APPENDIX U

HAZARD AND RISK ASSESSMENT

SNOWY 2.0

RISK ASSESSMENT

MAIN WORKS CONSTRUCTION AND OPERATIONAL PHASES

EMM CONSULTING PTY LTD

PREPARED FOR: **Lawrence Wallis**
EMM - Environmental Scientist

DOCUMENT NO: **21337-RP-001**
REVISION: **1**
DATE: **13-Sep-2019**

Sherpa Consulting Pty Ltd (ABN 40 110 961 898)
Phone: 61 2 9412 4555
Web: www.sherpaconsulting.com

DOCUMENT REVISION RECORD

Rev	Date	Description	Prepared	Checked	Approved	Method of issue
DRAFT	04-Jul-19	Draft for internal review	K. Loh	-	-	-
A	08-Jul-19	Issued to Client for comments Section 2 to 7	K. Loh	G. Peach	G. Peach	Email PDF
B	12-Aug-19	Re-issued for review	G. Peach	P. Johnson	G. Peach	Email PDF
C	03-Sep-19	Re-issued for review (change of scope due to SEARs)	G. Peach V. Bhasin	P. Johnson	G. Peach	Email PDF
0	11-Sep-19	Updated with minor comments from EMM	P. Johnson	G. Peach	G. Peach	Email PDF
1	13-Sep-19	Updated with minor comments from EMM	P. Johnson V Bhasin	G. Peach	G. Peach	Email PDF

Title: **Snowy 2.0** **Risk Assessment** **Main Works Construction and Operational Phases**	**QA verified:** H de Vries **Date: 13-Sep-2019**

CONTENTS

TABLES

FIGURES

ABBREVIATIONS

ADGC	Australian Dangerous Goods Code
AHD	Australian Height Datum
AN	Ammonium Nitrate
ANE	Ammonium Nitrate Emulsion
AS	Australian Standard
CSSI	Critical State Significant Infrastructure
DoEE	Commonwealth Department of Environment and Energy
DG	Dangerous Goods
DPIE	NSW Department of Planning, Industry and Environment
EMM	EMM Consulting Pty Ltd
EP&A Act	*NSW Environmental Planning and Assessment Act 1979*
EIS	Environmental Impact Statement
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence
ECVT	Emergency egress, cable and ventilation tunnel
FSL	Full Supply Level
GHS	Globally Harmonized System
GWh	Gigawatt hours
HIPAP	Hazardous Industry Planning Advisory Paper
KNP	Kosciuszko National Park
LGA	Local Government Areas
MAT	Main access tunnel
MW	Megawatts
NEM	National Electricity Market
NEQ	Net Explosive Quantity
NSW	New South Wales
PG	Packing group
PHA	Preliminary Hazard Analysis
SDS	Safety Data Sheet
SHC Act	*Snowy Hydro Corporatisation Act 1997*
Sherpa	Sherpa Consulting Pty Ltd
Snowy Hydro	Snowy Hydro Limited
Snowy Scheme	Snowy Mountains Hydro-electric Scheme
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SRD	State and Regional Development
TNT	Trinitrotoluene
UN	United Nations

1. SUMMARY

1.1. Background

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

EMM Consulting Pty Ltd (EMM) was retained by the project to develop the Environmental Impact Statement (EIS) for the Main Works. EMM has engaged Sherpa Consulting Pty Ltd (Sherpa) to conduct a risk assessment for the Main Works construction and operational phases.

The Main Works phase of the project covers the major construction elements of Snowy 2.0, including permanent infrastructure (such as the underground power station, power waterways, access tunnels, chambers and shafts), temporary construction infrastructure (such as construction sites, construction compounds and accommodation), management and storage of extracted rock material and establishing supporting infrastructure (such as road upgrades and extensions, water and sewage treatment infrastructure, and the provision of construction power). Snowy 2.0 Main Works also includes the operation of Snowy 2.0.

The risk assessment was conducted to AS/ISO 31000:2018 Risk Management Guidelines.

1.2. Context

The context of the risk assessment was set by the project Secretary's Environmental Assessment Requirements (SEARs) to undertake an assessment of:

- any potentially hazardous impacts of the project
- any public safety risks, including bushfires and flooding risks.

The assessment covers acute safety impacts to the public due to the construction and operation of the Main Works.

Other aspects of risk are managed as follows:

- Bushfire and flooding risks are covered in stand-alone EIS reports.
- Onsite risks to employees and those directly engaged during the construction and operations phase is managed under the *NSW Workplace Health and Safety Act*.
- Chronic effects are covered under the air quality impact assessment (Appendix V of the EIS).
- Environmental risks are covered under other sections of the EIS.

1.3. Hazard Identification and Risk Assessment

A Hazard Identification (HAZID) and risk assessment was completed for the proposed construction and operation phases of the Main Works.

In the construction phase the HAZID identified the storage and transport of explosives as a potentially hazardous scenario and potential risks to the public if they entered the construction area.

The risk due to storage of explosives was assessed quantitatively and the study concluded that whilst offsite consequences were credible, the risk met the NSW Department of Planning Land Use Planning Risk Criteria (NSW DPIE HIPAP 4 *Risk Criteria for Land Use Safety Planning*, Ref [1]).

The transport of explosives was qualitatively assessed. The risk will be managed by adherence to the Australian Dangerous Goods Code for the transport of dangerous goods.

The risk to the public, in the event they access a construction site, will be managed by site security arrangements.

In the operation phase the HAZID identified the storage of diesel and public access to the operational sites as potentially hazardous scenarios with risk to the public. The risks were qualitatively assessed.

The operational risks will be managed by segregation of diesel storage from the storage of flammable goods to prevent an escalation to a diesel incident. Public access will be managed by the design of the operational sites post rehabilitation and existing Snowy Hydro controls.

1.4. Conclusions

A risk assessment to AS/ISO 31000:2018 Risk Management Guidelines, Ref [2], has been undertaken for the construction and operations phase of the project. The risk assessment has identified and assessed potentially hazardous scenarios and risk to the public in the context of acute safety consequences.

The risk assessment identified the storage of explosives during construction as presenting potentially hazardous scenarios and demonstrated that the risks comply with the consequence and likelihood criteria in HIPAP 4.

The remaining risks associated with routine operations were qualitatively assessed. These risks are well understood and managed by adherence to codes and standards and Snowy operating procedures and controls that are in place for similar facilities.

It is concluded that the potentially hazardous scenarios and risk to the public associated with the Main Works for Snowy 2.0 comply with land use planning risk criteria and safeguards are in place to manage the residual risk.

2. INTRODUCTION

2.1. Background

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large-scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme). Snowy 2.0 is the largest committed renewable energy project in Australia and is critical to underpinning system security and reliability as Australia transitions to a decarbonised economy. Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and a new hydro-electric power station will be built underground.

Snowy 2.0 has been declared to be State Significant Infrastructure (SSI) and Critical State Significant Infrastructure (CSSI) by the former NSW Minister for Planning under Part 5 of the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act) and is defined in clause 9 of Schedule 5 of the State *Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). CSSI is infrastructure that is deemed by the NSW Minister to be essential for the State for economic, environmental or social reasons. An application for CSSI must be accompanied by an environmental impact statement (EIS).

Separate applications are being submitted by Snowy Hydro for different stages of Snowy 2.0 under Part 5, Division 5.2 of the EP&A Act. This includes the preceding first stage of Snowy 2.0, Exploratory Works for Snowy 2.0 (the Exploratory Works) and the stage subject of this current application, Snowy 2.0 Main Works (the Main Works). In addition, an application under Part 5, Division 5.2 of the EP&A Act is also being submitted by Snowy Hydro for a segment factory that will make tunnel segments for both the Exploratory Works and Main Works stages of Snowy 2.0.

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

This risk assessment has been prepared to accompany an application and supporting EIS for the **Snowy 2.0 Main Works**. This stage of the project covers the major construction elements of Snowy 2.0, including permanent infrastructure (such as the underground power station, power waterways, access tunnels, chambers and shafts), temporary construction infrastructure (such as construction audits, construction compounds and accommodation), management and storage of extracted rock material and establishing supporting infrastructure (such as road upgrades and extensions, water and sewage treatment infrastructure, and the provision of construction power). Snowy 2.0 Main Works also includes the operation of Snowy 2.0.

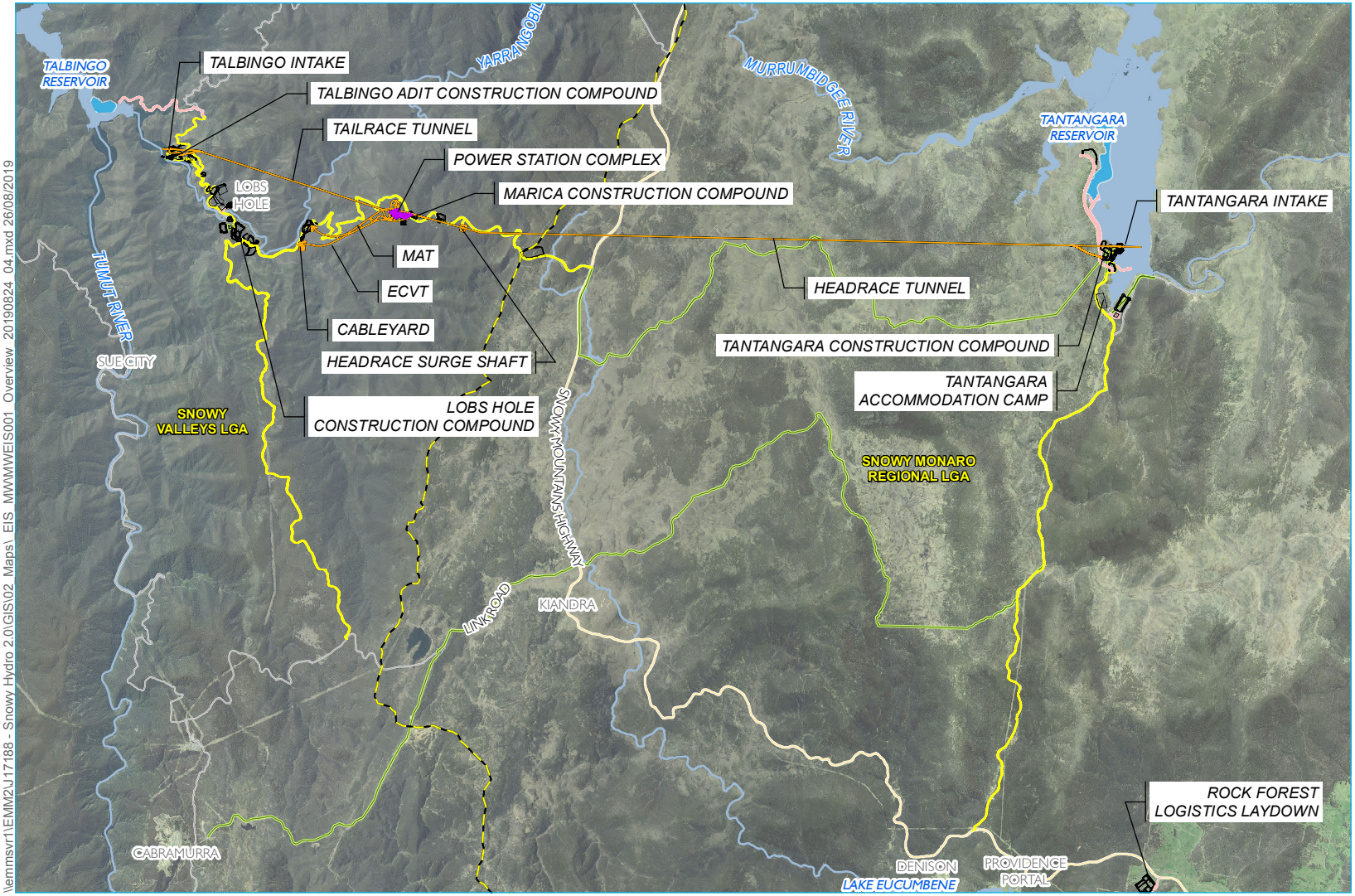
Snowy 2.0 Main Works is shown in Figure 2.1. If approved, the Snowy 2.0 Main Works would commence before completion of Exploratory Works.

