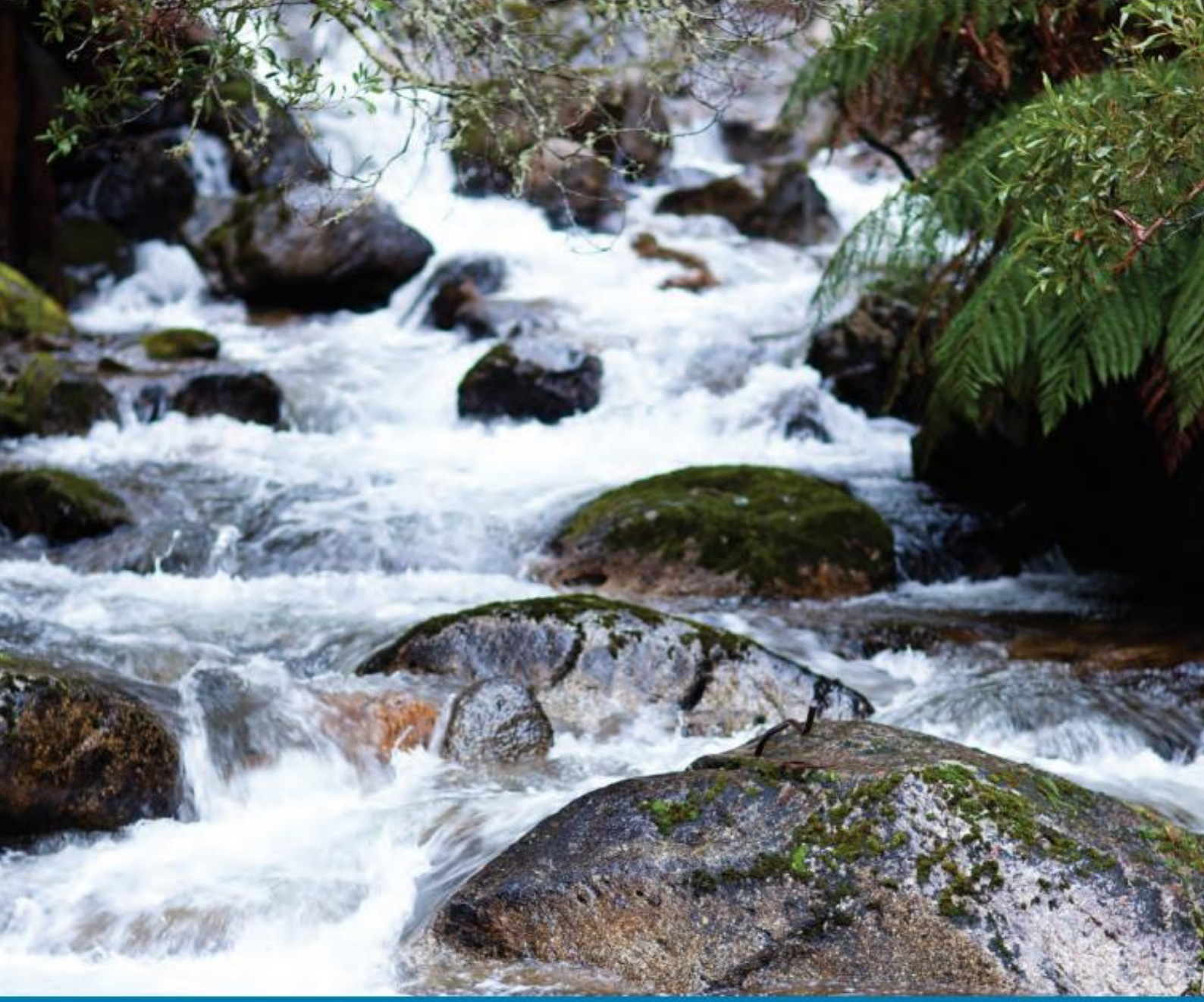

WATER MANAGEMENT PLAN
SNOWY 2.0 – EXPLORATORY WORKS

Stage 1 - Exploratory Works Access Roads

December 2019

snowy 2.0

leed

Water Management Plan

REV 1

Report Snowy 2.0 - Exploratory Works - Water Management Plan | Prepared for Snowy Hydro Limited

12 December 2019

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Abbreviations and Glossary

CSSI	Critical State Significant Infrastructure
DMP	Dredge Management Plan
DPIE	NSW Department of Planning, Industry and Environment *formerly* NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
EIS	*Environmental Impact Statement Exploratory Works for Snowy 2.0*
EMS	Environmental Management Strategy
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	NSW Environment Protection Authority
ESCP	Erosion and sediment control plan
EWMS	Environmental Work Method Statement
GWMP	Groundwater Management Plan
NPWS	National Park and Wildlife Services
POEO Act	*Protection of the Environment Operations Act 1997*
Submissions Report or RTS	*Response to Submissions Exploratory Works for Snowy 2.0*
SWMP	Surface Water Management Plan
WMP	Water Management Plan

1 Introduction

1.1 Background

Snowy Hydro Limited (Snowy Hydro) is the proponent of the Snowy 2.0 project which is a pumped hydro-electric storage and generation project proposed to address increasing demands for renewable energy supplies. Snowy 2.0 involves linking Talbingo and Tantangara reservoirs within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme) and building an underground power station between the two reservoirs.

Snowy Hydro proposes to carry out Exploratory Works prior to the main construction works for the Snowy 2.0 project, to inform the detailed design and to reduce project risk. Exploratory Works are required to obtain detailed geological data for the location of the underground power station. An exploratory tunnel is to be constructed to gain this information. The Exploratory Works will predominantly be in the Lobs Hole area of Kosciuszko National Park. If the Exploratory Works are not undertaken, risks to the design and construct elements of the power station cavern are significantly increased.

The *Environmental Impact Statement Exploratory Works for Snowy 2.0* (EIS) was prepared to assess the impact of these works on the environment, including an assessment of water impacts within Chapters 5.4 and M and N. MOD1 also identified water impacts as a result of the modification, assessed any impacts, and proposed any required mitigation measures within Chapter 6.3 and 7.1.

The EIS and MOD1 identified the potential for direct and indirect impacts on water quality from surface water runoff from disturbed and operating areas of the site, dredging, subaqueous excavated rock placement and discharges of process water and waste (effluent) water. The EIS concluded that, with the implementation of appropriate impact mitigation measures, there would be no significant impacts to waterways within the project area, to high risk areas or sensitive receiving environments downstream of the project.

With respect to groundwater modelling undertaken as part of the EIS predicted localised drawdown in the vicinity of the tunnel alignment, primarily around the portal. Only minor impacts to the baseflow of the Yarrangobilly River and tributaries are expected during construction. Losses are predicted to increase post construction until a new equilibrium is reached.

The *Response to Submissions Exploratory Works for Snowy 2.0* (Submissions Report or RTS) included revised environmental management measures within Chapter 8. The management measures from that report have been addressed within this WMP and appendices.

1.2 Context

This Water Management Plan (WMP or Plan) forms part of the Environmental Management Strategy (EMS) for Snowy 2.0 – Exploratory Works (the Project). The Exploratory Works is the first stage of Snowy 2.0, a pumped hydro-electric storage and generation project which will increase the hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme. The second stage, or main project, will be subject to a separate Environmental Impact Statement in 2019.

The WMP has been prepared to address the requirements of the Infrastructure Approval (SSI 9208) issued for Snowy 2.0 Exploratory Works on 11 February 2019, the *Environmental Impact Statement Exploratory Works for Snowy Hydro 2.0,* and the revised environmental management measures within the *Response to Submissions Exploratory Works for Snowy 2.0*.

This revision of the WMP has been prepared to address the requirements of the Exploratory Works for Snowy 2.0 Modification 1 Assessment Report (MOD1) and the REMMs within the Exploratory Works Modification 1 Response to Submissions Report which were approved by Department of Planning, Industry and Environment (DPIE) on 2 December 2019.

The original EIS approved Exploratory Works include:

- an exploratory tunnel about 3.1 km long to the site of the underground power station;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- a portal construction pad for the exploratory tunnel. This will provide the entrance structure to the tunnel and an area for infrastructure and equipment needed to support tunnelling activities;
- an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades to enable access and haulage routes during Exploratory Works. This includes upgrades to 26 km of existing roads and creating about 2 km of new roads;
- barge access infrastructure to enable access and transport by barge on Talbingo Reservoir. This includes one new barge ramp at Talbingo Spillway in the northern part of Talbingo Reservoir and one new barge ramp at Middle Bay near Lobs Hole at the southern part of Talbingo Reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir. Up to 750,000 m^3 of excavated rock will need to be tested for its geochemical properties (ie whether the rock is reactive or non-reactive) before being managed by a combination of the following options:
    - re-use - suitable material can be used as construction materials for roads or similar. Some materials will be provided to NPWS for use in road maintenance and upgrades in other areas of KNP;
    - on land placement - material will be temporarily placed in one of two on land emplacement areas.
    - subaqueous placement within Talbingo Reservoir – suitable material will be placed at a suitable location within Talbingo Reservoir, subject to a number of water quality controls and monitoring; and
- services infrastructure such as diesel-generated power, water and communication;
- post-construction revegetation and rehabilitation, management and monitoring.

Having regard to the design changes identified in Modification 1, the scope now comprises the following listed in Table 1.1 below :

Table 1.1 New scope items for EW (Stage 1 & 2) as a result of MOD1

Stage 1	
Lobbs Hole Substation	Additional disturbance area required for the construction power connection to an existing transmission line (Line 2) at Lobs Hole for power supply to the Exploratory Works accommodation camp and construction areas. This will provide a reliable and long-term source of construction power and will reduce the reliance on diesel generation and associated on-site storage requirements and emissions. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas; This will include: • construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation; • geotechnical investigation works to inform the detailed design of the construction power substation; • replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height; • short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54; • 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables; • establishment and upgrade of access tracks and roads to the new substation and transmission line structures; • installation of a fibre optic communication link into the new substation from the approved communication network; and • ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas. (Illustrated Appendix C Figure 1i)
Camps Bridge and Wallaces Creek	• additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment; (Illustrated in Appendix C Figures 1h and 1i of this plan and Modification 1 Assessment Report Figure 3.9)
Lobs Hill Ravine Road and Construction Boundary Changes	• minor changes to the project boundary identified through detailed design including: – revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; – minor additions to construction areas for design optimisation. • removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and

	Mine Trail Road; (Illustrated in Appendix C, Figures 1d, 1e, 1f and 1i)
Operating Hours	• modify operating hours from existing 7 am to 6pm to sunrise to sunset
Miscellaneous	• continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program; and • increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected. (location of communications towers illustrated in Appendix C Figures 1a, 1f, 1l)
Stage 2	
Borehole drilling and geophysical surveys	• Borehole drilling and geophysical surveys for further geotechnical investigation of the Snowy 2.0 power station and power waterway at Marica, Talbingo and Tantangara; • clearing of up to 2.79 hectares (ha) of additional vegetation for access tracks and drilling pads. • About 1.33 ha within Smokey Mouse potential habitat; • trimming of overhanging dangerous branches on adjacent trees (these trees will not require removal); • mulching of trees and vegetation; • establishment of an additional 1 km of access tracks (4 m wide), including minor earthworks, • placement of geofabric (as required) and import of stabilised material; • establishment of eight drilling pads and boreholes at top of the cavern area, with an area of 900 m2 per pad, including minor earthworks, placement of geofabric (as required) and import of stabilised material (as required); • undertaking geophysical surveys near Talbingo and Tantangara reservoirs; • establishment of two drilling pads and boreholes at both Tantangara and Talbingo with an area of • 900 m2 per pad, including approximately 400 m of additional access tracks and minor earthworks (as required); • establishment of in-reservoir boreholes including one in Talbingo Reservoir and two in Tantangara Reservoir; • drilling of additional nested vertical boreholes at each of the drilling pads up to a depth of 1,100 m; • conversion of the investigation boreholes into monitoring bores; • undertaking geophysical surveys; and • rehabilitation of the drilling pads and access tracks following completion of works • ongoing maintenance of existing access tracks required for geotechnical investigations within KNP

	(Illustrated in (Illustrated in Appendix C Figure 1j, 1k, 1l, 1m and 1n)
Talbingo Laydown	Outside of KNP, SHL is proposing to add four laydown locations to facilitate the construction of the communications cable linking Lobs Hole with the Tumut 3 Power Station. These are proposed on existing hardstand areas along Talbingo Reservoir within Snowy Hydro owned land. (Illustrated in Appendix C, Figure 1o)
Tantangara Access	Two additional geotechnical boreholes are required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures near Nungar Creek (Illustrated in Appendix C, Figure 1m and 1n)

The Exploratory Works is estimated to take around 30 to 34 months to complete.

As with most of the existing Snowy Scheme, the majority of Snowy 2.0 is within Kosciuszko National Park. Snowy Hydro has been working with NSW National Parks and Wildlife Service (NPWS) since the announcement of Snowy 2.0 to ensure long term management objectives for Kosciuszko National Park are considered in project development.

The Project has been designed in a way that avoids and minimises impacts to Kosciuszko National Park where possible. This has included the planning of access roads and construction areas to avoid impacting the heritage listed Washington Hotel ruins at Lobs Hole, and Smoky Mouse habitat along Upper Lobs Hole Ravine Road. It also includes designing road upgrades to minimise impacts to geodiversity features including a block stream and a fossil outcrop along Lower Lobs Hole Ravine Road. The former copper mine at Lobs Hole is also considered a geo-heritage site, however it is also a source of known contamination and has therefore been avoided as much as possible to prevent disturbance.

While there are some unavoidable impacts during construction, the Exploratory Works will allow for a number of longer-term benefits and contributions to Kosciuszko National Park through a biodiversity offset program, improved access roads and recreational facility upgrades. The completion of Exploratory Works will also allow for the greater benefits of Snowy 2.0 to be realised.

1.3 Construction activities and staging

Exploratory Works will be delivered in three stages:

- **Stage 1a – Pre-construction Minor Works** - pending the approval process, works may commence in the first quarter of 2019. The scope of pre-construction minor works includes dilapidation studies, survey work, borehole installation, site office establishment, minor access roads, installation of monitoring equipment, installation of erosion and sediment controls, archaeological salvage and minor clearing;

- **Stage 1b – Exploratory Works Access Roads (EWAR)** - pending the approval process, works may commence in the first quarter of 2019. The scope includes roadworks and upgrades to enable access and haulage routes during Exploratory Works;

- **Stage 2 – Exploratory Works** - pending progress with Stage 1, works may commence in quarter three of 2019. The scope for Stage 2 will be the remainder of the Exploratory Works, including the exploratory tunnel, portal construction pad, accommodation camp and excavated rock management. Stage 2 also includes subaqueous emplacement within Talbingo Reservoir.

To present the staging of plans a separate Staging Report has been prepared and was submitted to Department of Planning and Environment. Timing of the Exploratory Work stages is presented below.

Figure 1 Timing of Exploratory Works stages

1.3.1 Exploratory Works Access Roads

The Exploratory Works Access Roads (EWAR) will provide early access to the tunnel portal located to the east of the Talbingo Reservoir, and to Talbingo Reservoir itself. The works include upgrades to and/or construction of the following roads:

- Ravine Road;
- Mine Trail Road;
- Lobs Hole Road;
- Wharf Road.

The EWAR work scope includes but is not limited to the following:

- setting out the works including delineation of site boundaries;
- establishment of all site facilities required and removal upon completion, including all temporary safety and security measures required;
- locating and protecting all public and private utility services;
- maintenance of the existing roadway and associated infrastructure;
- clearing and grubbing of vegetation including creation of mulch and compost;
- establishment of short term and long-term (eg: detention and sedimentation basins) erosion and sedimentation control systems and devices;
- removal and disposal of existing infrastructure including pipes, culverts, drainage channels and other minor structures;

- excavation and stockpiling of topsoil;
- earthworks including excavation of cuttings, construction of fills including selected zone material, and placement of excess spoil in stockpile;
- progressive opening to traffic;
- treatment of cut and fill slope batter surfaces including slope retention systems where shown;
- construction of clean and dirty water drainage systems including culverts, open and subsoil drainage systems;
- construction of pavements including subgrades and pavements and road surfacing;
- design, supply, construction of temporary structures / bridges over Wallace Creek and the Yarrangobilly River and removal of completion;
- construction of permanent bridges over Wallace Creek and the Yarrangobilly River;
- installation of road furniture including but not limited to barriers, line marking, guide posts and road signs;
- placement / replacement of topsoil and revegetation and other surface treatments to disturbed earth surfaces including lining of open drains;
- clean up and restoration of work areas and areas disturbed by the contractor.

The additional scope as a result of MOD1 will include:

- construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation;
- geotechnical investigation works to inform the detailed design of the construction power substation;
- replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height;
- short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54;
- 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables;
- establishment and upgrade of access tracks and roads to the new substation and transmission line structures;
- installation of a fibre optic communication link into the new substation from the approved communication network; and

- ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas.

- minor changes to the project boundary identified through detailed design including:

  - additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment;

  - additional disturbance area required for the construction power connection to an existing transmission line at Lobs Hole. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas;

  - revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; and

  - minor additions to construction areas for design optimisation.

- removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road;

- continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program;

- increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected;

The works are proposed to commence in the first quarter of 2019.

Leed Engineering (Leed) are the contractor who will be carrying out the Snowy 2.0 Stage 1 work on behalf of Snowy Hydro.

This Plan identifies the project's environmental management measures in relation to water management. It has been developed for Stage 1 of the Exploratory Works project and will be revised prior to commencement of Stage 2 works.

The timing of the preparation, consultation, submission and approval of this plan is shown within Figure 4.3 of the Environmental Management Strategy (EMS). During Stage 1 of the work ongoing revisions to the WMP will occur in accordance with Section 1.6.1 of the EMS.

Some distinct work activities such as the management of dredging activities and rock emplacement on land and water, require greater detail and warrant separate plans. The activities which are also related to water which are detailed within other management plans, are shown within Table 1.2.

It is also noted that this plan includes a number of sub-plans required to comply with the requirements of condition 34 of the conditions of approval. These are also detailed in Table 1.2.

Table 1.2 Relationship to other plans

Activities	Relevant plan	Timing of the plan*	
		Stage 1	Stage 2
Road construction and tunnelling – general management of water	This plan	P	R
Surface Water	Appendix A - Surface Water Management Plan	P	R
Erosion and sedimentation management and soil disturbance	Appendix A - Surface Water Management Plan	P	R
Process and wastewater management	Appendix A - Surface Water Management Plan	P	R
Groundwater	Appendix B - Groundwater Management Plan	P	R
Dredge spoil disposal	Dredge Management Plan		P
Excavated tunnel rock stockpiling	Excavated Material Management Plan	P	R
Excavated spoil disposal in Talbingo Reservoir	Subaqueous Emplacement Management Plan	-	P
Geodiversity and karst features	Historic and Natural Heritage Management Plan	P	-
Existing land contamination	Contaminated Land Management Land	P	-
Flood response	Emergency Response Management Plan	P	-

* P – prepare, R - revise

Specific on-site management measures identified in this Plan will be incorporated into site documents which are to be prepared by the Contractor. These site-specific documents will be prepared for construction activities and will detail the management measures which are to be implemented on the ground.

Construction personnel will be required to undertake works in accordance with the mitigation measures identified in the site-specific documents.

1.4 Environmental management system

The overall environmental management system for the Project is described in the EMS. This WMP forms part of Snowy Hydro Limited's environmental management framework for the Project, as identified in Figure 1.2 and as described in Section 4 of the EMS. **This Plan aims to transfer the relevant requirements of the Approval documents into a management plan which can be practically applied on the Project site.**

Figure 1.2 EMS structure

1.5 Purpose and objectives

The key objective of the Water Management Plan is to describe the management measures and monitoring programs that are to be implemented to ensure that water impacts are minimised during Stage 1 delivery of the project. To achieve this, Snowy Hydro and the Contractor will:

- ensure appropriate measures are implemented to address the relevant conditions of the conditions of approval as detailed within Table 2.1 and of this Plan; and
- ensure appropriate measures are implemented during construction to avoid or minimise impacts to water and potential adverse impact.

1.6 Plan preparation

In accordance with the requirements of Condition 34 of the conditions of approval this plan has been prepared by Chris Kuczera and Sean Cassidy of EMM Consulting. These representatives were approved by the Secretary of Department of Planning and Environment on 13th February 2019.

1.7 Consultation

In accordance with condition 34 of the Infrastructure Approval (SSI 9208) (Approval), the WMP is to be prepared in consultation with the following agencies;

- National Parks and Wildlife Service (NPWS);
- NSW Environment Protection Authority (EPA);
- Department of Primary Industries - Fisheries (DPI Fisheries);
- Department of Industry Water (DOI Water).

Preliminary consultation for the Water Management Plan and subsequent Appendices began in November 2018 and has been presented in Table 1.2 below.

The MOD1 Assessment Report and associated technical studies were submitted by Snowy Hydro to DPIE in June 2019 and publicly exhibited in accordance with the EP&A Act between 26 June and 9 July 2019. Nine submissions were received during the public exhibition period, including one from a special interest group and two individual community submissions.

Table 1.2 Preliminary WMP consultations with stakeholder agencies

Date	Consultation	Outcomes
21st November 2018	Issued draft WMP to NSW EPA	Sent as information to these for their initial review.
22nd November 2018	Issued draft WMP to DOI Water	Sent as information to these for their initial review
26th November 2018	Meeting with NSW EPA	Presented the structure and contents of the WMP to OEH and discussed typical methods and control types.
12th December 2018	Initial consultation meeting with NPWS	Outlined the Project approval process and management plan development
17 / 18th December 2018	Site meeting with OEH	Visited the Exploratory Works site and discussed surface water controls
16th January 2019	Issued draft WMP to NPWS	Sent as information to these for their initial review

Date	Consultation	Outcomes
22nd January 2019	Initial consultation meeting with NPWS	Discussed revisions to management plans and consultation and approval program
30th January 2019	Received WMP comments from NPWS	Comments accepted and plans revised to address comments.
4th February 2019	Follow-up correspondence with DOI Water	Aiming to make contact to facilitate preliminary consultation
5th February 2019	Initial consultation meeting with NPWS	Discussion with NPWS about current plans, latest comments and the ongoing consultation process.
12th February 2019	Updated WMP, SWMP and GWMP issued to NPWS, EPA, DPI Fisheries and DOI Water for review and comment.	Sent for review and comment
25th February 2019	Received comments from NPWS regarding updated management plan	Comments received and plan revised accordingly
26th February 2019	Received comments from EPA regarding updated management plan	Comments received and plan revised accordingly
1st March 2019	Received comments from NRAR regarding updated management plan	Comments received and plan revised accordingly
4th October 2019	Updated plans were sent to NPWS for comment on changes as a result of MOD1	Comments received and plans updated accordingly.
25th October	Plans sent to EPA, DoI Water and DPI Fisheries for comment on changes as a result of MOD1	EPA responded with no comments

2 Environmental requirements

2.1 Legislation

Legislation relevant to water management includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Environmental Planning and Assessment Regulation 2000*;
- *Protection of the Environment Operations Act 1997;*
- *Protection of the Environment (General) Regulation 2009* (as amended);
- *Water Management Act 2000;*
- *Water Management Amendment Act 2014;*
- *Water Management (General) Regulation 2011;*
- *Water Sharing Plan for the Murrumbidgee unregulated and alluvial water sources* (2012);
- *Snowy Hydro Corporatisation Act 1997.*

The Surface Water and Ground Water Management Plans (Appendices A and B) contain legislation applicable to their respective aspects.

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the EMS.

2.2 Conditions of approval

Table 2.1 Conditions of approval relevant to water management

Condition	Requirement	Where addressed
31	The Proponent must ensure that it has sufficient water for all stages of the development; and if necessary, stage the development to match its available water supply. *Note: Under the Water Management Act 2000, the Proponent must obtain the necessary water licences for the development.*	WMP Section 2.4
32	Unless an environment protection licence authorises otherwise, the Proponent must comply with Section 120 of the POEO Act. *Note: Section 120 of the POEO Act makes it an offence to pollute any waters.*	WMP - Appendix A Surface Water Management Plan
33	The Proponent must: (a) minimise the use of clean water on site; (b) maximise the diversion of clean water runoff around the approved disturbance areas on site; (c) minimise the flow rates from any clean water runoff diversions to adjoining watercourses;	WMP - Appendix A Surface Water Management and WMP - Appendix B Groundwater Management Plan

Condition	Requirement	Where addressed
	(d) minimise any soil erosion associated with the development; (e) ensure all chemical and hydrocarbon products are stored on site in bunded areas in accordance with the relevant Australian Standards.	
34	Prior to carrying out any construction, unless the Planning Secretary agrees otherwise, the Proponent must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	
	(a) be prepared in consultation with the EPA, NPWS, DoI Water and DPI - Fisheries by a suitably qualified and experienced person/s whose appointment has been approved by the Planning Secretary;	WMP - Section 1.6
	(b) include a Site Water Balance for the development and a program to review and update the site water balance each calendar year;	WMP - Section 4 (for Stage 1)
	(c) include a Surface Water Management Plan with: • detailed baseline data on surface water flows and quality in the watercourses that could potentially be affected by the development; • a program to augment the baseline data during the development; • a description of the measures that would be implemented to minimise the impacts of: o any subaqueous emplacement; o the dredging within Talbingo Reservoir; o the barge infrastructure; o the water intake; o the water treatment pipes and outlets; o any in-stream works; o stockpiles; o eastern emplacement area; o western emplacement area; o construction portal; o accommodation camp; o road upgrades, and in particular the road works in the vicinity of the Yarrangobilly River; o chemical and hydrocarbon storage. • surface water assessment criteria, including trigger levels for investigating any potentially adverse surface water impacts of the development; • a description of the measures that would be implemented to minimise the surface water impacts of the development, and comply with the performance measures in condition 33 above; • a program to monitor and report on the surface water impacts of the development including water monitoring locations, analytes and sampling frequency for each monitoring location; • a program to monitor and report on the surface water impacts of the development • a plan to respond to any exceedances of the surface water trigger levels and/or assessment criteria and mitigate and/or offset any adverse surface water impacts of the development;	WMP - Appendix A Surface Water Management Plan (for Stage 1)
	(d) include a Dredging Management Plan with: • a description of the measures that would be implemented to minimise the generation and dispersion of sediments outside the identified works zone during dredging; • monitoring at representative locations to determine the extent of suspended sediment concentrations and any other potential pollutants dispersed by dredging;	Dredge Management Plan will be developed for Stage 2

Condition	Requirement	Where addressed
	• a plan to respond to any exceedances of the surface water trigger levels and/or assessment criteria and mitigate and/or offset any adverse surface water impacts of the development;	
	(e) include a Groundwater Management Plan with: • detailed baseline data on groundwater levels, yield and quality on the aquifers that could be affected by the development; • a program to augment the baseline data during the development; • groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts; • a description of the measures that would be implemented to minimise the groundwater impacts of the development • a program to monitor and report on: o groundwater inflows to the tunnel, including inflows to relevant water sources; o groundwater take from the groundwater bore o the impacts of the development on: – regional and local (including alluvial) aquifers; – groundwater dependent ecosystems, stygofauna and riparian vegetation; and – base flow to surface water sources; • a plan to respond to any exceedances of the trigger levels and/or assessment criteria and mitigate and/or offset any adverse groundwater impacts of the development.	WMP - Appendix B Groundwater Management Plan (for Stage 1)
35	The Proponent must implement the approved Water Management Plan for the development.	WMP - Section 1.3
39	The Proponent must: (a) ensure the temporary bridges over Wallace Creek and the Yarrangobilly River incorporate, to the greatest extent practicable, the requirements: • Guidelines for Controlled activities on Waterfront Land (NRAR, 2018); and • Policy and Guidelines for Fish Habitat Conservation (DPI 2013) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003); (b) remove temporary bridges as soon as practicable after the construction of the permanent bridges, and rehabilitate the land to the satisfaction of the NPWS; (c) consider scheduling to minimise in stream works between October to January, the migratory period of the Macquarie Perch (*Macquaria australasica*).	WMP - Appendix A Surface Water Management Plan and Aquatic Habitat Management Plan
40	The Proponent must: (a) ensure that permanent bridges over Wallace creek and the Yarrangobilly River are designed and constructed to comply with the relevant requirements of the: • Guidelines for Controlled activities on Waterfront Land (NRAR, 2018); and • Policy and Guidelines for Fish Habitat Conservation (DPI 2013) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003); (b) ensure that the permanent bridges over Wallace creek and the Yarrangobilly River are designed and constructed to comply with the relevant requirements of the relevant Austroads Standards (such as elevating them above the 1%	WMP - Appendix A Surface Water Management Plan and Aquatic Habitat Management Plan

Condition	Requirement	Where addressed
	AEP flood level); (c) minimise in stream works between October to January, the migratory period of the Macquarie Perch (*Macquaria australasica*).	

2.3 Revised environmental management measures

Environmental safeguards and management measures are included in the EIS in Section 6.3. During preparation of the Submissions Report, revised environmental management measures were developed and are included in Section 8 of the Submissions Report.

The management plans appended to the Water Management Plan contain the revised environmental management measures applicable to their respective aspects.

2.4 Licences and permits

For the work scope an Environment Protection Licence (EPL) has been obtained (EPL# 21266) by Snowy Hydro for the Scheduled Activity of Extractive Activities. The EPL details specific monitoring and reporting conditions which must be complied with when undertaking the extractive activities works.

Snowy Hydro is required to licence groundwater extraction in accordance with the *Aquifer Interference Policy 2012* (AIP), the *Water Management Act 2000* (WMA 2000), and the relevant statutory Water Sharing Plans (WSPs). This includes water taken for use as well as water intercepted and managed as a result of tunnelling activities. Sufficient share components and Water Access Licences (WALs) must be held to account for the peak annual volume of water intercepted from all water sources (directly or indirectly) as a result of the project activities. Consultation with DoI Water will continue in finalising licensing requirements.

Snowy Hydro and the Contractor will ensure that there is sufficient water for all stages of the development available through the approved licences. If necessary the development will be programmed to match its available water supply.

2.5 Guidelines

The guidelines also considered in the completion of this Plan include:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000);
- *Managing Urban Stormwater: Soils and Construction* (Landcom, 4th Edition March 2004 (reprinted 2006) (the "Blue Book")) Volume 1 and Volume 2;
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* – March 2004.

The management plans appended to this Water Management Plan contain additional guidelines applicable to their respective aspects.

3 Existing environment

3.1 Topography and landscape

Elevation across the project area ranges from 550 m above Australian Height Datum (AHD) to 1,400 m AHD. The project area is within a steeply incised ravine, along the western fringe of the Long Plains fault escarpment. Most of the project area is characterised by deep gorges and steep sloping ridges, the product of incision from watercourse flow and glaciations, with localised areas of lower grade, such as ridgelines, saddles, benches, and alluvium beside watercourses.

Glacial landforms within the project area are of national and international significance as they are the only examples of glacial landforms on the mainland of Australia. Landform features include terracing, sliding and shattered boulders and block streams. Karst formations of regional and national significance are also present in the project area. The karst landscape is caused by the action of natural water on soluble rock such as limestone and tufa (porous deposits of calcium carbonate with a sponge-like appearance). The Devonian limestone is also of interest for its fossils (which include corals, trilobites, brachiopods and molluscs. Fossiliferous rock is present in an outcrop adjacent to Lobs Hole Ravine Road and has been exposed and disturbed as a result of previous road construction.

The existing surface water environment is shown in Figure 3.1.

3.2 Surface water

The Yarrangobilly River and Talbingo Reservoir are the defining features of Lobs Hole. The river initially flows in a southerly direction before turning to the west, towards Talbingo Reservoir. The Yarrangobilly River and its tributaries (including Wallaces and Stable creeks) are shown in Figure 3.1 Watercourses in the project area are all 'gaining' streams with groundwater providing stream baseflows. Recharge to the groundwater system is via rainfall infiltration.

A pre-construction water quality monitoring program has been undertaken. This data will be used to evaluate broader water quality trends throughout and following construction of the project.

3.3 Groundwater

The groundwater units within the project area are defined as:

- localised unconsolidated shallow Quaternary gravels episodically recharged through rainfall/flooding events; and
- deep groundwater associated with deeper fractured rock (ie Ravine Beds).

The Ravine Beds is the main groundwater bearing unit to be intercepted by the exploratory tunnel. Groundwater within the Ravine Beds has a marginally brackish water quality and is low yielding. The groundwater quality is described as slightly alkaline with typically low concentrations of most dissolved metals. This is typical of alpine areas where groundwater is readily recharged via rainfall and snow melt.

Ecosystems that rely on groundwater (groundwater dependent ecosystems or GDEs) are important environmental assets and typically occur where groundwater is at or near the land surface. Within the project area they are associated with:

- creeks (such as Yarrangobilly River) where deep groundwater is discharging and provides baseflow;

- shallow (perched) groundwater systems;
- springs associated with the steep escarpment across the eastern extent of the project area; and
- terrestrial vegetation overlying shallow groundwater (within the vegetation's root zone).

There are no identified high-priority GDEs within the project area. Yarrangobilly Caves is the only High Priority GDE listed within the Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011 relevant to Snowy 2.0, and is approximately 8 km north east of the Exploratory Works project area.

Three native vegetation types were identified as having potential to access groundwater sporadically. None of these terrestrial ecosystems are highly dependent or entirely dependent on groundwater.

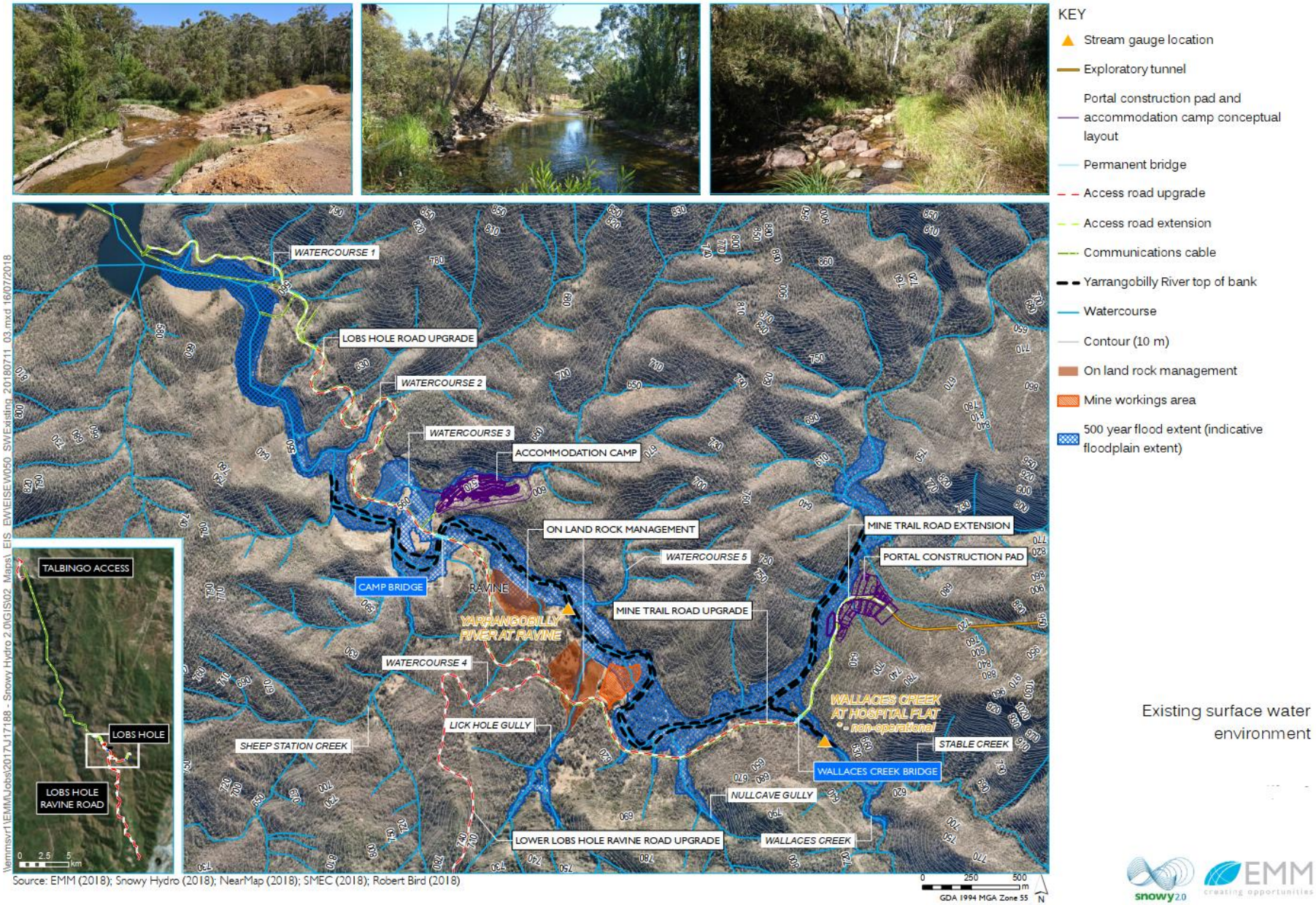

Figure 3.1 Existing surface water environment

4 Site water balance

4.1 Stage 1 – Exploratory Works (Roads)

During Stage 1 - Exploratory Works (Roads), construction water will be required for the following processes:

- earthworks to modify soil and gravel moisture conditions allowing proper compaction;
- dust suppression; and
- the wash down on plant and equipment.

During Stage 1 construction water will be sourced predominately from the groundwater extraction from bores within Lobs Hole, the extraction of water from Talbingo Reservoir and the harvesting of water from the site erosion and sediment control basins.

It is currently predicted that the site demand for water demand during this stage will be a maximum of 219 ML/year at peak construction sourced from a combination of one or more or more of the above or other approved water sources.

An updated Site Water Balance will be provided for Stage 2 of the Exploratory Works.

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5 Compliance management

5.1 Monitoring and inspection

Weekly environmental inspections of the project will occur in accordance with Section 7 of the EMS.

Monitoring will be undertaken specific to surface water and groundwater and is provided in the relevant appended Surface Water Management Plan and the Groundwater Management Plan. These plans include requirements for the monitoring of water extracted and used during construction in order to make comparisons against the site water balance model and groundwater model. The site water balance model will be updated annually based on the results of the monitoring.

5.2 Auditing

Audits will be undertaken to assess the effectiveness of the management measures, compliance with this WMP, the conditions of approval, EIS, Submissions Reports and other relevant approvals, licences and guidelines.

Audit requirements are detailed in Section 7.3 of the EMS.

5.3 Reporting

Reporting will include monthly internal project reports and six-monthly compliance reports as required by the conditions of approval. The six-monthly reports will track compliance against the conditions of approval and the revised environmental management measures. Reporting requirements and responsibilities are documented in Sections 6 and 7 of the EMS. All reporting to DPIE and NPWS will be via the Major Projects portal.

5.4 Environmental inspections

Implementation of a regular program of inspections is an essential part of the success of work activities. The effectiveness of environmental protection measures described in this EMS and management plans will be inspected and assessed on a weekly basis by the Contractor's environmental staff. The weekly checklist for the project will be developed by the Contractor prior to commencement of construction. The purpose of the checklist is to:

- provide a surveillance tool to ensure that safeguards are being implemented;
- identify where problems might be occurring;
- identify where sound environmental practices are not being implemented; and
- facilitate the identification and early resolution of problems.

Any non-conformances identified through the checklist process will be highlighted and an environmental inspection report (minor issues) or an environmental incident report completed.

The checklist will remain 'open' until:

- the issue has been resolved;
- a new or revised procedure has been established and implemented; or
- training has been provided to relevant personnel/ sub-contractors.

The findings of inspections will be discussed at toolbox meetings and concerns raised will be considered by the Contractor's project management team for review or improvement of the environment procedures.

In addition, the Contractor's Environment Manager and Supervisors and Snowy Hydro environment staff will jointly undertake regular inspections of works sites, and in particular critical activities throughout construction of the Project. Stakeholders such as DPIE and EPA will be invited to attend relevant inspections. Inspections will typically occur on a weekly or fortnightly basis depending on the complexity and anticipated risks associated with the stage of construction. Deficiencies and required actions will be analysed and prioritised at the completion of the inspection and timeframes for implementation of corrective actions agreed.

An inspection schedule is provided in below.

Table 5.1 Inspection schedule

Activity	Frequency	Location	Responsibility	Record
Environmental Site Inspection	Weekly	Site wide	Contractor's Environment Manager	Site inspection checklist
Joint Environmental Site Inspection	Fortnightly	As requested by Snowy Hydro	Snowy Hydro, Contractor's Environment Manager and Foreman / engineer	Snowy Hydro inspection report
Rainfall Inspection (assessed when there is a greater than 80% potential for 10mm or greater rainfall)	Within 3 hours of the start of a rainfall event during work hours* Within 24 hours of the start of a rainfall event (or on the following working day)*	Site wide	Contractor's Environment Manager or nominated representative	Site inspection checklist

* The events are to cause runoff to occur (ie when rainfall exceeds 10mm in a 24 hour period).

5.5 Monitoring

Monitoring will be undertaken for surface and groundwater to confirm the adequacy of implementation of the management measures and will highlight any non-conformances or potential non-conformances across the life of the Project. Specific monitoring programs have been developed for surface and groundwater, which are considered high risk aspects of the Project and the detailed programs are included within Appendix A and Appendix B for surface water and groundwater respectively.

The monitoring programs have been developed to address the requirements of the conditions of the Infrastructure Approval. In general these require that:

- baseline data available, additional data to be obtained and timing;
- the parameters to be monitored and the location and frequency;
- the reporting of monitoring and analysis results against relevant criteria;
- methods that will be used to analyse the monitoring data; and
- procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and
- any consultation to be undertaken in relation to the monitoring programs.

The timing, frequency, methodology, locations and responsibilities for the proposed environmental monitoring programs are specified in the respective management plans and summarised in **Table 5.2**. The monitoring programs range from those involving formal sample collection, analysis and measurement, to those involving a more qualitative assessment.

Table 5.2 Environmental monitoring summary

Activity	Management Plan	Frequency	Responsibility	Record	Timing
Receiving waters – Yarrangobilly River Wallaces Creek Talbingo Reservoir	Surface Water Management Plan	Water quality monitoring (comprehensive) – 12 times per year for each location upstream and downstream of the project Continuous monitoring for flow, pH and conductivity at nominated locations	Snowy	Field sampling and testing records and laboratory tests reports	All construction
Surface water – construction disturbance areas and access roads	Surface Water Management Plan	Water quality monitoring (comprehensive) – 4 times per year at least once during wet weather Daily basic testing during wet weather events	Contractor	Field sampling and testing records and laboratory tests reports	All construction
Groundwater	Groundwater Management Plan	Monthly monitoring of groundwater wells	Contractor	Field sampling and testing records and NATA tests reports	During all tunnelling activities and associated operations

Water Management Plan

Appendix A

Stage 1 - Surface Water Management Plan

Appendix A Surface Water Management Plan

Rev 1

Report Snowy 2.0 - Exploratory Works - Surface Water Management Plan | Prepared for Snowy Hydro Limited

12 December 2019

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Abbreviations and Glossary

AEP	Annual exceedance probability
ANZECC/ARMCANZ (2000)	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
AC	Acid consuming
ANC	Acid neutralising capacity
ARD	Acid rock drainage
ARI	Average recurrence interval
BMP	Biodiversity Management Plan
BOD	Biological oxygen demand
BoM	Bureau of Meteorology
COPC	Contaminants of potential concern
CSSI	Critical State Significant Infrastructure
DEC	Department of Environment and Conservation (now Office of Environment and Heritage)
DECC	Department of Environment and Climate Change (now Office of Environment and Heritage)
DEMP	Dredge Environmental Management Plan
DPIE	NSW Department of Planning, Industry and Environment *Formerly* NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
EC	Electrical conductivity
ESCP	Erosion and Sediment Control Plan
EIS	*Environmental Impact Statement Exploratory Works for Snowy 2.0*
EMS	Environmental Management Strategy
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
EWMS	Environmental Work Method Statement
FSL	Full supply level
GWMP	Groundwater Management Plan
IECA	International Erosion Control Association (IECA)
KNP	Kosciuszko National Park
NEPC	National Environmental Protection Council

NEPM	National Environmental Protection Measure
NERDDC	National Energy Research Development and Demonstration Council
NPWS	National Park and Wildlife Service
NRMMC	Natural Resource Management Ministerial Council
OEH	Office of Environment and Heritage
PAF	Potential acid forming
PESCP	Progressive erosion and sediment control plan
POEO Act	*Protection of the Environment Operations Act 1997*
PMF	Probable maximum flood
Snowy Hydro	Snowy Hydro Limited
Submissions Report or RTS	*Response to Submissions Exploratory Works for Snowy 2.0*
SWMP	Surface Water Management Plan
TARP	Trigger Action Response Plan
TSS	Total suspended solids
WQOs	Water quality objectives

1 Introduction

1.1 Background

Snowy Hydro Limited (Snowy Hydro) is the proponent of the Snowy 2.0 project which is a pumped hydro-electric storage and generation project to help address increasing demands for renewable energy supplies. Snowy 2.0 involves linking Talbingo and Tantangara reservoirs within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme) and building an underground power station between the two reservoirs.

Snowy Hydro proposes to carry out Exploratory Works prior to the main construction works for the Snowy 2.0 project, to inform the detailed design and to reduce project risk. Exploratory Works are required to obtain detailed geological data for the proposed location of the underground power station. An exploratory tunnel is to be constructed to gain this critical information. The Exploratory Works will predominantly be in the Lobs Hole area of Kosciuszko National Park. If the Exploratory Works are not undertaken, risks to the design and construct elements of the power station cavern are significantly increased.

The *Environmental Impact Statement Exploratory Works for Snowy 2.0* (EIS) was prepared to assess the impact of these works on the environment, including an assessment of surface water impacts and flooding within Chapter 5.4 and Appendix M. MOD1 also identified water impacts as a result of the modification, assessed any impacts, and proposed any required mitigation measures within Chapter 6.3 and 7.1.

The EIS and MOD1 identified the potential for direct and indirect impacts on water quality from surface water runoff from disturbed and operating areas of the site and from dredging, subaqueous excavated rock placement and discharges of process water and waste (effluent) water.

The EIS concluded that, with the implementation of appropriate impact mitigation measures, there would be no significant impacts to waterways within the project area, to high risk areas or sensitive receiving environments downstream of the project.

1.2 Context

This Surface Water Management Plan (SWMP or Plan) forms part of the Water Management Plan and Environmental Management Strategy (EMS) for the Snowy 2.0 – Exploratory Works (the Project). The Exploratory Works is the first stage of Snowy 2.0, a pumped hydro-electric storage and generation project which will increase the hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme. The second stage, or main project, will be subject to a separate Environmental Impact Statement in 2019.

The SWMP has been prepared to address the requirements of the Infrastructure Approval (SSI 9208) issued for Snowy 2.0 Exploratory Works on 11 February 2019, the *Environmental Impact Statement Exploratory Works for Snowy Hydro 2.0,* and the revised environmental management measures within the *Response to Submissions Exploratory Works for Snowy 2.0.*

This revision of the WMP has been prepared to address the requirements of the Exploratory Works for Snowy 2.0 Modification 1 Assessment Report (MOD1) and the REMMs within the Exploratory Works Modification 1 Response to Submissions Report which were approved by Department of Planning, Industry and Environment (DPIE) on 2 December 2019.

The original EIS Exploratory Works scope includes:

- an exploratory tunnel about 3.1 km long to the site of the underground power station;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- a portal construction pad for the exploratory tunnel. This will provide the entrance structure to the tunnel and an area for infrastructure and equipment needed to support tunnelling activities;
- an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades to enable access and haulage routes during Exploratory Works. This includes upgrades to 26 km of existing roads and creating about 2 km of new roads;
- barge access infrastructure to enable access and transport by barge on Talbingo Reservoir. This includes one new barge ramp at Talbingo Spillway in the northern part of Talbingo Reservoir and one new barge ramp at Middle Bay near Lobs Hole at the southern part of Talbingo Reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir. Up to 750,000 m^3 of excavated rock will need to be tested for its geochemical properties (ie whether the rock is reactive or non-reactive) before being managed by a combination of the following options:
  - re-use - suitable material can be used as construction materials for roads or similar. Some materials will be provided to NPWS for use in road maintenance and upgrades in other areas of KNP;
  - on land placement - material will be temporarily placed in one of two on land emplacement areas.
  - subaqueous placement within Talbingo Reservoir – suitable material will be placed at a suitable location within Talbingo Reservoir, subject to a number of water quality controls and monitoring; and
- services infrastructure such as diesel-generated power, water and communication;
- post-construction revegetation and rehabilitation, management and monitoring.

Having regard to the design changes identified in Modification 1, the Exploratory Works scope now comprises:

Table 1.1 New scope items for EW (Stage 1 & 2) as a result of MOD1

Stage 1	
Lobbs Hole	Additional disturbance area required for the construction power connection to an

Substation	existing transmission line (Line 2) at Lobs Hole for power supply to the Exploratory Works accommodation camp and construction areas. This will provide a reliable and long-term source of construction power and will reduce the reliance on diesel generation and associated on-site storage requirements and emissions. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas; This will include: • construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation; • geotechnical investigation works to inform the detailed design of the construction power substation; • replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height; • short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54; • 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables; • establishment and upgrade of access tracks and roads to the new substation and transmission line structures; • installation of a fibre optic communication link into the new substation from the approved communication network; and • ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas. (Illustrated Appendix C WMP Figure 1i)
Camps Bridge and Wallaces Creek	• additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment; (Illustrated in Appendix C WMP Figures 1h and 1i of this plan and Modification 1 Assessment Report Figure 3.9)
Lobs Hill Ravine Road and Construction Boundary Changes	• minor changes to the project boundary identified through detailed design including: – revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; – minor additions to construction areas for design optimisation. • removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road; (Illustrated in Appendix C, WMP Figures 1d, 1e, 1f and 1i)
Operating Hours	• modify operating hours from existing 7 am to 6pm to sunrise to sunset

Miscellaneous	• continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program; and • increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected. (location of communications towers illustrated in Appendix C WMP Figures 1a, 1f, 1l)
Stage 2	
Borehole drilling and geophysical surveys	• Borehole drilling and geophysical surveys for further geotechnical investigation of the Snowy 2.0 power station and power waterway at Marica, Talbingo and Tantangara; • clearing of up to 2.79 hectares (ha) of additional vegetation for access tracks and drilling pads. • About 1.33 ha within Smokey Mouse potential habitat; • trimming of overhanging dangerous branches on adjacent trees (these trees will not require removal); • mulching of trees and vegetation; • establishment of an additional 1 km of access tracks (4 m wide), including minor earthworks, • placement of geofabric (as required) and import of stabilised material; • establishment of eight drilling pads and boreholes at top of the cavern area, with an area of 900 m2 per pad, including minor earthworks, placement of geofabric (as required) and import of stabilised material (as required); • undertaking geophysical surveys near Talbingo and Tantangara reservoirs; • establishment of two drilling pads and boreholes at both Tantangara and Talbingo with an area of • 900 m2 per pad, including approximately 400 m of additional access tracks and minor earthworks (as required); • establishment of in-reservoir boreholes including one in Talbingo Reservoir and two in Tantangara Reservoir; • drilling of additional nested vertical boreholes at each of the drilling pads up to a depth of 1,100 m; • conversion of the investigation boreholes into monitoring bores; • undertaking geophysical surveys; and • rehabilitation of the drilling pads and access tracks following completion of works • ongoing maintenance of existing access tracks required for geotechnical investigations within KNP (Illustrated in (Illustrated in Appendix C WMP Figure 1j, 1k, 1l, 1m and 1n)
Talbingo Laydown	Outside of KNP, SHL is proposing to add four laydown locations to facilitate the construction of the communications cable linking Lobs Hole with the Tumut 3

	Power Station. These are proposed on existing hardstand areas along Talbingo Reservoir within Snowy Hydro owned land. (Illustrated in Appendix C, WMP Figure 1o)
Tantangara Access	Two additional geotechnical boreholes are required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures near Nungar Creek (Illustrated in Appendix C, WMP Figure 1m and 1n)

The Exploratory Works is estimated to take around 30 to 34 months to complete.

As with most of the existing Snowy Scheme, the majority of Snowy 2.0 is within Kosciuszko National Park. Snowy Hydro has been working with NSW National Parks and Wildlife Service (NPWS) since the announcement of Snowy 2.0 to ensure long term management objectives for Kosciuszko National Park are considered in project development.

The Project has been designed in a way that avoids and minimises impacts to Kosciuszko National Park where possible. This has included the planning of access roads and construction areas to avoid impacting the heritage listed Washington Hotel ruins at Lobs Hole, and Smoky Mouse habitat along Upper Lobs Hole Ravine Road. It also includes designing road upgrades to minimise impacts to geodiversity features including a block stream and a fossil outcrop along Lower Lobs Hole Ravine Road. The former copper mine at Lobs Hole is also considered a geoheritage site, however it is also a source of known contamination and has therefore been avoided as much as possible to prevent disturbance.

While there are some unavoidable impacts during construction, the Exploratory Works will allow for a number of longer-term benefits and contributions to Kosciuszko National Park through a biodiversity offset program, improved access roads and recreational facility upgrades. The completion of Exploratory Works will also allow for the greater benefits of Snowy 2.0 to be realised.

1.3 Construction activities and staging

Exploratory Works will be delivered in three stages:

- **Stage 1a – Pre-construction Minor Works -** pending the approval process, works may commence in the first quarter of 2019. The scope of pre-construction minor works includes dilapidation studies, survey work, borehole installation, site office establishment, minor access roads, installation of monitoring equipment, installation of erosion and sediment controls, archaeological salvage and minor clearing;

- **Stage 1b – Exploratory Works Access Roads (EWAR)** - pending the approval process, works may commence in the first quarter of 2019. The scope includes roadworks and upgrades to enable access and haulage routes during Exploratory Works;

- **Stage 2 – Exploratory Works** - pending progress with Stage 1, works may commence in quarter three of 2019. The scope for Stage 2 will be the remainder of the Exploratory Works, including the exploratory tunnel, portal construction pad, accommodation camp and excavated rock management. Stage 2 also includes subaqueous emplacement within Talbingo Reservoir.

To present the staging of plans a separate Staging Report has been prepared and was submitted to Department of Planning and Environment. Timing of the Exploratory Work stages is presented below.

