Two Mile Hill Slope Restoration

Review of Environmental Factors

Transport for NSW | November 2024

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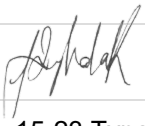
Two Mile Hill Slope Restoration
Review of Environmental Factors
Transport for NSW | November 2024

Prepared by GHD Pty Ltd and Transport for NSW

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Approval and authorisation

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Dated:	19/11/2024

Executive summary

The proposal

Transport for NSW proposes to stabilise and restore eight separate slopes along a three kilometre section of Jenolan Caves Road (commonly referred to as the Two Mile section) at Jenolan (the proposal site). These slopes were subject to slope failures following extensive rainfall during various events commence in July 2022 and continuing into 2023. Key features of the proposal include:

- installation of soil nails into eight slopes which were subject to failure to stabilise the slope
- surface stabilisation including the placement of shotcrete which would be appropriately tinted with colour to match the surrounding environment
- installation of drainage infrastructure within the impacted section of slope at three slope failure locations
- establishment of construction compound and stockpile sites at Kanangra Walls Road and Car Park 1 and 2.

Need for the proposal

The proposal is required because of safety issues associated with the failure of a number of slopes next to Jenolan Caves Road during extensive rainfall experienced in events commencing in July 2022 and continuing into 2023. Without stabilisation and restoration of the slope, there is a potential risk of further slope failures which can result in further impacts on vegetation and water quality as well as further restrictions to access into the Jenolan Caves Precinct. The proposal would allow temporary access measures which are in place as a result of the slope failures to be removed thus improving access into the Jenolan Caves Precinct.

Proposal objectives

The objectives of the proposal include:

- stabilise the existing failed slope profiles which occurred at various times between July 2022 and early 2023
- ensure that further risk of future slope failures is reduced, including the risk of debris falling onto Jenolan Caves Road and blocking access
- improve safety for road users along the section of Jenolan Caves Road
- enable full public vehicular access into the Jenolan Caves Precinct to be reinstated to improve overall access to the Precinct.

Options considered

The options assessment initially considered the need for works to occur with the two options considered being the do-nothing option and to undertake stabilisation works within the slope failure area. The do-nothing option was not considered to meet any of the objectives as access to Jenolan Caves Road would remain restricted, thus limiting access into the Jenolan Caves Precinct. The option to undertake works was then considered the preferred option as it would assist in meeting the objectives.

A number of stabilisation options were considered including the following:

- Option 1 – A-frame micro pile-wall
- Option 2 – Soil nails and shotcrete
- Option 3 – Upslope cutting.

Of the options considered, Option 1, was considered to be the preferred option from a design and environmental viewpoint as it provides the most robust design while also minimising environmental impact due to the option being able to be contained within the existing roadway with no requirements for work on the failed slope.

While Option 1 is the best option it is considered a longer term solution and would come with a longer construction period. Due to the western approach of Jenolan Caves Road (Two Mile section) being the sole access to the Jenolan Caves Precinct, there is a need to secure this access and prevent any further slope failures.

Given this, Transport for NSW has identified Option 2 as the preferred option as it would be able to be implemented quicker than Option 1 and it would allow the slopes to be stabilised quicker thus maintaining an access into the Jenolan Caves Precinct.

Statutory and planning framework

The proposal is to facilitate emergency and maintenance work for a road and is to be carried out by or on behalf of Transport for NSW. It can therefore be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979*. Development consent from council is not required.

The proposal is partially located on land contained within the Jenolan Karst Conservation Reserve. The proposal is permissible under the *National Parks and Wildlife Act 1974* (NPW Act) and fully consistent with the National Parks and Wildlife Services (NPWS) Policy.

The NPWS and Transport for NSW are the determining authorities for the proposal. This REF fulfils the determining authority's obligation under section 5.5 of the EP&A Act, including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

A section 57 approval under the Heritage Act is also required due to the positioning of the works within the State Heritage Listed Jenolan Caves Reserve.

Community and stakeholder consultation

Community consultation specific to the proposal has not been undertaken to date, however, communication with the community has been ongoing with regards to the status of impacts on Jenolan Caves Road because of the damage caused by multiple rain events since March 2021.

The Jenolan Caves Steering Committee was established following flood and fire events in the Jenolan Caves area and seeks to engage all relevant stakeholders of the Jenolan Caves Reserve as part of the rebuilding effort since these natural events.

Consultation has also been undertaken with Gundungurra people who jointly manage the Jenolan Karst Conservation Reserve in accordance with the Gundungurra Indigenous Land Use Agreement (ILUA).

Environmental impacts

The environmental impacts of the proposal are not likely to be significant and, therefore, it is not necessary for an Environmental Impact Statement to be prepared or approval sought for the proposal from the Minister for Planning under Division 5.1 of the EP&A Act.

The main environmental impacts of the proposal are:

- potential removal of up to 0.74 hectares of native vegetation consistent with PCT 3491 – Jenolan-Tuglow Limestone Forest
- potential impacts on the threatened Mountain Trachymene and Needle Geebung flora species which have the potential to occur based on vegetation present
- closure of Jenolan Caves Road to the public, noting that access into the Jenolan Caves Precinct is also to be closed to the public due to Jenolan Caves Trust construction works being undertaken from mid-March 2024
- short term noise and air impacts as a result of the operation of construction equipment
- minor visual impacts due to the introduction of shotcrete walls into a largely vegetated landscape.

The proposal, while resulting in some adverse impacts, would provide the following environmental benefits:

- reinstate unrestricted access into the Jenolan Caves Precinct from Oberon
- protection of vegetation from loss due to further slope failures
- improvement in water quality in downslope watercourses due to stablisation of exposed slopes and reduce risk of further (including larger) slope failures which deposit sediment into watercourses.

Justification and conclusion

The proposal would result in the ability to reopen public vehicular access down the Two Mile section without the need for a pilot vehicle. The proposal would also reduce the risk of future failures which, if they were to occur, would result in the Jenolan Caves Precinct being inaccessible until either the Two Mile or Five Mile sections of Jenolan Caves Road are reinstated. The maintenance of at least one access provides benefits to businesses operating out of the Jenolan Caves Precinct due to the improved accessibility of the Precinct. This reinstatement of access would ensure this key tourist destination within the Oberon LGA can operate more efficiently and draw increased visitors into the LGA.

The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity. The proposal would be unlikely to cause a significant impact on the environment. Therefore, it is not necessary for an environmental impact statement to be prepared nor approval to be sought from the Minister for Planning and Public Spaces under Division 5.2 of the EP&A Act. A Biodiversity Development Assessment Report or Species Impact Statement is not required. Additionally, there would be no significant impacts to matters of national environmental significance hence the proposal has not been referred to the Department of Agriculture, Water and the Environment.

This REF has concluded the adverse impacts and risks of the proposal would be outweighed by the long term benefits of providing access and road safety for all road users.

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Appendix I	Meeting Minutes with Gundungurra Indigenous Land Use Agreement parties

1. Introduction

1.1 Proposal identification

Transport for NSW proposes to carry out restoration work to manage land hazards following eight slope failures along what is known as the Two Mile section of Jenolan Caves Road (the proposal). The Two Mile section consists of the winding section of Jenolan Caves Road leading down into the Jenolan Caves Precinct from Oberon.

Key features of the proposal would include:

- installation of soil nails into eight failed slopes to stabilise and restore the slopes
- surface stabilisation including placement of shotcrete which would be appropriately tinted with colour to match the surrounding environment
- installation of drainage infrastructure along Jenolan Caves Road in the vicinity of three of the slope failure locations
- establishment of construction compound and stockpile sites at Kanangra Walls Road and Car Park 1 and 2.

The location of the proposal is shown in Figure 1-1 and an overview of the proposal is provided in Figure 1-2. Chapter 3 describes the proposal in more detail.

1.2 Purpose of the report

This review of environmental factors (REF) has been prepared by GHD Pty Ltd (GHD) on behalf of Transport for NSW. For the purposes of this work, Transport for NSW is the proponent and the determining authority under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of the REF is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail mitigation and management measures to be implemented.

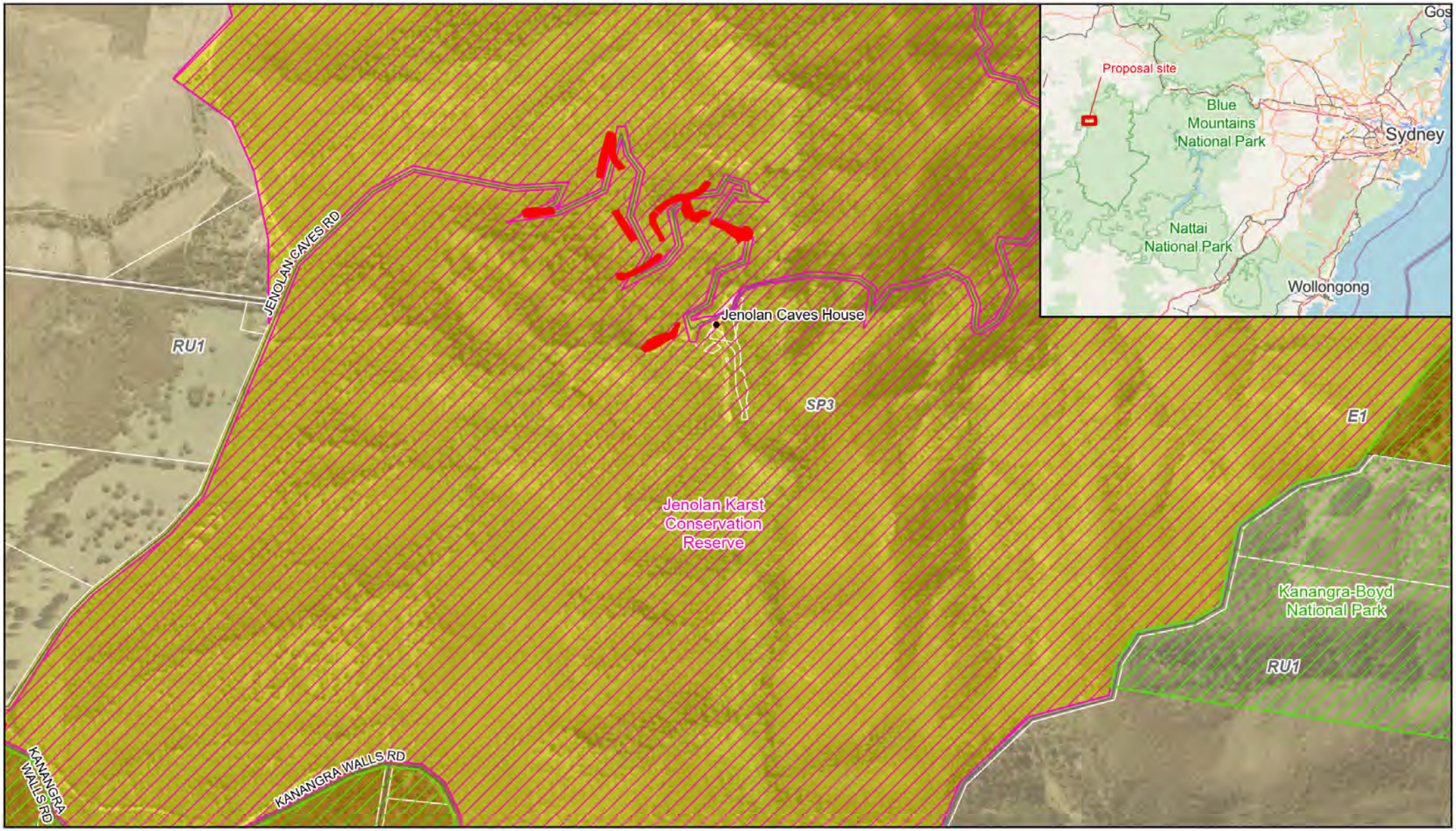
The description of the proposed work and assessment of associated environmental impacts has been carried out in the context of section 171 of the Environmental Planning and Assessment Regulation 2021, the factors in *Is an EIS Required? Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979* (Is an EIS required? Guidelines) (DUAP, 1995/1996), *Roads and Related Facilities EIS Guideline (DUAP 1996)*, the *Biodiversity Conservation Act 2016* (BC Act), *the Fisheries Management Act 1994* (FM Act), and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In doing so, the REF helps to fulfil the requirements of Section 5.5 of the EP&A Act including that Transport for NSW examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity.

- The strategic assessment approval granted by the Federal Government under the EPBC Act in September 2015, with respect to the impacts of Transport for NSW's road activities on nationally listed threatened species, ecological communities and migratory species.

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the necessity for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning and Public Spaces under Division 5.2 of the EP&A Act.
- The significance of any impact on threatened species as defined by the BC Act and/or FM Act, in section 1.7 of the EP&A Act and therefore the requirement for a Species Impact Statement or a Biodiversity Development Assessment Report.
- The significance of any impact on nationally listed biodiversity matters under the EPBC Act, including whether there is a real possibility that the activity may threaten long-term survival of these matters, and whether offsets are required and able to be secured.
- The potential for the proposal to significantly impact any other matters of national environmental significance or Commonwealth land and the need, subject to the EPBC Act strategic assessment approval, to make a referral to the Australian Government Department of Climate Change, Energy, the Environment and Water for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.



Legend

- Proposal site
- Conservation Reserve
- National Park

Land Zoning

- C1 - National Parks and Nature Reserves
- RU1 - Primary Production
- SP3 - Tourist

Paper Size ISO A4

0 200 400

Metres

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

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GHD

Transport for NSW
2 Mile Hill Restoration Project

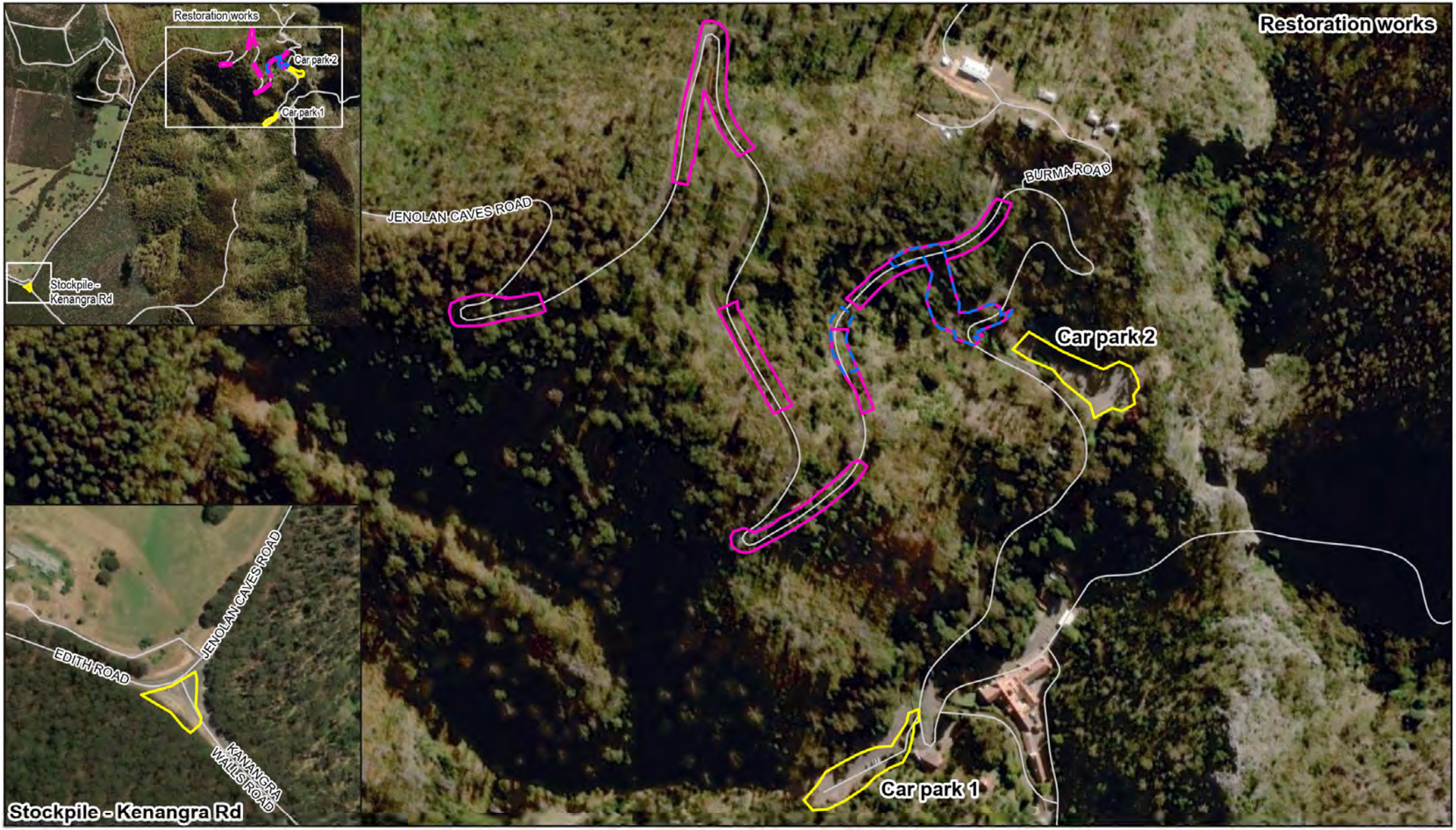
Location of the proposal

Project No. 12620185
Revision No. 1
Date 13/11/2024

FIGURE 1-1

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Print date: 13 Nov 2024 - 08:53

Data source: LPI: DCDB/DTDB, 2023, samaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2018 OpenStreetMap: Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community Maps contributors, Map layer by Esri. Created by: ehaverkamp



Legend

- Construction compounds / Stockpile areas
- Drainage infrastructure works
- Slope failure area
- Road

Paper Size ISO A4

0 100 200

Metres

Map Projection: Mercator Auxiliary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxiliary Sphere

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GHD

Transport for NSW
2 Mile Hill Restoration Project

The proposal

Project No. 12620185
Revision No. 2
Date 13/11/2024

FIGURE 1-2

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Print date: 13 Nov 2024 - 08:54

Data source: GHD, Site Features: 2021; LPI: DCDB/DTDB, 2017; World Imagery: Maxar. Created by: ehavenkamp

2. Need and options considered

2.1 Strategic need for the proposal

The proposal is required because of safety issues associated with the failure of a number of slopes next to Jenolan Caves Road following a number of rainfall events occurring from July 2022 into early 2023. While some emergency clearing work and temporary barriers have been installed to ensure the safety along this section of Jenolan Caves Road, the emergency measures put in place are not considered to be a long-term solution. Without stabilisation and restoration of the slope, there is a potential risk of further slope failures. The temporary measures currently in place also have resulted in some restrictions to public access to the Jenolan Caves Precinct (including Jenolan Caves, Jenolan Caves House and Jenolan Caves Mountain Lodge) with any vehicle access needing to be carried out under pilot vehicle operations due to sections of the road having reduced road widths in the vicinity of slope failures. Restrictions to the Precinct are further impacted as a result of other slope failures occurring on the Two Mile and Five Mile sections of Jenolan Caves Road during rainfall in March 2021. These restrictions are discussed further below.

The proposal would assist in meeting road safety objectives outlined in the *Long-Term Transport Master Plan* (Transport for NSW, 2014). The proposal would ensure that movements along this section of road can be carried out in a safe manner with a reduced risk of further slope failures.

The *Central West and Orana Regional Plan 2036* (NSW Government 2017) outlines the importance of Jenolan Caves as a significant tourism asset to both the Oberon Local Government Area (LGA) and the wider Central West. The Jenolan Caves Precinct is only accessible via Jenolan Caves Road both east and west of the Precinct. The extensive rainfall which occurred in March 2021 and then from July 2022 to early 2023 has resulted in both access routes to the Precinct being impacted due to slope failures. The access to the east (towards the Great Western Highway at Hartley) suffered more extensive damage, with restoration of this access to be a longer-term consideration due to the extent of work needed to stabilise and restore these areas. With the indefinite closure of the primary eastern access, access from Oberon (from the west) is currently the only access to the Jenolan Caves Precinct. A slope failure in March 2021 lead to public vehicular access into the Jenolan Caves Precinct being removed, with other arrangements (shuttle bus) put in place to maintain access to ensure the Precinct can remain operational. Additional slope failures at various times since July 2022 into early 2023 further restricted access into the Precinct with traffic control in place limiting movements along the Two Mile section of Jenolan Caves Road to being under pilot vehicle only. The additional access restrictions following the slope failures at various times since July 2022 into early 2023 has further left access into the Precinct to be less desirable for tourists.

Therefore, the proposal is required to ensure that unrestricted vehicular access into the Jenolan Caves Precinct can be restored, to allow continued use of this key tourism facility within the Oberon LGA. The proposal would also reduce the risk of further slope failures, particularly on the Two Mile access stretch of Jenolan Caves Road (road from the west), thereby minimising the potential for complete loss of access into the Precinct.

2.2 Limitations of existing infrastructure

Following the failure of the various slopes at the proposal site at various times since July 2022 into early 2023, Transport for NSW has installed plastic traffic barriers upslope of all the slope failure locations which has resulted in the narrowing of the roadway in some locations. Concrete barriers have also been installed downslope of the gully failure adjacent to a section of Jenolan Caves Road. Some stabilisation work including temporary mesh has been installed to help stabilise the slopes. These temporary measures are not considered to be a long-term solution due to the ongoing safety risk for use of the road, and the risk of further failures including the resulting access issues should further failures occur.

2.3 Proposal objectives and development criteria

2.3.1 Proposal objectives

The objectives of the proposal include:

- stabilise the existing failed slope profiles which occurred at various times between July 2022 and early 2023
- ensure that further risk of future slope failures is reduced, including the risk of debris falling onto Jenolan Caves Road and blocking access

- improve safety for road users along the section of Jenolan Caves Road
- enable full public vehicular access into the Jenolan Caves Precinct to be reinstated to improve overall access to the Precinct.

2.3.2 Development criteria

In the development of the options, the following development criteria and constraints were considered:

- construction access constraints due to the limited land located in the vicinity of the failed slope
- overall cost
- environmental constraints
- safety in design.

2.3.3 Urban design objectives

The urban design objective for the proposal is to ensure that the final finish is in keeping with the general characteristics of the area which is heavily focused on the natural setting within the Jenolan Karst Conservation Reserve. The positioning of the work within the State Heritage Listed Jenolan Caves Reserve (which encompasses the parts of the Conservation Reserve) and the presence of elements of this listing near the proposal means that the proposal is also required to suit the heritage listed Precinct.

2.4 Alternatives and options considered

2.4.1 Methodology for selection of preferred option

Shortly after the slope failure events occurring , site inspections and discussions were carried out on an emergency basis involving geotechnical engineers, Transport for NSW representatives, environment and planning specialists and specialist ground engineering contractors. Through those initial engagements, the development of options was discussed and a viable technical and practical option with appropriate visual features was broadly agreed. The key features of each option are provided in section 2.4.2.

Selection of the preferred option considered how each of the options satisfy the need for the proposal as well as its performance against the objectives and development criteria outlined in section 2.3.

The three stabilisation options were rated using a multicriteria assessment where a quantitative total weighted ranking was calculated for each option. The options were also assessed against the minimum acceptable Factor of Safety (FoS) needed for restoration of slopes along Transport for NSW roads.

2.4.2 Identified options

Proposal options

Option 1 – Do nothing

This option involves not carrying out any further work beyond the initial emergency response described in section 2.2. This option would involve the ongoing use of the emergency temporary measures (plastic barriers upslope of all the slope failure locations) put in place following the failure of the slopes.

Option 2 – Stabilisation work at areas subject to slope failure

This option would involve permanently stabilising the failed slopes to ensure that the risk of any further failures is reduced and to allow the road to be fully opened as per before the failure event. A review of options for stabilising the slope is presented below.

Stabilisation options

Option 1 – A-frame micro pile wall

This option involves installation of piles using an excavator. Minimal vegetation removal would be required. Two piles would be installed, with one pile to be placed outwards (closest to crest) with a 90 degree angle, and the second pile closest to the pavement placed at 60 degrees to form an 'A' shape. Figure 2-1 shows the typical cross section of a A-frame micro pile wall solution.

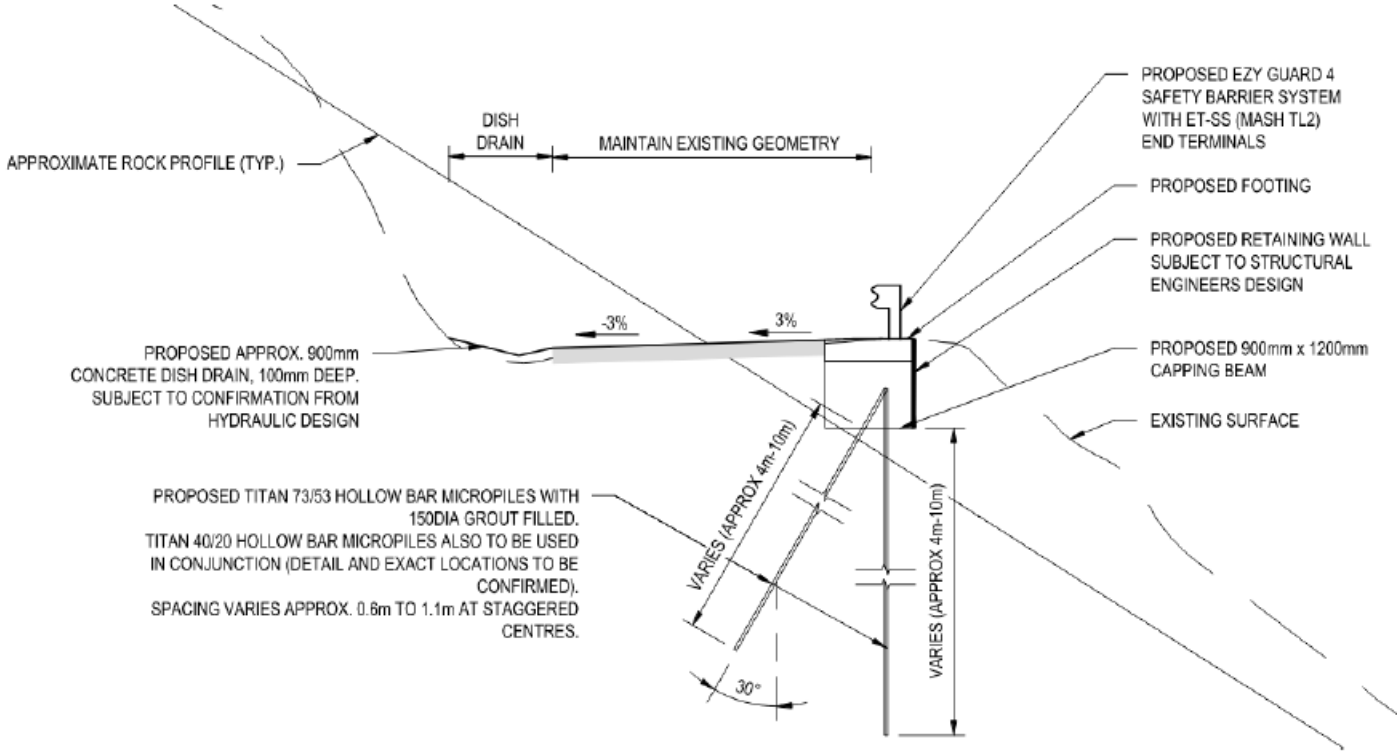


Figure 2-1: Typical section of A-frame micro pile wall

Option 2 – Soil nails and shotcrete

This option involves the installation of soil nails into the failed slope to stabilise the soil mass in situ. The face of the slope would then be protected with the application of structural shotcrete.

Option 3 – Upslope cutting

This option involves shifting the roadway in an upslope direction through widening of the existing upslope cuttings by three to four metres. This option would not result in any work on existing slope failure locations, with the new roadway to be constructed clear of the failure location atop of bed rock and not on fill material like the existing roadway.

2.4.3 Analysis of options

Proposal options

Option 1 – Do nothing

The 'do nothing' option is not considered to be a viable option as the temporary measures in place do not reduce the risk to a level which would allow the impacted section of road to be reopened in its full capacity.

The 'do nothing' option would not improve access into the Jenolan Caves Precinct and the existing traffic management of vehicles under pilot vehicles would likely remain due to the safety risks of using this section of Jenolan Caves Road. The continued inconvenience to accessing the Precinct for vehicles would potentially limit access for the community which then would impact on the operation of the Precinct. Leaving the site in its current state would continue to prevent efficient access as the other access route from the east (via the Five Mile stretch) is unavailable for an indefinite period. The importance of reopening the section of road subject to the proposal is further intensified due to the alternate access from the east being unlikely to be reopened soon.

This option would also result in a partially failed and exposed slope being left in-situ which poses an ongoing risk for water quality in downstream watercourses. The exposed slope causes a mobilisation risk for unstable sediment on the slope (including sediment from any further slope failures).

Option 2 – Stabilisation work

Option 2 is a viable option as it stabilises the existing slopes, thus reducing the risk of further slope failures. Stabilising the slope would also allow for the impacted section of Jenolan Caves Road to be reopened, allowing more free flowing public vehicular access into the Jenolan Caves Precinct.

Full access along Jenolan Caves Road from the east would provide some unimpeded vehicular access into the Precinct which is not currently available due to both sections of Jenolan Caves Road that provide access to the Precinct currently being impacted by slope failures. It would also allow the slope failure which occurred in March 2021 near the Precinct to be restored and therefore reopen vehicular access right into the Jenolan Cave Precinct.

Stabilisation method options

Option 1 – A-frame micro pile wall

Option 1 is considered to be the best technical option to stabilise the slope in the long term. This option would also not need any specialist construction equipment and would limit vegetation removal to the crest of the failed slope. This option would also enable intermittent access through the work areas during construction.

However, this option would use methods which are not commonly used by Transport for NSW and are not covered by any existing Transport for NSW guidelines or procedures. The proposed method would also involve costs to repair the traffic barrier which is integrated with the structure.

Option 2 – Soil nails and shotcrete

Option 2 would result in the physical restoration of the existing slope unlike other options which leave failed slope as per the existing condition. The option would also minimise the presence of heavy loads on the crest of the failed slope and the design could be adjusted to minimise any environmental impacts (for example the number of rows of nails could be revised as needed to minimise environmental impacts). The use of shotcrete allows the structure to be integrated into the natural environment through use of oxides or mock rock. This option would also allow more frequent access through the work areas during construction, when compared to options 1 and 3.

However, this option would not provide the desired design life of 100 years unlike the other considered options. This option would also have increased vegetation impacts and would need the use of specialist equipment due to the need to access the unstable slope from the road.

Option 3 – Upslope cutting

Option 3 would avoid the need for any work on the existing unstable slope and would enable the road to be constructed atop of bedrock thus minimising the risk of any future failure. The proposed work would also enable improved drainage work to be integrated into the design along the toe of the upslope.

These options would result in substantial increase in vegetation clearance due to the need to clear land atop of the existing cuttings. It would also result in substantial earthwork which would result in the need to dispose of a large amount of material.

2.5 Preferred option

2.5.1 Preferred proposal option

The preferred option was to carry out restoration work (option 2) which would improve safety along the section of Jenolan Caves Road subject to this slope failure. This would allow it to be reopened to the public, thus improving access to the Jenolan Caves Precinct.

2.5.2 Preferred stabilisation option

Of the options considered, Option 1, was considered to be the preferred option from a design and environmental viewpoint as it provides the most robust design while also minimising environmental impact due to the option being able to be contained within the existing roadway with no requirements for work on the failed slope.

While Option 1 is the best option it is considered a longer term solution and would come with a longer construction period. Due to the western approach of Jenolan Caves Road (Two Mile section) being the sole access to the Jenolan Caves Precinct, there is a need to secure this access and prevent any further slope failures.

Given this, Transport for NSW has identified Option 2 as the preferred option as it would be able to be implemented quicker than Option 1 and it would allow the slopes to be stabilised quicker thus maintaining an access into the Jenolan Caves Precinct. This would ensure the access is maintained for a suitable period while the eastern approach via the Five Mile stretch is restored, with this access to become the primary access to the Jenolan Caves Precinct. Following the establishment of the Five Mile stretch access from the east, further works on the Two Mile section of Jenolan Caves Road may be undertaken at a later date.

3. Description of the proposal

3.1 The proposal

Transport for NSW proposes to stabilise and restore eight separate slopes along a three kilometre section of Jenolan Caves Road (commonly referred to as the Two Mile section) at Jenolan (the proposal site). These slopes were subject to slope failures following extensive rainfall occurring at various times between July 2022 and early 2023. The proposal is shown in Figure 3-1.

Key features of the proposal include:

- installation of soil nails into eight slopes which were subject to failure to stabilise the slope
- surface stabilisation including the placement of shotcrete which would be appropriately tinted with colour to match the surrounding environment
- installation of drainage infrastructure within the impacted section of slope at three slope failure locations
- establishment of construction compound and stockpile sites at Kanangra Walls Road and Car Park 1 and 2.

Appendix A includes design plans for the proposal. It is noted that elements of these plans are still subject to ongoing detailed design.

3.1.1 Positioning of work within National Parks Estate

Transport for NSW are the relevant road authority for Jenolan Caves Road. Jenolan Caves Road exists within an infrastructure corridor which is not included in the surrounding Jenolan Karst Conservation Reserve. Cadastral information, as shown in Figure 3-2, for the road reserve is not accurate, and shows the road positioned outside the intended road corridor.

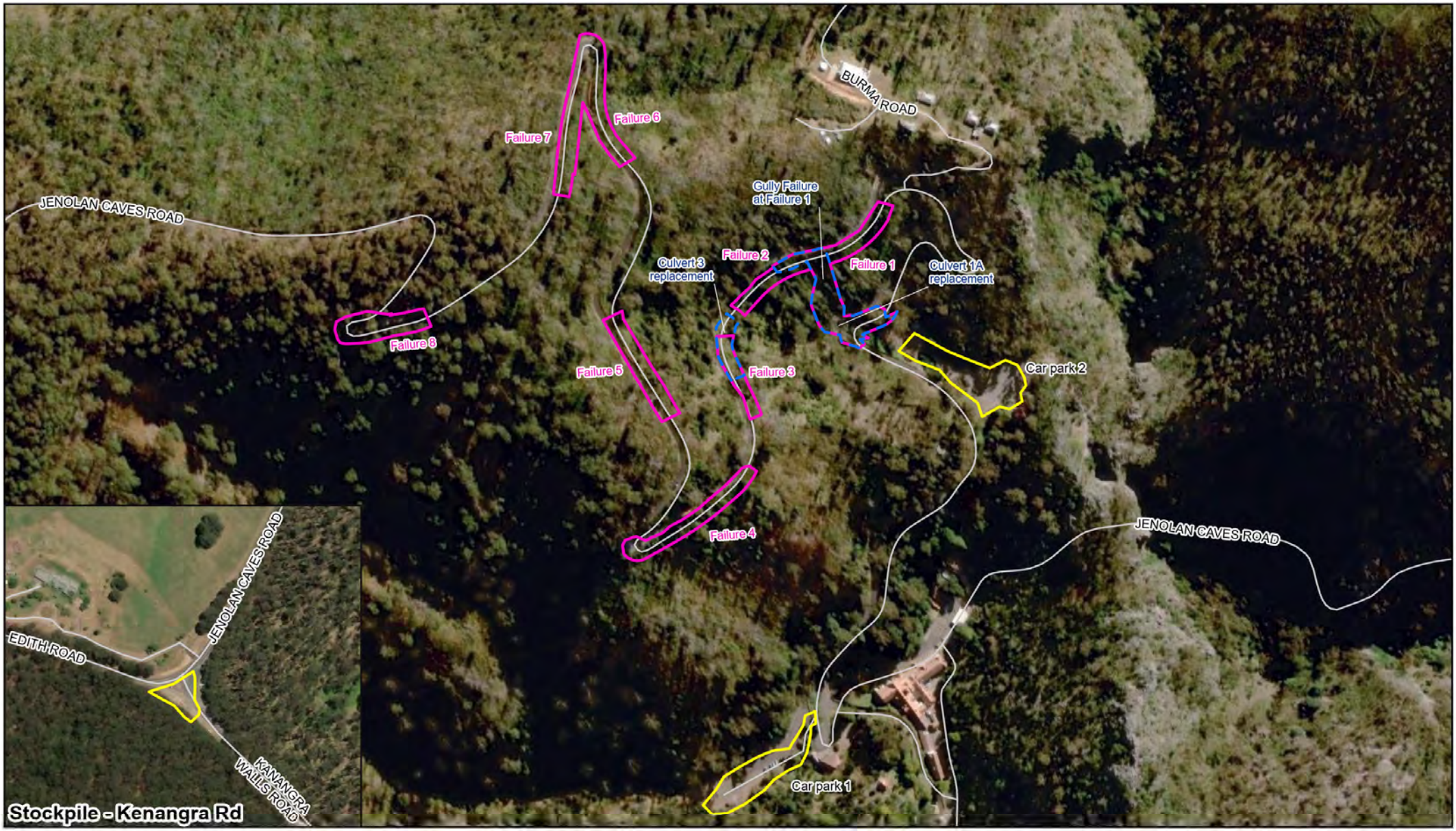
The road corridor is registered as being one chain or approximately 20 metres wide. For the purpose of this assessment this corridor is assumed to be centred on the centreline of the road with 10 metres located either side of the road. The approximate location of the Transport for NSW controlled corridor is shown on Figure 3-2.

For the purposes of this assessment, works in the National Parks Estate are considered to be the proposal elements located outside the 10 metre buffer either side of the road.

Table 3.1 outlines the proposal elements which are located on National Parks Estate.

Table 3.1: Positioning of work within National Parks Estate

	Description
Description of location	The following work are proposed on NSW National Parks and Wildlife Service (NPWS) land: • About 17 square metres of the proposal site at Failure 3 and Culvert 3, with no permanent infrastructure proposed, only construction areas located downslope of the road. • About 50 square metres of the proposal site at Failure 5, with no permanent infrastructure proposed, only construction areas located downslope of the road. • About 150 square metres of the proposal site at Failure 7, with no permanent infrastructure proposed, only construction areas located downslope of the road. • About 60 metres (measured horizontally out from top of slope) of the gully failure located between Failure 1/Culvert 1 and Culvert 1A. A total of about 1,500 square metres of the proposal site would be located within the National Park for the proposed gully restoration works. • Use of Carpark 1 and 2 as construction compounds (refer to section 3.4.1 for discussion on proposed use of Carpark 1). • Tree replacement offset planting, if selected as the preferred offset method, would potentially occur on National Park land in consultation with NPWS.
Park name	Jenolan Karst Conservation Reserve
Street address	Jenolan Caves Road
Site reference	Easting: 1335916.013 Northing: 6221111.027 MGA zone: (GDA2020-MGA54)



Legend

- Construction compounds / stockpile areas
- Drainage infrastructure works
- Slope failure area
- Road

Paper Size ISO A4

0 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Transport for NSW
2 Mile Hill Restoration Project

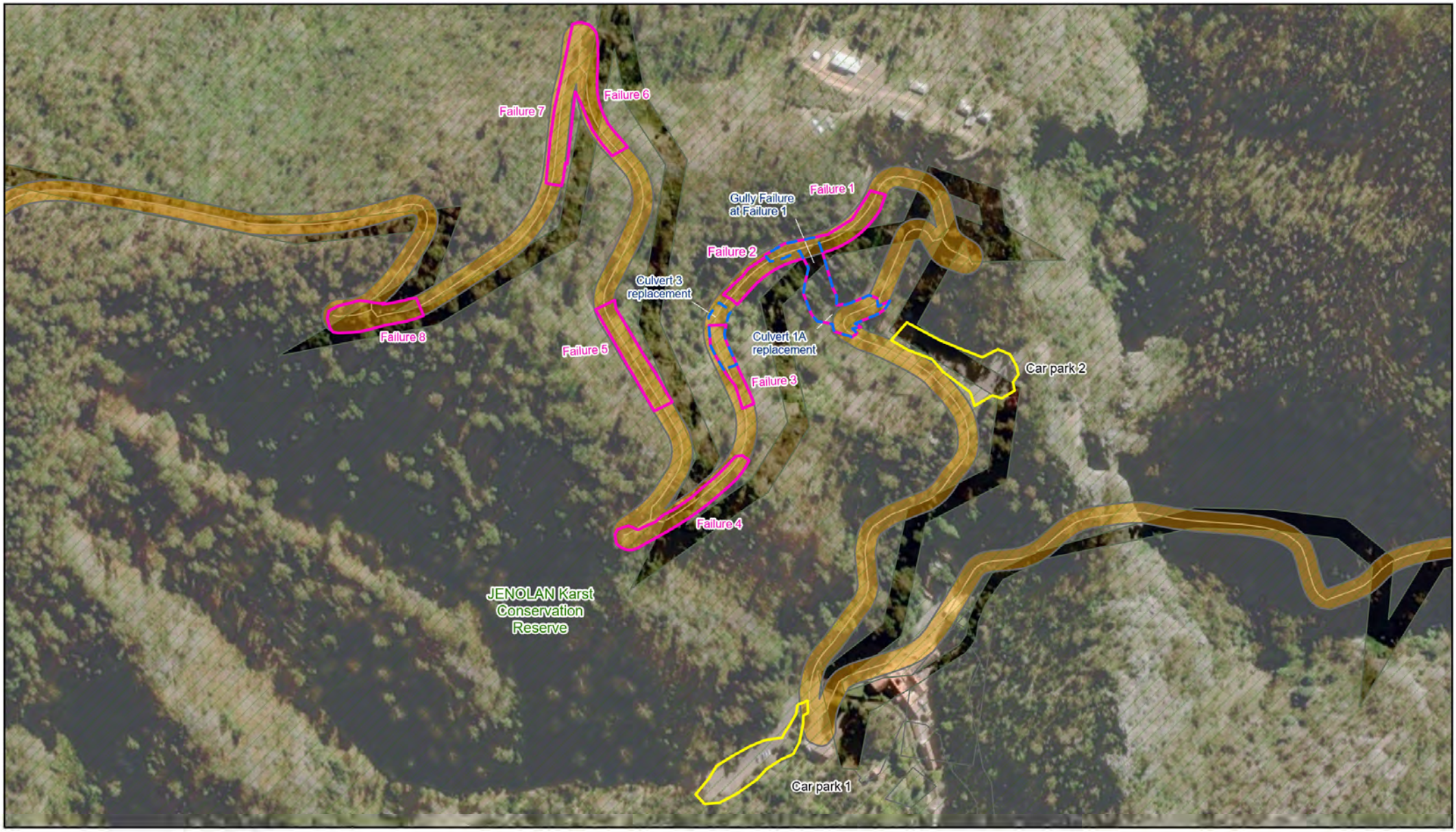
Project No. 12620185
Revision No. 2
Date 13/11/2024

Key features of the proposal

FIGURE 3-1

\\ghdnet\ghd\AU\Orange\Projects\21\12620185\GIS\Maps\Deliverables\12620185_2_Mile_Slope_Remediation_REF\12620185_2_Mile_Slope_Remediation_REF.aprx
Print date: 13 Nov 2024 - 08:56

Data source: GHD Site Features: 2021. LPI DCDB/DTDB, 2017; World Imagery: Maxar. Created by: ehaverkamp



Legend

- Transport for NSW's Jenolan Caves Road corridor
- Revised assumed road centreline
- Construction compounds / stockpile areas
- Drainage infrastructure works
- Slope failure area
- National Parks and Reserves
- Lot

Paper Size ISO A4

0 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Transport for NSW
2 Mile Hill Restoration Project

Project No. **12620185**
Revision No. **1**
Date **13/11/2024**

Jenolan Caves Road corridor

FIGURE 3-2

\\ghdnet\ghd\AU\Orange\Projects\21\12620185\GIS\Maps\Deliverables\12620185_2_Mile_Slope_Remediation_REF\12620185_2_Mile_Slope_Remediation_REF.aprx
Print date: 13 Nov 2024 - 08:59

Data source: GHD: Corrected roads and road corridors, 2024; Site Features: 2021 NSW SS; DCDB/DTDB, lots, NPWS 2017; World Imagery: Maxar. Created by: shaverkamp

3.2 Design

3.2.1 Design criteria

The design of the proposal was developed in accordance with the following documents, in order of precedence:

- Technical Direction GTD 2008/001, Geotechnical Design for Remediation of Existing Slopes and Embankments (Transport for NSW, 2018)
- Australian Standard 5100.3-2017, Bridge Design, Part 3: Foundation and soil-supporting structures – this was adopted for the assessment geotechnical stability for the soil nails
- *Soil Nail Walls – Reference Manual, Publication No. FHWA-NHI-14-007 US Department of Transport Federal Highway Administration* (FHWA 2015) – due to an absence of Australian Standards for soil nail walls (and specifically for shotcrete facing connection) this manual was adopted for the assessment of shotcrete stability
- *Australian Standard 3600-2018, Concrete Structures, Standards Australia Committee BD-002 Concrete Structures* – this standard was adopted with the strength reduction factors been used as part of the shotcrete stability calculations.

3.2.2 Engineering constraints

The engineering constraints for the design and construction of the proposal include the following:

- Jenolan Caves Road from Oberon (only available access) includes several tight radius curves which limits the size of construction vehicles and plant which can be used for the work.
- Access to the slope failure areas is limited due to topography issues and the risk of further failures. Therefore, works would need to be undertaken from the roadway, limiting the space available for construction. The equipment and/or methods selected also need to be appropriate to allow work to occur from the road with no, or limited physical impact to the slope.
- As the Two Mile section of Jenolan Caves Road is the only access to Jenolan Caves for Jenolan Caves Reserve Trust staff and construction workers, access along the road would need to be maintained. This means any construction methods used would have to allow passage past the work areas including the ability to quickly demobilise for any emergency situations.

3.2.3 Environmental constraints

The environmental constraints for the design and construction of the proposal are as follows:

- the surrounding Precinct is State heritage listed and is considered a sensitive environment
- natural landscape consisting of native vegetation makes the site sensitive to change, in particular the introduction of man-made structures
- the position of the site within the Sydney Water Drinking Catchment making it sensitive to changes in water quality
- the need to maintain access into the Precinct to allow ongoing tourism activities
- the slope failure areas are located within and adjacent to the Jenolan Karst Conservation Reserve which forms part of the World Heritage listed Greater Blue Mountains World Heritage Area (GBMWHA).

3.2.4 Major design features

Soil nail walls

The proposal would involve the installation of soil nails across all the failure locations. The potential extent of the proposed restoration works is shown in Figure 3-1, with the final extent to be confirmed during detailed design. Between four and eight rows of soil nails are expected to be required at each location. This would result in works extending up to 15 metres down the slope. The typical spacing between soil nails is expected to be 1.5 metres in both the horizontal and vertical direction.

Soil nails are expected to be between four and five metres long however longer nails would potentially be required subject to geotechnical investigations and detailed design. Differing lengths of nails would be used at each failure location with the upper rows typically longer than the lower rows.

The walls would include the installation of some drainage infrastructure, with the face of the wall to consist of shotcrete applied across the entire face of the slope. This drainage would consist of flexible strip filter drains which would be installed on a 45 degree angle across the face of the slope at about three metre intervals (refer to Figure 3-4). These drains would then discharge to the slope at each location.

A typical cross section of the arrangement of the soil nails at each failure location is shown in Figure 3-3. Figure 3-4 shows how the soil nails would typically be arranged in plan view across the slopes. This figure includes an indicative layout of the potential strip drains needed on each of the proposed soil nail walls.

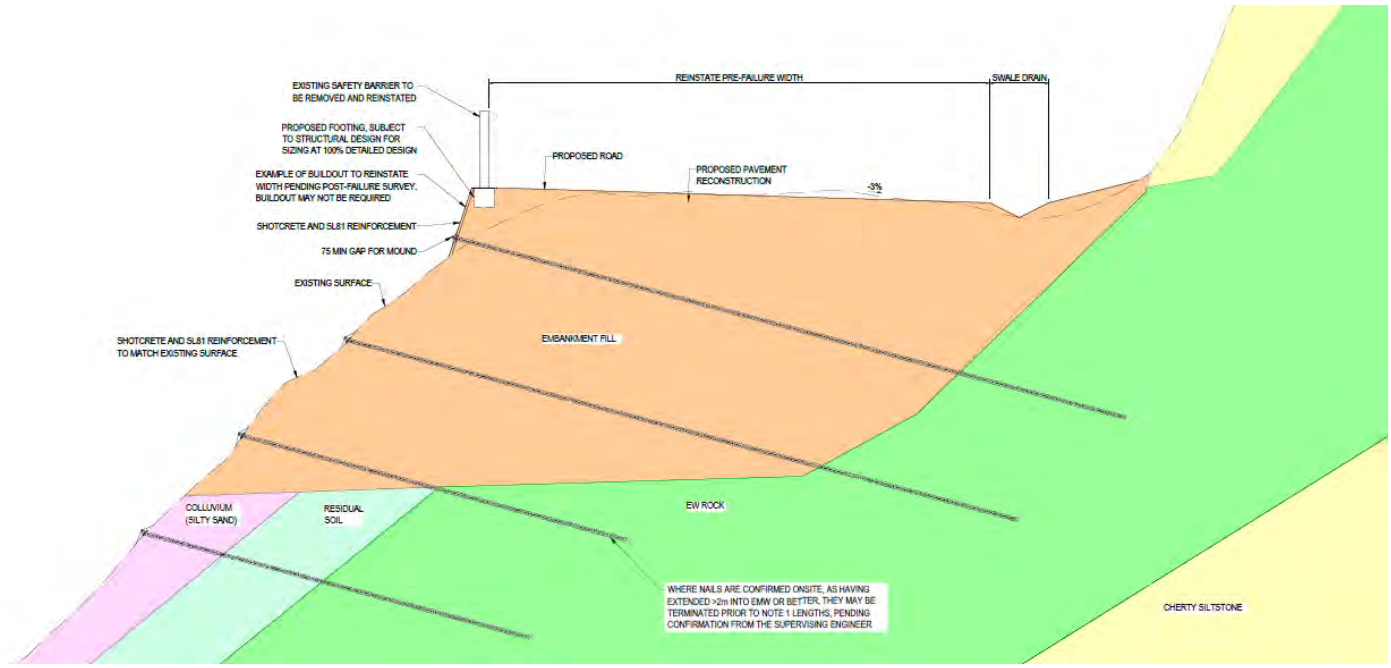


Figure 3-3: Typical cross section of soil nails

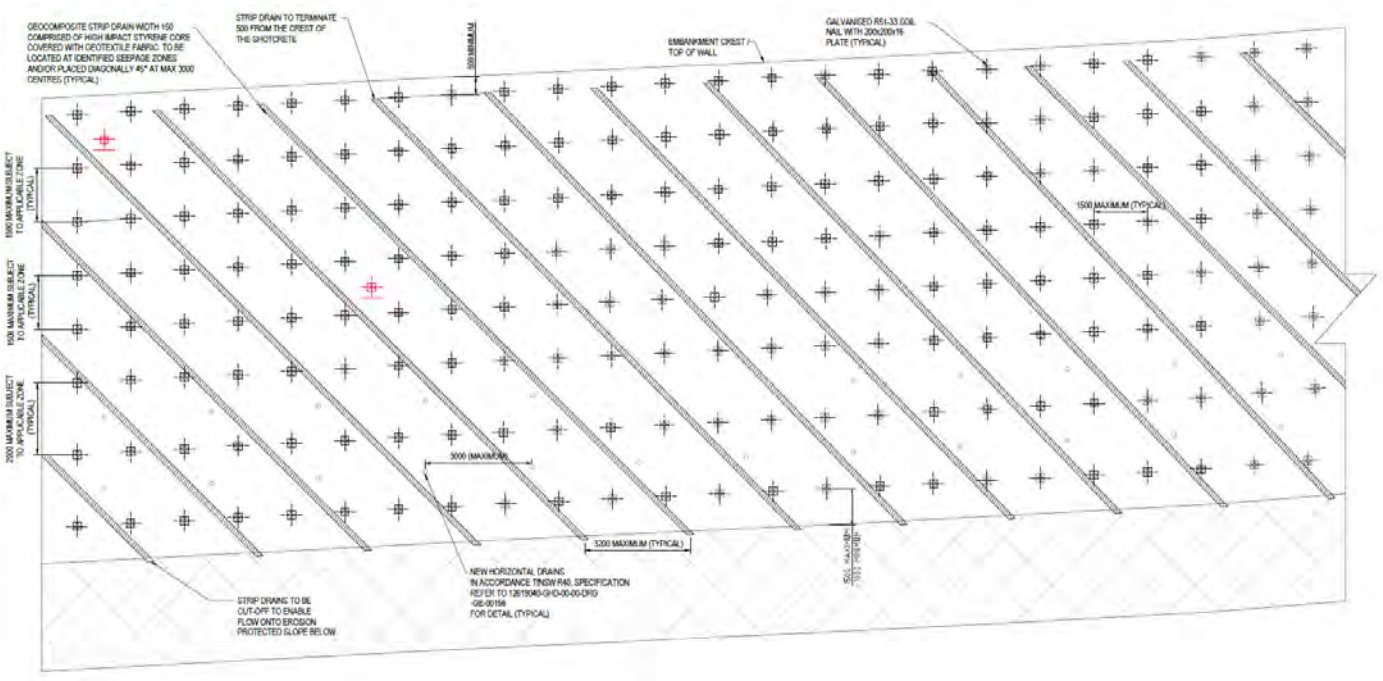


Figure 3-4: Typical plan arrangement of soil nails on a failed slope

Gully failure at failure 1

The gully failure downslope of Failure 1 would be restored through infilling with imported fill. The fill would be shaped and graded to suit the slopes. The area to be shaped and regraded would be about seven metres wide which represents the existing gully width. At the centre of the gully a two metres wide and 70 metres long rock mattress would be installed on top of the fill material. Land located on engineered fill outside the proposed rock mattress area would be left to revegetate naturally unless access tracks are required to access the slope. Where land is disturbed for access tracks, it would be restored and revegetated following works. The extent of the works at the gully failure are shown on the drawings located in Appendix A. The design of this element of the proposal is subject to ongoing detailed design.

Culvert replacement

Three existing culverts would be required to be upgraded as part of the proposal to enable flows to pass through the site and avoid flows running over the slopes. Table 3.2 outlines the proposed upgrade sizing of each of the culverts as well as any other proposed drainage work needed in relation to the culvert. The length of all culverts would remain generally the same as existing to cross Jenolan Caves Road.

Table 3.2: Proposed culvert upgrades

Culvert	Existing culvert size	Proposed culvert size	Rock mattress protection	Other associated drainage work
1	300mm diameter	2 x 450mm diameter	Yes, see gully failure scope	About 40 metre long dish drain upslope of culvert inlet along Jenolan Caves Road on the upslope side of the road. Reshaping of existing landform at inlet pit to direct water towards the inlet pit. About 70 metre long kerb on the downslope side of the road to redirect water not captured by infrastructure on the upslope side to other sections of the slope.
1a	600mm diameter	2 x 1.05m diameter	No	About 35 metre long dish drain upslope of culvert inlet along Jenolan Caves Road on the upslope side of the road. Reshaping of existing landform at inlet pit to direct water towards the inlet pit. New gabion mattress dissipating device positioned at outlet which would extend to the edge of Transport for NSW's road reserve. Water would then be directed into existing drainage infrastructure located within the Jenolan Karst Conservation Reserve.
3	600mm diameter	2 x 750mm diameter	Yes, 2m wide and about 12 m long	About 35 metre long dish drain upslope of culvert inlet along Jenolan Caves Road on the upslope side of the road. Reshaping of existing landform at inlet pit to direct water towards the inlet pit. About 60m long kerb on the downslope side of the road to redirect water not captured by infrastructure on the upslope side to other sections of the slope.

Road surface upgrade

At some failure locations the existing road pavement has been damaged. This would be repaired as part of the proposal. Any damaged road furniture (for example guard rails) would also be repaired as needed to establish the pre-failure road widths.

Major design features in national park

The only major design feature which is located within National Park estate is that associated with the restoration of the gully downslope of Failure 1. This section of gully restoration equates to about 60 metres of slope (measured horizontally) in the National Park Estate (or about 1,500 square metres of the proposal site) and would require regrading and the installation of rock mattress.

3.3 Construction activities

3.3.1 Work method

Construction activities would be guided by a Construction Environmental Management Plan (CEMP) to ensure the work is carried out in accordance with Transport for NSW specifications and that all safeguards and management measures described in this REF are implemented (refer to section 7.2 for a consolidated list of safeguards and management measures). Detailed work methodologies would be determined during construction planning. An indicative construction method for the proposal is provided below.

Early work and site establishment

- move and/or adjust affected utilities, services and signage
- implement pre-construction safeguards and management measures outlined in the CEMP, such as installing erosion, sediment and water quality controls
- establish temporary fencing, work compounds and stockpile sites and delineate the proposal site to reduce risk of work going outside the approved work area
- remove any temporary traffic controls such as water filled barriers
- install traffic management measures including temporary traffic signs and roadside safety barriers (where needed).

Stabilisation work

- carry out face scaling, excavation and removal of vegetation (including stump grinding) within proposed soil nail wall area
- mark out soil nail locations
- install test nails and carry out suitability testing
- install remaining nails at nominated locations and conduct suitability testing
- install horizontal and strip drains
- install steel wire mesh and face plates and undertake tensioning of soil nails
- apply shotcrete and conduct suitability testing
- apply final layer of shotcrete, including any texturing and colouring needed
- repair any road pavement and road furniture damaged as a result of the failures.

The above process would be carried out from Jenolan Caves Road. The work would be carried out using equipment which allows workers to remain on the roadway but to complete work over the edge of the slope. This may include the use of cherry-pickers or similar.

Culvert upgrades

- excavate and removal of existing culverts including road pavement
- reshape existing landform to enable flows towards new inlet pits
- install new culverts including inlet pits
- import fill to bury new culvert
- install new dish drains and kerb as needed
- reinstate road pavement
- install outlet scour protection or swale drains (depending on failure location).

Gully failure rehabilitation

- carry out face scaling, excavation and removal of vegetation (including stump grinding) within gully area
- import select fill material to allow the establishment of 200mm thick layer, this would be carried out using a method to be confirmed with the selected construction contractor
- compact fill material to desired levels (about 200mm think layer)
- repeat importation and compaction of layers until desired final design level is met
- install rock mattress down centre of compacted fill.

Demobilisation of construction site

Demobilising the construction site following the development of the proposal would include:

- rehabilitate disturbed areas (as needed) including existing road surface along Jenolan Caves Road where damage has occurred because of the proposal
- decommission stockpile and compound sites
- final site clean-up.

3.3.2 Construction workforce

The construction workforce is expected to fluctuate, with the expected workforce to peak at about 45 personnel per day. This is based on the assumption that three teams of up to 15 people would be working on different sections of the proposal. The final number of construction workers would be identified by the construction contractor.

3.3.3 Construction hours and duration

Due to a requirement to provide the Jenolan Caves Reserve Trust uninterrupted access to the Jenolan Caves Precinct for part of the week the proposal would be carried out Wednesday to Sunday with no work planned on Monday and Tuesday. During Monday and Tuesday the Jenolan Caves Reserve Trust would have uninterrupted access to the Jenolan Caves Precinct. The proposed work hours Wednesday to Sunday would be 7.30am to 5pm daily. This involves work outside the recommended standard working hours for the following periods:

- Saturday: 1pm to 5pm
- Sunday: 7.30am to 5pm.

Access for Jenolan Caves Reserve Trust vehicles would be limited to outside the construction period and therefore access would only be available before 7.30am and after 5pm daily. Some pedestrian access through the proposal's work areas may be feasible for a period of 30 minutes during the day however this would be confirmed as part of construction planning. Additional access through the work areas would need to be confirmed through discussions between Transport for NSW and the Jenolan Caves Reserve Trust.

Justification for work outside recommended standard working hours

Constructing the proposal during extended hours on Saturday and Sunday in lieu of work on Monday and Tuesday is considered to be justified as this arrangement would allow the Jenolan Caves Reserve Trust uninterrupted access to the proposed construction activities located within the Jenolan Caves Precinct for two days while still maintaining some access on the remaining days of the week. The extension of these hours is not expected to result in any noise and vibration impacts on any nearby sensitive receivers. This is a result of these receivers (and the whole Jenolan Caves Precinct) being shut to the public during this period as a result of the Jenolan Caves Reserve Trust's construction works.

The extension of the working hours would allow both the proposal and the works within the Jenolan Caves Precinct to occur simultaneously and therefore reduce the overall timeframe access to the Precinct would be lost either through construction works in the Precinct or due to loss of road access.

3.3.4 Plant and equipment

The plant and equipment needed for construction of the proposal would be determined during construction planning. The following equipment is anticipated to be needed:

- elevated work platform
- excavator (long reached version likely)
- drill mast for soil nailing which is attached to the excavator
- dump trucks
- skid steer
- sleds to provide access to slope (in particular the lower soil nails)
- shotcrete spray rig including air compressors and grout pumps
- cement trucks
- kerb machines
- light vehicles (utes/cars).

Final selection of equipment would be needed to account for the difficulty in access of the site due to tight curves along Jenolan caves Road.

3.3.5 Earthworks

To ensure safety during construction, the existing slopes would be required to be regraded as needed to obtain the optimal slope angle as outlined in the design.

The proposed excavation and scaling would seek to provide a more uniform slope for the installation of soil nails. Excavation would also remove any vegetative material remaining on the failed slopes and gully as well as removal of any stumps which were left following the removal of trees as part of the temporary restoration works.

The proposal would require the excavation of material, however the volume would be confirmed during detailed design. Excavated material would be disposed of in accordance with the *Protection of the Environmental Operations Act 1997* (POEO Act). Material would be initially stockpiled at one of the identified stockpile locations where it would be tested to confirm its classification. Once confirmed as suitable for reuse the material would be removed from site to other Transport for NSW projects where possible. If re-use is not feasible the material would be disposed of at an appropriately licenced facility.

3.3.6 Source and quantity of materials

Most materials would be sourced from a local licensed supplier.

The following materials would be required as part of the proposal:

- rock for gully failure
- soil nails
- shotcrete
- strip filter drains
- concrete (excluding shotcrete)
- asphalt for road restoration.

Volumes of these materials would be confirmed during the detailed design phase by the construction contractor, with further materials potentially being required.

Rock for the gully failure is proposed to be sourced from local quarries in the Oberon area. This material consists of similar geology to the proposal site and has been used on other Transport for NSW projects in the area.

3.3.7 Traffic management and access

Access to the proposal site

Existing access

Access to the Jenolan Caves Precinct before March 2021 was via Jenolan Caves Road from both the west (from Oberon) and the east (from the Great Western Highway at Hartley).

Access from the east (a section of Jenolan Caves Road known as the 'Five Mile' stretch) was closed due to several slope failures including several sections of road being washed away as a result. Extensive work will be required to reinstate the access from this direction. The restoration of this access route is not part of the proposal.

Access from the west is currently available along Jenolan Caves Road to Car Park 2. Visitors to the Precinct are currently required to park in Car Park 2, located north of the proposal site. From there, visitors may use the shuttle bus provided or walk to the south via existing tracks/packs from the car park to facilities within the Jenolan Caves Precinct. Access into the Jenolan Caves Precinct south from Car Park 2 is limited to a small number of movements needed to service the Jenolan Caves Precinct and associated businesses and facilities.

Access from the top of the Two Mile section of Jenolan Caves Road down into the Jenolan Caves Precinct is currently under traffic control with movement only possible with an escort vehicle requiring travel in one direction at any one time. Vehicles are therefore required to be held at the top of the Two Mile section or within Car Park 2 before heading down or up the slope respectively behind the escort vehicle.

Proposed changes to access

Public access along Jenolan Caves Road during the construction of the proposal would be removed due to both the proposal and construction works by the Jenolan Caves Reserve Trust requiring the closure of the Jenolan Caves Precinct. The closure of the Jenolan Caves Precinct would be occurring regardless of the timing of the proposal.

During construction, Jenolan Caves Road would remain open on Monday and Tuesday to provide Jenolan Caves Reserve Trust staff uninterrupted access to the Jenolan Caves Precinct. This would be carried out under traffic control as per the existing situation due to the limitations of lane widths in some sections of the Two Mile section of Jenolan Caves Road.

From Wednesday to Sunday, access along Jenolan Caves Road would be partially lost for the Jenolan Caves Reserve Trust. On these days access along the road would only be available before 7.30am and after 5pm. Between 7.30am and 5pm, Transport for NSW would have full occupation of the roadway to enable work at the failure locations to be carried out, unless previously organised between Transport for NSW and the Jenolan Caves Reserve Trust.

Emergency access through the proposal site would be maintained when needed. This includes access to the helipad located on Burma Road. An emergency response procedure would be developed which would outline the processes to be implemented at the alert of an emergency to ensure clear passage for emergency vehicles is available. This procedure is to be developed in line with the requirements outlined in Jenolan Caves Reserve Trust's emergency response procedure.

Notification of work and any pending road closures would be carried out by Transport for NSW in accordance with the CEMP for the proposal (that would include a Traffic Management Plan and Communications and Stakeholder Management Plan).

All construction vehicles would access the site via Jenolan Caves Road from Oberon.

Traffic generation due to the proposal

Construction of the proposal would require heavy vehicle movements for the transport of construction machinery and equipment, and the import and movement of materials. The following numbers assumes three work areas would be in operation, with separate teams completing the work. Around 18 heavy vehicle movements are anticipated per day, however, during peak periods such as during shotcreting activities, this could increase to around 30 heavy vehicle movements per day. Further light vehicle movements would be needed to allow for staff access to the proposal site. Light vehicle movements are anticipated to be about 45 movements per day.

Vehicles would be parked within the designated compound and stockpile areas.

Traffic management

A Traffic Management Plan would be prepared in accordance with the *Traffic Control at Work Sites Technical Manual* (Transport for NSW, 2022a). The Traffic Management Plan would provide details of the traffic management to be implemented during construction, to ensure that traffic flow on the surrounding network is maintained. The Traffic Management Plan would also ensure the safe separation of workers on site from vehicles along Jenolan Caves Road.

3.4 Ancillary facilities

3.4.1 Construction compound and stockpile sites

Construction compounds and stockpile locations are anticipated to be established in the following three locations:

- Car Park 1 – located south of the failed slope directly next to Jenolan Caves House
- Car Park 2 – located south of the gully failure at Failure 1 about 400 metres along Jenolan Caves Road
- Kanangra Walls Road stockpile site –a previously utilised area located at the corner of Kanangra Walls Road and Jenolan Caves Road intersection, about 2.5 kilometres south-west of the proposal.

The location of these compound areas is shown in Figure 3-1.

These areas would be used primarily as stockpile locations; however, a site office would potentially be established in Car Park 2. The use of each area would be dependent on the materials needed to be stockpiled, as the size of the vehicle completing the delivery may be restricted to particular stockpile locations due to the tight curves along the proposed access into the site. In these instances, the Kanangra Walls Road site may be used as a staging area for materials on large vehicles where equipment and materials are then moved down Jenolan Caves Road to the proposal site, where needed.

The use of Car Park 1 is currently not feasible due to its current use by the Jenolan Caves Reserve Trust as part of their proposed upgrade work within the Jenolan Caves Precinct. Following the completion of these works, use of Car Park 1 would only occur upon approval from the Jenolan Caves Reserve Trust.

Stockpiling at the Kanangra Walls Road site would not impact vehicular traffic along Kanangra Walls Road. The positioning of this stockpile area would be contained to the Transport for NSW managed road reserve and would not encroach on the Kanangra Boyd National Park. Fencing or other appropriate methods (for example high visibility tape) would be established to delineate the boundary of the Kanangra Boyd National Park to ensure no accidental use of land within the National Park.

Site specific management plans would be developed for each of the proposed stockpile areas. The plans would outline the requirements for clean-up of these areas including the times by which the areas need to be cleared. These plans would outline the accessibility to each site and outline the suitable storage timeframes for particular materials.

3.5 Public utility adjustment

The proposal would not impact upon any public utilities based on the information reviewed to date. No ‘in-ground’ utilities which may impact the installation of structures were found on site based on a Before You Dig Australia (BYDA) search . Therefore, public utility adjustments are not needed. Before the work begins, further investigations would be carried out to confirm the presence of any currently unidentified utilities.

In the event the need for utility relocation is identified, consultation with the Transport for NSW Senior Environmental Officer would be carried out to seek advice about further assessment requirements.

3.6 Property acquisition

The proposal would largely be contained within the existing road reserve and on the slope which is managed by Transport for NSW. Part of the work would be located on NPWS land however no property acquisition would be needed as part of the proposal.

4. Statutory and planning framework

4.1 Environmental Planning and Assessment Act 1979

4.1.1 State Environmental Planning Policies

State Environmental Planning Policy (Transport and Infrastructure) 2021

Chapter 2 of State Environmental Planning Policy (Transport and Infrastructure) 2021 (Transport and Infrastructure SEPP) aims to facilitate the effective delivery of infrastructure across NSW.

Section 2.109 of the Transport and Infrastructure SEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent.

As the proposal is for a road infrastructure facility and is to be carried out by Transport for NSW, it can be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979*. Development consent from council is not required.

The proposal does not require development consent or approval under the following:

- Chapter 2 of State Environmental Planning Policy (Resilience and Hazards) 2021
- Chapter 2 of State Environmental Planning Policy (Planning Systems) 2021
- State Environmental Planning Policy (Precincts—Regional) 2021.

Parts of the proposal are located on land reserved under the *National Parks and Wildlife Act 1974* (NPW Act) and require authorisation by or under the NPW Act which is further discussed in section 4.2.1. The activity is not designated development under Schedule 3 of the EP&A Regulation.

Part 2.2, Division 1 of the Transport and Infrastructure SEPP contains provisions for public authorities to consult with local councils and other public authorities before certain types of development take place. Consultation, including consultation as required by the Transport and Infrastructure SEPP (where applicable), is discussed in Chapter 5 of this REF.

State Environmental Planning Policy (Biodiversity and Conservation) 2021

Section 171A of the Environmental Planning and Assessment Regulation 2021 (the Regulations) outlines the considerations of activities undertaken in drinking water catchments. The proposal is located within the Mid Coxs River sub-catchment of the Sydney Drinking Water Catchment. The considerations outlined in Section 171A(1) of the Regulations and State Environmental Planning Policy (Biodiversity and Conservation) 2021 (Biodiversity and Conservation SEPP) relevant to the proposal due to its positioning in the Sydney Drinking Water Catchment are outlined in Table 4.1.

Part 6.5 of the Biodiversity and Conservation SEPP outlines the requirements to considered water quality within the Sydney Drinking Water Catchment. Appendix D includes an assessment of the proposal in accordance with the requirements outlined in Section 6.63 of the Biodiveristy and Conservation SEPP.

Table 4.1: Compliance with Section 171A of Environmental Planning and Assessment Regulation 2021 and Biodiversity and Conservation SEPP

Section	Consideration
Section 171A(3)(1) of Regulations	
(i) will have a neutral or beneficial effect on water quality	See the neutral or beneficial effect assessment included in Appendix D. The assessment concludes that the proposal would have a beneficial effect on water quality.
(ii) is consistent with the NorBE Guideline within the meaning of State Environmental Planning Policy (Biodiversity and Conservation) 2021, Part 6.5	The assessment completed In Appendix D is consistent with the NorBE Guideline.
Section 6.6 of Biodiversity and Conservation SEPP (water quality and quantity)	
1(a) and 2(a) – effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial	Not applicable due to the positioning of the proposal in the Sydney Drinking Water Catchment these two provisions do not apply in accordance with Section 171A(3)(b) of the Regulations and Section 6.6(3) of the Biodiversity and Conservation SEPP
1(b) and 2(b) – impacts on water flow in a natural waterbody	The proposal is not expected to impact flows into the Jenolan River with the works not altering any flow paths of run-off from the pre-existing condition prior to the slope failure
1(c) - whether the development will increase the amount of stormwater run-off from a site	The proposal is not expected to increase the stormwater run-off from the site, with the proposal reinstating the landform prior to the slope failure and any flow paths to be maintained.
1(d) - whether the development will incorporate on-site stormwater retention, infiltration or reuse	The proposal does not include any on-site retention or reuse. Any infiltration is not considered to differ from the pre-existing situation prior to the slope failure.
1(e) - the impact of the development on the level and quality of the water table	The proposal is not expected to impact on the water table as discussed further in section 6.2.2.
1(f) - the cumulative environmental impact of the development on the regulated catchment	The proposal is not expected to contribute any cumulative impacts within the catchment with impacts on water quality and flows considered to be minimal.
1(g) - whether the development makes adequate provision to protect the quality and quantity of ground water	The proposal includes restoration of existing slopes subject to failure and is considered to maintain the quality and quantity of groundwater (see section 6.2.2).
Section 6.7 of Biodiversity and Conservation SEPP (Aquatic ecology)	
1(a) and 2 (b) - whether the development will have a direct, indirect or cumulative adverse impact on terrestrial, aquatic or migratory animals or vegetation and that impacts are minimise to what is necessary	Impacts on biodiversity are discussed in section 6.1.3. The impacts identified are considered to have been minimised to what is necessary, with the proposal only impacting on areas required to stablise the failed slope
1(b) and 2(c) - whether the development involves the clearing of riparian vegetation	The proposal does not involve any clearance of riparian vegetation along the Jenolan River and therefore no associated approvals are required.
1(c) and 2(d) - the erosion of land abutting a natural waterbody or the sedimentation of a natural waterbody will be minimised,	The proposal involves the restoration of an existing slope failure which poses a risk of mobilsing sediment downslope into the Jenolan River. The proposal is therefore considered to be beneficial for impacts on the Jenolan River. Any

Section	Consideration
	impacts during construction would be managed through common erosion and sedimentation controls.
1(d) and 2(e) - whether the development will have an adverse impact on wetlands that are not in the coastal wetlands and littoral rainforests area,	The proposal is not expected to impact upon any wetland areas.
1(e) whether the development includes adequate safeguards and rehabilitation measures to protect aquatic ecology,	The proposal seeks to restore an existing slope failure which is currently posing a risk to any downslope aquatic habitat. Appropriate erosion and sedimentation controls would be put in place to manage any impacts during the construction works.
1(f) if the development site adjoins a natural waterbody—whether additional measures are required to ensure a neutral or beneficial effect on the water quality of the waterbody.	The proposal is not located directly adjacent to the Jenolan River, however measures would be put in place to ensure that construction of the proposal would not impact water quality.
2(b) the development will not have a direct, indirect or cumulative adverse impact on aquatic reserves,	The proposal is not expected to contribute any cumulative impacts within the catchment with regards to impacts on aquatic habitats.
Section 6.8 of Biodiversity and Conservation SEPP (Flooding)	
1 - Likely impact of the development on periodic flooding that benefits wetlands and other riverine ecosystems.	The proposal is not expected to alter any flow volumes or flow paths when compared to the preexisting condition at the site before the slope failure and therefore is not considered impact on any ecosystems which rely on floodwaters.
2 - development on flood liable land in a regulated catchment	The proposal is not located on flood liable land due to the extremely steep terrain.
Section 6.9 of Biodiversity and Conservation SEPP (Recreation and public access)	
1(a) - the likely impact of the development on recreational land uses in the regulated catchment	The proposal would enable Jenolan Caves Road to reopen to full capacity meaning that access to the Jenolan Caves precinct can be reinstated after some limitations to access which have been in place since the slope failure.
1(b) - whether the development will maintain or improve public access to and around foreshores without adverse impact on natural waterbodies, watercourses, wetlands or riparian vegetation.	The proposal would not impact access to any foreshore areas with the water catchment.
2(a) - the development will maintain or improve public access to and from natural waterbodies for recreational purposes	The proposal would enable Jenolan Caves Road to reopen to full capacity meaning that access to waterbodies for recreational purposes is improved.
2(b) - new or existing points of public access between natural waterbodies and the site of the development will be stable and safe,	The proposal involves the restoration of the existing access to areas along the Jenolan River to ensure that it would not be subject to any future slope failures.
2(c) - if land forming part of the foreshore of a natural waterbody will be made available for public access as a result of the development but is not in public ownership—public access to and use of the land will be safeguarded.	The proposal does not involve any public access to the foreshore of a natural waterbody.

Section	Consideration
Section 6.21 of Biodiversity and Conservation SEPP (Stormwater management)	
(3) Despite subsection (2), development to which this section applies is prohibited on land in a regulated catchment if the works will cause untreated stormwater to be disposed of into a natural waterbody.	With the proposal's primary purpose being to reinstate the existing failed slopes in line with the Natural Disaster Recovery Funding requirements, the proposal is only seeking to restore to the slopes to their pre-existing condition. For this reason improvement of the discharge water quality has not been a primary focus. The proposal would however result in improved water quality in the catchment due to restoration of the failed slopes which may currently exacerbate erosion and sedimentation in the catchment due to exposed surfaces on the slopes. The proposal would also include provision of primary water treatment devices to capture rubbish at all proposed new inlets and outlets to drainage infrastructure to meet Transport for NSW existing standards. The proposal would therefore reinstate the water quality conditions prior to the slope failures occurring and in some instances would improve water quality though the provision of additional water quality devices at drainage inlets and outlets. Due to the above, the proposal is therefore not considered to be prohibited in accordance with this section 6.21(3) of the Biodiversity and Conservation SEPP.

4.1.2 Local Environmental Plans

Oberon Local Environmental Plan 2013

The proposal site is located within the Oberon local government area and, therefore, the Oberon Local Environmental Plan 2013 (Oberon LEP) applies to the land.

Permissibility

The proposal site is located on land which is zoned SP3 Tourist under the Oberon LEP. The objectives of this zone are as follows:

- To provide for a variety of tourist-oriented development and related uses.
- To ensure that development occurs in a manner that maintains and enhances the scenic quality, the ecological and geological systems and the heritage significance of the Jenolan Caves Reserve.

The proposal, while not directly considered tourist-oriented development, would ensure that ongoing access to tourist facilities such as Jenolan Caves, is maintained. The proposal seeks to reduce the risk of further landslips which may result in access to Jenolan Caves being completely lost. The impacts on biodiversity and heritage are outlined in further detail in sections 6.1 and 6.7, respectively.

The proposal is considered to meet the definition of environmental protection work under the Oberon LEP as the work involves erosion protection work and would protect land from environmental degradation (that is, further landslips). Such work is permissible without consent under the Oberon LEP.

Regardless of the above permissibility of the proposal, clause 5.12(1) of the Oberon LEP states that '*This Plan does not restrict or prohibit, or enable the restriction or prohibition of, the carrying out of any development, by or on behalf of a public authority, that is permitted to be carried out with or without development consent, or that is exempt development, under State Environmental Planning Policy (Transport and Infrastructure) 2021.*'

As the proposal is permitted without consent under the Transport and Infrastructure SEPP (refer section 4.1.1), the consent requirements of the Oberon LEP do not apply.

Heritage

Section 5.10 of the Oberon LEP relates to heritage items. The proposal site is located within the following areas which are listed as heritage items under the Oberon LEP:

- Jenolan Caves heritage conservation area (C1)
- Jenolan Caves Archaeological site (A1).

Jenolan Caves (I1), Jenolan Caves House (I11) and Limestone Bridge (near Grand Arch) (I12) are also listed near the proposal site.

Impacts on these heritage items are considered further in section 6.7.

4.2 Other relevant NSW legislation

4.2.1 National Parks and Wildlife Act 1974

The proposal is partially located on land contained within the Jenolan Karst Conservation Reserve and the *National Parks and Wildlife Act 1974* (NPW Act) applies to the site, with parts of the proposed gully failure restoration work being located within the reserve.

Section 39 of the Act states that the reservation of land does not impact the uses permitted under existing interest. Given the Jenolan Caves Road and the associated slopes are considered existing interests, the proposal is therefore considered permissible under the NPW Act.

Table 4.2 outlines the consistency of the proposal with the objects of the NPW Act, while Table 4.3 outlines the consistency of the proposal against the reserve management principles for a karst conservation area in section 30I of the NPW Act. The proposal is considered to be consistent with both the objects of the Act and the management principles for a karst conservation area.

Section 81(4) of the NPW Act requires that all work within the National Parks estate must be in accordance with the plan of management for the relevant park or reserve. The proposal is consistent with the *Jenolan Karst Conservation Reserve Plan of Management* which establishes the permissibility of the proposal as it is related to the restoration of the main public access route of Jenolan Caves Road (OEH 2019).

This REF has been prepared with consideration of *Development adjacent to National Parks and Wildlife Service lands: Guidelines for consent and planning authorities* (NPWS 2020).

Table 4.2: Consistency with the Objects (section 2A) of the NPW Act

Object	Consistency with object
(a) the conservation of nature, including, but not limited to, the conservation of —	
(i) habitat, ecosystems and ecosystem processes, and	Impacts on native vegetation in the proposal site would be minimised where possible. Impacts on biodiversity are discussed further in section 6.1.
(ii) biological diversity at the community, species and genetic levels, and	The proposal is not considered to reduce the biodiversity in the locality as impacts would occur on areas which are consistent with the communities to remain in surrounding areas. Impacts on biodiversity are discussed further in section 6.1.
(iii) landforms of significance, including geological features and processes, and	The proposal site is not considered to contain any landforms of significance. Regardless, the proposal seeks to stabilise the existing slopes which have been subject to slope failures and at risk of additional failure at the site and in the surrounding areas.
(iv) landscapes and natural features of significance including wilderness and wild rivers,	The proposal is not in an area declared to be wilderness or wild river.
(b) the conservation of objects, places or features (including biological diversity) of cultural value within the landscape, including, but not limited to —	
(i) places, objects and features of significance to Aboriginal people, and	The proposal is not expected to impact upon any item of significance to Aboriginal people as outlined in section 6.6.2.

Object	Consistency with object
(ii) places of social value to the people of New South Wales, and	The proposal site is not considered a place of social value to the people of NSW.
(iii) places of historic, architectural or scientific significance,	The proposal site is located within the State Heritage-listed Jenolan Caves Reserve. The impacts on this listing are discussed in greater detail in section 6.7 and Appendix E.
(iv) fostering public appreciation, understanding and enjoyment of nature and cultural heritage and their conservation,	The proposal would improve access to the Jenolan Caves Precinct which provides the public the opportunity to appreciate, understand and enjoy the natural and cultural heritage of the Jenolan Caves area.
(d) providing for the management of land reserved under this Act in accordance with the management principles applicable for each type of reservation.	The consistency of the proposal with the management principles for a karst conservation area, as outlined in section 30I of the NPW Act, are detailed in Table 4.3.

The consistency of the proposal with the management principles for karst conservation areas (section 30I of the NPW Act) is described in Table 4.3.

Table 4.3: Consistency with the management principles for karst conservation areas

Management principles	Consistency with principles
(a) the conservation of the karst environment, including the protection of catchment values, such as hydrological processes and water quality,	The proposal would potentially result in some reduction in water quality during construction, however, these impacts are considered to be minimal and manageable with the implementation of safeguards and management measures. The proposal would also stabilise the failed slope locations which currently pose a potential risk of further slips which could result in impacts on water quality in downslope areas. Overall, the proposal (during both construction and operation) would not result in any reduction in the conservation of the karst environment.
(b) the conservation of cultural values,	Although the proposal is located in the State heritage-listed Jenolan Caves Reserve, the work is not anticipated to cause a significant impact on the cultural heritage values of the site. The work would also improve access to the Reserve and assist in making the reserve more accessible. The proposal is not expected to impact upon any item of significance to Aboriginal people as outlined in section 6.6.2.
(c) the protection of natural water movement and air movement regimes and processes within the karst environment,	The proposal would not impact upon the karst environment as it would occur outside of the location of the karst structure.
(d) the conservation of biodiversity, the maintenance of ecosystem function, the protection of the geological and geomorphological features and natural phenomena and the	Impacts on native vegetation in the proposal site would be minimised where possible. Impacts to geological features are proposed to be limited to the areas subject to slope failure. Impacts on biodiversity are discussed further in

Management principles	Consistency with principles
maintenance of natural landscapes, cave formations and fossil deposits,	section 6.1. The proposal would also reduce the risk of further slips which could impact upon vegetation.
(e) provision for research and monitoring,	The proposal involves stabilising existing roadside slopes which are part of an access route to the Jenolan Caves Precinct. The proposal aims to maintain the access which would enable access to the caves for research and monitoring purposes.
(f) the promotion of public appreciation and understanding of the karst conservation reserve's natural and cultural values,	The proposal would maintain access into the Jenolan Caves Precinct which would allow the ongoing public appreciation of the caves through existing tourist facilities located in the Precinct. It would enable some of the current traffic management controls to be removed, which are considered to be a deterrent for some tourists due to the associated time requirements.
(g) provision for sustainable visitor or tourist use and enjoyment that is compatible with the karst conservation reserve's natural and cultural values,	The proposal would not alter the tourist facilities currently provided at Jenolan Caves. The proposal would, however, reinstate vehicular access along Jenolan Caves Road for access into the Precinct.
(h) provision for sustainable use (including adaptive reuse) of any buildings or structures or modified natural areas having regard to the conservation of the karst conservation reserve's natural and cultural values,	The proposal would not alter the tourist facilities currently provided at the Jenolan Caves area.
(i) provision for the carrying out of development in any part of a special area (within the meaning of the Hunter Water Act 1991) in the karst conservation reserve that is permitted under section 185A having regard to the conservation of the karst conservation reserve's natural and cultural values.	The proposal is not located within a special area under *the Hunter Water Act 1991*, as per the Hunter Water Regulation 2015.

Authorisation of work encroaching onto National Parks estate

Where work is located on National Parks estate, authorisation from NPWS in accordance with the NPW Act is required to be obtained prior to work commencing. NPWS are required to assess a project against the sustainability criteria outlined in section 151B of the NPW Act. An assessment of the proposal against the criteria outlined in section 151B of the NPW Act is provided in Table 4.4.

Table 4.4: Consistency with matters for consideration under section 151B of the NPW Act

Criteria	Consistency with criteria
1. Site suitability and compatibility with natural and cultural values	The proposal is considered to be suitable for the site as it would seek to stabilise an existing slope which has been subject to slope failure. Stabilising the slope has been proposed to be carried out in a manner that seeks to maintain natural and cultural values, as outlined in sections 6.1, 6.6 and 6.7.
2. Sustainable resource use	The proposal is considered to sustainably use resources. The proposal is not expected to use any substantial volumes of water or electricity.
3. Appropriate built form and scale	Selection of the preferred option, described in section 2.5, included consideration of an appropriately built form for the highly sensitive environment and ensuring the new slope blends into the surrounding landscape as much as possible.

Consistency with NPWS policy

Landslides and rockfalls policy

Transport for NSW is seeking to stabilise the embankment next to Jenolan Caves Road, where multiple slope failures (also referred to as a landslide) have occurred. Stabilising the slopes is considered to be consistent with this policy as it would assist NPWS to meet their duty of care with Transport for NSW to minimise the risks of landslide to people using the reserve and accessing the Jenolan Caves Precinct. The stabilisation of this embankment would reduce the risk of any further slope failures both within the impacted areas and in nearby slopes, therefore reducing the risk to both life and the natural and cultural values of the Precinct.

Vehicle access policy

The proposal is considered to be consistent with the vehicle access policy as it would reinstate full vehicular access into the Jenolan Caves Precinct. This would ensure that access can once again meet the Precinct requirements and would benefit the less mobile members of the community who may be disadvantaged by the current temporary access measures.

Also consistent with the policy, the proposed new soil nail walls have been designed taking into account the sensitivity of the surrounding landscape from both a natural landscape and heritage viewpoint.

Visitor safety policy

The proposal would generally be consistent with this policy as it would ensure that safe vehicular access into the park is provided and that the risk of any further slope failure is low. Stabilising the slope failures is considered to be within the duty of care of NPWS.

4.2.2 Heritage Act 1977

The *Heritage Act 1977* (Heritage Act) provides protection for items of State heritage significance that are listed on the State Heritage Register, as well as for unlisted archaeological relics. Section 57 of the Heritage Act requires that work proposed for items protected by the Heritage Act are approved by the Heritage Council of NSW or its delegates, as appropriate.

The proposal is located within the curtilage of Jenolan Caves Reserve which is listed on the State Heritage Register under the Heritage Act.

An approval under section 57 of the Heritage Act is required due to the proposed work being located within the State Heritage curtilage. A section 60 application is, therefore, to be submitted for the proposed work.

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) a referral is required to the Australian Government for proposed actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land. These are considered in Appendix F and section 6.1.

A referral is not required for proposed road activities that may affect nationally listed threatened species, endangered ecological communities and migratory species. This is because requirements for considering impacts to these biodiversity matters are the subject of a strategic assessment approval granted under the EPBC Act by the Australian Government in September 2015.

Potential impacts to these biodiversity matters are considered as part of section 6.1.3 and Appendix F. The assessment found that there is unlikely to be a significant impact on relevant matters of national environmental significance. Chapter 6 of the REF describes the safeguards and management measures to be applied.

The proposal site is located next to the GBMWHA. The proposal will not have an impact on this listing, as outlined in section 6.7 and Appendix E.

4.3.2 Native Title Act 1993

The *Native Title Act 1993* (Native Title Act) recognises and protects native title. The Act covers actions affecting native title and the processes for determining whether native title exists and compensation for actions affecting native title. It establishes the Native Title Registrar, the National Native Title Tribunal, the Register of Native Title Claims and the Register

of Indigenous Land Use Agreements, and the National Native Title Register. Under the Act a future act includes proposed public infrastructure on land or waters that affects native title rights or interest.

A search of the Native Title Tribunal Native Title Vision website was completed in August 2023, with no Native Title claims identified. The proposal site is, however, located on land which is subject to an Indigenous Land Use Agreement held with the Gundungurra people.

Consultation was undertaken by Transport for NSW with the Gundungurra people. Further discussion on this consultation is included in section 5.3.

4.4 Confirmation of statutory position

The proposal is categorised as development for the purpose of a road infrastructure facility and is being carried out by or on behalf of a public authority. Under section 2.109 of the Transport and Infrastructure SEPP, the proposal is permissible without consent. The proposal is not State significant infrastructure or State significant development. The proposal can be assessed under Division 5.1 of the EP&A Act.

Transport for NSW is the determining authority for the proposal. This REF fulfils Transport for NSW's obligation under section 5.5 of the EP&A Act including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

The proposal is permissible under the NPW Act and fully consistent with the National Parks and Wildlife Services Policy.

The NPWS, Jenolan Caves Reserve Trust, and Transport for NSW are the determining authorities for the proposal. This REF fulfils the determining authority's obligation under section 5.5 of the EP&A Act, including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity. A Section 57 approval under the Heritage Act would be required for the proposal (in the form of a section 60 application).

5. Consultation

5.1 Consultation strategy

A consultation strategy would be developed to ensure consultation during construction is undertaken in an appropriate manner. This would include protocols for consultation between Transport for NSW and the Jenolan Caves Reserve Trust.

5.2 Community involvement

Community consultation specific to the proposal has not been carried out to date, however, communication has been ongoing about the status of impacts on Jenolan Caves Road because of the damage caused by the rain events in March 2021 and events occurring between July 2022 and early 2023. This communication has included any updates to traffic management along the Two Mile section of Jenolan Caves Road.

5.3 Aboriginal community involvement

The proposal has been considered against the requirements of the *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime Services, 2011). This procedure is generally consistent with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (Department of Environment, Climate Change and Water, 2010). A clearance letter was prepared on 3 March 2024 by Transport for NSWs' Aboriginal Cultural Heritage Advisor.

Based on the Stage 1 PACHCI preliminary assessment results, the proposal is unlikely to have an impact on Aboriginal cultural heritage.

Consultation has been undertaken with the Gundungurra Aboriginal Heritage Association (GAHA), who jointly manage the Jenolan Karst Conservation Reserve in accordance with the Gundungurra Indigenous Land Use Agreement (ILUA). Consultation regarding maintenance work on the Two Mile section of Jenolan Caves Road has been ongoing since 2021 following the failure at Carpark 1 slope. Consultation specific to the proposal commenced in August 2024 and included notification regarding the works forming part of the proposal. In mid September 2024, the chair of the GAHA and ILUA provided their support for the works forming part of the proposal.

Further consultation was also undertaken in October 2024 in accordance with the consultation requirements under Subdivision J of the Commonwealth Native Title Act 1993. This consultation involved a meeting with the chair of the ILUA. This consultation included confirmation that the parties of the ILUA agree that the proposal is considered maintenance of an existing road and that there was no objection to the proposal with regards to the ILUA. A copy of the meeting minutes of this meeting has been included in Appendix I.

5.4 Transport and Infrastructure SEPP consultation

A review of the proposal against the consultation requirements outlined in the Transport and Infrastructure SEPP has been carried out, as shown in Appendix C. This review concluded that no consultation was required. Consultation with NPWS is a requirement of the Transport and Infrastructure SEPP due to the proximity of the work to a National Park or reserve. NPWS has been involved in consultation to date, consultation specific to the REF is not considered to be required.

5.5 Government agency and stakeholder involvement

The Jenolan Caves Steering Committee was established following flood and fire events in the Jenolan Caves area and seeks to engage all relevant stakeholders of the Jenolan Caves Reserve as part of the wider rebuilding effort since these natural events.

Consultation with Government agencies and key stakeholders for the proposal has been limited to discussions between Transport for NSW, NPWS and Jenolan Caves Reserve Trust. This consultation has been in relation to the proposed options considered in the development of the proposal, the future plans around construction of the proposal and the Jenolan Caves Reserve Trusts proposed upgrade works.

Consultation with Heritage NSW has been undertaken due to the positioning of the proposal within the heritage listed precinct. During this consultation Heritage NSW has raised the following:

- the requirement to review the REF and the associated heritage and visual impact assessments
- development of a plan to deal with approvals that are required as the design and construction are occurring in parallel.

No other agencies or key stakeholders have been consulted to date.

5.6 Ongoing or future consultation

Ongoing consultation would be carried out by Transport for NSW, NPWS and the Jenolan Caves Reserve Trust and would involve the following:

- notification of road closures which would be put in place for the construction of proposal as well as other work in the locality, including with any property owners who would be in the closed sections of road, once confirmed
- notification of measures put in place to maintain access to the Jenolan Caves Precinct when the Precinct is open.

Consultation with the parties of the Gundungurra ILUA would also be ongoing through the construction phase, with consultation to be undertaken through the Transport for NSW Aboriginal Cultural Heritage Office.

All consultation and notification to the community would be carried out in advance of work occurring.

Ongoing consultation with Heritage NSW would be carried out in relation to the approvals required for the proposal as needed.

6. Environmental assessment

This section of the REF provides a detailed description of the potential environmental impacts associated with the construction and operation of the proposal. All aspects of the environment potentially impacted upon by the proposal are considered. This includes consideration of:

- Potential impacts on matters of national environmental significance under the EPBC Act.
- The factors specified in the guidelines Is an EIS required? (DUAP 1995/1996) and as required under clause 171(1) *of the* Environmental Planning and Assessment Regulation 2021 and the *Roads and Related Facilities EIS Guideline (DUAP 1996)*. The factors specified in section 171(2) of the Environmental Planning and Assessment Regulation 2021 are also considered in Appendix B.

Site-specific safeguards and management measures are provided to mitigate the identified potential impacts.

6.1 Biodiversity

A Biodiversity Assessment Report (BAR) was prepared by EnviroKey as part of the REF for the proposal and is provided in Appendix F and summarised in this section.

6.1.1 Methodology

The following activities were undertaken as part of the BAR:

- background research of potential flora and fauna in the study area using online databases and sources
- field surveys and targeted fauna surveys on 24 and 25 October and 4 November 2023 by two ecologists to ground truth the presence of threatened species on the proposal site
- assessment of anticipated impacts to biodiversity as a result of the proposal
- provision of mitigation measures to minimise the impacts on biodiversity.

For the purposes of the BAR, the study area consists of the slope failure locations along the road corridor and proposed compound locations, and the locality is the area inclusive of a 550 metre buffer around the proposal site, in accordance with the Biodiversity Assessment Method. The methodologies for the biodiversity study and findings reported in the BAR are summarised in this section. The full BAR is provided in Appendix F.

6.1.2 Existing environment

Flora

Plant community types

The *State Vegetation Type (SVT) Map* (DPE, 2022) identifies three plant community types (PCTs) present at the slope failure locations. However, the field survey revealed that the only PCT found to be present on the site is PCT 3491 – Jenolan-Tuglow Limestone Forest, which occupies 0.74 hectares of the proposal site. PCT 3491 has an upper canopy of Ribbon Gum (*Eucalyptus viminalis*), with Narrow-leaved Peppermint (*Eucalyptus radiata*) and Brown Barrel (*Eucalyptus fastigata*) frequently occurring in the PCT.

The canopy at the proposal site appears to have faced tree death due to the bushfires of 2019/2020, also known as the Black Summer fires , with the living canopy burnt out in some areas. It is estimated that about 7.57 per cent of the PCT has been cleared at the site and the existing parts of the PCT on site are varied in condition from poor-moderate to moderate-good.

PCT 3491 is not listed as a TEC and therefore no threatened ecological communities (TEC) are present within the site.

Threatened flora

The flora species Mountain Trachymene and Needle Geebung were identified to have a moderate to high likelihood to occur in the proposal site based on the habitat suitability assessment provided in Appendix B of the BAR. The locations with potential for the presence of these species could not be accessed for a targeted survey and therefore, presence could not be determined and has been assumed for the purpose of the assessment.

Fauna

Threatened fauna

The field survey recorded four threatened biota at the site, which include:

- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)
- Gang-gang Cockatoo (Callocephalon fimbriatum)
- Scarlet Robin (*Petroica boodang*)
- Koala (Phascolarctos cinereus).

Based on the habitat suitability assessment an additional 34 threatened species have been identified as having a moderate to high likelihood of occurrence:

- bats (Eastern False Pipistrelle, Greater Broad-nosed Bat, Large-eared Pied Bat, Large Bent-winged Bat, Southern Myotis)
- birds (Barking Owl, Brown Treecreeper (eastern subspecies), Diamond Firetail, Dusky Woodswallow, Flame Robin, Gang-gang Cockatoo, Little Eagle, Little Lorikeet, Masked Owl, Painted Honey Eater, Pilotbird, Powerful Owl, Rainbow Bee-eater, Regent Honeyeater, Rufous Fantail, Satin Flycatcher, Scarlet Robin, Sooty Owl, South-eastern Glossy Black-Cockatoo, Varied Sitella, Swift Parrot, White-throated Needletail)
- mammals (Eastern Pygmy-possum, Brush-tailed Rock-wallaby, Koala, Southern Greater Glider, Spotted-tailed Quoll, Yellow-bellied Glider)
- reptiles (Roseberg's Goanna).

Migratory species

The habitat suitability assessment found that threatened and migratory biota are regularly recorded in the locality and five threatened or migratory biota have a moderate to high potential to occur within a 10-kilometre radius from the proposal site.

Fauna habitats

There are eucalypt fauna habitats present on site, however, much of this habitat has been burned due to the 2019/2020 bushfires. There were 12 hollow bearing trees recorded around the proposal site, with eight of these within the proposal site. These habitat features are consistent with that located within the wider Jenolan Karst Conservation Reserve.

6.1.3 Potential impacts

Construction

Vegetation removal

Clearing of native vegetation is deemed a key threatening process (KTP) under the BC Act and the EPBC Act. As there have been no TECs identified on site, no TECs would be impacted by the proposal.

The proposal would remove about 0.74 hectares of native vegetation consistent with PCT 3491 – Jenolan-Tuglow Limestone Forest. The potential extent of clearing of this PCT of varying conditions was measured by overlaying a GIS shapefile of the proposal site with vegetation mapping carried out during the field survey. The anticipated extent is provided in Table 6.1.

Table 6.1: Summary of direct impacts on native vegetation

Plant community type (PCT)	Broad condition class	TEC	Area to be impacted (ha)[1]
Jenolan-Tuglow Limestone Forest	Poor – moderate	Not a TEC	0.27 ha
Jenolan-Tuglow Limestone Forest	Moderate	Not a TEC	0.34 ha
Jenolan-Tuglow Limestone Forest	Moderate – good	Not a TEC	0.13 ha
Total native vegetation			0.74 ha

Note: 1. Area to be cleared based on ground-truthed vegetation mapping within the proposal site.

Removal of threatened flora

No threatened flora species were recorded during the field survey. There is potential for two threatened flora species (Mountain Trachymene and Needle Geebung) to be present based on available habitat. However, due to safety concerns with accessing the slopes a targeted survey of these species was not undertaken and their presence has therefore been assumed.

Assessments of significance were undertaken for the identified threatened flora species (see Appendix C of the BAR) and no significant impact was determined.

Threatened fauna habitat and species

The removal of native vegetation and eight hollow bearing trees would result in the disturbance and removal of fauna habitat. All potentially occurring species have the potential to be impacted by this removal of native vegetation. The fauna species with high potential to occur on the site include:

- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) – vulnerable under the BC Act and EPBC Act
- Sooty Owl (*Tyto tenebricosa*) – vulnerable under the BC Act
- Brush-tailed Rock-wallaby (*Petrogale penicillate*) – endangered under the BC Act and vulnerable under the EPBC Act
- Southern Greater Glider (*Petauroides 34harac*) – endangered under the BC Act and EPBC Act
- Spotted-tailed Quoll (*Dasyurus maculatus*) – vulnerable under the BC act and endangered under the EPBC Act.

In addition to those with a high potential of occurring the following fauna species were recorded on the site:

- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) – vulnerable under the BC Act and EPBC Act
- Gang-gang Cockatoo, (*Callocephalon fimbriatum*) – vulnerable under the BC act and endangered under the EPBC Act
- Scarlet Robin (*Petroica boodang*) – vulnerable under the BC Act
- Koala (*Phascolarctos cinereus*) – endangered under the BC Act and EPBC Act.

No significant impacts on these species were determined by the assessments of significance (see Appendix C and D of the BAR).

Injury and mortality

Fauna injury or mortality can occur during the vegetation clearing phase of construction through the removal of habitat. During construction it is anticipated that some diurnal and mobile fauna species such as birds and larger reptiles may be able to move away from construction equipment during clearing operations. Other fauna species such as those that are less mobile and nocturnal, are less likely to move away from clearing activity. The impacts of vegetation clearing would be mitigated by the measures provided in section 6.1.4.

Noise, light, dust and vibration

Construction noise and vibration are likely to result from the proposal but would be limited to the construction period and daylight hours. Species that vocalise frequently, such as birds and amphibians, have the potential to be impacted by the noise and vibration in the long term. As the proposed construction work is temporary and short term, impacts from an increase in noise and vibration to species in the vicinity of the proposal site are anticipated to be unlikely.

No light impacts are expected due to construction occurring during daylight hours only.

Invasion and spread of weeds

At the proposal site, weed species are common given the long European history of the area. The proposal has the potential to disperse priority and environmental weed plant material into areas of native vegetation from incoming construction equipment. However, the impact on the long-term viability of the retained vegetation within the proposal site or the surrounding area is considered negligible given the current presence of weeds.

Invasion and spread of pathogens and disease

Pathogens can be found in living organisms such as fungus, bacteria, and virus and can result in disease in flora and fauna. Several pathogens are known to occur in the region, and are listed as a key threatening process (KTP) under the BC Act and EPBC Act, including:

- infection of native plants by Phytophthora (BC Act and EPBC Act)
- infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (BC Act and EPBC Act)
- infection by Psittacine Beak and Feather Disease affecting endangered psittacine species (BC Act and EPBC Act)
- introduction of Exotic Rust Fungi affecting plants of the Myrtaceae family (BC Act and EPBC Act)
- novel biota and their impact on biodiversity (EPBC Act) (covers Myrtle Rust).

Appropriate safeguards must be engaged in order to prevent or minimise pathogens from being transported into the proposal area by construction machinery and vehicles (see section 6.1.4).

Operational impacts

Wildlife connectivity and habitat fragmentation

The proposal is unlikely to affect potential wildlife corridors. The proposal is unlikely to increase habitat fragmentation as potential wildlife corridors are present in areas surrounding the proposal site.

Fauna Injury and mortality

During operation, fauna injury and mortality are not expected to increase given that the proposed work is not likely to result in an increase in vehicles using Jenolan Caves Road.

Noise, light, dust and vibration

Noise, vibration, and light impacts already occur on Jenolan Caves Road from vehicular movements therefore, operational noise, light and dust impacts would not change due to the proposal.

National park

Proposal works would involve the removal of 0.302 hectares (3,020 square metres) of native vegetation consisting of PCT 3491 – Jenolan-Tuglow Limestone Forest on National Parks land. Table 6.2 outlines the conditions of the vegetation within PCT 3491 which would be impacted. As mentioned above this PCT is not a listed TEC under either the BC Act or EPBC Act.

Table 6.2: Vegetation impacts within National Parks estate

Proposal element	Condition of PCT 3491	Area
Failures 1 and 2, Gully Failure and Culvert 1A	Poor-moderate	0.22
Culvert 1A	Moderate	0.06
Failure and Culvert 3	Moderate	0.002
Failure 5	Moderate	0.005
Failure 7	Moderate	0.015
Total native vegetation	-	0.302

The extent of vegetation proposed to be removed within the Jenolan Karst Conservation Reserve has been minimised where possible along with reduction in permanent infrastructure where possible. The area to be impacted within the reserve is considered to be minimal and would not result in any noticeable reduction in vegetation within the reserve.

Stabilising the slope failures would reduce the chance of future slope failures at the site, which would minimise impacts on other surrounding vegetation and vegetation down slope of the proposal site including vegetation within the Jenolan Karst Conservation Reserve.

Works have the potential to transport weeds and pathogens to the site and potentially impact the Jenolan Karst Conservation Reserve. Appropriate safeguards must be taken to prevent and minimise the transportation of weeds and pathogens.

Conclusion on significance of impacts

The proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the BC Act or FM Act and therefore a Species Impact Statement or Biodiversity Development Assessment Report is not required.

The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the EPBC Act.

6.1.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Biodiversity	A Flora and Fauna Management Plan will be prepared in accordance with Transport for NSW's *Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects* (RMS, 2011) and implemented as part of the CEMP. It will include, but not be limited to: • plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas • requirements set out in the *Landscape Guideline* • pre-clearing survey requirements • procedures for unexpected threatened species finds and fauna handling • procedures addressing relevant matters specified in the *Policy and guidelines for fish habitat conservation and management* (DPI Fisheries, 2013) • protocols to manage weeds and pathogens.	Contractor	Pre-construction	Section 4.8 of QA G36 Environment Protection
Removal of native vegetation	Pre-clearing surveys will be undertaken within vegetation once slope access is established, to survey for the threatened Mountain Trachymene (*Trachymene scapigera*) and Needle Geebung (*Persoonia acerosa*). Confirmation of these species presence would then be fed into the offsetting requirements for the proposal.	Contractor	Pre-construction	Additional safeguard
Removal of native vegetation and associated habitat	Vegetation and habitat removal will be carried out in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Contractor	Construction	Additional safeguard
Removal of native vegetation	Parking options will be limited to existing hard stand areas, or within any area that is pavement/existing formation or mapped as cleared land.	Contractor	Construction	Additional safeguard
Removal of threatened fauna habitat	The unexpected species find procedure under *Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011a) will be followed if threatened fauna, not assessed in the biodiversity assessment, are identified in the proposal site.	Contractor	Construction	Additional safeguard

Impact	Environmental safeguards	Responsibility	Timing	Reference
Edge effects on adjacent native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011b).	Contractor	Pre-construction	Additional safeguard
Injury and mortality of fauna	Fauna will be managed in accordance with *Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011c).	Contractor	Construction	Additional safeguard
Invasion and spread of weeds	Weed species will be managed in accordance with *Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011d).	Contractor	Construction	Additional safeguard
Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011b).	Contractor	Construction	Additional safeguard

6.1.5 Biodiversity offsets

With consideration of the biodiversity offset thresholds identified within the *Guideline for Biodiversity Offsets* (Transport for NSW, 2022b), biodiversity offsets or supplementary measures for the proposal are not required due to the following:

- the proposal would not impact a critically endangered, endangered or vulnerable ecological community
- the proposal is not known to remove any threatened flora (pending pre-clearance survey)
- the proposal would not impact more than one hectare of a known species credit fauna (e.g. Koala)
- the proposal would not result in loss of key fish habitats.

However, the *Transport tree and hollow replacement guidelines* (Transport for NSW, 2023c) applies to this proposal and would require the following offset requirements:

- plant a minimum of 430 trees
- provide up to 24 artificial hollows based on the assumption that all eight hollows are occupied (to be confirmed as part of pre-clearance surveys).

Should payment into the Transport Conservation Fund be the preferred option, the following maximum contributions would be required in accordance with Table 2-2 from the Tree and Hollow-replacement Guidelines 2023:

- 20-49 centimetres diameter at breast height (DBH) - $44,500
- 5-20 centimetres DBH - $4,625
- Hollows - $4,000.

Therefore, the total fund payment would be $53,125.

The method of offset to be employed (payment into fund or planting of offsets) would be confirmed following the confirmation of clearance requirements for the proposal. Should planting of offset trees be the chosen method, consultation with NPWS would be undertaken to determine the positioning of any proposed offset planting. Any offset planting within the proposal site would be required to consider the ongoing stability of any slopes.

6.2 Water

6.2.1 Existing environment

Surface water

There are no watercourses or tributaries that run through the proposal site, though there are a number of flow paths which are largely created by existing road drainage which focuses flows to specific locations down the slope. The majority of the proposal is located about 260 metres west of the Jenolan River at the downslope end of the gully failure at Failure 1. It is noted that the proposed discharge from Culvert 1A would travel west towards the Jenolan River via existing drainage infrastructure on National Parks land. Surveyors Creek is located below Car Park 1 in the form of a culvert.

Flooding

A desktop search of the Jenolan Caves study area on the DPE spatial viewer map was carried out in August 2023. The search did not identify the site to be in a flood planning area. Due to the topography of the site the proposal site is not considered to be subject to flooding.

Water quality

The proposal site is located within the upper reaches of the Sydney Drinking Water Catchment. Water quality in surrounding watercourses is generally good however due to recent slope failures in the wider area the potential for poor water quality has increased.

Groundwater

A search of the WaterNSW real-time water data identified there are no groundwater bores present at the proposal site or within about eight kilometres of the site.

Geotechnical investigations carried out during the design development phase did not encounter any groundwater. Previous investigation work associated with other slope failures have identified that aquifers in this landscape are unconfined to semi-confined with vertical groundwater flow occurring through fractured bedrock and saprolite. Minor lateral flow occurs through colluvial sediments on lower slopes and hydraulic conductivity and transmissivity are moderate. The groundwater flow systems are local with short flow lengths. Further geotechnical investigations to be undertaken as part of the detailed design would likely confirm the possibility of groundwater being present at each of the slope failure locations.

6.2.2 Potential impacts

Construction

Surface water

The proposal would result in some short-term changes to existing surface water movements, due to the excavation, scaling and construction associated with culvert upgrades within the proposal site. Any changes to surface water flows during construction would be minor and short-term only and flows would be redirected around the proposal site where possible.

Flooding

Construction of the proposal is not anticipated to cause any adverse impact to flooding at the proposal site.

Water quality

Pollutants such as sediment and construction waste have the potential to mobilise and enter drainage lines, particularly during high rainfall events.

Water quality impacts could also potentially occur from fuel or chemical spills from construction equipment. Such impacts are considered minimal as the facilities would be positioned to ensure that any potential leaks would not impact on downstream waters.

The risk of water quality impacts, and the significance of any impacts that may occur, would be minimised by implementing the safeguards and management measures provided in section 6.2.3.

Groundwater

No groundwater impacts are expected as a result of the proposal. Safeguards have been provided in section 6.2.3 to minimise erosion and sedimentation which would impact on waterways and groundwater quality.

Operation

Operation of the proposal is expected to improve surface water flows as a result of the proposed culvert work which would see existing undersized culverts upgraded to better handle the increased flows which have become more common recently. As part of the proposed drainage work, road side drainage infrastructure would be improved to better capture stormwater and direct it to the culverts thus better controlling where flows occur and reducing the risk of slope failures. Downslope of culvert 1A flows would utilise existing flow paths which generally take the path of least resistance. In summary, the drainage work proposed would improve surface water flows in the vicinity of the proposal and minimise the potential for future slope failures.

The proposal would improve water quality through the restoration of failed slopes, which would remove the source of sediment on the unstable slope, as well as providing new stablised slopes which will reduce the risk for further future failures. A Neutral or Beneficial Effect assessment has been carried out to determine the impacts of the work on water quality due to the proposal site being located within the Sydney Drinking Water Catchment (refer Appendix D). This assessment concluded that the proposal would have a neutral or beneficial effect on water quality within the Sydney Drinking Water Catchment.

National park

Construction of the proposal may potentially cause erosion and sedimentation of surrounding vegetation and watercourses, and the contamination of soil or water due to spills and leaks. However, the potential for these impacts would be minor and temporary, and would be managed through the implementation of the safeguards provided in section 6.2.3. Additionally, the gully and culvert upgrades would improve the flow of water on national park land and decrease the risk of further slope failures by reducing water runoff into the roadside areas and down unprotected sections of slope. The upgrades would also formalise the existing gully and culvert system and minimise uncontrolled surface water flows into national park land, reducing the potential for impacts caused by water flow, including future slope failures. As a result, it is anticipated that the work would reduce the chance of impacting the quality of watercourses within the Jenolan Karst Conservation Reserve.

6.2.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Soil and water	Soil and water management will be prepared in accordance with *Managing Urban Stormwater: Soils and Construction*, Volume 1 and 2D (Landcom, 2004) (the 'Blue Book') and implemented as part of the CEMP. The soil and water aspects will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction. The CSWMP will be prepared by or reviewed and endorsed by a soil conservationist on the Transport for NSW list of Registered Contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services. The CSWMP will then be revised to address the outcomes of the review.	Contractor	Pre-construction	Section 2.1 of QA *G38 Soil and Water Management*
Soil and water	A site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the CEMP. The Plan/s will include arrangements for managing wet weather events, including monitoring of potential high risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather.	Contractor	Pre-construction	Section 2.2 of QA *G38 Soil and Water Management*
Erosion and sedimentation	All stockpiles will be designed, established, operated and decommissioned in accordance with Transport's Stockpile Site Management Guideline.	Contractor	Pre-construction	Additional safeguard
Contamination of soils and waterways	An Incident Emergency Spill Plan will be developed and incorporated in the CEMP. The plan will include measures to avoid and manage spillage of fuels, chemicals, and fluids into any stormwater inlets and an emergency response procedure.	Contractor	Construction	Section 4.2 of QA *G36 Environment Protection*
Contamination of soils and waterways	Vehicle wash downs and/or concrete truck washouts will be carried out within a designated bunded area on an impervious surface or carried out off-site.	Contractor	Construction	Additional safeguard
Contamination of soils and waterways	Machinery will be checked daily to ensure there are no oil, fuels or other liquids leaking from the machinery.	Contractor	Construction	Additional safeguard
Contamination of soils and waterways	Refuelling of vehicles or machinery is to occur within a containment or hardstand area designed to prevent the escape of spilled substances to the surrounding environment.	Contractor	Construction	Additional safeguard

Other safeguards and management measures that would address water impacts are identified in section 6.3.3.

6.3 Soils

6.3.1 Existing environment

Topography

The topography of the proposal site is characterised as narrow crests and steep sideslopes with narrow valley, small cliff and narrow drainage line features (eSpade 2023). The embankment slopes are situated within regionally mountainous terrain, locally characterised by an east facing slope on which Jenolan Caves Road winds down to reach the Jenolan Caves Precinct. The geotechnical site survey data and visual inspection indicates the embankment slope angles are overly steep with near vertical scarps located in proximity to 'wash outs' caused by overland flow paths. Natural slope angles next to these eroded areas are often more than 40 degrees.

Geology

The *1:250,000 NSW Seamless Geology Version 2* (NSW Government 2022) dataset indicates the site is in proximity to the Karawina Formation. This formation is known to comprise metamorphosed feldspathic quartz sandstone, limestone, conglomerate and metasiltstone, and soils forming from their decomposition. The technical paper G*eology and Geomorphology of the Jenolan Caves and the Surrounding Regio*n (Branagan D et al 2014), indicates that the Two Mile section of Jenolan Caves Road is mainly underlain by Cherty Siltstone. Figure 6-1 shows the regional geology of the site.

The lower section of the Two Mile section of Jenolan Caves Road is however mapped as being underlain by Jenolan Caves Limestone and therefore potential karst landscapes. This landscape is mapped as being in the vicinity of Failure 1 and Culvert 1A. Geotechnical investigations undertaken as part of the development of the design have not identified the presence of any karst landscapes with siltstone found to underlay the failure locations. Investigations have not been undertaken in the vicinity of Culvert 1A and therefore the presence of karst landscapes at these locations has not been confirmed. In the vicinity of Culvert 1A the existing culvert to be replaced is expected to be positioned within ground previously disturbed which include some areas of fill material associated with the existing roadway.

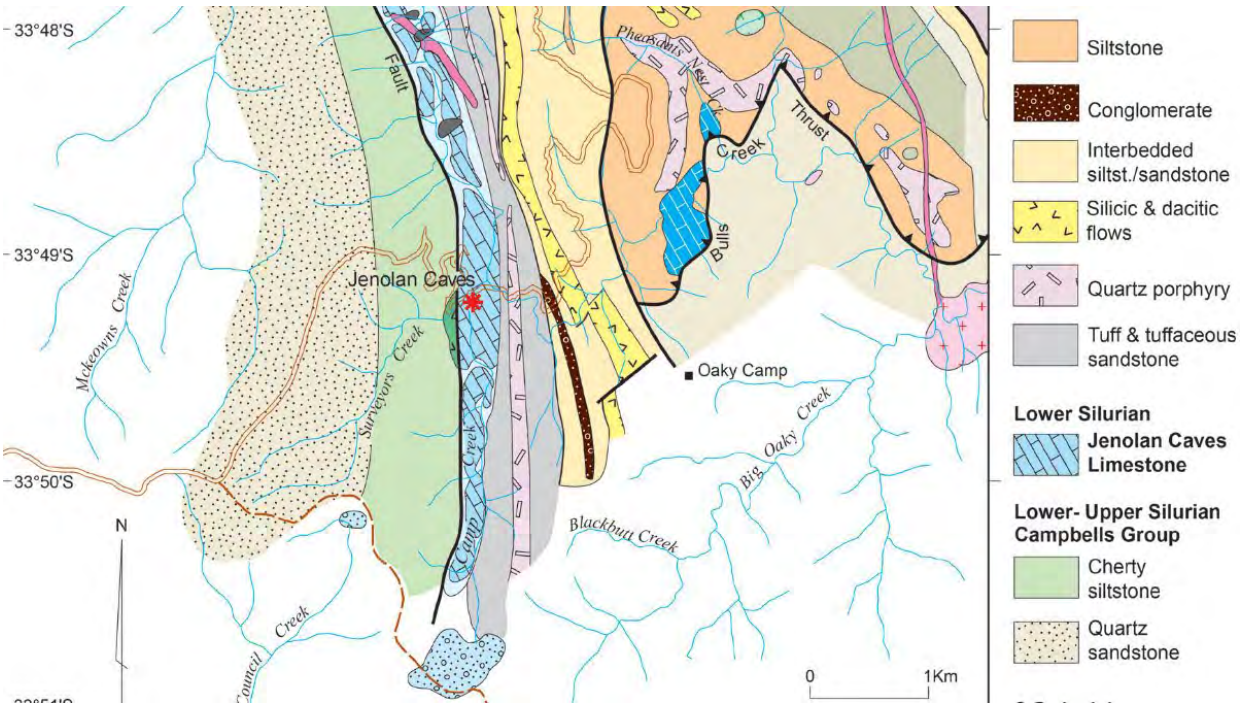


Figure 6-1: Regional geology of the site (Source: Branagan D et al 2014)

Soil

The proposal site is classified under two soil landscape profiles. The western area of the site falls under the Kanangra Gorge soil profile and the eastern area falls under the Jenolan Caves soil landscape profile (eSpade 2023).

The geotechnical profile of the site was inferred as part of the design options report investigations which included visual and tactile assessment along with back analysis. The inferred geotechnical profile was found to contain fill materials, colluvium

and weathered Cherty Siltstone. The fill materials, consisting of silt, clay, gravel, and cobble, are present on site to depths of 1.4 to 3.6 metres below ground level. Assessment of the fill and local topography indicates the material was placed as part of a side fill road embankment construction using materials obtained from cut areas on the upslope. Material density is expected to be highly varied with fill material consistency in close proximity to the failing sections expected to be very loose to loose. Although colluvium was not encountered during the investigation, visual inspection shows that it is likely for colluvium to be present on site. From visual inspection of the failed gully area, the colluvium is expected to be of similar composition and consistency to the fill material. Extremely weathered and typically fine to coarse grain Cherty Siltstone was encountered at depths of about 1.4 to 3.6 metres below ground level.

A review of the Department of Planning and Environment (DPE) spatial viewer in August 2023 has identified that the proposal site does not contain any acid sulfate soils.

Contamination

A search of the EPA contaminated sites land record of notices in August 2023 for the Oberon local government area indicated no contaminated land notices in the vicinity of the proposal site. Due to the lack of past land uses within the proposal site, the likelihood of contaminated material being present within the proposal site is considered to be minimal.

6.3.2 Potential impacts

Construction

Construction of the proposal would need excavation, face scaling and the removal of vegetation which has the potential to expose large areas of soil. If not adequately managed this could have the following impacts:

- dust generation during excavation
- erosion of exposed soil and any stockpiled material
- an increase in sediment loads entering the stormwater system and/or local runoff and therefore nearby waterways including Jenolan River.

Soil contamination could occur as a result of any accidental spills or leaks of fuels, oils and other chemicals from equipment and vehicles during construction. These impacts are considered likely to be minor as exposure of soil would be temporary and short term.

The proposal has the potential to impact upon karst landscapes which may occur in the area, but as outlined in section 6.3.1 are not considered to exist in the vicinity of failure locations. Where unexpected karst landscapes are encountered the *Standard Management Procedure – Unexpected Heritage Items* (Transport for NSW, 2022) would be implemented to identify the way forward to manage any impacts to the karst landscape.

Work associated with Culvert 1A are located in areas mapped as karst landscape however investigations have not confirmed the presence or absence of this landscape. Works associated with Culvert 1A would involve some excavation however this excavation is expected to be shallow and positioned along the alignment of the existing culvert and therefore the likelihood of encountering karst landscapes is considered to be minimal. Work at Culvert 1A would be subject to the unexpected finds procedures should a karst landscape be identified.

The safeguards and management measures provided in section 6.3.3 would be implemented to manage the potential for erosion and sedimentation impacts and potential soil contamination during construction. The potential for water quality impacts due to sedimentation is considered in section 6.2.2.

Operation

Operation of the proposal is not likely to result in any substantial impacts on soils, landscape, topography or geology. The risk of soil erosion during operation would be minimal as all areas impacted during construction would be either contained behind the new shotcrete wall or rehabilitated and revegetated to prevent soil erosion from occurring.

National park

Construction of the proposal may potentially cause erosion and sedimentation of surrounding vegetation and watercourses, and the contamination of soil or water due to spills and leaks. However, the gully and culvert upgrades would improve the flow of water on national park land and decrease the risk of further slope failures by reducing water runoff into the roadside ground areas.

There is potential for the proposal to impact upon mapped karst landscapes with this most likely to occur at Culvert 1A. As outlined further above, the positioning of excavation works for these elements of the proposal are considered to be in already disturbed ground including areas of fill material. Where unexpected karst landscapes are encountered Transport for NSW's *Standard Management Procedure – Unexpected Heritage Items* (Transport for NSW, 2022) would be implemented to manage any impacts to the karst landscape.

6.3.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Contaminated land	If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other work that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed.	Contractor	Construction	Section 4.2 of *QA G36 Environment Protection*
Excavated material/spoil	A waste classification report will be required to assess the potential for material reuse or disposal in accordance with the POEO Act and the NSW EPA Waste Classification Guidelines.	Contractor	Construction	Additional safeguard
Heavy rainfall management	Weather conditions will be monitored daily, and no work will be conducted if there is an imminent threat of a heavy rainfall event. In the event of a rainfall event, work will cease if there is a risk of sediment loss off site or ground disturbance due to waterlogged conditions.	Contractor	Construction	Additional safeguard
Karst Landscapes	Where unexpected karst landscapes are encountered, the *Standard Management Procedure – Unexpected Heritage Items* (Transport for NSW, 2022) will be implemented to identify the best way forward for managing any potential impacts.	Contractor	Construction	Additional safeguard

Other safeguards and management measures that would address soil impacts are identified in section 6.2.3.

6.4 Traffic and transport

6.4.1 Existing environment

The proposal site is located along the Two Mile section of Jenolan Caves Road, which is located to the north west of the Jenolan Caves Precinct and provides access towards Oberon. This portion of the road serves as the only currently operational vehicular access to the Jenolan Karst Conservation Reserve and Jenolan Caves Precinct. Prior to slope failures in 2021, the 'Five Mile' stretch of the Jenolan Caves Road to the east towards Hartley was the primary access however this access has been closed since these failures occurred. Jenolan Caves Road consists of a single travel lane in each direction with a posted speed limit of 50 kilometres per hour. The road is steep and narrow with posted speed limits of 25 kilometres per hour in winding sections of the road alignment. Due to temporary barrier fencing placed by Transport for NSW at the slope failure locations the road has been reduced to one lane in some locations thus resulting in movements along the Two Mile section of Jenolan Caves Road being only possible under traffic control. Vehicles wishing to enter the Precinct need to be held at the top of the slope, from which point they are driven down the Two Mile section under escort. Vehicles heading back towards Oberon are held within Car Park 2 until they can make the journey up the hill under escort.

Jenolan Caves Road within the proposal site has no pedestrian facilities or dedicated cyclist facilities. The use of the road by cyclists is not prohibited but is unlikely due to the grades of the road.

The key road features surrounding the proposal site include:

- Edith Road: A local road that consists of a single travel lane in each direction with no kerbs and an unmarked intersection between Jenolan Caves Road and Kanangra Walls Road. The posted speed limit is 60 kilometres per hour with additional signage identifying winter road closures due to snow and ice.
- Kanangra Walls Road: An unsealed narrow dirt road allowing traffic in both directions. This no through road transects high country grazing land and pine plantations and terminates at a carpark providing access to Kanangra Boyd Lookout.

There are a number of walking trails in the surrounding landscape including the Six Foot Trail which runs from within the Jenolan Caves Precinct east of the proposal site (near Car Park 2) to Katoomba.

No public transport is provided along Jenolan Caves Road (via the Two Mile section) into the Jenolan Caves Precinct.

6.4.2 Potential impacts

Construction

Construction of the proposal would need the full closure of Jenolan Caves Road to the public to allow work to be carried out at each of the slope failure locations. The proposal has been planned to occur during the closure period of the Jenolan Caves Precinct which also means public access is not required along Jenolan Caves Road. During construction, Jenolan Caves Road would remain open on Monday and Tuesday to provide uninterrupted access to the Jenolan Caves Reserve Trust staff and any contractors.

The proposal would be carried out Wednesday to Sunday, with Transport for NSW having full occupation of the road to enable safe construction of the proposal. On these days, access for Jenolan Caves Reserve Trust staff would be limited to before 7.30 am and after 5pm. Access through the proposal site would be maintained for emergency services with an emergency response procedure to be developed that outlines the processes to be implemented at the alert of an emergency.

The closure of Jenolan Caves Road for the proposal would only impact Jenolan Caves Trust staff as public access to the Jenolan Caves Precinct would not be available as it would be closed to allow the Jenolan Caves trust to complete their construction work within the Precinct.

Notification of work and any pending road closures (particularly any changes to the arrangements discussed in section 3.3.7) would be carried out by Transport for NSW in accordance with the CEMP for the proposal (that would include a Traffic Management Plan and Communications and Stakeholder Management Plan).

The construction work would generate traffic of heavy vehicles and worker vehicles along Jenolan Caves Road for access to the proposal site. Heavy vehicle traffic would be generated mainly by the following activities:

- delivery and removal of construction equipment and machinery to the proposal site and stockpiles at Car Parks 1 and 2 at Jenolan Caves
- spoil removal from stockpile locations to licensed spoil disposal facilities or reuse locations
- movement of construction personnel, including contractors, site labour force and specialist supervisory personnel.

This level of heavy vehicle traffic during construction would not significantly impact the traffic and transport of Jenolan Caves Road, as this additional construction traffic would be within the range of daily variation in traffic. As the road would be closed to the public and the Jenolan Caves Trust staff and contractors while construction is occurring, impacts to road users due to the presence of construction vehicles are not anticipated.

The proposal would primarily use Car Park 2 as a compound and stockpile site to enable Car Park 1 to be primarily used by the Jenolan Caves Trust for their construction work as well as by Transport for NSW for restoration work on an existing slope south of the proposal. As there is no public access during construction the loss of parking in any car park would not result in any impacts to visitors to the Precinct.

Operation

Operation of the proposal would have a positive impact by providing a long-term solution to the ongoing safety risks and resulting access issues in the Precinct. The restoration of slope along the roadway and proposed work at the gully and culvert upgrades would improve safety for road users and reduce the risk of further and/or more extensive slope failures at the site due to high rainfall. The proposal would enable Jenolan Caves Road to operate without traffic control and when

combined with completion of further slope restoration work at the failure near the Precinct, would enable vehicular access right into the Jenolan Caves Precinct for all visitors.

National Park

The proposal would improve access to the Jenolan Caves Precinct and the Jenolan Karst Conservation Reserve once it is in the operational stage. Jenolan Caves Road would be closed to the public during construction of the proposal and the Jenolan Caves Reserve Trust construction work which are anticipated to occur simultaneously. However, the proposal will reinstate unescorted public access to the Precinct and Jenolan Karst Conservation Reserve via Jenolan Caves Road.

6.4.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Traffic and transport	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Transport for NSW *Traffic Control at Work Sites Technical Manual* (Transport for NSW, 2022a) and *QA Specification G10 Control of Traffic* (Transport for NSW, 2008). The TMP will include: • confirmation of haulage routes • measures to maintain access to local roads and properties (as required) • site specific traffic control measures (including signage) to manage and regulate traffic movement • requirements and methods to consult and inform the local community of impacts on the local road network • access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads. • a response plan for any construction traffic incident • consideration of other developments that may be under construction, such as the works to be undertaken in the Jenolan Caves Precinct, to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • monitoring, review and amendment mechanisms.	Contractor	Pre-construction	Section 4.8 of *QA G36 Environment Protection*
Heavy vehicle management	Equipment and materials will be delivered to the lay down area at Kanangra Road and transferred to the site in vehicles which can better negotiate the limitations along Jenolan Caves Road.	Contractor	Construction	Additional safeguard

Impact	Environmental safeguards	Responsibility	Timing	Reference
Property access impacts	Access to properties along Jenolan Caves Road will be available throughout construction. Where impacts are anticipated, consultation will be carried out with the affected property owner to confirm any access arrangements.	Contractor	Construction	Additional safeguard
Impacts to existing car parks	Dilapidation reports are to be completed for all car park areas to be used by the proposal. Any damage to these areas will then be required to be repaired.	Contractor	Construction	Additional safeguard
Emergency access	Emergency access will be provided at all times. An emergency response plan will be developed to identify the requirements and processes to ensure access through the proposal site will be available upon notification of an emergency situation. The plan will detail the specific requirements for each work area due to the differing nature of work at each location. This plan is to be developed in line with the requirements outlined in the Jenolan Caves Reserve Trust's emergency response plan (or similar).	Contractor	Construction	Additional safeguard

6.5 Noise and vibration

6.5.1 Existing environment

Background noise within the vicinity of the proposal site is characteristic of a nature reserve area with low ambient noise levels dominated by natural sounds. Noise sources in the vicinity of the proposal site are largely associated with the use of the area for tourism. Noise sources include traffic noise from visitors accessing the site and some general noise from visitor activities within the Jenolan Caves Precinct.

Sensitive receivers located near the proposal site include:

- Jenolan Caves House hotel, located about 460 metres south-east of the nearest slope failure location
- Jenolan Mountain Lodge, located about 580 metres south-east of the nearest slope failure location
- Six Foot Track walking trail and other walking trails located in proximity to Jenolan Caves Road in the vicinity of Failure 1.

During the period of construction the road would be closed entirely to the public due to work being carried out by the Jenolan Caves Trust which would require the closure of the Jenolan Caves Precinct. The above receivers are therefore not considered sensitive receivers for this proposal as they would not be in use while construction takes place.

6.5.2 Potential impacts

Construction

During construction the proposal has the potential to generate noise from a variety of sources, including:

- site establishment and earthworks
- use of equipment and machinery

- loading and dumping of materials and waste
- movement of heavy vehicles to and from the site
- construction traffic on local roads.

Construction noise and vibration impacts would be short term and would not permanently affect the community and surrounding environment. The Jenolan Caves Precinct would be unoccupied and closed to the public during the construction period as a result of work being carried out by the Jenolan Caves Trust thus the number of receivers to be impacted would be limited to construction worker within the Precinct and some bushwalkers on the Six Foot Track (albeit expected to be minimal). Impacts on any receivers would be minimised through the implementation of mitigation measures. Noise and vibration impacts would be limited to the construction period and would occur over short durations when the construction equipment is operational.

Standard noise safeguards and management measures and controls are provided in section 6.5.3 and would be applied to receivers where feasible and reasonable.

