MOD2 to Snowy 2.0 Main Works (CSSI-9687)

Modification Report

Prepared for Snowy Hydro Limited

August 2023

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Snowy Hydro Limited

E230162 RP1

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Glossary

Abbreviation/Term	Definition
AEMO	Australian Energy Market Operator
ACHA	Aboriginal Cultural Heritage Assessment
AMD	Acid Mine Drainage
AIP	NSW *Aquifer interference Policy 2012*
BCS	Biodiversity Conservation Service Directorate of DPE
BDAR	Biodiversity Development Assessment Report
BAM	Biodiversity Assessment Method
BMP	Biodiversity Management Plan
CC Act	Commonwealth *Climate Change Act 2022*
CSSI	Critical State Significant Infrastructure
DPE	NSW Department of Planning and Environment
ECVT	Emergency Cable Ventilation Tunnel
EII	NSW *Energy Infrastructure Investment Act 2020*
EPA	NSW Environment Protection Authority
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EP&A Regulation	NSW *Environmental Planning and Assessment Regulation 2000*
EPI	Environmental Planning Instruments
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPI	Environmental Planning Instrument
EST	Energy Security Target
FGJV	Future Generation Joint Venture
GBR	Geotechnical Baseline Report
GDE	Groundwater Dependent Ecosystems
HHIA	Historic Heritage Impact Assessment
HRT	Head Race Tunnel
IBRA	Interim Biogeographic Regionalisation of Australia
ISP	*Integrated System Plan 2022*
KNP	Kosciuszko National Park
KPV	Kelly's Plain Volcanics
LEP	Local Environmental Plans
LFB	Lachlan Fold Belt

Abbreviation/Term	Definition
LGA	Local Government Areas
LRET	Large-scale Renewable Energy Target
Main Works project	Project activities related to Snowy 2.0 Main Works and Exploratory Works. 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.
MAT	Main Access Tunnel
MNES	Matters of National Environmental Significance
MOD2	Project works related to this modification report, MOD2.
NEM	National Electricity Market
NOA	Naturally Occurring Asbestos
NPWS	NSW National Parks and Wildlife Service
ODP	Optimal Development Path
PAF	Potential acid forming rock
Planning Systems SEPP	*State Environmental Planning Policy (Planning Systems) 2021*
PCT	Plant Community Types
Project area	The area required to carry out works related to this modification, including sinkhole remediation and possible ground consolidation works.
REZ	Renewable Energy Zones
SAII	Serious and Irreversible Impacts
SEPPs	State Environmental Planning Policies
Snowy Hydro	Snowy Hydro Limited
SRD SEPP	*State Environmental Planning Policy (State and Regional Development) 2011*
SSI	State Significant Infrastructure
TBM	Tunnel Boring Machine
TEC	Threatened Ecological Communities
The/This Project	Project works related to this modification report, MOD2.
TPZ	Tree Protection Zones
TSU	Tantangara Survey Unit
USS	Upstream Surge Shaft
VRE	Variable Renewable Energy

Executive summary

As with many electricity markets around the world, the Australian National Electricity Market (NEM) is undergoing a paradigm transformation that has been brought about by significant shifts in energy efficiency, rapidly decreasing costs of variable renewable electricity (such as solar and wind), coal power station retirements, increasing coal and gas costs and Australia's participation in global commitments to reduce carbon emissions. This transformation is creating a need for large scale energy storage projects such as Snowy 2.0.

Snowy 2.0 is the largest committed renewable energy project in Australia. By expanding the current Snowy Scheme's renewable energy capacity by almost 50%, the NEM will be served with an additional 2,000 megawatts (MW) of on-demand generating capacity and large-scale storage. It is expected to generate around 350,000 megawatt hours (MWh) of large-scale storage to the NEM over a seven-day period.

Snowy 2.0 was declared State significant infrastructure (SSI) and critical State significant infrastructure (CSSI) by the NSW Minister for Planning in March 2018 under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The declaration acknowledges that Snowy 2.0 is critical to the State for environmental, economic, or social reasons.

Snowy 2.0 is being developed in two stages, Exploratory Works and Main Works. Exploratory Works was approved by the NSW Minister for Planning on 7 February 2019 (Infrastructure Approval (SSI-9208) and Main Works was approved by the NSW Minister for Planning on 20 May 2020 (Infrastructure Approval SSI-9687). The Main Works approval incorporated all approved aspects of Exploratory Works.

Construction of Snowy 2.0 is being undertaken across three main work fronts, in Lobs Hole, Tantangara and Marica. At Lobs Hole, construction of the Talbingo intake is well underway, and the main access tunnel (MAT) and emergency, cable ventilation tunnel (ECVT) excavation by tunnel boring machines (TBMs) are complete. At Marica, construction of the upstream surge shaft (USS) is underway via drill and blast.

Webuild S.p.A, Clough Projects Australia Pty Limited and The Lane Construction Corporation, together trading as the Future Generation Joint Venture (FGJV), is undertaking the construction of Snowy 2.0 under contract with Snowy Hydro Limited (Snowy Hydro).

At Tantangara, tunnelling via TBM commenced excavation of the head race tunnel (HRT) adit portal in March 2022. Around May 2022, the TBM began encountering adverse geological conditions, which can be broadly characterised as unstable sub-surface materials. In December 2022, a sinkhole formed at the surface near the adit portal and TBM operations were suspended. The TBM cutting head is approximately 35 m directly below the sinkhole and 140 m horizontally from the HRT adit portal. The sinkhole is located outside of the approved construction envelope for Snowy 2.0.

Since February 2023, FGJV has also undertaken a range of geotechnical investigations around the TBM and the HRT adit portal. This was done through four surface boreholes including a sub-horizontal borehole aligned to the alignment of the Tantangara HRT adit. In addition to these boreholes, geophysical surveys around and in front of the TBM were completed.

Since March 2023, FGJV has been undertaking ground consolidation works around the cutting head of the TBM by grouting the sub-surface materials. The aim of these works is to stabilise the soil matrix sufficiently so that material will not fall into the TBM cutting head. These ground stabilisation works have been undertaken from the surface inside the approved construction envelope and from within the TBM. However, depending on the outcome of the works, further ground consolidation may also be required to be undertaken from the surface outside the construction envelope directly above the TBM cutting head.

Snowy Hydro proposes to modify the Snowy 2.0 Main Works infrastructure approval under Section 5.25 of the EP&A Act to facilitate the rehabilitation of the sinkhole and undertake the ground consolidation works from the surface, if required. These works would be undertaken outside the approved construction envelope for Snowy 2.0. The proposed modification will be the second modification (MOD2) to Infrastructure Approval SSI-9687.

This modification report has been prepared to support MOD2. It has been prepared in accordance with Section 5.25 of the EP&A Act, the *State significant infrastructure guidelines – preparing a modification report* (DPE 2022) and assessment requirements from the NSW Department of Planning and Environment (DPE). It has also been prepared following consultation with DPE and other government agencies, including the NSW National Parks and Wildlife Service (NPWS).

A geotechnical report has been prepared by FGJV and reviewed by SYSTRA Bamser. This report forms part of this modification report (Appendix A). The report includes the results of recent geotechnical investigations, including the drilling of the additional boreholes from within the approved construction boundary. The boreholes indicate that there is 50 m of soft unconsolidated ground ahead of the TBM followed by good quality rock mass.

The geotechnical report provides further management measures for minimising the potential of future sinkholes from occurring. These measures include ground consolidation and switching the TBM between open mode and closed mode (or slurry mode). Switching the TBM between open and closed mode as per the ground conditions will allow the TBM to move forward through the next 50 m of unconsolidated material without the risk of causing sinkholes or increasing the size of the existing sinkhole. After 50 m, the TBM can be switched back to open mode again to allow it to tunnel through the rock without risk of subsidence related impacts.

A biodiversity development assessment report (BDAR) has been prepared for MOD2. It shows MOD2 will not have any significant impacts on biodiversity. The proposed works will involve clearing of 0.63 ha of vegetation area to allow sinkhole remediation works and possible ground consolidation to take place. Residual impacts of MOD2 include direct loss of 0.63 ha of native vegetation and associated habitat for two threatened fauna species credit species (Alpine She-oak Skink and Broad-toothed Rat).

Under the Snowy 2.0 Main Works approval, the Exploratory Works and Main Works project can clear up to 532 ha of native vegetation. While MOD2 will result in the clearance of a maximum of 0.63 ha of native vegetation, no modification of this clearing limit is required. This is because less native vegetation will be required to be cleared for the Main Works project compared to that area approved to be cleared. As such, no changes to offset requirements for Snowy 2.0 are required.

A water assessment has been prepared for MOD2. It considers impacts to groundwater and surface water.

The water assessment does not anticipate any impacts to groundwater as a result of MOD2. The proposed ground consolidation works will interact with groundwater, impeding groundwater flow and potentially influencing water chemistry, however this effect is anticipated to be very local and negligible. Further, any potential impact from the activity is not anticipated to have an indirect impact on identified sensitive receptors. The sinkhole rehabilitation works will not interact with groundwater.

Converting the TBM between closed and open mode is not anticipated to impact groundwater.

The water assessment does not identify any material risks to the surface water environment as a result of MOD2. The MOD2 area is located adjacent to the much larger Tantangara construction worksite, which has an established water management system and operating protocols. It is proposed that the water management system and methods that have been established for the Tantangara construction worksite will be applied to the MOD2 works. The existing construction water management system at the Tantangara construction worksite is currently operating well below its design capacity and can therefore supply water to and manage any water produced by the proposed works without any material changes to either the system or existing regulatory arrangements.

The area of the MOD2 was surveyed and assessed as part of the Aboriginal cultural heritage assessment (ACHA) and historic heritage impact assessment (HHIA) for Snowy 2.0 Main Works. These assessments demonstrate that there will be no impacts on historic heritage values and minimal impacts to Aboriginal heritage as a result of MOD2. An extensive program of Aboriginal heritage impact mitigation has been undertaken previously and no further works are justified.

All other impacts of MOD2 would be negligible in the context of the existing construction of Snowy 2.0 Main Works and would be managed in accordance with the strict controls set out in the approved management plans.

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1 Introduction

1.1 Overview of Snowy 2.0

Snowy Hydro Limited (Snowy Hydro) owns and operates the Snowy Mountains Hydro-electric Scheme (Snowy Scheme), which is a large water storage and diversion scheme in the Australian Alps in southern New South Wales (NSW). Snowy Hydro is currently constructing Snowy 2.0, which is a pumped hydro-electric expansion of the Snowy Scheme.

Snowy 2.0 is the largest committed renewable energy project in Australia, increasing the generation capacity of the Snowy Scheme by almost 50%. The Main Works project has the capacity to provide an additional 2,000 megawatts (MW) of dispatchable generating capacity and provide approximately 350,000 megawatt hours (MWh) of large-scale storage available to the national electricity market (NEM).

Snowy 2.0 was declared State significant infrastructure (SSI) and critical State significant infrastructure (CSSI) by the NSW Minister for Planning in March 2018 under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The declaration acknowledges that Snowy 2.0 is critical to the State for environmental, economic or social reasons.

Snowy Hydro has appointed Webuild S.p.A, Clough Projects Australia Pty Limited and The Lane Construction Corporation, together trading as the Future Generation Joint Venture (FGJV), to carry out the engineering, design, procurement, supply, construction, testing, commissioning and delivery actions for Snowy 2.0. Once commissioning is complete, Snowy Hydro is responsible for the operation of Snowy 2.0 and its infrastructure.

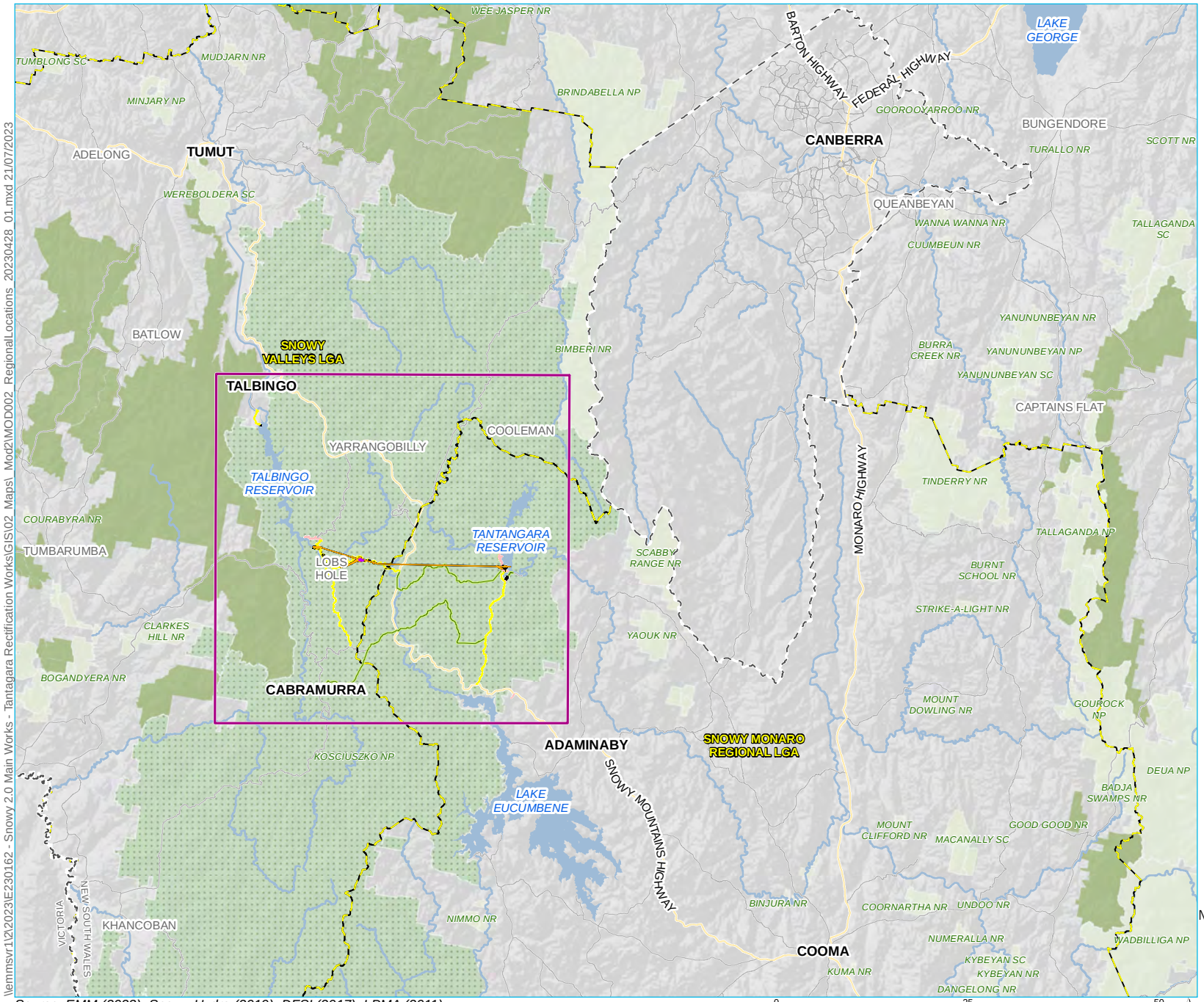
Snowy 2.0 is being developed in two stages, Exploratory Works and Main Works.

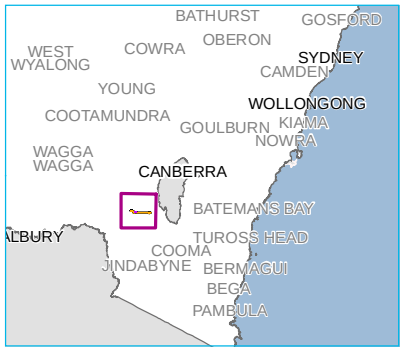
Exploratory Works involves developing a 3.1 km exploratory tunnel, adit and portal, and undertaking other exploratory and construction activities primarily in the Lobs Hole area of Kosciuszko National Park (KNP). Exploratory Works was approved by the NSW Minister for Planning on 7 February 2019 (Infrastructure Approval (SSI-9208) and construction is almost complete.

Main Works involves the construction and operation of Snowy 2.0. Construction works includes work across three locations, namely, Lobs Hole, Tantangara and Marica. Main Works was approved by the NSW Minister for Planning on 20 May 2020 (Infrastructure Approval SSI-9687). The Snowy 2.0 Main Works approval incorporated all approved aspects of Exploratory Works. Construction of Main Works is well underway.

There are three other projects connected to Snowy 2.0. These include the development and operation of a concrete tunnel lining segment factory, which was approved by the NSW Minister for Planning on 31 March 2020 (Infrastructure Approval SSI-10034), a transmission connection between Main Works and the existing transmission network which was approved by the NSW Minister for Planning on 2 September 2022 (Infrastructure Approval SSI-9717), and Snowy 2.0 Main Works Modification 1 approved on 28 January 2022, which is to permit horizontal directional drilling for utilities/services between the Lobs Hole and Marica areas of these projects.

The concrete tunnel lining segment factory is operational and supplying concrete segments to Snowy 2.0 for lining of the tunnels being excavated. Construction of the transmission connection project is expected to commence in September 2023.