Figure 1 Timing of Exploratory Works stages

1.3.1 Exploratory Works Access Roads

The Exploratory Works Access Roads (EWAR) will provide early access to the tunnel portal located to the east of the Talbingo Reservoir, and to Talbingo Reservoir itself. The works include upgrades to and/or construction of the following internal roads:

- Ravine Road;
- Mine Trail Road;
- Lobs Hole Road;
- Wharf Road.

The EWAR scope includes but is not limited to the following:

- setting out the works including delineation of site boundaries;
- establishment of all site facilities required and removal upon completion, including all temporary safety and security measures required;
- locating and protecting all public and private utility services;
- maintenance of the existing roadway and associated infrastructure;
- clearing and grubbing of vegetation including creation of mulch and compost;
- establishment of short term and long-term (eg: detention and sedimentation basins) erosion and sedimentation control systems and devices;
- removal and disposal of existing infrastructure including pipes, culverts, drainage channels and other minor structures;
- excavation and stockpiling of topsoil;
- earthworks including excavation of cuttings, construction of fills including selected zone material, and placement of excess spoil in stockpile;
- progressive opening to traffic;

- treatment of cut and fill slope batter surfaces including slope retention systems where shown;
- construction of clean and dirty water drainage systems including culverts, open and subsoil drainage systems;
- construction of pavements including subgrades and pavements and road surfacing;
- design, supply, construction of temporary structures / bridges over Wallace Creek and the Yarrangobilly River and removal of completion;
- construction of permanent bridges over Wallace Creek and the Yarrangobilly River;
- installation of road furniture including but not limited to barriers, line marking, guide posts and road signs;
- placement / replacement of topsoil and revegetation and other surface treatments to disturbed earth surfaces including lining of open drains;
- clean up and restoration of work areas and areas disturbed by the contractor.

The additional EWAR scope as a result of MOD1 will include:

- construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation;
- geotechnical investigation works to inform the detailed design of the construction power substation;
- replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height;
- short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54;
- 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables;
- establishment and upgrade of access tracks and roads to the new substation and transmission line structures;
- installation of a fibre optic communication link into the new substation from the approved communication network; and
- ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas.
- minor changes to the project boundary identified through detailed design including:
    - additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include

vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment;

  - additional disturbance area required for the construction power connection to an existing transmission line at Lobs Hole. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas;

  - revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; and

  - minor additions to construction areas for design optimisation.

- removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road;

- continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program; and

- increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected.

The works are proposed to commence in the first quarter of 2019.

This Plan identifies and describes surface water and soil erosion aspects and appropriate management measures. It has been developed for Stage 1 of the Exploratory Works project and will be revised prior to commencement of Stage 2 works to include further project specific details.

The timing of the preparation, consultation and submission of this plan is shown within Figure 4.3 of the Environmental Management Strategy (EMS). During Stage 1 work ongoing revisions to the SWMP will occur in accordance with Section 1.6.1 of the EMS.

Some distinct work activities such as the management of excavated rock from tunnelling activities and the management of surface water, require greater detail and warrant a separate plan. The activities related to surface water which are detailed within other management plans, are summarised within Table 1-2.

It is also noted that this plan includes a number of sub-plans required to comply with the requirements of condition 34 of the conditions of approval. These are also detailed in Table 1-2.

Table 1-2 Relationship to other plans

Activities	Relevant plan	Timing of the plan*	
		Stage 1	Stage 2
Road construction – general management of surface water runoff	This plan	P	R

Activities	Relevant plan	Timing of the plan*	
Erosion and sediment control	This plan	P	R
Process and waste effluent water management	This plan, however further detail will be included when revised prior to tunnelling including requirements for monitoring of treated process and waste effluent water	P	R
Excavated material	Excavated Material Management Plan	P	R
Subaqueous rock placement in Talbingo Reservoir	Subaqueous Emplacement Management Plan		P
Dredge spoil disposal	Dredge Management Plan		P
Groundwater	Groundwater Management Plan	P	R
Existing land contamination	Contaminated Land Management Plan	P	R
Work within waterways etc	Aquatic Habitat Management Plan	P	R

* P – prepare, R - revise

Specific on-site management measures identified in this Plan will be incorporated into site documents which are to be prepared by the Contractor. These documents will be prepared for construction activities and will detail the management measures which are to be implemented on the ground. Construction personnel will be required to undertake works in accordance with the mitigation measures identified in the site-specific documents.

A concept erosion and sediment control plan (ESCP) will be developed by the Contractor prior to construction to inform the development of detailed ESCPs during construction. ESCPs are designed to guide staff on the controls which are to be implemented for erosion and sedimentation management. ESCPs will be developed by the contractor's environmental team in consultation with construction personnel and the Project Soil Conservationist as required. They are to be updated as required when new work fronts start, site conditions evolve, flow paths change, and construction activities that affect the characteristics of ground conditions change. Section xyz of the

Snowy Hydro are committed to implementing all Water Management Plan (and sub plan) requirements for the duration of the project.

1.4 Environmental management system

The overall environmental management system for the Project is described in the EMS. This SWMP forms part of Snowy Hydro Limited's environmental management framework for the Project, as identified in Figure 1.2 and as described in Section 4 of the EMS.

This Plan aims to transfer the relevant requirements of the Approval documents into a management plan which can be practically applied on the Project site.

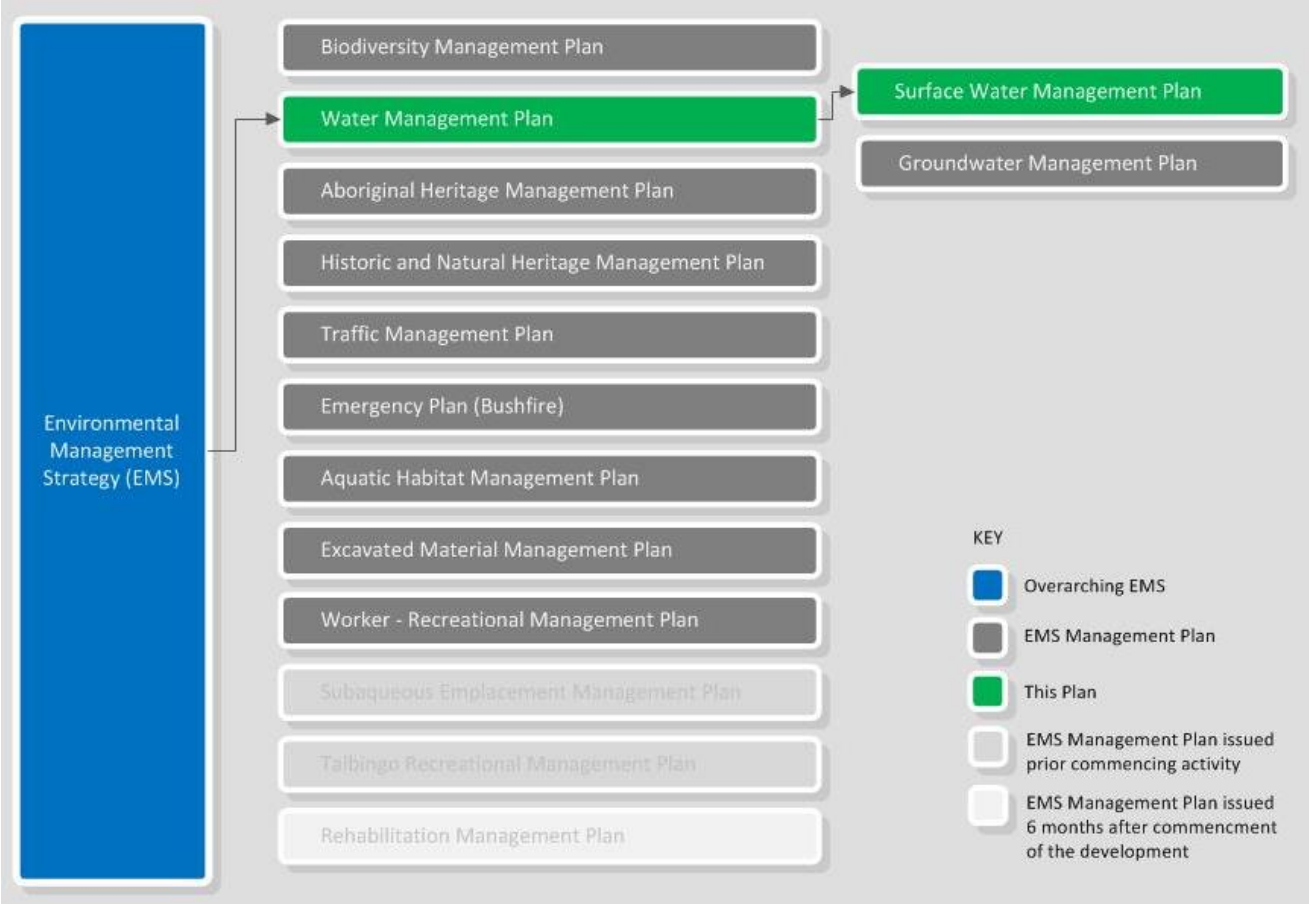


Figure 1.2 EMS structure

1.5 Purpose and objectives

The purpose of this Plan is to describe how construction impacts on surface water and soil due to erosion will be minimised and managed during construction.

The key objective of the SWMP is to ensure that impacts on surface water quality are minimised and within the scope permitted by the conditions of approval during Stage 1 of the project. To achieve this, Snowy Hydro and the Contractor will:

- ensure appropriate measures are implemented during construction to avoid or minimise potential impacts to water quality within the rivers and creeks across the Project;
- ensure appropriate measures are implemented to address the relevant conditions of approval and the revised environmental management measures;
- ensure appropriate measures are implemented to comply with all relevant legislation and other requirements as described in Section 2.1 and Section 2.5 of this Plan;
- establish a surface water monitoring program to assess the effectiveness of the quantitative and qualitative surface water management controls and impacts on the receiving environment;

- ensure appropriate measures are implemented during construction to avoid or minimise surface water impacts and potential adverse impact; and

- ensure that work activities are managed so as to minimise flood impacts and risks.

1.6 Targets

The following target has been established for the management of surface water impacts during the project:

- manage downstream water quality impacts attributable to the project by maintaining waterway health by avoiding, where practical, the introduction of nutrients, sediment, metals and hydrocarbons etc.

1.7 Plan preparation

In accordance with the requirements of Condition 34 of the conditions of approval this plan has been prepared with technical input from Chris Kuczera of EMM Consulting, a suitably qualified and experienced person. This representative was approved by the Secretary of Department of Planning and Environment on 13 February 2019

2 Environmental requirements

2.1 Legislation

Legislation relevant to surface water management includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Environmental Planning and Assessment Regulation 2000;*
- *Protection of the Environment Operations Act 1997;*
- *Protection of the Environment (General) Regulation 2009* (as amended);
- *Water Management Act 2000;*
- *Water Management Amendment Act 2014;*
- *Water Management (General) Regulation 2011;*
- *Fisheries Management Act 1994;*
- *Snowy Hydro Corporatisation Act 1997.*

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the EMS.

2.2 Conditions of approval

Surface water management conditions specified under Schedule 3 of the Infrastructure Approval are presented in Table 2-1

Table 2-1 Conditions of approval relevant to surface water management

Condition	Requirement	Where addressed
32	Unless an environmental protection licence authorises otherwise, the Proponent must comply with Section 120 of the POEO Act. Note: Section 120 of the POEO Act makes it an offence to pollute any waters.	Section 5
33	The Proponent must: (a) minimise the use of clean water on site; (b) maximise the diversion of clean water runoff around disturbance areas on site; (c) minimise the flow rates from any clean water runoff diversions to adjoining watercourses; (d) minimise any soil erosion; (e) ensure all chemicals and hydrocarbon products are stored on site in bunded areas in accordance with the relevant Australian Standards.	Section 5
34	The Water Management Plan required under this approval must: (c) include a Surface Water Management Plan with:	This plan
	• detailed baseline data on surface water flows and quality in the watercourses that could potentially be affected by the development;	Section 6
	• a program to augment the baseline data during the development;	Section 6
	• a description of the measures that would be implemented to minimise the impacts of:	Section 5
	– any subaqueous emplacement;	Stage 2
	– the dredging within Talbingo Reservoir;	Stage 2
	– the barge infrastructure;	Stage 2
	– the water intake;	Stage 2
	– the water treatment pipes and outlets;	Stage 2
	– any in-stream works;	Stage 2
	– stockpiles;	Stage 2
	– eastern emplacement area;	Stage 2
	– western emplacement area;	Stage 2
	– construction portal;	Stage 2
	– accommodation camp;	Stage 2
	– Lobs Hole substation and	Sections 5 & 6
	– road upgrades, and in particular the road works in the vicinity of the Yarrangobilly River;	Sections 5 & 6
	– chemical and hydrocarbon storage.	Sections 5 & 6
	• surface water assessment criteria, including trigger levels for investigating any potentially adverse surface water impacts of the development;	Sections 5 & 6
	• a description of the measures that would be implemented to minimise the surface water impacts of the development, and comply with the performance measures in condition 31 above;	Section 6
	• a program to monitor and report on the surface water impacts of the development including water monitoring locations, analytes and sampling frequency for each monitoring location;	Sections 5 & 6
	• a program to monitor and report on the surface water impacts of the development; and	

Condition	Requirement	Where addressed
	• a plan to respond to any exceedances of the surface water trigger levels and/or assessment criteria and mitigate and/or offset any adverse surface water impacts of the development;	Sections 5 & 6
39	The Proponent must: (a) ensure the temporary bridges over Wallace Creek and the Yarrangobilly River incorporate, to the greatest extent practicable, the requirements: • Guidelines for Controlled activities on Waterfront Land (NRAR, 2018); and • Policy and Guidelines for Fish Habitat Conservation (DPI 2013) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003); (b) remove temporary bridges as soon as practicable after the construction of the permanent bridges, and rehabilitate the land to the satisfaction of the NPWS; consider scheduling to minimise in stream works between October to January, the migratory period of the Macquarie Perch (Macquaria australasica).	Surface Water Management and Aquatic Habitat Management Plan
40	The Proponent must: (a) ensure that permanent bridges over Wallace creek and the Yarrangobilly River are designed and constructed to comply with the relevant requirements of the: • Guidelines for Controlled activities on Waterfront Land (NRAR, 2018); and • Policy and Guidelines for Fish Habitat Conservation (DPI 2013) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003); (b) ensure that the permanent bridges over Wallace creek and the Yarrangobilly River are designed and constructed to comply with the relevant requirements of the relevant Austroads Standards (such as elevating them above the 1% AEP flood level); minimise in stream works between October to January, the migratory period of the Macquarie Perch (Macquaria australasica).	Surface Water Management and Aquatic Habitat Management Plan

2.3 Revised environmental management measures

Environmental safeguards and management measures are included in the EIS in Section 6.3. During preparation of the Submissions Report, revised environmental management measures were developed and included in Section 8 of the Submissions Report and the Surface Water Assessment (EMM, 3 October 2018). MOD1 was granted approval by DPIE on 2 December, 2019.

The environmental management measures relevant to this Plan are listed in Table 2-2 below. If additional measures are cross-referenced from another section of the EIS or Submissions Report, these measures are also included.

Table 2-2 Management measures relevant to surface water and soils

Impact	Ref #	Environmental management measures	Document reference
Soils			
Impacts to soil resources	SOIL01	Soil management procedures (including stripping, stockpiling and application) will be implemented as part of the CEMP. The objectives of soil management will be to:	Excavated Material Management Plan

Impact	Ref #	Environmental management measures	Document reference
		• preserve as much of the topsoil and subsoil as possible; • prevent contamination; • ensure soil is not degraded or compacted during construction and following reinstatement; • avoid or ameliorate subsoil constraints immediately below topsoils; • ensure topsoil is not mixed with unsuitable soil and spoil materials; and • ensure reinstatement of soil horizons in the correct order and depths.	
Erosion and sediment transport	SOIL02	Erosion and sedimentation controls will be implemented as part of the Water Management Plan to minimise erosion potential in accordance with the guideline Managing Urban Stormwater, Volumes 1 and 2, or equivalent.	Section 5 and Table 5.1
Changes to landform and land use	SOIL03	A Landscape Management Plan will be prepared for the rehabilitation of disturbed areas: The Plan will include: • objectives for landform rehabilitation at each site; • measures to ensure successful rehabilitation and stabilisation of soils; and a soil balance to identify the depths and volume of soils to be reapplied in particular areas during rehabilitation.	Rehabilitation Management Plan
Compatibility of land use post-Exploratory Works	SOIL04	A Final Rehabilitation Strategy will be prepared to guide the long term rehabilitation of the site. Rehabilitation goals and objectives for the domains of the project area will be determined through the final land use. This strategy will be developed in consultation with NPWS and other relevant government agencies.	Rehabilitation Management Plan
Flood risks			
Flood risks	FM_1.1	Camp and Wallaces bridges will be designed in accordance with AustRoads bridge design standards which require the: • bridge deck soffit to be located above the 1% Annual Exceedance Probability (AEP) flood level; • bridge structure to be designed to withstand a 0.05% AEP event; and • abutments to be protected by appropriately designed scour protection.	Table 5.1
	FM_1.2	The western emplacement will be designed to minimise the risk of emplacement material being entrained in flood waters during a 0.2% AEP event. This may require a flood protection berm or rock armouring along the northern toe of the emplacement.	Excavated Material Management Plan
	M1.13	Protocols will be developed for the proposed modification elements for use and storage of plant, equipment and materials in flood prone areas commensurate with the frequency of inundation.	Table 5.1
Water management controls			
Clean Water Management Controls	WAT02	The following controls will be applied to the design of the clean water management system:	Section 5 and Erosion and Sediment Control Plans
	WM_1.1	• Where practical, all clean water will be diverted around or through water management areas. Runoff from clean water areas that cannot be diverted must be accounted for in the design of water	

Impact	Ref #	Environmental management measures	Document reference
		management systems.;	
	M1.8	• Where practicable, all clean water will be diverted around or through sites using cross-path drains or other similar measures to limit impact to existing flow regimes.	Table 5.1
	WM_1.2	• All permanent clean water drainage will be designed and constructed to convey the 1% AEP peak flow and will have adequate scour protection. Temporary clean water drainage will be designed to convey the 50% AEP peak flow;	
	WM_1.3	• Where practical, diversions will seek to avoid materially increasing flow rates in adjoining watercourses.; and	
	WM_1.4	• Where practical, the permanent diversion of drainage lines or watercourses using contour drains will be avoided.	
Controls for construction disturbance areas			
Controls for all construction disturbance areas	WAT01 WM_2.1 M1.11	An Erosion and Sediment Control Plan (ESCP) will be prepared for all proposed construction sites and drilling pads. Each ESCP will: • consider local soil characteristics, clean water management and site-specific measures to suit the proposed construction methods; • apply all practical source control and rehabilitation methods; and • be progressively amended as required during construction. • A suitably qualified erosion and sediment control expert will be commissioned to develop and execute each ESCP. The expert will be responsible for overseeing the development of the ESCP and inspecting and auditing controls during implementation. Regular expert input will ensure that erosion and sediment control practices will be established and operated to a high standard and progressively improved.	Section 5 and Erosion and Sediment Control Plans Table 5.1 Section 5.2
	WM_2.2	The clean water management controls WM_1.1 to 1.4 apply to all ESCPs.	
	WM_2.3	Stockpiles will be located where they are not exposed to concentrated or flood flow. Flood flow is defined as the 20% AEP flood extent. Monitoring for dispersion and erosion of soil stockpiles will be undertaken, particularly on moderately dispersive soils. Addition of ameliorants, such as gypsum and organic matter for dispersive soils will be undertaken as needed.	
	WM2.4	Soils will be lightly scarified on the contour to encourage rainfall infiltration and minimise run-off. As soon as practicable after respreading, a cover crop will be established to limit erosion and soil loss. This will also provide good mulch for native plant establishment.	
	WM_2.5	Sediment traps or filters will be maintained at all discharge locations. The filters will only use non-toxic or materials which will	

Impact	Ref #	Environmental management measures	Document reference
		not cause material harm to the environment, including biodegradable or natural materials where practicable. Sediment traps, filters and other appropriate sediment control devices will be installed to target the removal of coarse sediments.	
Additional controls for construction areas that are constrained by terrain or the proposed disturbance boundary	WM_2.6	Runoff from construction areas that are constrained by terrain or the proposed disturbance boundary and are larger than 2,500 m2 will be captured in a sump and pumped to a water treatment plant. The water treatment plant will use water treatment chemicals to enhance sedimentation and phosphorus and dissolved metal removal rates using an automated chemical dosing system. Only water treatment chemicals that have a low risk of increasing the toxicity of treated stormwater will be used. The design dewatering and treatment rate will be the 1 in 3 month average return interval (ARI) peak flow.	Section 5 and Erosion and Sediment Control Plans
Additional controls for construction areas that are not constrained by terrain	WAT03 WM_2.7	Where appropriate, sedimentation basins will be constructed in accordance with the methods recommended in *Managing Urban Stormwater: Soils and Construction: Volume 1* (Landcom 2004) and Volume 2D (DECC 2008). Water treatment chemicals will be applied to sedimentation basins with catchment areas greater than 2,500 m2 to enhance sedimentation and phosphorus and dissolved metal removal rates. Only water treatment chemicals that have a low risk of increasing the toxicity of treated stormwater will be used. Water treatment chemicals will be applied using an automated chemical dosing and mixing system. The design treatment rate will be the 1 year ARI peak flow.	Section 5 and Concept Erosion and Sediment Control Plans
	WM_2.8	When practical, water captured in sedimentation basins will be used for dust suppression.	
Regrading	M1.9	Drill sites that have been modified to allow for vehicle access will be regraded to natural lay of the land as part of the site rehabilitation.	Section 5 Table 5.1
Water management controls for access roads			
Controls for all access roads	WM_3.1	Sections of Lobs Hole Road that will no longer be required following the construction of the new access roads will be removed and rehabilitated. This will reduce associated sediment loads.	Section 5 and Erosion and Sediment Control Plans
	WM_3.2	All cut and fill batters will be stabilised as soon as practicable.	
	WM_3.3	The clean water management controls WM_1.1 to 1.4 will apply to the design of all access roads.	
	WM_3.4	Access road surfaces will be maintained with appropriate aggregate material to reduce the risk of erosion.	
	WM_3.5	Where practicable and safe to do so access roads will be single cross fall and will grade to a tables drain located against the toe of the cut batters. The drains will be stabilised by rock armouring as required.	
	WM_3.6	Where appropriate, the sedimentation basins established to manage runoff during construction of the access roads will be maintained during the Exploratory Works to provide ongoing treatment of runoff from access roads.	
Additional controls for access roads	WM_3.7	The sedimentation basins established to manage runoff during construction of the access roads will be modified to be constructed	Section 5 and Erosion and

Impact	Ref #	Environmental management measures	Document reference
that are not constrained by terrain or the proposed disturbance footprint.		wetland style basins where practicable. Constructed wetland style basins will maintain permanent water. An extended detention zone will be established above the permanent water. The extended detention zone will drain slowly through a low flow outlet control. Where practical, runoff from road embankments that have been stabilised by vegetation will be diverted into the clean water drainage system to minimise the contributing catchment area to the constructed wetlands. This will increase the effective size of the basin (in terms of depth of rainfall captured) and will result in a treatment volume that is greater than the 5 day 85th percentile volume that is proposed for sedimentation basins for construction areas.	Sediment Control Plans
Spills from hydrocarbons leaching/running into ground water/creeks	WAT11	Procedures to address spills and leaks will be developed and implemented as part of the EMS.	Table 5.1 and Section 5.3
	WAT01	Management measures will be implemented to minimise potential environmental impacts to water and soil from hydrocarbon and chemical spills and leaks including: • minimizing direct access to the river by construction vehicles and mechanical plant; • regular inspection of construction vehicles and mechanical plant for leakage of fuel and /or oils;. • establishing a bunded area for storage of fuel and oils; • refuelling and maintenance of vehicles and mechanical plant at least 50 m from watercourses;. • avoiding as far as possible re-fuelling, washing and maintenance of land based vehicles and plant within 50 m of watercourses; • reporting spillages to the appropriate officer and immediately deploying spill containment and / or absorption kits as required to restrict its spread; • vehicles, vessels and plant would be properly maintained and regularly inspected for fluid leaks; • emergency spill kits will be kept onsite, at refueling areas and on all vessels at all times during the Exploratory Works. The spill kit will be appropriately sized for the volume of substances on the vessel. All staff would be made aware of the location of the spill kit and trained in its use; • if any hydrocarbon spills were to occur during soil stripping, the impact will be isolated and clean-up procedures implemented; • areas to be used for long-term storage and handling of hydrocarbons and chemicals will be enclosed with concrete bunds; • chemicals will be handled and stored as per manufacturer's instructions; and • below ground, refuelling will be undertaken in dry, enclosed, bunded areas;.	Table 5.1 and Section 5.3
Refuelling	M1.10	A refuelling protocol will be developed for in-reservoir borehole drilling and will be included in the Construction Environment Management Plan (CEMP).	Table 5.1 and Section 5.3

Impact	Ref #	Environmental management measures	Document reference
Spills	M1.12	Geotechnical investigation drilling will be undertaken in accordance with the surface water management plan. The following mitigation measures are included in the existing surface water management plan: • All fuel and hazardous substances used in drilling will be stored in designated areas of the drill pad. Hazardous chemicals will be stored in accordance with relevant standards, including AS 1940:2004. • Designated fuel storage areas will be bunded to mitigate risk of contamination to surface water and soils should spills occur. Refuelling will also be carried out in the designated, bunded area. • Equipment should be appropriately maintained to ensure there are no leaks. • Spill kits will be available on site to contain contamination should any spills outside these bunded areas occur. If used, waste from the spill kits will be disposed of appropriately. • The safety data sheets of all hazardous chemicals required for drilling activities will be made available on site. All waste produced during drilling will be stored on site in above ground containers, and when required will be taken off-site by vehicles. All waste will be disposed of off-site to an EPA licensed facility.	Table 5.1 and Section 5.3
Surface and groundwater	WAT02	A Surface and Groundwater Monitoring Program will be developed and implemented to monitor the effectiveness of water quality controls and compliance with licence conditions. The program will: • establish monitoring locations to provide suitable baseline and detection monitoring of surface and groundwater parameters; • monitor groundwater inflows in the tunnel and groundwater levels as well as groundwater quality during construction; and • set out annual monitoring requirements for Yarrangobilly Caves and PCTs potentially reliant on groundwater.	Section 6 and Groundwater Management Plan
Ecology			
Impacts on fish eggs and larvae due to extraction of water from Talbingo Reservoir	ECO10	The water pipeline intake will be designed to: • prevent adult fish from entering the intake and discourage adult fish from approaching the intake which may include: – incorporation of an enclosed, dark and long passage approach to the intake; – if feasible, screening of the intake with at least 5 mm 3 mm mesh screen; – if feasible, installation of a coarse mesh (e.g. cm aperture) screen / cage a few metres around the intake and removal and control of any aquatic vegetation and wood debris within and immediately adjacent to the intake location; and – if feasible, limiting the approach water velocity at the headwall during normal operation ideally to 0.1 m/s. • locate the intake pump in deeper water where possible; and • allow for pump start up procedures involving initial slow water velocity to reduce likelihood of aquatic	Aquatic Habitat Management Plan

Impact	Ref #	Environmental management measures	Document reference
		biota being drawn into the pump.	
Impacts to fish passage	ECO11	The permanent bridges at Yarrangobilly River and at Wallaces Creek will be designed with consideration of Policy and Guidelines for Fish Habitat Conservation Update 2013 (DPI 2013) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003).	Table 5.1 and detailed design
	ECO12	The temporary bridges at Yarrangobilly River and at Wallaces Creek will be designed and constructed and removed to: • where practicable implement measures in line with the guidelines for temporary structures in Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update) (DPI 2013) and recommended crossing design considerations in Fairfull and Witheridge (2003) which includes: • temporary in-stream structures will avoid spanning the full width of the waterway channel to ensure base flow conditions are maintained down the waterway where practicable; • maintaining some unmodified channel so that a weir effect or flow through rock interstices only is not created where practicable; and • temporary in-stream structures will be inserted during low-flow periods where practicable • ensure any build-up of debris potentially obstructing fish passage will be removed; and • the temporary structures will be removed and the river channel rehabilitated following construction of the permanent bridges.	Table 5.1
	ECO13	Construction and removal of the temporary bridge at Yarrangobilly River will avoid or minimise in stream works during the migration time of Macquarie Perch (October to January) where possible.	Table 5.1 and Aquatic Habitat Management Plan
Impact to aquatic ecology from erosion and sedimentation	ECO14	The water quality controls described in in WAT01 to WAT05 and WM1.1 to WM 8.8 will be implemented.	Table 5.1

2.4 Licences and permits

2.4.1 Environment Protection Licence

The works carried out in Stage 1 scope are considered scheduled for the Land Based Extractive Activities category and an Environment Protection Licence (EPL) has been obtained (EPL 21266) for this Stage. The EPL details specific monitoring conditions which must be complied with when undertaking the extractive activities works.

This plan will be updated as required to reflect any water quality conditions or monitoring requirements specified in the EPL. Subsequent updates to this plan will be carried out should monitoring requirements in the EPL be in-consistent with those outlined in Section 6. However should there be in-consistencies between the EPL and SWMP then the requirements of the EPL will take precedence until such time that

the SWMP can be updated and approved. Any other relevant licences or permits will be obtained as required.

2.4.2 Water source

Snowy Hydro have lodged a Specific Purpose Access Licence (SPAL) application to take 287 ML of water from Talbingo Reservoir for the purpose of Exploratory Works project. The 287ML volume allows for:

- 60 ML of water take in the remainder of the 2018-19 water year; and
- 227 ML of water take in the 2019-20 water year. This is the volume estimated and stated in the Surface Water Assessment (EMM, 2018).

Snowy Hydro are also investigating groundwater supply options for the initial phases of the project. If this is successful in securing sufficient yields and suitable quality, groundwater may be used to offset the take of water from Talbingo.

2.4.3 Water access licence

The extraction of water from Talbingo Reservoir is proposed to be untaken via a Specific Purpose Access Licence (SPAL) , which is currently being considered and in final stages of approval by the NSW Government. Once the SPAL is approved, a Miscellaneous Work approval will be issued by NRAR and then Water NSW will approve the nomination (link) between the SPAL and the miscellaneous Work Approval. Snowy Hydro will not require a water use approval as the project is designated Critical State Significant Infrastructure (CSSI). Section 5.23 of the *Environmental Planning and Assessment Act 1979* provides that the following approvals are not required - a water use approval under section 89; a water management work approval under section 90; or an activity approval under section 91 of the *Water Management Act 2000* (it is noted that the provisions for granting Aquifer Interference Approvals under the Water Management Act 2000 are yet to be '*switched on*', and therefore this approval is not yet available).

To obtain the required water for Stage 1 Snowy Hydro are investigating both supply from Talbingo under the above SPAL, and supply from the Lachlan Fold Belt Groundwater Source via water supply bores in the Lobs Hole Ravine area. Piezometers are currently being constructed to consider the viability of groundwater in this area and each piezometer will be fitted with automated data-loggers and programmed to log groundwater levels every six hours. Once piezometers are established and a sustainable groundwater supply is confirmed Snowy Hydro will seek to 'nominate' their existing Water Access Licence (obtained under the controlled allocation release), with the water supply bores (via a miscellaneous Work approval for the water supply bores).

The Aquifer Interference Policy requires Snowy to hold sufficient water licence to account for water take (either direct take for water supply or indirect take from tunnel inflow). As such licences will be held to account for all water take for water supply from relevant water sources (ie Talbingo Reservoir via the SPAL, and the Lachlan Fold Belt via the WAL granted under the controlled allocation). Associated approvals are largely exempt, but do require Miscellaneous Work approvals granted, and associated 'nominations' of licences to these works.

This will then provide for Snowy to be compliant with the Aquifer Interference Policy 2012 (AIP), the Water Management Act 2000 (WMA 2000), and the relevant statutory Water Sharing Plans (WSPs).

Consultation with DoI Water will continue in finalising licensing requirements.

2.5 Guidelines and standards

The main guidelines, specifications and policy documents relevant to this Plan include:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000);
- *Australian Rainfall and Runoff (Commonwealth of Australia, 2016);*
- *Bunding and Spill Management: Liquid Chemical Storage, Handling and Spill Management: Review of Best Practice Regulation* (DECC, 2005);
- *Bunding and Spill Management: Storing and Handling Liquids: Environmental Protection: Participant's Manual* (DECC, 2007);
- Managing Urban Stormwater: Soils and Construction. Landcom, (4th Edition) March 2004 (reprinted 2006) (the "Blue Book"). Volume 1 and Volume 2;
- Volume 2C *Unsealed Roads* (DECCW 2008);
- Volume 2D *Main road construction* (DECCW 2008);
- Fairfull, S. and Witheridge, G. (2003) *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*. NSW Fisheries, Cronulla, 16 pp;
- *Department of Primary Industries Guidelines for Controlled Activities on Waterfront Land* (2012);
- NSW Office of Water *Guidelines for working within riparian corridors;*
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* – March 2004;
- *Environmental Best Management Practice Guideline for Concreting Contractors,* DEC, 2004;
- *NSW Floodplain Development Manual* (2005);
- *Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure* (AP- R232) (Austroads, 2003); and
- Australian Standard: AS1940 - 2004, T*he Storage and Handling of Flammable and Combustible Liquids* (Standards Australia, 2004).

3 Existing environment

The following section summarises what is known about surface water within and adjacent to the Project. The key reference documents are Chapter 5.4 of the EIS, and the Surface Water Assessment (EMM, 3 October 2018) provided in Appendix E of the Response to Submissions. Some additional data that was collected post submission of the Surface Water Assessment is also included in this summary.

A summary of the topography, soil types and contamination present in the Project area is also provided. The mobilisation of soil and contaminants, and the impacts of erosion and sediment loss, are relevant to surface water.

3.1 Topography and soil characteristics

The Exploratory Works will be undertaken in the Kosciusko National Park (KNP) which is part of the Australian Alps national heritage listing and contains landscapes with high scenic values. The Australian Alps landscape is characterised by peaked ranges, and broad, forested valleys, and is the only true alpine environment in NSW (NPWS 2003). The EIS advised that the Project area is within a steeply incised ravine, along the western fringe of the Long Plains fault escarpment. Most of the Project area is characterised by deep gorges and steep sloping ridges, the product of incision from watercourse flow and glaciations.

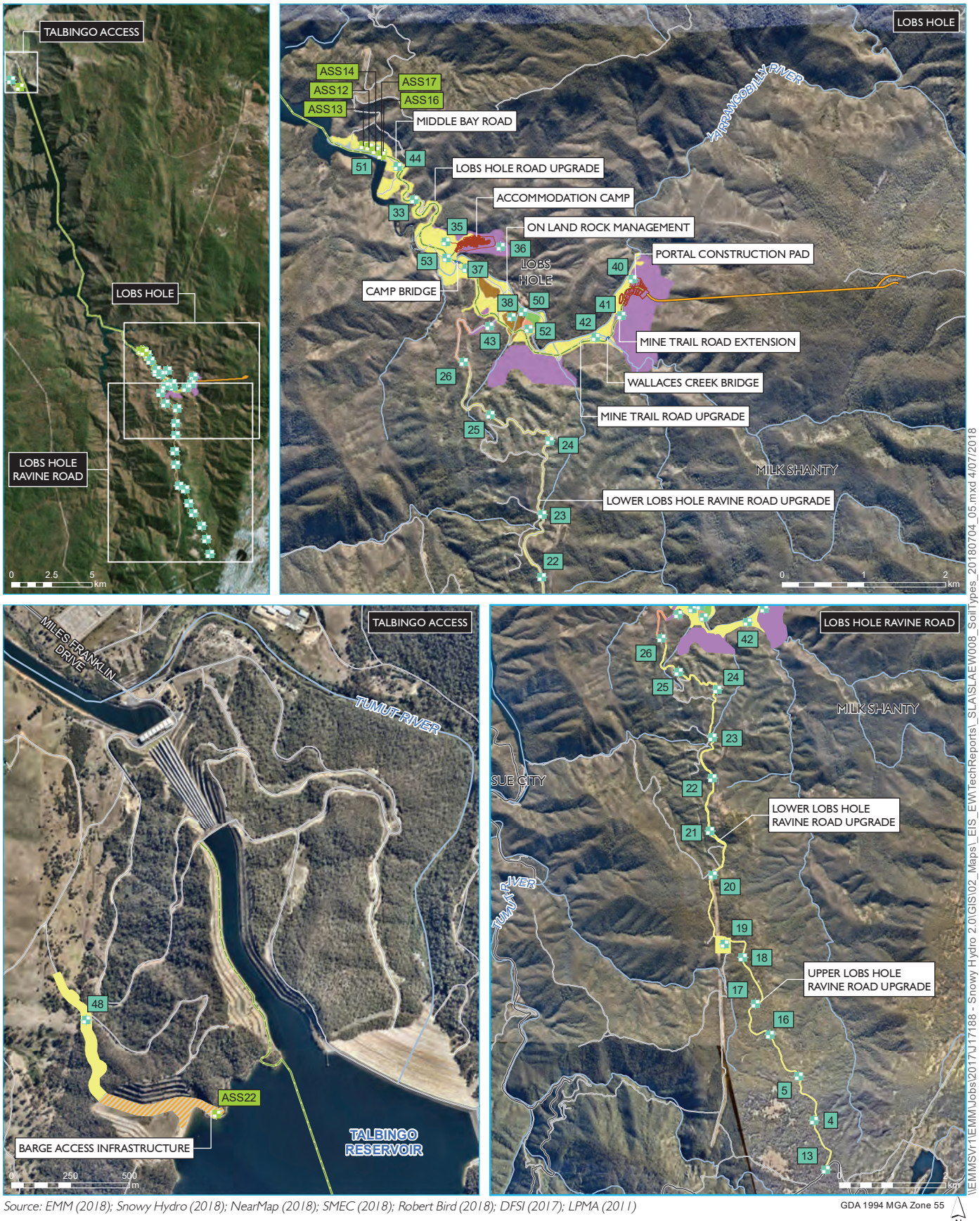
There are four major soil types within the Exploratory Work disturbance footprint: the major soil orders are Kandosols and Tenosols, with small areas of Dermosols and Vertosols. These soil types are described in Table 3-1 and their locations are shown in Figure 3.1.

Table 3-1 Soil types and characteristics in the project areas (EIS)

Soil type	Description	Hydrological Characteristics	Area (ha)[1]	Erosion potential
Tenosols	The Tenosols generally occur on mid to upper slopes and crests of undulating hills. They can also occur as a result of alluvial processes. Lithic Orthic Tenosols are characterised by a weakly developed B horizon, usually in terms of colour, texture or structure or a combination of these. The B horizon directly overlies hard rock. These soils vary in texture across the project area but typically contain loamy sand to sandy clay loam in the A horizon and silty loam to clay loam in the B horizon.	Low water holding capacity due to their shallowness. Moderately low inherent soil fertility. Categorised as Soil Hydrologic Group B due to their medium textures.	110.7	Low to moderate erosion potential. Moderately dispersive throughout the profile in the eastern portion of the project area.
Kandosol	The Kandosols occur along the gentler mid to upper slopes on Lobs Hole Road (Brown) as well as the lower slopes and flats of Lobs Hole Ravine (Red and Grey) on varying geology. There are two distinct variants of Brown Kandosol, those formed on Basalt surface geology (higher elevations) and those formed on Limestone and Shale surface geology (lower elevations). Haplic Eutrophic Red Kandosols lack a strong texture contrast and have a well-developed, weakly structured B horizon.	Moderate to moderately low water holding capacity due to the high clay content and deep profiles. Moderately low inherent soil fertility. Categorised as Soil Hydrologic Group C due to their moderately fine to fine textures and weak structure.	172.9	Low to moderate erosion potential. Moderately dispersive in the B horizon.

Soil type	Description	Hydrological Characteristics	Area (ha)[1]	Erosion potential
Vertosol	Haplic Epipedal Black Vertosols occur in a small area on a floodplain in the south-eastern corner of Lobs Hole. Clay alluvium has been deposited over time by the Yarrangobilly River on the inside of a meander. These soils exhibit strong cracking when dry and at depth have slicken slides and/or lenticular structural aggregates. Gilgai microrelief is not present. A clay texture of 35% or more is present throughout the profile with no thin, crusty surface horizon.	High water holding capacity due to the very high clay. High fertility and are considered some of the most fertile soils in Australia. Categorised as Soil Hydrologic Group D due to their shrink/swell properties.	4.9	Low erosion potential.
Dermosols	The Dermosols occurs as a small pocket on mid slopes on Lobs Hole Road and is associated with a reddish pink landscape. They are moderately well developed and do not have a strong texture contrast. These soils have a clay loam A horizon and a light clay B horizon. Some coarse fragments are present on the soil surface. The soil surface is of soft, organic condition. The profile has minimal gravel with moderate pedality in the B horizon.	Moderately high water holding capacity due to the medium-strong pedality, high clay content and deep profiles. Moderately high inherent soil fertility. Categorised as Soil Hydrologic Group C due to their moderately fine textures and moderate structure.	6.3	Low to moderate erosion potential. Bottom 0.3m of the profile is moderately dispersive.

Notes: 1. Area refers to the portion of soil type in the EIS assessment area. Soils were not characterised in 2.9 ha of the EIS assessment area.



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

GDA 1994 MGA Zone 55

N

KEY

- Soil sample site
- ASS sample site
- On land rock management
- Portal construction pad and accommodation camp conceptual layout
- Exploratory tunnel
- Communications cable
- Main road
- Local road or track
- Watercourse

Soils assessment area - Soil type

- Not assessed
- Dermosols
- Kandosols
- Tenosols
- Vertosols
- Water

Soil characteristics
Figure 3.1

3.2 Surface water

The Yarrangobilly River and Talbingo Reservoir are the defining features of Lobs Hole. The river initially flows in a southerly direction before turning to the west, towards Talbingo Reservoir. The Yarrangobilly River and its tributaries (including Wallaces and Stable creeks) are shown in Figure 3.2. Watercourses in the project area are all 'gaining' streams with groundwater providing baseflows.

A pre-construction water quality monitoring program commenced and will continue until construction beings. This data will be used to establish baseline water quality characteristics. The water quality monitoring program and summary of results to date are provided in Appendix B.

Major waterways are also shown within the sensitive area plans in Appendix A4 of the EMS.

The Yarrangobilly River is a major regional watercourse that flows into Talbingo Reservoir, downstream of Lobs Hole. The river's catchment has an area of 271 km2 that is wholly within the KNP. The catchment is characterised by a range of subalpine grasslands and woodlands and montane dry sclerophyll forests. Elevations range from 550 m AHD at Lobs Hole to more than 1,400 m AHD in the head water catchments. There are no dams or flow diversions in the Yarrangobilly River catchment upstream of the Talbingo Reservoir.

Stream flows in the Yarrangobilly River are perennial. However, the majority of the stream flows occur in late winter and early spring, which is a typical regime for rivers in the Australian Alps. In summer and autumn, stream flows are maintained by groundwater fed baseflows.

The EIS and Surface Water Assessment (EMM, 3 October 2018) found that the water quality during base flow conditions can be characterised as neutral to slightly alkaline, high carbonate levels, low salinity, low suspended solids and low levels of nutrients and metals. Water quality during non-base flow conditions is expected to have lower carbonate levels and potentially higher suspended solids and nutrient levels.

Wallaces Creek is a major tributary to the Yarrangobilly River and forms the southernmost portion of the catchment. Wallaces Creek has a similar flow regime and water quality characteristics to the Yarrangobilly River. Stable Creek is a watercourse that joins Wallaces Creek approximately 600 m upstream of the confluence of Wallaces Creek and the Yarrangobilly River. Other local named and unnamed watercourses in the area are all intermittent or ephemeral streams.

3.3 Aquatic ecology

Yarrangobilly River and Wallaces Creek are watercourses with substantial ecological value. The streams contain boulders, cobbles, pebbles and gravel with little evidence of siltation.

Nearby tributaries of Wallaces Creek (Lick Hole Creek and Sheep Station Creek) are ephemeral and provide aquatic habitat of lower value. These watercourses would provide very limited habitat for fish, but would provide more valuable refuge for aquatic macroinvertebrates and potentially burrowing crayfish.

An assessment of the likelihood of occurrence of all threatened aquatic species identified five with potential to occur:

- Murray crayfish has a high chance of occurring in Yarrangobilly River and Wallaces Creek;
- Trout cod – stocking records in Talbingo Reservoir suggest it has a moderate chance of occurring;

- Macquarie perch – stocking records in Talbingo Reservoir suggest it has a moderate chance of occurring both here and in the Yarrangobilly River; and

- Murray cod and Silver perch – these species have been stocked in Blowering Dam and there is a possibility, albeit low, that they have also been introduced to Talbingo Reservoir.

Threatened Macquarie perch and Trout cod were not identified during field surveys or in environmental deoxyribonucleic acid (DNA) samples from Talbingo Reservoir. It is not known whether any self-sustaining populations of these species are present. During surveys of Yarrangobilly River and Wallaces Creek, Murray crayfish were observed. There also appears to be suitable habitat for Macquarie perch within Yarrangobilly River.

3.4 Threatened terrestrial fauna

The Boorolong Frog was recorded along the Yarrangobilly River, from the full supply level of Talbingo Reservoir to the upper reaches of the Yarrangobilly River, as well as along Wallaces Creek. The Yarrangobilly River provides optimal breeding habitat for this species, with a series of cobble banks and bedrock structures, with slow flowing water. These areas are connected by larger, slow-flowing pools. The Boorolong Frog is listed as Endangered under the NSW *Biodiversity Conservation Act 2016* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

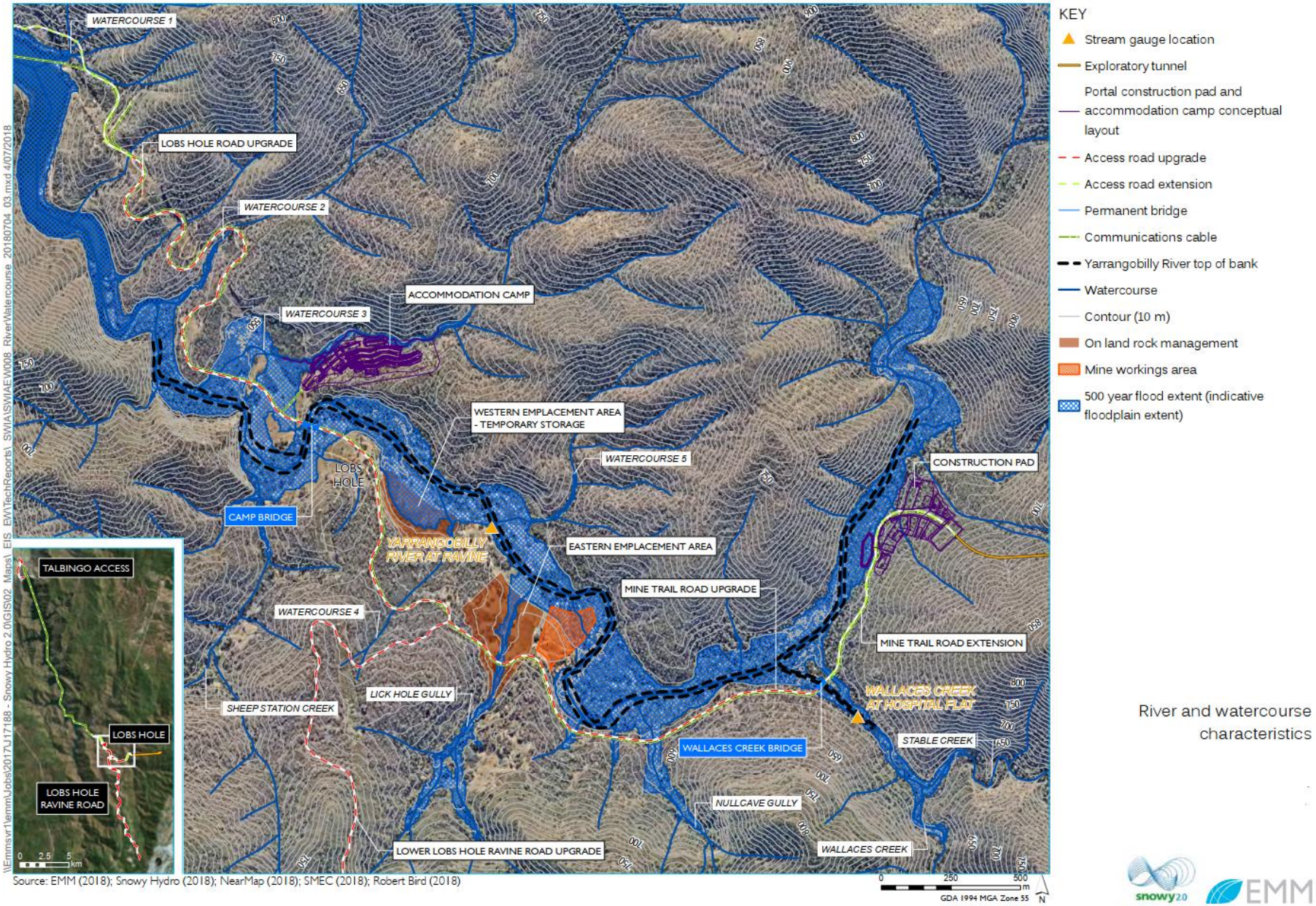


Figure 3.2 Existing surface water environment

3.5 Rainfall

Rainfall characteristics within the Yarrangobilly River catchment were determined in the EIS using information from Bureau of Meteorology (BoM) rainfall gauges and rainfall maps that are also produced by BoM. The following rainfall gauges are located within proximity to the Yarrangobilly River catchment:

- Talbingo (72131);
- Cabramurra SMHEA AWS (72161);
- Yarrangobilly Caves (72141).

Table 3-2 presents key information and statistical data from the three gauges.

Table 3-2 Rainfall statistics1

Rainfall[2] Statistics (annualised)		Talbingo (72131)	Cabramurra SMHEA AWS (72161)	Yarrangobilly Caves (72141)
Rainfall record		1997 - present	1996 - present	1906 – 1919 1978 - present
Distance from Lobs Hole	(km)	25 km to the north west	15 km to the south	15 km to the north-east
Elevation (m AHD)	(m AHD)	395	1482	980
Average rainfall	(mm/year)	952	1178	1169
Lowest rainfall	(mm/year)	361	567	552
5th percentile rainfall	(mm/year)	663	877	818
10th Percentile rainfall	(mm/year)	771	992	905
Median rainfall	(mm/year)	946	1202	1158
90th percentile rainfall	(mm/year)	1220	1386	1511
95th percentile rainfall	(mm/year)	1313	1427	1535
Highest rainfall	(mm/year)	1343	1634	1902

Notes: *1.Data sourced from BoM website (climate data online)*

2. Some precipitation will occur as snow fall but has been referred to as rainfall to maintain consistency with other sections in the EIS.

The median rainfall within Yarrangobilly catchment ranges from 1400 mm/year in the head water catchments to 950 mm/year at Lobs Hole (Surface Water Assessment). The variation in median rainfall generally reflects the variation in topography.

Figure 3.3 plots 10th, 50th and 90th percentile monthly rainfall depths that have been calculated by BoM from the Talbingo (72131) gauge. This information indicates that the highest and most consistent rainfall occurs in winter and early spring. Rainfall in summer is more variable with significant differences between 10th and 90th percentile monthly rainfall depths.

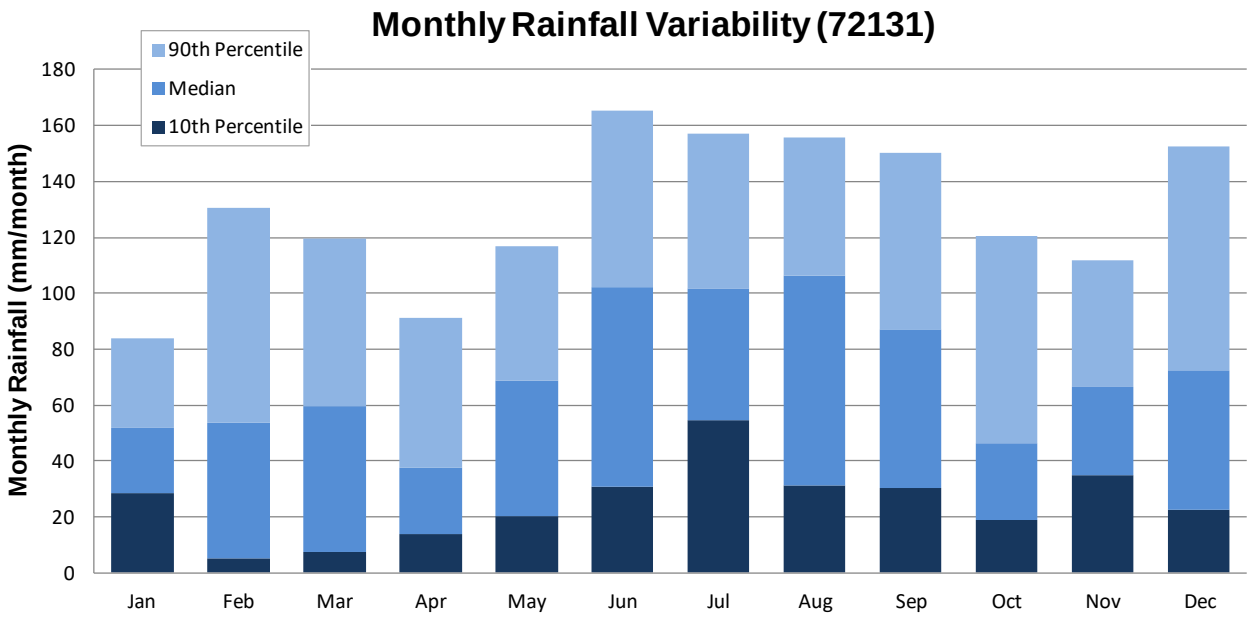


Figure 3.3 Monthly rainfall statistics - Talbingo

i Design rainfall information at Lobs Hole

Design rainfall information is used to calculate aspects of the stormwater management system. The following design rainfall information has been established for the Lobs Hole area:

- Table 3.3 provides design rainfall depths for a range of Annual Exceedance Probability (AEP) events of varying duration. This information was sourced from the ARR2016 data portal; and
- Table 3.4 presents rainfall depths for 2, 5, 10 and 20 day rainfall events. This information was calculated from the Talbingo (72131) rainfall record and is used for establishing sedimentation basin volumes.