Vibrational impacts would not be an issue for any nearby sensitive receivers due to the distance between the proposal site and the receivers. However, vibration has the potential to cause further landslips in nearby areas. Such impacts are considered to be minimal, with much of the surrounding area currently considered stable due to existing vegetation. Mitigation measures would be implemented to ensure that vibration from soil nail installation does not result in further slope failures.

Operation

The proposal would not have any noise and vibration impacts following completion of the construction work with the road to operate as it did before any slope failures occurring.

National park

The proposal would increase ambient noise levels in the Jenolan Karst Conservation Reserve area. However, little to no impact would be caused to sensitive receivers as the Jenolan Caves Precinct would be closed during construction of the proposal. The risk of further landslips from vibration during construction would be managed by the measures outlined in section 6.5.3.

6.5.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Noise and vibration	A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim *Construction Noise Guideline* (ICNG) (DECC, 2009) and identify: • all potential significant noise and vibration generating activities associated with the activity • feasible and reasonable mitigation measures to be implemented, taking into account *Beyond the Pavement: urban design policy, process and principles* (Transport for NSW, 2014). • arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • contingency measures to be implemented in the event of non-	Contactor	Detailed design / pre-construction	Section 4.6 of *QA G36 Environment Protection*

Impact	Environmental safeguards	Responsibility	Timing	Reference
	compliance with noise and vibration criteria • management measures to minimise the potential noise impacts from the quantitative noise assessment and for potential work outside of standard working hours.			
Construction noise	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.	Contractor	Construction	Additional safeguard
Construction noise from machinery and equipment	All plant and equipment will be appropriately maintained to ensure optimum running conditions, with periodic monitoring.	Contractor	Construction	Additional safeguard
Construction noise from machinery and equipment	Noise-emitting plant will be directed away from staff, where possible.	Contractor	Construction	Additional safeguard
Construction noise from machinery and equipment	Traffic flow, parking and loading and unloading areas would be planned to minimise reversing movements within the proposal site.	Contractor	Construction	Additional safeguard
Construction noise from machinery and equipment	Reversing alarms that have a tonal noise character are to be avoided during out of hours activities. Quacker style or 'smart' reversing alarms are to be used during night-time activities (pending safety approvals).	Contractor	Construction	Additional safeguard
Construction noise from construction compound	Delivery vehicles will be fitted with straps rather than chains for unloading, wherever possible.	Contractor	Construction	Additional safeguard

Impact	Environmental safeguards	Responsibility	Timing	Reference
Construction noise from inappropriate practices	Site inductions will be provided to train staff on ways to minimise construction noise impacts on-site. Responsible working practices include: • avoid shouting and slamming of doors • where practical, operate machines at low speed or power and switch off when not being used rather than left idling for prolonged periods • minimise reversing • avoid dropping materials from height and avoid metal to metal contact on material.	Contractor	Construction	Additional safeguard
Noise and vibration impact and appropriate complaints handling	The local community will be contacted and informed of the proposed work, location, duration of work, and hours involved. The contact would be made a minimum five days before work starts.	Contractor and Transport for NSW	Construction	Additional safeguard
Vibration causing further slope failures	A monitoring procedure is to be developed and included in the CEMP to ensure that activities with intensive vibration (such as drilling of soil nails) do not result in further slope failure. The procedure will outline methods to adjust the installation method to reduce vibration impacts.	Contractor	Construction	Additional safeguard

6.6 Aboriginal cultural heritage

6.6.1 Existing environment

The Jenolan Caves region is part of the land of the Gundungurra and Wiradjuri People. The Aboriginal history of the Jenolan Caves region is not well known, although the Blue Mountains region has been occupied for at least 15,000 years.

A search of the Aboriginal Heritage Information Management System (AHIMS) database maintained by OEH was carried out in August 2023. The search indicated that no Aboriginal heritage items have previously been recorded within the site. Five Aboriginal sites were found in the surrounding areas of the site.

Stage 1 of the PACHCI has been completed for the proposal and a copy of the Stage 1 PACHCI letter is provided in Appendix H. This concluded that the proposal is unlikely to have an impact on Aboriginal cultural heritage.

6.6.2 Potential impacts

Construction

The proposal site is located within an area that has been subject to extensive ground disturbance associated with the construction of the existing road, the subsequent slope failures and the existing carpark. As per section 6.6.1, no Aboriginal sites have been previously recorded within the site.

Due to the high level of ground disturbance at the site, there is low potential for the presence of unidentified archaeological deposits. Appropriate safeguards and management measures are proposed in the case of unexpected finds during construction work.

Operation

No impacts to Aboriginal heritage are anticipated during operation.

National park

There would be no impact to Aboriginal heritage at the Jenolan Karst Conservation Reserve as a result of the proposal.

6.6.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Aboriginal heritage	The *Standard Management Procedure – Unexpected Heritage Items* (Transport for NSW, 2022) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Transport for NSW does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contactor	Detailed design / pre-construction	Section 4.9 of QA *G36 Environment Protection*

6.7 Non-Aboriginal heritage

A Statement of Heritage Impacts Assessment (SOHI) was prepared by specialist heritage consultants, Mountains Heritage. The SOHI is provided in Appendix E and is summarised in this section.

6.7.1 Methodology

The following activities were undertaken as part of the SOHI:

- background research, including a search of statutory and non-statutory registers and a review of the available history of the study area to ascertain if any listed items may be impacted by the proposal
- inspection of the affected sections of the Two-Mile stretch of Jenolan Caves Road and views to and from the Caves House, tourist walk meeting point and Car Park 1
- review of restoration options considered by Transport for NSW
- provision of mitigation measures to mitigate the potential impact of the proposal on the heritage significance of the Jenolan Caves Reserve.

6.7.2 Existing environment

The proposal is partially located within the curtilage of the Jenolan Caves Reserve, a natural heritage item listed on the NSW State Heritage Register (SHR No. 01698). Jenolan Caves Road and parts along the roadside (including failure locations 1 to 8) are excluded from this curtilage. . Part of the proposal site (at the gully) is also located within the Jenolan Karst Conservation Reserve, which is one of eight reserves that comprise the GBMWHA, listed on the National Heritage List (No. 105999) and the UNESCO World Heritage List (No. 917).

The State Heritage Register Statement of Significance states, "Jenolan Caves Reserve is one of the most important areas of natural history in Australia. The area includes one of the largest and most beautiful interconnected cave systems in Australia and is an outstanding site of geological and speleological interest. The Jenolan Caves Reserve consists of a range of factors of significance, including World Heritage, landscape, catchment, geological, biological, Aboriginal, historic heritage, research, education, recreational and tourism values" (OEH 2019, p. 2). In particular, the karst environment of the reserve is the main aspect which the significance of the site is attributed to for various factors. The reserve also holds landscape values through the Jenolan Caves House which is an example of early Federation Arts and Craft architecture.

A summary of the heritage listings associated within and in close proximity to the study area, is provided in Table 6.3 with further detail provided in the SOHI.

Table 6.3: Summary of heritage listings associated with and within close proximity to the proposal

Item name	Item number/listing	Details of heritage items listed within / directly adjacent to the proposal site
Statutory Listings		
Greater Blue Mountains World Heritage Area (GBMWHA)	UNESCO World Heritage List Item No. 917	'Jenolan Caves Reserve' forms part of the listing, which is primarily focused on natural heritage values
Greater Blue Mountains	National Heritage List No. 105999	'Jenolan Caves Reserve' forms part of the listing, which is primarily focused on natural heritage values
Jenolan Caves Reserve	NSW State Heritage Register Item No. 01698	The Reserve is listed for its historical, aesthetic, research and rarity values
Jenolan Caves (4650 Jenolan Caves Road)	LEP Item No. I1	In addition to the Jenolan Caves listing, there are multiple listings for various elements within the Reserve.
Jenolan Caves House	LEP Item No. I11	
Limestone Bridge (near Grand Arch)	LEP Item No. I12	
Jenolan Caves Reserve Conservation Area (Part 2 – Heritage Conservation Areas of LEP)	LEP Item No. C1	
Jenolan Caves (Part 3 – Archaeological Sites of LEP)	LEP Item No. A1	
Homestead – "Rowes"	LEP Item No. I56	
Non-Statutory Listings		
Jenolan Caves Conservation Area	National Trust of Australia Item No. 3164	'Jenolan Caves Reserve' is listed for its geological formations, flora, fauna, Caves House and other buildings and landscape features.
Jenolan Caves and Reserve	Register of the National Estate Item No. 890	'Jenolan Caves Reserve' is listed for its geomorphology, diverse landscape and fossil elements.

6.7.3 Potential impacts

Construction

Construction of the proposal would have the potential to visually impact views from the state heritage-listed Jenolan Caves Reserve. However, the SOHI found that the slope failure locations would unlikely to be visible from any viewpoints, including the western side of the Jenolan Caves House where potential for visibility was previously considered. It is anticipated that the construction work would be mostly concealed from view due to the steep terrain and existing vegetation which would not be cleared. Additionally, the Jenolan Caves Precinct would be closed to the public while construction work is being carried out. The slope failure locations are not within notable view corridors or vistas mentioned in the Jenolan Caves Karst Reserve: Conservation Management Plan. Therefore, the extent of obstruction of views within a heritage-listed area is anticipated to cause little to no impact. During construction, the slope restoration and surrounding work sites would be kept clean to further reduce obstruction of views.

Vegetation clearing would be minimal and avoid the removal of mature trees unless necessary. The steep topography and existing vegetation on site would further conceal the work while it is being carried out at the slope failure locations. Therefore, the proposal would cause minimal change to the landscape within a heritage-listed area.

The cutting of the landform for the culvert upgrades would involve alteration of the natural environment within a heritage-listed area and induce risk of water and soil quality issues. However, the upgrades would not be significant and would reduce the risk of future landslips, improving water quality in the long term.

No other items of heritage significance identified in Table 6.3 would be impacted during the construction of the proposal. Furthermore, the proposal would not interrupt the heritage significance of the heritage sites and items identified in Table 6.3.

Operation

Operation of the proposal is expected to have a minor visual impact on views from the Jenolan Caves Precinct. The proposed use of tinted shotcrete is generally not compatible for a heritage area where work would be highly visible. As the work would not be visible from key locations, including the Jenolan Caves House, Carlotta Arch, booking office and cave tour meeting points, a mock-rock finish is not considered necessary. However, shotcrete with a tint which is compatible with the site topography would ensure consistency with the visual character of the heritage landscape. Safeguards provided in section 6.7.4 would reduce the long-term visual impact to the Precinct.

The proposed culvert upgrades would improve the stormwater drainage measures on site to increase the capacity of drainage, preventing further landslips within a heritage-listed area.

The proposal is unlikely to have a significant impact on the GBMWHA's national heritage values as it would not result in one or more of the National Heritage Values being lost, degraded or damaged, or notably altered, modified, obscured or diminished (Commonwealth of Australia 2013). The extensive presence of the *Eucalypt* genus and eucalypt habitats present in the GBMWHA would not be removed or impacted by the proposal. No other items of heritage significance identified in Table 6.3 would be impacted during operation of the proposal.

National park

The work would alter the view of part of a heritage-listed area within the Jenolan Karst Conservation Reserve through introducing new man-made structures. However, the slope failure restoration and culvert upgrades would improve the stability of adjacent roadside areas and improve stormwater drainage measures on National Parks land. The proposal provides a way to carry out this work without significantly affecting the heritage and cultural values of the Jenolan Caves and Jenolan Caves Reserve within the Jenolan Karst Conservation Reserve. Further, the slope failure restoration and culvert upgrades would improve access to the Jenolan Karst Conservation Reserve and Jenolan Caves Precinct, allowing improved access for the public and tourists to enjoy the heritage areas and heritage items within.

6.7.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Non-Aboriginal heritage	A Non-Aboriginal Heritage Management Plan (NAHMP) will be prepared and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented to avoid and mitigate impacts to Non-Aboriginal heritage.	Contractor	Pre-construction	Section 4.10 of QA G36 Environment Protection
Non-Aboriginal heritage	The Standard Management Procedure – Unexpected Heritage Items (Transport for NSW, 2022) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contractor	Construction	Section 4.10 of QA G36 Environment Protection
Non-Aboriginal heritage	The colour of the shotcrete is to be tinted to blend into the surrounding topography and vegetation.	Contractor	Construction	Additional safeguard
Non-Aboriginal heritage	The detailed design for the work should be reviewed against the existing SOHI by a suitably qualified heritage specialist to ensure that there are no additional impacts proposed by the work. If additional impacts are identified discussions with Heritage NSW would be undertaken to confirm whether any existing approvals provided are required to be modified under a Section 65A Modification Application.	Contractor	Pre-construction	Additional safeguard

Other safeguards and management measures that relate to non-Aboriginal impacts are identified in section 6.8.4.

6.8 Landscape character and visual impacts

A landscape character and visual impact assessment was undertaken by GHD in accordance with the *Guideline for landscape character and visual impact assessment – Environmental impact assessment practice note EIA-N04, Version 2.3* (Transport for NSW, 2023b) and is provided in Appendix G and summarised in this section.

6.8.1 Methodology

The landscape and visual impact assessment involved the following main tasks:

- desktop analysis, including analysing aerial photographs and topographic maps
- site visit and analysis to understand the existing landscape and visual context
- identifying representative viewpoints and their sensitivity to change
- understanding the key visual features of construction and operation
- assessing the potential for visual impacts during construction and operation

- determining the potential significance of impacts through a combined assessment of sensitivity and magnitude
- recommending mitigation and management measures.

The study area for the landscape character and visual impact assessment consists of the proposal site and a buffer of 550 metres around the proposal site.

Visual impact assessment

The area from where the proposal could be visible is referred to as the visual catchment or visual envelope. This is largely defined by the landform of the study area. Viewpoints were selected to illustrate the visual influence of the proposal both within and outside the proposal site. These generally represent publicly accessible views and vistas from a range of locations and viewing situations.

The potential visual impacts were determined based on the sensitivity of the viewpoint and the magnitude of the change. Sensitivity refers to the quality and value of the view and how it would be affected by the proposal. Magnitude refers to the nature, size and scale of the change in views resulting from the proposal and the proximity relative to the viewer. The combination of sensitivity and magnitude determines the visual impact, from negligible to high as shown in Figure 6-2.

Figure 6-2: Visual impact rating matrix (Transport for NSW, 2023b)

		Magnitude			
		High	**Moderate**	**Low**	**Negligible**
Sensitivity	**High**	High	High-moderate	Moderate	Negligible
	Moderate	High-moderate	Moderate	Moderate-low	Negligible
	Low	Moderate	Moderate-low	Low	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

6.8.2 Existing environment

The study area consists primarily of natural areas dominated by native vegetation with very steep terrain. The mountainous terrain confines views to short range local views, apart from along Jenolan Caves Road, the open car parking areas and other glimpses through vegetation in the surrounding areas. Middle distance views are available from Jenolan Caves Road to the south and east where the land falls away and local hilltops may be visible such as Mount George. Long distance views were not identified from publicly accessible locations in the study area.

A feature of the visual landscape is the heritage listed Jenolan Caves Precinct which includes a number of key natural and cultural heritage feature such as:

- The Blue Lake
- The Jenolan Caves
- Carlotta Arch
- Jenolan Mountain Lodge.

These features are the primary driver for tourist visitation to the area and so also have important economic benefits for the existence of the tourist areas and facilities.

Landscape character

Landscape character relates to the built, natural, cultural and community aspects which make a place unique. The broad landscape character within the study area is mainly associated with the natural bushland within the Jenolan Karst Conservation Reserve and the location of the proposal within the State Heritage Listed Jenolan Caves Reserve. It is characterised by steep terrain and vegetated slopes, within a predominately natural, open eucalypt forest setting.

Infrastructure elements include roads, carparks, signage and buildings, and are predominately associated with Jenolan Caves House Precinct as a tourist destination. Existing endemic vegetation and heritage listed buildings contribute to the visual quality of the study area.





Figure 6-3: Landscape character images

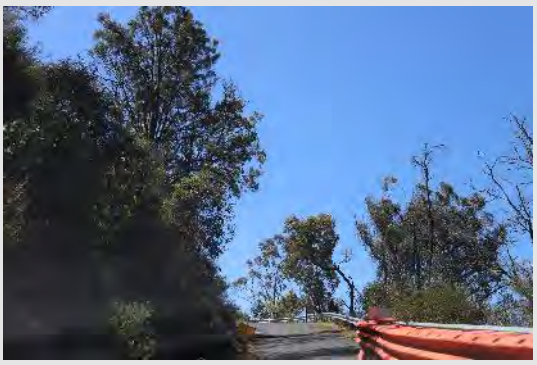
Viewpoints

Based on the analysis of sensitive visual receivers and the existing landscape and visual environment, eight viewpoints for the landscape character and visual impact assessment were identified.

Significant views identified within the Jenolan Karst Conservation Reserve Conservation Management Plan were reviewed as part of the Statement of Heritage Impact completed for the proposal, provided in Appendix E. This report found that none of the significant views would be impacted by the proposal due to existing/to be retained vegetation screening and also that the sites are located well above the precinct due to the steep terrain. As none of these significant views were considered impacted by the heritage team they were not considered as part of this visual impact assessment.

A summary of the viewpoints together with representative views is provided in Table 6.4. The location of the viewpoints is shown on Figure 6-4.

Table 6.4: Viewpoints identified for the proposal

Viewpoint	Description	Sensitivity	Existing view
1 – Jenolan Caves Road at Failure 6	Semi-enclosed view with a steep, vegetated embankment on the western verge and distant, filtered views to the east through existing native vegetation. Failure 7 is at the top of the slope on the western verge.	Low	
2 – Jenolan Caves Road at Failure 5	View is enclosed on the western verge by a steep, vegetated embankment. Open views to the south and east are of terrain and bushland associated with Jenolan Caves Reserve below.	Moderate	

Viewpoint	Description	Sensitivity	Existing view
3 – Burma Road tourist cabins	View is predominately of bushland and vegetated slopes associated with Jenolan Caves Reserve. A small section of Jenolan Caves Road at Failure 1 is visible through the vegetation.	Low	
4 – Walking track	View is open and includes Jenolan Caves Road from a section of a walking track. The road slopes down steeply and is framed on both sides by bushland and steeply vegetated terrain. Failure 1 is visible in middle ground of the view.	Low	
5 – Jenolan Caves Road at Failure 1	View is mostly enclosed by a steep embankment on the northern verge with dense vegetation below Failure 1 & 2.	Low	
6 – Car Park 2	Open view from Car Park 2 of a steep, vegetated slope with Failure 1 & 2 visible through the existing trees. The gully failure is visible on this slope.	Low	

Viewpoint	Description	Sensitivity	Existing view
7 – Carlotta Arch viewing area	Open view of steep, vegetated slopes within Jenolan Caves Reserve. Jenolan Caves Road may be partially visible at the top of the slope in this view however is mostly obscured by trees.	Moderate	
8 – Surveyors Creek walking track	Open view of steep, vegetated slopes within Jenolan Caves Reserve. Jenolan Caves Road may be partially visible at the top of the slope in this view however is mostly obscured by trees.	Low	

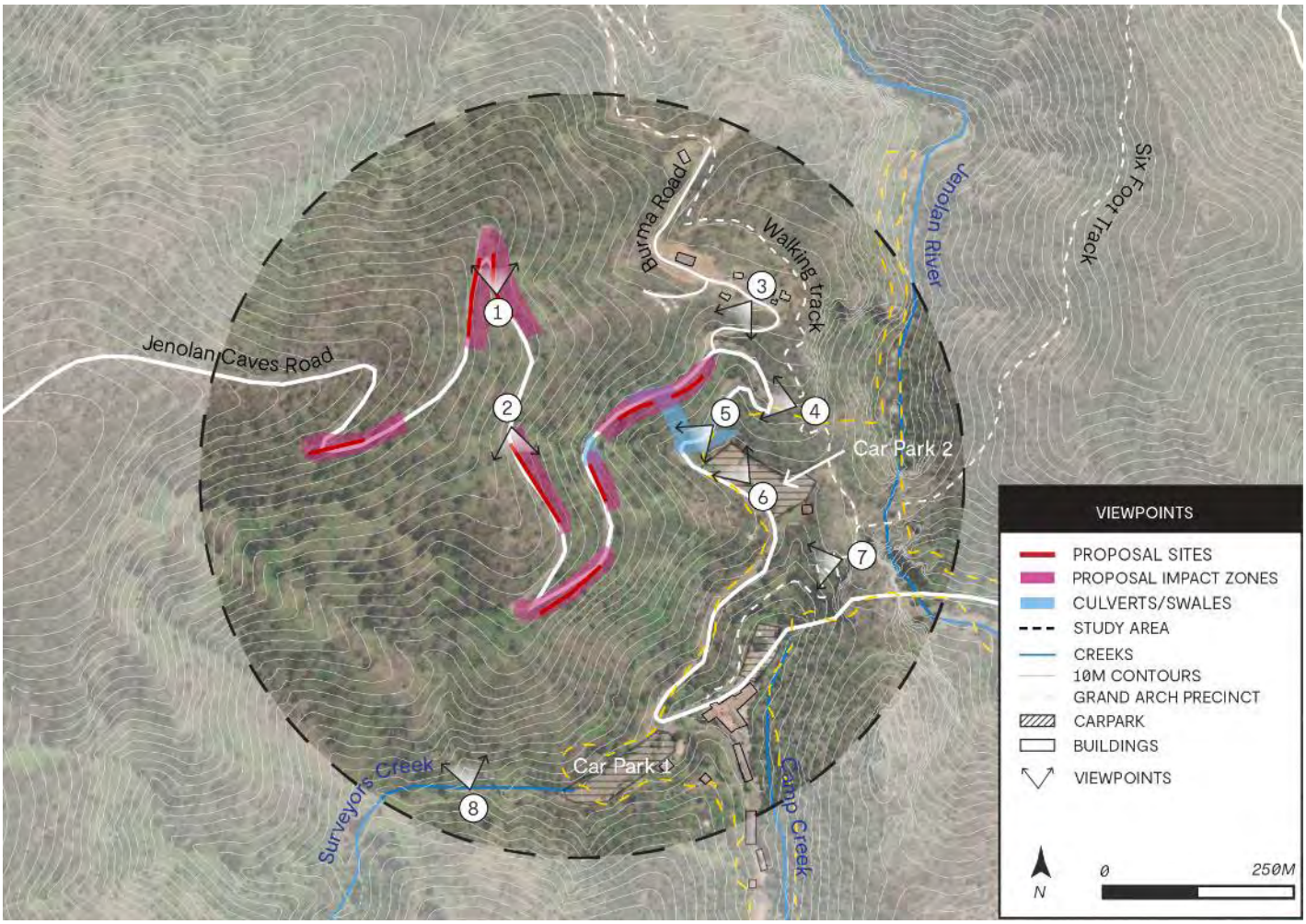


Figure 6-4: Viewpoints

6.8.3 Potential impacts

Construction

Construction would have the potential to result in temporary impacts on landscape character and visual amenity within and surrounding the proposal site. These impacts would include views of:

- construction plant and equipment
- construction activities
- stored materials and stockpiles
- activities in and around compound sites and ancillary facilities
- vegetation clearing, including mature tree removal
- excavation and earthworks.

Impacts during construction are considered minimal as the Jenolan Caves Precinct will be closed to the public and therefore there would be limited sensitive receptors with views of the proposal site. Some receptors may be present in the form of a small number of hikers potentially having views of the construction areas. View of any one failure location would be limited in duration.

Operation

The proposal has the potential to result in visual impacts across the proposal site. The potential impacts, which would range from negligible to moderate-low, are summarised in Table 6.5. In summary:

- one viewpoint would experience negligible impacts (viewpoint 8)
- one viewpoint would experience low impacts (viewpoint 3)

- six viewpoints would experience moderate-low impacts (viewpoints 1, 2, 4, 5, 6 and 7).

Generally, visual impacts would occur due to the presence of proposed soil nails and the removal of some vegetation. Overall, many sites would remain partially screened due to vegetation to be retained. Viewpoints located along Jenolan Caves Road, while open to changes due to proximity, are considered generally to be short term in nature as vehicles travel along the road.

Table 6.5: Potential visual impacts during operation

Viewpoint	Anticipated change	Sensitivity	Magnitude	Impact rating	Impact summary
1 – Jenolan Caves Road at Failure 6	Vegetation removal Shotcrete soil nail wall at Failure 7	Low	Moderate	Moderate-low	Changes would occur however views are from motorists, and their attention is focused on the road and short-term in nature.
2 – Jenolan Caves Road at Failure 5	Vegetation removal	Moderate	Low	Moderate-low	Changes would occur however they would likely open views to the east and enhance the motorist experience.
3 – Burma Road tourist cabins	Vegetation removal Shotcrete soil nail wall at Failure 1	Low	Low	Low	Changes result in a relatively small area of exposed landscape with existing vegetation obscuring much of the slope remediation works.
4 – Walking track	Vegetation removal Shotcrete soil nail wall at Failure 1	Low	Moderate	Moderate-low	Existing foreground vegetation would obscure much of the slope remediation works at Failure site 1. Views are short term in nature for users of the path walk.
5 – Jenolan Caves Road at Failure 1	Vegetation removal Culvert 1A works, including road side drainage works Gully failure restoration	Low	Moderate	Moderate-low	Changes would be limited to motorists and their attention is focused on the road and short-term in nature.
6 – Car Park 2	Vegetation removal Shotcrete soil nail wall at Failure 1 and 2 Gully failure	Low	Moderate	Moderate-low	Changes would be visible in the foreground, however views from this location are limited as visitors tend to not stay in the car park for very long.
7 – Carlotta Arch viewing area	Vegetation removal Shotcrete soil nail wall at Failure 4	Moderate	Low	Moderate-low	Existing vegetation would likely obscure most of the slope remediation works. Viewing distance is over 100 m, further reducing impact.
8 – Surveyors Creek walking track	No change due to existing screening	Low	Negligible	Negligible	Changes included as part of the proposal are not likely to be visible from this viewpoint due to existing screening.

National park

The work would be carried out partially next to the Jenolan Karst Conservation Reserve, however, construction work would not be highly visible from the Jenolan Karst Conservation Reserve due to the steep terrain and existing vegetation in the surrounding area. Part of the construction work (at the location of the gully site 1 and 1A) would be carried out within the Jenolan Karst Conservation Reserve. However, there would not be a significant impact to the visual character of the Jenolan Karst Conservation Reserve during construction and operation of the proposal.

6.8.4 Safeguards and management measures

All additional safeguards are subject to suitability for each slope failure location.

Impact	Environmental safeguards	Responsibility	Timing	Reference
Visual impacts due to shotcrete wall	Where required, shotcrete design will be based on the *Shotcrete design guideline* (Transport for NSW, 2023).	Contractor	Construction	Additional safeguard
Visual impacts due to shotcrete wall	Colour tinting of the shotcrete will blend in with the surrounding topography and adjacent natural stone surfaces. If the shotcrete is covering exposed rock, an unobtrusive, muted tone which fits the local context will be selected. Highly reflective colours will be avoided.	Contractor	Construction	Additional safeguard
Visual impacts due to shotcrete wall	The texture of shotcrete will mimic the adjacent landscape stone and blend into surrounding topography, such as having rough rather than smooth surfaces.	Contractor	Construction	Additional safeguard
Visual impacts due to shotcrete wall	The extent of shotcrete will be minimised where practicable, applying shotcrete precisely to unstable sections of slope and adapting its colour to match the local geology and/or surrounding vegetation.	Contractor	Construction	Additional safeguard
Visual impacts due to shotcrete wall	The application of shotcrete will finish or extend up to distinct edges, natural joints or changes in the face of the slope.	Contractor	Construction	Additional safeguard
Visual impacts due to shotcrete wall	Planting in key locations will be considered to help screen larger areas of visible exposed shotcrete.	Contractor	Construction	Additional safeguard
Visual impacts due to shotcrete wall	Salvaged woodland material (branches, logs, sandstone boulders) will be scattered over any disturbed areas to provide an edge transition.	Contractor	Construction	Additional safeguard
Impacts of gully failure	Damaged areas and edges of gully will be revegetated with mass planting of native grasses and low-mid height species to match surrounding vegetation. Native grass species that match surrounding vegetation will be used in grass-lined swales.	Contractor	Construction	Additional safeguard

Impact	Environmental safeguards	Responsibility	Timing	Reference
Impacts of drainage infrastructure	Natural materials will be utilised where possible in drainage infrastructure, such as local stone (Sandstone) and/or planting with organic erosion control mesh, coir logs. Coloured concrete (earthy tones) will be considered where a paved solution is preferred.	Contractor	Construction	Additional safeguard

6.9 Property and land use

6.9.1 Existing environment

The proposal site at each of the slope failure and culvert upgrades has no specific land use, with the area forming part of the roadside for Jenolan Caves Road.

The proposal site includes Car Park 1 and Car Park 2 of the Jenolan Caves Precinct, which are to be used for compound and stockpile areas. These car parks service the Jenolan Caves Precinct; however Car Park 1 is not currently accessible to the public due to closures of Jenolan Caves Road from both the east and west due to slope failures. Car Park 2 is currently used (when the Jenolan Caves Precinct is open) for all visitors to access the site, with a shuttle bus operating to transfer people into the Precinct or visitors can walk down to the Precinct using existing paths and tracks.

A stockpile site is also to be established at the intersection of Jenolan Caves Road and Kanangra Walls Road. This area consists of cleared land within the road reserve with no specific land use.

6.9.2 Potential impacts

Construction

The proposal is not expected to result in any impact on the use of the land as the impacted land is not used for any specific purpose.

The use of Car Park 1 and Car Park 2 is not expected to impact the public, as the whole Jenolan Caves Precinct would be closed during construction due to work being carried out by the Jenolan Caves Trust. The use of Car Park 1 for the proposal would be limited as much as possible as this area would mostly be used for construction work by the Jenolan Caves Reserve Trust and also by Transport for NSW for slope restoration work at an additional slope located south of the proposal (subject to separate REF approval). There is expected to be sufficient stockpiling space on site and little to no land use conflict anticipated between the Jenolan Caves Reserve Trust and Transport for NSW carrying out construction work during any overlapping timeframe. Any impacts would be short term in nature.

The use of the compound at the intersection of Jenolan Caves Road and Kanangra Walls Road would impact on land use, however as this land currently has no defined use, these impacts are anticipated to be minimal. This area is also likely to be used as a staging area for short periods before equipment and materials being transferred to the site in vehicles which can negotiate Jenolan Caves Road due to some limitations for larger vehicles.

Operation

The proposal would not result in any long-term changes in land use with all impacted areas to be returned to their existing use (including pre failure use). The proposal would result in indirect benefits for land use within the Jenolan Caves Precinct as it would reinstate road access for visitors to the Precinct.

National Park

The proposal would not impact upon the use of the Jenolan Karst Conservation Reserve as areas to be impacted directly are not used for any specific purpose. The proposal would however enable continued access to the reserve, in particular the Jenolan Caves Precinct. The proposal would also reduce the risk of further slope failures which could result in environmental damage to the Jenolan Karst Conservation Reserve and potentially result in the loss of access into the reserve.

6.9.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Use of compound areas	Site specific management plans would be developed in consultation with National Parks and Wildlife Service and Jenolan Caves Reserve Trust for the use of identified compound locations. These plans would include details of how these areas are to be used, what can be stockpiled, duration of any stockpiles, and other details needed to manage these areas as compound and stockpiling locations.	Contractor	Construction	Additional safeguard

6.10 Socio-economic

6.10.1 Existing environment

The Oberon local government area had a population of 5,577 in 2021. The current largest employment industries are wood fitting and manufacturing with 6.3 per cent of the population, log sawmilling at 3.8 per cent and beef cattle farming at 3.4 per cent. It is predicted that development projects in the LGA will provide more employment opportunities. The tourism sector is also anticipated to grow, given the natural attractions of the area. The Jenolan Caves, located near the proposal site, is considered a major tourist attraction with an estimate of 200,000 visitors annually (Office of Environment and Heritage 2019). The Jenolan Caves Precinct provides a number of options for overnight accommodation, including the Jenolan Caves House, Jenolan Mountain Lodge and Jenolan Cabins.

The area also contains several attractions such as Orient Cave, Blue Lake and Carlotta Arch, with a number of walking trails also located in the vegetated areas surrounding the proposal site.

6.10.2 Potential impacts

Construction

During construction it is proposed that the Jenolan Caves Precinct would be closed off to the public due to work being carried out by the Jenolan Caves Trust. The proposal has been timed to make use of this closure period as to minimise the impacts on any road closures on the Precinct. This would result in no impacts on the operation of the Precinct as a direct result of the proposal.

Operation

Following construction, the proposal is considered to provide a community benefit as it would allow vehicular access into the Precinct for the public, therefore removing the need for vehicle escorts to access the Precinct. The work in conjunction with other slope restoration work by Transport for NSW along the Two Mile section of Jenolan Caves Road would provide full vehicular access into the Jenolan Caves Precinct which due to slope failures occurring has not been possible since 2021. The improvement in access would most benefit those who are less mobile (elderly, disabled or parents with prams) for which transferring to a bus or walking may be difficult.

The improved access would also benefit businesses within the Jenolan Caves Precinct, as improved access would potentially attract visitors who currently opt not to visit due to the current access arrangements.

National park

The proposal is unlikely to affect community services or infrastructure as the Jenolan Karst Conservation Reserve which is used mostly for tourism and recreation would be closed while construction work takes place as a result of construction work being carried out by the Jenolan Caves Trust. The timing of the proposal during the Precinct closure would minimise the duration of any loss of access into the Jenolan Caves Precinct and the wider Jenolan Karst Conservation Reserve areas including walking tracks.

The proposal would cause the introduction of new man-made structures into the natural environment. However, these structures would be designed to be in keeping with the surrounding landscape.

The proposal (in conjunction with other Transport for NSW slope restoration work) would improve access to the Jenolan Karst Conservation Reserve area and the Jenolan Caves Precinct. The proposal would also create an improvement to public safety through stabilising the slope.

6.10.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Socio-economic	A Communication Plan (CP) will be prepared and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CP will include (as a minimum): • mechanisms to provide details and timing of proposed activities to the community and access conditions • contact name and number for complaints. The CP will be prepared in accordance with the *Community Involvement and Communications Resource Manual* (RTA, 2008).	Contactor	Pre-construction	Standard safeguard
Business impacts	Access into the Jenolan Caves Precinct for Jenolan Caves Trust staff and contractors is to be provided with no restrictions during the following periods: • Monday and Tuesday all day • Wednesday to Sunday before 7.30am and after 5pm. Any changes to this access are to be notified with the Jenolan Caves Trust in advance and alternative arrangements made. Any additional access to the above would be discussed with the Jenolan Caves Trust.	Contractor	Construction	Additional safeguard

6.11 Other impacts

The existing environment and the associated impacts resulting from the proposal for other environmental factors (air quality, bushfire, and waste) is provided in Table 6.6. Safeguards and management measures to avoid or minimise impacts to these environmental factors are provided in section 6.11.1.

Table 6.6: Other environmental factors – existing environment and impacts

Environmental factor	Existing environment	Potential impacts
Air quality	Air quality in the vicinity of the proposal is typical of a predominately vegetated area with limited access and facilities. Local air emissions are dominated by motor vehicles using Jenolan Caves Road to access the Jenolan Caves Precinct.	Potential impacts to air quality from disturbed top soil, removal of vegetation and construction of the proposal are minor. Potential dust and emissions from trucks and plant machinery would be considered likely during construction, although the impacts would be minor and short term.
Bushfire	The proposal site and surrounding study area is mapped as High Bushfire Prone land in the Oberon LEP.	The nature of the proposed work would not need the use of equipment or activities which are considered high risk to cause a bushfire. Any potential impacts would be managed through the implementation of standard control measures, particularly prohibiting any hot works during high fire danger periods.
Waste	Transport for NSW is committed to ensuring the responsible management of unavoidable waste and promotes the reuse of such waste in accordance with the resource management hierarchy principles outlined in the *Waste Avoidance and Resource Recovery Act 2001*. These resource management hierarchy principles, in order of priority are: • Avoidance of unnecessary resource consumption • Resource recovery (including reuse, reprocessing, recycling and energy recovery) • Disposal. By adopting the above principles, Transport for NSW aims to efficiently reduce resource use, reduce costs, and reduce environmental harm in accordance with the principles of ecologically sustainable development, as outlined in section 8.2.1 of this REF.	Potential impacts from waste relate to contamination of the surrounding environment (such as pollution of waterways, attracting pest fauna) through improper waste handling, storage and transport practices. The significance of these impacts is predicted to be low, as proposed safeguards and management measures would address potential impact pathways into the surrounding environment. Waste produced during construction would be managed in accordance with the waste management hierarchy principles of the *Waste Avoidance and Resource Recovery Act 2001*, within which waste avoidance is a priority, followed by reuse and recycling/reprocessing, with disposal as a last resort.

6.11.1 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Air quality	Air quality will be managed and implemented as part of the CEMP. The CEMP will include, but not be limited to: • potential sources of air pollution • air quality management objectives consistent with any relevant published EPA and/or OEH guidelines • mitigation and suppression measures to be implemented • methods to manage work during strong winds or other adverse weather conditions • a progressive rehabilitation strategy for exposed surfaces.	Contractor	Pre-construction	Section 4.4 of QA G36 Environment Protection
Waste	A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to: • measures to avoid and minimise waste associated with the proposal • classification of wastes and management options (re-use, recycle, stockpile, disposal) • statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • procedures for storage, transport and disposal • monitoring, record keeping and reporting. The WMP will be prepared taking into account the *Waste management guideline* (Transport for NSW, 2023) and relevant Transport for NSW Waste Fact Sheets.	Contractor	Pre-construction	Section 4.2 of QA G36 Environment Protection
Bushfire	Consultation with NPWS, Rural Fire Service and other emergency services is to be carried out throughout construction to advise of any access changes.	Contractor	Construction	Additional safeguard
Hazards and risk management	A Hazard and Risk Management Plan (HRMP) will be prepared and implemented as part of the CEMP. The HRMP will include, but not be limited to: • details of hazards and risks associated with the activity • measures to be implemented during construction to minimise these risks • record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials • a monitoring program to assess performance in managing the identified risks	Contractor	Pre-construction	Additional safeguard

Impact	Environmental safeguards	Responsibility	Timing	Reference
	• contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. • The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.			

6.12 Cumulative impacts

6.12.1 Broader program of work

Rainfall events in March 2021 and between July 2022 to 2023, resulted in a number of slope failures along Jenolan Caves Road along both the Two Mile section (west of Jenolan Caves) and the Five Mile section (east of Jenolan Caves). Transport for NSW, National Parks and Wildlife Services and the Jenolan Caves Reserve Trust are carrying out various work in the area to stabilise areas impacted by the rainfall events from the past few years.

In addition to the proposal, Transport for NSW slope restoration work at the slope located between Car Park 1 and Car Park 2 would be carried out concurrently to minimise on impacts on accessing the Jenolan Caves Precinct. These are approved under a separate approval.

Transport for NSW also proposes to commence work on restoring access to the Five Mile slope located east of the Jenolan Caves Precinct along Jenolan Caves Road. Work on this section of Jenolan Caves Road is considered unlikely to need access via the Two Mile section particularly during the construction of the proposal when access would be extremely limited. This access would only be used for light vehicles, if required. Upon completion of the proposal and other slope restoration work along the Two Mile section of Jenolan Caves Road, the Two Mile maybe used for the construction of the Five Mile project.

6.12.2 Other projects and developments

A search of the DPE Major Projects Portal on the 25 January 2023 revealed no major projects in the Oberon LGA.

In addition to the slope restoration work outlined in section 6.12.1, one other project has been identified as potentially resulting in cumulative impacts for the areas along Jenolan Caves Road. These are a series of work proposed by the Jenolan Caves Reserve Trust to upgrade their existing facilities within the Jenolan Caves Precinct. The proposal has been timed to occur at the same time as this Jenolan Caves Reserve Trust work which would result in the closure of the Jenolan Caves Precinct regardless of the proposal. This parallel carrying out of work would reduce the overall timeframe of any Precinct closures. Based on the program for the two projects, Wednesday to Friday would be the days on which construction of both projects would be active while on the remaining days of the week only one project would be being constructed.

6.12.3 Potential impacts

Environmental factor	Construction	Operation
Traffic and transport	Carrying out the proposal and other slope restoration work along Two Mile section would result in closures which would impact access to the Jenolan Caves Road with the existing Two Mile section the only access available. The potential impacts on access from the slope restoration work is however reduced by the work being carried out concurrently by the Jenolan Caves Reserve Trust. This concurrent work is considered to be a beneficial cumulative impact as this would limit access issues to a single period. The use of the Two Mile section following construction as access for the Five Mile section would extend the impacts of vehicle movements over a longer period due to back to back construction periods. However, these impacts are likely to be limited to light vehicles as heavy vehicle access along the Two Mile section is unlikely due to the road geometry. On this basis any cumulative impacts are considered to be minimal.	Unrestricted public access to the Jenolan Caves Road would be reinstated by the proposal and other slope restoration work. The closing of the Precinct while the proposal, Jenolan Caves Reserve Trust construction work, and other slope restoration work occurs with overlapping time periods would provide access to the Precinct which would be uninterrupted by any of these three activities. There is expected to be a beneficial cumulative impact on light vehicle access along the Two Mile section of Jenolan Caves Road as access would be reinstated as a result of the various slope failure restoration work. The various slope failure restoration works on the Two Mile section would also enable access to the Jenolan Caves Precinct while restoration of the Five Mile stretch takes place, which may otherwise be impossible due to safety concerns.

Environmental factor	Construction	Operation
Noise	Noise amenity impacts caused by the proposal, other slope restoration work at the Jenolan Caves Precinct and the Jenolan Caves Reserve Trust construction work would be cumulative due to their overlapping timeframes and proximity. However, the impact would be limited to a period when there are no sensitive receivers due to the closure of the Jenolan Caves Precinct.	There are no significant cumulative impacts anticipated by the operation of the proposal and surrounding work at the reopening of the Jenolan Caves Precinct as the use of the area would be as before the event of the various slope failures in the vicinity.

The various planned works located along Jenolan Caves Road, while potentially resulting in some cumulative impacts, are considered to have an overall cumulative benefit as once complete the restoration work would reinstate road access to the Jenolan Caves Precinct from both the east and west. The proposal would provide the initial improvement to access through protecting the only existing access, with the work along the Five Mile stretch then looking to reinstate full access including access for larger vehicles. The proposed work would also ensure that the pristine natural environment, which is a major selling point for the area, is not further impacted by further slope failures and impacts such as the sedimentation of waterways.

6.12.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Cumulative impacts	The Communication Plan will include consultation with Transport for NSW, NPWS and Jenolan Caves Reserve Trust to determine the timing of all work proposed and details of how to manage any impacts.	Transport for NSW/NPWS/Jenolan Caves Reserve Trust and any relevant contractors	Construction	Cumulative impacts

7. Environmental management

This chapter describes how the proposal will be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A framework for managing the potential impacts is provided. A summary of site-specific environmental safeguards is provided and the licence and/or approval requirements needed before construction are also listed.

7.1 Environmental management plans (or system)

A number of safeguards and management measures have been identified in the REF in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these safeguards and management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

A Construction Environmental Management Plan (CEMP) will be prepared to describe the safeguards and management measures identified. The CEMP will provide a framework for establishing how these measures will be implemented and who would be responsible for their implementation.

The CEMP will be prepared prior to construction of the proposal and must be reviewed and certified by the Transport for NSW Environment Officer, Western Region, prior to the commencement of any on-site work. The CEMP will be a working document, subject to ongoing change and updated as necessary to respond to specific requirements. The CEMP would be developed in accordance with the specifications set out in the: QA Specification *G36 – Environmental Protection (Management System)*, QA Specification *G38 – Soil and Water Management (Soil and Water Plan)*, QA Specification *G40 – Clearing and Grubbing*, QA Specification *G10 – Traffic Management.*

7.2 Summary of safeguards and management measures

Environmental safeguards and management measures outlined in this REF will be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards and management measures will minimise any potential adverse impacts arising from the proposed work on the surrounding environment. The safeguards and management measures are summarised in Table 7.1.

Table 7.1: Summary of safeguards and management measures

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
GEN1	General – minimise environmental impacts during construction	A CEMP will be prepared and submitted for review and endorsement of the Transport for NSW Environment Manager prior to commencement of the activity. Development of the CEMP would be undertaken in consultation with National Parks and Wildlife Service and Jenolan Caves Reserve Trust. As a minimum, the CEMP will address the following: • any requirements associated with statutory approvals • details of how the proposal will implement the identified safeguards outlined in the REF • issue-specific environmental management plans • roles and responsibilities • communication requirements • induction and training requirements • procedures for monitoring and evaluating environmental performance, and for corrective action • reporting requirements and record-keeping • procedures for emergency and incident management • procedures for audit and review. The endorsed CEMP will be implemented during the undertaking of the activity.	Contractor / Transport for NSW project manager	Pre-construction / detailed design	Standard safeguard	☒
GEN2	General – notification	All businesses, residential properties and other key stakeholders (eg schools, local councils) affected by the activity will be notified at least five days prior to start of the activity.	Contractor / Transport for NSW project manager	Pre-construction	Standard safeguard	☐

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
GEN3	General – environmental awareness	All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the proposal. This will include up-front site induction and regular "toolbox" style briefings. Site-specific training will be provided to personnel engaged in activities or areas of higher risk. These include: • areas of Aboriginal heritage sensitivity • site location in or near a non-Aboriginal heritage area • threatened species habitat	Contractor / Transport for NSW project manager	Pre-construction / detailed design	Standard safeguard	☒
BIO1	Biodiversity	A Flora and Fauna Management Plan will be prepared in accordance with Transport for NSW's *Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects* (RMS, 2011) and implemented as part of the CEMP. It will include, but not be limited to: • plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas • requirements set out in the *Landscape Guideline* • pre-clearing survey requirements • procedures for unexpected threatened species finds and fauna handling • procedures addressing relevant matters specified in the *Policy and guidelines for fish habitat conservation and management* (DPI Fisheries, 2013) • protocols to manage weeds and pathogens.	Contractor	Pre-construction	Section 4.8 of QA G36 Environment Protection	☒
BIO2	Removal of native vegetation	Pre-clearing surveys will be undertaken within vegetation once slope access is established, to survey for the threatened Mountain Trachymene (*Trachymene scapigera*) and Needle Geebung (*Persoonia acerosa*). Confirmation of these species presence would then be fed into the offsetting requirements for the proposal.	Contractor	Pre-construction	Additional safeguard	☒
BIO3	Removal of native vegetation and associated habitat	Vegetation and habitat removal will be carried out in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Contractor	Construction	Additional safeguard	☒
BIO4	Removal of native vegetation	Parking options will be limited to existing hard stand areas, or within any area that is pavement/existing formation or mapped as cleared land.	Contractor	Construction	Additional safeguard	☐

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
BIO5	Removal of threatened fauna habitat	The unexpected species find procedure under *Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011a) will be followed if threatened fauna, not assessed in the biodiversity assessment, are identified in the proposal site.	Contractor	Construction	Additional safeguard	☒
BIO6	Edge effects on adjacent native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011b).	Contractor	Pre-construction	Additional safeguard	☒
BIO7	Injury and mortality of fauna	Fauna will be managed in accordance with *Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011c).	Contractor	Construction	Additional safeguard	☒
BIO8	Invasion and spread of weeds	Weed species will be managed in accordance with *Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011d).	Contractor	Construction	Additional safeguard	☒
BIO9	Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011b).	Contractor	Construction	Additional safeguard	☒
WAT1	Soil and water	Soil and water management will be prepared in accordance with *Managing Urban Stormwater: Soils and Construction*, Volume 1 and 2D (Landcom, 2004) (the 'Blue Book') and implemented as part of the CEMP. The soil and water aspects will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction. The CSWMP will be prepared by or reviewed and endorsed by a soil conservationist on the Transport for NSW list of Registered Contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services. The CSWMP will then be revised to address the outcomes of the review.	Contractor	Pre-construction	Section 2.1 of QA *G38 Soil and Water Management*	☒

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
WAT2	Soil and water	A site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the CEMP. The Plan/s will include arrangements for managing wet weather events, including monitoring of potential high risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather.	Contractor	Pre-construction	Section 2.2 of QA *G38 Soil and Water Management*	☒
WAT3	Erosion and sedimentation	All stockpiles will be designed, established, operated and decommissioned in accordance with Roads and Maritime Services' Stockpile Management Procedures.	Contractor	Pre-construction	Additional safeguard	☐
WAT4	Contamination of soils and waterways	An Incident Emergency Spill Plan will be developed and incorporated in the CEMP. The plan will include measures to avoid and manage spillage of fuels, chemicals, and fluids into any stormwater inlets and an emergency response procedure.	Contractor	Construction	Section 4.3 of QA G36 Environment Protection	☒
WAT5	Contamination of soils and waterways	Vehicle wash downs and/or concrete truck washouts will be carried out within a designated bunded area on an impervious surface or carried out off-site.	Contractor	Construction	Additional safeguard	☐
WAT6	Contamination of soils and waterways	Machinery will be checked daily to ensure there are no oil, fuels or other liquids leaking from the machinery.	Contractor	Construction	Additional safeguard	☒
WAT7	Contamination of soils and waterways	Refuelling of vehicles or machinery is to occur within a containment or hardstand area designed to prevent the escape of spilled substances to the surrounding environment.	Contractor	Construction	Additional safeguard	☐
SOIL1	Contaminated land	If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other work that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed.	Contractor	Construction	Section 4.2 of QA G36 Environment Protection	☒
SOIL2	Excavated material/spoil	A waste classification report will be required to assess the potential for material reuse or disposal in accordance with the POEO Act and the NSW EPA Waste Classification Guidelines.	Contractor	Construction	Additional safeguard	☐

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
SOIL3	Heavy rainfall management	Weather conditions will be monitored daily, and no work will be conducted if there is an imminent threat of a heavy rainfall event. In the event of a rainfall event, work will cease if there is a risk of sediment loss off site or ground disturbance due to waterlogged conditions.	Contractor	Construction	Additional safeguard	☒
SOIL4	Karst Landscapes	Where unexpected karst landscapes are encountered, the *Standard Management Procedure – Unexpected Heritage Items* (Transport for NSW, 2022) will be implemented to identify the best way forward for managing any potential impacts.	Contractor	Construction	Additional safeguard	☒
TT1	Traffic and transport	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Transport for NSW *Traffic Control at Work Sites Technical Manual* (Transport for NSW, 2022a) and *QA Specification G10 Control of Traffic* (Transport for NSW, 2008). The TMP will include: • confirmation of haulage routes • measures to maintain access to local roads and properties (as required) • site specific traffic control measures (including signage) to manage and regulate traffic movement • requirements and methods to consult and inform the local community of impacts on the local road network • access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads. • a response plan for any construction traffic incident • consideration of other developments that may be under construction, such as the works to be undertaken in the Jenolan Caves Precinct, to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • monitoring, review and amendment mechanisms.	Contractor	Pre-construction	Section 4.8 of QA G36 Environment Protection	☐
TT2	Heavy vehicle management	Equipment and materials will be delivered to the lay down area at Kanangra Road and transferred to the site in vehicles which can better negotiate the limitations along Jenolan Caves Road.	Contractor	Construction	Additional safeguard	☐

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
TT3	Property access impacts	Access to properties along Jenolan Caves Road will be available throughout construction. Where impacts are anticipated, consultation will be carried out with the affected property owner to confirm any access arrangements.	Contractor	Construction	Additional safeguard	☐
TT4	Impacts to existing car parks	Dilapidation reports are to be completed for all car park areas to be used by the proposal. Any damage to these areas will then be required to be repaired.	Contractor	Construction	Additional safeguard	☐
TT5	Emergency access	Emergency access will be provided at all times. An emergency response plan will be developed to identify the requirements and processes to ensure access through the proposal site will be available upon notification of an emergency situation. The plan will detail the specific requirements for each work area due to the differing nature of work at each location. This plan is to be developed in line with the requirements outlined in the Jenolan Caves Reserve Trust's emergency response plan (or similar).	Contractor	Construction	Additional safeguard	☒
NV1	Noise and vibration	A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim *Construction Noise Guideline* (ICNG) (DECC, 2009) and identify: • all potential significant noise and vibration generating activities associated with the activity • feasible and reasonable mitigation measures to be implemented, taking into account *Beyond the Pavement: urban design policy, process and principles* (Transport for NSW, 2014). • arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • contingency measures to be implemented in the event of non-compliance with noise and vibration criteria • management measures to minimise the potential noise impacts from the quantitative noise assessment and for potential work outside of standard working hours.	Contactor	Detailed design / pre-construction	Section 4.6 of QA G36 Environment Protection	☒
NV2	Construction noise	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.	Contractor	Construction	Additional safeguard	☐

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
NV3	Construction noise from machinery and equipment	All plant and equipment will be appropriately maintained to ensure optimum running conditions, with periodic monitoring.	Contractor	Construction	Additional safeguard	☒
NV4	Construction noise from machinery and equipment	Noise-emitting plant will be directed away from staff, where possible.	Contractor	Construction	Additional safeguard	☐
NV5	Construction noise from machinery and equipment	Traffic flow, parking and loading and unloading areas would be planned to minimise reversing movements within the proposal site.	Contractor	Construction	Additional safeguard	☐
NV6	Construction noise from machinery and equipment	Reversing alarms that have a tonal noise character are to be avoided during out of hours activities. Quacker style or 'smart' reversing alarms are to be used during night-time activities (pending safety approvals).	Contractor	Construction	Additional safeguard	☐
NV7	Construction noise from construction compound	Delivery vehicles will be fitted with straps rather than chains for unloading, wherever possible.	Contractor	Construction	Additional safeguard	☐
NV8	Construction noise from inappropriate practices	Site inductions will be provided to train staff on ways to minimise construction noise impacts on-site. Responsible working practices include: • avoid shouting and slamming of doors • where practical, operate machines at low speed or power and switch off when not being used rather than left idling for prolonged periods • minimise reversing • avoid dropping materials from height and avoid metal to metal contact on material.	Contractor	Construction	Additional safeguard	☒

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
NV9	Noise and vibration impact and appropriate complaints handling	The local community will be contacted and informed of the proposed work, location, duration of work, and hours involved. The contact would be made a minimum five days before work starts.	Contractor and Transport for NSW	Construction	Additional safeguard	☐
NV10	Vibration causing further slope failures	A monitoring procedure is to be developed and included in the CEMP to ensure that activities with intensive vibration (such as drilling of soil nails) do not result in further slope failure. The procedure will outline methods to adjust the installation method to reduce vibration impacts.	Contractor	Construction	Additional safeguard	☐
AH1	Aboriginal heritage	The *Standard Management Procedure – Unexpected Heritage Items* (Transport for NSW, 2022) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Transport for NSW does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contactor	Detailed design / pre-construction	Section 4.9 of QA G36 Environment Protection	☒
NAH1	Non-Aboriginal heritage	A Non-Aboriginal Heritage Management Plan (NAHMP) will be prepared and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented to avoid and mitigate impacts to Non-Aboriginal heritage.	Contactor	Pre-construction	Section 4.10 of QA G36 Environment Protection	☐
NAH2	Non-Aboriginal heritage	The Standard Management Procedure – Unexpected Heritage Items (Transport for NSW, 2022) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contactor	Construction	Section 4.10 of QA G36 Environment Protection	☒
NAH3	Non-Aboriginal heritage	The colour of the shotcrete is to be tinted to blend into the surrounding topography and vegetation.	Contractor	Construction	Additional safeguard	☐

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
NAH4	Non-Aboriginal heritage	The detailed design for the work should be reviewed against the existing SOHI by a suitably qualified heritage specialist to ensure that there are no additional impacts proposed by the work. If additional impacts are identified discussions with Heritage NSW would be undertaken to confirm whether any existing approvals provided are required to be modified under a Section 65A Modification Application.	Contractor	Pre-construction	Additional safeguard	☒
VIS1	Visual impacts due to shotcrete wall	Where required, shotcrete design will be based on the Shotcrete design guideline (Transport for NSW, 2023).	Contractor	Construction	Additional safeguard	☒
VIS2	Visual impacts due to shotcrete wall	Colour tinting of the shotcrete will blend in with the surrounding topography and adjacent natural stone surfaces. If the shotcrete is covering exposed rock, an unobtrusive, muted tone which fits the local context will be selected. Highly reflective colours will be avoided.	Contractor	Construction	Additional safeguard	☐
VIS3	Visual impacts due to shotcrete wall	The texture of shotcrete will mimic the adjacent landscape stone and blend into surrounding topography, such as having rough rather than smooth surfaces.	Contractor	Construction	Additional safeguard	☐
VIS4	Visual impacts due to shotcrete wall	The extent of shotcrete will be minimised where practicable, applying shotcrete precisely to unstable sections of slope and adapting its colour to match the local geology and/or surrounding vegetation.	Contractor	Construction	Additional safeguard	☐
VIS5	Visual impacts due to shotcrete wall	The application of shotcrete will finish or extend up to distinct edges, natural joints or changes in the face of the slope.	Contractor	Construction	Additional safeguard	☒
VIS6	Visual impacts due to shotcrete wall	Planting in key locations will be considered to help screen larger areas of visible exposed shotcrete.	Contractor	Construction	Additional safeguard	☒
VIS7	Visual impacts due to shotcrete wall	Salvaged woodland material (branches, logs, sandstone boulders) will be scattered over any disturbed areas to provide an edge transition.	Contractor	Construction	Additional safeguard	☒

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
VIS8	Impacts of gully failure	Damaged areas and edges of gully will be revegetated with mass planting of native grasses and low-mid height species to match surrounding vegetation. Native grass species that match surrounding vegetation will be used in grass-lined swales.	Contractor	Construction	Additional safeguard	☒
VIS9	Impacts of drainage infrastructure	Natural materials will be utilised where possible in drainage infrastructure, such as local stone (Sandstone) and/or planting with organic erosion control mesh, coir logs. Coloured concrete (earthy tones) will be considered where a paved solution is preferred.	Contractor	Construction	Additional safeguard	☒
LUP1	Use of compound areas	Site specific management plans would be developed in consultation with National Parks and Wildlife Service and Jenolan Caves Reserve Trust for the use of identified compound locations. These plans would include details of how these areas are to be used, what can be stockpiled, duration of any stockpiles, and other details needed to manage these areas as compound and stockpiling locations.	Contractor	Construction	Additional safeguard	☒
SE1	Socio-economic	A Communication Plan (CP) will be prepared and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CP will include (as a minimum): • mechanisms to provide details and timing of proposed activities to the community and access conditions • contact name and number for complaints. The CP will be prepared in accordance with the *Community Involvement and Communications Resource Manual* (RTA, 2008).	Contactor	Pre-construction	Standard safeguard	☐
SE2	Business impacts	Access into the Jenolan Caves Precincts for Jenolan Caves Trust staff and contractors is to be provided with no restrictions during the following periods: • Monday and Tuesday all day • Wednesday to Sunday before 7.30 am and after 5pm. Any changes to this access are to be notified with the Jenolan Caves Trust in advance and alternative arrangements made. Any additional access to the above would be discussed with the Jenolan Caves Trust.	Contractor	Construction	Additional safeguard	☐

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
OTH1	Air quality	Air quality will be managed and implemented as part of the CEMP. The CEMP will include, but not be limited to: • potential sources of air pollution • air quality management objectives consistent with any relevant published EPA and/or OEH guidelines • mitigation and suppression measures to be implemented • methods to manage work during strong winds or other adverse weather conditions • a progressive rehabilitation strategy for exposed surfaces.	Contractor	Pre-construction	Section 4.4 of QA G36 Environment Protection	☒
OTH2	Waste	A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to: • measures to avoid and minimise waste associated with the proposal • classification of wastes and management options (re-use, recycle, stockpile, disposal) • statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • procedures for storage, transport and disposal • monitoring, record keeping and reporting. The WMP will be prepared taking into account the *Waste management guideline* (Transport for NSW, 2023) and relevant Transport for NSW Waste Fact Sheets.	Contractor	Pre-construction	Section 4.2 of QA G36 Environment Protection	☐
OTH3	Bushfire	Consultation with NPWS, Rural Fire Service and other emergency services is to be carried out throughout construction to advise of any access changes.	Contractor	Construction	Additional safeguard	☒
OTH4	Hazards and risk management	A Hazard and Risk Management Plan (HRMP) will be prepared and implemented as part of the CEMP. The HRMP will include, but not be limited to: • details of hazards and risks associated with the activity • measures to be implemented during construction to minimise these risks • record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials	Contractor	Pre-construction	Standard safeguard	☒

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference	NPWS
		• a monitoring program to assess performance in managing the identified risks • contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.				

7.3 Licensing and approvals

Table 7.2 outlines the licences and approvals which are required for the proposal.

Table 7.2: Summary of licensing and approvals required

Instrument	Requirement	Timing
Heritage Act 1977 (s60)	Permit to carry out activities to an item listed on the State Heritage Register or to which an interim heritage order applies from the Heritage Council of NSW.	Prior to start of the activity.
National Parks and Wildlife Act 1974 (s90)	Authorisation to undertake works within the Jenolan Karst Conservation Reserve.	Prior to start of the activity.

8. Conclusion

This chapter provides the justification for the proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the proposal is in the public interest. The proposal is also considered in the context of the objectives of the EP&A Act, including the principles of ecologically sustainable development as defined in Section 193 of the Environmental Planning and Assessment Regulation 2021.

8.1 Justification

Since March 2021, access into the Jenolan Caves Precinct has been impacted due to numerous slope failures along Jenolan Caves Road. This was further impacted by various rainfall events which commenced in July 2022 and continued into 2023 which resulted in the failures subject to this REF. This has resulted in some restrictions to access into the Precinct including traffic management measures additional to those already implemented following the March 2021 slope failures. The introduction of a 'travel under pilot vehicle only' for movements down the Two Mile section has resulted in increased travel times due to the requirement to wait for the pilot vehicle. This, coupled with other restrictions to vehicular access into the Jenolan Caves Precincts due to previous slope failures has become somewhat inconvenient particularly for those less mobile visitors.

The proposal would result in the ability to reopen public vehicular access down the Two Mile section without the need for a pilot vehicle. The proposal would also reduce the risk of future failures which if they were to occur would result in the Jenolan Caves Precinct being inaccessible until either the Two Mile or the Five Mile sections of Jenolan Caves Road are reinstated. The maintenance of at least one access provides benefits to businesses operating out of the Jenolan Caves Precinct due to the improved accessibility of the Precinct. This reinstatement of access would ensure this key tourist destination within the Oberon LGA can operate more efficiently and draw increased visitors into the LGA.

The proposal would remove the safety risks associated with the restricted use of this section of Jenolan Caves Road. The proposal would also stabilise the areas of slope failures which are currently at risk of further slope failure. This work would reduce the potential for movement of sediment into the downslope receiving waters and as a result, affecting the water quality within part of Sydney's Drinking Water Catchment.

The majority of the proposal is located on land managed by Transport for NSW. A portion of the proposal is located on National Parks Estate within the Jenolan Karst Conservation Reserve. While there is limited work directly on National Parks Estate, the proposal has the potential to impact on the adjacent areas of the estate. A summary of impacts relevant to the proposal on National Parks land is provided in Table 8.1.

Table 8.1: Summary of National Park impacts

Category of impact	Significance of impacts		
	Extent of impact	Nature of impact	Environmentally sensitive features
Physical and chemical	Short term - low adverse	• Potential erosion and sedimentation of surrounding vegetation and watercourses • Contamination of soil or water due to spills and leaks • Generation of dust and noise	• Steep slope • Watercourses • Native vegetation • Sydney Drinking Water Catchment
Physical and chemical	Long term - positive	• Stabilising existing slopes	• Jenolan Caves Precinct, including accommodation
Biological	Short term - low adverse	• Potential clearance of native vegetation (not threatened) • Impacts on habitat for threatened species.	• Native vegetation • Jenolan Karst Conservation Reserve • Threatened species found at the site

Category of impact	Significance of impacts		
	Extent of impact	Nature of impact	Environmentally sensitive features
Biological	Long term - positive	• Stabilising the slopes would prevent any future failures, thus minimising impacts on other surrounding vegetation and vegetation down slope	• Native vegetation • Jenolan Karst Conservation Reserve
Natural resources	Short term - low adverse	• Impacts on access to the Jenolan Karst Conservation Reserve due to road closures during construction	• Watercourses • Native vegetation • Sydney Drinking Water Catchment
Natural resources	Long term - positive	• Improved access into the Jenolan Karst Conservation Reserve	• Jenolan Karst Conservation Reserve • Watercourses • Native vegetation • Sydney Drinking Water Catchment
Community	Short term – low adverse	• Road closures and closure of Jenolan Caves Precinct • Impacted access to Jenolan Caves Precinct and flow on impact on tourism including visitor numbers	• Jenolan Caves Precinct including accommodation
Community	Long term – low adverse	• Introduction of new man-made structure into the natural visual environment, though its design reduces the dominance of this structure	• Jenolan Caves Precinct including accommodation
Community	Long term - positive	• Stabilising would allow existing road to reopen with no traffic management, improving access to the Jenolan Caves Precinct • Improvement to public safety through stabilising the slope	• Jenolan Caves Precinct including accommodation
Cultural heritage	Nil (Aboriginal heritage)	• Nil	• State Heritage Listed Jenolan Caves Reserve
Cultural heritage	Long term - Low adverse (non-Aboriginal heritage)	• Introduction of new man-made structure into natural environment forming part of heritage listing	• State Heritage Listed Jenolan Caves Reserve

8.2 Objects of the EP&A Act

Object	Comment
1.3(a) To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources.	The proposal would allow improved vehicular access into the Jenolan Caves Precinct through the removal of some traffic management measures which currently increase the time needed to access the Precinct. Such delays may be resulting in lower visitation into the Precinct, impacting on the businesses in this location. The proposal would also seek to reduce the risk of further slope failures thus allowing the Two Mile section to remain open as it is the only current access into the Jenolan Caves Precinct.
1.3(b) To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment.	Details of how the proposal meets the principles of ecologically sustainable development are outlined in section 8.2.1.
1.3(c) To promote the orderly and economic use and development of land.	The proposal would allow improved vehicular access into the Jenolan Caves Precinct through the removal of some traffic management measures which currently increase the time needed to access the Precinct. Such delays may be resulting in lower visitation into the Precinct, impacting on the businesses in this location. The proposal would also seek to reduce the risk of further slope failures thus allowing the Two Mile section to remain open as it is the only current access into the Jenolan Caves Precinct.
1.3(d) To promote the delivery and maintenance of affordable housing.	Not relevant to the proposal.
1.3(e) To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats.	The proposal would involve the clearing of native vegetation and the removal of eight hollow bearing trees and fauna habitat. There would be no clearance of threatened vegetation communities. Although the presence of two threatened flora species with potential to be present could not be tested due to safety issues in accessing the slope areas, no threatened species were recorded on site. Therefore, no significant impact to threatened species is anticipated as a result to the clearing proposed. The proposal would also have a long-term benefit in that it reduces the risk of further failures which have the potential to result in the loss of vegetation in the event of a more substantial failure of the slope.
1.3(f) To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).	The proposal would not impact Aboriginal heritage and would have a minor visual impact on items of non-Aboriginal heritage significance. Refer to section 6.6 and section 6.7 respectively.
1.3(g) To promote good design and amenity of the built environment.	The proposal would incorporate design features to reduce the visual impact of the proposal on the surrounding natural and built environment.
1.3(h) To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants.	Not relevant to the proposal.

Object	Comment
1.3(i) To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State.	Not relevant to the proposal.
1.3(j) To provide increased opportunity for community participation in environmental planning and assessment.	Due to the small-scale of the proposal and its nature as a maintenance activity to ensure ongoing use of the existing access to the Jenolan Caves Precinct, limited consultation has been carried out to date. However, the community would be well informed of the work throughout construction to ensure impacts are minimised, where possible.

8.2.1 Ecologically sustainable development

Ecologically sustainable development (ESD) is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The principles of ESD have been an integral consideration throughout the development of the proposal.

ESD requires the effective integration of economic and environmental considerations in decision-making processes. The four main principles supporting the achievement of ESD are discussed below.

The precautionary principle

The precautionary principle deals with reconciling scientific uncertainty about environmental impacts with certainty in decision-making. It provides that where there is a threat of serious or irreversible environmental damage, the absence of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation.

This principle was considered during options development (refer to Chapter 2). The precautionary principle has guided the assessment of environmental impacts for this REF and the development of mitigation measures.

The preferred option was selected as it provides the security to ensure that at least one access into the Jenolan Caves Precinct is available and that further slope failures along the Two Mile section do not result in this access also being lost. The preferred option is not considered the long-term solution but more the solution which provides the security for the existing access until the primary access via the Five Mile stretch is restored.

The proposal does not pose a risk of serious or irreversible environmental damage. Adverse impacts associated with the proposal would be short-term and minor. Measures to reduce adverse impacts as far as practicable have also been identified within this REF.

Best available technical information, environmental standards and measures have been used to minimise environmental risks. These include several safeguards that have been proposed to minimise potential impacts. These safeguards would be implemented during construction and operation of the proposal, as applicable. No safeguards have been postponed because of lack of scientific certainty.

A CEMP would be prepared before construction starts. This requirement would ensure the proposal achieves a high-level of environmental performance. No mitigation measures or management mechanisms would be postponed because of a lack of information.

Intergenerational equity

Social equity is concerned with the distribution of economic, social and environmental costs and benefits. Inter-generational equity introduces a temporal element with a focus on minimising the distribution of costs to future generations.

The proposal would not result in any impacts that are likely to adversely impact on the health, diversity or productivity of the environment for future generations. Economic benefits are anticipated from the proposal by encouraging more visitors and sustained tourism to the Jenolan Caves Precinct through reinstating a more efficient access route than the currently restricted access arrangements. Therefore, the proposal would improve access to the Jenolan Caves Precinct and Jenolan Karst Conservation Reserve, which is an important asset for environmental conservation and recreational tourism in the Oberon local government area.

The proposal would improve access to the Jenolan Caves Precinct which is an important tourism asset identified in the *Central West and Orana Regional Plan 2026* (NSW Government 2017) and improve road safety as per an objective of the *Long-Term Transport Master Plan* (Transport for NSW, 2014).

Conservation of biological diversity and ecological integrity

The environment in which the proposal would be carried out is a group of roadside hillslopes which have been subject to slope failure. A thorough assessment of the existing local environment was carried out to identify and manage any potential impacts of the proposal on local biodiversity.

The proposal would not have a significant impact on biological diversity and ecological integrity. An assessment of the biodiversity impacts and appropriate site-specific safeguards are provided in section 6.1. The proposal would also have a long-term benefit in that it reduces the risk of further failures which have the potential to result in the loss of vegetation in the event of a more substantial failure of the slope. The proposal would also improve water quality in downstream watercourses by stablising the existing exposed slopes and also reducing the risk of further larger failures.

An assessment of section 171 of the EP&A Regulation factors that broadly considers biological diversity and ecological integrity of the proposal area has been included in Appendix B.

Improved valuation, pricing and incentive mechanisms

The principle of internalising environmental costs into decision making needs consideration of all environmental resources which may be affected by the carrying out of a proposal, including air, water, land and living things.

The REF has examined the environmental consequences of the proposal and identified mitigation measures to manage the potential for adverse impacts. The requirement to implement these mitigation measures would result in an economic cost to Transport for NSW. The implementation of mitigation measures would increase both the capital and operating maintenance costs of the proposal. This signifies that environmental resources have been given appropriate valuation for the proposal.

The proposal has value for the community as it would improve safety for all road users in the area, including both local community residents and visitors. The proposal would assist in preventing future landslips in an area which has experienced various slope failures during recent heavy rainfall events.

The design has been developed with an objective of minimising potential impacts on the surrounding environment. This indicates that the proposal is being developed with an environmental objective in mind.

8.3 Conclusion

The proposed restoration of eight slope failure locations on the Two Mile section of Jenolan Caves Road is subject to assessment under Division 5.1 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

This has included consideration (where relevant) of conservation agreements and plans of management under the NPW Act, biodiversity stewardship sites under the BC Act, wilderness areas, areas of outstanding value, impacts on threatened species and ecological communities and their habitats and other protected fauna and native plants. It has also considered potential impacts to matters of national environmental significance listed under the Federal EPBC Act.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design development and options assessment. The proposal as described in the REF best meets the proposal objectives but would still result in some impacts on water quality, biodiversity and non-Aboriginal heritage. Safeguards and management measures as detailed in this REF would ameliorate or minimise these expected impacts. The proposal would also improve safety for road users along the section of Jenolan Caves Road and reinstate access for the public into the Jenolan Caves Precinct without the need for traffic control. On balance the proposal is considered justified and the following conclusions are made.

Significance of impact under NSW legislation

The proposal would be unlikely to cause a significant impact on the environment. Therefore, it is not necessary for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Division 5.2 of the EP&A Act. A Biodiversity Development Assessment Report or Species Impact Statement is not required. The proposal is subject to assessment under Division 5.1 of the EP&A Act. Consent from Council is not required.

Significance of impact under Australian legislation

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Australian Department of Climate Change, Energy, the Environment and Water is not required.

9. Certification

This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.



Ben James

Senior Environmental Planner

GHD Pty Ltd

Date: 04/11/2024

I have examined this review of environmental factors and accept it on behalf of Transport for NSW.

Name:

Position: Senior Project Manager

Transport for NSW – Western Region:

Date: 19/11/2024

10. References

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Terms and acronyms used in this REF

Term / Acronym	Description
BC Act	Biodiversity Conservation Act 2016 (NSW).
Biodiversity and Conservation SEPP	State Environmental Planning Policy (Biodiversity and Conservation) 2021
CEMP	Construction environmental management plan
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
ESD	Ecologically sustainable development. Development which uses, conserves and enhances the resources of the community so that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased.
FM Act	Fisheries Management Act 1994 (NSW)
FoS	Factor of Safety
GBMWHA	Greater Blue Mountains World Heritage Area
Heritage Act	Heritage Act 1977 (NSW)
ILUA	Indigenous Land Use Agreement
Jenolan Caves Precinct	The area which contains the Jenolan Caves and associated tourist facilities
Jenolan Caves Reserve Trust	The management body of the Jenolan Caves environment and tourism.
LEP	Local Environmental Plan. A type of planning instrument made under Part 3 of the EP&A Act.
LGA	Local government area
NPW Act	National Parks and Wildlife Act 1974 (NSW)
NSW NPWS	NSW National Parks and Wildlife Service
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation
POEO Act	*Protection of the Environment Operations Act 1997*
Roads and Maritime	NSW Roads and Maritime Services, now known as Transport for NSW

Term / Acronym	Description
SEPP	State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act.
Transport and Infrastructure SEPP	State Environmental Planning Policy (Transport and Infrastructure) 2021

Appendix A
Design plans

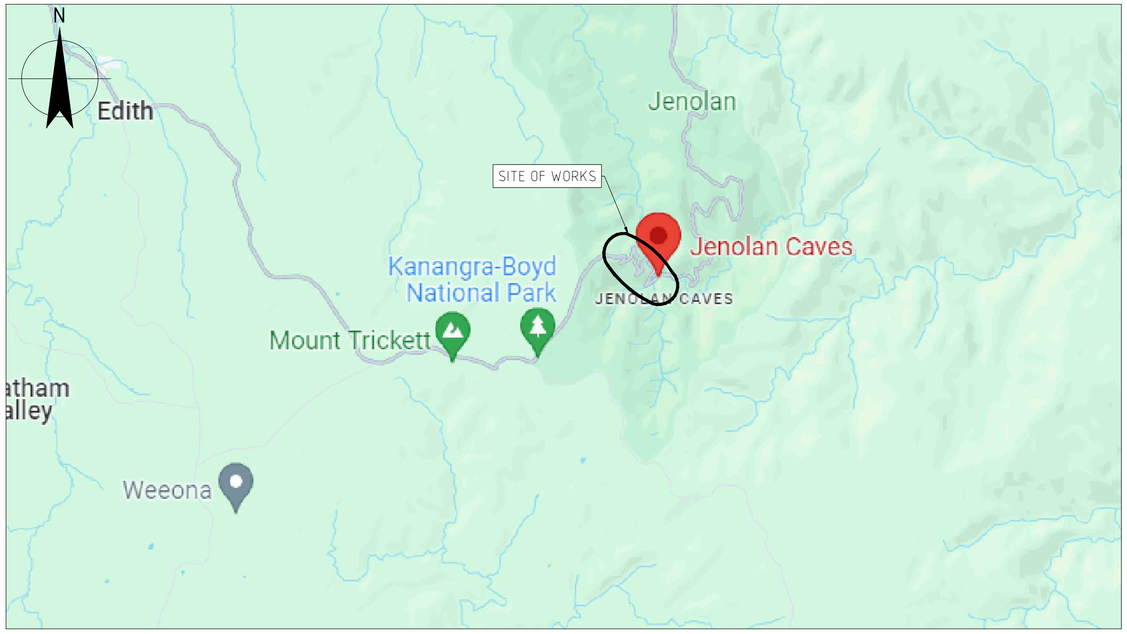
SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD

TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)

SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

ISSUED FOR CONSTRUCTION



LOCALITY PLAN

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD | DESIGN LOT CODE: --

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SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
COVER SHEET

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DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-GN-00001				

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12825782-GHD-DD-DRG-CI-00051	TYPICAL DETAILS - GEOTECHNICAL SHOTCRETE AND SOIL NAIL ARRANGEMENT - SHEET 1 OF 3
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12825782-GHD-DD-DRG-CI-00381	CROSS SECTIONS - SHEET 1 OF 4
12825782-GHD-DD-DRG-CI-00382	CROSS SECTIONS - SHEET 2 OF 4
12825782-GHD-DD-DRG-CI-00383	CROSS SECTIONS - SHEET 3 OF 4
12825782-GHD-DD-DRG-CI-00384	CROSS SECTIONS - SHEET 4 OF 4
GEOTECHNICAL FAILURE SITE 5	
12825782-GHD-DD-DRG-CI-00401	TYPICAL SECTION
12825782-GHD-DD-DRG-CI-00431	GENERAL ARRANGEMENT PLAN
12825782-GHD-DD-DRG-CI-00481	CROSS SECTIONS - SHEET 1 OF 2
12825782-GHD-DD-DRG-CI-00482	CROSS SECTIONS - SHEET 2 OF 2
GEOTECHNICAL FAILURE SITE 6	
12825782-GHD-DD-DRG-CI-00501	TYPICAL SECTION
12825782-GHD-DD-DRG-CI-00531	GENERAL ARRANGEMENT PLAN
12825782-GHD-DD-DRG-CI-00581	CROSS SECTIONS - SHEET 1 OF 2
12825782-GHD-DD-DRG-CI-00582	CROSS SECTIONS - SHEET 2 OF 2
GEOTECHNICAL FAILURE SITE 7	
12825782-GHD-DD-DRG-CI-00601	TYPICAL SECTION
12825782-GHD-DD-DRG-CI-00631	GENERAL ARRANGEMENT PLAN
12825782-GHD-DD-DRG-CI-00681	CROSS SECTIONS - SHEET 1 OF 2
12825782-GHD-DD-DRG-CI-00682	CROSS SECTIONS - SHEET 2 OF 2
GEOTECHNICAL FAILURE SITE 8	
12825782-GHD-DD-DRG-CI-00701	TYPICAL SECTION
12825782-GHD-DD-DRG-CI-00731	GENERAL ARRANGEMENT PLAN
12825782-GHD-DD-DRG-CI-00781	CROSS SECTIONS - SHEET 1 OF 2
12825782-GHD-DD-DRG-CI-00782	CROSS SECTIONS - SHEET 2 OF 2
DRAINAGE CULVERT FAILURE SITE 1A	
12825782-GHD-DD-DRG-CI-00831	GENERAL ARRANGEMENT PLAN
12825782-GHD-DD-DRG-CI-00851	LONGITUDINAL SECTIONS, TYPICAL DETAILS AND CROSS SECTIONS - CULVERT 1A - SHEET 1 OF 1
12825782-GHD-DD-DRG-CI-00871	TYPICAL DETAILS AND CROSS SCTIONS - CULVERT 1A

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: N/A

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DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

DRAWING INDEX

DRAWING SET No: -	PART:	SHEET: 1 OF 2	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12825782-GHD-DD-DRG-GN-00002				

FILE NAME: 21-12825782-GHD-DD-DRG-GN-00002.dwg

PLOT DATE & TIME: 10/10/2024 7:18:11 PM

DRAWING INDEX	
DRAWING NUMBER	DRAWING TITLE
DRAINAGE CULVERT FAILURE SITE 1A	
12625762-GHD-DD-DRG-CI-00891	CROSS SECTION - SHEET 1 OF 6
12625762-GHD-DD-DRG-CI-00892	CROSS SECTION - SHEET 2 OF 6
12625762-GHD-DD-DRG-CI-00893	CROSS SECTION - SHEET 3 OF 6
12625762-GHD-DD-DRG-CI-00894	CROSS SECTION - SHEET 4 OF 6
12625762-GHD-DD-DRG-CI-00895	CROSS SECTION - SHEET 5 OF 6
12625762-GHD-DD-DRG-CI-00896	CROSS SECTION - SHEET 6 OF 6
DRAINAGE CULVERT FAILURE SITE 1	
12625762-GHD-DD-DRG-CI-00931	GENERAL ARRANGEMENT PLAN
12625762-GHD-DD-DRG-CI-00951	LONGITUDINAL SECTIONS, TYPICAL DETAILS AND CROSS SECTIONS - CULVERT 1
12625762-GHD-DD-DRG-CI-00971	TYPICAL DETAILS AND CROSS SECTIONS - CULVERT 1 - SHEET 1 OF 1
DRAINAGE CULVERT FAILURE SITE 3	
12625762-GHD-DD-DRG-CI-01031	GENERAL ARRANGEMENT PLAN
12625762-GHD-DD-DRG-CI-01051	LONGITUDINAL SECTIONS, TYPICAL DETAILS AND CROSS SECTIONS - CULVERT 3
12625762-GHD-DD-DRG-CI-01071	TYPICAL DETAILS AND CROSS SECTIONS - CULVERT 3 - SHEET 1 OF 1

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: N/A

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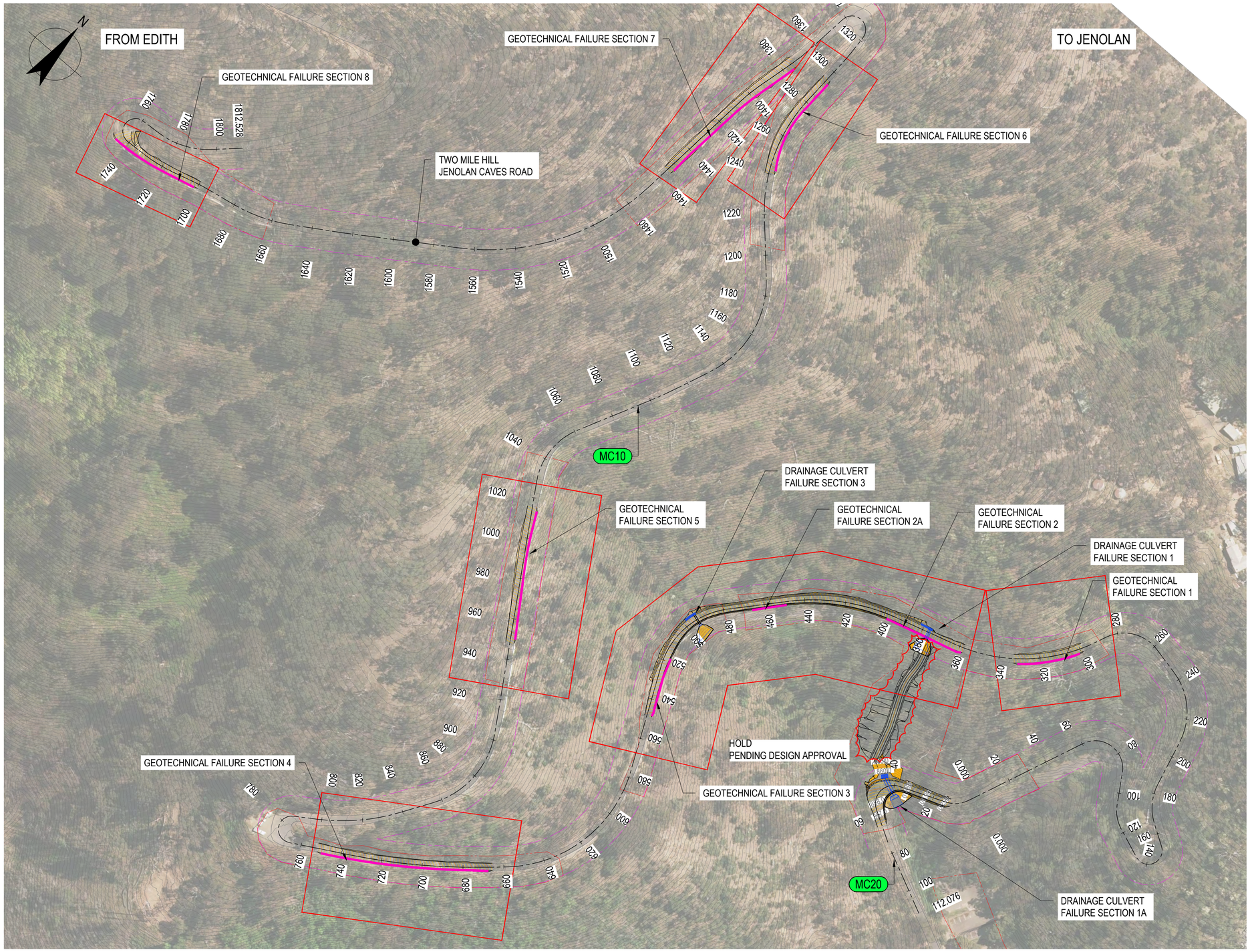
DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
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SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

DRAWING INDEX

DRAWING SET No: -	PART:	SHEET: 2 OF 2		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-GN-00003	REV	VER	EDMS No.	AMD No.



LEGEND

- 1560 - CHAINAGES
- MC10
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD DESIGN
- APPROXIMATE EXTENTS OF GEOTECHNICAL FAILURE AREAS
- TfNSW BOUNDARY
- REF PROJECT SITE
- DRAINAGE CULVERT FAILURES

NOTES:

1. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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SCALE: 1:1000

0 10 20 30m

SCALE 1:1000 AT ORIGINAL SIZE

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SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

OVERVIEW PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-GN-00004	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-GN-00004.dwg

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GENERAL NOTES

1. THESE DESIGN DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE TWO MILE NATURAL DISASTER RESTORATION (MR253) DETAILED DESIGN REPORT (REF: 12625762-CV-RPT-0001)
2. EXTENT OF REMEDIATION TREATMENT AND CHAINAGES ARE APPROXIMATE ONLY AND SHALL BE CONFIRMED ON SITE PRIOR TO COMMENCEMENT OF CONSTRUCTION WORKS.
3. THE GEOLOGICAL PROFILE AND GEOTECHNICAL CONDITIONS SHOWN ON DRAWINGS ARE INDICATIVE, AND HAVE BEEN INFERRED FROM LIMITED INVESTIGATIONS. SHOULD THE ENCOUNTERED GEOLOGICAL PROFILE AND GEOTECHNICAL CONDITIONS DIFFER, THE DESIGN SHALL BE REVIEWED FOR APPLICABILITY TO ENCOUNTERED CONDITIONS.
4. PRIOR TO CONSTRUCTION SITE SET-UP, THE CONTRACTOR SHALL SUBMIT THE FOLLOWING TO THE PRINCIPAL FOR REVIEW AND ACCEPTANCE:
   a. ALL SAFE WORKING METHOD STATEMENTS AND PLANS.
   b. TRAFFIC CONTROL AND CONSTRUCTION STAGING PLANS.
   c. ALL SHOP DRAWINGS.
   d. SOIL NAIL PRODUCT DETAILS AND INSTALLATION METHOD.
   e. STEEL MESH AND SOIL NAIL DETAILS AND PLANNED INSTALLATION METHOD.
   f. GROUT MIX PROPORTIONS, TYPES OF ADDITIVES/ADMIXTURES (IF USED) AND TEST RESULTS DEMONSTRATING COMPLIANCE WITH COMPRESSIVE STRENGTH REQUIREMENTS ON THESE DRAWINGS.
   g. SELF-DRILLING HOLLOW NAIL INSTALLATION METHODOLOGY MUST BE PROVIDED AND APPROVED BY TfNSW PRIOR TO SITE WORKS COMMENCING.
5. SITE COMPOUND, ACCESS OR OTHER AREAS OUTSIDE OF THE TREATMENT WORKS EXTENTS ARE TO BE REINSTATED TO THE ORIGINAL CONDITION POST CONSTRUCTION.
6. REFER DISCREPANCIES TO THE PRINCIPAL BEFORE PROCEEDING WITH WORK.
7. THE NOTICE PERIOD FOR HOLD POINTS AND WITNESS POINTS MUST BE AS PER THE SPECIFICATIONS. THIS IS NOT ALWAYS 2 WORKING DAYS
8. INSPECTIONS AND REVIEWS UNDERTAKEN BY THE PRINCIPAL OR OTHERS DO NOT RELIEVE THE CONTRACTOR OF RESPONSIBILITY FOR COMPLIANCE WITH DRAWINGS.
9. DO NOT OBTAIN DIMENSIONS BY SCALING FROM DRAWINGS.
10. EXISTING STRUCTURES SHOWN ON DRAWINGS ARE IN APPROXIMATE LOCATIONS ONLY.
11. CONTRACT SOIL NAIL LENGTHS AND NUMBERS PROVIDED BELOW, TO BE CONFIRMED DURING CONSTRUCTION. THE CONTRACTOR SHALL MAKE ALLOWANCE IN THE METHODOLOGY AND SUPPLY CHAIN FOR VARIATIONS IN GROUND CONDITIONS AND SUBSEQUENT SOIL NAIL NUMBERS AND LENGTH CHANGES TO ACHIEVE THE MINIMUM SOCKET REQUIREMENTS NOMINATED. R40 DRAINS AND SHOTCRETE EXTENTS MAY ALSO VARY.
12. NO KNOWN SERVICES ARE LOCATED WITHIN THE WORK SITE. CONTRACTOR TO CONFIRM BY ADOPTING INDEPENDENT SERVICES SEARCHES AND CONSTRUCTION PROTOCOLS.

SAFETY IN DESIGN

1. THE SAFETY RISK MITIGATION ITEMS BELOW ARE BASED ON GHD'S DESIGN OFFICE EXPERIENCE AND DO NOT NECESSARILY ACCOUNT FOR ALL CONSTRUCTION, OPERATION, MAINTENANCE AND DEMOLITION SAFETY RISKS. BASED ON INFORMATION AVAILABLE WHEN THIS DRAWING WAS MADE, IN ITS CAPACITY AS DESIGNER ONLY, GHD HAS TRIED TO IDENTIFY SAFETY RISKS PERTAINING TO CONSTRUCTION, OPERATION, MAINTENANCE AND DEMOLITION PHASES OF THE ASSET. INCLUSION (OR NOT) OF ANY ITEM DOES NOT REDUCE OR LIMIT OBLIGATIONS OF CONSTRUCTOR, USER, MAINTAINER AND DEMOLISHER TO UNDERTAKE APPROPRIATE RISK MANAGEMENT ACTIVITIES TO REDUCE RISK AND IS NOT AN ADMISSION BY GHD THAT INCLUSION OF ANY ITEM IS DESIGNER'S RESPONSIBILITY.
2. REVIEW ADEQUACY OF WORKING SPACE AVAILABLE FOR CONSTRUCTION ACTIVITIES. ENSURE SEPARATION OF PLANT AND PERSONNEL ON SITE, INCLUDING MOVEMENTS OF BOTH.
3. ALL PERSONNEL OPERATING AND WITHIN THE ELEVATED WORKING PLATFORM SHALL BE SUITABLY QUALIFIED AND EXPERIENCED.
4. PROVIDE PROTECTION TO PERSONNEL AND THE PUBLIC FROM PLANT, EQUIPMENT AND CONSTRUCTION ACTIVITIES PROVIDING ADEQUATE TRAFFIC MANAGEMENT MEASURES WHERE REQUIRED.
5. ENSURE ISOLATION SAFE SYSTEMS OF WORK OR PROTECTIVE MEASURES ARE INSTALLED BEFORE WORKING NEAR LIVE ELECTRICAL INFRASTRUCTURE. PROVIDE PROTECTION OF ELECTRICAL OVERHEAD WIRING SYSTEMS DURING CONSTRUCTION (AS APPLICABLE).
6. SAFE DISTANCE AND PROTECTION MEASURES TO BE IN PLACE FROM FALLING DEBRIS DURING TRIMMING AND SCALING WORKS.

SOIL NAILS

1. SOIL NAILS TO BE IN ACCORDANCE WITH TfNSW QA SPECIFICATION R64. THE ONLY EXCEPTION TO R64 WILL BE THE USE OF SELF-DRILLING SOIL NAILS IN PLACE OF DOUBLE ENCAPSULATED SOIL NAILS.
2. SOIL NAILS TO BE DRILLED TO DEPTHS AS PER DESIGN DOCUMENTATION WITH MINIMUM SPECIFIED BONDED LENGTHS ACHIEVED.
3. DRILLING FOR SOIL NAILS MAY ENCOUNTER MEDIUM TO HIGH STRENGTH, BOULDERS, COBBLES,VERY LOOSE COLLUVIUM (SAND) AND UNCONTROLLED FILLING (SAND), MEDIUM DENSE RESIDUAL GRAVELS, AND / OR MEDIUM DENSE TO DENSE EXTREMELY WEATHERED MATERIAL. SELECTION OF DRILLING EQUIPMENT TO BE SUITABLE FOR EXPECTED GROUND CONDITIONS.
4. VARIATIONS IN DRILLING METHODS REQUIRE PRIOR APPROVAL FROM PROJECT PRINCIPAL.
5. MINIMUM SOIL NAIL DIAMETER - 120mm FOR ALL SOIL NAILS.
6. CENTRALISERS TO BE A MAXIMUM OF 2m CENTRES WITH A MINIMUM OF 3 CENTRALISERS REQUIRED FOR EACH NAIL. TESTING PROCEDURE AND NOTES WHERE SPECIFIED:
   a. SOIL NAIL TESTING TO BE CONDUCTED IN ACCORDANCE WITH R64.
   b. CONTRACTOR TO CONFIGURE TEST SOIL NAILS (INCLUDING NAIL DIAMETER AND BEARING PLATE) TO ENSURE 200% OF THE WORKING BOND STRESS CAN BE ACHIEVED PRIOR TO 80% OF THE BAR YIELD LOAD.
   c. A TOTAL OF 1% OF THE NUMBER OF PERMANENT NAILS, BUT NOT LESS THAN 2 SHALL BE ASSESSED BY SUITABILITY TESTS. TESTS SHALL BE CONDUCTED AT LOCATIONS NOMINATED BY THE PRINCIPAL'S REPRESENTATIVE.
   d. A TOTAL OF 3% OF PERMANENT NAILS SHALL BE SUBJECTED TO ACCEPTANCE TESTS AT LOCATIONS NOMINATED BY THE PRINCIPAL'S REPRESENTATIVE.
7. CONSTRUCTION CONFORMITY RECORDS ARE TO BE COMPLETED AS PER R64.

CEMENT GROUT

1. GROUTS FOR SOIL NAILS TO BE IN ACCORDANCE WITH TfNSW QA SPECIFICATION R64.
2. GROUT FLUIDITY BLEED AND COMPRESSIVE STRENGTH TESTING TO BE IN ACCORDANCE WITH TfNSW R64 CLAUSE 3.4.3.
3. 28 DAY COMPRESSIVE STRENGTH - 40MPA.

SHOTCRETE

1. SHOTCRETE TO BE IN ACCORDANCE WITH TfNSW R68.
2. MINIMUM COMPRESSIVE STRENGTH OF SHOTCRETE MUST BE 40MPa AT 28 DAYS.
3. SHOTCRETE MIX DESIGN TO EXPOSURE CLASSIFICATION B2 IN ACCORDANCE WITH TfNSW R64 CLAUSE 2.3.3 AND AS5100.5-2017.
4. SHOTCRETE QUALITY TESTING IN ACCORDANCE WITH TfNSW R68 CLAUSE 8.5 AND ANNEXURE R68/L.
5. SHOTCRETE FINISH REQUIRED - TBC BY TfNSW PENDING FINALISATION OF REF AND SECTION 60 APPROVAL.

SLOPE DRAINAGE

1. 150mm HDPE STRIP FILTER DRAIN TO BE IN ACCORDANCE WITH TfNSW R3557.
2. HORIZONTAL DRAINS TO BE INSTALLED AT 3 DEGREES AND IN ACCORDANCE WITH TfNSW R40.
3. DRILLING FOR SUB-HORIZONTAL DRAINS TO BE ROTARY OR ROTARY PERCUSSION. DO NOT USE DRILLING LUBRICANTS OTHER THAN AIR OR WATER. HOLES MUST BE CLEAN AND SMOOTH.
4. MAXIMUM PERMISSIBLE DEVIATION OF THE HOLE MUST NOT EXCEED 2° (AS MEASURED ON A HORIZONTAL PLANE). DEVIATION FROM STRAIGHT MUST NOT EXCEED 25mm IN ANY 2m LENGTH OF HOLE.

REINFORCEMENT

1. REINFORCEMENT AND ANCHOR BARS FOR FIXING TO BE IN ACCORDANCE WITH TfNSW R64
2. MESH LAPS TO AT LEAST OVERLAP THE TWO OUTERMOST WIRES OF EACH SHEET BY 25mm SUCH AT THE MINIMUM LAP FOR SL81 IS 125mm. LAP LENGTHS ARE TO BE BASED ON THE LARGEST MESH SPACING.

CIVIL WORKS

1. CIVIL SCOPE HAS BEEN BASED ON POST-FAILURE LIDAR SURVEY. LOCAL ADJUSTMENT MAY BE REQUIRED FOR CULVERT INLET AND OUTLET STRUCTURES TO SUIT GROUND PROFILE AND CONDITIONS.
2. SURFACE WATER TO BE DISCHARGED INTO THE EXISTING STORMWATER SYSTEM NEAR THE TOP CAR PARK (CAR PARK 2).
3. FOR CULVERT INSTALLATION REFER TO TfNSW STANDARD DRAWINGS R0240-01
4. CARE IS TO BE TAKEN WITH LEVELS OF STORMWATER INFRASTRUCTURE. GRADE SHOWN ARE NOT TO BE REDUCED WITHOUT APPROVAL.
5. EXTENT OF WORKS INCLUDING SURVEY OF LOCAL SITE CHAINAGE SYSTEM, SET OUT OF SOIL NAIL AND DRAINAGE STRUCTURES INCLUDING ADJUSTMENT FOR CLASHES - REFER DRAINAGE LAYOUT PLANS FOR DETAILS.
6. ALL WORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH CURRENT STANDARDS AND CONSTRUCTION SPECIFICATIONS.
7. THE CONTRACTOR SHALL VERIFY LOCATIONS OF EXISTING SERVICES WITH ALL RELEVANT AUTHORITIES BEFORE COMMENCING CONSTRUCTION.
8. ALL STRUCTURES TO BE CONSTRUCTED TO NEW FINISHED SURFACE LEVELS.
9. ORIGIN OF LEVELS ARE BASED ON AHD, THE POSITION, SIZE, SURFACE LEVELS AND INVERT LEVEL OF EXISTING STORMWATER MANHOLES AND PITS ARE TAKEN FROM POST FAILURE LIDAR SURVEY. THESE NEED TO BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.
10. DRAINAGE DESIGN AND INDICATIVE CONSTRUCTION SEQUENCE BASED ON FULL ROAD CLOSURE.
11. DRAINAGE DESIGN BASED ON HYDROLOGY ASSESSMENT ASSUMING 1% AEP.

SCHEDULE OF HOLD POINTS AND WITNESS POINTS

1. HOLD POINT - SUBMISSION OF MATERIAL CERTIFICATES (TfNSW R64 CL. 2.1).
2. HOLD POINT - SUBMISSION OF GROUT AND SHOTCRETE MIX, INCLUDING TEST RESULTS (TfNSW R64 CL 2.2.7 & TfNSW R68 CL. 3.8.1).
3. HOLD POINT - SUBMISSION OF CONSTRUCTION METHOD STATEMENT (TfNSW R64 3.1).
4. EXTENT OF WORKS INCLUDING SURVEY OF LOCAL SITE CHAINAGE SYSTEM, SET OUT OF SOIL NAIL AND DRAINAGE STRUCTURES INCLUDING ADJUSTMENTS FOR CLASHES - REFER DRAINAGE LAYOUT PLANS FOR DETAILS.
5. WITNESS POINT - ASSEMBLY OF SUITABILITY TEST NAILS (TfNSW R64 CL. 5.2.1).
6. WITNESS POINT - UNDERTAKE SUITABILITY TESTING OF SOIL NAILS (TfNSW R64 CL. 5.2.1).
7. HOLD POINT - ACCEPTANCE OF SUITABILITY TEST RESULTS BY THE PRINCIPAL FOR THE TEST NAILS (TfNSW R64 CL. 5.2.1).
8. WITNESS POINT - EXPOSED SLOPE FACE AFTER CLEARING OF EACH SECTION (TfNSW R64 CL. 3.3).
9. WITNESS POINT - INSTALLATION OF PRODUCTION SOIL NAILS (TfNSW R64 CL 3.4).
10. WITNESS POINT - GROUTING OF SOIL NAILS (TfNSW R64 CL 3.4).
11. HOLD POINT - ACCEPTANCE OF TEST RESULTS FOR PERMANENT NAILS BY THE PRINCIPAL (TfNSW R64 CL. 5.4).
12. HOLD POINT - SET-OUT OF DRAIN HOLES AND COMMENCEMENT OF DRILLING (TfNSW R40 CL. 3.1).
13. HOLD POINT - INSTALLATION OF UPVC DRAIN PIPE INTO DRILL HOLES (TfNSW R40 CL. 4).
14. HOLD POINT - SURFACE PREPARATION FOR MESH PLACEMENT AND SHOTCRETING (TfNSW R64 CL. 6.2 & TfNSW R68 CL. 4.2).
15. WITNESS POINT - SHOTCRETE MESH PLACEMENT AND WALL DRAINAGE (TfNSW R68 CL. 5.5 AND CL. 5.6).
16. WITNESS POINT - SHOTCRETE PLACEMENT (TfNSW R68 CL. 7).
17. HOLD POINT - SUBMISSION OF SHOTCRETE TEST RESULTS (TfNSW R68 CL. 8.5).
18. FOR SCHEDULE OF HOLD POINTS - DRAINAGE REFER TO ANNEXURE R11/C - SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS.

REFERENCES

1. TfNSW QA SPECIFICATION R64, SOIL NAILING, EDITION 1 / REVISION 7, NOVEMBER 2020.
2. TfNSW QA SPECIFICATION R68, SHOTCRETE WORK WITHOUT STEEL FIBRES, EDITION 1 / REVISION 4, JUNE 2020.
3. TfNSW QA SPECIFICATION 3557, FLEXIBLE STRIP FILTER DRAINS, EDITION 1 / REVISION 1, JUNE 2020.
4. TfNSW QA SPECIFICATION R40, HORIZONTAL DRAINS, EDITION 1 / REVISION 4, JUNE 2020.
5. AS5100.5 (2017), BRIDGE DESIGN, PART 5: CONCRETE, COMMITTEE BD-090, BRIDGE DESIGN.
6. TfNSW QA SPECIFICATION R11, STORMWATER DRAINAGE EDITION 5 / REVISION 8, SEPTEMBER 2021.
7. TfNSW QA SPECIFICATION R44, EARTHWORKS, EDITION 5 / REVISION 1, JUNE 2020.
8. TfNSW QA SPECIFICATION R15, KERBS AND CHANNELS (GUTTERS), EDITION 5 / REVISION 0, AUGUST 2020.

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B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
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SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD

TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)

SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GENERAL NOTES

DRAWING SET No: -	PART:	SHEET: 1 OF 3		A1
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INDICATIVE CONSTRUCTION SEQUENCE

THE FOLLOWING INDICATIVE CONSTRUCTION SEQUENCE MAY BE ADOPTED BY THE CONTRACTOR

1. IDENTIFY, RELOCATE / DIVERT ANY UTILITIES WITHIN THE VICINITY PRIOR TO COMMENCEMENT OF STABILISATION WORKS.
2. SET-UP TRAFFIC CONTROL AS NECESSARY IN ACCORDANCE WITH THE TRAFFIC CONTROL PLAN, ROAD OCCUPANCY LICENCE AND PRINCIPAL'S REQUIREMENTS.
3. INSTALL ENVIRONMENTAL CONTROLS AROUND THE CONSTRUCTION SITE AS NECESSARY.
4. INSTALL SITE DELINEATION AND PROTECTION.
5. PRIOR TO REMOVING EDGE PROTECTION BARRIERS ENSURE LOCAL PROJECT CHAINAGE IS SETOUT. CONFIRM THE EXTENT OF WORKS WITH THE PRINCIPAL.
6. CONDUCT FACE SCALING, EXCAVATION AND GENERAL DEVEGETATION OF THE SLOPE TO REMOVE VEGETATION WHICH MAY IMPACT THE INSTALLATION OF SOIL NAILS, REINFORCING MESH, GABION MATTRESSES AND SHOTCRETE UNDER SUPERVISION OF THE PRINCIPAL OR THE PRINCIPAL'S GEOTECHNICAL REPRESENTATIVE.

FOR CULVERT REINSTATEMENT SEE 7 TO 11:

7. SAWCUT EXISTING ASPHALT THEN EXCAVATE PIPE TRENCH, CULVERT INLET AND CULVERT OUTLET. USE TEMPORARY SHORING AS NEEDED.
8. INSTALL NEW DRAINAGE PIPE, PROVDING A BLOCKOUT TO PREVENT BACKFILL FROM ENTERING DRAINAGE PIPE.
9. PREPARE FOUNDATION AND INSTALL CULVERT OUTLET HEADWALL AND REINFORCED CONCRETE KEYED WALL. CONNECT TO DRAINAGE PIPE. REINSTATE BEHIND WITH COMPACTED ROAD BASE OR MATERIAL APPROVED BY GEOTECHNICAL ENGINEER.
10. PREPARE DOWNSLOPE OF OUTLET AND INSTALL GABION MATTRESS OUTLET PROTECTION.
11. CONSTRUCT INLET WITHIN UPSLOPE VERGE AND CONNECT TO DRAINAGE PIPE.
12. INSTALL SO KERB WITHIN VERGE.

FOR SOIL NAIL REINSTATEMENT SEE 13 TO 25.

13. SET OUT SYSTEMATIC SOIL NAIL LOCATIONS AT HORIZONTAL AND VERTICAL SPACING NOMINATED. SOIL NAILS MAY BE RELOCATED OR REMOVED BY THE
14. PRINCIPALS GEOTECHNICAL REPRESENTATIVE TO INTERSECT GEOTECHNICAL HAZARDS IDENTIFIED OR AVOID AREAS OF SHALLOW ROCK.
15. INSTALL SUITABILITY NAILS. NAILS SUBJECT TO SUITABILITY TESTING ARE ADDITIONAL TO THE PERMANENT NAILS AS DIRECTED BY THE PRINCIPALS GEOTECHNICAL REPRESENTATIVE.
16. CONDUCT SUITABILITY TESTING IN ACCORDING WITH TFNSW R64.
17. CONFIRM SUITABILITY TEST RESULTS WITH THE PRINCIPAL.
18. INSTALL PRODUCTION NAILS.
19. CONDUCT ACCEPTANCE TESTING . CONFIRM ACCEPTANCE TEST RESULTS WITH PRINCIPAL.
20. SET-OUT HORIZONTAL DRAINS.
21. INSTALL HORIZONTAL DRAINS AND STRIP DRAINS.
22. INSTALL INITIAL SHOTCRETE LAYER
23. INSTALL STEEL WIRE MESH IN ACCORDANCE WITH TFNSW R64 & R68 AND THE DRAWINGS. APPLY INTERMEDIATE LAYER OF SHOTCRETE.
24. INSTALL FACE PLATES AND TENSION NAILS.
25. APPLY FINAL LAYER OF SHOTCRETE AND FINISH AS DIRECTED BY THE PRINCIPAL.
26. CONDUCT SUITABILITY TESTING OF SHOTCRETE.
27. EXCAVATE FOOTPRINT OF STRIP FOOTINGS.
28. INSTALL STRIP FOOTINGS AND NEW EDGE PROTECTION BARRIERS.
29. CONNECT NEW BARRIERS TO EXISTING BARRIERS ON EITHER SIDE.
30. RESTORE SITE TO ITS ORIGINAL CONDITION, OR BETTER, REPAIRING ANY DAMAGE TO ROAD PAVEMENT OR FURNITURE (SIGNPOSTS, ETC.).

CEMENT STABILIZED SAND

1. CEMENT STABILIZED SAND TO HAVE MIN. 3% CEMENT CONTENT, UNCONFINED COMPRESSIVE STRENGTH 2 TO 3 MPA AND COMPACTED TO 95% STANDARD DENSITY.

GABION MATTRESSESS

1. SURFACE PREPARATION, PLACING AND INSTALLATION, FILLING UNITS AND CLOSING THEM TO BE ACOORDING TO THE MANUFACTURERS DATA SHEETS AND SPECIFICATIONS.
2. THE FOUNDING SURFACE WHERE GABION MATTRESSES ARE TO BE PLACED SHALL BE LEVEL AND UNIFORMLY GRADED TO SUIT THE ELEVATION OF EMBANKMENT.
3. THE FOUNDING SURFACE SHALL BE SMOOTH AND FREE FROM SURFACE IRREGULARITIES, LOOSE MATERIALS AND VEGETATION WITH REASONABLE COMPACTION.
4. APPROPRIATE MEASURES SHALL BE TAKEN FOR FILTERING AND DRAINAGE OF THE FOUNDATION.
5. ANY SOFT SPOTS OR HOLES DETECTED ON THE FOUNDING SURFACES CAN BE FILLED UP USING 3% CEMENT STABILISED SAND.
6. THE PLACEMENT OF THE GABION MATRESSES SHALL BE IN CLOSE CONFORMITY TO THE LINES AND GRADES AS SHOWN ON THE PLANS.
7. THE PRE-ASSEMBLED MATTRESSES SHALL BE PLACES IN POSITION EMPTY AND SHALL BE TIED OR FASTENED TO ADJACENT MATTRESSES ALONG ALL CONTACTING EDGES IN ORDER TO FORM A CONTINUOUSLY CONNECTED MONOLITHIC STRUCTURAL UNITS.
8. ON SLOPES, THE MATTRESS SHALL BE LAID WITH WIDTH PERPENDICULAR TO THE SLOPE EXCEPT FOR VERY SMALL DITCHES. IF THE BANKS AND BEDS ARE TO BE COVERED COMPLETELY, THE UNITS OF THE BED SHOULD BE LAID IN THE DIRECTION OF FLOW.
9. MATTRESSES SHALL BE PLACED AND SECURELY ATTACHED WHILE EMPTY. EMPTY UNITS CAN BE HARDLY CONNECTED TO ADJACENT UNITS ALREADY FILLED.
10. WHERE MATTRESSES ARE TO BE PLACED ON STEEP SLOPES (1.5H:1V OR STEEPER), THE UNIT MAY BE SECURED BY ANCHORING SYSTEMS (HARDWOOD PEGS, PIPES, STEEL BARS, ETC.) DRIVEN INTO GROUND JUST BELOW UPPER END PANEL. DIAMETER, DISTANCE AND THE LENGTH OF THE ANCHORING SYSTEM SHALL BE ESTABLISHED BY THE CONTRACTOR BASED ON THE SLOPE, MESH OPENING AND STRENGTH, MATTRESS THICKNESS OR AS SPECIFIED BY THE MANUFACTURER'S DATASHEET.
11. IN CASE OF STEEPER SLOPES (INCLINATION GREATER THAN 40 DEG), STONE FILLING AND THE FOLLOWING LID CLOSING SHALL BE DONE STARTING FROM BOTTOM PART OF THE MATTRESS. THE FOLLOWING STONE FILLING AND LID CLOSING PHASES SHALL BE CARRIED OUT GOING UPWARDS UNTIL THE COMPLETE CLOSURE OF THE GABION MATTRESS.
12. CARE SHALL BE TAKEN WHEN PLACING THE STONE TO ENSURE THAT THE POLYMER COATING ON MATTRESSES IS NOT DAMAGED.
13. EACH COMPARTMENT SHALL BE FILLED WITH A MINIMUM TWO LAYERS OF ROCK TO ENSURE UNIFORM FLEXIBILITY OF THE UNIT.
14. STABILITY OF GABION MATTRESS TO BE CHECKED BY THE SUPPLIER DURING THE INSTALLATION PROCESS.
15. THE SIZE AND NUMBER OF GABION MATTRES TO COVER THE CULVERT OUTLET TO BE DETERMINED ON SITE, SUBJECT TO THE APPROVAL OF PROJECT MANAGER.

SITE INSPECTION OBSERVATION NOTES

1. ORIGINAL ROAD CONSTRUCTION COMPLETED BY CUTTING INTO EXISTING HILLSIDE WITH EXPOSED ROCK CUTS ON UP-SLOPE SIDE AND SOIL REMAINING ON DOWN-SLOPE ROAD EDGE TO VARYING DEGREES.
2. LOSS OF DOWNSLOPE ROAD EDGE AND OR EDGE SETTLEMENT SHOWS FAILURE ALONG SOIL / ROCK INTERFACE UNDER SATURATED CONDITIONS
3. MAJORITY OF THE ALIGNMENT COULD BE VULNERABLE TO THIS MECHANISM OVER TIME UNLESS REMEDIATED. IT IS POSSIBLE MORE STABLE AREAS ARE ENTIRELY IN ROCK CUT OR WITH VERY LIMITED SOIL ON THE DOWNSLOPE EDGE

SCHEDULE OF CONTRACT QUANTITIES - MAY BE VARIED THROUGH CONSTRUCTION TO SUIT SITE CONDITIONS

GEOTECHNICAL

NO.	DESCRIPTION	COMMENTS	QUANTITY	UNIT
Q1	SOIL NAIL OF 7 M LENGTH	INCL. SUPPLY AND INSTALL OF NAIL AND OTHER ELEMENTS AS SHOWN ON DRAWINGS.	357.000	ITEM
Q2	SOIL NAIL OF 6 M LENGTH	INCL. SUPPLY AND INSTALL OF NAIL AND OTHER ELEMENTS AS SHOWN ON DRAWINGS.	318.000	ITEM
Q3	SOIL NAIL OF 4 M LENGTH	INCL. SUPPLY AND INSTALL OF NAIL AND OTHER ELEMENTS AS SHOWN ON DRAWINGS.	597.000	ITEM
Q4	SHOTCRETE (150 MM THICK)	INCLUDING SUPPLY AND INSTALL OF SHOTCRETE, REINFORCEMENT MESH AND OTHER ELEMENTS AS SHOWN ON DRAWINGS.	2667.000	m2

CIVIL DRAINAGE - BULK EARTHWORKS

NO.	DESCRIPTION	COMMENTS	QUANTITY	UNIT
Q5	CLEARING AND GRUBBING OF SITE	TOTAL AREA FOR CLEARING AND GRUBBING, INCLUDING REMOVAL AND DISPOSAL OF RUBBISH, DEBRIS AND TREES APPROVED TO BE REMOVED, EXCLUDING EXISTING PAVEMENT MILLING/RESURFACING TREATMENT AREAS.	908.000	m2
Q6	CUT TO DESIGN SURFACE LEVEL	VOLUME OF BULK CUT EARTHWORKS REQUIRED. EXCLUDES ANY EARTHWORKS REQUIRED FOR GULLY FAILURE.	165.000	m3
Q7	FILL TO DESIGN SURFACE LEVEL	VOLUME OF BULK FILL EARTHWORKS REQUIRED. EXCLUDES ANY EARTHWORKS REQUIRED FOR GULLY FAILURE.	242.000	m3
Q8	IMPORT FILL	TOTAL VOLUME OF IMPORT FILL REQUIRED FOR EARTHWORKS.	77.000	m3

CIVIL DRAINAGE - CULVERT 1A

NO.	DESCRIPTION	COMMENTS	QUANTITY	UNIT
Q9	SUPPLY AND INSTALL (2X) 1050 CLASS 3 REINFORCED CONCRETE PIPE	INCLUDING EXCAVATION OF TRENCH, SUPPLY AND INSTALL OF BACKFILL MATERIAL	20.000	m
Q10	3400X1900 CAST IN-SITU PIT INCLUDING REINFORCEMENT TO DETAIL	INCLUDING EXCAVATION, BACKFILL, COVERS AND GRATES AND ALL NECESSARY CONNECTIONS	1.000	ITEM
Q11	CULVERT 1A CAST-INSITU HEADWALL INCLUDING REINFORCEMENT TO DETAIL	INCLUDING EXCAVATION, BACKFILL AND ALL NECESSARY CONNECTIONS	1.000	ITEM
Q12	SUPPLY AND INSTALL CLASS D NON-WOVEN GEOFABRIC OR APPROVED BENEATH THE GABION MATTRESS		40.000	m2
Q13	SUPPLY AND INSTALL GABION MATTRESS ON CULVERT OUTLET, 300mm THICKNESS		10.000	m3

CIVIL DRAINAGE - CULVERT 1

NO.	DESCRIPTION	COMMENTS	QUANTITY	UNIT
Q14	SUPPLY AND INSTALL (2X) 525 CLASS 4 REINFORCED CONCRETE PIPE	INCLUDING EXCAVATION OF TRENCH, SUPPLY AND INSTALL OF BACKFILL MATERIAL	10.000	m
Q15	3400X1900 CAST IN-SITU REINFORCED CONCRETE CHANNEL AND PIT TO DETAIL	INCLUDING EXCAVATION, BACKFILL, COVERS AND GRATES, STEP IRONS AND ALL NECESSARY CONNECTIONS	1.000	ITEM
Q16	CULVERT 1 CAST-INSITU HEADWALL INCLUDING REINFORCEMENT TO DETAIL	INCLUDING EXCAVATION, BACKFILL AND ALL NECESSARY CONNECTIONS	1.000	ITEM
Q17	SUPPLY AND INSTALL CLASS D NON-WOVEN GEOFABRIC OR APPROVED BENEATH THE GABION MATTRESS		38.000	m2
Q18	SUPPLY AND INSTALL 50mm THICK SHOTCRETE		2.000	m2
Q19	SUPPLY AND INSTALL 300MM THICK SHOTCRETE		11.000	m3

CIVIL DRAINAGE - CULVERT 3

NO.	DESCRIPTION	COMMENTS	QUANTITY	UNIT
Q20	SUPPLY AND INSTALL (1X) 600 CLASS 4 REINFORCED CONCRETE PIPE	INCLUDING EXCAVATION OF TRENCH, SUPPLY AND INSTALL OF BACKFILL MATERIAL	6.000	ITEM
Q21	SUPPLY AND INSTALL (1X) 600 CLASS 3 REINFORCED CONCRETE PIPE	INCLUDING EXCAVATION OF TRENCH, SUPPLY AND INSTALL OF BACKFILL MATERIAL	1.000	ITEM
Q22	CULVERT 1 CAST-INSITU HEADWALL INCLUDING REINFORCEMENT TO DETAIL	INCLUDING EXCAVATION, BACKFILL AND ALL NECESSARY CONNECTIONS	1.000	ITEM
Q23	SUPPLY AND INSTALL CLASS D NON-WOVEN GEOFABRIC OR APPROVED BENEATH THE GABION MATTRESS		38.000	m2
Q24	SUPPLY AND INSTALL 50mm THICK BLINDING SHOTCRETE		2.000	m3
Q25	SUPPLY AND INSTALL GABION MATTRESS ON CULVERT OUTLET, 300mm THICKNESS		11.000	m3

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SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
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GENERAL NOTES

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SCHEDULE OF CONTRACT QUANTITIES - MAY BE VARIED THROUGH CONSTRUCTION TO SUIT SITE CONDITIONS

PAVEMENTS				
NO.	DESCRIPTION	COMMENTS	QUANTITY	UNIT
Q28	MILLING OF EXISTING ASPHALT FOR RESURFACING	SQUARE METERAGE OF MILLING/RESURFACING REQUIRED.	2,801	m2
Q29	SM KERB	TOTAL LENGTH OF SM KERB REQUIRED.	217.000	m
Q30	SO KERB	TOTAL LENGTH OF SO KERB REQUIRED.	179.000	m

ROAD FURNITURE				
NO.	DESCRIPTION	COMMENTS	QUANTITY	UNIT
Q31	SAFETY BARRIER REPLACEMENT	TOTAL LENGTH OF SAFETY BARRIER REPLACEMENT REQUIRED	584.000	m
Q32	TYPE F SINGLE SIDED CONCRETE SAFETY BARRIER	TOTAL LENGTH OF TYPE F SINGLE SIDED CONCRETE SAFETY BARRIER REPLACEMENT REQUIRED	14.000	m

STRUCTURES				
NO.	DESCRIPTION	COMMENTS	QUANTITY	UNIT
Q33	DRAINAGE CHANNELS	"V DRAIN CHANNELS AT CULVERTS 1 AND 3 - 150MM THICK RC WALLS - 600MM WIDE (CLEAR INTERNAL) - APPROX. 4.2M LONG / 0.5M HEIGHT "	2.000	ITEMS
Q34	PITS	PITS OF VARIOUS DIMENSIONS AT CULVERTS 1, 1A AND 3; 150MM THICK RC WALLS	3.000	ITEMS
Q35	HEADWALLS	1-1.5M HIGH RETAINING WALLS WITH PIPE PENETRATIONS. 250MM THICK RC WALLS	3.000	ITEMS
Q36	SAFETY BARRIER FOOTING	RC STRIP FOOTING FOR POSTS. MIN. 11M3 OF CONCRETE PER SECTION OF BARRIER (SECTIONS OF 18M / 12M AND 24M LONG WITH DIFFERENT CROSS SECTIONAL AREAS)	VARIES	VARIES

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

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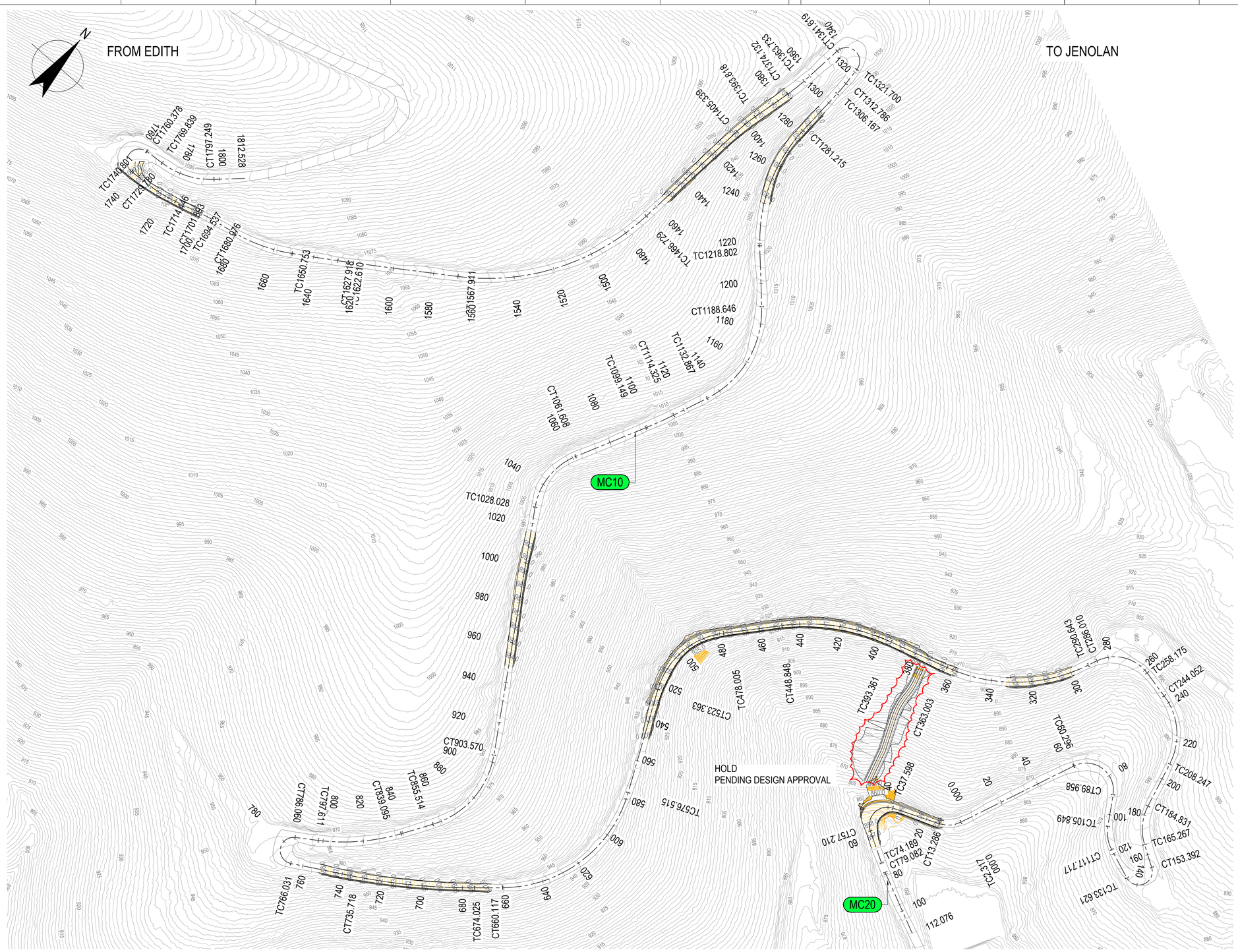
DRAWN	K.GORDON	10.10.24
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LEGEND

- 1560 - CHAINAGES
- MC10
- 995 — DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- 995 — EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD DESIGN

NOTES:

1. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.
2. FOR ALIGNMENT SETOUT SCHEDULES, REFER TO SHEETS:
   12625762-GHD-DD-DRG-CI-00011
   12625762-GHD-DD-DRG-CI-00012
   12625762-GHD-DD-DRG-CI-00013
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE. ALL LEVELS, METREAGES, CHANINAGES AND CO-ORDINATES ARE EXPRESSED IN METRES.

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TfNSW ACKNOWLEDGES THE TEMPORARY WORKS NATURE OF THE CHOSEN SOLUTION AND THE FACT THAT IT DOES NOT SATISFY THE REQUIRED 100-YEAR DESIGN LIFE REQUIREMENT FOR LONG TERM STABILITY, UNDERSTANDING THAT THE DESIGN LIFE CANNOT BE QUANTIFIED OR GUARANTEED BY THE CONSULTANT. TfNSW ACKNOWLEDGES THAT A TEMPORARY SOIL NAIL SOLUTION INVOLVING LIMITED SOIL NAILING OF THE CREST AREA AND WILL REQUIRE ONGOING MONITORING AND MAINTENANCE WHILE LONG-TERM ACCESS SOLUTIONS ARE EXPLORED.

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REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD | DESIGN LOT CODE: --

SCALE: 1:1000

0 10 20 30m

SCALE 1:1000 AT ORIGINAL SIZE

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

ALIGNMENT SETOUT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00001	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00001.dwg

PLOT DATE & TIME: 10/10/2024 7:00:22 PM

HORIZONTAL ALIGNMENT REPORT - MC10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224268.176	6254125.636	22°48'05.50"	LINE		60.296
	10.000	224272.051	6254134.855	22°48'05.50"			
	20.000	224275.926	6254144.073	22°48'05.50"			
	30.000	224279.802	6254153.292	22°48'05.50"			
	40.000	224283.677	6254162.510	22°48'05.50"			
	50.000	224287.553	6254171.729	22°48'05.50"			
	60.000	224291.428	6254180.947	22°48'05.50"			
TC	60.296	224291.543	6254181.220	22°48'05.50"	ARC	13.500	29.662
	70.000	224298.067	6254188.121	63°59'12.40"		13.500	
	80.000	224307.806	6254188.937	106°25'41.14"		13.500	
CT	89.958	224315.522	6254183.004	148°41'23.04"	LINE		15.892
	90.000	224315.544	6254182.968	148°41'23.04"			
	100.000	224320.740	6254174.424	148°41'23.04"			
TC	105.849	224323.780	6254169.427	148°41'23.04"	ARC	-18.000	11.868
	110.000	224326.325	6254166.159	135°28'38.83"		-18.000	
CT	117.717	224332.734	6254161.967	110°54'44.94"	LINE		15.904
	120.000	224334.866	6254161.152	110°54'44.94"			
	130.000	224344.207	6254157.582	110°54'44.94"			
TC	133.621	224347.590	6254156.290	110°54'44.94"	ARC	-6.700	19.772
	140.000	224353.693	6254156.971	56°21'38.02"		-6.700	
	150.000	224355.832	6254165.813	330°50'40.10"		-6.700	
CT	153.392	224353.515	6254168.241	301°50'01.59"	LINE		11.874
	160.000	224347.901	6254171.726	301°50'01.59"			
TC	165.267	224343.427	6254174.504	301°50'01.59"	ARC	25.000	19.564
	170.000	224339.665	6254177.365	312°40'52.61"		25.000	
	180.000	224333.846	6254185.416	335°35'58.53"		25.000	
CT	184.831	224332.287	6254189.980	346°40'14.42"	LINE		23.416
	190.000	224331.095	6254195.010	346°40'14.42"			
	200.000	224328.789	6254204.741	346°40'14.42"			
TC	208.247	224326.888	6254212.765	346°40'14.42"	ARC	-32.000	35.805
	210.000	224326.437	6254214.459	343°31'54.83"		-32.000	
	220.000	224322.162	6254223.454	325°37'37.08"		-32.000	
	230.000	224315.329	6254230.699	307°43'19.33"		-32.000	
	240.000	224306.599	6254235.493	289°49'01.57"		-32.000	
CT	244.052	224302.710	6254236.622	282°33'41.81"	LINE		14.123
	250.000	224296.904	6254237.915	282°33'41.81"			
TC	258.175	224288.925	6254239.693	282°33'41.81"	ARC	-20.000	27.835
	260.000	224287.128	6254240.009	277°19'58.36"		-20.000	
	270.000	224277.305	6254238.804	248°41'05.95"		-20.000	
	280.000	224269.263	6254233.038	220°02'13.55"		-20.000	
CT	286.010	224266.141	6254227.929	202°49'11.50"	LINE		4.634
	290.000	224264.593	6254224.251	202°49'11.50"			
TC	290.643	224264.344	6254223.658	202°49'11.50"	ARC	81.500	72.360
	300.000	224260.228	6254215.261	209°23'51.47"		81.500	
	310.000	224254.798	6254206.871	216°25'40.03"		81.500	
	320.000	224248.382	6254199.209	223°27'28.60"		81.500	
	330.000	224241.076	6254192.390	230°29'17.17"		81.500	
	340.000	224232.991	6254186.516	237°31'05.73"		81.500	
	350.000	224224.247	6254181.676	244°32'54.30"		81.500	
	360.000	224214.977	6254177.943	251°34'42.86"		81.500	
CT	363.003	224212.111	6254177.046	253°41'23.20"	LINE		30.358
	370.000	224205.396	6254175.081	253°41'23.20"			
	380.000	224195.798	6254172.273	253°41'23.20"			

HORIZONTAL ALIGNMENT REPORT - MC10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
	390.000	224186.201	6254169.465	253°41'23.20"			
TC	393.361	224182.975	6254168.521	253°41'23.20"	ARC	-100.000	55.487
	400.000	224176.670	6254166.446	249°53'09.94"		-100.000	
	410.000	224167.467	6254162.544	244°09'23.46"		-100.000	
	420.000	224158.700	6254157.743	238°25'36.98"		-100.000	
	430.000	224150.456	6254152.090	232°41'50.50"		-100.000	
	440.000	224142.817	6254145.642	226°58'04.01"		-100.000	
CT	448.848	224136.625	6254139.326	221°53'53.31"	LINE		29.157
	450.000	224135.856	6254138.469	221°53'53.31"			
	460.000	224129.178	6254131.025	221°53'53.31"			
	470.000	224122.500	6254123.582	221°53'53.31"			
TC	478.005	224117.154	6254117.624	221°53'53.31"	ARC	-39.000	45.358
	480.000	224115.860	6254116.105	218°58'01.88"		-39.000	
	490.000	224110.632	6254107.613	204°16'33.46"		-39.000	
	500.000	224107.727	6254098.073	189°35'05.05"		-39.000	
	510.000	224107.338	6254088.108	174°53'36.64"		-39.000	
	520.000	224109.488	6254078.370	160°12'08.23"		-39.000	
CT	523.363	224110.762	6254075.259	155°15'42.63"	LINE		53.153
	530.000	224113.539	6254069.231	155°15'42.63"			
	540.000	224117.724	6254060.148	155°15'42.63"			
	550.000	224121.909	6254051.066	155°15'42.63"			
	560.000	224126.094	6254041.984	155°15'42.63"			
	570.000	224130.278	6254032.902	155°15'42.63"			
TC	576.515	224133.005	6254026.984	155°15'42.63"	ARC	65.000	83.602
	580.000	224134.378	6254023.782	158°20'00.09"		65.000	
	590.000	224137.342	6254014.241	167°08'53.14"		65.000	
	600.000	224138.809	6254004.360	175°57'46.18"		65.000	
	610.000	224138.744	6253994.370	184°46'39.23"		65.000	
	620.000	224137.149	6253984.508	193°35'32.28"		65.000	
	630.000	224134.062	6253975.006	202°24'25.32"		65.000	
	640.000	224129.556	6253966.090	211°13'18.37"		65.000	
	650.000	224123.736	6253957.970	220°02'11.42"		65.000	
	660.000	224116.741	6253950.838	228°51'04.47"		65.000	
CT	660.117	224116.653	6253950.761	228°57'16.08"	LINE		13.908
	670.000	224109.199	6253944.271	228°57'16.08"			
TC	674.025	224106.164	6253941.628	228°57'16.08"	ARC	300.000	61.693
	680.000	224101.619	6253937.750	230°05'44.09"		300.000	
	690.000	224093.842	6253931.464	232°00'19.58"		300.000	
	700.000	224085.860	6253925.440	233°54'55.08"		300.000	
	710.000	224077.682	6253919.686	235°49'30.57"		300.000	
	720.000	224069.317	6253914.208	237°44'06.06"		300.000	
	730.000	224060.773	6253909.012	239°38'41.56"		300.000	
CT	735.718	224055.812	6253906.169	240°44'12.80"	LINE		30.314
	740.000	224052.076	6253904.076	240°44'12.80"			
	750.000	224043.353	6253899.188	240°44'12.80"			
	760.000	224034.629	6253894.300	240°44'12.80"			
TC	766.031	224029.367	6253891.351	240°44'12.80"	ARC	6.530	20.028
	770.000	224025.543	6253890.549	275°33'29.40"		6.530	
	780.000	224019.656	6253897.424	3°18'02.00"		6.530	
CT	786.060	224022.568	6253902.492	56°28'13.39"	LINE		11.551
	790.000	224025.853	6253904.668	56°28'13.39"			
TC	797.611	224032.197	6253908.872	56°28'13.39"	ARC	-100.000	41.484
	800.000	224034.173	6253910.215	55°06'05.12"		-100.000	

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FILE NAME: 21-12625762-GHD-DD-DRG-CI-00011.dwg

PLOT DATE & TIME: 10/10/2024 7:00:34 PM

REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: N/A

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

ALIGNMENT SETOUT SCHEDULES

DRAWING SET No: -	PART:	SHEET: 1 OF 3		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00011	REV	VER	EDMS No.	AMD No.