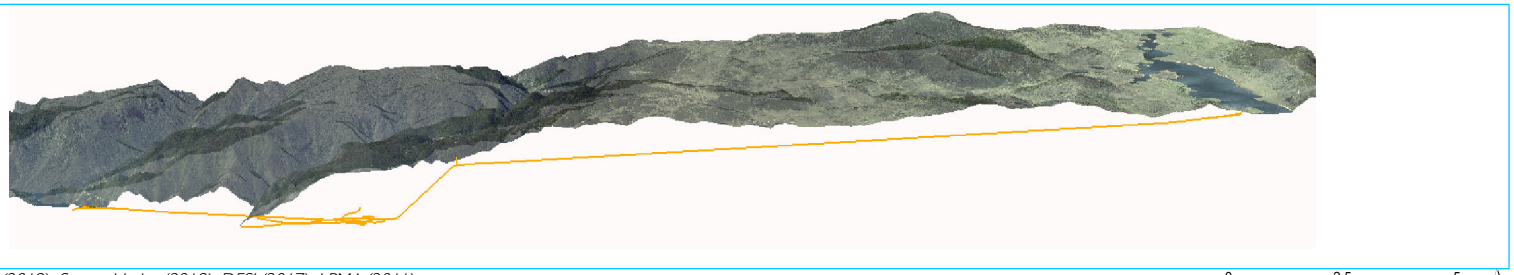
The Snowy 2.0 Main Works do not include the transmission works proposed by TransGrid (TransGrid 2018) that provide connection between the cableyard and the NEM. These transmission works will provide the ability for Snowy 2.0 (and other generators) to efficiently and reliably transmit additional renewable energy to major load centres during periods of peak demand, as well as enable a supply of renewable energy to pump water from Talbingo Reservoir to Tantangara Reservoir during periods of low demand. While the upgrade works to the wider transmission network and connection between the cableyard and the network form part of the CSSI declaration for Snowy 2.0 and Transmission Project, they do not form part of this application and will be subject to separate application and approval processes, managed by TransGrid. This project is known as the HumeLink and is part of AEMO's Integrated System Plan.

With respect to the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), on 30 October 2018 Snowy Hydro referred Snowy 2.0 Main Works to the Commonwealth Department of Environment and Energy (DoEE) on a precautionary basis, nominated that Snowy 2.0 Main Works has potential to have a significant impact on MNES and the environment generally.

On 5 December 2018, Snowy 2.0 Main Works were deemed a controlled action by the Assistant Secretary of the DoEE. It was also determined that potential impacts of the project will be assessed by accredited assessment under Division 5.2 of the EP&A Act. This accredited process will enable DPIE to manage the assessment of Snowy 2.0 Main Works, including the issuing of the assessment requirements for the EIS. Once the assessment has been completed, the Commonwealth Minister for the Environment will make a determination under the EPBC Act.

EMM Consulting Pty Ltd (EMM) was retained by the project to develop the Environmental Impact Statement (EIS) for the Main Works. EMM has engaged Sherpa Consulting Pty Ltd (Sherpa) to conduct a risk assessment for the Main Works as required by the SEARs.





KEY

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

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road
- Indicative rock emplacement area

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

0 2.5 5 km
GDA 1994 MGA Zone 55

N

Snowy 2.0 project elements

Snowy 2.0
Hazard and risk assessment
Main Works
Figure 2.1

snowy 2.0

EMM creating opportunities

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS001 Overview 20190824 04.mxd 26/08/2019

2.2. Scope

The scope of the risk assessment includes the storage, handling and transportation of hazardous chemicals given in the 'Combined Main Works Chemical Register' (Ref [3]), at the major work sites during construction and operational phase of the facility and activities that may present a risk of potentially hazardous scenarios and risk to the public.

The relevant sites for Snowy 2.0 Main Works project area are identified as the locations listed below, and are referred to as the 'major work locations' of the project:

- Talbingo intake
- Talbingo adit construction compound
- Main camp (Lobs Hole)
- Main yard (Lobs Hole)
- Lobs Hole substation
- Main access tunnel (MAT) portal
- Emergency egress, cable and ventilation tunnel (ECVT) portal
- Cable yard
- Marica ventilation shaft
- Marica accommodation camp
- Headrace Surge shaft
- Tantangara intake
- Tantangara construction compound
- Tantangara accommodation camp
- Rock Forest logistics laydown.

The maps of each major work location are in Section 3 of this report.

2.3. Related projects

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

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

While these projects form part of the CSSI declaration for Snowy 2.0 and Transmission Project, they do not form part of Snowy Hydro's application for Snowy 2.0 Main Works.

These related projects are subject to separate application and approval processes. Staged submission and separate approval is appropriate for a project of this magnitude, due to its complexity and funding and procurement processes. However, cumulative impacts have been considered in this report where relevant.

3. DESCRIPTION OF DEVELOPMENT

3.1. Project location

Snowy 2.0 Main Works are within the Australian Alps, in southern NSW, about mid-way between Canberra and Albury. Snowy 2.0 Main Works is within both the Snowy Valleys and Snowy Monaro Regional Local Government Areas (LGAs).

The nearest large towns to Snowy 2.0 Main Works are Cooma and Tumut. Cooma is located about 50 kilometres (km) south east of the project area (or 70 km by road from Providence Portal at the southern edge of the project area), and Tumut is located about 35 km north west of the project areas (or 45 km by road from Tumut 3 power station at the northern edge of the project area). Other townships near the project area include Talbingo, Cabramurra, Adaminaby and Tumbarumba. Talbingo and Cabramurra were built for the original Snowy Scheme workers and their families, while Adaminaby was relocated in 1957 to make way for the establishment of Lake Eucumbene.

The location of Snowy 2.0 Main Works with respect to the region is shown in Figure 2.1.

The pumped hydro-electric scheme elements of Snowy 2.0 Main Works are mostly underground between the southern ends of Tantangara and Talbingo reservoirs, a straight-line distance of 27 km. Surface works will also occur at locations on and between the two reservoirs. Key locations for surface works include:

- **Tantangara Reservoir** - at a full supply level (FSL) of about 1,229 metres (m) to Australian Height Datum (AHD), Tantangara Reservoir will be the upper reservoir for Snowy 2.0 and include the headrace tunnel and intake structure. The site will also be used for a temporary construction compound, accommodation camp and other temporary ancillary activities.
- **Marica** - the site will be used primarily for construction to excavate the ventilation shaft to the underground power station as well as for the excavation and construction of the headrace surge shaft.
- **Lobs Hole** - the site will be used primarily for construction but will also become the main entrance to the power station during operation. Lobs Hole will provide access to the Exploratory Works tunnel, which will be refitted to become the Main Access Tunnel (MAT), as well as the location of the Emergency egress, Cable and Ventilation Tunnel (ECVT), portal, associated services and accommodation camp.
- **Talbingo Reservoir** - at a FSL of about 546 m AHD, Talbingo Reservoir will be the lower reservoir for Snowy 2.0 and will include the tailrace tunnel and water intake structure. The site will also be used for temporary construction compounds and other temporary ancillary activities.

Works will also be required within the two reservoirs for the placement of excavated rock and surplus cut material. Supporting infrastructure will include establishing or upgrading access tracks and roads and electricity connections to construction sites.

Most of the proposed pumped hydro-electric and temporary construction elements and most of the supporting infrastructure for Snowy 2.0 Main Works are located within the boundaries of KNP, although the disturbance footprint for the project during construction is less than 0.25% of the total KNP area. Some of the supporting infrastructure and construction sites and activities (including sections of road upgrade, power and communications infrastructure) extends beyond the national park boundaries. These sections of infrastructure are primarily located to the east and south of Tantangara Reservoir. One temporary construction site is located beyond the national park along the Snowy Mountains Highway about 3 km east of Providence Portal (referred to as Rock Forest).

3.2. Project area

A project area for Snowy 2.0 Main Works has been identified that includes the elements of the project, including all construction and operational elements. The project area is shown in Figure 2.1. Key features of the project area are:

- the water bodies of Tantangara and Talbingo reservoirs, covering areas of 19.4 square kilometres (km^2) and 21.2 km^2 respectively. The reservoirs provide the water to be utilised in Snowy 2.0
- major watercourses including the Yarrangobilly, Eucumbene and Murrumbidgee rivers and some of their tributaries
- KNP, within which the majority of the project area is located. Within the project area, KNP is characterised by two key zones: upper slopes and inverted treelines in the west of the project area (referred to as the 'ravine') and associated subalpine treeless flats and valleys in the east of the project area (referred to as the 'plateau')
- farm land southeast of KNP at Rock Forest.

The project area is interspersed with built infrastructure including recreational sites and facilities, main roads as well as unsealed access tracks, hiking trails, farm land, electricity infrastructure, and infrastructure associated with the Snowy Scheme.

3.3. Site layout

The work locations identified for Snowy 2.0 Main Works are provided in Table 3.1 below. Some locations will be remediated post Main Works construction while some will be retained during operation phase as identified in the same table.

Table 3.1: Key work locations for Snowy 2.0 Main Works

No.	Construction site	Construction/Operational phase
1	Talbingo intake	Operational[(a)]
2	Talbingo adit construction compound	Construction
3	Main camp (Lobs Hole)	Construction
4	Main yard (Lobs Hole)	Construction
5	Lobs Hole substation	Construction/Operational
6	Main access tunnel (MAT) portal	Construction/Operational[(b)]
7	Emergency egress, cable and ventilation tunnel (ECVT) portal	Construction/Operational[(b)]
8	Cable yard	Construction/Operational
9	Marica ventilation shaft	Construction/Operational
10	Marica accommodation camp	Construction
11	Headrace Surge shaft	Construction/Operation
12	Tantangara intake	Construction/Operation[(c)]
13	Tantangara construction compound	Construction
14	Tantangara accommodation camp	Construction
15	Rock Forest logistics laydown	Construction

Note:

(a) Talbingo surface building will be used for chemical storage during operational phase.

(b) MAT portal and ECVT buildings will be used for chemical storage during operational phase once the Main yard is decommissioned and rehabilitated.

(c) Tantangara surface building will be used for chemical storage during operational phase.

3.4. Hazardous chemicals

Hazardous chemicals will be stored at different locations during construction and operational phases. Based on 'Combined Main Works Chemical Register' (Ref [3]), a summary of where the chemicals will be stored during different phases of the project, i.e. construction and operational phase, is provided in Table 3.2.

Details on indicative storage type and quantity stored for the chemicals are provided in APPENDIX B based on 'Combined Main Works Chemical Register', Ref [3], and Australian Dangerous Goods Code, Ref [4].

