (EMM 2019), Cyanophytes are a major component of the phytoplankton in both reservoirs, although they have not been detected in either reservoir at levels indicative of an algal bloom.

Snowy 2.0 is not expected to influence the occurrence or frequency of blue-green algal blooms in Tantangara and Talbingo reservoirs, or elsewhere in their catchments. Transfer of water between reservoirs may entrain phytoplankton species, including Cyanophytes. However, the movement of water between reservoirs will not cause algal blooms, and since blooms typically occur when water conditions are calm and the water becomes stratified, the transfer and movement of large volumes of water during operation of Snowy 2.0 may actually break down stratification in the receiving environment and hinder the development of blue-green algal blooms. Destratification is one recommended method to prevent formation of harmful algal blooms in reservoirs (Water NSW 2019). Also, phytoplankton tend to populate well-lit surface waters and the proposed placement of the Snowy 2.0 intakes at water depths below 6 m is likely to reduce the number of phytoplankton entrained and transferred between reservoirs.

d Upper Murrumbidgee Galaxiids

During surveys for the Main Works EIS, galaxids were captured in the Murrumbidgee River catchment. Galaxias expert Tarmo Raadik from the Arthur Rylah Institute (2018), was engaged to capture and undertake morphological examination of specimens in these areas. This project confirmed that the critically endangered stocky galaxias (Galaxias tantangara) and the native narrow-range species, *Galaxias supremus*, were not identified at the two sites sampled in the upper Murrumbidgee River in the area of the proposed Snowy 2.0 project. The galaxiids collected from the two sites are part of the *Galaxias olidus* 'cryptic species complex' and were tentatively identified as *Galaxias olidus* (Raadik 2019). However, due to subtle morphological variation between fish from each site and from other nearby *Galaxias olidus* populations, and some differences compared to the published description of *Galaxias olidus*, it is likely that previously unrecognised levels of within species variation or

additional, undiscovered species may be present. This uncertainty could only be resolved through targeted genetic and detailed morphological studies and, in the absence of clear evidence for speciation, both samples were grouped under the *Galaxias olidus* 'cryptic species complex' banner.

e Primary research

Snowy Hydro engaged a variety of technical specialists to undertake studies and trials in support of the impact assessment process. Following a request during exhibition of the EIS, these studies have been released in full and are available as part of the Main Works EIS.

v Level of detail

Submissions raised concerns regarding insufficient detail on proposed mitigation measures and their demonstrated effectiveness, such as:

- translocation of Murray crayfish in Talbingo Reservoir away from the excavated rock placement area [see *ii. Excavated material management*].
- lack of design detail and information about the fish barrier on Tantangara Creek and fish control structures at Tantangara Reservoir wall - insufficient detail to determine whether the barrier will be effective, whether the design has considered a range of scenarios such as flooding events, and what is proposed for its ongoing operation and maintenance [see *i. Fish transfer*].
- adequate monitoring is needed to ensure the effectiveness of barriers and mitigation measures, and adaptive measures are to be put in place if the physical barrier is not proven to be effective.
- detail of the Weed, Pest and Pathogen Management Plan should be provided to ensure suitable threat mitigation and implementation strategies are determined.
- management response to future changes of fish ecology or status.
- cumulative impacts.

a Monitoring effectiveness

Mitigation measures included within the AEA include commitments to management plans and monitoring programs that will be applied within a framework of adaptive management to provide the best opportunity to respond in a timely manner to impacts of unpredicted magnitude.

Design features of the fish control structure at Tantangara Dam will seek to minimise the potential for blockages and impact damage to the fine screens. Sensors will be installed to monitor changes to head loss (that could indicate a blockage or damage to the screen) and monitoring data will be used to facilitate adaptive management of the barrier's performance. The proposed redundancy of an additional screen and chamber will allow any chamber requiring maintenance or repair to be isolated, drained, and accessed for inspections, maintenance and repairs while not impacting the operation of the remaining screens or providing conditions that could lead to fish transfer.

b Management plans

Refer to Section 4.3.2 Approvals process and compliance.

One submission suggested that the environmental management plans should be completed prior to the assessment of the EIS. Given the nature and scale of the Main Works, it is appropriate that any fine management detail within management plans should be required as conditions of any approval granted to Main Works, and therefore cannot be developed in advance of the approval. The management plans will have to meet certain outcomes specified in the conditions of approval and will be subject to separate approval by the Planning Secretary. If the Planning Secretary grants approval to Main Works, future consultation with stakeholders will be undertaken regarding the development of appropriate management plans.

DPI Fisheries would be consulted during the preparation of management plans associated with the management of impacts to aquatic ecology, such as the Aquatic Habitat Management Plan (AqHMP) and the Dredging and Excavated Materials Management Plan (DEMMP).

c Future fish ecology

One respondent commented that the EIS does not address the risk or what the management response will be to future changes in fish ecology or status, specifically referring to the possible establishment of trout cod (*Maccullochella macquariensis*) or EHNV in Talbingo Reservoir and no Trout cod were detected in surveys of the reservoir during preparation of the EIS (Cardno, 2019).

A total of 15,000 trout cod fingerlings have been released by DPIF into Talbingo Reservoir since 2014 with the aim of providing more opportunities for recreational fishers (trout cod can only be caught in Talbingo Reservoir) and creating community awareness and understanding of species (NSW DPI 2006). A self-sustaining (breeding) population is not confirmed for Talbingo Reservoir.

Construction of Snowy 2.0 is not expected to affect the survival of trout cod in Talbingo Reservoir since only a small area (<1 ha) of nearshore habitat will be directly impacted, and the in-water placement of coarse D&B material is predicted to materially reduce TSS concentrations and turbidity in the reservoir compared to the scenario presented in the EIS. Changes to the emplacement design are expected to reduce the maximum TSS concentration increase at the dam wall (all depths) to 2.5 mg/L, which is similar to the measured maximum concentration in the reservoir, and that a maximum increase in surface water TSS of 5 mg/L would be achieved within about 1 km of Ravine Bay. Operational impacts will be even less.

EHNV has never been detected in either Tantangara or Talbingo reservoirs but the possibility of an outbreak at some point in the future cannot be excluded. For this reason, Snowy Hydro made a commitment in the EIS to undertake an EHNV Monitoring Program (see Appendix A of the Biosecurity document attached as Appendix N). If Snowy 2.0 is approved, a final version of the EHNV program will form part of the Aquatic Habitat Management Plan (AqHMP) which will be developed in consultation with DPI Fisheries.

d Cumulative impacts

Regarding the assessment of cumulative impacts, the following is provided in Section 8 of the AEA:

> "All identified construction and operational related activities and associated impacts have potential to affect sensitive aquatic receptors in Talbingo Reservoir, Tantangara Reservoir and other catchments within the study area. Although the potential effects of the various project impacts have been considered separately, there are likely to be interactions among impacts associated with the project design that could reduce or magnify the intensity of a response or raise or lower the threshold of response. Moreover, there is also potential for cumulative effects between the project and external factors. Interactive effects of multiple impacts are poorly understood but given most of the impacts affect similar receptors within the study area and a worst case scenario has been assumed for each impact (i.e. mortality to biota), then cumulative impacts are considered unlikely to change the conclusions of this assessment. Cumulative impacts may lengthen the recovery time in some areas for some sensitive receptors but not to the extent that would change the stated conclusions."

It is reiterated that while cumulative impacts could occur, interactive effects are poorly understood to the extent that providing any more than a qualitative assessment (ie the severity of two impacts may be greater than the sum of their parts) is not possible. Given that worse case scenarios are considered where appropriate (eg loss of threatened species or populations of threatened species), then indeed cumulative impacts are considered unlikely to change the conclusions of this assessment.

Notwithstanding these issues, the mitigation measures included within the AEA include commitments to management plans and monitoring programs that will be applied within a framework of adaptive management to provide the best opportunity to respond in a timely manner to impacts of unpredicted magnitude.

4.4.4 Land

i Contamination

Comments were received in submissions regarding contamination. Issues raised included:

- Concerns about how asbestos containing material encountered during excavation would be managed and disposed.
- Concerns regarding the management and disposal of potentially acid forming material as part of the excavated rock management.
- Concerns regarding contamination to water due to excavated rock management both on-land and in-reservoir.

a Management and disposal of naturally occurring asbestos (NOA)

Naturally occurring asbestos (NOA), along with potentially acid-forming (PAF) material and other contaminants (such as might be encountered at the disused copper mine at Lobs Hole), was raised as a key matter for the Snowy 2.0 Main Works.

The assessment of potential impacts as undertaken in the Main Works EIS was based on project-specific investigations undertaken to evaluate the presence of NOA, and to inform the development of protocols to appropriately manage the excavation, placement and encapsulation of NOA material.

As reported, geological strata testing confirmed the presence of NOA at locations to be disturbed by tunnelling, excavation and other construction activities. Investigations carried out to date concluded that risks of contamination (including NOA) were considered to be low at:

- Talbingo Reservoir;
- Marica; and
- Rock Forest (outside the national park).

However, proactive measures are required to manage NOA at other locations, including the Plateau. As a result, appropriate management measures and protocols have been proposed in these areas that are intended to minimise contamination risks. This includes:

- the use of dual mode TBMs (described in Chapter 2 of the Main Works EIS) that allows the operators to transfer to slurry mode when NOA is encountered. Material subject to the slurry treatment process will be wet which will limit the dispersion of fibres into the air during operation. Residual slurry will be encapsulated within an air/watertight enclosure shed;
- stringent practices for the loading, transport and disposal of NOA containment spoil that will minimise the generation of airborne respirable asbestos fibres and the loss of potentially contaminated material to the environment;
- specially designed lined trucks for the transportation of NOA contaminated material (including standards and procedures for the ventilation and cleaning of vehicle cabins) which will prevent the material loss during transport;
- stringent workplace health and safety measures, including personal protective clothing, respiratory protective equipment and associated policies, education and training, in accordance with NSW Work Health and Safety Regulations; and
- decontamination facilities and compliance and monitoring procedures.

An Asbestos Management Plan (AMP) will be prepared in accordance with the NSW Work Health and Safety Regulation 2017: Regulation 432. This plan will include information about:

- the identification of NOA,
- decisions, and reasons for decisions, about the management of NOA at the workplace;
- procedures for detailing incidents or emergencies involving NOA at the workplace; and
- workers carrying out work involving NOA.

Since completion of the Main Works EIS, further detailed design has been undertaken that confirms the proposed on-site disposal strategy as being the most practicable, safe, and environmentally responsible method for management and disposal of the NOA contaminated excavated material. Benefits of the proposed NOA strategy include:

- the relative proximity of point of generation of NOA contaminated material to the disposal site;
- adoption of a conservative health and safety approach through the consistent application of a single specific AMP for the project;
- a standalone solution within the project area;
- significant reduction of heavy equipment traffic compared to disposal to a rock disposal area outside the boundaries of the KNP;
- easier long-term management; and
- permanent placement of excavated material within emplacement, using a design that prevents the migration and leachate of contaminants including NOA.

b Management and disposal of potentially acid forming material

Potentially acid forming (PAF) materials comprise typically naturally occurring soils, sediments or organic substrates that are formed under waterlogged conditions and contain iron sulphide minerals or their oxidation products. While they remain in a waterlogged state, they are benign. However, if drained or excavated the material may be acid forming.

Appropriate management measures and protocols have been designed to minimise contamination risks. Where excavated rock may be PAF (as indicated by chemical analysis), stockpiling and screening procedures will be implemented as part of the characterisation process which will inform their use.

c Potential for contamination to water due to excavated rock management

Key impacts of Snowy 2.0 Main Works relating to land include the presence of PAF material, NOA, and other contaminating materials in some limited areas that could be disturbed by tunnelling, excavation and other construction activities. Lobs Hole is the main area of potential contamination concern, due to its previous use as a copper mine and existing areas of identified metal contamination primarily associated with historical stockpiles. Some areas in the project area have also been identified as potentially containing NOA. Other locations include potential NOA from tunnelling across the Plateau (mostly).

Appropriate management measures and protocols are proposed to minimise contamination risks including the development of an Excavated Material Management Plan (EMMP) which would include:

- procedures for handling, sampling and testing, classification, storage and disposal/placement of excavated rock to ensure that excavated material is appropriately managed;
- monitoring of the placement of excavated rock material;
- allowances for the treatment and separate placement of some PAF/NOA material in dedicated permanent emplacements in accordance with excavated rock management strategies for the Project;
- a process for the identification/characterisation/quantification of PAF/NOA material; and
- a continued excavated material characterisation program would be developed which will allow for adequate assessment of NOA and PAF, and reduce the risk of material being misclassified as 'benign' and being managed inappropriately.

d New landforms

A key impact of the project is the creation of new landforms. These landforms are directly linked to the excavated material management strategy for Snowy 2.0 Main Works and the Rehabilitation Strategy prepared for the project, which have been previously described in Chapter 2. The Rehabilitation Strategy has been developed to provide guidance on the rehabilitation of disturbed areas, as well as final land use consistent with the KNP PoM. The strategy identifies measures to enhance landforms to remain permanently within KNP at completion of construction, and outlines rehabilitation objectives are met.

As discussed in Section 1.3.2 above, since the exhibition of the Main Works EIS, DPIE has requested that Snowy Hydro consider alternative options for management of excavated rock. As a result, alternative excavated spoil management options compared to that articulated in the Main Works EIS, are provided in Section 3.2.2 of this report.

ii Geodiversity

Comments were received in submissions regarding impacts to geodiversity. Matters raised included:

- Concerns regarding impacts to block streams on Lobs Hole Ravine Road.
- Concerns regarding impacts to the Ravine tufa deposits.
- Concerns regarding impacts to the Devonian fossil beds on Lobs Hole Ravine Road.
- Concerns regarding impacts to the Yarrangobilly Caves. In particular the potential for impacts to water to adversely impact the Yarrangobilly Caves.
- Concerns regarding impacts to geological features generally.

a General geodiversity impacts

A comprehensive assessment of geodiversity was undertaken as part of the Main Works EIS. Two specialist geodiversity assessment were prepared that assessed the impacts of the Main Works to Palaeozoic and Cenozoic geodiversity features. The geodiversity assessments found that while there will be some impacts to geodiversity features, that with careful design and management, the proposed works can effectively minimise those impacts. The geodiversity assessments also identified several opportunities for the project to enhance the geotourism potential of geodiversity sites likely to be impacted by the Main Works as well as other sites in the north of KNP which present opportunities for the project to add value to the geotourism potential of the KNP.

b Block streams, tufa and Devonian fossil beds

As identified in the submissions received one of the key impacts to geodiversity is associated with the road upgrades to Lobs Hole Ravine Road. The road upgrades on Lobs Hole Ravine Road will impact on three known

geodiversity features; the Ravine block streams, the Ravine tufa and the Devonian fossil beds. The proposed road widening is expected to have some impacts on theses geodiversity features.