KEY

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

Source: EMM (2023); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

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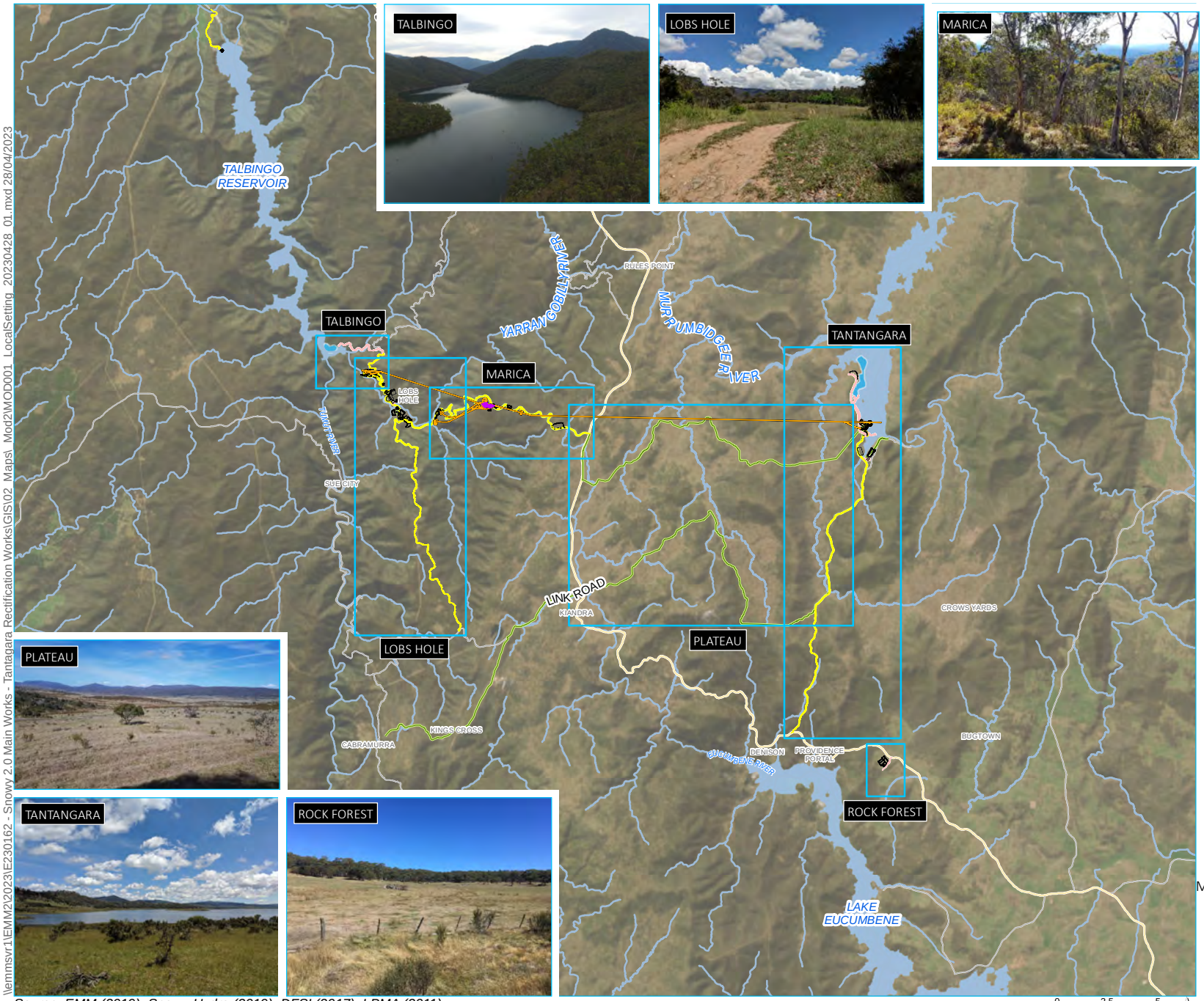
Regional setting

Snowy 2.0

Proposed modification (MOD2) to Snowy 2.0 Main Works infrastructure approval (CSSI-9687) for Tantangara rectification works

Figure 1.1



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

Local setting

Snowy 2.0

Proposed modification (MOD2) to Snowy 2.0 Main Works infrastructure approval (CSSI-9687) for Tantangara rectification works

Figure 1.2

1.2 Location of Snowy 2.0

Snowy 2.0 is in the Australian Alps in southern NSW, about mid-way between Canberra and Albury. Snowy 2.0 is within both the Snowy Valleys and Snowy Monaro Regional local government areas (LGAs). The nearest large towns to Snowy 2.0 are Cooma and Tumut. Cooma is about 50 km south-east of the Main Works project area (or 70 km by road from Providence Portal), and Tumut is about 35 km north-west of the Main Works project area (or 45 km by road from Tumut 3 power station). Other nearby towns include Talbingo, Cabramurra, Adaminaby and Tumbarumba.

The location of Snowy 2.0 in its regional and local context can be seen in Figure 1.1 and Figure 1.2.

The pumped hydro-electric scheme elements of Snowy 2.0 are mostly underground and run between the southern ends of Talbingo and Tantangara reservoirs, a straight-line distance of 27 km. Key locations for the Main Works project are shown on Figure 1.2 and include Talbingo Reservoir, Marica, Lobs Hole, Plateau and Tantangara Reservoir. A site outside the boundary of KNP (referred to as Rock Forest) is also being used for logistics and staging during construction and is accessed directly from the Snowy Mountains Highway.

1.3 Summary of Snowy 2.0

A summary of the key elements of Snowy 2.0 is provided in Table 1.1.

Table 1.1 Summary of key elements of Snowy 2.0

Main Works Project element	Summary
Main Works project area	The Main Works project area is the broader region within which Snowy 2.0 is being built and will be operated, and the extent within which direct impacts from Snowy 2.0 are anticipated. The Main Works project area can be seen in Figure 1.2.
Permanent infrastructure	Snowy 2.0 infrastructure is being built and will be operated for the life of the assets including: • 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 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 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.
Construction envelope	The construction envelope is the maximum extent within which the disturbance area (see below) can move to allow the final siting of infrastructure through the detailed design process.

Table 1.1 Summary of key elements of Snowy 2.0

Main Works Project element	Summary
Disturbance area	The disturbance area is the extent of construction works required to build Snowy 2.0. The approved maximum disturbance area is 630 hectares (ha) which is less than 0.1% of the KNP. Most of the disturbance area will be rehabilitated and land formed, and other parts will be retained permanently for operation (operational footprint). Within the maximum disturbance area, the maximum area of native vegetation clearing is 532 ha.
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 MAT, ECVT and power waterway is by tunnel boring machine (TBM), with portals, adits and construction tunnels using drill and blast methods. Excavation for other underground caverns, chambers and shafts are via combinations of drill and blast, blind sink, or raise bore techniques.
Excavated rock management	Excavated rock is generated as a result of tunnelling activities and earthworks. The material produced through these activities are stockpiled and either reused by the contractor (or the NSW National Parks and Wildlife Service (NPWS)), placed permanently in approved spoil emplacement areas in Tantangara or Talbingo, 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 is presently from the two existing reservoirs (Talbingo and Tantangara) and reticulated via buried pipelines (along access roads). There are also bores at Marica, with water access licenses. Raw water is treated as necessary wherever potable water is required (e.g., at accommodation camps). Water to be discharged (comprising process water, wastewater, and stormwater) is treated before discharge to the two existing reservoirs (Talbingo and Tantangara) as follows: • treated process water is reused onsite where possible to reduce the amount of discharge to reservoirs, however excess treated water is discharged to the reservoirs • collected sewage is treated at sewage treatment plants to meet the specified discharge limits before discharge and/or disposal • stormwater is 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 a 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 (e.g. intakes and portal entrances)
Construction workforce	The construction workforce for Snowy 2.0 is expected to peak at around 2,000 personnel.
Operational life	The operational life of Snowy 2.0 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.

1.4 Modification of Main Works approval

1.4.1 Sinkhole

Tunnelling of the MAT commenced in June 2021 by TBM #2 Lady Eileen Hudson and was completed in October 2022. Tunnelling of the ECVT commenced in April 2022 by TBM #1 Kirsten and was completed in May 2023.

In March 2022, tunnelling of the head race tunnel (HRT) commenced at the Tantangara HRT adit portal using TBM #3 Florence. Around May 2022, the TBM began encountering adverse geological conditions. In December 2022, a small sinkhole formed at the surface near the adit portal immediately outside of the construction envelope. TBM operations were then suspended. The sinkhole is a result of the TBM tunnelling through incohesive sandy material and forming an inferred chimney structure above the TBM cutting head (FGJV 2023). The material that the TBM encountered was not expected based on the results of previous geotechnical investigations undertaken for Snowy 2.0.

Works are required to remediate the sinkhole including filling and rehabilitating it. These works are referred to as the Project and/or MOD2 and the area required to carry out these activities has been termed as Project area or MOD2 area.

1.4.2 The location of the sinkhole can be seen in Figure 1.3.Sinkhole monitoring

FGJV have undertaken repeated drone surveys of the sinkhole and its surrounding area. Using the drone eliminates the safety risk to the team members and negates installing concrete targets in the national park.

The drone survey will be repeated if the surface inside the zone of influence area is visibly observed to change and compared to the original and current drone surveys. These will be done to a repeatable accuracy of 30 millimetres (mm) in height and will define the epicentre of movement of the sinkhole.

If there is movement of the epicentre of the sinkhole, FGJV will then assess and install physical targets in the area, in a circle surrounding the epicentre with a radius of 5 m and 10 m. This can be densified outwards further on if movement continues.

1.4.3 TBM modes

TBM Florence was designed to operate in two modes – open and closed. Open mode is its normal operational mode and will be mainly used to tunnel through normal competent rock conditions. In closed mode, which is also known as slurry mode, the TBM can tunnel through incohesive sandy conditions encountered at the Tantangara HRT adit.

Tunnelling of the Tantangara HRT adit commenced in open mode. FGJV are in the process of installing the required additional support plants to convert the TBM from open mode to closed mode if required. However, before confirmation that conversion is needed, the ground around the TBM cutting head is required to be consolidated. Ground consolidation involves the injection of grout into the sandy material.

Following formation of the sinkhole, FGJV have been undertaking ground consolidation works around the cutting head of the TBM. These works have been undertaken from the surface, inside the construction envelope of Snowy 2.0 and from within the TBM. It is probable these works will be sufficient to allow the TBM to progress in open mode. Notwithstanding this, conversion of the TBM to closed mode, or further ground consolidation from the surface directly outside the construction envelope above the TBM cutting head may be required.

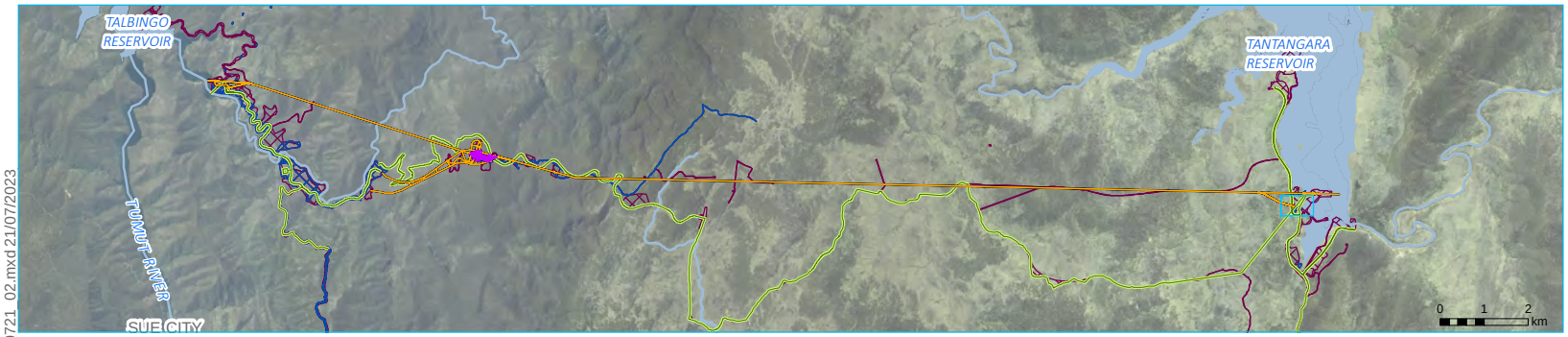
1.4.4 Modification process

Snowy Hydro proposes to modify the Main Works approval under Section 5.25 of the EP&A Act to facilitate the rehabilitation of the sinkhole and undertake ground consolidation from the surface, if required. The proposed modification will be the second modification (MOD2) to the infrastructure approval.

On 3 April 2023, EMM Consulting Pty Limited (EMM), on behalf of Snowy Hydro, submitted a scoping letter to the NSW Department of Planning and Environment (DPE) which provided the scope of:

- the works to rehabilitate the sinkhole
- ground consolidation activities from surface outside of the construction envelope
- environmental assessments to be undertaken as part of a modification report (this report).

Prior to preparing the scoping letter, Snowy Hydro consulted with DPE and a number of other NSW government agencies, including NPWS, the Biodiversity Conservation Service Directorate of DPE (BCS), DPE-Water and the NSW Environment Protection Authority (EPA).



KEY

- First order watersources (DCSSS, 2023)
- Sinkhole
- Exploratory Works disturbance area
- Main Works disturbance area

Snowy 2.0 operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Watercourse
- Waterbodies

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.
Note that the Approved Exploratory Works disturbance area (SSI 9208) will also be a disturbance area for Main Works, even following surrender of the Exploratory Works Approval. The cumulative disturbance area for the Main Works and approved Exploratory Works is therefore presented in this figure.

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Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); (DCSSS, 2023), LPMA (2011); FGJV (2023)

GDA2020 MGA Zone 55

Location of sinkhole

Snowy 2.0

Proposed modification (MOD2) to Snowy 2.0 Main Works infrastructure approval (CSSI-9687) for Tantangara rectification works

Figure 1.3

snowy 2.0

EMM creating opportunities

On 14 April 2023, DPE wrote to Snowy Hydro confirming that the proposed works require a modification of the Snowy 2.0 Main Works approval and requested that the following matters be assessed in the modification report:

- the potential for subsidence and subsidence related impacts from continuing TBM operation
- biodiversity impacts associated with the additional disturbance footprint
- surface water and groundwater impacts of the proposed ground remediation works and any changes to the operating mode of the TBM
- undertake and present the outcomes of consultation with key government agencies including NPWS, EPA and BCS.

1.5 Purpose of this report

This report provides an environmental assessment of MOD2. It has been prepared in accordance with section 5.25 of the EP&A Act, the *State significant infrastructure guidelines – preparing a modification report* (DPE 2022) and the letter from DPE dated 14 April 2023. This report covers:

- the strategic context of Snowy 2.0
- a description of MOD2
- the statutory context for MOD2
- an overview of consultation undertaken with government agencies
- an assessment of the potential environmental impacts of MOD2 including potential geotechnical impacts of recommencing TBM operations
- justification for MOD2.

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 variable renewable energy, 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 over seven days) 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.
- 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 it 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 (see Table 2.1).

In recognition of the need to manage the transition and future energy mix in the NEM, Snowy 2.0 was declared CSSI by the 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.

An overview of relevant Commonwealth and State key policies, strategies and legislation and how Snowy 2.0 aligns with these, is provided in Table 2.1 below. It also provides an overview of how Snowy 2.0 fits into the Commonwealth government's commitment to *The Paris Agreement*.

Table 2.1 Relevant government policies and legislation

Government plan or policy	Alignment of Snowy 2.0 with policy
International context	
The Paris Agreement *The Paris Agreement* is a legally binding international treaty designed to strengthen international efforts to limit the effects of climate change. It aims to hold the global increase in temperature to below 2 degrees Celsius (^{0}C) above pre-industrial levels. The Paris Agreement has been adopted by 196 countries, including Australia, and came into force on 10 December 2016. In June 2022, the Australian Government committed to reduce emissions by 43% on 2005 levels, by 2030. This will put Australia on track to achieve net zero emissions by 2050. This commitment has been legislated through the Commonwealth *Climate Change Act 2022* (CC Act), passed in September 2022. As part of this pledge the Australian Government are supporting the transition to renewable energy by investing in the transmission and storage needed to balance the grid, which will lower energy prices and support economic growth.	Snowy 2.0 will contribute to meeting Australia's commitments under the Paris Agreement by reducing the NEM's annual GHG emissions. Snowy 2.0 is expected to generate around 350,000 megawatt hours (MWh) of large-scale storage to the NEM over a seven-day period. Snowy 2.0 will contribute to the NEM by providing long duration storage services supporting grid reliability as coal fired generation retires and the firming of substantial amounts of additional renewable energy generation capacity.
National context	
Commonwealth *Climate Change Act 2022* The CC Act commenced in September 2022 and for the first time in Australia's history, mandates the Australian Government's commitment under the Paris Agreement to reduce GHG emissions by 43% on 2005 levels, by 2030. The objects of the CC Act are to advance an effective response to the urgent threat of climate change, set out Australia's emissions reductions targets, require annual climate statements to be prepared by the responsible Minister to ensure accountability, and ensure independent advice from the Commonwealth Climate Change Authority informs the preparation of the Government's annual climate statements.	As noted above, Snowy 2.0 will contribute to meeting the commitments to reduce Australia's climate change emissions through the production of renewable energy and firming capabilities provided to enable VRE growth within the NEM.
Large-scale Renewable Energy Target The Australian Government Clean Energy Regulator administers the Large-scale Renewable Energy Target (LRET) which incentivises investment in eligible renewable energy power stations. The LRET of 33,000 gigawatt hours (GWh) of additional renewable electricity generation was met at the end of January 2021 (Clean Energy Regulator 2021). The annual target will remain at 33,000 GWh until the scheme ends in 2030.	Energy produced by pumped hydro-electric power stations falls within the eligible renewable power station energy sources category for the LRET. Once operational, Snowy 2.0 is expected to generate approximately 350,000 MWh of electricity over seven days, which will contribute towards meeting the LRET in future years.