HORIZONTAL ALIGNMENT REPORT - MC10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
	810.000	224042.075	6253916.337	49°22'18.63"		-100.000	
	820.000	224049.326	6253923.217	43°38'32.15"		-100.000	
	830.000	224055.855	6253930.786	37°54'45.67"		-100.000	
CT	839.095	224061.110	6253938.206	32°42'05.60"	LINE		16.419
	840.000	224061.599	6253938.967	32°42'05.60"			
	850.000	224067.001	6253947.382	32°42'05.60"			
TC	855.514	224069.980	6253952.022	32°42'05.60"	ARC	-43.000	48.056
	860.000	224072.203	6253955.916	26°43'26.54"		-43.000	
	870.000	224075.625	6253965.289	13°23'57.98"		-43.000	
	880.000	224076.796	6253975.197	0°04'29.42"		-43.000	
	890.000	224075.651	6253985.109	346°45'00.86"		-43.000	
	900.000	224072.253	6253994.490	333°25'32.30"		-43.000	
CT	903.570	224070.525	6253997.613	328°40'05.66"	LINE		124.457
	910.000	224067.182	6254003.105	328°40'05.66"			
	920.000	224061.982	6254011.647	328°40'05.66"			
	930.000	224056.782	6254020.188	328°40'05.66"			
	940.000	224051.582	6254028.730	328°40'05.66"			
	950.000	224046.382	6254037.272	328°40'05.66"			
	960.000	224041.182	6254045.813	328°40'05.66"			
	970.000	224035.982	6254054.355	328°40'05.66"			
	980.000	224030.782	6254062.897	328°40'05.66"			
	990.000	224025.582	6254071.439	328°40'05.66"			
	1000.000	224020.383	6254079.980	328°40'05.66"			
	1010.000	224015.183	6254088.522	328°40'05.66"			
	1020.000	224009.983	6254097.064	328°40'05.66"			
TC	1028.028	224005.808	6254103.921	328°40'05.66"	ARC	33.000	33.580
	1030.000	224004.834	6254105.635	332°05'34.07"		33.000	
	1040.000	224001.553	6254115.041	349°27'18.56"		33.000	
	1050.000	224001.229	6254124.998	6°49'03.05"		33.000	
	1060.000	224003.891	6254134.597	24°10'47.53"		33.000	
CT	1061.608	224004.585	6254136.047	26°58'16.86"	LINE		37.541
	1070.000	224008.392	6254143.527	26°58'16.86"			
	1080.000	224012.927	6254152.439	26°58'16.86"			
	1090.000	224017.462	6254161.351	26°58'16.86"			
TC	1099.149	224021.612	6254169.506	26°58'16.86"	ARC	-200.000	15.176
	1100.000	224021.996	6254170.265	26°43'39.36"		-200.000	
	1110.000	224026.269	6254179.305	23°51'46.12"		-200.000	
CT	1114.325	224027.976	6254183.279	22°37'25.22"	LINE		18.541
	1120.000	224030.159	6254188.517	22°37'25.22"			
	1130.000	224034.005	6254197.748	22°37'25.22"			
TC	1132.867	224035.108	6254200.394	22°37'25.22"	ARC	-49.000	55.780
	1140.000	224037.364	6254207.154	14°16'56.91"		-49.000	
	1150.000	224038.828	6254217.029	2°35'22.05"		-49.000	
	1160.000	224038.261	6254226.995	350°53'47.19"		-49.000	
	1170.000	224035.686	6254236.640	339°12'12.33"		-49.000	
	1180.000	224031.209	6254245.563	327°30'37.47"		-49.000	
CT	1188.646	224025.947	6254252.409	317°24'01.00"	LINE		30.156
	1190.000	224025.031	6254253.406	317°24'01.00"			
	1200.000	224018.262	6254260.767	317°24'01.00"			
	1210.000	224011.494	6254268.128	317°24'01.00"			
TC	1218.802	224005.536	6254274.607	317°24'01.00"	ARC	80.000	62.413
	1220.000	224004.732	6254275.495	318°15'29.36"		80.000	
	1230.000	223998.557	6254283.353	325°25'12.47"		80.000	

HORIZONTAL ALIGNMENT REPORT - MC10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
	1240.000	223993.410	6254291.919	332°34'55.57"		80.000	
	1250.000	223989.371	6254301.060	339°44'38.67"		80.000	
	1260.000	223986.504	6254310.633	346°54'21.77"		80.000	
	1270.000	223984.852	6254320.489	354°04'04.87"		80.000	
	1280.000	223984.442	6254330.474	1°13'47.97"		80.000	
CT	1281.215	223984.477	6254331.689	2°06'00.06"	LINE		24.952
	1290.000	223984.799	6254340.468	2°06'00.06"			
	1300.000	223985.166	6254350.461	2°06'00.06"			
TC	1306.167	223985.392	6254356.623	2°06'00.06"	ARC	-80.000	6.620
	1310.000	223985.440	6254360.456	359°21'16.15"		-80.000	
CT	1312.786	223985.361	6254363.241	357°21'32.81"	LINE		8.914
	1320.000	223985.028	6254370.447	357°21'32.81"			
TC	1321.700	223984.950	6254372.145	357°21'32.81"	ARC	-6.700	19.919
	1330.000	223980.146	6254378.265	286°22'46.19"		-6.700	
	1340.000	223971.996	6254374.223	200°51'48.27"		-6.700	
CT	1341.619	223971.607	6254372.656	187°01'20.47"	LINE		22.114
	1350.000	223970.583	6254364.337	187°01'20.47"			
	1360.000	223969.360	6254354.412	187°01'20.47"			
TC	1363.733	223968.904	6254350.708	187°01'20.47"	ARC	80.000	10.400
	1370.000	223967.895	6254344.524	191°30'39.53"		80.000	
CT	1374.132	223966.966	6254340.498	194°28'13.79"	LINE		19.685
	1380.000	223965.500	6254334.816	194°28'13.79"			
	1390.000	223963.001	6254325.133	194°28'13.79"			
TC	1393.818	223962.047	6254321.437	194°28'13.79"	ARC	-80.000	11.521
	1400.000	223960.735	6254315.397	190°02'33.84"		-80.000	
CT	1405.339	223959.980	6254310.113	186°13'08.71"	LINE		61.391
	1410.000	223959.475	6254305.479	186°13'08.71"			
	1420.000	223958.391	6254295.538	186°13'08.71"			
	1430.000	223957.308	6254285.597	186°13'08.71"			
	1440.000	223956.225	6254275.655	186°13'08.71"			
	1450.000	223955.142	6254265.714	186°13'08.71"			
	1460.000	223954.058	6254255.773	186°13'08.71"			
TC	1466.729	223953.329	6254249.083	186°13'08.71"	ARC	115.000	101.182
	1470.000	223952.929	6254245.837	187°50'54.83"		115.000	
	1480.000	223951.134	6254236.003	192°49'50.90"		115.000	
	1490.000	223948.493	6254226.361	197°48'46.97"		115.000	
	1500.000	223945.024	6254216.986	202°47'43.04"		115.000	
	1510.000	223940.754	6254207.947	207°46'39.11"		115.000	
	1520.000	223935.715	6254199.313	212°45'35.18"		115.000	
	1530.000	223929.945	6254191.149	217°44'31.25"		115.000	
	1540.000	223923.488	6254183.517	222°43'27.32"		115.000	
	1550.000	223916.393	6254176.475	227°42'23.39"		115.000	
	1560.000	223908.713	6254170.075	232°41'19.46"		115.000	
CT	1567.911	223902.261	6254165.500	236°37'48.64"	LINE		54.699
	1570.000	223900.516	6254164.351	236°37'48.64"			
	1580.000	223892.165	6254158.851	236°37'48.64"			
	1590.000	223883.813	6254153.351	236°37'48.64"			
	1600.000	223875.462	6254147.850	236°37'48.64"			
	1610.000	223867.111	6254142.350	236°37'48.64"			
	1620.000	223858.759	6254136.849	236°37'48.64"			
TC	1622.610	223856.580	6254135.414	236°37'48.64"	ARC	200.000	5.308
CT	1627.918	223852.108	6254132.553	238°09'03.17"	LINE		22.835
	1630.000	223850.340	6254131.455	238°09'03.17"			

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FILE NAME: 21-12625762-GHD-DD-DRG-CI-00012.dwg

PLOT DATE & TIME: 10/10/2024 7:00:45 PM

REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: N/A

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

ALIGNMENT SETOUT SCHEDULES

DRAWING SET No: -	PART:	SHEET: 2 OF 3	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00012				

HORIZONTAL ALIGNMENT REPORT - MC10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
	1640.000	223841.845	6254126.178	238°09'03.17"			
	1650.000	223833.351	6254120.901	238°09'03.17"			
TC	1650.753	223832.712	6254120.504	238°09'03.17"	ARC	80.000	30.223
	1660.000	223824.592	6254116.088	244°46'25.26"		80.000	
	1670.000	223815.304	6254112.402	251°56'08.36"		80.000	
	1680.000	223805.628	6254109.903	259°05'51.46"		80.000	
CT	1680.976	223804.668	6254109.724	259°47'48.50"	LINE		13.561
	1690.000	223795.787	6254108.126	259°47'48.50"			
TC	1694.537	223791.322	6254107.322	259°47'48.50"	ARC	-80.000	7.356
	1700.000	223785.982	6254106.171	255°53'03.24"		-80.000	
CT	1701.893	223784.152	6254105.688	254°31'42.44"	LINE		12.553
	1710.000	223776.339	6254103.525	254°31'42.44"			
TC	1714.446	223772.054	6254102.340	254°31'42.44"	ARC	70.000	15.334
	1720.000	223766.648	6254101.072	259°04'29.18"		70.000	
CT	1729.780	223756.948	6254099.894	267°04'46.03"	LINE		11.021
	1730.000	223756.728	6254099.883	267°04'46.03"			
	1740.000	223746.741	6254099.373	267°04'46.03"			
TC	1740.801	223745.941	6254099.332	267°04'46.04"	ARC	6.255	19.577
	1750.000	223739.438	6254104.638	351°20'45.06"		6.255	
	1760.000	223744.854	6254111.787	82°56'44.94"		6.255	
CT	1760.378	223745.230	6254111.822	86°24'18.97"	LINE		9.462
TC	1769.839	223754.673	6254112.415	86°24'18.97"	ARC	-40.000	27.410
	1770.000	223754.833	6254112.426	86°10'30.36"		-40.000	
	1780.000	223764.625	6254114.326	71°51'04.16"		-40.000	
	1790.000	223773.641	6254118.591	57°31'37.95"		-40.000	
CT	1797.249	223779.372	6254123.014	47°08'37.48"	LINE		15.279
	1800.000	223781.388	6254124.885	47°08'37.48"			
	1810.000	223788.719	6254131.687	47°08'37.48"			
E	1812.528	223790.572	6254133.406	47°08'37.48"			

HORIZONTAL ALIGNMENT REPORT - GULLY

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224202.751	6254168.490	164°07'50.37"	LINE		7.033
TC	7.033	224204.674	6254161.725	164°07'50.37"	ARC	30.000	7.887
	10.000	224205.343	6254158.836	169°47'46.91"		30.000	
CT	14.921	224205.814	6254153.943	179°11'40.38"	LINE		1.133
TC	16.054	224205.830	6254152.810	179°11'40.38"	ARC	-30.000	11.580
	20.000	224206.145	6254148.880	171°39'28.19"		-30.000	
CT	27.633	224208.196	6254141.548	157°04'44.72"	LINE		15.489
	30.000	224209.118	6254139.369	157°04'44.72"			
	40.000	224213.012	6254130.158	157°04'44.72"			
TC	43.122	224214.228	6254127.282	157°04'44.72"	ARC	30.000	3.692
CT	46.815	224215.454	6254123.802	164°07'50.94"	LINE		16.147
	50.000	224216.325	6254120.738	164°07'50.94"			
	60.000	224219.059	6254111.119	164°07'50.94"			
E	62.961	224219.869	6254108.270	164°07'50.94"			

HOLD
PENDING DESIGN APPROVAL

HORIZONTAL ALIGNMENT REPORT - MC20

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224268.176	6254125.636	202°48'05.50"	LINE		2.317
TC	2.317	224267.277	6254123.500	202°48'05.50"	ARC	14.000	10.969
	10.000	224262.552	6254117.564	234°14'34.73"		14.000	
CT	13.286	224259.686	6254115.973	247°41'32.76"	LINE		24.311
	20.000	224253.474	6254113.425	247°41'32.76"			
	30.000	224244.223	6254109.629	247°41'32.76"			
TC	37.598	224237.194	6254106.745	247°41'32.76"	ARC	-8.800	19.613
	40.000	224235.122	6254105.543	232°03'01.81"		-8.800	
	50.000	224231.962	6254096.615	166°56'29.98"		-8.800	
CT	57.210	224236.134	6254090.983	119°59'50.19"	LINE		16.979
	60.000	224238.551	6254089.588	119°59'50.19"			
	70.000	224247.211	6254084.588	119°59'50.19"			
TC	74.189	224250.839	6254082.494	119°59'50.19"	ARC	-60.000	4.893
CT	79.082	224255.171	6254080.223	115°19'29.51"	LINE		32.994
	80.000	224256.001	6254079.830	115°19'29.51"			
	90.000	224265.040	6254075.553	115°19'29.51"			
	100.000	224274.079	6254071.275	115°19'29.51"			
	110.000	224283.118	6254066.998	115°19'29.51"			
E	112.076	224284.995	6254066.110	115°19'29.51"			

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD | DESIGN LOT CODE: --

SCALE: N/A

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
ALIGNMENT SETOUT SCHEDULES

DRAWING SET No: -	PART:	SHEET: 3 OF 3	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00013				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00013.dwg
PLOT DATE & TIME: 10/10/2024 7:00:56 PM

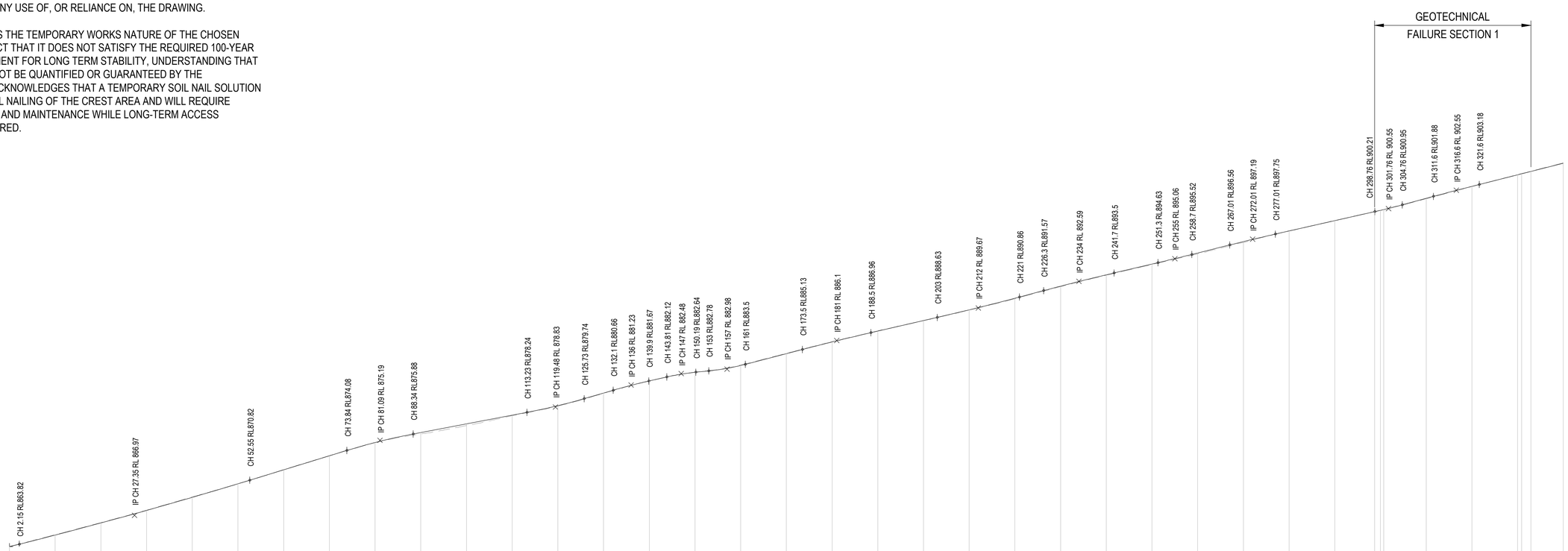
LEGEND

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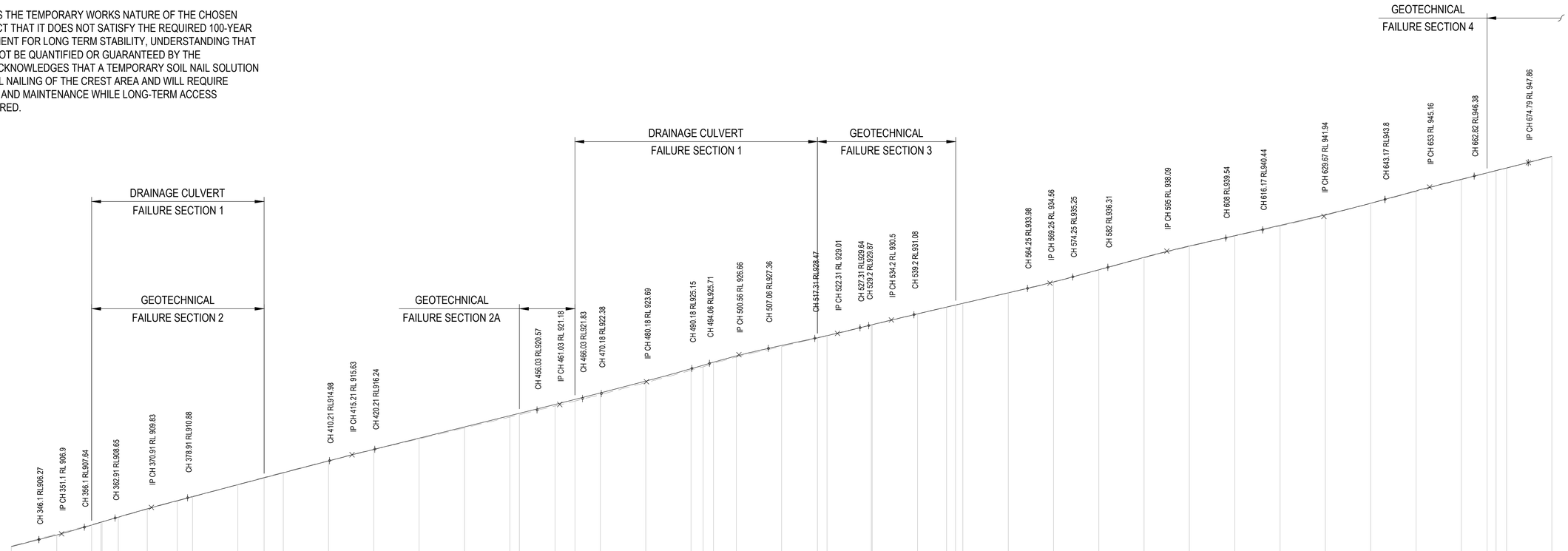
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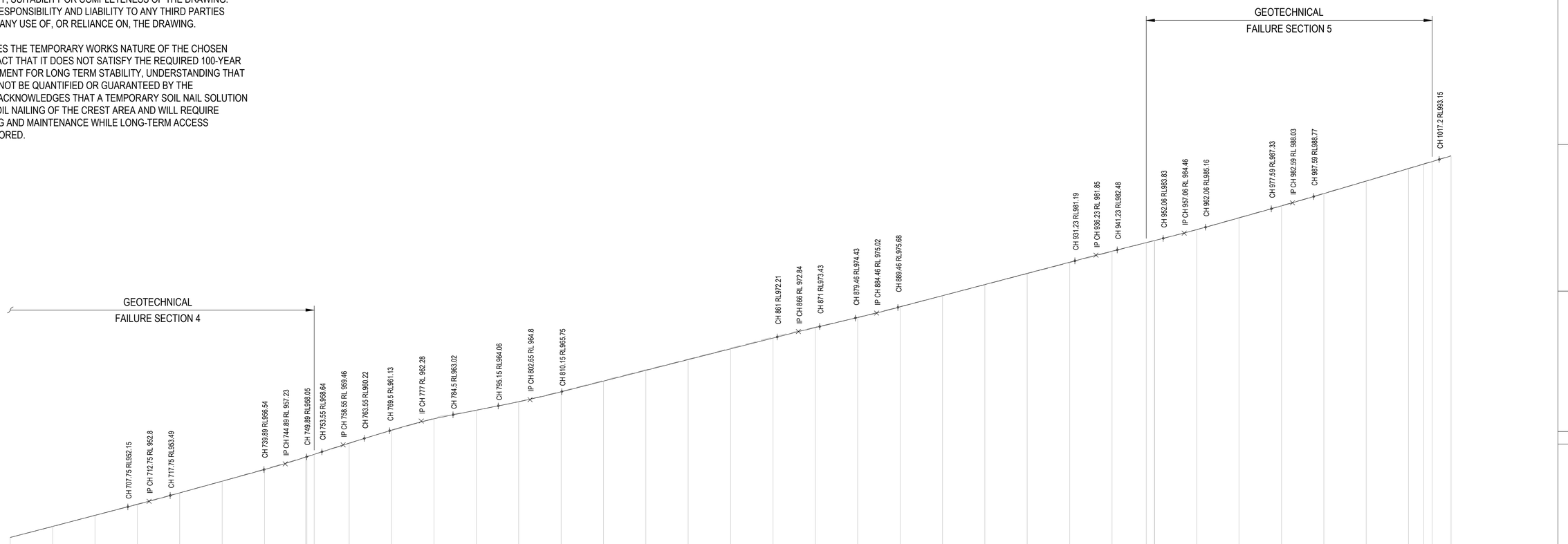
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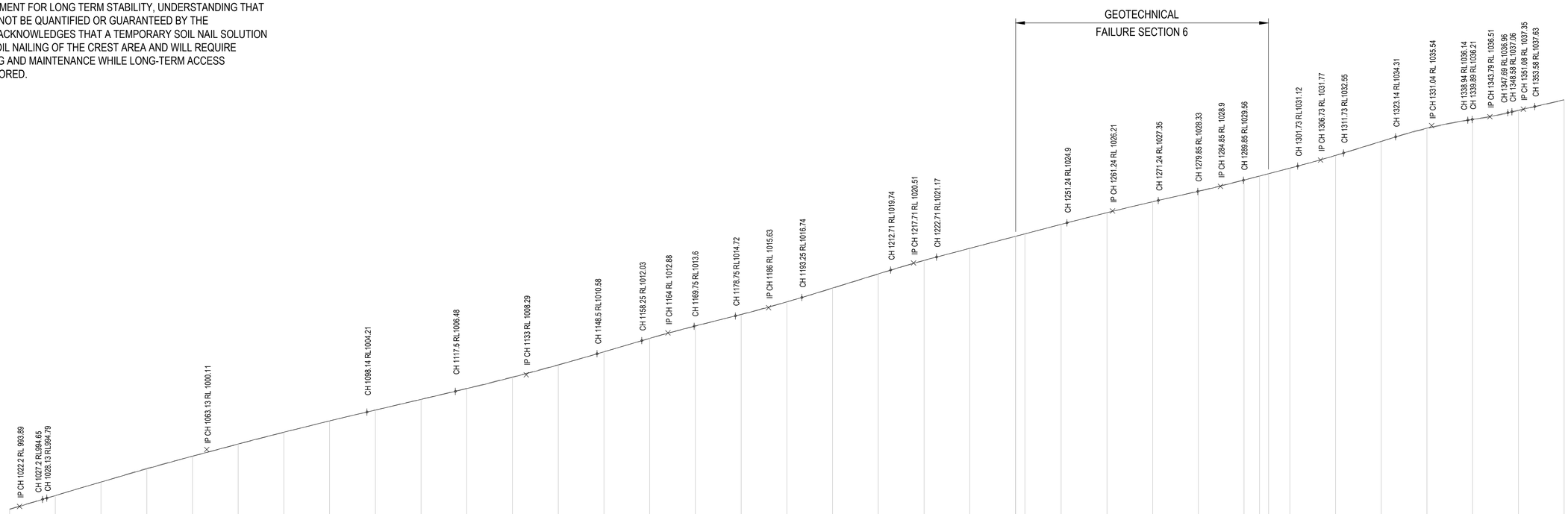
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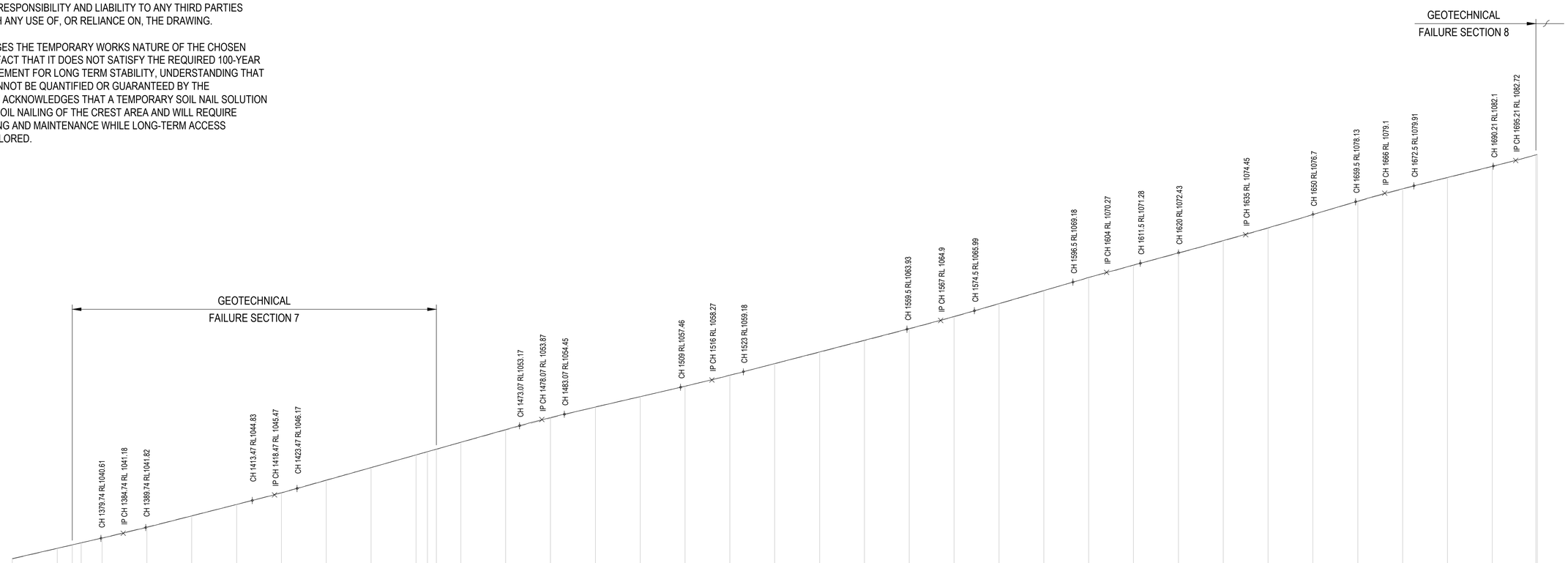
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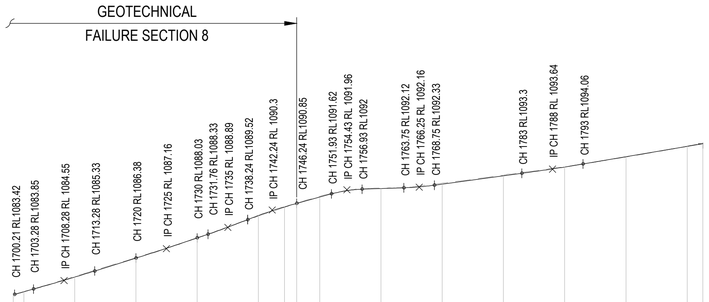
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EXISTING SURFACE

DESIGN SURFACE



DATUM RL. 859.00

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LEGEND

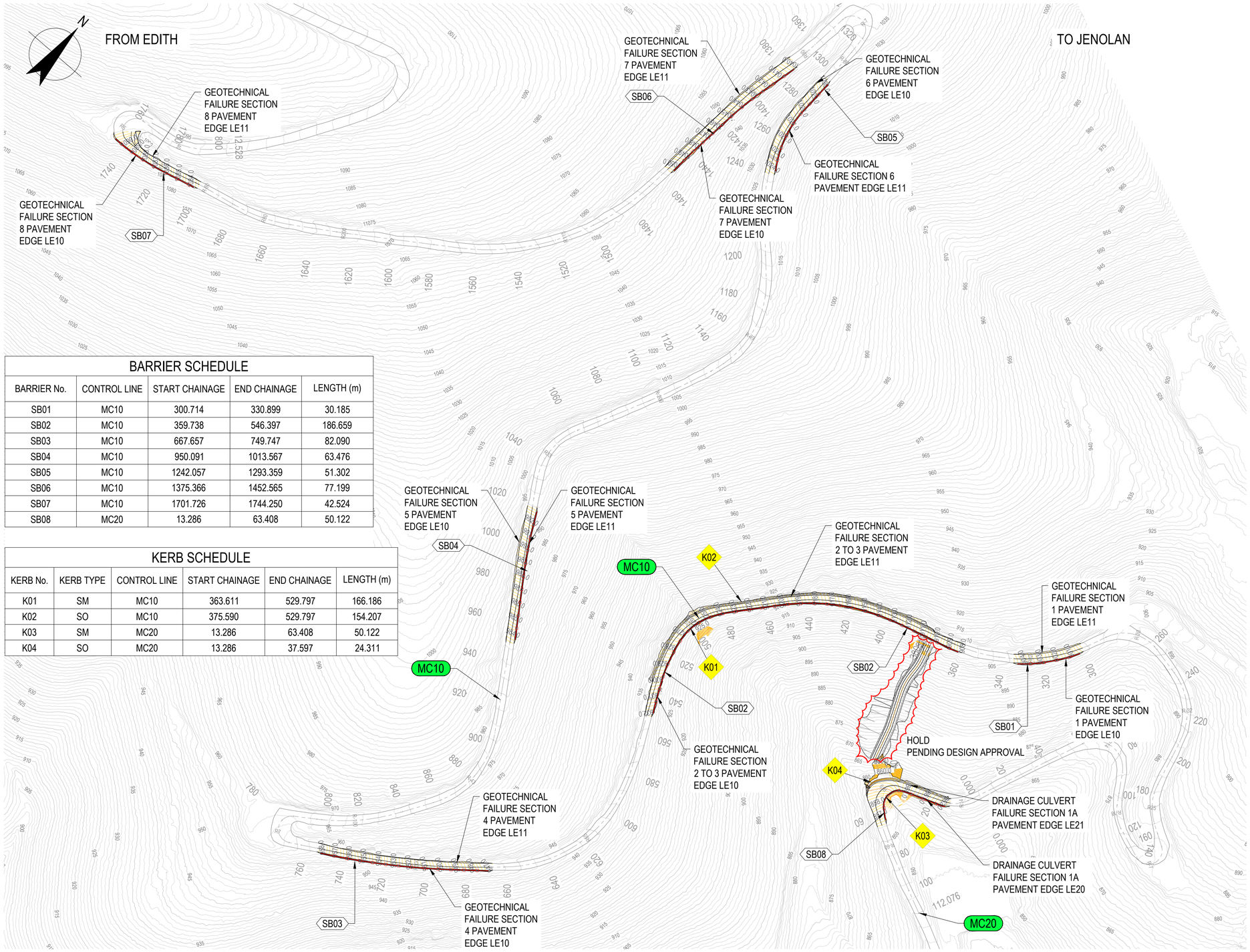
EXISTING SURFACE

DESIGN SURFACE



DATUM RL. 846.00

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BARRIER SCHEDULE

BARRIER No.	CONTROL LINE	START CHAINAGE	END CHAINAGE	LENGTH (m)
SB01	MC10	300.714	330.899	30.185
SB02	MC10	359.738	546.397	186.659
SB03	MC10	667.657	749.747	82.090
SB04	MC10	950.091	1013.567	63.476
SB05	MC10	1242.057	1293.359	51.302
SB06	MC10	1375.366	1452.565	77.199
SB07	MC10	1701.726	1744.250	42.524
SB08	MC20	13.286	63.408	50.122

KERB SCHEDULE

KERB No.	KERB TYPE	CONTROL LINE	START CHAINAGE	END CHAINAGE	LENGTH (m)
K01	SM	MC10	363.611	529.797	166.186
K02	SO	MC10	375.590	529.797	154.207
K03	SM	MC20	13.286	63.408	50.122
K04	SO	MC20	13.286	37.597	24.311

LEGEND

- 1560 - CHAINAGES
- MC10
- 995 DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- 995 EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD DESIGN
- ROAD SAFETY BARRIER
- SB** ROAD SAFETY BARRIER NUMBER
- KXX ROAD KERB NUMBER

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:1000

0 10 20 30m

SCALE 1:1000 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
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DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

PAVEMENT EDGE SETOUT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00031				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00031.dwg

PLOT DATE & TIME: 10/10/2024 7:03:04 PM

DRAINAGE CULVERT FAILURE SECTION 1A PAVEMENT EDGE LE20

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224262.272	6254115.509	231°52'22.23"	LINE		0.101
TC	0.101	224262.193	6254115.447	231°52'22.23"	ARC	17.000	5.466
CT	5.567	224257.428	6254112.816	250°17'44.84"	LINE		15.735
	10.000	224253.255	6254111.321	250°17'44.84"			
	20.000	224243.840	6254107.949	250°17'44.84"			
TS	21.302	224242.615	6254107.510	250°17'44.84"	TRANSITION		6.000
SC	27.302	224237.437	6254104.613	221°38'52.44"	ARC	-6.000	3.022
	30.000	224236.150	6254102.267	195°52'53.04"		-6.000	
CT	30.324	224236.069	6254101.953	192°47'13.52"	LINE		1.208
TC	31.532	224235.802	6254100.775	192°47'13.52"	ARC	-7.000	7.260
CT	38.793	224237.822	6254094.136	133°21'37.54"	LINE		2.975
	40.000	224238.700	6254093.307	133°21'37.54"			
TC	41.768	224239.985	6254092.094	133°21'37.54"	ARC	-20.000	3.906
CT	45.673	224243.068	6254089.706	122°10'17.66"	LINE		1.557
E	47.230	224244.385	6254088.877	122°10'17.66"			

DRAINAGE CULVERT FAILURE SECTION 1A PAVEMENT EDGE LE21

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224260.392	6254118.701	226°50'08.43"	LINE		1.373
TC	1.373	224259.391	6254117.762	226°50'08.43"	ARC	6.000	2.472
CT	3.845	224257.295	6254116.484	250°26'25.40"	LINE		17.684
	10.000	224251.495	6254114.424	250°26'25.40"			
	20.000	224242.072	6254111.076	250°26'25.40"			
TC	21.529	224240.632	6254110.564	250°26'25.40"	ARC	-30.000	1.790
CT	23.319	224238.964	6254109.915	247°01'17.47"	LINE		1.821
TC	25.140	224237.288	6254109.204	247°01'17.47"	ARC	-21.000	12.112
	30.000	224233.071	6254106.808	233°45'37.11"		-21.000	
CT	37.252	224228.071	6254101.606	213°58'30.63"	LINE		0.103
TC	37.355	224228.013	6254101.520	213°58'30.63"	ARC	-7.000	11.798
	40.000	224226.979	6254099.103	192°19'22.38"		-7.000	
CT	49.153	224230.596	6254091.394	117°24'23.18"	LINE		5.699
	50.000	224231.348	6254091.004	117°24'23.18"			
TC	54.852	224235.655	6254088.771	117°24'23.18"	ARC	20.000	1.464
CT	56.316	224236.929	6254088.050	121°36'03.36"	LINE		6.049
	60.000	224240.067	6254086.120	121°36'03.36"			
E	62.365	224242.081	6254084.880	121°36'03.36"			

GEOTECHNICAL FAILURE SECTION 1 PAVEMENT EDGE LE10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224262.379	6254215.557	208°12'38.85"	LINE		2.820
TC	2.820	224261.046	6254213.072	208°12'38.85"	ARC	60.000	10.910
	10.000	224257.282	6254206.963	215°04'00.21"		60.000	
CT	13.730	224255.045	6254203.978	218°37'44.08"	LINE		3.478
TC	17.208	224252.874	6254201.261	218°37'44.08"	ARC	70.000	14.775
	20.000	224251.088	6254199.116	220°54'49.67"		70.000	
	30.000	224244.022	6254192.051	229°05'56.08"		70.000	
CT	31.983	224242.505	6254190.774	230°43'20.43"	LINE		3.050
E	35.034	224240.144	6254188.843	230°43'20.43"			

GEOTECHNICAL FAILURE SECTION 1 PAVEMENT EDGE LE11

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224258.833	6254217.482	208°51'12.83"	LINE		5.934
TC	5.934	224255.969	6254212.284	208°51'12.83"	ARC	35.000	7.622
	10.000	224253.805	6254208.845	215°30'32.02"		35.000	
CT	13.556	224251.596	6254206.060	221°19'49.93"	LINE		4.149
TC	17.705	224248.856	6254202.945	221°19'49.93"	ARC	80.000	14.188
	20.000	224247.316	6254201.243	222°58'26.69"		80.000	
	30.000	224240.060	6254194.371	230°08'09.80"		80.000	
CT	31.894	224238.592	6254193.175	231°29'31.93"	LINE		1.405
E	33.298	224237.493	6254192.300	231°29'31.93"			

GEOTECHNICAL FAILURE SECTION 2 TO 3 PAVEMENT EDGE LE10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224217.966	6254176.344	250°41'13.85"	LINE		2.534
TC	2.534	224215.575	6254175.506	250°41'13.85"	ARC	100.000	9.530
	10.000	224208.443	6254173.302	254°57'53.51"		100.000	
CT	12.064	224206.445	6254172.788	256°08'50.01"	LINE		2.906
TC	14.969	224203.624	6254172.092	256°08'50.01"	ARC	-500.000	19.915
	20.000	224198.745	6254170.863	255°34'14.68"		-500.000	
	30.000	224189.086	6254168.274	254°25'29.38"		-500.000	
CT	34.884	224184.388	6254166.940	253°51'54.48"	LINE		1.418
TC	36.302	224183.026	6254166.546	253°51'54.48"	ARC	-101.000	57.656
	40.000	224179.493	6254165.453	251°46'03.31"		-101.000	
	50.000	224170.166	6254161.860	246°05'41.05"		-101.000	
	60.000	224161.239	6254157.362	240°25'18.79"		-101.000	
	70.000	224152.800	6254152.004	234°44'56.54"		-101.000	
	80.000	224144.933	6254145.838	229°04'34.28"		-101.000	
	90.000	224137.713	6254138.924	223°24'12.02"		-101.000	
CT	93.958	224135.051	6254135.996	221°09'28.40"	LINE		20.901
	100.000	224131.074	6254131.447	221°09'28.40"			
	110.000	224124.493	6254123.918	221°09'28.40"			
TS	114.859	224121.295	6254120.259	221°09'28.40"	TRANSITION		16.000
	120.000	224117.949	6254116.357	219°31'34.79"			
	130.000	224112.325	6254108.113	207°00'16.15"			
SC	130.859	224111.946	6254107.341	205°21'07.77"	ARC	-29.000	12.911
	140.000	224109.388	6254098.605	187°17'34.52"		-29.000	
CS	143.770	224109.153	6254094.845	179°50'36.91"	TRANSITION		15.000
	150.000	224109.745	6254088.651	170°05'29.39"			
ST	158.770	224111.760	6254080.118	165°01'32.56"	LINE		0.262
TC	159.032	224111.828	6254079.866	165°01'32.56"	ARC	-58.000	9.085
	160.000	224112.086	6254078.933	164°04'10.13"		-58.000	
CT	168.117	224114.851	6254071.309	156°03'04.67"	LINE		4.614
	170.000	224115.616	6254069.588	156°03'04.67"			
TC	172.731	224116.725	6254067.092	156°03'04.67"	ARC	-150.000	8.674
	180.000	224119.835	6254060.523	153°16'29.35"		-150.000	
CT	181.405	224120.472	6254059.271	152°44'17.50"	LINE		6.456
E	187.861	224123.430	6254053.532	152°44'17.50"			

GEOTECHNICAL FAILURE SECTION 2 TO 3 PAVEMENT EDGE LE11

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224216.532	6254180.283	249°26'24.97"	LINE		5.681
TC	5.681	224211.213	6254178.288	249°26'24.97"	ARC	100.000	14.674
	10.000	224207.137	6254176.859	251°54'54.15"		100.000	
	20.000	224197.492	6254174.235	257°38'40.63"		100.000	
CT	20.354	224197.146	6254174.159	257°50'51.52"	LINE		1.525
TC	21.879	224195.655	6254173.838	257°50'51.52"	ARC	-115.000	18.156
	30.000	224187.783	6254171.850	253°48'06.09"		-115.000	
	40.000	224178.313	6254168.647	248°49'10.02"		-115.000	
CT	40.035	224178.280	6254168.634	248°48'06.72"	LINE		11.144
	50.000	224168.990	6254165.031	248°48'06.72"			
TC	51.179	224167.891	6254164.605	248°48'06.72"	ARC	-75.000	21.563
	60.000	224159.873	6254160.939	242°03'47.17"		-75.000	
	70.000	224151.376	6254155.680	234°25'25.20"		-75.000	
CS	72.742	224149.176	6254154.045	232°19'45.09"	TRANSITION		30.000
	80.000	224143.635	6254149.359	227°27'18.06"			
	90.000	224136.568	6254142.288	222°56'13.70"			
	100.000	224129.911	6254134.826	220°57'56.67"			
ST	102.742	224128.116	6254132.754	220°52'12.13"	LINE		1.751
TC	104.493	224126.970	6254131.430	220°52'12.13"	ARC	100.000	0.356
CT	104.849	224126.736	6254131.161	221°04'27.11"	LINE		21.553
	110.000	224123.352	6254127.278	221°04'27.11"			
	120.000	224116.782	6254119.739	221°04'27.11"			
TC	126.402	224112.576	6254114.913	221°04'27.11"	ARC	-30.000	22.300
	130.000	224110.380	6254112.066	214°12'07.76"		-30.000	
	140.000	224106.228	6254103.019	195°06'12.83"		-30.000	
CS	148.702	224105.202	6254094.409	178°29'04.62"	TRANSITION		16.000
	150.000	224105.263	6254093.112	176°06'20.08"			
	160.000	224107.113	6254083.302	164°31'30.26"			
ST	164.702	224108.437	6254078.791	163°12'20.67"	LINE		4.536
TC	169.238	224109.748	6254074.448	163°12'20.67"	ARC	-65.000	8.474
	170.000	224109.973	6254073.720	162°32'01.93"		-65.000	
CS	177.711	224112.717	6254066.518	155°44'11.04"	TRANSITION		10.000
	180.000	224113.692	6254064.448	153°56'59.86"			
ST	187.711	224117.288	6254057.627	151°19'44.51"	LINE		6.304
	190.000	224118.386	6254055.619	151°19'44.51"			
E	194.015	224120.312	6254052.096	151°19'44.51"			

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: N/A

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SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

KERB AND BARRIER ALIGNMENT SETOUT SCHEDULES

DRAWING SET No: -	PART:	SHEET: 1 OF 2	A1
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DRG No.	REV	VER	EDMS No.	AMD No.
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FILE NAME: 21-12625762-GHD-DD-DRG-CI-00041.dwg

PLOT DATE & TIME: 10/10/2024 7:03:17 PM

GEOTECHNICAL FAILURE SECTION 4 PAVEMENT EDGE LE10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224113.533	6253945.907	231°34'50.29"	LINE		2.761
TC	2.761	224111.369	6253944.192	231°34'50.29"	ARC	-1000.000	11.522
	10.000	224105.714	6253939.673	231°09'57.16"		-1000.000	
CT	14.283	224102.383	6253936.980	230°55'13.69"	LINE		3.415
TC	17.698	224099.733	6253934.827	230°55'13.69"	ARC	360.000	63.651
	20.000	224097.941	6253933.382	231°17'12.74"		360.000	
	30.000	224090.052	6253927.237	232°52'42.31"		360.000	
	40.000	224081.996	6253921.313	234°28'11.89"		360.000	
	50.000	224073.778	6253915.616	236°03'41.47"		360.000	
	60.000	224065.405	6253910.149	237°39'11.05"		360.000	
	70.000	224056.884	6253904.916	239°14'40.63"		360.000	
	80.000	224048.220	6253899.922	240°50'10.20"		360.000	
CT	81.349	224047.041	6253899.267	241°03'02.91"	LINE		5.004
E	86.353	224042.662	6253896.845	241°03'02.91"			

GEOTECHNICAL FAILURE SECTION 4 PAVEMENT EDGE LE11

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224111.258	6253948.520	229°20'26.84"	LINE		0.675
TC	0.675	224110.746	6253948.080	229°20'26.84"	ARC	400.000	42.189
	10.000	224103.602	6253942.087	230°40'35.55"		400.000	
	20.000	224095.788	6253935.848	232°06'32.17"		400.000	
	30.000	224087.820	6253929.805	233°32'28.79"		400.000	
	40.000	224079.704	6253923.964	234°58'25.41"		400.000	
CT	42.863	224077.353	6253922.329	235°23'01.94"	LINE		3.969
TC	46.833	224074.086	6253920.074	235°23'01.94"	ARC	250.000	36.477
	50.000	224071.469	6253918.291	236°06'35.14"		250.000	
	60.000	224063.058	6253912.883	238°24'05.73"		250.000	
	70.000	224054.438	6253907.815	240°41'36.32"		250.000	
	80.000	224045.623	6253903.096	242°59'06.91"		250.000	
CT	83.310	224042.664	6253901.612	243°44'37.81"	LINE		2.335
E	85.645	224040.570	6253900.579	243°44'37.81"			

GEOTECHNICAL FAILURE SECTION 5 PAVEMENT EDGE LE10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224045.699	6254034.621	327°20'53.85"	LINE		41.879
	10.000	224040.304	6254043.041	327°20'53.85"			
	20.000	224034.909	6254051.461	327°20'53.85"			
	30.000	224029.514	6254059.880	327°20'53.85"			
	40.000	224024.118	6254068.300	327°20'53.85"			
TC	41.879	224023.105	6254069.882	327°20'53.85"	ARC	200.000	11.211
	50.000	224018.863	6254076.807	329°40'29.59"		200.000	
CT	53.090	224017.324	6254079.485	330°33'35.94"	LINE		14.407
	60.000	224013.927	6254085.503	330°33'35.94"			
E	67.497	224010.242	6254092.032	330°33'35.94"			

GEOTECHNICAL FAILURE SECTION 5 PAVEMENT EDGE LE11

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	224049.111	6254036.698	326°48'56.75"	LINE		34.791
	10.000	224043.638	6254045.067	326°48'56.75"			
	20.000	224038.165	6254053.436	326°48'56.75"			
	30.000	224032.691	6254061.806	326°48'56.75"			
TC	34.791	224030.069	6254065.815	326°48'56.75"	ARC	200.000	24.256
	40.000	224027.275	6254070.211	328°18'29.24"		200.000	
	50.000	224022.236	6254078.848	331°10'22.48"		200.000	
CT	59.047	224018.055	6254086.870	333°45'52.86"	LINE		8.506
	60.000	224017.634	6254087.725	333°45'52.86"			
E	67.553	224014.295	6254094.499	333°45'52.86"			

GEOTECHNICAL FAILURE SECTION 6 PAVEMENT EDGE LE10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	223991.661	6254291.077	332°30'20.11"	LINE		2.627
TS	2.627	223990.448	6254293.407	332°30'20.11"	TRANSITION		10.000
	10.000	223987.153	6254300.002	335°20'13.79"			
SC	12.627	223986.104	6254302.410	337°42'51.45"	ARC	55.000	13.387
	20.000	223983.773	6254309.399	345°23'42.51"		55.000	
CS	26.014	223982.577	6254315.289	351°39'35.38"	TRANSITION		20.000
	30.000	223982.133	6254319.250	355°23'55.33"			
	40.000	223981.906	6254329.243	1°08'07.44"			
ST	46.014	223982.091	6254335.254	2°04'38.08"	LINE		10.668
	50.000	223982.236	6254339.238	2°04'38.08"			
E	56.682	223982.478	6254345.915	2°04'38.08"			

GEOTECHNICAL FAILURE SECTION 6 PAVEMENT EDGE LE11

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	223995.875	6254293.259	328°12'24.10"	LINE		3.924
TC	3.924	223993.807	6254296.594	328°12'24.10"	ARC	53.000	31.435
	10.000	223990.909	6254301.930	334°46'31.76"		53.000	
	20.000	223987.523	6254311.324	345°35'09.65"		53.000	
	30.000	223985.960	6254321.186	356°23'47.54"		53.000	
CT	35.358	223985.894	6254326.542	2°11'21.51"	LINE		19.235
	40.000	223986.071	6254331.180	2°11'21.51"			
	50.000	223986.453	6254341.173	2°11'21.51"			
E	54.594	223986.628	6254345.763	2°11'21.51"			

GEOTECHNICAL FAILURE SECTION 7 PAVEMENT EDGE LE10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	223969.633	6254340.626	193°57'15.62"	LINE		22.379
	10.000	223967.221	6254330.921	193°57'15.62"			
	20.000	223964.810	6254321.216	193°57'15.62"			
TC	22.379	223964.236	6254318.907	193°57'15.62"	ARC	-145.000	18.602
	30.000	223962.594	6254311.466	190°56'35.06"		-145.000	
	40.000	223961.035	6254301.590	186°59'29.90"		-145.000	
CT	40.982	223960.919	6254300.615	186°36'13.28"	LINE		27.867
	50.000	223959.882	6254291.657	186°36'13.28"			
	60.000	223958.732	6254281.723	186°36'13.28"			
DIS	68.849	223957.714	6254272.933	183°41'56.69"	LINE		12.031
	70.000	223957.640	6254271.784	183°41'56.69"			
	80.000	223956.995	6254261.805	183°41'56.69"			
E	80.880	223956.938	6254260.927	183°41'56.69"			

GEOTECHNICAL FAILURE SECTION 7 PAVEMENT EDGE LE11

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	223964.037	6254342.013	192°17'56.22"	LINE		6.694
TS	6.694	223962.611	6254335.472	192°17'56.22"	TRANSITION		20.000
	10.000	223961.908	6254332.242	192°14'10.79"			
	20.000	223959.853	6254322.455	191°17'04.37"			
SC	26.694	223958.612	6254315.878	190°00'25.63"	ARC	-250.000	11.650
	30.000	223958.059	6254312.618	189°14'58.08"		-250.000	
CS	38.345	223956.855	6254304.361	187°20'13.31"	TRANSITION		20.000
	40.000	223956.649	6254302.719	186°58'24.01"			
	50.000	223955.584	6254292.776	185°26'38.98"			
ST	58.345	223954.831	6254284.465	185°02'42.72"	LINE		23.177
	60.000	223954.686	6254282.816	185°02'42.72"			
	70.000	223953.806	6254272.855	185°02'42.72"			
	80.000	223952.927	6254262.894	185°02'42.72"			
E	81.521	223952.793	6254261.378	185°02'42.72"			

GEOTECHNICAL FAILURE SECTION 8 PAVEMENT EDGE LE10

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	223786.736	6254104.268	256°25'08.84"	LINE		19.162
	10.000	223777.016	6254101.920	256°25'08.84"			
TC	19.162	223768.110	6254099.768	256°25'08.84"	ARC	109.000	26.858
	20.000	223767.295	6254099.575	256°51'34.84"		109.000	
	30.000	223757.466	6254097.751	262°06'58.22"		109.000	
	40.000	223747.511	6254096.835	267°22'21.60"		109.000	
CT	46.020	223741.493	6254096.725	270°32'14.12"	LINE		0.395
TC	46.415	223741.098	6254096.729	270°32'14.12"	ARC	4.000	3.655
	50.000	223737.988	6254098.260	321°53'14.05"		4.000	
CT	50.070	223737.946	6254098.315	322°53'11.92"	LINE		0.077
E	50.147	223737.899	6254098.377	322°53'11.92"			

GEOTECHNICAL FAILURE SECTION 8 PAVEMENT EDGE LE11

PT	CHAINAGE	EASTING	NORTHING	BEARING	ELEMENT	RADIUS	LENGTH
S	0.000	223785.869	6254107.767	255°50'11.36"	LINE		11.989
	10.000	223776.173	6254105.320	255°50'11.36"			
TC	11.989	223774.245	6254104.834	255°50'11.36"	ARC	100.000	4.018
CT	16.007	223770.330	6254103.929	258°08'20.02"	LINE		11.519
	20.000	223766.422	6254103.108	258°08'20.02"			
TC	27.526	223759.057	6254101.561	258°08'20.02"	ARC	20.000	5.151
	30.000	223756.610	6254101.204	265°13'37.78"		20.000	
CT	32.677	223753.936	6254101.160	272°53'46.83"	LINE		0.227
TC	32.904	223753.709	6254101.171	272°53'46.83"	ARC	6.500	8.596
	40.000	223748.125	6254104.962	335°26'34.21"		6.500	
CT	41.500	223747.664	6254106.386	348°39'59.20"	LINE		0.943
E	42.443	223747.478	6254107.310	348°39'59.20"			

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DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
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APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

KERB AND BARRIER ALIGNMENT SETOUT SCHEDULES

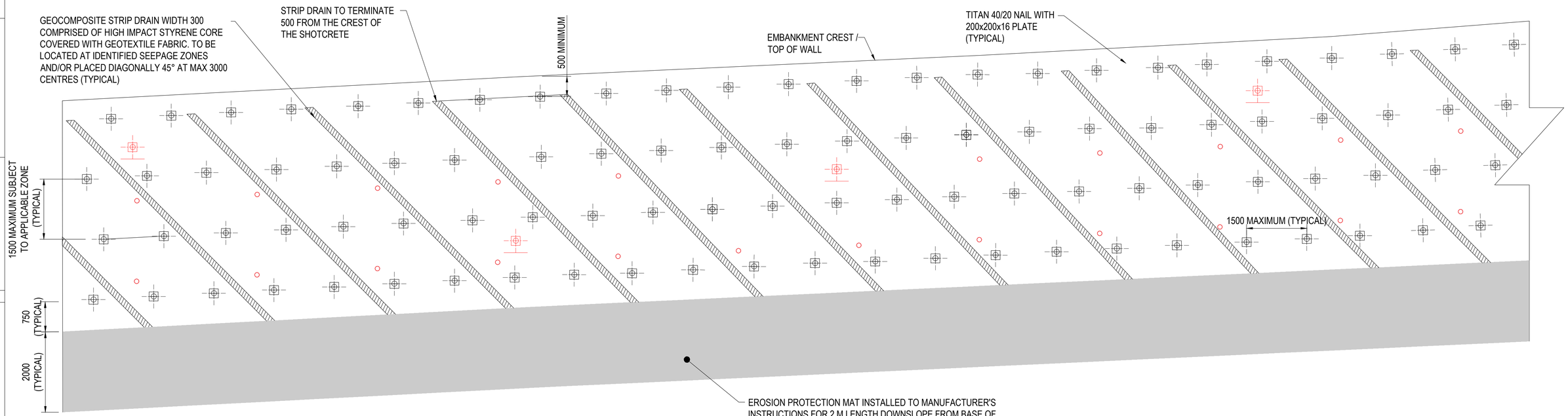
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SUITABILITY TEST SCHEDULE		
MODEL	NO. SUITABILITY TEST	TEST LOCATION
FS1	2	1 BETWEEN FIRST AND SECOND ROW, 1 BETWEEN SECOND AND THIRD ROW
FS2	1	1 BETWEEN FIRST AND SECOND ROW
FS2a	1	1 BETWEEN SECOND AND THIRD ROW
FS3	1	1 BETWEEN THIRD AND FOURTH ROW
FS4	3	1 BETWEEN FIRST AND SECOND ROW, 1 BETWEEN SECOND AND THIRD ROW, 1 BETWEEN THIRD AND FOURTH ROW
FS5	2	1 BETWEEN FIRST AND SECOND ROW, 1 BETWEEN SECOND AND THIRD ROW
FS6	2	1 BETWEEN FIRST AND SECOND ROW, 1 BETWEEN SECOND AND THIRD ROW
FS7	3	1 BETWEEN FIRST AND SECOND ROW, 1 BETWEEN SECOND AND THIRD ROW, 1 BETWEEN THIRD AND FOURTH ROW
FS8	2	1 BETWEEN FIRST AND SECOND ROW, 1 BETWEEN SECOND AND THIRD ROW



NOTES

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2. FOR GENERAL NOTES REFER TO DRAWING No. 12619040-GHD-00-00-DRG-GE-00021.
3. SOIL NAIL SPACING IS TYPICAL ONLY AND MAY BE ADJUSTED LOCALLY BY THE PRINCIPALS GEOTECHNICAL REPRESENTATIVE. REFERENCE TO THE DETAILED DESIGN REPORT AND APPLICABLE ZONE SECTION SHOULD BE REFERRED.
4. APPROXIMATE SUITABILITY TEST NAIL LOCATIONS SHOWN. LOCATIONS MAY VARY PENDING DISCUSSION BETWEEN CONTRACTOR AND DESIGN ENGINEER.
5. FOR NUMBER OF THE SUITABILITY TESTS FOR EACH SECTION REFER TO SUITABILITY TEST SCHEDULE

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LEGEND

- SOIL NAIL
- NEW HORIZONTAL DRAIN
- STRIP DRAIN
- APPROXIMATE SUITABILITY TEST NAIL LOCATION

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DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

TYPICAL DETAIL GEOTECHNICAL SHOTCRETE AND SOIL NAIL ARRANGEMENT

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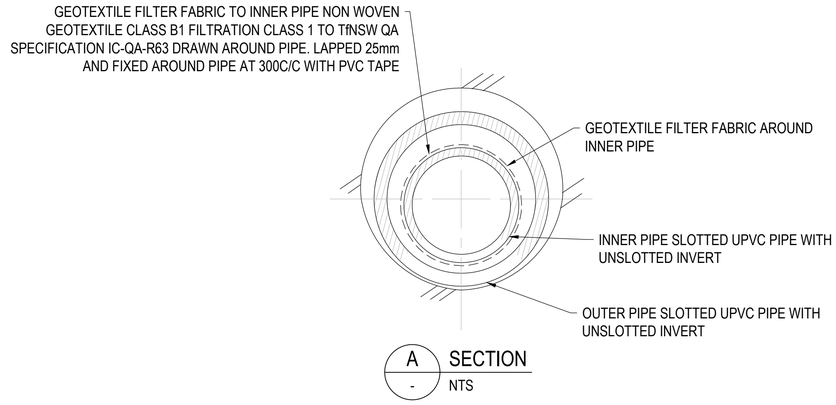
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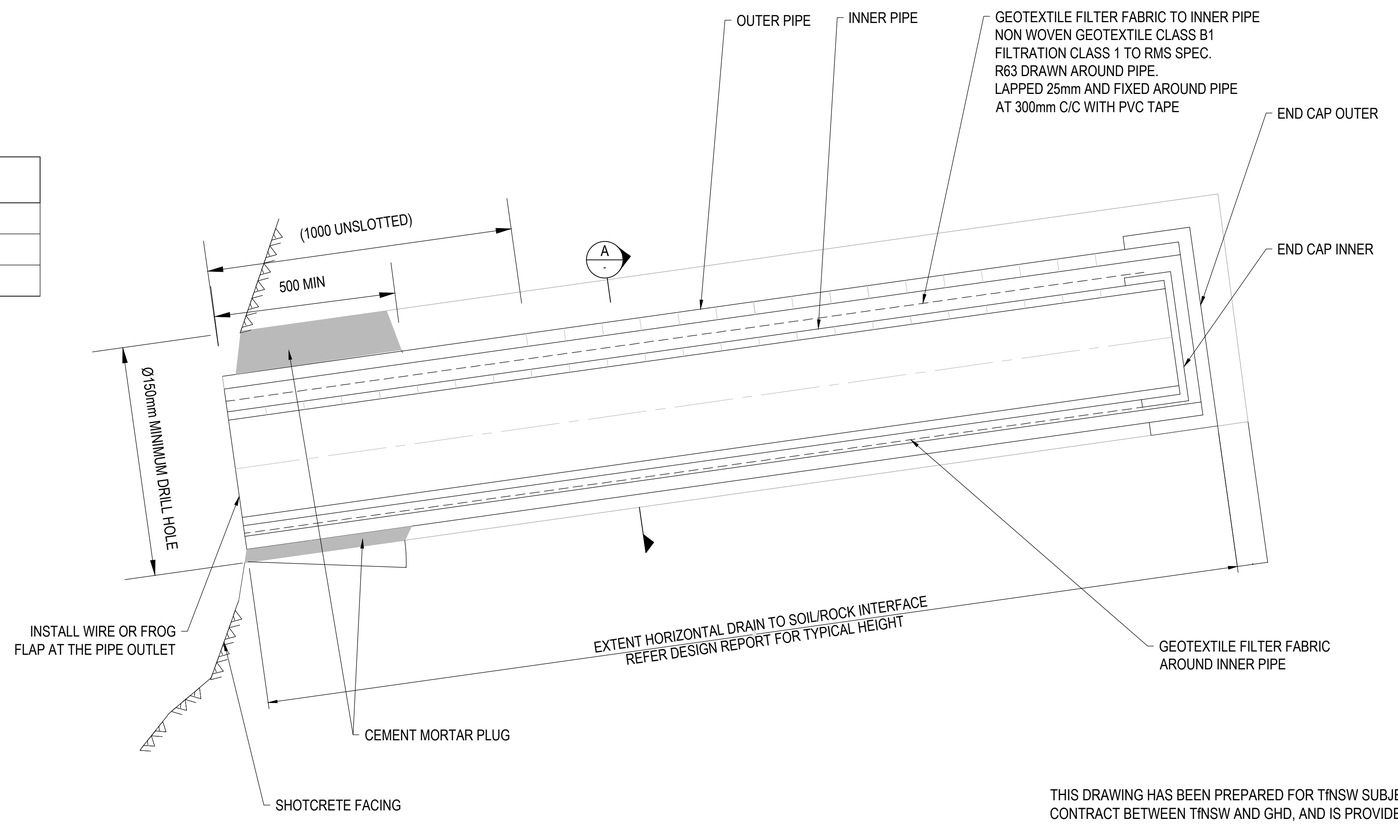
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TABLE R40.1 - PIPE DIAMETERS AND WALL THICKNESS		
	OUTER PIPE (mm)	INNER PIPE (mm)
OUTSIDE DIAMETER	114	75
MINIMUM WALL THICKNESS	8.5	5.5





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SHIRE OF OBERON

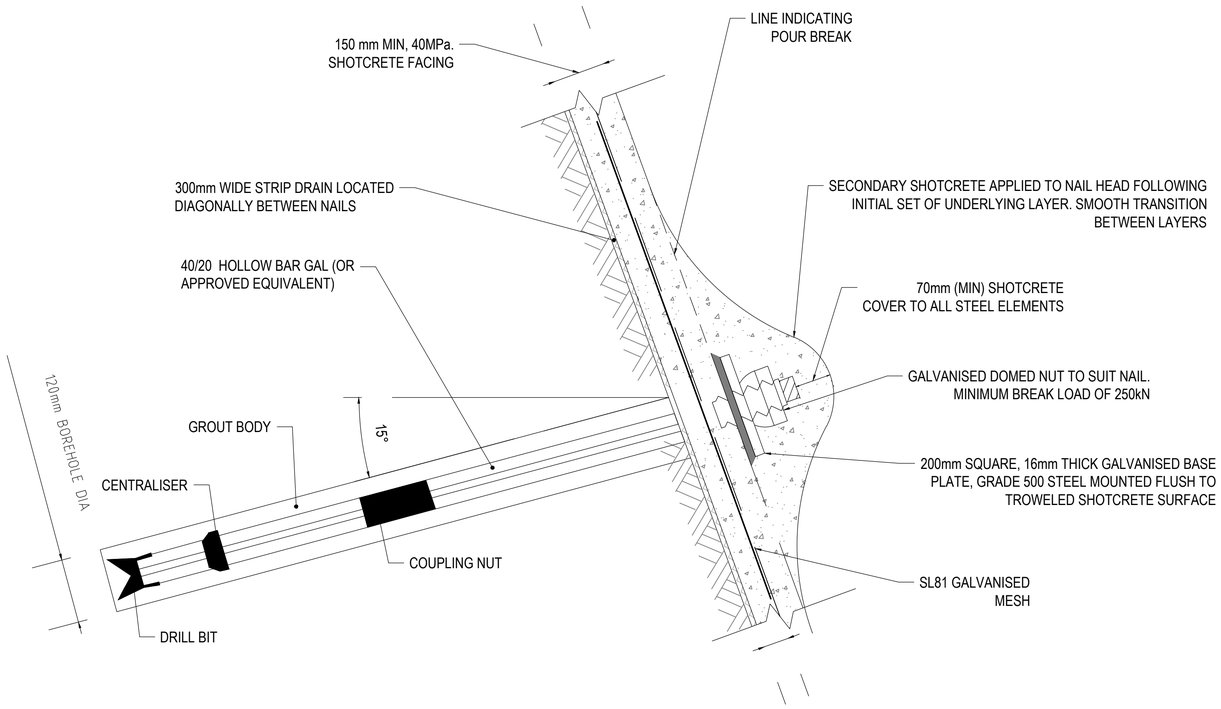
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

TYPICAL DETAIL GEOTECHNICAL SHOTCRETE AND SOIL NAIL ARRANGEMENT

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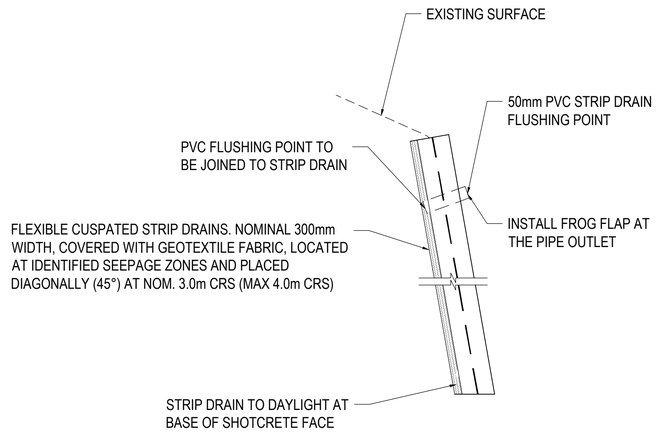
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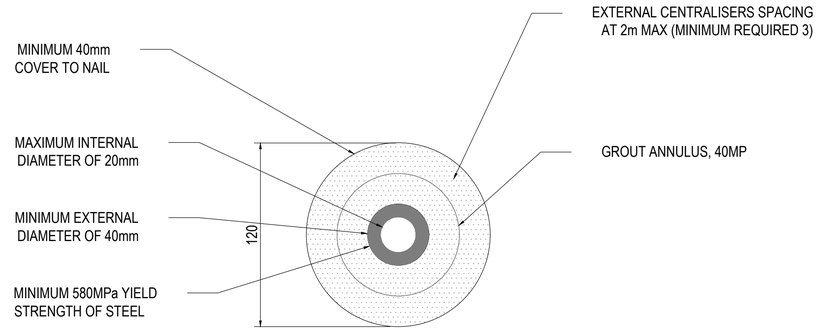
SOIL NAIL AND SHOTCRETE DETAIL
NTS

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SHOTCRETE DRAINAGE (TYP) DETAIL
NTS



HOLLOW BAR SECTION
NTS

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SCALE: N.T.S

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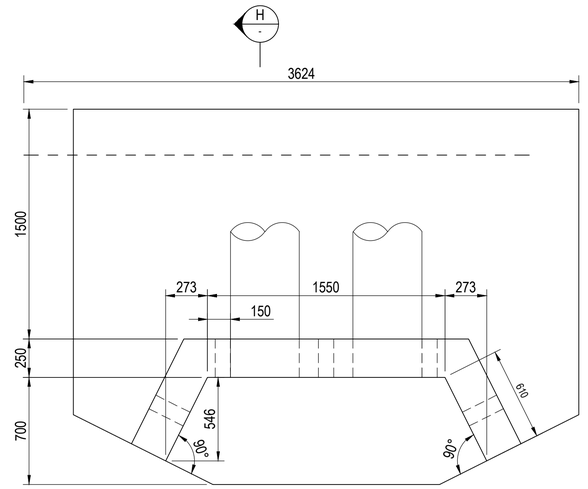
GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	P. HOPPER	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

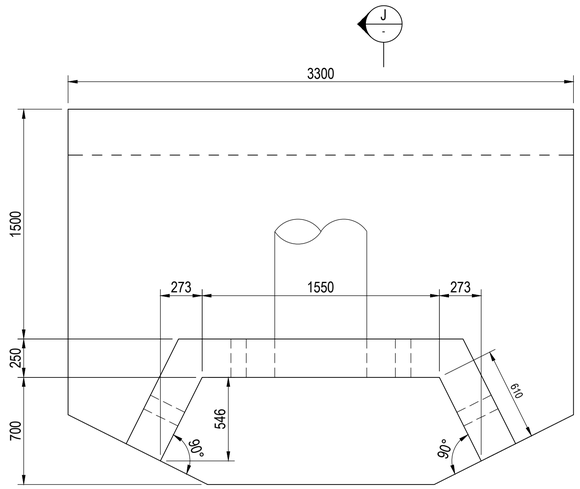
SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
TYPICAL DETAIL GEOTECHNICAL SHOTCRETE AND SOIL NAIL ARRANGEMENT

DRAWING SET No: -	PART:	SHEET: 3 OF 3		A1
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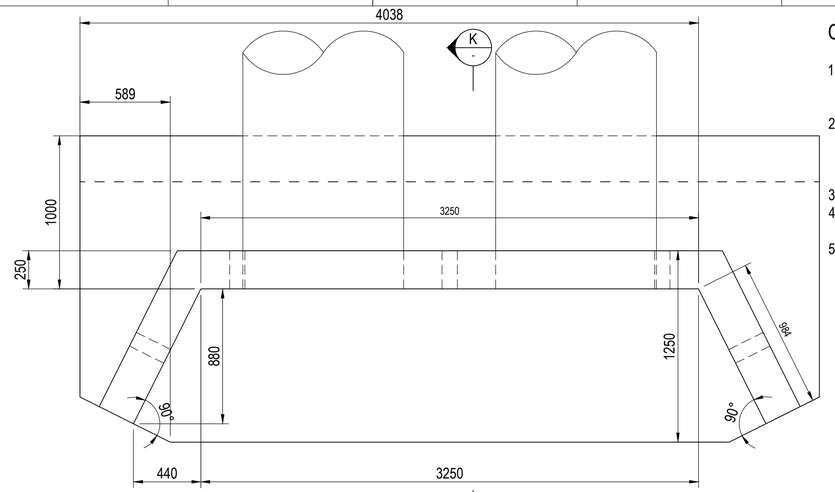
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CULVERT 1 DRAIN SYSTEM PLAN
SCALE 1:20



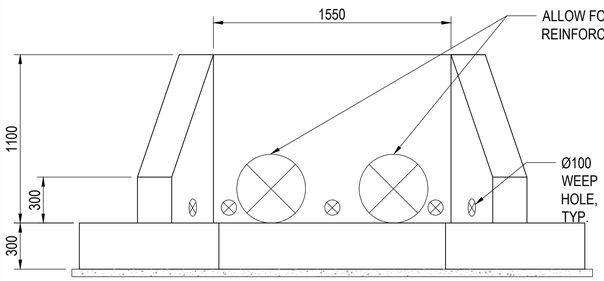
CULVERT 3 DRAIN SYSTEM PLAN
SCALE 1:20



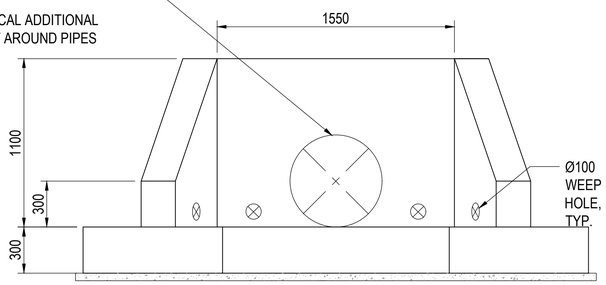
CULVERT 1A DRAIN SYSTEM PLAN
SCALE 1:20

CONCRETE NOTES:

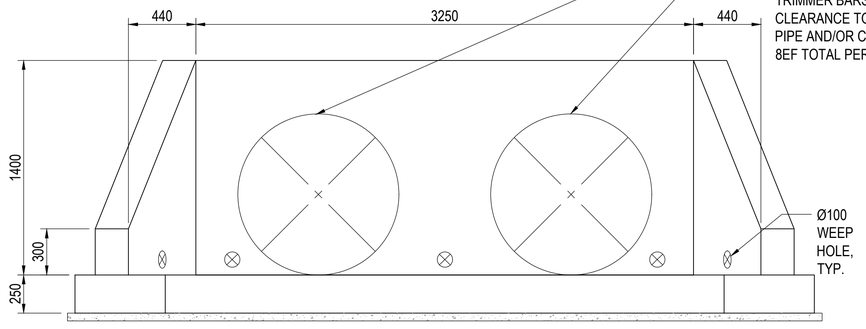
1. ALL REINFORCED CONCRETE SHALL BE S40. ALL CONCRETE BENCHING SHALL BE N20. ALL CONCRETE BLINDING LAYER TO BE N10.
2. CLEAR COVER SHALL BE MIN 50mm TO EXTERNAL SURFACES IN CONTACT WITH GROUND AND INTERNAL SURFACES. PROVIDE MIN 50mm COVER ELSEWHERE.
3. ALLOW FOR 750 LAP LENGTHS TO ALL BARS
4. ALTERNATIVE TO USE PRECAST WALLS TO MANUFACTURERS DETAILS.
5. ENGINEERED BACKFILL TO GEOTECHNICAL ENGINEERING REPORT AND SUBSURFACE DRAIN BEHIND CULVERTS TO TfNSW REQUIREMENTS



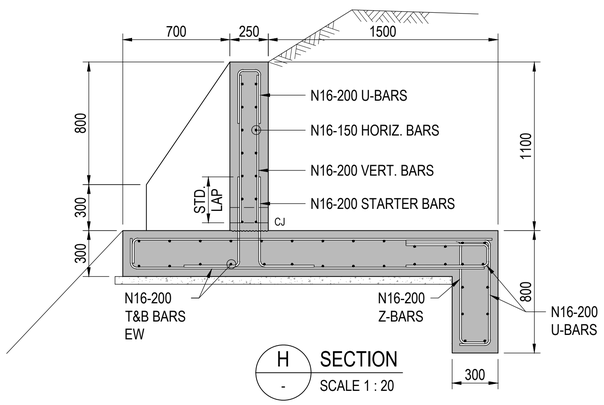
FRONT ELEVATION
SCALE 1:20



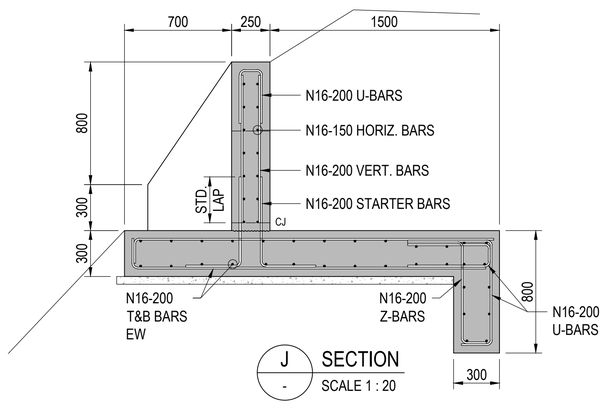
FRONT ELEVATION
SCALE 1:20



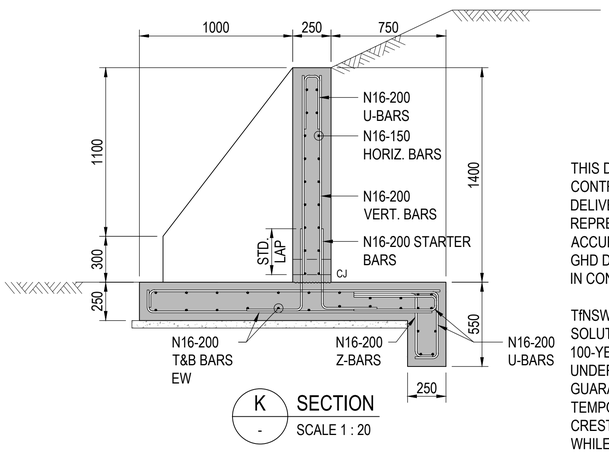
FRONT ELEVATION
SCALE 1:20



H SECTION
SCALE 1 : 20



J SECTION
SCALE 1 : 20



K SECTION
SCALE 1 : 20

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SCALE: N.T.S

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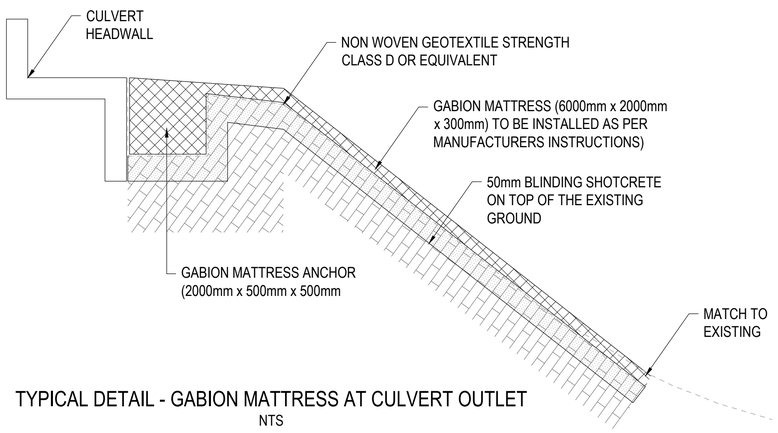
GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	J.KEEM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.RAHMAN	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
TYPICAL DRAINAGE DETAILS

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TYPICAL DETAIL - GABION MATTRESS AT CULVERT OUTLET
NTS

NOTES:

GENERAL

1. ALL DIMENSIONS ARE IN mm AND ALL ELEVATIONS AND COORDINATIONS ARE IN m, UNO.
2. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.
3. SURFACE WATER TO BE DISCHARGED INTO THE EXISTING STORMWATER SYSTEM NEAR THE TOP CAR PARK (CAR PARK 2)

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GHD

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DESIGNED	J.KEEM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.RAHMAN	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

TYPICAL DRAINAGE DETAILS

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HEIGHT DATUM: AHD

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DESIGNED	J.KEEM	10.10.24
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PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

TYPICAL DRAINAGE DETAILS

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DRAWN	K.GORDON	10.10.24
DESIGNED	S.ZARGAR	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.HOWARD	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

TYPICAL PAVEMENT DETAILS

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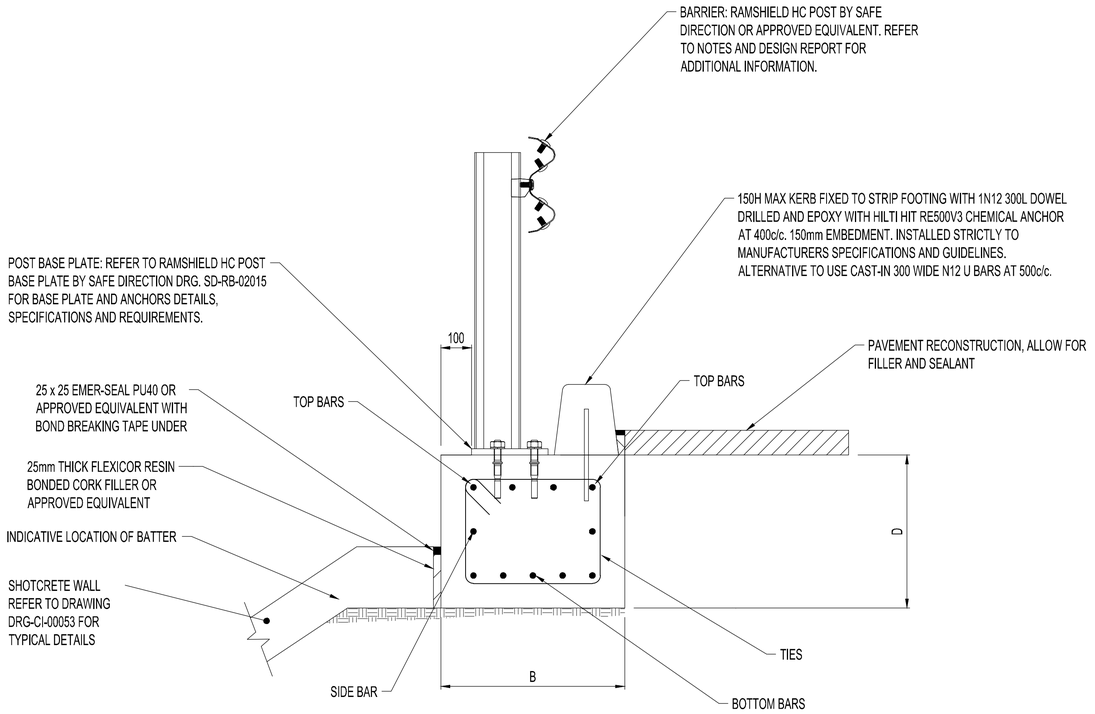
STRIP FOOTING SPECIFICATIONS (REINFORCING BAR)						
D MIN. DEPTH (mm)	B MIN. WIDTH (mm)	L MIN. LENGTH OF FOOTING (m)	TOP BARS	BOTTOM BARS	TIES	SIDE BARS
500	600	17	3N12	5N12	N12-150	1N12

32MPa REINFORCED CONCRETE STRIP FOOTING
MIN 80mm CONCRETE COVER EXCEPT FOR 50mm ON TOP SURFACE
ALL TOP AND BOTTOM BARS TO HAVE 500mm LONG LAPS ALONG MIN. FOOTING LENGTH 'L'

NOTES:

1. GEOTECHNICAL ENGINEER ON SITE TO CONFIRM MINIMUM DESIGNED SOIL PARAMETERS OF:
   150kPa ALLOWABLE BEARING PRESSURE
   0.53 FRICTION COEFFICIENT CONCRETE / SOIL , MIN. DESIGN BASE FRICTION ANGLE OF 28DEG.
   TO BE ACHIEVED BY COMPACTION OF GROUND AND/OR ALLOWING FOR CONCRETE BLINDING LAYER
2. FOR LOCATIONS WHERE THE BATTER HINGE POINT OF A 1:1 WEAK SOIL EMBANKMENT IS BEYOND THE MINIMUM DYNAMIC DEFLECTION OF THE BARRIER SYSTEM AN ALTERNATIVE SYSTEM, i.e. RAMSHIELD EDGE BY SAFE DIRECTION, CAN BE SPECIFIED SUBJECT TO ENGINEER AND MANUFACTURERS APPROVAL.
3. CURVED ALLOWANCE ON SITE TO BE MADE FOR FORMWORK AND LONGITUDINAL REINFORCEMENT (TOP AND BOTTOM BARS). FITTING FORMWORK AT DISCRETION OF PRINCIPALS

FOOTING SIZE BASED ON SAFE DIRECTION TECHNICAL DIRECTORATE 022: RAMSHIELD HIGH CONTAINMENT POSTS WITH BASEPLATE AND SAFE DIRECTION DRAWINGS SD-RB-02018 AND SD-RB-02015. REFER TO THE DESIGN REPORT FOR FURTHER INFORMATION.



HC GROUND BEAM DETAIL
ADJACENT TO SHOTCRETE WALL
SCALE 1:10

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:10

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

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GHD

DRAWN	B.COONEY	10.10.24
DESIGNED	M.YOUNES	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	N.SCHWARTZMANN	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
TYPICAL BARRIER DETAILS

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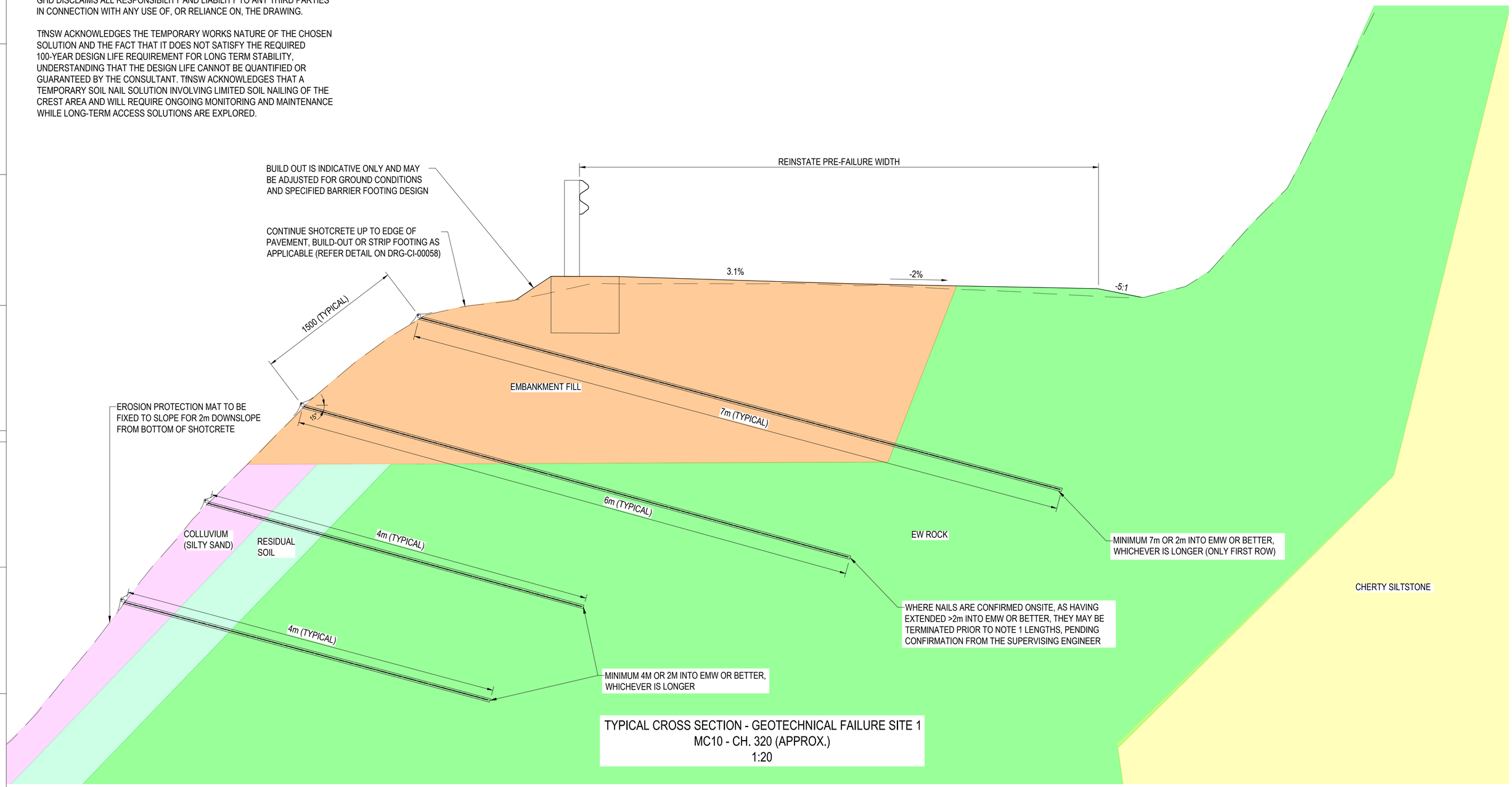
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NOTES:

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TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 1
MC10 - CH. 320 (APPROX.)
1:20

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REFERENCES:

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

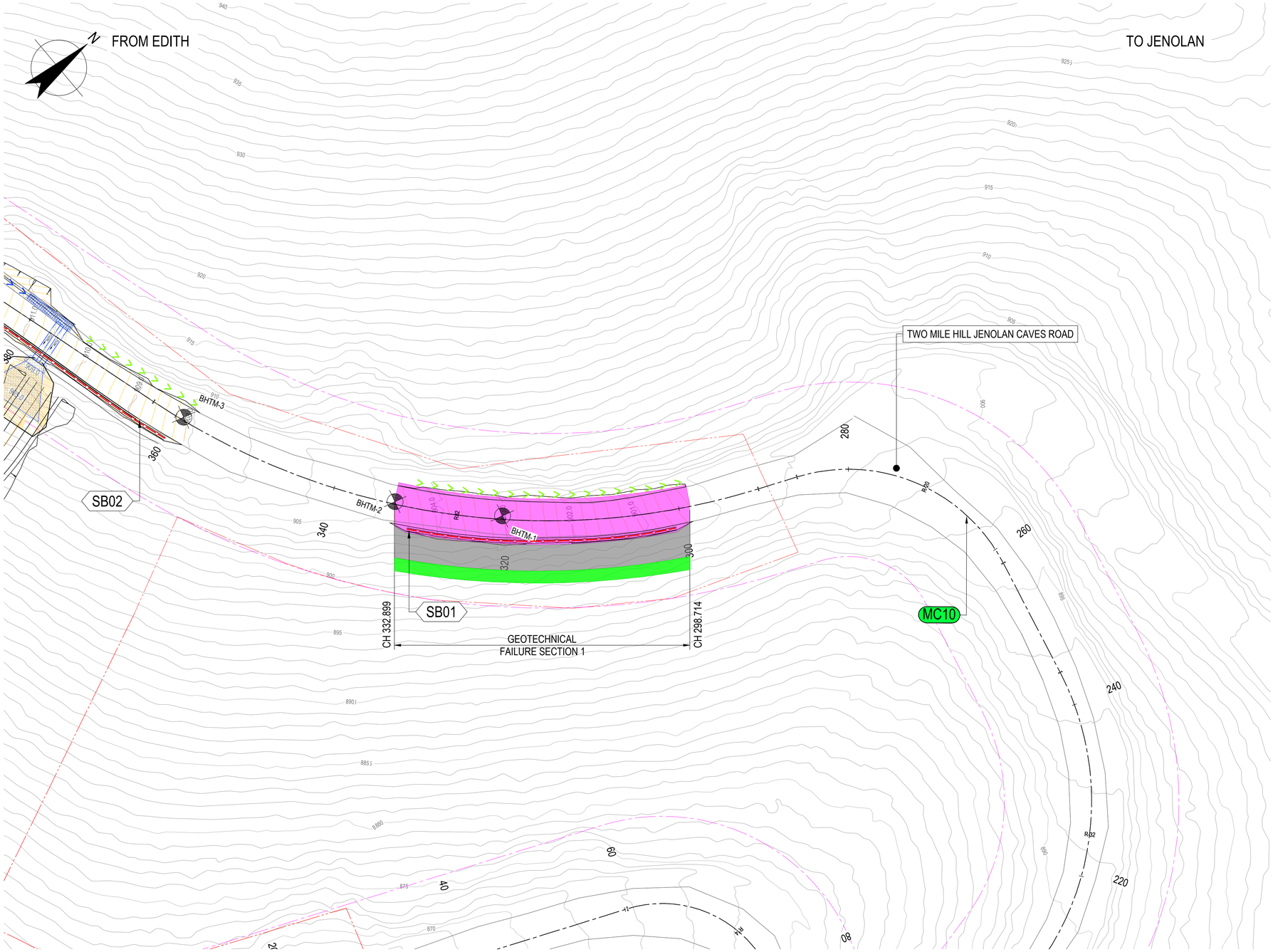
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DRAWN	K.GORDON	10.10.24
DESIGNED	P. HOPPER	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 1
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00101	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00101.dwg
PLOT DATE & TIME: 10/10/2024 7:05:16 PM



LEGEND

- 1560 - CHAINAGES
- MC10
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD SAFETY BARRIER (31.068m)
- TfNSW BOUNDARY
- REF PROJECT SITE
- SB** ROAD SAFETY BARRIER NUMBER
- APPROXIMATE EXTENTS OF PAVEMENT RECONSTRUCTION

GEOTECHNICAL LEGEND

- APPROXIMATE SOIL NAIL AND SHOTCRETE AREA
- APPROXIMATE EROSION PROTECTION
- BOREHOLES

DRAINAGE LEGEND

- KERB ONLY
- DRAINAGE CHANNEL (CONCRETE) (REFER SM-2141)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- DRAINAGE CULVERT FAILURES

NOTES:

1. THE PAVEMENT HATCHING ONLY INDICATIVELY SHOWS THE EXTENTS OF PAVEMENT TREATMENT REQUIRED. REFER TO DRG-CI-00056 FOR PAVEMENT PROFILES AND INTERFACE DETAILS.
2. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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FILE NAME: 21-12625762-GHD-DD-DRG-CI-00131.dwg

PLOT DATE & TIME: 10/10/2024 7:05:47 PM

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD | DESIGN LOT CODE: --

SCALE: 1:250

0 2.5 5 7.5 10 12.5m

SCALE 1:250 AT ORIGINAL SIZE

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

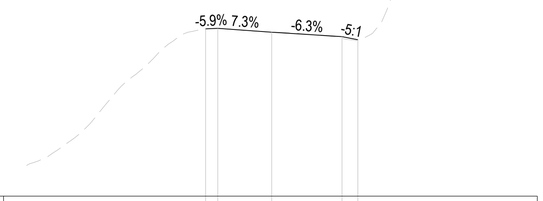
GEOTECHNICAL FAILURE SITE 1

GENERAL ARRANGEMENT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
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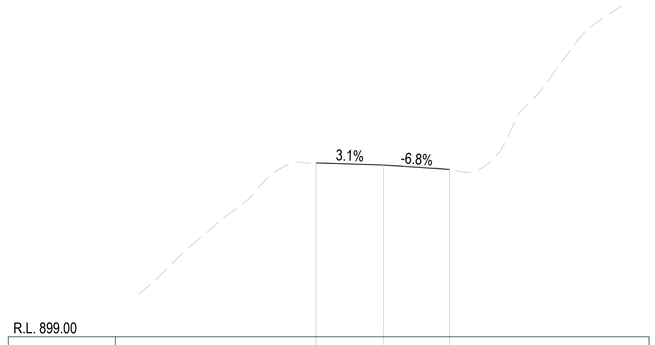


R.L. 895.00

| | | |

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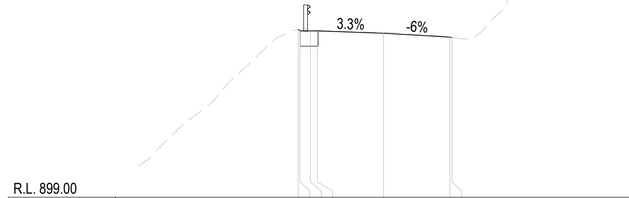
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R.L. 899.00

CUT STRINGS	IA10	MC10	LE11
LEVEL DIFFERENCE	-0.000	-0.002	0.000
DESIGN LEVELS	904.674	904.687	904.459
EXISTING LEVELS	904.67	904.61	904.46
DESIGN OFFSETS	-2.196	0.000	2.160

CH 332.899



R.L. 899.00

CUT STRINGS	IA10	BF10	LE10	MC10	LE11	CF11
LEVEL DIFFERENCE	0.000	-0.058	-0.080	-0.022	0.004	-0.000
DESIGN LEVELS	904.478	904.425	904.425	904.355	904.224	904.211
EXISTING LEVELS	904.48	904.48	904.47	904.38	904.22	904.21
DESIGN OFFSETS	-2.779	-2.727	-2.284	0.000	2.174	2.239

CH 330.899

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FILE NAME: 21-12625762-GHD-DD-DRG-CI-00181.dwg

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
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GHD

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DESIGNED	D.KIM	10.10.24
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DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 1

CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 2 OF 2	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

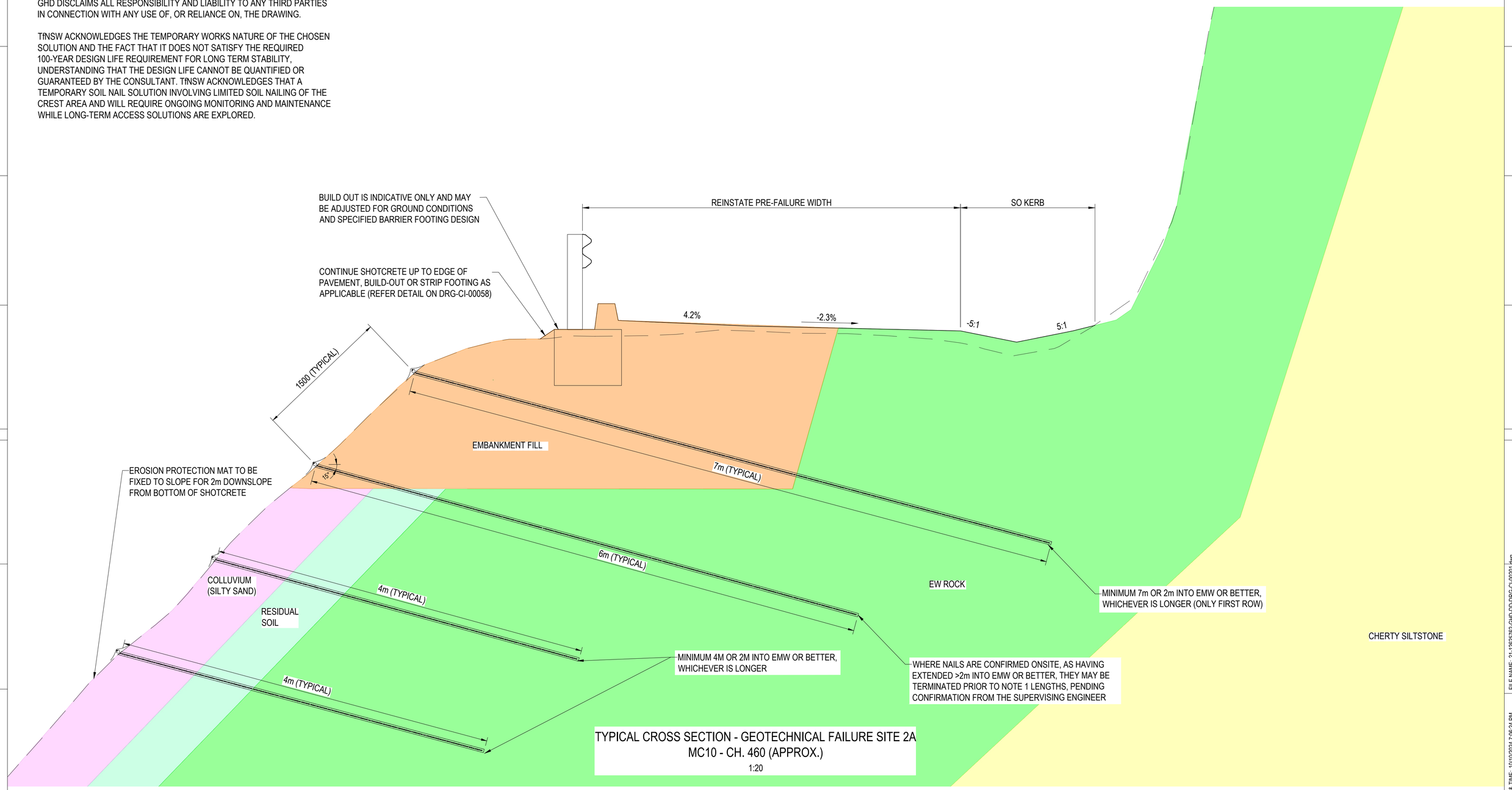
DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00182				

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TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 2A
MC10 - CH. 460 (APPROX.)
1:20

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT:
NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

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DESIGNED	P. HOPPER	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 2A
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00201	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00201.dwg

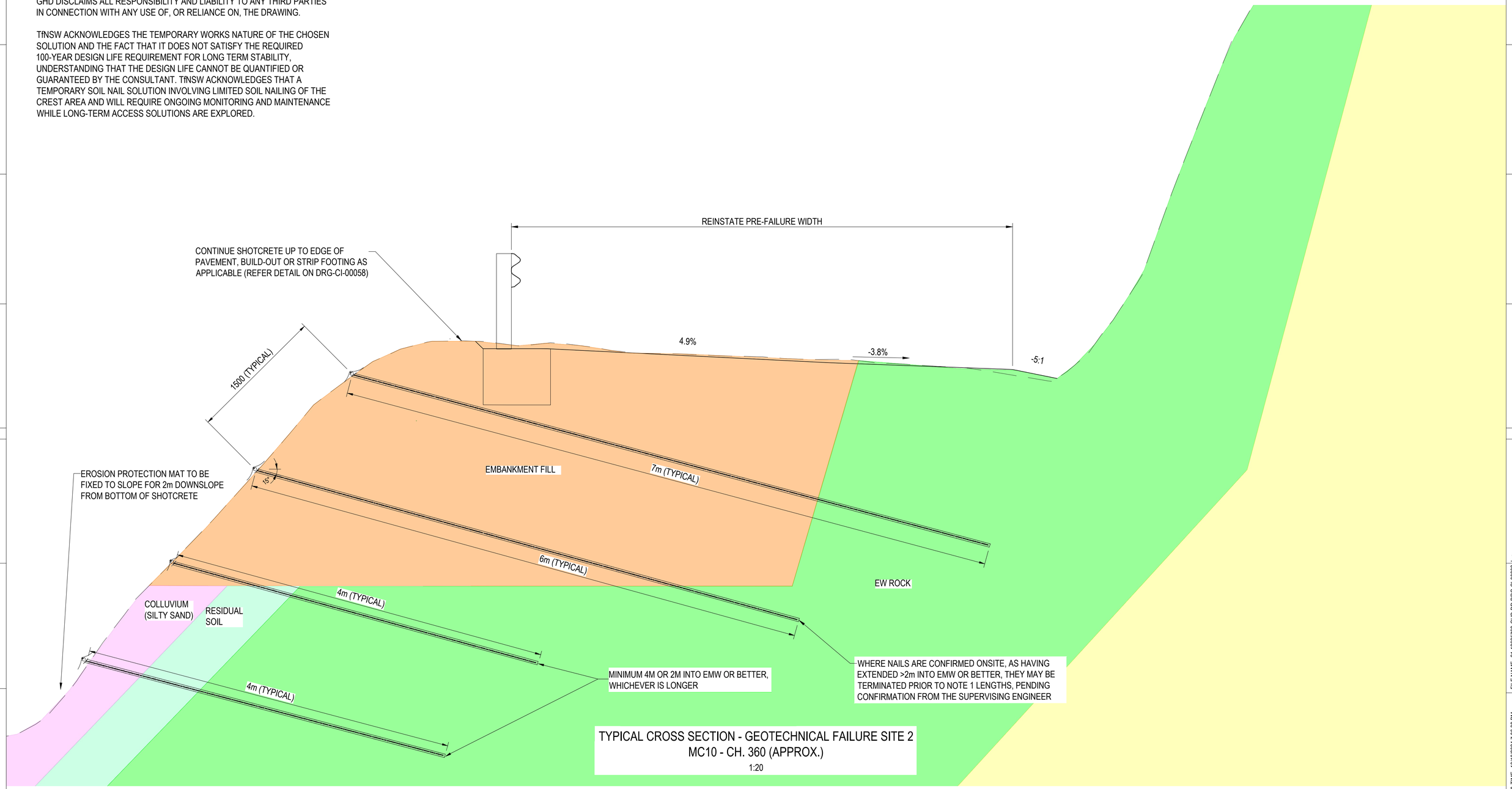
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TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 2
MC10 - CH. 360 (APPROX.)
1:20

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

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NETWORK AND ASSETS
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SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 2 CH 360
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00202	REV	VER	EDMS No.	AMD No.

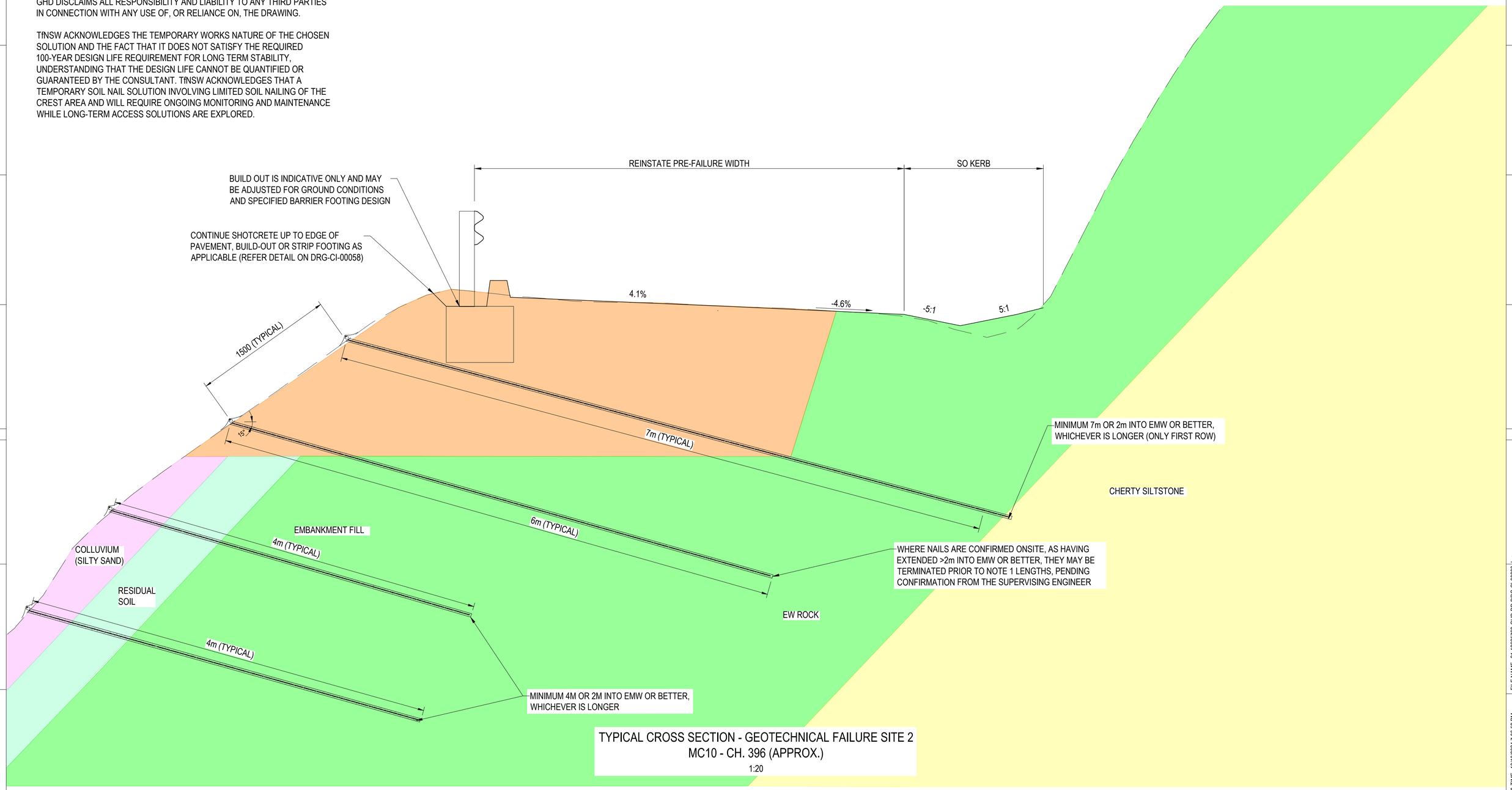
FILE NAME: 21-12625762-GHD-DD-DRG-CI-00202.dwg
PLOT DATE & TIME: 10/10/2024 7:06:38 PM

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TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 2
MC10 - CH. 396 (APPROX.)
1:20

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	P. HOPPER	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 2 CH 395.762
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00203	REV	VER	EDMS No.	AMD No.

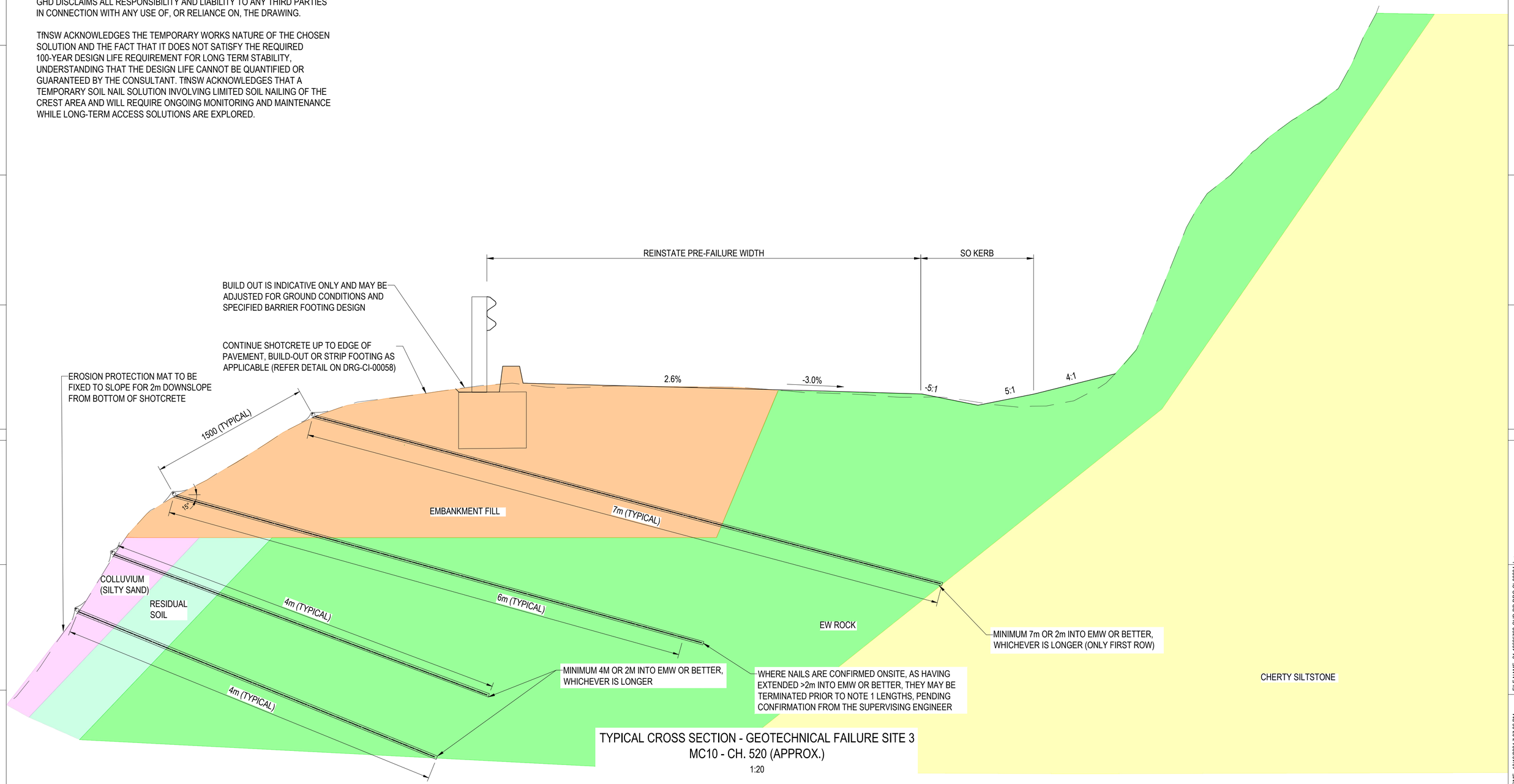
FILE NAME: 21-12625762-GHD-DD-DRG-CI-00203.dwg
PLOT DATE & TIME: 10/10/2024 7:06:52 PM

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NOTES:

1. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.



TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 3
MC10 - CH. 520 (APPROX.)
1:20

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REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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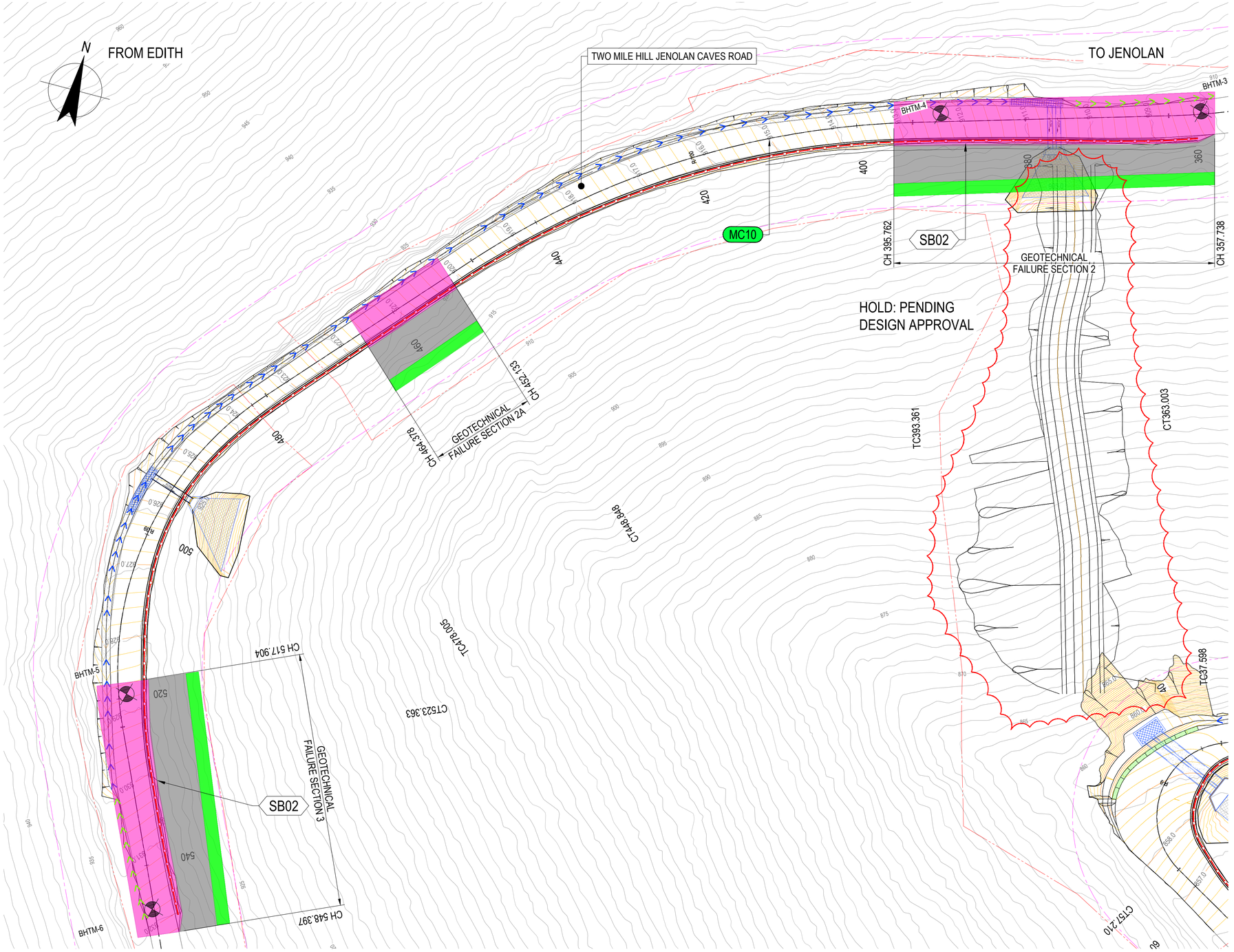
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DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 3
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00204	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00204.dwg
PLOT DATE & TIME: 10/10/2024 7:07:06 PM



LEGEND

- 1560 - CHAINAGES
- MC10
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD SAFETY BARRIER (183.204m)
- TfNSW BOUNDARY
- REF PROJECT SITE
- SB** — ROAD SAFETY BARRIER NUMBER
- APPROXIMATE EXTENTS OF PAVEMENT RECONSTRUCTION

GEOTECHNICAL LEGEND

- APPROXIMATE SOIL NAIL AND SHOTCRETE AREA
- APPROXIMATE EROSION PROTECTION
- BOREHOLES

DRAINAGE LEGEND

- KERB ONLY
- DRAINAGE CHANNEL (CONCRETE) (REFER SM-2141)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- DRAINAGE CULVERT FAILURES

NOTES:

1. THE PAVEMENT HATCHING ONLY INDICATIVELY SHOWS THE EXTENTS OF PAVEMENT TREATMENT REQUIRED. REFER TO DRG-CI-00056 FOR PAVEMENT PROFILES AND INTERFACE DETAILS.
2. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:250

0 2.5 5 7.5 10 12.5m
SCALE 1:250 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
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GHD

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DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

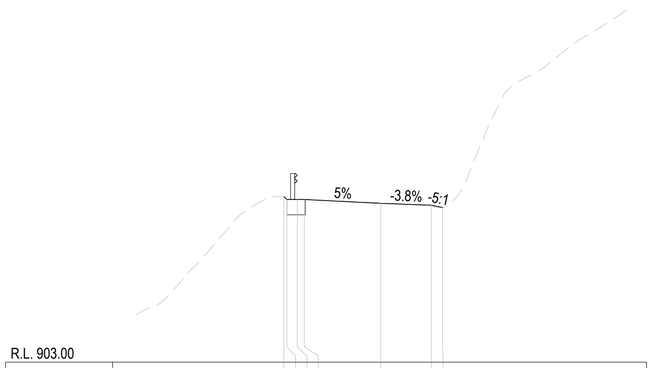
GEOTECHNICAL FAILURE SITE 2, 2A AND 3
GENERAL ARRANGEMENT

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00231	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00231.dwg
PLOT DATE & TIME: 10/10/2024 7:07:30 PM

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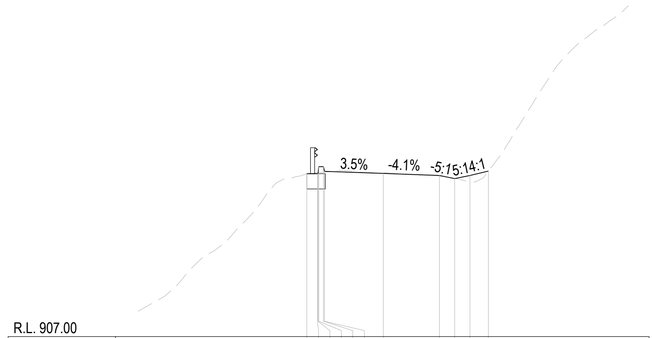


R.L. 903.00

| | | |

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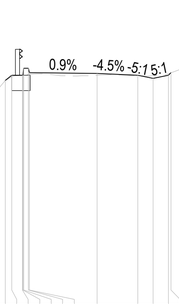
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R.L. 907.00

CUT STRINGS			EH10	BF10	CBO10	CB10	CT10	LE10	MC10		LE11	CF11	CB11	IA11
LEVEL DIFFERENCE			-0.001	-0.032	-0.033	0.195	0.165	0.053	-0.014		0.014	-0.009	0.190	0.000
DESIGN LEVELS			912.320	912.320	912.320	912.550	912.550	912.400	912.333		912.258	912.158	912.258	912.408
EXISTING LEVELS			912.32	912.35	912.35	912.35	912.36	912.37	912.35		912.24	912.17	912.07	912.41
DESIGN OFFSETS			-2.498	-2.155	-2.138	-2.108	-1.958	-1.928	0.000		1.829	2.329	2.829	3.427

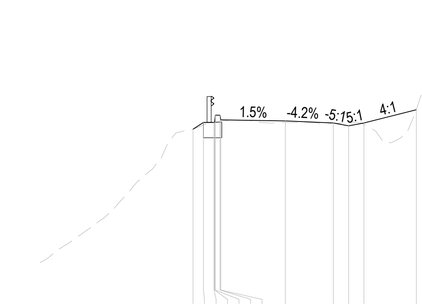
CH 390



R.L. 903.00

CUT STRINGS		IA10	EH10	BF10	CBO10	CB10	CT10	LE10	MC10		LE11	CF11	CB11	IA11
LEVEL DIFFERENCE		0.000	0.056	-0.004	-0.007	0.219	0.204	0.051	0.065		0.015	-0.082	-0.052	0.000
DESIGN LEVELS		910.344	910.514	910.514	910.514	910.744	910.744	910.594	910.573		910.513	910.413	910.513	910.594
EXISTING LEVELS		910.34	910.46	910.52	910.52	910.52	910.54	910.54	910.51		910.50	910.50	910.96	910.59
DESIGN OFFSETS		-2.999	-2.784	-2.441	-2.424	-2.394	-2.244	-2.214	0.000		1.329	1.829	2.329	2.410

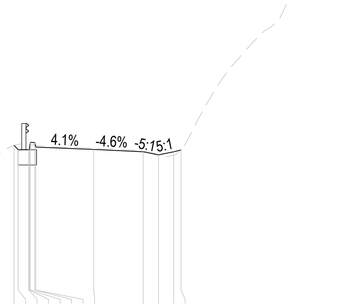
CH 376.59



R.L. 905.00

CUT STRINGS		IA10	EH10	BF10	CBO10	CB10	CT10	LE10	MC10		LE11	CF11	CB11	IA11
LEVEL DIFFERENCE		0.000	0.087	-0.012	-0.015	-0.070	0.193	0.040	0.052		0.012	-0.115	0.047	0.000
DESIGN LEVELS		910.749	910.974	910.974	910.974	911.204	911.204	911.054	911.023		910.957	910.857	910.957	911.384
EXISTING LEVELS		910.75	910.89	910.99	910.99	911.01	911.01	911.01	910.97		910.95	910.97	910.91	911.38
DESIGN OFFSETS		-3.015	-2.677	-2.334	-2.317	-2.137	-2.137	-2.107	0.000		1.564	2.064	2.564	4.269

CH 380



R.L. 908.00

CUT STRINGS		IA10	EH10	BF10	CBO10	CB10	CT10	LE10	MC10		LE11	CF11	CB11	IA11
LEVEL DIFFERENCE		0.000	-0.169	-0.170	-0.167	-0.068	0.084	-0.062	-0.043		-0.029	-0.006	0.108	0.000
DESIGN LEVELS		913.221	913.086	913.086	913.086	913.315	913.315	913.166	913.087		913.013	912.913	913.013	913.073
EXISTING LEVELS		913.22	913.25	913.26	913.25	913.23	913.23	913.23	913.13		913.04	912.92	913.90	913.07
DESIGN OFFSETS		-2.599	-2.463	-2.120	-2.103	-1.973	-1.923	-1.893	0.000		1.612	2.112	2.612	2.860

CH 395.762

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FILE NAME: 21-12625762-GHD-DD-DRG-CI-00281.dwg

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REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m
SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 2, 2A AND 3

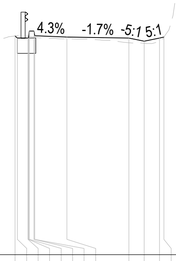
CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 2 OF 5	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00282				

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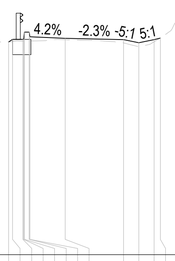
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R.L. 913.00

	IA10	EH10	BF10	CB010	CB10	CT10	LE10	MC10	LE11	CF11	CB11	IA11
CUT STRINGS												
LEVEL DIFFERENCE	0.000	-0.083	-0.059	-0.057	0.177	0.197	0.050	0.057	0.147	0.068	0.088	0.000
DESIGN LEVELS	920.141	920.068	920.068	920.068	920.298	920.298	920.148	920.103	920.068	919.968	920.068	920.104
EXISTING LEVELS	920.14	920.15	920.13	920.12	920.12	920.10	920.10	920.05	919.92	919.90	919.98	920.10
DESIGN OFFSETS	-1.692	-1.619	-1.276	-1.249	-1.229	-1.079	-1.049	0.000	2.022	2.522	3.022	3.167

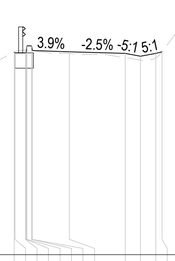
CH 452.133



R.L. 914.00

	IA10	EH10	BF10	CB010	CB10	CT10	LE10	MC10	LE11	CF11	CB11	IA11
CUT STRINGS												
LEVEL DIFFERENCE	0.000	0.074	-0.051	0.061	0.291	0.289	0.139	0.045	0.107	0.125	0.068	0.000
DESIGN LEVELS	920.947	921.031	920.951	921.031	921.261	921.261	921.111	921.063	921.018	920.918	921.018	921.068
EXISTING LEVELS	920.95	920.96	920.97	920.97	920.97	920.97	920.97	921.02	920.91	920.79	920.95	921.07
DESIGN OFFSETS	-1.847	-1.720	-1.470	-1.360	-1.330	-1.180	-1.150	0.000	1.902	2.402	2.902	3.101

CH 460



R.L. 915.00

	IA10	EH10	BF10	CB010	CB10	CT10	LE10	MC10	LE11	CF11	CB11	IA11
CUT STRINGS												
LEVEL DIFFERENCE	0.000	-0.042	-0.089	-0.087	-0.149	0.172	0.028	0.059	0.142	0.120	0.146	0.000
DESIGN LEVELS	921.617	921.587	921.587	921.587	921.357	921.817	921.667	921.619	921.574	921.474	921.574	921.624
EXISTING LEVELS	921.62	921.63	921.68	921.67	921.67	921.64	921.64	921.56	921.43	921.35	921.43	921.62
DESIGN OFFSETS	-1.807	-1.777	-1.434	-1.417	-1.397	-1.237	-1.207	0.000	1.820	2.320	2.820	3.020

CH 464.379

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FOR CONSTRUCTION

REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 2, 2A AND 3

CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 3 OF 5	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

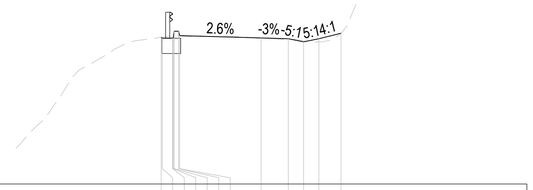
DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00283				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00281.dwg

PLOT DATE & TIME: 10/10/2024 7:07:59 PM

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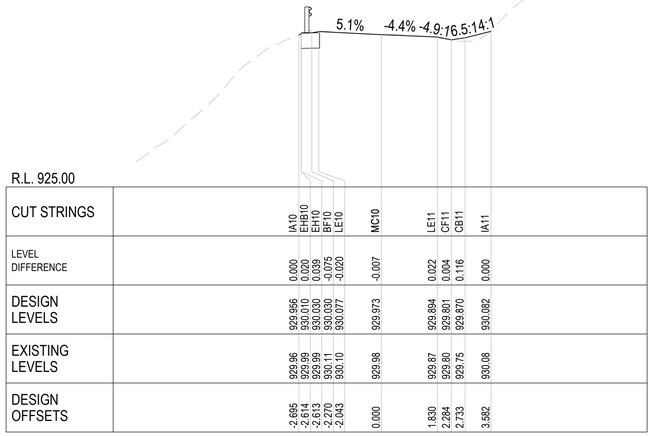
TfNSW ACKNOWLEDGES THE TEMPORARY WORKS NATURE OF THE CHOSEN SOLUTION AND THE FACT THAT IT DOES NOT SATISFY THE REQUIRED 100-YEAR DESIGN LIFE REQUIREMENT FOR LONG TERM STABILITY, UNDERSTANDING THAT THE DESIGN LIFE CANNOT BE QUANTIFIED OR GUARANTEED BY THE CONSULTANT. TfNSW ACKNOWLEDGES THAT A TEMPORARY SOIL NAIL SOLUTION INVOLVING LIMITED SOIL NAILING OF THE CREST AREA AND WILL REQUIRE ONGOING MONITORING AND MAINTENANCE WHILE LONG-TERM ACCESS SOLUTIONS ARE EXPLORED.