The proposed road widening works will be refined through the detailed design process to minimise impacts to the Ravine block streams and Devonian fossil beds. A key consideration in finalising the design will be to minimise the removal or permanent covering of these features. Where permanent covering is required for geotechnical stability and road safety construction methods with low visual impacts will be selected where practical.

While the proposed works will impact the visible geodiversity features, they will remain largely intact. Post construction, the access road works adjacent to the block streams and Devonian fossil beds will provide an opportunity to enhance the geotourism potential of these features with the establishment of educational interpretive signage.

The road upgrades will not impact any of the high value cliff edge tufa within Cave Gully or Lick Hole Gully. Similarly, vibration impacts to tufa deposits outside the existing roadway are expected to be negligible. Three small tufa outcrops within the existing Lobs Hole Ravine Road corridor will be directly impacted by the proposed road upgrades. These impacts are considered to be minor relative to the remaining areas of high value tufa in the vicinity.

Overall, with careful design the proposed works will avoid significant impacts and enhance the geotourism potential of geodiversity sites on Lobs Hole Ravine Road

c Yarrangobilly Caves

The potential for the Main Works to cause adverse hydrological impacts to the Yarrangobilly Caves was investigated through the groundwater assessment undertaken as part of the EIS.

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

The groundwater modelling predicted that a 0.5 m drawdown contour will remain several kilometres away from the Yarrangobilly Caves. The groundwater model therefore demonstrates that there are no predicted impacts to the Yarrangobilly Caves as a result of Snowy 2.0 Main Works. Further information on the groundwater assessment completed for the Main Works EIS is provided in Section 6.2.4 of the Main Works EIS.

iii Landforms within KNP

Some submissions argued that the proposed works would result in inappropriate landforms within the KNP. In particular these submissions objected to changes to landforms within KNP due to proposed cut and fill earthworks for road construction and site establishment as well as permanent on-land placement of excavated rock.

As previously mentioned in Section 1.3.2 above, Snowy Hydro has investigated a potential alternative excavated rock placement location and activities in response to requests from key government agencies (DPIE, EPA, NPWS). If pursued, it is expected this option will lead to improved water quality outcomes compared to the excavated rock placement proposal described in the Main Works EIS. Further details on the revised design methodology can be seen in Section 3.2.2.

4.4.5 Heritage

Comments raised in submissions regarding heritage referred to:

- sustainable energy values clashing with the NSW government's obligations to manage, protect and conserve the National heritage values of Australian Alps;
- engagement with Aboriginal groups both for the purpose of understanding Aboriginal history as well as views for water management;
- adequacy of the heritage assessment raised by Heritage Council of NSW including:
  - the historic heritage impact assessment includes consideration of heritage items that are not linked to historical research undertaken as part of the assessment, and some inconsistency identified in consideration of assessment guidelines;
  - the Aboriginal cultural heritage assessment does not adequately consider the proposed impacts to identified and potential additional Aboriginal artefacts within the development footprint, nor address cumulative impacts of the proposal in consideration of other similar landscapes and environmental contexts; and
- support for and further recommendations relating to archaeological management.

i National heritage values

Section 6.6 of the Main Works EIS provided an assessment of the project's impacts against the MNES criteria. Although some impacts to MNES have been identified, the proposed impacts are within a manageable framework and result in only limited impact on official values. Suitable mitigation and management will be implemented to further minimise these impacts.

ii Engagement with Aboriginal groups

Two submissions raised matters relating engagement with Aboriginal groups regarding the Snowy 2.0 Project. One submission was from the Office of the Commissioner for Sustainability and Environment and Environment and the other from a member of the public.

The following issues are addressed below.

Aboriginal history: the mountains are the setting for ancient ceremonies and meetings. What account has been taken of Aboriginal sensitivities in the Mountains; has there been any consultation with appropriate custodians and peoples from surrounding lands? Aboriginal wisdom must be integrated into any proposals for this special area should the scheme proceed

The ACHA was undertaken in accordance with the process of Aboriginal community consultation in the OEH *Aboriginal cultural heritage consultation requirements for proponents 2010* (NSW DECCW 2010). This process was documented in Section 6.7 of the Main Works EIS. This includes regular and ongoing consultation with the Aboriginal community including the five registered Aboriginal parties (RAPs) for the project and five additional groups that expressed interest in the project. Through the Aboriginal cultural heritage consultation process undertaken to date no issues regarding water were identified.

iii Adequacy of the heritage assessment(s)

The Heritage Council of NSW submission included commentary on the structure and content of the Historical Heritage Assessment and Statement of Heritage Impact (HHA&SoHI), along with management recommendations for historical heritage. These identified issues and recommendations have been extracted from the Heritage Council of NSW submission and responded to below.

The way the HHA has been structured emphasises already known heritage items in existing registers with heritage significance (as a local or state level). There are tables which list these and while they identify relevant associated historic themes, they do not link to historical research discussed in earlier chapters. Section 8 discusses significance for each of the survey areas discussed. It also identifies where the Exploratory or Early works package has impacted significant sites and those have been subject to archaeological investigation.

The detailed historical research presented in the HHA & SoHi report has aimed to provide context for the myriad of previously unrecorded heritage items located during the field surveys - particularly as the impacts are highest at these sites, not at the previously listed items. As noted on page 154 of the Historic report, the historical sites recorded during Exploratory Works at Ravine Lobs Hole are summarised briefly in Table 15 only as detailed descriptions and historical references for these are provided in Dibden 2018b Appendix 3. The recommendations relating to interpretation plans and additional research as part of mitigation will also address this issue for all of the sites where impacts will occur. It is noted that the majority of historic sites recorded are not currently in proposed impact areas. No sites of previously listed state significance are in impact areas. Few sites of previously listed local significance are in impact areas. Those sites of local significance in Lobs Hole Ravine are currently subject to an extensive salvage project relating to Exploratory Works which will be detailed along with the relevant historic referencing in the report currently being compiled.

The results of the Early Works for the Snowy Package were not supplied to the Heritage Council of NSW to assist our assessment. The reports should be provided for inclusion in the Heritage Council of NSW library.

It is assumed that this statement is referring to the Exploratory Works archaeological salvage and archival recording program. Although the Exploratory Works salvage fieldwork has been completed, the reporting phase is yet to be completed.

The conditions of approval for Exploratory Works state that associated reporting is required to be submitted within one year of the salvage program (unless the Planning Secretary Agrees otherwise).

Snowy Hydro will consult with DPIE around the timing and nature of salvage works reporting as it may be more comprehensive to present the archaeological findings of the combined Exploratory Works and Main Works salvage activities to aid overall analysis and interpretation. Snowy Hydro will provide archaeological salvage and archival reporting to the Heritage Council of NSW once completed.

The Overview of Significant rankings for items e.g. Table 66 for Lobs Hole Ravine, provides an 'archaeological ranking' which appears to confuse the significance of the item and its archaeological potential (likelihood to survive) and it is unclear why the ranking was included. The 'ranking assessment may have confused the requirements for assessing significance in NSW as explained in the 2008 Heritage Council of NSW guideline 'Level of Heritage Significance'. Nevertheless, the HHA has attempted to relate the findings of the survey with a significance assessment, although without detailed site-specific research underpinning each in the document. This is summarised in the Significance Tables in Section 8, with a concluding statement for each of local or state significance, which is consistent with Heritage Council assessment processes.

It is acknowledged that this approach is atypical, but it was developed as a proactive response to the challenges surrounding assessing significance at archaeological sites. The strategy behind including the archaeological ranking was to provide a means of systematically tackling the archaeological research potential at each item. This was considered a critical component given that decisions regarding mitigation strategies (e.g. test/salvage excavation) need to address the issue of whether or not subsurface deposits may be present, how intact those deposits may be, and whether or not those deposits have potential to also contribute to heritage values against other significance criteria. Rather than confusing the requirements for assessing significance in NSW, the archaeological ranking was a deliberate effort to proactively address the complexities of the significance assessment for the sites that are present across the project area, through inclusion of an additional level of assessment. While it may be that the inclusion of this ranking complicates the significance assessment process, it is also hoped that it demonstrates the complexities that exist with assessing the significance of the suite of sites that are present.

iv Archaeological management

Heritage Council of NSW recommend that:

a) The Applicant shall nominate a suitably qualified and experienced historical archaeologist to manage the historical archaeological program according the following conditions. This person must fulfil the Heritage Council's Excavation Director Criteria for the excavation of locally significant archaeological sites.

b) Archaeological Research Design and Excavation Methodology shall be prepared to guide the archaeological program and prepared according to Heritage Council of NSW guidelines. This document shall be submitted for comments to the Heritage Council of NSW prior to approval by the Department of Planning, Industry and Environment (DPIE).

c) A Final archaeological excavation report shall be prepared within 12 months of the completion of archaeological works. It should include details of any significant artefacts recovered, where they are located and details of their ongoing conservation and protection in perpetuity by the land owner. Copies of the final excavation report shall be provided to the Department of Planning, Industry and Environment (DPIE), the Heritage Council of NSW and to the relevant Council's local studies unit.

Snowy Hydro are committed to complying with Heritage Council of NSW recommendations to prepare an Archaeological Research Design and Excavation Methodology for the Main Works. In relation to recommendation c), Snowy Hydro will consult with DPIE around the timing and nature of salvage works reporting as it may be more comprehensive to present the archaeological findings as a combined Exploratory Works and Main Works salvage activities to aid overall analysis and interpretation.

Heritage Council of NSW recommend that:

As a project commitment, it may be appropriate to include a further condition to ensure there are appropriate protection mechanisms in place during works to identify, protect and avoid the R20 (Washington Hotel) and R118 (Ravine Cemetery) during works.

The HHA & SoHI specified that no-go fencing will apply to R118 and R20 and a minimum construction buffer of 20 m applied to R20.Specific details of protective measures for R20 and R118 will be developed during the preparation of the Main Works historic heritage management plan.

Heritage Council of NSW recommend that:

It is appropriate to point out that designated survey marks, including trigonometrical markers are likely still directly linked into the NSW Cadastre and cannot be simply removed without appropriate replacement. Further liaison with the Surveyor General may be required to determine whether additional management under Surveying and Spatial Information Act 2002 is required, separate to heritage requirements.

Snowy Hydro will consult with the Surveyor General to determine appropriate approval and management pathways for the removal of trigonometrical markers adjacent to existing roadways impacted by the Main Works project.

4.4.6 Transport

Comments raised in submissions were made regarding impacts to:

- Traffic movements, including:
  - SMRC does not support route option 'Cooma Option 2' due to additional disruption to residential and business areas, and on-street parking
  - Need to consider cumulative impacts associated with the TransGrid project
- Public safety, including:
  - Impacts of construction traffic on cycling routes along the Snowy Mountains and Monaro Highways, including increased risk of vehicle/cyclist incidents
  - Increased potential for vehicle accidents resulting from increased traffic volume/trucks
  - Adequacy of mitigation measures, including consideration of speed reductions through Adaminaby; provision of permanent stock crossing signage; and specific measures to improve safety during peak (winter) periods, which coincide with snow/ice conditions
- Road upgrade and maintenance, including:
  - Timing of upgrades, ie prior to expected peak traffic movements
  - Consideration of alternatives for upgrades in Sharp Street
  - Opportunity for utilisation of (upgraded) Bobeyan Road as a transport route for DIDO or FIFO employees
  - Requirement for agreement on defects and rectification regime, including frequency of assessment and repair of the impacted road network

i Construction traffic

a Reduction in reported project traffic movements

A clarification of the predicted construction traffic volumes for the Main Works as reported in the Main Works EIS and associated traffic and transport assessment (TTA) has identified a significant reduction in the previously reported construction traffic volumes. The change was the result of how the data provided by FGJV was interpreted with respect to the definition of 'traffic movements'. Accordingly, predicted project-related traffic volumes are now half those reported in the Main Works and Segment Factory EISs. It was these higher numbers that were used to determine Main Works impacts in the Main Works EIS and supporting TTA.

The corrected number of heavy vehicle movements for both the Main Works and segment factory projects peak at 410 (205 movements in each direction) per day for several months in 2022 through Cooma, with an average of 208 heavy vehicle movements per day at this location for the duration of the construction of Snowy 2.0.

The assessment of impacts of the Main Works were based on the higher numbers that are double those now proposed.

The corrected, predicted average and peak daily light and heavy vehicle movements during the construction of the Main Works are presented in more detail in Chapter 3 and in full at Appendix J Snowy 2.0 Main Works - Traffic and Transport Assessment.

It is also possible that there will be a further major reduction in heavy vehicle volumes on the network between the Main Works and segment factory proposed for a site at Polo Flat. FGJV is in the process of applying to use a new Performance-Based Standards (PBS) vehicle (an articulated triple-trailer) to transport pre-cast concrete tunnel segments from the segment factory at Polo Flat to the various construction sites for Snowy 2.0. These vehicles comprise three articulated trailers with the ability to carry three times the number of segments as the 19m semi-trailer that was used as the design vehicle in the Main Works and Segment Factory EISs.

While the use of the PBS vehicles, in place of the 19m semi-trailer vehicles for the transport of pre-cast concrete segments, will result in a significant reduction in heavy vehicle numbers, including through the town of Cooma,

other advantages of the PBS configuration include reduced axle load, greater manoeuvrability (shorter trailer length) and increased safety (as a result of fewer trips).

A decision has yet to be finalized on the use of the PBS vehicles for the project. The design of the PBS vehicles is currently under assessment by the National Heavy Vehicle Regulator. It is anticipated that a decision on the use of these vehicles will be made in quarter 1 2020. If approved, FGJV anticipate that the PBS vehicles would transport all segments between the Polo Flat site and the construction sites.

Further details of the PBS vehicle and revised project traffic numbers, with and without the adoption of the PBS vehicles, are provided in Chapter 3.

b Cumulative traffic impacts

As discussed in Section 4.1.5 of this report, the TTA undertaken in the preparation of the EIS considered traffic volumes associated with the Transmission Connection Project being carried out by TransGrid. Estimated traffic volumes associated with the construction of the Transmission Connection Project was provided by TransGrid and considered within the Main Works and Segment Factory EISs. In terms of the potential impacts of these vehicles on the road network and construction schedule proposed for Snowy 2.0, the contribution of traffic from the Transmission Connection Project was minimal.

c The use of "Cooma Option 2" route

During the assessment process, alternatives to the main traffic routes (as shown in the Main Works and Segment Factory EISs) were identified and tested to ensure that the best traffic routes (principally the route between the Main Works and the proposed segment factory at Polo Flat) were selected.

Early in the design and assessment process, it was determined that the use of Bombala Street (between Sharp Street and Saleyards Road) by heavy vehicles should be avoided. This means that project traffic travelling between the Main Works sites and the proposed segment factory at Polo Flat will use Sharp Street, through the centre of Cooma.

During the design and assessment process, several alternative routes to Sharp Street were identified, considered and all but one rejected.