Table 3.3 Design rainfall depths from Australian Rainfall and Runoff 2016

	Annual Exceedance Probability (AEP) – Rainfall depths (mm)						
	63.2%	**50%**	**20%**	**10%**	**5%**	**2%**	**1%**
15 min	10	11	14	17	20	24	27
30 min	13	14	19	22	26	31	35
1 hour	17	18	24	28	32	38	43
2 hour	21	24	30	35	40	47	52
3 hour	25	27	35	40	46	53	59
6 hour	32	36	46	52	59	69	76
12 hour	42	46	60	69	78	91	101
24 hour	54	59	77	89	101	118	131
48 hour	65	73	95	109	123	144	160
72 hour	72	80	104	120	134	156	173

Notes: Data sourced from Australian Rainfall Runoff Data Portal.

Table 3.4 Design rainfall depths for frequent events

	Rainfall Duration			
	2 day	**5 day**	**10 day**	**20 day**
80th Percentile event	7.5 mm	24.2 mm	47.4 mm	86.9 mm
85th Percentile event	11.4 mm	30.6 mm	56.0 mm	99.0 mm
90th Percentile event	18.4 mm	41.6 mm	68.1 mm	116.0 mm
95th Percentile event	30.0 mm	56.8 mm	85.0 mm	138.0 mm

Notes: Rainfall depths have been calculated from the Talbingo (72131) gauge record

3.6 Flooding

The area is subject to flooding from the Yarrangobilly River which flows through the site in a westerly direction. Minor tributaries which enter the River from both the north and south are also subject to flooding.

A flood assessment was undertaken as part of the EIS by GRC Hydro Pty Ltd.

The flood model results were used to establish flood characteristics within Lobs Hole for the 20%, 5%, 1%, 0.2%, 0.05% annual exceedance probability (AEP) and probable maximum flood (PMF) events. It was found that the Exploratory Works avoid flood prone land where possible, however, the following infrastructure will unavoidably need to be constructed on flood prone land:

- bridge crossings over the Yarrangobilly River and Wallaces Creek;

It is noted that:

- the flood extents of minor tributaries were not considered to be flood prone land for the purposes of this assessment. Management of runoff from minor tributaries were addressed was in Appendix M, Section 6.2 of the EIS; and

- minor portions of the eastern emplacement area, accommodation camp and portal construction pad are located within the periphery of the PMF extent, but below the 0.05% AEP event. As the magnitude of inundation is minor the EIS determined that further assessment of flood risks and impacts was not considered to be necessary.

The flood model was applied to assess changes to the existing flooding regime associated with the infrastructure. This process concluded that the predicted changes to flood regimes will not impact infrastructure or items of heritage significance.

Flood maps for the 5% and 20% AEP events developed as part of the assessment and EIS are included in Appendix A for reference.

3.7 Site water balance

During Stage 1 - Exploratory Works (Roads) water will be required for the following processes:

- earthworks to modify soil and gravel moisture conditions allowing proper compaction;

- dust suppression; and

- the wash down on plant and equipment.

Water will be preferentially sourced from sedimentation dams when available. During dry conditions water will be sourced from either Talbingo Reservoir or from local groundwater bores. The expected net water use is expected to be less than 219 ML/year, which is the volume estimated and stated in the Surface Water Assessment (EMM, 2018). Licencing arrangements are discussed in Section 2.4.

4 Environmental aspects, impacts and risks

4.1 Environmental aspects

An environmental aspect is an element of an organisation's activities, products, or services that has or may have an impact on the environment (ISO 14001 Environmental management systems). The relationship of aspects and impacts is one of cause and effect.

Key aspects of the Project that could result in surface water impacts are identified in Table 4-1. The extent of these impacts will depend on the nature, extent and magnitude of construction activities and their interaction with the natural environment (Column 2). This is further exacerbated by environmental factors (Column 3).

Table 4-1 Project aspects and impacts relevant to surface water

Environmental Aspects (Construction activities likely to cause impact to surface water)	**Environmental Impacts**	**Environmental Factors** (Conditions)
Vegetation clearing Topsoil stripping Bulk earthworks Site access including waterway crossings Culvert and drainage works Stockpiling Water use and extraction Dewatering Bridge construction Ancillary facility operation and storage of fuels and chemicals Instream work platforms and crossings Drilling and piling	Sediment-laden runoff entering into Yarrangobilly River, Wallaces Creek and other local waterways. Contamination of stormwater runoff due to construction activities (including accidental spills). Changes to flow regime from new infrastructure. Uncontrolled discharge of process water into the stormwater system. Water quality impacts associated with the discharge of process and treated wastewater (sewage) to Talbingo Reservoir.	**Soil type** – more erodible soil types have an increased soil erosion potential; **Soil moisture** – increased soil moisture decreases soil mobilisation; **Rainfall** – heavy rainfall increases soil entrainment **Extent of vegetation cover** – vegetation assists in stabilising soils and reduces the ability for erosion The presence of acid forming and acid neutralising materials Existing soil and water contamination

With the implementation of practical controls to avoid or mitigate impacts the residual impacts were described as follows:

The assessment of residual impacts concluded (with the implementation of practical controls) that:

- stormwater discharges from disturbed areas >2,500 m^2 will occur up to ten times per year on average – during and immediately following rainfall;

- stormwater discharges from disturbed areas <2,500 m^2 will occur up to 50 times per year on average but discharge volumes will be small;
- turbidity, and suspended solids and nutrients concentrations in discharged stormwater are expected to exceed default trigger levels for physical and chemical stressors on occasions and it is possible that metal concentrations may also exceed the relevant default trigger levels;
- stormwater discharges will rapidly mix with river flows, so no concentration impacts are predicted;
- load increases due to stormwater discharges are conservatively estimated to be less than 2.6% of existing loads for all pollutants;
- no change to stream flow regimes is predicted; and
- no ecological impacts are predicted.

4.2 Environmental risk assessment

The environmental aspects and impacts for surface water are further considered within Appendix A3 of the EMS. This includes a risk assessment process. The risk assessment is based on (1) the likelihood of an impact occurring as a result of the aspect; and (2) the consequences of the impact if the event occurred. The major risks for surface water during Stage 1 are the risk of hydrocarbon spills, degradation of water quality, loss of amenity and increased sediment and nutrient loads within waterways. Mitigation measures are discussed below in Section 5.

5 Environmental management measures

5.1 Management measures

A range of environmental requirements and control measures are identified in the EIS, Submissions Report and the Infrastructure Approval. Safeguards and management measures will be implemented to avoid, minimise and manage impacts to surface water.

Specific safeguards and management measures are outlined in Table 5-1.

Table 5-1 Surface water management and mitigation measures

ID	Measures/Requirements	Applicable Stage	When to implement	Responsibility	Reference
General					
WM01	Training will be provided to all project personnel, including relevant sub-contractors on surface water and soil management practices and the requirements from this plan through inductions, toolboxes and targeted training.	All	Pre-construction and construction	Contractor	Condition 34
WM02	Surface water and soil management measures from this plan will be included in relevant site environmental documents including for example, Environmental Work Method Statements (EWMS) and/or Site Environmental Plans (SEPs).	All	Pre-construction and construction	Contractor	Condition 34
WM03	A Project Soil Conservationist will be engaged during the project and will be consulted throughout construction to provide advice on erosion and sediment control design, installation and maintenance.	All	Construction	Contractor	Good practice REMM WM_2.1
WM04	The use of clean water shall be minimised through the efficient use of water generated and treated during construction.	All	Construction	Contractor	Condition 33
WM05	Unless authorised otherwise by an environmental protection licence the requirements of Section 120 of the POEO Act will be complied with.	All	Construction	Contractor	Condition 32
WM06	The stockpiling and use of mulch shall minimise generation of tannins where practicable.	All	Construction	Contractor	Good practice
WM07	Works will be programmed to minimise the extent and duration of disturbance to vegetation where practicable. This will include minimising the time between clearing and initial earthworks and commencement of subsequent works including rehabilitation.	All	Construction	Contractor	Condition 34
Procedures and plans					
WM08	Emergency flood response will be managed in accordance with the Emergency Response Management Plan.	All	Pre-construction and construction	Contractor	REMM FM_1.3
WM09	Emergency response to spills of oils and fuel etc will be managed in accordance with the Emergency Spill Response Procedure included in Appendix C of this plan.	All	Construction	Contractor	REMM WAT01 REMM WAT 11
WM10	Excavated materials including the management of the eastern and western emplacement areas will be in accordance with the Excavated Material Management Plan.	All	Construction	Contractor	REMM CON02 Condition 29
WM11	The placement of rock within emplacement areas and Talbingo Reservoir will be managed in accordance with the Subaqueous Emplacement Management Plan which includes details of subaqueous placement monitoring.	Stage 2	Construction	Contractor	REMM WAT05 Condition 25

ID	Measures/Requirements	Applicable Stage	When to implement	Responsibility	Reference
WM12	Dredging for construction for the construction of the Barge Access Infrastructure will be managed in accordance with the Dredge Management Plan.	Stage 2	Construction	Contractor	REMM WAT04 Condition 34 d)
Clean water diversions					
WM13	Where practicable, all clean water will be diverted around or through water management areas. Runoff from clean water areas that cannot be diverted will be accounted for in the design of the water management systems.	All	Pre-construction and construction	Designer and Contractor	REMM WM_1.1 Condition 33 M1.8
WM14	All permanent clean water drainage will be designed and constructed to convey the 1% AEP peak flow and will have adequate scour protection. Temporary clean water drainage will be designed to convey the 50% AEP peak flow.	All	Pre-construction	Designer and Contractor	REMM WM_1.2
WM15	Where practicable, diversions will seek to avoid materially increasing flow rates in adjoining watercourses.	All	Construction	Contractor	REMM WM_1.3 Condition 33
WM16	Where practicable, the diversion of drainage lines or watercourses using contour drains cut across steep slopes will be avoided.	All	Construction	Contractor	REMM WM_1.3
Construction disturbance areas and access roads					
WM17	The concept ESCP will be developed by the Contractor prior to construction and be used as a basis for the development of PESCPs during construction. The PESCPs will be prepared and implemented in accordance with *Soils and Construction – Managing Urban Stormwater* (The Blue Book) (Landcom 2004) for each construction area in advance of disturbance. The plans will consider local soil characteristics, clean water management and the proposed construction methods. The PESCPs will be submitted to Snowy Hydro for approval prior to site disturbance. Erosion and sedimentation controls will be implemented to minimise erosion potential, in particular in areas of dispersive soils, in accordance with the guideline *Managing Urban Stormwater, Volume 1 and Volume 2,* or equivalent.	All	Construction	Contractor	REMM WM_2.1 REMM SOIL 02 REMM WM_2.7 Condition 33 and 34 M1.11
WM18	Where practicable, vegetation clearing will occur immediately before construction works so as to minimise the period of exposure.	All	Construction	Contractor	EIS App N Table 11.5
WM19	Where practicable, vegetation clearing and construction works will be restricted during periods of rainfall where there is a risk of sediment runoff and pollution of downstream watercourses.	All	Construction	Contractor	EIS App G Table 5.4
WM20	Windrows or similar alternatives will be used along contours to reduce slope length and surface flow velocities.	All	Construction	Contractor	EIS App N Table 11.5

ID	Measures/Requirements	Applicable Stage	When to implement	Responsibility	Reference
WM21	Stockpiles will be located where they are not exposed to concentrated or flood flow. Flood flow is defined as the 20% AEP flood extent. Monitoring for dispersion and erosion of soil stockpiles will be undertaken, particularly on moderately dispersive soils. Ameliorants, such as gypsum and organic matter for dispersive soils will be applied to stockpiles of dispersive soils as needed.	All	Construction	Contractor	REMM_2.3
WM22	Soils will be lightly scarified on the contour to encourage rainfall infiltration and minimise run-off. As soon as practicable after respreading, a cover crop will be established to limit erosion and soil loss.	All	Construction	Contractor	REMM_2.4
WM23	Sediment traps or filters will be maintained at all discharge locations. The filters will only use non-toxic or materials which will not cause material harm to the environment, including biodegradable or natural materials where practicable. Sediment traps, filters and other appropriate sediment control devices will be installed to target the removal of coarse sediments.	All	Construction	Contractor	REMM_2.5
WM24	Access road surfaces will be maintained with appropriate aggregate material or sealed to reduce the risk of erosion.	All	Pre-construction and construction	Designer and Contractor	REMM_3.4
WM25	Where practicable and safe to do so access roads will be single cross fall and will grade to a table drain located against the toe of the cut batters. The drains will be stabilised by rock armouring or other suitable methods as required.	All	Pre-construction and construction	Designer and Contractor	REMM_3.5
WM26	Drill sites that have been modified to allow for vehicle access will be regraded to natural lay of the land as part of the site rehabilitation.	All	Pre-construction and construction	Designer and Contractor	M1.9
Sediment basins and water treatment – Construction disturbance areas and access roads (construction areas > 2500m^2)					
WM27	**Areas that are constrained by terrain - for construction areas > 2500m^2:** • Water treatment will be applied using the methods described in Appendix E of Surface Water Assessment (EMM, 3 October 2018) or other reasonable and practical controls applied that aim achieve the water quality objective described in the Surface Water Assessment. • Water will be captured in a sump and pumped to a water treatment plant where it cannot be gravity fed to the basin. • The design dewatering and treatment rate will be the 1 in 3 month average recurrence interval (ARI) event.	All	Construction	Contractor	REMM WM_2.6

ID	Measures/Requirements	Applicable Stage	When to implement	Responsibility	Reference
WM28	**<u>Areas that are not constrained by terrain - for construction areas > 2500m^2:</u>** • Where appropriate, sedimentation basins will be constructed in accordance with the methods recommended in *Managing Urban Stormwater: Soils and Construction:* Volume 1 (Landcom 2004) and Volume 2D (DECC 2008). However, the basins will be adjusted to accommodate the water treatment system requirements described below, where adopted. • Water treatment systems will be applied to the basins using the methods described in Appendix E of the Surface Water Assessment (EMM, 3 October 2018) or other reasonable and practical controls applied that aim to achieve the water quality objective described in the Surface Water Assessment. • The water treatment systems will be designed to treat all runoff during a 1 year ARI event. • When practical, water captured in sedimentation basins will be used for dust suppression.	All	Pre-construction and construction	Designer and Contractor	REMM WM_2.7 REMM WM_2.8
WM29	Where appropriate, the sedimentation basins established to manage runoff during construction of the access roads will be maintained during the Exploratory Works to provide ongoing treatment of runoff from access roads. These will be modified to be constructed wetland style basins where practicable. Constructed wetland style basins will maintain permanent water. An extended detention zone will be established above the permanent water. The extended detention zone will drain slowly through a low flow outlet control. On completion of the project NPWS will be consulted in relation to the wetland basins intended to remain operational post completion.	Stage 2	Construction - tunnelling	Contractor	REMM_3.6 REMM_3.7
WM30	Where practical, runoff from road embankments that have been stabilised by vegetation will be diverted into the clean water drainage system to minimise the contributing catchment area to the constructed wetlands.	All	Construction - tunnelling	Contractor	REMM_3.7
Disturbance within creeks, rivers and riparian areas					
WM31	The construction footprint and extent to which soil and vegetation within the riparian zone are disturbed will be minimised where practicable.	All	Construction	Contractor	EIS App G Table 5.1
WM32	Direct access to the rivers and creeks by construction vehicles and mechanical plant will be minimised and permitted only within the limits of clearing and designated areas of disturbance.	All	Construction	Contractor	EIS App G Table 5.1
WM33	Erosion control matting or other practical methods will be used in the riparian zone to minimise sediment entering the river channel and provision of protection against scouring and erosion of the river bed.	All	Construction	Contractor	EIS App G Table 5.4
WM34	The construction footprint and use of temporary structures within creeks and riparian zones will be minimised where practicable.	All	Construction	Contractor	EIS App G Table 5.4

ID	Measures/Requirements	Applicable Stage	When to implement	Responsibility	Reference
WM35	Construction material will not be stockpiled within 50m of watercourses.	All	Construction	Contractor	EIS App G Table 5.4
WM36	Any temporary structure will be removed and the river channel rehabilitated to the satisfaction of NPWS following construction of permanent bridges.	All	Construction	Contractor	EIS App G Table 5.4 Condition 39
WM37	Temporary watercourse crossings at Yarrangobilly River and Wallaces Creek where feasible and reasonable, will be consistent with the *Guidelines for Controlled Activities Watercourse Crossings* (NRAR, 2018), *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge, 2003), *Policy and Guidelines for Fish Friendly Waterway Crossings* (NSW Fisheries, February 2004), and *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI Fisheries, 2013). Management measures will include: • temporary in-stream structures will avoid spanning the full width of the waterway channel to ensure base flow conditions are maintained down the waterway where practicable; • maintaining some unmodified channel so that a weir effect or flow through rock interstices only is not created where practicable; • temporary in-stream structures will be inserted during low-flow periods where practicable; • ensure any build-up of debris potentially obstructing fish passage will be removed; • considering scheduling to minimise in stream works between October to January, the migratory period of the Macquarie Perch (Macquaria australasica). • Removal of temporary crossings will be carried out the consideration of the above and within 3 months of permanent bridge completion.	Stage 1	Construction	Contractor	EIS App G Table 5.4 REMM ECO11 REMM ECO12 REMM ECO13 Condition 39
WM38	The permanent bridges at Yarrangobilly River and at Wallaces Creek will be designed and constructed to comply with the *Policy and Guidelines for Fish Habitat Conservation - Update 2013* (DPI 2013) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003) and *Guidelines for Controlled activities on Waterfront Land (NRAR, 2018).*	Stage 1	Pre-construction and construction	Designer and contractor	REMM ECO11 Condition 40
WM39	Construction of the permanent crossing at Yarrangobilly River and Wallace's Creek will minimise in stream works during the migration time of Macquarie Perch (October to January) where possible.	Stage 1	Construction	Contractor	REMM ECO13 Condition 40
Contamination of surface waters and soils by hydrocarbons and other hazardous materials					

ID	Measures/Requirements	Applicable Stage	When to implement	Responsibility	Reference
WM40	In the event of unexpected contamination, whether from known or unexpected sources, work within the areas will cease until a contamination assessment is prepared to advise the need for further investigation or a remediation strategy were appropriate. The investigation will determine the extent, magnitude, and type of contaminants. The unexpected find procedure included within the Contaminated Land Management Plan will be followed in these circumstances.	All	Construction	Contractor	REMM CON01
WM41	Construction, vessels, vehicles and mechanical plant will be regularly maintained and checked for leakage of fuel and /or oils.	All	Construction	Contractor	REMM WAT01 M1.12
WM42	Bunded areas for the storage of fuel and oils, refuelling and maintenance of vehicles and mechanical plant will be established at least 50 m from watercourses.	All	Construction	Contractor	REMM WAT01
WM43	Vehicles and machines will be properly maintained to minimise risk of fuel and oil leaks.	All	Construction	Contractor	REMM WAT01 M1.12
WM44	Refuelling, washing and maintenance of vehicles and plant will be avoided as far as practicable within 50 m of watercourses.	All	Construction	Contractor	REMM WAT01
WM45	Emergency spill kits will be kept onsite and on all vessels at all times during the Exploratory Works. The spill kit must be appropriately sized for the volume of substances on the vessel. All staff would be made aware of the location of the spill kit and trained in its use.	All	Construction	Contractor	REMM WAT01 M1.12
WM46	Fuels and chemicals will be stored in bunded areas to prevent chemical spills or leakages in accordance with the relevant Australian Standards. Areas to be used for long-term storage and handling (i.e those at a site compound or dedicated fuel storage area) of hydrocarbons and chemicals will be enclosed with concrete bunds or other suitably sealed bunding.	All	Construction	Contractor	REMM WAT01 Condition 33 M1.12
WM47	Designated impervious bunded facilities will be provided for washout of concrete trucks and cleaning and/or maintenance of other vehicles, plant or equipment. These facilities will be located at least 50 metres away from natural and built drainage lines.	All	Construction	Contractor	Good practice M1.12
WM48	Prior to disturbance of known or identified land contamination an upstream diversion and downstream bunding will be installed. Water captured within the contaminated area will be tested and treated to an acceptable standard prior to discharge.	All	Construction	Contractor	REMM CON01
WM49	Spill response will be managed in accordance with the Spill Emergency Response Procedure which is provided in Appendix C.	All	Construction	Contractor	REMM WAT11 M1.12

ID	Measures/Requirements	Applicable Stage	When to implement	Responsibility	Reference
WM50	Where practical, all activities that will occur on the portal construction pad during tunnelling with potential to contaminate stormwater runoff will be isolated from the stormwater system through the use of covering (ie by a building or roof) and bunding. Water produced within the covered and bunded areas will be either: • managed by the process water system; or • disposed as liquid waste to an appropriate facility.	Stage 2	Construction	Contractor	REMM WM_5.2
WM51	The Portal Pad water management basin used during tunnelling will be designed to provide a freeboard between its overflow pipe and spillway. The freeboard volume will be calculated to contain probable leaks, spills and firewater runoff volumes. The overflow pipe will have a manual shutoff valve that will enable site management to shut off the overflow pipe to enable the basin to contain any leak, spill or fire water runoff. Further detail regarding stormwater management at the Portal Pad will be included in the Stormwater Management Plan (Accommodation Camp and Portal Pad).	Stage 2	Pre-construction and Construction	Contractor	REMM WM_5.7
Flooding					
WM52	Camp and Wallaces bridges will be designed in accordance with AustRoads bridge design standards which require the: • bridge deck soffit to be located above the 1% AEP flood level; • bridge structure to be designed to withstand a 0.05% AEP event; and • abutments to be protected by appropriately designed scour protection.	Stage 1	Pre-construction	Contractor	REMM FM_1.1
WM53	Protocols will be developed for the proposed modification elements for use and storage of plant, equipment and materials in flood prone areas commensurate with the frequency of inundation.	All	Construction	Contractor	M1.13
Rehabilitation					
WM54	Final Landscaping and Rehabilitation will be undertaken in accordance with the Rehabilitation Management Plan.	Stage 2	Construction	Contractor	REMM SOIL03 REMM SOIL04
WM55	Exposed areas will be progressively rehabilitated. Methods will include permanent revegetation, or temporary protection with spray mulching, cover crops or biodegradable matting. Application of non-native grass species within KNP will be used only as permitted by NPWS. Where practicable, the general principles of stabilisation and the required stabilisation timeframes will be applied as defined in the Blue Book section 7.1.2. Wherever possible, permanent landscaping and revegetation works will take place progressively in accordance with the Rehabilitation Management Plan.	All	Construction	Contractor	REMM SOIL03
WM56	Soil nutrient decline will be amended at the time of rehabilitation by utilising fertilisers and amendment techniques (eg gypsum, organic matter or lime application).	All	Construction	Contractor	REMM SOIL03

ID	Measures/Requirements	Applicable Stage	When to implement	Responsibility	Reference
WM57	Any topsoil and material brought onto site will need to be clean and weed and contaminant-free. Topsoil will be certified from the supplier as "weed free" prior to being brought into KNP. This will be managed in accordance with procedures outlined in the Environmental Management Strategy and Landscape Management Plan.	All	Construction	Contractor	REMM SOIL03
WM58	All cut and fill batters will be stabilised to minimise the risk of erosion.	All	Construction	Contractor	REMM_3.1
WM59	Sections of Lobs Hole Road that will no longer be required following the construction of the new access roads will be removed and rehabilitated. This will reduce associated sediment loads.	All	Construction	Contractor	REMM_3.1 Condition 37
WM60	Disturbed banks and areas cleared of vegetation will be revegetated with appropriate native species. Native species selected for planting beneath the bridge structures will be tolerant of shade.	Stage 2	Construction	Contractor	REMM SOIL03
Monitoring					
WM61	Visual inspection will be undertaken of stockpiles to identify evidence of erosion or weed growth. Appropriate ameliorants will be implemented to minimise the risk of soil degradation, erosion or offsite impacts where required.	All	Construction	Contractor	REMM SOIL01
WM62	Rainfall forecasts will be monitored daily and the works planned and the site works managed to minimise the potential impact of heavy rainfall and flood events. Prior to heavy rain events erosion and sediment controls will be reviewed and improved where necessary to minimise impacts.	All	Construction	Contractor	Good practice
WM63	Erosion and sediment controls including clean water diversions will be inspected at least weekly (with maintenance and/or modifications made as necessary). Inspections and/or maintenance during wet-weather may be increased where necessary.	All	Construction	Contractor	Revised SWA
WM64	A Surface Water Monitoring Program has been developed for Stage 1 and is included within Section 6.1 of this plan. The Surface Water Monitoring Program establishes monitoring requirements to assess the quality of the receiving waters.	All	Construction	Snowy Hydro/ Contractor	EPL REMM WAT02
WM65	A Trigger Action Response Plan has been developed as part of the Surface Water Monitoring Program and provides detail of the response actions that will be implemented in the event of an exceedance.	All	Pre-construction and construction	Snowy Hydro/ Contractor	REMM WAT02 Condition 34
WM66	The Booroolong Frog Monitoring Program will be prepared as part of the Biodiversity Monitoring Program. The Biodiversity Monitoring Program is included within Appendix B of the Biodiversity Management Plan.	All	Construction	Snowy Hydro/ Contractor	REMM ECO04

5.2 Erosion and sedimentation control strategy and methods

The construction of surface infrastructure will require the removal of vegetation and disturbance of soils. This disturbance is expected to occur for a period of up to twelve months during the initial stage of the project. Erosion and sediment controls are proposed to limit the generation of sediment and manage sediment laden runoff from construction areas.

Following initial mobilisation, clearing and basin construction within each location a number of options are available to treat surface runoff from construction areas > 2,500m2 to improve the discharge water quality. This may include automated dosing/water treatment systems or other reasonable and practical controls maybe implemented that aim to achieve the water quality objective.

Used together erosion and sediment controls, basins and other methodologies will aim to achieve the water quality objectives.

Plans will be developed and reviewed by Certified Professionals in Erosion and Sediment Control (CPESC) who will provide the assurance of plan effectiveness to achieve the desired water quality objectives. Furthermore due to the location and nature of the work a progressive approach will be adopted to ESCPs to ensure they are achieving the required objectives.

Given the sensitivity of the receiving environment, as a minimum the Blue Book principles of erosion and sediment control, including volumes 1 and 2, will be adopted as management strategies for the Project.

The management strategies for the Project are detailed below:

- provide quality training and education;
- engage and employ experienced personnel;
- assess the project and plan for erosion and sediment control;
- minimise the extent and duration of disturbance;
- monitor weather conditions and modify work programs accordingly
- control stormwater flows onto, through and from the site;
- minimise soil erosion;
- maximise sediment retention on the site;
- promptly stabilise disturbed areas;
- inspect regularly and maintain controls in working order;
- monitor the site and respond appropriately;
- prepare and maintain documents;
- report outcomes and impacts.

Surface Water Appendix C provides further and specific details as the instruction and general requirements for Stage 1 Erosion and Sediment Control.

5.3 Spill Management

i Purpose

The purpose of this procedure is to guide the project team in the response to emergency spills of fuels, oils or other chemicals which have the potential to contaminate soil and water during construction. A prompt and managed response to emergency spills will aid in ensuring the potential impact to the environment is minimised.

In the event of a spill the emergency response procedure provided on the following page will be implemented.

Where a spill incident either causes or threatens to cause material harm to the environment the Emergency Response Plan (incorporating the requirements of the Pollution Incident Response Plan) is to be implemented. This will require notification to the EPA and response agencies. Additionally, if there is a substantial spill the appropriate regulatory authority (ARA) needs to be called in addition to emergency services. Under section 148 of the POEO Act, where an incident either causes or threatens to cause material harm to the environment, each of the following response agencies needs to be informed quickly, so action can be coordinated to prevent or limit harm to the environment and human health generally:

- appropriate regulatory authority (ARA)
- Environment Protection Authority (EPA) if they are not the ARA
- Ministry of Health
- SafeWork NSW (formerly WorkCover)
- local authority, if they are not the ARA
- Fire and Rescue NSW.

Typical Emergency Spill Response Procedure

At all times ensure the safety of yourself and others whilst implementing this procedure. Wear appropriate PPE prior to making any contact with the spilt material.

1. If safe to do so, control the spill

- Stop the flow
- Contain the spill
- Divert the spill away from waterways if needed
- Use bunds, hydrocarbon booms, sand etc to limit the spread of the spill
- If spill enters the drainage system also stop the spill at the low point (or it's furthest extent) if possible

2. Report the incident

- In the event of a spill or leak of fuel, oil or chemicals immediately notify your supervisor
- Provide brief details of the event – where is it, what is it, how much is there, emergency response provided or other related information

3. Assess the situation

- Is it safe to take action?
- What is the source of the spill and can it be controlled or shutdown?
- Consult the Safety Data Sheet - What PPE and emergency equipment is required?
- Are there any other hazards that need to be controlled? E.g. ignition sources
- Do I need further assistance? For large spills beyond capacity of work crew to contain or hazardous substances, call 000 and request NSW Fire and Rescue HAZMAT. Notify the appropriate regulatory authority (ARA).

4. Clean up the spill

- Do not hose away spills into the drains or waterways
- If necessary cover spills during rain events to avoid spread and further contamination
- Clean up all contaminated material, soils and water

5. Dispose of contaminated materials

- Contaminated materials will be disposed of offsite at licensed waste disposal facility. This includes the absorbent material used for clean up.
- Burning of contaminated waste material on site is not permitted.

6. Investigation and reporting

- Re-stock spill kits as soon as possible after the incident

- The environmental team will investigate the spill
- Implement lessons learnt to avoid reoccurrence of the incident

6 Compliance management

6.1 Monitoring and inspection

This surface water monitoring program will be implemented during Stage 1 of Exploratory Works. The program is an extension of the current baseline monitoring program. The primary objectives of the program are to:

- continue to monitor baseline conditions upstream of disturbance areas;
- monitor water quality at the point of discharge to enable the effectiveness of water quality controls to be assessed; and
- monitor receiving waters downstream of disturbance areas to identify and quantify any water quality impacts.

The program includes requirements to monitor rainfall, stream flows, stormwater quality and receiving water quality. Detailed information for the Stage 1 monitoring locations, methods and frequencies are summarised in Table 6-4.

The monitoring program will be updated prior to the commencement of Stage 2 to include monitoring for treated process and waste effluent water, emplacement area monitoring and the portal pad and accommodation camp stormwater dam monitoring.

6.1.1 Responsibilities

During Stage 1, sampling and testing will be coordinated by either Snowy Hydro or the Contractor as defined below:

- Stream gauge monitoring – Snowy Hydro
- Comprehensive monitoring as described in Section 6.1.5 – Snowy Hydro
- Wet weather event-based (basic) monitoring as described in Section 6.1.5 – Contractor

Sample data collected by Snowy Hydro will be provided to the Contractor for analysis, investigation and reporting as described in Section 7. At all times during construction the Contractor will be responsible for initiation of the TARP's and implementation of corrective measures.

Additional requirements and responsibilities in relation to inspections are documented in Section 7 of the EMS.

6.1.2 Water Quality Objectives (WQOs)

i Receiving waters

The WQOs reference the default trigger values that are published in the ANZECC/ARMCANZ 2000 guidelines. The following approach to selecting default trigger values was adopted in the development of this program:

- Yarrangobilly River is of high conservation and ecological value:
  - physical and chemical stressor trigger values – no change beyond natural variability. Provisional Site Specific Trigger Values (SSTVs) will be calculated and updated monthly using available data. The calculation of provisional SSTVs will consider seasonal trends in water quality and variations in water quality during wet weather conditions. The provisional SSTVs will be presented with the default values until there is sufficient data available to calculate SSTVs for a full range of flow conditions, including summer baseflow, winter baseflow and wet weather conditions; and
  - toxicant trigger values for the protection of 99% of aquatic species.
- Talbingo Reservoir:
  - physical and chemical stressor trigger values for fresh water lakes and reservoirs – slightly to moderately disturbed; and
  - toxicant trigger values for the protection of 99% of aquatic species.

Table 6-1 provides a summary of the adopted WQOs.

Table 6-1 Receiving water quality objectives

Category	analyte	Unit	WQO value	
			Yarrangobilly River	Talbingo Reservoir
Physico-chemical Properties	pH		The mean of the stressor will be updated monthly for control sites and compared to disturbed site sample data	6.5 – 8.0[1]
	Electrical conductivity (EC)	µS/cm		20 – 30[1]
	Turbidity	NTU		1- 20[1]
	Dissolved oxygen (DO)	%		90 – 110[1]
Nutrients	Total ammonia (NH_4^+)	mg/l		0.010[1]
	Oxidised Nitrogen (NOx)	mg/l		0.010[1]
	Total Nitrogen (TN)	mg/l		0.35[1]
	Filterable Reactive phosphorus (FRP)	mg/l		0.005[1]
	Total Phosphorus (TP)	mg/l		0.01[1]
Inorganics (dissolved)	Cyanide	mg/l	0.004	0.007
Metals (dissolved)[2]	Aluminium (Al)	mg/l	0.027	0.055
	Arsenic (As)[4]	mg/l	0.0008	0.013
	Boron (B)	mg/l	0.090	0.370
	Cobalt (Co)[3]	mg/l	0.0014	0.0014
	Total Chromium (Cr)[5]	mg/l	0.0001	0.001
	Copper (Cu)	mg/l	0.0010	0.0014
	Manganese (Mn)	mg/l	1.2	1.9
	Nickel (Ni)	mg/l	0.008	0.011

Category	analyte	Unit	WQO value	
			Yarrangobilly River	Talbingo Reservoir
	Lead (Pb)	mg/l	0.001	0.0034
	Selenium (Se)	mg/l	0.005	0.005
	Silver (Ag)	mg/l	0.00002	0.00005
	Vanadium (V)[3]	mg/l	0.006	0.006
	Zinc (Zn)	mg/l	0.0024	0.008
	Mercury (Hg)	mg/l	0.00006	0.00006
	Iron (Fe)[3]	mg/l	0.3	0.3
Pathogenic organisms	E-coli	cfu/100ml	n/a	150
	Enterococci	cfu/100ml	n/a	35
	Protozoans	orgs/100ml	n/a	nil

Note: *1. The trigger values for field parameters and nutrients refer to the trigger values for physical and chemical stressors in south-east Australia (freshwater lakes and reservoirs) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC/ARMCANZ (2000).*
2. The trigger values for metals refer to the trigger values of 99% protection for the Yarrangobilly River and 95% protection for Talbingo Reservoir that are reported in Tables 3.4.1 of ANZECC/ARMCANZ (2000).
3. WQO value refers to a low reliability trigger value.
4. For As (V).
5. For Cr (VI).

ii Discharge water quality characteristics

The SWMP describes water quality controls that will be implemented during Exploratory Works to minimise and mitigate impacts to surface water. The effectiveness of these controls will be assessed during Stage 1 construction by bench-marking discharge water quality against the discharge water quality characteristics that were presented in the Surface Water Assessment (EMM, 2018). These characteristics are reproduced in Table 6-2. Further details as to how these targets will be monitored and the actions required in the event of exceedances are provided in Sections 6.1.7 and 6.1.8.

Table 6-2 Predicted discharge water quality characteristics

Parameter	Units	Maximum concentration at point of discharge		
		Construction areas <2,500 m² (erosion and sediment controls, no chemical water treatment)	**Construction areas >2,500 m²** (erosion and sediment controls, with chemical water treatment)	**Operational basins[1] for access roads and accommodation camp**
Physio-chemical				
Electrical conductivity (EC)	µS/cm	No value provided	No value provided	No value provided
pH	-	6.5 – 8.0	6.5 – 8.0	6.5 – 8.0
Turbidity	NTU	150	25	50
Suspended sediment	mg/l	40	20	25
Oil and Grease	mg/l	Not visible	Not visible	Not visible
Nutrients				
Total ammonia - N	mg/l	No value provided	No value provided	No value provided

Parameter	Units	Maximum concentration at point of discharge		
		Construction areas <2,500 m² (erosion and sediment controls, no chemical water treatment)	**Construction areas >2,500 m²** (erosion and sediment controls, with chemical water treatment)	**Operational basins[1] for access roads and accommodation camp**
Oxidised nitrogen (NOx)	mg/l	0.5	0.5	0.4
Total nitrogen (TN)	mg/l	1.5	1.5	1.0
Reactive phosphorus (FRP)	mg/l	0.12	0.05	0.05
Total phosphorus (TP)	mg/l	0.20	0.05	0.1
Metals (dissolved)				
Dissolved metals	mg/l	Concentrations of some metals may exceed relevant trigger values		

Note: 1. These characteristics apply once construction sediment basins have been converted to wetland style basins

6.1.3 Monitoring parameters

Sample collection is to comply with the NSW EPA's *Approved Methods for the Sampling and Interpretation of Results of Water Pollutants in NSW*. Table 6-3 describes proposed sampling analytes and analysis methods.

Table 6-3 Proposed sampling analytes and analysis methods

Category	Proposed sampling analytes	Analysis method
Basic monitoring		
Physico-chemical Properties	pH and turbidity	To be measured using a portable water quality meter in the field
Inspection	Visible oil and grease	Inspection of erosion and sediment controls, downstream drainage and clean water diversions
Comprehensive monitoring		
Physico-chemical Properties	pH, electrical conductivity (EC), turbidity, dissolved oxygen, temperature, redox potential	To be measured using a portable water quality meter in the field
	major cations (Na, K, Mg, Ca) and major anions (Cl, SO_4, HCO_3 and CO_3)	Analysis to be undertaken by a NATA certified laboratory
	total suspended solids, total dissolved solids, total hardness	
Nutrients	total nitrogen, ammonia, oxidised nitrogen and total kjeldahl nitrogen	
	total phosphorus and reactive phosphorous	
Metals (dissolved)	Al, As, Ag, B, Cr (total), Co, Cu, Fe, Hg, Mn, Ni, Pb, Se, V and Zn	
Inorganics	Cyanide	

6.1.4 Monitoring locations

Proposed monitoring locations for Stage 1 are included in EPL 21266. It is noted that receiving water monitoring will be located more than 10m from any discharge location to ensure monitoring is

undertaken outside of any mixing zone. These receiving water locations will be the EPL 21266 monitoring locations. Table 6.4 refers to the discharge locations from the sediment basins.

Additional or varied/reduced monitoring locations may be warranted following detailed design and during construction as risk requires or where it can be demonstrated that no risk remains. Changes to the monitoring locations would be approved by Snowy Hydro prior to relocation or addition and updated in subsequent revisions of the water quality monitoring program.

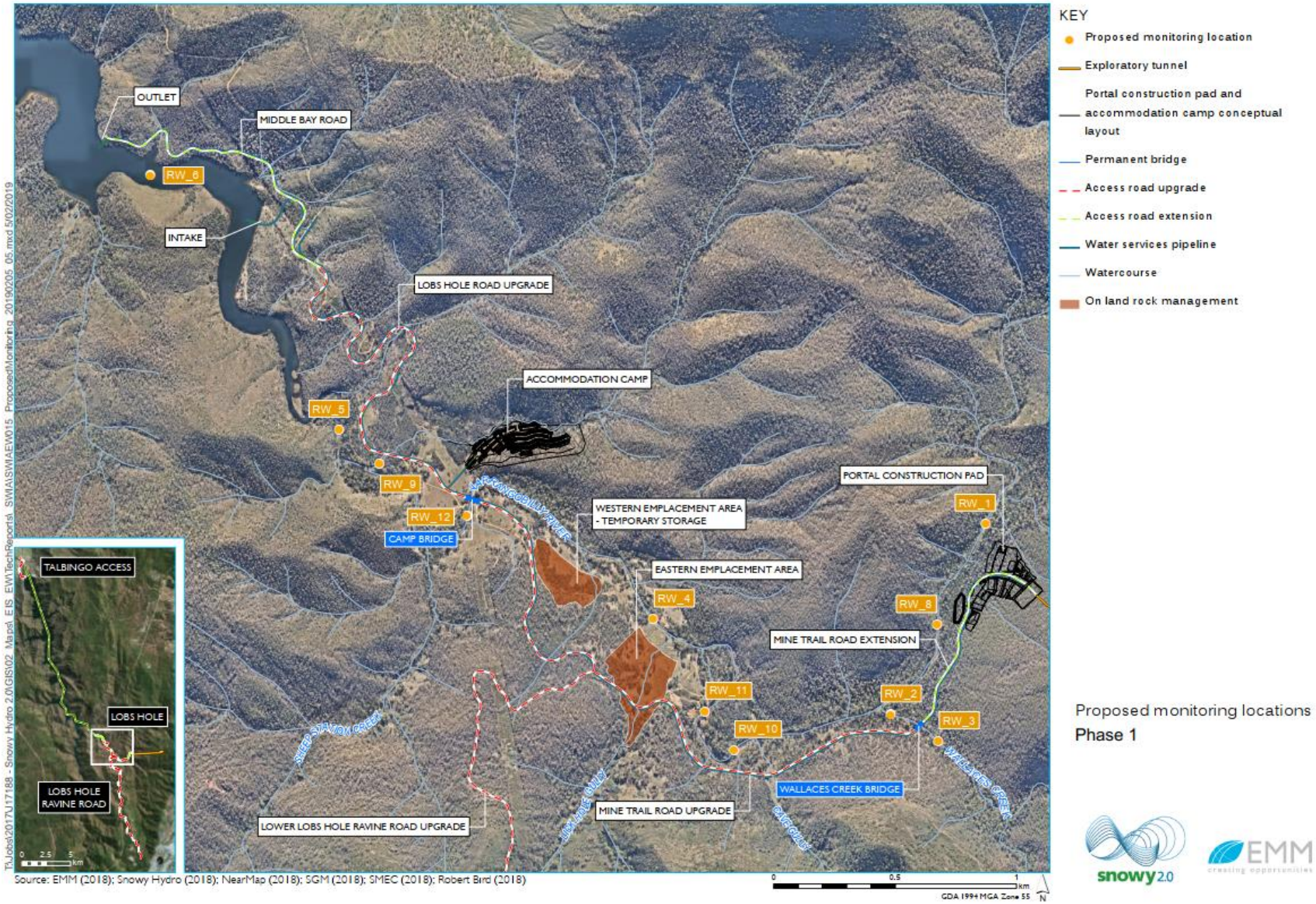


Figure 6.1 Surface water monitoring locations

Table 6-4 Consolidated water monitoring program

ID	Location	Timing	Comment	Monitoring frequency	Sampling Analysis	Wet weather event[1] (Basic Suite/once daily during event)	Objectives/Targets	Threshold for exceedance/Exceedance protocol
Construction disturbance area monitoring								
CA_1a to CA_5a CA_1b to CA_5b	Sediment basin discharges	Stage 1	Monitoring locations will be included in the Erosion and Sediment Control Plans developed by the Contractor prior to construction. Sampling will be undertaken from the overflow from sediment basins and upstream of the water treatment system.	For comprehensive suite - At each location sampled each quarter during a wet weather event. Total 4/yr/location.	**Comprehensive suite** Physico-chemical (detailed) Visual Inspection Nutrients Metals (dissolved)	**Basic Suite (once daily during wet weather event)** Physico-chemical (basic) Visual inspection	Discharge water quality characteristics Table 6-2 - Construction Areas > 2500m2. Compared for basin discharge samples only.	If discharge WQOs are exceeded/Refer to TARP 2

Note: 1. A wet weather event refers to any rainfall event that results in the discharge of surface water from the project's water management dams and sediment basins. Monitoring shall occur once daily during the events where shown.

6.1.5 Monitoring frequency

The following categories of monitoring will be undertaken:

- Monitoring types:
    - Basic/ in-situ monitoring - refers to monthly inspection and measurements with a portable water quality meter.
    - Comprehensive/ laboratory monitoring – refers to monitoring where samples are collected and analysed at a laboratory.
- Monitoring events:
    - Monthly EPL Monitoring – refers to routine monitoring that will be undertaken monthly, regardless of weather and as required by EPL 21266.
    - Wet Weather Monitoring - refers to monitoring that will be undertaken during wet weather events. Wet weather events will typically require 30 to 50 mm of rainfall over a 2 to 3 day period. Wet weather monitoring will be undertaken during and after wet weather events.

It is noted that additional or varied/reduced monitoring frequencies and parameters may be warranted following detailed design and during construction as risk requires or where it can be demonstrated that no risk remains. Changes to the frequencies and parameters would be approved by Snowy Hydro prior to amendment and update in subsequent revisions of the water quality monitoring program. Snowy Hydro will refer any changes to the SWMP to DPE.

6.1.6 Baseline surface water monitoring data

Water quality data from the Yarrangobilly River and its tributaries, Talbingo Reservoir and Tumut River sampling locations are relevant to Stage 1 Exploratory Works and are presented in Appendix A.

It is noted that all sampling to date has been undertaken during baseflow conditions or shortly after wet weather. Wet weather sampling is proposed.

6.1.7 Departures from the Water Quality Objectives

This program includes monitoring at both discharge and receiving water locations. Receiving water monitoring results will be bench-marked to the relevant WQOs as presented in Table 6-1. Monitoring at discharge locations will be bench-marked to the discharge limits (discharge monitoring locations only) that are presented in Table 6-2.

Baseline water quality results presented in Section 6.1.6 and Appendix A have identified several analytes that exceeded WQO values either on a frequent or occasional basis. As noted in Section 6.1.6 all monitoring was undertaken during either base flow or shortly following wet weather conditions.

During wet weather conditions streams flows will predominantly comprise surface water runoff (rather than groundwater fed base flow) and may have different water chemistry. As sediment laden runoff from existing access tracks and other disturbed areas is known to occur in Lobs Hole, it is likely that turbidity levels may exceed WQO values in some minor watercourses and potentially the Yarrangobilly River. Elevated concentrations of phosphorus and some metals can also be associated with sediment laden runoff and may therefore exceed WQO values. Generally, it is expected that during wet weather

conditions, the water quality in minor watercourses in Lobs Hole will be degraded relative to the water quality in the Yarrangobilly River. Monitoring of wet weather conditions is proposed.

Identified and expected WQO departures are considered in the trigger value exceedance protocols that are discussed in Section 6.1.8.

6.1.8 Review and response procedures

Monitoring will be undertaken using a combination of methods and will require varying levels of processing and review before it can be used to inform assessment and decision making. Table 6-5 provides an overview of data collection methods and expected timeframes for data to be available.

Table 6-5 Data availability timeframes

Monitoring Type	Data collection and review methods	Data availability
In-situ water quality monitoring	• Site observations • Insitu measurements using a portable water quality meter	• Same day
Comprehensive water quality monitoring	• Grab samples collected in the field • Samples will be sent to a NATA certified laboratory for analysis. Analysis typically takes 5 business days. • Once received, laboratory results require processing, interpretation and review • Data from non-telemetered stream gauges and flow and water quality meters requires download, processing and review	• Within two weeks of sampling

Monitoring will be undertaken from within the water management system, water management system discharge locations and at the nominated receiving water locations. Exceedances will be identified by benchmarking the data as follows:

- Receiving water monitoring results will be bench-marked to the relevant WQOs - Table 6-1.
- Point of discharge monitoring results will be bench-marked to the discharge limits - Table 6-2.
- Monitoring from locations within the water management system (ie upstream of water treatment systems) will be undertaken to enable the effectiveness of the water treatment systems to be assessed. As this data relates to the pre-treatment water quality, it will not be bench-marked to either WQOs or discharge limits.

Table 6-4 describes the relevant WQO, threshold for exceedance and exceedance protocols for each monitoring location.

As noted in Table 6-5, monitoring data from basic monitoring will be available on the same day of monitoring, enabling rapid responses to identified exceedances. Data from the more informative comprehensive monitoring will not be available for up to two weeks following monitoring. Hence, this data cannot be used to inform rapid responses. The comprehensive monitoring data can be used to inform a detailed understanding of water quality impacts and impact mechanisms. This information can then be applied to establish targeted improvements to the water management system.

As discussed in Section 6.1.6 and Appendix A, baseline receiving water quality monitoring has identified that WQO values for several analytes are exceeded on a frequent or occasional basis. The baseline monitoring has only characterised water quality during baseflow and after wet weather events. There is also potential for exceedances of additional analytes during wet weather conditions. Hence, regular exceedances of some analytes are expected to occur due to natural or anthropogenic catchment processes that are not associated with Exploratory Works.

TARPs have been prepared to establish methods to identify the source of each exceedance and if necessary, establish actions to either improve water management or further investigate the exceedance.

Separate TARPs have been prepared for:

- receiving water and point of discharge exceedances with WQO; and
- exceedances identified by basic and comprehensive monitoring.

Table 6-6 provides an overview of the TARPs. All TARPs are provided in Appendix B.

Table 6-6 Overview of trigger action response plans

TARP	Trigger	Objectives
Receiving water exceedance TARP 1a - Basic water quality monitoring TARP 1b - Comprehensive water quality monitoring	• If a WQO value is exceeded in receiving waters.	• To identify (where possible) if the exceedance is naturally occurring or due to Exploratory Works
Point of discharge exceedance TARP 2a - Basic water quality monitoring TARP 2a - Comprehensive water quality monitoring	• If a discharge WQO value is exceeded	• To identify the source (where possible) of each exceedance. • To establish actions to either improve water management or further investigate the exceedance mechanism.

6.2 Training

All site personnel will undergo site induction training relating to surface water and soil management issues.

The induction training will address elements related to surface water management including:

- existence and requirements of this SWMP;
- roles and responsibilities for surface water management;
- surface water mitigation and management measures;
- procedures to be implemented in the event of an incident (e.g. spill or contamination).

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in surface water management. Examples of training topics include:

- erosion and sediment control installation methodology;

- sediment basin and treatment system construction, operation and maintenance;
- working near or in drainage lines and creeks;
- emergency response measures in high rainfall events;
- lessons learnt from incidents and other event eg high rainfall/flooding;
- spill response and Pollution Incident Response Management Plan (PIRMP) if required;
- stockpile locations and requirements; and
- identification of potentially contaminated materials.

Further details regarding the staff induction and training are outlined in Section 4 of the EMS.

6.3 Auditing

Audits will be undertaken to assess the effectiveness of surface water management measures, compliance with this SWMP, the conditions of approval, EIS, Submissions Reports and other relevant approvals, licences and guidelines.

Audit requirements are detailed in Section 7.3 of the EMS.

6.4 Reporting

Reporting will include monthly internal project reports and six monthly compliance reports as required by the conditions of approval. The six-monthly reports will track compliance against the conditions of approval and the revised environmental management measures. Reporting requirements and responsibilities are documented in Section 7 of the EMS. All reporting to DPIE and NPWS will be via the Major Projects portal.

A monthly water quality report will be prepared by the Contractor that presents:

- all monitoring data;
- exceedances and identified sources; and
- any response measures that have been undertaken.

Where required by the EPL monitoring results of sampling undertaken within the receiving waters and licenced discharges will be posted on the project website.

Response to incidents will be undertaken as described in Section 6 of the EMS and in accordance with the Environmental Incident Procedure (refer to Appendix A5 of the EMS) and The Pollution Incident Response Management Plan (PIRMP).