R.L. 924.00

	IA10	EH10	BF10	CBO10	CB10	CT10	LE10	MC10	LE11	CF11	CB11	IA11
CUT STRINGS												
LEVEL DIFFERENCE	0.000	-0.034	-0.077	-0.079	0.147	0.152	0.005	0.013	0.022	-0.032	0.103	0.000
DESIGN LEVELS	928.788	928.759	928.754	928.753	928.989	928.989	928.839	928.769	928.742	928.642	928.742	928.922
EXISTING LEVELS	928.79	928.79	928.84	928.84	928.84	928.84	928.83	928.76	928.72	928.67	928.64	928.92
DESIGN OFFSETS	-3.259	-3.229	-2.985	-2.869	-2.839	-2.689	-2.659	0.000	0.885	1.385	1.885	2.604

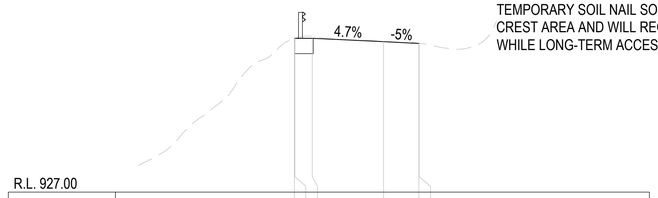
CH 520



R.L. 925.00

	IA10	EHB10	EH10	BF10	LE10	MC10	LE11	CF11	CB11	IA11
CUT STRINGS										
LEVEL DIFFERENCE	0.000	0.020	0.039	-0.075	-0.020	-0.007	0.022	0.004	0.116	0.000
DESIGN LEVELS	929.956	930.010	930.030	930.030	930.077	929.973	929.894	929.801	929.870	930.082
EXISTING LEVELS	929.96	929.99	929.99	930.11	930.10	929.98	929.87	929.80	929.75	930.08
DESIGN OFFSETS	-2.695	-2.614	-2.613	-2.270	-2.043	0.000	1.830	2.284	2.733	3.582

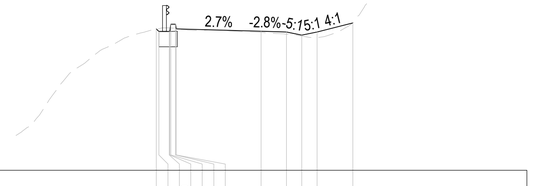
CH 530



R.L. 927.00

	IA10	EHB10	LE10	MC10	LE11	IA11
CUT STRINGS						
LEVEL DIFFERENCE	0.000	0.006	-0.068	-0.014	-0.005	0.000
DESIGN LEVELS	932.012	932.023	932.023	931.913	931.855	931.860
EXISTING LEVELS	932.01	932.02	932.09	931.93	931.86	931.86
DESIGN OFFSETS	-2.912	-2.896	-2.325	0.000	1.157	1.162

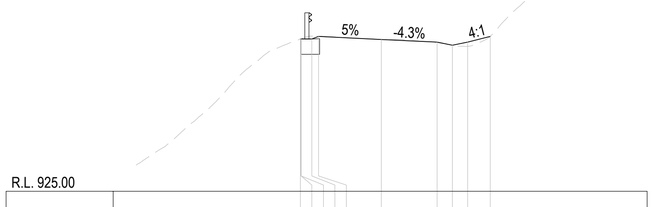
CH 546.397



R.L. 924.00

	IA10	EH10	BF10	CBO10	CB10	CT10	LE10	MC10	LE11	CF11	CB11	IA11
CUT STRINGS												
LEVEL DIFFERENCE	0.000	-0.093	-0.116	-0.115	0.117	0.102	-0.013	0.035	0.069	0.038	0.181	0.000
DESIGN LEVELS	928.613	928.533	928.533	928.533	928.763	928.763	928.613	928.537	928.513	928.413	928.513	928.805
EXISTING LEVELS	928.61	928.63	928.65	928.65	928.65	928.63	928.63	928.50	928.44	928.37	928.33	928.80
DESIGN OFFSETS	-3.419	-3.338	-2.995	-2.978	-2.948	-2.798	-2.768	0.000	0.830	1.330	1.830	2.996

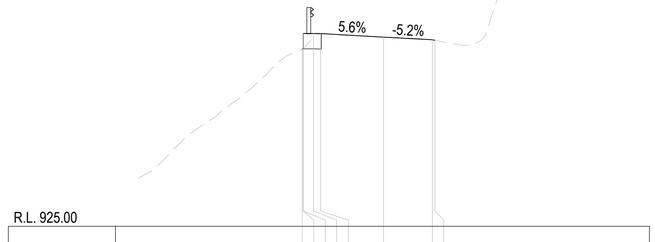
CH 517.904



R.L. 925.00

	IA10	EHB10	EH10	BF10	LE10	MC10	LE11	CF11	CB11	IA11
CUT STRINGS										
LEVEL DIFFERENCE	0.000	-0.008	-0.008	-0.094	-0.016	-0.008	0.015	0.001	0.141	0.000
DESIGN LEVELS	929.969	929.971	929.971	929.971	930.051	929.948	929.869	929.769	929.869	930.052
EXISTING LEVELS	929.97	929.98	929.98	930.07	930.07	929.96	929.85	929.77	929.73	930.05
DESIGN OFFSETS	-2.641	-2.617	-2.616	-2.273	-2.046	0.000	1.821	2.321	2.821	3.553

CH 529.797



R.L. 925.00

	IA10	EHB10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS								
LEVEL DIFFERENCE	0.000	-0.020	0.480	0.146	0.009	-0.001	0.007	0.000
DESIGN LEVELS	930.784	930.767	931.267	931.287	931.287	931.171	931.089	931.088
EXISTING LEVELS	930.78	930.81	930.81	931.14	931.28	931.17	931.08	931.07
DESIGN OFFSETS	-2.654	-2.627	-2.626	-2.283	-2.056	0.000	1.594	1.681

CH 540

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD | DESIGN LOT CODE: --

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	S.PARNELL	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 2, 2A AND 3

CROSS SECTION

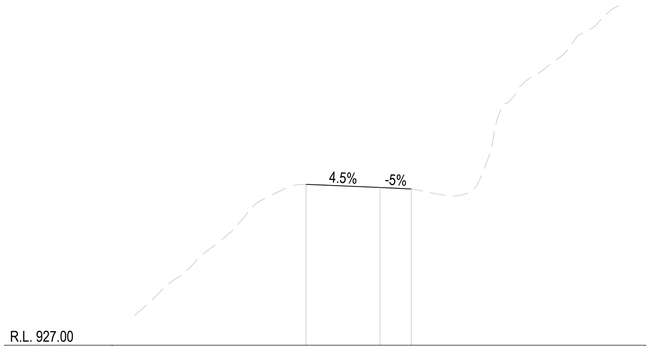
DRAWING SET No: -	PART:	SHEET: 4	OF 5	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00284	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00281.dwg

PLOT DATE & TIME: 10/10/2024 7:08:05 PM

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R.L. 927.00

CUT STRINGS	IA10	MC10	LE11
LEVEL DIFFERENCE	-0.000	-0.000	-0.000
DESIGN LEVELS	932.253	932.145	932.095
EXISTING LEVELS	932.25	932.15	932.09
DESIGN OFFSETS	-2.413	0.000	1.020

CH 548.397

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT:

NSW GOVERNMENT Transport for NSW

PREPARED FOR:

PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	S.PARNELL	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 2, 2A AND 3

CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 5 OF 5		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00285	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00281.dwg

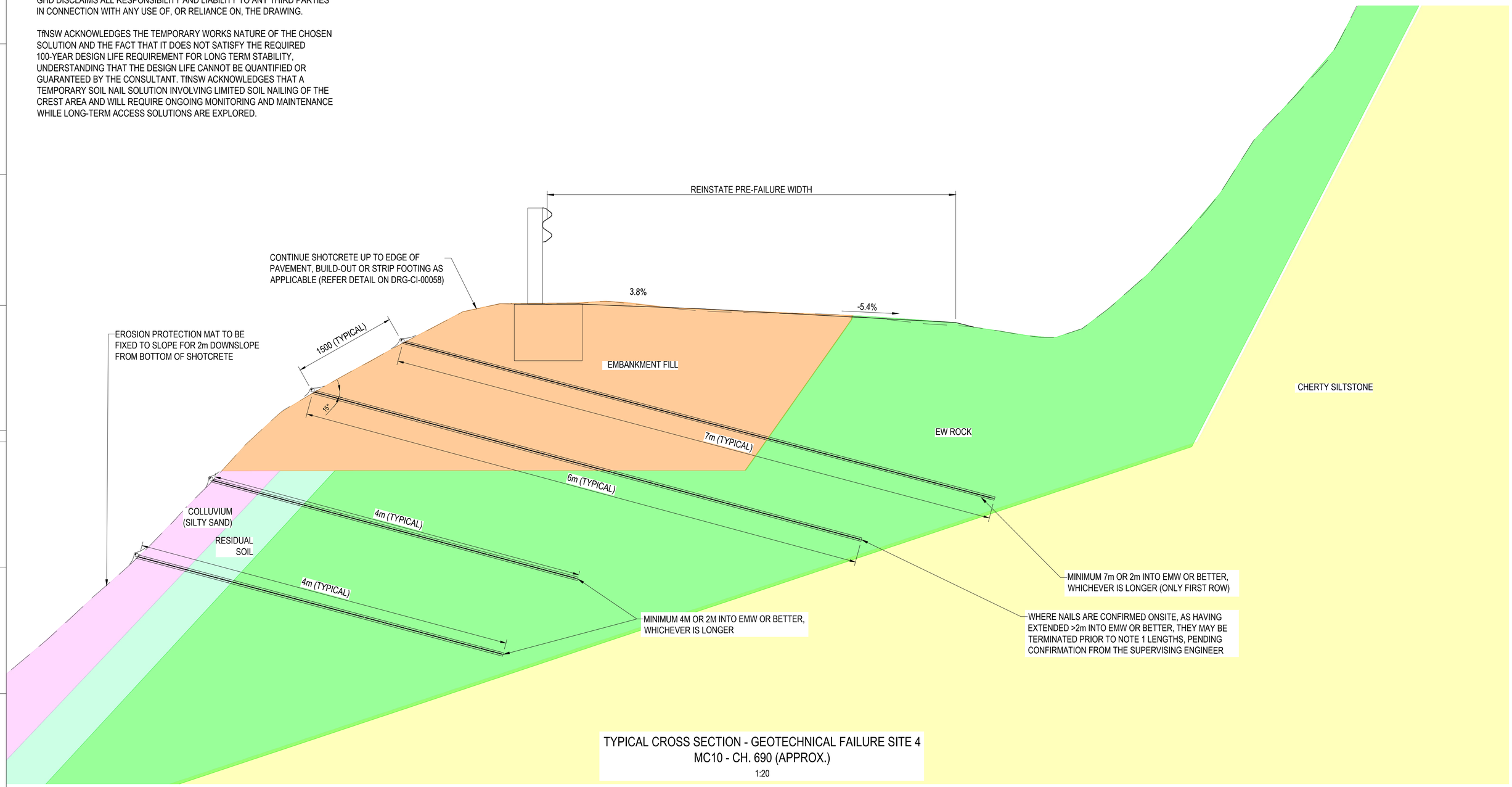
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NOTES:

1. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.



TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 4
MC10 - CH. 690 (APPROX.)
1:20

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD | DESIGN LOT CODE: --

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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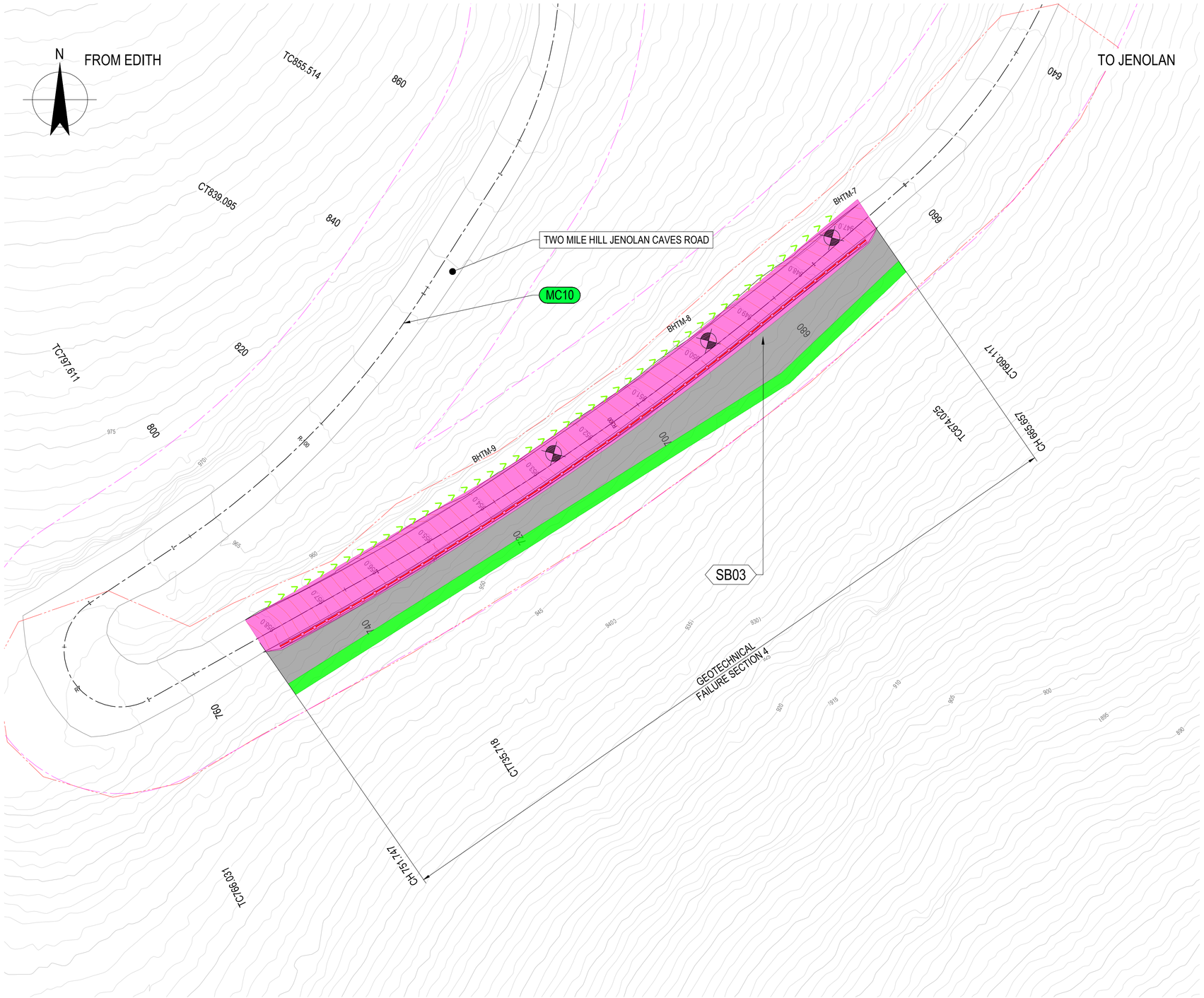
GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	P. HOPPER	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 4
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00301	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00301.dwg
PLOT DATE & TIME: 10/10/2024 7:08:27 PM



LEGEND

- 1560 - CHAINAGES
- MC10
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD SAFETY BARRIER (82.417m)
- TfNSW BOUNDARY
- REF PROJECT SITE
- SB** ROAD SAFETY BARRIER NUMBER
- APPROXIMATE EXTENTS OF PAVEMENT RECONSTRUCTION

GEOTECHNICAL LEGEND

- APPROXIMATE SOIL NAIL AND SHOTCRETE AREA
- APPROXIMATE EROSION PROTECTION
- BOREHOLES

DRAINAGE LEGEND

- KERB ONLY
- DRAINAGE CHANNEL (CONCRETE) (REFER SM-2141)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- DRAINAGE CULVERT FAILURES

NOTES:

1. THE PAVEMENT HATCHING ONLY INDICATIVELY SHOWS THE EXTENTS OF PAVEMENT TREATMENT REQUIRED. REFER TO DRG-CI-00056 FOR PAVEMENT PROFILES AND INTERFACE DETAILS.
2. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD | DESIGN LOT CODE: --

SCALE: 1:250

0 2.5 5 7.5 10 12.5m

SCALE 1:250 AT ORIGINAL SIZE

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 4
GENERAL ARRANGEMENT PLAN

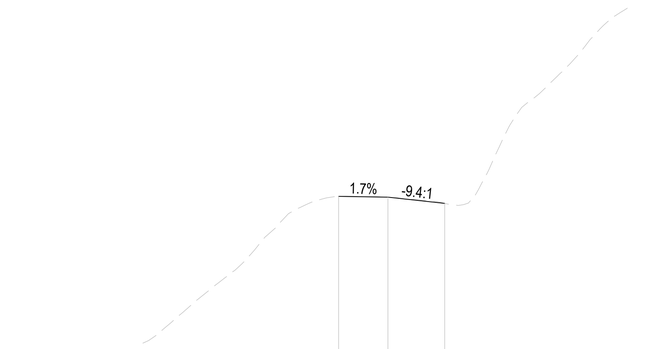
DRAWING SET No: -	PART:	SHEET: 1 OF 1	A1	
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00331	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00331.dwg

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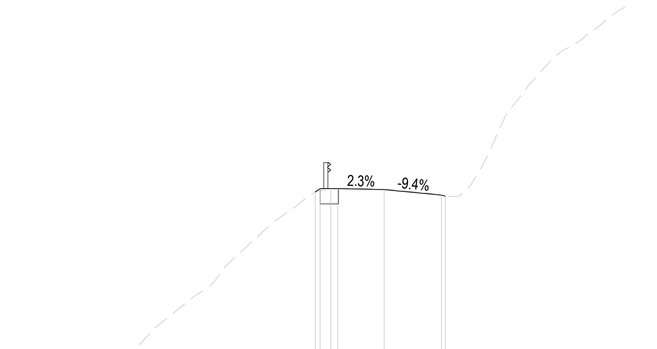
TfNSW ACKNOWLEDGES THE TEMPORARY WORKS NATURE OF THE CHOSEN SOLUTION AND THE FACT THAT IT DOES NOT SATISFY THE REQUIRED 100-YEAR DESIGN LIFE REQUIREMENT FOR LONG TERM STABILITY, UNDERSTANDING THAT THE DESIGN LIFE CANNOT BE QUANTIFIED OR GUARANTEED BY THE CONSULTANT. TfNSW ACKNOWLEDGES THAT A TEMPORARY SOIL NAIL SOLUTION INVOLVING LIMITED SOIL NAILING OF THE CREST AREA AND WILL REQUIRE ONGOING MONITORING AND MAINTENANCE WHILE LONG-TERM ACCESS SOLUTIONS ARE EXPLORED.



R.L. 941.00

CUT STRINGS	LE10	MC10	LE11
LEVEL DIFFERENCE	-0.000	-0.001	0.000
DESIGN LEVELS	946.758	946.730	946.533
EXISTING LEVELS	946.76	946.73	946.53
DESIGN OFFSETS	-1.612	0.000	1.852

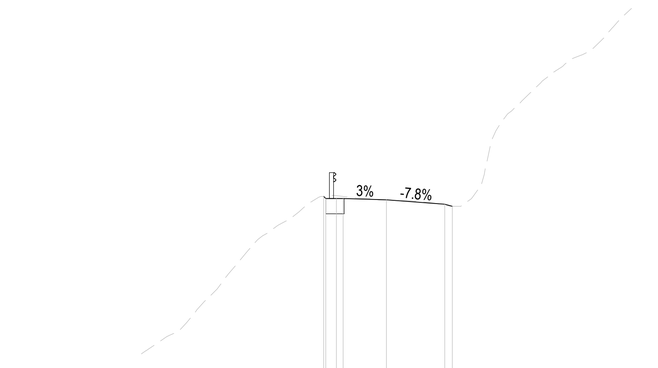
CH 665.657



R.L. 941.00

CUT STRINGS	IA10	EH10	BF10	LE10	MC10	LE11	IA11
LEVEL DIFFERENCE	0.000	0.067	0.022	-0.002	-0.020	0.011	0.000
DESIGN LEVELS	946.902	947.012	947.012	947.012	946.978	946.803	946.770
EXISTING LEVELS	946.90	946.95	946.99	947.01	947.00	946.79	946.77
DESIGN OFFSETS	-2.255	-2.090	-1.747	-1.520	0.000	1.868	1.999

CH 667.657



R.L. 941.00

CUT STRINGS	IA10	EH10	BF10	LE10	MC10	LE11	IA11
LEVEL DIFFERENCE	0.000	-0.075	-0.090	-0.065	0.012	0.028	0.000
DESIGN LEVELS	947.380	947.310	947.310	947.310	947.268	947.119	947.056
EXISTING LEVELS	947.38	947.38	947.40	947.38	947.26	947.09	947.06
DESIGN OFFSETS	-2.054	-1.984	-1.641	-1.414	0.000	1.868	2.150

CH 670

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REFERENCES:

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

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DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 4

CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 4	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

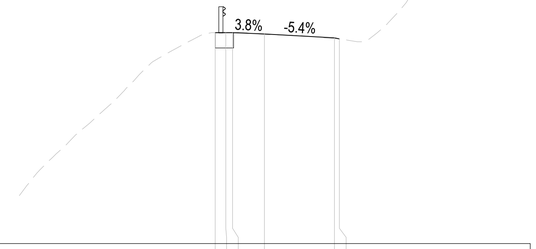
DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00381				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00381.dwg

PLOT DATE & TIME: 10/10/2024 7:09:02 PM

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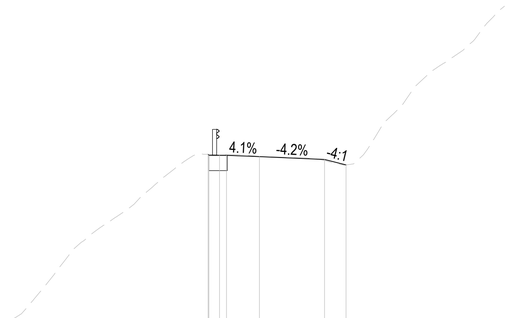
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R.L. 943.00

CUT STRINGS					EH10	BF10	LE10		MC10						LE11	IA11							
LEVEL DIFFERENCE					-0.001	0.006	-0.004		0.016						0.027	0.000							
DESIGN LEVELS					949.879	949.879	949.879		949.840						949.716	949.676							
EXISTING LEVELS					949.88	949.87	949.88		949.82						949.69	949.68							
DESIGN OFFSETS					-1.610	-1.267	-1.040		0.000						2.287	2.446							

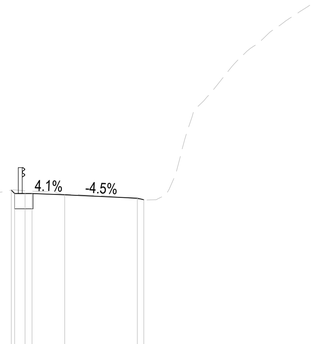
CH 690



R.L. 942.00

CUT STRINGS				IA10	EH10	BF10	LE10		MC10						LE11	IA11							
LEVEL DIFFERENCE				0.000	-0.026	-0.013	-0.013		-0.001						0.034	0.000							
DESIGN LEVELS				948.612	948.584	948.584	948.584		948.540						948.450	948.273							
EXISTING LEVELS				948.61	948.61	948.60	948.60		948.54						948.42	948.27							
DESIGN OFFSETS				-1.678	-1.650	-1.307	-1.080		0.000						2.122	2.828							

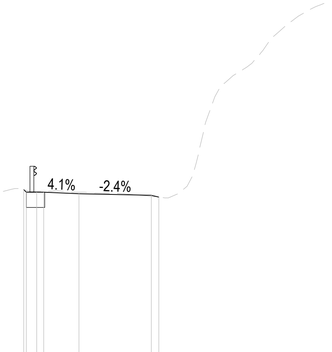
CH 680



R.L. 945.00

CUT STRINGS				IA10	EH10	BF10	LE10		MC10						LE11	IA11							
LEVEL DIFFERENCE				0.000	-0.116	-0.087	-0.074		-0.020						0.037	0.000							
DESIGN LEVELS				951.292	951.184	951.184	951.184		951.140						951.033	950.979							
EXISTING LEVELS				951.29	951.30	951.27	951.26		951.16						951.00	950.98							
DESIGN OFFSETS				-1.749	-1.640	-1.297	-1.070		0.000						2.367	2.581							

CH 700



R.L. 946.00

CUT STRINGS				IA10	EH10	BF10	LE10		MC10						LE11	IA11							
LEVEL DIFFERENCE				0.000	-0.056	-0.029	-0.034		-0.046						0.042	0.000							
DESIGN LEVELS				952.570	952.489	952.489	952.489		952.442						952.386	952.325							
EXISTING LEVELS				952.57	952.54	952.52	952.52		952.49						952.34	952.33							
DESIGN OFFSETS				-1.807	-1.726	-1.383	-1.156		0.000						2.362	2.603							

CH 710

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B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m
SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

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DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

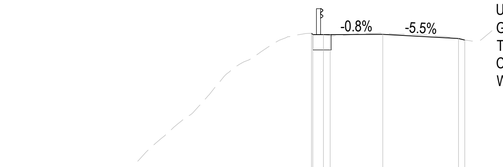
SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 4
CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 2 OF 4		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00382	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00381.dwg
PLOT DATE & TIME: 10/10/2024 7:09:07 PM

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R.L. 953.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	-0.041	0.000	0.031	-0.036	0.019	0.000
DESIGN LEVELS	958.052	958.011	958.011	958.011	958.024	957.888	957.837
EXISTING LEVELS	958.05	958.05	958.01	957.98	958.06	957.87	957.84
DESIGN OFFSETS	-2.328	-2.287	-1.944	-1.717	0.000	2.469	2.873

CH 749.747

R.L. 947.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	-0.030	0.006	0.010	-0.005	0.008	0.000
DESIGN LEVELS	953.854	953.820	953.820	953.820	953.798	953.754	953.676
EXISTING LEVELS	953.85	953.85	953.81	953.81	953.80	953.75	953.68
DESIGN OFFSETS	-1.889	-1.665	-1.322	-1.295	0.000	2.222	2.536

CH 720

R.L. 949.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	0.060	0.027	0.016	-0.028	0.031	0.000
DESIGN LEVELS	955.157	955.223	955.223	955.223	955.178	955.100	954.946
EXISTING LEVELS	955.16	955.16	955.20	955.21	955.21	955.07	954.95
DESIGN OFFSETS	-2.160	-2.060	-1.717	-1.490	0.000	2.131	2.749

CH 730

R.L. 951.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	0.091	0.064	0.082	-0.068	0.018	0.000
DESIGN LEVELS	956.493	956.605	956.605	956.605	956.558	956.503	956.470
EXISTING LEVELS	956.49	956.51	956.54	956.52	956.63	956.49	956.47
DESIGN OFFSETS	-2.446	-2.278	-1.935	-1.708	0.000	2.134	2.664

CH 740

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 4

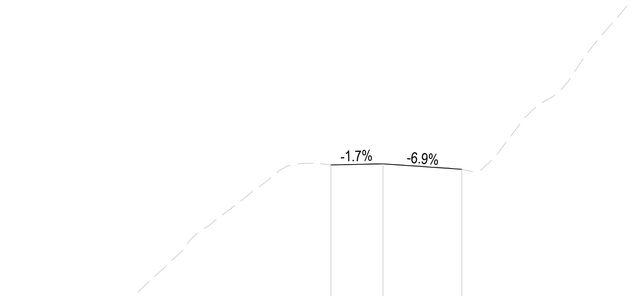
CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 3 OF 4	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00383				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00381.dwg

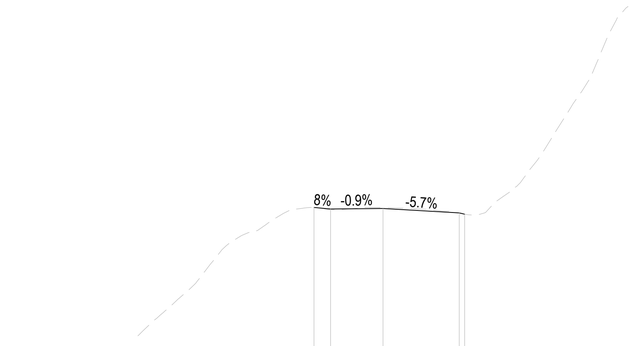
PLOT DATE & TIME: 10/10/2024 7:09:13 PM



R.L. 953.00

CUT STRINGS	IA10	MC10	LE11
LEVEL DIFFERENCE	0.000	0.000	0.000
DESIGN LEVELS	958.321	958.350	958.172
EXISTING LEVELS	958.32	958.35	958.17
DESIGN OFFSETS	-1.707	0.000	2.574

CH 751.747



R.L. 953.00

CUT STRINGS	IA10	LE10	MC10	LE11	IA11
LEVEL DIFFERENCE	0.000	0.021	-0.030	0.013	-0.000
DESIGN LEVELS	958.094	958.050	958.065	957.924	957.879
EXISTING LEVELS	958.09	958.03	958.10	957.91	957.88
DESIGN OFFSETS	-2.257	-1.716	0.000	2.482	2.661

CH 750

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B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 4

CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 4 OF 4		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00384	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00381.dwg

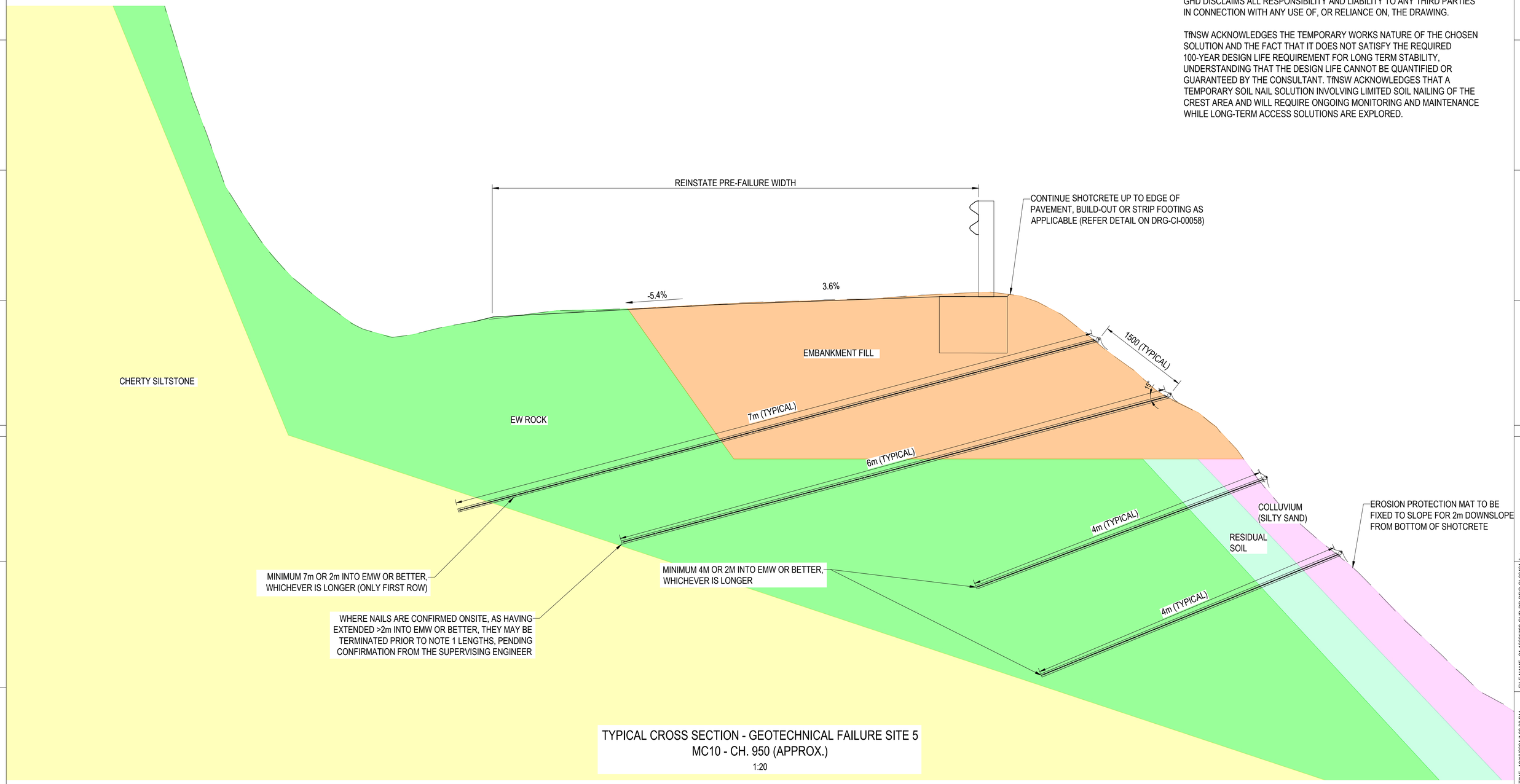
PLOT DATE & TIME: 10/10/2024 7:09:19 PM

NOTES:

1. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 5
MC10 - CH. 950 (APPROX.)
1:20

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REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

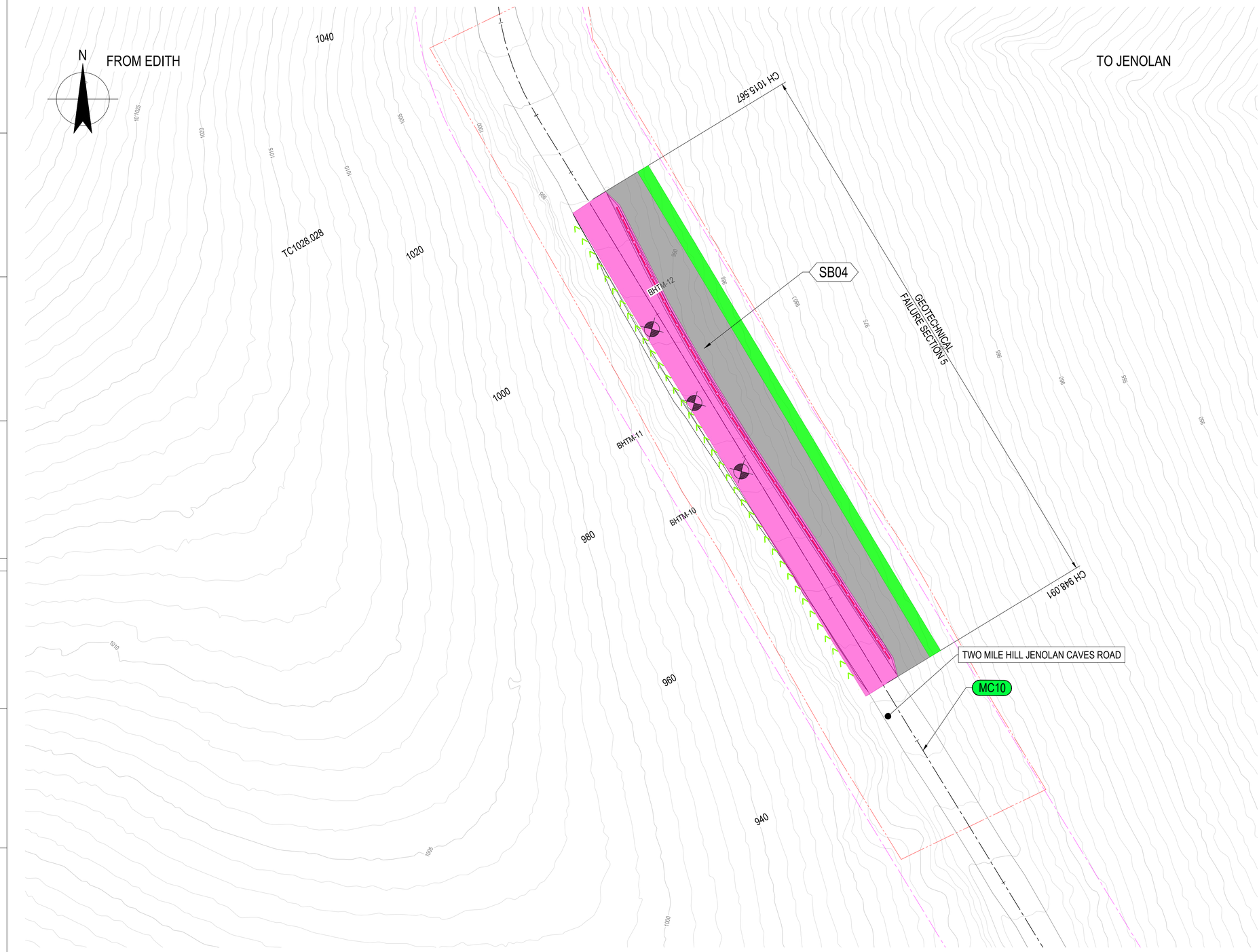
DRAWN	K.GORDON	10.10.24
DESIGNED	P. HOPPER	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 5
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00401				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00401.dwg
PLOT DATE & TIME: 10/10/2024 7:09:32 PM



LEGEND

- 1560 - CHAINAGES
- MC10
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD SAFETY BARRIER (63.525m)
- TfNSW BOUNDARY
- REF PROJECT SITE
- SB** ROAD SAFETY BARRIER NUMBER
- APPROXIMATE EXTENTS OF PAVEMENT RECONSTRUCTION

GEOTECHNICAL LEGEND

- APPROXIMATE SOIL NAIL AND SHOTCRETE AREA
- APPROXIMATE EROSION PROTECTION
- BOREHOLES

DRAINAGE LEGEND

- KERB ONLY
- DRAINAGE CHANNEL (CONCRETE) (REFER SM-2141)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- DRAINAGE CULVERT FAILURES

NOTES:

1. THE PAVEMENT HATCHING ONLY INDICATIVELY SHOWS THE EXTENTS OF PAVEMENT TREATMENT REQUIRED. REFER TO DRG-CI-00056 FOR PAVEMENT PROFILES AND INTERFACE DETAILS.
2. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:250

0 2.5 5 7.5 10 12.5m
SCALE 1:250 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT:
NSW GOVERNMENT Transport for NSW

PREPARED FOR:
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GHD

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DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 5

GENERAL ARRANGEMENT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

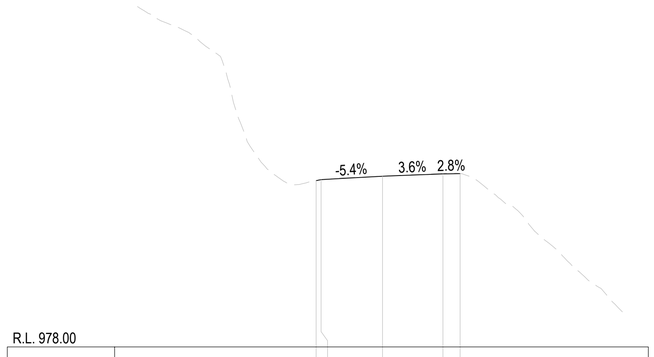
DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00431				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00431.dwg

PLOT DATE & TIME: 10/10/2024 7:09:46 PM

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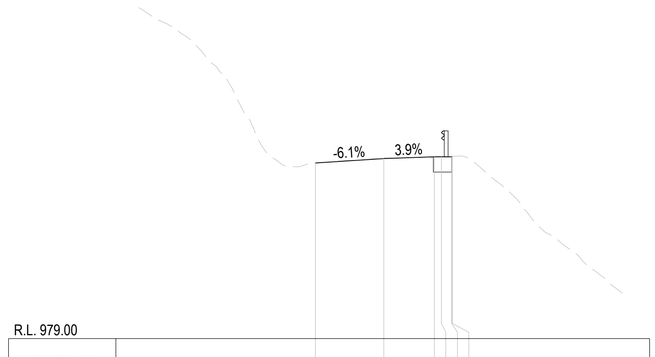
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R.L. 978.00

CUT STRINGS	IA10	LE10	MC10	LE11	IA11	
LEVEL DIFFERENCE	-0.003	0.014	-0.003	-0.021	0.000	
DESIGN LEVELS	983.425	983.465	983.574	983.645	983.661	
EXISTING LEVELS	983.43	983.45	983.58	983.67	983.66	
DESIGN OFFSETS	-2.173	-2.005	0.000	1.971	2.531	

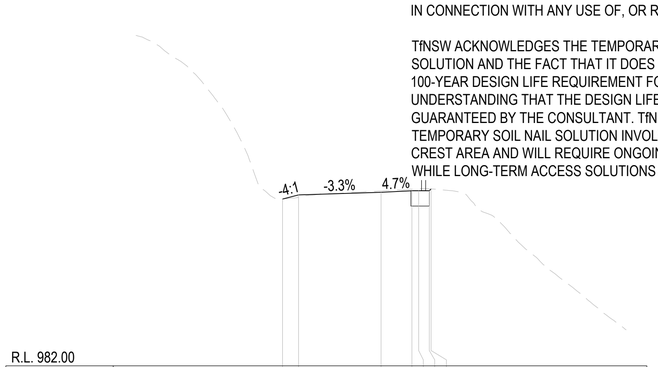
CH 950



R.L. 979.00

CUT STRINGS	LE10	MC10	LE11	BG11	EH11	IA11	
LEVEL DIFFERENCE	0.000	-0.025	0.015	-0.009	-0.012	0.000	
DESIGN LEVELS	984.735	984.871	984.936	984.936	984.936	984.948	
EXISTING LEVELS	984.73	984.90	984.92	984.95	984.95	984.95	
DESIGN OFFSETS	-2.236	0.000	1.648	1.815	2.218	2.230	

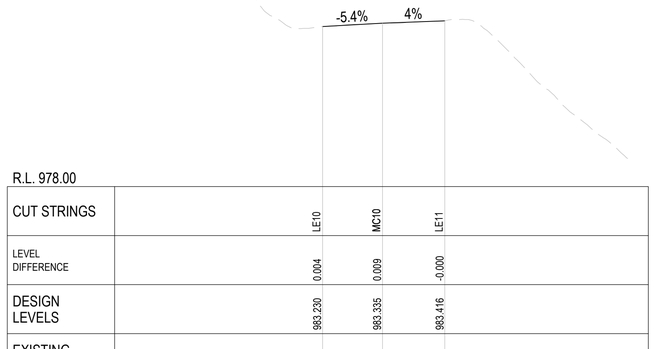
CH 960



R.L. 982.00

CUT STRINGS	IA10	LE10	MC10	LE11	BG11	EH11	IA11
LEVEL DIFFERENCE	0.000	0.077	-0.042	-0.055	-0.065	-0.064	0.000
DESIGN LEVELS	987.451	987.582	987.670	987.717	987.717	987.717	987.777
EXISTING LEVELS	987.45	987.50	987.71	987.77	987.78	987.78	987.78
DESIGN OFFSETS	-3.220	-2.697	0.000	1.001	1.228	1.571	1.630

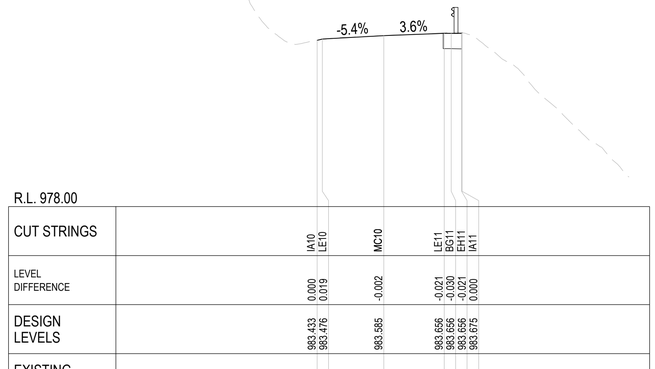
CH 980



R.L. 978.00

CUT STRINGS	LE10	MC10	LE11
LEVEL DIFFERENCE	0.004	0.009	-0.000
DESIGN LEVELS	983.230	983.335	983.416
EXISTING LEVELS	983.23	983.33	983.42
DESIGN OFFSETS	-1.961	0.000	2.033

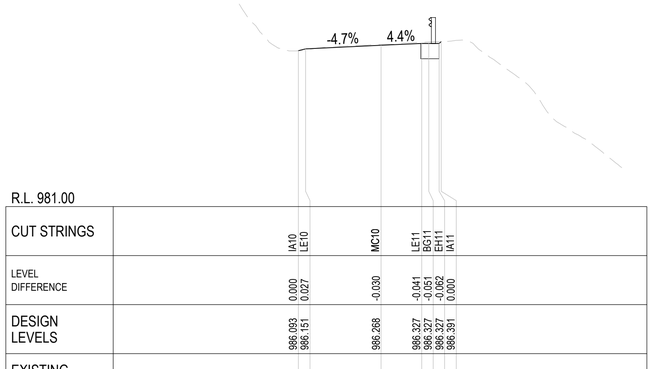
CH 948.091



R.L. 978.00

CUT STRINGS	IA10	LE10	MC10	LE11	BG11	EH11	IA11
LEVEL DIFFERENCE	0.000	0.019	-0.002	-0.021	-0.030	-0.021	0.000
DESIGN LEVELS	983.433	983.476	983.585	983.656	983.656	983.656	983.675
EXISTING LEVELS	983.43	983.46	983.59	983.68	983.69	983.68	983.68
DESIGN OFFSETS	-2.163	-2.008	0.000	1.968	2.195	2.538	2.557

CH 950.091



R.L. 981.00

CUT STRINGS	IA10	LE10	MC10	LE11	BG11	EH11	IA11
LEVEL DIFFERENCE	0.000	0.027	-0.030	-0.041	-0.051	-0.062	0.000
DESIGN LEVELS	986.093	986.151	986.268	986.327	986.327	986.327	986.391
EXISTING LEVELS	986.09	986.12	986.30	986.37	986.38	986.39	986.39
DESIGN OFFSETS	-2.701	-2.466	0.000	1.324	1.551	1.894	1.959

CH 970

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
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GHD

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DRG CHECK	D.TAING	10.10.24
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PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 5

CROSS SECTION

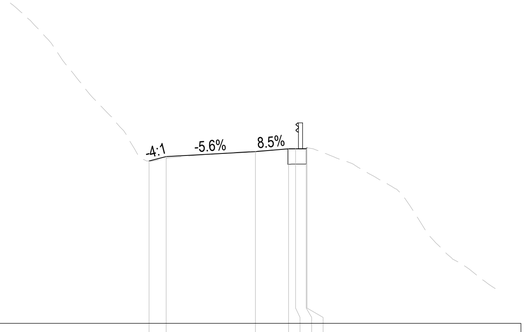
DRAWING SET No: -	PART:	SHEET: 1 OF 3		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00481	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00481.dwg

PLOT DATE & TIME: 10/10/2024 7:10:02 PM

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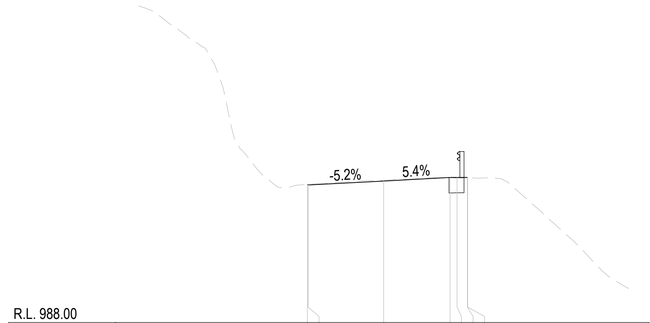
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R.L. 985.00

CUT STRINGS	IA10	LE10	MC10	LE11	BG11	EH11	IA11
LEVEL DIFFERENCE	0.000	0.053	-0.019	0.007	0.000	-0.030	0.000
DESIGN LEVELS	990.303	990.444	990.607	990.700	990.700	990.700	990.732
EXISTING LEVELS	990.30	990.39	990.63	990.69	990.70	990.73	990.73
DESIGN OFFSETS	-3.469	-2.905	0.000	1.089	1.316	1.659	1.991

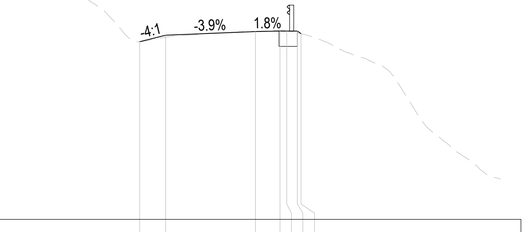
CH 1000



R.L. 988.00

CUT STRINGS	IA10	LE10	MC10	LE11	BG11	EH11	IA11
LEVEL DIFFERENCE	0.000	-0.023	-0.034	0.004	0.015	0.003	0.000
DESIGN LEVELS	992.509	992.487	992.615	992.732	992.732	992.732	992.730
EXISTING LEVELS	992.51	992.51	992.65	992.73	992.72	992.73	992.73
DESIGN OFFSETS	-2.483	-2.461	0.000	2.172	2.399	2.742	2.745

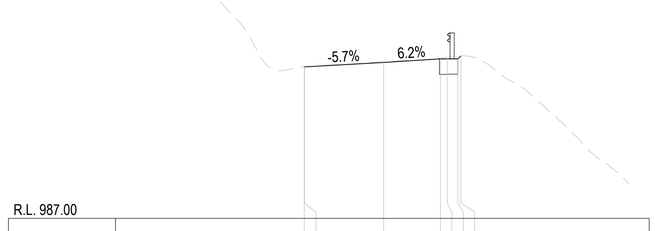
CH 1013.567



R.L. 983.00

CUT STRINGS	IA10	LE10	MC10	LE11	BG11	EH11	IA11
LEVEL DIFFERENCE	0.000	0.063	-0.011	-0.017	-0.009	0.056	0.000
DESIGN LEVELS	988.800	989.012	989.127	989.142	989.142	989.142	989.062
EXISTING LEVELS	988.80	988.95	989.14	989.16	989.15	989.09	989.06
DESIGN OFFSETS	-3.775	-2.927	0.000	0.805	1.032	1.375	1.495

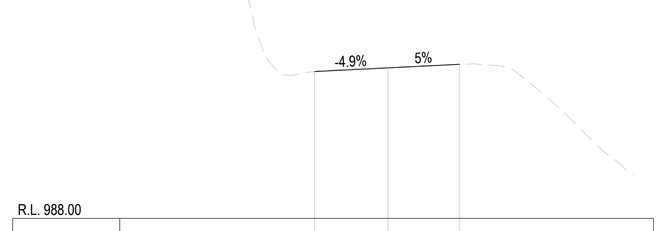
CH 990



R.L. 987.00

CUT STRINGS	IA10	LE10	MC10	LE11	BG11	EH11	IA11
LEVEL DIFFERENCE	0.000	-0.007	-0.036	-0.025	-0.050	-0.088	0.000
DESIGN LEVELS	991.947	991.941	992.087	992.202	992.202	992.202	992.301
EXISTING LEVELS	991.95	991.95	992.12	992.23	992.25	992.29	992.30
DESIGN OFFSETS	-2.585	-2.578	0.000	1.853	2.080	2.423	2.522

CH 1010



R.L. 988.00

CUT STRINGS	IA10	MC10	LE11
LEVEL DIFFERENCE	0.000	-0.038	-0.000
DESIGN LEVELS	992.793	992.911	993.029
EXISTING LEVELS	992.79	992.95	993.03
DESIGN OFFSETS	-2.395	0.000	2.350

CH 1015.567

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C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 5

CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 2 OF 3	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00482				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00481.dwg

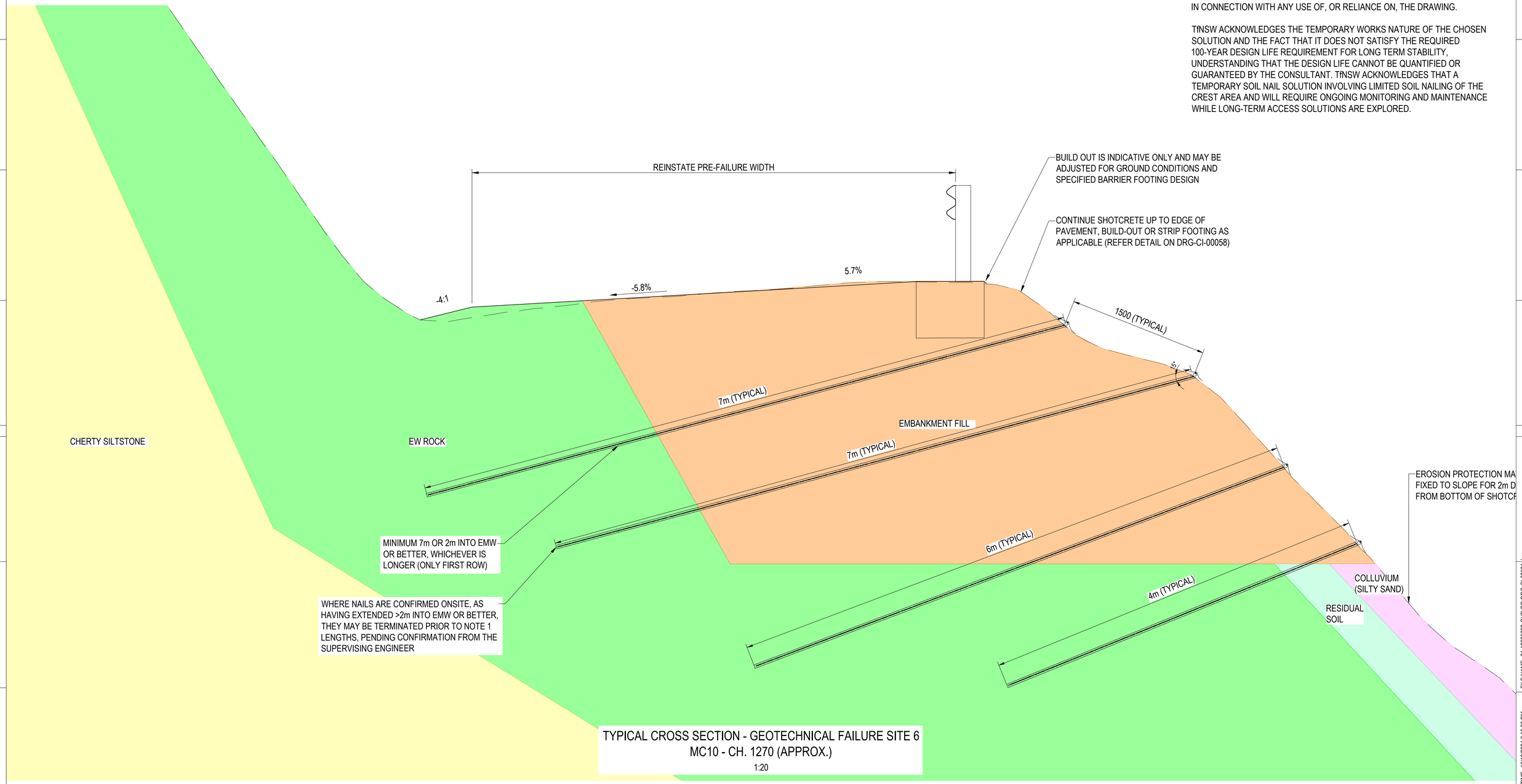
PLOT DATE & TIME: 10/10/2024 7:10:07 PM

NOTES:

1. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 6
MC10 - CH. 1270 (APPROX.)
1:20

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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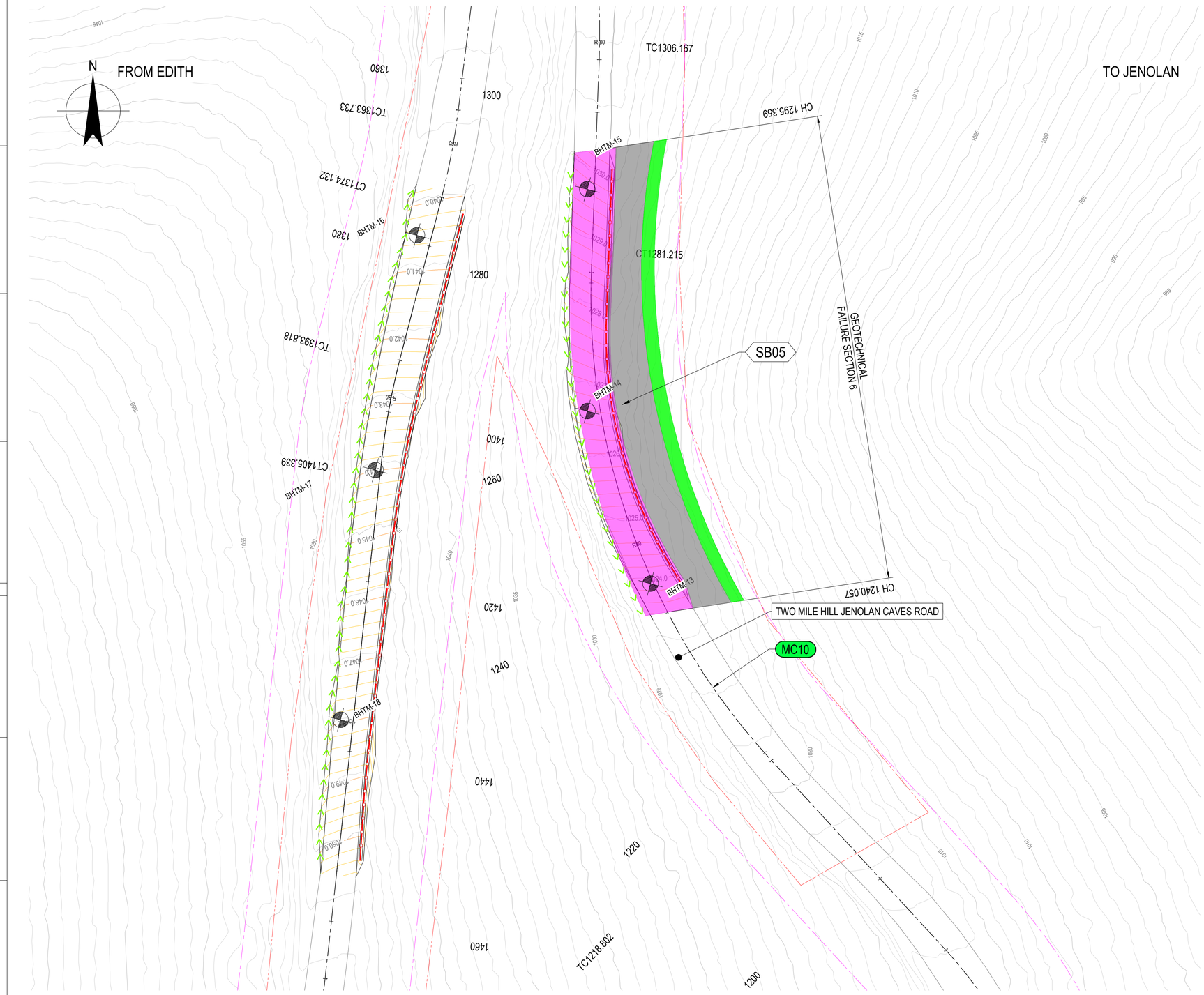
GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	P. HOPPER	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 6
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00501	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00501.dwg
PLOT DATE & TIME: 10/10/2024 7:10:20 PM



LEGEND

- 1560 - CHAINAGES
- MC10
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD SAFETY BARRIER (50.465m)
- TfNSW BOUNDARY
- REF PROJECT SITE
- SB** ROAD SAFETY BARRIER NUMBER
- APPROXIMATE EXTENTS OF PAVEMENT RECONSTRUCTION

GEOTECHNICAL LEGEND

- APPROXIMATE SOIL NAIL AND SHOTCRETE AREA
- APPROXIMATE EROSION PROTECTION
- BOREHOLES

DRAINAGE LEGEND

- KERB ONLY
- DRAINAGE CHANNEL (CONCRETE) (REFER SM-2141)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- DRAINAGE CULVERT FAILURES

NOTES:

1. THE PAVEMENT HATCHING ONLY INDICATIVELY SHOWS THE EXTENTS OF PAVEMENT TREATMENT REQUIRED. REFER TO DRG-CI-00056 FOR PAVEMENT PROFILES AND INTERFACE DETAILS.
2. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:250

0 2.5 5 7.5 10 12.5m
SCALE 1:250 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 6
GENERAL ARRANGEMENT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00531				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00531.dwg

PLOT DATE & TIME: 10/10/2024 7:10:35 PM

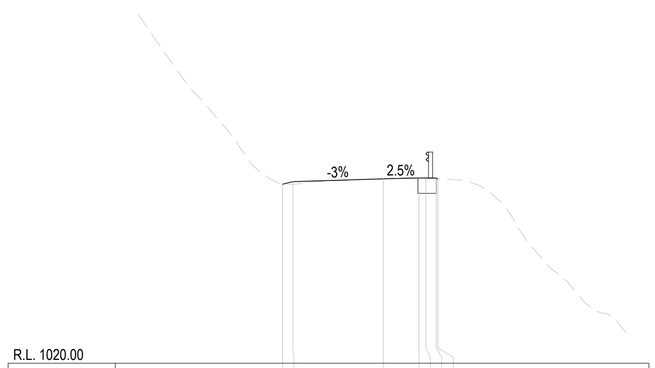
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R.L. 1019.00

CUT STRINGS			IA10	LE10		MC10		LE11	BG11	EH11	IA11
LEVEL DIFFERENCE			0.000	-0.009		-0.011		0.013	0.006	0.033	0.000
DESIGN LEVELS			1023.571	1023.563		1023.700		1023.789	1023.789	1023.789	1023.730
EXISTING LEVELS			1023.57	1023.57		1023.71		1023.78	1023.78	1023.76	1023.73
DESIGN OFFSETS			-1.979	-1.971		0.000		2.631	2.858	3.201	3.290

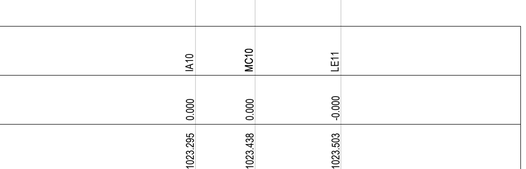
CH 1242.057



R.L. 1020.00

CUT STRINGS			IA10	LE10		MC10		LE11	BG11	EH11	IA11
LEVEL DIFFERENCE			0.000	0.086		0.009		0.010	0.031	0.031	0.000
DESIGN LEVELS			1025.847	1025.930		1026.018		1026.047	1026.047	1026.047	1026.016
EXISTING LEVELS			1025.85	1025.84		1026.01		1026.04	1026.02	1026.02	1026.02
DESIGN OFFSETS			-3.287	-2.952		0.000		1.162	1.389	1.732	1.778

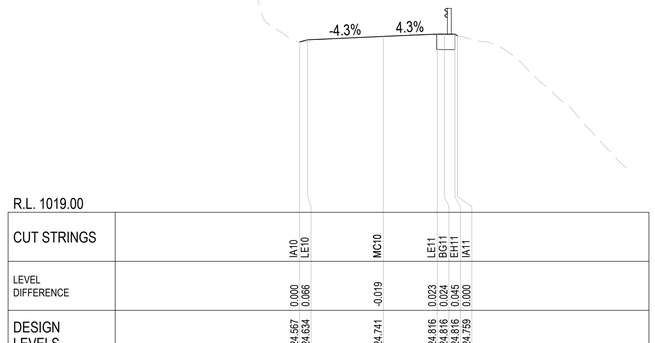
CH 1260



R.L. 1019.00

CUT STRINGS			IA10			MC10		LE11			
LEVEL DIFFERENCE			0.000			0.000		-0.000			
DESIGN LEVELS			1023.295			1023.438		1023.503			
EXISTING LEVELS			1023.29			1023.44		1023.50			
DESIGN OFFSETS			-1.941			0.000		2.805			

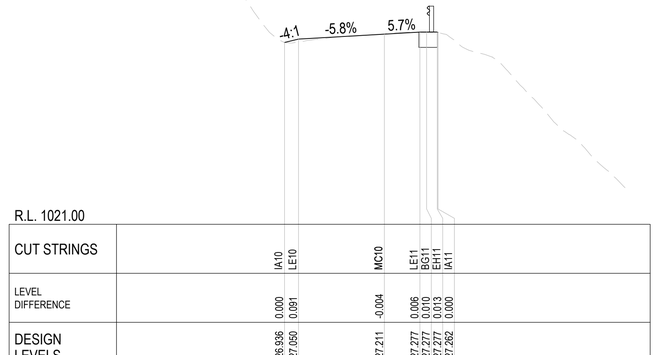
CH 1240.057



R.L. 1019.00

CUT STRINGS			IA10	LE10		MC10		LE11	BG11	EH11	IA11
LEVEL DIFFERENCE			0.000	0.066		-0.019		0.023	0.024	0.045	0.000
DESIGN LEVELS			1024.587	1024.634		1024.741		1024.816	1024.816	1024.816	1024.759
EXISTING LEVELS			1024.57	1024.57		1024.76		1024.79	1024.79	1024.77	1024.76
DESIGN OFFSETS			-2.734	-2.465		0.000		1.769	1.995	2.339	2.425

CH 1250



R.L. 1021.00

CUT STRINGS			IA10	LE10		MC10		LE11	BG11	EH11	IA11
LEVEL DIFFERENCE			0.000	0.091		-0.004		0.006	0.010	0.013	0.000
DESIGN LEVELS			1026.936	1027.050		1027.211		1027.277	1027.277	1027.277	1027.262
EXISTING LEVELS			1026.94	1026.96		1027.21		1027.27	1027.27	1027.26	1027.26
DESIGN OFFSETS			-3.261	-2.804		0.000		1.153	1.380	1.723	1.746

CH 1270

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 6

CROSS SECTION

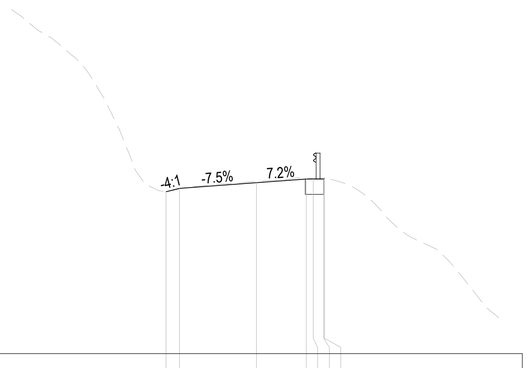
DRAWING SET No: -	PART:	SHEET: 1 OF 3		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00581	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00581.dwg

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R.L. 1024.00

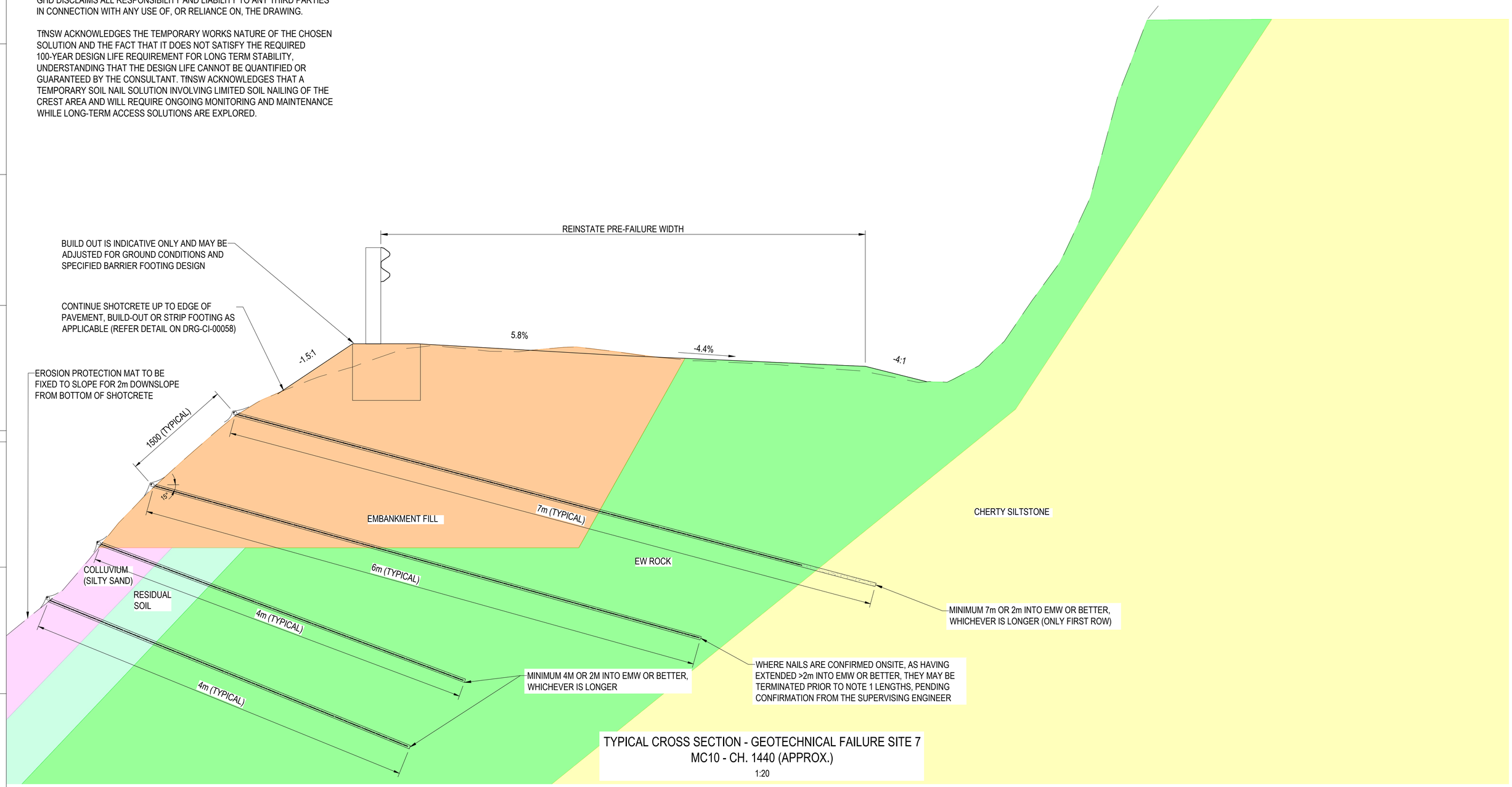
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NOTES:

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TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 7
MC10 - CH. 1440 (APPROX.)
1:20

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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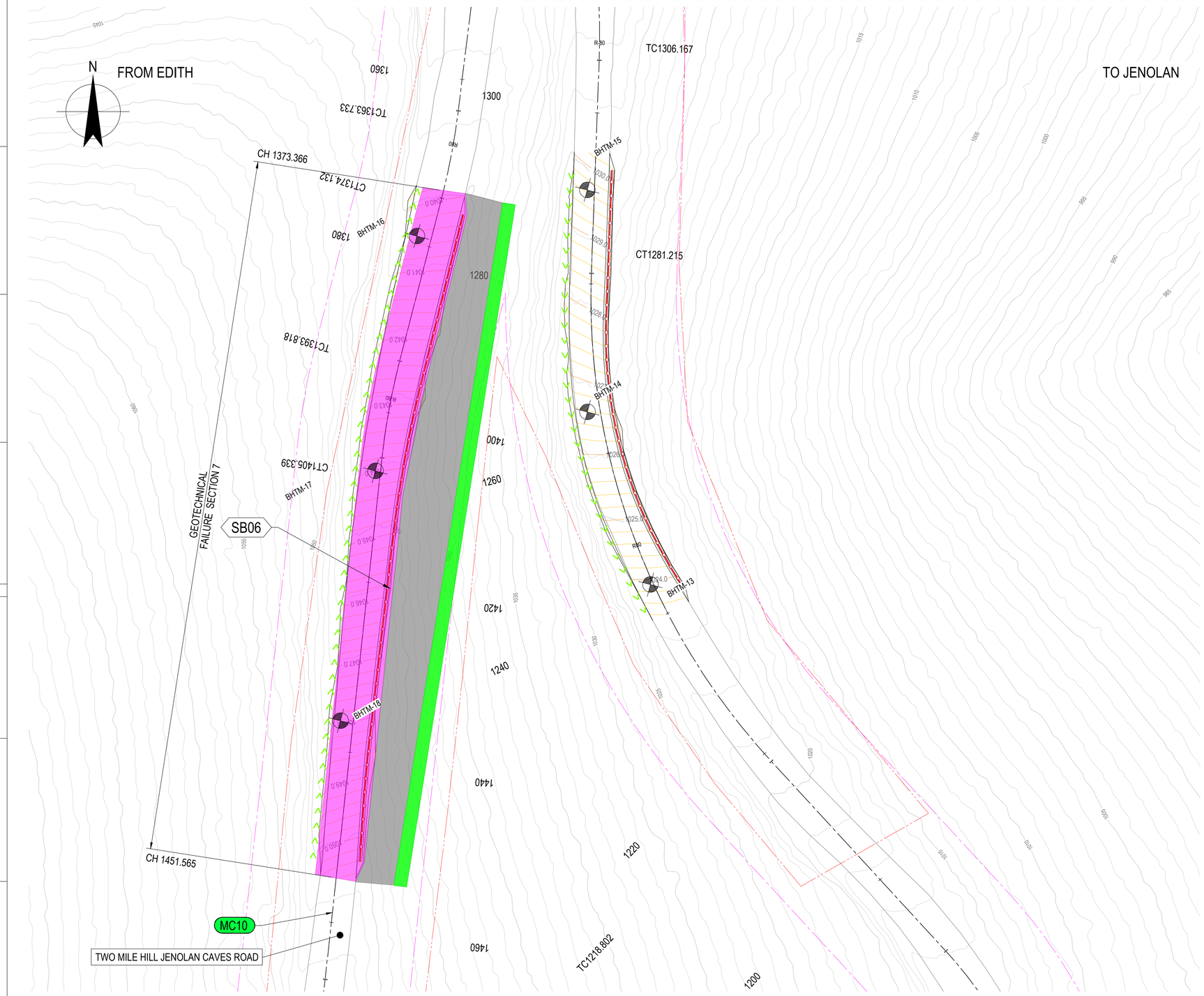
GHD

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PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 7
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00601	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00601.dwg
PLOT DATE & TIME: 10/10/2024 7:11:11 PM



LEGEND

- 1560 - CHAINAGES
- MC10
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD SAFETY BARRIER (76.796m)
- TfNSW BOUNDARY
- REF PROJECT SITE
- SB** ROAD SAFETY BARRIER NUMBER
- APPROXIMATE EXTENTS OF PAVEMENT RECONSTRUCTION

GEOTECHNICAL LEGEND

- APPROXIMATE SOIL NAIL AND SHOTCRETE AREA
- APPROXIMATE EROSION PROTECTION
- BOREHOLES

DRAINAGE LEGEND

- KERB ONLY
- DRAINAGE CHANNEL (CONCRETE) (REFER SM-2141)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- DRAINAGE CULVERT FAILURES

NOTES:

1. THE PAVEMENT HATCHING ONLY INDICATIVELY SHOWS THE EXTENTS OF PAVEMENT TREATMENT REQUIRED. REFER TO DRG-CI-00056 FOR PAVEMENT PROFILES AND INTERFACE DETAILS.
2. ALL CIVIL AND ROAD DESIGN SCOPE HAS BEEN UPDATED FROM THE 50% DETAILED DESIGN BASED ON THE POST-FAILURE SURVEY FROM DIOSPATIAL DATED 24/04/2024.

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REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
C	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD | DESIGN LOT CODE: --

SCALE: 1:250

0 2.5 5 7.5 10 12.5m

SCALE 1:250 AT ORIGINAL SIZE

CLIENT:

NSW GOVERNMENT | Transport for NSW

PREPARED FOR:

PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON		10.10.24
DESIGNED	D.KIM		10.10.24
DRG CHECK	D.TAING		10.10.24
DESIGN CHECK	J.LEE		10.10.24
PROJ/DES MNGR	J.FORDHAM		10.10.24
APPROVED	J.HELLMUTH		10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 7

GENERAL ARRANGEMENT PLAN

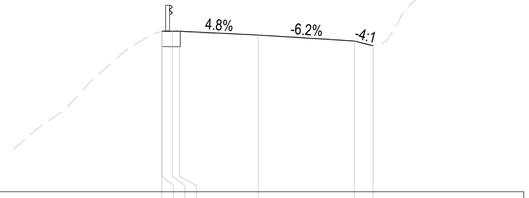
DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00631	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00631.dwg

PLOT DATE & TIME: 10/10/2024 7:11:27 PM

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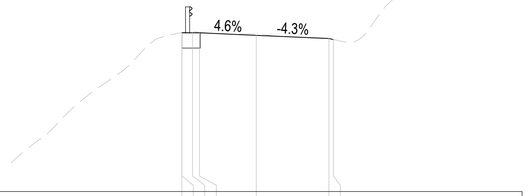


R.L. 1035.00

| | | |

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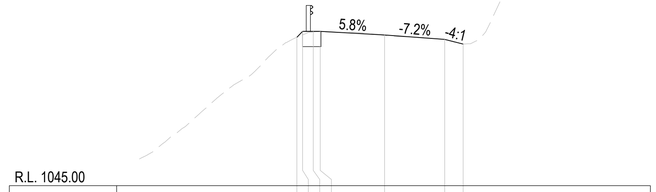
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R.L. 1042.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	-0.006	-0.041	-0.016	-0.047	0.020	0.000
DESIGN LEVELS	1047.183	1047.178	1047.178	1047.178	1047.093	1046.991	1046.955
EXISTING LEVELS	1047.18	1047.18	1047.22	1047.19	1047.14	1046.97	1046.95
DESIGN OFFSETS	-2.435	-2.267	-2.087	-1.860	0.000	2.368	2.513

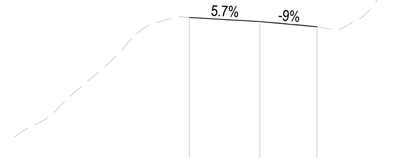
CH 1430



R.L. 1045.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	0.113	0.018	0.007	0.010	0.008	0.000
DESIGN LEVELS	1049.842	1050.035	1050.035	1050.035	1049.913	1049.771	1049.621
EXISTING LEVELS	1049.84	1049.92	1050.05	1050.03	1049.90	1049.76	1049.62
DESIGN OFFSETS	-2.866	-2.674	-2.331	-2.104	0.000	1.958	2.562

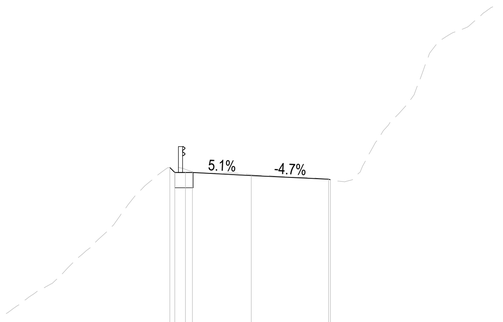
CH 1450



R.L. 1046.00

	IA10	MC10	LE11
CUT STRINGS			
LEVEL DIFFERENCE	-0.000	0.001	0.003
DESIGN LEVELS	1050.688	1050.556	1050.388
EXISTING LEVELS	1050.69	1050.56	1050.38
DESIGN OFFSETS	-2.305	0.000	1.865

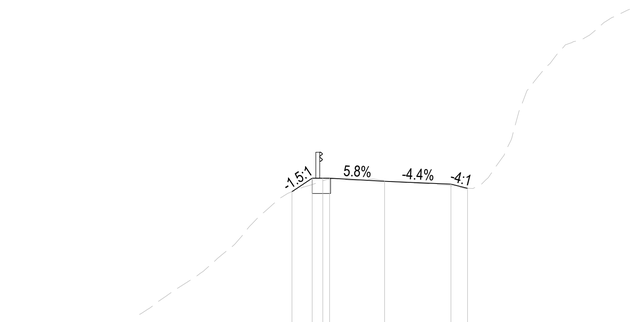
CH 1454.565



R.L. 1040.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	-0.186	-0.107	-0.031	-0.026	0.004	0.000
DESIGN LEVELS	1045.951	1045.789	1045.789	1045.789	1045.691	1045.571	1045.557
EXISTING LEVELS	1045.95	1045.97	1045.90	1045.82	1045.72	1045.57	1045.56
DESIGN OFFSETS	-2.659	-2.497	-2.154	-1.927	0.000	2.524	2.580

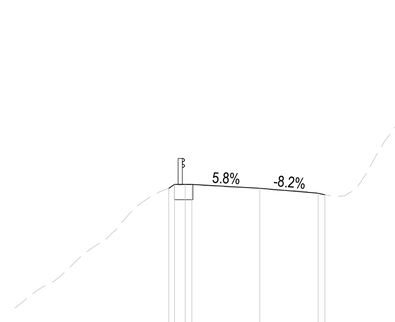
CH 1420



R.L. 1043.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	0.209	0.088	0.034	-0.028	0.048	0.000
DESIGN LEVELS	1048.165	1048.606	1048.606	1048.606	1048.503	1048.407	1048.271
EXISTING LEVELS	1048.16	1048.40	1048.52	1048.57	1048.53	1048.36	1048.27
DESIGN OFFSETS	-3.025	-2.363	-2.020	-1.793	0.000	2.163	2.705

CH 1440



R.L. 1045.00

	IA10	EH10	BF10	LE10	MC10	LE11	IA11
CUT STRINGS							
LEVEL DIFFERENCE	0.000	0.065	0.022	0.018	0.001	0.011	0.000
DESIGN LEVELS	1050.277	1050.402	1050.402	1050.402	1050.274	1050.118	1050.064
EXISTING LEVELS	1050.28	1050.34	1050.38	1050.38	1050.27	1050.11	1050.06
DESIGN OFFSETS	-2.973	-2.786	-2.443	-2.216	0.000	1.906	2.120

CH 1452.565

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B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 7

CROSS SECTION

DRAWING SET No: -	PART:	SHEET: 2 OF 3	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00682				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00681.dwg

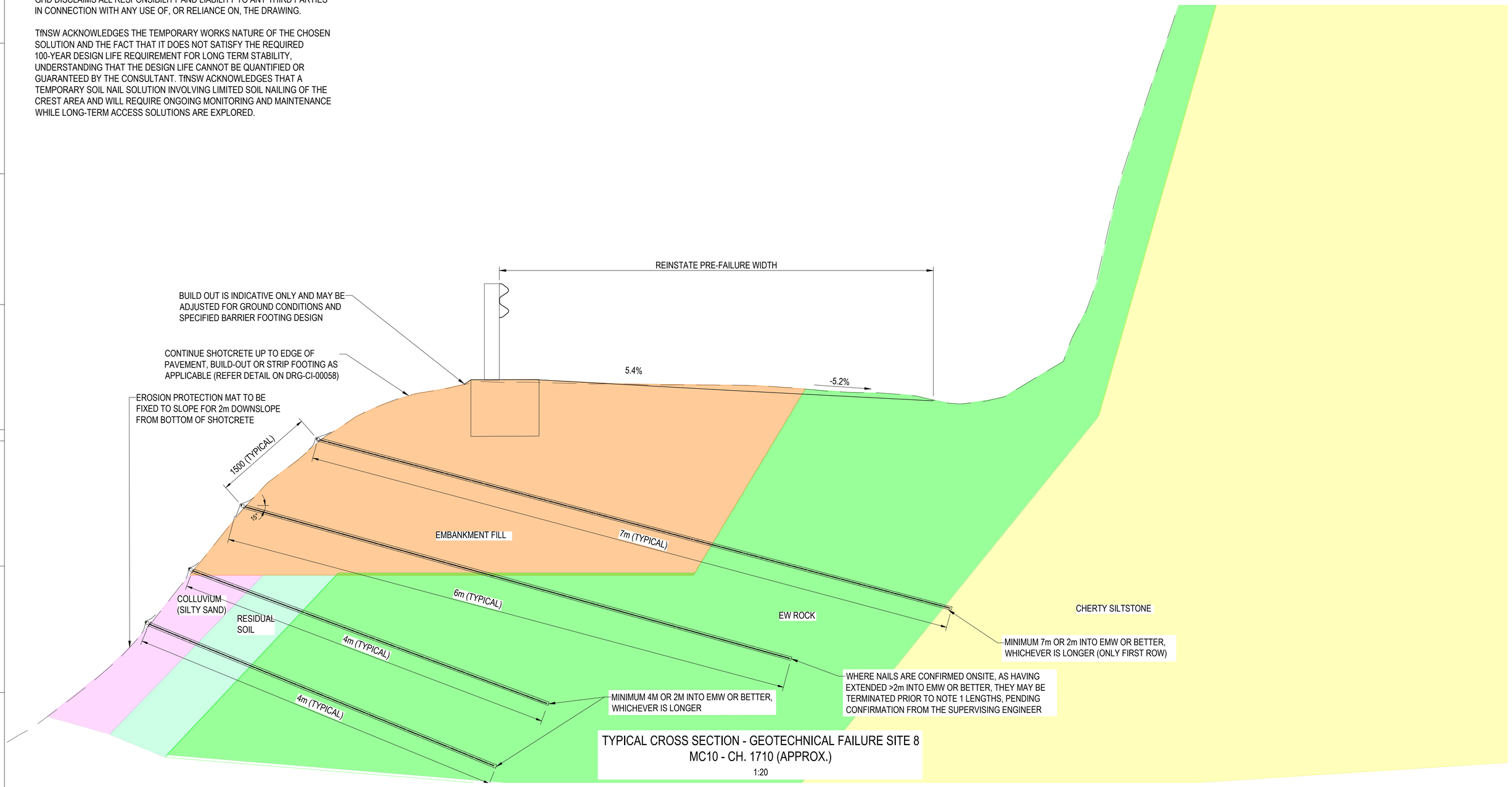
PLOT DATE & TIME: 10/10/2024 7:11:48 PM

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NOTES:

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TYPICAL CROSS SECTION - GEOTECHNICAL FAILURE SITE 8
MC10 - CH. 1710 (APPROX.)
1:20

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A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:20

0 0.2 0.4 0.6m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	P. HOPPER	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	M.TAMADON	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
GEOTECHNICAL FAILURE SITE 8
TYPICAL SECTION

DRAWING SET No: -	PART:	SHEET: 1 OF 1	A1	
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00701	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00701.dwg
PLOT DATE & TIME: 10/10/2024 7:12:01 PM



LEGEND

- 1560 - CHAINAGES
- MC10
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- INDICATIVE EXISTING ROAD EDGE
- ROAD SAFETY BARRIER (44.972m)
- TfNSW BOUNDARY
- REF PROJECT SITE
- SB** — ROAD SAFETY BARRIER NUMBER
- APPROXIMATE EXTENTS OF PAVEMENT RECONSTRUCTION

GEOTECHNICAL LEGEND

- APPROXIMATE SOIL NAIL AND SHOTCRETE AREA
- APPROXIMATE EROSION PROTECTION
- BOREHOLES

DRAINAGE LEGEND

- KERB ONLY
- DRAINAGE CHANNEL (CONCRETE) (REFER SM-2141)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- DRAINAGE CULVERT FAILURES

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:250

0 2.5 5 7.5 10 12.5m
SCALE 1:250 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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DESIGN CHECK	J.LEE	10.10.24
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SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

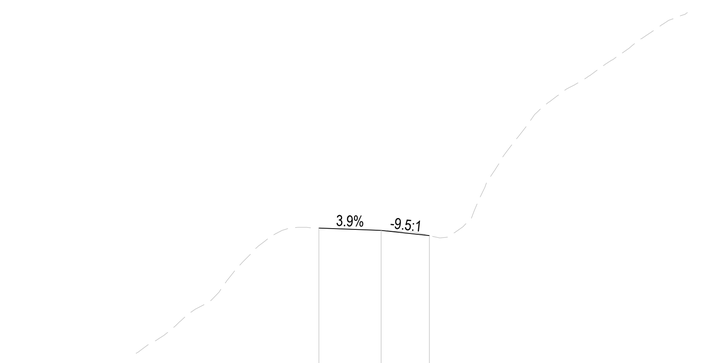
GEOTECHNICAL FAILURE SITE 8
GENERAL ARRANGEMENT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00731	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00731.dwg
PLOT DATE & TIME: 10/10/2024 7:12:16 PM

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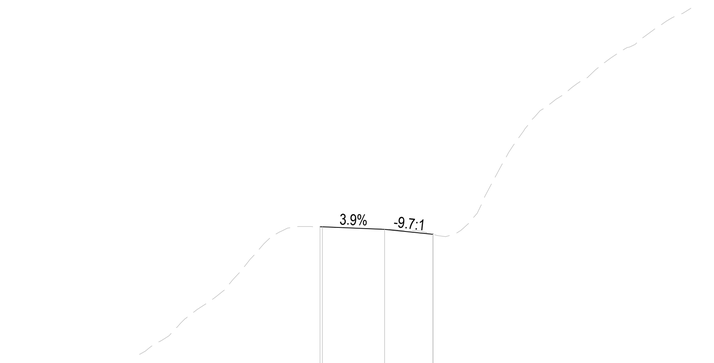
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R.L. 1078.00

CUT STRINGS	LE10	MC10	LE11
LEVEL DIFFERENCE	0.000	-0.000	-0.000
DESIGN LEVELS	1083.433	1083.355	1083.189
EXISTING LEVELS	1083.43	1083.36	1083.19
DESIGN OFFSETS	-2.029	0.000	1.576

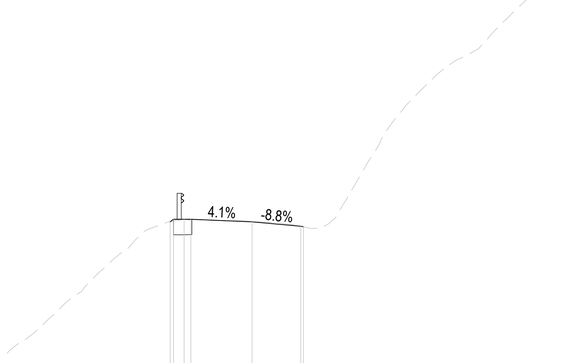
CH 1699.726



R.L. 1078.00

CUT STRINGS	IA10 LE10	MC10	LE11 IA11
LEVEL DIFFERENCE	0.001 0.002	-0.009	-0.004 0.012
DESIGN LEVELS	1083.472 1083.472	1083.393	1083.230 1083.242
EXISTING LEVELS	1083.47 1083.47	1083.40	1083.23 1083.23
DESIGN OFFSETS	-2.105 -2.027	0.000	1.575 1.587

CH 1700



R.L. 1078.00

CUT STRINGS	IA10 EP10 EP10 LE10	MC10	LE11 IA11
LEVEL DIFFERENCE	0.000 0.057 0.041 0.013	-0.012	0.004 0.000
DESIGN LEVELS	1083.639 1083.716 1083.716 1083.716	1083.635	1083.494 1083.473
EXISTING LEVELS	1083.64 1083.66 1083.68 1083.70	1083.65	1083.49 1083.47
DESIGN OFFSETS	-2.678 -2.564 -2.227 -1.994	0.000	1.592 1.680

CH 1701.726

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B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	DK 23.04.24	JL 23.04.24	JF 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	D.KIM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	J.LEE	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

GEOTECHNICAL FAILURE SITE 8

CROSS SECTION

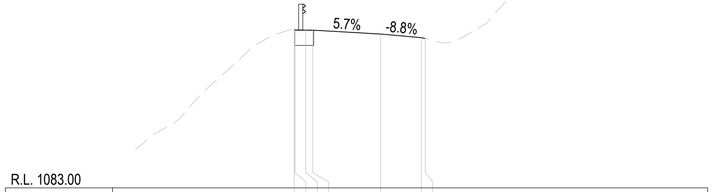
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STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00781	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00781.dwg

PLOT DATE & TIME: 10/10/2024 7:12:39 PM

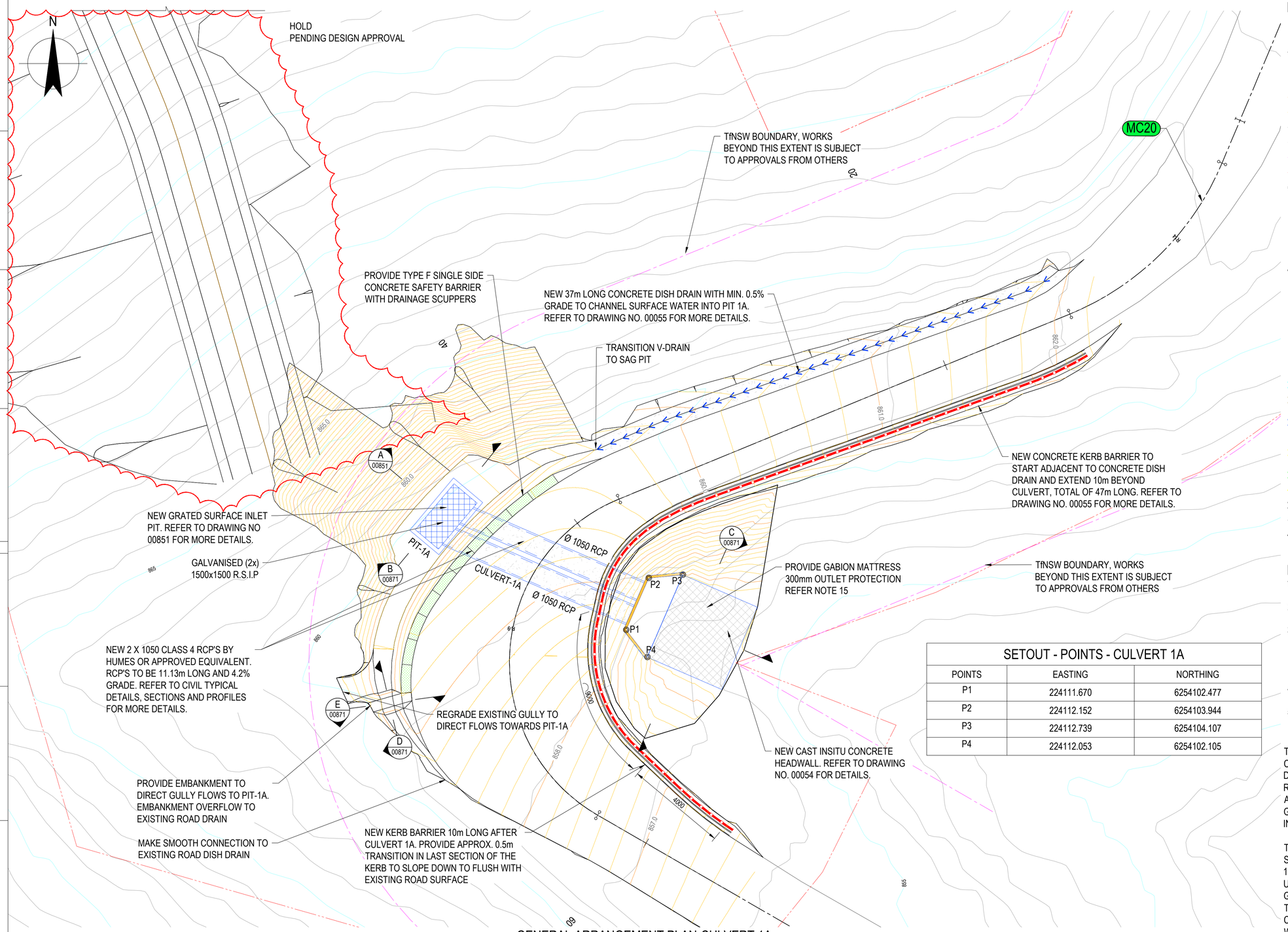
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R.L. 1083.00

| | | |



GENERAL ARRANGEMENT PLAN-CULVERT 1A

SCALE 1:100

LEGEND

- 100 - CHAINAGES
- MCD1 — DESIGN CONTROL STRING LABEL
- 995 — DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- 995 — EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- TfNSW BOUNDARY
- REF PROJECT SITE
- KERB ONLY
- T2-05-3.C — CHANNEL TYPE IDENTIFIER
- 03.01 — DRAINAGE PIT LABEL
- C 96.02 A — DRAINAGE CULVERT LABEL
- DRAINAGE PIT
- Ø375 — DRAINAGE PIPE WITH DIAMETER AND DIRECTION OF FLOW
- Ø 650 RPC — DRAINAGE CULVERT WITH SIZE AND TYPE LABEL
- TYPE F SINGLE SIDE CONCRETE SAFETY BARRIER
- B 96.02 R — WATER QUALITY/SPILL BASIN WITH LABEL
- DRAINAGE CHANNEL GRASS (REFER SM-2141)
- DRAINAGE CHANNEL ROCK (REFER SM-2141)
- DRAINAGE CHANNEL CONCRETE (REFER SM-2141)
- BERM DRAIN PARTIAL CONCRETE (REFER SM-2142)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- LEVEL SPREADER (REFER SM-2142)
- SO TURNOUT (REFER SM-2143)
- BATTER CHUTE (REFER SM-2153)
- BOX DRAIN (REFER SM-2156)
- SETOUT POINTS

SETOUT - POINTS - CULVERT 1A

POINTS	EASTING	NORTHING
P1	224111.670	6254102.477
P2	224112.152	6254103.944
P3	224112.739	6254104.107
P4	224112.053	6254102.105

NOTES:

1. ALL DIMENSIONS ARE IN mm AND ALL ELEVATIONS AND COORDINATIONS ARE IN m, UNO.
2. ALL CIVIL SCOPE HAS BEEN DESIGNED BASED ON THE POST FAILURE LIDAR SURVEY.
3. SURFACE WATER TO BE DISCHARGED INTO THE EXISTING STORMWATER SYSTEM NEAR THE TOP CAR PARK (CAR PARK 2). JENOLAN CAVES TRUST TO EXPLORE OPTIONS TO RE-SIZE OR UPGRADE. THE EXISTING STORMWATER SYSTEM TO ACCOMMODATE THE RE-DIRECTED VOLUME OF WATER.
4. FOR CULVERT INSTALLATION REFER TO TfNSW STANDARD DRAWING R0240-01.
5. THE CURRENT GULLY FAILURE EXTENT AND ALIGNMENT WILL BE UPDATED AND REALIGNED ON RECEIPT OF POST DISASTER AERIAL LIDAR SURVEY AND PRESENTED WITHIN 100% DETAILED DESIGN.

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A	50% DETAILED DESIGN	SR 23.04.24	AR 23.04.24	JH 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m
SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

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PROJECT SERVICES WEST
NETWORK AND ASSETS
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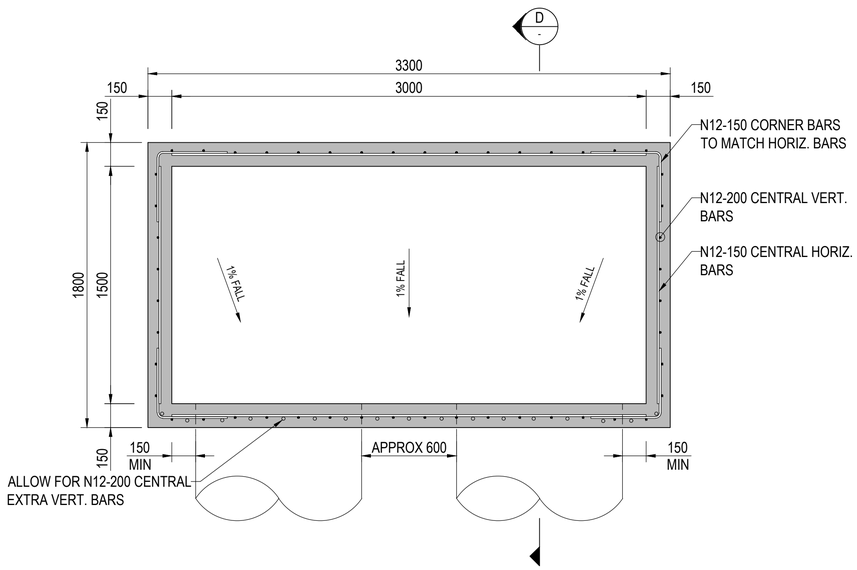
GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	J.KEEM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.RAHMAN	10.10.24
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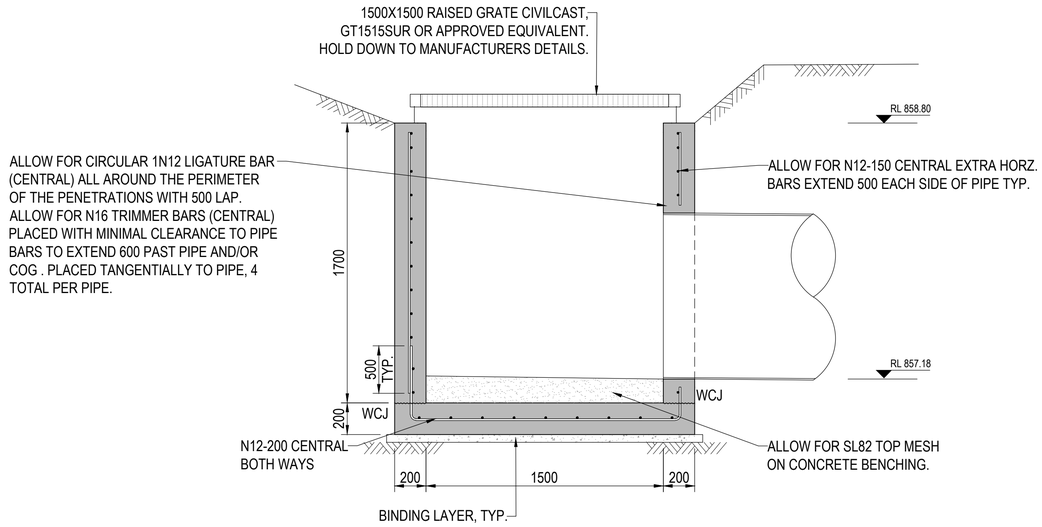
SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
DRAINAGE CULVERT FAILURE SITE 1A
GENERAL ARRANGEMENT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00831	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00831.dwg
PLOT DATE & TIME: 10/10/2024 7:13:32 PM



CULVERT 1A REINFORCEMENT PLAN
SCALE 1 : 20



CULVERT 1A REINFORCEMENT SECTION
SCALE 1 : 20

LEGEND

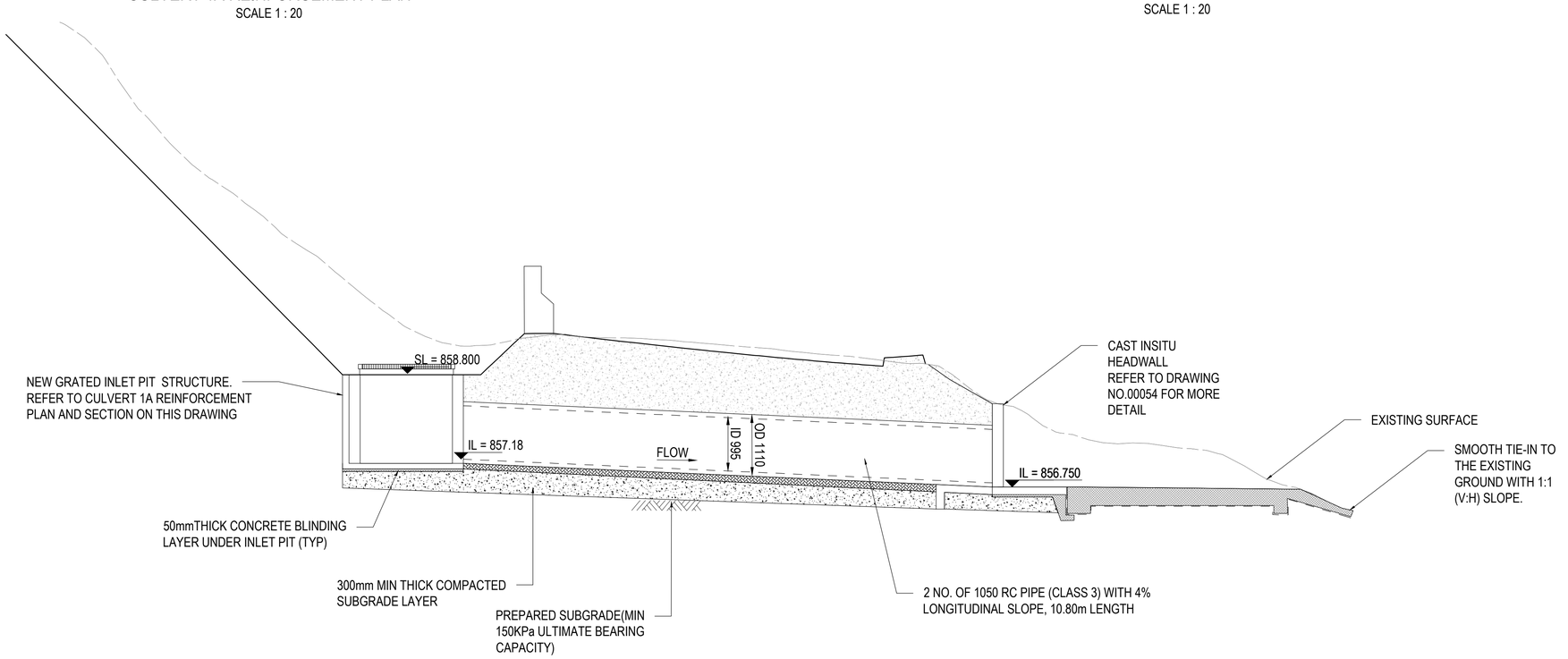
	COMPACTED BACKFILL
	PIPE BEDDING
	COMPACTED SUBBASE LAYER
IL =	INVERT LEVEL
SL =	SURFACE LEVEL

NOTES:

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3. SURFACE WATER TO BE DISCHARGED INTO THE EXISTING STORMWATER SYSTEM NEAR THE TOP CAR PARK (CAR PARK 2). JENOLAN CAVES TRUST TO EXPLORE OPTIONS TO RE-SIZE OR UPGRADE. THE EXISTING STORMWATER SYSTEM TO ACCOMMODATE THE RE-DIRECTED VOLUME OF WATER.
4. 4.FOR CULVERT INSTALLATION REFER TO TFNSW STANDARD DRAWING R0240-01.

CONCRETE NOTES:

1. ALL REINFORCED CONCRETE SHALL BE S40. ALL CONCRETE BENCHING SHALL BE N20. ALL CONCRETE BLINDING LAYER TO BE N10.
2. CLEAR COVER SHALL BE MIN 50mm TO EXTERNAL SURFACES IN CONTACT WITH GROUND AND INTERNAL SURFACES. PROVIDE MIN 50mm COVER ELSEWHERE.
3. PRECAST PITS ARE TO BE DESIGNED IN ACCORDANCE WITH AS5100 WITH SM1600 LOADS, INCLUDING A160 AXLE LOAD AND W80 WHEEL LOADS.
4. PRECAST REINFORCEMENT AND CONCRETE SHALL BE DESIGN IN ACCORDANCE WITH AS5100.5 WITH A DURABILITY CLASS C WITH A MIN 100 YEAR DESIGN LIFE.
5. WCJ DENOTES WATER STOP CONSTRUCTION JOINT. ALLOW PARCHEM SUPERSWELL 47B HYDROPHILLIC WATER STOP MIN. 50mm COVER TYP. SECURE WITH LEAKMASTER SEALANT. SCABBLE SURFACE AND EXPOSE AGGREGATE AND APPLY 1mm XPLEX CONCENTRATE TO THROUGH THE JOINT



A 00831 LONGITUDINAL SECTION - CULVERT 1A
SCALE 1 : 50

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A	50% DETAILED DESIGN	SR 23.04.24	AR 23.04.24	JH 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:50

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

DESIGN LOT CODE: --

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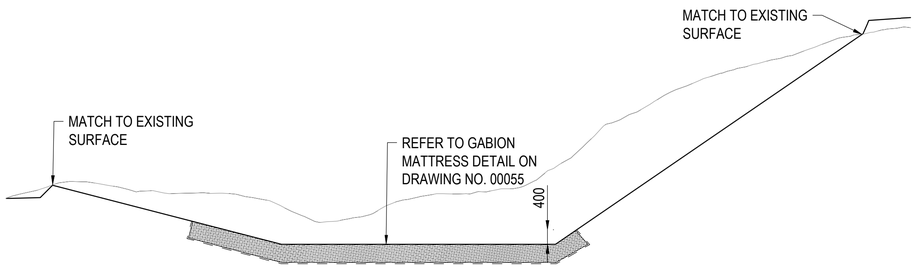
GHD

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DESIGNED	J.KEEM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.RAHMAN	10.10.24
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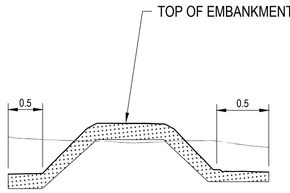
SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
DRAINAGE CULVERT FAILURE SITE 1A
LONGITUDINAL SECTION, TYPICAL SECTION AND CROSS SECTION - CULVERT 1A

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00851	REV	VER	EDMS No.	AMD No.

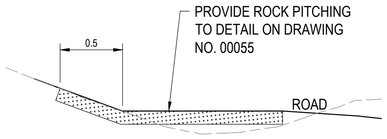
FILE NAME: 21-12625762-GHD-DD-DRG-CI-00851.dwg
PLOT DATE & TIME: 10/10/2024 7:13:59 PM



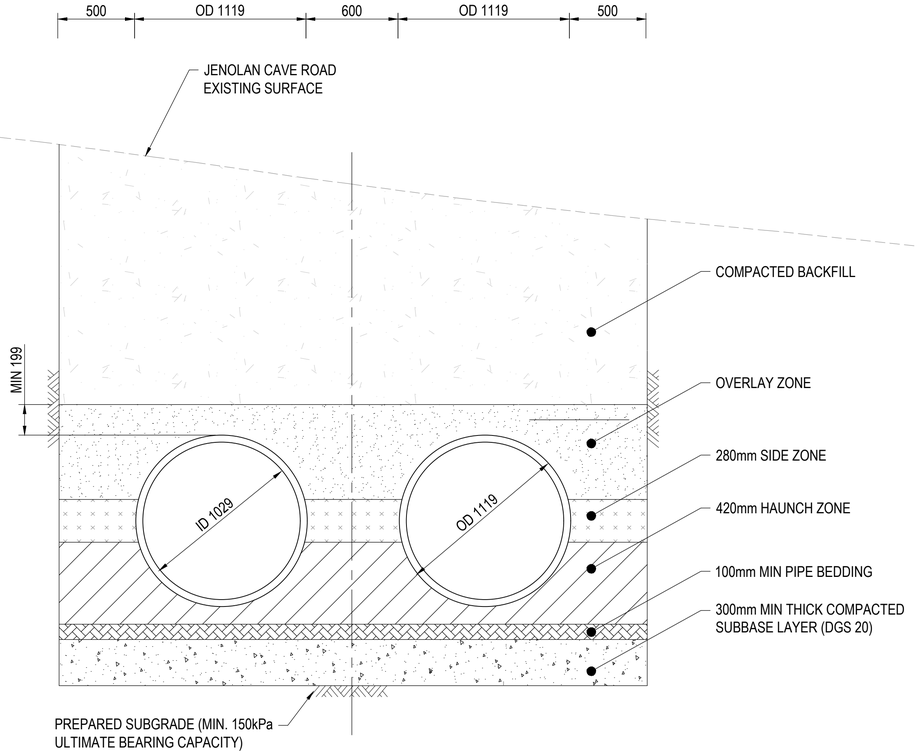
C 00831 CROSS SECTION
SCALE 1 : 50



D 00831 CROSS SECTION
SCALE 1 : 20



E 00831 CROSS SECTION
SCALE 1 : 20



TYPICAL BACK FILL DETAILS - CULVERT 1A
SCALE 1 : 20

LEGEND

	COMPACTED BACKFILL
	OVERLAY ZONE
	SIDE ZONE
	HAUNCHE ZONE
	PIPE BEDDING
	COMPACTED SUBBASE LAYER
IL =	INVERT LEVEL
SL =	SURFACE LEVEL

NOTES:

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A	50% DETAILED DESIGN	SR 23.04.24	AR 23.04.24	JH 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: AS SHOWN

0 0.2 0.4 0.6 0.8 1.0m
SCALE 1:20 AT ORIGINAL SIZE

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

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APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

DRAINAGE CULVERT FAILURE SITE 1A

TYPICAL DETAILS AND CROSS SECTION - CULVERT 1A

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©

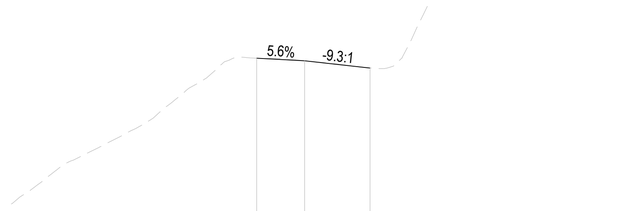
DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00871				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00871.dwg

PLOT DATE & TIME: 10/10/2024 7:14:21 PM

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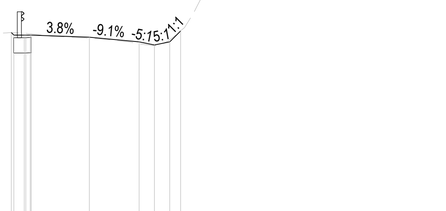
TfNSW ACKNOWLEDGES THE TEMPORARY WORKS NATURE OF THE CHOSEN SOLUTION AND THE FACT THAT IT DOES NOT SATISFY THE REQUIRED 100-YEAR DESIGN LIFE REQUIREMENT FOR LONG TERM STABILITY, UNDERSTANDING THAT THE DESIGN LIFE CANNOT BE QUANTIFIED OR GUARANTEED BY THE CONSULTANT. TfNSW ACKNOWLEDGES THAT A TEMPORARY SOIL NAIL SOLUTION INVOLVING LIMITED SOIL NAILING OF THE CREST AREA AND WILL REQUIRE ONGOING MONITORING AND MAINTENANCE WHILE LONG-TERM ACCESS SOLUTIONS ARE EXPLORED.



R.L. 856.00

CUT STRINGS	EH20	MC20	LE21	
LEVEL DIFFERENCE	0.000	-0.007	-0.000	
DESIGN LEVELS	862.412	862.324	862.094	
EXISTING LEVELS	862.412	862.331	862.094	
DESIGN OFFSETS	-1.569	0.000	2.135	

CH 11.286



R.L. 855.00

CUT STRINGS	IA20	EH20	BF20	CB20	CT20	LE20	MC20	LE21	CF21	CB21	IA21	
LEVEL DIFFERENCE	0.000	-0.077	-0.062	-0.057	-0.041	-0.038	0.030	0.061	0.019	-0.068	0.000	
DESIGN LEVELS	862.248	862.167	862.167	862.167	862.167	862.167	862.094	861.947	861.847	861.947	862.301	
EXISTING LEVELS	862.248	862.244	862.228	862.223	862.208	862.204	862.065	861.885	861.827	862.015	862.301	
DESIGN OFFSETS	-2.546	-2.465	-2.172	-2.075	-1.925	-1.895	0.000	1.628	2.128	2.628	2.982	

CH 13.286

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REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
B	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
A	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT:

NSW GOVERNMENT | Transport for NSW

PREPARED FOR:

PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

DRAWN	K.GORDON		10.10.24
DESIGNED	S.RAFIEI		10.10.24
DRG CHECK	D.TAING		10.10.24
DESIGN CHECK	A.RAHMAN		10.10.24
PROJ/DES MNGR	J.FORDHAM		10.10.24
APPROVED	J.HELLMUTH		10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

DRAINAGE CULVERT FAILURE SITE 1A

CROSS SECTIONS - CULVERT 1A

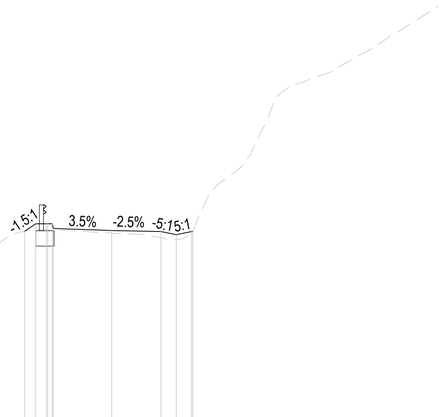
DRAWING SET No: -	PART:	SHEET: 1	OF 1	A1	
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:				©
DRG No. 12625762-GHD-DD-DRG-CI-00891	REV	VER	EDMS No.	AMD No.	

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00891.dwg

PLOT DATE & TIME: 10/10/2024 7:14:43 PM

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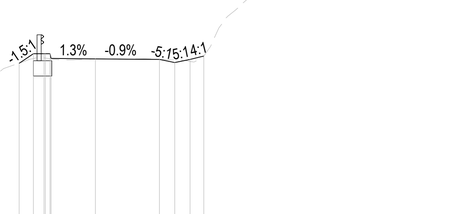
TfNSW ACKNOWLEDGES THE TEMPORARY WORKS NATURE OF THE CHOSEN SOLUTION AND THE FACT THAT IT DOES NOT SATISFY THE REQUIRED 100-YEAR DESIGN LIFE REQUIREMENT FOR LONG TERM STABILITY, UNDERSTANDING THAT THE DESIGN LIFE CANNOT BE QUANTIFIED OR GUARANTEED BY THE CONSULTANT. TfNSW ACKNOWLEDGES THAT A TEMPORARY SOIL NAIL SOLUTION INVOLVING LIMITED SOIL NAILING OF THE CREST AREA AND WILL REQUIRE ONGOING MONITORING AND MAINTENANCE WHILE LONG-TERM ACCESS SOLUTIONS ARE EXPLORED.



R.L. 854.00

	IA20	EH20	BF20	CB20	CT20	LE20	MC20	LE21	CF21	CB21	IA21
CUT STRINGS											
LEVEL DIFFERENCE	0.000	0.192	0.195	0.197	0.204	0.055	0.088	0.200	0.150	0.063	0.000
DESIGN LEVELS	861.346	861.590	861.590	861.590	861.590	861.440	861.374	861.334	861.234	861.334	861.345
EXISTING LEVELS	861.346	861.398	861.395	861.393	861.386	861.385	861.286	861.133	861.084	861.271	861.345
DESIGN OFFSETS	-2.845	-2.475	-2.136	-2.089	-1.939	-1.909	0.000	1.606	2.106	2.606	2.649

CH 20



R.L. 854.00

	IA20	EH20	BF20	CB20	CT20	LE20	MC20	LE21	CF21	CB21	IA21
CUT STRINGS											
LEVEL DIFFERENCE	0.000	0.155	0.137	0.143	0.160	0.013	-0.004	-0.007	-0.081	0.063	0.000
DESIGN LEVELS	860.203	860.514	860.514	860.514	860.514	860.364	860.344	860.325	860.225	860.325	860.438
EXISTING LEVELS	860.203	860.358	860.376	860.357	860.354	860.350	860.348	860.331	860.306	860.262	860.438
DESIGN OFFSETS	-2.490	-2.024	-1.681	-1.641	-1.484	-1.454	0.000	2.086	2.586	3.086	3.537

CH 30

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
B	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
A	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

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DESIGNED	S.RAFIEI		10.10.24
DRG CHECK	D.TAING		10.10.24
DESIGN CHECK	A.RAHMAN		10.10.24
PROJ/DES MNGR	J.FORDHAM		10.10.24
APPROVED	J.HELLMUTH		10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

DRAINAGE CULVERT FAILURE SITE 1A

CROSS SECTIONS - CULVERT 1A

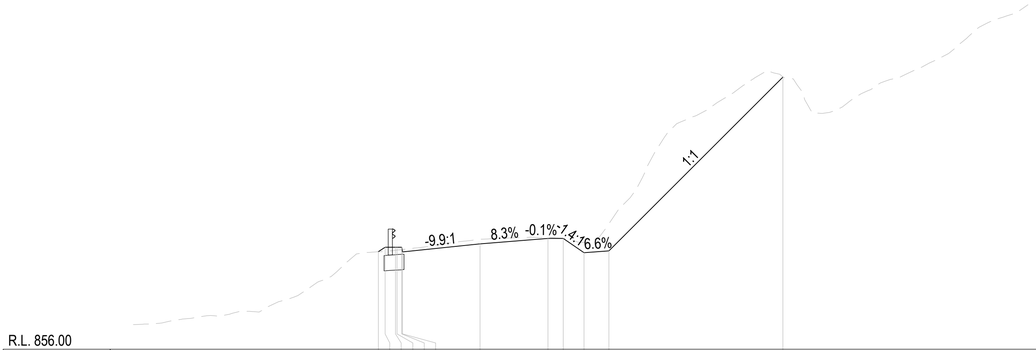
DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00892	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00891.dwg

PLOT DATE & TIME: 10/10/2024 7:14:55 PM

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R.L. 856.00

	IA20	EH20	BF20	BR20	CT20	LE20	MC20	LE21	EH21	ID21	IE21	IA21
CUT STRINGS												
LEVEL DIFFERENCE	0.000	0.136	0.098	0.093	0.075	-0.078	-0.152	-0.028	0.008	-0.335	-0.891	0.000
DESIGN LEVELS	859.177	859.325	859.325	859.325	859.325	859.175	859.431	859.616	859.615	859.149	859.203	864.880
EXISTING LEVELS	859.177	859.189	859.226	859.232	859.249	859.253	859.582	859.644	859.607	859.484	860.094	864.880
DESIGN OFFSETS	-3.324	-3.102	-2.759	-2.717	-2.542	-2.532	0.000	2.217	2.718	3.392	4.206	9.884

CH 40

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REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
B	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
A	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020

HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT:

NSW GOVERNMENT Transport for NSW

PREPARED FOR:

PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

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DESIGNED	S.RAFIEI	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.RAHMAN	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

DRAINAGE CULVERT FAILURE SITE 1A

CROSS SECTIONS - CULVERT 1A

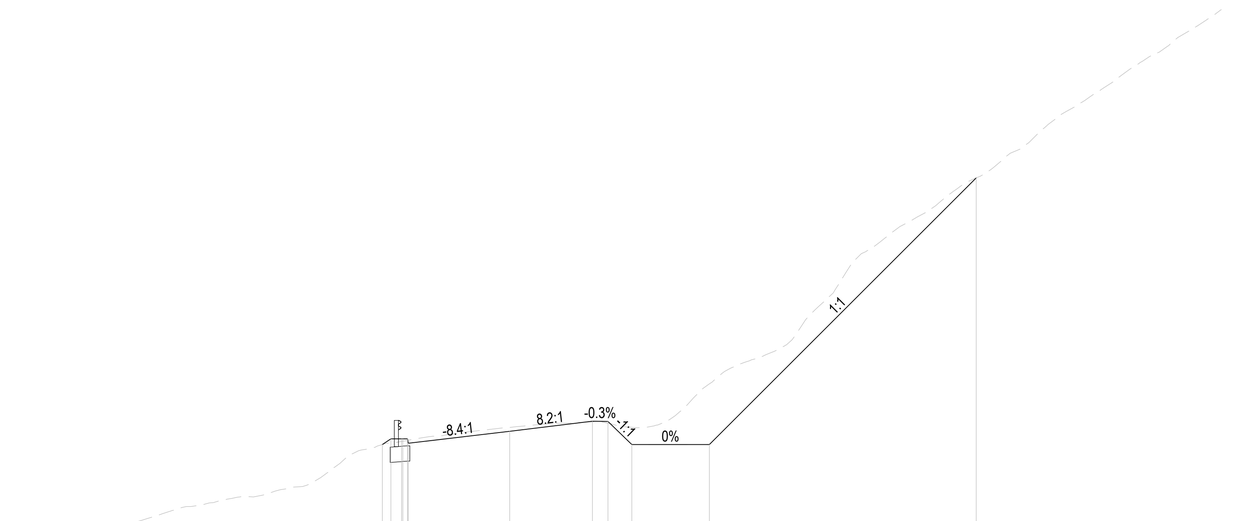
DRAWING SET No: -	PART:	SHEET: 1	OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:				©
DRG No. 12625762-GHD-DD-DRG-CI-00893	REV	VER	EDMS No.		AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00891.dwg

PLOT DATE & TIME: 10/10/2024 7:15:07 PM

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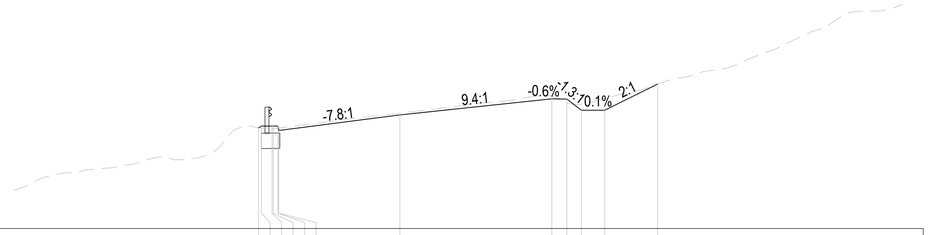


R.L. 855.00

| | | |

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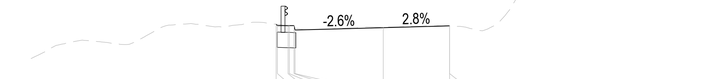
TfNSW ACKNOWLEDGES THE TEMPORARY WORKS NATURE OF THE CHOSEN SOLUTION AND THE FACT THAT IT DOES NOT SATISFY THE REQUIRED 100-YEAR DESIGN LIFE REQUIREMENT FOR LONG TERM STABILITY, UNDERSTANDING THAT THE DESIGN LIFE CANNOT BE QUANTIFIED OR GUARANTEED BY THE CONSULTANT. TfNSW ACKNOWLEDGES THAT A TEMPORARY SOIL NAIL SOLUTION INVOLVING LIMITED SOIL NAILING OF THE CREST AREA AND WILL REQUIRE ONGOING MONITORING AND MAINTENANCE WHILE LONG-TERM ACCESS SOLUTIONS ARE EXPLORED.



R.L. 855.00

	IA20	EH20	BF20	CB20	CT20	LE20	MC20	LE21	EH21	ID21	IE21	IA21
CUT STRINGS												
LEVEL DIFFERENCE	0.000	0.072	0.090	0.025	0.074	-0.081	-0.061	-0.091	0.131	-0.197	-0.397	0.000
DESIGN LEVELS	858.290	858.351	858.351	858.351	858.351	858.201	858.708	859.234	859.231	858.867	858.868	859.722
EXISTING LEVELS	858.290	858.279	858.260	858.326	858.277	858.281	858.770	859.326	859.101	859.064	859.265	859.722
DESIGN OFFSETS	-4.613	-4.522	-4.179	-4.122	-3.982	-3.952	0.000	4.959	5.449	5.920	6.681	8.409

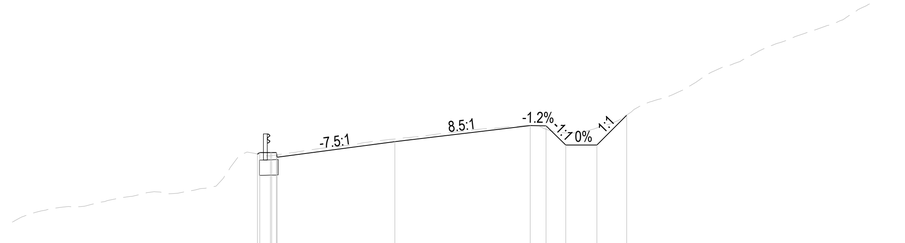
CH 48.7



R.L. 855.00

	IA20	EH20	BF20	CB20	CT20	LE20	MC20	LE21	IA21
CUT STRINGS									
LEVEL DIFFERENCE	0.000	-0.036	0.025	0.078	0.078	-0.068	-0.023	-0.006	0.000
DESIGN LEVELS	857.110	857.069	857.069	857.069	857.069	856.919	856.995	857.056	857.061
EXISTING LEVELS	857.110	857.105	857.044	857.003	856.991	856.987	857.018	857.062	857.061
DESIGN OFFSETS	-3.496	-3.455	-3.112	-3.065	-2.915	-2.865	0.000	2.160	2.166

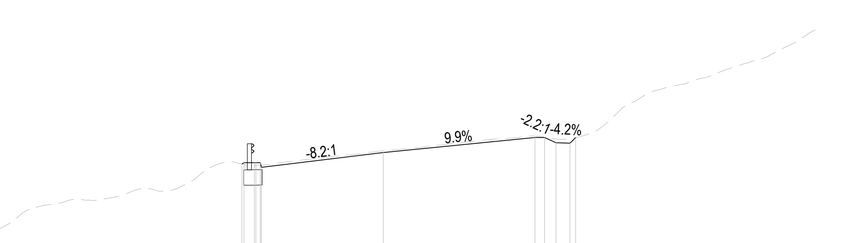
CH 60



R.L. 855.00

	IA20	EH20	BF20	CB20	CT20	LE20	MC20	LE21	EH21	ID21	IE21	IA21
CUT STRINGS												
LEVEL DIFFERENCE	0.000	0.074	0.110	0.102	0.075	-0.079	-0.084	-0.006	0.113	-0.399	-0.558	0.000
DESIGN LEVELS	858.499	858.551	858.551	858.551	858.551	858.401	858.912	859.432	859.426	858.800	858.800	859.776
EXISTING LEVELS	858.499	858.477	858.441	858.449	858.475	858.480	858.996	859.438	859.313	859.199	859.358	859.776
DESIGN OFFSETS	-4.490	-4.412	-4.069	-4.022	-3.972	-3.942	0.000	4.418	4.935	5.573	6.583	7.570

CH 46.708



R.L. 855.00

	IA20	EH20	BF20	CB20	CT20	LE20	MC20	LE21	EH21	ID21	IE21	IA21
CUT STRINGS												
LEVEL DIFFERENCE	0.000	0.060	0.090	0.087	0.084	-0.068	-0.054	-0.047	-0.006	-0.114	-0.157	0.000
DESIGN LEVELS	858.177	858.222	858.222	858.222	858.222	858.072	858.555	859.045	859.046	858.878	858.859	859.043
EXISTING LEVELS	858.177	858.162	858.132	858.135	858.138	858.140	858.609	859.092	859.051	858.992	859.016	859.043
DESIGN OFFSETS	-4.619	-4.552	-4.209	-4.162	-4.012	-3.982	0.000	4.946	5.280	5.632	6.092	6.276

CH 50

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REFERENCES:

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REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
B	ISSUED FOR CONSTRUCTION	MT 10.10.24	JL 10.10.24	JF 10.10.24
A	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m

SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
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GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	S.RAFIEI	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.RAHMAN	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

DRAINAGE CULVERT FAILURE SITE 1A

CROSS SECTIONS - CULVERT 1A

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00895	REV	VER	EDMS No.	AMD No.

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00891.dwg

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R.L. 854.00

CUT STRINGS			IA20	EH20	LE20	MC20		LE21	IA21				
LEVEL DIFFERENCE			0.000	-0.011	-0.005	-0.018		-0.002	0.000				
DESIGN LEVELS			856.596	856.455	856.450	856.468		856.493	856.494				
EXISTING LEVELS			856.596	856.551	856.455	856.486		856.495	856.494				
DESIGN OFFSETS			-3.098	-2.922	-2.302	0.000		2.255	2.257				

CH 63.408

R.L. 853.00

CUT STRINGS						EH20		MC20		LE21			
LEVEL DIFFERENCE						0.000		-0.010		-0.000			
DESIGN LEVELS						856.210		856.192		856.163			
EXISTING LEVELS						856.210		856.192		856.163			
DESIGN OFFSETS						-2.302		0.000		2.311			

CH 65.408

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	REV	DESCRIPTION	DESIGNER INITIAL/DATE	VERIFIED INITIAL/DATE	APPROVED INITIAL/DATE
	A	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
	COORDINATE SYSTEM: MGA ZONE 56 GDA2020		HEIGHT DATUM: AHD		DESIGN LOT CODE: --

0 1 2 3 4 5m
SCALE 1:100 AT ORIGINAL SIZE

CLIENT:
NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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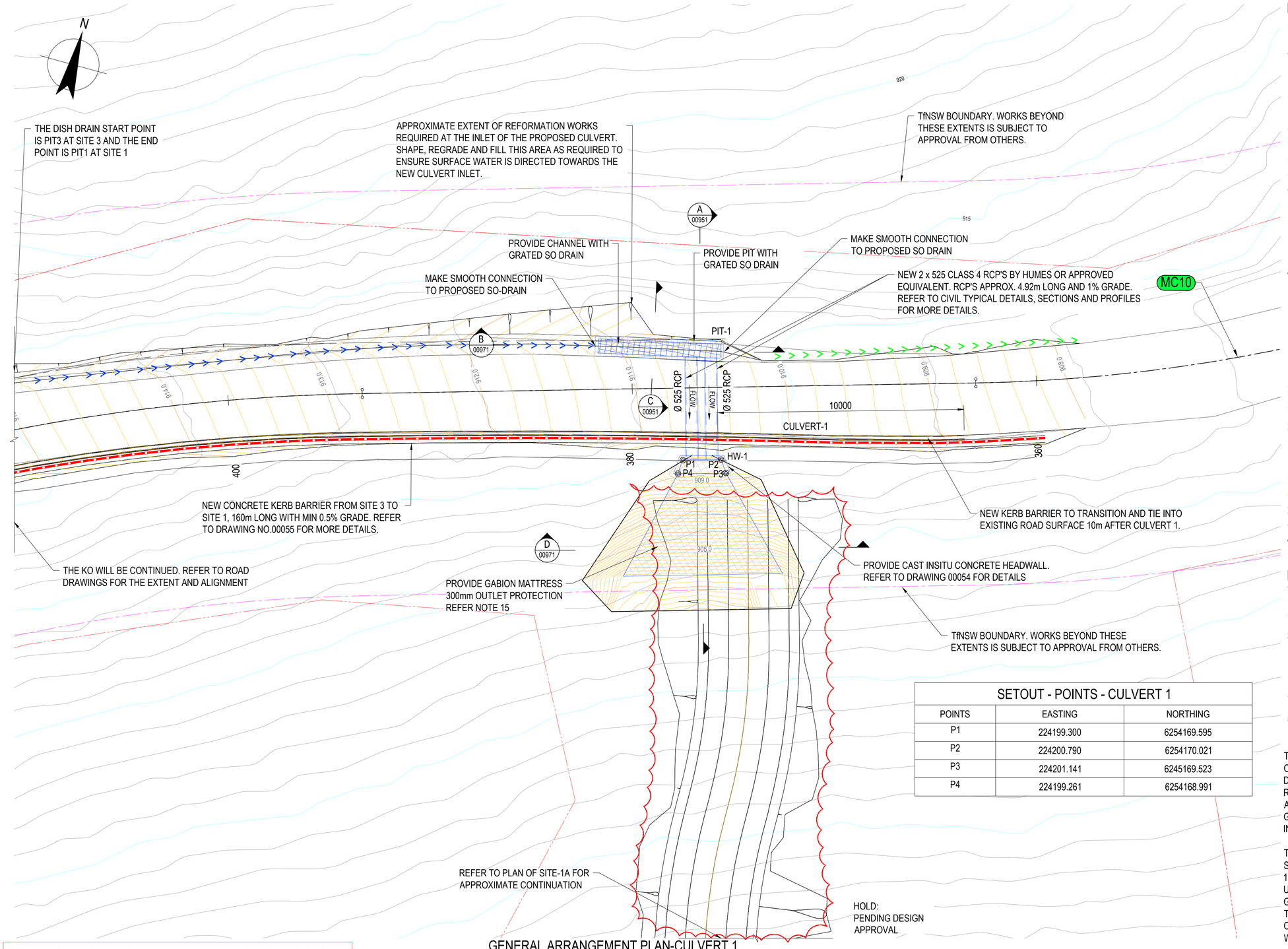
GHD

DRAWN	K.GORDON	10.10.24
DESIGNED	S.RAFIEI	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.RAHMAN	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
DRAINAGE CULVERT FAILURE SITE 1A
CROSS SECTIONS - CULVERT 1A

DRAWING SET No: -	PART:	SHEET: 1	OF 1	A1		
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:					©
DRG No. 12625762-GHD-DD-DRG-CI-00896	REV	VER	EDMS No.		AMD No.	