The only alternative route that remains "on the table" is the route to the north of Cooma that includes Yallakool, Mittagang, Shannons Flat and Bobeyan roads. Details of this alternative are provided in the Segment Factory EIS. The use of this route would reduce impacts on the Monaro and Snowy Mountains highways and on Sharp Street in Cooma, including during peak holiday periods. However, it should be noted that the use of this or other alternative transport routes does not form part of the project.

d Road and intersection upgrades

Recommendations for the locations and extent of road and intersection upgrades were provided in the TTA that accompanied the Main Works and Segment Factory EISs. Further recommendations were set out in the road safety audit (RSA) (see further discussion on the RSA below).

Since the public exhibition period, further details can be made available on the proposed external road and intersection upgrades. Snowy Hydro has been working with TfNSW in relation to proposed road upgrades required for the Snowy 2.0 project. Location and extent of road and intersection upgrades required for the project is based on the outcomes of the TTA and RSA.

Additional information on proposed roadworks is detailed in Chapter 3. Agreed upgrades are contained at:

- Table 3.5 that summarises the upgrades to the external road network that will be undertaken by Snowy Hydro; and

- Table 3.6 that sets out the intersection upgrades to be undertaken by TfNSW.

It should be noted that consultation between agencies and the project are on-going. Further discussion on traffic and transport matters may result in the identification of additional issues and the need for additional works to those set out in this report.

The identification of additional works includes the outcomes of the RSA which covered the extent of the haul route between the segment factory proposed for a site at Polo Flat and the construction sites within KNP. Further investigations and further discussions are required with road authorities to determine the audit outcomes that should be undertaken as part of this project.

ii Road safety

a Public safety and construction traffic

The safety impacts of project traffic will be managed throughout the life of the project. Management measures for public safety, such as a drivers' code of conduct will be developed and included in a traffic management plan. Snowy Hydro and FGJV would work with relevant road authorities (SMRC and TfNSW) to agree and implement these strategies during the construction of the Main Works.

Road safety was included in the TTA undertaken in support of the Main Works. The TTA addressed the impacts of the project on the capacity, condition, safety and efficiency of the local, national park and State road networks in accordance with the SEARs.

A road safety audit was also undertaken of the primary transport route between the site of the proposed segment factory and the Main Works sites within KNP. Snowy Hydro is working with TfNSW to address the findings of the road safety audit.

Road safety related recommendations in the TTA and RSA included:

- proposed intersection upgrades and roadworks;
- a review of sign-posted speed limits;
- the use of traffic controllers, driver warning signs and variable messaging signs;
- the use of traffic management plans and traffic control plans associated with traffic works or events such as scheduled Over Size or Over Mass movements; and
- the use of web notifications, public notices and other forms of communication.

In addition, a Snowy 2.0 communications working group has been established. The focus of the group includes coordinating effective and broad-reaching communications around Snowy Mountains road safety, the effects of increased traffic in the region and roadworks (either scheduled upgrades or works occurring as a result of Snowy 2.0). Further information on the group is provided in Chapter 3.

The group includes representation from Snowy Hydro, FGJV, TfNSW, local governments (SMRC and Snowy Valleys Council), the NSW Police, National Parks and Wildlife Service, Destination NSW and DPIE, and provides the opportunity to ensure that important information about Snowy 2.0 is disseminated as appropriate.

Tools at their disposal include videos, variable message signs, other signage, works notifications, print and electronic newsletters, written materials, radio advertising. Channels include traditional and social media, websites, apps such as Live Traffic, stakeholder networks, Snowy Mountains region business networks and community information sessions.

b Impacts of construction on cycling routes

On and off-road cycling is encouraged as a summer sport and recreational activity across the region. The sport of cycling, cycling facilities and events are actively promoted by Snowy Monaro and Snowy Valleys councils, tourist and recreation organisations and businesses.

While the TTA includes reference to the network of off-road, dedicated walking-cycle facilities in Cooma and the increasing popularity of mountain biking at locations throughout the national park, the use of these facilities are unlikely to be impacted by the increase in project traffic required during the construction of Snowy 2.0.

There are also major sporting events that occur across the region. These include L'Etape Australia that takes place in early summer and a cluster of road-cycling, mountain bike and triathlon events that occur in late summer and early autumn. While there may be no direct impacts as a result of these events, there is the potential for increased numbers of recreational road cyclists in the region during the summer months and in the weeks around these events.

These cyclists are likely to use road-based cycling trails that are promoted for the area. These include sections of the Monaro and Snowy Mountains highways, including sections that will be used by project traffic.

As discussed above, road safety has been addressed through the TTA and by an independently prepared RSA. The safety and mitigation measures listed above and as contained in the Main Works EIS and the TTA are intended to provide a safer road environment for all road users.

Further, the Snowy 2.0 communications working group, also described above, provides the means by which potential road safety issues can be promoted to particular user groups, activities or events, providing targeted responses to achieve beneficial road safety outcomes.

c Road safety audit

As detailed in the TTA, an initial assessment of the road network, where construction traffic was anticipated, determined that a road safety review was warranted. Hence an independent third party was engaged to prepare a RSA covering the proposed haulage route that is to be used for the transport of precast concrete segments between the proposed site at Polo Flat and the Snowy 2.0 construction sites. This review was undertaken by Safe Systems Solutions.

The RSA is attached to the TTA in full. The key findings of the RSA (safety items identified with medium or higher level of risks only) are summarised in the traffic and transport assessment.

The RSA has been conducted in accordance with the procedures set out in the Austroads Guide to Road Safety Part 6: Managing Road Safety Audits (2019) and Austroads Guide to Road Safety Part 6A: Implementing Road Safety Audits (2019). Details of the process undertaken and the outcomes as well as the credentials of the audit team are contained within the RSA report contained at Annexure C of the TTA report.

d Management and mitigation of road network

The TTA and RSA provide an assessment of the adequacy of the existing road network for the project traffic predicted for Snowy 2.0.

Predicted traffic and transport impacts were based on estimates of project traffic volumes for the Main Works and segment factory. It was determined that consideration should be given to upgrades to identified intersections, including the roundabouts at the intersections of Sharp Street with Bombala and Vale streets.

In addition, the project will require two new intersections providing access to project worksites (at the Polo Flat and Rock Forest sites).

Elsewhere across the study area, recommendations have been made for mitigation measures to address residual impacts. These measures would be the result of detailed design, with guidelines, principles and management provisions set out in traffic management plans, determined prior to operation.

The RSA undertaken of the haul route between the site of the proposed segment factory at Polo Flat and the construction sites within KNP determined a range of issues that need to be considered in management and mitigation works as a result of the project. Further investigations and further discussions are required with road authorities to determine the audit outcomes that should be undertaken as part of this project.

Further details regarding the proposed road upgrades are provided in Chapter 3 of the PIR-RTS.

As outlined in the mitigation measure TRA04 road maintenance will be managed through the following measures:

- a Road Dilapidation Report to be prepared and approved prior to and following Snowy 2.0 Main Works;
- routine defect identification and rectification of the internal road network to be managed as part of the project maintenance procedure; and
- internal access roads to be designed in accordance with the relevant vehicle loading requirements.

4.4.7 Amenity

Comments raised in submissions relating to amenity included:

- landscape and visual impacts caused by new roads and transmission lines (with 120-metre wide easements), visible from vantage points over thousands of square kilometres;
- overall sense and experience of the aesthetic national park setting will be compromised by construction activities and new infrastructure;
- long term visual impacts at Marica due to the headrace surge shaft and ventilation shaft, and at Tantangara and Talbingo reservoirs due to impacts of exposed surfaces and spoil disposal; and
- comments raised by the EPA and Snowy Monaro Regional Council in relation to the assessment of construction traffic noise and consideration mitigation measures.

i Landscape and visual impacts

The assessment of amenity impacts provided in Section 6.10 of the Main Works EIS assessed both short term (construction) and long term (operation) landscape and visual impacts from a number of vantage points within KNP. The assessment found that visual impacts would be greatest during construction, but as public access will be restricted during construction, these impacts will largely not be experienced.

The introduction of new permanent elements of the Main Works into the landscape will result in a permanent change to the landscape character and visual setting of KNP in the publicly accessible areas of Talbingo Reservoir, Lobs Hole and Tantangara Reservoir. The visual impacts of permanent infrastructure at Marica were found to be moderate to negligible during both construction and operation. The visual analysis found that infrastructure was either unlikely to be visible or likely to be screened by existing vegetation at the viewpoint assessed in the Marica area.

A 120-metre wide easement is planned for new transmission lines proposed as part of the Snowy 2.0 Transmission Connection Project. This project is subject to a separate approval application and subject to separate assessment requirements. As such, assessment of vantage points for this separate project was not carried out as part of the EIS for the Main Works. However, cumulative impacts were considered where the proposed transmission infrastructure will intersect with views of Main Works infrastructure.

It is proposed that all areas not retained for permanent infrastructure will be revegetated and rehabilitated. Activities during (or prior to) construction to enhance rehabilitation will be performed, such as salvaging habitat

resources and native seed collection. Other progressive rehabilitation techniques will be carried out including temporary stabilisation of batters and construction of appropriate erosion and sediment control devices, collection of seeds, sods or cuttings from appropriate plant community types (PCTs) for use in final rehabilitation. An initial Rehabilitation Strategy for Snowy 2.0 Main Works was prepared and was provided in Appendix F of the EIS. This document provides information on the objectives and desired outcomes for rehabilitation activities from Snowy 2.0 Main Works. Further work regarding rehabilitation on new landforms created through excavated rock management is being carried out as part of the request for additional information from the DPIE. This information will be provided separately to DPIE for assessment and determination, as described in DPIEs request for additional information published online (DPIE NSW Planning Portal).

As outlined in Section 4.4.8 below the recreational offset package has been further developed in consultation with NPWS in the period since exhibition and includes measures to enhance the recreational values of areas that have been impacted by the landscape and visual impacts of the Main Works.

ii Overall sense and experience of KNP

The assessment of amenity impacts provided in Section 6.10 of the Main Works EIS concluded that noise and visual impacts would be greatest during construction, but as public access will be restricted during construction, these impacts will largely not be experienced. The assessment also found that the introduction of new permanent elements into the landscape would result in a permanent change to the landscape character and visual setting of KNP in the publicly accessible areas of Talbingo Reservoir, Lobs Hole and Tantangara Reservoir. However, opportunities to provide recreational facilities as part of the permanent rehabilitation of these sites may mitigate the magnitude of predicted impacts during operation.

As outlined in Section 4.4.8 below the recreational offset package has been further developed in consultation with NPWS in the period since exhibition and includes measures to enhance the recreational values of areas that have been impacted by the amenity impacts of the Main Works.

iii Construction noise

a Cumulative impacts

The EPA recommends that DPIE carefully consider the cumulative changes to the acoustic environment and the potential for this to impact on the amenity of the community that live in and around the Snowy 2.0 project areas.

It is acknowledged that road traffic noise levels will change from increased traffic volumes associated with the Main Works and the proposed segment factory. The NVIA has considered combined peak traffic generation from the Snowy 2.0 Main Works and proposed segment factory and hence addressed potential for cumulative traffic noise impacts from both project components.

It is acknowledged that the segment factory is being constructed and operated to support the construction of Snowy 2.0 Main Works. The closest construction components of Main Works are greater than 50 km from the Cooma township therefore, cumulative construction and operational noise impacts are not expected.

b Construction noise impacts at Rock Forest

As outlined in Section 6.10 the NVIA assessed construction noise impacts and found that construction noise levels satisfy noise management levels (NMLs) at all assessment locations with exception of the nearest receiver (R6) at 6560 Snowy Mountains Highway, Adaminaby where exceedance of 11-14 dB is predicted during the day and out of hours periods during calm and adverse weather conditions, respectively. While noise levels at passive recreation areas satisfy the required NML, noise generated by construction would still be perceptible and clearly audible at these locations.

The predicted exceedance of day and night-time criteria at assessment location R6 would be managed during construction. Affected landholders will be consulted prior to and during construction and will be notified of proposed mitigation measures that will be used to manage construction noise levels to below Interim Construction Noise Guideline (EPA 2009) NMLs where practicable.

c Road traffic noise

As discussed in Section 4.4.6, in the period since exhibition further work has been carried out which has refined the traffic volumes assessed in the TTA for the Main Works. Notwithstanding this the proposed traffic volumes required for the Main Works are consistent with the volumes previously assessed in the traffic noise assessment as part of the NVIA.

As demonstrated in the clarification of traffic volumes for the Main Works and the Segment Factory EIS provided in Section 4.4.6, the project's traffic impacts to Cooma township including increased traffic volumes on Polo Flat Road and Monaro Highway/Snowy Mountains Highway (Sharp Street) have been considered and assessed under the application for the Snowy 2.0 Segment Factory subject to SSI-10034. The road traffic noise impacts of Snowy 2.0 have thereby been primarily assessed in the EIS and NVIA prepared for the Segment Factory application.

4.4.8 Social and recreation

Comments raised in submissions relating to social and recreational impacts were focused on:

- impacts to the recreational fishing industry, predominantly associated with introduction of pest species (in particular Redfin) from Talbingo Reservoir to Tantangara and Murrumbidgee River, or impacts on fish populations from spoil placement within Talbingo and Tantangara Dams
- closure of Tantangara Road, including:

  uncertainty on the duration and timing of closure, and the flow on impacts this will have to recreational sites, campgrounds and businesses during closure and any timeframe beyond a nine-month closure period;

  lack of alternative all vehicle access to Currango via Port Phillip Trail;

  lack of collaborative discussion with recreational groups impacted by the road closure;
- impacts to campgrounds: Wares Yard, Rocky Plain, Old Snowy Camp, Currango Homestead (through proposed road closures) as well as amenity impacts (dust, noise, traffic) that will impact desirability of recreational activities/facilities within the area if they remain open. It was queried whether alternative campgrounds will be made available to offset these impacts;
- long term access restrictions to areas of KNP:

  uncertainty on how this will impact maintenance requirements for the heritage mountain huts in the immediate area;

  subsequent impacts to tourism and flow on effects to the local economy (concern for job losses rather than gains);
- impacts to local businesses, noting closure or restricted access to recreational sites will cause a loss of business for commercial operators; and
- potential social impacts on Adaminaby, with concern for house and property prices raised.

i Recreational impacts

a Recreational fishing

It is not certain that a population of redfin or other pest fish will establish in the Tantangara Reservoir catchment and impact recreational fishing, given the operating and environmental conditions. An impact will only eventuate if the following series of events occur:

1. Pest fish occur in the vicinity of and are entrained into, the Talbingo intake;

2. A proportion of these fish survive the effects of extreme pressure, high shear stress and avoid being fatally struck by the turbine blades during transport through the Snowy 2.0 tunnels and station;

3. Sufficient numbers of these fish are transferred and survive such that breeding in Tantangara Reservoir is possible;

4. Conditions in Tantangara Reservoir prove favourable for breeding success leading to population establishment; and

5. The population numbers increase to such an extent over such an area that an adverse effect on the economy, the environment or the community occurs.