Table 2.1 Relevant government policies and legislation

Government plan or policy	Alignment of Snowy 2.0 with policy
2022 Integrated System Plan The *2022 Integrated System Plan* (2022) ISP prepared by the Australian Energy Market Operator (AEMO) sets out an optimal development path (ODP) to achieve the once in a century transformation of the NEM that is required to achieve net zero emissions by 2050. As part of the ODP, the following is required: • treble the amount of firming capacity provided by sources other than coal, that includes pumped hydro • 16 GW of pumped hydro storage capacity and utility scale batteries • double the amount of VRE.	Snowy 2.0 will contribute to the NEM by providing long duration storage services supporting grid reliability and the firming of additional renewable energy generation capacity. Snowy 2.0 will be connected to a high voltage transmission backbone in NSW which connects to major load centres in NSW.
State context	
NSW Electricity Strategy The *NSW Electricity Strategy* (DPE 2019) is the NSW Government's plan for a reliable, affordable, and sustainable electricity future that supports a growing economy. Developed at a time when four of NSW's five remaining coal-fired generators were scheduled to close by 2033, the strategy outlines a reliable energy system which meets NSW's energy requirements and emission reduction targets. The *NSW Electricity Strategy* includes three layers: 1. supporting the market to deliver reliable electricity at the lowest price, while protecting the environment 2. setting an Energy Security Target (EST) to ensure NSW has enough generation capacity to cope with unexpected generator outages during periods of peak demand, such as heatwaves 3. ensuring the NSW Government has sufficient powers to deal with an electricity emergency, if one arises. The *NSW Electricity Strategy*, together with the *NSW Electricity Infrastructure Roadmap* (DPE 2020) (Electricity Roadmap) discussed below and its enabling legislation the NSW *Energy Infrastructure Investment Act 2020* (EII Act) supports the rolling out of REZs.	Snowy 2.0 will contribute to the development of REZs which will in turn meet the aims of the *NSW Electricity Strategy* by ensuring a secure, reliable energy system. Once operational, the Snowy 2.0 is expected to generate approximately 350,000 MWh of electricity over seven days.
NSW Electricity Infrastructure Roadmap (enabled by the EII Act) The Electricity Roadmap, completed in late 2020, builds on the *NSW Electricity Strategy* and is the NSW Government's plan to transform the electricity system into one that is cheap, reliable and clean. The Electricity Roadmap coordinates investment in transmission, generation, storage and firming infrastructure as ageing coal-fired generation plants retire. The Electricity Roadmap includes actions that will deliver 'whole-of system' benefits. These include: • a plan to deliver the state's first five REZs in the Central-West Orana, New England, South-West, Hunter-Central Coast, and Illawarra regions • a Transmission Acceleration Facility to fast-track the delivery of critical transmission infrastructure • commitment to further funding to pumped hydro projects and the *Pumped Hydro Recoverable Grants Program*. To achieve the needed energy reliability, the Electricity Roadmap draws on AEMO's projection of approximately 2.3 GW of long duration storage required in NSW over and above the 2 GW from the Snowy 2.0 Project. Pumped hydro energy storage is the primary source of long duration energy storage globally and is able to provide the bulk energy time shifting when needed.	Snowy 2.0 forms a major part of the development of the REZs in NSW, providing long duration storage combined with up to 2,000 MW of generating capacity. By utilising natural terrain features, pumped hydro energy storage can provide efficient, responsive, and reliable long duration storage over an operational life of 100+ years. Its large capacity and quick-start energy generation will allow it to operate in tandem with and stabilise the energy generation of VRE technologies located within REZs. It will smooth out peaks and troughs in both supply and demand for electricity by pumping water to the upper reservoir when intermittent renewable energy output is high, and by providing quick-start electricity generation when renewable energy output is low and when demand is high. Snowy 2.0 may also be used to create additional inertia to provide the power grid with additional stability if necessary.

Table 2.1 Relevant government policies and legislation

Government plan or policy	Alignment of Snowy 2.0 with policy
NSW Energy Security Target and Safeguard The objective of the *NSW Energy Security Target* (DPIE 2020) is to give the market certainty about how much new electricity is needed to deliver a reliable energy system over the medium to long term, in light of the retirement of several large coal-fired generators. The *NSW Energy Security Target* is established under the EII Act and is equivalent to the maximum demand experienced in NSW every 10 years, plus a reserve margin. AEMO has been appointed as the *Energy Security Target Monitor* and its first report released in December 2021 predicts a target breach from 2029–30. A further Energy Security Target Monitor report was released by AEMO in October 2022. With the announcement by Origin that Eraring Power Station retirement will be brought forward to 2025 (earlier than planned under the 2020 ISP), there is a firming shortfall, and a target breach is now forecast to result in 2025–26. This signals the critical and urgent need for new generation and transmission infrastructure to ensure energy security for NSW consumers.	At up to 2,000 MW of generating capacity and up to seven days storage, Snowy 2.0 provides long-duration storage which cannot be economically provided by batteries. As such, Snowy 2.0 is of a sufficient scale to significantly and positively influence the State's ongoing energy reliability and security. Based on the target breach identified in AEMO's latest Energy Security Monitor Report, Snowy 2.0 is vital to be deployed to provide resilience and energy security for NSW consumers and to support the transition in the NEM away from coal-fired generation. This need also aligns and supports the CSSI status of Snowy 2.0 being essential for social, economic, or environmental reasons.
NSW Climate Change Policy Framework The *NSW Climate Change Policy Framework* (the Framework) defines the NSW Government's role in reducing carbon emissions and adapting to the impacts of climate change. It commits NSW to achieving net zero emissions by 2050 and sets policy directions to help guide implementation of the Framework.	Snowy 2.0 will contribute to the overall reduction of carbon emissions in NSW, helping the State of NSW to achieve its objective of net zero emissions by 2050.
Net Zero Plan Stage 1: 2020–2030 Following on from the Framework, the *Net Zero Plan Stage 1 2020–2030* (DPIE 2020) is the foundation for NSW action on climate change. It outlines the NSW Government's plan to grow the economy and create jobs while helping the state to deliver a 50% cut in emissions compared to 2005 levels. The implementation of the Net Zero Plan, together with the Electricity Roadmap, will result in more than 9,000 jobs and up to $37 billion (B) in private investment, the majority expected to be across regional NSW.	Snowy 2.0 contributes to Priority 1 of four priorities identified in the Plan: "Drive uptake of proven emissions reduction technologies that grow the economy, create new jobs or reduce the cost of living."
Pumped Hydro Roadmap The *Pumped Hydro Roadmap*, completed in late 2018, sets out actions aimed towards encouraging and promoting increased pumped hydro energy storage across NSW. The key actions of the roadmap include: • bringing forward private investment by opening state-owned water infrastructure and supporting the commercialisation of new, large scale, on-demand electricity projects • mapping the landscape for pumped hydro energy storage • providing guidance on the regulatory process for large-scale hydro energy projects.	Snowy 2.0 is directly aligned to the *Pumped Hydro Roadmap*.
State Environmental Planning Policy (Planning Systems) 2021 Under the EP&A Act, the NSW Planning Minister has the power to declare a specified project on specified land to be CSSI if the Minister forms the view that it is essential to the State for environmental, economic, or social reasons.	The NSW Planning Minister has formed the view that Snowy 2.0 is essential to NSW for environmental, economic, or social reasons. Therefore, the Minister declared Snowy 2.0 to be CSSI.

3 Description of modification

3.1 Background

Construction of Snowy 2.0 is being undertaken across three main work fronts, in Lobs Hole, Tantangara and Marica. At Lobs Hole, construction of the Talbingo intake is well underway, and the MAT and ECVT excavation by TBM Lady Eileen Hudson and TBM Kirsten, consecutively, are complete. At Marica, construction of the upstream surge shaft (USS) is underway via conventional excavation methodology which will switch to drill and blast techniques.

At Tantangara, TBM Florence commenced excavation of the Tantangara HRT adit in March 2022. Around May 2022, the TBM began encountering adverse geological conditions which hindered the advancement of the TBM. In December 2022, the TBM passed into a fault zone and encountered sandy material with no apparent cohesion at approximately tunnel length 146 m. On stalling the cutterhead rotation the sandy material entered the muck chamber of the TBM in an uncontrolled manner, forming an inferred chimney structure above the tunnelling excavations. The sinkhole is located outside the approved construction envelope and disturbance boundary. Upon formation of the sinkhole, TBM operations were suspended (FGJV 2023).

The geotechnical baseline report (GBR) for Snowy 2.0 (FGJV 2019) indicated that the HRT consisted of naturally occurring asbestos (NOA) approximately 7 km inside the Tantangara HRT and an unlikely occurrence of fault affected zones or weak material (FGJV 2023). The design of TBM Florence was informed by the GBR and includes a single shield TBM capable of operating in two different modes – open mode and closed mode (also known as slurry mode). Open mode is the main mode for excavation and will be used to tunnel through competent rock conditions where NOA is not present. However, open mode excavation can be subject to challenges when facing unconsolidated material (FGJV 2023) as was encountered by the TBM in May to December 2022. However, with additional control measures including, but not limited to working in closed mode, the TBM can work through the unconsolidated material as it is able to support the excavation face by a pressurized, bentonite slurry pumped into the excavation chamber.

Based on the results of the GBR, though the fault affected zones were envisaged, the amount of unconsolidated material was not apprehended in the Tantangara HRT adit, because of which TBM Florence was operating in open mode. Given the occurrence of the incohesive sandy material, the TBM will be changed between open and closed mode depending on ground conditions. However, before it can be changed to closed mode, the ground around the TBM cutting head is required to be consolidated to improve safety conditions for working in the TBM so that material will not fall into the advancing TBM cutting head. Consolidation is achieved by grouting the sandy material.

FGJV has been undertaking ground consolidation work near the TBM cutting head since March 2023 from surface inside the approved construction envelope and from within the TBM. Further details on ground consolidation works are provided below in Section 3.6.

Since February 2023, FGJV have also been undertaking a range of geotechnical investigations in the Tantangara HRT adit, again from the surface within the construction envelope. This was done through drilling of four surface boreholes, including one long sub-horizontal borehole aligned to the path of the TBM to assess geological conditions of the HRT adit through to its intersection with the HRT. At the time of preparation of this modification report, the long borehole reached a final length of 866.73 m from the portal in June 2023. The other three boreholes are almost vertically aligned at an angle of ~35° in front of the TBM cutterhead and were aimed at investigating geological conditions around the fault zone encountered by the TBM. Further details on the geotechnical investigations are provided in Chapter 6 and Appendix A.

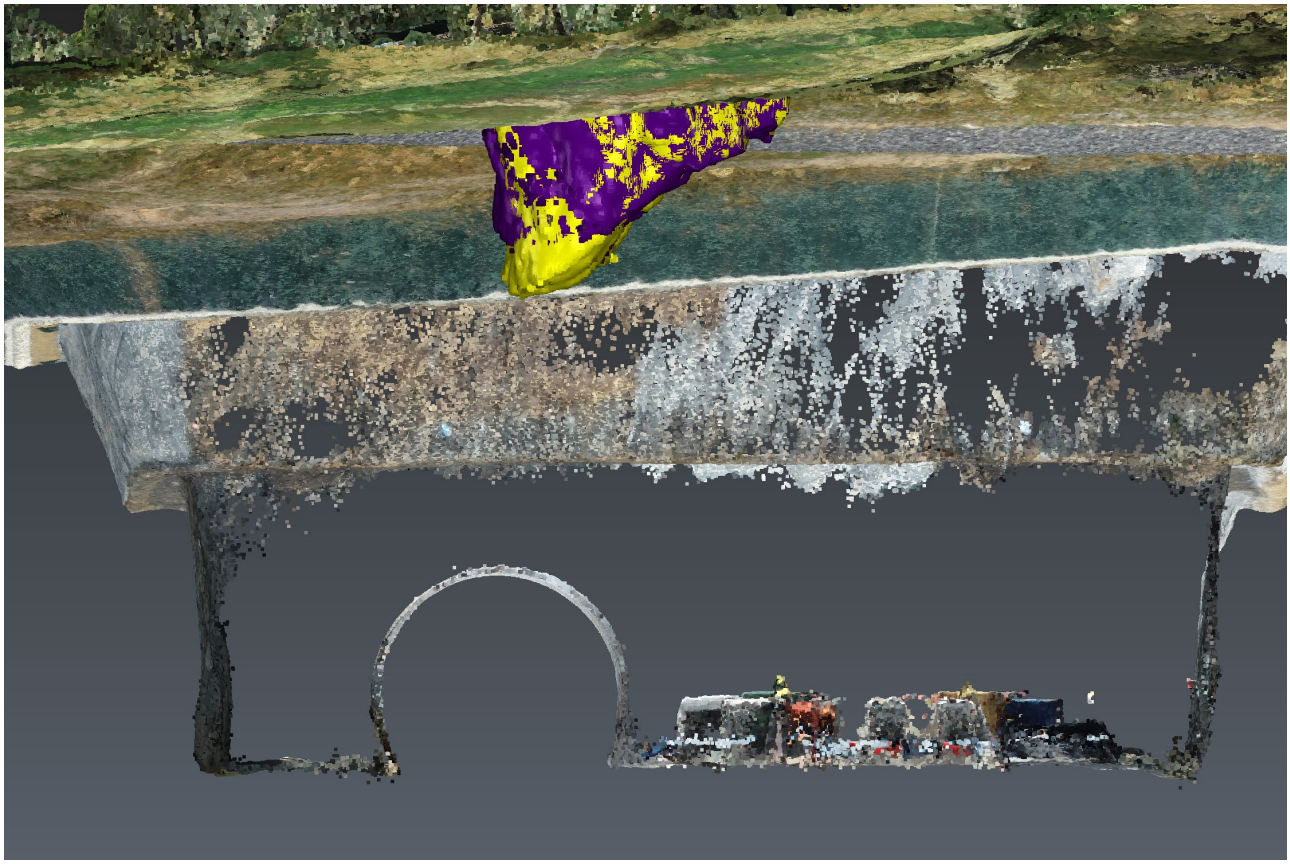
3.2 Location of sinkhole

The area required to remediate the sinkhole and undertake the possible ground consolidation works is located west of the Tantangara Reservoir and adjacent to the existing much larger Tantangara construction worksite.

The sinkhole is located approximately 10 m outside the approved construction envelope and disturbance boundary and 140 m horizontally from the Tantangara HRT adit portal.

The sinkhole is at an angle of 65°–70° from TBM Florence and is located 35 m vertically above the TBM cutting head. It has a diameter of approximately 8 m and is 5 m deep. It is estimated to have a volume of approximately 250 to 300 m^3.

The location of the sinkhole can be seen in Figure 1.3. Imagery of the sink hole in comparison to the TBM can be seen in Figure 3.1.



Source: FGJV (2023)

Imagery of sinkhole on 4 January 2023 shown in Yellow – estimated volume of 219.8 m^3

Imagery of sinkhole on 21 January 2023 shown in Purple – estimated volume of 239.1 m^3

The sinkhole currently has an estimated volume of 250 to 300 m^3

Figure 3.1 Imagery of the sinkhole in comparison to the TBM

3.3 Overview of MOD2

MOD2 seeks to allow works to be undertaken outside of the approved construction envelope which mainly includes remediation works for the sinkhole. There may also be a requirement for consolidation of ground in front of the TBM in case the present ground consolidation works do not achieve the required ground stability.

The following actives will be undertaken under this modification:

- remediation of sinkhole
- ground consolidation, only if necessary.

Details on these activities are provided below.

3.4 Feasible alternatives considered for sinkhole remediation

Remediation of the sinkhole was considered in several stages. However, the remediation cannot be finalised until the TBM has tunnelled out of the immediate area and reinforcement of the segment lined tunnel has been achieved. The steps for the remediation are below:

- Stage 1 – Stabilise ground conditions at depth above and in front of the TBM, to facilitate further advance
- Stage 2 – Backfill the surface depression, once the TBM is clear and the tunnel reinforced
- Stage 3 – Rehabilitation of the surface area

Stage 1 has already been carried out from inside the approved construction boundary of the Main Works project. This stage involved stabilising the ground conditions at depth surrounding the TBM, which would prevent the soils from freely entering the TBM and allowing the TBM to advance forward without further over excavation. Many options were considered, predominately considering ground improvement options consisting of grouting, jet grouting, micro-piling and deep soil mixing techniques, along with filling of the void created above and in front of the TBM. Other considerations were to excavate down and expose the TBM and rock surface in advance of the TBM, and construct foundation to support the TBM as it advances to the rock contact.

These options were considered feasible due to the relatively shallow depth of the TBM (35 m). Initially it was thought that access directly above the TBM was required to achieve this (outside the approved construction envelope boundary), likely requiring backfilling of the surface depression in advance. Following consultation with specialist subcontractors, stabilisation of the ground conditions surrounding the TBM was achieved by inclined drilling from inside the existing Main Works boundary and utilising localised pressure grouting and jet grouting techniques. This was possible due to the close proximity of the depression to the approved construction envelope boundary.

Further to this, the in-situ ground improvement/stabilisation has been completed in front of and above the TBM for the next 10–15 m. This will allow the TBM to advance further in open mode into more stable ground conditions to facilitate conversion to closed mode, helping manage the safety risks as personnel need to access the cutterhead to complete conversion works, which may take up to two weeks.

MOD2 is now required to facilitate Stage 2 works, and the potential to undertake further ground improvement works 15-40 m in front of the TBM.

3.5 Remediation of sinkhole

FGJV proposes to remediate the sinkhole by creating a working platform around it. Then the sides of the sinkhole will be excavated and shaped to enable backfill material to be keyed in.

The initial 2 m of the sinkhole would likely be filled by a fine grained natural material and to prevent ingress of water from surface directly to underground. The remaining void would likely be filled with a natural grained material in order for it to be grouted in a second phase if required.The type of material to be used for the fill works will be natural material excavated from the Main Works project footprint.

Materials used to fill the sinkhole will be won from within the existing Main Works project footprint at Tantangara. The likely material source will be near surface materials excavated from either the Tantangara Intake channel structure, or spoil emplacement area. These materials will typically be sourced, placed and compacted to the Main Works project's general fill specifications. The maximum footprint for the area required to remediate the sinkhole is 2,066 m^2. This includes the area of the sinkhole and the surrounding work area. The area required to remediate the sinkhole can be seen in Figure 3.2.