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00891.dwg
PLOT DATE & TIME: 10/10/2024 7:15:40 PM



GENERAL ARRANGEMENT PLAN-CULVERT 1

SCALE 1:100

LEGEND

- 100 - CHAINAGES
- MCD1 - DESIGN CONTROL STRING LABEL
- 995 - DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- 995 - EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- TfNSW BOUNDARY
- REF PROJECT SITE
- KERB ONLY
- T2-05-3.C - CHANNEL TYPE IDENTIFIER
- 03.01 - DRAINAGE PIT LABEL
- C 96.02 A - DRAINAGE CULVERT LABEL
- DRAINAGE PIT
- Ø375 - DRAINAGE PIPE WITH DIAMETER AND DIRECTION OF FLOW
- Ø 650 RPC - DRAINAGE CULVERT WITH SIZE AND TYPE LABEL
- TYPE F SINGLE SIDE CONCRETE SAFETY BARRIER
- B 96.02 R - WATER QUALITY/SPILL BASIN WITH LABEL
- DRAINAGE CHANNEL GRASS (REFER SM-2141)
- DRAINAGE CHANNEL ROCK (REFER SM-2141)
- DRAINAGE CHANNEL CONCRETE (REFER SM-2141)
- BERM DRAIN PARTIAL CONCRETE (REFER SM-2142)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- LEVEL SPREADER (REFER SM-2142)
- SO TURNOUT (REFER SM-2143)
- BATTER CHUTE (REFER SM-2153)
- BOX DRAIN (REFER SM-2156)
- SETOUT POINTS

SETOUT - POINTS - CULVERT 1

POINTS	EASTING	NORTHING
P1	224199.300	6254169.595
P2	224200.790	6254170.021
P3	224201.141	6245169.523
P4	224199.261	6254168.991

NOTES:

1. ALL DIMENSIONS ARE IN mm AND ALL ELEVATIONS AND COORDINATIONS ARE IN m, UNO.
2. ALL CIVIL SCOPE HAS BEEN DESIGNED BASED ON THE POST FAILURE LIDAR SURVEY.
3. SURFACE WATER TO BE DISCHARGED INTO THE EXISTING STORMWATER SYSTEM NEAR THE TOP CAR PARK (CAR PARK 2). JENOLAN CAVES TRUST TO EXPLORE OPTIONS TO RE-SIZE OR UPGRADE. THE EXISTING STORMWATER SYSTEM TO ACCOMMODATE THE RE-DIRECTED VOLUME OF WATER.
4. 4.FOR CULVERT INSTALLATION REFER TO TFNSW STANDARD DRAWING R0240-01.
5. THE CURRENT GULLY FAILURE EXTENT AND ALIGNMENT WILL BE UPDATED AND REALIGNED ON RECEIPT OF POST DISASTER AERIAL LIDAR SURVEY AND PRESENTED WITHIN 100% DETAILED DESIGN.

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B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	SR 23.04.24	AR 23.04.24	JH 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:100

0 1 2 3 4 5m
SCALE 1:100 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
PROJECT SERVICES WEST
NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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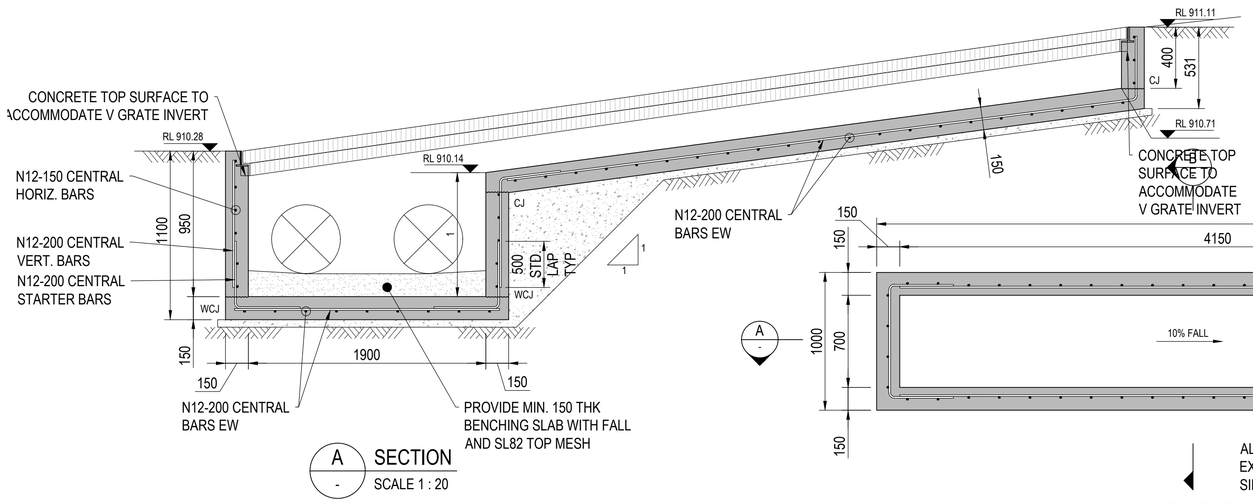
GHD

DRAWN	K.GORDON		10.10.24
DESIGNED	J.KEEM		10.10.24
DRG CHECK	D.TAING		10.10.24
DESIGN CHECK	A.RAHMAN		10.10.24
PROJ/DES MNGR	J.FORDHAM		10.10.24
APPROVED	J.HELLMUTH		10.10.24

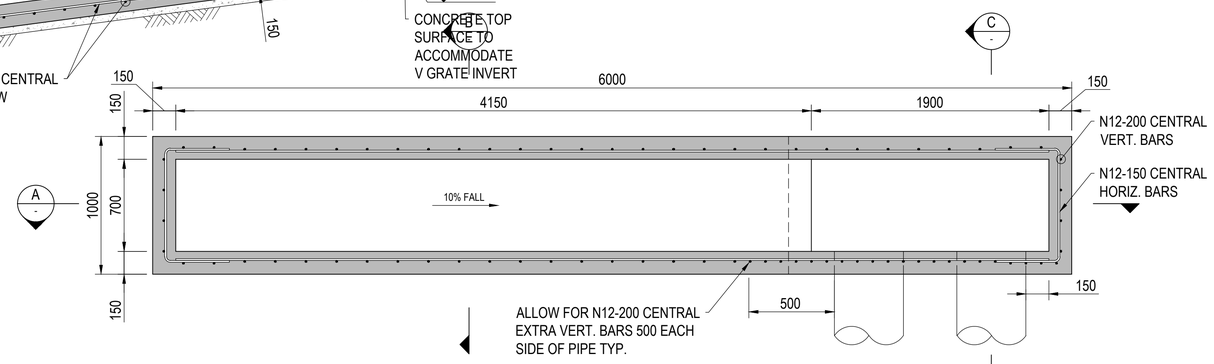
SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
DRAINAGE CULVERT FAILURE SITE 1
GENERAL ARRANGEMENT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©
DRG No. 12625762-GHD-DD-DRG-CI-00931	REV	VER	EDMS No.	AMD No.

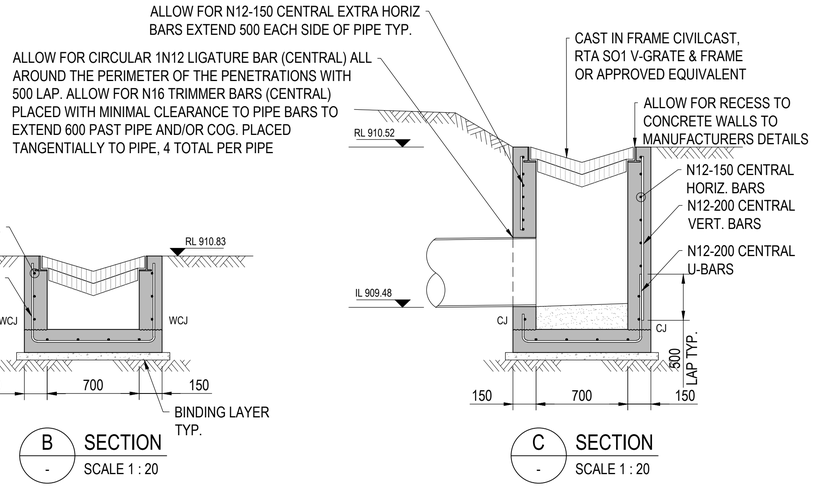
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PLOT DATE & TIME: 10/10/2024 7:16:10 PM



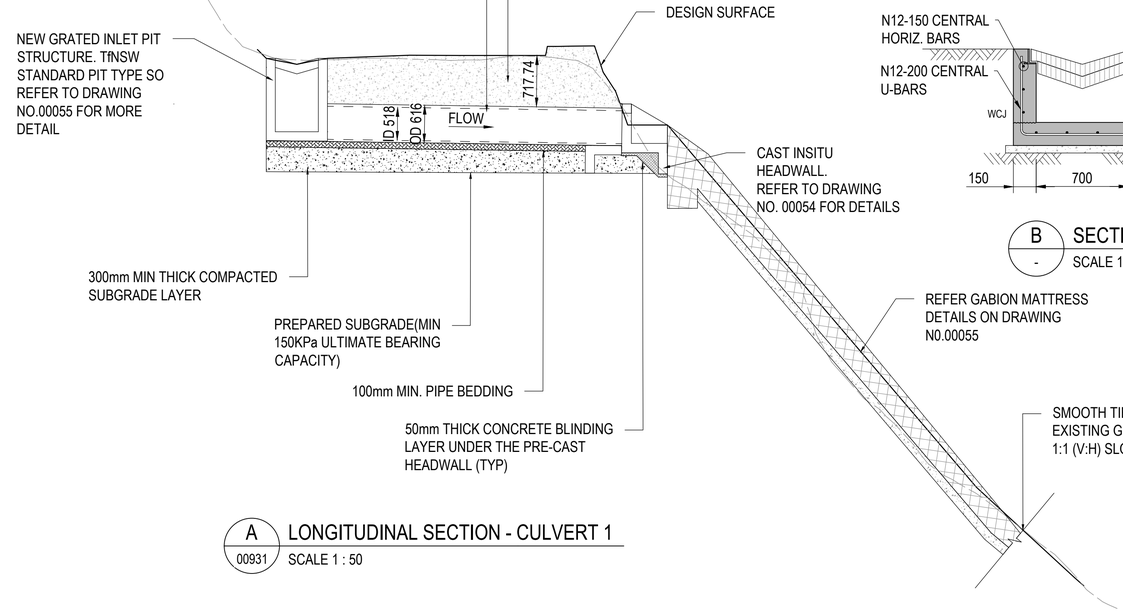
A SECTION
SCALE 1 : 20



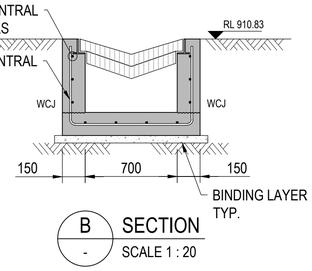
INLET PIT AT CULVERT 1 REINFORCEMENT PLAN
SCALE 1 : 20



C SECTION
SCALE 1 : 20



A 00931 LONGITUDINAL SECTION - CULVERT 1
SCALE 1 : 50



B SECTION
SCALE 1 : 20

LEGEND

	COMPACTED BACKFILL
	PIPE BEDDING
	COMPACTED SUBBASE LAYER
IL =	INVERT LEVEL
SL =	SURFACE LEVEL

NOTES:

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2. ALL CIVIL SCOPE HAS BEEN DESIGNED BASED ON THE POST FAILURE LIDAR SURVEY.
3. SURFACE WATER TO BE DISCHARGED INTO THE EXISTING STORMWATER SYSTEM NEAR THE TOP CAR PARK (CAR PARK 2). JENOLAN CAVES TRUST TO EXPLORE OPTIONS TO RE-SIZE OR UPGRADE. THE EXISTING STORMWATER SYSTEM TO ACCOMMODATE THE RE-DIRECTED VOLUME OF WATER.
4. FOR CULVERT INSTALLATION REFER TO TFNSW STANDARD DRAWING R0240-01.

CONCRETE NOTES:

1. ALL REINFORCED CONCRETE SHALL BE S40. ALL CONCRETE BENCHING SHALL BE N20. ALL CONCRETE BLINDING LAYER TO BE N10.
2. CLEAR COVER SHALL BE MIN 50mm TO EXTERNAL SURFACES IN CONTACT WITH GROUND AND INTERNAL SURFACES. PROVIDE MIN 50mm COVER ELSEWHERE.
3. PRECAST PITS ARE TO BE DESIGNED IN ACCORDANCE WITH AS5100 WITH SM1600 LOADS, INCLUDING A160 AXLE LOAD AND W80 WHEEL LOADS.
4. PRECAST REINFORCEMENT AND CONCRETE SHALL BE DESIGN IN ACCORDANCE WITH AS5100.5 WITH A DURABILITY CLASS C WITH A MIN 100 YEAR DESIGN LIFE.
5. WCJ DENOTES WATER STOP CONSTRUCTION JOINT. ALLOW PARCHEM SUPERSWELL 47B HYDROPHYLLIC WATER STOP MIN. 50mm COVER TYP. SECURE WITH LEAKMASTER SEALANT. SCABBLE SURFACE AND EXPOSE AGGREGATE AND APPLY 1mm XPLEX CONCENTRATE TO THROUGH THE JOINT.

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B	100% DETAILED DESIGN	MT 23.08.24	JL 23.08.24	JF 23.08.24
A	50% DETAILED DESIGN	SR 23.04.24	AR 23.04.24	JH 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: AS SHOWN

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
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NETWORK AND ASSETS
REGIONAL AND OUTER METRPOLITAN

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GHD

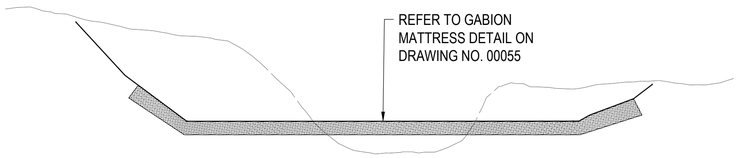
DRAWN	K.GORDON	10.10.24
DESIGNED	J.KEEM	10.10.24
DRG CHECK	D.TAING	10.10.24
DESIGN CHECK	A.RAHMAN	10.10.24
PROJ/DES MNGR	J.FORDHAM	10.10.24
APPROVED	J.HELLMUTH	10.10.24

SHIRE OF OBERON
TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
DRAINAGE CULVERT FAILURE SITE 1
LONGITUDINAL SECTION - CULVERT 1

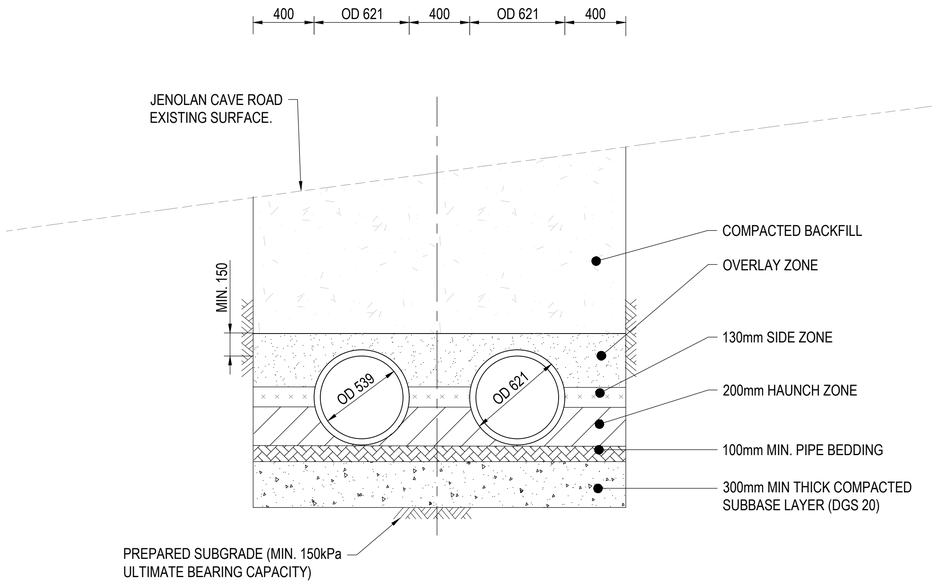
DRAWING SET No: -	PART:	SHEET: 1 OF 1	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00951				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00951.dwg
PLOT DATE & TIME: 10/10/2024 7:16:29 PM



D 00831 CROSS SECTION
SCALE 1 : 20



TYPICAL BACK FILL DETAILS - CULVERT 1
SCALE 1 : 20

LEGEND

	COMPACTED BACKFILL
	OVERLAY ZONE
	SIDE ZONE
	HAUNCHE ZONE
	PIPE BEDDING
	COMPACTED SUBBASE LAYER
IL =	INVERT LEVEL
SL =	SURFACE LEVEL

NOTES:

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3. SURFACE WATER TO BE DISCHARGED INTO THE EXISTING STORMWATER SYSTEM NEAR THE TOP CAR PARK (CAR PARK 2). JENOLAN CAVES TRUST TO EXPLORE OPTIONS TO RE-SIZE OR UPGRADE. THE EXISTING STORMWATER SYSTEM TO ACCOMMODATE THE RE-DIRECTED VOLUME OF WATER.
4. 4.FOR CULVERT INSTALLATION REFER TO TFNSW STANDARD DRAWING R0240-01.

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: AS SHOWN

0 0.2 0.4 0.6 0.8 1.0m
SCALE 1:20 AT ORIGINAL SIZE

DESIGN LOT CODE: --

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
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GHD

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SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS

DRAINAGE CULVERT FAILURE SITE 1

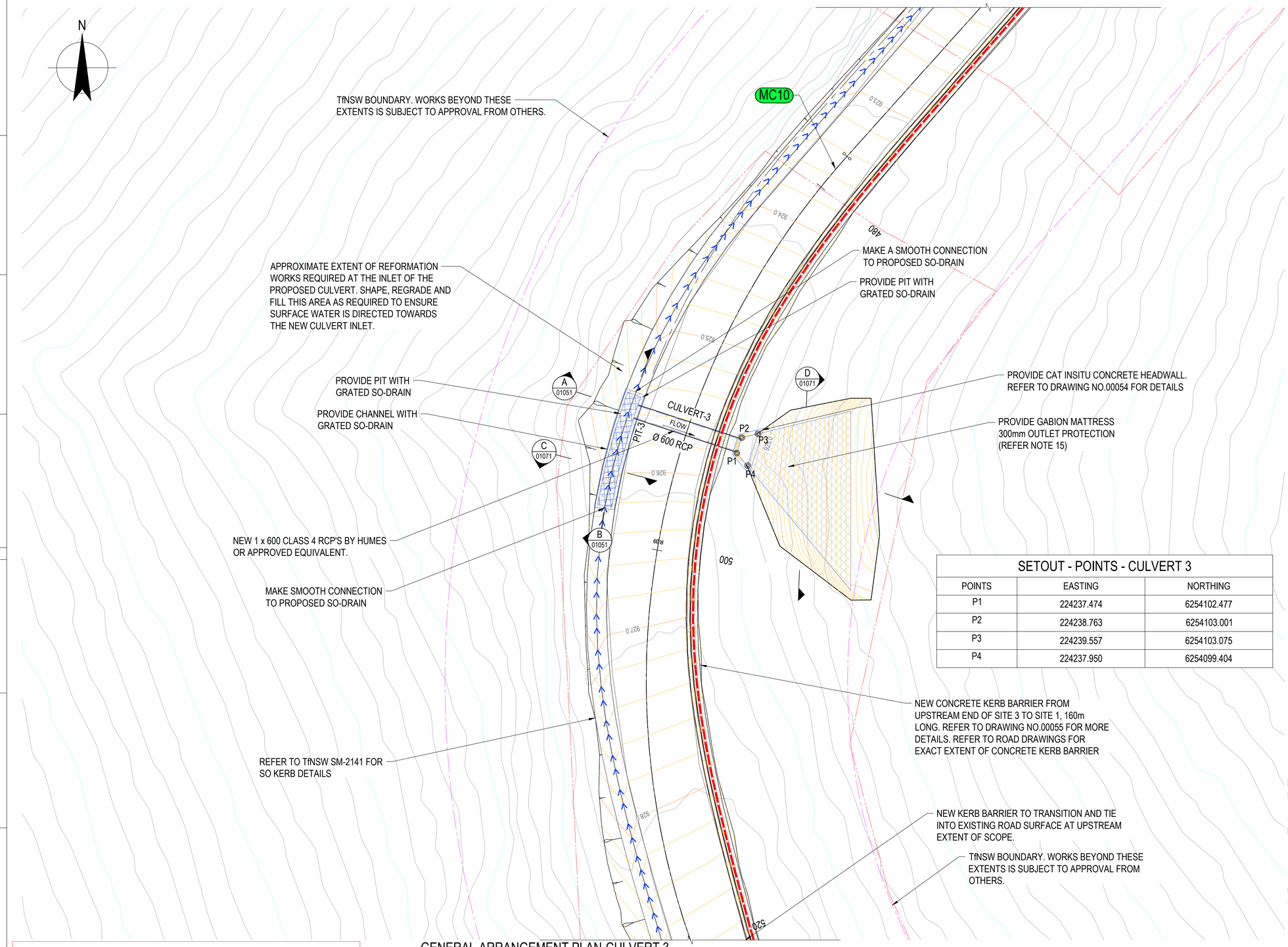
LONGITUDINAL SECTIONS, TYPICAL DETAILS AND CROSS SECTIONS - CULVERT 1

DRAWING SET No: -	PART:	SHEET: 1 OF 1		A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:			©

DRG No.	REV	VER	EDMS No.	AMD No.
12625762-GHD-DD-DRG-CI-00971				

FILE NAME: 21-12625762-GHD-DD-DRG-CI-00971.dwg

PLOT DATE & TIME: 10/10/2024 7:16:44 PM



LEGEND

- 100 - CHAINAGES
- MCD1 — DESIGN CONTROL STRING LABEL
- DESIGN CONTOUR MAJOR (1m INTERVAL)
- DESIGN CONTOUR MINOR (0.2m INTERVAL)
- EXISTING CONTOUR MAJOR (5m INTERVAL)
- EXISTING CONTOUR MINOR (1m INTERVAL)
- TfNSW BOUNDARY
- REF PROJECT SITE
- KERB ONLY
- T2-05-3.C — CHANNEL TYPE IDENTIFIER
- 03.01 — DRAINAGE PIT LABEL
- C 96.02 A — DRAINAGE CULVERT LABEL
- DRAINAGE PIT
- Ø375 — DRAINAGE PIPE WITH DIAMETER AND DIRECTION OF FLOW
- Ø 650 RPC — DRAINAGE CULVERT WITH SIZE AND TYPE LABEL
- TYPE F SINGLE SIDE CONCRETE SAFETY BARRIER
- B 96.02 R — WATER QUALITY/SPILL BASIN WITH LABEL
- DRAINAGE CHANNEL GRASS (REFER SM-2141)
- DRAINAGE CHANNEL ROCK (REFER SM-2141)
- DRAINAGE CHANNEL CONCRETE (REFER SM-2141)
- BERM DRAIN PARTIAL CONCRETE (REFER SM-2142)
- DRAINAGE CHANNEL (MEDIUM GRASS LINED)
- LEVEL SPREADER (REFER SM-2142)
- SO TURNOUT (REFER SM-2143)
- BATTER CHUTE (REFER SM-2153)
- BOX DRAIN (REFER SM-2156)
- SETOUT POINTS

SETOUT - POINTS - CULVERT 3

POINTS	EASTING	NORTHING
P1	224237.474	6254102.477
P2	224238.763	6254103.001
P3	224239.557	6254103.075
P4	224237.950	6254099.404

NOTES:

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3. SURFACE WATER TO BE DISCHARGED INTO THE EXISTING STORMWATER SYSTEM NEAR THE TOP CAR PARK (CAR PARK 2). JENOLAN CAVES TRUST TO EXPLORE OPTIONS TO RE-SIZE OR UPGRADE. THE EXISTING STORMWATER SYSTEM TO ACCOMMODATE THE RE-DIRECTED VOLUME OF WATER.
4. 4.FOR CULVERT INSTALLATION REFER TO TfNSW STANDARD DRAWING R0240-01.
5. THE CURRENT GULLY FAILURE EXTENT AND ALIGNMENT WILL BE UPDATED AND REALIGNED ON RECEIPT OF POST DISASTER AERIAL LIDAR SURVEY AND PRESENTED WITHIN 100% DETAILED DESIGN.

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GENERAL ARRANGEMENT PLAN-CULVERT 3

SCALE 1:100

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A	50% DETAILED DESIGN	SR 23.04.24	AR 23.04.24	JH 23.04.24

COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: 1:100

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SCALE 1:100 AT ORIGINAL SIZE

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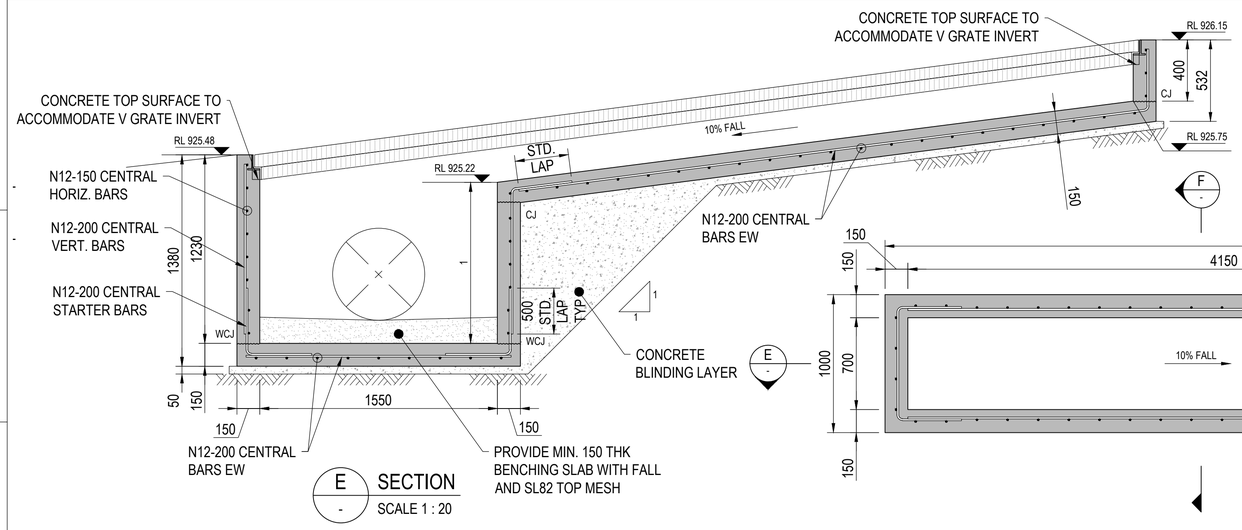
SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
DRAINAGE CULVERT FAILURE SITE 3
GENERAL ARRANGEMENT PLAN

DRAWING SET No: -	PART:	SHEET: 1 OF 1	A1
STATUS: ISSUED FOR CONSTRUCTION	BRIDGE No:		©

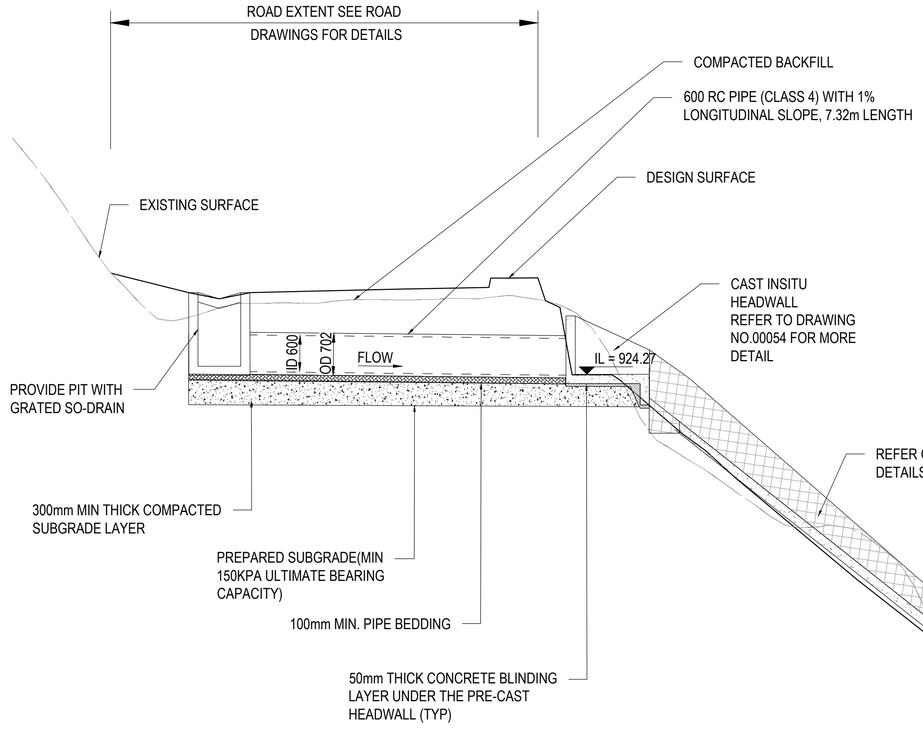
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12625762-GHD-DD-DRG-CI-01031				

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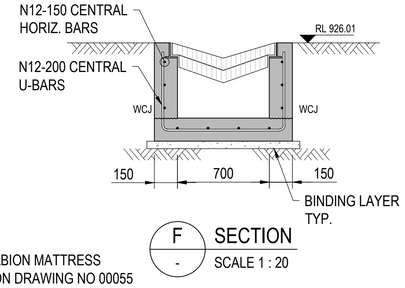


INLET PIT AT CULVERT 3 REINFORCEMENT PLAN

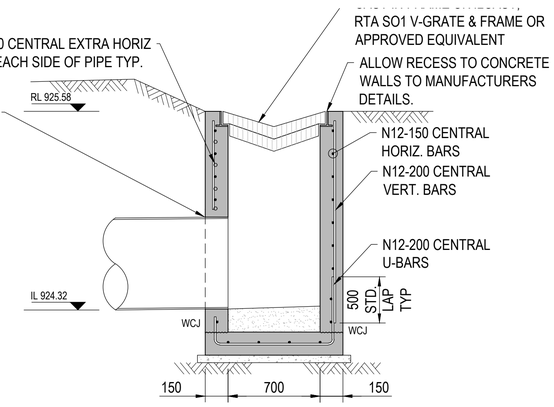
SCALE 1 : 20



A 01031 LONGITUDINAL SECTION - CULVERT 3
SCALE 1 : 50



F SECTION
SCALE 1 : 20



G SECTION
SCALE 1 : 20

LEGEND

	COMPACTED BACKFILL
	PIPE BEDDING
	COMPACTED SUBBASE LAYER
IL =	INVERT LEVEL
SL =	SURFACE LEVEL

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4. 4.FOR CULVERT INSTALLATION REFER TO TFNSW STANDARD DRAWING R0240-01.

CONCRETE NOTES:

1. ALL REINFORCED CONCRETE SHALL BE S40. ALL CONCRETE BENCHING SHALL BE N20. ALL CONCRETE BLINDING LAYER TO BE N10.
2. CLEAR COVER SHALL BE MIN 50mm TO EXTERNAL SURFACES IN CONTACT WITH GROUND AND INTERNAL SURFACES. PROVIDE MIN 50mm COVER ELSEWHERE.
3. PRECAST PITS ARE TO BE DESIGNED IN ACCORDANCE WITH AS5100 WITH SM1600 LOADS, INCLUDING A160 AXLE LOAD AND W80 WHEEL LOADS.
4. PRECAST REINFORCEMENT AND CONCRETE SHALL BE DESIGN IN ACCORDANCE WITH AS5100.5 WITH A DURABILITY CLASS C WITH A MIN 100 YEAR DESIGN LIFE.
5. WCJ DENOTES WATER STOP CONSTRUCTION JOINT. ALLOW PARCHEM SUPERSWELL 47B HYDROPHILLIC WATER STOP MIN. 50mm COVER TYP. SECURE WITH LEAKMASTER SEALANT. SCABBLE SURFACE AND EXPOSE AGGREGATE AND APPLY 1mm XPLEX CONCENTRATE TO THROUGH THE JOINT

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

SCALE: AS SHOWN

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

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SHIRE OF OBERON

TWO MILE HILL JENOLAN CAVES ROAD
TWO MILE HILL NATURAL DISASTER RESTORATION (MR253)
SLOPE REMEDIATION WORKS AND ASSOCIATED CIVIL WORKS
DRAINAGE CULVERT FAILURE SITE 3
LONGITUDINAL SECTIONS, TYPICAL DETAILS AND CROSS SECTIONS - CULVERT 3

DRAWING SET No: -	PART:	SHEET: 1	OF 1	A1
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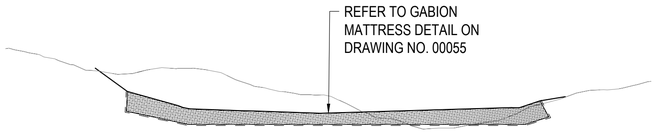
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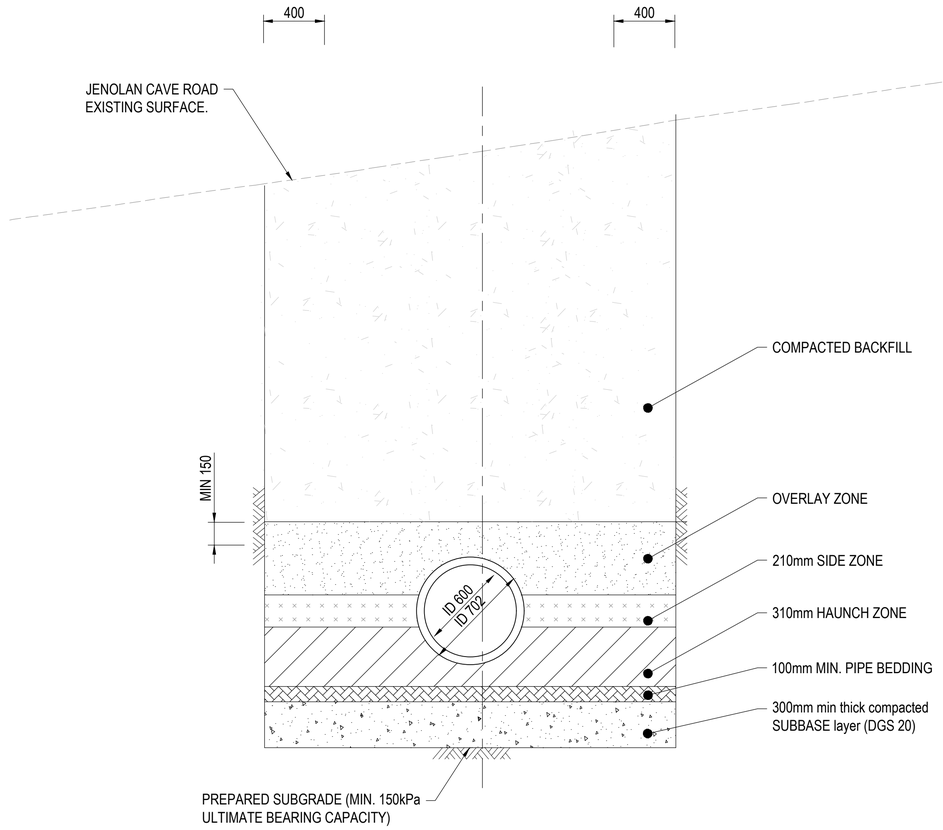
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C CROSS SECTION
00831 SCALE 1 : 20



D CROSS SECTION
00831 SCALE 1 : 50



TYPICAL BACK FILL DETAILS - CULVERT 3
SCALE 1 : 20

LEGEND

	COMPACTED BACKFILL
	OVERLAY ZONE
	SIDE ZONE
	HAUNCHE ZONE
	PIPE BEDDING
	COMPACTED SUBBASE LAYER
IL =	INVERT LEVEL
SL =	SURFACE LEVEL

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COORDINATE SYSTEM: MGA ZONE 56 GDA2020 | HEIGHT DATUM: AHD

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SCALE 1:20 AT ORIGINAL SIZE

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SCALE 1:50 AT ORIGINAL SIZE

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DRAINAGE CULVERT FAILURE SITE 3
TYPICAL DETAILS AND CROSS SECTION - CULVERT 3

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Appendix B
Consideration of clause 171(2) factors and matters of national environmental significance and Commonwealth land

Clause 171(2) Checklist

In addition to the requirements of the *Is an EIS required?* guideline (DUAP 1995/1996) and the *Roads and Related Facilities EIS Guideline* (DUAP 1996) as detailed in the REF, the following factors, listed in clause 171(2) of the Environmental Planning and Assessment Regulation 2021, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

Factor	Impact
a) *Any environmental impact on a community?* Construction of the proposal would result in short term noise impacts, impacts to biodiversity and impacts to water quality. Construction would be carried out during closure of the entire Jenolan Caves Precinct, therefore significant impacts to receivers are not anticipated. Impacts would be minimised by the implementation of safeguards and management measures included in section 7.2. The proposal would have a positive long-term effect on the community by improving access to Jenolan Caves Precinct, improving the safety for road users of Jenolan Caves Road, and better structuring stormwater drainage to avoid uncontrolled water flows onto the roadside and reduce the chance of further slope failures.	Short term: Minor adverse Long term: Minor benefit
b) *Any transformation of a locality?* Construction of the proposal would result in some short-term transformation of the locality from a roadway to a construction site inaccessible to the public. The proposal would not result in any substantial change to the locality as the work involves restoring the existing road which has been exposed to slope failure and upgrading the existing culvert and gully structures. The locality would continue to be dominated by the existing environment, including the surrounding national park and Jenolan Caves Precinct.	Short term: Minor adverse Long term: Nil
c) *Any environmental impact on the ecosystems of the locality?* The proposal would result in the removal of native vegetation and fauna habitat, including hollow bearing trees. No TECs were found to be present on site but some threatened flora and fauna species were found to be potentially present on site. Assessment concluded that the proposal is unlikely to have a significant effect on any listed threatened flora and fauna species, communities, and their habitats in accordance with the BC Act. Impacts would be minimised by the implementation of safeguards and management measures included in section 7.2.	Short term: Minor adverse Long term: Nil
d) *Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?* During construction, the proposal would result in a reduction in the aesthetic quality of the locality as a result of dust generation, noise and a change in the visual landscape. These impacts would be mitigated with the implementation of safeguards and management measures located in section 7.2. At completion, the restored slope failures and culvert upgrades are expected to have minimal impact to the value of the locality. Rather, the work is expected to cause a beneficial impact through improving the safety of Jenolan Caves Road for road users and improving the water quality on site.	Short term: Minor adverse Long term: Nil
e) *Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?* The proposal is located within the curtilage of the Jenolan Caves Reserve which is listed on the State Heritage Register, the Greater Blue Mountains listed on the National heritage List and UNESCO-listed Greater Blue Mountains World Heritage Area. The proposal site is visible from a number of areas within the heritage Precinct, in particular certain walking tracks and Jenolan Caves Road and therefore has the potential to impact upon the significance of the area. The development of the proposal has included consideration of the type of stabilising work to occur with the preferred option being a shotcrete wall with soil nails with the shotcrete to be	Short-term: Minor adverse Long term: Neutral

Factor	Impact
tinted to match the surrounding landscape. With this finish, the wall would not have a significant impact upon the heritage significance of the Jenolan Caves Reserve. The proposal is not considered to impact upon Aboriginal heritage due to the past disturbance at the site caused by construction of the road and the recent slope failures.	
f) Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974)? The proposal site was subject to slope failures which caused damage to the landform at the roadside. Although the proposal involves the clearing of native vegetation and hollow bearing trees, it is not anticipated to cause significant impacts on the habitat of any protected fauna within the meaning of the NPW Act as the presence of protected fauna were not detected at the site.	Short term: Minor Long term: Minor
g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? The removal of intact native vegetation and hollow bearing trees has the potential to impact on local populations of fauna species. Such impacts are anticipated to be minimal as the proposal has been assessed to likely cause no impact on the provision of wildlife corridors or habitat fragmentation. These impacts would be minimised through the implementation of safeguards and management measures summarised in section 7.2.	Short term: Minor Long term: Minor
h) Any long-term effects on the environment? The implementation of the slope restoration and culvert upgrades would reduce the chance of further slope failures by increasing the factor of safety of the slope failures and formalising the stormwater flow to avoid uncontrolled water flows to the roadside.	Long term: Major benefit
i) Any degradation of the quality of the environment? Construction activities have the potential to result in impacts to water quality as a result of pollutants such as sediment and construction waste entering the stormwater drainage system. Potential impacts to water quality would be managed with the implementation of controls provided in section 7.2.	Short term: Minor adverse Long term: Major benefit
j) Any risk to the safety of the environment? During construction, there would be some short-term safety risks for workers, working on or below failed slope. These risks would be managed through safety procedures of the selected contractor. The restoration work and culvert upgrades are designed to improve safety and prevent risks of further slope failures.	Short term: Minor adverse Long term: Nil
k) Any reduction in the range of beneficial uses of the environment? During construction, the proposal and other projects would be carried out while the Jenolan Caves Precinct, including the proposal site, is under closure. The closure would be short term in nature and minimised with the implementation of safeguards and management measures in section 7.2. The closure of the Precinct would also reduce the number of sensitive receivers with the potential to be impacted by construction. During operation the use of Jenolan Caves Road would be reinstated and improve access to Jenolan Caves Precinct from the east. The culvert upgrades would also provide a formalised drainage system to avoid uncontrolled water flows onto the roadway.	Short term: Minor adverse Long term: Major benefit
l) Any pollution of the environment? The proposal could potentially result in water pollution from pollutants such as sediment and construction waste. Management of water quality impacts would be carried out in accordance with the safeguards and management measures summarised in 7.2.	Short term: Minor adverse Long term: Nil

Factor	Impact
The proposal would result in minor short-term air emissions from plant and machinery and the generation of dust during construction. Management of air quality impacts would be carried out in accordance with the safeguards and management measures summarised in section 7.2.	
m) Any environmental problems associated with the disposal of waste? Waste would be generated by construction and appropriately stockpiled on site at the designated compound areas of Car Park 1, Car park 2 and the Kanangra Walls Road intersection.	Short term: Minor adverse Long term: Nil
n) Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply? All resources required for the proposal are readily available and are not in short supply. The proposal is not anticipated to cause a shortage of supply of any resources.	Nil
o) Any cumulative environmental effect with other existing or likely future activities? The proposal, other slope restoration work and the Jenolan Caves Reserve Trust would result in some cumulative impacts of noise, air quality and waste. However, as the work would be carried out during closure of the Precinct to the public, the number and radius of sensitive receivers would be reduced. The work is considered to have an overall cumulative benefit once they are complete as the restoration work would reinstate road access to the Jenolan Caves Precinct and improve water drainage to an area proposed to be refurbished.	Short term: Minor adverse Long term: Benefit
p) Any impact on coastal processes and coastal hazards, including those under projected climate change conditions? No impact to coastal process and coastal hazards is anticipated.	Nil
q) Applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1, The proposal would assist in meeting road safety objectives outlined in the *Long-Term Transport Master Plan* (Transport for NSW, 2012). The proposal would ensure that movements along this section of road can be carried out in a safe manner with a reduced risk of further slope failures which would potentially impact the ability to use the road and the safety of road users. The *Central West and Orana Regional Plan 2036* (NSW Government 2017) outlines the importance of Jenolan Caves as a significant tourism asset to both the Oberon LGA and the wider Central West. The Jenolan Caves Precinct is only accessible via Jenolan Caves Road both east and west of the Precinct. Therefore, the proposal would reinstate one of the two exclusive access routes to a major tourism asset and reduce the chance of further slope failures at Jenolan Caves Road. Refer to section 2.1 of this REF for further detail on how the applicable strategic plans align with the strategic need for the proposal.	Nil

Matters of National Environmental Significance and Commonwealth land

Under the environmental assessment provisions of the EPBC Act 1999, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of Agriculture, Water and the Environment.

A referral is not required for proposed actions that may affect nationally listed threatened species, endangered ecological communities and migratory species. Impacts on these matters are still assessed as part of the REF in accordance with Australian Government significant impact criteria and taking into account relevant guidelines and policies.

Factor	Impact
a) Any impact on a World Heritage property? The site is within the Greater Blue Mountain Area which is classified as a world heritage item. As the work involves restoration of slope failures and upgrades of culverts over capacity, the impacts are anticipated to be minimal.	Minor
b) Any impact on a National Heritage place? Similar to the above, the Greater Blue Mountains area is a national heritage place, but the nature of the work is for restoration and upgrade of existing infrastructure with no proposed change to the footprint of any structure, therefore the work has minor impact.	Minor
c) Any impact on a wetland of international importance? The site is not located in any wetland of state, national or international significance.	Nil
d) Any impact on a listed threatened species or communities? The BAR identified the presence of four threatened fauna and the potential presence of two threatened flora at the proposal site. The proposal would result in the removal of intact native vegetation and fauna habitat including eight hollow bearing trees. However, the BAR concluded that no significant impact to threatened species is anticipated. Refer to section 6.1 for further details on impacts to biodiversity.	Minor
e) Any impacts on listed migratory species? The BAR found that five migratory species have the potential to occur within the vicinity of the site. However, significant impacts to migratory species as a result of the proposal would be unlikely.	Nil
f) Any impact on a Commonwealth marine area? The proposal is not located within a Commonwealth marine area.	Nil
g) Does the proposal involve a nuclear action (including uranium mining)? The proposal would not involve a nuclear action.	Nil
h) Additionally, any impact (direct or indirect) on the environment of Commonwealth land? The proposal would not impact on any Commonwealth land.	Nil

Appendix C
Statutory consultation checklists

Transport and Infrastructure SEPP

Council related infrastructure or services

Issue	Potential impact	Yes / No	If 'yes' consult with	T&I SEPP section
Stormwater	Are the works likely to have a *substantial* impact on the stormwater management services which are provided by council?	No		Section 2.10(1)(a)
Traffic	Are the works likely to generate traffic to an extent that will *strain* the capacity of the existing road system in a local government area?	No		Section 2.10(1)(b)
Sewerage system	Will the works involve connection to a council owned sewerage system? If so, will this connection have a *substantial* impact on the capacity of any part of the system?	No		Section 2.10(1)(c)
Water usage	Will the works involve connection to a council owned water supply system? If so, will this require the use of a *substantial* volume of water?	No		Section 2.10(1)(d)
Temporary structures	Will the works involve the installation of a temporary structure on, or the enclosing of, a public place which is under local council management or control? If so, will this cause more than a *minor* or *inconsequential* disruption to pedestrian or vehicular flow?	No		Section 2.10(1)(e)
Road & footpath excavation	Will the works involve more than *minor* or *inconsequential* excavation of a road or adjacent footpath for which council is the roads authority and responsible for maintenance?	No		Section 2.10(1)(f)

Local heritage items

Issue	Potential impact	Yes / No	If 'yes' consult with	T&I SEPP section
Local heritage	Is there is a local heritage item (that is not also a State heritage item) or a heritage conservation area in the study area for the works? If yes, does a heritage assessment indicate that the potential impacts to the heritage significance of the item/area are more than *minor* or *inconsequential?*	No		Section 2.11

Flood liable land

Issue	Potential impact	Yes / No	If 'yes' consult with	T&I SEPP section
Flood liable land	Are the works located on flood liable land? If so, will the works change flood patterns to more than a *minor* extent?	No		Section 2.12
Flood liable land	Are the works located on flood liable land? (to any extent). If so, do the works comprise more than minor alterations or additions to, or the demolition of, a building, emergency works or routine maintenance	No		Section 2.13

Note: Flood liable land means land that is susceptible to flooding by the probable maximum flood event, identified in accordance with the principles set out in the manual entitled *Floodplain Development Manual: the management of flood liable* land published by the New South Wales Government.

Development within the Coastal Zone

Issue	Description	Yes / No / NA	If 'yes' consult with	T&I SEPP section
Development with impacts on certain land within the coastal zone	Is the proposal within a coastal vulnerability area and is inconsistent with a certified coastal management program applying to that land?	N/A		Section 2.14

Note: See interactive map here: ***https://www.planning.nsw.gov.au/policy-and-legislation/coastal-management***. Note the coastal vulnerability area has not yet been mapped.

Note: a certified coastal zone management plan is taken to be a certified coastal management program

Public authorities other than councils

Issue	Potential impact	Yes / No	If 'yes' consult with	T&I SEPP section
National parks and reserves	Are the works adjacent to a national park or nature reserve, or other area reserved under the *National Parks and Wildlife Act 1974*, or on land acquired under that Act?	Yes	Environment, Energy and Science, DPE	Section 2.15(2)(a)
National parks and reserves	Are the works on land in Zone E1 National Parks and Nature Reserves or in a land use zone equivalent to that zone?	No	Environment, Energy and Science, DPE	Section 2.15(2)(b)
Navigable Waters	Would the works comprise a fixed or floating structure in or over navigable waters	No	Transport for NSW	Section 2.15(2)(c)
Artificial light	Would the works increase the amount of artificial light in the night sky and that is on land within the dark sky region as identified on the dark sky region map? (Note: the dark sky region is within 200 kilometres of the Siding Spring Observatory)	No	Director of the Siding Spring Observatory	Section 2.15(2)(d)

Issue	Potential impact	Yes / No	If 'yes' consult with	T&I SEPP section
Defence communications buffer land	Are the works on buffer land around the defence communications facility near Morundah? (Note: refer to Defence Communications Facility Buffer Map referred to in clause 5.15 of Lockhardt LEP 2012, Narrandera LEP 2013 and Urana LEP 2011.	No	Secretary of the Commonwealth Department of Defence	Section 2.15(2)(e)
Mine subsidence land	Are the works on land in a mine subsidence district within the meaning of the *Mine Subsidence Compensation Act 1961*?	No	Mine Subsidence Board	Section 2.15(2)(f)
Willandra Lakes	Would the works involve development on, or reasonably likely to have an impact on, part of the Willandra Lakes Region World Heritage Property?	No	World Heritage Advisory Committee and Heritage NSW	Section 2.15(2)(g)
Western Parkland City	Would the works involved development within the Western City operational areas specified in *Western Parkland City Authority Act 2018*, Schedule 2 with a capital investment value of $30 million or more?	No	Western Parkland City Authority	Section 2.15(2)(h)
Bush fire prone land	Are the works for the purpose of residential development, an educational establishment, a health services facility, a correctional centre or group home in bush fire prone land?	No	Rural Fire Service	Section 2.16

Certain development types

Development type	Description	Yes / No	If 'yes' consult with	T&I SEPP section
Car Park	Does the project include a car park intended for the use by commuters using regular bus services?	No		Section 2.111(1)(a)
Bus Depots	Does the project propose a bus depot?	No		Section 2.111(1)(b)
Permanent road maintenance depot and associated infrastructure	Does the project propose a permanent road maintenance depot or associated infrastructure such as garages, sheds, tool houses, storage yards, training facilities and workers' amenities?	No		Section 2.111(1)(c)

Appendix D
Neutral or beneficial effect on water quality assessment

Neutral or Beneficial Effect Assessment

Chapter 6 of the Biodiversity and Conservation SEPP relates to the use of land within water catchments. In accordance with section 6.63 of the SEPP and the WaterNSW NorBE Assessment Guideline Appendix 2 - Part 5 (2022), Transport for NSW is required to consider whether an activity to which Division 5.1 of the EP&A Act applies will have a neutral or beneficial effect on water quality before carrying out the activity.

Factor	Impact
1. Are there any identifiable potential impacts on water quality?	There is the potential for pollutants such as sediment and construction waste to mobilise and enter drainage lines, particularly during high rainfall events. Water quality impacts could also potentially occur from fuel or chemical spills from construction equipment. If these impacts are not mitigated there would be implications for downstream waters and the aquatic environment.
What pollutants are likely?	Likely pollutants range from oils/fuels to nitrogen, phosphorous or other chemicals that may be used to operate plant and equipment for the proposal.
During construction and/or post construction?	Water quality impacts could potentially occur during construction of the proposal. No water quality impacts would occur during operation.
2. For each pollutant, list the safeguards needed to prevent or mitigate potential impacts on water quality (these may be Water NSW endorsed current recommended practices and/or equally effective other practices)	Relevant safeguards to prevent pollutants entering the waterways have been provided in section 7.2.
3. Will the safeguards be adequate for the time required? How will they need to be maintained?	The safeguards provided in section 7.2 are adequate for the time required and include the need for the contractor to identify specific mitigation to be implemented during rainfall events that may increase the potential for pollutants to enter nearby waterways.
4. Will all impacts on water quality be effectively contained on the site by the identified safeguards (above) and not reach any watercourse, waterbody or drainage depression? Or will impacts on water quality be transferred outside the site for treatment? How? Why?	The implementation of safeguards and mitigation measures identified in section 7.2 would effectively contain any water quality impacts resulting from the proposal. No additional water quality impacts downstream of the proposal site would occur with the implementation of the proposed mitigation measures.
5. Is it likely that a neutral or beneficial effect on water quality will occur? Why?	The construction of the proposal is considered to have a neutral effect on water quality as the potential impacts would be manageable with the implementation of mitigation measures. Following completion of the proposal, a beneficial impact is considered likely as the proposal would stabilise the existing failed slopes which are still at risk of further slips and could impact on water quality downslope of the proposal site. The proposed culvert upgrades would also improve stormwater flow thus reducing the risk of further failures resulting from uncontrolled stormwater flows, with any further slope failures likely to result in some reduction in water quality in any downstream waterways. Overall, the proposal is considered to have a beneficial effect on water quality.

Appendix E
Statement of Heritage Impacts Assessment
Mountains Heritage

Two-Mile Slope Restoration

Statement of Heritage Impact

Report prepared for Transport for NSW

May 2024

MTS Heritage Pty Ltd, 92 Douglas Street, Springwood NSW 2777 ABN: 68668095458

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Executive Summary

MTS Heritage (Mountains Heritage) was engaged by GHD Pty Ltd (GHD), on behalf of Transport for NSW, to prepare a Statement of Heritage Impact (SoHI) report for proposed remediation works to eight (8) failed slope areas on the Two Mile stretch of Jenolan Caves Road, 15 km west of the Edith Township. Historically, Two Mile was a supplementary service vehicle access to Jenolan Caves tourist site; however, following significant rainfall events in 2021 the primary access road to the tourist site, known as the 'Five Mile Access', has been closed due to flood damage. This has left the Two Mile Access as the only entrance into and out of Jenolan Caves.

The eight failure sections of road are located within the heritage curtilage of the 'Jenolan Caves Reserve', a landscape heritage item listed on the NSW State Heritage Register (SHR No. 01698). The Reserve forms part of 'Jenolan Karst Conservation Reserve', which is one of eight reserves that comprise the Greater Blue Mountains World Heritage Area, listed on the National Heritage List and the World Heritage List.

GHD prepared an options assessment report that outlined three permanent remediation options. Transport for NSW have decided to implement a modified version of Option 2 as a short to medium term solution to repair the failure sections. This option was chosen to prevent the failure sections degrading further and allow the road to remain open while the main Five Mile Access is being rebuilt. Option 2 involves the installation of 8 rows of soil nails and shotcrete that would extend up to 15 m down the slope below the road at each failure section.

This SoHI report has determined the failure sections are all located outside the Grand Arch Precinct and would not impact on any of the significant buildings, geology, views or vistas associated with the various listings. The proposed works would also not have any impact on original or historic cuttings, embankments or retaining walls. The repaired failure sections are not expected to be visible from any of the significant buildings or other locations, including Caves House, Carlotta Arch, or the Blue Lake and the works are not expected to be visible from any areas where visitors generally congregate. As such, the aesthetic and landscape heritage values of the Jenolan Caves Reserve would not be impacted by the proposed works.

Based on the results of this assessment, it is recommended that:

- Despite the failure sections not being visible from significant buildings or areas within the Grand Arch Precinct, the colour of the shotcrete should be tinted to blend into the surrounding topography and vegetation. This is to soften the look of the shotcrete if visible from any other locations along the Two Mile Access on Jenolan Caves Road.
- A copy of this report be provided to Transport for NSW for its review and endorsement. Following the issue of this endorsement, a copy of this report be provided to Heritage NSW to support a S.60 Application.
- Following the issue of a S.60 Approval, a detailed design is expected to be developed for the works. Once completed, the detailed design should be reviewed by a suitably qualified heritage specialist to ensure that there are no additional impacts posed by the works. If additional impacts are identified, an updated SoHI report would be required, and the updated assessment submitted to Heritage NSW for approval under a Section 65A Modification Application.
- In the unlikely event that any historical archaeological relics or 'works' are unexpectedly found during excavation for drainage, the *TfNSW Unexpected Heritage Finds Guideline* (2016) should be followed.

1 Introduction

1.1 Project background

MTS Heritage (Mountains Heritage) has been engaged by GHD Pty Ltd (GHD) on behalf of Transport for NSW to prepare a Statement of Heritage Impact (SoHI) report for proposed remediation works to eight (8) failed slope areas on the Two Mile stretch of Jenolan Caves Road, 15 km west of the Edith Township. Jenolan Caves Road (MR253) provides access to the Jenolan Caves Precinct, as well as campgrounds and other tourist attractions within Jenolan Karst Conservation Reserve. The Two Mile Access on Jenolan Caves Road is currently the primary access into the Jenolan Caves precinct due to the closure of the Five Mile access (that is from the east), due to substantial slope failures in 2021. This leaves the Two Mile Access as the only access into and out of the precinct. These slopes were subject to slope failures following extensive rainfall during various events commencing in July 2022 and continuing in to 2023 which has further restricted its use as the sole access into the Jenolan Caves Precinct. This proposal was identified to align with the objectives of improving road safety along the Two Mile Access by stabilising the high-risk slope and improving drainage conditions to mitigate future impacts of inclement weather.

The eight failure sections of road are located within the heritage curtilage of the 'Jenolan Caves Reserve', a landscape heritage item listed on the NSW State Heritage Register (SHR No. 01698). The Reserve forms part of 'Jenolan Karst Conservation Reserve', which is one of eight reserves that comprise the Greater Blue Mountains World Heritage Area, listed on the National Heritage List and World Heritage List. The Reserve is considered one of Australia's oldest visitor destinations and is recognised for its outstanding natural, cultural historic, scientific and recreational values (Urbis, 2017: 1).

As outlined by this report, Transport for NSW has considered several remediation options to stabilise and remediate the failed slope sections. Due to the nature of the slope failures and requirement to maintain an open access to the Jenolan Caves tourist site, a short to medium term solution involving the use of soil nails and shotcrete was chosen as the preferred option.

This report assesses the potential impact of the remediation works on the heritage significance of the 'Jenolan Caves Reserve' and the Greater Blue Mountains World Heritage Area and provides recommendations to minimise and/or avoid significant impacts to their heritage values. It has been prepared to satisfy the requirements of the *Environmental Planning and Assessment Act 1979,* the *Heritage Act 1977* and the *Environmental Protection and Biodiversity Act 1999.* The report follows the *Statements of Heritage Impact* guideline (Department of Planning and Environment, 2023) and *Matters of Environmental Significance, Significant Impact Guidelines 1.1* (Department of the Environment, 2013).

1.2 Site location

'Jenolan Caves Reserve' is situated on the western edge of the Blue Mountains, about 180 kilometres (KM) west of Sydney. The reserve is situated on a highland plateau to the east of Oberon and is normally accessed via both the Two Mile section of Jenolan Caves Road from the west and the Five Mile section from the east. The caves are situated roughly 80km west of Katoomba, and form part of McKeowns Valley - a significant fluvial karst valley (Figure 1.1).

The slope failures on the Two Mile Road section of Jenolan Caves Road (the subject site) are situated between 240m and 670 m west of Caves House (see Figure 1.2).

1.3 Heritage significance and status

'Jenolan Caves Reserve' is listed on the NSW State Heritage Register (SHR No. 01698). A copy of this listing is included in Annexure A. The subject site is partially located within the heritage curtilage of the reserve (a 20 m corridor representing Jenolan Caves Road is excluded from the curtilage). The subject site is also included within the 'Jenolan Karst Conservation Reserve', which is one of eight (8) reserves that form part of the Greater Blue Mountains World Heritage Area (GBMWHA). The GBMWHA is listed on the National Heritage List and World Heritage List.

As outlined in its SHR listing 'Jenolan Caves Reserve' is recognised for its historical and aesthetic heritage values, its research potential and rarity (See Annexure A):

> *Jenolan is one of the most important areas of natural and cultural history in Australia. The area includes one of the largest and most beautiful interconnected cave systems in Australia and is an outstanding site of geological and speleological interest. The Jenolan River, Blue Lake and a system of intimate valleys and watercourses provide a magnificent setting for a distinctive range of native vegetation and fauna. The Caves Reserve was created in 1866, six years before the declaration of the world's first National Park. Since its reported discovery by James Whalan between 1838 and 1841 the area has attracted more than three million visitors. Caves House, and its associated outbuildings, adds to the area's cultural significance. The area also contains a number of important industrial relics, including Australia's first hydro-electric power station and the remnants of the first electric lighting of caves which was installed in the Chifley Cave in 1887 (See https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051578)*

As outlined in the Plan of Management prepared for the Jenolan Caves Karst Conservation Reserve:

> *The Jenolan Karst Conservation Reserve protects a range of significant World Heritage, landscape, catchment, geological, biological, Aboriginal, historic heritage, research, education, recreational and tourism values. The most significant attribute of this reserve, however, is its karst environment which significantly contributes to the attribution of all other determinations of significance for this site (Office of Environment and Heritage, 2000: 2).*

The GBMWHA is of international significance because it contains:

- *outstanding examples of ongoing ecological and biological processes significant in the evolution of Australia's highly diverse ecosystems and communities of plants and animals, particularly eucalypt dominated ecosystems; and*
- *significant natural habitats for the in-situ conservation of biological diversity, including the eucalypt sand eucalypt-dominated communities, taxa with Gondwanan affinities, and taxa of conservation significance. (NSW NPWS 2015: 9)*

1.4 Aims and scope

The following report aims to assess the potential impact of the remediation works on the heritage significance of 'Jenolan Caves Reserve' and the World Heritage values and National Heritage values of the GBMWHA. The restoration options considered by Transport for NSW are presented and discussed and recommendations to minimise visual impacts are provided.

Preparation of the SoHI involved the following tasks:

- Review of previous reports, focussing on the 2017 Conservation Management Plan (CMP) prepared by Urbis Pty Ltd (Urbis) and the Greater Blue Mountains World Heritage Area Strategic Plan prepared by the Department of Environment and Climate Change;

- Inspection of the failed slope sections of the Two Mile section of Jenolan Caves Road and views to and from the Caves House;
- Review of remediation options prepared by GHD for Transport for NSW regarding the various options and engineering constraints; and
- Conclusions and recommendations to mitigate the potential impact of the works on the heritage significance of the 'Jenolan Caves Reserve'.

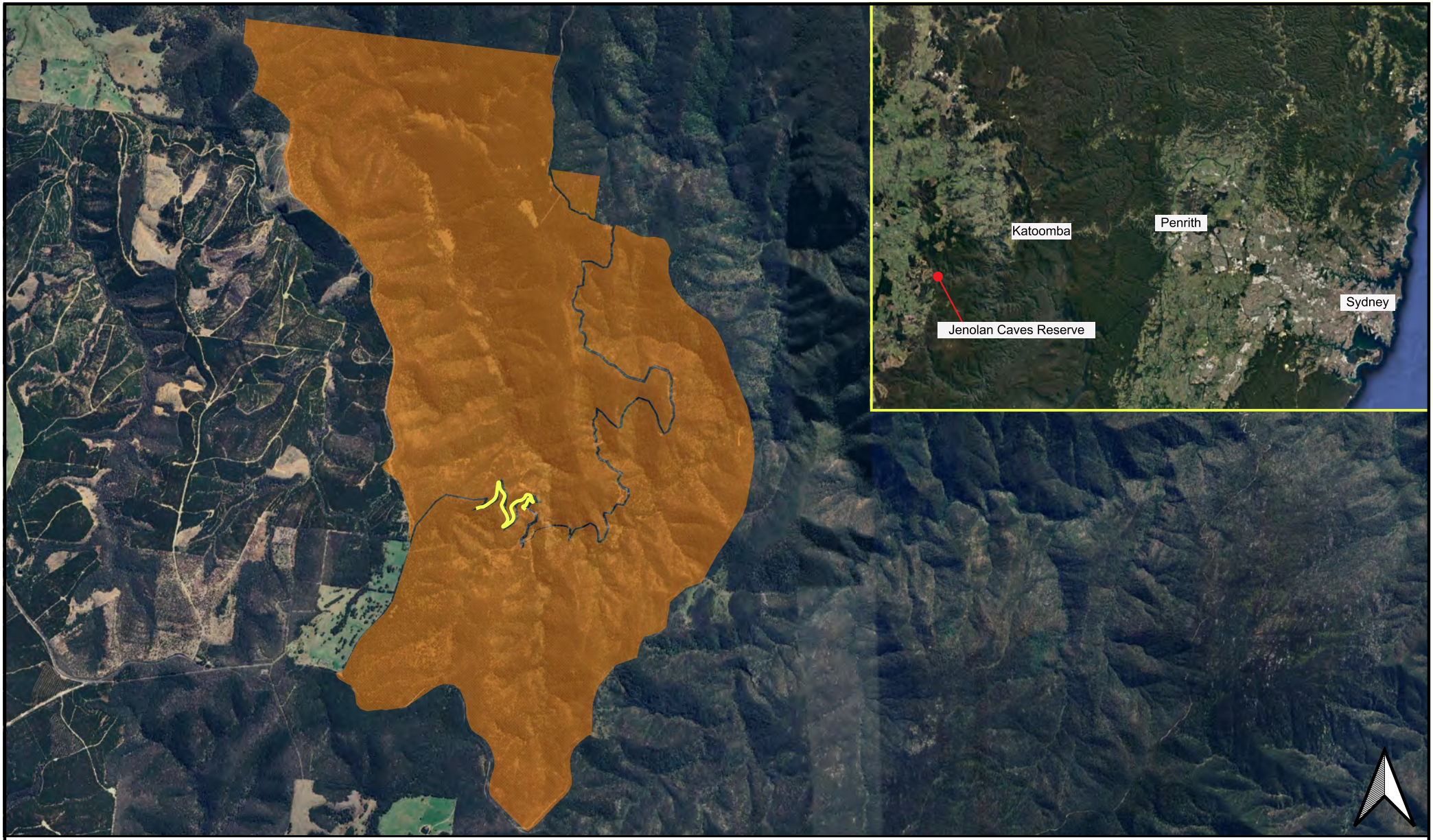
1.5 Report outline

The following report includes:

- legislative background (Section 2)
- a summary history of the Jenolan Caves Reserve (Section 3);
- a review of key heritage studies (Section 4);
- the results of a site inspection, including a description of subject site and views to and from Caves House (Section 5)
- presentation and consideration of the various levels of heritage significance attributed to 'Jenolan Caves Reserve', as included in State, National and World heritage listings (Section 6);
- review of remediation options considered and the preferred short to medium turn solution selected by Transport for NSW (Section 7); and
- conclusions and recommendations (Section 8).

1.6 Authorship and acknowledgements

This report has been prepared by Chris Lewczak (Principal Heritage Consultant, Mountains Heritage) with the history summarised by Charles Barnett (Heritage Consultant, Mountains Heritage). The report has been reviewed by Fiona Leslie (Principal Heritage Consultant, Mountains Heritage). We would like to acknowledge the assistance provided by Ben James (Senior Environmental Planner, GHD), Kris Petersen (Senior Landscape Architect, GHD) and Jack Zyhalak (Project Manager, Transport for NSW).



MOUNTAINS HERITAGE

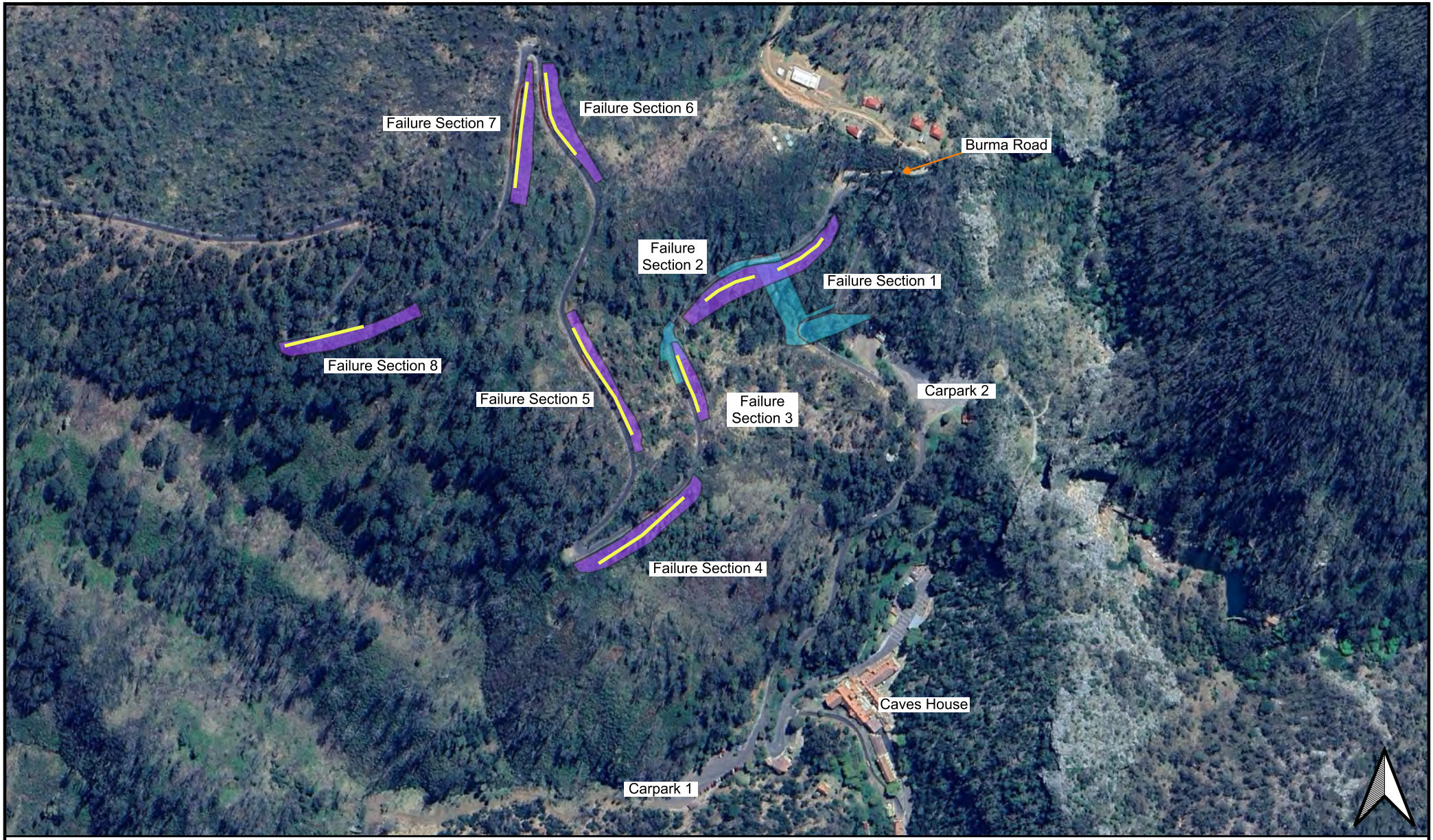
Legend

Jenolan Caves Reserve

Figure 1.1 General location of 'Jenolan Caves Reserve' in the Oberon Local Government Area, NSW

0 1 2 3 4 5 km

Map Source: NSW Six Maps (NSW Spatial Data)



MOUNTAINS HERITAGE

Legend

- Slope Failures
- Restoration Works
- Culvert and Drainage Works

Figure 1.1: Location and extent of the slope failures, proposed restoration and drainage upgrades on the Two Mile Section of Jenolan Caves Road (the subject site)

0 50 100 150 200 250 m

Map Source: NSW Six Maps (NSW Spatial Data)

2 Legislative context

The following report section provides a summary of environmental and heritage legislation relevant to 'Jenolan Caves Reserve', 'Jenolan Caves Karst Reserve' and the subject site.

2.1 Environmental Planning & Assessment Act 1979 (EP&A Act)

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides the framework for environmental planning and assessment in NSW. It includes a requirement for impacts, or likely impacts, upon historical heritage to be assessed as part of a project's environmental approval, and for Local Government Areas (LGAs) to prepare Local Environment Plans (LEPs) and Development Control Plans (DCPs) to provide guidance on the level of environmental assessment required.

Division 5.1 of the EP& A Act outlines the provisions for approval of activities and specifies the requirement for consideration of environmental impacts. Under Clause 5.5:

'(1) For the purpose of attaining the objects of this Act relating to the protection and enhancement of the environment, a determining authority in its consideration of an activity shall, notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act, examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity.'

In the case of the subject site, preparation of this SoHI will assist Transport for NSW to determine the potential impact of the proposed remediation works on the Two Mile section of Jenolan Caves Road in accordance with the provisions of the EP& A Act.

2.2 Heritage Act of New South Wales (NSW) 1977

The *Heritage Act 1977* (Heritage Act) is a statutory tool designed to conserve environmental heritage in NSW. It is used to regulate development impacts on the State's historical heritage assets. The Act defines a heritage item as '*a place, building, work, relic, moveable object or precinct*'.

To assist management of the State's heritage assets, the Act distinguishes between items of Local and State heritage significance.

'*Local heritage significance', in relation to a place, building, work, relic, moveable object or precinct means significance to an area in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item'*

'State heritage significance', in relation to a place, building, work, relic, moveable object or precinct means significance to the State in relation to the historical scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item'.

As outlined in the following subsections, different parts of the Heritage Act are designed to protect and conserve heritage items.

State Heritage Register

Under Part 3A of the Heritage Act, the NSW Heritage Council is required to maintain a State Heritage Register (SHR). This register lists items of State heritage significance, as determined by the Heritage Council and/or the Minister. To list an item on the SHR, the Heritage Council must consider that the item satisfies more than one of the heritage assessment criteria in Section 4A of the Act.

Listing on the SHR controls activities such as alteration, damage, demolition and development. When a place is listed on the SHR, the approval of the Heritage Council of NSW is required for any major work.

Section 57(1) of the Act, states that the approval of the Heritage Council of NSW or its delegate is required for most activities within an SHR listed place, including works to the grounds or structures, or excavation that may disturb archaeological 'relics.'

Section 57 of the Act states:

(1) When an interim heritage order or listing on the State Heritage Register applies to a place, building, work, relic, moveable object, precinct, or land, a person must not do any of the following things except in pursuance of an approval granted by the approval body under Subdivision 1 of Division 3:

(a) demolish the building or work,

(b) damage or despoil the place, precinct or land, or any part of the place, precinct or land,

(c) move, damage or destroy the relic or moveable object,

(d) excavate any land for the purpose of exposing or moving the relic,

(e) carry out any development in relation to the land on which the building, work or relic is situated, the land that comprises the place, or land within the precinct,

(f) alter the building, work, relic or moveable object,

(g) display any notice or advertisement on the place, building, work, relic, moveable object or land, or in the precinct,

(h) damage or destroy any tree or other vegetation on or remove any tree or other vegetation from the place, precinct or land.

- 'Jenolan Caves Reserve' is listed on the SHR and protected and managed in accordance with the provisions of Part 4 Division 2 of the Heritage Act.

Archaeological relics

Archaeological 'relics' are defined by the Heritage Act as:

'any deposit, artefact, object or material evidence that: (a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and (b) is of State or local heritage significance'

Part 6 Division 9 of the Heritage Act protects archaeological relics from being 'exposed, moved, damaged or destroyed' by the disturbance or excavation of land. This protection extends to the situation where a person has 'reasonable cause to suspect' that archaeological remains may be affected by the disturbance or excavation of the land. It applies to all land in NSW that is not included in the SHR.

Section 139 of the Act requires any person who knows, or has reasonable cause to suspect, that their proposed works will expose or disturb a 'relic' to first obtain an Excavation Permit from the Heritage Council of NSW (pursuant to section 140), unless there is an applicable exception (pursuant to Section 139(4)). If there is an exception, an Excavation Permit Exception Notification Form must be submitted and endorsed by Heritage NSW for places not listed on the SHR.

Section 146 of the Act requires any person who is aware or believes that they have discovered or located a relic must notify the Heritage Council of NSW providing details of the location and other information required.

- It is one of the objectives of this report to determine if the proposed works could affect any potential archaeological relics.

Works

The Heritage Act identifies 'works' as a category separate to relics. Although there is no formal definition, 'works' generally refer to past evidence of infrastructure which may be buried, and therefore 'archaeological' in nature and with the potential to provide information that contributes to our knowledge. Unlike a 'relic', exposure of a 'work' does not trigger reporting obligations under the Act. However, good environmental practice recognises the archaeological potential of such discoveries and the need to balance these against the requirements of development. Good heritage management practice includes a comprehensive Unexpected Finds Protocol to be implemented during construction.

Section 170 Heritage and Conservation Registers

Government agencies have responsibilities to manage their heritage assets under section 170 of the Heritage Act. Section 170 requires agencies to identify, conserve and manage heritage assets owned, occupied or managed by that agency. Section 170 requires government agencies to keep a Register of heritage items, which is called a Heritage and Conservation Register or more commonly, a s170 Register.

The Heritage Act obliges government agencies to maintain their assets with due diligence in accordance with State-Owned Heritage Management Principles approved by the Minister on the advice of the Heritage Council and notified by the Minister to government instrumentalities from time to time. Broad principles and guidelines for the management of State-owned heritage assets have been published by the NSW Heritage Office under s170 of the Act (NSW Heritage Office, 2004).

- 'Jenolan Caves Reserve' and the subject site is not solely owned by Transport for NSW and is not listed on the Transport Asset Holding Entity S170 Heritage and Conservation Register.

2.3 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) includes 'national heritage' as a matter of National Environmental Significance (NES) and protects listed places to the fullest extent under the Constitution. Working with the states and territories, it enables the Australian Government to provide a national scheme of environment and heritage protection and biodiversity conservation. It also establishes the World Heritage List (WHL), National Heritage List (NHL) and the Commonwealth Heritage List (CHL).

In addition, the EPBC Act is the statutory instrument for Australia to fulfill its obligations under multilateral environmental agreements, including the World Heritage Convention. The act is triggered by development or actions that pose a significant threat on matters of NES, including world heritage areas and national heritage sites and nationally threatened species and ecological communities. The Act outlines a process of assessment for proposed action that have, or will have, a significant impact on matters of NES. If such an action is identified, it requires referral and approval from the Minister for Department of Agriculture, Water and the Environment.

A referral must be made for actions that are likely to have a significant impact on the following matters protected under Part 3 of the EPBC Act:

- World Heritage properties;
- National Heritage places;
- Wetlands of international importance; and
- Listed threatened species and communities.

An action that needs approval under the EPBC Act is known as a 'controlled action'.

A significant impact is regarded as being:

> *Important, notable or of consequence, having regard to its context or intensity and depends upon the sensitivity, value and quality of the environment which is impacted and upon the duration, magnitude and geographic extent of the impacts. A significant impact is likely when it is real and not a remote chance or possibility. (EPBC Policy Statement).*

As outlined in the NES Significant Impact Guidelines:

> *An action is likely to have a significant impact on the World Heritage Values of a declared World Heritage property if there is a real chance or possibility that it will cause:*
>
> - *One or more of the World Heritage values to be lost*
> - *One or more of the World Heritage values to be degraded or damaged, or*
> - *One or more of the World Heritage values to be notably altered, modified, obscured or diminished. (Department of the Environment, 2013: 16)*

The same applies for places of National Heritage value, listed on the National Heritage List.

The requirement for referral is subject to self-assessment with the onus on the Proponent to make the application and not the Council or other consent authorities. Subsequent penalties apply for taking such an action without approval. The EPBC Act referral process included in the NES Significant Impact Guidelines is reproduced overleaf (Plate 2.1):

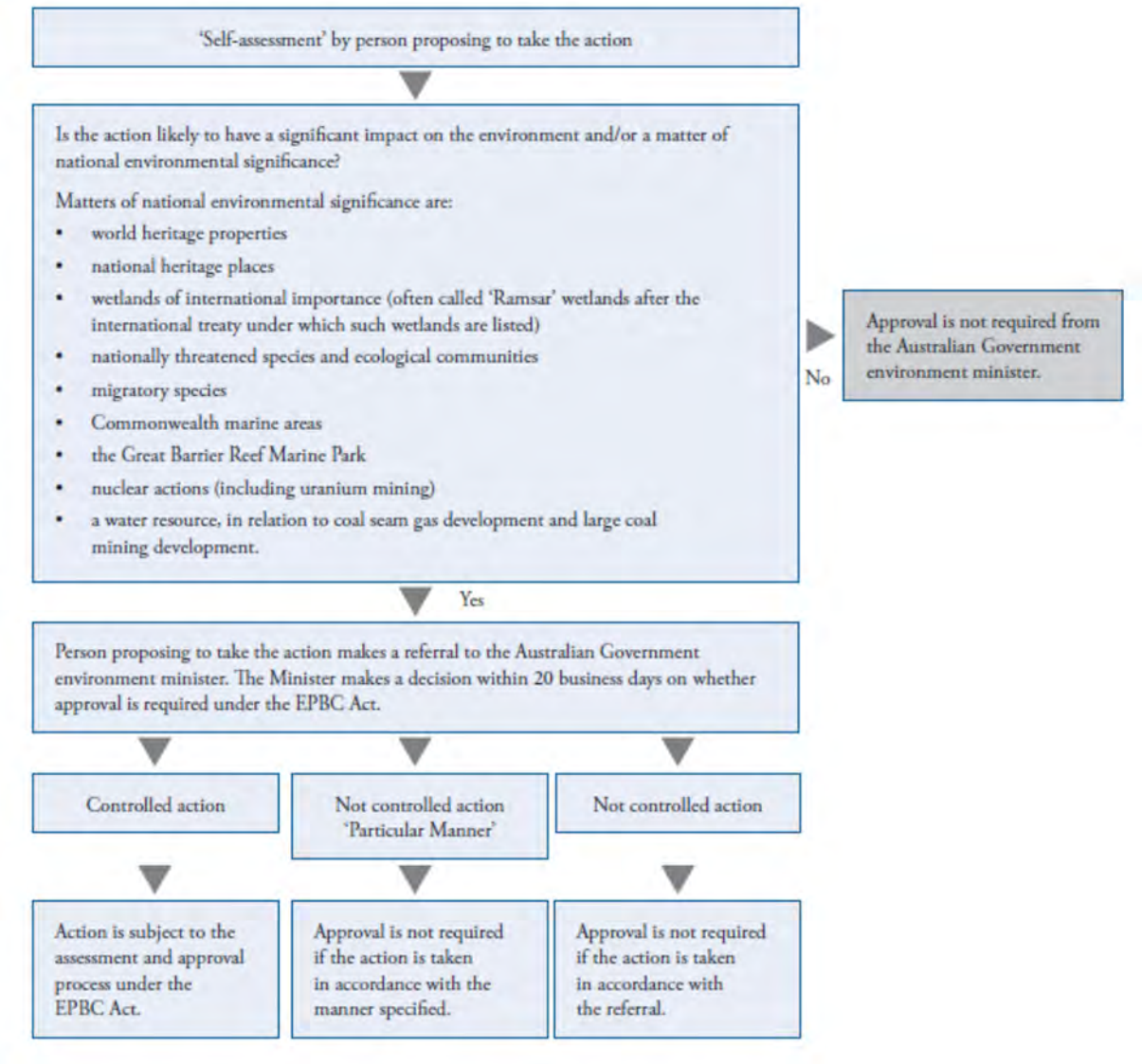


Plate 2.1: EPBC Act Referral Process (Source: Department of the Environment, 2013: 27)

The following is a description of each of the heritage lists and the protection afforded to places listed on them.

World Heritage List

The WHL is a list of sites that are designated as having ''outstanding universal value'' under the *Convention Concerning the Protection of the World Heritage and National Heritage* (UNESCO 1972) known as the World Heritage Convention. This document was adopted by UNESCO in 1972 and formally took effect in 1975 after being ratified by 20 countries. It provides a framework for international cooperation in preserving and protecting cultural treasures and natural areas throughout the world.

As outlined above, any proposed actions on WHL sites must be assessed for their impact on the World Heritage values of the place in accordance with *Management of National Environmental Significance (Significant Impact Guidelines 1.1*). The guidelines require the proponent to carry out a self-assessment process to decide whether or not the action is likely to have a significant impact on a matter of National Environmental Significance, including the World Heritage value of places. If an

action is likely to have a significant impact an EPBC Act referral must be prepared and submitted to the Minister for approval.

National Heritage List

The NHL is a list of places with outstanding heritage value to Australia, including places overseas. Any proposed actions on NHL places must be assessed for their impact on the heritage values of the place in accordance with *Management of National Environmental Significance (Significant Impact Guidelines 1.1).* The guidelines require the proponent to carry out a self-assessment process to decide whether or not the action is likely to have a significant impact on a matter of National Environmental Significance, including the national heritage value of places. If an action is likely to have a significant impact an EPBC Act referral must be prepared and submitted to the Minister for approval.

Commonwealth Heritage List

The CHL is established under the EPBC Act. The CHL is a list of properties owned by the Commonwealth that have been assessed as having significant heritage value. Any proposed actions on CHL places must be assessed for their impact on the heritage values of the place in accordance with *Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies (Significant Impact Guidelines 1.2)*. The guidelines require the proponent to carry out a self-assessment process to decide whether or not the action is likely to have a significant impact on the environment, including the heritage value of places. If an action is likely to have a significant impact an EPBC Act referral must be prepared and submitted to the Minister for approval.

Register of the National Estate

The Register of the National Estate (RNE) was formerly compiled as a record of Australia's cultural and Aboriginal heritage places worth keeping for the future. The RNE was frozen on 19 February 2007, which means that no new places have been added or removed since that time. From February 2012 all references to the RNE were removed from the EPBC Act. The RNE is maintained on a non-statutory basis as a publicly available archive.

2.4 Heritage Database Searches

Table 2.1 (overleaf) summarises the relevant heritage listing for 'Jenolan Caves Reserve' which includes the subject site. Heritage registers searches were conducted on 23 October 2023.

Table 2.1: Summary of Heritage Listings for 'Jenolan Caves Reserve' (Search date: 23 October 2023)

Heritage Listing	*Listing Name*	*Listing No*	*Date Listed or Inscribed*	*Details of Heritage Items listed within / directly adjacent to the subject site*
Statutory Listing				
UNESCO World Heritage List	Greater Blue Mountains World Heritage Area	917	2000	'Jenolan Caves Reserve' forms part of the listing, which is primarily focused on natural heritage values (see Figure 2.1).
National Heritage List	Greater Blue Mountains		2007	'Jenolan Caves Reserve' forms part of the listing, which is primarily focused on natural heritage values (see Figure 2.1).
NSW State Heritage Register	Jenolan Caves Reserve	01698	2004	The Reserve is listed for its historical, aesthetic, research and rarity values (see Figure 2.2).
Oberon Local Environmental Plan 2013 – Schedule 5	Jenolan Caves, 4650 Jenolan Caves Road, Part Lot 49, DP 728898	Item #I1		In addition to the Caves listing, there are multiple listing for various elements within the Reserve.
	Jenolan Caves House, Lot 39 DP 728898, Jenolan Caves Road.	Item #I11		
	Stone Bridge, Lot 49 DP 728898, Jenolan Caves Road.	Item #I11		
	Jenolan Caves Reserve Conservation Area (Part 2 – Heritage Conservation Areas)	C1		
	Jenolan Caves (Part 3 – Archaeological Sites)	A1		
	Rowe's Homestead, Lot 49 DP 728898, 13 Burma Road	Item #I56		
	The Six Foot Track	Item #I18		
Non-Statutory Listing				
National Trust of Australia	Jenolan Caves Conservation Area	3164		'Jenolan Caves Reserve' is listed for its geological formations, flora, fauna, Caves House and other buildings and landscape features.
Register of the National Estate	Jenolan Caves and Reserve	890	1978	'Jenolan Caves Reserve' is listed for its geomorphology, diverse landscape and fossil elements.



Figure 2.1: The Greater Blue Mountains Area inscribed on the UNESCO World Heritage List. The general location of the subject site is circled in blue (Source: http://whc.unesco.org/en/list/917/multiple=1&unique_number=1071).

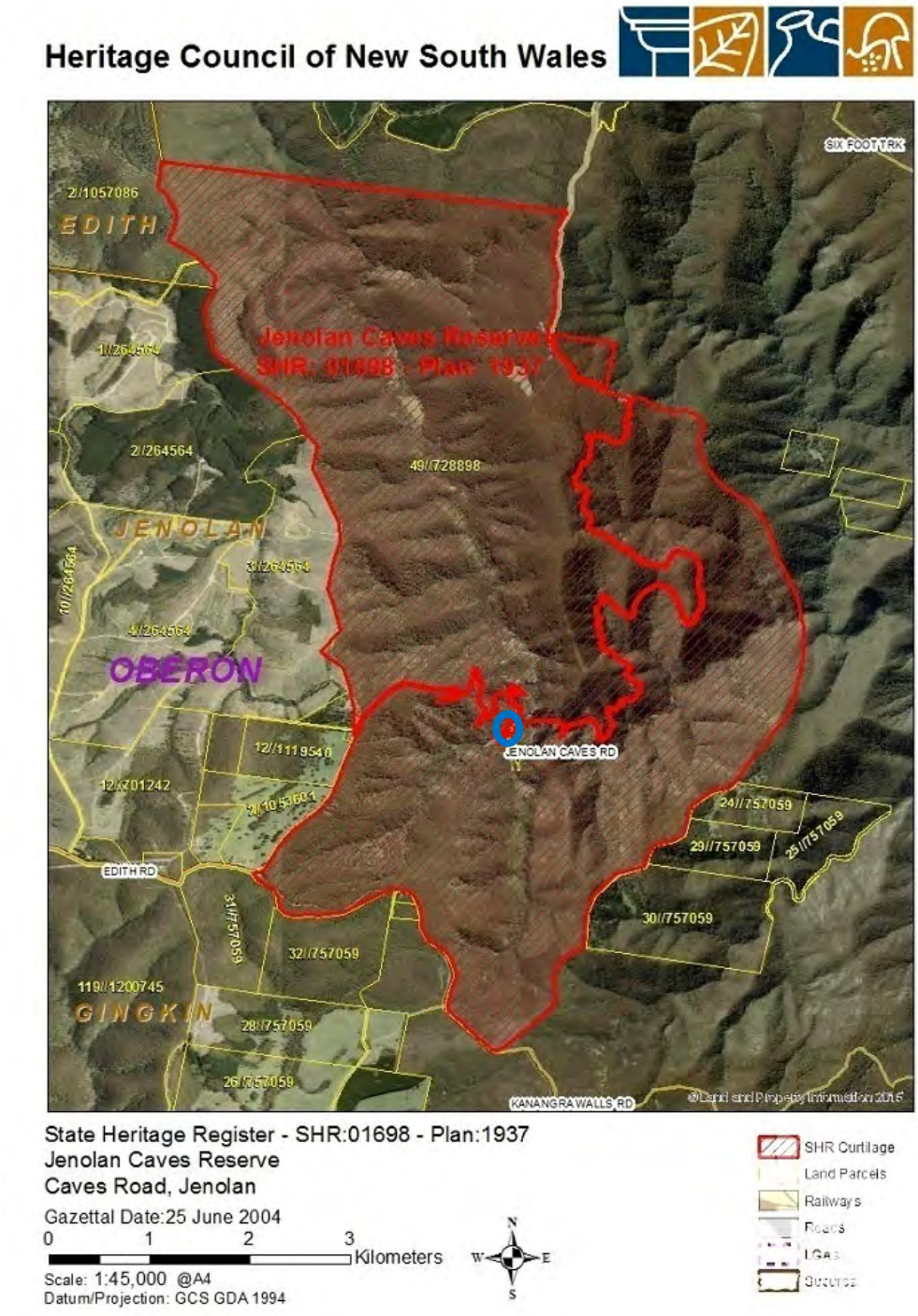


Figure 2.2: The heritage curtilage of 'Jenolan Caves Reserve' as listed on the NSW SHR. The general location of the subject site is circled in blue (Source: https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051578).

3 Summary Site History

The 2017 CMP, which built upon the 1988 version, provides a comprehensive analysis of the history of the Jenolan Karst Conservation Reserve. The following section outlines the contextual history of the reserve provided in the CMP, including key phases of European development, with a focus on the Jenolan Caves House and the Two Mile section of Jenolan Caves Road.

3.1 Aboriginal History

The Jenolan Caves region is part of the land of the Gundungurra and Wiradjuri People. The Gundungurra people referred to the Jenolan area as 'Binomil', 'Bin-oo-mur' or 'Binoomea', meaning 'dark places'. According to a Gundungurra Elder, Old Jimmy Lynch, who lived near Katoomba during the latter stages of his life, the Jenolan Caves were visited for their healing powers:

The old natives knew the caves. They penetrated them as far as the subterranean water, carrying sick people to be bathed in this water, which they believed to have great curative powers. Sick people were carried there from considerable distances (Betteridge 2020: 10).

While the Aboriginal history of the Jenolan Caves region is not well known at this stage, the Blue Mountains region has been occupied for at least 15,000 years. A site at Kings Tableland, 35km east of Jenolan Caves, dates to 22,000 years ago and is the oldest known in the region. Aboriginal archaeological sites in the Reserve are usually found around watercourses (Urbis 2017: 59). While a comprehensive study of Aboriginal sites is lacking, 21 are recorded in the Reserve, including artefact scatters and isolated finds, art sites, grinding grooves and a burial. Stone artefacts include mostly flakes, though two potential cores and a potential axe or stone hammer were identified during surveys and site inspections. Several sites have been impacted by activities in the Jenolan Conservation Reserve, including one example (A08) that retains clear evidence of grading and/or other soil truncation through mechanical means (Urbis 2017: 20-21). The known Aboriginal sites from within the Reserve are characteristic of examples from the broader Blue Mountains region, and most likely date to within the last 5,000 years (Urbis 2017: 134-135).

3.2 Early Europeans at Jenolan Caves

James McKeown, a bushranger and runaway convict, and local pastoralist James Whalan are considered the earliest European visitors to the caves. In 1838, Whalan captured McKeown, who had been hiding in the caves for around 3 years. Charles and Edwin Whalan, brothers of James, explored the caves and by 1842 were guiding tourists to the area for the next 3 decades. The caves were first known as McKeown's Caves, though the name Fish River Caves was soon adopted (Urbis 2017: 60-61). An early tourist at the caves was John Lucas, MLA, who visited in 1861 (*The Sydney morning Herald*, 5 June 1863). Lucas campaigned for the caves to be declared a reserve, and one of the largest caverns is named after him (Rathbone 1974). In 1866 the Fish River Caves Reserve was gazetted in order to preserve this natural phenomenon, 6 years earlier than the world's first National Park. With the support of Lucas, a local farmer and early explorer of the caves, Jeremiah Wilson, was appointed Keeper of the caves, which were now known as the Binda Caves. They were renamed the Jenolan Caves in 1884.

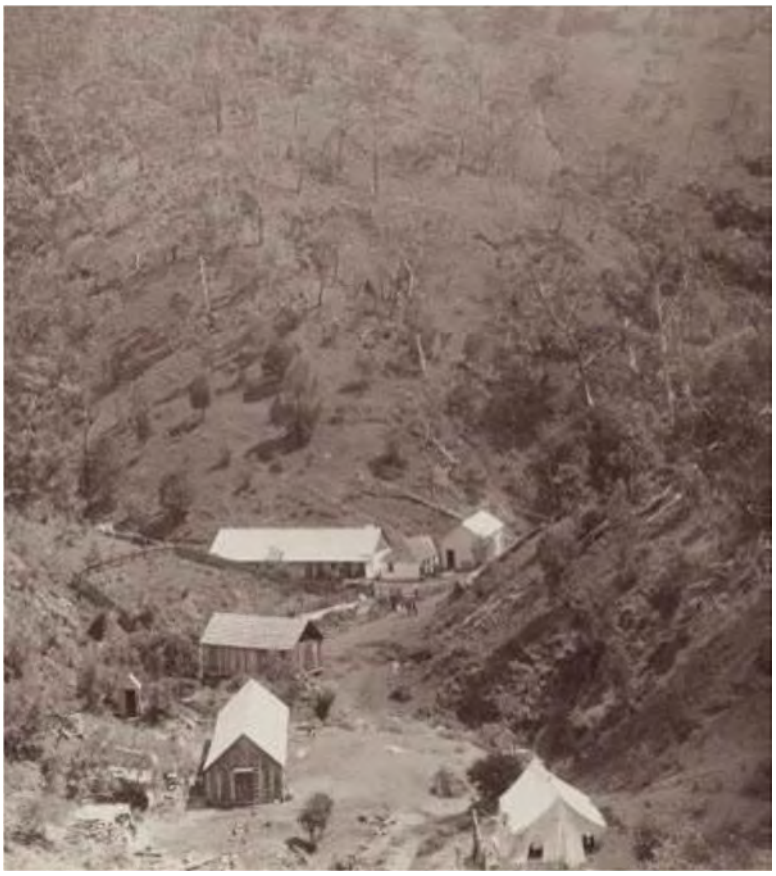


Plate 3.1: Wilson's accommodation at the Reserve, c. 1880. (Source: Urbis 2017: 72).

3.3 Development of the Site

Jeremiah Wilson explored the caves and developed camping facilities for tourists. A number of safety measures around the caves, including steps, gates, railings, ladders and mesh cages were set up to help preserve the site. In 1880, Wilson was provided with materials from the Department of Mines to construct an initial accommodation building, with 4 bedrooms and a dining room and a separate kitchen. This accommodation was soon found inadequate and in 1887, a two-story timber-framed, weatherboard-clad hotel was constructed on the site now occupied by the Second Wing of the current Caves House. Another two-storey timber building was constructed in 1890, which replaced the earlier kitchen building. A fire caused much damage to the buildings in 1895, after which Wilson was not able to rebuild, and his lease on the site was resumed by the NSW Government (Betteridge 2020: 13).

In 1887 a steam-driven dynamo was installed in the Grand Arch to provide power to run lights that illuminated the Imperial Cave. This was the first time in the world that caves were lit through electrical lighting. In another first, the dynamo was replaced two years later with a water-driven Leffel Wheel placed at a waterfall on the Jenolan River. This was the first hydro-electric scheme in Australia and provided lighting for both the caves and accommodation (Urbis 2017: 62).



Plate 3.2: Accommodation in the reserve, 1880s. The stone footings of the two-storey timber accommodation can be seen on the left (Source: Urbis 2017: 62).

The government decided when rebuilding in the 1890s that the site was to become a resort for wealthy travellers and those wanting a retreat from Sydney. Improvements were underway soon after the government took over and are mentioned in an 1891 article from the Sydney Morning Herald. The author wrote of the attractive landscape and gardens of the renewed resort, which had benefitted after coming under the 'paternal care' of the government and was reminiscent of Swiss Alpine villages (*The Sydney Morning Herald*, Wednesday 6 May 1891). A new Caves House, designed by Government Architect Liberty Vernon in the Arts and Crafts style, was completed in 1898. The slopes around Cave House were also terraced and remodelled, under the design of Joseph Maiden, the Director of the Royal Botanical Gardens, providing a park-like setting (Urbis 2017: 63). The area was described in an article of the *Lithgow Mercury* (9 June 1899) as 'a sylvan beauty spot', with charming gardens and all the comforts of a metropolitan hotel. The increased safety of the site and the caves themselves was also mentioned. Between 1907 and 1909 the Caves House was extended, with the original timber buildings replaced with a stone construction. A third wing was built between 1915 and 1917 and a fourth wing was completed in 1923 (Urbis 2017: 74).

The introduction of the motor car and promotion by tourism authorities led to increased popularity and visits to the caves during the early 20th century. To cope with increasing visitor numbers, the Caves House was expanded, and additional service buildings were constructed. During the depression and Second World War, visits to the Jenolan Caves greatly reduced. Post-war renovations to the Caves House included alterations of the style of the original buildings and gardens to fit 'modern' sensibilities. By the end of the 1960s, 120 staff were employed at Jenolan Caves, including the House personnel and cave operators. Despite a downturn in tourism in the Blue Mountains during the 1960s and 70s, Jenolan increased in popularity, particularly due to increasing numbers of day-trippers arriving from Sydney. The Five Mile Road was upgraded in 1964, being sealed with bitumen. The Two Mile Road was upgraded in the mid-1980s (Urbis 2017: 64 - 68).



Plate 3.3: Accommodation at the Reserve, c. 1895 prior to the fire. (Source: Urbis 2017: 72).



Plate 3.4: The remaining double story timber accommodation building, with new stone Caves House behind, as well as post office and kiosk. (Source: Urbis, 2017: 73).

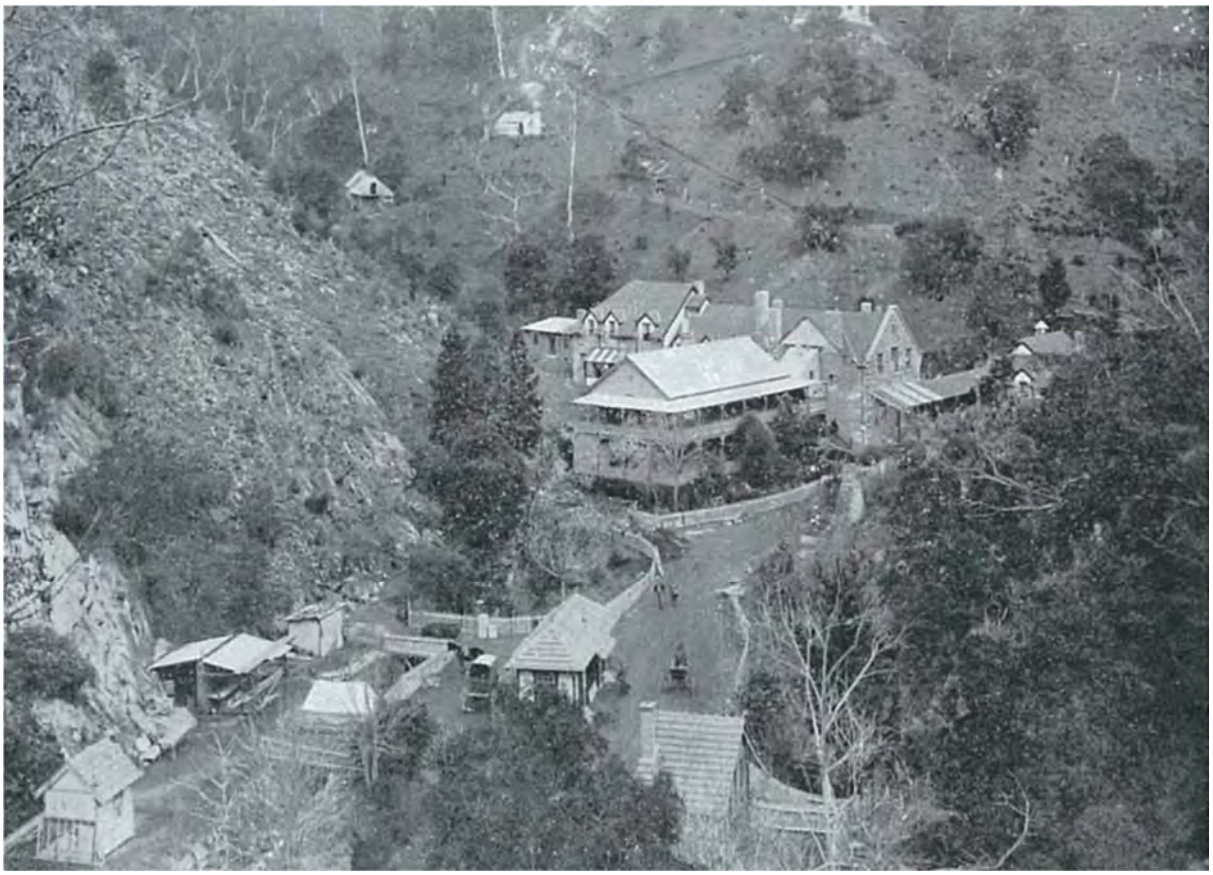


Plate 3.5: Multiple buildings, sheds and kiosks between Caves House and the Grand Arch, c. 1900. (Source: Urbis 2017: 75).



Plate 3.6: Caves House 1910-19. (Source: Urbis 2017: 76).



Plate 3.7: View of Caves House from Carlotta Arch. (Source: Urbis 2017: 77).

3.4 The Jenolan Caves Road

To bring visitors to the site, Wilson would meet them at Tarana railway station, bring them by buggy through Oberon and guide them on foot through the last 3.2 kms, since vehicle access was not possible without proper roads (Betteridge 2020: 13). Earlier roads, constructed as part of a colonial works program to improve access to land west of the Great Dividing Range, provided basic routes to the edge of the Reserve, but not into the caves site. The first road descending into the Jenolan Caves, approaching from the Oberon side, was surveyed in 1878 and completed in 1879 (Urbis 2017: 71). This was the Two Mile Hill descent and was constructed by the Public Works Department Road Superintendent Henry Cambridge. Increasing tourism demands meant that by the mid-1880s the government was lobbied to complete another connection from the east to connect the caves to the Blue Mountains. This road was completed in 1887 and followed the descent known as Five Mile Hill, though terminated half a mile before the caves, with the last leg of the journey made on foot (Urbis 2017: 61-2). Governor of NSW, Lord Carrington, and his wife, Lady Carrington, were some of the first visitors to travel to Jenolan Caves from Katoomba along this new route (Betteridge 2020: 12).

In 1896, the Five Mile Road was extended so that it reached the caves site, now incorporating the limestone arch bridge designed by PWD Engineer, E. M. Burgh. This effectively linked the two roads that approached the caves from west and east. With increasing visitors in the post-War period, the roads leading to the Jenolan Caves, which were still dirt tracks, required substantial improvement. The Five Mile Road was upgraded in 1964, being sealed with bitumen. The Two Mile Road was upgraded in the mid-1980s (Urbis 2017: 63, 68). The Jenolan Caves Road now winds through the Reserve with some steep sections, and often no clearly defined pedestrian routes. There are three carparks within the Grand Arch precinct and several walking tracks radiating from the roads into the Reserve (Urbis 2017: 43).



Plate 3.8: Cars driving to the caves, 1920s. (Source: Urbis 2017: 64).

4 Site Management

The following section provides a summary of key heritage studies that provide a management framework for 'Jenolan Caves Reserve' and the GBMWHA and their heritage values. These studies include the most recent *Jenolan Karst Conservation Reserve: Conservation Management Plan* prepared by Urbis in 2017 and the *Greater Blue Mountains World Heritage Area Strategic Plan* published by the (then) Department of Environment Climate Change (NSW).

4.1 The Jenolan Karst Conservation Reserve Conservation Management Plan

Urbis completed a CMP for the Jenolan Karst Conservation Reserve in 2017 (Urbis 2017). The CMP was jointly commissioned by the Jenolan Caves Reserve Trust and the Office of Environment and Heritage. Its authors aimed to develop policies and strategies for conservation and management of sites, structures and the cultural landscape of the Reserve. The Reserve was divided into two zones – the Visitor Use and Services Zone (VUSZ), which contains the 7 precincts in which development has occurred, and the Conservation Management Zone (CMZ), which covers the natural sections of the Reserve. Key objectives of the CMP included achieving long-term conservation and management outcomes for the VUSZ, placing the cultural significance of the VUSZ within the context of the Reserve as a whole and ensuring balanced and compatible management of cultural and natural heritage values within the Reserve (Urbis 2017: 1-2).

> *The primary significance of the Jenolan Karst Conservation Reserve is embodied in the karst system itself and the flora and fauna the reserve supports. However, the human-modified cultural landscape comprising the access roads and walking tracks, the numerous buildings and their landscape settings, the developments within the caves and the movable heritage including building contents and historical archives are also items with varying levels of heritage significance.*
>
> *The cultural landscape setting has been progressively modified over time, commencing in the late 1800s and early 1900s. The cultural landscape we see today is largely a pastiche of remnants from the last decade of the 19th century and subsequent development phases.*

A particularly appealing feature of the Reserve is the intermix of aesthetically significant natural landscape features and elements of the built environment. "*The reserve has unique aesthetic appeal that incorporates the most important and visually sensitive natural features together with elements of the built environment"* (Urbis, 2017; 36). Jenolan Caves are located within a network of hills and valleys lacking flat spaces, and the building of roads and sites for structures has led to significant manipulation of the natural environment and landscapes. This includes excavation in the Grand Arch Precinct, where the current subject site is located (see Figure 4.1), associated with construction of the road leading into the Caves House. The steep slopes surrounding the site has led to the use of stone walling and terracing (see Plates 4.1 and 4.2 including to the west and south of the Caves House (Urbis 2017: 36). Numerous embankment types are found on the site, and ongoing localised slips have been noted.

The roads of the Reserve are considered historic, incorporating historic cuts and fills as well as retaining walls and fencing. On its descent into the area, the Two Mile section of Jenolan Caves Road provides a view of the Grand Arch Precinct that includes the steep forested slopes as well as the Caves House and the surrounding valley. The House and its complex of buildings have an Edwardian romantic vernacular style and provide a 'European Resort' atmosphere. (Urbis 2017: 42-43). Urbis found that the aesthetic values of Caves House are significant at a State level, particularly due to its setting within the valley (Urbis 2017: 151). Several specific views around the Reserve were noted for

their heritage value (see Figure 4.2). Details regarding these significant views are reproduced in Table 4.1 below.

Urbis also noted the general character of significance within the VUSZ as including a "*romantic mix of dramatic slopes and nostalgic English vernacular architecture*" (Urbis 2017: 155). Their report suggested future works should seek to investigate the significance of these and other views (Urbis 2017: 157). Several significant plant species were also noted. The only species in close proximity to the subject site is LO5 *Thuja Pilcata*, a Western Red Cedar, graded to be of Local heritage significance (see Figure 4.1).

Table 4.1: Significant views identified in the CMP (Figure 4.2) (Source: Reproduced from Urbis 2017: Table 5)

View	Significance
1) View to Caves House (1) and the Engineers House (17) from the Walking Track (to Car Park 2)	This view encompasses picturesque and dramatic vistas to Caves House and the Engineers House. Caves House has aesthetic significance for its high quality design and execution as an embodiment of the romantic Old English Domestic Revival style with Edwardian/ Arts and Crafts influences. It was skilfully and dramatically sited in the valley at the confluence of the two rivers and the massing of Caves House makes use of the topography of the site, ensuring a distinctive and enduring image dominated by the steep terracotta tiled gable roofs, chimneys and dormer windows. Landscape elements, such as the dry stone walling and terracing and garden settings, further compliment this. The elevated position of the loop road and the Track provide for dramatic views. Similarly the former Caretakers/ Engineer's House (17) is a significant landmark on Gingkin Hill and views to the building should be retained and conserved. Landscaping should be managed with consideration for key views and vistas.
2) View to Caves House (1) and over the Grand Arch Precinct from the former Caretaker's House/ Engineer's Cottage (17)	Built as the residence of the Reserve's Caretaker, the former Caretaker's Cottage was specifically sited and designed to have oversight over Caves House and the Grand Arch Precinct. Early photos illustrate that the slopes of Gingkin Hill below the cottage were partially cleared, likely to facilitate views.
3) View to Carlotta Arch and the Blue Lake from the Walking Track (to Car Park 2)	Carlotta Arch is a stone bridge containing stalactites which are part of a collapsed cave system. This view provides an excellent vantage point to view not only the arch, but frames the long vista to the Blue Lake through the arch. Significant views to the arch should be retained and conserved and landscape managed with consideration for key views and vistas.
4) View to The Grand Arch, Carlotta Arch, the Blue Lake and De Burgh's Bridge, from Jenolan Caves Road near the old Diesel House (37)	Collectively the significant above ground limestone features, (being the Grand Arch and Carlotta Arch), the Blue Lake and stone bridge present a unique and impressive vista on the approach to the Reserve from Jenolan Caves Road. Significant views should be retained and conserved and landscape managed with consideration for key views and vistas.
5) View over McKeown's Valley and to the Devil's Coach House from the Burma Road lookout	This view provides a dramatic vista over the McKeown Valley to the Devil's Coach House (which is the floodwater channel of McKeowns Creek) and enables a strong appreciation of the site's unique natural heritage values, augmented by the impressive karst bridge.

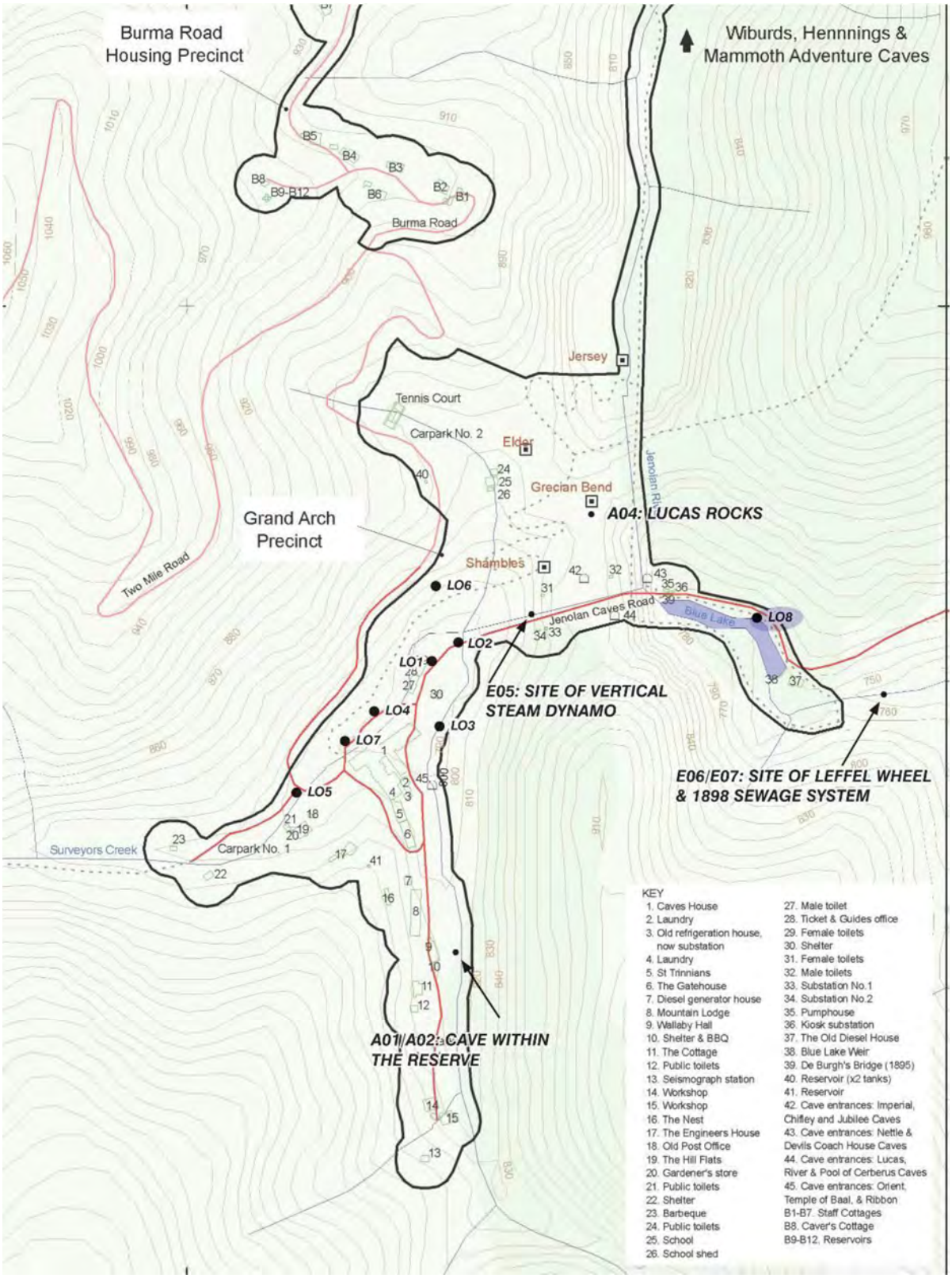


Figure 4.1: Site Plan – Grand Arch Precinct. (Source: Urbis 2017: 46).



Plate 4.1: View of Caves House and the area to the south in December 1927, showing the extensive stone walling and terracing (Source: Urbis, 2017: 97)



Plate 4.2: View of the area directly south of Caves House in c.1927, showing the extensive dry stone walling and terracing (Source: Urbis, 2017: 97)

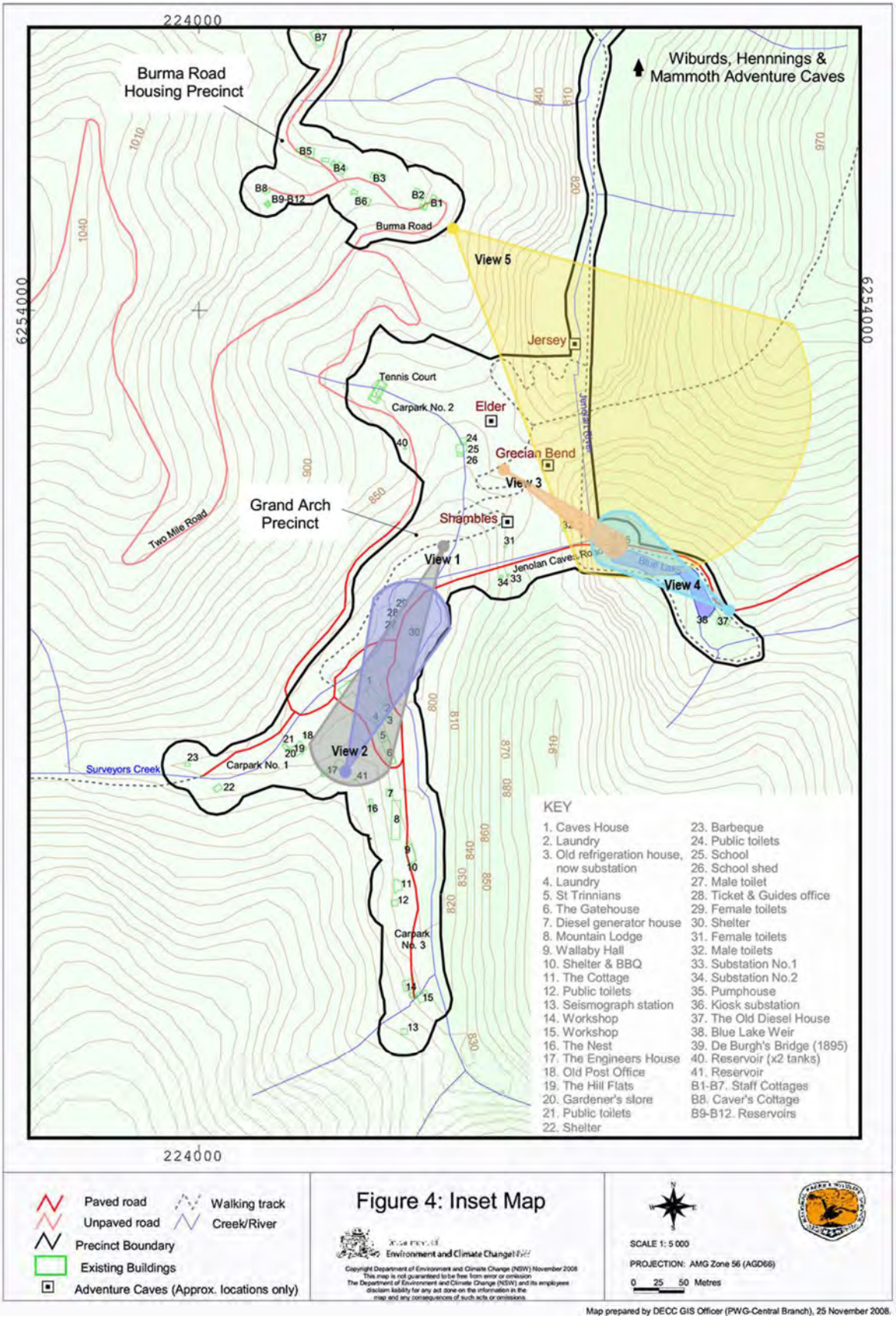


Figure 4.2: Primary significant views and vistas identified in the 2017 CMP (Source: Urbis 2017: 175).

Several European archaeological resources were identified by the CMP, however none of the identified sites were located in close proximity to the subject site (see Section 2.9, Urbis, 2017: pp24-25).

In addition to broader conservation policies that provide a vision for the Reserve's ongoing use and sustainability, Urbis lists some specific strategies that seek to preserve its landscape and setting.

With regards to Cuts, Embankments, Retaining Walls, Weirs and Paths (2017: 210):

Policy 19. All original or early historic cuts, embankments, retaining walls, weirs, paths and stairs should be retained and conserved wherever possible whilst also ensuring compliance with contemporary building codes, safety and engineering standards.

Policy 20. Repairs should be undertaken immediately with original materials. Where deterioration of cuts, embankments and retaining walls affects a more extensive area, then geotechnical advice should be sought. Gabion or modern wall solutions may be used for remedial works however they should be faced with stone walling that is sympathetic to walling in the immediate vicinity.

Policy 22. A representative sample of timber baulks and the guardrail system on roads should be considered for retention (and possibly treated with a preservative such as Preschem Polesaver Rods) in liaison with the Roads and Maritimes Services in any future road upgrading.

The cultural landscape of the Jenolan Karst Conservation Reserve is considered of exceptional or high heritage significance, with retention and conservation as key policy strategies (Urbis 2017: 211). Urbis listed policies with regards to Conservation of Settings, Layouts, Views and Vistas (Urbis 2017: 212):

Policy 38. The significant components that combine to define the cultural landscape of the setting including significant geological and landscape features, heritage structures and samples of exotic and indigenous vegetation, must be preserved, maintained and interpreted.

Policy 39. Significant geological features, layouts, views, vistas, spaces and hard and soft landscape elements should be retained and conserved to maintain the significant landscape character and fabric of the reserve as a whole and its component precincts.

Policy 40. Significant views and vistas should be identified and protected as part of the development of a Landscape Management Plan. A detailed view analysis should be prepared for the Reserve however reference should be made to the identified views in Section 6.5.9. Views and vistas to, from, and within Jenolan Karst Conservation Reserve should be retained and conserved through sensitive treatments such as trimming and lopping.

Policy 41. Adaptive reuse and redevelopment within the precincts should be informed by conservation of significant layouts, views, spaces and hard and soft landscaping.

Policy 42. Future development applications for new buildings, other structures and infrastructure should ensure that appropriate settings are retained for significant built and landscape elements.

4.2 Greater Blue Mountains World Heritage Area Strategic Plan

A Strategic Plan for the Greater Blue Mountains World Heritage Area (GBMWHA) was prepared by the Department of Environment and Climate Change (NSW) with the purpose of assisting Australia's international responsibilities under the World Heritage Convention. It outlines strategies proposed for the management of the GBMWHA and its World Heritage values (Department of Environment and Climate Change 2009: 4-5). The GBMWHA was inscribed on the World Heritage List in 2000 due to its outstanding examples representing on-going ecological and biological processes and important natural habitats (Department of Environment and Climate Change 2009: 7).

The GBMWHA is comprised of 8 protected areas, including the Blue Mountains, Kanangra-Boyd, Gardens of Stone, Wollemi, Nattai, Yengo and Thirlmere Lakes National Parks and the Jenolan Karst Conservation Reserve. The GBMWHA is a significant example of major stages of the Earth's ongoing biological and geological processes and diversity. It is also an important resource for nature-based recreational activities, and the dramatic landscapes of the Reserve have attracted visitors since the early days of tourist activity (Department of Environment and Climate Change 2009: 4). The caves were one of the earliest tourist attractions in Australia, with European visitors arriving from the mid-1800s. A number of the Reserve's historical sites and structures, lookouts and walking tracks have been in use since the late 19th century. Today a range of formal accommodation and camping facilities are available, including at Jenolan Caves House and in self-contained cottages. With around 220,000 visitors per annum, activities available to tourists at Jenolan Caves include cave tours, adventure caving, picnicking and walking (Department of Environment and Climate Change 2009: 14).

The karst landscape and its cave system are noted for their importance in their antiquity, scientific and recreational values, with the Jenolan Caves being the world's oldest open case system (Department of Environment and Climate Change 2009: 12). The GBMWHA is significant for its biological and habitat diversity for numerous reasons, among which are the 67 cave invertebrate taxa found in the Jenolan Caves (one of the richest recorded in temperate Australia) (Department of Environment and Climate Change 2009: 10). The scenic landscape, with extensive caves, also has outstanding aesthetic value and is responsible for a large number of visitors to the Reserve each year (Department of Environment and Climate Change 2009: 17).

The GBMWHA represents a major geological feature of eastern Australia. It is a dissected upland plateau extending from the Southern Tablelands in the south to the Hunter Valley in the north, and from the Central Tablelands in the west to the Cumberland Plain in the east. Numerous narrow gorges and steep ridges have been eroded into the plateau surface during the westward incision of eastward-flowing streams. Narrow belts of Silurian limestone are a particularly significant component of the folded metasediments, producing the karst landscapes of Jenolan Caves, Colong, Tuglow, Little Wombeyan, Billys Creek, Church Creek and Blue Rocks in the Capertee Valley. The Strategic Plan notes several objectives relating to the protection of the GBMWHA's geodiversity, including developing infrastructure and maintenance regimes at Jenolan Caves to protect the karst environment, and finalising and implementing the Jenolan Karst Conservation Reserve Plan of Management (Department of Environment and Climate Change 2009: 30-31).

With regards to management of the GBMWHA, the Strategic Plan outlines strategies to retain its significant values. Whilst the World Heritage values of the GBMWHA relate to its natural values of Outstanding Universal Significance, other values are considered in the plan, including its historic values. The following objectives were specified for the GBMWHA's cultural heritage:

> *To identify, formally recognise and protect the cultural heritage values of the GBMWHA and*
>
> *To manage the GMBWHA jointly with local Indigenous people. (*Department of Environment and Climate Change 2009: 32).

The following strategies were outlined to achieve these objectives:

6.1 Continue and further develop close consultation with local Aboriginal peoples through the Living Country Aboriginal Co-management Project and the Central Coast / Hunter Range Region Co-management Committee.

6.2 Through the Mapping Country Project and in partnership with local Aboriginal communities, appropriately document the Indigenous cultural values of the GBMWHA.

6.3 Ensure valid native title is recognised and Indigenous Land Use Agreements negotiated, consistent with Australia's obligations under the World Heritage Convention and the restrictions on land use imposed by law.

6.4 Through the Living Country Co-management Project, prepare and implement agreed GBMWHA Indigenous heritage strategies, consistent with government and agency cultural heritage policies (e.g. Cultural Heritage Conservation and Cultural Heritage Community Consultation Policies).

6.5 Investigate the feasibility of establishing an Aboriginal employment / capacity-building program and develop strategies for working towards Aboriginal co-management of the GBMWHA reserves.

6.6 Research, record and assess the significance of the cultural heritage values of the GBMWHA against State, National and World Heritage listing criteria and seek formal recognition as appropriate.

6.7 Encourage cultural heritage research projects which assist with the protection and management of the GBMWHA's cultural heritage values.

6.8 Emphasise the importance of Indigenous culture and history, by identifying suitable Aboriginal words for naming / co-naming the GBMWHA and its reserves.

6.9 Ensure recognition of non-Aboriginal heritage values, including art inspired by the landscape, relationships between people and the environment, early conservation campaigns, built heritage, and recreational activities and infrastructure.

(Department of Environment and Climate Change 2009: 32-33).

The plan also recognises and aims to protect the landscape, natural beauty and aesthetic values of the GMBWHA. To do this it includes the following strategies:

7.1 Research, record and assess the significance of the natural beauty and aesthetic values of the GBMWHA against State, National and World Heritage listing criteria and seek formal recognition as appropriate.

7.2 Ensure that management activities and visitor use within and adjacent to the GBMWHA have minimal impacts on the area's scenic and aesthetic values.

7.3 Improve visitor identification of the GBMWHA as a region, develop a sense of arrival at entry points, and ensure development of visitor facilities / interpretation of appropriate character, design and construction.

7.4 Ensure that the impact of new developments within and adjacent to the GBMWHA on the area's scenic and aesthetic values are considered, including any adverse impacts associated with lighting.

7.5 C Continue to work with the relevant agencies, aviation industry and military to implement and monitor the existing Fly Neighbourly program to ensure that any impact of aircraft on the

GBMWHA (especially wilderness areas), park visitors and neighbouring communities is minimised.

7.6 Seek the establishment of a Restricted Area under the Air Services Regulations to provide statutory restrictions on tourist flights over the GBMWHA.

7.7 Work with local government authorities to introduce appropriate development controls for lands adjoining and within, scenery catchments of the GBMWHA.

(Department of Environment and Climate Change 2009: 34).

The plan provides the following summary of Major Desired Outcomes for Cultural Heritage and Landscape Natural Beauty and Aesthetic Values:

- *The cultural heritage values of the GBMWHA are retained and better understood, and that their significance is formally recognised at State, National and World Heritage level as appropriate.*
- *The natural beauty and aesthetic values of the GBMWHA are identified, better understood and their significance is formally recognised at State, National and World Heritage level as appropriate.*
- *Any adverse impacts on the natural beauty and aesthetic values are prevented, eliminated, or at least minimised.*
- *Recreational and tourist overflights do not interfere with the natural quiet, biodiversity and GBMWHA aesthetic values.*
- *Adjacent lands are managed so as to retain the landscape values of the GBMWHA.*

(Department of Environment and Climate Change 2009: 40-41).



Plate 4.3: Jenolan Caves House. (Source: Department of Environment and Climate Change 2009: 14)

4.3 Heritage Impact Statement of proposed upgrade of walking tracks and other visitor facilities around Blue Lake, Jenolan Caves

In March 2020, Betteridge Consulting Pty Ltd was engaged by the Jenolan Caves Reserve Trust (JCRT) to prepare a Heritage Impact Statement (HIS) for the proposed upgrade to the existing walking track around Blue Lake and to introduce new facilities to make the Lake and its environment more attractive and accessible. In additional to the walking track upgrade, the retaining wall supporting Jenolan Caves Road between the De Burgh Bridge and Diesel House was considered by the assessment, as it required stabilisation and shotcrete was proposed as a replacement to the wall (Plate 4.4).

After a detailed consideration of the landscape heritage values associated with the retaining wall, Betteridge Consulting concluded that changes to the views of Blue Lake and its immediate environment would be affected by the proposed works. However, the potential impact could be mitigated through sympathetic design, materials and surface finishes. The initial proposal for shotcreting was for a colour that was inconsistent with the predominantly grey tones of the limestone surrounds. It was therefore recommended that the detailed design of the landscaping be subject to further approval by the NSW Heritage Council.

To determine an appropriate design and treatment for the wall, Transport for NSW undertook extensive consultation with NPWS, Heritage NSW, JCRT, Oberon Council, Jenolan Caves Road Steering Committee and representatives of the GMBWHA over a number of years. Once the design and treatment for the wall were resolved, a S.60 Approval for the Slope Stabilisation Project (Slope 17550), Jenolan Caves Road, Jenolan was issued by the NSW Heritage Council on 3 December 2020, with the following conditions.

SHOTCRETE FINISH TO MATCH ADJACENT NATURAL ROCK FINISH

2. *The shotcrete colour and sculpted finish must match, in accordance with the RMS Shotcrete Design Guidelines (June 2005), the natural rock colour, geological pattern and texture of the rock outcrops and cuttings at Jenolan Caves near and adjacent to the site. The overall appearance of the mock rock finish must be unobtrusive in the context of the local rock outcrops, cutting and adjacent slope faces.*

SHOTCRETE TEST PANELS

3. *Prior to the first application of shotcrete on the project, at least three test panels must be prepared by the nominated nozzle operators and submitted to the Principal and nominated heritage consultant for approval. Test panel size shall be at least 750 mm x 750 mm with an applied shotcrete thickness of the sculpted layer, showing both the colours and texture proposed to be used. The Contractor shall demonstrate the method and approach in achieving a realistic, neat and unobtrusive sculpted joint against the adjoining slope face.*



Plate 4.4: View of an Artistic impression of the proposed shotcrete to replace the existing retaining wall on the boundary of Blue Lake, Jenolan Caves (Source: Betteridge Consulting, 2020: 35).

4.4 Two Mile Slope Rehabilitation, Jenolan Caves Road: Statement of Heritage Impact

MTS Heritage prepared a SoHI for proposed remediation works to a failed section of slope along the Two Mile section of Jenolan Caves Road. The failure occurred during heavy rain located near Caves House within the Grand Arch Precinct. The location of the slope failure was highly visible from Caves House and other vantage points from the northeast and east. Day visitors and overnight visitors would be able to view the slope from both the downstairs windows in the dining room and from the upstairs windows in the guest rooms. As a result, the proposed works were assessed as potentially having a significant visual impact.

Transport for NSW considered five (5) options to remediate the slope. These included: gabion wall or other type of retaining wall; soil nails and shotcrete; soils nails and shotcrete hidden by architectural panels or other suitable covering; regrading of the slope and soil nails with mesh and erosion mat. Due to the multiple hair-pin turns on the 2-Mile descent and its narrow road width, access for certain construction access was limited and, due to the height of the slope and its soil composition, excavation for terracing poses a considerable risk of de-stabilising the slope further. As a result of these constraints, the geotechnical advice concluded that soil nails and shotcrete was the only viable solution.

As the failure site was located in an area that would be highly visible, a 'mock rock' finish was proposed to the shotcrete finish. This was chosen as it would blend into the existing environment and match the rock face present nearby. Consultation was undertaken with Heritage NSW to discuss the proposed shotcrete finish. It was agreed that the mock rock finish would likely be the most appropriate solution, with Heritage NSW stipulating that Contractors with prior experience with the mock rock finish be used, and that test panels be produced that demonstrate the colour and finish. A S.60 Approval was granted for these works, however, the works have been delayed due to the recent slope failures and difficulty accessing the slope with machinery.

5 Site Inspection

An inspection of the subject site was undertaken by Chris Lewczak (Principal Heritage Consultant, Mountains Heritage) on 1 November 2023. The aim of the survey was to inspect each of the slope failures on the Two Mile section of Jenolan Caves Road to understand the views, vistas and setting of Caves House Precinct. It should be noted that photographs were taken at each of the slope failure sites along Jenolan Caves Road. It should also be noted there are no locations along the Two Mile section that allows vehicles to stop to view the Grand Arch Precinct along this route. That is, there are no parking or pull over areas for visitors to admire views or access lookouts.