If each of the steps in this pathway are realised, there may be impacts to recreationally important trout fishing (noting that redfin is also an important recreational fishing species). Whilst Snowy Hydro acknowledges that some impacts to trout fishing could occur if redfin establish in the reservoir (Main Works EIS, Appendix M.2), SHL have proposed a screening system for the outlets of Tantangara Dam will also protect the recreational fishing values of the Mid-Murrumbidgee River and Lake Eucumbene and connected catchments to the greatest extent practicable. Additionally, offsets are also proposed (see Section 4.5.2) to mitigate potential impacts and ensure the recreational value of Tantangara reservoir is maintained.

With respect to the potential impacts to recreational fishing due to placement of excavated material in both reservoirs, the preferred approach after refinements since the EIS is to only place D&B material below FSL in the reservoirs. Due to the lower suspended sediments potentially being mobilised, this method has improved the expected water quality impacts above the method proposed in the EIS. Additionally, at Tantangara, construction will be undertaken using standard 'dry' earthmoving equipment and techniques with the reservoir being held at lower levels as much as possible. As such, impacts to water quality and aquatic species, including trout, will be minimised which is considered to improve conditions for recreational fishing and improve on what was previously assessed for the EIS.

b Camp grounds

Dust, noise and traffic impacts to Rocky Plain, Old Snowy Camp and Currango campsites are expected to be moderate due to the availability of alternate access and the distance between these camps and active project works. There will be more noticeable amenity impacts to Ware's Yards due to its proximity to Tantangara Rd. Access is expected to be restricted during the upgrades to Tantangara road and then impacts of this reduced through managed access for the duration of the project. However, once the project has been completed, access to all these campsites via Tantangara Road will be improved for the long term. Due to the impacts, opportunities for alternate temporary campsites are being identified in consultation with NPWS

c Long term access to KNP

Access to very specific operational areas around Tantangara, Marica and Talbingo will be restricted in the long term. Otherwise, access to areas within the project footprint will be improved significantly because of Snowy 2.0. In particular long term access to areas services by Tantangara road and Lobs Hole Ravine road will be improved. Some mountain Huts in the immediate area may be easier to access in the long term because of this. The maintenance requirement depends not just on any increased use due to improved access but on the location of the hut in relation to the project and access roads, current condition of the hut and the current / existing usage rates.

ii Closure of Tantangara road

The timing of upgrades and temporary closures of Tantangara road depends on numerous variables, in particular the date of receipt of planning approvals, post approval management plans and subsequent contractor mobilisation. It is currently targeted around mid-2020 and construction will take around 9 months depending on weather. Limited access will be maintained during this period with traffic controls and closures during high risk activities. Access via the Port Philip Trail to Currango is expected to continue under the current arrangements with

NPWS. During construction, the reservoir will be maintained at low water levels as much as possible, and consequently, access to Currango via the Port Phillip track is likely to be better than in years when water levels are covering the existing causeway.

Extensive consultation with local community and recreational users has been undertaken around the use of Tantangara road by the project. This includes sessions with the broader community during the Snowy Mountains Trout Festival, surveys during peak periods (Easter and long weekends) and online materials to target non local users of Tantangara road.

iii Impacts to local business due to loss of recreational assets

The net impact of Snowy 2.0 on the regional economy of the Snowy Monaro Regional and Snowy Valleys LGAs is expected to be positive, with predictions of increased business activity, increased average annual additional wage expenditure by $8 M, and increase employment of local workers through flow-on effects. The only direct loss (or partial loss) of recreational assets will be at Lobs Hole and Ware's Yards. This is not expected to have a measurable impact on local business compared to the expected benefits.

iv Potential social impacts to Adaminaby and housing

Social impacts may arise from both increased demand for housing and services by project contractors or employees that choose to relocate to Adaminaby for the duration of their work contract, as well as indirect employment workforces that will seek to take advantage of ancillary employment opportunities in the locality. The project has worked closely with Council and NSW Agencies to identify ways mitigate the social impacts and prepare frontline services for any increased demands. The project will be building accommodation for 2000 workers across three sites. This is expected to significantly reduce impacts on Adaminaby housing availability and affordability.

v Offsetting recreational impacts

In the period since exhibition, further potential opportunities to offset residual recreational impacts have been identified. Potential options and opportunities for new recreational facilities or upgrading existing recreational facilities that have been identified include:

- improving access to Lobs Hole Ravine and Tantangara Reservoir;
- upgrade facilities at the horse riding camps;
- upgrade of recreational facilities at Tantangara Reservoir and Lobs Hole including improvements for day visitors, campers, fishers, horse riders, bike riders and other recreational users;
- provision for supporting the establishment of Geotrails around Lobs Hole and Tantangara Reservoir; and
- protection of historic sites and interpretation of stories relating to these sites.

As committed by mitigation measure REC01, a recreational plan will be prepared for sites impacts by the project and will:

- be prepared in consultation with NPWS;
- detail recreational offsets to be provided by the project; and
- describe measures to be implemented to minimise impacts during construction, including a process for advance communication to stakeholders and visitors when closures are expected.

4.4.9 Economic benefits

Some submissions supported the economic benefits of the project. Other submissions raised concerns about the expressed economic benefits, including:

- the need for a sufficient cost-benefit analysis, taking into account environmental losses; and
- the need to more clearly demonstrate the economic benefits to the community.

As required by the SEARs an assessment of the economic impacts of the project on the locality and NSW was provided in the Main Works EIS. The environmental impacts of the Main Works have also been assessed in accordance with the SEARs and suitable mitigation and management measures identified.

As set out in Chapter 6.14 of the Snowy 2.0 Main Works EIS, Gillespie Economics Pty Limited (Gillespie Economics) was engaged by Snowy Hydro to assess the economic impact of the project on the local economy (Snowy Monaro Regional and Snowy Valleys LGAs), the NEM, and the NSW and Australian economies.

Gillespie Economics concluded that the project is expected to increase all three economic indicators modelled - gross state product (GSP), gross state income (GSI), and employment - across all NEM state economies:

- GSP is expected to increase by $2,692 M in the NSW/ACT region and by $4,176 M in aggregate across all NEM states (in net present value terms);
- GSI is expected to increase by $1,608 M in the NSW/ACT region and by $2,982 M in aggregate across all NEM states (in net present value terms); and
- employment is expected to rise in the NSW/ACT region during construction, peaking in 2021/22.

The local economy is also expected to benefit from the project, driven primarily by expenditure of wages by labour and, to a lesser extent, by non-labour expenditure. It is estimated that annual wage expenditure in the regional economy will increase by $8 M on average across the period to 2026, resulting in increased regional output, value-added, and income. Local employment is also expected to increase.

Snowy Hydro is an economic driver for the regional communities across the mountains and one of the biggest employers. Snowy Hydro's positive local economic and social contribution will be significantly boosted by Snowy 2.0. Sadly, given the devastating impacts of the bushfires on the landscape and the flow on impacts to economic sectors such as tourism the need for the economic boost from Snowy 2.0 is more critical than ever.

On a practical level hundreds of millions of dollars will flow through the regional economies of the mountains as a direct result of Snowy 2.0. Local supplies of project materials, the provision of goods and services and the use of local accommodation and hospitality sectors to name a few. To date tens of million of dollars have been spent locally with more than 100 local businesses and there are many more opportunities for local businesses over the life of the project. Snowy Hydro has already received feedback from business working on the Exploratory Works Program that they are hiring additional staff, lengthening business opening hours due to increased trade, have significantly increased revenue projects and are investing in new machinery and equipment off the back of the revenue certainty provided by their Snowy 2.0 contracts.

Snowy 2.0 will provide direct employment for people across the Snowy Mountains regions which is a significant benefit to the community. It will also provide training and development opportunities for young people starting out in their careers or those who may wish to retrain, the training and the skills developed stay with the workforce in the region providing lasting positive impacts.

i Snowy 2.0's role in minimising consumer electricity prices

As discussed in Section 4.1.1, Snowy 2.0 is required to support the ongoing decarbonisation of the NEM and is part of the solution to the other two components of the policy trilemma: high prices and poor reliability. Snowy 2.0 will contribute to the lowering of consumer electricity prices in the following ways:

- Snowy 2.0 will put downward pressure on future energy prices by supporting low-cost VRE generation and avoiding excessive reliance on (more costly) gas-fired generation plants and batteries (as an alternative storage medium). Figure 4.8 below shows the impact that Snowy 2.0 will have on the composition of the various generation sources within the NEM according to MJA's modelling - Snowy 2.0 enables VRE of approximately 3 GW and backs off growth in batteries and gas plants of approximately 1 GW (in initial years of operation) and 2 GW, respectively (see the MJA Modelling Snowy 2.0 in the NEM report for further information).

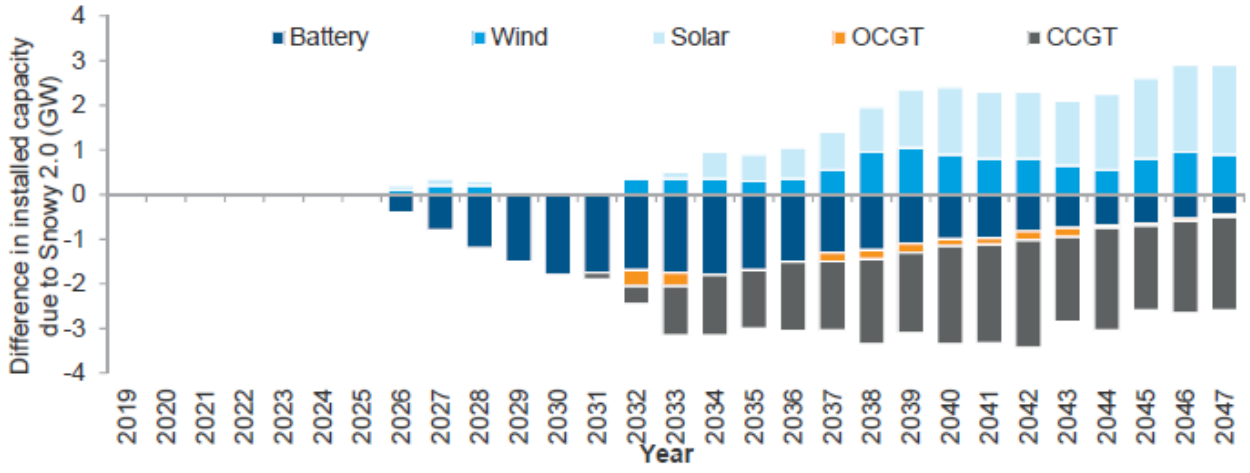

Figure 4.8 Impact of Snowy 2.0 on generation and storage in the NEM (MJA 2018)

- Snowy 2.0 will support further reduction in the cost of VRE. Snowy's pumping capabilities will absorb energy that is produced at times of low system demand and would otherwise be wasted (i.e. excess wind and solar) and use it in a productive way (i.e. to pump water uphill and store it for future periods of peak system demand). This improves the economics of wind and solar producers because it gives them a reliable customer for off-peak energy. This brings down the prices the wind and solar produces need at other times (for their plants to be economic) and therefore lowers the overall cost of energy.

- Snowy 2.0 will add 2,000 MW of capacity. During periods of peak demand, the project will increase supply, reducing customers' (and ultimately consumers') financial exposures to NEM price volatility.

4.4.10 Other matters

Comments raised in submissions concerning other matters included:

- consideration of climate change, referring to:
  exacerbating the effects of climate change by clearing of vegetation proposed by Snowy 2.0;
  the use of fossil fuels used in constructing Snowy 2.0 will result in the project having an unacceptable carbon footprint;
  water availability and reliance on water and river systems already at risk of climate change effects;
- consideration of fire risk and alternative evacuation routes given closure of Port Phillip Trail at times; and
- lack of capacity at local waste facilities should offsite disposal be required (primarily concerning spoil containing asbestos).

i Climate change

Snowy Hydro has reduced the overall amount of clearing required for the project (refer to Section 3.2.1). While there remains a need for permanent clearing to allow for operational infrastructure at the surface, all other areas disturbed during construction will be rehabilitated. Rehabilitation will involve revegetation of disturbed areas commensurate with the surrounding vegetation communities and landscape at each site. Further information regarding the proposed rehabilitation strategy is provided in Section 4.2.5.

Snowy Hydro is a key provider of fast-start, “capacity”-type products, and we keep the lights on at times of high demand. However, Snowy hydro is ‘energy short’ (meaning that they do not generate enough energy from their own power stations to cover all of their customers) so Snowy Hydro purchase energy from the wholesale market.

By the time Snowy 2.0 is built and operational, several NSW coal power stations will have closed and replaced with renewable projects. However, it is recognised that if this does not happen then power to operate Snowy 2.0 would require other forms of energy generation to provide the shortfall in renewable energy supply. The broader challenges in the NEM and government policies with the ability to drive these changes are beyond Snowy Hydro’s control. However, Snowy Hydro has invested in over 888 MW from new wind and solar power projects in NSW and Victoria.

For more than 65 years Snowy Hydro has successfully managed the Scheme through periods of high inflows and very severe droughts. Snowy Hydro constantly monitors inflows and weather forecasts to plan for current and future operations to balance short and long-term energy and water needs.

Pumped hydro and other energy storage technologies are critical in responding to climate change and storing renewables. Snowy 2.0 is able to move water between Talbingo and Tantangara Reservoirs, recycling water for generation. This system minimises reliance on inflows and increases the Scheme’s resilience to drought conditions.

ii Fire risk

The primary emergency access and egress route from Tantangara is Tantangara Road. While no specific secondary egress route was formulated in the EIS, the EIS identified there are a number of access tracks to the east of Tantangara (toward Yaouk) that could provide alternative evacuation routes. Identification of alternative access and egress routes will be carried out as part of the preparation of the Bushfire Emergency Management Plan (Revised mitigation measure HAZ 08).

The secondary access identified for the Marica area involves travelling towards Lobs Hole via Marica Road west once it is established. While it is acknowledged that this secondary access will not be available prior to the establishment of Marica Road west, the proposed Marica accommodation camp is not scheduled to be commissioned until the completion of Marica Road west. Therefore, secondary access to the Marica area will be established prior to the commissioning of the Marica Camp. This is considered to be the primary activity in the Marica area, for which secondary access is required. Secondary access will be provided to Lobs Hole via Lobs Hole Ravine Road north prior to the establishment of Marica Road west.

iii Waste

Snowy Monaro Regional Council noted the nearby waste facilities have limited capacity to accept asbestos waste, should offsite disposal be required for spoil containing asbestos material. Snowy Hydro notes this comment and confirms that the project will place asbestos containing material within the Tantangara adit which will be decommissioned and rehabilitated at the end of construction. This method is preferred to minimise offsite transport of material. It is not anticipated that disposal of this material at other facilities offsite will be required.