After remediation and following completion of the ground consolidation works, the sinkhole and surrounding work area will be rehabilitated in accordance with a Rehabilitation Management Plan for Snowy 2.0. This management plan is currently in preparation and would include provisions for remediation of the sinkhole.

Monitoring of the sinkhole and its surrounds would continue to be undertaken in accordance with the monitoring detailed in Section 1.4.2. Works to remediate the sinkhole would be undertaken only after approval is granted for MOD2.

3.6 Ground consolidation

The ground in front of the TBM cutterhead is required to be consolidated for the TBM to be converted into closed mode. This work has already commenced from equipment located within the approved construction area and from within the TBM. It is anticipated that this work will be sufficient to consolidate the ground as required. However, there is possibility that additional works are required from the surface above and in front of the TBM cutting head.

Consolidation is achieved by grouting the soft sandy material. The objectives of grouting include:

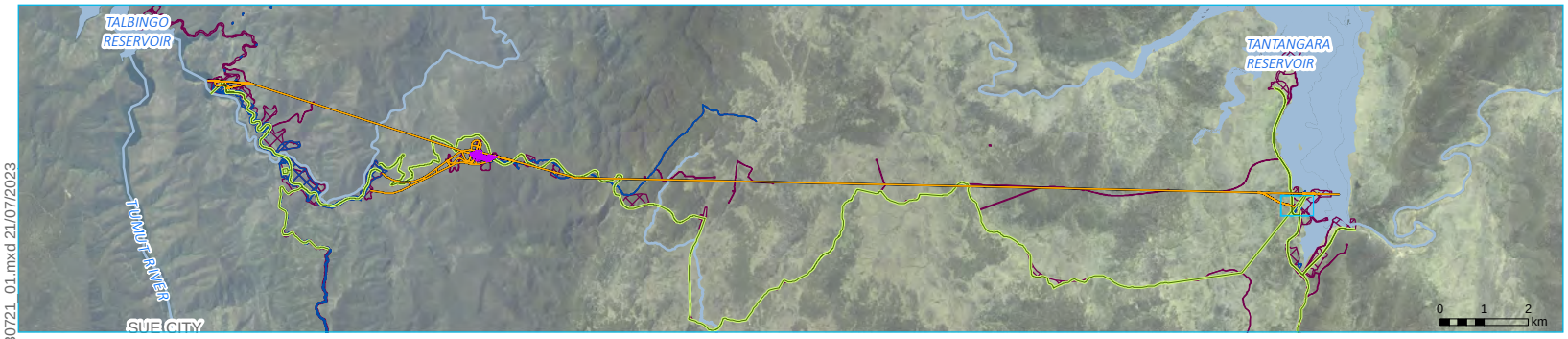
- cement the sinkhole matrix sufficiently so that material will not fall into the advancing TBM cutting head
- improve safety conditions for working within the TBM
- to grout all the natural material sufficiently.

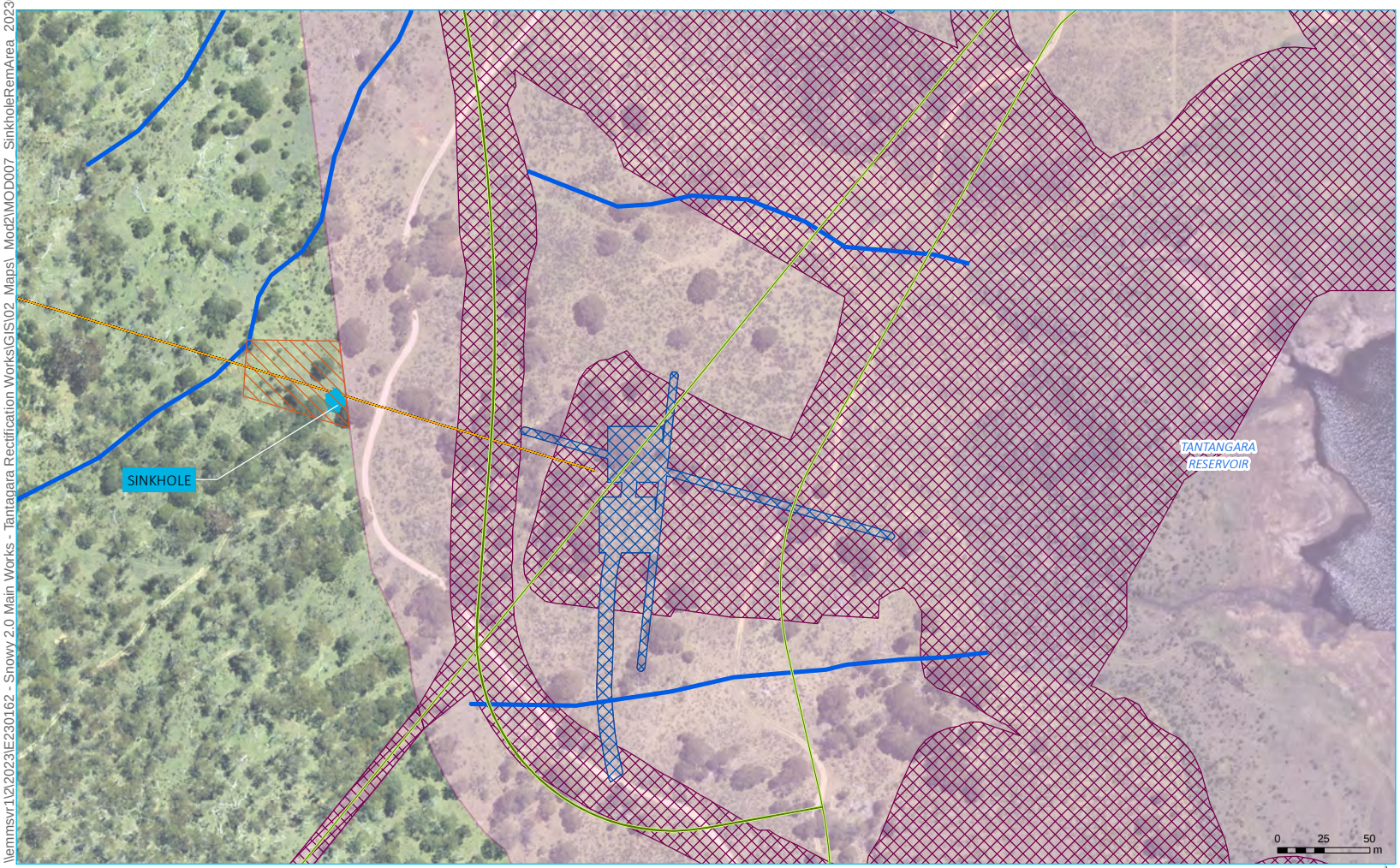
3.7 TBM next steps

The next steps of the TBM movement will include advancing the TBM to approximately 6 m in open mode under the umbrella of inclined surface consolidation. This will be done since the geo-technical investigations already carried out revealed that the next 6 m in front on the TBM is unstable ground and is not favourable for conversion of the TBM mode from open to closed mode (FGJV 2023).

During this movement there will be monitoring of over-excavation through use of belt scales on the TBM, visual inspection of the ground from TBM, and surface monitoring through drones.

Once the TBM has advanced 6 m from its present position, the TBM will be converted to closed/slurry mode. At this stage monitoring of over excavation will be continued through use of spoil reconciliation system (density and flow meters). Thereafter, tunnelling will be continued in slurry mode for up to 50 m or until encountering competent rock. Finally, when competent rock is reached, the TBM mode will be converted back to open mode for tunnelling.





KEY

- First order watersources (DCSSS, 2023)
- Sinkhole
- Sinkhole remediation area
- Exploratory Works disturbance area
- Main Works disturbance area

Snowy 2.0 operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Watercourse
- Waterbodies

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.
Note that the Approved Exploratory Works disturbance area (SSI 9208) will also be a disturbance area for Main Works, even following surrender of the Exploratory Works Approval. The cumulative disturbance area for the Main Works and approved Exploratory Works is therefore presented in this figure.

\\emmsvr1\2\2023\E230162 - Snowy 2.0 Main Works - Tantagara Rectification Works\GIS\02 Maps\ Mod2\MOD007 SinkholeRemArea 20230721 01.mxd 21/07/2023

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); (DCSSS, 2023), LPMA (2011); FGJV (2023)

GDA2020 MGA Zone 55

Sinkhole remediation area

Snowy 2.0

Proposed modification (MOD2) to Snowy 2.0 Main Works infrastructure approval (CSSI-9687) for Tantangara rectification works

Figure 3.2

Grouting works consist of several distinctive working phases, including:

- drilling through the ground using a double rotary drilling technique and outer casing
- upon reaching the bottom of the required depth, the inner drill string is removed leaving only the outer casing in place
- grouting through the end of the outer casing starting with the bottom stage simultaneously with the withdrawal of the outer casing
- extracting the outer casing further opening up the next grouting stage for injection
- extract casing sections incrementally and continue grouting until the entire casing is extracted.

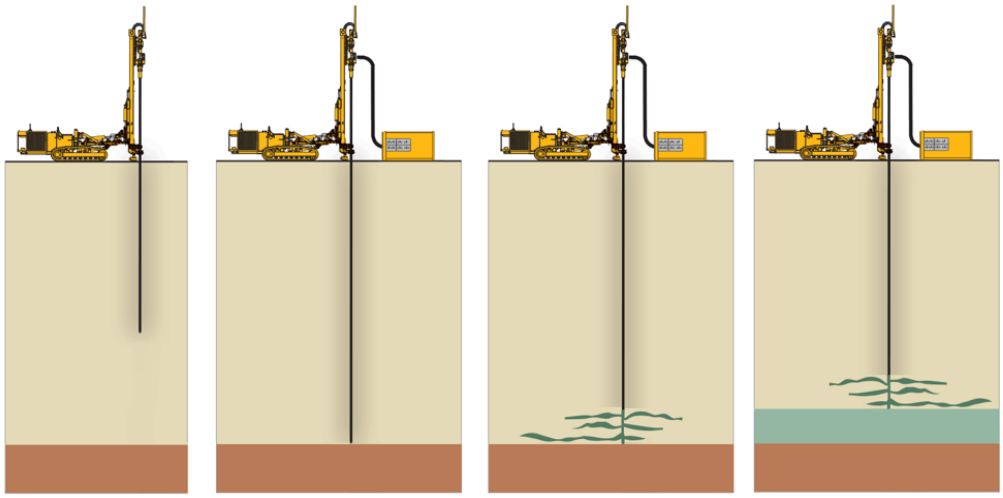
The grout mix used for the sinkhole consolidation works is consistent with the mix currently used by all Snowy 2.0 TBMs. This includes a cement-bentonite slurry and sodium silicate solution. Figure 3.3 outlines the grouting methodology proposed for the consolidation works outside of the construction envelope, if required. The graphic shows the consolidation method for ground consolidation works in front of the TBM. (refer to Figure 3.4).

The number of holes required for the consolidation works would depend on the results of the current stabilisation works being undertaken from behind the construction envelope and from within the TBM.

If required, ground consolidation would be carried out over a surface area of approximately 6,294 m^2, which includes the area required for remediation of the sinkhole (refer to Figure 3.5). Ground consolidation will extend 5 m below the invert level of the TBM.

Further details of the grouting material composition and the equipment used for ground consolidation are detailed in Appendix A.

After ground consolidation works are completed, the area will be rehabilitated in accordance with a Rehabilitation Management Plan for Snowy 2.0. As stated above, this management plan is currently in preparation and would include provisions for rehabilitation of the ground consolidation works.



Drilling through the existing ground and sink hole.

When the end point is reached the inner drill string with the DTH is removed.

Mixing of all grout components, testing of grout parameters, and grouting of the virgin material and sink hole.

When the grouting criteria for a grouting stage are fulfilled, the outer casing is extracted further opening up the next grouting stage for injection.

Source: FGJV (2023)

Figure 3.3 Ground consolidation grouting method

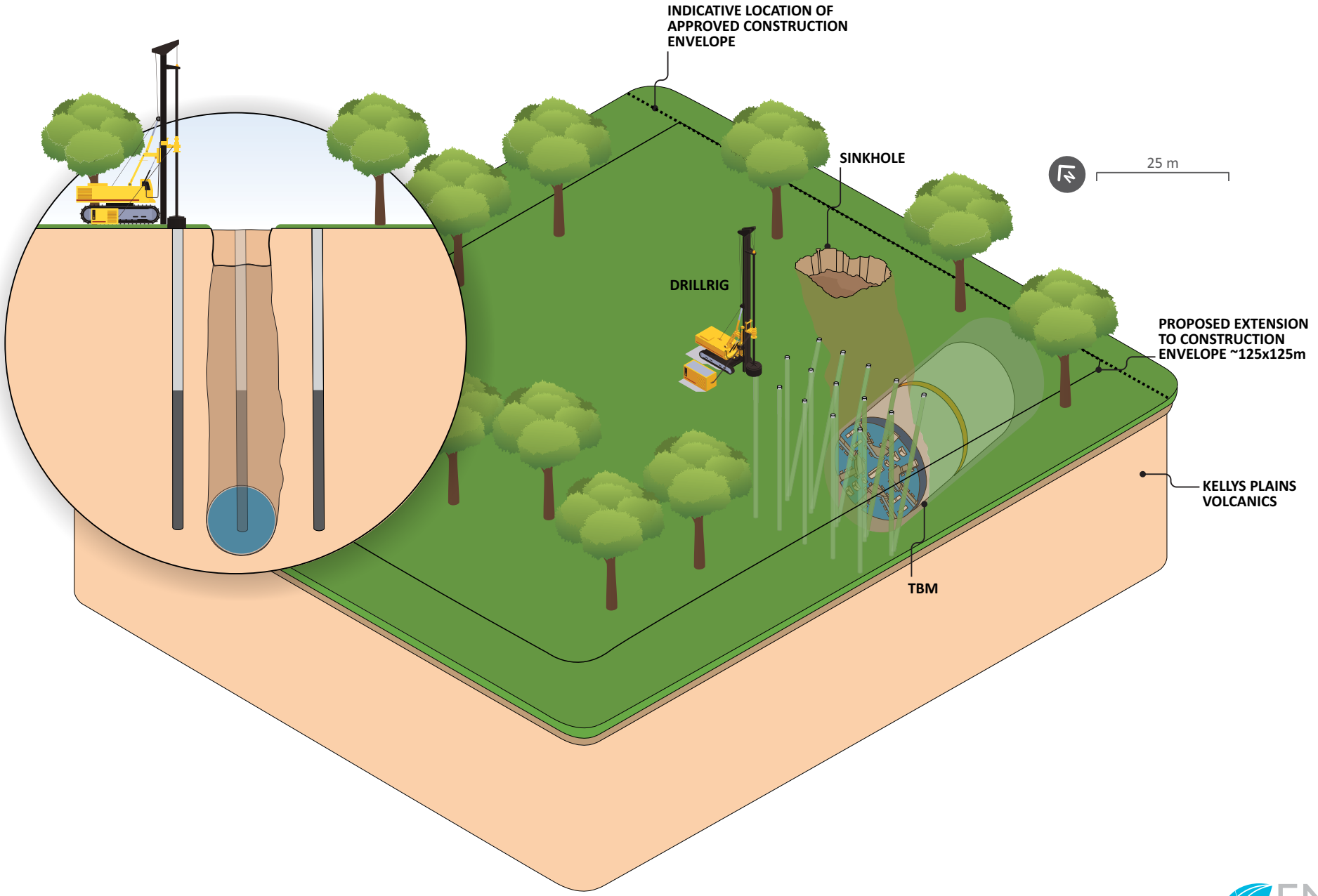
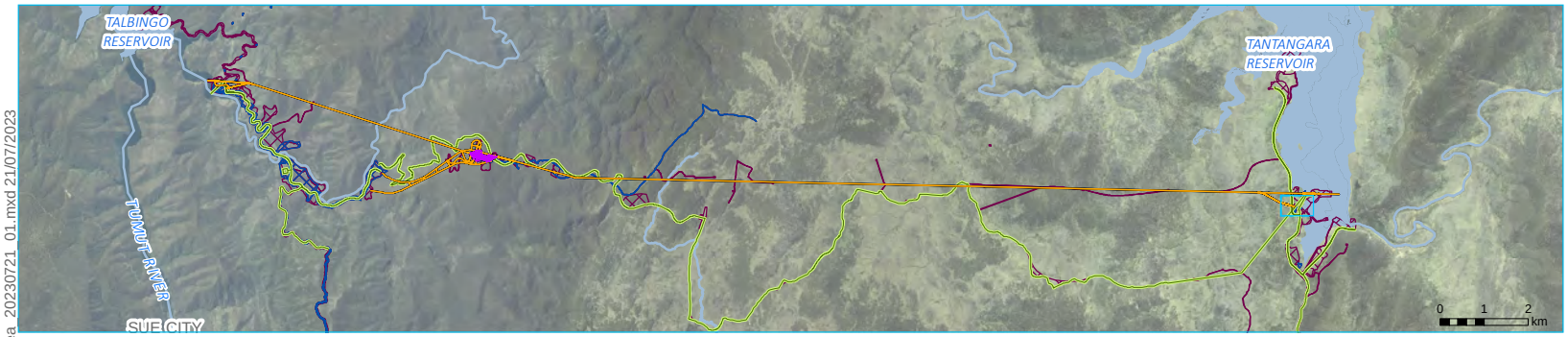
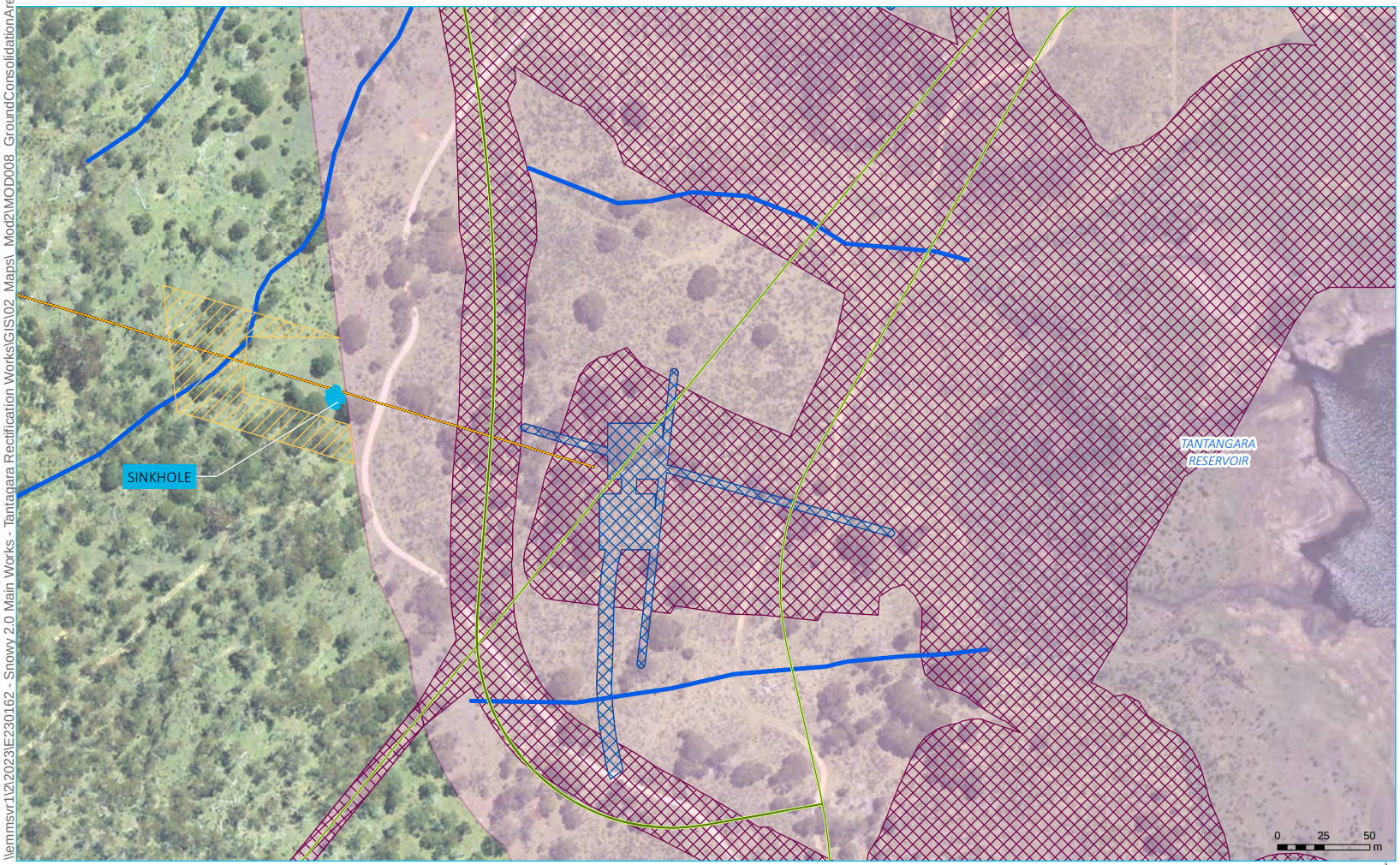