Surface Water - Appendix A

Baseline water quality data

Table A1 Baseline water quality results summary: Yarrangobilly River and Wallaces Creek

			Yarrangobilly River (PN_SW_001, LH_SW_004, LH_SW_006, LH_SW_007)				Wallaces Creek (LH_SW_001, LH_SW_002, LH_SW_003)			
	Unit	**WQO value[1]**	**# Samples / exceedances[6]**	**10th percentile[5]**	**Median**	**90th percentile[5]**	**# Samples / exceedances[6]**	**10th percentile[5]**	**Median**	**90th percentile[5]**
Field Parameters										
Temperature	°C	-	34 / -	4.0	13.1	21.4	13 / -	4.0	13.0	14.6
Dissolved Oxygen (DO)	%	-	34 / -	33	78	105	13 / -	69	77	102
Electrical Conductivity (EC)	µS/cm	-	34 / -	27	71	173	13 / -	39	73	182
pH		-	34 / -	7.3	7.9	8.2	13 / -	7.2	7.8	8.1
Oxidising and Reducing Potential (ORP)		-	34 / -	54	124	197	13 / -	62	146	203
Turbidity	NTU	-	20 / -	0.0	1.4	4.4	8 /-	0.2	1.2	1.5
Analytical Results - General										
Suspended Solids (SS)	mg/l	-	34 / -	3	5	5	13 / -	<2	5	5
Total Alkalinity (as $CACO_3$)	mg/l	-	8 / -	16	77	109	3 / -	38	99	104
Total Hardness (as $CACO_3$)	mg/l	-	27 / -	7	29	65	10 / -	16	30	88
Analytical Results - Nutrients										
Ammonia	mg/l	-	29 / -	<0.01	<0.01	0.012	10 / -	<0.01	<0.01	<0.01
Oxidised Nitrogen (NOx)	mg/l	-	30 / -	<0.01	0.015	0.041	10 / -	<0.01	0.015	0.031
Total Kjeldahl Nitrogen (TKN)	mg/l	-	29 / -	<0.1	<0.1	<0.1	10 / -	<0.1	<0.1	0.12
Total Nitrogen (TN)	mg/l	-	29 / -	<0.1	<0.1	<0.1	10 / -	<0.1	<0.1	0.12
Reactive Phosphorus	mg/l	-	27 / -	<0.01	<0.01	<0.01	10 /-	<0.01	<0.01	0.02
Total Phosphorus (TP)	mg/l	-	29 / -	<0.01	<0.01	<0.01	10 /-	<0.01	<0.01	0.011
Total Organic Carbon	mg/l	-	26 / -	<1	2	8	10 / -	<1	<1	10
Dissolved Organic Carbon	mg/l	-	26 / -	<1	2	5	10 / -	<1	2	4
Analytical Results - Inorganics (Dissolved)										
Cyanide	mg/l	0.004	8 / 0	<0.004	<0.004	<0.004	2 / 0	<0.004	<0.004	<0.004
Analytical Results - Metals (Dissolved)										
Aluminium (Al)	mg/l	0.027	26 / 17	<0.01	**0.03**	**0.125**	10 / 0	<0.01	<0.01	0.02

Table A1 Baseline water quality results summary: Yarrangobilly River and Wallaces Creek

			Yarrangobilly River (PN_SW_001, LH_SW_004, LH_SW_006, LH_SW_007)				Wallaces Creek (LH_SW_001, LH_SW_002, LH_SW_003)			
	Unit	**WQO value[1]**	**# Samples / exceedances[6]**	**10th percentile[5]**	**Median**	**90th percentile[5]**	**# Samples / exceedances[6]**	**10th percentile[5]**	**Median**	**90th percentile[5]**
Arsenic (As)	mg/l	0.0008[3]	26 / 0	<0.001	<0.001	<0.001	10 / 0	<0.001	<0.001	<0.001
Boron (B)	mg/l	0.09	26 / 0	<0.05	<0.05	<0.05	10 / 0	<0.05	<0.05	<0.05
Cobalt (Co)	mg/l	0.0014[2]	26 / 0	<0.001	<0.001	<0.001	10 / 0	<0.001	<0.001	<0.001
Total Chromium (Cr)	mg/l	0.0001[4]	26 / 1	<0.001	<0.001	<0.001	10 / 0	<0.001	<0.001	<0.001
Copper (Cu)	mg/l	0.001	26 / 2	<0.001	<0.001	<0.001	10 / 3	<0.001	<0.001	**0.0021**
Manganese (Mn)	mg/l	1.2	26 / 0	<0.001	<0.001	0.002	10 / 0	<0.001	<0.001	0.0011
Nickel (Ni)	mg/l	0.008	26 / 0	<0.001	<0.001	<0.001	10 / 0	<0.001	<0.001	<0.001
Lead (Pb)	mg/l	0.001	26 / 0	<0.001	<0.001	<0.001	10 / 0	<0.001	<0.001	<0.001
Selenium (Se)	mg/l	0.005	26 / 0	<0.01	<0.01	<0.01	10 / 0	<0.01	<0.01	<0.01
Silver (Ag)	mg/l	0.00002	26 / 0	<0.001	<0.001	<0.001	10 / 0	<0.001	<0.001	<0.001
Vanadium (V)	mg/l	0.006[2]	26 / 0	<0.01	<0.01	<0.01	10 / 0	<0.01	<0.01	<0.01
Zinc (Zn)	mg/l	0.0024	26 / 7	<0.005	<0.005	**0.0065**	10 / 3	<0.005	<0.005	**0.0079**
Mercury (Hg)	mg/l	0.00006	26 / 0	<0.0001	<0.0001	<0.0001	10 / 0	<0.0001	<0.0001	<0.0001
Iron (Fe)	mg/l	0.3[2]	26 / 0	<0.05	<0.05	0.08	10 / 0	<0.05	<0.05	0.057

Notes: *1. WQO values refer to the values established in the EIS Surface Water Assessment. It is noted that no hardness adjustments have been made.*
2. WQO value refers to a low reliability trigger value.
3. For As (V).
4. For Cr (VI).
5. If less than 10 samples are available, the minimum value is reported instead of the 10th percentile value and the maximum value is reported instead of the 90th percentile value.
6. An exceedance refers to any result that is above detection limit and exceeds the WQO value. Where a range is given for the WQO value, exceedances are determined in relation to the upper limit for turbidity and electrical conductivity, the lower limit for dissolved oxygen and the lower and upper limit for pH.
***Bold** denotes trigger value is exceeded.*

Table A2 Baseline water quality results summary: minor watercourses and Tumut River

			Minor watercourses (LH_SW_005, LH_SW_008, LH_SW_009)				Tumut River (TalS_SW_001)			
	Unit	**WQO value[1]**	**# Samples / exceedances[6]**	**10th percentile[5]**	**Median**	**90th percentile[5]**	**# Samples / exceedances[6]**	**10th percentile[5]**	**Median**	**90th percentile[5]**
Field Parameters										
Temperature	°C	-	8 / -	8.6	11.7	13.9	7 / -	4.5	7.7	21.6
Dissolved Oxygen (DO)	%	-	8 /-	37	59	75	7 / 6	52	81	160
Electrical Conductivity (EC)	µS/cm	-	8 / -	42	241	641	7 / 0	36	68	157
pH		-	8 / -	6.6	7.3	7.9	7 / 2	5.6	7.8	9.5
Oxidising and Reducing Potential (ORP)		-	8 / -	131	147	175	7 / -	84	149	185
Turbidity	NTU	-	6 / -	0.4	2.6	5.7	5 / 0	0.2	3.7	7.7
Analytical Results - General										
Suspended Solids (SS)	mg/l	-	8 / -	<5	<5	18	7 / -	<2	5	6
Total Alkalinity (as $CACO_3$)	mg/l	-	0 / -	-	-	-	1 / -	46	46	46
Total Hardness (as $CACO_3$)	mg/l	-	8 / -	21	168	497	6 / -	12	22	30
Analytical Results - Nutrients										
Ammonia	mg/l	-	8 / -	<0.01	<0.01	0.02	6 / 2	<0.01	<0.01	0.02
Oxidised Nitrogen (NOx)	mg/l	-	8 / -	<0.01	<0.01	0.11	6 / 3	<0.01	0.015	0.04
Total Kjeldahl Nitrogen (TKN)	mg/l	-	8 / -	<0.1	<0.1	<0.1	6 / -	<0.1	<0.1	<0.1
Total Nitrogen (TN)	mg/l	-	8 / -	<0.1	<0.1	<0.1	6 / 0	<0.1	<0.1	<0.1
Reactive Phosphorus	mg/l	-	8 / -	<0.01	<0.01	<0.01	6 / 0	<0.01	<0.01	<0.01
Total Phosphorus (TP)	mg/l	-	8 / -	<0.01	<0.01	<0.01	6 / 0	<0.01	<0.01	<0.01
Total Organic Carbon	mg/l	-	8 / -	<1	<1	2	6 / -	<1	2	6
Dissolved Organic Carbon	mg/l	-	8 / -	<1	2.5	5	6 / -	<1	2.5	4
Analytical Results - Inorganics (Dissolved)										
Cyanide	mg/l	0.004	4 / 0	<0.004	<0.004	<0.004	2 / 0	<0.004	<0.004	<0.004
Analytical Results - Metals (Dissolved)										
Aluminium (Al)	mg/l	0.027	8 / 1	<0.01	<0.01	**0.10**	6 / 5	<0.01	**0.03**	**0.11**

Table A2 Baseline water quality results summary: minor watercourses and Tumut River

			Minor watercourses (LH_SW_005, LH_SW_008, LH_SW_009)				Tumut River (TalS_SW_001)			
	Unit	**WQO value[1]**	**# Samples / exceedances[6]**	**10th percentile[5]**	**Median**	**90th percentile[5]**	**# Samples / exceedances[6]**	**10th percentile[5]**	**Median**	**90th percentile[5]**
Arsenic (As)	mg/l	0.0008[3]	8 / 1	<0.001	<0.001	**0.002**	6 / 0	<0.001	<0.001	<0.001
Boron (B)	mg/l	0.09	8 / 1	<0.05	<0.05	<0.05	6 / 0	<0.05	<0.05	<0.05
Cobalt (Co)	mg/l	0.0014[2]	8 / 0	<0.001	<0.001	<0.001	6 / 0	<0.001	<0.001	<0.001
Total Chromium (Cr)	mg/l	0.0001[4]	8 / 0	<0.001	<0.001	<0.001	6 / 1	<0.001	<0.001	<0.001
Copper (Cu)	mg/l	0.001	8 / 4	<0.001	**0.002**	**0.004**	6 / 0	<0.001	<0.001	<0.001
Manganese (Mn)	mg/l	1.2	8 / 0	<0.001	0.0015	0.015	6 / 0	0.002	0.0035	0.008
Nickel (Ni)	mg/l	0.008	8 / 0	<0.001	<0.001	0.002	6 / 0	<0.001	<0.001	<0.001
Lead (Pb)	mg/l	0.001	8 / 0	<0.001	<0.001	<0.001	6 / 0	<0.001	<0.001	<0.001
Selenium (Se)	mg/l	0.005	8 / 0	<0.01	<0.01	<0.01	6 / 0	<0.01	<0.01	<0.01
Silver (Ag)	mg/l	0.00002	8 / 0	<0.001	<0.001	<0.001	6 / 0	<0.001	<0.001	<0.001
Vanadium (V)	mg/l	0.006[2]	8 / 0	<0.01	<0.01	<0.01	6 / 0	<0.01	<0.01	<0.01
Zinc (Zn)	mg/l	0.0024	8 / 1	<0.005	<0.005	**0.006**	6 / 3	<0.005	**0.006**	**0.007**
Mercury (Hg)	mg/l	0.00006	8 / 0	<0.0001	<0.0001	<0.0001	6 / 0	<0.0001	<0.0001	<0.0001
Iron (Fe)	mg/l	0.3[2]	8 / 0	<0.05	<0.05	0.06	6 / 0	<0.05	0.08	0.09

Notes: *1. WQO values refer to the values established in EIS Surface Water Assessment. It is noted that no hardness adjustments have been made.*
2. WQO value refers to a low reliability trigger value.
3. For As (V).
4. For Cr (VI).
5. If less than 10 samples are available, the minimum value is reported instead of the 10th percentile value and the maximum value is reported instead of the 90th percentile value.
6. An exceedance refers to any result that is above detection limit and exceeds the WQO value. Where a range is given for the WQO value, exceedances are determined in relation to the upper limit for turbidity and electrical conductivity, the lower limit for dissolved oxygen and the lower and upper limit for pH.
***Bold** denotes trigger value is exceeded.*

Table A3 Baseline water quality results summary: Talbingo Reservoir

			Talbingo Reservoir (March 2018 Samples)				Talbingo Reservoir (October 2018 Samples)			
	Unit	**WQO value[2]**	**# Samples / exceedances[7]**	**10th percentile[6]**	**Median**	**90th percentile[6]**	**# Samples / exceedances[7]**	**10th percentile[6]**	**Median**	**90th percentile[6]**
Field Parameters										
Temperature	°C	-	15 / -	6.9	13.3	18.4	24 / -	6.1	8.1	12.4
Dissolved Oxygen (DO)	%	90 – 110[1]	0 / -	-	-	-	0 / -	-	-	-
Electrical Conductivity (EC)	µS/cm	20 – 30[1]	15 / 1	17	19	29	24 / 0	12	17	24
pH		6.5 – 8.0[1]	15 / 3	**6.2**	6.8	7.0	24 / 13	7.7	8.1	8.2
Oxidising and Reducing Potential (ORP)		-	0 / -	-	-	-	0 / -	-	-	-
Turbidity	NTU	1 – 20[1]	0 / -	-	-	-	24 / 0	0.4	0.6	0.8
Analytical Results - General										
Suspended Solids (SS)	mg/l	-	15 / -	<1	2	5	24 / -	<1	<1	2
Total Alkalinity (as $CACO_3$)	mg/l	-	15 / -	<20	<20	<20	24 / -	9	10	14
Total Hardness (as $CACO_3$)	mg/l	-	15 / -	6	7	10	24 / -	5	5	12
Analytical Results - Nutrients										
Ammonia	mg/l	0.010	15 / 0	<0.01	<0.01	0.01	24 / 20	0.006	**0.016**	**0.027**
Oxidised Nitrogen (NOx)	mg/l	0.01	15 / 3[8]	<0.05[8]	<0.05[8]	**0.066**	24 / 23	**0.015**	**0.032**	**0.045**
Total Kjeldahl Nitrogen (TKN)	mg/l	-	15 / -	<0.2	<0.2	<0.2	24 / -	0.07	0.09	0.20
Total Nitrogen (TN)	mg/l	0.35	15 / 1	<0.2	<0.2	<0.2	24 / 1	0.10	0.12	0.23
Reactive Phosphorus	mg/l	0.005	15 / 0[8]	<0.05[8]	<0.05[8]	<0.05[8]	24 / 0	0.002	0.002	0.003
Total Phosphorus (TP)	mg/l	0.01	15 /0[8]	<0.05[8]	<0.05[8]	<0.05[8]	24 / 4	<0.01	<0.01	**0.02**
Total Organic Carbon	mg/l	-	15 / -	<5	<5	<5	24 / -	<1	<1	2
Dissolved Organic Carbon	mg/l	-	15 / -	<5	<5	<5	24 / -	<1	2	2
Analytical Results - Inorganics (Dissolved)										
Cyanide	mg/l	0.007	0 / -	-	-	-	0 / -	-	-	-
Analytical Results - Metals (Dissolved)										
Aluminium (Al)	mg/l	0.055	15 / 0	<0.05	<0.05	<0.05	24 / 0	<0.01	0.02	0.03

Table A3 Baseline water quality results summary: Talbingo Reservoir

			Talbingo Reservoir (March 2018 Samples)				Talbingo Reservoir (October 2018 Samples)			
	Unit	**WQO value[2]**	**# Samples / exceedances[7]**	**10th percentile[6]**	**Median**	**90th percentile[6]**	**# Samples / exceedances[7]**	**10th percentile[6]**	**Median**	**90th percentile[6]**
Arsenic (As)	mg/l	0.013[4]	15 / 0	<0.001	<0.001	<0.001	24 / 0	<0.001	<0.001	<0.001
Boron (B)	mg/l	0.370	15 / 0	<0.05	<0.05	<0.05	24 / 0	<0.05	<0.05	<0.05
Cobalt (Co)	mg/l	0.0014[3]	15 / 0	<0.001	<0.001	<0.001	24 / 0	<0.001	<0.001	<0.001
Total Chromium (Cr)	mg/l	0.001[5]	15 / 0	<0.001	<0.001	<0.001	24 / 0	<0.001	<0.001	<0.001
Copper (Cu)	mg/l	0.0014	15 / 10	<0.001	**0.015**	**0.057**	24 / 0	<0.001	<0.001	<0.001
Manganese (Mn)	mg/l	1.9	15 / 0	<0.005	<0.005	<0.005	24 / 0	<0.001	<0.001	0.0054
Nickel (Ni)	mg/l	0.011	15 / 0	<0.001	0.003	0.004	24 / 0	<0.001	<0.001	<0.001
Lead (Pb)	mg/l	0.0034	15 / 1	<0.001	0.002	**0.003**	24 / 0	<0.001	<0.001	<0.001
Selenium (Se)	mg/l	0.005	15 / 0	<0.001	<0.001	<0.001	24 / 0	<0.01	<0.01	<0.01
Silver (Ag)	mg/l	0.00005	15 / 0	<0.005	<0.005	<0.005	24 / 0	<0.001	<0.001	<0.001
Vanadium (V)	mg/l	0.006[3]	15 / 0	<0.005	<0.005	<0.005	24 / 0	<0.01	<0.01	<0.01
Zinc (Zn)	mg/l	0.008	15 / 12	0.0054	**0.024**	**0.065**	24 / 0	<0.005	<0.005	<0.005
Mercury (Hg)	mg/l	0.00006	15 / 0	<0.0001	<0.0001	<0.0001	24 / 0	<0.0001	<0.0001	<0.0001
Iron (Fe)	mg/l	0.3[3]	15 / 0	<0.05	<0.05	<0.05	24 / 0	<0.05	<0.05	<0.05

Notes: *1. The trigger values for field parameters and nutrients refer to the trigger values for physical and chemical stressors in south-east Australia (fresh water lakes and reservoirs) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC/ARMCANZ (2000).*

2. WQO values refer to the values established in EIS Surface Water Assessment. It is noted that no hardness adjustments have been made.

3. WQO value refers to a low reliability trigger value.

4. For As (V).

5. For Cr (VI).

6. If less than 10 samples are available, the minimum value is reported instead of the 10th percentile value and the maximum value is reported instead of the 90th percentile value.

7. An exceedance refers to any result that is above detection limit and exceeds the WQO value. Where a range is given for the WQO value, exceedances are determined in relation to the upper limit for turbidity and electrical conductivity, the lower limit for dissolved oxygen and the lower and upper limit for pH.

8. For the March 2018 sampling round, analysis of oxidised nitrogen, and total and reactive phosphorous was undertaken using a Limit of Reporting that was greater than the Guideline Value. A lower Limit of Reporting that was lower or equal to the Guideline Value was applied to the October 2018 sampling round.

***Bold** denotes trigger value is exceeded.*

Surface Water - Appendix B

Trigger, action, response plans

Trigger Action Response Plan 1a

Receiving water exceedance during basic water quality monitoring

Basic water quality monitoring program

- Monitoring undertaken daily during wet weather conditions
- Monitoring includes visual inspection and measurement of pH and turbidity using a portable water quality meter
- Monitoring results are available on the same day that monitoring is undertaken

Trigger action response plan objective

To identify (where possible) if the exceedance is naturally occurring or due to Exploratory Works.

Potential exceedances include exceedance of pH or turbidity WQO values or visible signs of sedimentation, turbid water or floating hydrocarbons.

Review point of discharge monitoring and inspection results. Is there any evidence that the exceedance is due to Exploratory Works?

YES → Source of exceedance identified. Refer to actions in TARP 2a (Discharge water quality exceedance during basic water quality monitoring).

NO

Does a similar exceedance(s) occur in any receiving water monitoring location that is upstream of the disturbance area?

YES → Exceedance is unlikely to be associated with Exploratory Works, no further action is required.

NO

Review baseline sampling data. Are similar exceedances known to occur on a frequent or occasional basis?

YES → Exceedance may not be associated with Exploratory Works. Exceedance is to be noted in database as an unexplained exceedance for consideration in future monitoring rounds, no further action is required.

NO

Source of exceedance not identified. Has a similar exceedance occurred at this location in at least 1 of the last 3 monitoring rounds?

NO → Exceedance is to be noted in database as an unexplained exceedance for consideration in future monitoring rounds, no further action is required.

YES

Undertake further site inspections to identify potential sources of the exceedance.

Required Actions

1) Report reoccurring exceedance in monthly water quality report.
2) Increase the number of monitoring and inspection locations in the vicinity of the exceedance in future basic water quality monitoring rounds.

Trigger Action Response Plan 1b

Exceedance at point of discharge during basic water quality monitoring

Basic water quality monitoring program

- Monitoring undertaken daily during wet weather conditions
- Monitoring includes visual inspection and measurement of pH and turbidity using a portable water quality meter
- Monitoring results are available on the same day that monitoring is undertaken

Trigger action response plan objective

- To identify the source (where possible) of each exceedance.
- To establish actions to either improve water management or further investigate the exceedance mechanism.

Potential exceedances include exceedance of pH or turbidity discharge targets or visibly turbid water or hydrocarbons in discharge.

Review rainfall data and water treatment system design capacity. Was the design capacity exceeded?

YES → The exceedance is to be noted in a database as occurring due to water treatment system design capacity being exceeded. No further action is required.

NO

Were water quality controls and treatment systems functioning adequately prior to and during monitoring?

NO → The exceedance is likely to be due to poorly functioning water quality controls or treatment systems. Identified issues are to be rectified. The exceedance is to be noted in a database as occurring due to water quality controls or treatment systems functioning adequately.

YES

Has a similar exceedance occurred at this location in at least 1 of the last 3 monitoring rounds?

NO → Exceedance is to be noted in a database for consideration in future monitoring rounds.

YES

Further actions are required to identify the source of the exceedance and potential improvements to the water management system.

Required Actions

1) Report reoccurring exceedance in monthly water quality report.
2) Review receiving water results to identify any potential receiving water impacts.
3) Investigate the source of the exceedance and potential improvements to the water management system that can be made to reduce the risk of the exceedance reoccurring. The scope of the investigation will depend on the extent and nature of the exceedance. The outcomes of the investigation including identified actions are to be included in the monthly water quality report.

Trigger Action Response Plan 2b

Receiving water exceedance during comprehensive water quality monitoring

Comprehensive water quality monitoring program

- Monitoring undertaken quarterly during wet weather, after wet weather and baseflow conditions (12 monitoring events per year)
- Monitoring includes a full range of physico-chemical parameters, nutrients and metals.
- Monitoring results are available approximately 2 weeks after monitoring

Trigger action response plan objective

To identify (where possible) if the exceedance is naturally occurring or due to Exploratory Works

Exceedance(s) of one or more analytes identified at a receiving water monitoring location

If an exceedance is a metal, undertake hardness adjustment. Is the post hardness adjustment above the WQO value?

NO → No further action is required as the post hardness adjustment is below the WQO value.

YES

Does a similar exceedance(s) occur in any receiving water monitoring location that is upstream of the disturbance area?

YES → Exceedance is unlikely to be associated with Exploratory Works, no further action is required.

NO

Review point of discharge monitoring and inspection results. Is there any evidence that the exceedance is due to Exploratory Works?

YES → Source of exceedance identified. Refer to actions in TARP 2b (Discharge water quality exceedance during comprehensive water quality monitoring).

NO

Review baseline sampling data. Are similar exceedance(s) known to occur on an frequent or occasional basis?

YES → Exceedance may not be associated with Exploratory Works. Exceedance is to be noted in database as an unexplained exceedance for consideration in future monitoring rounds, no further action is required.

NO

Source of exceedance not identified. Has a similar exceedance occurred at this location in at least 1 of the last 3 monitoring rounds?

NO → Exceedance is to be noted in database as an unexplained exceedance for consideration in future monitoring rounds, no further action is required.

YES

Undertake further site inspections to identify potential sources of the exceedance.

Required Actions

1) Report reoccurring exceedance in monthly water quality report.

2) Increase the number of monitoring and inspection locations in the vicinity of the exceedance in future comprehensive water quality monitoring rounds.

Trigger Action Response Plan 2b

Exceedance at point of discharge during comprehensive water quality monitoring

Comprehensive water quality monitoring program

- Monitoring will undertaken quarterly during wet weather (stormwater systems) and monthly for process and waste water discharges.
- Monitoring includes a full range of physico-chemical parameters, nutrients and metals.
- Monitoring results are available approximately 2 weeks after monitoring

Trigger action response plan objective

- To identify the source (where possible) of each exceedance.
- To establish actions to either improve water management or further investigate the exceedance mechanism.

Exceedance(s) of one or more analytes identified at a receiving water monitoring location

↓

Review rainfall data and water treatment system design capacity. Was the design capacity exceeded?

YES → The exceedance is to be noted in a database as occurring due to water treatment system design capacity being exceeded. No further action is required.

NO ↓

Were water quality controls and treatment systems functioning adequately prior to and during monitoring?

NO → The exceedance is likely to be due to poorly functioning water quality controls or treatment systems. Identified issues are to be rectified. The exceedance is to be noted in a database as occurring due to water quality controls or treatment systems functioning adequately.

YES ↓

Has a similar exceedance occurred at this location in at least 1 of the last 3 monitoring rounds?

NO → Exceedance is to be noted in a database for consideration in future monitoring rounds.

YES ↓

Further actions are required to identify the source of the exceedance and potential improvements to the water management system.

↓

Required Actions

1) Report reoccurring exceedance in monthly water quality report.
2) Review receiving water results to identify any potential receiving water impacts.
3) Investigate the source of the exceedance and potential improvements to the water management system that can be made to reduce the risk of the exceedance reoccurring. The scope of the investigation will depend on the extent and nature of the exceedance. The outcomes of the investigation including identified actions are to be included in the monthly water quality report.

Surface Water - Appendix C

Erosion and Sediment Control

Typical Instructions and General Requirements

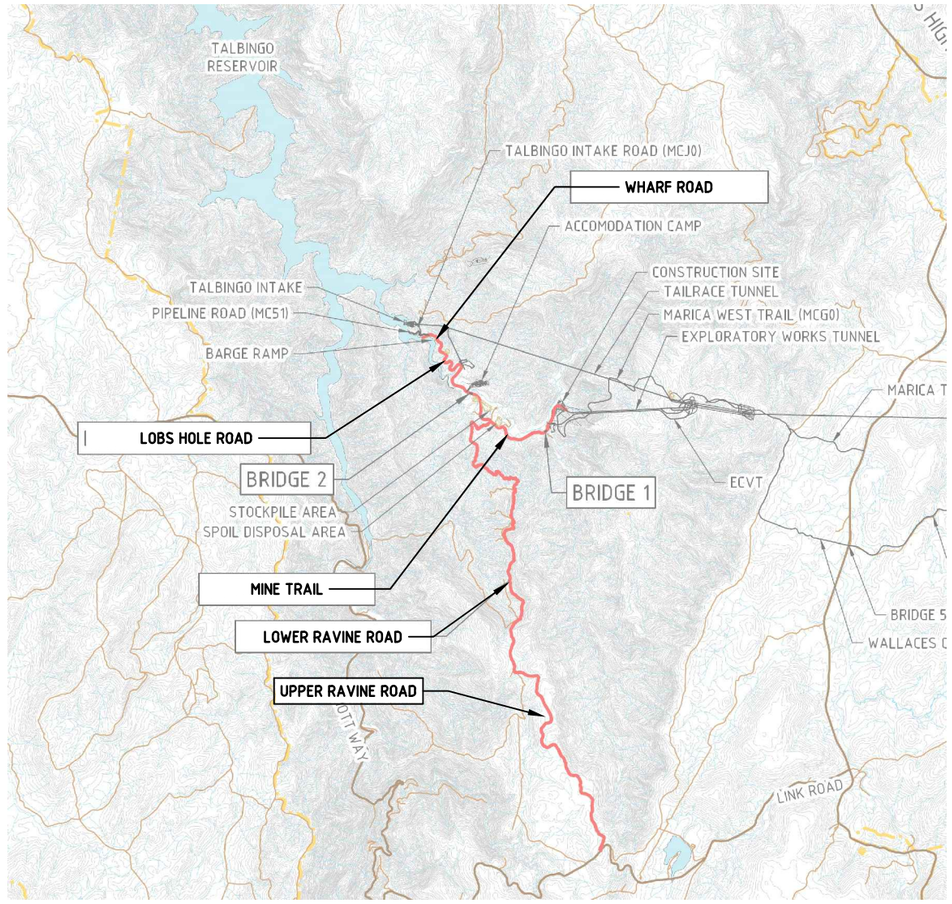
RAVINE, LOBS HOLE, MINE TRAIL AND WHARF ACCESS ROADS – SNOWY HYDRO

CONCEPT EROSION AND SEDIMENT CONTROL PLANS

DRAFT

DRAWING SCHEDUE

DRAWING NUMBER	DRAWING TITLE
P00 – ESCP000	ESCP – TITLE SHEET, DRAWING SCHEDULE AND LOCALITY PLAN
P00 – ESCP001	INSTRUCTIONS, BACKGROUND INFORMATION AND GENERAL REQUIREMENTS
P00 – ESCP002	INSTRUCTIONS AND GENERAL REQUIREMENTS CONTINUED
P00 – ESCP003	ESCP – TABLE 1 STABILISATION REQUIREMENTS
P00 – ESCP004	ESCP – BLUE BOOK STANDARD DRAWINGS
P00 – ESCP005	ESCP – IECA STANDARD DRAWINGS SHEET 1 OF 2
P00 – ESCP006	ESCP – IECA STANDARD DRAWINGS SHEET 2 OF 2
P00 – ESCP007	ESCP – CULVERT EXTENSION TYPICAL DRAWINGS SHEET 1 OF 3
P00 – ESCP008	ESCP – CULVERT EXTENSION TYPICAL DRAWINGS SHEET 2 OF 3
P00 – ESCP009	ESCP – CULVERT EXTENSION TYPICAL DRAWINGS SHEET 3 OF 3
P00 – ESCP010	ESCP – NEW OFFLINE CULVERT TYPICAL DRAWING
P00 – ESCP011	ESCP – CUT BATTER DRAINAGE TYPICAL DRAWING
P00 – ESCP012	ESCP – CUT/FILL INTERFACE TYPICAL DRAWING
P00 – ESCP013	ESCP – BRIDGE CONSTRUCTION TYPICAL DETAILS AND PHOTOS
P01 – ESCP100	WHARF ROAD SECTION TYPICAL REQUIREMENTS
P02 – ESCP100	TYPICAL EROSION AND SEDIMENT CONTROL PLAN – UPPER RAVINE ROAD
P02 – ESCP101	TYPICAL EROSION AND SEDIMENT CONTROL PLAN – LOWER RAVINE ROAD
P03 – ESCP100	MINE TRAIL ESCP SHEET 1 OF 4
P03 – ESCP101	MINE TRAIL ESCP SHEET 2 OF 4
P03 – ESCP102	MINE TRAIL ESCP SHEET 3 OF 4
P03 – ESCP103	MINE TRAIL ESCP SHEET 4 OF 4
P04 – ESCP100	LOBS HOLE ROAD SHEET 1 OF X
P04 – ESCP101	LOBS HOLE ROAD SHEET 2 OF X
P06 – ESCP100	ESCP LAYDOWN AREA #!



LOCALITY PLAN
N.T.S.

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REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
A	05/03/19	M.P.	L.O.	A.M.	DRAFT ISSUE

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PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: ESCP – TITLE SHEET, DRAWING SCHEDULE AND LOCALITY PLAN

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP000	A

Plot Date: Tuesday, 5 March 2019 10:04:35 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg

GENERAL INFORMATION

BACKGROUND
This concept Erosion and Sediment Control Plan (ESCP) provides details for soil and water management associated with works on the **Ravine, Mine Trail, Lobs Hole and Wharf Access Roads**. This ESCP has been prepared in accordance with Blue Book Volume 1 (Landcom, 2004), Volume 2c (DECC, 2008) and with IECA (2008). This ESCP should be read in conjunction with the project Soil and Water Management Plan (SWMP).

EROSION HAZARD ASSESSMENT
A = R x K x LS x C x P
Where
A = Annual soil loss due to erosion (t/ha/yr)
R = Rainfall erosivity factor
K = Soil erodibility factor
LS = Topographic factor derived from slope length (L) and slope gradient (S)
C = Cover and management factor
P = Erosion control practice factor

The following values have been used:
R : 1200
K : 0.05 (assumed for all soils)
L : Varies from 30 to 80m
S : Varies from 7.5 to 50%
LS : Varies from 1.9 to 8.2
C : 1.0 (Construction stage - i.e. no soil surface protection or ground cover applied)
P : 1.3 (for general construction areas - assumes smooth and compacted)

Therefore, based on the above data, the potential soil losses across the exposed site areas are typically:
Soil loss = 148 t/ha/yr (soil loss class 1; very low); and
= 640 t/ha/yr (soil loss class 5; high)
The 5-day 85th %ile rainfall depth is 45mm

UPDATES TO THIS ESCP
These ESCP drawings can be updated as required to address changes to construction scheduling or staging. Minor changes can be annotated on these drawings by hand. However, any changes that alter catchment sizes or clean/dirty water seperation will require these plans to be updated accordingly.

SOILS
Soils are derived on Silurian siltstone, sandstone and limestone. They are generally fine grained (Type F) and possibly dispersive (Type D). A K-factor of 0.05 is conservatively assumed for all soils.

EROSION AND SEDIMENT CONTROL INSTRUCTIONS

INSTRUCTIONS FOR SITE SETUP AND CLEARING
Note that SD refers to Standard Drawing, which can be found on Drawing sheets ESCP004-006.
1. Establish the site compounds. Install sediment controls as shown on drawings 14000428-P05-ESCP100.
2. Establish clearing limits and no-disturbance zones. Refer to the 'Access Control' notes for further details.
3. Install sediment fences, mulch bunds, sediment traps etc. in the locations shown on ESCPs and in accordance with SD 6-8, IECA SD MB-01 and the 'Sediment Traps/Fences' notes.
4. Install clean water diversions as shown on the plans and to the engineering details (if they are permanent). Stablise (line) all drains.
5. If required, install temporary minor waterway crossings in accordance with SD 5-1.
6. Stabilise and rehabilitate any disturbance upslope of the newly-constructed clean water diversions. Achieve 70% cover (minimum) within 10 days. Refer to the 'Stabilisation' notes.
7. Conduct all early culvert extension/replacement works to the engineering details. Refer to ESCPs and typical details on ESCP007-010.
8. Rehabilitate the areas disturbed for culvert extensions/replacements in accordance with the 'Stabilisation' notes. Achieve 70% cover (min.) within 10 days.
9. Install sediment basins where shown on the plans and in accordance with 'Sediment Basin Management' notes.
10. Install dirty water diversion drains as shown on the plans. Connect them to the sediment basins/sediment traps. Stabilise (line) all drains.
11. Undertake clearing and stripping of the work area. Refer to the 'Topsoil Stripping' and 'Stockpiling' notes.
12. Refer to the instructions on 'Enhanced Erosion Controls' whenever rain is forecast (>50% chance of 5mm or more in 24 hours).
13. Undertake regular site inspections and maintenance of all controls in accordance with the 'Site Inspection, Monitoring and Maintenance' notes.
14. Undertake dust suppression as required in accordance with the 'Dust Suppression' notes.
15. At all times, dirty water accumulating in excavations is to be managed in accordance with the Sediment Sumps/Traps ect. notes.
16. Progressively stabilise and rehabilitate areas as they are finished. Refer to the 'Stabilisation' notes.
17. As areas are completed (i.e at least 70% final cover over the catchment), temporary sediment and drainage controls can be decommissioned and removed.

ACCESS CONTROL
- Install barrier fences or suitable administrative controls to define the project works, clearing limits and no-go areas.
- Barrier fencing can simply be made from tape wound around star pickets or stakes. Alternatively, flagging, site fence or chain wire fences can be used for this purpose if so desired.

TOPSOIL STRIPPING
Soils are to be managed in accordance with the following:
- As much as possible topsoils are to be stripped when moist (not wet or dry).
- Topsoils are to be stripped and stockpiled separately from the underlying subsoils.
- Clear areas progressively as they are required for construction.

STOCKPILING
Stockpile areas (Refer to Appendix E of the SWMP) are to be established within the locations specified. If additional or alternative locations for stockpiling are required then they are to be subject to approval prior to establishment. All stockpiles will incorporate clearly defined access controls and comply with the regulations outlined below.

All stockpiles must be constructed and maintained in accordance with Standard Drawing SD 4-1 and the following:
- All stockpiles must have sediment controls around their bases as per Standard Drawing SD 4-1.
- Stockpiles are not to be positioned next to drainage lines or within 50m of a watercourse or below the 20% AEP flood level.
- Mulched vegetation, topsoil and subsoil (if applicable) are to be stockpiled separately.
- Inactive stockpiles are to be stabilised to achieve a C-factor of 0.1 (i.e - equivalent to 60% grass cover) within 10 days of formation using a temporary soil stabiliser (e.g. Vital Stonewall, geotextile, jute matting or equivalent).
- Topsoil stockpiles should be constructed to no more than 2 meters in height. Stockpiles of subsoil may be higher.
- Stockpiles should be battered at a maximum slope of 2:1 as much as possible.
- Stockpiles should be placed on land <10% as much as possible.

STABILISATION
- Where applicable, leave mulch and leaf litter on cleared or grubbed surfaces.
- Undertake progressive stabilisation of ground surface as they are completed rather than at the end of the works program. Refer to Table 1. Note Table 1 primarily applies to lands that drain to sediment basins. For lands that don't - refer to the 'Enhanced Erosion Control' notes.
- In areas to be revegetated, progressively revegetate disturbed areas utilising appropriate species; refer to the re-vegetation plan.
- Stabilise and/or rehabilitate lands within 20 days of works being completed or if an area will be left inactive for more than 20 days. Refer to Table 1.
- Final stabilisation is to achieve a C-factor of 0.05 (i.e. 70% cover) within 60 days of completion (or 10 days for watercourse works). Refer to Table 1.
- Subgrade surfaces are to be lightly scarified prior to placing topsoil (if applicable). See SD 4-2
- Appropriate seedbed preparation will be carried out when revegetating lands (See Standard Drawing (SD 7-1)) (if applicable).
- Temporary diversion drains are to be immediately stabilised to achieve a C-factor of 0.05 (70% cover) using jute mesh plus seed and soil binder (e.g. Vital Stonewall) or rock or rip-rap. Refer to engineering plans for permanent drain sizing and lining details.
- In revegetation areas, re-spread or import topsoil to minimum 50mm depth over completed areas prior to seeding, or planting. Ensure topsoil is properly keyed with subsoil (roughen the topsoil first), especially on slopes, to avoid slippage/slumping. See SD 7-1 and also refer to the re-vegetation plan.
- Culvert inlet/outlets are to be stabilised as detailed in the permanent drainage design plans.
- As surfaces are stabilised (at least 70% ground cover) and permanent drainage measures are installed, temporary sediment control structures and water management structures can be removed (e.g. sediment fence and dviersion drains).
- Following batter construction, the permanent rehabilitation must be implemented within 20 days of completion. If batters are to be revegetated, this will include:
  - Roughening up the underlying subsoil to aid in topsoil keying;
  - Spreading topsoil to approximately 50 mm depth;
  - Broadcast or drill seeding (or hydroseeding as part of hydromulching);
  - Providing erosion protection in addition to the seed. This can be in the form of pinned organic fibre matting (e.g. jute mesh), a hydraulic mulch (i.e. Hydromulch) or compost blanket.
- The final ground cover must achieve at least 70% dispersed cover.

SEDIMENT BASIN MANAGEMENT
- There will be two types of sediment basins. Most will be "Type A" basins but, where their management regime is not possible , "Type F/D" basins will be installed.
- Type A basins are self flocculationg and self draining. Any active discharge of water from them (up to and including the 1-year 24-hour ARI rain event (53.5mm)) is to achieve (IECA 2018):
  - 90th percentile NTU <100
  - 50th percentile NTU <60
  - pH 6.5 to 8.5; and
  - No visible trace oil and grease.
- Type F/D basins are total capture basins and will be manually flocculated. Trapped waters must be treated to achieve the same quality given above and the treated water removed to regain the design capacity within five days of a rainfall event that causes inflow. If it rains again within that five days the five day interval is re-set. The Type F/D basins are designed to the 5-day 85th %ile rainfall depth which is 38.6mm.
- Water detained onsite may be reused for construction purposes (e.g. dust suppression, compaction etc) or pumped onto adjacent well-grassed areas for infiltration.
- Any discharge to waterways will include appropriate scour protection or dissipation.
- Water quality will be checked with calibrated field equipment.
- Samples will also be taken and tested for Total Suspended Solids (TSS). A correlation will be made with NTU.
- pH stabilisers will be kept on site and used if necessary.

(GENERAL REQUIREMENTS ARE CONTINUED ON THE FOLLOWING PAGE)

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PROJECT TITLE
RAVINE ROAD UPGRADE

DRAWING TITLE
INSTRUCTIONS, BACKGROUND INFORMATION AND GENERAL REQUIREMENTS

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP001	A

SEDIMENT TRAPS/FENCING

- Install sediment fences or mulch filter berms in the locations shown and at the discretion of the site manager.
- Install all sediment fencing in accordance with Standard Drawing SD 6-8.
- Sediment fences must be firmly trenched into the ground for their entire length.
- Sediment fences and mulch bunds must include small 'returns' at maximum 20m intervals (see Standard Drawing 6-8 & IECA SD MB-01) to minimise the risk of water flowing along them.
- If used, excavated sediment sumps/traps are to be formed as a sump (detention storage area) with a rock filter outlet. Refer to IECA SD EST-01, RFD-01 & 02 and photo 4.
- If used, install U-shaped sediment traps in accordance with IECA SD UST-01 and UST-02.
- Place gypsum or flocblocs at the inlets to RFDs or ESTs or U-Traps prior to rainfall to help pre-treat site water.
- Sediment is to be removed from sediment traps and filter outlets regularly and filter structures replaced as required.

DUST SUPPRESSION

- Re-sheet or roll loose friable pavement surfaces as required.
- Dust suppression is to be carried out whenever necessary to minimise sediment becoming air borne due to wind.
- An appropriate water source for dust suppression and/or dust suppressant management system (e.g. Vital Bon-Matt HR or equivalent) must be identified prior to starting construction works. Any chemicals used for dust suppression must be biodegradable, non-toxic and non-hazardous.
- Chemical dust suppressants are not to be applied within 5 m of the banks of a watercourse.
- Temporary stabilisers (e.g. Vital Bon Matt Stonewall), geotextile, jute matting or equivalent can be used in non-trafficked areas or on stockpiles to assist with dust control.
- If site water is going to be used within the construction site for dust-suppression or construction purposes and will drain back into the sediment capture system it does not require treatment.

SITE INSPECTION, MONITORING AND MAINTENANCE

- Regular site inspections are to be conducted by the site environment manager (or their representative) and records of all such inspections are to be made available for review. Inspections are to be undertaken:
  - ●●● At least weekly during normal construction hours; and
  - ●●● Prior to forecast rainfall; and
  - ●●● Daily during rain events (if safe to do so); and
  - ●●● Within 24 hours of the cessation of a rain event that causes runoff (if safe to do so).
- The following will be inspected:
  - ●●● All water diversions (clean & dirty);
  - ●●● All erosion control structures/products;
  - ●●● All sediment control structures/products
  - ●●● Stockpiles;
  - ●●● Material storage areas;
  - ●●● Drainage structures (culverts, drains, windrows, batter-chutes etc.).
- Additional erosion and sediment controls will be installed as necessary to ensure satisfactory outcomes in keeping with the project conditions.
- After rainfall, sediment accumulated in trapping devices (e.g. sediment traps, sediment fence) will be removed to a secure location where it can't wash or blow offsite (preferably to an active stockpile).
- Weather conditions will be monitored onsite and daily rainfall will be recorded.
- Safe storage areas for wastes, fuels, excess concrete and other potential contaminants are to be delineated by the site manager.
- Adequate supplies of erosion control measures (e.g. geofabric rolls, jute matting, polymer soil binders) are to be maintained in the site compound for rapid deployment as required.
- Adequate supplies of flocculant (and flocculating equipment) are to be available as required.
- Dust suppression is to be undertaken as required to minimise the risk of offsite dust impacts. Refer to the Dust Suppression notes for details.
- Spills will be managed per the spill emergency procedure.

ENHANCED EROSION CONTROLS

In the areas marked on the ESCPs for Enhanced Erosion Controls, the following will apply:

- Temporary groundcovers (e.g. geofabric, soil binders, tarps or similar) will be used to provide temporary surface protection on disturbed areas prior to forecast rainfall (>50% chance of 5mm or more in 24 hours).

RAINFALL PREPARATION PROCEDURE

- The weather forecast is to be monitored regularly by the site environmental manager (or their representative).
- Prior to forecast rainfall (> 50% chance of 5mm or more over 24 hours), controls will be implemented to minimise erosion in the areas nominated for Enhanced Erosion Controls. These will include the following:
  - ●●● Applying temporary ground cover (e.g. soil binder) on exposed areas, particularly batters;
  - ●●● Check dams in boxed-out areas, in flowpaths and in partially-completed table drains (min. 40m intervals);
  - ●●● Slope breaks in boxed-out areas (min. 80m intervals);
  - ●●● Batter chutes in areas where water could flow in concentrated form down a batter (max. 80m apart);
  - ●●● Fill windrows, to avoid water cascading over the hinge point of fill batters (direct it to a batter chute instead);
  - ●●● Ensuring temporary drainage (e.g. for runoff from the new roadway) is in place to convey dirty water to sediment traps;
  - ●●● All exposed soils within waterway locations (e.g. culvert work areas and including batters) are to be temporarily stabilised. Geotextile fabric, black plastic or equivalent is to be used for this purpose.
  - ●●● Place "Flocblocs" or similar at the inlet point to all ESTs, U-Traps and RFDs.

REFERENCES

Catchments and Creeks drawings are provided in IECA (2008). Best-Practice Erosion and Sediment Control. International Erosion Control Association (Australasia), Picton, NSW.

DECC (2008). Managing Urban Stormwater: Soils and Construction. Volume 2C: Unsealed Road Construction. NSW Department of Environment and Climate Change, Sydney.

IECA (2018) Sediment Basins - Technical Notes.

IECA (2008) Best Practice Erosion and Sediment Contol. International Erosion Control Association (Australasia), Picton, NSW.

Landcom (2004). Managing Urban Stormwater: Soils and Construction. Volume 1, 4th Edition. NSW Government, Sydney. "The Blue Book"

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REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
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PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: INSTRUCTIONS AND GENERAL REQUIREMENTS CONTINUED

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TABLE 1 - STABILISATION REQUIREMENTS AND TREATMENT METHODS

DURING CONSTRUCTION - TEMPORARY STABILISATION
(During periods of inactivity when works are on hold)

LANDS	STABILISATION REQUIREMENT	TIMEFRAMES	TREATMENT METHODS - PRODUCTS	REMARKS
Areas marked for Enhanced Erosion Controls on ESCPs	C-factor = 0.05 (70% grass cover or equivalent ground cover [1])	Applies prior to forecast rainfall (>50% chance of 5mm or more in 24 hours) and after 10 working days of inactivity (even though works might continue later)	Soil binder (i.e. Vital P47/stonewall or equivalent [1])	- Stabilise all exposed soils by spraying surfaces with Vital P47/stonewall or equivalent [1]. - Vital dilution rate = 1:10 (Vital:Water). - Application rate = 1L / m^2 of diluted Vital mixture. - Re-apply/maintain as necessary to ensure the required cover is provided.
			Geotextile, jute matting, black plastic or equivalent [1]	- Cover all exposed soils. Re-apply/maintain as necessary to ensure the required cover is provided.
All lands (including waterways and stockpiles)	C-factor = 0.15 (50% grass cover or equivalent ground cover [1])	Applies after 20 working days of inactivity (even though works might continue later)	Soil binder (i.e. Vital P47/stonewall or equivalent [1])	- Spray all stockpile surfaces with Vital P47/stonewall or equivalent [1]. - Vital dilution rate = 1:10 (Vital:Water). - Application rate = 1L / m^2 of diluted Vital mixture. - Re-apply/maintain as necessary (approx. every 3-6 months without suitable vegetation cover) to ensure the required cover is provided.
			Geotextile, jute matting, black plastic or equivalent [1]	- Cover all exposed soils. - Re-apply/maintain as necessary to ensure the required cover is provided.

TABLE 1 - STABILISATION REQUIREMENTS AND TREATMENT METHODS CONTINUED

POST CONSTRUCTION

LANDS	STABILISATION REQUIREMENT	TIMEFRAMES	TREATMENT METHODS - PRODUCTS	REMARKS
Waterways, drainage lines and concentrated flow areas	C-factor = 0.05 (70% grass cover or equivalent ground cover [1])	Applies after 10 working days from completion of formation and before they are allowed to carry concentrated flows	Refer to the drain specifications detailed on the plan for specific lining/stabilisation requirements. Example treatment methods are shown below.	
			Temporary lining - Geotextile (i.e. Bidim A24 or equivalent [1])	- Complete any subsoil treatment before laying the matting. - Install matting in accordance with SD 5-7. - Re-apply/maintain as necessary to ensure the required cover is provided.
			Jute mesh, seeding and soil binder (i.e. Vital P47/stonewall or equivalent [1]) - Low flows	- Complete subsoil treatment (i.e. gypsum lightly ripped into subgrade at a rate of 5tonnes/ha). - Place topsoil to a depth of at least 75mm. - Complete any fertilisation and seeding before laying the matting. - Install matting in accordance with SD 5-7. - Spray all surfaces with Vital P47/stonewall or equivalent [1]. - Vital dilution rate = 1:10 (Vital:Water). - Application rate = 1L / m^2 of diluted Vital mixture. - Re-apply/maintain as necessary to ensure the required cover is permanently maintained.
			Jute matting (~350gsm) and seeding or equivalent [1] - Low to moderate flows	- Complete subsoil treatment (i.e. gypsum lightly ripped into subgrade at a rate of 5tonnes/ha). - Place topsoil to a depth of at least 75mm. - Complete any fertilisation and seeding before laying the matting. - Install matting in accordance with SD 5-7. - Re-apply/maintain as necessary to ensure the required cover is permanently maintained.
			Turf reinforcement matting (TRM) (e.g. TerraMat or equivalent [1]) - Moderate flows	- Complete subsoil treatment (i.e. gypsum lightly ripped into subgrade at a rate of 5tonnes/ha). - Place topsoil to a depth of at least 75mm. - Complete any fertilisation and seeding before laying the matting. - Install matting in accordance with SD 5-7. - Re-apply/maintain as necessary to ensure the required cover is permanently maintained.
			Rock lining - High flows	- Complete subsoil treatment (i.e. gypsum lightly ripped into subgrade at a rate of 5tonnes/ha). - Install geotextile underlay (if specified) in accordance with SD 5-7. - Install rock armouring (to the depth and size as specified on the plan). - Re-apply/maintain as necessary to ensure the required cover is provided.
Stockpiles	C-factor = 0.10 (60% grass cover or equivalent ground cover [1])	Applies after 10 working days from completion of formation of stockpiles or any ono-working faces	Seeding and soil binder (i.e. Vital P47/stonewall or equivalent [1])	- Apply seed to all stockpile surfaces (Note: seeding may not be required if existing seedbed is present). - Spray all stockpile surfaces with Vital P47/stonewall or equivalent [1]. - Vital dilution rate = 1:10 (Vital:Water). - Application rate = 1L / m^2 of diluted Vital mixture. - Re-apply/maintain as necessary to ensure the required cover is permanently maintained.
			Geotextile, jute matting, black plastic or equivalent [1]	- Cover all exposed soils. - Re-apply/maintain as necessary to ensure the required cover is provided.
All other Surfaces	C-factor = 0.10 / 0.05 (60% / 70% grass cover or equivalent ground cover [1])	C-factor = 0.1 (60%) applies after 20 working days from completion of formation and C-factor = 0.05 (70%) applies within a further 60 days	Topsoil, seeding and soil binder (i.e. Vital P47/stonewall or equivalent [1])	- Refer to SD 7-1. - Complete subsoil treatment (i.e. gypsum lightly ripped into subgrade at a rate of 5tonnes/ha). - Place gypsum treated topsoil to a depth of at least 75mm. - Apply any fertilisers required. - Apply seed to all surfaces (Note: seeding may not be required if existing seedbed is present). - Spray all surfaces with Vital P47/stonewall or equivalent [1]. - Vital dilution rate = 1:10 (Vital:Water). - Application rate = 1L / m^2 of diluted Vital mixture. - Re-apply/maintain as necessary to ensure the required cover is permanently maintained.
			Hydromulch or equivalent [1]	- Refer to SD 7-1. - Complete subsoil treatment (i.e. gypsum lightly ripped into subgrade at a rate of 5tonnes/ha). - Place topsoil to a depth of at least 75mm. - Apply hydromulch to soil surfaces. - Re-apply/maintain as necessary to ensure the required cover is permanently maintained.

[1] - Equivalent cover/product must achieve the equivalent C-factor with reasearch/documentation to verify this.

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DESIGN BY	M.P.
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FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	NTS

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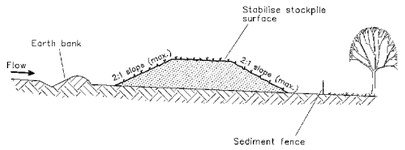
PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: ESCP TABLE 1 – STABILISATION REQUIREMENTS

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP003	A

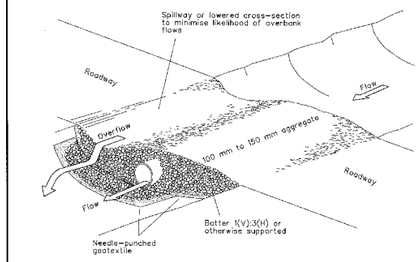
Plot Date: Tuesday, 5 March 2019 10:04:51 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg



Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

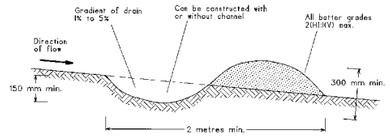
STOCKPILES **SD 4-1**



Construction Notes

1. Prohibit all traffic until the access way is constructed.
2. Strip any topsoil and place a needle-punched textile over the base of the crossing.
3. Place clean, rigid, non polluting aggregate or gravel in the 100 mm to 150 mm size class over the fabric to a minimum depth of 200 mm.
4. Provide a 3-metre wide carriageway with sufficient length of culvert pipe to allow less than a 3(H): 1 (V) slope on side batters.
5. Install a lower section to act as an emergency spillway in greater than design storm events.
6. Ensure that culvert outlets extend beyond the toe of fill embankments.

TEMPORARY WATERWAY CROSSING **SD 5-1**

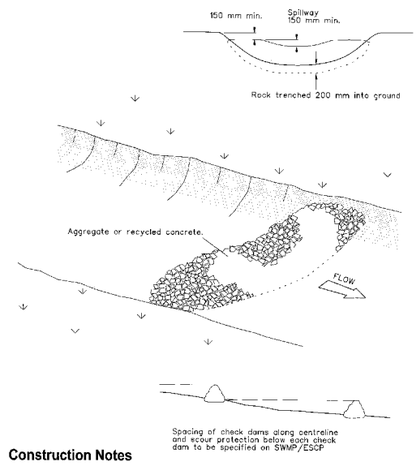


NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

Construction Notes

1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

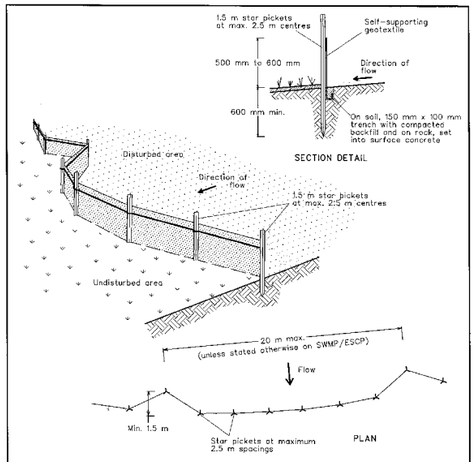
EARTH BANK (LOW FLOW) **SD 5-5**



Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.
4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

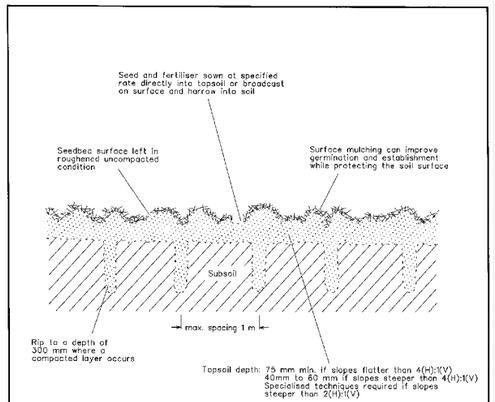
ROCK CHECK DAM **SD 5-4**



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

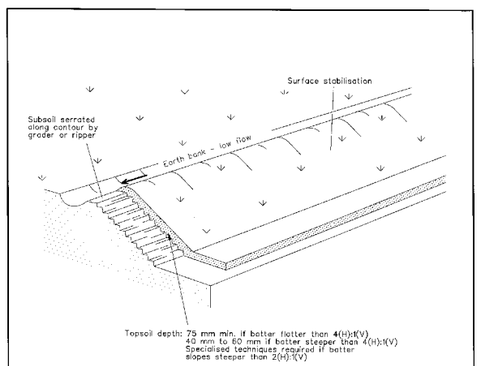
SEDIMENT FENCE **SD 6-8**



Construction Notes

1. Loosen compacted soil before sowing any seed. If necessary, rip the soil to a depth of 300 mm. Avoid rotary hoe cultivation.
2. Work the ground only as much as necessary to achieve the desired tilth and prepare a good seedbed.
3. Avoid cultivation in very wet or very dry conditions.
4. Cultivate on or close to the contour where possible, not up and down the slope.