5.1 Location and topography

The failed sections along the 'Two Mile' section of Jenolan Caves Road are situated within mountainous terrain, locally characterised by an east facing slope on which the road winds down to reach the Jenolan Caves system. The natural slope angles adjacent to these failure sites are generally in excess of 40 degrees (GHD July 2023).

Vegetation at, and surrounding, each of the slope failure sites typically comprises grass and shrubs with scattered semi mature to mature eucalyptus and other native trees down the slopes.

5.2 Survey results

Observations made during the site inspection for each slope failure are presented in the following subsections. These include an assessment of culverts and views toward the Grand Arch Precinct.

Failure Sections 1 and 2

Failure Sections 1 and 2 are located within close proximity to one another. Failure Section 1 is located between Project Chainage 320 and 340 and Failure Section 2 is between 380 and 405 (Plate 5.2). The failure extends from the road down the slope approximately 75 m long, 7 m wide and 2.2 m high on the slope (Plate 5.3:).

There are two culverts in this location. The first is at Failure Section 1, known as Culvert 1, is a 300 mm concrete culvert that captured water on the upslope side of the road via a rough formed swale drain (Plate 5.5). There is a concrete headwall on the downslope side, but no scour protection at the outlet. The culvert has completely collapsed and does not function .

The second culvert is located at the base of the slope failure. This culvert, known as Culvert 1A, is a 600 mm concrete culvert with a roughly formed inlet, and a concrete headwall on the downslope outlet. There is no scour protection or other water directing infrastructure on the downslope. Material from the upslope side, including from the failure section, has blocked this culvert.

From Failure Section 1, there is no view of the Grand Arch Precinct, only a partial view to Carpark 2 which is located above and to the north of Caves House in the Grand Arch Precinct (Plate 5.4:). At Failure Section 2 there is a partial view of the top of Carlotta Arch only. There is no view of Caves House due to the slope and vegetation that obscures this view.



Plate 5.1: Extent of the gully failure at Failure Section 1 (View to north) (Source GHD 2023)



Plate 5.2: View along Jenolan Caves Road approaching Failure Section 1 and 2 (view to northeast)



Plate 5.3: View from Failure Section 1 towards the Jenolan Caves House Precinct. Note – only Carpark 2 is visible from this failure location (lefthand side of photograph) (view to south).



Plate 5.4: View from Failure Section 2 towards the Grand Arch Precinct. Only the top of the Carlotta Arch can be seen from this location (view to south).



Plate 5.5: Existing swale drain and culvert entry towards the collapsed Culvert 1 (view to east)(Source: GHD 2023a).

Failure Section 3

Failure Section 3 is located between Project Chainage 480 and 500. This failure is located below the road and occurred in the location of an existing 600 mm culvert. The culvert appears to be a modern ceramic culvert with no header wall. There is a rough stone embankment retaining wall located immediately below the road, sitting above the culvert outlet. The culvert has collapsed in sections below the road and is completely blocked (Plate 5.6).

There is no view directly to the Caves House Precinct from the section of road above this failure. Only a partial view of the northwestern top of Carpark 2 can be seen (Plate 5.7).



Plate 5.6: View looking downhill towards Failure Section 3 along Jenolan Caves Road (view to north)



Plate 5.7: View from Failure Section 3 towards the Grand Arch Precinct (view to east).



Plate 5.8: View of the blocked Culvert 3 and the rough stone retaining wall above (View to north) (Source: GHD, 2023a)

Failure Section 4

Failure Section 4 is a long singular failure located between Project Chainage 650 m and 745 m. The failure is on the downslope below this section of road. The failure appears to have impacted the outer edge of the road and safety barrier, as well as the slope below it (Plate 5.9).

From this location the southern end of Caves House in the Grand Arch Precinct is visible. This includes the roof of Caves House and St Trinnians, the Gate House roofs located immediately behind it, and the large two storey Mountain Lodge behind it. Other houses that are visible in this location are "the Neck" and the Engineers House (Plate 5.10).



Plate 5.9: General View looking uphill along Jenolan Caves Road of Failure Section 4 (view to west).



Plate 5.10: View from Jenolan Caves Road immediately above Failure Section 4 towards Grand Arch Precinct (view to southeast).

Failure Section 5

Failure Section 5 is located between Project Chainage 925 and 1015. This 90 m failure is located immediately below the Jenolan Caves Road in this section. From the southern end of the failure site, near Chainage 925, there is a partial view of the roofs of the Caves House Precinct through the vegetation present on the slope (Plate 5.11).



Plate 5.11: Partial view of roofs in Caves House Precinct visible from Failure Section 5 (view to southeast).

Failure Section 6 and 7

These two failure sections are located close to each other on one of the hairpin turns on Jenolan Caves Road. Failure 6 is located on the lower portion of the road after the sharp turn, between Project Chainage 1215 and 1300. Failure Section 7 is located immediately above between Project Chainage 1340 and 1445. Both slope failures have caused damage to the outside edge of the existing road (Plate 5.12).

Both slope failures have a similar view towards the Caves House and the Grand Arch Precinct. The Precinct is not visible from either failure. The view to the Caves House and the Grand Arch Precinct is obscured by the local topography and vegetation on the slopes (Plate 5.13). The houses and RFS building on Burma Road, to the east of Jenolan Caves Road and the Grand Arch Precinct, are visible from both locations (Plate 5.14).



Plate 5.12: View of Slope Failure 6 (lower road) and 7 (upper road) on Jenolan Caves Road (view to southwest).



Plate 5.13: View towards the Grand Arch Precinct from the lower portion of Failure Section 6 (view to south).



Plate 5.14: View from the northern ends of Failure Sections 6 and 7 towards the houses and RFS buildings on Burma Road (view to southeast).

Failure Section 8

Failure Section 8 is the furthest of the failure sections along the Two Mile section of Jenolan Caves Road and is the most uphill. This failure is located between Project Chainage 1690 and 1730 just after one of the hairpin corners of the road (Plate 5.15). The failure is on the lower road, close to the hairpin turn. The slope in this section is covered with mature and semi-mature trees. From this elevated position, and the vegetation that is present, there is no view to the Grand Arch Precinct (Plate 5.16).



Plate 5.15: General view along Jenolan Caves Road at the location of Failure Section 8 (View to east).



Plate 5.16: General view from Failure Section 8 towards Caves House Precinct (view to southeast).

5.3 Views and setting from the Grand Arch Precinct

Given the location of the failure sections in relation to the Grand Arch Precinct, several locations were surveyed to understand if any of the slope failure sections are currently visible or could potentially be visible after works to stabilisation each failure section.

A pedestrian survey around the Grand Arch Precinct was conducted to identified potential locations where works to the failure sections may be most visible from. This included the:

- Western end of Caves House;
- Entrance into Caves House;
- Ticket Sales and meeting point location for the caves tourist walk;
- General views from Carpark 1.

The direction that the photos were taken are shown in Figure 5.1.

Western Wing of Caves House

The view from the western end of Caves House looks across the pedestrian walkway from Carpark 1 and up towards the section of the Two Mile Access where Failure Section 4 is located. Jenolan Caves Road and the failure section are not visible from this location. The steep topography and the existing vegetation, including trees, shrubs and other grasses conceals or obscures the location of this failure section (Plate 5.17 and Plate 5.18:).

Previous slope failures near Caves House, including a repaired section with gabion walls and a separate section that has been approved to be repaired, are highly visible from this location. This is because they are at the base of the slope, immediately at the Caves House site. Given the steep terrain, it is possible that without any vegetation present, the failure site would still not be visible.

Figure 5.1: Photographs taken from significant view locations within the Grand Arch Precinct.



Plate 5.17: View from the western end of Caves House up towards Failure Section 4. Note – failure in the foreground was previously assessed by Mountains Heritage (MTS Heritage 2021) and is not the subject of this assessment (see Figure 5.1; view to east).



Plate 5.18: View from the western end of Caves House up towards Failure Section 4 (see Figure 5.1; view to northwest).

Entrance into Caves House

The entrance into Caves House is located further towards the centre of the Grand Arch Precinct. The front of the house faces northwest and is accessed via an access road located along its frontage. Standing on the access road in front of the main house entrance the view back towards the north is channelled between the west wing of the house and the natural hill slope and retaining walls to the east (Plate 5.19). The view towards Jenolan Caves Road and the areas where the failure sections are located is obscured by the existing vegetation and general surrounding topography (Plate 5.19 and Plate 5.20).



Plate 5.19:View from in front of the main entrance to Caves House looking west towards Jenolan Caves Road and the Failure Sections (see Figure 5.1).

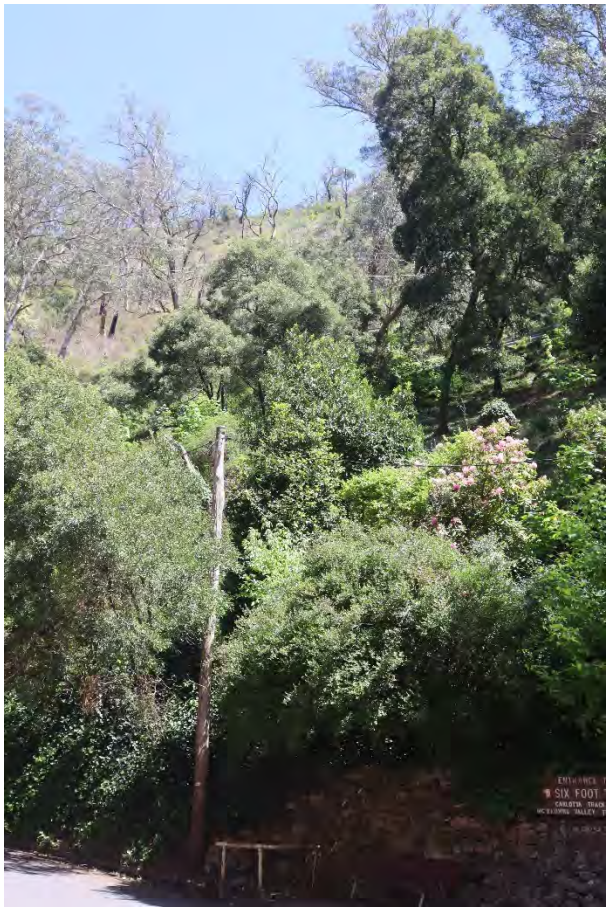


Plate 5.20: View from in front of the main entrance to Caves House looking north towards Jenolan Caves Road and the failure sections (see Figure 5.1).

Ticket sales and meeting point location for the caves walk

This location is situated to the northeast of Caves House, in the middle of the Grand Arch Precinct. This locality was investigated for potential views to the failure sections as it is where most people congregate when waiting for the various tours to commence.

From this location, the lower portion of Jenolan Caves Road can be seen clearly towards the north, as can a small section of Jenolan Caves Road. The section of Jenolan Caves Road that is visible is between Failure Section 3 and Failure Section 4. The mature trees and other vegetation conceal the views to both Failure Sections (Plate 5.21:).



Plate 5.21: View from in front of the Ticket Office Building in Caves House Precinct looking north towards Jenolan Caves Road. A portion of the upper section of Jenolan Caves Road near to Failure Section 3 and 4 is only partially visible (see Figure 5.1; view to northwest).

General views from Carpark 1

Carpark 1 is located to the northwest of Caves House and is a central point where visitors to Jenolan Caves assemble. The carpark is located between Surveyors Creek to the south and hill slope to the north. Visitors walk along the southern side of the carpark to a set of stairs that leads to the Grand Arch Precinct. From the top of the stairs, at the entrance to the carpark, Jenolan Caves Road is not visible. The steep rise of the slope and the existing vegetation hides the road, including the failure sites (Plate 5.22:).



Plate 5.22: View from the exit of Carpark 1 and the start of the stairs that lead to Caves House Precinct (see Figure 5.1; view to north).

5.4 Potential for historical archaeological relics

Following a review of the 2017 CMP and observations on the ground at each failure section, the potential for historical archaeological relics within the subject site is considered to be low to nil. Whilst the Two Mile section of road to Caves House was completed in 1879 by the (then) Public Works Department, the road remained a dirt track until the mid-1980s, when it was bituminised. The remains of a rough stone retaining wall are present above the ceramic culvert at Failure Section 3. However, this retaining wall is contemporary with the culvert, acting as a head wall, and is not considered to be original or early fabric. Given the steep slope on the side of the hill where the road has been constructed, there is no potential for other structures to be present in these areas.

6 Heritage Significance

This section presents relevant significance assessments prepared for State, National and World heritage listings.

6.1 Significance at a Precinct level - Grand Arch Precinct

The following Statement of Significance was included for the Grand Arch Precinct as part of the 2017 CMP (Urbis, 2017: 150-151).

The Grand Arch Precinct, as the focus of the Jenolan Karst Conservation Area and a principal component of Australia's environmental heritage, is of high heritage significance. This includes:

- *The natural significance of the valleys and watercourses of the Jenolan River system, encompassing landscape, flora and fauna;*
- *The presence of one of Australia's largest, most beautiful and accessible inter-connected cave systems of the foremost geological and speleological interest;*
- *The historic and cultural importance of the precinct as the focus of a Reserve founded and developed by a Colonial Government, prior to the establishment of the World's first "national park", to facilitate both the protection and enjoyment of a natural wonder.*

Its development for recreation centred on the inspection of the cave system and the enjoyment of the surrounding natural environments, the Precinct has acquired:

- *Historic and aesthetic significance through the development of a complex of buildings and settings important for their architectural design and association with a prominent architect, Col Walter Liberty Vernon and his successors in the NSW Government Architect's Office;*
- *Historic significance for the individuality of the Precinct's role, and its survival as the last, substantially intact example of its kind, the government-owned and managed public guest house;*
- *Technical and research significance for the innovative structural methods employed in building some components, and the relics of early hydro-electric power and electric lighting installations, thought to be the first applications to specific use of their kind in the World;*
- *Social and historical values for its reflection of the changing interest in, and attitude to, the natural environment and the pursuit of recreational activities within its context.*

The Grand Arch Precinct has historical significance at State level as the primary focus of the Visitor experience of the caves since the camping establishment set up by Jeremiah Wilsons in 1879. The precinct has local significance as the focus of both explorers and administrators who have been key to developing appreciation and protection for the Caves. The Grand Arch Precinct contains the most significant building in the Reserve, Caves House, which developed primarily between 1896-1923 under the direction of prominent Government architect Walter Liberty Vernon. Caves House is considered to have aesthetic significance at a State level for its internal and external attributes, and particularly for its skilful siting in the valley. The precinct is rare as a remote Government run guest house in a spectacular park setting, and is generally representative of the development of the site as the appreciation of the Caves has drawn visitors to the site.

Buildings or structures in the precinct considered to be of state significance for the respective historical, aesthetic or technical values are Caves House (1), the Seismograph equipment (13), the Engineers Cottage (17), the Blue Lake and Weir (38, L08), De Burgh's Bridge (39), the site of the

Vertical Steam Dynamo (E05), the Leffel Wheel (E06), remnants of the first Sewerage System (E07), and the Terrace Gardens (L04).

There are a number of supporting buildings, structures and landscaping elements dating from the 19th century and the 20th century which are considered to be of local significance and which contribute to the significance of the Reserve and the collective state significant values of the Grand Arch Precinct, including the Old Post Office (18), the Boilerhouse (2), the Old Refrigeration House (3), the Gatehouse (6), the Diesel generator House (7), The Nest (16), the Hill Flats (19), former School (25), the Guides Office (Building 28), Substations 1 and 2 (33 and 34), Old Diesel House (37) two Holm Oaks (L01 and L02), Group of Chinese Weeping Cyprus (L03), the Western Red Cedar (L05), and The Big Tree (L06). (L06).

6.2 Significance at a State level – Jenolan Caves Reserve

Significance Assessment Criteria

The significance of heritage items listed on the NSW SHR is assessed against specific criteria specified in the Heritage Act. These are as follows:

Criterion (a)	*an item is important in the course, or pattern, of NSW's cultural or natural history (or the local area);*
Criterion (b)	*an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the local area);*
Criterion (c)	*an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area);*
Criterion (d)	*an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons (or the local area);*
Criterion (e)	*an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the local area);*
Criterion (f)	*an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the local area); and*
Criterion (g)	*an item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places or cultural or natural environments (or the local area).*

Significance Assessment

The following significance assessment for Jenolan Caves Reserve is reproduced from the NSW SHR Listing (See - https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051578)

Criterion (a) - an item is important in the course, or pattern, of NSW's cultural or natural history (or the local area);

Jenolan Caves Reserve is of state significance for its ability to demonstrate the significant historical activity of identifying and conserving the natural resources of NSW - in this case, the caves and karst landscapes that have developed as important scientific and tourist destinations throughout the late 19th and 20th centuries. The Reserve is highly significant as the first public reserve set aside in NSW for the protection of a natural resource - in this case, the caves, and as such predates the creation of The National Park in 1879. The caves hamlet illustrates the significant human activity of providing

accommodation for travellers and tourists since the 1890s in romantic buildings especially designed for this purpose by the Government Architect (HO).

Criterion (b) - an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the local area);

Jenolan Caves Reserve is significant for its associations with Government Architect Walter Liberty Vernon, who designed much of Caves House. Although only the first or 1897 wing was built during his tenure, his plans were respected and adapted by subsequent government architects so that the original style and setting for the building has been largely maintained to the present day (HO).

Criterion (c) - an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area);

Jenolan Caves Reserve is of state significance for the highly regarded aesthetic qualities of the caves and cave formations, reflected in cave and formation names such as Aladdin, Orient and Temple of Baal caves and Gem, Arabesque, Angel's Wing and Pool of Reflections formations; for the ability of the caves to demonstrate technological developments such as the first use of electric cave lighting in the 1880s, and the first development of hydro-electric power in Australia. The setting of the caves hamlet in the Jenolan Valley, with the tiny hamlet and picturesque Caves House almost dwarfed by steeply rising cliffs on all sides, the entrance into the hamlet through the fortress-like Grand Arch, and the distinctive Blue Lake formed by the weir for the hydro-electric scheme, all combine to form a landmark landscape of great beauty and distinctiveness (HO).

Criterion (d) - an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons (or the local area);

Jenolan Caves Reserve is of state significance for its associations with many groups of people, three of which have been particularly identified – tourists, speleologists (that is, those who study caves and engage in caving) and guides. From the 1860s travellers and cavers have visited the Reserve, and cavers have continued to explore and make known to the public more of the caves, their connecting passages and the often unique plants and animals that inhabit this subterranean and lightless world. The caves are also important to the community of caretakers and guides who for nearly 150 years have guided visitors through the caves, shown them the beauty and wonders of the caverns, interpreted and educated people about the geological history of eastern Australia, and made the caves hamlet their home (HO).

Criterion (e) - an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the local area);

Jenolan Caves Reserve is of state significance for its ability to yield information on the geological history of NSW and of the Australian continent, as the benchmark karst landscapes contained within the NSW reserve system, and for the archaeological potential of the hamlet area to provide evidence of the early period in the development of tourism in NSW (HO).

Criterion (f) - an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the local area)

The Jenolan Caves Reserve is of state significance for the number of rare and uncommon flora and fauna species to which it is home, especially within the caves; for containing the greatest diversity of cave invertebrates in NSW; and for the evidence it can demonstrate of the development of tourism, especially mountain and caving tourism, for over a century and a half in NSW (HO).

Statement of Significance

Jenolan Caves Reserve is of state significance for its historical, aesthetic, research and rarity values. The caves and karst landscapes developed as important scientific and tourist destinations throughout the late 19th and 20th centuries, and the Reserve is highly significant as the first public reserve set aside in NSW for the protection of a natural resource - in this case, the Jenolan Caves.

The Reserve is highly regarded for the aesthetic qualities of the caves and cave formations, reflected in cave names such as Aladdin and Gem Cave; for the ability of the caves to demonstrate technological developments such as the first use of electric cave lighting in the 1880s, and the first development of hydro-electric power in Australia. The setting of the caves hamlet in the Jenolan Valley, with the tiny hamlet and picturesque Caves House almost dwarfed by steeply rising cliffs on all sides, the entrance into the hamlet through the fortress-like Grand Arch, and the distinctive Blue Lake formed by the weir for the hydro-electric scheme, all combine to form a landscape of great beauty and distinctiveness.

The Reserve has the ability to yield information on the geological history of NSW and of the Australian continent, and for the archaeological potential of the hamlet area to provide evidence of the early period in the development of tourism in NSW.

The number of rare and uncommon flora and fauna species to which it is home, especially within the caves; and the evidence it can demonstrate of the development of tourism, especially mountain and caving tourism, in NSW, add to the significance of the Jenolan Caves Reserve (HO).

The geomorphic history of the Jenolan Caves system is extremely complex, the cave system contains an exceptionally diverse variety of karst and cave types illustrating the full range of processes and products from incipient, scarcely perceptible depressions through to multistage cave developments and decayed remnant features. The McKeowns Valley, north of Blue Lake contains the finest such assemblage in Australia. The Jenolan River valley is one of the most outstanding fluviokarst valleys in the world. The range and diversity of the karst and decoration, including a remarkable diversity of mineral species, is varied, profuse and equal to the finest in the world. The Jenolan Caves and surrounding areas contains a very diverse assemblage of morphologies and mineral species. There is evidence in these features of the influences of palaeo-landscapes.

The contribution to the formation of the landscape of structural influences, lithological influences, and drainage patterns is the source of considerable scientific and educational interest at Jenolan. The geomorphology of Jenolan includes a variety of non karstic phenomena that are important because of their relationship with the karst. Because these features lie adjacent to, and in some cases over, the karst they give considerable insight into the formation of the karst. A large number of invertebrate fossils have been discovered in the limestone of the Jenolan Caves. These include corals, stromatoporoids, algae, brachiopods, gastropods and straight nautiloids. Subfossil remains of many vertebrates are also found in the caves.

The caves provide shelter and habitat for a number of rare species including the sooty owl (TYTO TENEBRICOSA TENEBRICOSA) (rare in Australia) which roosts in the cave known as the Devil's Coach House and the Jenolan Caves Reserve supports a population of the brush tailed rock wallaby (PETROGALE PENICILLATA). This species is listed as vulnerable on Schedule 12 of the NSW National Parks and Wildlife Act. Also found in the caves is the opilionid arachnid (HOLONUNCIA CAVERNICOLA) which is known only from the Jenolan Caves system. The Caves Reserve contains three rare or endangered plant species. These are PSEUDANTHUS DIVARICATISSIMUS (3RC), GONOCARPUS LONGIFOLIUS (3RC), and GERANIUM GRANITICOLA (3RC). In the latter half of the 19th century the caves were recognised as perhaps the premier natural attraction in Australia. Although they no longer occupy this role, Jenolan remains one of the most important natural heritage areas in Australia. The caves are a very high profile natural feature in NSW. The Jenolan Caves area is widely

used as a research and teaching site for studying the geomorphology and processes involved in karst formation (RNE, 1978).

Jenolan is one of the most important areas of natural and cultural history in Australia. The area includes one of the largest and most beautiful interconnected cave systems in Australia and is an outstanding site of geological and speleological interest. The Jenolan River, Blue Lake and a system of intimate valleys and watercourses provide a magnificent setting for a distinctive range of native vegetation and fauna. The Caves Reserve was created in 1866, six years before the declaration of the world's first National Park. Since its reported discovery by James Whalan between 1838 and 1841 the area has attracted more than three million visitors. Caves House, and its associated outbuildings, adds to the area's cultural significance. The area also contains a number of important industrial relics, including Australia's first hydro-electric power station and the remnants of the first electric lighting of caves which was installed in the Chifley Cave in 1887 (National Trust of Australia, 1985).

6.3 National Heritage Values – Blue Mountains World Heritage Area

National Heritage List Assessment Criteria

To reach the threshold for the National Heritage List in Australia, a place must have 'outstanding' heritage value to the nation, as assessed by the Australian Heritage Council. This means that it must be important to the Australian community as a whole. There are nine National Heritage criteria against which the heritage values of a place are assessed.

a) *The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history;*
b) *The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history*
c) *The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history*
d) *The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:*
e) *a class of Australia's natural or cultural places; or*
f) *a class of Australia's natural or cultural environments;*
g) *The place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group*
h) *The place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period*
i) *The place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons*
j) *The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history*
k) *The place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.*

Significance Assessment – Official Values

The following significance assessment has been reproduced from the 2017 CMP (Urbis 2017: 148-149):

Criterion A - Events, Processes

This place is taken to meet this National Heritage criterion in accordance with subitem 1A(3) of Schedule 3 of the Environment and Heritage Legislation Amendment Act (No.1) 2003, as the World Heritage Committee has determined that this place meets World Heritage criteria (ix) and (x).

Criterion B - Rarity

This place is taken to meet this National Heritage criterion in accordance with subitem 1A(3) of Schedule 3 of the Environment and Heritage Legislation Amendment Act (No.1) 2003, as the World Heritage Committee has determined that this place meets World Heritage criterion (x).

Criterion C - Research

This place is taken to meet this National Heritage criterion in accordance with subitem 1A(3) of Schedule 3 of the Environment and Heritage Legislation Amendment Act (No.1) 2003, as the World Heritage Committee has determined that this place meets World Heritage criteria (ix) and (x).

Criterion D - Principal characteristics of a class of places

This place is taken to meet this National Heritage criterion in accordance with subitem 1A(3) of Schedule 3 of the Environment and Heritage Legislation Amendment Act (No.1) 2003, as the World Heritage Committee has determined that this place meets World Heritage criterion (ix)

Statement of Significance

The Greater Blue Mountains Area was inscribed on the World Heritage List at the 24th Session of the World Heritage Committee, held in Cairns from 27 November to 2 December 2000.

It is an area of breathtaking views, rugged tablelands, sheer cliffs, deep, inaccessible valleys and swamps teeming with life. The unique plants and animals that live in this outstanding natural place relate an extraordinary story of Australia's antiquity, its diversity of life and its superlative beauty. This is the story of the evolution of Australia's unique eucalypt vegetation and its associated communities, plants and animals.

The Greater Blue Mountains Area consists of 1.03 million hectares of mostly forested landscape on a sandstone plateau 60 to 180 kilometres inland from central Sydney, New South Wales. The property includes vast expanses of wilderness and is equivalent in area to almost one third of Belgium, or twice the size of Brunei.

The property, which includes eight protected areas in two blocks separated by a transportation and urban development corridor, is made up of seven outstanding national parks as well as the famous Jenolan Caves Karst Conservation Reserve. These are the Blue Mountains, Wollemi, Yengo, Nattai, Kanangra-Boyd, Gardens of Stone and Thirlmere Lakes National Parks.

The area does not contain mountains in the conventional sense but is described as a deeply incised sandstone plateau rising from less than 100 metres above sea level to 1 300 metres at the highest point. There are basalt outcrops on the higher ridges. This plateau is thought to have enabled the survival of a rich diversity of plant and animal life by providing a refuge from climatic changes during recent geological history. It is particularly noted for its wide and balanced representation of eucalypt habitats from wet and dry sclerophyll, mallee heathlands, as well as localised swamps, wetlands, and grassland. Ninety-one species of eucalypts (thirteen percent of the global total) occur in the Greater Blue Mountains Area. Twelve of these are believed to occur only in the Sydney sandstone region.

The property has been described as a natural laboratory for studying the evolution of the eucalypts. The largest area of high diversity of eucalypts on the continent is located in south-east Australia. The Greater Blue Mountains Area includes much of this eucalypt diversity.

As well as supporting such a significant proportion of the world's eucalypt species, the property provides examples of the range of structural adaptations of the eucalypts to Australian environments. These vary from tall forests at the margins of rainforest in the deep valleys, through open forests and woodlands, to shrublands of stunted mallees on the exposed tablelands.

In addition to its outstanding eucalypts, the Greater Blue Mountains Area also contains ancient, relict species of global significance. The most famous of these is the recently-discovered Wollemi pine, a "living fossil" dating back to the age of the dinosaurs. Thought to have been extinct for millions of years, the few surviving trees of this ancient species are known only from three small populations located in remote, inaccessible gorges within the nominated property. The Wollemi pine is one of the World's rarest species.

More than 400 different kinds of animals live within the rugged gorges and tablelands of the Greater Blue Mountains Area. These include threatened or rare species of conservation significance, such as the spotted-tailed quoll, the koala, the yellow-bellied glider and the long-nosed potoroo as well as rare reptiles including the green & golden bell frog and the Blue Mountains water skink.

6.4 World Heritage Values – Blue Mountains World Heritage Area

Criteria

To be included on the UNESCO World Heritage List, sites must be of outstanding universal value and meet at least one out of ten of the following selection criteria:

1. *To represent a masterpiece of human creative genius;*
2. *To exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;*
3. *To bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;*
4. *To be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;*
5. *To be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;*
6. *To be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria);*
7. *To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;*
8. *To be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;*
9. *To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;*
10. *To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.*

Retrospective Statement of Outstanding Universal Value

The Greater Blue Mountains World Heritage Area (GBMWHA) is a deeply incised sandstone tableland that encompasses 1.03 million hectares of eucalypt-dominated landscape. Spread across eight adjacent conservation reserves, it constitutes one of the largest and most intact tracts of protected bushland in Australia. It also supports an exceptional representation of the taxonomic, physiognomic and ecological diversity that eucalypts have developed: an outstanding illustration of the evolution of plant life. A number of rare and endemic taxa, including relict flora such as the Wollemi pine, also occur here. Its exceptional biodiversity values are complemented by numerous others, including indigenous and post-European-settlement cultural values, geodiversity, water production, wilderness, recreation and natural beauty. – (See http://whc.unesco.org/en/list/917/)

The Greater Blue Mountains Area (GBMWHA) (of which the subject site is part) was inscribed on the World Heritage List in 2000 as having outstanding value under criteria 9 and 10.

The Statement of Outstanding Universal Value notes:

> ***Criterion (ix):*** *The Greater Blue Mountains include outstanding and representative examples in a relatively small area of the evolution and adaptation of the genus Eucalyptus and eucalypt-dominated vegetation on the Australian continent. The site contains a wide and balanced representation of eucalypt habitats including wet and dry sclerophyll forests and mallee heathlands, as well as localised swamps, wetlands and grassland. It is a centre of diversification for the Australian scleromorphic flora, including significant aspects of eucalypt evolution and radiation. Representative examples of the dynamic processes in its eucalypt-dominated ecosystems cover the full range of interactions between eucalypts, understorey, fauna, environment and fire. The site includes primitive species of outstanding significance to the evolution of the earth's plant life, such as the highly restricted Wollemi pine (Wollemia nobilis) and the Blue Mountains pine (Pherosphaera fitzgeraldii). These are examples of ancient, relict species with Gondwanan affinities that have survived past climatic changes and demonstrate the highly unusual juxtaposition of Gondwanan taxa with the diverse scleromorphic flora.*
>
> ***Criterion (x):*** *The site includes an outstanding diversity of habitats and plant communities that support its globally significant species and ecosystem diversity (152 plant families, 484 genera and c.1,500 species). A significant proportion of the Australian continent's biodiversity, especially its scleromorphic flora, occur in the area. Plant families represented by exceptionally high levels of species diversity here include Myrtaceae (150 species), Fabaceae (149 species), and Proteaeceae (77 species). Eucalypts (Eucalyptus, Angophora and Corymbia, all in the family Myrtaceae) which dominate the Australian continent are well represented by more than 90 species (13% of the global total). The genus Acacia (in the family Fabaceae) is represented by 64 species. The site includes primitive and relictual species with Gondwanan affinities (Wollemia, Pherosphaera, Lomatia, Dracophyllum, Acrophyllum, Podocarpus and Atkinsonia) and supports many plants of conservation significance including 114 endemic species and 177 threatened species.*
>
> *The diverse plant communities and habitats support more than 400 vertebrate taxa (of which 40 are threatened), comprising some 52 mammal, 63 reptile, over 30 frog and about one third (265 species) of Australia's bird species. Charismatic vertebrates such as the platypus and echidna occur in the area. Although invertebrates are still poorly known, the area supports an estimated 120 butterfly and 4,000 moth species, and a rich cave invertebrate fauna (67 taxa).*

7 Impact Assessment

7.1 The Proposal

Prior to finalisation of the design, Transport for NSW investigated several options to remediate the failed slopes. These are outlined in the subsections below. Further details on the preferred option are provided. The detailed design for the preferred method has yet to be developed, however, the details presented in the options assessment have been used to assess its potential impact on the heritage significance of 'Jenolan Caves Reserve' and the broader GBMWHA.

Initial Options Assessment

A '*Design Options Report*' for the failed sections of the Two Mile Access section of Jenolan Caves Road was prepared by GHD for Transport for NSW (GHD 2023). The report presented a concept level design option to remediate the failed sections. The purpose of the report was to identify potential viable slope treatment and drainage options that would facilitate and improve drainage conditions to mitigate future impacts on inclement weather on the route.

This design report identified that the current road was constructed on a side fill embankment. That is, material from the upslope cut to form the road was pushed downslope to create a level bench. The conditions of the road, including the overly steep and poorly constructed embankments, along with the steep natural terrain, contributed to the slip failures. Coupled with this were erosion of up and downslope sections due to concentrated overland water flow paths.

Based on an understanding of the local geology, the construction of the current road and drainage, and the nature of the failures, three options were prepared by GHD. These were:

Option 1: A-Frame Micro Pile Wall.

This option involves the excavation of the failure site along the outside edge of the road that would also include some limited, localised, vegetation clearing. A series of grout filled hollow bar micro piles would be installed vertically and on a 30 degree angle back under the road to stabilise the slope. A capping beam and retaining wall would then be constructed above that would support the road safety barrier (Figure 7.1).

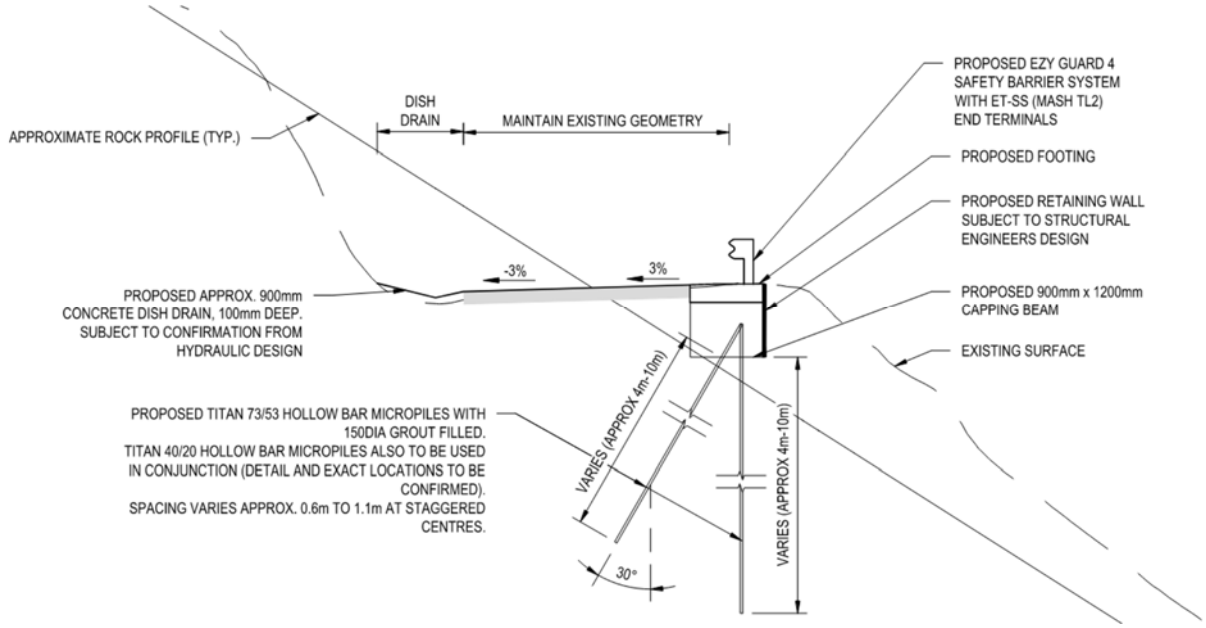


Figure 7.1: A-Frame Micro Pile design option (Source: GHD 2023). Two

Option 2: Soil Nail and Shotcrete.

This option would involve the installation of either solid bar or hollow bar system that would require 2 rows of 5 m long nails to be drilled in, followed by 6 rows of 4 m long nails. The nails would be horizontally and vertically spaced by 1.5 m. In total, it would be expected that up to 15 m of the failed slope section would be affected by this method. Existing vegetation within this localised area would need to be removed during construction (Figure 7.2).

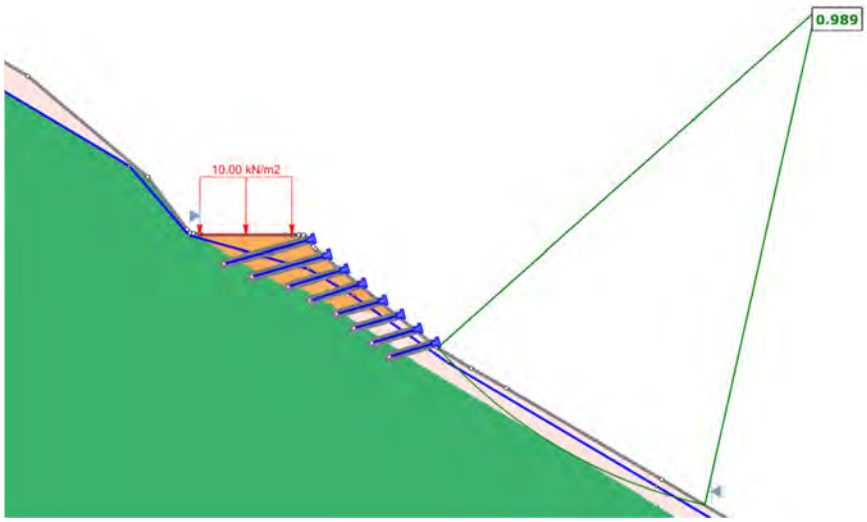


Figure 7.2: Typical construction of 8 rows of soil nails below the road at each Failure Section (Source: GHD 2023).

Option 3: Upslope Cutting

An option to perform an upslope cutting was presented, that would create a 4 m cut back into the existing slope at road level. This would effectively create a new road that would also include increased drainage infrastructure. This option would require extensive vegetation clearing of the area to be excavated, and above the new road wall.

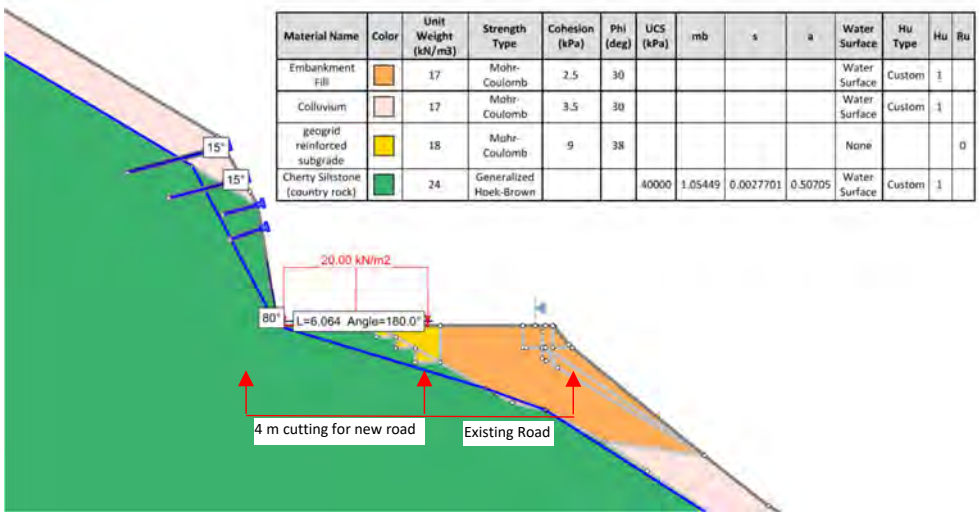


Figure 7.3: Upslope cutting option (Source: GHD 2023, additional annotations by MTS Heritage).

Based on the advantages and disadvantages of each option presented, GHD recommended that the A-Frame Micro Pile Wall was the most favourable permanent slope remediation option. This was because construction techniques would utilise conventional construction plant and structural elements. Environmental and aesthetic impacts were also considered to have limited impacts. This option, however, would require the road to be closed for a long period of time for the construction works to be completed. With the Two Mile section of Jenolan Caves Road being the only current access closure of this road was not considered viable until the Five Mile section was restored.

The soil nail option, as a permanent solution, was not considered to be optimal as it would have a larger environmental and technical impact. This would be due to the need to install the soil nails further down the slope than either of the other options. The impact area was originally estimated to be 20 m but has been further refined to a total impact area up to 15 m down the slope.

The upslope cutting was recommended above the permanent soil nail solution, as its construction could be completed using conventional construction equipment, however, larger plant machinery may be needed depending on the geotechnical investigations. Upslope cutting was not preferred over the A-Frame Micro Pile as the design may change during construction, and the impact on the environment was assessed to be significant.

A fourth option was also discussed as a temporary option to ensure the stability of the Two Mile access while the main, Five Mile access, is being rebuilt. Option 2a was a modified soil nail option with shotcrete in a similar configuration as described above in Option 2. This would be considered a short to medium term fix that could be installed with the least disruption to the road. This option would ensure the road remains in operation while the Five Mile access is being built.

Since completion of the Concept Options assessment, Transport for NSW have decided to further pursue a short to medium term solution to ensure the Two Mile Access on Jenolan Caves Road remains in operation while the Five Mile Access is being rebuilt. This option is based on Option 2, which would include up to 8 rows of soil nails, spaced horizontally and vertically 1.5 m apart. This option would also require localised clearing of vegetation along each slope failure, and up to 15m down slope from the road. The works area would also include shotcrete over the soil nails.

Failure Section 1

Failure Section 1 requires its own design for restoration because it is a 70 m vertical failure. The works would include the importing of engineered fill that would be shaped and regraded where possible to integrate with the surrounding slope. The area to be shaped and regraded is approximately 7 m wide, which is the width of the current failure. At the centre of the gully slope, rock mattresses, approximately two metres wide, would be installed for the entire 70 metre length of the gully failure (Figure 7.4). Land located on engineered fill outside the rock mattresses would be left to revegetate naturally. Active revegetation of this area may be required if additional access tracks are required for the restoration works.

These works would also require the replacement of the culvert located above the road, and associated drainage improvements. These are discussed separately below.

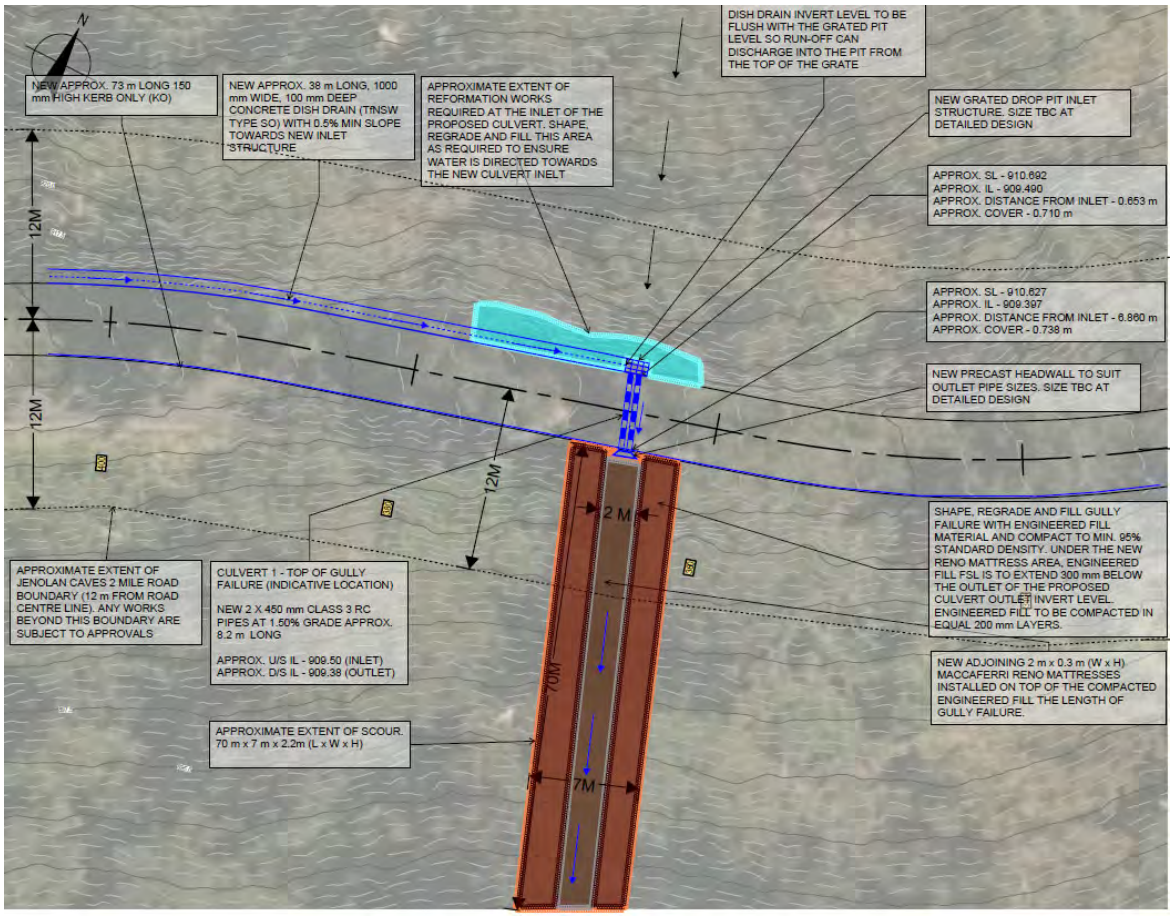


Figure 7.4: Proposed design of restoration works at Failure Section 1 (source GHD 2023 in prep).

Culvert Upgrade

Three of the existing culverts would be required to be upgraded as part of the works to enable water to pass through the site and avoid flows running over the slopes (GHD 2023b in prep). The three culverts that require upgrading are as follows:

- Culvert 1: This collapsed 300 mm diameter culvert would be replaced with two 450 mm diameter concrete culverts in a similar location. The existing drainage would be improved by installing an approximately 40 m long dish drain between the road and upper slope; and a 70 m kerb along the edge of the road on the downslope side to redirect water captured by infrastructure on the upslip side towards other sections of the slope.
- Culvert 1a: This culvert is located at the base of Failure Section 1. The existing culvert is a 600 mm diameter concrete pipe and would be replaced with 2 x 1.05 m diameter culverts. The works would also include an improvement to a 35 m section of the existing dish drain upslope of the culvert inlet and reshaping of the area around the inlet pipe. An additional rock lined swale drain, approximately 30 m long and 4 m wide would be constructed from the outflow of Culvert 1a on the downslope side to transport water towards Jenolan Caves River.
- Culvert 3: The existing 600 mm concrete culvert would be replaced with 2 x 750 mm diameter concrete culverts in a similar position. The works would include a 35 m long dish drain upslope of the intake along the upslope side of the road and reshaping of the inlet pit to direct water into the culvert. Approximately 60 m of concrete kerb would be installed along the downslope side of the road to redirect water not captured by infrastructure on the upslope side to other infrastructure.

7.2 Impact Assessment – State Heritage Values of Jenolan Caves Reserve

The significance of 'Jenolan Caves Reserve', as outlined in the SHR Listing and in the 2017 CMP, lies in its historical, aesthetic, research and rarity values. The landscape is unique, combining visually sensitive natural features with elements of the built environment. Whilst the primary significance of the landscape lies in its karst system and its flora and fauna, the cultural landscape of walking tracks, access roads, buildings and archives contribute to its significance (Urbis, 2017: 36). Caves House, in particular, is a dominant building in this landscape providing a distinctive 'European Resort' atmosphere (Urbis, 2018: 43). Due to the steep terrain and topography, Caves House is highly visible from multiple vantage points, particularly from vantage points within the Grand Arch Precinct.

The significance of the Reserve's cultural landscape is recognised by the 2017 CMP and various policies have been created to conserve and protect its landscape heritage values. These policies provide guidance on the repairs and maintenance of cuts, embankments, retaining walls, weirs and paths. As outlined by Policy 19, early original historic cuts and embankments should be retained and conserved, while complying with building codes, safety and engineering standards. Repairs should be undertaken with original material, where possible. However, as outlined by Policy 20, in areas where deterioration affects an extensive area, geotechnical advice should be sought. It is suggested that Gabion or modern wall solution be used but faced with stone walling that is sympathetic to its immediate vicinity.

The listing of Jenolan Caves Reserve does not include Jenolan Caves Road, including the Two Mile access. The listing does include the slopes immediately above and below the road, and therefore the policies outlined in the CMP must be complied with.

As outlined by the site inspection (Section 5), all of the failure sections on the Two Mile section of Jenolan Caves Road are located outside the Grand Arch Precinct, and there are no vantage points along the road for visitors to stop to view Caves House. Significant views identified within the CMP are all located within the Grand Arch Precinct. These views are generally concentrated on views to and from Caves House, Carlotta Arch, and the Blue Lake.

Day and overnight visitors would only be able to view the failure sections if they are visible from accessible locations within the Grand Arch Precinct, such as from Caves House, or one of the other significant viewpoints identified in the CMP. The site inspection found that it was unlikely that any of the slope failures would be visible from any of these locations. The only failure section that may be visible from the western end of Caves House, Failure Section 4, is in fact not visible due to the steep terrain, and the existing vegetation midway up the slope between Caves House and Jenolan Caves Road. Clearing of vegetation would be limited to 15 m down the slope toward the road. This would mean that the existing stand of trees and other vegetation would not be cleared. As such, the location of the repair work would be obscured from view.

Failure Section 1 is a vertical failure that extends approximately 70 m down the slope from the road towards the section of Jenolan Caves Road below. The failure is partially visible when driving from the Two Mile access towards the hairpin turn but is not visible from the road above. Once completed, the works would be partially visible from Carpark 2 until natural revegetation of the area had occurred. Once regenerated, the vegetation would eventually grow to obscure the rock mattress drainage. The improved drainage would ensure future failures are less likely to occur. These works would also not be visible from any of the other significant locations within the Grand Arch Precinct.

The remaining failure sections are either located higher up on Jenolan Caves Road and away from the Grand Arch Precinct, or in the case of Failure Sections 2 and 3, located on top of steep vegetated slopes with the vegetation concealing the sites. The existing vegetation that helps block the view of these failure sections would not be removed as part of the proposed remediation works.

The failure sections are not located within any of the significant view corridors or vistas identified by the CMP (see Figure 7.1). As such, any works to repair each failure would not impact on significant views and would comply with Policy 40 of the CMP.

The proposed short to medium term repair solution has been informed by geotechnical advice. This option was decided by Transport for NSW to maintain access to the Jenolan Caves Precinct while the Five Mile access is being repaired. The works would include the placement of 8 rows of soil nails up to 15 m below the road sections within each Failure Section. The soil nails would then be covered with shotcrete. The preparation of this design complies with Policy 20 and Policy 26, where design advice was informed by the geotechnical investigations. The use of soil nails and shotcrete are not expected to impact on original or early historic cuts, embankments, retaining walls, paths or stairs. The presence of a stone retaining wall in the vicinity of the culvert at Failure Section 3 is believed to have been constructed when the modern culvert was installed below the road. As there is not believed to be any impacts to the original or early embankments or retaining walls, these works would also conform with Policy 19 of the CMP.

Vegetation removal would be limited to the work areas only and would aim to minimise the potential loss of mature trees. There are existing stands of trees and other vegetation present on the slopes beyond the work areas at each failure section. Given the steep topography, the remaining stands of trees and other vegetation would conceal, or at the very least obscure, each of these sites. As such, the works would satisfy Policy 37, where the landscape character and condition of the Jenolan Karst Conservation Reserve would be retained and conserved.

Shotcrete is proposed to be installed provide structural support in between the nails and is resistant to bushfires. Installing only mesh between the nails is less effective in preventing slope movements between the nails, and can also be compromised by bushfire events in bushfire prone areas. The use of shotcrete, including a tinted colour, is generally not a preferred option from a heritage perspective, especially when working in a landscape where the works are highly visible. These works, however, are not likely to be visible from visitor locations within the Grand Arch Precinct. Specifically they are not expected to be visible from Caves House, Carlotta Arch or from the various visitor muster points, such as the booking office and cave tour meeting locations. As such, the use of more technical '*mock rock*' finish is not considered to be necessary. The tinting of the colour of the shotcrete, however, should be carefully selected to blend in with the surrounding topography.

The culvert upgrades, including the improvements to the existing dish drains and construction of kerbing would take place within the road corridor. The road corridor is not included within the SHR curtilage. These works would not have a direct impact on the heritage significance, heritage fabric or identified views of Jenolan Caves Reserve. The improvements to the drainage at the failure locations has a positive heritage outcome as the works would maintain and protect access to the heritage site.

The construction of a 30 m long rock lined swale drain from the outlet of Culvert 1a would be 4 m wide and would be placed at the northwest from the end of Carpark 2 extension, below Jenolan Caves Road. This area is not visible from Jenolan Caves Road due to the steep assent when leaving tourist site. This section of the site is located on the boundary of the Grand Arch Precinct; however, it is in a location adjacent the carparking area. The presence of this swale drain is unlikely to impact on any significant views or fabric.

Table 7.1 overleaf provides a response to general questions posed by the Statement of Heritage Impact guidelines (Department of Planning and Environment, June 2023). Table 7.2 assesses the consistency of the project proposal against relevant policies from the 2017 CMP.

Table 7.1: Response to Questions posed by the Statements of Heritage Impact guideline

Relevant Questions	*Response*
How has the impact on the heritage significance of the existing landscape been minimised?	The proposed short to medium term repair works on the Two Mile Failure Sections are not expected to be visible from the Grand Arch Precinct. When completed, the use of soil nails and shotcrete would be at ground level, meaning that the works are unlikely to be visible. Vegetation clearance around each of the work areas would extend up to 15 m below the road level at each failure section. Vegetation in these sections is generally limited, with trees being present further down slope. These trees and other vegetation would assist in concealing any possible view to these works from vantage points within the Grand Arch Precinct. It has been recommended that shotcrete used should be coloured to match the surrounding topography to blend into the surrounding environment. The repair of the gully failure at Failure Section 1 includes the natural revegetation of the surrounding area. When completed, the vegetation would obscure the view to the rock mattress drainage works. These works would also ensure that the gully failure does not become worse over time. Improvements to the existing culverts are outside of the SHR curtilage, however, these drainage improvements are being undertaken to ensure future slope failures are less likely to occur.
Are works to the landscape or pathways necessary to comply with the access requirements of the Disability Discrimination Act 1992?	The works are necessary to maintain access to the Jenolan Caves Tourist Site while the main access section is being restored. The works are to ensure the failures do not degrade further that would result in the closure of this access road as well, and leaving the precinct with no road access.
Has evidence (archival and physical) of previous landscape work been investigated? Are previous works being reinstated?	Yes. The history of the Two Mile access of Jenolan Caves Road is well documented and the remnant and more modern landscaping in the Grand Arch Precinct viewed and considered. The only landscape work present below the existing road is a rock wall embankment located above a modern culvert. It is believed this retaining wall was installed to form part of a head wall for the culvert.
Will any known or potential archaeological relics be affected by the landscape works? Has advice been sought from a suitably qualified archaeologist	No. There are no known or potential archaeological deposits likely to be affected by the works. Yes, the advice from a suitably qualified archaeologist has been sought.
Do the proposed works impact views to, from and within adjacent heritage items?	The proposed works are not believed to impact on any views to, from and within the adjacent Grand Arch Precinct. There are no views from the failed sections to the Grand Arch Precinct and no places for visitors to stop on the Two Mile Access road. There are not expected to be any views from the Grand Arch Precinct or from significant buildings or locations, such as Caves House and Carlotta Arch, to each of the failure section works sites. The steep topography and vegetation conceal or obscure the failed sections. The five significant views and vistas identified in the CMP would not be impacted. The views are within different significant buildings or elements the Grand Arch Precinct. All five of these views and vistas would be maintained.

	Works to repair the gully slope failure would include the installation of engineered fill and rock mattresses to improve drainage down the slope. Once the area has been naturally revegetated, the vegetation would partially obscure view of the rock mattresses down the slope. This gully slope restoration would not be visible from significant buildings or elements the Grand Arch Precinct

Table 7.2: Summary of relevant policies from the 2017 CMP and an assessment of the consistency of the proposed works against those policies

Policy No.	*Policy*	*Consistency Assessment*
19	All original or early historic cuts, embankments, retaining walls, weirs, paths and stairs should be retained and conserved wherever possible whilst also ensuring compliance with contemporary building codes, safety and engineering standards.	The original cutting made for the Two Mile Access section of Jenolan Caves Road would be preserved, with the works ensuring that the Two Mile Access remains operational. A rubble stone retaining wall is present above a modern ceramic culvert near Failure Section 3. This retaining wall acts as the head wall to the culvert and is not believed to be original or early fabric.
20	Repairs should be undertaken immediately with original materials. Where deterioration of cuts, embankments and retaining walls affects a more extensive area, then geotechnical advice should be sought. Gabion or modern wall solutions may be used for remedial works however they should be faced with stone walling that is sympathetic to walling in the immediate vicinity.	It is not possible to repair the failed slope without the introduction of new material. Geotechnical advice has been sought and has indicated that soil nails and shotcrete is the only viable solution for the failed slope as a short and medium term solution. This will allow the access road to remain open while the Five Mile access is being repaired.
38	The significant components that combine to define the cultural landscape of the setting including significant geological and landscape features, heritage structures and samples of exotic and indigenous vegetation, must be preserved, maintained and interpreted.	The soil nail and coloured shotcrete finish is not expected to be visible as it would be concealed or obscure from the Grand Arch Precinct by the topography and existing retained vegetation. This would preserve the setting of Caves House and the broader cultural landscape of the reserve.
39	Significant geological features, layouts, views, vistas, spaces and hard and soft landscape elements should be retained and conserved to maintain the significant landscape character and fabric of the reserve as a whole and its component precincts.	The proposed works would not impact on significant geological features, layouts view or vistas.
40	Significant views and vistas should be identified and protected as part of the development of a Landscape Management Plan. A detailed view analysis should be prepared for the Reserve however reference should be made to the identified views in Section 6.5.9. Views and vistas to, from, and within Jenolan Karst Conservation Reserve should be retained and conserved through sensitive treatments such as trimming and lopping.	A Landscape Management Plan has not yet been developed for Jenolan Caves Reserve. None of the significant views and vistas identified in the CMP would be impacted by the works.

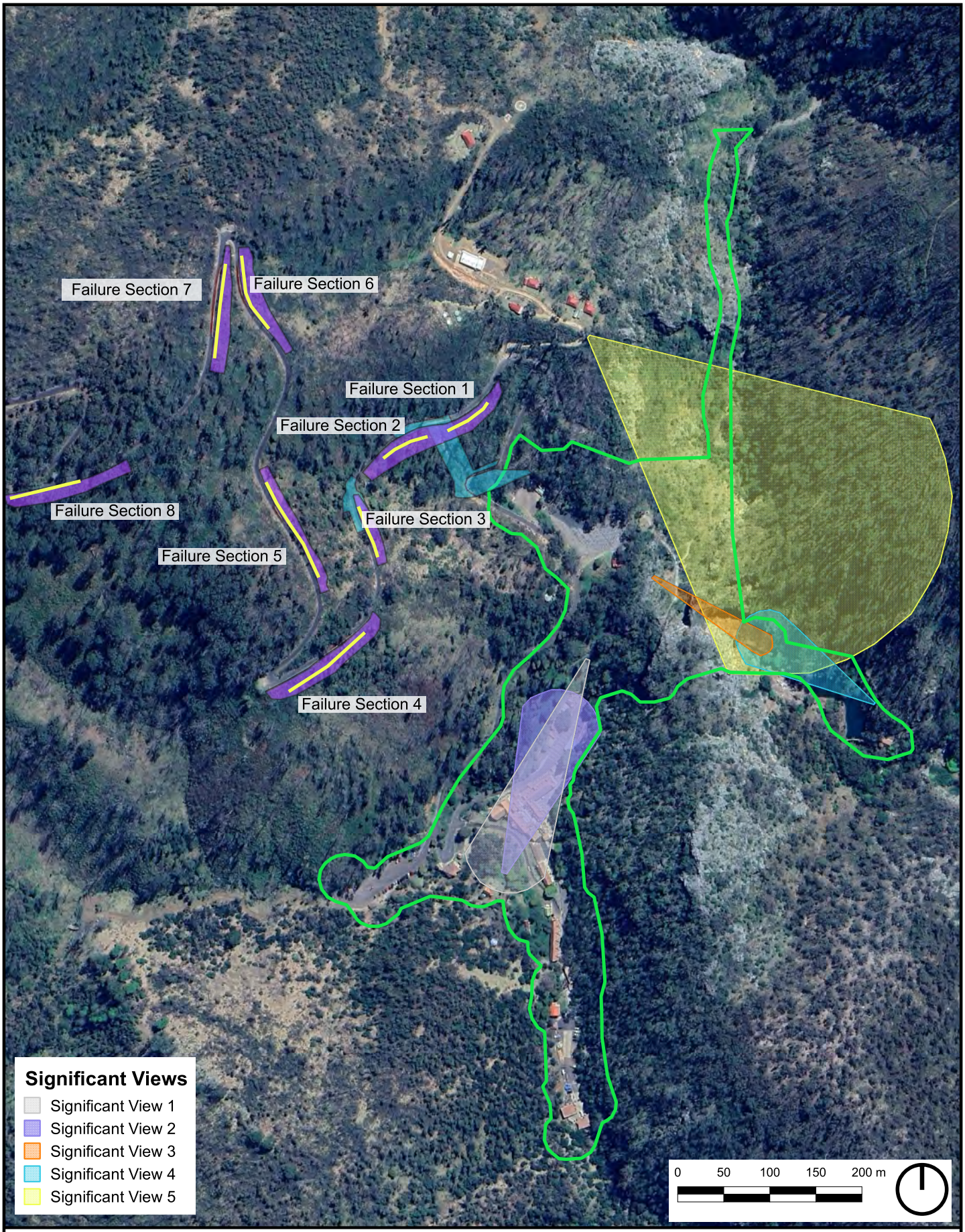


Figure 7.5: Location of failure sections and proposed works in relation to significant views identified in the CMP.

MOUNTAINS HERITAGE

Legend

- Grand Arch Precinct
- Slope Failures
- Restoration Works
- Culvert and Drainage Works

Map Source: NSW Six Maps (NSW Spatial Data)

7.3 Impact Assessment – National Heritage values of the Greater Blue Mountains World Heritage Area

Significant impact criteria

An action is likely to have a significant impact on the National Heritage values of a National Heritage place if there is a real chance or possibility that it will cause:

- *one or more of the National Heritage values to be lost*
- *one or more of the National Heritage values to be degraded or damaged, or*
- *one or more of the National Heritage values to be notably altered, modified, obscured or diminished.*

Self Assessment

The National Heritage values of the GBMWHA largely reflect the values identified through its nomination to the World Heritage List. The information available on the Australian Heritage Database indicates that the GBMWHA is significant for its natural heritage values. These values lie in its high diversity of eucalypts, its ancient relict species of global experience, including the Wollemi pine, and the rare and threatened fauna and flora species.

Given that the listing is largely based on natural heritage values, the proposed repair to the failure sections on the Two Mile section of Jenolan Caves Road is highly unlikely to impact on the GBMWHA's National Heritage values. The works would not result in one or more of the National Heritage Values to be lost, degraded or damaged or notably altered, modified, obscured or diminished. No eucalypt or ancient relic species or rare and threatened fauna or flora species would be impacted, and the diversity and composition of plant and animal species would not be affected. Stabilising the slope from further failure would also ensure impacts to the natural heritage values are preserved in the area. Given that the action is not likely to have a significant impact on the National Heritage values of the GBMWHA, approval from the Minister for Department of Climate Changes, Energy, the Environment and Water is not required.

7.4 Impact Assessment – World Heritage values of the Greater Blue Mountains World Heritage Area

Significant impact criteria

An action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:

- *one or more of the World Heritage values to be lost*
- *one or more of the World Heritage values to be degraded or damaged, or*
- *one or more of the World Heritage values to be notably altered, modified, obscured or diminished.*

Self Assessment

The GBMWHA is inscribed on the World Heritage List in 2000 for its outstanding values under Criteria 9 and 10, which state that:

9. To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;

10. To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

As indicated in the Statement of Outstanding Universal Value, the GBMWHA has outstanding and representative examples of the genus *Eucalyptus*, which shows its evolution and adaptation. The Greater Blue Mountains includes a variety of eucalypt habitats, and these demonstrate the range of interactions between eucalypts, understorey, fauna, environment and fire. The presence of the Wollemi Pine also demonstrates the evolution of the earth's plant life. In addition, the site also has an outstanding diversity of habitats and plant communities that support globally significant species and ecosystem diversity. These habitats support a huge diversity of vertebrate taxa, mammals, reptiles, frogs and bird species and inveterate species, although many of these are still poorly known. (see http://whc.unesco.org/en/list/917/).

As indicated by this Statement, the World Heritage values of the GBMWHA lie in its natural heritage. The remediation of the failure sections on the Two Mile Section of Jenolan Caves Road is not likely to have a significant impact on these World Heritage values. One or more of these World Heritage Values will not be lost, degraded or damaged or altered, modified, obscured or diminished. No habitats would be affected by the proposed works and as a result, no flora and fauna species would be affected. Stabilising the slope would also ensure impacts to the natural heritage values are preserved in the area. Given that the action is not likely to have a significant impact on the World Heritage values of the GBMWHA, approval from the Minister for Department of Climate Change, Energy, Environment and Water is not required.

8 Conclusions and Recommendations

8.1 Conclusions

- The eight failure sections of the Two Mile access of Jenolan Caves Road are located within 'Jenolan Caves Reserve' listed on the NSW SHR (SHR No. 01698). The Reserve is considered one of Australia's oldest visitor destinations and is recognised for its outstanding natural, cultural historic, scientific and recreational values, as outlined in its SHR Listing.
- The subject site is also included within the 'Jenolan Karst Conservation Reserve', which is one of eight reserves that form part of the Greater Blue Mountains World Heritage Area (GBMWHA). The GBMWHA is listed on the National Heritage List and World Heritage List. It was inscribed on the World Heritage List in 2000 for its natural values (Criteria 9 and 10).
- All eight failure sections are located outside the Grand Arch Precinct and would not impact on any of the significant buildings, geology, views or vistas associated with the various listings. The proposed works would not have a direct impact on any original or historic cuttings, embankments or retaining walls.
- Three (3) options were considered to remediate the slope. However, Transport for NSW have decided to implement a modified version of Option 2 as a short to medium term solution to the failure sections. This was chosen to prevent the failure sections degrading further, and allow the road to remain open while the main, Five Mile Access, road is being rebuilt. This option involves the use of soil nails and coloured shotcrete to stabilise the slope. Three culverts would be upgraded as part of the works. Some vegetation may need to be removed. A rock lined swale drain would also be installed near Carpark 2.
- The repaired failure sections are not expected to be visible from any of the significant buildings or other locations, including Caves House, Carlotta Arch or Blue Lake. There are also not expected to be any views to these work sites from any areas where visitors generally congregate, such as from Caves House entrance, booking office or from the areas where the cave tours commence from. Given the topography and existing vegetation that obscures the failure sections, the works would not impact on the aesthetic or landscape heritage values of the Jenolan Caves Reserve.
- Maintaining access to Jenolan Caves Reserve via the Two Mile Access is considered a positive heritage outcome, as it will ensure continued use and appreciation of the reserve.

8.2 Recommendations

Based on the results of this assessment, it is recommended that:

- Despite the failure section work areas not being visible from significant buildings or areas within the Grand Arch Precinct, the colour of the shotcrete should be tinted to blend into the surrounding topography and vegetation. This is to soften the look of the shotcrete if visible from any other locations along the decent or assent of the Two Mile Access on Jenolan Caves Road.
- A copy of this report be provided to Transport for NSW for its review and endorsement. Following the issue of this endorsement, a copy of this report be provided to Heritage NSW to support a S.60 Application.
- Following the issue of a S.60 Approval, a detailed design is expected to be developed for the works. Once completed, the detailed design should be reviewed by a suitably qualified

heritage specialist to ensure that there are no additional impacts proposed by the works. If additional impacts are identified, an updated SoHI report would be required, and the updated assessment submitted to Heritage NSW for approval under a Section 65A Modification Application.

- In the unlikely event that any historical archaeological relics or 'works' are unexpectedly found during excavation for drainage, the *TfNSW Unexpected Heritage Finds Guideline* (2016) should be followed.

References

Secondary Sources

Betteridge Heritage Pty Ltd, 2020, *Heritage Impact Statement for potential impacts of proposed upgrade to walking tracks and other visitor facilities around Blue Lake, Jenolan Caves*. Unpublished report for Jenolan Caves Trust.

Department of the Environment and Climate Change (NSW) 2009, *Blue Mountains World Heritage Area: Strategic Plan*.

Department of Urban Affairs and Planning, 1996 and Revised 2002, *Statements of Heritage Impact* guideline NSW Heritage Council.

GHD Pty Ltd, 2021, *Jenolan Caves Road 2-Mile Remediation: 80% Detailed Design Report*. Unpublished report to Transport for NSW.

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Transport for NSW, 2016, *Shotcrete design guideline*.

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Department of the Environment, Water, Heritage and the Arts, 2009, 'Greater Blue Mountains World Heritage Nomination'. See: www.environment.gov.au/heritage/places/world/blue-mountains/values.html

Heritage NSW, Department of Premier and Cabinet, State Heritage Inventory Listing for 'Jenolan Caves Reserve'. See: www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051578

Annexure A: Copy of the SHR Listing for Jenolan Caves Reserve

Item Details

Name

Jenolan Caves Reserve

Other/Former Names

Binoomea, Binda Caves, Fish River Caves, McKeon's Caves, McEwan's Creek Caves, Bendo Caves, Jenolan Karst Conservation Reserve

Address

Caves Road JENOLAN NSW 2790



Local Govt Area

Oberon

Group Name

Item Classification

Item Type	Item Group	Item Category
Landscape	Landscape - Natural	Cave

Statement Of Significance

Jenolan Caves Reserve is of state significance for its historical, aesthetic, research and rarity values. The caves and karst landscapes developed as important scientific and tourist destinations throughout the late 19th and 20th centuries, and the Reserve is highly significant as the first public reserve set aside in NSW for the protection of a natural resource - in this case, the Jenolan Caves.

The Reserve is highly regarded for the aesthetic qualities of the caves and cave formations, reflected in cave names such as Aladdin and Gem Cave; for the ability of the caves to demonstrate technological developments such as the first use of electric cave lighting in the 1880s, and the first development of hydro-electric power in Australia. The setting of the caves hamlet in the Jenolan Valley, with the tiny hamlet and picturesque Caves House almost dwarfed by steeply rising cliffs on all sides, the entrance into the hamlet through the fortress-like Grand Arch, and the distinctive Blue Lake formed by the weir for the hydro-electric scheme, all combine to form a landscape of great beauty and distinctiveness.

The Reserve has the ability to yield information on the geological history of NSW and of the Australian continent, and for the archaeological potential of the hamlet area to provide evidence of the early period in the development of tourism in NSW.

The number of rare and uncommon flora and fauna species to which it is home, especially within the caves; and the evidence it can demonstrate of the development of tourism, especially mountain and caving tourism, in NSW, add to the significance of the Jenolan Caves Reserve (HO).

The geomorphic history of the Jenolan Caves system is extremely complex, the cave system contains an exceptionally diverse variety of karst and cave types illustrating the full range of processes and products from incipient, scarcely perceptible depressions through to multistage cave developments and decayed remnant features. The McKeowns Valley, north of Blue Lake contains the finest such assemblage in Australia. The Jenolan River valley is one of the most outstanding fluviokarst valleys in the world. The range and diversity of the karst and decoration, including a remarkable diversity of mineral species, is varied, profuse and equal to the finest in the world. The Jenolan Caves and surrounding areas contains a very diverse assemblage of morphologies and mineral species. There is evidence in these features of the influences of palaeo-landscapes.
The contribution to the formation of the landscape of structural influences, lithological influences, and drainage patterns is the source of considerable scientific and educational interest at Jenolan. The geomorphology of Jenolan includes a variety of non karstic phenomena that are important because of their relationship with the karst. Because these features lie adjacent to, and in some cases over, the karst they give considerable insight into the formation of the karst. A large number of invertebrate fossils have been discovered in the limestone of the Jenolan Caves. These include corals, stromatoporoids, algae, brachiopods, gastropods and straight nautiloids. Subfossil remains of many vertebrates are also found in the caves.

The caves provide shelter and habitat for a number of rare species including the sooty owl (TYTO TENEBRICOSA TENEBRICOSA) (rare in Australia) which roosts in the cave known as the Devil's Coach House and the Jenolan Caves Reserve supports a population of the brush tailed rock wallaby (PETROGALE PENICILLATA). This species is listed as vulnerable on Schedule 12 of the NSW National Parks and Wildlife Act. Also found in the caves is the opilionid arachnid (HOLONUNCIA CAVERNICOLA) which is known only from the Jenolan Caves system. The Caves Reserve contains three rare or endangered plant species. These are PSEUDANTHUS DIVARICATISSIMUS βRC), GONOCARPUS LONGIFOLIUS (3RC), and GERANIUM GRANITICOLA (3RC). In the latter half of the 19th century the caves were recognised as perhaps the premier natural attraction in Australia. Although they no longer occupy this role, Jenolan remains one of the most important natural heritage areas in Australia. The caves are a very high profile natural feature in NSW. The Jenolan Caves area is widely used as a research and teaching site for studying the geomorphology and processes involved in karst formation (RNE, 1978).

Jenolan is one of the most important areas of natural and cultural history in Australia. The area includes one of the largest and most beautiful interconnected cave systems in Australia and is an outstanding site of geological and speleological interest. The Jenolan River, Blue Lake and a system of intimate valleys and watercourses provide a magnificent setting for a distinctive range of native vegetation and fauna. The Caves Reserve was created in1866, six years before the declaration of the world's first National Park. Since its reported discovery by James Whalan between 1838 and 1841 the area has attracted more than three million visitors. Caves House, and its associated outbuildings, adds to the area's cultural significance. The area also contains a number of important industrial relics, including Australia's first hydro-electic power station and the remants of the first electric lighting of caves which was installed in the Chifley Cave in 1887 (National Trust of Australia, 1985).

Assessed Significance Type	Endorsed Significance	Date Significance Updated
State	State	6/15/2004

Listings

Listing Name	Listing Date	Instrument Name	Instrument No.	Plan No.	Gazette Page	Gazette Number
Local Environmental Plan	13/0/1998	Schedule 2 Part 2 Caves				48
Heritage Act - State Heritage Register	25/0/2004		01698	1937	4807	104
Local Environmental Plan	13/0/2013	LEP 2013 (amdt.5): Jenolan Caves House; Limestone	113, 114			
Register of the National Estate	21/0/1978	Jenolan Caves and Reserve	780			
National Trust of Australia register	23/0/1985	Jenolan Caves Conservation Area	3164			

Heritage Item ID	Source
5051578	Heritage NSW

Location

Addresses

Records Retrieved: 1

Street No	Street Name	Suburb/Town/Postcode	Local Govt. Area	LALC	Parish	County	Electorate	Address Type
	Caves Road	JENOLAN/NSW/2790	Oberon	Pejar	Jenolan	Westmoreland	BATHURST	Primary Address

Description

Designer	Builder/Maker	
Construction Year Start & End	**Circa**	**Period**
1866	N0	1851 to 1900

Physical Description **Updated**

Location:
The Jenolan Caves Reserve is situated on the western spur of the Blue Mountains, about 180 kilometres west of Sydney. The Reserve is located in mountainous country, forming a dissected eastern margin of the highland plateau east of Oberon.

The caves are 80km west of Katoomba, and part of McKeowns Valley, which is a very significant fluvial karst valley (Department of Public Works, 1979).

Geology:
The caves are a result of this karst land form which characterised by caves, disrupted surface drainage, underground drainage and closed depressions that can all be witnessed as part of the Jenolan Caves Reserve. There are over 300 Limestone caves as part of the Jenolan Caves area that are very diverse in their nature and demonstrate contrasting characteristics. The caves can be horizontal or vertical and there are both inactive (dry) and active caves in the area that contain either abandoned or active underground stream ways (Caves Reserve Trust 1996:10). The caves can also be classified into 'dark' caves and above ground systems (Department of Public Works, 1979).

The geological structure of the karst is complex, resulting from two periods of major folding and a number of faulting events. In addition to many smaller scale structures, a change in the strike of the limestone 1 kilometre north of the Grand Archway is the expression of a large scale fold described as the Jenolan Mega-Kink. The most spectacular surface karst feature is the wall of limestone 90 metres high and 150 metres wide at the confluence of the Jenolan River, Surveyors Creek and Camp Creek. The three spectacular karst bridges - the Grand Archway and Devil's Coachhouse (at present stream level) and Carlotta Arch (at a higher level) are internationally renowned.

Cave System:
The main cave system contains over 20 kilometres of passage developed in a one kilometre length of limestone body. The Reserve is renowned for its range and profusion of calcite speleotherms, including examples of less common forms such as helictites, ribbon helictites, shields, monocrystalline stalagmites and sub aerial stromaltilites. Aragonite speleotherms, often with spectacular morphology, and also found in restricted localities. Gypsum speleotherms are significant and include forms not reported elsewhere.

The karst contains over 300 tagged cave entrances. A large percentage of the discovered cave passage is linked and effectively is one large cave system formed by three major catchment areas. The caves contain a rich troglobitic fauna, an outstanding level of aesthetic quality, and a diverse range of speleotherms and minerals.

Three Rock Arches:
A large amount of highly decorated cave passageway is located in close proximity to three natural rock arches. This area also contains areas where underground river systems can be viewed. The development of these caves provides visitors with an opportunity to view some of the most highly decorated areas of cave as well as caves that have formed over many different time spans under different conditions and which demonstrate a diverse range of shape, form and decoration.

Many caves contain a wide range of river sediments and surface infills relating to the different environmental conditions that have occurred over millions of years. The sediments contain information about changes to climate, vegetation and land formation processes. Many caves and 'unroofed surface cave' sediments contain fossil faunal remains deposited under a range of conditions. Very little study and documentation of the fossil bone deposits has been undertaken (Manidis Roberts 2003: 17, 22-23).

The caves contain large sediment banks that are able to reveal a stratigraphy of many thousands of years. Bone deposits are prevalent in many of the caves on the Jenolan Reserve and some of these fossils are of human remains and have and important anthropological significance. There are also many animal bone deposits as the caves have acted as a natural trap for animals and these deposits are now of a significant palaeontological value such as a 20,000 year old owl pellet site and bone deposits of the Mountain Pygmy Possum (Caves Reserve Trust, 1996, 11).

The caves entertain a wide variety of invertebrate, flora and fauna species many of which have been studied and recorded as part of the complex ecological system. The cave system and the surrounding area also supports rare animals and plants such as the Sooty Owl and the Brush Tailed Rock Wallaby (Register of the National Estate Database,2001).

Reserve Pleasure Grounds around Caves House:
Caves House is surrounded by pleasure grounds, landscaped with walks, retaining walls and mixed plantings of mostly exotic trees and shrubs. Trees include Huntingdon elm (Ulmus x hollandica 'Vegeta')(Spencer, A Horticultural Flora of SE Australia, online at: https://hortflora.rbg.vic.gov.au/taxon/64af150-5340-11e7-b82b-005056b0018f).

Blue Lake:

Physical Condition **Updated** 03/24/2004

Physical condition is good. Some caves have been damaged through poor past management and vandalism, and there are concerns about the impacts of visitor numbers on the physical condition of some caves.

Modifications And Dates

1870s - visitation to the caves associated with destruction and theft of cave features
1878 - first road to the caves hamlet built from Oberon.
1880 - first permanent buildings erected, with some clearing of the land.
1887 - electric lighting introduced into the caves
1895 - fire destroys most existing buildings
1896 - first wing of Caves House built
1897 - remodelling of landscape around Caves House
1920s - new buildings erected in the hamlet area
1960s - interiors of the caves extensively renovated
1980s - new wave of building works
(Moore 1989, 21-22)

Further Comments

History

Historical Notes or Provenance **Updated**

The Aboriginal peoples of the Reserve left many artefacts that have been noted and recorded. Several caves would have made good occupation sites and artefacts have been found

at Jenolan. The nature of the landscapes, including caves, arches and steep sided slopes, would have developed many strong anthropological links. Gar-rang-atch, part fish and part reptile, formed many of the holes and caves in a number of karst landscapes in the south east of NSW while trying to escape Mir-ra-gan. Kohn (1993) states that at the time of contact with Europeans, Jenolan Caves fell within the territory of Gundungarra-speaking people, with Wiradjuri-speaking people to the north and west. The traditional land owners were probably Gundungarra-speakers, who had territory which included the Megalong and Burragorang valleys (Jenolan Reserve Trust1995: 6).

The Post-contact history of the Reserve, or at least of the caves hamlet, was summarised by Moore in 1989 in six distinct phases.

Phase 1, 1838-1866, began with runaway convict James McKeown using the caves as a hideout for about 3 years, where he was found and captured by local pastoralist James Whalen in 1841. News of the caves then attracted a trickle of visitors willing to make the arduous journey. Unfortunately, the visitors were prone to taking large pieces of cave formations with them back to Sydney, and in 1865 local MLA John Lucas, after removing a large formation from Exhibition Cave, then persuaded the colonial government to declare the area a reserve to protect the caves. In 1866, the Fish River Caves Reserve was gazetted, the first reserve in NSW made for the protection of a natural feature.

Phase 2, 1867-1895, covers the gradual increase in public control over the reserve, especially the caves, and the provision of accommodation and access.

Caves Reserve was created in 1866, six years before the declaration of the world's first National Park.

The destruction of formations was made an offence in 1872, and in 1879 Jeremiah Wilson was appointed as first resident caretaker, a year after the first road (from Oberon) was made to the caves. Visitors then had to sleep in the Grand Arch - ladies on one side, gentlemen the other - along with caretaker and guide, Jeremiah Wilson. He took a lease of 2 acres on flat land on the Oberon side of the Grand Arch. Previously the site of a surveyor's camp, he erected a kitchen in the same year, and in1880 built a 'rough house', with an iron roof supplied by the Government. This first Caves House, with its white washed walls, low roof line and no verandah, would not have looked out of place in mid-Wales. Rough and ready it may have been, but to visitors weary of the long train trip from Sydney to Tarana, a lurching buggy ride to the top of the steep2 mile hilll from Oberon, then a walk down to the caves, ti was welcome indeed (Hay, 2013, 29).

By the mid-1880s Wilson was flooded with requests for accommodation. In 1887, with more visitors he extended his original buildings several times to include a two storey wooden building catering for 30 guests, with another joining it the following year. By then 1829 visitors a year were coming, including Governors of NSW and distinguished personages such as Prince Louis of Batternberg (Hay, 2013, 29).

Charles Bogue Luffman worked as an acting caretaker there some time either in 1883, or from 1890-1895 (Sandra Pullman, pers.comm., 9/8/2019) Luffman went on to run the Burnley College of Horticulture, Victoria's principal place of education for the horticulture industry, now part of Melbourne University (Stuart Read, pers.comm., 2/9/2019).

On 14 March 1895 fire destroyed most of them - rumour has it that this was deliberately lit - Wilson, the 'Crown Prince of Guides' had a reputation for being free with other mens' wives, sheep and horses, so it may well have been a settling of scoresi(Hay, 2013, 29) and brought an end to Wilson's caretakership. Wilson campaigned for 'improvements' in the caves, and steps, gates, railings, ladders and wire mesh cages were built for the safety and comfort of visitors, and to protect the formations. In1887 a steam-driven dynamo was installed in the Grand Arch to provide electricity to light the Imperial, then the Nettle and Arch caves. This was replaced in 1889 by a water driven Leffel Wheel near a waterfall on the Jenolan River. This was the first hydro-electric scheme in Australia and the first time electricity was used to light caves anywhere in the world.

The new lessee was Harry Curzon Smith, the king of railway refreshment rooms. Sir Sydney Smith, who, as Minister for Mines ultimately controlled the caves, engaged Walter Liberty Vernon, the Government Architect (see below)(Hay, 2013, 29).

Walter Liberty Vernon (1846-1914) was both architect and soldier. Born in England, he ran successful practices in Hastings and London and had estimable connections in artistic and architectural circles. In 1883 he had a recurrence of bronchitic asthma and was advised to leave the damp of England. He and his wife sailed to New South Wales. Before leaving, he

gained a commission to build new premesis for Merrrs David Jones and Co., in Sydney's George Street. In 1890 he was appointed Government Architect - the first to hold that title - in the newly reorganised branch of the Public Works Department. He saw his role as building 'monuments to art'. His major buildings, such as the Art Gallery of New South Wales (1904-6) are large in scale, finely wrought in sandstone, and maintaining the classical tradition. Among others are the Mitchell Wing of the State Library, Fisher Library at the University of Sydney and Central Railway Station Le Sueur, 2016, 7).

Vernon also added to a number of buildings designed by his predecessors, including Customs House, the GPO and Chief Secretary's Building - with changes which did not meet with the approval of his immediate precedessor, James Barnet who, nine years after his resignation, denounced Vernon's additions in an essay and documentation of his own works. In England, Vernon had delighted his clients with buildings in the fashionable Queen Anne style. In NSW, a number of British trained architects whow were proponents of hte Arts and Crafts style joined his office and under their influence, Vernon changed his approach to suburban projects. Buildings such as the Darlinghurst First Station (Federation Free style, 1910) took on the sacale and character of their surroundings. Under Vernon's leadership, an impressive array of buildings was produced which were distinguished by interesting brickwork and careful climatic considerations, by shady verandahs, sheltered courtyards and provision for cross-flow ventilation. Examples are courthouses in Parkes (1904), Wellington (1912) and Bourke, Lands Offices in Dubbo (1897) and Orange (1904) and the Post Office in Wellington (1904)(Le Sueur, 2016, 7).

Phase 3, 1896-1906, was marked by a strong commitment by the government to development of the caves as a resort for wealthy travellers and a retreat from Sydney. The Government Architect, Walter Liberty Vernon, designed the first wing of Caves House, built in 1897, which could then be reached by a new road through the Grand Arch. Vernon designed Caves House in an Arts & Crafts style to reflect the romantic and picturesque associations of the caves, describing it as a 'large comfortable hotel of the type best known in the tourist districts of England, Scotland, Ireland'. Moore describes it as having a craggy gabled faade and series of picturesque gablets, knobbly tile roof and deep recessed openings with multi-paned windows, giving the new building an instant air of old-age, charm and respectability. In 1897 the Director of the Royal Botanic Gardens, Joseph Henry Maiden remodelled and terraced the slopes around Caves House, providing a setting of park-like gardens.

Phase 4, 1907-1929, covers the gradually widening popularity of the Caves made possible by motor transport and promoted by tourism literature. In 1907, a second wing, also designed by Vernon, was added to Caves House, with subsequent wings in 1914 and 1923, probably also designed by Vernon but supervised by George McCrae. Numerous service buildings were also constructed in the hamlet during the period, reflecting a move towards day trips as well as overnight stayers.

Botanist and plant collector William Blakely worked at Caves House as a gardener (AGHS/Betteridge, 2018), likely between 1900 (when he joined the staff of Sydney Botanic Gardens as a gardener, and 1913 when he worked in its Herbarium (until 1940) (Read, Stuart, 12/7/2018, using ANBG.gov.au/biography/).

Phase 5, 1930-1965, was marked by the Depression, World War 2, and the post war years which saw a great drop in the numbers of visitors, then a gradual rise towards the end of the period marked by extensive renovations to Caves House.

Phase 6, 1965-1989, covers a period of strong growth in visitor numbers with consequent further renovations and building programs to keep up with demand. At the same time the growing environmental awareness lead to visitors and others taking a greater interest in the reserve's natural and scientific values, and an Environment Protection Committee was formed to approach the perceived conflicts between natural values and tourist activities (Moore 1989, 13-20).

Phase 7, 1990-2003, covers the period of the Jenolan Caves Trust, established in 1989, when the first conservation plan for the Reserve's cultural heritage was produced after its transfer from control by the NSW Tourism Commission. The Trust was set up to manage the karst reserves of Jenolan, Wombeyan and Abercrombie, with Borenore added in 1996. In November 2000 the Reserve was included in the Greater Blue Mountains Area that was inscribed on the World Heritage List in recognition of its natural heritage values. Visitor numbers to the Reserve peaked during this period at about 250,000, then began to decline. In late 2003 the Trust Board was replaced by an administrator (HO).

In the 20th century visitor numbers continued to increase and the caves are now a major tourist attraction of NSW. Hence, alterations have been made to the access points of some caves although there are still many caves in the region that remain relatively untouched by tourism (Mackay, Quint, Pratten 1985), (Department of Public Works and Services: 1979).

Since its reported discovery by James Whalan between 1838 and 1841 the area has attracted more than three million visitors. The area also contains a number of important industrial relics, including Australia's first hydro-electic power station and the remants of the first electric lighting of caves which was installed in the Chifley Cave in1887 (National Trust of Australia, 1985).

A photo of a healthy-looking koala raises hopes the marsupial is moving back to the Jenolan Caves area after a 48 year absence. The image was captured by accident on a remote camera used to monitor endangered brush-tailed rock wallabies as the koala wandered around a conservation area. Koalas have not been active in the area for decades, despite a breeding program trying to reintroduce them in the 1960s. A NSW OEH senior threatened species spokeswoman said she was amazed to see the koala walk through a gate twice in as many weeks. The conservation area is protected under a state government five year,$100m Save Our Species programme designed to protect the endangered wallabies but it has also lured other species. The government also recently announced a koala strategy to boost populations across the state and plough$10m into cultivating vital habitat. The Australian Koala Foundation estimates there are less than 100,000 of the animals left in the wild, possibly as few as 43,000, across Qld., NSW, Victoria and South Australia (Gusmaroli, 2016, 5).

In 2018 the state government announced funding of $8.5m for a facelift of Jenolan Caves, to be concentrated on 3 projects:key projects. Trust Director Jodie Anderson states they're excited about a new Jenolan gateway, a new field study centre, and longer trails or walking tracks. Glover says JC has230,000 visitors a year. JCRTrust want to grow it by 160,000 visitors more. She mentions they'll add walking tracks using the funding (ABC radio interview with Jodie Anderson, Director, JCR Trust,30/5/2018).

In March 2019 further state goverment funding of $10.4m was announced to transform Caves into a 5 star tourist destination. MP for Bathurst, Paul Toole said all 36 guest rooms would be refurbished, including ensuites for each, the hotel's grand dining room, reception and entry areas would be improved and heating, cooling and power systems upgraded. Deputy Preimer John Barilaro said the funding complements NSW government's $8.5m grant announced in April 2018 to upgrade Jenolan Caves including the unforgettable Blue Lake, upgraded walking tracks and lookouts over stunning bushland (Village Voice, 7/3/2019).

In late December 2019 a massive bushfire, centred on Green Wattle Creek, burnt 278,722 hectares and came dangerously close to the Jenolan Caves complex. On 30 December all tours, accommodation and eateries were suspended as firefighters from across NSW rushed to defend the site. Four buildings were destroyed: including its RFS fire station, but the precinct will reopen to the public on 1 February 2020. This was the worst bushfire threat to Caves House since the 1960s, a Dept. of Planning, Industry & Environment spokesperson said. All bushwalks remain off limits due to damage: longer tracks will be offline for some time. Jenolan Caves Road, the main approach, is yet to be declared safe. Visitor must use Edith Road (Morton, 2020). Floods followed, closing the site again from 11-23 February 2020 (Morton, 2020). The Jenolan Caves Road is expected to reopen to the public this week, after being cut off by floods and a landslip in March (12/5/2021).

Historic Themes

Records Retrieved: 45

National Theme	State Theme	Local Theme
Developing cultural institutions and ways of life	Environment	Ways of life 1950-2000
Developing cultural institutions and ways of life	Environment	Ways of life 1900-1950
Developing cultural institutions and ways of life	Environment	Ways of life 1850-1900
Developing cultural institutions and ways of life	Environment	Living in a bushland setting
Developing cultural institutions and ways of life	Environment	Holidaying in hill stations and mountain retreats
Developing cultural institutions and ways of life	Pastoralism	Visiting lookouts and places of natural beauty

Developing cultural institutions and ways of life	Pastoralism	Visiting heritage places
Developing cultural institutions and ways of life	Pastoralism	Tourism
Developing cultural institutions and ways of life	Pastoralism	Outdoor relief
Developing cultural institutions and ways of life	Pastoralism	Going to see the caves
Developing cultural institutions and ways of life	Pastoralism	Going bushwalking
Developing cultural institutions and ways of life	Pastoralism	Gathering at landmark places to socialise
Developing cultural institutions and ways of life	Pastoralism	Climbing mountains and peaks
Developing cultural institutions and ways of life	Pastoralism	Activities associated with relaxation and recreation
Developing cultural institutions and ways of life	Defence	work of stonemasons
Developing cultural institutions and ways of life	Defence	Landscaping - Victorian period
Developing cultural institutions and ways of life	Defence	Landscaping - Federation period
Developing cultural institutions and ways of life	Defence	Landscaping - Federation period
Developing cultural institutions and ways of life	Defence	Landscaping - 20th century interwar
Developing cultural institutions and ways of life	Defence	Interior design styles and periods - Victorian
Developing cultural institutions and ways of life	Defence	Interior design styles and periods - Edwardian
Developing cultural institutions and ways of life	Defence	Building in response to natural landscape features.
Developing cultural institutions and ways of life	Defence	Architectural styles and periods - Victorian (late)
Developing cultural institutions and ways of life	Defence	Adaptation of overseas design for local use
Marking the phases of life	Social institutions	Associations with Joseph Henry Maiden, Director Botanic Gardens 1896-1924, botanist, museum curator
Marking the phases of life	Social institutions	Associations with Charles Bogue Luffman, horticulturist, educator
Marking the phases of life	Social institutions	Associations with Walter Liberty Vernon, Government Architect 1890-1911, private architect
Marking the phases of life	Social institutions	Associations with William Blakely (1875-1941), botanist and plant collector
Marking the phases of life	Social institutions	Associations with George McRae, architect
Governing	Land tenure	State government
Governing	Land tenure	Developing roles for government - conserving cultural and natural heritage

Governing	Land tenure	Developing roles for government - administration of land
Building settlements, towns and cities	Welfare	Vernacular hamlets and settlements
Building settlements, towns and cities	Welfare	Planned towns serving a specific industry
Building settlements, towns and cities	Mining	Changing land uses - from rural to tourist
Building settlements, towns and cities	Agriculture	Adapted heritage building or structure
Building settlements, towns and cities	Agriculture	Accommodating travellers and tourists
Developing local, regional and national economies	Events	Places important in developing conservation processes
Developing local, regional and national economies	Events	Landscapes of cultural and natural interaction
Developing local, regional and national economies	Convict	Operating a tourism venture
Peopling the continent	Aboriginal post-contact	Gundungurra Nation - evidencing creation stories
Tracing the evolution of a continent's special environments	Exploration	Scientific: Geoperiod Quarternary Epoch Pleistocene 10 000 to 1.7 million years ago
Tracing the evolution of a continent's special environments	Exploration	Other open space
Tracing the evolution of a continent's special environments	Exploration	Cultural: Conserving and protecting natural features
Tracing the evolution of a continent's special environments	Exploration	Cultural: Caves and underground spaces known to humans

Assessment

Criteria a)

Historical Significance	**Include**	**Exclude**
Jenolan Caves Reserve is of state significance for its ability to demonstrate the significant historical activity of identifying and conserving the natural resources of NSW - in this case, the caves and karst landscapes that have developed as important scientific and tourist destinations throughout the late 19th and 20th centuries. The Reserve is highly significant as the first public reserve set aside in NSW for the protection of a natural resource - in this case, the caves, and as such predates the creation of The National Park in 1879. The caves hamlet illustrates the significant human activity of providing accommodation for travellers and tourists since the 1890s in romantic buildings especially designed for this purpose by the Government Architect (HO).		

Criteria b)

Historical Association Significance **Include** **Exclude**

Jenolan Caves Reserve is significant for its associations with Government Architect Walter Liberty Vernon, who design much of Caves House. Although only the first or 1897 wing was built during his tenure, his plans were respected and adapted by subsequent government architects so that the original style and setting for the building has been largely maintained to the present day (HO).

Criteria c)

Aesthetic/Technical Significance **Include** **Exclude**

Jenolan Caves Reserve is of state significance for the highly regarded aesthetic qualities of the caves and cave formations, reflected in cave and formation names such as Aladdin, Orient and Temple of Baal caves and Gem, Arabesque, Angel's Wing and Pool of Reflections formations; for the ability of the caves to demonstrate technological developments such as the first use of electric cave lighting in the 1880s, and the first development of hydro-electric power in Australia. The setting of the caves hamlet in the Jenolan Valley, with the tiny hamlet and picturesque Caves House almost dwarfed by steeply rising cliffs on all sides, the entrance into the hamlet through the fortress-like Grand Arch, and the distinctive Blue Lake formed by the weir for the hydro-electric scheme, all combine to form a landmark landscape of great beauty and distinctiveness (HO).

Criteria d)

Social/Cultural Significance **Include** **Exclude**

Jenolan Caves Reserve is of state significance for its associations with many groups of people, three of which have been particularly identified – tourists, speleologists (that is, those who study caves and engage in caving) and guides. From the 1860s travellers and cavers have visited the Reserve, and cavers have continued to explore and make know to the public more of the caves, their connecting passages and the often unique plants and animals that inhabit this subterranean and lightless world. The caves are also important to the community of caretakers and guides who for nearly 150 years have guided visitors through the caves, shown them the beauty and wonders of the caverns, interpreted and educated people about the geological history of eastern Australia, and made the caves hamlet their home (HO).

Criteria e)

Research Potential **Include** **Exclude**

Jenolan Caves Reserve is of state significance for its ability to yield information on the geological history of NSW and of the Australian continent, as the benchmark karst landscapes contained within the NSW reserve system, and for the archaeological potential of the hamlet area to provide evidence of the early period in the development of tourism in NSW (HO).

Criteria f)

Rarity **Include** **Exclude**

The Jenolan Caves Reserve is of state significance for the number of rare and uncommon flora and fauna species to which it is home, especially within the caves; for containing the greatest diversity of cave invertebrates in NSW; and for the evidence it can demonstrate of the development of tourism, especially mountain and caving tourism, for over a century and a half in NSW (HO).

Criteria g)

Representative **Include** **Exclude**

Integrity/Intactness **Updated** 03/25/2004

High

References

References

Records Retrieved: 30

Title	Author	Year	Link	Type
Jenolan Caves Trust receives $7.9m to aid flood repair, restoration	unattributed, The Lithgow Mercury, 14/7/2021	2021	https://www.lithgowmercury.com.au/story/7339624/jenolan-caves-flood-recovery-boosted-by-79-million-injection/	Written
Jenolan Caves: opening date set for visitors to the historic tourist site	Morton, Nadine	2020	www.redlandcitybulletin.com.au/story.floods-and-fires-but-jenolan-caves-is-ready-to-reopen-again	Written
House survives 'worst threat' in 50 years	Morton, Nadine	2020		Written
'Jenolan Caves Tourism: Stalactite to Stalacmite: return to the halcyon days'	Power, Julie	2018		Written
Caves House - and its landscape setting - a talk by Chris Betteridge (flier)	Australian Garden History Society, Sydney & Northern NSW Branch / Betteridge, Chris & Margaret	2018	www.gardenhistorysociety.org.au/branches	Written
Government Architects - part 2	Le Sueur, Angela	2016		Written

Conservation Management Plan - Caves House & Jenolan Caves, Jenolan Karst Conservation Reserve	Urbis; and Musecape (Chris & Margaret Betteridge: Caves infrastructure and moveable heritage inventory)	2016		Written
'The First Caves House'	Hay, David	2013	www.jenolancaves.org.au	Written
Jenolan Caves House - Historic Landscape (report & slideshow)	Eddison, Ian	2010		Written
Jenolan Caves	Tourism NSW	2007	http://www.visitnsw.com.au/Operator.aspx?ProductId=9013717	Tourism
Jenolan Caves Cottages	Tourism NSW	2007	http://www.visitnsw.com.au/Operator.aspx?ProductId=9006217	Tourism
Jenolan Caves	Tourism NSW	2007	http://www.visitnsw.com.au/Destination.aspx?DProductId=9002727	Tourism
Jenolan Caves Reserve	Attraction Homepage	2007	http://www.jenolancaves.org.au/	Tourism
Jenolan Caves Resort	Tourism NSW	2007	http://www.visitnsw.com.au/Operator.aspx?ProductId=9000202	Tourism
'Blakely, William F. (1875-1941)' entry	Australian National Botanic Gardens	2007	http://www.anbg.gov.au/biography/blakely-william.html	Written
Jenolan Karst Conservation Reserve - Draft Plan of Management	Jenolan Caves Reserve Trust & Department of Environment & Conservation	2006		Written
Building Report of Caves House	NSW Department of Commerce	2005		Written
New Aboriginal nominations to the State Heritage Register 20/1/04	NSW Heritage Office	2004		Written
Draft Plan of Management Jenolan Caves Karst Conservation Reserve	Manidis Roberts	2003		Written

Progress Report - 28 March 1996 - Jenolan Caves Reserve Natural, Cultural and Heritage Resource Inventory	Jenolan Caves Reserve Trust	1996		Written
Determining an Environmental & Social Carrying Capacity for Jenolan Caves Reserve	Manidis Roberts Consultants	1995		Written
The Caves House Precinct, Jenolan Caves Reserve: Conservation Plan (Built Environment)	Moore, Robert thrtough the NSW Department of Public Works, Architectural Division, Public Buildings Branch	1988		Written
Helictite - Journal of Australasian Cave Research volume 15(2)	Cox, G., James, J. & Dyson, H. (ed.s)	1984		Written
Helictite - Journal of Australasian Cave Research volume 22(2)	Cox, G. & James, J. (ed.s)	1984		Written
The Exploration and Speleogeography of Mammoth Cave, Jenolan	Dunkley, John & Anderson, Edward	1978		Written
The Caves of Jenolan 2: The Northern Limestone	Welch, B. (ed.)	1976		Written
'Australian Natural History' Special Issue - Australian Caves	The Australian Museum	1975		Written
Experiences in Cave Management of the NSW Department of Tourism	Brennan, W.	1973		Written

A Bibliography of the Jenolan Caves - Part 1 - Speleological Literature	Dunkley, John R.			Written
Danielle Gusmaroli, 'Koala comes strolling back after a 48 year break'	Gusmaroli, Danielle			Written

Heritage Studies

Records Retrieved: 1

Title	Year	Item Number	Author	Inspected By	Guidelines Used
Central West Pilot Program SHRP	2001	5051578	Heritage Office SHRP		Yes

Procedures / Workflows / Notes

Records Retrieved: 1

Application ID / Procedure ID	Section of Act	Description	Title	Officer	Date Received	Status	Outcome
32866	57(2)	Exemption to allow work	Standard Exemptions	Minister Cowied	11/09/2020		

Management

Management

Records Retrieved: 3

Management Category	Management Name	Date Updated
Recommended Management	Carry out interpretation, promotion and/or education	
Recommended Management	Prepare a maintenance schedule or guidelines	
Recommended Management	Review a Conservation Management Plan (CMP)	

Management Summary



Caption: SHR Plan 1937

Photographer: Heritage Division

Copyright Owner: No Credit

Date: 6/25/2004 12:00:00 AM



Caption: Cave formations in the Chifley Cave, with metal pipe and wire handrails for visitors

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 7/19/2000 12:00:00 AM



Caption: Cave formations in the Temple of Baal Cave, with metal pipe and chicken wire visitor guides and electric lighting amongst formations

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM

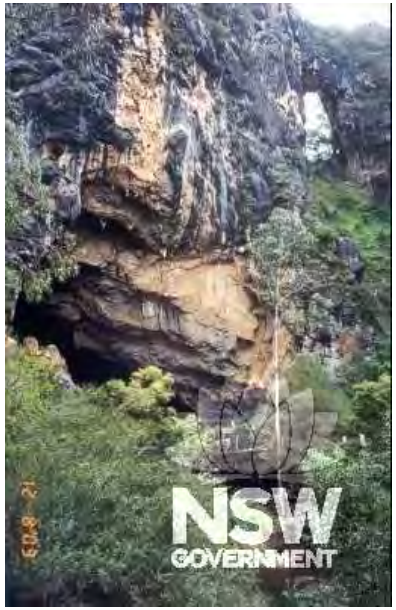


Caption: Pond (the Blue Lake) behind weir that originally supplied hydro-electrcity for lighting in the caves

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM



Caption: Entrance to the caves hamlet passes through the Grand Arch

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM



Caption: The caves hamlet, with Caves House in centre and ticket office of left, looking from the Grand Arch

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM



Caption: Roadway into the caves hamlet as it passes through the Grand Arch to reveal view towards Caves House across open square.

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM



Caption: SHR Plan 1937

Photographer: B. Baskerville

Copyright Owner: No Credit

Date: 6/25/2004 12:00:00 AM



Caption: Cave formations in the Temple of Baal Cave

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM



Caption: Cave formations in the Temple of Baal Cave

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM



Caption: De Burgh bridge leading to the Grand Arch and entrance to Caves House hamlet - the stream feeds into the weir pond (the Blue Lake)

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM



Caption: Cave formations in the Chifley Cave

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 7/19/2000 12:00:00 AM



Caption: Cave formations (helictites) in the Temple of Baal Cave

Photographer: Bruce Baskerville

Copyright Owner: No Credit

Date: 8/12/2003 12:00:00 AM

Appendix F
Biodiversity Assessment Report
EnviroKey

Transport
for NSW

Biodiversity assessment report

Two Mile Slope Remediation

October 2024 (ver 2)



NSW GOVERNMENT

transport.nsw.gov.au

Document review tracking

Project Title: Jenolan Caves Two Mile Hill Restoration Biodiversity Assessment Report	
Project Identifier:	23.BAR-113
Project Location:	\EnviroKey Public\Projects\TransportforNSW\JenolanCaves2Mile

Revision	Date	Prepared by (name)	Reviewed by (name)	Approved by (name)
Draft v1	10.11.2023	SS	-	Steve Sass (CEnvP)
Draft v2 (issued to GHD)	16.11.2023	SS, AM	LS	Steve Sass (CEnvP)
Draft v3	27.11.2023	SS	LS	Steve Sass (CEnvP)
Final draft	28.02.2024	AM	SS	Steve Sass (CEnvP)
Final draft v2	03.03.2024	SS	-	Steve Sass (CEnvP)
Final	15.05.2024	SS	-	Steve Sass (CEnvP)
Final v2	10.10.2024	SS	ZS	Steve Sass (CEnvP)

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Executive summary

Transport for NSW (Transport) proposes to remediate eight slope failures along the section of Jenolan Caves Road (MR253) commonly referred to as the 'Two Mile Access', at Jenolan Caves. The proposal is located within the South Eastern Highlands bioregion.

EnviroKey were engaged by GHD Pty Ltd on behalf of Transport for NSW to prepare a Biodiversity Assessment Report (BAR) that would form part of a Project Review of Environmental Factors (REF) to be assessed under Division 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The key impact from the proposal is the direct removal of up to 0.81 hectares of native vegetation, and removal of eight hollow-bearing trees. One plant community type (PCT) was identified during the field survey (PCT 3491: Jenolan-Tuglow Limestone Forest).

During the field survey, four threatened fauna species were recorded and are as follows:

- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) (V BC Act)
- Gang-gang Cockatoo (*Callocephalon fimbriatum*) (E EPBC Act, V BC Act)
- Scarlet Robin (*Petroica boodang*) (V BC Act)
- Koala (*Phascolarctos cinereus*) (E EPBC Act, E BC Act).

For those threatened and migratory biota that have potential to occur within the proposal area but went undetected during the field survey, further analysis by detailed habitat assessment was conducted. This found that an additional 32 threatened or migratory species have a moderate to high potential to occur within the study area based on habitat present. The fauna species detected during the field survey are typical of those occurring in similar habitats across the locality. No threatened flora species were detected.

This assessment has concluded that the proposal is '*unlikely*' to have a significant effect on any listed threatened flora and fauna species, communities, and their habitats in accordance with the BC Act with the exception of Mountain Trachymene and Needle Geebung. While field surveys completed did not record these species within the study area, there is some potential that these species may occur on the slopes and within gullies within the proposal site. As personnel were unable to access the slopes for the purpose of a targeted survey (due to safety on the previously failed slopes), presence/absence could not be confirmed. On that basis, EnviroKey have assumed potential presence for the purpose of this BAR. A pre-clearance survey of the slope would be required to ascertain presence/absence once access to the failed slopes is possible.

For the remaining biota, the assessment has also determined that the proposal is '*unlikely*' to have a significant effect on any EPBC Act listed threatened and migratory biota and their habitats or other matters of national environmental significance.

A series of mitigation measures as well as site-specific safeguards are proposed that have been developed to minimise potential impacts to biodiversity.

1. Introduction

1.1 Proposal background

Jenolan Caves Road (MR253) provides access to the Jenolan Caves Precinct, as well as campgrounds and other tourist attractions within Jenolan Karst Conservation Reserve (Figure 1-1). The Two Mile Access on Jenolan Caves Road is currently the primary access into the Jenolan Caves precinct due to the closure of the Five Mile access (that is from the east), due to substantial slope failures in 2021. This leaves the Two Mile Access as the only access into and out of the precinct. The Two Mile Access has also been subject to eight slope failures following extensive rainfall during various events commencing in July 2022 and continuing in to 2023, which has further restricted its use as the sole access into the Jenolan Caves Precinct. This proposal was identified to align with the objectives of improving road safety along the Two Mile Access by stabilising the high-risk slope and improving drainage conditions to mitigate future impacts of inclement weather.

EnviroKey were engaged by GHD Pty Ltd on behalf of Transport for NSW to prepare a Biodiversity Assessment Report (BAR) that would form part of a Project Review of Environmental Factors (REF) to be assessed under Division 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 The proposal

The key objective of the proposal is to stabilise and rehabilitate eight separate slopes along a three kilometre section of the 'Two Mile Access' stretch of Jenolan Caves Road at Jenolan. Key features of the proposal include:

- Installation of soil nails into eight failed slopes to stabilise and restore the slopes
- Surface stabilisation including placement of shotcrete
- Installation of drainage infrastructure along Jenolan Caves Road in the vicinity of three of the slope failure locations
- Establishment of construction compound and stockpile sites at Kanangra Walls Road and Car Park 1 and 2.

The study area applied to this BAR is the portion of the road corridor that contains the proposed impact area as provided by Transport. The locality is defined as a 550 metre buffer around the proposal which is consistent with the Biodiversity Assessment Methodology (BAM). The proposal site is identified in Figure 1-2.

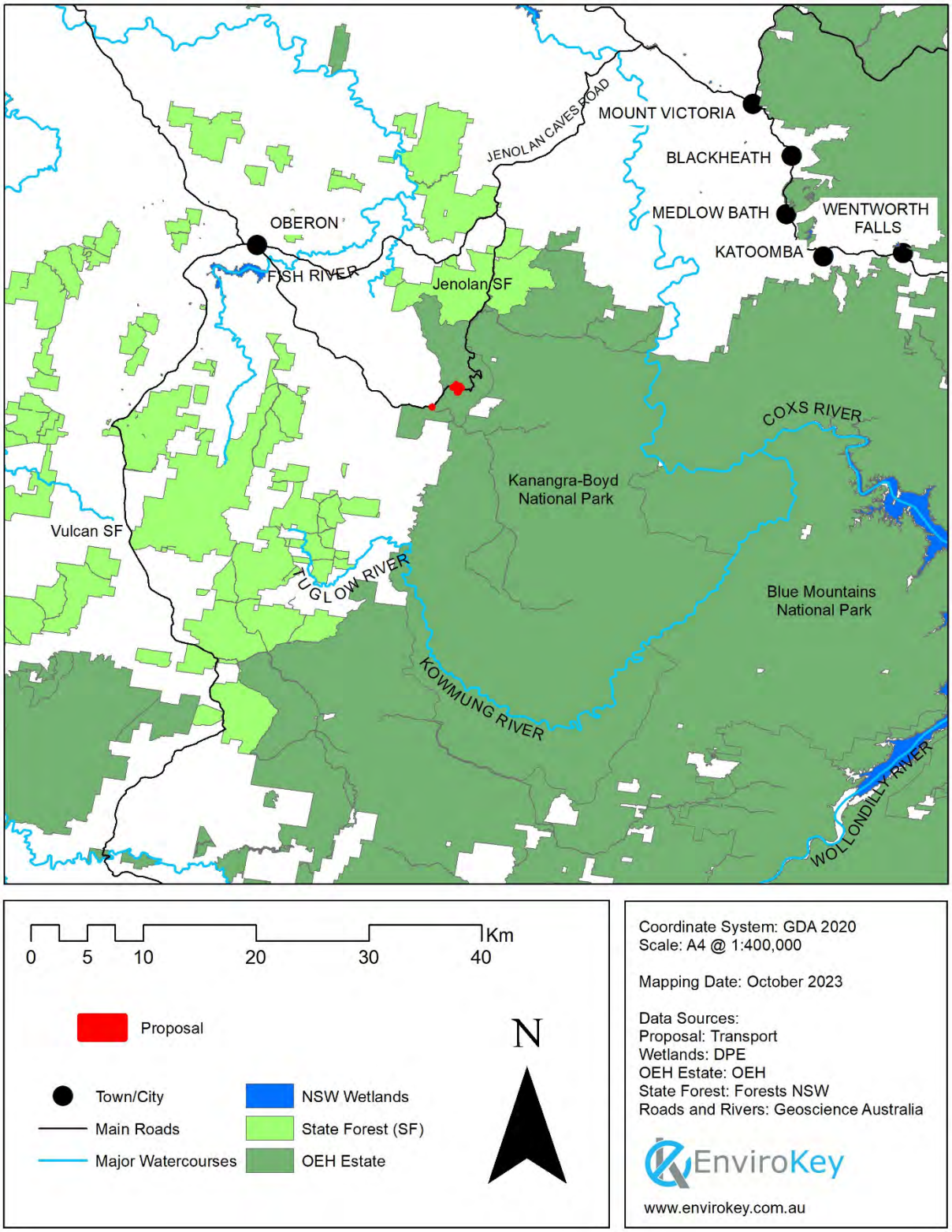


Figure 1-1: Proposal context

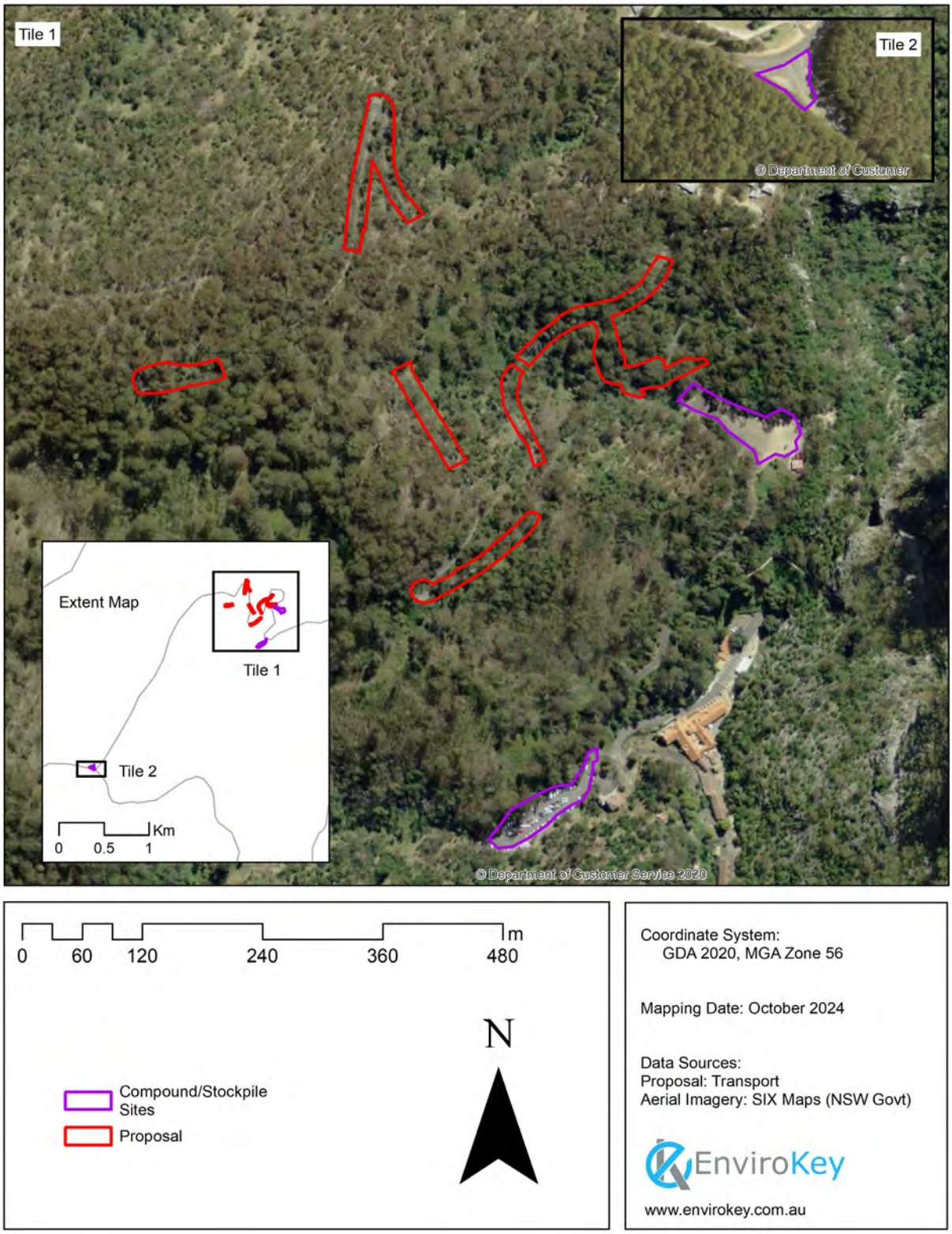


Figure 1-2: The proposal

1.3 Legislative context

A Review of Environmental Factors (REF) is prepared to satisfy Transport's duties under section 5.5 of the EP&A Act to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity" in making decisions on the likely significance of any environmental impacts. This biodiversity impact assessment forms part of the REF being prepared for the Two Mile Slope Remediation and assesses the biodiversity impacts of the proposal to meet the requirements of the EP&A Act.

The BC Act requires that the significance of the impact on threatened species, populations and threatened ecological communities is assessed using the test listed in Section 7.3 of the BC Act. Similarly, Part 7A of the FM Act requires that significance assessments are undertaken in accordance with Division 12 of the FM Act. Where a significant impact is likely to occur, a species impact statement (SIS) must be prepared in accordance with the Environment Agency Head's requirements, or a biodiversity development assessment report (BDAR) must be prepared by an accredited assessor in accordance with the biodiversity assessment method (BAM) (DPE 2020a).

In September 2015, a 'strategic assessment' approval was granted by the Federal Minister in accordance with the EPBC Act. The approval applies to Transport road activities being assessed under Division 5.1 (formerly Part 5) of the EP&A Act with respect to potential impacts on nationally listed threatened species, ecological communities, and migratory species.

As a result, Transport road proposals assessed via an REF:

- Must address and consider potential impacts on EPBC Act listed threatened species, populations, ecological communities, and migratory species, including application of the "avoid, minimise, mitigate and offset" hierarchy
- Do not require referral to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) for these matters, even if the activity is likely to have a significant impact
- Must use the Biodiversity Assessment Method (BAM) to calculate credits that would offset significant impacts on EPBC Act listed threatened species, populations, ecological communities, and migratory species.

To assist with this, assessments of impact significance are required for all relevant biodiversity values in accordance with the *Matters of National Environmental Significance: Significant impact guidelines 1.1. Environment Protection and Biodiversity Conservation Act 1999* (DoE 2013).

2. Methods

2.1 Personnel

The following personnel were involved in the field work and preparation of this BAR.

Table 2-1: Personnel

Name	Role	Qualifications
Steve Sass	Director / Principal Ecologist	B.App.Sci (Env.Sci) (Hons) GradCertCaptVertMngt (CSU) Biodiversity accredited assessor (BAAS17047)
Linda Sass	Director / Senior Ecologist	Ass.Deg.Gen.Stu (Science), B.A, Dip Ed (Sec), Cert III CaptAnimMngt
Alex Metcalfe	Project Officer (Ecology)	B.Env.Sci (on-going) Cert III CaptAnimMngt
Zoe Sass	Project Officer (GIS)	B.Sci/BA (Biology/Geography)
James Schlunke	Senior Botanist	B.Sci PhD

2.2 Background research

Background research was carried out to collect and review information on the presence or likelihood of occurrence of:

- Threatened terrestrial and aquatic species and their habitat
- Threatened ecological communities
- Important habitat for migratory species
- Areas of outstanding biodiversity value.

The following databases and information sources were reviewed:

- BioNet - the website for the Atlas of NSW Wildlife and Threatened Biodiversity Data Collection (TBDC) – searched [18.10.2023, 10km radius]
- BioNet Vegetation Classification database – reviewed [18.10.2023, 550m radius]
- BAM calculator (BAM-C)
- Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool – searched [09.10.2023, 10km radius]
- SEED Layer Intersection Tool – searched [18.10.2023]
- NSW DPI Fisheries Spatial Data Portal
- Regional vegetation mapping e.g., 'State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019)'
- Commonwealth Atlas of Groundwater Dependent Ecosystems (GDE): GDE Atlas Map: Water Information: Bureau of Meteorology (bom.gov.au)
- National Flying-fox monitoring viewer (environment.gov.au)
- Core Koala Habitat identified by the Biodiversity and Conservation SEPP 2022
- Any previous recent and relevant surveys (e.g., preliminary environmental investigation, options assessments) or studies.

2.3 Vegetation assessment

2.3.1 Vegetation mapping

To better understand the extent of native vegetation within the general vicinity of the proposal, an assessment using the Biodiversity Assessment Methodology (BAM) was carried out on the existing vegetation community datasets that occur within the study area. The NSW State Vegetation Type (SVT) Map covers the study area (DPE, 2022). The NSW SVT identifies nine plant community types (PCT) within a 550 metre radius of the proposal (Table 2-2, Figure 2-1). The SVT mapping datasets are produced through a combination of previous map sets, GIS modelling, but with limited ground validation, they often have widespread inaccuracies, including not mapping existing vegetation with a PCT unit. However, the SVT mapping does provide an indicative analysis of the potential PCTs that may occur in the vicinity of the proposal, and these were used to guide field surveys and understanding of vegetation types and extent beyond the boundaries of the proposal.

Table 2-2: Existing vegetation mapping (NSW State Vegetation Type Map) within a 550 metre buffer of the proposal

Plant community type (PCT)	Threatened ecological community	Area (ha)
PCT 3211 – Central Tableland Montane Wet Forest	-	120.74
PCT 3294 – Central Tableland Peppermint-Gum Montane Forest	-	95.71
PCT 3303 – Central Tableland Ribbon Gum Sheltered Forest	Endangered (BC Act) Mt Canobolas Xanthoparmelia Lichen Community	2.77
PCT 3347 – Southern Tableland Creekflat Ribbon Gum Forest	-	0.9
PCT 3369 – Central Tableland Ranges Peppermint-Gum Grassy Forest	-	0.02
PCT 3491 – Jenolan-Tuglow Limestone Forest	-	77.02
PCT 3650 – Goulburn-Lithgow Ranges Silvertop Ash Forest	-	4.82
PCT 3735 – Central Tableland Peppermint Shrub-Grass Forest	-	3.18
PCT 3946 – Newnes Plateau Swamp Woodland	-	3.37
Non-native vegetation	-	25.89

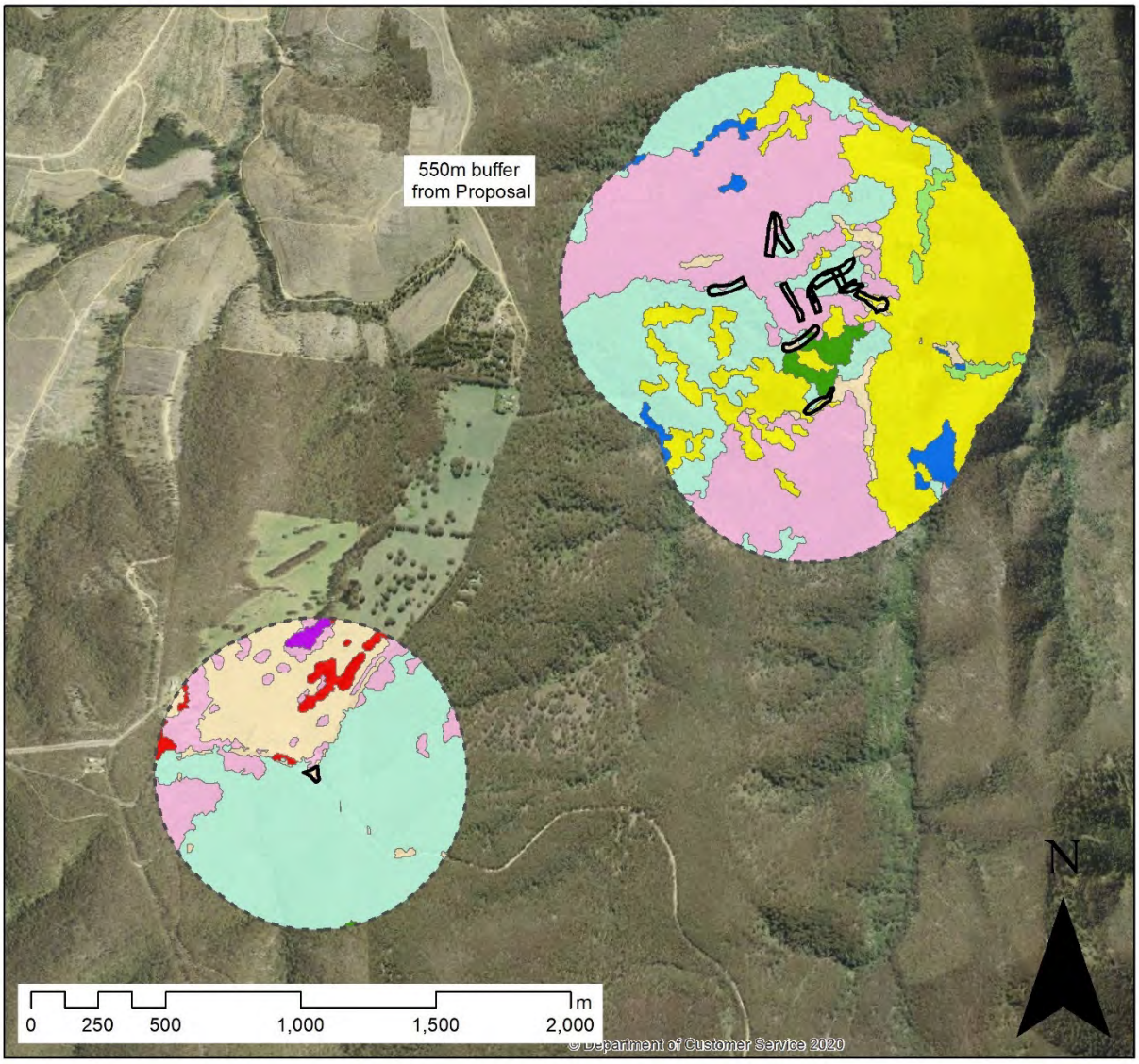


Figure 2-1: Existing regional vegetation mapping within a 550-metre buffer of the study area

2.3.2 Vegetation survey and classification

Threatened species searches and general vegetation surveys were carried out over numerous days. Field surveys occurred on the 24 and 25 October 2023, as well as 4 November 2023. A total of 12 hours of field surveys were completed by two persons.

The aims of the flora surveys were to:

- Determine all vegetation communities present within the study area, their condition and extent, with reference to the DPE plant community type (PCT) classification
- Identify potential Threatened Ecological Communities (TECs) within the study area and determine their condition and extent
- Identify whether threatened flora species are present within the study area, and whether it is likely that any have the potential to occur within the habitats present
- Identify areas of high weed infestation.

Species and vegetation communities identified from the background searches as potentially occurring in the study area were targeted during the surveys.

Flora survey methods were based on the *Threatened Species Survey and Assessment: Guidelines for developments and activities* (DEC, 2004) using the random meander method. A plot based vegetation survey in accordance with the BAM could not be completed due to the WHS requirement that personnel were not permitted to leave the road formation for safety reasons. As such, a native tree stem count within a 20 metre x 20 metre plot estimate, was attempted by visual estimate (Figure 2-2).

Native vegetation communities/types were classified in accordance with the NSW Vegetation Information System (DPE, 2023). Threatened ecological communities (if present) were classified in accordance with relevant State and Federal threatened ecological community descriptions (DPE/BCS, 2023, SPRAT, 2017).

Exotic species were checked for priority weed status on the Department of Primary Industries website (DPI, 2022).

2.3.3 Plot-based vegetation survey

No Plot-based full floristic surveys were completed due to WHS requirement that personnel were not permitted to leave the road formation due to safety concerns with the stability of the previously failed slope. Not undertaking the survey using the plot-based survey was discussed with Transport prior to the survey commencement.

2.4 Threatened species assessment

2.4.1 Habitat suitability assessment

The desktop analysis, database searches and literature reviews found that threatened and migratory biota are regularly recorded in the locality. Figure 2-2 to Figure 2-5 provide the spatial locations of records of these biota within the locality of the proposal (10-kilometre radius).

A habitat assessment for the threatened and migratory species with the potential to occur within the vicinity of the proposal is provided in Appendix B. This revealed that a total of 36 threatened or migratory biota were known to or have a moderate to high potential to occur in the vicinity of the proposal.

EnviroKey also attempted to map important habitat features including hollow-bearing trees from the road formation. On this basis, exact locations are estimated only given that access to the slopes was not possible due to safety reasons.

2.4.2 Targeted flora surveys

Targeted flora surveys were carried out on the 24 October 2023. Random meander transects were completed for threatened flora species from the road formation only (Figure 2-2).

2.4.3 Targeted fauna surveys

Targeted fauna surveys were carried out on the 24 October and 4 November 2023. The locations of these surveys are mapped on Figure 2-6. A total of six person hours of field survey was conducted with the proposed nocturnal surveys cancelled due to

deteriorating weather conditions. The presence of potential habitat and previous records within the JKCR were considered as the surrogate for presence given that the field survey would not be completed.

The following surveys were carried out within the proposal area:

Diurnal Bird Survey

Diurnal bird surveys were conducted using the widely accepted 'standardised method' (Watson, 2003). Any species of bird observed or identified from call recognition, were recorded during the field survey period. Surveys were completed across a range of environmental variables to encompass the range of avifaunal assemblages and their periods of activity (For e.g., within gullies, mid-slope, and during weather conditions (sunny, cloudy, rain, no rain).

Systematic Reptile Search

Reptile hand searches were completed. These were carried out by an experienced ecologist well known for their reptile expertise, by actively seeking basking animals and searching through leaf litter, roadside rubbish, and under fallen timber for inactive reptiles.

Systematic Amphibian Search

Where habitat was present, an experienced ecologist searched for active frogs through leaf litter, roadside rubbish and under fallen timber.

2.5 Limitations

A common limitation of many biodiversity studies is the short period of time in which they are conducted. When combined with a lack of seasonal sampling this can lead to either low detection rates or false absences being reported. This is also particularly relevant to highly mobile species that may not have been in the study area at the time of the survey. Additionally, the deteriorating weather conditions resulted in the cancellation of the proposed nocturnal survey. This was due to WHS concerns in the windy conditions. Given this, further analysis was conducted to evaluate which threatened and migratory biota were likely to occur within the vicinity of the proposal based on the presence of habitat. This is detailed within Appendix B.

The floristic survey carried out recorded as many species as possible and provides a comprehensive but likely not definitive species list particularly given that access to the failed slopes was not possible. Only flora species observed from the road pavement could be identified and included within this BAR. More species would have been recorded should access to the slopes have been possible, and more species would probably be recorded during a longer survey over various seasons. Nevertheless, the techniques used in this investigation are considered adequate to gather the data necessary to assess the impacts of the proposal on the flora species and vegetation communities found in the study area.