Table 3.2: Chemicals storage locations during construction and operational phase

No.	Construction site	Construction	Operations
1	Talbingo intake	-	Stored
2	Talbingo adit construction compound	Stored	-
3	Main camp (Lobs Hole)	Stored	-
4	Main yard (Lobs Hole)	Stored	-
5	Lobs Hole substation	-	Stored
6	Main access tunnel (MAT) portal	Stored	Stored
7	Emergency egress, cable and ventilation tunnel (ECVT) portal	Stored	Stored
8	Cable yard	-	Stored
9	Marica ventilation shaft	-	Stored
10	Marica accommodation camp	Stored	-
11	Headrace Surge shaft	Stored	-
12	Tantangara intake	Stored	Stored
13	Tantangara construction compound	Stored	-
14	Tantangara accommodation camp	Stored	-
15	Rock Forest logistics laydown	Stored	-

Locations where hazardous chemicals are stored are referred to as the ‘major works locations’ and are shown in the following pages of this report:

Figure 3.1: Indicative Talbingo intake/adit construction compound

Figure 3.2: Indicative main camp (Lobs Hole)

Figure 3.3: Indicative main yard (Lobs Hole)

Figure 3.4: Indicative MAT portal (Lobs Hole)

Figure 3.5: Indicative ECVT portal (Lobs Hole)

Figure 3.6: Indicative Marica ventilation shaft and accommodation camp

Figure 3.7: Indicative headrace surge shaft

Figure 3.8: Indicative Tantangara intake and construction compound

Figure 3.9: Indicative Tantangara accommodation camp

Figure 3.10: Indicative Rock Forest logistics laydown

Figure 3.1: Indicative Talbingo intake/adit construction compound

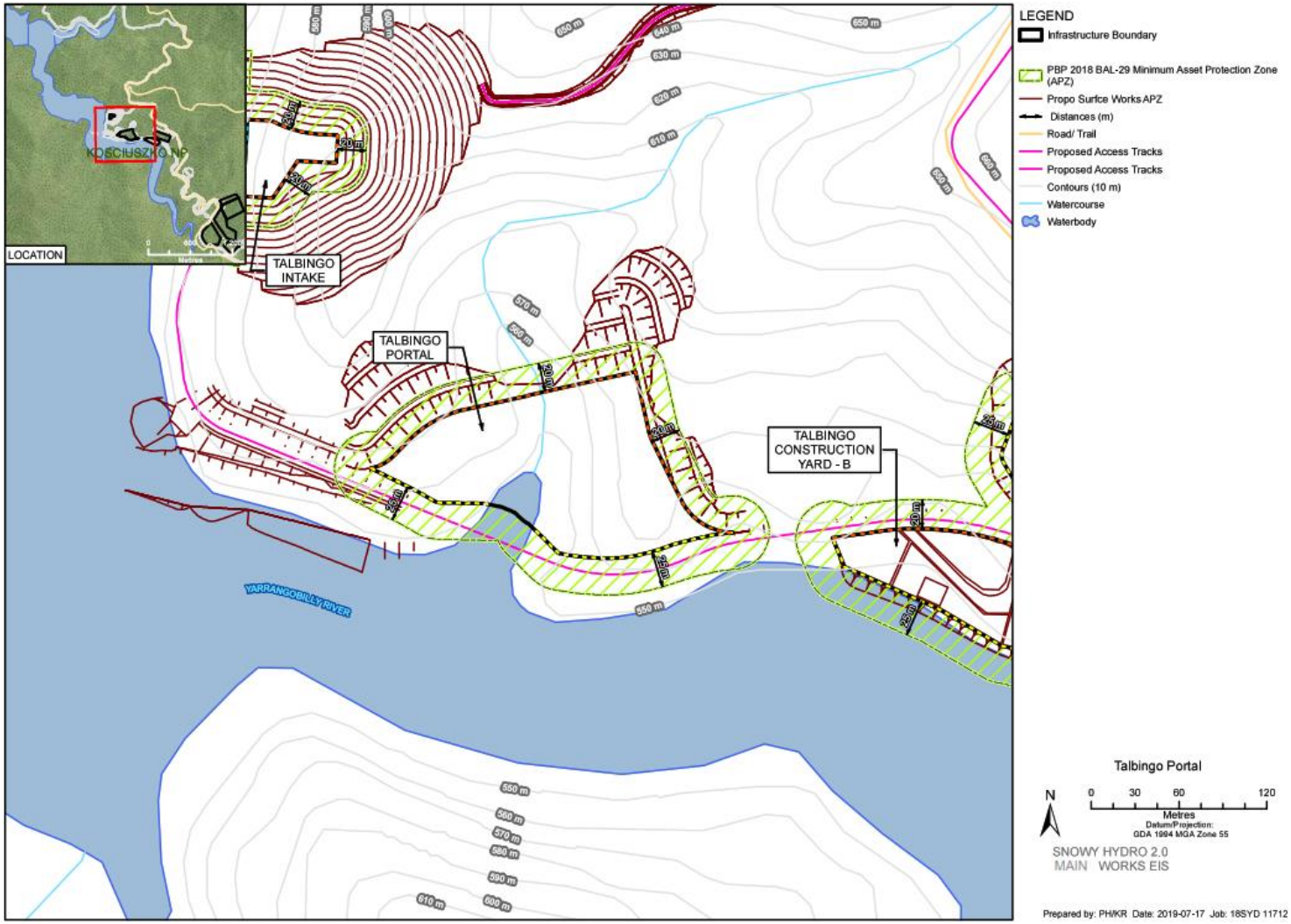


Figure 3.2: Indicative main camp (Lobs Hole)

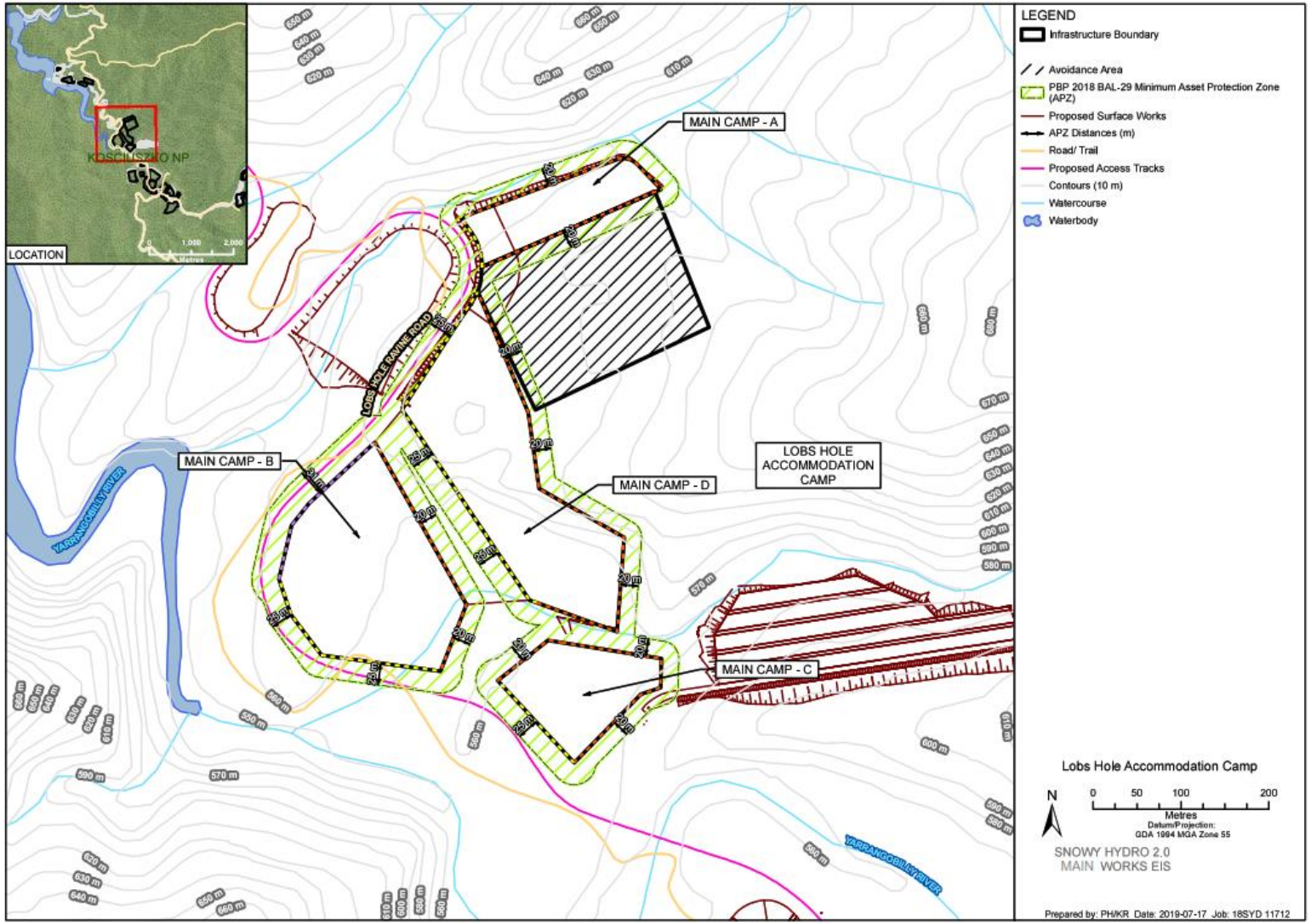


Figure 3.3: Indicative main yard (Lobs Hole)

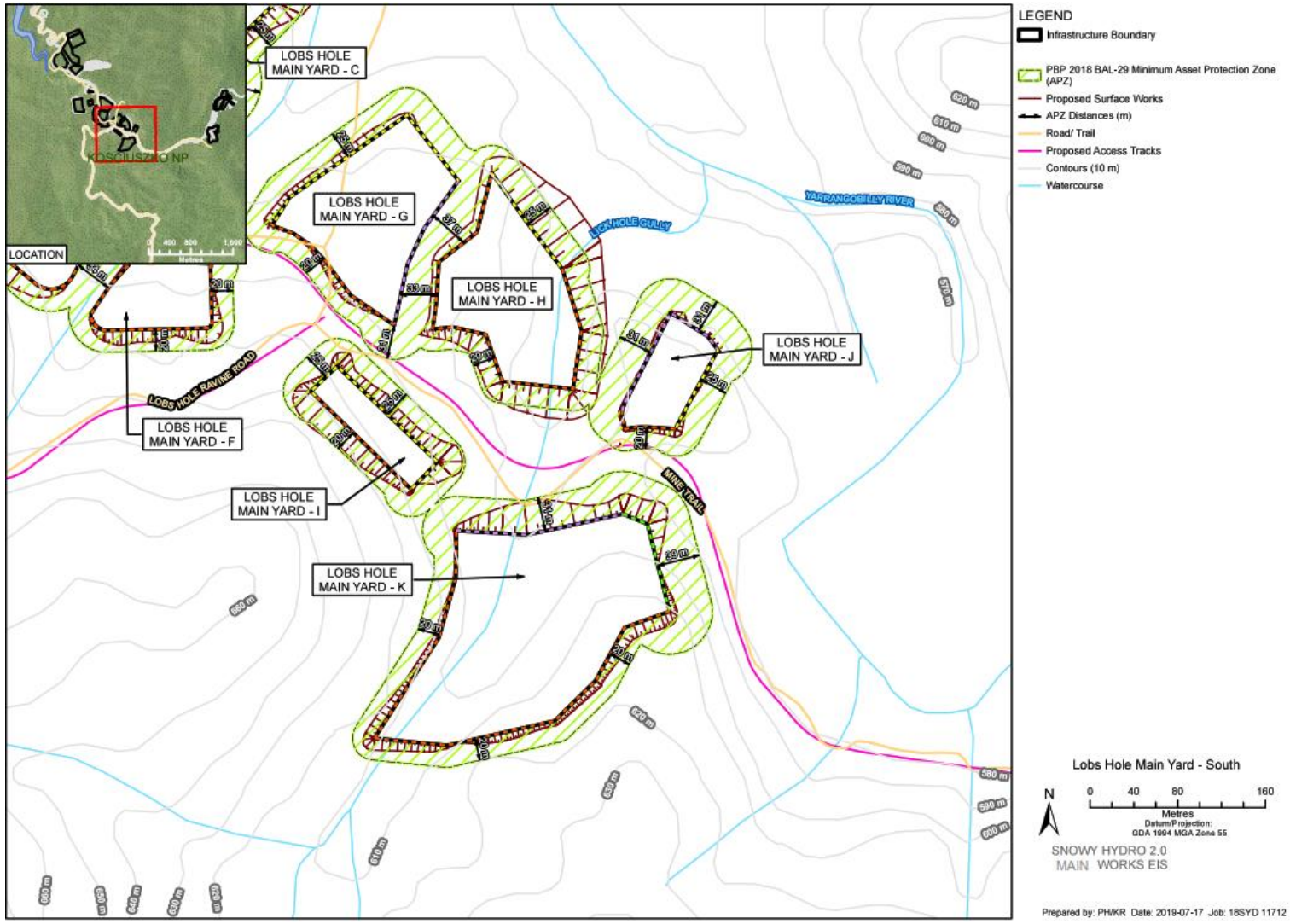


Figure 3.4: Indicative MAT portal (Lobs Hole)