SEEDBED PREPARATION **SD 7-1**



Construction Notes

1. Scarify the ground surface along the line of the contour to a depth of 50 mm to 100 mm to break up any hardsetting surfaces and to provide a good bond between the respread material and subsoil.
2. Add soil ameliorants as required by the ESCP or SWMP.
3. Rip to a depth of 300 mm if compacted layers occur.
4. Where possible, replace topsoil to a depth of 40 to 60 mm on lands where the slope exceeds 4(H):1(V) and to at least 75 mm on lower gradients.

REPLACING TOPSOIL **SD 4-2**

STANDARD DRAWINGS ARE FROM LANDCOM 2004.

DRAFT

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
A	05/03/19	M.P.	L.O.	A.M.	DRAFT ISSUE

DRAWING STATUS

DESIGN BY	M.P.
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FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	NTS

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PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: EROSION AND SEDIMENT CONTROL – BLUE BOOK STANDARD DRAWINGS

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP004	A

Plot Date: Tuesday, 5 March 2019 10:04:56 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg

MATERIALS

(i) MULCH MUST COMPLY WITH THE REQUIREMENTS OF AS4454.

(ii) MAXIMUM SOLUBLE SALT CONCENTRATION OF 5dS/m.

(iii) MOISTURE CONTENT OF 30 TO 50% PRIOR TO APPLICATION.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND EXTENT. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, MATERIAL TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEN SELECTING THE LOCATION OF A MULCH FILTER BERM, TO THE MAXIMUM DEGREE PRACTICAL, ENSURE THE BERM IS LOCATED:

(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;

(ii) ALONG A LINE OF CONSTANT ELEVATION (PREFERRED, BUT NOT ALWAYS PRACTICAL);

(iii) AT LEAST 1m, IDEALLY 3m, FROM THE TOE OF A FILL EMBANKMENT;

(iv) AWAY FROM AREAS OF CONCENTRATED FLOW.

3. ENSURE THE BERM IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE BERM, OR THE UNDESIRABLE DISCHARGE OF WATER AROUND THE END OF THE BERM.

4. ENSURE THE BERM HAS BEEN PLACED SUCH THAT PONDING UP-SLOPE OF THE BERM IS MAXIMISED.

5. ENSURE BOTH ENDS OF THE BERM ARE ADEQUATELY TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING PRIOR TO WATER PASSING OVER THE BERM.

6. ENSURE 100% CONTACT WITH THE SOIL SURFACE.

7. WHERE SPECIFIED, TAKE APPROPRIATE STEPS TO VEGETATE THE BERM.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL BERMS AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR OR REPLACE ANY DAMAGED SECTIONS.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 100mm OR 1/3 THE HEIGHT OF THE BERM.

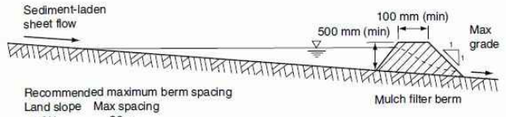
5. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL (IF REQUIRED)

1. WHEN DISTURBED AREAS UP-SLOPE OF THE BERM ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BERM MAYBE REMOVED.

2. REMOVE ANY COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.



Recommended maximum berm spacing

Land slope	Max spacing
< 2%	30 m
5%	25 m
10%	15 m
20%	8 m

Figure 1 - Typical placement of mulch filter berm

Drawn:	Date:		
GMW	Apr-10	Mulch Filter Berms	MB-01

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CONSTRUCTION

1. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE FOUNDATION AREA OF THE OUTLET STRUCTURE (IF ANY), AND INSTALL AS PER SEPARATE INSTRUCTIONS.

3. EXCAVATE THE SETTLING POND IN ACCORDANCE WITH THE APPROVED PLANS. UNLESS OTHERWISE SPECIFIED, THE EXCAVATED PIT SHOULD HAVE A SIDE SLOPE OF 2:1(H:V) OR FLATTER.

4. APPROPRIATELY STABILISE ANY BANK SUBJECT TO DIRECT INFLOW.

5. ESTABLISH ALL NECESSARY UP-SLOPE DRAINAGE CONTROL MEASURES TO ENSURE THAT SEDIMENT-LADEN RUNOFF IS APPROPRIATELY DIRECTED INTO THE SEDIMENT TRAP.

6. TAKE ALL NECESSARY MEASURE TO MINIMISE THE SAFETY RISK CAUSED BY THE STRUCTURE.

MAINTENANCE

1. CHECK EXCAVATED SEDIMENT TRAPS AFTER EACH RUNOFF EVENT AND MAKE REPAIRS IMMEDIATELY.

2. INSPECT THE BANKS FOR SLUMPING OR EXCESSIVE SCOUR.

3. IF FLOW THROUGH THE STRUCTURE IS REDUCED TO AN UNACCEPTABLE LEVEL DUE TO BLOCKAGE OF THE OUTLET STRUCTURE (IF ANY), THEN MAKE ALL NECESSARY REPAIRS AND MAINTENANCE TO RESTORE THE DESIRED FLOW CONDITIONS.

4. CHECK THE STRUCTURE AND SURROUNDING CHANNEL BANKS FOR DAMAGE FROM OVERTOPPING FLOWS AND MAKE REPAIRS AS NECESSARY.

5. REMOVE SEDIMENT AND RESTORE ORIGINAL SEDIMENT STORAGE VOLUME WHEN COLLECTED SEDIMENT EXCEEDS 30% OF THE PIT VOLUME.

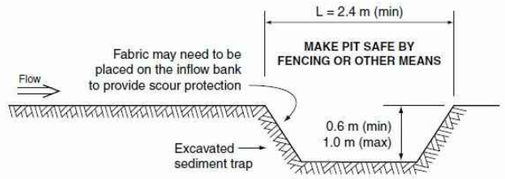
6. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

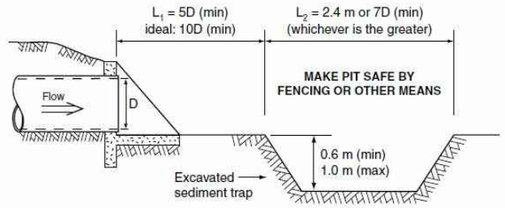
1. WHEN THE UP-SLOPE DRAINAGE AREA HAS BEEN STABILISED, REMOVE ALL MATERIALS INCLUDED DEPOSITED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

2. ALL WATER AND SEDIMENT SHOULD BE REMOVED FROM THE BASIN PRIOR TO THE DAM'S REMOVAL. DISPOSE OF SEDIMENT AND WATER IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. BRING THE DISTURBED AREA TO A PROPER GRADE, THEN SMOOTH, COMPACT AND STABILISE AND/OR REVEGETATE AS REQUIRED.



(a) Excavated sediment trap located within a minor drainage path



Where space is not available, make optimum use of the available space

(b) Excavated sediment trap located downstream of a stormwater outlet

Drawn:	Date:		
GMW	Apr-10	Excavated Sediment Trap	EST-01

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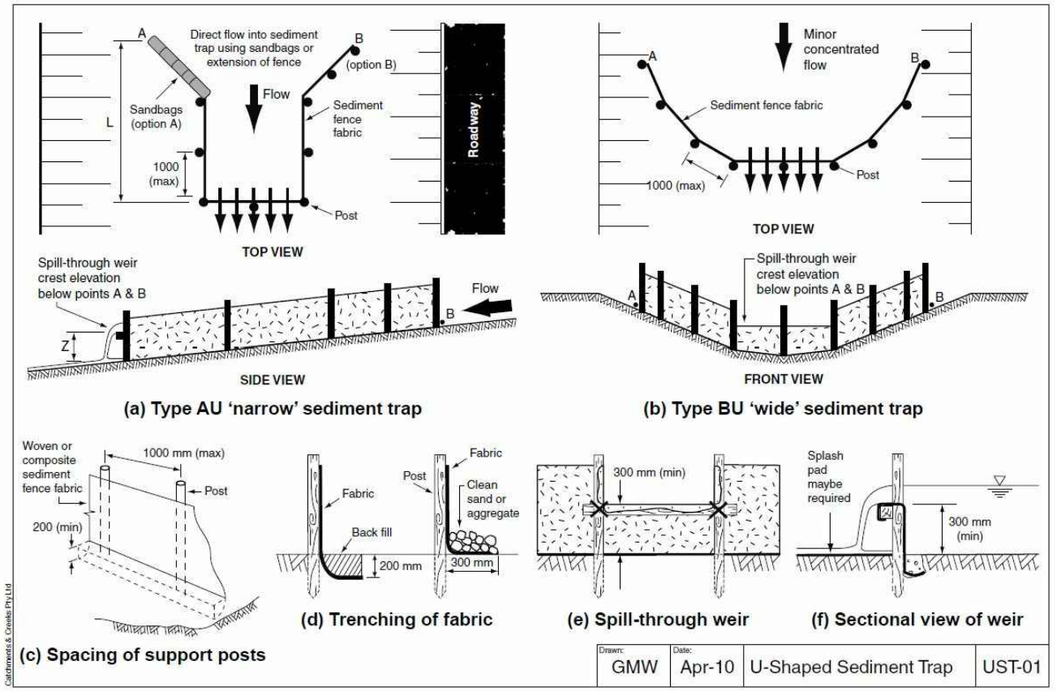

Drawn:	Date:		
GMW	Apr-10	U-Shaped Sediment Trap	UST-01

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MATERIALS

FABRIC: POLYPROPYLENE, POLYAMIDE, NYLON, POLYESTER, OR POLYETHYLENE WOVEN OR NON-WOVEN FABRIC, AT LEAST 700mm IN WIDTH AND A MINIMUM UNIT WEIGHT OF 140g/m². ALL FABRICS TO CONTAIN ULTRAVIOLET INHIBITORS AND STABILISERS TO PROVIDE A MINIMUM OF 6 MONTHS OF USEABLE CONSTRUCTION LIFE (ULTRAVIOLET STABILITY EXCEEDING 70%).

FABRIC REINFORCEMENT: (IF USED) WIRE OR STEEL MESH MINIMUM 14-GAUGE WITH A MAXIMUM MESH SPACING OF 200mm.

SUPPORT POSTS/STAKES: 1500mm² (MIN) HARDWOOD, 2500mm² (MIN) SOFTWOOD, OR 1.5kg/m (MIN) STEEL STAR PICKETS SUITABLE FOR ATTACHING FABRIC.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND REQUIRED TYPE OF FABRIC (IF SPECIFIED). IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, FABRIC TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. INSTALL THE FABRIC IN A U-SHAPE, EXTENDING THE WING WALLS EITHER UP THE SIDE SLOPES AND/OR UP THE CHANNEL INVERT (AS DIRECTED) TO A POINT WHERE THE GROUND LEVEL IS AT LEAST 100mm HIGHER THAN THE CREST OF THE SPILL-THROUGH WEIR.

3. ENSURE THAT THE EXPECTED CHANNEL FLOW WILL ENTER THE SEDIMENT TRAP, EITHER BY EXTENDING THE WING WALLS UP THE BANK SLOPE, OR CONSTRUCTING SANDBAG FLOW DIVERSION BANKS.

4. UNLESS DIRECTED BY THE SITE SUPERVISOR, EXCAVATE A 200mm WIDE BY 200mm DEEP TRENCH ALONG THE ALIGNMENT OF THE SPILL-THROUGH WEIR AND WING WALLS.

5. ALONG THE LOWER SIDE OF THE TRENCH, APPROPRIATELY SECURE THE STAKES INTO THE GROUND SPACED NO GREATER THAN 1m.

6. CONSTRUCT THE SEDIMENT TRAP FROM A CONTINUOUS ROLL OF FABRIC.

7. SECURELY ATTACH THE FABRIC TO THE SUPPORT POSTS/STAKES USING 25mm STAPLES OR TIE WIRE AT MAXIMUM 150mm SPACING WITH THE FABRIC EXTENDED AT LEAST 200mm INTO THE TRENCH.

8. INSTALL A SPILL-THOUGH WEIR AT THE LOWEST POINT IN THE FENCE. THE WEIR MUST BE AT LEAST 300mm ABOVE ADJACENT GROUND LEVEL, AND BELOW THE LOWEST GROUND LEVEL AT THE ENDS OF THE WING WALLS.

9. SECURELY TIE A HORIZONTAL CROSS MEMBER (WEIR) TO THE ADJACENT SUPPORT POSTS. CUT THE FABRIC DOWN THE SIDE OF THE POSTS AND FOLD THE FABRIC OVER THE CROSS MEMBER AND APPROPRIATELY SECURE THE FABRIC.

10. IF DIRECTED, INSTALL A SUITABLE SPLASH PAD IMMEDIATELY DOWN-SLOPE OF THE SPILL-THROUGH WEIR TO CONTROL SOIL EROSION DOWNSTREAM OF THE SEDIMENT TRAP.

11. BACKFILL THE TRENCH AND TAMP THE FILL TO FIRMLY ANCHOR THE BOTTOM OF THE FABRIC AND MESH TO PREVENT WATER FROM FLOWING UNDER THE FENCE.

MAINTENANCE

1. INSPECT THE SEDIMENT TRAP AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR ANY TORN SECTIONS WITH A CONTINUOUS PIECE OF FABRIC FROM POST TO POST.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. IF THE FABRIC IS SAGGING BETWEEN STAKES, INSTALL ADDITIONAL SUPPORT POSTS/STAKES.

5. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 150mm.

6. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. REPLACE THE FABRIC IF THE SERVICE LIFE OF THE EXISTING FABRIC EXCEEDS SIX MONTHS.

REMOVAL

1. WHEN DISTURBED AREAS UP-SLOPE OF THE SEDIMENT TRAP ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE SEDIMENT TRAP MUST BE REMOVED.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

Drawn:	Date:		
GMW	Apr-10	U-Shaped Sediment Trap	UST-02

Catchments & Creeks Pty Ltd

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REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
A	05/03/19	M.P.	L.O.	A.M.	DRAFT ISSUE

DRAWING STATUS

DESIGN BY	M.P.
DRAWN BY	L.O.
FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	NTS

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PROJECT TITLE

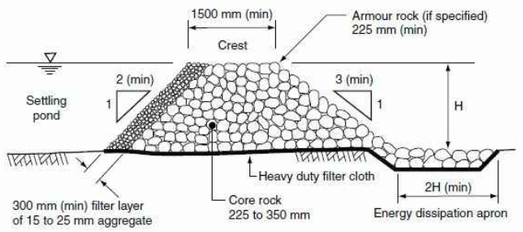
RAVINE ROAD UPGRADE

DRAWING TITLE

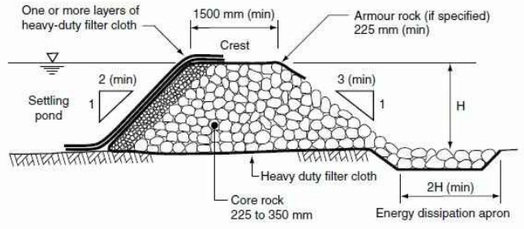
EROSION AND SEDIMENT CONTROL – IECA STANDARD DRAWINGS

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP005	A

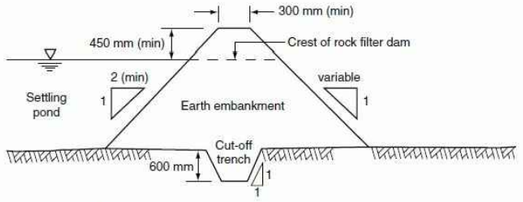
Plot Date: Tuesday, 5 March 2019 10:05:00 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg



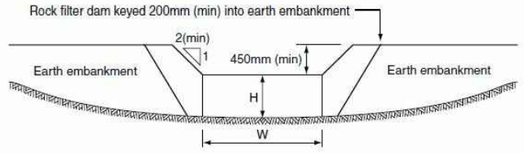
(a) Rock filter dam with aggregate filter



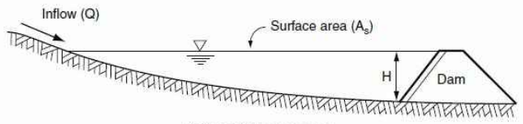
(b) Rock filter dam with geotextile and aggregate filter



(c) Typical cross-section of constructed earth abutment



(d) Typical profile of rock filter dam crest when integrated into an earth embankment



(e) Settling pond

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Drawn:	Date:		
GMW	Feb-10	Rock Filter Dam	RFD-01

MATERIALS

PRIMARY CORE ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, WITH MEAN SIZE AS SPECIFIED IN THE APPROVED PLAN, BUT NOT LESS THAN 225mm, OR GREATER THAN 350mm.

ARMOUR ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, WITH MEAN SIZE AS SPECIFIED IN THE APPROVED PLAN, BUT NOT LESS THAN 225mm.

AGGREGATE FILTER: 15 TO 25mm CLEAN AGGREGATE.

GEOTEXTILE FILTER FABRIC: HEAVY-DUTY NON-WOVEN, NEEDLE-PUNCHED FILTER FABRIC, MINIMUM 'BIDIM' A34 OR EQUIVALENT.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE FOUNDATION AREA OF THE ROCK FILTER DAM OF WOODY VEGETATION AND ORGANIC MATTER. DELAY CLEARING THE UP-SLOPE POND AREA UNTIL THE DAM IS FORMED AND IS ABLE TO ACT AS A SUITABLE SEDIMENT TRAP. OTHERWISE AN ALTERNATIVE TEMPORARY DOWNSTREAM SEDIMENT TRAP MAY BE REQUIRED DURING CONSTRUCTION OF THE ROCK FILTER DAM.

3. IF SPECIFIED ON THE PLANS, EXCAVATE A CUT-OFF TRENCH ALONG THE CENTRE-LINE OF THE DAM AND EARTH ABUTMENTS (IF ANY).

4. COVER THE FOUNDATION AREA AND CUT-OFF TRENCH WITH HEAVY-DUTY FILTER FABRIC BEFORE BACKFILLING WITH THE CORE ROCK. OVERLAP ADJOINING FABRIC SHEETS A MINIMUM OF 600mm.

5. CONSTRUCT THE ASSOCIATED EARTH ABUTMENT (IF ANY). ALL CUT AND FILL SLOPES SHOULD BE 2:1(H:V) OR FLATTER. THE DOWNSTREAM FACE OF EARTH ABUTMENTS SHOULD BE 3:1(H:V) OR FLATTER. EARTH ABUTMENTS SHOULD BE CONSTRUCTED OF WELL-COMPACTED, EROSION RESISTANT SOIL THAT IS FREE OF VEGETATION AND ROOTS. OVERFILL EARTH ABUTMENTS 150mm TO ALLOW FOR SETTLEMENT.

6. PLACE THE CORE ROCK FOR THE ROCK FILTER DAM. ENSURE THE UPSTREAM FACE IS 2:1(H:V) OR FLATTER, AND THE DOWNSTREAM FACE IS 3:1(H:V) OR FLATTER.

7. ENSURE THE ROCK IS MACHINE PLACED WITH THE SMALLER ROCKS WORKED INTO THE VOIDS OF THE LARGER ROCKS.

8. IF SPECIFIED, CONSTRUCT THE SPILLWAY SECTION USING THE SPECIFIED ARMOUR ROCK. THE SPILLWAY SHOULD HAVE A MINIMUM PROFILE DEPTH OF 300mm. THE SPILLWAY WEIR CREST MUST BE LEVEL ACROSS ITS FULL WIDTH. THE MAXIMUM LONGITUDINAL SLOPE OF THE ROCK SPILLWAY SHOULD BE 3:1(H:V). THE MINIMUM THICKNESS OF ARMOUR ROCK PROTECTION SHOULD BE 500mm, OR TWICE THE NOMINAL ROCK SIZE, WHICHEVER IS THE GREATER.

9. ENSURE THE SPILLWAY OUTLET SECTION EXTENDS DOWNSTREAM PAST THE TOE OF THE FORMED EMBANKMENT UNTIL STABLE CONDITIONS ARE REACHED, OR A DISTANCE EQUAL TO THE HEIGHT OF THE DAM, WHICHEVER IS THE GREATER. THE EDGES OF THE SPILLWAY SHOULD BE LEFT FLUSH WITH THE SURROUNDING GROUND.

10. INSTALL THE SPECIFIED FILTER (AGGREGATE AND/OR FILTER CLOTH) ON THE UPSTREAM FACE OF THE ROCK FILTER DAM.

11. IF FILTER CLOTH IS USED, THEN:
(i) EXTEND THE FABRIC OVER THE CREST OF THE ROCK FILTER DAM INTO THE SPILLWAY CHUTE;
(ii) CONSIDER THE PLACEMENT OF SEVERAL LAYERS OF OVERLAPPING FABRIC, THUS ALLOWING EACH LAYER TO BE REMOVED INDIVIDUALLY ONCE THE FABRIC BECOMES BLOCKED WITH SEDIMENT.

12. CLEAR THE SETTLING POND AREA OF WOODY VEGETATION AND ORGANIC MATTER TO THE DIMENSIONS SPECIFIED WITHIN THE PLANS.

13. WHERE NECESSARY, EXCAVATE THE UPSTREAM SETTLING POND AND/OR SEDIMENT STORAGE PIT IN ACCORDANCE WITH THE APPROVED PLANS. EXCAVATED PITS TYPICALLY HAVE SIDE SLOPES OF 2:1(H:V) OR FLATTER UNLESS STEEPER SLOPES ARE KNOWN TO BE STABLE.

14. STABILISE ANY ASSOCIATED EARTH EMBANKMENTS IMMEDIATELY AFTER CONSTRUCTION THROUGH APPROPRIATE COMPACTION, VEGETATION AND/OR EROSION CONTROL MATTING.

15. ESTABLISH ALL NECESSARY UP-SLOPE DRAINAGE CONTROL MEASURES TO ENSURE THAT SEDIMENT-LADEN RUNOFF IS APPROPRIATELY DIRECTED INTO THE SEDIMENT TRAP.

16. TAKE ALL NECESSARY MEASURE TO MINIMISE THE SAFETY RISK CAUSED BY THE STRUCTURE.

MAINTENANCE

1. CHECK ALL ROCK FILTER DAMS AFTER EACH RUNOFF EVENT AND MAKE REPAIRS IMMEDIATELY.

2. INSPECT ALL ROCK AND EARTH EMBANKMENTS FOR UNDERCUTTING OR UNDESIRABLE SEEPAGE FLOWS.

3. IDEALLY, ROCK FILTER DAMS SHOULD DISCHARGE (FROM FULL) OVER NO LESS THAN 8 HOURS. IF DRAINAGE IS TOO RAPID, THEN ADDITIONAL FILTER AGGREGATE MAYBE REQUIRED TO ACHIEVE OPTIMUM HYDRAULIC PERFORMANCE.

4. IF FLOW THROUGH THE STRUCTURE IS REDUCED TO AN UNACCEPTABLE LEVEL, THE UPSTREAM FILTER MEDIUM (AGGREGATE OR FILTER CLOTH) SHOULD BE REMOVED AND REPLACED.

5. IF A GREATER DEGREE OF WATER TREATMENT (FILTRATION) IS REQUIRED, EXTRA GEOTEXTILE FILTER FABRIC SHOULD BE PLACED OVER THE UPSTREAM FACE OF THE STRUCTURE.

6. CHECK THE STRUCTURE AND DOWNSTREAM CHANNEL BANKS FOR DAMAGE FROM OVERTOPPING FLOWS. MAKE REPAIRS AS NECESSARY.

7. IMMEDIATELY REPLACE ANY ROCK DISPLACED FROM THE SPILLWAY.

8. REMOVE SEDIMENT AND RESTORE ORIGINAL SEDIMENT STORAGE VOLUME WHEN COLLECTED SEDIMENT EXCEEDS 10% OF THE SPECIFIED STORAGE VOLUME.

9. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE UP-SLOPE DRAINAGE AREA HAS BEEN STABILISED, REMOVE ALL MATERIALS INCLUDED DEPOSITED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

2. ALL WATER AND SEDIMENT SHOULD BE REMOVED FROM THE SETTLING POND PRIOR TO THE DAM'S REMOVAL. DISPOSE OF SEDIMENT AND WATER IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. BRING THE DISTURBED AREA TO A PROPER GRADE, THEN SMOOTH, COMPACT AND STABILISE AND/OR REVEGETATE AS REQUIRED TO MINIMISE THE EROSION HAZARD.

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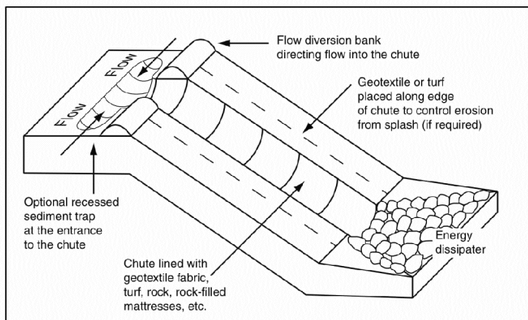
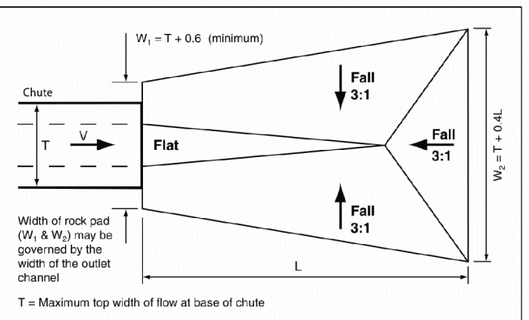
Drawn:	Date:		
GMW	Apr-10	Rock Filter Dam	RFD-02

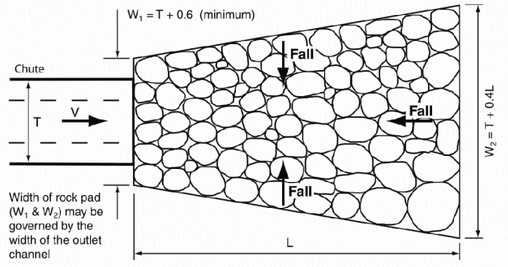


(a) Temporary drainage chute with rock pad outlet structure

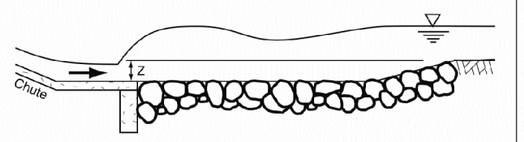


T = Maximum top width of flow at base of chute

(b) Typical layout of an outlet energy dissipater for a drainage chute



(c) Typical layout of a rock pad outlet structure for a drainage chute



(d) Typical profile of a rock pad outlet structure for a drainage chute

Notes:
1. Drawings applicable to temporary drainage chutes, **not** basin spillways.
2. A rock pad outlet structure is just one option for the design of the outlet energy dissipater.

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Drawn:	Date:		
GMW	Dec-09	Chutes - General	CH-01

CHUTES - GENERAL SPECIFICATIONS

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CONSTRUCT THE SUBGRADE TO THE ELEVATIONS SHOWN ON THE PLANS. REMOVE ALL UNSUITABLE MATERIAL AND REPLACE WITH STABLE MATERIAL TO ACHIEVE THE DESIRED FOUNDATIONS.

3. IF THE CHUTE IS TEMPORARY, THEN COMPACT THE SUBGRADE TO A FIRM CONSISTENCY. IF THE CHUTE IS INTENDED TO BE PERMANENT, THEN COMPACT AND FINISH THE SUBGRADE AS SPECIFIED WITHIN THE DESIGN PLANS.

4. IF THE CHUTE IS TO BE LINED WITH ROCK, THEN AVOID COMPACTING THE SUBGRADE TO A CONDITION THAT WOULD PREVENT THE ROCK LINING FROM ADEQUATELY BEDDING INTO THE SUBGRADE.

5. ENSURE THE SUBGRADE IS FIRM ENOUGH TO MINIMISE WATER SEEPAGE.

6. ON FILL SLOPES, ENSURE THAT THE SOIL IS ADEQUATELY COMPACTED FOR A WIDTH OF AT LEAST ONE METRE EACH SIDE OF THE CHUTE TO MINIMISE THE RISK OF SOIL EROSION, OTHERWISE PROTECT THE SOIL WITH SUITABLE SCOUR PROTECTION MEASURES SUCH AS TURF OR EROSION CONTROL MATS.

7. PLACE AND SECURE THE CHUTE LINING AS DIRECTED.

8. IF CONCRETE IS USED AS A LINING, THEN KEEP THE SUBGRADE MOIST AT THE TIME CONCRETE IS PLACED. FORM, CUT-OFF WALLS AND ANCHOR BLOCKS AS DIRECTED IN THE APPROVED PLANS.

9. INSTALL AN APPROPRIATE OUTLET STRUCTURE (ENERGY DISSIPATER) AT THE BASE OF THE CHUTE (REFER TO SEPARATE SPECIFICATIONS).

10. ENSURE WATER LEAVING THE CHUTE AND THE OUTLET STRUCTURE WILL FLOW FREELY WITHOUT CAUSING UNDESIRABLE PONDING OR SCOUR.

11. APPROPRIATELY STABILISE ALL DISTURBED AREAS IMMEDIATELY AFTER CONSTRUCTION.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL CHUTES PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING STORM EVENTS, OR OTHERWISE ON A WEEKLY BASIS. MAKE REPAIRS AS NECESSARY.

2. CHECK FOR MOVEMENT OF, OR DAMAGE TO, THE CHUTE LINING, INCLUDING SURFACE CRACKING.

3. CHECK FOR SOIL SCOUR ADJACENT THE CHUTE. INVESTIGATE THE CAUSE OF ANY SCOUR, AND REPAIR AS NECESSARY.

4. WHEN MAKING REPAIRS, ALWAYS RESTORE THE CHUTE TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED.

REMOVAL

1. TEMPORARY CHUTES SHOULD BE REMOVED WHEN AN ALTERNATIVE, STABLE, DRAINAGE SYSTEM IS AVAILABLE.

2. REMOVE ALL MATERIALS AND DEPOSITED SEDIMENT, AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA IN PREPARATION FOR STABILISATION, THEN STABILISE THE AREA AS SPECIFIED IN THE APPROVED PLAN.

ADDITIONAL SPECIFICATIONS FOR ROCK PAD OUTLET STRUCTURE AT BASE OF CHUTE:

MATERIALS:

ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION (ROCK OUTLET PADS)

1. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. THE DIMENSIONS OF THE OUTLET STRUCTURE MUST ALIGN WITH THE DOMINANT FLOW DIRECTION.

3. EXCAVATE THE OUTLET PAD FOOTPRINT TO THE SPECIFIED DIMENSION SUCH THE WHEN THE ROCK IS PLACED IN THE EXCAVATED PIT THE TOP OF THE ROCKS WILL BE LEVEL WITH THE SURROUNDING GROUND, UNLESS OTHERWISE DIRECTED.

4. IF THE EXCAVATED SOILS ARE DISPERSIVE, OVER-EXCAVATED THE ROCK PAD BY AT LEAST 300mm AND BACKFILL WITH STABLE, NON-DISPERSIVE MATERIAL.

5. LINE THE EXCAVATED PIT WITH GEOTEXTILE FILTER CLOTH, PREFERABLY USING A SINGLE SHEET. IF JOINTS ARE REQUIRED, OVERLAP THE FABRIC AT LEAST 300mm.

6. ENSURE THE FILTER CLOTH IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

7. ENSURE THERE ARE AT LEAST TWO LAYERS OF ROCKS. WHERE NECESSARY, REPOSITION THE LARGER ROCKS TO ENSURE TWO LAYERS OF ROCKS ARE ACHIEVED WITHOUT ELEVATING THE UPPER SURFACE ABOVE THE PIPE INVERT.

8. ENSURE THE ROCK IS PLACED IN A MANNER THAT WILL ALLOW WATER TO DISCHARGE FREELY FROM THE PIPE.

9. ENSURE THE UPPER SURFACE OF THE ROCK PAD DOES NOT CAUSE WATER TO BE DEFLECTED AROUND THE EDGE OF THE ROCK PAD.

10. IMMEDIATELY AFTER CONSTRUCTION, APPROPRIATELY STABILISE ALL DISTURBED AREAS.

MAINTENANCE

1. WHILE CONSTRUCTION WORKS CONTINUE ON THE SITE, INSPECT THE OUTLET STRUCTURE PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING RAINFALL, AND ON AT LEAST A WEEKLY BASIS.

2. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

REMOVAL

1. TEMPORARY OUTLET STRUCTURES SHOULD BE COMPLETELY REMOVED, OR WHERE APPROPRIATE, REHABILITATED SO AS NOT TO CAUSE ONGOING ENVIRONMENTAL NUISANCE OR HARM.

2. FOLLOWING REMOVAL OF THE DEVICE, THE DISTURBED AREA MUST BE APPROPRIATELY REHABILITATED SO AS NOT TO CAUSE ONGOING ENVIRONMENTAL NUISANCE OR HARM.

3. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

Catchments & Creeks Pty Ltd

Drawn:	Date:		
GMW	Dec-09	Chutes - General	CH-02

DRAFT

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
A	05/03/19	M.P.	L.O.	A.M.	DRAFT ISSUE

DRAWING STATUS	
DESIGN BY	M.P.
DRAWN BY	L.O.
FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	NTS
DRAFT	

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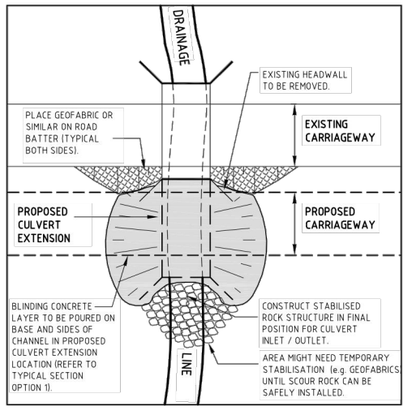
PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: EROSION AND SEDIMENT CONTROL – IECA STANDARD DRAWINGS

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP006	A

Plot Date: Tuesday, 5 March 2019 10:05:06 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg

CONTINUOUS CULVERT EXTENSION (ONLINE) OPTION 1



SITE STABILISATION PROCEDURE

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

1. Watch the weather forecast for a dry period (a period longer than the time required to complete earthworks up to the required level).
2. When a dry period is forecast, undertake earthworks quickly (preferably in less than three days).
3. Pour blinding concrete layer and lay rock inlet / outlet.
4. Lay geofabric (or similar) on existing road batter.

(Ensure steps 2, 3 and 4 occur within the forecast period of dry weather and no flow)

5. Complete culvert construction works over the top of the blinding concrete layer.
6. Maintain the blinding layer until the culvert extension is complete and stabilised. once flows are secure within the new culverts, excess blinding can be removed if desired.

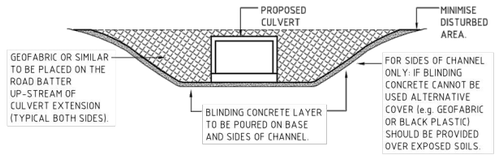
At any time during steps 1 – 4 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

OTHER NOTES

- For divided culvert extensions this stabilisation method could also be applied or alternatively the flows could be diverted as for a new online culvert.
- Note that this method is not suitable for perennial creeks unless additional measures (e.g. pumping or coffer dams) can be reliably included as well.
- This method might not be appropriate where there is a significant depth of unsuitable soil material to be removed.
- For systems with very minor flows in dry periods, temporary damming of flows might be required to hold water back for the nominated work period until the blinding concrete layer and rock is placed.
- Note that not all onsite water management and sediment controls are shown here.

ENSURE THAT 'OFFSITE' CREEK FLOWS DO NOT COME INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

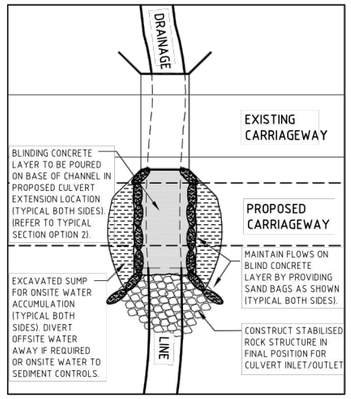
NOTE: MAINTAIN OR INSTALL TEMPORARY GROUND COVER THROUGH FLOW AREA ANYTIME FLOWS ARE IMMINENT.



TYPICAL SECTION – OPTION 1

OPTION 1 FROM RMS (2011).

CONTINUOUS CULVERT EXTENSION (ONLINE) OPTION 2



SITE STABILISATION PROCEDURE

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

1. Watch the weather forecast for a dry period (a period longer than the time required to complete earthworks up to the required level).
2. When a dry period is forecast, undertake earthworks quickly (preferably in less than three days).
3. Pour blinding concrete layer and lay rock inlet / outlet.
4. Position sand bags on the blind concrete layer.

(Ensure steps 2, 3 and 4 occur within the forecast period of dry weather and no flow)

5. Complete culvert construction works over the top of the blinding concrete layer. Take care not to disturb the integrity of the blinding layer.
6. Maintain the sandbag walls on the base slab if a flow event occurs.

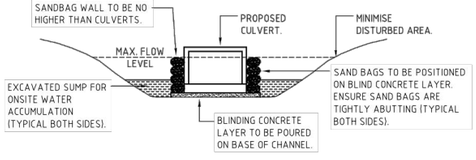
At any time during steps 1 – 4 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

OTHER NOTES

- For divided culvert extensions this stabilisation method could also be applied or alternatively the flows could be diverted as for a new online culvert.
- Note that this method is not suitable for perennial creeks unless additional measures (e.g. pumping or coffer dams) can be reliably included as well.
- This method might not be appropriate where there is a significant depth of unsuitable soil material to be removed.
- For systems with very minor flows in dry periods, temporary damming of flows might be required to hold water back for the nominated work period until the blinding concrete layer and rock is placed.
- Note that not all onsite water management measures and sediment controls are shown here.

ENSURE THAT 'OFFSITE' CREEK FLOWS DO NOT COME INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

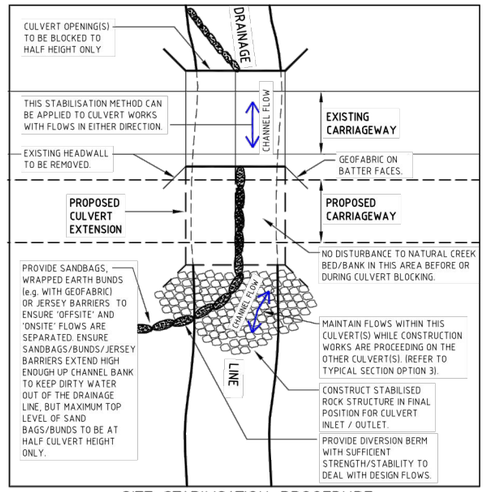
NOTE: MAINTAIN OR INSTALL TEMPORARY GROUND COVER THROUGH FLOW AREA ANYTIME FLOWS ARE IMMINENT.



TYPICAL SECTION – OPTION 2

OPTION 2 FROM RMS (2011).

CONTINUOUS CULVERT EXTENSION (ONLINE) OPTION 3



SITE STABILISATION PROCEDURE

OTHER NOTES

- This option will only work when existing ground surface level can be maintained in at least one culvert cell. Therefore this method might not work for deep excavations requiring benching.
- Suitable for use in perennial streams providing in-stream works are conducted when flows are minimal.
- However, regardless of scheduling and timing the adopted controls need to be considerate of the risk of significant flows at any time.
- Note that not all water management and sediment controls are shown here.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

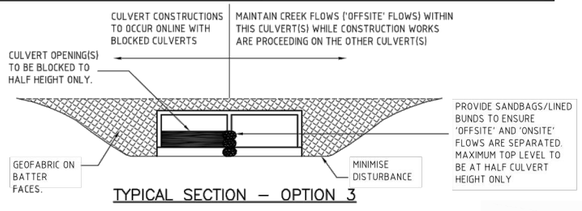
Stage 1.

1. Monitor creek flows ensuring flows levels are not too high.
2. Position sandbags/bunds around culvert works area and block existing culvert end to half culvert height only.
3. Undertake culvert extension construction works only on the blocked side of the culvert(s).
4. Complete inlet/outlet protections.

Stage 2

5. Divert the creek flows into the newly constructed culvert extension by blocking off the alternate side using a half-height wall/bund.
6. Complete the culvert extension on the other side including the stabilised inlet/outlet.

At any time where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.



TYPICAL SECTION – OPTION 3

OPTION 3 FROM RMS (2011)

DRAFT

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
A	05/03/19	M.P.	L.O.	A.M.	DRAFT ISSUE

DRAWING STATUS	
DESIGN BY	M.P.
DRAWN BY	L.O.
FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	NTS

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PROJECT TITLE: RAVINE ROAD UPGRADE

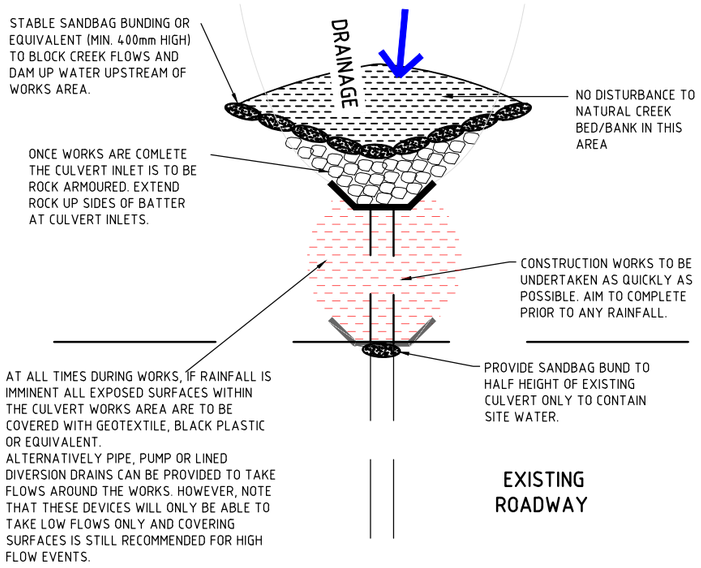
DRAWING TITLE: ESCP CULVERT EXTENSION OPTIONS TYPICAL DRAWINGS (1)

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP007	A

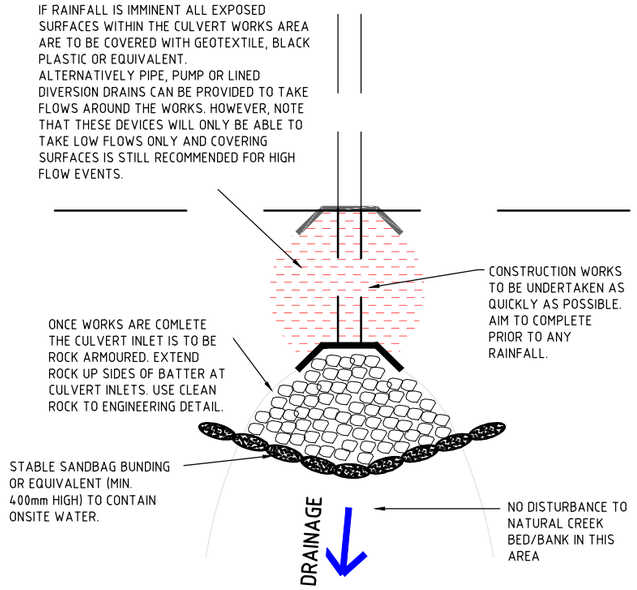
Plot Date: Tuesday, 5 March 2019 10:05:11 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg

OPTION 4

DETAIL 1 - TYIPCAL WATER MANAGEMENT FOR PIPE EXTENSION WORKS



THE DETAIL ABOVE IS FOR AN UPSTREAM PIPE EXTENSION.



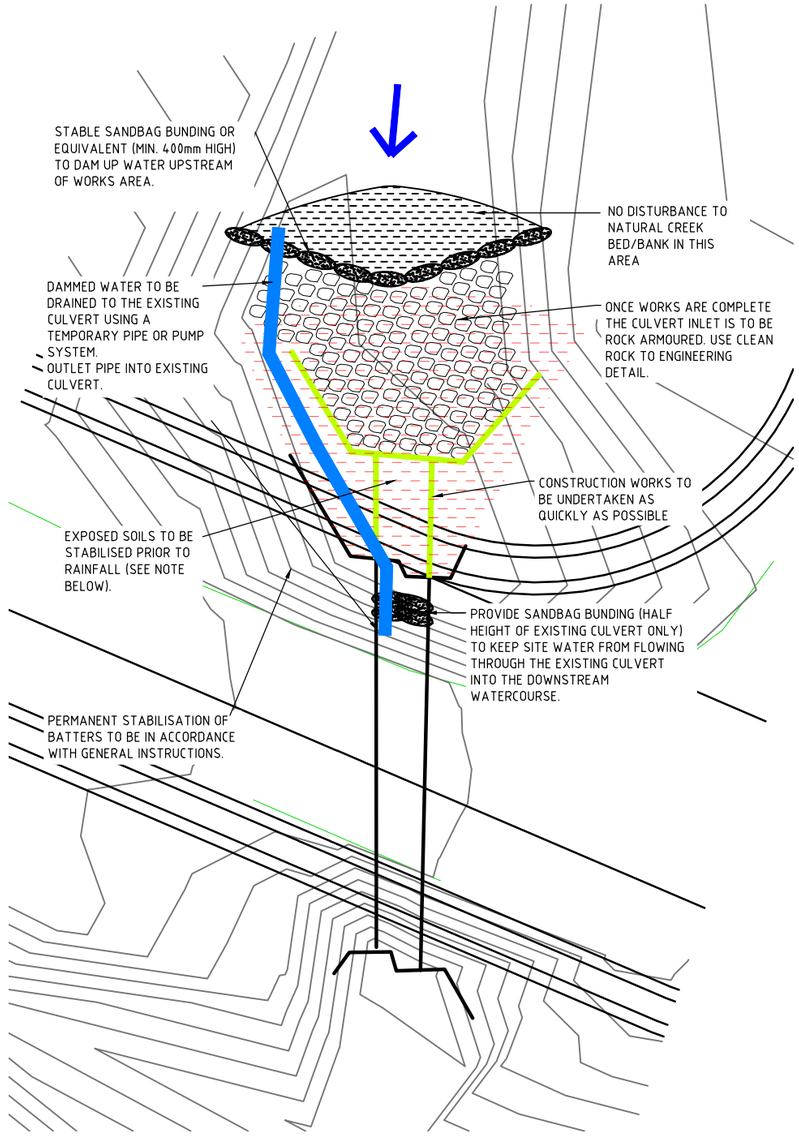
THE DETAIL ABOVE IS FOR A DOWNSTREAM PIPE EXTENSION.

REFER TO THE " EROSION AND SEDIMENT CONTROL REQUIREMENTS FOR ALL CULVERT/PIPE WORKS" NOTES FOR INSTRUCTIONS AND REQUIREMENTS.

EROSION AND SEDIMENT CONTROL REQUIREMENTS FOR ALL CULVERT/PIPE WORKS (REFER TO DETAILS 1 & 2) IN OPTION 4

- ALL WORKS ARE TO BE SCHEDULED FOR A PERIOD OF NO RAINFALL AND ARE TO BE COMPLETED AS QUICKLY AS POSSIBLE (INCLUDING INLET DISSIPATION STRUCTURES AND STABILISATION).
- PRIOR TO UNDERTAKING ANY CONSTRUCTION OR EARTHWORKS ENSURE TEMPORARY GROUNDCOVER MATERIALS (E.G. GEOFABRIC OR BLACK PLASTIC) ARE TO BE LOCATED ON SITE FOR STABILISATION OF EXPOSED SURFACES.
- AT ALL TIMES DURING WORKS, ENSURE THAT NATURAL UPSTREAM FLOWS ARE DIRECTED AROUND OR THROUGH THE WORK SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR DIRTY CONSTRUCTION WATER.
- IF RAINFALL IS IMMINENT ALL EXPOSED SURFACES ARE TO BE COVERED WITH GEOTEXTILE, BLACK PLASTIC OR EQUIVALENT. ALTERNATIVELY LINED DIVERSIONS, PIPES, OR PUMPS CAN BE INSTALLED. HOWEVER, NOTE THAT THESE DEVICES WILL ONLY BE ABLE TO TAKE LOW FLOWS ONLY AND COVERING SURFACES IS STILL RECOMMENDED FOR HIGH FLOW EVENTS.
- THE TOP SURFACE OF THE EARTHWORKS FILL PLATFORM (ABOVE THE PIPE HEADWALL) MUST BE STABILISED PRIOR TO RAINFALL (>60% CHANCE OF RAINFALL >30mm). USE SOIL POLYMER (EG. VITAL STONEWALL), GEOTEXTILE OR SIMILAR.
- EXPOSED BATTERS WITHIN THE DRAINAGE LINE EXTENT WHERE WORKS ARE NOT ACTIVELY OCCURRING ARE TO BE TEMPORARILY COVERED WITH GEOTEXTILE OR EQUIVALENT.
- DISTURBANCE WITHIN IN-STREAM LOCATIONS IS TO BE MINIMISED AS MUCH AS POSSIBLE.
- FINAL STABILISATION OF SURFACES IS TO OCCUR PROGRESSIVELY AS EACH SECTION OF WORKS ARE COMPLETE.
- DIRTY (ON-SITE) WATER ACCUMULATING WITHIN THE WORKS AREA IS TO BE TREATED PRIOR TO DISCHARGING.
- ALTERNATIVELY ONSITE WATER CAN BE USED FOR DUST SUPPRESSION ON THE ROADWORK AREAS OUTSIDE OF THE WATERWAY EXTENT.

DETAIL 2 - TYIPCAL WATER MANAGEMENT FOR PIPE EXTENSION WORKS



NOTE

PIPED DIVERSION IS ONLY ADEQUATE FOR SMALL TRICKLE FLOWS. ALL EXPOSED SOILS WITHIN THE CULVERT/PIPE CONSTRUCTION AREA INCLUDING ROAD BATTERS ARE TO BE STABILISED PRIOR TO RAINFALL (>60% CHANCE OF RAINFALL >5mm) WITH GEOTEXTILE, BLACK PLASTIC OR EQUIVALENT OR ALTERNATIVELY A LINED DIVERSION CAN BE USED INSTEAD.

REFER TO THE " EROSION AND SEDIMENT CONTROL REQUIREMENTS FOR ALL CULVERT/PIPE WORKS" NOTES FOR INSTRUCTIONS AND REQUIREMENTS.

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REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
A	05/03/19	M.P.	L.O.	A.M.	DRAFT ISSUE

DRAWING STATUS	
DESIGN BY	M.P.
DRAWN BY	L.O.
FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	NTS

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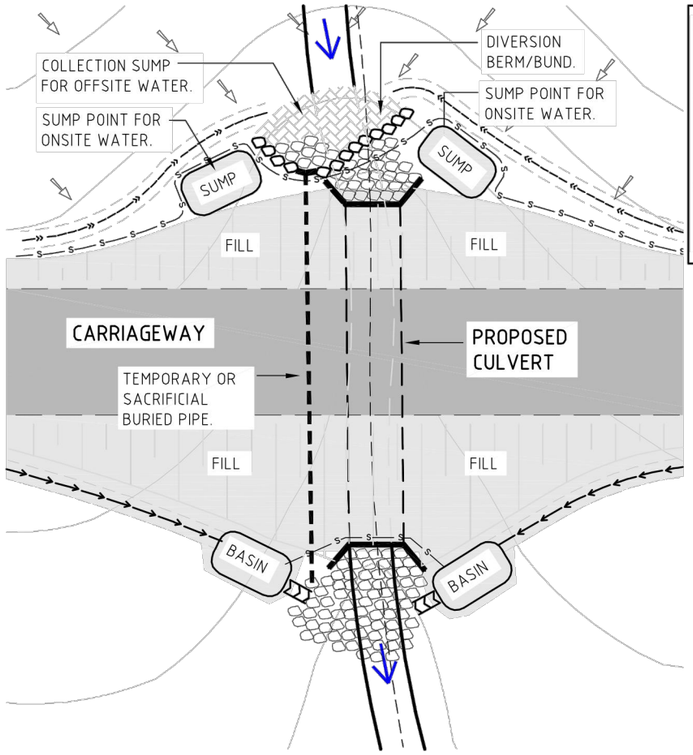
PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: ESCP CULVERT EXTENSION OPTIONS TYPICAL DRAWINGS (2)

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP008	A

Plot Date: Tuesday, 5 March 2019 10:05:16 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg

TEMPORARY WATER MANAGEMENT OF ROAD WORKS POSITIONED IN DEPRESSION



- **THIS SCENARIO IS ONLY APPLICABLE FOR DEPRESSIONS AND INTERMITTENT SMALL CREEKS NOT FOR PERENNIAL OR LARGER SYSTEMS.**
- **AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER.**
- **ADDITIONAL BATTER PROTECTION (e.g GEOFABRIC) TO BE PROVIDED WHEN SIGNIFICANT RAINFALL FORECAST THAT MIGHT EXCEED PIPE CAPACITY.**

LEGEND

- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ROCK STABILISED OUTLET (SD)
- CUT/FILL BATTER
- DIVERSION BERM (SD)
- CREEK/PIPE FLOW ROUTE
- AREA TO BE LINED
- SPILLWAY
- SEDIMENT FENCE (SD 6-8)

CONSTRUCTION NOTES

THESE STEPS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW.

Stage 1: Establish Temporary Diversion

1. Monitor creek flows ensuring flow levels are not too high.
2. Establish diversion drains for offsite water.
3. Position the temporary pipe and construct the stabilised inlet and outlets for this pipe.
4. Establish the diversion berm (including lining where applicable) to direct water into the temporary pipe.
5. Line the collection sump up to the height of the top pipe level.
6. Flows to be diverted into the temporary pipe. This is to take place prior to undertaking any bulk earthworks, stripping or culvert constructions.

Stage 2: Culvert Construction Works

7. Prior to undertaking any stripping, earthworks or culvert construction works, 'onsite' soil and water management controls are to be established.
8. Complete bulk earthworks and construct the new culvert including the stabilised culvert inlet and outlets.
9. Once the bulk earthworks and the culvert constructions including stabilisation of culvert inlet / outlets have been completed, creek flows can be diverted into new culvert and temporary pipe removed or capped / sealed.

GENERAL NOTES

- An offset pipe is to be used where depressions are to be filled before culvert works (eg. to provide access during bulk earthworks).
- Ensure offsite flows are diverted into the temporary pipe prior to undertaking any stripping, bulk earthworks or culvert construction works.
- Include seepage collars on the temporary pipe.
- Temporary pipes are to include seepage collars.
- Water will pool in the collection sump up to the level of the temporary pipe invert. The area of the collection sump up to the height of the top of pipe level should be lined with rock, geofabric, plastic or similar (NOT BARE SOIL).
- The inlet and outlets of the temporary pipe are to stabilised with rock.
- The diversion berms used to direct 'offsite' flows into the temporary pipe are to be construction out of either rock or lined earth berms.
- Where sediment basins are not possible to construct in steep locations with space restrictions an alternative sediment device must be implemented (i.e. a sediment trap made out of sediment fence, sandbags or lined earth bunding). This is only suitable in very small catchments.
- Creek flows can only be re-diverted into the new culvert once culvert constructions have been completed and the culvert inlet and outlets have been rock lined and stabilised.
- If required, temporary pipes can be left in place after culvert works are completed.
- If temporary pipes are to remain in place, drain them, then cap or seal them to minimise the risk of water ingress.
- Note that not all onsite water management and sediment controls are shown here.