Figure 3.4 Graphic of ground consolidation works





KEY

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- Waterbodies

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Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); (DCSSS, 2023), LPMA (2011); FGJV (2023)

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Ground consolidation area

Snowy 2.0

Proposed modification (MOD2) to Snowy 2.0 Main Works infrastructure approval (CSSI-9687) for Tantangara rectification works

Figure 3.5

3.8 Disturbance footprint

As with Snowy 2.0 Main Works, an indicative disturbance footprint and construction envelope has been developed for the proposed works. As per Table 1.1, the construction envelope is the maximum extent within which the disturbance area can move to allow the final siting of infrastructure through the detailed design process.

The disturbance area is the extent of construction works required to build Snowy 2.0. Condition 5 of Schedule 2 of the Snowy 2.0 Main Works approval states that the current approved maximum disturbance area is 630 ha. Within the maximum disturbance area, the maximum area of native vegetation clearing allowed is 532 ha. Condition 5 is repeated below.

5. The Proponent must comply with the restrictions in Table 1 below.

Table 1: Restrictions on Approval

Matter	***Exploratory Works***	***Main Works***	***Total***
Maximum Disturbance Area	126 ha	504 ha	630 ha
Maximum Native Vegetation Clearing	107 ha	425 ha	532 ha

The disturbance footprint for MOD 2 is 6,294 m^2 or 0.63 ha rounded up. Accordingly, as part of MOD2, it is proposed to increase the maximum disturbance footprint of Snowy 2.0 from 630 ha to 630.63 ha. However, it is not proposed to increase the area of native vegetation allowed to be cleared for Snowy 2.0. This is because less native vegetation will be required to be cleared for the Main Works project compared to that area approved to be cleared.

Accordingly, it is proposed that Condition 5 is amended as follows.

5. The Proponent must comply with the restrictions in Table 1 below.

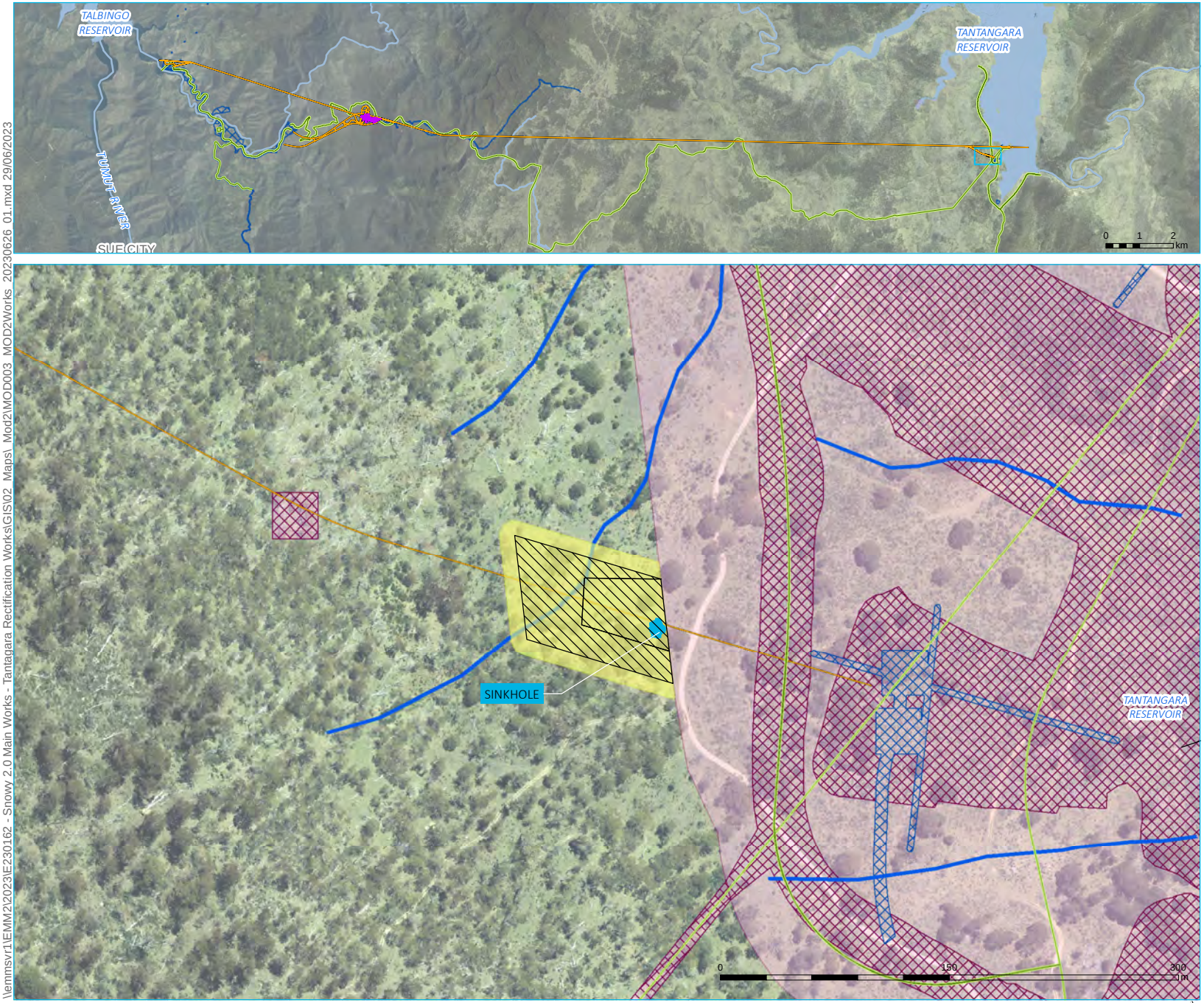
Table 1: Restrictions on Approval

Matter	***Exploratory Works***	***Main Works***	***Total***
Maximum Disturbance Area	126 ha	504.63 ha	630.63 ha
Maximum Native Vegetation Clearing	107 ha	425 ha	532 ha

The proposed construction envelope and disturbance area for MOD 2 can be seen in Figure 3.6.

3.9 Sequence and timing of works

As stated above, ground stabilisation has and is currently being undertaken near the TBM cutting head from the surface level inside the approved construction envelope and from the TBM. If these present consolidation works are deemed insufficient, additional ground consolidation works may be carried out directly above the TBM outside the construction boundary. Both the additional ground consolidation and the works to remediate the sinkhole would be undertaken immediately following approval of MOD2. Weather permitting, remediation works would take about six weeks. Following the completion of the remediation works to the sinkhole, the ground consolidation works would be undertaken. Weather permitting, it is expected these works would take about 16 weeks.



KEY

- First order watersources (DCSSS, 2023)
- Sinkhole
- Indicative MOD2 disturbance area
- Proposed additional construction envelope
- Exploratory Works disturbance area
- Main Works disturbance area

Snowy 2.0 operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Watercourse
- Waterbodies

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.
Note that the Approved Exploratory Works disturbance area (SSI 9208) will also be a disturbance area for Main Works, even following surrender of the Exploratory Works Approval. The cumulative disturbance area for the Main Works and approved Exploratory Works is therefore presented in this figure.

\\emmsvr1\EMM2\2023\E230162 - Snowy 2.0 Main Works - Tantagara Rectification Works\GIS\02 Maps\ Mod2\MOD003 MOD2Works 20230626 01.mxd 29/06/2023

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); (DCSSS, 2023), LPMA (2011)

Proposed construction envelope and disturbance area

Snowy 2.0

Proposed modification (MOD2) to Snowy 2.0 Main Works infrastructure approval (CSSI-9687) for Tantangara rectification works

Figure 3.6

4 Statutory context

4.1 NSW planning framework

The EP&A Act and NSW *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) form the statutory framework for planning approval and environmental assessment in NSW. This legislation is supported by environmental planning instruments (EPIs) including State environmental planning policies (SEPPs) and local environmental plans (LEPs).

4.1.1 Critical State significant infrastructure

Section 5.12 of the EP&A Act provides for the declaration of SSI, and Section 5.13 enables the NSW Minister for Planning to declare SSI to be CSSI if 'it is of a category that, in the opinion of the Minister, is essential for the State for economic, environmental or social reasons'.

On 7 March 2018, the NSW Minister for Planning declared Snowy 2.0 to be SSI and CSSI. The declaration came into effect on 9 March 2018 and was reflected in clause 9 of Schedule 5 of the former *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). The declaration is now reflected in Section 9 of Schedule 5 of the *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP).

Snowy 2.0 is development of the kind specified in schedule 9 of Schedule 5 to the Planning Systems SEPP and, accordingly, may be carried out without development consent under Part 4 of the Act and is declared to be SSI and CSSI.

As previously stated, approval for Snowy 2.0 Main Works was granted by the NSW Minister for Planning under Section 5.19 of the EP&A Act on 20 May 2020.

One modification to the infrastructure approval was granted by a delegate of the NSW Minister for Planning on 27 January 2022. This modification (MOD1) was for the installation of services cabling between the MAT portal at Lobs Hole and Marica.

4.1.2 Modification pathway

Snowy Hydro is seeking a second modification (MOD2) of infrastructure approval for Snowy 2.0 Main Works (CSSI-9687) pursuant to Section 5.25 of the EP&A Act in order to undertake the remediation of the sinkhole and possible ground consolidation works. Section 5.25 of the EP&A Act states:

> **5.25 Modification of Minister's approval**
>
> (1) In this section:
>
> **Minister's approval** means an approval to carry out State significant infrastructure under this Division, and includes an approval granted on the determination of a staged infrastructure application.
>
> **Modification** of an approval means changing the terms of the approval, including revoking or varying a condition of the approval or imposing an additional condition on the approval.
>
> (2) The proponent may request the Minister to modify the Minister's approval for State significant infrastructure. The Minister's approval for a modification is not required if the infrastructure as modified will be consistent with the existing approval under this Division.
>
> (3) The request for the Minister's approval is to be lodged with the Planning Secretary. The Planning Secretary may notify the proponent of environmental assessment requirements with respect to the proposed modification that the proponent must comply with before the matter will be considered by the Minister.

(4) The Minister may modify the approval (with or without conditions) or disapprove of the modification.

Snowy Hydro met with representatives from DPE on 23 December 2022 and 2 February 2023 to discuss the sinkhole, temporary cessation of TBM operations and need for the proposed works. At the meeting in February, it was agreed that a modification to the Main Works approval would be required for the proposed works. It was also agreed that Snowy Hydro would prepare and submit a scoping letter to DPE setting out the proposed works and the scope of environmental assessments that would be undertaken to support a modification report.

A scoping letter was submitted to DPE on 3 April 2023. On 14 April 2023, DPE wrote to Snowy Hydro confirming that a modification to the Main Works approval would be required and set out requirements for the modification report (this report).

4.2 Commonwealth framework

The EPBC Act is the primary piece of Commonwealth legislation that governs the protection of the environment. Relevantly, under the EPBC Act:

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

Snowy Hydro became a 'Commonwealth agency' only for the purposes of the EPBC Act on 2 July 2018, following the acquisition of all remaining shares by the Commonwealth from the States of NSW and Victoria. Snowy 2.0 Main Works is a controlled action and was assessed by accredited assessment process under Part 5, Division 5.2 of the EP&A Act. On 29 June 2020, the Minister for the Environment provided approval (EPBC 2018/8322) for the Main Works under Sections 130(1) and 133(1) of the EPBC Act subject to conditions.

An assessment of the environmental impacts of the proposed works for MOD2 has been undertaken to determine if the works are consistent with the approved action and whether they are likely to have any significant impacts on MNES or the environment generally. This assessment indicates that the proposed works are consistent with the approved action and are unlikely to have any significant impacts on MNES or the environment generally (refer to Chapter 6 below). Accordingly, a referral or variation to the action is not considered necessary.

5 Engagement

Table 5.1 provides a summary of the consultation undertaken with government agencies on the sinkhole and on MOD2, including the key matters raised by the agencies during the consultation.

Consultation with government agencies commenced immediately after the sinkhole appeared in December 2022, and has continued through to preparation of this modification report. Consultation will continue post lodgement of the report and through the proposed works.

Table 5.1 Engagement with government agencies

Date	Stakeholder	Details
15 December 2022	DPE, NPWS, EPA	• Agencies advised of detection of sinkhole and suspension of TBM operations.
20 December 2022	DPE, NPWS	• Agencies notified of proposal to undertake seismic investigations.
21 December 2022	DPE, NPWS, EPA	• Update was provided to the agencies on the status of the sinkhole and details provided around unexpected geological conditions. • Update provided on proposed seismic investigations.
22 December 2022	DPE, NPWS	• Agencies undertook site visit of sinkhole.
23 December 2022	NPWS	• NPWS provided approval to undertake seismic investigations.
4 January 2023	NPWS	• NPWS undertook site visit of sinkhole.
16 January 2023	NPWS	• NPWS notified of proposal to undertake fencing and additional seismic investigations.
18 January 2023	NPWS	• NPWS provided approval to undertake additional seismic investigations.
2 February 2023	DPE, NPWS	• Meeting held to provide an update on the status of TBM Florence and the sinkhole. • Potential works required to assist with the recommencement of tunnelling presented to the agencies. • The approval process for the potential works were discussed, including the scope of any technical assessments required to accompany a modification report.
13 February 2023	DPE	• Letter issued to DPE providing an update on the status of TBM Florence and the sinkhole.
10 March 2023	DPE-Water	• Briefing on MOD2 provided to DPE-Water. • Approach to a groundwater and surface water assessment of the proposed works was presented.
14 March 2023	DPE, NPWS, EPA	• Meeting held to provide an update on the status of TBM Florence and the sinkhole. • Details provided on proposed remediation works and approach to undertaking the geotechnical surveys. • Assessment approach for MOD2 presented. • EPA requested a detailed background on the Project (MOD2). • SHL committed to providing a scoping report which sets out the scope of the proposed works and assessments that would be undertaken as part of a modification report. • DPE advised that the modification report would need to provide a detailed assessment of geotechnical risks associated with the proposed works and the ongoing operation of TBM Florence.

Table 5.1 Engagement with government agencies

Date	Stakeholder	Details
23 March 2023	EPA	• Following meeting on 14 March 2023, a detailed briefing was provided to the EPA including a background, how the remediation works were proposed be carried out and provided details on the approach to undertaking the geotechnical surveys. • The approach to the groundwater assessment was discussed in detail.
27 March 2023	BCS	• A briefing on MOD2 was provided to BCS. • Briefing focused on the proposed approach to assessing biodiversity impacts associated with MOD2.
28 March 2023	DPE, NPWS, EPA	• Meeting held to discuss the approach to the geotechnical assessment. • Updated details on the method for the remediation works were provided.
21 April 2023	DPE	• Letter issued to DPE providing an update on the status of TBM Florence and the sinkhole.
4 May 2023	DPE	• Letter issued to DPE providing an update on the status of TBM Florence and the sinkhole.
25 May 2023	DPE	• Meeting held to provide update on MOD2.
14 June 2023	DPE	• Presentation on results of geotechnical assessment provided.
26 June	DPE, NPWS, EPA	• Site inspection and overview as part of Joint Agency Inspection

Matters raised and requested by the government agencies in consultation have been addressed in this modification report.