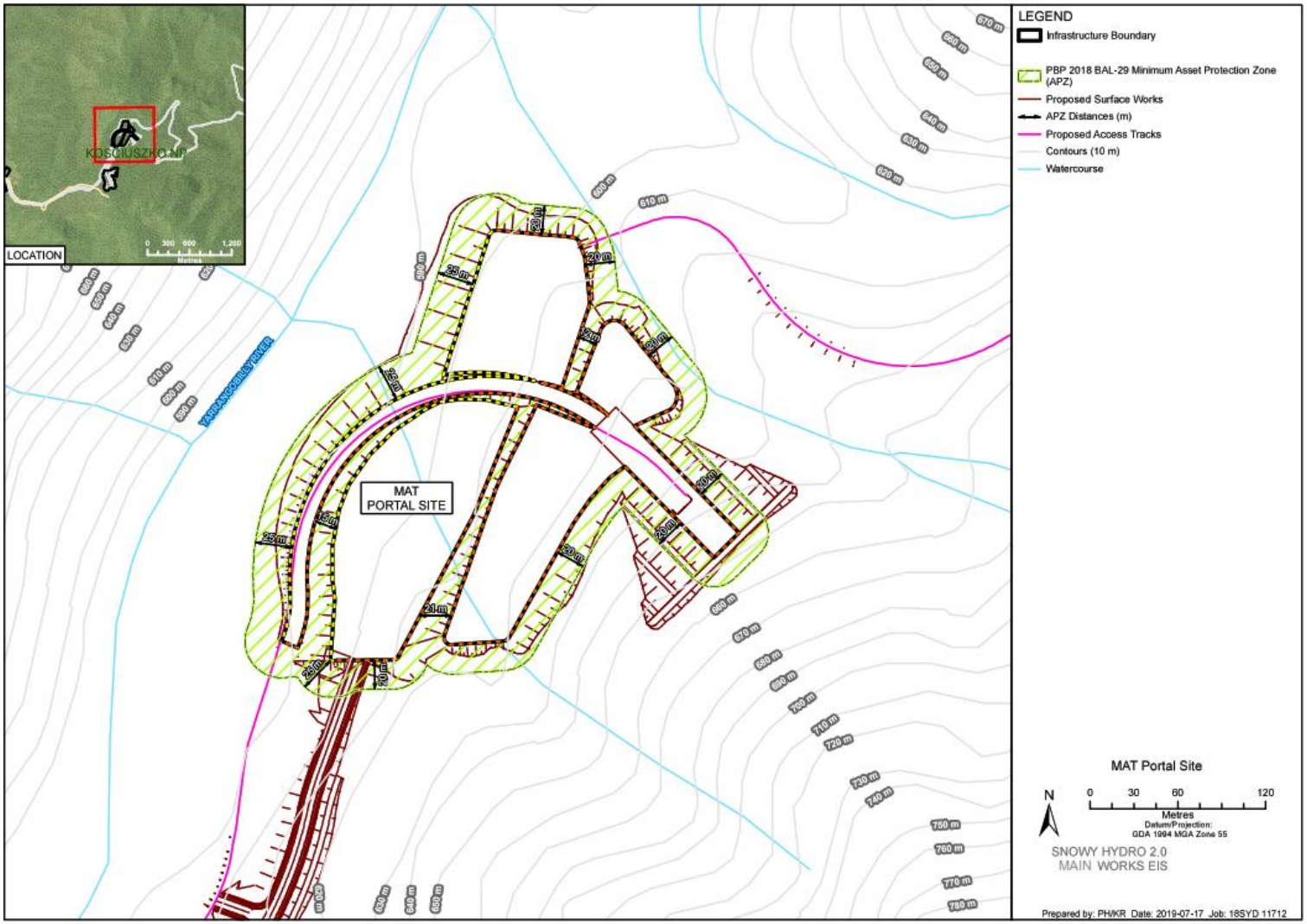


Figure 3.5: Indicative ECVT portal (Lobs Hole)