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DRAWING STATUS	
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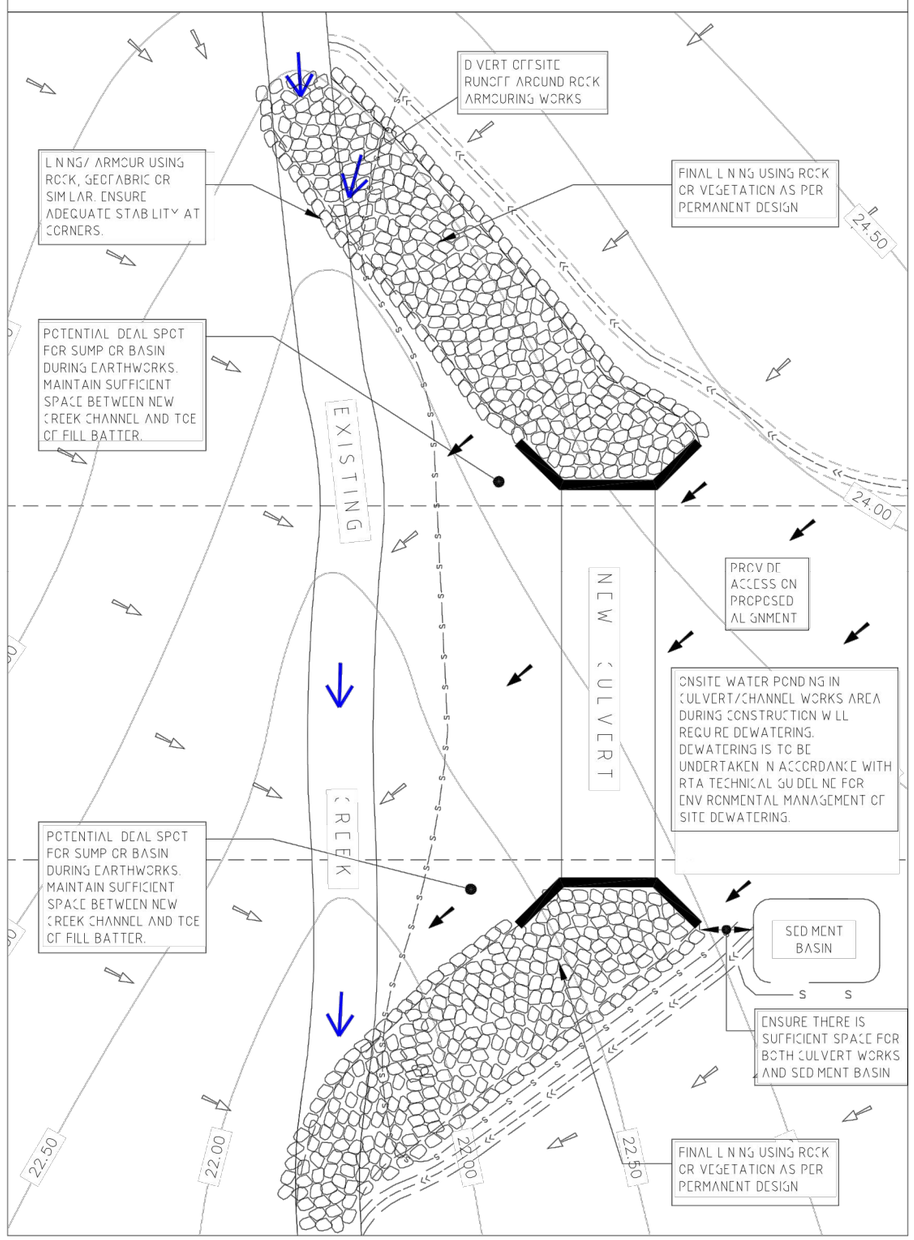
PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: ESCP CULVERT EXTENSION OPTIONS TYPICAL DRAWINGS (3)

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
18000428	P00	ESCP009	A

Plot Date: Tuesday, 5 March 2019 10:05:21 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg

NEW OFFLINE CULVERT (PREFERABLY AS "EARLY WORKS")



SWMP OFFLINE CULVERT CONSTRUCTION AND CREEK STABILISATION WORKS

NEW OFFLINE CULVERT - CONSTRUCTION NOTES

THESE STEPS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Stage 1: Site Preparation Works
- Establish diversion drains for offsite water
- Install berms to block off new channel and ensure all works remain offline from the existing creek.

Stage 2: Culvert Construction Works
- Construct the new culvert including the stabilised culvert inlet and outlets.
- Stabilise the culvert construction works area.

Stage 3: Final Diversion and Rehabilitation Works
- Install in-stream (online) rock armouring at the locations where flows are turned into and out of the new channel.
- Remove berms used to block off new channel during construction works starting at downstream end.
- Divert creek flows into new culvert.
- Disturbed area to be stabilised.

STANDARD DRAWINGS FROM VOL 1 OF THE BLUE BOOK (LANDCOM, 2004) USED HERE:

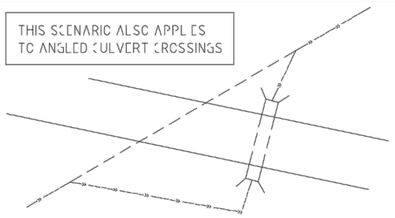
Sediment fence SD 6-8
High flow earth bank (diversion drain) SD 5-6
Energy dissipater SD 5-8
Temporary waterway crossing SD 5-1

OTHER NOTES

1. This design assumes that culvert construction is part of the 'early works' for the site.
3. Ideally schedule works to periods when rainfall erosivity is low (Refer to Table 4.3 - Landcom, 2004)
4. Only undertake in-stream works (e.g. placement of rock) during periods of zero or very low flow and only when the 24 hour weather forecast suggests a significant rain event is not likely.
5. Ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils within in-stream locations if an unexpected rain or flow event occurs.
6. Culverts are to be completed before being allowed to convey flows. This includes all inlet and outlet protection, wingwalls etc.
7. Stabilisation, as defined by the Blue Book, means achieving
   - For concentrated flows- At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability)
   - For all other areas- At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.
8. If temporary access is required across the existing creek or a diversion channel, use a temporary water crossing (see standard drawing list)
9. Minimise the time that soil is exposed to erosion.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

THIS SCENARIO ALSO APPLIES TO ANGLED CULVERT CROSSINGS



LEGEND

S S	SEDIMENT FENCE (SD 6-8)
» »	DIVERSION DRAIN FOR OFFSITE WATER (SD 5-6)
	SURFACE CONTOURS
	'ONSITE' FLOWS
	'OFFSITE' FLOWS
	CREEK/CHANNEL FLOWS
	CUT/FILL BATTER
	ROCK DISSIPATION/STABILISATION STRUCTURES (SD 5-8)
	DIVERSION BERMS (e.g. SANDBAG WALLS, LINED EARTH BUNDS, ROCK)

NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

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REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
A	05/03/19	M.P.	L.O.	A.M.	DRAFT ISSUE

DRAWING STATUS	
DESIGN BY	M.P.
DRAWN BY	L.O.
FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	NTS
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PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: ESCP OFFLINE CULVERT EXTENSION TYPICAL DRAWING

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18000428	P00	ESCP010	A

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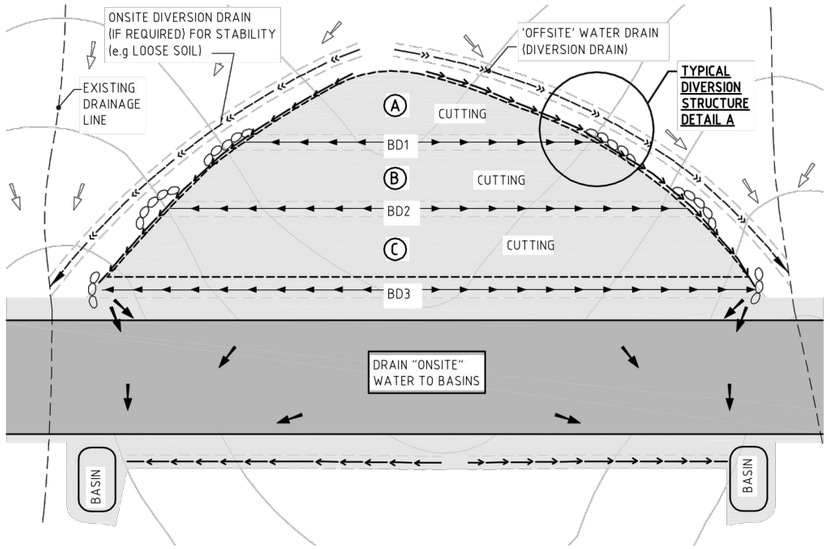
TEMPORARY WATER MANAGEMENT ON A ROADSIDE CUTTING

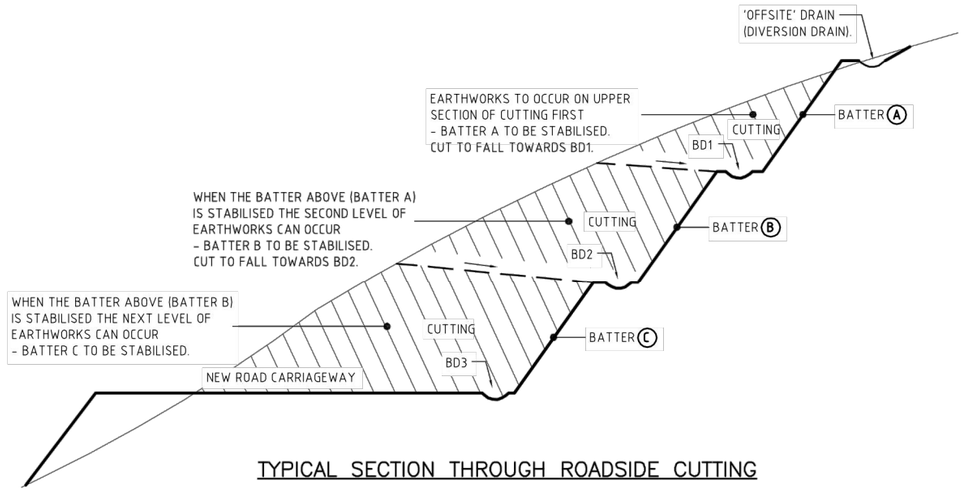


PROGRESSIVE STABILISATION OF BATTERS IS ESSENTIAL. EACH SECTION OF THE BATTER SHOULD BE SHAPED, TOPSOILED, AND REHABILITATED BEFORE PROCEEDING TO THE NEXT SECTION.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

LEGEND

- DIVERSION DRAIN FOR 'OFFSITE' WATER (SD 5-6)
- DIVERSION DRAIN FOR 'ONSITE' WATER (SD 5-6)
- BERM DRAIN (BD)
- SURFACE CONTOURS
- 'OFFSITE' WATER FLOWS
- 'ONSITE' WATER FLOWS



TYPICAL SECTION THROUGH ROADSIDE CUTTING

GENERAL NOTES

1. Progressive stabilisation of batters is essential. Each section of the batter should be shaped, topsoiled, and rehabilitated before proceeding to the next section.
2. Permanent cut off drains used as 'offsite' drains during construction works.
3. Take care with mixing flows from 'offsite' (cut off) drains with flows from berm drains ('onsite' water until upslope batter is vegetated). Diversion structures should be used to ensure this (Refer to 'Typical Diversion Structure Detail A').
4. All 'onsite' water is to drain to a sediment trap/basin.
5. Outlet 'offsite' water drains to existing drainage line or culvert.
6. A suitable 'offsite' water management system is to be used for conveying 'offsite' flows from the drainage line through the worksite.
7. Note that not all onsite water management and sediment controls are shown here.

Stabilisation means achieving:

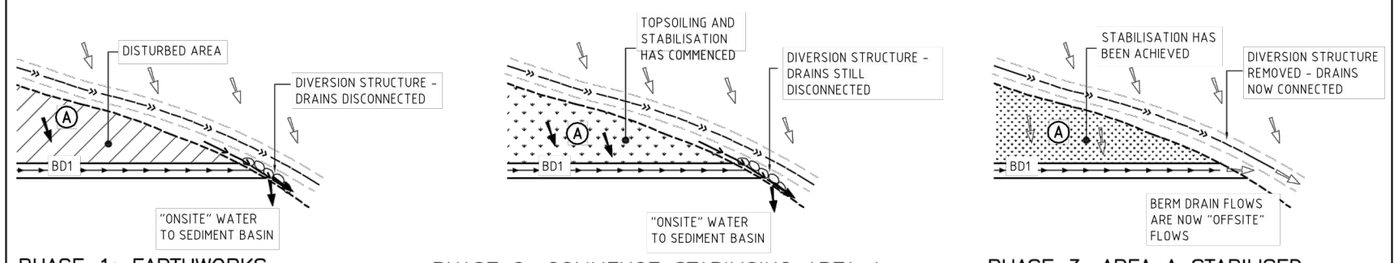
- For concentrated flows- At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability).
- For all other areas- At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.

TYPICAL DIVERSION STRUCTURE DETAIL A

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

1. Permanent diversion drains ('offsite' water drains) to be established.
2. Earthworks on upper section of cutting (i.e. section A) to be undertaken including construction of BD1.
3. Construction of BD1 must include diversion structures as per Phase 1 detail.
4. Section A should be stabilised as per Phase 2 detail.
5. Once section A is successfully stabilised (i.e. at least 60% ground cover has been achieved), BD1 can be connected to the cut off drain as per Phase 3 detail.
6. Earthworks can now proceed on the next section down (i.e. section B) and the process above (2 to 4) should be again carried out.
7. This process should continue for the entire cutting (i.e. section C and any lower sections if present).



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REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
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DRAWING STATUS

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FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	NTS

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PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: ESCP CUT BATTER DRAINAGE TYPICAL DRAWINGS

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
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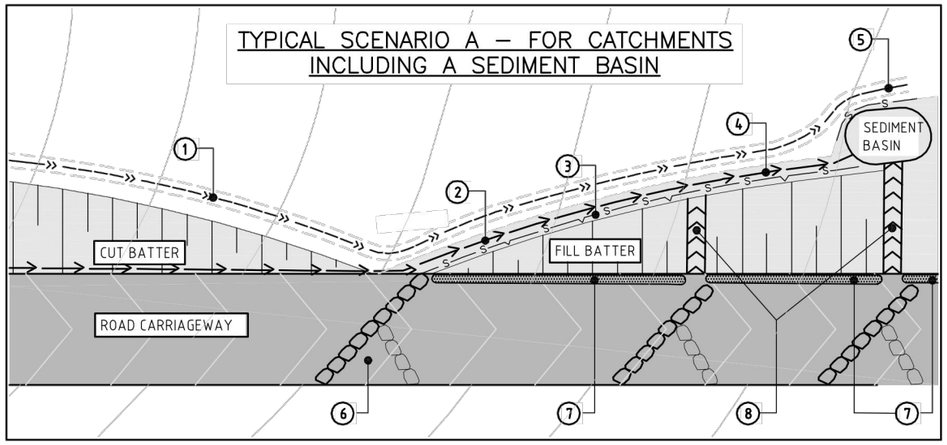
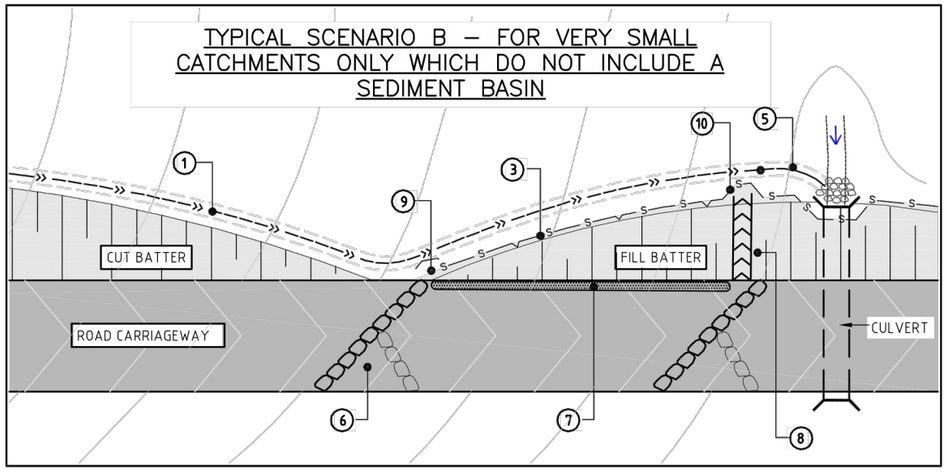
Plot Date: Tuesday, 5 March 2019 10:05:31 AM CAD File Name: U:\18000428 Snowy 2.0 Ravine Road Works\Drawings\18000428_P00_ESCP_REV A.dwg

CUT / FILL BATTER WATER MANAGEMENT





LEGEND

- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ROCK STABILISED OUTLET/INLET (SD 5-8)
- CUT / FILL BATTER
- DIVERSION BERM (SD 5-5)
- CREEK / PIPE FLOW ROUTE
- SPILLWAY
- SEDIMENT FENCE (SD 6-8)

CONSTRUCTION NOTES

THE FOLLOWING WORKS ARE TO BE UNDERTAKEN AS SHOWN ON THE RELEVANT DIAGRAMS

1. Lined permanent diversion drains to be used as 'offsite' water drains during construction. Must convey water all the way to a watercourse or depression and onto a stabilised outlet point.
2. Provide sufficient room between toe of fill and 'offsite' water drain for management of 'onsite' water. 'Onsite' water diversion (temporary drain) - to drain to sediment basin.
3. Sediment fence at toe of batter. Include returns at 20m intervals.
4. 'Onsite' water diversion (temporary drain) - to drain to sediment basin.
5. Ensure 'offsite' water drain extends all the way to drainage line and onto a stabilised outlet point.
6. Use earth bank or sandbags to divert runoff at cut / fill line to onsite drain or sediment trap. Do not mix with 'offsite' water in cut-off drain. Use arrowhead shape if water is being shed from both sides of formation. It is only required at end of day or when rain is imminent.
7. Earth or sandbag windrow for directing water into drop-down flume. To be installed at end of day or when rain is imminent.
8. Lined drop-down chute to carry 'onsite' water to basin or trap. Only required when rain is imminent.
9. Install sediment trap at cut/fill line if runoff is not flowing to a basin.
10. Install sediment trap at base of drop-down flume if runoff is not flowing to a basin. This can simply be formed as a section of the sediment fence with returns both sides.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

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PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: ESCP CUT/FILL INTERFACE TYPICAL DRAWINGS

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
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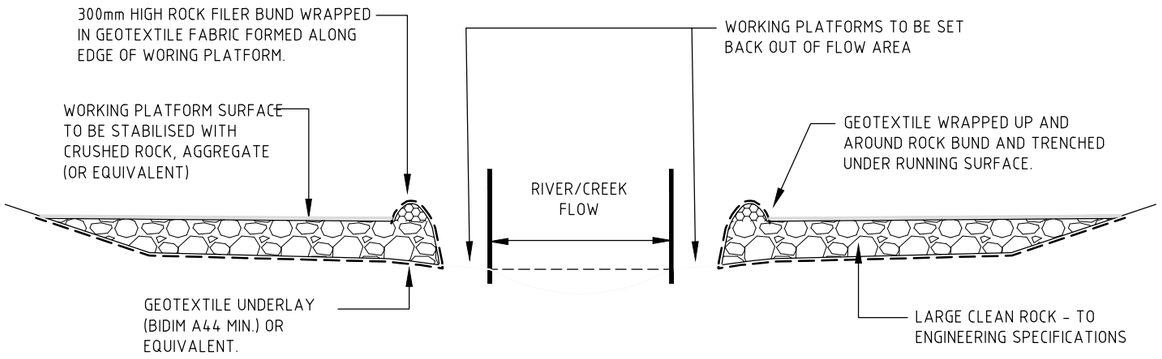
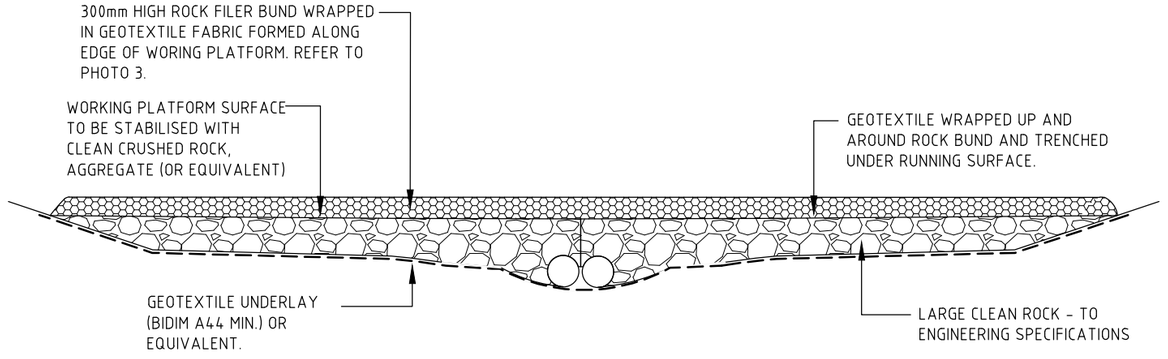
WORKS TO FORM WORKING PLATFORM TO BE UNDERTAKEN IN A FORECAST PERIOD OF NO RAINFALL AND LOW FLOW. ENSURE ALL EXPOSED SOIL SURFACES WITHIN 40m OF THE TOP BANK OF WATERWAY ARE STABILISED/COVERED PRIOR TO RAINFALL AND SITE CLOSURE EACH DAY. USE GEOTEXTILE, ROCK, AGGREGATE OR EQUIVALENT TO ACHIEVE THIS.



DETAIL 2 - WORKING PLATFORM CONTROL MEASURES
SEE PHOTO 2 FOR EXAMPLE

WORKS TO FORM WORKING PLATFORM TO BE UNDERTAKEN IN A FORECAST PERIOD OF NO RAINFALL AND LOW FLOW. ENSURE ALL EXPOSED SOIL SURFACES WITHIN 40m OF THE TOP BANK OF WATERWAY ARE STABILISED/COVERED PRIOR TO RAINFALL AND SITE CLOSURE EACH DAY. USE GEOTEXTILE, ROCK, AGGREGATE OR EQUIVALENT TO ACHIEVE THIS.



DETAIL 3 - WORKING PLATFORM CONTROL MEASURES (PIPED)
SEE PHOTO 3 FOR EXAMPLE

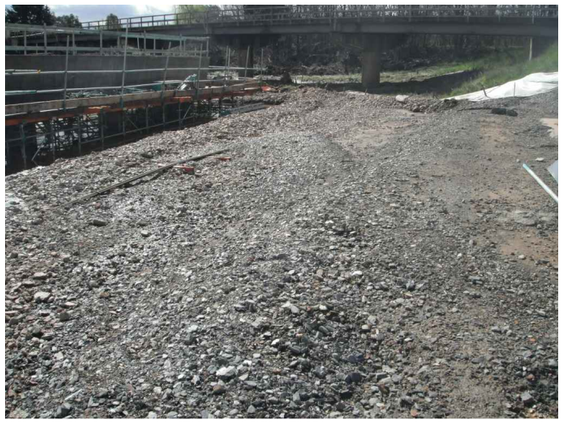


PHOTO 1 - EXAMPLE OF A WORKING PLATFORM STABILISED SURFACE

PHOTO 2 - EXAMPLE OF A WORKING PLATFORM WITH ROCK FILTER BUND

PHOTO 3 - EXAMPLE OF A WORKING PLATFORM ACROSS CHANNEL WITH ROCK FILTER BUND ALONG EDGE

PHOTO 4 - EXAMPLE OF ROCK FILTER DAM AND SUMP SEDIMENT TRAP

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PROJECT TITLE: RAVINE ROAD UPGRADE

DRAWING TITLE: ESCP
BRIDGE CONSTRUCTION
TYPICAL DETAILS AND PHOTOS

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Water Management Plan

Appendix B

Stage 1 - Groundwater Management Plan

Appendix B - Groundwater Management Plan

Rev 1

Report Snowy 2.0 - Exploratory Works - Groundwater Management Plan | Prepared for Snowy Hydro Limited | 12 December 2019

Document Control

Version	Date	Prepared by	Contributions by	Reviewed by
Rev A	17 December 2019	C Bentley	S Cassidy	R Walker-Edwards J Slattery
	15 January 2019	C Bentley	S Cassidy	R Walker-Edwards J Slattery
	11 February 2019	C Bentley	S Cassidy	R Walker-Edwards J Slattery
	3 March 2019	C Bentley	J Tait S Cassidy	C Buscall
Rev 0	12 April 2019	J Tait	S Cassidy	C.Litchfield
Rev 1	12 December 2019	J Slattery		C Buscall

Plan approved by:

Tom Fallon
Leed Project Director

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Abbreviations and Glossary

AGMG	Australian Groundwater Modelling Guidelines
AIP	*Aquifer Interference Policy 2012*
ANZECC	*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*
BoM	Bureau of Meteorology
CSSI	Critical State Significant Infrastructure
DEC	Department of Environment and Conservation (now Office of Environment and Heritage)
DECC	Department of Environment and Climate Change (now Office of Environment and Heritage)
DoI Water	NSW Department of Industry Water
DPIE	NSW Department of Planning, Industry and Environment *Formerly* NSW Department of Planning and Environment
DPI	Formerly NSW Department of Industry
ESCP	Erosion and Sediment Control Plan
EIS	*Environmental Impact Statement Exploratory Works for Snowy 2.0*
EMS	Environmental Management Strategy
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	NSW Environment Protection Authority
EWMS	Environmental Work Method Statement
GDE	Groundwater dependant ecosystem
GMP	Groundwater Monitoring Program
GWMP	Groundwater Management Plan
KNP	Kosciuszko National Park
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure
NERDDC	National Energy Research Development and Demonstration Council
NOW	NSW Office of Water
NPWS	National Park and Wildlife Service
NRMMC	Natural Resource Management Ministerial Council
OEH	Office of Environment and Heritage
PCT	Plant community type
PESCP	Progressive erosion and sediment control plan

POEO Act	*Protection of the Environment Operations Act 1997*
REMM	Revised Environmental Management Measures
Submissions Report or RTS	*Response to Submissions Exploratory Works for Snowy 2.0*
SWMP	Surface Water Management Plan
TARP	Trigger Action Response Plan
WAL	Water Access Licence
WMA 2000	*Water Management Act 2000*
WMP	Water Management Plan
WSP	Water Sharing Plans

1 Introduction

1.1 Background

Snowy Hydro Limited (Snowy Hydro) is the proponent of the Snowy 2.0 project which is a pumped hydro-electric storage and generation project proposed to address increasing demands for renewable energy supplies. Snowy 2.0 involves linking Talbingo and Tantangara reservoirs within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme) and building an underground power station between the two reservoirs.

Snowy Hydro will carry out Exploratory Works prior to the main construction works for the Snowy 2.0 project, to inform the detailed design and to reduce project risk. Exploratory Works are required to obtain detailed geological data for the proposed location of the underground power station. An exploratory tunnel is to be constructed to gain this information. The Exploratory Works will predominantly be in the Lobs Hole area of Kosciuszko National Park (KNP). If the Exploratory Works are not undertaken, risks to the design and construct elements of the power station cavern are significantly increased.

The *Environmental Impact Statement Exploratory Works for Snowy 2.0* (EIS) was prepared to assess the impact of these works on the environment, including an assessment of traffic and transport impacts within Chapter 5.6 and Appendix Q. MOD1 also identified water impacts as a result of the modification, assessed any impacts, and proposed any required mitigation measures within Chapter 6.3 and 7.1.

The EIS and MOD1 identified the potential for direct and indirect impacts on water quality from surface water runoff from disturbed and operating areas of the site, dredging, subaqueous excavated rock placement and discharges of process water and waste (effluent) water. The EIS concluded that, with the implementation of appropriate impact mitigation measures, there would be no significant impacts to waterways within the project area, to high risk areas or sensitive receiving environments downstream of the project.

With respect to groundwater modelling undertaken as part of the EIS predicted localised drawdown in the vicinity of the tunnel alignment, primarily around the portal. Only minor impacts to the baseflow of the Yarrangobilly River and tributaries are expected during construction. Losses are predicted to increase post construction until a new equilibrium is reached.

The Response to Submissions Exploratory Works for Snowy 2.0 (Submissions Report or RTS) included revised environmental management measures (REMM) within Chapter 8. The management measures from that report have been addressed within this GWMP.

1.2 Context

This Groundwater Management Plan (GWMP or Plan) forms part of the Water Management Plan and Environmental Management Strategy (EMS) for Snowy 2.0 - Exploratory Works (the Project). The Exploratory Works is the first stage of Snowy 2.0, a pumped hydro-electric storage and generation project which will increase the hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme. The second stage, or main project, will be subject to a separate Environmental Impact Statement in 2019.

The GWMP has been prepared to address the requirements of the Infrastructure Approval (SSI 9208) issued for Snowy 2.0 Exploratory Works on 7 February 2019, the *Environmental Impact Statement Exploratory Works for Snowy Hydro 2.0,* and the revised environmental management measures within the *Response to Submissions Exploratory Works for Snowy 2.0*.

This revision of the WMP has been prepared to address the requirements of the Exploratory Works for Snowy 2.0 Modification 1 Assessment Report (MOD1) and the REMMs within the Exploratory Works Modification 1 Response to Submissions Report which were approved by Department of Planning, Industry and Environment (DPIE) on 2 December 2019.

The original EIS Exploratory Works scope includes:

- an exploratory tunnel about 3.1 km long to the site of the underground power station;
- horizontal and other test drilling, investigations and analysis in situ at the proposed cavern location and associated areas, and around the portal construction pad, access roads and excavated rock management areas all within the disturbance footprint;
- a portal construction pad for the exploratory tunnel. This will provide the entrance structure to the tunnel and an area for infrastructure and equipment needed to support tunnelling activities;
- an accommodation camp for the Exploratory Works construction workforce;
- road works and upgrades to enable access and haulage routes during Exploratory Works. This includes upgrades to 26 km of existing roads and creating about 2 km of new roads;
- barge access infrastructure to enable access and transport by barge on Talbingo Reservoir. This includes one new barge ramp at Talbingo Spillway in the northern part of Talbingo Reservoir and one new barge ramp at Middle Bay near Lobs Hole at the southern part of Talbingo Reservoir;
- excavated rock management, including subaqueous placement within Talbingo Reservoir. Up to 750,000 m^3 of excavated rock will need to be tested for its geochemical properties (ie whether the rock is reactive or non-reactive) before being managed by a combination of the following options:
    - re-use - suitable material can be used as construction materials for roads or similar. Some materials will be provided to NPWS for use in road maintenance and upgrades in other areas of KNP;
    - on land placement - material will be temporarily placed in one of two on land emplacement areas.
    - subaqueous placement within Talbingo Reservoir – suitable material will be placed at a suitable location within Talbingo Reservoir, subject to a number of water quality controls and monitoring; and
- services infrastructure such as diesel-generated power, water and communication;
- post-construction revegetation and rehabilitation, management and monitoring.

Having regard to the design changes identified in Modification 1, the Exploratory Works scope now comprises:

Table 1.1 New scope items for EW (Stage 1 & 2) as a result of MOD1

Stage 1	
Lobbs Hole Substation	Additional disturbance area required for the construction power connection to an existing transmission line (Line 2) at Lobs Hole for power supply to the Exploratory Works accommodation camp and construction areas. This will provide a reliable and long-term source of construction power and will reduce the reliance on diesel generation and associated on-site storage requirements and emissions. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas; This will include: • construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation; • geotechnical investigation works to inform the detailed design of the construction power substation; • replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height; • short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54; • 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables; • establishment and upgrade of access tracks and roads to the new substation and transmission line structures; • installation of a fibre optic communication link into the new substation from the approved communication network; and • ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas. (Illustrated Appendix C WMP Figure 1i)
Camps Bridge and Wallaces Creek	• additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment; (Illustrated in Appendix C WMP Figures 1h and 1i of this plan and Modification 1 Assessment Report Figure 3.9)
Lobs Hill Ravine Road and Construction Boundary Changes	• minor changes to the project boundary identified through detailed design including: – revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; – minor additions to construction areas for design optimisation.

	• removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road; (Illustrated in Appendix C, WMP Figures 1d, 1e, 1f and 1i)
Operating Hours	• modify operating hours from existing 7 am to 6pm to sunrise to sunset
Miscellaneous	• continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program; and • increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected. (location of communications towers illustrated in Appendix C WMP Figures 1a, 1f, 1l)
Stage 2	
Borehole drilling and geophysical surveys	• Borehole drilling and geophysical surveys for further geotechnical investigation of the Snowy 2.0 power station and power waterway at Marica, Talbingo and Tantangara; • clearing of up to 2.79 hectares (ha) of additional vegetation for access tracks and drilling pads. • About 1.33 ha within Smokey Mouse potential habitat; • trimming of overhanging dangerous branches on adjacent trees (these trees will not require removal); • mulching of trees and vegetation; • establishment of an additional 1 km of access tracks (4 m wide), including minor earthworks, • placement of geofabric (as required) and import of stabilised material; • establishment of eight drilling pads and boreholes at top of the cavern area, with an area of 900 m2 per pad, including minor earthworks, placement of geofabric (as required) and import of stabilised material (as required); • undertaking geophysical surveys near Talbingo and Tantangara reservoirs; • establishment of two drilling pads and boreholes at both Tantangara and Talbingo with an area of • 900 m2 per pad, including approximately 400 m of additional access tracks and minor earthworks (as required); • establishment of in-reservoir boreholes including one in Talbingo Reservoir and two in Tantangara Reservoir; • drilling of additional nested vertical boreholes at each of the drilling pads up to a depth of 1,100 m; • conversion of the investigation boreholes into monitoring bores; • undertaking geophysical surveys; and

	• rehabilitation of the drilling pads and access tracks following completion of works • ongoing maintenance of existing access tracks required for geotechnical investigations within KNP (Illustrated in (Illustrated in Appendix C WMP Figure 1j, 1k, 1l, 1m and 1n)
Talbingo Laydown	Outside of KNP, SHL is proposing to add four laydown locations to facilitate the construction of the communications cable linking Lobs Hole with the Tumut 3 Power Station. These are proposed on existing hardstand areas along Talbingo Reservoir within Snowy Hydro owned land. (Illustrated in Appendix C, WMP Figure 1o)
Tantangara Access	Two additional geotechnical boreholes are required to facilitate the detailed design of cuttings, bridge foundations, retaining wall foundations, and drainage structures near Nungar Creek (Illustrated in Appendix C, WMP Figure 1m and 1n)

The Exploratory Works is estimated to take around 30 to 34 months to complete.

As with most of the existing Snowy Scheme, the majority of Snowy 2.0 is within Kosciuszko National Park. Snowy Hydro has been working with NSW National Parks and Wildlife Service (NPWS) since the announcement of Snowy 2.0 to ensure long term management objectives for Kosciuszko National Park are considered in project development.

The Project has been designed in a way that avoids and minimises impacts to Kosciuszko National Park where possible. This has included the planning of access roads and construction areas to avoid impacting the heritage listed Washington Hotel ruins at Lobs Hole, and Smoky Mouse habitat along Upper Lobs Hole Ravine Road. It also includes designing road upgrades to minimise impacts to geodiversity features including a block stream and a fossil outcrop along Lower Lobs Hole Ravine Road. The former copper mine at Lobs Hole is also considered a geo-heritage site, however it is also a source of known contamination and has therefore been avoided as much as possible to prevent disturbance.

While there are some unavoidable impacts during construction, the Exploratory Works will allow for a number of longer-term benefits and contributions to Kosciuszko National Park through a biodiversity offset program, improved access roads and recreational facility upgrades. The completion of Exploratory Works will also allow for the greater benefits of Snowy 2.0 to be realised.

1.3 Construction activities and staging

Exploratory Works will be delivered in three stages:

- **Stage 1a – Pre-construction Minor Works -** pending the approval process, works may commence in the first quarter of 2019. The scope of pre-construction minor works includes dilapidation studies, survey work, borehole installation, site office establishment, minor access roads, installation of monitoring equipment, installation of erosion and sediment controls, archaeological salvage and minor clearing;

- **Stage 1b – Exploratory Works Access Roads (EWAR)** - pending the approval process, works may commence in the first quarter of 2019. The scope includes roadworks and upgrades to enable access and haulage routes during Exploratory Works;

- **Stage 2 – Exploratory Works** - pending progress with Stage 1, works may commence in quarter three of 2019. The scope for Stage 2 will be the remainder of the Exploratory Works, including the exploratory tunnel, portal construction pad, accommodation camp and excavated rock management. Stage 2 also includes subaqueous emplacement within Talbingo Reservoir.

To present the staging of plans a separate Staging Report has been prepared and was submitted to Department of Planning and Environment. Timing of the Exploratory Work stages is presented below.

Figure 1.1 Timing of Exploratory Works stages

1.3.1 Exploratory Works Access Roads

The Exploratory Works Access Roads (EWAR) will provide early access to the tunnel portal located to the east of the Talbingo Reservoir, and to Talbingo Reservoir itself. The works include upgrades to and/or construction of the following internal roads:

- Ravine Road;
- Mine Trail Road;
- Lobs Hole Road;
- Wharf Road.

The EWAR scope includes but is not limited to the following:

- setting out the works including delineation of site boundaries;
- establishment of all site facilities required and removal upon completion, including all temporary safety and security measures required;
- locating and protecting all public and private utility services;
- maintenance of the existing roadway and associated infrastructure;
- clearing and grubbing of vegetation including creation of mulch and compost;
- establishment of short term and long-term (eg: detention and sedimentation basins) erosion and sedimentation control systems and devices;
- removal and disposal of existing infrastructure including pipes, culverts, drainage channels and other minor structures;
- excavation and stockpiling of topsoil;

- earthworks including excavation of cuttings, construction of fills including selected zone material, and placement of excess spoil in stockpile;
- progressive opening to traffic;
- treatment of cut and fill slope batter surfaces including slope retention systems where shown;
- construction of clean and dirty water drainage systems including culverts, open and subsoil drainage systems;
- construction of pavements including subgrades and pavements and road surfacing;
- design, supply, construction of temporary structures / bridges over Wallace Creek and the Yarrangobilly River and removal of completion;
- construction of permanent bridges over Wallace Creek and the Yarrangobilly River;
- installation of road furniture including but not limited to barriers, line marking, guide posts and road signs;
- placement / replacement of topsoil and revegetation and other surface treatments to disturbed earth surfaces including lining of open drains;
- clean up and restoration of work areas and areas disturbed by the contractor.

The additional EWAR scope as a result of MOD1 will include:

- construction of a 330/33 kV substation within Kosciuszko National Park and adjacent to Line 2, which forms a 330-kV connection between Upper Tumut Switching Station and Yass Substation;
- geotechnical investigation works to inform the detailed design of the construction power substation;
- replacement of one transmission support structure (Structure 54) within the existing transmission easement. This will involve removal of the existing structure and establishment of one new steel lattice tower, approximately 50 m in height;
- short overhead 330 kV transmission line connections (approximately 100 m in length) between the substation and the new Structure 54;
- 33 kV feeder connection between the substation and the Exploratory Works construction power network. This will be either overhead lines or underground cables;
- establishment and upgrade of access tracks and roads to the new substation and transmission line structures;
- installation of a fibre optic communication link into the new substation from the approved communication network; and
- ancillary activities, including brake and winch sites, crane pads, site compounds and equipment laydown areas.

- minor changes to the project boundary identified through detailed design including:
  - additional disturbance area around Camp Bridge and Wallaces Creek Bridge required for improved constructability of the crossings. Works within these areas will include vegetation clearing, levelling earthwork, erection of falsework, sediment controls, laydown, parking and movement of equipment;
  - additional disturbance area required for the construction power connection to an existing transmission line at Lobs Hole. Works in this area will include establishing a substation, connection infrastructure, access roads and ancillary construction areas;
  - revised road upgrade for Lobs Hole/Ravine Road to improve access, drainage and safety; and
  - minor additions to construction areas for design optimisation.
- removal of dangerous trees on Lobs Hole Ravine Road. This will involve either complete or partial removal of up to 91 trees that have been identified to pose a safety risk to road users on Lobs Hole Ravine Road and Mine Trail Road;
- continued use of existing communications towers within KNP that were previously approved by the NPWS under a separate review of environmental factors (REF R – Wallaces Creek Geotechnical drilling) environmental impact assessment carried out under the NSW National Parks and Wildlife Act 1974 (NPW Act) and its regulation for the geotechnical investigation program; and
- increase in peak traffic volumes. Additional vehicles will be required to access the site to facilitate construction of Exploratory Works, however no change in impacts to the road network are expected.

The works are proposed to commence in the first quarter of 2019

This Plan identifies the project's environmental management measures in relation to general groundwater management. aspects and appropriate management measures. It has been specifically developed for Stage 1 of the Exploratory Works project and includes management measures for aspects and impacts previously addressed within the Pre-Construction management documents. This GWMP will be revised prior to commencement of Stage 2 works as detailed in the Environmental Management Strategy (EMS) Section 2.1 and Section 4.1.3 and the Staging Report (February 2019).

The timing of the preparation, consultation and submission of this plan is shown within Figure 4.3 of the Environmental Management Strategy (EMS). During Stage 1 of the work ongoing revisions to the GWMP will occur in accordance with Section 1.6.1 of the EMS.

Some distinct work activities such as the management of waste rock from the tunnelling activities, require greater detail and therefore warrant a separate plan. The activities which are also related to groundwater management which are detailed within other management plans, are shown within Table 1.2.

It is also noted that this plan includes a number of sub-plans required to comply with the requirements of condition 34 of the conditions of approval. These are also detailed in Table 1.2.

Table 1.2 Relationship to other plans

Activities	Relevant plan	Timing of the plan*	
		Stage 1	Stage 2
Road construction and tunnelling – general management of groundwater	This plan	P	R
Surface Water	Surface Water Management Plan	P	R
Erosion and sedimentation management	Surface Water Management Plan	P	R
Extracted tunnel groundwater processing within the process water system	Surface Water Management Plan		P
Excavated tunnel rock stockpiling	Excavated Material Management Plan	P	R
Excavated spoil disposal in Talbingo Reservoir	Subaqueous Emplacement Management Plan		P
Dredge spoil disposal	Dredge Management Plan	P	R
Geodiversity and karst features	Historic and Natural Heritage Management Plan	P	R
Existing land contamination	Contaminated Land Management Land	P	R

* P – prepare, R – revise

Specific on-site management measures identified in this Plan will be incorporated into these documents which are to be prepared by the Contractor. These documents will be prepared for construction activities and will detail the management measures which are to be implemented on the ground. Construction personnel will be required to undertake works in accordance with the mitigation measures identified in the site-specific documents.

1.4 Environmental management system

The overall environmental management system for the Project is described in the EMS. This GWMP forms part of Snowy Hydro Limited's environmental management framework for the Project, as identified in Figure 1.2 and as described in Section 4 of the EMS.

This Plan aims to transfer the relevant requirements of the Approval documents into a management plan which can be practically applied on the Project site.

Figure 1.2 EMS structure

1.5 Purpose and objectives

The key objective of the GWMP is to ensure that impacts on groundwater are minimised and within the scope permitted by the Infrastructure Approval during Stage 1 delivery of the project. To achieve this objective, Snowy Hydro and the Contractor will implement this approved plan and:

- ensure appropriate controls and procedures are implemented during construction to avoid or minimise groundwater impacts and potential adverse impact;
- ensure appropriate measures are implemented to address the relevant conditions of approval and the REMMs listed within the Submissions Report, as detailed within Table 2.1 and Table 2.2 of this Plan; and
- establish a groundwater monitoring program to assess impacts on the surrounding environment.

1.6 Plan preparation

In accordance with the requirements of Condition 34 of the conditions of approval this plan has been prepared by Sean Cassidy of EMM Consulting. These representatives were approved by the Secretary of Department of Planning and Environment (DPE) on 13 February 2019.

2 Environmental requirements

2.1 Legislation

Legislation relevant to groundwater management includes:

- *E*nvironmental Planning and Assessment Act 1979 (EP&A Act);
- *Environmental Planning and Assessment Regulation 2000*;
- *Protection of the Environment Operations Act 1997;*
- *Protection of the Environment (General) Regulation 2009* (as amended);
- *Water Management Act 2000;*
- *Water Management Amendment Act 2014;*
- *Water Management (General) Regulation 2011;*
- *Aquifer Interference Regulation 2011;*
- *Snowy Hydro Corporatisation Act 1997;*
- *Water Sharing Plan for the Murrumbidgee unregulated and alluvial water source 2012* (unregulated WSP);
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011;*
- *Water Sharing Plan for the South Coast Groundwater Sources 2016.*

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the EMS.

2.2 Conditions of Approval

Groundwater management conditions specified under Schedule 3 of the Approval are presented in Table 2.1.

Table 2.1 Conditions of approval relevant to groundwater management

Condition	Requirement	Where addressed
31	The Proponent must ensure that it has sufficient water for all stages of the development; and if necessary, stage the development to match its available water supply. Note: Under the Water Management Act 2000, the Proponent must obtain the necessary water licences for the development.	Section 2.4
32	Unless an environmental protection licence authorises otherwise, the Proponent must comply with Section 120 of the POEO Act. Note: Section 120 of the POEO Act makes it an offence to pollute any waters.	Section 5
34	The Water Management Plan required under this approval must: (e) include a Groundwater Management Plan that includes:	This Plan
	• detailed baseline data on groundwater levels, yield and quality on the aquifers that could be affected by the development;	Appendix A
	• a program to augment the baseline data during the development;	Section 6
	• groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;	Section 6
	• a description of the measures that would be implemented to minimise the groundwater impacts of the development	Section 5 Section 6
	• a program to monitor and report on:	Section 6
	○ groundwater inflows to the tunnel, including inflows to relevant water sources;	Stage 2
	○ groundwater take from the groundwater bore;	Section 6
	○ the impacts of the development on: – regional and local (including alluvial) aquifers; – groundwater dependent ecosystems, stygofauna and riparian vegetation; and – base flow to surface water sources;	Section 6
	a plan to respond to any exceedances of the trigger levels and/or assessment criteria and mitigate and/or offset any adverse groundwater impacts of the development.	Section 6 Appendix B
35.	• The Proponent must implement the approved Water Management Plan for the development.	Section 1.4

2.3 Revised environmental management measures

Environmental safeguards and management measures are included in the EIS in Section 6.3. During preparation of the Submissions Report, revised environmental management measures were developed and are included in Section 8 of the Submissions Report. MOD1 was granted approval by DPIE on 2 December 2019.

The environmental management measures relevant to this Plan are listed in below. If additional measures are cross-referenced from another section of the EIS or Submissions Report, these measures are also included.

2.4 Licences and permits

2.4.1 Water source and licencing

For the Stage 1 work scope Snowy Hydro is required to licence groundwater extraction in accordance with the *Aquifer Interference Policy 2012* (AIP), the *Water Management Act 2000* (WMA 2000), and the relevant statutory Water Sharing Plans (WSPs). Sufficient water entitlement in the relevant groundwater or source will be held by Snowy Hydro and linked to the project via a dealing prior to that water take occurring. Where water is to be obtained via an existing licensed user or water supplier, an agreement will be put in place to ensure the necessary volumes can be obtain when required.

During Stage 1 construction water will be sourced predominately from the groundwater extraction from bores within Lobs Hole and the harvesting of water from the site erosion and sediment control basins. Consultation with DoI Water will continue in finalising licensing requirements.

Section 5.23 of the Environmental Planning and Assessment Act 1979 provides that a water use approval under section 89; a water management work approval under section 90; or an activity approval (other than an aquifer interference approval) under section 91 of the Water Management Act 2000 are not required for Critical State Significant Infrastructure.

2.4.2 Water Access Licence

The extraction of water from Talbingo Reservoir is proposed to be untaken via a Specific Purpose Access Licence (SPAL), which is currently being considered and in final stages of approval by the NSW Government. Once the SPAL is approved, a Miscellaneous Work approval will be issued by NRAR and then Water NSW will approve the nomination (link) between the SPAL and the miscellaneous Work Approval. Snowy Hydro will not require a water use approval as the project is designated Critical State Significant Infrastructure (CSSI). Section 5.23 of the *Environmental Planning and Assessment Act 1979* provides that the following approvals are not required - a water use approval under section 89; a water management work approval under section 90; or an activity approval under section 91 of the *Water Management Act 2000* (it is noted that the provisions for granting Aquifer Interference Approvals under the Water Management Act 2000 are yet to be '*switched on*', and therefore this approval is not yet available).

To obtain the required water for Stage 1 Snowy Hydro are investigating both supply from Talbingo under the above SPAL, and supply from the Lachlan Fold Belt Groundwater Source via water supply bores in the Lobs Hole Ravine area. Piezometers are currently being constructed to consider the viability of groundwater in this area and each piezometer will be fitted with automated data-loggers and programmed to log groundwater levels every six hours. Once piezometers are established and a sustainable groundwater supply is confirmed Snowy Hydro will seek to 'nominate' their existing Water Access Licence (obtained under the controlled allocation release), with the water supply bores (via a miscellaneous Work approval for the water supply bores).

The Aquifer Interference Policy requires Snowy to hold sufficient water licence to account for water take (either direct take for water supply or indirect take from tunnel inflow). As such licences will be held to account for all water take for water supply from relevant water sources (ie Talbingo Reservoir via the SPAL, and the Lachlan Fold Belt via the WAL granted under the controlled allocation). Associated approvals are largely exempt, but do require Miscellaneous Work approvals granted, and associated 'nominations' of licences to these works.

This will then provide for Snowy to be compliant with the Aquifer Interference Policy 2012 (AIP), the Water Management Act 2000 (WMA 2000), and the relevant statutory Water Sharing Plans (WSPs).

Consultation with DPIE will continue in finalising licensing requirements.

2.4.3 Environment Protection Licence

The works carried out in Stage 1 scope are considered scheduled for the Land Based Extractive Activities category and an Environment Protection Licence (EPL) has been obtained (EPL 21266) for this Stage. The EPL details specific monitoring conditions which must be complied with when undertaking the extractive activities works.

This plan will be updated as required to reflect any water quality conditions or monitoring requirements specified in the EPL. Subsequent updates to this plan will be carried out should monitoring requirements in the EPL be in-consistent with those outlined in Section 6. However should there be inconsistencies between the EPL and GWMP then the requirements of the EPL will take precedence until such time that the GWMP can be updated and approved. Any other relevant licences or permits will be obtained as required.

2.5 Guidelines and standards

The main guidelines, specifications and policy documents relevant to this Plan include:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000);
- *Australian Drinking Water Guidelines* (Natural Resource Management Ministerial Council (NRMMC), 2011);
- *Groundwater Dependent Ecosystems Risk Assessment Guidelines* (NOW 2012d);
- NSW State *Groundwater Quantity Management Policy* (2001 (unpublished));
- NSW State *Groundwater Quality Protection Policy* (DLWC 1998);
- NSW State *Groundwater Dependent Ecosystem Policy* (DLWC 2002);
- Australian *Groundwater Modelling Guidelines* (National Water Commission 2012);
- *National Water Quality Management Strategy Guidelines for Groundwater Quality Protection in Australia* (NWQMS 2013);
- Department of Primary Industries *Guidelines for Controlled Activities* (2012);
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* – March 2004.

3 Existing environment

The following section summarises existing groundwater conditions within and adjacent to the Project based on the information provided within the EIS. The EIS includes, in Appendix N, a Groundwater Assessment (GWA) which was prepared by EMM Consulting Pty Ltd. The following information has been extracted from the GWA where relevant.

3.1 Geology

The Exploratory Works project area is within a steeply incised ravine, along the western fringe of the Long Plains fault escarpment. Elevations typically range from around 550 to 1,400 metres Australian Height Datum (AHD). Most of the project area is characterised by deep gorges and steep sloping ridges, the product of incision from watercourse flow and historic glaciation.

Two distinct geological terrains ('Incised Ravine Area' and the 'Plateau Area') are within the broader Snowy 2.0 project area, separated by an escarpment caused by movement on the Long Plain Fault. The Exploratory Works project is situated on the western side of this fault structure, in the Incised Ravine Area.

The area is dominated by sedimentary and igneous rock of Silurian to Devonian age. The Silurian aged Ravine Beds, composed of stratified altered siltstone, sandstone and limestone, provide the structural framework and topographic control for this area. The Ravine Beds are overlain in areas, typically along the escarpment, by younger volcanic rock.

The Yarrangobilly Caves, a karstic limestone, is approximately 8 km north of the project. The caves will not be intercepted by the exploratory tunnel, as demonstrated through geotechnical drilling.

3.2 Hydrogeological units

The groundwater units within the area are defined as:

- localised unconsolidated shallow Quaternary gravels episodically recharged through rainfall/flooding events;
- shallow groundwater associated with weathered fractured rock (between 5 and 30 metres below ground level); and
- deep groundwater associated with deeper fractured rock (ie the Ravine Beds).

3.3 Groundwater recharge and discharge

The EIS advised of two primary sources of groundwater recharge:

- rainfall recharge (dominant recharge source) - estimated to be up to 10% within the Ravine region;
- direct leakage from rivers and storages (secondary recharge source).

Given the prominence of groundwater springs across the Project area, it is likely that the water table is locally elevated. The shallow water table is likely to be contributing to local drainage lines and larger creek systems. However, during periods of extended drought and seasonal fluxes associated with wet and dry seasons, hydraulic gradients may be reversed, prompting surface water systems to discharge to a reduced groundwater table.

The discharge area from the conceptualised groundwater systems is likely to be the Talbingo Reservoir. Locally, the Yarrangobilly River is also likely to gain from shallow groundwaters.

3.4 Groundwater levels and flow

The main groundwater flow direction in the Project area is regionally from areas of higher elevation in the east towards the west.

Groundwater levels are currently monitored at two monitoring sites (TMB01 and TMB05) adjacent to the proposed exploratory tunnel. Groundwater levels have shown little fluctuation since monitoring commenced in mid-February 2018.