6 Assessment of impacts

This chapter provides an assessment of the potential impacts of MOD2 as required by DPE in its letter dated 14 April 2023. This includes:

- the potential for subsidence and subsidence related impacts from continuing TBM operation
- biodiversity impacts associated with the additional disturbance footprint
- surface water and groundwater impacts of the proposed ground remediation works and any changes to the operating mode of the TBM.

In addition, an assessment of potential heritage impacts associated with the additional disturbance footprint has been undertaken and provided in this chapter.

6.1 Geotechnical

6.1.1 Introduction

A report which assesses the potential for subsidence and subsidence related impacts from continuing TBM operation has been prepared by FGJV and peer reviewed by SYSTRA Bamser. The geotechnical report can be found in Appendix A. This section provides a summary of the report.

The geotechnical report (FGJV 2023) was developed to improve the knowledge of the actual geotechnical conditions in the MOD2 area and Tantangara HRT adit, including importantly, ground stability. It allows implementation of the most effective technical solutions for the continuation of the tunnelling works, increasing the safety of personnel and minimising the risk of further sinkholes and subsidence related impacts.

The report includes the outcomes of recent geotechnical investigations and compares it to geotechnical data provided in the GBR (FGJV 2019). It also includes a geotechnical investigation plan to better understand the reasons for the development of the sinkhole and management measures to avoid future sinkholes in the path of the TBM.

The report better defines the geological conditions within the Tantangara area, including the presence, or potential for, soil-like behaviour that has the possibility of generating a sinkhole.

6.1.2 Baseline

Regionally, the MOD2 area is located within the Lachlan Fold Belt (LFB), a belt of deformed deep and shallow marine sedimentary rocks, cherts and mafic volcanics. The area has undergone multiple stages of volcanism, metamorphism and deposition and is complexly folded and faulted (GHD 2022).

The geological unit at the Tantangara HRT adit is the Kelly's Plain Volcanics (KPV) Unit. The unit consists of dacite ignimbrite, rhyodacite ignimbrite, tuff, agglomerate and rhyolite. The unit is situated at the eastern end of the Snowy 2.0 alignment and unconformably overlies the Tantangara and Peppercorn formations, with the contact dipping shallowly to the east with an irregular surface.

The KPV Unit consists of two sub-ground types, KPV01 and KPV02. Both KP01 and KP02 are characterised by blocky-massive rock mass with good to fair surface condition.

Across Snowy 2.0, the GBR (FGJV 2019) anticipated 11 major faults, including the Tantangara Fault which is closest to the Tantangara HRT adit. The fault outcrops east of the Tantangara intake area, with no direct effect on the HRT (or waterway) alignment. It is a north-north-east (~30° azimuth) trending, east-dipping reverse fault, over 30 km in length, with numerous potential splays and possible subsidiary faults on the footwall (west) side of the fault (FGJV 2019).

6.1.3 Assessment

Geological assessments were carried out during the TBM excavation phase and after the sinkhole was formed via boreholes inside the approved construction boundary and from within the TBM.

During the TBM excavation, geological investigations indicated that even though the lithology encountered corresponds to KPV01, after tunnel length 81 m, at the start of the fault zone, a weak zone made up of fault breccia and gouge with void was recorded at the face. This was followed by significant quantities of fine material and water flowing into the TBM excavation during further advances (ravelling ground). This was identified as the fault core.

Further borehole investigations were conducted in February 2023 after the TBM operations were stopped. Three surface boreholes were drilled adjacent to the sinkhole from inside the approved construction envelope. The results of the borehole investigations identified multiple zones of core loss and included voids, calcareous formation and highly weathered limestone. These are the reasons the TBM could not progress further in open mode where the ground conditions had loose soil.

A long sub-horizontal borehole parallel to the Tantangara HRT adit has also been drilled (see Figure 6.1). The outcomes of this borehole investigation shows that the geological conditions for the next 50 m in front of the TBM is highly weathered material causing unconsolidated ground conditions.

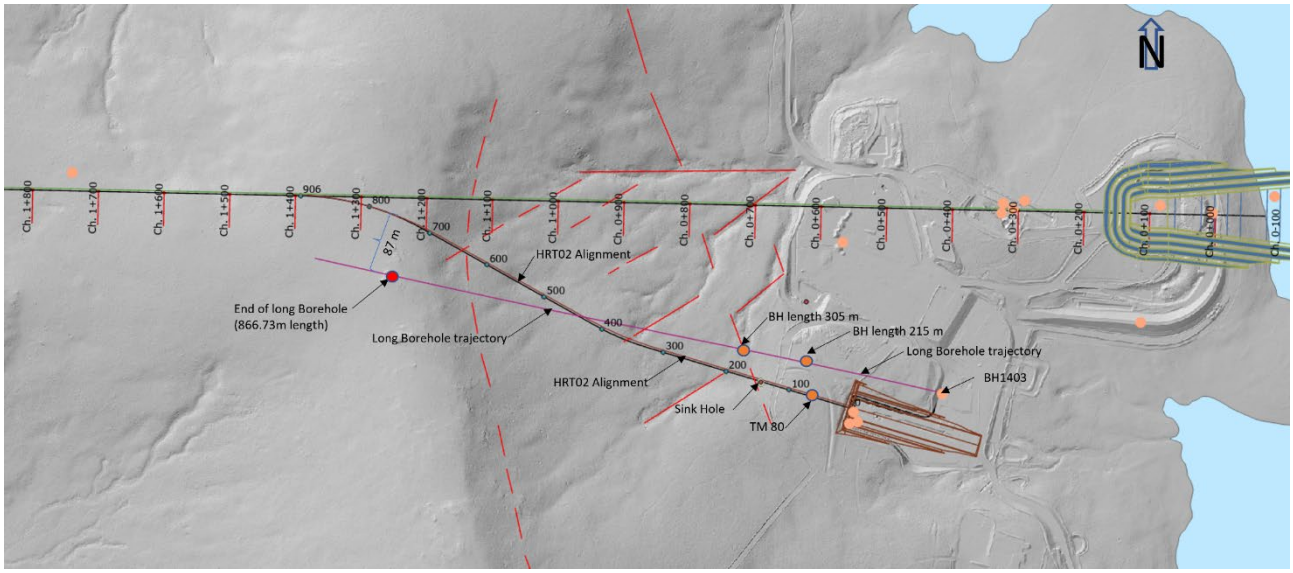


Figure 6.1 Long sub-horizontal borehole location

Geophysical surveys and geomorphological assessments were also carried out. The outcome of these assessments, along with the borehole investigations, have helped to identify the ground characteristics of the area in front of the TBM.

The geotechnical report (FGJV 2023) provides management measures for managing future sinkholes from reoccurring. These measures include ground consolidation from surface and from inside the TBM for the present location and the ability to switch the TBM between open and closed mode (or slurry mode) where required, so that it can navigate through different soil conditions. Details of these modes was provided in Section 1.4.3 and the geotechnical report (see Appendix A).

The additional management measures including grouting and switching the TBM between modes (open and closed/slurry mode) depending on the ground conditions will allow the TBM to move forward through the next 50 m of unconsolidated material without the risk of causing sinkholes or increasing the size of the existing sinkhole. After 50 m, the dominant lithology is slightly weathered rhyodacite which is good quality rock mass.

If required, further ground consolidation will be undertaken near the sinkhole from surface as the key measure to manage the unfavourable soil conditions and to assist the TBM to move forward from its current location. Consolidation will be done by injecting grout material which mainly consists of cement-bentonite slurry and sodium silicate solution. This mix is presently being used for tunnelling for Snowy 2.0.

Both the open and closed modes will help in manoeuvring the TBM in soft ground conditions, which is present 50 m in front of the TBM. The closed mode of the TBM provides additional support through soft ground conditions using a pressurized, bentonite slurry pumped into the excavation chamber, which will combat ground loss and the risk of future sink hole formation.

The long borehole reached a final length of 866.73 m from the portal in June 2023. After 305 m of borehole length and until the end of the borehole, the dominant lithology corresponds to slightly weathered rhyodacite which represents a good quality and competent rock mass for TBM excavation activities.

Due to the hard rock conditions following the unconsolidated zone and the progressively increasing cover from the tunnel level to surface, the potential risk of a sinkhole as a result of tunnelling becomes increasingly rare.

6.2 Biodiversity

6.2.1 Introduction

A biodiversity development assessment report (BDAR) has been prepared to assess the potential biodiversity impacts of MOD2. The BDAR can be found in Appendix B. This section provides a summary of the BDAR.

The BDAR has been prepared in accordance with relevant government assessment requirements, guidelines and policies, and in consultation with BCS. The NSW *Biodiversity Conservation Act 2016* (BC Act) requires that a modification of a CSSI project must be accompanied by a BDAR. The BDAR has been prepared in accordance with the Biodiversity Assessment Method (BAM) (DPIE 2020a).

The MOD2 area was also extensively assessed as a part of the BDAR undertaken for Snowy 2.0 Main Works (EMM 2019a), with detailed vegetation mapping and targeted flora surveys undertaken across the construction envelope and targeted fauna surveys undertaken in proximity and in equivalent habitat types.

The BDAR has been developed with the following objectives:

- describe biodiversity values of the study area
- assess the likelihood that threatened species and communities (threatened biodiversity) listed under the BC Act or Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) could occur in the study area
- document the strategies implemented to avoid and/or minimise impacts of the modification on threatened biodiversity
- assess residual threatened biodiversity impacts, after avoidance and minimisation strategies have been implemented
- provide environmental safeguards to mitigate threatened biodiversity impacts during construction and operation.

6.2.2 Baseline

The MOD2 area is located within the bioregion of Australian Alps IBRA (Interim Biogeographic Regionalisation of Australia) and Snowy Mountains subregion and within the Kings Cross Montane Bionet NSW Landscapes (formerly Mitchell Landscapes, OEH 2016a).

The waterbodies in the broader Main Works project area are within the Murrumbidgee catchment in the Australian Alps, south-eastern NSW. The Murrumbidgee catchment covers 84,000 km^2 of southern NSW. It is bordered by the Great Dividing Range to the east, the Lachlan Catchment to the north and the Murray Catchment to the south (NOW 2011). A first order stream is located within the MOD2 area. This stream connects to a second order stream before entering Tantangara Reservoir. This stream is unlikely to provide connectivity for aquatic and semi-aquatic species (such as fish and amphibians) or species which use linear features (such as birds and bats) to navigate. This is due to the absence of surface water flow.

The vegetation of MOD2 area, located at the southern end of Tantangara Reservoir, consists of grassy woodlands and grasslands that are moderately disturbed as a result of fire damage, historical clearing, weed invasion and heavy recreational use. In 2003, a large-scale bushfire burnt thousands of hectares within the Australian Alps, particularly affecting the Tantangara area. In 2019–2020 another bushfire impacted 231,000 ha of the KNP, but this fire did not burn the study area.

The Tantangara area is used regularly by campers, four-wheel-drive enthusiasts and fisherman, with impacts from these activities evident, including clearing of vegetation, prolific track creation and weed invasion. Feral horse numbers are also high in this area.

There are no areas of outstanding biodiversity value, as defined in Part 3 of the BC Act, and no areas of geological significance within the 1,500 m buffer of the Project area.

Extensive biodiversity surveys in and around the MOD2 area have been undertaken, including vegetation mapping and targeted flora and fauna surveys. These included surveys undertaken for Snowy 2.0 Main Works between December 2017 and June 2019, and recent surveys of the MOD2 area conducted on 22 March 2023.

Surveys identified the presence of two native plant community types (PCTs) within the MOD2 area:

- PCT 303 – Black Sally grassy low woodland in valleys in the upper slopes sub-region of the NSW Southwestern Slopes Bioregion and western Southeastern Highlands Bioregion.
- PCT 1224 – Sub-alpine dry grasslands and heathlands of valley slopes, southern Southeastern Highlands Bioregion and Australian Alps Bioregion.

No EPBC Act or BC Act listed threatened ecological communities (TECs) have been recorded in or surrounding the MOD2 area.

No threated flora or fauna species were recorded in or immediately surrounding the MOD2 area during the surveys for Snowy 2.0 Main Works between December 2017 and June 2019.

However, one threatened flora species with the potential to occur in the area, *Pimelea bracteata* was listed after the Snowy 2.0 Main Works biodiversity surveys were undertaken and was therefore surveyed for on 22 March 2023. While the plant was recorded in the vicinity of the MOD2 area during the survey, no plants were found within the MOD2 area.

While none were recorded within the MOD2 area during surveys, it does provide habitat for some threatened fauna species. These include the Alpine She-oak Skink and Broad-toothed Rat.

6.2.3 Assessment

The assessment includes a description of potential direct and in-direct impacts and their mitigation measures, serious and irreversible impacts, impacts requiring off-sets, likelihood of occurrence assessment and significant impacts assessment.

While there will be increase in the disturbance footprint due to MOD2, there will be no additional increase in the maximum native vegetation clearing limit of 425 ha already approved for Snowy 2.0 Main Works. Residual impacts of the MOD2 include direct loss of 0.63 ha of native vegetation and associated habitat for two threatened fauna species credit species (Alpine She-oak Skink and Broad-toothed Rat).

i Direct and indirect impacts

The main direct impacts will be clearing of 0.63 ha of native vegetation.

Indirect impacts that could occur if unmitigated include:

- increased noise, vibration and dust levels
- increase in weeds and pathogens
- increase in predatory and pest animal species
- potential inadvertent disturbance of adjacent habitats
- removal of habitat resources for threatened fauna
- runoff, scouring, erosion and sedimentation impacts.

Given the extent and duration of works, and existing impacts from Snowy 2.0 Main Works, works associated with MOD2 are not expected to significantly increase indirect impacts.

The direct impacts will be mitigated by following the below measures and updating the Biodiversity Management Plan (BMP) (FGJV 2020) prepared for Snowy 2.0 Main Works to include the MOD2 area. The mitigation measures for the indirect impacts are detailed out in Appendix B.

ii Serious and Irreversible impacts

One species was identified as candidate species for serious and irreversible impacts (SAII), as per Section 6.5 of the BC Act which is the Large Bent-winged Bat. No potential breeding features for the Large Bent-winged Bat were recorded within the study area. This species is not at risk of a SAII as a result of the proposed works as breeding habitat is unlikely to be affected. This species is therefore excluded from further assessment.

iii Impacts requiring offsets

Impacts to native vegetation requiring offsets include:

- Direct impacts on 0.55 ha of PCT 303 – Black Sally grassy low woodland in valleys in the upper slopes sub-region of the NSW South Western Slopes Bioregion and western South Eastern Highlands Bioregion.
- Direct impacts on 0.08 ha of PCT 1224 – Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion.

Impacts to threatened species habitat requiring offsets include:

- direct impacts to 0.08 ha of habitat for Alpine She-oak Skink
- direct impacts to 0.08 ha of habitat for Broad-toothed Rat.

While MOD2 will result in the clearance of a maximum of 0.63 ha of native vegetation, no modification of this clearing limit is required. This is because less native vegetation will be required to be cleared for the Main Works project compared to that area already approved to be cleared. As such, no changes to offset requirements for Snowy 2.0 are required.

iv Significant impacts assessment under EPBC Act

Significant impact assessments have been completed for six threatened species and one migratory species, considered to have potential to be impacted by MOD2 following the process outlined in the BDAR:

- Alpine She-oak Skink
- Broad-toothed Rat
- Brown Treecreeper (south-eastern)
- Diamond Firetail
- Satin Flycatcher (migratory)
- Spot-tailed Quoll (southeastern mainland population)
- White-throated Needletail.

The assessment concluded that a significant impact on matters of national environmental significance (MNES) was unlikely to result from cumulative impacts associated with Main Works, including the works proposed as part of MOD2.

v Biodiversity off-set strategy

Snowy Hydro and their contractor, FGJV, are currently well below the native vegetation clearing limits set out in the Snowy 2.0 Main Works approval. As such, impacts arising from MOD2 will be offset using the biodiversity offset payments set out in Conditions 12–14 of the approval. No additional payments or retirement of credits are required to offset the impacts of this modification.

6.3 Water

6.3.1 Introduction

A water assessment of MOD2 was undertaken by EMM and is contained in Appendix C. The report elaborates on the conceptual water model, water management methods and short- and long-term risk management methods. This section provides a summary of the outcomes of the water assessment.

6.3.2 Baseline

i Surface water

The MOD2 area is located to the west of Tantangara Reservoir within a vegetated area that falls steeply (approximately 1 in 4) to the north-east towards Tantangara Reservoir. There are two first order watercourses within the local area that also drain to the north-east, initially through the approved construction envelope before entering Tantangara Reservoir. The sinkhole is near one of these drainage lines. Figure 6.2 shows the location of the watercourses relative to the sinkhole and MOD2 area.

ii Groundwater

The groundwater units within the MOD2 area are defined as:

- a low permeability fractured rock groundwater system associated with the weathered and oxidised shallow component of the geology across the plateau area
- a low permeability regional fractured rock groundwater system associated with the volcanic and metasedimentary rock across the plateau area.

In addition, localised groundwater systems are associated with unconsolidated Quaternary alluvium and colluvium deposited in major creeks and river valleys, such as Nungar Creek to the west of the MOD2 area.

The fractured rock volcanic and metasedimentary rock is the main hydrogeological unit in the MOD2 area. The unit is accessed by various environmental users, including alpine bog/fen vegetation, deep rooted Eucalypt species and gaining creeks and rivers. There are no recorded third-party bores located within the area.