Snowy Hydro and FGJV anticipate ongoing consultation with SMRC in relation to any offsite disposal of general waste generated by the project, noting Council's capacity limitations at nearby landfills.

4.5 Avoidance, mitigation and offsetting

Comments raised in submissions queried how impacts have been avoided, mitigated or offset, comments:

- interrogated the offsets package proposed for Snowy 2.0 and queried its management and delivery, in particular:
  - the offset strategy provided with the EIS lacked adequate detail on programs, timing and implementation;
  - Snowy 2.0 offsetting process is not appropriate:
    - Snowy Hydro has not done enough to avoid and minimise impacts;
    - like-for-like offsets to be in place before construction begins;
    - ability for appropriate offsets to be provided, given that all comparable alpine and subalpine areas of NSW are already included in KNP;
    - a single proposed offset payment is demonstrably unreasonable and inequitable for impacts to KNP;
    - call for a trust fund to be established to manage offset monies in perpetuity, with Snowy Hydro making compulsory annual contributions to offset ongoing impacts and monitoring;
  - compensation to be provided in the form of offsets that attain additional restoration of current degradation in KNP including the removal of feral horses and rehabilitation of damage to bogs and fens created by their presence;
  - support for a trout hatchery and stocking program as an offset to transfer of Redfin perch;
  - the offset scheme should contribute to conserving the Macquarie perch and Stocky galaxias species. In the case of the Macquarie perch this includes supporting conservation efforts more broadly across the whole of the species and its range. In terms of the Stocky galaxias work to increase its current range is critically needed;
  - alternative horse camps and camping areas to be provided to offset impact on recreational users and horse riders in the area;
  - offset package to consider funding catchment restoration and maintenance;
- requested governance arrangements and accountabilities to ensure effective construction environmental management; and
- suggested opportunities for scientific research and innovation both in engineering and environmental management.

4.5.1 Avoidance and minimisation of impacts

As described in Section 2.2.2 of the EIS, an iterative and risk-based design and assessment process was adopted in identifying and assessing potential environmental impacts (the DIAA process). This process was undertaken to develop the design and construction methods with the guiding principles of avoiding and minimising environmental impacts where possible and engaging with key stakeholders throughout the process. This process continued beyond the preparation of the EIS, with further design refinements and environmental assessment being undertaken as part of the PIR-RTS. Consistent with the DIAA process, the detailed design continues to be optimised to meet construction requirements while continuing to minimise environmental impacts.

In the period since exhibition further work has been undertaken to avoid and minimise the impacts of the proposed Main Works. A key area where further avoidance and minimisation has been achieved is the reduction of the disturbance area by 62% from 1,680 ha to 640 ha. This is expected to substantially reduce the project's impacts to terrestrial ecology and surface water.

As discussed in Section 4.4.1, revised groundwater modelling was undertaken based on feedback received during the exhibition period. The revised groundwater modelling showed reduced groundwater drawdown and an improvement of outcomes compared to what was predicted in the EIS.

Similarly, refinements have also been made to the predicted traffic volumes which has seen reductions in the predicted project impacts to the external road network. Details of the clarification to traffic volumes is provided in Section 3.2.5.

4.5.2 Offsets

The proposed offset strategy has been further developed since the exhibition period including for biodiversity and recreational offsets.

i Biodiversity

Residual biodiversity impacts from the project will be subject to an offset package which has been developed in consultation with DPIE, BCD and NPWS. The residual impacts to biodiversity have been calculated using the Biodiversity Assessment Method (BAM) calculator to derive both ecosystem and species credits. An overarching principle for the project is to maximise the implementation of biodiversity offsetting activities within the KNP proximate to the project's impacts.

The BAM calculator has been used to inform the nature of the biodiversity offsetting activities to be implemented Following discussions with DPIE, BCD and NPWS, the core components of this offset package are listed below.

- Ecosystem credits – based on the project's indicative disturbance footprint, a liability of ecosystems credits has been estimated for each plant community type.
    - Snowy Hydro will acquit this liability through payment to NPWS to spend on activities to enhance biodiversity values of the KNP.
- Species credits – similarly, a liability of species credits has been estimated for each relevant species.
    - Snowy Hydro will acquit the liability of species credits for individual species which are the equivalent of more than $100,000 using the baseline credit price within the BOPC, through the implementation of Species Action Plans for each of the relevant species.
    - Snowy Hydro will acquit the liability of species credits, which are the equivalent of less than $100,000 using the baseline credit price within the BOPC, through payment to NPWS to spend on activities to enhance biodiversity values of the KNP.
- These actions and commitments will be detailed within the updated BDAR.

ii Recreational opportunities

Information is provided in Section 4.4.8 above regarding recreational offsets.

4.6 Issues beyond the scope of the project

Some comments were raised in submissions that are considered beyond the scope of this current project application (Snowy 2.0 Main Works), they related to:

- History of and NPWS management of KNP especially relating to the management of brumbies; and
- Government incentivisation of solar panel installation.

It is recognised that land management is a key issue for KNP and as such is one of the key areas of focus in offsetting the impacts of Snowy 2.0. The proposed management practices to be carried out by Snowy Hydro was outlined in the EIS and further details on the proposed Offset Strategy is provided at Appendix L of this PIR-RTS. However, the management of brumbies and history of NPWS management is not within the remit of Snowy Hydro or the Snowy 2.0 Main Works application.

Snowy Hydro is supportive of other renewable energy developments and incentives. The incentivisation of solar panel installation by the government is a matter for the Department of Environment and Energy or the NSW Department of Industry (Division of Resources and Energy).

CHAPTER 5

UPDATED EVALUATION AND CONCLUSION

5 Updated evaluation and conclusion

This chapter provides an overall evaluation of the Snowy 2.0 Main Works, with regard to the strategic need for the project and its environmental, social and economic impacts.

5.1 Design development

5.1.1 Principles

Consistent with the principles of ESD, Snowy 2.0 Main Works has been designed to avoid and minimise impacts where possible. These principles were implemented through an iterative approach (known as DIAA), supported by consultation with numerous technical specialists and government agencies. The NPWS, as land manager of KNP, was consulted throughout design development and as part of the preparation of this EIS and this PIR-RTS.

The design process has continued post lodgement of the EIS consistent with the objective to identify and avoid sensitive locations, to minimise the construction footprint and maintain as much of the existing natural environment as is reasonable and feasible. These recent activities have focussed on matters raised in submissions received and through discussions with key stakeholders.

5.1.2 Design challenges

The challenges for the design team included the need to develop solutions that balance the need to preserve and protect the values of the KNP and the environmental constraints of the location, with the need for ensuring a safe working environment for the construction of Snowy 2.0 Main Works, including the safe movement of plant, equipment, materials and personnel across the sites.

As previously stated, Snowy Hydro has appointed a highly experienced contractor (FGJV) for the design and construction of Snowy 2.0 Main Works. The EIS was based on the design provided by FGJV during the tender process, noting that improvements and optimisations to the design have continued since the EIS was prepared.

This process has resulted in considerable refinement of the disturbance area, which has reduced the overall disturbance area by 62% and therefore improved the project outcomes compared to previously predicted impacts in the EIS.

To acknowledge the detailed design not yet being complete (as is normal for a major project at this stage of the process), the new concept of a larger ‘construction envelope’ has been introduced and used in this report. The construction envelope represents the limits of where disturbance may occur during construction of the Main Works. The disturbance area is a smaller indicative corridor inside the construction envelope. As detailed design continues, final siting of the infrastructure (ie the disturbance area) can move within the assessed construction envelope subject to recommended environmental management measures.

The design principles also provide for the rehabilitation of disturbed areas which will be returned to NPWS and the KNP. Snowy Hydro has been working with NPWS since the announcement of Snowy 2.0 in early 2017. Specific consultation with NPWS on Snowy 2.0 Main Works has been to ensure its development and design avoids and minimises impacts to biodiversity, heritage and recreation and considers their long term objectives for land management in KNP.

The DIAA process developed during the design of Exploratory Works has been carried through Snowy 2.0 Main Works. Further refinements (as described in Chapter 3) have been informed and refined by the results of further design work and consultation with key stakeholders, in particular NPWS, EPA and BCD. On this basis, further

avoidance of minimisation of potential significant impacts on biodiversity, heritage, recreation and land use have been realised.

5.1.3 Avoidance and minimisation

Implementation of the DIAA process to optimise the design resulted in some significant environmental improvements and outcomes. Primary design improvements through the EIS and PIR-RTS include:

- Discounting construction of a power station, and associated access adits, beneath the Plateau rather than Marica. This avoided significant direct surface impacts to threatened ecological communities, such as Alpine bogs and fens, and species, such as Alpine she-oak skink.

- Significant reduction in the disturbance footprint for the Marica West track down to Lobs Hole. There were further design improvements in this area through the removal of a construction adit and associated construction area to facilitate these excavations. Together, these improvements have avoided significant impacts to the critically endangered Smoky Mouse.

- Reduction in overall excavated materials due to revised tunnelling layouts and alignments, including removal of adits and relocation of the power station further west minimising the currently approved exploratory tunnel (which would be the MAT if Snowy 2.0 Main Works is approved). This reduced the volumes of materials to be handled and placed within the emplacement areas.

- Removal of some construction areas and requirements from the footprint within KNP by choosing to construct a segment factory at Polo Flat in Cooma (subject to a separate application) which significantly reduced traffic volumes for the construction materials for these segments within KNP, and reduced the amount of land required to be cleared in the park by about 32 ha.

- Establish a logistics yard at Rock Forest, just outside the KNP (rather than within the project area), to store materials and manage traffic when required such as during adverse conditions. This improves Snowy Hydro's ability to manage impacts to the road network and improves road user safety during adverse conditions.

- Reuse 1,400,000 m3 of materials to landform and rehabilitate areas at Lobs Hole disturbed from construction, reducing the footprint volumes and timeframe of the Ravine Bay placement which reduces potential water quality impacts to Talbingo Reservoir.

- Reduction in barge infrastructure resulting in avoidance of areas being disturbed and longer term potential for disruption to the Talbingo community.

- Removal of an option to construct a road east of Tantangara Reservoir to a nearby private property, just outside KNP, to place excavated rock materials rather than in the reservoir. This avoided significant impacts to the critically endangered flora, Clover Glycine.

- Reduction in excavated rock emplacement footprint within the reservoirs to focus on a single location within Talbingo Reservoir and within active (and dry during construction) storage at Tantangara Reservoir. This avoids direct impacts to previously proposed emplacement areas.

- Maintenance of the 50 m buffer around the Yarrangobilly River to protect its values and habitat to the endangered Booroolong Frog.

- Reduction of access road works by some 20 km which avoids further environmental impacts through disturbance activities.

- Removal of the need to augment the existing Essential Energy transmission line for power for power to infrastructure at Tantangara Reservoir. This avoids further environmental impacts through disturbance activities.

- Avoidance of the Ravine cemetery within Lobs Hole which preserves the heritage values of this location.

- Reduced traffic volumes, which has improved the performance of the local and regional road network compared to previously predicted impacts.

- Reduced groundwater flows into the excavated headrace tunnel across the plateau, which has also improved predicted drawdown of shallow aquifers and expressions at surface where there is potential for interactions with existing bogs and fens.

- Avoidance of excavated material fines to be placed within the reservoir which significantly reduces impacts to water quality during emplacement - only drill and blast materials will be placed in reservoir.

- Significant reduction and minimisation in the direct impacts to the reservoir bed from emplacement at Ravine Bay. This has reduced from approximately 21 ha presented in the EIS to 3 ha within the currently proposed footprint within the reservoir.

- Significant minimisation of visual amenity impacts from the emplacement areas due to the incorporation of Geomorphic methodology design principles and techniques. Geomorphic methodology provides for the integration of the landform into the existing landscape.

5.2 Strategic context

Snowy 2.0 is the largest committed renewable energy project in Australia. By expanding the current Snowy Scheme's renewable energy capacity by almost 50%, the NEM will be served with an additional 2,000 MW of on-demand generating capacity and large-scale storage. Changes to the NSW and Australian energy system and market are creating a need for large scale energy storage projects such as Snowy 2.0. As with many electricity markets around the world, the NEM is undergoing a paradigm transformation that has been brought about by significant shifts in energy efficiency, rapidly decreasing costs of wind and solar generation (or VRE), coal power station retirements, increasing coal and gas costs and Australia's participation in global commitments to reduce carbon emissions.

While VRE provide energy during model conditions, the challenge for these sources are they are dependent on weather conditions and during prolonged wind and/or solar droughts when they would not operate. Energy storage helps build power system resilience to weather events by storing surplus renewable generation for use at times when these resources are scarce and allowing more constant operation of less flexible existing generation. This, in turn, creates a more dispatchable and reliable power system, while helping to keep prices down for consumers including by maximising use of existing, low-cost, thermal generation assets. A large pumped hydro system such as Snowy 2.0 (with approximately 350,000 MWh of energy storage) can provide significant energy storage capable of delivering large-scale generation within minutes in times when VRE is not operating.

The key benefits of Snowy 2.0 are summarised as follows:

- Snowy 2.0 makes a significant contribution to the continued decarbonisation of the economy;

- Snowy 2.0 provides large-scale energy storages at the least cost to allow more flexibility to respond to seasonal variability when compared to other VRE and batteries;

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

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

Snowy 2.0 has strong support from the community with consultation identifying the public expect the project will create economic opportunities for the region, improve the reliability of the electricity network, lower energy prices and increase and expand sources of reliable, renewable energy to reduce reliance on fossil fuels which will have an overall benefit to the environment.

The development of Snowy 2.0 is consistent with Commonwealth and NSW strategic planning and policy objectives, including the NSW Renewable Energy Action Plan and the Australian Renewable Energy Target.

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

5.3 Engagement

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

A range of tools and established communication channels continue to be used to support communication and engagement for Snowy 2.0 Main Works. Feedback from the local community, local industry groups and special interest groups on Snowy 2.0 has been mainly positive, with the most recent survey results indicating that matters such as employment, business opportunities, energy reliability, renewable energy and environmental interests are still very important to the community as the project progresses into Snowy 2.0 Main Works.

Engagement with government agencies during the Snowy 2.0 Main Works application has continued to be priority for Snowy Hydro following the exhibition of the EIS. Primary matters raised during these engagement sessions include potential impacts to local water quality during construction, potential impacts on reservoir water quality from the excavated material placement, impacts on native and threatened species, recreational opportunities following construction and traffic impacts across the project.

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

A stakeholder engagement framework has been developed for Snowy 2.0 that provides a structure for the management of stakeholder relations and communication related to the project. The proposed engagement approach is tailored to each stakeholder group, is flexible and will be reviewed regularly following Snowy 2.0 engagement activities. The proposed approach to community engagement if the project is approved, is to focus on providing engagement activities and communication materials that provide up to date project information to those stakeholders likely to be affected during construction. It will also ensure there are opportunities for stakeholders, is particular the community to communicate their concerns with the project.