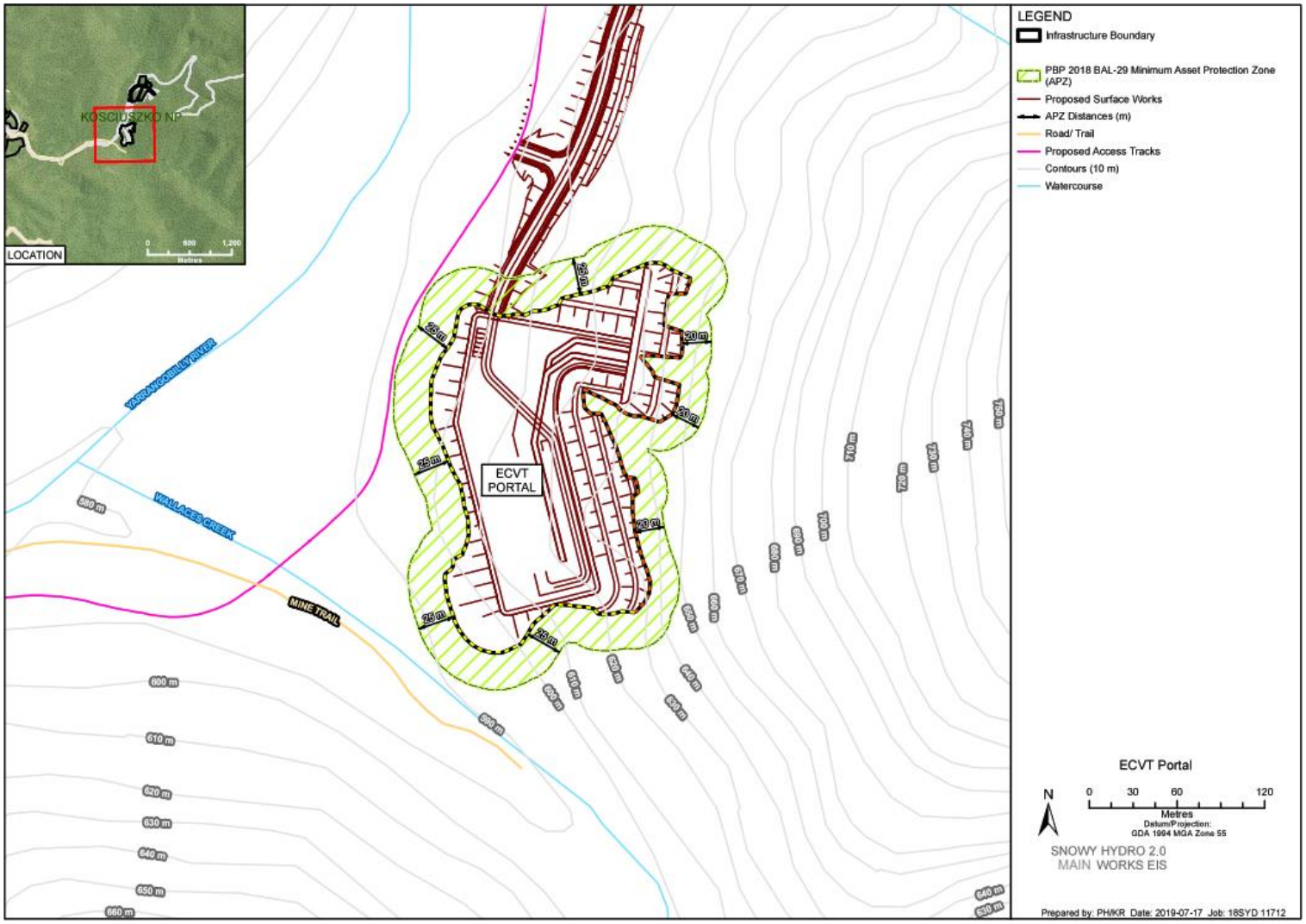


Figure 3.6: Indicative Marica ventilation shaft and accommodation camp

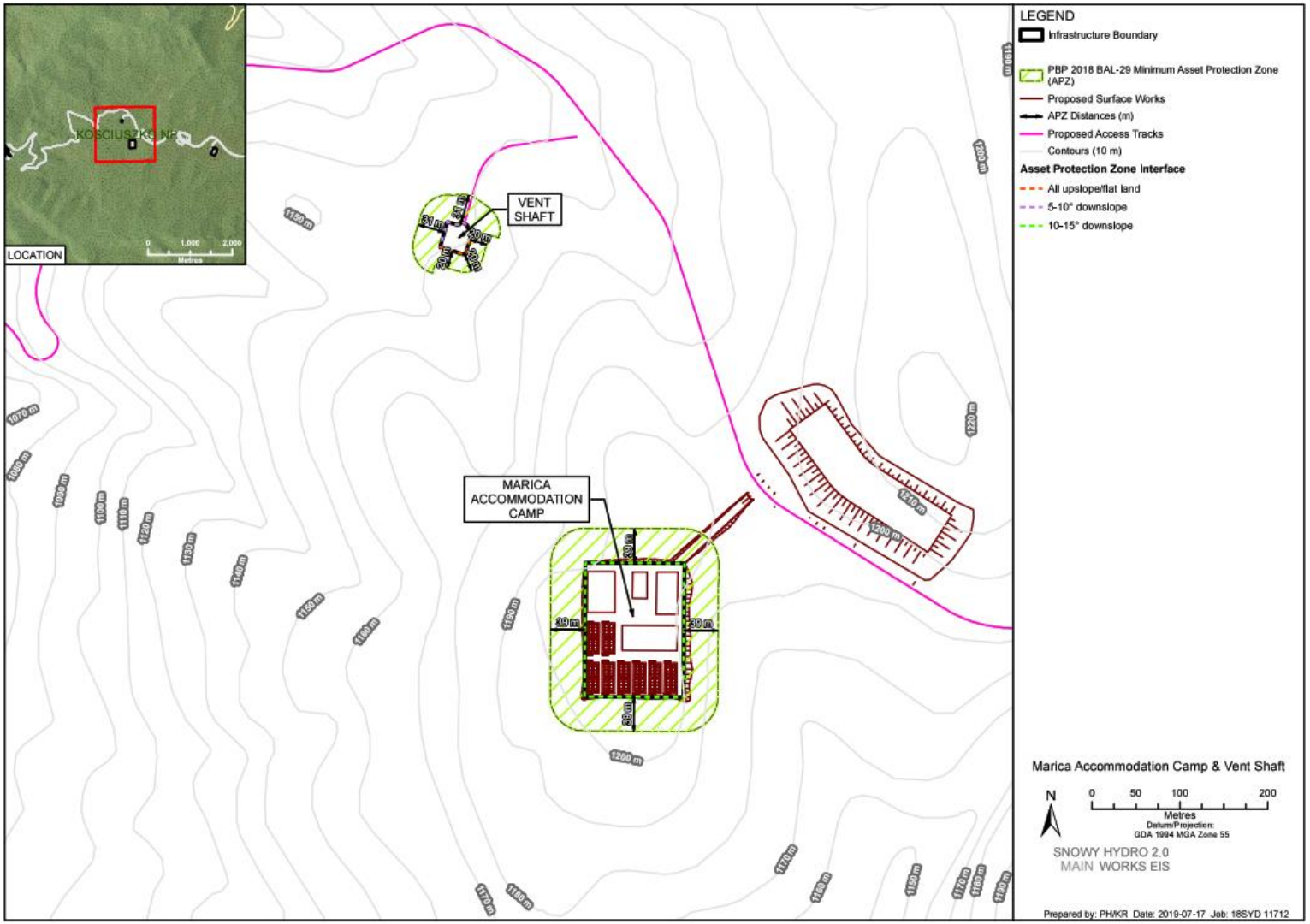


Figure 3.7: Indicative headrace surge shaft

Figure 3.8: Indicative Tantangara intake and construction compound

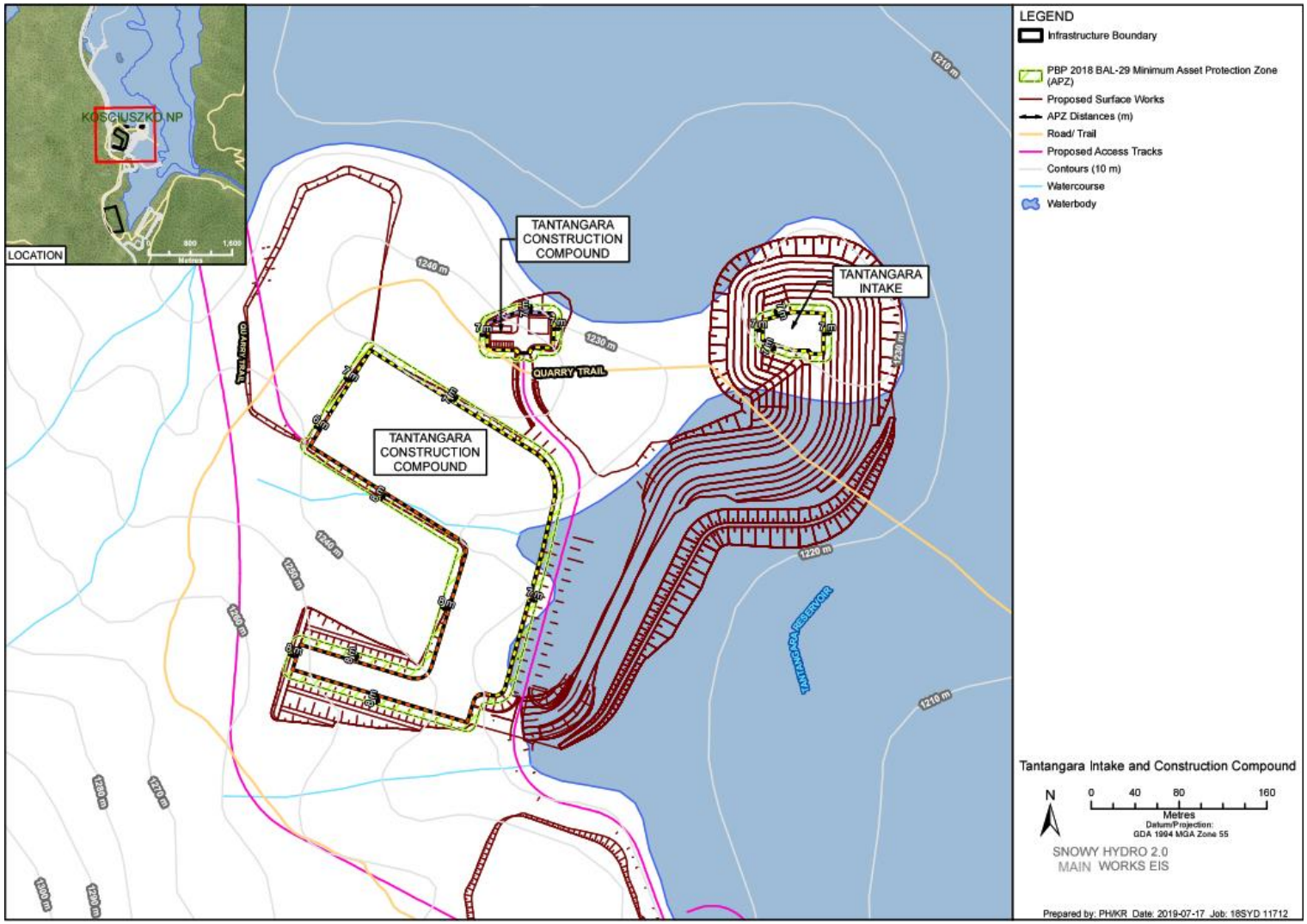


Figure 3.9: Indicative Tantangara accommodation camp

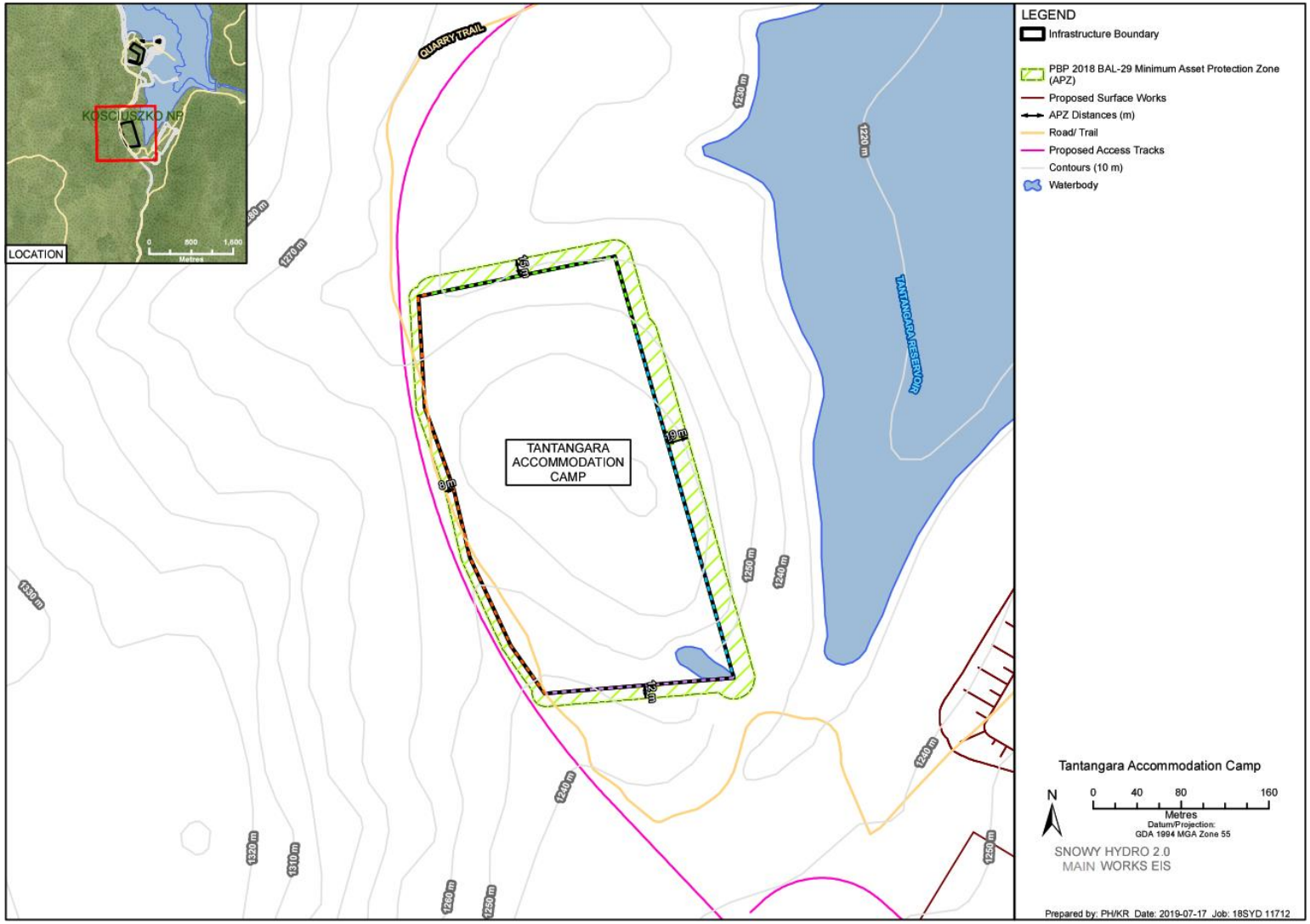
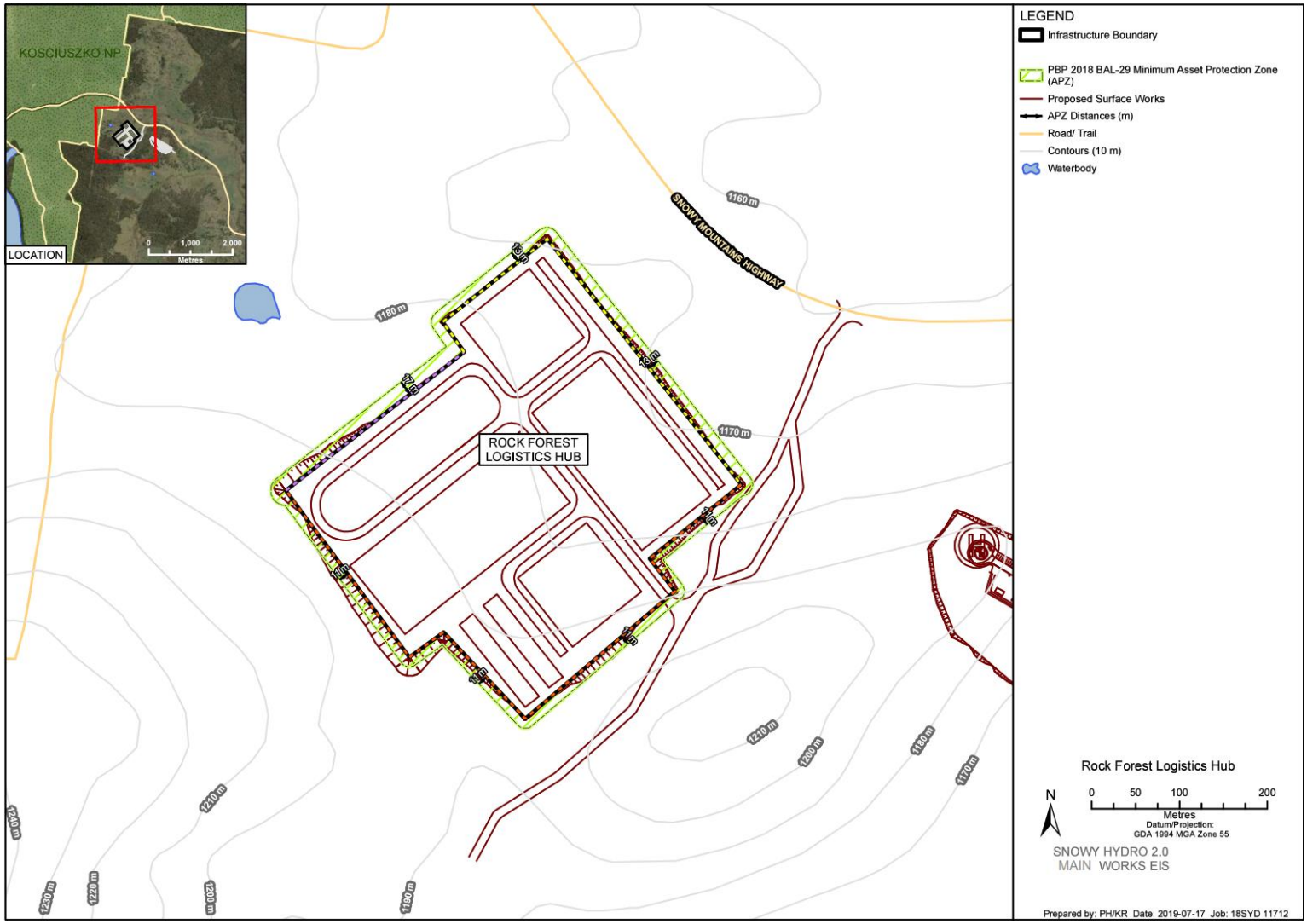


Figure 3.10: Indicative Rock Forest logistics laydown



4. ASSESSMENT OVERVIEW

4.1. Overall Approach

The risk assessment was conducted in line with AS/ISO 31000:2018 Risk Management Guidelines. It includes the following steps:

1. Establish the context
2. Identify hazards
3. Assess consequences
4. Assess likelihood
5. Determine the risk
6. Evaluate the risk
7. Treat the risk if required.

4.2. Context

The context of the risk assessment was set by the project Secretary's Environmental Assessment Requirements (SEARs) to undertake an assessment of:

- any potentially hazardous impacts of the project
- any public safety risks, including bushfires and flooding risks.

The assessment covers acute safety impacts to the public due to the construction and operation of the Main Works. Other aspects of risk are managed as follows:

- Bushfire and flooding risks are covered in stand-alone EIS reports.
- Onsite risks to employees and those directly engaged during the construction and operations phase is managed under the *NSW Workplace Health and Safety Act*.
- Chronic effects are covered under air quality sections of the EIS
- Environmental risks are covered under other sections of the EIS.

4.3. Guidance

The following documents were used as guidance in this assessment.

Potential hazardous impacts were identified following the *NSW Department of Planning, Hazardous and Offensive Development Application Guidelines, Applying SEPP33, January 2011* (referred to as SEPP 33 in this document)

The hazard analysis followed the requirements of the NSW Department of Planning Hazardous Industry Planning Advisory Paper (HIPAP) No. 6, Hazard Analysis, January 2011.

Risk criteria follow the requirements of the NSW Department of Planning Hazardous Industry Planning Advisory paper (HIPAP) No 4. Risk Criteria for Land Use Safety Planning.

4.4. Risk criteria

Risk criteria are provided in HIPAP 4, Ref [5]. Criteria are reproduced below for fatality (Table 4.1), injury (Table 4.2) and accident propagation/escalation (Table 4.3).