Groundwater levels within the MOD2 area are influenced by the relief and generally mirror the topography. Groundwater levels are above creek beds and therefore groundwater provides baseflow to all streams, termed gaining streams.

Regionally, across the plateau region, groundwater flow direction is west to east, toward Tantangara reservoir. Within the vicinity of the MOD2 area, local groundwater flow direction is again toward the east, influenced by a topographic high to the immediate west.

iii Water dependent receptors

Initial vegetation mapping was undertaken in support of Snowy 2.0 Main Works between August 2017 and March 2018. Further refinement of preliminary vegetation mapping was undertaken in November and December 2018. Additional surveys including scat searches were conducted adjacent to the MOD2 area on 22 March 2023.

EMM identified the presence of two PCTs within the MOD2 disturbance footprint. The total MOD2 project footprint supports 0.63 ha of native vegetation communities. Dominant vegetation communities include grassy woodlands including PCT 303 - Black Sally grassy low woodland in valleys in the upper slopes sub-region of the NSW South Western Slopes Bioregion and western South Eastern Highlands Bioregion and PCT 1224 – Sub-alpine dry grasslands and heathlands of valley slopes, southern South Eastern Highlands Bioregion and Australian Alps Bioregion.

The degree of groundwater dependence for most plant communities is influenced by climate and seasonality of rainfall. Groundwater dependency can therefore range from total reliance (i.e. obligate) to a proportional, opportunistic reliance, and in some cases are classified as groundwater dependent in certain environments.

The following PCT has been identified as GDEs:

- PCT 303 – Black Sally grassy low woodland in valleys in the upper slopes sub-region of the NSW South Western Slopes Bioregion and western South Eastern Highlands Bioregion.

This PCT was assessed as entirely/obligate and/or having facultative-opportunistic dependencies on groundwater:

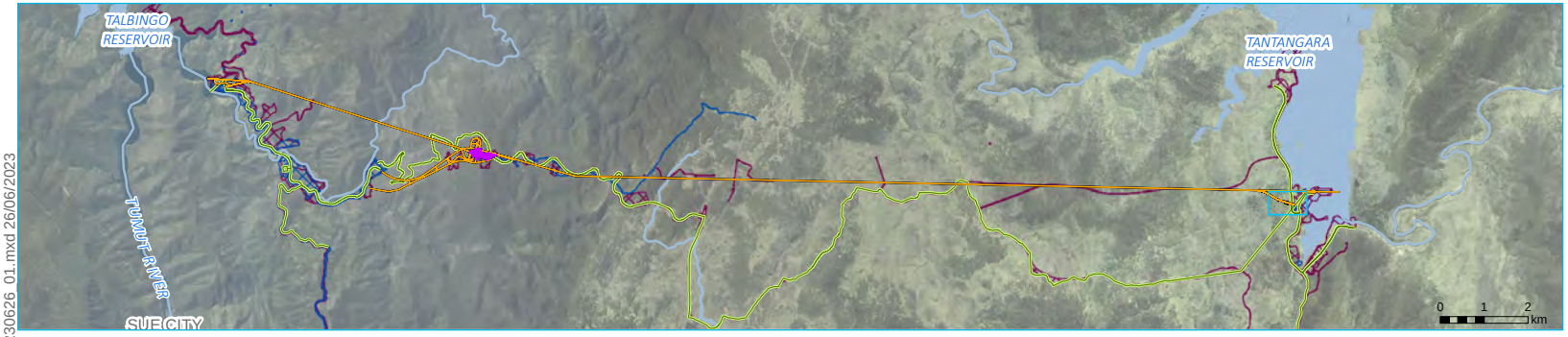
- Entirely/obligate: more than 50% of the PCT is mapped in areas with groundwater at 0.5 metres below ground level (m BGL) or less, or more than 75% of the PCT is mapped in areas with groundwater at 2 m BGL or less.
- Facultative-opportunistic: more than 50% of the PCT is mapped in areas with groundwater at 5 m BGL or less, but less than 75% of the PCT is mapped in areas with groundwater at 5 m BGL and/or less than 50% of the PCT is mapped in areas with groundwater at 2 m BGL.

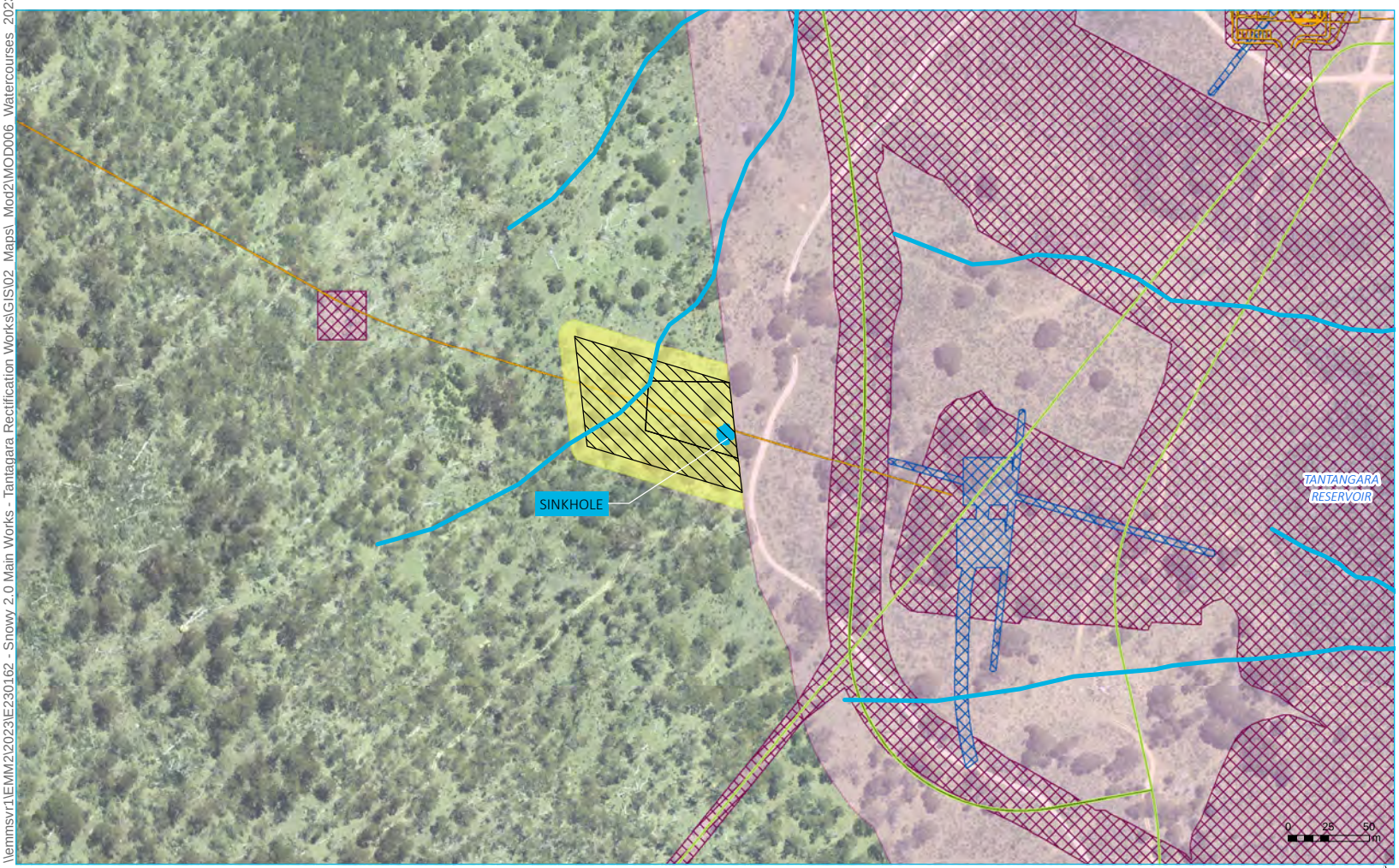
Targeted field surveys were undertaken to inform aspects of the aquatic ecology assessment and to characterise the aquatic flora and fauna within the Project area, with a focus on locations expected to be directly disturbed by Snowy 2.0 Main Works, and MOD2 by association (Appendix B). No aquatic GDEs were identified within the MOD2 project area.

6.3.3 Subterranean groundwater dependent ecosystems

A stygofauna assessment was undertaken by Macquarie University (2019) at 16 sites located within 2 km of the Main Works project alignment. These include existing monitoring bores installed within fractured rock aquifers (subsurface phreatic aquifer ecosystems – 11 sites) at various depths, as well as colluvial aquifers associated with the alpine bogs and fens (baseflow stream hyporheic ecosystems – five sites).

There were no obligate stygofauna species obtained from samples collected in bores established in the KPV, nor were any observed at shallow monitoring sites established in Nungar Creek.





KEY

- First order watersources (DCSSS, 2023)
- Sinkhole
- Indicative additional disturbance area
- Proposed additional construction envelope
- Exploratory Works disturbance area
- Main Works disturbance area

Snowy 2.0 operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Watercourse
- Waterbodies

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.
Note that the Approved Exploratory Works disturbance area (SSI 9208) will also be a disturbance area for Main Works, even following surrender of the Exploratory Works Approval. The cumulative disturbance area for the Main Works and approved Exploratory Works is therefore presented in this figure.

\\emmsvr1\EMM2\2023\E230162 - Snowy 2.0 Main Works - Tantagara Rectification Works\GIS\02 Maps\ Mod2\MOD006 Watercourses 20230626 01.mxd 26/06/2023

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); (DCSSS, 2023), LPMA (2011); FGJV (2023)

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Location of water courses relative to MOD2 area

Snowy 2.0

Proposed modification (MOD2) to Snowy 2.0 Main Works infrastructure approval (CSSI-9687) for Tantangara rectification works

Figure 6.2

snowy2.0

EMM creating opportunities

6.3.4 Assessment

The following aspects of MOD2 have been addressed in the water assessment:

- assessment of environmental and human users dependent on groundwater, including:
  - terrestrial, subterranean and aquatic groundwater dependent ecosystems (GDEs)
  - landholder water supplies
- management of groundwater during MOD2 works, including:
  - consideration of ground consolidation, sinkhole rehabilitation and the TBM slurry mode influence on groundwater inflow and environmental impacts
  - changes to water quality due to construction
- assessment of the Project against the assessment requirements of the NSW *Aquifer interference Policy 2012* (AIP), including:
  - consideration for the minimal impact criteria, as it relates to groundwater pressures, levels and quality
  - consideration for impacts to high priority (as defined by relevant water sharing plans) listed Groundwater Dependent Ecosystems (GDEs)
- water management during the proposed works and modification to the TBM operation (i.e. use of closed or slurry mode).

i Water model

An EIS was prepared by EMM in 2019 in support of the application for Snowy 2.0 Main Works (EMM 2019c). The EIS included an integrated assessment of construction and operational impacts on water resources across the Snowy 2.0 Main Works project area (EMM 2019b).

Numerical modelling was used in the assessment to predict potential changes in groundwater and surface water resources. Groundwater flow into the subsurface Main Works project elements (i.e. power waterways, power station etc.) was expected to occur primarily as a function of secondary porosity (i.e. via fractures and along bedding planes). Groundwater modelling predicted localised watertable drawdown in the vicinity of the Main Works project area, throughout construction and operation. Watertable drawdown was predicted to extend approximately 1.5 km north and south of Main Works project within the plateau area, east of the Snowy Mountains Highway, once the Main Works project had advanced into year 5 of construction and into operations. Watertable drawdown across the ravine area (west of the Snowy Mountains Highway) was predicted to be less extensive and restricted to less than 100 m from the Snowy 2.0 Main Works project infrastructure.

Based on the model, watertable drawdown was predicted to affect terrestrial, aquatic and subterranean GDEs, and reduce groundwater availability for baseflow to rivers and creeks. The modelled reduction in baseflow was predicted to have the greatest effect to Gooandra Creek and the upper reaches of the Eucumbene River. The predicted effects would be localised to the area directly overlying the drawdown zone and are not predicted to significantly affect downstream reaches of these watercourses. Snowy 2.0 is not predicted to impact the Yarrangobilly Caves or any groundwater/surface water users.

With respect to the works directly adjacent to Tantangara Reservoir and in the vicinity of the MOD2 Project area, the following predictions are noted:

- Within two years of construction, significant (>2 m) watertable drawdown is predicted between Tantangara Reservoir and Nungar Creek; associated with the construction of the HRT and Tantangara HRT adit. The model simulates the geological unit (KPV) intercepted by the Project at this location to have a much higher permeability (consistent with values estimated from field assessments). After three years of construction the drawdown footprint associated with the KPV increases to approximately 1 km north and south of the HRT and expands immediately above the HRT to over 50 m from the HRT alignment. After five years of construction the KPV drawdown is predicted to further expand to approximately 1.5 km north and south of the HRT alignment.

- Modelled baseflow reduction to Nungar Creek is predicted to be negligible (-0.9%) and as such, aquatic fauna is not anticipated to be impacted in this area.

- Terrestrial vegetation mapped being entirely dependent on groundwater are predicted to be impacted, with the overall risk to the listed community considered low. Vegetation community inferred as being entirely dependent on groundwater include PCT 303.

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

- Water quality impacts, arising through uncontrolled releases of stormwater or catchment runoff, is characterised as having a low potential to impact Nungar Creek, Kellys Plains Creek and Tantangara Reservoir, subject to the performance of water treatment and implementation of erosion and sediment control measures.

- Potential acid forming (PAF) rock was intersected through drilling investigations in the KPV or Peppercorn Formation, with only one sample retrieved from the Tantangara Formation (BH2102), intercepting PAF material. This low level can be mixed with NAF material to neutralise. Acid mine drainage (AMD) potential within this area was therefore characterised as low.

ii Flooding assessment

Instream works and disturbance of waterfront land have the potential to affect the flood regime within the Yarrangobilly River (including Lobs Hole), Kellys Plains Creek, and the Rock Forest area. The flooding assessment identified that increases in flood water level would be limited to locations in the immediate vicinity of the Snowy 2.0 Main Works project area. No increase in flood risk to private property was identified. No change to total flood runoff will occur. Talbingo and Tantangara reservoirs will receive the same volumes of flood water that they would in the absence of the main works project.

As per Main Works water assessment report (EMM 2019b), infrastructure will unavoidably need to be constructed on flood prone land in the ravine area, particularly around Lobs Hole. This includes temporary infrastructure (e.g. associated with construction phase works, such as the western and eastern emplacement areas) and permanent infrastructure (e.g. Camp Bridge, Wallaces Bridge and paved access roads). Project infrastructure placed for both Main Works and for this Project on flood prone land will be designed to be flood resistant.

iii Water management

The MOD2 Project area is located adjacent to the Tantangara construction worksite, which has an established water management system and operating protocols. It is proposed that the water management system and methods that have been established for the Tantangara construction worksite will be applied to MOD2.

Surface water runoff from the area disturbed by MOD2 will be managed in accordance with the methods recommended in *Managing Urban Stormwater: Volume 1* (Landcom 2004). An erosion and sediment control plan will be prepared as part of the WMP for Snowy 2.0.

FGJV operate a construction water management system at the Tantangara construction worksite. The purpose of this system is to supply water to, and manage water produced by, construction activities, which includes dewatering groundwater that accumulates in the HRT sumps. Surplus water from the system is treated by an advanced water treatment plant and is discharged to Tantangara Reservoir or re-used on-site for dust suppression. Discharges to Tantangara Reservoir are regulated by EPL 21266.

Snowy Hydro also holds a surface water entitlement to extract water from Tantangara Reservoir to top up the construction water system as required. The existing construction water management system is currently operating well below its design capacity and can therefore supply water to and manage any water produced by the proposed rectification works without any material changes to either the system or existing regulatory arrangements (i.e. EPL and water access entitlements).

Groundwater inflows into the HRT are managed by the construction water management system. Groundwater recharge is predominantly from infiltration of rainfall and snow melt. Recharge is higher when the soil and weathered rock is saturated which generally occurs during winter and spring or following significant rainfall events.

Any wastes produced by the proposed rectification works will be transferred to the Tantangara construction worksite where they will be managed using existing infrastructure and established protocols.

iv Impacts on water due to MOD2

The MOD2 works are not anticipated to impact groundwater. The proposed ground consolidation works will interact with groundwater, impeding groundwater flow and potentially influencing water chemistry, however this effect is anticipated to be very local and negligible. Further, any potential impact from the activity is not anticipated to have an indirect impact on identified sensitive receptors. The sinkhole rehabilitation works will not interact with groundwater. The modification of the TBM to enable slurry mode is not anticipated to impact groundwater.

The sinkhole is not located online to any watercourse or drainage line, therefore no impacts on surface water is envisaged. Hence, the capture of surface runoff is limited to direct rainfall and runoff from a small area that adjoins the sinkhole. Once the sinkhole is backfilled the natural catchment will be restored. The proposed backfill material for the sinkhole material is mainly stone material, grout and concrete, and will not affect the surface water in the area. The water assessment did not identify any material risks to the surface water environment.

6.4 Heritage

This section provides a summary of the results of the Aboriginal cultural heritage assessment (ACHA) (New South Wales Archaeology 2019a) and historic heritage impact assessment (HHIA) for Snowy 2.0 Main Works (New South Wales Archaeology 2019b).

The area of the MOD2 was surveyed and assessed as part of the ACHA and HHIA. The surveys for the ACHA were undertaken in conjunction with representatives from local Aboriginal groups.

This section was prepared based on advice provided by New South Wales Archaeology.

6.4.1 Aboriginal Heritage

i Baseline

The area of the MOD2 was surveyed and assessed as part of the Aboriginal cultural heritage assessment for Snowy 2.0 Main Works (NSWA 2019a). These surveys were undertaken in conjunction with representatives from local Aboriginal groups.