5.4 Statutory context

Two main approvals are required for Snowy 2.0 Main Works; an approval under the CSSI provisions of the EP&A Act from the NSW Minister for Planning and Public Spaces, and an approval under the EPBC Act from the Commonwealth Minister for the Environment.

The existing Snowy Scheme has been operating successfully in the KNP in accordance with a range of administrative and management arrangements for many years, and similar arrangements would be put in place for Snowy 2.0, if approved.

Snowy Hydro has a number of arrangements with NPWS for the existing Snowy Scheme that have been in place since 2002 when it was corporatized. These arrangements allow Snowy Hydro to occupy and operate the Snowy Scheme within the KNP, and include the Snowy Park Lease, a Roads Maintenance Agreement and the Snowy Management Plan.

Prior to Snowy 2.0 Main Works proceeding, Snowy Hydro would require a new lease for the project from the NSW Minister for the Environment under the NPW Act, and the existing management plans and agreements would need to be updated and revised to incorporate the approved project.

5.5 Long term benefits

As discussed in Section 4.1.1 above, once operational, Snowy 2.0 will provide numerous benefits to the NEM and energy consumers. Snowy 2.0 will provide broad-scale environmental benefits through its long-term provision of low emission energy and by physically firming and financially supporting VRE coming online. Snowy 2.0 will also improve the drought resilience of the Snowy Scheme and the existing Tantangara and Talbingo reservoirs by providing capability to pump water between the two and reuse available inflows. Snowy 2.0 Main Works will also provide numerous long-term benefits to the local region including within the KNP and the community. The project development has identified several opportunities to provide a legacy of environmental, social and economic benefits through the comprehensive environmental impact assessment process and extensive community consultation.

Snowy Hydro has responsibly and carefully operated the Snowy Scheme in the KNP for more than half a century and will continue to act in an environmentally responsible manner throughout the construction and operation of Snowy 2.0. Some of the key long-term benefits that will be provided by the Snowy 2.0 Main Works to the KNP and local region include improved infrastructure and access, enhanced recreational areas, contributions to scientific research within the KNP, provision of biodiversity offsets and creating economic growth in the region.

While there will be some impacts to recreational uses at Lobs Hole and Tantangara, it is proposed to rehabilitate these impacted areas to provide improved recreational facilities in the long term. There is opportunity to improve the social values of KNP by providing improved access and facilities at these locations post construction. Similarly, several geodiversity sites have been identified where the proposed works provide an opportunity to enhance the

geotourism potential of the KNP by providing improved access and educational signage. The rehabilitation and master planning of potential recreational facilities will be determined in consultation with NPWS, to ensure relevant KNP values are maintained. In the long-term improved access infrastructure in KNP and along the project main transport route will provide permanent access infrastructure assets to the community.

The additional scientific research that has been completed for the Snowy 2.0 investigations, EIS and PIR-RTS will constitute a positive contribution to knowledge about the environmental values of the KNP. This includes significant ecological findings (eg larger population of the endangered Smoky Mouse and mapping of more bogs and fens), additional investigations into the geology and hydrogeology of the KNP, geodiversity sites and their public accessibility and interpretation, and increased evidence of Aboriginal and historical occupation of the KNP.

As detailed in Section 6.14 of the Main Works EIS, Snowy 2.0 Main Works will provide economic opportunities for the local region. To date more than 100 local businesses have been part of Snowy 2.0 and more opportunities are expected to follow. The Main Works will provide opportunities for sub-contracting jobs and training associated with the project construction and would provide economic growth to the local region. Community consultation for Snowy 2.0 has shown that the community is highly supportive and expects that Snowy 2.0 will provide lasting benefits for the region. There is also community recognition of the economic benefit that the project has generated with work undertaken since the Feasibility Study.

Snowy Hydro will provide biodiversity offsets for the project impacts to native vegetation, ecological communities and threatened species. Snowy Hydro supports the use of this funding to undertake conservation projects in the local region and recognises the opportunity this provides for improved environmental management within the KNP. It is expected that in consultation with DPIE and NPWS the funding provided for biodiversity offsets for the project will be used to provide lasting environmental benefits for the KNP and NSW.

5.6 Likely or predicted impacts

Potential impacts of the project were comprehensively assessed in the EIS and updates based on project refinements are presented in this PIR-RTS. This section provides a summary of the key predicted impacts from the Snowy 2.0 Main Works inclusive of both the EIS and PIR-RTS.

5.6.1 Broader region

Some of the project's predicted impacts are expected to be experienced at a regional level rather than on a site by site basis. These include economic, social and transport impacts that would have a broad area of influence.

The key social impacts relate to economic benefits, but also some potential negative impacts associated with housing affordability and increased demand for access to community services and infrastructure. Social changes relating to these potential impacts and consult with relevant government agencies to provide a collaborative response if needed, to social impacts.

Construction activities within KNP is expected to have some impacts on recreational users of KNP. On balance these impacts are considered acceptable as management measures have been identified to minimise disruptions to recreational activities, displacement is not expected to occur at high levels and will be to sites with capacity to absorb extra visitors and in the long-term impacts to recreation will be positive through improved access and facilities.

Snowy 2.0 Main Works will deliver substantial economic benefits to the local region, NSW and NEM states, with key drivers being the direct investment to establish the project, wage expenditure, reduced ongoing electricity fuel costs, and reduced electricity costs. The greatest effect will be experienced by the NSW/ACT economies with GSP expected to increase by $2,692 M and additional employment during peak construction.

The aggregated beneficial effect across the remaining NEM participants is predicted to be an increase in GSP of $4,176 M and an increase in employment. The local economies of Snowy Monaro Regional and Snowy Valleys LGAs will also benefit from Snowy 2.0 Main Works, increasing the average annual additional wage expenditure by $8 M, and increasing average annual employment through flow-on effects.

The key traffic and transport impacts include the generation of traffic and suitability of existing intersections within the KNP and in Cooma township. Two new intersections will be established for construction access from the Snowy Mountains Highway (Marica Track and Rock Forest) with potential improvements carried out within Cooma to address existing peak traffic conditions in the winter period to accommodate Snowy 2.0 Main Works traffic. Further engagement with RMS will be carried out to determine appropriate solutions during these peak periods.

Some temporary reductions in speed limits are proposed to ensure intersection sight distance requirements are met at the intersection of Snowy Mountains Highway/Tantangara Road, Snowy Mountains Highway/Rock Forest access and Link Road/Lobs Hole Ravine Road. Construction management protocols will be implemented to manage road maintenance, traffic control and community consultation requirements arising from the project traffic.

5.6.2 Talbingo Reservoir

Likely impacts to Talbingo Reservoir include water quality and aquatic ecology impacts due to the placement of excavated rock at Ravine Bay. There will also be temporary impacts to visual and recreational values. However, these impacts have been significantly reduced through augmentation of the emplacement area and method to provide for these improvements in outcomes. It is proposed that only drill and blast materials (ie large particle size) will be placed within the reservoir and the finer materials placed above the FSL (ie above water) which will manage water quality risks associated with the emplacement activities.

Significant design effort was carried out to explore reasonable and feasible alternatives to the emplacement of excavated materials in order to improve water quality outcomes and minimisation overall impacts to KNP. These alternatives focussed on further reducing volumes and types of material to be emplaced in Talbingo Reservoir. Adoption of these alternative provides an opportunity to reduce and/or remove the water quality impacts within the reservoir by adopting a land based approach for managing fine materials. This iterative process was carried out in consultation with key government agencies, including NPWS, to determine a reasonable and feasible emplacement method and location which balanced the various key environmental and social considerations needed for water quality, biodiversity, heritage, visual amenity and long-term end use within KNP.

During commissioning of the power station's turbines, emplaced material within Ravine Bay is unlikely to be disturbed by generation and pumping flows. Rock armouring placed on the upper slope of the Ravine Bay placement will not be disturbed by these flows and, if the drill and blast material diameter on the lower part of the slope is greater than 8 mm, it is also unlikely to be disturbed. There is potential for existing sediments near the intake to be disturbed by generation and pumping flows. Sediment may also be discharged from the reservoir via the T3 Power Station. The design of the intake channels and the measures set out in the WMP and Commissioning plan would ensure that the potential for sediment mobilisation in the reservoirs and downstream transport of harmful volumes of sediment out of the reservoirs during commissioning and operation is minimised to the greatest extent practicable.

Some direct impacts from construction of the intake and dredging works are expected on some aquatic ecology habitat and species, including Murray crayfish although the total area of disturbance across all activities in the reservoir is estimated to be <1% of the total available Murray crayfish habitat in the reservoir. In-reservoir blast management controls will be implemented to minimise blasting impacts to aquatic fauna. Suitable management measures, such as pre-clearance surveys and translocation, will be implemented to avoid and minimise effects to the Murray crayfish.

The extent of clearing and excavation to facilitate construction will be a significant change to a section of the landscape, changing its visual appearance. As stated above, placement of excavated rock will also result in temporary elevated levels of turbidity in the water in the area surrounding the emplacement area. However, there will be limited public views to these areas for the duration of the emplacement period. Nonetheless, design techniques (ie Geomorphic methodology) have been implemented to create an undulating natural landform consistent with the existing landscape, minimising any impacts to these limited viewing locations.

Upon completion, public access will be reinstated, and views of the landscape will include some permanent infrastructure contrasting to the previously undisturbed natural setting. Revegetation activities will be implemented to improve the infrastructure's integration with the landscape, where possible. There are some likely limitations to some infrastructure components such as the steep batters of the intake where stable revegetation may not be able to successfully establish. In summary, the visual impact during construction is high, but temporary with most construction areas having limited public views.

Snowy 2.0 Main Works will impact on-reservoir recreational users through establishment of exclusion zones around the in-reservoir construction areas as well as the operational intake and will restrict boat access to some areas of the reservoir.

5.6.3 Lobs Hole

Likely impacts to Lobs Hole include stormwater discharges to the Yarrangobilly River from temporary disturbed areas, permanent placement of excavated material, contamination risks, impacts to known geodiversity sites and restricted access to recreational users during construction.

There will be temporary impacts to recreation activities at Lobs Hole as it will be closed for the duration of construction of Snowy 2.0 Main Works. Accordingly, closure from Exploratory Works will be extended for about another six years. The existing use of Lobs Hole as a remote campground within KNP presents opportunities for the project to enhance recreational values within the KNP. Key enhancements to recreation values at Lobs Hole include improving access roads as well as enhancing the geotourism potential of several geodiversity sites. A recreation master plan will be prepared for impacted recreational areas including Lobs Hole.

Approximately 1,400,000 m^3 of surplus material will be used to landform and rehabilitate disturbed areas at Lobs Hole following construction. Snowy Hydro will continue to engage with NPWS regarding the longer term use and design of Lobs Hole for recreational purposes. Detailed design will follow the principles and concepts in the Rehabilitation Strategy to achieve stable non-polluting landforms and recreational areas.

Additional land adjacent to the Main Works accommodation camp will be used to emplace excavated materials from the TBM. This emplacement area has been designed using Geomorphic design principles and techniques. Geomorphic methodology provides for the integration of the landform into the existing landscape. This area will be cleared to allow for the placement of these materials with suitable environmental management measures implemented to avoid and minimise impacts to the surrounding environment where practical.

There is potential for impacts to water quality of the Yarrangobilly River during the initial establishment phases of construction when the greatest area of disturbance and poorest water quality will occur due to surface construction activities. Suitable erosion and sediment controls will be implemented during construction to minimise this risk.

There are some contamination risks in this area associated with disturbance to the existing excavated rock stockpiles at the former Lobs Hole copper mine as well as potential to intercept PAF rock through site excavations for site establishment. Contamination risks will be minimised through further contamination investigations and suitable controls implemented during construction.

The road upgrades on Lobs Hole Ravine Road will directly impact on three known geodiversity features; the Ravine block streams, the Ravine tufa and the Devonian fossil beds. The road works will be further optimised

through the detailed design process to minimise impacts to these geodiversity features. While the proposed works will impact the visible geodiversity features, they will remain largely intact. Post-construction, the access road works adjacent to these geodiversity features provide an opportunity to enhance the geotourism potential of these features through the establishment of educational signage and a suitable stopping area from which to view the features. Snowy Hydro will continue to engage with NPWS regarding these opportunities.

Likely impacts to historical heritage complexes at Lobs Hole include items from the former settlement. Importantly, two prominent heritage features have been avoided, Ravine cemetery and the Washington Hotel.

There will also be some impacts to biodiversity at Lobs Hole with impacts to threatened species including the Smoky Mouse from road upgrades to Lobs Hole Ravine Road. Upgrades to this road are currently being undertaken as part of Exploratory Works. Targeted Smoky Mouse surveys during the design development improved the scientific knowledge of the Smoky Mouse population and distribution in the local area, with records spread over a very large area providing valuable context for the design of an important access road for the project. As such, the population of Smoky Mouse is much larger than previously thought. Notwithstanding, impacts to Smoky Mouse have been minimised where possible whilst ensuring that the project has a safe and reliable access to facilitate the construction and long-term operation of Snowy 2.0.

5.6.4 Marica

As previously mentioned, significant environmental improvements were realised through the DIAA process with the design with surface disturbance greatly reduced. Design processes are continuing to refine the surge shaft infrastructure required for the project, which is described in Section 3.2.

Likely surface impacts in the Marica area include impacts to threatened fauna and their habitat including the Smoky Mouse. Disturbance within this area will be minimised as far as practicable within the construction envelope. However, these impacts will be offset to provide for long-term improvements and conservation outcomes for KNP.

Most construction activities within Marica occur underground through excavation of access tunnels and the cavern. Minimal groundwater impacts are anticipated in Marica due to these activities.

5.6.5 Plateau

Likely impacts to the Plateau area are limited due to the minimal surface infrastructure proposed. Like Marica, impacts at the Plateau area were reduced through the DIAA process.

There will be impacts to about 4 ha of Alpine bogs and fens, and some threatened species including Alpine She-oak skink, Broad-toothed rat and Alpine tree frog, directly affected due to the construction of communications cable. As previously discussed, the route of the communications cable was thoroughly investigated using the DIAA process to avoid and minimise impacts.

Further refinement of the design characteristics for the lining of the power waterway has been processed through the numerical groundwater model. This has significantly reduced the predicted groundwater drawdown along the tunnel alignment with a 50% reduction of potential impacts to Alpine bogs and fens (from 17 ha to 8 ha) expected to experience a drawdown of greater than 0.5 m. This represents 0.1% of the mapped extent of the community in the Snowy Mountains (OEH 2012b) and 0.08% of the 11,100 ha mapped at a national scale (TSSC 2009). Overall, this is considered to be a very low risk to the listed community.