A summary of the groundwater level data collected from locations relevant to Stage 1 to date are shown in Appendix A

3.5 Groundwater quality

A summary of the groundwater quality monitoring results to date are included in Appendix A of this plan.

The groundwater quality results are comparable and typical for the different formations across the larger Snowy 2.0 project area. Within the Exploratory Works area, pH is slightly alkaline, averaging 7.5, while salinity is observed to be marginal (780 µS/cm).

Concentrations of most dissolved metals are typically low, with many measurements below detection limits. This is typical of groundwaters with reasonably neutral pH and in alpine areas where the groundwater is readily recharged via rainfall and snow melt.

3.6 Ecosystems that rely on groundwater

An assessment of ecosystem groundwater reliance is described in Appendix F of the EIS which contains the Biodiversity Assessment.

The Yarrangobilly Caves are listed as the only high priority GDE in the Fractured Rock WSP within a 50 km radius of the Exploratory Works project area. The Yarrangobilly Caves are an important limestone karst feature approximately 8 km north of the project area. The Yarrangobilly Caves have an entirely obligate dependence on groundwater. Their formation over time and current structure is maintained by groundwater levels, flow, and quality.

Three native vegetation types were identified to occur where groundwater is less than 5 m deep, and therefore have potential to access groundwater sporadically at these locations. These terrestrial plant community types include:

- Broad-leaved Sally grass – sedge woodland on valley flats and swamps;
- Brittle Gum peppermint open forest of the Woomargama to Tumut region; and
- Riparian Blakeley's Red Gum Woodland Broad-leaved Sally woodland, tea-tree, bottlebrush, wattle shrubland wetland.

These terrestrial ecosystems are not highly dependent or entirely dependent on groundwater.

3.7 Extractive water users

There are no registered groundwater users within the project area or within a 20 km search around the project area boundary.

4 Environmental aspects, impacts and risks

4.1 Environmental aspects and impacts

An environmental aspect is an element of an organisation's activities, products, or services that has or may have an impact on the environment (ISO 14001 Environmental management systems). The relationship of aspects and impacts is one of cause and effect.

Key aspects during Stage 1 of the Project that could result in groundwater impacts are identified in Table 4.1. The extent of these impacts will depend on the nature, extent and magnitude of construction activities and their interaction with the natural environment (Column 2). This is further exacerbated by environmental factors (Column 3).

The EIS indicated that the construction of the exploratory tunnel would draw up to a maximum of 354 megalitres per year (ML/year) of groundwater from the Ravine Beds. The assessment, indicated that extraction of water at this rate would not have an impact on the local environment, including the local groundwater source, groundwater users, baseflows to nearby rivers and tributaries and groundwater dependent ecosystems (GDEs). The EIS found that there will be some localised drawdown of groundwater due to tunnelling but this will not adversely impact local ecosystems or vegetation potentially dependent on groundwater.

Groundwater extraction for construction purposes would be undertaken prior to tunnelling works in existing disturbed areas of Lobs Hole. The amount of groundwater extracted for construction purposes prior to tunnelling would be limited to less than 219 ML at peak construction demand, and therefore will not exceed the maximum of 354 ML/yr modelled as part of the groundwater assessment. Groundwater impacts associated with the construction and operation of a bore for the purposes of water supply for pre-construction and construction purposes would not have an impact on the local environment.

In terms of groundwater quality, the potential for groundwater contamination is greatest adjacent to excavated rock emplacement areas, given the areas proximity to the highly porous, unconsolidated colluvium. Potential impacts and management measures associated with the rock emplacement areas are discussed in the Excavated Material Management Plan and revisions of this plan for Stage 2. Appropriate engineering controls will be implemented during construction do minimise the likelihood of impact on shallow groundwater.

Table 4.1 Project aspects and impacts relevant to groundwater

	**Environmental Aspects** (Construction activities likely to cause groundwater impacts)	**Environmental Impacts**	**Environmental Factors** (Conditions)
	Water use and extraction Dewatering Refuelling and chemical handling Drilling and piling Excavations intercepting the groundwater table	Reduction in groundwater levels Groundwater contamination Reduction in baseflow from groundwater into waterways Loss of groundwater dependant ecosystems or species	**Existing groundwater levels and inflows** – groundwater inflows will be influenced by the existing groundwater level and groundwater pressure. **Existing baseflow dependency** – some waterways are not reliant on groundwater to contribute to baseflow conditions. **Geology type** – rock and soil types can impact the flow of groundwater into excavations. **Seasonal fluctuations** – waterways may be more reliant on groundwater inflows during periods of dryer weather. **Existing groundwater quality** – Existing groundwater quality in the Lobs Hole Mine area, mainly around the South Adit Area (Eastern Emplacement) due to mine workings and waste and to a lesser degree the Western Emplacement.

4.2 Environmental risk assessment

The environmental aspects and impacts for groundwater are further considered within Appendix A3 of the EMS. This includes a risk assessment process. The risk assessment is based on (1) the likelihood of an impact occurring as a result of the aspect; and (2) the consequences of the impact if the event occurred. The major risks for groundwater during Stage 1 are the risk of hydrocarbon spills. Mitigation measures are discussed below in Section 5.

5 Environmental management measures

5.1 Management measures

A range of environmental requirements and control measures are identified in the EIS, Submissions Report and the Infrastructure Approval. Safeguards and management measures will be implemented to avoid, minimise or manage impacts to groundwater.

Specific safeguards and management measures to address the construction groundwater impacts during Stage 1 of the Project are outlined in Table 5.1.

Table 5.1 Groundwater management and mitigation measures

ID	Measures/Requirements	Stage applicable	When to implement	Responsibility	Reference
General					
GW01	Training will be provided to all project personnel, including relevant sub-contractors on groundwater management, emergency spill response and the use of spill kits and the requirements from this plan through inductions, toolboxes and targeted training.	All	Pre-construction / Construction	Contractor	Condition 34 REMM WAT01
GW02	Groundwater management measures from this plan will be included in relevant Environmental Work Method Statements (EWMS) and/or Erosion and Sediment Control Plans (ESCPs).	All	Pre-construction / Construction	Contractor	Good practice
Procedures and plans					
GW03	Spills and emergency response will be managed in accordance with the Emergency spill response procedure included in Appendix E of the SWSMP.	All	Construction	Contractor	REMM WAT01
Groundwater management					
GW04	Groundwater discharged to water courses will be within the agreed receiving water quality criteria and unless an environmental protection licence authorises otherwise, in compliance with Section 120 of the POEO Act.	All	Construction	Contractor	REMM WAT03 Condition 32
GW05	Where reasonable and feasible, sites used for batch plants, refuelling and chemical storage will be managed so that no groundwater intrusion occurs.	All	Construction	Contractor	REMM WAT01
Groundwater contamination					
GW06	Emergency spill kits will be readily available at key construction sites across the project and workers trained in their use.	All	Construction	Contractor	REMM WAT01
GW07	At surface refuelling is to be undertaken away from waterways in designated impermeable areas.	All	Construction	Contractor	REMM WAT01
GW08	Storage and handling of chemicals, fuels and oils will be as per manufacturer's instructions in bunded storage areas.	All	Construction	Contractor	REMM WAT01
GW09	In the event of existing contaminated groundwater being identified during construction the associated works will cease and the unexpected find procedures included in the Contaminated Land Management Plan will be followed.	All	Construction	Contractor	Good Practice

Table 5.1 Groundwater management and mitigation measures

ID	Measures/Requirements	Stage applicable	When to implement	Responsibility	Reference
GW10	In the event of existing contaminated groundwater being identified during construction the associated works will cease and the unexpected find procedures included in the Contaminated Land Management Plan will be followed.	All	Construction	Contractor	Good Practice
GW11	All workers are to conduct regular vehicle pre-starts to inspect construction vehicles and mechanical plant for leakage of fuel and /or oils and any other defects.	All	Construction	Contractor	Good Practice
GW12	During borehole drilling slurries used will be of appropriate grade and composition such that it poses no threat to groundwater quality should it infiltrate intersected aquifers.	All	Construction	Contractor	REMM M1.6
GW13	During construction of the Lobs Hole substation contractors should assess groundwater conditions as a precaution during excavation. If water is encountered, excavation should cease pending further advice and site-based assessment of conditions.	All	Construction	Contractor	REMM M1.7
Monitoring and model validation					
GW14	Groundwater monitoring for Stage 1 will be undertaken in accordance with the Groundwater Monitoring Program in Section 6. Additional baseline development including the installation of further monitoring wells (shallow groundwater at Lobs Hole and the tunnel portal) will be undertaken outside of this monitoring program and will be used to inform the development of the Stage 2 monitoring program.	All	Pre-construction and construction	Snowy Hydro	Condition 34 REMM 02
GW15	Groundwater extraction during Stage 1 will be monitored in accordance with the Ground Water Monitoring Program in Section 6. The data will be used to confirm water use.	All	Construction	Snowy Hydro	Submissions Report Section 4.4.4 Condition 34
GW16	Groundwater level monitoring will be undertaken in accordance with the Groundwater Monitoring Program to provide early warning for impacts beyond those assessed for: • baseflow connected waterways; • the local groundwater flow system; • local depressurisation of groundwater resources; • groundwater dependant ecosystems.	All	Construction	Snowy Hydro	REMM WAT02 Condition 34

Table 5.1 Groundwater management and mitigation measures

ID	Measures/Requirements	Stage applicable	When to implement	Responsibility	Reference
GW17	Groundwater monitoring results will be reviewed and if results indicate that the mitigation measures employed are not effective modification to the mitigations controls will be implemented and the GWMP updated.	All	Construction	Snowy Hydro	Condition 34

5.2 Model validation

Groundwater modelling for the EIS included an assessment of two predictive scenarios:

- a steady state simulation was produced to predict maximum impacts on baseflow to the Yarrangobilly River and drawdown at the water table across the model domain; and
- a transient simulation. This was undertaken because an aquifer access licence will be required for the maximum annual tunnel inflow, which will occur during tunnelling, a transient simulation was also constructed to identify likely tunnel inflow during tunnelling, not just after the groundwater system has re-equilibrated.

Prior to and during construction, the groundwater model predictions from the scenarios above will be validated regularly as new monitoring data and new monitoring sites become available. Significant deviations from the predicted impacts will be analysed and investigated by Snowy Hydro.

Further detail relating to groundwater monitoring is included in Section 6.

6 Compliance management

This groundwater program is not intended to provide for the collection of all additional baseline data required for Stage 2 (tunneling), however the data collected as part of Stage 1 from existing bores will be used to inform the baseline data required for Stage 2 construction.

Additional or varied monitoring locations may be warranted following detailed design and during construction. Changes to the monitoring locations would be approved by Snowy Hydro prior to relocation or addition of monitoring locations and updated in subsequent revisions of the water quality monitoring program.

6.1 Monitoring and inspection

This groundwater monitoring program will be implemented during Stage 1 of Exploratory Works.

The primary objectives of the program are to:

- enable the effectiveness of water quality controls and mitigation measures to be confirmed for Stage 1;
- identify and quantify water quality impacts for Stage 1;
- provide the actions required in the event of trigger value exceedances during Stage 1; and
- assess compliance with relevant consent and license conditions and other monitoring requirements including prescribed targets for the project.

6.1.1 Responsibilities

During Stage 1, sampling and testing will be coordinated by Snowy Hydro.

Sample data collected by Snowy Hydro will be provided to the Contractor for analysis, investigation and reporting as described in Section 6.6. At all times during construction the Contractor will be responsible for initiation of the TARP's and implementation of corrective measures.

Additional requirements and responsibilities in relation to inspections are documented in Section 7 of the EMS.

6.1.2 Monitoring locations

Proposed monitoring locations for Stage 1 are shown in Figure 6-1. The requirements for groundwater analysis are also shown in Table 6.2 with detailed analysis shown in Table 6-3.

At the time of writing, a drilling program to explore groundwater in the Ravine area as a potential source of construction water for Stage 1 Exploratory Works is being completed. If exploratory boreholes are converted to Exploratory Works Production Bores, they will be monitored as detailed in Table 6-1. For exploratory boreholes that are not converted to production bores, boreholes will be backfilled to the first water strike and converted into Ravine Shallow Monitoring Bores to monitor the shallow groundwater system in the Ravine. Shallow monitoring bores will be monitored as detailed in Table 6-1. Both production and/or shallow monitoring bores will be used to monitor groundwater in the Ravine/Lick Hole areas.

Existing monitoring bore BH8108 has been drilled upgradient and BH8101 has been drilled downgradient of the proposed portal and adit areas. These monitoring bores will be used as baseline monitoring bores for Stage 2 Exploratory Works.

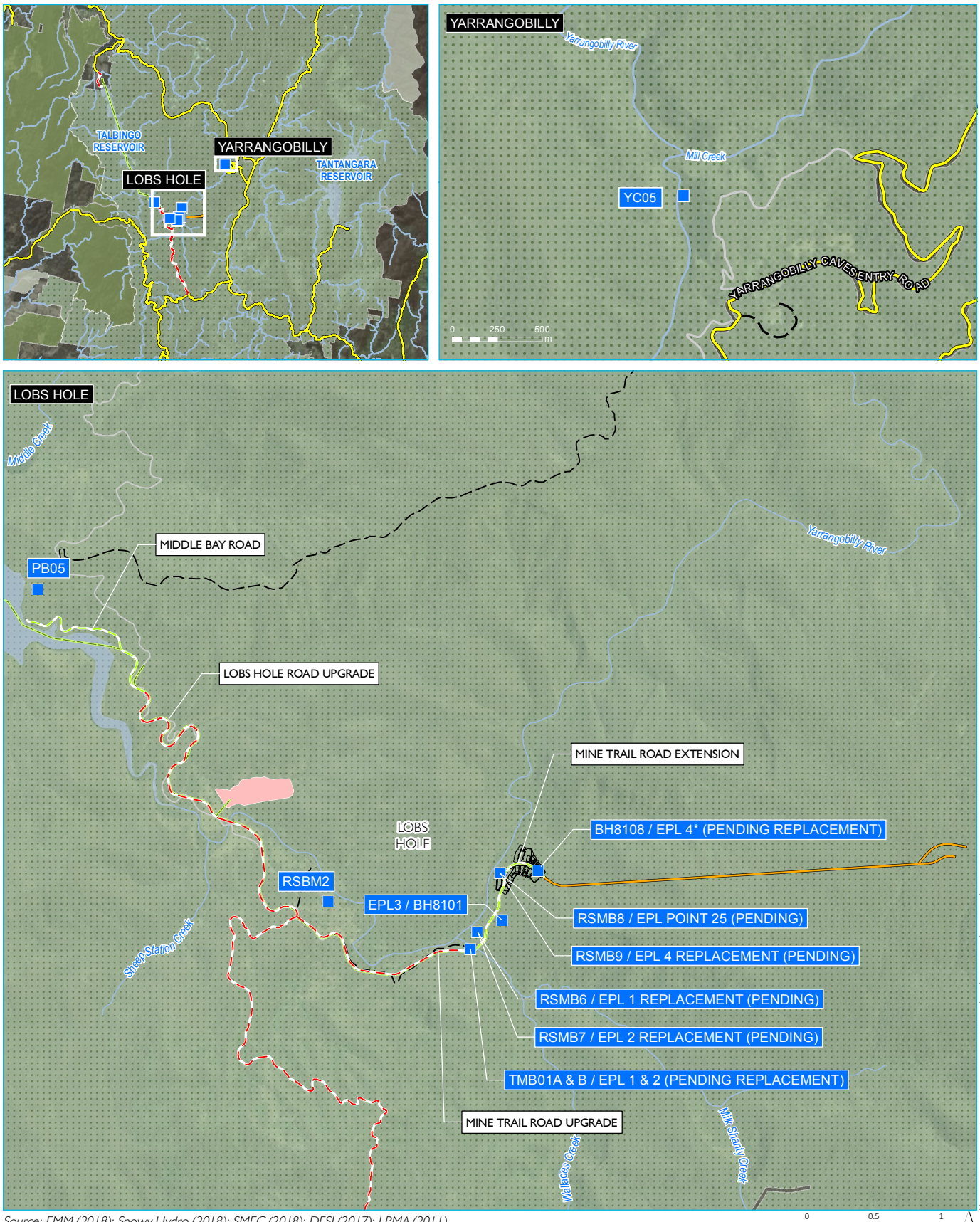
Available groundwater level hydrographs for TMB01A, TMB01B, TMB05A and TMB05B are illustrated in Figure 6-2 and Figure 6-3. PB05 groundwater level hydrograph is illustrated in Figure 6-4. YC05 Yarrangobilly Caves pool depth hydrograph is illustrated in Figure 6-5. Hydrographs for BH8101 and BH8108 will be provided in later revisions of this GWMP.

Table 6.1 Stage 1 Groundwater monitoring locations

Site ID	Type	Easting	Northing	Ground level (m AHD)	Total depth (m BGL)	Screen interval (m BGL)	Apparent yield (L/sec)	Monitored formation	Monitored parameters	Sampling frequency
TMB01A (pending replacement)	Impact – monitoring bore	627670	6038074	581.2	15	11-14	0.10	Boraig Group	Water quality (pH, EC, T, DO, ORP, Nutrients, Dissolved Metals) Groundwater level (pressure transducer)	Monthly water quality 6 hourly groundwater level monitoring
TMB01B (pending replacement)	Impact – monitoring bore	627670	6038074	581.8	72	63-69	0.50 – 3.00	Ravine Formation		
RSMB6	Reference – monitoring bore	TBA	TBA	TBA	TBA	TBA	TBA	Ravine Formation		
RSMB7	Reference – monitoring bore	TBA	TBA	TBA	TBA	TBA	TBA	Ravine Formation		
RSMB8	Reference – monitoring bore	TBA	TBA	TBA	TBA	TBA	TBA	Ravine Formation		
RSMB9	Reference – monitoring bore	TBA	TBA	TBA	TBA	TBA	TBA	Ravine Formation		
BH8101	Impact – monitoring bore	627906	6038287	610.0	69	53-65	No data	Ravine Formation		
BH8108 (pending replacement)	Impact – monitoring bore	628173	6038656	629.0	60	45-57	No data	Ravine Formation		
PB05	Reference – monitoring bore	624,500	6,040,714	614.3	100	50-100	0.01	Ravine Formation		

Table 6.1 Stage 1 Groundwater monitoring locations

Site ID	Type	Easting	Northing	Ground level (m AHD)	Total depth (m BGL)	Screen interval (m BGL)	Apparent yield (L/sec)	Monitored formation	Monitored parameters	Sampling frequency
Shallow Ravine Monitoring Bores*	Impact – Monitoring bore	TBA	TBA	TBA	TBA	TBA	TBA	Ravine Formation		
YC05	Reference – Cave pool depth	634324	6045941	884.2	NA	NA	NA	Yarrangobilly caves	Pool depth (pressure transducer)	Continuous
Groundwater extraction from Exploratory Works Production Bores*	Impact – Production bore	TBA	TBA	TBA	TBA	TBA	TBA	Ravine Formation	Volume - Measured extraction volume Water quality (pH, EC, T, DO, ORP, Nutrients, Dissolved Metals) Manual groundwater level measurement	Weekly volume Monthly manual groundwater level and water quality



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

KEY

- Groundwater monitoring point
- Access road upgrade
- Access road extension
- Exploratory tunnel
- Portal construction pad and accommodation camp conceptual layout
- Communications cable
- Portal construction pad and accommodation camp conceptual area
- Local road
- Vehicular track
- Perennial watercourse
- Scheme storage
- Kosciuszko National Park

Proposed Groundwater Management Plan monitoring locations (REV 1)

Snowy 2.0
Groundwater management plan
Figure 6.1

snowy 2.0

EMM creating opportunities

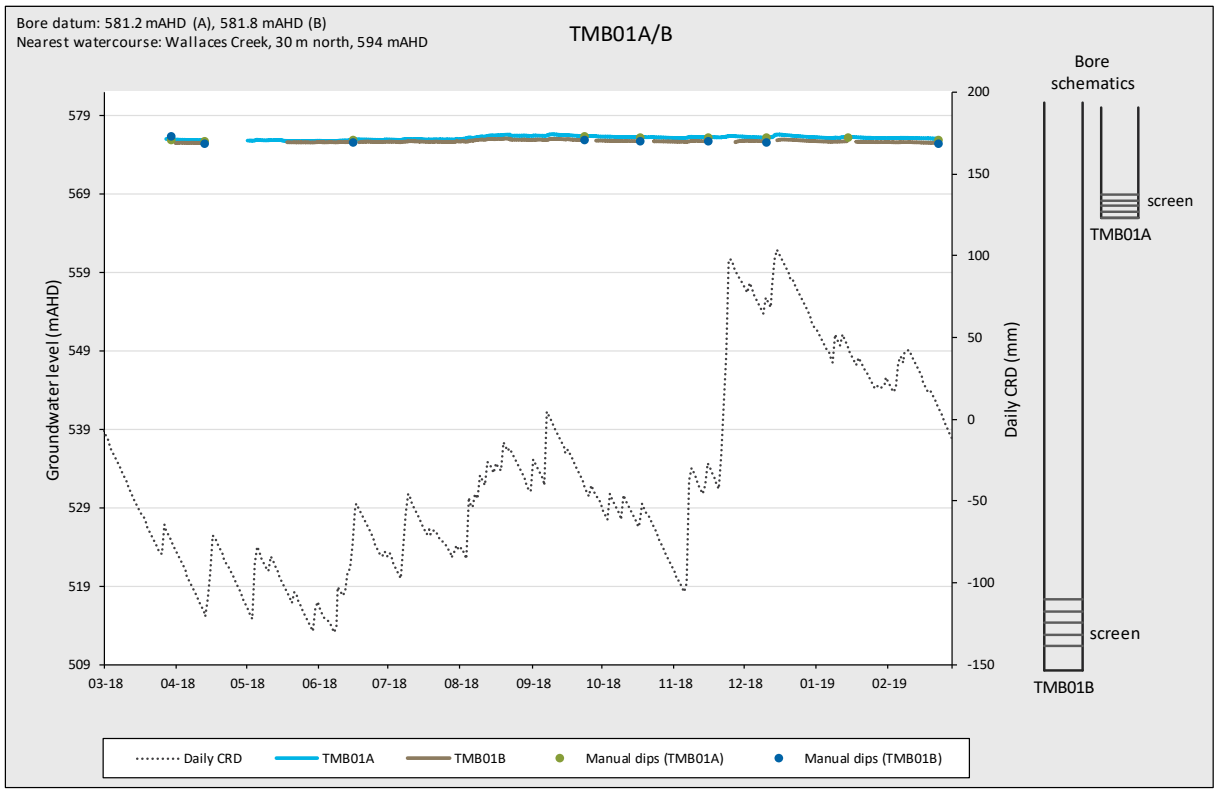


Figure 6.2 TMB01A and TMB01B groundwater level hydrograph

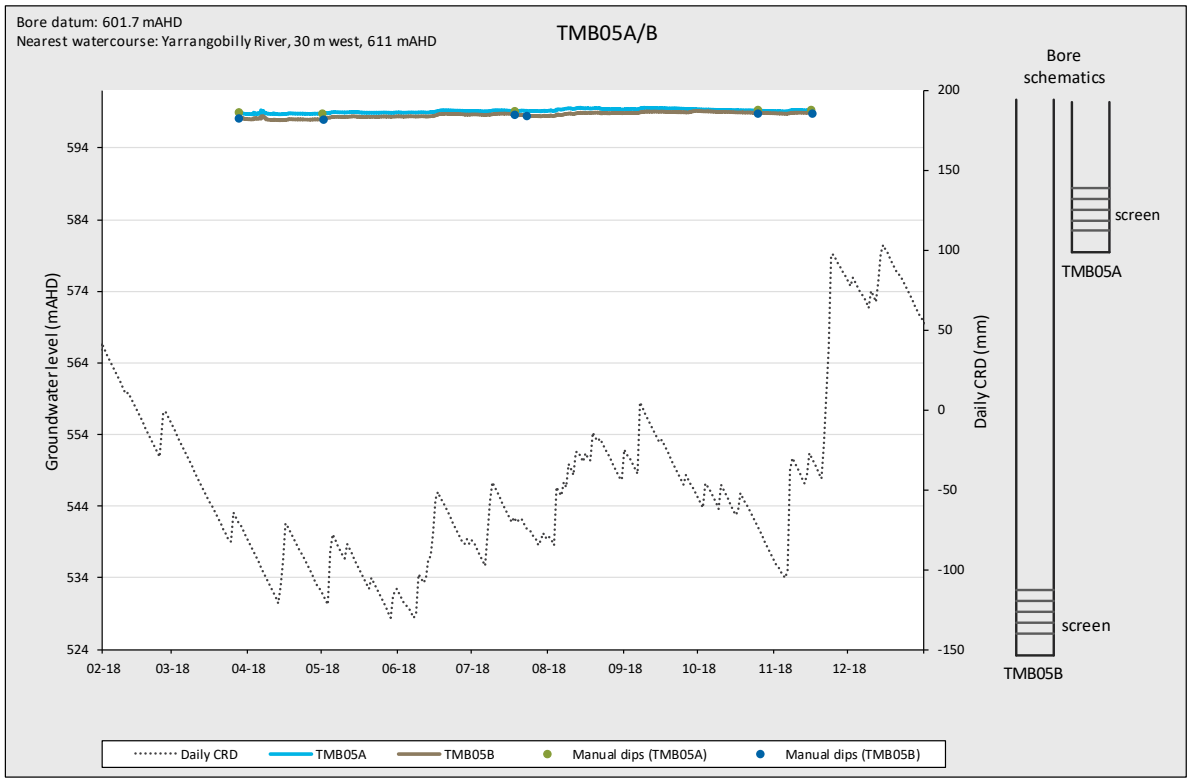


Figure 6.3 TMB05A and TMB05B groundwater level hydrograph

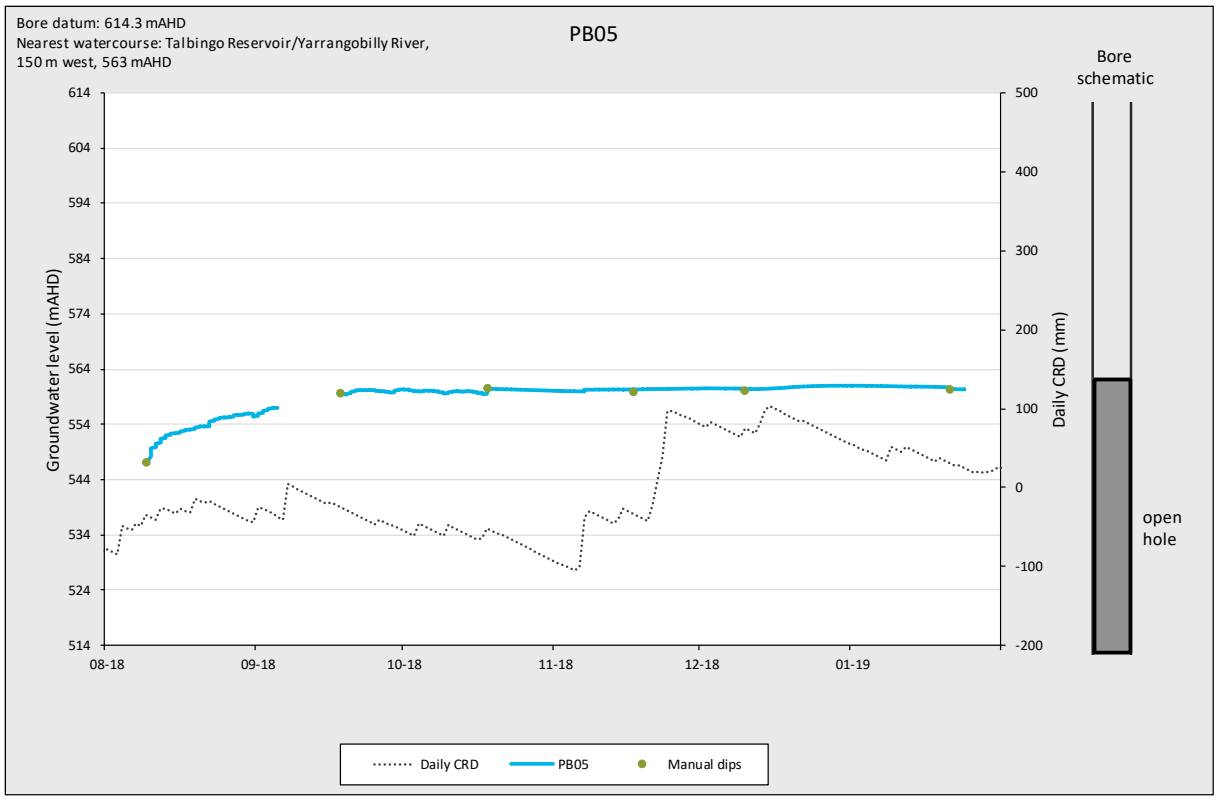


Figure 6.4 PB05 groundwater level hydrograph

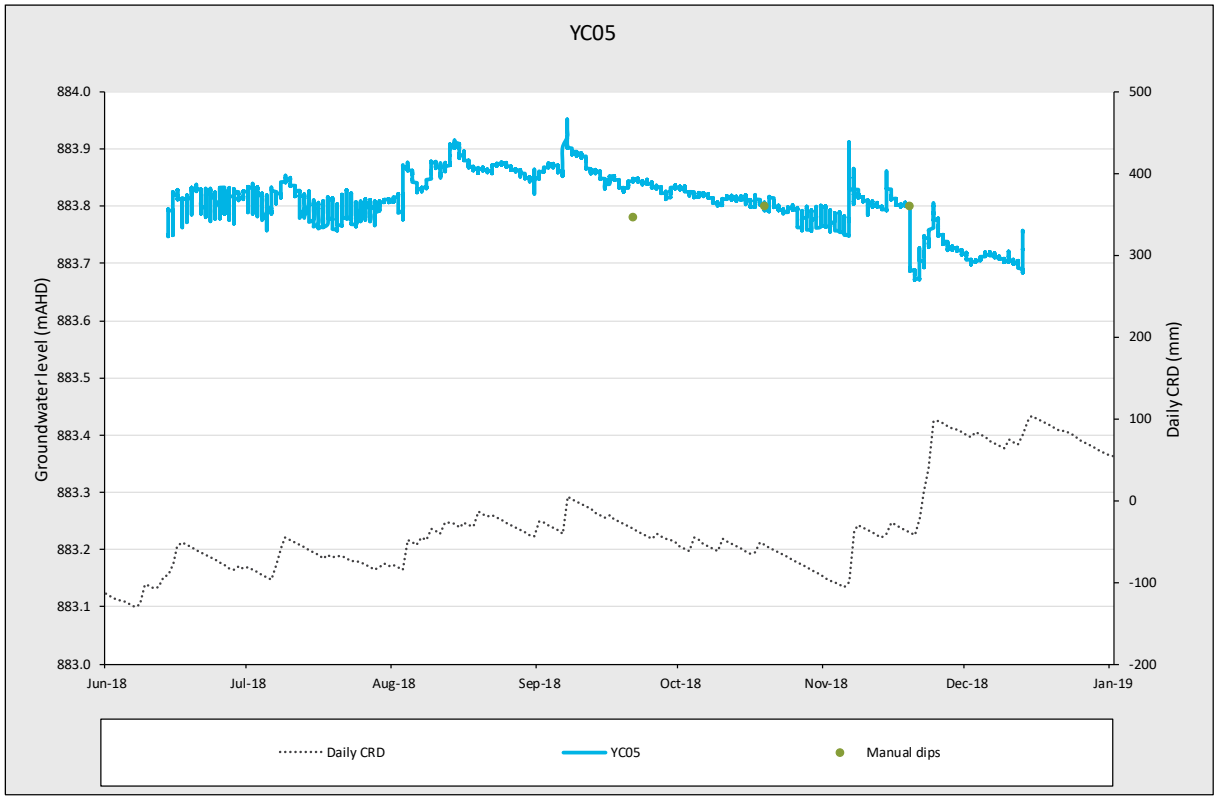


Figure 6.5 YC05 pool depth level hydrograph

6.2 Trigger levels and methodology

TMB01A, TMB01B, BH8101 and BH8108 have been designated as impact monitoring bores. Bores RSMB6, RSMB7 and RSMB9 are proposed to replace TMB01A, TMB01B and BH8108 as detailed within Table 6-1. When completed, either Shallow Ravine Monitoring Bores and Exploratory Works Production Bores will also be designated impact bores due to their proximity to Stage 1 activities. PB05 and YC05 have been designated reference monitoring sites due to their distance away from the proposed Stage 1 impact/work area. Data from transducer YC05 in Yarrangobilly Caves will be collected monthly to ensure trends are consistent with historical and climatic data.

6.2.1 Groundwater quality triggers

The ANZECC trigger values have been used to determine appropriate water quality targets to be applied to groundwater during construction. The proposed target values are shown in Table 6.2 and these will be used as the initial baseline to confirm the water quality within groundwater at nominated sampling locations.

The following ANZECC trigger values have been used to determine water quality targets:

- default trigger values that were sourced from relevant sections of ANZECC (2000) for south-east Australia (upland rivers), where applicable; and
- trigger values for the protection of 99% of species (freshwater), that are reported in Table 3.4.1 of ANZECC/ARMCANZ (2000), where applicable.

These default trigger values were also applied in the EIS during assessment of baseline groundwater quality, where relevant.

Should consistent exceedances be observed, a revision of this GWMP will be completed and Site Specific Trigger Values (SSTV's) established. If the exceedances are believed to be related to exploratory works, investigation into the exceedances are required as per Table 6-5 in Section 6.3.

Table 6.2 Groundwater quality trigger values

Category	Proposed sampling analytes	Unit	Analytical method	Water quality target
Physiochemical Properties (Basic)	pH	-	Field analysis	6.5 – 8.5
	Electrical conductivity (EC)	µS/cm		30 – 350
	Dissolved Oxygen	%/ppm		-
	Redox Potential (Eh)	mV		-
	Temperature	˚C		-
Nutrients	Total nitrogen (TN)	mg/l	NATA laboratory analysis	0.25
	Total phosphorus (TP)	mg/l		0.02
	Reactive phosphorus	mg/l		0.015
Metals (dissolved)	Aluminium (Al)	mg/l	NATA laboratory analysis	0.027
	Copper (Cu)	mg/l		0.0004
	Iron (Fe)	mg/l		0.3
	Lead (Pb)	mg/l		0.001
	Mercury (Hg)	mg/l		0.00006
	Manganese (Mn)	mg/l		1.2
	Nickel (Ni)	mg/l		0.008
	Silver (As)	mg/l		0.00002
	Zinc (Zn)	mg/l		0.0024

6.2.2 Groundwater level triggers

Initial groundwater level triggers assigned for Stage 1 monitoring bores have been calculated using baseline data collected since late March 2018 (Table 6.3). Groundwater level triggers presented in Table 6.3 have been calculated using the 20th percentile minus two (2) standard deviations.

Over extraction of groundwater in the Ravine Beds (from proposed Exploratory Works Production Bores currently being drilled) have the potential to draw down the natural groundwater table presenting a risk to groundwater dependent plants and/or ecosystems known within the area (Section 6.2.3). As such, only lower limit groundwater level triggers have been calculated.

Table 6.3 Groundwater level triggers

Bore ID	Type	Data range	Mean (mAHD)	Median (mAHD)	20th percentile (mAHD)	Standard Deviation (mAHD)	Trigger level (mAHD)*
TMB01A	Impact	27/03/18 – 1/02/19	575.902	575.906	575.855	0.053	575.749
TMB01B	Impact	27/03/18 – 1/02/19	575.749	575.713	575.629	0.135	575.360
TMB05A	Reference	28/03/18 – 16/11/18	599.162	599.184	598.922	0.247	598.427
TMB05B	Reference	28/03/18 – 16/11/18	598.614	598.714	598.326	0.352	597.622
BH8101[1]	Impact	TBA	TBA	TBA	TBA	TBA	TBA
BH8108[1]	Impact	TBA	TBA	TBA	TBA	TBA	TBA
RSMB2	Impact	TBA	TBA	TBA	TBA	TBA	TBA
RSMB6	Impact	TBA	TBA	TBA	TBA	TBA	TBA
RSMB7	Impact	TBA	TBA	TBA	TBA	TBA	TBA
RSMB8	Impact	TBA	TBA	TBA	TBA	TBA	TBA
RSMB9	Impact	TBA	TBA	TBA	TBA	TBA	TBA

Note: Exploratory Works Production Bores not included for groundwater level triggers because they will be pumped for water supply; * Trigger level – 20th percentile minus 2 x standard deviations, [1] Will be updated in later GWMP revisions as bore is to be installed and baseline data is still to be obtained.

Groundwater level triggers are an evolving mechanism, to account for seasonal and/or climatic related fluctuations, and will be updated with the collection of new data as Stage 1 progresses.

Groundwater level triggers will be updated to the date of the previous months collected data. If the 7 day moving average of the recently collected data exceeds the previous months trigger level for more than 30 days, an exceedance has occurred and investigation into the exceedance to discern whether it is a natural, anthropogenic or Exploratory Works related exceedance is required. If the exceedance is deemed to be seasonal and/or climatically driven, the recently collected data will be incorporated into the data set and the water level triggers updated for comparison for the following monitoring event. If the exceedance is deemed to be related to exploratory works, the groundwater level trigger is set at the previous months trigger level to assess the extent of impacts thereafter.

6.2.3 Groundwater Dependent Ecosystems

Figure 6-6 illustrates the locations and extent of groundwater dependent community types within the Exploratory Works area.

6.2.4 Groundwater dependent plant communities

An annual assessment of the Brittle Gum Peppermint Open Forest, White Box Yellow Box Blakeley's Red Gum Woodland, and Broad-leaved Sally grass-sedge, woodland and wetland ecosystem health (Section 3.6) will be undertaken using the Rapid Appraisal of Riparian Condition guidelines.

6.2.5 Yarrangobilly caves

An annual visual inspection of Yarrangobilly caves will be undertaken to confirm that there have been no groundwater related impacts that have affected the cave groundwater system.

6.2.6 Stygofauna

One stygofauna assessment will be completed prior to the commencement of Stage 2 exploratory works on bores that have not previously been assessed for stygofauna. Hereafter, one stygofauna assessment will be completed annually on monitoring bores listed in Table 6.1 until Stage 1 Exploratory Works are completed.

6.2.7 Groundwater Extraction

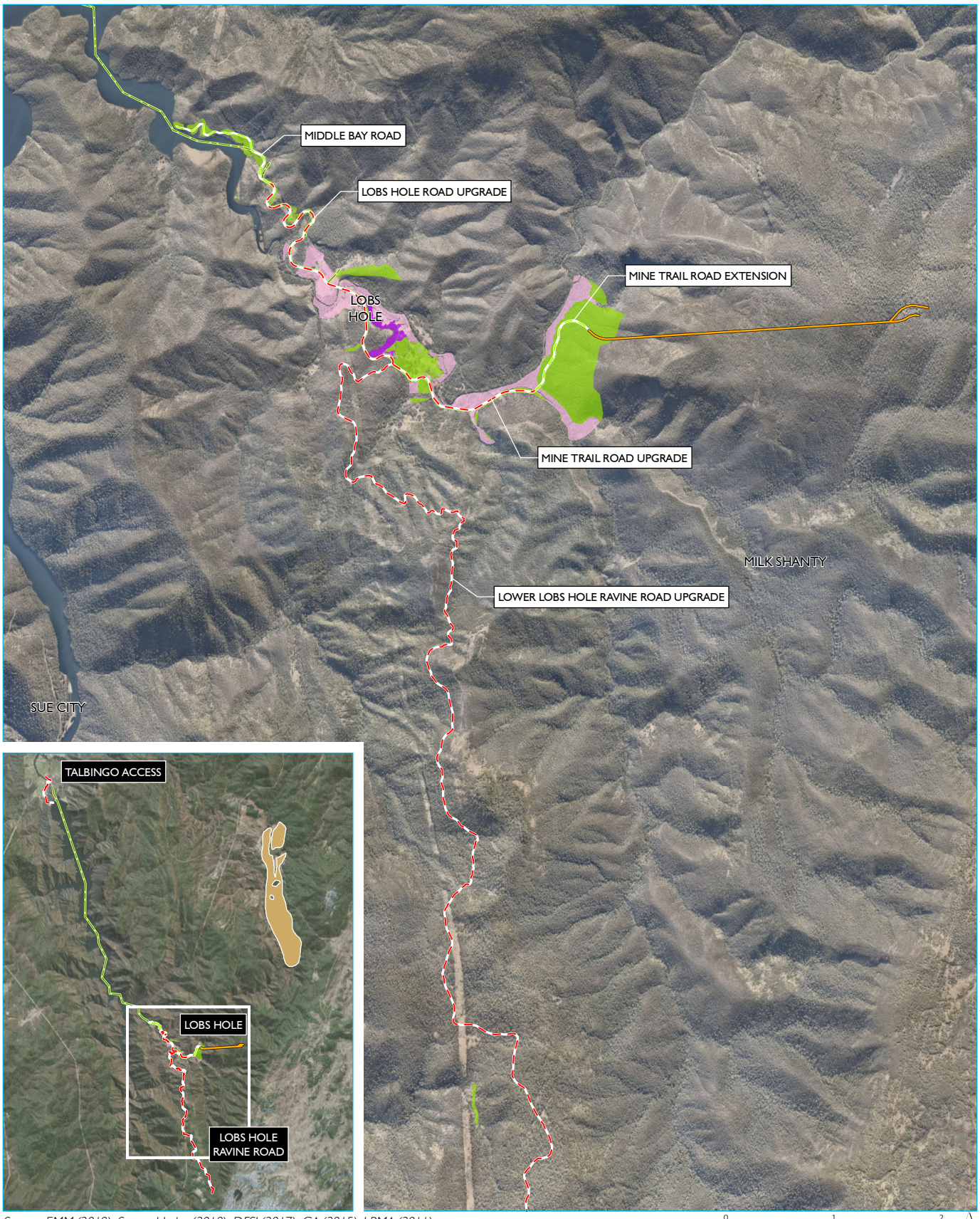
Groundwater extracted through proposed Exploratory Works Production Bores will be monitored to confirm that these remain below licenced extraction limits. Volumes will be recorded weekly and a record maintained on the project website.

6.3 Review and response procedures

Monitoring outcomes which exceed certain thresholds will be subject to the implementation of a Trigger Action Response Plans (TARPs). They allow prompt identification of unpredicted impacts and guide the implementation of additional management measures and corrective actions should certain unacceptable conditions arise. Mitigation measures will be adopted on a case by case basis, determined by the result of the investigation detailed in the TARP.

The TARPs will be is to be progressively updated with site specifics garnered from the monitoring program and management actions during the construction stage. A monthly monitoring data review and 6 monthly TARP review will be completed to ensure the TARP is consistent with the requirements of the groundwater monitoring program and works being completed.

Trigger Action Response Plans associated with groundwater are included in Appendix B and are summarised below.



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

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GDA 1994 MGA Zone 55

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KEY

- Exploratory tunnel
- Access road upgrade
- Access road extension
- Communications cable
- Yarrangobilly Caves - High Priority GDE

Plant community types

- PCT 285 - Broad-leaved Sally grass - sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion
- PCT 296 - Brittle Gum - peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion
- PCT 302 - Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion

Ecosystems that potentially rely on groundwater

Snowy 2.0
Groundwater management plan
Figure 6.6

snowy 2.0

EMM creating opportunities

Table 6.4 Overview of trigger action response plans

Objectives	Performance measure	Monitoring sites	Frequency	Trigger	Actions
To identify (where possible) if the exceedance is naturally occurring or due to Exploratory Works using flow chart in Appendix B.	Groundwater quality monitoring.	• TMB01A/B • TMB05A/B • BH8101 • BH8108 • RSMB2 • RSMB6 • RSMB7 • RSMB* • RSMB9* • Production Bores*	Monthly groundwater quality sampling	If a parameter exceeds one or more of the nominated water quality triggers for two consecutive monitoring events.	1) Notify Snowy 2.0 of the exceedance. Notify the relevant agency within 1 week of becoming aware of the exceedance. 2) 2) Investigate the source of the exceedance and potential improvements to the water management system that can be made to reduce the risk of the exceedance reoccurring. The outcomes of the investigation including identified actions are to be included in the internal monthly groundwater level and quality report. The scope of the investigation will depend on the extent and nature of the exceedance. Examples of management measures include (but not limited to): • Carrying out further field inspections to determine to extent of the causes • Consider additional or more frequent monitoring • Check for anthropogenic or other natural cause of the anomalous data • Check for climate related impacts or similar impacts at reference sites • If required, engage a Hydrogeologist to provide an opinion on the exceedance 3) Provide the relevant agency with a summary of the investigation's findings, potential reasons for the exceedance and mitigation measures undertaken to potentially rectify/correct the
	Groundwater level monitoring.	• TMB01A/B • TMB05A/B • BH8101 • BH8108 • RSMB2 • RSMB6 • RSMB7 • RSMB* • RSMB9 • YC05 • Ravine Shallow Monitoring Bores*	Daily – 6 hourly (collected monthly during water quality sampling events)	If the 7 day moving average exceeds the previous months established trigger level for more than 30 days.	

Table 6.4 Overview of trigger action response plans

Objectives	Performance measure	Monitoring sites	Frequency	Trigger	Actions
					exceedance within 60 days from the date of notification to the agency. 4) Continue monitoring the exceedance for 6 months — if conditions worsen, notify the relevant agency and conduct a severe impact investigation.

*Being drilled at the time of writing – will be updated in later GWMP revisions; Exploratory Works Production bores not included for groundwater level triggers because they will be pumped for water supply.

6.4 Training

All site personnel will undergo site induction training relating to groundwater management issues, including:

- existence and requirements of this GWMP;
- relevant legislation;
- roles and responsibilities for groundwater management;
- groundwater mitigation and management measures; and
- procedures to be implemented in the event of an incident.

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in groundwater management. Examples of training topics include:

- spill response and the location of spill kits on site;
- storage and handling of fuels, oils and hazardous chemicals; and
- plant refuelling procedures including those undertaken below grounds.

Further details regarding the staff induction and training are outlined in Section 4.4 of the EMS.

6.5 Auditing

Audits will be undertaken to assess the effectiveness of groundwater management measures, compliance with this GWMP, the Infrastructure Approval, EIS, Submissions Report and other relevant approvals, licences, and guidelines.

Audit requirements are detailed in Section 7.3 of the EMS.

6.6 Reporting

Reporting will include monthly internal project reports and six monthly compliance reports as required by the conditions of approval. The six-monthly reports will track compliance against the conditions of approval and the revised environmental management measures. Reporting requirements and responsibilities are documented in the Sections 7 of the EMS.

A monthly ground water quality report will be prepared by Snowy Hydro that presents:

- the locations and description of monitoring undertaken;
- a tabulation of results (eg groundwater levels and water quality results);
- summary of any measurements exceeding the nominated criteria;
- detail of any corrective actions and confirmation of their successful implementation.

Groundwater extraction volumes will be provided to the relevant agency as part of the annual return and posted on the project website, where required.

Response to incidents will be undertaken as described in Section 8 of the EMS and in accordance with the Environmental Incident Procedure (refer to Appendix A5 of the EMS) and The Pollution Incident Response Management Plan.

6.7 Groundwater Modelling

Prior to the commencement of Stage 2 Exploratory Works, the groundwater model will be reviewed and/or updated every six months with the availability of new data. The revised model will be submitted to the relevant agencies on completion.

Groundwater - Appendix A

Baseline groundwater data

Table A1 Mean groundwater quality results (February 2018 – February 2019)

Analyte			TMB05A[6]	TMB05B[6]	TMB01A	TMB01B
Formation	**Units**	**ANZECC 99% protection**	**Ravine Beds (w)**	**Ravine Beds**	**Boraig Group**	**Ravine Beds**
Field analytes						
pH[4]	-	6.5-8.5	7.99	9.16	6.58	7.54
EC[1]	µS/cm	30-350	562	634	337	1626
Temperature	°C	-	14.2	15.4	14.5	15.8
Dissolved oxygen	mg/L	-	1.87	2.93	0.91	1.39
Laboratory analytes						
TDS[2]	mg/L	-	383	444	226	1086
Major ions						
Calcium	mg/L	-	24.5	6.00	8.71	16.29
Chloride	mg/L	-	5.50	12	11.29	130.43
Magnesium	mg/L	-	9.00	4.50	4.00	12.71
Sodium	mg/L	-	89.75	155.75	69.71	388.57
Potassium	mg/L	-	6.50	5.75	2.43	10.00
Sulfate	mg/L	-	104	8.25	11.43	12.29
Fluoride	mg/L	-	1.13	1.73	1.34	3.67
Alkalinity						
Bicarbonate as $CaCO_3$	mg/L	-	207.5	292.25	194.14	771.00
Carbonate as $CaCO_3$	mg/L	-	<1	72.75	<1	<1
Hydroxide as $CaCO_3$	mg/L	-	<1	<1	<1	<1
Total as $CaCO_3$	mg/L	-	207.50	365.25	173.43	771.00
Total metals						
Arsenic	mg/L	-	0.006	0.002	0.0058	0.0290
Cadmium	mg/L	0.00006	<0.0001	0.72	<0.0001	<0.0001
Chromium (III+VI)	mg/L	-	0.003	<0.001	<0.001	0.0020
Copper	mg/L	0.001	0.003	0.001	0.0015	0.004
Mercury	mg/L	0.00006	<0.0001	0.002	<0.0001	<0.0001
Nickel	mg/L	0.008	0.001	0.003	0.002	0.008
Zinc	mg/L	0.0024	0.0065	<0.0001	0.0078	0.037
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001

Table A1 Mean groundwater quality results (February 2018 – February 2019)

Analyte			TMB05A[6]	TMB05B[6]	TMB01A	TMB01B
Formation	**Units**	**ANZECC 99% protection**	**Ravine Beds (w)**	**Ravine Beds**	**Boraig Group**	**Ravine Beds**
Nutrients						
Ammonia as N	mg/L	-	0.25	0.19	0.04	0.11
Kjeldahl Nitrogen Total	mg/L	-	0.53	0.35	0.88	0.17
Nitrate (as N)	mg/L	-	0.03	0.08	6.18	0.09
Nitrite (as N)	mg/L	-	<0.01	<0.01	0.04	0.05
Nitrogen (Total)	mg/L	0.25	0.53	0.40	5.50	0.27
Phosphorus	mg/L	-	0.039	0.04	0.21	0.45

Notes: *1. EC = electrical conductivity;*

2. TDS = total dissolved solids;

3. (w) = weathered;

4. arithmetic mean was calculated for pH; and

5. values less than the limit of recording were treated as half the LOR when calculating mean values.