The entire MOD2 area was subject to a comprehensive field survey. This Project area includes parts of Survey Unit 2 (the very west end), and Survey Unit 7. These areas are summarised:

- TSU2 comprises a gently undulating crest of a northeast facing spur. Numerous low density stone artefact scatters were recorded in TSU2. In addition, test excavations were conducted across the landform including in an area c. 65 m south-east of the sinkhole. The artefact density in TSU2 is assessed to be low.
- In accordance with conditions of the Snowy 2.0 Main Works approval, impact mitigation (salvage excavation) has been carried out in TSU2 approximately 50 m south-east of the sinkhole.
- TSU7 comprises a series of gentle to very gentle gradient simple slopes. Numerous low density artefact scatters were recorded in TSU7, all well to the north of this Project area. The predicted artefact density in TSU7 is negligible or very low. Given TSU7 is assessed to be of low significance, the Snowy 2.0 Main Works management and mitigation measure for TSU7 is unmitigated impact.

ii Assessment

The area of the MOD2 works was comprehensively surveyed and assessed as part of the Aboriginal cultural heritage assessment for Snowy 2.0 Main Works (New South Wales Archaeology 2019a). These surveys were undertaken in conjunction with representatives from local Aboriginal groups.

The MOD2 area includes parts of Survey Unit 2 (the very west end), and Survey Unit 7.

The proposed remediation and consolidation work around the sinkhole is small in area and will impact a section of the very west end of TSU2 and a small area TSU7. Both TSU2 and TSU7 are assessed to be of low significance.

The assessment of impact in the Survey Unit areas is presented below:

- TSU2: Test and salvage excavations conducted in an area c. 65 m south-east of the sinkhole has confirmed the low artefact density and significance of TSU2. Impact mitigation (salvage excavation) in accordance with the conditions of the Snowy 2.0 Main Works approval has already been conducted in TSU2. Accordingly, no further impact mitigation work is warranted in respect of the proposed works in TSU2.
- TSU7: The predicted artefact density in TSU7 is negligible or very low. Given TSU7 is assessed to be of low significance, unmitigated impact is appropriate in respect of the proposed works.

6.4.2 Historic heritage

i Baseline

The MOD2 area forms part of two listings on the Australian Heritage Database (AHD), as follows:

- Australian Alps National Parks and Reserves (AANP) – Place ID 05891
- the Snowy Mountains Scheme – Place ID 105919.

National heritage places are protected under the EPBC Act and are deemed MNES under the EPBC Act. The AANP is the mountainous bioregion that extends over NSW, ACT and Victoria. The AANP has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural and cultural history. The AANP is part of a unique Australian mountainous region. Human interaction with the region has been distinctive in its response to the challenges and opportunities presented by the unique environment (Commonwealth of Australia Gazette 7 Nov. 2008). The key components of the AANP national environmental significance are described in detail in Section 11.2 of the Snowy 2.0 Main Works EIS. The Kosciuszko National Park (KNP) is not listed as a National Heritage place individually but is one of the 11 national parks and reserves that comprise the AANP.

The Snowy Mountains Hydro-electric Scheme (Snowy Scheme) was established by the Commonwealth in July 1949. The first power project within the scheme commenced operation in 1955 and the works were largely completed by 1974. The Snowy Scheme was and remains one of the largest engineering and construction projects in the world. The scheme consists of a network of reservoirs, tunnels, pipes and power stations in the Snowy Mountains of New South Wales. It is the largest public works engineering scheme ever undertaken in Australia. It is nationally significant for its engineering success and as a symbol of Australian achievement (Commonwealth of Australia Gazette 14 October 2016).

There are no World Heritage List (WHL), Commonwealth Heritage List (CHL), State Heritage Register (SHR) or locally listed heritage items within or proximate to the area of MOD2 works.

The area of MOD2 works was surveyed and assessed as part of the historic heritage assessment for Snowy 2.0 Main Works (New South Wales Archaeology 2019b). Numerous historic heritage items or relics were found in the development area at Tantangara. However, none of these occur within MOD2 area.

The historic heritage recorded at Tantangara relates to pastoralism and summer grazing, mining and the construction of Tantangara Reservoir, a component of the Snowy Scheme. The sites closest to MOD2 area are listed as follows:

- E17 shallow costeans
- E18 Surveying trig associated with the Snowy Scheme
- E19 remnant stock fencing.

In summary, a comprehensive field survey has encompassed MOD2 area and no historic heritage items or values are present or likely to be impacted.

ii Assessment

A formal impact assessment presented in the Snowy 2.0 Main Works EIS concluded that the Snowy 2.0 Main Works project would have a minor impact on AANP values through ground disturbance activities within the Project disturbance footprint to natural and heritage landscape characteristics through constructed project elements. The formal impact assessment concluded that proposed impacts are within a manageable framework that would be minimised and result in only limited loss of official values, which will be confined to the areas within the Project disturbance footprint and vantage points overlooking the affected landscapes.

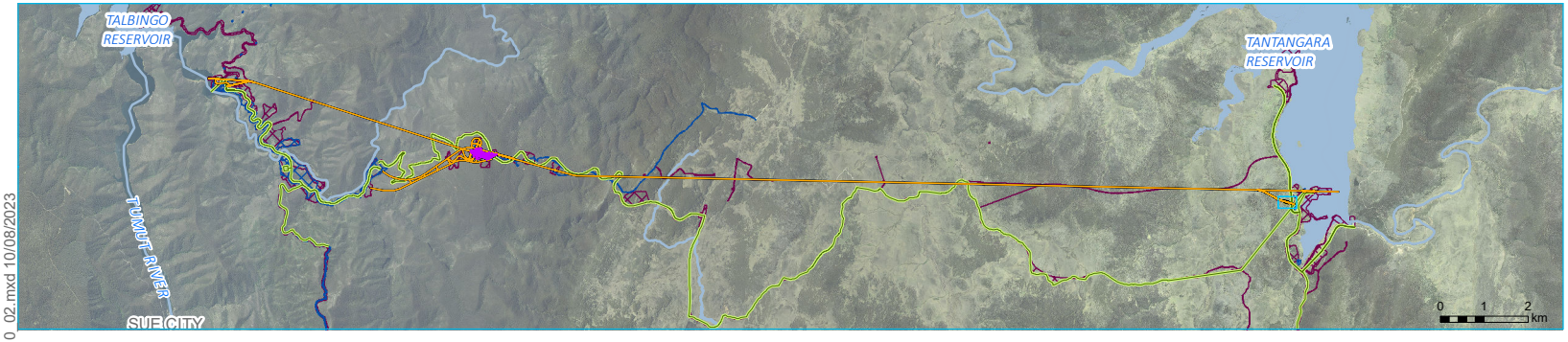
The proposed works are minor in area and nature, and it is concluded that impacts on AANP values can be considered negligible.

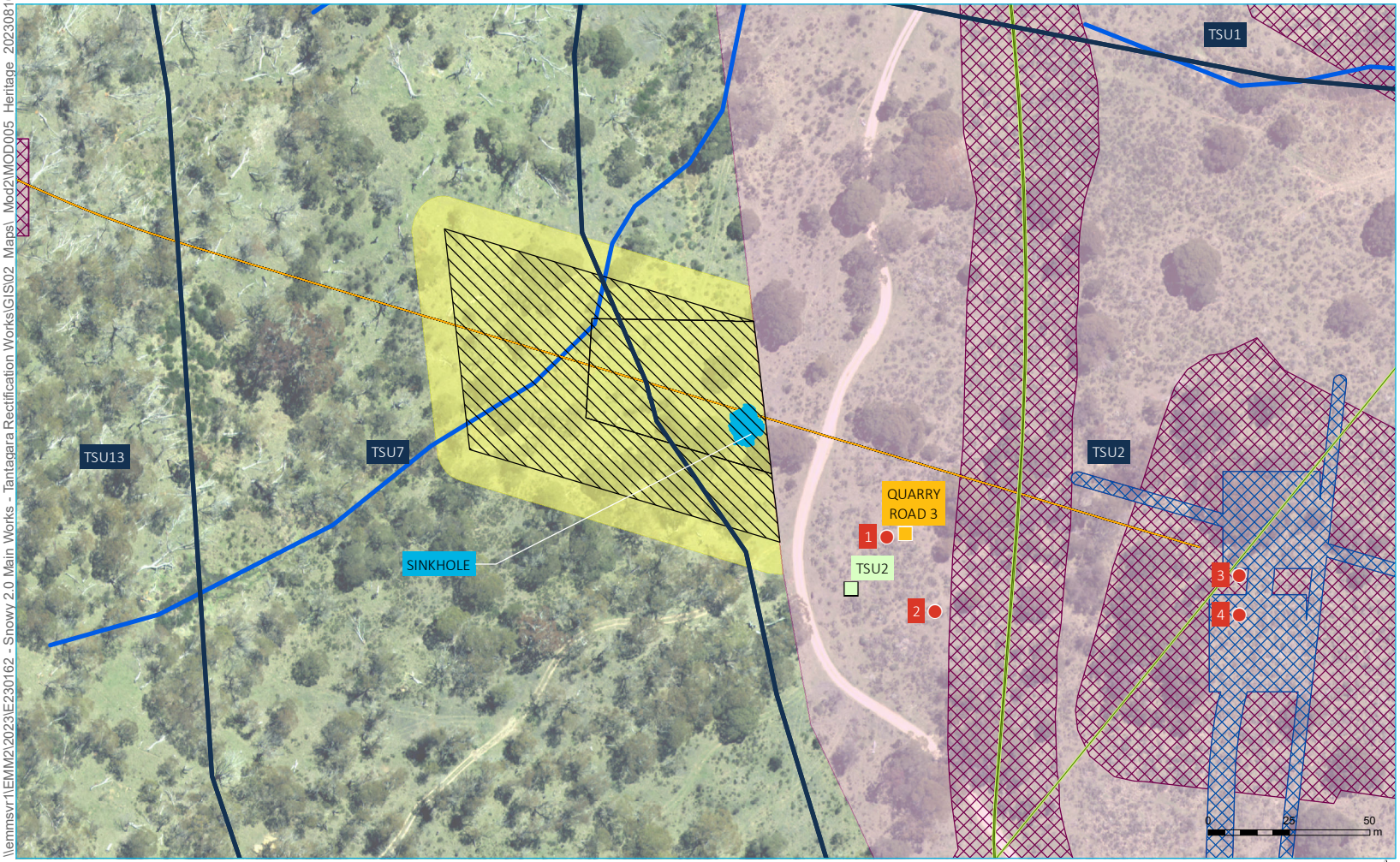
The Project is assessed to have a direct positive on the National Heritage values of the Snowy Scheme through further developing the civil engineering project stated in 1949 and is likely to reignite an interest in the scheme and its symbolism relating to a multicultural, independent and resourceful Australian identity. Overall, the Project represents an expansion of a major engineering achievement which is a key value of the Snowy Scheme.

The proposed works will have no negative impacts to the National Heritage values of the Snowy Scheme.

A comprehensive field survey has encompassed the MOD2 area and no historic heritage items or values are present or are likely to be impacted.

The proposed works will have no impact on the values of the Nationally listed AANP. In addition, no impacts will occur to any historic heritage items or relics.





KEY

- Test transects
- Salvage site
- AHIMS
- First order watersources (DCSSS, 2023)
- Sinkhole
- Indicative additional disturbance area
- Proposed additional construction envelope
- Exploratory Works disturbance area
- Main Works disturbance area
- Heritage survey unit

Snowy 2.0 operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Watercourse
- Waterbodies

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.
Note that the Approved Exploratory Works disturbance area (SSI 9208) will also be a disturbance area for Main Works, even following surrender of the Exploratory Works Approval. The cumulative disturbance area for the Main Works and approved Exploratory Works is therefore presented in this figure.

\\emmsvr1\EMM\2023\E230162 - Snowy 2.0 Main Works - Tantagara Rectification Works\GIS\02 Maps\ Mod2\MOD005 Heritage 20230810 02.mxd 10/08/2023

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); (DCSSS, 2023), LPMA (2011); FGJV (2023)

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Heritage sites in and around the sink hole

Snowy 2.0

Proposed modification (MOD2) to Snowy 2.0 Main Works infrastructure approval (CSSI-9687) for Tantangara rectification works

Figure 6.3

snowy 2.0

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7 Justification and conclusion

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 VRE, coal power station retirements, increasing coal and gas costs and Australia's participation in global commitments to reduce carbon emissions. This transformation is creating a need for large scale energy storage projects such as Snowy 2.0.

Snowy 2.0 is the largest committed renewable energy project in Australia. By expanding the current Snowy Scheme's renewable energy capacity by almost 50%, the NEM will be served with an additional 2,000 MW of on-demand generating capacity and large-scale storage. It is expected to generate around 350,000 MWh of large-scale storage to the NEM over a seven-day period.

In March 2022, TBM operations commenced at the Tantangara HRT adit portal. Around May 2022, the TBM began encountering adverse geological conditions, which can be broadly characterised as unstable sub-surface materials. In December 2022, a sinkhole formed at the surface near the adit portal and TBM operations were suspended.

TBM Florence is one of three TBMs that is being used to undertake tunnelling of Snowy 2.0. It is essential that the TBM operations recommence to carry out the tunnelling the HRT connecting Tantangara reservoir with Snowy 2.0's power station. Afterwards operation of Snowy 2.0 can commence with the transfer of water through a series of newly established power waterway tunnels and the underground power station to provide for energy generation, as well as large-scale energy storage.

TBM Florence can only move if the loose ground in front of it is consolidated through grouting. This will enable the TBM to operate between open and closed mode (or slurry mode) to enable it to tunnel through the unconsolidated ground in front of it.

Since March 2023, FGJV has been undertaking ground consolidation works around the cutting head of the TBM by grouting the unstable sub-surface materials. The aim of these works is to stabilise the ground matrix sufficiently so that material will not fall into the TBM cutting head. These ground stabilisation works have been undertaken from the surface inside the approved construction envelope and from within the TBM. However, depending on the outcome of the works, further ground consolidation may also be required to be undertaken from the surface outside the construction envelope directly above the TBM cutting head.

Since February 2023, FGJV has also undertaken a range of geotechnical investigations around the TBM and the HRT adit portal. This was done through surface boreholes and a sub-horizontal borehole aligned to the path of the TBM. The geotechnical investigations were undertaken to improve the knowledge of the actual geotechnical conditions in the MOD2 area and Tantangara HRT adit, including importantly, ground stability. It allows implementation of the most effective technical solutions for the continuation of the tunnelling works, increasing the safety of personnel and minimising the risk of further sinkholes and subsidence related impacts.

Snowy Hydro proposes to modify the Snowy 2.0 Main Works infrastructure approval under Section 5.25 of the EP&A Act to facilitate the rehabilitation of the sinkhole and undertake the ground consolidation works from the surface, only if required. These works would be undertaken within the modified construction envelope for Snowy 2.0. The proposed modification will be the second modification (MOD2) to Infrastructure Approval SSI-9687.

A geotechnical report of MOD2 has been prepared by FGJV and reviewed by SYSTRA Bamser. The report includes the results of the recent geotechnical investigations, including the drilling of the additional boreholes inside the approved construction boundary. The boreholes indicate that there is 50 m of soft unconsolidated ground ahead of the TBM followed by good quality rock mass.

The geotechnical report provides management measures for preventing future sinkholes from occurring. These measures include pre grouting from the TBM, canopy tubes, conveyor belt scales, ground consolidation and switching the TBM from open mode to closed mode (slurry mode). Switching the TBM between open and closed mode as per the ground conditions will allow the TBM to move forward through the next 50 m of unconsolidated material without the risk of causing sinkholes or increasing the size of the existing sinkhole. After 50 m, the TBM can be switched back to open mode again to allow it to tunnel through the rock without risk of subsidence related impacts. Due to the hard rock conditions following the unconsolidated zone and the progressively increasing cover from the tunnel level to surface, the potential risk of a sinkhole becomes increasingly rare.

The BDAR shows that MOD2 will not have any significant impacts in biodiversity. It will result in clearing 0.63 ha of vegetation area to allow remediation works to take place.

Under the Snowy 2.0 Main Works approval, Exploratory Works and Main Works can clear up to 532 ha of native vegetation. While MOD2 will result in the clearance of a maximum of 0.63 ha of native vegetation, no modification of this clearing limit is required. This is because less native vegetation will be required to be cleared for the Main Works project compared to that area approved to be cleared. As such, no changes to offset requirements for Snowy 2.0 are required.

The water assessment does not anticipate any impacts to groundwater as a result of MOD2. The proposed ground consolidation works will interact with groundwater, impeding groundwater flow and potentially influencing water chemistry, however this effect is anticipated to be very local and negligible. Further, any potential impact from the activity is not anticipated to have an indirect impact on identified sensitive receptors. The sinkhole rehabilitation works will not interact with groundwater.

The modification of the TBM to closed mode is not anticipated to impact groundwater.

The water assessment does not identify any material risks to the surface water environment. The MOD2 area is located adjacent to the much larger Tantangara construction worksite, which has an established water management system and operating protocols. It is proposed that the water management system and methods that have been established for the Tantangara construction worksite will be applied to the MOD2 works. The existing construction water management system at the Tantangara construction worksite is currently operating well below its design capacity and can therefore supply water to and manage any water produced by the proposed works without any material changes to either the system or existing regulatory arrangements.

The area of the MOD2 was surveyed and assessed as part of the ACHA and HHIA for Snowy 2.0 Main Works. These assessments demonstrate that there will be no impacts on historic heritage values and minimal impacts to Aboriginal heritage as a result of MOD2. An extensive program of Aboriginal heritage impact mitigation has been undertaken previously and no further works are justified.

All other impacts would be negligible in the context of the existing construction of Snowy 2.0 Main Works and would be managed in accordance with the strict controls set out in the approved management plans.

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Appendix A
Geotechnical report

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Appendix B

Biodiversity development assessment report

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Appendix C
Water assessment

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