5.6.6 Tantangara Reservoir

Likely construction impacts to Tantangara Reservoir include impacts to visual, recreational and historic heritage values. Snowy Hydro has proposed several management measures to minimise these impacts.

During operations there is potential that pest fish species including Redfin perch, Eastern gambusia and climbing galaxias may be transferred from Talbingo Reservoir to Tantangara Reservoir via the power waterway. If these species reach Tantangara Reservoir, there is potential that they could establish breeding populations in the reservoir, although it is not certain that conditions will be favourable for population establishment. Whether this series of events will occur cannot be known with certainty until Snowy 2.0 becomes operational. Should this risk eventuate in Tantangara Reservoir, there may be impacts to native fish and/or recreationally important salmonids. A key point is that the aquatic environment of Tantangara Reservoir and the catchment upstream (with the exception of the Tantangara Creek headwaters) are dominated by introduced salmonids and there are no known threatened fish species or Endangered Ecological Communities (EEC's) present within Tantangara Reservoir or immediately upstream (Cardno, 2019).

There are however, threatened species known to occur further upstream in the headwaters of Tantangara Creek (Stocky galaxias), downstream in the Mid-Murrumbidgee River below Tantangara Dam (Macquarie Perch, Trout Cod and Murray Cod) and the catchment of Lake Eucumbene forms part of the Snowy River EEC (Cardno, 2019).

Should redfin or other pest fish be transferred and establish within Tantangara Reservoir (noting that it is not certain that this will in fact occur), Snowy Hydro will minimise the potential impact of fish transfer by installing barriers that will seek to avoid the subsequent spread of these fish to other catchments. These secondary controls form part of the Snowy 2.0 Main Works project.

Major impacts to water quality from excavated rock emplacement are not expected due to the excavated rock emplacement being constructed predominantly above the water level in Tantangara Reservoir with suitable erosion and sediment control measures in place. The specifications and locations of these measures will be determined as part of detailed design. In addition, there will be significant minimisation of visual amenity impacts from the emplacement areas from that presented in the EIS due to the incorporation of Geomorphic methodology design principles and techniques. Geomorphic methodology provides for the integration of the landform into the existing landscape.

During commissioning of the turbines, there is potential for the existing reservoir sediments within the intake channel and areas directly offshore and adjacent (mostly to the north) to be disturbed by generation and pumping flows. Through the iteration of the design, Tantangara Reservoir excavated rock emplacement has moved further south but still north of the intake structure. It will not be intersected by generation and pumping flows to any material extent. The design of the intake channels and the measures set out in the WMP and Commissioning plan would ensure that the potential for sediment mobilisation in the reservoirs and downstream transport of harmful volumes of sediment out of the reservoirs during commissioning and operation is minimised to the greatest extent practicable.

Clearing and excavation activities will change the landscape, both temporarily during construction and permanently following completion of the project given public accessibility along the foreshore, the openness of the landscape, and the popularity of the reservoir for recreational boating and fishing activities. Public access will generally be available from parts of Tantangara Reservoir during construction.

Public access using Tantangara Road will be facilitated through the construction period but may be temporarily restricted or require additional safety measures. Disturbed areas will be rehabilitated with Snowy Hydro continuing to engage with NPWS regarding opportunities to allow for future recreational uses and facilities. Exclusion zones around the construction areas and operational intake will be established including some existing recreational areas on Tantangara foreshore within the active storage of the reservoir.

Some minor impacts to historic heritage values are expected with overall impacts to the broader cultural landscape of the Snowy Mountains considered to be low. Importantly a highly significant Aboriginal heritage rock shelter was identified during the project investigations and has been avoided.

5.6.7 Rock Forest

Negligible environmental impacts are anticipated at Rock Forest, with the key matter related to construction noise received at the nearest residential receiver. Noise generating activities are predicted to exceed criteria (day and night) at one residential receiver to the north-east along Snowy Mountains Highway. To minimise emplacement activities at Tantangara Reservoir, excavated material from Marica will now be transported to Rock Forest for emplacement. The emplacement area is within the assessed disturbance footprint.

5.7 Public interest

Snowy 2.0 is the largest committed renewable energy project in Australia. It would provide an additional 2,000 MW of dispatchable generating capacity, and make approximately 350,000 MWh (about 175 hours at full power) of storage available to the NEM at any one time. It will provide more flexibility for the NEM to respond to seasonal variability when compared to other VRE and batteries. Most importantly, Snowy 2.0 will make a significant contribution to the continued decarbonisation of the economy.

Stakeholder engagement clearly indicates that Snowy 2.0 has strong support from the community with consultation identifying the public expect the project will contribute to reliability in the electricity network, lower energy prices, increasing and expanding sources of reliable, renewable energy and minimising reliance on fossil fuels, minimising environmental impacts, increased drought-proofing and providing economic benefits to local communities.

The development of Snowy 2.0 is consistent with Commonwealth and NSW strategic planning and policy objectives, including the NSW Renewable Energy Action Plan and the Australian Renewable Energy Target.

Snowy 2.0 was declared CSSI by the former NSW Minister for Planning under the NSW EP&A Act in March 2018. At the time of the declaration the Minister stated that that Snowy 2.0 was “essential for the future security of our energy system, the economy and the environment.” The declaration signifies the critical role that Snowy 2.0, together with the upgrades to the NSW transmission network, will play in providing reliable energy and large-scale storage to NSW as it transitions to a low emissions economy.

Snowy 2.0 Main Works has been designed to avoid and minimise impacts where possible in accordance with the principles of ESD. These principles were implemented through an iterative approach (known as DIAA), supported by consultation with relevant technical advisors and government agencies. The land manager of KNP, the NPWS, was consulted throughout design development and as part of the preparation of the EIS and PIR-RTS. Throughout the design process, the objective was to identify and avoid sensitive locations, to minimise the construction footprint and maintain as much of the existing natural environment as is reasonable and feasible.

Most impacts from construction are localised and temporary and will generally be experienced for the duration of the six year construction period. These impacts will be managed through the implementation of appropriate environmental controls which will be documented in management plans and publicly reported against for consent and licensing purposes. However, some impacts will be permanent with the introduction of infrastructure into the KNP to operate Snowy 2.0. These permanent impacts will predominantly be changes to the existing natural landscape and its setting, affecting biodiversity, aquatic ecology and recreational users of the disturbed area. To offset these impacts, Snowy Hydro will prepare an offset strategy to deliver actions which provide for long-term improvements and conservation outcomes for KNP.

Snowy 2.0 Main Works will deliver substantial economic benefits to the local region, NSW and NEM states, with key drivers being the direct investment to establish the project, wage expenditure, reduced ongoing electricity fuel costs, and reduced electricity costs. The greatest effect will be experienced by the NSW/ACT economies with GSP expected to increase by $2,692 M. The aggregated beneficial effect across the remaining NEM participants is predicted to be an increase in GSP of $4,176 M. The local economies of Snowy Monaro Regional and Snowy Valleys LGAs will also benefit from Snowy 2.0 Main Works, increasing the average annual additional wage

expenditure by $8 M. Furthermore, after the recent bushfires, Snowy 2.0's economic contribution to the region will be pivotal, as the project is a critical part of the rebuilding efforts across the region.

Snowy Hydro will continue to consult and engage with the stakeholders as the Snowy 2.0 Main Works progresses through the assessment phase, and if approved, through the construction phase. Snowy Hydro will continue to engagement with government agencies, to refine mitigation measures and develop and enhance long-term recreational values for the KNP. The proposed approach to community engagement is to focus on providing engagement activities and communication materials that provide up to date project information to those likely to be affected during construction and also allow the community to communicate their concerns with the project.

Through the implementation of proposed mitigation, management and offsetting measures, the EIS and PIR-RTS demonstrates that Snowy 2.0 Main Works could be undertaken without any significant long term impacts on the local environment. As such, Snowy 2.0 is considered to be in the public interest.

REFERENCES

References

ABC (2019) *Fears brumbies are contributing to blue-green algae in NSW Kosciuszko National Park* https://www.abc.net.au/news/2019-04-01/brumbies-feared-to-be-contributing-to-algae-in-snowy-mountains/10959382

Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council (ANZECC and ARMCANZ) 2000, *Australian and New Zealand guidelines for fresh and marine water quality.*

ALA (2020). https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2904517

Aplin, K, Ford, F & Hiscock, P 2010, Early Holocene human occupation and environment of the southeast Australian Alps: new evidence from the Yarrangobilly Plateau, New South Wales. In S. Haberle, J. Stevenson and M. Prebble (eds). *Altered Ecologies: Fire, Climate and Human Influence on Terrestrial Landscapes*, Terra Australia 32 Canberra: ANU E-Press, 187-212.

Australian Energy Market Operator (AEMO) 2018, *Integrated System Plan*, Australian Energy Market Commission.

Australian Energy Market Operator (AEMO) 2019, *Building power system resilience with pumped hydro energy storage*, July 2019, An Insights paper following the 2019 Integrated System Plan for the National Electricity Market.

Australian Government 2016, *Snowy Mountains Scheme*, Commonwealth of Australia. https://www.environment.gov.au/heritage/places/national/snowy-mountains-scheme

Australia International Council on Monuments and Sites (ICOMOS) 2013a, *Australia ICOMOS Burra Charter,* International Council on Monuments and Sites.

- 2013b, *Understanding and Assessing Cultural Significance. International Council on Monuments and Sites*, International Council on Monuments and Sites.
- 2013c, *The Burra Charter and Archaeological Practice. International Council on Monuments and Sites*, International Council on Monuments and Sites.
- 2017, *Intangible Cultural Heritage and Place. International Council on Monuments and Sites*, International Council on Monuments and Sites.

Barrows, T, Stone, J, Fifield, & Cresswell, R 2001 Late Pleistocene Glaciation of the Kosciuszko Massif, Snowy Mountains, *Australia. Quaternary Research 55*, 179–189. https://doi.org/10.1006/qres.2001.2216

Baumgartner LJ, Boys, CA, Gilligan DM, Silva, LG, Pflugrath B, Ning N (2017). *Fish transfer risk associated with Snowy 2.0 pumped hydro scheme.* Report prepared for Snowy Hydro Ltd by the Institute for Land, Water and Society, Charles Sturt University. 35 pp.

Boot, P 2000, An archaeological assessment of proposed track upgrade, pit toilet construction and camping area construction at Denison, Lake Eucumbene, Kosciuszko National Park. A report to South West Slopes Region, NSW National Parks and Wildlife Service, Tumut.

Brown C and Morgan J (2015) Predator recognition and responses in the endangered Macquarie perch (*Macquarie australasica*). *Marine and Freshwater Research* 66:127-134

Bugosh, N. (2009). *U.S. Patent No. 7,596,418*. Washington, DC: U.S. Patent and Trademark Office.

Cadwallader PL (1996) Overview of the Impacts of Introduced Salmonids on Australian Native Fauna. Australian Nature Conservation Agency, Canberra

Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2018, *Forest Climate Risk. Online data for Maragle State Forest*, prepared by CSIRO, retrieved November 29 2018 www.forestclimaterisk.com.au/map/explorer /theme/heat-fire.

Department of the Environment and Energy (DEE) 2018, *National Greenhouse Accounts Factors*, Department of the Environment and Energy, Canberra.

EMM Pty Limited (EMM) 2018 *Environmental Impact Statement: Exploratory Works for Snowy 2.0*, prepared for Snowy Hydro Limited.

Heritage Council of NSW 1996, *NSW Heritage Manual,* Heritage Council of NSW, Sydney.

Hick P, Whittington R and Becker J (2019) Assessment of the potential for increased distribution of Epizootic haematopoietic necrosis virus (EHNV) associated with Snowy 2.0. Unpublished Client Report for EMM Consulting by Sydney School of Veterinary Science and School of Life and Environmental Science, Faculty of Science, the University of Sydney.

ISSG (2020) http://www.iucngisd.org/gisd/species.php?sc=290#

Knight, T. 2009 *Kiandra Heritage Precinct. Aboriginal Cultural Heritage Study,* prepared for the NSW National Parks and Wildlife Service (Department of Environment and Climate Change), Tumut.

Marsden Jacobs Associates 2018, *NEM outlook and Snowy 2.0*, prepared for Snowy Hydro Limited by Marsden Jacobs Associates.

Murray Darling Basin Commission (MDBC 2007) Fishes of The Murray Darling Basin/Native Species/Trout Cod. https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2203_factsheet_native_trout_cod.pdf

NSW Department of Environment and Climate Change (DECC) 2008, *Kosciuszko National Park Fire Management Strategy 2008–2013*, National Parks and Wildlife Group, Sydney.

NSW Department of Environment and Conservation (DEC) 2006, *Kosciuszko National Park Plan of Management,* NSW Department of Environment and Conservation, Sydney.

NSW Department of Environment Climate Change and Water (DECCW) 2010a, *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales 2010*, NSW Department of Environment, Climate Change and Water.

- 2010b, *Aboriginal cultural heritage consultation requirements for proponents 2010,* NSW Department of Environment, Climate Change and Water.

NSW Department of Planning and Environment (DPE) 2017, *Preparing an Environmental Impact Statement Guideline (Draft)*, Department of Planning and Environment, Sydney.

- 2017, *Social Impact Assessment Guideline for State significant mining, petroleum production and extractive industry development*, Department of Planning and Environment, Sydney.

NSW DPI (2006) Trout cod (*Maccullochella macquariensis*) recovery plan.

- (2008) Threatened Species Management. Threatened Species Guidelines. The Assessment of Significance.

- (2013) Policy and guidelines for fish habitat conservation and management (Update 2013).

NSW Environment Protection Authority (EPA) 2009, *The Interim Construction Noise Guideline*, NSW Environment Protection Authority, Sydney.

- 2014, Waste Classification Guidelines, Part 1: Classifying Waste, NSW Environment Protection Authority, Sydney.

- 2016, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. New South Wales Environment Protection Authority, Sydney.

- 2017, *NSW Noise Policy for Industry*, NSW Environment Protection Authority, Sydney.

NSW Government 2018, *NSW Government Submission on AEMO's Integrated System Plan*, prepared by NSW Government, retrieved June 10 2018 https://www.energy.nsw.gov.au/__data/assets/pdf_file/0006/803751/NSW-Government-Submission-on-Integrated-System-Plan.pdf.

NSW National Parks and Wildlife Services (NPWS) 2006, *Kosciuszko National Park Plan of Management*, NSW National Parks and Wildlife Services.

NSW Office of Environment and Heritage (OEH) 2011, *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW,* NSW Office of Environment and Heritage, Sydney.

- 2017, *Biodiversity Assessment Method (BAM),* NSW Office of Environment and Heritage, Sydney.

NSW Rural Fire Services (NSW RFS) 2018, Planning for Bush Fire Protection. A guide for Councils, planners, fire authorities and developers, NSW Rural Fire Services, Sydney.