6. Data from February 2018 to November 2018 only.

Table A2 Groundwater level summary (mAHD)

	TMB01A			TMB01B			TMB05A			TMB05B		
Month	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**
March 2018	576.040	575.978	575.935	575.548	575.537	575.527	599.219	598.813	598.718	598.373	598.111	598.004
April 2018	575.961	575.912	575.870	575.566	575.545	575.512	599.265	598.776	598.683	598.413	597.983	597.849
May 2018	575.944	575.822	575.763	575.618	575.599	575.578	599.031	598.932	598.766	598.420	598.322	597.963
June 2018	575.990	575.876	575.762	575.699	575.637	575.593	599.268	599.069	598.906	598.764	598.542	598.357
July 2018	576.053	575.969	575.891	575.751	575.676	575.600	599.269	599.172	599.070	598.798	598.619	598.385
August 2018	576.582	576.372	575.995	576.095	575.935	575.668	599.626	599.435	599.133	598.936	598.784	598.413
September 2018	576.636	576.464	576.331	576.052	575.943	575.809	599.622	599.487	599.358	599.161	598.996	598.840
October 2018	576.337	576.259	576.166	575.824	575.758	575.692	599.401	599.270	599.147	599.153	598.980	598.825
November 2018	576.422	576.269	576.144	575.802	575.726	575.597	599.293	599.201	599.085	598.941	598.860	598.758
December 2018	576.594	576.346	576.187	575.961	575.831	575.723	NA	NA	NA	NA	NA	NA
January 2019	576.305	576.199	576.134	575.740	575.668	575.609	NA	NA	NA	NA	NA	NA
February 2019[1]	576.132	576.732	576.131	575.628	575.626	575.625	NA	NA	NA	NA	NA	NA
All periods	576.636	576.162	575.762	576.076	575.749	575.512	599.626	599.162	598.683	599.161	598.614	597.849

Note: 1. 2 samples only within data at hand at time of writing

NA. Data not available at time of writing

Groundwater - Appendix B

Trigger action response plans

Trigger Action Response Plan

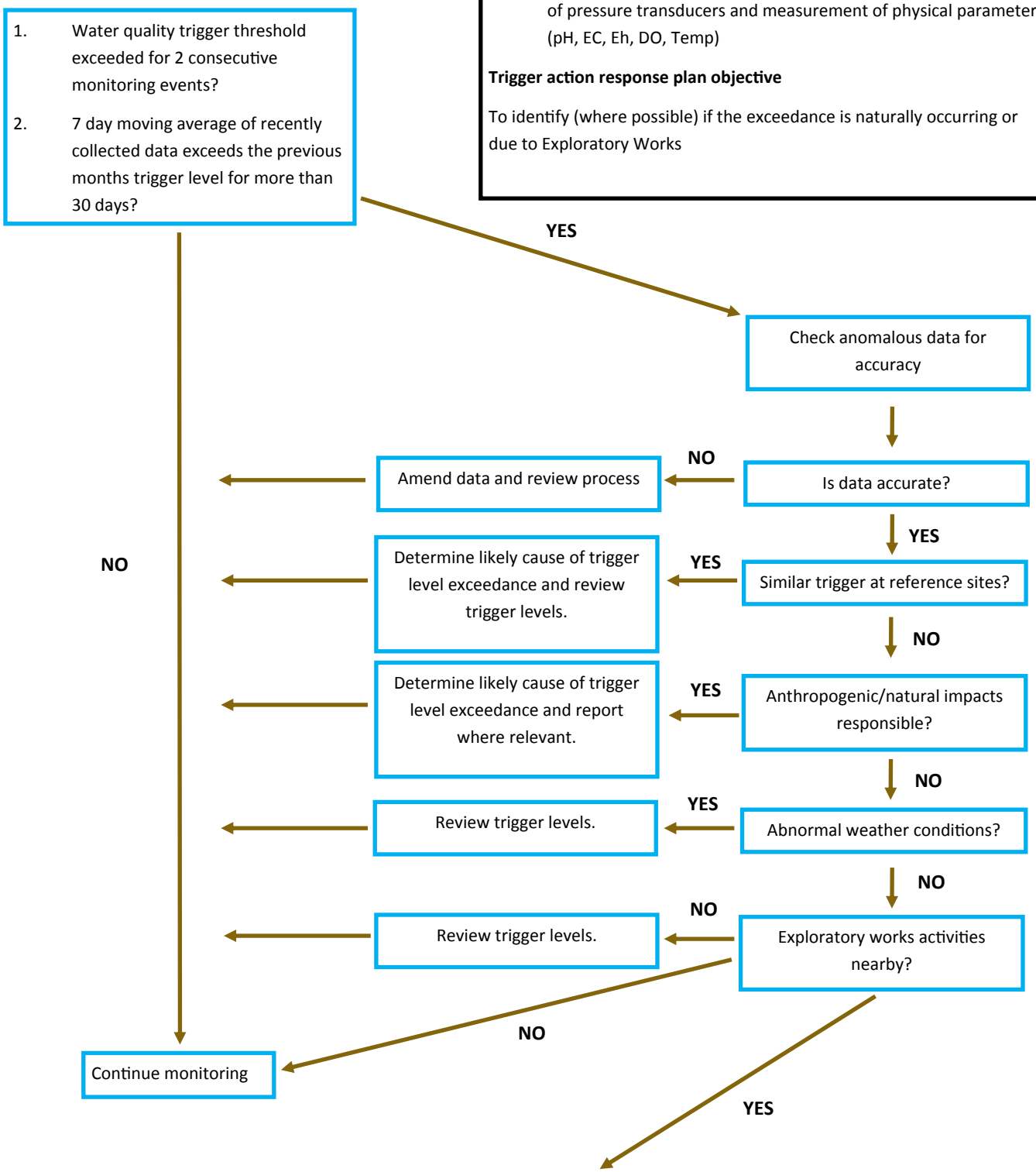
Groundwater Quality and Level Trigger Action Response Plan (TARP)

Basic groundwater quality monitoring program

- Groundwater quality and levels collected and measured once-monthly.
- Monitoring includes manual water level measurements, download of pressure transducers and measurement of physical parameters (pH, EC, Eh, DO, Temp)

Trigger action response plan objective

To identify (where possible) if the exceedance is naturally occurring or due to Exploratory Works



Required Actions

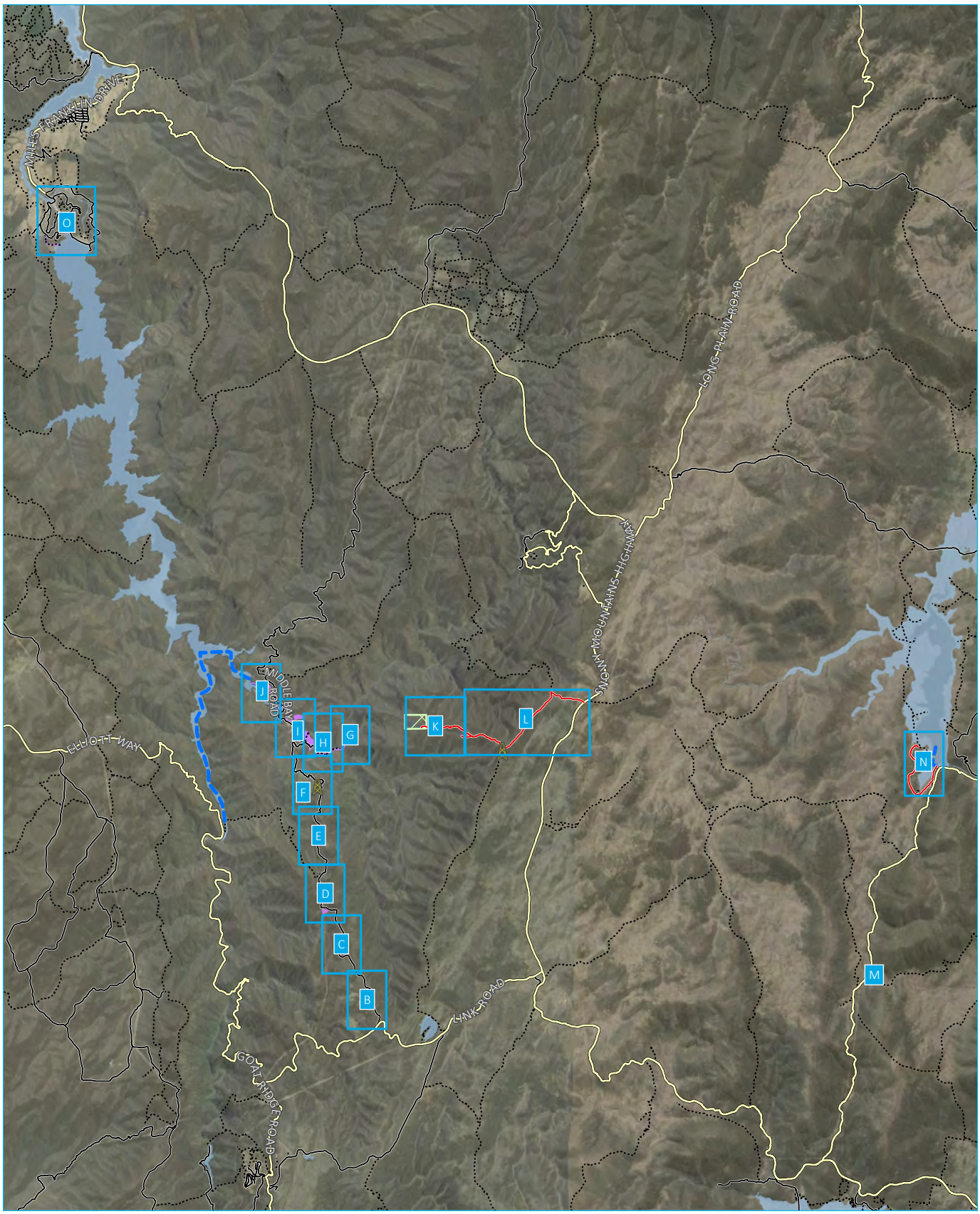
1) Report exceedance in the monthly water quality report.

2) Investigate the source of the exceedance and potential improvements to the water management system that can be made to reduce the risk of the exceedance reoccurring. The scope of the investigation will depend on the extent and nature of the exceedance. The outcomes of the investigation including identified actions are to be included in the monthly groundwater level and quality report.

Water Management Plan

Appendix C

Project Boundary



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

0 5 10 km

GDA 1994 MGA Zone 55

N

KEY

- Proposed temporary communications upgrade location
- Existing access track
- Boat access
- Main road
- Local road
- Vehicular track
- Map index
- EW approved construction footprint
- EW modification construction footprint (additional)
- Boreholes requiring on-site adjustment
- Waterbody

Exploratory Works project boundary - overview

Snowy 2.0
Exploratory Works EIS
Modification 1
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EMM creating opportunities

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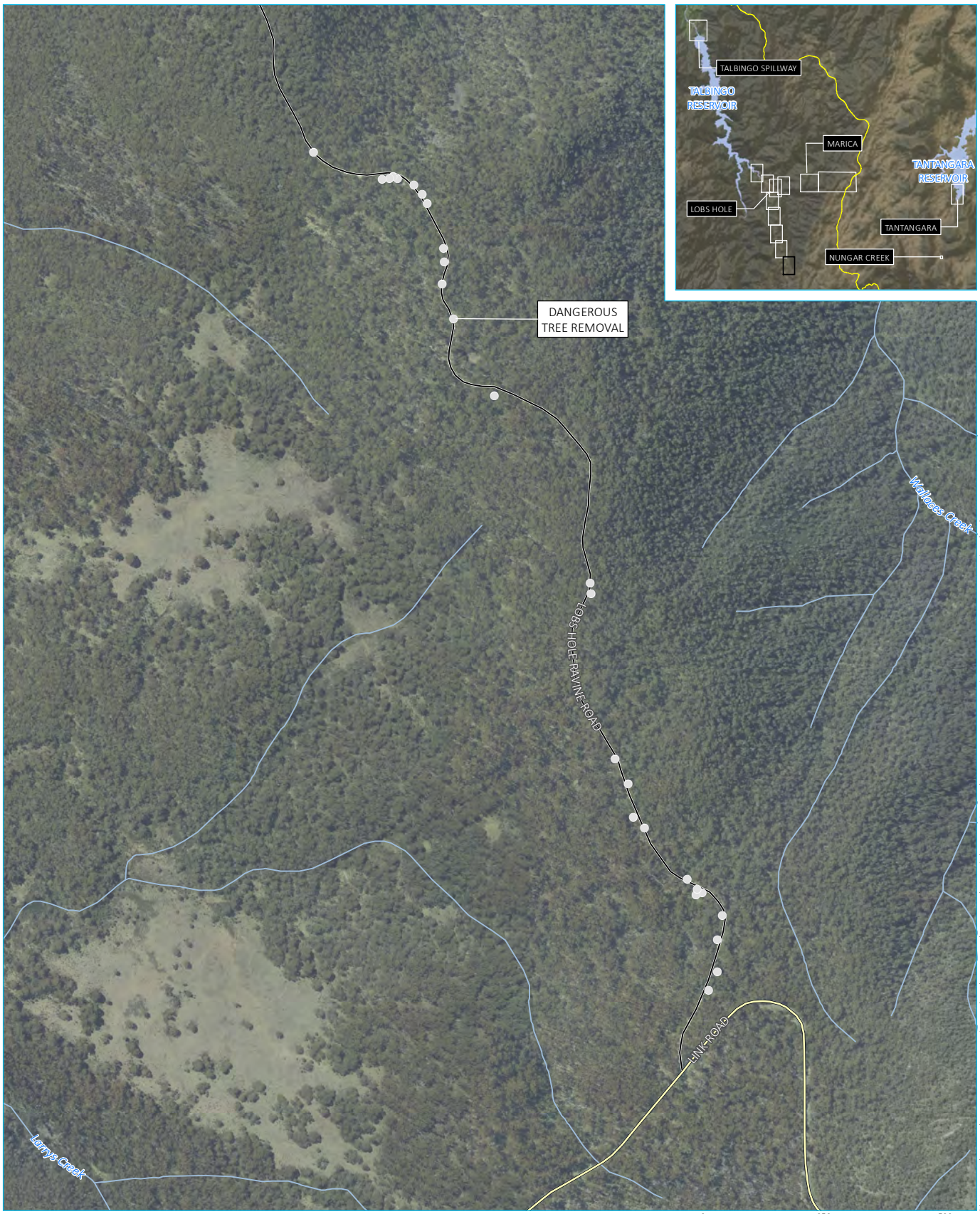

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Main road
- Local road
- Watercourse/drainage line

Exploratory Works project boundary
- Lobs Hole Ravine Road (Upper) 1

Snowy 2.0
Exploratory Works EIS
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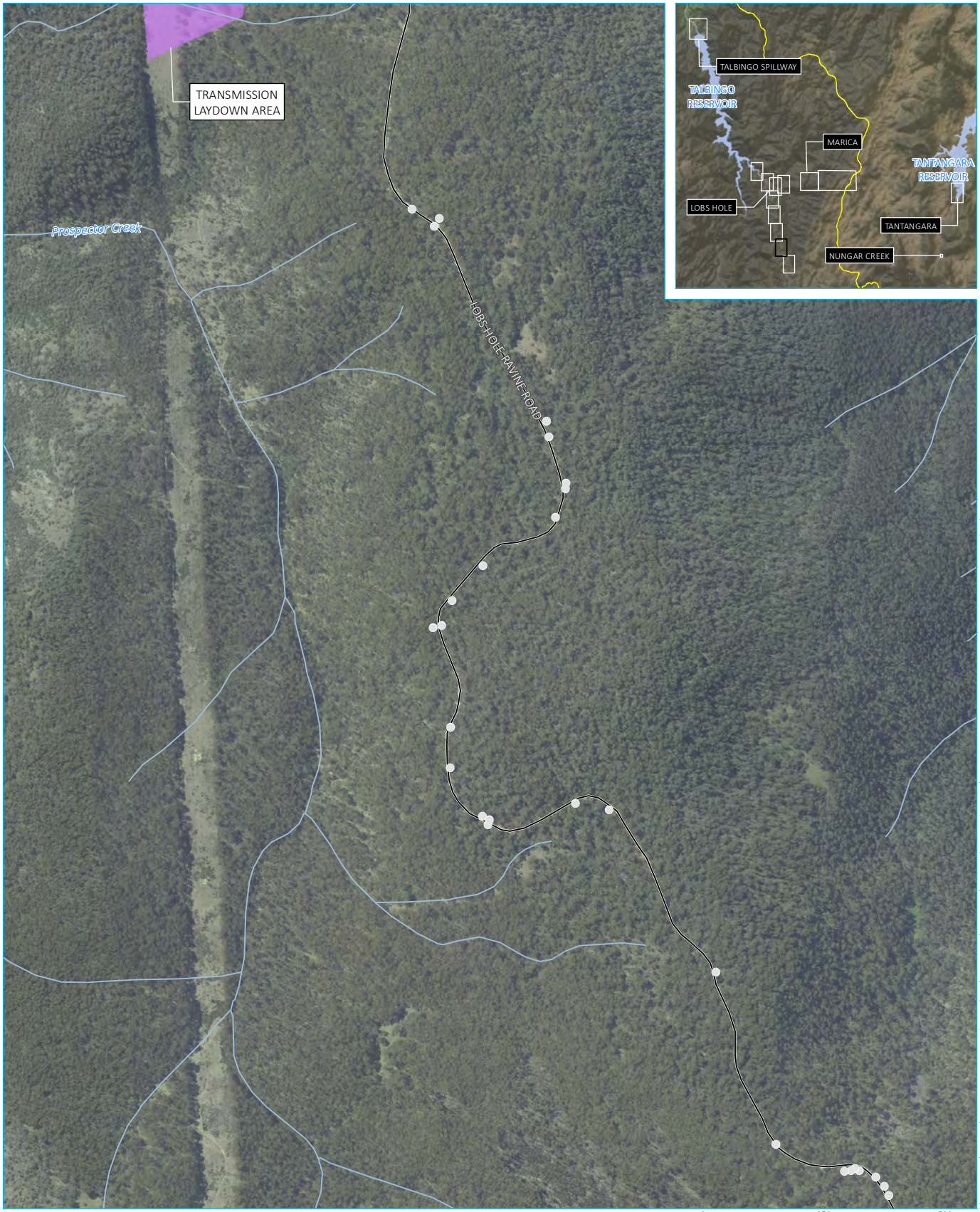

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- Local road
- Watercourse/drainage line
- EW approved construction footprint

0 250 500 m

GDA 1994 MGA Zone 55

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Exploratory Works project boundary
- Lobs Hole Ravine Road (Upper) 2

Snowy 2.0
Exploratory Works EIS
Modification 1
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Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)

Exploratory Works project boundary - Lobs Hole Ravine Road (Upper) 3

Snowy 2.0
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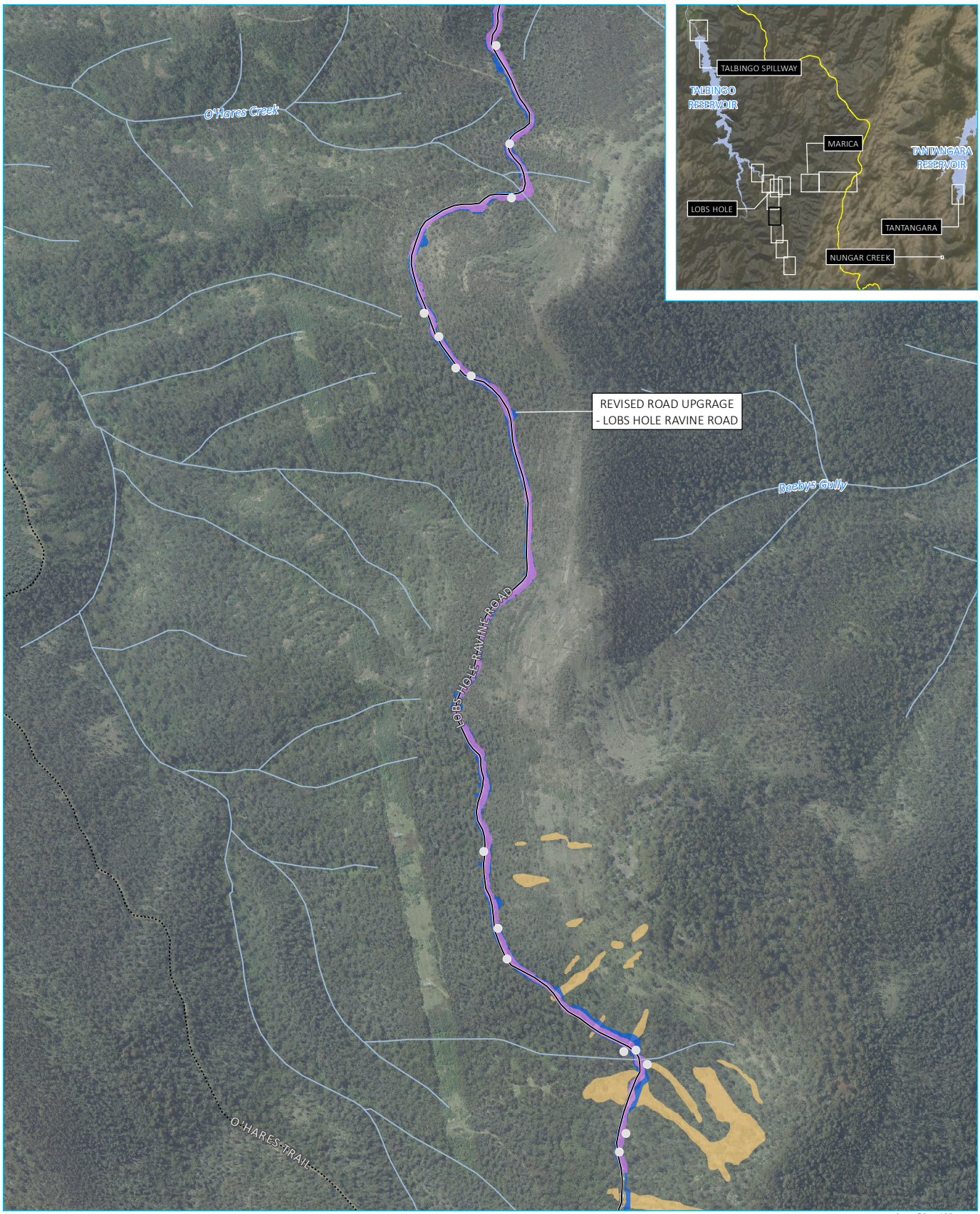

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

KEY

- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Boulder stream

0 50 100 m

GDA 1994 MGA Zone 55

N

Exploratory Works project boundary
- Lobs Hole Ravine Road (Lower) 1

Snowy 2.0
Exploratory Works EIS
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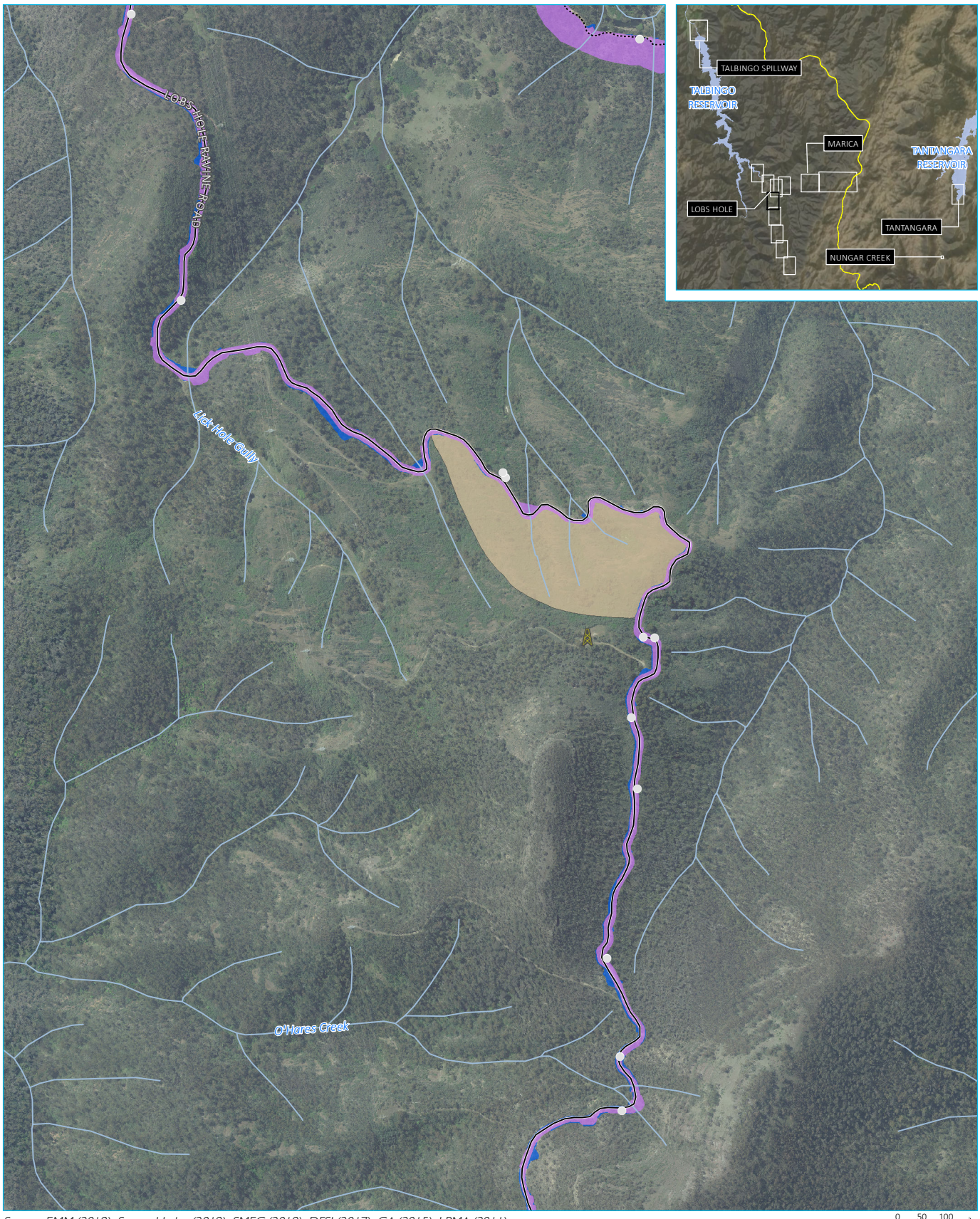

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 50 100 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Existing temporary communications
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Fossil area

Exploratory Works project boundary - Lobs Hole Ravine Road (Lower) 2

Snowy 2.0
Exploratory Works EIS
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EMM creating opportunities

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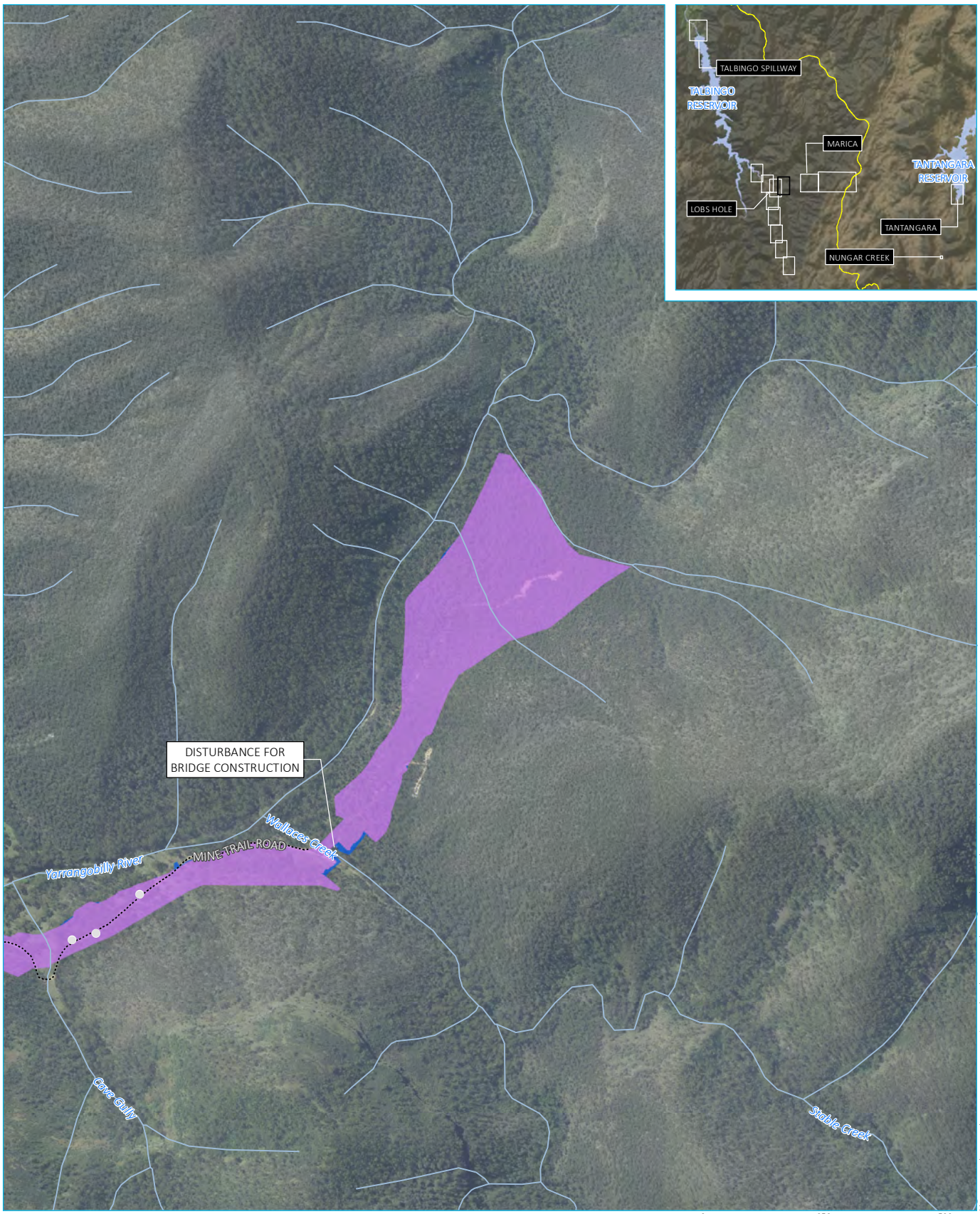

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)

Exploratory Works project boundary
- Mine Trail Road 1

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Exploratory Works EIS
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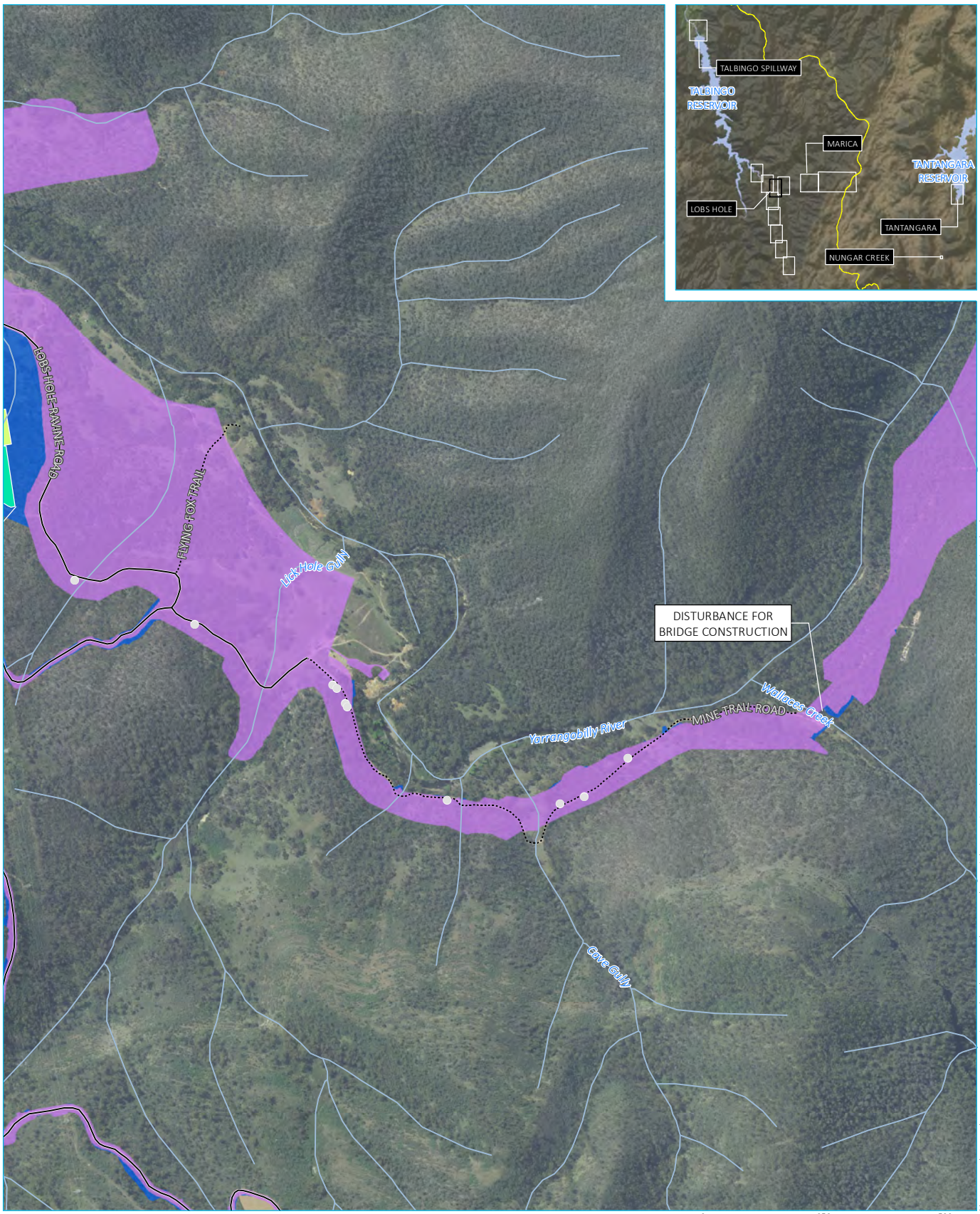

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Indicative laydown area
- Proposed substation
- Fossil area

Exploratory Works project boundary
- Mine Trail Road 2

Snowy 2.0
Exploratory Works EIS
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EMM creating opportunities

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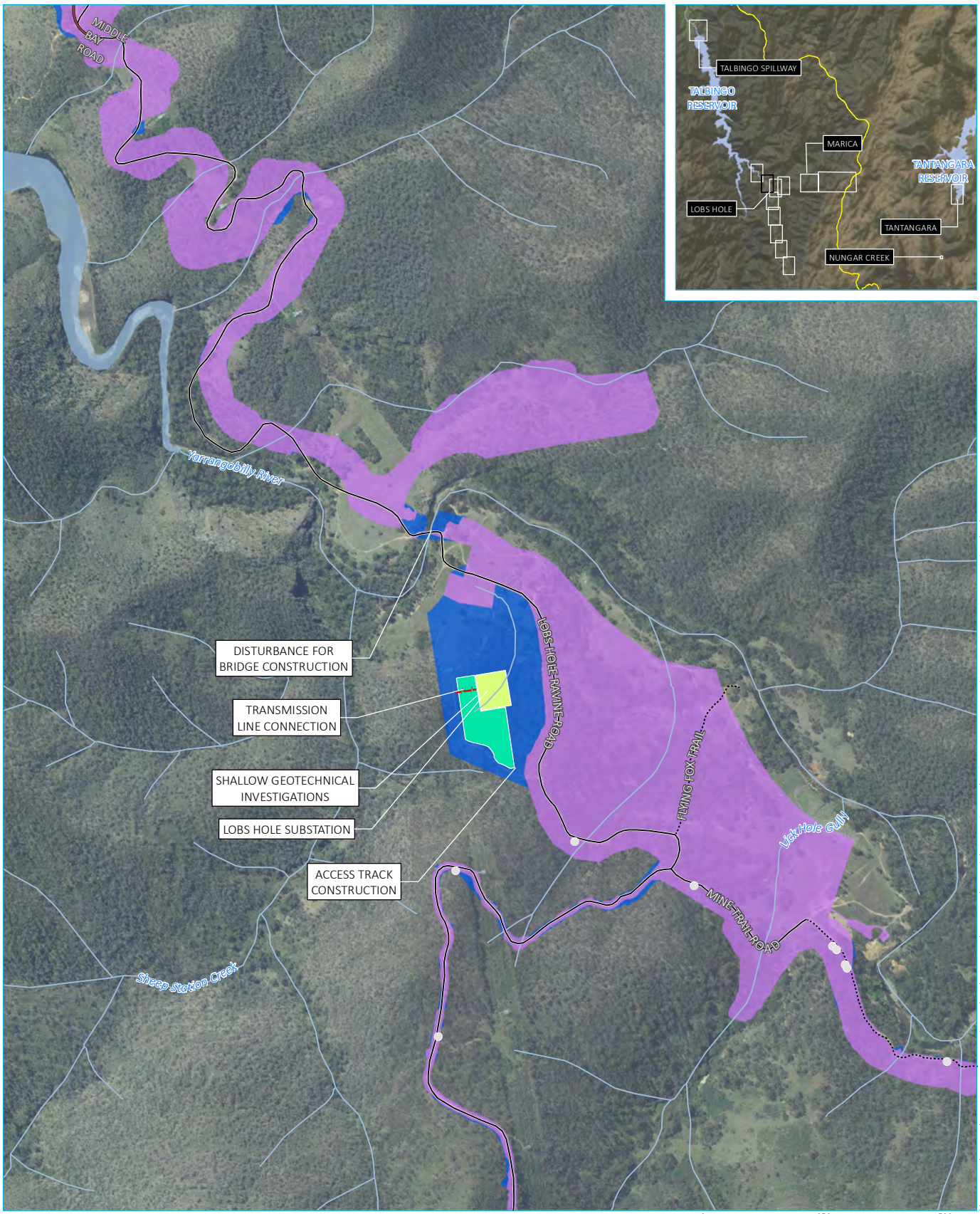

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Dangerous tree
- Approved EW access
- Transmission line connection
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Indicative laydown area
- Proposed substation
- Waterbody

Exploratory Works project boundary - Lobs Hole

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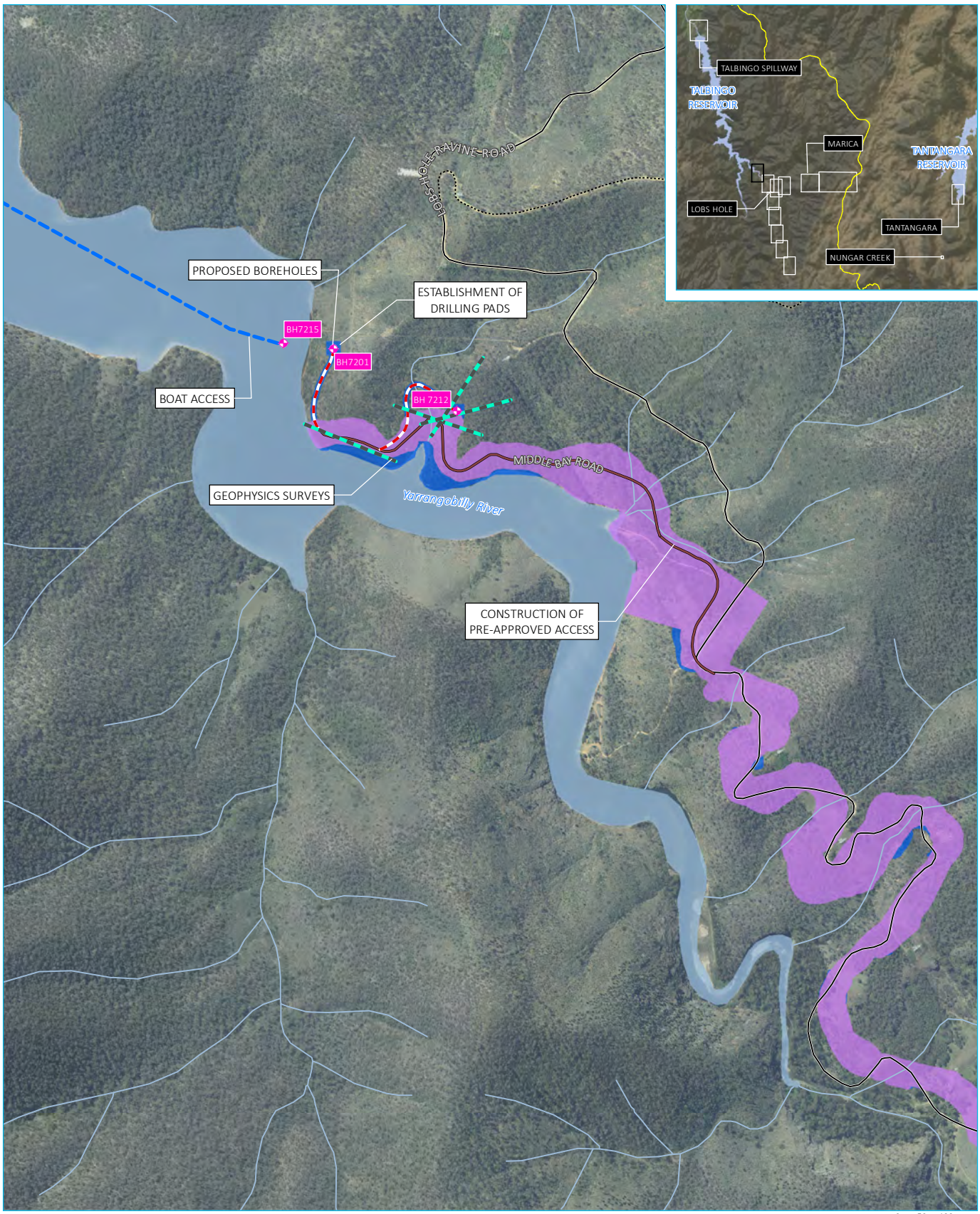
EMM creating opportunities



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

0 50 100 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Proposed geophysics
- Proposed access track
- Approved EW access
- Boat access
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Waterbody

Exploratory Works project boundary - Lobs Hole Ravine Road

Snowy 2.0
Exploratory Works EIS
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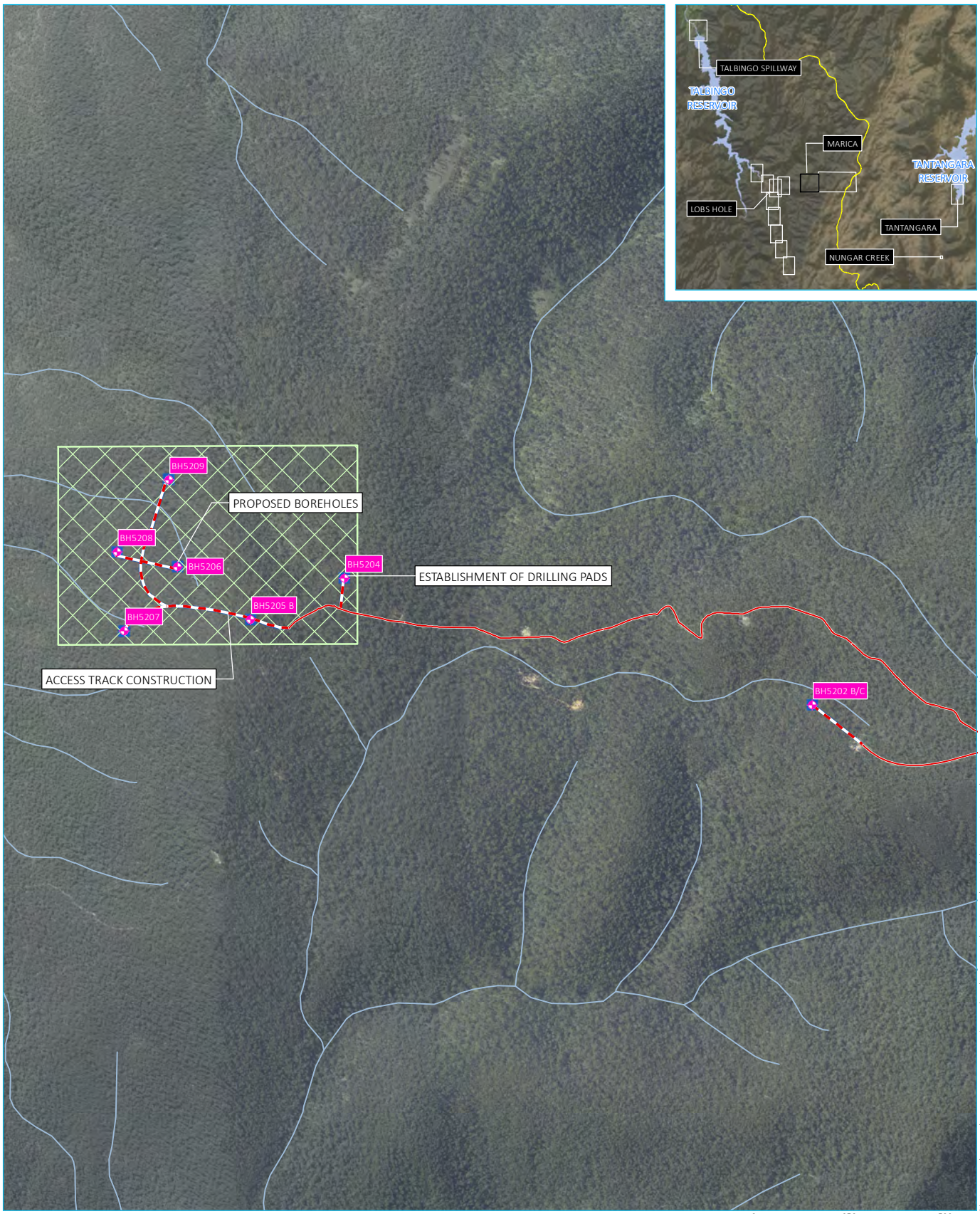

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Existing access track
- Proposed access track
- Watercourse/drainage line
- EW modification construction footprint (additional)
- Boreholes requiring on-site adjustment

Exploratory Works project boundary - Marica 1

Snowy 2.0
Exploratory Works EIS
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EMM creating opportunities

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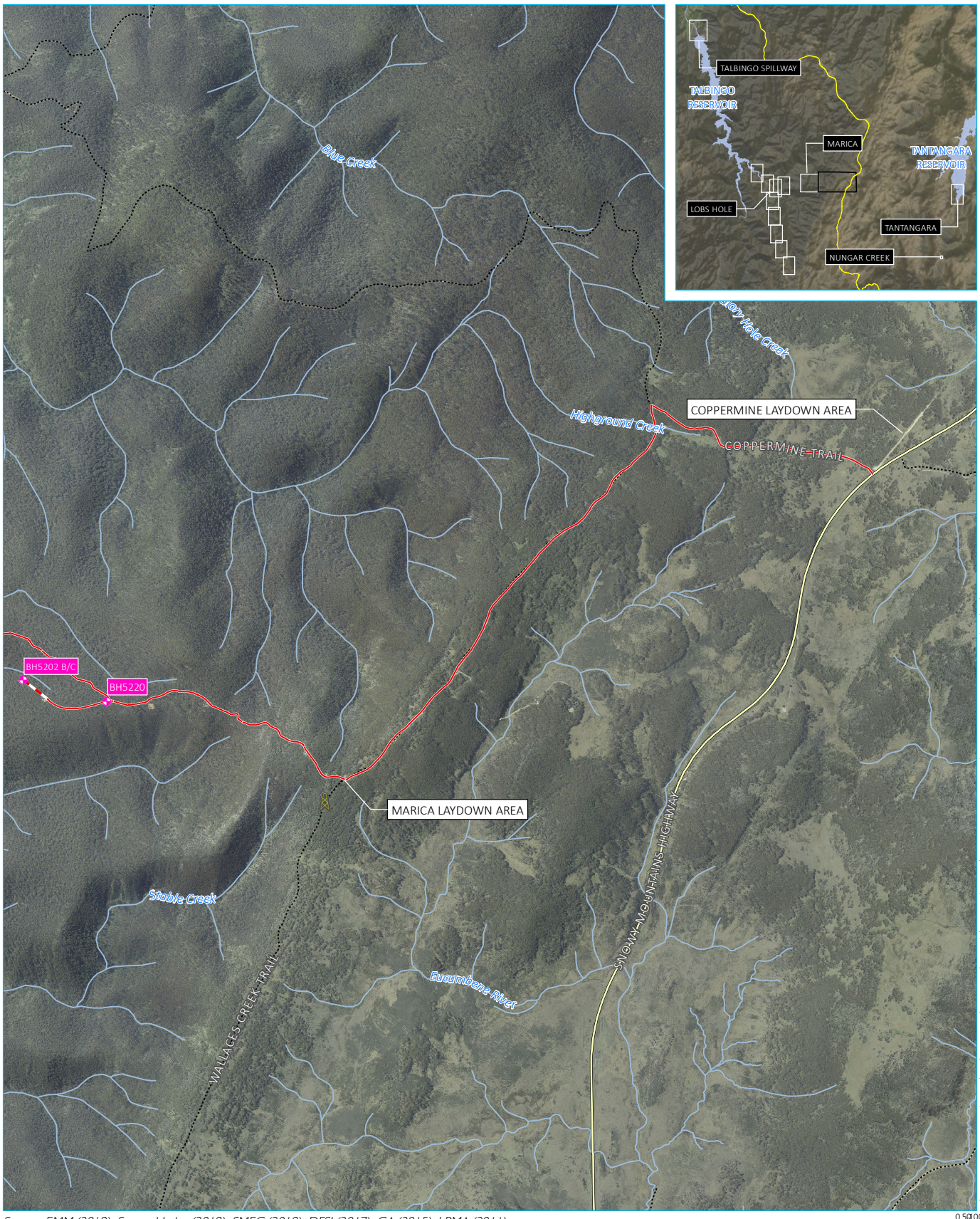

Source: EMM (2019); Snowy Hydro (2019); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 500 1000 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Existing temporary communications
- Existing access track
- Proposed access track
- Main road
- Vehicular track
- Watercourse/drainage line
- EW modification construction footprint (additional)

Exploratory Works project boundary - Marica 2

Snowy 2.0
Exploratory Works EIS
Modification 1
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EMM creating opportunities

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

0 50 100 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Main road
- Watercourse/drainage line
- Proposed work area

Exploratory Works project boundary - Nungar Creek

Snowy 2.0
Exploratory Works EIS
Modification 1
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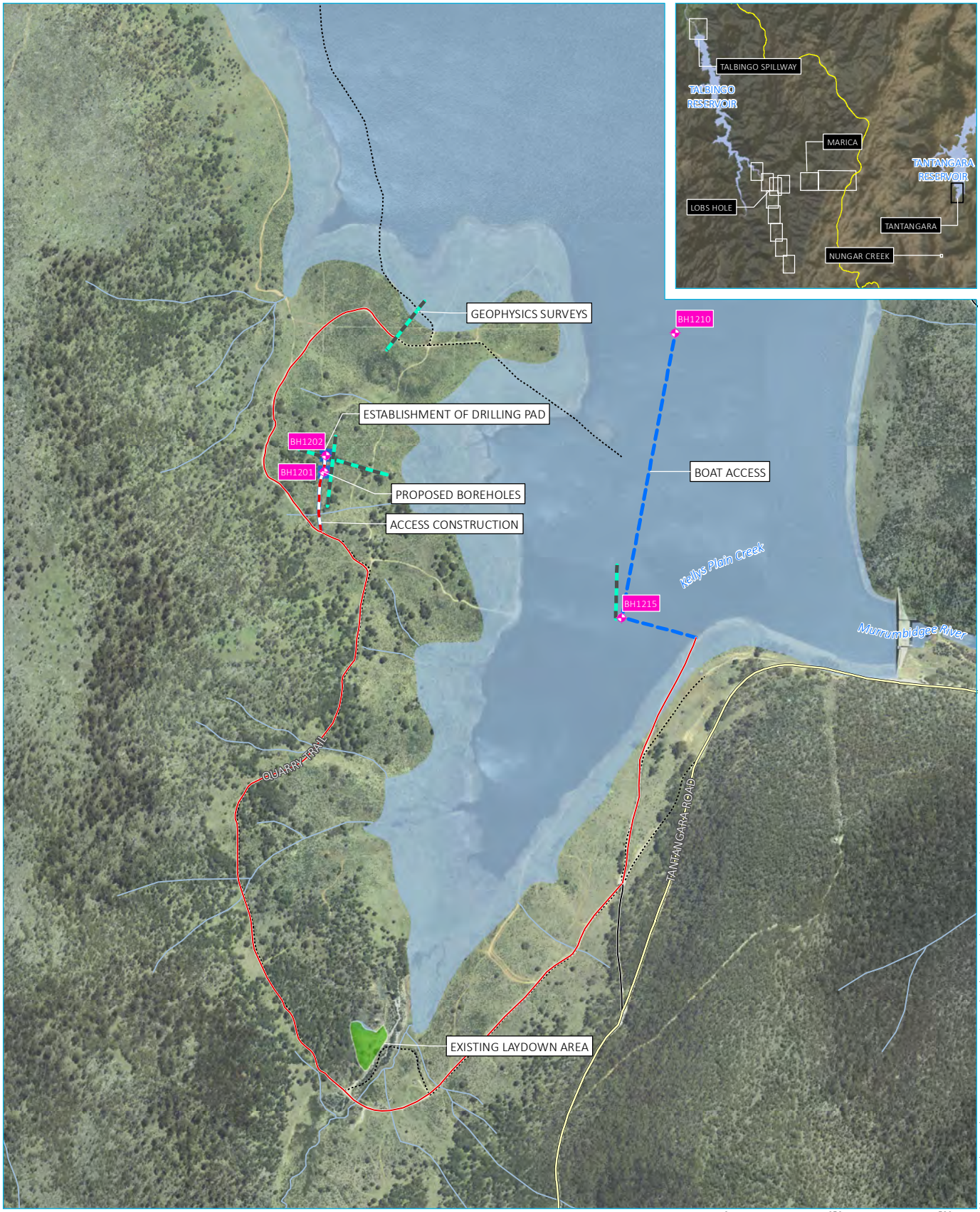

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Proposed borehole
- Proposed geophysics
- Existing access track
- Proposed access track
- Boat access
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- EW modification construction footprint (additional)
- Existing laydown area
- Waterbody

Exploratory Works project boundary - Tantangara Reservoir

Snowy 2.0
Exploratory Works EIS
Modification 1
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EMM creating opportunities

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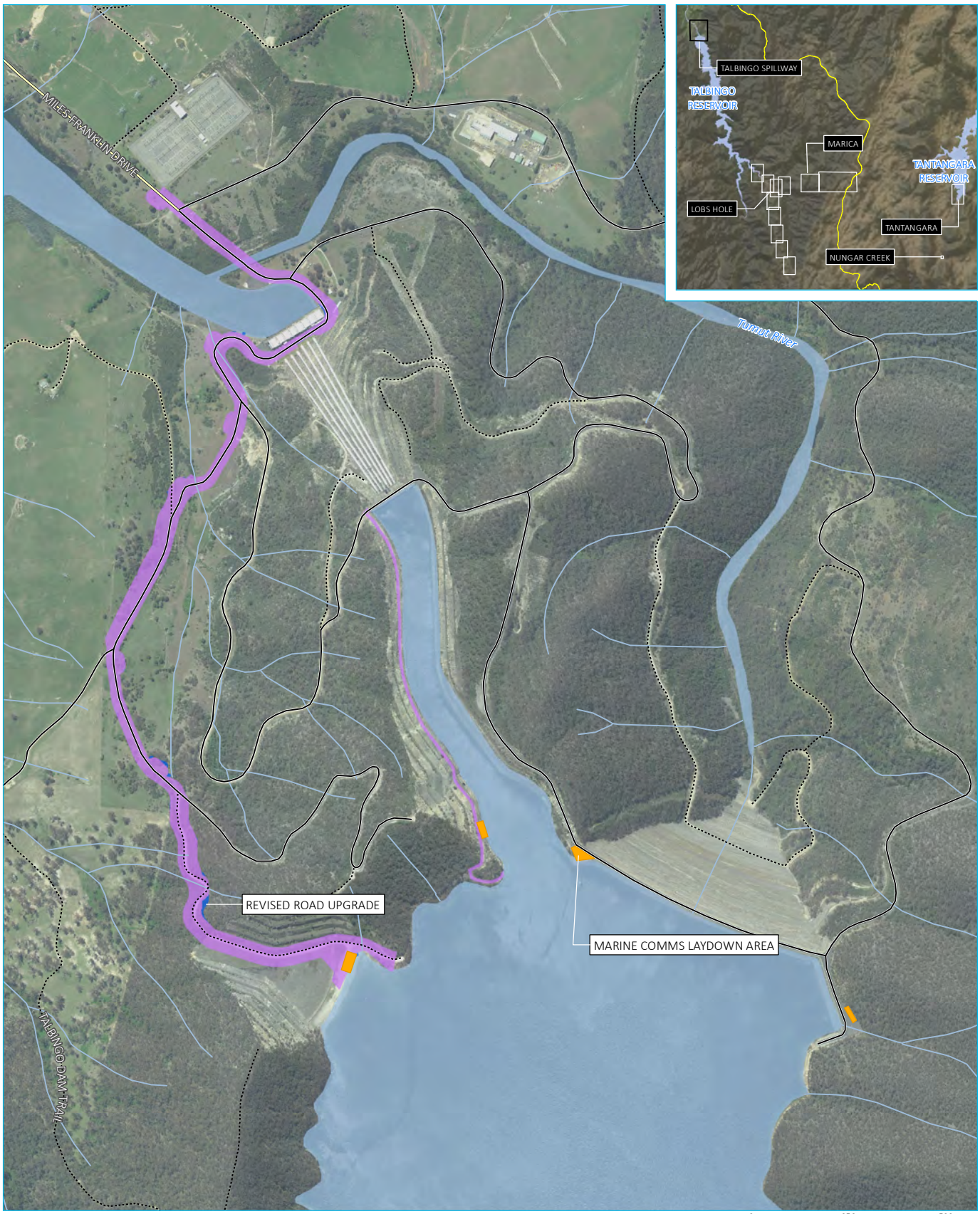

Source: EMM (2019); Snowy Hydro (2019); PhotoMapping (2018); SMEC (2019); DFSI (2017); GA (2015); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- EW approved construction footprint
- EW modification construction footprint (additional)
- Marine comms laydown (proposed)
- Waterbody

Exploratory Works project boundary
- Talbingo spillway

Snowy 2.0
Exploratory Works EIS
Modification 1
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snowy 2.0

EMM creating opportunities

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