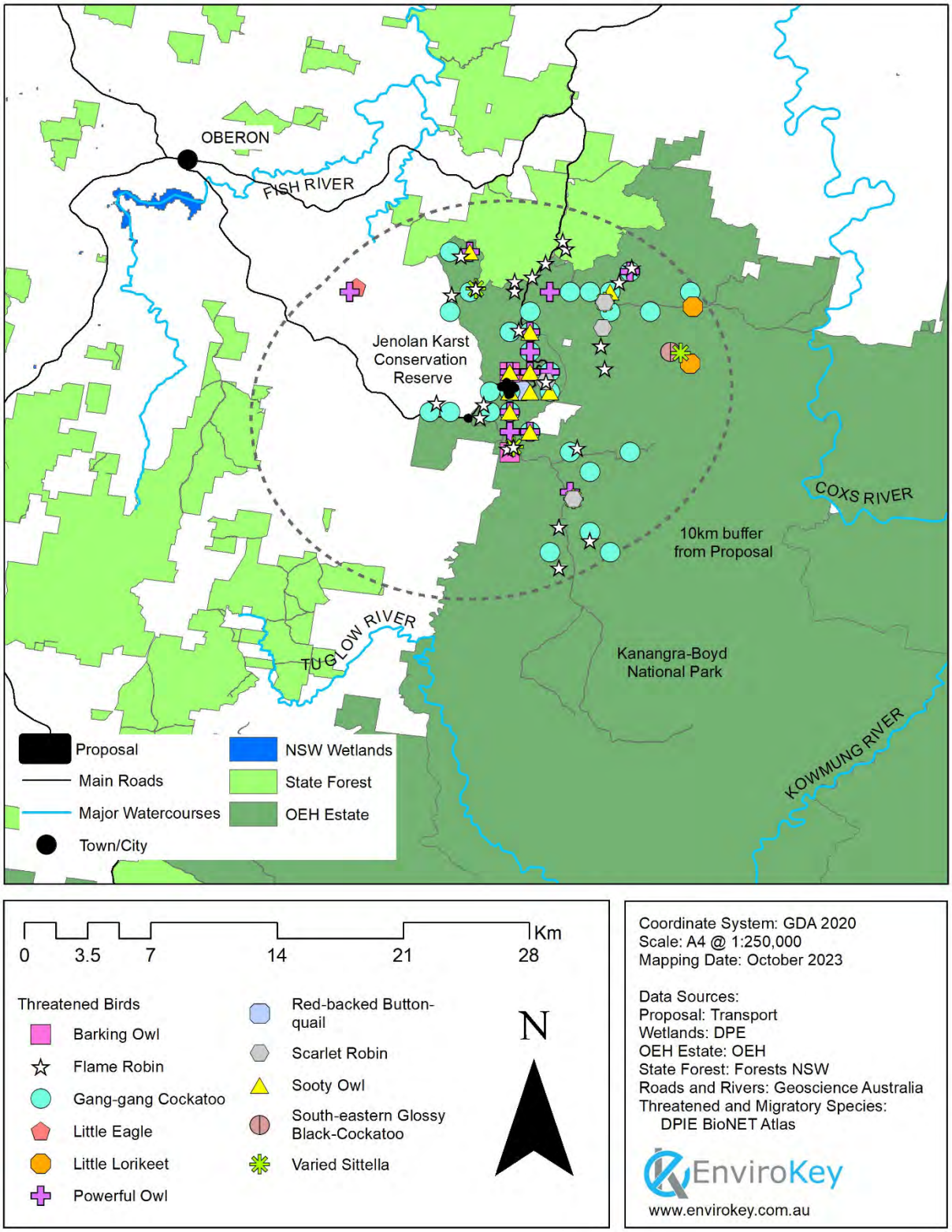


Figure 2-2: Existing threatened bird species records within the locality

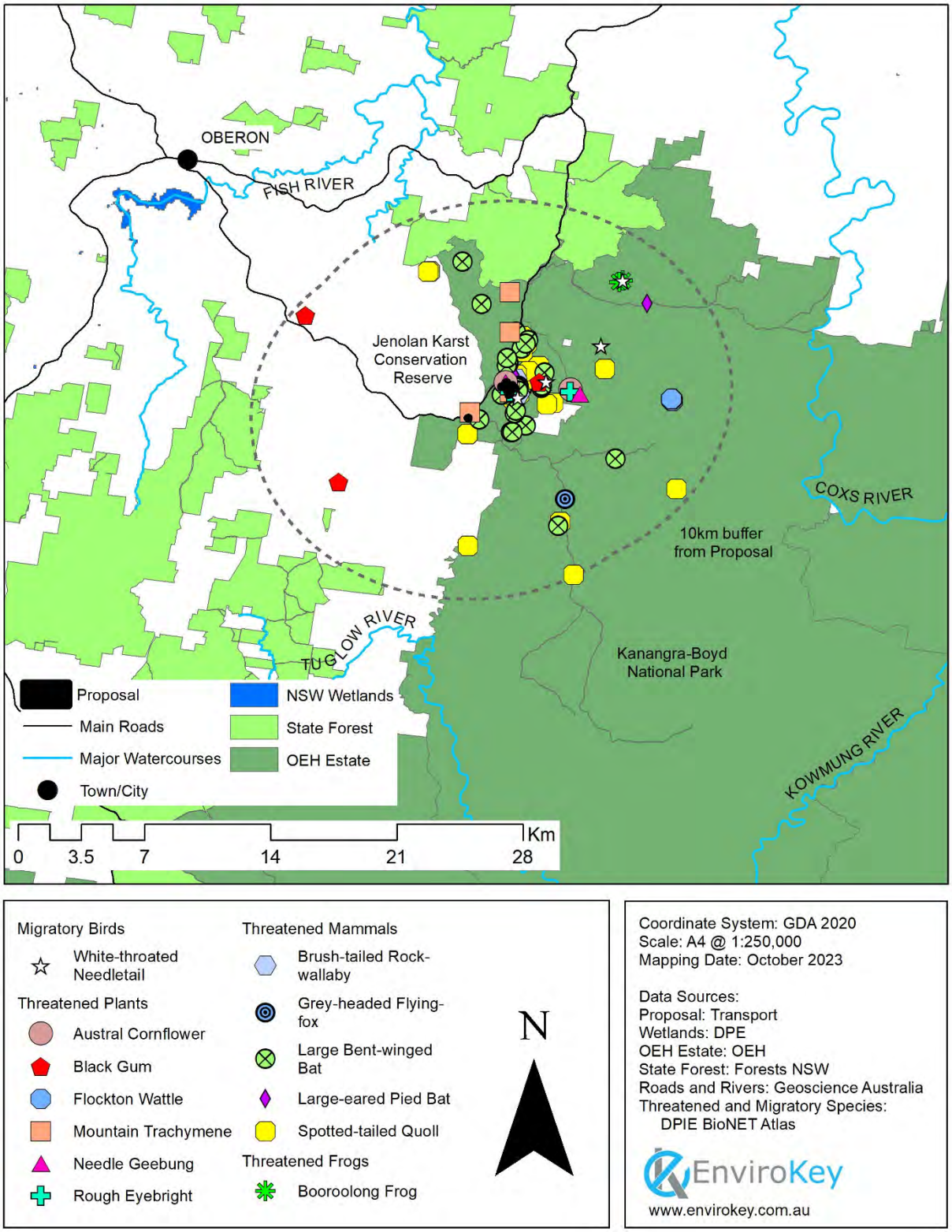


Figure 2-3: Existing threatened flora, frogs, mammals and migratory bird species records within the locality

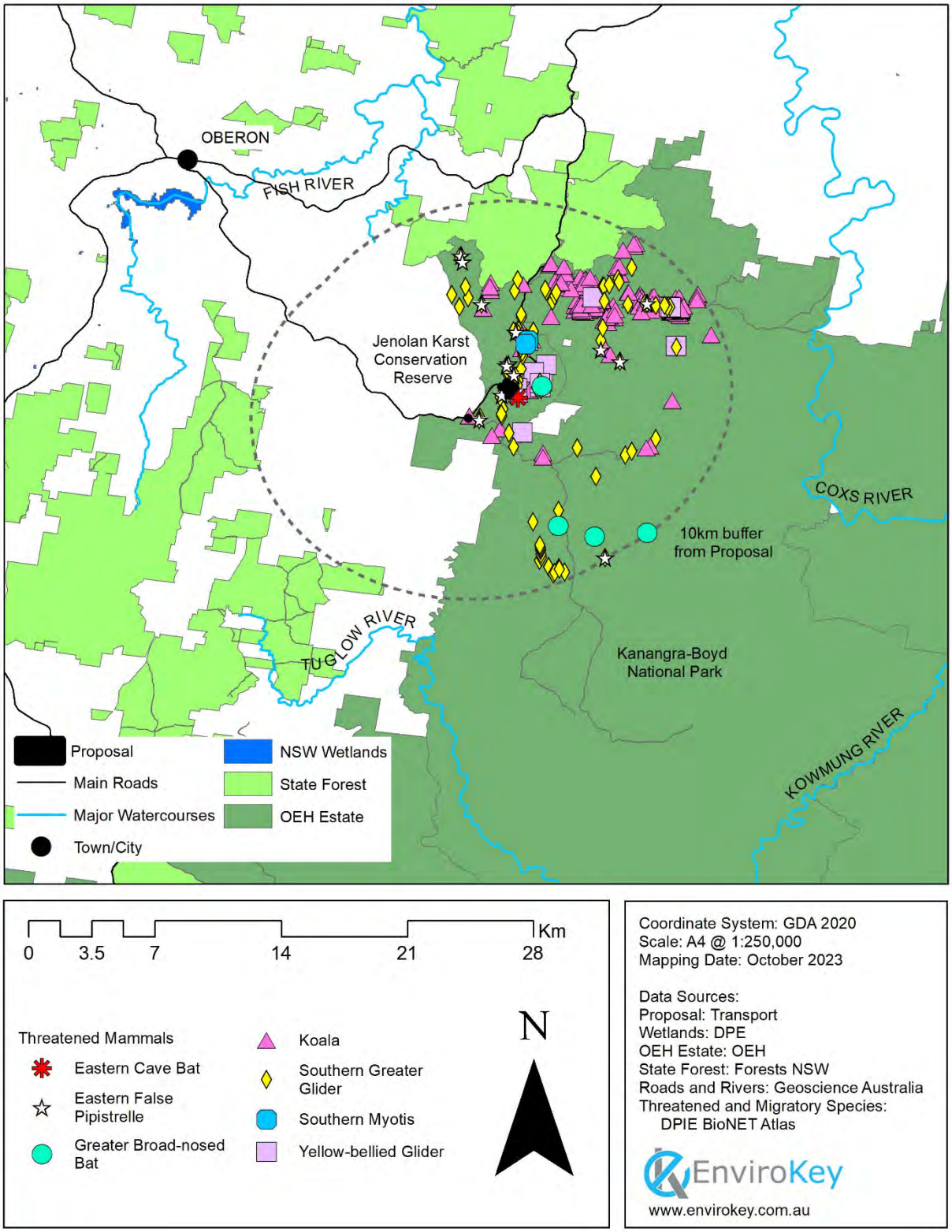


Figure 2-4: Existing threatened mammal species records within the locality

3. Existing environment

3.1 Plant community types and vegetation zones

The study area is located within the Jenolan Karst Conservation Reserve. This area was significantly burnt in the 2019/2020 Black Summer fires and due to the intensity of the fire events, regeneration has been poor.

Our desktop review of the State Vegetation Type (SVT) Map (DPE, 2023) identifies nine plant community types (PCT) within a 550 metre radius of the proposal (Table 2-2) and three within the proposal site (Figure 2-1). The field survey revealed inaccuracies with the SVT Mapping where all but two sections of the proposal area are not mapped as PCT 3491 – Jenolan-Tuglow Limestone Forest. The SVT mapping datasets are produced through a combination of previous map sets, GIS modelling, but with limited ground validation, so they often have widespread inaccuracies, including not mapping existing vegetation with a PCT unit. The SVT provides an indicative analysis of the potential PCT that may occur in the vicinity of the proposal. We have used this to guide our field surveys and our understanding of vegetation types and extent beyond the boundaries of the proposal. Nonetheless, the floristic diversity recorded and the landscape position, strongly suggests that only a single PCT is present within the study area and this fits neatly within PCT 3491 – Jenolan-Tuglow Limestone Forest (Figure 3-1). Unmapped portions of the proposal site are the existing road formation, unpaved shoulders, and car park areas.

Table 3-1 identifies the PCT and its extent within the proposal site and the study area. Section 3.1.1 includes a more detailed description of this PCT including photographs of this community within the proposal site (Photo 3-1 to Photo 3-2).

Table 3-1: Plant community types and vegetation zones

Plant community type (PCT)	Threatened ecological community	Area (ha)	
		Proposal site	Study area
PCT 3491 – Jenolan-Tuglow Limestone Forest	Not a TEC	0.81	2.84

3.1.1 PCT 3491: Jenolan-Tuglow Limestone Forest

Description

PCT 3491 is a tall open forest with a canopy characterised by an upper canopy of Ribbon Gum (*Eucalyptus viminalis*), with Narrow-leaved Peppermint (*Eucalyptus radiata*) and Brown Barrel (*Eucalyptus fastigata*) also commonly occurring. An occasionally dense lower canopy of Broad-leaved Hickory (*Acacia falciformis*) and Blackwood (*Acacia melanoxylon*) is typical, with Currajong (*Brachychiton populneus*) also occasionally present. The mid-storey is dense in response to recent fires and is dominated by Fireweed Groundsel (*Senecio linearifolius*), Blackthorn (*Bursaria spinosa*) and Tree Violet (*Melicytus dentatus*), with Mountain Kangaroo Apple (*Solanum linearifolium*) and Australian Indigo (*Indigofera australis*) also common in places. The climber Headache Vine (*Clematis glycinoides*) is also common in the mid-storey. The ground-storey features grasses Tussock (*Poa labillardierei*), Weeping Grass (*Microlaena stipoides*), Long-leaved Wallaby Grass (*Rytidosperma longifolium*) and Snowgrass (*Poa sieberiana*), and forbs Stinging Nettle (*Urtica incisa*), *Veronica derwentiana* subsp. *subglauca*, *Geranium solanderi* var. *solanderi* and Prickly Starwort (*Stellaria pungens*).

The canopy in PCT 3491 at the proposal site comprises a variably sparse canopy due to tree death associated with the 2019-2020 bushfires, with some areas almost entirely lacking a living canopy. Some areas around the two carparks and lower road sections contain a high cover of exotic plant species in the ground-storey, particularly Periwinkle (*Vinca major*) and Titsan (*Hypericum androsaemum*).

PCT ID	3491
PCT name	Jenolan-Tuglow Limestone Forest
Vegetation class	Southern Escarpment Wet Sclerophyll Forests
Vegetation formation	Dry Sclerophyll Forests (Shrub/grass sub-formation)
Estimate of per cent cleared	7.57 %

Area in subject land	0.81 ha
Conservation status	Not a TEC
Vegetation zones (condition) and plots	Poor to moderate to moderate-good (no BAM plots)

Floristic and structural summary of PCT 3491 within the proposal site

Growth form	Typical species
Trees	*Eucalyptus viminalis, Eucalyptus fastigata, Eucalyptus radiata, Acacia melanoxylon, Brachychiton populneus*
Shrubs	*Acacia falciformis, Bursaria spinosa, Melicytus dentatus, Solanum linearifolium, Indigofera australis, Exocarpos cupressiformis*
Grass and grass-like	*Rytidosperma longifolium, Carex appressa, Microlaena stipoides var. stipoides, Rytidosperma racemosum var. racemosum, Poa labillardierei, Lomandra longifolia*
Forb	*Senecio linearifolius*, *Veronia derwentiana*, *Geranium solanderi var. solanderi*, *Rumex brownie*, *Urtica incisa*, *Wahlenbergia gracilis*, *Cynoglossum australe*
Fern	*Pteridium esculentum*
Other	*Clematis glycinoides*, *Glycine clandestina*, *Hardenbergia violacea*
Exotic	N/A
High Threat Exotic	N/A

Condition states

Three condition classes were identified within the proposal site:

- Poor – moderate (0.27 ha)
- Moderate (0.41 ha)
- Moderate – good (0.13 ha).



Photo 3-1: PCT 3491 within the study area



Photo 3-2: PCT 3491 within the study area

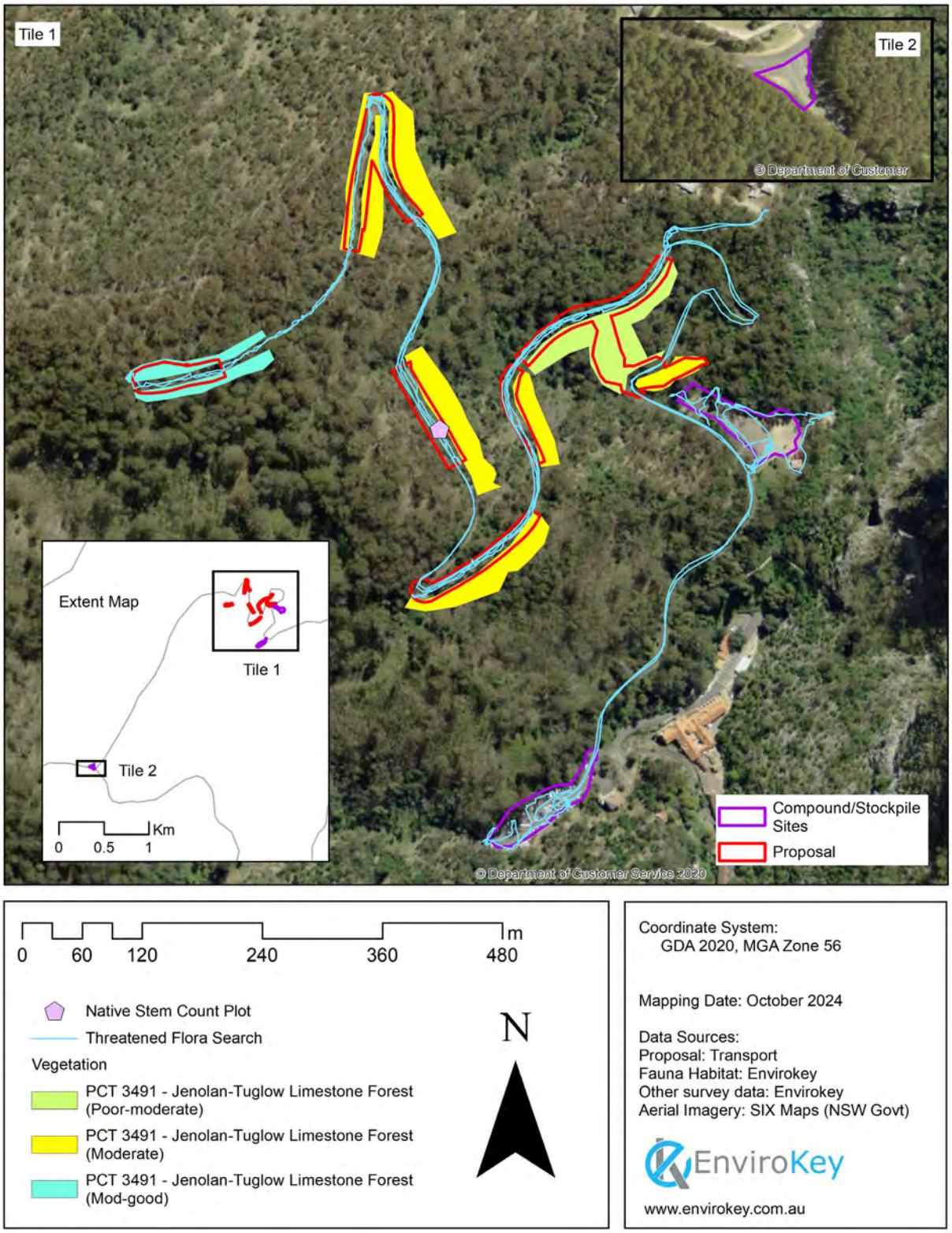


Figure 3-1: Plant community types within the study area (unmapped areas are road formation)

3.2 Threatened ecological communities

No threatened ecological communities (TEC) were recorded during the field survey. PCT 3491 is not listed as a TEC within the BioNET Vegetation Information System Classification.

3.3 Fauna habitats

The study area is characterised by eucalypt forest (Figure 3-2). However, as a result of the Black Summer fires, large open gaps in the canopy are present, and many trees are dead with little to no epicormic growth present (Photo 3-3). Some forest regrowth is occurring, but this is sporadic across the slopes. This degradation of the vegetation present could be as a result of the slope failures.

A total of 12 hollow-bearing trees were identified within the vicinity of the proposal, with eight of these within the proposal site (Appendix F). The fauna habitats present are consistent with those occurring across the 3,085 hectare Jenolan Karst Conservation Reserve.



Photo 3-3: Example of eucalypt forest within the proposal site

3.4 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes, and ecosystem services. The proposal does not cross any waterways; however, Surveyors Creek does flow underneath carpark no. 1 (Figure 3-3, Photo 3-4).



Photo 3-4: Surveyors Creek flows underneath carpark no. 1.

3.5 Threatened species

The field survey revealed the presence of four threatened biota within the study area (Figure 2-6) with these being:

- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)
- Gang-gang Cockatoo (*Callocephalon fimbriatum*)
- Scarlet Robin (*Petroica boodang*)
- Koala (*Phascolarctos cinereus*).

Based on the Habitat Assessment carried out in Appendix B, 32 additional biota have a moderate to high likelihood of occurrence within the study area, these being:

- Bats (Eastern False Pipistrelle, Greater Broad-nosed Bat, Large-eared Pied Bat, Large Bent-winged Bat, Southern Myotis)
- Birds (Barking Owl, Diamond Firetail, Dusky Woodswallow, Flame Robin, Little Eagle, Little Lorikeet, Masked Owl, Painted Honey Eater, Pilotbird, Powerful Owl, Rainbow Bee-eater, Regent Honeyeater, Rufous Fantail, Satin Flycatcher, Sooty Owl, South-eastern Glossy Black-Cockatoo, Varied Sitella, Swift Parrot, White-throated Needletail)
- Mammals (Eastern Pygmy-possum, Brush-tailed Rock-wallaby, Southern Greater Glider, Spotted-tailed Quoll, Yellow-bellied Glider)
- Reptiles (Rosenberg's Goanna)
- Flora (Mountain Trachymene, Needle Geebung).

These species are discussed in further detail below.

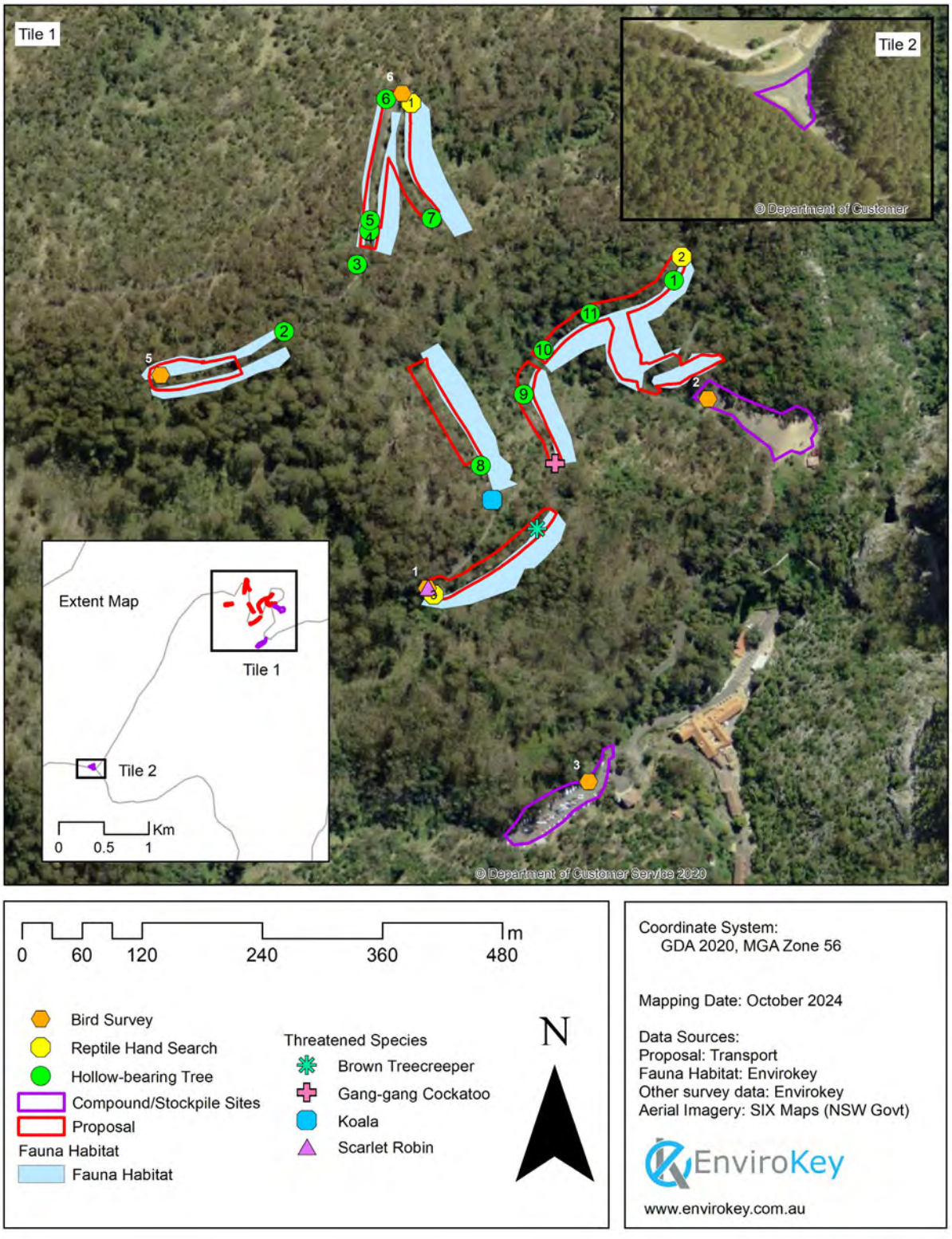


Figure 3-2: Fauna habitats and field survey locations within the study area (unmapped areas are road formation)

Table 3-2: Threatened species surveys results

Species name	EPBC Act	BC Act	Identification method (not recorded, assumed, recorded, expert report)	Results
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	Not recorded	High likelihood of occurrence
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	-	V	Not recorded	Moderate likelihood of occurrence
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	Not recorded	Moderate likelihood of occurrence
Large Bent-winged Bat (*Miniopterus orianae oceanensis*)	-	V	Not recorded	High likelihood of occurrence
Southern Myotis (*Myotis macropus*)	-	V	Not recorded	Moderate likelihood of occurrence
Barking Owl (*Ninox connivens*)	-	V	Not recorded	Moderate likelihood of occurrence
Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)	V	V	Recorded	Recorded
Diamond Firetail (*Stagonopleura guttata*)	V	V	Not recorded	Moderate likelihood of occurrence
Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)	-	V	Not recorded	Moderate likelihood of occurrence
Flame Robin (*Petroica phoenicea*)	-	V	Not recorded	Moderate likelihood of occurrence
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	E	V	Recorded	Recorded
Little Eagle (*Hieraaetus morphnoides*)	-	V	Not recorded	Moderate likelihood of occurrence
Little Lorikeet (*Glossopsitta pusilla*)	-	V	Not recorded	Moderate likelihood of occurrence
Masked Owl (*Tyto novaehollandiae*)	-	V	Not recorded	Moderate likelihood of occurrence
Painted Honeyeater (*Grantiella picta*)	V	V	Not recorded	Moderate likelihood of occurrence
Pilotbird (*Pycnoptilus floccosus*)	V	-	Not recorded	Moderate likelihood of occurrence
Powerful Owl (*Ninox strenua*)	-	V	Not recorded	High likelihood of occurrence
Rainbow Bee-eater (*Merops ornatus*)	M	-	Not recorded	Moderate likelihood of occurrence

Species name	EPBC Act	BC Act	Identification method (not recorded, assumed, recorded, expert report)	Results
Regent Honeyeater (*Anthochaera phrygia*)	CE	CE	Not recorded	Moderate likelihood of occurrence
Rufous Fantail (*Rhipidura rufifrons*)	M	-	Not recorded	Moderate likelihood of occurrence
Satin Flycatcher (*Myiagra cyanoleuca*)	M	-	Not recorded	Moderate likelihood of occurrence
Scarlet Robin (*Petroica boodang*)	-	V	Recorded	Recorded
Sooty Owl (*Tyto tenebricosa*)	-	V	Not recorded	High likelihood of occurrence
South-eastern Glossy Black-Cockatoo (*Calyptorhynchus lathami lathami*)	V	V	Not recorded	Moderate likelihood of occurrence
Swift Parrot (*Lathamus discolor*)	CE M	E	Not recorded	Moderate likelihood of occurrence
Varied Sittella (*Daphoenositta chrysoptera*)	-	V	Not recorded	Moderate likelihood of occurrence
White-throated Needletail (*Hirundapus caudacutus*)	V M	-	Not recorded	Moderate likelihood of occurrence
Eastern Pygmy-possum (*Cercartetus nanus*)	-	V	Not recorded	Moderate likelihood of occurrence
Brush-tailed Rock-wallaby (*Petrogale penicillate*)	V	E	Not recorded	High likelihood of occurrence
Koala (*Phascolarctos cinereus*)	E	E	Recorded	Recorded
Southern Greater Glider (*Petauroides volans*)	E	E	Not recorded	Moderate likelihood of occurrence
Spotted-tailed Quoll (*Dasyurus maculatus*)	E	V	Not recorded	High likelihood of occurrence
Yellow-bellied Glider (*Petaurus australis*)	V	V	Not recorded	Moderate likelihood of occurrence
Rosenberg's Goanna (*Varanus rosenbergi*)	-	V	Not recorded	Moderate likelihood of occurrence
Mountain Trachymene (*Trachymene scapigera*)	E	E	Not recorded	Moderate likelihood of occurrence
Needle Geebung (*Persoonia acerosa*)	V	V	Not recorded	Moderate likelihood of occurrence

V= Vulnerable, E= Endangered, CE = Critically endangered, M = Migratory

Eastern False Pipistrelle

The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania (Churchill, 2008). They appear to show a preference for moist habitats, with trees taller than 20 m. They generally roost in eucalypt hollows, but they have also been found under loose bark on trees or in buildings. They forage on beetles, moths, weevils and other flying insects above or just below the tree canopy. While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present, this species is likely to forage in the surrounding forest and could potentially roost in hollow-bearing trees.

Eastern False Pipistrelle is known to occur within the Jenolan Karst Conservation Reserve (JKCR) (OEH, 2012). The JKCR has a high density of insectivorous bats presumably due to ample roosting resources (caves and tree hollows) and the elevated soil fertility.

Greater Broad-nosed Bat

The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland (DPE/BCS, 2023). It extends to the coast over much of its range (Churchill, 2008). The species is known to use a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present, this species is likely to forage in the surrounding forest and could potentially roost in hollow-bearing trees.

Greater Broad-nosed Bat is known to occur within the Jenolan Karst Conservation Reserve (JKCR) (OEH, 2012).

Large-eared Pied Bat

Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands (Williams and Thomson, 2018, Pennay, 2008). It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. Also found in well-timbered areas containing gullies. This species probably forages for small, flying insects below the forest canopy. While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present, this species is likely to roost in the extensive limestone caves of the area and forage in the surrounding forest. In a previous study, Large-eared pied bats were generally recorded near water or in the vicinity of the Grand Arch and the Devil's Coach House where they roost (OEH, 2012).

Large Bent-winged Bat

Large Bent-winged Bats occur along the east coast of Australia (van Harten, 2020, Gration, 2011, White, 2011, Slade and Law, 2007, Wilson, 2003). Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures (DPE/BCS, 2023). This species forms discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. At other times of the year, populations disperse within about 300 km range of maternity caves. Breeding or roosting colonies can number from 100 to 150,000 individuals. While a nocturnal survey was not completed due to WHS concerns for personnel, the species is a common resident in the JKCR which hosts regionally important roosting sites (OEH, 2012). The karst system at JKCR provides a wide diversity of caves, overhangs and other features that this species uses to roost. Surveys in 2011 recorded a large number of eastern bentwing-bats (~1000) in the 'southern limestone' area (Paradox Cave).

Southern Myotis

The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria (Gorecki et al., 2020, Gorecki, 2020, Gonsalves and Law, 2017, Marshall, 2011, Law and Urquhart, 2000, Law and Anderson, 1999). It is rarely found more than 100 km inland, except along major rivers. Generally, roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December. While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present, this species has the potential to roost in the extensive cave system, culverts and other infastructure and then forage in the surrounding forest.

Barking Owl

The Barking Owl is found throughout continental Australia except for the central arid regions. Although still common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in

NSW (Garnett and Baker, 2020i, Kavanagh and Stanton, 2012, Shelly, 2006, NPWS, 2003, Schedvin et al., 2001, Kavanagh et al., 1995). Core populations exist on the western slopes and plains and in some northeast coastal and escarpment forests. Many populations crashed as woodland on fertile soils was cleared over the past century, leaving linear riparian strips of remnant trees as the last inhabitable areas. While a nocturnal survey was not completed due to WHS concerns for personnel, the species is known to occur within the JKCR. A breeding event was recorded in 2005 in a tree close to the study area off Burmah Road where chicks successfully fledged (OEH, 2012). It is likely that the species is more common in areas closer to grassy and open habitats that flank the JKCR, as these preferences have been identified in other valleys such as the Capertee to the north and Burragorang to the east (OEH, 2012).

Brown Treecreeper (eastern subspecies)

The Brown Treecreeper is endemic to eastern Australia and occurs in eucalypt woodlands of inland plains and slopes of the Great Dividing Range (Garnett and Baker, 2020g, BOUNDS, 2019, DPI, 2019, Bennett et al., 2013, Montague-Drake et al., 2009, Cooper et al., 2002). It is less commonly found on coastal plains and ranges. The western boundary of the range of *Climacteris picumnus victoriae* runs approximately through Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell and along this line the subspecies intergrades with the arid zone subspecies of Brown Treecreeper (*Climacteris picumnus picumnus*) which then occupies the remaining parts of the state. A pair of Brown Treecreeper was recorded during the field survey. The pair was observed foraging on the eucalypts, but no observations of breeding behaviour were recorded. While the species has not been detected previously within the JKCR, the observer is very familiar with the species and its call, and so there is no doubt regarding its identification. It may be possible that the species has moved into the JKCR post-Black Summer Fires given the relatively open nature of the canopy in areas that were burnt, and that this species is generally considered a woodland species.

Diamond Firetail

The Diamond Firetail is endemic to south-eastern Australia, extending from central Queensland to the Eyre Peninsula in South Australia. It is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina (Garnett and Baker, 2020a, Krause and Caspers, 2018). Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species has a scattered distribution over the rest of NSW, though is very rare west of the Darling River. While the field survey did not detect any Diamond firetail, the species is well known from the forests and woodlands of the central tablelands including the Jenolan, Hampton and Edith localities. The presence of forest, albeit burnt forests, suggests that the species may occur in the study area as well as the 3,085 hectare JKCR.

Dusky Woodswallow

Dusky Woodswallow are widespread in eastern, southern and south western Australia. The species occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region. Depending on location and local climatic conditions (primarily temperature and rainfall), Dusky Woodswallow can be resident year-round or migratory. In NSW, after breeding, birds migrate to the north of the state and to southeastern Queensland, while Tasmanian birds migrate to southeastern NSW after breeding. Migrants generally depart between March and May, heading south to breed again in spring (Maddocks and Geiser, 2007, Sims, 2007, Fulton, 2005, Rowley, 2000, Robinson, 1993, Cooper, 1972).

While the field survey did not detect any Dusky Woodswallow, the species is well known from the forests and woodlands of the central tablelands. The presence of forest, albeit burnt forests, suggests that the species may occur in the study area as well as the 3,085 hectare JKCR.

Flame Robin

The Flame Robin is endemic to south eastern Australia, and ranges from near the Queensland border to south east South Australia and also in Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands. Flame Robin are occasionally known from temperate rainforest, but at high altitudes, are regularly seen in herbfields, heathlands, shrublands and sedgelands. Often occurs in recently burnt areas; however, habitat becomes unsuitable as vegetation closes up following regeneration (Garnett and Baker, 2020b, Robinson, 1992, Robinson, 1990).

While the field survey did not detect any Flame Robin, the species is well known from the forests and woodlands of the central tablelands including the Jenolan, Hampton and Edith localities. Flame Robin has been identified as a common breeding resident of the JKCR and has been previously recorded as being present in more than 40% of bird surveys prior to the Black Summer fires.

The presence of forest, albeit burnt forest, suggests that the species may occur in the study area as well as the 3,085 hectare JKCR.

Gang-gang Cockatoo

The Gang-gang Cockatoo is distributed from southern Victoria through south-eastern and central-eastern New South Wales (Garnett and Baker, 2020c, Davey and Eyles, 2016, NSWSC, 2008a, Lane et al., 2007, Cameron, 2007). In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. The species has undergone significant decline since the Black Summer fires resulting in listing under the EPBC Act (Mills, 2021, Garnett and Baker, 2020c).

A female Gang-gang Cockatoo was recorded during the field survey, flying across the study area through zone 4. The individual was observed flying toward carpark no. 1 where visual confirmation was lost. This sighting is not surprising given the presence of forest within the study area, as well as the larger extent of forest in the locality including the 3,085 hectare JKCR. The 2012 surveys by OEH confirm that the species was regularly recorded within the JKCR.

Little Eagle

The Little Eagle are found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. They are found in eucalypt forest, woodland or open woodland. Sheoak or *Acacia* woodlands and riparian woodlands of interior NSW are also used (Larkin et al., 2020, Rae et al., 2020, Brawata et al., 2019).

While the field survey did not detect any Little Eagle, the species is known from the locality and uses a wide variety of habitats. A single bird was recorded in McKeowns Valley in 2011 (OEH, 2012). The presence of forest, albeit burnt forest, suggests that the species may occur in the study area as well as the 3,085 hectare JKCR.

Little Lorikeet

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia (Courtney and Debus, 2006, DPE/BCS, 2023). NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs.

While the field survey did not detect any Little Lorikeet, the species is known to occur in the eucalypt forests of the Great Dividing range. The presence of forest, albeit burnt forest, suggests that the species may occur in the study area as well as the 3,085 hectare JKCR.

Masked Owl

The distribution of the Masked Owl extends from the coast where it is most abundant to the western plains (DECC, 2006, McNABB et al., 2003, Kavanagh, 2002b, Debus, 2001, Kavanagh and Murray, 1996). Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There does not appear to be any seasonal variation in its distribution.

While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present, this species is likely to occur in the JKCR.

Painted Honeyeater

The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution (Garnett and Baker, 2020d, Barea, 2012, Barea, 2008, Oliver et al., 2003).

While the field survey did not detect any Painted Honeyeater, the species is known to occur in the locality from time to time. The presence of forest, albeit burnt forest, suggests that the species may occur in the study area as well as the 3,085 hectare JKCR.

Pilotbird

Pilotbirds are a common resident of mountain gullies, on the coast and inland to the Great Divide, from the Blue Mountains to eastern Victoria including Gippsland. Pilotbirds are found in the ground level of wet forests on coastal mountain ranges and in moist gullies timbered with mature gumtrees and with a dense understorey of bracken, low shrubs or tree ferns (Garnett and Baker, 2020e).

While the field survey did not detect any Pilotbird, the species is known to occur in the eucalypt forests of the Great Dividing range. The presence of forest, albeit burnt forest, suggests that the species may occur in the study area as well as the 3,085 hectare JKCR.

Powerful Owl

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria (Soderquist and Gibbons, 2007, DECC, 2006). In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing. Now at low densities throughout most of its eastern range, rare along the Murray River and former inland populations may never recover.

The species is known to occur in the eucalypt forests of the Great Dividing range and within the 3,085 hectare JKCR. It has been acknowledged that the detection rate of Powerful Owl within the JKCR is much higher than other areas of their distribution, strongly suggesting the habitats present are of high quality to this species.

Rainbow Bee-eater

The Rainbow Bee-eater is found throughout mainland Australia, as well as eastern Indonesia, New Guinea and, rarely, the Solomon Islands (Lill and Fell, 2007, Chambers, 2005, Boland, 2004, Alan and Peter, 1997, Lill, 1993). In Australia it is widespread, except in desert areas, and breeds throughout most of its range, although southern birds move north to breed. The Rainbow Bee-eater is most often found in open forests, woodlands and shrublands, and cleared areas, usually near water. It will be found on farmland with remnant vegetation and in orchards and vineyards. It will use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels.

While the field survey did not detect any Rainbow Bee-eater, the species is known to occur in the eucalypt forests of the Great Dividing range and has been previously recorded in the 3,085 hectare JKCR (OEH, 2012).

Regent Honeyeater

The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Once recorded between Adelaide and the central coast of Queensland, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region (Meney et al., 2022, Garnett and Baker, 2020f, Crates et al., 2019, Crates, 2019). In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests. While the species has been previously recorded in the JKCR, it is generally consered that no suitable habitat is present and that any individuals are likely to be moving through on their winter migration (OEH, 2012).

Rufous Fantail

The Rufous Fantail is found in eastern coastal Australia. The Rufous Fantail is found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas. The Rufous Fantail is strongly migratory in the south of its range, it moves northwards in winter, and virtually disappears from Victoria and New South Wales at this time.

While the field survey did not detect any Rufous Fantail, the species is known to occur in the eucalypt forests of the Great Dividing Range and is likely to occur within the 3,085 hectare JKCR.

Satin Flycatcher

The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. The Satin Flycatcher is not a commonly seen species, especially in the far south of its range, where it is a summer breeding migrant. The Satin Flycatcher is found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests. The Satin Flycatcher is a migratory species, moving northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring.

While the field survey did not detect any Satin Flycatcher, the species is known to occur in the eucalypt forests of the Great Dividing Range and is likely to occur within the 3,085 hectare JKCR.

Scarlet Robin

The Scarlet Robin is found from southeast Queensland to south east South Australia and also in Tasmania and south west Western Australia. In NSW, it occurs from the coast to the inland slopes (Robinson, 1990). The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. The species occurs in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat (Robinson, 1992).

One male Scarlet robin was recorded during the field survey at the end of Zone 4. While the species is known to occur in JKCR, it is considered an uncommon visitor (OEH, 2012).

Sooty Owl

Sooty Owl occupies the eastern most one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands (DECC, 2006, Kavanagh, 2002a, Kavanagh and Bamkin, 1995, Kavanagh, 1991). They occur in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Territories are occupied permanently. The JKCR is well known for Sooty Owls, including where they are known to breed and roost in the reserve, including within the tourist precinct (OEH, 2012).

Substantial accumulation of regurgitated prey pellets shows that the caves within the JKCR have been used for a long period of time (OEH, 2012). Caves used include the Devil's Coach House, Nettle and Arch Cave, The Ballroom and Dreamtime Cave. During the 2012 survey a roost was also detected in a fig tree on the Jenolan River. Successful breeding of sooty owls has previously been observed in Devil's Coach House where mating occurred in March, eggs were laid in April and the young had left the nest by October. Based on detection location and timing and published territory size (after Higgins 1999) a minimum of three pairs of sooty owls should be present within JKCR according to OEH (2012). Aside from the caves, the most important habitats at JKCR are likely to be the sheltered gullies with tall forest, particularly with a mesic influence.

South-eastern Glossy Black-Cockatoo

The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia. Glossy Black Cockatoos feed almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species), shredding the cones with the massive bill (Delzoppo et al., 2021, North et al., 2020, Garnett and Baker, 2020h, NSWSC, 2008b, Cameron, 2007, Cameron and Cunningham, 2006).

While the field survey did not detect any, the species is known to occur in the eucalypt forests of the Great Dividing Range and is likely to occur within the 3,085 hectare JKCR, particularly in habitats that support she oaks.

Swift Parrot

Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland (Garnett and Baker, 2020j, BirdsAustralia, 2011, Saunders et al., 2007, Mac Nally and Horrocks, 2000). In NSW mostly occurs on the coast and south west slopes. Migrates to the Australian south-east mainland between February and October.

While the species has not been previously recorded in the JKCR, it is generally considered that any individuals that do occur there are likley to be moving through on their winter migration (OEH, 2012).

Varied Sitella

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands (Noske, 2001, Noske and Ford, 1984). Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades. The species can be found in eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland.

While the field survey did not detect any, the species is known to occur in the eucalypt forests of the Great Dividing Range and is likely to occur within the 3,085 hectare JKCR, particularly in habitats that support she oaks.

White-throated Needletail

Migratory and usually seen in eastern Australia from October to April. Breeds in forests in south-eastern Siberia, Mongolia, the Korean Peninsula and northern Japan June-August. Most often seen in eastern Australia before storms, low pressure troughs and approaching cold fronts and occasionally bushfire. Almost exclusively aerial; over a wide variety of habitats.

While the field survey did not detect any, the species is known to occur in the eucalypt forests of the Great Dividing Range and is likely to occur within the 3,085 hectare JKCR, particularly in habitats that support she oaks.

Eastern Pygmy Possum

The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. They may occupy small patches of vegetation in fragmented landscapes and although the species prefers habitat with a rich shrub understory, they are known to occur in grassy woodlands and the presence of Eucalypts alone is sufficient to support populations in low densities (Harris et al., 2007a, Harris et al., 2007b, Tulloch and Dickman, 2006, Harris and Goldingay, 2005, Bowen and Goldingay, 2000).

Eastern Pygmy-possum has been previously recorded within JKCR and is considered a rare resident occurring in heathy vegetation. There are higher densities of this species on the Boyd Plateau to the south-west of JKCR where *Banksia ericifolia* are abundant (OEH, 2012).

Brush-tailed Rock-wallaby

The range of the Brush-tailed Rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. In the Jenolan Caves area, individuals are part of the Central Evolutionary Significant Unit (ESU) (OEH, 2012). However, the distribution of the species across its original range has declined significantly in the west and south and has become more fragmented. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit.

JKCR is known to support a population of Brush-tailed Rock-wallaby and there is some potential that they could occur within the study area from time to time. None were recorded during the field survey.

Koala

The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia (Jurskis, 2017, DotE, 2014, DECC, 2008a). In New South Wales, koala populations are found on the central and north coasts, southern highlands, southern and northern tablelands, Kanangra-Boyd, southern coastal forests, with some smaller populations on the plains west of the Great Dividing Range. Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Inactive for most of the day, feeding and moving mostly at night.

A single Koala was recorded during the field survey whilst personnel were moving in a vehicle under escort. Upon return to the location on foot, the Koala could not be located. Koala are known from the JKCR and are regarded as an uncommon non-breeding visitor (OEH, 2012).

Southern Greater Glider

Greater gliders are found in southern Queensland, eastern New South Wales and the montane forests of the Victorian central highlands (Maloney, 2007, Lindenmayer et al., 2002, McCarthy and Lindenmayer, 1999). Greater gliders choose habitat based on several factors, the dominant factor being the presence of specific species of eucalypt. Distribution levels are higher in regions of montane forest containing manna gum (*E. viminalis*) and mountain gum (*E. dalrympleana*, *E. obliqua*). The presence of *E. cypellocarpa* appears to improve the quality of habitat for Greater gliders in forests dominated by *E. obliqua*. Another factor determining population density is elevation. Optimal levels are 845 m above sea level. Within a forest of suitable habitat, they prefer overstorey basal areas in old-growth tree stands.

This species is known to occur within the JKCR and are referred to as “particularly plentiful” in the 2012 surveys (OEH, 2012). For example, in a 200 metre spotlighting transect, 13 greater glider were recorded. While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present and previous results, this species is likely to occur within the the proposal site and surrounding forest and could potentially roost in hollow-bearing trees.

Spotted-tailed Quoll

The range of the Spotted-tailed Quoll has contracted considerably since European settlement (DEWHA, 2008, Claridge et al., 2005). It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common. Spotted-tailed Quoll are known from across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Quolls use hollow-bearing trees, fallen logs, other animal burrows, small caves and rock outcrops as den sites.

Spotted-tailed Quoll is known to occur within JKCR (OEH, 2012). While a secretive animal in general, this species has been recorded regularly by staff and park visitors including foraging at a picnic area and crossing roads at night (OEH, 2012). Given this, it is likely that the study area would contain a portion of a home range of this species.

Yellow-bellied Glider

The Yellow-bellied Glider has a wide distribution along the east coast and adjacent ranges from north Queensland to western Victoria (Menkhorst and Knight, 2010). Its occurrence within its range is patchy however, and population density generally very low. Several studies on this species are reported in Goldingay and Kavanagh (1991) and other studies of their feeding behaviour and habitat requirements (Rees et al., 2007, Goldingay and Possingham, 1995, Eyre and Goldingay, 2005, Kavanagh, 2004, Craig, 1985, Goldingay, 1992, NPWS, 1999, Goldingay, 1989, Goldingay, 2000, Goldingay and Kavanagh, 1991). The important factor is that they exploit a range of plant exudates including sap, manna (a substance formed by exudation of sap at the site of insect damage on branchlets and foliage of eucalypts and angophoras) and nectar of eucalypt flowers, honeydew (excretions of certain sap-sucking insects) and obtain protein by foraging for insects and other invertebrates mostly under the peeling bark of smooth-barked eucalypts, and by consuming pollen when it is available in eucalypt blossom.

While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present and previous results from earlier surveys, this species is likely to occur within the the proposal site and surrounding forest and could potentially roost in hollow-bearing trees. It is considered an uncommon resident of the JKCR (OEH, 2012).

Rosenberg's Goanna

Rosenberg's Goanna occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south (Sass and Metzler, 2022, Sass et al., 2014, Traynor, 2010, DECC, 2008b, Sass, 2008, DECC, 2007). There are records from the South West Slopes near Khancoban and Tooma River. Also occurs in South Australia and Western Australia. They occur in heath, open forest and woodland and given the habitats of the study area, it may occur there from time to time.

Mountain Trachymene

The species occurs at around four general locations between Jenolan caves and Gurnang State Forest on the Central Tablelands south east of Oberon. Among these locations, the species occurs in Kanangra-Boyd National Park. Associated vegetation across known sites varies from riparian tea-tree thickets to tall forest, to frost hollows and includes the following species: *Leptospermum obovatum*, *Eucalyptus fastigata*, *E. dalrympleana*, *Acacia melanoxylon*, *E. stellulata*, *E. pauciflora*, *E. rubida*.

There is some potential that the species may occur on the slopes and within gullies within the proposal site. As personnel were unable to access the slopes for the purpose of a targeted survey, presence/absence could not be determined.

Needle Geebung

The Needle Geebung has been recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. At the JKCR, a single record exists within the proposal site from a specimen collected in 1889. The Conservation Advice for this species provides commentary on the relative accuracy of this location as follows:

> *"The 1889 Jenolan Cave collection record is spatially vague and of questionable spatial merit given that there are no other records of the species from that locality, and that the lithology of this locality differs greatly from that of all extant and other historic records of the species. Some early collections described as occurring at Jenolan Caves are actually from the Boyd Plateau which is more plausible habitat (D Keith 2022. pers comm 1 September), however, there are no more recent records from this area either. Spatial uncertainty aside, the species does not appear to have extant populations in this region because there are no modern records, despite reasonable general survey effort, and especially so in relatively accessible sites such as where the 1889 collection was made".*

However, given that the single record that is mapped, is within the proposal site, there remains uncertainty of whether this species occurs within the study area or not. As personnel were unable to access the slopes for the purpose of a targeted survey, presence/absence could not be determined but was assumed present for the purpose of this BAR.

3.6 Aquatic habitat

There is one natural waterway within the proposal area, Surveyors Creek (Figure 3-3). This creek has been diverted to flow beneath Car Park 1 (Photo 3-4). While the proposed drainage works would lead to this waterway, they are formalising existing drainage with the objective of minimising silt and sediment entering this waterway. Therefore, Surveyors Creek would not be impacted by the proposed works. Surveyors Creek is identified by DPI Fisheries as Key Fish Habitat (Figure 3-4).

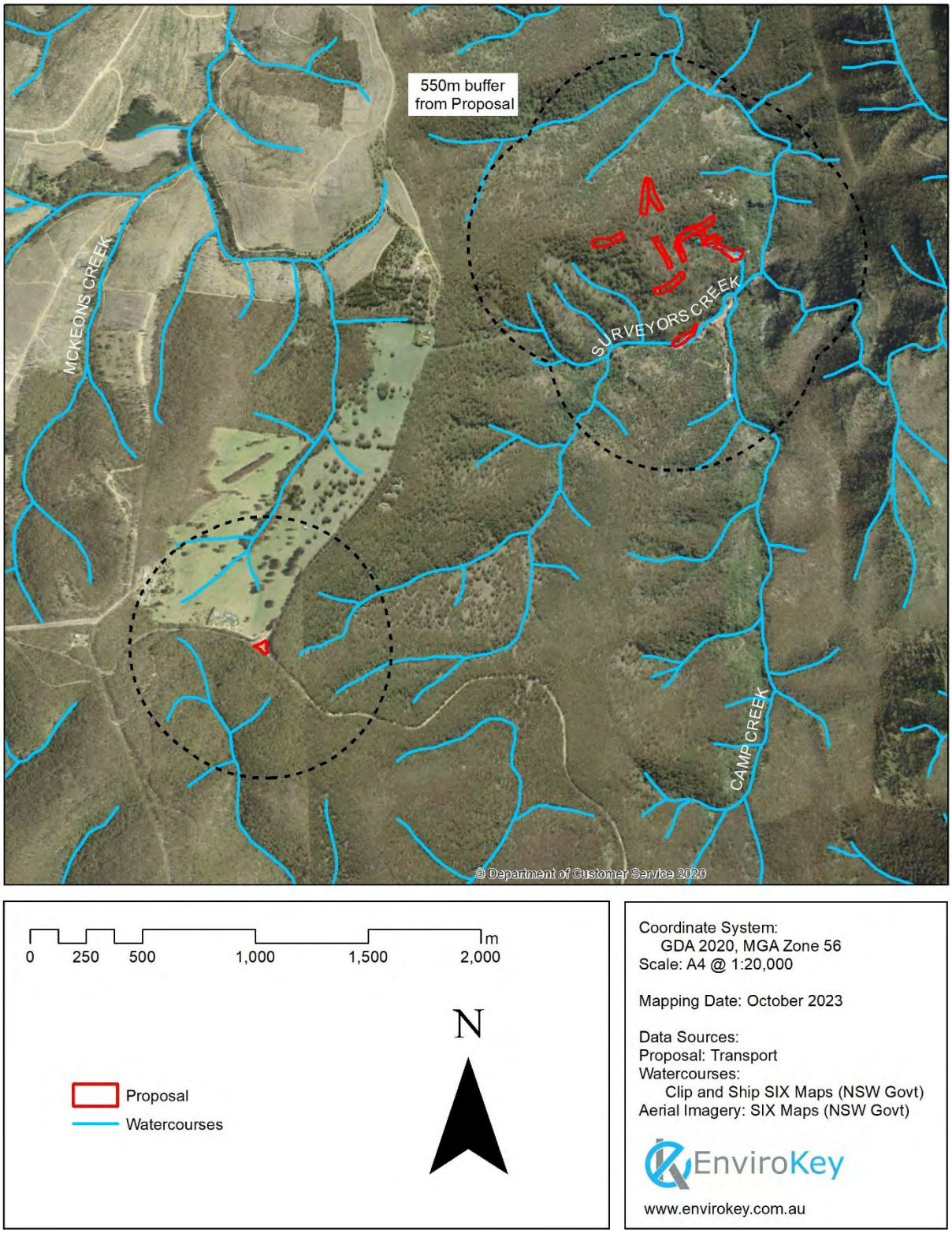


Figure 3-3: Waterways within the vicinity of the proposal

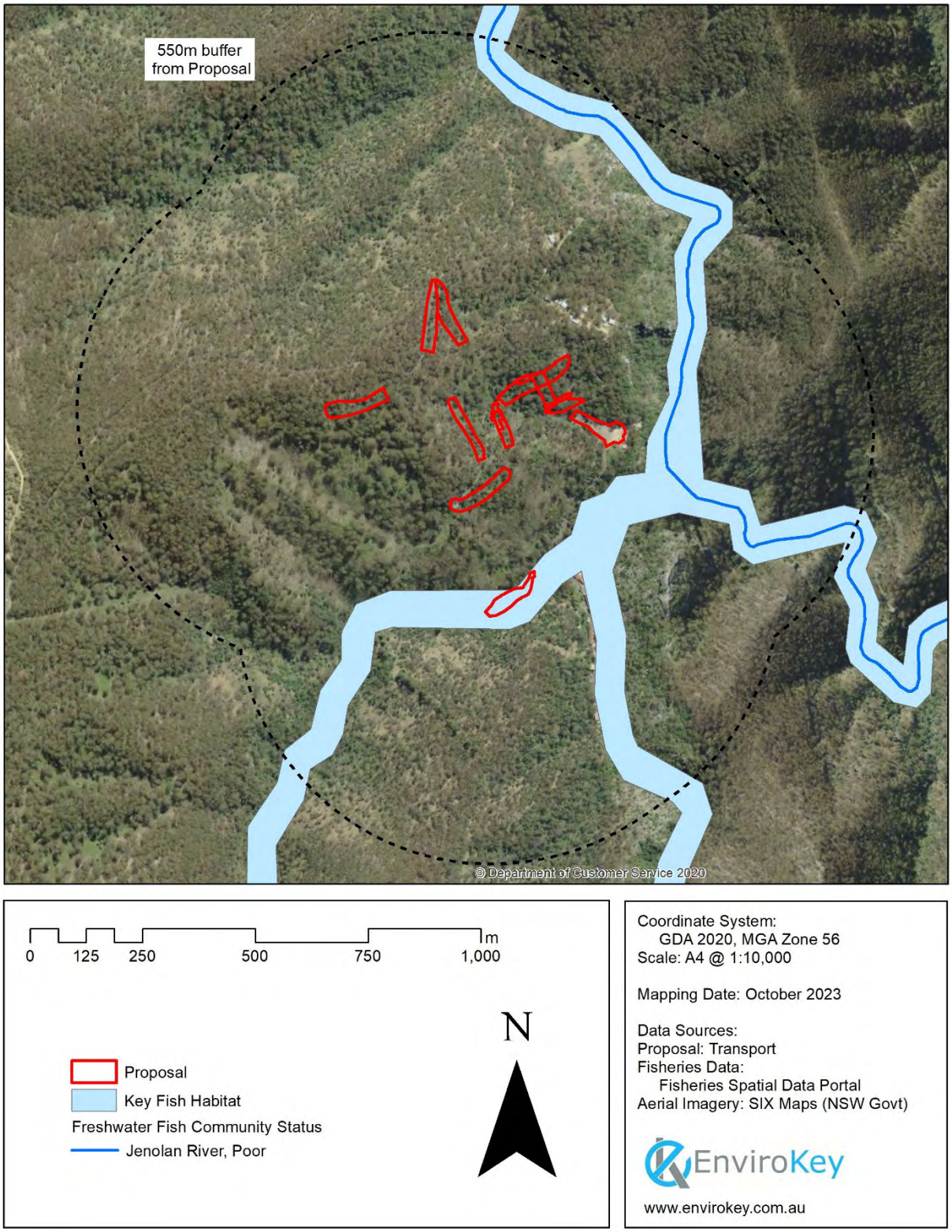


Figure 3-4: Fisheries Spatial data in the vicinity of the proposal

3.7 Areas of outstanding biodiversity value

No outstanding biodiversity values as listed on the *Register of Declared Areas of Outstanding Biodiversity Value* are present in the study area or within the JKCR.

3.8 Wildlife connectivity corridors

The importance of corridors cannot be overstated within any landscape (Lindenmayer and Nix, 1993, MacDonald, 2003, Johnson et al., 2007). Features such as these are considered important to maintain long-term genetic diversity amongst forest, woodland and grassland flora and fauna, and this is well known in regional NSW (Spooner and Lunt, 2004). The proposal lies within the largely intact JKCR (DEC, 2006) and therefore, forms part of a landscape scale corridor.

3.9 Matters of national environmental significance

The proposal is located within the Greater Kanangra-Boyd Area, a world heritage property and a nationally heritage listed place. Two Matters of National Environmental Significance (MNES) were recorded during the field surveys, these being Koala and Brown Treecreeper. Both species are listed as threatened species under the EPBC Act.

The EPBC Act Protected Matters Search identified a number of MNES with potential to occur within the study area. There are no wetlands of international importance within the vicinity of the proposal. Further assessment of matters of MNES relating to threatened ecological communities, threatened species and migratory species are considered further in Appendix B.

4. Avoidance and minimisation

Avoidance and minimisation of impacts to biodiversity are difficult in this proposal given that the slopes are failing and impacts to biodiversity are already occurring. Without remediation works being carried out, significant slope failure is likely, and unmanaged, this would result in significant impacts to large areas of biodiversity value. Additionally, sediment from a catastrophic slope failure have the potential to significantly impact the tourist precinct and caves in that precinct and any downstream watercourses

Given this, the proposal has been designed with the objective of minimising the risk of catastrophic slope failure while minimising the required impacts on biodiversity where possible.

5. Impact assessment

5.1 Construction direct impacts

Slope remediation, road construction, operation of the road post-construction and associated maintenance can have a range of potential impacts to biodiversity. The potential impacts as a result of this proposal are summarised below and in the following sections. These include:

- Removal of native vegetation
- Removal of threatened fauna species habitat and habitat features
- Injury and mortality
- Invasion and spread of weeds
- Noise, light, and vibration.

5.1.1 Removal of native vegetation

The clearing of native vegetation is a key threatening process (KTP) listed under the BC Act and the EPBC Act. There are no threatened ecological communities present, so none would be impacted by the proposal.

The proposal would result in the removal of up to 0.81 hectares of native vegetation that is consistent with one plant community type (PCT). The area of impact has been calculated using a geographic information system (GIS) shapefile of the proposed impact areas which was overlain onto our vegetation mapping prepared from the field survey. The potential extent of clearing expected as a result of the proposal is listed in Table 5-1.

Table 5-1: Summary of direct impacts on native vegetation

Plant community type (PCT)	Broad condition class	TEC	Area to be impacted (ha or m^2)[1]
Jenolan-Tuglow Limestone Forest	Poor - moderate	Not a TEC	0.27 ha
Jenolan-Tuglow Limestone Forest	Moderate	Not a TEC	0.41 ha
Jenolan-Tuglow Limestone Forest	Moderate - good	Not a TEC	0.13 ha
Total native vegetation			0.81 ha
NOTE 1: Area to be cleared based on ground-truthed vegetation mapping within the subject land.			

5.1.2 Removal of threatened fauna habitat

The removal of native vegetation would result in the removal of fauna habitat. Up to 0.81 hectares of forest vegetation is proposed for removal. A total of eight HBT were identified within the study area and would require removal by the proposed works. There are no threatened ecological communities present, so none would be impacted by the proposal.

Potential impacts to the threatened fauna species with a moderate to high potential to occur in the study area due to their habitat are listed in Table 5-2. All species would be subject to the 0.81 hectares of impact which aligns with the impacts on the sole PCT (PCT 3491) within the proposal site.

Table 5-2: Summary of direct impacts on threatened fauna and habitat

Species name	EPBC Act	BC Act	Potential occurrence (Moderate, High, Recorded)
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	Moderate
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	-	V	Moderate

Species name	EPBC Act	BC Act	Potential occurrence (Moderate, High, Recorded)
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	Moderate
Large Bent-winged Bat (*Miniopterus orianae oceanensis*)	-	V	High
Southern Myotis (*Myotis macropus*)	-	V	Moderate
Barking Owl (*Ninox connivens*)	-	V	Moderate
Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)	V	V	Recorded
Diamond Firetail (*Stagonopleura guttata*)	V	V	Moderate
Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)	-	V	Moderate
Flame Robin (*Petroica phoenicea*)	-	V	Moderate
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	E	V	Recorded
Little Eagle (*Hieraaetus morphnoides*)	-	V	Moderate
Little Lorikeet (*Glossopsitta pusilla*)	-	V	Moderate
Masked Owl (*Tyto novaehollandiae*)	-	V	Moderate
Painted Honeyeater (*Grantiella picta*)	V	V	Moderate
Pilotbird (*Pycnoptilus floccosus*)	V	-	Moderate
Powerful Owl (*Ninox strenua*)	-	V	Moderate
Rainbow Bee-eater (*Merops ornatus*)	M	-	Moderate
Regent Honeyeater (*Anthochaera phrygia*)	CE	CE	Moderate
Rufous Fantail (*Rhipidura rufifrons*)	M	-	Moderate
Satin Flycatcher (*Myiagra cyanoleuca*)	M	-	Moderate
Scarlet Robin (*Petroica boodang*)	-	V	Recorded
Sooty Owl (*Tyto tenebricosa*)	-	V	High
South-eastern Glossy Black-Cockatoo (*Calyptorhynchus lathami lathami*)	V	V	Moderate
Swift Parrot (*Lathamus discolor*)	CE M	E	Moderate
Varied Sittella (*Daphoenositta chrysoptera*)	-	V	Moderate
White-throated Needletail (*Hirundapus caudacutus*)	V M	-	Moderate

Species name	EPBC Act	BC Act	Potential occurrence (Moderate, High, Recorded)
Eastern Pygmy-possum (*Cercartetus nanus*)	-	V	Moderate
Brush-tailed Rock-wallaby (*Petrogale penicillate*)	V	E	High
Koala (*Phascolarctos cinereus*)	E	E	Recorded
Southern Greater Glider (*Petauroides volans*)	E	E	High
Spotted-tailed Quoll (*Dasyurus maculatus*)	E	V	High
Yellow-bellied Glider (*Petaurus australis*)	V	V	Moderate
Rosenberg's Goanna (*Varanus rosenbergi*)	-	V	Moderate
Mountain Trachymene (*Trachymene scapigera*)	E	E	Moderate
Needle Geebung (*Persoonia acerosa*)	V	V	Moderate

5.1.3 Removal of threatened flora

No threatened flora species were recorded during the field survey. However, there is potential for two species to occur and given that access to the slopes was not possible due to safety reasons with accessing the slope, presence/absence of these species could not be determined and were assumed present.

5.2 Indirect and operational impacts

5.2.1 Wildlife connectivity and habitat fragmentation

The proposal is likely to have no negative affect on potential wildlife corridors, or markedly increase habitat fragmentation in the context of the proposed work and that potential wildlife corridors remain within the locality and broader landscape.

5.2.2 Injury and mortality

Fauna injury or mortality can occur during the vegetation clearing phase of construction through the removal of habitat. During construction it is anticipated that some diurnal and mobile fauna species such as birds and larger reptiles may be able to move from the path of construction equipment during any clearing operations, other fauna species such as those that are less mobile and nocturnal, are less likely to move away from clearing activity. Safeguards identified in section 6 of this BAR reduce the risk to a manageable level.

During operation, impacts are not expected to increase given that the proposed work is not likely to result in an increase in vehicles using Jenolan Caves Road.

5.2.3 Invasion and spread of weeds

Across the study area, weed species are common given the long-term European history of the area. The proposed work has some potential to disperse priority and environmental weed plant material into retained areas of native vegetation from incoming construction equipment. The most likely cause would be once construction vehicles and machinery first enter the proposal area from elsewhere. For the extent of weeds already present within the study area, the general impact is negligible and of no significance to the long-term viability of the retained vegetation within the study area or the locality given the current presence of weeds.

Appropriate safeguards regarding machinery and vehicle parking are required to minimise impacts to areas of retained native vegetation.

5.2.4 Invasion and spread of pathogens and disease

Pathogens result in disease in flora and fauna and can be found living in organisms such as fungus, bacteria, and virus. Several pathogens are known from the region, and these are listed as KTPs, including:

- Infection of native plants by Phytophthora (BC Act and EPBC Act)
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (BC Act and EPBC Act)
- Infection by Psittacine Beak and Feather Disease affecting endangered psittacine species (BC Act and EPBC Act)
- Introduction of Exotic Rust Fungi affecting plants of the Myrtaceae family (BC Act and EPBC Act)
- Novel biota and their impact on biodiversity (EPBC Act) (covers Myrtle Rust).

Without appropriate mitigation measures, all of these pathogens could be inadvertently transported into the proposal area by construction machinery and vehicles.

5.2.5 Noise, light, dust, and vibration

Noise, vibration, and light impact already pre-exists on Jenolan Caves Road from vehicular movements and so, potential impacts are restricted to the construction period.

Construction noise and vibration are likely to result from the proposal but would be limited to the construction period and during daylight hours. While it is important to remember that no multi-species study has found species to be sensitive to noise and vibration, it is generally agreed that for species that vocalise frequently such as birds and amphibians, there is some potential for negative effects over the long-term. In the context of the proposal, the work is expected to be conducted over a relatively short time frame and over a length of about three kilometres. Potential impact, if any, is therefore considered to be relatively minor and temporary with extensive areas of the JKCR and other habitats in the locality remaining unaffected by temporary increases in noise and vibration. Additionally, a catastrophic failure of the slopes would lead to significant impacts to areas downslope.

No light impacts are expected due to construction occurring during daylight hours only.

From an operational perspective, the restoration works are located directly adjacent to Jenolan Caves Road, so impacts are also likely to be not significantly greater than existing vehicular traffic, albeit some increases may occur.

5.3 Cumulative impacts

There is a single slope failure being considered near the current proposal by Transport.

Overall, the proposed work is considered relatively minor in nature in the context of the existing landscape and the configuration of the proposal, and therefore, cumulative impacts are unlikely from the proposal.

5.4 Assessments of significance

Section 7.3 of the BC Act details five factors which are to be considered when determining if a proposed development or activity 'is likely to have a significant effect on the threatened species, ecological communities, or their habitats'. These five factors must be taken into account by consent of determining authorities when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species.

The Test of Significance (Appendix C) has determined that the proposed activity is 'unlikely' to have a 'significant effect' on species that are known from the study area, or that have been assessed as having a moderate to high potential of occurring in the study area (Table 5-5). They include the following biota and their habitats:

- Bats (Eastern False Pipistrelle, Greater Broad-nosed Bat, Large-eared Pied Bat, Large Bent-winged Bat, Southern Myotis)
- Forest and Woodland Birds (Brown Treecreeper (eastern subspecies), Diamond Firetail, Dusky Woodswallow, Flame Robin, Little Eagle, Painted Honey Eater, Regent Honeyeater, Scarlet Robin, Swift Parrot, Varied Sitella)
- Hollow-dependent Birds (Barking Owl, Gang-gang Cockatoo, Little Lorikeet, Masked Owl, Powerful Owl, Sooty Owl, South-eastern Glossy Black-Cockatoo)
- Mammals (Eastern Pygmy-possum, Brush-tailed Rock-wallaby, Koala, Southern Greater Glider, Spotted-tailed Quoll, Yellow-bellied Glider)
- Reptiles (Rosenberg's Goanna)
- Flora (Mountain Trachymene, Needle Geebung).

Table 5-3: Summary of BC Act significance assessments findings

Significance assessment question *(per Section 7.2 of the BC Act and Threatened Species Test of Significance Guidelines (OEH 2018))*						
Threatened species, or communities	a	b	c	d	e	Likely significant impact?
Eastern False Pipistrelle	N	X	N	N	N	No
Greater Broad-nosed Bat	N	X	N	N	N	No
Large-eared Pied Bat	N	X	N	N	N	No
Large Bent-winged Bat	N	X	N	N	N	No
Southern Myotis	N	X	N	N	N	No
Brown Treecreeper (eastern subspecies)	N	X	N	N	N	No
Diamond Firetail	N	X	N	N	N	No
Dusky Woodswallow	N	X	N	N	N	No
Flame Robin	N	X	N	N	N	No
Little Eagle	N	X	N	N	N	No
Painted Honey Eater	N	X	N	N	N	No
Regent Honeyeater	N	X	N	N	N	No
Scarlet Robin	N	X	N	N	N	No
Swift Parrot	N	X	N	N	N	No
Varied Sitella	N	X	N	N	N	No
Barking Owl	N	X	N	N	N	No
Gang-gang Cockatoo	N	X	N	N	N	No
Little Lorikeet	N	X	N	N	N	No
Masked Owl	N	X	N	N	N	No
Powerful Owl	N	X	N	N	N	No
Sooty Owl	N	X	N	N	N	No
South-eastern Glossy Black-Cockatoo	N	X	N	N	N	No
Eastern Pygmy-possum	N	X	N	N	N	No
Brush-tailed Rock-wallaby	N	X	N	N	N	No
Koala	N	X	N	N	N	No
Southern Greater Glider	N	X	N	N	N	No
Spotted-tailed Quoll	N	X	N	N	N	No
Yellow-bellied Glider	N	X	N	N	N	No

Significance assessment question *(per Section 7.2 of the BC Act and Threatened Species Test of Significance Guidelines (OEH 2018))*						
Threatened species, or communities	a	b	c	d	e	Likely significant impact?
Rosenberg's Goanna	N	X	N	N	N	No
Mountain Trachymene	N	X	N	N	N	No
Needle Geebung	N	X	N	N	N	No
***Y** = Yes (negative impact), **N** = No (no or positive impact), **X** = Yes/No answer not applicable, **?** = unknown impact.*						

Similarly, EPBC Act significance assessments also found that a significant impact is unlikely (Table 5-6).

Table 5-4: Summary of EPBC Act significance assessments findings

Threatened species, or communities	Important population *(per Significant Impact Guidelines 1.1 (DoE 2013))*	Likely significant impact?
Large-eared Pied Bat	N	No
Brown Treecreeper (eastern subspecies)	N	No
Diamond Firetail	N	No
Gang-gang Cockatoo	N	No
Painted Honeyeater	N	No
Pilotbird	N	No
Regent Honeyeater	N	No
South-eastern Glossy Black-Cockatoo	N	No
Swift Parrot	N	No
White-throated Needletail	N	No
Brush-tailed Rock-wallaby	N	No
Koala	N	No
Southern Greater Glider	N	No
Spotted-tailed Quoll	N	No
Yellow-bellied Glider	N	No
Mountain Trachymene	N	No
Needle Geebung	N	No
***Y** = Yes (negative impact), **N** = No (no or positive impact), **X** = Yes/No answer not applicable, **?** = unknown impact.*		

6. Mitigation

Measures to minimise impacts on threatened species have been recommended as part of this assessment and are summarised in Table 6-1.

Safeguards and management measures proposed have been developed by referring to the best practice management measures found in the Transport for NSW Biodiversity Guidelines: *Protecting and managing biodiversity on RTA projects* (2011) and site-specific mitigation measures have been specifically developed for the proposed work as deemed necessary.

Table 6-1: Mitigation measures

ID	Impact	Mitigation measure	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated?	Responsibility
BIO01	Removal of native vegetation	Pre-clearing surveys will be undertaken within vegetation once slope access is established, to survey for the threatened Mountain Trachymene (*Trachymene scapigera*) and Needle Geebung (*Persoonia acerosa*). The Assessment of Significance contained within this BAR would be reconsidered once these surveys are completed. Pre-clearing surveys will also be undertaken to check for occupancy of hollow-bearing trees recorded within the proposal site.	Prior to construction	Proven	None	Transport
BIO02		Vegetation removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Effective	None	Transport
BIO03		Parking options should be limited to existing hard stand areas, or within any area that is pavement/existing formation or mapped as cleared land.	During construction	Proven	None	Transport
BIO04 BIO05	Removal of threatened fauna habitat	Habitat removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Prior to construction	Effective	None	Transport
BIO06		The unexpected species find procedure is to be followed under *Guide 1: Pre-clearing process* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) if threatened fauna, not assessed in the biodiversity assessment, are identified in the proposal site.	During construction	Proven	None	Transport
BIO07	Edge effects on adjacent native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance *with Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	Prior to construction	Effective	None	Transport
BIO08	Injury and mortality of fauna	Fauna will be managed in accordance with *Guide 9: Fauna* handling of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Effective	None	Transport
BIO09	Invasion and spread of weeds	Weed species will be managed in accordance *with Guide 6: Weed management* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Effective	None	Transport

ID	Impact	Mitigation measure	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated?	Responsibility
BIO10	Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011).	During construction	Effective	None	Transport

7. Offsets and other measures

With consideration of the biodiversity offset thresholds identified within the *2022 Transport Guideline for Biodiversity Offsets*, biodiversity offsets or supplementary measures do not require consideration by Transport.

This is on the basis of the following:

- The proposal would not impact a critically endangered, endangered or vulnerable ecological community
- The proposal is not known to remove any threatened flora (pending pre-clearance survey)
- The proposal would not impact more than 1 hectare of a known species credit fauna (Koala)
- The proposal would not result in loss of key fish habitats.

However, the *2023 Transport Tree and hollow replacement Guidelines* do apply to this proposal. An analysis of this guideline is provided in Appendix E.

8. Conclusion

This assessment has confirmed that the study area contains one native plant community type (PCT), and the presence of four threatened fauna species were detected during the field survey.

This assessment has concluded that the proposal is '*unlikely*' to have a significant effect on any listed threatened flora and fauna species, communities, and their habitats in accordance with the BC Act. While field surveys completed did not record these species within the study area, there is some potential that these species may occur on the slopes and within gullies within the proposal site. As field survey staff were unable to access the slopes for the purpose of a targeted survey, presence/absence could not be determined so for the purpose of this BAR, presence was assumed.

Additional assessment has also determined that the proposal is '*unlikely*' to have a significant effect on any EPBC Act listed threatened and migratory biota and their habitats or other matters of national environmental significance. Overall, these assessments concluded that the proposal is unlikely to have a significant impact on any threatened biota. Therefore, a species impact statement or a referral to the Commonwealth is not required.

A number of mitigation measures have been recommended to minimise and mitigate impacts from the proposal. The measures aim to mitigate impacts to threatened species, threatened fauna species habitat and habitat features, and other potential impacts identified by this BAR.

The October 2023 Transport for NSW *Tree and Hollow Replacement Guidelines* apply to this proposal.

9. Glossary

Term	Definition
Accredited person or assessor	Means as person accredited under section 6.10 (of the BC Act) to prepare reports in accordance with the BAM.
Biodiversity Assessment Method	The Biodiversity Assessment Method is established under section 6.7 of the BC Act. The BAM is established for the purpose of assessing certain impacts on threatened species and threatened ecological communities (TECs), and their habitats, and the impact on biodiversity values.
Biodiversity Assessment Method Calculator	Biodiversity Assessment Method Calculator (BAM-C) – the online computer program that provides decision support to assessors and proponents by applying the BAM and referred to as the BAM-C. The BAM-C contains biodiversity data from the BioNet Vegetation Classification and the Threatened Biodiversity Data Collection that the assessor is required to use in a BAM assessment. The BAM-C applies the equations used in the BAM, including those to determine the number and class of biodiversity credits required to offset the impacts of a development, or created at a biodiversity stewardship site. It is published by the Department (DPE 2020a).
Biodiversity credit report	The report produced by the BAM-C that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site, or on land to be biodiversity certified, or that sets out the number and class of biodiversity credits that are created at a biodiversity stewardship site (DPE 2020a).
Biodiversity offsets	The gain in biodiversity values achieved from the implementation of management actions on areas of land, to compensate for losses to biodiversity values from the impacts of development (DPE 2020a).
Biodiversity Offsets and Agreement Management System	The online system used to administer the Biodiversity Offsets Scheme. The BOAMS is used by accredited assessors (to carry out specific BAM-related tasks involving access to the BAM-C to perform assessments, submit data, generate credits and calculate a credit price), by landholders (to apply for a Biodiversity Stewardship Agreement and manage ongoing reporting obligations for their agreement) and by proponents of developments (to view their credit obligation or the payment required to the Biodiversity Conservation Fund).
Biodiversity risk weighting	A factor of the formulas used by the BAM to calculate credits. The biodiversity risk weighting (BRW) is a score given to each vegetation zone and species based on the 'sensitivity to loss' versus the 'sensitivity to gain'. The value is set for threatened species and listed in the TBDC. The BRW for vegetation is calculated for each vegetation zone by the BAM-C using a factor of the 'sensitivity to loss' of the PCT or TEC (located in the BioNet vegetation classification) and the 'sensitivity to gain' of the ecosystem credit species (in the TBDC) that are predicted to occur.
Biodiversity Stewardship site	Refers to land which is the subject to a Biodiversity Stewardship Agreement under the BC Act.
BioNet Atlas	The DPE database of flora and fauna records (formerly known as the NSW Wildlife Atlas). The Atlas contains records of plants, mammals, birds, reptiles, amphibians, some fungi, some invertebrates (such as insects and snails listed under the BC Act) and some fish (DPE 2020a).
BioNet Vegetation classification	Refers to the vegetation community-level classification for use in vegetation mapping programs and regulatory biodiversity impact assessment frameworks in NSW. Refer About BioNet Vegetation Classification | NSW Environment and Heritage (DPE 2020a).
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts

Term	Definition
	can result from individually minor but collectively significant actions taking place over a period of time. Refer to Clause 228(2) of the EP&A Regulation 2000 for cumulative impact assessment requirements.
Direct impact	Direct impacts on biodiversity values include those related to clearing native vegetation and threatened species habitat and impacts on biodiversity values prescribed by the Biodiversity Conservation Regulation 2017 (the BC Regulation) (DPE 2020a).
Ecosystem credit species	Threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for ecosystem credits. This is analogous with the definition of 'predicted species'.
Ecosystem credits	A measurement of the value of threatened ecological communities, threatened species habitat for species that can be reliably predicted to occur with a PCT, and PCTs generally. Ecosystem credits measure the loss in biodiversity values at a development, activity, clearing or biodiversity certification site and the gain in biodiversity values at a biodiversity stewardship site (DPE 2020a).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population, or ecological community, including any biotic or abiotic component (DPE 2020a).
Indirect impact	Impacts that occur when the proposal affects native vegetation and threatened species habitat beyond the development footprint or within retained areas (e.g., transporting weeds or pathogens, dumping rubbish). This includes impacts from activities related to the construction or operational phase of the proposal and prescribed impacts (DPE 2020a).
Landscape assessment area	The area which includes the subject land and a 1500 m buffer surrounding the outside edge of the boundary of the subject land or 500 m along each side of the centre line of a linear-shaped proposal
Local population	The population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions: • *The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.* • *The local population of resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.* • *The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the study area from time to time or return year to year (OEH 2018).*
Matter of national environmental significance	A matter of national environmental significance (MNES) is any of the nine defined components protected by a provision of Part 3 of the EPBC Act (Commonwealth).
Mitigation	Action to reduce the severity of an impact.
Native vegetation	Has the same meaning as in section 1.6 of the BC Act and section 60B of the LLS Act. In summary, a) trees (including any sapling or shrub or any scrub) b) understorey plants c) groundcover (being any type of herbaceous vegetation) d) plants occurring in a wetland.

Term	Definition
	A plant is native to New South Wales if it was established in New South Wales before European settlement (BC Act). Native vegetation does not extend to marine vegetation (being mangroves, seagrasses, or any other species of plant that at any time in its life cycle must inhabit water other than fresh water). Marine vegetation is covered by the provisions of the FM Act.
NSW (Mitchell) landscape	Landscapes with relatively homogeneous geomorphology, soils, and broad vegetation types, mapped at a scale of 1:250,000 (DPE 2020a).
Patch size	An area of native vegetation that: • *occurs on the development site or biodiversity stewardship site* • *includes native vegetation that has a gap of less than 100 m from the next area of native vegetation (or ≤30 m for non-woody ecosystems).* Patch size may extend onto adjoining land that is not part of the development site or biodiversity stewardship site (DPE 2020a).
PlantNET	An online database of the flora of New South Wales which contains currently accepted taxonomy for plants found in the State, both native and exotic.
Population	A group of organisms, all of the same species, occupying a particular area (DPE 2020a).
Proposal site	The area to be directly impacted by the proposal during construction activities. See also definition for subject land.
Spatial datasets	Spatial databases required to prepare a BAR • *BioNet NSW (Mitchell) Landscapes – Version 3.1* • *NSW Interim Biogeographic Regions of Australia (IBRA region and sub-regions) – Version 7* • *NSW soil profiles* • *hydrogeological landscapes* • *acid sulfate soils risk* • *digital cadastral database* • *Vegetation Information Systems maps* • *Geological sites of NSW.*
Species credit species	Threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for species credits (DPE 2020a). This is analogous with the definition of 'candidate species'.
Species credits	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Biodiversity Data Collection (DPE 2020a).
Species polygon	An area of land identified in Chapter 5 (of the BAM) that contains habitat or is occupied by a threatened species (DPE 2020a).
Study area	The area directly affected by the proposal (subject land or construction footprint) and any additional areas likely to be affected by the proposal, either directly or indirectly.
Subject land	Land subject to a development, activity, clearing, biodiversity certification or a biodiversity stewardship proposal. It excludes the landscape assessment area which surrounds the subject land (i.e., the area of land in the 1500 m buffer zone around the subject land or 500m buffer zone for linear proposals). In the case of a biodiversity certification proposal, subject land includes the biodiversity certification assessment area (DPE 2020a). See also definition for construction footprint.

Term	Definition
Threatened Biodiversity Data Collection	A publicly assessable online database (registration required) which contains information for listed threatened species, populations, and ecological communities (DPE 2020a). Part of the BioNet database, published by the EHG and accessible from the BioNet website at www.bionet.nsw.gov.au.
Vegetation integrity (score)	The condition of native vegetation assessed for each vegetation zone against the benchmark for the PCT. The vegetation integrity score is the quantitative measure of vegetation condition calculated by the BAM-C (DPE 2020a).
Vegetation zone	A relatively homogeneous area of native vegetation on a development site, clearing site, land to be biodiversity certified or biodiversity stewardship site that is the same PCT and has the same broad condition state (DPE 2020a).

10. Abbreviations

Term	Definition
AOBV	Area of Outstanding Biodiversity Value
BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Assessment Method calculator
BC Act	Biodiversity Conservation Act 2016 (NSW)
BC Regulation	Biodiversity Conservation Regulation 2017 (NSW)
BDAR	Biodiversity Development Assessment Report
BOAMS	Biodiversity Offsets and Agreement Management System
BOS	Biodiversity Offset Scheme
BRW	Biodiversity risk weighting
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DIWA	Directory of Important Wetlands in Australia
DPE	Department of Planning and Environment
DPI	Department of Primary Industries
EEC	Endangered ecological community
EHG	NSW Environment and Heritage Group within the Department of Planning and Environment
EIS	Environmental Impact Statement
EP&A Act	*Environment Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
Fisheries NSW Policy and guidelines	Fisheries NSW Policy and guidelines for fish habitat conservation and management (Update 2013)
FM Act	Fisheries Management Act 1994 (NSW)
GDE	Groundwater dependent ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia
MNES	Matters of national environmental significance
PCT	Plant community type
PMST	Protected Matters Search Tool
REF	Review of Environmental Factors
SAII	Serious and Irreversible Impacts
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
SSI	State Significant Infrastructure
TBDC	Threatened Biodiversity Data Collection
TECs	Threatened ecological communities (VECs, EECs and CEECs)
TfNSW	Transport for NSW
VEC	Vulnerable Ecological Community

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Appendix A: Species recorded

Recorded flora

Family	Scientific name	Common name	Status	
			BC Act	EPBC Act
NATIVE				
Asteraceae	*Chrysocephalum semipapposum*	Clustered Everlasting	-	-
Asteraceae	*Coronidium scorpioides*	Button Everlasting	-	-
Asteraceae	*Senecio linearifolius*	Fireweed Groundsel	-	-
Asteraceae	*Xerochrysum bracteatum*	Golden Everlasting	-	-
Boraginaceae	*Cynoglossum australe*		-	-
Boraginaceae	*Hackelia latifolia*		-	-
Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell	-	-
Campanulaceae	*Wahlenbergia stricta*	Tall Bluebell	-	-
Caryophyllaceae	*Stellaria pungens*	Prickly Starwort	-	-
Cyperaceae	*Carex appressa*	Tall Sedge	-	-
Dennstaedtiaceae	*Pteridium esculentum*	Bracken	-	-
Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine	-	-
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla	-	-
Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo	-	-
Fabaceae (Mimosoideae)	*Acacia falciformis*	Broad-leaved Hickory	-	-
Fabaceae (Mimosoideae)	*Acacia melanoxylon*	Blackwood	-	-

Family	Scientific name	Common name	Status	
			BC Act	EPBC Act
Geraniaceae	*Geranium solanderi var. solanderi*		-	-
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	-	-
Malvaceae	*Brachychiton populneus*	Kurrajong	-	-
Myrtaceae	*Eucalyptus fastigata*	Brown Barrel	-	-
Myrtaceae	*Eucalyptus radiata*	Narrow-leaved Peppermint	-	-
Myrtaceae	*Eucalyptus stellulata*	Black Sally	-	-
Myrtaceae	*Eucalyptus viminalis*	Ribbon Gum	-	-
Onagraceae	*Epilobium billardierianum*		-	-
Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	-	-
Plantaginaceae	*Veronica derwentiana subsp. subglauca*		-	-
Poaceae	*Anthosachne scabra*	Wheatgrass, Common Wheatgrass	-	-
Poaceae	*Cynodon dactylon*	Common Couch	-	-
Poaceae	*Microlaena stipoides var. stipoides*	Weeping Grass	-	-
Poaceae	*Poa labillardierei var. labillardierei*	Tussock	-	-
Poaceae	*Poa sieberiana*	Snowgrass	-	-
Poaceae	*Rytidosperma longifolium*	Long-leaved Wallaby Grass	-	-
Poaceae	*Rytidosperma racemosum var. racemosum*	Wallaby Grass	-	-
Polygonaceae	*Rumex brownii*	Swamp Dock	-	-
Ranunculaceae	*Clematis glycinoides*	Headache Vine	-	-
Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart	-	-

Family	Scientific name	Common name	Status	
			BC Act	EPBC Act
Solanaceae	*Solanum linearifolium*	Mountain Kangaroo Apple	-	-
Urticaceae	*Urtica incisa*	Stinging Nettle	-	-
Violaceae	*Viola hederacea*	Ivy-leaved Violet	-	-
Violaceae	*Melicytus dentatus*	Tree Violet	-	-
NON-NATIVE				
Apiaceae	*Conium maculatum*	Hemlock	-	-
Apocynaceae	*Vinca major*	Periwinkle	-	-
Araliaceae	*Hedera helix*	English Ivy	-	-
Asteraceae	*Carduus pycnocephalus*	Slender Thistle	-	-
Asteraceae	*Cirsium vulgare*	Spear Thistle	-	-
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	-	-
Asteraceae	*Hypochaeris radicata*	Catsear	-	-
Asteraceae	*Soliva sessilis*	Bindyi	-	-
Asteraceae	*Sonchus asper*	Prickly Sowthistle	-	-
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	-	-
Asteraceae	*Taraxacum officinale*	Dandelion	-	-
Caryophyllaceae	*Cerastium glomeratum*	Mouse-ear Chickweed	-	-
Caryophyllaceae	*Stellaria media*	Common Chickweed	-	-
Clusiaceae	*Hypericum androsaemum*	Tutsan	-	-
Fabaceae (Faboideae)	*Trifolium dubium*	Yellow Suckling Clover	-	-

Family	Scientific name	Common name	Status	
			BC Act	EPBC Act
Fabaceae (Faboideae)	*Trifolium repens*	White Clover	-	-
Fumariaceae	*Fumaria muralis subsp. muralis*	Wall Fumitory	-	-
Lamiaceae	*Prunella vulgaris*	Self-heal	-	-
Poaceae	*Anthoxanthum odoratum*	Sweet Vernal Grass	-	-
Poaceae	*Bromus catharticus*	Praire Grass	-	-
Poaceae	*Bromus diandrus*	Great Brome	-	-
Poaceae	*Bromus molliformis*	Soft Brome	-	-
Poaceae	*Dactylis glomerata*	Cocksfoot	-	-
Poaceae	*Poa annua*	Winter Grass	-	-
Poaceae	*Vulpia bromoides*	Squirrel Tail Fesque	-	-
Rosaceae	*Rubus fruticosus sp. agg.*	Blackberry complex	-	-
Rubiaceae	*Galium aparine*	Goosegrass	-	-

Recorded fauna

Class	Scientific name	Common name	Status	
			BC Act	EPBC Act
Aves	*Acanthiza lineata*	Striated Thornbill	-	-
Aves	*Acanthiza pusilla*	Brown Thornbill	-	-
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	-	-
Aves	*Aquila audax*	Wedge-tailed Eagle	-	-
Aves	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	-	-
Aves	*Cacomantis pallidus*	Pallid Cuckoo	-	-
Aves	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V	E
Aves	*Climacteris picumnus*	Brown Treecreeper	V	V
Aves	*Colluricincla harmonica*	Grey Shrike-thrush	-	-
Aves	*Cormobates leucophaea*	White-throated Treecreeper	-	-
Aves	*Corvus coronoides*	Australian Raven	-	-
Aves	*Corvus mellori*	Little Raven	-	-
Aves	*Dacelo novaeguineae*	Laughing Kookaburra	-	-
Aves	*Eopsaltria australis*	Eastern Yellow Robin	-	-
Aves	*Lichenostomus chrysops*	Yellow-faced Honeyeater	-	-
Aves	*Malurus cyaneus*	Superb Fairy-wren	-	-
Aves	*Meliphaga lewinii*	Lewin's Honeyeater	-	-
Aves	*Menura novaehollandiae*	Superb Lyrebird	-	-
Aves	*Neochmia temporalis*	Red-browed Finch	-	-

Class	Scientific name	Common name	Status	
			BC Act	EPBC Act
Aves	*Pachycephala pectoralis*	Golden Whistler	-	-
Aves	*Pachycephala rufiventris*	Rufous Whistler	-	-
Aves	*Pardalotus punctatus*	Spotted Pardalote	-	-
Aves	*Pardalotus striatus*	Striated Pardalote	-	-
Aves	*Petroica boodang*	Scarlet Robin	V	-
Aves	*Platycercus elegans*	Crimson Rosella	-	-
Aves	*Psophodes olivaceus*	Eastern Whipbird	-	-
Aves	*Rhipidura albiscapa*	Grey Fantail	-	-
Aves	*Sericornis frontalis*	White-browed Scrubwren	-	-
Aves	*Smicrornis brevirostris*	Weebill	-	-
Aves	*Strepera graculina*	Pied Currawong	-	-
Aves	*Strepera versicolor*	Grey Currawong	-	-
Aves	*Todiramphus sanctus*	Sacred Kingfisher	-	-
Aves	*Zosterops lateralis*	Silvereye	-	-
Mammalia	*Phascolarctos cinereus*	Koala	E	E
Mammalia	*Vombatus ursinus*	Common Wombat	-	-
Mammalia	*Wallabia bicolor*	Swamp Wallaby	-	-

Appendix B: Habitat suitability assessment

Use the below criteria to determine the likelihood that a threatened species could occur in the study area. The criteria are designed for use in a BAR only and is not applicable for use in a BDAR (i.e., where the BAM-C is being used). Only recorded sightings from BioNet are valid for these criteria.

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey or has been recorded within the past five years (known from a reputable source).
High	A species is considered highly likely to occur in the study area if: • *There are previous credible records on BioNet within the study area from the last 10 years and suitable habitat is present.* **OR** • *The species is highly mobile, is dependent on identified suitable habitat within the study area (i.e., for breeding or important life cycle periods such as winter flowering resources) and has been recorded recently (within five years) on BioNet in the locality. This also includes species known or likely to visit the study area during regular seasonal movements or migration.*
Moderate	A species is considered moderately likely to occur in the study area if: • *Any suitable habitat (e.g., foraging) is present in the study area, the species is highly mobile and has been recorded in the locality in the last 10 years on BioNet. The species may be unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (i.e., for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area.* **OR** • *The species is not highly mobile, is dependent on identified suitable habitat features (e.g., hollows, rocky outcrops) within the study area and has been recorded in the locality in the last 10 years on BioNet.* **OR** • *For flora species that are associated with PCTs in the study area (see TBDC) or have been recorded in the locality in the last 10 years on BioNet – the associated PCT/habitat present in the study area is not degraded and the species was not targeted by surveys in accordance with the BAM and relevant survey guidelines. In addition, for flora species known to occur in disturbed areas (e.g., orchids), records from any time within the locality may warrant inclusion in this category.*
Low	A species is considered to have a low likelihood of occurring in the study area if: • *For highly mobile species, the species may be an occasional visitor, but habitat similar to the study area is widely distributed in the locality, meaning that the species is not dependent (i.e., for breeding or important life cycle periods such as winter flowering resources) on habitats in the study area and the species has not been recorded in the locality in the last 10 years on BioNet.* **OR** • *The species is not highly mobile, is dependent on identified suitable habitat features (e.g., hollows, rocky outcrops) within the study area and has not been recorded in the locality in the last 10 years on BioNet.* **OR** • *For flora species that are associated with PCTs in the study area (see TBDC) and the species was not identified following targeted surveys in accordance with the BAM and relevant survey guidelines. Flora species that have been recorded in the locality on BioNet at any time, associated suitable habitat (see the TBDC) is not present in the study area, though similar habitats of the same vegetation formation is present in the study area.*

Likelihood	Criteria
Unlikely	Suitable habitat for the species is absent from the study area.

Habitat suitability assessment table

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
AMPHIBIANS					
Booroolong Frog *Litoria booroolongensis*	E	E	Live along permanent streams with some fringing vegetation cover such as ferns, sedges, or grasses. Adults occur on or near cobble banks and other rock structures within stream margins.	2 (BioNET)	Unlikely
Giant Burrowing Frog *Heleioporus australiacus*	V	V	Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based.	0	Low
Littlejohn's Tree Frog *Litoria littlejohni*	E	E	This species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath-based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground.	0	Low
Red-crowned Toadlet *Pseudophryne australis*	V	-	Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings.	0	Unlikely
Stuttering Frog *Mixophyes balbus*	E	V	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor.	0	Unlikely
Yellow-spotted Tree Frog *Litoria castanea*	CE	CE	Found in large permanent pools or slow flowing chain of ponds streams with abundant emergent vegetation.	0	Unlikely
BATS					

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Eastern Coastal Free-tailed Bat *Micronomus norfolkensis*	`V	-	Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range.	0	Unlikely
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	V	-	Prefers moist habitats, with trees taller than 20m. Generally roosts in eucalypt hollows.	38 (BioNET)	Moderate
Greater Broad-nosed Bat *Scoteanax rueppellii*	V	-	Various habitats include woodland through to moist and dry eucalypt forest and rainforest, through it is most commonly found in tall wet forests. Roosts in tree hollows but it has also been found in buildings. Forages after sunset, flying slowly and directly along creek and river corridors.	5 (BioNET)	Moderate
Grey-headed flying fox *Pteropus poliocephalus*	V	V	Found in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heath and swamps as well as urban gardens and cultivated fruit crops.	3 (BioNET)	Low
Large-eared Pied Bat *Chalinolobus dwyeri*	V	V	Found in well-timbered areas containing gullies often staying loyal to the same cave for many years. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*).	22 (BioNET)	Moderate
Large Bent-winged Bat *Miniopterus orianae oceanensis*	V	-	Prefers caves but also uses derelict mines, storm water tunnels, buildings, and other built structures for roosting. They hunt in forested areas.	55 (BioNET)	High
Southern Myotis *Myotis macropus*	V	-	Close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools.	2 (BioNET)	Moderate
FISH					
Australian Grayling *Prototroctes maraena*	-	V	Currently, the Australian Grayling occurs in streams and rivers on the eastern and southern flanks of the Great Dividing Range, from Sydney, southwards to the Otway Ranges of Victoria and in Tasmania. The species is found in fresh and brackish waters of coastal lagoons, from Shoalhaven River in NSW to Ewan Ponds in South Australia.	0	None (no suitable habitat present)

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Macquarie Perch *Macquaria australasica*	E (FM Act)	E	Found in the upstream reaches of the Murray-Darling Basin. Found in rivers and lakes.	0	None (no suitable habitat present)
Murray Cod *Maccullochella peelii*	-	V	Prefers deep, slow flowing turbid water in rivers and streams with boulders or undercut banks.	0	None (no suitable habitat present)
Trout Cod *Maccullochella macquariensis*	E (FM Act)	CE	Found in the southern Murray-Darling River system, this fish inhabits fast flowing freshwater streams.	0	None (no suitable habitat present)
BIRDS					
Australasian Bittern *Botaurus poiciloptilus*	E	E	Prefers permanent freshwater wetlands with tall, dense vegetation. Spends the day in reeds or rushes and feeds mostly at night.	0	Unlikely
Australian Painted Snipe *Rostratula australis*	E	E	Prefers fringes of swamps, dams, and nearby marshy areas where there is a cover of grasses, lignum, low scrub, or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks, or reeds.	0	Unlikely
Barking Owl *Ninox connivens*	V	-	Inhabits woodland and open forest, included fragmented remnants, and partly cleared farmland. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats. Roosts in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as *Acacia* and *Casuarina* species.	2 (BioNET)	Moderate
Black-eared Cuckoo *Chrysococcyx osculans*	-	M	The Black-eared Cuckoo is found in drier country where species such as mulga and mallee form open woodlands and shrublands. It is often found in vegetation along creek beds.	0	Unlikely
Black-faced Monarch *Monarcha melanopsis*	-	M	They are found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	0	Low
Blue-winged Parrot *Neophema chrysostoma*	-	V M	Inhabits a range of habitats from coastal, sub-coastal and inland areas, right through to semi-arid zones. Throughout their range they favour grasslands and grassy woodlands.	0	Unlikely

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*	V	V	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species.	0	Recorded
Cattle Egret *Bubulcus ibis*	-	M	The Cattle Egret occurs in tropical and temperate grasslands, wooded lands, and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare.	0	Unlikely
Common Sandpiper *Actitis hypoleucos*	-	M	A small sandpiper that is widely distributed in small numbers along the coast of Australia and in many inland regions.	0	Unlikely
Curlew Sandpiper *Calidris ferruginea*	E	CE M	It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes, and lagoons on the coast and sometimes inland.	0	Unlikely
Diamond Firetail *Stagonopleura guttata*	V	V	Found in grassy woodlands including Box-Gum Woodlands and Snow Gum Woodland.	0	Moderate
Dusky Woodswallow *Artamus cyanopterus cyanopterus*	V	-	Found mostly in dry, open eucalypt forests and woodlands.	0	Moderate
Flame Robin *Petroica phoenicea*	V	-	This species breeds in upland tall moist eucalypt forests and woodlands though also inhabits clearings or open understorey areas.	26 (BioNET)	Moderate
Fork-tailed Swift *Apus pacificus*	-	M	They mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea.	0 (BioNET)	Unlikely
Gang-gang Cockatoo *Callocephalon fimbriatum*	V	E	In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in	42 (BioNET)	Recorded

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			drier more open eucalypt forests and woodlands, and often found in urban areas.		
Grey Falcon *Falco hypoleucos*	V	V	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast.	0	Unlikely
Hooded Robin *Melanodryas cucullata cucullata*	V	E	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs, and a ground layer of moderately tall native grasses.	0	Low
Latham's Snipe *Gallinago hardwickii*	-	M	Habitat in Australia includes permanent and ephemeral wetlands.	0	Unlikely
Little Eagle *Hieraaetus morphnoides*	V	-	Little Eagle is distributed across all of the Australian mainland except for densely vegetated areas, particularly on the Dividing Range escarpment. In NSW the Little Eagle is considered a single population. They inhabit open eucalypt woodland, woodland, and open woodland, including Sheoak, *Acacia* woodland and riparian woodland in arid and semi-arid regions.	2 (BioNET)	Moderate
Little Lorikeet *Glossopsitta pusilla*	V	-	Forages primarily in the canopy of open Eucalypt forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity.	2 (BioNET)	Moderate
Masked Owl *Tyto novaehollandiae*	V	-	Lives in dry eucalypt forests and woodlands from sea level to 1100m, but often hunts along the edges of forests, including roadsides. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	0	Moderate
Painted Honeyeater *Grantiella picta*	V	V	Inhabits Boree/Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests. Feeds on mistletoes preferably the genus *Amyema*.	0	Moderate

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Pectoral Sandpiper *Calidris melanotos*	-	M	A small to medium sandpiper. In Australia it can be found in both shallow fresh and salt water. The sandpiper flies to Russia and Northern America to breed.	0	Unlikely
Pilotbird *Pycnoptilus floccosus*	-	V	Occurs in temperate wet sclerophyll forests and occasionally temperate rainforest, where there is dense undergrowth with abundant debris.	0	Moderate
Powerful Owl *Ninox strenua*	V	-	Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well.	109 (BioNET)	High
Rainbow Bee-eater *Merops ornatus*	-	M	Occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation.	0	Moderate
Red-backed Button-quail *Turnix maculosus*	V	-	Over their Australian range, Red-backed Button-quail inhabit grasslands, open and savannah woodlands with grassy ground layer, pastures and crops of warm temperate areas.	1 (BioNET)	Unlikely
Regent Honeyeater *Anthochaera phrygia*	CE	CE	Lives in dry open forest and woodland especially Box-Ironbark woodland, and riparian forests of River Sheoak. Woodlands they inhabit often support high abundance and species richness of bird species.	0	Moderate
Rufous Fantail *Rhipidura rufifrons*	-	M	Mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (*Eucalyptus microcorys*), Mountain Grey Gum (*E. cypellocarpa*), Narrow-leaved Peppermint (*E. radiata*), Mountain Ash (*E. regnans*), Alpine Ash (*E. delegatensis*), Blackbutt (*E. pilularis*) or Red Mahogany (*E. resinifera*); usually with a dense shrubby understorey often including ferns.	0	Moderate
Satin Flycatcher *Myiagra cyanoleuca*	-	M	Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	0	Moderate

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Scarlet Robin *Petroica boodang*	V	-	Inhabits dry eucalypt forests and woodlands with open understorey. This species is occasionally found up to 1000 metres in altitude.	4 (BioNET)	Recorded
Sharp-tailed Sandpiper *Calidris acuminata*	-	M	Occurs in Australia during the non-breeding part of the year. Found on both the coast and inland areas. Flies north to Siberia to breed.	0	Unlikely
Sooty Owl *Tyto tenebricosa*	V	-	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	19 (BioNET)	High
South-eastern Glossy Black-Cockatoo *Calyptorhynchus lathami lathami*	V	V	Inhabit open forests and woodlands. She-oak is an important food source and they feed almost exclusively on several species (*Casurina and Allocasaurina*).	3 (BioNET)	Moderate
Southern Whiteface *Aphelocephala leucopsis*	-	V	Inhabits relatively undisturbed open woodlands and shrublands with an understorey of grasses or shrubs.	0	Unlikely
Speckled Warbler *Chthonicola sagittata*	V	-	Found in woodland and grassland habitats with a native understorey, often on rocky ridges or in gullies.	0	Low
Swift Parrot *Lathamus discolor*	E	CE M	Occurs in areas with flowering eucalypts or abundant lerp (from sap sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Forest Red Gum *E. tereticornis*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana*, Blackbutt *E. pilularis*, and Yellow Box *E. melliodora*.	0	Moderate
Varied Sittella *Daphoenositta chrysoptera*	V	-	This species is sedentary and known to inhabit most forest/woodland habitats.	5 (BioNET)	Moderate

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
White-bellied Sea-eagle *Haliaeetus leucogaster*	V	M	The species is normally seen perched high in a tree, or soaring over waterways and adjacent land, particularly along coastlines, lakes, and rivers.	0	Low
White-throated Needletail *Hirundapus caudacutus*	-	V M	Migratory and usually seen in eastern Australia from October to April. Breeds in forests in south-eastern Siberia, Mongolia, the Korean Peninsula, and northern Japan June-August. Most often seen in eastern Australia before storms, low pressure troughs and approaching cold fronts and occasionally bushfire.	4 (BioNET)	Moderate
Yellow Wagtail *Motacilla flava*	-	M	Occurs in a variety of habitats, favouring damp or wet vegetation. Forages on the edges of rivers, dams, and wetlands.	0	Low
INVERTEBRATES					
Giant Dragonfly *Petalura gigantea*	E	-	Live in permanent swamps and bogs with some free water and open vegetation.	0	Unlikely
Purple Copper Butterfly *Paralucia spinifera*	E	V	Geology, soils, topographic position and dominant vegetation canopy species vary between habitat locations. However, vegetation structure is consistent, commonly open woodland or open forest with a sparse understorey that is dominated by the shrub, Native Blackthorn (*Bursaria spinosa subsp. lasiophylla*).	0	Unlikely
MAMMALS					
Eastern Pygmy-possum *Cercartetus nanus*	V	-	Found in a broad range of habitats from rainforest through to sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. They may occupy small patches of vegetation in fragmented landscapes and although the species prefers habitat with a rich shrub understory, they are known to occur in grassy woodlands and the presence of	0	Moderate

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			Eucalypts alone is sufficient to support populations in low densities.		
Brush-tailed Rock-wallaby *Petrogale penicillata*	E	V	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night when foraging.	43 (BioNET)	Moderate
Koala *Phascolarctos cinereus*	E	E	Inhabit eucalypt woodlands and forests. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.	360 (BioNET)	Recorded
New Holland Mouse *Pseudomys novaehollandiae*	-	V	Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes.	0	Low
Southern Brown Bandicoot (eastern) *Isoodon obesulus obesulus*	E	E	Southern Brown Bandicoots are largely crepuscular (active mainly after dusk and/or before dawn). They are generally only found in heath or open forest with a heathy understorey on sandy or friable soils.	0	Unlikely
Southern Greater Glider *Petauroides volans*	E	E	The Southern Greater Glider occurs in eastern Australia, in eucalypt forests and woodlands.	101 (BioNET)	High
Spotted-tailed Quoll *Dasyurus maculatus*	V	E	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath, and inland riparian forest, from the sub-alpine zone to the coastline.	34 (BioNET)	High
Squirrel Glider *Petaurus norfolcensis*	V	-	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey.	0	Unlikely
Yellow-bellied Glider *Petaurus australis*	V	V	Occur in tall mature eucalypt forests generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry	12 (BioNET)	Moderate

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south.		
REPTILES					
Bathurst Grassland Earless Dragon *Tympanocryptis mccartneyi*	CE	CE	Inhabiting treeless plains and open grasslands.	0	Unlikely
Kanangra-Boyd Water Skink *Eulamprus leuraensis*	E	E	It is restricted to an isolated and naturally fragmented habitat of sedge and shrub swamps that have boggy soils and appear to be permanently wet. The vegetation in these swamps typically takes the form of a sedgeland interspersed with shrubs but may occur as a dense shrub thicket.	0	Low
Broad-headed Snake *Hoplocephalus bungaroides*	E	V	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring.	0	Low
Pink-tailed Legless Lizard *Aprasia parapulchella*	V	V	Habitat sites are generally sloping, open woodland areas with native grassy ground layer, particularly dominated by Kangaroo Grass (*Themeda australis*). Sites are well drained with rocky outcrops or scattered, partially buried rocks.	0	Unlikely
Rosenberg's Goanna *Varanus rosenbergi*	V	-	Found in heath, open forest, and woodland. Nests in termite mounds. Shelters in hollow logs, rock crevices and in burrows – may use other species burrows such as rabbit warrens.	0	Moderate
Striped Legless Lizard *Delma impar*	V	V	Found mainly in Natural Temperate Grassland but has also been captured in grasslands that have a high exotic component. Also found in secondary grassland near Natural Temperate Grassland and occasionally in open Box-Gum Woodland.	0	Unlikely
PLANTS					
Alpine Sun-orchid *Thelymitra alpicola*	V	-	In Kosciuszko National Park and the Bago plateau the species occurs in wet heaths and adjacent to Sphagnum bogs between 1000-1500 metres. Associated species include *Hakea microcarpa, Leptospermum myrtifolium, Baeckea utilis,*	0	Unlikely

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
			Baeckia gunniana, Epacris breviflora, Epacris paludosa, Baloskion austral and *Empodisma minus*. Apparently the species does not occur in Sphagnum where *Thelymitra cyanea* is more likely to occur. Near Clyde Mountain the species has been found in wet heaths with *Banksia paludosa* and *Baeckea utilis* near a creek. The habitat described on the collection notes at Kanangra-Boyd NP were swamp/heath, and swamp. The only other information was "under Leptospermum" and open sites "between sedges". Flowering occurs from late November to mid December with fruits taking about a month to ripen.		
Aromatic Peppercress *Lepidium hyssopifolium*	E	E	In NSW the species was known to have occurred in both woodland with a grassy understorey and in grassland. The species may be a disturbance opportunist, as it was discovered at the most recently discovered site (near Bungendore) following soil disturbance. The cryptic and non-descript nature (appearing like several weed species) of the species makes it hard to detect.	0	Unlikely
Asterolasia buxifolia	E	-	Rediscovered in 2000, little is known about the species. The growth rate appears to be very slow, and the flowering season short. Apparently restricted to the riparian zone of a granitic rocky section of the Lett River.	0	Unlikely
Austral Toadflax *Thesium australe*	V	V	Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass (*Themeda australis*).	0	Unlikely
Black Gum *Eucalyptus aggregata*	V	V	Grows in the lowest parts of the landscape. Grows on alluvial soils, on cold, poorly drained flats and hollows adjacent to creeks and small rivers.	4 (BioNET)	Unlikely
Brown Pomaderris *Pomaderris brunnea*	E	V	Brown Pomaderris grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	0	Unlikely
Buttercup Doubletail	E	E	Recorded in forest, low open woodland with grassy understorey and secondary grassland on the higher parts of	0	Unlikely

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Diuris aequalis Pterostylis oreophila			the Southern and Central Tablelands (especially on the Great Dividing Range).		
Bynoe's Wattle *Acacia bynoeana*	E	V	Occurs in heath or dry sclerophyll forest on sandy soils.	0	Unlikely
Cambage Kunzea *Kunzea cambagei*	V	V	Cambage Kunzea is restricted to damp, sandy soils in wet heath or mallee open scrub at higher altitudes on sandstone outcrops or Silurian group sediments.	0	Unlikely
Cotoneaster Pomaderris *Pomaderris cotoneaster*	E	E	Cotoneaster Pomaderris has been recorded in a range of habitats in predominantly forested country. The habitats include forest with deep, friable soil, amongst rock beside a creek, on rocky forested slopes and in steep gullies between sandstone cliffs.	0	Unlikely
Deane's Boronia *Boronia deanei*	V	V	Grows in wet heath, often at the margins of open forest adjoining swamps or along streams.	0	Unlikely
Dense Cord-rush *Baloskion longipes*	V	V	Commonly found in swamps or depressions in sandy alluvium, sometimes growing with sphagnum moss. Also occurs in swails within tall forest, and in Black Gum (*Eucalyptus aggregata*) Woodland.	0	Unlikely
Dillwynia tenuifolia	V	-	In western Sydney, may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays.	0	Unlikely
Eastern Australian Underground Orchid *Rhizanthella slateri*	V	E	Habitat requirements are poorly understood, and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest.	0	Unlikely
Flockton Wattle *Acacia flocktoniae*	V	V	Grows in dry sclerophyll forest on sandstone.	17 (BioNET)	Unlikely
Gyrostemon thesioides	E	-	In NSW, known from hillsides, slopes, terraces and riverbanks within 180 metres of watercourses.	0	Unlikely

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Hibbertia acaulothrix	-	E	Occurs on rocky outcrops within *E. sieberi* woodland or in association with black she-oak, red bloodwood and flaky-barked tea-tree.	0	Unlikely
Hoary Sunray *Leucochrysum albicans subsp. tricolor*	E	E	Occurs in a wide variety of grassland, woodland, and forest habitats, generally on relatively heavy soils. Can occur in modified habitats such as semi-urban areas and roadsides.	0	Unlikely
Hygrocybe anomala var. ianthinomarginata	V	-	Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*).	0	Unlikely
Kanangra Wattle *Acacia clunies-rossiae*	V	-	Grows in dry sclerophyll forest on skeletal soils on rocky slopes, or on alluvium along creeks.	0	Unlikely
Kowmung Hakea *Hakea dohertyi*	E	E	Kowmung Hakea grows in dry sclerophyll forest, usually dominated by grey gum or silvertop ash, with a sparse groundcover and midstorey.	0	Unlikely
Leafless Tongue Orchid *Cryptostylis hunteriana*	V	V	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.	0	Unlikely
Leionema lachnaeoides	-	E	Occur on exposed sandstone cliff tops and terraces at 960-1000m altitude with aspects from south-east to south-west.	0	Unlikely
Mittagong Geebung *Persoonia glaucescens*	V	V	The Mittagong Geebung grows in woodland to dry sclerophyll forest on clayey and gravely laterite. The preferred topography is ridge-tops, plateaux and upper slopes. Aspect does not appear to be a significant factor.	0	Unlikely
Mountain Trachymene *Trachymene scapigera*	E	E	Associated vegetation across known sites varies from riparian tea-tree thickets to tall forest, to frost hollows and includes the following species: *Leptospermum obovatum*, *Eucalyptus fastigata*, *E. dalrympleana*, *Acacia melanoxylon*, *E. stellulata*, *E. pauciflora*, *E. rubida*.	6 (BioNET)	Moderate

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Needle Geebung *Persoonia acerosa*	V	V	The Needle Geebung occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils.	2 (BioNET)	Moderate
Paddys River Box *Eucalyptus macarthurii*	E	E	Occurs on grassy woodland on relatively fertile soils on broad cold flats.	0	Unlikely
Persoonia oxycoccoides	E	-	*Persoonia oxycoccoides* is endemic to New South Wales where it is currently known from the Wingecarribee Shire in the south-eastern portion of the Central Tablelands, with the easternmost records in the municipality of Kiama, and a south-western outlier at Tallong in Goulburn-Mulwaree Shire in the Southern Tablelands.	0	Unlikely
Rough Eyebright *Euphrasia scabra*	E	-	Occurs in or at the margins of swampy grassland or in sphagnum bogs, often in wet, peaty soil.	2 (BioNET)	Unlikely
Silver-leafed Gum *Eucalyptus pulverulenta*	V	V	Grows in shallow soils as an understorey plant in open forest, typically dominated by Brittle Gum (*Eucalyptus mannifera*), Red Stringybark (*E. macrorhynca*), Broad-leafed Peppermint (*E. dives*), Silvertop Ash (*E. sieberi*) and Apple Box (*E. bridgesiana*).	0	Unlikely
Slaty Red Gum *Eucalyptus glaucina*	V	V	Grows in grassy woodland and dry eucalypt forest, and on deep, moderately fertile and well-watered soils.	0	Unlikely
Smooth Bush-Pea *Pultenaea glabra*	V	V	This species is primarily associated with riparian or swamp habitat areas in the mid to upper altitudes of the central Kanangra-Boyd on sandstone derived soils. Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	0	Unlikely
Solanum armourense	E	-	Occurs in eucalypt woodland, in shallow soil on steep rocky hillsides.	0	Unlikely
Square Raspwort *Haloragis exalata subsp. exalata*	V	V	Appears to require protected and shaded damp situations in riparian habitats. Flowering specimens in NSW are recorded from November to January.	0	Unlikely

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Swamp Everlasting *Xerochrysum palustre*	-	V	Grows in swamps and bogs which are often dominated by heaths. Also grows at the edges of bog margins on peaty soils with a cover of shrubs or grasses.	0	Unlikely
Sydney Plains Greenhood *Pterostylis Saxicola*	E	E	Habitat ranges from grassy woodland on flat to gently sloping landscapes on shale soils, to open forest on hilly landscapes on transitional soils, and woodland on the rims and steep sides of river valleys on sandstone soils.	0	Unlikely
Thick-leaf Star-hair *Astrotricha crassifolia*	V	V	Occurs in dry sclerophyll woodland on sandstone.	0	Unlikely
Veronica blakelyi	V	-	Occurs in eucalypt forest, often in moist and sheltered areas. Associated canopy species include *Eucalyptus dives*, *E. dalrympleana, E. rossii* and *E. pauciflora*.	0	Unlikely
Veronica lithophila	-	E	Occurs in shallow pockets of soil with high soil moisture in crevices on flat to almost vertical rock faces or cliffs.	0	Unlikely
White-flowered Wax Plant *Cynanchum elegans*	E	E	The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation.	0	Unlikely
THREATENED ECOLOGICAL COMUNITIES					
Monaro Tableland Cool Temperate Grassy Woodland in the South Eastern Highlands Bioregion	CEEC	-	Characterised by the presence or prior occurrence of snow gum, and associated candlebark, ribbon gum, black sallee or blackwood. The trees may occur as pure stands dominated by Snow Gum, or with other characteristic trees as co-dominant to sub-dominant. Non-characteristic trees may occur as subdominant.	0	Unlikely
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern	EEC	E	The Montane Peatlands community is associated with accumulated peaty or organic-mineral sediments on poorly drained flats in the headwaters of streams. It occurs on undulating tablelands and plateau, above 400-500 m elevation, generally in catchments with basic volcanic or fine-grained sedimentary substrates or, occasionally, granite.	0	Unlikely

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Highlands and Australian Alps bioregions					
Natural Temperate Grassland of the South Eastern Highlands	-	CE	The community is often treeless, though trees of a range of species may occur in low densities, either as isolated individuals or in clumps. Seasonally wet areas within a site may also contain a range of wetland flora species, including rushes, sedges, and a variety of wetland specialist forbs. A limited range of shrub species may occur at some sites, but these too occur in low densities.	0	Unlikely
Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions	EEC	-	Tableland Basalt Forest in the Sydney Basin and South-eastern Highlands Bioregions is the name given to the ecological community found on plateaus and tablelands with loam or clay soils derived primarily from basalt, but may also be derived from mudstones, granites, alluvium and other substrates. The community typically has an open canopy of eucalypts with sparse shrubs and a dense groundcover of herbs and grass, although disturbed stands may lack either or both of the woody strata.	0	Unlikely
Temperate Highland Peat Swamps on Sandstone	-	E	These swamps are found in a range of locations in the landscape, from hanging swamps in the Kanangra-Boyd to the valley and watercourse swamps of Wingecarribee Swamp and the Paddy's River Swamps.	0	Unlikely
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	-	E	The structure of the ecological community varies from tall open forest to woodland depending on aspect, slope, soil conditions, soil depth, and previous disturbance.	0	Unlikely
Werriwa Tablelands Cool Temperate Grassy Woodland in the South Eastern Highlands and South East Corner Bioregions	CEEC	-	The trees may occur as pure stands dominated by snow Gum, or with candlebark as co-dominant to sub-dominant. Non-characteristic trees may occur as subdominant.	0	Unlikely
White Box – Yellow Box – Blakely's Red Gum Grassy	CEEC	CE	An open woodland community characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's	0	Unlikely

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat requirements	Number of records (source)	Likelihood of occurrence
Woodland and Derived Native Grassland in the NSW North Coast, New England, Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions			Red Gum and a generally grassy understorey. Remnants generally occur on fertile lower parts of the landscape.		

Appendix C: Tests of Significance (BC Act)

BC Act Test of Significance

Section 7.3 of the *BC Act* has five factors which are to be considered when determining if a proposed development or activity '*is likely to have a significant effect on the threatened species, or ecological communities, or their habitats'*. These five factors must be taken into account by consent or determining authorities when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species.

The habitat assessment table found that 31 threatened biota are known to or have the potential to occur within the study area based on the evaluation completed. Given this, further assessment by application of the 5-part test is completed on the following biota:

- Bats (Eastern False Pipistrelle, Greater Broad-nosed Bat, Large-eared Pied Bat, Large Bent-winged Bat, Southern Myotis)
- Forest birds (Brown Treecreeper (eastern subspecies), Diamond Firetail, Dusky Woodswallow, Flame Robin, Little Eagle, Painted Honeyeater, Regent Honeyeater, Scarlet Robin, Swift Parrot, Varied Sitella)
- Hollow-dependent Birds (Barking Owl, Gang-gang Cockatoo, Little Lorikeet, Masked Owl, Powerful Owl, Sooty Owl, South-eastern Glossy Black-Cockatoo)
- Mammals (Eastern Pygmy-possum, Brush-tailed Rock-wallaby, Koala, Southern Greater Glider, Spotted-tailed Quoll, Yellow-bellied Glider)
- Reptiles (Rosenberg's Goanna)
- Flora (Mountain Trachymene, Needle Geebung)

Bats (Eastern False Pipistrelle, Greater Broad-nosed Bat, Large-eared Pied Bat, Large Bent-winged Bat, Southern Myotis)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Eastern False Pipistrelle

The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. They appear to show a preference for moist habitats, with trees taller than 20 m. They generally roost in eucalypt hollows, but they have also been found under loose bark on trees or in buildings. They forage on beetles, moths, weevils and other flying insects above or just below the tree canopy.

DPE/BCS (2023) identify the following threats to the Eastern False Pipistrelle:

- Disturbance to winter roosting and breeding sites
- Loss of roosting habitat, primarily hollow-bearing eucalypts
- Loss and fragmentation of foraging habitat, particularly extensive areas of continuous forest and areas of high productivity.

Field surveys completed did not record any Eastern False Pipistrelle within the road corridor. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected.

The native vegetation of the wider locality would remain unaffected and would continue to provide potential foraging and roosting habitat for this species. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is *unlikely* that the proposed activity could have an adverse effect on the life cycle of Eastern False Pipistrelle, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Greater Broad-nosed Bat

The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. The species is known to use a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall

wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.

Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young.

DPE/BCS (2023) identify the following threats to the Greater Broad-nosed bat:

- Disturbance to roosting and summer breeding sites
- Foraging habitats are being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions
- Loss of hollow-bearing trees
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores
- Changes to water regimes are likely to impact food resources, as is the use of pesticides and herbicides near waterways.

Field surveys completed did not record any Greater Broad-nosed Bat within the road corridor. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected.

The native vegetation of the wider locality would remain unaffected and would continue to provide potential foraging and roosting habitat for this species. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Greater Broad-nosed Bat, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Large-eared Pied Bat

Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. Also found in well-timbered areas containing gullies. This species probably forages for small, flying insects below the forest canopy. Likely to hibernate through the coolest months.

Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. It is uncertain whether mating occurs early in winter or in spring.

DPE/BCS (2023) identify the following threats to the Large-eared Pied Bat:

- Clearing and isolation of forest and woodland habitats near cliffs, caves and old mine workings for agriculture or development
- Loss of foraging habitat close to cliffs, caves and old mine workings from forestry activities and too-frequent burning, usually associated with grazing
- Damage to roosting and maternity sites from mining operations, and recreational caving activities
- Use of pesticides
- Disturbance to roosting areas by goats
- Insufficient understanding of habitat requirements.

Field surveys completed did not record any Large-eared Pied Bat within the road corridor. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected.

The native vegetation of the wider locality would remain unaffected and would continue to provide potential foraging and roosting habitat for this species. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Large-eared Pied Bat, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Large Bent-winged Bat

Large Bent-winged Bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. This species forms discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. At other times of the year, populations disperse within about 300 km range of maternity caves. Breeding or roosting colonies can number from 100 to 150,000 individuals. Hunt in forested areas, catching moths and other flying insects above the tree tops. The karst system at JKCR provides a wide diversity of caves, overhangs and other features that this species uses to roost. Surveys in 2011 recorded a large number of eastern bentwing-bats (~1000) in the 'southern limestone' area (Paradox Cave).

DPE/BCS (2023) identify the following threats to the Large Bent-winged Bat:

- Disturbance by recreational cavers and general public accessing caves and adjacent areas particularly during winter or breeding
- Loss of high productivity foraging habitat
- Introduction of exotic pathogens, particularly white-nose fungus
- Cave entrances being blocked for human health and safety reasons, or vegetation (particularly blackberries) encroaching on and blocking cave entrances
- Hazard reduction and wildfire fires during the breeding season
- Predation by feral cats.

Field surveys completed did not record any Large Bent-winged Bat within the road corridor. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected.

The native vegetation of the wider locality would remain unaffected and would continue to provide potential foraging and roosting habitat for this species. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Large Bent-winged Bat, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Southern Myotis

The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. Generally, roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December.

DPE/BCS (2023) identify the following threats to the Southern Myotis:

- Loss or disturbance of roosting sites
- Clearing adjacent to foraging areas
- Application of pesticides in or adjacent to foraging areas
- Reduction in stream water quality affecting food resources.

Field surveys completed did not record any Southern Myotis within the road corridor. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected.

The native vegetation of the wider locality would remain unaffected and would continue to provide potential foraging and roosting habitat for this species. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Southern Myotis, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

These species are not listed as an endangered ecological community or critically endangered ecological community.

(c) in relation to the habitat of a threatened species, or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented, or isolated to the long-term survival of the species or ecological community in the locality,

i. The proposed work would result in the removal or disturbance of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees.

ii. The proposal would not isolate or fragment other areas of habitats further than the impact that pre-exists given the ability of these species to move (fly), the relatively small nature of proposed work and the extent of habitat in the wider locality, which would remain unaffected by the proposed work.

iii. For these species, the potential and known habitat to be removed is considered to be of little importance to the long-term viability of these species in the locality. Particularly with consideration of the remaining forest that occurs across the locality that would remain unaffected by the proposal.

(d) whether the action proposed is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

No declared areas of outstanding biodiversity value are known from the vicinity of the proposed work.

(e) whether the action proposed constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process.

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Clearing of any area of native vegetation, may impact on biological diversity such as habitat fragmentation limiting gene flow between small, isolated populations, which may result in a reduction in the potential for biodiversity to adapt to environmental change.

The proposed work includes the clearing or disturbance of up to 0.81 hectares of native forest vegetation. The direct impact is considered negligible in the context of forest habitat adjacent to the study area, and within the wider locality which would remain unaffected.

The 'loss of hollow-bearing trees' (HBT) has resulted from extensive clearing of native vegetation during the past two centuries, primarily for agriculture. A range of direct and indirect processes contribute to the ongoing loss of HBTs, the relative importance of these processes varies according to past and present land management regimes.

During the field survey, 11 HBTs were recorded. Of these 11 HBTs, eight would be removed by the proposed activity. Given the extent of aged forest adjoining the proposal, it is highly probable that other HBTs occur outside the proposal site and within higher quality habitat (away from disturbance from the road). The removal of eight HBTs is therefore considered negligible in this context.

The proposal is unlikely to result in the operation of, or increase the impact of, a key threatening process with consideration of relatively minor nature of the works proposed and the mitigation measures detailed within this BA.

Conclusion

This Test of Significance has determined that the proposed activity is *'unlikely'* to have a *'significant effect'* on Eastern False Pipistrelle, Greater Broad-nosed Bat, Large-eared Pied Bat, Large Bent-winged Bat, Southern Myotis, and their habitats.

Forest birds (Brown Treecreeper (eastern subspecies), Diamond Firetail, Dusky Woodswallow, Flame Robin, Little Eagle, Painted Honey Eater, Regent Honeyeater, Scarlet Robin, Swift Parrot, Varied Sitella)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Brown Treecreeper (eastern subspecies)

The Brown Treecreeper is endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is less commonly found on coastal plains and ranges. The western boundary of the range of *Climacteris picumnus victoriae* runs approximately through Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell and along this line the subspecies intergrades with the arid zone subspecies of Brown Treecreeper (*Climacteris picumnus picumnus*) which then occupies the remaining parts of the state.

The population density of this subspecies has been greatly reduced over much of its range, with major declines recorded in central NSW and the northern and southern tablelands. Declines have occurred in remnant vegetation fragments smaller than 300 hectares, that have been isolated or fragmented for more than 50 years.

Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.

Brown Treecreeper is considered to be relatively sedentary being resident in many locations throughout its range and present in all seasons. They are territorial year-round, and some birds may disperse locally after breeding. Gregarious and usually observed in pairs or small groups of 8 to 12 birds. Where present, they are active, noisy and conspicuous while foraging on trunks and branches of trees and amongst fallen timber and spend much more time foraging on the ground and fallen logs than other treecreepers.

When foraging in trees and on the ground, they peck and probe for insects, mostly ants, amongst the litter, tussocks and fallen timber, and along trunks and lateral branches; up to 80% of the diet is comprised of ants; other invertebrates (including spiders, insects larvae, moths, beetles, flies, hemipteran bugs, cockroaches, termites and lacewings) make up the remaining percentage; nectar from Mugga Ironbark (*Eucalyptus sideroxylon*) and paperbarks, and sap from an unidentified eucalypt are also eaten, along with lizards and food scraps; young birds are fed ants, insect larvae, moths, craneflies, spiders and butterfly and moth larvae.

This species breeds in pairs or co-operatively in territories which range in size from 1.1 to 10.7 ha (mean = 4.4 ha). Each group is composed of a breeding pair with retained male offspring and, rarely, retained female offspring. Often in pairs or cooperatively breeding groups of two to five birds. Hollows in standing dead or live trees and tree stumps are essential for nesting.

DPE/BCS (2023) identify the following threats to the Brown Treecreeper (eastern subspecies):

- Historical loss of woodland, forest and mallee habitats as a result of agriculture, forestry, mining and residential development
- Fragmentation of woodland and forest remnants which isolates populations and causes local extinctions
- Ongoing degradation of habitat, particularly the loss of tree hollows and fallen timber from firewood collection and overgrazing
- Lack of regeneration of eucalypt overstorey in woodland due to overgrazing and too-frequent fires
- Loss of ground litter from compaction and overgrazing
- Inappropriate forestry management practices
- Loss of understorey habitat
- Competition from invasive weeds
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners.

A pair of Brown Treecreeper was recorded during the field survey within zone 4 of the study area. The pair was observed foraging on the eucalypts, but no observations of breeding behaviour were recorded. While the species has not been detected previously within the JKCR, the observer is very familiar with the species and its call, and so there is no doubt regarding its identification. It may be possible that the species has moved into the JKCR post-Black Summer Fires given the relatively open nature of the canopy in areas that were burnt, and that this species is generally considered a woodland species.

The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is *unlikely* that the proposed activity could have an adverse effect on the life cycle of Brown Treecreeper (eastern subspecies), or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Diamond Firetail

The Diamond Firetail is endemic to south-eastern Australia, extending from central Queensland to the Eyre Peninsula in South Australia. It is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species has a scattered distribution over the rest of NSW, though is very rare west of the Darling River.

They usually occur in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum (*Eucalyptus pauciflora*) Woodlands but can also be found in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Diamond Firetails are also known to occur around waterways and sometimes in lightly wooded farmland.

This species feeds exclusively on the ground, on ripe and partly ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season) and they are usually encountered in flocks of between 5 to 40 birds. In the breeding season (between August and January), these larger groups separate into smaller colonies to breed.