Table 4.1: NSW individual fatality risk criteria

Limit (per year)	Land-Use
0.5×10^{-6}	Hospitals, child-care facilities and age care facilities
1×10^{-6}	Residential developments and places of continuous occupancy such as hotels and tourist resorts
1×10^{-6}	Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres
10×10^{-6}	Sporting complexes and active open space areas
50×10^{-6}	Industrial – must not be exceeded any boundary adjacent to another industrial facility

Table 4.2: NSW individual injury risk criteria

Limit (per year)	Land-Use
50×10^{-6}	Residential areas[(a)] – 4.7 kW/m^2 heat flux radiation
50×10^{-6}	Residential areas[(a)] – 7 kPa explosion overpressure
10×10^{-6}	Residential areas[(a)] – injurious toxic concentrations
50×10^{-6}	Residential areas[(a)] – toxic concentrations causing irritation
(a) Although not zoned residential, the accommodation camps were used in the evaluation of the residential areas to confirm adequate separation.	

Table 4.3: NSW accident propagation/escalation risk criteria

Limit (per year)	Land-Use
50×10^{-6}	Potentially hazardous installations – 23 kW/m^2 heat flux radiation (flame impingement)
50×10^{-6}	Potentially hazardous installations – 14 kPa explosion overpressure

4.5. Risk Assessment Methodology

The risk assessment for the Main Works was carried out in accordance with HIPAP 6, Ref. [6], and included the following steps:

- Identification of hazards resulting from the Main Works and identification of potentially hazardous impacts and risk to the public

- Assessment of the consequences for those scenarios that were judged to be potentially hazardous and a risk to the public
- Assessment of the frequency and risk of scenarios confirmed to have an offsite impact in the consequence analysis
- Comparison of the estimated total risk resulting from the proposed facility with the appropriate criteria for acceptable risk.

5. HAZARD IDENTIFICATION

5.1. Overview

The hazard identification exercise comprised:

- A review of hazards implicit in the chemicals and materials handled at site (refer to APPENDIX B)
- A review of significant incidents involving storage of explosives
- A review of other incidents with offsite potential
- A review of external events.

The identified hazards were then extended and developed into hazardous scenarios and the risk assessed.

5.2. Chemicals and materials

Whilst not required for the Main Works, the screening process in SEPP 33 was used to provide a framework to determine the 'potentially hazardous' nature of the Main Works.

SEPP 33 includes a process to determine if a development is 'potentially hazardous' or 'not potentially hazardous' based on substances stored and used on site. The definition of 'potentially hazardous' is as follows:

> *'Potentially hazardous industry' means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:*
>
> *(a) to human health, life or property; or*
>
> *(b) to the biophysical environment, and*
>
> *includes a hazardous industry and a hazardous storage establishment.*

To determine whether a proposed development is potentially hazardous, the risk screening process in the Applying SEPP 33 guideline considers the type and quantity of hazardous chemicals to be stored on the site, other operations with the potential for offsite impact and the distance of the storage and operational areas to the nearest site boundary, as well as the expected number of transport movements.

The Applying SEPP 33 guideline is based on the Australian Dangerous Goods Code (ADGC) (7th edition, 2009) and so refers to hazardous chemicals by their Dangerous Goods (DG) classification. In this document, substances will be referred to by their DG classification rather than their classification under the Globally Harmonized System (GHS), which is used in the ADGC Edition 7.6, 2018, Ref [4].

In this SEPP 33 screening, it is to be noted that:

- Miscellaneous dangerous substances and articles which belong to DG Class 9, including environmentally hazardous substances, are not considered to be hazardous and hence are not included in the SEPP 33 screening.
- Class 2.2 are non-flammable, non-toxic gases and are not considered to be potentially hazardous with respect to offsite risk.
- C1 Combustible liquids, which are stored in a separate bund or within a storage area where there are no flammable materials stored are not dangerous good under UN (United Nations) classification.

The risk screening results for each 'major works location' are summarised in Section 5.2.1 and Section 5.2.2 for construction and operational phase respectively. The result tables include the expected types and approximate quantities of DG to be stored or handled at each 'major works location', together with the relevant SEPP 33 screening threshold.

5.2.1. SEPP 33 screening results – Construction Phase

The locations where hazardous chemicals are stored during construction phase are summarised in Section 3.4 of this document. The SEPP 33 screening results for each of these 'Main Works locations' are presented in Table 5.1 to Table 5.9

Note that diesel fuel is classified as a 'combustible liquid' for the purpose of this screening, rather than the more unusual classification of Class 3 PGIII.

Table 5.1: Talbingo adit construction compound – SEPP 33 screening

		Quantities in tonnes		Potentially hazardous?
Class	**PG**	**Stored (indicative)**	**Threshold in SEPP 33, Ref [7]**	
8	III	23	50[(a)]	No
Note: (a) Ref [7] Table 3.				

Table 5.2: Main camp (Lobs Hole) – SEPP 33 screening

		Quantities in tonnes		Potentially hazardous?
Class	**PG**	**Stored (indicative)**	**Threshold in SEPP 33, Ref [7]**	
8	III	2	50[(a)]	No
Note: (a) Ref [7] Table 3.				

Table 5.3: Main yard (Lobs Hole) – SEPP 33 screening

Class	PG	Quantities in tonnes		Potentially hazardous?
		Stored (indicative)	Threshold in SEPP 33, Ref [7]	
1.1	-	10	Potentially Hazardous if less than 300 m from site boundary[(a)]	Yes
2.1	-	9[(b)(c)]	10[(d)]	No
3	II/III	23[(b)]	Potentially hazardous if less than 6 m from site boundary[(e)]	No[(f)]
8	II	0.3[(b)]	25[(g)]	No

Note:
(a) Ref [7] Figure 5, as quantity > 100 kg.
(b) Not used
(c) These are made up of aerosols with the potential for LPG propellants. It has been conservatively assumed that the full water volume is LPG and the aerosols are stored in one location.
(d) Ref [7] Table 3, assuming LPG aboveground.
(e) Ref [7] Figure 9, as quantity > 5,000 kg.
(f) There will be at least 20m distance based on APZ.
(g) Ref [7] Table 3.

Table 5.4: MAT portal – SEPP 33 screening

Class	PG	Quantities in tonnes		Potentially hazardous?
		Stored (indicative)	Threshold in SEPP 33, Ref [7]	
1.1	-	10	Potentially Hazardous if less than 300 m from site boundary[(a)]	Yes
8	III	5	50[(b)]	No

Note:
(a) Ref [7] Figure 5, as quantity > 100 kg.
(b) Ref [7] Table 3.

Table 5.5: ECVT portal - SEPP 33 screening

Class	PG	Quantities in tonnes		Potentially hazardous?
		Stored (indicative)	Threshold in SEPP 33, Ref [7]	
1.1	-	10	Potentially Hazardous if less than 300 m from site boundary[(a)]	Yes
8	III	16	50[(b)]	No

Note:
(a) Ref [7] Figure 5, as quantity > 100 kg.
(b) Ref [7] Table 3.

Table 5.6: Marica accommodation camp - SEPP 33 screening

		Quantities in tonnes		Potentially hazardous?
Class	**PG**	**Stored (indicative)**	**Threshold in SEPP 33, Ref [7]**	
8	III	1	50[(a)]	No
Note: (a) Ref [7] Table 3.				

Table 5.7: Headrace Surge shaft – SEPP 33 screening

		Quantities in tonnes		Potentially hazardous?
Class	**PG**	**Stored (indicative)**	**Threshold in SEPP 33, Ref [7]**	
8	III	16	50[(a)]	No
Note: (a) Ref [7] Table 3.				

Table 5.8: Tantangara intake and construction compound– SEPP 33 summary

		Quantities in tonnes		Potentially hazardous?
Class	**PG**	**Stored**	**Threshold in SEPP 33, Ref [7]**	
1.1	-	10	Potentially Hazardous if less than 300 m from site boundary[(a)]	Yes
8	III	23	50[(b)]	No
Note: (a) Ref [7] Figure 5, as quantity > 100 kg. (b) Ref [7] Table 3.				

Table 5.9: Tantangara accommodation camp – SEPP 33 screening

		Quantities in tonnes		Potentially hazardous?
Class	**PG**	**Stored**	**Threshold in SEPP 33, Ref [7]**	
8	III	0.85	50[(a)]	No
Note: (a) Ref [7] Table 3.				

There are some chemicals identified in the 'Combined Main Works Chemical Register' (Ref [3]), which have an arbitrary or general storage location name as listed below:

- Ablutions
- Offices/workshop
- Construction sites
- Workshops.

These general storage areas can be located anywhere across the Main Works Project area and their listed chemicals can be found in APPENDIX B, along with the SEPP 33 screening results.

The screening result, assuming that all the general site chemicals are stored in one location, is presented in Table 5.10.

Table 5.10: Screening outcome for the general construction sites

		Quantities in tonnes		Potentially hazardous?
Class	**PG**	**Stored (indicative)**	**Threshold in SEPP 33, Ref [7]**	
2.1	-	1.5[(a)(b)]	10[(d)]	No
2.1	-	0.01[(c)]	0.1	No
3	II/III	25[(a)]	Potentially hazardous if less than 6 m from the site boundary[(e)]	No[(f)]
8	III	11[(a)]	50[(g)]	No

Note:

(a) This is the total quantity of materials stored in all camps across Main Works project area.

(b) These are made up of aerosols with the potential for LPG propellants. It has been conservatively assumed that the full water volume is LPG and the aerosols are stored in one location.

(c) Ref [7].Figure 6, acetylene

(d) Ref [7] Table 3, assuming LPG aboveground.

(e) Ref [7] Figure 9, as quantity > 5,000 kg.

(f) It is assumed that there will be a distance of at least 6 m from all storage locations to the nearest site boundary for the project in line with minimum APZ distance.

(g) Ref [7] Table 3.

Table 5.1 to Table 5.10 show that the SEPP 33 threshold is only exceeded by Class 1.1 material during the construction phase of the project. Scenarios associated with Class 1.1 chemicals are carried forward to the hazard identification as potentially hazardous.

Storages of chemicals below the SEPP 33 thresholds are not potentially hazardous.

5.2.2. SEPP 33 Risk screening results for operational phase

During the operational phase minor quantities of chemicals will be stored and used across the Main Works area. These may include aerosols, paints and lubricants.

Based on the 'Combined Main Works Chemical Register' (Ref [3]), these will be well below any screening criteria and will not present an offsite risk.

In addition to the minor quantities described above, diesel will be stored in bulk for emergency generators. Whilst diesel is not defined as a dangerous good under the ADGC (it is a combustible liquid rather than a flammable liquid), there is the risk of an incident escalating to the diesel store.

The risk of an incident escalating to a diesel store has been carried forward to the hazard identification.

5.2.3. SEPP 33 Screening - Transportation of Dangerous Goods

The transport of Dangerous Goods of class 2.1, 3 and 8 were reviewed against the screening criteria in SEPP 33. The volumes used in the operational phase will result in vehicle movements well below the screening threshold.

Transport of explosives during the construction phase is carried forward to the hazard identification.

5.2.4. SEPP 33 - Other risk factors

Appendix 2 of Applying SEPP 33 outlines other risk factors for consideration to identify hazards outside the scope of the risk screening method.

A review of these risk factors was undertaken as shown in Table 5.11. In general, it was noted that the project would not involve:

- Storage or transport of incompatible materials (i.e. hazardous and non-hazardous). Hazardous materials will be stored in dedicated areas and storage protocols in accordance with standard and guidelines will be followed.
- Possible generation of explosive dusts within confined areas.
- Other than explosives, incompatible, reactive or unstable materials and process conditions that could lead to uncontrolled reaction or decomposition.

Table 5.11: Review of other factors in SEPP 33

Information required to identify other risk factors	Comments
Any incompatible materials (hazardous and non-hazardous materials	Material incompatibility and segregation will be managed by the design of the storage facilities and operational controls. The SEPP 33 screening identified that, except for explosives, the quantities of other materials were below the potentially hazardous quantities. As mixing is possible the scenario has been carried forward to the HAZID.
Any wastes that could be hazardous	There is the potential for tunnelling and drilling operations to generate waste containing asbestos. This is a chronic health risk detailed in the Contamination Assessment.
The possible existence of dusts within confined areas	Dust may be generated leading to an environmental risk which is addressed in the Air Quality Impact Assessment, or an occupational health impact, which will be managed by appropriate construction method controls.
Types of activities the dangerous goods and otherwise hazardous materials are associated with (storage, processing, reaction, etc.)	The use of the dangerous goods is considered in the SEPP 33 quantity screening.
Incompatible, reactive or unstable materials and process conditions that	The potential for an explosion associated with the explosive store has been considered in the HAZID.