Raadik TA (2019) *Tantangara Creek fish barrier design criteria – Snowy 2.0 Project*. Unpublished Client Report for EMM Consulting by Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Snowy Hydro 2017, *Snowy 2.0 Feasibility Study*, prepared by Snowy Hydro Limited, retrieved June 2, https://www.snowyhydro.com.au/our-scheme/snowy20/snowy-2-0-feasibility-study/.

Snowy Mountains Hydro-electric Authority (SMA) 1991 Scheme Augmentation Ranking Study

Theden-Ringl, F 2016, Aboriginal presence in the high country: new dates from the Namadgi Ranges in the Australian Capital Territory. *Australian Archaeology*. 82:1, 25 - 42.

Tindale, N 1974, *Aboriginal Tribes of Australia*, ANU Press, Canberra.

Toy, T. J., & Chuse, W. R. (2005). Topographic reconstruction: a geomorphic approach. *Ecological Engineering*, *24*(1-2), 29-35.

USFWS (2020) https://www.fws.gov/refuge/Yukon_Flats/Elodea.html

Water NSW (2019) What causes algal blooms? https://www.waternsw.com.au/water-quality/algae/what-causes-algal-blooms#stay

Wyborn D, Owen M & Wyborn L 1990. Kosciuszko National Park (1:250,000 scale map).

Zukowski S and Whiterod N (2019) *The status of Murray Crayfish in Talbingo Reservoir, 2019*. Confidential report to EMM Consulting by Aquasave–Nature Glenelg Trust, Goolwa Beach.

GLOSSARY

Glossary

Term	Definition
Accommodation camp	Area used for temporary housing and facilities for construction personnel
Adit	Temporary access tunnel for access to underground construction areas
Ancillary construction facilities	Facilities required to support construction activities such as concrete batching plants, crushing plants, warehouses and laydown, stockpiles
Backfill	Refill an excavated hole with the material dug out of it
Baseflow	The component of streamflow supplied by groundwater discharge. Baseflow is characterised by an exponential decay curve following the cessation of surface runoff.
Bifurcation	Division into two branches
Biodiversity offsets	Management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development (OEH 2017)
Blasting	Rock blasting is the controlled use of explosives and other methods to excavate, break down or remove rock
Blind sink	Excavating a vertical or near-vertical tunnel from the top down, where there is initially no access to the bottom
Boring / shaft boring	Excavating a shaft downwards, usually from the surface
Cable yard	Permanent site for the high voltage transmission connection from the NEM to Snowy 2.0
Capital investment value	All costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment
Communications cable	Fibre optic cable to provide a communications connection
Construction compound	A temporary site used for construction ancillary facilities and laydown
Construction footprint / disturbance area	The area subject to clearing and ground disturbance. The disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design
Contractor	Contractor engaged by Snowy Hydro Limited to construct Snowy 2.0
Detailed design	The phase of the project where the design is refined into drawings, plans, specifications and estimates, suitable for construction
Diffuser	A duct, chamber, or section in which high-velocity flow is converted to low-velocity, high-pressure flow
Drawdown	The lowering of water levels in a surface water or groundwater storage resulting from the loss or take of water from the storage
Drill and blast	The controlled use of explosives to break rock for excavation
ECVT	Emergency egress, cabling and ventilation tunnel
Earthworks	All works involving the loosening, excavating, placing, shaping and compacting of soil or rock
Ecosystem	A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit
Excavated rock	Hard, compacted, or cemented materials that have been removed using blasting or other excavation methods
Exploratory Works	A program of exploratory works for Snowy 2.0, approved by the former NSW Minister for Planning on 7 February 2019 as a separate project application to DPIE (SSI 9208)
Firming capacity	Energy available within the network to respond to demand when other energy sources, such as intermittent renewables are not operating (due to low wind or low sunlight)

Term	Definition
Full supply level	The normal maximum operating water level of a surface water storage when not affected by floods. This water level corresponds to 100% capacity
Gate shaft	A shaft for the gate tower bored at the highest ground along the wet tunnel alignment, approximately 200 m away from the intake mouth
Generating mode	When water flows from Tantangara Reservoir into Talbingo Reservoir, providing on-demand energy generation
Geodiversity	Geodiversity refers to the variety of the geological and physical elements of nature, such as minerals, rocks, soils, fossils and landforms, and active geological and geomorphological processes
Groundwater dependent ecosystem (GDE)	Natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services.
Headrace surge shaft	A shaft structure constructed from the surface and breaking through to the headrace tunnel, most likely using a blind sink method
Headrace tunnel	The upstream tunnel between Tantangara Reservoir and the underground power station
Hydro-electric	Generation of electricity using flowing water (typically from a reservoir held behind a dam or barrage) to drive a turbine which powers a generator
Intake gate	A gate installed at the entrance of the headrace or tailrace tunnels to allow/stop water from entering the tunnels
Karst	Karst is a distinctive topography in which the landscape is largely shaped by the dissolution of carbonate bedrocks (usually limestone, dolomite, or marble)
Kosciuszko National Park	A National Park protected under the NSW *National Parks and Wildlife Act 1974* and managed by NSW National Parks and Wildlife Service. It covers an area of 673,543 hectares and forms part of Australia's only Alpine area
Laydown area	An area for laydown and maintenance of construction plant, equipment and materials storage
Lobs Hole	A remote campsite and former settlement location within Kosciuszko National Park
Lobs Hole camp	Main Works accommodation camp at Lobs Hole
Lobs Hole Road	The road at Lobs Hole, not the main access down to Lobs Hole
Lobs Hole Ravine Road	The main access road to Lobs Hole
Lower Lobs Hole Ravine Road	The section of Lobs Hole Ravine Road from Link Road to where it crosses the transmission easement
Marica camp	Main Works accommodation camp at Marica
Marica West Track	New access road proposed from the MAT to Marica, above the proposed power station location
Marica Trail	Access road to Marica from the Snowy Mountains Highway
Mine Trail Road	The access road from the intersection with Lower Lobs Hole Ravine Road and the MAT
Minimum operating level	The lowest level to which a reservoir can be drawn down under normal operating conditions and is the lower limit of active storage
National Electricity Market (NEM)	The wholesale exchange of electricity operated by AEMO under the National Electricity Rules (NER). It is the wholesale market for the supply of electricity in all states of Australia except Western Australia and the Northern Territory.
Open cut	Method of excavating a trench from the surface and building the structure within the trench
Portal	Location of surface connection with underground access tunnels
Power station	The 2,000MW underground pumped hydro-electric power station proposed for Snowy 2.0
Project area	The area required to access and build project infrastructure, including surface and tunnel components of the project

Term	Definition
Reference design	Design for Snowy 2.0 prepared by SMEC on behalf of Snowy Hydro, for the purpose of specifying Snowy Hydro's functional and performance requirements for tenders for the detailed design and construction of Snowy 2.0
Residual impact	Those effects that remain following the application of mitigation measures to reduce adverse impacts from the project
Riparian	An area or zone within or along the banks of a stream or adjacent to a watercourse or wetland; relating to a riverbank and its environment, particularly to the vegetation.
Snowy 2.0	A pumped hydro-electric expansion of the Snowy Scheme that will link the two existing reservoirs of Tantangara and Talbingo through underground tunnels, and include a new underground power station with pumping capabilities
Snowy 2.0 Transmission Connection Project	Project proposed by TransGrid to connect Snowy 2.0 with the existing high voltage transmission network subject to a separate application
Storage mode	When water is pumped out of Talbingo Reservoir to Tantangara Reservoir, to provide large-scale energy storage
Streamflow	The flow of water in streams, rivers and other channels
Subaqueous	Existing, formed, or taking place under water
Surface water	Water that flows over or is stored on the surface of the earth that includes: (a) water in a watercourse, lake or wetland and (b) any water flowing over or lying on land: (i) after having precipitated naturally or (ii) after having risen to the surface naturally from underground
Surge shaft	A hydraulic structure designed to control pressure and flow fluctuations in the tunnel
Tailrace surge tank	An underground shaft structure off the tailrace tunnel west of the power station complex at the start of the tailrace tunnel
Tailrace tunnel	The downstream tunnel between the underground power station and Talbingo Reservoir
Talbingo intake	Water intake structure to be constructed at Talbingo Reservoir
Talbingo rock emplacement area	Location for permanent rock emplacement within Talbingo Reservoir
Tantangara camp	Main Works accommodation camp at Tantangara
Tantangara rock emplacement area	Location for permanent rock emplacement within Tantangara Reservoir
Transformer	An electromagnetic device used to change the velocity of ac electricity
Transmission	The conveyance of electric energy
Trashrack	A rack or screen of parallel bars installed to prevent debris from entering the turbine
Tumut 2 power station	Underground power station south of Talbingo Reservoir
Tumut 3 power station	Power station at the northern end of Talbingo Reservoir
Turbidity	The measure of the light scattering properties of water and is an indicator of the presence of suspended solids
Turbine	A machine which converts the energy of water to mechanical energy
Variable renewable generation	Intermittent renewable wind and solar energy sources that are non-dispatchable and fluctuating in nature
Water intake	Structures at Talbingo and Tantangara reservoirs used to take water in and out of the headrace and tailrace tunnels

ABBREVIATIONS

Abbreviations

AANP	Australian Alps National Parks and Reserves
ACHA	Aboriginal Cultural Heritage Assessment
ACHAR	Aboriginal Cultural Heritage Assessment Report
ACM	Asbestos Containing Materials
ACT	Australian Capital Territory
AEMO	Australian Energy Market Operator
AEP	Annual exceedance probability
AFL	Agreement for Lease
AHD	Australian height datum
AHIMS	Aboriginal Heritage Management Information System
AHMP	Aboriginal Heritage Management Plan
AIP	NSW Aquifer Interference Policy
AMP	Asbestos management plan
APZ	Asset protection zone
AQIA	Air Quality Impact Assessment
AqHMP	Aquatic Habitat Management Plan
AUR	Auxiliary right turn
AUL	Auxiliary left turn
BAM	Biodiversity assessment method
BDAR	Biodiversity Development Assessment Report
BFMC	Bush Fire Management Committee
BFRHA	Bushfire Risk and Hazard Assessment
BOS	Biodiversity Offset Scheme
CATI	Computer assisted telephone interviews
CBP	Concrete batching plant
CGE	Computable general equilibrium
CHL	Commonwealth Heritage List
CHMP	Cultural Heritage Management Plan
CHR	Channelised right turn

CNVMP	Construction Noise and Vibration Management Plan
CPESC	Certified Professional in Erosion and Sediment Control
CSMP	Community and Stakeholder Management Plan
CSSI	Critical State significant infrastructure
DEE	Commonwealth Department of the Environment and Energy
DIAA	Design integration and assessment approach
DPIE	NSW Department of Planning, Industry and Environment
ECVT	Egress, cabling and ventilation tunnel
EEC	Endangered ecology community
EHNV	Epizootic haematopoietic necrosis virus
EIS	Environmental impact statement
EMM	EMM Consulting Pty Limited
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EP&A Regulation	NSW Environmental Planning and Assessment Regulation 2000
EPA	NSW Environment Protection Authority
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
EPIs	Environmental planning instruments
EPL	Environment protection licence
ERT	Emergency Response Team
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically sustainable development
FGJV	Future Generation Joint Venture
FIFO	Fly-in fly-out
FSL	Full supply level
FID	Final investment decision
FTE	Full time equivalent
GDE	Groundwater dependent ecosystem
GHG	Greenhouse gas
GIS	Gas insulated switchgear
GL	Gigalitre
GSP	Gross state product
GWh	Gigawatt hour

ha	Hectares
HA&SoHI	Heritage Assessment and Statement of Heritage Impact
HABs	Harmful algal blooms
HV	Heavy vehicle
ICNG	Interim construction noise guideline
IO	Input - output
ISQG	Interim sediment quality guidelines
IPB	Isolated Phase Busduct
KFH	Key fish habitat
KGAP	Kosciuszko National Park Geodiversity Action Plan
KHA	Kosciuszko Huts Association
km	Kilometre
km²	Square kilometre
KNP	Kosciuszko National Park
KTP	Key threatening processes
LFB	Lachlan Fold Belt
LG Act	Local Government Act 1993
LGA	Local government area
LPF	Long Plain Fault
LV	Light vehicle
m	Metre
M	Million
m²	Square metre
m³	Cubic metre
M2	Murray 2 Reservoir Catchment
MAT	Main access tunnel
MJA	Marsden Jacob Associates
mm	Millimetre
MNES	Matters of National Environmental Significance
MOL	Minimum operating level
MVA	Megavolt amps
MW	Megawatt

MWh	Megawatt hour
NEM	National Electricity Market
NGAF	National Greenhouse Accounts Factors
NHL	National Heritage List
NML	Noise management level
NO_2	Nitrogen dioxide
NOA	Naturally occurring asbestos
NPW Act	NSW National Parks and Wildlife Act 1995
NPW Regulation	NSW National Parks and Wildlife Regulation 2009
NPWS	NSW National Parks and Wildlife Service
NSW	New South Wales
OSOM	Oversize over-mass
PAF	Potentially acid forming
PBP	Planning for Bush Fire Protection Guideline
PCTs	Plant community types
PCU	Passenger Car Units
PHA	Preliminary Hazard Assessment
$PM_{2.5}$	Particulate matter smaller than 2.5 micrometres in diameter
PM_{10}	Particulate matter smaller than 10 micrometres in diameter
POEO Act	Protection of the Environment Operations Act 1997
PoM	Plan of Management
PSI	Preliminary Site Investigation
Q&As	Questions and answers
RAPS	Registered Aboriginal Parties
RFS	NSW Rural Fire Service
RMS	NSW Roads and Maritime Services
SEARs	Secretary's environmental assessment requirements
SEPP	State Environmental Planning Policy
SEPP 33	State Environmental Planning Policy No. 33 – Hazardous and Offensive Development
SEPP 44	State Environmental Planning Policy No. 44 – Koala Habitat Protection
SEPP 55	State Environmental Planning Policy No. 55 – Remediation of Land
SHC Act	NSW Snowy Hydro Corporatisation Act 1997

SHR	State Heritage Register
SIMMP	Social Impact management and Monitoring Plan
SISD	Safe intersection sight distance
SMA	Snowy Mountains Authority
SMCC	Snowy Mountains Control Centre
Snowy Scheme	Snowy Mountains Hydro-electric Scheme
Snowy Hydro	Snowy Hydro Limited
SLA	Soils and Land Assessment
SMRC	Snowy Monaro Regional Council
SRD SEPP	State Environmental Planning Policy (State and Regional Development) 2011
SSI	State significant infrastructure
SVC	Snowy Valleys Council
TARP	Trigger action response plan
TCP	Traffic Control Plan
TBM	Tunnel boring machine
TF	Tantangara Fault
TSP	Total suspended particulate matter
VENM	Virgin Excavated Natural Material
WHL	World Heritage List
WM Act	Water Management Act 2000
WQO	Water Quality Objectives
µm	micrometre