DPE/BCS (2023) identify the following threats to the Diamond Firetail:

- Clearing and fragmentation of woodland, open forest, grassland and mallee habitat for agriculture and residential development, and firewood collection
- Poor regeneration of open forest and woodland habitats
- Invasion of weeds, resulting in the loss of important food plants
- Modification and destruction of ground- and shrub layers within habitat through removal of native plants, litter and fallen timber; introduction of exotic pasture grasses; heavy grazing and compaction by stock; and frequent fire
- Predation of eggs and nestlings by increased populations of native predators such as the Pied Currawong *Strepera graculina*
- Risk of local extinction due to small, isolated populations
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners.

Field surveys completed did not record any Diamond Firetail within the road corridor. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Diamond Firetail, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Dusky Woodswallow

Dusky Woodswallow are widespread in eastern, southern and south western Australia. The species occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region. Depending on location and local climatic conditions (primarily temperature and rainfall), Dusky Woodswallow can be resident year-round or migratory. In NSW, after breeding, birds migrate to the north of the state and to southeastern Queensland, while Tasmanian birds migrate to southeastern NSW after breeding. Migrants generally depart between March and May, heading south to breed again in spring. There is some evidence of site fidelity for breeding. Although dusky Woodswallow generally breed as solitary pairs or occasionally in small flocks, large flocks may form around abundant food sources in winter. Large flocks may also form before migration, which is often undertaken with other species.

They occur mostly in dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and groundcover of grasses or sedges and fallen woody debris. It

has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. The species can also be found in farmland, usually at the edges of forest or woodland.

They are known to feed on invertebrates, mainly insects, which are captured whilst hovering or sallying above the canopy or over water. Also frequently hovers, sallies and pounces under the canopy, primarily over leaf litter and dead timber. Also occasionally take nectar, fruit and seed.

DPE/BCS (2023) identify the following threats to the Dusky Woodswallow

- Historical and ongoing loss of woodlands and dry open sclerophyll forests, including mallee because of agriculture, mining, forestry and residential development
- Reduction in area, and increased isolation of patches of remnant woodland and open forest
- Ongoing degradation of habitat through the loss of dead timber, removal of coarse woody debris and other disturbances of the ground layer
- Aggressive exclusion by over abundant noisy miners
- Reduction in the availability of food resources due to overgrazing and loss of leaf litter
- Lack of knowledge within the community regarding the species and its habitat requirements
- Habitat degradation from invasion by weeds including exotic grasses and woody weeds, and inappropriate land uses.

Field surveys completed did not record any Dusky Woodswallow within the road corridor. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Dusky Woodswallow, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Flame Robin

The Flame Robin is endemic to south eastern Australia, and ranges from near the Queensland border to south east South Australia and also in Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands. Flame Robin are occasionally known from temperate rainforest, but at high altitudes, are regularly seen in herbfields, heathlands, shrublands and sedgelands. Often occurs in recently burnt areas; however, habitat becomes unsuitable as vegetation closes up following regeneration.

They are known to breed in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Often, the ground layer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. Breeds in spring to late summer. Nests are often near the ground and are built in sheltered sites, such as shallow cavities in trees, stumps or banks. Builds an open cup nest made of plant materials and spider webs. Eggs are oval in shape and are pale bluish- or greenish-white and marked with brownish blotches; clutch size is three or four eggs.

In winter, birds migrate to drier more open habitats in the lowlands (i.e., valleys below the ranges, and to the western slopes and plains) where they are known from dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees. They can occasional be recorded within heathland or other shrublands in coastal areas. Occur singly, in pairs, or in flocks of up to 40 birds or more; in the non-breeding season they will join up with other insectivorous birds in mixed feeding flocks.

Birds forage from low perches, from which they sally or pounce onto small invertebrates which they take from the ground or off tree trunks, logs and other coarse woody debris. Flying insects are often taken in the air and sometimes gleans for invertebrates from foliage and bark.

DPE/BCS (2023) identify the following threats to the Flame Robin:

- Clearing and degradation of breeding and wintering habitats
- Loss of nest sites, food sources and foraging sites, such as standing dead timber, logs and coarse woody debris from depletion by grazing, firewood collection and ‘tidying up’ of rough pasture
- Predation by over-abundant populations of Pied Currawong (*Strepera graculina*) which are supported by planted exotic berry-producing shrubs; this pressure, is addition to that from other native and exotic predators, may be a potentially severe threat to the breeding success of Flame Robin populations

- Habitat for the Flame Robin may become unsuitable if dense regeneration occurs after bushfires or other disturbances
- Competitive exclusion by over-abundant Noisy Miners (*Manorina melanocephala*) within habitat
- Isolation of patches of habitat, particularly where these patches are smaller than 10 ha, and in landscapes where clearing has been heavy or where remnants are surrounded by cropping or stock grazing
- Habitat modification due to overgrazing
- Reduction of the native ground cover in favour of exotic grasses
- Reduction in the structural complexity of habitat, including reductions in canopy cover, shrub cover, ground cover, logs, fallen branches and leaf litter
- Reduction of size of remnant patches.

Field surveys completed did not record any Flame Robin within the study area. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Flame Robin, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Little Eagle

The Little Eagle are found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. They are found in eucalypt forest, woodland or open woodland. Sheoak or *Acacia* woodlands and riparian woodlands of interior NSW are also used.

The species nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Two or three eggs are laid in spring and young fledge in early summer. They feed on birds, reptiles and mammals, occasionally adding large insects and carrion.

DPE/BCS (2023) identify the following threats to the Little Eagle:

- Secondary poisoning from rabbit baiting
- Clearing and degradation of foraging and breeding habitat.

Field surveys completed did not record any Little Eagle within the study area. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Little Eagle, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Painted Honeyeater

The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution.

The species key habitats are Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests. It is a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias, with a preference for mistletoes of the genus *Amyema*. Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.

DPE/BCS (2023) identify the following threats to the Painted Honeyeater:

- Clearing of woodlands and open forests
- Removal of large, old trees with heavy mistletoe infestations
- Degradation of open forest and woodland remnants, including thinning of trees bearing mistletoe
- Heavy grazing of grassy woodlands
- Habitat infestation by weeds such as African boxthorn, Gazania and invasive grasses

- Inappropriate fire regimes
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners
- Degradation and simplification of habitat due to overgrazing.

Field surveys completed did not record any Painted Honeyeater within the study area. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Painted Honeyeater, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Regent Honeyeater

The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Once recorded between Adelaide and the central coast of Queensland, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests.

The Regent Honeyeater is a flagship threatened woodland bird whose conservation will benefit a large suite of other threatened and declining woodland fauna. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes.

Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast. In the last 10 years Regent Honeyeaters have been recorded in urban areas around Albury where woodlands tree species such as Mugga Ironbark and Yellow Box were planted 20 years ago.

The Regent Honeyeater is a generalist forager, although it feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important. For example, the Lower Hunter Spotted Gum forests have recently been demonstrated to support regular breeding events. Flowering of associated species such as Thin-leaved Stringybark (*Eucalyptus eugenioides*) and other Stringybark species, and Broad-leaved Ironbark *E. fibrosa* can also contribute important nectar flows at times. Nectar and fruit from the mistletoes *Amyema miquelii, A. pendula* and *A. cambagei* are also utilised. When nectar is scarce lerp and honeydew can comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings.

Colour-banding of Regent Honeyeater has shown that the species can undertake large-scale nomadic movements in the order of hundreds of kilometres. However, the exact nature of these movements is still poorly understood. It is likely that movements are dependent on spatial and temporal flowering and other resource patterns. To successfully manage the recovery of this species a full understanding of the habitats used in the non-breeding season is critical.

There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria.

An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female. Two or three eggs are laid and incubated by the female for 14 days. Nestlings are brooded and fed by both parents at an average rate of 23 times per hour and fledge after 16 days. Fledglings fed by both parents 29 times per hour.

DPE/BCS (2023) identify the following threats to the Regent Honeyeater:

- Historical loss, fragmentation and degradation of habitat from clearing for agricultural and residential development, particularly fertile Yellow Box-White Box-Blakely's Red Gum Woodlands
- Continuing loss of key habitat tree species and remnant woodlands from major developments (mining and agricultural), timber gathering and residential developments

- Key habitats continue to degrade from lack of recruitment of key forage species and loss of paddock trees and small remnants increasingly fragmenting the available habitat
- Suppression of natural regeneration of overstorey tree species and shrub species from overgrazing. Riparian gallery forests have been particularly impacted by overgrazing
- Competition from larger aggressive honeyeaters, particularly noisy miners, noisy friarbirds and red wattlebirds
- The small population size and restricted habitat availability make the species highly vulnerable to extinction via stochastic processes and loss of genetic diversity, and reduced ability to compete, increased predation and reduced fledging rates
- Egg and nest predation by native birds and mammals
- Inappropriate forestry management practices that remove large mature resource-abundant trees. Firewood collection and harvesting in Box-Ironbark woodlands can also remove important habitat components
- Disturbance at nesting sites leading to reduced nesting success by recreational users
- Loss of key foraging resources as a result of inappropriate fire regimes
- Drought has limited the availability of free-standing water, which is considered a key component of an optimal nesting site.

Field surveys completed did not record any Regent Honeyeater within the study area. While the species has been previously recorded in the JKCR, it is generally consered that no suitable habitat is present and that any individuals are likely to be moving through on their winter migration (OEH, 2012). In this context, however, the loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Regent Honeyeater, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Scarlet Robin

The Scarlet Robin is found from southeast Queensland to south east South Australia and also in Tasmania and south west Western Australia. In NSW, it occurs from the coast to the inland slopes. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. The species occurs in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat.

The Scarlet Robin generally breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees. Birds usually occur singly or in pairs, occasionally in small family parties; pairs stay together year-round.

DPE/BCS (2023) identify the following threats to the Scarlet Robin:

- Historical habitat clearing and degradation
- Habitat modification due to overgrazing
- Reduction of size of remnant patches
- Reduction in the structural complexity of habitat, including reductions in canopy cover, shrub cover, ground cover, logs, fallen branches and leaf litter
- Reduction in native ground cover from invasion by weeds including exotic grasses and woody weeds
- Loss of nest sites, food sources and foraging sites, such as standing dead timber, logs and coarse woody debris, from depletion by grazing, firewood collection and 'tidying up' of rough pasture
- Predation by over-abundant populations of pied currawong (*Strepera graculina*) which are supported by planted exotic berry-producing shrubs; this pressure, in addition to that from other native and exotic predators, may be a potentially severe threat to the breeding success of scarlet robin populations
- Predation by feral cats (*Felis catus*)
- Isolation of patches of habitat, particularly where these patches are smaller than 10 ha, and in landscapes where clearing has been heavy or where remnants are surrounded by cropping or stock grazing
- Habitat for the scarlet robin may become unsuitable if dense regeneration occurs after bushfires or other disturbances

- Competitive exclusion by over-abundant Noisy Miners (*Manorina melanocephala*) within habitat.

One male Scarlet robin was recorded during the field survey at the end of Zone 4. While the species is known to occur in JKCR, it is considered an uncommon visitor (OEH, 2012). In this context, the loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Scarlet Robin, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Swift Parrot

Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes. Migrates to the Australian south-east mainland between February and October.

On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculate*), Red Bloodwood (*C. gummifera*), Forest Red Gum (*E. tereticornis*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*). Commonly used lerp infested trees include Inland Grey Box (*E. macrocarpa*), Grey Box (*E. moluccana*), Blackbutt (*E. pilularis*), and Yellow Box (*E. melliodora*). Return to some foraging sites on a cyclic basis depending on food availability.

Following winter, they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum *Eucalyptus globulus*.

DPE\BCS (2023) identify the following threats to the Swift Parrot:

- Habitat loss and fragmentation from forest harvesting, residential/industrial development, agricultural clearing, senescence and dieback
- Changes in spatial and temporal distribution of habitat due to climate change
- Reduced food availability due to drought conditions
- Competition from introduced bees and large, aggressive honeyeaters for food resources
- Collisions with human made structures resulting in death or injury
- Psittacine Beak and Feather Disease vulnerability
- Weed invasion impacting on habitat regeneration and health
- High fire frequency impacting on food resource availability
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners
- Predation by cats
- Illegal capture and trade of wild birds for aviculture.

While the species has not been previoulsy recorded in the JKCR, it is generally considered that any individuals that do occur there are likley to be moving through on their winter migration (OEH, 2012). In this context, the loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Swift Parrot, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Varied Sitella

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades. The species can be found in eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland.

DPE\BCS (2023) identify the following threats to the Varied Sittella:

- Apparent decline has been attributed to declining habitat. The sedentary nature of the Varied Sittella makes cleared land a potential barrier to movement
- The Varied Sittella is also adversely affected by the dominance of Noisy Miners in woodland patches
- Threats include habitat degradation through small-scale clearing for fence lines and road verges, rural tree decline, loss of paddock trees and connectivity, 'tidying up' on farms, and firewood collection
- Infestation of habitat by invasive weeds
- Inappropriate fire regimes
- Climate change impacts including reduction in resources due to drought
- Overgrazing by stock impacting on leaf litter and shrub layer.

Field surveys completed did not record any Varied Sitella within the road corridor. However, the habitat assessment within Appendix B found that likely potential habitat does occur. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Varied Sitella, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

These species are not listed as an endangered ecological community or critically endangered ecological community.

(c) in relation to the habitat of a threatened species, or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented, or isolated to the long-term survival of the species or ecological community in the locality,

i. The proposed work would result in the removal or disturbance of up to 0.81 hectares of native forest vegetation.

ii. The proposal would not isolate or fragment other areas of habitats further than the impact that pre-exists given the ability of these species to move (fly), the relatively small nature of proposed work and the extent of habitat in the wider locality, which would remain unaffected by the proposed work.

iii. For these species, the potential and known habitat to be removed is considered to be of little importance to the long-term viability of these species in the locality. Particularly with consideration of the remaining forest that occurs across the locality that would remain unaffected by the proposal.

(d) whether the action proposed is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

No declared areas of outstanding biodiversity value are known from the vicinity of the proposed work.

(e) whether the action proposed constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process.

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Clearing of any area of native vegetation, may impact on biological diversity such as habitat fragmentation limiting gene flow between small, isolated populations, which may result in a reduction in the potential for biodiversity to adapt to environmental change.

The proposed work includes the clearing or disturbance of up to 0.81 hectares of native forest vegetation. The direct impact is considered negligible in the context of forest habitat adjacent to the study area, and within the wider locality which would remain unaffected by this proposal.

The proposal is unlikely to result in the operation of, or increase the impact of, a key threatening process with consideration of relatively minor nature of the works proposed and the mitigation measures detailed within this BA.

Conclusion

This Test of Significance has determined that the proposed activity is *'unlikely'* to have a *'significant effect'* on Brown Treecreeper (eastern subspecies), Diamond Firetail, Dusky Woodswallow, Flame Robin, Little Eagle, Painted Honey Eater, Regent Honeyeater, Scarlet Robin, Swift Parrot, Varied Sitella, and their habitats.

Hollow-dependent Birds (Barking Owl, Gang-gang Cockatoo, Little Lorikeet, Masked Owl, Powerful Owl, Sooty Owl, South-eastern Glossy Black-Cockatoo)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Barking Owl

The Barking Owl is found throughout continental Australia except for the central arid regions. Although still common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains and in some northeast coastal and escarpment forests. Many populations crashed as woodland on fertile soils was cleared over the past century, leaving linear riparian strips of remnant trees as the last inhabitable areas. Surveys in 2001 demonstrated that the Pilliga Forest supported the largest population in southern Australia. The owls sometimes extend their home range into urban areas, hunting birds in garden trees and insects attracted to streetlights. Extensive wildfires in 2019-20 reduced habitat quality further, burnt many old, hollow-bearing trees needed as refuge by prey species and reduced the viability of some regional owl populations.

Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g., western NSW) due to the higher density of prey found on these fertile riparian soils. Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as *Acacia* and *Casuarina* species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance.

Preferentially hunts small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch. Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats.

Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g., goannas). Nesting occurs during mid-winter and spring, being variable between pairs and among years. As a rule of thumb, laying occurs during August and fledging in November. The female incubates for 5 weeks, roosts outside the hollow when chicks are 4 weeks old, then fledging occurs 2-3 weeks later. Young are dependent on their parents for several months.

Territorial pairs respond strongly to recordings of Barking Owl calls from up to 6 km away, though humans rarely hear this response farther than 1.5 km. Because disturbance reduces the pair's foraging time and can pull the female off her eggs even on cold nights, recordings should not be broadcast unnecessarily nor during the nesting season.

DPE\BCS (2023) identify the following threats to the Barking Owl:

- Clearing and degradation of habitat, mostly through cultivation, intense grazing and the establishment of exotic pastures
- Inappropriate forest harvesting practices that remove old, hollow-bearing trees and change open forest structure to dense regrowth
- Firewood harvesting resulting in the removal of fallen logs and felling of large dead trees
- Too-frequent fire leading to degradation of understorey vegetation which provides shelter and foraging substrates for prey species
- Destruction of hollow-bearing trees, which provide both nest sites for the owls and refuge sites for their prey
- Competition for prey by foxes
- Poor organisation and availability of species data
- Nestling predation by native species such as goannas and brush-tailed possums

- High use of rodenticide impacts on large forest owls through secondary poisoning
- Disturbance of nesting and excessive disturbance of foraging by inappropriate use of call-playback surveys.

Field surveys completed did not record Barking Owl within the study area. While a nocturnal survey was not completed due to WHS concerns for personnel, the species is known to occur within the JKCR. A breeding event was recorded in 2005 in a tree close to the study area off Burmah Road where chicks successfully fledged (OEH, 2012). It is likely that the species is more common in areas closer to grassy and open habitats that flank the JKCR, as these preferences have been identified in other valleys such as the Capertee to the north and Burragorang to the east (OEH, 2012). The loss of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Barking Owl, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Gang-gang Cockatoo

The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee.

In spring and summer, they are generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. They are also known from sub-alpine Snow Gum (*Eucalyptus pauciflora*) woodland. Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 10 cm in diameter or larger in eucalypts.

Gang-gang Cockatoo was also recently listed as Endangered under the EPBC Act. The main factor for the listing is a result of the Black Summer Fires in 2019/2020. The population of Gang-gang Cockatoo has declined by approximately 69 percent in the last three generations (approximately 21 years). In addition to this continuous decline in population numbers, the species also suffered mortality and habitat loss during Black Summer Fires. Estimates of the distribution impacted by fire range from 28 to 36 percent. The 2019/2020 fires may have reduced the carrying capacity of 40 percent of occupied grid cells by half and resulted in a 10 percent reduction in the overall population size. An analysis based on expert analysis estimated that three generations post-fire the population could still be 29 percent lower than the pre-fire population size. These predictions assume no further extreme drought or extensive fire events; however, such events are likely to reoccur over the assessment period, which would worsen the extent of population decline.

DPE/BCS (2023) identify the following threats to the Gang-gang Cockatoo:

- Loss of key breeding and foraging habitat from intensive wildfire events and inappropriate hazard reduction burns
- Loss and degradation of breeding and foraging habitat from rural and urban development
- Loss of breeding and foraging habitat from forestry management practices
- Climate change impacts to habitat suitability and distribution
- Psittacine cirovirus disease (PCD)
- Lack of knowledge of locations of key breeding habitat and breeding ecology and success
- Infestation of habitat by invasive weeds
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners.

A female Gang-gang Cockatoo was recorded during the field survey, flying across the study area through zone 4. The individual was observed flying toward carpark no. 1 where visual confirmation was lost. This sighting is not surprising given the presence of forest within the study area, as well as the larger extent of forest in the locality including the 3,085 hectare JKCR. The 2012 surveys by OEH confirm that the species was regularly recorded within the JKCR.

The loss of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Gang-gang Cockatoo, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Glossy Black-Cockatoo

The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia. Glossy Black Cockatoos feed almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species), shredding the cones with the massive bill.

They are known to occur within open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (*Allocasuarina littoralis*) and Forest Sheoak (*A. torulosa*) are important food resources. West of the Great Dividing Range populations feed on a wide range of sheoaks, including Drooping Sheoak (*Allocasuaraina diminuta*), and *A. gymnathera*. Belah is also utilised and may be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah (*Casuarina cristata*).

Dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.

DPE/BCS (2023) identify the following threats to the Glossy Black-Cockatoo:

- Reduction of suitable habitat through clearing for development
- Decline of hollow bearing trees over time due to land management activities
- Excessively frequent fire which eliminates sheoaks from areas, prevents the development of mature sheoak stands, and destroys nest trees
- Firewood collection resulting in loss of hollow-bearing trees, reduced recruitment of hollow-bearing trees, and disturbance of breeding attempts
- Decline in extent and productivity of sheoak foraging habitat due to feral herbivores
- Reduced access to surface water in close proximity to foraging and nesting habitat
- Limited information on the location of nesting aggregations and the distribution of high quality breeding habitat
- Disturbance from coal seam gas and open cut coal mining causing loss of foraging and breeding habitat as well as disturbing reproductive attempts
- Decline in extent and productivity of sheoak foraging habitat caused by moisture stress due to climate change
- Forestry activity resulting in loss of hollow-bearing trees, reduced recruitment of hollow-bearing trees, degradation of foraging habitat, and disturbance of breeding attempts
- Degradation of foraging habitat and reduced regeneration of sheoak stands due to grazing by domestic stock
- Loss of foraging habitat due to slashing/under scrubbing
- Change in the spatial and temporal distribution of resources due to global warming
- Illegal bird smuggling and egg-collecting
- Habitat infestation by weeds such as African boxthorn, Gazania, buffel grass and other invasive grasses.

Field surveys completed did not record Glossy Black-Cockatoo within the study area. The loss of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Glossy Black-Cockatoo or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Little Lorikeet

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs.

Forages primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in *Angophora, Melaleuca* and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g., paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards. Gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries.

Roosts in treetops, often distant from feeding areas. Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like *Allocasuarina*. Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown.

DPE/BCS (2023) identify the following threats to the Little Lorikeet:

- Given that large old *Eucalyptus* trees on fertile soils produce more nectar, the extensive clearing of woodlands for agriculture has significantly decreased food for the lorikeet, thus reducing survival and reproduction. Small scale clearing, such as during roadworks and fence construction, continues to destroy habitat and it will be decades before revegetated areas supply adequate forage sites
- The loss of old hollow bearing trees has reduced nest sites, and increased competition with other native and exotic species that need large hollows with small entrances to avoid predation. Felling of hollow trees for firewood collection or other human demands increases this competition
- Competition with the introduced Honeybee for both nectar and hollows exacerbates these resource limitations
- Infestation of habitat by invasive weeds
- Inappropriate fire regimes
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners
- Climate change impacts including reduction in resources due to drought
- Degradation of woodland habitat and vegetation structure due to overgrazing.

Field surveys completed did not record Little Lorikeet within the study area. The loss of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Little Lorikeet, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Masked Owl

The distribution of the Masked Owl extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There does not appear to be any seasonal variation in its distribution.

They can be found in dry eucalypt forests and woodlands from sea level to 1100 m and often hunt along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1000 hectares. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.

DPE\BCS (2023) identify the following threats to the Masked Owl:

- Loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future
- Clearing of habitat for grazing, agriculture, forestry or other development
- A combination of grazing and regular burning is a threat, through the effects on the quality of ground cover for mammal prey, particularly in open, grassy forests
- Secondary poisoning from rodenticides
- Being hit by vehicles.

The loss of up to 0.81 hectares of native woodland vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Masked Owl, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Powerful Owl

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing. Now at low densities throughout most of its eastern range, rare along the Murray River and former inland populations may never recover.

The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine (*Syncarpia glomulifera*), Black She-oak (*Allocasuarina littoralis*), Blackwood *Acacia melanoxylon*, Rough-barked Apple (*Angophora floribunda*), Cherry Ballart (*Exocarpus cupressiformis*) and a number of eucalypt species.

The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls. For example, in southern NSW, Ringtail Possum make up the bulk of prey in the lowland or coastal habitat. At higher elevations, such as the tableland forests, the Greater Glider may constitute almost all of the prey for a pair of Powerful Owls. Flying foxes are important prey in some areas; birds comprise about 10-50% of the diet depending on the availability of preferred mammals. As most prey species require hollows and a shrub layer, these are important habitat components for the owl.

Pairs of Powerful Owls demonstrate high fidelity to a large territory, the size of which varies with habitat quality and thus prey densities. In good habitats a mere 400 can support a pair; where hollow trees and prey have been depleted the owls need up to 4000 ha.

Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him. Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to mid-winter but is slightly earlier in north-eastern NSW (late summer - mid autumn). Clutches consist of two dull white eggs and incubation lasts approximately 38 days.

DPE\BCS (2023) identify the following threats to the Powerful Owl:

- Historical loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development. Inappropriate forest harvesting practices that have changed forest structure and removed old growth hollow-bearing trees
- Loss of hollow-bearing trees reduces the availability of suitable nest sites and prey habitat
- Can be extremely sensitive to disturbance around the nest site, particularly during pre-laying, laying and downy chick stages. Disturbance during the breeding period may affect breeding success
- High frequency hazard reduction burning may also reduce the longevity of individuals by affecting prey availability
- Road kills
- Secondary poisoning
- Predation of fledglings by foxes, dogs, and cats.

The species is known to occur in the eucalypt forests of the Great Dividing range and within the 3,085 hectare JKCR. It has been acknowledged that the detection rate of Powerful Owl within the JKCR is much higher than other areas of their distribution, strongly suggesting the habitats present are of high quality to this species.

The loss of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. No known nesting locations were identified within the proposal site. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Powerful Owl, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Sooty Owl

Sooty Owl occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. They occur in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Territories are occupied permanently.

Roosting during the day in the hollow of a tall forest tree or in heavy vegetation, Sooty Owl hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum (*Pseudocheirus peregrinus*) or Sugar Glider (*Petaurus breviceps*). Hollow-bearing trees are critical resources, and very large tree hollows are needed for nest sites.

DPE\BCS (2023) identify the following threats to the Sooty Owl:

- Loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future
- Clearing of habitat for grazing, agriculture, forestry or other development
- A combination of grazing and regular burning is a threat, through the effects on the quality of ground cover for mammal prey, particularly in open, grassy forests
- Secondary poisoning from rodenticides.

Substantial accumulation of regurgitated prey pellets shows that the caves within the JKCR have been used for a long period of time (OEH, 2012). Caves used include the Devil's Coach House, Nettle and Arch Cave, The Ballroom and Dreamtime Cave. During the 2012 survey a roost was also detected in a fig tree on the Jenolan River. Successful breeding of sooty owls has previously been observed in Devil's Coach House where mating occurred in March, eggs were laid in April and the young had left the nest by October. Based on detection location and timing and published territory size (after Higgins 1999) a minimum of three pairs of Sooty owls should be present within JKCR according to OEH (2012). Aside from the caves, the most important habitats at JKCR are likely to be the sheltered gullies with tall forest, particularly with a mesic influence.

The loss of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Sooty Owl, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

These species are not listed as an endangered ecological community or critically endangered ecological community.

(c) in relation to the habitat of a threatened species, or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented, or isolated to the long-term survival of the species or ecological community in the locality,

i. The proposed work would result in the removal or disturbance of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees.

ii. The proposal would not isolate or fragment other areas of habitats further than the impact that pre-exists given the ability of these species to move (fly), the relatively small nature of proposed work and the extent of habitat in the wider locality, which would remain unaffected by the proposed work.

iii. For these species, the potential and known habitat to be removed is considered to be of little importance to the long-term viability of these species in the locality. Particularly with consideration of the remaining forest and woodland that occurs across the locality that would remain unaffected by the proposal.

(d) whether the action proposed is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

No declared areas of outstanding biodiversity value are known from the vicinity of the proposed work.

(e) whether the action proposed constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process.

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Clearing of any area of native vegetation, may impact on biological diversity such as habitat fragmentation limiting gene flow between small, isolated populations, which may result in a reduction in the potential for biodiversity to adapt to environmental change.

The proposed work includes the clearing or disturbance of up to 0.81 hectares of native forest vegetation. The direct impact is considered negligible in the context of habitat adjacent to the study area, and within the wider locality which would remain unaffected.

The 'loss of hollow-bearing trees' (HBT) has resulted from extensive clearing of native vegetation during the past two centuries, primarily for agriculture. A range of direct and indirect processes contribute to the ongoing loss of HBTs, the relative importance of these processes varies according to past and present land management regimes.

During the field survey, 11 HBTs were recorded. Of these 11 HBTs, eight would be removed by the proposed activity. Given the extent of aged forest adjoining the proposal, it is highly probable that other HBTs occur outside the proposal site and within higher quality habitat (away from disturbance from the road). The removal of eight HBTs is therefore considered negligible in this context.

The proposal is unlikely to result in the operation of, or increase the impact of, a key threatening process with consideration of relatively minor nature of the works proposed and the mitigation measures detailed within this BA.

Conclusion

This Test of Significance has determined that the proposed activity is *'unlikely'* to have a *'significant effect'* on Barking Owl, Gang-gang Cockatoo, Little Lorikeet, Masked Owl, Powerful Owl, Sooty Owl, South-eastern Glossy Black-Cockatoo, or their habitats.

Mammals (Eastern Pygmy-possum, Brush-tailed Rock-wallaby, Koala, Southern Greater Glider, Spotted-tailed Quoll, Yellow-bellied Glider)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Eastern Pygmy-possum

The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. They may occupy small patches of vegetation in fragmented landscapes and although the species prefers habitat with a rich shrub understory, they are known to occur in grassy woodlands and the presence of Eucalypts alone is sufficient to support populations in low densities.

Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests.

Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (e.g., grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks. Young can be born whenever food sources are available, however most births occur between late spring and early autumn.

Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares. Agile climbers, but can be caught on the ground in traps, pitfalls or postholes; generally nocturnal. Frequently spends time in torpor especially in winter, with body curled, ears folded and internal temperature close to the surroundings.

DPE/BCS (2023) identify the following threats to the Eastern Pygmy-possum:

- Loss and fragmentation habitat through land-clearing for agriculture, forestry and urban development
- Changed fire regimes that affect the abundance of flowering proteaceous and myrtaceous shrubs, particularly banksias

- Declining shrub diversity in forests and woodlands due to overgrazing by stock and rabbits
- Predation from cats, dogs and foxes
- Loss of nest sites due to removal of firewood
- Mortality on roads through habitat and movement areas.

Eastern Pygmy-possum has been previously recorded within JKCR and is considered a rare resident occurring in heathy vegetation. There are higher densities of this species on the Boyd Plateau to the south-west of JKCR where *Banksia ericifolia* are abundant (OEH, 2012).

The loss of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Eastern Pygmy Possum, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Brush-tailed Rock-wallaby

The range of the Brush-tailed Rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. However, the distribution of the species across its original range has declined significantly in the west and south and has become more fragmented. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit.

Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night when foraging. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.

Highly territorial and have strong site fidelity with an average home range size of about 15 ha. Males tend to have larger home ranges than females. The home range consists of a refuge area and a foraging range linked by habitually used commuting routes. Females settle in or near their mother's range, while males mainly disperse between female groups within colonies, and less commonly between colonies. Dominant males associate and breed with multiple females. Breeding occurs throughout the year with a peak in births between February and May, especially in the southern parts of the range and at higher altitudes.

DPE/BCS (2023) identify the following threats to the Brush-tailed Rock-wallaby:

- Predation by foxes and wild dogs
- Competition for forage and refuge areas with feral goats
- Loss, degradation and fragmentation of habitat
- The small and isolated nature of some populations may lead to demographic effects (e.g., inbreeding depression)
- Fire regimes that reduce the abundance and diversity of ground forage
- Competition for food and shelter from wallaroos and other native macropods
- Infestation by invasive weeds causing loss and degradation of foraging habitat
- Poor understanding of the distribution, abundance and population structure at some locations
- Potential for individuals to be killed on roads
- Predation by feral cats
- Limited understanding of the species' ecology, threat dynamics and response to management
- Habitat degradation caused by feral pigs
- Creation of tracks within colony leading to greater predator incursions.

Field surveys completed did not record Brush-tailed Rock-wallaby within the study area. JKCR is known to support a population of Brush-tailed Rock-wallaby and there is some potential that they could occur within the study area from time to time. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Brush-tailed Rock-wallaby, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Koala

The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In New South Wales, koala populations are found on the central and north coasts, southern highlands, southern and northern tablelands, Kanangra-Boyd, southern coastal forests, with some smaller populations on the plains west of the Great Dividing Range. Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Inactive for most of the day, feeding and moving mostly at night.

Spend most of their time in trees but will descend and traverse open ground to move between trees. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery. Females breed at two years of age and produce one young per year.

DPE/BCS (2023) identify the following threats to the Koala:

- Loss, modification and fragmentation of habitat
- Vehicle strike
- Predation by roaming or domestic dogs
- Intense prescribed burns or wildfires that scorch or burn the tree canopy
- Koala disease
- Heat stress through drought and heatwaves
- Human-induced climate change
- Inadequate support for fauna rehabilitation
- Poor understanding of sources of trauma and mortality
- Poor understanding of population distribution and trend
- Poor understanding of animal movements and use of habitat.

A single Koala was recorded in zone 5 during the field survey whilst personnel were moving in a vehicle under escort. Upon return to the location on foot, the Koala could not be located. Koala are known from the JKCR and are regarded as an uncommon non-breeding visitor (OEH, 2012).

The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Koala, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Southern Greater Glider

Greater gliders are found in southern Queensland, eastern New South Wales and the montane forests of the Victorian central highlands. Greater gliders choose habitat based on several factors, the dominant factor being the presence of specific species of eucalypt. Distribution levels are higher in regions of montane forest containing manna gum (*E. viminalis*) and mountain gum (*E. dalrympleana*, *E. obliqua*). The presence of *E. cypellocarpa* appears to improve the quality of habitat for Greater gliders in forests dominated by *E. obliqua*. Another factor determining population density is elevation. Optimal levels are 845 m above sea level. Within a forest of suitable habitat, they prefer overstorey basal areas in old-growth tree stands.

DPE/BCS (2023) identify the following threats to the Southern Greater Glider:

- Reduction in habitat area and quality is predicted to occur as a result of urban and rural development which poses a significant threat to this population of Greater Gliders. Specific threats are listed below
- Loss of habitat including fragmentation and lack of connectivity to surrounding habitat as a result of urban and rural development
- Loss of hollow-bearing trees
- Too frequent or high severity fires impacting the population and hollow bearing trees
- Small population size susceptible to unmanageable threats including loss of individuals (e.g., from powerful owl predation) and threats impacting habitat quality and food availability (e.g., climate change and drought)
- Too frequent or high severity fires impacting the population and hollow bearing trees
- Small population size susceptible to unmanageable threats including loss of individuals (e.g., from powerful owl predation) and threats impacting habitat quality and food availability (e.g., climate change and drought)

- Barbed wire fences can entangle gliders and damage their gliding membranes.

This species is known to occur within the JKCR and are referred to as "particularly plentiful" in the 2012 surveys (OEH, 2012). For example, in a 200 metre spotlighting transect, 13 greater glider were recorded. While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present and previous results, this species is likely to occur within the the proposal site and surrounding forest and could potentially roost in hollow-bearing trees.

The loss of up to 0.81 hectares of native woodland vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Southern Greater Glider, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Spotted-tailed Quoll

The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common. Spotted-tailed Quoll are known from across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Quolls use hollow-bearing trees, fallen logs, other animal burrows, small caves and rock outcrops as den sites.

The species is mostly nocturnal, although they are known to hunt during the day; spending most of the time on the ground. However, they are also excellent climbers and will hunt possums and gliders in tree hollows and prey on roosting birds. The species uses communal 'latrine sites', often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Such sites may be visited by multiple individuals and can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals.

A generalist predator with a preference for medium-sized (500g-5kg) mammals, they are known to have a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. They are also known to feed on carrion and take domestic fowl. Females occupy home ranges of between 200-500 hectares, while males occupy very large home ranges from 500 to over 4000 hectares. They are also known to move across their home ranges by following densely vegetated creek lines.

DPE/BCS (2023) identify the following threats to the Spotted-tailed Quoll:

- Loss, fragmentation and degradation of habitat
- Competition with introduced predators such as cats and foxes
- Deliberate poisoning, shooting and trapping, primarily in response to chicken predation
- Roadkill
- Poisoning from eating cane toads in the wild.

Spotted-tailed Quoll is known to occur within JKCR (OEH, 2012). While a secretive animal in general, this species has been recorded regularly by staff and park visitors including foraging at a picnic area and crossing roads at night (OEH, 2012). Given this, it is likely that the study area would contain a portion of a home range of this species.

The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Spotted-tailed Quoll, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Yellow-bellied Glider

The Yellow-bellied Glider has a wide distribution along the east coast and adjacent ranges from north Queensland to western Victoria (Menkhorst and Knight, 2010). Its occurrence within its range is patchy however, and population density generally very low. Several studies on this species are reported in Goldingay and Kavanagh (1991) and other studies of their feeding behaviour and habitat requirements (Rees et al., 2007, Goldingay and Possingham, 1995, Eyre and Goldingay, 2005, Kavanagh, 2004, Craig, 1985, Goldingay, 1992, NPWS, 1999, Goldingay, 1989, Goldingay, 2000, Goldingay and Kavanagh, 1991). The important factor is that they exploit a range of plant exudates including sap, manna (a substance formed by exudation of sap at the site of insect

damage on branchlets and foliage of eucalypts and angophoras) and nectar of eucalypt flowers, honeydew (excretions of certain sap-sucking insects) and obtain protein by foraging for insects and other invertebrates mostly under the peeling bark of smooth-barked eucalypts, and by consuming pollen when it is available in eucalypt blossom.

Because Yellow-bellied Gliders exploit food resources which are largely ephemeral in nature, they require large home ranges compared with similar sized animals which feed on foliage. Goldingay (1989) found that they spend all night out of their dens, and in this time they spend 90% of the time foraging (Goldingay, 1989). Because of the ephemeral and widely distributed nature of their food resources they need to be very mobile animals, and they are known to be capable of glides of more than 100 metres length, and to cover large distances between den sites and feeding areas (Goldingay and Possingham, 1995, Jackson, 1999). However, at times when other food resources are limited they can be heavily dependent on eucalypt sap, which is licked from incisions which they chew in the bark of selected trees (Eyre and Goldingay, 2005, Goldingay, 2000).

Kavanagh (1987) found that gliders selectively foraged in larger trees of more than 80 cm diameter. Only when foraging for insects under bark did they utilise smaller (<40 cm diameter) trees; for all other food resources they preferred large trees (Kavanagh, 1987). They also require large trees to provide the hollows in which they shelter during the day. There are two main habitat requirements for this species, large old trees containing hollows to provide den sites, and a sufficient diversity of eucalypt species to provide them with the range of food resources they require throughout the year. No Yellow-bellied Glider sap feed trees were recorded adjacent to the proposed work suggesting that the study area is of little importance to this species.

DPE\BCS (2023) identify the following threats to the Yellow-bellied Glider:

- Loss and fragmentation of habitat
- Loss of hollow-bearing trees
- Loss of feed trees.

While a nocturnal survey was not completed due to WHS concerns for personnel, based on the habitats present and previous results from earlier surveys, this species is likely to occur within the the proposal site and surrounding forest and could potentially roost in hollow-bearing trees. It is considered an uncommon resident of the JKCR (OEH, 2012).

The loss of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Yellow-bellied Glider, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

These species are not listed as an endangered ecological community or critically endangered ecological community.

(c) in relation to the habitat of a threatened species, or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented, or isolated to the long-term survival of the species or ecological community in the locality,

i. The proposed work would result in the removal or disturbance of up to 0.81 hectares of native forest vegetation and eight hollow-bearing trees.

ii. The proposal would not isolate or fragment other areas of habitats further than the impact that pre-exists given the ability of these species to move, the relatively small nature of proposed work and the extent of habitat in the wider locality, which would remain unaffected by the proposed work.

iii. For these species, the potential and known habitat to be removed is considered to be of little importance to the long-term viability of these species in the locality. Particularly with consideration of the remaining forest that occurs across the locality that would remain unaffected by the proposal.

(d) whether the action proposed is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

No declared areas of outstanding biodiversity value are known from the vicinity of the proposed work.

(e) whether the action proposed constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process.

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Clearing of any area of native vegetation, may impact on biological diversity such as habitat fragmentation limiting gene flow between small, isolated populations, which may result in a reduction in the potential for biodiversity to adapt to environmental change.

The proposed work includes the clearing or disturbance of up to 0.81 hectares of native forest vegetation. The direct impact is considered negligible in the context of habitat adjacent to the study area, and within the wider locality which would remain unaffected.

The 'loss of hollow-bearing trees' (HBT) has resulted from extensive clearing of native vegetation during the past two centuries, primarily for agriculture. A range of direct and indirect processes contribute to the ongoing loss of HBTs, the relative importance of these processes varies according to past and present land management regimes.

During the field survey, 11 HBTs were recorded. Of these 11 HBTs, eight would be removed by the proposed activity. Given the extent of aged forest adjoining the proposal, it is highly probable that other HBTs occur outside the proposal site and within higher quality habitat (away from disturbance from the road). The removal of eight HBTs is therefore considered negligible in this context.

The proposal is unlikely to result in the operation of, or increase the impact of, a key threatening process with consideration of relatively minor nature of the works proposed and the mitigation measures detailed within this BA.

Conclusion

This Test of Significance has determined that the proposed activity is *'unlikely'* to have a *'significant effect'* on Eastern Pygmy-possum, Brush-tailed Rock-wallaby, Koala, Southern Greater Glider, Spotted-tailed Quoll, Yellow-bellied Glider, or their habitats.

Reptiles (Rosenberg's Goanna)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Rosenberg's Goanna

Rosenberg's Goanna occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. There are records from the South West Slopes near Khancoban and Tooma River. Also occurs in South Australia and Western Australia. They occur in heath, open forest and woodland.

Rosenberg's Goanna are associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. Large areas of habitat are also required. Shelters in hollow logs, rock crevices and in burrows, which they may dig for themselves, or they may use other species' burrows, such as rabbit warrens. Generally slow moving; on the tablelands likely only to be seen on the hottest days.

DPE\BCS (2023) identify the following threats to the Rosenberg's Goanna:

- Habitat loss and fragmentation as land is cleared for residential, agricultural and industrial developments
- Removal of habitat elements, such as termite mounds and fallen timber
- Animals are killed by moving vehicles - upgrading of dirt roads to bitumen, which increases the speed of through traffic, is likely to increase the instances of road kills
- Predation by cats and dogs.

Field surveys completed did not record Rosenberg's Goanna within the study area. The loss of up to 0.81 hectares of native forest vegetation is considered negligible in the context of the potential habitat within a 550-metre buffer of the proposal. The

proposed impact equates to only 0.27% of the native vegetation within the locality, suggesting that suitable habitat remains unaffected. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Rosenberg's Goanna, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

This species is not listed as an endangered ecological community or critically endangered ecological community.

(c) in relation to the habitat of a threatened species, or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented, or isolated to the long-term survival of the species or ecological community in the locality,

i. The proposed work would result in the removal or disturbance of up to 0.81 hectares of native forest vegetation.

ii. The proposal would not isolate or fragment other areas of habitats further than the impact that pre-exists given the ability of these species to move, the relatively small nature of proposed work and the extent of habitat in the wider locality, which would remain unaffected by the proposed work.

iii. For this species, the potential habitat to be removed is considered to be of little importance to the long-term viability of these species in the locality. Particularly with consideration of the remaining forest that occurs across the locality that would remain unaffected by the proposal.

(d) whether the action proposed is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

No declared areas of outstanding biodiversity value are known from the vicinity of the proposed work.

(e) whether the action proposed constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process.

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Clearing of any area of native vegetation, may impact on biological diversity such as habitat fragmentation limiting gene flow between small, isolated populations, which may result in a reduction in the potential for biodiversity to adapt to environmental change.

The proposed work includes the clearing or disturbance of up to 0.81 hectares of native forest vegetation. The direct impact is considered negligible in the context of habitat adjacent to the study area, and within the wider locality which would remain unaffected.

The proposal is unlikely to result in the operation of, or increase the impact of, a key threatening process with consideration of relatively minor nature of the works proposed and the mitigation measures detailed within this BA.

Conclusion

This Test of Significance has determined that the proposed activity is *'unlikely'* to have a *'significant effect'* on Rosenberg's Goanna or their habitats.

Flora (Mountain Trachymene, Needle Geebung)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Mountain Trachymene

The species occurs at around four general locations between Jenolan caves and Gurnang State Forest on the Central Tablelands south east of Oberon. Among these locations, the species occurs in Kanangra-Boyd National Park. Associated vegetation across known sites varies from riparian tea-tree thickets to tall forest, to frost hollows and includes the following species: *Leptospermum obovatum*, *Eucalyptus fastigata*, *E. dalrympleana*, *Acacia melanoxylon*, *E. stellulata*, *E. pauciflora*, *E. rubida*.

Despite being perennial, above-ground parts of this herb die back over winter. Over winter, the leaves turn brown and die with total foliage loss occurring for many patches around July. By October, regrowth of the foliage has commenced, and seedlings emerge. Flowers from December until March, with seed dispersing in April. Seed viability declines precipitously after dispersal, with almost no viable seed remaining after 12 months. Can reproduce clonally via rhizomes, often leading to the formation of dense mats or patches of plants.

DPE\BCS (2023) identify the following threats to the Mountain Trachymene:

- Disturbance via recreational use (camping, etc.)
- Grazing may be a threat by reducing recruitment and rates of establishment
- Sedimentation and erosion smothering populations
- Invasion and competition from various woody and herbaceous weed species, including blackberry and pine
- Inappropriate tracking / road building and changes to hydrology as a result of crossing and tracks.

Field surveys completed did not record this species within the study area. There is some potential that the species may occur on the slopes and within gullies within the proposal site. As personnel were unable to access the slopes for the purpose of a targeted survey, presence/absence could not be determined. However, this assessment assumes presence, although the form of this presence is unknown.

The loss of up to 0.81 hectares of native forest vegetation that may support this species would be regarded as significant if the plant was present. However, the species is known only from four locations of varying habitats. The study area does not appear to be one of the three priority managed sites by DPE (referred to as Tuglow River, Boyd Crossing and Long Flat Creek). On this basis, it is unlikely that a significant population occurs within the study area. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species including a pre-clearance survey once access to the slopes is available, to confirm that the species is not present.

With consideration of these factors, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Mountain Trachymene, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

Needle Geebung

The Needle Geebung has been recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba/ Wentworth Falls/ Springwood area.

The Needle Geebung occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils. Plants are likely to be killed by fire and recruitment is solely from seed. This species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides.

At the JKCR, a single record exists within the proposal site from a specimen collected in 1889. The Conservation Advice for this species provides commentary on the relative accuracy of this location as follows:

> *"The 1889 Jenolan Cave collection record is spatially vague and of questionable spatial merit given that there are no other records of the species from that locality, and that the lithology of this locality differs greatly from that of all extant and other historic records of the species. Some early collections described as occurring at Jenolan Caves are actually from the Boyd Plateau which is more plausible habitat (D Keith 2022. pers comm 1 September), however, there are no more recent records from this area either. Spatial uncertainty aside, the species does not appear to have extant populations in this region because there are no modern records, despite reasonable general survey effort, and especially so in relatively accessible sites such as where the 1889 collection was made".*

However, given that the single record that is mapped, is within the proposal site, there remains uncertainty of whether this species occurs within the study area or not. As personnel were unable to access the slopes for the purpose of a targeted survey, presence/absence could not be determined.

DPE\BCS (2023) identify the following threats to the Needle Geebung:

- Loss of habitat through clearing for urban and small-rural-lot development
- Burning for hazard reduction and other unnatural ignitions have increased fire frequency and may threaten the species' survival
- Weed invasion on trail and road margins and on the edge of bushland
- Many *Persoonia* species are killed following infection by *Phytophthora cinnamomi*
- Habitat disturbance during road maintenance
- Lack of knowledge about the distribution of the species and threats
- Localised distribution places the species at risk of extinction
- Disturbance by recreational trail bikes, 4WDs and rubbish dumping.

The loss of up to 0.81 hectares of native forest vegetation that may support this species would be regarded as potentially significant if the plant was present and did occur elsewhere in the locality. However, based on the information above from the Conservation Advice, it is unlikely that the proposed activity could have an adverse effect on the life cycle of Needle Geebung, or their habitats, such that a viable local population is likely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

These species is not listed as an endangered ecological community or critically endangered ecological community.

(c) in relation to the habitat of a threatened species, or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented, or isolated to the long-term survival of the species or ecological community in the locality,

i. The proposed work would result in the removal or disturbance of up to 0.81 hectares of native forest vegetation.

ii. The proposal would not isolate or fragment other areas of habitats further than the impact that pre-exists along Jenolan Caves Road, the relatively small nature of proposed work and the extent of habitat in the wider locality, which would remain unaffected by the proposed work.

iii. The potential habitat to be removed is of little importance to the long-term viability in the locality, particularly with consideration of the remaining forest that occurs across the locality that would remain unaffected by the proposal.

(d) whether the action proposed is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

No declared areas of outstanding biodiversity value are known from the vicinity of the proposed work.

(e) whether the action proposed constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process.

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Clearing of any area of native vegetation, may impact on biological diversity such as habitat fragmentation limiting gene flow between small, isolated populations, which may result in a reduction in the potential for biodiversity to adapt to environmental change.

The proposed work includes the clearing or disturbance of up to 0.81 hectares of native forest vegetation. The direct impact is considered negligible in the context of habitat adjacent to the study area, and within the wider locality which would remain unaffected.

The proposal is unlikely to result in the operation of, or increase the impact of, a key threatening process with consideration of relatively minor nature of the works proposed and the mitigation measures detailed within this BAR.

Conclusion

This Test of Significance has determined that the proposed activity is *'unlikely'* to have a *'significant effect'* on Mountain Trachymene, Needle Geebung or their habitats.

Appendix D: Assessments of significance (EPBC Act)

EPBC Act Significant Impact Criteria

Migratory Species

Protected under several international agreements to which Australia is a signatory, Migratory species are considered Matters of National Environmental Significance under the EPBC Act.

Five migratory species were found to have the potential to occur within the vicinity of the proposal: Rainbow Bee-eater, Rufous Fantail, Satin Flycatcher, Swift Parrot, and White-throated Needletail (Habitat Assessment, Appendix B).

Under the EPBC Act, an action is likely to have a significant impact on a migratory species if it substantially modifies, destroys or isolates an area of 'important habitat' for the species (DEWHA, 2009). The study area is not considered to comprise 'important habitat' as it does not contain:

- Habitat used by a migratory species occasionally or periodically within a region that supports an ecological significant proportion of the population of the species
- Habitat that is of critical importance to the species at particular life-cycle stages
- Habitat used by a migratory species that is at the limit of the species' range
- Habitat within an area where the species is declining.

Given this, the proposal would not impact on Rainbow Bee-eater, Rufous Fantail, Satin Flycatcher, Swift Parrot, or White-throated Needletail, or any migratory species and is not considered further.

Threatened Species

The study area and immediate surrounds was found to contain potential habitat for biota listed as threatened under the EPBC Act; Large-eared Pied Bat, Brown Treecreeper (eastern subspecies), Diamond Firetail, Gang-gang Cockatoo, Painted Honeyeater, Pilotbird, Regent Honeyeater, South-eastern Glossy Black-Cockatoo, Swift Parrot, White-throated Needletail, Brush-tailed Rock-wallaby, Koala, Southern Greater Glider, Spotted-tailed Quoll, Yellow-bellied Glider, Mountain Trachymene, Needle Geebung. The following section provides significance assessments for these species.

Vulnerable Species (Large-eared Pied Bat, Brown Treecreeper (eastern subspecies), Diamond Firetail, Painted Honeyeater, Pilotbird, South-eastern Glossy Black-Cockatoo, White-throated Needletail, Brush-tailed Rock-wallaby, Yellow-bellied Glider)

Will the action lead to a long-term decrease in the size of an important population of a species?

No. There is no evidence that an important population of these species occurs within the study area. It is highly probable that they may occur in high quality habitats adjoining the study area and their apparent absence within the study area is not surprising given the ongoing disturbances of Jenolan Caves Road.

Nonetheless, the proposed action would result in the direct impact to or removal of up to 0.81 hectares of native vegetation. There are large areas of existing native vegetation in the wider locality in the form of Jenolan Karst Conservation Reserve which will remain unaffected by the proposal and would continue to provide habitat for these species. Given this, it is unlikely that the proposed action would lead to a long-term decrease in an area of occupancy of an important population of these species.

Will the action reduce the area of occupancy of an important population?

No. While there is no evidence to suggest that an 'important' population of these species occurs within the study area, the proposed action would result in the direct impact to or removal of 0.81 hectares of native vegetation and eight hollow-bearing trees. There are large areas of existing native vegetation in the wider locality (and directly adjoining the proposal in the form of Jenolan Karst Conservation Reserve) which would remain unaffected by the proposal and would continue to provide habitat for these species in the locality. Given this, it is unlikely that the proposed action would lead to a long-term decrease in an area of occupancy of an important population of these species, even if one did occur there.

Will the action fragment an existing population into two or more populations?

No population of these species would be fragmented into two or more populations by the current design of the proposed action and the existing fragmentation from Jenolan Caves Road.

Will the action adversely affect habitat critical to the survival of a species?

No. The habitat present is not considered critical for the survival of these species. There are large areas of existing native vegetation in the wider locality (and directly adjoining the proposal in the form of Jenolan Karst Conservation Reserve) which will remain unaffected by the proposal and would continue to provide habitat for these species in the locality.

Will the action disrupt the breeding cycle of an important population?

No. The proposal would not disrupt the breeding cycle of an 'important population' (should one occur there) as the removal of habitat is relatively minor.

Will the action modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

No. Potential habitat would not be impacted to a level that would cause these species to decline with consideration of the extent of the habitat that occurs within the wider locality of Jenolan Karst Conservation Reserve.

Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

No. Mitigation measures within this BAR provide a framework to minimise the risk of weed species becoming established as a result of this proposal.

Will the action introduce disease that may cause the species to decline?

No. Recommendations within this BAR provide a framework for managing potential risks to biodiversity.

Will the action interfere with the recovery of the species?

No. Mitigation measures outlined in this BAR suggest that it is unlikely that the proposed action would have an impact on the recovery of these species, given the relatively minor level of impact proposed. Mitigation measures would be implemented and have been designed specifically to minimise potential impacts.

Conclusion

With consideration of the assessments completed, the proposal is unlikely to have a significant effect on threatened or migratory species as listed by the EPBC Act. Based on this, referral to the Commonwealth Minister is not warranted.

Vulnerable Species (Needle Geebung)

Will the action lead to a long-term decrease in the size of an important population of a species?

Uncertain. Field surveys completed did not record this species within the study area. There is some potential that this species may occur on the slopes and within gullies within the proposal site. As personnel were unable to access the slopes for the purpose of a targeted survey, presence/absence could not be determined. However, this assessment assumes presence, although the form of this presence is unknown.

The loss of up to 0.81 hectares of native forest vegetation that may support this species. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species including a pre-clearance survey once access to the slopes is available, to confirm that the species is not present.

At the JKCR, a single record for Needle Geebung exists within the proposal site from a specimen collected in 1889. The Conservation Advice for this species provides commentary on the relative accuracy of this location as follows:

"The 1889 Jenolan Cave collection record is spatially vague and of questionable spatial merit given that there are no other records of the species from that locality, and that the lithology of this locality differs greatly from that of all extant and other historic records of the species. Some early collections described as occurring at Jenolan Caves are actually from the Boyd Plateau which is more plausible habitat (D Keith 2022. pers comm 1 September), however, there are no more recent records from this area either. Spatial uncertainty aside, the species does not appear to have extant populations in this region because there are no modern records, despite reasonable general survey effort, and especially so in relatively accessible sites such as where the 1889 collection was made".

Will the action reduce the area of occupancy of an important population?

Uncertain. Field surveys completed did not record this species within the study area. There is some potential that this species may occur on the slopes and within gullies within the proposal site. In the context of information presented within this BAR, it

is unlikely that a significant population of either species occurs within the study area. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species, including a pre-clearance survey once access to the slopes is available to confirm that this species is not present.

Will the action fragment an existing population into two or more populations?

No. The design of the proposal would not fragment an existing population.

Will the action adversely affect habitat critical to the survival of a species?

No. The habitat present is not considered critical for the survival of this species.

Will the action disrupt the breeding cycle of an important population?

No. Given that known populations would not be affected by the proposed action.

Will the action modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Uncertain. However, it is unlikely given the nature of the proposal and the likelihood that this species is not present.

Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

No. Mitigation measures within this BAR provide a framework to minimise the risk of weed species becoming established as a result of this proposal.

Will the action introduce disease that may cause the species to decline?

No. Recommendations within this BAR provide a framework for managing potential risks to biodiversity.

Will the action interfere with the recovery of the species?

Uncertain. While mitigation measures outlined within this BAR suggest that it is unlikely that the proposed action would have an impact on the recovery of this species given the level of impact proposed and that a range of mitigation measures designed specifically to minimise potential impacts would be implemented, it cannot be stated with certainty that this species is present or absent given that no field survey has investigated the slopes.

Conclusion

The proposal is unlikely to have a significant effect on threatened or migratory species as listed by the EPBC Act. Based on this, referral to the Commonwealth Minister is not warranted.

The EPBC Act Assessment of Significance for Needle Geebung should be reconsidered at the conclusion of the pre-clearance surveys.

Endangered and Critically Endangered Species (Gang-gang Cockatoo, Koala, Regent Honeyeater, Southern Greater Glider, Spotted-tailed Quoll, Swift Parrot)

Will the action lead to a long-term decrease in the size of a population of a species?

No. There is no evidence that an important population of these species occurs within the study area. It is highly probable that they may occur in high quality habitats adjoining the study area and their apparent absence within the study area is not surprising given the ongoing disturbances of Jenolan Caves Road.

Nonetheless, the proposed action would result in the direct impact to or removal of up to 0.81 hectares of native vegetation. There are large areas of existing native vegetation in the wider locality in the form of Jenolan Karst Conservation Reserve which will remain unaffected by the proposal and would continue to provide habitat for these species. Given this, it is unlikely that the proposed action would lead to a long-term decrease in an area of occupancy of an important population of these species.

Will the action reduce the area of occupancy of the species?

No. There is no evidence to suggest that a population of these species relies upon the resources of the study area in its entirety, given the existing environment adjacent to the study area in Jenolan Karst Conservation Reserve. Given the extent of the habitat

of the locality adjacent to the proposal, it is unlikely that the proposed works would result in a reduction of the area of occupancy of these species.

Will the action fragment an existing population into two or more populations?

No population would be fragmented into two or more populations by the current design of the proposed works.

Will the action adversely affect habitat critical to the survival of a species?

No. The habitat present is not considered critical for the survival of these species.

Will the action disrupt the breeding cycle of a population?

No. The proposal would not disrupt the breeding cycle of a population (should one occur there) given the safeguards relating to areas of retained vegetation.

Will the action modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

No. Potential yet marginal habitat would not be impacted to a level that would cause these species to decline with consideration of the extent of habitat that occurs adjacent to the study area and within Jenolan Karst Conservation Reserve.

Will the action result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?

No. Safeguards within this BAR provide a framework to minimise the risk of weed species becoming established as a result of this proposal.

Will the action introduce disease that may cause the species to decline?

No. Recommendations within this BAR provide a framework for managing potential risks to biodiversity.

Will the action interfere with the recovery of the species?

No. Safeguards outlined within this BAR suggest that it is unlikely that the proposed action would have an impact on the recovery of these species given the level of impact proposed and that a range of mitigation measures designed specifically to minimise potential impacts would be implemented.

Conclusion

With consideration of the assessments completed, the proposal is unlikely to have a significant effect on threatened or migratory species as listed by the EPBC Act. Based on this, referral to the Commonwealth Minister is not warranted.

Endangered and Critically Endangered Species (Mountain Trachymene)

Will the action lead to a long-term decrease in the size of a population of a species?

Uncertain. Field surveys completed did not record this species within the study area. There is some potential that this species may occur on the slopes and within gullies within the proposal site. As personnel were unable to access the slopes for the purpose of a targeted survey, presence/absence could not be determined. However, this assessment assumes presence, although the form of this presence is unknown.

The loss of up to 0.81 hectares of native forest vegetation that may support this species. However, Mountain Trachymene is known only from four locations of varying habitats. The study area does not appear to be one of the three priority managed sites by DPE (referred to as Tuglow River, Boyd Crossing and Long Flat Creek). On this basis, it is unlikely that a significant population occurs within the study area. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species including a pre-clearance survey once access to the slopes is available, to confirm that the species is not present.

Will the action reduce the area of occupancy of the species?

Uncertain. Field surveys completed did not record this species within the study area. There is some potential that this species may occur on the slopes and within gullies within the proposal site. In the context of information presented within this BAR, it is unlikely that a significant population of this species occurs within the study area. Recommendations detailed within section 6 provide a framework for minimising potential direct and indirect impacts to this species, including a pre-clearance survey once access to the slopes is available to confirm that this species is not present.

Will the action fragment an existing population into two or more populations?

No. The design of the proposal would not fragment an existing population.

Will the action adversely affect habitat critical to the survival of a species?

No. The habitat present is not considered critical for the survival of this species.

Will the action disrupt the breeding cycle of a population?

No. Given that known populations would not be affected by the proposed action.

Will the action modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Uncertain. However, it is unlikely given the nature of the proposal and the likelihood that this species is not present.

Will the action result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?

No. Safeguards within this BAR provide a framework to minimise the risk of weed species becoming established as a result of this proposal.

Will the action introduce disease that may cause the species to decline?

No. Recommendations within this BAR provide a framework for managing potential risks to biodiversity.

Will the action interfere with the recovery of the species?

Uncertain. While safeguards outlined within this BAR suggest that it is unlikely that the proposed action would have an impact on the recovery of this species given the level of impact proposed and that a range of mitigation measures designed specifically to minimise potential impacts would be implemented, it cannot be stated with certainty that this species is present or absent given that no field survey has investigated the slopes.

Conclusion

The proposal is unlikely to have a significant effect on threatened or migratory species as listed by the EPBC Act. Based on this, referral to the Commonwealth Minister is not warranted.

The EPBC Act Assessment of Significance for Mountain Trachymene should be reconsidered at the conclusion of the pre-clearance surveys.

Appendix E: Native tree stem count analysis

Tree stem count

DBH (cm)	Tree Stem Count within Stem plot (1000m^2)	Tree Stem Count estimate for proposed impact area (0.81ha or 8100m^2) (rounded up)
100 +	0	0
50-100	0	0
20-49	12	98
5-20	5	41

Tree and hollow replacement requirements

Table 2-1 from the guidelines identify the requirements of relevance to this proposal:

- For every tree between 20-49cm, plant a minimum of four trees
- For every tree between 5-20cm, plant a minimum of two trees
- Provide three hollows for every occupied hollow

Guided by these requirements, the following is the requirement for this proposal:

- Plant a minimum of 474 trees
- Provide 24 artificial hollows assuming one hollow in each of the 8 HBT to be removed – assuming all hollows recorded are occupied, actual hollows would be checked during the pre-clearance survey.

Should payment into the Transport Conservation Fund be the preferred option, the following contributions would be required in accordance with Table 2-2 from the Tree and Hollow-replacement Guidelines:

- 20-49cm DBH - $52,000.00
- 5-20cm DBH - $3,375.00
- Hollows (see Appendix F) - $4,000.00

Total fund payment $59,375.00

Appendix F: Hollow-bearing tree data

ID	Notes	Latitude	Longitude	Easting	Northing	Within proposal site
1	HBT downslope	-33.8165	150.021	224258.83	6254199.356	YES
2	HBT stag downhill side	-33.8169	150.0168	223869.523	6254147.993	NO
3	HBT downhill side	-33.8163	150.0176	223942.361	6254215.166	NO
4	HBT stag downhill side	-33.816	150.0177	223954.462	6254248.491	YES
5	HBT stag downhill side	-33.8159	150.0178	223955.079	6254259.168	YES
6	HBT stag downhill side	-33.8148	150.018	223971.207	6254380.542	YES
7	HBT stag downhill side	-33.8159	150.0184	224016.558	6254261.061	NO
8	HBT downhill side	-33.8181	150.0189	224065.703	6254013.899	YES
9	HBT stag downhill side	-33.8175	150.0194	224108.767	6254085.205	YES
10	HBT stag downhill side	-33.8171	150.0196	224128.608	6254129.634	YES
11	HBT stag downhill side	-33.8168	150.0201	224175.281	6254165.96	YES

Appendix G: Protected Matter Search tool results

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 09-Oct-2023

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance (Ramsar	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	57
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	19
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	2
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	3
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Legal Status	Buffer Status
Greater Blue Mountains Area	NSW	Declared property	In feature area

National Heritage Places [Resource Information]

Name	State	Legal Status	Buffer Status
Natural			
The Greater Blue Mountains Area	NSW	Listed place	In feature area

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity	Buffer Status
Banrock station wetland complex	800 - 900km upstream from Ramsar site	In buffer area only
Riverland	800 - 900km upstream from Ramsar site	In buffer area only
The coorong, and lakes alexandrina and albert wetland	900 - 1000km upstream from Ramsar site	In buffer area only
The macquarie marshes	300 - 400km upstream from Ramsar site	In buffer area only

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Natural Temperate Grassland of the South Eastern Highlands	Critically Endangered	Community likely to occur within area	In feature area
Temperate Highland Peat Swamps on Sandstone	Endangered	Community may occur within area	In buffer area only
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Community likely to occur within area	In feature area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area	In feature area
Calyptorhynchus lathami lathami South-eastern Glossy Black-Cockatoo [67036]	Vulnerable	Species or species habitat known to occur within area	In feature area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Lathamus discolor			
Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area	In feature area
Melanodryas cucullata cucullata			
South-eastern Hooded Robin, Hooded Robin (south-eastern) [67093]	Endangered	Species or species habitat likely to occur within area	In feature area
Neophema chrysostoma			
Blue-winged Parrot [726]	Vulnerable	Species or species habitat may occur within area	In feature area
Pycnoptilus floccosus			
Pilotbird [525]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Rostratula australis			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
Stagonopleura guttata			
Diamond Firetail [59398]	Vulnerable	Species or species habitat likely to occur within area	In feature area
FISH			
Maccullochella macquariensis			
Trout Cod [26171]	Endangered	Species or species habitat may occur within area	In buffer area only
Maccullochella peelii			
Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Macquaria australasica			
Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area	In feature area
Prototroctes maraena			
Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area	In feature area
FROG			
Litoria booroolongensis			
Booroolong Frog [1844]	Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Mixophyes balbus](#)			
Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat may occur within area	In feature area
INSECT			
[Paralucia spinifera](#)			
Bathurst Copper Butterfly, Purple Copper Butterfly, Bathurst Copper, Bathurst Copper Wing, Bathurst-Lithgow Copper, Purple Copper [26335]	Vulnerable	Species or species habitat likely to occur within area	In feature area
MAMMAL			
[Chalinolobus dwyeri](#)			
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Dasyurus maculatus maculatus (SE mainland population)](#)			
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area	In feature area
[Petauroides volans](#)			
Greater Glider (southern and central) [254]	Endangered	Species or species habitat known to occur within area	In feature area
[Petaurus australis australis](#)			
Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Petrogale penicillata](#)			
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)](#)			
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat known to occur within area	In feature area
[Pseudomys novaehollandiae](#)			
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area	In feature area
[Pteropus poliocephalus](#)			
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area	In feature area
PLANT			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Acacia bynoeana Bynoe's Wattle, Tiny Wattle [8575]	Vulnerable	Species or species habitat may occur within area	In feature area
Acacia flocktoniae Flockton Wattle [3134]	Vulnerable	Species or species habitat known to occur within area	In feature area
Baloskion longipes Dense Cord-rush [68511]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Boronia deanei Deane's Boronia [8397]	Vulnerable	Species or species habitat known to occur within area	In feature area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat may occur within area	In buffer area only
Diuris aequalis Buttercup Doubletail [21588]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Eucalyptus aggregata Black Gum [20890]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Eucalyptus macarthurii Camden Woollybutt, Paddys River Box [7827]	Endangered	Species or species habitat known to occur within area	In buffer area only
Eucalyptus pulverulenta Silver-leaved Mountain Gum, Silver-leaved Gum [21537]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Hakea dohertyi Kowmung Hakea [66701]	Endangered	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Hibbertia acaulothrix [87409]	Endangered	Species or species habitat may occur within area	In feature area
Kunzea cambagei [11420]	Vulnerable	Species or species habitat may occur within area	In feature area
Leionema lachnaeoides [64924]	Endangered	Species or species habitat may occur within area	In buffer area only
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area	In buffer area only
Leucochrysum albicans subsp. tricolor Hoary Sunray, Grassland Paper-daisy [89104]	Endangered	Species or species habitat may occur within area	In buffer area only
Pomaderris cotoneaster Cotoneaster Pomaderris [2043]	Endangered	Species or species habitat likely to occur within area	In feature area
Pultenaea glabra Smooth Bush-pea, Swamp Bush-pea [11887]	Vulnerable	Species or species habitat may occur within area	In feature area
Rhizanthella slateri Eastern Underground Orchid [11768]	Endangered	Species or species habitat may occur within area	In feature area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Trachymene scapigera Mountain Trachymene [9367]	Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Veronica lithophila [87479]	Endangered	Species or species habitat likely to occur within area	In feature area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area	In feature area
REPTILE			
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Tympanocryptis mccartneyi Bathurst Grassland Earless Dragon [90478]	Critically Endangered	Species or species habitat may occur within area	In buffer area only

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area	In feature area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area	In feature area
Migratory Wetlands Species			

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area	In feature area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State	Buffer Status
Transport and Regional Services - Airservices Australia		
Commonwealth Land - Airservices Australia [12916]	NSW	In buffer area only

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area overfly marine area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Breeding known to occur within area overfly marine area	In feature area
[Neophema chrysostoma](#) Blue-winged Parrot [726]	Vulnerable	Species or species habitat may occur within area overfly marine area	In feature area
[Pterodroma cervicalis](#) White-necked Petrel [59642]		Species or species habitat may occur within area	In feature area
[Rhipidura rufifrons](#) Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area	In feature area
[Rostratula australis as Rostratula benghalensis (sensu lato)](#) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State	Buffer Status
Jenolan	Karst Conservation Reserve	NSW	In feature area
Kanangra-Boyd	National Park	NSW	In buffer area only

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed	In feature area
Not controlled action (particular manner)				
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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Appendix G
Landscape and Visual Impact Assessment
GHD

Two Mile Hill Slope Restoration

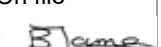
Landscape and Visual Impact Assessment

Transport for NSW

May 2024

→ The Power of Commitment



Project name	Two Mile Access Slope Remediation						
Document title	Two Mile Hill Slope Restoration | Landscape and Visual Impact Assessment						
Project number	12620185						
File name	Visual Impact Assessment						
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	D Taylor	K Petersen B James	On file 	A Pyliotis		20/05/24

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1. Introduction

1.1 Proposal background

Jenolan Caves Road (MR253) provides access to the Jenolan Caves Precinct, as well as campgrounds and other tourist attractions within Jenolan Karst Conservation Reserve. The Two Mile Access on Jenolan Caves Road is currently the primary access into the Jenolan Caves precinct due to the closure of the Five Mile Access (that is from the east), due to substantial slope failures in 2021. This leaves the Two Mile Access as the only access into and out of the precinct. The Two Mile Access has also been subject to eight slope failures between July 2022 and early 2023 which has further restricted its use as the sole access into the Jenolan Caves Precinct. This proposal was identified to align with the objectives of improving road safety along the Two Mile Access by stabilising the high-risk slope and improving drainage conditions to mitigate future impacts of inclement weather.

EnviroKey were engaged by GHD Pty Ltd on behalf of Transport for NSW to prepare a Biodiversity Assessment Report (BAR) that would form part of a Project Review of Environmental Factors (REF) to be assessed under Division 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). MTS Heritage (Mountains Heritage) was also engaged by GHD Pty Ltd (GHD), on behalf of Transport for NSW, to prepare a *Statement of Heritage Impact* (SoHI) report for the proposed remediation works.

1.2 The proposal

The key objective of the proposal is to stabilise and remediate eight separate slopes along a three kilometre section of the 'Two Mile Access' stretch of Jenolan Caves Road at Jenolan. Key features of the proposal include:

– installation of soil nails into eight slopes which were subject to failure to stabilise the slope
– surface stabilisation including the placement of shotcrete which would be appropriately tinted with colour to match the surrounding environment
– installation of drainage infrastructure within the impacted section of slope at three slope failure locations
– establishment of construction compound and stockpile sites at Kanangra Walls Road and Car Park 1 and 2.

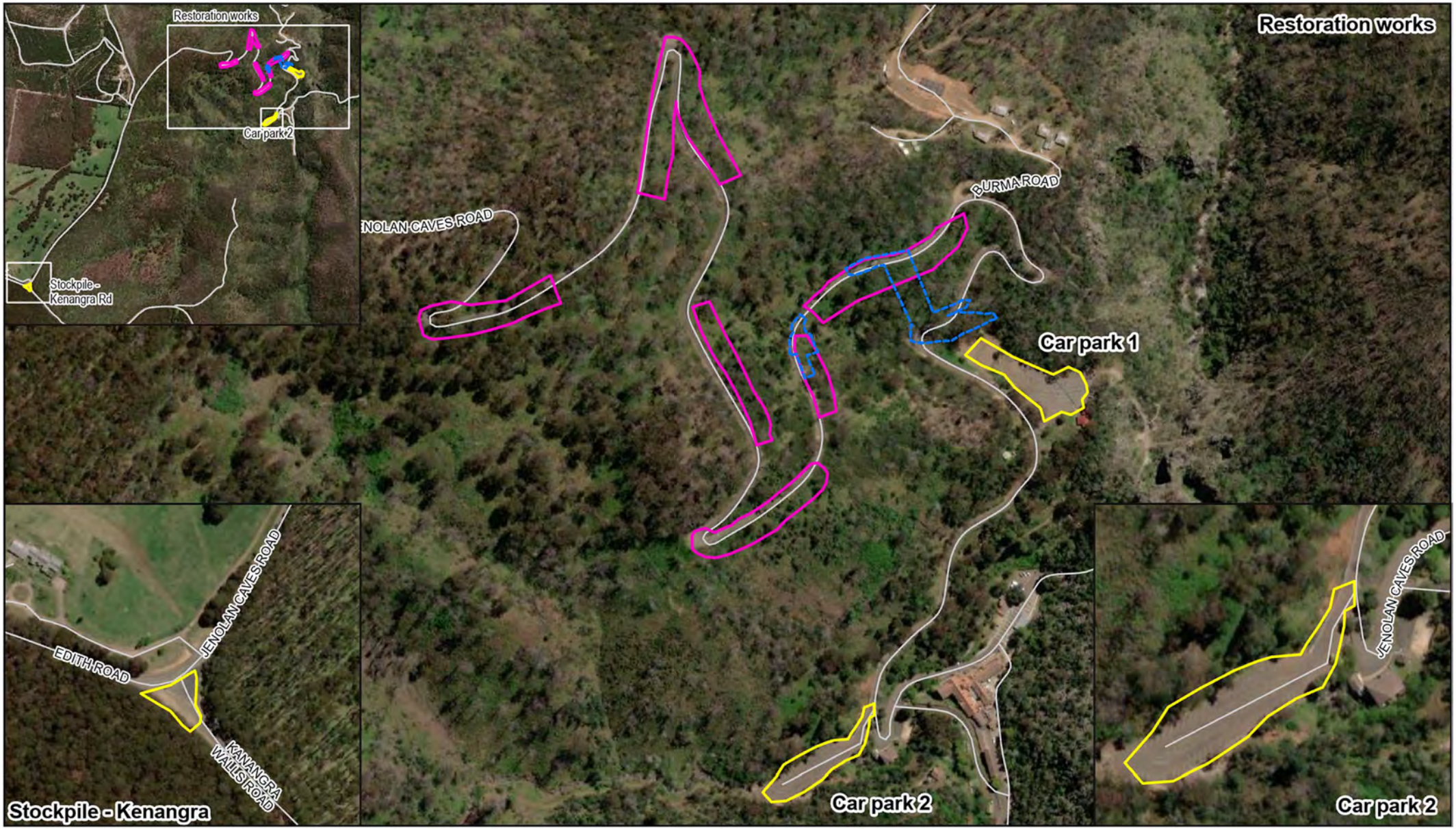
The study area applied to this landscape visual impact assessment is the portion of the road corridor that contains the proposed impact area as provided by Transport. The locality is defined as a 550 metre buffer around the proposal which is consistent with the Biodiversity Assessment Methodology (BAM). The proposal site is identified in Figure 1.1.

1.3 Purpose of this report

This Landscape Visual Impact Assessment (LVIA) assesses the impacts of the proposal with consideration of the sensitive landscape and visual receptors in the surrounding areas. Where appropriate, mitigation measures are identified to address potential impacts.

The report comprises the following:

– evaluation of the landscape and visual attributes of the study area
– identification of the sensitivity of landscape and visual receptors / viewpoints
– assessment of potential landscape and visual impacts associated with the proposal
– provision of recommendations for managing identified landscape and visual impacts arising from the proposal.



Legend

- Construction compounds / Stockpile areas
- Drainage infrastructure works
- Slope failure area
- Road

Paper Size ISO A4

0 60 120 180 240

Metres

Map Projection: Mercator Auxiliary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxiliary Sphere

N

GHD

Transport for NSW
2 Mile Hill Restoration Project

The proposal

Project No. **12620185**
Revision No. **C**
Date **21/05/2024**

FIGURE 1.1

N:\AU\Orange\Projects\21\12620185\GIS\Maps\Deliverables\12620185_2_Mile_Slope_Remediation_REF\12620185_2_Mile_Slope_Remediation_REF.aprx
Print date: 21 May 2024 - 09:28

Data source: GHD: Site Features, 2021; LP: DCDB/DTDB, 2017; World Imagery: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
World Imagery: Maxar. Created by: ehaverkamp

1.4 Structure of this report

The report is comprised of the following sections:

- **Section 1 – Introduction:** provides background information and an overview of the proposal and assessment
- **Section 2 – Methodology:** describes the methodology used for the purposes of this assessment
- **Section 3 – Existing environment:** provides an overview and describes the landscape and visual environment within the study area
- **Section 4 – Visual impact assessment:** identifies viewpoint locations and provides an assessment of impacts to visual amenity from the project
- **Section 5 – Mitigation measures:** recommends mitigation measures in response to issues arising in the assessment during construction, operation, decommissioning and rehabilitation phases of the project.

1.5 Scope and limitations

This report has been prepared by GHD for Transport for NSW and may only be used and relied on by Transport for NSW for the purpose agreed between GHD and Transport for NSW as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Transport for NSW arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Methodology

2.1 Relevant standards and guidelines

This landscape and visual impact assessment has been prepared in accordance with the following:

– Transport for NSW, 2023, Guideline for landscape character and visual impact assessment – Environmental impact assessment practice note EIA-N04, Version 2.3
– Transport for NSW, 2023, Shotcrete design guideline, June 2023.

2.2 Study area

The study area is based on the project description, guideline recommendations and a review of similar assessments. The study area used for this assessment is approximately a 550 metre radius from the proposal.

2.3 Site work

A site inspection was undertaken by a Senior and a Graduate Landscape Architect on 31 October 2023. The purpose of the inspection was to:

– inspect the site and appreciate views to / from potential sensitive visual receivers
– inspect publicly accessible locations identified in the desktop study as likely to provide views of the project, including from roads, car parks, trails and other publicly accessible areas
– identify sensitive visual receiver locations.

2.4 Existing landscape and visual environment

A landscape baseline assessment was undertaken to determine the existing natural and cultural features within the study area. This includes determination of key landscape and spatial elements, features and values. Aspects considered include vegetation, topography, hydrology and flooding, land uses, heritage and landscape character. Landscape character, as described by the *Guideline for landscape character and visual impact assessment* (Transport for NSW, 2023), is the 'combined quality of built, natural and cultural aspects that make up an area and provide its unique sense of place'.

The visual baseline assessment included establishment of the key viewpoints, the visual catchment and other visual features within the study area based on a desktop review and visual appraisal of the study area during the site inspection.

2.5 Visual impact assessment

The evaluation of potential impacts on visual amenity is based on the sensitivity of the viewpoint (and the visual receivers it represents) to change, and the magnitude of change that is likely to occur. The combination of sensitivity and magnitude determines the significance of the impact on a representative viewpoint. Table 2.1 provides the matrix used to determine the significance of impact, as per the *Guideline for landscape character and visual impact assessment* (Transport for NSW, 2023).

Table 2.1 Visual impact rating matrix (Transport for NSW, 2023)

Sensitivity	Magnitude: High	Magnitude: Moderate	Magnitude: Low	Magnitude: Negligible
High	High	High-moderate	Moderate	Negligible
Moderate	High-moderate	Moderate	Moderate-low	Negligible
Low	Moderate	Moderate-low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

The sensitivity of each viewpoint is considered to be dependent on the:

– importance of the view, its existing scenic qualities and the presence of other existing human-made elements in the view
– type of visual receiver and their likely interest in the view.

The magnitude of change to views and visual amenity depends on the nature, scale and duration of the change that is expected to occur. The magnitude of change also depends on the loss, change or addition of any feature in the field of view of the receiver including an assessment of the level to which the change contrasts with the existing view or expected view of the landscape. This includes the degree of any change to the backdrop to, or outlook from a viewpoint. The magnitude also considers cumulative impacts, which is the consideration of the result of the potential impacts of the proposal when combined with other past, present or known likely future activity (Transport for NSW, 2023).

The assessment considers the likely impacts of the proposal. The level of effects on a view depends on factors such as the extent of visibility, degree of obstruction of existing features, degree of contrast with the existing view, angle of view, duration of view and distance from the proposal.

Steps undertaken to assess visual impacts include an assessment of visual effects, comprising:

– sensitivity of visual receivers to proposed change, based on susceptibility of visual receivers to change and value attached to views
– magnitude of visual effect, based on the size or scale of change, geographical extent of effects, and duration and reversibility of effects.

An assessment is undertaken of the overall level of significance of the visual effects in relation to the existing view. Table 2.2 describes the sensitivity criteria for visual impacts. Table 2.3 describes the magnitude of change criteria for visual impacts.

Table 2.2 Sensitivity criteria (visual) – as interpreted by GHD

Rating	Criteria
High	Occupiers of residential properties, at home or going to or from, with long viewing periods, within close proximity to the proposed development; Tourists and visitors who place value upon the natural landscape and enjoyment of views of their setting, particularly from lookouts, heritage buildings and landmarks.
Moderate	Outdoor workers who have a key focus on their work who may also have intermittent views of the study area; Occupiers of residential properties with long viewing periods, at a distance from or screened from the study area. Tourists and visitors who place value upon the natural landscape and enjoyment of views of their setting, but views are at a distance or screened from the study area.
Low	Road users in motor vehicles, trains or on transport routes that are passing through or adjacent to the study area and therefore have short term views; Viewers indoor at their place of work, schools or similar.
Negligible	Viewers from locations where there is screening by vegetation or structures where only occasional screened views are available and viewing times are short; Road users in motor vehicles, trains or on transport routes that are passing through/adjacent to the study area and have partially screened views and short viewing times.

Table 2.3 Magnitude criteria (visual) – as interpreted by GHD

Rating	Criteria
High	A substantial/obvious change to the existing view due to total loss of, or change to, elements, features or characteristics of the view. Would cause a view to be permanently changed and its quality diminished.
Moderate	Discernible changes in the existing view due to partial loss of, or change to elements, features or characteristics of the view, however, has potential to be partly mitigated. The change would be out of scale with the existing view, and would leave an adverse impact on the view.
Low	Minor loss or alteration to one or more key view elements, features or characteristics, or the introduction of components that may be visible but may not be uncharacteristic within the existing view.
Negligible	Almost imperceptible or no change in the view as there is little or no loss of/or change to the elements, features or characteristics of the view.

3. Existing environment

3.1 Site context

The proposal site is located at Jenolan Caves which is located within Jenolan Caves Karst Conservation Reserve. The proposal site is located within the curtilage of the State Heritage listed 'Jenolan Caves Reserve' (SHR No. 01698). The State Heritage listing does exclude the road corridor for Jenolan Caves Road in which the majority of the project is located. The proposal sites positioning within the Jenolan Caves Karst Conservation Reserve also results in the proposal site being located in the Greater Blue Mountains World Heritage Area (GBMWHA) which includes a total of eight reserves in the locality as part of this listing. The GBMWHA is listed on the National Heritage List and the World Heritage List.

The 'Jenolan Caves Reserve' is recognised as a State Heritage item for its historical and aesthetic heritage values, its research potential and rarity, while the World Heritage listings significance is primarily focused on the natural heritage values of the GBMWHA including the proposal site.

The proposal site is located north-west of Jenolan Caves House (Caves House), refer to Figure 3.4. The Two Mile Access of Jenolan Caves Road is currently the main access route to the Jenolan Caves connecting with Edith Road and Kanangara Walls Road to the south-west. The Five Mile Access of Jenolan Caves Road was previously the primary access to the caves from the east, however slope and road failures in 2021 have now made this route inaccessible until works can be completed to reinstate the slope and roadway.

The proposal study area comprises eight (8) slope remediation areas (key sites) located at various intervals along Two Mile Access just north-west of the Caves House. Additional areas in the vicinity of these areas are proposed for some drainage works as well as the remediation of a gully failure located downslope of Failure 1.

The study area is located within steep terrain, with rivers and creeks converging in the study area. Notable waterways in the area include Jenolan River, Surveyors Creek, Camp Creek, Pheasants Nest Creek and Bulls Creek.

Key natural and cultural heritage features in the study area are clustered around the Jenolan Caves House south-east of the proposal and include:

– The Blue Lake
– The Jenolan Caves
– Carlotta Arch
– Jenolan Mountain Lodge.

These features are the primary drivers for tourist visitation to the area and have economic benefits for the existence of the tourist areas and facilities.

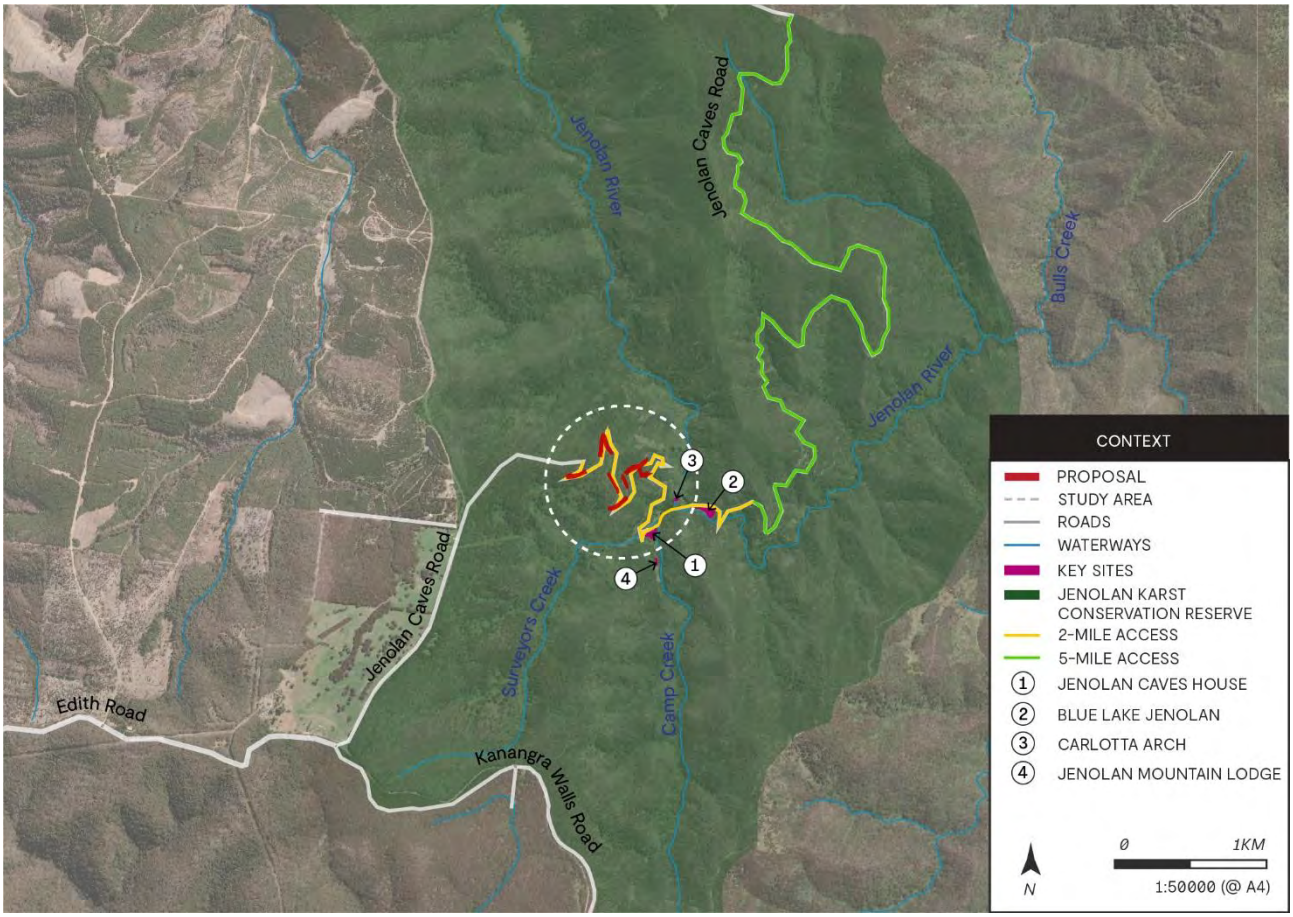


Figure 3.1 Site context

3.2 Context analysis

A contextual analysis was undertaken to identify the existing local landscape factors within the study area including determination of the key landscape and spatial elements, features, and values. Context analysis includes mapping utilising Geographic Information Systems (GIS) data. Considerations include the following which are discussed in detail in the following sections:

- vegetation
- topography and views
- hydrology and flooding
- land uses
- heritage
- landscape character.

3.2.1 Vegetation

The study area is located within the Jenolan Karst Conservation Reserve and is generally characterised by native eucalypt forests on sometimes steep, undulating terrain. The area was significantly burnt in the 2019/2020 Black Summer fires and due to the intensity of the fire events, regeneration has been slow to re-establish.

The NSW State Vegetation Type (SVT) Map (DPE, 2022) identifies nine plant community types (PCT) within proximity of the proposal and study area. Data sources available for this information are only indicative of potential PCTs occurring in the area and were hence used to inform a field survey undertaken by EnviroKey. During this field survey, one plant community type (PCT) was identified within the proposal area - PCT 3491: *Jenolan-Tuglow Limestone Forest*.

PCT 3491 is part of the Dry Sclerophyll Forests vegetation formation and is a tall open forest with a canopy comprising predominately eucalypt species including the Ribbon Gum (*Eucalyptus viminalis*), Narrow-leaved Peppermint (*Eucalyptus radiata*) and Brown Barrel (*Eucalyptus fastigata*). The mid storey is dense in response to

recent fires and some areas around the two carparks and lower road sections contain a high cover of exotic plant species in the ground-storey, including Periwinkle (*Vinca major*) and Titsan (*Hypericum androsaemum*). PCT 3491 is not a threatened ecological community.

The vegetation on the slopes immediately above and below the slope failures are part of the Jenolan Karst Conservation Reserve and contribute to the Jenolan Caves Reserve natural bushland character and scenic value.

Considerations:

– Vegetation should be retained where possible to maintain the existing natural landscape character.
– Consider revegetation using local, endemic species to replace endemic vegetation removed as part of construction or lost due to erosion and land slips.



Figure 3.2 Examples of Dry Sclerophyll Forest on steep terrain on Jenolan Caves Road

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3.2.2 Topography and views

The topography within the study area is characterised by steep slopes forming deep valleys and gullies with reduced levels (RL) ranging from the highest point on Jenolan Caves Road at the western extent of the study area (RL 1140m) to the lowest point near Jenolan caves House (RL 780m). The lowest RLs are predominately associated with the Jenolan River, Surveyors Creek and Camp Creek with slopes rising sharply from the base of these valleys. The steep terrain confines views to short range local views apart from along Jenolan Caves Road, the open car parking areas and other glimpses through vegetation in the surrounding areas. Middle distance views are available from Jenolan Caves Road to the south and east where the land falls away and local hilltops may be visible such as Mount George, refer also Figure 3.3. These views are brief but contribute to the entry experience to the Caves precinct. Long distance views were not identified from publicly accessible locations in the study area.

Considerations:

– Design proposals should consider the relationships between the local character, the design and how it may impact views of the proposal from the wider study area including any identified key locations.

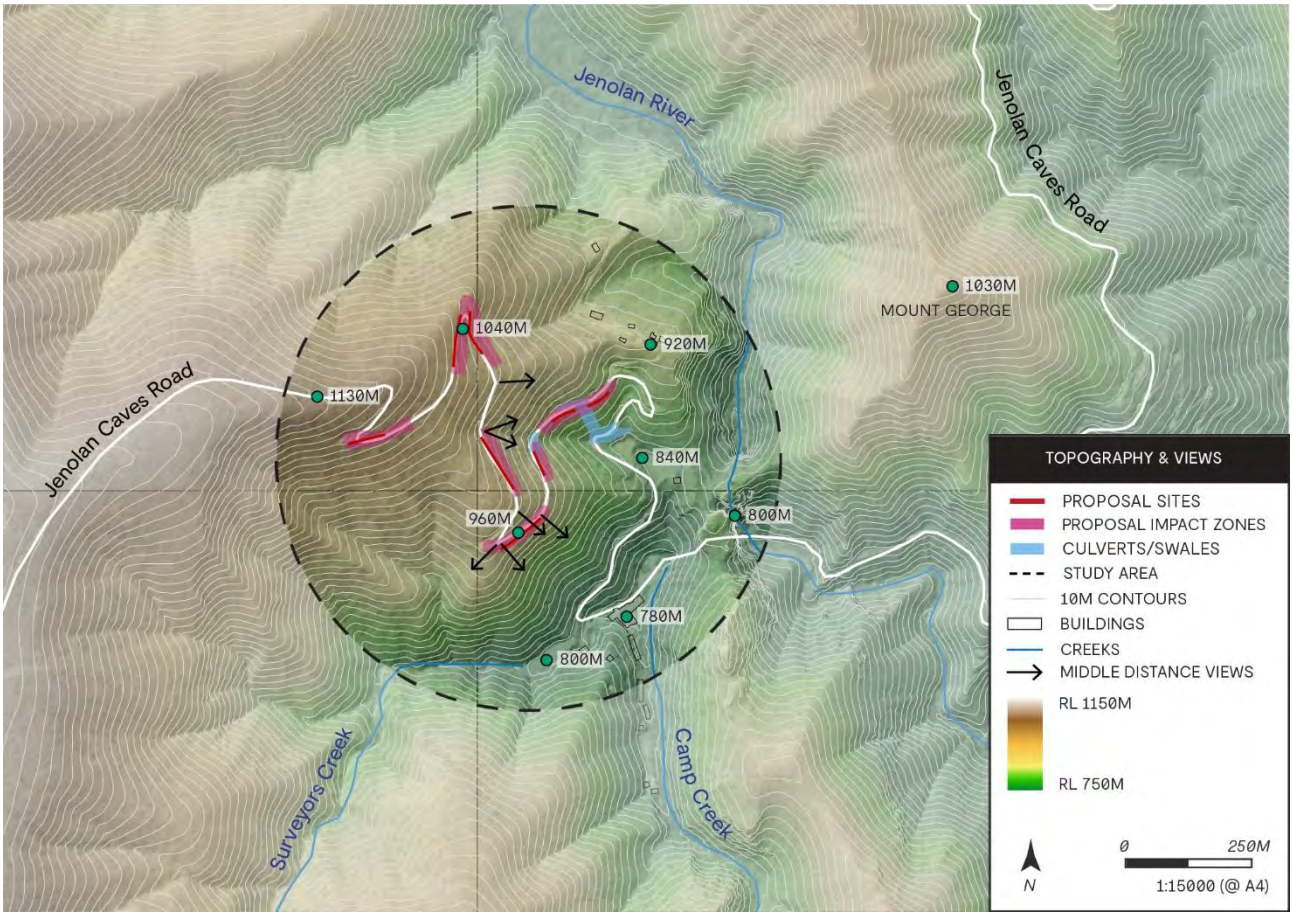


Figure 3.3 Topography

3.2.3 Hydrology and flooding

Existing watercourses are lower than the proposal site and generally not within visual proximity of Jenolan Caves Road. A search of the proposal on the DPE Spatial Viewer map revealed the site is not mapped as a flood planning area (NSW DPE 2023).

3.2.4 Land use

The land within the study area has been allocated as a Tourist (SP3) land use as indicated in the *Oberon Local Environmental Plan 2013*. Tourist zones include land reserved for a variety of tourist-oriented developments and related uses and the objectives of the zone are to ensure that any development occurs in a way that maintains and enhances existing scenic quality and value, specifically the heritage values of the Jenolan Caves and Jenolan Karst Conservation Reserves.

Considerations:

– The proposal should consider the conservation values and tourism uses of the area to ensure that the design maintains and enhances the existing landscape values.
– As the proposal is situated along one of the two entrance points to the Jenolan Caves and is the only open access, it should be considered that the predominant users of this road would likely be tourists, hence slope mediation measures should be visually integrated with the surrounding natural environment.

3.2.5 Heritage

The proposal is located within the State Heritage curtilage of the 'Jenolan Caves Reserve'. The State Heritage listing is recognised for its historical and aesthetic heritage values and its research potential and rarity. The following outlines the significance of this item:

> *Jenolan is one of the most important areas of natural and cultural history in Australia. The area includes one of the largest and most beautiful interconnected cave systems in Australia and is an outstanding site of geological and speleological interest. The Jenolan River, Blue Lake and a system of intimate valleys and watercourses provide a magnificent setting for a distinctive range of native vegetation and fauna. The Caves Reserve was created in 1866, six years before the declaration of the world's first National Park. Since its reported discovery by James Whalan between 1838 and 1841 the area has attracted more than three million visitors. Caves House, and its associated outbuildings, adds to the area's cultural significance. The area also contains a number of important industrial relics, including Australia's first hydro-electric power station and the remnants of the first electric lighting of caves which was installed in the Chifley Cave in 1887 (See https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051578)*

While the Plan of Management for the Jenolan Karst Conservation Reserve states:

> *The Jenolan Karst Conservation Reserve protects a range of significant World Heritage, landscape, catchment, geological, biological, Aboriginal, historic heritage, research, education, recreational and tourism values. The most significant attribute of this reserve, however, is its karst environment which significantly contributes to the attribution of all other determinations of significance for this site (Office of Environment and Heritage, 2000: 2).*

The proposal site is located within the 'Jenolan Karst Conservation Reserve' which is the oldest of eight protected reserves within the GBMWHA. As the reserve forms part of the GBMWHA the proposal site is therefore subject to both National and World Heritage listing. The GBMWHA has heritage significant due to the following:

- *outstanding examples of ongoing ecological and biological processes significant in the evolution of Australia's highly diverse ecosystems and communities of plants and animals, particularly eucalypt dominated ecosystems; and*
- *significant natural habitats for the in-situ conservation of biological diversity, including the eucalypt sand eucalypt-dominated communities, taxa with Gondwanan affinities, and taxa of conservation significance. (NSW NPWS 2015: 9)*

In addition to the World Heritage, National Heritage and State Heritage listing there are multiple local heritage listing under the Oberon Local Environmental Plan 2013, these include the following items:

– Jenolan Caves, 4650 Jenolan Caves Road, Part Lot 49, DP 728898 (Item I1)
– Jenolan Caves House, Lot 39 DP 728898, Jenolan Caves Road (Item I11) – see Figure 3.5
– Limestone Bridge, Lot 49 DP 728898, Jenolan Caves Road (Item I12) – also referred to as De Burghs Bridge – see Figure 3.5
– Jenolan Caves Reserve Conservation Area (Conservation Area C1)
– Jenolan Caves (Archaeological site A1)
– Rowe's Homestead, Lot 49 DP 728898, 13 Burma Road (Item I56)

– The Six Foot Track (Item I18).

The proposal site is the current main access route to the Jenolan Caves. Local heritage listed items within the study area include Jenolan Caves House and De Burgh's Bridge near the Grand Arch, as shown on Figure 3.4. The Grand Arch Precinct (as defined in the Jenolan Karst Conservation Reserve Conservation Management Plan (Urbis, 2017) contains significant buildings and destinations associated with the Jenolan Caves including Jenolan Caves House, Carlotta's Arch, and the Blue Lake. All failure sites are located outside of the Grand Arch Precinct.

The Conservation Management Plan also identifies a number of views within the Grand Arch Precinct based on their heritage value. These views are shown on Figure 3.4.

Considerations:

– To enhance the motorist experience and protect the unique character and historical significance of the road corridor, slope restoration works should be integrated into the existing landscape where possible.
– Vegetation removal should be minimised where possible to maintain a consistent character and maintain visual screening of the proposal from significant heritage sites.

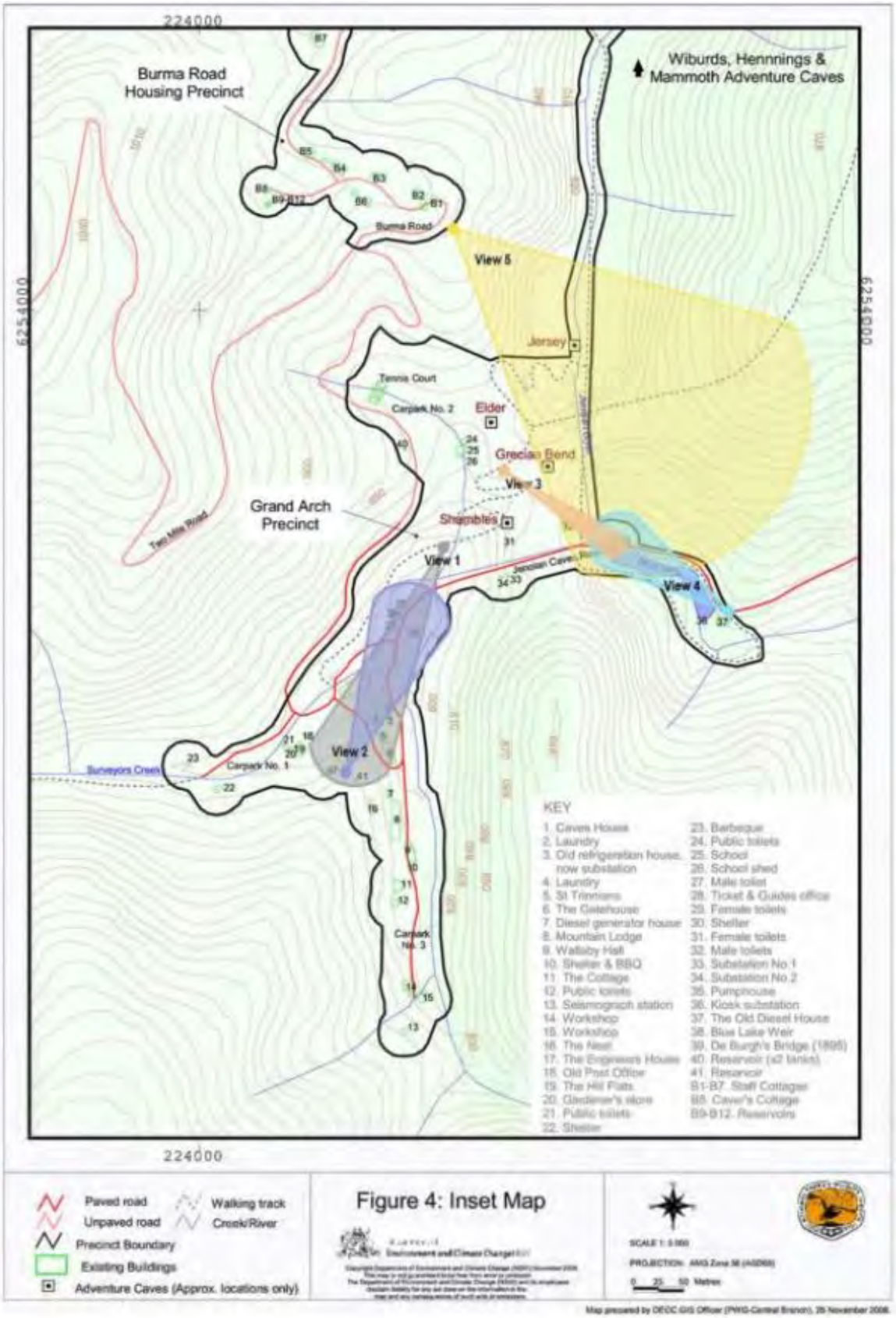


Figure 3.4 Significant views within the Grand Arch Precinct

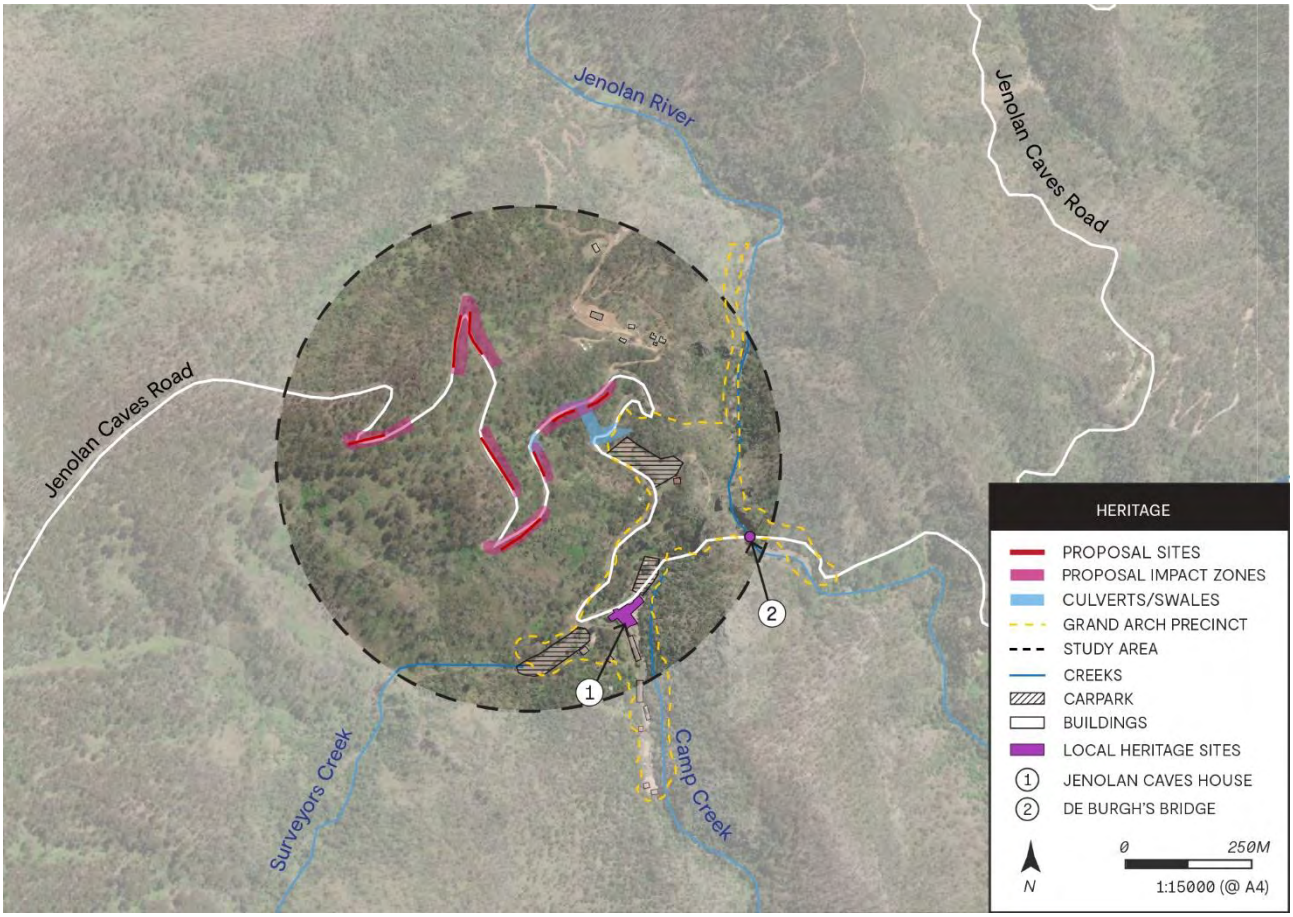


Figure 3.5 Heritage

3.2.6 Landscape character

Landscape character relates to the built, natural, cultural and community aspects which make a place unique. The broad landscape character within the study area is predominantly associated with the natural bushland within the Jenolan Karst Conservation Reserve and the location of the proposal within the State Heritage Listed Jenolan Caves Reserve. It is characterised by steep terrain and vegetated slopes, within a predominately natural, open eucalypt forest setting.

Infrastructure elements include roads, carparks, signage and buildings, and are predominately associated with Jenolan Caves House precinct as a tourist destination. Existing endemic vegetation and heritage listed buildings contribute to the visual quality of the study area.

Considerations:

– Potential impacts on existing landscape character resulting from the loss of vegetation through clearing activities associated with slope restoration works should be considered and minimised where possible in order to maintain the existing landscape character.
– The design of the proposal should consider the constituent parts (vegetation, stone, slope) that create the natural appearance along Jenolan Caves Road and emulate their appearance wherever practicable to maintain consistency with the overall landscape character of the Blue Mountains.



Figure 3.6 Landscape character images

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4. Visual impact assessment

4.1 Visual catchment

The visual catchment is considered to be the boundary of possible visual exposure of the proposal. The proposal's visual catchment is predominately confined to the Jenolan Caves Road corridor with some views of the proposal possible from nearby Jenolan Caves House precinct, walking tracks and carparking areas. Existing vegetation and terrain currently screen many views of the proposal.

4.2 Viewpoints

Viewpoints have been identified in terms of typical views that are likely to be obtained from Jenolan Caves Road near the failure sites as well as from the surrounding areas. Consideration was also given to key vantage points, such as tourist destinations, landmarks, carparks and walking trails, where there is particular interest in the view.

A total of eight (8) viewpoints were identified and assessed as shown in Figure 4.1.

Significant views identified within the Jenolan Karst Conservation Reserve Conservation Management Plan (refer to Figure 3.4) were reviewed as part of the Statement of Heritage Impact completed as part of the project. This report found that none of the significant views would be impacted by the proposal due to existing/to be retained vegetation screening and also that the sites are located well above the precinct due to the steep terrain. As none of these significant views were considered impacted by the heritage team they were not considered as part of this visual impact assessment.

Selected viewpoints have been identified based on:

– Type of receiver, as different viewer types would have different perceptions of the change
– Type of view, as some locations have a particular interest in the view such as heritage sites or key vantage points and lookouts
– Proximity to the proposal and existing vegetation or landform which may obscure views from specific locations.

Viewpoint Locations

– Viewpoint 01 (VP01) – Jenolan Caves Road at Failure site 6
– Viewpoint 02 (VP02) – Jenolan Caves Road at Failure site 5
– Viewpoint 03 (VP03) – Burma Road tourist cabins
– Viewpoint 04 (VP04) – Walking track
– Viewpoint 05 (VP05) – Jenolan Caves Road at Failure site 1
– Viewpoint 06 (VP06) – Car Park 2
– Viewpoint 07 (VP07) – Carlotta Arch viewing area
– Viewpoint 08 (VP08) – Surveyors Creek walking track

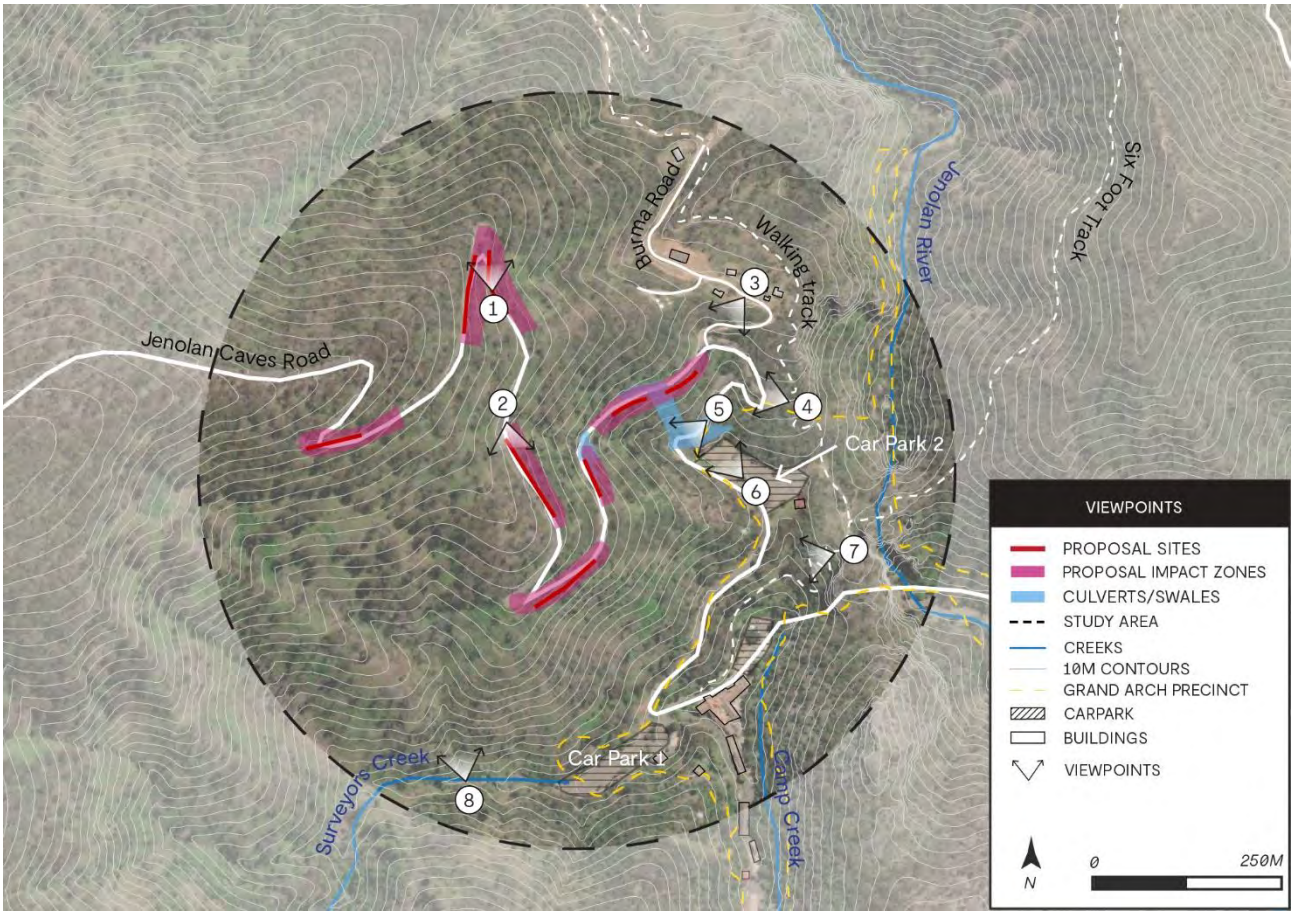


Figure 4.1 Viewpoints

4.3 Visual analysis

The following section describes the location and existing conditions of each viewpoint, as well as how the proposal will impact each view.

4.3.1 VP01 - Jenolan Caves Road at Failure site 6



Location and view direction: View north from Jenolan Caves Road at Failure site 6.

Description of existing view: Semi-enclosed view with a steep, vegetated embankment on the western verge and distant, filtered views to the east through existing native vegetation. Failure site 7 is at the top of the slope on the western verge.

Anticipated change to view: Shotcrete and soil nails associated with Failure site 7 would cover the existing slope on the western verge. Failure site 6 remediation works would likely not be visible to motorists at this location as the terrain drops down steeply to the east, however vegetation removal associated with the work would likely increase views to the east from the road.

Figure 4.2 Indicative landscape modifications VP01

4.3.2 VP02 - Jenolan Caves Road at Failure site 5



Location and view direction: View south along Jenolan Caves Road approaching Failure site 5.

Description of existing view: View is enclosed on the western verge by a steep, vegetated embankment. Open views to the south and east are of terrain and bushland associated with Jenolan Caves Reserve below.

Anticipated change to view: Slope remediation works to be carried out on the eastern verge would likely not be visible to motorists at this location as the land drops off. Vegetation removal on the slope to allow soil nailing to occur would likely increase views to the east from Jenolan Caves Road.

Figure 4.3 Indicative landscape modifications VP02

4.3.3 VP03 - Burma Road tourist cabins



Figure 4.4 Indicative landscape modifications VP03

Location and view direction: View south-west from Burma Road, near the tourist cabins, north of Failure site 1.

Description of existing view: View is predominately of bushland and vegetated slopes associated with Jenolan Caves Reserve. A small section of Jenolan Caves Road at Failure site 1 is visible through the vegetation.

Anticipated change to view: Vegetation removal on the slope to allow soil nailing to occur at Failure site 1 and the associated gully failure downslope would be required and shotcrete and soil nail treatments would replace the existing vegetation. However, most of these works would likely be obscured from view by the terrain and foreground vegetation.

4.3.4 VP04 – Walking track



Figure 4.5 Indicative landscape modifications VP04

Location and view direction: View west from walking track located on the eastern verge of Jenolan Caves Road, east of Failure Site 1.

Description of existing view: View is open and includes Jenolan Caves Road from a section of a walking track. The road slopes down steeply and is framed on both sides by bushland and steeply vegetated terrain. Failure Site 1 is visible in middle ground of the view.

Anticipated change to view: Shotcrete and soil nail treatments along with associated vegetation removal would extend up to approximately 15 metres down the slope at Failure Site 1 creating an exposed, unvegetated area distinctly different to its surroundings.

4.3.5 VP05 – Jenolan Caves Road at Failure site 1



Figure 4.6 Indicative landscape modifications VP05

Location and view direction: View south-west from Jenolan Caves Road immediately south of Failure site 1, approaching Failure Site 2 and the gully failure.

Description of existing view: View is mostly enclosed by a steep embankment on the northern verge with dense vegetation below Failure sites 1 & 2.

Anticipated change to view: The existing gully failure would be cleared of all vegetation and replaced with imported fill and a new rock mattress to transfer water from Failure site 1 location to new drainage infrastructure adjacent to the roadway. The land on the northern verge would be regraded to accommodate water flow through the culvert under the road. Roadside drainage would likely be visible on both sides of the road.

4.3.6 VP06 – Car Park 2



Figure 4.7 Indicative landscape modifications VP06

Location and view direction: View north from Car Park 2 towards Failure site 1 & 2 and the gully failure.

Description of existing view: Open view from Car Park 2 of a steep, vegetated slope with Failure site 1 & 2 visible through the existing trees. The gully failure is visible on this slope.

Anticipated change to view: Shotcrete and soil nail treatments, along with associated vegetation removal at Failure Site 1 & 2 would likely be visible towards the top of the embankment. Works involving vegetation clearance, filling and installation of rock mattress drainage down the gully failure is potentially visible.

4.3.7 VP07 – Carlotta Arch and Six Foot Track

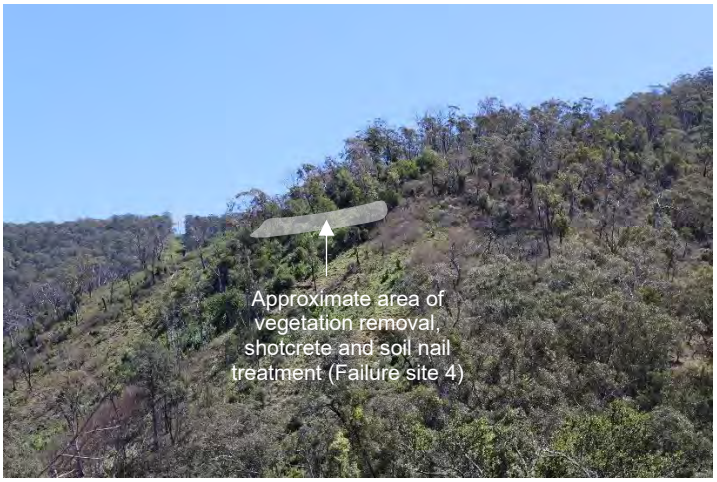


Figure 4.8 Indicative landscape modifications VP07

Location and view direction: View west from the Six Foot Track just south of the Carlotta Arch viewing area.

Description of existing view: Open view of steep, vegetated slopes within Jenolan Caves Reserve. Jenolan Caves Road may be partially visible at the top of the slope in this view however is mostly obscured by trees.

Anticipated change to view: Shotcrete and soil nail treatments, along with associated vegetation removal at Failure Site 4 may be visible.

4.3.8 VP08 – Surveyors Creek walking track



Figure 4.9 Indicative landscape modifications VP08

Location and view direction: View north from the Surveyors Creek walking track west of car park 1.

Description of existing view: Open view of steep, vegetated slopes within Jenolan Caves Reserve. Evidence of diminished, sparse vegetation from previous bushfires. Jenolan Caves Road is not visible from this view.

Anticipated change to view: Jenolan Caves Road and the proposal would most likely not be visible from this view.

4.4 Impact assessment

4.4.1 Construction impacts

During construction, traffic would access the proposal via the 2 Mile section of Jenolan Caves Road. Parking for construction workers would potentially be in the two primary carparks, that service the lower areas of the Jenolan Caves House precinct. The impacts from construction are expected to be Low or Negligible as construction activities would be temporary and be associated primarily with; portable site offices, large machinery and vehicles for earthworks that are generally stationary. The Jenolan Caves Precinct would also be closed during construction therefore there would be no tourists visiting the precinct during this time thus limiting receivers to construction workers on the planned upgrades within the Jenolan Caves Precinct who would largely be focus on their work and not the surrounding views.

The main visual components expected to contribute to visual impacts are:

– earth-moving equipment (trucks, forklifts, excavators) for civil works within the proposal site
– earthworks including for foundations and trenches
– temporary lighting for nightworks (if required)
– stockpiles of materials.

4.4.2 Operational impacts

Table 4.1 assesses the sensitivity, magnitude and overall visual impact rating of the proposal from each viewpoint.

Table 4.1 Visual impact assessment

	Sensitivity	Magnitude	Overall visual impact rating
VP01	**Low** Visual receivers would be limited to motorists driving along Jenolan Caves Road with short viewing times.	**Moderate** Changes to views would include vegetation removal and shotcrete and soil nail treatment along western verge associated with Failure site 6 works upslope of Failure site 7.	**Moderate-low** Vegetation removal and new shotcrete and soil nail treatments would impact the view, however views are by motorists, and their attention is focused on the road therefore resulting in an overall rating of Moderate-low.
VP02	**Moderate** Visual receivers would be limited to motorists driving on Jenolan Caves Road with short viewing times. Sensitivity is increased to moderate due to open, desirable views towards the Jenolan Caves Reserve to the east.	**Low** Slope remediation works would likely have minimal impacts on the view, as land slopes down steeply to the east and vegetation removal would likely open views to the east.	**Moderate-low** Vegetation removal would impact view, however would likely open views to the east and enhance the motorist experience, resulting in a Moderate-low overall rating.
VP03	**Low** Visual receivers include guests at the cabins on Burma Road, Rural Fire Service staff. Views of interest would likely be directed to the north and south-east across the reserve rather than toward the road.	**Low** Works visible potentially include; shotcrete, soil nails, vegetation removal and a new rock lined swale. Existing vegetation would potentially obscure much of these works from this view.	**Low** A relatively small area of exposed landscape and existing vegetation obscuring much of the slope remediation works, results in a Low overall visual impact rating.
VP04	**Low** Viewing duration would be short as people would likely be moving with their attention focused on the track and overall landscape.	**Moderate** Shotcrete and soil nail treatments at Failure site 1 would likely be visible from this location. Significant vegetation removal for slope remediation works may impact the view.	**Moderate-low** Existing foreground vegetation would obscure much of the slope remediation works at Failure site 1. A short view duration for visual receivers brings the overall rating down to Moderate-low.

	Sensitivity	Magnitude	Overall visual impact rating
VP05	**Low** Visual receivers would be limited to motorists driving along Jenolan Caves Road with short viewing times.	**Moderate** Significant works including vegetation removal, a new rock lined swale and roadside drainage works associated with the gully failure would likely be visible from this view.	**Moderate-low** Vegetation removal, a new rock lined swale and roadside drainage works would result in visual impacts, however the limited viewing times of motorists results in a Moderate-low rating.
VP06	**Low** Visual receivers would have short viewing times and are generally limited to Jenolan Caves visitors and staff using the carpark.	**Moderate** Significant works including shotcrete, soil nails, vegetation removal and a new rock lined swale associated with Failure site 1 & 2, and the gully failure would likely be visible from this view.	**Moderate-low** Vegetation removal, shotcrete and soil nail treatments and a new rock lined swale would result in significant visual impacts, however the limited viewing times of visual receivers brings the overall rating down to Moderate-low.
VP07	**Moderate** Carlotta Arch is an important cultural landmark. The sensitivity is Moderate due to the proximity to a key tourist destination and potential views from an internationally recognised walking track. Views however would be of short duration.	**Low** Slope stabilisation works including shotcrete, soil nails and vegetation removal associated with Failure site 4, would mostly be obscured from view by existing vegetation.	**Moderate-low** Existing vegetation would likely obscure most of the slope remediation works. Viewing distance is over 100 metres further reducing impacts thereby resulting in a Moderate-low overall rating.
VP08	**Low** Visual receivers would have short viewing times as people are moving along the track with their attention focused towards the areas in front of them.	**Negligible** Jenolan Caves Road and the proposal would most likely not be visible from this view.	**Negligible** Changes included as part of the proposal are not likely to be visible from this viewpoint thereby resulting in a Negligible rating.

5. Conclusion

5.1 Proposed mitigation measures

The following section outlines potential mitigation strategies that would assist in minimising the visual impacts of the proposal on the identified viewpoints. Mitigation strategies include different measures to ensure best practice and sustainable outcomes are achieved by integrating new works with the local landscape and heritage environment.

1. Retaining trees and native vegetation where practicable and revegetating damaged areas with seed collected from locally endemic species.
2. Revegetate damaged areas and edges of gully with mass planting of native grasses and low-mid height species to match surrounding vegetation. Use native grass species in grass-lined swales that match surrounding vegetation.
3. Minimise the extent of shotcrete where practicable, applying shotcrete precisely to unstable sections of slope and adapting its colour to match the local geology and/or surrounding vegetation.
4. Application of place-based solutions in response to the conditions present at each of the failure sites.
5. Finish or extend the application of shotcrete up to distinct edges, natural joints or changes in the face of the slope.
6. Consider planting in key locations to help screen larger areas of visible exposed shotcrete.
7. Colour tinting of the shotcrete to blend in with the surrounding topography and adjacent natural stone surfaces. If the shotcrete is covering exposed rock, then select an unobtrusive, muted tones that fit the local context. Avoid highly reflective colours.
8. Consider texturing shotcrete to mimic the adjacent landscape stone and blend into surrounding topography, such as rough rather than smooth surfaces.
9. Use local stone, such as sandstone, for rock gullies and scour protection.
10. Utilise natural materials where possible in swales and for erosion control such as local stone (Sandstone) in swales and/or planted with organic erosion control mesh, coir logs. Consider coloured concrete (earthy tones) where a paved solution is preferred.
11. Scatter salvaged woodland material (branches, logs, sandstone boulders) over any disturbed areas to provide an edge transition.
12. Where required, shotcrete design is to be based on the *Shotcrete design guideline* (Transport for NSW, 2023).

5.2 Summary of visual impacts

Viewpoint assessment ratings are assessed as being as moderate-low, except for VP08 which was assessed as negligible and VP03 which was assessed as low.

The low to negligible overall ratings are generally attributed to:

– existing vegetation and landform obscuring views of the proposal
– the sensitivity to change being assessed as low due to short viewing times from motorists on Jenolan Caves Road or visitors using carparks and walking tracks.

The Moderate-low overall ratings are generally attributed to:

– moderate magnitude ratings as a result of introduction of new infrastructure in the form of soil nails with shotcrete face and also the new rock mattress associated with the gully failure
– trees and vegetation removal resulting in bare areas visible from the surrounding areas.

Table 5.1 Summary of visual impact assessment

	Sensitivity	Magnitude	Overall visual impact rating
VP01	**Low**	**Moderate**	**Moderate-low**
VP02	**Moderate**	**Low**	**Moderate-low**
VP03	**Low**	**Low**	**Low**
VP04	**Low**	**Moderate**	**Moderate-low**
VP05	**Low**	**Moderate**	**Moderate-low**
VP06	**Low**	**Moderate**	**Moderate-low**
VP07	**Moderate**	**Low**	**Moderate-low**
VP08	**Low**	**Negligible**	**Negligible**

Appendix H
Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI)
Transport for NSW

Jack Zyhalak
Senior Project Manager

03/04/2024

Dear Jack

Preliminary assessment results for the Jenolan Caves Road, 2 Mile Section Natural Disaster Recovery Project. Based on Stage 1 of the *Procedure for Aboriginal cultural heritage consultation and investigation* (PACHCI).

The project, as described in the REF was assessed as being unlikely to have an impact on Aboriginal cultural heritage.

The assessment is based on the following due diligence considerations:

- The project is unlikely to harm known Aboriginal objects or places.
- The AHIMS search did not indicate, moderate to high concentrations of Aboriginal objects and places inside the study area**.** Ref AHIMS Search
- The study does contain landscape features that indicated the presence of Aboriginal objects, based on the Office of Environment and Heritage's *Due diligence Code of Practice for the Protection of Aboriginal objects in NSW* and the Roads and Maritime Services' procedure.
- The cultural heritage potential of the study area appears to be heavily reduced due to past disturbance. (Previous Construction Activities)
- Site inspections carried out on 12/03/2024 and previous ground truthing survey evaluations along the Jenolan Caves Road on 23/10/2020, 25/11/2021 and 24/01/2023.

Safe Guards: The described activities must be restricted to the project information if there are any changes to the maintenance methodology, please contact the ACHO in Western Region, Please be vigilant for potential Aboriginal objects when construction/ works commences.

Your project may proceed in accordance with the environmental impact assessment process, as relevant, and all other relevant approvals.

If the scope of your project changes, you must contact me and your regional environmental staff to reassess any potential impacts on Aboriginal cultural heritage.

If any potential Aboriginal objects (including skeletal remains) are discovered during the course of the project, all works in the vicinity of the find must cease. Follow the steps outlined in the Roads and Maritime Services' Unexpected Heritage Item Procedure.

For further assistance in this matter do not hesitate to contact me.
Yours sincerely



Aboriginal Cultural Heritage Advisor – Western Region

Transport for NSW
Level 1, 51-55 Currajong Street Parkes NSW 2870 | PO Box 21 Parkes NSW 2870
T 02 68611658 | F 02 68611414 | E Jeffery.charlton@transport.nsw.gov.au ABN 18 804 239 602

Appendix I
Meeting Minutes of Meeting with Gundungurra ILUA

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Minutes
Meeting with Gundungarra ILUA

29 October 2024
10am
[redacted]

Chair	Jack Zyhalak, TfNSW (JZ)
Attendees	Aunty Sharyn Halls (SH) Ike Gordon (IG)
Apologies	Nil
Items	
Item 1: **Meeting Purpose**	The meeting was held in person at [redacted] JZ explained that the meeting purpose was to address an item raised during review of the REF for the Two Mile Slope Remediation Project. The item requested TfNSW carry out further consultation to validate the works. The item in question was raised by National Parks and Wildlife Services (NPWS) in a letter sent to Neil Glastonbury from David Crust on 24th September.
Item 2: **Project Scope**	JZ explained that the works involved installation of soil nails and shotcrete to stabilise nine embankment slope failures along the length of the Two Mile Road at Jenolan Caves as well as the repairs to drainage lines and a gully failure. JZ explained that the works was mostly within the road corridor except for the gully failure and some very minor areas on embankments. JZ showed some photos of the gully failure to provide context for the scale of the works. JZ explained that the gully would be repaired using shotcrete. SH asked if there would be any revegetation planting around the gully as well, to which JZ said this will be considered. JZ explained that the gully is an existing drainage line between two culverts. During heavy rains, water discharges from the top culvert to the bottom culvert via this drainage line. Without treatment it will continue to scour out and deposit material on the road and further destabilise the slope. JZ explained that the work was essential to maintaining access to the Jenolan Caves through repairs to the roadway and supporting embankments and drainage structures.
Item 3: **Agreement to carry**	JZ asked Aunty Sharyn if she was the authorised representative of the Gundungurra Aboriginal Heritage Association (GAHA) and the

out works	Gundungurra Tribal Council Aboriginal Corporation (GTCAC) ? SH confirmed yes to the GAHA, but not to the GTCAC. However, SH confirmed that she is the Chair of the Gundungurra ILUA which includes and represents both parties (GAHA and GTCAC). SH agrees on behalf of the Gundungurra ILUA. JZ asked if SH agreed that the proposed works on Jenolan Caves Road at Two Mile classified as maintenance of an existing road, maintenance or repair of a public work or may be replacement of an existing public work with a similar or upgraded work in roughly the same area as the old one? If this is the case, then we would consider it a Class 3 post registration act. SH agreed that the works would be considered maintenance as it is for the existing roadway and is needed to keep the road open to the Jenolan Caves. SH agreed on behalf of the Gundungurra ILUA that the works should go ahead as planned and discussed.
Item 4: **Meeting conclusion**	Meeting concluded 10:30 am. Actions: 1. JZ to update the REF with details of the meeting consultation notes and outcomes.

November 2024