Information required to identify other risk factors	Comments
could lead to uncontrolled reaction or decomposition	
Storage or processing operations involving high (or extremely low) temperatures and/or pressures	There is the potential for water, air and other machinery fluids to be at an elevated pressure. Failure of a system leading to a release of pressurise material has been carried forward to the HAZID.
Details of known past incidents (and near misses) involving hazardous materials and processes in similar industries	Details of incidents with explosives have been reviewed in this assessment. Other risks to the public are based on Snowy Hydro experience.

In addition, Appendix 3 of Applying SEPP 33 was reviewed lists specific industries that may be potentially hazardous, the Main Works do not fall into any of the industries.

5.3. Hazard identification word diagram

The HAZID tables identify the following for each scenario:

- the hazardous event
- the consequence of the event
- the initiating causes of the event
- safeguards
- whether the scenario has a potential offsite impact
- the proposed level of assessment.

5.4. Potentially hazardous and public risk scenarios

Based on the HAZID, potentially hazardous scenarios and scenarios with a risk to the public were identified, as shown in Table 5.12 for the construction phase. No scenarios with risk to the public were identified for the operations phase.

Table 5.12: Summary of potentially hazardous scenarios and risks to the public

Scenario No.	HAZID Minute	Scenario Description	Safeguards/Comments
INC-001	1	Detonation of Pentex D explosives (UN0042) including 'Package/cartridge' in magazine store	Single no through road access. Bunding to suppress shrapnel or flying debris.
INC-002	2	Detonation of Cordtex 3.6W detonating cords (UN0065) in magazine store	The magazine and security provisions were assumed to comply with

Scenario No.	HAZID Minute	Scenario Description	Safeguards/Comments
INC-003	3	Detonation of Civec Control explosives (UN0241) in ventilated magazine store	AS 2187 Explosives – Storage, Transport and Use All authorised employees will have an Unsupervised Handling License.
-	1, 2, 3	Simultaneous detonation of all explosives in a magazine (10 tonnes)	As above
-	6	Accident involving transport of explosives	Licensed and competent dangerous goods transport companies. Vehicle design Driver training *Risk is managed by codes and standards.* *No additional assessment required.*

Consequence analysis for the scenarios with offsite impact is conducted in Section 6 for explosives (in the construction phase).

6. CONSEQUENCE ANALYSIS

6.1. Introduction

Consequence analysis was undertaken for scenarios involving explosives to determine the potential for offsite impacts. The consequence modelling was completed to determine the distance to specified overpressures.

6.2. Consequence criteria

For this study, the relevant consequence criteria from HIPAP 4, Ref [5] relating to overpressure are reproduced in Table 6.1.

Table 6.1: Overpressure consequence criteria

Overpressure (kPa)	Definition extract from HIPAP 4	Definition in this report
35	50% chance of fatality for a person in a building	-
21	20% chance of fatality for a person in a building Damage to reinforced structures	-
14	Severe damage to residences	Fatality
7	10% chance of injury	Injury
4	90% glass breakage - Very Low probability of injury	-

6.3. Modelling

Consequence calculations were carried out using commercially available consequence assessment software, TNO Effects v10.1.9. TNO Effects is a software package that performs calculations to predict the physical effects (e.g. explosion overpressure) of various scenarios involving hazardous materials.

The TNT equivalence model within TNO Effects was used to estimate explosion overpressure effects due to detonation of explosives. This method requires equating the material of interest to an equivalent mass of TNT, using a TNT equivalence factor. TNT equivalence is essentially a ratio of the blast energy produced by the explosive of interest to the blast energy produced by the same quantity of TNT. Based on the composition of the explosives, it was considered that:

- Pentex D was TNT, and no equivalence factor was required. Explosives named ‘Package/cartridge’ were considered as Pentex.
- Cordtex 3.6W detonating cords were considered as TNT, and no equivalence factor was required.
- Civec Control is like Ammonium Nitrate Emulsion (ANE) and a TNT equivalence factor of 0.68 was used in line with industry practice.

Rather than split the explosives between the three types, this analysis used the ‘worst case’ equivalent factor of 1, giving a Net Explosive Quantity (NEQ) of 10,000 kg for each storage location, this was used in TNO Effects.

The explosives will be stored at four Main Works locations i.e. Main yard (Lobs Hole), MAT portal (Lobs Hole), ECVT portal (Lobs Hole) and Tantangara construction compound.

Toxic gases (including ammonia and nitrogen oxides) may be formed in the event of a fire/explosion involving AN explosives. Toxic gas dispersion was not assessed quantitatively in this study. Evolved gases are at elevated temperature, hence buoyant, and would not have a significant impact at ground level.

The consequence modelling results for each location are summarised in Table 6.2, with more detailed results provided in APPENDIX C.

Table 6.2: Results

Scenario	Overpressure (kPa)	Criteria	Distance to overpressure impact (m)	Potential offsite impact?
INC-001/2/3	14	Fatality	234	Yes
	7	Injury	379	Yes

7. QUANTITATIVE RISK ANALYSIS

7.1. Overview

Based on the potential for offsite impact, the following scenarios have been carried forward for further analysis:

- Detonation of explosives in magazine store for all construction sites.

7.2. Explosives risk evaluation

7.2.1. Reviews of significant incidents involving explosives

Explosives are the main hazard during construction a review of past incidents involving explosives at similar facilities was undertaken, using:

- Australian Disaster Resilience Knowledge Hub Ref [8]
- Japan Science and Technology Agency Failure Knowledge Database Ref [9]
- European Major Accident Reporting System Ref [10].

Information from the searches is listed below:

- Australian Disaster Resilience Knowledge Hub Ref [8]
  - Keyword: Explosion
  - Result: No relevant incidents found
- Japan Science and Technology Agency Failure Knowledge Database Ref [9]
  - Area: Chemistry
  - Result: No relevant incidents found; explosions at explosives manufacturing facilities only
- European Major Accident Reporting System Ref [10]
  - Keyword: Explosion
  - Results:
    - Explosion at a storage facility containing ammonium nitrate explosives, detonating cord and various other explosive products. This was caused by escalation from a fire-cracker to fireworks and then to Trinitrotoluene (TNT) and Ammonium Nitrate (AN).
    - Detonation of approximately 15-20 tonnes of Ammonium Nitrate at a storage shed at an AN manufacturing facility in Toulouse, France.
    - Detonation of approximately 3-5 tonnes of AN at a storage warehouse in France.
- Other sources

- Various incidents due to transportation of ammonium nitrate involving a fire and subsequent explosion, e.g. in Queensland – Taroom[1], Wyandra[2].

The key learning from the incidents are as follows:

- Segregate explosive material to limit escalation.
- Fires can lead to detonation of AN.
- AN is subject to explosive decomposition if contaminated.
- No incidents were found involving industrial explosives stored in magazine.

7.3. Assessment

Table 7.1 compares the injury, fatality or property damage threshold overpressure to actual distances for land use categories of concern in HIPAP 4. If the explosion consequence impacts do not reach the land use categories considered in HIPAP 4, the explosion risk levels are considered acceptable.

Table 7.1: Overpressure Threshold for HIPAP 4 Land Uses

Land Uses	Maximum Distance to Overpressure Threshold (m)		Receptors[(a)]	Minimum Distance to Nearest Receptors (m)	Separation Distance Acceptable?
	7 kPa (Injury)	14 kPa (Fatality or Property Damage)			
Sensitive land uses, incl. hospitals, schools, aged care	379	234	Nurenmerenmong	10,000	Yes
Residential and hotels	379	234	Nurenmerenmong	10,000	Yes
			Accommodation Camp[(b)]	1,000	Yes
Commercial areas including offices, retail centres, warehouses	379	234	Nurenmerenmong	10,000	Yes
Sporting complexes and active open spaces	379	234	Nurenmerenmong	10,000	Yes

(a) Nurenmerenmong is the closest marked location on the Australian Bureau of Statistics 2016 Census data. The area is shown with 3 dwellings and a population of 11. Land uses assumed to be in the town.

(b) Although not zoned residential, the accommodation camps were used in the evaluation of the residential and hotel land use to confirm adequate separation. The closest camp is 1km from an explosives store, refer to Table 7.2.

[1] https://trove.nla.gov.au/newspaper/article/102002031

[2] https://www.brisbanetimes.com.au/national/queensland/truck-explosion-injures-eight-closes-mitchell-highway-20140906-10dam3.html

Table 7.2: Accommodation camp and explosive store separation distances

Accommodation Camps	Nearest Explosives Store	Distance (m)
Main Camp	Main Yard	>1000
Marica Camp	MAT Portal	>2000
Tantangara Camp	Tantangara Portal and construction compound	>1000

7.3.1. Risk at site boundary

In addition to the land uses assessed above, HIPAP 4 has a target risk criterion that the 50 in a million per year chance of fatality will be retained onsite. The likelihood of the consequence exceeding the site boundary risk criteria was assessed.

The frequency of a mass detonation of an explosives store is reported in the TNO Purple book (Guidelines for Quantitative Risk Assessment CPR 18E) as 1 x 10^{-5} per year. This is less than 50 x 10^{-6} risk criteria.

In addition, AS 2187.1:1998 'Explosives Storage, Transport and Use' clause 3.2.1 states that compliance with the separation distances in the standard should provide an acceptable level of risk. The risk is summarised in Table 7.3.

Table 7.3: Summary of compliance with risk criteria

Land Uses	Max Risk (per year)	Comments	Complies with HIPAP 4 Criteria?
Individual Fatality Risk			
Remain within boundary of an industrial site	50 x 10^{-6}	Explosions are the only scenarios with potential offsite impacts. These have a likelihood, of 1 x 10-5 per year which is compliant with the risk criterion. In addition, as the explosives magazines will comply with AS 2187.1 1998 separation distances, they will provide an 'acceptable level of risk'.	Yes

7.4. Conclusions

The risk due to storage of explosives was assessed quantitatively and it was concluded that whilst offsite consequences were credible, the risk met the NSW Department of Planning Land Use Planning Risk Criteria, Ref [1].

APPENDIX A. HAZARD IDENTIFICATION

The purpose of the HAZID is to identify potentially hazardous scenarios (i.e. those with the potential to cause harm offsite) or hazards that present a risk to the public. The HAZID covered the construction and operations phase of the Main Works.

Inputs the HAZID were:

1. Chemical register
2. SEPP 33 screening thresholds
3. SEPP 33 list of additional considerations for potentially hazardous industries
4. Construction hazards (based on the NSW Construction Hazard Assessment Implication Review[3])
5. Operational hazards based on the facility locations and operations.

The hazard identification table for the construction phase is in Table A.1 and for the operations phase in Table A.2. External events that are common to both phases are in Table A.3.

The tables record the following for each scenario:

- The hazardous event
- Potential consequences
- Potential threats or causes that may lead to the consequence being realised
- The safeguards proposed which will either reduce the likelihood of the event occurring or minimise the consequences of the event if it should occur.
- Whether the scenario has a potential offsite impact. (Incidents which have been identified to have an offsite impact have been identified with a code, e.g. INC 001 for clarification in reporting).
- Discussion on the need for risk analysis.

[3] https://www.safedesignaustralia.com.au/wp-content/uploads/2018/10/CHAIR_Safety_in_Design_Tool_WorkCoverNSW.pdf

Table A.1: Hazard Identification table - Construction

HAZID No	Hazardous Events	Potential Consequence / Effects	Threats / Causes	Safeguards	Assessment / Recommendations	Potential offsite impact	Comments
1	Detonation of Pentex explosives (including 'Package/ cartridge')	Explosion Sympathetic explosion of other stored explosives	Sabotage Unauthorised access Missile or high energy shock wave due to explosion in magazine store External fire	Single no through road access It is assumed that magazine and security provisions comply with AS 2187 Explosives – Storage, Transport and Use All authorised employees will have an Unsupervised Handling License Bunding to suppress shrapnel or flying debris	Possible offsite impact	Yes	Carried forward to consequence model and risk assessment
2	Detonation of Cordtex 3.6W detonating cords	Explosion Sympathetic explosion of other stored explosives.	Sabotage Unauthorised access Missile or high energy shock wave due to explosion in magazine store External fire	Single no through road access It is assumed that magazine and security provisions comply with AS 2187 Explosives – Storage, Transport and Use All authorised employees will have an Unsupervised Handling License Bunding to suppress shrapnel or flying debris	Possible offsite impact	Yes	Carried forward to consequence model and risk assessment
3	Detonation of Civec Control explosives	Explosion, release of toxic nitrogen oxide (NO_x) gases Sympathetic explosion of other stored explosives	Sabotage Unauthorised access Missile or high energy shock wave due to explosion in magazine store External fire	Single no through road access It is assumed that magazine and security provisions comply with AS 2187 Explosives – Storage, Transport and Use All authorised employees will have an Unsupervised Handling License Bunding to suppress shrapnel or flying debris	Possible offsite impact	Yes	Carried forward to consequence model and risk assessment
4	Storage of DGs below SEPP 33 threshold quantities	Limited to onsite risks	Loss of containment	Storage areas designed to codes and standards including segregation of incompatible material Building design	Quantities below the potentially hazardous threshold	Localised to store	Risk is limited to onsite and is managed by the current controls. No additional assessment required.
5	Unauthorised access to site by public	Injury to or fatality of a member of the public	Typical construction threats include: Open excavations, steep benching, unguarded edges, equipment movements, chemical storage areas, electrocution	Site security arrangements	No offsite impact.	No	Risk is limited to onsite and is managed by the current controls. No additional assessment required.

HAZID No	Hazardous Events	Potential Consequence / Effects	Threats / Causes	Safeguards	Assessment / Recommendations	Potential offsite impact	Comments
6	Accident involving transport of explosives	Explosion, release of toxic nitrogen oxide (NO_x) gases Sympathetic explosion of other stored explosives	Deliberate act Transport accident	Licensed and competent dangerous goods transport companies. Vehicle design Diver training	Risk can be appropriately managed by the current controls.	Yes	Risk is managed by codes and standards. No additional assessment required.

Table A.2: Hazard Identification table - Operations

HAZID No	Hazardous Events	Potential Consequence / Effects	Threats / Causes	Safeguards	Assessment / Recommendations	Potential offsite impact	Comments
1	Incident escalates to diesel store	Diesel fire with heat radiation	Flammable material escalates to diesel store	Segregation design Codes and standards Manual intervention	Well understood risks. Managed by codes and standards	Localised to diesel store	No further assessment required.
2	DGs stored below SEPP 33 thresholds	Limited to onsite risks	Spill or leak	Storage areas designed to codes and standards including segregation of incompatible material Building design	Well understood risks Managed by codes and standards	Localised to store	No further assessment required.
3	Water under pressure	Sudden release of pressure, injury or fatality to person in immediate vicinity. Would require public to be onsite for public impact.	Overpressure, system failure	Site security and access control System control System design Alarms Localised impact	Well understood risks. Managed by codes and standards	Localised to pressure system	No further assessment required.
4	Station inundation	Leak and station flooding. Would require public to be onsite for public impact.	System failure	Site security and access control System control System Design Alarms Drainage pumps No offsite impact	Well understood risks. Managed by codes and standards and existing Snowy Hydro systems	Localised to station	No further assessment required.

HAZID No	Hazardous Events	Potential Consequence / Effects	Threats / Causes	Safeguards	Assessment / Recommendations	Potential offsite impact	Comments
5	Public access to Main Works operational facilities	Injury from interaction with operational Main Works facilities	Trespass	Site security and access control Alarms No offsite impact	Well understood risk, Managed by existing Snowy Hydro systems	On site	No further assessment required.
6	Impact from rotation equipment or electrocution	Sudden release of energy. Would require public to be onsite for public impact.	System or equipment failure	Site security and access control System control System design Alarms Localised impact	Well understood risks. Managed by codes and standards	Localised to equipment	No further assessment required.

Table A.3: Hazard Identification table – External events

HAZID No	Hazardous Events	Potential Consequence / Effects	Threats / Causes	Safeguards	Assessment / Recommendations	Comments
1	Heavy Rain	Site flooding	External flooding	Codes and standards Engineering design	Covered in EIS flooding assessment	No additional assessment
2	Earthquakes	Injuries on site from sudden movement	Earthquakes	Codes and standards Engineering design	Considered during design and managed by codes and standards	No additional assessment
3	Land slip/subsidence	Injuries on site from sudden movement	Land slip/subsidence	Codes and standards Engineering design	Considered during design and managed by codes and standards	No additional assessment
4	Cyclones	Injuries on site from sudden movement	Cyclones	Codes and standards Engineering design	Not a cyclone area. But designed in accordance with the relevant wind/loading codes	No additional assessment
5	Tsunami/storm surge tides	Injuries on site from sudden movement	Tsunami/storm surge tides	-	Located inland- not a potential threat	No additional assessment
6	Lightning	Struck by lightning. Fire/explosion	Lightning	Codes and standards Engineering design	Designed to all codes and standards for lightning	No additional assessment
7	Plane Crash	Struck by plane, Fire/explosion	Plane Crash	-	No airstrips present in the project area. Nearest airport is 50 km north west, therefore unlikely for plane crash	No additional assessment

HAZID No	Hazardous Events	Potential Consequence / Effects	Threats / Causes	Safeguards	Assessment / Recommendations	Comments
8	Helicopter Crash	Struck by helicopter, Fire/explosion	Helicopter Crash	Codes and standards	Authorised personnel to use heliport with permission for landing/take off. Unlikely for helicopter crash to impact the public.	No additional assessment
9	Vehicle Crash	Fire/explosion	Vehicle Crash	Traffic management rules on site (speed limit, licensed driver).	Traffic management plan followed on site. Existing Snowy Hydro procedures.	No additional assessment
10	Sabotage/vandalism		Sabotage/vandalism	Site security management system	Existing Snowy Hydro procedures	No additional assessment
11	Power failure		Utilities failure	Engineering design	Unlikely to have any significant impact on explosive storage in case of power failure. Power lines separated from storage areas., therefore no significant risk. Back up power supply to be provided for critical equipment at construction and operational sites.	No additional assessment
12	Bushfire	Fire/explosion	Bushfire	Covered in EIS Bushfire assessment	Asset Protection Zones (APZs) in place between vegetation and portal construction, therefore no significant risk	No additional assessment

APPENDIX B. CHEMICAL STORAGE AND HANDLING

Table B.1 and Table B.2 contain indicative chemical storage and volumes during the construction and operations phases which are location specific and non-location specific respectively.

Table B.1: Location specific chemical storage

Locations	Phase	Classification	Class	Sub	PG	Typical (L) (kg for explosives only)	Typical quantity (tonnes)	Storage type/ arrangement	Comments
Talbingo intake Tantangara intake	Operational	Combustible Liquid	-	-	-	2,000	-	-	Combustible liquid not stored with flammable liquids and so does not have a SEPP 33 screening threshold.
Talbingo adit construction compound	Construction	Corrosive	8	-	III	22,500	22.5	Process Water Treatment Plant	
Main camp (Lobs Hole)	Construction	Corrosive	8	-	III	2,000	2	Wastewater Treatment Plant	
Main yard (Lobs Hole)	Construction	Explosives	1.1	D	-	10,000	10	Magazine Store	
		Flammable gases	2	2.1	-	15,200	9.12	Warehouse	Made up of aerosols, sprays and cleaning agents
		Flammable liquid	3	-	II	100	0.08	Warehouse	
					III	28,500	22.8	Warehouse	Stored more at least 20 m from site boundary (APZ)
		Corrosive	8	-	II	300	0.3	Warehouse	
MAT portal	Construction	Explosives	1.1	D	-	10,000	10	Ventilated Magazine Store	
		Corrosive	8	-	III	5,000	5	Process Water Treatment Plant	
	Operational	Combustible Liquid	-	-	-	155,000	-	-	Combustible liquid not stored with flammable liquids and so does not have a SEPP 33 screening threshold.
ECVT portal	Construction	Explosives	1.1	D	-	10,000	10	Ventilated Magazine Store	
		Corrosive	8	-	III	16,000	16	Process Water Treatment Plant	
Cableyard	Operational	Combustible Liquid	-	-	-	155,000	-	-	Combustible liquid not stored with flammable liquids and so does not have a SEPP 33 screening threshold.
Marica accommodation camp	Construction	Corrosive	8	-	III	1,150	1.15	Wastewater Treatment Plant	
Headrace Surge shaft	Construction	Corrosive	8	-	III	16,000	16	Process Water Treatment Plant	
Tantangara construction compound	Construction	Explosives	1.1	D	-	10,000	10	Magazine Store	
		Corrosive	8	-	III	22,500	22.5	Process Water Treatment Plant	
	Operational	Combustible Liquid	-	-	-	2,000	-	-	Combustible liquid not stored with flammable liquids and so does not have a SEPP 33 screening threshold.
Tantangara accommodation camp	Construction	Corrosive	8	-	III	850	0.85	Wastewater Treatment Plant	
Rock Forest logistics laydown	Construction	Combustible Liquid	-	-	-	320,000	-	-	Combustible liquid not stored with flammable liquids and so does not have a SEPP 33 screening threshold.

Table B.2: Non-location specific chemical storage

Storage not linked to a specific location	Phase	Classification	Class	Sub	PG	Typical (L) (kg for explosives only)	Typical quantity (tonnes)	Storage type/ arrangement	Comments
Camps/ablutions	Construction	Flammable gases	2	2.1	-	200	0.12	DG Container/Store	
Camps/Offices/workshop	Construction	Flammable gases	2	2.1	-	200	0.12	DG Container/Store	
Construction sites	Construction	Flammable gases	2	2.1	-	10 – Non LPG	0.01	DG Container/Store	
						1,860 - LPG	1.116	DG Container/Store	
		Flammable liquid	3	-	II	11,000	8.8	DG Container/Store	
					III	9,000	7.2	DG Container/Store	
		Corrosive	8	-	III	1,000	1	DG Container/Store	
Workshops	Construction	Flammable gases	2	2.1	-	410	0.2	DG Container/Store	
		Flammable liquid	3	-	III	11,100	8.9	DG Container/Store	
		Corrosive	8	-	III	10,000	10	DG Container/Store	

APPENDIX C. CONSEQUENCE RESULTS

Table C.1: Consequence results (All locations)

Scenario			Consequence model parameters				Distance (m) to overpressure level from the centre of location From TNO Effects					
Scenario ID	**Area**	**Scenario description**	**Material**	**Max storage quantity (te)**	**Equivalence**	**NEQ (kg)**	**70 kPa**	**35 kPa**	**21 kPa**	**14 kPa**	**7 kPa**	**2 kPa**
All	Magazine and vented magazine	Detonation of all explosives at explosive magazine stores	TNT/ANE	10	1	10,000	85	128	178	234	379	964

APPENDIX D. REFERENCES

[1] NSW Department of Planning, “HIPAP 4 - Risk Criteria for Land Use Planning,” 2011.

[2] Committee OB-007, “AS ISO 31000:2018 Risk management - Guidelines,” Standards Australia, 2018.

[3] EMM Consulting, “[Excel Spreadsheet] Combined Main Works Chemical Register EIS 19Mar2019.xlsx,” 2019.

[4] National Transport Commission, “Australian Code for the Transport of Dangerous Goods by Road and Rail Edition 7.6,” July 2018.

[5] NSW Department of Planning, “HIPAP 4 - Risk Criteria for Land Use Planning,” 2011.

[6] NSW Department of Planning, “HIPAP 6 - Hazard Analysis,” 2011.

[7] NSW Department of Planning, “Hazardous and Offensive Development Application Guidelines: Applying SEPP 33,” 2011.

[8] Australian Institute for Disaster Resilience, “Australian Disaster Resilience - Knowledge Hub,” AIDR, 2007. [Online]. Available: https://knowledge.aidr.org.au/. [Accessed 16 April 2019].

[9] Hatamura institute for the advancement of technology, “Failure Knowledge Database,” [Online]. Available: http://www.sozogaku.com/fkd/en/index.html. [Accessed 16 April 2019].

[10] European Commission - Joint Research Centre, “Major Accident Reporting System,” [Online]. Available: https://emars.jrc.ec.europa.eu/?id=4. [Accessed 16 April 2019].

[11] L. Wallis, *Updated Hazchem Register,* 26 June 2019.